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A QUALITY COMPANY TO AS/ISO9001

SP281 METROPLEX SEWAGE PUMP STATION SWITCHBOARD

OPERATION & MAINTENANCE MANUAL

JOB No A4214

HALMAC SERVICES IS A QUALITY COMPANY SERVING QUEENSLAND SINCE 1960

ELECTRICAL ENGINEERS & CONTRACTORS, DATA & COMMUNICATIONS, SERVICE AND MAINTENANCE, SWITCHBOARD MANUFACTURE, PLC, SCADA, TELEMETRY DESIGN & INSTALLATION

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**SP281 METROPLEX
 SEWAGE PUMP
 STATION**

**OPERATION &
 MAINTENANCE
 MANUAL**

JOB NO: A4214

1	<i>MOULDED CASE CIRCUIT BREAKER</i>
2	<i>MINIATURE CIRCUIT BREAKER</i>
3	<i>CONTACTOR</i>
4	<i>CONTROL RELAY & PHASE FAILURE RELAY</i>
5	<i>CHASSIS</i>
6	<i>FUSE & FUSE HOLDER</i>
7	<i>FAN & FILTER</i>
8	<i>GSM MODEM</i>
9	<i>HUMAN MACHINE INTERFACE</i>
10	<i>LOAD BREAK SWITCH</i>
11	<i>LEVEL TRANSMITTER</i>
12	<i>MULTITRODE LEVEL RELAY</i>
13	<i>POWER SUPPLY & BATTERY</i>
14	<i>PROXIMITY SWITCH</i>
15	<i>PUSHBUTTON & INDICATOR</i>
16	<i>PRESSURE TRANSMITTER & ADJUSTMENT UNIT</i>
17	<i>RADIO MODEM</i>
18	<i>RADIO TELEMETRY MODULE</i>
19	<i>SIGNAL ISOLATOR</i>
20	<i>SURGE DIVERTER & SURGE REDUCTION FILTER</i>
21	<i>TIMER</i>
22	<i>VARIABLE SPEED DRIVE</i>
23	<i>TEST SHEETS</i>
24	<i>SECTION NOT USED</i>

1. Moulded Case Circuit Breaker



Halmac Services (Qld) Pty. Ltd.
A.C.N. 098 852 923
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MOULDED CASE CIRCUIT BREAKER

1. S400NE MCCB TECHNICAL DETAILS
2. S125GJ & S125NJ MCCB TECHNICAL DETAILS
3. MCCB ACCESSORIES

Electronic type

S400NE

50kA

Current rating: 100 – 400A

Approvals and Tests:

Standards: AS/NZS 3947-2, and IEC60947-2

Interrupting capacity:

	Voltage	Icu	Ics
AC use	380/415	50	50

Over Current Relay:

- Electronic, for general & selectivity applications
- 7 dial selectable characteristic curves suited for a variety of applications
- Base current I_R is adjustable from 40% - 100% of the nominal rated current I_n .
- STD setting 2.5 – 10 ($\times I_R$)²)
- INST setting 13 – 14 ($\times I_R$)²)

OCR Options:

- Ground Fault Trip
- Neutral Pole protection for 4 pole ONLY MCCBs
- Pre-Trip Alarm

Dimensions (mm)

Poles	3	4
H	260	260
W	140	185
D (less toggle)	103	103



Ampere

Rating NRC	I_R Adjustment		Cat. No. 1)
	Min.	Max.	
250	100	250	S400 NE _ 250
400	160	400	S400 NE _ 400

Price Adder - if OCR options are required, add the selected OCR option price below to the above MCCB price to calculate the total MCCB cost.

3P OCR options: PTA ³⁾	S400 NE 3 AP #
GF ³⁾	S400 NE 3 AG #
PTA + GF ³⁾	S400 NE 3 APG #

4P OCR options: PTA ³⁾	S400 NE 4 AP #
AP ³⁾	S400 NE 4 AN #
PTA + NP ³⁾	S400 NE 4 APN #
GF + NP ³⁾	S400 NE 4 AGN #
PTA + GF + NP ³⁾	S400 NE 4 APGN #

- 1) Add poles to complete MCCB catalogue number. Eg: 3 pole 250A: S400NE 3 250. “#” add OCR trip unit rating where shown.
- 2) The STD and Instantaneous pickup currents (I_{sd} & I_i) settings are not individually adjustable, however by selecting different curve types and different I_R settings the values will vary. Curve 1 & 2 $I_{sd} = 2.5 \times I_R$, curve 3 $I_{sd} = 5 \times I_R$, curve 4 - 7 $I_{sd} = 10 \times I_R$. I_R dial setting 0.4 – 0.9 $I_i = 14 \times I_R$ and I_R dial setting 0.95 – 1.0 $I_i = 13 \times I_R$. Refer curve examples & setting data on pages 18 to 30.
NRC = Nominal rated current, I_R = Current adjustment dial setting, STD = Short Time Delay, INST = instantaneous
- 3) To order a MCCB with the above options insert the required option after the pole to make up the cat. number. Eg: S400NE 4 **APGN** 250 is a S400GE 4 Pole 250A MCCB c/w Pre-trip Alarm, Neutral Protection and Ground Fault protection.

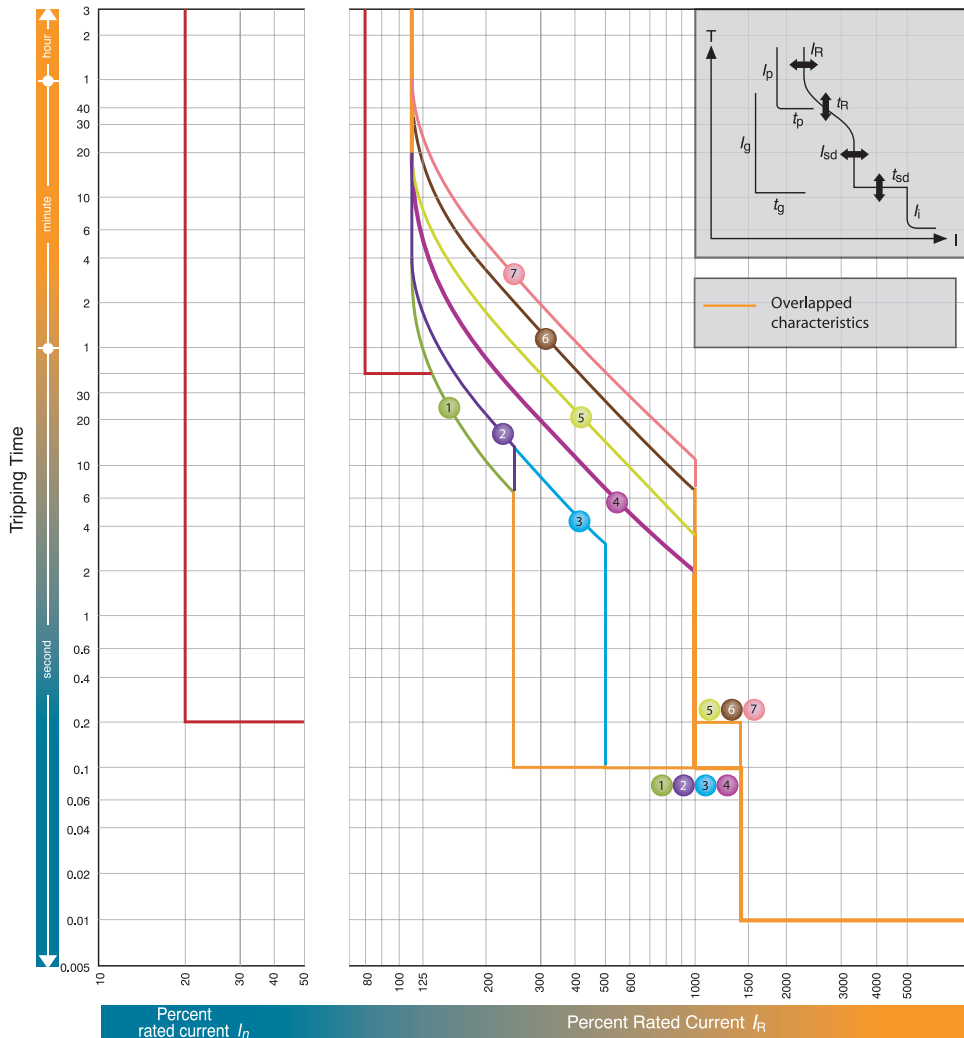
Replaces: XS400SE, Note: check exact ratings or dimensions to suit your application requirement

OPERATING CHARACTERISTICS

ELECTRONIC CHARACTERISTICS

S400-NE, S400-GE, H400-NE, L400-NE

SECTION 3



$I_n = 400A; 250A$

I_R (A)									
LTD Pick-up current	I_R	$x I_n$	0.4	0.5	0.63	0.8	0.9	0.95	1.0

Characteristics		No.	1	2	3	4	5	6	7		
Standard	LTD	t_R (s)	11	21	21	5	10	19	29		
	STD	I_{sd}	2.5		5	10					
		t_{sd} (s)	0.1			0.2					
INST	I_i	$x I_n$	14(Max: 13 x I_n) Note (1)								
Option	PTA	I_p	$x I_R$				0.8				
		t_p (s)					40				
	GFT	I_g	$x I_n$					0.2			
		t_g (s)						0.2			
	N	I_N	$x I_n$					1.0			
	t_N (s)		$t_N = t_R$ Note(2)								

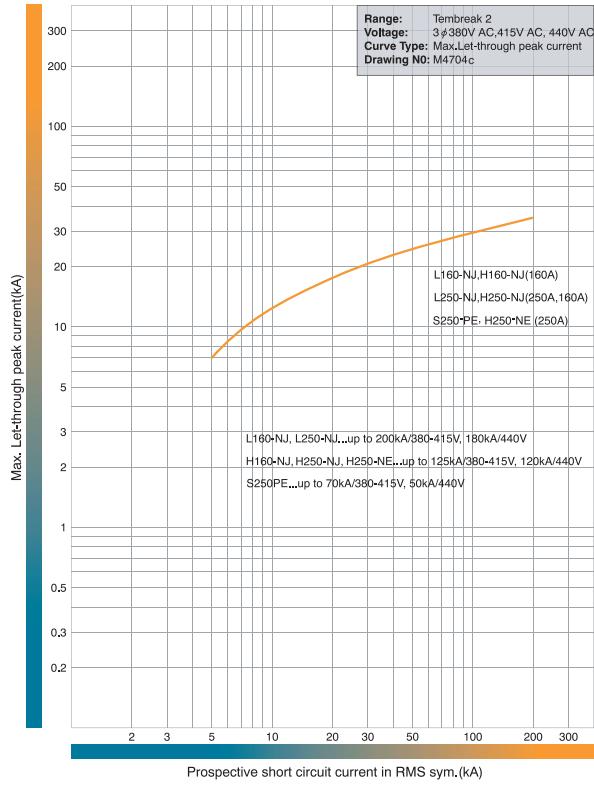
Note

(1) I_i max. = 13 x I_n . (2) Standard setting of I_N is 100% of I_n . For any other setting please specify when ordering.

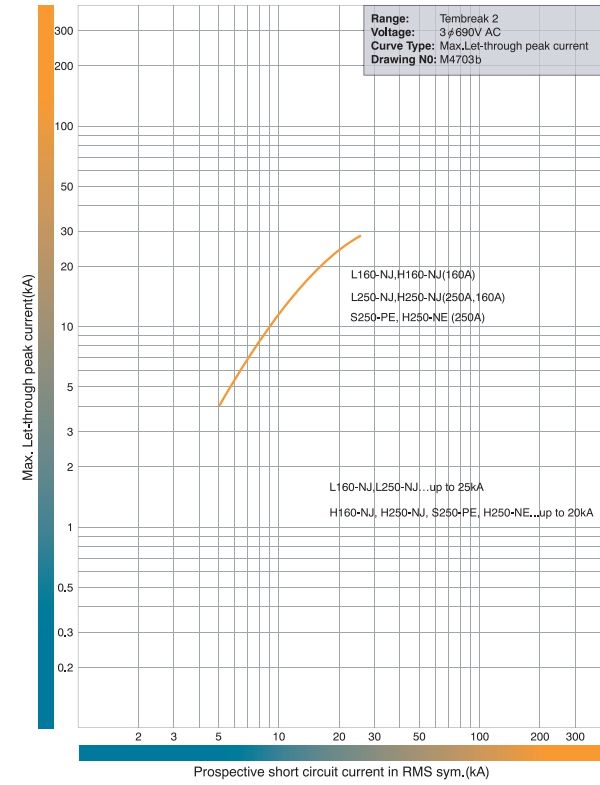
OPERATING CHARACTERISTICS

LET-THROUGH PEAK CURRENT CHARACTERISTICS

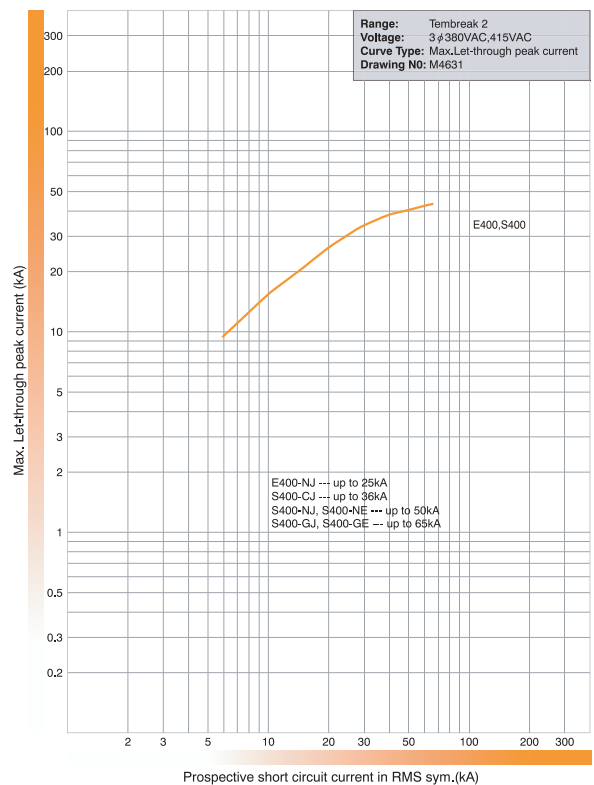
H160-NJ, L160-NJ, S250-PE, H250-NJ, H250-NE, L250-NJ. 440V AC.



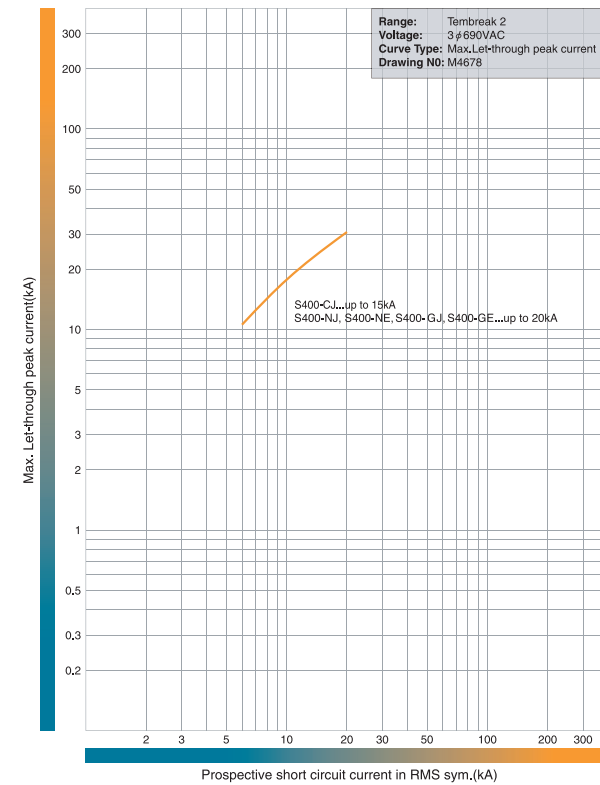
H160-NJ, L160-NJ, S250-PE, H250-NJ, H250-NE, L250-NJ. 690V AC.



E400-NJ, S400-CJ, S400-NJ, S400-NE, S400-GJ, S400-GE, 415V AC.



S400-CJ, S400-NJ, S400-NE, S400-GJ, S400-GE, 690V AC.



SECTION 3

APPLICATION DATA

SELECTIVITY TABLES

Selectivity & Cascade Tables
@ 400 / 415 V

XX / YY
Selectivity/ Cascade

Upstream MCCBs (RMS)	Downstream MCCBs (RMS)	S630GE	TL630NE	XS800SE	XH800SE	TL800NE	XS1250SE	TL1250NE	XS1600SE	XS2000NE	XS2500NE
E125NJ	25	25/50	25/25	25/36	25/36	25/65	25/25	25/25	25/25	25/25	25/25
S125NJ	36	36/65	36/36	36/50	36/36	36/36	36/36	36/36	36/36	36/36	36/36
S125GJ	65	65/70	65/65	65/50	65/65	65/65	65/65	65/65	65/65	65/65	65/65
H125NJ	125	70/70	70/70	50/50	65/65	65/65	85/50	85/50	100/100	85/85	85/85
S160NJ	36	36/50	36/36	36/36	36/65	36/65	36/36	36/36	36/36	36/36	36/36
S160GJ	65	65/70	65/65	50/50	50/65	50/65	65/65	65/65	65/65	65/65	65/65
H160NJ	125	70/70	70/70	50/50	50/65	50/65	85/65	85/65	100/100	85/85	85/85
E250NJ	25	25/50	25/25	25/25	25/50	25/50	25/25	25/25	25/25	25/25	25/25
S250NJ	36	36/65	36/36	36/36	36/36	36/36	36/36	36/36	36/36	36/36	36/36
S250GJ	65	65/70	65/65	50/50	50/65	50/65	65/65	65/65	65/65	65/65	65/65
S250PE	70	70/70	70/70	50/50	50/65	50/65	70/70	70/70	70/70	70/70	70/70
H250NJ	125	70/70	70/70	50/50	50/65	50/65	85/85	85/85	100/100	85/85	85/85
H250PE	125	70/70	70/70	50/50	50/65	50/65	85/85	85/85	100/100	85/85	85/85
E400NJ	25	10/50	10/36	25/25	25/25	25/36	25/25	25/25	25/36	25/25	25/25
S400CJ	36	10/65	10/50	25/36	25/36	25/50	36/36	36/36	36/50	36/36	36/36
S400NE	50	10/50	10/50	25/50	25/50	25/50	50/50	50/50	50/50	50/50	50/50
S400NJ	50	10/70	10/65	25/50	25/50	25/65	50/50	50/50	50/65	50/50	50/50
S400GJ	70	10/70	10/70	25/50	25/50	25/65	70/36	70/36	70/85	70/70	70/70
H400NJ	125	10/70	10/70	25/50	25/65	25/65	125/85	125/85	125/100	125/85	125/85
H400NE	125	10/70	10/70	25/50	25/65	25/65	125/85	125/85	125/100	125/85	125/85
E630NE	36			25/36	25/36	25/36	36/36	36/36	36/36	36/36	36/36
E630CE	50			25/50	25/50	25/50	50/50	50/50	50/50	50/50	50/50
S630GE	70						70/70	70/70	70/70	70/70	70/70
XS630CJ	45						30/45	30/45	30/45	35/45	35/45
XS630NJ	65						30/65	30/65	30/65	35/65	36/65
XS630PJ	85						30/85	30/85	30/85	35/85	35/85
XS630SE	50						30/65	30/65	30/85	30/85	30/85
XH630SE	65						30/65	30/65	30/85	30/85	30/85
XH630PE	65						15/65	15/65	20/65	35/65	35/65
XS800NJ	65						15/50	15/50	20/50	35/50	35/50
XS800SE	50						15/85	15/85	20/85	35/85	35/85
XJ800PJ	85						15/65	15/65	20/65	35/65	35/65
XH800SE	65						15/65	15/65	20/65	35/65	35/65
XH800PE	65						15/65	15/65	20/65	35/65	35/65
XS1250SE	65								20/65	35/65	35/65
XS1600SE	85									35/85	35/85

Upstream MCCBs (RMS)	Downstream MCCBs (RMS)	S630CE	E630NE	L400NE	H400NE	S400GE	S400NE	H250NE	S250PE
E125NJ	25	25/25	25/36	25/65	25/65	25/50	25/36	25/65	70
S125NJ	36	36/36	36/36	36/125	36/85	36/65	36/36	36/85	36
S125GJ	65	50/50	36/36	65/150	65/125	65/70	50/50	65/125	65
H125NJ	125	50/50	36/36	125/200	125/125	70/70	50/50	125/125	125
S160NJ	36	36/50	36/36	36/125	36/85	36/65	36/50	36/125	70
S160GJ	65	50/50	36/36	65/150	65/125	65/70	50/50	65/125	65
H160NJ	125	50/50	36/36	125/200	125/125	70/70	50/50	125/200	125
E250NJ	25	25/25	25/36	25/85	25/65			25/85	25
S250NJ	36	36/36	36/36	36/125	36/85			36/125	36
S250GJ	65	50/50	36/36	65/150	65/125			65/150	65
S250PE	70	50/50	36/36	70/150	40/125			70/150	70
H250NJ	125	50/50	36/36	125/200	125/125			125/200	125
H250PE	125	50/50	36/36	125/200	125/125			125/200	125
E400NJ	25	10/25	10/36						25
S400CJ	36	10/36	10/36						36
S400NE	50	10/50	10/36						50
S400NJ	50	10/36	10/36						50
S400GJ	70	10/50	10/36						70
H400NJ	125	10/50	10/36						125
H400NE	125	10/50	10/36						125
E630NE	36								36
E630CE	50								50
S630GE	70								70
XS630CJ	45								45
XS630NJ	65								65
XS630PJ	85								85
XS630SE	50								50
XH630SE	65								65
XH630PE	65								65
XS800NJ	65								65
XS800SE	50								50
XJ800PJ	85								85
XH800SE	65								65
XH800PE	65								65
XS1250SE	65								65
XS1600SE	85								85

APPLICATION DATA

CASCADE TABLES

SECTION 4

CASCADE @ 380 – 415 V AC ')	Downstream MCCBs	kA (RMS)	E125NJ	S125NJ	S125GJ	H125NJ	L125NJ	S160NJ	S160GJ	H160NJ	L160NJ	E250NJ	S250NJ	S250GJ	S250PE	H250NJ	H250NE	L250NJ
			25	36	65	125	200	36	65	125	200	25	36	65	70	125	125	200
E125NJ	25	–	36	36	65	85	36	36	65	85	–	36	36	–	65	65	85	
S125NJ	36	–	–	50	85	125	–	50	85	125	–	–	–	–	85	85	125	
S125GJ	65	–	–	–	125	150	–	–	125	150	–	–	65	–	125	125	150	
H125NJ	125	–	–	–	–	200	–	–	–	200	–	–	65	–	–	–	200	
S160NJ	36	–	–	65	–	–	–	65	85	125	–	–	65	65	85	85	125	
S160GJ	65	–	–	–	–	–	–	–	125	150	–	–	–	70	125	125	150	
H160NJ	125	–	–	–	–	–	–	–	–	200	–	–	–	–	–	–	200	
S250NJ	36	–	–	–	–	–	–	65	–	–	–	–	–	65	85	85	125	
S250GJ	65	–	–	–	–	–	–	–	–	–	–	–	–	70	125	125	150	
S250PE	70	–	–	–	–	–	–	–	–	–	–	–	–	–	125	125	150	
H250NJ	125	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	200	
E400NJ	25	–	–	–	–	–	–	–	–	–	–	–	–	36	65	65	–	
S400CJ	36	–	–	–	–	–	–	–	–	–	–	–	–	50	70	70	–	
S400NJ	50	–	–	–	–	–	–	–	–	–	–	–	–	50	65	85	85	–
S400GJ	70	–	–	–	–	–	–	–	–	–	–	–	–	50	–	125	125	–
H400NJ	125	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–

Note: ') Ratings have not been verified where a dash “–” is shown.

All pick-up and time delay settings are to be set at a maximum for upstream MCCB's

CASCADE @ 380 – 415 V AC ')	Downstream MCCBs	kA (RMS)	Upstream MCCBs																			
			S400CJ	S400NJ	S400NE	S400GJ	S400GE	H400NJ	H400NE	L400NJ	L400NE	E630NE	S630CE	S630GE	TL630NE	XS800SE	XS800NJ	XH800SE	TL800NE	XS1250SE	XS1600SE	
E125NJ	25	36	36	50	65	85	85	36	–	50	–	36	36	36	–	–	–	–	–	–	–	–
S125NJ	36	–	50	65	85	125	125	–	–	65	–	50	50	–	–	–	–	–	–	–	–	–
S125GJ	65	–	–	70	125	150	150	–	50	70	–	–	–	65	–	–	–	–	–	–	–	–
H125NJ	125	–	–	–	–	200	200	–	–	–	–	–	–	65	–	50	–	–	–	–	–	–
S160NJ	36	–	50	65	85	125	125	–	50	50	–	–	65	65	–	–	–	–	–	–	–	–
S160GJ	65	–	–	70	125	150	150	–	–	70	–	–	–	–	–	–	–	–	–	–	–	–
H160NJ	125	–	–	–	–	200	200	–	–	–	–	–	–	65	–	65	–	–	–	–	–	–
E250NJ	25	36	36	50	65	85	85	36	–	50	–	–	36	50	–	–	–	–	–	–	–	–
S250NJ	36	–	50	65	85	125	125	–	–	65	–	–	65	–	–	–	–	–	–	–	–	–
S250GJ	65	–	–	70	125	150	150	–	–	70	–	–	–	–	–	–	–	–	–	–	–	–
S250PE	70	–	–	–	125	150	150	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–
H250NJ	125	–	–	–	–	200	200	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–
E400NJ	25	36	36	50	65	85	85	36	–	50	36	–	–	–	36	–	36	–	–	–	–	36
S400CJ	36	–	50	65	70	100	100	–	–	65	50	–	–	–	50	–	50	–	–	–	–	50
S400NJ	50	–	–	70	85	125	125	–	36	70	65	–	–	50	65	–	65	–	–	–	–	65
S400GJ	70	–	–	–	125	150	150	–	36	–	–	–	–	50	–	36	85	–	–	–	–	85
H400NJ	125	–	–	–	–	200	200	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–

Note: ') Ratings have not been verified where a dash “–” is shown.

All pick-up and time delay settings are to be set at a maximum for upstream MCCBs

APPLICATION DATA

SELECTIVITY AND CASCADE TEMBREAK 2 MCCBs AND DIN-T / SAFE-T MCBs

Downstream MCB	Amp rating	kA (RMS)	Upstream MCCB							
			E125NJ	S125NJ	H125NJ S125GJ	S250NJ	S250GJ	S400CJ	S400GE S400GJ	H400NJ
			25	36	65	36	65	36	70	125
DTCB6	2 – 20	6	18/18	25/25	35/35	35/35	35/35	–	–	–
	25 – 63	6	18/18	20/25	20/25	30/30	30/30	–	–	–
DTCB10	0.5 – 32	10	18/18	30/30	30/50	35/35	40/50	35/35	40/50	40/50
	40 – 63	10	18/18	20/25	25/25	30/30	30/30	30/30	30/30	30/30
DSRCBH /	0.5 – 32	10	18/18	30/30	30/50	35/35	40/50	35/35	40/50	40/50
DSRCD	40	10	18/18	20/25	25/25	30/30	30/30	30/30	30/30	30/30
Din-T10H	80 – 125	10	4/18	4/25	4/25	15/15	15/15	10/10	10/10	–
DTCH15	0.5 – 32	15	18/18	30	30/50	35/35	40/50	35/35	40/50	40/50
	40 – 63	15	18/18	20	25/25	30/30	30/30	30/30	30/30	30/30
Safe-T	16 – 20	6	3/10	3/10	3/10	–	–	–	–	–
SRCB	16 – 20	6	3/10	3/10	3/10	–	–	–	–	–

Guide



Notes: All figures stated are at 400/415 V AC.

APPLICATION DATA

MOTOR STARTING TYPE 1 CO-ORDINATION TABLES

Short-Circuit Co-Ordination Motor Starting Table

Type '1'
Terasaki MCCB's & Sprecher + Schuh KT7's
DOL starting 50/65 kA @ 400/415 V to AS/NZS 60947.4.1

TYPE 1
50/65 kA

SECTION 4

Motor Size (kW)	Approx. amps @ 400/415 V (A)	Terasaki Combinations	
		MCCB	Contactors
0.37	1.1	XM30PB/1.4	CA7-9
0.55	1.5	XM30PB/2	CA7-9
0.75	1.8	XM30PB/2.6	CA7-9
1.1	2.6	XM30PB/4.0	CA7-9
1.5	3.4	XM30PB/5	CA7-9
2.2	4.8	XM30PB/8	CA7-9
3	6.5	XM30PB/10	CA7-9
4	8.2	XM30PB/12	CA7-9
5.5	11	S125GJ/20	CA7-12
7.5	14	S125GJ/20	CA7-16
11	21	S125GJ/32	CA7-23
15	28	S125GJ/50	CA7-30
18.5	34	S125GJ/50	CA7-37
22	40	S125GJ/63	CA7-43
30	55	S125GJ/100	CA7-60
37	66	S125GJ/100	CA7-72
45	80	S125GJ/125	CA7-85
55	100	S125GJ/125	CA6-110
5	130	S250PE/250	CA6-140
0	155	S250PE/250	CA6-180
10	200	S250PE/250	CA6-210
32	225	S400GE/400	CA6-210
60	270	S400GE/400	CA6-300
00	361	S400GE/400	CA6-420

Terasaki Combinations		Sprecher + Schuh Combinations	
Overload Relay	Thermal Setting (A)	KT7 Circuit Breaker	Contactors
CT 7-24	1.0 - 1.6	KTA7-25S-1.0A	CA7-9
CT 7-24	1.0 - 1.6	KTA7-25S-1.6A	CA7-9
CT 7-24	1.6 - 2.4	KTA7-25S-2.5A	CA7-9
CT 7-24	2.4 - 4.0	KTA7-25S-2.5A	CA7-9
CT 7-24	2.4 - 4.0	KTA7-25S-4.0A	CA7-9
CT 7-24	4.0 - 6.0	KTA7-25S-6.3A	CA7-9
CT 7-24	6.0 - 10	KTA7-25S-6.3A	CA7-9
CT 7-24	6.0 - 10	KTA7-25S-10A	CA7-9
CT 7-24	10 - 16	KTA7-25H-16A	CA7-12
CT 7-24	10 - 16	KTA7-25H-16A	CA7-16
CT 7-24	16 - 24	KTA7-45H-20A	CA7-23
CT 7-45	18 - 30	KTA7-45H-32A	CA7-30
CT 7-45	30 - 45	KTA7-45H-45A	CA7-37
CT 7-45	30 - 45	KTA7-45H-45A	CA7-43
CT 7-75	45 - 60	KTA3-100-63A	CA7-60
CT 7-75	60 - 75	KTA3-100-90A	CA7-72
CT 7-100	70 - 90	KTA3-100-90A	CA7-85
CEF 1-11/12	20 - 180	KTA3-160S-100A	CA6-110
CEF 1-11/12	20 - 180	KTA3-160S-160A	CA6-140
CEF 1-11/12	20 - 180	KTA3-160S-160A	CA6-180
CEF 1-41/42	160 - 400	KTA3-250S-200A	CA6-210
CEF 1-41/42	160 - 400	KTA3-250S-250A	CA6-250
CEF 1-41/42	160 - 400	KTA3-400S-320A	CA6-300
CEF 1-41/42	160 - 400	KTA3-400S-400A	CA6-420

- Notes:**
- Thermal or electronic overload relays may be used.
 - XM30PB MCCB's can be replaced with S125GJ/20 if required.
 - Combinations based on the thermal overload relay tripping before the circuit breaker at overload currents up to the motor locked rotor current.

APPLICATION DATA

MOTOR STARTING TYPE 2 CO-ORDINATION TABLES

Short-Circuit Co-Ordination DOL Motor Starting Table

Type '2'
 Terasaki MCCB's & Sprecher + Schuh KT7's
 DOL starting 50/65 kA @ 400/415 V to AS/NZS 60947.4.1

TYPE 2
50/65 kA

Motor Size (kW)	Approx. amps @ 400/415 V (A)	Terasaki Combinations	
		MCCB	Contactors
0.37	1.1	XM30PB/1.4	CA7-9
0.55	1.5	XM30PB/2	CA7-9
0.75	1.8	XM30PB/2.6	CA7-9
1.1	2.6	XM30PB/4.0	CA7-16
1.5	3.4	XM30PB/5	CA7-16
2.2	4.8	XM30PB/8	CA7-16
3	6.5	XM30PB/10	CA7-30
4	8.2	XM30PB/12	CA7-30
5.5	11	S125GJ/20	CA7-30
7.5	14	S125GJ/20	CA7-30
11	21	S125GJ/32	CA7-30
15	28	S125GJ/50	CA7-43
18.5	34	S125GJ/50	CA7-43
22	40	S125GJ/63	CA7-43
30	55	S125GJ/100	CA7-72
37	66	S125GJ/100	CA7-72
45	80	S125GJ/125	CA6-105
55	100	S250PE/160	CA6-105
75	130	S250PE/250	CA6-140
90	155	S250PE/250	CA6-170
110	200	S250PE/250	CA6-210
132	225	S400PE/400	CA6-210
160	270	S400PE/400	CA6-300
200	361	S400PE/400	CA6-420

Terasaki Combinations		Sprecher + Schuh Combinations	
Overload Relay	Thermal Setting (A)	KT7 Circuit Breaker	Contactors
CT 7-24	1.0 - 1.6	KTA7-25S-1A	CA7-9
CT 7-24	1.0 - 1.6	KTA7-25S-1.6A	CA7-9
CT 7-24	1.6 - 2.4	KTA7-25S-2.5A	CA7-9
CT 7-24	2.4 - 4.0	KTA7-25S-2.5A	CA7-9
CT 7-24	2.4 - 4.0	KTA7-25S-4A	CA7-9
CT 7-24	4.0 - 6.0	KTA7-25S-6.3A	CA7-9
CT 7-24	6.0 - 10	KTA7-25S-6.3A	CA7-9
CT 7-24	6.0 - 10	KTA7-25S-10A	CA7-9
CT 7-24	10 - 16	KTA7-25H-16A	CA7-12
CT 7-24	10 - 16	KTA7-25H-16A	CA7-16
CT 7-24	16 - 24	KTA7-45H-20A	CA7-23
CT 7-45	18 - 30	KTA7-45H-32A	CA7-30
CT 7-45	30 - 45	KTA7-45H-45A	CA7-37
CT 7-45	30 - 45	KTA7-45H-45A	CA7-43
CT 7-75	45 - 60	KTA3-100-63A	CA7-60
CT 7-75	60 - 75	KTA3-100-90A	CA7-72
CT 7-100	70 - 90	KTA3-100-90A	CA7-85
CEF 1-11/12	20 - 180	KTA3-160S-100A	CA6-110
CEF 1-11/12	20 - 180	KTA3-160S-160A	CA6-140
CEF 1-11/12	20 - 180	KTA3-160S-160A	CA6-180
CEF 1-41/42	160 - 400	KTA3-250S-200A	CA6-210
CEF 1-41/42	160 - 400	KTA3-250S-250A	CA6-250
CEF 1-41/42	160 - 400	KTA3-400S-320A	CA6-300
CEF 1-41/42	160 - 400	KTA3-400S-400A	CA6-420

- Notes:**
- Thermal or electronic overload relays may be used.
 - XM30PB combinations can be replaced with S125GJ/20 and CA7-30 if required.
 - Combinations based on the thermal overload relay tripping before the circuit breaker at overload currents up to the motor locked rotor current.

SECTION 4

APPLICATION DATA

MOTOR STARTING TYPE 2 CO-ORDINATION

Short-Circuit Co-Ordination DOL Motor Starting Table

Type '2'
Terasaki MCCB's & Sprecher + Schuh KT7's
DOL starting 85 kA @ 400/415 V to AS/NZS 60947.4.1

TYPE 2
85 kA

Motor Size (kW)	Approx. amps @ 400/415 V (A)	Terasaki Combinations	
		MCCB	Contactore
0.37	1.1	XM30PB/1.4	CA 7-9
0.55	1.5	XM30PB/2	CA 7-9
0.75	1.8	XM30PB/2.6	CA 7-9
1.1	2.6	XM30PB/4.0	CA 7-16
1.5	3.4	XM30PB/5	CA 7-16
2.2	4.8	XM30PB/8	CA 7-30
3	6.5	XM30PB/10	CA 7-30
4	8.2	XM30PB/12	CA 7-30
5.5	11	H125NJ/20	CA 7-30
7.5	14	H125NJ/20	CA 7-30
11	21	H125NJ/32	CA 7-30
15	28	H125NJ/50	CA 7-43
18.5	34	H125NJ/50	CA 7-43
22	40	H125NJ/63	CA 7-43
30	55	H125NJ/100	CA 7-72
37	66	H125NJ/100	CA 7-72
45	80	H125NJ/160	CA 6-105
55	100	H160NJ/160	CA 6-105
75	130	H250PE/250	CA 6-210
90	155	H250PE/250	CA 6-210
110	200	H250PE/250	CA 6-210
132	225	H400NE/400	CA 6-210
160	270	H400NE/400	CA 6-300
200	361	H400NE/400	CA 6-420

Terasaki Combinations		Sprecher + Schuh Combinations	
Overload Relay	Thermal Setting (A)	KT7 Circuit Breaker	Contactore
CT 7-24	1.0 - 1.6	KTA7-25S-1A	CA 7-9
CT 7-24	1.0 - 1.6	KTA7-25S-1.6A	CA 7-9
CT 7-24	1.6 - 2.4	KTA7-25S-2.5A	CA 7-9
CT 7-24	2.4 - 4.0	KTA7-25H-2.5A	CA 7-9
CT 7-24	2.4 - 4.0	KTA7-25H-4A	CA 7-9
CT 7-24	4.0 - 6.0	KTA7-25H-6.3A	CA 7-9
CT 7-24	6.0 - 10	KTA7-25H-6.3A	CA 7-9
CT 7-24	6.0 - 10	KTA7-25H-10A	CA 7-9
CT 7-24	10 - 16	KTA7-45H-16A	CA 7-12
CT 7-24	10 - 16	KTA7-45H-16A	CA 7-16
CT 7-24	16 - 24	KTA7-45H-20A	CA 7-23
CT 7-45	18 - 30	KTA7-45H-32A	CA 7-30
CT 7-45	30 - 45	KTA7-45H-45A	CA 7-37
CT 7-45	30 - 45	KTA7-45H-45A	CA 7-43
CT 7-75	45 - 60	KTA3-100-63A	CA7-60
CT 7-75	60 - 75	KTA3-100-90A	CA7-72
CT 7-100	70 - 90	KTA3-100-90A	CA7-85
CEF 1-11/12	20 - 180	-	-
CEF 1-11/12	20 - 180	-	-
CEF 1-11/12	20 - 180	-	-
CEF 1-41/42	160 - 400	-	-
CEF 1-41/42	160 - 400	-	-
CEF 1-41/42	160 - 400	-	-
CEF 1-41/42	160 - 400	-	-

- Notes:**
- Thermal or electronic overload relays may be used.
 - XM30PB combinations can be replaced with H125GJ/20 and CA7-30 if required.
 - Combinations based on the thermal overload relay tripping before the circuit breaker at overload currents up to the motor locked rotor current.

APPLICATION DATA

MOTOR STARTING TYPE 2 CO-ORDINATION

Short-Circuit Co-Ordination DOL Motor Starting Table

Type '2'
 Terasaki MCCB's & Sprecher + Schuh KT7's
 DOL starting 100 kA @ 400/415 V to AS/NZS 60947.4.1

**TYPE 2
 100 kA**

Motor Size (kW)	Approx. amps @ 400/415 V (A)	Terasaki Combinations	
		MCCB	Contactore
0.37	1.1	H125NJ/20	CA 7-30
0.55	1.5	H125NJ/20	CA 7-30
0.75	1.8	H125NJ/20	CA 7-30
1.1	2.6	H125NJ/20	CA 7-30
1.5	3.4	H125NJ/20	CA 7-30
2.2	4.8	H125NJ/20	CA 7-30
3	6.5	H125NJ/20	CA 7-30
4	8.2	H125NJ/20	CA 7-30
5.5	11	H125NJ/20	CA 7-30
7.5	14	H125NJ/20	CA 7-30
11	21	H125NJ/32	CA 7-30
15	28	H125NJ/50	CA 7-43
18.5	34	H125NJ/50	CA 7-43
22	40	H125NJ/63	CA 7-43
30	55	H125-NJ/100	CA 7-60
37	66	H125-NJ/100	CA 7-72
45	80	H125-NJ/125	CA 7-85
55	100	H250-NE/160	CA 6-95
75	130	H250-NE/250	CA 6-140
90	155	H250-NE/250	CA 6-140
110	200	H250-NE/250	CA 6-180
132	225	H400-NE/400	CA 6-420
160	270	H400-NE/400	CA 6-420
200	361	H400-NE/400	CA 6-420

Terasaki Combinations		Sprecher + Schuh Combinations	
Overload Relay	Thermal Setting (A)	KT7 Circuit Breaker	Contactore
CT 7-24	1.0 - 1.6	KTA7-25S-1A	CA 7-9
CT 7-24	1.0 - 1.6	KTA7-25S-1.6A	CA 7-9
CT 7-24	1.6 - 2.4	KTA7-25S-2.5A	CA 7-9
CT 7-24	2.4 - 4.0	KTA7-25H-2.5A	CA 7-9
CT 7-24	2.4 - 4.0	KTA7-25H-4A	CA 7-9
CT 7-24	4.0 - 6.0	KTA7-25H-6.3A	CA 7-9
CT 7-24	6.0 - 10	KTA7-25H-6.3A	CA 7-9
CT 7-24	6.0 - 10	KTA7-25H-10A	CA 7-9
CT 7-24	10 - 16	KTA7-45H-16A	CA 7-12
CT 7-24	10 - 16	KTA7-45H-16A	CA 7-16
CT 7-24	16 - 24	KTA7-45H-20A	CA 7-23
CT 7-45	18 - 30	KTA7-45H-32A	CA 7-30
CT 7-45	30 - 45	KTA7-45H-45A	CA 7-37
CT 7-45	30 - 45	KTA7-45H-45A	CA 7-43
CT 7-75	45 - 60	-	-
CT 7-75	60 - 75	-	-
CT 7-100	70 - 90	-	-
CEF 1-11/12	20 - 180	-	-
CEF 1-11/12	20 - 180	-	-
CEF 1-11/12	20 - 180	-	-
CEF 1-41/42	160 - 400	-	-
CEF 1-41/42	160 - 400	-	-
CEF 1-41/42	160 - 400	-	-
CEF 1-41/42	160 - 400	-	-

- Notes:
- Thermal or electronic overload relays may be used.
 - Combinations based on the thermal overload relay tripping before the circuit breaker at overload currents up to the motor locked rotor current.

SECTION 4

INSTALLATION

TEMPERATURE RATINGS & DERATINGS

Calibration Temperature: 45°C

MCCB Type	Connection Type	Rating at calibration temperature (50°C)	Rated Current (A)			
			50°C	55°C	60°C	65°C
E125-NJ S125-NJ S125-GJ	Front	20A	19	18.5	18	17.5
	Rear	32A	31	30.5	30	29
	Plug-in	50A	48	45	43	41
		63A	60	57	55	52
		100A	97	94	90	87
		125A	121	117	113	109
H125-NJ L125-NJ	Front	20A	19	18.5	18	17.5
	Rear	32A	31	30	29	28
	Plug-in	50A	48	47	45	44
		63A	61	59	57	55
		100A	97	95	92	89
		125A	121	118	114	111
S160-NJ S160-GJ	Front	20A	19	18.5	18	17.5
	Rear	32A	31	30	29	28
	Plug-in	50A	48	46	44	42
		63A	61	59	57	55
		100A	97	94	91	88
		125A	121	117	113	109
H160-NJ L160-NJ	Front	160A	156	151	146	141
	Rear		156	151	146	141
E250-NJ	Front	20A	19	18.5	18	17.5
	Rear	32A	31	30	29	28
	Plug-in	50A	48	46	44	42
		63A	61	59	57	55
		100A	97	94	91	88
		125A	121	117	113	109
E250-NJ S250-NJ S250-GJ	Front	160A	156	151	146	141
	Rear	250A	243	235	227	219
	Plug-in	250A	243	235	227	219
H250-NJ L250-NJ	Front	160A	156	151	147	143
	Rear					
	Plug-in					
E400-NJ S400-CJ S400-NJ S400-GJ	Front	250A	244	237	230	223
	Rear	400A	390	380	369	358
	Plug-in	250A	243	237	230	223
		400A	392	384	376	368

Calibration Temperature: 30°C

MCCB Type	Connection Type	Rating at calibration temperature (30°C)	Rated Current (A)						
			35°C	40°C	45°C	50°C	55°C	60°C	65°C
H250-NJ L250-NJ	Plug-in Conn.	250A	244	236	225	219	209	200	190

MCCB Type	Connection Type	Rating	Rated Current (A)							
			30°C	35°C	40°C	45°C	50°C	55°C	60°C	65°C
S250-PE H250-NE	Front	250A	250	250	250	250	237.5	225	200	200
	Rear		250	237.5	225	225	200	200	157.5	157.5
S400-NE S400-GE	Front	250A	250	250	250	250	250	250	225	200
	Rear	400A	400	400	400	400	400	380	360	320
	Plug-in	400A	400	400	400	400	400	380	360	320
H400-NE L400-NE	Front	250A	250	250	250	250	250	250	225	200
	Rear	400A	400	400	400	400	400	380	360	320
	Plug-in	250A	250	250	250	250	250	250	225	200
		400A	400	400	400	400	400	380	360	320
E630-NE S630-CE S630-GE	Front Rear*	630A	630	630	630	630	598.5	598.5	567	504

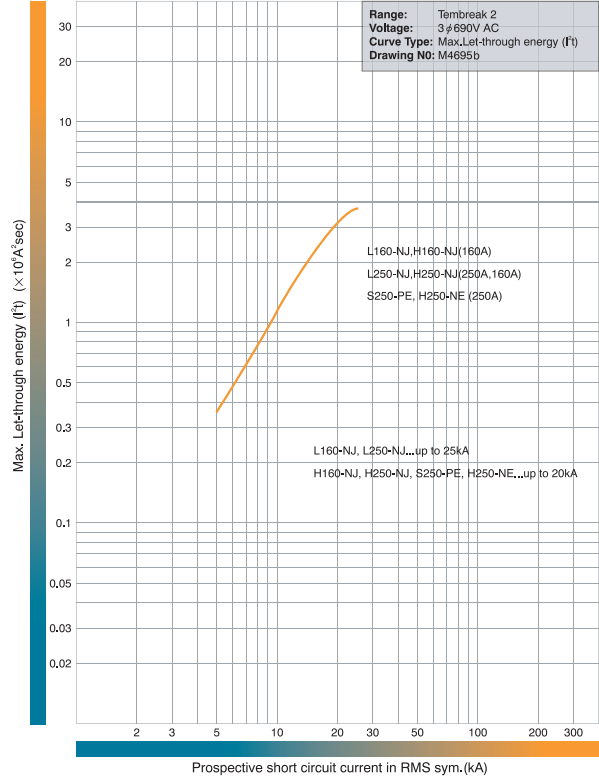
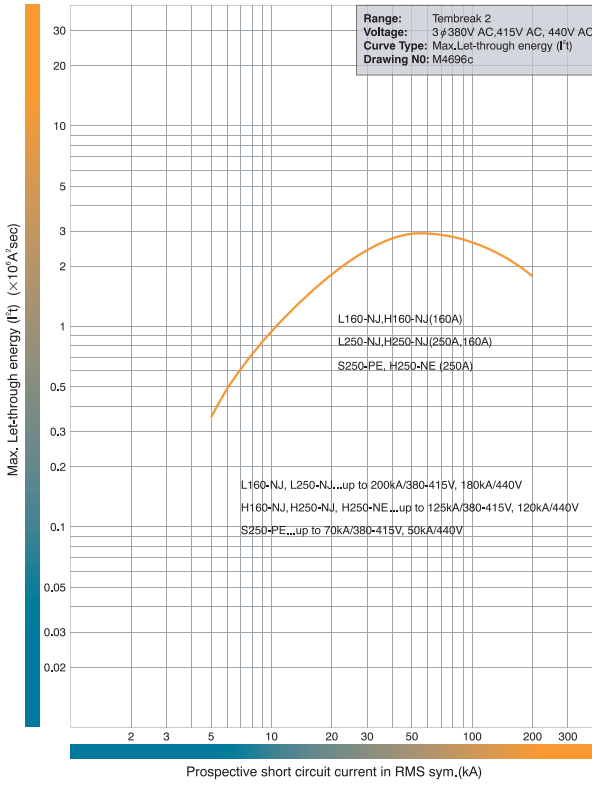
OPERATING CHARACTERISTICS

LET-THROUGH ENERGY CHARACTERISTICS

H160-NJ, L160-NJ, S250-PE, H250-NE, H250-NJ, L250-NJ. 440V AC.

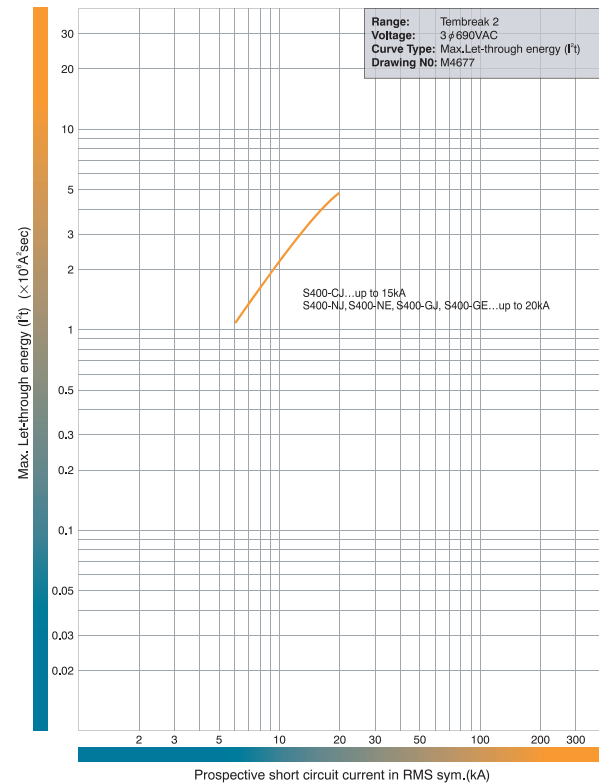
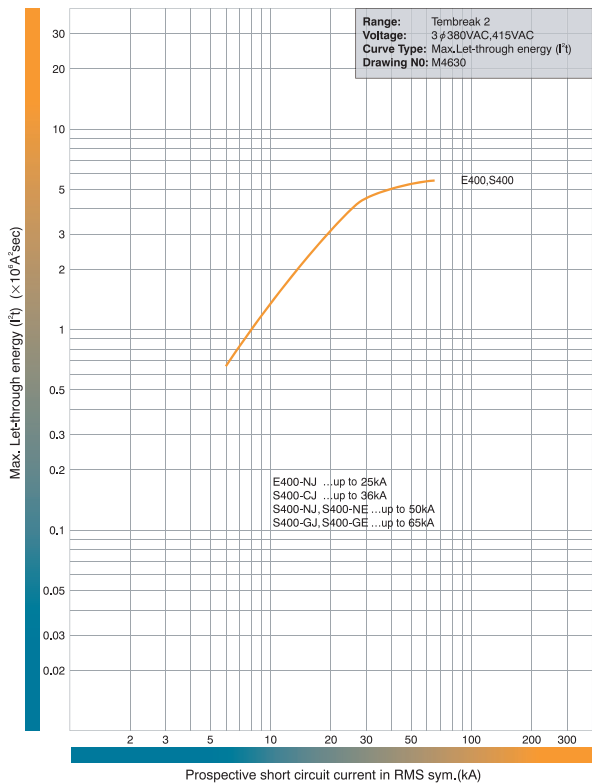
H160-NJ, L160-NJ, S250-PE, H250-NE, H250-NJ, L250-NJ. 690V AC.

SECTION 3



E400-NJ, S400-CJ, S400-NJ, S400-NE, S400-GJ, S400-GE. 415V AC.

S400-CJ, S400-NJ, S400-NE, S400-GJ, S400-GE. 690V AC.

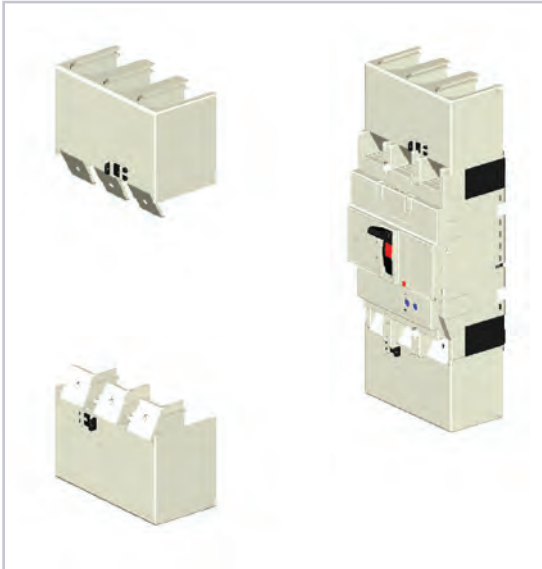


ACCESSORIES

INSULATION ACCESSORIES

Terminal Covers for Front Connection (CF)

Terminal covers for front connection are suitable for covering the exposed live parts of conductors terminated on the MCCB.



Terminal Covers for Front Connection



Flush Terminal Covers

Flush Terminal Covers (CS)

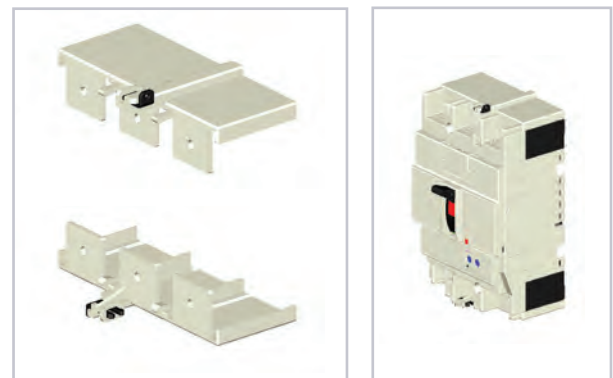
Flush terminal covers are useful for increasing the ingress protection rating at the terminals without increasing the overall length. They can be used with busbar and for direct entry of stranded cable (with solderless cable clamp terminals (FW), refer to Section 6, Installation).

Flush terminal covers are identical to rear terminal covers for 400A and 630A frame models.

The user can remove a section of the rear terminal cover using a tool to allow entry of the conductor.

Terminal covers for Rear Connection (CR)

Terminal covers for rear connection may be used on MCCBs fitted with rear connections (RP) or plug-in connections (PM). They prevent access to the terminals from the front and top.



Terminal Covers for Rear Connection

INSTALLATION

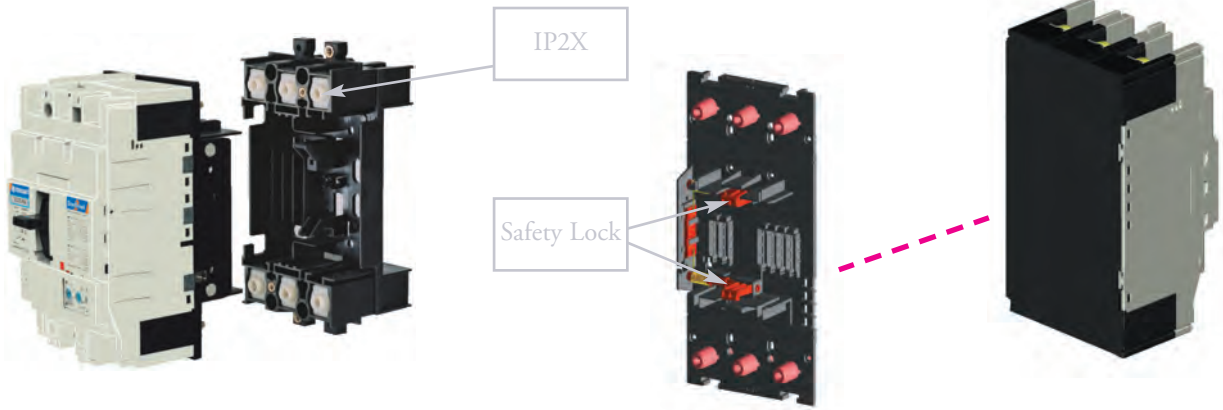
CONNECTION AND MOUNTING OPTIONS AND ACCESSORIES

Plug-in Mounting

The plug in mounting system allows fast replacement of the MCCB body without the need to disturb the terminations. Solid conductors or cables terminated with compression terminals can be used.

Plug-In Safety Lock

The plug-in MCCB body is automatically locked to the base when the contacts are closed (toggle ON). It cannot be removed unless the contacts are in the isolated position (toggle OFF or TRIPPED). This system ensures safe removal of the MCCB from the base.



Plug-in MCCB and base

Plug-in connections and safety lock are fitted to the back of the MCCB

The connection bars for plug-in bases are optional and can be configured in the field either for front or rear access. The illustrations below show possible mounting and connection options for plug in bases.



1. Mounted on base plate with connection bars mounted for front access. Insulation plates are supplied as standard and must be fitted.
2. Terminations in separate compartment. Connection bars are mounted for top access at the top and rear access at the bottom.
3. Mounted on angle bars. Connection bars are mounted for rear access.

SECTION 6

Thermal magnetic type S125GJ

65kA

Current rating: 12.5 – 125A

Approvals and Tests:

Standards AS/NZS 3947-2, and IEC60947-2

Interrupting capacity:

	Voltage	Icu	Ics
AC use	380/400	65	36
DC use	250V	40	40

Trip unit:

Adjustable thermal (0.63 *I_r* to 100% *I_r*) and adjustable magnetic (6 *I_m* to 12 *I_m*)

Dimensions (mm)

Poles	3	4
H	155	155
W	90	120
D (less toggle)	68	68
Toggle cut-out	Standard DIN	

Ampere Rating NRC	Adj. <i>I_r</i> ¹⁾ Min - Max.	Adj. <i>I_m</i> ¹⁾ Min - Max.	Cat. No.
20	12.5 - 20	120 - 240	S125 GJ 3 20 S125 GJ 4 20
32	20 - 32	192 - 384	S125 GJ 3 32 S125 GJ 4 32
50	32 - 50	300 - 600	S125 GJ 3 50 S125 GJ 4 50
63	40 - 63	378 - 756	S125 GJ 3 63 S125 GJ 4 63
100	63 - 100	600 - 1200	S125 GJ 3 100 S125 GJ 4 100
125	80 - 125	750 - 1500	S125 GJ 3 125 S125 GJ 4 125

1) NRC: Nominal rated current
 Adj. *I_r*: Adjustable thermal setting
 Adj. *I_m*: Adjustable magnetic setting

Replaces: XH125NJ, TL100NJ, Note: check exact ratings or dimensions to suit your application requirement



Thermal magnetic type S125NJ



36kA

Current rating: 12.5 – 125A

Approvals and Tests:

Standards AS/NZS 3947-2, and IEC60947-2

Interrupting capacity:

	Voltage	Icu	Ics
AC use	380/400	36	36
DC use	250V	25	19

Trip unit:

Adjustable thermal (0.63 *I_r* to 100% *I_r*) and adjustable magnetic (6 *I_m* to 12 *I_m*)

Dimensions (mm)

Poles	3	4
H	155	155
W	90	120
D (less toggle)	68	68
Toggle cut-out	Standard DIN	

Ampere

Rating NRC	Adj. <i>I_r</i> ¹⁾ Min - Max.	Adj. <i>I_m</i> ¹⁾ Min - Max.	Cat. No.
20	12.5 - 20	120 – 240	S125 NJ 3 20 S125 NJ 4 20
32	20 - 32	192 – 384	S125 NJ 3 32 S125 NJ 4 32
50	32 - 50	300 - 600	S125 NJ 3 50 S125 NJ 4 50
63	40 - 63	378 - 756	S125 NJ 3 63 S125 NJ 4 63
100	63 - 100	600 - 1200	S125 NJ 3 100 S125 NJ 4 100
125	80 - 125	750 - 1500	S125 NJ 3 125 S125 NJ 4 125

1) NRC: Nominal rated current
 Adj. *I_r*: Adjustable thermal setting
 Adj. *I_m*: Adjustable magnetic setting

Replaces: XS125NJ, Note: check exact ratings or dimensions to suit your application requirement

TEMBREAK 2 MCCBs



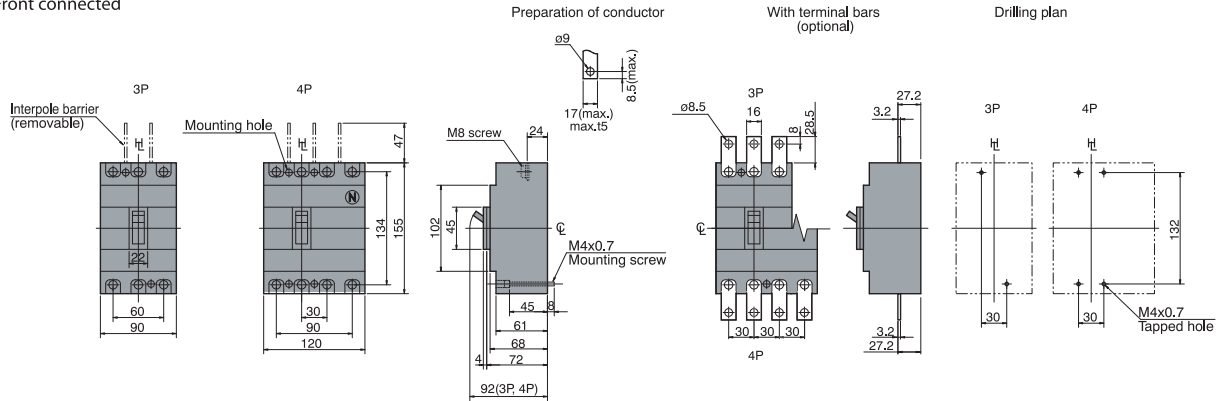
DIMENSIONS

E125-NJ, S125-NJ, S125-GJ

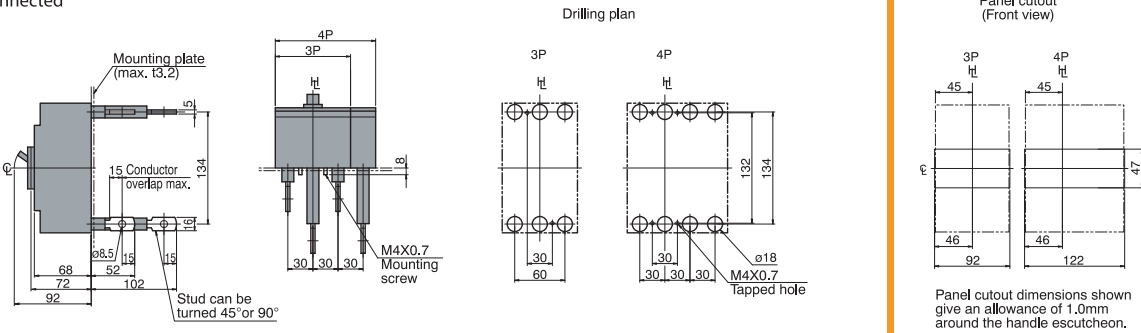
ASL: Arrangement Standard Line

HL: Handle Frame Centre Line

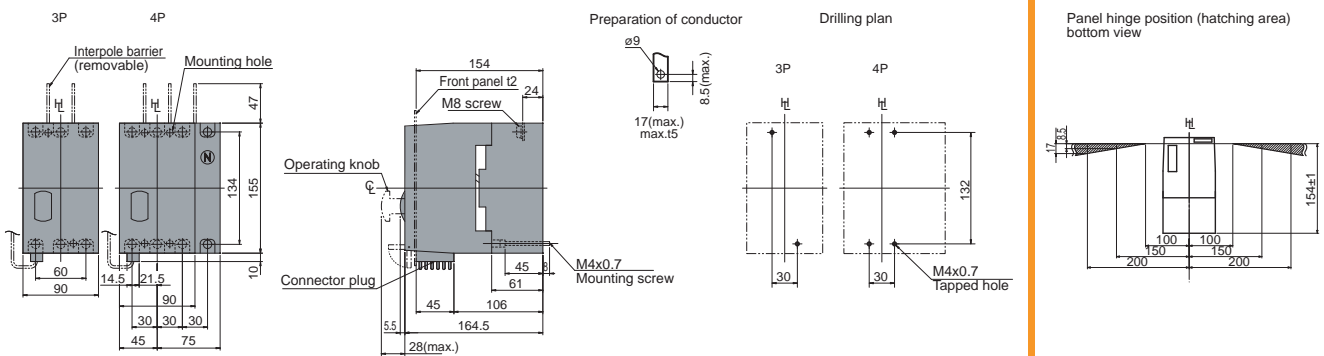
Front connected



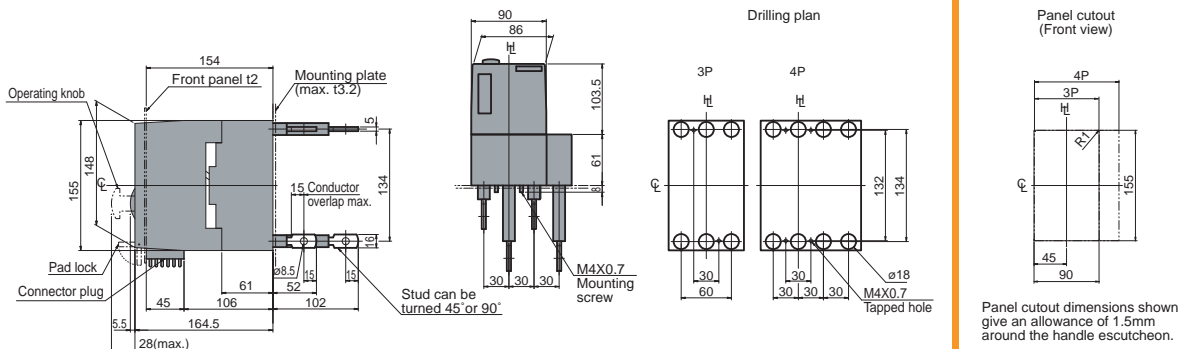
Rear connected



Front connected with Motor Operator



Rear connected with Motor Operator



SECTION 7

INSTALLATION

INSULATION DISTANCE IN mm (AT 440V AC MAXIMUM)

Model	Type	A	B1	B2	C	D	E
E125	NJ	50	10	10	0	25	*(1)
S125	NF	50	10	10	0	25	*(1)
S125	NJ	50	10	10	0	25	*(1)
S125	GJ	75	45	25	0	25	*(1)
H125	NJ	100	80	60	0	50	*(1)
L125	NJ	100	80	60	0	50	*(1)
S160	NF	50	40	30	0	25	*(1)
S160	NJ	50	40	30	0	25	*(1)
S160	GJ	100	80	60	0	50	*(1)
H160	NJ	100	80	60	0	50	*(1)
L160	NJ	100	80	60	0	50	*(1)
E250	NJ	50	40	30	0	25	*(1)
S250	NJ	50	40	30	0	25	*(1)
S250	GJ	100	80	30	0	25	*(1)
S250	PE	100	80	60	0	50	*(1)
H250	NJ	100	80	60	0	50	*(1)
H250	NE	100	80	60	0	50	*(1)
L250	NJ	100	80	60	0	50	*(1)
E400	NJ	100	80	40	0	30	*(1)
S400	CJ	100	80	40	0	30	*(1)
S400	NJ	100	80	40	0	30	*(1)
S400	GJ	100	80	40	0	30	*(1)
S400	GE	100	80	40	0	30	*(1)
H400	NJ	120	120	80	0	80	*(1)
H400	NE	120	120	80	0	80	*(1)
L400	NJ	120	120	80	0	80	*(1)
L400	NE	120	120	80	0	80	*(1)
E630	NE	120	100	80	0	80	*(1)
S630	CE	120	100	80	0	80	*(1)
S630	GE	120	100	80	0	80	*(1)

***Note:** (1) Insulate the exposed conductor until it overlaps the moulded case at the terminal, or the terminal cover.

APPLICATION DATA

SELECTIVITY (DISCRIMINATION) AND CASCADE

Selectivity

The principle of Selectivity (Discrimination) is based upon an analysis of several circuit breaker characteristics. These include time-current (tripping) curves, peak-let-through current (I_{peak}) and energy let-through (I^2t).

The figures stated give the maximum selectivity level with the two nominated breakers in series under short-circuit conditions. For an indication on selectivity under overloads refer to the circuit breaker tripping/characteristic curves, or use the NHP TemCurve selectivity analysis software package.

Selectivity can be enhanced beyond the breaking capacity of the downstream breaker provided it is backed up by an appropriately selected upstream breaker, which should not trip (unlatch) under the stated short circuit current.

Cascade

Cascading is achieved by using an upstream device to assist (back-up) a downstream device in clearing a fault current. This principal is necessary should the downstream device be required to clear a prospective short circuit current greater than the devices' breaking capacity.

In most cascading applications it is generally necessary for the upstream breaker to trip (unlatch), as well as the downstream breaker to give adequate back-up protection. As such, cascade is commonly used in feeding and protecting non-essential loads, such as basic lighting.

For more information on selectivity and cascading please refer to the latest NHP Part C catalogue.

APPLICATION DATA

SELECTIVITY TABLES

Selectivity & Cascade Tables @ 400 / 415 V

Upstream MCCBs (RMS)	Downstream MCCBs (RMS)	XX / YY		Selectivity/ Cascade
		70	125	
E125NJ	25	25/25	25/65	25/25
S125NJ	36	36/36	36/85	36/36
S125GJ	65	65/65	65/125	65/65
H125NJ	125	70/70	125/125	100/100
S160NJ	36	36/36	36/85	36/36
S160GJ	65	65/65	65/125	65/65
H160NJ	125	70/70	125/125	100/100
E250NJ	25	25/25	25/65	25/25
S250NJ	36	36/36	36/85	36/36
S250GJ	65	65/65	65/125	65/65
S250PE	70	70/70	70/125	70/70
H250NJ	125	70/70	125/125	70/70
H250PE	125	70/70	125/125	70/70
E400NJ	25	10/36	25/65	25/25
S400CJ	36	10/36	36/85	36/36
S400NE	50	10/50	50/125	50/50
S400NJ	50	10/65	50/125	50/50
S400GJ	70	10/70	70/125	70/70
H400NJ	125	10/70	125/125	125/100
H400NE	125	10/70	125/125	125/100
E630NE	36	25/36	36/85	36/36
E630CE	50	25/50	50/125	50/50
S630GE	70	25/70	70/125	70/70
XS630CJ	45	30/45	45/125	35/45
XS630NJ	65	30/65	65/125	35/65
XS630PJ	85	30/85	85/125	35/85
XS630SE	50	30/65	50/125	30/85
XH630SE	65	30/65	65/125	30/85
XH630PE	65	30/65	65/125	30/85
XS800NJ	65	15/65	65/125	35/65
XS800SE	50	15/50	50/125	35/50
XJ800PJ	85	15/85	85/125	35/85
XH800SE	65	15/65	65/125	35/65
XH800PE	65	15/65	65/125	35/65
XS1250SE	65	15/65	65/125	35/65
XS1600SE	85	15/85	85/125	35/85

APPLICATION DATA

CASCADE TABLES

SECTION 4

CASCADE @ 380 – 415 V AC ')	Downstream MCCBs	kA (RMS)	E125NJ	S125NJ	S125GJ	H125NJ	L125NJ	S160NJ	S160GJ	H160NJ	L160NJ	E250NJ	S250NJ	S250GJ	S250PE	H250NJ	H250NE	L250NJ
			25	36	65	125	200	36	65	125	200	25	36	65	70	125	125	200
E125NJ	25	–	36	36	65	85	36	36	65	85	–	36	36	–	65	65	85	
S125NJ	36	–	–	50	85	125	–	50	85	125	–	–	–	–	85	85	125	
S125GJ	65	–	–	–	125	150	–	–	125	150	–	–	65	–	125	125	150	
H125NJ	125	–	–	–	–	200	–	–	–	200	–	–	65	–	–	–	200	
S160NJ	36	–	–	65	–	–	–	65	85	125	–	–	65	65	85	85	125	
S160GJ	65	–	–	–	–	–	–	–	125	150	–	–	–	70	125	125	150	
H160NJ	125	–	–	–	–	–	–	–	–	200	–	–	–	–	–	–	200	
S250NJ	36	–	–	–	–	–	–	65	–	–	–	–	–	65	85	85	125	
S250GJ	65	–	–	–	–	–	–	–	–	–	–	–	–	70	125	125	150	
S250PE	70	–	–	–	–	–	–	–	–	–	–	–	–	–	125	125	150	
H250NJ	125	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	200	
E400NJ	25	–	–	–	–	–	–	–	–	–	–	–	–	36	65	65	–	
S400CJ	36	–	–	–	–	–	–	–	–	–	–	–	–	50	70	70	–	
S400NJ	50	–	–	–	–	–	–	–	–	–	–	–	–	50	65	85	85	
S400GJ	70	–	–	–	–	–	–	–	–	–	–	–	–	50	–	125	125	
H400NJ	125	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	

Note: ') Ratings have not been verified where a dash “–” is shown.

All pick-up and time delay settings are to be set at a maximum for upstream MCCB's

CASCADE @ 380 – 415 V AC ')	Downstream MCCBs	kA (RMS)	Upstream MCCBs																			
			S400CJ	S400NJ	S400NE	S400GJ	S400GE	H400NJ	H400NE	L400NJ	L400NE	E630NE	S630CE	S630GE	TL630NE	XS800SE	XS800NJ	XH800SE	TL800NE	XS1250SE	XS1600SE	
E125NJ	25	36	36	50	65	85	85	36	–	50	–	36	36	36	–	–	–	–	–	–	–	–
S125NJ	36	–	50	65	85	125	125	–	–	65	–	50	50	–	–	–	–	–	–	–	–	–
S125GJ	65	–	–	70	125	150	150	–	50	70	–	–	–	65	–	–	–	–	–	–	–	–
H125NJ	125	–	–	–	–	200	200	–	–	–	–	–	–	65	–	50	–	–	–	–	–	–
S160NJ	36	–	50	65	85	125	125	–	50	50	–	–	65	65	–	–	–	–	–	–	–	–
S160GJ	65	–	–	70	125	150	150	–	–	70	–	–	–	–	–	–	–	–	–	–	–	–
H160NJ	125	–	–	–	–	200	200	–	–	–	–	–	–	65	–	65	–	–	–	–	–	–
E250NJ	25	36	36	50	65	85	85	36	–	50	–	–	36	50	–	–	–	–	–	–	–	–
S250NJ	36	–	50	65	85	125	125	–	–	65	–	–	65	–	–	–	–	–	–	–	–	–
S250GJ	65	–	–	70	125	150	150	–	–	70	–	–	–	–	–	–	–	–	–	–	–	–
S250PE	70	–	–	–	125	150	150	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–
H250NJ	125	–	–	–	–	200	200	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–
E400NJ	25	36	36	50	65	85	85	36	–	50	36	–	–	–	36	–	36	–	–	–	–	36
S400CJ	36	–	50	65	70	100	100	–	–	65	50	–	–	–	50	–	50	–	–	–	–	50
S400NJ	50	–	–	70	85	125	125	–	36	70	65	–	–	50	65	–	65	–	–	–	–	65
S400GJ	70	–	–	–	125	150	150	–	36	–	–	–	–	50	–	36	85	–	–	–	–	85
H400NJ	125	–	–	–	–	200	200	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–

Note: ') Ratings have not been verified where a dash “–” is shown.

All pick-up and time delay settings are to be set at a maximum for upstream MCCBs

APPLICATION DATA

SELECTIVITY AND CASCADE TEMBREAK 2 MCCBs AND DIN-T / SAFE-T MCBs

Downstream MCB	Amp rating	kA (RMS)	Upstream MCCB							
			E125NJ	S125NJ	H125NJ S125GJ	S250NJ	S250GJ	S400CJ	S400GE S400GJ	H400NJ
			25	36	65	36	65	36	70	125
DTCB6	2 – 20	6	18/18	25/25	35/35	35/35	35/35	–	–	–
	25 – 63	6	18/18	20/25	20/25	30/30	30/30	–	–	–
DTCB10	0.5 – 32	10	18/18	30/30	30/50	35/35	40/50	35/35	40/50	40/50
	40 – 63	10	18/18	20/25	25/25	30/30	30/30	30/30	30/30	30/30
DSRCBH /	0.5 – 32	10	18/18	30/30	30/50	35/35	40/50	35/35	40/50	40/50
DSRCD	40	10	18/18	20/25	25/25	30/30	30/30	30/30	30/30	30/30
Din-T10H	80 – 125	10	4/18	4/25	4/25	15/15	15/15	10/10	10/10	–
DTCH15	0.5 – 32	15	18/18	30	30/50	35/35	40/50	35/35	40/50	40/50
	40 – 63	15	18/18	20	25/25	30/30	30/30	30/30	30/30	30/30
Safe-T	16 – 20	6	3/10	3/10	3/10	–	–	–	–	–
SRCB	16 – 20	6	3/10	3/10	3/10	–	–	–	–	–

Guide



Notes: All figures stated are at 400/415 V AC.

SECTION 4

APPLICATION DATA

MOTOR STARTING TYPE 1 CO-ORDINATION TABLES

Short-Circuit Co-Ordination Motor Starting Table

Type '1'
Terasaki MCCB's & Sprecher + Schuh KT7's
DOL starting 50/65 kA @ 400/415 V to AS/NZS 60947.4.1

TYPE 1
50/65 kA

SECTION 4

Motor Size (kW)	Approx. amps @ 400/415 V (A)	Terasaki Combinations	
		MCCB	Contactors
0.37	1.1	XM30PB/1.4	CA7-9
0.55	1.5	XM30PB/2	CA7-9
0.75	1.8	XM30PB/2.6	CA7-9
1.1	2.6	XM30PB/4.0	CA7-9
1.5	3.4	XM30PB/5	CA7-9
2.2	4.8	XM30PB/8	CA7-9
3	6.5	XM30PB/10	CA7-9
4	8.2	XM30PB/12	CA7-9
5.5	11	S125GJ/20	CA7-12
7.5	14	S125GJ/20	CA7-16
11	21	S125GJ/32	CA7-23
15	28	S125GJ/50	CA7-30
18.5	34	S125GJ/50	CA7-37
22	40	S125GJ/63	CA7-43
30	55	S125GJ/100	CA7-60
37	66	S125GJ/100	CA7-72
45	80	S125GJ/125	CA7-85
55	100	S125GJ/125	CA6-110
5	130	S250PE/250	CA6-140
0	155	S250PE/250	CA6-180
10	200	S250PE/250	CA6-210
32	225	S400GE/400	CA6-210
60	270	S400GE/400	CA6-300
00	361	S400GE/400	CA6-420

Terasaki Combinations		Sprecher + Schuh Combinations	
Overload Relay	Thermal Setting (A)	KT7 Circuit Breaker	Contactors
CT 7-24	1.0 - 1.6	KTA7-25S-1.0A	CA7-9
CT 7-24	1.0 - 1.6	KTA7-25S-1.6A	CA7-9
CT 7-24	1.6 - 2.4	KTA7-25S-2.5A	CA7-9
CT 7-24	2.4 - 4.0	KTA7-25S-2.5A	CA7-9
CT 7-24	2.4 - 4.0	KTA7-25S-4.0A	CA7-9
CT 7-24	4.0 - 6.0	KTA7-25S-6.3A	CA7-9
CT 7-24	6.0 - 10	KTA7-25S-6.3A	CA7-9
CT 7-24	6.0 - 10	KTA7-25S-10A	CA7-9
CT 7-24	10 - 16	KTA7-25H-16A	CA7-12
CT 7-24	10 - 16	KTA7-25H-16A	CA7-16
CT 7-24	16 - 24	KTA7-45H-20A	CA7-23
CT 7-45	18 - 30	KTA7-45H-32A	CA7-30
CT 7-45	30 - 45	KTA7-45H-45A	CA7-37
CT 7-45	30 - 45	KTA7-45H-45A	CA7-43
CT 7-75	45 - 60	KTA3-100-63A	CA7-60
CT 7-75	60 - 75	KTA3-100-90A	CA7-72
CT 7-100	70 - 90	KTA3-100-90A	CA7-85
CEF 1-11/12	20 - 180	KTA3-160S-100A	CA6-110
CEF 1-11/12	20 - 180	KTA3-160S-160A	CA6-140
CEF 1-11/12	20 - 180	KTA3-160S-160A	CA6-180
CEF 1-41/42	160 - 400	KTA3-250S-200A	CA6-210
CEF 1-41/42	160 - 400	KTA3-250S-250A	CA6-250
CEF 1-41/42	160 - 400	KTA3-400S-320A	CA6-300
CEF 1-41/42	160 - 400	KTA3-400S-400A	CA6-420

- Notes:**
- Thermal or electronic overload relays may be used.
 - XM30PB MCCB's can be replaced with S125GJ/20 if required.
 - Combinations based on the thermal overload relay tripping before the circuit breaker at overload currents up to the motor locked rotor current.

APPLICATION DATA

MOTOR STARTING TYPE 2 CO-ORDINATION TABLES

Short-Circuit Co-Ordination DOL Motor Starting Table

Type '2'
 Terasaki MCCB's & Sprecher + Schuh KT7's
 DOL starting 50/65 kA @ 400/415 V to AS/NZS 60947.4.1

TYPE 2
50/65 kA

Motor Size (kW)	Approx. amps @ 400/415 V (A)	Terasaki Combinations	
		MCCB	Contactors
0.37	1.1	XM30PB/1.4	CA7-9
0.55	1.5	XM30PB/2	CA7-9
0.75	1.8	XM30PB/2.6	CA7-9
1.1	2.6	XM30PB/4.0	CA7-16
1.5	3.4	XM30PB/5	CA7-16
2.2	4.8	XM30PB/8	CA7-16
3	6.5	XM30PB/10	CA7-30
4	8.2	XM30PB/12	CA7-30
5.5	11	S125GJ/20	CA7-30
7.5	14	S125GJ/20	CA7-30
11	21	S125GJ/32	CA7-30
15	28	S125GJ/50	CA7-43
18.5	34	S125GJ/50	CA7-43
22	40	S125GJ/63	CA7-43
30	55	S125GJ/100	CA7-72
37	66	S125GJ/100	CA7-72
45	80	S125GJ/125	CA6-105
55	100	S250PE/160	CA6-105
75	130	S250PE/250	CA6-140
90	155	S250PE/250	CA6-170
110	200	S250PE/250	CA6-210
132	225	S400PE/400	CA6-210
160	270	S400PE/400	CA6-300
200	361	S400PE/400	CA6-420

Terasaki Combinations		Sprecher + Schuh Combinations	
Overload Relay	Thermal Setting (A)	KT7 Circuit Breaker	Contactors
CT 7-24	1.0 - 1.6	KTA7-25S-1A	CA7-9
CT 7-24	1.0 - 1.6	KTA7-25S-1.6A	CA7-9
CT 7-24	1.6 - 2.4	KTA7-25S-2.5A	CA7-9
CT 7-24	2.4 - 4.0	KTA7-25S-2.5A	CA7-9
CT 7-24	2.4 - 4.0	KTA7-25S-4A	CA7-9
CT 7-24	4.0 - 6.0	KTA7-25S-6.3A	CA7-9
CT 7-24	6.0 - 10	KTA7-25S-6.3A	CA7-9
CT 7-24	6.0 - 10	KTA7-25S-10A	CA7-9
CT 7-24	10 - 16	KTA7-25H-16A	CA7-12
CT 7-24	10 - 16	KTA7-25H-16A	CA7-16
CT 7-24	16 - 24	KTA7-45H-20A	CA7-23
CT 7-45	18 - 30	KTA7-45H-32A	CA7-30
CT 7-45	30 - 45	KTA7-45H-45A	CA7-37
CT 7-45	30 - 45	KTA7-45H-45A	CA7-43
CT 7-75	45 - 60	KTA3-100-63A	CA7-60
CT 7-75	60 - 75	KTA3-100-90A	CA7-72
CT 7-100	70 - 90	KTA3-100-90A	CA7-85
CEF 1-11/12	20 - 180	KTA3-160S-100A	CA6-110
CEF 1-11/12	20 - 180	KTA3-160S-160A	CA6-140
CEF 1-11/12	20 - 180	KTA3-160S-160A	CA6-180
CEF 1-41/42	160 - 400	KTA3-250S-200A	CA6-210
CEF 1-41/42	160 - 400	KTA3-250S-250A	CA6-250
CEF 1-41/42	160 - 400	KTA3-400S-320A	CA6-300
CEF 1-41/42	160 - 400	KTA3-400S-400A	CA6-420

- Notes:
- Thermal or electronic overload relays may be used.
 - XM30PB combinations can be replaced with S125GJ/20 and CA7-30 if required.
 - Combinations based on the thermal overload relay tripping before the circuit breaker at overload currents up to the motor locked rotor current.

SECTION 4

APPLICATION DATA

MOTOR STARTING TYPE 2 CO-ORDINATION

Short-Circuit Co-Ordination DOL Motor Starting Table

Type '2'
Terasaki MCCB's & Sprecher + Schuh KT7's
DOL starting 85 kA @ 400/415 V to AS/NZS 60947.4.1

TYPE 2
85 kA

Motor Size (kW)	Approx. amps @ 400/415 V (A)	Terasaki Combinations	
		MCCB	Contactors
0.37	1.1	XM30PB/1.4	CA 7-9
0.55	1.5	XM30PB/2	CA 7-9
0.75	1.8	XM30PB/2.6	CA 7-9
1.1	2.6	XM30PB/4.0	CA 7-16
1.5	3.4	XM30PB/5	CA 7-16
2.2	4.8	XM30PB/8	CA 7-30
3	6.5	XM30PB/10	CA 7-30
4	8.2	XM30PB/12	CA 7-30
5.5	11	H125NJ/20	CA 7-30
7.5	14	H125NJ/20	CA 7-30
11	21	H125NJ/32	CA 7-30
15	28	H125NJ/50	CA 7-43
18.5	34	H125NJ/50	CA 7-43
22	40	H125NJ/63	CA 7-43
30	55	H125NJ/100	CA 7-72
37	66	H125NJ/100	CA 7-72
45	80	H125NJ/160	CA 6-105
55	100	H160NJ/160	CA 6-105
75	130	H250PE/250	CA 6-210
90	155	H250PE/250	CA 6-210
110	200	H250PE/250	CA 6-210
132	225	H400NE/400	CA 6-210
160	270	H400NE/400	CA 6-300
200	361	H400NE/400	CA 6-420

Terasaki Combinations		Sprecher + Schuh Combinations	
Overload Relay	Thermal Setting (A)	KT7 Circuit Breaker	Contactors
CT 7-24	1.0 - 1.6	KTA7-25S-1A	CA 7-9
CT 7-24	1.0 - 1.6	KTA7-25S-1.6A	CA 7-9
CT 7-24	1.6 - 2.4	KTA7-25S-2.5A	CA 7-9
CT 7-24	2.4 - 4.0	KTA7-25H-2.5A	CA 7-9
CT 7-24	2.4 - 4.0	KTA7-25H-4A	CA 7-9
CT 7-24	4.0 - 6.0	KTA7-25H-6.3A	CA 7-9
CT 7-24	6.0 - 10	KTA7-25H-6.3A	CA 7-9
CT 7-24	6.0 - 10	KTA7-25H-10A	CA 7-9
CT 7-24	10 - 16	KTA7-45H-16A	CA 7-12
CT 7-24	10 - 16	KTA7-45H-16A	CA 7-16
CT 7-24	16 - 24	KTA7-45H-20A	CA 7-23
CT 7-45	18 - 30	KTA7-45H-32A	CA 7-30
CT 7-45	30 - 45	KTA7-45H-45A	CA 7-37
CT 7-45	30 - 45	KTA7-45H-45A	CA 7-43
CT 7-75	45 - 60	KTA3-100-63A	CA7-60
CT 7-75	60 - 75	KTA3-100-90A	CA7-72
CT 7-100	70 - 90	KTA3-100-90A	CA7-85
CEF 1-11/12	20 - 180	-	-
CEF 1-11/12	20 - 180	-	-
CEF 1-11/12	20 - 180	-	-
CEF 1-41/42	160 - 400	-	-
CEF 1-41/42	160 - 400	-	-
CEF 1-41/42	160 - 400	-	-
CEF 1-41/42	160 - 400	-	-

- Notes:**
- Thermal or electronic overload relays may be used.
 - XM30PB combinations can be replaced with H125GJ/20 and CA7-30 if required.
 - Combinations based on the thermal overload relay tripping before the circuit breaker at overload currents up to the motor locked rotor current.

APPLICATION DATA

MOTOR STARTING TYPE 2 CO-ORDINATION

Short-Circuit Co-Ordination DOL Motor Starting Table

Type '2'
 Terasaki MCCB's & Sprecher + Schuh KT7's
 DOL starting 100 kA @ 400/415 V to AS/NZS 60947.4.1

**TYPE 2
 100 kA**

Motor Size (kW)	Approx. amps @ 400/415 V (A)	Terasaki Combinations	
		MCCB	Contactors
0.37	1.1	H125NJ/20	CA 7-30
0.55	1.5	H125NJ/20	CA 7-30
0.75	1.8	H125NJ/20	CA 7-30
1.1	2.6	H125NJ/20	CA 7-30
1.5	3.4	H125NJ/20	CA 7-30
2.2	4.8	H125NJ/20	CA 7-30
3	6.5	H125NJ/20	CA 7-30
4	8.2	H125NJ/20	CA 7-30
5.5	11	H125NJ/20	CA 7-30
7.5	14	H125NJ/20	CA 7-30
11	21	H125NJ/32	CA 7-30
15	28	H125NJ/50	CA 7-43
18.5	34	H125NJ/50	CA 7-43
22	40	H125NJ/63	CA 7-43
30	55	H125-NJ/100	CA 7-60
37	66	H125-NJ/100	CA 7-72
45	80	H125-NJ/125	CA 7-85
55	100	H250-NE/160	CA 6-95
75	130	H250-NE/250	CA 6-140
90	155	H250-NE/250	CA 6-140
110	200	H250-NE/250	CA 6-180
132	225	H400-NE/400	CA 6-420
160	270	H400-NE/400	CA 6-420
200	361	H400-NE/400	CA 6-420

Terasaki Combinations		Sprecher + Schuh Combinations	
Overload Relay	Thermal Setting (A)	KT7 Circuit Breaker	Contactors
CT 7-24	1.0 - 1.6	KTA7-25S-1A	CA 7-9
CT 7-24	1.0 - 1.6	KTA7-25S-1.6A	CA 7-9
CT 7-24	1.6 - 2.4	KTA7-25S-2.5A	CA 7-9
CT 7-24	2.4 - 4.0	KTA7-25H-2.5A	CA 7-9
CT 7-24	2.4 - 4.0	KTA7-25H-4A	CA 7-9
CT 7-24	4.0 - 6.0	KTA7-25H-6.3A	CA 7-9
CT 7-24	6.0 - 10	KTA7-25H-6.3A	CA 7-9
CT 7-24	6.0 - 10	KTA7-25H-10A	CA 7-9
CT 7-24	10 - 16	KTA7-45H-16A	CA 7-12
CT 7-24	10 - 16	KTA7-45H-16A	CA 7-16
CT 7-24	16 - 24	KTA7-45H-20A	CA 7-23
CT 7-45	18 - 30	KTA7-45H-32A	CA 7-30
CT 7-45	30 - 45	KTA7-45H-45A	CA 7-37
CT 7-45	30 - 45	KTA7-45H-45A	CA 7-43
CT 7-75	45 - 60	-	-
CT 7-75	60 - 75	-	-
CT 7-100	70 - 90	-	-
CEF 1-11/12	20 - 180	-	-
CEF 1-11/12	20 - 180	-	-
CEF 1-11/12	20 - 180	-	-
CEF 1-41/42	160 - 400	-	-
CEF 1-41/42	160 - 400	-	-
CEF 1-41/42	160 - 400	-	-
CEF 1-41/42	160 - 400	-	-

- Notes:
- Thermal or electronic overload relays may be used.
 - Combinations based on the thermal overload relay tripping before the circuit breaker at overload currents up to the motor locked rotor current.

SECTION 4

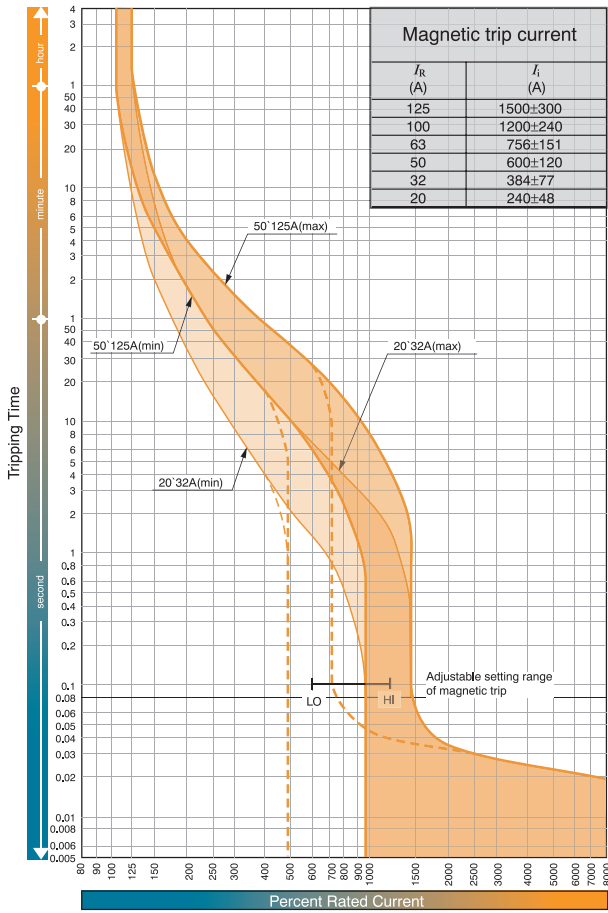
OPERATING CHARACTERISTICS

THERMAL MAGNETIC CHARACTERISTICS

125A Frame MCCBs

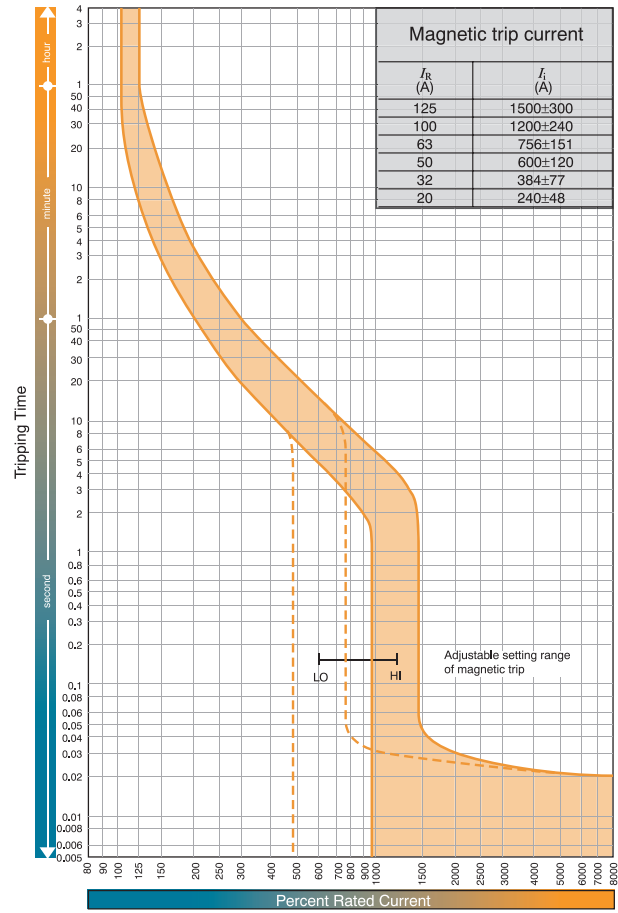
Time/current characteristic curves

E125-NJ, S125-NJ, S125-GJ



Time/current characteristic curves

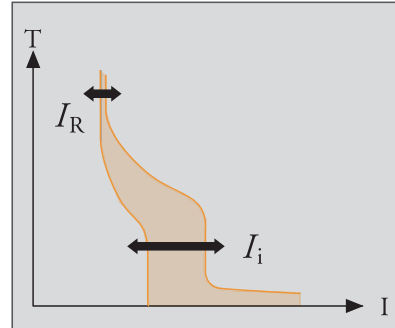
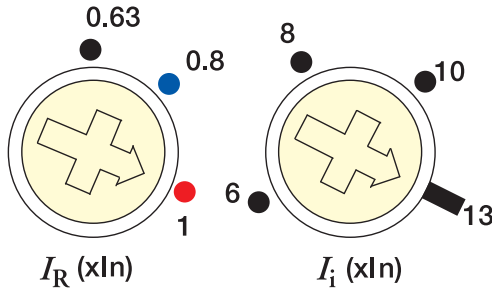
H125-NJ, L125-NJ



OPERATING CHARACTERISTICS

THERMAL MAGNETIC PROTECTION

Adjustment Dials



1. I_R is the thermal element adjustment dial and is used to set the rated current to match the conductor rating.

I_R can be set between 0.63 and 1.0 times I_n .

2. I_i is the magnetic element adjustment dial and is used to set the short circuit tripping threshold to suit the application.

I_i can be set between 6 and 12 times I_n on 125A and 400A frame models.

I_i can be set between 6 and 13 times I_n on 250A frame models with ratings of 160A, 200A and 250A.

I_i can be set between 6 and 12 times I_n on 250A frame models with ratings of 125A and less.

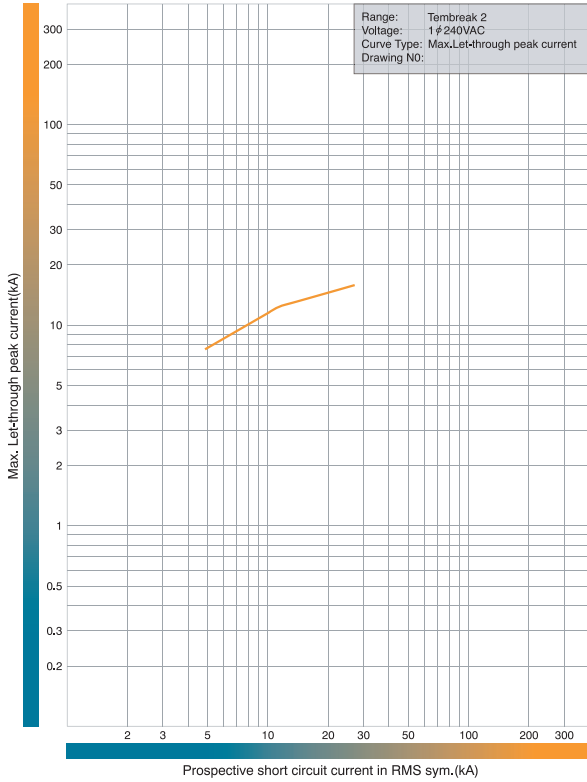
Models, Types and Rated Currents of Thermal Elements

Model	Type	Current Rating I_n (A)
S125	-NF	16, 20, 25, 32, 40, 50, 63, 80, 100, 125
E125	-NJ	20, 32, 50, 63, 100, 125
S125	-NJ	20, 32, 50, 63, 100, 125
S125	-GJ	20, 32, 50, 63, 100, 125
H125	-NJ	20, 32, 50, 63, 100, 125
L125	-NJ	20, 32, 50, 63, 100, 125
S160	-NF	16, 20, 25, 32, 40, 50, 63, 80, 100, 125, 160
S160	-NJ	20, 32, 50, 63, 100, 125, 160
S160	-GJ	50, 63, 100, 125, 160
H160	-NJ	160
L160	-NJ	160
E250	-NJ	20, 32, 50, 63, 100, 125, 160, 200, 250
S250	-NJ	160, 200, 250
S250	-GJ	160, 200, 250
H250	-NJ	160, 250
L250	-NJ	160, 250
E400	-NJ	250, 400
S400	-CJ	250, 400
S400	-NJ	250, 400
S400	-GJ	250, 400
H400	-NJ	250, 400
L400	-NJ	250, 400

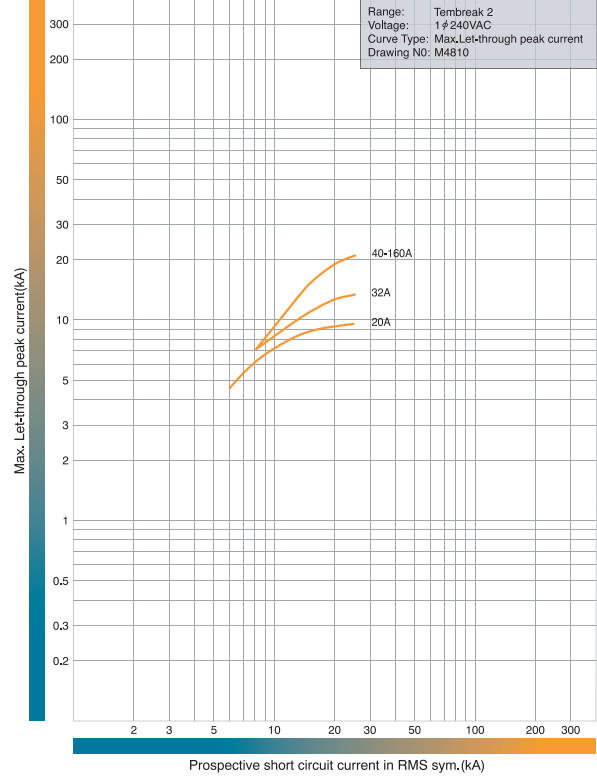
OPERATING CHARACTERISTICS

LET-THROUGH PEAK CURRENT CHARACTERISTICS

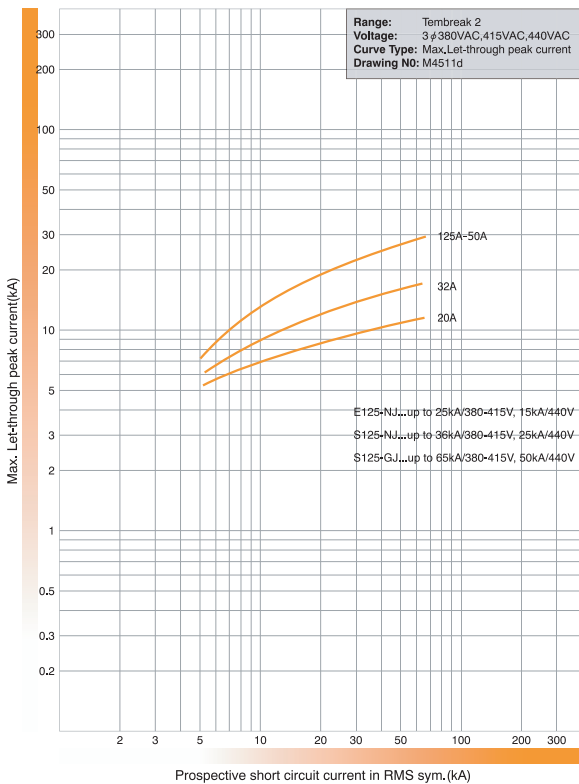
S125-NF, 240V AC



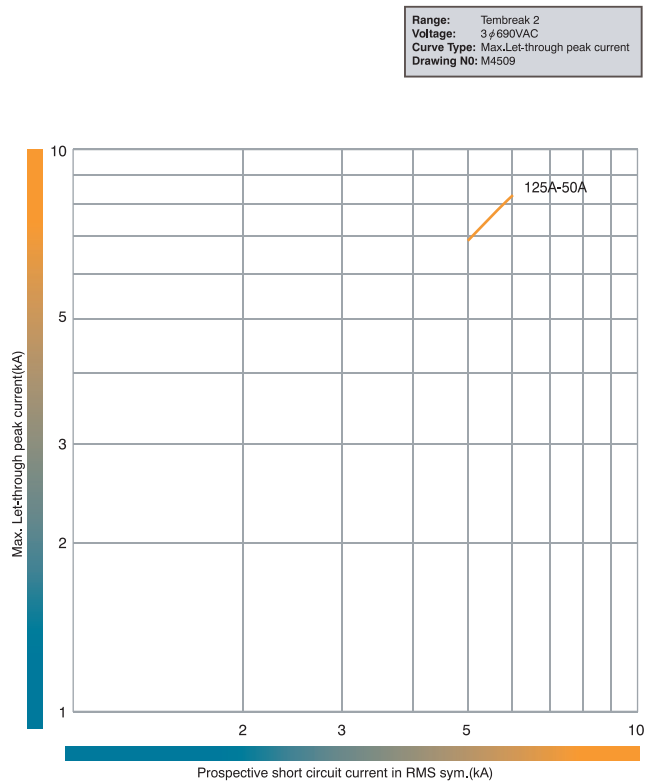
S160-NF, 240V AC.



E125-NJ, S125-NJ, S125-GJ, 440V AC.



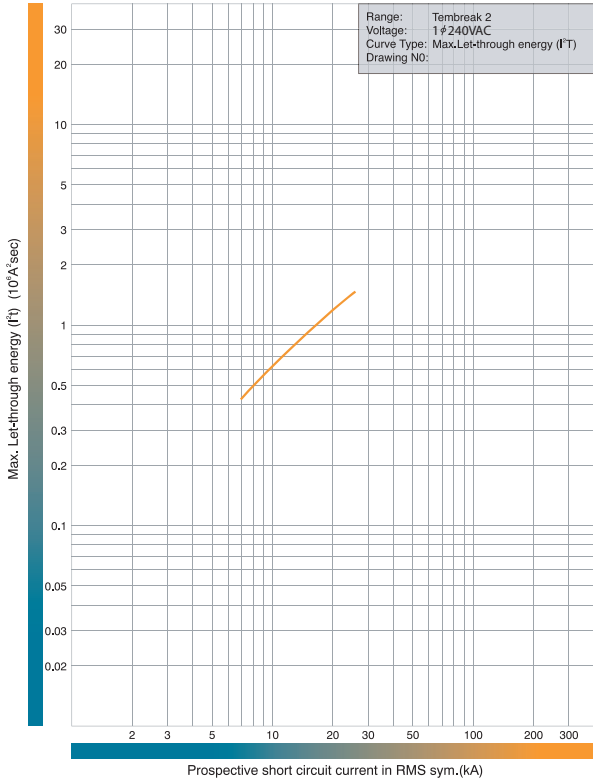
S125-NJ, S125-GJ, 690V AC.



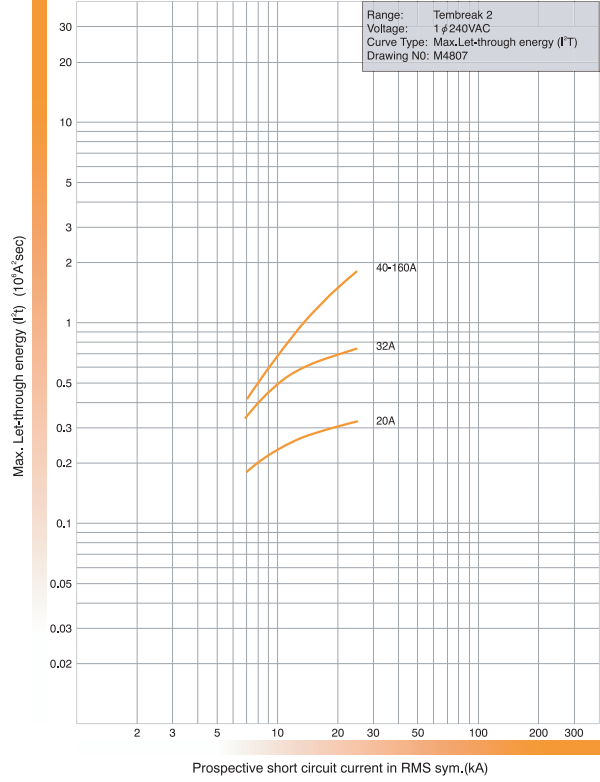
OPERATING CHARACTERISTICS

LET-THROUGH ENERGY CHARACTERISTICS

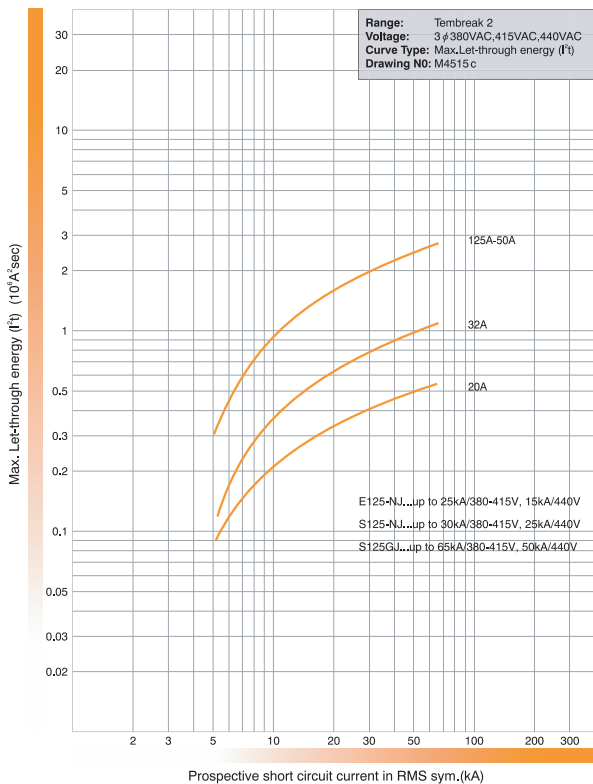
S125-NE. 240V AC



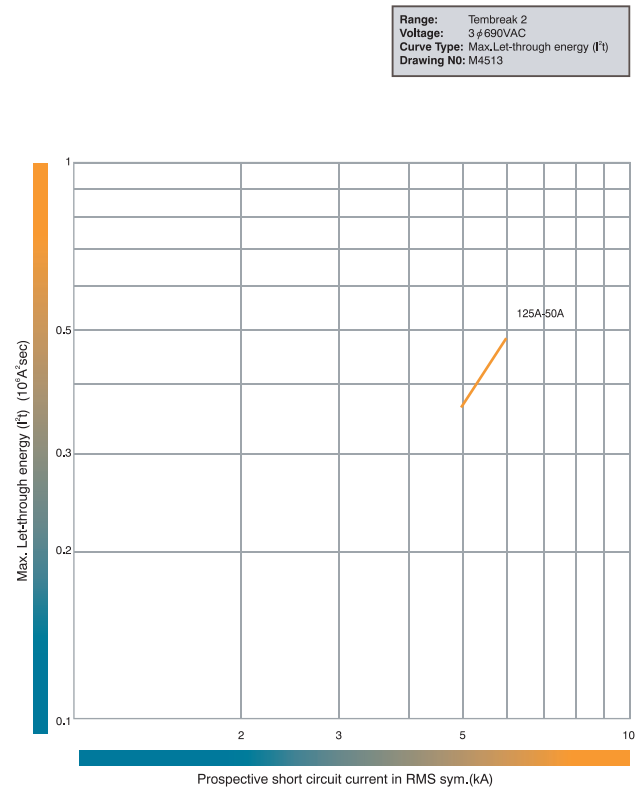
S160-NE. 240V AC



E125-NJ, S125-NJ, S125-GJ. 440V AC.



S125-NJ, S125-GJ. 690V AC.



SECTION 3

Accessories to suit 125 - 630AF MCCBs

External accessories

Cat. No.

Door interlocking, variable depth **Suits MCCB types**

E125, S125



IP54 rated

Grey/black
 Grey/black c/w key lock
 Red/yellow
 Red/yellow c/w key lock

T2HP12R5BNA4
T2HP12R5BKA4
T2HP12R5RNA4
T2HP12R5RKA4

IP65 rated

Grey/black
 Grey/black c/w key lock
 Red/yellow
 Red/yellow c/w key lock

T2HP12R6BNA4
T2HP12R6BKA4
T2HP12R6RNA4
T2HP12R6RKA4



H125, L125, S160, H160, L160, E250, S250, H250, L250

IP54 rated

Grey/black
 Grey/black c/w key lock
 Red/yellow
 Red/yellow c/w key lock

T2HP25R5BNA4
T2HP25R5BKA4
T2HP25R5RNA4
T2HP25R5RKA4

IP65 rated

Grey/black
 Grey/black c/w key lock
 Red/yellow
 Red/yellow c/w key lock

T2HP25R6BNA4
T2HP25R6BKA4
T2HP25R6RNA4
T2HP25R6RKA4

Note: Handles supplied with shaft

ACCESSORIES

OPERATING HANDLES & LOCKING DEVICES

TemBreak 2 handles are extremely reliable, having been designed to endure the same switching duty as the host MCCB.

It is easy to fit the operating unit to the MCCB. Fitting involves three easy steps:

1. Align breaker toggle with operating mechanism
2. Push handle into position (the handle's round pegs locate securely in the breaker's round holes and the handle's* square pegs in the breaker's square holes).
3. Twist locking screws through 45 degrees.*

Safety Features

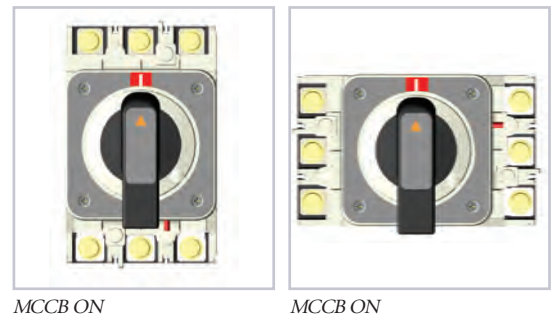
- Door interlock mechanism with override facility included as standard
- IP54 (door mounted version), IP 54 as standard (breaker mounted version)
- IP65 (door mounted version), IP 65 optional (breaker mounted version)
- Locks OFF with up to 3 padlocks (8mm hasps)
- Optional keylock in OFF position
- Available in black or red and yellow
- A trip test can be performed with the handle fitted to the MCCB

Orientation

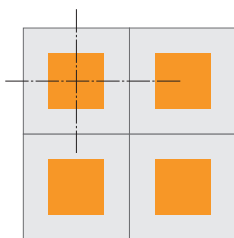
To switch the breaker from OFF to ON the handle is rotated through 90 degrees in a clockwise direction.

The ON (I) and OFF (O) indication of the handle can be re-oriented in steps of 90 degrees with respect to the operating mechanism. This allows the indication position to remain the same whether the breaker is mounted vertically (right side up or upside down) or horizontally (on its left side or on its right side). The hole cut-out dimensions for a panel or door will remain unchanged if the handle is re-oriented. The handle's axis of rotation is on the intersection of the centre lines of a 3P MCCB.

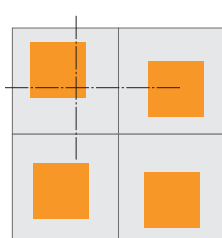
This means that the positioning of the door cutouts is symmetrical for breakers mounted horizontally on either side of a vertical busbar system.



Cubicle Door Cutouts



Using TemBreak 2 Operating Handles



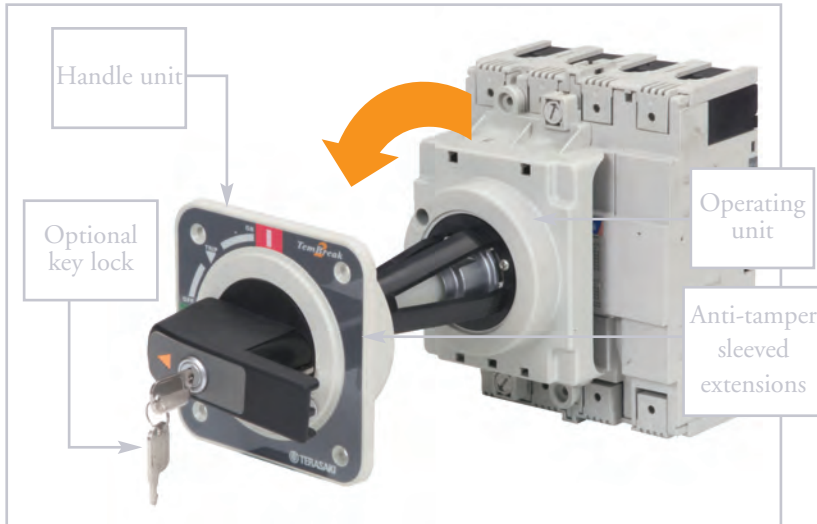
Using other MCCB Operating Handles

*handles for 400A and 630A Frame models are secured with four screws.

ACCESSORIES

OPERATING HANDLES & LOCKING DEVICES

Door Mounted Handle (HP)



The door mounted operating handle is used to operate a circuit breaker mounted inside a cubicle from outside the door. It consists of an operating mechanism that is mounted on the breaker, an operating handle that is mounted on the door, and a shaft that transmits the turning force from the handle to the operating unit. The shaft can be cut to the required length.

Door Mounted Handle with Optional Keylock

Breaker Mounted Handle (HB)



Breaker Mounted Handle Padlocked in the OFF Position

This handle is used to operate a circuit breaker mounted just behind a compartment door with the door closed. The operating unit and the handle itself are mounted directly onto the circuit breaker. The handle protrudes through a cutout in the door. A moulded door flange is supplied with the handle which covers the cutout from the front.

Padlocking and keylocking is possible in the OFF position or both the ON and OFF position depending on the mounting direction.

Locking Devices

Toggle locking devices allow MCCBs to be locked ON or OFF using up to three padlocks. Locking devices for 125A, 160A and 250A frame models accept padlocks with 5mm hasp diameter. Locking devices for 400A and 630A frame models accept padlocks with 8mm hasp diameter.



S250 Locked OFF



S400 Locked OFF

Fittings for Castell and Fortress locks are available. They are suitable for use on toggle-operated MCCBs, or on door mounted handles (HP) for MCCBs.

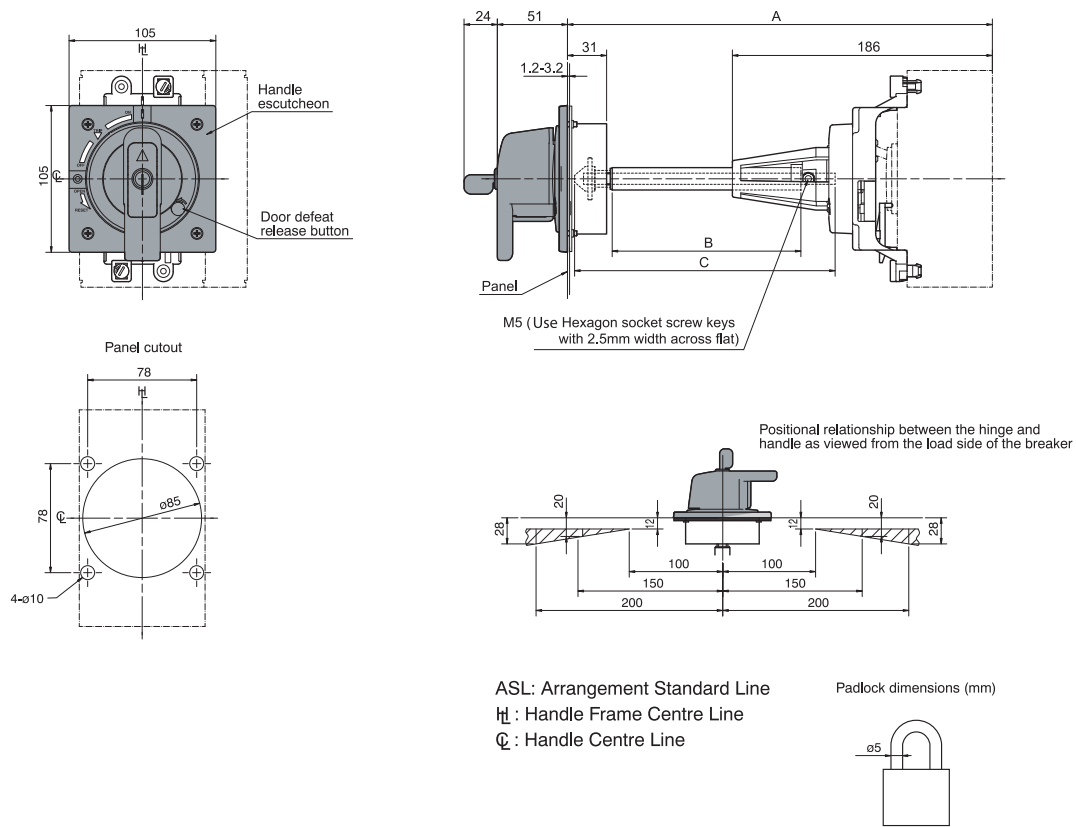
DIMENSIONS

Door Mounted Handle

Applicable MCCB	A *1	B	C	Shaft support
E125 S125	540 max.	370	421	With +

*1: Max. means the maximum length for A without cutting the shaft.

+ The shaft can be cut to the required length. If it is necessary to cut the shaft so short that it does not protrude beyond the shaft support, the shaft support may be removed.



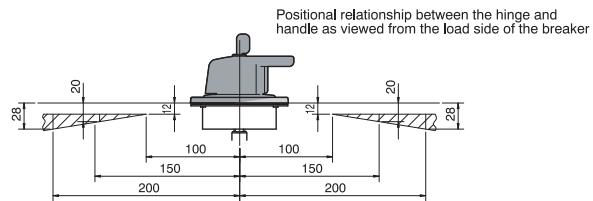
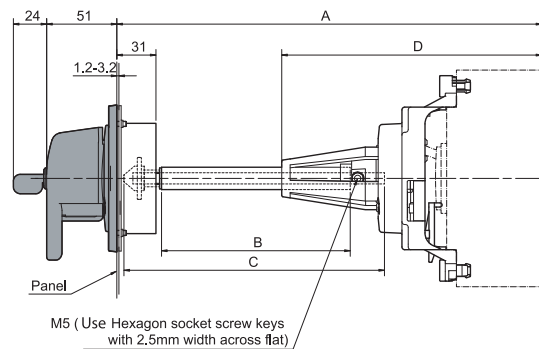
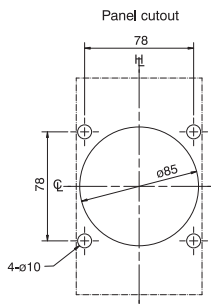
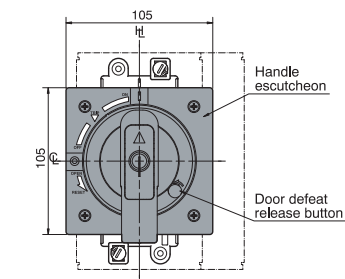
DIMENSIONS

Door Mounted Handle

Applicable MCCB	A *1	B	C	D	Shaft support
E250 S250 (except S250-PE)	540 max.	370	421	186	With +
S250-PE H125 L125 H160 L160 H250 L250	575 max.	370	421	221	With +

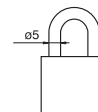
*1: Max. means the maximum length for A without cutting the shaft.

+ The shaft can be cut to the required length. If it is necessary to cut the shaft so short that it does not protrude beyond the shaft support, the shaft support may be removed.



ASL: Arrangement Standard Line
 ht: Handle Frame Centre Line
 CL: Handle Centre Line

Padlock dimensions (mm)



DIMENSIONS

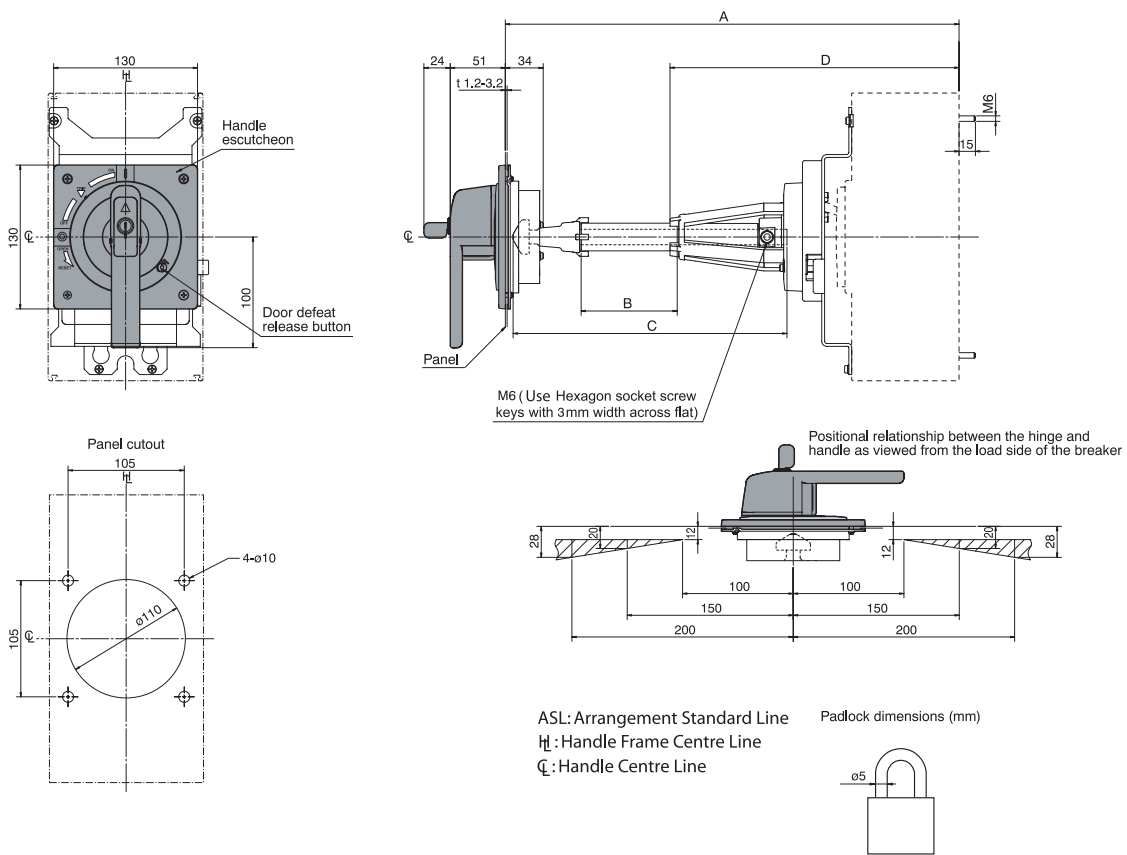
Door Mounted Handle

Applicable MCCB	A *1	B	C	D	Shaft support
E400 E630	270 min.	12	107.5	—	Without
S400 S630	610 max.	280	447.5	261	With +
H400	307 min.	12	107.5	—	Without
L400	647 max.	280	447.5	298	With +

*1: Min. means the minimum length for A by cutting the shaft.

Max. means the maximum length for A without cutting the shaft.

+ The shaft can be cut to the required length. If it is necessary to cut the shaft so short that it does not protrude beyond the shaft support, the shaft support may be removed.



Accessories to suit 125 - 630AF MCCBs

External accessories

Cat. No.

Door interlocking, variable depth **Suits MCCB types**

E400, S400, H400, L400, E630, S630



IP54 rated

Grey/black
 Grey/black c/w key lock
 Red/yellow
 Red/yellow c/w key lock

T2HP40R5BNA4
T2HP40R5BKA4
T2HP40R5RNA4
T2HP40R5RKA4

IP65 rated

Grey/black
 Grey/black c/w key lock
 Red/yellow
 Red/yellow c/w key lock

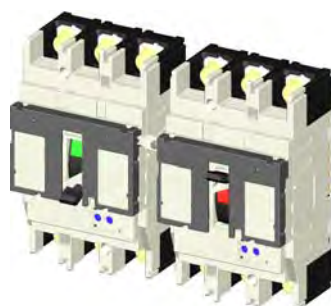
T2HP40R6BNA4
T2HP40R6BKA4
T2HP40R6RNA4
T2HP40R6RKA4

Note: Handles supplied with shaft

Mechanical Interlocks

Link Interlock – suitable for manual or motorised operation. Will accept handles. Suitable for front or rear connection

E125, S125



With trip interlock function

3 or 4 pole right side section
 3 pole left side section
 4 pole left side section

T2ML12RA
T2ML12L3A
T2ML12L4A

H125, L125, S160, H160, L160, E250, S250, H250, L250

With trip interlock function

3 or 4 pole right side section
 3 pole left side section
 4 pole left side section

T2ML25RA
T2ML25L3A
T2ML25L4A

E400, S400, H400, L400, E630, S630

With trip interlock function

3 or 4 pole right side section
 3 pole left side section
 4 pole left side section

T2ML40RA
T2ML40L3A
T2ML40L4A

Refer page 53 if MCCB labels are required or refer to NHP.

ACCESSORIES

OPERATING HANDLES & LOCKING DEVICES

TemBreak 2 handles are extremely reliable, having been designed to endure the same switching duty as the host MCCB.

It is easy to fit the operating unit to the MCCB. Fitting involves three easy steps:

1. Align breaker toggle with operating mechanism
2. Push handle into position (the handle's round pegs locate securely in the breaker's round holes and the handle's* square pegs in the breaker's square holes).
3. Twist locking screws through 45 degrees.*

Safety Features

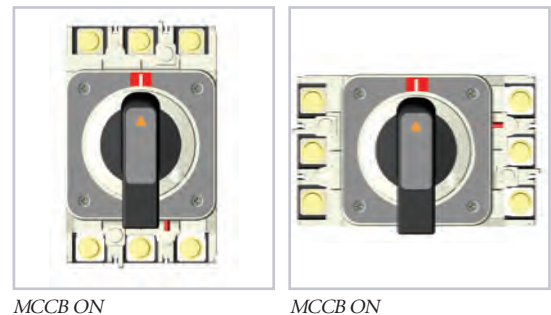
- Door interlock mechanism with override facility included as standard
- IP54 (door mounted version), IP 54 as standard (breaker mounted version)
- IP65 (door mounted version), IP 65 optional (breaker mounted version)
- Locks OFF with up to 3 padlocks (8mm hasps)
- Optional keylock in OFF position
- Available in black or red and yellow
- A trip test can be performed with the handle fitted to the MCCB

Orientation

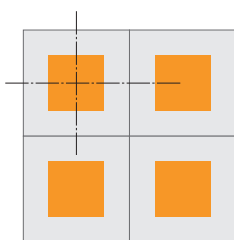
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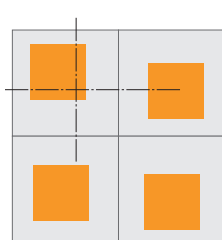
This means that the positioning of the door cutouts is symmetrical for breakers mounted horizontally on either side of a vertical busbar system.



Cubicle Door Cutouts



Using TemBreak 2 Operating Handles



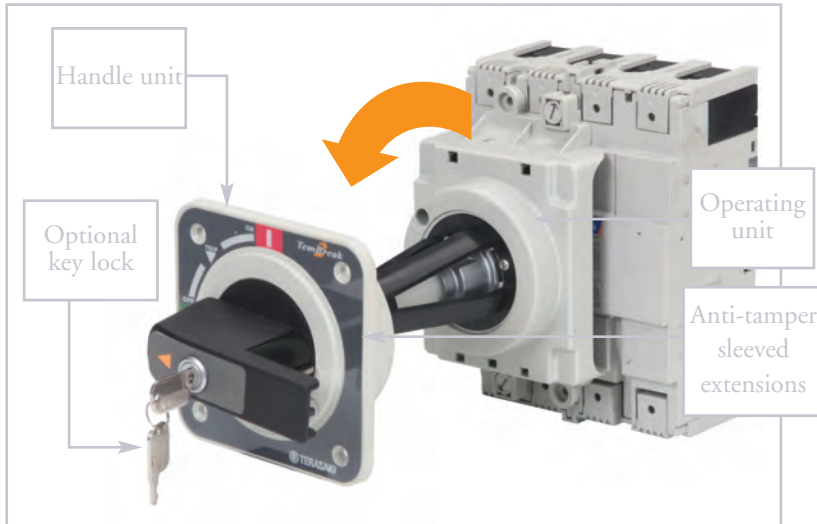
Using other MCCB Operating Handles

*handles for 400A and 630A Frame models are secured with four screws.

ACCESSORIES

OPERATING HANDLES & LOCKING DEVICES

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Door Mounted Handle with Optional Keylock

Breaker Mounted Handle (HB)



Breaker Mounted Handle Padlocked in the OFF Position

This handle is used to operate a circuit breaker mounted just behind a compartment door with the door closed. The operating unit and the handle itself are mounted directly onto the circuit breaker. The handle protrudes through a cutout in the door. A moulded door flange is supplied with the handle which covers the cutout from the front.

Padlocking and keylocking is possible in the OFF position or both the ON and OFF position depending on the mounting direction.

Locking Devices

Toggle locking devices allow MCCBs to be locked ON or OFF using up to three padlocks. Locking devices for 125A, 160A and 250A frame models accept padlocks with 5mm hasp diameter. Locking devices for 400A and 630A frame models accept padlocks with 8mm hasp diameter.



S250 Locked OFF



S400 Locked OFF

Fittings for Castell and Fortress locks are available. They are suitable for use on toggle-operated MCCBs, or on door mounted handles (HP) for MCCBs.

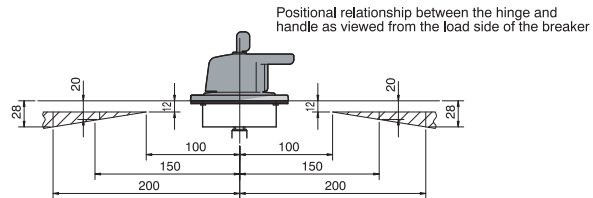
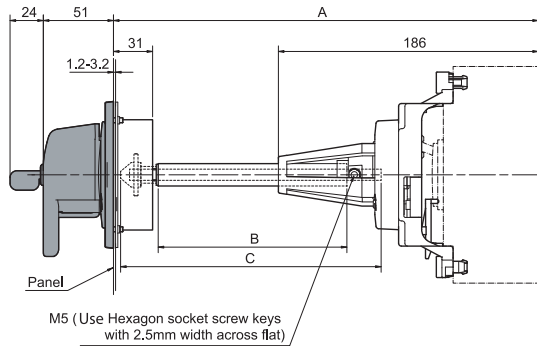
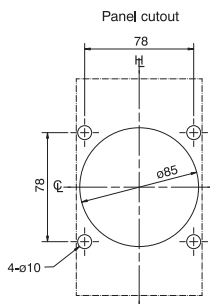
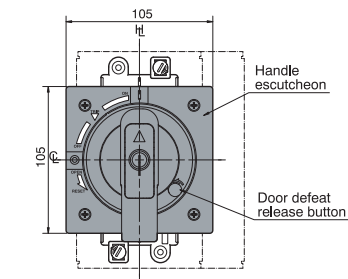
DIMENSIONS

Door Mounted Handle

Applicable MCCB	A *1	B	C	Shaft support
E125 S125	540 max.	370	421	With +

*1: Max. means the maximum length for A without cutting the shaft.

+ The shaft can be cut to the required length. If it is necessary to cut the shaft so short that it does not protrude beyond the shaft support, the shaft support may be removed.

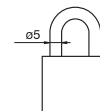


ASL: Arrangement Standard Line

H : Handle Frame Centre Line

C : Handle Centre Line

Padlock dimensions (mm)



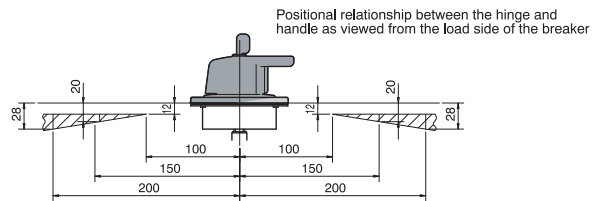
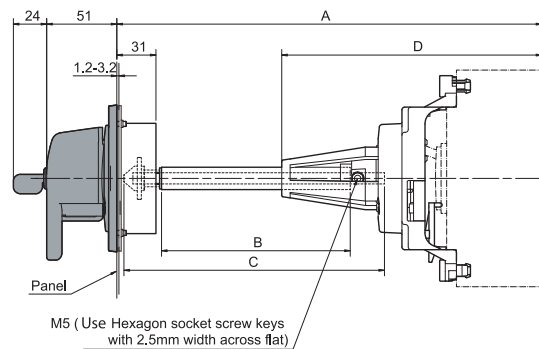
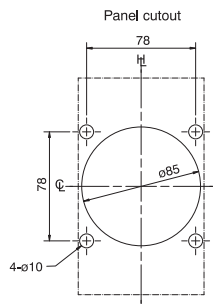
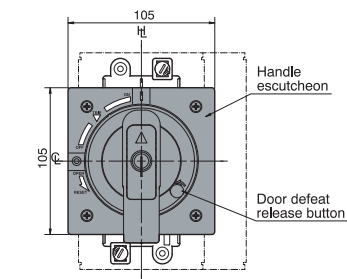
DIMENSIONS

Door Mounted Handle

Applicable MCCB	A *1	B	C	D	Shaft support
E250 S250 (except S250-PE)	540 max.	370	421	186	With +
S250-PE H125 L125 H160 L160 H250 L250	575 max.	370	421	221	With +

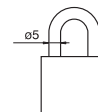
*1: Max. means the maximum length for A without cutting the shaft.

+ The shaft can be cut to the required length. If it is necessary to cut the shaft so short that it does not protrude beyond the shaft support, the shaft support may be removed.



ASL: Arrangement Standard Line
Ht: Handle Frame Centre Line
C: Handle Centre Line

Padlock dimensions (mm)



DIMENSIONS

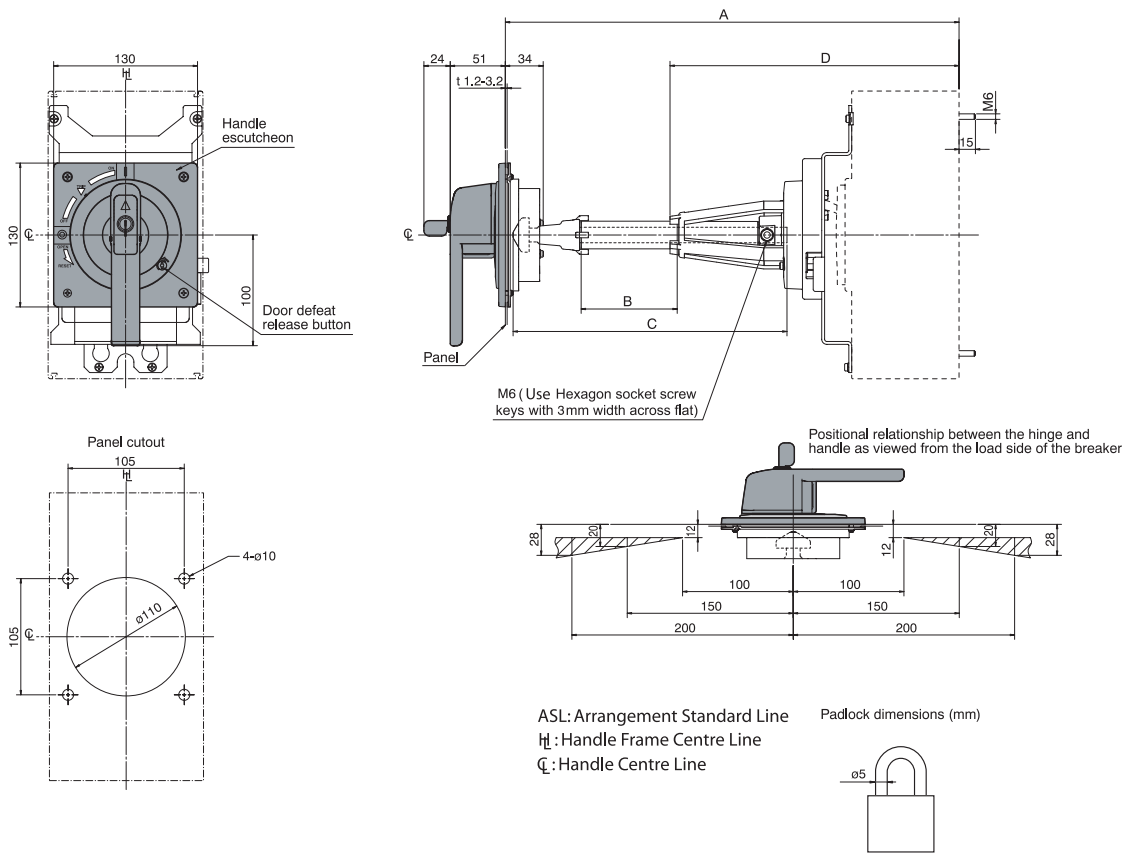
Door Mounted Handle

Applicable MCCB	A *1	B	C	D	Shaft support
E400 E630	270 min.	12	107.5	—	Without
S400 S630	610 max.	280	447.5	261	With +
H400	307 min.	12	107.5	—	Without
L400	647 max.	280	447.5	298	With +

*1: Min. means the minimum length for A by cutting the shaft.

Max. means the maximum length for A without cutting the shaft.

+ The shaft can be cut to the required length. If it is necessary to cut the shaft so short that it does not protrude beyond the shaft support, the shaft support may be removed.



2. Miniature Circuit Breaker



Halmac Services (Qld) Pty. Ltd.
A.C.N. 098 852 923
A.B.N. 40 741 712 113

MINIATURE CIRCUIT BREAKER

1. MCB TECHNICAL DETAILS
2. MCB/RCD TECHNICAL DETAILS

Miniature circuit breakers

Din-Safe single pole width residual current circuit breaker (RCBO)

- Standards AS/NZS 61009
- Approval N17482
- One module wide (18 mm)
- Short circuit, overcurrent and earth leakage protection
- Short circuit protection 10 kA
- Sensitivity 10 and 30 mA
- Din rail mount
- Suits CD chassis
- Type "A" residual current device (AC/DC)



Amp rating (A)	Modules (18mm)	Voltage (AC)	Short circuit (kA)	Trip Sensitivity (mA)	Cat. No ¹⁾ ²⁾
6	1	240	10	30	DSRCBH0630A
10	1	240	10	30	DSRCBH1030A
16	1	240	10	30	DSRCBH1630A
20	1	240	10	30	DSRCBH2030A
25	1	240	10	30	DSRCBH2530A
32	1	240	10	30	DSRCBH3230A
40	1	240	10	30	DSRCBH4030A
6	1	240	10	10	<i>i</i> DSRCBH0610A
10	1	240	10	10	DSRCBH1010A
16	1	240	10	10	DSRCBH1610A
20	1	240	10	10	DSRCBH2010A
25	1	240	10	10	<i>i</i> DSRCBH2510A
32	1	240	10	10	<i>i</i> DSRCBH3210A
40	1	240	10	10	<i>i</i> DSRCBH4010A

Note: ¹⁾ Neutral not switched.
²⁾ Will not accept side mounting accessories.
i Available on indent only.

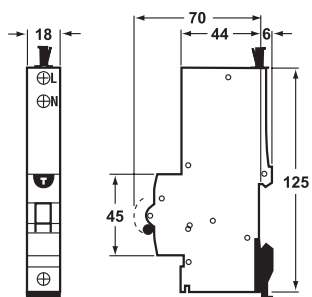
Operation

This unit combines the overload and short circuit protection of an MCB with earth leakage protection of an RCD. The unit occupies one, sub- circuit (one pole) of the distribution board and provides single phase protection against overload, short circuit and earth leakage current.

- The MCB element provides thermal and magnetic tripping protection which is rated to 10 kA prospective fault current.
- The RCD element of the device provides core-balance detection of the difference between the active and neutral currents and amplification to provide high sensitivity. The rated residual operating current ($I_{\Delta n}$) is 10 mA or 30 mA.
- The green/yellow earth reference cable, in case of loss of supply neutral, ensures the device will continue to provide earth leakage protection and will operate normally upon detection of an earth leakage current.

Dimensions (mm)

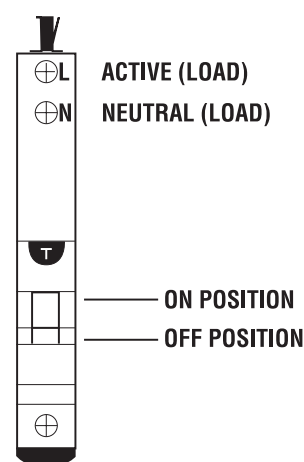
Note: A 1.2 m long pigtail lead is included as standard.



Application

The Din-Safe single pole width residual current circuit breaker will fit the standard Din-T chassis for use in NHP panelboards. The design makes it possible to provide an MCB complete with earth leakage protection in an 18 mm wide module, which allows a greater number of devices to be fitted into a distribution board.

Connection diagram



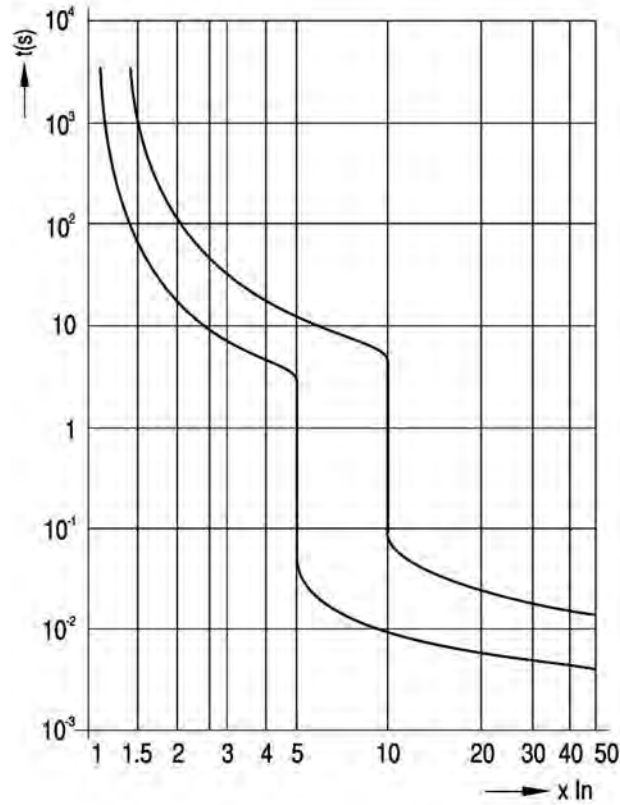
Note: Nuisance tripping may be experienced in VFD and motor starting applications refer NHP.

Din-T MCBs + RCDs Technical data

Tripping curves according to EN 60898

The following tables show the average tripping curves of the Terasaki Din-T MCBs based on the thermal and magnetic characteristics.

Curve C



3

Din-T MCBs + RCDs Technical data

What is an RCD?

3

The RCD (Residual Current Device) is a device intended to protect people against indirect contact, the exposed conductive parts of the installation being connected to an appropriate earth electrode. It may be used to provide protection against fire hazards due to a persistent earth fault current, without operation of the overcurrent protective device.

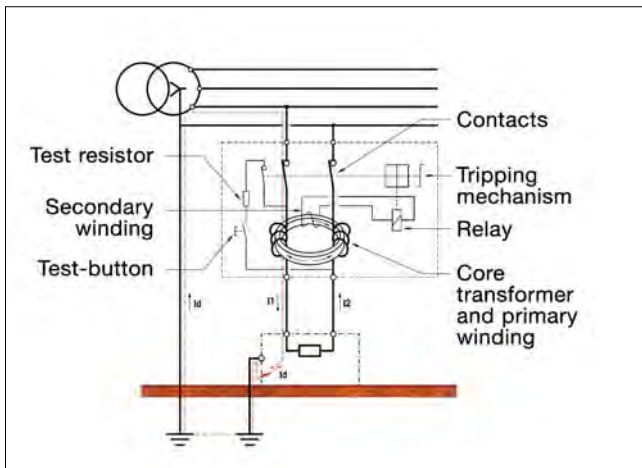
RCDs having a rated residual operating current not exceeding 30 mA are also used as a means for additional protection in case of failure of the protective means against electric shock (direct contact).

Working Principle

The main components of an RCD are the following:

- The core transformer: which detects the earth fault current.
- The relay: when an earth fault current is detected, the relay reacts by tripping and opening the contacts.
- The mechanism: element to open and close the contacts either manually or automatically.
- The contacts: to open or close the main circuit.

The RCD constantly monitors the vectorial sum of the current passing through all the conductors. In normal conditions the vectorial sum is zero ($I_1+I_2=0$) but in case of an earth fault, the vectorial sum differs from zero ($I_1+I_2=I_d$), this causes the actuation of the relay and therefore the release of the main contacts.



Definitions related to RCDs

RCCB = Residual Current Circuit Breaker without overcurrent protection.

RCBO = Residual Current Circuit Breaker with overcurrent protection.

Breaking capacity

A value of AC component of a prospective current that an RCCB is capable of breaking at a stated voltage under prescribed conditions of use and behaviour.

Residual making and breaking capacity ($I_{\Delta m}$)

A value of the AC component of a residual prospective current which an RCCB can make, carry for its opening time and break under specified conditions of use and behaviour.

Conditional residual short-circuit current ($I_{\Delta c}$)

A value of the AC component of a prospective current which an RCCB protected by a suitable SCPD (short-circuit protective device) in series, can withstand, under specific conditions of use and behaviour.

Conditional short-circuit current (I_{nc})

A value of the AC component of a residual prospective current which an RCCB protected by a suitable SCPD in series, can withstand, under specific conditions of use and behaviour.

Residual short-circuit withstand current

Maximum value of the residual current for which the operation of the RCCB is ensured under specified conditions, and above which the device can undergo irreversible alterations.

Prospective current

The current that would flow in the circuit, if each main current path of the RCCB and the overcurrent protective device (if any) were replaced by a conductor of negligible impedance.

Making capacity

A value of AC component of a prospective current that an RCCB is capable to make at a stated voltage under prescribed conditions of use and behaviour.

Open position

The position in which the predetermined clearance between open contacts in the main circuit of the RCCB is secured.

Closed position

The position in which the predetermined continuity of the main circuit of the RCCB is secured.

Tripping time

The time which elapses between the instant when the residual operating current is suddenly attained and the instant of arc extinction in all poles.

Residual current ($I_{\Delta n}$)

Vector sum of the instantaneous values of the current flowing in the main circuit of the RCCB.

Residual operating current

Value of residual current which causes the RCCB to operate under specified conditions.

Rated short-circuit capacity (I_{cn})

Is the value of the ultimate short-circuit breaking capacity assigned to the circuit breaker. (Only applicable to RCBO)

Conventional non-tripping current (I_{nt})

A specified value of current which the circuit breaker is capable of carrying for a specified time without tripping. (Only applicable to RCBO)

Conventional tripping current (I_t)

A specified value of current which causes the circuit breaker to trip within a specified time. (Only applicable to RCBO)

Din-T MCBs + RCDs Technical data

RCDs classification according to EN 61008/61009

3

RCDs may be classified according to:

The behaviour in the presence of DC current (types for general use).

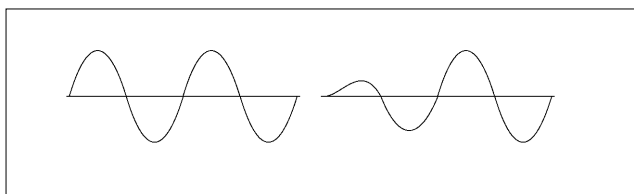
- Type AC
- Type A

The time-delay (in the presence of residual current)

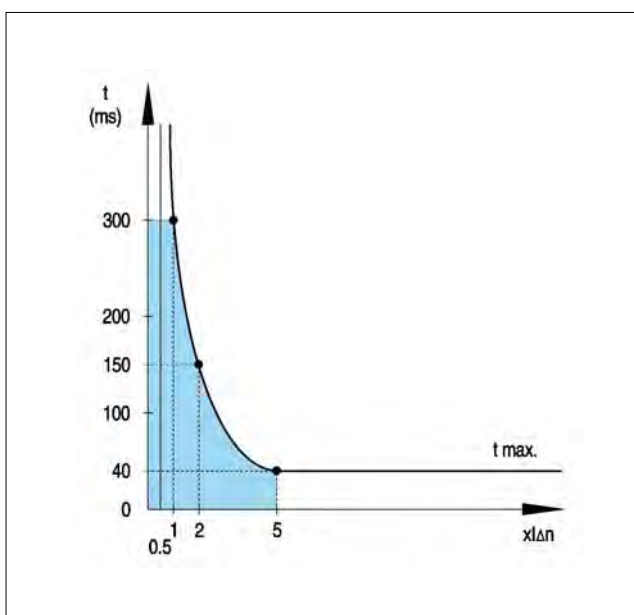
- RCDs without time delay: type for general use
- RCDs with time delay: type S for selectivity

Type AC ^{1) 2)}

The type AC RCDs are designed to release with sinusoidal residual currents which occur suddenly or slowly rise in magnitude.



Residual current	Tripping time
0.5 x IΔn	t = ∞
1 x IΔn	t = <300 ms
2 x IΔn	t = <150 ms
5 x IΔn	t = ≤40 ms



Tripping curve type AC

¹⁾ Standard in Australia
²⁾ Type A acceptable in Australia

Type A ^{3) 4)}

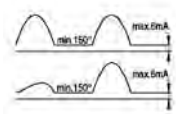
Certain devices during faults can be the source of non-sinusoidal earth leakage currents (DC components) due to the electronic components e.g. diodes, thyristors etc.

Type A RCDs are designed to ensure that under these conditions the residual current devices operate on sinusoidal residual current and also with pulsating direct current(*) which occur suddenly or slowly rise in magnitude.

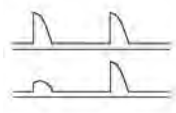
(*) Pulsating direct current: current of pulsating wave form which assumes, in each period of the rated power frequency, the value 0 or a value not exceeding 0.006 A DC during one single interval of time, expressed in angular measure of at least 150°.

Residual current	Tripping time
1. For sinusoidal residual current	
0.5 x IΔn	t = ∞
1 x IΔn	t = <300 ms
2 x IΔn	t = <150 ms
5 x IΔn	t = ≤40 ms

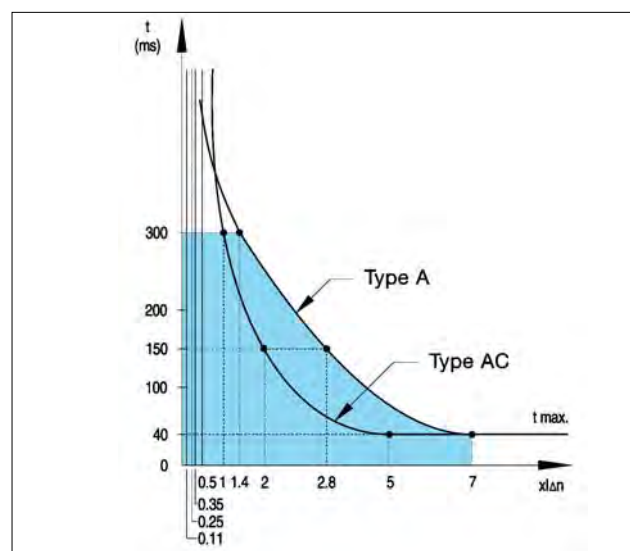
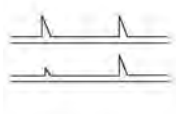
Residual current	Tripping time
2. For residual pulsating direct current	
At point of wave 0°	
0.35 x IΔn	t = ∞
1.4 x IΔn	t = <300 ms
2.8 x IΔn	t = <150 ms
7 x IΔn	t = ≤40 ms



Residual current	Tripping time
At point of wave 90°	
0.25 x IΔn	t = ∞
1.4 x IΔn	t = <300 ms
2.8 x IΔn	t = <150 ms
7 x IΔn	t = ≤40 ms



Residual current	Tripping time
At point of wave 135°	
0.11 x IΔn	t = ∞
1.4 x IΔn	t = <300 ms
2.8 x IΔn	t = <150 ms
7 x IΔn	t = ≤40 ms



Tripping curve type A
³⁾ Standard in New Zealand
⁴⁾ DSRCBH is type A.

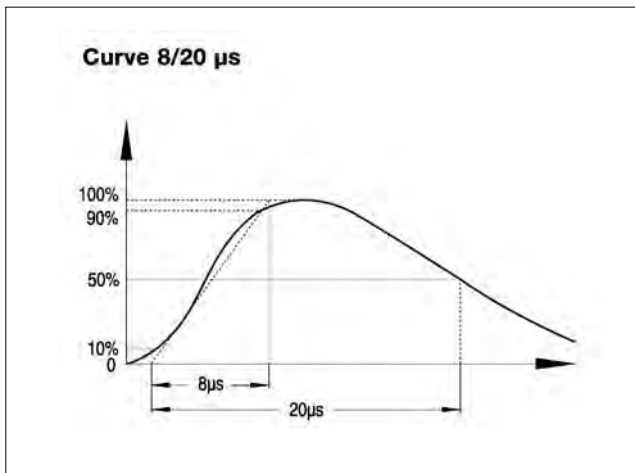
Din-T MCBs + RCDs Technical data

Nuisance tripping

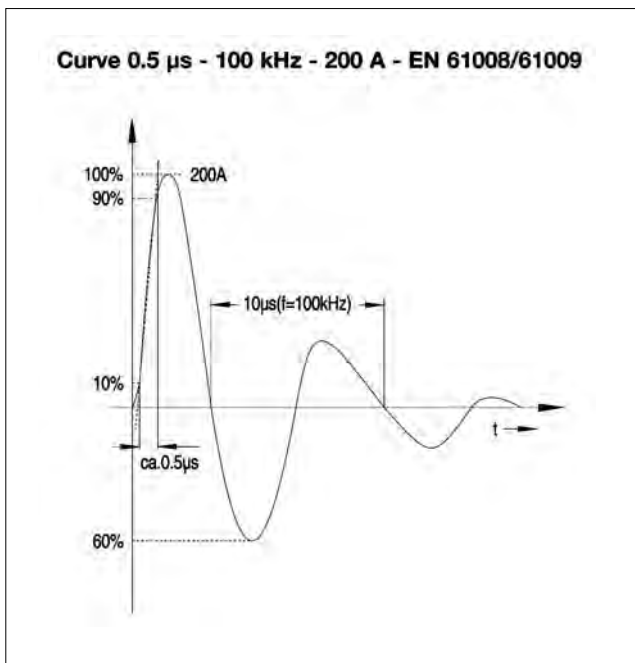
All DinSafe RCDs have a high level of immunity to transient currents, against current impulses of 8/20 μ s according to EN 61008/61009 and VDE 0664.T1.

Type A, AC.....250 A 8/20 μ s

Type S.....3000 A 8/20 μ s

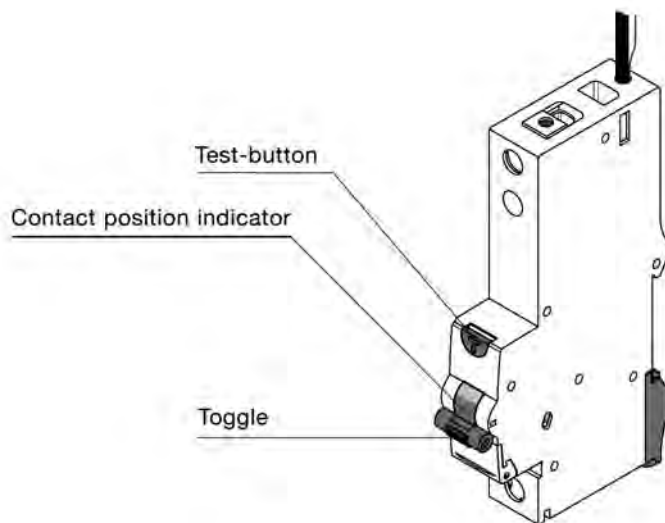


RCDs have a high level of immunity against alternating currents of high frequency according to EN 61008/61009.



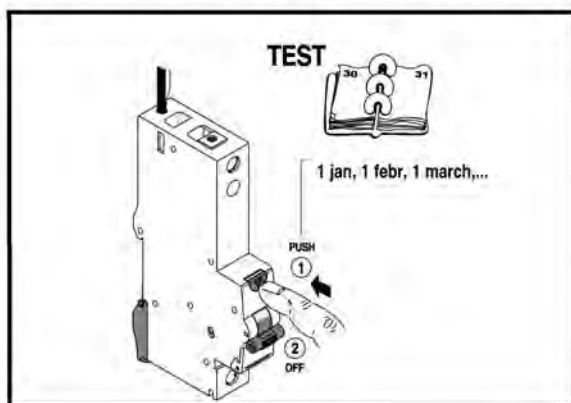
Din-T MCBs + RCDs Technical data

Use of an RCBO (DSRCBH)



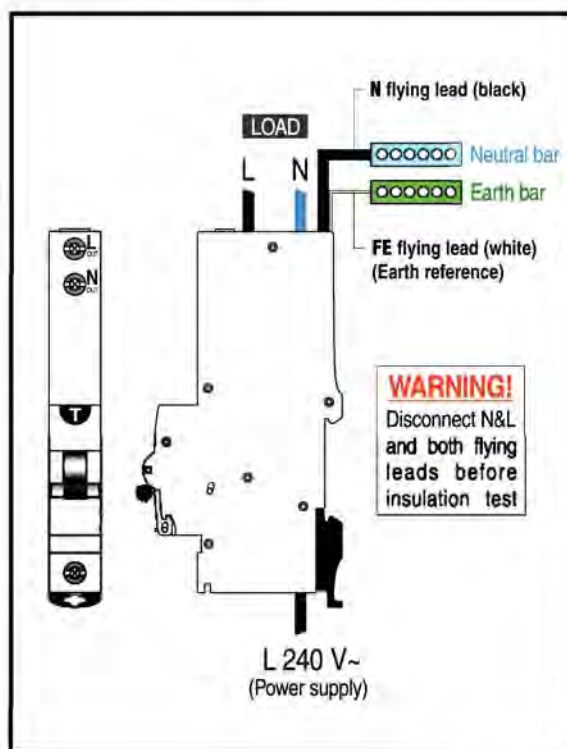
TEST-BUTTON

To ensure the correct functioning of the RCBO, the test-button T shall be pressed frequently. The device must trip when the test-button is pressed.



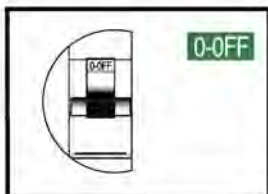
CABLE CONNECTION

The power supply (L) must be done at the bottom terminal, and the supply neutral flying cable (black) shall be connected to the neutral bar. Load connection shall be done in both terminals at the top side (L out / N out). The earth reference cable (FE white) ensures protection against earth leakage in case of loss of supply neutral.

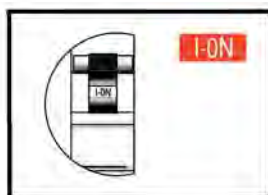


CONTACT POSITION INDICATOR

Printing on the toggle to provide information of the real contact position.



O-OFF
Contacts in open position. Ensure a distance between contacts > 4 mm.



I-ON
Contacts in closed position. Ensure continuity in the main circuit.

TOGGLE

To manually switch the RCBO ON or OFF

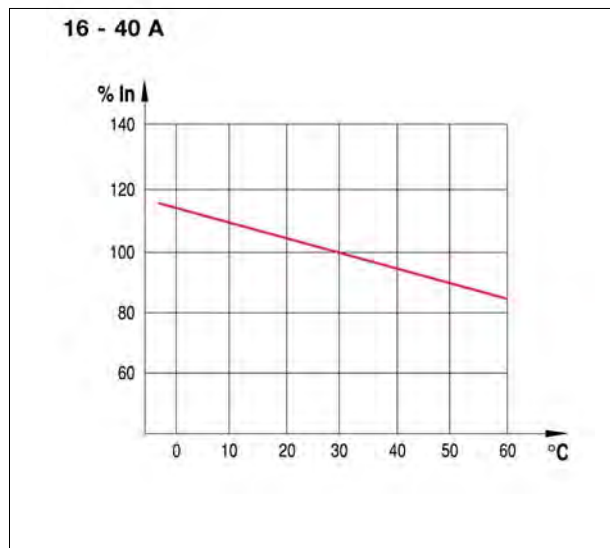
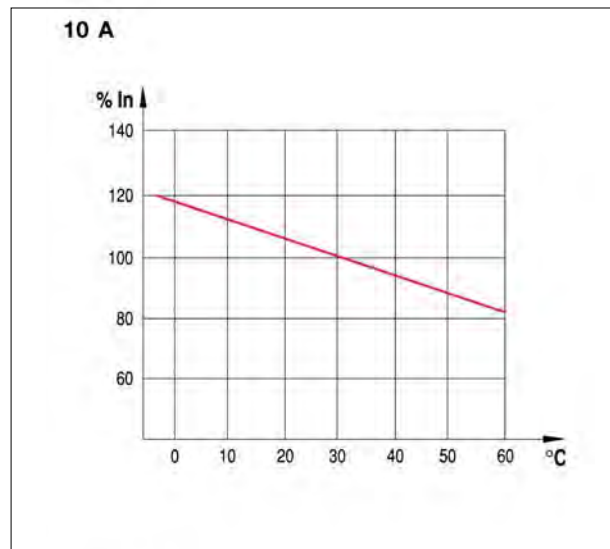
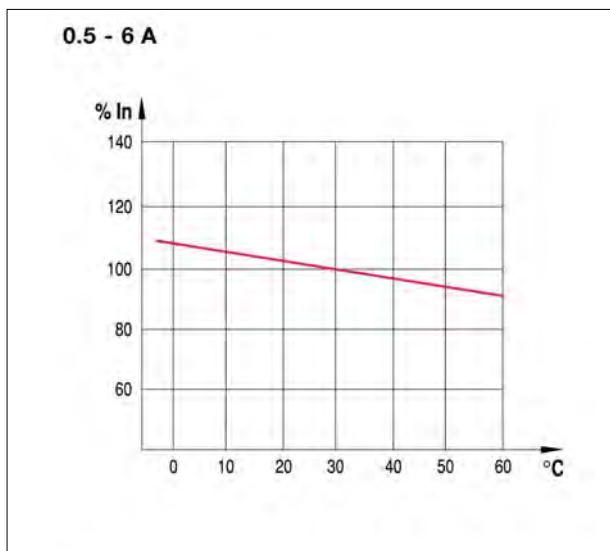
Din-T MCBs + RCDs Technical data

Product related information

Influence of temperature on RCBOs (DinSafe DSRCB)

The thermal calibration of the RCBO was carried out at an ambient temperature of 30 °C. Ambient temperatures different from 30 °C influence the bimetal and this results in earlier or later thermal tripping.

3



Din-T MCBs + RCDs Technical data

Tripping current as a function of the frequency

All RCDs are designed to work at frequencies of 50-60 Hz, therefore to work at different values, we must consider the variation of the tripping sensitivity according to the tables below. It should be taken into consideration that there is a no tripping risk when pushing the test-button, due to the fact that such action is made by means of an internal resistor with a fixed value.

RCBO DSRCBH ³⁾

Type AC ¹⁾	10 Hz	30 Hz	50 Hz	100 Hz	200 Hz	300 Hz	400 Hz
30 mA	0.62	0.65	0.80	0.91	1.24	1.55	1.88
100 mA	0.74	0.71	0.80	0.95	1.16	1.38	1.59
300 mA	0.80	0.74	0.80	0.97	1.19	1.44	1.64
500 mA	1.10	0.81	0.80	0.89	1.18	1.38	1.68
Type A ²⁾							
30 mA	8.17	3.13	0.75	1.70	3.10	3.52	3.67
100 mA	6.81	2.71	0.75	1.43	2.35	2.58	2.71
300 mA	6.20	2.16	0.75	0.49	0.87	0.74	0.95
500 mA	4.34	1.53	0.75	0.39	0.59	0.62	0.64

Notes: ¹⁾ The standard NHP/Terasaki type is the "type AC" in Australia, Type "A" in New Zealand.

²⁾ The standard NHP/Terasaki DSRCBH single pole RCBO is "type A" in Australia and New Zealand.

³⁾ The numbers in the table above are multipliers, e.g. A "DSRCD" at 50 hz has an 0.8 multiplier. Therefore a 30 mA, "type AC" RCD will trip at (0.8 x 30 mA) 24 mA.

Power losses

The power losses are calculated by means of measuring the voltage drop between the incoming and the outgoing terminal of the device at rated current. Power loss per pole:

RCBO-Single pole DSRCBH

In (A)	6	10	13	16	20	25	32	40	50	63
Z (mOhm)	45.8	16.4	12.5	10.6	7.3	5.4	3.2	2.6	1.9	1.4
Pw (W)	1.65	1.7	2.1	2.7	2.9	3.3	3.4	4.2	4.8	5.6

Din-T MCBs + RCDs Technical data

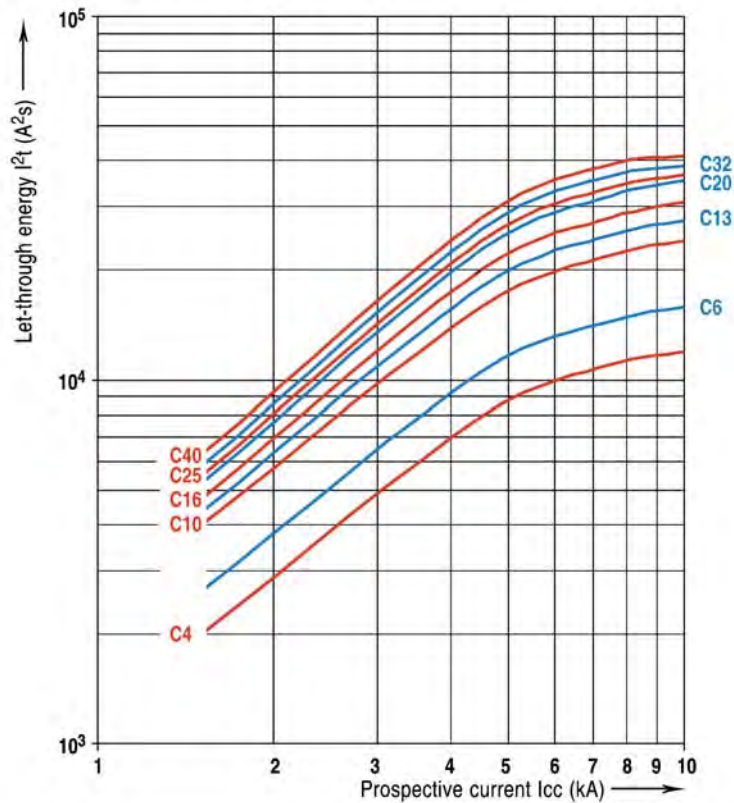
RCBO (DSRCB) let-through energy I^2t

The benefit of an RCBO in short-circuit conditions, is its ability to reduce the value of the let-through energy that the short-circuit would be generating.

Din-T single pole width RCD (DSRCBH)

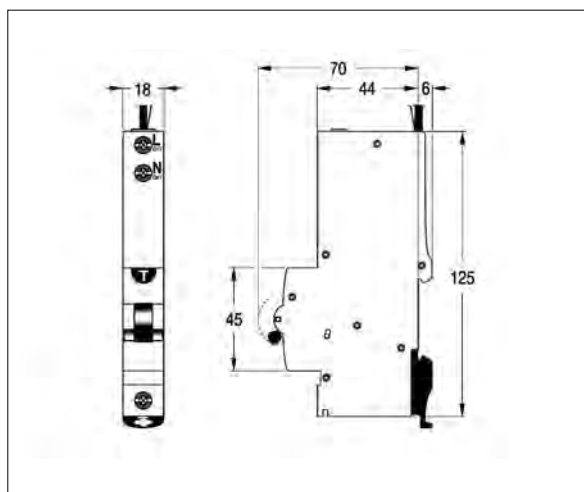
Curve C

Let-through energy at 230 V



RCCB - Din-Safe safety switch (DSRCD)

RCBO - Din-Safe (DSRCBH)



Dimensions in mm

Din-T MCBs + RCDs Technical data

Overview Din-Safe RCDs

RCBO



Device type definition

Rating/description	Cat. No.	DSRCBH
Standards		IEC 61009-1
Magnetic tripping characteristics		C
Residual tripping characteristic ¹⁾		A
Tripping time at IΔn	Instantaneous	ms
	Selective	ms
Rated current	A	6, 10, 16, 20, 25, 32, 40
Rated residual current IΔn	mA	10, 30
Calibration temperature	°C	30
Number of poles versus modules		1
Rated voltage Un	2 P AC	V
	3 P AC	V
	4 P AC	V
Frequency	Hz	50/60
Maximum service voltage U _{Bmax}	V	255
Minimum service voltage U _{Bmin}	V	100
Power supply		Bottom
Selectivity class		3
Rated making and breaking capacity (I _m)	A	10xI _n
Residual making and breaking capacity (IΔ _m)	A	10000
Conditional short-circuit capacity (I _{nc})	A	-
Conditional residual short-circuit capacity (IΔ _c)	A	-
Short-circuit capacity (I _{cn})	A	10000
Grid distance (safety distance between two devices)	mm	-
Isolator application		yes
Insulation degree	Insulation voltage	V (DC)
	Shock voltage (1.2/50 ms)	kV
	Insulation resistance	(mΩm)
	Dielectric strength	V
Shock resistance (in x, y, z direction)(IEC 60077/16.3)		40 g, 18 shocks 5 ms
Vibration resistance (in x, y, z direction; IEC 60068-2-6)		2 g, 30 min, 0...80 Hz
Endurance	electrical at Un, In	10000
	mechanical at Un, In	20000
Protection degree (outside/inside electrical enclosure)		IP 20 / IP 40
Self extinguish degree (according to UL 94)		V2
Tropicalisation (according to IEC 60068-2, DIN 40046)	°C/RH	+55/95 %
Pollution degree (acc. IEC 60947-1)		3
Operating temperature	°C	-5...+60
Storage temperature	°C	-25...+70
Terminals capacity	Rigid cable min/max (Top)	mm ²
	Flexible cable min*/max (Top)	mm ²
	Rigid cable min/max (bottom)	mm ²
	Flexible cable min*/max (bottom)	mm ²
	(*Flexible cable 0.75/1/1.5 mm ² with cable lug)	
Torque	Top/Bottom	Nm
Add-on devices (side add-on)	Auxiliary contacts	-
	UVT	-
	Shunt trip	-
	Motor operator	-
	Panelboard switch	Bottom
Busbars systems	Pin	Bottom
	Fork	yes
Accessories		
Dimensions, weights, packaging	# Poles	1+N
	(HxDxW) 86x68xW	mm
	Weight/unit	g
	Package/unit	1

Note: ¹⁾ Refer catalogue section for types.
²⁾ Making sure that N-L and both flying leads are disconnected.

Miniature circuit breakers

Din-T6 series 6 kA MCB

- Standards AS/NZS 4898
- Approval No. N17481
- Current range 2-63 Amps 1, 2 and 3 pole
- Sealable and lockable handle
- Available in curve type C and D
- Mounts on CD chassis (250 A and 355 A)

1 pole 1 module

In (A)	C – Curve 5-10 In
2	DTCB6102C
4	DTCB6104C
6	DTCB6106C
10	DTCB6110C
13	DTCB6113C
16	DTCB6116C
20	DTCB6120C
25	DTCB6125C
32	DTCB6132C
40	DTCB6140C
50	DTCB6150C
63	DTCB6163C

2 pole 2 modules

2	DTCB6202C
4	DTCB6204C
6	DTCB6206C
10	DTCB6210C
13	ⁱ DTCB6213C
16	DTCB6216C
20	DTCB6220C
25	DTCB6225C
32	DTCB6232C
40	DTCB6240C
50	DTCB6250C
63	DTCB6263C

3 pole 3 modules

2	DTCB6302C
4	DTCB6304C
6	DTCB6306C
10	DTCB6310C
13	ⁱ DTCB6313C
16	DTCB6316C
20	DTCB6320C
25	DTCB6325C
32	DTCB6332C
40	DTCB6340C
50	DTCB6350C
63	DTCB6363C

DTCB6
1 pole



Short circuit capacity 6 kA

In (A)	2 - 63
1 P	240 V AC
2 P	240 - 415 V AC
3 P	240 - 415 V AC

DC use	1 P	2 P ¹⁾
Short circuit	20 kA	25 kA
Max.voltage (DC)	48 V	110 V

Use at DC

When using Din-T6 in a DC application the magnetic tripping current is approximately 40 % higher than in AC 50/60 Hz.

Shock resistance (In X, Y, Z directions).

20 g with shock duration 10 ms (minimum 18 shocks).
40 g with shock duration 5 ms (minimum 18 shocks).

Vibration resistance (In X, Y, Z directions).

3 g in frequency range 10 to 55 Hz
(operating time at least 30 min).
According to IEC 60068-2-6.

Storage temperature

From -55 °C to +55 °C, according to IEC 88 part 2 - 1
(duration 96 hours).

Operating temperature

From -25 °C to +55 °C, according to
VDE 0664 parts 1 and 2.

Use at 400 Hz

At 400 Hz the magnetic trip current is approximately
50 % higher than in AC 50/60 Hz.

Notes: ¹⁾ 2 pole MCB connected in series.

The line side is the "OFF" (bottom) side of the MCB, and connects to CD chassis tee-offs.

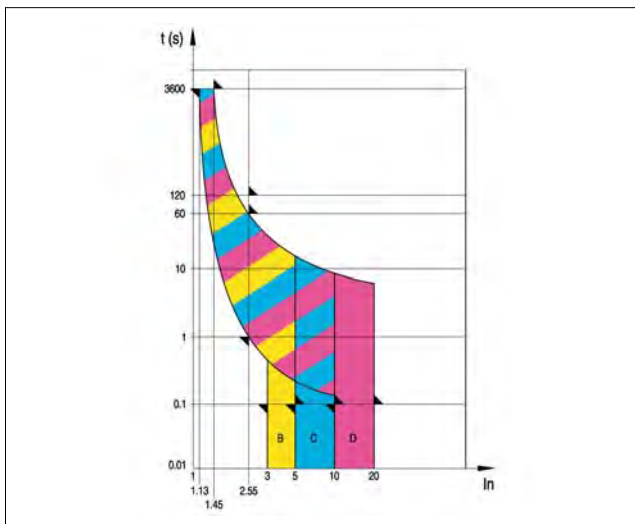
ⁱ Available on indent only.

Din-T MCBs Technical data

Characteristics according to BS EN 60898

Miniature Circuit Breakers are intended for the protection of wiring installations against both overloads and short-circuits in **domestic** or **commercial** wiring installations where operation is possible by **uninstructed** people

3 Tripping characteristic curves



Magnetic release

An electromagnet with plunger ensures instantaneous tripping in the event of short-circuit. The NHP Din-T range has 3 different types, following the current for instantaneous release: types B, C and D curve.

ICn (A)	Test current	Tripping time	Applications
B	3 x In 5 x In	0.1 < t < 45 s (In ≤ 32 A) 0.1 < t < 90 s (In > 32 A) t < 0.1 s	Only for resistive loads eg: • electrical heating • water heater • stoves.
C	5 x In 10 x In	0.1 < t < 15 s (In ≤ 32 A) 0.1 < t < 30 s (In > 32 A) t < 0.1 s	Usual loads such as: • lighting • socket outlets • small motors
D	10 x In 20 x In	0.1 < t < 4 s (**) (In ≤ 32 A) 0.1 < t < 8 s (In > 32 A) t < 0.1 s	Control and protection of circuits having important transient inrush currents (large motors)

Thermal release

The release is initiated by a bimetal strip in the event of overload. The standard defines the range of releases for specific overload values. Reference ambient temperature is 30 °C.

Test current	Tripping time
1.13 x In	t ≥ 1 h (In ≤ 63 A) t ≥ 2 h (In > 63 A)
1.45 x In	t < 1 h (In ≤ 63 A) t < 2 h (In > 63 A)
2.55 x In	1 s < t < 60 s (In ≤ 32 A) 1 s < t < 120 s (In > 32 A)

Rated short-circuit breaking capacity (Icn)

Is the value of the short-circuit that the MCB is capable of withstanding in the following test of sequence of operations: O-t-CO.

After the test the MCB is capable, without maintenance, to withstand a dielectric strength test at a test voltage of 900 V. Moreover, the MCB shall be capable of tripping when loaded with 2.8 In within the time corresponding to 2.55 In but greater than 0.1s.

Service short-circuit breaking capacity (Ics)

Is the value of the short-circuit that the MCB is capable of withstanding in the following test of sequence of operations: O-t-CO-t-CO.

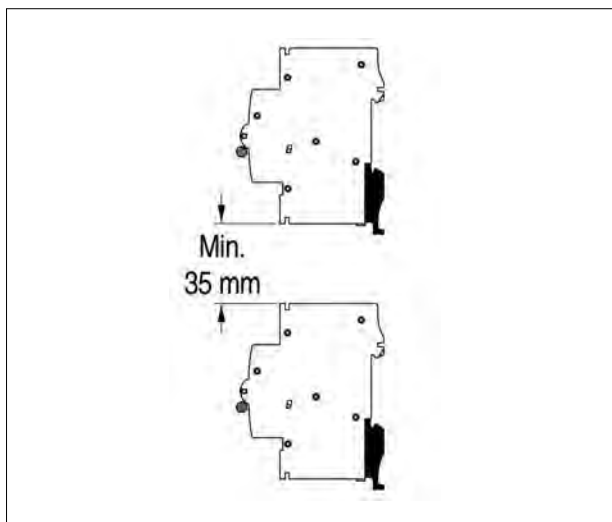
After the test the MCB is capable, without maintenance, to withstand a dielectric strength test at a test voltage of 1500 V. Moreover, the MCB shall not trip at a current of 0.96 In. The MCB shall trip within 1h when current is 1.6 In.

- O - Represents an opening operation
- C - Represents a closing operation followed by an automatic opening.
- t - Represents the time interval between two successive short-circuit operations: 3 minutes.

The relation between the rated short-circuit capacity (Icn) and the rated service short-circuit breaking capacity (Ics) shall be as follows:

ICn (A)	Ics (A)
≤ 6000	6000
> 6000 ≤ 10000	0.75 Icn min. 6000
> 10000	0.75 Icn min. 7500

In both sequences all MCBs are tested for emission of ionized gases during short-circuit (grid distance), in a safety distance between two MCBs of 35 mm when devices are installed in two different rows in the enclosure. This performance allows the use of any NHP/Terasaki enclosure.

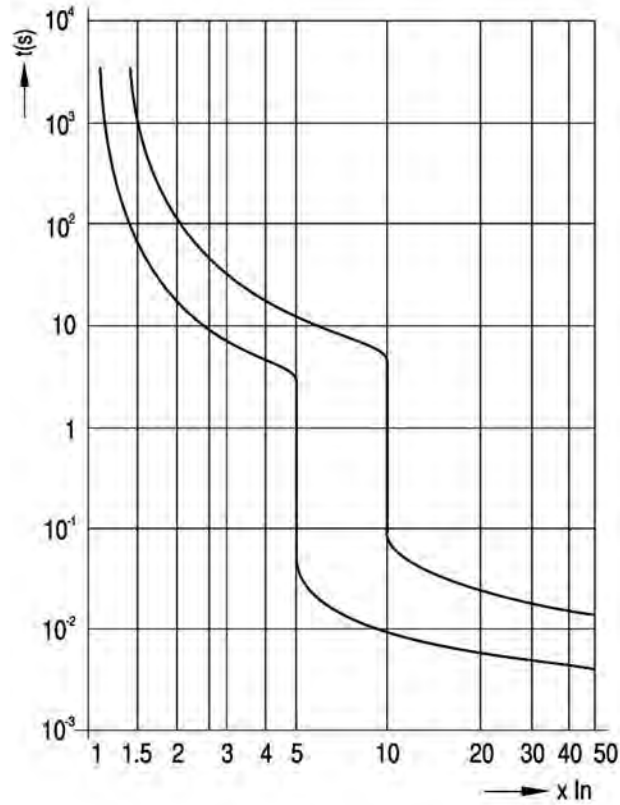


Din-T MCBs Technical data

Tripping curves according to EN 60898

The following tables show the average tripping curves of the Terasaki Din-T MCBs based on the thermal and magnetic characteristics.

Curve C



Din-T MCBs Technical data

Influence of ambient air temperature on the rated current

The maximum value of the current which can flow through an MCB depends on the nominal current of the MCB, the conductor cross-section and the ambient air temperature.

The values shown in the table below are for devices in free air. For devices installed with other modular devices in the same switchboard, a correction factor (K) shall be applied relative to the mounting situation of the MCB, the ambient temperature and the number of main circuits in the installation.

No of devices	K ¹⁾
2 or 3	0.9
4 or 5	0.8
6 or 9	0.7
> 10	0.6

Calculation example

Within a distribution board consisting of eight 2 Pole, 16 A, 'C' curve type MCBs, with an operating ambient temperature of 45 °C, which is the highest temperature the MCB can operate at without unwanted tripping?

Calculation

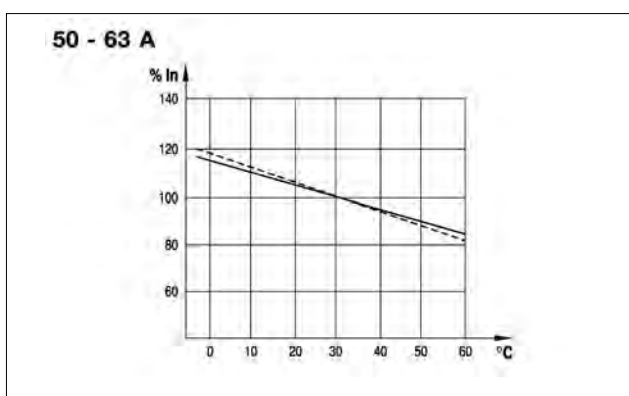
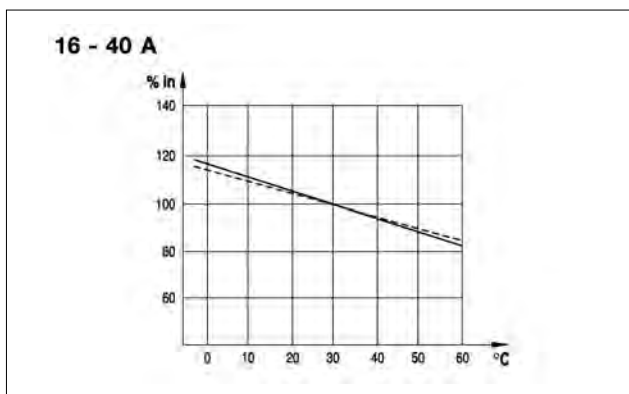
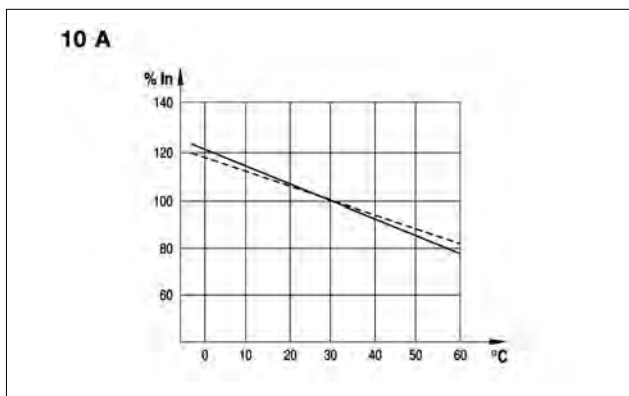
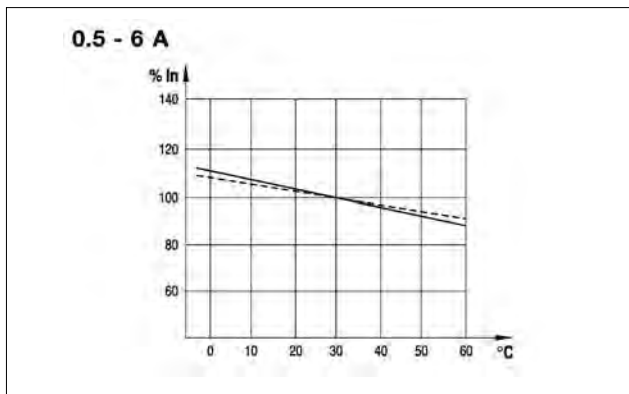
The correction factor $K = 0.7$, for use in an eight circuit installation: $16 \text{ A} \times 0.7 = 11.2 \text{ A}$

As the MCB is working at 45 °C it shall be given another factor (90 % = 0.9):

In at 45 °C = In at 30 °C \times 0.9 = 11.2 A \times 0.9 = 10.1 A.

Note: ¹⁾ Applicable for MCBs working at maximum rated currents.

The thermal calibration of the MCBs was carried out at an ambient temperature of 30 °C. Ambient temperatures different from 30 °C influence the bimetal and this results in earlier or later thermal tripping.



———— : 1P (single pole)

----- : mP (multi-pole)

Din-T MCBs Technical data

Effects of frequency on the tripping characteristic

All the MCBs are designed to work at frequencies of 50-60 Hz, therefore to work at different values, consideration must be given to the variation of the tripping characteristics. The thermal tripping does not change with variation of the frequency but the magnetic tripping values can be up to 50 % higher than the ones at 50-60 Hz.

Tripping current variation

60 Hz	100 Hz	200 Hz	300 Hz	400 Hz
1	1.1	1.2	1.4	1.5

Power losses

The power losses are calculated by measuring the voltage drop between the incoming and the outgoing terminals of the device at rated current.

Power loss per pole

In (A)	Voltage drop (V)	Energy loss (W)	Resistance (mOhm)
0.5	2.230	1.115	4458.00
1	1.270	1.272	1272.00
2	0.620	1.240	310.00
3	0.520	1.557	173.00
4	0.370	1.488	93.00
6	0.260	1.570	43.60
8	0.160	1.242	19.40
10	0.160	1.560	15.60
13	0.155	2.011	11.90
16	0.162	2.586	10.10
20	0.138	2.760	6.90
25	0.128	3.188	5.10
32	0.096	3.072	3.00
40	0.100	4.000	2.50
50	0.090	4.500	1.80
63	0.082	5.160	1.30
80	0.075	6.000	0.90
100	0.075	7.500	0.75
125	0.076	9.500	0.60

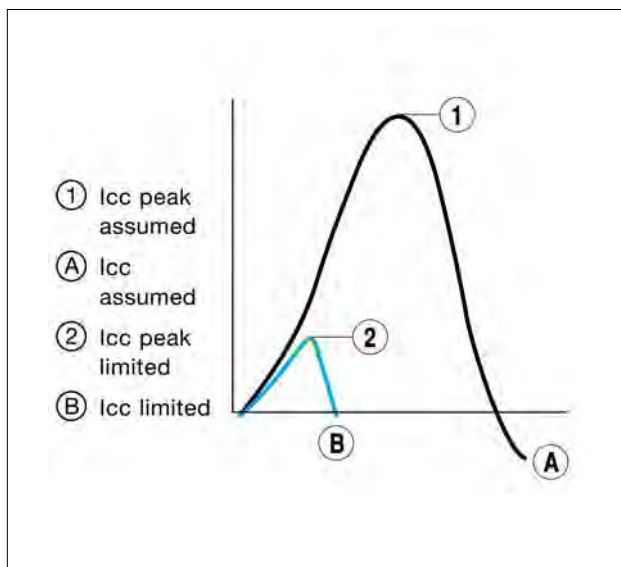
Limitation curves

Let-through energy I^2t

The limitation capacity of an MCB in short-circuit conditions, is its capacity to reduce the value of the let-through energy that the short-circuit would be generating.

Peak current I_p

Is the value of the maximum peak of the short-circuit current limited by the MCB.



See following pages

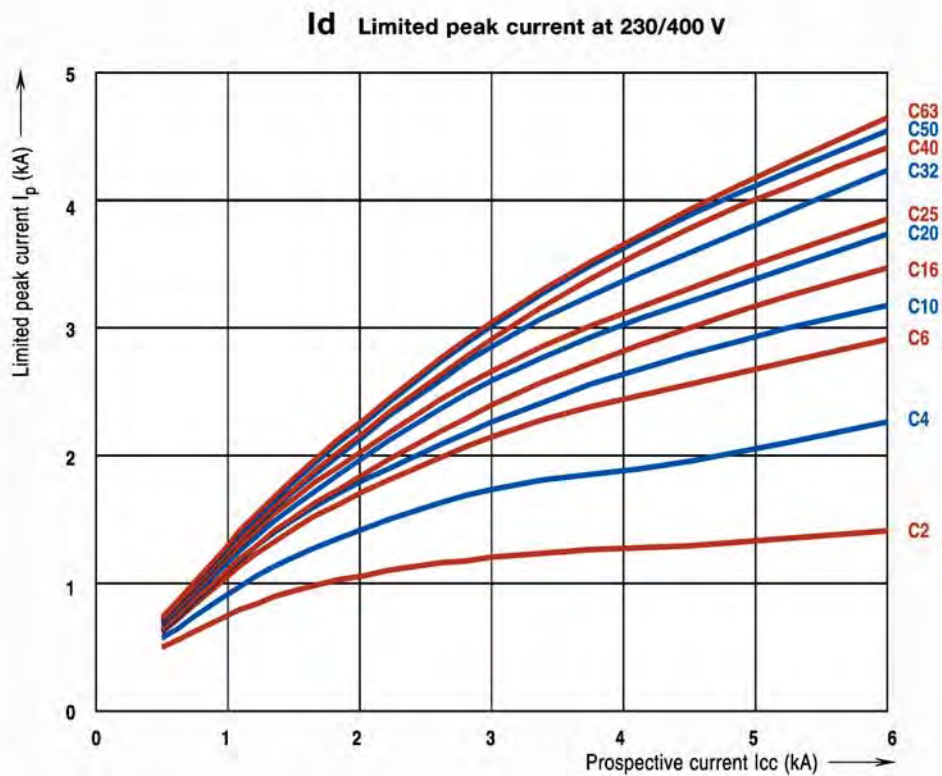
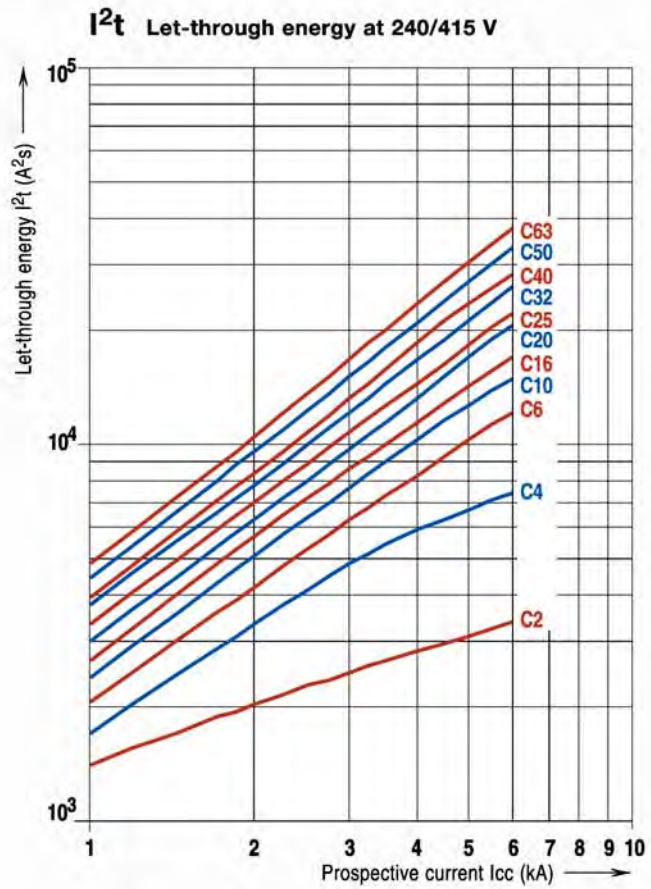
Din-T MCBs Technical data

Din-T 6

6 kA

C curve

3





Din-T MCBs Technical data

Use of standard MCB for DC use

For MCBs designed to be used in alternating current but used in installations in direct current, the following should be taken into consideration:

- For protection against overloads it is necessary to connect the two poles to the MCB. In these conditions the tripping characteristic of the MCB in direct current is similar to alternating current.

- For protection against short-circuits it is necessary to connect the two poles to the MCB. In these conditions the tripping characteristic of the MCB in direct current is 40% higher than the one in alternating current.

3

Use in DC selection table

Series	Rated current (A)	48 V 1 pole Icu (kA)	110 V 2 poles in series Icu (kA)	250 V 1 pole Icu (kA)	440 V 2 poles in series Icu (kA)
Din-T 6	0.5....63 A	20	25	-	-

Din-T MCBs Technical data

Text for specifiers

MCB Series Din-T 6

- According to EN 60898 standard
- For DIN rail mounting according to DIN EN 50022; EN 50022; future EN 60715; IEC 60715 (top hat rail 35 mm)
- Grid distance 35 mm
- Working ambient temperature from -25 °C up to +50 °C
- Approved by CEBEC, VDE, KEMA, IMQ.
- 1 pole is a module of 18 mm wide
- Nominal rated currents are:
0.5/1/2/3/4/6/10/13/16/20/25/32/40/50/63 A
- Tripping characteristics: B,C,D (B curve Din-T 10 only).
- Number of poles: 1 P, 1 P+N, 2 P, 3 P, 3 P+N, 4 P
- The short-circuit breaking capacity is: 6/10k A, energy limiting class 3
- Terminal capacity from 1 up to 35 mm² rigid wire or 1.5 up to 25 mm² flexible wire.
- Screw head suitable for flat or Pozidrive screwdriver
- Can be connected by means of both pin or fork busbars
- The toggle can be sealed in the ON or OFF position
- Rapid closing
- Both incoming and outgoing terminals have a protection degree of IP 20 and they are sealable
- Isolator function thanks to Red/Green printing on the toggle.
- Maximum voltage between two phases; 440 V~
- Maximum voltage for utilisation in DC current: 48 V 1 P and 110 V 2 P
- Two position rail clip
- Mechanical shock resistance 40 g (direction x, y, z) minimum 18 shocks 5 ms half-sinusoidal acc. to IEC 60068-2-27
- Vibration resistance: 3 g (direction x, y, z) minimum 30 min. according to IEC 60068-2-6
- Extensions can be added on both left or right hand side
 - ☛ Auxiliary contact
 - ☛ Shunt trip
 - ☛ Undervoltage release
 - ☛ Motor operator
 - ☛ Panelboard switch
- Add-on RCD can be coupled.

Din-T MCBs Technical data

Series				Din-T6 AS/NZS 4898		
Standards (Aust / NZ / International)				IEC 60898		
Tripping characteristics				C, D		
Nominal current				A	C/D(0.5-63)	
Calibration temperature				°C	30	
Number of poles (# mod)				1/2/3/4		
Neutral pole protected				yes		
Nominal voltage Un	AC	1 P	V	240/415		
		3 P/4 P	V	415		
	DC	1 P ¹⁾	V DC	48		
		2 P (in series) ¹⁾	V DC	110		
Frequency				Hz	50/60	
				Hz	DC: magn.trip +40%	
				Hz	400: magn.trip +50%	
Maximum service voltage U _{bmax} between two wires				V	250/440; 53/120	
Minimum service voltage U _{bmin}				V	12; 12	
Selectivity class (IEC 60898)				3		
Isolator application IEC 60947-2				yes		
Rated insulation voltage	Pollution degree 2		V	500		
	Pollution degree 3		V	440		
Impulse withstand test voltage				kV	6	
Insulation resistance				mOhm	10,000	
Dielectric rigidity				kV	2.5	
Vibration resistance (in x, y, z direction) (IEC 77/16.3)				3 g		
Endurance	Electrical at Un, In		10,000			
	mechanical		20,000			
Utilisation category (IEC 60947-2)				A		
Protection degree (outside / inside, in enclosure with door)				IP 20/IP 40		
Self-extinguish degree (according to UL94)				V2		
Tropicalisation (according to IEC 60068-2 / DIN 40046) °C/RH				+55 °C/95 % RH		
Operating temperature				°C	-25/+55	
Storage temperature				°C	-55/+55	
Terminal capacity	Rigid cable min/max (top)		mm ²	1/35		
	Flexible cable min*/max (top)		mm ²	0.75/25		
	Rigid cable min/max (bottom)		mm ²	1/35		
	Flexible cable min*/max (bottom)		mm ²	0.75/25		
	(* Flexible cable 0.75/1/1.5 mm ² with cable lug)					
	Torque		Nm	4.5		
Add-on devices (side add-on)	Auxiliary contacts		yes			
	UVT		yes			
	Shunt trip		yes			
	Motor operator		yes			
	Panelboard switch		yes			
Busbar systems	Pin (top/bottom)		yes/yes			
	Fork (top/bottom)		-/yes			
Accessories				yes		
Dimensions, weights, packaging						
(HxDxW) 86x68xW			mm/mod.	18		
Weight/mod.			g	120		
Package			mod.	12		
Short-circuit capacity AC (kA)				AS/NZS 4898		
IEC 60898	I _{cn}	1 P	230/400 V	6		
		2 P	230/400 V	6		
		3 P/4 P	230/400 V	6		
I _{cs} (service)		100 % I _{cn}				
IEC 60947-2	I _{cu} (ultimate)	1 P	127 V	20		
			240 V	10		
			415 V	3		
	2 P	127 V	-			
		240 V	15			
		415 V	10			
	3 P, 4 P	240 V	15			
		415 V	10			
		440 V	6			
I _{cs} (service)		75 % I _{cu}				
NEMA AB1 (120/240V)		20				
Short-circuit capacity DC (kA)						
IEC 60947-2	I _{cu} (ultimate)	1 P	≤60 V	20		
			≤220 V	-		
	2 P	≤125 V	25			
		≤440 V	-			
I _{cs} (service)		100 % I _{cu}				

Notes Refer pages 3 - 23, 24 for information on SAFE-T MCBs.

¹⁾ Preferred values of rated control supply voltage (IEC 60947 - 2): 24 V, 48 V, 110 V, 125 V, 250 V

²⁾ 0.5-4 A/6-25 A/32-40 A/50-63 A

³⁾ 10 (125 V DC)

⁴⁾ 10 (250 V DC)

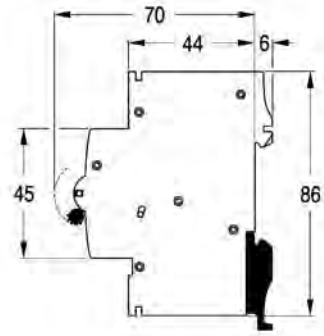
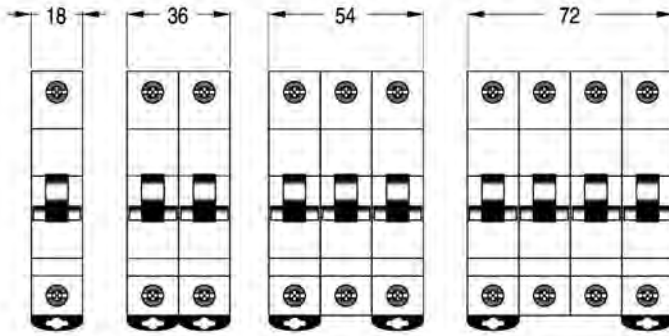
⁵⁾ On request.

Din-T MCBs Technical data

Miniature circuit breakers - Din-T 6

Dimensions in mm.

3



Miniature circuit breakers

Din-T15 series 15 kA, 20 kA, 25 kA MCBs

- Standards AS/NZS 3947-2
- Current range 6-63 Amp 1, 2, 3 and 4 pole
- Sealable and lockable handle
- Modular design
- Mounts on CD chassis (250 A and 355 A)
- Industrial applications



DTCB15
1 pole

1 pole 1 module ³⁾

In (A)	Icu (kA)	C - Curve 5 - 10 In
6	25	DTCB15106C
10	25	DTCB15110C
13	25	<i>i</i> DTCB15113C
16	25	DTCB15116C
20	25	DTCB15120C
25	25	DTCB15125C
32	20	DTCB15132C
40	20	DTCB15140C
50	15	DTCB15150C
63	15	DTCB15163C

2 pole 2 modules ³⁾

In (A)	Icu (kA)	C - Curve 5 - 10 In
6	25	<i>i</i> DTCB15206C
10	25	<i>i</i> DTCB15210C
13	25	<i>i</i> DTCB15213C
16	25	<i>i</i> DTCB15216C
20	25	<i>i</i> DTCB15220C
25	25	<i>i</i> DTCB15225C
32	20	<i>i</i> DTCB15232C
40	20	<i>i</i> DTCB15240C
50	15	<i>i</i> DTCB15250C
63	15	<i>i</i> DTCB15263C

In (A)	6 - 63
1 P	240 V AC
2 P	240/415 V AC
3 P	240/415 V AC
4 P	240/415 V AC

Shock resistance (in x, y, z direction)

20 g with shock duration of 10 ms
(minimum 18 shocks)
40 g with shock duration of 5 ms
(minimum 18 shocks)

Vibration resistance (in x, y, z direction)

3 g in frequency range 10 to 55 Hz
(operating time at least 30 mins)
according to IEC 60068-2-6

3 pole 3 modules ³⁾

6	25	DTCB15306C
10	25	DTCB15310C
13	25	<i>i</i> DTCB15313C
16	25	DTCB15316C
20	25	DTCB15320C
25	25	DTCB15325C
32	20	DTCB15332C
40	20	DTCB15340C
50	15	DTCB15350C
63	15	DTCB15363C

4 pole 4 modules ^{2) 3)}

6	25	<i>i</i> DTCB15406C
10	25	<i>i</i> DTCB15410C
13	25	<i>i</i> DTCB15413C
16	25	<i>i</i> DTCB15416C
20	25	<i>i</i> DTCB15420C
25	25	<i>i</i> DTCB15425C
32	20	<i>i</i> DTCB15432C
40	20	<i>i</i> DTCB15440C
50	15	<i>i</i> DTCB15450C
63	15	<i>i</i> DTCB15463C

Storage temperature

from -55 °C to +55 °C according to
VDE 0664 parts 1 and 2

Operating temperature

from -25 °C to +55 °C according to
VDE 0664 Parts 1 and 2.

Use at 400 Hz

At 400 Hz the magnetic tripping current
is approximately 50 % higher than at AC
50/60 Hz



DTCB15
2 pole



DTCB15
3 pole

Notes: ¹⁾ 2 P MCB connected in series.
The LINE-side is the OFF or bottom of the MCB and connects to CD chassis tee-offs.

²⁾ All poles include overcurrent and short circuit protection.

³⁾ Refer Section 3 for kA ratings at 240/415 V. The above ratings are at 415 V AC.

i Available on indent only.

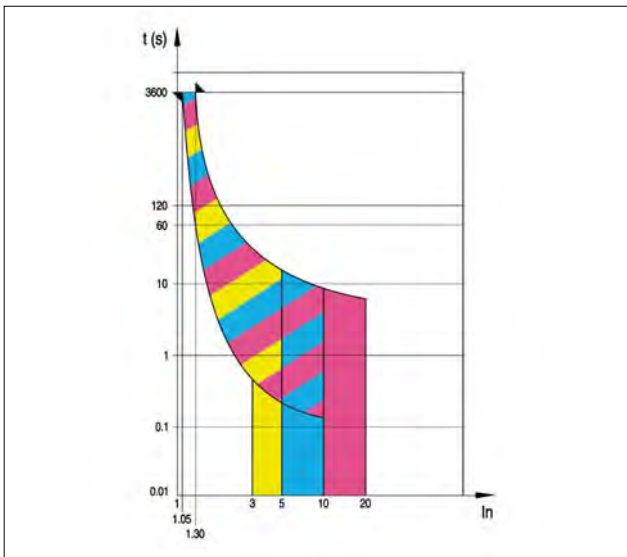
Din-T MCBs Technical data

Characteristics according to EN 60947-2

3

Miniature Circuit Breakers are intended for the protection of the lines against both overloads and short-circuits in **industrial** wiring installations where normal operation is done by **instructed** people

Tripping characteristic curves



Magnetic release

An electromagnet with plunger ensures instantaneous tripping in the event of short-circuit. The standard leaves the calibration of magnetic release to the manufacturers discretion.

NHP offers instantaneous tripping ranges:

- release between 5 and 10 In
- release between 10 and 20 In

Thermal release

The release is initiated by a bimetal strip in the event of overload. The standard defines the range of release for two special overload values. Reference ambient temperature is 40 °C.

Test current	Tripping time
1.05 x In	t ≥ 1 h (In ≤ 63 A) t ≥ 2 h (In > 63 A)
1.30 x In	t < 1 h (In ≤ 63 A) t < 2 h (In > 63 A)

Rated ultimate short-circuit breaking capacity (Icu)

Is the value of the short-circuit that the MCB is capable of withstanding in the following test of sequence of operations: O-t-CO.

After the test the MCB is capable, without maintenance, to withstand a dielectric strength test at a test voltage of 1000 V. Moreover the MCB shall be capable of tripping when loaded with 2.5 In within the time corresponding to 2 In but greater than 0.1 s.

Rated service short-circuit breaking capacity (Ics)

Is the value of the short-circuit that the MCB is capable of withstanding in the following test of sequence of operations: O-t-CO-t-CO.

After the test the MCB is capable, without maintenance, to withstand a dielectric strength test at a test voltage of twice its rated insulation voltage with a minimum of 1000 V.

A verification of the overload releases on In and moreover the MCB shall trip within 1 h when current is 1.45 In (for In<63 A) and 2 h (for In>63 A).

- O - Represents an opening operation
- C - Represents a closing operation followed by an automatic opening.
- t - Represents the time interval between two successive short-circuit operations: 3 minutes.

Category A: Without a short-time withstand current rating.

Utilization category

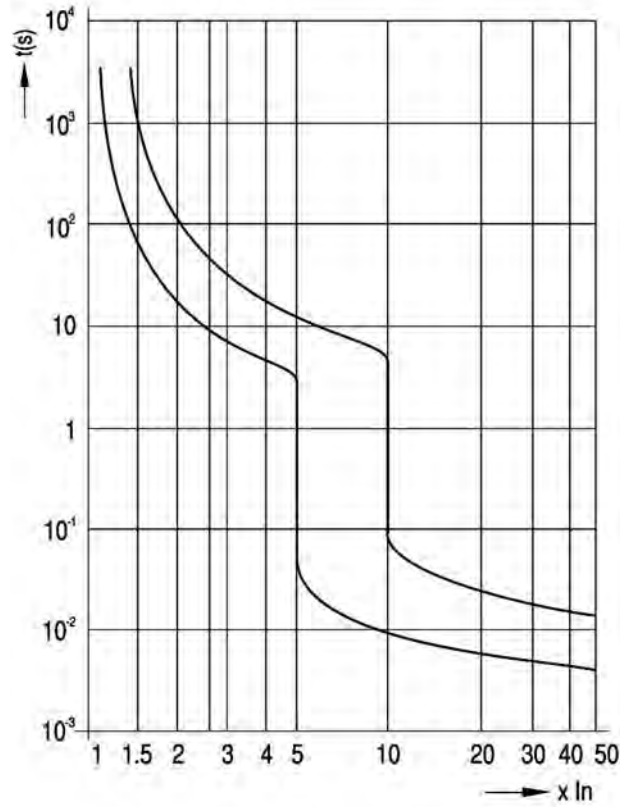
category	Application with respect to selectivity
A	Circuit breakers not specifically intended for selectivity under short-circuit conditions with respect to other short-circuit protective devices in series on the load side, i.e. without an intentional short-time delay provided for selectivity under short-circuit conditions, and therefore without a short-time withstand current rating according to 4.3.5.4
B	Circuit breakers specifically intended for selectivity under short-circuit conditions with respect to other short-circuit protective devices in series on the load side, i.e. without an intentional short-time delay (which may be adjustable), provided for selectivity under short-circuit conditions. Such circuit-breakers have a short-time withstand current rating according to 4.3.5.4

Din-T MCBs Technical data

Tripping curves according to EN 60898

The following tables show the average tripping curves of the Terasaki Din-T MCBs based on the thermal and magnetic characteristics.

Curve C



3

Din-T MCBs Technical data

Definitions related to circuit breakers

MCB = Miniature Circuit Breaker

Short-circuit (making and breaking) capacity

Alternating component of the prospective current, expressed by its RMS value, which the circuit breaker is designed to make, to carry for its opening time and to break under specified conditions.

Ultimate or rated short-circuit breaking capacity (I_{cn} - EN 60898)

A breaking capacity for which the prescribed conditions, according to a specified test sequence, do not include the capability of the MCB to carry 0.96 times its rated current for the conventional time.

Ultimate short-circuit breaking capacity (I_{cu} - EN 60947-2)

A breaking capacity for which the prescribed conditions, according to a specified test sequence, do not include the capability of the MCB to carry its rated current for the conventional time.

Service short-circuit breaking capacity (I_{cs} - EN 60898)

A breaking capacity for which the prescribed conditions, according to a specified test sequence, include the capability of the MCB to carry 0.96 times its rated current for the conventional time.

Prospective current

The current that would flow in the circuit, if each main current path of the MCB were replaced by a conductor of negligible impedance.

Conventional non-tripping current (I_{nt})

A specified value of current which the circuit breaker is capable of carrying for a specified time without tripping.

Open position

The position in which the predetermined clearance between open contacts in the main circuit of the MCB is secured.

Closed position

The position in which the predetermined continuity of the main circuit of the MCB is secured.

Maximum prospective peak current (I_p)

The prospective peak current when the initiation of the current takes place at the instant which leads to the highest possible value.

Din-T MCBs Technical data

Influence of ambient air temperature on the rated current

The maximum value of the current which can flow through an MCB depends on the nominal current of the MCB, the conductor cross-section and the ambient air temperature.

The values shown in the table below are for devices in free air. For devices installed with other modular devices in the same switchboard, a correction factor (K) shall be applied relative to the mounting situation of the MCB, the ambient temperature and the number of main circuits in the installation.

No of devices	K ¹⁾
2 or 3	0.9
4 or 5	0.8
6 or 9	0.7
> 10	0.6

Calculation example

Within a distribution board consisting of eight 2 Pole, 16 A, 'C' curve type MCBs, with an operating ambient temperature of 45 °C, which is the highest temperature the MCB can operate at without unwanted tripping?

Calculation

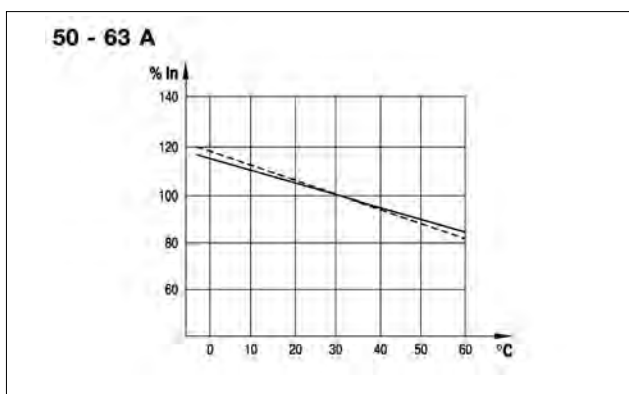
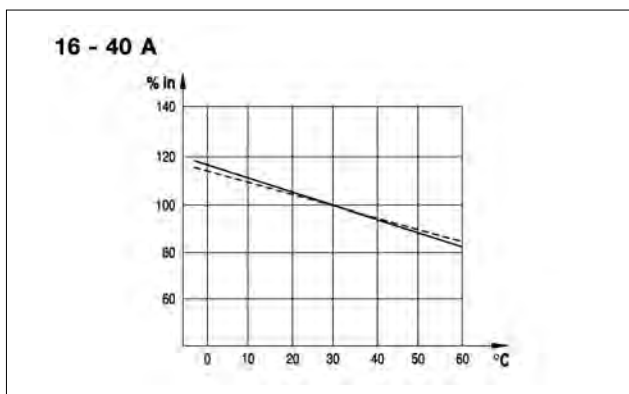
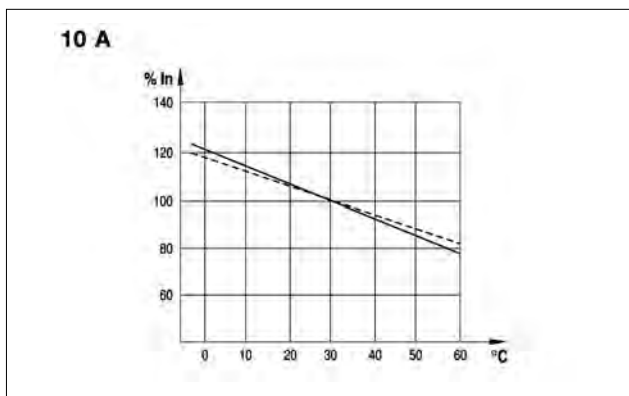
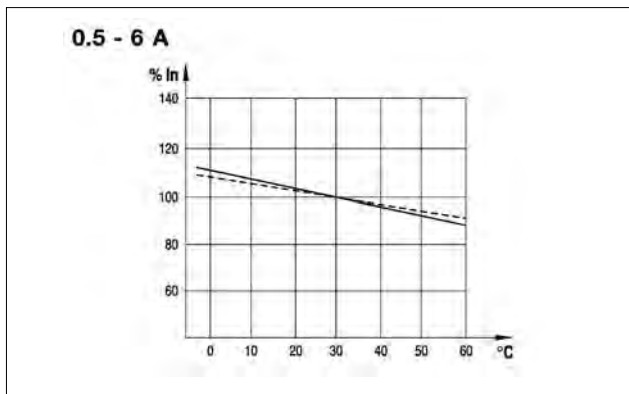
The correction factor $K = 0.7$, for use in an eight circuit installation: $16 \text{ A} \times 0.7 = 11.2 \text{ A}$

As the MCB is working at 45 °C it shall be given another factor (90 % = 0.9):

In at 45 °C = In at 30 °C \times 0.9 = 11.2 A \times 0.9 = 10.1 A.

Note: ¹⁾ Applicable for MCBs working at maximum rated currents.

The thermal calibration of the MCBs was carried out at an ambient temperature of 30 °C. Ambient temperatures different from 30 °C influence the bimetal and this results in earlier or later thermal tripping.



———— : 1P (single pole)

----- : mP (multi-pole)

Din-T MCBs Technical data

Effects of frequency on the tripping characteristic

All the MCBs are designed to work at frequencies of 50-60 Hz, therefore to work at different values, consideration must be given to the variation of the tripping characteristics. The thermal tripping does not change with variation of the frequency but the magnetic tripping values can be up to 50 % higher than the ones at 50-60 Hz.

Tripping current variation

60 Hz	100 Hz	200 Hz	300 Hz	400 Hz
1	1.1	1.2	1.4	1.5

Power losses

The power losses are calculated by measuring the voltage drop between the incoming and the outgoing terminals of the device at rated current.

Power loss per pole

In (A)	Voltage drop (V)	Energy loss (W)	Resistance (mOhm)
0.5	2.230	1.115	4458.00
1	1.270	1.272	1272.00
2	0.620	1.240	310.00
3	0.520	1.557	173.00
4	0.370	1.488	93.00
6	0.260	1.570	43.60
8	0.160	1.242	19.40
10	0.160	1.560	15.60
13	0.155	2.011	11.90
16	0.162	2.586	10.10
20	0.138	2.760	6.90
25	0.128	3.188	5.10
32	0.096	3.072	3.00
40	0.100	4.000	2.50
50	0.090	4.500	1.80
63	0.082	5.160	1.30

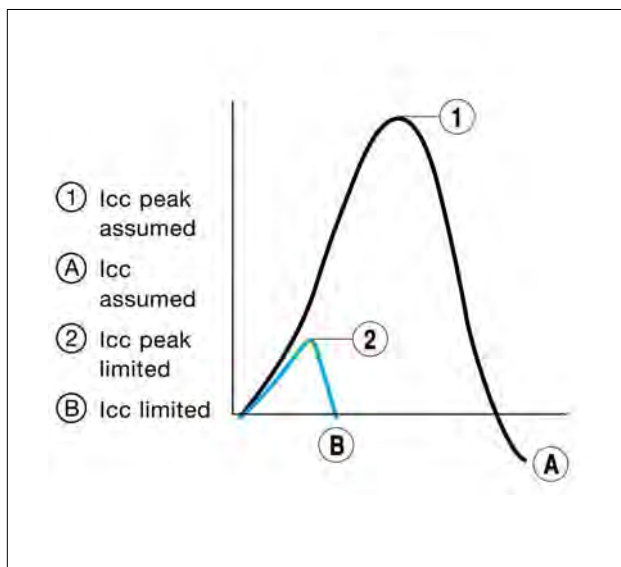
Limitation curves

Let-through energy I^2t

The limitation capacity of an MCB in short-circuit conditions, is its capacity to reduce the value of the let-through energy that the short-circuit would be generating.

Peak current I_p

Is the value of the maximum peak of the short-circuit current limited by the MCB.



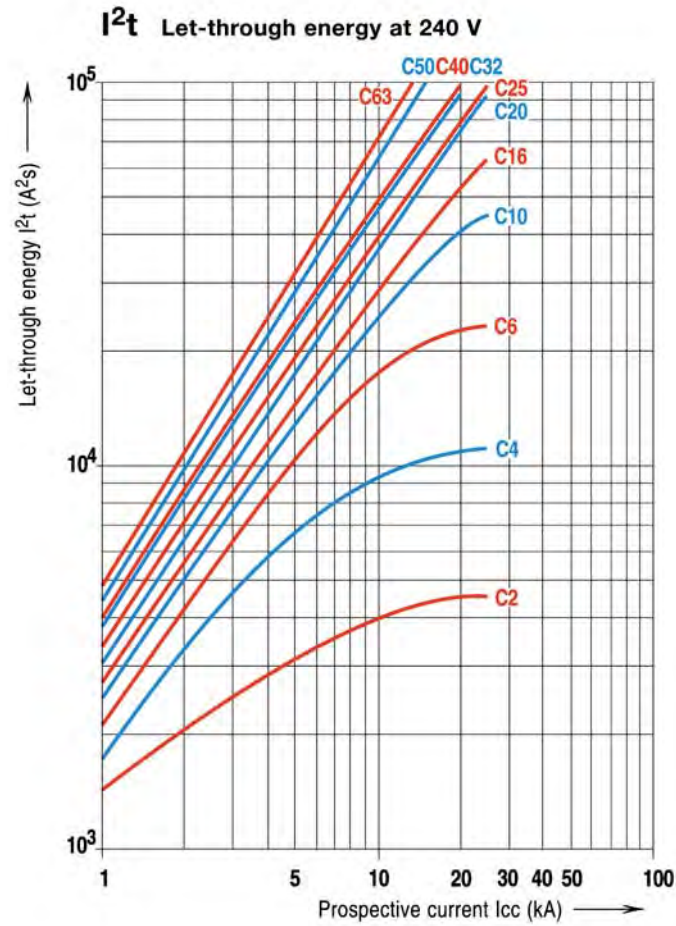
See following pages

Din-T MCBs Technical data

Din-T 15

15 kA

C curve



Din-T MCBs Technical data

Use of standard MCB for DC use

For MCBs designed to be used in alternating current but used in installations in direct current, the following should be taken into consideration:

- For protection against overloads it is necessary to connect the two poles to the MCB. In these conditions the tripping characteristic of the MCB in direct current is similar to alternating current.

- For protection against short-circuits it is necessary to connect the two poles to the MCB. In these conditions the tripping characteristic of the MCB in direct current is 40% higher than the one in alternating current.

3

Use in DC selection table

Series	Rated current (A)	48 V 1 pole Icu (kA)	110 V 2 poles in series Icu (kA)	250 V 1 pole Icu (kA)	440 V 2 poles in series Icu (kA)
Din-T 15	6...25 A	10	10	-	-

Installation of Din-T DC MCBs in direct current

Din-T MCBs + RCDs Technical data

Text for specifiers

MCB Series Din-T 15

- According to EN 60947.2 standard
- For DIN rail mounting according to DIN EN 50022; EN 50022; future EN 60715; IEC 60715 (top hat rail 35 mm)
- Working ambient temperature from -25 °C up to +50 °C
- 1 pole is a module of 18 mm wide
- Nominal rated currents are:
6/10/13/16/20/25/32/40/50/63 A
- Tripping characteristic: C
- Number of poles: 1 P, 2 P, 3 P, 4 P
- Short-circuit capacity is: 15 kA
- Terminal capacity from 1 up to 35 mm² rigid wire or 1.5 up to 25 mm² flexible wire
- Screw head suitable for flat or Pozidrive screwdriver
- Can be connected by means of both pin or fork busbars
- The toggle can be sealed in the ON or OFF position
- Rapid closing
- Both incoming and outgoing terminals have a protection degree of IP 20 and they are sealable
- Isolator function thanks to Red/Green printing on the toggle.
- Maximum voltage between two phases; 440 V~
- Maximum voltage for utilisation in DC current: 48 V 1 P and 110 V 2 P
- Two position rail clip
- Mechanical shock resistance 40 g (direction x, y, z) minimum 18 shocks 5 ms half-sinusoidal acc. to IEC 60068-2-27
- Vibration resistance: 3 g (direction x, y, z) minimum 30 min. according to IEC 60068-2-6
- Extensions can be added on both left or right hand side
 - ☛ Auxiliary contact
 - ☛ Shunt trip
 - ☛ Undervoltage release
 - ☛ Motor operator
 - ☛ Panelboard switch
- Add-on RCD can be coupled.

Din-T MCBs Technical data

Series		Din-T15		
		AS/NZS 3947-2		
Standards (Aust / NZ / International)		IEC 60947-2		
Tripping characteristics		C		
Nominal current	A	0.5-63		
Calibration temperature	°C	40		
Number of poles (# mod)		1/2/3/4		
Neutral pole protected		-		
Nominal voltage Un	AC 1 P	V	240/415	
	3 P/4 P	V	415	
	DC 1 P ¹⁾	V DC	48	
	2 P (in series) ¹⁾	V DC	110	
Frequency		Hz	50/60	
		Hz	DC: magn.trip +40%	
		Hz	400: magn.trip +50%	
Maximum service voltage U _{max} between two wires	V	250/440; 53/120		
Minimum service voltage U _{min}	V	12; 12		
Selectivity class (IEC 60898)		3		
Isolator application	IEC 60947-2	yes		
Rated insulation voltage	Pollution degree 2	V	500	
	Pollution degree 3	V	440	
Impulse withstand test voltage	kV	6		
Insulation resistance	mΩ	10,000		
Dielectric rigidity	kV	2.5		
Vibration resistance (in x, y, z direction) (IEC 77/16.3)		3 g		
Endurance	Electrical at Un, In	4000		
	mechanical	20,000		
Utilisation category (IEC 60947-2)		A		
Protection degree (outside / inside, in enclosure with door)		IP 20/IP 40		
Self-extinguish degree (according to UL94)		V2		
Tropicalisation (according to IEC 60068-2 / DIN 40046)	°C/RH	+55 °C/95 % RH		
Operating temperature	°C	-25/+55		
Storage temperature	°C	-55/+55		
Terminal capacity Rigid cable min/max (top)		mm ²	1/35	
	Flexible cable min*/max (top)	mm ²	0.75/25	
	Rigid cable min/max (bottom)	mm ²	1/35	
	Flexible cable min*/max (bottom)	mm ²	0.75/25	
	(* Flexible cable 0.75/1.5 mm ² with cable lug)			
	Torque	Nm	4.5	
Add-on devices (side add-on)	Auxiliary contacts	yes		
	UVT	yes		
	Shunt trip	yes		
	Motor operator	yes		
	Panelboard switch	yes		
Busbar systems	Pin (top/bottom)	yes/yes		
	Fork (top/bottom)	-/yes		
Accessories		yes		
Dimensions, weights, packaging				
	(HxDxW) 86x68xW	mm/mod.	18	
	Weight/mod.	g	120	
	Package	mod.	12	
Short-circuit capacity AC (kA)			AS/NZS 3947-2	
IEC 60898	I _{cn}	1 P	230/400 V	-
		2 P	230/400 V	-
		3 P/4 P	230/400 V	-
I _{cs} (service)				-
IEC 60947-2	I _{cu} (ultimate)	1 P	127 V	50
			240 V	50/25/20/15 ²⁾
		415 V	-	
		2 P	127 V	-
	240 V		50/50/40/30 ²⁾	
	415 V	50/25/20/15 ²⁾		
	3 P, 4 P	240 V	50/50/40/30 ²⁾	
		415 V	50/25/20/15 ²⁾	
440 V	50/20/15/10 ²⁾			
I _{cs} (service)				75 % I _{cu}
NEMA AB1 (120/240V)			-	
Short-circuit capacity DC (kA)				
IEC 60947-2	I _{cu} (ultimate)	1 P	≤60 V	25
			≤220 V	-
	2 P	≤125 V	30	
		≤440 V	-	
I _{cs} (service)				100 % I _{cu}

Notes Refer pages 3 - 23, 24 for information on SAFE-T MCBs.

¹⁾ Preferred values of rated control supply voltage (IEC 60947 - 2): 24 V, 48 V, 110 V, 125 V, 250 V

²⁾ 0.5-4 A/6-25 A/32-40 A/50-63 A

³⁾ 10 (125 V DC)

⁴⁾ 10 (250 V DC)

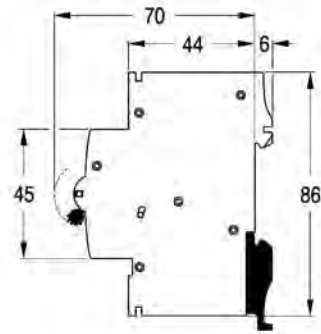
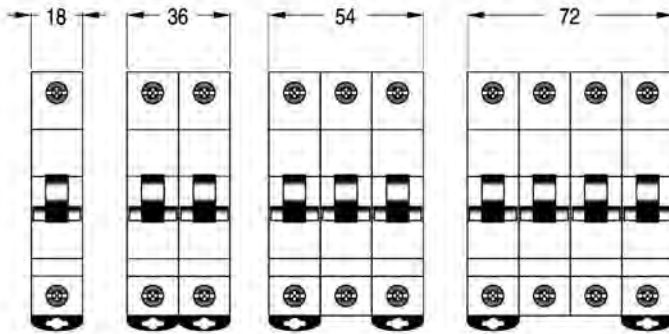
⁵⁾ On request.

Din-T MCBs + RCDs Technical data

Miniature circuit breakers - Din-T 15

Dimensions in mm.

3



3. Contactor



Halmac Services (Qld) Pty. Ltd.
A.C.N. 098 852 923
A.B.N. 40 741 712 113

CONTACTOR

1. CA7 CONTACTOR TECHNICAL DETAILS

AC contactors

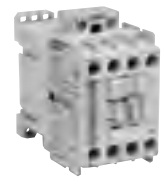
3 pole open type with AC coil

Refer catalogue CA 6, 2212, SACS

AC 3 rating at 60°C

Ratings to IEC 947 and AS 3497 400/415 V

- For CA 7 contactors with coil terminals on line side, add ...V AC to Catalogue No. Eg - CA 7-9-10-240 V AC³⁾
- For CA 7 contactors with coil terminals on load side, add ...V AC-U to Catalogue No. Eg - CA 7-9-10-240 V AC-U



Contactor CA 7-9



Contactor CA 7-72



Contactor CA 6-105-EI



Contactor CA 6-170-EI



Contactor CA 6-250-EI



Contactor CA 6-420-EI

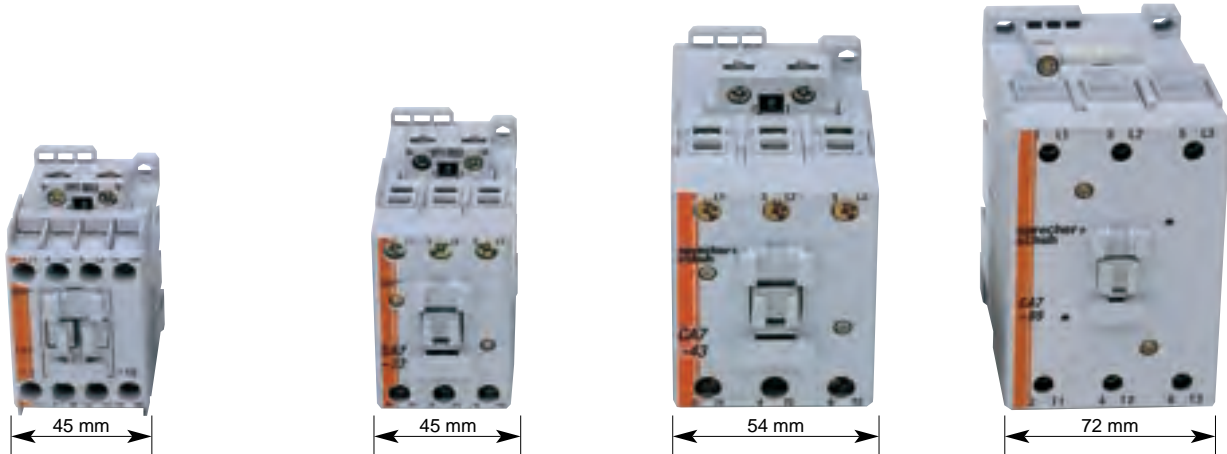
AC 3 400/415 V kW ¹⁾	AC 3 400/415 V Amps ¹⁾	AC 1 ⁶⁾ Amps 40 °C	AC 1 ⁶⁾ Amps 60 °C	Auxiliary contacts			Cat. No. ²⁾
				standard N/O	N/C	Max.	
4	9	32	32	1	0	9	CA 7-9-10...V AC
				0	1	9	CA 7-9-01...V AC
5.5	12	32	32	1	0	9	CA 7-12-10...V AC
				0	1	9	CA 7-12-01...V AC
7.5	16	32	32	1	0	9	CA 7-16-10...V AC
				0	1	9	CA 7-16-01...V AC
11	23	32	32	1	0	9	CA 7-23-10...V AC
				0	1	9	CA 7-23-01...V AC
15	30	50	45	0	0	8	CA 7-30-00...V AC
18.5	37	50	45	0	0	8	CA 7-37-00...V AC
22	43	85	63	0	0	8	CA 7-43-00...V AC
30	60	100	100	0	0	8	CA 7-60-00...V AC
37	72	100	100	0	0	8	CA 7-72-00...V AC
45	85	100	100	0	0	8	CA 7-85-00...V AC
55 (45)	95 (33)	160	135	1	1	8	CA 6-85-11...V AC
75 (55)	130 (40)	160	135	1	1	8	CA 6-105-11...V AC
90 (75)	155 (55)	250	210	1	1	8	CA 6-140-11...V AC
75 (55)	130 (40)	160	135	1	1	8	CA 6-105-EI-11...V AC ⁴⁾
90 (75)	155 (55)	250	210	1	1	8	CA 6-140-EI-11...V AC ⁴⁾
100 (90)	170 (65)	250	210	1	1	8	CA 6-170-EI-11...V AC ⁴⁾
132 (111)	225 (80)	350	300	1	1	8	CA 6-210-EI-11...V AC ⁴⁾
150 (133)	258 (95)	350	300	1	1	8	CA 6-250-EI-11...V AC ⁴⁾
185 (163)	320 (115)	450	380	1	1	8	CA 6-300-EI-11...V AC ⁴⁾
250 (225)	425 (160)	500	425	1	1	8	CA 6-420-EI-11...V AC ⁴⁾
220 (220)	370 (155)	500	420	2	2	8	CA 5-370...V AC ⁵⁾
265 (280)	450 (200)	600	510	2	2	8	CA 5-450...V AC ⁵⁾
325 (355)	550 (250)	780	645	2	2	8	CA 5-550...V AC ⁵⁾
430 (500)	700 (340)	1000	850	2	2	8	CA 5-700...V AC ⁵⁾
520 (550)	860 (380)	1100	930	2	2	8	CA 5-860...V AC ⁵⁾
600	1000	1200	1020	1	1	8	CA 5-1000...V AC ⁵⁾
700	1150	1350	1150	1	1	8	CA 5-1200...V AC ⁵⁾

- Notes:
- 1) 1000 volt ratings ().
 - 2) Add control voltage to Cat. No. when ordering: 24, 32, 110, 240, 415, 440V 50 Hz. Standard voltages for CA 6-105-EI...250-EI are 24, 48, 110, 240 and 415 V AC. Standard voltages for CA 6-300-EI...420-EI are 48, 110, 240 and 415 V AC. Standard voltages for CA 5-370...1200, 110, 240 and 415 V AC.
 - 3) All CA 7 coils can be reversed for line or load side coil terminals as required. Both versions are held in NHP stock for convenience.
 - 4) Electronically controlled mechanism (ECM) with interface suffix (EI).
 - 5) 55 °C enclosed.
 - 6) Contact NHP for recommended cable size.

240/415 V rated coils are suitable for use on 230/400 V in accordance with AS 60038 : 2000.

Refer catalogue SACS

The highest switching capacity in the smallest space



Compact without compromise

Compact without compromise is the best way to describe the CA 7 range of contactors and motor protection relays from Sprecher + Schuh. In spite of the new compact dimensions, the CA 7 range features high breaking capacity and extraordinary flexibility. Up to 18.5 kW the contactors are only 45 mm wide and even the largest 45 kW frame is only 72 mm wide. The CA 7 contactors are the main component in the new Advanced Control System (ACS).

With CA 7 you have flexibility with auxiliary contacts

Common auxiliaries from 9 to 85 amps

Three fitting positions

- Front mounting
- Side mounting left
- Side mounting right

Alternatively you can choose to combine left, right and front mounting auxiliary contacts to fulfil your requirements.

Instead of the top mounted auxiliary contacts, on or off delay timing modules or mechanical latches can be fitted.



Motor switching rating AC 3 @ 400/415 V

CA 7-9	4 kW	45 mm		9 A
CA 7-12	5.5 kW			12 A
CA 7-16	7.5 kW			16 A
CA 7-23	11 kW			23 A
CA 7-30	15 kW	45 mm		30 A
CA 7-37	18.5 kW			37 A
CA 7-43	22 kW	54 mm		43 A
CA 7-60	30 kW	72 mm		60 A
CA 7-72	37 kW			72 A
CA 7-85	45 kW			85 A

With CA 7 you have more clip on accessories

Common accessories from 9 to 85 amps

- On and off delay pneumatic timers
- Coil mounted electronic timers on delay, off delay, star delta
- Coil mounted 24 V DC interface
- Coil mounted RC and varistor suppressor modules
- Mechanical latch
- Mechanical interlock
- Mechanical interlock with integrated N/C interlock contacts
- Moulded wire link sets for DOL, reversing and star delta starters
- Large choice of front and side mounting auxiliary contacts

Refer catalogue SACS

Innovation and ease of use provide solutions for your control systems

Coil terminals are always in the correct position

The coil terminations on the CA 7 contactors can be supplied optionally at the top or the bottom of the contactor. It is also a simple task to change this on site should the requirements change.

When CA 7 contactors are used in combination with KTA 7 circuit motor circuit breakers the bottom coil terminations are used. For use with standard CT 7 thermal or CEP 7 electronic overloads the top coil termination should be selected.



Mechanical interlocks save space

Only 9mm wide, the CM 7 mechanical interlock snaps into place between any of the CA 7 contactors. It is allowed also to interlock different sizes of the CA 7 range with the same interlock.

The basic mechanical interlock is supplemented by a variation with built in N/C auxiliary contacts for electrical interlocking. This version is also only 9mm wide and further minimises space requirements.



CA 7 contactors provide improved wiring terminals

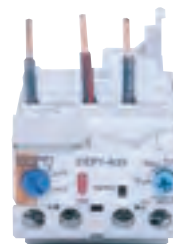
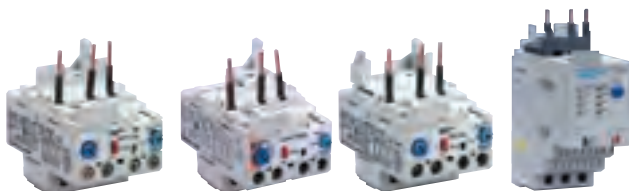
The main terminals of all CA 7 contactors are designed to accept at least two cables. At the same time they comply with safety standards regarding touch protection.

The larger contactors CA 7-30 and upwards employ a special cage terminal which allows the connection of two cables in separate chambers.

The ease of wiring with CA 7 contactors saves both time and money.



With Sprecher + Schuh you can choose the best protection for your motors.



High tech electronic protection type CEP 7 in trip class 10 or 20.



Standard thermal overloads type CT 7

ACS Short circuit co-ordination

Type '2' with KT 7 circuit breakers

Refer Catalogue C-CO

Automatic Type '2' co-ordination ¹⁾ with no-oversizing of contactors

**DOL starting
50/65 kA @ 400/415 V**

**NEW
Automatic
Type '2'**

Motor size kW	Approx. amps @ 400/415 V	Sprecher + Schuh circuit breaker	Setting range amps	Magnetic amps	Sprecher + Schuh contactor	AC-3 amps
0.18	0.60	KT 7-25S	0.40 - 0.63	8.2	CA 7-9	9
0.25	0.80	KT 7-25S	0.63 - 1.00	13	CA 7-9	9
0.37	1.10	KT 7-25S	1.00 - 1.60	21	CA 7-9	9
0.55	1.50	KT 7-25S	1.00 - 1.60	21	CA 7-9	9
0.75	1.80	KT 7-25S	1.60 - 2.50	33	CA 7-9	9
1.10	2.60	KT 7-25S	2.50 - 4.00	52	CA 7-9	9
1.15	3.40	KT 7-25S	2.50 - 4.00	52	CA 7-9	9
2.20	4.80	KT 7-25S	4.00 - 6.30	80	CA 7-9	9
3.00	6.50	KT 7-25S	6.30 - 10.0	130	CA 7-9	9
4.00	8.20	KT 7-25S	6.30 - 10.0	130	CA 7-9	9
5.50	11.00	KT 7-25S	10.0 - 16.0	208	CA 7-12	12
7.50	14.00	KT 7-25S	10.0 - 16.0	208	CA 7-16	16
9.00	17.00	KT 7-25H	14.5 - 20.0	260	CA 7-23	23
11.00	21.00	KT 7-25H	18.0 - 25.0	325	CA 7-23	23
15.00	28.00	KT 7-45H	23.0 - 32.0	416	CA 7-30	30
18.50	34.00	KT 7-45H	32.0 - 45.0	585	CA 7-37	37
22.00	40.00	KT 7-45H	32.0 - 45.0	585	CA 7-43	43
30.00	55.00	KT 3-100	40.0 - 63.0	882	CA 7-60	60
37.00	66.00	KT 3-100	63.0 - 90.0	1260	CA 7-72	72
45.00	80.00	KT 3-100	63.0 - 90.0	1260	CA 7-85	85

Definition Type '2' co-ordination according to IEC 947-4-1:

- The contactor or the starter must not endanger persons or systems in the event of a short circuit
- The contactor or the starter must be suitable for further use
- No damage to the overload relay or other parts may occur with the exception of welding of the contactor or starter contacts provided that these can be easily separated without significant deformation (such as with a screwdriver)
- In the event of a short circuit, fast opening current limiting circuit breakers KT 7 make it possible to build economical, fully short circuit co-ordinated starter combinations in accordance with IEC 947-4-1, Type '2' co-ordination
- Type '2' co-ordination without oversizing of contactors means: Type '1' = Type '2'

Note: ¹⁾ What is meant by Automatic Type '2' co-ordination?
The high speed operation of the new KT 7 motor protection circuit breakers means that contactors need not be oversized to achieve type '2' co-ordination. Simply select the normal AC 3 rated contactor and the corresponding KT 7 circuit breaker and type '2' co-ordination is assured.
240/415 V rating suitable for use on 230/400 V in accordance with AS 60038 : 2000



Refer Catalogue C-CO

MCCB or fuse DOL starting
50/65 kA @ 400/415 V to AS 3947.4.1

TemBreak Moulded Case
Circuit Breaker or fuse

Motor size kW	Approx. amps	Terasaki circuit breaker	or	NHP HRC fuse to BS88	Sprecher + Schuh contactor type	Sprecher + Schuh thermal O/L relay type	Setting range amps
0.37	1.1	XM30PB/1.4		NTIA-6	CA 7-9	CT 7-24	1 - 1.6
0.55	1.5	XM30PB/2		NTIA-6	CA 7-9	CT 7-24	1 - 1.6
0.75	1.8	XM30PB/2.6		NTIA-10	CA 7-9	CT 7-24	1.6 - 2.4
1.1	2.6	XM30PB/4.0		NTIA-10	CA 7-9	CT 7-24	2.4 - 4
1.5	3.4	XM30PB/5		NTIA-10	CA 7-9	CT 7-24	2.4 - 4
2.2	4.8	XM30PB/8		NTIA-16	CA 7-9	CT 7-24	4 - 6
3.0	6.5	XM30PB/10		NTIA-16	CA 7-9	CT 7-24	6 - 10
4.0	8.2	XM30PB/12		NTIA-25	CA 7-9	CT 7-24	6 - 10
5.5	11	XH125NJ/20		NTIA-32	CA 7-12	CT 7-24	10 - 16
7.5	14	XH125NJ/20		NTIS-40	CA 7-16	CT 7-24	10 - 16
11	21	XH125NJ/32		NTIS-50	CA 7-23	CT 7-24	16 - 24
15	28	XH125NJ/50		NTIS-63	CA 7-30	CT 7-45	18 - 30
18.5	34	XH125NJ/50		NTCP-80	CA 7-37	CT 7-45	30 - 45
22	40	XH125NJ/63		NTCP-80	CA 7-43	CT 7-45	30 - 45
30	55	XH125NJ/100		NTCP-100	CA 7-60	CT 7-75	45 - 60
37	66	XH125NJ/100		NTF-160	CA 7-72	CT 7-75	60 - 75
45	80	XH125NJ/125 ¹⁾		NTF-160	CA 6-85	CT 7-100	70 - 90
55	100	XH125NJ/125 ¹⁾		NTF-200	CA 6-105-EI	CT 6-110	85 - 110
75	130	XH250NJ/250		NTKF-250	CA 6-140-EI	CT 6-150	105 - 150
90	155	XH250NJ/250 ¹⁾		NTKF-250	CA 6-170-EI	CT 6-200	140 - 200
110	200	XH250NJ/250 ¹⁾		NTKF-315	CA 6-210-EI	CEF 1-41/42	160 - 400
132	225	XH400NE/400		NTMF-355	CA 6-210-EI	CEF 1-41/42	160 - 400
150	250	XH400NE/400		NTMF-355	CA 6-250-EI	CEF 1-41/42	160 - 400
160	270	XH400NE/400		NTMF-400	CA 6-300-EI	CEF 1-41/42	160 - 400
185	310	XH400NE/400		NTTF-450	CA 6-300-EI	CEF 1-41/42	160 - 400
200	361	XH400NE/400		NTTM-500	CA 6-420-EI/CA 5-450	CEF 1-41/42	160 - 400
250	425	XH630NE/630		NTTM-630	CA 6-420-EI/CA 5-450	CEF 1-52	160 - 630
315	530	XH630NE/630		NTLM-710	CA 5-550	CEF 1-52	160 - 630

Notes: Fuses 65 kA. XH125NJ circuit breaker combinations limited to 50 kA, others 65 kA.
Overloads may be changed to different types eg. thermal style to electronic.
Some combinations also gives Type '2' performance.
¹⁾ Use 'magnetic only' breaker - Refer NHP.

240/415 V rating suitable for use on 230/400 V in accordance with AS 60038 : 2000

Refer Catalogue C-CO

Fuse protection DOL starting ¹⁾
50/65 kA @ 400/415 V to AS 3947.4.1

Fuse

Motor size kW	Approx. amps @ 400/415 V	NHP HRC fuse to BS88	Sprecher + Schuh contactor	Sprecher + Schuh overload relay ²⁾ ³⁾	Setting range amps
0.37	1.1	NTIA-4	CA 7-9	CEP 7	1.0 - 2.9
0.75	1.8	NTIA-6	CA 7-9	CEP 7	1.0 - 2.9
1.5	3.4	NTIA-10	CA 7-9	CEP 7	1.6 - 5
2.2	4.8	NTIA-16	CA 7-9	CEP 7	3.7 - 12
4.0	8.2	NTIA-20	CA 7-9	CEP 7	3.7 - 12
5.5	11	NTIA-25	CA 7-12	CEP 7	3.7 - 12
7.5	14	NTIA-32	CA 7-16	CEP 7	12 - 32
11	21	NTIS-50	CA 7-30	CEP 7	12 - 32
15	28	NTIS-63	CA 7-30	CEP 7	12 - 37
18.5	34	NTCP-80	CA 7-37	CEP 7	12 - 37
22	40	NTCP-80	CA 7-43	CEP 7	14- 45
30	55	NTCP-100	CA 7-60	CEP 7	26 - 85
37	66	NTF-125	CA 7-72	CEP 7	26 - 85
45	80	NTF-160	CA 7-85	CEP 7	26 - 85
55	100	NTF-200	CA 6-105-EI	CT 6-110	85 - 110
75	130	NTKF-250	CA 6-140-EI	CT 6-150	105 - 150
90	155	NTKF-250	CA 6-170-EI	CT 6-200	140 - 200
110	200	NTKF-315	CA 6-210-EI	CEF 1-41/42 ⁴⁾	160 - 400
132	225	NTMF-355	CA 6-210-EI	CEF 1-41/42 ⁴⁾	160 - 400
150	250	NTMF-355	CA 6-250-EI	CEF 1-41/42 ⁴⁾	160 - 400
185	320	NTTM-450	CA 6-300-EI	CEF 1-41/42 ⁴⁾	160 - 400
250	425	NTTM-560	CA 6-420-EI	CEF 1-52 ⁴⁾	160 - 630
320	538	NTLM-710	CA 5-550	CEF 1-52 ⁴⁾	160 - 630
380	650	NTLM-800	CA 5-700	CEF 1-11/12P ⁴⁾	300 - 1200

- Notes:**
- ¹⁾ Fuses with equal or lower let through energy may also be used.
 - ²⁾ Thermal overloads may be used instead of electronic CEP 7.
 - ³⁾ Above 37 kW overloads may also be electronic or thermal.
 - ⁴⁾ CET 4 may be used instead of CEF 1.

240/415 V rating suitable for use on 230/400 V in accordance with AS 60038 : 2000

Refer Catalogue C-CO

**TemBreak circuit breakers DOL starting
50 kA @ 400/415 V to AS 3947.4.1**

TemBreak MCCBs

Motor size kW	Approx. amps	Terasaki circuit breaker	Sprecher + Schuh contactor	Sprecher + Schuh overload relay	Setting range amps
0.37	1.1	XM30PB/1.4	CA 7-9	CT 7-24-1.6	1 - 1.6
0.55	1.5	XM30PB/2	CA 7-9	CT 7-24-1.6	1 - 1.6
0.75	1.8	XM30PB/2.6	CA 7-9	CT 7-24-2.4	1.6 - 2.4
1.1	2.6	XM30PB/4.0	CA 7-16	CT 7-24-4	2.4 - 4
1.5	3.4	XM30PB/5	CA 7-16	CT 7-24-4	2.4 - 4
2.2	4.8	XM30PB/8	CA 7-16	CT 7-24-6	4 - 6
3	6.5	XM30PB/10	CA 7-30	CT 7-24-10	6 - 10
4	8.2	XM30PB/12	CA 7-30	CT 7-24-10	6 - 10
5.5	11	XH125NJ/20	CA 7-30	CT 7-24-16	10 - 16
7.5	14	XH125NJ/20	CA 7-30	CT 7-24-16	10 - 16
11	21	XH125NJ/32	CA 7-30	CT 7-24-24	16 - 24
15	28	XH125NJ/50	CA 7-43	CT 7-45-30	18 - 30
18.5	34	XH125NJ/50	CA 7-43	CT 7-45-45	30 - 45
22	40	XH125NJ/63	CA 7-43	CT 7-45-45	30 - 45
30	55	XH125NJ/100	CA 6-85	CT 7-75 ²⁾	45 - 60
37	66	XH125NJ/100	CA 6-85	CT 7-75 ²⁾	60 - 75
45	80	XH125NJ/125	CA 6-105-EI	CT 6-90	70 - 90
55	100	XH125NJ/125 ¹⁾	CA 6-105-EI	CT 6-110	85 - 110
75	130	XH250NJ/250	CA 6-140-EI	CT 6-150	105 - 150
90	155	XH250NJ/250	C A6-170-EI	CT 6-200	140 - 200
110	200	XH250NJ/250 ¹⁾	CA 6-210-EI	CEF 1-41/42	160 - 400
132	225	XS400SE/400	CA 6-210-EI	CEF 1-41/42	160 - 400
150	250	XS400SE/400	CA 6-250-EI	CEF 1-41/42	160 - 400
160	270	XS400SE/400	CA 6-300-EI	CEF 1-41/42	160 - 400
200	361	XS400SE/400	CA 6-420-EI	CEF 1-41/42	160 - 400
200	361	XS400SE/400	CA 5-450	CEF 1-22 ²⁾	160 - 400
250	425	XS630SE/630	CA 5-700	CEF 1-52 ²⁾	160 - 630
320	538	XS630SE/630	CA 5-700	CEF 1-52 ²⁾	160 - 630

Notes: Overloads may be thermal or electronic.
Combinations based on the overload tripping before the circuit breaker at overload currents up to the motor locked rotor current.

¹⁾ Use 'magnetic only' breaker or next higher circuit breaker / contactor combination.

²⁾ Use with separate mounting bracket.

Data for 65 kA co-ordination available refer Cat. C-CO.

240/415 V rating suitable for use on 230/400 V in accordance with AS 60038 : 2000

Short circuit co-ordination

Type '2' using Terasaki circuit breakers

Refer Catalogue C-CO

TemBreak circuit breakers DOL starting. 85 kA @ 400/415 V to AS 3947.4.1

MCCBs

Motor size kW	Approx. FLC @ 400/415 V (A)	Terasaki circuit breaker	Sprecher + Schuh contactor	Sprecher + Schuh thermal O/L type	Setting range (A)
0.37	1.1	XM30PB/1.4	CA 7-9	CEP 7-M32-2.9-10	1.0 - 2.9
0.55	1.5	XM30PB/2.0	CA 7-9	CEP 7-M32-2.9-10	1.0 - 2.9
0.75	1.8	XM30PB/2.6	CA 7-9	CEP 7-M32-2.9-10	1.0 - 2.9
1.1	2.6	XM30PB/4	CA 7-16	CEP 7-M32-2.9-10	1.0 - 2.9
1.5	3.4	XM30PB/5	CA 7-16	CEP 7-M32-5-10	1.6 - 5
2.2	4.8	XM30PB/8	CA 7-30	CEP 7-M32-12-10	3.7 - 12
3	6.5	XM30PB/8	CA 7-30	CEP 7-M32-12-10	3.7 - 12
4	8.2	XM30PB/10	CA 7-30	CEP 7-M32-12-10	3.7 - 12
5.5	11	TL100NJ/20	CA 7-30	CEP 7-M32-12-10	3.7 - 12
7.5	14	TL100NJ/20	CA 7-30	CEP 7-M32-32-10	12 - 32
9	17	TL100NJ/32	CA 7-30	CEP 7-M32-32-10	12 - 32
10	19	TL100NJ/32	CA 7-30	CEP 7-M32-32-10	12 - 32
11	21	TL100NJ/32	CA 7-30	CEP 7-M32-32-10	12 - 32
15	28	TL100NJ/50	CA 7-43	CEP 7-M32-32-10	12 - 32
18.5	34	TL100NJ/50	CA 7-43	CEP 7-M37-37-10	12 - 37
22	40	TL100NJ/63	CA 7-43	CEP 7-M45-45-10	14 - 45
30	55	TL100NJ/100	CA 7-72	CEP 7-M85-85-10	26 - 85
37	66	TL100NJ/100	CA 7-72	CEP 7-M85-85-10	26 - 85
45	80	TL250NJ/160	CA 6-105	CEP 7-M85-85-10	26 - 85
55	100	TL250NJ/160	CA 6-105	CEF 1-11/12	0.5 - 180
75	135	TL250NJ/250	CA 6-210-EI	CEF 1-11/12	0.5 - 180
90	160	TL250NJ/250	CA 6-210-EI	CEF 1-11/12	0.5 - 180
110	200	TL250NJ/250	CA 6-210-EI	CEF 1-41/42/52	160 - 630
132	230	TL400NE/400	CA 6-210-EI	CEF 1-41/42/52	160 - 630
160	270	TL400NE/400	CA 6-300-EI	CEF 1-41/42/52	160 - 630
200	361	TL400NE/400	CA 6-420-EI	CEF 1-41/42/52	160 - 630

Din-T circuit breakers with rotary isolator. DOL starting. 50 kA @ 400/415 V to AS 3947.4.1

Din-T MCBs

Motor size kW	Approx. amps @ 400/415 V	Sprecher + Schuh isolator	Terasaki circuit breaker	Sprecher + Schuh current limiter	Sprecher + Schuh contactor	Sprecher + Schuh thermal O/L relay	Thermal overload range
0.37	1.1	LA 7-80	Din-T 10 / 4	-	CA 7-9	CT 7-24	0.6 - 1.6
0.55	1.5	LA 7-80	Din-T 10 / 4	-	CA 7-9	CT 7-24	1 - 1.6
0.75	1.8	LA 7-80	Din-T 10 / 4	-	CA 7-9	CT 7-24	1.6 - 2.4
1.1	2.6	LA 7-80	Din-T 10 / 6	-	CA 7-23	CT 7-24	2.4 - 4
1.5	3.4	LA 7-80	Din-T 10 / 6	-	CA 7-23	CT 7-24	2.4 - 4
2.2	4.8	LA 7-80	Din-T 10 / 10	KTL 3-65	CA 7-23	CT 7-24	4 - 6
3	6.5	LA 7-80	Din-T 10 / 16	KTL 3-65	CA 7-23	CT 7-24	6 - 10
4	8.2	LA 7-80	Din-T 10 / 16	KTL 3-65	CA 7-23	CT 7-24	6 - 10
5.5	11	LA 7-80	Din-T 10 / 20	KTL 3-65	CA 7-23	CT 7-24	10 - 16
7.5	14	LA 7-80	Din-T 10 / 32	KTL 3-65	CA 7-30	CT 7-45	10 - 16
11	21	LA 7-80	Din-T 10 / 40	KTL 3-65	CA 7-30	CT 7-24	16 - 24
15	28	LA 7-100	Din-T 10 / 63	KTL 3-65	CA 7-37	CT 7-45	18 - 30
18.5	34	LA 7-100	Din-T 10 / 63	KTL 3-65	CA 7-37	CT 7-45	30 - 45

Note: 240/415 V rating suitable for use on 230/400 V in accordance with AS 60038 : 2000

ACS contactors CA 7

Technical data

Refer Catalogue C-CO

TemBreak circuit breakers DOL starting. 85 kA @ 400/415 V to AS 3947.4.1

MCCBs

Motor size kW	Approx. FLC @ 400/415 V (A)	Terasaki circuit breaker	Sprecher + Schuh contactor	Sprecher + Schuh thermal O/L type	Setting range (A)
0.37	1.1	XM30PB/1.4	CA 7-9	CEP 7-M32-2.9-10	1.0 - 2.9
0.55	1.5	XM30PB/2.0	CA 7-9	CEP 7-M32-2.9-10	1.0 - 2.9
0.75	1.8	XM30PB/2.6	CA 7-9	CEP 7-M32-2.9-10	1.0 - 2.9
1.1	2.6	XM30PB/4	CA 7-16	CEP 7-M32-2.9-10	1.0 - 2.9
1.5	3.4	XM30PB/5	CA 7-16	CEP 7-M32-5-10	1.6 - 5
2.2	4.8	XM30PB/8	CA 7-30	CEP 7-M32-12-10	3.7 - 12
3	6.5	XM30PB/8	CA 7-30	CEP 7-M32-12-10	3.7 - 12
4	8.2	XM30PB/10	CA 7-30	CEP 7-M32-12-10	3.7 - 12
5.5	11	TL100NJ/20	CA 7-30	CEP 7-M32-12-10	3.7 - 12
7.5	14	TL100NJ/20	CA 7-30	CEP 7-M32-32-10	12 - 32
9	17	TL100NJ/32	CA 7-30	CEP 7-M32-32-10	12 - 32
10	19	TL100NJ/32	CA 7-30	CEP 7-M32-32-10	12 - 32
11	21	TL100NJ/32	CA 7-30	CEP 7-M32-32-10	12 - 32
15	28	TL100NJ/50	CA 7-43	CEP 7-M32-32-10	12 - 32
18.5	34	TL100NJ/50	CA 7-43	CEP 7-M37-37-10	12 - 37
22	40	TL100NJ/63	CA 7-43	CEP 7-M45-45-10	14 - 45
30	55	TL100NJ/100	CA 7-72	CEP 7-M85-85-10	26 - 85
37	66	TL100NJ/100	CA 7-72	CEP 7-M85-85-10	26 - 85
45	80	TL250NJ/160	CA 6-105	CEP 7-M85-85-10	26 - 85
55	100	TL250NJ/160	CA 6-105	CEF 1-11/12	0.5 - 180
75	135	TL250NJ/250	CA 6-210-EI	CEF 1-11/12	0.5 - 180
90	160	TL250NJ/250	CA 6-210-EI	CEF 1-11/12	0.5 - 180
110	200	TL250NJ/250	CA 6-210-EI	CEF 1-41/42/52	160 - 630
132	230	TL400NE/400	CA 6-210-EI	CEF 1-41/42/52	160 - 630
160	270	TL400NE/400	CA 6-300-EI	CEF 1-41/42/52	160 - 630
200	361	TL400NE/400	CA 6-420-EI	CEF 1-41/42/52	160 - 630

Din-T circuit breakers with rotary isolator. DOL starting. 50 kA @ 400/415 V to AS 3947.4.1

Din-T MCBs

Motor size kW	Approx. amps @ 400/415 V	Sprecher + Schuh isolator	Terasaki circuit breaker	Sprecher + Schuh current limiter	Sprecher + Schuh contactor	Sprecher + Schuh thermal O/L relay	Thermal overload range
0.37	1.1	LA 7-80	Din-T 10 / 4	-	CA 7-9	CT 7-24	0.6 - 1.6
0.55	1.5	LA 7-80	Din-T 10 / 4	-	CA 7-9	CT 7-24	1 - 1.6
0.75	1.8	LA 7-80	Din-T 10 / 4	-	CA 7-9	CT 7-24	1.6 - 2.4
1.1	2.6	LA 7-80	Din-T 10 / 6	-	CA 7-23	CT 7-24	2.4 - 4
1.5	3.4	LA 7-80	Din-T 10 / 6	-	CA 7-23	CT 7-24	2.4 - 4
2.2	4.8	LA 7-80	Din-T 10 / 10	KTL 3-65	CA 7-23	CT 7-24	4 - 6
3	6.5	LA 7-80	Din-T 10 / 16	KTL 3-65	CA 7-23	CT 7-24	6 - 10
4	8.2	LA 7-80	Din-T 10 / 16	KTL 3-65	CA 7-23	CT 7-24	6 - 10
5.5	11	LA 7-80	Din-T 10 / 20	KTL 3-65	CA 7-23	CT 7-24	10 - 16
7.5	14	LA 7-80	Din-T 10 / 32	KTL 3-65	CA 7-30	CT 7-45	10 - 16
11	21	LA 7-80	Din-T 10 / 40	KTL 3-65	CA 7-30	CT 7-24	16 - 24
15	28	LA 7-100	Din-T 10 / 63	KTL 3-65	CA 7-37	CT 7-45	18 - 30
18.5	34	LA 7-100	Din-T 10 / 63	KTL 3-65	CA 7-37	CT 7-45	30 - 45

Note: 240/415 V rating suitable for use on 230/400 V in accordance with AS 60038 : 2000

ACS contactors CA 7

Technical data

General data

CA 7-9...CA 7-85

Rated insulation voltage U_i										
IEC	690 V									
UL, CSA	600 V									
Rated impulse voltage withstand U_{imp}	8k V									
Test voltage										
1 minute (to IEC 947-4)	2500 V									
Rated voltage U_e										
AC	110,	240,	400/415,	500,	690 V					
DC	24,	48,	110,	220,	440 V					
Rated frequency of coil	50/60 Hz									
Ambient temperature										
Storage	-55...+80 °C (-67...176 °F)									
Operation at nominal current	-25...+60 °C (-13...140 °F)									
Maximum with 15 % AC 1 current reduction > 60 °C	-25...+70 °C (-13...158 °F)									
Climatic withstand	Cyclicly changing humid atmosphere to IEC 68-2-30 and DIN 50 016, 56									
Maximum altitude	2000 m NN, to IEC 947-4									
Protection class										
IP 2LX (IEC 529 and DIN 40050)	In connected condition									
Protection against contact	Touch protection to VDE 0106, Part 100									
Standards	IEC 947-1/4; VDE 0660, Part 100/104; UL 508; CSA 22.2. Part 14									
Compliance	CE; UL; CSA									
Short time withstand										
I_{cw} , 60°	CA7-9	CA7-12	CA7-16	CA7-23	CA7-30	CA7-37	CA7-43	CA7-60	CA7-72	CA7-85
1 s (A)	210	210	290	380	480	525	650	1100	1150	1250
4 s (A)	140	150	220	280	360	390	480	820	860	910
10 s (A)	100	120	175	220	290	310	375	640	680	710
15 s (A)	90	100	150	200	250	270	325	560	600	620
60 s (A)	60	60	90	125	170	175	200	350	370	380
240 s (A)	40	40	50	60	100	100	120	190	190	200
900 s (A)	30	30	38	38	54	60	76	108	108	120
Minimum cooling time at zero current [Min]	20	20	20	20	20	20	20	20	20	20

ACS contactors CA 7

Technical data

Auxiliary contact data

		Built-in auxiliary contacts CA 7-9...23							Clip-on auxiliary contacts and accessories									
Switching of AC current																		
AC I _{th}	at 40 °C	[A]	25							10								
	at 60 °C	[A]	20							6								
AC 15	at rated voltage	[V]	24	48	120	240	400	500	600	690	24	48	120	240	400	500	600	690
		[A]	16	16	14	10	5	2.5	1.8	1	6	6	6	3	2	1.5	1.2	0.7
Short circuit protection		Fuse gG																
Co-ordination type '2'		[A]	10							10								
Rated impulse voltage																		
withstand U _{imp}		[kV]	8							6								
Isolation between control and load										Between auxiliary circuit 250 V,								
circuits to DIN, VDE 0106, parts		[V]	400							between load & auxiliary circuit 690 V								
Contact reliability to DIN 19240			17 V, 5 mA,							17 V, 5 mA,								
without soiling, normal industry atmosphere			>10 ⁸ switchings per failure							>10 ⁸ switchings per failure								
Terminals for auxiliary contacts																		
Terminal size to IEC 947-1			2 x A4							2 x A4								
Flexible wire with sleeve		1 wire [mm ²]	1...4							0.5...2.5								
		2 wire [mm ²]	1...4							0.75...2.5								
Stranded/solid core		1 wire [mm ²]	1.5...6							0.5...2.5								
		2 wire [mm ²]	1.5...6							0.75...2.5								
Tightening torque		[Nm]	1...2.5							1...1.5								

		Built-in auxiliary contacts CA 7-9...85					Clip-on auxiliary contacts									
							Front mount					Side mount				
Switching DC loads																
L/R < 1 ms, resistive loads at:	[V]	24	48	110	220	440	24	48	110	220	440	24	48	110	220	440
	[A]	12	9	3.5	0.55	0.2	12	9	3.5	0.55	0.2	6	3.2	0.45	0.18	0.1
L/R < 15 ms, inductive loads with economy resistor in series at:																
	[V]	24	48	110	220	440	24	48	110	220	440	24	48	110	220	440
	[A]	9	5	2	0.4	0.16	9	5	2	0.4	0.16	2	1.6	0.3	0.12	0.05
DC-13, switching electro magnets at:																
	[V]	24	48	110	220	440	24	48	110	220	440	24	48	110	220	440
	[A]	5	2	0.7	0.25	0.12	5	2	0.7	0.25	0.12	3	1.5	0.6	0.3	0.2

Additional rating data - contactors to IEC 947

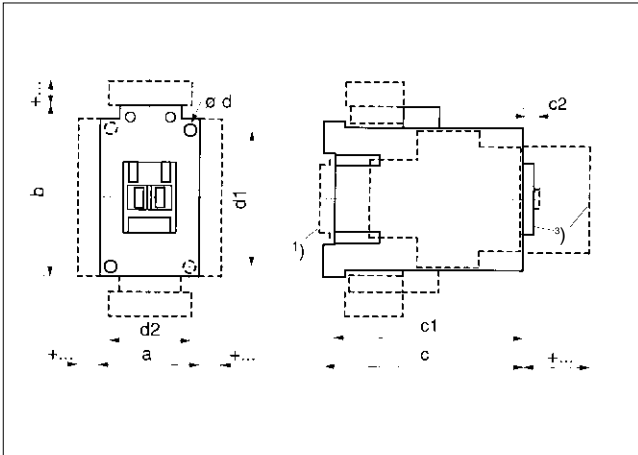
Contactor		CA 7-9	CA 7-12	CA 7-16	CA 7-23	CA 7-30	CA 7-37	CA 7-43	CA 7-60	CA 7-72	CA 7-85
AC 1 resistive load											
switching 3~											
Ambient temperature 40 °C											
I_e ¹⁾	[A]	32	32	32	32	50	50	85	100	100	100
230/240 V	[kW]	10	10	13	13	18	20	25	36	36	40
400/415 V	[kW]	18	18	23	23	32	36	45	64	64	71
690 V	[kW]	30	30	38	38	54	60	75	108	108	120
Ambient temperature 60 °C											
I_e ¹⁾	[A]	32	32	32	32	45	45	63	100	100	100
230/240 V	[kW]	8	8	10	10	14	16	20	29	29	34
400/415 V	[kW]	14	14	17	17	26	28	36	51	51	61
690 V	[kW]	24	24	29	29	44	48	60	86	86	102
AC motor switching											
AC 2, AC 3, AC 4											
230/240 V	[A]	11.5	14.5	20	26.5	34	37	42	62	70	85
400/415 V	[A]	9	12	16	23	30	37	43	60	72	85
690 V	[A]	5	7	9.3	12	17	20	25	34	42	49
230/240 V	[kW]	3	4	5.5	7.5	10	11	13	18.5	22	25
400/415 V	[kW]	4	5.5	7.5	11	15	18.5	22	30	37	45
690 V	[kW]	4	5.5	7.5	10	15	18.5	22	30	37	45
Rated making capacity											
I_e AC 4, 50 Hz	max. 690 V [A]	135	180	240	345	450	555	645	900	1080	1275
Rated breaking capacity											
I_e AC 4	max. 460 V [A]	135	180	240	345	450	555	645	900	1080	1275
	max. 690 V [A]	75	105	140	140	255	300	375	510	630	735
Short circuit protection											
without protection relay											
fuse gG to IEC 947-4-1											
	co-ordination type '1' [A]	50	50	50	63	100	125	160	200	250	250
	co-ordination type '2' [A]	20	25	25	35	50	80	100	100	125	160
Main current circuit											
resistance	[mΩ]	2.7	2.7	2.7	2	2	2	1.5	0.9	0.9	0.9
Power dissipated by all											
circuits at I_e AC 3	[w]	0.7	1.2	2.1	3.2	5.4	8.2	8.3	9.7	14	19.5
Total power dissipation											
at I_e AC 3	AC control [w]	3.3	3.8	4.7	6.2	8.4	11.2	11.5	14.2	18.5	–
	DC control [w]	6.7	7.2	8.1	12.4	14.6	17.4	18.4	14.6	18.9	–
Life span in millions of operations											
Mechanical	AC control	13	13	13	13	13	13	12	10	10	10
	DC control	13	13	13	13	13	13	13	10	10	10
Operating times (DC)											
	Make (mS)	40...70	40...70	40...70	40...70	50...80	50...80	50...80	20...40	20...40	20...40
	Break (mS)	7...15	7...15	7...15	7...15	7...15	7...15	–	–	–	–

Note: ¹⁾ Contact NHP for recommended cable size.

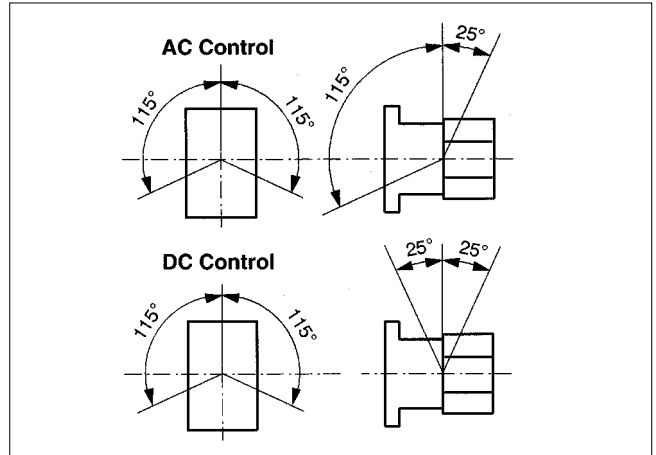
ACS contactors CA 7

Dimensions

Dimensions in (mm)



Mounting position



Contactor (AC control)

Type	a	b	c	c1	c2	ød	d1	d2 ¹⁾
CA 7-9...CA 7-23 ²⁾	45	81	80.5	75.5	6	4.5	60	35
CA 7-30...CA 7-37	45	81	97.5	92.6	6.5	4.5	60	35
CA 7-43	54	81	100.5	95.6	6.5	4.5	60	45
CA 7-60...CA 7-85	72	122	117	111.5	8.5	5.4	100	55

(DC control)

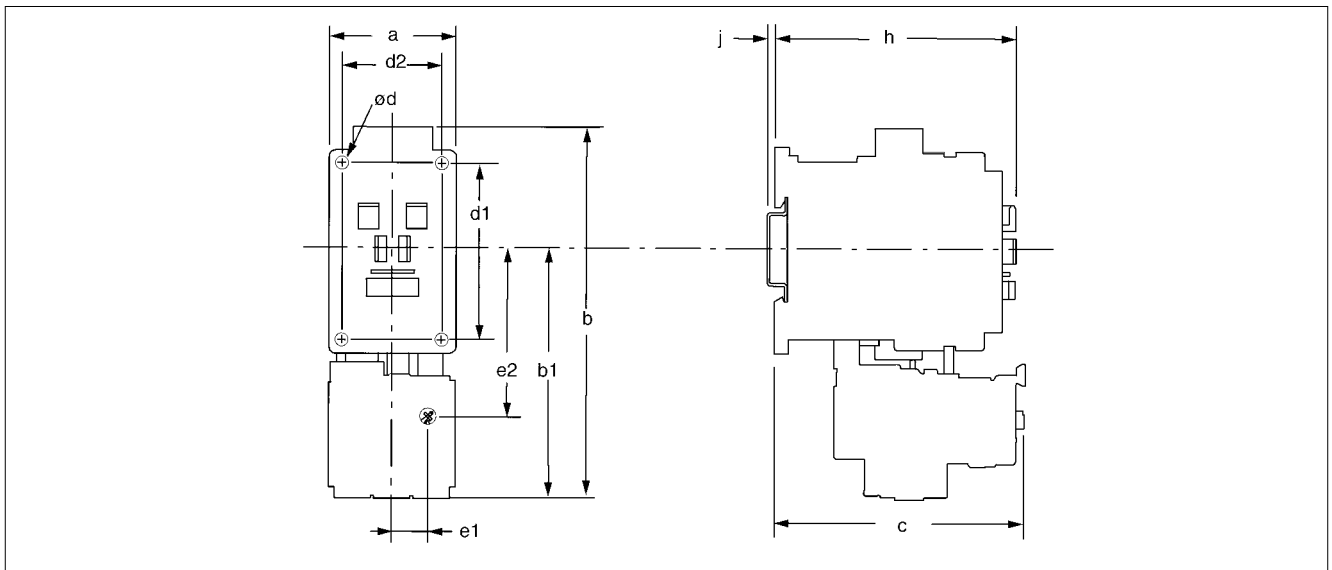
Type	a	b	c	c1	c2	ød	d1	d2 ¹⁾
CA 7-9C...CA 7-16C	45	81	106.5	101.5	6	4.5	60	35
CA 7-23C	45	81	123.5	119	6	4.5	60	35
CA 7-30C...CA 7-37C	45	81	141.5	136.5	6.5	4.5	60	35
CA 7-43C	54	81	144.5	140	6.5	4.5	60	45
CA 7-60C...CA 7-85C	72	122	117	111.5	8.5	5.4	100	55

Accessories

Contactor with		(AC control) (mm)	(DC control) (mm)
Front mounting auxiliary contact	2 or 4 pole	c/c1 + 39	c/c1 + 39
Side mounting auxiliary contact	1 or 2 pole	a + 9	a + 9
Pneumatic timing module		c/c1 + 58	–
Electronic timing module	coil mounting	b + 24	b + 24
Mechanical interlock	mounts between contactors	a + 9	a + 9
Mechanical latch		c/c1 + 61	–
Interface	coil mounting	b + 9	–
Suppressor	coil mounting	b + 3	b + 3
With inscriptions ³⁾	labels	+0	+0
	label support system V4/V5	+5.5	+5.5

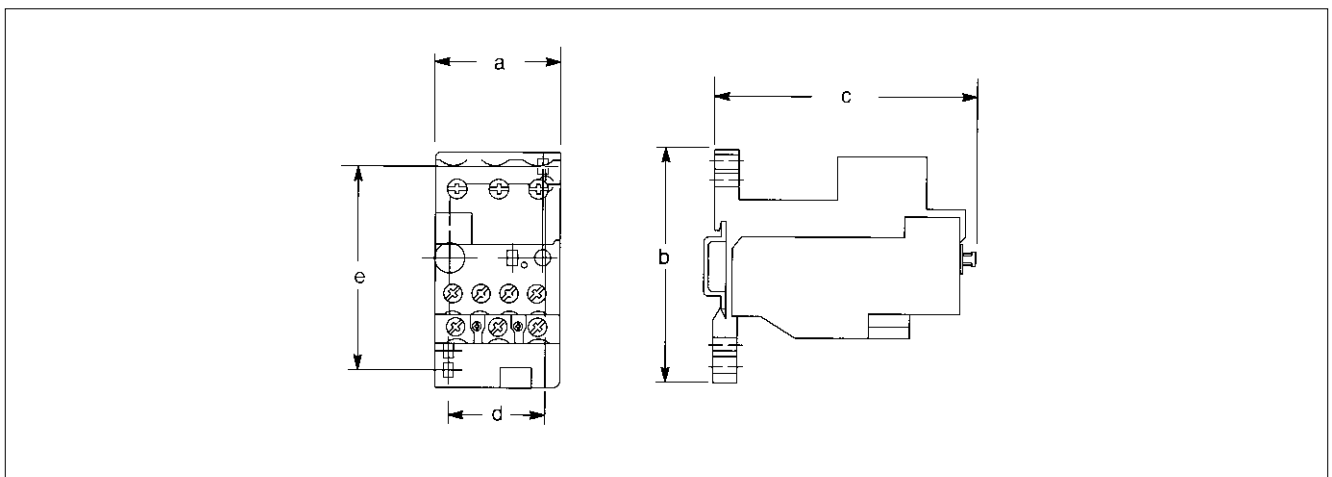
Notes: 1) DIN Rail mounting 35 mm to EN 50 022.
 2) Dimensions for 4 pole contactors same as 3 pole with auxiliary.
 3) Dimensions with inscriptions.

Dimensions in (mm) CEP 7, CEP 7s and CEP 7-B mounted on CA 7 contactors



Cat. No.	a	b	b1	c	e1	e2	d1	d2	h	j	ød
CA 7-9/12/16/23 with CEP 7 or CEP 7S	45	131	86	88.5	16.5	69	60	35	86.5	2	4.2
CA 7-9/12/16/23 with CEP 7-B	54	137	97	90.7	5.1	59	60	35	85.1	2	4.2
CA 7-30/37 with CEP 7 or CEP 7S	45	136.5	91.5	92	16.5	69	60	35	104	2	4.2
CA 7-30/37 with CEP 7-B	54	137	97	92.1	5.2	59	60	35	104.7	2	4.2
CA 7-43 with CEP 7, CEP 7S or CEP 7-B	54	136.5	91.5	93	22	69	60	45	107	2	4.2
CA 7-60/72/85 with CEP 7, CEP 7S or CEP 7-B	72	188.5	120	120	18	84.5	100	55	125.5	2	5.5

CEP 7 with separate mounting bracket



Type	a	b	c	d	e
CEP 7-37-P-A	45	90	75	30	75
CEP 7-45-P-A	55	90	96.5	40	75
CEP 7-85-P-A	70	115	110	55	105

ACS thermal overloads CT 7

Technical data



General	CT 7-24	CT 7-45	CT 7-75	CT 7-100
Weight	[kg] 0.13	0.21	0.21	1.3
Standards	IEC 947, EN 60 947, DIN VDE 0660, UL, LRS, GUS, CSA			
Climatic	damp/heat, constant, to DIN, IEC 68, Part 2 - 3 damp/heat, cyclic, to DIN, IEC 68, Part 2 - 30			
Ambient temperature	open	-25...+60 °C		
	enclosed	-25...+50 °C		
Temperature compensation	continuous temperature range -5...+40 °C to IEC 947, EN 60947; PTB: -5...+50 °C			
Shock resistance (sinusoidal 10 ms) [G]	10			
Protection	IP 00 IP 2LX			
Protection	touch proof (VDE 0106, Part 100)			

Contactor, timer and overload selection chart for auto transformer starters

ATS kW	Line contactor	Trans contactor	Star contactor	Timer	Overload
11	CA 7-23-10	CA 7-16-10	CA 7-9-10	RZ7 FSY2D	CEP 7-M32-32-10
15	CA 7-30-00	CA 7-23-10	CA 7-12-10	RZ7 FSY2D	CEP 7-M37-37-10
18.5	CA 7-37-00	CA 7-30-00	CA 7-16-10	RZ7 FSY2D	CEP 7-M37-37-10
22	CA 7-43-00	CA 7-30-00	CA 7-23-10	RZ7 FSY2D	CEP 7-M45-45-10
30	CA 7-60-00	CA 7-37-00	CA 7-30-00	RZ7 FSY2D	CEP 7-M85-85-10
37	CA 7-72-00	CA 7-43-00	CA 7-30-00	RZ7 FSY2D	CEP 7-M85-85-10
45	CA 7-85-00	CA 7-60-00	CA 7-37-00	RZ7 FSY2D	CEP 7-M85-85-10
55	CA 6-85-11	CA 7-60-00	CA 7-43-00	RZ7 FSY2D	CT 6-110
75	CA 6-105-11	CA 7-85-00	CA 7-60-00	RZ7 FSY2D	CT 6-150
90	CA 6-140EI-11	CA 6-85-11	CA 7-72-00	RZ7 FSY2D	CT 6-200
110	CA 6-170EI-11	CA 6-105-11	CA 7-85-00	RZ7 FSY2D	CEF 1-41
132	CA 6-210EI-11	CA 6-140EI-11	CA 6-105-11	RZ7 FSY2D	CEF 1-41
150	CA 6-250EI-11	CA 6-140EI-11	CA 6-105-11	RZ7 FSY2D	CEF 1-41
185	CA 6-300EI-11	CA 6-210EI-11	CA 6-140EI-11	RZ7 FSY2D	CEF 1-41
220	CA 6-420EI-11	CA 6-210EI-11	CA 6-140EI-11	RZ7 FSY2D	CEF 1-41

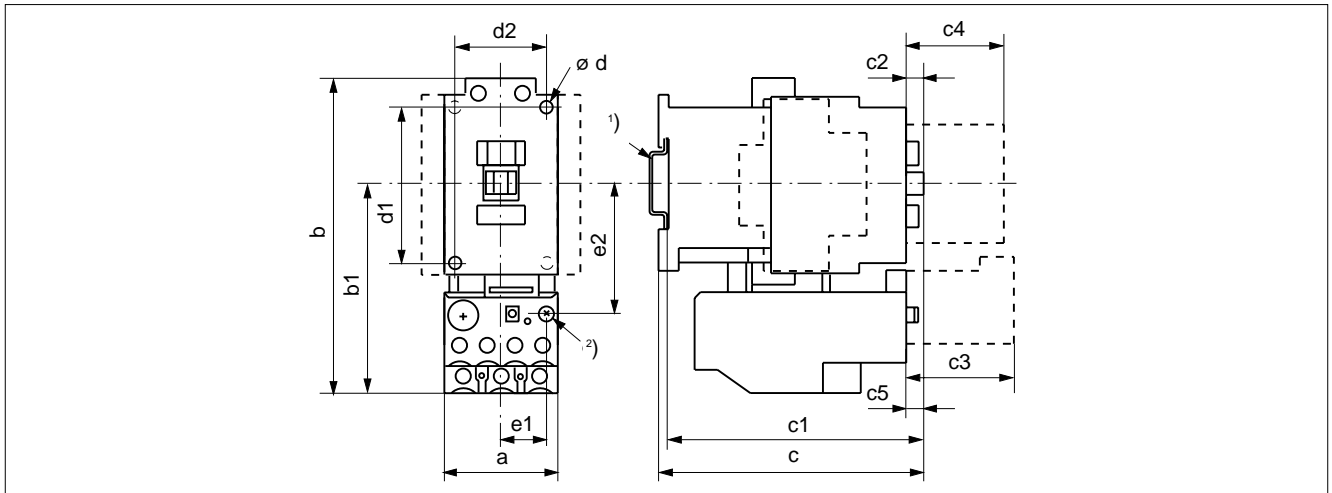
Contactor, timer and overload selection chart for star delta starters

SDS kW	Line contactor	Delta contactor	Star contactor	Timer	Overload
7.5	CA 7-9-10	CA 7-9-01	CA 7-9-01	RZ7 FSY2D	CEP 7-M32-12-10
11	CA 7-12-10	CA 7-12-01	CA 7-9-01	RZ7 FSY2D	CEP 7-M32-32-10
15	CA 7-16-10	CA 7-16-01	CA 7-9-01	RZ7 FSY2D	CEP 7-M32-32-10
18.5	CA 7-23-10	CA 7-23-01	CA 7-12-01	RZ7 FSY2D	CEP 7-M32-32-10
22	CA 7-23-10	CA 7-23-01	CA 7-16-01	RZ7 FSY2D	CEP 7-M32-32-10
30-37	CA 7-37-00	CA 7-37-00	CA 7-23-01	RZ7 FSY2D	CEP 7-M45-45-10
45	CA 7-60-11	CA 7-60-11	CA 7-30-00	RZ7 FSY2D	CEP 7-M85-85-10
55	CA 7-60-11	CA 7-60-11	CA 7-37-00	RZ7 FSY2D	CEP 7-M85-85-10
75	CA 7-85-00	CA 7-85-00	CA 7-43-00	RZ7 FSY2D	CEP 7-M85-85-10
90	CA 6-85-11	CA 6-85-11	CA 7-60-00	RZ7 FSY2D	CT 6-90
110	CA 6-105-11	CA 6-105-11	CA 7-72-00	RZ7 FSY2D	CT 6-110
132	CA 6-140EI-11	CA 6-140EI-11	CA 7-85-00	RZ7 FSY2D	CT 6-150
150	CA 6-170EI-11	CA 6-170EI-11	CA 6-85-00	RZ7 FSY2D	CTA 6-200
185	CA 6-210EI-11	CA 6-210EI-11	CA 6-105-11	RZ7 FSY2D	CEF 1-41
220	CA 6-210EI-11	CA 6-210EI-11	CA 6-140EI-11	RZ7 FSY2D	CEF 1-41

ACS thermal overloads CT 7

Dimensions with and without contactors

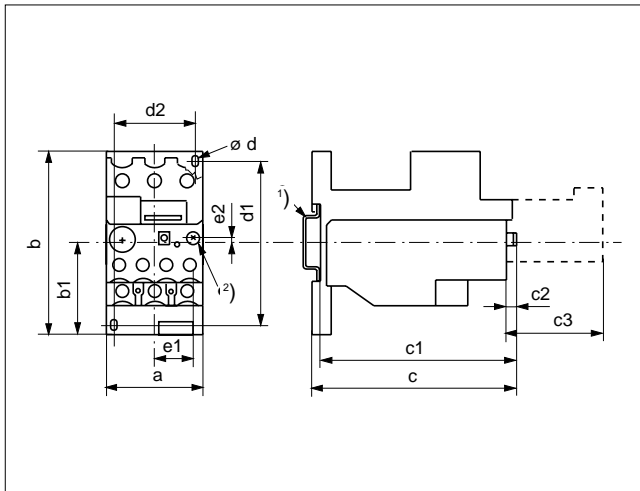
Mounted on CA 7 contactors



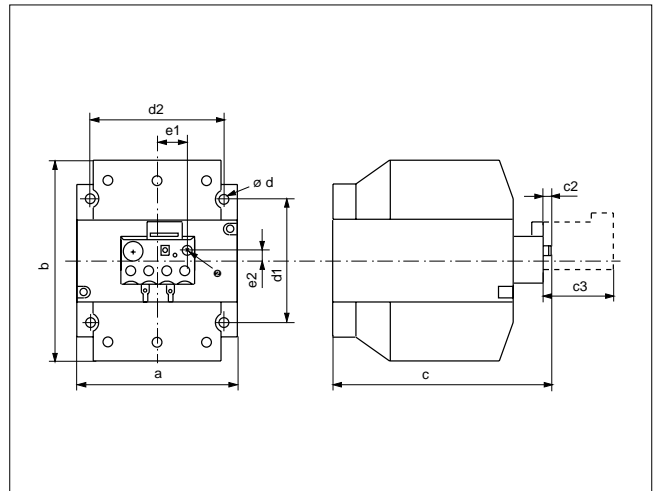
CT 7-24, CT 7-45, CT 7-75

Type	For contactor	a	b	b1	c	c1	c2	c3	c4	c5	ød	d1	d2	e1	e2
CT 7-24	CA 7-9...23	45	127	83	96	91	15	51	39	5	4.5	60	35 ¹⁾	16.5	51
	CA 7-30...37	45	127	83	105	99	6.5	51	39	9.5	4.5	60	35 ¹⁾	16.5	51
CT 7-45	CA 7-30...37	60	140	97	105	99	6.5	51	39	6.5	4.5	60	35 ¹⁾	16.5	57
	CA 7-43	60	140	97	107	103	6.5	51	39	8.5	4.5	60	45 ¹⁾	16.5	57
CT 7-75	CA 7-60...85	72	185	120	125	120	8.5	51	39	28.5	5.4	100	55 ¹⁾	16.5	82

Separate mounting with bracket



Separate mounting



Type	a	b	b1	c	c1	c2	c3	ød	d1	d2	e1	e2
CT 7-24	45	85	44	95	70.5	5	51	4.5	60...74	35 ¹⁾	16	3
CT 7-75	60	90	44	117	112	15	51	5.4	74	50 ¹⁾	16	0
CT 7-90	100	120	-	135	-	5	51	6.2	74	80 ¹⁾	16	7

- Notes:**
- 1) Standard DIN rail to EN 50 022-35.
 - 2) With reset rod, maintain 9 mm maximum operating radius from centre of reset button.
 - c3 Reset magnet.
 - c4 Auxiliary contact block.

4. Control Relay & Phase Failure Relay



Halmac Services (Qld) Pty. Ltd.
A.C.N. 098 852 923
A.B.N. 40 741 712 113

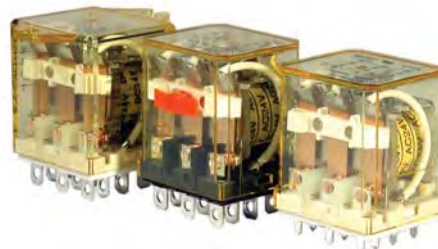
CONTROL RELAY & PHASE FAILURE RELAY

1. IDEC CONTROL RELAY TECHNICAL DETAILS
2. PHASE FAILURE RELAY TECHNICAL DETAILS

RH Series Compact Power Relays

SPDT through 4PDT, 10A contacts Compact power type relays

The RH series are miniature power relays with a large capacity. The RH relays feature 10A contact capacity as large as the RR series but in a miniature package. The compact size saves space.



Part Number Selection

Contact	Model	Part Number		Coil Voltage Code (Standard Stock in bold)
		Blade Terminal	PCB Terminal	
 SPDT	Basic	RH1B-U	RH1V2-U	
	With Indicator	RH1B-UL	—	
	With Check Button	RH1B-UC	—	AC6V, AC12V, AC24V , AC110V, AC120V , AC220V, AC240V DC6V, DC12V , DC24V , DC48V, DC110V
	With Indicator and Check Button	RH1B-ULC	—	
	Top Bracket Mounting	RH1B-UT	—	
	With Diode (DC coil only)	RH1B-UD	RH1V2-UD	DC6V, DC12V , DC24V , DC48V, DC110V
	With Indicator and Diode (DC coil only)	RH1B-ULD	—	DC12V , DC24V , DC48V, DC110V
 DPDT	Basic	RH2B-U	RH2V2-U	
	With Indicator	RH2B-UL	RH2V2-UL	AC6V, AC12V, AC24V , AC110-120V , AC220-240V
	With Check Button	RH2B-UC	—	DC6V, DC12V , DC24V , DC48V, DC100-110V
	With Indicator and Check Button	RH2B-ULC	—	
	Top Bracket Mounting	RH2B-UT	—	
	With Diode (DC coil only)	RH2B-UD	RH2V2-UD	DC6V, DC12V , DC24V , DC48V, DC100-110V
	With Indicator and Diode (DC coil only)	RH2B-ULD	—	
 3PDT	Basic	RH3B-U	RH3V2-U	
	With Indicator	RH3B-UL	RH3V2-UL	AC6V, AC12V, AC24V , AC110V, AC120V , AC220V, AC240V DC6V, DC12V , DC24V , DC48V, DC110V
	With Check Button	RH3B-UC	—	
	With Indicator and Check Button	RH3B-ULC	—	
	Top Bracket Mounting	RH3B-UT	—	
	With Diode (DC coil only)	RH3B-D*	RH3V2-D*	DC6V, DC12V, DC24V, DC48V, DC110V
	With Indicator and Diode (DC coil only)	RH3B-LD*	—	
 4PDT	Basic	RH4B-U	RH4V2-U	
	With Indicator	RH4B-UL	RH4V2-UL	AC6V, AC12V, AC24V , AC110V, AC120V , AC220V, AC240V DC6V, DC12V , DC24V , DC48V, DC110V
	With Check Button	RH4B-UC	—	
	With Indicator and Check Button	RH4B-ULC	—	
	Top Bracket Mounting	RH4B-UT	—	
	With Diode (DC coil only)	RH4B-UD	RH4V2-UD	DC6V, DC12V, DC24V, DC48V, DC110V
	With Indicator and Diode (DC coil only)	RH4B-LD*	—	

- *Carries no UL recognition mark.
- PCB terminal relays are designed to mount directly to a circuit board without any socket.

Ordering Information

When ordering, specify the Part No. and coil voltage code:

(example) **RH3B-U** **AC120V**
 Part No. Coil Voltage Code

Switches & Pilot Lights

Display Lights

Relays & Sockets





Timers

Terminal Blocks

Circuit Breakers



Sockets (for Blade Terminal Models)

Relays	Standard DIN Rail Mount ¹	Finger-safe DIN Rail Mount ¹	Through Panel Mount	PCB Mount
RH1B	SH1B-05	SH1B-05C	SH1B-51	SH1B-62
RH2B	SH2B-05	SH2B-05C	SH2B-51	SH2B-62
RH3B	SH3B-05	SH3B-05C	SH3B-51	SH3B-62
RH4B	SH4B-05	SH4B-05C	SH4B-51	SH4B-62

1. DIN Rail mount socket comes with two horseshoe clips. Do not use unless you plan to insert pullover wire spring. Replacement horseshoe clip part number is Y778-011.

Hold Down Springs & Clips

Appearance	Description	Relay	For DIN Mount Socket	For Through Panel & PCB Mount Socket	Min Order Qty
	Pullover Wire Spring	RH1B	SY2S-02F1 ²	SY4S-51F1	10
		RH2B	SY4S-02F1 ²		
		RH3B	SH3B-05F1 ²		
		RH4B	SH4B-02F1 ²		
	Leaf Spring (side latch)	RH1B, RH2B, RH3B, RH4B	SFA-202 ³	SFA-302 ³	20
		RH1B, RH2B, RH3B, RH4B	SFA-101 ³	SFA-301 ³	

2. Must use horseshoe clip when mounting in DIN mount socket. Replacement horseshoe clip part number is Y778-011.
3. Two required per relay.

AC Coil Ratings

Voltage (V)	Rated Current (mA) ±15% at 20°C								Coil Resistance (Ω) ±10% at 20°C				Operation Characteristics (against rated values at 20°C)		
	AC 50Hz				AC 60Hz				SPDT	DPDT	3PDT	4PDT	Max. Continuous Applied Voltage	Pickup Voltage	Dropout Voltage
	SPDT	DPDT	3PDT	4PDT	SPDT	DPDT	3PDT	4PDT							
6	170	240	330	387	150	200	280	330	330	9.4	6.4	5.4			
12	86	121	165	196	75	100	140	165	165	39.3	25.3	21.2			
24	42	60.5	81	98	37	50	70	83	83	153	103	84.5			
110	9.6	—	18.1	21.6	8.4	—	15.5	18.2	18.2	—	2,200	1,800			
110-120	—	9.4-10.8	—	—	—	8.0-9.2	—	—	—	—	—	—			
120	8.6	—	16.4	19.5	7.5	—	14.2	16.5	16.5	—	10,800	7,360			
220	4.7	—	8.8	10.7	4.1	—	7.7	9.1	9.1	—	10,800	7,360			
220-240	—	4.7-5.4	—	—	—	4.0-4.6	—	—	—	18,820	—	—			
240	4.9	—	8.2	9.8	4.3	—	7.1	8.3	8.3	—	12,100	9,120			

DC Coil Ratings

Voltage (V)	Rated Current (mA) ±15% at 20°C				Coil Resistance (Ω) ±10% at 20°C				Operation Characteristics (against rated values at 20°C)		
	SPDT	DPDT	3PDT	4PDT	SPDT	DPDT	3PDT	4PDT	Max. Continuous Applied Voltage	Pickup Voltage	Dropout Voltage
6	128	150	240	250	47	40	25	24	110%	80% maximum	10% minimum
12	64	75	120	125	188	160	100	96			
24	32	36.9	60	62	750	650	400	388			
48	18	18.5	30	31	2,660	2,600	1,600	1,550			
100-110	—	8.2-9.0	—	—	—	12,250	—	—			
110	8	—	12.8	15	13,800	—	8,600	7,340			

Standard coil voltages are in **BOLD**.

Switches & Pilot Lights

Contact Ratings

Maximum Contact Capacity						
Model	Continuous Current	Allowable Contact Power		Rated Load		
		Resistive Load	Inductive Load	Voltage (V)	Res. Load	Ind. Load
SPDT	10A	1540VA 300W	990VA 210W	110 AC	10A	7A
				220 AC	7A	4.5A
				30 DC	10A	7A
DPDT 3PDT 4PDT	10A	1650VA 300W	1100VA 225W	110 AC	10A	7.5A
				220 AC	7.5A	5A
				30 DC	10A	7.5A

Note: Inductive load for the rated load — $\cos \phi = 0.3$, L/R = 7 ms



Display Lights

TÜV Ratings

Voltage	RH1	RH2	RH3	RH4
240V AC	10A	10A	7.5A	7.5A
30V DC	10A	10A	10A	10A

AC: $\cos \phi = 1.0$, DC: L/R = 0 ms



Relays & Sockets

Socket Specifications

	Sockets	Terminal	Electrical Rating	Wire Size	Torque
DIN Rail Mount Sockets	SH1B-05	(Coil) M3 screws (contact) M3.5 screws with captive wire clamp	250V, 10A	Maximum up to 2-#12AWG	5.5 - 9 in•lbs 9 - 11.5 in•lbs
	SH2B-05 SH3B-05 SH4B-05	M3.5 screws with captive wire clamp	300V, 10A	Maximum up to 2-#12AWG	9 - 11.5 in•lbs
	SH1B-05C	(coil) M3 screws (contact) M3.5 screws with captive wire clamp, fingersafe	250V, 10A	Maximum up to 2-#12AWG	5.5 - 9 in•lbs 9 - 11.5 in•lbs
	SH2B-05C SH3B-05C SH4B-05C	M3.5 screws with captive wire clamp, fingersafe	300V, 10A	Maximum up to 2-#12AWG	9 - 11.5 in•lbs
Through Panel Mount Socket	SH1B-51 SH2B-51 SH3B-51 SH4B-51	Solder	300V, 10A	—	—
PCB Mount Socket	SH1B-62	PCB mount	250V, 10A	—	—
	SH2B-62 SH3B-62 SH4B-62	PCB mount	300V, 10A	—	—

Timers

Terminal Blocks

Accessories

Description	Appearance	Use with	Part No.	Remarks
Aluminum DIN Rail (1 meter length)		All DIN rail sockets	BNDN1000	IDEC offers a low-profile DIN rail (BNDN1000). The BNDN1000 is designed to accommodate DIN mount sockets. Made of durable extruded aluminum, the BNDN1000 measures 0.413 (10.5mm) in height and 1.37 (35mm) in width (DIN standard). Standard length is 39" (1,000mm).
DIN Rail End Stop		DIN rail	BNL5	9.1 mm wide.
Replacement Hold-Down Spring Anchor		DIN mount sockets and hold down springs.	Y778-011	For use on DIN rail mount socket when using pullover wire hold down spring. 2 pieces included with each socket.

Circuit Breakers

UL Ratings

Voltage	Resistive			General Use			Horse Power Rating		
	RH1 RH2	RH3	RH4	RH1 RH2	RH3	RH4	RH1 RH2	RH3	RH4
240V AC	10A	7.5A	7.5A	7A	6.5A	5A	1/3 HP	1/3 HP	—
120V AC	—	10A	10A	—	7.5A	7.5A	1/6 HP	1/6 HP	—
30V DC	10A	10A	—	7A	—	—	—	—	—
28V DC	—	—	10A	—	—	—	—	—	—

CSA Ratings

Voltage	Resistive				General Use				Horse Power Rating
	RH1	RH2	RH3	RH4	RH1	RH2	RH3	RH4	RH1, 2, 3
240V AC	10A	10A	—	7.5A	7A	7A	7A	5A	1/3 HP
120V AC	10A	10A	10A	10A	7.5A	7.5A	—	7.5A	1/6 HP
30V DC	10A	10A	10A	10A	7A	7.5A	—	—	—

Specifications

Contact Material		Silver cadmium oxide
Contact Resistance ¹		50mΩ maximum
Minimum Applicable Load		24V DC, 30 mA; 5V DC, 100 mA (reference value)
Operate Time ²	SPDT DPDT	20ms maximum
	3PDT 4PDT	25ms maximum
Release Time ²	SPDT DPDT	20ms maximum
	3PDT 4PDT	25ms maximum
Power Consumption (approx.)	SPDT	AC: 1.1VA (50Hz), 1VA (60Hz) DC: 0.8W
	DPDT	AC: 1.4VA (50Hz), 1.2VA (60Hz) DC: 0.9W
	3PDT	AC: 2VA (50Hz), 1.7VA (60Hz) DC: 1.5W
	4PDT	AC: 2.5VA (50Hz), 2VA (60Hz) DC: 1.5W
Insulation Resistance		100MΩ minimum (500V DC megger)
Dielectric Strength ³	SPDT	Between live and dead parts: 2,000V AC, 1 minute
		Between contact and coil: 2,000V AC, 1 minute
		Between contacts of the same pole: 1,000V AC, 1 minute
	DPDT 3PDT 4PDT	Between live and dead parts: 2,000V AC, 1 minute
		Between contact and coil: 2,000V AC, 1 minute
		Between contacts of different poles: 2,000V AC, 1 minute
		Between contacts of the same pole: 1,000V AC, 1 minute
Operating Frequency		Electrical: 1,800 operations/hour maximum Mechanical: 18,000 operations/hour maximum
Vibration Resistance		Damage limits: 10 to 55Hz, amplitude 0.5 mm Operating extremes: 10 to 55Hz, amplitude 0.5 mm
Shock Resistance		Damage limits: 1,000m/s ² (100G) Operating extremes: 200m/s ² (20G - SPDT, DPDT) 100m/s ² (10G - 3PDT, 4PDT)
Mechanical Life		50,000,000 operations minimum
Electrical Life	DPDT	500,000 operations minimum (120V AC, 10A)
	SPDT 3PDT 4PDT	200,000 operations minimum (120V AC, 10A)
Operating Temperature ⁴	SPDT	-25 to +50°C (no freezing)
	DPDT 3PDT 4PDT	-25 to +40°C (no freezing)
Operating Humidity		45 to 85% RH (no condensation)
Weight (approx.)		SPDT: 24g, DPDT: 37g, 3PDT: 50g, 4PDT: 74g



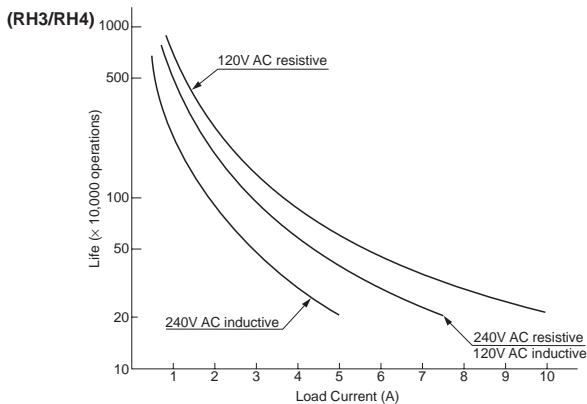
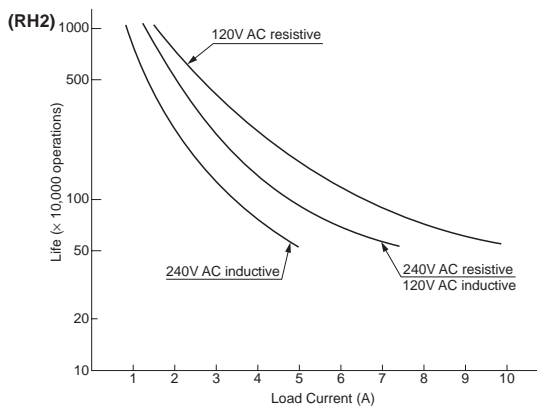
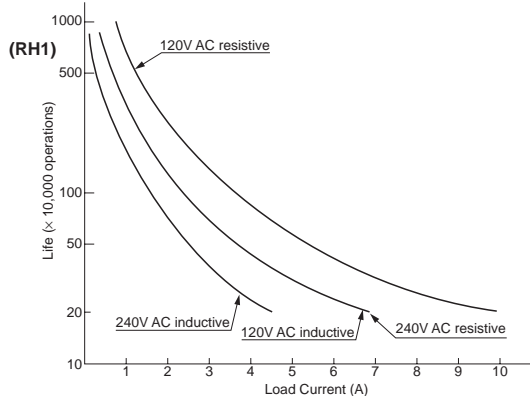
Note: Above values are initial values.

1. Measured using 5V DC, 1A voltage drop method
2. Measured at the rated voltage (at 20°C), excluding contact bouncing
Release time of relays with diode: 40 ms maximum
3. Relays with indicator or diode: 1000V AC, 1 minute
4. For use under different temperature conditions, refer to Continuous Load Current vs. Operating Temperature Curve. The operating temperature range of relays with indicator or diode is -25 to +40°C.

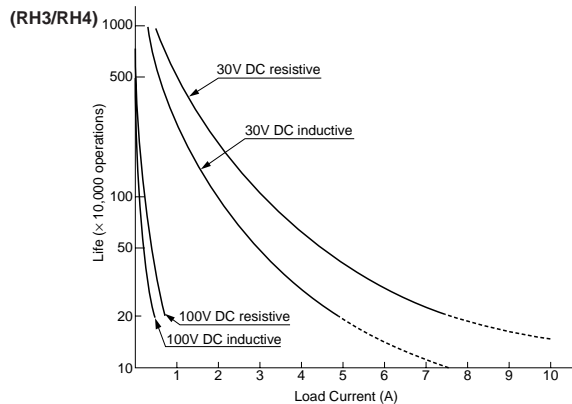
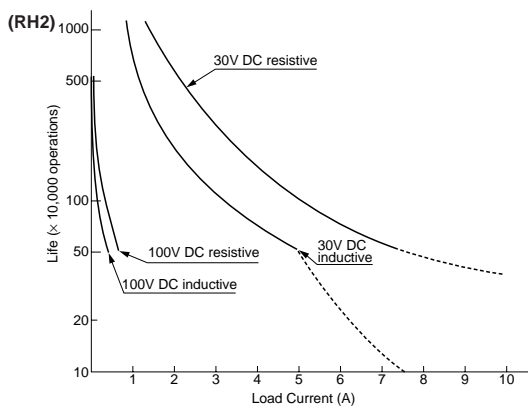
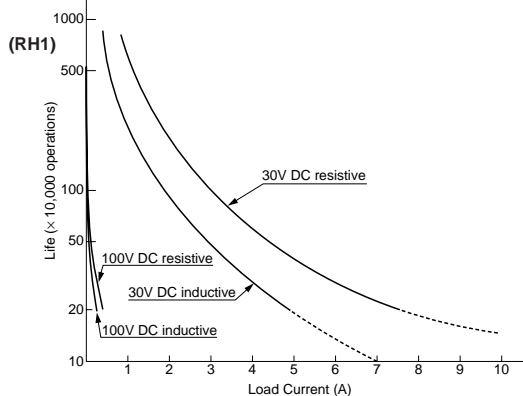
Characteristics (Reference Data)

Electrical Life Curves

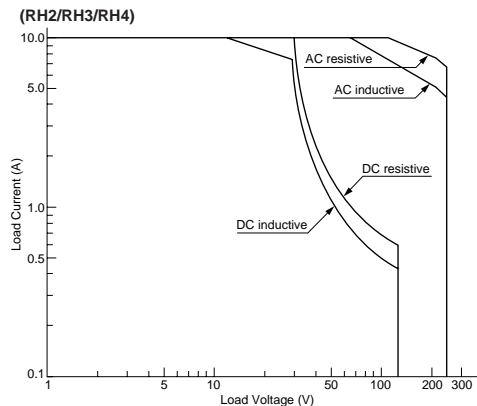
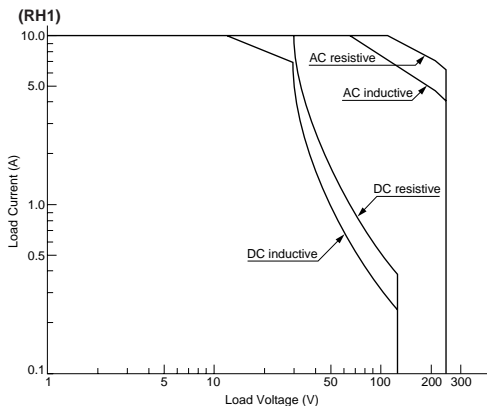
AC Load



DC Load



Maximum Switching Capacity



Switches & Pilot Lights

Display Lights

Relays & Sockets

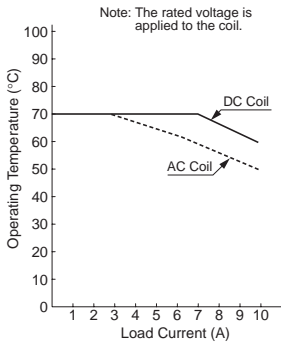
Timers

Terminal Blocks

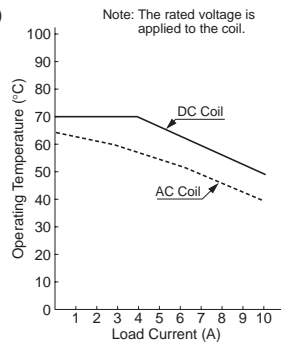
Circuit Breakers

Continuous Load Current vs. Operating Temperature Curve (Basic Type, With Check Button, and Top Bracket Mounting Type)

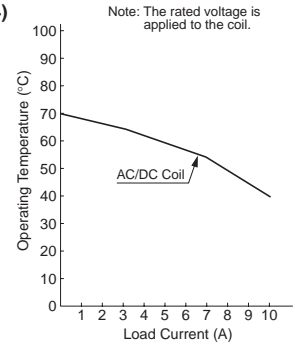
(RH1)



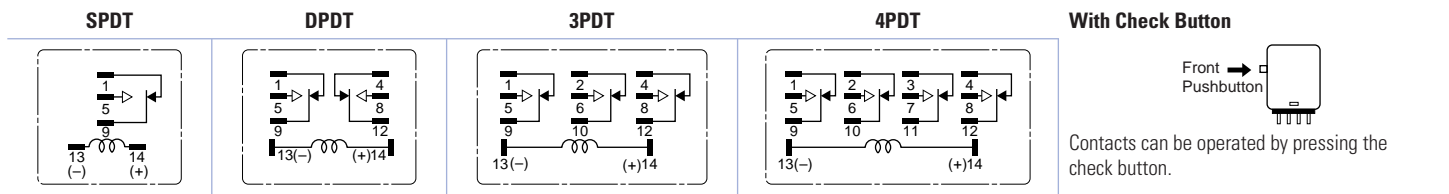
(RH2)



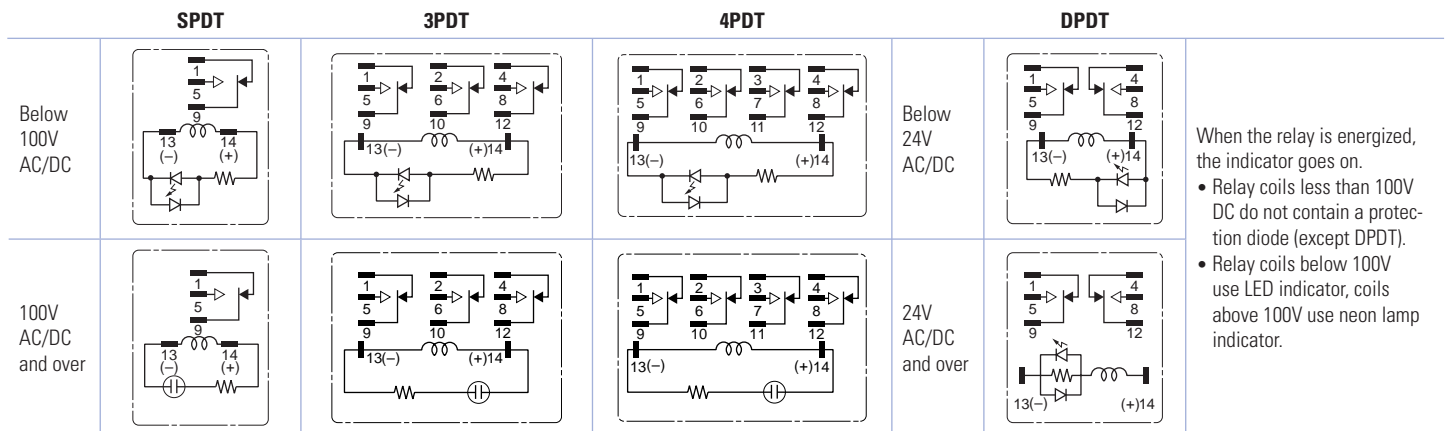
(RH3/RH4)



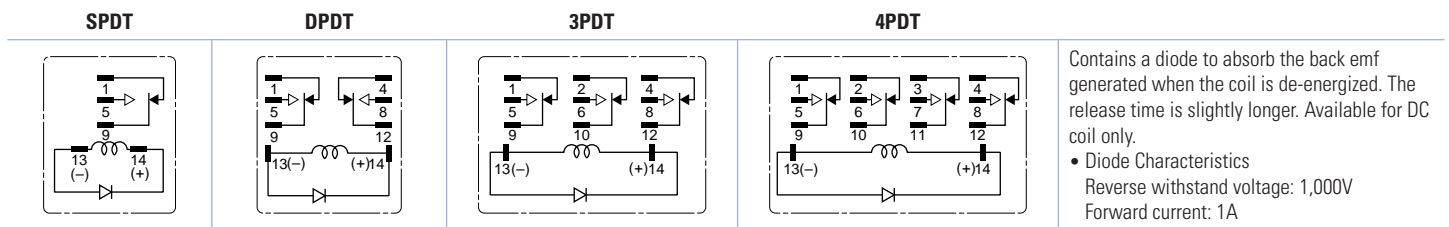
**Internal Connection (View from Bottom)
 Basic Type**



With Indicator (-L type)



With Diode (-D type)



Switches & Pilot Lights

Display Lights

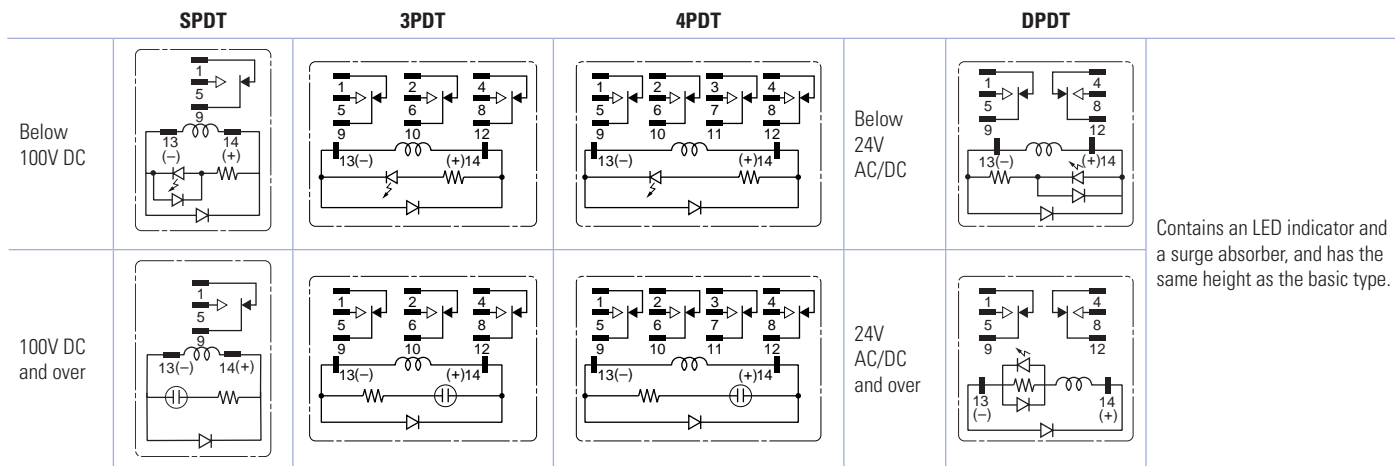
Relays & Sockets

Timers

Terminal Blocks

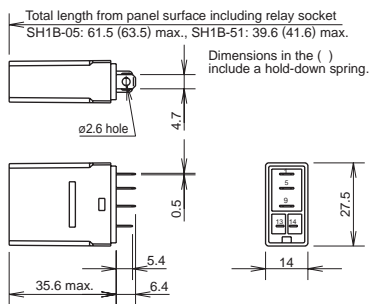
Circuit Breakers

With Indicator LED & Diode (-LD type)

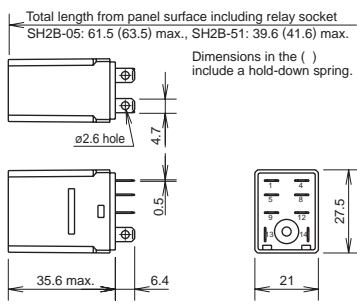


Dimensions (mm)

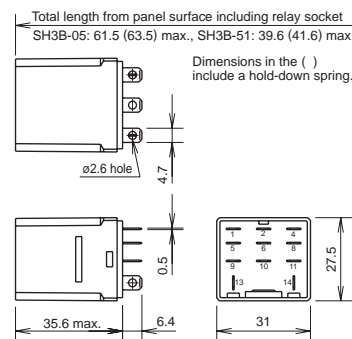
RH1B-U/RH1B-UL/RH1B-UD/RH1B-ULD



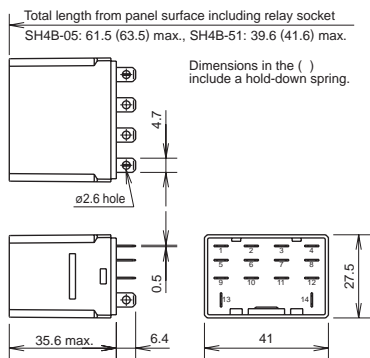
RH2B-U/RH2B-UL/RH2B-UD/RH2B-ULD



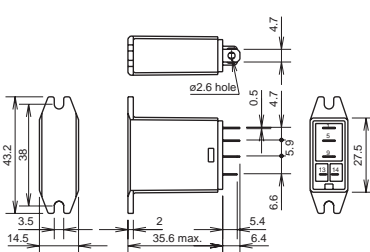
RH3B-U/RH3B-UL/RH3B-D/RH3B-LD



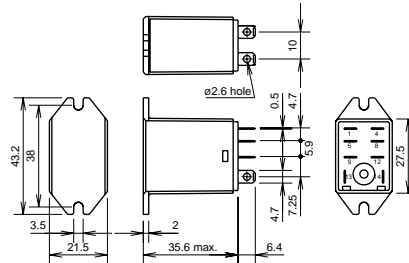
RH4B-U/RH4B-UL/RH4B-UD/RH4B-LD



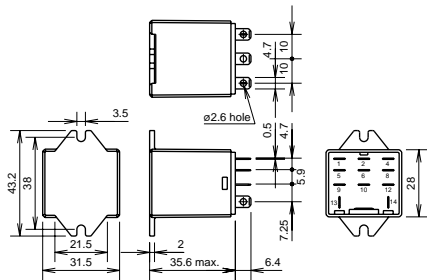
RH1B-UT



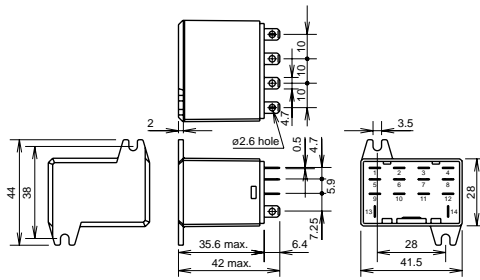
RH2B-UT



RH3B-UT



RH4B-UT



Switches & Pilot Lights

Display Lights

Relays & Sockets

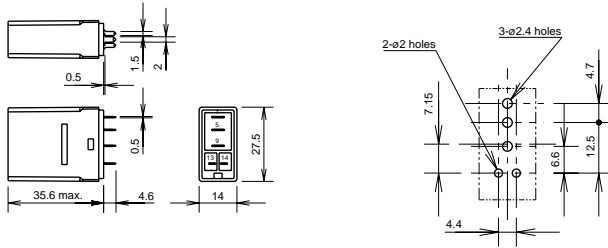
Timers

Terminal Blocks

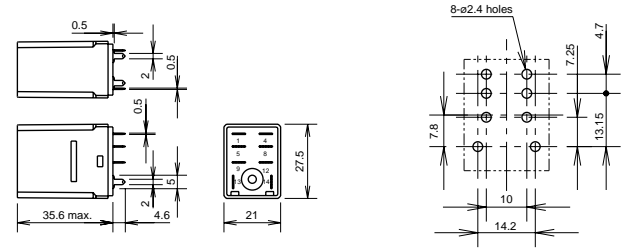
Circuit Breakers

Dimensions con't (mm)

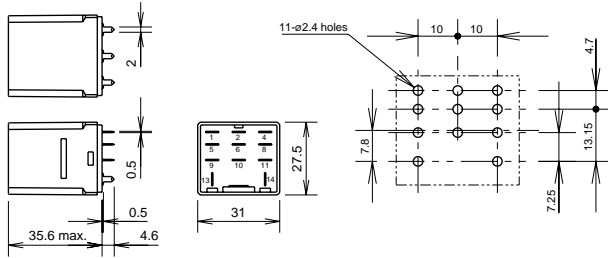
RH1V2-U/RH1V2-UD



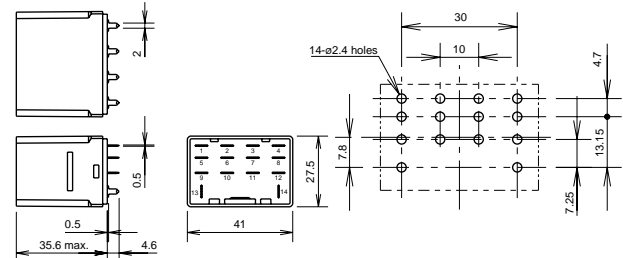
RH2V2-U/RH2V2-UL/RH2V2-UD



RH3V2-U/RH3V2-UL/RH3V2-D

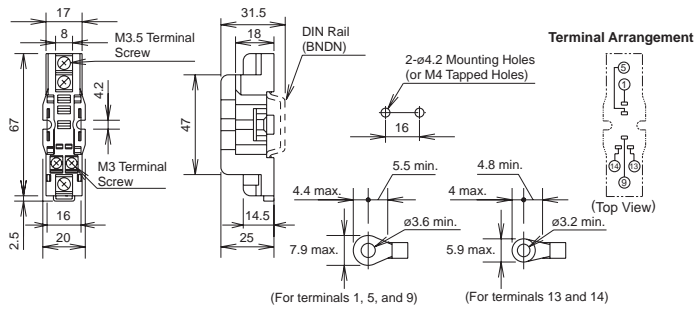


RH4V2-U/RH4V2-UL/RH4V2-UD

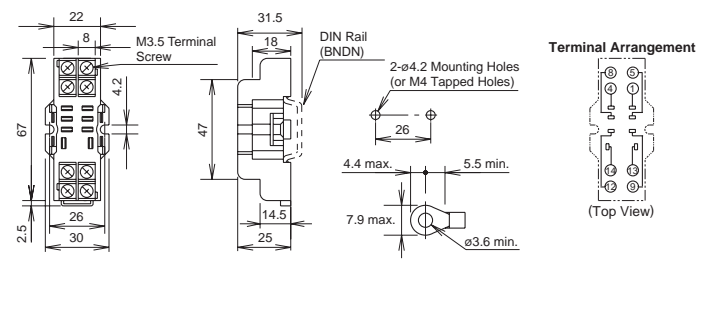


Standard DIN Rail Mount Sockets

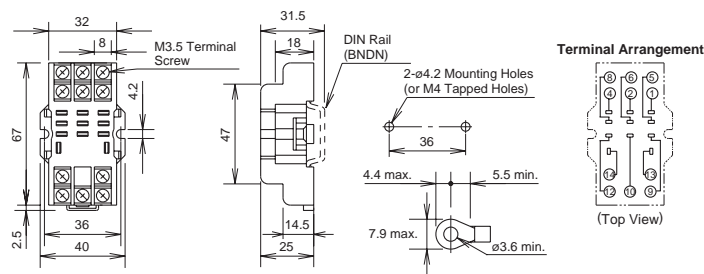
SH1B-05



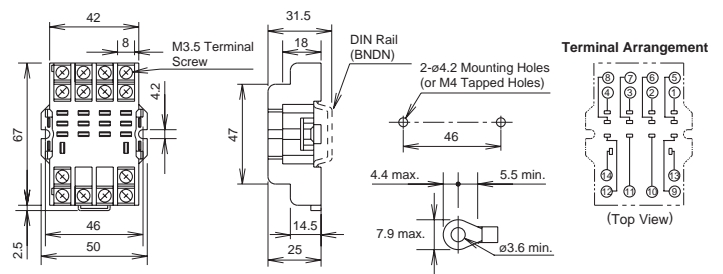
SH2B-05



SH3B-05



SH4B-05



Switches & Pilot Lights

Display Lights

Relays & Sockets

Timers

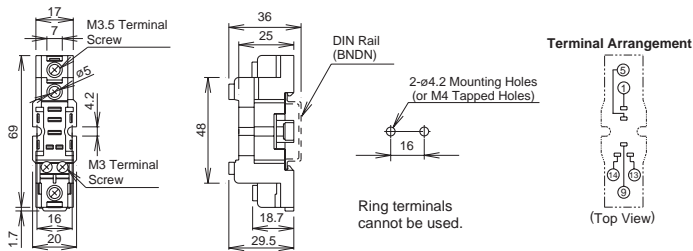
Terminal Blocks

Circuit Breakers

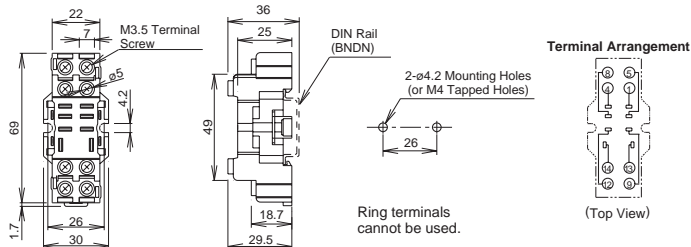
Dimensions con't (mm)

Finger-safe DIN Rail Mount Sockets

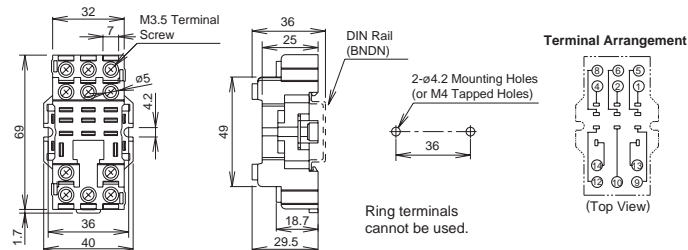
SH1B-05C



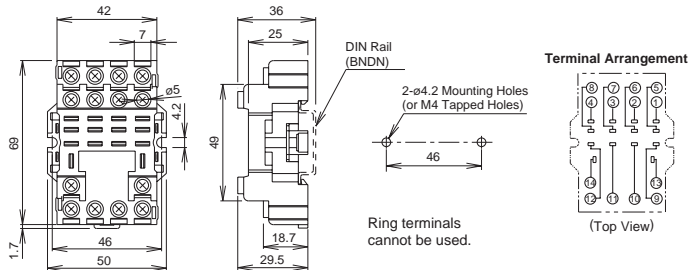
SH2B-05C



SH3B-05C

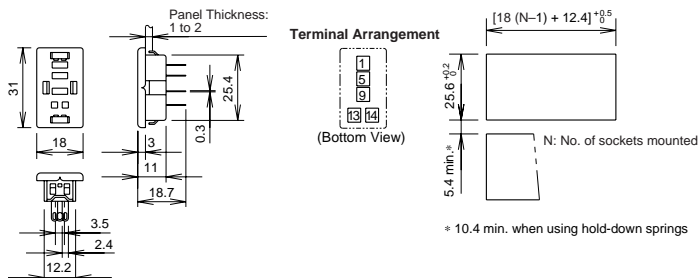


SH4B-05C

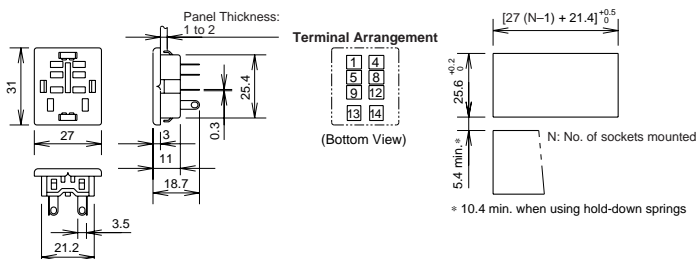


Through Panel Mount Socket

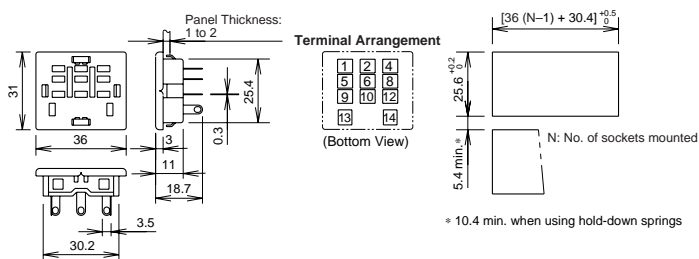
SH1B-51



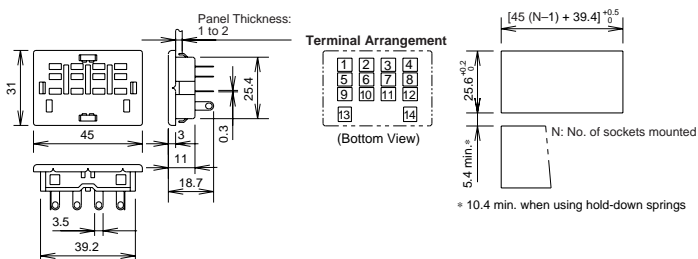
SH2B-51



SH3B-51



SH4B-51



Switches & Pilot Lights

Display Lights

Relays & Sockets

Timers

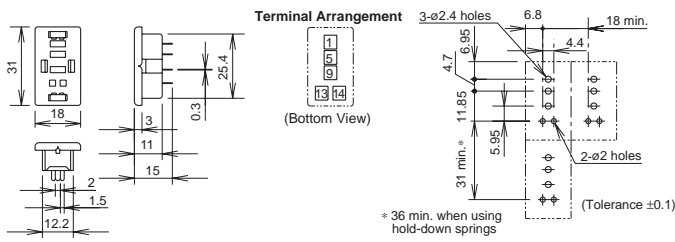
Terminal Blocks

Circuit Breakers

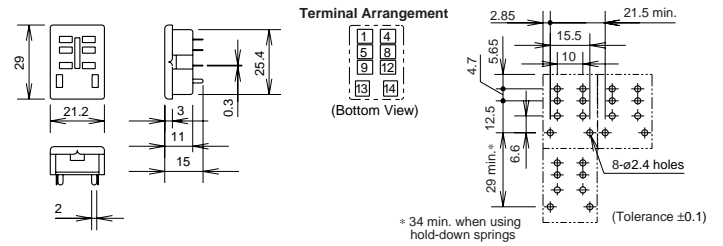
Dimensions con't (mm)

PCB Mount Sockets

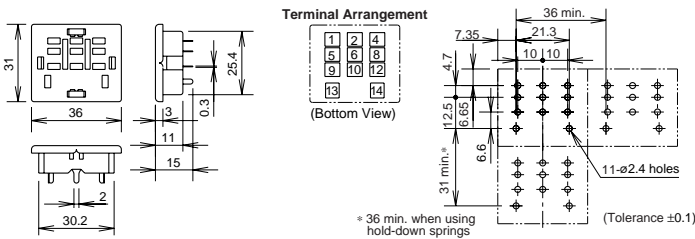
SH1B-62



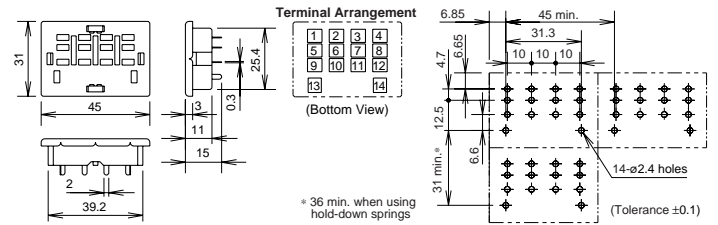
SH2B-62



SH3B-62



SH4B-62



Switches & Pilot Lights

Display Lights

Relays & Sockets

Timers

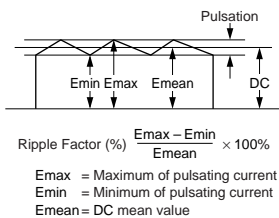
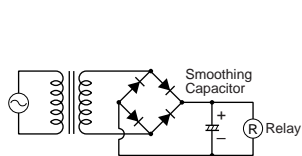
Terminal Blocks

Circuit Breakers

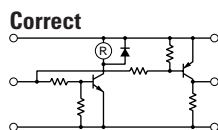
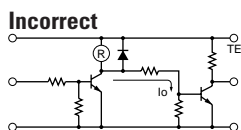
Operating Instructions

Driving Circuit for Relays

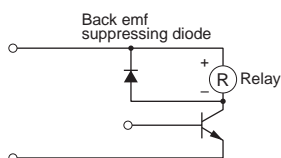
- To ensure correct relay operation, apply rated voltage to the relay coil.
- Input voltage for the DC coil:
A complete DC voltage is best for the coil power to make sure of stable relay operation. When using a power supply containing a ripple voltage, suppress the ripple factor within 5%. When power is supplied through a rectification circuit, the relay operating characteristics, such as pickup voltage and dropout voltage, depend on the ripple factor. Connect a smoothing capacitor for better operating characteristics as shown below.



- Leakage current while relay is off:
When driving an element at the same time as the relay operation, special consideration is needed for the circuit design. As shown in the incorrect circuit below, leakage current (I_0) flows through the relay coil while the relay is off. Leakage current causes coil release failure or adversely affects the vibration resistance and shock resistance. Design a circuit as shown in the correct example.



- Surge suppression for transistor driving circuits:
When the relay coil is turned off, a high-voltage pulse is generated, causing a transistor to deteriorate and sometimes to break. Be sure to connect a diode to suppress the back electromotive force. Then, the coil release time becomes slightly longer. To shorten the coil release time, connect a Zener diode between the collector and emitter of the transistor. Select a Zener voltage slightly higher than the power voltage.



Protection for Relay Contacts

- The contact ratings show maximum values. Make sure that these values are not exceeded. When an inrush current flows through the load, the contact may become welded. If this is the case, connect a contact protection circuit, such as a current limiting resistor.
- Contact protection circuit:
When switching an inductive load, arcing causes carbides to form on the contacts, resulting in increased contact resistance. In consideration of contact reliability, contact life, and noise suppression, use of a surge absorbing circuit is recommended. Note that the release time of the load becomes slightly longer. Check the operation using the actual load. Incorrect use of a contact protection circuit will adversely affect switching characteristics. Four typical examples of contact protection circuits are shown in the following table:

RC		This protection circuit can be used when the load impedance is smaller than the RC impedance in an AC load power circuit. • R: Resistor of approximately the same resistance value as the load • C: 0.1 to 1 μF
Diode		This protection circuit can be used for DC load power circuits. Use a diode with the following ratings. Reverse withstand voltage: Power voltage of the load circuit x 10 Forward current: More than the load current
Varistor		This protection circuit can be used for both AC and DC load power circuits. For a best result, when using a power voltage of 24 to 48V AC/DC, connect a varistor across the load. When using a power voltage of 100 to 240V AC/DC, connect a varistor across the contacts.

- Do not use a contact protection circuit as shown below:

	This protection circuit is very effective in arc suppression when opening the contacts. But, the capacitor is charged while the contacts are opened. When the contacts are closed, the capacitor is discharged through the contacts, increasing the possibility of contact welding.
	This protection circuit is very effective in arc suppression when opening the contacts. But, when the contacts are closed, a current flows to charge the capacitor, causing contact welding.

Generally, switching a DC inductive load is more difficult than switching a DC resistive load. Using an appropriate arc suppressor, however, will improve the switching characteristics of a DC inductive load.

Soldering

- When soldering the relay terminals, use a soldering iron of 30 to 60W, and quickly complete soldering (within approximately 3 seconds).
- Use a non-corrosive rosin flux.

Operating Instructions con't

Other Precautions

1. General notice:
 - To maintain the initial characteristics, do not drop or shock the relay.
 - The relay cover cannot be removed from the base during normal operation. To maintain the initial characteristics, do not remove the relay cover.
 - Use the relay in environments free from condensation, dust, sulfur dioxide (SO₂), and hydrogen sulfide (H₂S).
 - Make sure that the coil voltage does not exceed applicable coil voltage range.
2. UL and CSA ratings may differ from product rated values determined by IDEC.
3. Do not use relays in the vicinity of strong magnetic field, as this may affect relay operation.

Safety Precautions

- Turn off the power to the relay before starting installation, removal, wiring, maintenance, and inspection of the relays. Failure to turn power off may cause electrical shock or fire hazard.
- Observe specifications and rated values, otherwise electrical shock or fire hazard may be caused.
- Use wires of the proper size to meet voltage and current requirements. Tighten the terminal screws on the relay socket to the proper tightening torque.
- Surge absorbing elements on AC relays with RC or DC relays with diode are provided to absorb the back electromotive force generated by the coil. When the relay is subject to an excessive external surge voltage, the surge absorbing element may be damaged. Add another surge absorbing provision to the relay to prevent damage.

Precautions for the RU Relays

- Before operating the latching lever of the RU relay, turn off the power to the RU relay. After checking the circuit, return the latching lever to the original position.
- Do not use the latching lever as a switch. The durability of the latching lever is a minimum of 100 operations.
- When using DC loads on 4PDT relays, apply a positive voltage to terminals of neighboring poles and a negative voltage to the other terminals of neighboring poles to prevent the possibility of short circuits.
- DC relays with a diode have a polarity in the coil terminals. Apply the DC voltage to the correct terminals.



250 Series DIN-rail and Wall Mounted Relays

Phase Balance

The 250 series phase balance protector module provides continuous surveillance of a three-phase, three- or four-wire system and monitors the correct phase rotation or sequence of three-phase supply systems. The module protects against phase loss, reversal or sequence, phase unbalance and system under-voltage.

Operation

Rotating machines are particularly vulnerable to incorrect phase sequence. Three-phase motors can rotate in the wrong direction, potentially leading to physical damage or the risk of injury to personnel, yet voltage and current readings may appear normal. If one phase is lost because of a blown fuse, electric motors can continue to operate (single-phasing) which can result in severe electrical or mechanical damage. This relay has the added advantage that it will detect the phantom or regenerated phase that can be caused by a single-phase failure on some equipment or when running motors at low load levels.

An unbalanced supply voltage can lead to temperature rises in motors. An unbalanced voltage as little as 10% can increase operating temperature to 150% of normal. For permanent installations, this relay should be used to monitor the incoming supply, protecting all equipment against incorrect connection at initial installation or after maintenance work. Rotating machines that cannot tolerate reverse rotation or pose significant risk to personnel under this condition should be individually protected with this relay. The possibility of incorrect supply connection is much more likely in portable equipment or marine applications.

The protector continuously monitors the three-phase supply. With the correct phase sequence applied and all three voltages balanced within the required limits, the front panel LED will illuminate and the output relay will be energised. An incorrect sequence, missing phase, out of balance or under-voltage condition will de-energise the relay and the LED will be extinguished.

The set point control allows adjustment of the voltage matching between 5% and 15%. The time delay function operates only for the voltage unbalance condition. The delay can be used to prevent nuisance tripping due to short term unbalance situations. Incorrect phase rotation, a missing phase or an under-voltage condition trip the relay immediately.

Features

- Three-phase, three or four-wire
- Adjustable set point
- Adjustable time delay
- Internal differential
- LED trip indication
- Double-pole relay contacts
- Automatic reset

Benefits

- Monitoring of correct phase rotation
- Protects against phantom or regenerated phase voltage
- Protection against phase loss, reversal or sequence
- Under-voltage and unbalanced voltage monitoring
- Prevents reverse rotation of motor driven equipment
- Ensures correct engine rotation
- Protects portable electrical equipment
- Nuisance tripping avoidance

Applications

- Marine panels
- Switchgear
- Distribution systems
- Generator sets
- Control panels
- Process control
- Motor protection
- Transformers
- Overload protection

Product Codes

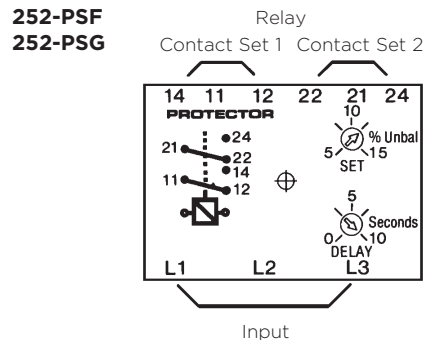
Relay	Protection	ANSI no.	Cat. no.
3-phase 3- or 4-wire	Phase loss and unbalance 5-15%	47	252-PSF
3-phase 3- or 4-wire	Phase loss, unbalance and under-voltage 5-15%	47/27	252-PSG

Please specify system voltage, frequency and required options at time of ordering.

Specification - Phase Balance

Nominal voltage	110V, 120V, 208V, 220V, 230V, 240V, 277V, 380V, 400V, 415V, 440V or 480V
System frequency	50 or 60Hz
Voltage burden	3VA approx.
Overload	1.2 x rating continuously, 1.5 x rating for 10 x seconds
Set point repeatability	>0.5% of full span
Under-voltage set point	Pre-set at 15% of nominal voltage. Other values 10 to 30% to order (model 252-PSG only)
Trip level adjustment	Phase unbalance adjustable 5 to 15%
Time delay	10 seconds as standard. Up to 30 seconds available
Auxiliary voltage burden	4VA (max)
Output relay	2-pole change over
Relay contact rating	AC: 240V 5A, non inductive DC: 24V 5A resistive
Relay mechanical life	0.2 million operations at rated loads
Relay reset	Automatic
Operating temperature	0°C to +60°C (0°C to +40°C for UL models)
Storage temperature	-20°C to +70°C
Temperature co-efficient	0.05% per °C
Interference immunity	Electrical stress surge withstand and non-function to ANSI/IEEE C37 90a
Enclosure style	DIN-rail with wall mounting facility
Material	Flame retardant polycarbonate/ABS
Enclosure integrity	IP50
Model 252 dimensions	55mm (2.2") wide x 70mm (2.8") high x 112mm (4.4") deep
Weight	0.4Kg approx.

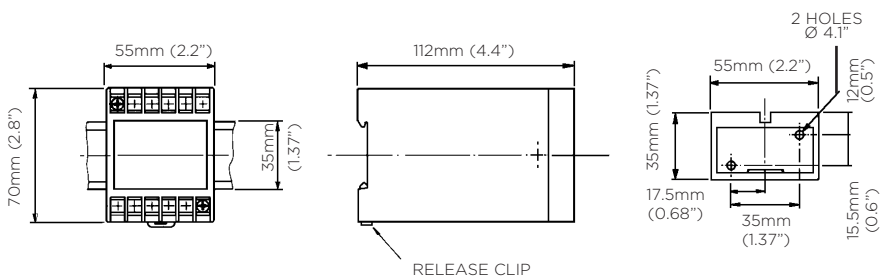
Connections



Note: Neutral connection not required.

Dimensions

Model 252



5. Chassis



Halmac Services (Qld) Pty. Ltd.
A.C.N. 098 852 923
A.B.N. 40 741 712 113

CHASSIS

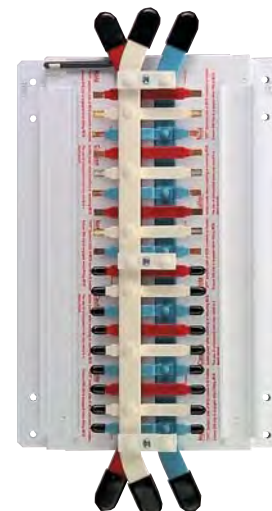
1. CD-2 CHASSIS TECHNICAL DETAILS



Panelboards, loadcentres and accessories

2 CONCEPT•PLUS and Premier busbar chassis – Din-T

- Standards AS/NZS 3439
- Current rating 250 A
- Withstand rating 250 A/20 kA for 0.2 sec
- Splayed busbar to suit 160 A & 250 A switch
- Top and bottom feed – splayed top & bottom
- Tee-offs stripped and 50% capped
- Top power feed stripped and capped
- Full 35 mm DIN rail, improved MCB mounting security
- Improved insulation coating



3 pole CD chassis to suit Din-T MCBs

Concept Din-T – 250 to suit Din-T MCBs (18 mm pole pitch) ³⁾

Pole capacity	250 A Cat. No. ¹⁾
12	CD-2-12/18-3U
18	CD-2-18/18-3U
24	CD-2-24/18-3U
30	CD-2-30/18-3U
36	CD-2-36/18-3U
42	CD-2-42/18-3U
48	CD-2-48/18-3U
54	CD-2-54/18-3U
60	CD-2-60/18-3U
72	CD-2-72/18-3U
78	CD-2-78/18-3U
84	CD-2-84/18-3U
96	CD-2-96/18-3U

- Notes:** ¹⁾ 4 pole and other special configurations available to special order refer NHP. 'OFF' (line) side of MCB connects to chassis tee-off.
 MCB DIN clips may be disengaged or removed when mounting onto "CD" chassis. If applicable use insulated tool provided to disengage DIN clip when removing MCB from chassis.
³⁾ Not suitable for CONCEPT economy Panelboards. Contact NHP for availability. Available on indent only.

Accessories

Description	Cat. No.
Split tariff kit 250/355 A (supplied loose)	STKCD
Split tariff kit (fitted)	REFER NHP
Plastic tee-off cap 250 / 355 A	CD250TOPC

Technical data – CD/CT busbar chassis

Description	CD-250 A
Busbar rating (Amp)	250
Voltage rating (V)	415
Short circuit rating (kA)	20
Short circuit time (sec)	0.2
Insulation material	Polyolefin PPA-441

Catalogue number structure – CD/CT busbar chassis

XX	X	XX	XX	X
Type	Current rating	No. of ways	Pole pitch (mm)	No. of phases
CD Din-T	2 250 A	12	18 Din-T	2 1 P + N (red, black)
CDH Din-T10H	3 355 A	18	27 Din-T10H	3 3 P (red, white, blue)
CT Safe-T	Etc.	24	27/18 Hybrid Din-T10H/Din-T	4 3 P + N (red, white, blue, black)
		30	25 Safe-T	
		36 etc.		
		27 mm/18 mm		
		6/24		
		12/60		



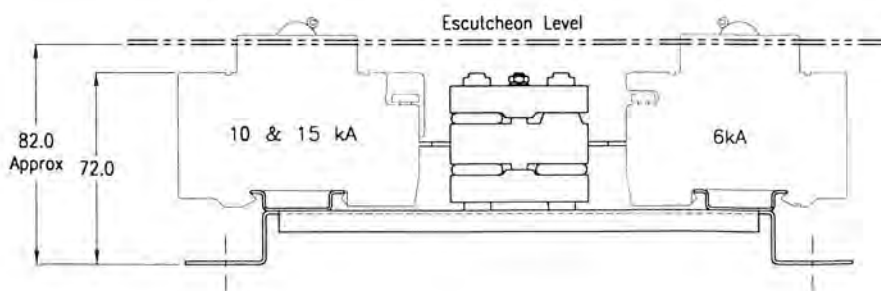
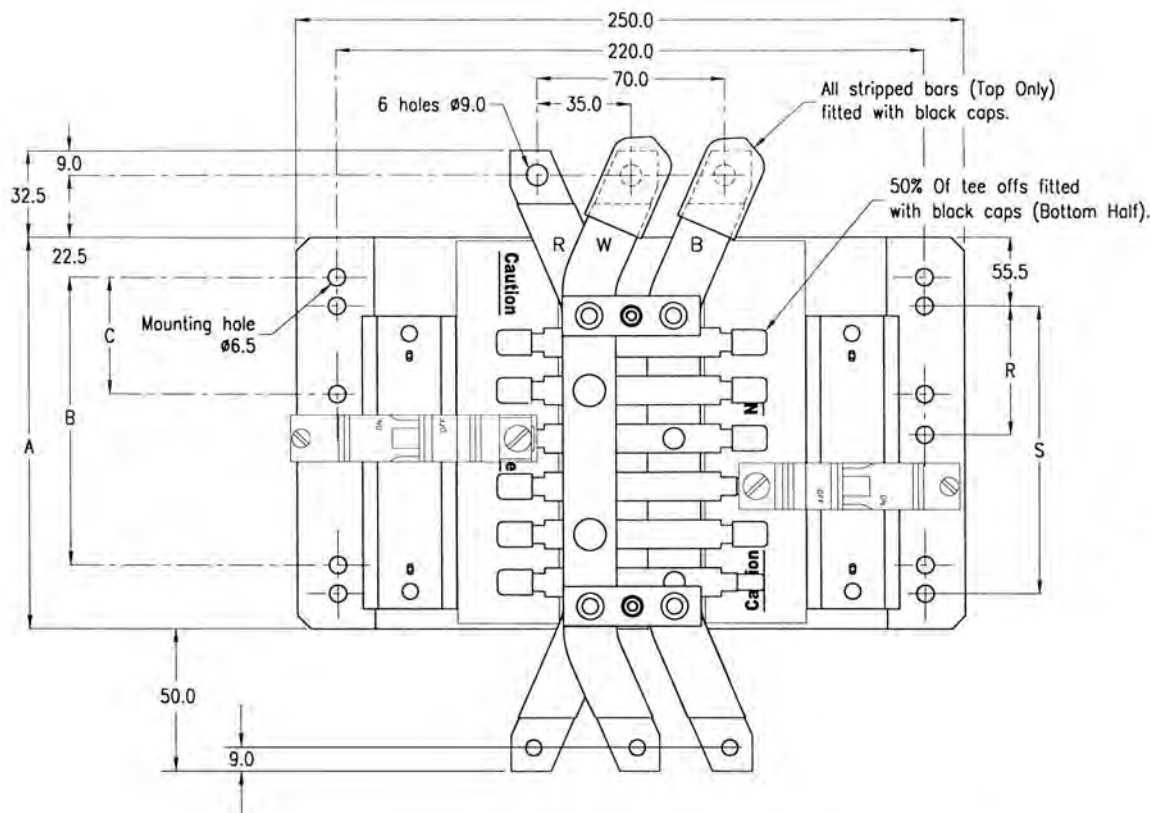


Panelboards, loadcentres and accessories

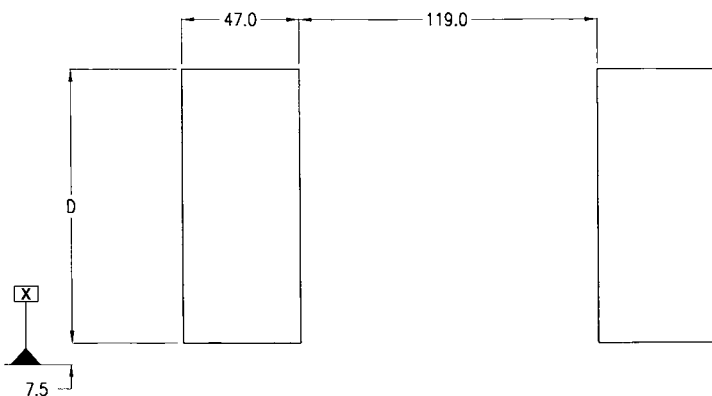
Dimensions (mm)

2

CD chassis 250 to suit Din-T6, 10 and 15



Escutcheon cut-out details



Dimensions (mm)

Chassis size ¹⁾	A	B	C	D	R	S
CD-X-12/18-3U	152	100	-	110	-	100
CD-X-18/18-3U	206	100	-	164	-	100
CD-X-24/18-3U	260	100	-	218	-	100
CD-X-30/18-3U	314	200	-	272	-	200
CD-X-36/18-3U	368	300	-	326	-	300
CD-X-42/18-3U	422	300	-	280	-	300
CD-X-48/18-3U	476	400	-	434	-	400
CD-X-54/18-3U	530	400	-	488	-	400
CD-X-60/18-3U	584	500	-	542	-	500
CD-X-72/18-3U	692	600	-	650	-	600
CD-X-78/18-3U	745	700	300	704	300	700
CD-X-84/18-3U	800	700	300	758	300	700
CD-X-96/18-3U	908	800	400	866	400	800

Notes: ¹⁾ "X" insert **2** = 250 A or **3** = 355 A, current rating does not effect above dims.
 Maximum current rating of tee-off = 100 A.
 'OFF' (line) side of MCB connects to chassis tee-off.
 MCB DIN clips may be disengaged or removed when mounting onto "CD" chassis.
 Use insulated tool provided to disengage DIN clip when removing MCB from chassis.

6. Fuse & Fuse Holder



Halmac Services (Qld) Pty. Ltd.
A.C.N. 098 852 923
A.B.N. 40 741 712 113

FUSE & FUSE HOLDER

1. FUSE LINKS TECHNICAL DETAILS
2. FUSE HOLDER TECHNICAL DETAILS

BS compact fuse links

- Complies with BS 88
- Reduced dimensions
- Low watts loss

Refer catalogue NF

Clip-in offset tags

Rating (A)	BS 88 ref.	Overall length (mm)	Overall Dia. (mm)	Cat. No. ¹⁾			
2	F1	60	14	NNS 2			
4				NNS 4			
6				NNS 6			
10				NNS 10			
16				NNS 16			
20				NNS 20			
25				NNS 25			
32				NNS 32			
20M25				NNS 20M25			
20M32				NNS 20M32			
20				F2	68	17	NES 20
25							NES 25
32	NES 32						
40	NES 40						
50	NES 50						
63	NES 63						

FUSES PROVIDE SUPERIOR SHORT CIRCUIT PROTECTION



NNS 2



NES 20



NNIT 16



NTIA 16

Bolted pattern offset tags

Rating (A)	BS 88 ref.	Fixing centres (mm)	Cat. No. ¹⁾		
2	A1	44.5	NNIT 2		
4			NNIT 4		
6			NNIT 6		
10			NNIT 10		
16			NNIT 16		
20			NNIT 20		
25			NNIT 25		
32			NNIT 32		
20M25			NNIT 20M25		
20M32			NNIT 20M32		
32M40			NNIT 32M40		
32M50			NNIT 32M50		
32M63			NNIT 32M63		
2			A2	73	NTIA 2
4					NTIA 4
6	NTIA 6				
10	NTIA 10				
16	NTIA 16				
20	NTIA 20				
25	NTIA 25				
32	NTIA 32				
32M40	NTIA 32M40				
32M50	NTIA 32M50				
32M63	NTIA 32M63				

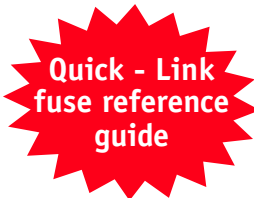
Note: ¹⁾ 'M' in catalogue No. denotes motor starting type.

DIN and BS fuse link selection chart

BS Fuses

Switch-fuses								Fuse type Cat. No. Prefix
800	630	400	315	250	200	160	125	
								NNS_
								NNIT_
						✓	✓	NTIA_
						✓	✓	NTIS_
						✓	✓	NOS_
						✓		NTCP_
								NTFP_
								NTSLOO_
		✓	✓	✓	✓			NTBC_
		✓	✓	✓	✓			NTC_
		✓	✓	✓	✓			NTF_
		✓	✓	✓				NTKF_
								NTSL3_
		✓						NTMF_
✓	✓							NTM_
✓	✓							NTTM_
✓								NTLM_

NHP HRC fuse holders									Fuse type Cat. No. Prefix
NC (Bolt-in)						NV (Clip-in)			
315	200	100	63	32	20	63	32	20	
							✓	✓	NNS_
						✓			NES_
				✓	✓				NNIT_
	✓ ¹⁾	✓	✓						NTIA_
	✓ ¹⁾	✓	✓ ²⁾						NTIS_
	✓ ¹⁾	✓							NOS_
	✓								NTCP_
	✓								NTFP_
✓									NTBC_
✓									NTC_
✓									NTF_
✓									NTKF_



DIN Fuses

Switch-fuses						Fuse type Cat. No. Prefix
800	630	400	250	160	125	
				✓	✓	N00_
			✓			N1_
		✓				N2_
✓	✓					N3_

- Legend:**
- ✓ Fuse links fit direct.
 - ✓¹⁾ Fuses require 100MFLK adaptor, see page 11-107.
 - ✓²⁾ 'M' type (motor rated) NTIS not suitable for NC63_. Use NC100 fuse holder.

HRC

High rupturing capacity (HRC) or High breaking capacity denotes the ability of a fuse-link to interrupt extremely high fault currents, usually up to 80kA.

Current limiting fuse-link

A fuse-link that limits the circuit current during it's operation to a value much lower than the peak value of the prospective current. In practice, the terms HRC and current limiting are synonymous.

Rated breaking capacity

The highest value of fault current that a fuse-link has been tested to interrupt eg. 80kA.

Rated voltage

The maximum system voltage that the fuse-link is designed to interrupt. Rated voltages may be in AC, DC, or both.

Current rating

The value of current that a fuse-link will carry continuously without deterioration under specified conditions.

Minimum fusing current

The minimum value of current that will cause melting of the fuse element.

Power dissipation

The power released in a fuse-link carrying rated current under a specified condition, usually expressed in watts.

Time current characteristics (refer table 1)

A curve detailing the pre-arcing or operating time as a function of prospective current.

Let through characteristics (I²t) (refer table 2)

A curve or chart showing values 'pre-arcing' and 'operating' let through energies as a function of prospective current, I²t is proportional to energy in Amp² seconds.

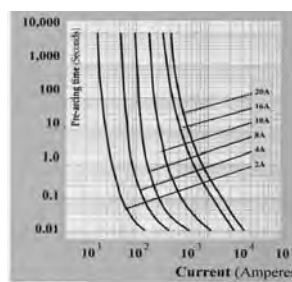
Cut off characteristics (refer table 3)

A curve detailing the cut off current as a function of prospective current. Cut off current being the maximum instantaneous value of current let through by the fuse-link during operation.

Discrimination (refer tables 4 and 5)

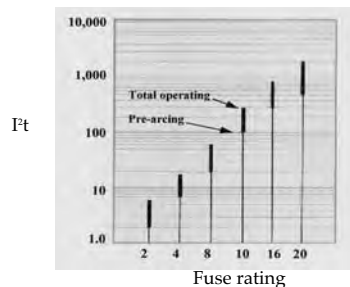
Discrimination is the ability of fuse-links to operate selectively and to disconnect only the parts of the circuit that are subject to faults. Discrimination can be checked by ensuring that the time current characteristics, including their tolerances, do not overlap at any point and that the total let through energy (I²t) of the downstream (or minor) fuse-link does not exceed the pre-arcing energy (I²t) of the upstream (or major) fuse-link at the applied system voltage. Discrimination is normally achieved with the ratio of 1.6 between upstream and downstream fuses.

Table 1



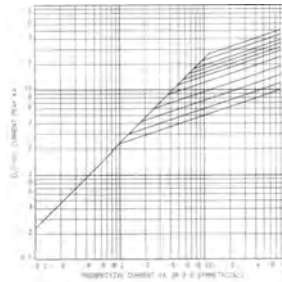
Typical time current curves

Table 2



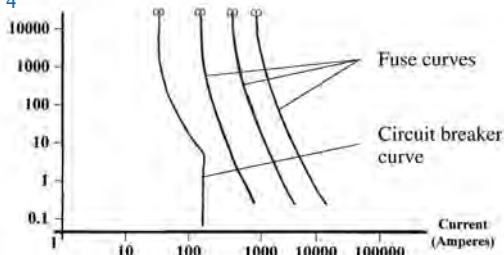
Operating and pre-arcing I²t values

Table 3



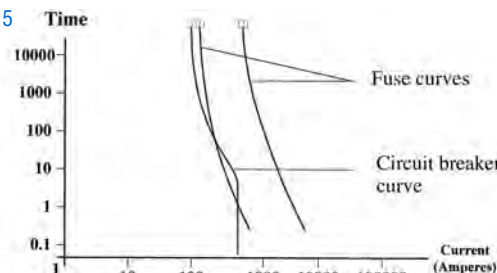
Cut off characteristics

Table 4



Discrimination achieved

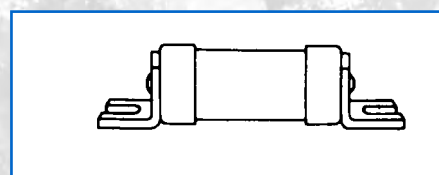
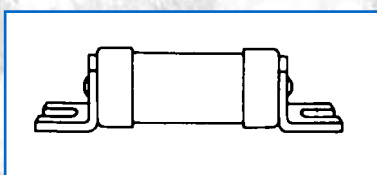
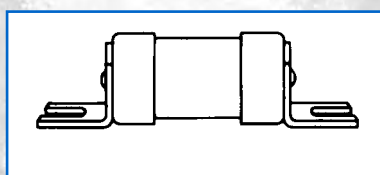
Table 5



Discrimination NOT achieved

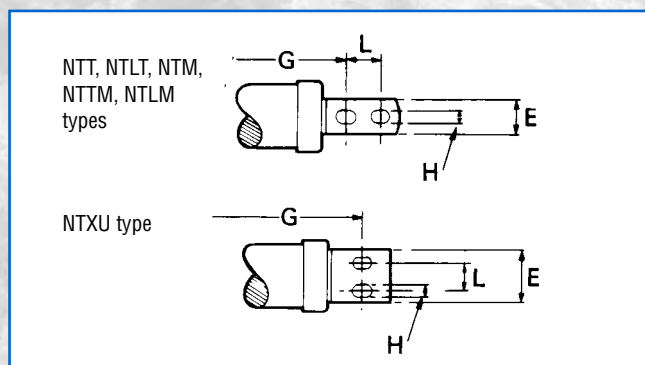
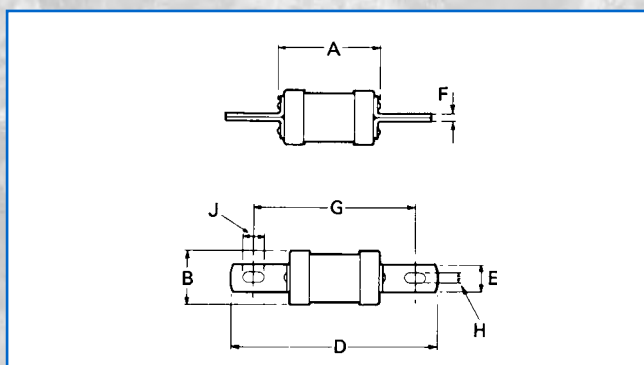
Dimensions (mm)

Fuse link type	A max. mm	B max. mm	D max. mm	E mm	F mm	G nom. mm	H mm	J mm
NNIT	36	14	55	11	0.8	44.5	4.8	-
NTIA } NTIS }	56	21	86	9	1.2	73	5.5	7.5
NTIS(M)	58	26	90	13	1.6	73	5.5	-
NOS	58	27	90	13	1.6	73	5.5	-
NTCP	62	27	110	19	2.4	94	8.7	-
NTCP(M)	62	30	110	19	2.4	94	8.7	-
NTFP	77	30	110	19	2.4	94	8.7	10.3
NTFP(M)	77	40	110	19	2.4	94	8.7	10.3

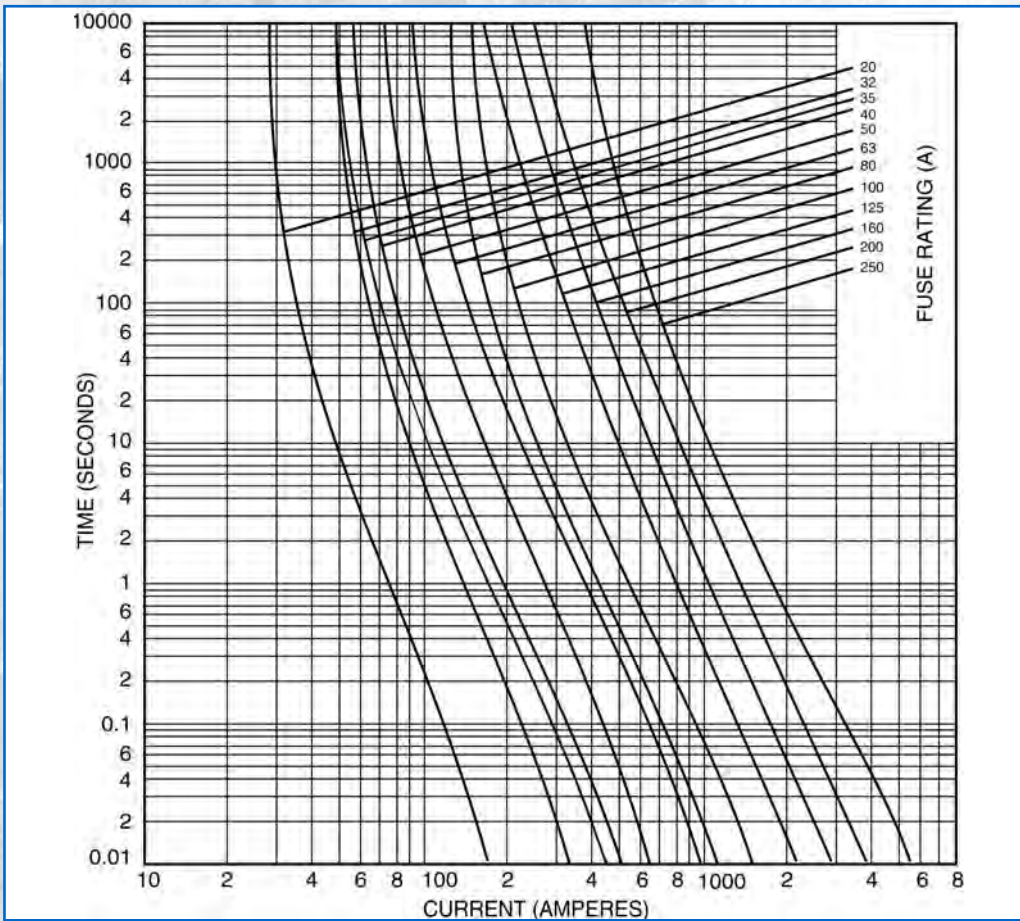


Dimensions (mm)

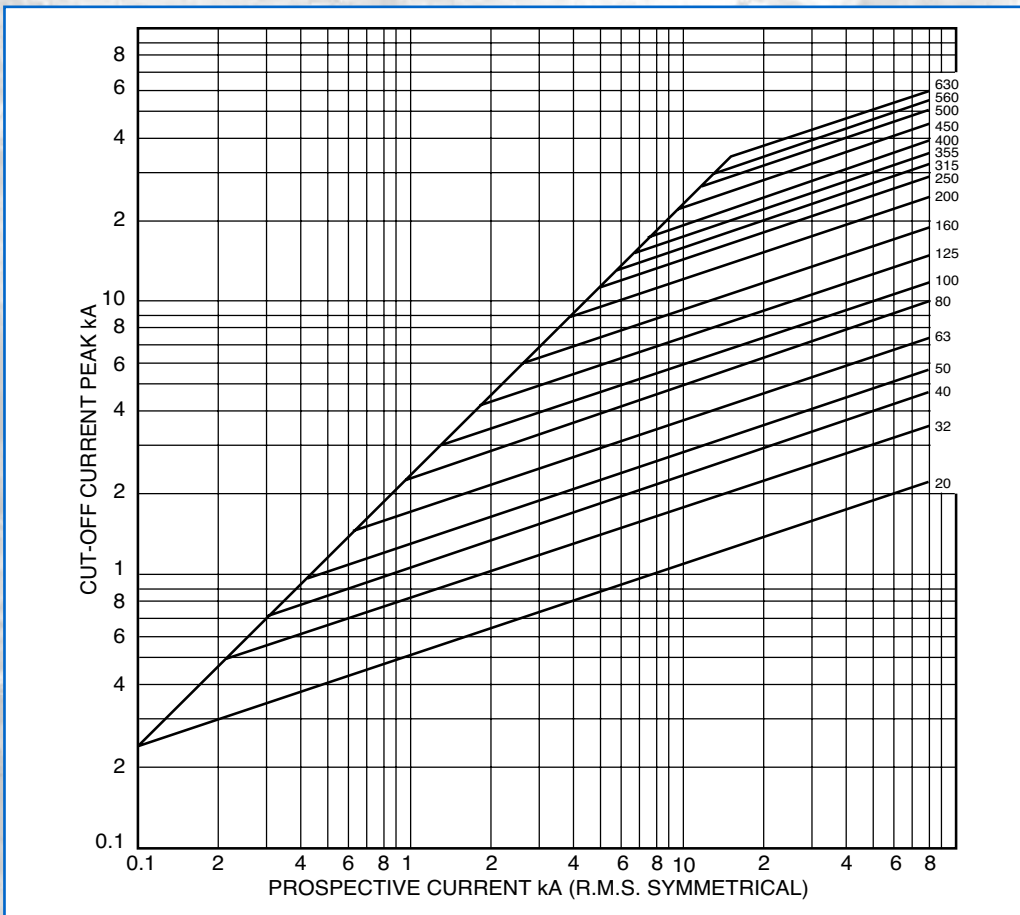
Fuse link type	A max. mm	B max. mm	D max. mm	E mm	F mm	G nom. mm	H mm	J mm	L mm
NTB	57	21	114	13	1.6	97	7.2	11	-
NTB...M...	57	26	116	13	1.6	97	7.2	11	-
NTBC	57	21	134	16	2.0	111	8.7	16	-
NTBC...M...	58	26	136	16	3.2	111	8.7	16	-
NTC	66	36	135	19	3.6	111	8.7	16	-
NTF	76	41	137	19	3.6	111	8.7	16	-
NTKF	76	51	137	26	4.0	111	8.7	16	-
NTMF	81	58	136	26	5.2	111	8.7	16	-
NTKM	76	51	158	26	4.0	133	8.7	16	-
NTM	81	58	210	26	5.2	133/184	10.3	16	25.4
NTTM	83	74	210	26	6.5	133/184	10.3	16	25.4
NLTM	84	82	210	26	10	133/184	10.3	16	25.4
NTT	83	74	267	38	6.5	165	10.3	16	32
NLTL	84	82	267	38	10	165	10.3	16	32
NTXU	83	100	198	63.5	9.5	149	14.3	19	32



I ² t characteristics			
Rating (amperes)	I ² t pre-arcing	I ² t total @ 240 volts	I ² t total @ 415 volts
2	2	2	4
4	10	15	21
6	34	52	74
10	188	289	408
16	92	211	412
20	155	355	690
20M25	574	1084	1809
20M32	574	1561	2605
25	826	1084	1809
32	826	1561	2605
35	1200	2400	4100
32M40	2482	4416	7019
32M50	3305	5879	9345
32M63	5875	10452	16612
40	2482	4416	7019
50	3305	5879	9345
63	5875	10452	16612
80 & 63M80	7800	15500	26000
100 & 63M100	14000	28000	46000
125 & 100M125	30000	51000	75500
160 & 100M160	58500	99000	145000
200 & 100M200	120000	205000	300000
250 & 200M250	210000	360000	530000
315 & 200M315	270000	460000	680000
355	365000	620000	915000
400 & 315M400	480000	820000	1200000
450	755000	1300000	1900000
500	1100000	1850000	2700000
560	1200000	2400000	4000000
630	1550000	3100000	5150000
710	1903565	2992861	4306813
800	3820349	6006505	8643534
1000	7000000	1500000	16000000
1250	12000000	20500000	30000000



NHP Compact BS fuses from 20 to 250 amps



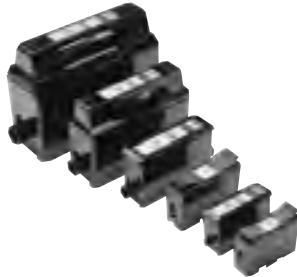
NHP Compact BS fuses cut-off current data from 20 to 630 amps

FUSES PROVIDE SUPERIOR SHORT CIRCUIT PROTECTION

Refer Catalogue NF

Compact fuse holders (Bolt-in)

- New compact size
- Front (FW) or stud/front (SFW) versions
- Smaller dimensions
- Saves panel space



Dimensions (mm)

	H	W	D	Suggested Max. cable size
NC32_	87	27	50	10 mm ²
NC63_	109	31	62	25 mm ²
NC100_	118	35	72	50 mm ²
NC200_	154	54	108	95 mm ²



UP TO 30% SMALLER

Rating (A)	Fuse link to suit		Cat. No.
Front wired – bolt in			
32	NNIT		NC32FW
63	NTIA	NTIS	NC63FW
100	NOS	NTIA NTIS	NC100FW
200	NTIA ¹⁾	NTIS ¹⁾	NC200FW
	NTFP	NOS ¹⁾ NTCP	

Back stud/front wired – bolt in

32	NNIT		NC32SFW
63	NTIA	NTIS	NC63SFW
100	NOS	NTIA NTIS	NC100SFW
200	NTIA ¹⁾	NTIS ¹⁾	NC200SFW
	NTFP	NOS ¹⁾ NTCP	

Note: ¹⁾ Fuses can be fitted using adaptor 100M FLK.

Standard fuse holders (Bolt-in)

- Ratings from 20 to 200 A
- Front (FW) or stud/front (SFW) versions
- Complies with BS88



N20FW

OLD STYLE

Dimensions (mm)

	H	W	D	Suggested Max. cable size
N20_	87	27	50	10 mm ²
N32_	109	31	62	10 mm ²
N63_	118	35	72	50 mm ²
N100_	154	54	108	70 mm ²
N200_	193	70	149	150 mm ²

Rating (A)	Fuse link to suit		Cat. No.
Front wired – bolt in			
20	NNIT		N20FW
32	NTIA		N32FW
63	NTIA	NTIS	N63FW
100	NTIA ¹⁾	NTIS ¹⁾	N100FW
	NOS ¹⁾	NTCP	
200	NTBC	NTC	N200FW
	NTF		

Back stud/front wired – bolt in

20	NNIT		N20SFW
32	NTIA		N32SFW
63	NTIA	NTIS	N63SFW
100	NTIA ¹⁾	NTIS ¹⁾	N100SFW
	NOS ¹⁾	NTCP	
200	NTBC	NTC	N200SFW
	NTF		

Clip-in fuse holders - DIN rail mount

Fast, reliable fitting and removal of fuse links



NV20FW



NV32FW



NV63FW

Rating (A)	Fuse link to suit		Cat. No.
Front wired – clip-in – Black			
20	NSS		NV20FW
32	NSS		NV32FW
63	NES		NV63FW
Front wired – Clip-in – White			
32	NNS		NV32FWW
63	NES		NV63FWW

7. Fan & Filter



Halmac Services (Qld) Pty. Ltd.
A.C.N. 098 852 923
A.B.N. 40 741 712 113

FAN & FILTER

1. FAN & FILTER TECHNICAL DETAILS

Rittal
SK



Filterlüfter

**Fan-and-filter
units**

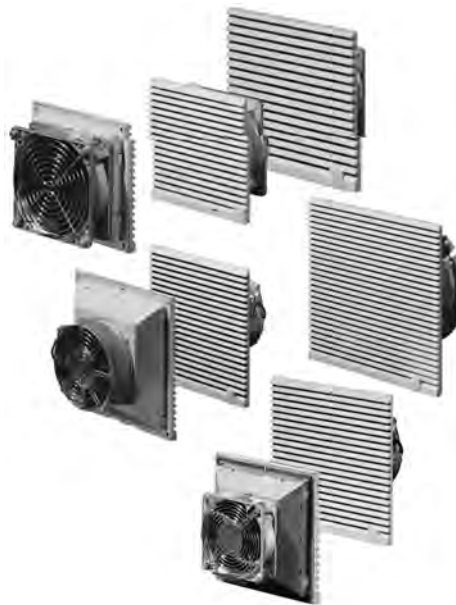
**Ventilateur
à filtre**

Ventilator

Filterfläkt

Ventilatore-filtro

**Ventilador
con filtro**



SK 3322.xxx
SK 3323.xxx
SK 3324.xxx

SK 3325.xxx
SK 3326.xxx

Montageanleitung

Assembly instructions

Notice de montage

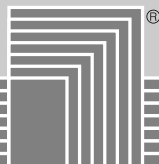
Montage-instructie

Montageanvisning

Istruzioni di montaggio

Instrucciones de montaje

取扱説明書



Umschalten auf Perfektion **RITTAL**

Active 10/12/2013

Page 130 of 765

English

Model No. fan-and-filter units SK	3322.100 3322.107 3322.600	3322.115 3322.117 3322.615	3322.024 3322.027	3322.048 3322.047	3323.100 3323.107 3323.600	3323.115 3323.117 3323.615	3323.024 3323.027	3323.048 3323.047
Rated voltage Volt/Hz	230/50/60	115/50/60	24 (DC)	48 (DC)	230/50/60	115/50/60	24 (DC)	48 (DC)
Air throughput unimpeded airflow	55/66 m³/h				105/120 m³/h			
Axial fan	self-starting shaded pole motor		DC motor		self-starting shaded pole motor		DC motor	
Rated current	0.12 A/ 0.11 A	0.24 A/ 0.23 A	0.35 A	0.09 A	0.12 A/ 0.11 A	0.24 A/ 0.23 A	0.35 A	0.09 A
Nominal output	19 W/18 W		7.7 W	4.4 W	19 W/18 W		8.0 W	4.3 A
Spare filter mat	3322.700				3171.100			
Fine filter mat	-				3181.100			
Hose-proof hood	3322.800				3323.800			
Noise level	46/49 dB (A)				46/49 dB (A)			

Model No. fan-and-filter units SK	3324.100 3324.107 3324.600	3324.115 3324.117 3324.615	3324.024 3324.027	3324.048 3324.047	3325.100 3325.107 3325.600	3325.115 3325.117 3325.615	3325.024 3325.027	3325.048 3325.047	3326.100 3326.107 3326.600	3326.115 3326.117 3326.615
Rated voltage Volt/Hz	230/50/60	115/50/60	24 (DC)	48 (DC)	230/50/60	115/50/60	24 (DC)	48 (DC)	230/50/60	115/50/60
Air throughput unimpeded airflow	180/160 m³/h				230/265 m³/h				500/560 m³/h	
Axial fan	self-starting shaded pole motor		DC motor		self-starting shaded pole motor		DC motor		capacitor motor	
Rated current	0.19 A/ 0.20 A	0.38 A/ 0.40 A	0.30 A	0.34 A	0.28 A/ 0.24 A	0.53 A/ 0.49 A	0.58 A	0.31 A	0.29 A/ 0.35 A	0.58 A/ 0.70 A
Nominal output	30 W/35 W		7.2 W	14 W	41 W/38 W		14 W	15 W	64 W/80 W	
Noise level	52/48 dB (A)				54/56 dB (A)				59/61 dB (A)	
Spare filter mats					3172.100				3173.100	
Fine filter mat					3182.100				3183.100	
Hose-proof hood					3324.800				3326.800	
Temperature range	-10°C to +55°C									
Protection category to EN 60 529/10.91	IP 54 by using of filter mat IP 55 by using of filter mat and hose-proof hood Complies with NEMA 1.									

2. Assembly

Observe sequence of assembly 1 – 4, and mounting position!
Airflow direction can be changed by reversing the fitting of fan.
Fully compatible with the cutouts and holes of the "old" units.
Quick-assembly system for fan-and-filter units and outlet filter.

Simply snap into place, and that's it.

3. Electrical connection

Supply voltage and frequency must correspond to the rated values stated on the nameplate. The relevant requirements of the local electricity board must be observed.

Electrical connection and repair must be carried out by authorised specialist personnel only.
Use original spares only.

4. Filter replacement and cleaning

The frequency of filter replacements should be determined individually, depending on dust accumulation and operating period.

Note: Filter replacement must be carried out in good time.
A soiled filter mat will cause the temperature to rise inside the enclosure!

The filter mat can be regenerated by washing or blowing out.

5. Supply includes

1 fan-and-filter unit, ready for connection,
1 drilling template.

6. Guarantee

We will guarantee this unit, if used correctly, for 1 year in respect of materials and manufacturing faults, from the date of its supply.

7. Waste disposal

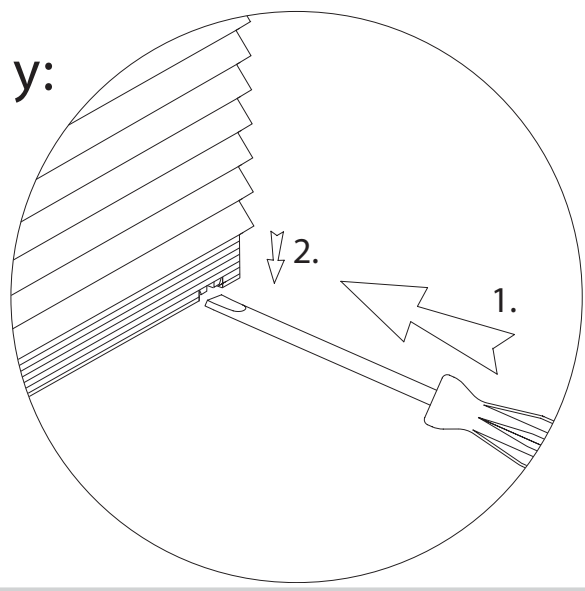
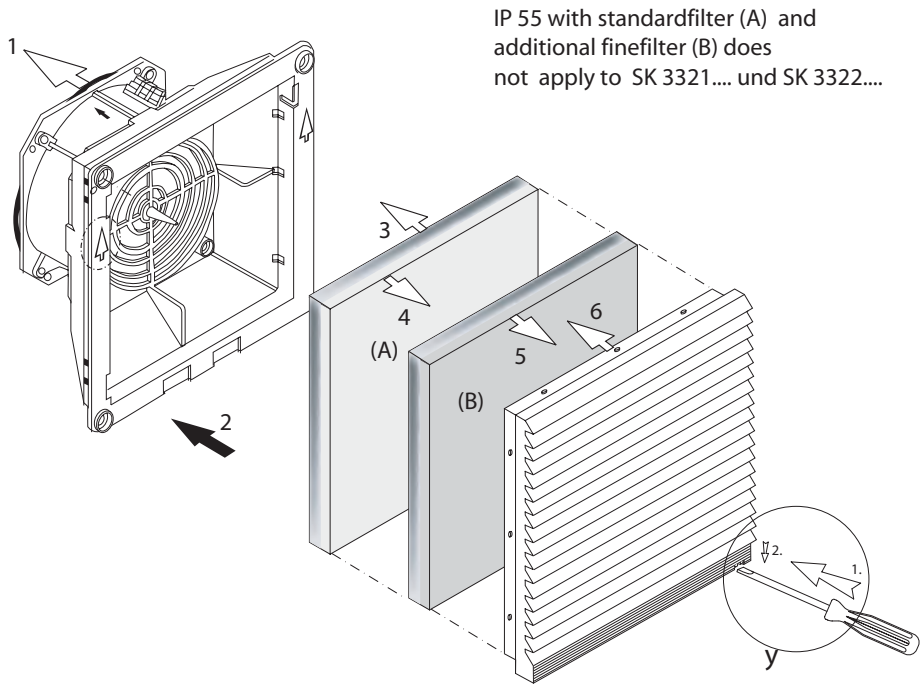
The plastic material used in the components can be recycled.

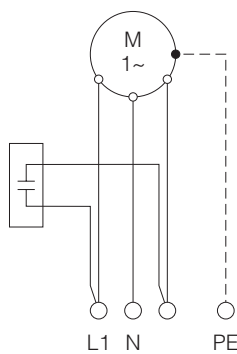
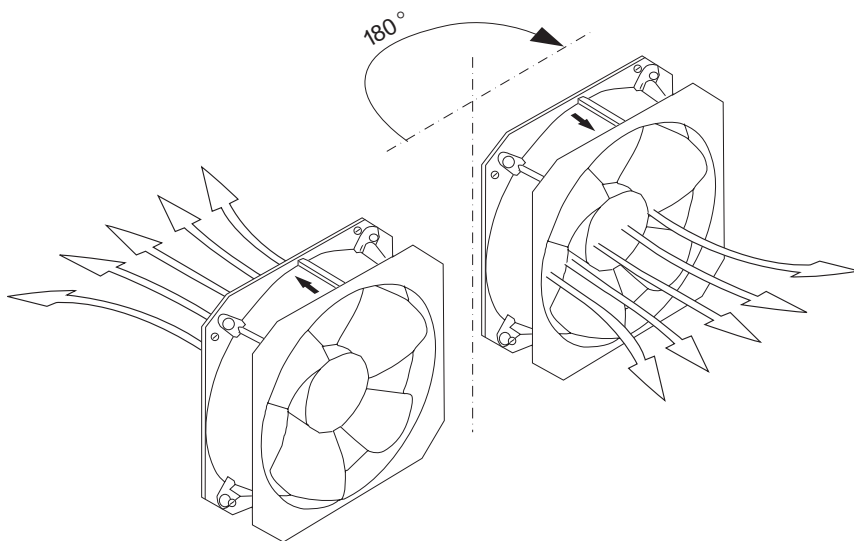
8. Accessories

- 8.1 Spare filter mats, fine filter mats
- 8.2 Hose-proof hood
- 8.3 Thermostat SK 3110.000
- 8.4 Temperature indicator with switch contact SK 3114.000 (only for 230 V AC fan)
- 8.5 Speed control SK 3120.000 (only for 230 V AC fan).

9. Colour

RAL 7032:100 / .115 / .048 / .024
RAL 7035:107 / .117 / .047 / .027







Schaltschrank-Systeme
Industrial Enclosures
Systèmes d'armoires électriques
Schakelkastsystemen
Apparatskåpssystem
Sistemi di armadi per quadri di comando
Sistemas de armarios de distribución
エンクロージャシステム



Elektronik-Aufbau-Systeme EL
Electronic Packaging EL
Systèmes d'intégration électronique EL
Elektronica opbouwssystemen EL
Elektronikuppbyggnad och inkapsling EL
Sistemi di allestimento per l'elettronica industriale EL
Sistemas para electrónica EL
エレクトロニクスシステム EL



System-Klimatisierung SK
System Climate Control SK
Systèmes de climatisation SK
Systemklimatisering SK
Systemklimatisering SK
Soluzioni di climatizzazione per quadri di comando SK
Climatización de sistemas SK
システム空調製品 SK



Stromverteilung SV
Power Distribution SV
Distribution du courant SV
Stroomverdeling SV
Strömfördelning SV
Distribuzione di corrente SV
Distribución de corriente SV
ブスバー分電・配電システム SV



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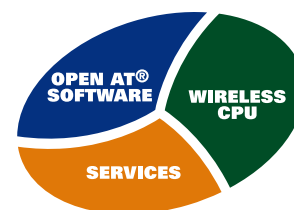
8. Gsm Modem



Halmac Services (Qld) Pty. Ltd.
A.C.N. 098 852 923
A.B.N. 40 741 712 113

GSM MODEM

1. **FASTRACK SUPREME GSM MODEM
TECHNICAL DETAILS**
2. **FASTRACK SUPREME GSM MODEM USER
GUIDE**



Fastrack Supreme

GSM/GPRS/EDGE with unlimited expandability

Fastrack Supreme is a versatile Plug & Play Wireless CPU® that will carry your applications well into the future. It has been designed to accommodate any additional features you can imagine, thanks to a revolutionary, open standard Internal Expansion Socket which you can populate with an expansion card from Wavecom – or one of your own.

SECURE CELLULAR INTERNET

Prevent hacker attacks by using our Security software Plug-In to connect your sales terminal, meter, vehicle, asset tracking or monitoring product via GSM, GPRS or high speed EDGE to the cellular Internet highway.

POWERFUL CORE APPLICATION PROCESSING

Every Fastrack Supreme features a Wavecom Q26-family Wireless CPU®: a powerful central processing unit with an ARM9 32 bit, 26-104MHz core, programmable via any combination of AT commands, C and Lua.

FASTRACK = YOUR PRODUCT

By designing your product value as an expansion card you save time and money in cellular learning curve, certification, mechanical design and time to market. Fastrack can now become *your* product.

UNHEARD-OF EXPANDABILITY

Add additional IO connectivity or features like GPS, WiFi, Bluetooth, Zigbee and more. The open interface means you can develop your own expansion modules for your specific needs.

INTELLIGENT DEVICE SERVICES

Our Intelligent Device Services enable you to remotely monitor and securely upgrade the software of your product, in order to reduce post-deployment field maintenance costs.

PROFESSIONAL SERVICES

Accelerate your product design and ensure you capitalize on market opportunities!

wavecom[®]
Smart wireless. Smart business.



Fastrack Supreme

Plug and play with unlimited expandability

Evolve to the latest cellular technology and add functionality without sacrificing the form factor you have come to rely on. The Fastrack Supreme is the same size, has the same interfaces and is completely backward compatible with previous Fastrack products, and is packed with a host of new features.

Wavecom has developed an exciting new, open-standard Internal Expansion Socket (IES) interface for you to add additional IO connectivity or features like GPS, WiFi, Bluetooth, Zigbee and more. The open interface means you can develop your own expansion modules and customize the product for your specific requirements, or you can look to Wavecom for new expansion modules designed to address your most-pressing needs.

Features

	Wireless CPU		IESM			
	FASTRACK Supreme 10	FASTRACK Supreme 20	IESM GPS+USB	IESM IO+USB	IESM IO+USB+GPS	IESM Ethernet
Core CPU	ARM9, 32 bit with cache	ARM9, 32 bit with cache				MAC ethernet
Open AT® Software Suite	FW6.63/OS4.20	FW6.63/OS4.20				
VariSpeed	26/104MHz	26/104MHz				
MIPS	87 max.	87 max.				
DOTA	Type I & II	Type I & II				
External Interruption	<1ms	<1ms				
RTC Interruption	<1ms	<1ms				
GPIO	2	2		3+2	2	
Analogue Audio	2	2				
ADC/DAC/SPI/I2C				1/1/1/1	1/1/1/1	
RS232	1	1		1		
USB			1	1	1	1
SIM/RUIM	3V/1.8V SIM	3V/1.8V SIM				
Voltage/VDC (nom)	5.5 to 32	5.5 to 32	4		4	4
Current/A (max)	0.48 @ 5.5V	0.48 @ 5.5V	0.12 @ 5.5V		0.12 @ 5.5V	
MMCx			•		•	
SMA	•	•				
RJ45						•
Size/mm	73x54.5x25.5	73x54.5x25.5	58x35.7x10.01	58x35.7x10.01	58x35.7x10.01	58x35.7x10.01
Weight/g	89	89	<10	<10	<10	<10
SIM holder	•	•				
Operating t° range	-30°C+75°C	-30°C+75°C	-30°C+65°C	-30°C+65°C	-30°C+65°C	-30°C+65°C
GSM	•	•				
GPRS class	10	10				
EDGE class		10				
850/900/1800/1900	•	•				
Max Sensitivity (dBm)	-109 @ 900	-109 @ 900				
Codecs	FR/EFR/HR	FR/EFR/HR				
RIL	•	•				
TCP/IP & Internet	Plug-In	Plug-In				
Ethernet						Companion
Bluetooth	Plug-In	Plug-In				
Security	Plug-In	Plug-In				
GPS	Plug-In	Plug-In	Companion		Companion	



Open AT® Software Suite 2.0

Industrial software for industrial design demands

The Open AT® Software Suite allows you to develop, compile, test, debug, download and natively execute your applications written in standard ANSI C directly on the Fastrack Supreme, or indeed any other Wavecom Wireless CPU®. It is royalty free and comprises operating system, compiler and integrated development environments. There are no hidden costs - maintenance and qualification are provided for free by Wavecom.



- Multitasked Pre-Emptive Event-Based Real-Time Operating System
- Integrated Development Environment built on Eclipse™
- Extensive Set of Plug-Ins (Internet Suite, C-GPS and more)
- GSM Release 99 compliant modem firmware
- Secure Intelligent Device Services (IDS) compatible

REAL TIME OPERATING SYSTEM

Real-Time

Guaranteed response time to interruption (even during GSM/GPRS/EDGE activities, calls and transfer).

Wireless CPU® Resources Direct Access and IT Management

- Hardware and Software Timers
- DSP
- SPI
- ADC
- External Interrupt Pins
- GPIOs
- UARTS (coming in 2008)

Multitasking

Auto shut-down feature

Feature improving the overall consumption of the application by deactivating the RS232 interface.

Application dedicated Hardware Watchdog

- application dedicated for close monitoring
- tunable depending on the complexity of the processing (ex: Pulse count Vs RSA signature calculation...)

CROSS-PLATFORM INTEGRATED DEVELOPMENT ENVIRONMENT

For eased application debug it can be performed on PC: for very fast and convenient application debugging through RemoteTask Environment.

On target for final Integration and time-critical behavior management:

- Live through Traces
- Post mortem through BackTraces

On field:

- for difficult error causing operating scenarios through IDS device monitoring services and BackTraces over the air retrieval.

SEAMLESSLY PLUG-IN ADDITIONAL FEATURES

Plug-Ins are an optional range of software feature packages that are selected when your order your Wireless CPU®. The standard range provides access to Internet clients & protocols, controller-less companion wireless peripherals such as Bluetooth & GPS. Of course, the powerful flexibility of Open AT® Software Suite means that you can also develop your own Plug-Ins and own custom AT commands.



Lua

Easy Scripting



Internet

Clients & Protocols



C-GPS

Companion



C-Bluetooth™

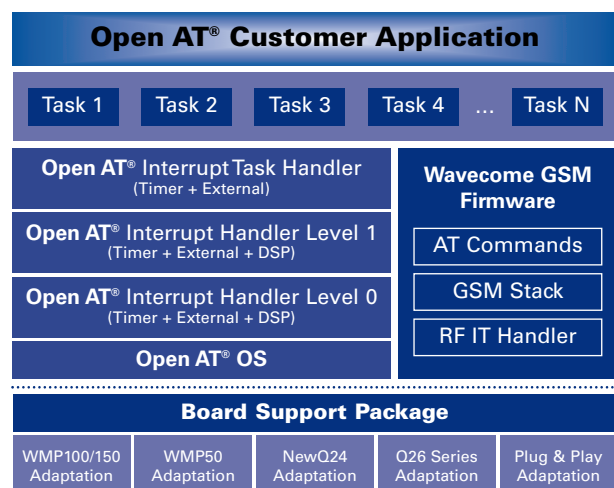
Companion



aqLink®

in-band modem

WAVECOM BSP-BASED EMBEDDED SOFTWARE ARCHITECTURE



Wavecom Services

The wireless products you are developing are most probably very complex, and they will stay in the field for many years. With this in mind, Wavecom has created a range of professional and operated services to make the development process easier and to help you protect your investment, enrich your products and services, and reduce the lifetime cost of your device network.

Professional services: Less pain, more gain

Wavecom Professional Services help you be faster, sleeker and more adaptable to the ever changing needs of your market, all along the typical product lifecycle timeline:

WAVECOM UNIVERSITY

- Open AT® Developer course
- Open AT® Expert course

PRODUCT DESIGN

- Customer Design Review
- Customer Product Certification
- Open AT® Application Code Review

PRODUCT BUILD

- IMEI implementation
- Tailored Delivery (Express & Fast)
- Tailored Product Configuration

AFTER SALES

- Reconfiguration for Wireless CPU®
- Out Of Warranty repair for Wireless CPU®
- Repair Equipment Wireless CPU®

Intelligent Device Services: Investment protection

Wavecom has created the world's first cellular operated service portfolio to benefit from easy to use end-to-end Intelligent Device Services that enable to remotely monitor and securely upgrade the application software of your product in addition to the entire Wavecom embedded Open AT® Software:

WIRELESS DEVICE MANAGEMENT

- Simplify your device installation and protect your wireless investment while reducing your field service costs

COMMUNICATION MANAGEMENT

- Analyze your traffic load and roaming usage, and adjust your tariff plans to your real usage

APPLICATION MANAGEMENT

- Benefit from proactive maintenance services to diagnose issues and take action before a significant problem occurs

See the Fastrack Supreme online:
www.wavecom.com/fastracksupreme

Join the Wavecom Developer community:
www.wavecom.com/forum



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 Wavecom, Inc. - 4810 Eastgate Mall - Second Floor - San Diego, CA 92121 - USA - Tel: +1 858 362 0101 - Fax: +1 858 558 5485
 WAVECOM Asia Pacific Ltd. - Unit 201-207, 2nd Floor - Bio-Informatics Centre - No. 2 Science Park West Avenue - Hong Kong
 Science Park, Shatin - New Territories, Hong Kong - Tel: +852 2824 0254 - Fax: +852 2824 0255



Fastrack Supreme User Guide

WA_DEV_Fastrk_UGD_001

Plug and Play Wireless CPU®

FASTRACK Supreme User Guide

Reference: WA_DEV_Fastrk_UGD_001

Revision: 001e

Date: 5 june, 2007



Supports Open AT® embedded ANSI C applications



Fastrack Supreme User Guide
WA_DEV_Fastrk_UGD_001

Document History

Revision	Date	List of revisions	
001	9 February, 07	First Issue	
001a	23 February, 2007	Update DC cable GPIO mapping, add AutoShutDown	
001b	21 May, 07	Add detail of IES, RTC and serial port autoshtutdown	
001c	1 Jun, 07	Change to Quad Band	
001d	4 Jun, 07	Update label/packaging photo	
001e	5 Jun, 07	Comment	

Overview

The FASTRACK Supreme 10 and FASTRACK Supreme 20 are discrete, rugged cellular Plug & Play Wireless CPU[®] offering state-of-the-art GSM/GPRS (and EGPRS for FASTRACK Supreme 20) connectivity for machine to machine applications.

Proven for reliable, stable performance on wireless networks worldwide, Wavecom's latest generation of FASTRACK Supreme continues to deliver rapid time to market and painless integration.

Having comparable size with the previous M1306B generation, and updated with new features, the FASTRACK Supreme offers an Internal Expansion Socket (IES) interface accessible for customer use. Expanding application features is easy without voiding the warranty of the FASTRACK Supreme by simply plugging in of an Internal Expansion Socket Module (IESM) board.

Fully certified, the quad band 850/900/1800/1900 MHz FASTRACK Supreme 10 offers GPRS Class 10 capability and FASTRACK Supreme 20 offers GPRS/EGPRS Class 10 capability. Both support a powerful open software platform (Open AT[®]). Open AT[®] is the world's most comprehensive cellular development environment, which allows embedded standard ANSI C applications to be natively executed directly on the Wireless CPU[®].

FASTRACK Supreme is controlled by firmware through a set of AT commands.

This document describes the FASTRACK Supreme and gives information on the following topics:

- general presentation,
- functional description,
- basic services available,
- technical characteristics,
- installing and using the FASTRACK Supreme,
- user-level troubleshooting.
- recommended accessories to be used with the product.

Note:

This document covers the FASTRACK Supreme Plug & Play alone and does not include

- The programmable capabilities provided via the use of Open AT[®] Software Suites.
- The development guide for IESM for expanding the application feature through the IES interface.

For detailed, please refer to the documents shown in the "Reference documents" section.

Fastrack Supreme User Guide

WA_DEV_Fastrk_UGD_001

RoHS Directive

The FASTRACK Supreme is now compliant with RoHS Directive 2002/95/EC, which sets limits for the use of certain restricted hazardous substances. This directive states that "from 1st July 2006, new electrical and electronic equipment put on the market does not contain lead, mercury, cadmium, hexavalent chromium, polybrominated biphenyls (PBB), and polybrominated diphenyl ethers (PBDE)".

Plug & Plays which are compliant with this directive are identified by the RoHS logo on their label.



Disposing of the product


This electronic product is subject to the EU Directive 2002/96/EC for Waste Electrical and Electronic Equipment (WEEE). As such, this product must not be disposed off at a municipal waste collection point. Please refer to local regulations for directions on how to dispose off this product in an environmental friendly manner.



Cautions

Information furnished herein by WAVECOM is accurate and reliable. However, no responsibility is assumed for its use. Please read carefully the safety recommendations given in Section 9 for an application based on FASTRACK Supreme Plug & Play.

Trademarks

®, WAVECOM®, Wireless CPU®, Open AT® and certain other trademarks and logos appearing on this document, are filed or registered trademarks of Wavecom S.A. in France or in other countries. All other company and/or product names mentioned may be filed or registered trademarks of their respective owners.

Copyright

This manual is copyrighted by WAVECOM with all rights reserved. No part of this manual may be reproduced in any form without the prior written permission of WAVECOM. No patent liability is assumed with respect to the use of their respective owners.



Fastrack Supreme User Guide
WA_DEV_Fastrk_UGD_001

Web Site Support

General information about Wavecom and its range of products:	www.wavecom.com
Specific support is available for the FASTRACK Supreme Plug & Play Wireless CPU®:	TBD
Open AT® Introduction:	www.wavecom.com/OpenAT
Developer community for software and hardware:	www.wavecom.com/forum



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1 References

1.1 Reference Documents

For more details, several reference documents may be consulted. The Wavecom reference documents are provided in the Wavecom documents package contrary to the general reference documents, which are not Wavecom owned.

1.1.1 Open AT[®] Software Documentation

- [1] Getting started with Open AT[®] (Ref.WM_ASW_OAT_CTI_001)
- [2] Open AT[®] Tutorial (Ref.WM_ASW_OAT_UGD_001)
- [3] Tools Manual (Ref. WM_ASW_OAT_UGD_003)
- [4] Open AT[®] Programming Guide (Ref. TBD)
- [5] Open AT[®] Customer Release Note (Ref. WM_ASW_OAT_DVD_00062)

Remark: The document above is for Open AT3.12 and FASTRACK Supreme will use new release of Open AT4.21. Reference document not yet available and TBC.

1.1.2 AT Software Documentation

- [6] AT commands interface Guide for X51 (Ref. WM_ASW_OAT_UGD_00016)
- [7] Customer Release Note X51 (Ref. WM_ASW_OAT_DVD_00120)

Remark: The document above is for X51 and FASTRACK Supreme will use new release of FW6.63. Reference document not yet available and TBC.

1.1.3 Firmware Upgrade Documents

- [8] Firmware upgrade procedure (Ref. WM_SW_GEN_UGD_001)

1.1.4 Delta between M1306B Documents

- [9] Delta between M1306B and FASTRACK Supreme (Ref. WA_DEV_Fastrk_UGD_004)

1.1.5 IESM Related Documents

- [10] IESM Product Technical Specification (Ref. WA_DEV_Fastrk_PTS_001)
- [11] IESM-GPS+USB User Guide (Ref. WA_DEV_Fastrk_UGD_002)
- [12] IESM-GPS+USB Installation Guide (Ref. WA_DEV_Fastrk_UGD_003)
- [13] IESM-IO+USB Installation Guide (Ref. WA_DEV_Fastrk_UGD_005)
- [14] IESM-IO+USB User Guide (Ref. WA_DEV_Fastrk_UGD_006)

Fastrack Supreme User Guide

References

Note:

New versions of software may be available. Wavecom recommends customers to check the web site for the latest documentation.

1.2 Abbreviations

Abbreviation	Definition
AC	A lternating C urrent
ACM	A ccumulated C all M eter
AMR	A daptive M ulti- R ate
AT	A Ttention (prefix for Wireless CPU [®] commands)
CLK	C Lo C K
CMOS	C omplementary M etal O xide S emiconductor
CS	C oding S cheme
CTS	C lear T o S end
dB	D ecibel
dBc	D ecibel relative to the C arrier power
dB<i>i</i>	D ecibel relative to an I sotropic radiator
dBm	D ecibel relative to one m illiwatt
DC	D irect C urrent
DCD	D ata C arrier D etect
DCE	D ata C ommunication E quipment
DCS	D igital C ellular S ystem
DSR	D ata S et R eady
DTE	D ata T erminal E quipment
DTMF	D ual T one M ulti- F requency
DTR	D ata T erminal R eady
EEPROM	E lectrically E rasable P rogrammable R ead- O nly M emory
EFR	E nhanced F ull R ate
E-GSM	E xtended G SM
EMC	E lectro M agnetic C ompatib l ity
EMI	E lectro M agnetic I nterference
ESD	E lectro S tatic D ischarges
ETSI	E uropean T elecommunications S tandards I nstitute
FIT	S eries of connectors (m icro- F IT)
FR	F ull R ate

Fastrack Supreme User Guide

References

Abbreviation	Definition
FTA	F ull T ype A pproval
GCF	G lobal C ertification F orum
GND	G rou N D
GPIO	G eneral P urpose I nput O utput
GPRS	G eneral P acket R adio S ervice
GSM	G lobal S ystem for M obile communications
HR	H alf R ate
I	I nput
IEC	I nternational E lectrotechnical C ommission
IES	I nternal E xpansion S ocket
IESM	I nternal E xpansion S ocket M odule
IMEI	I nternational M obile E quipment I dentification
I/O	I nput / O utput
LED	L ight E mitting D iode
MAX	M A X imum
ME	M obile E quipment
MIC	M I C rophone
Micro-Fit	F amily of c onnectors from M olex
MIN	M I N imum
MNP	M icrocom N etworking P rotocol
MO	M obile O riginated
MS	M obile S tation
MT	M obile T erminated
NOM	N O M inal
O	O utput
Pa	P ascal (for speaker sound pressure measurements)
PBCCH	P acket B roadcast C ontrol C Hannel
PC	P ersonal C omputer
PCL	P ower C ontrol L evel
PDP	P acket D ata P rotocol
PIN	P ersonal I dentify N umber
PLMN	P ublic L and M obile N etwork
PUK	P ersonal U nblocking K ey
RF	R adio F requency



Fastrack Supreme User Guide

References

Abbreviation	Definition
RFI	Radio Frequency Interference
RI	Ring Indicator
RMS	Root Mean Square
RTS	Request To Send
RX	Receive
SIM	Subscriber Identification Module
SMA	SubMiniature version A RF connector
SMS	Short Message Service
SNR	Signal-to-Noise Ratio
SPL	Sound Pressure Level
SPK	SpeaKer
SRAM	Static RAM
TCP/IP	Transmission Control Protocol / Internet Protocol
TDMA	Time Division Multiple Access
TU	Typical Urban fading profile
TUHigh	Typical Urban, High speed fading profile
TX	Transmit
TYP	TYPical
VSWR	Voltage Stationary Wave Ratio

2 Packaging

2.1 Contents

The complete package content of the FASTRACK Supreme consists of (see):

- one packaging box (A),
- one FASTRACK Supreme (B),
- two holding bridles (C),
- one power supply cable with fuse integrated (D)
- a mini notice (E) with:
 - a summary of the main technical features,
 - safety recommendations,
 - EC declaration of conformity.

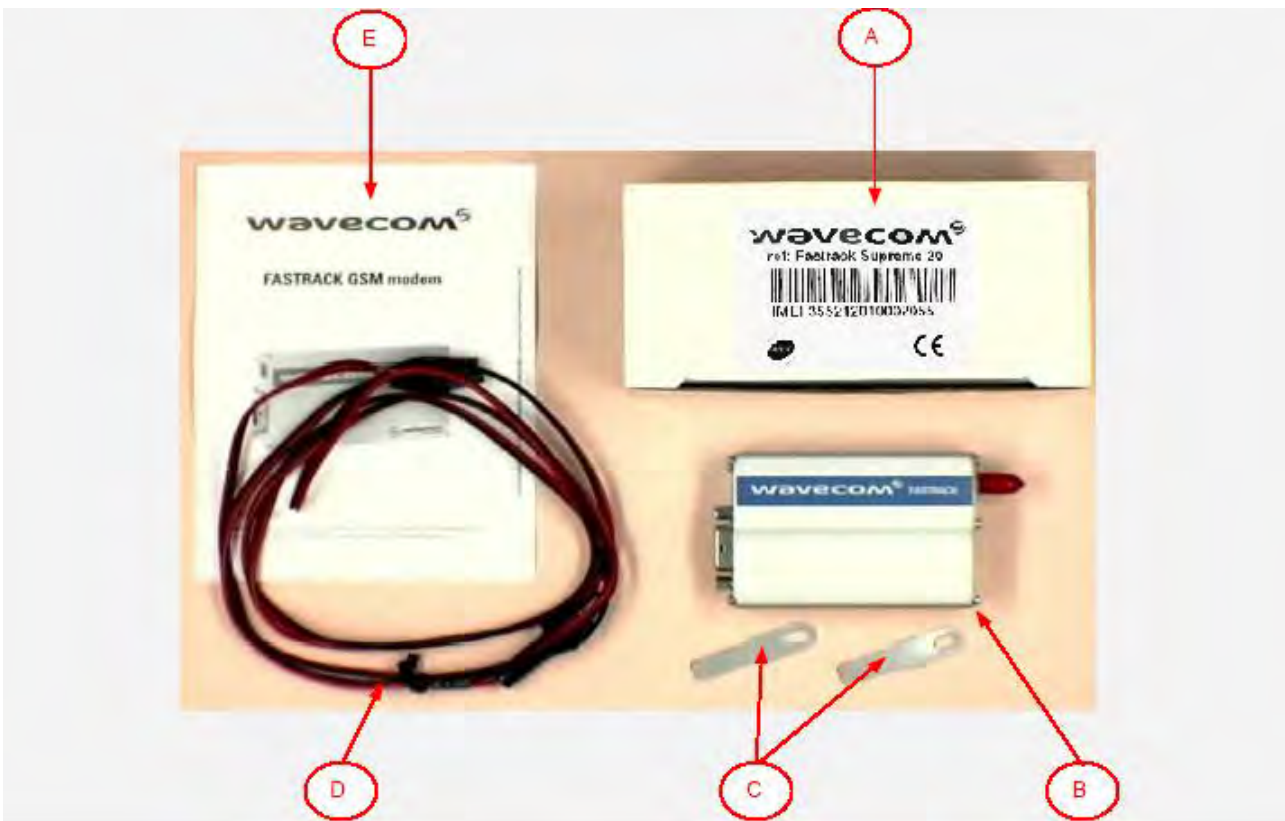


Figure 1: Complete package contents

Fastrack Supreme User Guide

Packaging

2.2 Packaging Box

The packaging box is a carton box (see) with the following external dimensions:

- width: 54.5 mm,
- height: 68 mm,
- length: 108 mm.

A packaging label is slicked on the packaging box cover and supports the:

- WAVECOM logo,
- Product reference (Supreme),
- CE marking
- 15-digit IMEI code
- Open AT[®] Logo
- RoHS logo
- WEEE logo



Figure 2: Packaging box

The packaging label dimensions are:

- height: 40 mm,
- length: 65 mm.

Fastrack Supreme User Guide

Packaging

2.3 Production Labelling

A production label (see Figure 3) located at the FASTRACK Supreme back side gives the following information:

- product reference (**FASTRACK Supreme 10** or **FASTRACK Supreme 20**),
- part number (WM19183),
- CE marking,
- 15-digit IMEI code,
- OpenAT[®] logo



Figure 3: Production Label

3 General Presentation

3.1 Description

The FASTRACK Supreme description is given in the Figure 4 below.

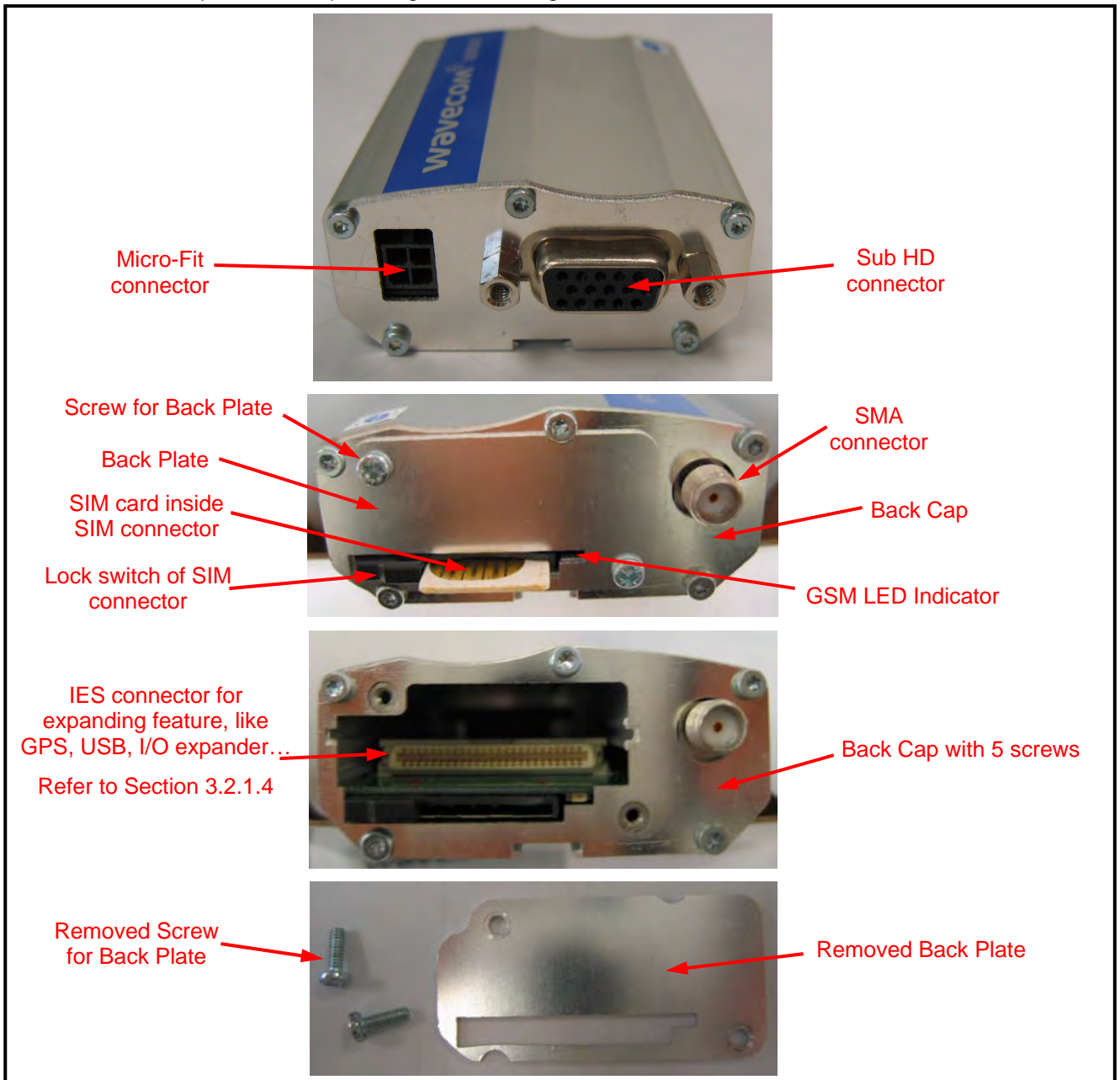


Figure 4: FASTRACK Supreme general description

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General Presentation

CAUTION: Users are free to remove the back plate for IESM board plug in/unplug without voiding the warranty of the FASTRACK Supreme. **However, the warranty will be voided if unscrewing any screw of the back cap.**

In addition, two holding bridles are provided to tighten the FASTRACK Supreme on a support.

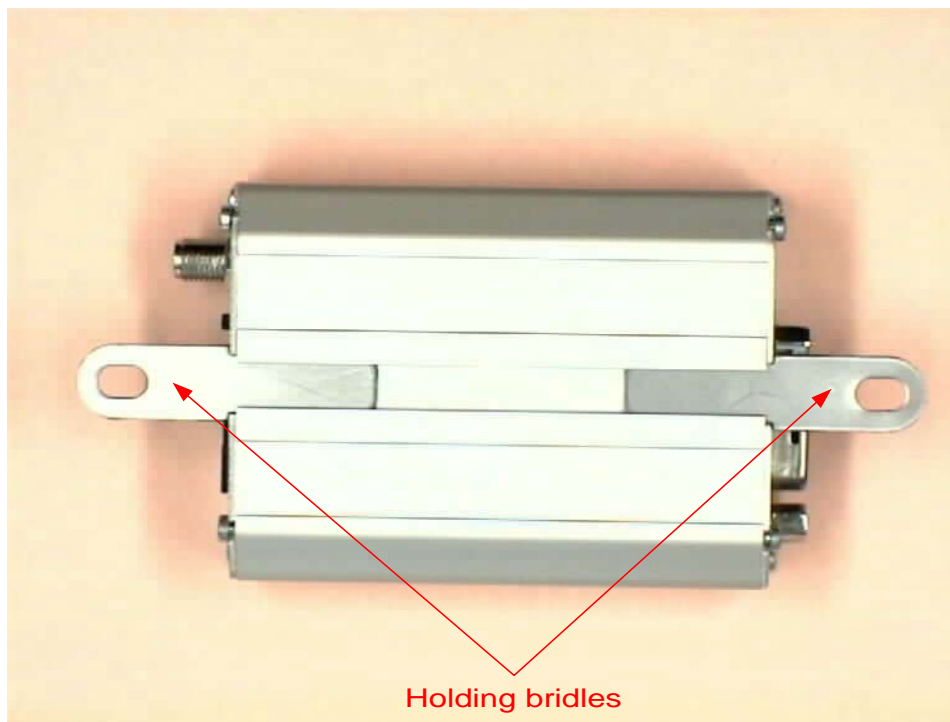


Figure 5: FASTRACK Supreme holding bridles

Fastrack Supreme User Guide

General Presentation

3.2 External Connections

3.2.1 Connectors

3.2.1.1 Antenna Connector

The antenna connector is a SMA type connector for a 50 Ω RF connection.



SMA connector for antenna connection

Figure 6: SMA connector for antenna connection

3.2.1.2 Power Supply Connector

The power supply connector is a 4-pin Micro FIT connector for:

- external DC Power Supply connection,
- GPIOs connection (two General Purpose Input/Output signals available).

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General Presentation



Figure 7: Power supply connector

Table 1: Power supply connector pin description

Pin #	Signal	I/O	I/O type	Description	Reset State	Comment
1	V+BATTERY	I	Power supply	Battery voltage input: <ul style="list-style-type: none"> ▪ 5.5 V Min. ▪ 13.2 V Typ. ▪ 32 V Max. 		High current
2	GND		Power supply	Ground		
3	GPIO21	I/O	2V8	General Purpose Input/output	Undefined	Not mux
4	GPIO25	I/O	2V8	General Purpose Input/output	Z	Multiplex with INT1

Warning:

Both pin 3 and pin 4 are used by GPIO interface. It is strictly prohibited to connect them to any power supply at the risk of damage to the FASTRACK Supreme.

3.2.1.3 Sub HD 15-pin Connector

The Sub D high density 15-pin connector is used for:

- RS232 serial link connection,
- Audio lines (microphone and speaker) connection,
- BOOT and RESET signal connection.

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Figure 8: Sub HD 15-pin connector

Table 2: Sub HD 15-pin connector description

Pin #	Signal (CCITT / EIA)	I/O	I/O type	Description	Comment
1	CDCD/CT109	O	STANDARD RS232	RS232 Data Carrier Detect	
2	CTXD/CT103	I	STANDARD RS232	RS232 Transmit serial data	
3	BOOT	I	CMOS	Boot	This signal must not be connected. Its use is strictly reserved to Wavecom or competent retailers.
4	CMIC2P	I	Analog	Microphone positive line	
5	CMIC2N	I	Analog	Microphone negative line	
6	CRXD/CT104	O	STANDARD RS232	RS232 Receive serial data	
7	CDSR/CT107	O	STANDARD RS232	RS232 Data Set Ready	
8	CDTR/CT108-2	I	STANDARD RS232	RS232 Data Terminal Ready	
9	GND	-	GND	Ground	

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Pin #	Signal (CCITT / EIA)	I/O	I/O type	Description	Comment
10	CSPK2P	O	Analog	Speaker positive line	
11	CCTS/CT106	O	STANDARD RS232	RS232 Clear To Send	
12	CRTS/CT105	I	STANDARD RS232	RS232 Request To Send	
13	CRI/CT125	O	STANDARD RS232	RS232 Ring Indicator	
14	RESET	I/O	Schmitt	Supreme Plug & Play reset	Active low
15	CSPK2N	O	Analog	Speaker negative line	

3.2.1.4 IES Connector

The IES connector is a 50 pins board-to-board connector for expanding application features like GPS, USB, I/O expander... Currently there are already 3 IESM boards available for customer to expand the FASTRACK Supreme features immediately. They are:

- IESM-GPS+USB+I/O
- IESM-GPS+USB
- IESM-USB+I/O

For detail, please refer to Document in Section 1.1.5.

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For sales and support, please contact Wavecom sales/FAE or your distributor.

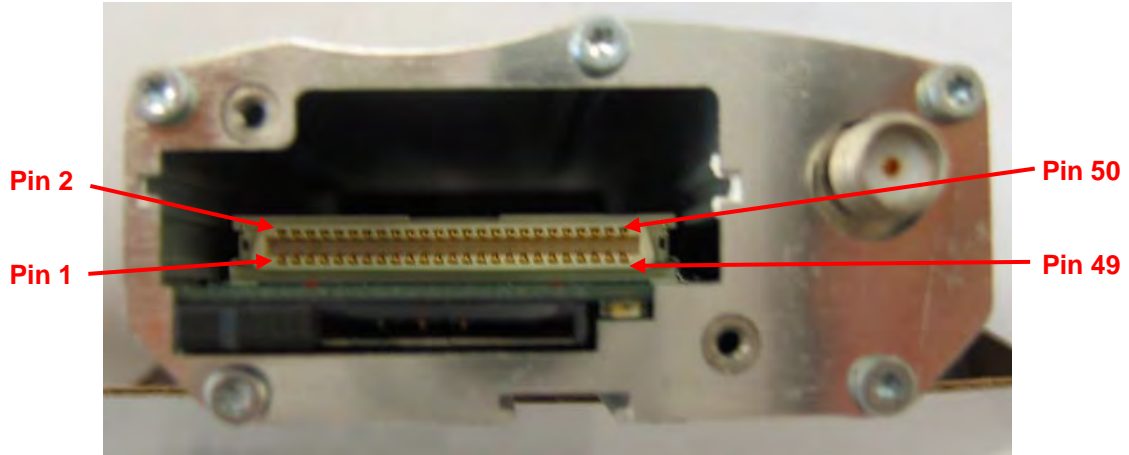


Figure 9: IES connector for feature expansion

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General Presentation

Table 3: IES Connector Description

Pin Number	Signal Name		I/O type	Voltage	I/O*	Reset State	Description	Dealing with unused pins
	Nominal	Mux						
1	GND						Ground	
2	GND						Ground	
3	GPIO4	COL0	C8	GSM-1V8	I/O	Pull-up	Keypad column 0	NC
4	GPIO5	COL1	C8	GSM-1V8	I/O	Pull-up	Keypad column 1	NC
5	GPIO6	COL2	C8	GSM-1V8	I/O	Pull-up	Keypad column 2	NC
6	GPIO7	COL3	C8	GSM-1V8	I/O	Pull-up	Keypad column 3	NC
7	VPAD-USB			VPAD-USB	I		USB Power supply input	NC
8	USB-DP			VPAD-USB	I/O		USB Data	NC
9	USB-DM			VPAD-USB	I/O		USB Data	NC
10	GSM-1V8*			GSM-1V8	O		1.8V Supply Output (for GPIO pull-up only)	NC
11	GSM-2V8*			GSM-1V8	O		2.8V Supply Output (for GPIO pull-up only)	NC
12	BOOT			GSM-1V8	I		Not Used	Add a test point / a jumper/ a switch to VCC_1V8 (Pin 10) in case Download Specific mode is used (See product specification for details)
13	~RESET		C4	GSM-1V8	I/O		RESET Input	NC or add a test point
14	AUX-ADC		A2	Analog	I		Analog to Digital Input	Pull to GND
15	~SPI1-CS	GPIO31	C1	GSM-2V8	O	Z	SPI1 Chip Select	NC
16	SPI1-CLK	GPIO32	C1	GSM-2V8	O	Z	SPI1 Clock	NC
17	SPI1-I	GPIO30	C1	GSM-2V8	I	Z	SPI1 Data Input	NC
18	SPI1-IO	GPIO29	C1	GSM-2V8	I/O	Z	SPI1 Data Input / Output	NC
19	SPI2-CLK	GPIO32	C1	GSM-2V8	O	Z	SPI2 Clock	NC
20	SPI2-IO	GPIO33	C1	GSM-2V8	I/O	Z	SPI2 Data Input / Output	NC
21	~SPI2-CS	GPIO35	C1	GSM-2V8	O	Z	SPI2 Chip Select	NC
22	SPI2-I	GPIO34	C1	GSM-2V8	I	Z	SPI2 Data Input	NC
23	CT104-RXD2	GPIO15	C1	GSM-1V8	O	Z	Auxiliary RS232 Receive	Add a test point for firmware upgrade
24	CT103-TXD2	GPIO14	C1	GSM-1V8	I	Z	Auxiliary RS232 Transmit	(TXD2) Pull-up to VCC_1V8 with 100kΩ and add a test point for firmware update
25	~CT106-CTS2	GPIO16	C1	GSM-1V8	O	Z	Auxiliary RS232 Clear To Send	(CTS2) Add a test point for firmware update
26	~CT105-RTS2	GPIO17	C1	GSM-1V8	I	Z	Auxiliary RS232 Request To Send	(RTS2) Pull-up to VCC_1V8 with 100kΩ and add a test point for



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Pin Number	Signal Name		I/O type	Voltage	I/O*	Reset State	Description	Dealing with unused pins
	Nominal	Mux						
								firmware update
27	GPIO8	COL4	C8	GSM-1V8	I/O	Pull-up	Keypad column 4	NC
28	GPIO26	SCL	A1	Open Drain	O	Z	I ² C Clock	NC
29	GPIO19		C1	GSM-2V8	I/O	Z		NC
30	GPIO27	SDA	A1	Open Drain	I/O	Z	I ² C Data	NC
31	GPIO20		C1	GSM-2V8	I/O	Undefined		NC
32	INT0	GPIO3	C1	GSM-1V8	I	Z	Interruption 0 Input	If INT0 is not used, it should be configured as GPIO
33	GPIO23	**	C1	GSM-2V8	I/O	Z		NC
34	GPIO22	**	C1	GSM-2V8	I/O	Z		NC
35	~CT108-2-DTR1	GPIO41	C1	GSM-2V8	I	Z	Main RS232 Data Terminal Ready	(DTR1) Pull-up to VCC_2V8 with 100kΩ
36	PCM-SYNC			GSM-1V8	O	Pull-down	PCM Frame Synchro	NC
37	PCM-IN		C5	GSM-1V8	I	Pull-up	PCM Data Input	NC
38	PCM-CLK			GSM-1V8	O	Pull-down	PCM Clock	NC
39	PCM-OUT			GSM-1V8	O	Pull-up	PCM Data Output	NC
40	AUX-DAC			Analog	O		Digital to Analog Output	NC
41	VCC-2V8			VCC_2V8	O		LDO 2.8V Supply Output	NC
42	GND						Ground	
43	DC-IN			DC-IN from 5.5V~32VDC	O		DC voltage input through Micro-Fit connector	NC
44	DC-IN			DC-IN from 5.5V~32VDC	O		DC voltage input through Micro-Fit connector	NC
45	GND						Ground	
46	4V			4V	O		4V DC/DC converter Output	NC
47	4V			4V	O		4V DC/DC converter Output	NC
48	GND						Ground	
49	GND						Ground	
50	GND						Ground	

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3.2.2 Power supply cable

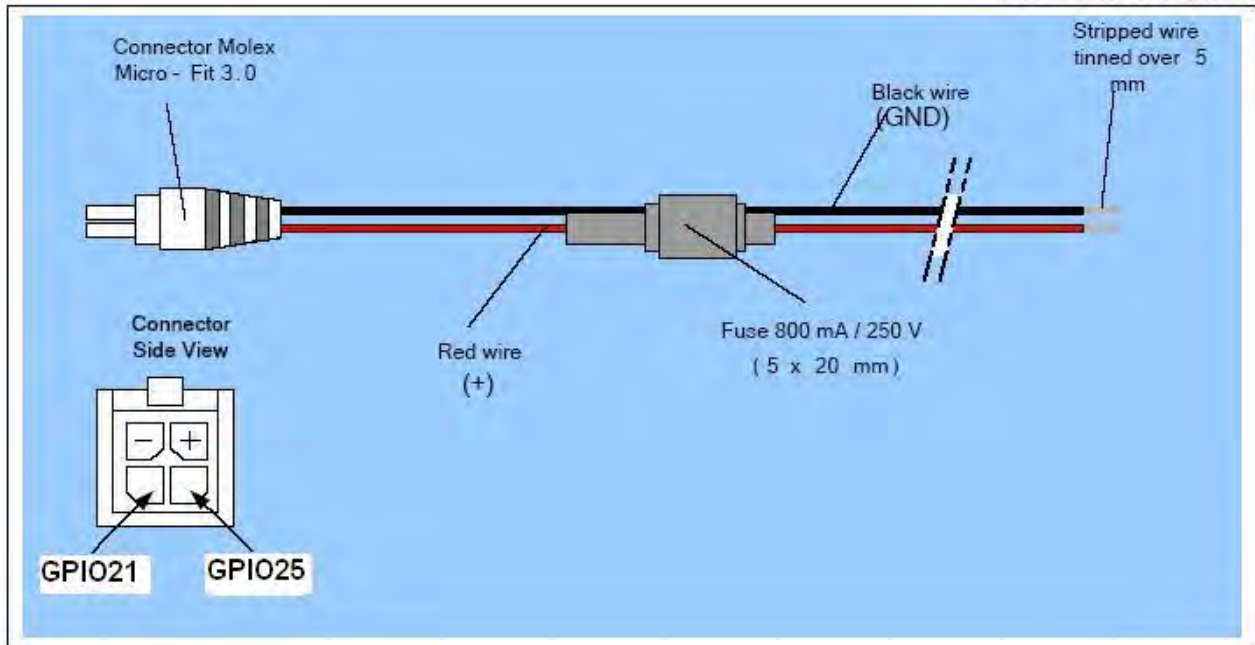


Figure 10: Power supply cable

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General Presentation

Component	Characteristics
Micro-Fit connector 4-pin	Part number: MOLEX 43025-0400
Cable	Cable length: ~1.5 m
Wire	Core: tinned copper 24 x 0.2 mm
	Section: 0.75 mm ²



Fastrack Supreme User Guide

Features and Services

4 Features and Services

4.1 Basic Features and Services

Basic features of the FASTRACK Supreme and available services are summarized in the table below.

Table 4: Basic features of the FASTRACK Supreme

Features	GSM850 / GSM900	DCS1800 / PCS1900
Open AT[®]	Open AT [®] programmable: Native execution of embedded standard ANSI C applications, Custom AT command creation, Custom application library creation, Standalone operation.	
Standard	850MHz / 900 MHz. E-GSM compliant. Output power: class 4 (2W). Fully compliant with ETSI GSM phase 2 + small MS.	1800 MHz / 1900MHz Output power: class 1 (1W). Fully compliant with ETSI GSM phase 2 + small MS.
GPRS	Class 10. PBCCH support. Coding schemes: CS1 to CS4. Compliant with SMG31bis. Embedded TCP/IP stack.	
EGPRS	Output power: 0.5W	Output power: 0.4W
(for FASTRACK Supreme 20 only)	Class 10. PBCCH support. Coding schemes: MCS1 to MCS9. Compliant with SMG31bis. Embedded TCP/IP stack.	



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Features and Services

Features	GSM850 / GSM900	DCS1800 / PCS1900
Interfaces	RS232 (V.24/V.28) Serial interface supporting: <ul style="list-style-type: none"> ▪ Baud rate (bits/s): 300, 600, 1200, 2400, 4800, 9600, 19200, 38400, 57600, 115200, 230400, 460800 and 921600. ▪ Autobauding (bits/s): from 1200 to 921600. 2 General Purpose Input/Output gates (GPIOs) available. 1.8 V / 3 V SIM interface. AT command set based on V.25ter and GSM 07.05 & 07.07. Open AT [®] interface for embedded application. Open AT [®] Plug-In Compatible.	
SMS	Text & PDU. Point to point (MT/MO). Cell broadcast.	
Data	Data circuit asynchronous. Transparent and Non Transparent modes. Up to 14.400 bits/s. MNP Class 2 error correction. V42.bis data compression.	
Fax	Automatic fax group 3 (class 1 and Class 2).	
Audio	Echo cancellation Noise reduction Telephony. Emergency calls. Full Rate, Enhanced Full Rate, Half Rate operation and Adaptive Multi-Rate (FR/EFR/HR/AMR). Dual Tone Multi Frequency function (DTMF).	



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Features and Services

Features	GSM850 / GSM900	DCS1800 / PCS1900
GSM supplement services	Call forwarding. Call barring. Multiparty. Call waiting and call hold. Calling line identity. Advice of charge. USSD	
Other	DC power supply Real Time Clock with calendar Complete shielding	

For other detailed technical characteristics, refer to Section 8.

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Features and Services

4.2 Additional NEW Features

4.2.1 Support Additional GSM850/PCS1900 Bands

Apart from GSM900/DCS1800, the FASTRACK Supreme Plug & Play now supports also the GSM850/PCS1900 bands. FASTRACK Supreme is fully compliant to PTCRB and FCC also.

4.2.2 IES Interface for Easy Expansion of Application Features

The FASTRACK Supreme Plug & Play offers a 50 pin Internal Expansion Socket (IES) Interface accessible for customer use. It is the additional interface which is easy for customers to expand their application features without voiding the warranty of the FASTRACK Supreme, by simply plugging in an Internal Expansion Socket Module (IESM) board through the matting connector of the IES interface.

Thanks to the flexible IES interface, customers are ready to expand the application features by plugging in the corresponding Internal Expansion Socket Module (IESM) of GPS, I/O expander..., etc.

For brief description of the interface, please refer to Section 3.2.1.4.

For technical detail, please refer to Document [11] or contact your Wavecom distributor or Wavecom FAE.

4.2.3 Serial Port Auto Shut Down or Improving Power Consumption

In order to save power consumption when there is no data communication between the Plug & Play and the DTE, FASTRACK Supreme has now implemented the Serial Port Auto Shut Down feature. User can activate or deactivate the Serial Port Auto Shut Down mode by simple AT-command.

For detail, please refer to Section 7.3.4.

4.2.4 Real Time Clock (RTC) for Saving Date and Time

The FASTRACK Supreme has now implemented the Real Time Clock for saving date and time when the Plug & Play is unplugged from the DC power supply through the DC power cable.

For detail, please refer to Section 7.8.

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Features and Services

4.2.5 SIM Card Lock Feature

The FASTRACK Supreme has now implemented a SIM connector having a carrier with lock. This helps ensuring the user to have proper SIM card insertion and locked before proper use of GSM network.

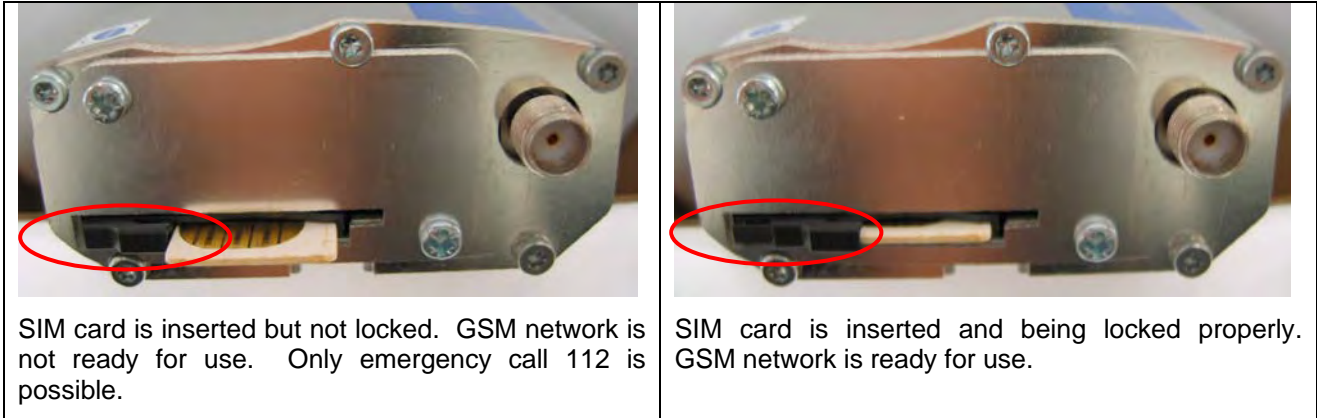


Figure 11: SIM card lock feature

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Using the FASTRACK Supreme Plug & Play

5 Using the FASTRACK Supreme Plug & Play

5.1 Getting Started

5.1.1 Mount the FASTRACK Supreme

To mount the FASTRACK Supreme on its support, bind it using the holding bridles as shown in the Figure 12 below.

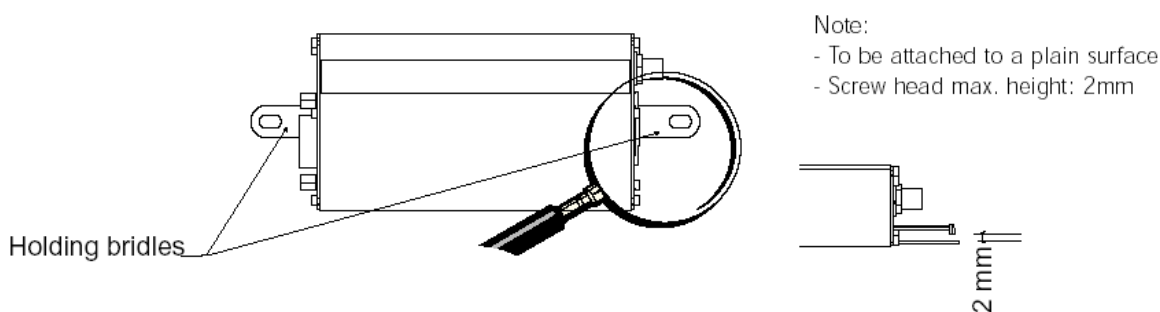


Figure 12: FASTRACK Supreme mounting

For the drill template, refer to Figure 18.

5.1.2 Set up the FASTRACK Supreme

To set up the FASTRACK Supreme, perform the following operations:

- Insert the SIM card into the SIM card holder of the FASTRACK Supreme.
- Lock the SIM card by sliding the lever towards the SIM card.
- Connect the antenna to the SMA connector.
- Connect both sides of the serial and control cable (15-pin Sub HD connector on the FASTRACK Supreme side).
- Connect the power supply cable to the external power supply source.

Note:

For automotive application, it is recommended to connect the V+BATTERY line of the FASTRACK Supreme directly to the battery positive terminal.

- Plug the power supply cable into the FASTRACK Supreme and switch on the external power supply source.
- The FASTRACK Supreme is ready to work. Refer to Section 5.10 for the description of AT commands used to configure the FASTRACK Supreme.

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Using the FASTRACK Supreme Plug & Play

5.1.3 Check the communication with the FASTRACK Supreme

To check the communication with the FASTRACK Supreme, do the following operations:

- Connect the RS232 link between the DTE (port COM) and the FASTRACK Supreme (DCE).
- Configure the RS232 port of the DTE as follows:
 - Bits per second: **115.200 bps**,
 - Data bits: **8**,
 - Parity: **None**,
 - Stop bits: **1**,
 - Flow control: **hardware**.
- Using a communication software such as a HyperTerminal, enter the **AT** command. The response of the FASTRACK Supreme must be **OK** displayed in the HyperTerminal window.
- If the communication cannot be established with the FASTRACK Supreme, do the following:
 - Check the RS232 connection between the DTE and the FASTRACK Supreme (DCE),
 - Check the configuration of the port COM used on the DTE.
- Example of AT commands which can be used after getting started the FASTRACK Supreme:
 - **AT+CGMI**: FASTRACK Supreme answer is "WAVECOM MODEM" when serial link is OK.
 - **AT+CPIN=xxxx**: to enter a PIN code xxxx (if activated).
 - **AT+CSQ**: to verify the received signal strength.
 - **AT+CREG?**: to verify the registration of the FASTRACK Supreme Plug & Play on the network.
 - **ATD<phone number>;**: to initiate a voice call.
 - **ATH**: to hang up (end of call).

For further information on these AT commands and their associated parameters, refer to "AT Commands Interface Guide" [6].

5.1.4 Reset the FASTRACK Supreme

To reset the FASTRACK Supreme, a hardware reset signal is available on pin 14 of the Sub HD 15-pin connector (RESET).

The FASTRACK Supreme reset is carried out when this pin is low for at least 200 μ s.

Warning This signal has to be considered as an emergency reset only. For further details on the FASTRACK Supreme reset, refer to Section 7.7.

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Using the FASTRACK Supreme Plug & Play

5.2 Specific Recommendations when Using the FASTRACK Supreme on Trucks

Warning: The power supply connection of the FASTRACK Supreme must NEVER be directly connected to the truck battery.

5.2.1 Recommended Power Supply Connection on Trucks

All trucks have a circuit breaker on the exterior of the cabin. The circuit breaker is used for safety reasons: if a fire blazes in the trucks, (for example, on the wiring trunk) the driver may cut the current source to avoid any damage (explosion). The circuit breaker is connected to the truck ground, most often associated with the fuse box.

Most of truck circuit breakers do not cut the Positive Supply line of the battery, but cut the ground line of the later.

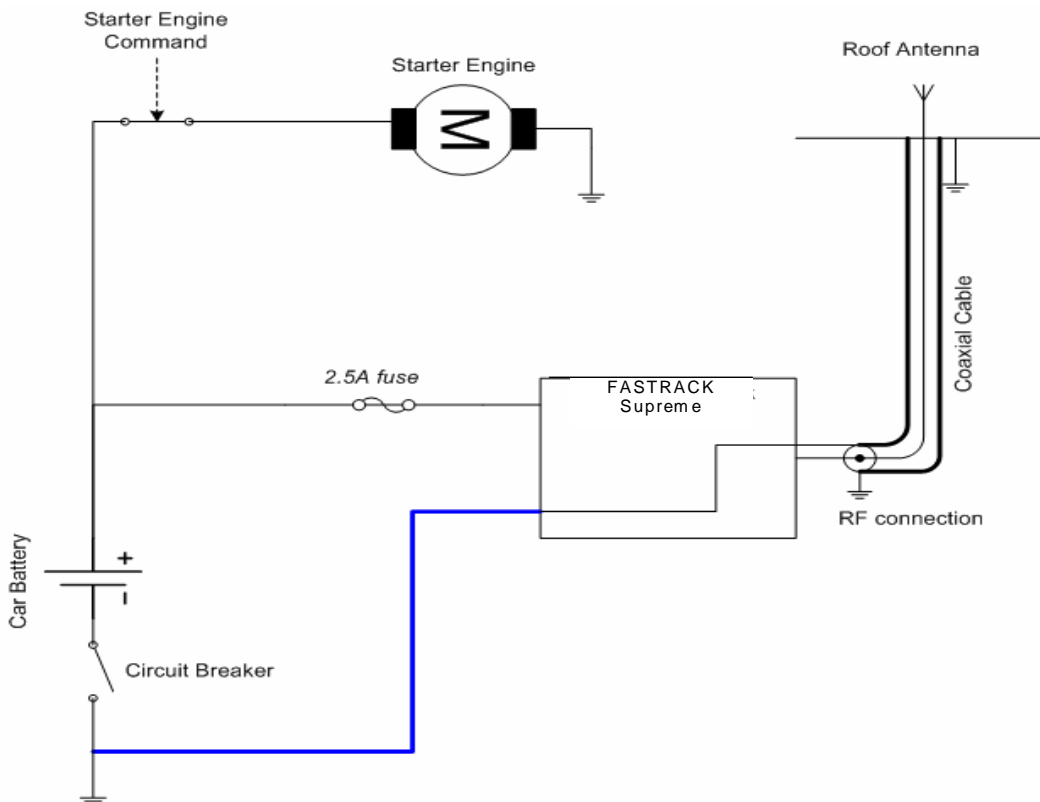


Figure 13: Recommended power supply connection on trucks

Figure 13 gives the recommended power supply connection where the ground connection of the FASTRACK Supreme is not directly connected to the battery but is connected after the Circuit Breaker (on the truck ground or the fuse box).

5.2.2 Technical Constraints on Trucks

It is highly not recommended to connect directly the power supply on the battery rather than on the circuit breaker. The FASTRACK Supreme may be damaged when starting the truck if the circuit breaker is switched OFF (in this case, the truck ground and the battery ground will be connected through the FASTRACK Supreme as shown in the figure below).

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Using the FASTRACK Supreme Plug & Play

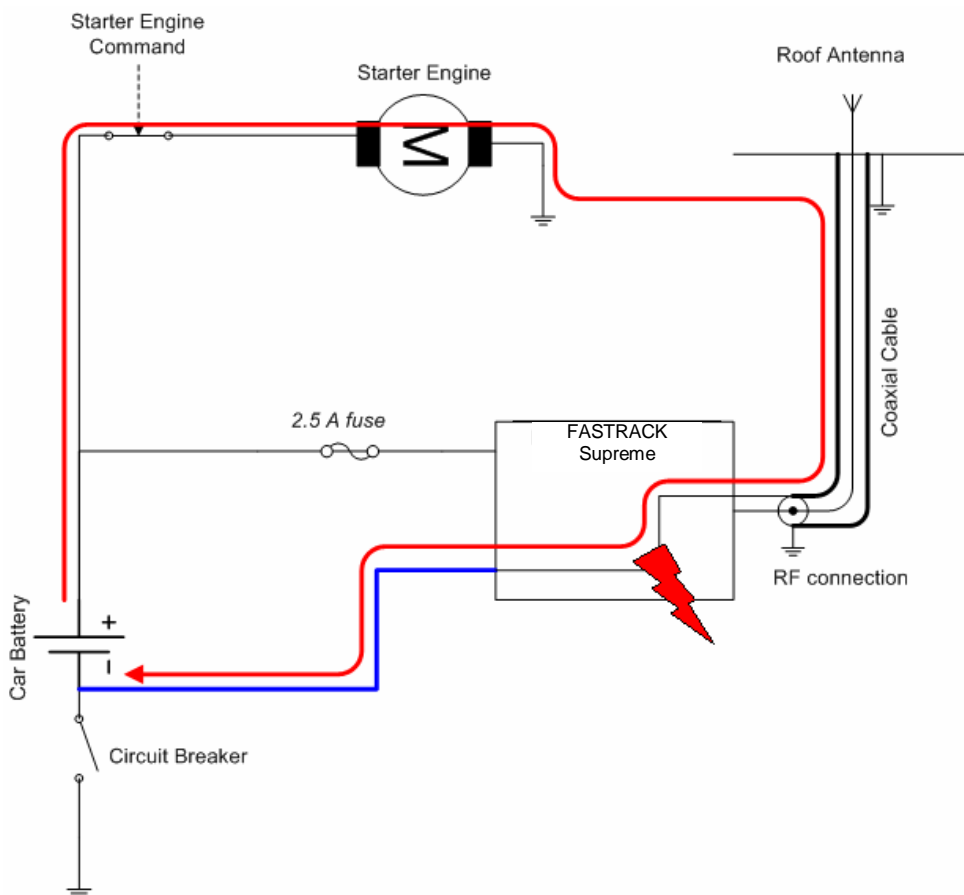


Figure 14: Example of electrical connection which may dramatically damage the FASTRACK Supreme

Figure 14 gives an example of electrical connection which may dramatically damage the FASTRACK Supreme when its ground connection is directly connected to the battery ground.

In this example, when the circuit breaker is switched OFF, the current flows through the FASTRACK Supreme and powers the electrical circuit of the truck (for example, dashboard).

Furthermore, when the Starter Engine command will be used, it will destroy the cables or the FASTRACK Supreme.

Since the internal tracks are not designed to support high current (up to 60 A when starting the truck), they will be destroyed.

5.3 FASTRACK Supreme Operational Status

The FASTRACK Supreme operational status is given by the red LED status located next to the SIM connector on the FASTRACK Supreme panel.

The Table 5 below gives the meaning of the various statuses available.



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Using the FASTRACK Supreme Plug & Play

Table 5: FASTRACK Supreme operational status

LED Status	LED light activity	FASTRACK Supreme Plug & Play status
ON	LED ON permanent	FASTRACK Supreme is switched ON but not registered on the network
	LED Flashing slowly	FASTRACK Supreme is switched ON and registered on the network, but no communication is in progress (Idle mode)
	LED Flashing rapidly	FASTRACK Supreme is switched ON and registered on the network, and a communication is in progress
OFF	LED OFF	FASTRACK Supreme is switched OFF, or Flash LED is disabled* by the user.

* : Flash LED can be disabled by user when in Slow Standby mode in order to save power consumption. For detail, please refer to Section 7.9.

5.4 Echo Function Disabled

If no echo is displayed when entering an AT command, that means:

- The "local echo" parameter of your communication software (such as HyperTerminal) is disabled.
- The FASTRACK Supreme echo function is disabled.

To enable the FASTRACK Supreme echo function, enter the **ATE1**.

When sending AT commands to the FASTRACK Supreme by using a communication software, it is recommended:

- to disable the "local echo" parameter of your communication software (such as HyperTerminal),
- to enable the FASTRACK Supreme echo function (**ATE1** command).

In a Machine To Machine communication with the FASTRACK Supreme, it is recommended to disable the FASTRACK Supreme echo function (**ATE0** command) in order to avoid useless CPU processing.

For further information on **ATE0** and **ATE1** commands, refer to "AT Commands Interface Guide" [6].

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Using the FASTRACK Supreme Plug & Play

5.5 Verify the Received Signal Strength

The FASTRACK Supreme establishes a call only if the received signal is sufficiently strong.

To verify the received signal strength, do the following operations:

- Using a communication software such as HyperTerminal, enter the AT command **AT+CSQ** .
The response returned has the following format:
+CSQ: <rsssi>,<ber> with:
 - **<rsssi>** = received signal strength indication,
 - **<ber>** = channel bit error rate.
- Verify the **<rsssi>** value returned using the Table 6 below.

Table 6: Values of received signal strength

Value of received signal strength indication (<rsssi>)	Interpretation of the received signal strength
0 - 10	Insufficient(*)
11 - 31	Sufficient(*)
32 - 98	Not defined
99	No measure available

(*) Based on general observations.

For further information on AT commands, refer to "AT Commands Interface Guide" [6].

5.6 Check the Pin Code Status

To check that the pin code has been entered, use a communication software such as a HyperTerminal, then enter **AT+CPIN?** command.

The table below gives the main responses returned:

Table 7: AT+CPIN Responses

AT+CPIN response (*)	Interpretation
+CPIN: READY	Code PIN has been entered
+CPIN: SIM PIN	Code PIN has not been entered

(*)For further information on the other possible responses and their meaning, refer to "AT Commands Interface Guide" [6].

5.7 Switch between EU/US Band(s)

To switch between EU/US band(s) for the FASTRACK Supreme, use a communication software such as a HyperTerminal, then enter **AT+WMBS=<band> [, <param>]** command.

The table below gives the commands for various band(s) selection:



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Table 8: AT+WMBS Band Selection

AT+WMBS response (*)	Interpretation
AT+WMBS=0 , x	Select mono band mode 850MHz.
AT+WMBS=1 , x	Select mono band mode extended 900MHz
AT+WMBS=2 , x	Select mono band mode 1800MHz
AT+WMBS=3 , x	Select mono band mode 1900MHz
AT+WMBS=4 , x	Select dual band mode 850/1900MHz
AT+WMBS=5 , x	Select dual band mode extended 900MHz/1800MHz
AT+WMBS=6 , x	Select dual band mode extended 900MHz/1900MHz

(*)For further information on the other possible responses and their meaning, refer to "AT Commands Interface Guide" [6].

Remark:

x=0 : The Plug & Play will have to be reset to start on specified band(s).

x=1 : The change is effective immediately. This mode is forbidden while in communication and during Plug & Play initialization.

Refer to "AT Commands Interface Guide" [6] for further information on AT commands.

5.8 Check the Band(s) Selection

To check the band selection for the FASTRACK Supreme, use a communication software such as a HyperTerminal, then enter **AT+WMBS?** command.

The table below gives the main responses returned:

Table 9: AT+WMBS Responses

AT+WMBS response (*)	Interpretation
+WMBS: 0 , x	Mono band mode 850MHz is selected
+WMBS: 1 , x	Mono band mode extended 900MHz is selected
+WMBS: 2 , x	Mono band mode 1800MHz is selected
+WMBS: 3 , x	Mono band mode 1900MHz is selected
+WMBS: 4 , x	Dual band mode 850/1900MHz are selected
+WMBS: 5 , x	Dual band mode extended 900MHz/1800MHz are selected
+WMBS: 6 , x	Dual band mode extended 900MHz/1900MHz are selected

(*)For further information on the other possible responses and their meaning, refer to "AT Commands Interface Guide" [6].



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5.9 Verify the FASTRACK Supreme Network Registration

1. Make sure a valid SIM card has been previously inserted and locked in the FASTRACK Supreme SIM card holder.
2. Using a communication software such as a HyperTerminal, enter the following AT commands:
 - a. **AT+CPIN=xxxx** to enter PIN code xxxx.
 - b. **AT+WMBS?** To check the current band setting in the Plug & Play
 - c. **AT+WMBS=<Band> [,<param>]** To switch band/mode when needed
 - d. **AT+CREG?** . To ascertain the registration status.
 The format of the returned response is as follows:
+CREG: <mode>,<stat> with:
 - **<mode>** = unsolicited registration message configuration,
 - **<stat>** = registration state.
3. Verify the state of registration according the returned value given in the table below.

Table 10: Values of network registration

Returned Value (*) <mode>,<stat>	Network registration
+CREG: 0,0	No (not registered)
+CREG: 0,1	Yes (registered, home network)
+CREG: 0,5	Yes (registered, roaming)

(*)For further information on the other returned values and their meaning, refer to "AT Commands Interface Guide" [6].



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If the FASTRACK Supreme is not registered, perform the following procedure:

- Check the connection between the FASTRACK Supreme and the antenna.
- Verify the signal strength to determine the received signal strength (refer to Section 5.5).

Note: For information on AT command relating to the network registration in GPRS mode, and in particular: CGREG, CGCLASS, CGATT, refer to "AT Commands Interface Guide" [6].

5.10 Main AT Commands for the Plug & Play

The table below lists the main AT commands required for starting the Plug & Play.

For other AT commands available or further information on the AT commands, refer to "AT Commands Interface Guide" [6].

Table 11: Main usual AT commands for the Plug & Play

Description	AT commands	FASTRACK Supreme Plug & Play response	Comment
Check for selected band(s)	AT+WMBS?	+WMBS:<Band>,<ResetFlag> OK	Current selected band mode is return
Band(s) switch	AT+WMBS=<Band>	OK	Band switch is accepted, Plug & Play has to be reset for change to be effective
	AT+WMBS=<Band>,0	OK	Band switch is accepted, Plug & Play has to be reset for change to be effective
	AT+WMBS=<Band>,1	OK	Band switch is accepted and GSMS stack restarted
	AT+WMBS=<Band>	+CME ERROR: 3	Band not allowed
Enter PIN Code	AT+CPIN=xxxx (xxxx = PIN code)	OK	PIN Code accepted.
		+CME ERROR: 16	Incorrect PIN Code (with +CMEE = 1 mode) (1*)
		+CME ERROR: 3	PIN code already entered (with +CMEE = 1 mode) (1*)
Network registration checking	AT+CREG?	+CREG: 0,1	FASTRACK Supreme Plug & Play registered on the network.
		+CREG: 0,2	FASTRACK Supreme Plug & Play not registered on the network, registration attempt.



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Description	AT commands	FASTRACK Supreme Plug & Play response	Comment
		+CREG: 0,0	FASTRACK Supreme Plug & Play not registered on the network, no registration attempt.
Receiving an incoming call	ATA	OK	Answer the call.
Initiate a call	ATD<phone number>; (Don't forget the « ; » at the end for « voice » call)	OK	Communication established.
		+CME ERROR: 11	PIN code not entered (with +CMEE = 1 mode).
		+CME ERROR: 3	AOC credit exceeded or a communication is already established.
Initiate an emergency call	ATD112; (Don't forget the « ; » at the end for « voice » call)	OK	Communication established.
Communication loss		NO CARRIER	
Hang up	ATH	OK	
Store the parameters in EEPROM	AT&W	OK	The configuration settings are stored in EEPROM.

(1*) The command "AT+CMEE=1" switch to a mode enabling more complete error diagnostics.

5.11 Firmware Upgrade Procedure

The firmware upgrade procedure is used to update the firmware embedded into the FASTRACK Supreme.

That procedure consists in downloading the firmware into internal memories through the RS232 serial link available on the SUB-D 15-pin connector.

Refer to "Firmware upgrade procedure" [8] for a detailed description of this procedure.



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6 Troubleshooting

This section of the document describes possible problems encountered when using the FASTRACK Supreme and their solutions.

To review other troubleshooting information, refer the 'FAQs' (Frequently Asked Questions) page at www.wavecom.com or use the following link:
<http://www.wavecom.com/support/faqs.php>

6.1 No Communication with the FASTRACK Supreme through the Serial Link

If the FASTRACK Supreme does not answer to AT commands through the serial link, refer to the table below for possible causes and solutions.

Table 12: Solutions for no connection with FASTRACK Supreme through serial link

If the Supreme returns	then ask	Action
Nothing	Is the FASTRACK Supreme powered correctly?	Make sure the external power supply is connected to the FASTRACK Supreme and provides a voltage in the range of 5.5 V to 32 V.
	Is the serial cable connected at both sides?	Check the serial cable connection
	Does the serial cable follow correctly pin assignment shown in paragraph 3.2.1.2.	Connect the cable by following pin assignment given in paragraph 3.2.1.1.
Nothing or non-significant characters	Is the communication program properly configured on PC?	Ensure the setting of the communication program is fit to setting of FASTRACK Supreme. FASTRACK Supreme factory setting is: Data bits = 8 Parity = none Stop bits = 1 Baud = 115 200 bps. Flow control = hardware
	Is there another program interfering with the communication program (i.e. Conflict on communication port access)	Close the interfering program.

6.2 Receiving "ERROR" Message

The FASTRACK Supreme returns an "ERROR" message (in reply to an AT command) in the following cases:

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- AT command syntax is incorrect: check the command syntax (refer to "AT Commands Interface Guide" [6]),
- AT command syntax is correct, but transmitted with wrong parameters:
- Enter the **AT+CME=1** command in order to change the error report method to the verbose method, which includes the error codes.
- Enter again the AT command which previously caused the reception of "ERROR" message in order to get the Mobile Equipment error code.

When the verbose error report method is enabled, the response of the FASTRACK Supreme in case of error is as follows:

- Either +CME ERROR: <error result code>,
- Or +CMS ERROR: <error result code>.

Refer to "AT Commands Interface Guide" [6] for error result code description and further details on the **AT +CME** command.

Note: It is strongly recommended to always enable the verbose error report method to get the Mobile Equipment error code (enter **AT +CME=1** command).

6.3 Receiving "NO CARRIER" Message

If the FASTRACK Supreme returns a "NO CARRIER" message upon an attempted call (voice or data), then refer to the table below for possible causes and solutions.

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Table 13: Solutions for "NO CARRIER" message

If the Supreme returns...	Then ask...	Action...
"NO CARRIER"	Is the received signal strong enough?	Refer to section 5.5 to verify the strength of the received signal.
	Is the FASTRACK Supreme registered on the network?	Refer to section 5.9 to verify the registration.
	Is the antenna properly connected?	Refer to section 8.2.7.3 for antenna requirements.
	Is the band selection correction?	Refer to Section 7.2 for band switch
"NO CARRIER" (when trying to issue a voice communication)	Is the semicolon (;) entered immediately after the phone number in the AT command?	Ensure that the semicolon (;) is entered immediately after the phone number in the AT command. e.g. ATD#####;
"NO CARRIER" (when trying to issue a data communication)	Is the SIM card configured for data / fax calls?	Configure the SIM card for data / fax calls (Ask your network provider if necessary).
	Is the selected bearer type supported by the called party?	Ensure that the selected bearer type is supported by the called party.
	Is the selected bearer type supported by the network?	Ensure that the selected bearer type is supported by the network. If no success, try bearer selection type by AT command: AT+CBST=0,0,3

If the FASTRACK Supreme returns a **"NO CARRIER"** message, you may have the **extended error code** by using AT command **AT+CEER**. Refer to the table below for interpretation of **extended error code**.

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Table 14: Interpretation of extended error code

Error Code	Diagnostic	Hint
1	Unallocated phone number	
16	Normal call clearing	
17	User busy	
18	No user responding	
19	User alerting, no answer	
21	Call rejected	
22	Number changed	
31	Normal, unspecified	
50	Requested facility not subscribed	
68	ACM equal or greater than ACMmax	Credit of your pre-paid SIM card expired.
252	Call barring on outgoing calls	
253	Call barring on incoming calls	
3, 6, 8, 29, 34, 38, 41, 42, 43, 44, 47, 49, 57, 58, 63, 65, 69, 70, 79, 254	Network causes	See "AT Commands Interface Guide" [6] for further details or call network provider.

Note: For all other codes, and/or details, see AT commands documentation [6].

7 Functional Description

7.1 Architecture

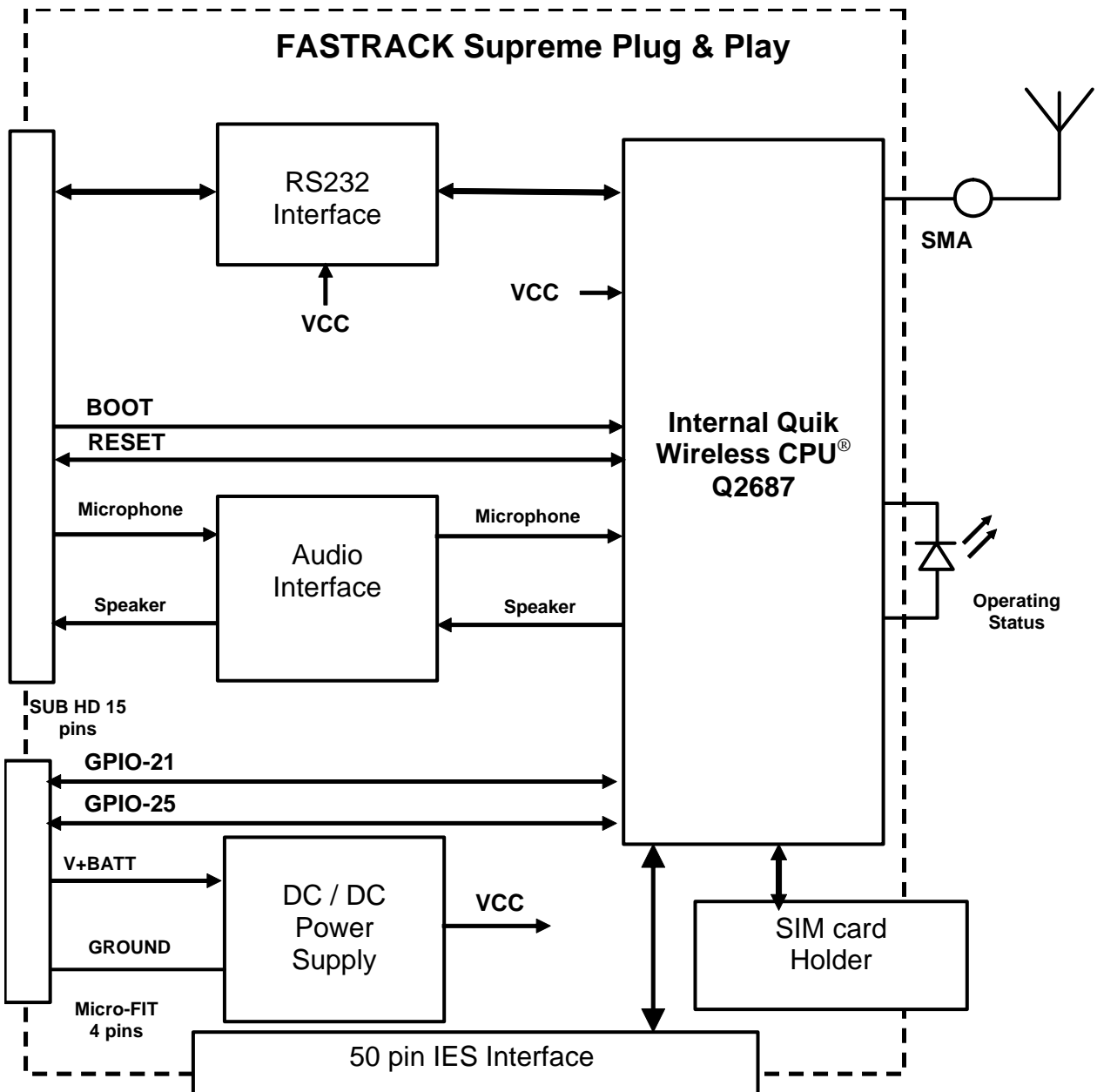


Figure 15: Functional architecture

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Functional Description

7.2 EU and US Bands

7.2.1 General Presentation

The FASTRACK Supreme is a quad band Plug & Play. It supports either EU bands (EGSM900/DCS1800) or US bands (GSM850/ PCS1900), depending on the band setting within the Plug & Play. Users are free to switch between EU bands and US bands by simple AT commands when the selected bands are supported.

7.2.2 AT COMMAND for Bands Switch

EU/US band is easily switched/checked by AT command **AT+WMBS**.

For detail, please refer to Section 5.7 and 5.8.

7.3 Power Supply

7.3.1 General Presentation

The FASTRACK Supreme is supplied by an external DC voltage (V+BATTERY) from +5.5 V to +32 V at 2.2 A.

Main regulation is made with an internal DC/DC converter in order to supply all the internal functions with a DC voltage.

Correct operation of the FASTRACK Supreme in communication mode is not guaranteed if input voltage (V+BATTERY) falls below 5.5 V.

Note: The minimum input voltage specified here is at the FASTRACK Supreme input. Be careful of the input voltage decrease caused by the power cable. See paragraph 8.2.1 for more information.

7.3.2 Protections

The FASTRACK Supreme is protected by a 800 mA / 250 V fuse directly bonded on the power supply cable.

The FASTRACK Supreme is also protected against voltage over +32 V.

Filtering guarantees:

- EMI/RFI protection in input and output,
- Signal smoothing.

7.4 RS232 Serial Link

7.4.1 General Presentation

The RS232 interface performs the voltage level adaptation (V24/CMOS \leftrightarrow V24/V28) between the internal FASTRACK Supreme Plug & Play (DCE) and the external world (DTE).

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The RS232 interface is internally protected (by ESD protection) against electrostatic surges on the RS232 lines.

Filtering guarantees:

- EMI/RFI protection in input and output,
- Signal smoothing.

Signals available on the RS232 serial link are:

- TX data (CT103/TX),
- RX data (CT104/RX),
- Request To Send (CT105/RTS),
- Clear To Send (CT106/CTS),
- Data Terminal Ready (CT108-2/DTR),
- Data Set Ready (CT107/DSR),
- Data Carrier Detect (CT109/DCD),
- Ring Indicator (CT125/RI).

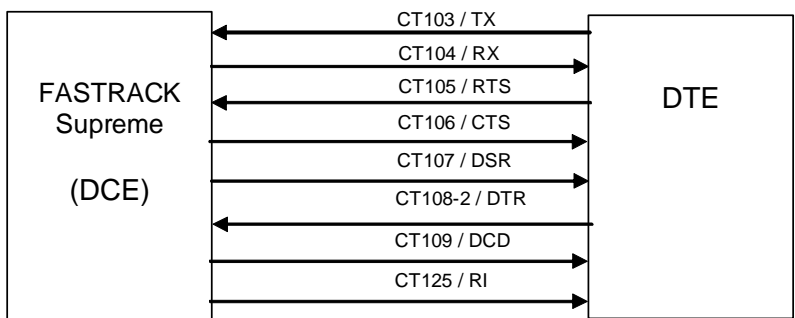


Figure 16: RS232 Serial Link signals

RS232 interface has been designed to allow flexibility in the use of the serial interface signals. However, the use of TX, RX, CTS and RTS signals is mandatory, which is not the case for DTR, DSR, DCD and RI signals which can be not used.

7.4.2 Autobauding Mode

The autobauding mode allows the FASTRACK Supreme to detect the baud rate used by the DTE connected to the RS232 serial link.

Autobauding mode is controlled by AT commands. See "AT Commands Interface Guide" [6] for details on this function.

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7.4.3 Pin Description

Signal	Sub HD connector Pin number	I/O	I/O type RS232 STANDARD	Description
CTXD/CT103	2	I	TX	Transmit serial data
CRXD/CT104	6	O	RX	Receive serial data
CRTS/CT105	12	I	RTS	Request To Send
CCTS/CT106	11	O	CTS	Clear To Send
CDSR/CT107	7	O	DSR	Data Set Ready
CDTR/CT108-2	8	I	DTR	Data Terminal Ready
CDCD/CT109	1	O	DCD	Data Carrier Detect
CRI/CT125	13	O	RI	Ring Indicator
CT102/GND	9		GND	Ground

7.4.4 Serial Port Auto shut down Feature

The UART1 can be shut down when there is no activity between the DTE and the FASTRACK Supreme Plug & Play. This can help for improving power consumption performance.

Serial Port Auto shut down feature is easily controlled by AT command **AT+WASR**.

- **AT+WASR=1** for entering the serial port auto shut down mode
- **AT+WASR=0** for exiting the serial port auto shut down mode

Refer to "AT Commands Interface Guide" [6] for further information on AT commands.

CAUTION: GPIO24 is reserved for serial port auto shut down feature. It is prohibited for customer use. Improper access to GPIO24 by customer may lead to unexpected behavior on UART1 performance.



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7.5 General Purpose Input/Output (GPIO)

The FASTRACK Supreme provides two General Purpose Input / Output lines available for external use: GPIO21 and GPIO25.

These GPIOs may be controlled by AT commands:

- **AT+WIOV** for a write access to the GPIO value, when the GPIO is used as an output,
- **AT+WIOR** for a read access to the GPIO value, when the GPIO is used as an input.

Refer to "AT Commands Interface Guide" [6] for further information on AT commands.

After reset, both GPIOs are configured as inputs. The **AT+WIOM** command has to be used to change this configuration (refer to "AT Commands Interface Guide" [6] for further details).

Pin description

Signal	Power Supply connector (4-pin Micro-Fit)	I/O	I/O Voltage	Reset state	Description	Multiplex with
GPIO21	3	I/O	2V8	Undefined	General Purpose I/O	No mux
GPIO25	4	I/O	2V8	Z	General Purpose I/O	INT1

Notes:

- The power supply cable may need to be modified due to the GPIO signals (GPIO21 & GPIO25) available on the 4-pin Micro-FIT connector of the FASTRACK Supreme.
- The previous generation M1306B have GPIO4 and GPIO5 being replaced by GPIO21 and GPIO25 respectively, for which **both are of LOW level at reset state.**

7.6 BOOT

This signal must not be connected. Its use is strictly reserved to Wavecom or competent retailers.

Caution: Previous generation M1306B has BOOT signal of HIGH level at 2.8V. But the FASTRACK Supreme now of 1.8V BOOT instead.

7.7 RESET

7.7.1 General presentation

This signal is used to force a reset procedure by providing low level during at least 200 µs.

This signal must be considered as an emergency reset only. A reset procedure is automatically driven by an internal hardware during the power-up sequence.



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This signal may also be used to provide a reset to an external device. It then behaves as an output. If no external reset is necessary, this input may be left open, if used (emergency reset), it has to be driven either by an open collector or an open drain output:

- RESET pin 14 = 0, for FASTRACK Supreme Reset,
- RESET pin 14 = 1, for normal mode.

Pin description

Signal	Sub HD 15-Pin connector Pin number	I/O	I/O type	Voltage	Description
RESET	14	I/O	Open Drain	1V8	FASTRACK Supreme Reset

Caution: Previous generation M1306B has RESET signal of HIGH level at 2.8V. But the FASTRACK Supreme now of 1.8V RESET instead.

Additional comments on RESET:

The RESET process is activated either by the external RESET signal or by an internal signal (coming from a RESET generator). This automatic reset is activated at Power-up.

The FASTRACK Supreme remains in RESET mode as long as the RESET signal is held low.

Caution: This signal should be used only for "emergency" reset.

A software reset is always preferred to a hardware reset.

Note: See "AT Commands Interface Guide" [6] for further information on software reset.

7.7.2 Reset Sequence

To activate the "emergency" reset sequence, the RESET signal has to be set to low for 200 μs minimum.

As soon as the reset is done, the AT interface answers "OK" to the application. For this, the application must send **AT+J**.

If the application manages hardware flow control, the AT command may be sent during the initialization phase. Another solution is to use the **AT+WIND** command to get an unsolicited status from the FASTRACK Supreme.

For further details, refer to AT commands "AT Commands Interface Guide" [6].

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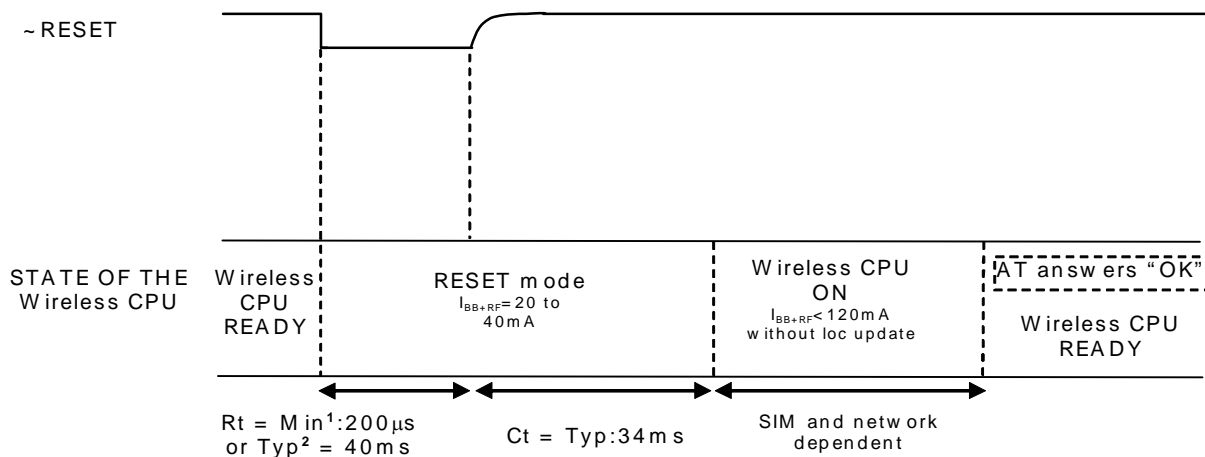


Figure 17: Reset sequence diagram

7.8 Audio

Audio interface is a standard one for connecting a phone handset.

Echo cancellation and noise reduction features are also available to improve the audio quality in case of hand-free application.

7.8.1 Microphone Inputs

The microphone inputs are differential ones in order to reject common mode noise and TDMA noise.

They already include the convenient biasing for an electret microphone (0.5 mA and 2 Volts) and are ESD protected.

This electret microphone may be directly connected to these inputs allowing an easy connection to a handset.

The microphone impedance must be around 2 kΩ.

AC coupling is already embedded in the Wireless CPU®.

The gain of the microphone inputs is internally adjusted and may be tuned from 30 dB to 51 dB using an **AT +VGT** command (refer to AT commands documentation [6]).

Pin description

Signal	Sub D 15-pin Pin #	I/O	I/O type	Description
CMIC2P	4	I	Analog	Microphone positive input
CMIC2N	5	I	Analog	Microphone negative input

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7.8.2 Speaker Outputs

This connection is differential to reject common mode noise and TDMA noise.

Speaker outputs are connected to internal push-pull amplifiers and may be loaded down between 32 to 150 Ohms and up to 1 nF (see details in table *Speaker gain vs Max output voltage*, in "AT Commands Interface Guide" [6]). These outputs may be directly connected to a speaker.

The output power may be adjusted by step of 2 dB. The gain of the speaker outputs is internally adjusted and may be tuned using an **AT +VGR** command (refer to AT commands documentation [6]).

Pin description

Signal	Sub D 15-pin Pin #	I/O	I/O type	Description
CSPK2P	10	O	Analog	Speaker positive output
CSPK2N	15	O	Analog	Speaker negative output



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Functional Description

7.9 Real Time Clock (RTC)

The FASTRACK Supreme has now implemented the Real Time Clock for saving date and time when the Plug & Play is unplugged from the DC power supply through the DC power cable.

Item	Min	Typical	Max
Charging Time start from fully discharged to fully charged		940 min	
RTC Time Period*	Guarantee	2475 min	
	Non-guarantee	5225 min	

Remark: The RTC time period is measured from the RTC battery is fully charged before being unplugged from the DC power source.

7.10 FLASH LED

The FASTRACK Supreme has a red LED indicator to show the status of the GSM network. For detail description of the various status, please refer to Section 5.3.

However, during operation mode of Slow Standby, there will be no network registration and so the red LED indicator will always be ON. It is possible for user to deactivate the LED indication during Slow Standby mode, in order to reduce power consumption.

The Flash LED can be deactivated by AT command *at+whcnf=1,0*

The Flash LED can be activated by AT command *at+whcnf=1,1*

However, the new setting will be taken into account only after a restart. For detail, please refer to Document[6].

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Technical Characteristics

8 Technical Characteristics

8.1 Mechanical Characteristics

Table 15: Mechanical characteristics

Dimensions	73 x 54.5 x 25.5 mm (excluding connectors)
Overall Dimension	88 x 54.5 x 25.5 mm
Weight	≈ 80 grams (FASTRACK Supreme only) < 120 grams (FASTRACK Supreme + bridles + power supply cable)
Volume	101.5 cm ³
Housing	Aluminum profiled

The next page gives the dimensioning diagram of the FASTRACK Supreme including the clearance areas to take into account for the FASTRACK Supreme installation.

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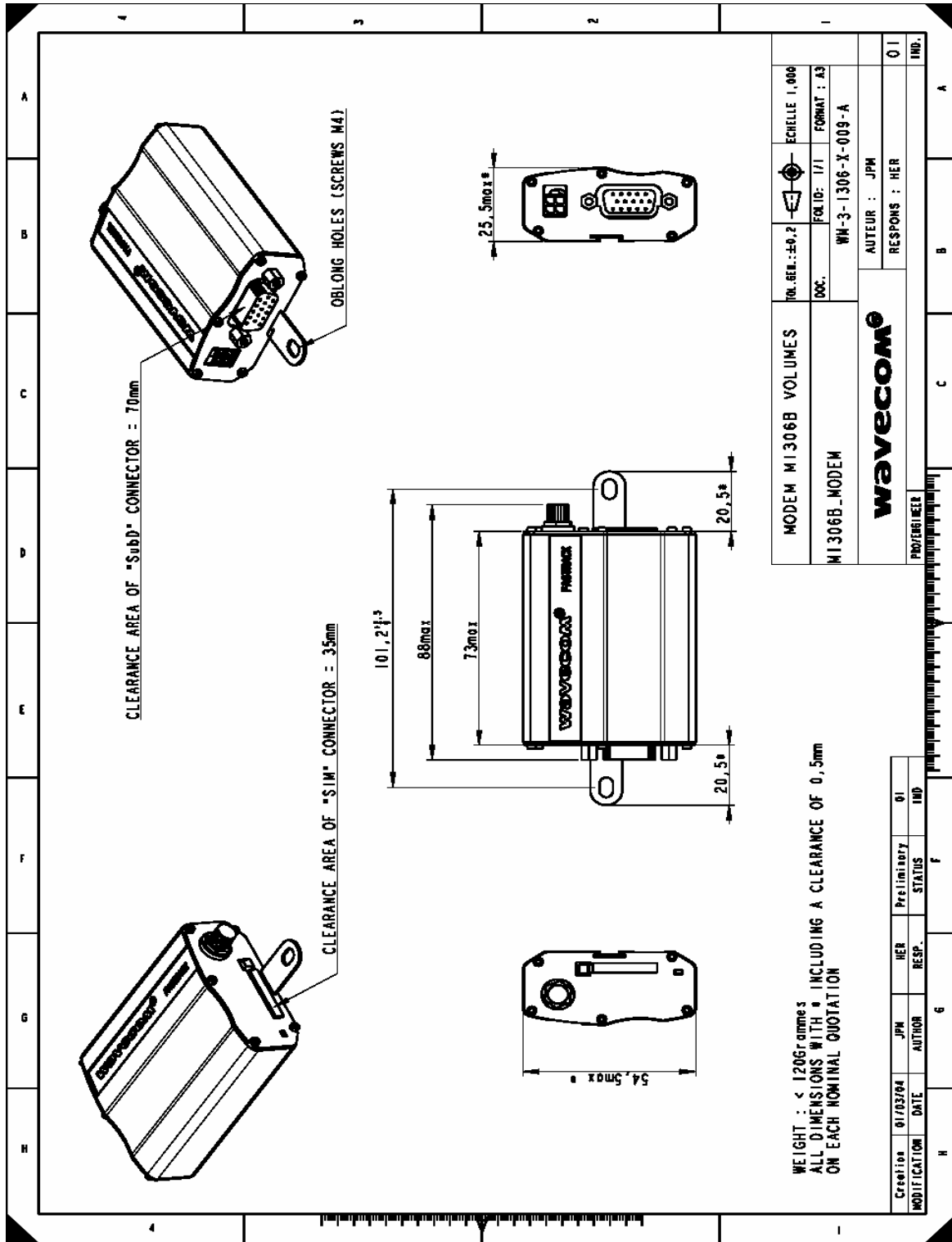


Figure 18: Dimensioning diagram

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Technical Characteristics

8.2 Electrical Characteristics

8.2.1 Power Supply

Table 16: Electrical characteristics

Operating Voltage ranges	5.5 V to 32 V DC.
Maximum current	480 mA Average at 5.5V. 2.1 A Peak at 5.5 V. (TBC)

Note:

The FASTRACK Supreme is permanently powered once the power supply is connected. The following table describes the consequences of over-voltage and under-voltage with the FASTRACK Supreme.

Warning:

All the input voltages specification described in this Section are at the FASTRACK Supreme input. While powering the FASTRACK Supreme, take into account the input drop caused by the power cable. With the delivered cable, this input drop is around 700 mV at 5.5 V and 220 mV at 32V.

Table 17: Effects of power supply defect

If the voltage	then
falls below 5.5 V,	the GSM communication is not guaranteed.
is over 32 V (Transient peaks),	the FASTRACK Supreme guarantees its own protection.
Is over 32 V (continuous overvoltage)	the protection of the FASTRACK Supreme is done by the fuse (the supply voltage is disconnected).

The fuse is a 800 mA / 250 V FAST-ACTING 5*20mm. See Section 10 for recommended references.

The following table provides information on power consumption of the FASTRACK Supreme, assuming an operating temperature of +25 °C and using a 3 V SIM card.

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8.2.2 Power Consumption

The following table provides information on power consumption of the FASTRACK Supreme, assuming an operating temperature of +25 °C and using a 3 V SIM card.

Table 18: Power consumption (1*)

Power Consumption in E-GSM 900/DCS 1800 MHz - GPRS class 10				E-GSM 900	DCS 1800
GSM	I_{peak}	GSM900: During TX bursts @ PCL5 DCS1800: During TX bursts @ PCL0	@ 5.5V	TBC	TBC
			@ 13.2V	TBC	TBC
			@ 32V	TBC	TBC
	I_{avg}	GSM900: Average @ PCL5 DCS1800: Average @ PCL0	@ 5.5V	TBC	TBC
			@ 13.2V	TBC	TBC
			@ 32V	TBC	TBC
GPRS Class 2	I_{peak}	GSM900: During 1TX bursts @ PCL5 DCS1800: During 1TX bursts @ PCL0	@ 5.5V	TBC	TBC
			@ 13.2V	TBC	TBC
			@ 32V	TBC	TBC
	I_{avg}	GSM900: Average 1TX/1RX @PCL5 DCS1800: Average 1TX/1RX @PCL0	@ 5.5V	TBC	TBC
			@ 13.2V	TBC	TBC
			@ 32V	TBC	TBC
GPRS Class 10	I_{peak}	GSM900: During 2TX bursts @ PCL5 (Gamma 3) DCS1800: During 2TX bursts @ PCL0 (Gamma 2)	@ 5.5V	TBC	TBC
			@ 13.2V	TBC	TBC
			@ 32V	TBC	TBC
	I_{avg}	GSM900: Average 2TX/3RX @ PCL5 (Gamma 3) DCS1800: Average 2TX/3RX @ PCL0 (Gamma 2)	@ 5.5V	TBC	TBC
			@ 13.2V	TBC	TBC
			@ 32V	TBC	TBC
EGPRS Class 2	I_{peak}	GSM900: During 1TX bursts @ PCL8 (Gamma 6) DCS1800: During 1TX bursts @ PCL2 (Gamma 5)	@ 5.5V	TBC	TBC
			@ 13.2V	TBC	TBC
			@ 32V	TBC	TBC
	I_{avg}	GSM900: Average 1TX/1RX @ PCL8 (Gamma 6) DCS1800: Average 1TX/1RX @ PCL2 (Gamma 5)	@ 5.5V	TBC	TBC
			@ 13.2V	TBC	TBC
			@ 32V	TBC	TBC



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Power Consumption in E-GSM 900/DCS 1800 MHz - GPRS class 10			E-GSM 900	DCS 1800	
EGPRS Class 10	I_{peak}	GSM900: During 2TX bursts @ PCL8 (Gamma 6) DCS1800 : During 2TX bursts @ PCL2 (Gamma 5)	@ 5.5V	TBC	TBC
			@ 13.2V	TBC	TBC
			@ 32V	TBC	TBC
	I_{avg}	GSM900 : Average 2TX/3RX @ PCL8 (Gamma 6) DCS1800 : Average 2TX/3RX @ PCL2 (Gamma 5)	@ 5.5V	TBC	TBC
			@ 13.2V	TBC	TBC
			@ 32V	TBC	TBC
I_{avg} in Fast Idle mode Page 9 (2*)	Serial port auto shut down deactivated	@ 5.5V	33	TBC	
		@ 13.2V	TBC	TBC	
		@ 32V	TBC	TBC	
	Serial port auto shut down activated	@ 5.5V	17	TBC	
		@ 13.2V	TBC	TBC	
		@ 32V	TBC	TBC	
I_{avg} in Slow Idle mode Page 9 (3*)	Serial port auto shut down deactivated	@ 5.5V	23	TBC	
		@ 13.2V	TBC	TBC	
		@ 32V	TBC	TBC	
	Serial port auto shut down activated	@ 5.5V	5	TBC	
		@ 13.2V	TBC	TBC	
		@ 32V	TBC	TBC	
I_{avg} in Fast Standby mode (4*)	Serial port auto shut down deactivated	@ 5.5V	52	TBC	
		@ 13.2V	TBC	TBC	
		@ 32V	TBC	TBC	
	Serial port auto shut down activated	@ 5.5V	35	TBC	
		@ 13.2V	TBC	TBC	
		@ 32V	TBC	TBC	



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Power Consumption in E-GSM 900/DCS 1800 MHz - GPRS class 10			E-GSM 900	DCS 1800
I_{avg} in Slow Standby mode (with FLASH LED activated) (4*)	Serial port auto shut down deactivated	@ 5.5V	24	TBC
		@ 13.2V	TBC	TBC
		@ 32V	TBC	TBC
	Serial port auto shut down activated	@ 5.5V	8	TBC
		@ 13.2V	TBC	TBC
		@ 32V	TBC	TBC
I_{avg} in Slow Standby mode (with FLASH LED deactivated) (4*)	Serial port auto shut down deactivated	@ 5.5V	TBC	TBC
		@ 13.2V	TBC	TBC
		@ 32V	TBC	TBC
	Serial port auto shut down activated	@ 5.5V	4	TBC
		@ 13.2V	TBC	TBC
		@ 32V	TBC	TBC

(1*): The power consumption might vary by 5 % over the whole operating temperature range (-20 °C to +55 °C).

(2*): In this Mode, the RF function is active and the FASTRACK Supreme synchronized with the network, but there is no communication.

(3*): In this Mode, the RF function is disabled, but regularly activated to keep the synchronization with the network. This Mode works only when the DTE send AT command to shut down the serial link by software approach (DTE turns DTR in inactive state).

(4*): In this Mode, the RF function is disabled, and there is no synchronization with the network.

Fastrack Supreme User Guide

Technical Characteristics

8.2.3 Audio Interface

The audio interface is available through the Sub HD 15-pin connector.

Table 19: Audio parameters characteristics

Audio parameters	Min	Typ	Max	Unit	Comments
Microphone input current @2 V/2 k Ω		0.5		mA	
Absolute microphone input voltage			100	mVpp	AC voltage
Speaker output current 150 Ω //1 nF		16		mA	
Absolute speaker impedance	32	50		Ω	
Impedance of the speaker amplifier output in differential mode			1	Ω	+/-10 %

Table 20: Microphone inputs internal audio filter characteristics

Frequency	Gain
0-150 Hz	< -22 dB
150-180 Hz	< -11 dB
180-200 Hz	< -3 dB
200-3700 Hz	0 dB
>4000 Hz	< -60 dB

Table 21: Recommended characteristics for the microphone:

Feature	Value
Type	Electret 2 V / 0.5 mA
Impedance	Z = 2 k Ω
Sensitivity	-40 dB to -50 dB
SNR	> 50 dB
Frequency response	compatible with the GSM specifications



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Table 22: Recommended characteristics for the speaker:

Feature	Value
Type	10 mW, electro-magnetic
Impedance	Z = 32 to 50 Ω
Sensitivity	110 dB SPL min. (0 dB = 20 μPa)
Frequency response	compatible with the GSM specifications

8.2.4 General Purpose Input/Output

Both GPIO21 and GPIO25 may be interfaced with a component that comply with 3 Volts CMOS levels.

Table 23: Operating conditions

Parameter	I/O type	Min	Typ	Max	Condition
V _{IL}	CMOS			0.84 V	
V _{IH}	CMOS	1.96 V			
V _{OL}	CMOS			0.4 V	I _{OL} = -4 mA
V _{OH}	CMOS	2.4 V			I _{OH} = 4 mA
I _{OH}				4mA	
I _{OL}				-4mA	

Clamping diodes are present on I/O pads.

8.2.5 SIM Interface

Table 24: SIM card characteristics

SIM card	1.8V / 3 V
-----------------	------------

8.2.6 RESET Signal

Table 25: Electrical characteristics

Parameter	Min	Typ	Max	Unit
Input Impedance (R)*		330K		kΩ
Input Impedance (C)		10n		nF

*Internal pull-up

Fastrack Supreme User Guide

Technical Characteristics

Table 26: Operating conditions

Parameter	Minimum	Typ	Maximum	Unit
~RESET time (Rt) ¹	200			µs
~RESET time (Rt) ² at power up only	20	40	100	ms
Cancellation time (Ct)		34		ms
V _H	0.57			V
V _{IL}	0		0.57	V
V _{IH}	1.33			V

* V_H: Hysteresis Voltage

1 This reset time is the minimum to be carried out on the ~RESET signal when the power supply is already stabilized.

2 This reset time is internally carried out by the Wireless CPU power supply supervisor only when the Wireless CPU power supplies are powered ON.

8.2.7 RF Characteristics

8.2.7.1 Frequency Ranges

Table 27: Frequency ranges

Characteristic	GSM 850	E-GSM 900	DCS 1800	PCS 1900
Frequency TX	824 to 849 MHz	880 to 915 MHz	1710 to 1785 MHz	1850 to 1910 MHz
Frequency RX	869 to 894 MHz	925 to 960 MHz	1805 to 1880 MHz	1930 to 1990 MHz

Fastrack Supreme User Guide

Technical Characteristics

8.2.7.2 RF Performances

RF performances are compliant with the ETSI recommendation GSM 05.05.

The RF performances for receiver and transmitter are given in the table below.

Table 28: Receiver and transmitter RF performances

Receiver	
E-GSM900/GSM850 Reference Sensitivity	-104 dBm Static & TUHigh
DCS1800/PCS1900 Reference Sensitivity	-102 dBm Static & TUHigh
Selectivity @ 200 kHz	> +9 dBc
Selectivity @ 400 kHz	> +41 dBc
Linear dynamic range	63 dB
Co-channel rejection	>= 9 dBc
Transmitter	
Maximum output power (E-GSM 900/GSM850) at ambient temperature	33 dBm +/- 2 dB
Maximum output power (DCS1800/PCS1900) at ambient temperature	30 dBm +/- 2 dB
Minimum output power (E-GSM 900/GSM850) at ambient temperature	5 dBm +/- 5 dB
Minimum output power (DCS1800/PCS1900) at ambient temperature	0 dBm +/- 5 dB



Fastrack Supreme User Guide

Technical Characteristics

8.2.7.3 External Antenna

The external antenna is connected to the FASTRACK Supreme via the SMA connector.

The external antenna must fulfill the characteristics listed in the table below.

Table 29: External antenna characteristics

Antenna frequency range	Quad-band GSM 850/GSM900/DCS1800/PCS1900 MHz
Impedance	50 Ohms nominal
DC impedance	0 Ohm
Gain (antenna + cable)	0 dBi
VSWR (antenna + cable)	2

Note: Refer to Section 10 for recommended antenna.

8.3 Environmental Characteristics

The FASTRACK Supreme Plug & Play is compliant with the following operating class. To ensure the proper operation of the FASTRACK Supreme, the temperature of the environment must be within a specific range as described in the table below.

Table 30: Ranges of temperature

Conditions	Temperature range
Operating / Class A	-20 °C to +55°C
Operating / Class B	-30 °C to +85°C
Storage	-40 °C to +85°C

Function Status Classification:

Class A:

The FASTRACK Supreme remains fully functional, meeting GSM performance criteria in accordance with ETSI requirements, across the specified temperature range.

Class B:

The FASTRACK Supreme remains fully functional, across the specified temperature range. Some GSM parameters may occasionally deviate from the ETSI/PTCRB specified requirements and this deviation does not affect the ability of the FASTRACK Supreme to connect to the cellular network and function fully, as it does within the Class A range.

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The detailed climatic and mechanics standard environmental constraints applicable to the FASTRACK Supreme are listed in the table below:

Table 31: Environmental standard constraints

Environmental Tests (IEC TR 60721-4)		Environmental Classes (IEC 60721-3)			
Tests	Standards	Storage (IEC 60721-3-1) Class IE13	Transportation (IEC 60721-3-2) Class IE23	Operation	
				Stationary (IEC 60721-3-3) Class IE35	Non-Stationary (IEC 60721-3-7) Class IE73
Cold	IEC 60068-2-1 : Ab/Ad	-25°C, 16 h	-40°C, 16 h	-5°C, 16 h	-5°C, 16 h
Dry heat	IEC 60068-2-2 : Bb/Bd	+70°C, 16 h	+70°C, 16 h	+55°C, 16 h	+55°C, 16 h
Change of temperature	IEC 60068-2-14 : Na/Nb	-33°C to ambient 2 cycles, t1=3 h 1 °C.min ⁻¹	-40°C to ambient 5 cycles, t1=3 h t2<3 min	-5°C to ambient 2 cycles, t1=3 h 0,5 °C.min ⁻¹	-5°C to ambient 5 cycles, t1=3 h t2<3 min
Damp heat	IEC 60068-2-56 : Cb	+30°C, 93% RH 96 h	+40°C, 93% RH 96 h minimum	+30°C, 93% RH, 96 h	+30°C, 93% RH, 96 h
Damp heat, cyclic	60068-2-30 : Db Variant 1 or 2	+40°C, 90% to 100% RH One cycle Variant 2	+55°C, 90% to 100% RH Two cycles Variant 2	+30°C, 90% to 100% RH Two cycles Variant 2	+40°C, 90% to 100% RH Two cycles Variant 1
Vibration (sinusoidal)	IEC 60068-2-6 : Fc	1-200 Hz 2 m.s ⁻² 0,75 mm 3 axes 10 sweep cycles	1-500 Hz 10 m.s ⁻² 3,5 mm 3 axes 10 sweep cycles	1-150 Hz 2 m.s ⁻² 0,75 mm 3 axes 5 sweep cycles	1-500 Hz 10 m.s ⁻² 3,5 mm 3 axes 10 sweep cycles
Vibration (random)	IEC 60068-2-64 : Fh	-	10-100 Hz / 1,0 m ² .s ⁻³ 100-200 Hz / -3 dB.octave ⁻¹ 200-2000 Hz / 0,5 m ² .s ⁻³ 3 axes 30 min	-	-
Shock (half-sine)	IEC 60068-2-27 : Ea	-	-	50 m.s ⁻² 6 ms 3 shocks 6 directions	150 m.s ⁻² 11 ms 3 shocks 6 directions
Bump	IEC 60068-2-29 : Eb	-	250 m.s ⁻² 6 ms 50 bumps vertical direction	-	-
Free fall	ISO 4180-2	-	Two falls in each specified attitude	-	2 falls in each specified attitude 0,025 m (<1kg)
Drop and topple	IEC 60068-2-31 : Ec	-	One drop on relevant corner One topple about each bottom edge	-	One drop on each relevant corner One topple on each of 4 bottom edges

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Technical Characteristics

Notes:

Short description of Class IE13 (For more information see standard IEC 60721-3-1)

"Locations without controlled temperature and humidity, where heating may be used to raise low temperatures, locations in buildings providing minimal protection against daily variations of external climate, prone to receiving rainfall from carrying wind".

Short description of Class IE23 (For more information, see standard IEC 60721-3-2)

"Transportation in unventilated compartments and in conditions without protection against bad weather, in all sorts of trucks and trailers in areas of well developed road network, in trains equipped with buffers specially designed to reduce shocks and by boat".

Short description of Class IE35 (For more information see standard IEC 60721-3-3)

"Locations with no control on heat or humidity where heating may be used to raise low temperatures, to places inside a building to avoid extremely high temperatures, to places such as hallways, building staircases, cellars, certain workshops, equipment stations without surveillance".

Short description of Class IE73 (For more information see standard IEC 60721-3-7)

"Transfer to places where neither temperature nor humidity are controlled but where heating may be used to raise low temperatures, to places exposed to water droplets, products can be subjected to ice formation, these conditions are found in hallways and building staircases, garages, certain workshops, factory building and places for industrial processes and hardware stations without surveillance".

Warning: The specification in the above table applies to the FASTRACK Supreme product only. Customers are advised to verify that the environmental specification of the SIM Card used is compliant with the FASTRACK Supreme environmental specifications. Any application must be qualified by the customer with the SIM Card in storage, transportation and operation.

The use of standard SIM cards may drastically reduce the environmental conditions in which the Product can be used. These cards are particularly sensible to humidity and temperature changes. These conditions may produce oxidation of the SIM card metallic layers and cause, in the long term, electrical discontinuities. This is particularly true in left alone applications, where no frequent extraction/insertion of the SIM card is performed.

In case of mobility when the application is moved through different environments with temperature variations, some condensation may appear. These events have a negative impact on the SIM and may favor oxidation.

If the use of standard SIM card, with exposition to the environmental conditions described above, can not be avoided, special care must be taken in the integration of the final application in order to minimize the impact of these conditions. The solutions that may be proposed are:

- Lubrication of the SIM card to protect the SIM Contact from oxidation.
- Putting the FASTRACK Supreme Plug & Play in a waterproof enclosure with desiccant bags.

Lubrication of the SIM card had been tested by Wavecom (using Tutela Fluid 43EM from MOLYDUVAL) and gives very good results.

If waterproof enclosure with a desiccant solution is used, check with your desiccant retailer the quantity that must be used according to the enclosure dimensions. Ensure humidity has been removed before sealing the enclosure.

Any solution selected must be qualified by the customer on the final application.

To minimize oxidation problem on the SIM card, its manipulation must be done with the greatest precautions. In particular, the metallic contacts of the card must never be touched with bare fingers or any matter which

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Technical Characteristics

may contain polluted materials liable to produce oxidation (such as, e.g. substances including chlorine). In case a cleaning of the Card is necessary, a dry cloth must be used (never use any chemical substance).

8.4 Conformity

The complete product complies with the essential requirements of article 3 of R&TTE 1999/5/EC Directive and satisfied the following standards:

Domain	Applicable standard
Safety standard	EN 60950 (ed.1999)
Efficient use of the radio frequency spectrum	EN 301 419-(v 4.1.1) EN 301 511 (V 7.0.1)
EMC	EN 301 489-1 (edition 2002) EN 301 489-7 (edition 2002)
Global Certification Forum – Certification Criteria	GCF-CC V3.13.0
PTCRB	
FCC	
IC	

8.5 Protections

8.5.1 Power Supply

The FASTRACK Supreme is protected by a 800 mA / 250 V fuse directly bonded on the power supply cable.

The model of fuse used is: **FSD 800 mA / 250 V FAST-ACTING**.

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8.5.2 Overvoltage

The FASTRACK Supreme is protected against voltage over +32 V.

When input voltages exceed +32 V, the supply voltage is disconnected in order to protect the internal electronic components from an overvoltage.

8.5.3 Electrostatic Discharge

The FASTRACK Supreme withstands ESD according to IEC 1000-4-2 requirements for all accessible parts of the FASTRACK Supreme except the RF part:

- 8 kV of air discharge,
- 4 kV of contact discharge.

8.5.4 Miscellaneous

Filtering guarantees:

- EMI/RFI protection in input and output,
- Signal smoothing.

Fastrack Supreme User Guide

Safety recommendations

9 Safety recommendations

9.1 General Safety

It is important to follow any special regulations regarding the use of radio equipment due in particular to the possibility of radio frequency (RF) interference. Please follow the safety advice given below carefully.

Switch OFF your Wireless CPU®:

- When in an aircraft. The use of cellular telephones in an aircraft may endanger the operation of the aircraft, disrupt the cellular network and is illegal. Failure to observe this instruction may lead to suspension or denial of cellular telephone services to the offender, or legal action or both,
- When at a refueling point,
- When in any area with a potentially explosive atmosphere which could cause an explosion or fire,
- In hospitals and any other place where medical equipment may be in use.

Respect restrictions on the use of radio equipment in:

- Fuel depots,
- Chemical plants,
- Places where blasting operations are in progress,
- Any other area where signalization reminds that the use of cellular telephone is forbidden or dangerous.
- Any other area where you would normally be advised to turn off your vehicle engine.

There may be a hazard associated with the operation of your FASTRACK Supreme Plug & Play close to inadequately protected personal medical devices such as hearing aids and pacemakers. Consult the manufacturers of the medical device to determine if it is adequately protected.

Operation of your FASTRACK Supreme Plug & Play close to other electronic equipment may also cause interference if the equipment is inadequately protected. Observe any warning signs and manufacturers' recommendations.

The FASTRACK Supreme Plug & Play is designed for and intended to be used in "**fixed**" and "**mobile**" applications:

- "**Fixed**" means that the device is physically secured at one location and is not able to be easily moved to another location.
- "**Mobile**" means that the device is designed to be used in other than fixed locations and generally in such a way that a separation distance of at least 20 cm (8 inches) is normally maintained between the transmitter's antenna and the body of the user or nearby persons.

The FASTRACK Supreme Plug & Play is not designed for and intended to be used in portable applications (within 20 cm or 8 inches of the body of the user) and such uses are strictly prohibited.

9.2 Vehicle Safety

Do not use your FASTRACK Supreme Plug & Play while driving, unless equipped with a correctly installed vehicle kit allowing 'Hands-Free' Operation.

Respect national regulations on the use of cellular telephones in vehicles. Road safety always comes first.

Fastrack Supreme User Guide

Safety recommendations

If incorrectly installed in a vehicle, the operation of FASTRACK Supreme Plug & Play telephone could interfere with the correct functioning of vehicle electronics. To avoid such problems, make sure that the installation has been performed by a qualified personnel. Verification of the protection of vehicle electronics should form part of the installation.

The use of an alert device to operate a vehicle's lights or horn on public roads is not permitted.

9.3 Care and Maintenance

Your FASTRACK Supreme Plug & Play is the product of advanced engineering, design and craftsmanship and should be treated with care. The suggestion below will help you to enjoy this product for many years.

Do not expose the FASTRACK Supreme Plug & Play to any extreme environment where the temperature or humidity is high.

Do not use or store the FASTRACK Supreme Plug & Play in dusty or dirty areas. Its moving parts (SIM holder for example) can be damaged.

Do not attempt to disassemble the Wireless CPU[®]. There are no user serviceable parts inside.

Do not expose the FASTRACK Supreme Plug & Play to water, rain or spilt beverages. It is not waterproof.

Do not abuse your FASTRACK Supreme Plug & Play by dropping, knocking, or violently shaking it. Rough handling can damage it.

Do not place the FASTRACK Supreme Plug & Play alongside computer discs, credit or travel cards or other magnetic media. The information contained on discs or cards may be affected by the Wireless CPU[®].

The use of third party equipment or accessories, not made or authorized by Wavecom may invalidate the warranty of the Wireless CPU[®].

Do contact an authorized Service Center in the unlikely event of a fault in the Wireless CPU[®].

9.4 Your Responsibility

This FASTRACK Supreme Plug & Play is under your responsibility. Please treat it with care respecting all local regulations. It is not a toy. Therefore, keep it in a safe place at all times and out of the reach of children.

Try to remember your Unlock and PIN codes. Become familiar with and use the security features to block unauthorized use and theft.

Fastrack Supreme User Guide

Recommended Accessories

10 Recommended Accessories

Accessories recommended by Wavecom for the FASTRACK Supreme are given in the table below.

Table 32: List of recommended accessories

Designation	Part number	Supplier
Quad-band antenna	1140.26	ALLGON
	MA112VX00	MAT Equipement
	MCA1890 MH/PB/SMA m	HIRSCHMANN
SMA/FME Antenna adaptor		PROCOM
Power adaptor (Europe)	EGSTDW P2 EF9W3 24W Out:12 V - 2A In: 100 to 240 V – 50/60 Hz – 550 mA Mounted with micro-fit connector	EGSTDW (for power adaptor) MOLEX (for micro-fit connector)*
Fuse	F800L250V	Shanghai Fullness
IESM GPS + USB	M13SUE01	WAVECOM
IESM IO + USB	M13SUE02	WAVECOM
IESM IO + USB + GPS	M13SUE03	WAVECOM

* Information not available for this preliminary version.

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Online Support

11 Online Support

Wavecom provides an extensive range on online support which includes the following areas of Wavecom's wireless expertise:

- the latest version of this document
- new versions of our Operating System user guides
- comprehensive support for Open AT[®]
- regulatory certifications
- carrier certifications
- application notes

To gain access to this support, simply visit our web site at www.wavecom.com or click on the desire link in Page. Privileged access via user login is provided to Wavecom authorized distributors.

9. Human Machine Interface



Halmac Services (Qld) Pty. Ltd.
A.C.N. 098 852 923
A.B.N. 40 741 712 113

HUMAN MACHINE INTERFACE

1. HUMAN MACHINE INTERFACE TECHNICAL DETAILS



Tel +1 (717) 767-6511
 Fax +1 (717) 764-0839
 www.redlion.net

Bulletin No. G306A-B
 Drawing No. LP0666
 Released 4/08

MODEL G306A - GRAPHIC COLOR LCD OPERATOR INTERFACE TERMINAL WITH TFT QVGA DISPLAY AND TOUCHSCREEN



- CONFIGURED USING CRIMSON® SOFTWARE (BUILD 424 OR NEWER)
- UP TO 5 RS-232/422/485 COMMUNICATIONS PORTS (2 RS-232 AND 1 RS-422/485 ON BOARD, 1 RS-232 AND 1 RS422/485 ON OPTIONAL COMMUNICATIONS CARD)
- 10 BASE T/100 BASE-TX ETHERNET PORT TO NETWORK UNITS AND HOST WEB PAGES
- USB PORT TO DOWNLOAD THE UNIT'S CONFIGURATION FROM A PC OR FOR DATA TRANSFERS TO A PC
- UNIT'S CONFIGURATION IS STORED IN NON-VOLATILE MEMORY (8 MBYTE FLASH)
- COMPACTFLASH® SOCKET TO INCREASE MEMORY CAPACITY
- 5.7-INCH TFT ACTIVE MATRIX 256 COLOR QVGA 320 X 240 PIXEL LCD
- 5-BUTTON KEYPAD FOR ON-SCREEN MENUS
- THREE FRONT PANEL LED INDICATORS
- POWER UNIT FROM 24 VDC ±20% SUPPLY
- RESISTIVE ANALOG TOUCHSCREEN



FOR USE IN HAZARDOUS LOCATIONS:
 Class I, Division 2, Groups A, B, C, and D
 Class II, Division 2, Groups F and G
 Class III, Division 2

GENERAL DESCRIPTION

The G306A Operator Interface Terminal combines unique capabilities normally expected from high-end units with a very affordable price. It is built around a high performance core with integrated functionality. This core allows the G306A to perform many of the normal features of the Paradigm range of Operator Interfaces while improving and adding new features.

The G306A is able to communicate with many different types of hardware using high-speed RS232/422/485 communications ports and Ethernet 10 Base T/100 Base-TX communications. In addition, the G306A features USB for fast downloads of configuration files and access to trending and data logging. A CompactFlash socket is provided so that Flash cards can be used to collect your trending and data logging information as well as to store larger configuration files.

In addition to accessing and controlling of external resources, the G306A allows a user to easily view and enter information. Users can enter data through the touchscreen and/or front panel 5-button keypad.

SAFETY SUMMARY

All safety related regulations, local codes and instructions that appear in the manual or on equipment must be observed to ensure personal safety and to prevent damage to either the instrument or equipment connected to it. If equipment is used in a manner not specified by the manufacturer, the protection provided by the equipment may be impaired.

Do not use the controller to directly command motors, valves, or other actuators not equipped with safeguards. To do so can be potentially harmful to persons or equipment in the event of a fault to the controller.



The protective conductor terminal is bonded to conductive parts of the equipment for safety purposes and must be connected to an external protective earthing system.



WARNING - EXPLOSION HAZARD - SUBSTITUTION OF COMPONENTS MAY IMPAIR SUITABILITY FOR CLASS I, DIVISION 2/CLASS II, DIVISION 2/CLASS III, DIVISION 2



CAUTION: Risk Of Danger.
 Read complete instructions prior to installation and operation of the unit.



CAUTION: Risk of electric shock.

CompactFlash is a registered trademark of CompactFlash Association.

CONTENTS OF PACKAGE

- G306A Operator Interface.
- Panel gasket.
- Template for panel cutout.
- Hardware packet for mounting unit into panel.
- Terminal block for connecting power.

ORDERING INFORMATION

MODEL NO.	DESCRIPTION	PART NUMBER
G306A	Operator Interface for indoor applications, textured finish with embossed keys	G306A000
G3CF	64 MB CompactFlash Card ⁵	G3CF064M
	256 MB CompactFlash Card ⁵	G3CF256M
	512 MB CompactFlash Card ⁵	G3CF512M
G3RS	RS232/485 Optional Communication Card	G3RS0000
G3CN	CANopen Optional Communication Card	G3CN0000
G3DN	DeviceNet option card for G3 operator interfaces lated high speed communications ports	G3DN0000
G3PBDP	Profibus DP Optional Communication Card	G3PBDP00
PSDR7	DIN Rail Power Supply	PSDR7000
SFCRM2	Crimson 2.0 ²	SFCRM200
CBL	RS-232 Programming Cable	CBLPROG0
	USB Cable	CBLUSB00
	Communications Cables ¹	CBLxxxx
DR	DIN Rail Mountable Adapter Products ³	DRxxxxxx
	Replacement Battery ⁴	BNL20000
G3FILM	Protective Films	G3FILM06

¹ Contact your Red Lion distributor or visit our website for complete selection.

² Use this part number to purchase the Crimson® software on CD with a printed manual, USB cable, and RS-232 cable. Otherwise, download for free from www.redlion.net.

³ Red Lion offers RJ modular jack adapters. Refer to the DR literature for complete details.

⁴ Battery type is lithium coin type CR2025.

⁵ Industrial grade two million write cycles.

SPECIFICATIONS

1. POWER REQUIREMENTS:

Must use Class 2 or SELV rated power supply.
Power connection via removable three position terminal block.

Supply Voltage: +24 VDC ±20%
Typical Power¹: 8 W
Maximum Power²: 14 W

Notes:

1. Typical power with +24 VDC, RS232/485 communications, Ethernet communications, CompactFlash card installed, and display at full brightness.
2. Maximum power indicates the most power that can be drawn from the G306A. Refer to "Power Supply Requirements" under "Installing and Powering the G306A."
3. The G306A's circuit common is not connected to the enclosure of the unit. See "Connecting to Earth Ground" in the section "Installing and Powering the G306A."
4. Read "Power Supply Requirements" in the section "Installing and Powering the G306A" for additional power supply information.

2. BATTERY: Lithium coin cell. Typical lifetime of 10 years.

3. LCD DISPLAY:

SIZE	5.7-inch
TYPE	TFT
COLORS	256
PIXELS	320 X 240
BRIGHTNESS	500 cd/m ²
BACKLIGHT*	40,000 HR TYP.

*Lifetime at room temperature. Refer to "Display" in "Software/Unit Operation"

4. 5-KEY KEYPAD: for on-screen menus.


5. TOUCHSCREEN: Resistive analog

6. MEMORY:

On Board User Memory: 8 Mbyte of non-volatile Flash memory.
Memory Card: CompactFlash Type II slot for Type I and Type II CompactFlash cards.

7. COMMUNICATIONS:

USB Port: Adheres to USB specification 1.1. Device only using Type B connection.



WARNING - DO NOT CONNECT OR DISCONNECT CABLES WHILE POWER IS APPLIED UNLESS AREA IS KNOWN TO BE NON-HAZARDOUS. USB PORT IS FOR SYSTEM SET-UP AND DIAGNOSTICS AND IS NOT INTENDED FOR PERMANENT CONNECTION.

Serial Ports: Format and Baud Rates for each port are individually software programmable up to 115,200 baud.

PGM Port: RS232 port via RJ12.
COMMS Ports: RS422/485 port via RJ45, and RS232 port via RJ12.
DH485 TXEN: Transmit enable; open collector, V_{OH} = 15 VDC, V_{OL} = 0.5 V @ 25 mA max.

Note: For additional information on the communications or signal common and connections to earth ground please see the "Connecting to Earth Ground" in the section "Installing and Powering the G306A."

Ethernet Port: 10 BASE-T / 100 BASE-TX

RJ45 jack is wired as a NIC (Network Interface Card).
Isolation from Ethernet network to G3 operator interface: 1500 Vrms

8. ENVIRONMENTAL CONDITIONS:

Operating Temperature Range: 0 to 50°C
Storage Temperature Range: -20 to 70°C
Operating and Storage Humidity: 80% maximum relative humidity (non-condensing) from 0 to 50°C.
Vibration according to IEC 68-2-6: Operational 5 to 8 Hz, 0.8" (p-p), 8 to 500 Hz, in X, Y, Z direction, duration: 1 hour, 3 g.
Shock according to IEC 68-2-27: Operational 40 g, 9 msec in 3 directions.
Altitude: Up to 2000 meters.

9. CERTIFICATIONS AND COMPLIANCES:

SAFETY
UL Recognized Component, File #E179259, UL61010-1, CSA 22.2 No.61010-1 Recognized to U.S. and Canadian requirements under the Component Recognition Program of Underwriters Laboratories, Inc.
UL Listed, File #E211967, UL61010-1, UL1604, CSA 22.2 No. 61010.1, CSA 22.2 No. 213-M1987
LISTED by Und. Lab. Inc. to U.S. and Canadian safety standards
Type 4X Indoor Enclosure rating (Face only), UL50
IECEE CB Scheme Test Certificate #US/12460/UL,
CB Scheme Test Report #E179259-A1-CB-1
Issued by Underwriters Laboratories Inc.
IEC 61010-1, EN 61010-1: Safety requirements for electrical equipment for measurement, control, and laboratory use, Part 1.
IP66 Enclosure rating (Face only), IEC 529

ELECTROMAGNETIC COMPATIBILITY

Emissions and Immunity to EN 61326: Electrical Equipment for Measurement, Control and Laboratory use.

Immunity to Industrial Locations:

Electrostatic discharge	EN 61000-4-2	Criterion A 4 kV contact discharge 8 kV air discharge
Electromagnetic RF fields	EN 61000-4-3	Criterion A 10 V/m
Fast transients (burst)	EN 61000-4-4	Criterion A 2 kV power 1 kV signal
Surge	EN 61000-4-5	Criterion A 1 kV L-L, 2 kV L&N-E power
RF conducted interference	EN 61000-4-6	Criterion A 3 V/rms
Emissions:		
Emissions	EN 55011	Class A

Note:

1. *Criterion A: Normal operation within specified limits.*

10. CONNECTIONS: Compression cage-clamp terminal block.

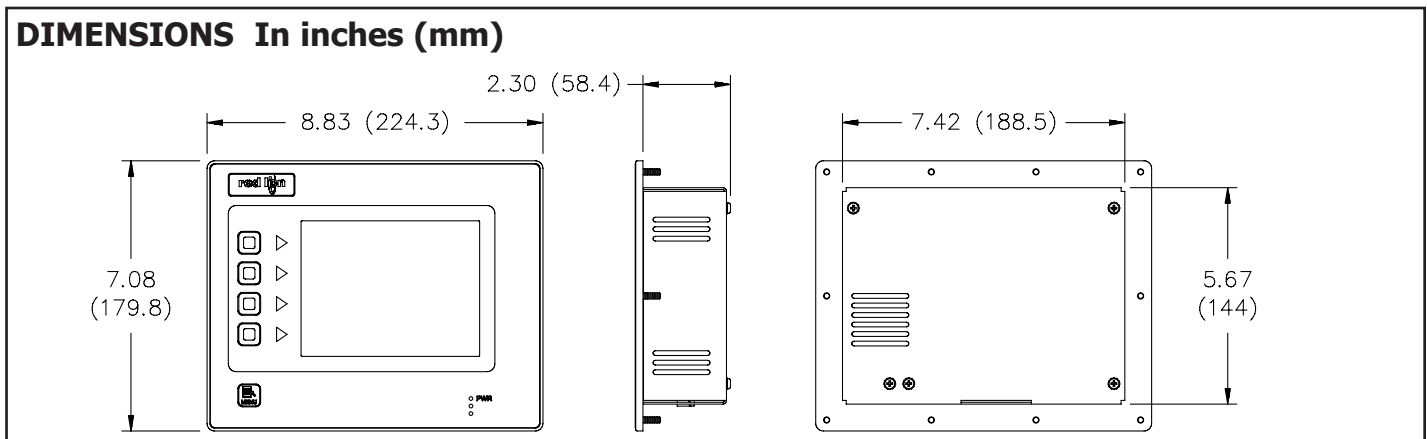
Wire Gage: 12-30 AWG copper wire
Torque: 5-7 inch-pounds (56-79 N-cm)

11. CONSTRUCTION: Steel rear metal enclosure with NEMA 4X/IP66 aluminum front plate for indoor use only when correctly fitted with the gasket provided. Installation Category II, Pollution Degree 2.

12. MOUNTING REQUIREMENTS: Maximum panel thickness is 0.25" (6.3 mm). For NEMA 4X/IP66 sealing, a steel panel with a minimum thickness of 0.125" (3.17 mm) is recommended.

Maximum Mounting Stud Torque: 17 inch-pounds (1.92 N-m)

13. WEIGHT: 3.0 lbs (1.36 Kg)

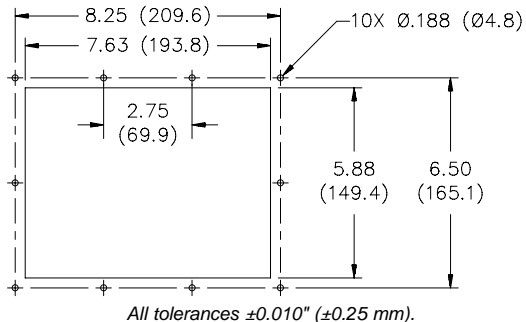



INSTALLING AND POWERING THE G306A

MOUNTING INSTRUCTIONS

This operator interface is designed for through-panel mounting. A panel cut-out diagram and a template are provided. Care should be taken to remove any loose material from the mounting cut-out to prevent that material from falling into the operator interface during installation. A gasket is provided to enable sealing to NEMA 4X/IP66 specification. Install the ten keps nuts provided and tighten evenly for uniform gasket compression.

Note: Tightening the keps nuts beyond a maximum of 17 inch-pounds (1.92 N-m) may cause damage to the front panel.





ALL NONINCENDIVE CIRCUITS MUST BE WIRED USING DIVISION 2 WIRING METHODS AS SPECIFIED IN ARTICLE 501-4 (b), 502-4 (b), AND 503-3 (b) OF THE NATIONAL ELECTRICAL CODE, NFPA 70 FOR INSTALLATION WITHIN THE UNITED STATES, OR AS SPECIFIED IN SECTION 19-152 OF CANADIAN ELECTRICAL CODE FOR INSTALLATION IN CANADA.

CONNECTING TO EARTH GROUND



The protective conductor terminal is bonded to conductive parts of the equipment for safety purposes and must be connected to an external protective earthing system.

Each G306A has a chassis ground terminal on the back of the unit. Your unit should be connected to earth ground (protective earth).

COMMUNICATING WITH THE G306A

CONFIGURING A G306A


The G306A is configured using Crimson[®] software. Crimson is available as a free download from Red Lion's website, or it can be purchased on CD. Updates to Crimson for new features and drivers are posted on the website as they become available. By configuring the G306A using the latest version of Crimson, you are assured that your unit has the most up to date feature set. Crimson[®] software can configure the G306A through the RS232 PGM port, USB port, or CompactFlash.

The USB port is connected using a standard USB cable with a Type B connector. The driver needed to use the USB port will be installed with Crimson.

The RS232 PGM port uses a programming cable made by Red Lion to connect to the DB9 COM port of your computer. If you choose to make your own cable, use the "G306A Port Pin Out Diagram" for wiring information.

The CompactFlash can be used to program a G3 by placing a configuration file and firmware on the CompactFlash card. The card is then inserted into the target G3 and powered. Refer to the Crimson literature for more information on the proper names and locations of the files.

USB, DATA TRANSFERS FROM THE COMPACTFLASH CARD



WARNING - DO NOT CONNECT OR DISCONNECT CABLES WHILE POWER IS APPLIED UNLESS AREA IS KNOWN TO BE NON-HAZARDOUS. USB PORT IS FOR SYSTEM SET-UP AND DIAGNOSTICS AND IS NOT INTENDED FOR PERMANENT CONNECTION.

In order to transfer data from the CompactFlash card via the USB port, a driver must be installed on your computer. This driver is installed with Crimson and is located in the folder C:\Program Files\Red Lion Controls\Crimson 2.0\Device\ after Crimson is installed. This may have already been accomplished if your G306A was configured using the USB port.

Once the driver is installed, connect the G306A to your PC with a USB cable, and follow "Mounting the CompactFlash" instructions in the Crimson 2 user manual.

The chassis ground is not connected to signal common of the unit. Maintaining isolation between earth ground and signal common is not required to operate your unit. But, other equipment connected to this unit may require isolation between signal common and earth ground. *To maintain isolation between signal common and earth ground care must be taken when connections are made to the unit.* For example, a power supply with isolation between its signal common and earth ground must be used. Also, plugging in a USB cable may connect signal common and earth ground.¹

¹ USB's shield may be connected to earth ground at the host. USB's shield in turn may also be connected to signal common.

POWER SUPPLY REQUIREMENTS

The G306A requires a 24 VDC power supply. Your unit may draw considerably less than the maximum rated power depending upon the options being used. As additional features are used your unit will draw increasing amounts of power. Items that could cause increases in current are additional communications, optional communications card, CompactFlash card, and other features programmed through Crimson.

In any case, it is very important that the power supply is mounted correctly if the unit is to operate reliably. Please take care to observe the following points:

- The power supply must be mounted close to the unit, with usually not more than 6 feet (1.8 m) of cable between the supply and the operator interface. Ideally, the shortest length possible should be used.
- The wire used to connect the operator interface's power supply should be at least 22-gage wire. If a longer cable run is used, a heavier gage wire should be used. The routing of the cable should be kept away from large contactors, inverters, and other devices which may generate significant electrical noise.
- A power supply with a Class 2 or SELV rating is to be used. A Class 2 or SELV power supply provides isolation to accessible circuits from hazardous voltage levels generated by a mains power supply due to single faults. SELV is an acronym for "safety extra-low voltage." Safety extra-low voltage circuits shall exhibit voltages safe to touch both under normal operating conditions and after a single fault, such as a breakdown of a layer of basic insulation or after the failure of a single component has occurred.

CABLES AND DRIVERS

Red Lion has a wide range of cables and drivers for use with many different communication types. A list of these drivers and cables along with pin outs is available from Red Lion's website. New cables and drivers are added on a regular basis. If making your own cable, refer to the "G306A Port Pin Outs" for wiring information.

ETHERNET COMMUNICATIONS

Ethernet communications can be established at either 10 BASE-T or 100 BASE-TX. The G306A unit's RJ45 jack is wired as a NIC (Network Interface Card). For example, when wiring to a hub or switch use a straight-through cable, but when connecting to another NIC use a crossover cable.

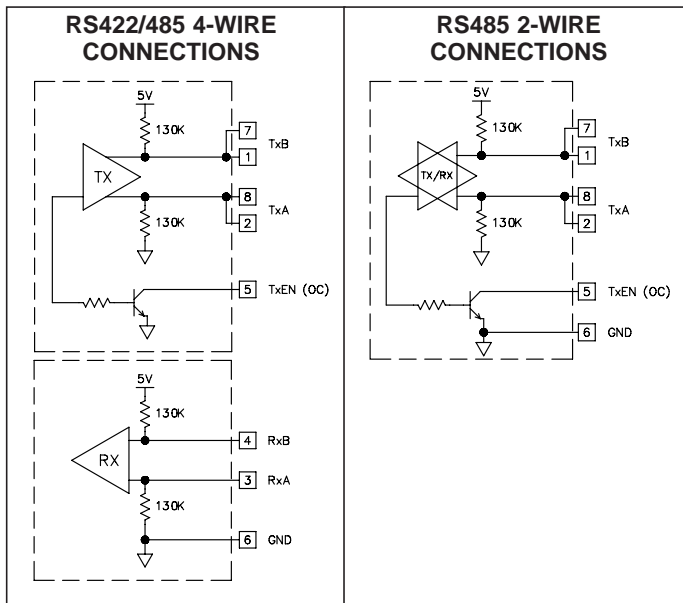
The Ethernet connector contains two LEDs. A yellow LED in the upper right, and a bi-color green/amber LED in the upper left. The LEDs represent the following statuses:

LED COLOR	DESCRIPTION
YELLOW solid	Link established.
YELLOW flashing	Data being transferred.
GREEN	10 BASE-T Communications
AMBER	100 BASE-TX Communications

On the rear of each unit is a unique 12-digit MAC address and a block for marking the unit with an IP address. Refer to the Crimson manual and Red Lion's website for additional information on Ethernet communications.

RS422/485 COMMS PORT

The G306A has one RS422/485 port. This port can be configured to act as either RS422 or RS485.



Note: All Red Lion devices connect A to A and B to B, except for Paradigm devices. Refer to www.redlion.net for additional information.

DH485 COMMUNICATIONS

The G306A's RS422/485 COMMS port can also be used for Allen Bradley DH485 communications.

WARNING: DO NOT use a standard DH485 cable to connect this port to Allen Bradley equipment. A cable and wiring diagram are available from Red Lion.

G3 to AB SLC 500 (CBLAB003)

Connections			
RJ45: RLC	Name	RJ45: A-B	Name
1	TxB	1	A
2	TxA	2	B
3, 8	RxA	-	24V
4, 7	RxB	-	COMM
5	TxEN	5	TxEN
6	COMM	4	SHIELD
4, 7	TxB	-	COMM
3, 8	TxA	-	24V

Examples of RS485 2-Wire Connections

G3 to Red Lion RJ11 (CBLRLC00) DLC, IAMS, ITMS, PAXCDC4C

Connections			
G3: RJ45	Name	RLC: RJ11	Name
5	TxEN	2	TxEN
6	COM	3	COM
1	TxB	5	B-
2	TxA	4	A+

G3 to Modular Controller (CBLRLC05)

Connections			
G3	Name	Modular Controller	Name
1,4	TxB	1,4	TxB
4,1	RxB	4,1	RxB
2,3	TxA	2,3	TxA
3,2	RxA	3,2	RxA
5	TxEN	5	TxEN
6	COM	6	COM
7	TxB	7	TxB
8	TxA	8	TxA

SOFTWARE/UNIT OPERATION

CRIMSON® SOFTWARE

Crimson® software is available as a free download from Red Lion's website or it can be purchased on a CD, see "Ordering Information" for part number. The latest version of the software is always available from the website, and updating your copy is free.

DISPLAY

This operator interface uses a liquid crystal display (LCD) for displaying text and graphics. The display utilizes a cold cathode fluorescent tube (CCFL) for lighting the display. The CCFL tubes can be dimmed for low light conditions.

These CCFL tubes have a limited lifetime. Backlight lifetime is based upon the amount of time the display is turned on at full intensity. Turning the backlight off when the display is not in use can extend the lifetime of your backlight. This can be accomplished through the Crimson® software when configuring your unit.

FRONT PANEL LEDs

There are three front panel LEDs. Shown below is the default status of the LEDs.

LED	INDICATION
RED (TOP, LABELED "PWR")	
FLASHING	Unit is in the boot loader, no valid configuration is loaded. ¹
STEADY	Unit is powered and running an application.
YELLOW (MIDDLE)	
OFF	No CompactFlash card is present.
STEADY	Valid CompactFlash card present.
FLASHING RAPIDLY	CompactFlash card being checked.
FLICKERING	Unit is writing to the CompactFlash, either because it is storing data, or because the PC connected via the USB port has locked the drive. ²
FLASHING SLOWLY	Incorrectly formatted CompactFlash card present.
GREEN (BOTTOM)	
FLASHING	A tag is in an alarm state.
STEADY	Valid configuration is loaded and there are no alarms present.

¹ The operator interface is shipped without a configuration. After downloading a configuration, if the light remains in the flashing state continuously, try cycling power. If the LED still continues to flash, try downloading a configuration again.

² Do not turn off power to the unit while this light is flickering. The unit writes data in two minute intervals. Later Microsoft operating systems will not lock the drive unless they need to write data; Windows 98 may lock the drive any time it is mounted, thereby interfering with logging. Refer to "Mounting the CompactFlash" in the Crimson 2 User Manual.

TOUCHSCREEN

This operator interface utilizes a resistive analog touchscreen for user input. The unit will only produce an audible tone (beep) when a touch on an active touchscreen cell is sensed. The touchscreen is fully functional as soon as the operator interface is initialized, and can be operated with gloved hands.

KEYPAD

The G306A keypad consists of five keys that can be used for on-screen menus.


TROUBLESHOOTING YOUR G306A


If for any reason you have trouble operating, connecting, or simply have questions concerning your new G306A, contact Red Lion's technical support. For contact information, refer to the back page of this bulletin for phone and fax numbers.

EMAIL: techsupport@redlion.net

Web Site: <http://www.redlion.net>

BATTERY & TIME KEEPING

 **WARNING - EXPLOSION HAZARD - THE AREA MUST BE KNOWN TO BE NON-HAZARDOUS BEFORE SERVICING/ REPLACING THE UNIT AND BEFORE INSTALLING OR REMOVING I/O WIRING AND BATTERY.**

 **WARNING - EXPLOSION HAZARD - DO NOT DISCONNECT EQUIPMENT UNLESS POWER HAS BEEN DISCONNECTED AND THE AREA IS KNOWN TO BE NON-HAZARDOUS.**

A battery is used to keep time when the unit is without power. Typical accuracy of the G306A time keeping is less than one minute per month drift. The battery of a G306A unit does not affect the unit’s memory, all configurations and data is stored in non-volatile memory.



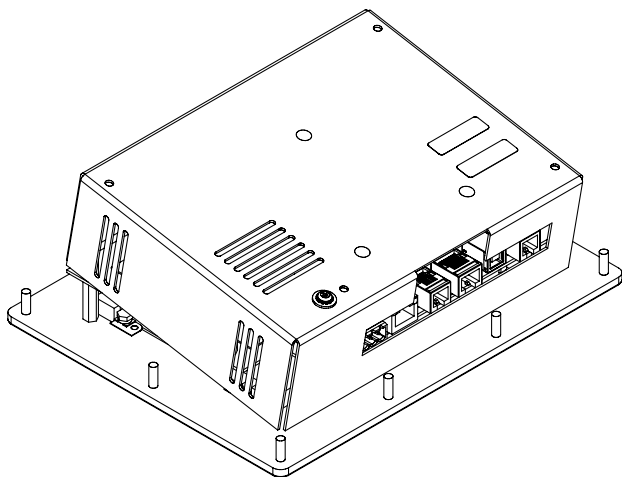
CAUTION: RISK OF ELECTRIC SHOCK

The inverter board, attached to the mounting plate, supplies the high voltage to operate the backlight. Touching the inverter board may result in injury to personnel.



CAUTION: The circuit board contains static sensitive components. Before handling the operator interface without the rear cover attached, discharge static charges from your body by touching a grounded bare metal object. Ideally, handle the operator interface at a static controlled clean workstation. Also, do not touch the surface areas of the circuit board. Dirt, oil, or other contaminants may adversely affect circuit operation.

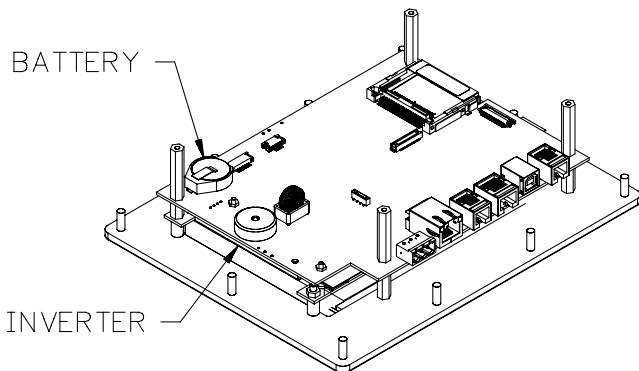
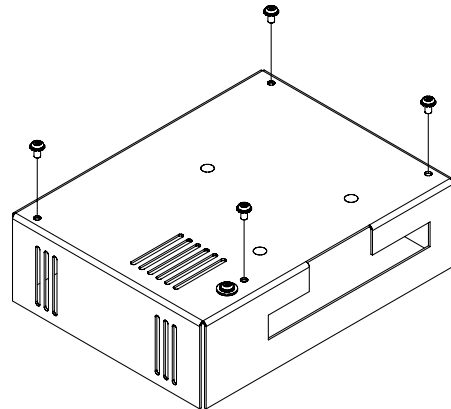
To change the battery of a G306A, remove power, cabling, and then the rear cover of the unit. To remove the cover, remove the four screws designated by the arrows on the rear of the unit. Then, by lifting the top side, hinge the cover, thus providing clearance for the connectors on the bottom side of the PCB as shown in the illustration below. Install in the reverse manner.



Remove the old battery* from the holder and replace with the new battery. Replace the rear cover, cables, and re-apply power. Using Crimson or the unit’s keypad, enter the correct time and date.

** Please note that the old battery must be disposed of in a manner that complies with your local waste regulations. Also, the battery must not be disposed of in fire, or in a manner whereby it may be damaged and its contents come into contact with human skin.*

The battery used by the G306A is a lithium type CR2025.



OPTIONAL FEATURES AND ACCESSORIES

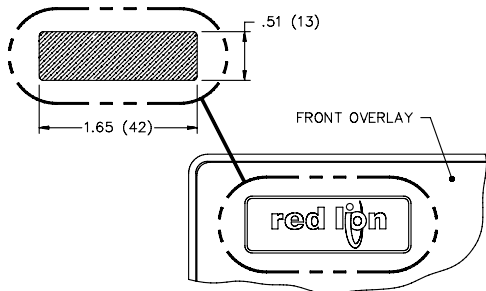
OPTIONAL COMMUNICATION CARD

Red Lion offers optional communication cards for fieldbus communications. These communication cards will allow your G306A to communicate with many of the popular fieldbus protocols.

Red Lion is also offering a communications card for additional RS232 and RS422/485 communications. Visit Red Lion's website for information and availability of these cards.

CUSTOM LOGO

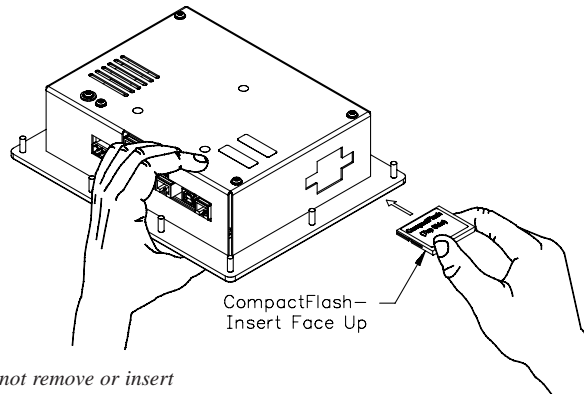
Each G3 operator interface has an embossed area containing the Red Lion logo. Red Lion can provide custom logos to apply to this area. Contact your distributor for additional information and pricing.



COMPACTFLASH SOCKET

CompactFlash socket is a Type II socket that can accept either Type I or II cards. Use cards with a minimum of 4 Mbytes and a maximum of 2 Gbytes with the G306A's CompactFlash socket. Cards are available at most computer and office supply retailers.

CompactFlash can be used for configuration transfers, larger configurations, data logging, and trending.



Note: Do not remove or insert the CompactFlash card while power is applied. Refer to "Front Panel LEDs."

Information stored on a CompactFlash card by a G306A can be read by a card reader attached to a PC. This information is stored in IBM (Windows®) PC compatible FAT16 file format.

NOTE

For reliable operation in all of our products, Red Lion recommends the use of SanDisk® and SimpleTech brands of CompactFlash cards. Industrial grade versions that provide up to two million write/erase cycles minimum are available from Red Lion.

LIMITED WARRANTY

The Company warrants the products it manufactures against defects in materials and workmanship for a period limited to two years from the date of shipment, provided the products have been stored, handled, installed, and used under proper conditions. The Company's liability under this limited warranty shall extend only to the repair or replacement of a defective product, at The Company's option. The Company disclaims all liability for any affirmation, promise or representation with respect to the products.

The customer agrees to hold Red Lion Controls harmless from, defend, and indemnify RLC against damages, claims, and expenses arising out of subsequent sales of RLC products or products containing components manufactured by RLC and based upon personal injuries, deaths, property damage, lost profits, and other matters which Buyer, its employees, or sub-contractors are or may be to any extent liable, including without limitation penalties imposed by the Consumer Product Safety Act (P.L. 92-573) and liability imposed upon any person pursuant to the Magnuson-Moss Warranty Act (P.L. 93-637), as now in effect or as amended hereafter.

No warranties expressed or implied are created with respect to The Company's products except those expressly contained herein. The Customer acknowledges the disclaimers and limitations contained herein and relies on no other warranties or affirmations.

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10. Load Break Switch



Halmac Services (Qld) Pty. Ltd.
A.C.N. 098 852 923
A.B.N. 40 741 712 113

LOAD BREAK SWITCH

1. SLB SERIES LOAD BREAK SWITCH TECHNICAL DETAILS

SLB Standard load-break switches COMO M 20 to 100 A

New Range



SLB 20...40

The COMO M range of load-break switches offer compact IP 20 finger safe solutions for switching up to and including 100 A. They are ideal for the arduous switching of motors.

Standard mounting is by DIN rail or base mount with screws.

The COMO M comes complete with direct mount handle, or pistol handles and shaft. Fourth pole and auxiliary switching can also be achieved with easy clip-on modules - refer accessories.

Front operated surface mount (Supplied with direct or external handle)

	AC 22 400 V (A)	AC 23 400 V (A)	AC 23 400 V (kW)	Handle type	Cat. No.
20 A	20	20	9	Direct	SLB 20D 3P
				Pistol	SLB 20P 3P
25 A	25	25	11	Direct	SLB 25D 3P
				Pistol	SLB 25P 3P
32 A	32	32	15	Direct	SLB 32D 3P
				Pistol	SLB 32P 3P
40 A	40	40	18.5	Direct	SLB 40D 3P
				Pistol	SLB 40P 3P
63 A	63	63	30	Direct	SLB 63D 3P
				Pistol	SLB 63P 3P
80 A	80	80	40	Direct	SLB 80D 3P
				Pistol	SLB 80P 3P
100 A	100	80	40	Direct	SLB 100D 3P
				Pistol	SLB 100P 3P



SLB 63...100



SLB Standard load-break switches

New Range

SIRCO 125 to 4000 A



SLB 125...630

The SIRCO range of load-break switches offer compact solutions for switching from 125 A to 4000 A. Base mounting is standard.

The SIRCO range are a proven, reliable design that more than suit harsh Australian conditions.

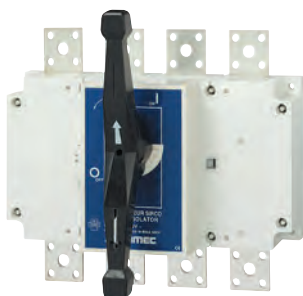
The switches come complete with extended shaft and door mountable pistol grip handle. Available in three and four pole versions with a large range of accessories to choose from.

Front operated surface mount (Supplied with external handle and shaft)

	AC 21 400 V (A)	AC 23 400 V (A)	AC 23 400 V (kW)	No. of poles ¹⁾	Cat. No.
125 A	125	125	63	3	SLB 125 3P
				4	SLB 125 4P
160 A	160	160	80	3	SLB 160 3P
				4	SLB 160 4P
200 A	200	200	100	3	SLB 200 3P
				4	SLB 200 4P
250 A	250	250	132	3	SLB 250 3P
				4	SLB 250 4P
315 A	315	315	160	3	SLB 315 3P
				4	SLB 315 4P
400 A	400	400	220	3	SLB 400 3P
				4	SLB 400 4P
500 A	500	400	280	3	SLB 500 3P
				4	SLB 500 4P
630 A	630	500	280	3	SLB 630 3P
				4	<input type="checkbox"/> SLB 630 4P
800 A	800	800	450	3	SLB 800 3P
				4	<input type="checkbox"/> SLB 800 4P

Notes: ¹⁾ 6 and 8 pole switches available on indent. Refer NHP.

Available on indent only.



SLB 800...3150

SLB Standard load-break switches SIRCO 125 to 4000 A (cont'd)

New Range

The SIRCO range of load-break switches offer compact solutions for switching from 125 A to 4000 A. Base mounting is standard.

The SIRCO switches come complete with extended shaft and door mountable pistol grip handle. Available in three and four pole versions with a large range of accessories to choose from.



SLB 800...3150

Front operated surface mount (Supplied with external handle and shaft)

	AC 21 400 V (A)	AC 23 400 V (A)	AC 23 400 V (kW)	No. of poles ¹⁾	Cat. No.
1000 A	1000	1000	560	3	SLB 1000 3P
				4	<input type="checkbox"/> SLB 1000 4P
1250 A	1250	1000	560	3	SLB 1250 3P
				4	<input type="checkbox"/> SLB 1250 4P
1600 A	1600	1000	560	3	SLB 1600 3P
				4	<input type="checkbox"/> SLB 1600 4P
1800 A	1800	1000	560	3	SLB 1800 3P
				4	<input type="checkbox"/> SLB 1800 4P
2000 A	2000	1250	710	3	SLB 2000 3P
				4	<input type="checkbox"/> SLB 2000 4P
2500 A	2500	1250	710	3	SLB 2500 3P
				4	<input type="checkbox"/> SLB 2500 4P
3150 A	3150	1250	710	3	SLB 3150 3P
				4	<input type="checkbox"/> SLB 3150 4P
4000 A	4000	1250	710	3	SLB 4000 3P ²⁾
				4	<input type="checkbox"/> SLB 4000 4P ²⁾

Notes: ¹⁾ 6 and 8 pole switches available on indent. Refer NHP.

²⁾ Supplied with 2 N/O and 2 N/C auxiliaries as standard.

Available on indent only.

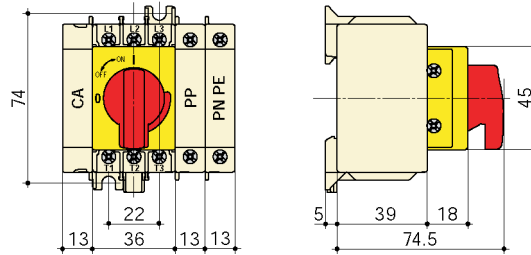


SLB 4000

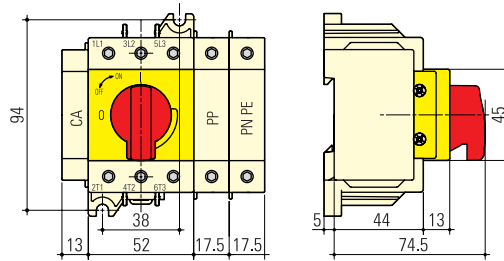
Technical data and dimensions (mm)

COMO M SLB 20 to 100 A

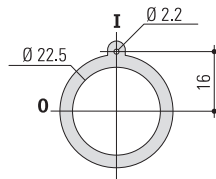
COMO M 20 to 40 A



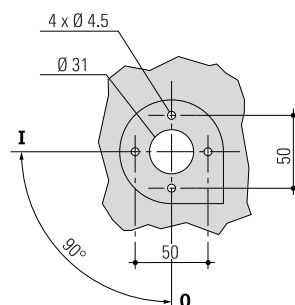
COMO M 63 to 100 A



COMO M Selector handle door drilling



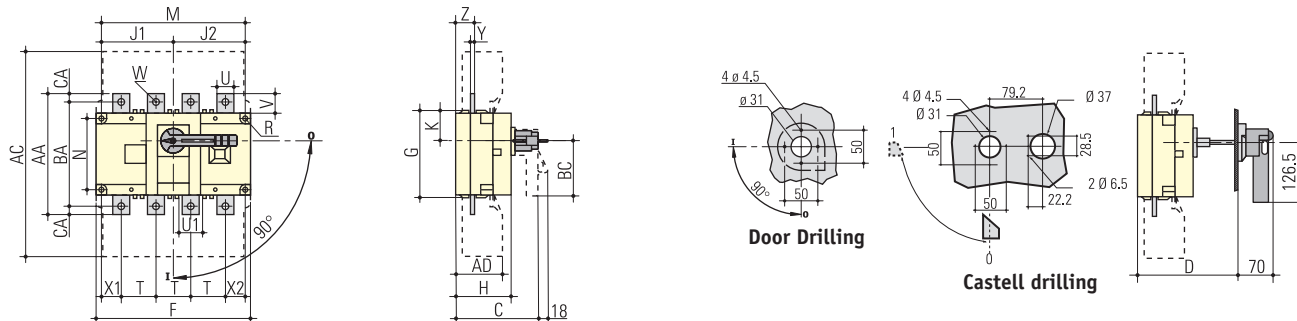
COMO M Pistol handle door drilling



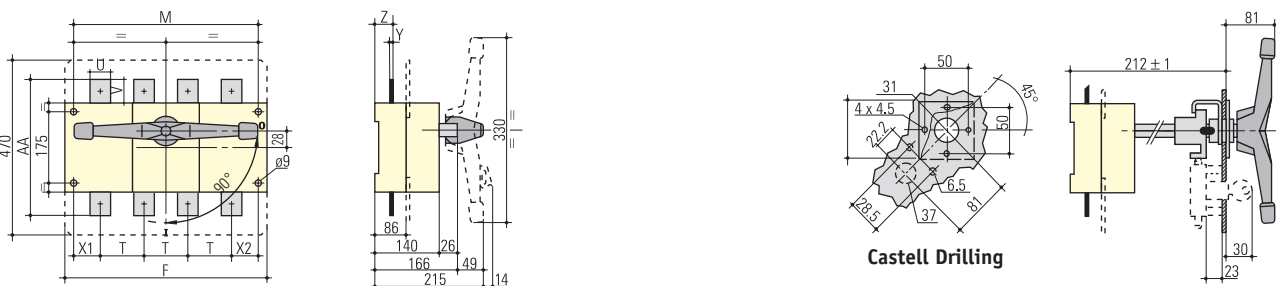
Technical data and dimensions (mm)

SIRCO SLB 125 to 2500 A

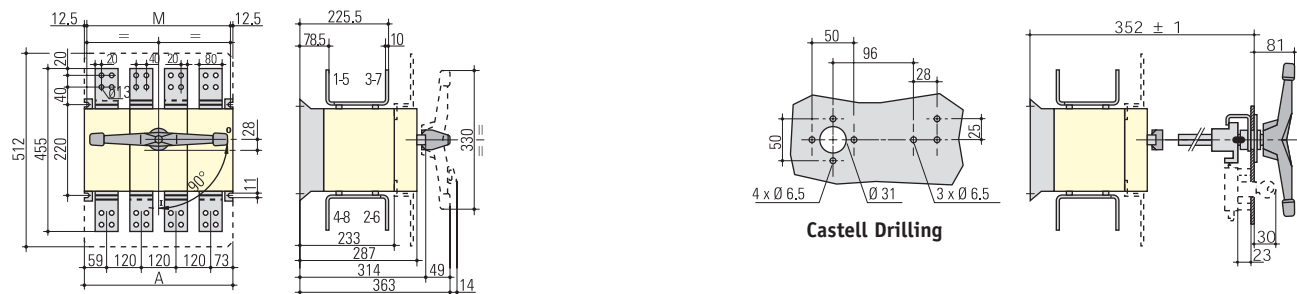
SIRCO 125 to 2500 A



Rating A	Overall dimensions		Terminal shrouds		Switch body								Switch mounting				Connection terminals													
	C	D	AC	AD	F	F	G	H	J1	J2	K	BC	M	M	N	R	T	U	U1	V	W	X1	X1	X2	Y	Z	AA	BA	CA	
125	120	124...354	235	50	140	170	93	65	45	75	75	31.5	80	120	150	65	5.5	36	20	20.5	25	9	28	22	20	3.5	20.5	135	115	10
160	120	124...354	235	50	140	170	93	65	45	75	75	31.5	80	120	150	65	5.5	36	20	20.5	25	9	28	22	20	3.5	20.5	135	115	10
200	130	135...365	290	60	180	230	108	75	55	105	105	34	115	160	210	80	5.5	50	25	25.5	30	11	33	33	27	3.5	22.5	160	130	15
250	130	135...365	290	60	180	230	108	75	55	105	105	34	115	160	210	80	5.5	50	25	25.5	30	11	33	33	27	3.5	22.5	160	130	15
315	165	167...397	401	89	230	290	170	110	75	135	135	55	115	210	270	140	7	65	32	45.5	37.5	11	42.5	37.5	37.5	5	36	235	205	15
400	165	167...397	401	89	230	290	170	110	75	135	135	55	115	210	270	140	7	65	32	45.5	37.5	11	42.5	37.5	37.5	5	36	235	205	15
500	165	167...397	401	89	230	290	170	110	75	135	135	55	115	210	270	140	7	65	32	45.5	37.5	13	42.5	37.5	37.5	5	36	235	205	15
630	165	167...397	400	89	230	290	170	110	75	135	135	55	115	210	270	140	7	65	45	45.5	50	13	42.5	37.5	37.5	5	36	260	220	20



Rating A	Switch body		Switch mounting		T	U	V	Connection terminals				
	F 3p	F 4p	M 3p	M 4p				Y	X1	X2	Z	AA
800	280	360	255	335	80	50	60.5	7	47.5	47.5	46.5	321
1000	280	360	255	335	80	50	60.5	7	47.5	47.5	46.5	321
1250	372	492	347	467	120	90	44	8	53.5	53.5	47.5	288
1600	372	492	347	467	120	90	44	8	53.5	53.5	47.5	288
1800	372	492	347	467	120	90	44	8	53.5	53.5	47.5	288



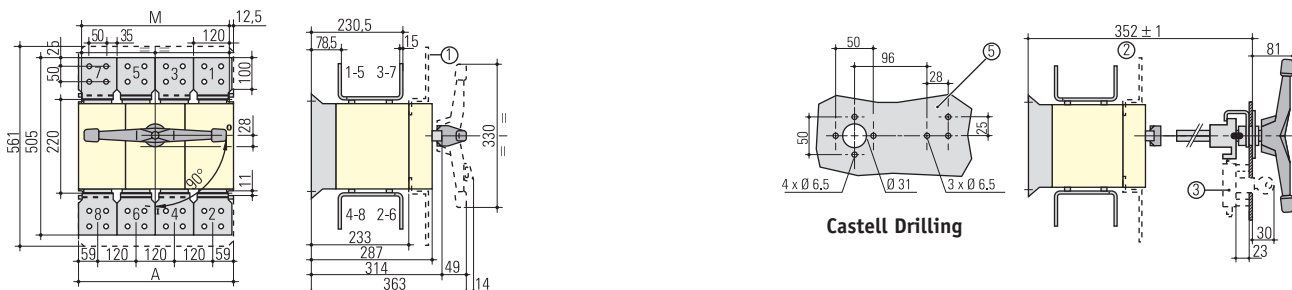
Rating A	Overall dimensions		Switch mounting	
	A 3p	A 4p	M 3p	M 4p
2000	372	492	347	467
2500	372	492	347	467



Technical data and dimensions (mm)

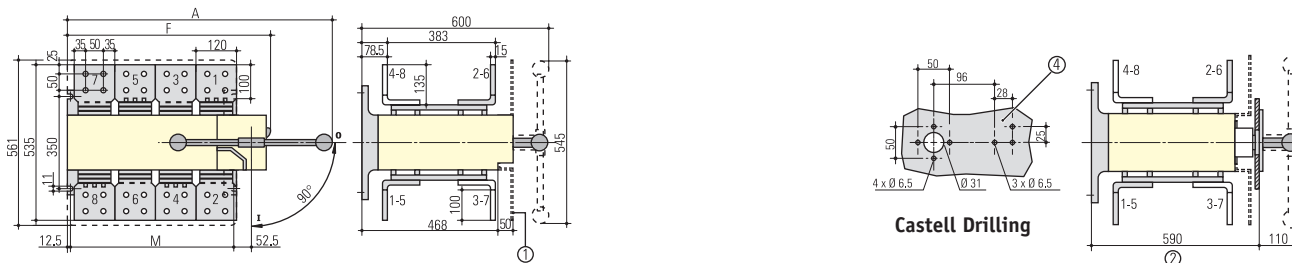
SIRCO SLB 3150 to 4000 A

SIRCO 3150 A



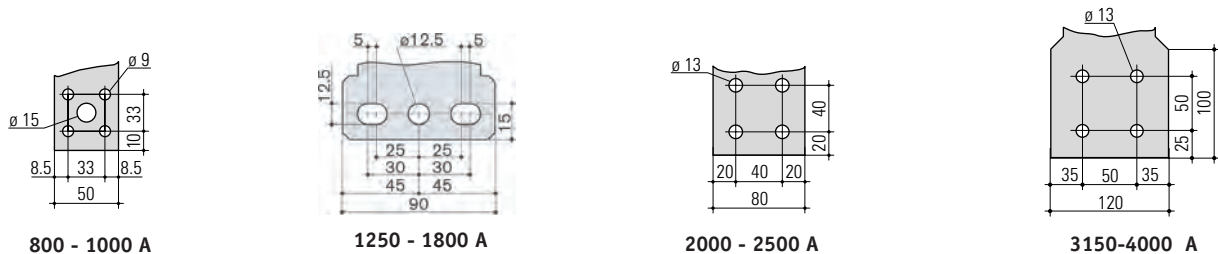
Rating A	Overall dimensions		Switch mounting	
	A 3p	A 4p	M 3p	M 4p
3150	372	492	347	467

SIRCO 4000 A



Rating A	Overall dimensions		Switch body		Switch mounting	
	A 3p	A 4p	F 3p	F 4p	M 3p	M 4p
4000	684	804	470	590	347	467

SIRCO Connection terminals - 800 to 4000 A





Technical data and ratings chart COMO M SLB 20 to 100 A

Ratings to AS 3947-3 and IEC 60947-3

			20 A	25 A	32 A	40 A	63 A	80 A	100 A
Rated insulation voltage and rated operation voltage AC 20/DC 20	V		800	800	800	800	800	800	800
Rated impulse withstand voltage	kV		8	8	8	8	8	8	8
Rated operational current									
AC 21A	400 V	A	20	25	32	40	63	80	100
	500 V	A	20	25	32	40	63	80	100
	690 V	A	20	25	32	40	63	80	100
AC 22A	400 V	A	20	25	32	40	63	80	100
	500 V	A	20	25	32	40	63	80	100
	690 V	A	20	25	32	40	63	80	100
AC23A	400 V	A	20	25	32	40	63	80	80
	500 V	A	16	20	25	32	50	63	63
	690 V	A	16	20	20	20	50	50	50
Rated operational current									
DC 21A	400 V	A	Refer NHP						
	500 V	A							
DC 22A	400 V	A							
	500 V	A							
DC 23A	400 V	A							
	500 V	A							
Operational power									
AC 23A	400 V	kW	9	11	15	18.5	30	40	40
	500 V	kW	9	11	15	18.5	33	40	40
	690 V	kW	11	15	15	15	45	45	45
Overload capacity									
Short time withstand current I _{cw} (RMS 1s) 690 V	kA		1.26	1.26	1.26	1.26	1.5	1.5	1.5
Breaking capacity AC 23A	400 V	A	160	200	256	320	504	640	640
Fuse protected short circuit withstand. (kA RMS prospective)	400 V AC	kA	50	50	50	50	25	25	25
	Fuse	A	20	25	32	40	63	80	100
Mechanical endurance	Ops		100000	100000	100000	100000	30000	30000	30000
Weight (3 pole)	Kg		0.13	0.13	0.13	0.13	0.25	0.25	0.25
Min. tightening torque	Nm		2	2	2	2	4	4	4
Connection cable size	mm ²		2.5/16	2.5/16	4/16	6/16	16/50	16/50	25/50

Note: 240/415 V ratings suitable for use on 230/400 V in accordance with AS 60038 : 2000.



Technical data and ratings chart

SIRCO SLB 125 to 630 A

Ratings to AS 3947-3 and IEC 60947-3

			125 A	160 A	200 A	250 A	315 A	400 A	500 A	630 A
Rated insulation voltage and rated operation voltage AC 20/DC 20	V		800	800	800	800	1000	1000	1000	1000
Rated impulse withstand voltage	kV		8	8	8	8	12	12	12	12
Rated operational current										
AC 21A	400 V	A	125	160	200	250	315	400	500	630
	500 V	A	125	160	200	250	315	400	500	630
	690 V	A	125	160	200	250	315	400	500	500
AC 22A	400 V	A	125	160	200	250	315	400	500	630
	500 V	A	125	125	200	250	315	400	500	500
	690 V	A	-	-	-	125	250	250	250	315
AC23A	400 V	A	125	160	200	250	315	400	500	500
	500 V	A	100	100	160	200	315	315	315	315
	690 V	A	-	-	-	100	160	160	160	160
Rated operational current										
DC 21A	400 V	A	125	160	160	250	315	400	400	630
	500 V	A	125	125	160	200	315	400	400	500
DC 22A	400 V	A	125	160	160	200	315	400	400	500
	500 V	A	125	125	160	200	315	315	315	500
DC 23A	400 V	A	125	125	160	200	315	400	400	500
	500 V	A	125	125	160	200	315	400	400	500
Operational power										
AC 23A	400 V	kW	63	80	100	132	160	220	280	280
	500 V	kW	63	63	110	140	220	220	220	220
	690 V	kW	55	55	75	90	150	150	150	150
Overload capacity										
Short time withstand current I _{cw} (RMS 1s) 690 V	kA		7	7	9	9	13	13	13	13
Breaking capacity AC 23A	400 V	A	1000	1280	1600	2000	2520	3200	4000	4000
Fuse protected short circuit withstand. (kA RMS prospective)	400 V AC	kA	100	100	80	50	100	100	100	70
	Fuse	A	125	160	200	250	315	400	500	630
Rated capacitor power	kVAr		55	75	90	115	145	185	230	290
Mechanical endurance	Ops		10000	10000	10000	10000	5000	5000	5000	5000
Weight (3 pole)	Kg		1	1.5	2	2	3.5	3.5	3.5	3.5
Min. tightening torque	Nm		6.5	6.5	10	10	15.4	14.5	14.5	14.5
Connection cable size	mm ²		35/50	50/95	70/95	95/150	150/240	185/240	240/240	2 (150/300)

Note: 240/415 V ratings suitable for use on 230/400 V in accordance with AS 60038 : 2000.



Technical data and ratings chart

SIRCO SLB 800 to 4000 A

Ratings to AS 3947-3 and IEC 60947-3

		800 A	1000 A	1250 A	1600 A	1800 A	2000 A	2500 A	3150 A	4000 A
Rated insulation voltage and rated operation voltage AC 20/DC 20	V	1000	1000	1000	1000	1000	1000	1000	1000	1000
Rated impulse withstand voltage	kV	12	12	12	12	12	12	12	12	12
Rated operational current										
AC 21A	400 V A	800	1000	1250	1600	1600	2000	2500	3150	3150
	500 V A	800	1000	1250	1600	1600	2000	2500	3150	3150
	690 V A	800	1000	1000	1600	1600	2000	2000	2000	2000
AC 22A	400 V A	800	1000	1250	1250	1250	2000	2000	2500	2500
	500 V A	800	1000	1000	1250	1250	1600	1600	2000	2000
	690 V A	800	630	630	800	800	1000	1000	1000	1000
AC 23A	400 V A	800	1000	1000	1000	1000	1250	1250	1250	1250
	500 V A	630	800	800	1000	1000	1000	1000	1000	1000
	690 V A	200	400	400	500	500	800	800	800	800
Rated operational current										
DC 21A	400 V A	800	1000	1250	1600	1600	2000	2000	2000	2000
	500 V A	630	1000	1250	1250	1250	1250	1250	1250	1250
DC 22A	400 V A	800	1000	1250	1250	1250	1250	1250	1250	1250
	500 V A	800	1000	1250	1250	1250	1250	1250	1250	1250
DC 23A	400 V A	800	1000	1000	1000	1000	1000	1000	1000	1000
	500 V A	800	1000	1000	1000	1000	1000	1000	1000	1000
Operational power										
AC 23A	400 V kW	450	560	560	560	560	710	710	710	710
	500 V kW	450	560	560	710	710	710	710	710	710
	690 V kW	185	400	400	475	475	750	750	750	750
Overload capacity										
Short time withstand current I _{cw} (RMS 1s) 690 V	kA	26	35 ¹⁾	50	50	50	50	50	55	70
Breaking capacity AC 23A	400 V A	6400	8000	8000	8000	8000	10000	10000	10000	10000
Fuse protected short circuit withstand. (kA RMS prospective)	400 V AC kA	50	100	100	100	100	100	100	-	-
	Fuse A	800	1000	1250	2x800	2x800	2x1000	2x1000	-	-
Rated capacitor power	kVAr	365	460	575	-	-	-	-	-	-
Mechanical endurance	Ops	4000	4000	4000	3000	3000	3000	2500	2500	2500
Weight (3 pole)	Kg	8	10.5	10.5	16	17	31	32	42	90
Min. tightening torque	Nm	37	37	37	50	50	60	60	60	110
Connection cable size	mm ²	2 (185/300)	2 240/4 185	4 185 max	6 240 max	-	-	-	-	-

Notes: ¹⁾ 50 kA switch available in larger frame size. Refer NHP.
240/415 V ratings suitable for use on 230/400 V in accordance with AS 60038 : 2000.

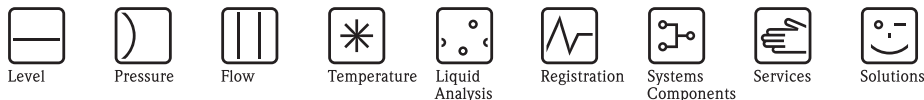
11. Level Transmitter



Halmac Services (Qld) Pty. Ltd.
A.C.N. 098 852 923
A.B.N. 40 741 712 113

LEVEL TRANSMITTER

1. LEVEL TRANSMITTER TECHNICAL DETAILS



Technical Information

Waterpilot FMX167

Hydrostatic level measurement

Reliable and robust level probe with ceramic measuring cell

Compact device for level measurement in fresh water, wastewater and saltwater



Application

The Waterpilot FMX167 is a pressure sensor for hydrostatic level measurement.

Three versions of FMX167 are available at Endress+Hauser:

- FMX167 with a stainless steel housing, outer diameter of 22 mm (0.87 inch): Standard version suitable for drinking water applications and for use in bore holes and wells with small diameters
- FMX167 with a stainless steel housing, outer diameter of 42 mm (1.66 inch): Heavy duty version, easy clean flush-mounted process diaphragm. Ideally suited to wastewater and sewage treatment plants
- FMX167 with a coated housing, outer diameter of 29 mm (1.15 inch): Corrosion resistant version generally for use in saltwater, particularly for ship ballast water tanks.

Your benefits





- High mechanical resistance to overload and aggressive media
- High-precision, robust ceramic measuring cell with long-term stability
- Climate proofed sensor thanks to completely potted electronics and 2-filter pressure compensation system
- 4 to 20 mA output signal with integrated overvoltage protection
- Simultaneous measurement of level and temperature with optionally integrated Pt100 temperature sensor
- Drinking water approvals: KTW, NSF, ACS
- Approvals: ATEX, FM and CSA
- Marine certificate: GL, ABS
- Extensive range of accessories provides complete measuring point solutions

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Function and system design

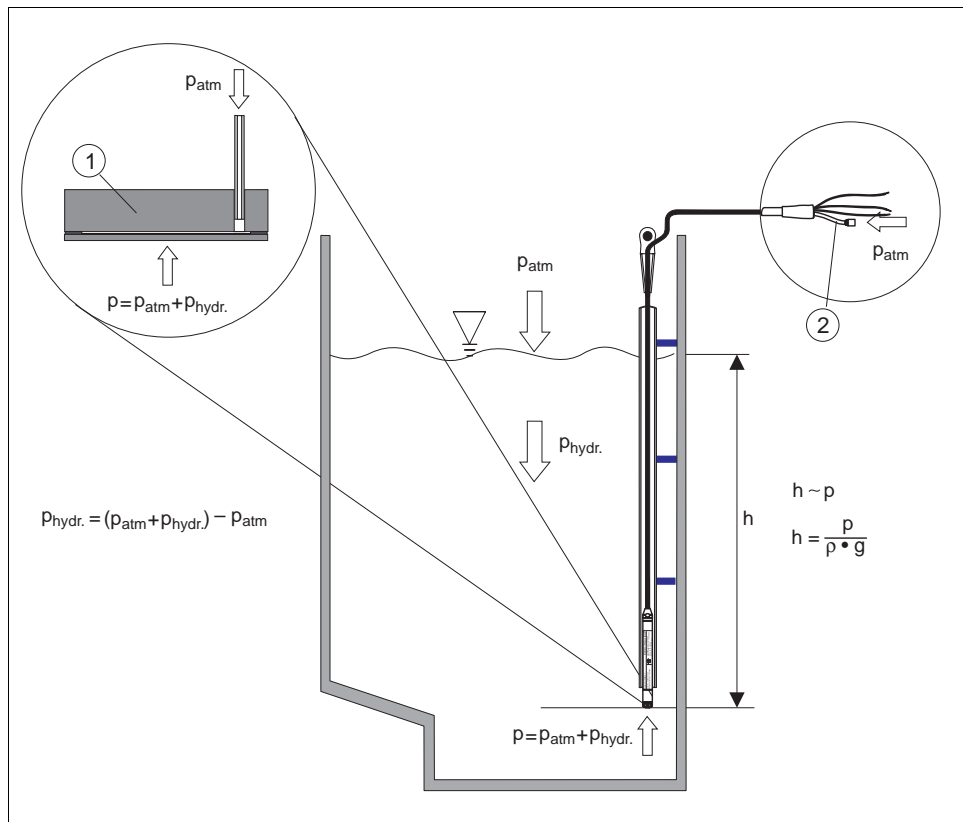
Device selection

Waterpilot FMX167	 <p style="text-align: center;">P01-FMX167xx-16-xx-xx-xx-002</p>	 <p style="text-align: center;">P01-FMX167xx-16-xx-xx-xx-003</p>	 <p style="text-align: center;">P01-FMX167xx-16-xx-xx-xx-004</p>
Field of application	Hydrostatic level measurement in deep wells e.g. drinking water	Hydrostatic level measurement in wastewater	Hydrostatic level measurement in saltwater
<p> Caution! The Waterpilot is not suitable for use in biogas plants since the gases can diffuse through the elastomers (seals, extension cable). Endress+Hauser offers the Deltapilot level transmitter for biogas applications.</p>			
Process connection	– Mounting clamp – Extension cable mounting screw with G1 ½ A or 1 ½ NPT thread		
Outer diameter	22 mm (0.87")	42 mm (1.65")	Max. 29 mm (1.14")
Extension cable	– PE extension cable – PUR extension cable – FEP extension cable		
Seals	– FKM Viton – EPDM ¹⁾	– FKM Viton	– FKM Viton – EPDM
Measuring ranges	– Nine fixed pressure measuring ranges in bar, mH ₂ O, psi and ftH ₂ O, from 0 to 0.1 bar to 0 to 20 bar (0 to 1 mH ₂ O to 0 to 200 mH ₂ O/ 0 to 1.5 psi to 0 to 300 psi/0 to 3 ftH ₂ O to 0 to 600 ftH ₂ O) – Customer-specific measuring ranges; factory-calibrated		– Seven fixed pressure measuring ranges in bar, mH ₂ O, psi and ftH ₂ O, from 0 to 0.1 bar to 0 to 4 bar (0 to 1 mH ₂ O to 0 to 40 mH ₂ O/ 0 to 1.5 psi to 0 to 60 psi/ 0 to 3 ftH ₂ O to 0 to 150 ftH ₂ O) – Customer-specific measuring ranges; factory-calibrated
Overload	Up to 40 bar (580 psi)		Up to 25 bar (362 psi)
Process temperature	–10 to +70 °C (14 to 158°F)		
Ambient temperature range	–10 to +70 °C (14 to 158°F)		
Maximum measured error	±0.2 % of upper range value (URV)		
Supply voltage	10 to 30 V DC		
Output	4 to 20 mA		
Options	– Drinking water approval		
	– Integrated Pt100 temperature sensor – Integrated Pt100 temperature sensor and TMT181 temperature head transmitter (4 to 20 mA/HART) – Marine approval		
Specialties	– Large selection of approvals, including ATEX II 2 G, FM and CSA – High-precision, robust ceramic measuring cell with long-term stability – Customer-specific cable marking		

1) Recommended for drinking water applications, not suitable for use in hazardous areas

Measuring principle

The ceramic measuring cell is a dry measuring cell, i.e. pressure acts directly on the robust ceramic process isolating diaphragm of the Waterpilot. Any changes in the air pressure are routed through the extension cable, via a pressure compensation tube, to the rear of the ceramic process isolating diaphragm and compensated for. A pressure-dependent change in capacitance caused by the movement of the process isolating diaphragm is measured at the electrodes of the ceramic carrier. The electronics convert the movement into a pressure-proportional signal which is linear to the medium level.



P01-FMX167xx-15-xx-xx-xx-002

Measuring principle

- 1 Ceramic measuring cell
- 2 Pressure compensation tube
- h Level height
- p Total pressure = hydrostatic pressure + atmospheric pressure
- ρ Density of the medium
- g Gravitational acceleration
- p_{hydr.} Hydrostatic pressure
- p_{atm} Atmospheric pressure

Temperature measurement with optional Pt100¹⁾

Endress+Hauser also offers the Waterpilot FMX167 with an optional 4-wire Pt100 resistance thermometer to measure level and temperature simultaneously. The Pt100 belongs to Accuracy Class B in accordance with DIN EN 60751, see also → 22, Sect. "Accessories."

Temperature measurement with optional Pt100 and TMT181 temperature head transmitter

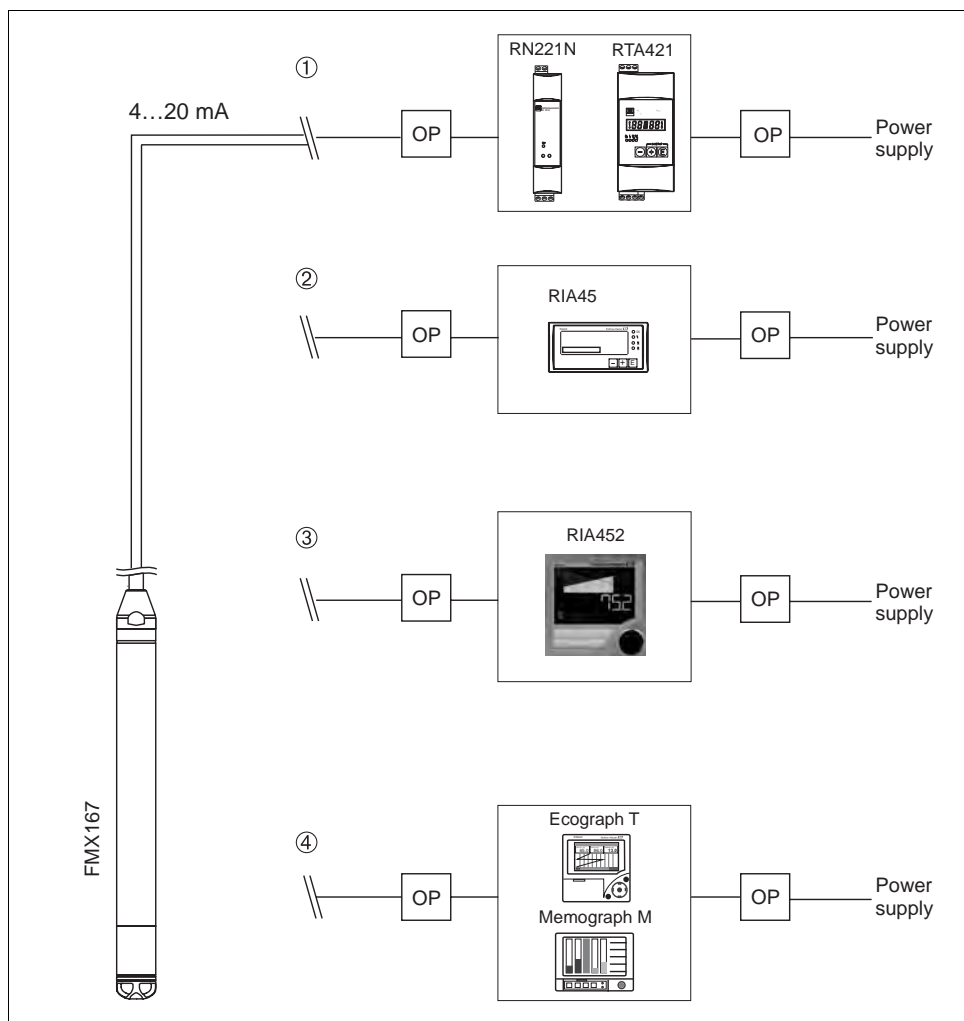
To convert the Pt100 signal to a 4 to 20 mA signal, Endress+Hauser also offers the TMT181 temperature transmitter.

1) Not for use in hazardous areas.

Measuring system

The complete standard measuring system consists of Waterpilot and a transmitter power supply unit with supply voltage of 10 to 30 V DC.

Possible measuring point solutions with a transmitter and evaluation units from Endress+Hauser:



Application examples with FMX167

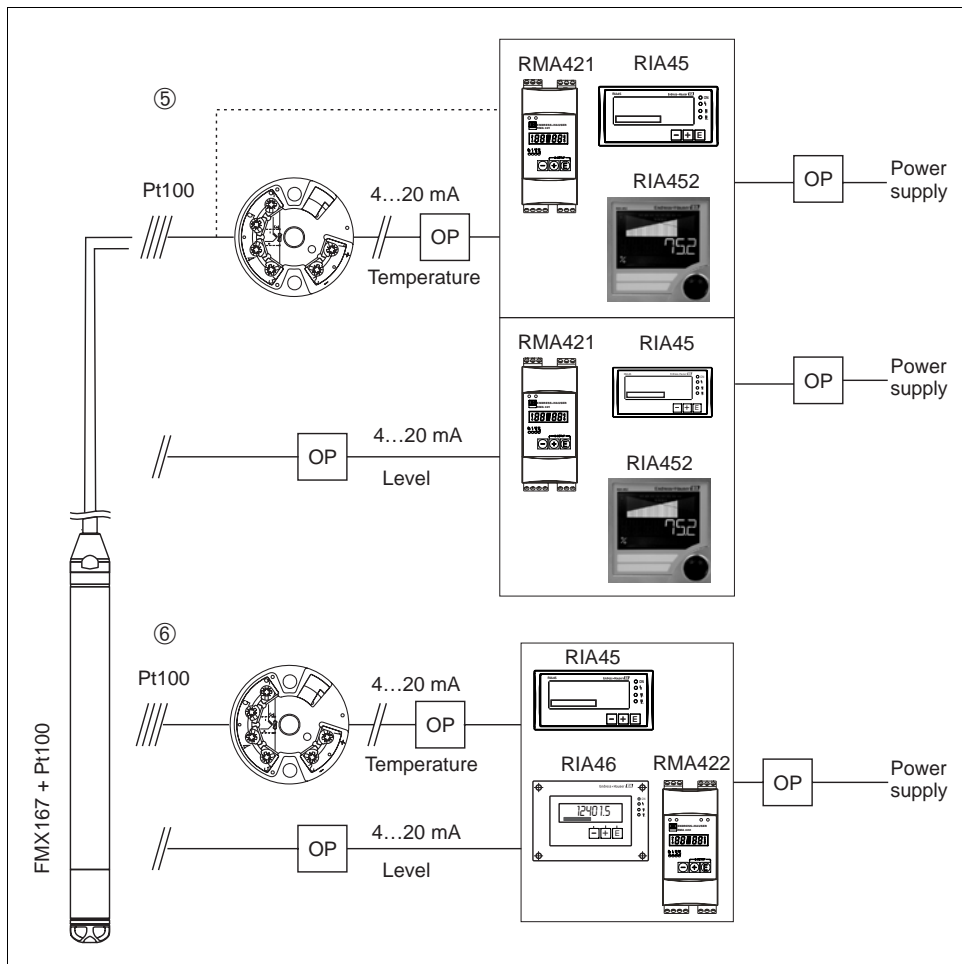
OVP = Overvoltage protection e.g. HAW from Endress+Hauser (not for use in hazardous areas)

- OVP on the sensor side for field installation: HAW569/for top-hat rail/DINrail: HAW562

- OVP on the supply side for top-hat rail/DINrail: HAW561 (115/230 V) and HAW561K (24/48 V AC/DC)

Option dependent on supply voltage.

1. Simple cost-effective measuring point solution: Power supply of Waterpilot in hazardous and non-hazardous areas using RN221N active barrier.
 Power supply and additional control of two consumers, e.g. pumps, via limit switch RTA421 with onsite display.
2. Evaluation unit RIA45 (for panel mounting) provides a power supply system, an onsite display and two switch outputs.
3. If several pumps are used, the pump service life can be prolonged by alternate switching. With alternating pump control, the pump which was out of service for the longest period of time is switched on. The evaluation unit RIA452 (for panel mounting) provides this option in additional to several other functions.
4. State-of-the-art recording technology with graphic display recorders from Endress+Hauser, such as Ecograph T, Memograph M, or paper recorders such as Alphalog for documenting, monitoring, visualizing and archiving purposes.



Application examples with FMX167

OVP = Overvoltage protection e.g. HAW from Endress+Hauser (not for use in hazardous areas)

- OVP on the sensor side for field installation: HAW569/for top-hat rail/DINrail: HAW562

- OVP on the supply side for top-hat rail/DINrail: HAW561 (115/230 V) and HAW561K (24/48 V AC/DC)

Option dependent on supply voltage.

5. If you want to measure, display and evaluate the temperature as well as the level, e.g. to monitor temperature in fresh water to detect temperature limits for germ formation, you have the following options:
The optional TMT181 temperature head transmitter can convert the Pt100 signal to a 4 to 20 mA HART signal and transfer it to any common evaluation unit. The RMA421, RIA45 and RIA452 evaluation units also offer a direct input for the Pt100 signal.
6. If you want to record and evaluate the level and temperature measured value with one device, use the RMA422, RIA45 and RIA46 evaluation units with two inputs. It is even possible to mathematically link the input signals with this unit. These evaluation units are not HART-compatible.

System integration

The device can be fitted with a tag name, see → 21 ff, "Ordering information", feature 995 "Marking" version "1".

Input

Measured variable	FMX167 + Pt100 (optional)	TMT181 temperature head transmitter (optional)
	<ul style="list-style-type: none"> ■ Hydrostatic pressure of a liquid ■ Pt100: Temperature of a liquid 	<ul style="list-style-type: none"> ■ Temperature

Measuring range	<ul style="list-style-type: none"> ■ Nine fixed pressure measuring ranges in bar, mH₂O, psi and ftH₂O; → 21, "Ordering information" Section ■ Customer-specific measuring ranges; factory-calibrated ■ Temperature measurement from -10 to +70 °C (optional with Pt100)
------------------------	--

Sensor measuring range	Lowest span that can be calibrated	Maximum overload/OPL ¹⁾	Vacuum resistance
bar (psi)	bar (psi)	bar (psi)	bar _{abs} (psia)
0.1 (1.5)	0.01 (0.15)	5.0 (73)	0.3 (4.3)
0.2 (3)	0.02 (0.29)	5.0 (73)	0.3 (4.3)
0.4 (6)	0.04 (0.58)	7.0 (101)	0
0.6 (10)	0.06 (0.87)	10.0 (150)	0
1.0 (15)	0.1 (1.5)	10.0 (150)	0
2.0 (30)	0.2 (3)	18.0 (261)	0
4.0 (60)	0.4 (6)	25.0 (362)	0
10.0 ²⁾ (150)	1.0 (15)	40.0 (580)	0
20.0 ²⁾ (300)	2.0 (30)	40.0 (580)	0

- 1) OPL: overpressure limit, depending on the weakest element, in terms of pressure, of the selected components
- 2) These measuring ranges are not offered for the probe version with a coated housing, outer diameter 29 mm (1.14").

Input signal	FMX167 + Pt100 (optional)	TMT181 temperature head transmitter (optional)
	<ul style="list-style-type: none"> ■ Change in capacitance ■ Pt100: change in resistance 	<ul style="list-style-type: none"> ■ Pt100 resistance signal, 4-wire

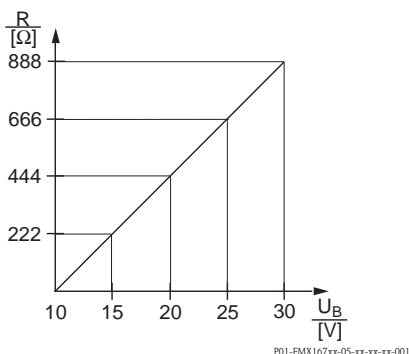
Output

Output signal	<p>FMX167 + Pt100 (optional)</p> <ul style="list-style-type: none"> ■ FMX167: 4 to 20 mA for hydrostatic pressure measured value, two-wire ■ Pt100: Temperature-dependent resistance value of the Pt100 	<p>TMT181 temperature head transmitter (optional)</p> <ul style="list-style-type: none"> ■ 4 to 20 mA for temperature measured value, two-wire
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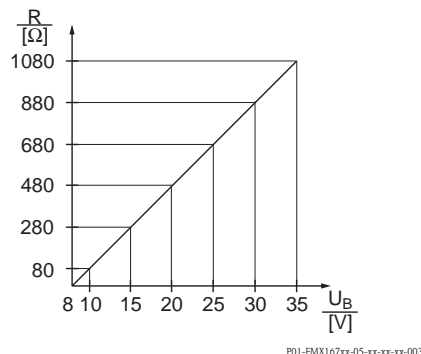
Load	<p>FMX167 + Pt100 (optional)</p> $R_{tot} \leq \frac{U_b - 10 \text{ V}}{0.0225 \text{ A}} - 2 \cdot 0.09 \frac{\Omega}{\text{m}} \cdot l - R_{add}$ <p style="text-align: right; font-size: small;">P01-FMX167xx-16-xx-xx-xx-000</p>	<p>TMT181 temperature head transmitter (optional)</p> $R_{tot} \leq \frac{U_b - 8 \text{ V}}{0.025 \text{ A}} - R_{add}$ <p style="text-align: right; font-size: small;">P01-FMX167xx-16-xx-xx-xx-001</p>
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- R_{ges} = Max. load resistance [Ω]
- R_{add} = additional resistances such as resistance of evaluation unit and/or display unit, cable resistance [Ω]
- U_b = Supply voltage [V]
- l = Simple length of extension cable [m] (cable resistance per wire ≤ 0.09 /Ωm)

Note!
 When using the measuring device in hazardous areas, installation must comply with the applicable national standards and regulations and the Safety Instructions or Installation or Control Drawings.



FMX167 load chart for estimating the load resistance. Additional resistances, such as the resistance of the extension cable, have to be subtracted from the value calculated as shown in the equation.



Temperature head transmitter load chart for estimating the load resistance. Additional resistances have to be subtracted from the value calculated as shown in the equation.

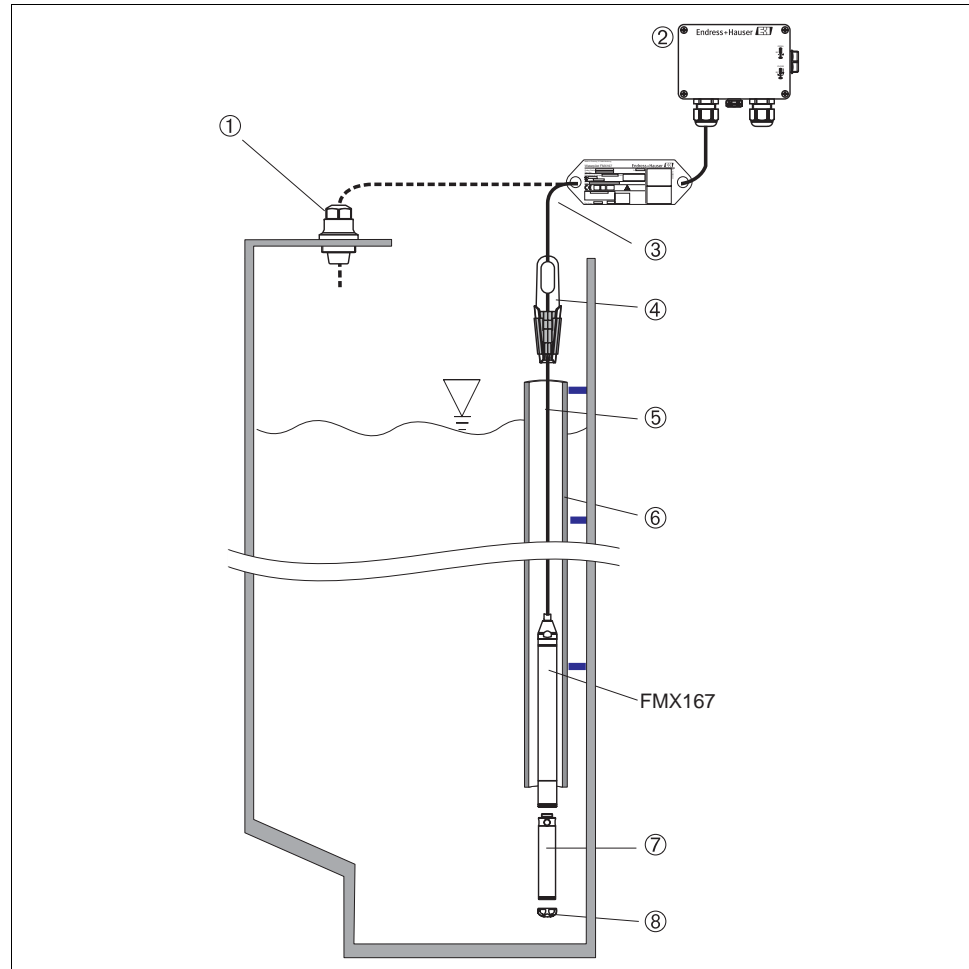
Supply voltage	<p>Note! When using the measuring device in hazardous areas, installation must comply with the applicable national standards and regulations and the Safety Instructions (XAs) or the Installation or Control Drawings (ZDs). → 23, Sect. "Safety instructions", "Installation/Control Drawings".</p> <p>FMX167 + Pt100 (optional)</p> <ul style="list-style-type: none"> ■ FMX167: 10 to 30 V DC ■ Pt100: 10 to 30 V DC 	<p>TMT181 temperature head transmitter (optional)</p> <ul style="list-style-type: none"> ■ 8 to 35 V DC
Cable specifications	<p>FMX167 + Pt100 (optional)</p> <ul style="list-style-type: none"> ■ Commercially available instrument cable ■ Terminals in terminal housing FMX167: 0.08 to 2.5 mm² (20 to 14 AWG) ■ If the Pt100 signal is directly connected to a display and/or evaluation unit, Endress+Hauser recommends using a shielded cable. 	<p>TMT181 temperature head transmitter (optional)</p> <ul style="list-style-type: none"> ■ Commercially available instrument cable ■ Terminals in terminal housing FMX167: 0.08 to 2.5 mm² (20 to 14 AWG) ■ Transmitter connection: max. 1.75 mm² (16 AWG)
Power consumption	<p>FMX167 + Pt100 (optional)</p> <p>≤ 0.675 W at 30 V DC</p>	<p>TMT181 temperature head transmitter (optional)</p> <p>≤ 0.875 W at 35 V DC</p>
Current consumption	<p>FMX167 + Pt100 (optional)</p> <ul style="list-style-type: none"> ■ Max. current consumption: ≤ 22.5 mA Min. current consumption: ≥ 3.5 mA ■ Pt100: ≤ 0.6 mA 	<p>TMT181 temperature head transmitter (optional)</p> <ul style="list-style-type: none"> ■ Max. current consumption: ≤ 25 mA Min. current consumption: ≥ 3.5 mA ■ Pt100 via temperature head transmitter: ≤ 0.6 mA
Residual ripple	<p>FMX167 + Pt100 (optional)</p> <p>No effect for 4 to 20 mA signal up to ±5 % residual ripple within permissible range</p>	<p>TMT181 temperature head transmitter (optional)</p> <p>$U_{ss} \geq 5 \text{ V}$ at $U_B \geq 13 \text{ V}$, $f_{max.} = 1 \text{ kHz}$</p>

Accuracy

Reference operating conditions	FMX167 + Pt100 (optional) DIN EN 60770 $T_U = 25\text{ °C}$ (77°F)	TMT181 temperature head transmitter (optional) Calibration temperature $23\text{ °C} \pm 5\text{ K}$ (73°F $\pm 5\text{ K}$)
Maximum measured error	FMX167 + Pt100 (optional) <ul style="list-style-type: none"> ■ Non-linearity including hysteresis and non-repeatability as per DIN EN 60770: $\pm 0.2\%$ of upper range value (URV) ■ Pt100: max. $\pm 0.7\text{ K}$ (Class B to DIN EN 60751) 	TMT181 temperature head transmitter (optional) <ul style="list-style-type: none"> ■ $\pm 0.2\text{ K}$ ■ With Pt100: max. $\pm 0.9\text{ K}$
Long-term stability	FMX167 + Pt100 (optional) $\pm 0.1\%$ of the upper range limit (URL) per year	TMT181 temperature head transmitter (optional) $\leq 0.1\text{ K}$ per year
Influence of medium temperature	<ul style="list-style-type: none"> ■ Thermal change in zero signal and output span for typical application temperature range $0\text{ to }+30\text{ °C}$ ($+32\text{ to }+86\text{ °F}$): $\pm 0.4\%$ ($\pm 0.5\%$)* of the upper range limit (URL) ■ Thermal change in zero signal and output span for the entire medium temperature range $-10\text{ to }+70\text{ °C}$ ($+14\text{ to }+158\text{ °F}$): $\pm 1.0\%$ ($\pm 1.5\%$)* of the upper range limit (URL) ■ Temperature coefficient k_T of zero signal and output span: $0.15\%/10\text{ K}$ ($0.3\%/10\text{ K}$)* of the upper range limit (URL) <p style="margin-left: 20px;">* Specifications for sensors 0.1 bar (1 mH₂O, 1.5 psi, 3 ftH₂O) and 0.6 bar (6 mH₂O, 10 psi, 20 ftH₂O)</p>	
Warm-up period	FMX167 + Pt100 (optional) 20 ms	TMT181 temperature head transmitter (optional) 4 s
Rise time	FMX167 + Pt100 (optional) <ul style="list-style-type: none"> ■ FMX167: 80 ms ■ Pt100: 160 s 	– –
Settling time	FMX167 + Pt100 (optional) <ul style="list-style-type: none"> ■ FMX167: 150 ms ■ Pt100: 300 s 	– –

Installation conditions

Installation instructions



P01-FMX167xx-11-xx-xx-xx-003

Installation examples, here shown with FMX167 with an outer diameter 22 mm

- 1 Extension cable mounting screw can be ordered via order code or as an accessory, → 21 ff
- 2 Terminal housing can be ordered using the order code or as an accessory → 21
- 3 Extension cable bending radius > 120 mm
- 4 Mounting clamp can be ordered via order code or as an accessory, → 21 ff
- 5 Extension cable, cable length → 18
- 6 Guide pipe
- 7 Additional weight can be ordered as an accessory with an outer diameter of 22 mm and 29 mm (0.87" and 1.14"), → 22
- 8 Protection cap

Note!

- Sideways movement of the level probe can result in measuring errors. For this reason, install the probe at a point free from flow and turbulence, or use a guide tube. The internal diameter of the guide tube should be at least 1 mm (0.04") larger than the outer diameter of the selected FMX167.
- The cable must end in a dry room or a suitable terminal box. The terminal box from Endress+Hauser provides optimum humidity and climatic protection and is suitable for outdoor installation.
- Protection cap: The device is provided with a protection cap to prevent mechanical damage to the measuring cell. This cap should not be removed during the transportation and installation process.
- Endress+Hauser recommends using twisted, shielded cables for any further wiring.

Environment

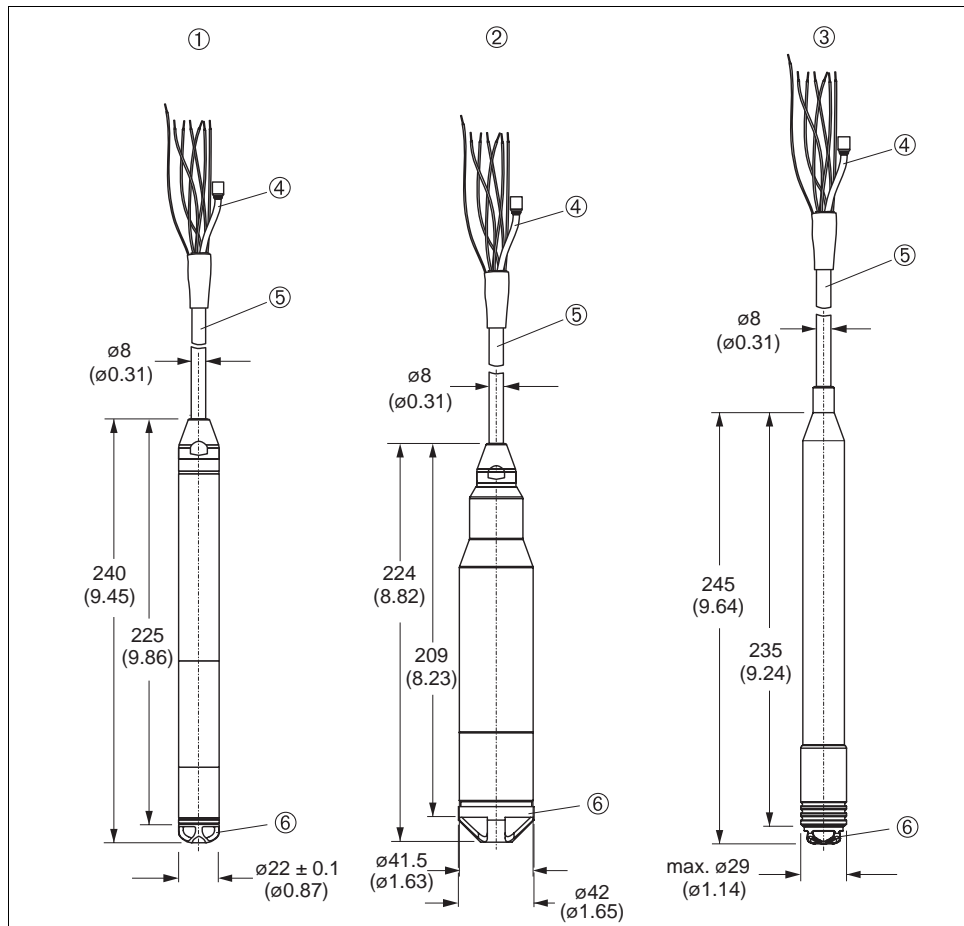
Ambient temperature range	FMX167 + Pt100 (optional) <ul style="list-style-type: none"> ■ FMX167 with outer diameter of 22 mm (0.87") and 42 mm (1.65"): -10 to +70°C (14 to 158°F) = medium temperature) ■ FMX167 with outer diameter of 29 mm (1.14"): 0 to +50°C (32 to 122°F) = medium temperature) <p>Terminal box</p> <p>-40 to +80°C (-40 to + 176°F)</p>	TMT181 temperature head transmitter (optional) <p>-40 to +85°C (-40 to + 185°F)</p>
Storage temperature range	FMX167 + Pt100 (optional) <p>-40 to +80°C (-40 to + 176°F)</p> <p>Terminal box</p> <p>-40 to +80°C (-40 to + 176°F)</p>	TMT181 temperature head transmitter (optional) <p>-40 to +100°C (-40 to +212°F)</p>
Degree of protection	FMX167 + Pt100 (optional) <ul style="list-style-type: none"> ■ IP 68 (NEMA 6P), permanently hermetically sealed ■ Optional terminal box: IP 66/IP 67 (NEMA 4X) 	TMT181 temperature head transmitter (optional) <ul style="list-style-type: none"> ■ IP 00, moisture condensation permissible ■ When mounted in the optional terminal boxes: IP 66/IP67 (NEMA 4X)
Electromagnetic compatibility (EMC)	FMX167 + Pt100 (optional) <ul style="list-style-type: none"> ■ Interference emission to EN 61326 Class B equipment, interference immunity to EN 61326 Appendix A (Industrial) ■ Maximum deviation < 0.5 % of the span. 	TMT181 temperature head transmitter (optional) <ul style="list-style-type: none"> ■ Interference emission to EN 61326 Class B equipment, interference immunity to EN 61326 Appendix A (Industrial)
Overvoltage protection	FMX167 + Pt100 (optional) <p>Integrated overvoltage protection to EN 61000-4-5 (500 V symmetrical/1000 asymmetrical) Install overvoltage protection ≥ 1.0 kV, external if necessary</p>	TMT181 temperature head transmitter (optional) <p>Install overvoltage protection, external if necessary.</p>

Process conditions

Medium temperature range	FMX167 + Pt100 (optional) <ul style="list-style-type: none"> ■ FMX167 with outer diameter of 22 mm (0.87") and 42 mm (1.65"): -10 to +70°C (14 to 158°F) ■ FMX167 with outer diameter of 29 mm (1.14"): 0 to +50°C (32 to 122°F) 	TMT181 temperature head transmitter (optional) -40 to +85 °C (-40 to +185°F) = ambient temperature, install temperature head transmitter outside medium.
Medium temperature limits	FMX167 + Pt100 (optional) <ul style="list-style-type: none"> ■ FMX167 with outer diameter of 22 mm (0.87") and 42 mm (1.65"): -20 to +70°C (-4 to +158°F) ■ FMX167 with outer diameter of 29 mm (1.14"): 0 to +50°C (32 to 122°F) <p>(You may operate the FMX167 in this temperature range. The specification can then be exceeded, e.g. measuring accuracy).</p>	

Mechanical construction

Dimensions of the level probe

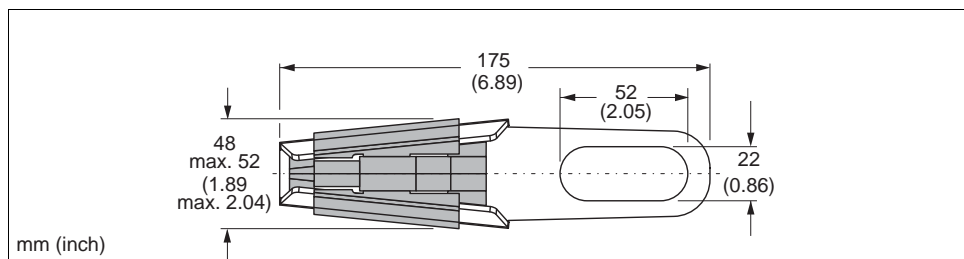


P01-FMX167xx-06-xx-xx-xx-008

Versions of FMX167

- 1 FMX167, version "A" or "D" for Feature 30 "Probe tube" in the order code (→ 21)
- 2 FMX167, version "B" for Feature 30 "Probe tube" in the order code (→ 21)
- 3 FMX167, version "C" for Feature 30 "Probe tube" in the order code (→ 21)
- 4 Pressure compensation tube
- 5 Extension cable
- 6 Protection cap

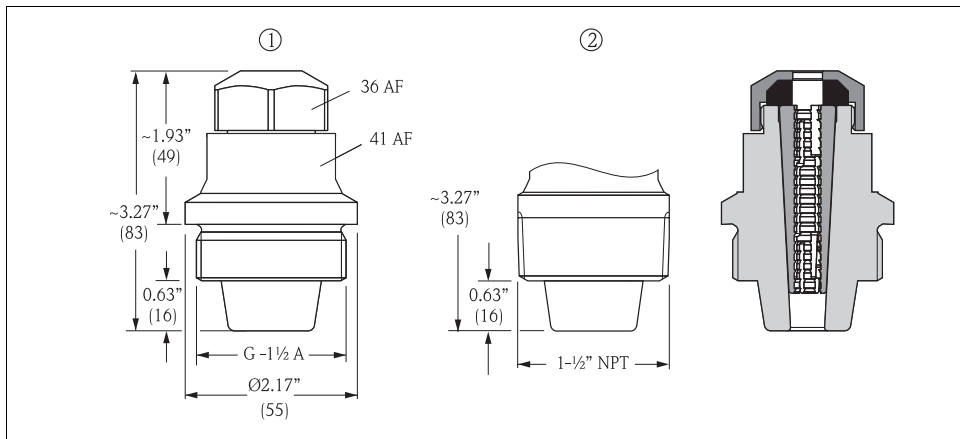
Dimensions of the mounting clamp



P01-FMXxxxx-06-xx-xx-xx-010

Mounting clamp, version "2" for Feature 20 "Connection" in the order code (→ 21)

Dimensions of the extension cable mounting screws



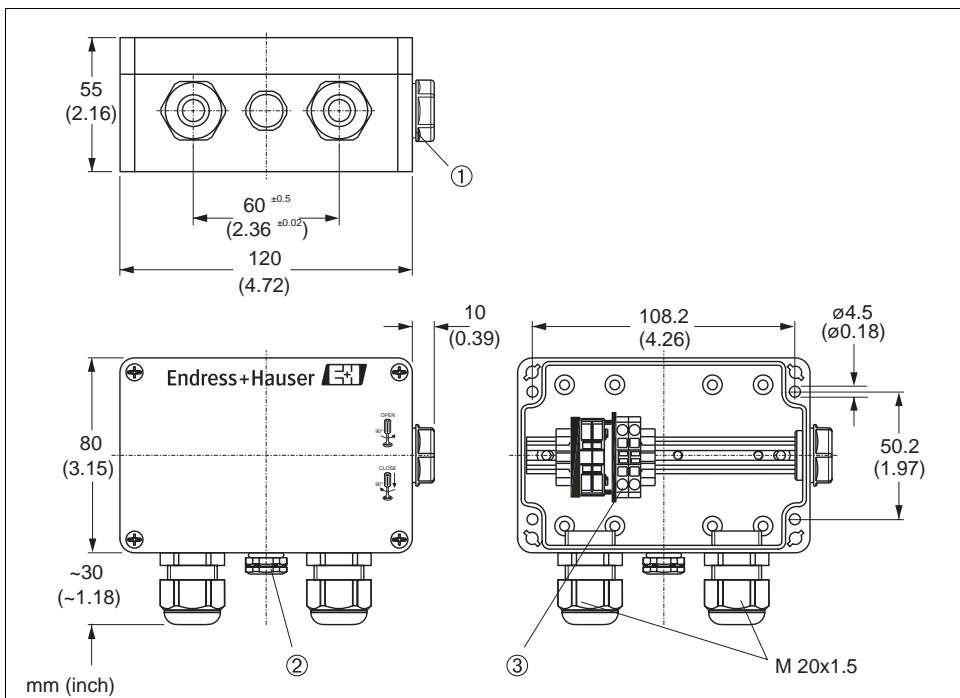
P01-FMXxxxx-06-xx-xx-en-009

Extension cable mounting screws

- 1 Extension cable mounting screw G1 1/2 A, version "3" for Feature 20 "Connection" in the order code (→ 21)
- 2 Extension cable mounting screw 1 1/2 NPT, version "4" for Feature 20 "Connection" in the order code (→ 21)

Note!
Application in unpressurized containers only.

Dimensions of the terminal box IP 66/IP 67 with filter



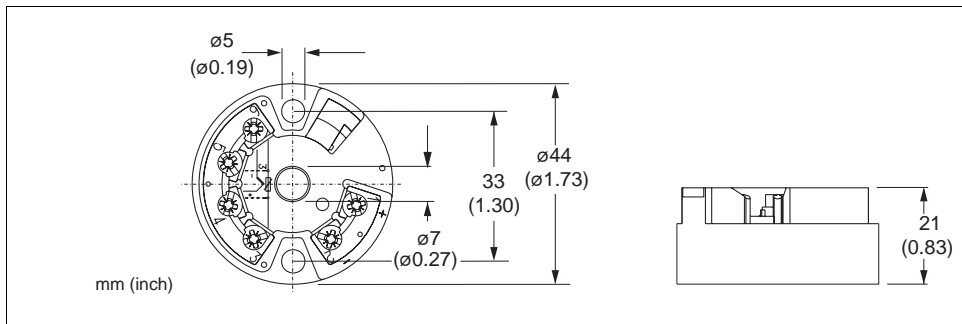
P01-FMX167xx-06-xx-xx-xx-011

Terminal box

Version "3", "4" or "5" for Feature 70 "Additional options" in the order code (→ 21)

- 1 Dummy plug M 20x1.5
- 2 GORE-TEX® filter
- 3 Terminals for 0.08 to 2.5 mm²

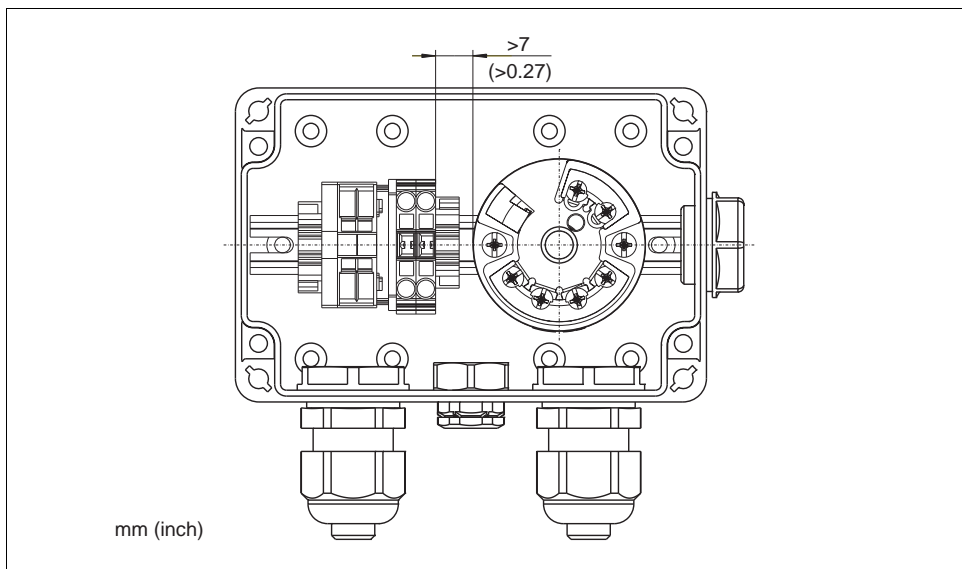
Dimensions of the TMT181 temperature head transmitter



TMT181 temperature head transmitter (4 to 20 mA)

Version "5" for Feature 70 "Additional options" in the order code (→ 21). The temperature head transmitter can be used in non-hazardous areas and for EEx nA.

Terminal box with integrated TMT181 temperature head transmitter



Note!

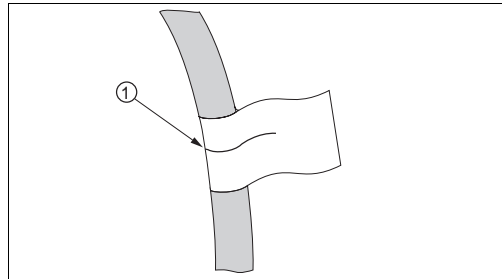
A distance of >7 mm (0.27") must be maintained between the terminal strip and the TMT181 temperature head transmitter.

Weight

- Level probe, outer diameter 22 mm (0.87"): 290 g (0.6 lb)
- Level probe, outer diameter 42 mm (1.65"): 1150 g (2.5 lb)
- Level probe, outer diameter 29 mm (1.14"): 340 g (0.7 lb)
- PE extension cable: 52 g/m (1.8 oz/3 ft)
- PUR extension cable: 60 g/m (2.1 oz/3 ft)
- FEP extension cable: 108 g/m (3.8 oz/3 ft)
- Mounting clamp: 170 g (0.4 lb)
- Extension cable mounting screw G 1 ½ A: 770 g (1.7 lb)
- Extension cable mounting screw 1 ½ NPT: 724 g (1.6 lb)
- Terminal box: 235 g (0.5 lb)
- Temperature head transmitter TMT181: 40 g (0.08 lb)
- Additional weight: 300 g (0.7 lb)
- Testing adapter: 39 g (1.4 lb)

Material	<p>Level probe</p> <ul style="list-style-type: none"> ■ Level probe, outer diameter 22 mm (0.87"): 1.4435 (AISI 316L SS) ■ Level probe, outer diameter 42 mm (1.65"): 1.4435 (AISI 316L SS) ■ Level probe, outer diameter 29 mm (1.14"): 1.4435 (AISI 316L SS) <ul style="list-style-type: none"> – Sensor sleeve: PPS (polyphenylene sulfide) – Heat-shrink sleeve/cover: Polyolefin <p>Metal does not come into contact with the medium.</p> <ul style="list-style-type: none"> ■ Process ceramic: Al₂O₃ aluminum oxide ceramic ■ Seal (internal): EPDM or Viton ■ Protection cap: <ul style="list-style-type: none"> – PE-HD (high-density polyethylene) for FMX167 with outer diameter 22 mm (0.87") and 29 mm (1.14"). – PFA (perfluoroalkoxy) for FMX167 with outer diameter 42 mm (1.65"). ■ Extension cable insulation: Either PE-LD (low-density polyethylene), FEP (fluorinated ethylene propylene) or PUR (polyurethane). For more information, see → 18, "Extension cable" ■ Mounting clamp: 1.4404 (AISI 316L SS) and fiberglass reinforced PA (polyamide) ■ Extension cable mounting screw G 1 ½A: 1.4301 (AISI 304 SS) ■ Extension cable mounting screw 1 ½NPT: 1.4301 (AISI 304 SS) ■ Terminal box: PC (polycarbonate) ■ Temperature head transmitter TMT181: PC housing (polycarbonate)
Extension cable	<p>PE extension cable</p> <ul style="list-style-type: none"> ■ Abrasion-resistant extension cable with Dynema strain-relief members; shielded with aluminum-coated film; insulated with polyethylene (PE), black; copper wires, twisted ■ Pressure compensation tube with Teflon filter <p>PUR extension cable</p> <ul style="list-style-type: none"> ■ Abrasion-resistant extension cable with Dynema strain-relief members; shielded with aluminum-coated film; insulated with polyurethane (PUR), black; copper wires, twisted ■ Pressure compensation tube with Teflon filter <p>FEP extension cable</p> <ul style="list-style-type: none"> ■ Abrasion-resistant extension cable; shielded with galvanized steel wire netting; insulated with fluorinated ethylene propylene (FEP), black; copper wires, twisted ■ Pressure compensation tube with Teflon filter <p>Cross-section of PE/PUR/FEP extension cable</p> <ul style="list-style-type: none"> ■ Total outer diameter: 8.0 mm (0.31") ± 0.25 mm (0.001") ■ FMX167: 3 x 0.227 mm² (0.0004") + pressure compensation tube with Teflon filter ■ FMX167 with Pt100 (optional): 7 x 0.227 mm² (0.0004") + pressure compensation tube with Teflon filter ■ Pressure compensation tube with Teflon filter: Outer diameter 2.5 mm (0.1 inch), internal diameter 1.5 mm (0.06 inch) <p>Cable resistance of PE/PUR/FEP extension cable</p> <ul style="list-style-type: none"> ■ Cable resistance per wire: ≤ 0.09 Ω/m <p>Cable length of PE/PUR/FEP extension cable</p> <ul style="list-style-type: none"> ■ Please refer also to → 8, Sect. "Load". ■ Cable length that can be ordered <ul style="list-style-type: none"> – Customer-specific length in meters or feet (→ 21, "Ordering information") – Limited cable length when performing installation with freely suspended device with extension cable mounting screw or mounting clamp, as well as for Ex approval: max. 300 m (984 ft). ■ When using the measuring device in hazardous areas, installation must comply with the applicable national standards and regulations and the Safety Instructions (XAs) or the Installation or Control Drawings (ZDs). See also → 23, "Safety instructions" and "Installation/Control Drawings" Sections. <p>Further technical data of PE /PUR/FEP extension cable</p> <ul style="list-style-type: none"> ■ Minimum bending radius: 120 mm (4.7") ■ Tensile strength: max. 950 N (214 lbf) ■ Cable extraction force: typical ≥ 450 N/101 lbf (FE, FEP) / typical ≥ 150 N/34 lbf (PUR) (The extension cable could be extracted from the level probe with a appropriate tensile force.) ■ Resistance to UV light ■ PE: Approved for use with drinking water
Terminals	<ul style="list-style-type: none"> ■ Three terminals as standard in the terminal box ■ 4-terminal strip can be ordered as an accessory, Order No: 52008938 Conductor cross-section 0.08 to 2.5 mm² (20 to 14 AWG)

**Installation tool –
indicating the customer-
specific length on the cable**



1 cable marking, distance to the lower end of the cable probe

- To make installation easier, Endress+Hauser offers a mark on the extension cable for a customer-specific length, see also → 21, "Ordering information".
- Mark tolerance: up to ± 50 mm (2") (the mark tolerance corresponds to a measured error from up to ± 50 mm/2")
- Material: PET
- Adhesive: acrylic
- Immunity to temperature change: -30 to $+100^{\circ}\text{C}$ (-22 to $+212^{\circ}\text{F}$)

Note!

- The mark is for installation purposes only. It must be thoroughly removed without trace in the case of devices with drinking water approval. The extension cable must not be damaged in the process.
- Not for use in hazardous areas.

Certificates and approvals

CE mark	The device meets the legal requirements of the applicable EC Directives. Endress+Hauser confirms successful testing of the device by affixing to it the CE mark.
Ex approval, type of protection	<ul style="list-style-type: none"> ■ ATEX II 2 G EEx ia IIC T6¹⁾ ■ ATEX II 3 G EEx nA II T6¹⁾ ■ FM: IS, Class I, Division 1, Groups A–D¹⁾ ■ CSA: IS, Class I, Division 1, Groups A–D¹⁾ <p>¹⁾ Only for Waterpilot FMX167 without Pt100 and TMT181</p> <p>Note!</p> <ul style="list-style-type: none"> ■ Waterpilot FMX167 is only available for use in hazardous areas with the FKM Viton seal. ■ The cable marking cannot be ordered with the Ex approvals listed due to a potential electrostatic charge (see → 21, "Ordering information"). ■ All explosion-protection data are given in a separate documentation which is available upon request. The Ex documentation is provided with all Ex-systems as standards, see also → 23, Sect. "Additional documentation", "Safety instructions" and "Installation/Control Drawings".
Drinking water approval (for FMX167 with Outer diameter 22 mm (0.87 in))	<ul style="list-style-type: none"> ■ KTW certificate ■ NSF 61 approval ■ ACS approval
Marine approval	<ul style="list-style-type: none"> ■ GL approval ■ ABS approval
Standards and guidelines applied	<p>The European standards and guidelines that have been applied are listed in the associated EC Declarations of Conformity. In addition, the following standards were also applied for the Waterpilot FMX167:</p> <p>DIN EN 60770 (IEC 60770): Transmitters for use in industrial process control systems Part 1: Methods for performance evaluation</p> <p>DIN 16086: Electrical pressure measuring instruments, pressure sensors, pressure transmitters, pressure measuring instruments, concepts, specifications on data sheets</p> <p>EN 61326: Electrical equipment for measurement, control and laboratory use – EMC requirements</p>

Ordering information

FMX167

You can enter the versions for the specific feature in the following table. The versions entered make up the complete order code. Options which are mutually exclusive are not marked.

10		Approval	
	A	Non-hazardous area	
	B	ATEX II 2 G EEx ia IIC T6	
	C	ATEX II 3 G EEx nA II T6	
	D	FM IS, Class I, Division 1, Groups A – D	
	E	CSA IS, Class I, Division 1, Groups A – D	
	F	CSA General Purpose	
20		Connection	
	1	Probe cable	
	2	Mounting clamp, AISI 316L	
	3	Cable mounting screw G1-1/2, AISI 304	
	4	Cable mounting screw NPT 1-1/2, AISI 304	
30		Probe tube:	
	A	Outer diameter d = 22 mm, AISI 316L	
	B	Outer diameter d = 42 mm, flush-mounted, AISI 316L	
	C	Outer diameter d = 29 mm (1.15 in), AISI 316L with heat-shrink sleeve PPS/polyolefin for saltwater applications	
	D	Outer diameter d = 22 mm (0.87 in), AISI 316L + drinking water approval (can only be selected in conjunction with EPDM seal and PE probe cable)	
40		Measuring range:	
		Measuring range	Measuring range
	BA	0 to 0.1 bar	MA 0 to 1 mH ₂ O
	BB	0 to 0.2 bar	MB 0 to 2 mH ₂ O
	BC	0 to 0.4 bar	MC 0 to 4 mH ₂ O
	BD	0 to 0.6 bar	MD 0 to 6 mH ₂ O
	BE	0 to 1.0 bar	ME 0 to 10 mH ₂ O
	BF	0 to 2.0 bar	MF 0 to 20 mH ₂ O
	BG	0 to 4.0 bar	MG 0 to 40 mH ₂ O
	BH	0 to 10.0 bar	MH 0 to 100 mH ₂ O
	BK	0 to 20.0 bar	MK 0 to 200 mH ₂ O
	PA	0 to 1.5 psi	FA 0 to 3 ftH ₂ O
	PB	0 to 3 psi	FB 0 to 6 ftH ₂ O
	PC	0 to 6 psi	FC 0 to 15 ftH ₂ O
	PD	0 to 10 psi	FD 0 to 20 ftH ₂ O
	PE	0 to 15 psi	FE 0 to 30 ftH ₂ O
	PF	0 to 30 psi	FF 0 to 60 ftH ₂ O
	PG	0 to 60 psi	FG 0 to 150 ftH ₂ O
	PH	0 to 150 psi	FH 0 to 300 ftH ₂ O
	PK	0 to 300 psi	FK 0 to 600 ftH ₂ O
	VV	Adjusted to customer specifications from 0 to ____ (upper range value) in ____ (unit), upper range value: 0.1 bar (1 mH ₂ O, 1.5 psi, 3 ftH ₂ O) to 20 bar (200 m ₂ HO, 300 psi, 600 ft ₂ HO)	
50		Sensor seal:	
	1	FKM Viton	
	2	EPDM	
60		Probe cable (can be shortened):	
	A	... m, PE	
	B	10 m, PE	
	C	20 m, PE	
	E	30 ft, PE	
	F	60 ft, PE	
	G	... ft, PE	
	I	... m, FEP	
	K	10 m, FEP	
	L	20 m, FEP	
	M	30 ft, FEP	
	N	60 ft, FEP	
	P	... ft, FEP	
FMX167			Order code
→ Ordering information for FMX167 continued on next page.			

FMX167 (continued)

60	Probe cable (can be shortened):
	R ... m cable, PUR
	S 10 m cable, PUR
	T 20 m cable, PUR
	U ... m cable, PUR
	V 30 ft cable, PUR
	W 60 ft cable, PUR
70	Additional option:
	7 Basic version
	1 Pt100, 4-wire
	5 Pt100 + temperature head transmitter TMT181, 2-wire, 4 to 20 mA = -20 to +80 °C (-4 to +176°F) ¹⁾
	3 Terminal box IP66/67
	4 Terminal box IP66/67 + Pt, 4-wire
	A m cable marking>installation
	B ft cable marking>installation
	C m cable marking, terminal box, cable marking>installation, terminal box IP66/67
	D ft cable marking, terminal box, cable marking>installation, terminal box IP66/67
	S GL/ABS marine certificate
995	Marking
	1 Measuring point (TAG)
FMX167	Complete order code

¹⁾ incl. terminal box, see feature "3" or "4"

Accessories

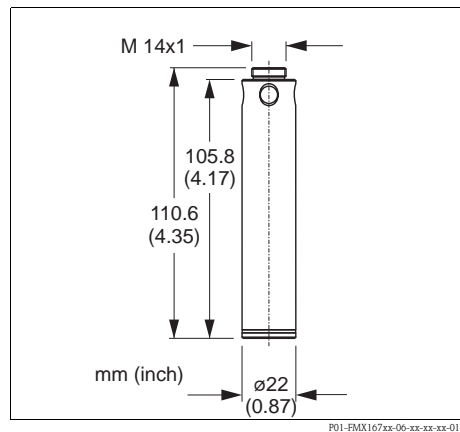
Mounting clamp

- Endress+Hauser offers a mounting clamp for simple FMX167 mounting → 15
- Material: 1.4404 (AISI 316L SS) and fiberglass reinforced PA (polyamide)
- Order number: 52006151
- See also → 21, "Ordering information"

Terminal box

- Terminal box IP 66/IP 67 with GORE-TEX®-filter incl. 3 installed terminals. The terminal box is also suitable for installing a temperature head transmitter (Order No. 52008794) or for four additional terminals (Order No. 52008938) → 23.
- Order number: 52006152

Additional weight (for FMX167 with an outer diameter of 22 mm and 29 mm)



- Endress+Hauser offers additional weights to prevent sideways movement that results in measuring errors, or to make it easier to lower the device in a guide tube. You can thread several weights together. The weights are then attached directly to the FMX167. For FMX167 with outer diameter 29 mm (1.14 in), a maximum of 5 weights may be threaded onto the FMX167.
- Material: 1.4435 (AISI 316L SS)
- Weight: 300 g (0.7 lb)
- Order number: 52006153

TMT181 temperature head transmitter

- 2-wire temperature head transmitter, configured for a measuring range from -20 to +80°C (-4 to +176°F). This setting offers a temperature range of 100 K which can be easily mapped. Please note that the Pt100 resistance thermometer is designed for a temperature range from -10 to +70°C (14 to 158°F) → 22.
- Order number: 52008794

Waterpilot FMX167

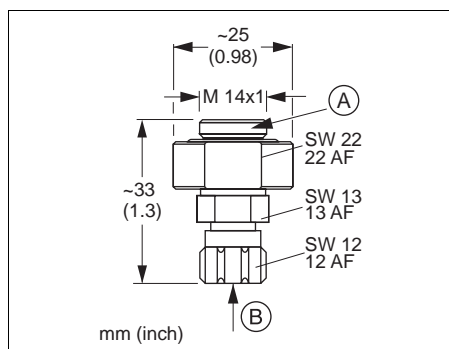
Extension cable mounting screw

- Endress+Hauser offers extension cable mounting screws to simplify the installation of the FMX167 and to close the measuring open → 16.
- Material: 1.4301 (AISI 304 SS)
- Order number for extension cable mounting screw with G 1 ½ A thread: 52008264
- Order number for extension cable mounting screw with 1 ½ NPT thread: 52009311

Terminals

- Four terminals in strip for FMX167 terminal box, suitable for wire cross-section of 0.08 to 2.5 mm² (20 to 14 AWG)
- Order number: 52008938

**Test adapter
(for FMX167 with an outer diameter of 22 mm/0.87" and 29 mm/1.14")**



Testing adapter

- A FMX167 level probe connection
- B Compressed air hose connection, internal diameter of quick coupling piece 4 mm

- Endress+Hauser offers a testing adapter to ease function-testing of the level probes.
- Observe the maximum pressure for the compressed air hose and the maximum overload for the level probe → 7.
- Maximum pressure of the quick coupling piece supplied: 10 bar (145 psi)
- Adapter material: 1.4301 (AISI 304 SS)
- Quick coupling piece material: anodized aluminum
- Adapter weight: 39 g (0.1 lb)
- Order number: 52011868

Additional documentation

Field of activities

- Pressure measurement: FA004P/00/EN
- Recording technology: FA014R/09/EN
- System components: FA016K/09/EN

Technical Information

- Technical Information Waterpilot FMX21 with 4 to 20 mA with HART output signal: TI431P/00/EN
- Technical Information Deltapilot M: TI437P/00/EN
- Temperature Head Transmitter iTEMP PCP TMT181: TI070R/09/EN

Operating Instructions

- Waterpilot FMX167: BA231P/00/EN

Safety instructions

- ATEX II 2 G Ex ia IIC T6: XA131P/00/A3
- ATEX II 3 G Ex nA II T6: XA132P/00/A3

Installation/Control Drawings

- FM IS Class I, Div. 1, Groups A – D: ZD063P/00/EN
- CSA IS Class I, Div. 1, Groups A – D: ZD064P/00/EN

Drinking water approval

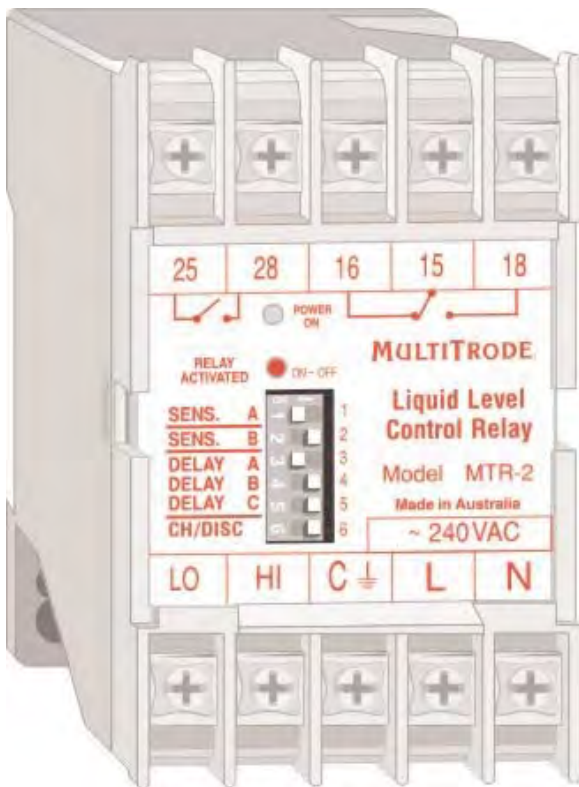
- SD126P/00/A3

12. Multitrode Level Relay



MULTITRODE LEVEL RELAY

1. MTR LEVEL RELAY TECHNICAL DETAILS
2. MTR WIRING DETAILS
3. MTR INSTALLATION & TROUBLESHOOTING DETAILS



Controls either one pump, alarm or solenoid.

The MultiTrode MTR is a latching conductive liquid level relay. When connected to a MultiTrode probe, the MTR controls the activation and de-activation of pumps, alarms and other monitoring and control equipment.

The relay senses the liquid via a safe extra-low voltage signal and latches. This state is maintained until the circuit is broken when the liquid passes the selected stop sensor. The relay then resets for the next operation. A single sensor may be used for alarms.

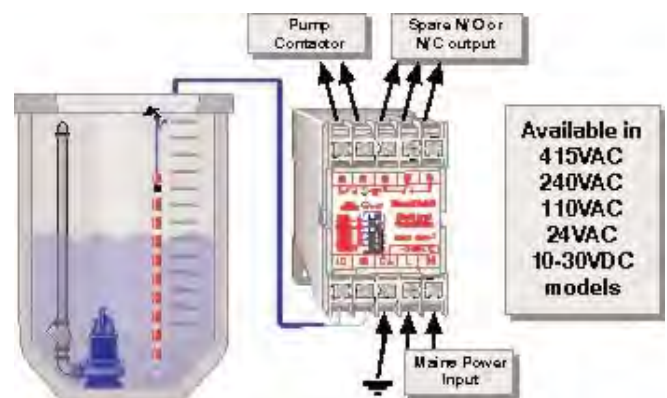
The MTR relay offers many features found in several discrete devices such as latching and time delay relays. Normally all of these devices must be installed individually. MultiTrode's MTR includes all of these features in one compact case, simplifying installation and reducing labour costs.

Use the MTR in any applications where level control is required, such as sumps, wells, bores, collection tanks, effluent pits, drainage ponds, pump stations, reservoirs, and sillage pits.

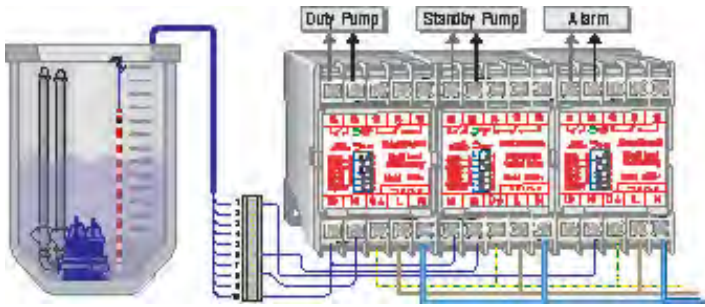
After many years of field use, the simplicity and reliability of these units is unquestionable.

- Safe, extra-low, sensing voltage: Ensures safety for operators and maintenance personnel .
- Charge or discharge: The modes of operation are selectable to either fill or empty a tank.
- Dip Switch Programmable: All settings are easily selected from the front panel. Fixed settings ensure repetition and accuracy.
- 4 Sensitivities: Enable the relay to operate effectively in a wide range of conductive liquids.
- 8 Activation Delays. Used for staggering multiple pump starts or to overcome premature activation due to wave action or turbulence.
- LED Indication. Power On (green) and Relay Activation (red) via high intensity LED indicators.
- Battery Operation. As well as 24, 110, 240 and 415VAC, the MTR Relay is also available in 10-30 VDC.
- Proven Reliability. The proven design of the relay ensures long-term reliability of the MultiTrode system.
- I.S. application Perfect for I.S. application when used with MTISB.
- DIN rail or screw mounting
- Low installed cost

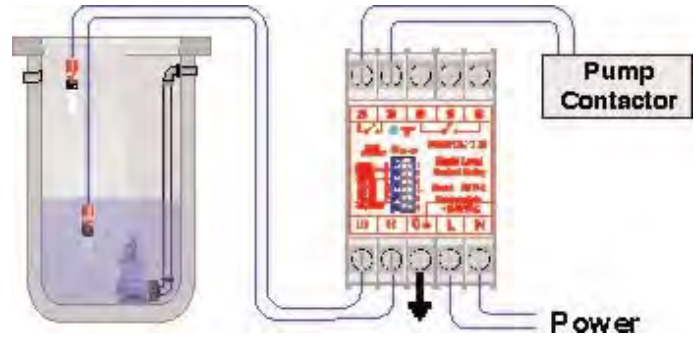
SAMPLE MTR APPLICATION



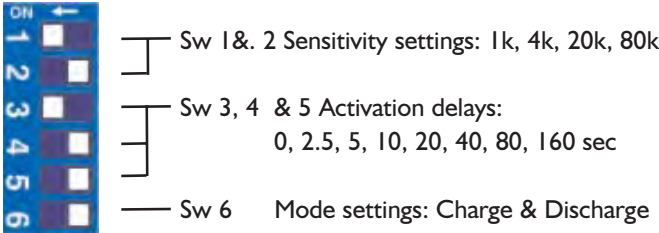
SAMPLE MTR APPLICATION



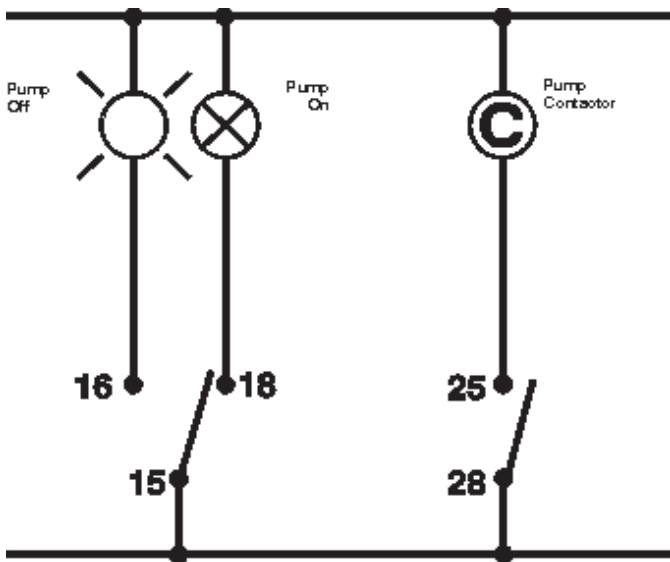
SAMPLE APPLICATION



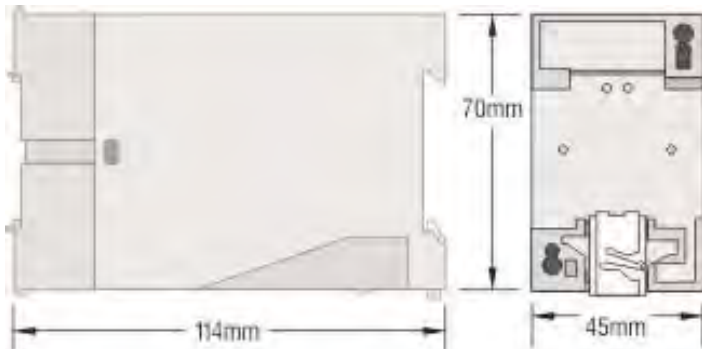
DIP SWITCH SETTINGS



WIRING DIAGRAM



PHYSICAL DIMENSIONS



PRODUCT SPECIFICATIONS

Mode of operation:

MTR Charge/Discharge (Fill or Empty)

Probe Inputs:

Sensor inputs MTR : 2 / MTRA : 3
 Sensor voltage 10/12VAC Nominal
 Sensor current 0.8mA max. (per sensor)
 Sensitivity 1k, 4k, 20k, 80k

Relay Outputs:

MTR relay output 2 contact sets : 1 N/O & 1 C/O
 MTR Output delay 0, 2.5, 5, 10, 20, 40, 80, 160 sec
 Relay contact rating 250 VAC
 5A Resistive, 2A Inductive
 Relay contact life 10⁶ Operations
 Terminal size 2 x 2.5mm², #13

Display LEDs:

MTR Power On Pump Alarm
 Green Red

Physical Product:

Dimensions (mm) 72H x 45W x 114D
 Mounting DIN Rail or 2 x M4 Screws #6
 Enclosure Makrolon (self extinguishing)

Power Supply:

Supply Voltage AC 24, 110, 240, 415VAC* - 50/60Hz
 Power Consumption 3.5 Watts max *(MTR only)
 Supply Voltage DC 12 or 24VDC,
 Power Consumption 3 watts max

Environmental Range:

Centigrade - 10° to +60°C
 Fahrenheit +14° to +140°F



AVAILABLE MODELS

415VAC	MTR1	n/a
240VAC	MTR2	MTRA2
110VAC	MTR3	MTRA3
24VAC	MTR4	MTRA4
24VDC	MTR5	MTRA5
12VDC	MTR6	MTRA6

Ordering Information & Example



This order code is for a 240VAC MTRA.

All MultiTrodE Products carry a two year warranty

MultiTrodE Pty Ltd Head Office
 130 Kingston Road, Underwood Qld 4119
 PO Box 2465, Logan City D.C. Qld 4114
 Ph:+61 7 3808 4011 Fax:+61 7 3808 0011
 sales@multitrode.com.au

Sydney - Australia
 Tel:+61 2 9774 2433
 Fax:+61 2 9774 2566

Melbourne - Australia
 Tel:+61 3 5978 6900
 Fax:+61 3 5978 6932

MultiTrodE Inc. - USA
 6560 East Rogers Circle,
 Boca Raton FL 33487
 Tel:+1 561 994 8090 Fax:+1 561 994 6282
 E-mail: sales@multitrode.net

MULTITRODE RELAY 240VAC (MTR 2) INSTALLATION SHEET. NO1

CONTROL OF THREE APPLIANCES IN A CHARGING SITUATION

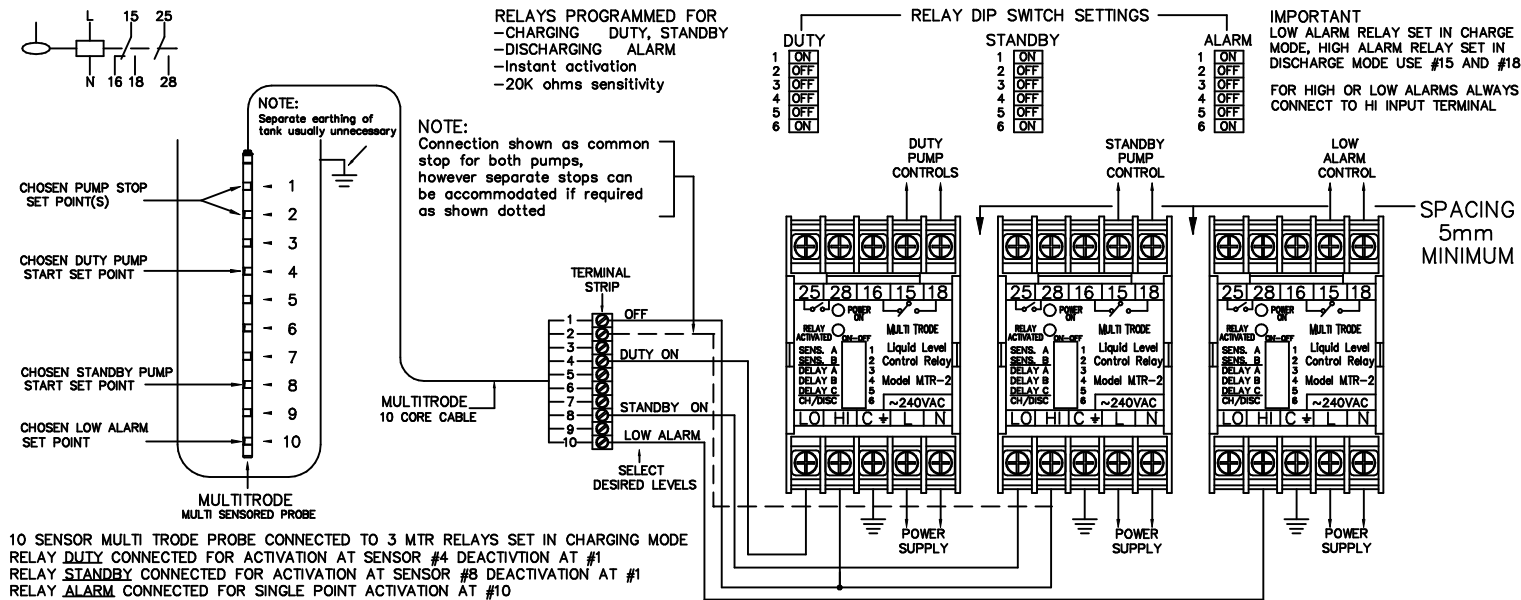
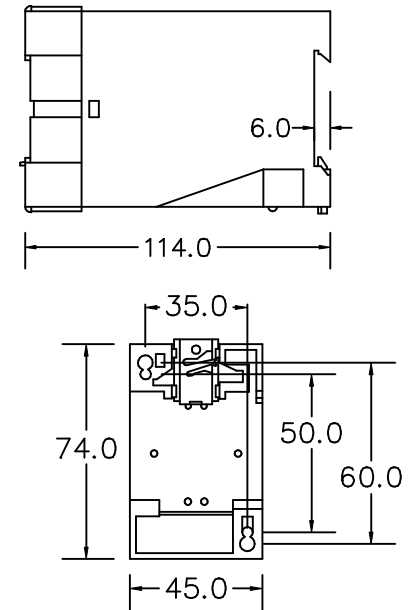


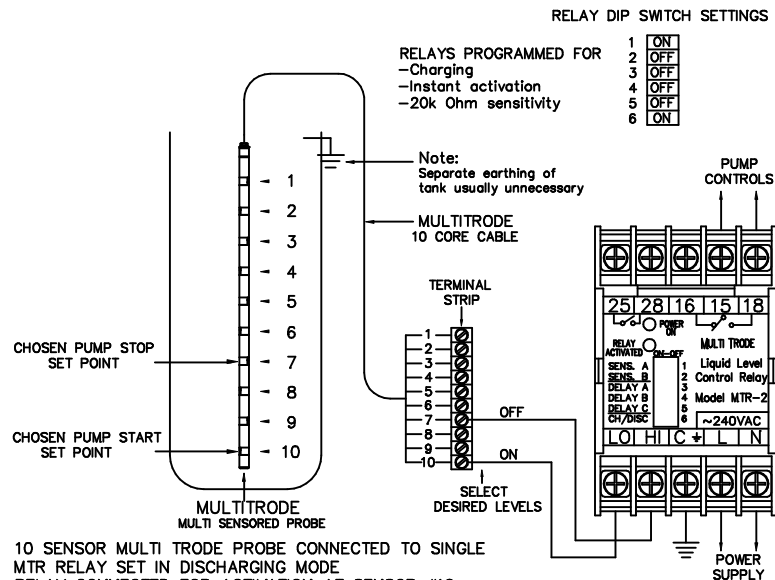
FIGURE-4

SWITCH NO		SENSITIVITY	
1	2		
OFF	OFF	1k Ω	Concentrated Acids, Minerals, Alkalines
OFF	ON	4k Ω	Acids, Alkalines, Diluted brine, Sea water
ON	OFF	20k Ω	Sullage, Sewage effluent Town water
ON	ON	80k Ω	Low conductive liquids, Purified water
3 4 5		DELAY ON ACTIVATION	
OFF	OFF	OFF	Zero Seconds
OFF	OFF	ON	2.5 Seconds
OFF	ON	OFF	5 Seconds
OFF	ON	ON	10 Seconds
ON	OFF	OFF	20 Seconds
ON	OFF	ON	40 Seconds
ON	ON	OFF	80 Seconds
ON	ON	ON	160 Seconds
6		MODE	
OFF		Discharge	
ON		Charge	

MTR DIMENSIONS IN mm.



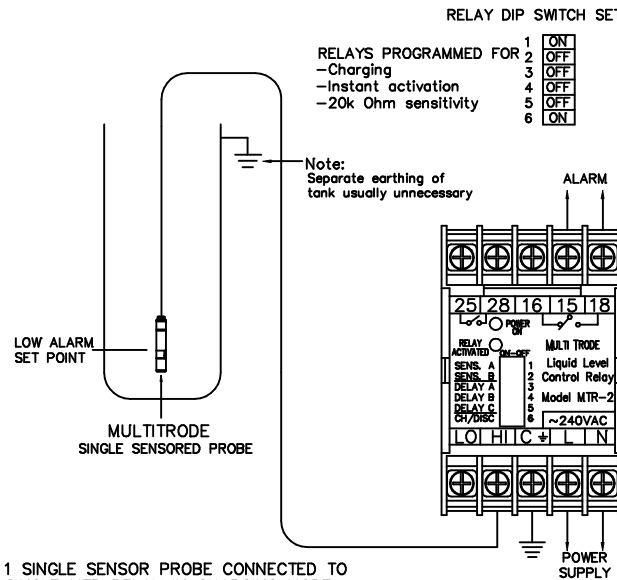
ON-OFF CONTROL IN A CHARGING SITUATION



10 SENSOR MULTI TRODE PROBE CONNECTED TO SINGLE MTR RELAY SET IN DISCHARGING MODE RELAY CONNECTED FOR ACTIVATION AT SENSOR #10 DEACTIVATED AT SENSOR #7

FIGURE-5

SINGLE POINT OPERATION IN A CHARGING SITUATION



1 SINGLE SENSOR PROBE CONNECTED TO SINGLE MTR RELAY IN CHARGING MODE ACTIVATION AND DEACTIVATION AT SAME POINT

FIGURE-6

PHONE (07) 808-4011 FOR INSTALLATION SHEET - INCLUDED WITH PRODUCT
 FAX (07) 808-0011 TITLE MTR - WIRING DIAGRAMS Pg.1 of 2
 DESIGNED BY REV.2.1 SCALE NO
 CHECKED BY DATE APRIL 2000
MULTITRODE DRAWN BY TRAVIS PARKINSON DRAWING # 9956
 Designed & Manufactured by MULTITRODE Pty. Ltd. BRISBANE, AUSTRALIA

MULTITRODE RELAY 240VAC (MTR 2) INSTALLATION SHEET. NO2

CONTROL OF THREE APPLIANCES IN A DISCHARGING SITUATION

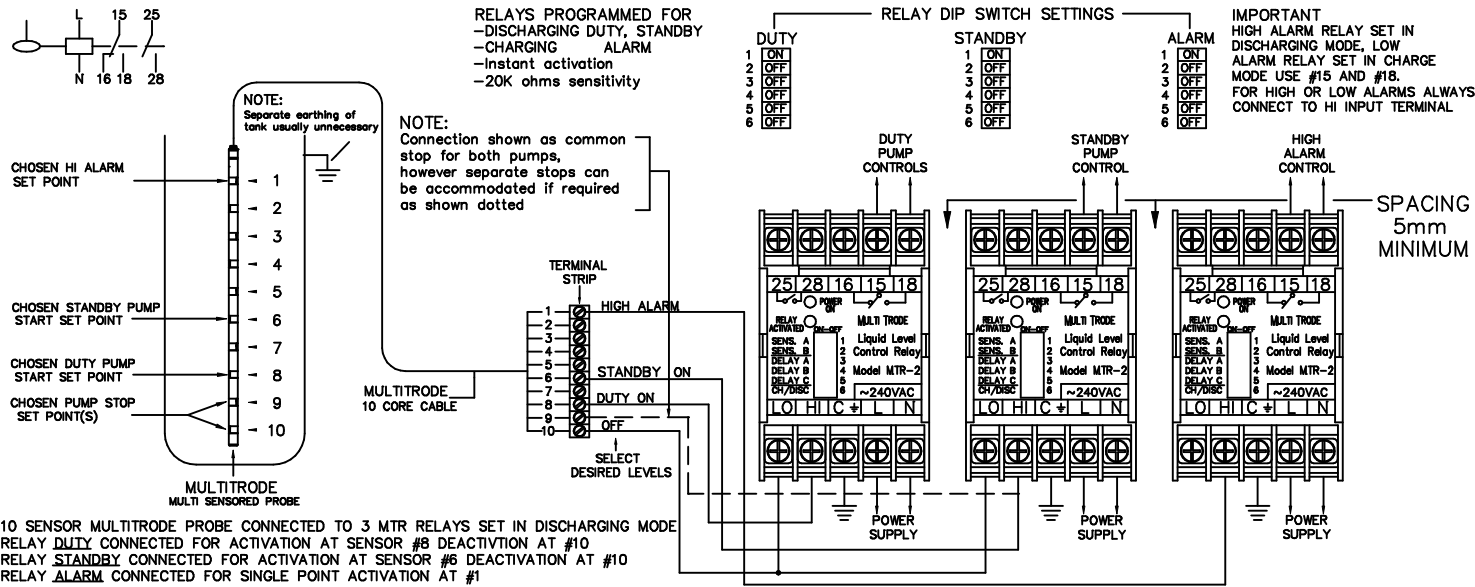


FIGURE-4

RELAY PROGRAM FUNCTIONS		
SWITCH NO	SETTING	SENSITIVITY
1	2	
OFF	OFF	1k Ω Concentrated Acids, Minerals, Alkalines
OFF	ON	4k Ω Acids, Alkalines, Diluted brine, Sea water
ON	OFF	20k Ω Sullage, Sewage effluent Town water
ON	ON	80k Ω Low conductive liquids, Purified water
3	4	5
OFF	OFF	OFF
OFF	OFF	OFF
OFF	ON	OFF
OFF	ON	ON
ON	OFF	OFF
ON	OFF	ON
ON	ON	OFF
ON	ON	ON
6	MODE	
OFF	Discharge	
ON	Charge	

SPECIFICATIONS	
SENSOR VOLTAGE	12VAC NOMINAL
NO OF OUTPUTS	2 SETS, 1 NO & 1 CHANGEOVER
CONTACT RATING	5 AMP 250VAC RESISTIVE
CONTACT LIFE	10 ⁵ OPERATIONS
SUPPLY VOLTAGE(+/-10%)	240, 110, 240VAC, 50/60Hz 24, 12VDC
POWER CONSUMPTION	3.4VA (MAX)
DIMENSIONS mm (inches)	H74(2.78) X W45(1.77) X D114(4.5)
TERMINAL SIZE mm (in)	2 X 2.5mm ² (0.64 ² INCH)
DISPLAY LEDS	GREEN - POWER ON RED - ACTIVATION
MOUNTING ARRANGEMENT	DIN RAIL OR 2X4mm SCREWS (3/16")
SENSITIVITY (OHMS)	SELECTABLE VIA SWITCHES 1K, 4K, 20K, 80K
MODE	SELECTABLE VIA SWITCHES CHARGE/DISCHARGE
DELAYS (SECS)	SELECTABLE VIA SWITCHES 2.5, 5, 10, 20, 40, 80, 160
WORKING TEMP C(F)	MINUS 10° C (+14° F) PLUS 60° C (140° F)

PHONE (07) 808-4011 FOR INSTALLATION SHEET - INCLUDED WITH PRODUCT
 FAX (07) 808-0011 TITLE MTR - WIRING DIAGRAMS Pg. 2 of 2
 DESIGNED BY REV. 2 SCALE NO
MULTITRODE CHECKED DATE JANUARY 1995
 DRAWN BY JAN PARKINSON DRAWING # 9957
 Designed & Manufactured by MULTITRODE Pty. Ltd. BRISBANE, AUSTRALIA

ON-OFF CONTROL IN A DISCHARGING SITUATION

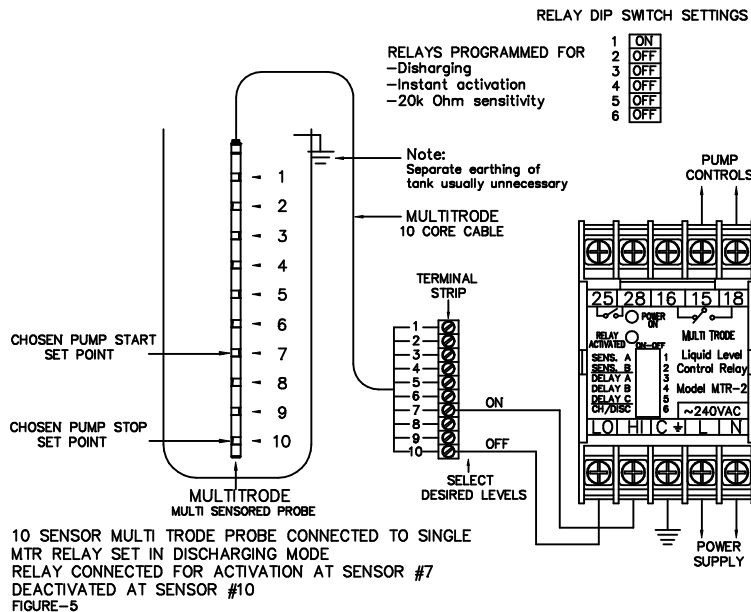


FIGURE-5

SINGLE POINT OPERATION FOR DISCHARGING

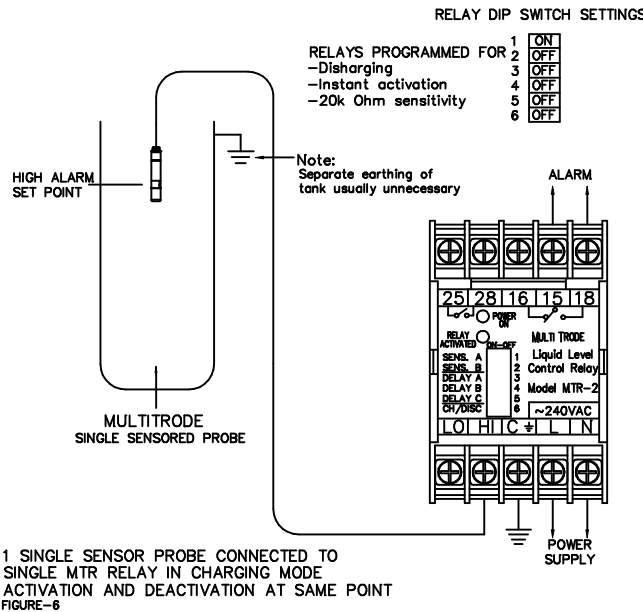


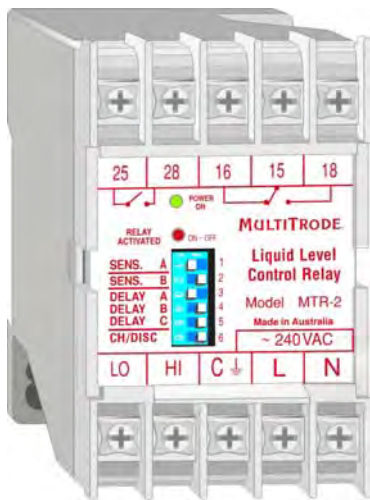
FIGURE-6

1 Introduction

The MultiTrobe level control relay is a solid-state electronic module in a hi-impact plastic case with a DIN rail attachment on the back, making a snap-on-snap-off installation. Any number of relays can be easily added to the DIN metal rail then wired together to form a complex pumping system that other wise may have to be controlled and operated by a programmed PLC.

The relay is normally matched with the MultiTrobe probe which works in conjunction with the relay and uses the conductivity of the liquid to complete an electrical circuit.

2 Electrical Overview



There are 10 screw terminals on the unit. Facing the relay as shown, we look at the bottom terminals (left to right):

- Lo – (Charge mode). This is the point when the probe is dry the relay will turn on.
- Lo – (Discharge mode). This is the point when the probe in the tank is dry the relay will turn off.
- Hi – (Charge mode). This is the point when the probe in the tank is wet a relay will turn off
- Hi – (Discharge mode). This is the point when the probe in the tank is wet a relay will turn on.
- C - is common earth. All earth bonding must be terminated here for correct operation.
- “ L “ is “live” (240V AC)
- “ N “ is “neutral” (240V AC)

If the tank is plastic, or if you are conducting tests in a plastic bucket, or the vessel has no earth point inside, you must install an earth rod within the tank, vessel or bucket and make sure that it is bonded back to C on the relay unit.

3 DIP Switches

3.1 DIP Switches

(See Wiring Diagram for full program functions.)

3.1.1 DIP 1 & 2

DIP 1 and 2 control the Sensitivity, in other words the cleaner the liquid the higher the sensitivity setting must be. Concentrated acids, minerals are by their own chemical composition highly conductive, so a low level of sensitivity is required, purified water is almost an insulator against electrical current flow so a higher sensitivity inside the relay is required.

3.1.2 DIP 3, 4 & 5

DIP switches 3, 4 and 5, control delay on activation. For example, in discharge mode with DIP switches 3, 4 and 5 set to 10 seconds, when the Hi point becomes wet it will activate the motor and it will take 10 seconds of continual coverage of the probe sensor to make the relay close and start the pump. This is invaluable when the probe is in a turbulent part of a well where fluid is splashing around touching the sensors momentarily, and false activation cannot be tolerated.

3.1.3 DIP 6

DIP switch 6 controls the charge/discharge function. Set “ON” for charge, and “OFF” for discharge

3.2 Relay Contacts & their Applications

3.2.1 Contacts 15, 16 & 18

Contacts 15, 16, and 18 are used for electronic or visual notification of a change in state at the pump itself. Contacts 15, 16, and 18 are used for more advanced applications because they are a changeover relay, their state may be the same as contacts 25, 28 or the opposite. Both sets of contactors are triggered simultaneously. An example is when in discharge mode, (see Figure 1).

You have a gravity flow coming in so the fluid reaches the lower sensor PB1, contacts 15 and 18 are open (15 being common to both contact 16 and 18) contacts 25 and 28 are also normally open but contacts 15 16 in this current situation are closed, whether PB1 is wet or dry is of no concern all will stay the same. The level now rises to PB2 and both relays change state, contacts 25 and 28 close to turn on the pump, contacts 15 and 16 are open, with 15 and 18 closed.

In advanced applications this state change may be fed into a logic device to indicate the pump is running or the pump has stopped and perhaps light an LED or incandescent light source for visual confirmation that a change has occurred in the relay.

3.2.2 Contacts 25 & 28

Contacts 25 and 28 are used to control pump states. Contacts 25 and 28 are mostly used for turning on motors via a starting relay or solenoid, so, these sets of contacts react to the rising or falling levels of the fluid inside the tank, they will operate to turn on a pump in discharge mode when the top sensor is wet and in charge mode turn on the pump when the bottom sensor is dry.

4 Practical Overview

4.1 Discharge Mode – DIP switch 6 set to “OFF”

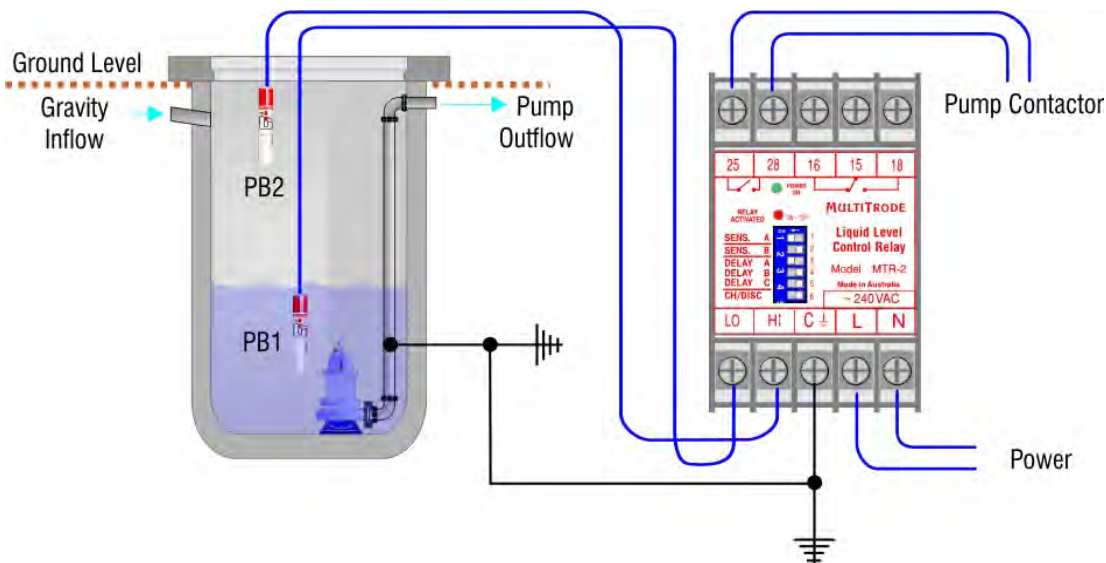
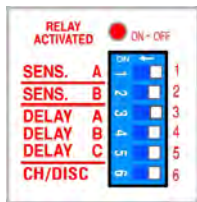


Figure 1 – Discharge Mode

Figure 1 shows two probes, (PB1 connected to Lo and PB2 connected to Hi). The pit is mostly underground and there is a gravity-fed inlet at the top left-hand side. The pit is empty with PB1 completely dry. Dipswitch 6 is set to “OFF.”



The relay operation depends on the electrical conductivity of liquid in the pit, i.e. no liquid = no current flow. The level starts to rise and covers PB1.

This is a discharge operation so we do not want the relay to close and start a pump until the well is full so as the water rises it reaches PB2, the relay closes and the pump starts. The level now drops below PB2 but the pump still continues to run, the level continues to drop below PB1 the relay opens the pump stops.

4.2 Charge Mode – DIP switch 6 set to “On”

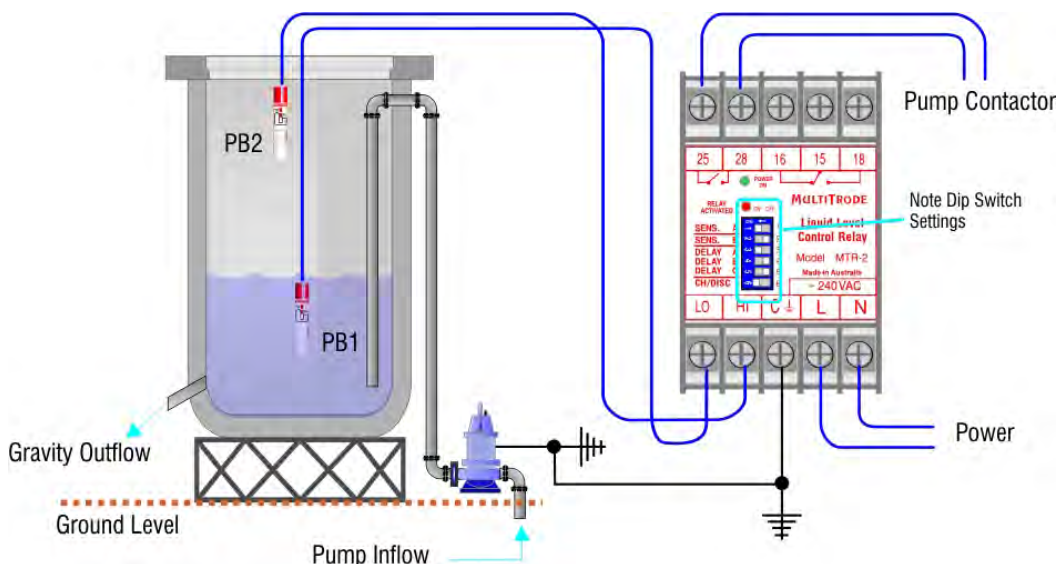
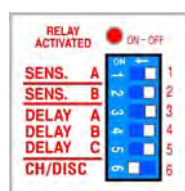


Figure 2 – Charge Mode



NOTE: “C” is connected to common bonded earth. The unit will not operate correctly if not earthed.

Let’s look at the same relay but in a tank that is charging (DIP 6 is now on). See Figure 3, where liquid is being pumped into a tank, and discharging through a gravity feed, the tank is on steel stands “x” metres above the ground.



With the tank full, PB1 and PB2 will be wet, the relay is off, and the pump has stopped. Water is slowly fed out from the bottom, and now as PB2 (HI) becomes dry nothing happens; the water now drops to below PB1 (Lo), and the pumps restarts to fill the tank.

The pump will continue to fill the tank until PB2 (HI), becomes wet again.

4.3 MTRA Relay with Alarm (Discharge Applications Only)

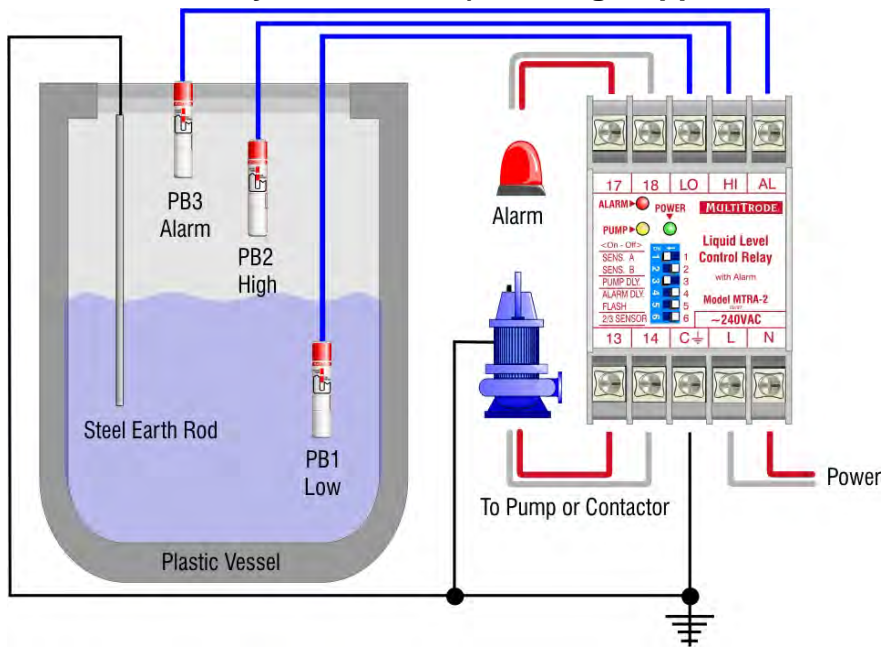


Figure 3 - MTRA Operation

The MTRA relay works in the same way as the MTR relay except the MTRA has a separate alarm output, and does not have a charge mode. The planned application is to close a contact to illuminate a warning alarm light. . Various other applications have included introducing a third probe to latch another relay.

In Figure 2 we see three probes in a pit that is plastic, note the steel rod in the tank. (In a plastic vessel a steel rod must be used to create an earth return in the liquid so probes can function.) PB1, PB2, and PB3 are dry, and the relay power LED is on. When water enters the pit and wets PB1, nothing happens, water now reaches PB2 causing contacts 13 and 14 to close, the pump LED to light, and the water to drop.

If, for example, the pump has its inlet partially blocked, the level continues to rise and wets PB3. This closes a separate relay that can activate a red flashing light, an audible fog horn or send a 5 volt pulse into another device with the common cause to warn human beings that a spill is due to occur. If the pumps become unclogged and PB3 becomes dry the alarm opens again and breaks the circuit that stops the light from flashing or the foghorn from sounding.

5 Most Common Installation Problems

The relay requires a path between the probes to earth through the liquid. If you are testing in a plastic bucket, have installed the probe in a plastic tank or have no good earthing in the vessel you will need to install a separate earth and make sure all earth bonding comes back to the C terminal. Most problems like these are traced back to a lack of or poor earthing, or open circuits in the probe wiring.

Now is the time to check the relay by using “the bridge testing line technique” remember you must simulate a fluid flow to correctly ascertain a good relay or a bad one. (All DIPswitch settings from 1 to 6 should be off.)

Cut two pieces of insulated flexible copper wire one black one red 250 mm long, strip both ends back 10 mm on both cables, and join one black end and one red end. Insert the joined ends into C on the relay box, observing all safe electrical practises. You should have one black wire and one red wire free.

Set your relay for discharge mode (DIP switch 6 is off) with no sensors connected to the unit, connect the red wire to Lo – nothing should happen (if it does return the relay for replacement or repair*). Now connect the black wire to the Hi terminal the relay activated LED should light instantly (if it does not, the relay should be returned for repair*).

6 Troubleshooting

<p>I have checked all the DIPswitches and settings but in discharge mode as soon as the bottom sensor gets wet the pump turns on then turns off almost straight away.</p>	<ul style="list-style-type: none"> This is the most common problem encountered with relay set up and commissioning, the probe in the bottom of the tank is wired into the Hi terminal instead of the Lo terminal.
<p>The installation went fine but now and again the pump will not turn on even though I am sure the probe is wet.</p>	<ul style="list-style-type: none"> Check the sensitivity level set on the relay, some times the level is set for foul water but due to changes in the flow the water becomes grey or clear, try changing the setting from 20KΩ to 80KΩ and monitor the results carefully.
<p>All wiring is complete and all DIPswitches have been checked but the pump will not turn on at all.</p>	<ul style="list-style-type: none"> If you have completed the test schedule for the relay and it passed then check the wiring to the sensors – for this is now where the problem lies or in the earthing arrangements. If possible check the resistance between the sensor cable and the steel sensor on the probe to prove a solid connection.

*** Please contact your distributor or agent before returning any product for repair or warranty claim.**



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Boca Raton Florida 33487

Tel: +1 561 994 8090
Fax: +1 561 994 6282

E-mail: USSales@multitrode.net

Visit www.multitrode.com for the latest information

13. Power Supply & Battery



Halmac Services (Qld) Pty. Ltd.
A.C.N. 098 852 923
A.B.N. 40 741 712 113

POWER SUPPLY & BATTERY

1. 24VDC POWER SUPPLY TECHNICAL DETAILS
2. 24VDC/13VDC CONVERTER TECHNICAL DETAILS
3. BATTERY TECHNICAL DETAILS

PB251 Series

220-330 WATTS DC UPS

Features

- Ultra-low noise output
- Independent battery charging output
- DC output OK & battery OK alarms & LEDs
- Battery-LVD and alarm
- Over-temperature protection
- Battery fuse fail LED



Specifications

INPUT

Voltage:	190 to 264 vac, or 190 to 400VDC
Line regulation:	0.2% typical
Current:	1.4A maximum
Inrush current:	10A maximum
Frequency:	45 to 65 Hz

OUTPUT

Voltage	See table
Current	See table
Load regulation	0.5% typical
Current limit type - load cct	Constant current
Current limit type - batt. cct	Constant current
Short circuit protection	Indefinite, auto-resetting
Over-voltage protection	17.5 to 20V latching (13.8Vdc output) 31.5 to 39V latching (27.6Vdc output)
Ripple & noise 100 MHz bandwidth	28mVp-p (13.8Vdc output) 55mVp-p (27.6Vdc output)

ENVIRONMENTAL

Operating temperature	0 to 70°C ambient with derating, 5...90% relative humidity (non-condensing)
Over-temperature protection	Automatic & auto-resetting
Cooling requirement	Natural convection
Efficiency	80% minimum

Selection Table

MODEL NUMBER	VDC	OUTPUT		OUTPUT POWER
		I _{LOAD}	I _{BATT}	
PB251-12CM	13.8V	16A	2A	220W
PB251-12CM-H	13.8V	20A	2A	275W
PB251-24CM	27.6V	11A	2A	300W
PB251-24CM-H	27.6V	12A	2A	330W
PB251-12RML	13.8V	20A	4A	275W
PB251-12B	13.8V	20A	4A	275W
PB251-24RML	27.6V	12A	2A	330W

Note: Non standard battery charging current available on request. ie PB251-12CM-H-10 for 10A.

STANDARDS & APPROVALS

Safety	Complies with AS/NZS 60950, class 1, NSW Office of Fair Trading Approval N20602
EMC	Emissions comply with AS/NZS CISPR11, Group 1, Class B. Complies with ACA EMC Scheme, Safety & EMC Regulatory Compliance Marked
Isolation i/p-o/p i/p-ground o/p-ground	4242VDC for 1 minute 2121VDC for 1 minute 707VDC for 1 minute

ALARMS & BATTERY FUNCTIONS

Converter ON/OK alarm	Indicated by voltage-free changeover relay contacts &
green LED	ON=PSU OK
Battery low (& fuse) alarm	10.2 to 12.6V for 12V battery, adjustable 20.4 to 25.2V for 24V battery, adjustable Indicated by voltage-free changeover relay contacts & green LED: ON=BATT OK
Low voltage disconnect	9.6 to 12V for 12V battery, adjustable 19.2 to 24V for 24V battery, adjustable
Charger over-load protection	Auto-resetting electronic circuit breaker
Reverse polarity protection	Internal battery fuse
Battery to load voltage drop	0.2 to 0.25V typical

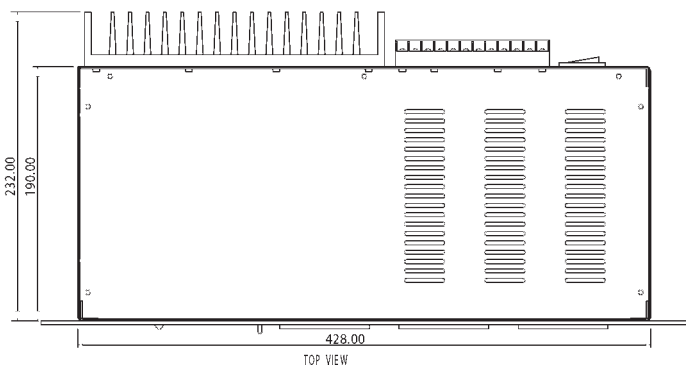
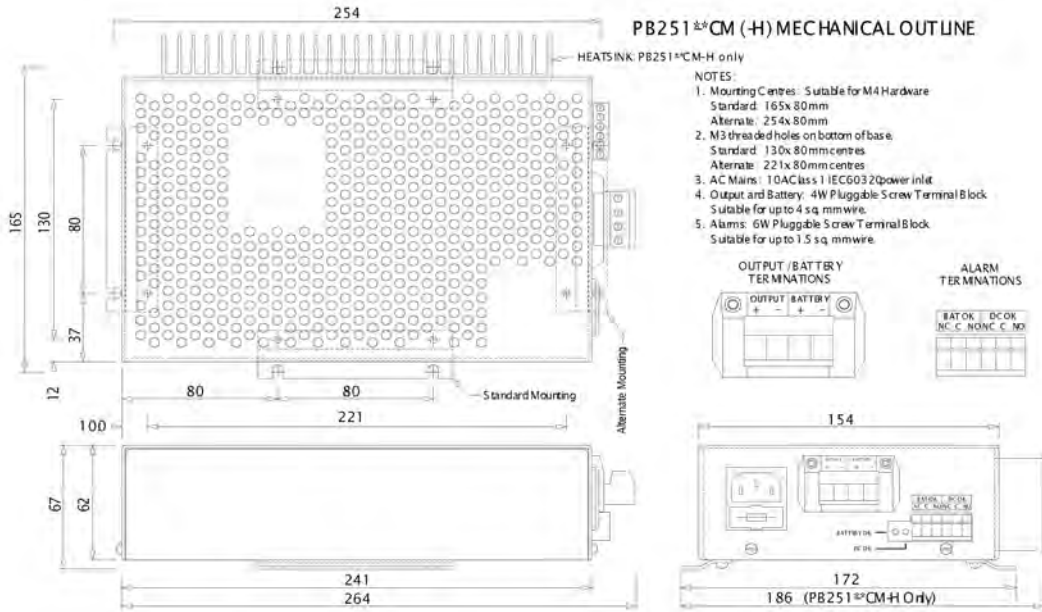
MECHANICAL

Case size	264 L x 172 W x 67 H mm
Case size with heatsink	264 L x 186 W x 67 H mm
Rack size	232 D x 19" W x 2RU H
Weight	1.9 kg
Weight with heatsink	2.1 kg
Weight (rack mounted version)	5.5 kg

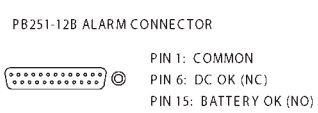
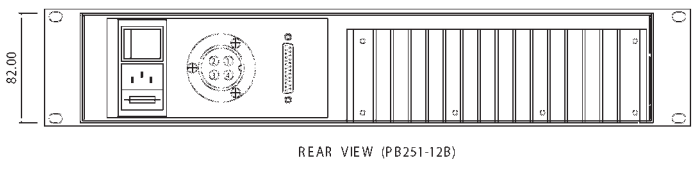
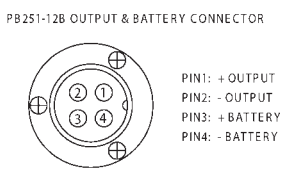
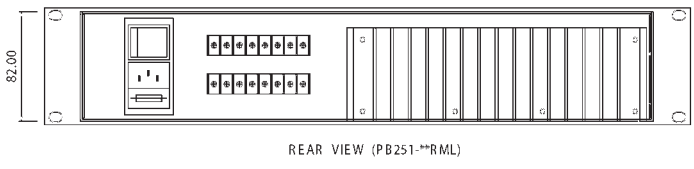
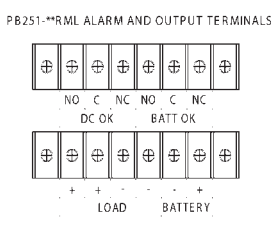
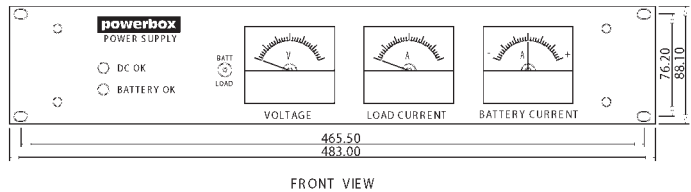
PB251 Series

275-330 WATTS DC UPS

Technical Illustrations



- NOTES:
1. 2RU x 19" rack enclosure per IEC 297
 2. Mounting slots are suitable for M6 hardware.
 3. Input connector is a 10A Class 1 IEC 60320 inlet.
 4. 2 meter IEC mains cord with Australian plug is supplied with unit.
 5. PB251-12B alarm terminal is DB25 female.
 6. PB251-12B output and battery connector is Hirose pn. HS 28R-4A. Mating connector is Hirose pn. HS 28P-4A (not supplied).
 7. PB251-**RML alarm and output terminals are M3.5 screws suitable for ring or fork lugs up to 8 mm wide.



PBIH Series

15-150 WATTS DC/DC SINGLE OUTPUT

Features

- Wide selection of models
- 4 input voltage ranges
- High efficiency
- Low output ripple
- Proven reliability
- Good thermal margins



Specifications

INPUT

Input voltage	12VDC (9.2–16) 24VDC (19–32) 48VDC (38–63) 110VDC (85–140)
Inrush current	20A max. for 110V only

OUTPUT

Output voltage	See table
Voltage adjustment	±10%, ±5% for PBIH-F
Output current	See table
Ripple & noise	Output Volts x 1% + 50mV to -100mV pk-pk
Line regulation	0.8% over input range
Load regulation	0.9%, 0%–100% load
Temperature coefficient	0°C to 50°C, 0.03% per °C
Overvoltage protection	O.V. clamp, PBIH-F Output shutdown, PBIH-G, J, M, R – input must be switched off for at least 30S to reactivate
Overcurrent protection	Fold back – PBIH-F Current limiting, PBIH-G, J, M, R (PBIH-R series is adjustable); PBIH110xxR models are not adjustable
Drift	Output V x 0.5% + 15(mV) per 8 hrs after 1 hr warm-up
Rise Time	200mS max. – PBIH-F, M, R 100mS max. – PBIH-G, J (at 25°C)
Holdup time	10mS (only 110V input)
Remote sense	PBIH-R Series only

OPERATING

Efficiency	70%–89%
Safety isolation (1 minute)	Type – 12, 24, 48V input Input – Output: 1500VAC Input– Case: 1500VAC Output– Case: 500VAC Type– 110V input Input– Output: 2000VAC Input– Case: 2000VAC Output– Case: 500VAC
Insulation resistance	50M (500VDC) Input – Case
Parallel operation	Consult sales office for details
Remote control	PBIH-R Series: Open link: output normal Short link: output off

ENVIRONMENTAL

Operating temperature	0°C to 50°C full load
Cooling	Convection cooled
Storage temperature	-20°C to +85°C
Humidity	85%
Shock	30G, PBIH-F, G and J
Vibration	(5Hz–10Hz, 10mm), (10Hz–50Hz) 2G, PBIH-F, G and J

STANDARDS AND APPROVALS

Safety	Designed to UL1950
C-tick	AS/NZS CISPR11 Group 1, Class A

MECHANICAL

Weight	PBIH-F : 250g PBIH-G : 380g PBIH-J : 410g PBIH-M : 800g PBIH-R : 1.4kg
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PBIH Series

15-150 WATTS DC/DC SINGLE OUTPUT

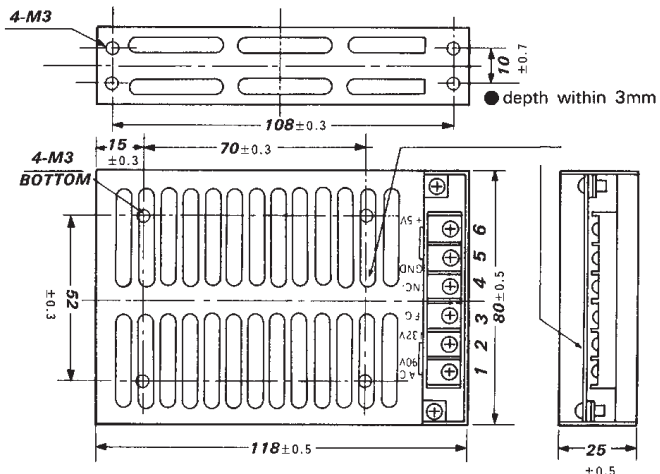
Selection Table

MODEL NUMBER	INPUT	OUTPUT	OUTPUT POWER
PBIH-1205F	9.2-16V	5V 3A	15W
PBIH-1212F	9.2-16V	12V 1.2A	15W
PBIH-1215F	9.2-16V	15V 1A	15W
PBIH-1224F	9.2-16V	24V 0.62A	15W
PBIH-2405F	19-32V	5V 3A	15W
PBIH-2412F	19-32V	12V 1.2A	15W
PBIH-2415F	19-32V	15V 1A	15W
PBIH-2424F	19-32V	24V 0.62A	15W
PBIH-4805F	38-63V	5V 3A	15W
PBIH-4812F	38-63V	12V 1.2A	15W
PBIH-4815F	38-63V	15V 1A	15W
PBIH-4824F	38-63V	24V 0.62A	15W
PBIH-11005F	85-140V	5V 3A	15W
PBIH-11012F	85-140V	12V 1.2A	15W
PBIH-11015F	85-140V	15V 1A	15W
PBIH-11024F	85-140V	24V 0.62A	15W
PBIH-1205G	9.2-16V	5V 5A	25W
PBIH-1212G	9.2-16V	12V 2.1A	25W
PBIH-1215G	9.2-16V	15V 1.7A	25W
PBIH-1224G	9.2-16V	24V 1.1A	25W
PBIH-1248G	9.2-16V	48V 0.5A	25W
PBIH-2405G	19-32V	5V 5A	25W
PBIH-2412G	19-32V	12V 2.1A	25W
PBIH-2415G	19-32V	15V 1.7A	25W
PBIH-2424G	19-32V	24V 1.1A	25W
PBIH-2448G	19-32V	48V 0.5A	25W
PBIH-4805G	38-63V	5V 5A	25W
PBIH-4812G	38-63V	12V 2.1A	25W
PBIH-4815G	38-63V	15V 1.7A	25W
PBIH-4824G	38-63V	24V 1.1A	25W
PBIH-4848G	38-63V	48V 0.5A	25W
PBIH-11005G	85-140V	5V 5A	25W

MODEL NUMBER	INPUT	OUTPUT	OUTPUT POWER
PBIH-11012G	85-140V	12V 2.1A	25W
PBIH-11015G	85-140V	15V 1.7A	25W
PBIH-11024G	85-140V	24V 1.1A	25W
PBIH-11048G	85-140V	48V 0.5A	25W
PBIH-1205J	9.2-16V	5V 8A	50W
PBIH-1212J	9.2-16V	12V 3.3A	50W
PBIH-1215J	9.2-16V	15V 2.7A	50W
PBIH-1224J	9.2-16V	24V 1.7A	50W
PBIH-1248J	9.2-16V	48V 0.8A	50W
PBIH-2405J	19-32V	5V 10A	50W
PBIH-2412J	19-32V	12V 4.3A	50W
PBIH-2415J	19-32V	15V 3.4A	50W
PBIH-2424J	19-32V	24V 2.5A	50W
PBIH-2448J	19-32V	48V 1A	50W
PBIH-4805J	38-63V	5V 10A	50W
PBIH-4812J	38-63V	12V 4.3A	50W
PBIH-4815J	38-63V	15V 3.4A	50W
PBIH-4824J	38-63V	24V 2.5A	50W
PBIH-4848J	38-63V	48V 1A	50W
PBIH-11005J	85-140V	5V 10A	50W
PBIH-11012J	85-140V	12V 4.3A	50W
PBIH-11015J	85-140V	15V 3.4A	50W
PBIH-11024J	85-140V	24V 2.5A	50W
PBIH-11048J	85-140V	48V 1A	50W
PBIH-1205M	9.2-16V	5V 18A	100W
PBIH-1212M	9.2-16V	12V 9A	100W
PBIH-1215M	9.2-16V	15V 7A	100W
PBIH-1224M	9.2-16V	24V 4.5A	100W
PBIH-1248M	9.2-16V	48V 2A	100W
PBIH-2405M	19-32V	5V 20A	100W
PBIH-2412M	19-32V	12V 9A	100W
PBIH-2415M	19-32V	15V 7A	100W

MODEL NUMBER	INPUT	OUTPUT	OUTPUT POWER
PBIH-2424M	19-32V	24V 5A	100W
PBIH-2448M	19-32V	48V 2A	100W
PBIH-4805M	38-63V	5V 20A	100W
PBIH-4812M	38-63V	12V 9A	100W
PBIH-4815M	38-63V	15V 7A	100W
PBIH-4824M	38-63V	24V 5A	100W
PBIH-4848M	38-63V	48V 2A	100W
PBIH-11005M	85-140V	5V 20A	100W
PBIH-11012M	85-140V	12V 9A	100W
PBIH-11015M	85-140V	15V 7A	100W
PBIH-11024M	85-140V	24V 5A	100W
PBIH-11048M	85-140V	48V 2A	100W
PBIH-1205R	9.2-16V	5V 27A	150W
PBIH-1212R	9.2-16V	12V 13A	150W
PBIH-1215R	9.2-16V	15V 10A	150W
PBIH-1224R	9.2-16V	24V 6.5A	150W
PBIH-1248R	9.2-16V	48V 3.3A	150W
PBIH-2405R	19-32V	5V 30A	150W
PBIH-2412R	19-32V	12V 14A	150W
PBIH-2415R	19-32V	15V 11A	150W
PBIH-2424R	19-32V	24V 7A	150W
PBIH-2448R	19-32V	48V 3.5A	150W
PBIH-4805R	38-63V	5V 30A	150W
PBIH-4812R	38-63V	12V 14A	150W
PBIH-4815R	38-63V	15V 11A	150W
PBIH-4824R	38-63V	24V 7A	150W
PBIH-4848R	38-63V	48V 3.5A	150W
PBIH-11005R	85-140V	5V 30A	150W
PBIH-11012R	85-140V	12V 14A	150W
PBIH-11015R	85-140V	15V 11A	150W
PBIH-11024R	85-140V	24V 7A	150W
PBIH-11048R	85-140V	48V 3.5A	150W

PBIH-F



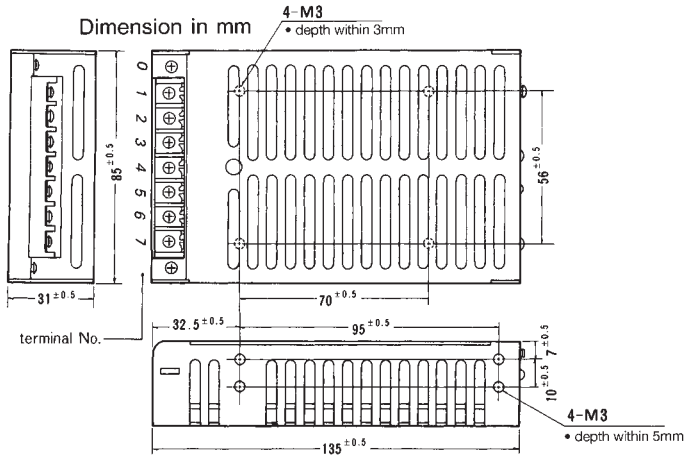
• Dimensions in mm

terminal No.	
1	0 V (DC in)
2	+V (DC in)
3	FG
4	NO Connection
5	-V out
6	+V out

PBIH Series

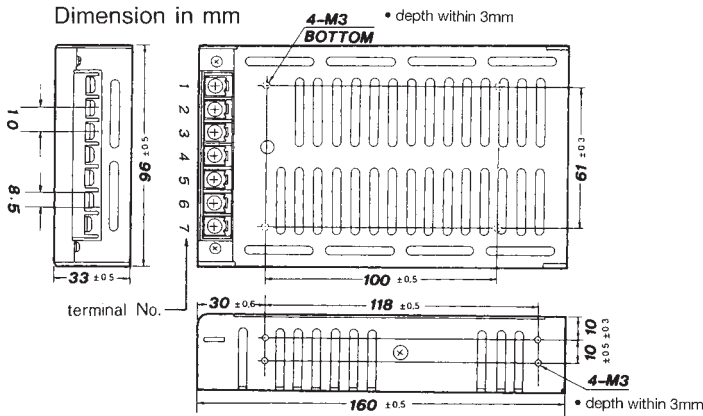
15-150 WATTS SINGLE OUTPUT

PBIH-G



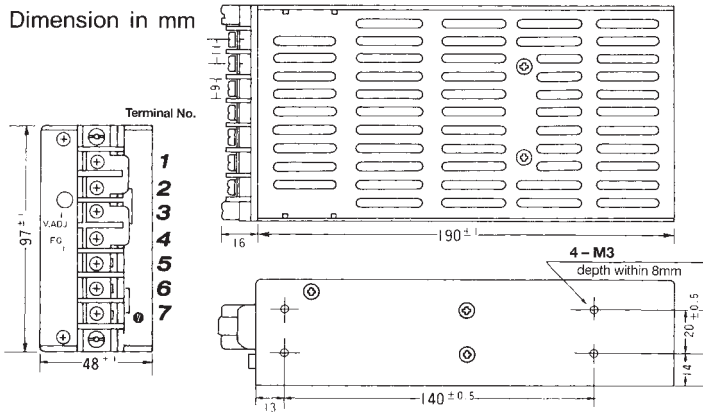
Terminal	Connection
0	FG
1	DC +V in
2	0V in
3	LFG
4	NO
5	NO
6	-V out
7	+V out

PBIH-J



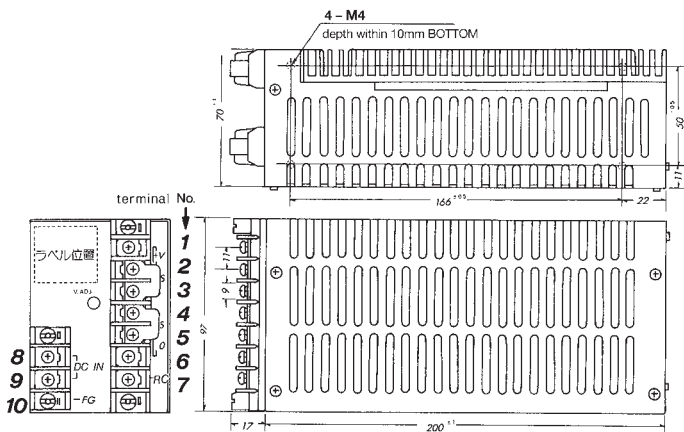
Terminal	Connection
1	FG
2	DC +V in
3	0V in
4	LFG
5	-V out
6	+V out
7	NC

PBIH-M



Terminal	Connection
1	+V out
2	+V out
3	-V out
4	-V out
5	FG
6	-V in
7	+V in

PBIH-R

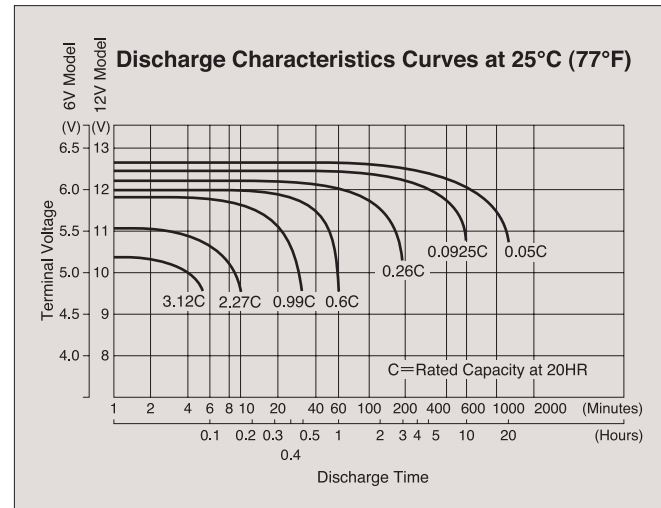


Terminal	Connection
1, 2	+V out
3	+S
4	-S
5, 6	-V out
7	Remote Control
8	DC +V in
9	DC 0V in
10	FG

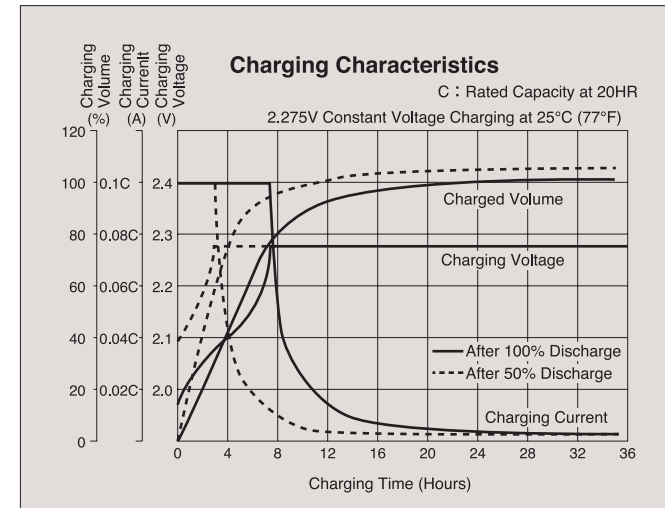


General Characteristics

DISCHARGE CHARACTERISTICS



CHARGING CHARACTERISTICS



“Yuasa” Brand Maintenance-Free Valve Regulated Lead-Acid Stationary Batteries

UXH SERIES



Peripheral Device

A life diagnosis device for valve regulated lead-acid batteries, “JUST FEEL” .
The battery monitor, JUST FEEL, diagnoses life of valve regulated lead-acid batteries.
Battery life can be diagnosed without disconnecting a power supply as a result of measuring battery internal impedance during floating charge.

- Diagnoses battery life during floating charge.
- A compact, portable device.
- Can be used for a large variety of valve regulated lead-acid batteries.
- Mounted with comparator function.
- May be used for UPS batteries. (Some models may prohibit the use of this device. If you intend to use the device for UPS, please contact us for consultation.)



● Specifications subject to change without prior notice

Distributed by:
GS Yuasa International Ltd.
 1-8-1, Nishi-Shimbashi, Minato-ku
 Tokyo 105-0003
 Japan
 Tel +81-3-3597-2403
 Fax +81-3-3597-2405

UXH SERIES

The latest in YUASA's state-of-the-art technology has brought about a new UXH series capable of yielding even greater capacity than comparable batteries.

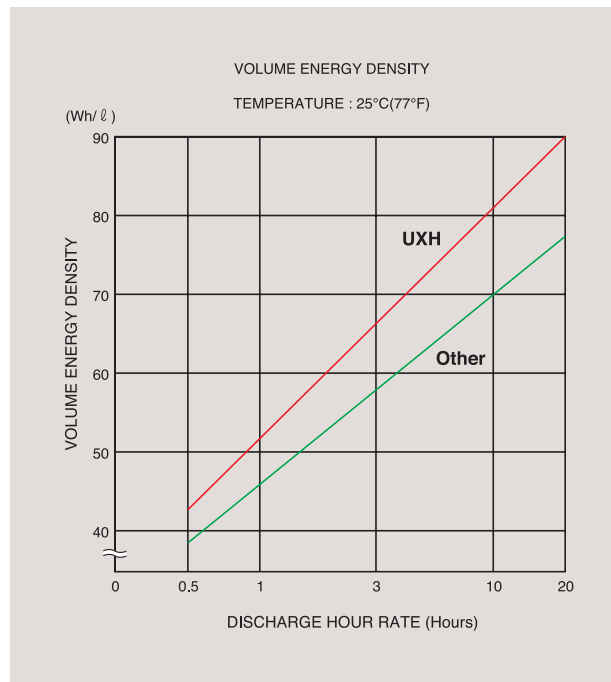
YUASA UXH batteries are designed with unique valve regulating devices and acid free constructions, ensuring safety and suitability to the contemporary business environment.

Designed Life

10 years

Features

- Up to 15% more capacity
- Maintenance-free
- Higher energy efficiency
- Negligible gas emissions
- Valve regulated
- Systems compatible
- Fitted with explosion proof filter (Except UXH100-12N and UXH200-6N)
- No equalizing charge required
- (Option) Flame retardant version available
- No free Acid (Non-spillable Battery)



Float charge voltage: 2.275V per cell
Permissible operating temperature: -15~45°C
Container material: ABS
Terminal: L terminal

Applications

- UPS
- Telecommunications
- Alarm systems
- Fire & security systems
- Emergency lighting
- Engine starting
- Solar powered systems
- Utilities
- Rail

General Specifications

Battery Model	Nominal Voltage(V)	20HR Rated Capacity(Ah) *1	Internal Resistance(mΩ) *2	Approx. Dimensions, mm(inch)				Approx. Weight kg(lbs.)	Explosion Proof Filter
				Length	Width	Height	Overall Height		
UXH38-12	12	38	7.0	235 (9.3)	128 (5.0)	190 (7.5)	217 (8.5)	17 (37)	○
UXH50-12	12	50	6.0	299 (11.8)	128 (5.0)	190 (7.5)	217 (8.5)	21 (46)	○
UXH63-12	12	63	5.0	363 (14.3)	128 (5.0)	190 (7.5)	217 (8.5)	25 (55)	○
UXH75-6	6	75	2.2	217 (8.5)	128 (5.0)	190 (7.5)	217 (8.5)	16 (35)	○
UXH100-6	6	100	1.8	281 (11.1)	128 (5.0)	190 (7.5)	217 (8.5)	20 (44)	○
UXH125-6	6	125	1.5	345 (13.6)	128 (5.0)	190 (7.5)	217 (8.5)	24 (53)	○
UXH100-12N	12	100	4.0	407 (16.0)	172.5 (6.8)	210 (8.3)	240 (9.4)	39 (86)	×
UXH200-6N	6	200	1.3	398 (15.6)	176 (6.9)	216 (8.5)	250 (9.8)	39 (86)	×

*1 Final Voltage: 1.80V/cell, Temperature: 25°C(77°F)
*2 In a fully charged state and measured through a 1000Hz AC bridge.

Performance Data at 25°C(77°F)

(Amperes and Watts per cell)
Amperes to F.V. 1.60 Volts Per Cell

Battery Model	Time	1 min	5 min	10 min	15 min	20 min	25 min	30 min	35 min	40 min	45 min	1 h
		A	W	A	W	A	W	A	W	A	W	A
UXH38-12	A	141.0	119.0	86.3	63.5	50.9	42.6	37.6	33.4	30.8	28.0	22.8
	W	229.0	199.0	154.0	116.0	94.2	79.4	71.1	63.5	58.5	53.6	43.7
UXH50-12	A	185.0	156.0	114.0	83.5	67.0	56.0	49.5	44.0	40.5	37.0	30.0
	W	302.0	262.0	203.0	153.0	124.0	105.0	93.5	83.5	77.0	70.5	57.5
UXH63-12	A	233.0	197.0	143.0	105.0	84.4	70.6	62.4	55.4	51.0	46.6	37.8
	W	380.0	330.0	255.0	193.0	156.0	132.0	118.0	105.0	97.0	88.8	72.5
UXH75-6	A	278.0	234.0	170.0	125.0	101.0	84.0	74.3	66.0	60.8	55.5	45.0
	W	452.0	393.0	304.0	230.0	186.0	157.0	140.0	125.0	116.0	106.0	86.3
UXH100-6	A	370.0	312.0	227.0	167.0	134.0	112.0	99.0	88.0	81.0	74.0	60.0
	W	603.0	524.0	405.0	306.0	248.0	209.0	187.0	167.0	154.0	141.0	115.0
UXH125-6	A	463.0	390.0	284.0	209.0	168.0	140.0	124.0	110.0	101.0	92.5	75.0
	W	754.0	655.0	506.0	383.0	310.0	261.0	234.0	209.0	193.0	176.0	144.0
UXH100-12N	A	370.0	312.0	227.0	167.0	134.0	112.0	99.0	88.0	81.0	74.0	60.0
	W	603.0	524.0	405.0	306.0	248.0	209.0	187.0	167.0	154.0	141.0	115.0
UXH200-6	A	740.0	624.0	452.0	334.0	268.0	224.0	198.0	176.0	162.0	148.0	120.0
	W	1204.0	1048.0	808.0	612.0	496.0	416.0	374.0	334.0	308.0	282.0	230.0

Amperes to F.V. 1.70 Volts Per Cell

Battery Model	Time	1 min	5 min	10 min	15 min	20 min	25 min	30 min	35 min	40 min	45 min	1 h	2 h	3 h
		A	W	A	W	A	W	A	W	A	W	A	W	A
UXH38-12	A	123.0	106.0	73.7	57.4	47.9	41.4	36.5	32.3	29.3	27.0	22.0	13.7	9.9
	W	211.0	186.0	133.0	106.0	88.9	77.9	69.2	61.6	55.9	51.7	42.6	26.6	19.4
UXH50-12	A	162.0	139.0	97.0	75.5	63.0	54.5	48.0	42.5	38.5	35.5	29.0	18.0	13.0
	W	277.0	245.0	176.0	139.0	117.0	103.0	91.0	81.0	73.5	68.0	56.0	35.0	25.5
UXH63-12	A	204.0	175.0	122.0	95.1	79.4	68.7	60.5	53.6	48.5	44.7	36.5	22.7	16.4
	W	349.0	308.0	221.0	175.0	147.0	129.0	115.0	102.0	92.6	85.7	70.6	44.1	32.1
UXH75-6	A	243.0	209.0	146.0	113.0	94.5	81.8	72.0	63.8	57.8	53.3	43.5	27.0	19.5
	W	416.0	367.0	263.0	209.0	176.0	154.0	137.0	122.0	110.0	102.0	84.0	52.5	38.3
UXH100-6	A	324.0	278.0	194.0	151.0	126.0	109.0	96.0	85.0	77.0	71.0	58.0	36.0	26.0
	W	554.0	489.0	351.0	278.0	234.0	205.0	182.0	162.0	147.0	136.0	112.0	70.0	51.0
UXH125-6	A	405.0	348.0	243.0	189.0	158.0	136.0	120.0	106.0	96.3	88.8	72.5	45.0	32.5
	W	693.0	611.0	439.0	348.0	293.0	256.0	228.0	203.0	184.0	170.0	140.0	87.5	63.8
UXH100-12N	A	324.0	278.0	194.0	151.0	126.0	109.0	96.0	85.0	77.0	71.0	58.0	36.0	26.0
	W	554.0	489.0	351.0	278.0	234.0	205.0	182.0	162.0	147.0	136.0	112.0	70.0	51.0
UXH200-6	A	648.0	556.0	388.0	302.0	252.0	218.0	192.0	170.0	154.0	142.0	116.0	72.0	52.0
	W	1106.0	976.0	700.0	556.0	468.0	408.0	364.0	324.0	294.0	272.0	224.0	140.0	102.0

Amperes to F.V. 1.80 Volts Per Cell

Battery Model	Time	1 min	5 min	10 min	15 min	20 min	25 min	30 min	35 min	40 min	45 min	1 h	2 h	3 h	5 h	8 h	10 h	20 h
		A	W	A	W	A	W	A	W	A	W	A	W	A	W	A	W	A
UXH38-12	A	99.2	86.3	63.8	52.8	44.8	38.8	35.0	31.2	28.1	26.2	21.3	12.9	9.5	6.1	4.2	3.5	1.90
	W	179.0	157.0	118.0	99.2	84.7	73.7	66.9	59.7	54.3	50.5	41.4	25.1	18.6	12.2	8.4	6.8	3.80
UXH50-12	A	131.0	114.0	84.0	69.5	59.0	51.0	46.0	41.0	37.0	34.5	28.0	17.0	12.5	8.0	5.5	4.6	2.50
	W	236.0	207.0	156.0	131.0	112.0	97.0	88.0	78.5	71.5	66.5	54.5	33.0	24.5	16.0	11.0	9.0	5.00
UXH63-12	A	164.0	143.0	106.0	87.6	74.3	64.3	58.0	51.7	46.6	43.5	35.3	21.4	15.8	10.1	6.9	5.8	3.15
	W	297.0	260.0	196.0	164.0	140.0	122.0	111.0	98.9	90.1	83.8	68.7	41.6	30.9	20.2	13.9	11.3	6.30
UXH75-6	A	196.0	170.0	126.0	104.0	88.5	76.5	69.0	61.5	55.5	51.8	42.0	25.5	18.8	12.0	8.3	6.9	3.75
	W	353.0	310.0	233.0	196.0	167.0	146.0	132.0	118.0	107.0	99.8	81.8	49.5	36.8	24.0	16.5	13.5	7.50
UXH100-6	A	261.0	227.0	168.0	139.0	118.0	102.0	92.0	82.0	74.0	69.0	56.0	34.0	25.0	16.0	11.0	9.3	5.00
	W	471.0	413.0	311.0	261.0	223.0	194.0	176.0	157.0	143.0	133.0	109.0	66.0	49.0	32.0	22.0	18.0	10.00
UXH125-6	A	326.0	284.0	210.0	174.0	148.0	128.0	115.0	103.0	92.5	86.3	70.0	42.5	31.3	20.0	13.8	11.6	6.25
	W	589.0	516.0	389.0	326.0	279.0	243.0	220.0	196.0	179.0	166.0	136.0	82.5	61.3	40.0	27.5	22.5	12.50
UXH100-12N	A	261.0	227.0	168.0	139.0	118.0	102.0	92.0	82.0	74.0	69.0	56.0	34.0	25.0	16.0	11.0	9.3	5.00
	W	471.0	413.0	311.0	261.0	223.0	194.0	176.0	157.0	143.0	133.0	109.0	66.0	49.0	32.0	22.0	18.0	10.00
UXH200-6	A	520.0	452.0	336.0	278.0	236.0	204.0	184.0	164.0	148.0	138.0	112.0	68.0	50.0	32.0	22.0	18.6	10.00
	W	940.0	824.0	620.0	520.0	444.0	388.0	352.0	314.0	286.0	266.0	218.0	132.0	98.0	64.0	44.0	36.0	20.00

14. Proximity Switch



Halmac Services (Qld) Pty. Ltd.
A.C.N. 098 852 923
A.B.N. 40 741 712 113

PROXIMITY SWITCH

1. NCB5-18GM40-Z0 PROXIMITY SWITCH
TECHNICAL DETAILS



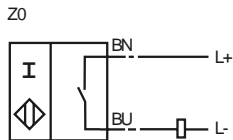
Model Number

NCB5-18GM40-Z0

Features

- Comfort series
- 5 mm embeddable

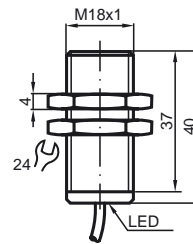
Connection



Accessories

- EXG-18**
Mounting aid
- BF 18**
Mounting flange

Dimensions



Technical Data

General specifications		
Switching element function		DC Make function
Rated operating distance	s_n	5 mm
Installation		embeddable
Output polarity		DC
Assured operating distance	s_a	0 ... 4.05 mm
Reduction factor r_{AI}		0.37
Reduction factor r_{Cu}		0.33
Reduction factor r_{V2A}		0.7
Nominal ratings		
Operating voltage	U_B	5 ... 60 V
Switching frequency	f	0 ... 350 Hz
Hysteresis	H	1 ... 10 typ. 5 %
Reverse polarity protection		tolerant
Short-circuit protection		pulsing
Voltage drop	U_d	≤ 5 V
Operating current	I_L	2 ... 100 mA
Off-state current	I_r	0 ... 0.5 mA typ.
Indication of the switching state		all direction LED, yellow
Standard conformity		
Standards		IEC / EN 60947-5-2:2004
Ambient conditions		
Ambient temperature		-25 ... 70 °C (248 ... 343 K)
Mechanical specifications		
Connection type		2 m, PUR cable
Cable version		PA
Core cross-section		0.34 mm ²
Housing material		Stainless steel
Sensing face		PBT
Protection degree		IP67
Approvals and certificates		
CCC approval		Certified by China Compulsory Certification (CCC)

Release date: 2009-05-07 10:31 Date of issue: 2009-05-07 089258_ENG.xml

15. Pushbutton & Indicator



Halmac Services (Qld) Pty. Ltd.
A.C.N. 098 852 923
A.B.N. 40 741 712 113

PUSHBUTTON & INDICATORS

1. PUSH BUTTON TECHNICAL DETAILS
2. HOUR RUN METER TECHNICAL DETAILS



Economical Devices for High Performance Switching & Control Solutions

Series D7 Pilot Devices

**22mm Design
Saves Panel Space**

**Heavy Duty
Ratings**

**Modular Design
Reduces Inventory**

**Order Assembled
or by Component**

Features

TWO OPERATOR TYPES

- Plastic operator with captive front bezel
- Metal operator with die-cast zinc housing and captive shiny metal bezel

LESS INVENTORY, MORE CHOICES

- Wide range of style choices
- Modular design for mix and match flexibility
- Endless configurations from core components

QUICK, EASY INSTALLATION

- Tool-less mounting latch for quick assembly
- Anti-rotation tab for one person installation
- Snap-on back panel components

LONG ELECTRICAL & MECHANICAL LIFE

- 10 million mechanical operations
- 10 million electrical cycles

ENVIRONMENTAL RATINGS

- UL Type 4/4X/13, IP66 Sealing
- Chemical resistant industrial grade thermoplastic body
- Corrosion and UV resistant

Sprecher + Schuh's rugged D7 pilot devices offer maximum flexibility and a wide choice for all applications. This 22mm line is aesthetically appealing and modularly designed to make assembly and interchangeability easy. The D7 operators are available in two different body styles to meet every industrial application need. Both operators exhibit a new lower profile stylish appearance while maintaining the rugged performance necessary for demanding environments.

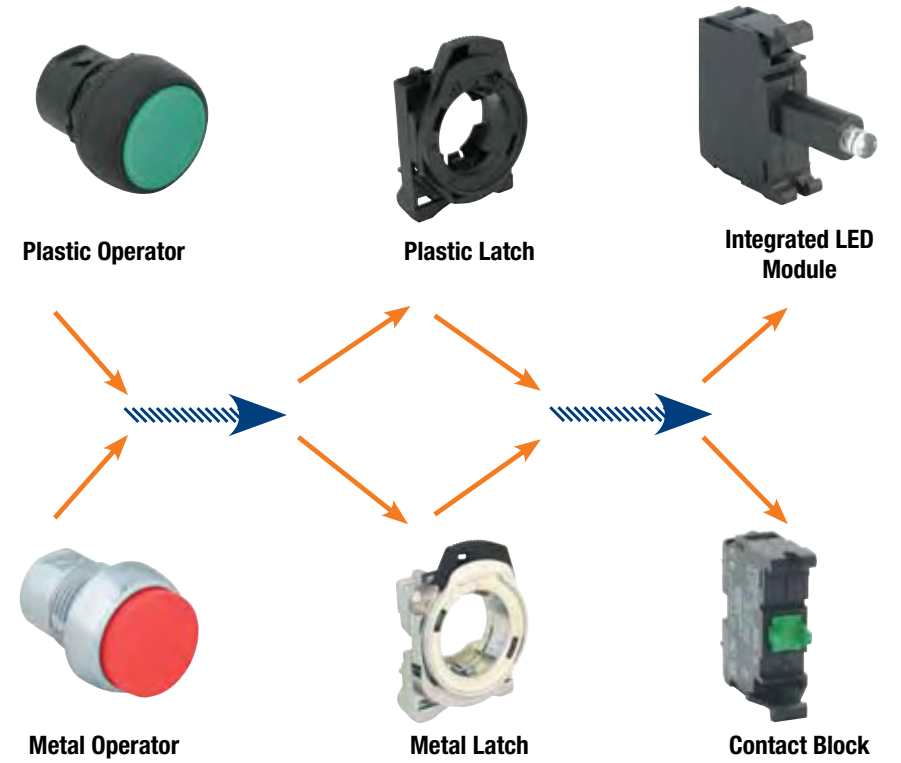


Fast Mounting

Tool-less, snap-in design for fast assembly



Flexibility



Complete Accessories



Superior Design



Push Buttons



Extended



Flush Guarded*



Extended



Flush



Illuminated

Momentary, Extended Plastic Metal

- D7P-LE0 D7M-LE0
- D7P-LE3 D7M-LE3
- D7P-LE4 D7M-LE4
- D7P-LE5 D7M-LE5
- D7P-LE6 D7M-LE6
- D7P-LE7 D7M-LE7
- ∅ D7P-LE9 D7M-LE9

∅ Push Button without Cap

Momentary, Flush* Plastic Metal

- D7P-LF0 D7M-LF0
- D7P-LF3 D7M-LF3
- D7P-LF4 D7M-LF4
- D7P-LF5 D7M-LF5
- D7P-LF6 D7M-LF6
- D7P-LF7 D7M-LF7
- D7P-LF9 D7M-LF9

* Guarded available on Momentary Flush only

Maintained, Flush Plastic Metal

- D7P-LFA0 D7M-LFA0
- D7P-LFA3 D7M-LFA3
- D7P-LFA4 D7M-LFA4
- D7P-LFA5 D7M-LFA5
- D7P-LFA6 D7M-LFA6
- D7P-LFA7 D7M-LFA7
- D7P-LFA9 D7M-LFA9

Non-Illuminated

Momentary, Extended Plastic Metal

- D7P-E0 D7M-E0
- D7P-E1 D7M-E1
- D7P-E2 D7M-E2
- D7P-E3 D7M-E3
- D7P-E4 D7M-E4
- D7P-E5 D7M-E5
- D7P-E6 D7M-E6
- ∅ D7P-E9 D7M-E9

∅ Push Button without Cap

Momentary, Flush* Plastic Metal

- D7P-F0 D7M-F0
- D7P-F1 D7M-F1
- D7P-F2 D7M-F2
- D7P-F3 D7M-F3
- D7P-F4 D7M-F4
- D7P-F5 D7M-F5
- D7P-F6 D7M-F6
- D7P-F9 D7M-F9

* Guarded available on Momentary Flush only

Maintained, Flush Plastic Metal

- D7P-FA0 D7M-FA0
- D7P-FA1 D7M-FA1
- D7P-FA2 D7M-FA2
- D7P-FA3 D7M-FA3
- D7P-FA4 D7M-FA4
- D7P-FA5 D7M-FA5
- D7P-FA6 D7M-FA6
- D7P-FA9 D7M-FA9

Illuminated 40mm Mushroom, Momentary

- | Plastic | Metal |
|------------|----------|
| • D7P-LMM3 | D7M-LMM3 |
| • D7P-LMM4 | D7M-LMM4 |
| • D7P-LMM5 | D7M-LMM5 |
| • D7P-LMM6 | D7M-LMM6 |
| ○ D7P-LMM7 | D7M-LMM7 |



Also available in 60mm Mushroom

Non-Illuminated 40mm Mushroom, Momentary

- | Plastic | Metal |
|------------|----------|
| • D7P-MM42 | D7M-MM42 |
| • D7P-MM43 | D7M-MM43 |
| • D7P-MM44 | D7M-MM44 |
| • D7P-MM45 | D7M-MM45 |
| • D7P-MM46 | D7M-MM46 |

PUSH buttons

Emergency Stops



Illuminated Twist-to-release, 40mm Mushroom

- | Plastic | Metal |
|-----------|-----------|
| D7P-LMT44 | D7M-LMT44 |

Complete Unit

- | | | |
|-------------|----------------|----------------|
| 1NC: | D7P-LMT44PX01 | D7M-LMT44PX01 |
| 1 Guardian: | D7P-LMT44PX01S | D7M-LMT44PX01S |



Non-Illuminated Twist-to-release, 30mm Mushroom

- | Plastic | Metal |
|----------|----------|
| D7P-MT34 | D7M-MT34 |

Complete Unit

- | | | |
|-------------|---------------|---------------|
| 1NC: | D7P-MT34PX01 | D7M-MT34PX01 |
| 1 Guardian: | D7P-MT34PX01S | D7M-MT34PX01S |



Keyed Twist-to-release, 40mm Mushroom

- | Plastic | Metal |
|----------|----------|
| D7P-MK44 | D7M-MK44 |

Complete Unit

- | | | |
|-------------|---------------|---------------|
| 1NC: | D7P-MK44PX01 | D7M-MK44PX01 |
| 1 Guardian: | D7P-MK44PX01S | D7M-MK44PX01S |



Twist-to-release, 40mm Mushroom

Complete Unit

- | | | |
|-------------|---------------|---------------|
| 1NC: | D7P-MT44PX01 | D7M-MT44PX01 |
| 1 Guardian: | D7P-MT44PX01S | D7M-MT44PX01S |



Twist-to-release, 60mm Mushroom

Complete Unit

- | | | |
|-------------|---------------|---------------|
| 1NC: | D7P-MT64PX01 | D7M-MT64PX01 |
| 1 Guardian: | D7P-MT64PX01S | D7M-MT64PX01S |

MONOLITHIC

emergency STOP

SELECTOR switches

MULTIfunction push buttons

COMPONENTS

Push-Pull Operators



2 Position Illuminated Push-Pull, 40mm Mushroom

- | Plastic | Metal |
|-------------|-----------|
| • D7P-LMP43 | D7M-LMP43 |
| • D7P-LMP44 | D7M-LMP44 |
| • D7P-LMP45 | D7M-LMP45 |

Complete Unit

- | | | |
|-------------|----------------|----------------|
| 1NC: | D7P-LMP44PX01 | D7M-LMP44PX01 |
| 1 Guardian: | D7P-LMP44PX01S | D7M-LMP44PX01S |



2 Position Non-Illuminated Push-Pull, 40mm Mushroom

- | Plastic | Metal |
|------------|----------|
| • D7P-MP42 | D7M-MP42 |
| • D7P-MP44 | D7M-MP44 |

Complete Unit

- | | | |
|-------------|---------------|---------------|
| 1NC: | D7P-MP44PX01 | D7M-MP44PX01 |
| 1 Guardian: | D7P-MP44PX01S | D7M-MP44PX01S |



3 Position Illuminated Push-Pull, 40mm Mushroom

- | Momentary Plastic | Maintained Metal |
|-------------------|------------------|
| • D7M-LMM40-E3 | D7M-LMP40-E3 |
| • D7M-LMM43-E3 | D7M-LMP43-E3 |
| • D7M-LMM44-E3 | D7M-LMP44-E3 |
| • D7M-LMM46-E3 | D7M-LMP46-E3 |
| • D7M-LMM47-E3 | D7M-LMP47-E3 |



3 Position Non-Illuminated Push-Pull, 40mm Mushroom

- | Momentary Plastic | Maintained Metal |
|-------------------|------------------|
| • D7M-MM42-E3 | D7M-MP42-E3 |
| • D7M-MM43-E3 | D7M-MP43-E3 |
| • D7M-MM44-E3 | D7M-MP44-E3 |



Pilot Lights

- | Plastic | Metal |
|----------|--------|
| • D7P-P0 | D7M-P0 |
| • D7P-P3 | D7M-P3 |
| • D7P-P4 | D7M-P4 |
| • D7P-P5 | D7M-P5 |
| • D7P-P6 | D7M-P6 |
| ○ D7P-P7 | D7M-P7 |
| ∅ D7P-P9 | D7M-P9 |
- ∅ Pilot light without lens or diffuser

PILOT lights

PUSH-PULL operators

Reset Operators



Mechanical and/or Electrical Reset

- | Plastic | Metal |
|----------|--------|
| ○ D7P-R1 | D7M-R1 |
| • D7P-R2 | D7M-R2 |
| • D7P-R6 | D7M-R6 |

RESET operators

OTHER switches

Monolithic

Indicator Light
Plastic

LED	Incandescent
• D7D-P0N♣	D7D-P0D♣
• D7D-P3N♣	D7D-P3D♣
• D7D-P4N♣	D7D-P4D♣
• D7D-P5N♣	D7D-P5D♣
• D7D-P6N♣	D7D-P6D♣
○ D7D-P7N♣	D7D-P7D♣

♣ Select lamp voltage and terminal type

Push Button
Non-Illuminated, Plastic, Momentary

Flush Cap	Extended Cap
○ D7D-F1♣	D7D-E1♣
• D7D-F2♣	D7D-E2♣
• D7D-F3♣	D7D-E3♣
• D7D-F4♣	D7D-E4♣
• D7D-F5♣	D7D-E5♣
• D7D-F6♣	D7D-E6♣

♣ Select cap text and contact configuration

E-STOP Push Button
Push-Pull and Twist-to-release,
40mm Mushroom, Plastic

D7D-MT44X01 1NC
D7D-MT44X11 1NO 1NC
D7D-MT44X02 2NC

Selector Switch
Non-Illuminated, Plastic

2 Position, Maintained

- D7D-SM22X10 1NO
- D7D-SM22X01 1NC
- D7D-SM22X20 2NO
- D7D-SM22X02 2NC
- D7D-SM22X11 1NO, 1NC

Also available with spring return

3 Position, Maintained

- D7D-SM32X20 2NO
- D7D-SM32X02 2NC
- D7D-SM32X11 1NO, 1NC

Selector Switches

Non-Illuminated

2 Position, Maintained

Plastic	Metal
• D7P-SM22	D7M-SM22

Also available with spring return

3 Position, Maintained

Plastic	Metal
• D7P-SM32	D7M-SM32

Illuminated

2 Position, Maintained

Plastic	Metal
• D7P-LSM20	D7M-LSM20
• D7P-LSM23	D7M-LSM23
• D7P-LSM24	D7M-LSM24
• D7P-LSM25	D7M-LSM25
• D7P-LSM26	D7M-LSM26
○ D7P-LSM27	D7M-LSM27

3 Position, Maintained

Plastic	Metal
• D7P-LSM30	D7M-LSM30
• D7P-LSM33	D7M-LSM33
• D7P-LSM34	D7M-LSM34
• D7P-LSM35	D7M-LSM35
• D7P-LSM36	D7M-LSM36
○ D7P-LSM37	D7M-LSM37

Multi-function

Illuminated

2 Function

Plastic	Metal
D7P-LU2X	D7M-LU2X

Non-Illuminated

2 Function

Plastic	Metal
D7P-U2X	D7M-U2X

3 Functions

Plastic	Metal
D7P-U3X	D7M-U3X

Other Switches

Toggle Switch
Metal

2 Position

D7M-JR2	Momentary
D7M-JM2	Maintained

4 Position

D7M-JR4	Momentary
D7M-JM4	Maintained

Potentiometer
Single Turn, Assembled

Plastic	Resistive Element
D7P-POT	None (Operator Only)
D7P-POT1	150 Ω
D7P-POT2	500 Ω
D7P-POT3	1000 Ω
D7P-POT4	2500 Ω
D7P-POT5	5000 Ω
D7P-POT6	10000 Ω

Key Selector Switches

2 Position, Maintained

Plastic	Metal
D7P-KM21	D7M-KM21
D7P-KM22	D7M-KM22
D7P-KM23	D7M-KM23

Also available with spring return

3 Position, Maintained

Plastic	Metal
D7P-KM31	D7M-KM31
D7P-KM33	D7M-KM33
D7P-KM34	D7M-KM34
D7P-KM35	D7M-KM35

Selector/Jog Operators

2 Position

Plastic	Metal
• D7P-SJ22	D7M-SJ22
• D7P-SJ23	D7M-SJ23

3 Position

Plastic	Metal
• D7P-SJ32	D7M-SJ32
• D7P-SJ33	D7M-SJ33

Components

Contact Blocks
(latch not included)

D7-X10	1NO
D7-X01	1NC
D7-X01B	1NC Early Break
D7-X10E	1NO Early Make
D7-X01L	1NC Late Break
D7-X10V(1mA)	1NO Low Voltage
D7-X01V(1mA)	1NC Low Voltage
D7-X01S	Guardian Block
D7-Q10	1NO Screwless
D7-Q01	1NC Screwless

Integrated LED Module
(latch not included)

Screw Type

D7-N3*	24V AC/DC
D7-N5*	120V AC
D7-N7*	240V AC

Spring-Clamp

D7-Q3*	24V AC/DC
D7-Q5*	120V AC
D7-Q7*	240V AC

* Add LED Color, R=red, G=green, Y=yellow, B=blue, W=white

Plastic Latch
D7-ALP

Metal Latch
D7-ALM

Incandescent Power Module
(bulb not included)

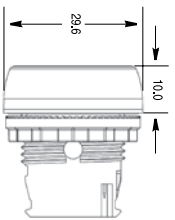
D7-D0C	6-240V AC/DC
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D7 Pilot Devices

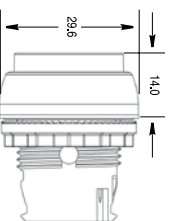
Metroplex Ave Murarrie SPS SP281 Sewage Pump Station Switchboard Operation and Maintenance Manual (Halmac)

Dimensions* (Approximately in millimeters)

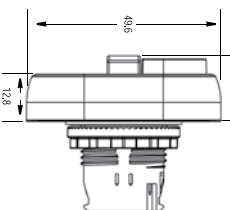
Non-Illuminated and Illuminated
Flush Push Button Operators (D7x-F)



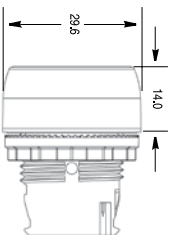
Illuminated and Non-Illuminated
Extended Push Button Operators



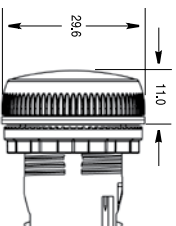
Non-Illuminated 3-Position Multi-Function Operators (D7x-U3)



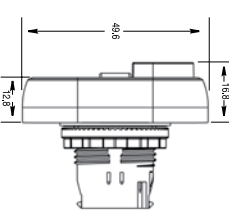
Non-Illuminated Guarded and Non-Illuminated
Maintained Push Button Operators (D7x-G and D7x-FA)



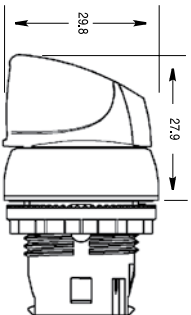
Pilot Light Operators (D7x-P)



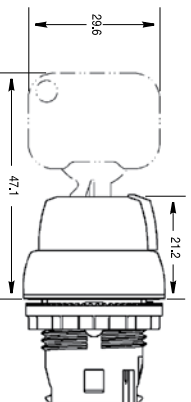
Illuminated and Non-Illuminated 2-Position Multi-Function
Operators (D7x-U1/2 & D7x-U2)



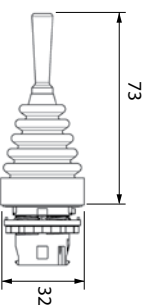
Illuminated and Non-Illuminated Knob Selector Switch
Operators (D7x-LS & D7x-S)



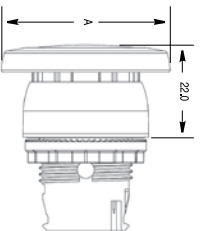
Key Selector Switch Operators (D7x-K)



Toggle Switch Operators (D7M-JM)

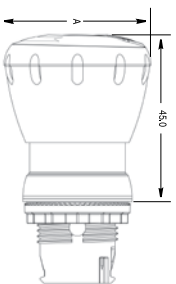


Illuminated and Non-Illuminated
Momentary Mushroom Operators
40mm and 60mm (D7x-LMM & D7x-MM)



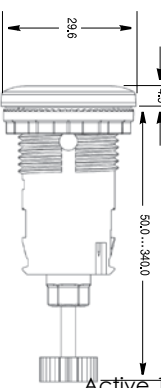
Operator	A
40mm	39.8
60mm	59.8

Illuminated and Non-Illuminated Twist-to-Release
Operators 30mm, 40mm, and 60mm (D7x-MT)



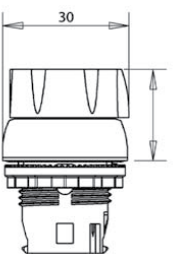
Operator	A
30mm	30
40mm	40
60mm	60

Reset Operators (D7x-R)

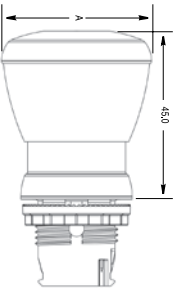


Active 10/12/2013

Selector Jog Operators (D7x-SJ)

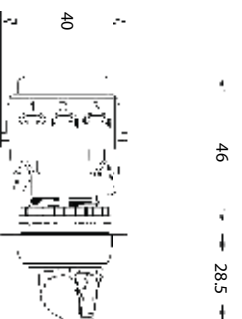


Illuminated and Non-Illuminated
Push-Pull Mushroom Operators 30mm, 40mm, and 60mm
(D7x-MP)



Operator	A
30mm	30
40mm	40
60mm	60

Potentiometer with Resistive Element (D7P-POT)



* For Monolithic Devices see the D7D Monolithic Flyer

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Publication No: F-D7Devices_107 11/07

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Q-Pulse Id TMS535

Front-of-Panel (Operators) ①

Mechanical Ratings

Description		Plastic (D7P)	Metal (D7M)
Vibration (assembled to panel)	[G]	Tested at 10...2000Hz, 1.52mm displacement (peak-to-peak) max./10G max. for 3hr duration, no damage	
Shock	[G]	Tested at 1/2 cycle sine wave for 11ms; no damage at 100G	
Degree of protection ②		UL Type 3/3R/4/4X/12/13 (IP65/66)	UL Type 3/3R/4/12/13 (IP65/66)
Mechanical durability per EN 60947-5-1 (Annex C)		10,000,000 Cycles 1,000,000 Cycles 500,000 Cycles 300,000 Cycles 100,000 Cycles	
Operating forces (typical with one contact block)	[N]	Momentary push buttons, momentary mushroom Multi-function, Selector Switch, Key Selector Switch, Selector Jog Non-illuminated Push-Pull E-Stop Twist-to-Release E-Stop, Illuminated Push-Pull E-Stop, Maintained Push Buttons, selector switches Potentiometer, Toggle Switch Flush/extended = 5N E-stop = 36N Mushroom = 9N	
Operating torque (typical application with one contact block)	[N·m]	Selector switch = 0.25 N·m (2.2 lb-in.)	
Mounting torque	[N·m]	1.7 N·m (15 lb-in.)	4.4 N·m (40 lb-in.)
Environmental			
Temperature range (operating) ③	[°C]	-25...+70°C (-13...+158°F)	
Temperature range (short-term storage)	[°C]	-40...+85°C (-40...+185°F)	
Humidity	[%]	50...95% RH from 25...60°C (77...140°F) per: Procedure IV of MIL-STD-810C, Method 507.1 cycling test	

Pilot Devices

D7

Back-of-Panel Components ①

Electrical Ratings

Standard contact block ratings		A600, Q600 600V AC AC15, DC 13 to EN 60947-5-1 and UL 508, 17V, 5mA min.		
Low voltage contact block ratings ④		5V, 1mA DC min. C300, R150, AC 15, DC 13 to EN 60947-5-1 and UL 508		
LED Module Ratings	Nominal Voltage	Range	Current Draw	Frequency
	24V AC	10...29V AC	31 mA	50/60 Hz
	24V DC	10...30V DC	24 mA	DC
	120V AC	70...132V AC	25 mA	50/60 Hz
	240V AC	180...264V AC	22 mA	50/60 Hz
Thermal current	[A]	10 A max. enclosed (40°C ambient) to UL 508, EN 60947-5-1		
Wire capacity	Screw terminal ⑤ [AWG]	#18...12 AWG (0.75...2.5mm ²) Max. (2) #14 AWG or (1) #12 AWG		
	Spring-clamp terminal [AWG]	#18...14 AWG (0.75...1.5mm ²)		
Recommended tightening torque on screw terminals	[N]	0.7...0.9 N·m (6...8 lb-in.)		
Insulation voltage	[U]	U _i = 690 V (screw terminal) U _i = 300 V (screwless terminal)		
Dielectric strength (minimum)	[V]	2500V for one minute		
External short circuit protection	Standard blocks	10 A type gL/gG cartridge fuse to EN 60269-2-1 or gN (Class J to UL 248-8 or Class C to UL 248-4)		
	Low voltage contact blocks	6 A type gL/gG cartridge fuse to EN 60269-2-1 or gN (Class J to UL 248-8 or Class C to UL 248-4)		
Electrical shock protection		Finger-safe conforming to IP2X		

Mechanical Ratings

Vibration (assembled to panel)	[G]	10...2000 Hz, 1.52mm displacement (peak-to-peak) max./10G max. 6hr	
Shock	[G]	Tested at 1/2 cycle sine wave for 11ms and no damage at 100G max.	
Contact durability per EN 60947-5-1 (Annex C)		10,000,000 cycles	
Contact operation	NO	Slow double make and break	
	NC	Slow double make and break - positive opening	
	NOEM	Double break / double make / early make	
	NCLB	Double break / double make, late break - positive opening	
	NCEB	Double break / double make, early break - positive opening	
Push button travel to change electrical state		N.C. and N.O.E. M.	1.5 mm (0.060 in.)
		N.O. and N.C.L.B.	2.5 mm (0.1 in.)
Operating forces (typical)	[N]	3.4 N: each single circuit contact block	
		5...6.5 N: each dual circuit contact block	

① Performance data given in this publication is provided only as a guide for the user in determining suitability and do not constitute a performance warranty of any kind. Such data may represent the results of accelerated testing at elevated stress levels, and the user is responsible for correlating the data to actual application requirements. ALL WARRANTIES AS TO ACTUAL PERFORMANCE, WHETHER EXPRESS OR IMPLIED, ARE EXPRESSLY DISCLAIMED.

② Momentary mushroom operators are IP65, multi-function operators have no Type 13 rating. Plastic operators with keys have no Type 4X rating.

③ Operating temperatures below 0°C (32°F) are based on the absence of freezing moisture and liquids, UL recognized to 55°C (131°F) - incandescent module, max 40°C (104°F).

④ Low voltage contacts are recommended for applications below 17V, 5 mA.

⑤ Wires less than #18 (0.75mm²) may not hold in terminal securely.

Back-of-Panel Components ❶, continued

❶ Illumination

LED dominant wavelength	Green	[nm]	525 nm
	Red		629 nm
	Yellow		590 nm
	Blue		470 nm
	White		—
LED luminous intensity	Green	[mcd]	890 mcd
	Red		890 mcd
	Yellow		690 mcd
	Blue		193 mcd
	White		412 mcd
Incandescent maximum wattage	[W]		2.6W

❶ Materials

Springs	Stainless steel and zinc coated music wire		
Electrical contacts	Standard		Silver-nickel
	Low voltage		Gold-plated over silver
Terminals	Screw		Brass
	Screwless		Silver-plated brass

Pilot Devices
D7

Environmental Approval Note: Front elements UL Recognized; Complete assemblies UL Approved. See Table A2 for your application.

This table is extracted from Sprecher + Schuh's UL 508A file and can be used to determine which D7 Pilot Device is approved for a particular enclosure type.

TABLE A2 - Openings in Enclosure	
Enclosure Type	Openings May Be Closed By Equipment Marked...
2	2, 3, 3R, 3S, 4, 4X, 6, 6P, 11, 12, 12K, 13
3	3, 3R, 3S, 4, 4X, 6, 6P
3R	3, 3R, 3S, 4, 4X, 6, 6P
3S	3, 3R, 3S, 4, 4X, 6, 6P
4	4, 4X, 6, 6P
4X	4X
6	6, 6P
6P	6P
11	11
12, 12K	12, 12K, 13
13	13

Product Certifications

Certifications	UL, UR, CSA, CCC, CE
Conformity of Standards - CE marked	NEMA ICS-5; UL 508, EN 418, EN 60947-1, EN 60947-5-1, EN 60947-5-5
Terminal identification	IEC 60947-1
Shipping approvals	RINA, LR, ABS
RoHS	✓

❶ Performance data given in this publication is provided only as a guide for the user in determining suitability and do not constitute a performance warranty of any kind. Such data may represent the results of accelerated testing at elevated stress levels, and the user is responsible for correlating the data to actual application requirements. ALL WARRANTIES AS TO ACTUAL PERFORMANCE, WHETHER EXPRESS OR IMPLIED, ARE EXPRESSLY DISCLAIMED.

Material Listing

Component	For Use with	Material Used
Panel gasket	All operators	Nitrile, TPE
Diaphragm seal	Illuminated push button, non-illuminated push button	Automotive industry acceptable silicone
K-seal	Selector switch, key selector switch, push/twist-to-release E-stop, key E-stop, push/pull mushroom	Nitrile
Diaphragm retainer, return spring I	Illuminated push button, non-illuminated push button, momentary mushroom	Stainless steel
Return spring II	Reset, selector switch, key selector switch, maintained action, push/twist-to-release E-stop, key E-stop, push/pull mushroom	Zinc coated music wire
Button cap/mushroom head	Non-illuminated push button, momentary mushroom, reset, push/twist-to-release E-stop, key E-stop, push/pull mushroom, multi-function	PBT/polycarbonate blend
2-color molded button cap	Non-illuminated push button	PBT/polycarbonate blend
Lens	Multi-function	Acetal
Lens, knob	Illuminated push button, illuminated momentary mushroom, illuminated selector switch	Polyamide
Knob	Non-illuminated selector switch	Glass-filled polyamide
Plastic bezel/bushing I	Non-illuminated push button, illuminated push button, momentary mushroom, selector switch, key selector switch, push/twist-to-release E-stop, key E-stop, push/pull mushroom, multi-function, reset	Glass-filled polyamide
Plastic bezel/bushing II, jam nut	Pilot light, reset jam nut, reset pusher	Glass-filled PBT
Metal bezel/bushing	All metal operators	Zinc
Diffuser	Illuminated push button, pilot light	Polycarbonate
Legend frames	—	Glass-filled polyamide
Plastic mounting ring	All plastic operators	Glass-filled polyamide
Metal mounting ring	All metal operators	Chromated zinc
Plastic latch	—	Glass-filled polyamide
Metal latch	—	Chromated zinc + stainless steel
Plastic enclosure	—	PBT/polycarbonate blend
Metal enclosure	—	Aluminum
Terminal screws	LED module, incandescent module, contact blocks	Zinc-plated steel with chromate
Terminals	LED module, incandescent module, contact blocks	Brass with silver-nickel contacts
Screwless	LED module, incandescent module, contact blocks	Stainless steel
Lamp socket	Incandescent module	Brass
Housing	Incandescent module, LED module	Glass-filled polyamide
Low voltage terminals	Contact blocks	Gold plated silver-nickel contacts
Low voltage spanner	Contact blocks	Gold-plated silver-nickel contacts
Spanner	Contact blocks	Brass with silver-nickel contacts
Boot	Toggle Switch, illuminated push button, non-illuminated push button, multi-function illuminated an non-illuminated	Automotive industry acceptable silicone

Pilot Devices

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Specifications

Mechanical Ratings

Vibration (assembled to panel)	Tested at 10...2000 Hz, 1.52 mm displacement (peak-to-peak) max./10 G max. for 3 hr duration, no damage	
Shock	Tested at 1/2 cycle sine wave for 11 ms; no damage at 100 G	
Degree of protection	IP 66 (Type 3/3R/4/4X/12/13)	
mechanical durability per EN 60947-5-1 (Annex C)	2,000,000 Cycles	Momentary Push Button
	300,000 Cycles	Selector Switch and E-Stop
Operating forces	Flush/Extended = 9 N, E-stop = 36 N	
Operating torque (typical application with one contact block)	Selector Switch = 0.25 N•m	
Contact operation	N.O.	Slow double make and break
	N.C.	Slow double make and break - positive opening ⇄
Push button travel to change electrical state	N.O.	2.5 mm (0.1 in.)
	N.C.	1.5 mm (0.060 in.)

⇄ Positive Opening per EN60947-5-1 (applies to all NC contact block styles)

Environmental

Temperature range (operating) ❶	-25...+60°C (-13...140°F)
Temperature range (short term storage)	-40...+85°C (-40...185°F)
Humidity	50...95% RH from 25...60°C (77...140°F)

Electrical Ratings

Standard contact block ratings	B300, R300; AC 15, DC 13; 300 VAC; EN/IEC 60947-5-1 and UL 508, 17V, 5 mA min.			
LED Module Ratings	Nominal Voltage	Range	Nominal Current Draw	Frequency
	24V AC	20...26V AC	32 mA	50/60 Hz
	24V DC	18...30V DC	24 mA	DC
	120V AC	102...132V AC	22 mA	50/60 Hz
	240V AC	204...264V AC	22 mA	50/60 Hz
Thermal current	5 A max. enclosed (40°C ambient) to UL508, EN/IEC 60947-5-1			
Insulation voltage (Ui)	300V			
Wire capacity (screw terminal)	#18...14 AWG (0.75...2.5 mm²), Max. (2) #14 AWG, uses same size wire only			
Recommendations for Ring Lug termination option ❷	6.35 mm (0.250 in.) Max. outer diameter with 3.8 mm (0.148 in.) hole diameter			
Recommended tightening torque on screw terminals	0.7...0.9 N•m (6...8 lb-in.)			
Dielectric strength (minimum)	2500V for one minute			
External short circuit protection	5 A type gL/gG cartridge fuse to EN 60269-2-1 or gN (Class J to UL 248-8 or Class CC to UL 248-4)			
Electrical shock protection	Finger-safe conforming to IP2X			

Illumination

LED Dominant Wavelength	Green	Red	Yellow	Blue	White
	525 nm	629 nm	590 nm	470 nm	
LED Luminous Wavelength	Green	Red	Yellow	Blue	White
	890 mcd	890 mcd	690 mcd	193 mcd	412 mcd
Incandescent maximum wattage	2.6 W				

Materials

Springs	Stainless steel and zinc coated music wire
Electrical contacts	Brass with silver-nickel contacts
Terminals	Brass and phosphor bronze
Panel gasket	nitrile and polyester-based TPE
Seal	Nitrile
Button cap/mushroom head	Polyester/polycarbonate blend
Lens (pilot light)	Acrylic
Knob (selector switch)	Glass-filled polyamide
Bezel/bushing, housing	Glass filled polyester
Legend frames	Glass filled polyamide
Mounting ring	Glass filled polyamide
Terminal screws	Zinc-plated steel with chromate
Lamp Socket	Brass and Phosphor bronze

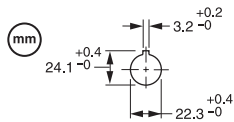
Product Certifications

Certifications	UL, CSA, CCC, CE
Conformity to standards - CE marked	UL 508, EN 60947-1, EN 60947-5-1, EN 60947-5-5
Terminal Identification	EN/IEC 60947-1

❶ Operating temperatures below 0°C (32°F) are based on the absence of freezing moisture and liquids.
 ❷ 3M MV018-R/S (#22...18 AWG) or 3M MVU14-6R/S (#16...14 AWG)

Approximate Dimensions – millimeters ①

Panel Hole Spacing



Approximate Dimensions – millimeters ❶

Illuminated and Non-illuminated Momentary Mushroom Operators 40mm and 60mm (D7x-LMM & D7x-MM)

Operator	A
40mm	39.8
60mm	59.8

Illuminated and Non-illuminated Knob Selector Switch Operators (D7x-LS & D7x-S)

Non-illuminated Knob Lever Selector Switch Operators (D7x-H)

Non-illuminated 3-Position Multi-Function Operators (D7x-U3)

Illuminated and Non-illuminated Push-Pull Mushroom Operators 30mm, 40mm, and 60mm (D7x-MP)

Operator	A
30mm	30
40mm	40
60mm	60

Illuminated and Non-illuminated Twist-to-Release Operators 30mm, 40mm, and 60mm (D7x-MT)

Operator	A
30mm	30
40mm	40
60mm	60

Illuminated and Non-illuminated 2-Position Multi-Function Operators (D7x-LU2 & D7x-U2)

Mushroom Key Release Operator 40mm (D7x-MK)

Key Selector Switch Operators (D7x-K)

Back-of-Panel Components — Incandescent Module with Latch (D7-DOC & D7-ALP/M)

Back-of-Panel Components — Contact Cartridges with Latch (D7-X/Q + D7-ALP/M)

30 x 40mm Snap-in-Legend Plate (D7-11)

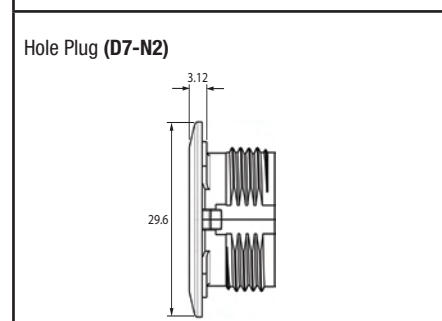
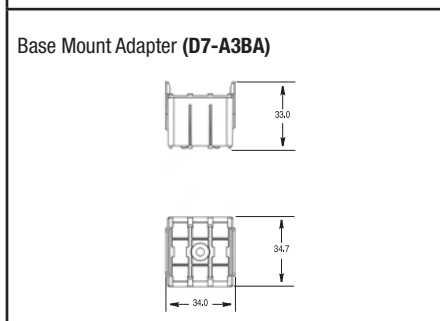
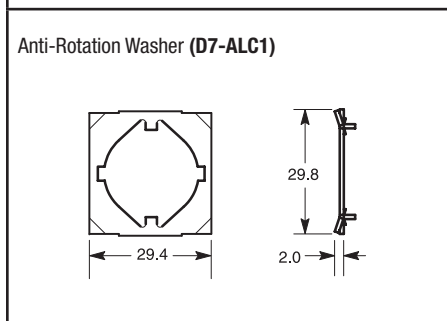
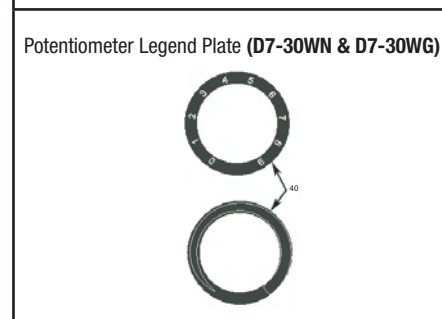
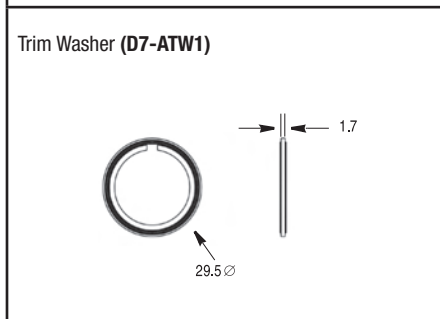
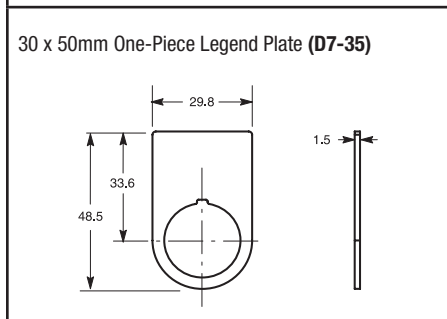
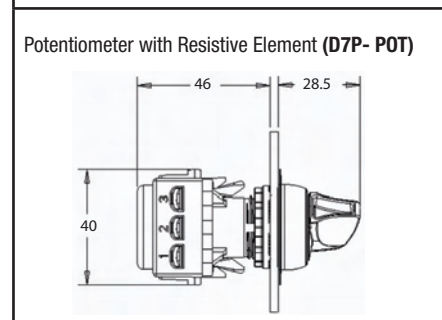
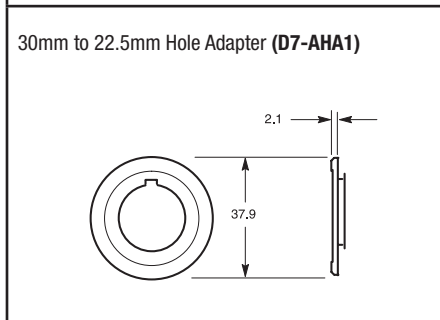
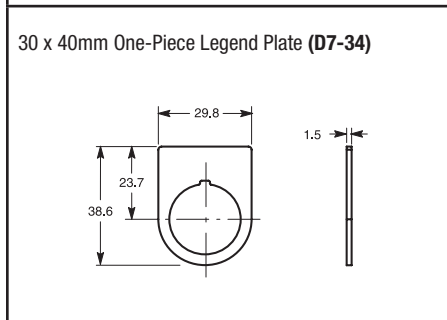
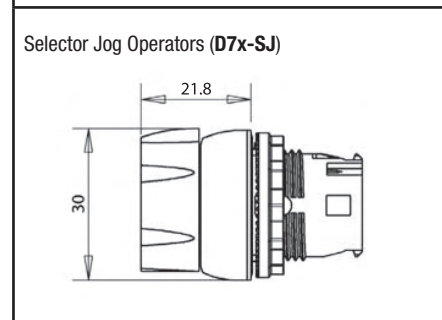
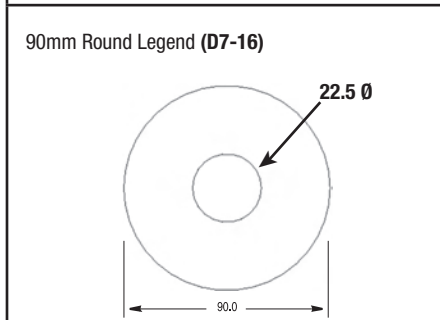
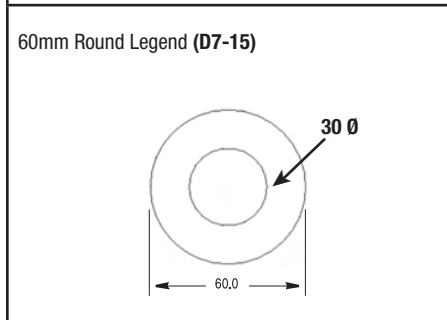
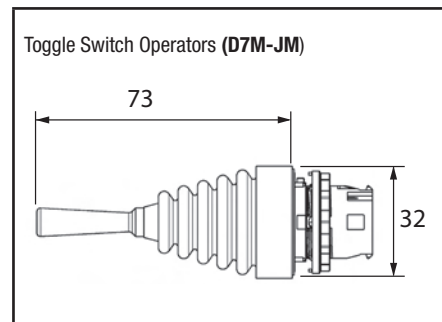
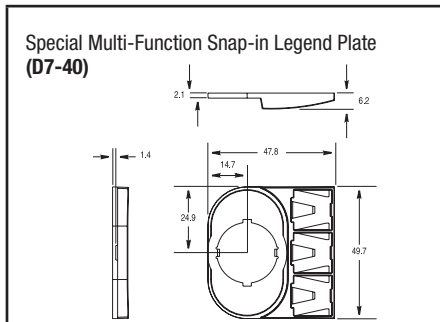
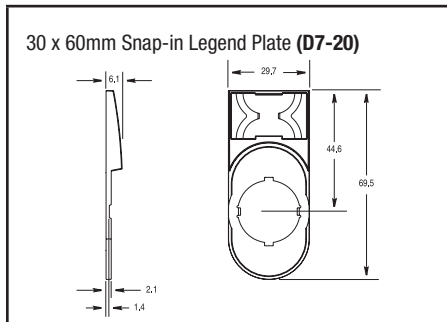
Back-of-Panel Components — LED Module with Latch (D7-N/Q & D7-ALP/M)

Back-of-Panel Components — Dual Circuit Contact Block (Max. of 1 Deep) (D7x-X_D/D7-X01S)

30 x 50mm Snap-in-Legend Plate (D7-12)

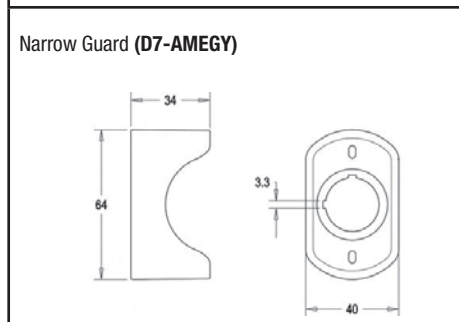
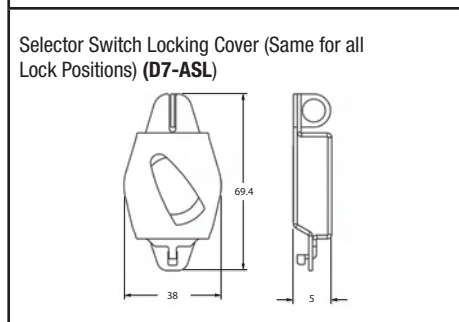
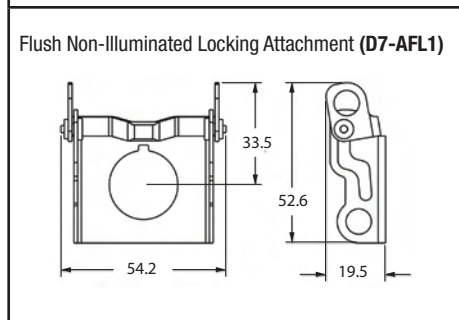
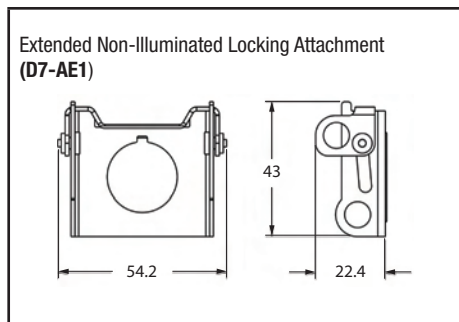
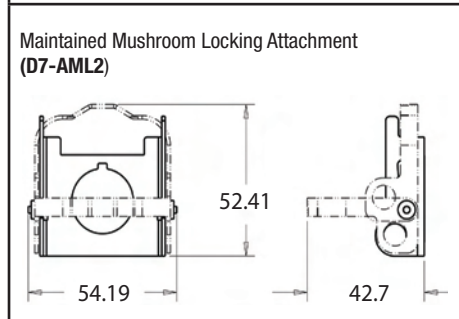
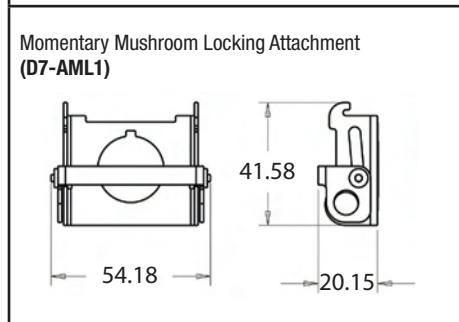
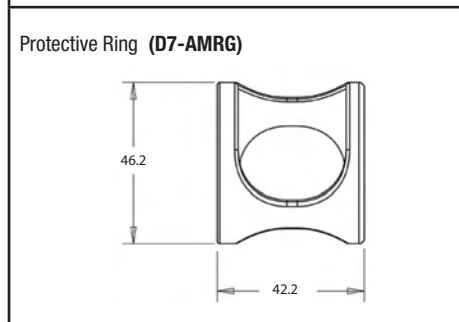
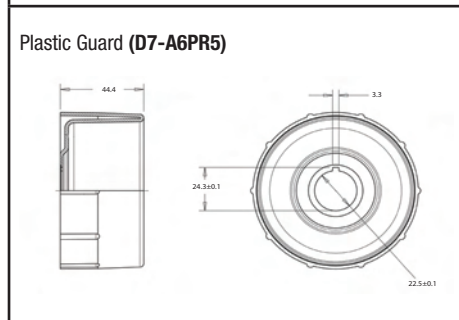
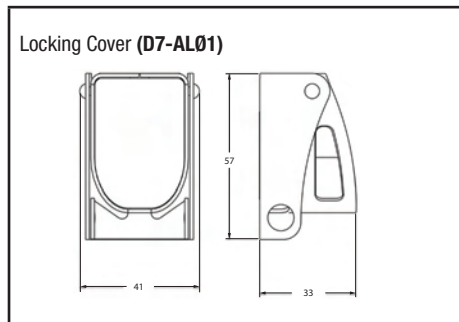
❶ Dimensions are not intended to be used for manufacturing purposes.

Approximate Dimensions – millimeters ①②



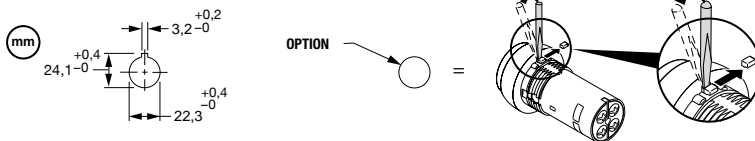
① Dimensions are not intended to be used for manufacturing purposes.
 ② Panel thickness range is 1.0...6.0 maximum. Panel thickness reduced to 4.5 when optional legend plates are used.

Approximate Dimensions – millimeters ①



① Dimensions are not intended to be used for manufacturing purposes.

Approximate Dimensions – millimeters ①

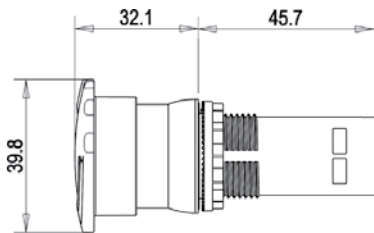


(A)						
(A)						
(B)						
						60, 90
	30	40	50	40	50	60 / 90
	30			40		

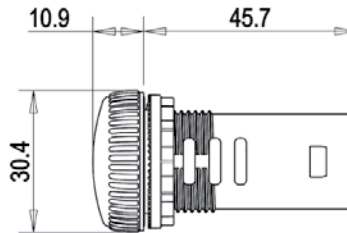
Pilot Devices

D7

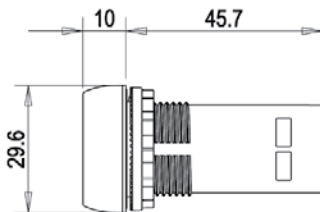
2-Position Push-Pull/Twist-to-Release Mushroom Devices (D7D-MT)



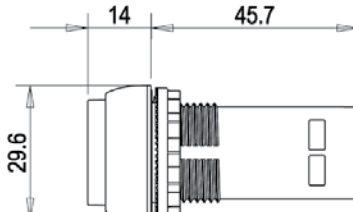
Pilot Light Devices (D7D-P)



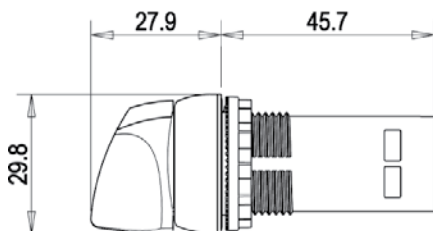
Momentary Pushbutton Device - Flush (D7D-F)



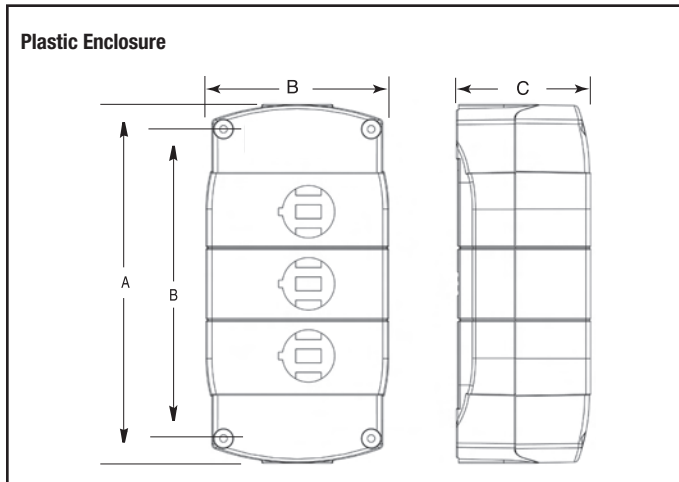
Momentary Pushbutton Device - Extended (D7D-E)



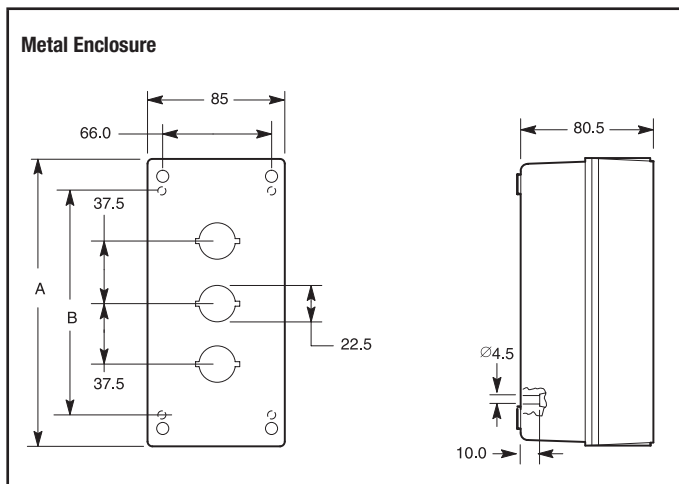
2 & 3 Position Selector Switch Devices (D7D-S)



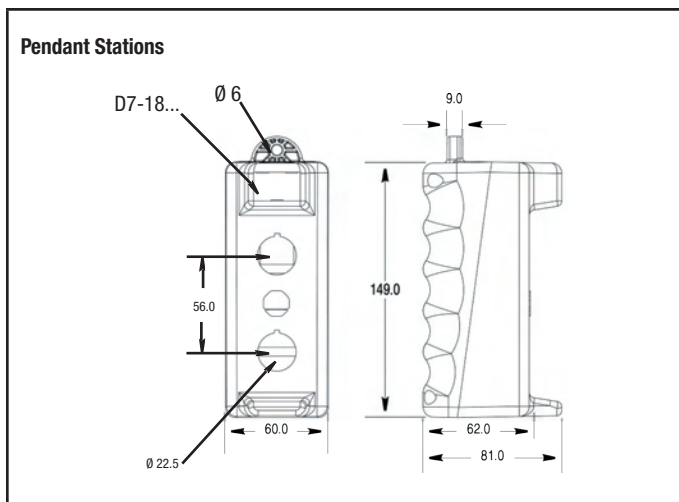
Approximate Dimensions – millimeters ❶



Type - 4/4X/13 (IP66) - Plastic Enclosures					
Cat. No.	No. of Units (Holes)	A	B	C	Knockout/Conduit Openings
D7-1PP (1YP)	1	85 (3-11/32)	89 (3-1/2)	58 (2-9/32)	PG11 PG16
D7-2PP	2	124 (4-7/8)	79 (3-1/8)	58 (2-9/32)	PG11 PG16
D7-3PP	3	155 (6-3/32)	79 (3-1/8)	58 (2-9/32)	PG11 PG16
D7-4PP	4	186 (7-5/16)	79 (3-1/8)	58 (2-9/32)	PG11 PG16
D7-6PP	6	248 (9-3/4)	87 (3-7/16)	64 (2-17/32)	PG16



Type 4/13 (IP66) - Metal Enclosures				
Cat. No.	No. of Units (Holes)	A	B	Knockout/Conduit Openings
D7-1MP (1MY)	1	99 (3-9/32)	62 (2-7/16)	PG11 PG16
D7-2MP	2	137 (5-13/32)	100 (3-15/16)	PG11 PG16
D7-3MP	3	174 (6-27/32)	137 (5-13/32)	PG11 PG16
D7-5MP	5	249 (9-13/32)	212 (8-11/32)	PG16



❶ Dimensions are not intended to be used for manufacturing purposes.

Panasonic
ideas for life

**DIN HALF SIZE
HOUR METER**

**TH63-TH64
Hour Meters**

**UL File No.: E42876
CSA File No.: LR39291**



2. Reset button

The hour meters can be reset to zero (TH64 series).

3. Wide-ranging measurement display

The measurement can be displayed from 0.1 hour up to 99999.9 hours (TH63 series). The dial size is the same as that of 48 × 48 DIN size hour meters (TH14 and TH24 series).

4. Easy to install

The flat terminals (#187) are used for easier wiring. There is no need to undo the lock spring.

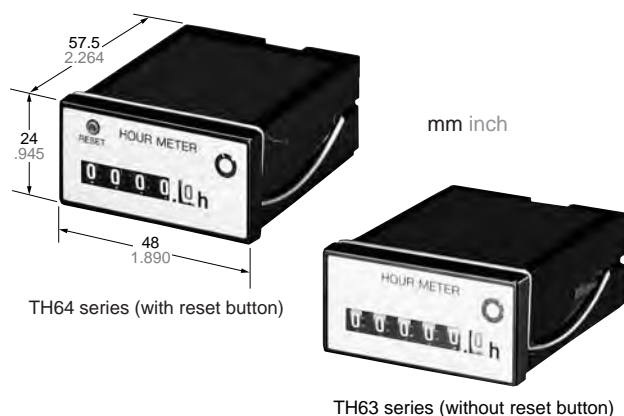
5. High-performance sync motor with 50/60 Hz selector

The noise-resistant, accurately turning motor is employed to provide for longer period of measurement. The power frequency can be selected for 50 or 60 Hz.

6. Rotary indicator

The rotary indicator makes one turn every 72 seconds for monitoring.

7. Compliant with UL, CSA and CE.



RoHS Directive compatibility information
<http://www.nais-e.com/>

Features

1. Compact to save panel space

The 24 × 48 mm hour meters are just half the DIN 48 × 48 standard size. They help save the panel space.

Typical applications

Management of small generators and food processing machines; hour counting for leased equipment; maintenance management of various equipment, etc.

Specifications

Rated operating voltage	12 V AC, 24 V AC, 48 V AC, 100 V AC, 110 V AC, 115 to 120 V AC, 200 V AC, 220 V AC, 240 V AC	
Allowable operating voltage range	85 to 115% of rated operating voltage	
Rated frequency	50/60 Hz (selectable by switch)	
Counting range	0 to 99999.9 hours (TH63 series) 0 to 9999.9 hours (TH64 series)	
Minimum time display	0.1 hours (6 min)	
Rated power consumption	Approx. 1.5 W	
Insulation resistance (Initial value)	Min. 100 MΩ, Between live and dead metal parts (At 500 V DC)	
Breakdown voltage (Initial value)	2,000 Vrms, Between live and dead metal parts	
Max. temperature rise	55°C 131°F	
Vibration resistance	Functional	10 to 55 Hz: 1 cycle/min double amplitude of 0.5 mm (10 min on 3 axes)
Shock resistance	Functional	Min 98 m/s ² {10 G} (4 times on 3 axes)
	Destructive	Min 980 m/s ² {100 G} (5 times on 3 axes)
Ambient temperature	-10 to +50°C +14 to +122°F	
Ambient humidity	Max. 85% RH (non-condensing)	
Weight	Approx. 80 g 2.82 oz	

Product types

Type	Operating voltage	Part number	Operating voltage	Part number	Operating voltage	Part number
TH63 series (without reset button)	100V AC	TH631	24V AC	TH634	115 to 120V AC	TH637
	200V AC	TH632	48V AC	TH635	220V AC	TH638
	12V AC	TH633	110V AC	TH636	240V AC	TH639
TH64 series (with reset button)	100V AC	TH641	24V AC	TH644	115 to 120V AC	TH647
	200V AC	TH642	48V AC	TH645	220V AC	TH648
	12V AC	TH643	110V AC	TH646	240V AC	TH649

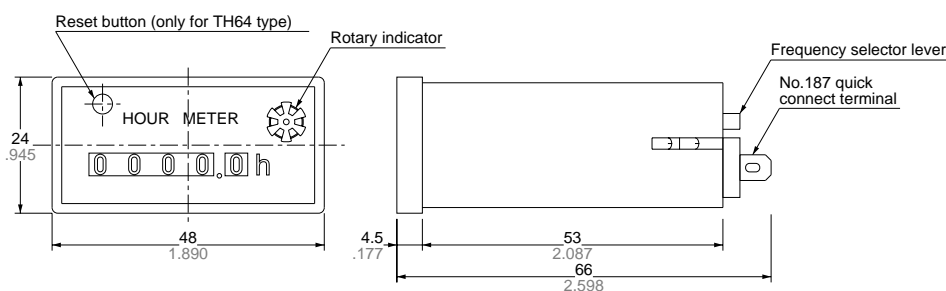
Notes) 1. Only the metallic-looking (silver) panel mounting type is available.
2. Standard products are UL-recognized as well as CSA-certified. There is no need to add "U" at the end of the part number. Just specify the standard part number when ordering.

Applicable standard

Safety standard	EN61010-1	Pollution Degree 2/Overvoltage Category II
EMC	(EMI)EN61000-6-4 Radiation interference electric field strength Noise terminal voltage (EMS)EN61000-6-2 Static discharge immunity	EN55011 Group1 ClassA EN55011 Group1 ClassA
	RF electromagnetic field immunity EFT/B immunity Surge immunity Conductivity noise immunity Power frequency magnetic field immunity Voltage dip/Instantaneous stop/Voltage fluctuation immunity	EN61000-4-2 4 kV contact 8 kV air EN61000-4-3 10 V/m AM modulation (80 MHz to 1 GHz) 10 V/m pulse modulation (895 MHz to 905 MHz) EN61000-4-4 2 kV (power supply line) EN61000-4-5 1 kV (power line) EN61000-4-6 10 V/m AM modulation (0.15 MHz to 80 MHz) EN61000-4-8 30 A/m (50 Hz) EN61000-4-11 10 ms, 30% (rated voltage) 100 ms, 60% (rated voltage) 1,000 ms, 60% (rated voltage) 5,000 ms, 95% (rated voltage)

Dimensions

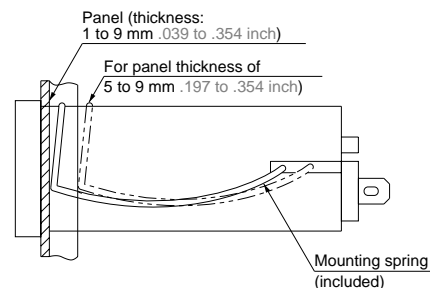
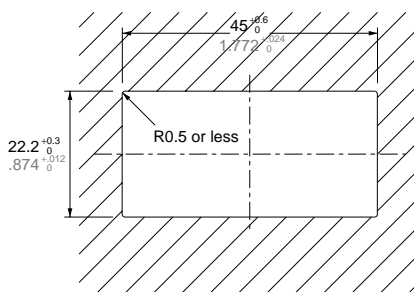
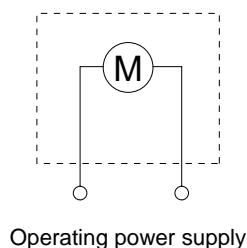
mm inch
General tolerance: ±0.5 ±.020



Wiring diagram

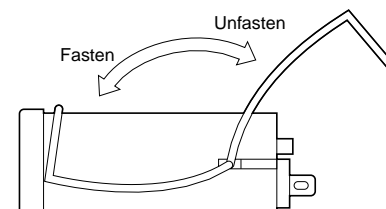
mm inch

• Panel cutout dimensions



Mounting

- Cut a 22.2^{+0.3} × 45^{+0.6} mm (.874^{+0.012} × 1.772^{+0.024} inch) opening in the panel.
- Swing the mounting spring to the rear of the hour meter and fit the hour meter into the panel opening. (There is no need to detach the mounting spring from the hour meter.) If the panel is 5 to 9 mm .197 to .354 inch thick, move the mounting spring to the other hole toward the rear of the hour meter.
- Swing the mounting spring to the front of the hour meter to secure the hour meter to the panel.
- Wire the supplied quick connectors and connect to the hour meter. Be sure to use the supplied insulating sleeves to cover the connectors.



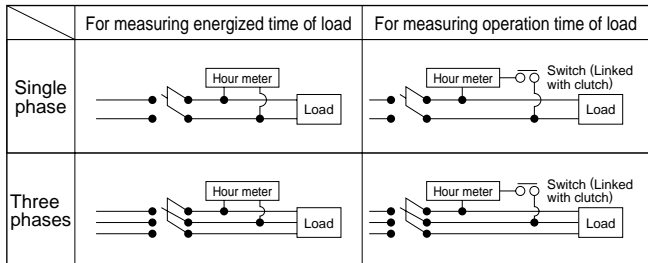
PRECAUTIONS IN USING THE HOUR METERS

1. Frequency setting

Frequency is specified for AC motor-driven hour meters. Before installing, be sure to check your local power frequency.

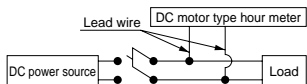
2. Connections

- TH13,23,14,24,40,50,63,64



Note) Make the connection with the accompanying flat connector first and then with the hour meter's terminal (#187). In such case, be sure to cover the connection with the accompanying insulating sleeve.

- TH70, TH8



Note) Solder the lead wires in position.

3. Safety precautions

Do not use the hour meters in the following places.

- Where ambient temperature is below -10° or above $+50^{\circ}\text{C}$
- In wet, dusty or gaseous environments
- Where exposed to vibrations and shocks
- Outdoors, or where exposed to rain or direct sunlight

4. Compliant with CE.

- LH2H

Ambient conditions:

Overvoltage category III, contamination factor 2, indoor use.
Ambient temperature and humidity -10 and $+55^{\circ}\text{C}$ and 35% to 85%RH respectively.

- TH13, 23, 14, 24, 40, 50, 63, 64

Ambient conditions:

Overvoltage category II, contamination factor 2, indoor use.
Ambient temperature and humidity -10 and $+50^{\circ}\text{C}$ and below 85%RH respectively.

5. Reset-type hour meter

- Precautions for use

If the number indications are off before use, press the reset button and confirm that all zeroes ("0") are displayed.

- Resetting caution

Exercise due caution as an insufficient amount of pressure on the reset button may result in abnormal readings.

6. Acquisition of CE marking

Please abide by the conditions below when using in applications that comply with EN 61010-1/IEC 61010-1

- 1) Ambient conditions

- Overvoltage category II, pollution level 2
- Indoor use
- Acceptable temperature and humidity range: -10 to $+55^{\circ}\text{C}$, 35 to 85%RH (with no condensation at 20°C)
- Under 2000 m elevation

- 2) Use the main unit in a location that matches the following conditions.

- There is minimal dust and no corrosive gas.
- There is no combustible or explosive gas.
- There is no mechanical vibration or impacts.
- There is no exposure to direct sunlight.
- Located away from large-volume electromagnetic switches and power lines with large electrical currents.

- 3) Connect a breaker that conforms to EN60947-1 or EN60947-3 to the voltage input section.

- 4) Applied voltage should be protected with an overcurrent protection device (example: T 1A, 250 V AC time lag fuse) that conforms to the EN/IEC standards. (Free voltage input type)

16. Pressure Transmitter & Adjustment Unit



Halmac Services (Qld) Pty. Ltd.
A.C.N. 098 852 923
A.B.N. 40 741 712 113

PRESSURE TRANSMITTER & ADJUSTMENT UNIT

1. VEGABAR74 PRESSURE TRANSMITTER
TECHNICAL DETAILS
2. VEGADIS PRESSURE ADJUSTMENT UNIT
TECHNICAL DETAILS

Process pressure/Hydrostatic

VEGABAR 74
VEGABAR 75



Product Information



VEGA

Content

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2	Type overview	4
3	Mounting instructions.	5
4	Electrical connection	
4.1	General prerequisites	6
4.2	Voltage supply	6
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4.5	Wiring plan VEGABAR 74, 75	6
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5.2	Adjustment with VEGADIS 12	7
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7	Dimensions.	12
8	Product code	15

Take note of safety instructions for Ex applications



Please note the Ex specific safety information which you can find on our homepage www.vega.com/services/downloads and which comes with every instrument. In hazardous areas you should take note of the appropriate regulations, conformity and type approval certificates of the sensors and power supply units. The sensors must only be operated on intrinsically safe circuits. The permissible electrical values are stated in the certificate.

1 Description of the measuring principle

Measuring principle

VEGABAR 74 and 75 pressure transmitters are specially adapted to their respective application areas. That is why different sensor elements and measuring units are implemented.

VEGABAR 74

The sensor element of VEGABAR 74 is the dry ceramic-capacitive CERTEC® measuring cell. Base element and diaphragm consist of high purity sapphire-ceramic®.

The process pressure causes via the diaphragm a change in an electrical parameter of the measuring cell. This change is converted into an appropriate output signal.

The CERTEC® measuring cell is also equipped with a temperature sensor. The temperature value can be displayed via the indicating and adjustment module or processed via the signal output.

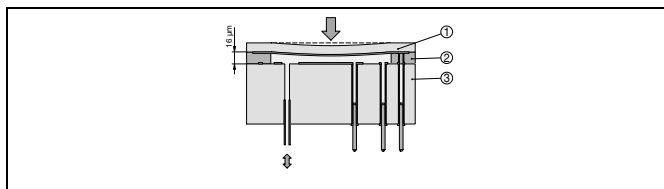


Fig. 1: Configuration of the CERTEC® measuring cell in VEGABAR 74

- 1 Diaphragm
- 2 Soldered glass bond
- 3 Base element

The advantages of the CERTEC® measuring cell are:

- Very high overload resistance
- No hysteresis
- Excellent long-term stability
- Completely front flush installation
- Good corrosion resistance
- Very high abrasion resistance

VEGABAR 75

The METEC® measuring cell is the measuring unit of VEGABAR 75. This unit consists of a CERTEC® measuring cell and a special isolating system with metallic process diaphragm. A special feature of this isolating system is the direct mechanical compensation of temperature influence.

The process pressure causes via the diaphragm a change in an electrical parameter of the measuring cell. This change is converted into an appropriate output signal.

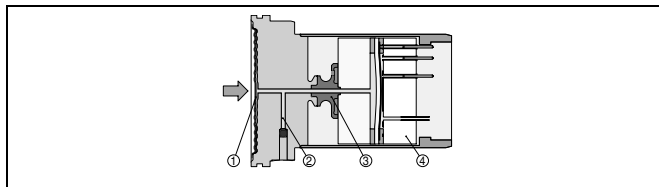


Fig. 2: Configuration of the METEC® measuring cell in VEGABAR 75

- 1 Diaphragm Hastelloy C276
- 2 Isolating liquid (approx. 0.3 cm³, FDA-listed)
- 3 FeNi adapter
- 4 CERTEC® measuring cell

The advantages of the METEC® measuring cell are:

- Completely welded, elastomer-free
- Very high overload resistance
- Full vacuum resistance (also with 0.1 bar measuring range)
- Good thermo-shock reaction
- Excellent long-term stability
- High degree of flushness

Wide application range

VEGABAR 74 and 75 transmitters are designed for front flush process pressure measurement of gases, vapours and liquids. Their application-optimised housings in IP 68 and high resistance materials ensure reliable use even in harsh environments and in extremely moist areas. Thanks to their compact configuration with completely integrated electronics, the instruments can be connected directly to the respective signal processing equipment.

VEGABAR 74 is best suited for use in abrasive media in the paper industry or in waste water treatment.

VEGABAR 75 with its hygienic fittings is particularly suitable for the food processing and pharmaceutical industries.



Information:

Continuative documentation such as operating instructions manuals:

- 28432 - VEGABAR 74
- 28433 - VEGABAR 75

2 Type overview

VEGABAR 74



VEGABAR 75



Measuring cell:	CERTEC®	METEC®
Diaphragm:	Ceramic	Metal
Media:	gas, vapours and liquids, also abrasive	gases, vapours and liquids also with higher temperatures
Process fitting:	Thread from 1½", flanges from DN 40, fittings for the food processing and paper industry	Thread from 1½", flanges from DN 40, fittings for the food processing industry
Material:	316L	316L
Measuring range:	-1 ... 60 bar (-14.5 ... 870 psi)	-1 ... 25 bar (-14.5 ... 363 psi)
Smallest measuring range:	0.1 bar (1.45 psi)	0.1 bar (1.45 psi)
Process temperature:	-40 ... +120 °C (-40 ... +248 °F)	-12 ... +200 °C (-40 ... +392 °F)
Deviation in characteristics:	< 0.075 %	< 0.075 %
Signal output:	4 ... 20 mA/HART	4 ... 20 mA/HART
Remote adjustment/ indication:	VEGADIS 12	VEGADIS 12

3 Mounting instructions

Installation position

VEGABAR functions in any installation position. Depending on the measuring system, the installation position can influence the measurement. This can be compensated by a position correction.



Information:

We recommend using parts from the line of VEGA mounting accessories.

4 Electrical connection

4.1 General prerequisites

The supply voltage range can differ depending on the instrument version. You can find exact specifications in chapter "Technical data".

The national installation standards as well as the valid safety regulations and accident prevention rules must be observed.



In hazardous areas you should take note of the appropriate regulations, conformity and type approval certificates of the sensors and power supply units.

4.2 Voltage supply

Supply voltage and current signal are carried on the same two-wire cable. The requirements on the power supply are specified in chapter "Technical data".

The VEGA power supply units VEGATRENN 149AEx, VEGAS-TAB 690, VEGADIS 371 as well as VEGAMET signal conditioning instruments are suitable for power supply. When one of these instruments is used, a reliable separation of the supply circuits from the mains circuits according to DIN VDE 0106 part 101 is ensured.

4.3 Connection cable

Generally

The sensors are connected with standard cable without screen. An outer cable diameter of 5 ... 9 mm ensures the seal effect of the cable entry.

4 ... 20 mA/HART two-wire and four-wire

If electromagnetic interference is expected which is above the test values of EN 61326 for industrial areas, screened cable should be used. In HART multidrop mode the use of screened cable is generally recommended.



In Ex applications, the corresponding installation regulations must be noted for the connection cable.

4.4 Cable screening and grounding

If screened cable is necessary, the cable screen must be connected on both ends to ground potential. If potential equalisation currents are expected, the connection on the evaluation side must be made via a ceramic capacitor (e.g. 1 nF, 1500 V).

4.5 Wiring plan VEGABAR 74, 75

Direct connection

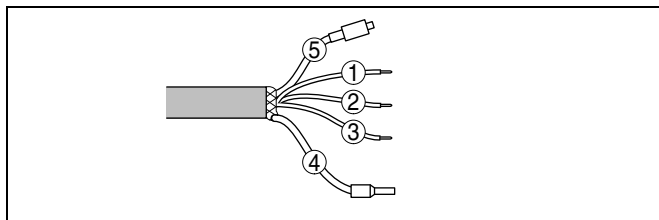


Fig. 3: Wire assignment, connection cable

- 1 brown (+): to power supply or to the processing system
- 2 blue (-): to power supply or to the processing system
- 3 yellow: is only required with VEGADIS 12, otherwise connect to minus
- 4 Screen
- 5 Breather capillaries with filter element

Connection via VEGABOX 02

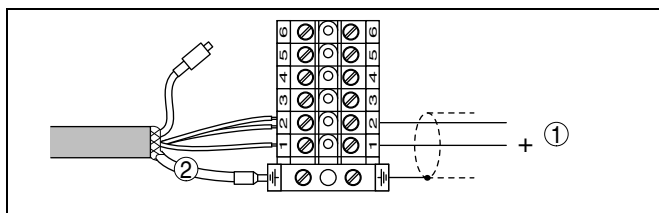


Fig. 4: Terminal assignment VEGABAR

- 1 To power supply or the processing system
- 2 Screen

Connection via VEGADIS 12

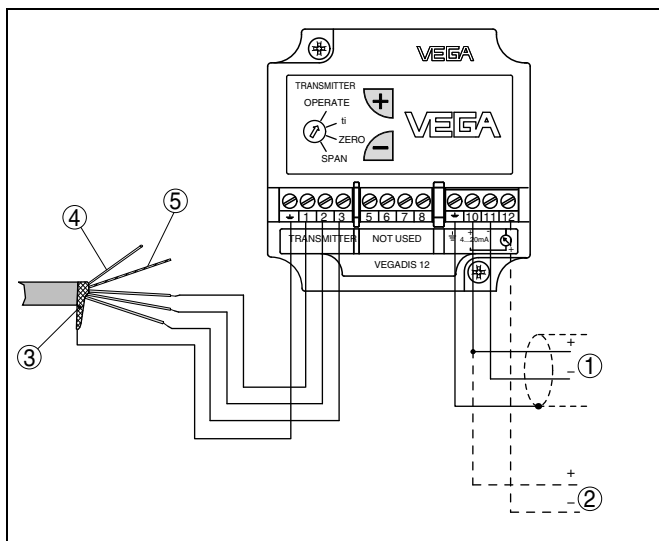


Fig. 5: Terminal assignment, VEGADIS 12

- 1 To power supply or the processing system
- 2 Control instrument (4 ... 20 mA measurement)
- 3 Screen
- 4 Breather capillaries
- 5 Suspension cable

5 Operation

5.1 Overview

VEGABAR 74 and 75 can be adjusted with the following adjustment media:

- Indication/Adjustment VEGADIS 12
- Adjustment software according to FDT/DTM standard, e.g. PACTware™ and PC
- HART handheld

5.2 Adjustment with VEGADIS 12

VEGADIS 12

VEGADIS 12 is connected directly to the connection or suspension cable of VEGABAR or VEGAWELL. It is looped into the supply and signal circuit and requires no separate external energy.

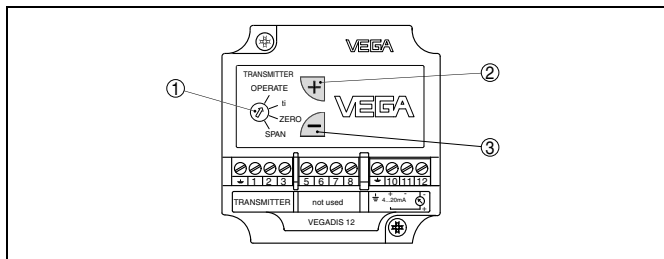


Fig. 6: Adjustment elements of VEGADIS 12

- 1 Rotary switch: choose the requested function
- 2 [+] key change value
- 3 [-] key change value

5.3 Adjustment with PACTware™

PACTware™/DTM

VEGABAR 74 and 75 sensors are adjusted via the signal cable by means of PACTware™.

An instrument driver for the respective VEGABAR is necessary for the adjustment with PACTware™.

All currently available VEGA DTMs are provided as DTM Collection with the current PACTware™ version on CD. They are available from the responsible VEGA agency for a token fee. The basic version of this DTM Collection incl. PACTware™ is available as a free-of-charge download from the Internet.

To use the entire range of functions of a DTM, incl. project documentation, a DTM licence is required for that particular instrument family, e.g. VEGABAR. This licence can be bought from the VEGA agency serving you.

Connection of the PC via VEGACONNECT 3

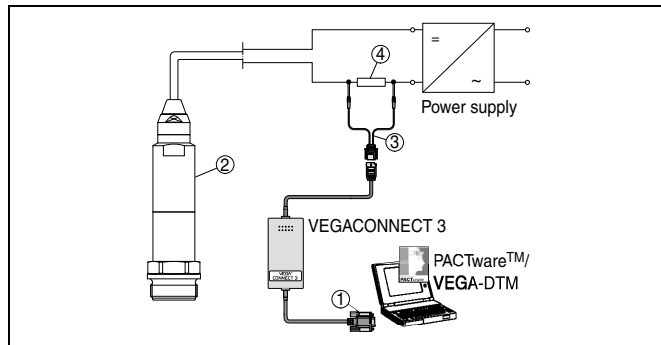


Fig. 7: Connecting the PC to the signal cable

- 1 RS232 connection (with VEGACONNECT 3) or USB connection (with VEGACONNECT 4)
- 2 VEGABAR
- 3 HART adapter cable
- 4 HART resistor 250 Ω

Connection of the PC via VEGACONNECT 4

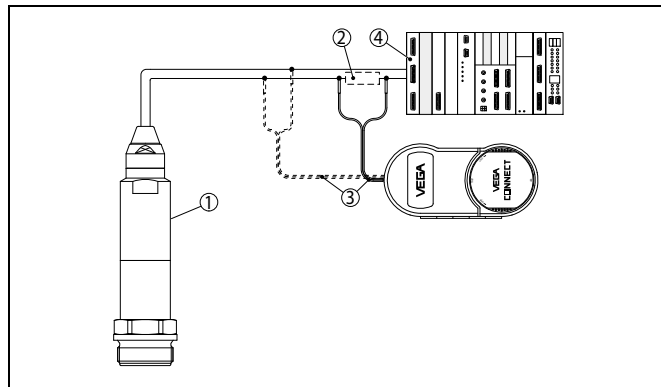


Fig. 8: Connecting the PC via HART to the signal cable

- 1 VEGABAR
- 2 HART resistor 250 Ω (optional depending on processing)
- 3 Connection cable with 2 mm pins and terminals
- 4 Processing system/PLC/Voltage supply

5.4 Adjustment with other adjustment programs

PDM

For VEGA PA sensors, instrument descriptions for the adjustment program PDM are available as EDD. The instrument descriptions are already implemented in the current version of PDM. For older versions of PDM, a free-of-charge download is available via Internet.

AMS

For VEGA FF sensors, instrument descriptions for the adjustment program AMS™ are available as DD. The instrument descriptions are already implemented in the current version of AMS™. For older versions of AMS™, a free-of-charge download is available via Internet.

6 Technical data

General data

Material 316L corresponds to 1.4404 or 1.4435

VEGABAR 74

Materials, wetted parts

– Process fitting	316L
– Diaphragm	sapphire ceramic® (99.9 % oxide ceramic)
– Seal	FKM (Viton), Kalrez 6375, EPDM, Chemraz 535
– Seal process fitting thread G½ A, G1½ A	Klingersil C-4400

VEGABAR 75

Materials, wetted parts

– Process fitting	316L
– Process diaphragm	Hastelloy C276

Materials, non-wetted parts

– Isolating liquid	med. white oil, FDA listed (silicone-free)
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Common data

Materials, non-wetted parts

– Housing	316L
– Ground terminal	316Ti/316L
– Connection cable	PUR, FEP, PE
– type label support on cable	PE-HART
Weight	0.8 ... 8 kg (1.764 ... 17.64 lbs), depending on process fitting

Output variable

Output signal	4 ... 20 mA/HART
Failure signal	22 mA (3.6 mA), adjustable
Max. output current	22.5 mA
Damping (63 % of the input variable)	0 ... 10 s, adjustable
Step response or adjustment time	70 ms (ti: 0 s, 0 ... 63 %)
Fulfilled NAMUR recommendations	NE 43

Additional output variable - temperature (with VEGABAR 74)

Processing is made via HART-Multidrop

Range	-50 ... +150 °C (-58 ... +302 °F)
Resolution	1 °C (1.8 °F)
Accuracy	
– in the range of 0 ... +100 °C (+32 ... +212 °F)	±3 K
– in the range of -50 ... 0 °C (-58 ... +32 °F) and +100 ... +150 °C (+212 ... +302 °F)	typ. ±4 K

Input variable

Parameter	Level
Measuring range	see product code
Turn down	
– recommended	1 : 10
– Max.	1 : 30

Reference conditions and actuating variables (similar to DIN EN 60770-1)

Reference conditions according to DIN EN 61298-1

– Temperature	+18 ... +30 °C (+64 ... +86 °F)
– Relative humidity	45 ... 75 %
– Air pressure	860 ... 1060 mbar/86 ... 106 kPa (12.5 ... 15.4 psi)
Determination of characteristics	limit point adjustment according to DIN 16086
Characteristics	linear
Calibration position	upright, diaphragm points downward

Deviation determined according to the limit point method according to IEC 60770¹⁾

Applies to **digital** HART interface as well as to **analogue** current output 4 ... 20 mA. Specifications refer to the set span. Turn down (TD) = nominal measuring range/set span.

Deviation

- Turn down 1 : 1 up to 5 : 1 < 0.075 %
- Turn down > 10 : 1 < 0.015 % x TD

Deviation with absolutely flush process fittings EV, FT

- Turn down 1 : 1 up to 5 : 1 < 0.05 %
- Turn down > 10 : 1 < 0.01 % x TD

Deviation with absolute pressure measuring range 0.1 bar

- Turn down 1 : 1 up to 5 : 1 < 0.25 % x TD
- Turn down > 10 : 1 < 0.05 % x TD

Influence of the product or ambient temperature

Applies to **digital** HART interface as well as to **analogue** current output 4 ... 20 mA. Specifications refer to the set span. Turn down (TD) = nominal measuring range/set span.

Average temperature coefficient of the zero signal

In the compensated temperature range 0 ... +100 °C (212 °F), reference temperature 20 °C (68 °F).

Average temperature coefficient of the zero signal

- Turn down 1 : 1 < 0.05 %/10 K
- Turn down 1 : 1 up to 5 : 1 < 0.1 %/10 K
- Turn down up to 10 : 1 < 0.15 %/10 K

Outside the compensated temperature range

Average temperature coefficient of the zero signal

- Turn down 1 : 1 typ. < 0.05 %/10 K

Thermal change, current output

Applies also to the **analogue** 4 ... 20 mA current output and refers to the set span.

Thermal change, current output < 0.15 % at -40 ... +80 °C (-40 ... +176 °F)

Long-term stability (similar to DIN 16086, DINV 19259-1 and IEC 60770-1)

Applies to **digital** interfaces (HART, Profibus PA, Foundation Fieldbus) as well as for the **analogue** current output 4 ... 20 mA. Specifications refer to the set span. Turn down (TD) = nominal measuring range/set span.

Long-term drift of the zero signal < (0.1 % x TD)/1 year

Ambient conditions

Ambient, storage and transport temperature

- Connection cable PE -40 ... +60 °C (-40 ... +140 °F)
- Connection cable PUR, FEP -40 ... +85 °C (-40 ... +185 °F)

Process conditions**VEGABAR 74**

Product temperature depending on the measuring cell seal

- FKM (e.g. Viton) -20 ... +100 °C (-4 ... +212 °F)
- EPDM -40 ... +100 °C (-40 ... +212 °F), 1 h: 140 °C/284 °F cleaning temperature
- Kalrez 6375 (FFKM) -10 ... +100 °C (+14 ... +212 °F)
- Chemraz 535 -30 ... +100 °C (-22 ... +212 °F)

VEGABAR 75

Medium temperature (temperature: $p_{abs} > 1$ bar (14.5 psi)/ $p_{abs} < 1$ bar (14.5 psi))

- Standard -12 ... +150 °C/-12 ... +130 °C (+10 ... +302 °F/+10 ... +266 °F)
- with cooling element -12 ... +180 °C/-12 ... +130 °C (+10 ... +356 °F/+10 ... +266 °F)
- with cooling element and screening sheet -12 ... +200 °C/-12 ... +130 °C (+10 ... +392 °F/+10 ... +266 °F)

¹⁾ Incl. non-linearity, hysteresis and non-repeatability.

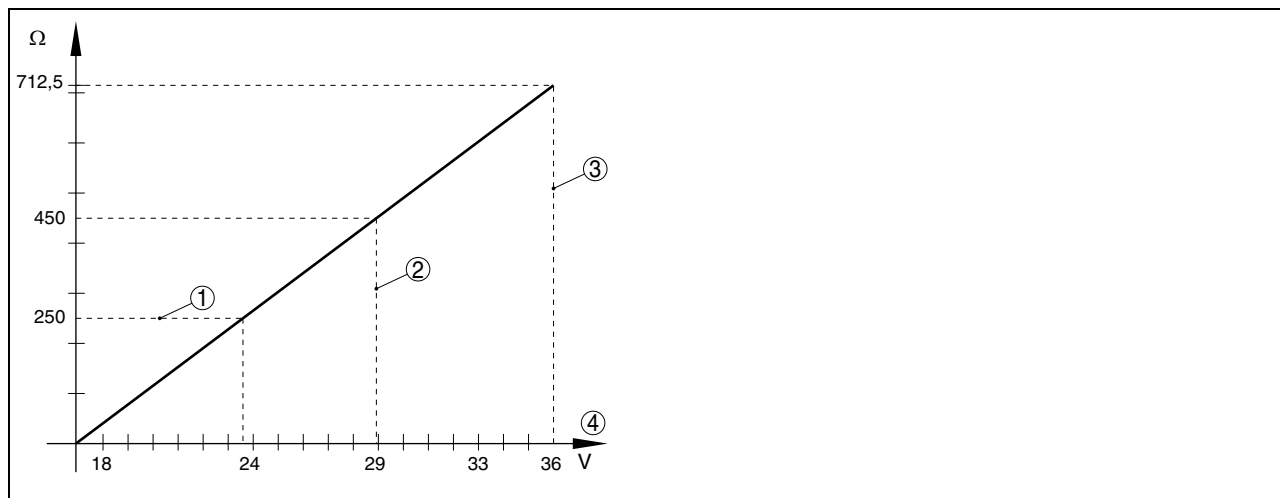


Fig. 10: Voltage diagram

- 1 HART load
- 2 Voltage limit Ex instrument
- 3 Voltage limit non-Ex instrument
- 4 Supply voltage

Electrical protective measures

Protection	IP 68 (25 bar)/IP 69K
Overvoltage category	III
Protection class	III

Approvals⁴⁾⁵⁾

ATEX ia	ATEX II 1G EEx ia IIC T6, ATEX II 2G EEx ia IIC T6
ATEX D	ATEX II 1/2D, 2D IP6X T
ATEX ia+D	ATEX II 1G EEx ia IIC T6, ATEX II 1/2D, 2D IP6X T
Ship approval	GL, LRS, ABS, CCS, RINA, DNV
Other approvals	WHG

CE conformity

EMC (89/336/EWG)	Emission EN 61326: 1997 (class B), susceptibility EN 61326: 1997/A1: 1998
LVD (73/23/EWG)	EN 61010-1: 2001

Environmental instructions

VEGA environment management system You can find detailed information under www.vega.com .	certified according to DIN EN ISO 14001
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⁴⁾ Deviating data in Ex applications: see separate safety instructions.
⁵⁾ You can find detailed information under www.vega.com.

7 Dimensions

VEGABAR 74 - threaded fitting

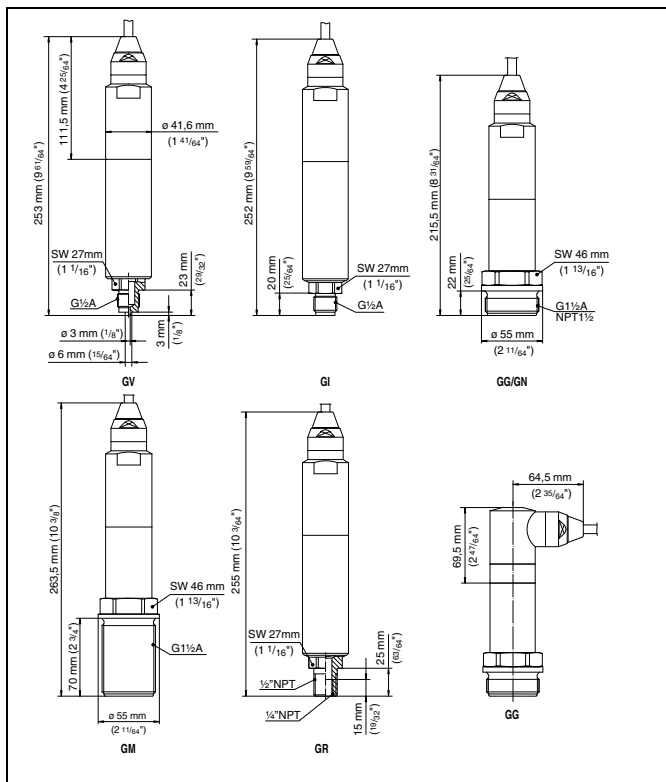


Fig. 11: VEGABAR 74 - threaded fitting: GV = G½ A manometer connection EN 837, GI = G½ A inner G¼ A, GG = G1½ A, GN = ½ NPT, GM = G1½ A 70 mm

VEGABAR 74 - hygienic fitting 1

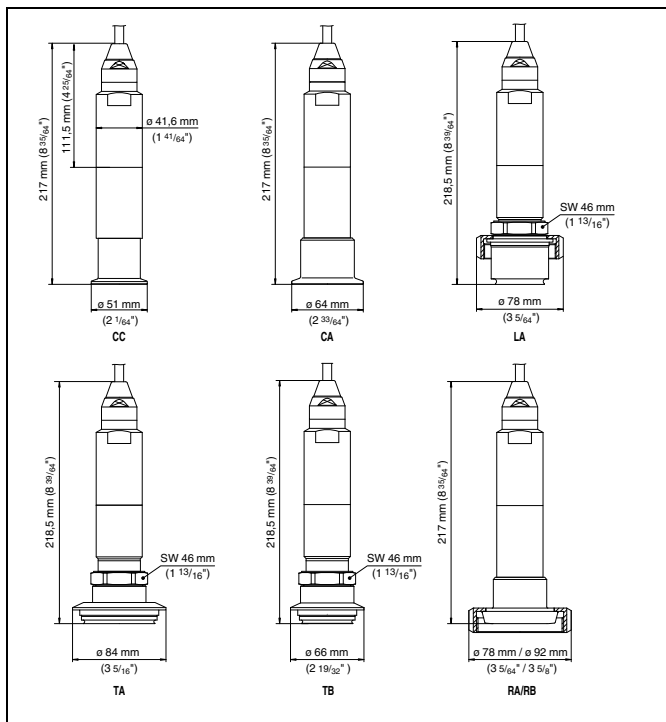


Fig. 12: VEGABAR 74 - hygienic fitting: CC = Tri-Clamp 1½", CA = Tri-Clamp 2", LA = hygienic fitting with compression nut F40, TA = Tuchenhagen Varivent DN 32, TB =

Tuchenhagen Varivent DN 25, RA/RB = bolting DN 40/DN 50 according to DIN 11851, KA = conus DN 40

VEGABAR 74 - hygienic fitting 2

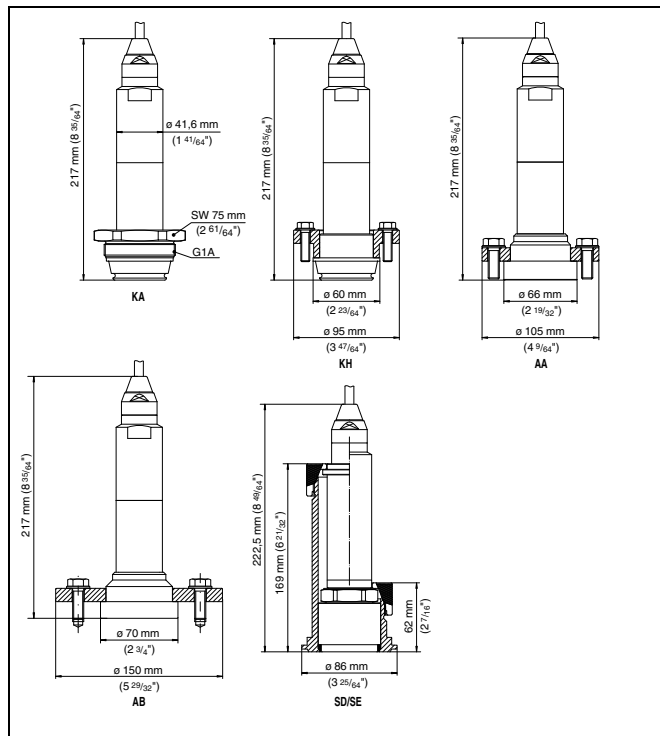


Fig. 13: VEGABAR 74 AA = DRD, KA = conus DN 40

VEGABAR 74 - flange fitting

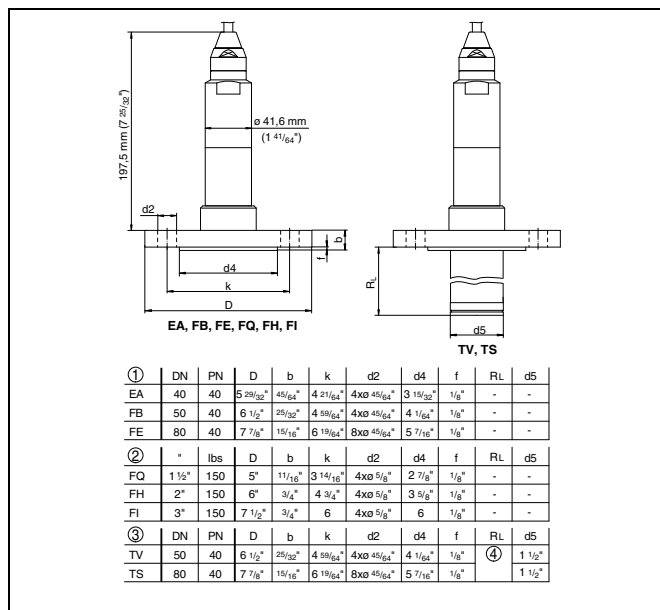


Fig. 14: VEGABAR 74 - flange fitting

- 1 Flange connection according to DIN 2501
- 2 Flange fitting according to ANSI B16.5
- 3 Flange with extension
- 4 Order-specific

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VEGABAR 74 - threaded fitting for paper industry

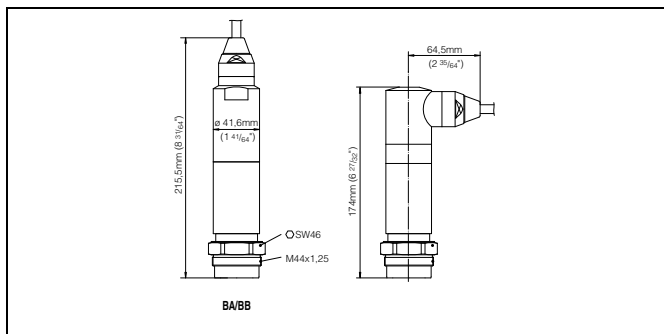


Fig. 15: VEGABAR - connection for paper industry: BA/BB = M44 x 1.25

VEGABAR 74 - extension fitting for paper industry

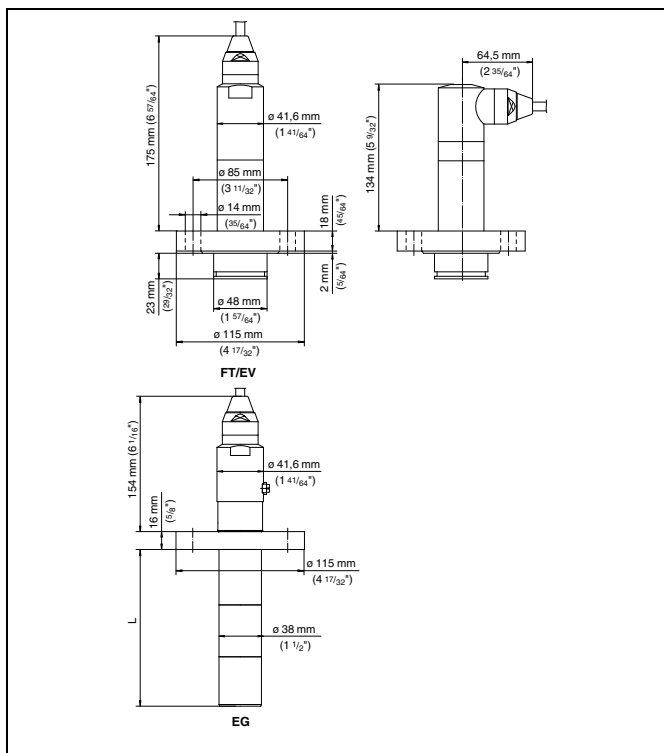


Fig. 16: VEGABAR - extension fitting for paper industry: EV/FT = absolutely flush for pulper (EV 2-times flattened), EG = extension for ball valve fitting (L = order-specific)

VEGABAR 75 - threaded fitting

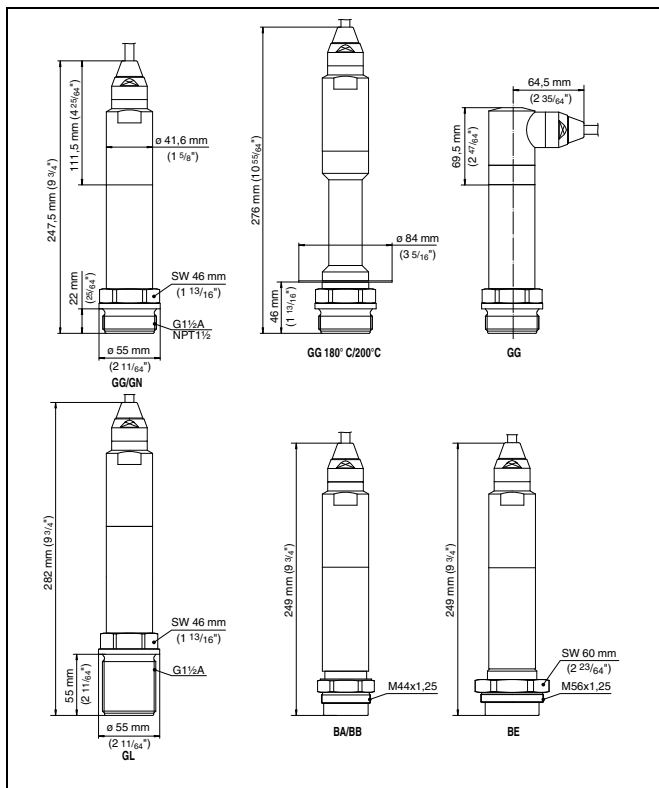


Fig. 17: VEGABAR - threaded fitting: GG = G1 1/2 A, GN = 1 1/2 NPT, GL = G1 1/2 A thread length 55 mm, BB = M44 x 1.25, BE = M56 x 1.25

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VEGABAR 75 - hygienic fitting 1

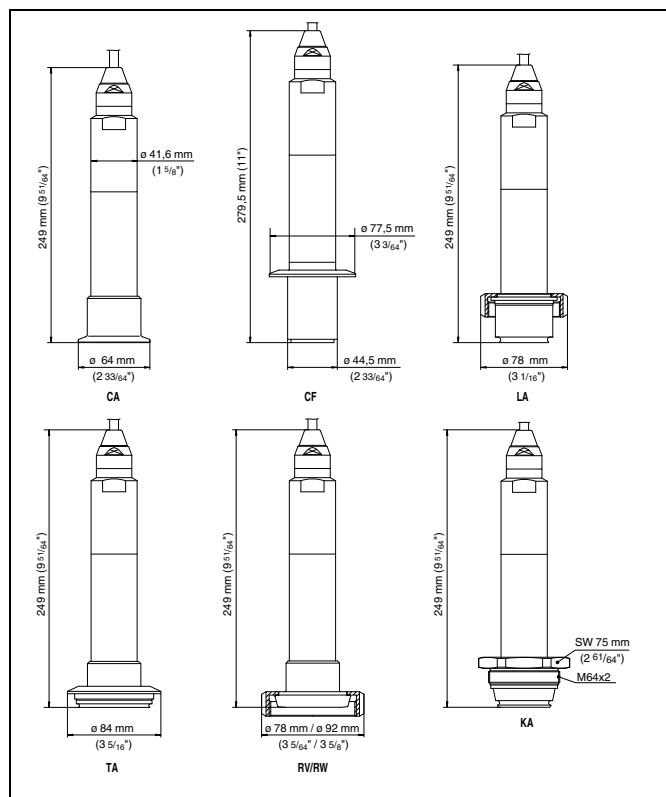


Fig. 18: VEGABAR 75 - hygienic fitting: CA/CF = Tri-Clamp 2"/Tri-Clamp 2½", LA = hygienic fitting with compression nut F40, TA = Tuchenhagen Varivent DN 32, RV/RW = bolting DN 40/DN 50 according to DIN 11851, KA = conus DN 40, AA = DRD

VEGABAR 75 - hygienic fitting 2

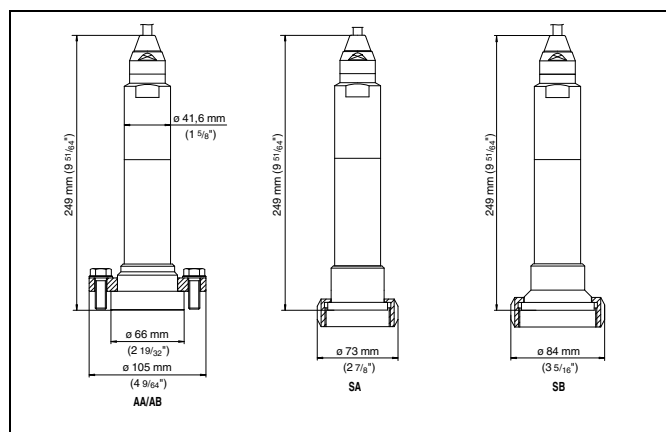


Fig. 19: VEGABAR 75 - hygienic fitting: SA = SMS DN 38, SB = SMS DN 51

VEGABAR 75 - flange fitting

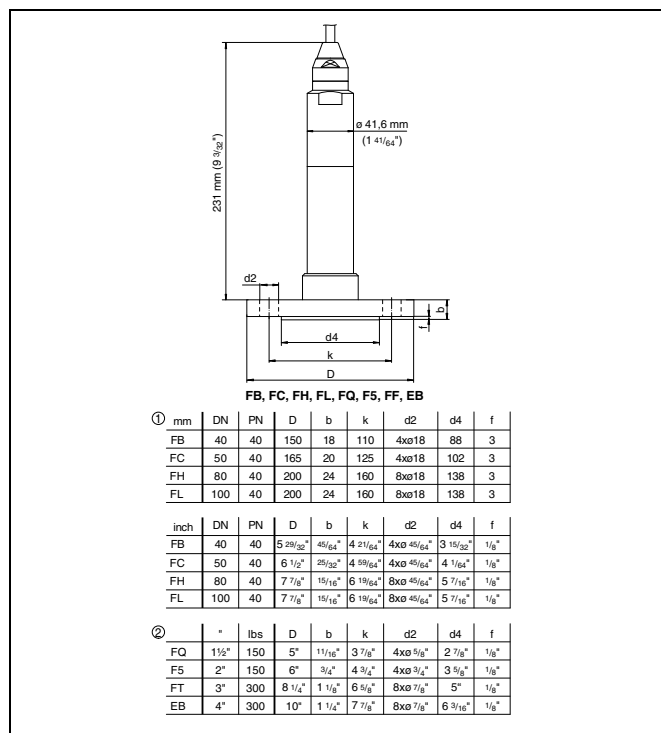


Fig. 20: VEGABAR - flange connection

- 1 Flange connection according to DIN 2501
- 2 Flange fitting according to ANSI B16.5

Indicating and adjustment

VEGADIS 11
VEGADIS 12
VEGADIS 61
PLICSCOM
VEGADIS 175



Product Information



VEGA

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Take note of safety instructions for Ex applications



Please note the Ex specific safety information which you will find on our homepage www.vega.com/services/downloads and which come with the appropriate instrument with Ex approval. In hazardous areas you should take note of the appropriate regulations, conformity and type approval certificates of the sensors and power supply units. Each VEGADIS with Ex approval is an associated, intrinsically safe instrument and must not be installed in hazardous areas.

1 Product description

In continuous measurement, the level in a vessel or the pressure in a pipeline, for example, is detected by a sensor. The measured value is converted into an analogue 4 ... 20 mA output signal or a digital output signal, e.g. Profibus PA. The output signal is then further processed, e.g. in a PLCS or a control system.

On-site indication of the measured value or sensor adjustment is often desired. To fulfill this need, VEGA offers a wide range of indicating instruments. Indication, power supply and mounting differ depending on the model. This product information manual provides an overview and helps you select a suitable instrument.

VEGADIS 11

VEGADIS 11 is a universal, digital indicating instrument that operates without additional power. It is used for remote (i.e. at some distance from the measuring site) measured value indication. VEGADIS 11 can be connected at any point to the 4 ... 20 mA signal cable. It is suitable for any VEGA sensor as well as sensors from other manufacturers, i.e. for active (four-wire) as well as passive (two-wire) sensors.



Fig. 1: Configuration VEGADIS 11

- 1 To the sensor
- 2 To the processing system

Advantages:

- Universal use for active or passive 4 ... 20 mA sensors
- No separate external energy required
- mounting to the wall or on carrier rail

VEGADIS 12

VEGADIS 12 is a digital indicating instrument that operates without additional power. It is used for remote (i.e. at some distance from the measuring site) measured value indication and adjustment of VEGABAR 74, 75 and VEGAWELL 72 - 4 ... 20 mA/HART hydrostatic pressure transmitters. VEGADIS 12 can be connected at any point to the 4 ... 20 mA signal cable. It is provided with a breather facility for sensor ventilation via the capillary line in the special cable.



Fig. 2: Configuration VEGADIS 12

- 1 To the sensor
- 2 To the processing system

Advantages:

- No separate external energy required
- mounting to the wall or on carrier rail

VEGADIS 61

VEGADIS 61 is an external indicating and adjustment module that operates without additional power. It is used for remote (i.e. at some distance from the measuring site) measured value indication and adjustment of VEGA plics® sensors. The sensors can be 4 ... 20 mA, Profibus PA or Foundation Fieldbus sensors. VEGADIS 61 is connected to the sensors with a standard four-wire screened cable up to 25 m long. Communication is carried out via this cable and, what is more, VEGADIS 61 is powered by the sensor. An additional power supply is not required.

PLICSCOM

The indicating and adjustment module PLICSCOM is used for measured value indication, adjustment and diagnosis of VEGA plics® sensors. It is mounted in the respective sensor housing or in the external indicating and adjustment module VEGADIS 61. After mounting, the sensor and PLICSCOM are splash-proof even without housing cover.

An integrated backlight enables reading even under unfavourable lighting conditions. As an option, the display can also be equipped with heating that ensures good readability at low temperatures down to -40 °C (-40 °F).

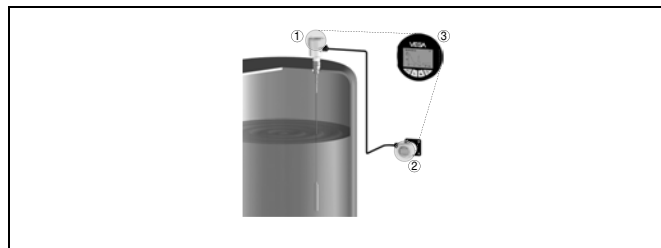


Fig. 3: Configuration VEGADIS 61 and PLICSCOM

- 1 Sensor
- 2 VEGADIS 61
- 3 PLICSCOM

Advantages:

- Universal use for all plics® sensors
- Splash-proof adjustment with open cover
- No separate external energy required
- mounting VEGADIS 61 to the wall, on carrier rail or tube

VEGADIS 175

VEGADIS 175 is a digital indicating instrument for front panel mounting. It can be connected at any point to the 4 ... 20 mA signal cable and is suitable for active (four-wire) as well as passive (two-wire) sensors.

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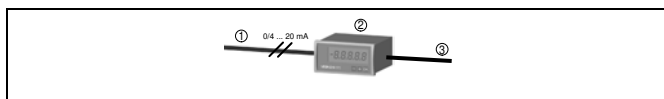


Fig. 4: Configuration VEGADIS 175

- 1 To the sensor
- 2 VEGADIS 175
- 3 To the processing system

Advantages:

- Universal use for passive or 4 ... 20 mA sensors
- No separate external energy required

1.1 Application examples

Pump shaft



Fig. 5: Level measurement in a pump shaft with VEGAWELL 72, remote indication and adjustment with VEGADIS 12

For hydrostatic level measurement in a pump shaft, VEGADIS 12 together a VEGAWELL 72 is well suited for remote indication and adjustment. The min./max. adjustment is carried out on site and the actual measured value can be read out during operation.

Chip silo

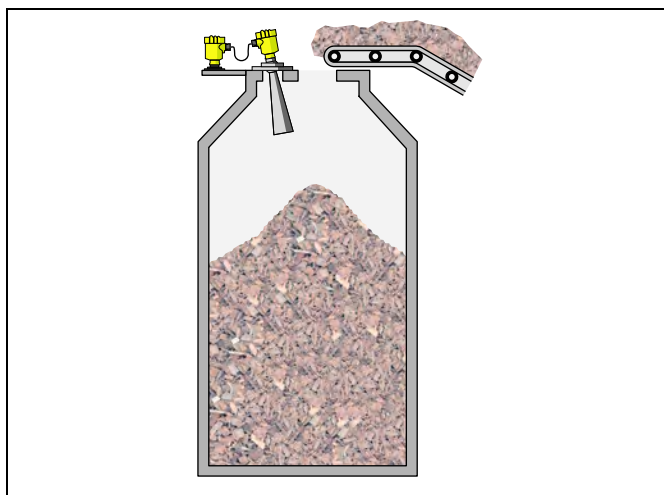


Fig. 6: Level measurement in a chip silo with VEGAPULS 68, remote indication and adjustment with VEGADIS 61

In non-contact level measurement in a chip silo with VEGAPULS 68, the mounting location is not directly accessible. For that reason VEGADIS 61 is an excellent solution for remote indication

and adjustment. The min./max. adjustment can be carried out locally with or without filling.

2 Type overview

VEGADIS 11



VEGADIS 12



VEGADIS 61



Indication:	digital and quasi-analogue	digital and quasi-analogue	Dot-Matrix
Signal:	4 ... 20 mA, 4 ... 20 mA/HART	4 ... 20 mA, 4 ... 20 mA/HART	I ² C bus
Sensors:	4 ... 20 mA passive or active	VEGABAR 74, 75; VEGAWELL 72 - 4 ... 20 mA/HART	plics [®] sensors
Mounting:	Wall, rail mounting	Wall, rail mounting	Wall, rail, tube mounting
Ambient temperature:	-20 ... +70 °C (-4 ... +158 °F)	-20 ... +70 °C (-4 ... +158 °F)	-20 ... +70 °C (-4 ... +158 °F)

PLICSCOM



VEGADIS 175



Indication:	Dot-Matrix	digital
Signal:	I ² C bus	4 ... 20 mA, 4 ... 20 mA/HART
Sensors:	plics [®] sensors	4 ... 20 mA passive or active
Mounting:	in the sensor or in VEGADIS 61	Front panel
Ambient temperature:	-15 ... +70 °C (+5 ... +158 °F)	-10 ... +60 °C (+14 ... +140 °F)

3 Mounting instructions

VEGADIS 11 and VEGADIS 12

VEGADIS 11 and VEGADIS 12 are configured for the following installation and mounting options:

- Carrier rail 35 x 7.5 according to EN 50022
- Wall mounting

Carrier rail mounting

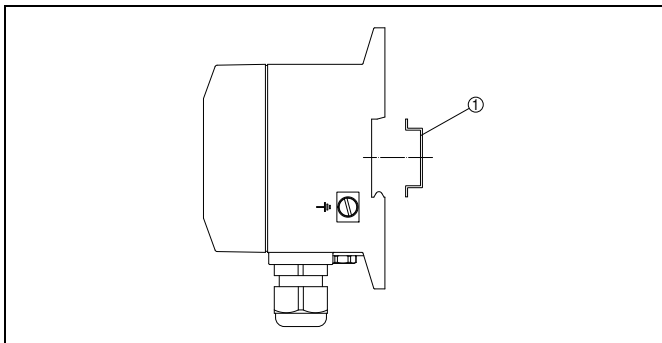


Fig. 7: VEGADIS 11 and VEGADIS 12 carrier rail mounting

- 1 Carrier rail

Wall mounting

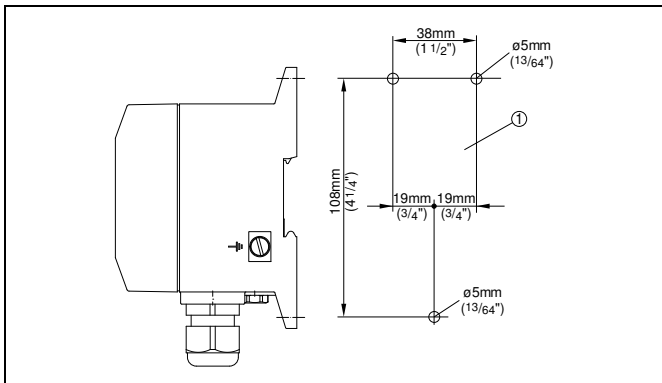


Fig. 8: VEGADIS 11 and VEGADIS 12 wall mounting

- 1 Drill dimension

VEGADIS 61

VEGADIS 61 can be mounted in the following ways:

- Carrier rail 35 x 7.5 according to EN 50022
- Wall mounting
- Tube mounting

Wall mounting

VEGADIS 61 for wall mounting is supplied with a mounting socket.

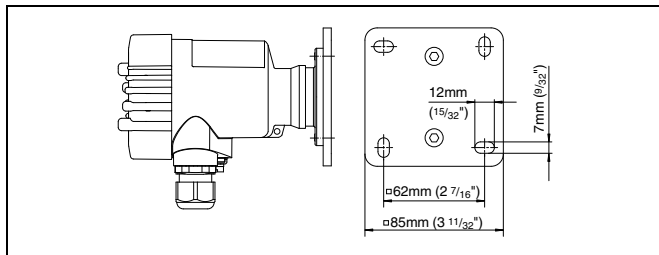


Fig. 9: VEGADIS 61 for wall mounting, bottom view of mounting plate.

- 1 Drill dimension

Carrier rail mounting

VEGADIS 61 for mounting on carrier rail is supplied with a mounting adapter.

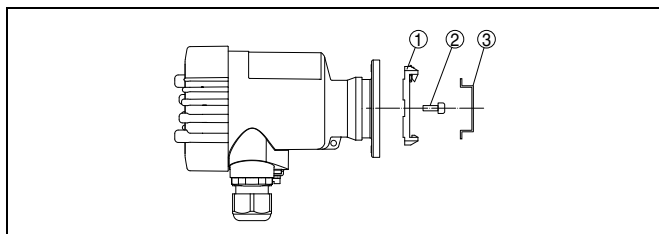


Fig. 10: VEGADIS 61 for mounting on carrier rail

- 1 Adapter plate
- 2 Screw M4 x 6
- 3 Carrier rail

Tube mounting

VEGADIS 61 for tube mounting is supplied with the measuring instrument holder BARMONT.C (comes with delivery as mounting accessory).

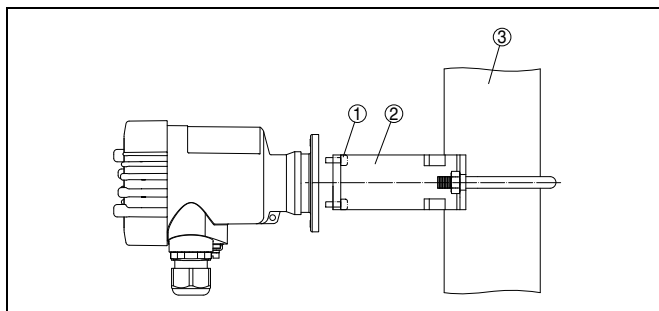


Fig. 11: VEGADIS 61 for tube mounting

- 1 4 screws M5 x 12
- 2 Measuring instrument holder BARMONT.C
- 3 Tube

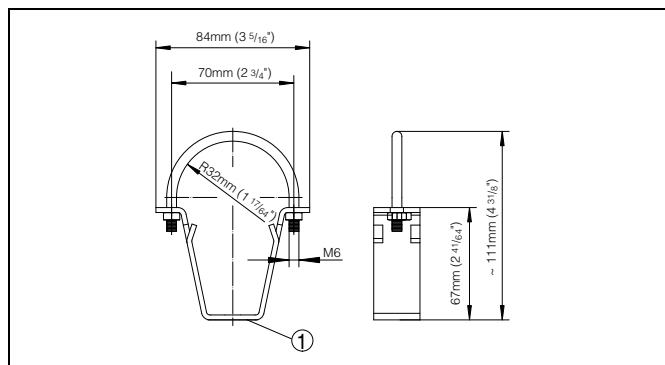


Fig. 12: Measuring instrument holder BARMONT.C

1 4 x holes 5 mm for mounting screws M5 x 12

PLICSCOM

The indicating and adjustment module PLICSCOM can be inserted in the following housing versions and instruments:

- All sensors of the plics[®] instrument family, in the single as well as in the double chamber housing (optionally in the electronics or connection compartment)
- External indicating and adjustment unit VEGADIS 61

VEGADIS 175

VEGADIS 175 can be mounted in the following ways:

- Front panel mounting

Front panel mounting

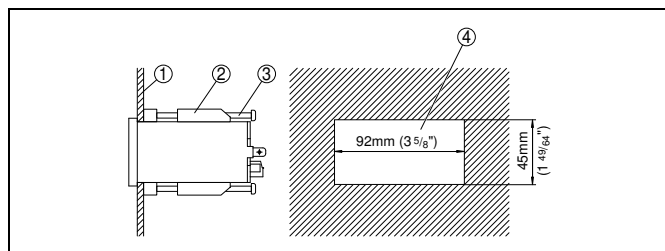


Fig. 13: VEGADIS 175 for panel mounting

- 1 Front panel
- 2 Fixing hook
- 3 Screw

4 Connecting to power supply

4.1 Preparing the connection

Note safety instructions

Always keep in mind the following safety instructions:

- Connect only in the complete absence of line voltage
- If overvoltage surges are expected, overvoltage arresters should be installed



Tip:

We recommend VEGA overvoltage arresters B61-300 (power supply VEGADIS) and B62-36G (sensor supply).

Take note of safety instructions for Ex applications



In hazardous areas you should take note of the appropriate regulations, conformity and type approval certificates of the sensors and power supply units.

Selecting connection cable

Standard two-wire cable without screen is used for connection of the sensors.

Cable screening and grounding

Connect the cable screen on both ends to ground potential. In the sensor, the screen must be connected directly to the internal ground terminal. The ground terminal outside on the housing must be connected to the potential equalisation.

If potential equalisation currents are expected, the screen connection on VEGADIS must be made via a ceramic capacitor (e. g. 1 nF, 1500 V). The low frequency potential equalisation currents are thus suppressed, but the protective effect against high frequency interference signals remains.

Select connection cable for Ex applications



Take note of the corresponding installation regulations for Ex applications. In particular, make sure that no potential equalisation currents flow over the cable screen. In case of grounding on both sides this can be achieved by the use of a capacitor or a separate potential equalisation.

4.2 Wiring plan, VEGADIS 11

Passive sensors

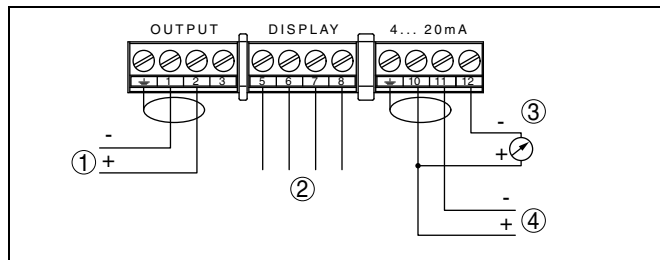


Fig. 14: Wiring plan, VEGADIS 11 for passive sensors

- 1 Sensor (passive)
- 2 Indicating module (assignment see chart)
- 3 Control instrument



Note:

Passive sensors need a power supply. They represent current sinks and emboss a current of 4 ... 20 mA to the supply circuit. The supply voltage is loop through VEGADIS 11. On the output (terminals 1/2), VEGADIS 11 provides the power supply for the connected sensors. Power supply and measured value transmission are carried along the same two-wire cable.

Active sensors

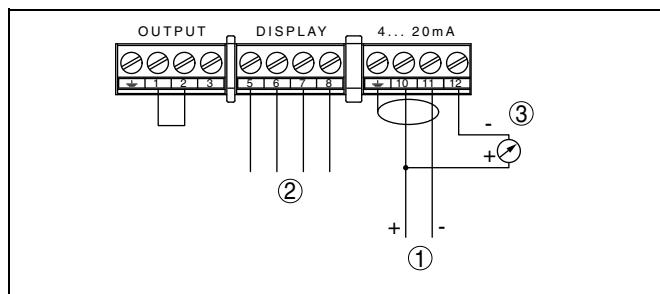


Fig. 15: Wiring plan, VEGADIS 11 for active sensors

- 1 Sensor (active)
- 2 Indicating module
- 3 Control instrument
- 4 Voltage supply/Signal output



Note:

The input (terminals 10/11) is provided for connection of transmitters with own, separate power supply. The output (terminal 1/2) is bridged.

Sensors with signal conditioning instrument

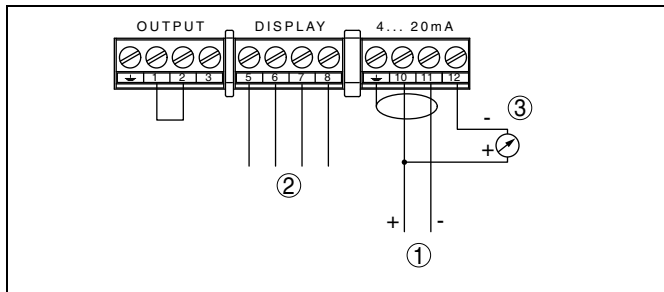


Fig. 16: Wiring plan, VEGADIS 11 for signal conditioning instrument

- 1 Signal conditioning instrument
- 2 Indicating module
- 3 Control instrument



Note:

The input (terminals 10/11) is provided for connection of signal conditioning instruments. Connection and operation in Ex ia is not possible. The output (terminal 1/2) is bridged.

4.3 Wiring plan, VEGADIS 12

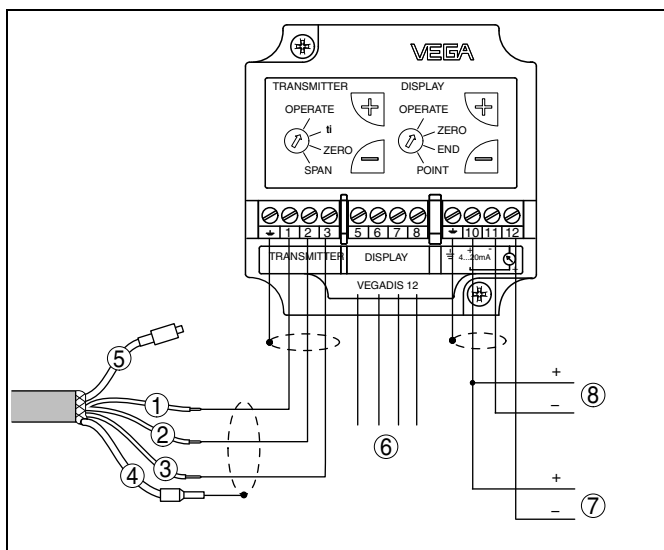


Fig. 17: Wiring plan, VEGADIS 12

- 1 brown (+)
- 2 blue (-)
- 3 Yellow
- 4 Screen
- 5 Breather capillaries with filter element
- 6 Indicating module
- 7 Control instrument
- 8 Voltage supply/Signal output

4.4 Wiring plan, VEGADIS 61

Wiring plan

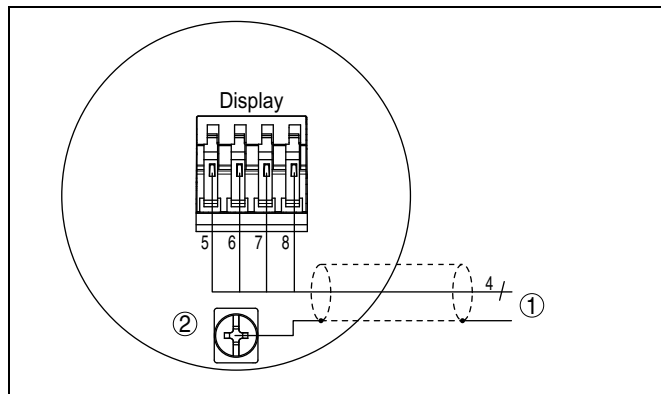


Fig. 18: Wiring plan, single chamber housing

- 1 plics® sensor
- 2 Grounding on both ends with non-Ex. With Ex, grounding at one sensor end is recommended, see EN 60079-14.

4.5 Wiring plan, VEGADIS 175

Passive sensors

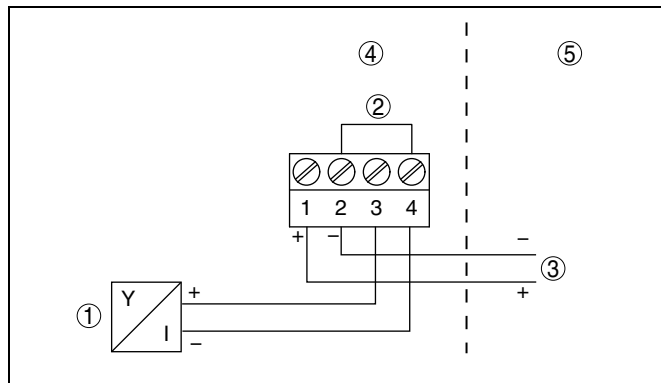


Fig. 19: Wiring plan, VEGADIS 175 for passive sensors

- 1 Sensor (passive)
- 2 Bridged internally
- 3 Voltage supply/Signal output
- 4 Ex area
- 5 Non-Ex area

Active sensors

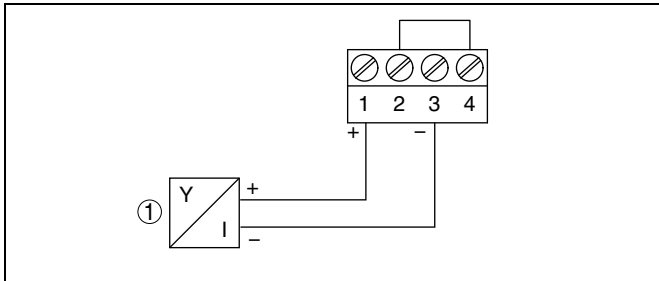


Fig. 20: Wiring plan, VEGADIS 175 for active sensors

- 1 Sensor (active)
- 2 Bridged internally

5 Operation

5.1 Adjustment on VEGADIS 11

The display is located in the housing cover, the adjustment elements are accessible after removing the cover.

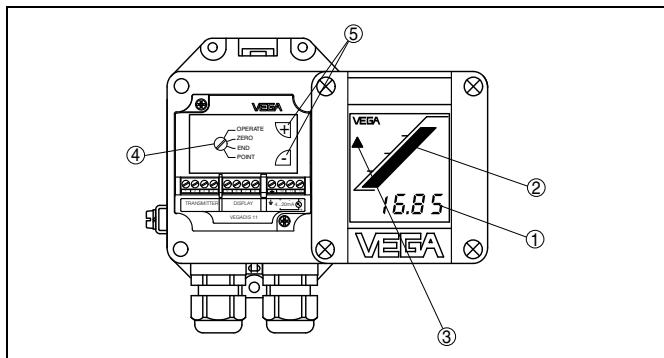


Fig. 21: Indicating and adjustment elements

- 1 Digital indication
- 2 Bar graph indication
- 3 Tendency indication
- 4 Rotary switch
- 5 Adjustment keys +/-

Key functions

- **[Rotary switch]** to select:
 - Operate = Measured value indication
 - ZERO = Adjustment of the min. value
 - SPAN = Adjustment of the max. value
 - Point = Shifting of the decimal point
- **[+/-] key:**
 - Change value of the digital indication

5.2 Adjustment on VEGADIS 12

The display is located in the housing cover, the adjustment elements are accessible after removing the cover.

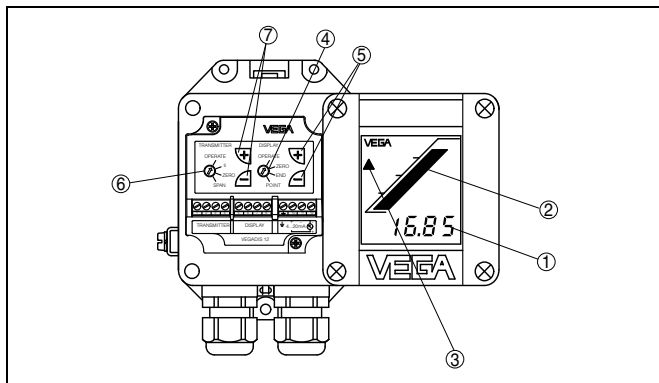


Fig. 22: Indicating and adjustment elements

- 1 Digital indication
- 2 Bar graph indication
- 3 Tendency indication
- 4 Rotary switch "Indication"
- 5 Adjustment keys +/- display
- 6 Rotary switch "Pressure transmitter"
- 7 Adjustment keys +/- Pressure transmitter

Key functions

- **[Rotary switch]** to select:
 - Operate = Measured value indication
 - ZERO = Adjustment of the min. value
 - SPAN = Adjustment of the max. value
 - Point = Shifting of the decimal point
- **[+/-] key:**
 - Change value of the digital indication

5.3 Adjustment on VEGADIS 61 and PLICSCOM

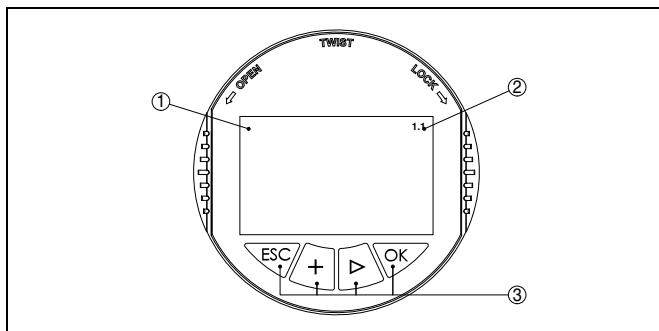


Fig. 23: Indicating and adjustment elements

- 1 LC display
- 2 Indication of the menu item number
- 3 Adjustment keys

Key functions

- **[OK]** key:
 - Move to the menu overview
 - Confirm selected menu
 - Edit parameter
 - Save value

- **[->]** key to select:
 - menu change
 - list entry
 - Select editing position

- **[+]** key:
 - Change value of the parameter

- **[ESC]** key:
 - interrupt input
 - jump to the next higher menu

5.4 Adjustment on VEGADIS 61 with PACTware™

PACTware™/DTM

plics® sensors can be adjusted via PACTware™ independent of the respective signal output 4 ... 20 mA/HART, Profibus PA or Foundation Fieldbus via VEGADIS 61. To adjust with PACTware™, an instrument driver for the particular sensor is required.

All currently available VEGA DTMs are provided as DTM Collection with the current PACTware™ version on CD. They are available from the responsible VEGA agency for a token fee. The basic version of this DTM Collection incl. PACTware™ is available as a free-of charge download from Internet.

To use the entire range of functions of a DTM, incl. project documentation, a DTM licence is required for that particular instrument family. This licence can be bought from the VEGA agency serving you.

Connection of the PC to VEGADIS 61

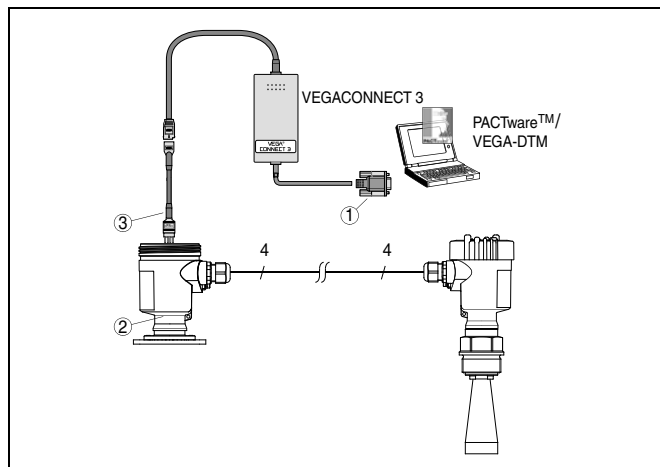


Fig. 24: Connection to VEGADIS 61

- 1 RS232 connection
- 2 VEGADIS 61
- 3 I²C adapter cable for VEGACONNECT 3

To adjust with PACTware™, a VEGACONNECT 3 with I²C adapter cable (art. no. 2.27323) as well as a power supply unit is necessary in addition to the PC and the suitable VEGA-DTM.

5.5 Adjustment on VEGADIS 175

Indication and adjustment are carried out on the front via a clear LC display and three keys.

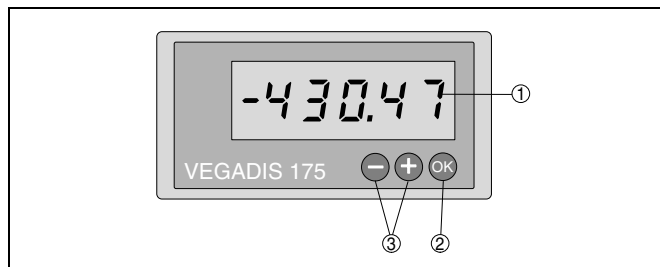


Fig. 25: Indicating and adjustment elements

- 1 Digital indication
- 2 Key (OK)
- 3 Adjustment keys +/-

Key functions

- **[OK]** key:
 - Move to the menu overview
 - Confirm selected menu
 - Edit parameter
 - Save value

- **[+]/[-]** keys:
 - Change value of the parameter

6 Technical data

General data

VEGADIS 11, 12

Series Instrument for panel or wall mounting or mounting on carrier rail 35 x 7.5 according to EN 50022

Materials

– Housing plastic PBT
 – Inspection window of the indication Lexan
 – Breather facility PTFE filter element
 – Ground terminal 316Ti/316L
 Weight approx. 400 g (0.882 lbs)

VEGADIS 61

Series Instrument for panel or wall mounting or mounting on carrier rail 35 x 7.5 according to EN 50022

Materials

– Housing Plastic PBT, Alu die-casting powder-coated, 316L
 – Inspection window in housing cover Polycarbonate (UL-746-C listed)
 – Ground terminal 316Ti/316L
 Weight, depending on the housing material and mounting technology 500 ... 1300 g (1.10 ... 2.87 lbs)

PLICSCOM

Series Module for insertion in VEGADIS 61

Materials

– Housing ABS
 – Inspection window Polyester foil
 Weight approx. 100 g (0.22 lbs)

VEGADIS 175

Series Module unit for front panel mounting

Materials

– Housing front Alu die-casting
 – Housing Sheet steel galvanized
 – Rear of the housing ABS
 Weight approx. 300 g (0.66 lbs)

Input

VEGADIS 11

Connection to individual passive or active sensors 4 ... 20 mA/HART

Transmission

analogue, 4 ... 20 mA
 Max. input current 150 mA
 Connection cable to the sensor 2-wire
 Voltage loss 4.5 V at 20 mA

VEGADIS 12

Connection to VEGAWELL 72 - 4 ... 20 mA/HART, VEGABAR 74, 75

Transmission

analogue, 4 ... 20 mA
 Max. input current 150 mA
 Connection cable to the sensor 3-wire (VEGA special cable with breather capillaries or standard cable)
 Max. cable length 200 m
 Voltage loss 4.5 V at 20 mA

VEGADIS 61

Connection to VEGA plics[®] sensors

Data transmission

digital (I²C-Bus)
 Connection cable 4-wire, screened
 Max. cable length 25 m

VEGADIS 175

Transmission analogue, 4 ... 20 mA (reverse battery protection)

HART protocol	The indicator is suitable for transmission of the HART protocol
Max. input current	150 mA (shortcircuit current)
Voltage loss	< 2 V with 20 mA

Indications

VEGADIS 11, 12

LC multiple function display	
– Bargraph (quasianalogue indication)	20 segments
– Digital value	-9999 ... 9999
– Tendency indicators	Symbols for rising or falling values

VEGADIS 61, PLICSCOM

LC display	in dot matrix
Power supply display light	through the sensor, voltage range see sensor operating instructions manual
Power supply display heating	
– Operating voltage	24 V DC +5 %
– Power	1.7 W
– Switch on point	-5 °C (+23 °F)

VEGADIS 175

LC display	
– Height of figures	17 mm
– Indication range	-19999 ... 19999
– Offset	-19999 ... 32767

Ambient conditions

VEGADIS 11, 12

Ambient temperature	-20 ... +70 °C (-4 ... +158 °F)
Storage and transport temperature	-40 ... +85 °C (-40 ... +185 °F)

VEGADIS 61, PLICSCOM

Ambient temperature	-15 ... +70 °C (+5 ... +158 °F)
Ambient temperature with heating	-40 ... +70 °C (-40 ... +158 °F)
Storage and transport temperature	-40 ... +80 °C (-40 ... +176 °F)

VEGADIS 175

Ambient temperature	-10 ... +60 °C (+14 ... +140 °F)
Storage and transport temperature	-25 ... +70 °C (-13 ... +158 °F)
Climatic class	according to EN 60654-1, class B2

Electrical protective measures

VEGADIS 11, 12

Protection	IP 67
Overvoltage category	III
Protection class	III

VEGADIS 61

Protection	IP 66/IP 67
Overvoltage category	III
Protection class	II

PLICSCOM

Protection	
– unassembled	IP 20
– mounted into VEGADIS 61 without cover	IP 40

VEGADIS 175

Protection	
– between front frame and front panel	IP 65
– Terminal	IP 20

ESD	6 kV/8 kV
Electromagnetic fields	10 V/m
Burst (power supply)	2 kV
Surge	1 kV
Electromagnetic fields	10 V/m

Approvals¹⁾

VEGADIS 11	
ATEX	ATEX II 2G EEx ia IIC T6
VEGADIS 12	
ATEX	ATEX II 2G EEx ia IIC T6
UL	Cl. I,II,II; Div. 1; Gr. A-G
VEGADIS 61	
ATEX ia	ATEX II 1G, 2G EEx ia IIC T6
ATEX D	ATEX II 1/2D IP6X T
IEC	IEC Ex ia IIC T6
FM	FM Cl.I-III, Div1 (IS)
CSA	CSA Cl.I-III, Div1 (IS)
VEGADIS 175	
ATEX	ATEX II 1G EEx ia IIC T6

Environmental instructions

VEGA environment management system certified according to DIN EN ISO 14001
 You can find detailed information under www.vega.com.

¹⁾ Deviating data in Ex applications: see separate safety instructions.

7 Dimensions

VEGADIS 11, 12

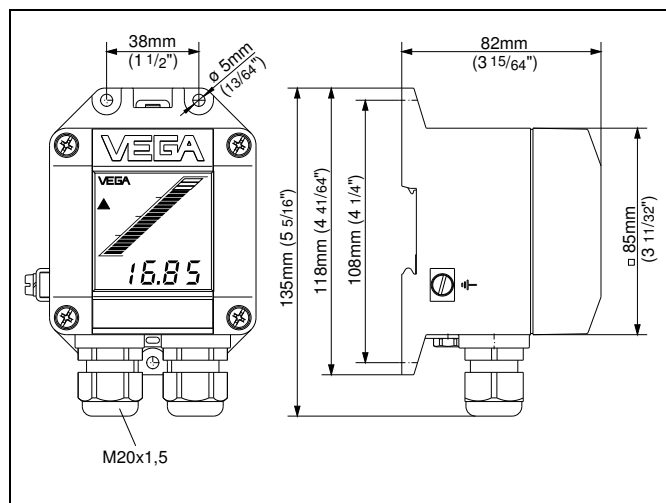


Fig. 26: VEGADIS 11, 12

VEGADIS 61

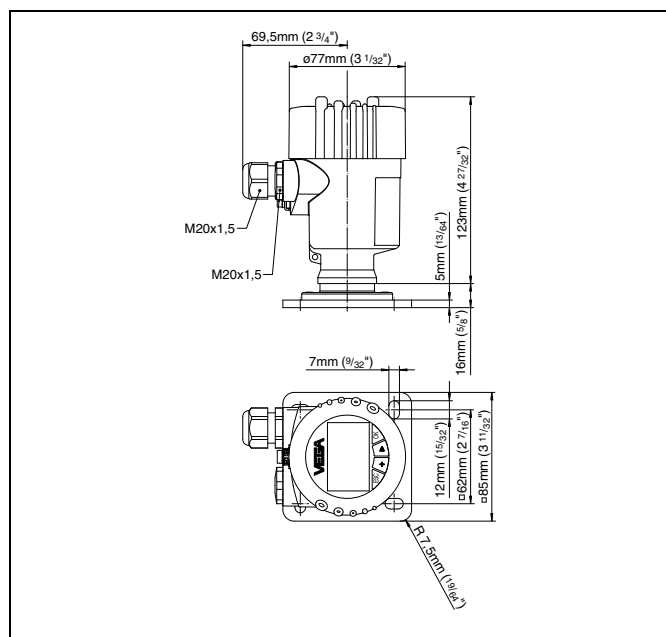


Fig. 27: VEGADIS 61

PLICSCOM

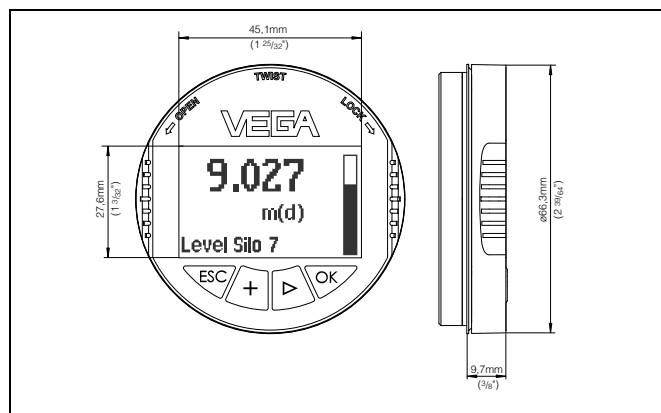


Fig. 28: PLICSCOM

VEGADIS 175

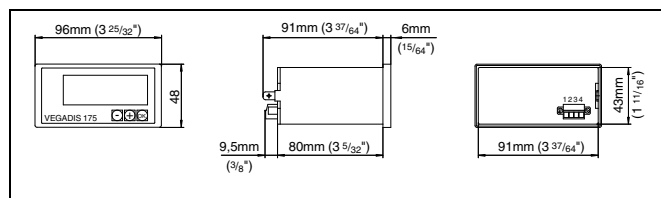
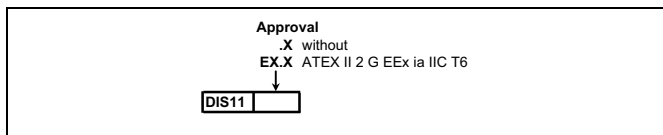


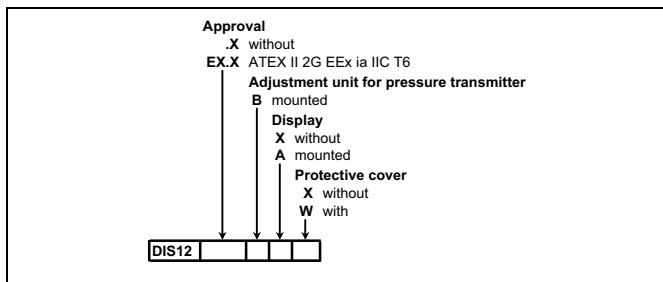
Fig. 29: VEGADIS 175

8 Product code

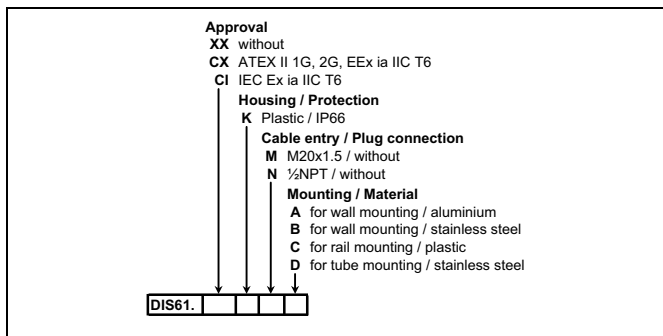
VEGADIS 11



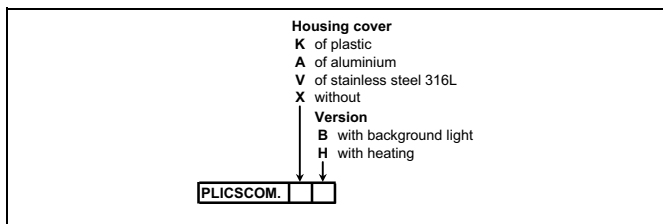
VEGADIS 12



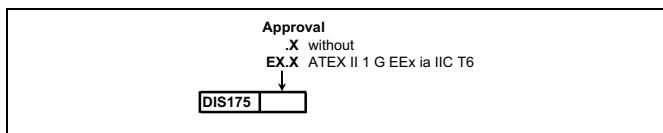
VEGADIS 61



PLICSCOM



VEGADIS 175



30143-EN-071203

17. Radio Modem



Halmac Services (Qld) Pty. Ltd.
A.C.N. 098 852 923
A.B.N. 40 741 712 113

RADIO MODEM

1. DR-900 DATA RADIO MODEM TECHNICAL DETAILS
2. TC-900DR USER MANUAL

D Series

Data Radio Modem

DR900 - Digital Radios

Trio DataCom's **D Series** are high performance cost effective data radio modems designed as an alternative to hard wired data transport. Transmit your data over radio with a fully integrated data radio modem designed for fixed point-to-point and point-to-multipoint applications.

The **D Series** is available as either a half duplex or a full duplex* 853-929 MHz +/- 5MHz radio, including a fully integrated 4800 / 9600 bps data modem. These units operate equally well in either a stand-alone configuration, or as part of a large communication system.

This complete package forms an attractively priced product for the transmission of data over radio in fixed applications thus providing a viable alternative to costly networks of buried media.



Features:

- ❖ Fully integrated half and full duplex* radio and modem
- ❖ Transparent and non-intrusive remote diagnostic facilities (Optional)
- ❖ Inbuilt data routing and multiplexing capabilities, multi-port operation
- ❖ Simultaneous delivery of multiple protocols using Trio DataCom's unique MultiStream™ technology
- ❖ Digital Signal Processing (DSP) modem
- ❖ Selectable 300-19,200 bps asynchronous RS232 user interface
- ❖ Built-in antenna diplexer*
- ❖ Integrated supervisory data channel
- ❖ Unique collision avoidance facility, for unsolicited report-by-exception
- ❖ Software selectable configuration parameters
- ❖ Internal repeater operation
- ❖ Housed in an attractive yet robust metal enclosure
- ❖ Range of ancillary equipment - full duplex base / repeater stations and hot-standby base station

Radio

The **D Series** radio has been designed to meet worldwide regulatory guidelines, including FCC, and has adjustable power output up to 5 Watts. This fully synthesised radio is programmable in 6.25/7.5 kHz increments to accommodate various worldwide channel spacings. The receiver section has a wide tuning range with an excellent signal-to-noise ratio. Exceptional frequency stability is achieved by intelligent microprocessor controlled temperature compensation. An extended operating temperature range of -30 to 60°C makes the unit ideal for commercial and industrial applications.

Modem

The in-built modem includes a custom DSP developed for data communications over narrow band radio systems.

This system offers minimum occupied bandwidth and optimal data integrity (using the standard HDLC protocol with CCITT CRC error detection) inhibiting the transfer of any rogue unwanted data caused by interference or squelch headers / tails.

The Trio DataCom DSP provides:

- the interface between the asynchronous RS232 user communication and the synchronous radio link layer.
- an inbuilt multiplexer / router which allows for simultaneous transportation of multiple protocols over the one radio network.

Applications

The **D Series** is ideal for use in a variety of sophisticated and critical SCADA and Distributed Information Systems, where complex routing of multiple data protocols and remote diagnostics and wireless network management are important factors.

Remote units and a number of full duplex base station / repeater models, suitable for a variety of requirements, make up the **D Series**. At the top of the range, the DH model is a genuine, duplicated hot standby base for systems where nothing short of ultra reliability is acceptable.

Telemetry Systems - Utilities (Gas, Water, Electricity), Railways, Mining, Telecommunications, Industry. Where network status, system control, data collection and fault conditions are required.

Transaction Processing - Point of Sale Credit Terminals, Stock Control, Direct Order, Banks, Building Societies, Stock Brokers, Gambling Organizations, etc, where Point of Sale, inventory, credit, or transaction data requires collection and distribution.

Common Carrier Data Services - The high speed, low cost and spectrum efficiency of this device make it well suited to all forms of common carrier data networking.

Alarm Monitoring - Fire, Power, Intrusion & Essential Services Alarm Reporting.

D Series - Data Radio Modem

DR900 - Digital Radios

Configuration

Configuration using Trio's **D Series** programming software (DRProg) is completely Windows® based for all parameters, such as; frequency, transmitter power, digital mute level, PTT timer, system configurations, port settings.

Network Management & Diagnostic (Optional)

A large distributed network, or even a simple point-to-point link, requires comprehensive fault reporting and diagnostics to ensure a high level of availability. Trio **D Series** data radio modem products offer sophisticated in-built diagnostics using the optional **TView™** software. This capability allows the customer to remotely monitor and maintain their system, minimising the likelihood of failures, by pointing out component degradation and decreasing the time to diagnose and repair. There is no necessity to visit the master station or interfere with the host data integrity, other than additional data transfer. For further details, consult the **TView** data sheet.

Specifications:

RADIO	
Frequency Range**	853-929 MHz +/- 5MHz
Channel Selection	Fully programmable
Frequency Splits	76 MHz Tx/Rx frequency split available including simplex
Frequency Stability	±1ppm (-10 to 60°C ambient, opt. -30 to 70°C) Higher frequency stability options are available due to intelligent processor controlled temperature compensation
Aging	<= 1ppm/annum
Half / Full Duplex	half duplex or full duplex*
Data Rate (rf)	4800 / 9600 bps
Configuration	All configuration via Windows software
TRANSMITTER	
Tx Power	5 W (+37 dBm) or 1 W* (+30 dBm) (software programmable)
Modulation	Narrow band digital filtering binary GMSK
Occupied Bandwidth	Meets various international regulatory guidelines for point-to-point and point-to-multipoint
Tx Attach Time	< 1 mSecond
Timeout Timer	Programmable 1-255 seconds
Tx Spurious	<= -65 dBm
RECEIVER	
Sensitivity	-115 dBm for 12 dB SINAB
Blocking	> 75 dB (EIA)
Intermodulation	<= 70 dB (EIA)
Spurious Response	<= 70 dB (EIA)
Select. and Desense	70 dB (EIA)
AFC Tracking	±3 kHz tracking @ -90 dBm/attack time <10 mS
Mute	Programmable digital mute

Collision Avoidance

A unique fully integrated, yet independent, low speed supervisory data channel embedded within the primary bit-stream provides collision avoidance facilities which are transparent to the user. The use of this feature makes this product ideally suited for reliable, error free data transmissions between stations in high density point-to-multipoint data networks.

The benefits include:

- Multiple asynchronous applications operating on the one radio channel.
- Enhanced performance of report-by-exception networks.

Related Products

- ❖ Base Stations (DB900)
- ❖ Hot Standby Base Station (DH900)
- ❖ 9 Port Stream Router Multiplexer (MSR)
- ❖ Network Management and Diagnostic Software (TView™)
- ❖ D Series Programming Software (DRProg™)

CONNECTIONS	
User Data Port	2 x DB9 RS232 female ports
Antenna	SMA female bulkhead (optional N)
Power	2 pin locking. Mating connector supplied
MODEM	
Data Serial Port #1	Full duplex, DB9 RS232, DCE (modem), 300-19,200 bps asynchronous, hardware/software handshaking
Data Serial Port #2	Full duplex, DB9 RS232, 300-9600 bps asynchronous, software handshaking
Data Storage	On-board RAM
Channel Data Rate	4800 / 9600 bps, full duplex
Bit Error Rate	< 1x10 ⁻⁶ @ -108 dBm (4800 bps) < 1x10 ⁻⁶ @ -105 dBm (9600 bps)
Collision Avoidance	Trio DataCom's unique supervisory channel C/DSMA collision avoidance system
MultiStream™	Trio DataCom's unique simultaneous delivery of multiple data streams (protocols)
GENERAL	
Power Supply	13.8 Vdc nominal (11-16 Vdc)
Transmit Current	600 mA max. @ 1 W 1700 mA max. @ 5 W
Receive Current	175 mA
Dimensions	260 x 161 x 65 mm (robust metal enclosure)
Weight	1.3 kg

* Available for DR900 full duplex 1 W version (853 ± 5 MHz / 929 ± 5 MHz)

** Various sub-frequency bands available.

Note: Model codes previously known as xxxDR are now depicted as DRxxx.

Local regulatory conditions may determine the suitability of individual versions in different countries. It is the responsibility of the buyer to confirm these regulatory conditions.

Performance data indicates typical values related to the described unit. Information subject to change without notice.

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TC-900DR

900 MHz

Full Duplex Data Transceiver

User Manual

Issue 13 : February 2001

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IMPORTANT NOTICE

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This handbook is for the installation, operation and maintenance of the TC-900DR. The specifications described are typical only, and are subject to normal manufacturing and service tolerances.

Trio DataCom Pty Ltd reserves the right to modify the equipment, its specifications or this manual without prior notice, in the interest of improving performance, reliability or servicing. At the time of publication all data is correct for the operation of the equipment at the voltage and/or temperature referred to. Performance data indicates typical values related to the particular product.

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Modifications

Issue 1	February 1993 (Preliminary)
Issue 2	May 1993 Major Changes to Section 3
Issue 3	September 1993 Minor Changes to sections, 3.1, 3.2.1, 3.2.2.1, 3.2.7, 3.4.3, 3.4.4, 4.4, 4.5, 4.7, 4.7.2, 4.7.3 Major Changes; Inserted new section 3.2.6 KISS/SLIP Deleted section 4 Programming Deleted section 5.7.5, 5.7.6, 5.7.7 AFC Alignment Removed Filter Alignment Setup Diagram Inserted RSSI Level of Received Signal (typical)
Issue 4	February 1994 Minor Changes to all sections Additions to Section 3 for Firmware V2.2 and Synchronous Operation
Issue 5	March 1994 Addition of section 5.2.6.1 and 5.2.6.4 Revised figure on page 75
Issue 6	September 1994 Addition to Section 3.2.5, 4.7.1, 4.7.2, 4.7.3, 4.7.4 Addition of Sections 3.3.11.1, 3.3.11.2, 4.5.1,
Issue 7	April 1995 Addition to Sections 3.8.11.2 and 3.8.12.5 Rev D Sync LED
Issue 8	September 1995 Insertion of new Section 3.2
Issue 9	June 1998 Section 3.3.6 replaced
Issue 10	February 1999

Modifications (cont.)

- | | |
|----------|--|
| Issue 11 | February 1999
Minor changes to Sections 1.5, 3.3.1,
Deleted Section 1.6, 4.5.1
Replaced Section 5 |
| Issue 12 | July 2000
Minor Change to Section 7 |
| Issue 13 | February 2001
Change of Company Name |

SECTION 1

INTRODUCTION

1 INTRODUCTION

1.1 GENERAL

The TC-900DR is a Full Duplex 900 MHz Radio, featuring a fully integrated 4800 or 9600 bps data modem.

The entire unit is housed in a robust metal enclosure that provides a compact and transportable means for the transmission of data over radio.

The product has been fully designed and developed in Australia, by an Australian owned and managed company.

The TC-900DR meets the ACA SP4/89 specification which covers radio data transmissions over point-to-point and point-to-multipoint systems.

It is ideally suited for applications such as :

- „ Transaction Processing.
- „ Public Utility Telemetry Systems.
- „ Alarm Monitoring.
- „ Supervisory Control and Data Acquisition.
- „ Energy Distribution.
- „ Inventory Control
- „ Common Carrier Data Services.
- „ Temporary Installations

The modem provides byte oriented packet data communications over narrow band FM systems, using digital filtered binary FSK modulation.

The TC-900DR can be supplied for use with 12.5kHz, 15kHz, 25kHz or 30kHz channel spacings. Its operational parameters can be programmed with the TC-D Series installation programmer. This is a separate software package that runs on an IBM compatible PC under Windows 95/98/NT.

1.2 FACTORY QUALITY ASSURANCE

The TC-900DR has been designed and manufactured with particular emphasis placed on the following points :

- { State of the art design techniques.
- { Simple assembly/disassembly.
- { Minimal alignment requirements.
- { Manufactured using quality components.

All units have been manufactured using automated assembly procedures. This assures attention to detail and a high level of quality control.

All components used are of high quality, and conform to Trio DataCom's required specifications. The component suppliers provide batch, date and manufacturing criteria that are required to meet quality control standards.

Each unit is individually tested with an inbuilt self diagnostic program. It is then passed through a set of automatic test procedures with minimal human intervention. This ensures a consistently manufactured and performing product. Many of the alignments are factory set and should not require re-alignment in the field.

Trio DataCom's quality control does not finish here. Once each unit has passed its individual tests, it is placed in a cyclic heat/cooling chamber. This chamber is automatically cycled from -10°C to +65°C, twice, over a twenty hour period. During this time, the modem controller - using external precision calibrated test equipment - monitors and stores frequency stability versus temperature data. The TC-900DR uses this information to achieve its temperature compensated, frequency stability level of 1ppm.

Power output is measured during the temperature cycling. This is achieved by having the unit connected to a PC and various test equipment via a GPIB. Units that fail any of these tests are reported by the test program and corrective action taken before going through the complete cycle once again. Each unit shipped from the factory comes with a factory alignment printout which details:

- „ Configuration.
- „ Transmit frequency.
- „ Receive frequency.
- „ Receiver sensitivity.
- „ Transmitter power output.
- „ Transmitter modulation.

In most cases, the radio transmitter as shipped from the factory will require no re-alignment.

It is this care and quality control that ensures that the purchaser of a TC-900DR radio modem, obtains a consistently manufactured and performance specified product, which has been "burned in" to minimise any operational failures.

1.3 FEATURES

Advanced microwave and digital techniques were employed during the design phase of the TC-900DR, ensuring an innovative and state of the art product.

Features include :

- { Fully integrated full duplex radio and modem
- { Built in antenna diplexer
- { Power output +30dBm (1 Watt nom) at antenna connector
- { Radio meets ACA SP4/89 requirements 2/90
- { In-built transparent remote diagnostics capability.
- { Custom single chip modem - digital signal processing
- { 4800 & 9600 bps transfer rates, full duplex
- { Selectable 110..19k2 asynchronous RS-232 host interface
- { Unique collision avoidance facilities
- { Integrated supervisory signalling channel
- { Software selectable configuration parameters
- { Configurable bit error rate testing
- { Excessive temperature power fold-back
- { Auxiliary port for use with an optional supervisory audio handset

1.4 SPECIFICATIONS

1.4.1 RADIO SECTION

Rx frequency range	:	923MHz to 933MHz (see note 1)
Tx frequency range	:	847MHz to 857MHz (see note 2)
Channel spacing	:	Fully synthesized 12.5kHz / 25kHz, [opt 15/30] with programmable 1/2 channel raster offset
Frequency stability	:	1 ppm (-10°C to 65°C amb), [opt -30°C to 70°C], aging \leq 1ppm/Annum
Power output at Antenna connector	:	+30 dBm \pm 1dBm (1W nom) switchable under software control 200mW/1W
Duty cycle	:	Continuous
Output impedance	:	50 Ohms
Timeout timer	:	Programmable from 1 sec. to 28 minutes (max)
Tx key up time	:	\leq to 1mS (output \sim 1dB of power).
Rx sensitivity	:	0.5uV at antenna input for 12 dB SINAD at "delayed Rx signal" test point.
Rx intermodulation	:	\geq 70 dB spurious free dynamic range.
Rx spurious responses	:	\leq -65 dB.
Tx spurious emissions	:	\leq -65 dBc (ref unmodulated carrier).

Full duplex with single antenna.

Note 1. The reciprocal frequency option for point-to-point operation or point to multi-point base repeaters is available as follows :

- Rx frequency range 847MHz to 857 MHz.
- Tx frequency range 923MHz to 933 MHz.

Note 2. The transmitter is normally supplied, with its frequency offset from the receiver by 76 MHz.

1.4.2 MODEM SECTION

User Ports	:	DB-9 connector, EIA RS232, DCE, serial asynchronous, 300..19k2 baud, 7/8 bit, no/odd/even parity.
Data Rate	:	4800/9600 bps Full Duplex.
BER	:	Less than 10E-6 @ -105dbm measured at antenna port
Data Format	:	Narrow band digital filtered binary FSK Modulation, using Trio DataCom's DFM4-9 digital modem chipset, including Trio's unique supervisory signalling channel C/DSMA collision avoidance scheme.
Synchronisation Delay	:	20 milliseconds.

1.4.3 RADIO AND MODEM SECTIONS COMBINED

Occupied bandwidth	:	Meets ACA SP4/89 guidelines for point-to-point and point-to-multipoint assignments.
Mean deviation	:	±1.5 kHz (4800bps), ±2.75 kHz (9600bps)
Power requirements	:	14 Volts AC 10VA or 13.8Volts DC (11 to 16V Max).
Transmit current	:	<= to 600 mA.
Receive current	:	175 mA.
Size	:	241mm x 161mm x 65mm.
Weight	:	1.3Kg.

1.4.4 CONNECTORS

User RS-232 Connection	:	DB9 female wired as DCE (modem). (AMP Part # 747844-5)
Mating connectors	:	DB9 male solder type. (AMP Part # 747983-3) Backshell to suit. (AMP Part # 205729-1). Optional supplied to order.
Antenna Connection	:	Gold plated SMA female bulkhead. (E.F.JOHNSON Part # 142-0701-501)
Mating connector	:	SMA male to RG223 crimp type. (E.F.JOHNSON Part # 142-0407-006) Optional supplied to order
AC/DC Power Connector	:	2 pin locking (9A rating). (PCB SOCKET MOLEX Part # M5569-2A2)
Mating connector	:	(RECEPTACLE MOLEX Part# M5557-2R) (RECEPT PINS MOLEX Part # M5556-TL). Supplied with standard unit.
Supervisory Audio Handset Connector	:	6 pin modular jack. (AMP Part # 520250-3)
Mating connector	:	6 pin modular jack plug. (AMP Part # 5-641337-3). Supplied with optional audio handset.

1.5 OPTIONAL ACCESSORIES

Trio stock a large range of ancillary devices including coax cables, RF connectors, antennas, lightning protection, power supplies, etc.

Please contact Sales for further information.

SECTION 2

HARDWARE TECHNICAL DESCRIPTION

2 HARDWARE TECHNICAL DESCRIPTION

2.1 GENERAL

The TC-900DR is a 900 MHz full duplex radio complete with radio modem and antenna diplexer. In this and subsequent descriptions to follow, references have been made to block diagrams, circuit diagrams and component loading diagrams.

These can be found in appendix A, at the rear of this manual.

The unit can be divided into five major sub-blocks :

Radio section.

Antenna diplexer section.

Audio handset.

Modem section.

Unit housing assembly.

2.2 RADIO SECTION

The radio section is built on a single PCB with approximate dimensions of 193mm x 152mm x 1.6mm.

This section consists of the following main blocks :

- Receiver.
- Transmitter.
- Frequency control.
- Interfaces.

Each of these blocks can be further broken down as follows :

- Receiver.
 - Pre-amplifier.
 - Mixer.
 - 45 MHz I.F. filter.
 - FM I.F. & Demodulator
 - Audio processing.
 - Data.
 - Voice.
 - RSSI processing.

- Transmitter.
 - Audio processing.
 - Data.
 - Voice.
 - Modulator.
 - Multiplier.
 - Mixer.
 - Power amplifier.
 - Control.
 - PTT.
 - Power.

- Frequency control
 - Synthesiser.
 - Local oscillator.
 - AFC

- Interfaces
 - Modem section.
 - Antenna diplexer.
 - Audio handset.

2.2.1 RECEIVER

The general form of the receiver circuitry is shown in diagrams "DR9 Macro Block Diagram" (drawing number TC01-05-19 sheet 3/3), and "900 MHz Radio - Block Diagram" (drawing number TC01-05-19 sheet 2/3).

2.2.1.1 PRE-AMPLIFIER

The receiver pre-amplifier obtains signal direct from the antenna diplexer port - connector X2. It consists of two stages. The first stage is optimised to give a low noise figure, while the second is optimised to produce gain.

The central devices used are MRF5711 high frequency transistors. They provide the basis for a wide band amplifier that can receive from the lowest band frequency range of 852 to 854 MHz to the higher band frequency range of 928 to 930 MHz.

The RF selectivity is provided by the diplexer filter.

Strip line impedance matching networks are employed to ensure optimum performance of the amplifier.

The overall gain of the pre-amplifier is set to 20dB.

2.2.1.2 MIXER

The receiver mixer consists of a 180 "rat race hybrid ring" followed by a passive Schottky mixer diode.

The mixer injection frequency is set 45MHz from the required receive frequency, (high side injection for 930 MHz receive and low side for 850 MHz receive). This results in an I.F. frequency output of 45 MHz.

The level of the injection is set to 6 dBm by the amplifier stage Q3.

2.2.1.3 FIRST I.F. STRIP FILTER

The required receiver mixer product is filtered by the first I.F. filter. The filter is a bandpass crystal controlled device, centred on 45 MHz, and provides image rejection for the second IF Mixer.

The filter is aligned for optimum response by adjustment of inductors L4,L3 and L5.

2.2.1.4 FM IF and DEMODULATOR

The heart of the demodulator section is an NE615D high performance low power mixer FM IF system IC.

This device incorporates a mixer/oscillator, two limiting intermediate frequency amplifiers, a quadrature detector, muting circuitry, logarithmic RSSI, and a voltage regulator.

The input to the device is from the output of the 45 MHz first IF strip filter. This is applied at RF_{in} and RF_{bypass} pins (U2-p1,p2).

This signal is applied internally to a Gilbert cell mixer, which is set to convert the signal down to 455kHz.

The mixer injection is supplied by an internal oscillator, which is driven by an external oscillating signal applied at the XTAL OSC pins (U2-p3,p4).

The basic injection frequency is governed by the 44.545 MHz crystal XTAL1. This produces a mixer output product of 455 kHz.

The output of the mixer is available at MIXER OUT (U1-p20). This is applied to a 455kHz centred bandpass filter. This acts as the "front end" filter, CF1.

The bandwidth and rolloff characteristics of this filter are set, depending on the required baud rate of the data being used on the modem, and the required channel spacing. Refer to Circuit Diagram for filter types.

The filtered output is then applied to the input of the internal IF amplifier, IF AMPIN (U1-p18). The bandwidth of the amplifier is about 40 MHz, with a gain of about 39 dB(uv). C10 and C11 provide IF amplifier decoupling.

The output is available at IF AMP OUT (U1-p16). This is applied to a 455kHz centered bandpass filter. This acts as the "rear end" filter, CF2.

Again the filter selection depends on the required bandwidth. Refer to Circuit Diagram for filter types.

The filtered output is then applied to the input of the internal IF limiter, LIMITER IN (U1-p14). The bandwidth of the limiter is about 28 MHz, with a gain of about 62 dB(uv). C13 and C14 provide IF limiter decoupling.

The signal from the second limiting amplifier is passed to an internal Gilbert cell quadrature detector, as well as to LIMITER OUT (U1-p11).

One of the Gilbert cell ports is driven directly by the IF, the other by a tuned quadrature network, which is driven by the IF signal from LIMITER OUT. The tuned network is based around a ceramic resonator CF3. The Q of the network is varied depending on the required baud rate used by the modem. For 9600 baud the link LK3 is inserted, giving a higher damping factor than that required for 4800 baud, where the link is removed.

This gives the two input signals applied to the Gilbert cell a 90 degree phase relationship, the output of which is the demodulated audio/data signal.

The output signal is available at UNMUTED AUDIO OUT (U1-p9). A gated output is also available at MUTED AUDIO OUT (U1-p8).

2.2.1.5 AUDIO PROCESSING

2.2.1.5.1 DATA

The demodulated data signal output has been assigned to the UNMUTED AUDIO OUT pin (U1-p9). This ensures no interruption to the flow of data.

The signal is filtered by the C22, R20, R29 and C23 filter network. This is to remove any high frequency components produced at the output of the quadrature detector.

It is then amplified and DC level shifted by op-amp U1:C. The amount of DC bias applied to the signal can be varied by the potentiometer VR2. For correct processing by the modem, this level is set to 2V. The AC level of the signal is set to about 1 V_{p-p}

2.2.1.5.2 AUDIO

The demodulated audio signal output has been assigned to the MUTED AUDIO OUT pin (U1-p8). This allows switching control of the audio passed to the handset earpiece.

The signal is filtered by R23 and C17. This is to remove any high frequency components produced at the output of the quadrature detector.

It is then buffered, amplified and level shifted by op-amp U1:D, and presented to the handset via coupling capacitor C20 and connector X3-p2.

The mute control signal is applied to the NE615 (FM IF system IC) MUTE IN pin (U2-p5). When active, the audio output signal from the IC is attenuated by greater than 60dB.

2.2.1.6 RSSI

The RSSI output is presented by the NE615 at RSSI OUT (U2-p7). This signal is logarithmic with an output range greater than 90 dB. It is used for audio mute processing, and by the modem section as a data qualifier signal.

The signal is first passed through a unity gain buffer, op-amp U1:B, before it is split.

The RSSI level is compared with the setting of "audio mute adj" potentiometer VR1, by op-amp U1:A. The result is passed to the MUTE IN pin of the NE615.

This allows a suitable mute cutoff point to be set for the received audio sent to the handset earpiece.

The RSSI signal is also passed to the modem section for processing via R19 and connector X1-p21.

2.2.2 TRANSMITTER

The general form of the transmit circuitry is shown in diagrams "DR9 Macro Block Diagram" (drawing number TC01-05-19 sheet 3/3), and "900 MHz Radio - Block Diagram" (drawing number TC01-05-19 sheet 2/3).

2.2.2.1 AUDIO PROCESSING

2.2.2.1.1 DATA

The transmit data signal enters the radio section via connector J*3-p13, from the modem section. It is biased via R68 and R75 to a DC level of about 0.86V. The signal is then passed through a level setting potentiometer VR2, used to set the level of transmit deviation.

It is then presented to the input of the modulator circuit.

2.2.2.1.2 VOICE

The transmit voice signal enters the radio section via connector X3-p4, from the microphone in the handset. The pre-amp in the microphone circuit is given some bias via R76.

The signal is first passed through a clipping circuit. This consists of back to back clamping diode pair D2, AC-coupled via C154. This ensures that a maximum transmit deviation level is imposed.

The modulator circuitry is based around a low power FM transmitter system IC, MC2833. Included in this device is a microphone amplifier and clipper. The audio is passed to the amplifier via R76 at the MIC AMP INPUT pin (U7-p5).

Feedback for gain is supplied by R76, and band limiting by C50. The amplifier output is presented at MIC AMP OUTPUT (U7-p4).

Further low pass filtering is provided by the network of R71, C49, R59.. and C42... C43 provides a rising response below 100Hz. This filtering is needed to shape the base band signal, so as the transmit frequency spectrum stays within channel boundaries.

The audio is coupled into the modulator circuit at the MODULATOR INPUT pin of the MC2833 (U7-p3).

2.2.2.2 MODULATOR

The heart of the modulator section is an MC2833 low power FM transmitter system IC. This device is a one chip FM transmitter subsystem designed for FM communication equipment. It includes a microphone amplifier, a variable reactance modulator, a voltage controlled oscillator, and two auxiliary transistors.

Data is fed directly to the input of the reactance modulator at the MODULATOR INPUT pin (U7-p3). The audio channel is fed via an inbuilt clipper amplifier in the MC2833. The output of this variable reactance circuit is used to modulate the FM carrier.

The carrier frequency of the modulator is provided by an internal oscillator, which is driven by an external oscillating signal applied at the RF OSC pins (U7-p15,p16).

This oscillating signal is governed by the 20.166 MHz crystal XTAL3. The actual applied frequency is set by the modulating signal, which slightly varies ("pulls") the crystal frequency. This is achieved by connection of the crystals circuit to the output of the variable reactance circuit VARIABLE REACTANCE OUTPUT (U7-p1). This output is coupled to the crystal via a frequency trimming coil L6.

The output FM signal is presented at the RF OUTPUT pin (U7-p14).

2.2.2.3 MULTIPLIER

The output of the modulator is passed to a frequency tripler stage employing auxiliary transistor TR2. This places the carrier frequency at 60.5 MHz.

It then passes to a frequency doubler stage employing auxiliary transistor TR1, where the carrier is moved up to 121 MHz.

The signal is amplified through these stages to a level of about -4 dBm at 121 MHz.

2.2.2.4 MIXER

The transmit FM signal at 121 MHz when mixed with the VCO frequency by U8 produces a transmitter signal 76 MHz from the receiver frequency.

The mixer employed is an MCL SBL-1X monolithic doubly balanced mixer (U8).

The transmit VCO signal is amplified to a level of about +6 dBm by Q2, and applied to the "L" input of the mixer. The 121 MHz signal is applied to the "I" input of the mixer.

To select the correct mixing product for the transmitter, a tunable filter using C78 and a coupled stripline circuit is used.

The output signal is then buffered by two MRF5711 transistors Q4 and Q5, to provide about +4 dBm of signal level, which is applied to the final amplifier section.

2.2.2.5 POWER AMPLIFIER

The power amplifier provides an overall gain of about 30dB. This is achieved by three stages of amplification.

The first stage uses an MRF5711 transistor (Q8). This device is primarily designed for high gain, low-noise, small signal amplifiers, and is ideal for a transmitter pre amplifier. This stage provides about 13 dB of gain. The power control circuit acts on this stage to provide constant power at the PA. output connector.

The second stage uses an MRF8372 transistor (Q9). This device is primarily designed for wideband, large signal predriver stages, in the 800MHz range. This provides a further 10 dB of gain.

The final stage uses two MRF8372 transistors (Q10, Q11) in a parallel configuration to provide the final output power. Each of these stages provides about 10 dB of gain. The output impedance is matched to 50 ohms via the use of balanced impedance strip lines.

The transmitted signal is presented at connector X4, at a level of about +32 dBm, where it is passed to the diplexer section.

2.2.2.6 CONTROL

2.2.2.6.1 PTT

PTT must be activated for the TC-900DR to transmit an RF signal. There are two sources of PTT, the audio handset, and the modem section.

PTT from the audio handset is referred to as "manual PTT". It enters the radio section via connector X3-p6. It is passed to the PTT control switch transistor Q12. PTT is active LOW, and turns on Q12 when applied.

PTT from the modem section enters the radio section via connector X1-p12, "/PTT". It is connected to the PTT control switch transistor Q12.

When PTT is not activated the transmitter is totally disabled. All stages of the transmit chain are turned off. This is to ensure that power consumption is kept to a minimum.

The PTT signal connects to the start of the transmit chain at the multiplier stage.

The internal transistors of the MC2833 IC, TR1 and TR2 have their bases effectively grounded, turning off the devices. Similarly the mixer output buffer and amplifier transistors Q4 and Q5 are turned off as are the final amplifier stages employing Q8, Q9, Q11 and Q10.

When the PTT is activated, bias is applied to all these stages and transmission is possible.

Note : Tx enable must also be active to allow transmission.

2.2.2.6.2 TRANSMIT ENABLE

Transmit enable is a further control placed on the transmitter circuits. No transmission is possible unless the transmit enable signal is active. The signal enters the radio section via connector X1-p11, "/TX EN", from the modem section.

This signal basically enables the PTT switching transistor Q12, thus providing VCC for the 20.166 MHz oscillator section of the MC2833 modulator IC, and bias to the handset microphone.

2.2.2.6.3 POWER

The RF power output of the TC-900DR can be set to two levels. Low power level is 200mW, and high power is 1W.

This level is controlled by two dc levels. One signal is a control level from the modem section, the other from an RF detector located at the output of the transmitter itself. These two signals are used in conjunction to hold the output power constant.

The signal from the modem section enters the radio section via connector X1-p10, "TXPWR". The signal is fed to an op-amp comparison circuit U9:A, via level setting potentiometer VR4.

The level is compared to that actually detected at the output of the transmitter, by the circuit based around diode D3. The comparator output is then used to bias the first stage of the P.A. section (Q8) of the transmitter, hence varying the transistor gain performance and ultimately the output RF power. This basic feedback network is required to keep the power at a constant level, regardless of any external conditions.

The detected output power level is also fed back to the modem section for monitoring and analysis via connector X1-p9, "TXPWR SENSE".

2.2.2.6.4 TEMPERATURE SENSE

A temperature sensing device is included in the radio section. The device used is an LM335 precision temperature sensor, U6. It is operated as a two terminal zener diode, with a breakdown voltage directly proportional to absolute temperature, with an output of +10 mV per degree kelvin.

The temperature data output is passed to the modem section for analysis and processing via connector X1-p14, "TEMP SENSE".

During the "Burn In" cycle, that the TC-900DR is passed through during production, the unit calibrates the output of the sensor to the test temperature. In particular it stores the hottest temperature reached by the test cycle (about 65C).

If the unit reaches this maximum temperature setting while operating in the field, the modem section of the TC-900DR will automatically signal the power control circuit to place the transmitter into low power mode (200mW).

This low level of output power is retained until the temperature sensor signals the modem section, that the temperature has fallen back below the maximum temperature. When this occurs the transmitter is placed back to its previous power setting. A hysteresis is built into the microprocessor control circuitry to stop power jitter.

This scheme is referred to as "High Temperature Fold Back". It is used to protect the transmitter final power transistors from any damage that may be encountered under extreme temperature conditions.

2.2.3 FREQUENCY CONTROL

2.2.3.1 SYNTHESISER

The synthesiser section provides a local oscillator for use by the receiver and transmitter sections.

The synthesiser circuitry is based around a TBB206 PLL frequency synthesiser IC.

This device is a complex PLL circuit in CMOS technology for processor controlled frequency synthesis. The processor resides in the modem section, and three basic control lines are used to interface to the device. The enable "EN", data "DA" and clock "CL" control signals are passed to the TBB206 via connector X1-p16,p17,p18 respectively.

The reference frequency for the synthesiser is applied to the "RI" pin of the TBB206 (U3-p2). This reference is provided by a 12.000 MHz voltage adjustable temperature compensated crystal oscillator (VTCXO), XTAL2. This input has a sensitive preamplifier for a 16-bit (R)eference divider. C33 provides AC coupling for the input.

The VCO frequency is applied to the "FI" input pin of the TBB206 (U3-p8). This input has a highly sensitive preamplifier for a 12-bit N divider and a 7-bit A divider. C29 provides AC coupling for the input.

The actual signal applied to the "FI" input is from the output of a TBB202 dual modulus divider IC (U4-p4). This is to transform the actual VCO frequency of between 786 MHz and 996 MHz, down to a frequency acceptable for use by the "FI" input.

The divider ratio selected by the TBB202 is determined by the state of the "MOD" input pin (U4-p6). If the signal is HIGH, then a ratio of 1:128 is used. If the signal is LOW, a ratio of 1:129 is used. The state of this signal is controlled by the TBB206 synthesiser "MOD" output pin (U3-p7). The TBB206 drives this output LOW at the beginning of a cycle. When the A divider has reached its set value, the "MOD" output is set to HIGH. When the N divider reaches its set value, the output is set LOW again and the cycle is repeated.

The input to the TBB202 divider is from the VCO output via a strip line impedance matching network. The signal is applied to the "I1" pin (U44-p1).

The TBB202 can be placed into standby mode, when not in use. This is achieved by connection of the "STB" pin (U4-p7), to the multi function output port of the TBB206 synthesiser (U3-p6). This port is driven by the DFM4-9 modem IC located in the modem section.

The phase detector signal is provided on the "PD" pin of the TBB206 (U3-p12). This signal has especially short anti backlash pulses to avoid any "dead zones", and to neutralise any small phase deviations. This signal is passed to the loop filter of the VCO circuit.

A lock detect indication is given by the TBB206 synthesiser at the "LD" output pin (U3-p14). This signal is filtered and shaped by the network using R47 and C36, and presented to the modem section for monitoring and processing, via connector X1-p19.

2.2.3.2 VCO

The VCO used is an MQC309 series VCO. The exact device used depends on the required frequencies that the unit has to work with.

Two types are used :

- A. MQC309 798 - Frequency range of 784 MHz to 816 MHz

Gives unit frequency ranges of :

- Transmit : 905 MHz to 937 MHz
- Receive : 829 MHz to 861 MHz

- B. MQC309 978 - Frequency range of 962 MHz to 994 MHz

Gives unit frequency ranges of :

- Transmit : 841 MHz to 873 MHz
- Receive : 917 MHz to 949 MHz

The 798 type employs low side injection to the mixers, whereas the 978 type employs high side injection.

The loop filter consists of R44, C40, C41 and R43.

The output of the VCO is passed to the receiver mixer via RXMIX, and to the transmitter mixer via TXMIX signal lines. Each of these is impedance matched by strip line circuits for optimum performance.

The layout and selection of all these components has been done in such a way so as to minimise VCO noise being impressed onto either the transmitted or received RF signals.

2.2.3.3 VCO TEMPERATURE COMPENSATION

Frequency temperature compensation is provided for by an input to the reference oscillator circuit.

During the "Burn In" cycle, that the TC-900DR is passed through during production, the unit calibrates the output of the temperature sensor to the test temperature and to any frequency variations that occur, and stores the results.

When the unit is operating in the field, the temperature of the unit is constantly being analysed. Should a frequency offset be required based on the calibration measurements, the modem section signals to the 12.000 MHz reference oscillator to vary its frequency slightly. This signal is passed to the radio section via connector X1-p15, "TEMP COMP". The voltage on this line "pulls" the reference oscillator XTAL2 onto a new frequency, which corresponds to the correct offset required.

Note : Because the temperature compensation for the installed VTCXO is held in the NVRAM of the modem it is imperative that modems and radio boards are maintained as matched pairs. Should either the VCO or NVRAM require replacement it is highly recommended that the unit be returned to the manufacturer for re-calibration.

2.2.3.4 RECEIVER AFC

Automatic frequency control is provided for the received signal. The control signal is applied to the radio section from the modem section via connector X1-p22, "AFC CTL".

The basic injection frequency to the front end mixer of the NE615 FM demodulator IC (U2), is governed by the 44.545 MHz crystal XTAL1. The actual applied frequency can be set by the level of the AFC signal, which slightly varies ("pulls") the XTAL1 crystal frequency via the varactor diode DV1.

The modem section monitors the average DC level of the received signal (DATA signal X1-p13), which gives an indication of received frequency drift.

From this the modem section calculates the required compensation necessary and applies it to the "AFC CTL" signal line.

A reference signal is passed back to the modem section from the radio section via connector X1-p23, "AFC REF". This is processed by the modem section, and used to help determine the level of AFC signal level.

2.2.4 INTERFACES

2.2.4.1 MODEM SECTION

The radio section interfaces to the modem section via connector X1. Attached permanently to this connector is a 90mm length of 26 way ribbon cable, fitted with a female 26 way connector at the other end. This attaches to connector JX3 on the modem section PCB.

Refer to interface diagram "RADIO MODEM INTERFACE", drawing number TC01-05-18 sheet 1/3.

<u>CONNECTOR X1/JX3</u>	<u>SIGNAL DESCRIPTION</u>
<u>PIN NUMBERS</u>	
1	13V8 POWER SUPPLY RAIL
2	13V8 POWER SUPPLY RAIL
3	13V8 POWER SUPPLY RAIL
4	GROUND
5	GROUND
6	GROUND
7	8V POWER SUPPLY
8	8V POWER SUPPLY
9	TXPWR SENSE (o/p- TRANSMIT POWER SENSE)
10	TXPWR (i/p - TRANSMIT POWER LEVEL)
11	/TX EN (i/p - TRANSMIT ENABLE)
12	/PTT (i/p - PRESS TO TALK)
13	DATA (i/p - TRANSMIT DATA)
14	TEMP SENSE (o/p - TEMPERATURE SENSOR)
15	TEMPCOMP (i/p-TEMPERATURE COMPENSATION)
16	EN (i/p - ENABLE FOR SYNTH)
17	DA (i/p - DATA FOR SYNTH)
18	CK (i/p - CLOCK FOR SYNTH)
19	LD (o/p - LOCK DETECT FROM SYNTH)
20	DATA OUT (o/p - RECEIVED DATA)
21	RSSI (o/p - RSSI SIGNAL)
22	AFC CTL (i/p - AFC CONTROL)
23	(UNUSED)
24	SUPPLY/MIC (UNUSED)
25	TEST1 (UNUSED)
26	TEST2 (UNUSED)

2.2.4.2 ANTENNA DIPLEXER

The interface between the radio section and the antenna diplexer section is via coaxial connectors X4 and X2, and low loss coaxial cables.

<u>CONNECTOR</u>	<u>SIGNAL DESCRIPTION</u>
X4	TRANSMITTER OUTPUT
X2	RECEIVER INPUT

2.2.4.3 AUDIO HANDSET

The interface between the radio section and the audio handset is via the modular-6 pin connector X3.

<u>CONNECTOR X3 PIN NUMBERS</u>	<u>SIGNAL DESCRIPTION</u>
1	8V POWER SUPPLY
2	AUDIO OUT (o/p - AUDIO TO EARPIECE)
3	GROUND
4	MIC (i/p - MICROPHONE AUDIO)
5	GROUND
6	MANUAL PTT (i/p - HANDSET PTT)

2.3 ANTENNA DIPLEXER SECTION

2.3.1 GENERAL

The antenna diplexer section of the TC-900DR is a separate plug in module, that "piggy backs" the radio section PCB.

The diplexer performs two major tasks. Firstly it couples both the transmit and receive RF paths to the antenna while providing high isolation between them, and secondly it provides image and spurious rejection for each of these paths, with high Q bandpass filters.

The isolation between the transmit side and the receive side is greater than 50 dB.

The diplexer consists of two teflon PCB's bonded together using a critical temperature and pressure process. The top and bottom outer layers are connected via brass eyelets, that are pressed through the PCB. This eliminates the need for through hole plating of Teflon, which requires the use of dangerous chemicals.

The design is essentially two continuous ground planes, filled in between, with laminate dielectric, and stripline filter tracks which are centrally located between these ground planes.

The etching of the filter tracks is closely monitored and controlled to ensure an accuracy of better than 0.001" in track width and spacing.

The diplexer has been factory tested to ensure bandpass and performance characteristics are met. The diplexer has approximately 3 dB of loss at 930 MHz and 2 dB of loss at 850 MHz.

This diplexer requires no alignment in the field.

2.3.2 INTERFACES

The antenna diplexer connects to the radio section via low loss coaxial cables and connectors, and to the units antenna via a SMA connector.

Two versions of the diplexer are available, depending on the transmit and receive frequencies used. The difference between the two is the loading of the SMA connector.

TYPE-A CONNECTIONS (*Transmit frequency = 930 MHz range*)

<u>DIPLEXER CONNECTOR</u>	<u>SIGNAL DESCRIPTION AND DESTINATION</u>
850 MHz port	RF RECEIVE - RADIO SECTION X2
930 MHz port	RF TRANSMIT - RADIO SECTION X4
ANT port	ANTENNA

TYPE-B CONNECTIONS (*Transmit frequency = 850 MHz range*)

<u>DIPLEXER CONNECTOR</u>	<u>SIGNAL DESCRIPTION AND DESTINATION</u>
850 MHz port	RF TRANSMIT - RADIO SECTION X4
930 MHz port	RF RECEIVE - RADIO SECTION X2
ANT port	ANTENNA

2.4 AUDIO HANDSET SECTION

2.4.1 GENERAL

Refer to diagram "MTCU HANDSET MAIN PCB & MIC PCB CIRCUIT DIAGRAM", drawing number 5015-A200-50.

The handset provides an audio link between units, to assist in link setup and commissioning. It is not intended for general use and the equipment is not licensed for voice operation only.

Caution : When the handset is inserted into the TC-900DR, reliable data transmission or reception is not possible. Unintentional voice traffic on a point to multi point system may cause data corruption to other units.

The data transmission section of the modem is totally disabled, if the handset is plugged in when the TC-900DR is turned on.

The handset contains two PCB's, a receive board and a microphone board, which are connected by a 10 way ribbon cable. Acoustic padding is also included in the handset for improved performance.

The microphone board contains an ECM30 electret microphone, along with a common emitter preamplifier stage (Q1), to provide transmit voice audio.

There are four indication LED's that are not used by the TC-900DR.

The receiver board contains a 78L05 5V voltage regulator (REG1). This is used to supply power to the LF353 receive amplifier (U2-p7), which drives a DH32-30 ohm earpiece.

The sidetone circuit provided by U2-p1 is disabled and not used by the TC-900DR. Similarly, the LED drivers are disabled.

The PTT switch places a ground connection onto its output signal line, for processing by the radio section.

2.4.2 INTERFACES

The audio handset connects directly to the radio section via the RJ11 connector, X3. Attached to the handset is an 8 way flexible curly cord.

<u>PIN NUMBER</u>	<u>HANDSET CONNECTOR</u>	<u>X3 PIN NUMBER</u>	<u>RADIO SECTION CONNECTOR X3</u>
1	LED CLK	-	UNUSED
2	LED DATA	-	UNUSED
3	13V2	1	8V POWER SUPPLY
4	DGND	3	GROUND
5	PTT	6	MANUAL PTT
6	MIC	4	MIC
7	MIC RET	5	GROUND
8	EAR PHONE	2	AUDIO OUT

2.5 MODEM SECTION

The modem section is built on a single PCB with approximate overall dimensions of 165mm x 152mm x 18mm.

It consists of the following main blocks :

Modem control

- DFM4-9 modem.
- Reset and watchdog.
- Memory.
 - External NVRAM.
 - External RAM.

Host interface.

Radio interface.

Transmit signal conditioning.

Receive signal conditioning.

- Data recovery.
- Clock recovery.

User indications.

Power supply

Interfaces.

- Radio section.
- Port A.
- Port B.
- Power.

2.5.1 MODEM CONTROL

2.5.1.1 DFM4-9 MODEM

The modem section is controlled by a DFM4-9 Trio DataCom modem IC, (U5).

This device is specifically designed to provide data communications from a host computer over a radio channel.

The DFM4-9 is capable of full duplex operation, at data rates of 4800 baud or 9600 baud over the radio channel. The transmitter and receiver data rates may be set independently. The host computer interface provides two RS232 asynchronous serial ports, configurable for a variety of baud rates, and data formats.

In the standard delivery format of the modem, only one asynchronous serial port is operational. (Port A).

Advanced data recovery techniques are employed to ensure excellent performance in both good and noisy signal environments.

The data transmission method used, employs advanced optimal waveform shaping techniques. This maximises the recovered signal at the destination receiver, while remaining within the allocated RF channel bandwidths. The method uses computer generated Finite Impulse Response (FIR) techniques, to derive the transmitted waveform data.

The modem features a unique supervisory signalling channel, which embeds low speed data in the primary bit-stream, and is transparent to the user of the primary channel.

To drive the DFM4-9 modem clocking circuits, an external resonator is required. A 19.6608 MHz crystal (XTAL1) is applied to the OSC pins (U5-p9,10) of the device to achieve this.

A 4 way DIP switch is supplied to set up some configuration parameters of the modem. These are only read by the DFM4-9 at device power up. They connect to the "ESx" pins of the device (U5-p3,p5,p6,p7). Switches 1 and 2 are presently unused, switches 3 and 4 are defined in section 4.5.1.

2.5.1.2 RESET AND WATCHDOG

A MAX690 reset and watchdog IC (U3), is used to perform a variety of ancillary functions. This device provides a fixed length reset pulse for the proper initialisation of the modem chip on power up and reinitialisation. The MAX690 monitors the level of the VCC power supply line. If the voltage moves out of specification, the reset output is activated. This ensures that the modem chip recovers correctly in the event of a power failure. The reset signal is applied to the "RESET" pin of the modem (U5-p8).

The MAX690 provides a power monitoring function, which gives advance warning of imminent power supply failure. The DFM4-9 modem checks this signal, applied to its "PF" pin (U5-p2), before performing any transactions with the non-volatile memory, thus preventing accidental corruption of the contents of this memory. This "advance warning", is the length of time that the power supply capacitors hold their charge, after loss of power, before the Vcc supply rail drops below its cutoff level, and a reset pulse is generated.

The MAX690 also includes a "watchdog" timer. This timer must be strobed at a minimum rate, to prevent a reset pulse being generated. The DFM4-9 provides this signal at its "WDO" pin (U5-p22). Should the DFM4-9 modem operation go astray for some reason, it is probable that it will no longer perform this strobing function correctly. This condition is treated as irrecoverable and the MAX690 will timeout on its watchdog function and re-initialise the modem.

2.5.1.3 MEMORY

2.5.1.3.1 EXTERNAL NVRAM

The DFM4-9 modem, has a wide variety of configurable operating parameters, all of which are stored in an ST24C04 NVRAM IC, (U4). These parameters are read at power up, and determine the operating characteristics of the modem.

The NVRAM has 4096 bits of memory. It is accessed using the standard I²C, two wire, bus interface . A feature of this particular device, is a write protect function for one area of the memory.

This write protect feature prevents configuration data being inadvertently corrupted should some anomaly in modem operation occur. A hardware signal line is used to override this write protection feature, so that the configuration data may be changed by manual means. This signal can be accessed via the front panel connector, and is used when the TC-DFM9IP modem programmer is connected.

2.5.1.3.2 EXTERNAL RAM

External RAM is used to store data frames.

The RAM used may be either a 6264-8K or 62256-32K byte IC (U9). The standard TC-900DR is supplied with an 8K package. The DFM4-9 modem, tests the size of the attached RAM on power up.

All of the externally connected RAM is used to store packet data, and is allocated evenly between transmit and receive data. This memory is connected to the modem chip, by an 8 bit bus, and 3 control lines.

Two 8 bit 74HC573 latches (U8 and U10), are used to latch the memory address off the bus, before the data read or write cycle. The read/write control line to the RAM, is passed as the top address line in the MSB address latch.

The RAM read cycle operates as follows :

- The modem sets the two latch control lines, LADR_EN and HADR_EN, high.
- The high-address/R_select is then placed on the 8 bit bus.
- The HADR_EN line is set low to latch the data into U8.
- The lower eight address bits are placed on the bus.
- The LADR_EN line is set to low to latch the data into U10.
- The modem bus port is set to input mode.
- The RAM CE line is set low.
- The modem reads the data off the bus.

The RAM write cycle operates as follows :

- The modem sets the two latch control lines LADR_EN and HADR_EN, high.
- The high-address/W_select is then placed on the 8 bit bus.
- The HADR_EN line is set low to latch the data into U8.
- The lower eight address bits are placed on the bus.
- The LADR_EN line is set to low to latch the data into U10.
- The modem bus port is set to output mode.
- The modem writes the data to the bus.
- The RAM CE line is set low to write the data into the RAM.

Note: WARNING

A modem containing a 32K RAM package will not be compatible with a modem containing an 8K RAM package if end to end flow control is being used over the data link.

2.5.2 HOST INTERFACE

The host interface is provided by two RS232 ports, configured as DCE. These ports are presented to the user as 9 way female DMIN connectors, designated as PORT A and PORT B.

With the standard TC-900DR, only PORT A is operational.

The RS232 level translation is performed by two LT1081/MAX232 line transceivers (U1 and U2). These require a single five volt supply, and include internal charge pumps to generator the required +10V and -10V rails.

The four input and four output lines implement one full duplex serial port with RTS/CTS/DTR and DCD. This is PORT A. A second full duplex port with no handshake lines is provided on PORT B.

2.5.3 RADIO INTERFACE

The interface to the radio is via a 26 pin PCB header connector, X4.

The modem section has full control over the connected radio transceiver. It provides :

- Four lines for synthesiser control (used for RF channel selection).
- RSSI detection.
- Temperature sense input.
- Transmit power sense input.
- Temperature compensation for the synthesiser reference frequency.
- Receiver AFC.
- PTT control.
- Analogue lines for receive and transmit data signals.
- Regulated +13.8V and +8V power supplies.

Input to the receiver signal port, RXSIG, is offset by 2.0V DC, with a signal level of 1Vp-p AC.

The transmit signal output, TXSIG, has a signal level of 1Vp-p for 4800BPS, and 2Vp-p for 9600BPS, with a nominal DC offset of 2.0V. This offset may vary by $\pm 1v$ according to the modulator temperature compensation requirements.

An ADC0834 four channel ADC (U6), is used to monitor various analogue quantities within the radio. The DFM4-9 modem communicates with the ADC by controlling 3 lines. An active high chip select, "ADCS" line (U5-p33), a data clock, "DCLK" line (U5-p35), and a serial data, "SD" line (U5-p36).

The state of the data line from the ADC is clocked into internal registers of the DFM4-9 on the rising edge of the clock line. The data stream consists of a four bit preamble, which includes the channel address. From the 5th clock pulse onward, the ADC drives the data line with the data of the conversion, MSB first. The transaction is terminated with the CS line being set to inactive low.

The first channel is used to monitor temperature, by measuring the voltage from an LM335 monolithic temperature sensor U6. The LM335 is situated in the radio section, adjacent to the 20.1666MHz XTAL and VCXO synthesiser reference oscillator, and is fed into the modem section via connector X4-p14, ADC0.

The second channel is used to monitor RSSI, by measuring the RSSI output of the NE615 IF circuit. This signal is fed to the modem section from the radio section via connector X4-p21, ADC1.

The third channel is used to monitor the power level output by the RF transmitter, by measuring a voltage derived in the power control section of the radio. This is used to determine the "health" of the radio transmitter. This signal is fed to the modem section from the radio section via connector X4-p9, ADC2.

The fourth channel of the ADC, is used to measure the voltage of the +13.8 volt supply rail and to sense the presence of the audio handset at power up. The handset derives microphone bias from the modulator stage, and the voltage at this point is measured and compared with a fixed nominal value, to determine if the handset is connected at the time of TC-900DR power up. This signal is fed to the modem section from the radio section via connector X4-p24, ADC3. This 4th ADC channel is also multiplexed to measure the AFC control voltage so that an indication of received signal frequency can be made. U14:D is used to perform this switching function.

An auxiliary latch (U11) is provided to supply some of the output control to the radio section.

The latch receives data from the same data buss as the RAM. The lower six bits are fed to an R/2R ladder network DAC (RN2), which is used to present an analogue voltage to the radio's local oscillator synthesiser frequency reference. This correction voltage provides for excellent temperature stability of the radio. This signal is fed to the radio section via connector X4-p15, TEMP COMP.

The two top bits of the latch, drive auxiliary functions within the radio section.

Bit 6 is used to control the power of the RF transmitter in the radio section. This can be set to a HIGH level of 1W, or to a LOW level of 200mW. This signal is fed to the radio section via connector X4-p10, TXPWR.

Bit 7 provides the RF transmitter enable signal to the radio section. No RF signal can be transmitted unless this signal is set to active. This signal is fed to the radio section via connector X4-p11, TX EN.

2.5.4 TRANSMIT SIGNAL CONDITIONING

The transmit section of the DFM4-9 modem, outputs a byte of data, four times per bit period, on the "TDx" pins (TD1..TD7, U5-p56..49).

The parallel data is presented to an eight bit R/2R ladder network (RN1). This is a simple DAC which produces the transmit waveform at its output.

This signal is fed into opamp (U13:C) for amplification and filtering. This stage is a single pole low pass filter, used to attenuate clocking noise in the waveform. Two more filter stages follow, U13:B and U13:D.

By using 4 samples per bit, and an 8 bit resolution, precise control of the waveform shape is possible.

The gain and pole frequency of amplifier stage U13:C is switched by the DFM4-9 modem, via a 74HC4066 CMOS FET switches (U14:A). This is to produce the required waveform for the two data rates currently available. The bit rate output signal, "BRO" is provided at U5-p44.

For 4800 baud, components C43 and R45, are "included" in the feedback loop of the amplifier stage. When 9600 baud is selected, switch U14:A is turned OFF, and the components are "excluded" from the circuit.

2.5.5 RECEIVE SIGNAL CONDITIONING

The data receiver, consists of several functional blocks. Some of these are implemented by internal functions of the modem IC, and the remainder by external circuitry.

The incoming analogue signal, is routed to two separate sections of circuitry. One to process the received clock, the other to process the received data.

2.5.5.1 DATA RECOVERY

The data recovery is based around an "Integrating Data Slicer" circuit.

This circuit consists of a non-inverting, resettable integrator (U16:A, U12:C and U15:D), a dual peak detector (U12:A,B) and a reference divider.

The received signal is passed into the modem section from the radio section via connector X4-p20, "RXSIG".

The signal is integrated by the non-inverting integrator formed by U16:A, and U12:C, and then forwarded on to a comparator (U7:B), where it is "squared up", ready to be read by the DFM4-9 modem.

An output signal is provided by the modem IC, to indicate the sampling point. In fact this signal, called "RxCLKOUT", is pulsed high immediately after the sampling operation has taken place.

The integrator is reset at the end of each bit period, by the 74HC4066 FET switch, U15:D, after the value of the bit has been read. The DFM4-9 provides this reset signal at the reset integrator "RxCLKOUT" pin (U5-p19).

The integrated receive signal, is then fed to the dual peak detector, where the positive and negative peaks of the integrated signal are detected, and stored on the capacitors C28 and C27.

The peak detector's attack time is determined by the output resistance of the opamps (U12:A,B) and the bulk resistance of the diodes (D7, D4). The decay time however is determined by the values of the hold capacitors (C28, C27) and the summing resistors (R24, R25).

Four diodes (D5, D6, D8, D9) are used to clamp the reference rail. If the incoming signal has a large DC shift, this clamping arrangement ensures that the data slicer reference level is quick to settle somewhere near its final operating point. This clamp however does impose a maximum allowable input signal level. Exceeding this level will cause the integrated signal to directly modulate the reference rail. The derived reference voltage level, is amplified and output back to the radio section, where it is used for AFC in the receiver.

2.5.5.2 CLOCK RECOVERY

The received clock signal is presented to the DFM4-9 modem at its "RXCLK" input (U5-p4).

Within the DFM4-9, a phase-locked-loop is used for data clock recovery, which relies on level transitions in the data signal.

This mechanism maintains the data sampling point in the center of the bit cells by comparing the signal's level transitions with an internal clock.

An error in the relative phase of the RXCLK signal and the internal clock, causes the internal clock to increase or decrease in speed, to bring the phase error to zero.

The phase-locked-loop clock recovery mechanism within the DFM4-9 modem, maintains the sampling point in the center of the bit cells, but the use of the integrator demands that this take place at the end of the bit cell. This means that the signal fed to the DFM4-9 modem RXCLK input must be delayed by half a bit period.

To obtain this, the received signal is passed through a half bit delay, low-pass filter (U16:D, U12:D, U7:A). The delay characteristics of this filter, are switchable between the available data rates of 4800 and 9600 baud operation, by five 74HC4066 FET switches. These switches are controlled by the "BRO" output of the DFM4-9.

2.5.6 USER INDICATIONS

There are four indication LED's supplied for user information. POWER, TXMIT, SYNC and RXSIG. The POWER LED is green, TXMIT LED is red and the other two are yellow.

The POWER LED (LED4), is driven from the 13V8 power supply line. When supply is present the LED is activated.

The TXMIT LED (LED3), is activated when PTT is present. It is driven when the switching transistor Q3 is turned ON by the DFM4-9 modem "PTT" output going active (UX3-p38).

The SYNC LED (LED2), is activated when a valid data stream has been detected. It is driven when the switching transistor Q2 is turned ON by the DFM4-9 modem "SYNC" output going active (U5-p43).

The RXSIG LED (LED1), is activated when the received signal level is at a usable level. It is driven when the switching transistor Q1 is turned ON by the DFM4-9 modem "RXSIG" output going active (U5-p43).

2.5.7 POWER SUPPLY

The power supply is based around the use of three voltage regulators that supply +13V8, +8V and +5V.

The incoming power is applied to a bridge rectifier (BR1),. Normally two legs of this bridge are linked out, so it provides only reverse polarity protection shunt diodes. A special manufacturing option allows for AC input, where the links are removed. A 2200uF electrolytic capacitor (C2), provides filtering for AC inputs.

This is then applied to an LT1086 low dropout regulator (REG1). The output of this is set to 13V8 and feeds the RF final amplifier, and the following two regulators.

The 8V regulator (REG2) takes it's input directly from the 13V8 rail, its output is routed to the radio section, and provides supply for one of the amplifier devices.

The 5V regulator (REG3) provides the supply rail for the modem section logic circuits. It takes it's input from the 13V8 rail via diode D1. Extra filtering capacitance is provided by C7.

2.5.8 INTERFACES

2.5.8.1 RADIO SECTION

The modem section interfaces to the radio section via connector JX3. The physical link between the two sections is achieved via a 90mm length of 26 way ribbon cable.

Refer to interface diagram "RADIO MODEM INTERFACE", drawing number TC01-05-18 sheet 1/3.

<u>CONNECTOR JX3</u>	<u>SIGNAL DESCRIPTION</u>
<u>PIN NUMBER</u>	
1	13V8 POWER SUPPLY RAIL
2	13V8 POWER SUPPLY RAIL
3	13V8 POWER SUPPLY RAIL
4	GROUND
5	GROUND
6	GROUND
7	8V POWER SUPPLY
8	8V POWER SUPPLY
9	ADC2 (i/p - TRANSMIT POWER SENSE)
10	TXPWR (o/p - TRANSMIT POWER LEVEL)
11	/TX EN (o/p - TRANSMIT ENABLE)
12	/PTT OUT (o/p - PRESS TO TALK)
13	TXSIG (o/p - TRANSMIT DATA)
14	ADC0 (i/p - TEMPERATURE SENSOR)
15	TEMPCOMP (o/p- TEMPERATURE COMPENSATION)
16	EN (o/p - ENABLE FOR SYNTH)
17	DA (o/p - DATA FOR SYNTH)
18	CK (o/p - CLOCK FOR SYNTH)
19	LD (i/p - LOCK DETECT FROM SYNTH)
20	RXSIG (i/p - RECEIVED DATA)
21	ADC1 (i/p - RSSI SIGNAL)
22	AFC CTL (o/p - AFC CONTROL)
23	SPARE (UNUSED)
24	ADC3 (FOR SUPPLY/HANDSET)
25	TEST1 (UNUSED)
26	TEST2 (UNUSED)

2.5.8.2 PORT A

The modem section interfaces to the host user via the 9 way female DMIN type connector JX1.

<u>CONNECTOR JX1</u> <u>PIN NUMBER</u>	<u>SIGNAL DESCRIPTION</u>	
1	DATA CARRIER DETECT	(DCD)
2	RECEIVE DATA OUTPUT	(RXD)
3	TRANSMIT DATA IN	(TXD)
4	DATA TERMINAL READY	(DTR)
5	COMMON	(COM)
6	DATA SET READY/prog mode	(DSR)
7	REQUEST TO SEND	(RTS)
8	CLEAR TO SEND	(CTS)
9	RING INDICATE/BER Test Mode	(RI)

Note: Pin 6 and pin 9 provide a dual function which depends on the mode that the TC-900DR is operating in.

2.5.8.3 PORT B

For the standard delivery version of the TC-900DR, port B is normally not enabled. This port provides no handshake lines except DCD (parallel connected with DCD on Port A) and DSR which is wired active.

<u>CONNECTOR JX1</u> <u>PIN NUMBER</u>	<u>SIGNAL DESCRIPTION</u>	
1	DATA CARRIER DETECT	(DCD)
2	RECEIVE DATA OUTPUT	(RXD)
3	TRANSMIT DATA IN	(TXD)
4		
5	COMMON	(COM)
6	DATA SET READY/prog mode	(DSR)
7		
8		
9	RECEIVE SIGNAL STRENGTH INDICATOR	(RSSI)

Pin 9 is used to output the RSSI signal for external measurement.

The RSSI output ranges from 0 to 5 Volts, where 5 volts indicates the strongest signal. It is important to note that this port output has a high impedance of around 50K ohms and loading will decrease accuracy of the recorded measurement.

2.5.8.4 POWER

Power is supplied to the modem section via connector X1. Typically +13.8V DC is applied to the top pin, with the common connected to the bottom pin.

SECTION 3

OPERATIONAL DESCRIPTION

3 OPERATIONAL DESCRIPTION

3.1 GENERAL

The Trio DataCom TC-900DR radio modem, is a full duplex 4800/9600 bits per second device, which converts digital data into an analogue form suitable for transmission over a radio channel. It uses specially filtered direct binary frequency modulation techniques to achieve this. It conversely, converts the analogue signal derived from a radio channel into a digital data signal.

The heart of the unit is the DFM4-9 modem IC. This performs all waveform shaping, randomising and de-randomising, NRZ/NRZI conversion, clock recovery, and HDLC framing and CRC error generation and checking. These functions are performed simultaneously, allowing full duplex operation at up to 9600bps.

The modem is fully HDLC compatible. The user is provided with two RS232 compatible ports, which may each be configured with a standard PAD interface or SLIP/KISS protocol driver. The unit may also be configured for repeater operation.

It may be configured to use RS232 handshake lines, or XON/XOFF flow control on Port A.

The modem features a unique supervisory signalling channel, which embeds low speed data in the primary bit-stream, and is transparent to the user of the primary channel.

The supervisory signalling channel can be disabled if not required. It could be used to pass low speed data such as E and M status or C/DSMA control schemes.

The data rate of the supervisory signalling channel can be set independently for transmit and receive. It can range from about 40 to 533 bps with the primary channel rate at 4800 baud, and 80 to 1067 bps at a primary channel rate of 9600 baud.

NOTE: with the supervisory signalling channel active, the bit-stream is not compatible with standard HDLC interface devices (such as 8530).

The host user port may be configured for baud rates of 300 to 19K2, with 7 or 8 bit character size, 1 or 2 stop bits, and parity off/odd/even.

The DFM4-9 modem includes several data tables which are used to generate waveforms with different characteristics. This is primarily for optimum performance at differing baud rates. A custom data table can be placed into the NVRAM of the modem, for specialised applications.

Configuration of the modem is fully programmable, with parameters held in non-volatile memory. All configuration parameters are accessible with the TC-DFM9IP Installation Program.

Configuration parameters include but are not limited to:

- Supervisory Signalling Channel rate.
- XON/XOFF or RTS/CTS/DTR/DCD handshake mode.
- Default transmitter lead in delay.
- Constant specifying minimum RF RSSI for valid receive.
- Constant specifying minimum Tx power level.
- Asynchronous serial port parameters.
- User interface operating mode :
 - User port interface protocol
 - PAD Parameters

3.2 TC-900DR MODEM FIRMWARE REVISION VA2.3.0

3.2.1 FUNCTIONAL CHANGES AND ADDITIONS

The Diagnostics "M" command (serial port Mode) completed. The implementation of this command was not finished in time for VA2.2 release. This command is used to configure either of the two user ports, for character length, number of stop bits, parity odd/even/off.

- 1 Bit 7 is used to address which port is being referenced (set to "0" for Port B, or set to "1" for Port A).
- 2 Bit 6 determines the character size. Set to "0" for 8 bit, or "1" for 7 bit character size.
- 3 Bit 5 is set to "1" to enable parity, "0" to disable parity.
- 4 Bit 4 determines Odd (set bit to "1"), or Even (set bit to "0") parity if Bit 5 is set.
- 5 Bit 3 determines the number of stop bits. Set to "0" for 1 stop bit, or set to "1" for 2 stop bits.
- 6 Bits 2, 1, and 0 are used to select the baud rate. The following table shows the available rates. The 19.2K baud selection should only be made for Port A if Port B is disabled. The last selection of 110 baud may be deleted from future firmware revisions.

Bit	Bit 1	Bit 0	Baud Rate
0	0	0	300
0	0	1	600
0	1	0	1,200
0	1	1	2,400
1	0	0	4,800
1	0	1	9,600
1	1	0	19,200
1	1	1	110

Channel Access Strategy 3 is now defined. This is selected by setting bits 1 and 0 (TxCtrl1 and TxCtrl0) in "Config1", both to "1". This mode forces a randomly generated delay **before** transmission begins, even if the channel is perceived to be clear. This delay mechanism is similar to that used in Channel Access Strategy 2 when the channel is perceived to be busy. This operating mode is useful in systems that include remote terminals that generate reports at regular fixed intervals. In such a system, slight differences in this interval between two remotes, would cause them to become synchronised for some time, and thus transmissions from them would consistently

collide. Inserting a randomly generated delay before all transmissions will reduce the incidence of this effect.

The RS232 DCD handshake line now becomes active only during output of received data. Formerly, the DCD line indicated real time SYNC status of the modem data receiver. To facilitate the use of RS232 to RS422/RS485 converters, the DCD line is driven **active** a short time (approximately 0.5mS) before the received data is output to the user port, and lingers for approximately 2 to 3 character times (i.e. is proportional to baud rate of user port). The modem generates only one DCD function, which is available on pin 1 of both Port A and Port B. Thus the DCD pin of both user ports will be activated when either port is outputting received data.

3.2.2 OTHER ENHANCEMENTS

Improvements in handling of the RS232 RTS line (Port A), makes the modem more tolerant in the timing of rapid OFF transitions of this handshake line, immediately after the end of the last character of a message. It has been observed that communications drivers in many PLCs turn their RTS output line OFF very shortly after the end of a message, resulting in the loss of the last character of the message with previous modem firmware revisions. This revision does not suffer this problem.

The random number generator used for the Channel Access Timer, has been improved to make it more random.

3.3 FACILITIES AND CONFIGURATION INFORMATION FIRMWARE VERSION 2.2

3.3.1 GENERAL

The TC-900DR provides fully transparent remote diagnostics facilities, and expanded data stream switching, which supports advanced stream trunking applications.

The diagnostics core, supports the reporting of current analogue conditions, including temperature, RSSI (Received Signal Strength Indication), RF transmitter power, AFC (i.e. received signal frequency offset), and supply voltage. Also, an extensive range of operating parameters may be changed remotely, including remote (RF) channel change.

Configuration options, allow various system topology's, so that the location of the system's diagnostics controller is flexible.

The data stream switching mechanism has been upgraded to allow either MUX/DeMUXing or multi-stream routing functions, independently for each port.

A few other minor upgrades to previous revisions of firmware are:

- * Two different "ticker clocks" implemented, one running at 1mS, and used for a) PAD Character Input Timers, and b) Channel Access Timer when running in Collision Avoidance mode. The other "ticker clock" runs at 10mS, and is used for the PTT timer, and a host of other internal functions, not accessible by configuration programming.
- * When XON/XOFF flow control is enabled on PortA, the CTS output line continues to operate correctly, indicating the flow control state. XON/XOFF characters are generated in addition to, and reflect state changes on this line. As before, the DTR input line is ignored while XON/XOFF flow control is set, and the RTS line is not required to be true to validate transmit data.
- * The modem stores data for transmission in buffer memory, which is limited. It also keeps track of frame boundaries of the stored data, and the number of frames it can manage is also limited by the amount of memory used to record the position of the frame boundaries. Thus it is possible that the modem can approach overflow before exhausting data buffer space, if frames are small. This flow control state is activated when the "frame boundary memory" approaches half full, for similar reasons used in data buffer management.
- * If the Supervisory Signalling Channel is enabled in both transmit and receive directions, and PortA is configured in Repeater Mode, then the received Supervisory Signalling Channel data is also repeated, by being copied from the Supervisory Signalling Channel receiver to the Supervisory Signalling Channel transmitter.
- * RSSI measurements are full eight bit conversion, so the "min_RSSI" configuration parameter lies in the range 0 - 255 (decimal). This is only important when setting this parameter without the aid of the DRPROG programmer.

3.3.2 INTERNAL DATA STREAM ROUTING

Essentially, all data streams travelling in both directions (transmit and receive), are examined and tested for a match with the diagnostics receive SID header code. If this match test is successful, then the data frame is copied into a buffer for the diagnostics core to process. The data frame also continues in the original direction as well. Thus diagnostics frames received from the radio channel (receive data), and from the stream switcher (transmit data, from one of the physical ports), are copied as they pass between the HDLC "device" and the data stream "switcher". Messages generated by the diagnostics core in response to received commands, are always sent back to the source of the command. That is, if a status request is received from the radio channel side of the modem, then the response is directed back out of the radio channel.

This dual access structure, allows the diagnostics controller to be located on either side of the modem, and thus supports any system topology.

3.3.3 DIAGNOSTICS REPEAT FUNCTION

Some applications will require that the "base" unit in a point to multi-point system repeats diagnostics frames. This will be the case where the system diagnostics controller is attached to a remote terminal in the system, and polls the system population from this point. The "base" unit must re-transmit diagnostics frames which are not addressed to itself. A "diagnostics repeat" configuration bit enables this function.

3.3.4 DIAGNOSTICS FRAME STRUCTURE

Diagnostics data frames, are structured according to a defined protocol. A frame consists 1st of the SID header code, which would normally (but not necessarily) be 00. Following this is a three byte address of the destination unit, followed by a three byte source address. An addressed unit responding to a diagnostics command, will swap these two address fields around, in the response frame. The destination address in a diagnostics frame to a TC-900DR unit, is in fact the unique (factory) serial number of the unit. By convention, the diagnostics controller (a DOS based PC), will use a unique address for itself, outside the range of permissible TC-900DR addresses (e.g. 000000). Following the two address fields, is a single character command/response code, which is in turn followed by any operands that may or may not be required for the command/response. Total frame size is limited to 17 bytes. After the SID header, address fields, and command/response mnemonic, this allows up to nine bytes of data to be transferred per diagnostics frame.

3.3.5 DIAGNOSTICS COMMAND SET

The following is a list of the command set recognised by the diagnostics core in the TC-900DR Firmware. Also is tabulated the response to each command. The following examples use address 123456 for the TC-900DR unit address, and 000000 for the address of the system diagnostics controller. For the purposes of clarity only, each byte in the example messages is separated by a comma. Mnemonics are represented in quoted form to indicate an ASCII character (e.g. "C" is actually binary byte h'43).

B Warm Boot Command.

This command forces the addressed unit to perform a "warm boot". Previous to this, the unit will have been halted (see "H" command), and one or more parameters changed with "P" and "W" commands.

Syntax:-

Command:- 12,34,56,00,00,00,"B"

Response:- 00,00,00,12,34,56,"b"

C Calibration Constant Poll.

This command requests the addressed unit to reply with it's internal Analogue To Digital Converter (ADC) calibration constants. These are necessary to accurately interpret the data sent in Status Poll ("S") replies. This command has no operands, and the response mnemonic is "c". The form of the command and reply is:

Syntax:-

Command:- 12,34,56,00,00,00,"C"

Response:- 00,00,00,12,34,56,"c",tt,rr,pp,ff,ss

Where:-

tt = Temperature calibration code

rr = RSSI calibration code

pp = Transmit Power calibration code

ff = Received Frequency Offset calibration code

ss = Power Supply calibration code

D Powered Up Response

This command is sent from the modem to the controller in response to a status poll ("S") immediately after the modem has been powered up. The modem will continue to send this command in response to a status poll until the controller acknowledges the command with a "d". The modem will then respond normally to a status poll.

This mechanism is used by the controller to determine whether it requires calibration data from the modem.

Syntax:-

Command:- 00,00,00,12,34,56"D"

Response:- 12,34,56,00,00,00"d"

F Set New RF Synthesiser Frequency.

This command forces the unit to set the RF synthesiser to a new frequency, thus selecting another radio channel. This command has one operand, which defines the source of the synthesiser data. A value of zero, indicates that the frequency data has already been set with a parameter set command. Values from one to four select one of the channels stored in the NVRAM of the modem configuration. The addressed unit responds with an "f" reply, before executing the channel change command (i.e. on the old channel).

Syntax:-

Command:- 12,34,56,00,00,00,"F",nn

Response:- 00,00,00,12,34,56,"f"

Where:-

nn = 00 to 04 to select data source.

H Halt Command.

This command forces the addressed unit to halt all internal operations, except diagnostics processing. This is necessary, when changing some parameters, before a warm boot command is issued to the re-configured unit.

Syntax:-

Command:- 12,34,56,00,00,00,"H"

Response:- 00,00,00,12,34,56,"h"

M Set Serial Port Mode.

This command forces the addressed unit to change the operating mode of one or both serial ports. Parameters such as character size, number of stop bits, parity etc. are changed with this command. It should be noted, that data may be lost while the operating mode of the serial ports is changed.

Syntax:-

Command:- 12,34,56,00,00,00,"M",xx

Response:- 00,00,00,12,34,56,"m"

Where:-

xx = Serial port address bit and mode data

P Parameter Set command.

This command stores the contents of the operand string to a storage buffer. No other action is taken. This command should be immediately followed by a "W" command. See "W" command below. The parameter may be either a bit quantity, a byte quantity, a word quantity, or a string quantity. The diagnostics core in the modem firmware determines this from the parameter identifier, which indexes an internal lookup table. String quantities are of indefinite length, and determined by the length of the operand string in the received "P" command. The "P" command response ("p"), echoes the complete received string. This is unique to the "P" and "W" commands.

Syntax:-

Command:- 12,34,56,00,00,00,"P",nn,aa,bb,cc,...

Response:- 00,00,00,12,34,56,"p",nn,aa,bb,cc,...

Where:-

nn = parameter identifier

aa, bb, cc,... are data value(s) for selected parameter

R Parameter Readback command.

This command forces the addressed unit to read the state of the addressed parameter, and send this data back the the command originator (diagnostics controller) in a reply message. Again the size of the parameter (bit, byte, word, or string) is determined by the parameter identifier. String parameters are returned as a string of eight consecutive bytes.

Syntax:-

Command:- 12,34,56,00,00,00,"R",nn

Response:- 00,00,00,12,34,56,"r",nn,aa,bb,...hh

S Status Poll.

This command requests the addressed unit to reply with the current value of analogue quantities, present temperature, last/present received RSSI, transmit power of last transmission, received frequency offset of last/present received signal, and present supply voltage.

Syntax:-

Command:- 12,34,56,00,00,00,"S"

Response:- 00,00,00,12,34,56,"s",tt,rr,pp,ff,ss

Where:-

tt = Temperature conversion code

rr = RSSI conversion code

pp = Transmit Power conversion code

ff = Received Frequency Offset conversion code

ss = Power Supply conversion code

T Diagnostics Watchdog Timer command.

This command forces the addressed unit to (re)set a special watchdog timer. The operand value is a word (16_bit) quantity. A zero value will disable the timer. A non-zero value will initialise the timer. This timer, while non-zero, will be decremented periodically. If the timer is decremented to zero, then the TC-900DR will perform a cold boot, thus restoring operating parameters from the NVRAM configuration memory. This command should be used in conjunction with parameter set and write commands. If a parameter change renders the unit in-operable, then either it will not continue to receive further "T" commands to reset the timer, or the system diagnostics controller may cease to send the timer reset commands, thus will eventually cause the unit to cold boot.

Syntax:-

Command:- 12,34,56,00,00,00,"T",nnnn

Response:- 00,00,00,12,34,56,"t"

Where:-

nnnn = timer reset value (16 bit value)

V Request Firmware Version String command.

This command requests the addressed unit to reply with a string indicating its firmware version number. Future firmware versions may provide further facilities that may then be used, by sending appropriate commands.

Syntax:-

Command:- 12,34,56,00,00,00,"V"

Response:- 00,00,00,12,34,56,"v","A2.2.0"

W Write Parameter command.

This command is used in conjunction with the "P" parameter set command. This parameter write command must be identical to the previous parameter set command. Providing they are identical (excepting the command mnemonic), then the operand is written to the selected modem operating parameter. Changing some parameters while normal operation continues could produce improper operation, possibly resulting in corrupted parameters, so the unit should be halted with a HALT command before such parameters are changed.

Syntax:-

Command:- 12,34,56,00,00,00,"W",nn,aa,bb,cc,...

Response:- 00,00,00,12,34,56,"w",nn,aa,bb,cc,...

Where:-

nn = parameter identifier

aa, bb, cc,... are data value(s) for selected parameter

3.3.6 PARAMETER SET

The following is a list of parameters which may be remotely set. Parameters marked with a "*", should only be changed while the unit is in a halted state, followed by a warm boot command. Parameters marked with a "#", may only be referenced in an "R" readback command. Attempts to change these with "P" and "W" commands may produce unpredictable results.

Parameter Identifier	Parameter Type(Size)	Parameter Name
00 (^@)	undefined	not defined, reserved to facilitate future expansion
01 (^A)	undefined	not defined, Trio DataCom test use only
02 (^B)	byte	Drift_Offset
03 (^C)	word	PTT_Time
04 (^D)	string	Synthesiser Data for channel change
05 (^E)	byte	min_RSSI
06 (^F)	byte	Tx_LID
07 (^G)	byte	Slot_Num
08 (^H)	byte	Slot_Time
09 (^I)	word	SIDA1 and SIDA2
0A (^J)	word	SIDB1 and SIDB2
0B (^K)	word	SIDD1 and SIDD2
0C (^L)	byte	KISS_adrA
0D (^M)	byte	KISS_adrB
0E (^N)	byte	EOMA_code
0F (^O)	byte	EOMB_code
10 (^P)	byte	input_timeA
11 (^Q)	byte	input_timeB
12 (^R)	byte	frame_sizeA
13 (^S)	byte	frame_sizeB
14 (^T)	bit *	SLIP/KISS_mode portA
15 (^U)	bit *	SLIP/KISS_mode portB
16 (^V)	bit	EOM_enable portA
17 (^W)	bit	EOM_enable portB
18 (^X)	bit *	KISS_mode portA
19 (^Y)	bit *	KISS_mode portB
1A (^Z)	bit	RTS/CTS_interlock portA
1B (^[)	bit *	PORTB_enable
1C (^\)	bit *	Repeat_Enable portA
1D (^\)	bit *	Repeat_Enable portB

1E (^)	bit *	(Not defined, reserved for Error Recovery Enable)
1F (^_)	bit *	(Not defined, reserved for Error Recovery Enable)
20 ()	bit	LiveFrame portA
21 (!)	bit	LiveFrame portB
22 (")	bit	XonXoffMode portA
23 (#)	bit	XonXoffMode portB
24 (\$)	byte	PORTA_Config
25 (%)	byte	PORTB_Config
26 (&)	bit	diags_repeat
27 (')	bit	TxPWR_HI/LOW
28 ((bit	SID_Enable
29 ())	bit	RTS2PTT
2A (*)	bit	SYNC2PTT
2B (+)	bit	SCDO_Default
2C (,)	bit	SupChnFunc
2D (-)	bit	TxCtrl1
2E (.)	bit	TxCtrl0
2F (/)	byte	Config1
30 (0)	byte #	SMR1 (portA serial port mode)
31 (1)	byte #	SMR0 (portB serial port mode)
32 (2)	byte #	BRR1 (portA serial port baud rate)
33 (3)	byte #	BRR0 (portB serial port baud rate)
		Additions for version A2.3.0
34 (4)	byte	err_limit (Frame Error output for Base Station)
35 (5)	byte	err_flags
36 (6)	word	good_cnt
37 (7)	word	bad_cnt
38 (8)	word	lost_sync_cnt
39 (9)	word	lost_RSSI_cnt
		Additions for version A2.3.1
3A (:)	byte	DCD_timeA
3B (;)	byte	DCD_timeB
3C (<)	byte	Diags_Delay

3.3.7 ADVANCED STREAM ROUTING FUNCTIONS

The TC-900DR provides advanced stream routing functions. For each port, there is allocated two SID (Stream IDentifier) codes, and a configuration flag that determines how these two codes are used.

With the flag off, SIDx1 (where x is A or B for portA and portB respectively) defines the SID code of received frames that are de-multiplexed to the port, and SIDx2 defines the SID code that is inserted by the modem at the front of every frame it transmits. Thus only one data stream passes through the port, and the modem manages the insertion and extraction of SID header codes.

With the configuration flag on, SIDx1 and SIDx2 define a range of streams that will be passed from the received data to the port. SIDx1 defines the lowest stream, while SIDx2 defines the highest stream. The SID header codes remain on the received frames, and are passed to the port. For transmit data, the modem assumes that the SID header codes are already in place, being inserted by some external device, and no processing is performed on the transmit data. For this application, it is highly desirable that a SLIP (or KISS) driver be employed so that frame boundaries are defined.

These functions are independent for each port, so it is possible to construct (say), a multi-drop, multi-hop repeated data system, where one stream can be "peeled off" at each repeater site. There are many other possibilities, the TC-900DR product simply requiring suitable configuration to construct a vast range of network topologies.

3.4 FACILITIES AND CONFIGURATION INFORMATION VERSION 2

3.4.1 GENERAL

The TC-900DR, provides two independent user data streams, which are multiplexed onto the radio channel data stream. The stream switching protocol also provides for an embedded remote diagnostics facility.

The two (asynchronous) user ports can be configured for a variety of baud rates, character sizes, parity, and stop bits.

Flow control on user Port_A may be set to use RTS/CTS/DTR/DCD handshake lines, or XON/XOFF characters. Flow control for Port_B may be set to use XON/XOFF characters, or no flow control. Port_B is not supported by RTS/CTS/DTR handshake lines.

Data is transported in (HDLC) frames, protected by a 16 bit CRC error checking sequence, conforming to the CCITT standard. Received frames found to contain errors are discarded. The TC-900DR does not release received data frames to the user port, until completely received, and error checked.

Maximum frame size is configurable for each port independently, and may be set to any value between 4 and 255. Frame size limiting is disabled by setting this parameter to zero (0).

Each user port, is supported with PAD functions conforming to X3, or SLIP*¹ or KISS* protocol interface.

For Point To Multipoint applications, a unique collision avoidance mechanism is available, with configurable channel access parameters.

All configuration parameters are held in a non-volatile memory. Normally, this memory can only be written when the radio modem is connected to a programmer.

3.4.2 BRIEF OVERVIEW OF MODEM INTERNAL OPERATION.

3.4.2.1 DATA TRANSMITTER

Each physical user port, is supported by a "driver", in this case a PAD (Packet Assembler/Dis-assembler) or SLIP/KISS. This function transfers the data from the port, to a buffer memory. This buffer not only stores the raw user data, but also keeps track of frame boundaries. Another functional block, retrieves that stored data, and feeds it to a third mechanism, which generates the data waveform which is applied to the radio transmitter modulator.

¹ * SLIP ®™ KISS ®™

3.4.2.2 DATA RECEIVER.

The receiver extracts data frames from the received signal, and stores the contents of the frames into buffer memory. It may also perform a steering function, if more than one port is enabled. A second function is to retrieve the stored data, and send it to the user port(s), consistent with some flow control regime.

3.4.3 SELECTING FRAME SIZE

The selection of maximum frame size is a compromise between channel through-put and data propagation time over the link.

The receiving modem collects and stores the incoming data frame, and on detecting the end of the frame, checks if an error has occurred. If not, then the stored data is released for transfer to the user data port. If an error has occurred, then the stored data is "flushed" from the data store. Thus a delay is introduced between the time the frame data begins to enter the destination radio modem, and the time this data begins to emanate from the user port. This delay is effectively the length of the data frame, which consists of the user's data, plus the framing overhead. This overhead will include at least 24 bits for the HDLC Flag and FCS (error checking data), plus another 8 bits if SID (Stream Identifier) codes are enabled (refer to detailed description elsewhere in this document), plus the duration of the transmitter Lead-In-Delay, if the radio transmitter had to be started up to send the data. Thus larger frames reduce the proportional overhead, but increase the end to end propagation delay.

On the assumption that the radio transmitter was already on, and that the frames include the SID header, then every frame includes 32 bits of overhead.

Assuming that the user port is configured for 8 bit character size (8 bit data no parity, or 7 bit data and parity), and 1 stop bit, then each character is carried as a 10 bit sequence on the asynchronous user channel. On the radio channel data stream, user data is stripped of the start and stop bits used on the asynchronous user port, and transmitted as eight bit "octets", and so the character rate is 1/8th of the bit rate, while on the asynchronous user port, the character rate is 1/10th of the bit rate. For every 16 user characters 32 bits are stripped off, so if the maximum frame size parameter is set to 16, and the nominal baud rates are the same, then the effective character rates on the asynchronous user channel and the synchronous radio data channel will be the same. This also assumes that the supervisory signalling channel is not enabled, and does not allow for the overhead introduced by the HDLC "dummy zero" stuffing mechanism.

3.4.4 CONFIGURING PAD PARAMETERS

The Packet Assembler/Dis-assembler (PAD) can be configured with a variety of parameters. Each user port is supported by an identical but independent PAD.

The configuration parameters of the PAD, control how the user data (to be transmitted) is framed. There are three distinct mechanisms that can cause the frame that will carry the user data to be closed.

The first of these is the Maximum Frame Size parameter, already discussed above. As each character is input to the modem, a counter is incremented, and when this counter reaches the set maximum frame size, the data storage mechanism that operates within the modem, will close the frame. This function may be disabled, by setting the parameter to zero.

The second mechanism, is the use of a specified End Of Message (EOM) character. This function is enabled/disabled by a flag in a configuration byte for the port driver. The EOM character may be any 8 bit character. When the EOM function is enabled, all incoming user data is compared to the selected EOM character code, and in the event of a match, the current frame is closed. Note that this match only triggers the frame closure mechanism. The matching character is not deleted from the user data stream, and in fact becomes the last user character in the frame.

The third mechanism, is the implementation of a timer. If the timer is enabled, each character received from the user port re-starts the timer. If the time duration between successive user characters allows the timer to expire, then the frame closure mechanism is invoked. The timer counts in units of "ticker clocks", which is a time interval generated by the modem internally, and is approximately 2.5mS. The reload value for the timer can be set from 1 to 255 ticker clocks. The timer mechanism is disabled by setting the PAD timer parameter to zero.

There is a single bit configuration flag, that allows the radio modem to begin transmitting user data, even before the frame is deemed to be complete. In this case, as soon as there is any data in the storage buffer, the modem begins the transmission procedure. Providing that the input character rate is greater than or equal to the character rate on the synchronous radio channel, then there is no danger of an under-run condition, where the modem transmitter runs out of data before the PAD deems a frame end. However, should this occur, the modem data transmitter function simply closes the frame itself. Further data is carried in the next frame. This may or may not cause problems elsewhere in a system context. If higher protocol layers are employed (e.g. X.25, AX.25 etc.), where address and control fields normally occupy fixed positions in data frames, then the above scenario should not be allowed to occur.

The major advantage of allowing the radio modem to begin the transmission procedure before the frame is deemed to be complete, is that it avoids a (store and forward) delay in the modem transmitter, similar to that required in the receiver. For applications where a transparent point to point link is all that is required, this mode provides the most time efficient transport mechanism.

In fact with the immediate transmission function enabled, there is little necessity to enable the EOM or timer functions of the PAD.

3.4.5 SUPERVISORY SIGNALLING CHANNEL: APPLICATIONS & CONFIGURATION.

The reader is referred to drawing number TC01-05-18, which provides a diagrammatic view of this section.

The Supervisory Signalling Channel (SSC) is implemented by the insertion of extra data bits in the primary bit-stream on the synchronous radio channel. These extra bits are inserted between primary data octets, at a rate which can be set to range from once every octet, to once every 15 octets. The SSC operates independently for transmit and receive directions, and can be disabled by setting the rate variable to zero.

The SSC, when enabled, can be configured either to provide end-to-end flow control for Port_A data, or implement the collision avoidance mechanism.

3.4.5.1 PORT_A END TO END FLOW CONTROL APPLICATION.

In this configuration, the SSC is used to carry flow control information for data on Port_A at each end of the link.

SSC data inserted into the transmitted bit-stream, relates to the flow of the primary data stream received. When handshake lines are employed, the DTR line locally controls the flow of receive data to the user port. The state of this line is also logically combined with the "fill" state of the receive buffer, and the result is then sent as SSC data in the transmit data stream. Thus the state of the transmitted SSC data bit is one ("1") if the DTR line is in a "false" state, OR the receive buffer is more than half (approximately) full. In the case where XON/XOFF flow control is used, the DTR line input is instead replaced with the state of the last received XON or XOFF control character.

SSC data extracted from the received bit-stream, is logically combined with the "fill" state of the transmit buffer, and the result is output to the CTS line of the modem. The CTS output line is set to "false" if the transmit buffer is more than half (approximately) full, OR the received SSC data bit is a one ("1"). Thus the CTS line is set to "false" if the local transmit buffer is more than half (approximately) full, OR the remote receive buffer is more than half full, OR the remote DTR input line is "false" (or equivalent XOFF received).

Data flow control is exercised only at the user port. No flow control is used on the radio channel, so once data is entered into the transmit buffer, it will be transmitted. This is the reason why the buffers are only allowed to become half full before the flow control mechanism engages. If the flow of receive data is stopped by deactivating the DTR line, the remaining data in the transmit buffer will not overflow the receive buffer. It should be noted that some hysteresis is used in the buffer occupancy tests, to prevent the CTS line from changing state too often, as some hosts (e.g. DOS machines) appear to get confused when this happens.

If the SSC is not configured for end to end flow control, or is disabled, then the flow control mechanisms still operate at a local level. That is, the CTS line (or equivalent XON/XOFF control regime) reflects the fill state of the local transmit buffer.

3.4.5.2 COLLISION AVOIDANCE APPLICATION.

When the SSC is allocated to transporting collision avoidance data, the transmitted SSC data reflects the state of the radio receiver. Other processes in the modem, measure the RSSI signal from the radio receiver, and compare this measurement to a preset threshold level. This threshold value is also held in the non-volatile configuration memory. The result of the comparison is copied to the modem pin that drives the RXSIG LED. The transition of the RXSIG signal from off to on, (re)starts an internal timer. This time is a fixed value of $35 \pm 5\text{mS}$. The SSC data transmitted, is simply a copy of the RXSIG pin state, until the timer terminates, and there-after, the modem data receiver must be "SYNC'd" to maintain the "1" state of the SSC transmit data. Thus the SSC data transmitted by the modem will indicate that the radio channel receiver is busy, using only RSSI for the first $35 \pm 5\text{mS}$, but after this time, data receiver SYNC is used to qualify this state. This prevents low level RF interference from effectively blocking the channel.

At the receiving end, the recovered SSC data is used by the radio modem to determine when the receiver of the destination station is free. This data can then be used to control it's channel access strategy. Channel access strategies are dealt with in more detail elsewhere in this document.

In such a data transport system, there is a single unit which performs the function of Master, and two or more stations which operate as Slaves. The SSC need only operate in one direction, that from Master to Slaves. In the reverse direction, the SSC can be disabled. That is the SSC in the Slaves is enabled in the data receiver only, while in the Master, it is enabled only in the data transmitter.

3.4.5.3 RECEIVED SSC DATA DEFAULT STATE

The received SSC data bit is stored in an internal latch. This latch is updated each time a SSC data bit is extracted from the incoming bit-stream. However, if the radio receiver loses signal, then a default state is forced into the latch. This default state is configurable.

For applications which use the SSC for collision avoidance, this configuration bit would normally be set to "1", so that the remote station would not attempt channel access while the signal from the base is lost.

For applications which use the SSC for end to end flow control, setting the default state of the SSC receive data latch to "0", would cause the CTS output line to indicate local flow control status only, until the destination unit enables it's transmitter, where-upon the received SSC data would reflect the state of the destination receive buffer and DTR input line. Alternatively, setting the default state to "1", would ensure that the CTS output line would be in a "FALSE" state, until the destination unit enables it's transmitter, where-upon the received SSC data would reflect the state of the destination receive buffer and DTR input line.

An associated configuration bit, is one that allows the automatic activation of the radio transmitter, whenever the data receiver attains SYNC. When this configuration bit is set to "1", the modem will automatically activate the radio transmitter's PTT control line when the data receiver is SYNC'd. This could be used at the base end of a small point to multipoint network, using the SSC for flow control, and would not require the host connected to base, to specifically activate the radio transmitter to establish the end to end link.

3.4.6 SLIP/KISS PROTOCOL DRIVERS

In addition to a generic PAD, two other host interface protocols are supported, "Serial Line Interface Protocol", SLIP, which hails from the world of UNIX(tm), and an extension of SLIP, KISS "Keep It Simple Stupid", (a rather unfortunate phrase in the present context, but a protocol standard proposed by Phil Kahn, USA, specifically for the control of radio connected data terminals) which includes a facility to send commands which are addressed to the DCE device itself. These commands set operating parameters of the radio-modem DCE, such as transmitter lead-in delay, or radio channel (RF frequency).

Neither of these protocol standards, specify anything about the construction of data packets on the radio channel. Allocation of address, control, and information fields is the user's responsibility.

As standard, the modem is equipped with an 8K (8192 bytes, 32K optional) data storage memory to hold transmit and receive data. This memory is divided equally between transmit and receive buffer space, and equally between the two user ports, so the largest frame size is 4095 bytes, if only PortA is enabled, (or 2047 bytes each if both user ports are enabled), before the frame check sequence (FCS)is appended.

Additionally, the modem can store up to sixty four separate frames for each direction, again split between the two user ports if both are enabled, though the total byte count is still limited to 8192 total.

3.4.6.1 SLIP Protocol Description/Definition

The SLIP protocol, is a data transport protocol, originated and used extensively in UNIX(tm) based systems, and thus also closely associated with TCP/IP networked systems. Although not truly a "standard" it is so widely used that it has become the defacto standard for serial interface in UNIX and many other networked systems. SLIP is a method of framing messages containing binary data, on asynchronous channels. The asynchronous serial channel is configured for eight bit character size, no parity, and one stop.

A specific binary code called FEND (Frame End, hexadecimal value=C0) is reserved to define a frame boundary. Should this same code occur in the data message to be transferred across the channel controlled under SLIP, then an escape sequence is used so that the message byte will not be confused for a FEND. This escape sequence, involves replacing the message hexadecimal C0 code with a two byte sequence FESC, TFEND. FESC (Frame Escape) is the binary code hexadecimal DB, and TFEND (Transposed FEND) is binary code hexadecimal DC. Likewise, if the FESC character ever appears in the user data, it is replaced with the two character sequence FESC, TFESC (Transposed FESC). The TFESC is the binary code hexadecimal DD. The following table clarifies this.

<u>ABBREVIATION</u>	<u>DESCRIPTION</u>	<u>HEX.VALUE</u>
FEND	Frame end	C0 (192)
FESC	Frame escape	DB (219)
TFEND	Transposed frame end	DC (220)
TFESC	Transposed frame escape	DD (221)

As characters arrive at the SLIP receiver, they are appended to a buffer containing the current frame. Receiving a FEND marks the end of the frame, and consequently, succeeding bytes are considered part of the next frame.

Receipt of a FESC code puts the SLIP receiver into "escaped mode", causing it to translate a following TFESC or TFEND back to a FESC or FEND code, appending it to the buffer, and resuming it's normal state. Receipt of any byte other than TFESC or TFEND while in escaped mode, is an error. No translation occurs, and the SLIP receiver leaves escaped mode. A TFESC or TFEND received while not in escaped mode is treated as an ordinary character and stored accordingly. Reception of consecutive FEND characters, causes no action to be taken (i.e. is not interpreted as zero length frames).

An example of a typical SLIP frame is shown below. The message consists of the string DA,C4,C0,C5,DB,20,BD,DC,DD. The SLIP frame will be:-

```
<FEND>,DA,C4,<FESC>,<TFEND>,C5,<FESC>,<TFESC>,20,BD,DC,DD,<FEND>
==>      C0,DA,C4,DB,DC,C5,DB,DD,20,BD,DC,DD,C0
```

3.4.6.2 KISS Protocol Description/Definition

The KISS protocol is an extension of SLIP. It uses the same method of framing packets, using FEND, FESC, TFEND, and TFESC codes. However, the first byte in each frame is reserved as a control code, that defines the function/content of the frame, and also contains an address.

This addressing scheme allows up to sixteen "Terminal node controllers" (TNC's), to share a multidrop buss. The top nibble of the control code carries the TNC address, and the lower nibble carries the command code. Normally the address is set at zero for installations containing only one TNC. Note that some extensions have been proposed for the KISS protocol, that properly support addressed multidrop line operation of multiple TNCs, that the present TC-900DR modem firmware does not implement. The following table shows the commands defined by KISS, and the comment column indicates how the TC-900DR modem interprets them.

<u>COMMAND</u>	<u>FUNCTION</u>	<u>COMMENTS</u>
0	Data Frame	The rest of the frame is data to be transmitted.
1	TxDelay	The next byte is the RF transmitter key-up delay in octets.
2	Slotnum	The next byte is the Slotnum parameter.
3	Slot-Time	The next byte is the "Slot" interval in "ticker clocks".
4	TxTail	The next byte is the time to hold up the RF transmitter after the closing FLAG has been sent. This command is obsolete, and not implemented in the TC-900DR.
5	FullDuplex	The next byte is zero for half duplex, non-zero for full duplex. This command is not implemented in the TC-900DR, as it always operates in full duplex mode.
6	SetHardware	Specific for each TNC. This parameter has values between 00 and 03, and commands the TC-900DR to set RF channels 0 to 3. Values above 3 are ignored by the present modem firmware, but may be used in future versions.
F	ExitKISS	Exit KISS and return control to higher level TNC control program. This command is not implemented in the TC-900DR.

3.4.7 RF TRANSMITTER CONTROL AND CHANNEL ACCESS STRATEGIES

There are three conditions which cause the modem to activate the radio transmitter. These are: a) receiver SYNC if enabled, as described above; b) RTS if enabled, as described below; and c) the existence of a data frame ready for transmission. The first two mechanisms are absolute, and if enabled, cause an immediate activation of the radio transmitter. There are two configuration bits that control how the availability of a data frame, will activate the radio transmitter, and thus gain access to the channel. For the purposes of this description, these are referred to as Modes A, B, and C.

In Mode A, channel access is immediate. The radio transmitter is activated, and the modem then proceeds to send a preamble sequence, followed by the data. The preamble sequence is necessary for receiver synchronisation, and the length is a configuration parameter. Further discussion of these aspects of the modem configuration are dealt with elsewhere in this document.

In Mode B, the modem will attempt channel access only if the radio receiver is NOT receiving a signal (i.e. the measured RSSI level is below the minimum RSSI threshold as described elsewhere in this document). This method could be used for small point to multipoint systems, where the base station would enable it's radio transmitter on receiving a transmission. Typically this would be done at the base unit by enabling the SYNC-PTT function, as described above. This implements a basic collision avoidance system, without the use of the Supervisory Signalling Channel, which then remains available for flow control applications.

In Mode C, the modem will attempt channel access only if the data receiver is SYNC'd, and the SSC data is "0" (i.e. base receiver free). This is the full Collision Avoidance system as described in detail above.

In the latter two cases, if another data frame is ready for transmission at the time the present one is ending, then it is automatically appended as another frame, and the transmission continues. Obviously since the radio transmitter is already enabled, no preamble is required or sent. The modem itself does not limit the number of consecutive frames it will transmit. If data continues to be input to the modem, once channel access is gained, it continues to be transmitted. It is the responsibility of the user to manage any maximum channel access time in overall system design. However, if the PTT timer is enabled (dealt with in detail elsewhere in this document), and the set time is reached, then the modem will disable the radio transmitter PTT line. User data will now be lost.

For the two latter strategies, if channel access fails (i.e. signal at radio receiver in the former case, or SSC=1 in latter case), then the modem uses a timed delay mechanism before testing for channel availability again.

3.4.7.1 SELECTING "SLOTIME" AND "SLOTNUM" VALUES

This delay time is necessary to prevent multiple remotes from attempting to gain access to the channel as soon as it is signalled to be clear after another transmission has finished, as this would result in the transmissions from all these remotes colliding. Instead, when a modem fails to gain channel access, it generates a randomly selected delay time, and when this time has expired, it again tests for channel availability.

There are two parameters which are used to generate the delay time. The "Slotime" parameter defines the size of the time increment used in selecting the delay. This value defines a time counted in "ticker clocks" (approximately 2.5mS), and has an allowable range of 0 to 255. The "SlotNum" parameter defines the upper limit of the random number generator. The random number generator selects an integer between one and the value of "SlotNum", and then multiplies this by the value of "Slotime" to derive the delay time. The "SlotNum" parameter has a maximum allowable range of 1 to 16.

These two parameters together provide a very flexible method of tuning the channel access characteristics of a system, and should be regarded as system tuning parameters. In the absence of any knowledge of a system configuration, Trio DataCom's set default values for these two parameters to 4 and 16 for "Slotime" and "SlotNum" respectively.

3.4.7.2 PTT CONTROL BY RTS LINE

Applications relying on establishing a point to point link before data is transferred, would normally require some "manual" method of activating the radio transmitter. A configuration bit enables the RTS input line to be used as a PTT control. The modem is always generating a data signal. During the time when no user data is available, the modem continually generates an "idle" bit-stream of HDLC FLAGS. This sequence produces no data output at the receiving radio modem.

3.4.8 SELECTING FLOW CONTROL REGIMES

The type of flow control to be used on the radio modem port(s), depends on the user's application and capabilities of the equipment which the user interfaces to the TC-900DR.

Port_A, which is always active, can be configured to use the standard RS232 handshake lines RTS/CTS/DTR, or use XON/XOFF protocol.

3.4.8.1 PORT_A, HARDWARE HANDSHAKE FLOW CONTROL

If hardware handshake lines are configured, then RTS must be active to validate characters input to the modem for transmission. As each character is received (i.e. at the end of each character bit sequence) the state of the RTS input line is tested to validate the character. If the RTS line is tested "true", then the character is stored ready for transmission. If "false", then the character is discarded. The modem provides flow control of transmit data with the CTS line. The CTS line is set "false" to indicate that no more transmit data should be input. Normally, most terminals or hosts will still send one or two more characters after the CTS line is set "false", and this is normal and allowed for in the CTS control logic. In fact the modem will continue to accept and store transmit data (providing the RTS line is still active) even though it has set the CTS line to "false", however the user then risks the occurrence of an overflow condition. If the transmit buffer becomes full, then further data is discarded.

A configuration bit, further controls the state of the CTS output line in relation to the RTS input line. If the bit is clear, then the CTS output will always indicate the flow control state, regardless of the state of the RTS input. If the bit is set, the CTS line is conditional on the state of the RTS input. If the RTS input is "false", then the CTS output is also "false". If the RTS input is "true", then the CTS output indicates the flow control state. This latter configuration is typical of a "wired" modem.

The modem's internal data store holds both the raw user data, and records the position of frame boundaries (as defined by PAD operation) in the data. A limited amount of memory is allocated to storing the frame boundary data. When this memory space is full, the modem sets the CTS output to false, even though the character storage space may not be full. The frame boundary storage space is sufficient to hold data for 64 frames. If the modem has both ports (Port_A and Port_B) enabled, then this space is evenly divided between the two, or if Port_B is disabled, then up to 64 frames can be stored for Port_A. If data continues to be input when the CTS line has been set to "false" because no more frame boundaries can be recorded, then the frame closure mechanism may abort. This has the effect that a frame will not be closed when defined by PAD configuration. An example of this, is where the PAD is configured to close the frame on receiving a <CR> (carriage return) EOM. If the frame boundary space is full, when a <CR> is input, then the subsequent characters will be appended to the same frame. Another attempt to create a new frame will not occur until the same or another frame close condition (as defined by PAD configuration) occurs, in this case another <CR>. This logic avoids the unnecessary loss of data.

Situations where the data storage space or frame boundary storage space become full, would be rare, and would only be likely to occur if the transmitter could not gain access to the channel, or the input data rate exceeds the channel transmission rate for some time.

Normally the TC-900DR is manufactured with an 8 kilobyte memory for data storage. This memory space is divided equally between transmit and receive data storage. If both user ports are enabled, then each half is equally divided between the ports (i.e. 2K/2K/2K/2K for Port_A transmit, Port_A receive, Port_B transmit, Port_B receive). If Port_B is disabled, then 4K is available for each of the transmit and receive data storage functions for Port_A.

The DTR line controls the flow of receive data to the user port. While the DTR input line is "true", available received data is output from the port. If the DTR input is "false", then receive data output ceases.

3.4.8.2 PORT_A XON/XOFF FLOW CONTROL PROTOCOL

When XON/XOFF flow control is configured for Port_A, the CTS line is set "true", the RTS input line is not required to validate input data, and receive data is not dependent on the state of the DTR line. Instead of controlling the CTS line, the modem sends XON/XOFF characters (embedded in the receive data stream), to the port. The flow of receive data is controlled by the receipt of XON/XOFF characters in the transmit data stream. These control characters are trapped out of the transmit data stream, and are not transmitted.

The underlying flow control logic is the same as RTS/CTS/DTR control. An XON is sent instead of a "false" to "true" transition of the CTS line, and an XOFF is sent instead of a "true" to "false" transition on the CTS line. A received XON is recorded by an internal flag that emulates a "true" state on the DTR line, and a received XOFF is recorded by the flag to emulate a "false" state on the DTR line.

This method of flow control would be considered to be less reliable, since a lost XON or XOFF control character could cause either an overflow condition, or data flow to stop altogether.

3.4.8.3 PORT_B FLOW CONTROL

User Port_B can be configured for no flow control, or XON/XOFF flow control. When XON/XOFF flow control is configured, it operates identically to Port_A, except that this port has no CTS line to set "true". Flow control on Port_B operates at a local level only, since end to end flow control via the SSC is available only for Port_A.

If XON/XOFF flow control is disabled, then no flow control is used on Port_B, as there are no RTS/CTS/DTR lines implemented on Port_B. Users should be careful to avoid overflow conditions, to avoid loss of data.

It will now be obvious that the RTS input line on Port_A can be used by more than one function in the modem. RTS can have no function, or be used in Port_A flow control, and/or provide a manual PTT facility.

3.4.9 SETTING MINIMUM RSSI LEVEL

The data receiver of the modem is continually running. It will be in one of two states. It is not SYNC'd, and thus looking for HDLC FLAGS in the radio receiver signal, or it is SYNC'd, and recovering frame data to be checked and stored. If the radio receiver is not receiving a signal, then the recovered signal applied to the data receiver of the modem, will consist only of noise. To prevent the modem from erroneously locking onto noise, a minimum RSSI level must be present to validate the recovered signal applied to the modem data decoder. This threshold level, is stored in the non-volatile configuration memory. It should be set by applying a signal to the radio receiver, which produces a desired SiNaD result, a desired bit error rate, or more crudely, a predetermined absolute signal level into the antenna connector of the TC-900DR. The modem (operating in Test/Program mode) is then commanded to measure the RSSI level, which produces a response of a message indicating the measured level, in hexadecimal. This process should be repeated several times, then an average taken. The analogue to digital conversion performed in this way, is an eight bit conversion. In normal operation, the modem performs a six bit conversion when measuring the RSSI level, so the average of the levels measured in the test mode should now be divided by four. The result should now be stored in the configuration memory, at the address reserved for it.

3.4.10 SETTING PTT TIMER

The modem implements a PTT timer. This timer can be disabled entirely by setting the PTT Timer configuration value to zero. The timer value is a 16 bit number, that counts in "ticker clocks". If the timer is enabled, whenever the modem activates the PTT control to the radio transmitter, it initialises the timer with the configured value. The timer is decremented while the PTT control remains active, and if it terminates, the PTT control is deactivated. No other action is taken, and all other functions within the modem are oblivious to this condition, so data frames continue to be output, and thus lost. The PTT timer is to be considered an emergency override mechanism only, in case an error occurs in the operation of the user's host equipment and/or software. To reset this time-out state, conditions must be met that would cause the modem to normally deactivate the PTT control. The PTT timer will then be re-initialised the next time the PTT control is activated. The time-out period may be set in "ticker clock" (2.5mS) increments to over 160 seconds.

3.4.11 DATA STREAM SWITCHING, SELECTING AND ENABLING SID CODES

The TC-900DR radio modem includes a feature that provides data stream switching. This is achieved by placing a Stream Identifier code (SID) at the beginning of every frame. This code functions as a simple addressing function. If both user ports of the TC-900DR are enabled, then SID codes should also be enabled, so that data frames carry a code which identifies the originating port (A or B), thus the port to which the frame data should be directed when the frame is received at the destination station.

However this stream switching mechanism is not only confined to this simple application. The SID codes for each user port, are contained in the configuration memory, and are thus "soft". It would be possible to engineer a small (up to 256 stations) network using an individual SID code for each remote station. Since the modem receiver will discard frames which are headed by an SID code which is not recognised, only frames specifically addressed would be stored and passed on to the attached host. The SID code is allocated to the port, so the modem uses the same SID code both for transmission and receipt of frames. Therefore in such a system, the master would be configured with SID codes disabled. The host attached to the master would preface each message with the eight bit address of the destination remote. The message from the remote emanating from the port will have the SID code removed. A message received from a remote, will have the SID code of the sending station at the beginning as the first byte. The remote modem itself places this code at the head of the frame.

Another application of the stream switching feature, is a remote diagnostics facility. This is a facility which is planned for release in the next firmware version. A reserved SID code will be used to address a diagnostics function within the modem. A command/addressing protocol is being developed that employs the units own unique serial number for addressing. "Stay tuned for further updates!".

The SID code is placed in the first octet of each frame. This provides up to 256 unique codes. However, to avoid possible future compatibility problems where higher level protocols are in use on the same channel (e.g. AX.25, etc.), it is suggested that the SID codes used have bit0 set to "1". Such higher level protocols normally use extended addressing where more than one octet is used to carry the destination/source address. A frame using an SID code with bit0 set, will fail an address test and be discarded by such systems. Conversely, if this modem receives a frame containing a higher level protocol, bit 0 of the first octet will normally be set to "0", so will not match any SID code stored in the configuration memory, and be discarded.

By default, Trio DataCom sets the SID codes to 03 and 05 for ports A and B respectively. We have also reserved SID code 00 for the diagnostics facilities.

3.4.11.1 Separate Tx And Rx SID Codes. (Firmware Revision V2.1 onwards)

Firmware revision V2.1.0 onwards allows the Transmit and Receive SID codes to be different. Normally the RxSID and TxSID parameters (separate for each port) would be programmed the same. By programming them to be different, means that a TC-900DR unit will receive frames carrying a SID code that matches the configured RxSID code, but transmit frames which carry a SID code that is specified by the TxSID code configuration parameter. Applications for this feature are in small point to multipoint systems, using a central "community" repeater.

3.4.11.2 Repeater Operation Mode. (Firmware Revision V2.1 onwards)

The TC-900DR radio modem may also be configured in a repeater mode. The repeater function is enabled as a protocol driver on a port. Thus each user port driver can individually be configured for repeater operation. Essentially, what this does is automatically routes the received data frames back to the transmitter. If SID codes are enabled, then the original SID codes are stored as part of the data frame, and thus the retransmitted frame is identical to that received. Note that only frames received error free will be repeated.

When a port driver is configured for repeater operation, the RxSID and TxSID codes stored in configuration data in the NVRAM are used to define a range of streams to be repeated. The RxSID code configuration parameter defines the lowest SID stream to be repeated, and the TxSID code configuration parameter defines the highest SID stream that will be repeated. Thus it is possible to configure a unit to perform a repeater function for two separate ranges of streams, by configuring both user ports with a repeater driver, or to configure one end of a data link to also be a repeater for a range of other streams.

3.4.12 SETTING TRANSMITTER LEAD_IN_DELAY

Whenever the radio transmitter is activated a timer is started. No data frames are transmitted until this timer terminates, so that the destination unit receiver has time to synchronise it's data receiver before frame data is begun. The radio transmitter is very fast, reaching final output power and frequency stability in a matter of a few hundred microseconds (other sections of this document deal with the receiver synchronising aspects). This timer counts in octets, not "ticker clocks" as most other timed functions do, so the actual time elapsed is a function of the radio channel bit rate. However, the synchronisation time is primarily a function of the number of bits to the receiver. Trio DataCom would suggest a value of 25 to 50 (decimal) for this parameter, but it's final value will depend on signal strength and quality at the receiving point, and should best be determined by test.

3.5 FACTORS AFFECTING MODEM SYNCHRONISATION TIME

3.5.1 (UN)SCRAMBLER AND HDLC STATE MACHINE

It can be shown, that the un-scrambler in the receiving unit will synchronise to the scrambler in the sending unit in 17 bits maximum.

The receiving unit must then detect an HDLC FLAG, which will take another 15 bits maximum. Thus the HDLC state machine and unscrambler should be synchronised in 32 bits maximum.

3.5.2 PHASE LOCKED LOOP

Before valid data can be read for the unscrambler, the phase locked loop (PLL) must lock. The time required for this to occur is affected by signal quality and content. The PLL relies on level transitions of the binary signal, on which to lock. It essentially compares the phase of an internal counter, with the phase of the incoming data bits. A detected phase error, will cause the internal counter to speed up or slow down, to reduce the phase error. The greater the error, then the greater the speed adjustment to the internal counter.

If the incoming data stream has few transitions, then the internal counter will "catch up" to it quicker, since it's speed is adjusted less often. The PLL will synchronise to within 90% of the correct phase (from 0%), in 16 to 36 bits time, depending on the number of transitions.

In practice, even though the PLL has not reached 90% lock, meaningful data will still be obtained as long as a good strength, clean signal is available.

3.5.3 ERROR CONTROL

Having recovered the raw data, the modem then applies the bit-stream to a de-randomiser, which is based on a recursive tapped shift register, described by the polynomial:

$$X^{17} + X^{12} + 1$$

The output of the de-randomiser is then fed through another conversion function, to convert the NRZI data to NRZ.

The data is now an HDLC data stream, conforming to ISO3309. It is then applied to a function which detects HDLC FLAGS, and extracts "dummy zeros", which were inserted by the transmitter. Frame boundaries are detected at this point.

The modem calculates and appends a 16 bit Cyclic Redundancy Checksum (CRC) word to the end of each frame. This calculation uses the polynomial:

$$X^{16} + X^{12} + X^5 + 1$$

This is sometimes referred to as CRC-CCITT since it is a CCITT standard.

The 1's complement is taken of the calculation result and this FCS is appended to the end of the data frame and sent MSB first. (Refer to ISO 3309 for more information)

At the receiver, this calculation is repeated on the received data, and the result checked. A detected error, will cause the receiver to discard the entire frame. A higher protocol level (determined by the user) will detect the lost packet, and initiate a re-send of the packet.

In terms of the reliability of this FCS, it can be claimed that the following will be detected :

²

- All single bit errors.
- All double bit errors.
- Any odd number of errors.
- Any burst error less than 16 bits long.
- Most large burst errors.

From here emanates the original frame data, provided the FCS was correct. If not then the frame data is discarded. The data is stored in externally addressed memory, connected to the modem IC. Maximum data packet size is determined by the amount of available memory. Normally the modem is fitted with an 8K CMOS RAM, of which half (4096 bytes) is allocated to the receiver. The modem can be fitted with an external memory up to 32K with no other modifications. The receiver section of the modem can store up to 32 separate data packets.

How this data is handled from this point on, depends on the user protocol implemented by the modem on the user interface.

3.5.4 TRANSMISSION FORMAT AND TIMING

The data to be transmitted is input to the modem, via the user interface protocol implemented on the user interface. The modem stores the data packet(s) in externally addressed memory, connected to the DFM4-9 modem IC. Maximum data packet size is determined by the amount of available memory. Normally the modem is fitted with an 8K CMOS RAM, of which half (4096 bytes) is allocated to the transmitter. The modem can be fitted with an external memory up to 32K with no other modifications. The transmitter section of the modem can store up to 32 separate data packets.

Most of the transmitter functions are performed internally in the modem IC, with only a DAC (Digital to Analogue Converter) and final low pass filter implemented by external circuitry.

The data is placed into an HDLC frame (consistent with ISO3309), complete with dummy zeroes where required. During transmission, a CRC calculation (CRC-CCITT) is performed, and when the end of the data packet is reached, this FCS (Frame Check Sequence) is appended to the end of the frame, before the closing HDLC FLAG.

Where two or more consecutive frames are sent, only one FLAG octet is used to delimit the frames. All frames are composed of an integral number of octets.

² "Data and Computer Communications" William Stallings

Data from the HDLC formatting stage is fed through a function, to convert the NRZ data to NRZI format.

The NRZI encoded data stream is now fed to a data randomiser, to ensure that there is no DC component to the data stream. This is based on a recursive seventeen bit shift register with two taps.

3.5.5 COLLISION AVOIDANCE SCHEME

The unique supervisory signalling channel facility available in this product is ideally suited to the implementation of a highly effective collision avoidance mechanism. This is a highly desirable feature in a multipoint data network, in that it allows vastly increased usage of the available channel capacity.

For instance, take a point-to-multipoint network, with a central base station, and a large number of remote data terminals scattered around the central station.

This is a split frequency duplex channel, where the central station is able to transmit on frequency F1, and simultaneously receive on frequency F2. Remote stations transmit on frequency F2, and receive on frequency F1.

If a transmission by one remote station is "crashed" by a transmission by another remote station, then the base station may not get the message correctly, and thus not acknowledge it. If there is no control over when the remote stations transmit, then because the remote stations cannot "hear" each other, their transmissions will begin to collide more often as the data traffic increases. This type of system will suffer a total blockage as the total traffic requirement approaches about 50% of the channel capacity.

Now, if the base station could quickly inform all other remote terminals, when the base receiver is busy because one of the remote terminals is transmitting, then this message can be delivered to the base receiver without being "jumped on" by another terminal blindly "crashing in". The next terminal can then deliver its message when the receiver is signaled to be free. Of course collisions are still possible, but the occurrence of these can be dramatically reduced by this type of scheme.

Now to implementation specifics. The supervisory signalling channel in the modem, can be set independently for transmit and receive directions. For the purposes of this collision avoidance scheme, the supervisory signalling channel is only required in the base transmit direction. In the reverse direction, the supervisory signalling channel is disabled. The base transmitter is active full time, sending only FLAGS when it has no real data to send. The base controller, then indicates to the whole population of remote terminals, the current status of the base receiver, in the value of the supervisory signalling channel data bits.

The remote data terminals are programmed so that they will not begin a transmission if the received supervisory signalling channel data indicates that the base receiver is currently busy. This would result in remote terminals queuing for access to the base receiver. To prevent all these remote terminals all beginning a transmission as soon as the base indicates a free receiver, a "windowed" timing mechanism would be implemented, with a random factor added in the terminal's selection of a "window".

There are many factors that would determine the quantification of system variables, but this short description serves to illustrate a basic approach.

3.6 TEMPERATURE COMPENSATION

Periodically, the modem controller reads the voltage on the temperature transducer mounted on the radio section. This value is then used in a table look-up procedure, to derive correction data to be applied to the modulator circuitry via a transmit waveform offset voltage. This is provided by the output of the six bit DAC (UX8/RN2), which is fed to the correction voltage input of the 12MHz reference oscillator.

The offset table is constructed in the temperature calibration cycle performed during the factory testing procedure. The radio-modem is temperature cycled twice from -10C to +65C. During this time, the necessary data is determined to correct the temperature induced frequency errors. At the end of the cycle, the final database is constructed and written to the non-volatile memory.

3.7 USER INDICATIONS

The TC-900DR provides three LED's that show status information to the user - RXSIG, SYNC, and TXMIT indications.

In all operation modes of the modem except "Programmer mode" (see the section below on special modes of operation), the RXSIG LED indicates the level of the RSSI signal from the radio IF strip, compared to a threshold set in the configuration data read from the non-volatile memory. If the signal is above the threshold, then the LED indicator is turned on. There is no hysteresis applied in this process.

In normal operation, the SYNC LED indicates when the modem has detected a valid data stream. The SYNC LED is activated, when the modem detects a valid HDLC flag sequence, and remains active until an invalid sequence of seven or more consecutive "1" bits is detected. The SYNC LED will not be turned on if the RSSI signal strength (as indicated by the RXSIG LED) is below the minimum threshold. This prevents false SYNC detection from noise. While the modem is SYNC'd, it does not continue to measure RSSI levels.

The TXMIT LED indicator is connected directly to the modem's PTT output transistor. It is active whenever the PTT line to the radio section is active low.

3.8 SPECIAL MODES OF OPERATION

3.8.1 GENERAL

Part of the power-up/reset initialisation phase of the TC-900DR modem, is a set of tests to determine whether the modem should enter a special operation mode.

There are three of these "special" modes. *Whilst in these modes the TC-900DR will not operate in its standard run mode.*

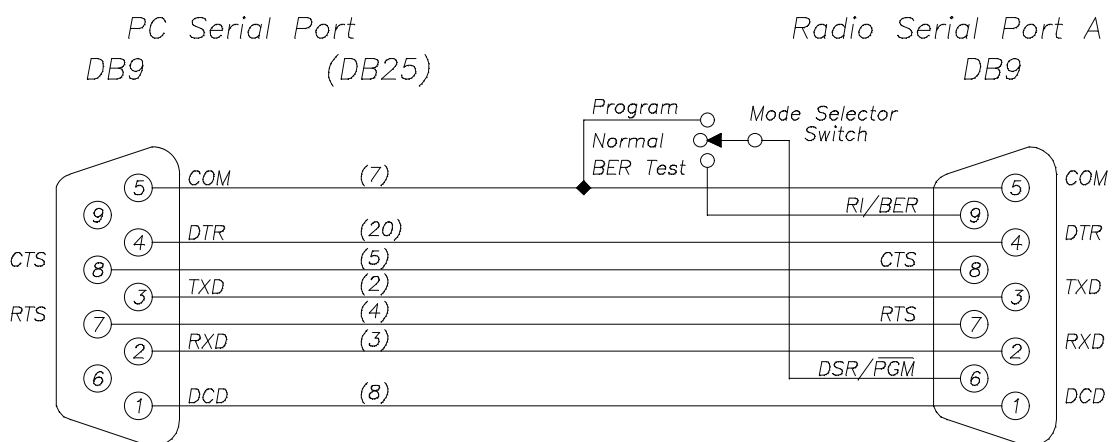
- Programmer mode.
- Bit error rate test mode.
- Handset mode.

These modes are only entered if the required setup conditions are present at power up of the TC-900DR. An error mode of operation can also be entered into, if during normal operation of the TC-900DR modem, an error condition occurs.

3.8.2 PROGRAMMER MODE

Pin 6 on the DB9 connector of Port A, is normally the DSR line. This pin is pulled high by a resistor to +13.8v, so that to a connected DTE the DSR signal implies that this DCE is ready.

However, if this pin is connected to pin 5 when the modem is powered up, the controller senses this, and attempts to enter "Programmer mode". The modem sends out of the serial port, an ASCII "?" (question mark) character, and waits for the programmer to reply with a password. The SYNC LED toggles on and off with every output of the "?" prompt until the correct password is entered. This mode is sustained for approximately 30 seconds. Failure to supply the correct password in time, will cause the modem to abandon the "Programmer mode" attempt, and go on with it's normal power-up procedure. This password protection scheme provides some defense against unauthorised tampering with the TC-900DR modems configuration data.



3.8.3 BIT ERROR RATE TEST MODE

Pin 9 of the DB9 connector of Port A, is normally the Ring Indicate output line. The modem includes a resistive pulldown to ground to show a negative condition on this line. However, if this pin is driven positive (typically by connecting it to pin 6), then the modem's data transmitter and receiver will enter the BER test mode.

It will activate the RF transmitter and generate a scrambled bit pattern which should be decoded at a receiver as a constant logic "1" level in the unscrambled data.

A test point on the modem section PCB, is available to monitor this point with a frequency counter. (In fact this test point is always active, and may be used to monitor the received data decoded by the DFM4-9 modem IC at any time). Any errors in the decoded bitstream, will be "0", and the receiver portion of the modem in this mode, will activate the SYNC LED every time it sees a "0" bit.

An internal timer is used to generate a time equivalent to 1000 bits. Every error bit detected, will activate the SYNC LED, and restart the timer. If and when the timer expires, the SYNC LED is deactivated. Thus, for error rates of 1 in 10³ and above, the SYNC LED will be ON most of the time. A 1 in 10⁴ error rate will show the SYNC LED active for approximately 10% of the time. This function provides a crude indication of Bit Error Rate for installation purposes.

Other functions performed in this state include RXSIG indication, and temperature compensation. The state of pin 9 is constantly monitored in this mode. If the pin ceases to be driven positive, then the BER Test mode is terminated, and the modem restarts its initialisation phase.

3.8.4 HANDSET MODE

The DFM4-9 modem tests for the presence of a handset plugged into the handset audio port at power up.

This is done by measuring the voltage on channel 4 of the analogue to digital converter (UX10-p6). This signal is passed into the modem section from the radio section via connector X4-p24, "ADC3".

If a handset is plugged in, then the measured voltage will be about 2V, but if it isn't installed, then the voltage will be about 4V. The measured voltage is compared to 3V to determine whether the handset is plugged in. If this test succeeds, then the modem will not generate a data stream. However, it will continue to indicate received RF signal strength, and perform temperature compensation. The handset has a PTT button, and this signal is connected across the modem's PTT output. Thus the handset PTT switch will activate the TXMIT LED.

3.8.5 ERROR INDICATION MODES

3.8.5.1 GENERAL

There are three error conditions that will cause the RXSIG and SYNC LEDs to be used for error indications and not their normal purpose. Two of these are fatal conditions, that cause the modem to restart after the duration of the error indication phase.

3.8.5.2 TRANSMIT POWER LOW

While the modem activates the radio transmitter, it periodically checks the transmit power. If the power measurement is less than a threshold set in the non-volatile memory, then the RXSIG and SYNC LEDs are made to alternate, approximately four times per second. The TXMIT LED will also be on during this process. This indication condition will persist for the duration of the transmission. As soon as the transmission is discontinued, the error indication will cease, and the two LEDs revert to their normal function.

3.8.5.3 NVRAM READ ERROR

The DFM4-9DR modem accesses the non-volatile memory as part of its initialisation phase, to get configuration data. If the communication protocol with the device is violated, or the non-volatile memory CRC checksum is found to be incorrect, then the modem indicates this by flashing the RXSIG and SYNC LEDs twice alternately. That is, one LED operates ON and OFF twice, then the other. A total of five cycles of this occurs, then the modem restarts its initialisation from scratch.

3.8.5.4 SYNTHESISER LOCK DETECT ERROR

If at any time during normal operation, BER mode, or handset mode, the TBB206 frequency synthesiser indicates an out of lock condition, the modem enters an error indication mode for a short time before restarting. One LED is turned ON (⊙), the LEDs are swapped, then both turned OFF (●). Then the latter LED ON again, swap LEDs, and then OFF. This will give the appearance of a sweeping motion between the LEDs.

The following table shows all error condition displays for comparison.

Tx PWR Error		NVRAM Error		TBB206 Error Synthesiser	
RXSIG	SYNC	RXSIG	SYNC	RXSIG	SYNC
⊙	●	⊙	●	⊙	●
●	⊙	●	●	●	⊙
⊙	●	⊙	●	●	●
●	⊙	●	●	●	⊙
⊙	●	●	⊙	⊙	●
●	⊙	●	●	●	●
⊙	●	●	⊙		repeat
●	⊙	●	●		
continue			repeat		

3.9 SYNCHRONOUS OPERATION MODE FIRMWARE REVISION: V2.1

3.9.1 GENERAL

The TC-900DR when operating in Synchronous mode, implements a V.24 like interface. The unit uses a special wiring harness that converts the two 9 pin "D" connectors on the end panel of the TC-900DR to a standard 25 pin "D" connector for user interface.

Synchronous Mode implements a bit level interface. Data is carried on a bit by bit basis. No framing or error detection is performed. Modem operation is full duplex.

Current implementations of SYNC mode, do not provide a DCD signal in the 25 pin RS232 interface.

3.9.2 DATA RECEIVER

While sufficient RF signal is present into the radio receiver, the data decoder is continually extracting data bits from the received signal, and outputting these to the user interface connector. If the received RF signal into the radio receiver falls below the minimum threshold, then the data decoder stops.

3.9.3 SETTING MINIMUM RSSI LEVEL

The data decoder of the modem is continually running while sufficient RF signal is present into the radio receiver. If the radio receiver is not receiving a signal, then the recovered signal applied to the data decoder of the modem, will consist only of noise. To prevent the modem from erroneously locking onto noise and producing "garbage" at the RxD pin, a minimum RSSI level must be present to validate the recovered signal applied to the modem data decoder. This threshold level, is stored in the non-volatile configuration memory. It should be set by applying a signal to the radio receiver, which produces a desired bit error rate, a desired SiNaD result, or more crudely, a predetermined absolute signal level into the antenna connector of the TC-900DR. The modem (operating in Test/Program mode) is then commanded to measure the RSSI level, which produces a response of a message indicating the measured level, in hexadecimal. This process should be repeated several times, then an average taken. The analogue to digital conversion performed in this way, is an eight bit conversion. In normal operation, the modem performs a six bit conversion when measuring the RSSI level, so the average of the levels measured in the test mode should now be divided by four. The result should now be stored in the configuration memory, at the address reserved for it. The DR9_PRGM programmer available from Trio DataCom Pty Ltd facilitates this process.

*Use a signal generator modulated with a sine wave frequency of half the nominal bit rate of the unit (e.g. for a 4800BPS unit, use 2400Hz modulation).

3.9.4 DATA RECEIVER CLOCK OUTPUT

The receive section of the modem, includes a clock line driven by the modem. This signal is used to synchronise the transfer of receive data to the user system. The RCO (Rx_Clock_Output, pin17 in the DB25 connector) line changes from ON (TRUE) to OFF (FALSE) as the RxD (Receive_Data, pin3 in the DB25 connector) line outputs the next bit, and from OFF (FALSE) to ON (TRUE) in the nominal centre of the bit cell. This conforms to the V.24 specification.

3.9.5 OTHER RS232 RECEIVER CONTROL LINES

The DSR (Data_Set_Ready) line is driven true by the modem. This line is in fact merely tied to the internal +13.8volt rail via a 4K7 resistor. The DTR (Data_Terminal_Ready) input is unused in Synchronous mode.

3.9.6 DATA TRANSMITTER

The transmit data input is continually sampled and coded for transmission. This process consists of sampling the data input, randomising the bit pattern so that the DC component of the transmitted stream is zero, and generating a waveform suitable for application to the modulator of the FM radio transmitter.

3.9.7 DATA TRANSMITTER CLOCKS

The modem transmit data interface, includes two clock lines. One clock line, TCO (Transmit_Clock_Out, pin15 in DB25 connector) is driven by the modem, the other, TCI (Transmit_Clock_In, pin24 in the DB25 connector) can be enabled to allow the external user to supply a transmit data clock. This is implemented by synchronising the internal clock generator to the user's clock (within a small frequency range). This function is essentially a Phase Locked Loop, and effectively adjusts the phase of the internal clock to match that of the input clock. If the user clock source stops, then the modem will continue to generate the internal clock at it's nominal rate. In accordance with specification V.24, the state of the transmit data line (TxD, pin2 in the DB25 connector) is sampled on the ON to OFF transition of the clock, the bit cell boundary occurs with the OFF to ON transition of the clock.

3.9.8 TRANSMITTER RTS/CTS LINES

Two other control lines are included in the transmitter interface. The RTS (Ready_To_Send) input line, is used to control the radio RF transmitter. The CTS (Clear_To_Send) output line is driven by the modem, to indicate that the modem transmitter is ready to accept transmit data. The RTS to CTS time is determined by an internal timer. A configuration parameter is used to load the internal timer when the RTS line is activated, which must expire before the modem activates the CTS line. This time is necessary to allow the remote receiver to settle and synchronise to the data stream, before the user at the transmitting end begins sending data. However it should be noted, that the CTS signal does not perform any flow control function within the modem.

3.9.9 PHASE SYNCHRONISM WITH GLOBAL CLOCKS

When data is transferred over more than short distances, and synchronism must be maintained to some external global master clock (e.g. Telecom DDN network), then the propagation delay, and thus phase shift of the data becomes significant. A facility is provided, to introduce a phase delay in the transmitted data stream, of up to 3/4 of a bit, in 1/4 bit steps. This delay is adjusted so that minimum phase offset results at the receiver of the destination station.

3.9.10 TRANSMIT TIMER

The modem implements a transmit (PTT) timer. This timer can be disabled entirely by setting the PTT Timer configuration value to zero. The timer value is a 16 bit number, that counts in increments of 2.5 milliseconds. If the timer is enabled, whenever the modem activates the PTT control to the radio transmitter, it initialises the timer with the configured value. The timer is decremented while the RTS line remains active, and if it terminates, the PTT control is deactivated. No other action is taken, and all other functions within the modem are oblivious to this condition, including the CTS line, so data continues to be "carried", and thus lost. The PTT timer is to be considered an emergency override mechanism only, in case an error occurs in the operation of the user's host equipment and/or software. To reset this timeout state, the RTS line must be taken from ON to OFF. The PTT timer will then be re-initialised the next time the RTS line is activated. The timeout period may be set in 2.5mS increments to over 160 seconds.

3.9.11 LED INDICATORS

3.9.11.1 Received Signal Strength Indication. RXSIG LED

In all operation modes of the modem except "Programmer Mode" (see section below on special modes of operation), the RXSIG LED indicates the level of the RSSI signal from the radio IF strip, compared to a threshold set in the configuration data read from the non-volatile memory. If the signal is above the threshold, then the LED indicator is turned on. There is no hysteresis applied in this process.

3.9.11.2 Data Carrier Detect Indication. SYNC LED

In "Synchronous" operation mode (V2.1.x), prior to modem hardware revision "D", and firmware revision "V2.1.4", the SYNC LED is superfluous and not driven.

Note that firmware revision V2.1.5 onwards should only be used in SYNC mode.

From modem hardware Revision D onwards, the SYNC LED drive is used to generate a DCD function in the user interface connector, and requires firmware revision V2.1.4 onwards (i.e. firmware revision V2.1.4 onwards drives the SYNC LED ON 20mS after the "leading edge" of the RxSig LED).

This means that the SYNC LED drive should always show this function and not be allowed to show low Tx Power (see Error indication modes section 3.8.5.2). To facilitate this the Min Tx Pwr parameter in the TC-900DR modem should be set to zero, when the modem is built for synchronous operation.

3.9.11.3 Radio Transmitter Active Indication. TXMIT LED

This LED indicator is connected directly to the modem's PTT output drive. It is illuminated whenever the PTT line to the radio board is active.

3.9.12 SPECIAL MODES OF OPERATION

3.9.12.1 Programmer Mode

Part of the power-up/reset initialisation phase of the modem, are tests to determine whether the modem should enter a special operation mode. The first, is a test for "Programmer Mode". Pin6 on the DB9 connector of Port A, is normally the DSR line. To this end, this pin is pulled high by a resistor to +13.8v, so that to a connected DTE this signal says that this DCE is ready. However, if this pin is connected to pin5 (Com) when the modem is powered up, the modem senses this, and attempts to enter "Programmer Mode". The modem sends out of PORTA, an ASCII "?" (question mark) character, and waits for the programmer to reply with a password. Failure to supply the correct password in time, will cause the modem to abandon the "Programmer Mode" attempt, and go on with it's normal power-up procedure. This password protection scheme provides some defence against unauthorised tampering with the radio/modem's configuration data.

3.9.12.2 Bit Error Rate Test Mode

The next test, is one for "Bit Error Rate Test Mode". Pin9 of the DB9 connector of Port A, is normally the Ring Indicate output line. The modem includes a resistive pulldown to Gnd to show a negative condition on this line. However, if this pin is driven positive (typically by connecting it to pin6), then the modem's data transmitter and receiver will enter the BER test mode. It will activate the RF transmitter and generate a scrambled bit pattern which should be decoded at a receiver as a constant logic "1" level in the unscrambled data. A test point on the modem PCB, is available to monitor this point with

a frequency/event counter. (In fact this test point is always active, and may be used to monitor the received data decoded by the modem IC). Each error bit in the decoded bitstream, will be "0", and the receiver portion of the modem in this mode, will activate the SYNC LED every time it sees a "0" bit. An internal timer is used to generate a time equivalent to 1000 bits. Every error bit detected, will activate the SYNC LED, and restart the timer. If and when the timer expires, the SYNC LED is deactivated. Thus, for error rates of 1 in 10^3 and above, the SYNC LED will be ON most of the time. A 1 in 10^4 error rate will show the SYNC LED active for approximately 10% of the time. This function provides a crude indication of Bit Error Rate for installation purposes. Other functions performed in this state include RXSIG indication, and temperature compensation. The state of pin9 is constantly monitored in this mode. If the pin ceases to be driven positive, then the BER Test mode is terminated, and the modem restarts it's initialisation phase.

3.9.12.3 Order_Wire/Handset Mode

Failure of the BERT Mode test, brings the modem to test for the presence of a handset plugged into the handset audio port. This is done by measuring the voltage on channel 4 of the analogue to digital converter. If a handset is plugged in, then the measured voltage will be about 2 volt, but if it isn't installed, then the voltage will be about 4 volt. The measured voltage is compared to 3 volt to determine whether the handset is plugged in. If this test succeeds, then the modem will not generate a data waveform to the radio transmitter. However, it will continue to indicate received RF signal strength, and perform temperature compensation. The handset has a PTT button, and this signal is connected across the modem's PTT output. Thus the handset PTT switch will activate the TXMIT LED.

3.9.12.4 Error Indication Modes

There are three error conditions that will cause the RXSIG and SYNC LEDs to be used for error indications and not their normal purpose. Two of these are "fatal" conditions, that cause the modem to restart after the duration of the error indication phase.

3.9.12.5 Transmit Power Low

While the modem activates the radio transmitter, it periodically checks the level of the radio transmitter output power. If the power measurement is less than a threshold set in the non-volatile memory, then the RXSIG and SYNC LEDs are made to alternate, approximately four times per second. Of course, the TXMIT LED will also be on in this case. This indication condition will persist for the duration of the transmission. As soon as the transmission is discontinued, the error indication will cease, and the two LEDs revert to their normal function. The user should be aware that from Revision D of the modem PCB, this state will cause incorrect operation of the DCD output line. As stated above, the Min Tx Pwr parameter should be set to zero.

3.9.12.6 NVRAM Read Error

The modem accesses the non-volatile memory as part of its initialisation phase, to get configuration data. If the communication protocol with the memory device is violated, or the non-volatile memory CRC checksum is found to be incorrect, then the modem indicates this by flashing the RXSIG and SYNC LEDs twice alternately. That is, one LED winks on and off twice, then the other. A total of five cycles of this occurs, then the modem restarts its initialisation from scratch.

3.9.12.7 Radio Frequency Synthesiser, Lock Detect Error

If at any time during normal operation, BERT mode, or handset mode, the frequency synthesiser indicates an out of lock condition, the modem enters an error indication mode for a short time before restarting. One LED is turned ON, the LEDs are swapped, then both off. Then the latter LED ON again, swap LEDs, and OFF. This will give the appearance of a sweeping motion between the LEDs. The following table shows all three modes for comparison.

Tx PWR Error		NVRAM Error		TBB206 Error Synthesiser	
RXSIG	SYNC	RXSIG	SYNC	RXSIG	SYNC
⊗	●	⊗	●	⊗	●
●	⊗	●	●	●	⊗
⊗	●	⊗	●	●	●
●	⊗	●	●	●	⊗
⊗	●	●	⊗	⊗	●
●	⊗	●	●	●	●
⊗	●	●	⊗		repeat
●	⊗	●	●		
continue			repeat		

3.9.13 WIRING ADAPTOR HARNESS FOR TC-900DR SYNCHRONOUS MODEL

PORT A	1 (DCD)	(RCO)	17	DB25F
	2 (RxD)	(RxD)	3	
	3 (TxD)	(TxD)	2	
	4 (DTR)	(DTR)	20	
	5 (Com)	(Com)	7	
	6 (DSR)	(DSR)	6	
	7 (RTS)	(RTS)	4	
	8 (CTS)	(CTS)	5	
	9 (RI)			
PORT B	1 (DCD)	(DCD)	8	
	2 (RxD)	(TCO)	15	
	3 (TxD)	(TCI)	24	
	4			
	5 (Com)			
	6 (DSR)			
	7			
	8			
	9 (RSSI)			

SECTION 4

ALIGNMENT PROCEDURE

4 ALIGNMENT PROCEDURE

4.1 GENERAL

This section details operational performance and alignment procedures that may be required for the TC-900DR. During servicing it may also be necessary to measure specific performance parameters as a means of verifying the presence of a fault condition.

4.2 TEST EQUIPMENT REQUIRED

The following list of test equipment is required to carry out all of the procedures detailed below.

- ^ Frequency counter accurate to better than 100 Hz at 1 GHz
- ^ FM Signal generator. 455 kHz to 1 GHz. -120 dBm to +10dbm. Synthesised in 100 Hz steps.
- ^ Spectrum analyser 10 MHz to 1GHz. Dispersion down to 2kHz/cm. 80+ dB dynamic range. IF b/w down to 1 kHz.
- ^ RF Power meter to 1GHz. -20 to +30 dbm. Accuracy ± 0.25 dB.
- ^ Digital volt meter.
- ^ HP3406 RF Millivoltmeter or similar.
- ^ RF Test leads, MCX male and SMA male.
- ^ Audio noise and distortion test set.
- ^ Audio oscillator.
- ^ Surface mount repair tools.

4.3 TEST POINT LOCATIONS

Both the radio section PCB and the modem section PCB contain numerous test points. They are easily located on the PCB's, and are detailed below.

4.3.1 MODEM SECTION PCB

<u>TEST POINT</u>	<u>SIGNAL</u>	<u>DESCRIPTION</u>
TP1	TxCLK	Transmit clock
TP2	BER TST	BER test output
TP3	SYNC	Synchronised output
TP4	RxCLKOUT	Integrator reset
TP5	RxCLK	Receive clock
TP6	RxDATA	Receive data
TP7	DATA OUT	Transmit data
TP8	INTEGRATOR	Rx integrator reset

4.3.2 RADIO SECTION PCB

<u>TEST POINT</u>	<u>SIGNAL</u>	<u>DESCRIPTION</u>
FINAL PA SECTION		
TP31	TXPWR-2	Bias to Q8
TP25	TXPWR-3	Bias to Q8
TP27	TXPWR-4	Bias to Q9
TP14	+8v	Power Supply
TP15	TXEN	Transmit enable
TP20	RxMIXOUT	Rx mixer bias
TP28	TXPA-1	Bias to Q10
TP29	TXPA-2	Bias to Q11
TP26	+13V8	Power supply
TP33	PWR CONT	Power control supply
TP30	PTT+8V	Press to talk
121 MHz SECTION		
TP13	DATA	Tx data input
TP17	60.5 MHz	Modulated 60.5MHz
TP16	121 MHz	Output of doubler
TP18	121 MHz	Modulated 121 MHz
TP32	MIC	Tx Mic audio input
NE615 IF SECTION		
TP6	415kHz I/P	455 filter input/second mixer output
TP9	QUAD	Quad detector
TP8	DATA	Rx data out
TP10	AUDIO	Rx audio out
TP7	RSSI	RSSI output
TP4	MUTE	Mute control output
TP1	2nd L.O	Second Xtal oscillator
TP2	2nd L.O	Second Xtal oscillator
TP3	IF Input	45 MHz IF filter input
TP5	IF Output	45 MHz IF filter output
TP19	VCO	VCO oscillator injection
SYNTHESISER/VCO SECTION		
TP12	LOCK DET	Synthesiser lock detect
TP11	+5V	Synthesiser +5v supply
AUXILIARY HANDSET INTERFACE SECTION		
TP21	MIC	Tx mic audio input
TP22	PTT	Manual press to talk
TP23	+8V	Handset +8V supply
TP24	AUDIO OUT	Rx audio output

4.4 ADJUSTMENT POINTS

All adjustment points are located on the radio section PCB. The following is a list of these adjustable components.

<u>COMPONENT</u>	<u>ADJUSTMENT</u>
XTAL2	VCO reference frequency
VR3	Deviation level set
L10	Tripler filter
L9	Doubler filter
L7	121 MHz filter
L8	121 MHz final filter
L6	Tx frequency set (121MHz Osc)
VR4	Tx power control adjust
C78	Tx mixer tunable filter
VR1	Rx audio mute adjust
VR2	Rx data DC BIAS offset adjust
L3	45 MHz filter alignment
L1	44.545 oscillator adjust
L4	45 MHz filter alignment
L5	45 MHz filter alignment

4.5 LINK OPTIONS

Several options are set in the TC-900DR modem by the setting of links on the radio section PCB. Listed below is an option table for the various combinations.

<u>LINK NUMBER</u>	<u>SETTING</u>	<u>DESCRIPTION</u>
LK2	IN	AFC option disabled
	OUT	AFC option enabled (factory standard)
LK4	IN	PWR control disable
	OUT	PWR control enabled

4.6 HOUSING

The TC-900DR has been designed with the serviceability of the unit in mind. Construction of the unit is robust yet easily dismantled. The unit is primarily assembled in an aluminium extrusion with a central chassis that is fixed to the front panel.

4.6.1 DISASSEMBLY PROCEDURE

To disassemble the unit, simply remove the two silver screws on the underside of the unit and the six black screws located on the front panel (the front panel of the unit has the two DB9 connectors protruding from it). Ensure you do not loose the attached nylon washers, as these prevent the Lexan front panel label being damaged upon replacing and tightening the six screws. Simply slide the unit out of the extrusion clasp front panel and the complete unit is exposed to you.

Caution : When re-assembling be careful not to foul the ribbon cable against the case when sliding the unit into its case as this may inadvertently damage the cable.

4.6.2 MODEM AND POWER SUPPLY PCB

All components and connections to the modem section PCB are accessible without removing the PCB from the chassis. If access to the rear of the PCB is required, firstly remove two nuts that clamp the C TO-220 power supply regulator to the front panel. Once this is removed, simply remove the four screws securing the PCB to the chassis.

The PCB is now free to work on, and can be folded out so as to service the unit in an open accessible condition whilst still connected to the radio section PCB. If required, the modem section PCB can be separated from the radio section PCB by simply unplugging the ribbon cable.

NOTE: Regulators will need to have heat-sinks fitted if unit is to be operated in this condition for excessive time periods.

4.6.3 ANTENNA DIPLEXER

The antenna diplexer is mounted on top of the radio section PCB. It is easily removed by firstly disconnecting the two miniature RF connectors (MCX type) from the PCB.

Care should be taken when unplugging these connectors so as not to damage them, it is important to remove and insert connectors in a vertical direction.

Secondly, remove the nut securing the antenna output connector from the central mounting chassis. The last two remaining screws must be removed which secure the diplexer to two metal PCB standoffs on the radio section PCB. The diplexer can now be removed.

Testing of the radio section PCB can be continued without the antenna diplexer, by connecting to the receiver and transmitter ports separately.

Miniature MCX RF Connectors are available from Trio DataCom if required.

4.6.4 RADIO SECTION PCB

The radio section consists of a two sided PCB which has surface mount components on one side and conventional components on the other. Several critical test points are accessible on the component side of the PCB which minimises removal of the PCB from the chassis.

To remove the PCB from the chassis, fifteen screws must be removed. Upon removal of these screws, the PCB can be manoeuvred from the chassis and once again can fold out so as to be serviceable as a complete unit.

NOTE : It is essential that all RF Deck mounting bolts are fitted and secure upon reassembly as many of these bolts provide inter-stage isolation and secure grounding ensuring the product meets all specifications.

Once service of the unit is complete, reassembly is simply the reversal of the above procedures.

Care should be taken when sliding the complete chassis assembly back into the extrusion. Ensure that the ribbon cable connecting the modem and radio section PCB's is carefully "tucked" away within its designated slot so as not to damage the cable.

4.7 ALIGNMENT DESCRIPTION

CAUTION - As the TC-900DR is capable of full duplex operation, care should be taken to avoid damage to sensitive test equipment such as signal generators or spectrum analysers. It is recommended that a 30db 2 Watt pad be connected between the unit and any test equipment prior to testing.

This section is for alignment/adjustment of the RF Deck and should be read in conjunction with Section 2 (Hardware Technical Description) and Section 7 (Fault Finding) if faults or difficulties are experienced.

For initial alignment, proceed in the following order :

Reference oscillator & synthesiser.

121 MHz Tx modulated injection oscillator.

Tx final stage/Power control.

Receiver and audio mute

4.7.1 REFERENCE OSCILLATOR AND SYNTHESIZER

- 1 Check VCXO (XTAL2) for reference frequency o/p at a level of 550 mV rms with an RF Millivoltmeter, and the VCO o/p for an RF level of around 150 mV rms.
- 2 Check that the TBB202 dual modulus prescaler (U4) is producing an output of approximately 7 MHz and a level of 550 mV rms at the "IF" i/p to the TBB206 synthesiser I.C.(U3-p8)
- 3 Ensure that the synthesiser has been programmed to a frequency within the range of the VCO, and check that the VCO is locked by observing a high (5V) level on Lock detect output of the synthesiser I.C.(U3-p14). Note that very short duration pulses to ground is normal.
- 4 Program the synthesiser with the following VCO frequencies according to VCO type and ensure lock occurs at both ends of the frequency range. These frequencies are 2 MHz beyond the published specification.

VCO TYPE: MQC-798

Maximum 786MHz VCO = 907MHz Tx or 831MHz Rx

Minimum 814MHz VCO = 935MHz Tx or 859MHz Rx

VCO TYPE: MQC-978

Maximum 996MHz VCO = 875MHz Tx or 951MHz Rx

Minimum 960MHz VCO = 839MHz Tx or 915MHz Rx

- 5 Program the VCO to a given frequency within the range as specified above and measuring the VCO o/p frequency, adjust the 12 MHz (VCXO) reference trimmer to bring the frequency within 250 Hz of the VCO frequency.

Note: Unit is temperature compensated at factory and no field adjustment of Ref. Oscillator is possible. If VCO frequency is not correct (± 1500 Hz), consult factory for service advice.

Note ensure that the VCXO control input is within its active range (1-4 Volts).

- 6 Check the VCO power o/p by monitoring the Rx mixer bias at TP20, where approximately 200 mVDC should be measured.
- 7 With a spectrum analyser set to the VCO frequency and a dispersion of about 5 or 10 kHz per cm, check that the reference sidebands are less than -60dBc in the adjacent channel.
- 8 Check VTCXO Reference frequency is $F(tx) + 121$ MHz for 853 remote units or $F(tx) - 121$ MHz for master units. If Reference is out by more than ± 1.5 kHz, drift offset should be applied via the programmer or unit should be returned for factory service. attempting to alter Reference trimmer will void temperature compensation process and should only be done in an emergency and as a temporary measure.

4.7.2 121 MHZ MODULATOR

Note - make sure the transmitter is loaded with a suitable attenuator on the antenna or Tx o/p socket before energising

1. For Initial alignment set all coil cores to their nominal positions as per the table below :

Miller coils	
L9	5 turns from top of coil can
L10	2 turns
L7	4 turns
L8	5 turns
L6	0 turns

To prevent the final transmitter stages from producing excessive power whilst low level stages are being aligned, it is suggested that the Tx post mixer tunable filter be de-tuned. Energise the transmitter via manual PTT from the auxiliary handset.

2. Tune L7 through L10 for peak o/p. For initial alignment this can be done by monitoring the 121 MHz level at TP18 initially and then at the input to the SBL-1X transmit mixer (U8), where a level of about 75mV should be measured by an RF millivoltmeter (e.g HP11960).

Typical RF millivoltmeter readings for each stage are :

TP17	125 mV RF = 0.25 VDC on HP11960 probe.
TP16	40 mV RF = 0.06 VDC on HP11960 probe.
TP18	550 mV RF = 1.0 VDC on HP11960 probe.
121 MHz i/p to mixer	75 mV RF = 0.13 VDC on HP11960 probe.

Note: The signal at TP17 is present as long as "Tx En" is active. The subsequent test points require PTT to also be active.

If the complete transmit chain is known to be operative then the 121 MHz o/p can be peaked by first de-tuning C78 on the tunable Tx filter until the Tx power o/p is less than 100 mW and then tuning Inductors L7 to L10 for maximum output at the Tx frequency.

3. With the radio section links set for the desired data rate (see link table above), set the peak deviation as per the chart below with VR3, and center frequency to 121.000 MHz with L6.

NOTE : THESE ADJUSTMENTS ARE INTERACTIVE. ENSURE ALL COILS ARE SECURE

<u>BAUD RATE</u>	<u>DEVIATION LEVEL</u>
4800 bps	± 1.5 kHz peak
9600 bps	± 2.75 kHz peak

4. Note that temperature compensation is applied to the 121MHz oscillator so attempting to adjust either VR3 or L6 will upset compensation and should only be done as a temporary measure. Return unit to factory for repair if errors >±500Hz are detected.

4.7.3 TX FINAL

NOTE: It is essential that all RF Deck mounting bolts are fitted and secure upon reassembly as many of these bolts provide inter-stage isolation and secure grounding ensuring the product meets all specifications.

- 1 Ensure the 121 MHz Tx injection is operating correctly.
- 2 Check Q2,4,5,8, are all biased correctly as per the voltage chart. Temporarily disable the Tx power control circuitry by shorting LK4 located on the top side of the board near the ribbon cable. Energise the transmitter via the manual PTT on the auxiliary handset.
- 3 Tune the Tx filter tuning capacitor C78 for a peak output power measured at Antenna port or X4.
- 4 With full drive, Q9 driver collector current as seen across TP26//TP27 should be approximately 45 mA (100mVDC), and NOT MORE THAN 55mA (120mVDC).
- 5 With full drive at Q9 each final transistor should be drawing around 175 mA(385mVDC) as seen across TP26/TP29 or TP28. The output power measured directly at the final connector should be between +32 and +34 dbm without power control.
- 6 Re-enable the power control circuitry and with the 'Txpwr' control line set at +5VDC, set VR4 for +32 dbm+/- 0.25 dB at the tx o/p socket X4. Check that the current in EACH final collector does NOT EXCEED 225 mA.
- 7 Check with the spectrum analyser that the Tx o/p is free from spurious signals.

Note 1 . Prior to the diplexer the VCO level is nominally about -20 dbc.

Note 2 . Close in mixing products (less than +/- 30 MHz) must be greater than 65db below the carrier, as they are not attenuated by the diplexer filters.

D.C. Voltages of Radio Section

RF Output Power set to +32 dbm at X4 (diplexer input) with 13.8 VDC supply

Transistor	Base	Emitter	Collector
Q2	1.66 VDC	0.92 VDC	6.96 VDC
Q4	1.79 VDC	1.06 VDC	6.46 VDC
Q5	1.80 VDC	1.08 VDC	7.51 VDC
Q8	1.05 VDC	0.31 VDC	4.02 VDC
Q9	0.47 VDC	0 VDC	13.35 VDC
Q10	0.28 VDC	0 VDC	13.05 VDC
Q11	0.29 VDC	0 VDC	13.16 VDC
Q12	7.17 VDC	7.97 VDC	7.88 VDC
Q1	7.29 VDC	7.97 VDC	7.91 VDC
Q13	4.56 VDC	3.84 VDC	7.97 VDC
Q7	1.14 VDC	0.41 VDC	6.68 VDC
Q6	1.13 VDC	0.40 VDC	7.52 VDC
Q3	1.06 VDC	0.33 VDC	7.59 VDC

4.7.4 RECEIVER

The receiver section requires little or no alignment once factory aligned.

4.7.4.1 No AFC Models (Xtal 1 = 45.455MHz)

- 1 Adjust L1 for 45.455 MHz measured with pickup loop near L1.
- 2 In emergency adjust coils L3, L4 and L5 for best SINAD at TP8.
- 3 Adjust audio mute VR1 to mute handset audio at 10dB SINAD
- 4 Adjust VR2 for 2.0 VDC at TP8 whilst receiving data off-air.

4.7.4.2 AFC Models

Monitor 44.545 MHz with pickup at L1. Test for 44.545 \pm 1.5KHz

Consult factory for alignment or service information.

SECTION 5

INSTALLATION AND COMMISSIONING

5 INSTALLATION OVERVIEW

All Data Radio Modem devices needs to be properly installed and commissioned in order to function reliably. It is important that installers are familiar with RF products / installations and are geared up with appropriate tools necessary to confirm the ongoing reliability of a communications system.

This chapter is intended as a short form checklist to ensure such radio devices are installed correctly and that important tests are made and recorded at each site for future reference should a problem eventuate.

Installers should check that each data radio has been programmed to suit their specific requirements before installation.

5.1 GENERAL

Installations play a critical role in network performance. Although this is a known fact, installations are often performed poorly or given little regard. It is essential that the installation is performed in a professional manner with careful attention and consideration to the following items :

1. Adequate primary power cable - relative to the length of cable to minimise voltage drop.
2. Shielded data cable between the unit and any external data equipment.
3. Low loss coax used for antenna feed line.
4. Careful termination of RF connectors.
5. A suitable antenna for the requirement.
6. Suitable placement of the antenna.
7. Adequate signal strength from the base station / other radio communications device.

5.2 INSTALLATION

The following information should assist when installing and commissioning data radio systems.

5.2.1 DATA CONNECTION

In industrial environments connection to any external device should be by shielded data cable with the shield connected to the connector shell to minimise data corruption, and/or radio interference.

5.2.2 MOUNTING

The radio modem should be mounted in a cool, dry, and vibration free environment. Mounting of the unit should be in a location providing easy access to screws and all connections.

5.2.3 POWER CONNECTIONS

The power required for 5 Watt (Tx) at 13.8VDC, is typically 2.0 Amps. As the Tx key up current is significant, the gauge of primary power wiring should be considered. It is suggested that a minimum of 18 gauge stranded copper wire be used for distances of up to two metres and a minimum of 14 gauge for longer distances up to 5 metres.

Ensure correct polarity to avoid costly repairs.

5.2.4 COAX CABLE CONNECTION

It is important to select the correct cable and connectors for each application as a poor selection can seriously degrade the performance of the unit.

As an example, for each 3dB of cable and connector loss, half the transmitter power is lost and twice the receiver signal power is required to produce the same bit error rate.

In some installations where strong signals are present, a compromise of cable and connector cost may be acceptable.

It is essential that all connector terminations are performed as per the manufacturers specifications (especially at 900MHz and above) and if connectors are to be used outside, it is essential that a sealant such as amalgamating tape be used to seal connectors. DO NOT use acetic cure silicon to seal the connectors.

It is also important that coax cables are not stressed by tight bends, kinking or excessive flexing. Ensure that coax cables have sufficient strain relief and are secure. If large diameter rigid or semi rigid cable is used, it is recommended to use a short length of high quality RG58 or RG223 cable between the unit and main cable feed.

The following chart is a guide to losses in various types of coaxes at 400MHz and 900MHz over distance, please consider this when installing the unit.

CABLE TYPE	LOSS RELATIVE TO DISTANCE							
	1 dB		3 dB		6 dB		9 dB	
	450MHz	900MHz	450MHz	900MHz	450MHz	900MHz	450MHz	900MHz
RG58C/U	2.3m	1.6m	7m	5m	14m	10m	20m	15m
RG223/U	3.1m	2.3m	9m	7m	18m	14m	28m	21m
RG213/U	6.1m	4m	18m	12m	37m	24m	55m	37m
HELIAX LDF4-50A	19m	14m	57m	43m	114m	87m	171m	130m
HELIAX LDF5-50A	38m	25m	114m	75m	229m	150m	343m	225m

5.3 ANTENNA INSTALLATION

The selection of antennas and their placement is one of the most important factors when installing a radio based network. People often use a simile, it is like putting square wheels on a Mercedes Benz..... very true comparison.

Antennas are generally mounted to a vertical pole with either vertical or horizontal polarisation as per the licence requirement.

Antennas should be mounted as high as practical and away from metal surfaces which can cause reflections.

Determining the type of antenna is very important and as a typical generic example, Point to Multipoint (PTMP) systems generally employ high gain (3, 6, or 9dB gain) omni directional antennas at the base station sites and either omni directional whips (unity gain) or preferably high gain directional yagi antennas (9 or 14dB gain) at the remote sites.

5.3.1 YAGI ANTENNAS

Yagi antennas not only provide signal gain and directivity, but also provides protection from interfering signals which are outside the beam width of the antenna. Yagi antennas are essential when communicating over very long distances.

Yagi antennas are polarised and must be mounted either vertically (elements pointing from the ground to the sky) or horizontally (elements in parallel with the horizon).

As a general rule, Point to Multipoint remote units are vertically polarised, while Point to Point links are horizontally polarised.

When mounting yagi antennas with vertical polarisation, it should be noted that the dipole (loop section of antenna) has a drain hole. The small drain hole on one end of the dipole must be pointed towards the ground so that water will drain out of the antenna.

5.3.2 OMNI DIRECTIONAL ANTENNAS

Omni directional antennas provide a radiation pattern of equal strength through 360° in the horizontal plane. This makes them ideal for base antennas in point to multipoint systems because they can reach the remote antennas.

Omni directional antennas are also used at remote sites (although yagi antennas are preferred) and are typically ground independent "whip" type antennas. The main reason for using whips at remote sites is for aesthetics as they are far less obtrusive than a yagi.

Regardless of the type, antennas need to be mounted properly and in a suitable location as covered below.

5.3.3 ANTENNA PLACEMENT

Antenna placement is of paramount importance and plays a big part of the antennas and in turn systems performance.

When choosing antenna locations the aim is to find the largest path of unobstructed space and locate the antennas within that space. It is important to locate antennas as high as possible and definitely clear of any moving obstructions.

Where possible it is important to avoid mounting antennas:

1. Against or adjacent to steel structures.
2. In an area which will have constant intermittent obstructions - people walking past, vehicles driving past etc. That is, mount antennas well above such moving obstructions.
3. Near any electrical equipment.
4. Near metal beams, structures etc.
5. Inside any metal enclosures, tin sheds / warehouses etc. - note meshed wire fences act like a "brick wall" to RF transmissions.
6. Away from guard rails or support beams.

Note: Sometimes installations in such environments are unavoidable and where this is the case, certain care can be taken to still ensure a reliable installation. Please consult Trio for assistance on a case by case basis.

If tests indicate poor signal strength then the antennas at one or both ends of the link should be raised, and/or moved clear of obstructing objects, or if directional antennas are employed they should be checked for correct directional orientation and polarisation (horizontal or vertical signal orientation).

5.3.4 REFLECTIONS AND OUTPUT POWER

Ideally, the propagation path should be clear Line of Site (LOS).

The biggest problem with UHF radio when used within "steel" buildings or obstructed paths is the large presence of signals randomly reflected from the surrounding obstructions or "steel" walls. These signals cannot be eliminated, but by maintaining a 10 to 20dB margin between the wanted and unwanted signals, problems should not be experienced. The simplest way to do this is to use directional gain antennas.

These antennas will provide attenuation to all signals arriving from a direction other than the direct path. Where steel walls or structure exist immediately behind the antenna location, the high front to back ratio of such antennas will negate such high level reflections. Power output should be set at the minimum level required to achieve a 25dB fade margin, in order to minimise the amount of RF being reflected, and to avoid saturating the receiver front end and therefore reducing the margin between wanted and unwanted signals.

5.4 COMMISSIONING - RSSI LEVEL

When commissioning a data radio network, it is important to ensure that the incoming received signal strength (RSSI) is adequate to provide reliable communications.

Note: A good signal path should allow for approximately 30dB fade margin.

Received signal strength (RSSI) of the incoming signal is available as an analogue output on Trio data radio modems. This RSSI output ranges from 0 to approx 4 Volts, where 4 Volts indicates the strongest signal. The actual values of received signal strength can be determined by comparing the output voltage against the calibrated graph supplied in the handbook.

By referring to the RSSI chart alignment of aerials can be optimised to achieve the greatest signal strength (highest output voltage).

Note: Be sure to stand clear of aerials when measuring this output voltage, touching or standing in close proximity to aerials will give inaccurate readings.

5.4.1 CHECKING DATA COMMUNICATIONS

If the host computer and remote equipment are capable of performing data integrity tests then connect the host and terminal data equipment to the radio modems.

Remove and re-apply power to each radio modem to ensure they are both in data comms mode, and run data tests on the link.

5.4.2 BIT ERROR RATE (BER) TESTING

If the connected data equipment is NOT capable of running data integrity tests then the TC-450DS modems can be put into a BER test mode, whereby the data channel can be tested in each direction to a reasonable level without external test equipment. To run a link test with the radio modems themselves, they must BOTH be put into BER test mode.

To place the unit in BER mode connect pin 6 and pin 9 of port A together and apply power..

The transmitter can be activated by driving the RTS pin (7) of port A positive. The unit will then send a predefined pseudo random sequence which is tested for accuracy by the receiving unit and any errors displayed on the front panel 'SYNC' lamp.

Each error bit will illuminate the lamp for approximately 1000 bits duration, therefore error rates above 1 in 1000 will show an almost constant error indication.

To return the unit to normal data transmission mode simply power it up without pin 9 connected to pin 6.

For further information on radio path problems please contact Trio DataCom for detailed advice.

Note : BER testing is not viable in an operational point to multi-point environment as the BER test will interfere with other operative units.

5.4.3 OUTPUT POWER - VSWR

Upon installation of equipment an output power measurement should be done using a suitable power meter. Forward and reflected power should be measured at the antenna port and recorded for future reference. The reflected power measurement should be as a minimum 3 : 1 of the forward power. If this is not the case, investigate possible causes such as poor terminations, faulty antenna etc.

5.4.4 DATA CONNECTION

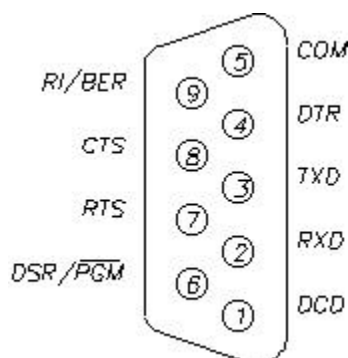
The data connection is via a DB9 connector labelled 'Port A', which is wired as a DCE as shown below. The port labelled 'Port B' is not used for the standard configuration but can be enabled by the programmer for use as a totally independent second data channel. In industrial environments connection to the modem should be by shielded data cable with the shield connected to the connector shell to minimise data corruption, and radio interference.

- User Serial "Port A" Pin Assignment

PIN NO. & FUNCTION

EXTERNAL VIEW OF `PORT A'

1. DATA CARRIER DETECT (DCD)
2. RECEIVE DATA OUTPUT (RXD)
3. TRANSMIT DATA IN (TXD)
4. DATA TERMINAL READY (DTR)
5. COMMON (COM) ____
6. PROGRAM PIN (PGM)
7. REQUEST TO SEND (RTS)
8. CLEAR TO SEND (CTS)
9. BIT ERROR RATE PIN (BER)



NOTE: Pin 6 and pin 9 provide a dual function which depends on the mode that the TC-450DR is operating in.

- User Serial "Port B" Pin Assignment.

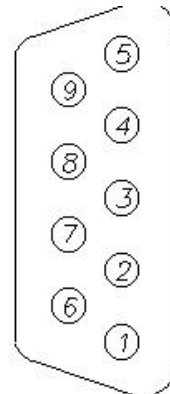
Port B of the TC450DR is essentially unused in its standard configuration but can be enabled by the Programmer for use as a totally independent second data channel. This port is essentially used for specific applications and only has one connection that may be of use for installation purposes. This connection (Pin 9) is Receive Signal Strength Indicator (RSSI) output.

This RSSI output ranges from 0 to 5 Volts, where 5 Volts indicates the strongest signal. It is important to note that this Port output has a high impedance of around 10K ohms and loading will decrease accuracy of the recorded measurement.

PIN NO. & FUNCTION

1. DATA CARRIER DETECT
2. RECEIVE DATA O/P (RxD)
3. TRANSMIT DATA O/P (TxD)
4. DATA TERMINAL READY (DTR)
5. COMMON
6. DATA SET READY (DSR)
7. REQUEST TO SEND (RTS)
8. CLEAR TO SEND (CTS)
9. RECEIVE SIGNAL STRENGTH

EXTERNAL VIEW OF `PORT B'



5.5 GENERAL CHECKLIST

The following is a simple commissioning checklist which should be used at every site not only to ensure correct installation, but also as a reference list for problems which may eventuate.

TRIO SITE COMMISSIONING CHECK LIST / RECORD			
Company:		Operator:	
Site Location:		Date:	
Link to:		Serial #:	
Radio Type:		Config File Name:	
Antenna Type / Gain		Path Distance	
Tx Power at Radio		Measured RSSI Volts	
Reflected Power		Fade Margin	
VSWR		Line of Site to Base	
Tx Power at Antenna		DC volts at Radio (Tx)	
Site QA Inspection:			
Notes:			
Signed		Date	

SECTION 6

FAULT FINDING

6 FAULT FINDING

This section is to assist with difficulties that may be experienced when installing or working on the TC-900DR.

6.1 MODEM/GENERAL

The following is a list of possible problem areas, and suggested checks that can be made to isolate any general problem that may have occurred.

1. POWER SUPPLY

- a) Check for +13.8 Volts at supply input.
- b) Check fuse on Modem P/S PCB (1 Amp SLO-BLOW).
- c) Check supply volts:
 - Modem P/S
 - i) 13.8 Volts
 - ii) 8 Volts
 - iii) 5 Volts
 - RF Deck
 - i) 13.8 Volts
 - ii) 8 Volts
 - iii) 5 Volts

2. ANTENNA

- a) Check antenna, cable and connectors for damage or water
- b) Check forward and reflected power at antenna connector of unit.
VSWR should be $\leq 1.5:1$

3. PROGRAMMING

- Check programming information. e.g.
- i) Transmit and receive frequencies are within the operating band of the unit
 - ii) User interface configuration.

4. INTERFACE

- a) Check connections to Port A (DB9 Connector).
- b) Check cable to host communications.
- c) Interface commands to unit are incorrect or communications are not established correctly.

5. POOR TRANSMITTER PERFORMANCE

- a) Check correct transmit frequency programmed.
- b) Check transmitter carrier frequency.
- c) Check transmitter deviation.
- d) Check RF output power level.

6. POOR RECEIVER PERFORMANCE

- a) Check correct receive frequency programmed.
- b) Check receive sensitivity.
- c) Check audio output level and DC bias to modem.
- d) Check mute threshold.

6.2 RECEIVER

The following is a list of problem areas, and suggested checks that can be made to isolate any receiver specific problems that may have occurred.

6.2.1 RECEIVE SENSITIVITY LOW

- 1 Check mixer drive level by measuring DC bias developed across R27.
- 2 Check for correct DC bias conditions and supply volts on RF Amp, Local Osc buffer, and IF Strip, compared to voltage charts.
- 3 Ensure 44.545 MHz oscillator (part of NE615 IF IC) is within ± 250 Hz. This is best carried out by using a communications test set such as an IFR1200 or similar in receiver mode with frequency error displayed.
- 4 Ensure that the local oscillator is netted to frequency by monitoring the Tx mixer injection with a pick up loop connected to a sensitive frequency counter of high stability. Adjust the VCXO frequency reference until correct L.O. frequency is observed. Note that the VCO and synthesiser use the VCXO as the frequency standard. Measure the Synthesiser LOCK signal to ensure the VCO is in phase lock.
- 5 With a 50 ohm signal generator tuned to 455 kHz, apply signal via a 1nF capacitor to the inputs of the 1st and second IF Amp sections of the 615 IF IC and compare the level required to produce the correct RSSI level.
- 6 With a 50 OHM signal generator tuned to 45.000 MHz, apply signal to the points defined on the IF test chart and compare RF level required to produce the reference RSSI level as specified at TP4.
- 7 Apply signal frequency to the RF input connector at X2 and compare the level required to produce RSSI reference level at TP4 with that shown in the IF Level Chart.
- 8 Reconnect the Antenna Diplexer and apply the signal generator to the Antenna terminal of the diplexer. Adjust the generator level to provide the same Rx mixer bias from applied RF signal as was noted in 7) above. The level required should be no more than 3 dB (Rx diplexer path loss) greater.

Note that the RSSI signal provided by the IF IC is a fairly accurate logarithmic scale between 0.5 and 4VDC, providing about 0.5 VDC for each 10 dB of signal applied to the input of the IF Strip, and can be used as a reasonable measure of signal providing it is unmodulated and on center frequency at 455 kHz.

6.2.2 RECEIVER LEVEL CHART

The following chart lists the level (terminated) of a 50 OHM signal generator to produce 2.0VDC of RSSI at TP4 when applied as specified to the point shown and at the frequency indicated.

FREQUENCY	CONNECTION POINT AND APPLICATION	NOM LEVEL
455 kHz	Pin 20 of IC U2 NE615 via 1nF	-72 dBm
455 kHz	Pin 18 of IC U2 NE615 via 1nF	-74 dBm
455 kHz	Pin 1(i/p) of IF Filter CF2 via 1nF	-58 dBm
455 kHz	Pin 14 of IC U2 NE615 via 1nF	-43 dBm
45 MHz	Rx i/p at X2 via coax direct	-49 dBm
45 MHz	Mixer i/p following R.F. Amp	-62 dBm
45 MHz	Mixer diode (D1) o/p across C100	-61 dBm
45 MHz	Junction of 1st & 2nd 45 MHz crystal filter	-77 dBm

6.3 TRANSMITTER

The following is a list of problem areas, and suggested checks that can be made to isolate any transmitter specific problems that may have occurred.

1. NO TRANSMIT

1. Check PTT circuit.
2. Check unit is programmed within its operational range.
3. Check if manual PTT (Rear Aux connector) keys transmitter.
4. Check if any transmitter output is present. Tuning required?

2. TRANSMITTER SPURIOUS EXCESSIVE

The probable cause is dependent upon the nature of the spurious as follows:

Carrier \pm 910kHz. - IF detector signal (2x455) modulating or mixing with carrier. - Check 1n bypass on reference i/p to power control op-amp. Check bypasses on collectors and supply lines of low level transmitter stages, and L.O. buffer.

Carrier \pm 20.166 and/or 40.333. - Excessive harmonics of 20.166 crystal oscillator in 121 MHz FM driver IC (U7). Check all pins of IC (U7) for correct DC conditions. Check all tuning inductors for 'normal Q', as 'soft' tuning will almost surely indicate an incorrect or faulty capacitor, or inductor.

Carrier \pm VCXO reference frequency (approximately 7 MHz). - Reference signal modulating VCO, or mixing with carrier in L.O.buffers. - Check Synthesiser supply bypasses, check for defective joints or components in and around the resistive divider at output of VCO.

Note that it is imperative that low frequency divider products be attenuated before they can reach the base/emitter junctions of the L.O. buffer transistors where they can mix with the VCO frequency.

Note also that poor SMD solder joints will provide nonlinear conductance and give rise to frequency mixing in this area. Check for faulty components or poor joints around the Synthesiser to VCO frequency control area, or VCO supply line bypassing.

Excessive Transmitter power radiated or conducted to the area of the VCO can also cause spurious effects and may enhance the levels of otherwise acceptable levels of spurious. If this is suspected, check that ALL chassis securing bolts are fitted and tight on the RF deck, and that ALL bypass capacitors and chokes are fitted and correct in and around the final Tx stages.

3. TRANSMITTER POWER LOW OR UNSTABLE :

- 1 *Firstly - Ensure that ALL RF Deck mounting bolts are fitted and secure.*
- 2 Check that the feed resistors used for current indication on all stages of the final are of correct value and firmly in circuit.
- 3 Check that the Tx L.O. buffer and post mixer buffers are correctly biased as per the voltage charts.
- 4 If necessary disconnect the final stages from the Tx post mixer buffers by removing the solder bridge between Q5 and Q8, and with an appropriate instrument measure the RF power available from the Tx buffers to the final pre-driver.
Note that the o/p impedance of the buffer is 50 OHM and must be measured by a 50 OHM instrument. It is highly recommended that a measuring spectrum analyser be used here as this instrument will also display the relationship between the wanted signal and other spurious or unwanted mixing products.
The nominal display seen at this point by a spectrum analyser is shown on the spectrum charts attached.
- 5 To test the final stages separate from the buffers - inject a signal from a 50 OHM generator at Tx frequency into pre-driver (Q8) via C122. The level required to drive the final to full output is shown on the Tx level chart.
- 6 Check that the current drawn by the driver transistor as measured across the feed resistor (TP28 to TP27) is within spec, and if not check and or replace the driver transistor or associated components as necessary.
- 7 Check that the current drawn by each final transistor as indicated by the voltage across the 2.2 OHM (2x4.7 ohm in parallel) collector feed resistors (TP26 to TP28 and TP29) is within the range stated in the voltage charts, and that both are within 10% of each other. If in error check components around final pair and replace final transistors as necessary.

NOTE it is possible for power transistors to be partly defective due to current or thermal abuse, and the fact that the devices are actually drawing current does not always indicate that they are producing full power at the collector.

TX LEVEL CHART :

Frequency	Connection Point & Application	Level Remarks
Base band	Data from modem section TP13 (4800 baud)	2 VD.C
Base band	Applied data signal to modulator U7 pin 3 (4800 baud level from modem)	1 V _{p-p}
Base band	Audio signal to modulator TP32	0.84 VD.C 60 mV _{p-p} for VR3 set for maximum value 400 mV _{p-p} for VR3 set for minimum value
Base band	Audio signal to modulator U7- pin 4	1.3 VD.C 0.5 V _{p-p}
121 MHz	Signal level at TP18:A	-5 dBm
Final Tx frequency	Output to diplexer connector X1	3W at maximum power setting

SECTION 7

APPENDIX A

DRAWINGS

7 APPENDIX A DRAWINGS

TC01-08-12	Data Radio Mounting Details
TC01-08-11	Data Radio Assembly Details
TC01-04-05	Data Radio Basic Modem 9K6/4K8 Component Loading Details
TC01-00-05	450DR / 900DR Packet Modem (2 sheets)
TC01-08-10	PWB Manufacturing Details 900DR Data Radio - Radio Board (2 sheets)
TC01-00-10	Data Radio Project Sheet
TC01-00-10	Data Radio Final PA (AFC Fitted)
TC01-00-10	Data Radio 121 MHz OSC (AFC Fitted)
TC01-00-10	Data Radio - Synthesiser - VCO (AFC Fitted)
TC01-00-10	Data Radio - NE6154K8/9K6 (AFC Fitted)
TC01-04-15	850-930 MHz Antenna Diplexer Component Side Assembly
TC01-05-10	Radio Board Top Side (C/S) Test Point & Adjustment Location Details
TC01-05-10	Radio Board Bottom Side (S/S) Test Point & Adjustment Location Details
TC01-05-16	Duplex Radio BER/S+N/N vs Sig
TC01-05-17	AFC Alignment Setup - Block Diagram
TC01-05-12	4800/9600 BPS Modem Functional Diagram
TC01-05-23	Asynchronous Modem Functional Diagram
TC01-05-19	Macro Block Diagram
TC01-05-18	Radio Section - Modem Section Interface
DR9-BLOK	900MHz Radio Block Diagram
	RSSI Level of Received Signal (typical)

SECTION 8

APPENDIX B

GLOSSARY of TERMS and ABBREVIATIONS

8 APPENDIX B GLOSSARY

ADC:	Analogue to digital converter.
AFC:	Automatic frequency control.
BER:	Bit error rate.
bps:	Bits per second.
C/DSMA:	Carrier or data sense, multiple access scheme.
COM:	Common.
CRC:	Cyclic redundancy checksum.
CTS:	Clear to send.
DAC:	Digital to analogue converter.
DCD:	Data carrier detect.
DCE:	Data communications equipment.
DFM4-9:	Trio DataCom digital modem chipset.
DIP:	Dual in line package.
DOTAC:	Department of Transport and Communications.
DSR:	Data set ready.
DTR:	Data terminal ready.
FCS:	Frame check sequence.
FEND:	Frame end.
FESC:	Frame escape.
FIFO:	First in first out.
FIR:	Finite impulse response.

FM :	Frequency modulation.
FSK:	Frequency shift keying.
GPIB:	General purpose interface bus.
HADR_EN:	High address enable signal.
IC :	Integrated circuit.
I.F.:	Intermediate frequency.
i/p:	Input.
KISS:	Keep it simple stupid.
LADR_EN:	Low address enable signal.
MSB:	Most significant bit.
NVRAM:	Non volatile RAM.
NRZ:	Non return to zero.
NRZI:	Non return to zero - inverted.
o/p:	Output.
PCB:	Printed circuit board.
PLL:	Phase locked loop.
PMP:	Point-to-multipoint.
ppm:	Parts per million.
PTP:	Point-to-point.
PTT:	Press to talk.
RF :	Radio frequency.
RI :	Ring indicate.
R_select:	RAM read select signal.
SIO:	Serial input/output.
RSSI:	Receive signal strength indication.
RTS:	Request to send.
Rx :	Receive.
RXD:	Receive data output.
SCADA:	Supervisory control and data acquisition.
SLIP:	Serial line interface protocol.

TC-900DR: Trio DataCom 900MHz full duplex data transceiver.
TC-DFM9IP: Trio DataCom TC-900DR parameter programming software suite.
TFEND: Transposed Frame End.
TFESC: Transposed Frame Escape.
TNC: Terminal node controller.
Tx : Transmit.
TXD: Transmit data in.
VCO: Voltage controlled oscillator.
W_select: RAM write select signal

18. Radio Telemetry Module



Halmac Services (Qld) Pty. Ltd.
A.C.N. 098 852 923
A.B.N. 40 741 712 113

RADIO TELEMETRY MODULE

1. 105U RADIO TELEMETRY MODULE TECHNICAL DETAILS
2. 105U USER MANUAL



The wireless alternative to expensive cabling...



New Products... New Solutions

The ELPRO 105 range of telemetry modules provide remote monitoring and control by radio or twisted-pair wire, over short or long distances. Transducer signals connected at one module (input signals) are transmitted to another module where the signals are re-created as output signals, or passed via RS232/485 to a host device such as a PLC or SCADA system.

Easy to Use

The ELPRO 105 range of telemetry modules have been designed to be easy to use and simple to install. The modules include power supply, microprocessor controller, input/output (I/O) circuits, radio transceiver and/or serial transceiver (RS485/232). The 105 modules are completely integrated and ready for use.

They are housed in a strong extruded aluminium case, with plug in terminal strips for ease of wiring connection and maintenance.

105U Radio Telemetry Modules

The ELPRO 105U radio telemetry modules are a low cost alternative to cable installations.

The 105U provides a wireless radio link for digital (switch contact), pulse and analogue signals.

As well as radio communications, the 105U has a port for RS485 multidrop twisted pair cable, enabling communications to 105S serial telemetry modules.

105S Serial Telemetry Modules

The 105S range of modules provide communications via RS485 multidrop.

RS485 is a method of transmitting between many devices using a common twisted pair wire. The maximum length of the wire is typically 2000 metres. This method of communications is particularly suitable for enclosed factory environments, where distances between modules are not very far, however radio paths may be obstructed.

105S modules may be used as a separate multidrop I/O system, or as I/O expansion for 105U modules.

In factories or building environments, groups of 105S modules, connected by RS485 multidrop, may also transmit information by radio to another remote multidrop group in another building. For example, several buildings on a large site may be connected by radio links, with signals inside the buildings being conveyed by multidrop twisted-pair.

Simple but Reliable

The ELPRO 105 modules use a very reliable transmission protocol designed for secure communications, even with external interference.

Because 105 modules have transceivers, modules are able to communicate with each other to control the flow of information.

Transmissions occur when an input signal changes. That is, when a digital (switch contact) input turns off or on, or when the value of an analogue input changes by a pre-configured amount. The 105 provides real-time communications, which polling systems cannot achieve.

There are also regular update transmissions to check the value of the input signals and to check the integrity of the communication path. The status of the communications path is available as an alarm output.

The input signals are transmitted in a "data frame" which includes the address of the transmitting module, the address of the destination module, and a CRC error check. The error check is used to ensure that there is no corruption of the data frame during transmission.

Each module will wait until the radio channel is "free" before transmitting a message. When the destination module receives the message, it will check the validity of the message and transmit a return acknowledgment - a "handshake". If the original module does not receive this acknowledgment, then it will resend the message another four times. Using this simple but secure communications protocol, the 105 provides reliable operation even in noisy environments.



The wireless alternative to expensive cabling...

Two-way Communications

The 105U internal radio is a transceiver - a transmitter and receiver. Because the 105U can communicate in both directions, each module is capable of both input and output signals. Both monitoring (input) and control (output) functions are provided on every 105U module.

Variety of I/O Configurations

The 105 range of products include the 105-1, 105-2, 105-3 and 105-4 modules with various I/O configurations. All modules in the ELPRO 105 range include the same flexible and reliable operating protocol.

Different versions will operate together in the one system. Each module provides different combinations of the following I/O :

- digital inputs for switch devices such as limit switches, level switches, security sensors, motor starters, pushbuttons
- analogue inputs (0-10 / 0-20 / 4-20 mA) for connecting transducers which measure parameters such as level, flow, pressure, temperature, vibration
- digital output contacts for controlling devices such as motor drives, lights, alarms
- analogue outputs (0-10 / 0-20 / 4-20mA) for connection to meters or indicators to display measured parameters.
- pulse inputs and outputs for transmitting pulse signals from flowmeters, energy meters etc.

Networking

Each ELPRO 105 module is configured with a system address and a unit address. Only modules with the same system address will communicate within the same system.

More than one system may operate within radio range or on the same multidrop wire without "cross-talk" or malfunction.

A system may comprise a simple two unit network, with input signals at one module appearing as outputs at the other. Or a system may comprise up to 95 105U modules communicating by radio, with each module connected to up to 31 105S modules via RS485. Any input may be configured to be transmitted to an output on any other modules.

Interfacing to Other Systems

A 105 network may also connect via RS232 or RS485 to a host device such as a supervisory computer or PLC. The host device will receive the status of input signals, and may set the value of output signals. Interfaces are available for many PLC's and SCADA software packages.

105U modules can also output signals transmitted from 505U modules, or act as an interface between 505U networks and PLC or computer systems.

For further information, refer to the 505U product brochure.

Pulse I/O

The 105 modules may be configured to count a pulse input and transmit the accumulated count to a remote module. At the destination module the pulse signal is recreated - the accumulated value is used to ensure that all input pulses are output accurately.

The 105 can also transmit the pulse input rate as a separate analogue value and the rate signal is provided as an analogue output at the destination module.

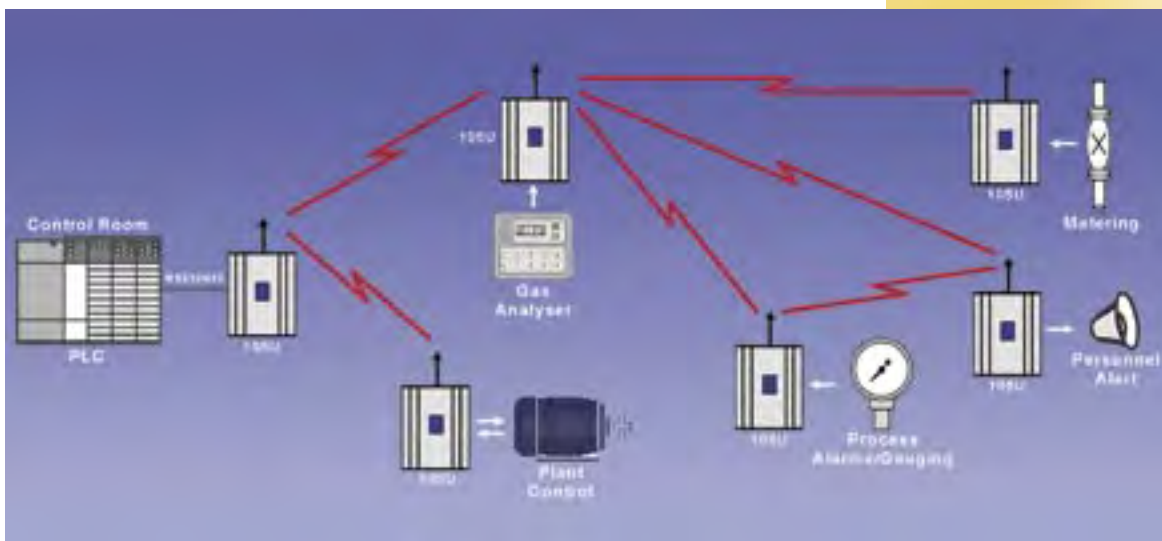
	105U-1	105S-1	105U-2	105S-2	105U-3	105S-3	105U-4	105S-4
Radio Port	✓		✓		✓		✓	
Serial Port	✓	✓	✓	✓	✓	✓	✓	✓
Digital inputs	4		4		0		4 - 16	
Digital outputs	4		1		8		4 - 16	
Analogue inputs	2		6		0		0	
Analogue outputs	2		0		8		0	
Pulse inputs	1		4		0		4	
Pulse outputs	1		0		4		4	

Pulse and digital I/O are same

The 105-4 has 4 fixed inputs and 4 fixed outputs and 12 which may be either input or output.

...Low cost and easy to use!

Industrial Automation



Analogue I/O

The 105-1 modules have two inputs which will accept 4-20mA analogue signals. One of these inputs has adjustable setpoints for controlling a digital output.

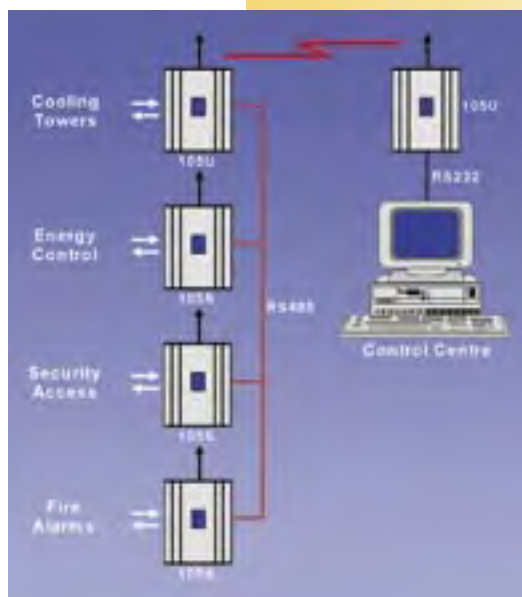
The 105-2 modules have six inputs which will accept 0-20mA analogue signals. Because of the inputs' high resolution, they may be used for 4-20mA signals or 0-10mA signals. Each analogue input has adjustable setpoints for controlling digital outputs.

The 105-3 modules provide eight analogue outputs with a range of 0-20mA. These outputs will reflect the same value as the analogue input signal.

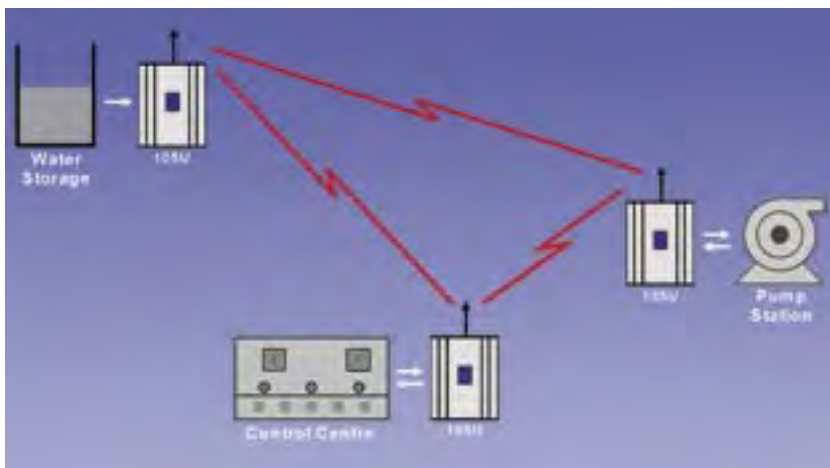
Analogue Setpoints

High and low setpoints may be configured for the analogue inputs to control a remote digital output contact. The digital output will set ("on") when the analogue input value drops below the low setpoint and will reset ("off") when the analogue value exceeds the high setpoint.

Building Management



Water Supply Utilities



ELPRO 105 Telemetry



Radio Communications

The ELPRO 105U transceiver can operate in several UHF radio bands. These bands provides a low noise environment, with a good radio range using low cost compact aerials. The 105U transmission power may be factory set between 10mW and 500mW. Many countries provide a licence-free channel in the UHF band for low power devices such as the 105U.

Radio channels are selected by connecting a PC terminal to the RS232 port on the 105U. If a radio channel is already heavily used, then another can be easily selected.

Radio Range

The operating radio range of the 105U depends on obstructions in the radio path, the height above ground of the aerials, and the type of aerial used.

Typical line-of-site ranges are:

- 500mW 10km or 6 miles
- 100mW 5km
- 10mW 2km

The 105U provides a measurement of both radio channel noise and radio signal strength to assist with installation and testing. Each 105U also provides a repeater function.

A module may be configured to retransmit a message to a remote module which does not have a reliable radio path.

The repeater acts as an intermediate module between the two ends of the radio link. Messages may be repeated up to five time by intermediate repeater units, allowing very long radio paths to be achieved. Repeaters can also have their own I/O.

Power Supply

The ELPRO 105 modules include a switch-mode power supply which will accept a variety of voltage sources.

The 105U will operate from a DC supply of 11 to 30 volts or an AC supply of 15 to 24 volts. Mains supply can be connected via a small transformer "plugpack".

The power supply includes a battery charger for backup batteries, and a solar regulator for direct connection of solar panels. The 105 power supply is intelligent and will automatically alarm on loss of mains supply, loss of solar charging or low battery voltage. These alarm signals may also be transmitted to remote modules as digital output signals.

Configuration

The 105 modules are easy to configure, using on-board selection switches, or by connecting a PC to the module serial port and downloading a configuration file.

Configuration software is provided with the modules. Configuration files may be uploaded from the modules for modification or archival.

Diagnostics, Testing

The 105 modules provide diagnostic and test functions by connecting a PC terminal to the module. I/O and communication functions may be tested.

The 105U module includes a radio strength measurement, which provides an indication of background noise and received radio strength. This feature allows radio paths to be tested without any additional test equipment.

WHAT IS RADIO TELEMETRY?

Radio Telemetry is a method of transmitting information by radio. Signals such as switch status or analogue signals may be transmitted to a remote location, and the signals "re-created".

APPLICATIONS

- Factories
- Warehouses
- Farming
- Mining
- Irrigation
- Security
- Agriculture
- Overhead cranes
- Manufacturing plants
- Marine
- Water and sewerage
- Tank farms
- Building management
- Lighting control
- PLC interconnection
- Mobile vehicles



Specifications

General

Environmental -20 to 60 degC 0 - 99 %RH
 EMC Compliant 89/336/EEC, EN55022, EN50082-1,AS3548
 Housing - extruded aluminium case
 130 x 185 x 60mm with DIN rail mounting
 Removable terminal blocks for ease of module replacement
 Terminals suitable for 2.5sqmm conductors
 LED indication for power supply, WDT, digital I/O, serial comms.

Inputs and Outputs

Digital Inputs

opto-isolated (5000V) inputs suitable for voltage free contacts or NPN transistor, contact wetting current 5mA

105-1 four inputs 105-2 four inputs
 105-4 up to 16 inputs (4 inputs + 12 selectable I/O)
 The 12 selectable inputs are surge protected but not isolated.

Digital Outputs

105-1 four relay output contacts, normally open, AC 50V 5A / DC 30V 2A
 105-2 one FET output 30VDC 500mA
 105-3 eight FET output 30VDC 500mA
 105-4 up to 16 FET output (4 outputs + 12 selectable I/O)

Analogue Inputs

"floating" differential inputs, common mode voltage 27V, 24VDC for powering external loops provided, digital filtering 1 sec.
 105-1 two 4-20mA resolution 15 bit, accuracy 10 bit
 105-2 six 0-20mA resolution 12 bit, accuracy 10 bit

Analogue Outputs

current sink to common, max loop voltage 27V, max loop resistance 1000 ohms
 105-1 two 4-20 mA resolution 15 bit, accuracy 10 bit
 105-3 eight 0-20 mA resolution 12 bit, accuracy 10 bit

Pulse Inputs

Specifications as per digital inputs
 Max pulse rate 100Hz, pulse width min 5ms
 105-1 one input (DI1)
 105-2 four input(DI1-4) - first pulse input (DI1) max 1000Hz, pulse width min 0.5ms
 105-4 four input(DI1-4) - first pulse input (DI1) max 1000Hz, pulse width min 0.5m

Pulse Outputs

FET 30VDC 500mA max 100Hz
 105-1 one
 105-3 four (DO1-4)
 105-4 four (DO1-4)

Power Supply

Battery supply 11.5-15.0 VDC
 Normal supply 12-24 VAC or 15-30 VDC, overvoltage and reverse power protected
 Mains supply 110-250 VAC available via plug-pack transformer
 Battery charging circuit included for 1.2-12 Ahr sealed battery
 Solar regulator for direct connection of solar panel (up to 30W) and solar battery (100Ahr)
 Internal monitoring of mains fail status, solar charge status, and battery voltage. These values may be transmitted to remote modules for monitoring.
 An internal inverter provides 24VDC 150mA for analogue loop supply.

Radio Transceiver

Single channel, synthesised, direct frequency modulation
 Synthesiser switching range 4MHz
 Frequency / Channel spacing / Transmitter power
 405 - 490 MHz / 12.5 KHz / 10 - 500mW
 220 - 230 MHz / 25KHz / 5W
 869 MHz / 250KHz / 5mW/500mW
 Receiver sensitivity 0.4(V (-115dBm) 12dB SINAD
 Signal detect / RSSI -120 to -100dBm
 Conforms to Europe ETS 300 220 10 - 500mW EIRP
 Australia AS4268.2 100mW EIRP
 New Zealand RFS29 500mW EIRP
 Other countries - check local government regulations
 Expected line-of-sight range @ 10mW EIRP - 2km
 @ 100mW EIRP - 5km, @ 500mW EIRP - 10 km
 Range may be extended by using up to five intermediate 105U modules as repeater units
 Aerial connector is BNC, protected by a gas discharge surge arrester, or SMA.

Serial Port

RS232/RS485 serial port 9600 baud, 8 bits, no parity, 1 stop bit
 RS232 9pin DB9 female connector
 RS485 max cable distance 2000 m terminal connections

Data Transmission

Data transmission on "change-of-state" of inputs as well as integrity update transmissions.
 The period for update transmissions is configurable. Data transmitted as bit stream data frame using a synchronous protocol with 16 bit CRC error checking. Automatic acknowledgment of error-free transmissions with up to 5 retries before communications fail is set. Communications failure status may be configured as a digital output. Resetting of outputs on communications failure is configurable.
 Transmission rates Radio 4800 bd Serial 9600 bd
 Typical radio message transmission time 80ms



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Available from:

BRO_105U_ELP_3.1



User Manual

105U Radio Telemetry Module

105S Serial Telemetry Module



For 105U-C and 105U-G products, refer to separate User Manuals

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Web: www.elprotech.com

Thank you for your selection of the 105 module for your telemetry needs. We trust it will give you many years of valuable service.

ATTENTION!

Incorrect termination of supply wires may cause internal damage and will void warranty.

To ensure your 105 enjoys a long life,
double check ALL your connections with the user's manual
before turning the power on.

Notices: Safety

Exposure to RF energy is an important safety consideration. The FCC has adopted a safety standard for human exposure to radio frequency electromagnetic energy emitted by FCC regulated equipment as a result of its actions in Docket 93-62 and OET Bulletin 65 Edition 97-01.

FCC Notice when used in USA: 105U Wireless I/O Module

- Part 15 – This device has been tested and found to comply with the limits for a Class B digital device, pursuant to Part 15 of the FCC rules (Code of Federal Regulations 47CFR Part 15). Operation is subject to the condition that this device does not cause harmful interference.
- Part 90 – This device has been type accepted for operation by the FCC in accordance with Part 90 of the FCC rules (47CFR Part 90). See the label on the unit for the specific FCC ID and any other certification designations.

Industry Canada: 105U Wireless I/O Module

RSS-119 - This device has been type accepted for operation by Industry Canada in accordance with RSS-119 of the Industry Canada rules. See the label on the unit for the specific Industry Canada certification number and any other certification designations.

Notice Any changes or modifications not expressly approved by ELPRO Technologies P/L could void the user's authority to operate this equipment.

To operate this equipment legally the user must obtain a radio operating license from the government agency. This is done so the government can coordinate radio users in order to minimize interference.

Limited Lifetime Warranty, Disclaimer and Limitation of Remedies

ELPRO products are warranted to be free from manufacturing defects for the “serviceable lifetime” of the product. The “serviceable lifetime” is limited to the availability of electronic components. If the serviceable life is reached in less than three years following the original purchase from ELPRO, ELPRO will replace the product with an equivalent product if an equivalent product is available.

This warranty does not extend to:

- failures caused by the operation of the equipment outside the particular product's specification, or
- use of the module not in accordance with this User Manual, or
- abuse, misuse, neglect or damage by external causes, or
- repairs, alterations, or modifications undertaken other than by an authorized Service Agent.

ELPRO’s liability under this warranty is limited to the replacement or repair of the product. This warranty is in lieu of and exclusive of all other warranties. This warranty does not indemnify the purchaser of products for any consequential claim for damages or loss of operations or profits and ELPRO is not liable for any consequential damages or loss of operations or profits resulting from the use of these products. ELPRO is not liable for damages, losses, costs, injury or harm incurred as a consequence of any representations, warranties or conditions made by ELPRO or its representatives or by any other party, except as expressed solely in this document.

How to Use This Manual

To receive the maximum benefit from your 105 product, please read the **Introduction**, **Installation** and **Operation** chapters of this manual thoroughly before putting the 105 to work.

Chapter Four **Configuration** explains how to configure the modules using the Configuration Software available.

Chapter Five **Specifications** details the features of the product and lists the standards to which the product is approved.

Chapter Six **Troubleshooting** will help if your system has problems and Chapter Seven specifies the **Warranty and Service** conditions.

The foldout sheet *105 Installation Guide* is an installation drawing appropriate for most applications.

Warning !

1. For 105U modules, a radio licence is not required in most countries, provided the module is installed using the antenna and equipment configuration described in the *105 Installation Guide*. Check with your local 105 distributor for further information on regulations.
2. For 105U modules, operation is authorised by the radio frequency regulatory authority in your country on a non-protection basis. Although all care is taken in the design of these units, there is no responsibility taken for sources of external interference. The 105 intelligent communications protocol aims to correct communication errors due to interference and to retransmit the required output conditions regularly. However some delay in the operation of outputs may occur during periods of interference. Systems should be designed to be tolerant of these delays.
3. To avoid the risk of electrocution, the antenna, antenna cable, serial cables and all terminals of the 105 module should be electrically protected. To provide maximum surge and lightning protection, the module should be connected to a suitable earth and the antenna, antenna cable, serial cables and the module should be installed as recommended in the *Installation Guide*.
4. To avoid accidents during maintenance or adjustment of remotely controlled equipment, all equipment should be first disconnected from the 105 module during these adjustments. Equipment should carry clear markings to indicate remote or automatic operation. E.g. "This equipment is remotely controlled and may start without warning. Isolate at the switchboard before attempting adjustments."
5. The 105 module is not suitable for use in explosive environments without additional protection.

Caution!

For continued protection against risk of fire, replace the internal fuse only with the same type and rating.

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Chapter One

INTRODUCTION

1.1

General

The 105 range of telemetry modules has been designed to provide standard “off-the-shelf” telemetry functions, for an economical price. *Telemetry* is the transmission of signals over a long distance via a medium such as radio or twisted-pair wire. Although the 105 is intended to be simple in its application, it also provides many sophisticated features. This manual should be read carefully to ensure that the modules are configured and installed to give reliable performance.

The unit can monitor and control the following types of signals:

Digital on/off signals

Example outputs - motor run, siren on

Example inputs - motor fault, tank overflow, intruder alarm

Analogue continuously variable signals (0-20mA)

Example outputs - tank level indication, required motor speed

Example inputs - measured tank level, actual motor speed

Pulse frequency signals

Examples - electricity metering, fluid flow

Internal Status signals

Examples - analogue battery voltage, power status, solar panel status and low battery status.

The unit will monitor the input signals and transmit the signal information by radio or RS485 twisted pair to another 105 module. At the remote unit, the signals will be reproduced as digital, analogue or pulse output signals. The 105 also provides analogue set points, so that a digital output may be configured to turn on and off depending on the value of an analogue input. The pulse I/O transmits an accumulated value and the pulses are reliably recreated at the remote unit regardless of ‘missed’ transmissions. The actual pulse rate is also calculated and is available as a remote analogue output.

This manual covers the 105U and 105S modules. We have provided a summary on all products available in the 105 telemetry range, below.

- **105U-1, 105U-2, 105U-3 and 105U-4** modules have UHF radio **and** serial communications. The modules differ only in their input/output (I/O) design, and are compatible, i.e. they can be used to communicate signals to each other in the same network.
- **105S-1, 105S-2, 105S-3 and 105S-4** modules have **only** serial communications. All other specifications are as per the 105U-1, 2, 3 & 4 modules. The 105S modules are compatible with 105U modules.

- The **105U-C** and **105U-G** modules provide an interface between host devices such as PLC's or SCADA computers, and a radio telemetry system comprising 105U and 505U radio telemetry modules. The 105U-C and -G allows 105U/505U modules to act as remote wireless I/O for the host devices. For more information, refer to the relevant User Manual.

Product naming convention:

1 0 5 a – x where a is:

U = UHF radio + RS232/RS485 serial S = RS232/RS485 serial only

and x is:

1 = Input / Output module 2 = Input module (includes one output) 3 = Output module

4 = Input / Output module C= Interface module G = Gateway module

	105U-1	105S-1	105U-2	105S-2	105U-3	105S-3	105U-4	105S-4
Radio	✓		✓		✓		✓	
Serial	✓	✓	✓	✓	✓	✓	✓	✓
Digital Inputs (DI)	4		4				4 to 16	
Digital Outputs (DO)	4 (relay)		1 (FET)		8 (FET)		4 to 16 (FET)	
Analogue Inputs (AI)	2 (4-20mA)		6 (0-20mA)					
Analogue Outputs (AO)	2 (4-20mA)				8 (0-20mA)			
Pulse Inputs (PI)	1 (100Hz)		4 (1x1KHz, 3x100Hz)				4 (1x1KHz, 3x100Hz)	
Pulse Outputs (PO)	1 (100Hz)				4 (100 Hz)		4 (100 Hz)	
Comments	PI is DI 1. PO is separate to DO.		PI's are the same as DI's.		PO's are the same as DO's .		PI/ PO's are the same as DI/ DO's.	

Note regarding 105-4 modules. The 105-4 has a total of 20 digital I/O. Four are fixed inputs (also PI's) and four are fixed outputs (also PO's). The other 12 are selectable individually as DI or DO. The I/O range can vary from 16DI + 4DO to 4DI + 16DO or any combination in between.

All modules include power supply, microprocessor controller, input/output circuits, RS485/232 serial port, and a UHF radio transceiver - no external electronics are required. The 105U version has both radio and serial port communications. The 105S version does not have a radio and has only serial communications.

The 105U can be fitted with different radio boards covering regulated frequency bands in different parts of the world, both license-free and licensed bands. See Chapter Five **Specifications** for details.

Input signals connected to a 105 module are transmitted to another 105 module and appear as output signals. These input signals may also be configured to appear as "inverted" signals on the output. A transmission occurs whenever a "change-of-state" occurs on an input signal. A "change-of-state" of a digital or digital internal input is a change from "off" to "on" or vice-versa. A "change-of-state" for an analogue input, internal analogue input or pulse input rate is a change in value of the signal of 3% (configurable from 0.8 to 50 %).

In addition to change-of-state messages, update messages are automatically transmitted on a regular basis. The time period may be configured by the user for each input. This update ensures the integrity of the system.

Pulse inputs are accumulated as a pulse count and the accumulated pulse count is transmitted regularly according to the configured update time.

The 105 modules transmit the input/output data as a data frame using radio or serial RS485 as the communications medium. The data frame includes the "address" of the transmitting 105 module and the receiving 105 module, so that each transmitted message is acted on only by the correct receiving unit. Each transmitted message also includes error checking to ensure that no corruption of the data frame has occurred due to noise or interference. The 105 module with the correct receiving "address" will acknowledge the message with a return transmission. If the original module does not receive a correct acknowledgement to a transmission, it will retry up to five times before setting the communications fail status of that path. In critical paths, this status can be reflected on an output on the module for alert purposes. The module will continue to try to establish communications and retry, if required, each time an update or change-of-state occurs.

A 105 telemetry system may be a complex network or a simple pair of modules. An easy-to-use configuration procedure allows the user to specify any output destination for each input.

The maximum number of modules in one system is 95 modules communicating by radio. Each of these modules may have up to 31 other modules connected by RS485 twisted pair. Modules may communicate by radio only, by RS485 only or by both RS485 and radio. Any input signal at any module may be configured to appear at any output on any module in the entire system.

Systems with a 105U-C or 105U-G module and host device can have more than 95 radio modules.

Modules can be used as repeaters to re-transmit messages on to the destination module. Repeaters can repeat messages on the radio channel, or from the radio channel to the serial channel (and serial to radio). Up to five repeater addresses may be configured for each input-to-output link.

The units may be configured by using a PC connected to the RS232 port. The default configuration is defined in Section 4.2 **Easy Configuration Using Default Settings**, and software configuration is defined in Section 4.2 **105 Configuration Software**.

Chapter Two

INSTALLATION

2.1

General

The 105 module is housed in a rugged aluminium case, suitable for DIN-rail mounting. Terminals are suitable for cables up to 2.5 sqmm in size.

Normal 110/220/240V mains supply should not be connected to any input terminal of the 105 module. Refer to Section 2.3 **Power Supply**.

Before installing a new system, it is preferable to bench test the complete system. Configuration problems are easier to recognise when the system units are adjacent. Following installation, the most common problem is poor communications on the radio channel or the serial channel. For radio modules, problems are caused by incorrectly installed antennas, or radio interference on the same channel, or the radio path being inadequate. If the radio path is a problem (i.e. path too long, or obstructions in the way), then higher performance antennas or a higher mounting point for the antenna may fix the problem. Alternately, use an intermediate 105 module as a repeater.

For serial modules, poorly installed serial cable, or interference on the serial cable is a common problem.

The foldout sheet 105 Installation Guide provides an installation drawing appropriate to most applications. Refer to Appendix B of this manual for terminal layout drawings of the modules.

Each 105 module should be effectively earthed via a "GND" terminal on the 105 module - this is to ensure that the surge protection circuits inside the 105 module are effective.

2.2

Antenna Installation (*105U units only*)

The 105 module will operate reliably over large distances. The distance which may be reliably achieved will vary with each application - depending on the type and location of antennas, the degree of radio interference, and obstructions (such as hills or trees) to the radio path. Please refer to your distributor for the expected maximum distance to comply with local radio regulations. Where it is not possible to achieve reliable communications between two 105 modules, then a third 105 module may be used to receive the message and re-transmit it. This module is referred to as a repeater. This module may also have input/output (I/O) signals connected to it and form part of the I/O network - refer to Chapter 4 **Configuration** of this manual.

An antenna must be connected to each 105 module using the coaxial female connector which protrudes through one of the end plates.

To achieve the maximum transmission distance, the antennas should be raised above intermediate obstructions so the radio path is true "line of sight". Because of the curvature of the earth, the antennas will need to be elevated at least 5 metres above ground for paths greater than 5 km (3 miles). For short distances, the modules will operate reliably with some obstruction of the radio path. Obstructions which are close to either antenna will have more of a blocking affect than obstructions in the middle of the radio path. For example, a group of trees around the antenna is a

larger obstruction than a group of trees 100 metres from the antenna.

An antenna should be connected to the module via 50 ohm coaxial cable (eg RG58 or RG213) terminated with a male coaxial connector. The higher the antenna is mounted, the greater the transmission range will be, however as the length of coaxial cable increases so do cable losses. For use on unlicensed frequency channels, there are several types of antennas suitable for use. It is important antenna are chosen carefully to avoid contravening the maximum power limit on the unlicensed channel - normally the net gain of the antenna/cable configuration should be no more than 2dB.

The net gain of an antenna/cable configuration is the gain of the antenna (in dBi) less the loss in the coaxial cable (in dB).

The gains and losses of typical antennas are

Antenna	Gain (dB)	
Dipole with integral 3m cable	0	
Dipole without cable	2	
5dBi Collinear(3dBd)	5	
8dBi Collinear (6dBd)	8	
3 element Yagi	5	
6 element Yagi	10	
Cable type	Loss (dB per 10 m)	
	400-500MHz	869MHz
RG58	-3	-5
RG213	-1.5	-2.5
Cellfoil	-1.5	-3

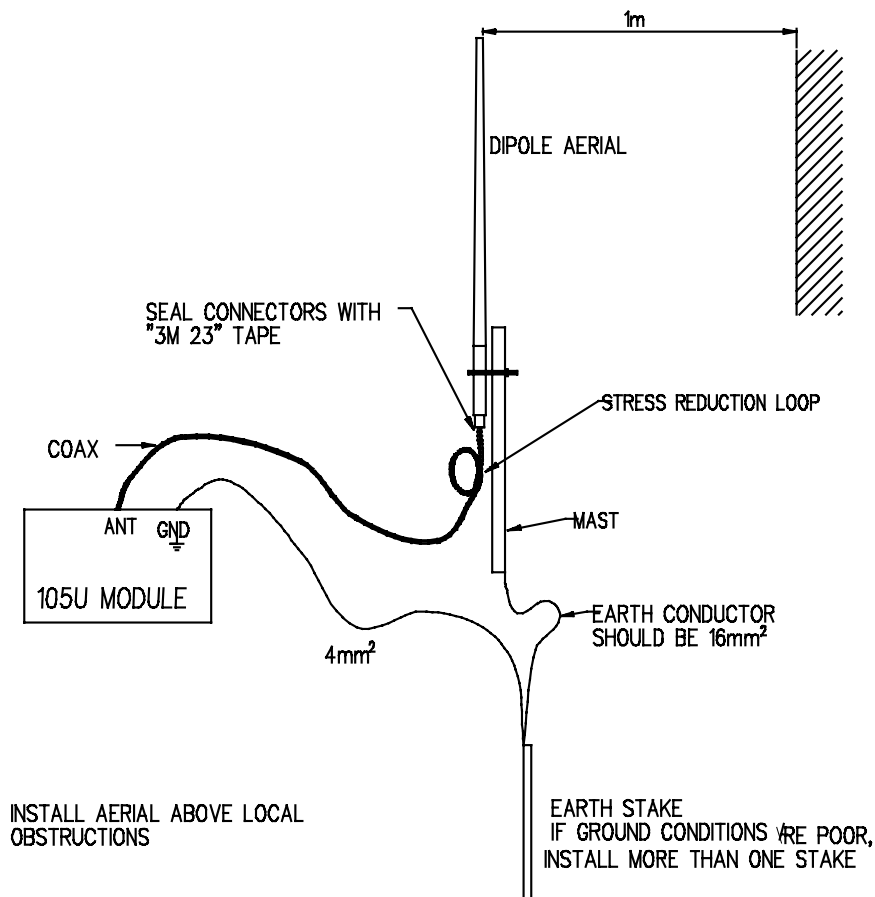
The net gain of the antenna/cable configuration is determined by adding the antenna gain and the cable loss. For example, a 3 element Yagi with 15 metres of RG58 has a net gain of 0.5dB (5dB – 4.5dB) at 450MHz.

Connections between the antenna and coaxial cable should be carefully taped to prevent ingress of moisture. Moisture ingress in the coaxial cable is a common cause for problems with radio systems, as it greatly increases the radio losses. We recommend that the connection be taped, firstly with a layer of PVC Tape, then with a vulcanising tape such as “3M 23 tape”, and finally with another layer of PVC UV Stabilised insulating tape. The first layer of tape allows the joint to be easily inspected when trouble shooting as the vulcanising seal can be easily removed.

Where antennas are mounted on elevated masts, the masts should be effectively earthed to avoid lightning surges. The 220MHz and 400 – 500MHz radios are fitted with surge protection, however the 868MHz radio does not. For high lightning risk areas, additional surge suppression devices are recommended. If the antenna is not already shielded from lightning strike by an adjacent earthed structure, a lightning rod may be installed above the antenna to provide shielding.

2.2.1 Dipole antenna.

A unity gain dipole is the normal antenna for use on unlicensed channels. As it does not provide



any gain, then the power transmitted from the antenna will be the same as the power out of the module, and hence will not exceed the permitted power of the unlicensed channel.

Dipole antennas should be mounted vertically, at least 1 metre away from a wall or mast for maximum performance.

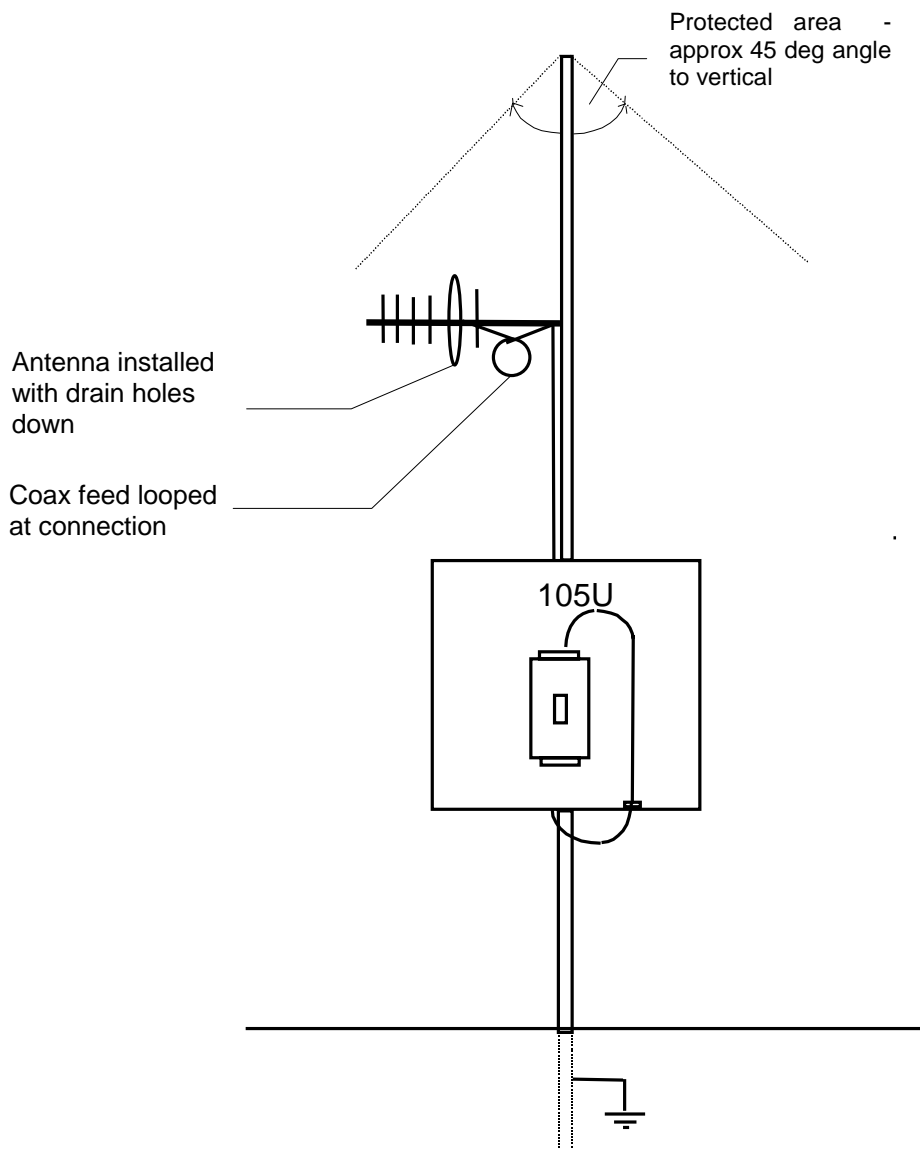
2.2.2 Yagi antenna.

Yagi antennas are directional. That is, they have positive gain to the front of the antenna, but negative gain in other directions. This may be used to compensate for coaxial cable loss for installations with marginal radio path.

Yagi antennas should be installed with the central beam horizontal and must be pointed exactly in the direction of transmission to benefit from the gain of the antenna.

The Yagi antennas may be installed with the elements in a vertical plane (vertically polarised) or in a horizontal plane (horizontally polarised). For a two station installation, with both modules using Yagi antennas, horizontal polarisation is recommended. If there are more than two stations transmitting to a common station, then the Yagi antennas should have vertical polarisation, and the common (or "central" station should have a dipole or collinear (non-directional) antenna.

Note that Yagi antennas normally have a drain hole on the folded element - the drain hole should be located on the bottom of the installed antenna.



2.2.3 Collinear antenna.

A collinear antenna may be used in the same way as a 3 element Yagi to compensate for the losses in long lengths of coaxial cable. This type of antenna is generally used at a central site with more than one remote site or at a repeater site. The collinear antenna looks similar to the dipole, except that it is longer.

2.3

Power Supply

The 105 power supply is a switch-mode design which will accept either AC or DC supply. The 105 module may also be powered from a solar panel without an external solar regulator.

The 105 module accepts supply voltages in the following ranges :

12 - 24 volts AC RMS or 15 - 30 volts DC at the “supply” terminals, or
 10.8 -15 volts DC at the “battery” terminals.

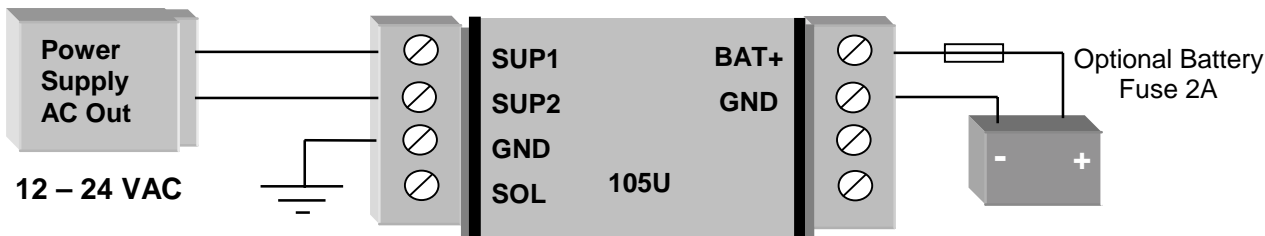
The power supply should have a minimum capacity of 9 Watts.

For units with RF power above 2W, the unit needs to be powered from the 12V “Battery” terminals with a power supply of at least 2A rating. Alternately, the unit can be powered via the SUP1 / SUP2 terminals, provided a backup battery is connected to the “Battery” terminals to supply the inrush current for the radio transmitter. This is not required for units with radio power less than 2W.

Note: Connect module to the same ground/earth point as the antenna mounting to avoid differences in earth potential during voltage surges. The modules needs an earth connection for the internal surge protection to be effective.

2.3.1 AC Supply

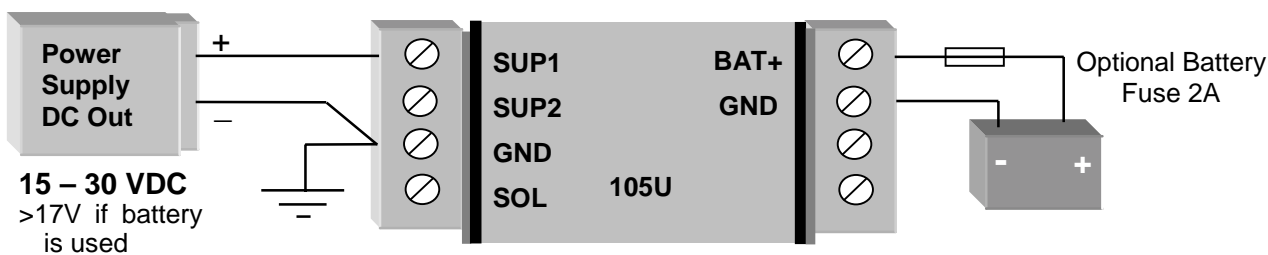
The AC supply is connected to the "SUP1" and "SUP2" terminals as shown below.



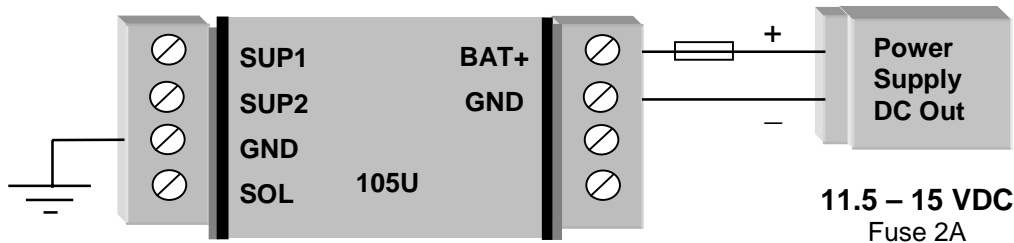
The AC supply should be "floating" relative to earth. AC transformers with grounded/earthed secondary windings should **not** be used.

2.3.2 DC Supply

For DC supplies, the positive lead is connected to "SUP1" and the negative to "GND". The positive side of the supply **must not be connected to earth**. The DC supply may be a floating supply or negatively grounded.



The 105 module may also be powered from an external 11.5 - 15 VDC battery supply without the need for a "normal" supply connected to "SUP1". This external battery supply is connected to "BAT+" and "GND" terminals. The positive lead of the external supply should be protected by a 2A fuse.



Upon failure of the normal supply, the 105 module may continue to operate for several hours from a backup battery. The 105 module includes battery charging circuits for charging up to a 12 Ahr sealed lead acid battery. The battery is connected to the "BAT+" (positive) and "GND" (negative) terminals. The positive lead from the battery should be protected with a 2A fuse, installed as near to the battery terminal as possible. On return of main supply, the unit will switch back to mains operation, and recharge the battery. To provide adequate current to recharge the backup battery, an AC supply of 15V minimum or a DC supply of 17V minimum must be used. Typically, a 6 Ahr battery will supply the 105 for 1 - 3 days, depending on I/O loads.

2.3.3 Solar Supply

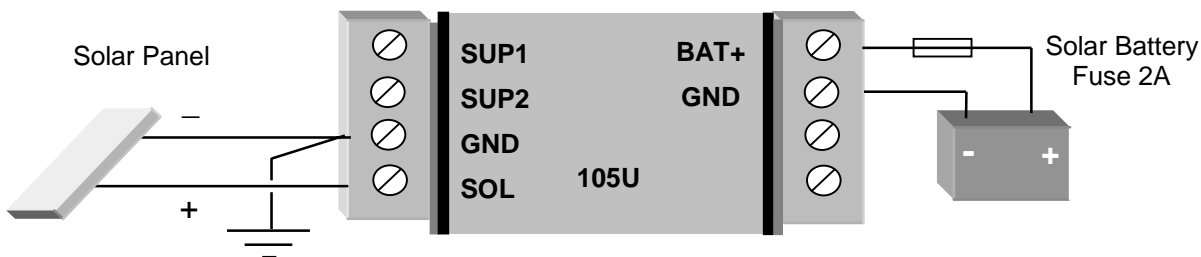
The 105 power supply also includes a 12 V solar regulator for connecting 12V solar panels of up to 30W, and solar batteries of up to 100Ahr. An 18W solar panel is sufficient for most solar applications. The size of the solar battery required depends on the I/O used. Batteries are sized for a number of sunless days with 50% battery capacity remaining as follows:

$$\text{No. of sunless days} = \frac{\text{Battery capacity (Ahr)} \times 0.5}{\text{Module load (A)} \times 1.2 \times 24}$$

The Module load depends on the I/O connected and can be calculated as follows:

$$\text{Module Load(A)} = 0.07 + (0.01 \times \text{No. of DI's}) + (0.025 \times \text{No. of DO's}) + (2 \times \text{Analogue loop load}).$$

The analogue loop load is the total signal current for the AI's and AO's which are powered from the internal 24V supply. Externally powered loops are not included in this.



The solar panel is connected to the "SOL" (positive) and "GND" (negative) terminals and the battery connected to the "BAT+" (positive) and "GND" (negative) terminals. Solar panels must be installed and connected as per the panel manufacturer's instructions. The positive lead of the battery should

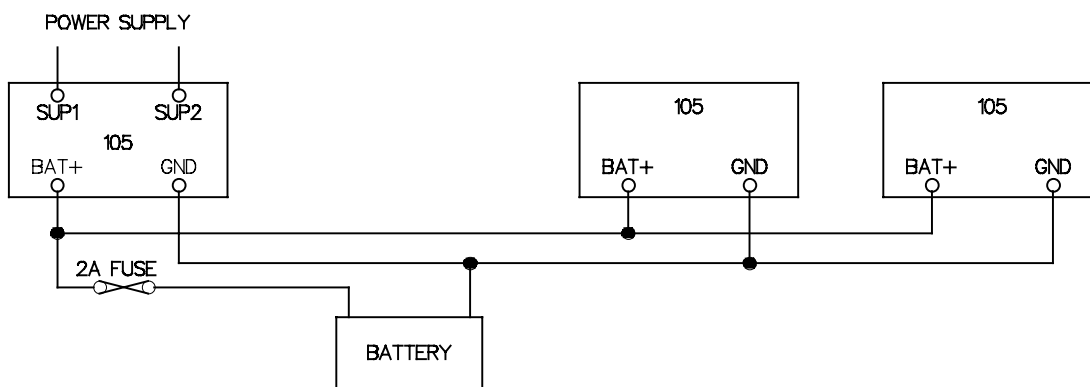
be protected by a 2A fuse installed as near as possible to the battery terminal.

Where a panel larger than 30W is required, an external solar regulator should be used.

Note: The unit must not be powered from a solar panel without a battery. For maintenance, disconnect the solar panel first before disconnecting the battery.

2.3.4 Multiple Modules

Where more than one module is installed at the one location, a shared power supply and battery may be used, provided the total load does not exceed the power supply.



The internal power supply of the 105 module can supply a maximum 12V load of 700mA. In order to achieve this, the input power supply must be above 15VAC or 17VDC. Using these figures, it can be determined whether there is enough supply for more than one module - allow 100mA for recharging a battery.

For example, assume there is a 105U-01 module and a 105S-01 module at the same location. The total I/O at the location is 3 analogue inputs, 6 digital inputs and 4 digital outputs. The total load will be :-

TYPE OF LOAD	LOAD mA
105U-01 quiescent	70
105S-01 quiescent	45
6 DI @ 10 mA	60
3 AI @ 20mA x 2	120
4 DO @ 25mA	100
Battery charging	100
TOTAL	495

So both modules could be powered from one power supply and one battery, provided the external supply voltage is more than 15VAC or 17VDC.

2.3.5 24V Regulated Supply

Each 105 module provides a 24V DC regulated supply for analogue loop power, except for 105-4.

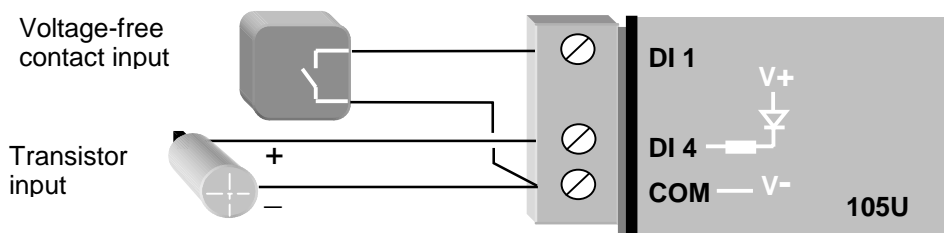
The supply is rated at 150mA, and should **only** be used for powering analogue loops.

2.4 Input / Output

2.4.1 Digital Inputs (105-1, 105-2 and 105-4)

The 105-1 and 105-2 modules each provide four digital inputs with 5000 volt opto-isolation, and the 105-4 provides 4 – 16 inputs with 3000 volt surge protection. All inputs are suitable for voltage free contacts (such as mechanical switches) or NPN transistor devices (such as electronic proximity switches). PNP transistor devices are not suitable. Contact wetting current of approximately 5mA is provided to maintain reliable operation of driving relays.

Each digital input is connected between the appropriate "DI" terminal and common "COM". Each digital input circuit includes a LED indicator which is lit when the digital input is active, that is, when the input circuit is closed. Provided the resistance of the switching device is less than 200

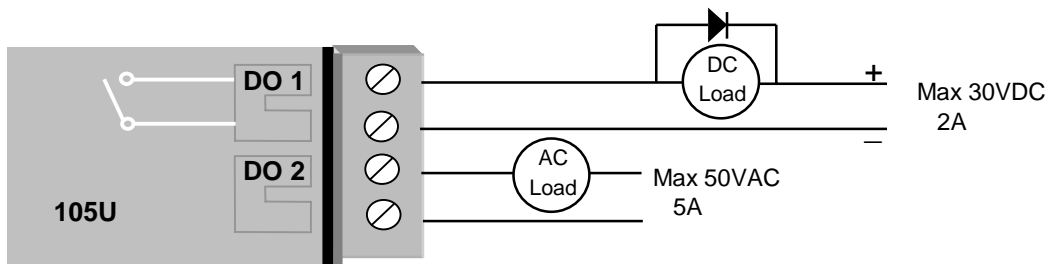


ohms, the device will be able to activate the digital input.

For pulse inputs, refer to Section 2.4.6.

2.4.2 Digital Outputs (105-1)

The 105-1 module provides four normally open voltage-free relay contacts, rated at AC3 50V/2A, ; DC - 30V/2A, 20V/5A. These outputs may be used to directly control low-powered equipment, or to power larger relays for higher powered equipment. When driving inductive loads such as AC relays, good installation should include capacitors (e.g. 10nf 250V) across the external circuit to prevent arcing across the relay contacts. For DC inductive loads, flyback diodes should be used across DC relays.

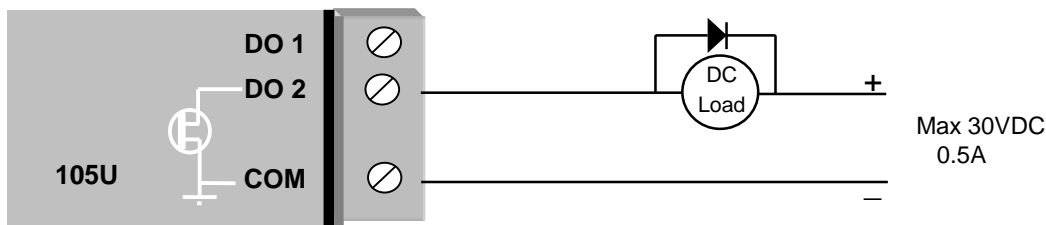


Digital outputs may be configured to individually turn off if no command message is received to that output for a certain period. This feature provides an intelligent watch dog for each output, so that a communications failure at a transmitting site causes the output to revert to a known state. See section 4.4 Changing User Options for further details.

The output circuit is connected to the appropriate pair of "DO" terminals. Each digital output circuit includes a LED indicator which is lit when the digital output is active.

2.4.3 Digital Outputs (105-2, 105-3 and 105-4)

The digital outputs on the 105-2, 105-3 and 105-4 modules are transistor switched DC signals, FET output to common rated at 30VDC 500 mA. The 105-2 provides one digital output; the 105-3 provides eight digital outputs and the 105-4 provides 4 – 16 outputs. The first four DO's on the 105-3 and 105-4 modules are also the pulse outputs - that is, the first four DO's can be either digital outputs or pulse outputs. The function of each of these outputs may be configured individually. For a description of pulse outputs, refer to Section 2.4.7.

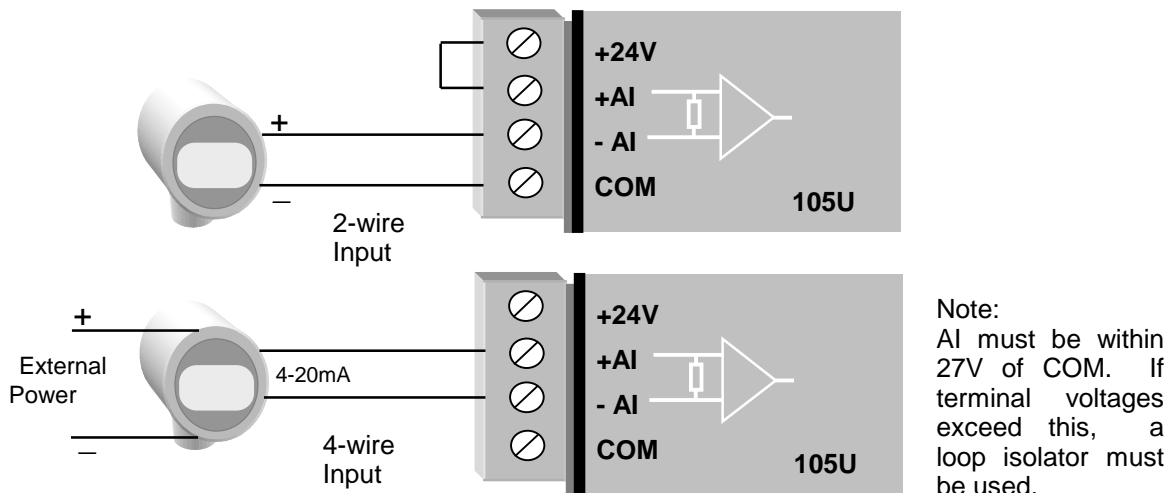


Digital outputs may be configured to individually turn off if no command message is received to that output for a certain period. This feature provides an intelligent watch dog for each output, so that a communications failure at a transmitting site causes the output to revert to a known state. See Chapter 4 **Configuration** for further details.

The output circuit is connected to the appropriate pair of "DO" terminals. Each digital output circuit includes a LED indicator which is lit when the digital output is active.

2.4.4 Analogue Inputs (105-1 and 105-2)

The 105-1 module provides two 4 - 20 mA DC analogue inputs for connecting to instrument transducers such as level, moisture, pressure transducers, etc. The 105-2 module provides six 0 - 20 mA DC analogue inputs. Note that the inputs on the 105-2 module will measure down to 0mA, so they can also be used for zero based signals such as 0 - 10 mA.



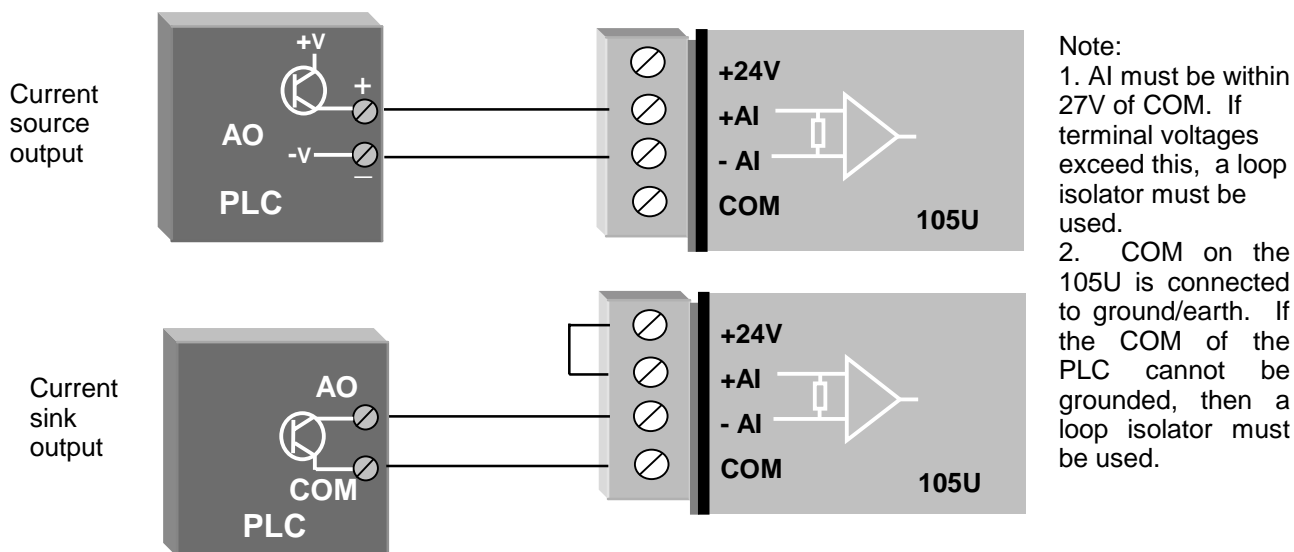
Each analogue input has a positive and negative terminal, and may be placed at any point in the current loop, as long as neither input rises above the 24 volt supply level. Each input has a loop resistance of less than 250 ohms and zener diode protection is provided against over-voltage and reverse voltage, however additional protection may be required in high voltage or noisy environments or for very long wiring runs.

A 24VDC loop supply is available on the 105 module for powering the analogue transducer loops. In this case, the analogue loop should be connected between a "AI 1-" terminal and "COM" (for the first analogue input) or "AI 2-" (for the second analogue input), and so on for other inputs. The positive terminal ("AI 1+" or "AI 2+", etc) should be connected to "+24V".

Externally powered loops may be connected by connecting the input between "AI 1+" and "AI 1-" for analogue input 1 or "AI 2+" and "AI 2-" for analogue input 2, and so on for other inputs. Common mode voltage may be -0.5V to 27V.

Shielded cable is recommended for analogue I/O loops to minimise induced noise and Radio Frequency Interference (RFI). The shield of the cable should be connected to earth at one of the cable only. The use of shielded wiring inside an enclosure containing a 105 module is also recommended.

To connect an AI on the 105U to an analogue signal from a PLC or DCS output, check the internal circuit of the output carefully as different devices use different ways to create an analogue signal. The following diagram shows two ways of connecting.



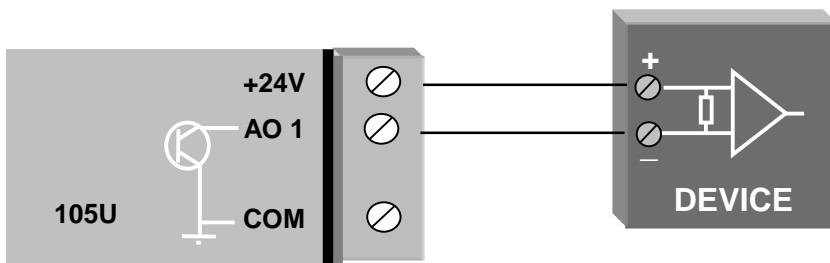
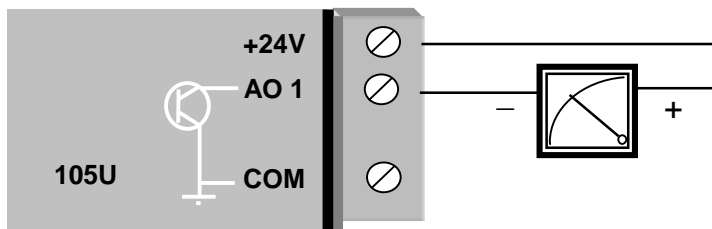
2.4.5 Analogue Outputs (105-1 and 105-3)

The 105-1 module provides two 4 - 20 mA DC analogue outputs for connecting to instrument indicators for the display of remote analogue measurements. The 105-3 module provides eight 0 - 20 mA DC analogue outputs. Each analogue output is a "sink" to common.

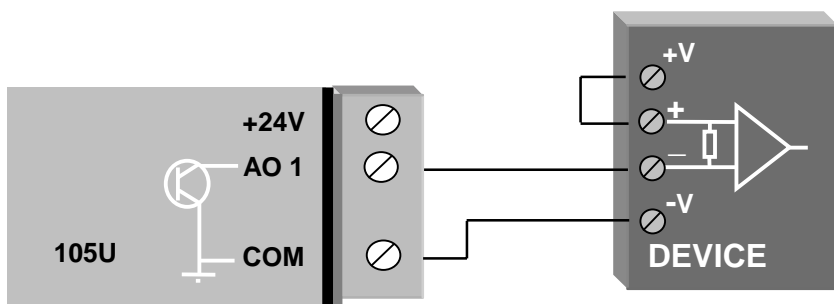
A 24VDC supply is available on the 105 module for powering the analogue output loop (max external loop resistance 1000 ohms). In this case, the analogue loop is connected between a "+24V" terminal and "AO 1" (for the first analogue output) or "AO 2" (for the second analogue output), and so on for the other output signals.

If connecting to an external device such as an electronic indicator, recorder or PLC / DCS input, the loop can be powered by either the 105U or the device. Externally powered loops to 27 VDC may be connected by connecting the output between the "AO" terminal (positive) and the "COM" terminal (negative). Zener protection of analogue outputs provides protection against short periods of over-voltage but longer periods **may result in module damage**.

Note that the 105 common is connected internally to ground and no other point in the analogue loop should be grounded. If the external device has single-ended grounded inputs, then a signal isolator must be used.

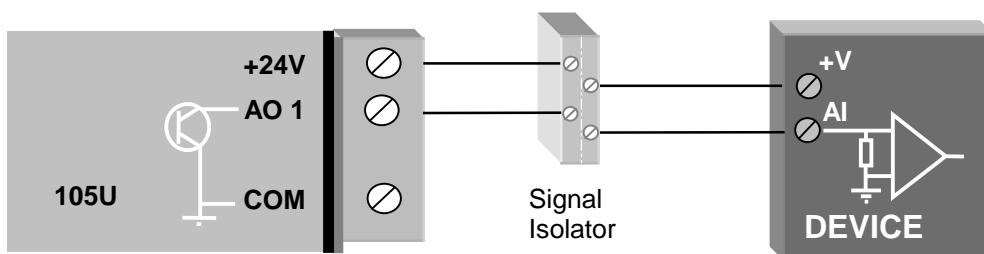


Connecting to a floating input device, powered from the 105U



Note:
COM on 105U is connected to ground/earth. If the external power supply cannot be grounded, a loop isolator must be used.

Connecting to an externally powered floating-input device

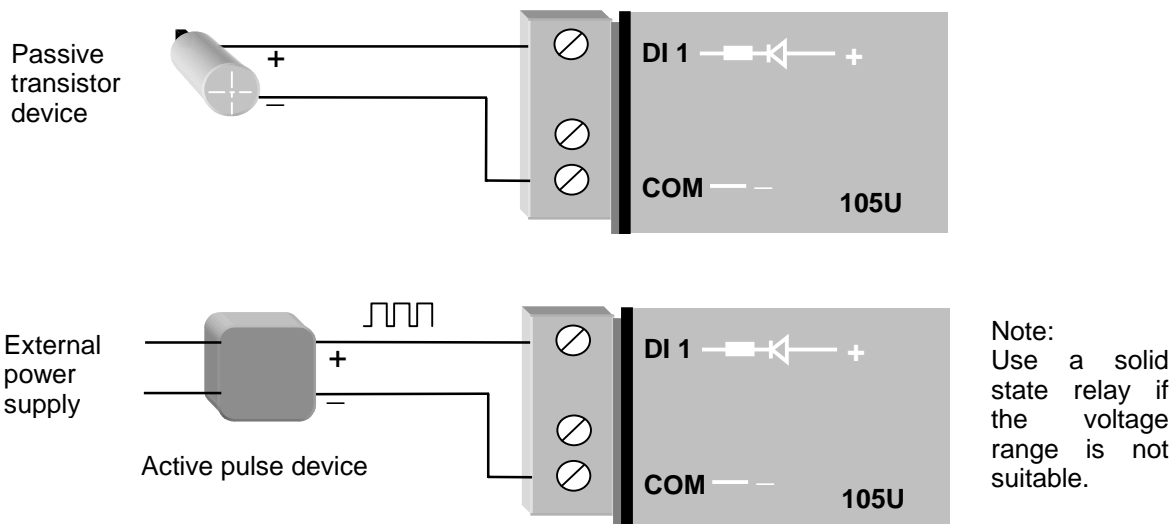


Connecting to a grounded input device via a signal isolator

Analogue outputs may also be configured to individually turn off (0 mA) if no command message is received to that output for a certain period. . See Chapter 4 **Configuration** for further details.

2.4.6 Pulse Input (105-1)

For the 105-1 module, digital input 1 may be configured as a pulse input (max rate 100 Hz, min. off time 5 ms). In this mode, both the pulse **rate** and the pulse **count** are available for mapping to a remote output. The pulse rate may appear at any analogue output on the remote unit, while the pulse count can appear at a Pulse Output on another 105-1 or Digital Output on a 105-3 unit. The pulse input should be connected in the same way as a digital input.



Active pulse signals can be connected directly provided the peak voltage is between 3.5–13V and the low voltage is less than 1.5V. Note that the 105U will ground the negative of the pulse signal. If the voltages are not compatible, use a solid state relay to isolate the two devices.

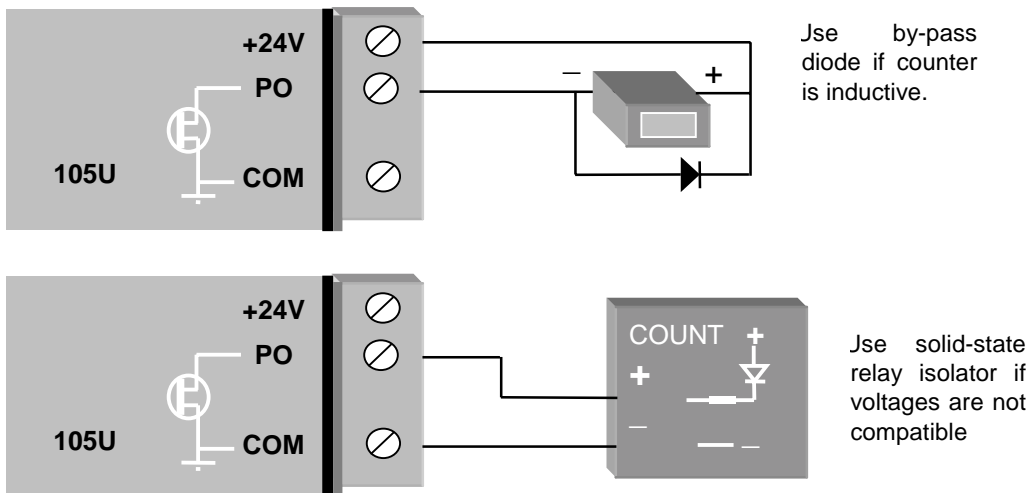
2.4.7 Pulse Inputs (105-2 and 105-4)

For the 105-2 and 105-4 modules, the four digital inputs (DI 1-4) may be configured as pulse inputs. The first digital/pulse input DI 1 has a maximum rate of 1000 Hz (min. off time 0.5 ms), while DI 2-4 have a maximum rate of 100 Hz (min. off time 5 ms). When using DI 1 at high pulse rates (more than 100 Hz), a divide by 10 function may be configured to reduce the pulse count at the output, as Pulse Outputs have a maximum rate of 100 Hz.

For each pulse input, both the pulse **rate** and the pulse **count** are available for mapping to a remote output. The pulse rate may appear at any analogue output on the remote unit, while the pulse count can appear at a Pulse Output. The default update time for pulse counts is 1 minute. This can be changed by changing the update time configuration - refer Chapter 4 **Configuration** for further details. The pulse count is a 16 bit value - “roll over” of the count when it exceeds the maximum value is automatically handled by the 105 modules.

2.4.8 Pulse Output (105-1)

A single FET output to common rated at 30VDC, 500 mA is provide for the pulse output "PO". This output accurately recreates the pulses counted at a pulse input at a 105-1 or 105-2 module.



If the counter device requires a voltage pulse signal (such as electronic or elector-mechanical counters), use the 24V analog loop supply, or the 12V BAT supply for the voltage source. Use a by-pass diode if the counter is inductive.

Some devices such as PLC counter modules power the pulse loop. For these devices, connect to the PO and COM terminals of the 105U. The COM terminal will connect a ground/earth to the external device. If this is not suitable, use a solid state relay to isolate the external device.

Although the count is accurately re-created, the rate of output pulses may not accurately reflect the input rate. The actual input pulse rate may be configured to appear at an analogue output if required. Note that the pulse rate and accumulated value will remain accurate even if a period of communications failure has occurred. The maximum output rate is 100 Hz. If a high speed pulse input is used (more than 100 Hz) on PI1 of a 105-2 module, the pulse input count should not be transmitted to a PO on the 105-1 or DO on the 105-3 without configuring the divide-by-10 function (on the 105-2 or 105-4 module)

2.4.9 Pulse Output (105-3 and 105-4)

The first four digital outputs on the 105-3 and 105-4 modules may also be used as pulse outputs. The outputs are FET output to common rated at 30VDC, 500 mA. The outputs will provide a pulse signal of up to 100 Hz. The outputs accurately recreate the pulses counted at pulse inputs at a 105-1, 105-2 or 105-4 module.

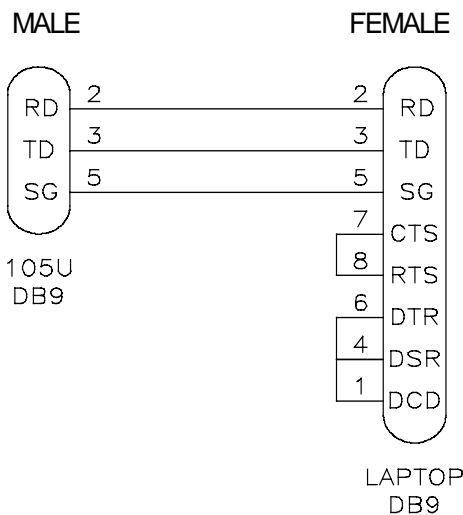
Although the count is accurately re-created, the rate of output pulses may not accurately reflect the input rate. The actual input pulse rate may be configured to appear at an analogue output if required. Note that the pulse rate and accumulated value will remain accurate even if a period of communications failure has occurred.

2.4.10 RS232 Serial Port

The serial port is a 9 pin DB9 female and provides for connection to a terminal or to a PC for configuration, field testing and for factory testing. This port is internally shared with the RS485 - ensure that the RS485 is disconnected before attempting to use the RS232 port. Communication is via standard RS-232 signals. The 105 is configured as DCE equipment with the pin-out detailed below. The serial port communicates at a baud rate of 9600 baud, 8 bits, no parity, one stop bit.

Pin	Name	Dirn	Function
1	DCD	Out	Data carrier detect - not used
2	RD	Out	Transmit Data - Serial Data Input (High = 0, Low = 1)
3	TD	In	Receive Data - Serial Data Output (High = 0, Low = 1)
4	DTR	In	Data Terminal Ready - not used
5	SG	-	Signal Ground
6	DSR	Out	Data Set Ready - not used
7	RTS	In	Request to Send - not used
8	CTS	Out	Clear to send - not used
9	RI	-	Ring indicator - not used.

An example cable drawing for connection to a laptop is detailed below:



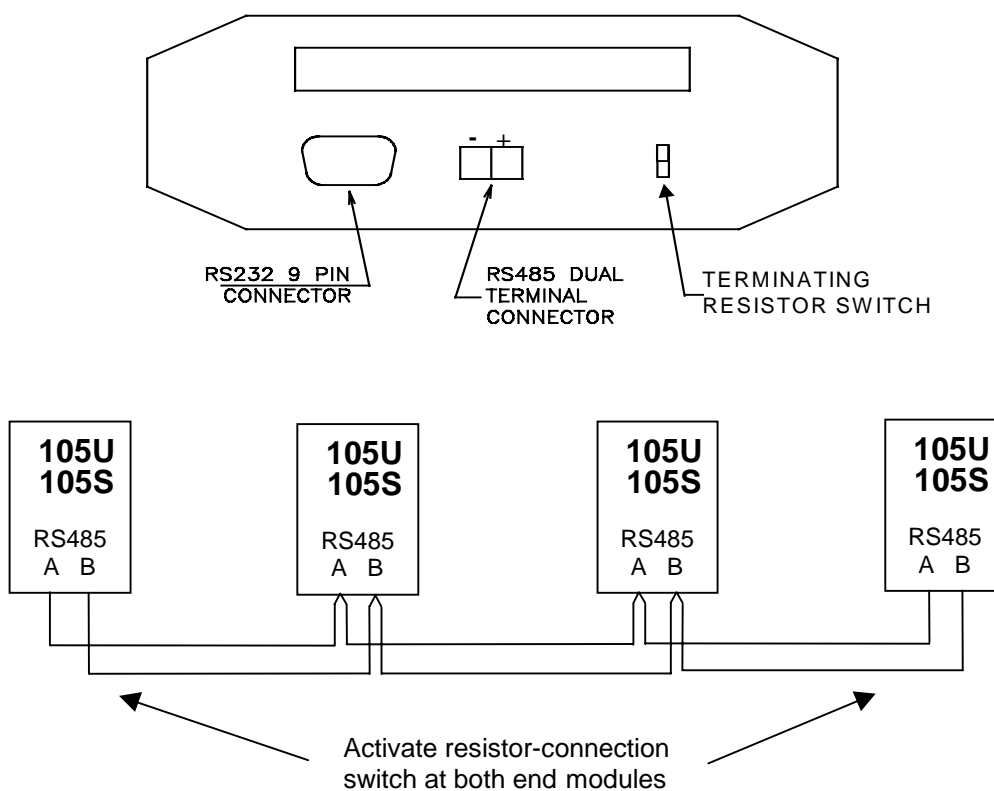
2.4.11 RS485 Serial Port

The RS485 port provides for communication between multiple 105 units using a multi-drop cable. Up to 32 units may be connected in each multi-drop network. Each multi-drop network may have one unit providing radio communications with other units in the system. The RS485 feature allows local hubs of control to operate without occupying radio bandwidth required for communication between remotely sited units.

The RS485 Communications format is 9600 baud, 8 data bits, one stop bit, no parity. Note that the RS485 port is shared internally with the RS232 port - disconnect the RS232 cable after configuration is complete.

RS485 is a balanced, differential standard but it is recommended that shielded, twisted pair cable be used to interconnect modules to reduce potential Radio Frequency Interference (RFI). An RS485 network should be wired as indicated in the diagram below and terminated at each end of the network with a 120 ohm resistor.

The 105U modules include a terminating resistor on-board. If the 105U module is the first or last module in the RS485 chain, then the terminating resistor may be connected by operating the single DIP switch in the end-plate next to the RS485 terminals. “On” or “down” means that the resistor is connected. The 105S modules also have a switchable resistor.



2.4.12 Connecting 105S Modules to 105U Modules

105S modules connect to a 105U via the RS485 port on each module - refer to section 2.4.11. Up to 31 x 105S modules can be connected to a 105U module. This number is reduced for 105S-3 and -4 modules, as these modules use two unit addresses (refer to chapter 4 of this manual).

The 105S modules can be mounted next to the 105U module, or they can be remote from the 105U. The reliable distance for a RS485 multi-drop line depends on the shielding of the wire and how close it is installed to electrical noise sources - distances of more than 1 km can be achieved by good installation methods. External RS485 isolators are recommended if the earth potential difference between modules is greater than 7V.

Chapter Three

OPERATION

3.1 Power-up and Normal Operation

When power is initially connected to the 105 module, the module will perform internal diagnostics to check its functions. The following table details the status of the indicating LED's on the front panel under **normal** operating conditions.

LED Indicator	Condition	Meaning
OK	On	Normal Operation
RX	Occasional flash	Radio Receiving, or Activity on serial ports
RX	Flashes continuously	Configuration Mode
RX	On	Button press when entering Configuration Mode
TX (only on 105U units)	Occasional flash	Radio Transmitting
PWR	On	Supply voltage available from Solar Panel or SUP1/SUP2
OK	Flashes every 5 seconds	+24V Supply overloaded

Additional LED's provide indication of the status of digital inputs and outputs. LED's display the status of each digital input (lit for active), and LED's display the status of each digital output (lit for active). Other conditions indicating a fault are described in Chapter Six **Troubleshooting**.

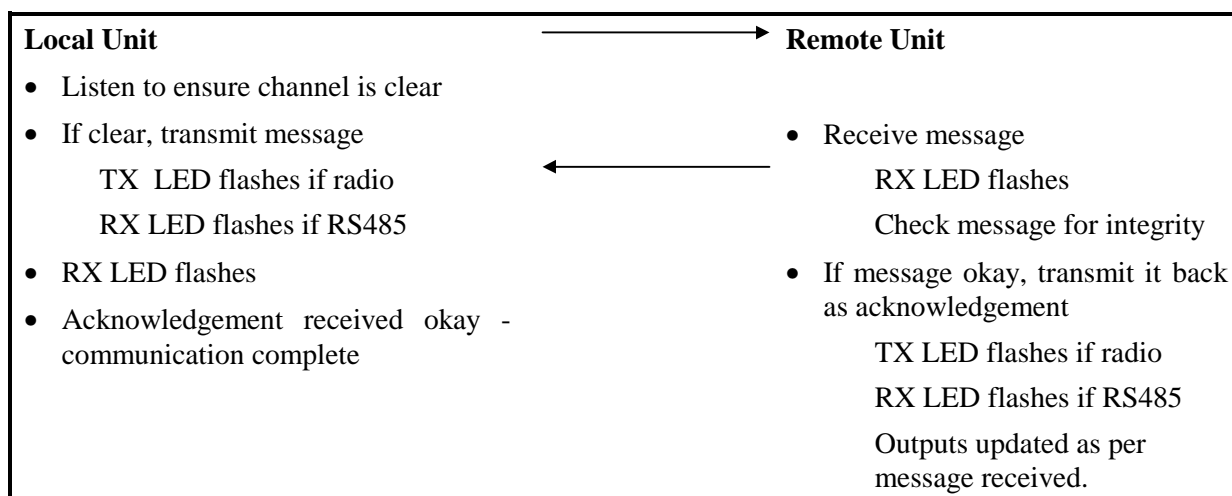
The 105 module monitors the power supply and provides status of supply failure and battery low voltage for "mapping" to one of the module's own outputs or transmitting to a remote output. When the 105 module is powered from a normal supply (i.e. via either of the "SUP" terminals), the *PWR* LED indicator is lit. When the 105 modules is powered from a solar panel and battery, the *PWR* LED indicator is lit only when the charge current is available (i.e. when the solar panel is receiving light). In the event of excessively low battery voltage (10.8V), the *OK* LED will go off, the unit will automatically set all outputs off, and disable the +24V analogue loop supply. the *OK* LED will turn on again after the battery voltage exceeds 11.3V. This enables installations to be configured so that the battery current drain is minimised in the event of extended mains failure, reducing the possibility of deep discharge of batteries.

3.1.1 Communications

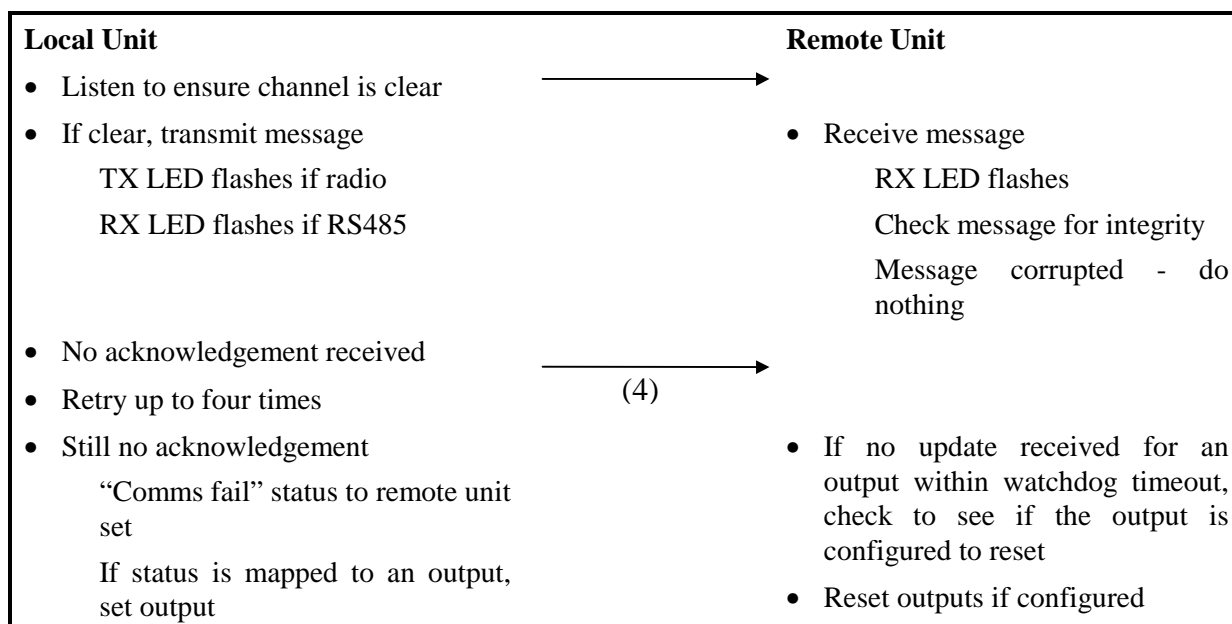
Before each transmission, the 105U radio will "listen-before-transmit" to make sure that another module is not already transmitting - if there is another transmission, the 105U will wait until the transmission is complete. When the 105U transmits, it will wait one second

for a return “acknowledgement” message from the destination module, indicating a successful message. If transmissions are not successful, then the 105 module will re-try up to four times at random intervals to transmit the message. If communications is still not successful, the “Comms Fail” internal status will be set. In the default configuration, this will have no consequence and the 105 module will continue to attempt to transmit to the remote module every ten minutes. For critical applications, this status can be configured to be reflected to an output on the module for alert purposes. The outputs on the module may also be configured to reset after a specified timeout (digital outputs reset to “off”, analogue outputs reset to 0 mA) allowing the system to turn off in a controlled manner e.g. a pump will never be left running because of a system failure.

Example of Successful Communications



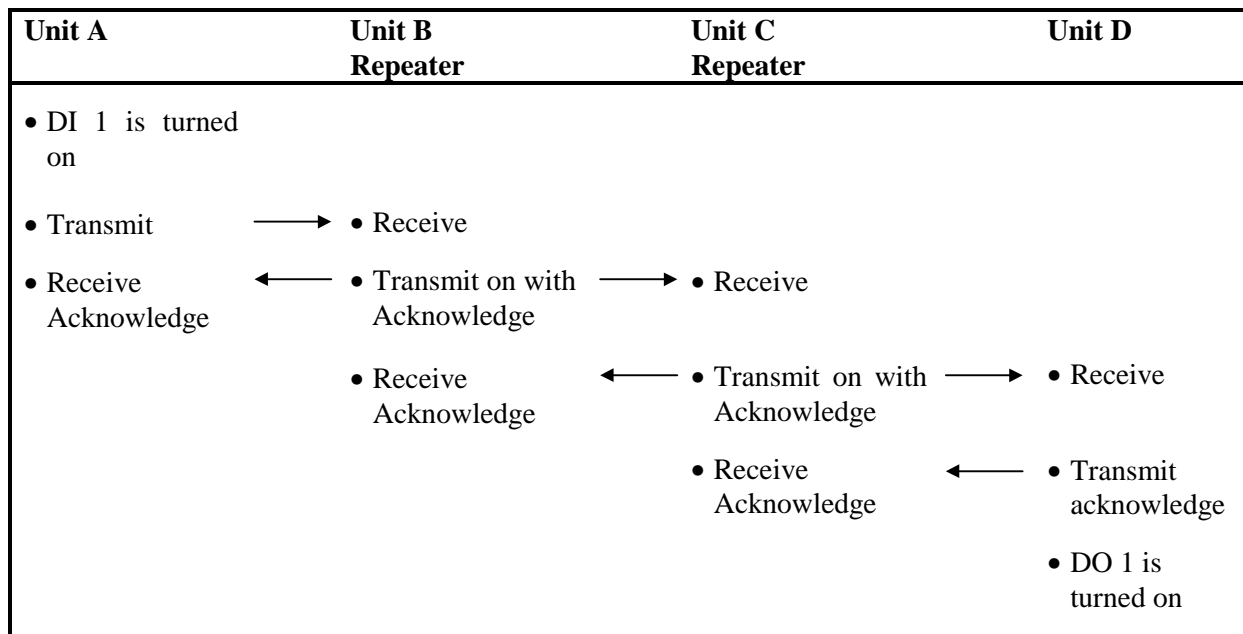
Example of unsuccessful communications



Repeaters can be used in a system to increase range. Each 105U unit can be configured to act as a repeater. When configuring an input to be mapped to an output, the communications path to the output unit, including the repeater addresses is specified. The 105U acts as a *digital repeater*, that is, the signal is decoded and then retransmitted “as new”.

Example Repeater Communications

Unit A DI 1 mapped to Unit D DO1 via Units B & C



3.1.2 Change of state conditions

The 105 module transmits a data message whenever it detects a "change-of-state" on one of its input signals. A "change-of-state" of a digital or digital internal input is a change from "off" to "on" or vice-versa provided the change is sustained for 0.5 second (i.e. 0.5 second debounce). The debounce delay is configurable.

In addition to "change-of-state" transmissions, each module will transmit the status of each input to its corresponding output every ten minutes (configurable). These **updates** mean that the outputs are set to the current input values regularly, even where no “change-of-state” has occurred. These update transmissions increase the accuracy of the output and give extra system reliability. Update times can be configured from 10 seconds to 16 minutes on the 105-1, -2 and -3 modules, and from 10 seconds to 5 days on the 105-4. Note that the accuracy of the time period is approx 0.5%.

Analogue Change-of-state

A "change-of-state" for an analogue input, battery voltage or pulse input rate is a change in value of the signal of 3% (configurable) since the last transmission. Note that the sensitivity of 3% refers to 3% of the analogue range, not 3% of the instantaneous analogue value. That is, if an analogue input changes from 64% (14.24 mA) to 67% (14.72 mA), a "change-of-state" will be detected. This “change-of-state” sensitivity is configurable between 0.8% and 50%.

Analogue inputs are digitally filtered to prevent multiple transmissions on continually varying

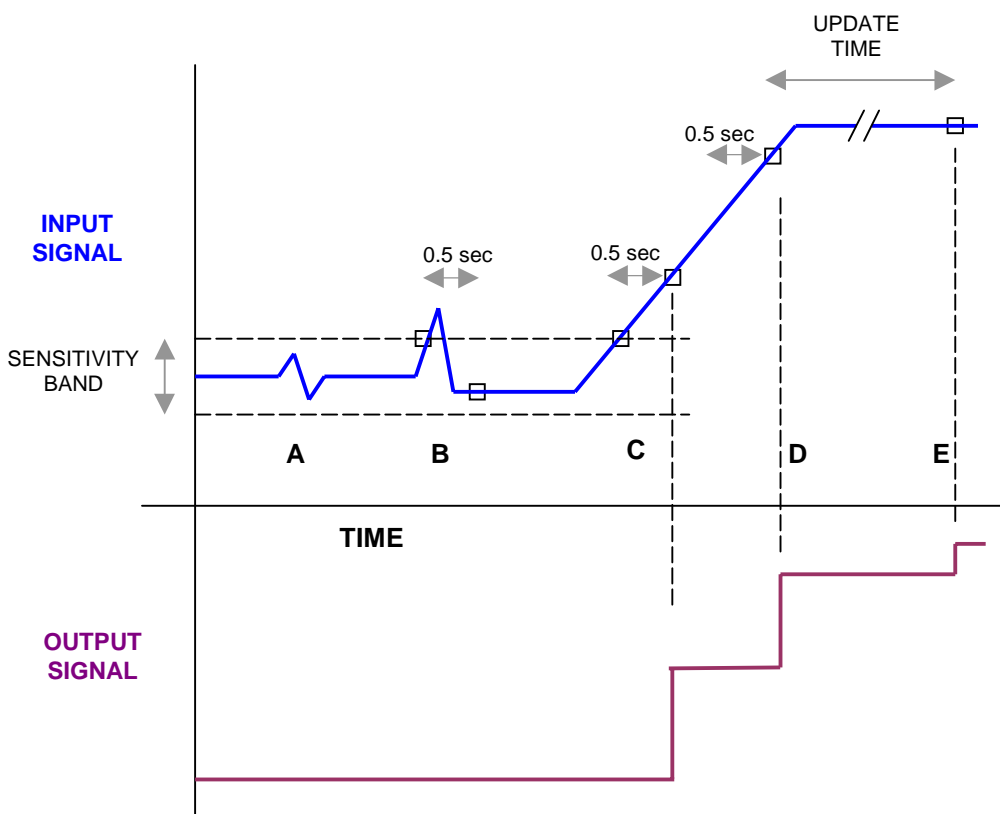
or "noisy" signals. The input is filtered with a 1 second time constant and a 1 second debounce. The analogue outputs are filtered with a 1 second time constant. An example explaining the interaction of these figures is shown below. In general, the following may be used as a rule of thumb for calculating the appropriate sensitivity required for a given application:

Instantaneous change of 2 x sensitivity on input → 3 second output response

Instantaneous change of 10 x sensitivity on input → 5 second output response

The analogue inputs have 15 bit resolution and 0.016mA accuracy.

An **example** of an **analogue** input and how the output follows it is shown below:



- A No transmission as the sensitivity band was not exceeded
- B The sensitivity band was exceeded, however the input returned to within the sensitivity band before the 0.5 sec debounce time - no transmission
- C Transmission occurs 0.5 sec after the sensitivity band is exceeded.
- D Another transmission 0.5 sec later as the input has changed by more than the sensitivity band
- E The input has not changed by more than the sensitivity, however the update time has elapsed since D.

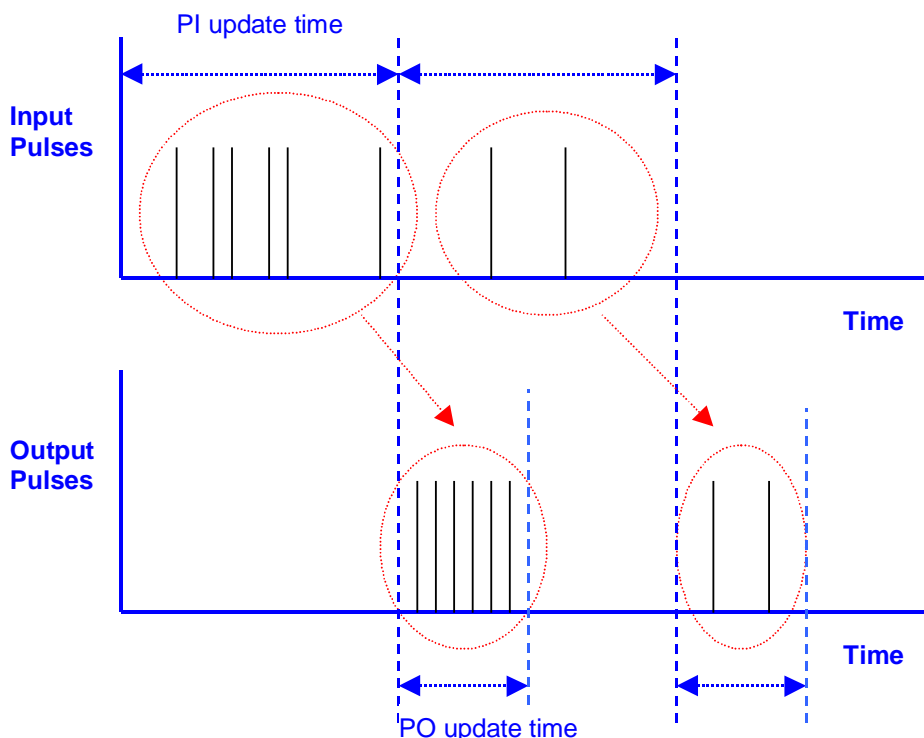
Pulse input change of state

Pulse input counts do not use “change-of-state” transmissions. Instead, accumulated pulse input counts are transmitted at set intervals. The default period is 1 minute and is

configurable. The absolute pulse count is transmitted. If the PI is transmitted to a PO on a 105 module, then the pulse outputs are re-created from the *accumulated* pulse count. Rollovers of the pulse count through zero are catered for. If a transmission is missed, the pulse output will still be re-created when the next accumulated value is transmitted. This ensures that no pulses are lost due to communications failures. If the PI is transmitted to a 105U-C interface module, then the accumulated pulse count is stored in the 105U-C for interfacing to the host device.

The following diagram shows how pulse inputs are re-created as pulse outputs. For pulse outputs, the 105 module keeps two counters in memory - the pulse input count received from the remote 105 module, and the count of output pulses. When the 105 receives an update of the input pulse count, it will output pulses until the output pulse count is the same as the input pulse count. The output pulse will be output evenly over the pulse output update time which is configured in the module. For example, assume that 105 module receives a pulse input update message from the remote 105 module, and the difference between the pulse input count and the pulse output count is 12 pulses. The 105 will then output the 12 pulses evenly over the next minute (if the pulse output update time is 1 minute).

The default values for the pulse input update time and pulse output update time is 1 minute. In this case, the output pulses are effectively 1 minute behind the input pulses. These update times may be changed by the user. The pulse output update time should not be set to be more than the pulse input update time. Note that the maximum pulse rate for both inputs and outputs is 100Hz.



As well as accumulating the pulse input, the 105 module will also calculate the rate of pulses. **Pulse rates** are treated as an “internal” analogue input and are configured with analogue sensitivities for change-of-state transmissions. The maximum pulse rate

corresponding to 20mA output may be configured by the user.

3.1.3 Analogue Set-points

On 105-1 modules, the “AI 1” input may be used to trigger the analogue set-point status. High set point and low set point levels are configurable. This set-point status turns ON when the analogue input moves below the low level, and turns OFF when it moves above the high level. The high level must always be greater than, or equal to, the low level set point. This set-point status may be mapped (inverted, if required) to any output in the network. The set-point status is effectively an internal digital input.

On 105-2 modules, analogue inputs 1 - 4 have set-point values for controlling digital outputs. The set-point operation works as for the 105-1 module.

3.1.4 Start-up Poll

After a 105 module has completed its initial diagnostics following power up, it will transmit update messages to remote modules based on the values of the module’s inputs. The module’s outputs will remain in the reset/off/zero condition until it receives update or “change-of-state” messages from the remote modules.

The 105 module can transmit a special “start-up poll” message to another module. The remote module will then immediately send update messages to this module such that its outputs can be set to the correct value. Start-up polls will only occur if they are configured. It is necessary to configure a start-up poll to each remote module which controls the module’s outputs. For further information, refer to Chapter 4 **Configuration**.

3.1.5 Communications Failure (CF)

The internal communications failure (CF) status is set if a module does not receive an acknowledgement message after five attempts at transmitting a message. The CF status may be configured to set a local digital output for an external alarm.

Although the CF status can set an output, it will not reset the output. That is, once communications is re-established (and the CF status is reset), the output will stay “on”. The Reset Output feature (see below) is used to reset the output.

The output will reset only when no communications failures occur within the configured “Reset Output Time” for the output that CF status is mapped to. Note that if the reset output time is not enabled, the CF status will remain set forever, once an unsuccessful transmission occurs. See Chapter 4 **Configuration** for further details.

3.1.6 Resetting Outputs

Each digital and analogue output may be individually configured to reset if that output has not received a change-of-state or an update message within a certain time period. Generally this time is set to twice the update period, so at least one update can be missed before an output is reset.

In most cases it is desirable to reset outputs which are controlling equipment if there is a system failure, however alarm or indication outputs are not reset so the last valid indication remains shown. See Chapter 4 **Configuration** for further details.

3.2

System Design Tips

The following tips will help to ensure that your system operates reliably.

3.2.1 System Dynamics

It is important to be aware of the dynamics of the system. Inputs have a configurable “debounce” delay (default 0.5 sec) - that is, a change message will not be sent for 0.5 sec after a change has occurred. This avoids transmitting spurious noise on the input signal. If you require faster (or slower) operation, change the debounce setting.

Messages transmitted via serial link are received in less than 20 msec, however a message sent by radio takes approx 60 msec.

These delays are not significant in most applications, however if your application requires faster responses, then the above delays need to be considered.

3.2.2 Radio Channel Capacity

Messages sent on a cable link are much faster than on a radio channel, and the capacity of the radio channel must be considered when designing a system. This becomes more important as the I/O size of a system increases.

The 105 modules are designed to provide “real-time” operation. When an input signal changes, a change message is sent to change the output. The system does not require continuous messages to provide fast operation (as in a polling system). Update messages are intended to check the integrity of the system, not to provide fast operation. Update times should be selected based on this principle. The default update time is 10 minutes - we recommend that you leave these times as 10 minutes unless particular inputs are very important and deserve a smaller update time.

It is important that radio paths be reliable. For large systems, we recommend a maximum average radio channel density of 100 messages per minute, including change messages and update messages. We suggest that you do not design for an average transmission rate of greater than 40 per minute - this will give a peak rate of approx 100 per minute. Note that this peak rate assumes that all radio paths are reliable - poor radio paths will require re-try transmissions and will reduce the peak channel density. If there are other users on the radio channel, then this peak figure will also decrease.

The 105 modules will only transmit one message at a time. If re-tries are necessary, another message cannot start. The time between re-tries is a random time between 1 and 5 seconds. The time for five tries is between 5 and 21 seconds. Another message cannot be sent until the last one has finished. This delay will obviously have an effect on a busy system.

3.2.3 Radio Path Reliability

Radio paths over short distances can operate reliably with a large amount of obstruction in the path. As the path distance increases, the amount of obstruction which can be tolerated decreases. At the maximum reliable distance, “line-of-sight” is required for reliable operation. If the path is over several kilometres (or miles), then the curvature of the earth is

also an obstacle and must be allowed for. For example, the earth curvature over 10 km is approx 4m, requiring each antenna to be elevated at least 5m to achieve “line-of-sight” even if the path is flat.

A radio path may act reliably in good weather, but poorly in bad weather - this is called a “marginal” radio path. If the radio path is more than 20% of the maximum reliable distance (see Specification section for these distances), we recommend that you test the radio path before installation. Each 105U module has a radio path testing feature - refer to section 6.2 and 6.3 of this manual.

There are several ways of improving a marginal path :-

- Relocate the antenna to a better position. If there is an obvious obstruction causing the problem, then locating the antenna to the side or higher will improve the path. If the radio path has a large distance, then increasing the height of the antenna will improve the path.
- Use an antenna with a higher gain. Before you do this, make sure that the radiated power from the new antenna is still within the regulations of your country. If you have a long length of coaxial cable, you can use a higher gain antenna to cancel the losses in the coaxial cable.
- If it is not practical to improve a marginal path, then the last method is to use another module as a repeater. A repeater does not have to be between the two modules (although often it is). If possible, use an existing module in the system which has good radio path to both modules. The repeater module can be to the side of the two modules, or even behind one of the modules, if the repeater module is installed at a high location (for example, a tower or mast). Repeater modules can have their own I/O and act as a “normal” 105U module in the system.

3.2.4 Design for Failures

All well designed systems consider system failure. I/O systems operating on a wire link will fail eventually, and a radio system is the same. Failures could be short-term (interference on the radio channel or power supply failure) or long-term (equipment failure).

The 105 modules provide the following features for system failure :-

- Outputs can reset if they do not receive a message within a configured time. If an output should receive an update or change message every 10 minutes, and it has not received a message within this time, then some form of failure is likely. If the output is controlling some machinery, then it is good design to switch off this equipment until communications has been re-established.

The 105 modules provide a “drop outputs on comms fail” time. This is a configurable time value for each output. If a message has not been received for this output within this time, then the output will reset (off, in-active, “0”). We suggest that this reset time be a little more than twice the update time of the input. It is possible to miss one update message because of short-term radio interference, however if two successive update messages are missed, then long term failure is likely and the output should be reset. For example, if the input update time is 3 minutes, set the output reset time to 7 minutes.

- A 105 module can provide an output which activates on communication failure to another

module. This can be used to provide an external alarm that there is a system fault.

3.2.5 Indicating a Communications Problem

There are two ways to provide an indication of communications problems.

Fail to transmit alarm. The first is to map the internal CF status to a local output, to generate a “fail-to-transmit” alarm. The configured output will activate when a comms fail occurs - that is, when the module attempts to transmit a message five times without an acknowledgement. This method provides an indication immediately an attempt to transmit a message fails. If you want the radio path to be “tested” regularly, then you need to configure the update times such that transmissions occur regularly (however do not overload the radio channel).

Notes regarding this method:

1. Each CF mapping corresponds to only one remote address - you need to make separate mappings for each remote address. You can map the CF for each remote module to a separate output, or to the same output.
2. You need to reset the comms fail output using the “reset output” parameter. Select a reset time which is greater than the effective update time period. For example, if there are four inputs mapped from module #1 to module #2, each with a 10 minute update, then you would expect at least four transmissions in each 10 minute period. At module #1, a comms fail for #2 is mapped to DO1. If you set the “reset time” for DO1 to 10 minutes, then there will be at least four transmissions made during the reset period - that is, the output will only reset when the communications has been successful four times.
3. This method will not work for radio links with repeaters. If a repeater is used, you will need to use the second method described below.

Fail to receive alarm. The second method is to set up a “comms OK” output using the “Reset Outputs” function. The output is normally on, indicating “comms OK”, and will reset if the module does not receive a message from the remote module within the configured reset time.

Consider a link between module #1 and #2, and assume that you want a “comms OK” output at #1. At #2, map an unused input to an output at #1 such that the output is normally active (‘on’). If there is no spare inputs at #2, you can use an internal input such as “low voltage status”. You will need to invert the mappings such that the output is normally on (because the input is normally off).

At #1, configure a reset time for the output. The reset time should be greater than the update time for the mapping at #2. If #1 fails to receive update messages from #2, then the output will reset, indicating a communications failure. Notes regarding this method:

1. This method will work with repeaters in the link.
2. The “comms OK” output is fail-safe - if module #1 fails, then the output will reset indicating a problem.
3. You should use separate outputs to indicate “comms OK” of different remote modules.
4. It is recommended that you set the reset time at #1 to more than twice the update time of

the mapping at #2. This means that the comms OK output will only reset if #1 misses two consecutive updates from #2.

3.2.6 Testing and Commissioning

We recommend that you set-up and test the system with all of the modules together **before** you install the modules. It is much easier to find a configuration problem.

When the system is configured, record the radio signal strength and background noise level for each radio link. If there are future communications problems, you can compare the present measurements to the as-commissioned values.

3.3 Security Considerations

There are three dimensions of security considerations:

1. Failure to operate when required - or “operational reliability”.

The features discussed above optimise operating reliability. Using an acknowledgement and re-try protocol ensures that the transmitting module is aware whether the transmitted message has been transmitted reliably. The “fail to transmit” and “fail to receive” alarms provide indication if the radio link has failed to operate.

2. Mal-operation, or operating when not requested.

This problem occurs when an output is “triggered” by the wrong radio device. The 905U modules use frequency encoding and a very secure addressing system to ensure this does not occur. An additional security level using data encryption can also be selected.

3. Malicious operation, or “hacking”

This is the problem most associated with security concerns - the ability for someone to access information from a radio system by “listening-in”, or to cause damage by transmitting radio messages to force outputs.

A security option can be selected during the module configuration to protect against this. The security option (if selected) adds data encryption to radio messages. Modules in the same system are automatically configured with the encryption key, such that only these modules can understand each other. “Foreign” modules will hear the messages, but cannot decrypt the messages. For more information, refer to section 4.3.7.

Chapter Four

CONFIGURATION

4.1

Introduction

The 105 modules are configured by connecting a computer (PC) using the 105 Configuration Software programme. The same software program is used to configure 105U-C and 105U-G modules - for more information, refer to the separate User Manuals.

Each 105 module is configured with a system address and a unit address. The system address is common to every module in the same system, and is used to prevent "cross-talk" between modules in different systems. Separate networks with different system addresses may operate independently in the same area without affecting each other. The system address may be any number between 1 and 32 767. The actual value of the system address is not important, provided all modules in the same system have the same system address value. **A system address of zero should not be used.** The configuration program automatically offers a random number for the system address - you can change this to any number in the valid range but we recommend that you use the random number.

Each module must have a unique unit address within the one system. A valid unit address is 1 to 127. A network may have up to 95 individual modules communicating via radio (unit addresses 1 to 95), each with up to 31 modules communicating via RS485 (unit addresses 96 to 127). In the network, any individual input signal may be "mapped" to one or more outputs anywhere in the system. The unit address determines the method of communication to a module. Any module with a unit address between 96 and 127 will communicate by RS485 only. Other units with a unit address below 95 may communicate by radio *or* RS485 - the unit will determine which way to communicate depending upon the unit address of the destination module. For example, Unit 31 will talk to Unit 97 by RS485 only, but will talk to unit 59 by radio only. 105S units must always have a unit address between 96 and 127 as serial communication is the only method of communication available. **A unit address of zero should not be used.**

The four different products in the range can be used together in the same system, as well as 105U-C and -G modules. Inputs to one product type can be transmitted to outputs of another product type. For example, an analogue input to a 105-2 may be transmitted to an analogue output of a 105-1 or 105-3. Repeaters may be any product type.

The 105-1 and 105-2 modules require only one unit address. The 105-3 and 105-4 modules use two addresses, however only one unit address has to be entered. The 105-3 and 105-4 modules require two addresses because of the large number of output channels. If the "entered" unit address is an even number, then the second address is the next number. If the "entered" address is an odd number, then the second address is the previous number. So the two addresses are two subsequent numbers, starting with an even number. If a 105-3 module is given a unit address of 10, then it will also take up the unit address 11 and will accept messages addressed to either 10 or 11. It is important to remember this when allocating unit addresses to other modules in the system.

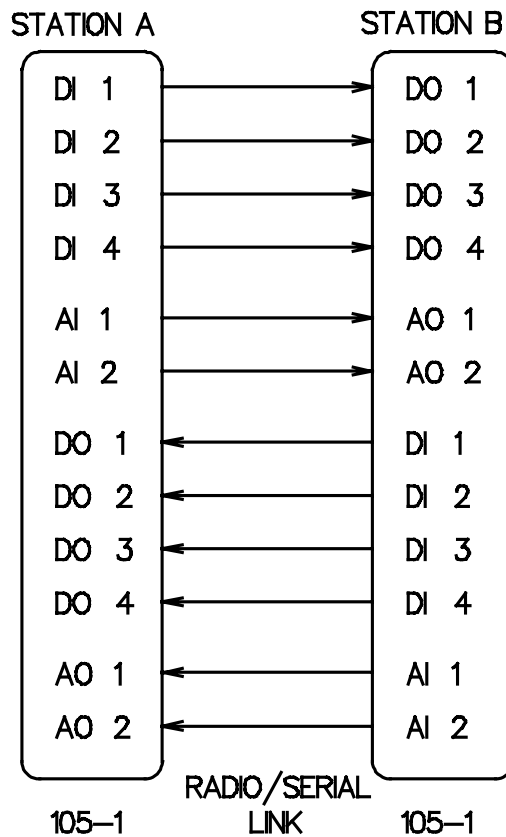
Warning - do not allocate the address number 1 to a 105-3 or 105-4.

In addition to these network configurations, operational parameters called **User Options** may be configured to change the features of the 105 operation.

4.2 Easy Configuration Using Default Settings

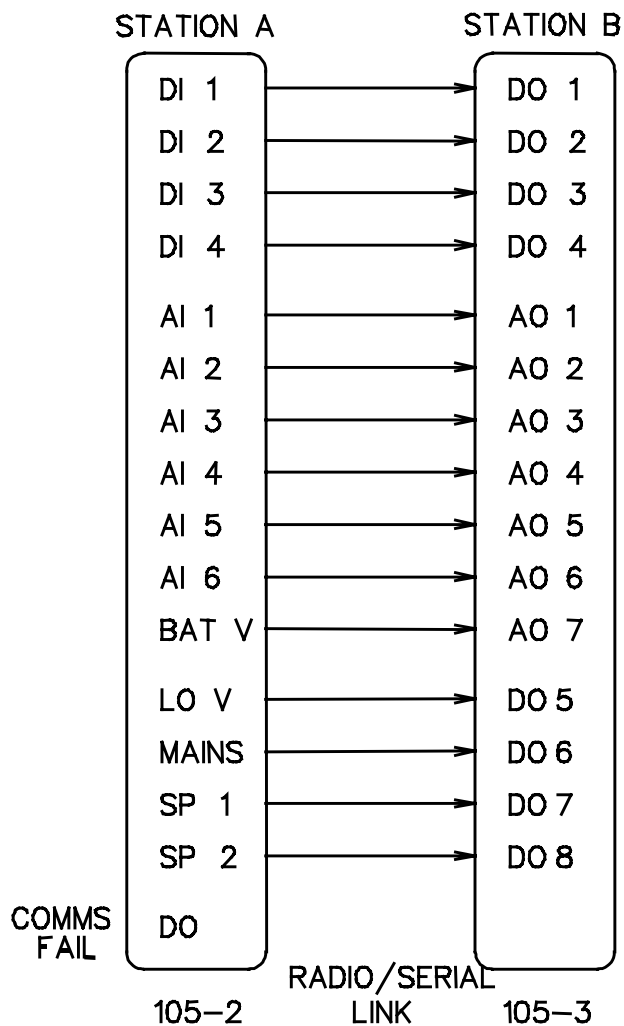
If your application requires only a single pair of 105 modules, communicating via radio or serial link, default settings may satisfy your needs. If so, no configuration is required. Essentially, all inputs at Module A are reflected at the corresponding outputs at Module B. All inputs at Module B are reflected at the corresponding outputs at Module A.

For **105-1** modules, the default configuration is as follows :-



In this configuration, the “PO” Pulse output is inactive and no special action is taken on “Comms fail”, “Mains fail” or “Battery Low”. “DI 1” is configured as a digital and not a pulse input.

For 105-2 and 105-3 modules, the default configuration is as follows :-



The following table details the default values for **User Options**:

Option	Factory Set Value
Update transmissions	Every 10 minutes
Analogue Change-of-state sensitivity	3%
Reset outputs on Comms fail	No
Analogue Setpoints (if mapped)	Low Set point = 30% High Set point = 75%
Pulse Output Rate Scaling (if Pulse Rate is mapped)	100 Hz
Digital Input Debounce Time	0.5 seconds

If any of the above values are not appropriate to your system, Section 4.4 below will detail how to change one or all of the above variables.

4.3 105 Configuration Software

This chapter describes installation and operation of configuration software for the 105 radio and serial telemetry modules. The configuration software runs on a conventional PC as a Windows application. The software creates a configuration file which can be loaded into a 105 module via RS232. The configuration software also allows the configuration of a 105 module to be loaded for display and modification. Configuration files are created and stored in project directories.

Configuration of 105 modules consists of entering I/O mappings, and selecting User Options. An I/O mapping is a link between an input on the module being configured and an output on another module. A mapping has the form :-

DI3 → Out2 at 4 via 3, 11

This mapping links DI3 on this module to output channel 2 on the module with address 4, and modules 3 and 11 are repeaters.

User Options may be selected to change the configuration of specific features.

Mappings configured to a 105U-G have the form :-

AI2 → I/O Reg 1036 at 10 via 7

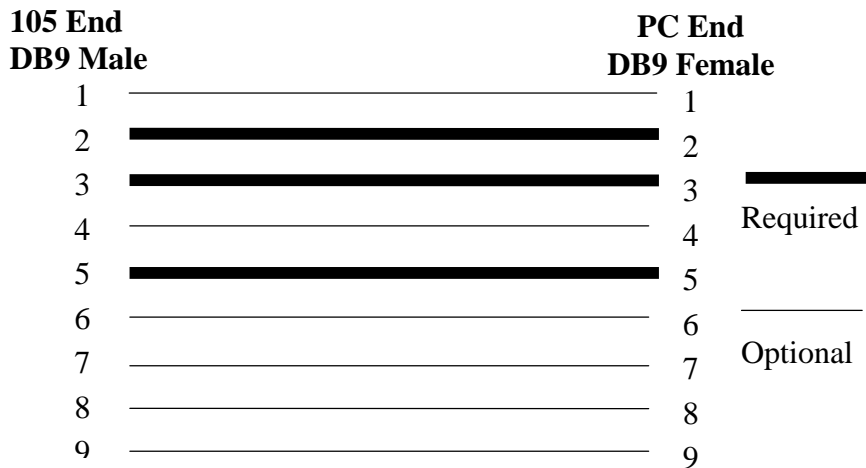
This mapping links AI2 on a 105 module to I/O Register 1036 in a 105U-G with address 10. Module #7 is used as a repeater. The host device connected to the 105U-G can read the I/O register.

Note: Every module must have at least one mapping configured to another module. If no mappings are required (for example, you are only using outputs at a module), then you need to configure a mapping for a spare input to an unused output on another module.

4.3.1 Hardware and Software Requirements

The configuration software is available on a CD, and needs to be installed on your PC before you can use it. The CD

contains a setup file called *setup.exe*. Select the configuration software window on the Product CD and an installation Wizard will guide you through the installation procedure. To upload and download configuration files to a module, you will need a RS-232 serial cable as



shown below.

4.3.2 Programme Operation

Start the software by either clicking on the start bar and navigating to the Configuration menu or by running ESERIES.EXE

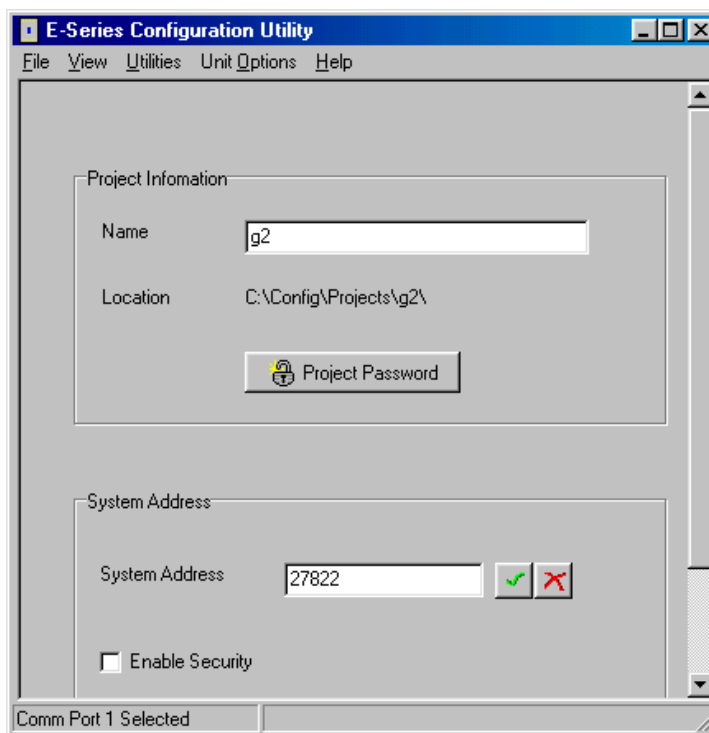
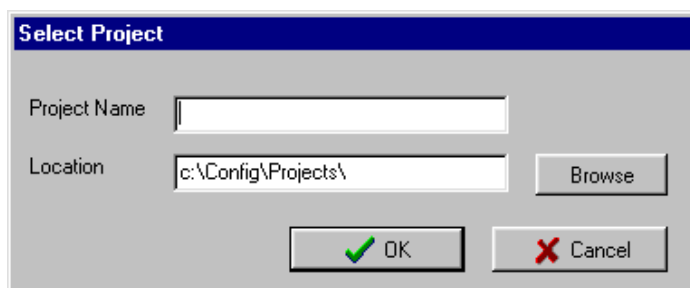
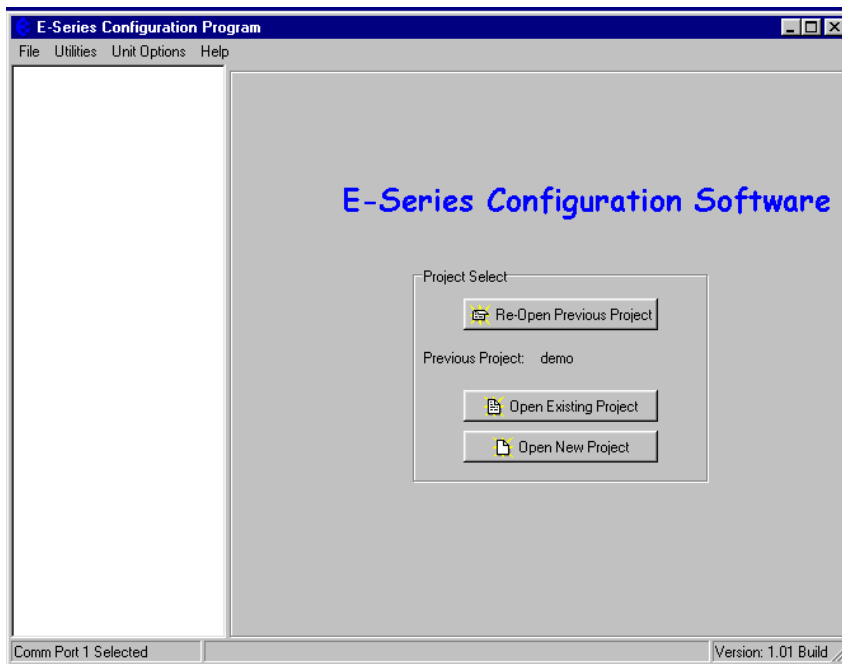
The Initial screen will appear. The configuration is performed for a complete system. The necessary configuration stages are :

- select system name and system address
- select individual units and unit addresses
- configure I/O mappings for each unit
- configure user options for each unit
- compile the system, which generates configuration files for each unit
- load the configuration files into each unit.

From the initial screen, you can select an existing project, or start a new project. The name of the project will create a new directory which will eventually contain the configuration files for the modules in this system.

When you have selected the project, a screen will appear where you may enter the system address.

If you are editing an existing project, the system address will already have been entered. Do not change the system address unless you are going to re-programme all of



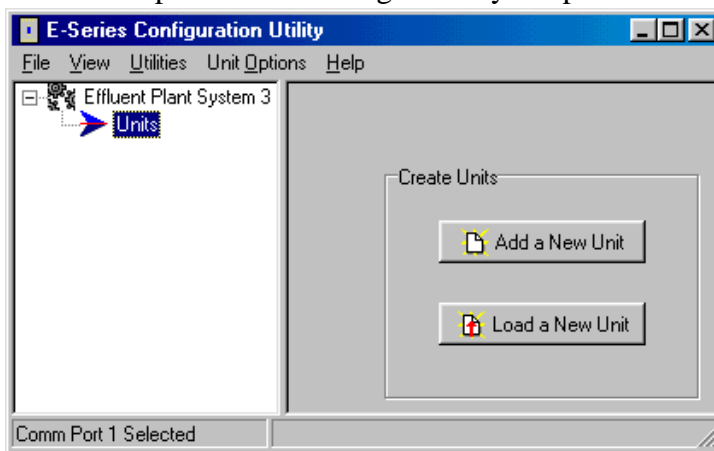
the modules in the system.

Password. You have the option of entering a password to protect the configuration files against unauthorized changes. When you open a new project, you will be asked to enter a password - if you do not enter any text - that is, press “ESC” or “Enter”, then password protection is disabled. If you do enter a password, then you will need to enter this password to make changes to the configuration or download or upload configuration. You only need to enter the password each time you enter the project. Without the password, you are able to view the configuration details but you cannot make changes.

The password can be between 6 and 256 characters. You can also change password by selecting this option from the “Utilities” menu.

If you are starting a new project, you have the option of “Enabling Security” - please read Section 4.3.7 and the associated warnings before using this option.

To proceed with the configuration, double-click on the project name on the menu on the left side of the screen. “Units” will appear. You can now enter the types of units which will be used in the system. If you double-click on “Units”, then the modules that have already been selected will appear.



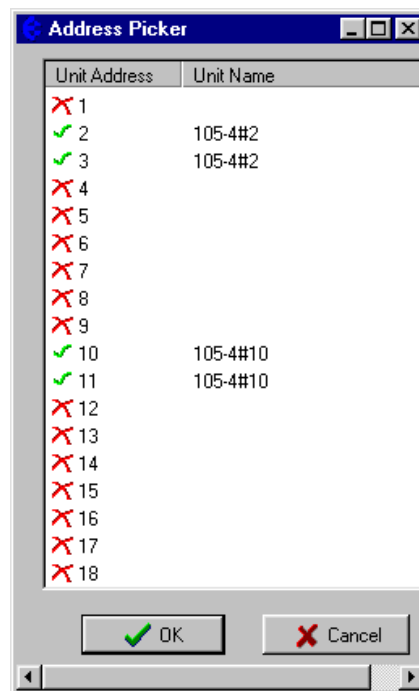
Loading configuration from an existing module

To load the configuration from a module, connect the module to the PC via the RS232 cable and click on “Load Unit”. This will allow you to view the module configuration, change it, or copy it for another module - refer to section 4.3.3 for more information.

Adding a new module to the system configuration

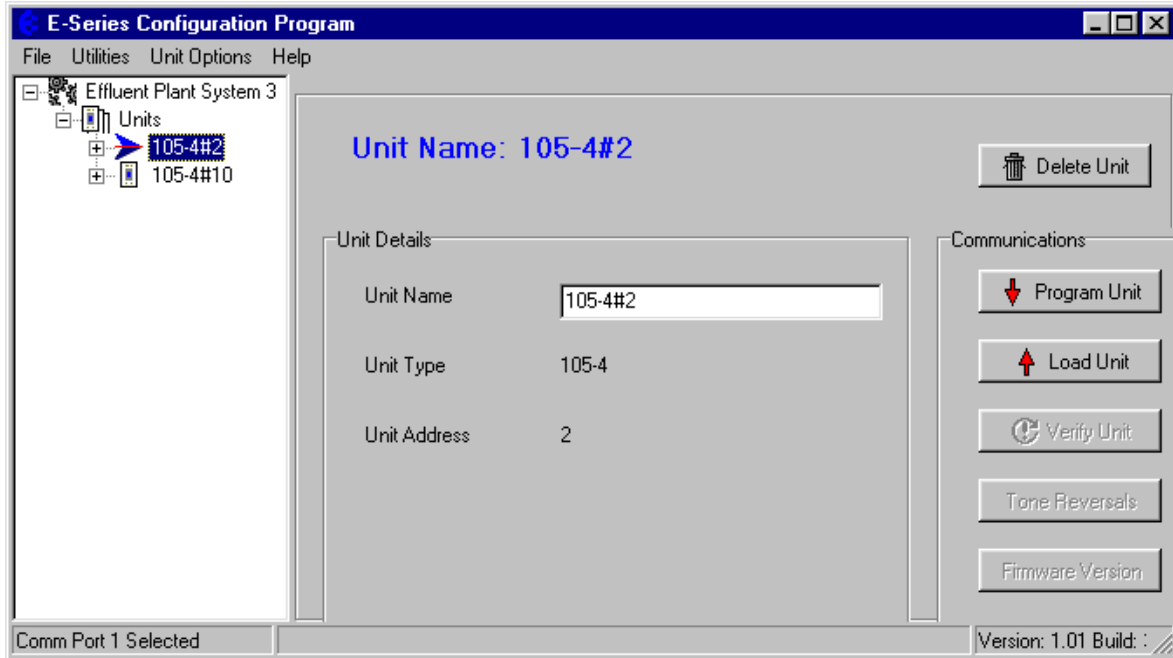
To add a new module to the system configuration, click on “Units” on the left-hand menu and then “Add Unit”. Select the type of module from the list. The programme will ask you to select the unit address. For 105U modules, select an address between 1 and 95. For 105S modules, select an address between 96 and 127.

The default name for a unit will include the unit address. For example, “105-4#8” is a 105-4 module with unit address 8 (and also 9, as a 105-4 takes two unit addresses). You can change the name of a unit - for example, you could replace the default name with “Pump Station 14”.



Deleting a Unit

A module can be deleted from the configuration by highlighting the unit and selecting “Delete Unit”.

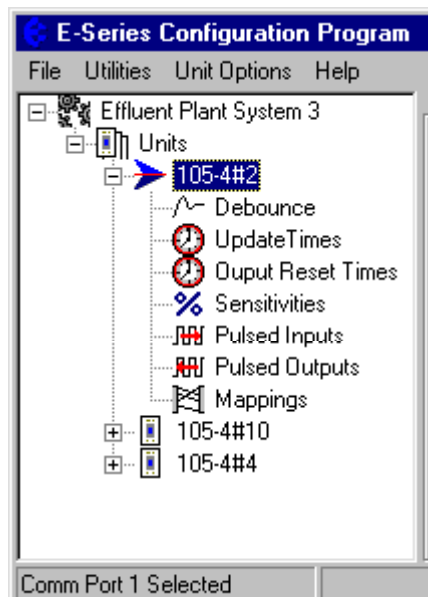


Configuring an individual module

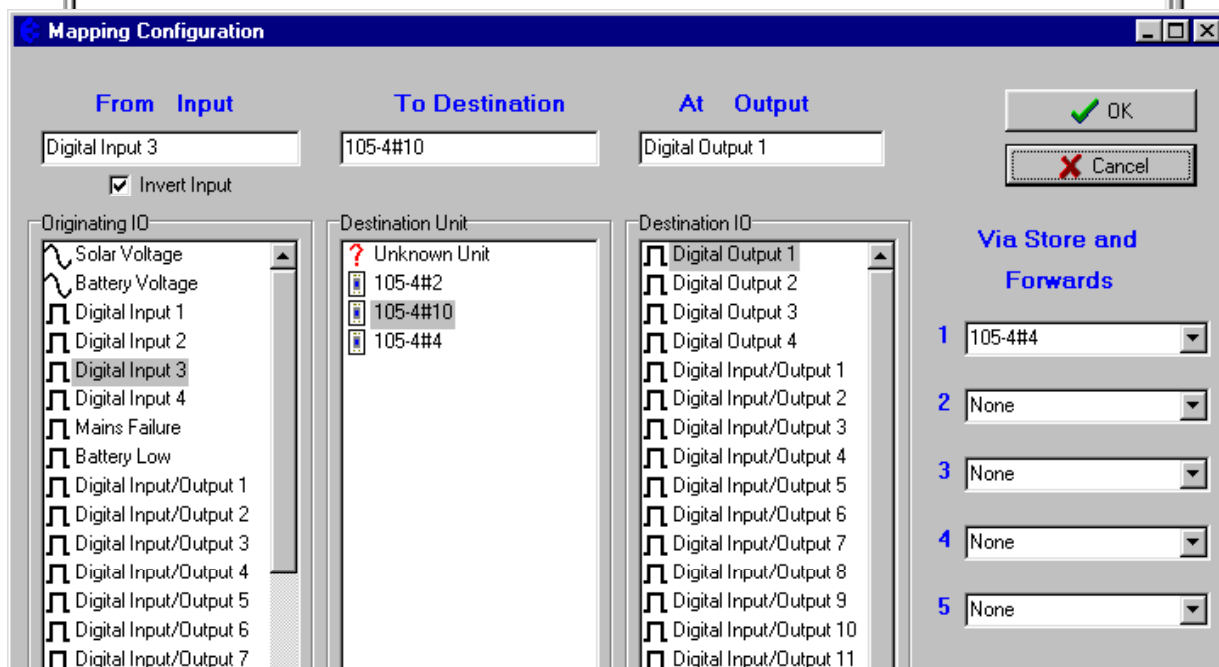
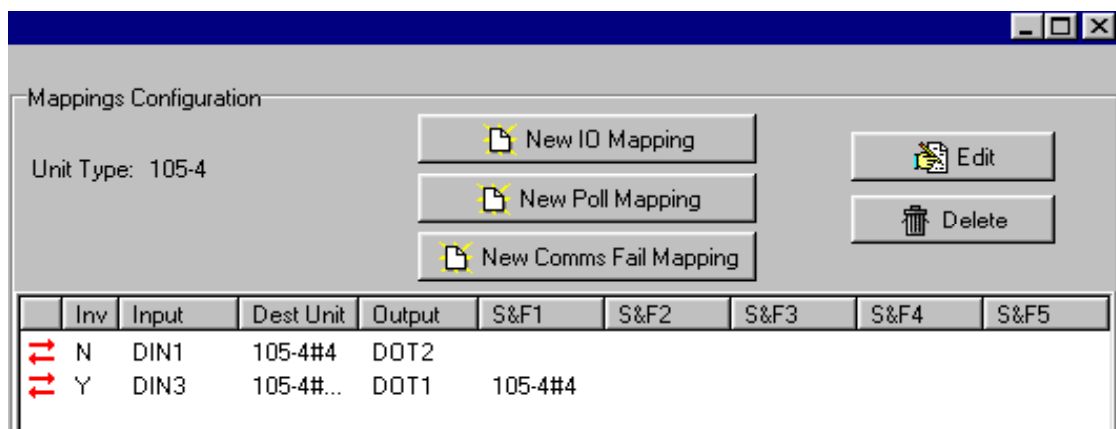
Double-click on a unit shown on the left-hand menu. The configuration options for each unit will appear. We recommend that you configure I/O mappings first, and then other options.

Select “Mappings” and the following screen appears. There are three types of mappings:

- I/O mappings which link inputs to outputs
- Poll mappings, which enables a module on start-up to request set its outputs quickly
- Comms Fail mappings, which maps communication failure status to an output on the local module.



I/O Mapping To enter an I/O mapping, select “New I/O Mapping”.



1. The I/O mapping display will show all inputs at the selected module - both physical inputs and internal inputs. Select the input to be mapped.
2. If you wish to invert the mapping, select the “Invert Input” box. If you invert an input, then the output will be the reverse of the input. Analogue I/O can also be reversed - 4mA will be 20mA etc. **Do not invert pulse inputs.**
3. The invert function is not available on 105-2 modules - only inverted digital inputs are available (as internal inputs on the input list).
4. To select the destination module, you can either select the module from the “Destination Unit” list, or enter the unit address in the “To Destination” box. You can enter an address that has not yet been allocated to another unit.
5. You can select the output by entering the output number (1 – 255) in the “output” box, or select an output from the displayed list. There will only be a list of possible outputs displayed if at step 2 you selected a destination unit that has already been configured in the system.

The output numbering for each module is:

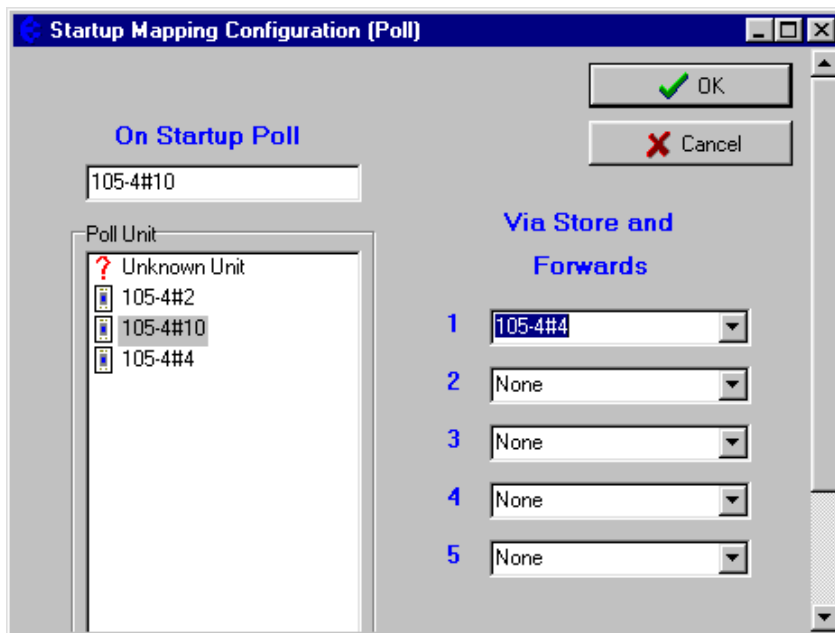
	105-1	105-2	105-3 First addr (Even)	105-3 Second addr (Odd)	105-4 First addr (Even)	105-4 Second addr (Odd)
Output 1	DO 1	DO 1	D/P O 1	AO 1	D/P O 1	DIO 5
Output 2	DO 2	None	D/P O 2	AO 2	D/P O 2	DIO 6
Output 3	DO 3	None	D/P O 3	AO 3	D/P O 3	DIO 7
Output 4	DO 4	None	D/P O 4	AO 4	D/P O 4	DIO 8
Output 5	AO 1	None	DO 5	AO 5	DIO 1	DIO 9
Output 6	AO 2	None	DO 6	AO 6	DIO 2	DIO 10
Output 7	PO	None	DO 7	AO 7	DIO 3	DIO 11
Output 8	None	None	DO 8	AO 8	DIO 4	DIO 12

6. If you select a 105U-C or –G as the destination module, you will be asked to select a I/O Register as the destination “output”. Note that the grey-shaded I/O registers have already been allocated.
7. Select any intermediate repeater units needed to reach the destination address (entered in order of nearest to furthest repeater). You can either select from the list of configured units or enter the unit address in the “Repeater” box. If no repeaters are required, do not enter anything in the repeater boxes. If only one repeater address is required, enter the address in box 1 and leave the other repeater boxes empty.

Note: Every module must have at least one mapping configured to another module. If no mappings are required (for example, you are only using outputs at a module), then you need to configure a mapping for a spare input to an unused output on another module.

It is possible to configure multiple mappings for an input - each mapping will generate separate transmissions. We recommend that you do not configure multiple mappings to the same output as the output will have the value of the last message that it receives. Each output should have only one mapped input.

It is possible to map a digital input to an analogue output - the output will be maximum value when the input is on and minimum value when the input is off. It is also possible to map an analogue input to a digital output - the output will be on when the input is equal or greater than 12mA and off when the input is less than 12mA.



For more information on using 105S modules, refer to Section 4.3.8.

Edit existing mappings

To edit an existing mapping, double-click on the mapping line, or select the mapping line and click “Edit”.

To delete an existing mapping

To delete a mapping, select the mapping and click “delete” or alternatively right-mouse button click and select delete.

Configuring Start-Up Polls

When a unit is first turned on, its outputs will not be set until it receives update messages from other units in the system. To ensure that outputs are set as soon as possible after start-up the unit may be configured to “Poll” any other units with mappings to its outputs.

Select the remote unit to be polled from the unit list, or enter the unit address in the box. If the remote unit communicates via repeaters, select the repeater units or enter the repeater addresses.

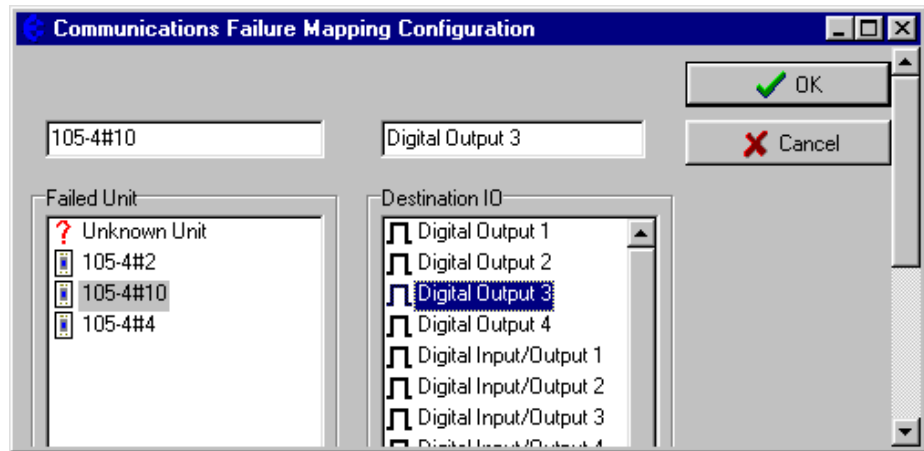
Remember that if more than one remote unit is controlling the local outputs, then more than one start-up poll should be configured.

Configuring Comms Fail Mappings

Each module has a “comms fail” status which may be mapped to a local output. The comms fail status is active (on) if the module is transmitting a message and does not receive an acknowledgement after five tries. By setting the comms fail status to a local output, you can

provide a communications alarm. The local output can be digital or analogue - if analogue, the output will go to maximum value.

Although communication failure will activate the output, successful comms does not reset the output. You must use the “Reset outputs on comms fail” option (Refer to User Options section).

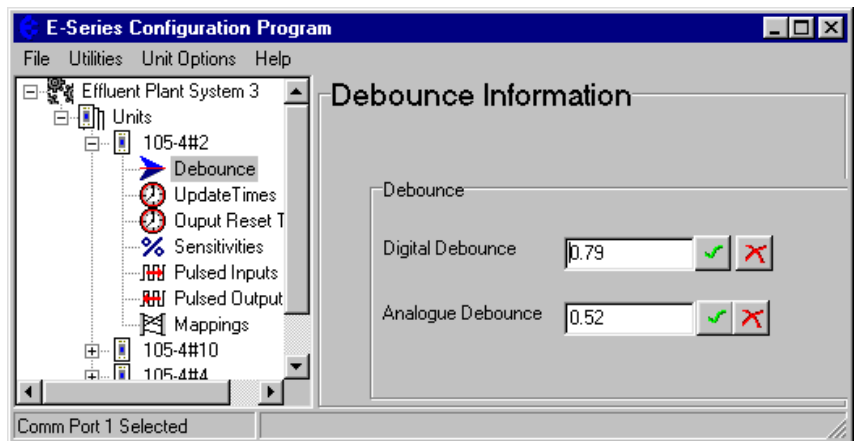


Each remote module has a separate comms fail status - you enter a separate comms fail mapping for different remote addresses. You can configure several comms fail mappings to the same output - the output will be active if there is comms fail to any of the remote addresses. You can also map a configure an output to activate upon any comms fail. Configuring a “Comms Fail Address” of zero causes communication failure to any destination module to be indicated on the selected output.

For example, if “Comms fail to unit 12” is configured to DO1, then the 105 module will set (or activate) DO1 each time communications to unit 12 is not successful. If DO1 has a “Reset output” time of 10 minutes configured for DO1, then DO1 will reset (de-activate) 10 minutes after the last comms fail to unit 12.

Debounce Configuration

Debounce is the time which an input must stay stable before the 105 module decides that a change of state has occurred. If a digital input changes (say 0 → 1) and changes again (1 → 0) in less than the debounce time, then the 105 module will ignore both changes. Debounce may be configured for digital inputs on the 105-1, 105-2 and 105-4 modules and the analogue inputs on the 105-2 module.



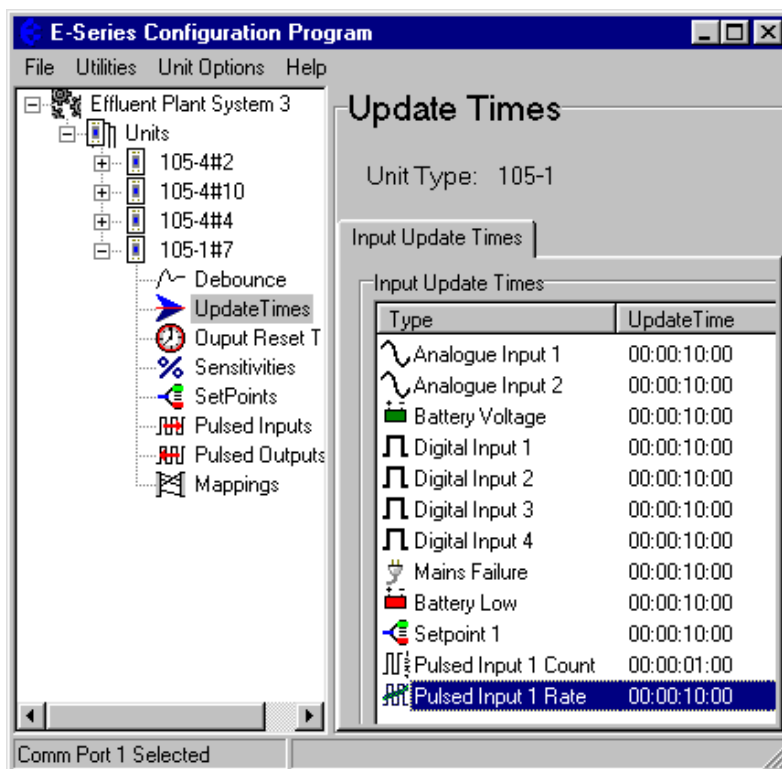
The default value of 0.5 seconds is suitable for most applications. In applications where a digital input may turn on and off several times slowly (for example, security switches or float switches) a debounce time of up to 8 seconds may be configured. *The configured debounce time has no affect on pulse inputs.*

Note that the analogue debounce is not configurable for the 105-1, but is configurable in the 105-2.

Update Time Configuration

Update messages are sent if a change message has not occurred within the update time period. The update time may be set for each input - both physical and internal inputs.

The default period is 10 minutes for all inputs, except for pulse inputs (1 minute). Short update times should only be used in special circumstances. It is important to remember the principle - “Less radio traffic means better communications”. Frequent updates from multiple units causes congestion of the radio



channel, which results in increased communication failures and poorer performance of the system. To change an update time, select “Update Times” on the left-hand menu and double-click the selected input. The update time will be shown in days:hours:minutes:seconds. Change the values in each field. The display also shows the maximum and minimum values.

For the 105-1, -2 and -3 modules, the maximum update time is 16 minutes, however the update time for 105-4 inputs can be up to 5 days. If a zero value is entered as an update time, then the input will not update at all.

Changing Multiple Settings

You can change the Update Times of several inputs simultaneously by using the <Shift> Select feature. For example, if you want to change all digital inputs to 1 minute update, you could change each individually, or you could “block” the four digital inputs using the “Shift” Select feature and select “Edit”. You only need to enter the change once to change all of the inputs selected. This feature is also available with the other configurable parameters.

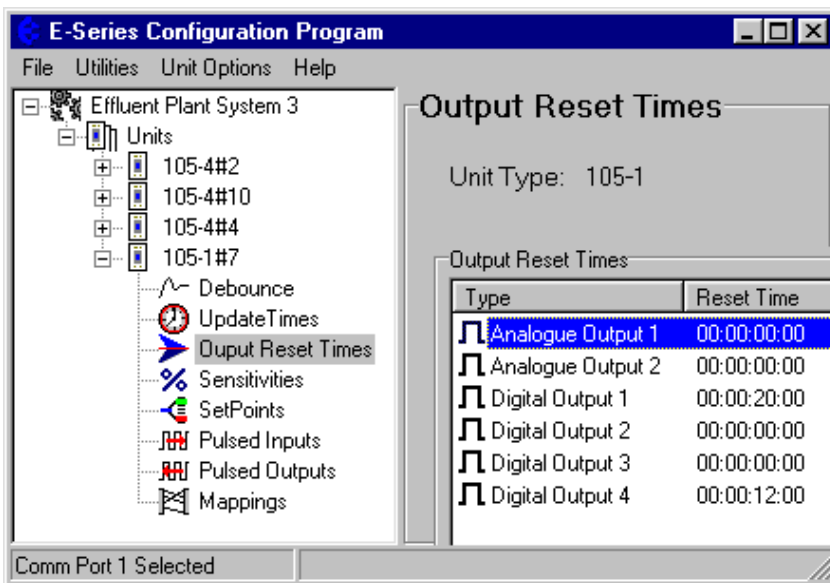
Output Reset Time Configuration

This allows the **Comms Fail Time** to be selected - this is the time for an output to reset if it has not received an update or change message.

Each output on the unit, either analogue or digital, may be configured to reset (off or 0mA) when no update transmission has been received for a certain time. This option can be used to ensure that communications failure will not result in loss of control. For example, outputs connected to pumps should be configured to reset on communications failure so that the pump will turn off. The default condition is zero (no reset).

If the reset time is less than the update time, then the output will reset when the reset time expires, and then set again when the update message is received. We recommend that the reset time be a little more than twice the update time.

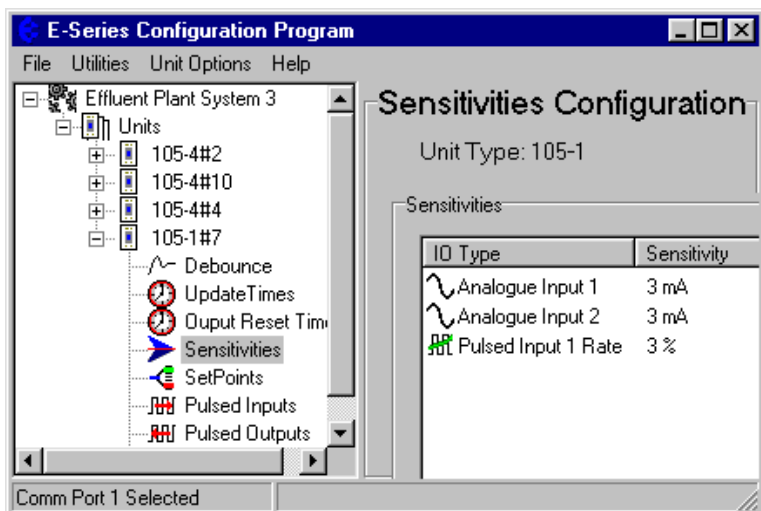
To set an output reset time, select “Output Reset Times” on the left-hand menu and double-click the selected input.



The update time will be shown in days:hours:minutes:seconds. Change the values in each field. The display also shows the maximum and minimum values.

Analogue Sensitivity Configuration

The analogue sensitivity is the change required in an analogue input before a “Change Of State” is detected, and the new analogue value is transmitted. For input signals which vary widely over a short period of time or have a normal oscillation, the analogue sensitivity should be set to an appropriately large value. This ensures that many change messages are not transmitted in too short a time. This will result in channel congestion, as described in the preceding section.



To change an analogue sensitivity, select “Sensitivities” on the left-hand menu and double-click the selected input. The sensitivity for physical inputs is shown in mA and internal input is shown as %.

SetPoint Configuration

Setpoints allow a remote digital output to be turned on and off depending on the value of an analogue input. The “set-point status” internal input must be mapped to an output for this option to have effect. When the AI is less than the Low Set-point (LSP), the set-point status will be active (on, “1”) - when the AI is more than the High Set Point (HSP), the set-point status will be reset (off, “0”). Note that the High Set Point (HSP) must always be higher than the Low Set Point (LSP). For the 105-1 module, only AI1 has set-point values. For 105-2 modules, analogue inputs 1 - 4 have set-points.

Debounce time operates on the set-point status in the same way as digital inputs.

To change a setpoint values, select “SetPoints” on the left-hand menu and double-click the selected Setpoint Status.

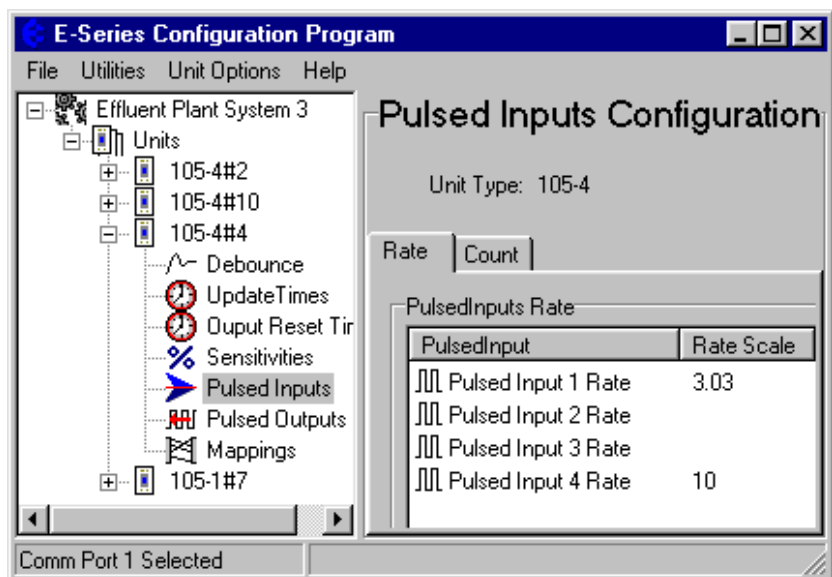
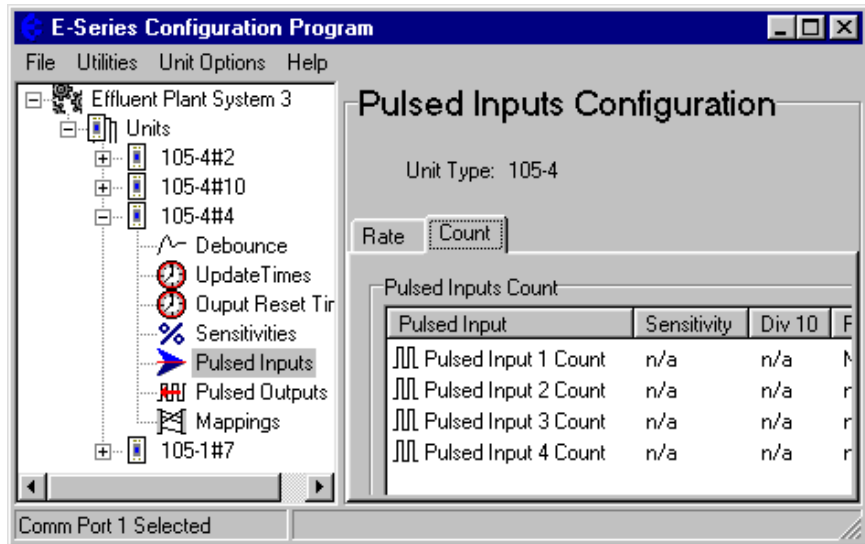
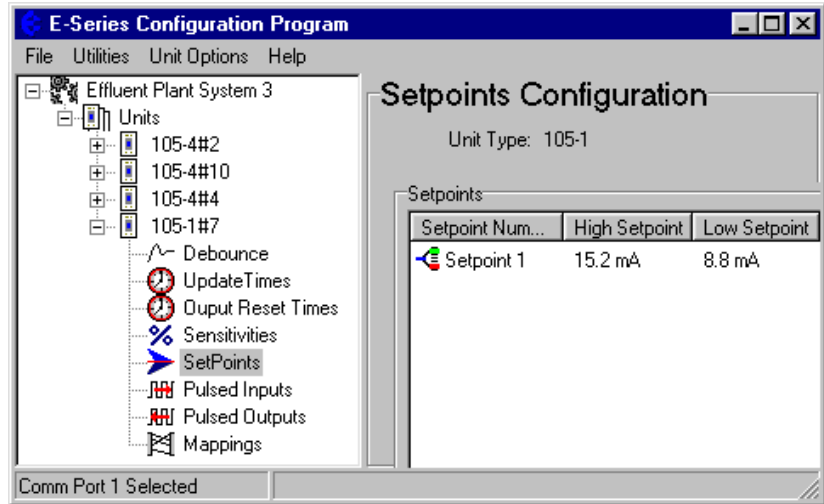
Pulse Input Count Configuration

PI1 of the 105-2 and 105-4 modules normally count up to 100Hz (as for the other PI’s), however can be configured to count up to 1000Hz. This configuration actually divides the input count by 10 - each count in the PI1 register is then equivalent to 10 input pulses. If PI1 is mapped to a PO, then the maximum output pulse rate is 100Hz, however each output pulse is equivalent to 10 input pulses.

To configure the “divide by 10” feature, select “Pulse Inputs” on the left-hand menu and select the “Count” page - double-click “Pulse Input 1 Count” and enable “divide by 10” counting.

Pulse Input Rate Scale Configuration

When a pulse rate is mapped to an analogue output, the rate must be scaled to the 4-20mA output. The pulse rate scale is the rate (in Hz) corresponding to the maximum value (20 mA

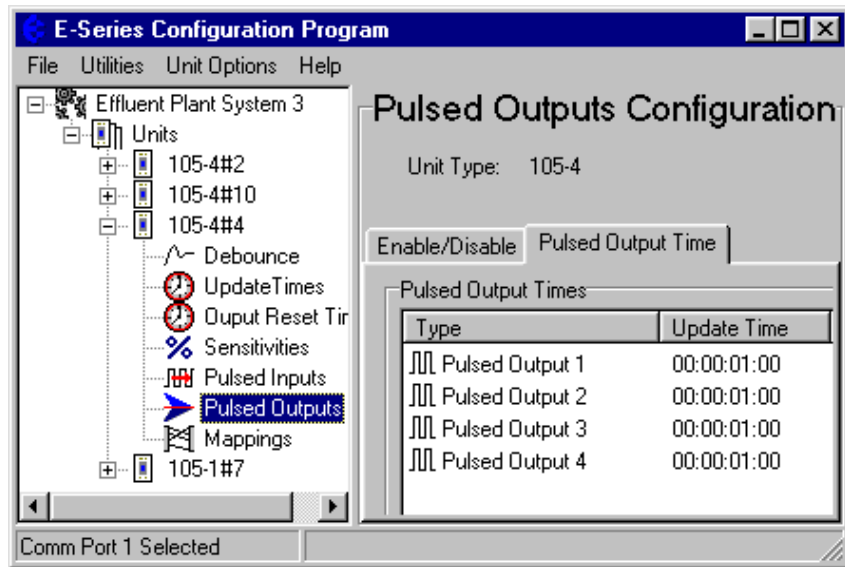


if mapped to an analogue output).

To configure the pulse rate scale, select “Pulse Inputs” on the left-hand menu and select the “Rate” page - double-click the pulse input rate and enter the scale value.

Pulse Output Update Time Configuration

The pulse output update time is the time period over which pulses are output after a PI update is received. It should be configured to correspond to the pulse input update time for the corresponding pulse input. This ensures that the pulse output rate matches as closely as possible the pulse input rate which it is reflecting.

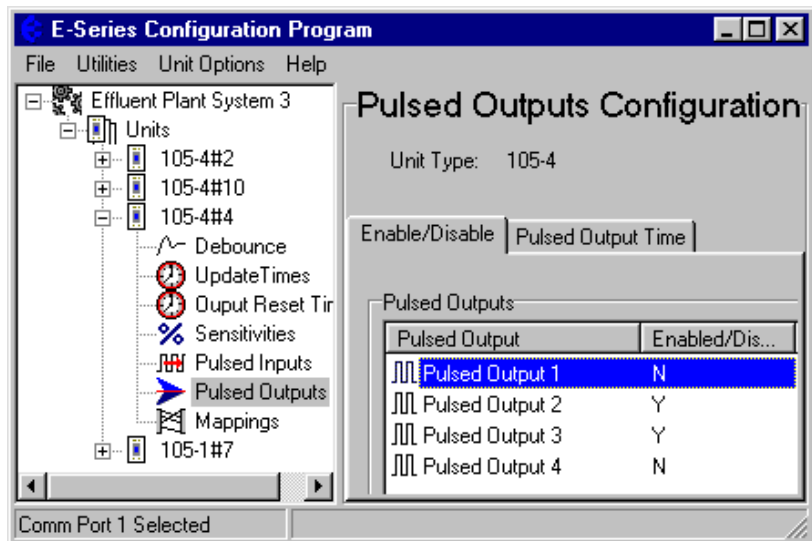


For example, if the PI update time is 1 minute, then the PO update time should also be 1 minute. If the PI update time is changed, then the PO update time at the remote module should be also changed. The PO will still operate if the time is not changed, however pulses may be output faster or slower than the input pulses.

To configure the pulse output time, select “Pulse Outputs” on the left-hand menu and select the “Pulsed Output Time” page - double-click the pulse output and enter the new time.

Pulse Output Enable

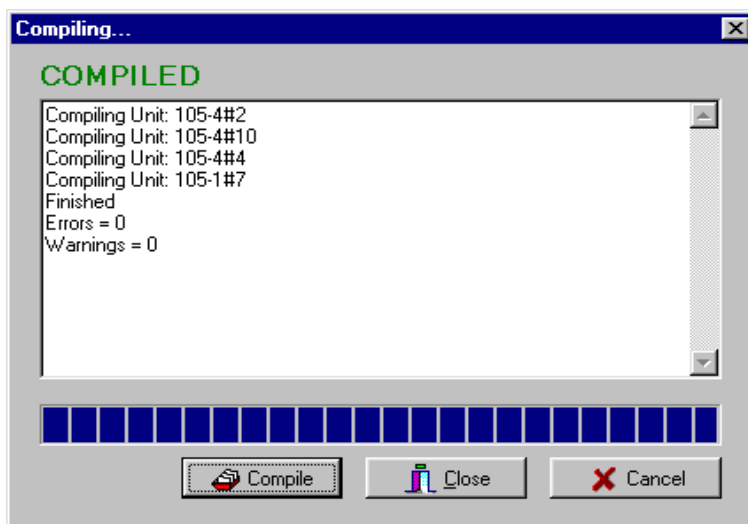
The PO’s for the 105-2 and 105-4 modules are also DO1-4. To use as pulse outputs, you need to enable them as pulse outputs.



To enable pulse outputs, select “Pulse Outputs” on the left-hand menu and select the “Enable/Disable” page - double-click the pulse output to enable.

Compiling a System

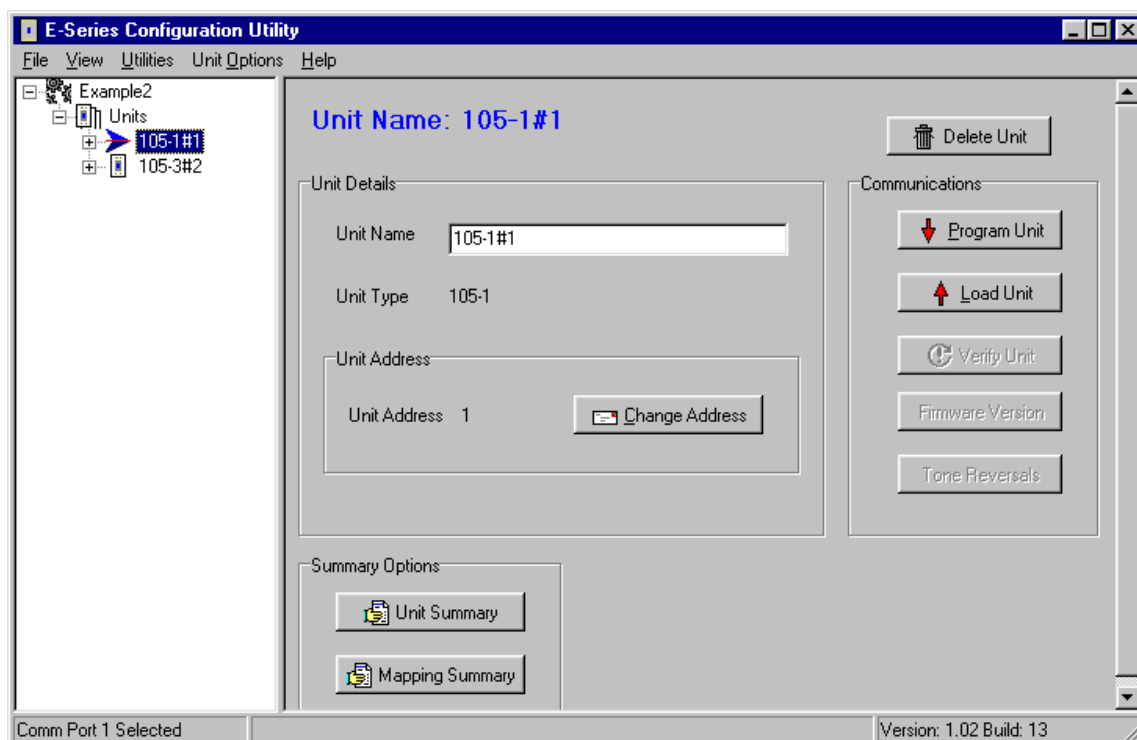
When you have finished configuring the modules, you should compile the system. The compile function scans the configuration and reports any detected errors. To compile the system, select “Compile System” from the “Utilities” menu. Select the “Compile” button. The system will compile - the display will show if there are any compile errors or warnings.



4.3.3 Programming Configurations to Modules

To programme a module :

- Connect the cable from the PC’s serial port to the 105 serial port (see 2.4.10 for cable connections)
- From the Utilities menu, select “Serial Port Setup”
- Select the appropriate serial port (COM1 - COM4)
- Select the unit to be configured from the left-hand menu
- Click on the “Program Unit” button.



- You will be asked to confirm if the module already has a different system or unit address.

Each module will need to be programmed individually.

4.3.4 Loading Configuration from a Module

Care should be taken when loading a configuration from a module. It is easy to lose the system address and unit address. We suggest that you first view the system address and unit address - you can do this via the “Unit Options” menu. Note these addresses before loading the configuration.

When you upload the configuration, the program will check if you want to load the addresses from the module. If you do not, then the system address and unit address will change.

You are able to upload the configuration from a module into a new “project”, to view the configuration and modify it. Note that as the “project” will not have the details of the other modules in the system, the other modules and outputs will be shown as unit addresses and output numbers. Don’t forget to download the configuration into the module after you modify it.

If security has been enabled for the system, please read section 4.3.7.

If you are adding additional mappings to a 105U-C or 105U-G module, then you need to change the archived configuration files first so you can download the modified configuration details into the 105U-C or 105U-G

4.3.5 Modifying and Archiving Configuration Files

As you build a system configuration, it is automatically saved in the “Project” directory. We recommend that all system additions and changes be made to the archived configuration files first, and then downloaded to the module/s. This ensures that the archived files are always maintained and accurate. If you modify the configuration of a module by uploading and then downloading, then the module configuration will be different than the archived files.

If you lose the configuration files for a system, then you can rebuild the configuration by uploading the configuration file from every module in the system.

4.3.6 Print Options

You can obtain a print-out of each module configuration. On each unit display, there are “Unit Summary” and “Mapping Summary” windows. Each of these will display a printable information page about that module. The Unit Summary page will display the user options configured, and the Mapping Summary will display the mappings entered for that unit.

The printer may be selected from the Printer Setup option in the File menu.

4.3.7 Security

There are two security features available. You can enter a password to protect the configuration files, and you can enable security encryption of the radio transmissions.

The password can be between 6 and 256 characters. The password is case sensitive and any

ASCII characters can be used. If you have entered a password, then this password will need to be entered if the configuration is to be changed later. You can view the configuration, but you will not be able to make any changes. You are able to change the password from the “Utilities” menu. If unauthorised access to the files is a concern, we recommend that you change the password regularly or whenever there is a change of staff.

Security Encryption is an additional level of security. The security option uses an 8-character security key to provide 64-bit data encryption of the radio messages. All modules in the same system will be configured with the same security key used to encrypt and decrypt the messages. This feature is available for modules with serial numbers with the middle three numbers greater than 210 - that is xxxx210xxxx, or xxxx220xxxx etc. If you are adding modules to an old system which does not have the security encryption feature, then you cannot use security encryption on the new modules.

Note that the security key is different than the password.

- To enable the security encryption, select the “Enable Security” box on the project display. An 8-character security key is entered and you will be prompted to enter the security code a second time to confirm. The security key can be any characters or numbers. Characters are case sensitive. The security key will never be displayed.
- If you do not enable security, there will be no data encryption of the radio messages. This is the default setting.
- If a security key has been entered, this key is downloaded into each module as part of the configuration download process. You can download another configuration at any time - if the security key is different, or if there is no security key in the new configuration, the old key will be over-written.
- You can change the security key in the configuration files simply by entering a new security key in the security key window. You will be prompted to confirm the new security key. If the configuration files are password-protected, you will be asked for the password. Note that if you change the security key, it will not match the security key previously loaded into existing modules.
- If you want to change a configuration, we recommend that you change the archived configuration, and then download the configuration onto the module. The archived configuration already has the valid security key.
- If you lose the archived configuration, you can upload the configuration from a module, but you cannot upload a security key. That is, you can upload the module configuration, view it, change it - but if you don't know the original security key, the old key will be over-written when you download the new configuration. This module will no longer communicate with other modules in the system as the security key is different.

The security options provide security against a “hacker” in the following way:

- ❑ A hacker cannot listen-in to radio messages without the security key to decrypt the radio messages. Similarly, a hacker cannot force outputs by transmitting a radio message to a module without the security key.
- ❑ A hacker cannot access the security key from an installed module or from the configuration files.

- The archived configuration files cannot be changed, downloaded or uploaded without the password.

Warning!!

These security options provide a high level of security, but no data-security system can provide “100% protection”. But it does make it very difficult for someone to interfere with the 905U system - difficult to the point where there would be many easier alternate ways to cause malicious damage.

The password must be kept in a secure place. Security procedures need to be adopted. If staff with access to the password leave your organisation, we recommend that the password be changed.

We recommend that you use a random 8-character string for the security key and that you do not record the key. It is not necessary to know what the security key is. The key will be recorded in the archived configuration files, and therefore the configuration files should be held in a secure place and backed up.

The security key does not prevent a hacker uploading a configuration from a module and downloading with a new security key. This module will no longer operate with other modules in the system. To prevent this, unauthorised access to modules must be prevented.

If you lose the configuration files, you can regenerate these by uploading the configuration from every module in the system into a new project with a new security key. After uploading each module, download the configuration with the new security key.

If you wish to change the security key, simply enter a new key in the configuration program, and download the new configuration to all modules in the system.

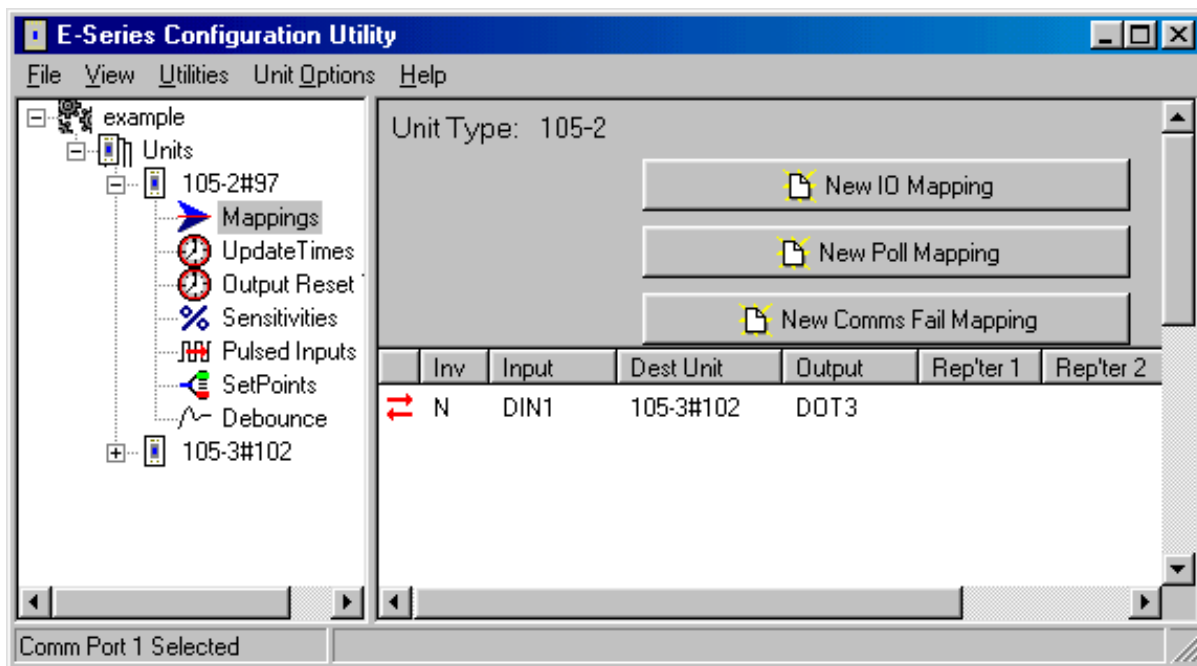
4.3.8 Using 105S Modules

105S modules can be used by themselves, as “line telemetry” or “wired I/O”, or they can be used as I/O expansion for 105U modules. As the 105S modules are connected by RS485, the 105S modules can be separated from the 105U modules by some distance. There can be up to 32 addresses on the one RS485 multi-drop link. Note that each -3 and -4 module takes up 2 addresses. For example, you could have up to 32 modules sharing a multi-drop link if they are all -1 or -2 modules - if they are all -3 or -4, then you could only have 16 modules on the link.

105S modules are configured with unit addresses in the range 96 – 127.

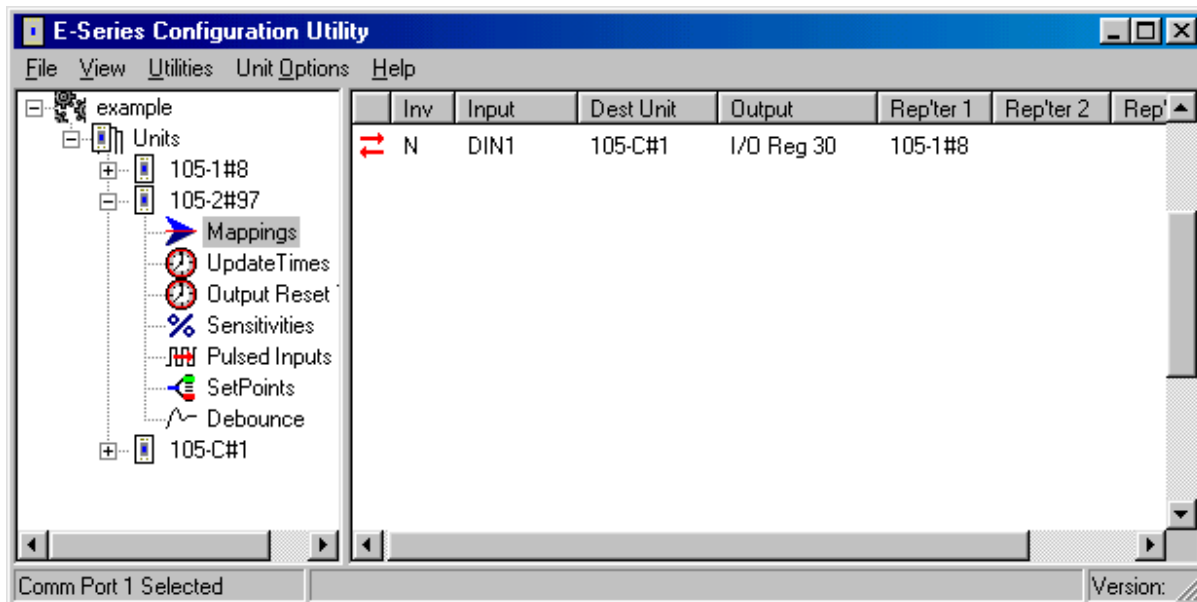
Example 1 - Mapping to another 105S module on the same link.

The I/O mapping is done in the same way as for 105U modules.



Example 2 - Mapping to a remote 105U.

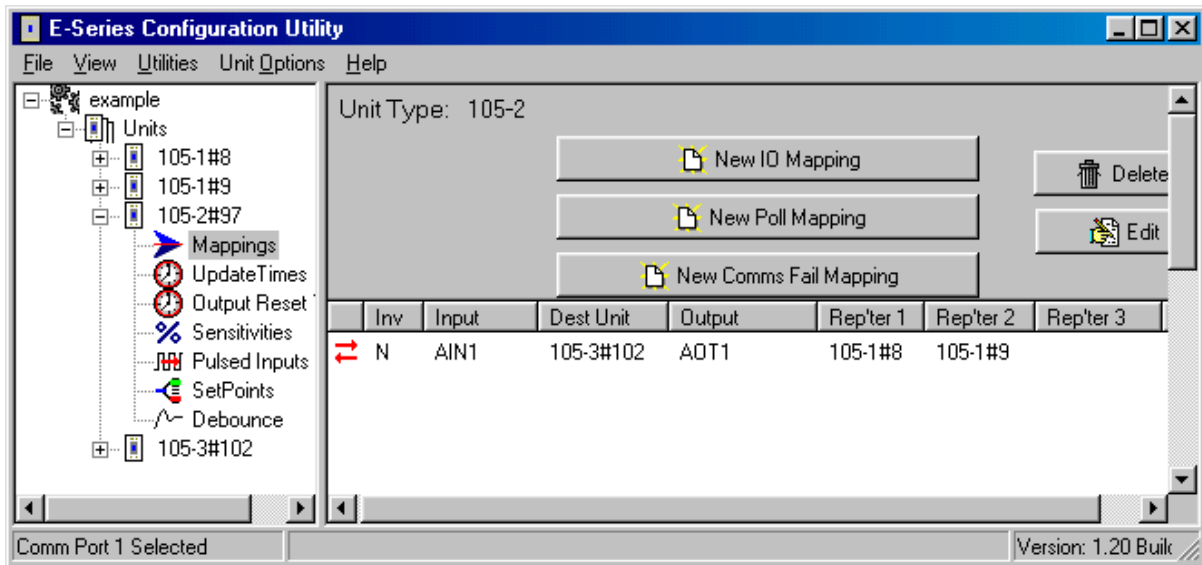
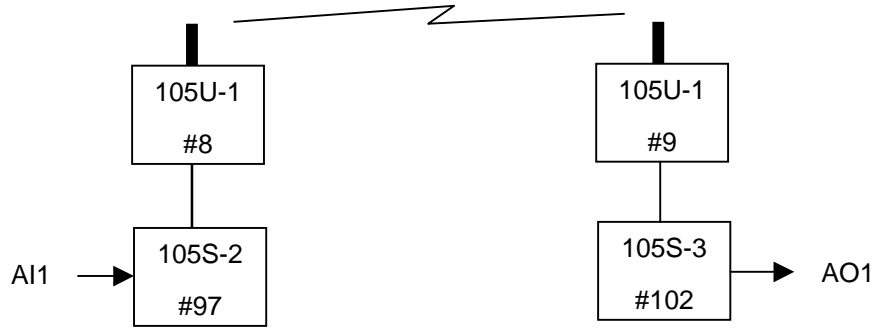
In this example, a 105S-2 is connected to 105U-1#8. DI1 is mapped to a remote 105U-C module. The 105U that is connected to the 105S module acts as a repeater - a serial-to-radio repeater.



When DI1 changes, the 105S will send a message via the serial link to 105U-1#8, and this 105U module will repeat the message by radio to the 105U-C module.

Example 3 - Mapping to another 105S which is connected to a different 105U

In this example, both 105U modules act as repeaters. The first is a “serial-to-radio” repeater and the second is a “radio-to-serial” repeater.



Chapter Five

SPECIFICATIONS

General		
EMC approval		EN55022, EN 50082-1, ETS 300 683, AS 3548 IEC60950
Radio standards 105U only	MPT 1329 UK EN-300-220 AS 4268.2 AUST RFS29 NZ EN 300 113, FCC Part 90	458 MHz, 500 mW EIRP 405 - 490 MHz, 10 - 500 mW 869 MHz, 500mW 472 MHz, 100 mW EIRP 458 MHz, 500 mW EIRP 380 – 520 MHz, 0.5 – 5W
Housing	130 x 185 x 60mm DIN rail mount	Powder-coated, extruded aluminium
Terminal blocks	Removable	Suitable for 2.5 mm ² conductors
LED indication	Power supply, OK operation, digital I/O, RX and TX	
Operating Temperature	-20 to 60 degrees C -40 to 60 degrees C -30 to 60 degrees C	405 – 490 MHz, 10 – 500mW 869 MHz, 500mW 380 – 520 MHz, 0.5 – 5W
Power Supply		
Battery supply	11.3 - 15.0 VDC	
AC supply	12 - 24 VAC, 50/60 Hz	Overvoltage protected Battery required for units with more than 2W RF power
DC supply	15 - 30 VDC	Overvoltage and reverse voltage protected > 17VDC required for charging battery Battery required for units with more than 2W RF power
Mains supply	110-250 VAC	via plug-pack transformer
Battery Charging circuit	Included	for 1.2-12 AHr sealed lead acid battery
Solar regulator	Included	Direct connection of solar panel (up to 30W) and solar battery (100 AHr)
Current Drain	70 mA quiescent for 'U' 45 mA quiescent for 'S'	+ 10 mA/active digital input + 25 mA/active digital output + 2 x analogue I/O loop (mA)

Radio transmitter inrush		450mA @ 13.8VDC (0.5W) 600mA @ 13.8VDC (1W) 800mA @ 13.8VDC (2W) 1.25A @ 13.8VDC (5W)
Analogue loop supply	Included, except 105-4	24V DC 150 mA
Mains fail status	Monitored	Can be transmitted to remote modules
Battery voltage	Monitored	As above

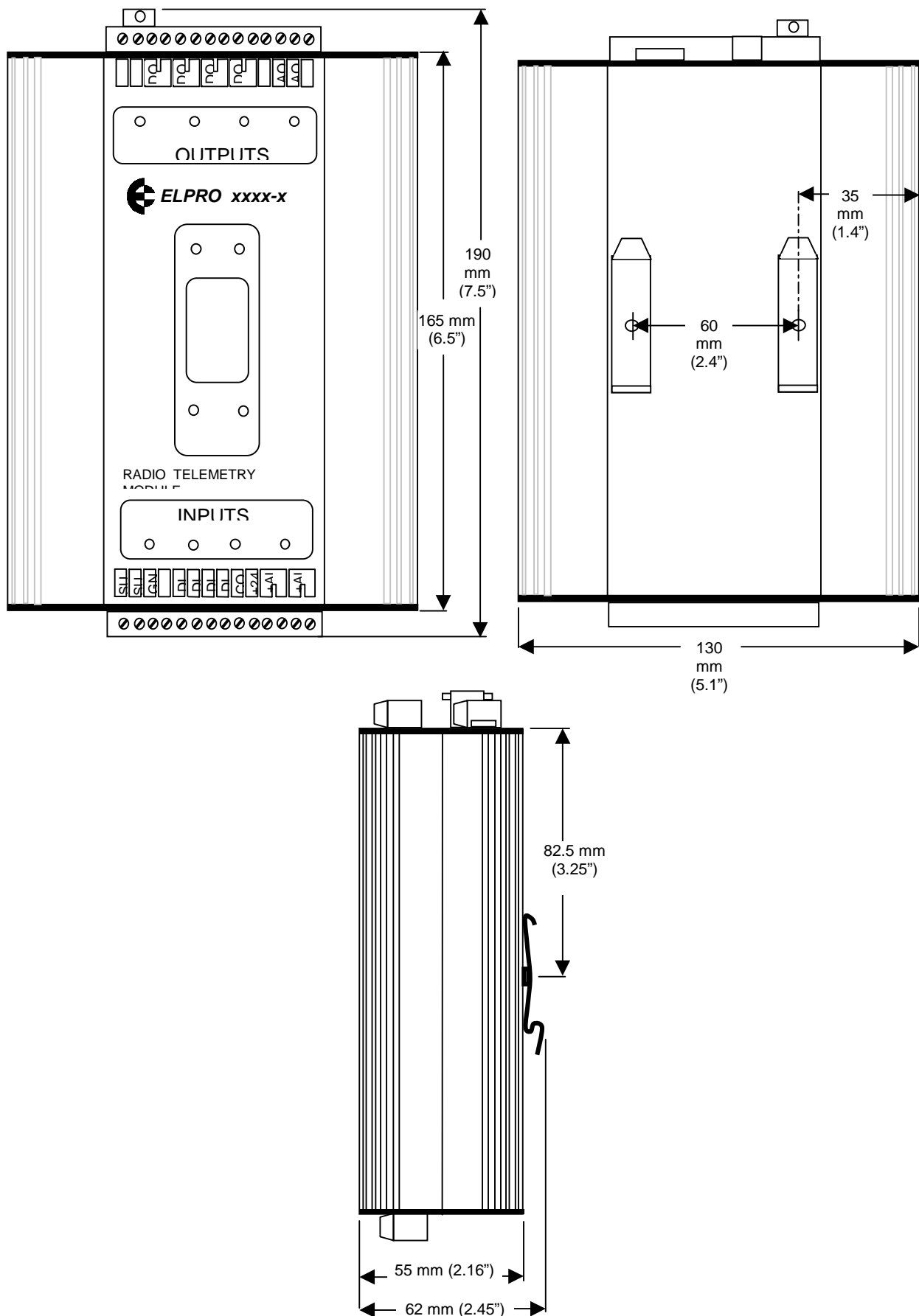
Radio Transceiver (105U)		
Single channel	synthesised	Direct frequency modulation
Frequency	405 - 490 MHz 220 – 235MHz 869.4 – 869.65 MHz 380 – 520 MHz	12.5 KHz, 10 - 500 mW 25 KHz, 4W 250KHz, 500mW 12.5 / 25 KHz, 0.5 – 5W
Frequency Stability	+/- 1.0 kHz	
Signal detect / RSSI	-120 to -80 dBm	
Expected line-of-sight range 400 – 500MHz	2 km @ 10mW EIRP 5 km @ 100mW EIRP 10 km @ 500 mW EIRP 40 km @ 5W EIRP	Range may be extended by up to 5 intermediate modules as repeaters
220 MHz	50 km @ 4W EIRP	
869 MHz	5 km @ 500mW EIRP	
Antenna Connector	Female coaxial	Protected by gas discharge surge arrester (not the 869MHz model).
Serial Ports		
RS232 Port	DB9 female DCE	9600 baud, no parity, 8 data bits, 1 stop bit
RS485 Port	2 pin terminal block	9600 baud, no parity, 8 data bits, 1 stop bit, Typical distance 1km
Data transmission	On change-of-state + integrity update	Update time configurable
Protocol - serial - radio	asynchronous ARQ, with 16 bit CRC synchronous ARQ	Automatic acknowledgements with up to 4 retries
Communications fail status	May be mapped to local or remote output	Resetting of outputs on comms fail configurable

Inputs and Outputs		
Digital Inputs	105-1 Four 105-2 Four 105-3 None 105-4 Four plus 12 selectable I/O	Opto-isolated (5000V)inputs, suitable for voltage free contacts or NPN transistor, contact wetting current 5mA, input debounce 0.5 second As above, but with 3000V surge protection instead of opto-isolation
Digital Outputs	105-1 Four	Relay output contacts, normally open, AC 5A 50V DC 2A 30V, 5A 20V
Digital Outputs	105-2 One 105-3 Eight 105-4 Four plus 12 selectable I/O	FET output, 30 VDC 500mA max.
Pulse Inputs	105-1 One 105-2 Four 105-3 None 105-4 Four	Uses DI1. Max rate 100Hz, min. off-time 5msec. Uses DI1-4. Max rate of DI1 is 1000Hz, min. off-time 0.5msec Max rate of DI2-4 is 100Hz, min. off-time 5msec.
Pulse Output	105-1 One 105-2 None 105-3 Four 105-4 Four	FET output, 30 VDC 500mA max Max rate for 105-1 is 100 Hz. Max rate for 105-3 is 1000 Hz. Pulse signal recreated, pulse rate avail. on analogue output, (scaling configurable). Divide-by-10 available for 1000Hz inputs.
Analogue Inputs	“floating” differential input, common mode voltage -0.5V to 27V 105-1 Two 4-20 mA 105-2 Six 0-20mA 105-3, -4 None	24 VDC for powering external loops provided, 150 mA max, Digital filter time constant 1 second. Resolution 15 bit, Accuracy 0.1% Resolution 12 bit, Accuracy 0.1%
Analogue Input Setpoints	105-1 AI 1 only 105-2 AI 1-4	Configurable high & low set-points, allowing set/reset of remote digital outputs

Analogue Outputs	current sink to common 105-1 Two 4-20mA 105-2, -4 None 105-3 Eight 0-20mA	max loop voltage 27V, Resolution 15 bit, Accuracy 0.1% Resolution 15 bit, Accuracy 0.1%
System Parameters		
Network Configurations	Communications via radio or RS485 or network of both	Up to 95 radio units with up to 32 serial units off each radio unit
Mapping	Any input to any output in system	
User Configuration		RS232, PC or laptop
Diagnostics		
On board diagnostics	Automatic check on start-up Via RS232 terminal or laptop	Input status Output test Incoming radio signal level Simple radio path testing

5.1

Dimensioned Drawing



Chapter Six TROUBLESHOOTING

6.1 Diagnostics Chart

INDICATOR	CONDITION	MEANING
OK LED OFF	Continuously	<ul style="list-style-type: none"> Battery Voltage low CPU failure +24V supply failure/overload
OK LED ON	Continuously	<ul style="list-style-type: none"> Normal Operation
PWR LED ON	Continuously	<ul style="list-style-type: none"> Supply available from SUP1/SUP2 Supply available from solar panel
TX LED ON	Flashes briefly	<ul style="list-style-type: none"> Radio transmitting
RX LED ON	Flashes briefly	<ul style="list-style-type: none"> Radio Receiving Serial port communicating
RX LED ON	Flashes continuously	<ul style="list-style-type: none"> Module in Configuration Mode
RX LED ON	Continuously	<ul style="list-style-type: none"> Test Button press in Configuration Mode
No transmission on change of state		<ul style="list-style-type: none"> Unit not configured correctly - re-configure and check operation

The green OK LED on the front panel indicates correct operation of the unit. This LED extinguishes on failure as described above. When the OK LED extinguishes shutdown state is indicated. In this state, all digital outputs turn OFF and the +24V supply turns off.

On processor failure, or on failure during start-up diagnostics, the unit shuts down, and remains in shutdown until the fault is rectified. The unit also shuts down if the battery voltage falls below 10.8 volts. This is a protection feature designed to protect the battery from deep discharge in case of extended period without supply voltage.

Note: During diagnostic testing, it is likely that the module will reset and restart. This will affect the output signals.

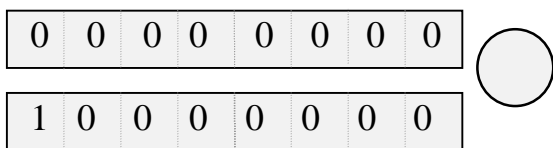
6.2 Self Test Functions

6.2.1 Input to Output Reflection (105-1 only)

The unit will require re-configuration after SELF TEST. Ensure you know the required operational configuration including system and unit addresses so that the network can be restored after testing.

Remove the cover in the front panel, and set the DIP switches as shown below. Hold down the

red button for five seconds, or until the Rx LED glows yellow, release the Red button (the Rx LED now flashes), then press and release the Red button (the flashing Rx LED extinguishes).



Input signals may now be connected to the input terminals of the module. If the module is operating correctly, then the input signals will be reflected to the corresponding output on the same module. For example, if DI 1 is connected to common - i.e. the first digital input is turned "ON" - then DO 1 will activate, if the module is functional. Similarly, if a 12mA signal is connected to AI 2, then a 12mA signal should be able to be measured from AO 2, if the module is functioning correctly.

If a module does not pass its self test function, then it should be returned to an authorised service agent for attention

6.2.2 Radio Testing using Tone Reversals

This function allows the unit to be configured to continuously transmit a sequence of alternate zeros and ones on the radio. This function provides the facility to check VSWR of antennas during installation, as well as checking the fade margin of the path between two units (see below - received signal strength indication).

The tone reversals function is initiated by setting all of the DIL switches to ON, and holding down the red button for approximately 5 seconds(until the RX LED lights continuously). On releasing the button, the RX LED will flash continuously, and the TX LED will light, indicating that the radio transmitter is on.

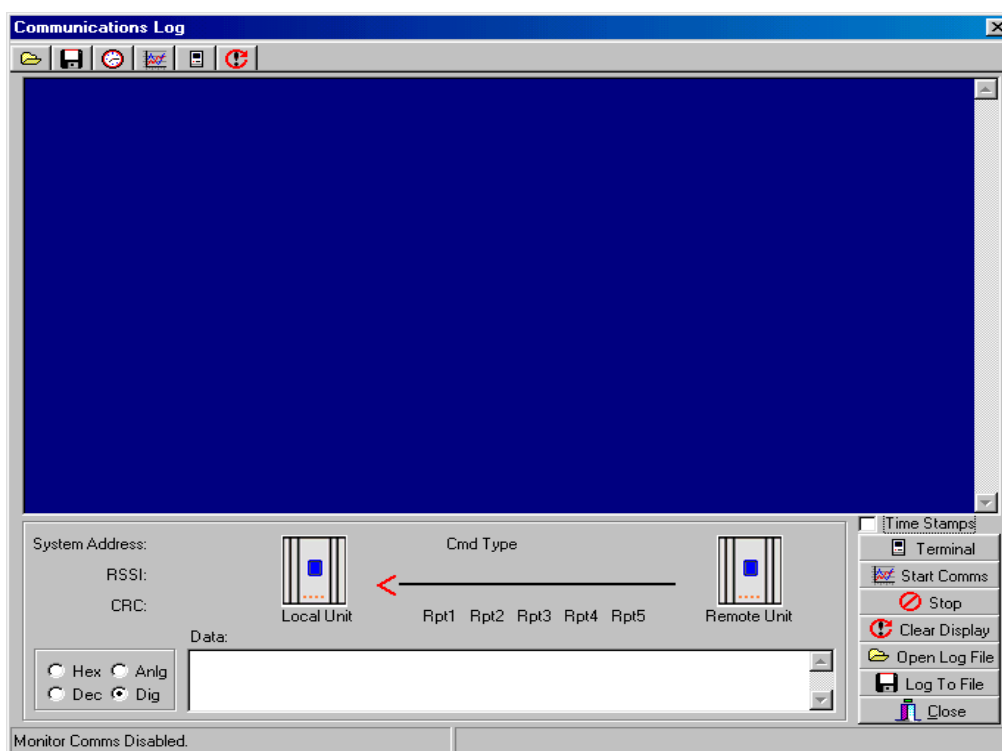
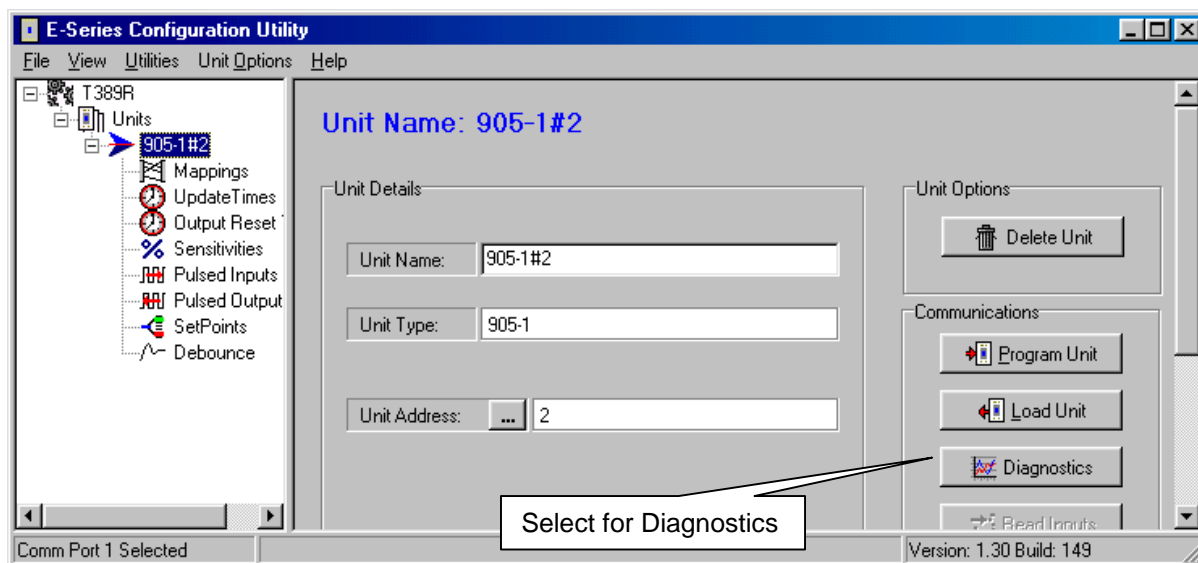
To finish the test, push the red button again or re-power the module.

6.2.3 Diagnostics functions

To aid in the checking and set-up of the 105 unit, a user friendly menu provides access to diagnostic functions in the 105. Use of the diagnostics menu does not affect module configuration.

The diagnostics functions can be accessed from the E Series Config software - the same software package used to configure the modules. Connect the laptop or PC to the module using a configuration RS232 cable.

Either open the archived project containing the module, or start a New Project and select "Load a New Unit" - select the correct type of module. After the unit has loaded, select the Diagnostics box.



A “Terminal” screen will appear. Select the “Terminal” box.

Connect the module (ensure the RS485 port is disconnected first) to the PC using the same serial cable used for configuration.

The diagnostics menu is accessed by removing the blue “plug” from the front of the module and setting all switches to ‘0’ or “Open”, and holding down the red button for approximately 5 seconds, until the RX LED lights continuously. One of the following menus will be displayed on the terminal :

1051 V1.0	1052 V1.0	1053 V1.0	1054 V1.0
a) Ins	a) Digital Ins	a) Ins	a) D Ins
b) Tones	b) Analog Ins	b) Tones	b) A Ins
c) Comms	c) Tones	c) Comms	c) Tones
d) DO1	d) Comms	d) DO1	d) Comms
e) DO2	e) DO1	e) DO2	e) DO1
f) DO3	f) Switch	f) DO3	f) DO2
g) DO4	g) Signal	g) DO4	g) DO3
h) AO1	>	h) DO5	h) DO4
i) AO2		i) DO6	i) DIO1
j) Switch		j) DO7	j) DIO2
k) Signal		k) DO8	k) DIO3
>		l) AO1	l) DIO4
		m) AO2	m) DIO5
		n) AO3	n) DIO6
		o) AO4	o) DIO7
		p) AO5	p) DIO8
		q) AO6	q) DIO9
		r) AO7	r) DIO10
		s) AO8	s) DIO11
		t) Switch	t) DIO12
		u) Signal	u) Signal
		>	>

Choose an item from the menu by entering the letter before that item. For example, to select the "Signal" function from the 105-1 Menu, enter :- k

During the diagnostics session, if you press Enter or Space while the menu is displayed, the module will restart in normal operating mode. To re-enter diagnostics mode, hold the red button for 5 seconds etc.

After the diagnostics session is over, force the module to restart, then select "Stop Terminal", then "Close".

Inputs

This option provides a dynamic display of the status of all of the inputs in the 105, both internal and external.

105-1 Modules

1234MLS	P CNT	AI1	AI2	P RATE	VBATT
0101001	00F6	C000	4000	8000	9C00

The first 7 values (1234MLS) each represent a single digital input. A '1' indicates that that input is ON, and a '0' indicates that the corresponding input is OFF. "1234" represents the four physical digital inputs, DI1 to DI4. "M" is the mains fail status ('1' for mains fail, '0' for mains OK). "L" is the battery low volts status ('1' for low volts '0' for OK). "S" is the set-point status.

P CNT, AI1, AI2, P RATE, and VBATT each represent 16 bit values, displayed as four hexadecimal digits.

P CNT is the current value of the pulsed input counter. This value should increment each time 'DI 1' turns from OFF to ON. P RATE displays the current pulse rate at DI1. This value is scaled according to the MAXRATE value configured (0 Hertz is displayed as 4000, and the maximum rate is displayed as C000).

AI1 and AI2 represent the value for the two analogue inputs. Full scale input (20 mA) is displayed as C000, 4mA is displayed as 4000, and 0ma is displayed as 2000. Analogue inputs are filtered digitally with a time constant of 1 second, so a sudden change in the analogue input current will result in a slower change in displayed analogue value, finally settling at the new value.

A guide to translate the displayed value to the analogue input current is provided below.

Add together the figures corresponding to each digit in each position to determine the current (mA) e.g. displayed value 3456 = 2.000+0.500+0.039+0.003 = 2.542mA				
Digit	Leftmost position	Next position	Next position	Rightmost position
0	-	0.000	0.000	0.000
1	-	0.125	0.008	0.000
2	0.000	0.250	0.016	0.001
3	2.000	0.375	0.023	0.001
4	4.000	0.500	0.031	0.002
5	6.000	0.625	0.039	0.002
6	8.000	0.750	0.047	0.003
7	10.000	0.875	0.055	0.003
8	12.000	1.000	0.063	0.004
9	14.000	1.125	0.070	0.004
A	16.000	1.250	0.078	0.005
B	18.000	1.375	0.086	0.005
C	20	1.500	0.094	0.006
D	22	1.625	0.102	0.006
E	-	1.750	0.109	0.007
F	-	1.875	0.117	0.007

VBATT is the current internally derived battery voltage. 4000 corresponds to 8 Volts, C000 represents 16 volts. A quicker method is use the calculation :

Battery voltage (volts) = $\frac{1}{2} I + 6$, where I is the mA value determined from the above table using VBATT. For example, a value of VBATT of A000 gives an I value of 16mA from the above table. The battery voltage corresponding to this is 14V (or $\frac{1}{2} \times 16 + 6$).

105-2 Modules

Digital Inputs

DIN	SETPNT	PULSED			
1234MSL123456		PIN1	PIN2	PIN3	PIN4
00001001111111		0000	0000	0000	0000

Analogue Inputs

VBAT	PR1	PR2	PR3	PR4	AI1	AI2	AI3	AI4	AI5	AI6
8138	4000	4000	4000	4000	0D3A	0CD2	0CC7	0CC7	0CD4	0CC7

105-3 Modules

ML	VBAT	VSLR
00	9FA2	0000

105-4 Modules

Digital Inputs

DIN	DIO	PULSED				
1234	123456789ABC	MLS	PIN1	PIN2	PIN3	PIN4
1001	010101010	001 101	0001	0001	0001	0001

Analogue Inputs

VBAT	PR1	PR2	PR3	PR4
8DBE	0000	0000	0000	0000

Tones

This provides the same function as described above in 6.2.2. Tone Reversals. This function may be used to check VSWR of antennas, and may be used in conjunction with the Signal option (described below) to check the path between two 105 units.

Comms

This function allows monitoring of all messages transmitted and received over the radio. A better comms display function is available using the “Comms Logging” feature in the configuration software - refer to section 6.2.4.

Transmitted messages are displayed starting in the leftmost column of the display. Received messages are displayed indented by one space. Received messages which have been corrupted are displayed with a '*' in the first column of the display. The first four hexadecimal digits are the system address attached to the message, and must match for units to communicate

successfully.

Example (105-1):

```
>c
Comms
01FA8106008005C6727D44      Command message transmitted by this unit.
<INVALID>01FA8186C6E0E3      Corrupt Acknowledge received from remote.
01FA8106008005C6727D44      Message re-transmitted by this unit. (no Ack)
01FA818600E0E3                Valid Acknowledge received from remote.
<INVALID>01FB860100800100009286  Corrupt message received from remote unit.
01FA860100800100009286        Re-sent message received from remote unit.
01FA868100FCE4                Acknowledge message from this unit to remote.
```

DO1 to DO8, DIO1 to DIO12

These options allow the user to set and clear digital outputs. To set an output, select the corresponding menu item, at the prompt, type the value FFFF to turn the output ON, or 0000 to turn the output OFF. For example, to set DO1 ON,

```
>e
DO1
>FFFF
```

AO1 to AO8

These options allow the user to set analogue outputs to any value. To set the output, select the corresponding menu item. At the prompt type the value required for the analogue output as a four digit hexadecimal value. Refer to the table above for analogue current/expected value relationship. To set AO2 on 105-3 to 19 mA :

```
>m
AO2
>B800
```

Switch

This option allows testing of the DIL (Dual In Line) switches. The diagram below indicates the layout of the switches of which there are two sets of eight, with an “Enter” button located to the right of the pair. the display indicates the current switch settings with the digit ‘1’ corresponding to ‘On’ and the digit ‘0’ corresponding to ‘Off’. Changing the switch settings in this mode will change the display. Test each switch and check to ensure the display changes accordingly.

<u>Switches</u>	<u>Displayed</u>								
<table border="1" style="border-collapse: collapse; width: 100%; height: 20px;"> <tr> <td style="width: 12.5%; text-align: center;">1</td> <td style="width: 12.5%; text-align: center;">1</td> <td style="width: 12.5%; text-align: center;">1</td> <td style="width: 12.5%; text-align: center;">0</td> <td style="width: 12.5%; text-align: center;">0</td> <td style="width: 12.5%; text-align: center;">0</td> <td style="width: 12.5%; text-align: center;">1</td> <td style="width: 12.5%; text-align: center;">0</td> </tr> </table>	1	1	1	0	0	0	1	0	1110001001010101
1	1	1	0	0	0	1	0		
<table border="1" style="border-collapse: collapse; width: 100%; height: 20px;"> <tr> <td style="width: 12.5%; text-align: center;">0</td> <td style="width: 12.5%; text-align: center;">1</td> <td style="width: 12.5%; text-align: center;">0</td> <td style="width: 12.5%; text-align: center;">1</td> <td style="width: 12.5%; text-align: center;">0</td> <td style="width: 12.5%; text-align: center;">1</td> <td style="width: 12.5%; text-align: center;">0</td> <td style="width: 12.5%; text-align: center;">1</td> </tr> </table>	0	1	0	1	0	1	0	1	
0	1	0	1	0	1	0	1		

Signal

This option provides for testing the radio path between two 105-U units for a suitable fade margin. Although a pair of units may communicate successfully, radio communication may be affected by a range of influences, including atmospheric conditions, changing landscape, degradation of antennas or co-axial cable, low battery voltage etc. Fade margin is an indication of how far a radio path can deteriorate before communication becomes unreliable.

When using the Signal feature, a meter is displayed with a mark indicating the current received radio signal level. To check the radio path between two units, select the signal option at the local unit. The remote unit may then be set up for tone reversals (refer 1 above) and the signal level read from the meter.

A simpler method when remote units are not easily accessible is to cause a transmission from the local unit to the remote unit (by setting a digital input which maps to the remote unit, for example). The meter will latch the received signal from the remote unit for half a second, allowing the received level to be read.

Under normal radio conditions, a reading of 0 indicates a very marginal communication path. For reliable communications, the signal reading should be 3 or above.

>k Minimum signal level for reliable comms

Signal

0123456789----
#

In areas experiencing radio interference or high background noise, reliable communications may not be achievable even with this signal level. To determine if interference is occurring the signal option may be selected without any other 105 units active. In a normal radio environment, no reading should be displayed. If a reading is displayed, then **the received signal strength from the remote should be at least two counts higher than the background noise** for reliable communication.

>k Displayed signal level of
Signal background noise/interference

0123456789----
#

>k Minimum signal level for reliable comms

Signal

0123456789----
#

The following table converts the indicated scale to a dBm value.

Scale	0	1	2	3	4	5	6	7	8	9	10
-dBm	-110	-106	-102	-98	-94	-90	-86	-82	-78	-74	-70

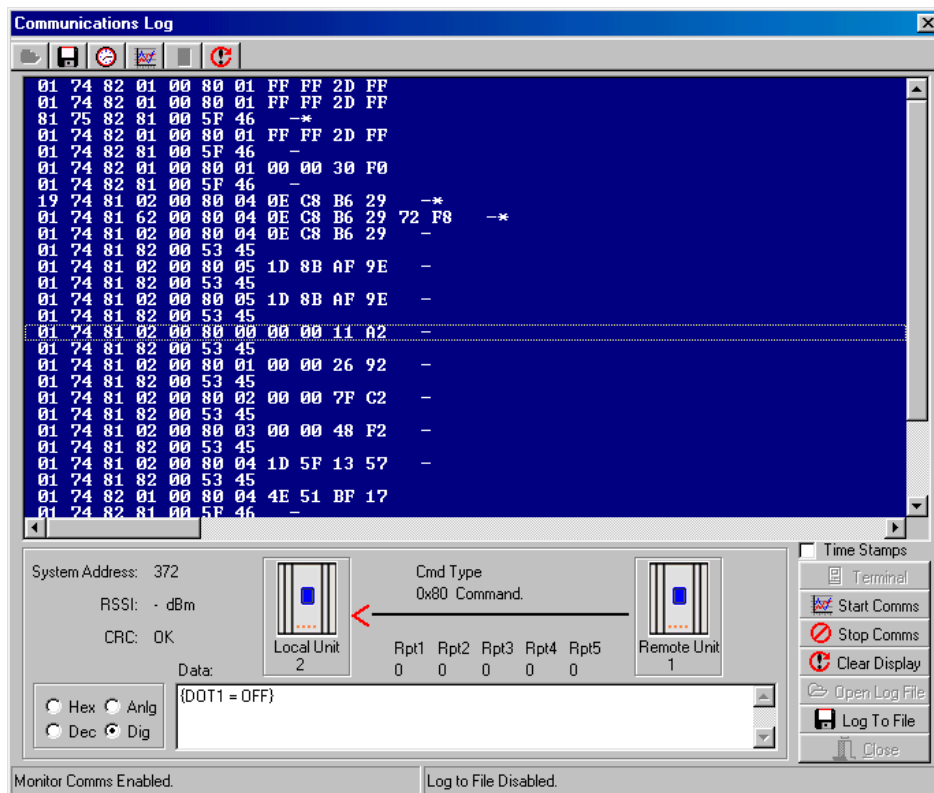
When using directional antennas (i.e. YAGI antennas) this feature may be used to peak the received signal level. Set-up the remote unit to transmit tone reversals as described above,

and observe the signal indication while adjusting the orientation of the antenna. A peak in signal level indicates optimum orientation of the antenna.

Some units will display the signal strength numerically instead of a scale measurement. The measurement is in units of negative dBm - a reading of 100 is -100dBm. For a reliable radio path, the signal strength must be at least 10dB lower than the noise level, or 98, whichever is less.

For example, if the noise level is 120, then the radio signal must be 98 or lower for a reliable path. If the noise level is 100, then the radio signal must be 90 or lower.

6.2.4 Comms Logging



These options allow logging and display of radio communications. To start “Comms logging”:

- select option the “Comms” option from the diagnostics menu (see section 6.2.3),
- ‘Stop Terminal’ and then
- ‘Start Comms’.

The display will show radio messages transmitted and received. Messages ending with a dash (-) are received messages. An asterisk after the dash indicates a corrupted message.

If you select any message line with the mouse, information about the message will be displayed at the bottom of the screen. The “text box” at the bottom middle of the screen decodes the message - that is, it decodes the message to display I/O channel and value.

You can display the register values in Decimal by selecting “Dec” at the bottom of the screen. If you select “Dig”, the values will be displayed as a 0 or 1 digital value (1 if the 16-bit value is greater than 50% - that is, the most significant bit is 1). If you select “Anlg”, the value

will be displayed as a 4-20mA range.

To stop “comms logging”, select the “Stop Comms” box. You can then shut down the diagnostics screen, or select “Terminal” to go back to the diagnostics menu.

Add Time Stamps

Time stamps can be added by selecting the “Time Stamps” box. This will allow the current time and date to be displayed with each message.

The “Comms log” can be saved to a file for future reference by selecting “Log to File”.

6.3

Radio Path Testing

To carry out a radio path test, you will need two 105U modules. One module will be “fixed” and the other “mobile”. Both units will need power supplies and antennas. The power supply for the mobile unit is normally a 12V battery, but make sure that the battery is fully charged - batteries with low voltage will lead to low radio power which will affect the test result.

The object of the test is to determine whether radio paths are reliable, marginal or unreliable. A reliable path will have a margin of at least 10dB above the background noise level in good weather - this margin is enough to ensure that the radio path remains reliable in poor conditions. A marginal path will work reliably in good conditions, however will fail during poor conditions. If the test is carried out during rainy or foggy weather, then a margin of only 5dB is required.

Procedure:

- ❑ Configure the modules to the same system address, and on each module, configure DI1 to DO1 on the other module. At the fixed module, wire DO1 to DI1 such that DI1 will turn ON when DO1 turns ON. Connect a switch to DI1 on the mobile unit.
- ❑ When the modules are close to each other, test the system - close the switch, forcing the mobile unit to transmit. The mobile unit will transmit to the fixed unit, and the fixed unit will transmit back to the mobile unit, activating DO1. Turning off the switch will result in two radio transmissions, turning off DO1. Each time the switch is changed, there should be two radio messages (two sets of TX/RX flashes) at the mobile unit. Note that when the modules are within a couple of metres, they may not work well with antennas connected - in this case, test without antennas.
- ❑ Set up the fixed module in one of the test positions - this is normally at a control centre or repeater site. Fix the antenna in a temporary fashion. You will need to make an initial assessment on how high the antenna should be mounted.
- ❑ Take the mobile module to the other end of the radio path. The antenna at this end can be either held by the tester, or fixed in a temporary fashion. Note that a person’s body will affect the radiation pattern of an antenna, so if the antenna is hand-held and the test is not successful, try again with the antenna fixed to a 1 metre length of plastic pipe or timber. The tester holds the length of pipe or timber with the antenna above head height.
- ❑ Test the radio path by operating the switch. If the radio path is short, and there is a high level of confidence that the radio path will be reliable, the result can be checked by

simply looking at the TX/RX leds on the mobile unit. If each TX flash is followed immediately by a RX flash (that is, the TX flash does not flash twice or more times before the RX flashes), then the radio path is likely to be reliable. Operate the switch several times - do not rely on one test. If the test is being done outside, the leds will need to be shaded to view the flashes.

- If the radio path is uncertain, then the result should be measured by connecting a laptop computer, following the procedure outlined in this manual for measuring the radio signal strength. Before the switch is operated, the background noise level should be measured and recorded. This measurement is likely to “jump around” or oscillate, to determine an average measurement. Now operate the switch several times - take the average measurement of the signal transmitted from the fixed unit.
- The radio path is reliable if the transmitted signal is 10dB above the noise level, or better than -98dBm. For example, if the noise level is -115dBm, then the minimum level for reliability is -98dBm. If the noise level is -100dBm, then you need -90dBm for a reliable path. If the laptop displays a scale measurement instead of a numerical measurement, then the transmitted signal should be at least 3 divisions, and at least 2 divisions above the noise level.
- If the weather is poor during the test, then the transmitted signal needs to be 5dB above noise, or 1 division. It is best not to do radio tests during poor weather.
- Record these measurements for comparison later during commissioning or if the system has problems later.

If the radio path test is not successful:

1. Increasing the height of the antenna at either module, or at both modules can significantly improve the result. Sometimes moving the antenna to the side helps, if there is an obvious obstruction in the radio path.
2. Change one or both antennas to a higher gain if regulations allow.
3. Use a shorter coaxial cable between the antenna and the 105U.(this may involve moving 105U nearer to antenna mounting), or use a different coaxial cable with lower loss.
4. If a reliable radio path is not possible because of distance or path obstructions, you will need to consider using a repeater module. The ideal repeater is another module in the system, in a good location to act as a repeater. If this is not the case, you need to consider installing a module to act specifically as a repeater.

Chapter Seven **WARRANTY & SERVICE**

We are pleased that you have purchased this product.

ELPRO products are warranted to be free from manufacturing defects for the “serviceable lifetime” of the product. The “serviceable lifetime” is limited to the availability of electronic components. If the serviceable life is reached in less than three years following the original purchase from ELPRO, ELPRO will replace the product with an equivalent product if an equivalent product is available.

This warranty does not extend to:

- failures caused by the operation of the equipment outside the particular product's specification, or
- use of the module not in accordance with this User Manual, or
- abuse, misuse, neglect or damage by external causes, or
- repairs, alterations, or modifications undertaken other than by an authorized Service Agent.

ELPRO's liability under this warranty is limited to the replacement or repair of the product. This warranty is in lieu of and exclusive of all other warranties. This warranty does not indemnify the purchaser of products for any consequential claim for damages or loss of operations or profits and ELPRO is not liable for any consequential damages or loss of operations or profits resulting from the use of these products. ELPRO is not liable for damages, losses, costs, injury or harm incurred as a consequence of any representations, warranties or conditions made by ELPRO or its representatives or by any other party, except as expressed solely in this document.

Full product specifications and maintenance instructions are available from your Service Agent, your source of purchase, or from the master distributor in your country upon request and should be noted if you are in any doubt about the operating environment for your equipment purchase

In the unlikely event of your purchase being faulty, your warranty extends to free repair or replacement of the faulty unit, after its receipt at the master distributor in your country. Our warranty does not include transport or insurance charges relating to a warranty claim.

This warranty does not indemnify the purchaser of products for any consequential claim for damages or loss of operations or profits.

Should you wish to make a warranty claim, or obtain service, please forward the module to the nearest authorised Service Agent along with proof of purchase. For details of authorised Service Agents, contact your sales distributor.

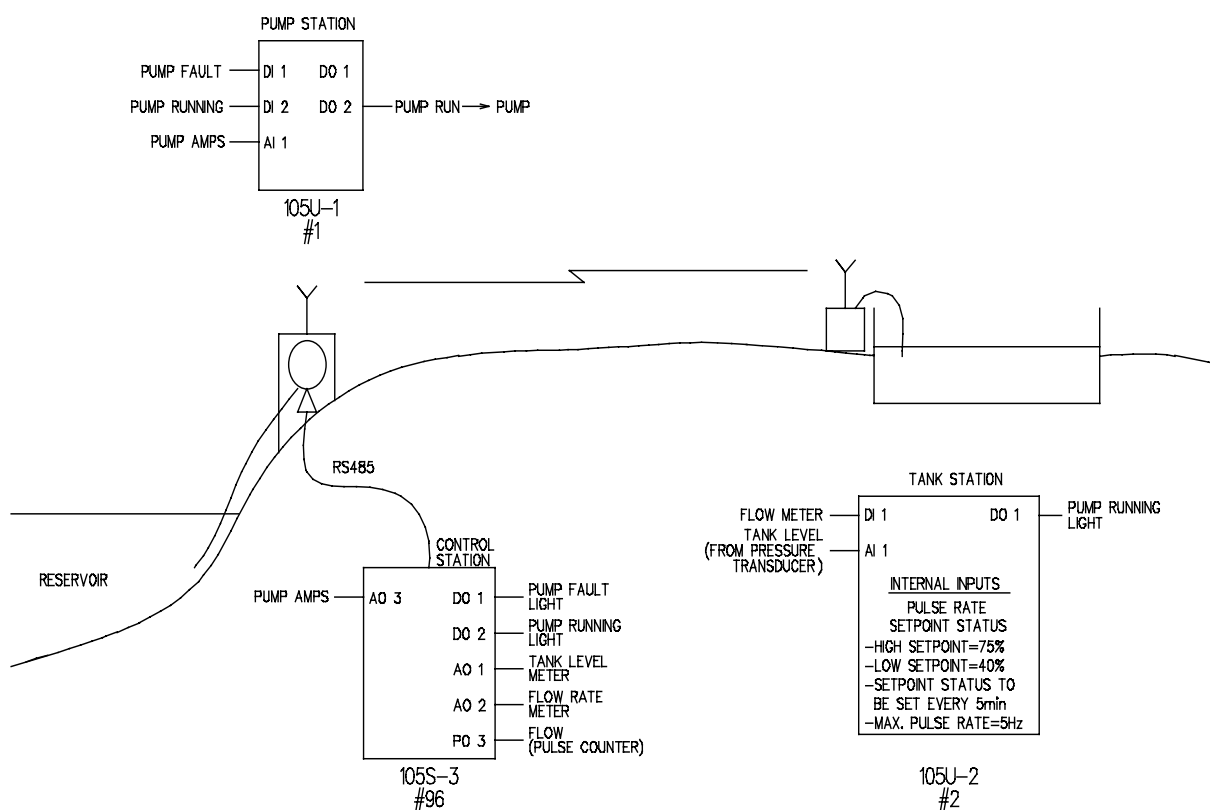
Appendix A SYSTEM EXAMPLE

The following example of a system is a comprehensive guide to using some of the features of the 105 range and design of 105 system.

The example application is a pump station which supplies water from a reservoir to a tank station. Signals are transferred between the pump station and tank station by radio - the distance between the two stations is 1.5 km (1 mile), and the radio path is heavily obstructed by buildings and trees. A control station is located near the pump station, and there is an existing signal cable between the control station and the pump station.

A 105U-1 module is installed at the pump station (with address 1) and a 105U-2 module is installed at the tank station (with address 2). Because the signal cable to the control station does not have enough cores for all of the signals required, the signal cable is used as a RS485 cable and a 105S-3 module is installed at the control station (with address 96). As this module has an address greater than 95, the 105U-1 at the pump station will communicate to it via its serial port.

The following diagram represents the system :-



The following design points should be noted :-

- A test of the radio path between the pump station and the tank station indicated that the radio path would be reliable provided antennas were installed at 6 m above the ground. At each site, the coaxial cable would be approx 10 m in length, so it was decided to use 3 element Yagi antennas with RG58 coaxial cable - the Yagi antennas would compensate for the loss in the cable.

The system was installed in a country which permitted the use of 500mW radio power. If this had not been the case, then an intermediate repeater station would have been required.

- At the tank station, there was an existing light pole with a mains power supply - the light pole was 10m high. Permission was obtained to mount the antenna from the pole and to use the power supply for the radio telemetry module.

As there was no existing electrical panel at this station, a small steel enclosure was installed on the light pole. A 2 Amp-Hour sealed battery was installed to provide power during any mains failure. The flow and level transducer were powered from the 24VDC loop supply provided by the 105 module.

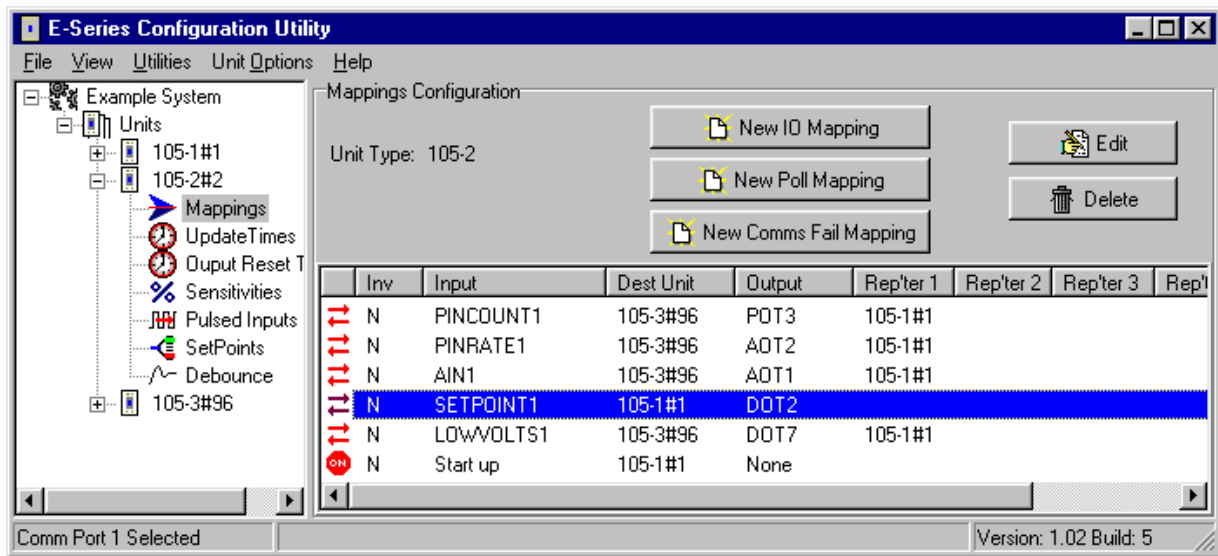
- At the pump station, the antenna was mounted on a 3 m J-bracket installed on the roof of the pump station building. The final height of the antenna was approx 6 m. Care was taken to align the Yagi antennas so they pointed at each other. The Yagi antennas were installed with horizontal polarity - that is, with the elements horizontal. These antennas will not "hear" other radio users on the same radio channel which generally use vertical polarity.

There was an existing electrical enclosure at the pump station, and the 105U module was installed inside this enclosure. The module was powered from 220VAC mains with a 2 Amp Hour sealed battery as backup.

- At the control station, the 105S module was installed inside the existing control panel enclosure. The module was powered from an existing 24VDC power supply.

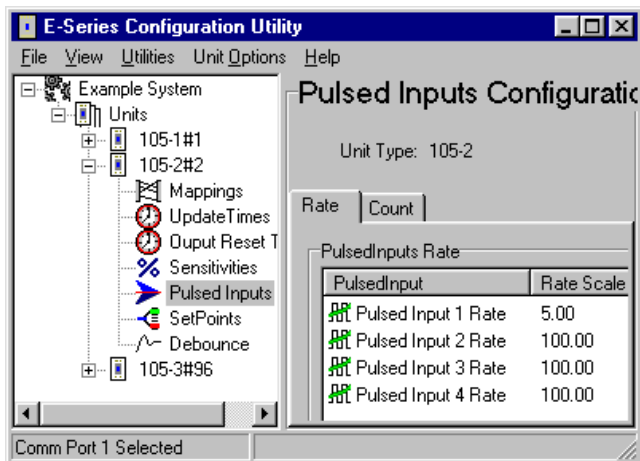
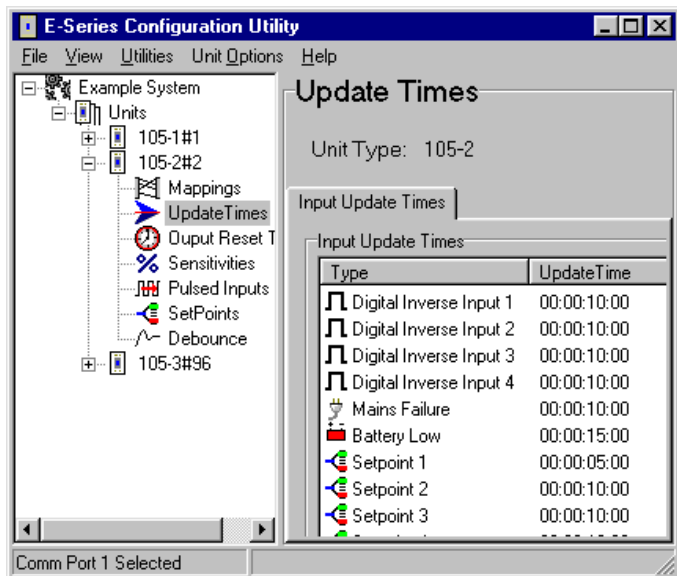
Tank Station Configuration

The 105U-2 module has the following configuration :-



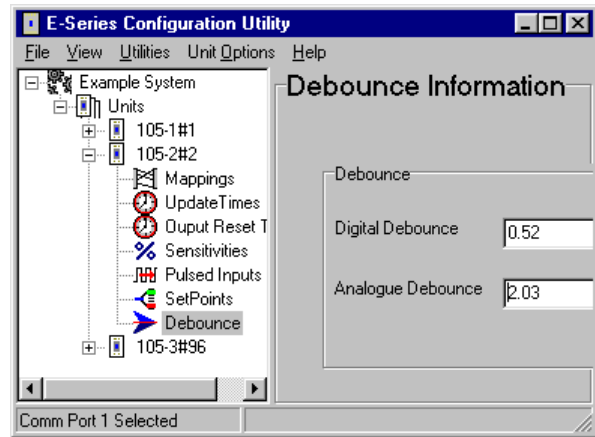
Note the following points in the configuration :

- #1 is a repeater for communications between #2 and #96
- The pulse rate scaling for PIN1 has been set to 5 Hz to match the maximum flow rate of the flow meter. Note that PIN1 has not been configured for "divide by 10" (for 1000 Hz pulse signals).
- AIN1 (the level transducer) is mapped to AO1 at the 105U-3. The analogue debounce has been set to 2 sec. This is because of concern of wave action on the surface of the tank causing un-necessary change transmissions. This debounce time will also operate on the Pulse Rate value, but as the flow rate changes slowly, this will not affect the performance of this signal.
- SETPOINT1 (the set-point status for AI1) is mapped to DO2 of #1 (pump station). The set-point values for this setpoint have been set to 40% and 75%. When the tank level drops to



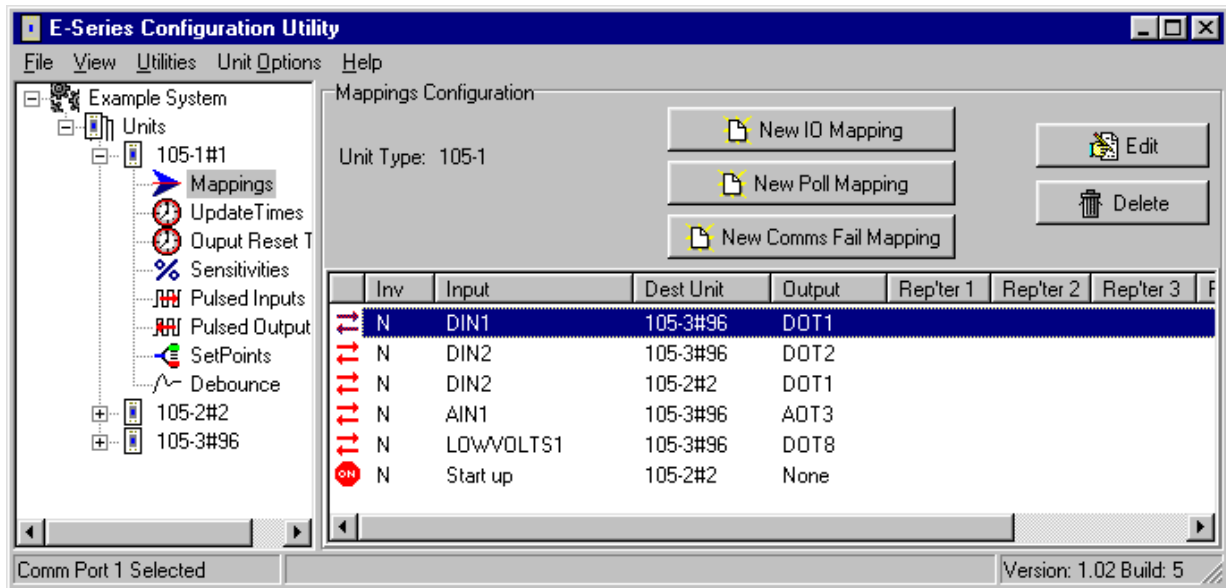
40%, DO2 at the pump station will activate to start the pump. When the level rises above 75%, DO2 will reset to stop the pump.

- The update time for SETPOINT1 has been changed to 5 minute, as required.
- An additional mapping has been entered - LOW VOLT has been mapped to DO7 at #96 via #1 (DO7 at the control station). This mapping is for future use - it will provide a low battery voltage alarm for the tank station. The update time for this mapping has been set to the maximum time of 15 minutes to reduce loading of the radio channel.
- A Start-up poll has been configured for #1, as DO1 at the tank station is controlled from the pump station. Note that no comms fail reset time has been configured for DO1. As this output drives an indication only, the indication will show the last correct status even during communication failures.



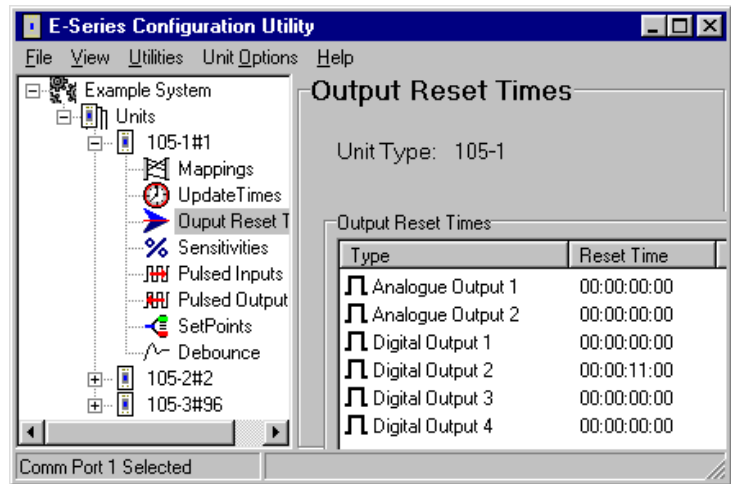
Pump Station Configuration

The 105U-1 module has the following configuration :-



Note the following points in the configuration:

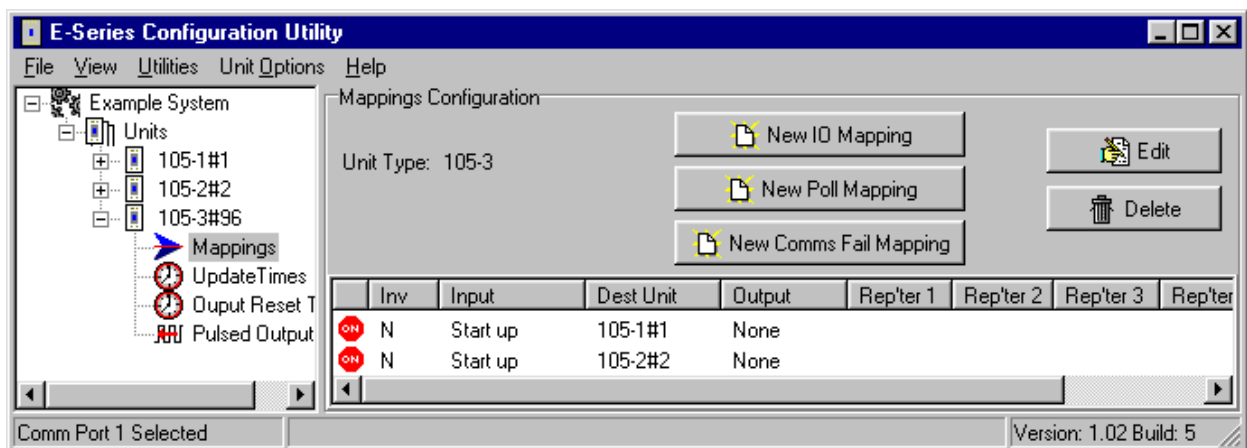
- Note that no repeater address is necessary between #1 and #96.
- DIN2 (pump running signal) has two mappings - a mapping to DO1 at #2 (tank station) and DO2 at #96 (control station). When DIN2 changes, there will be two separate change messages transmitted - one by radio to #2 and one by serial link to #96.



- AIN1 (pump amps) is mapped to AO3 at #97 (control station).
- An additional mapping has been entered - LOW VOLT has been mapped to DO8 at the control station. This mapping is for future use - it will provide a low battery voltage alarm for the pump station.
- A Start-up poll has been configured for #2, as DO2 at the pump station is controlled from the tank station. Note that a comms fail reset time of 11 minutes has been configured for DO2. This means that if a message has not been received for DO2 within 11 minutes, DO2 will reset and switch off the pump. The 11 min time was chosen as it means that two successive update messages have to be missed before the pump is reset, and there is no problems if the pump runs for 11 minutes during a system failure (the tank will not overflow during this time).

Control Station Configuration

The 105S-3 module has the following configuration :-

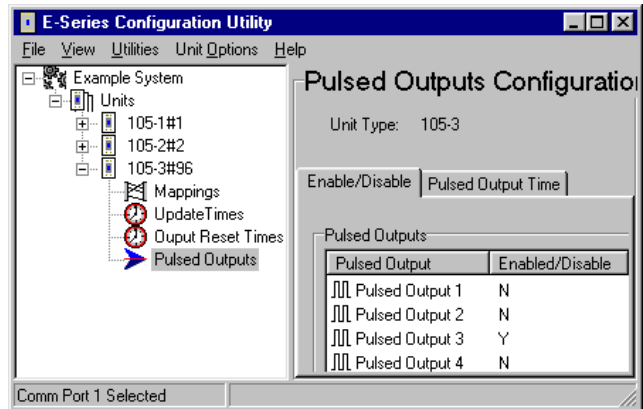


Note the following points in the configuration :

- The only mappings are Start-up polls. Note that there are two separate polls, one for each remote module.
- PO 3 has been configured as a PO. Its pulse output update time is the same as the PI

update time at the remote module (both have been left at their default value of 1 minute).

- Reset times have been selected for the analogue outputs (21 minutes) but not the digital outputs. In the event of a system failure, the digital outputs will stay at their last correct status, but the analogue outputs will reset to 0 mA.



System Failure Alarm

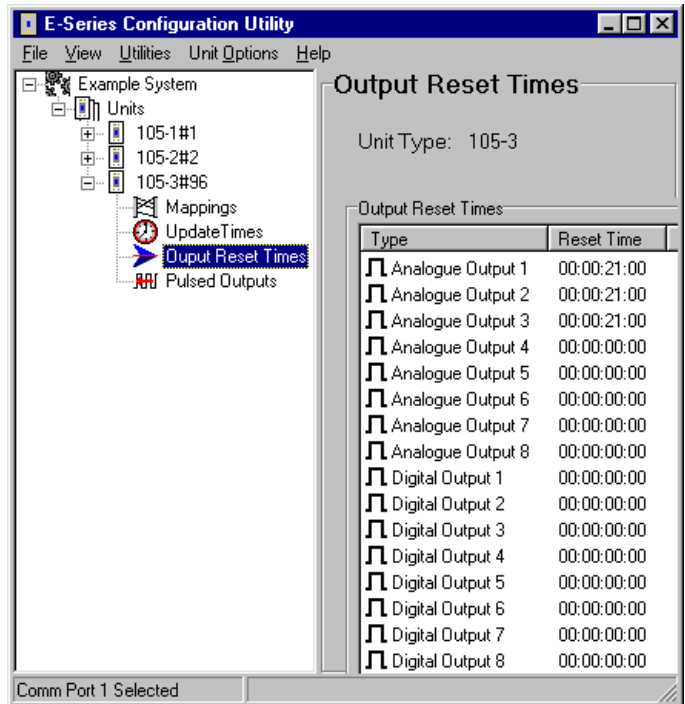
After the system had been running for some time, the operators wanted a "system failure" output at the control station, to warn the operators that there was a fault with the system.

The following configuration was added:

At #2 (tank station), Inverse DI4 → DO4 at #96 via 1 ; DI4 Update time = 1 minute

At #96 (control station), DO4 Comms fail reset time = 3.5 min

At the control station, DO4 was a "system OK" signal. It was normally active - if the signal reset, then this represented a system failure. At the tank station, there is no signal wired to DI4. By mapping Inv DI4 to DO4

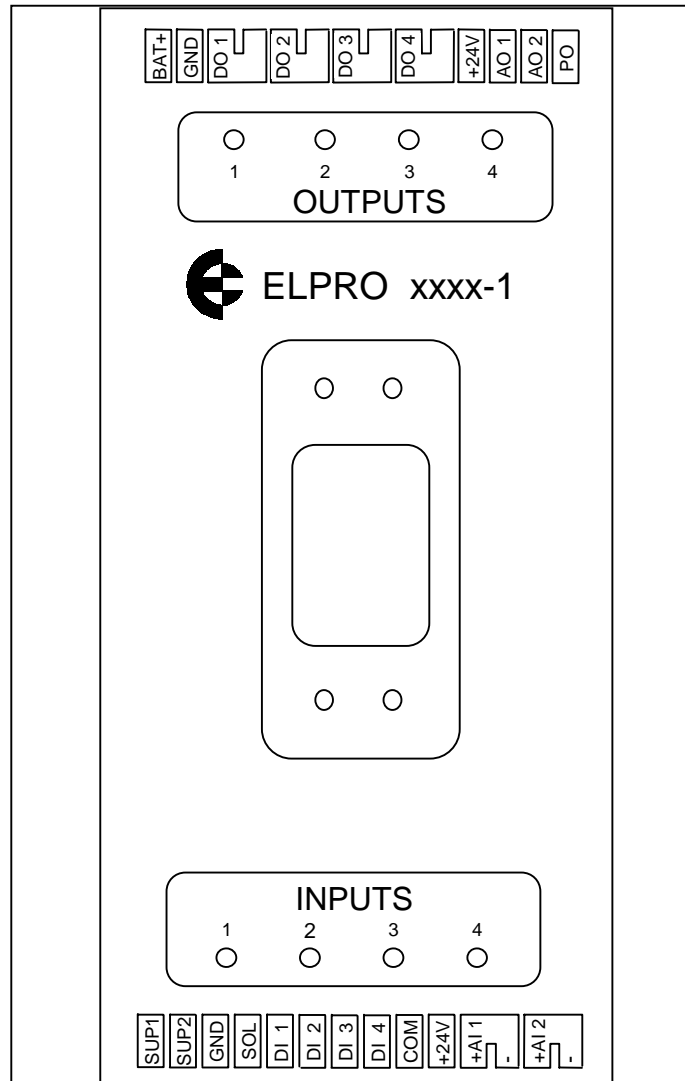


at the control station, a message is transmitted every minute to this output to activate it. The message is transmitted via the radio link to #1, and then by the serial link to #96. If anything happened to either module #2 or module #1, or the radio link, or the serial link, then the update messages for DO4 will not be received at the control station module. After 3.5 Minutes, DO4 will reset indicating a problem.

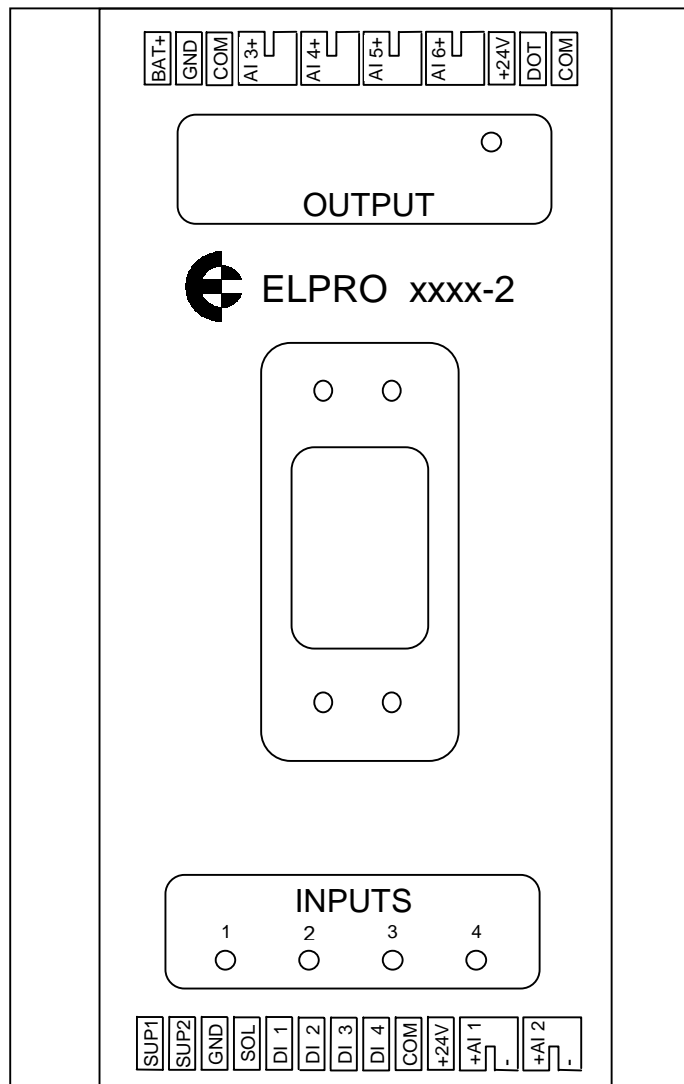
The time of 3.5 minutes was selected as this means that 3 successive update messages have to be missed before a system alarm occurs. Also note, that if module #96 fails, DO4 will reset and give an alarm signal.

Appendix B TERMINAL LAYOUTS

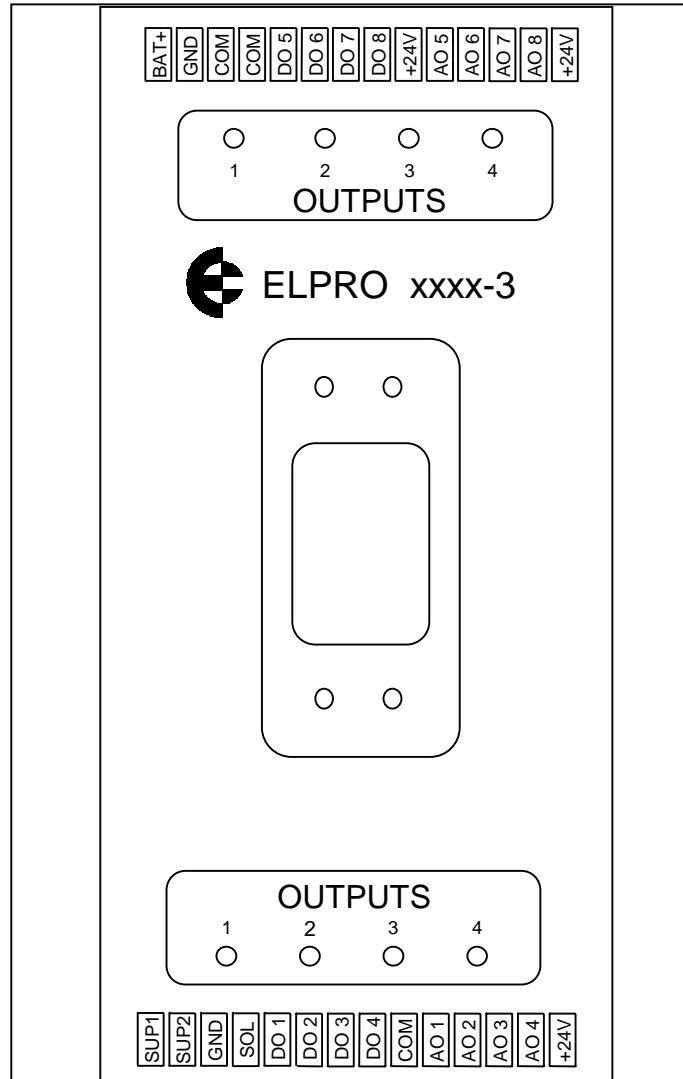
WIRING DRAWING - 105U-1, 905U-1 105S-1



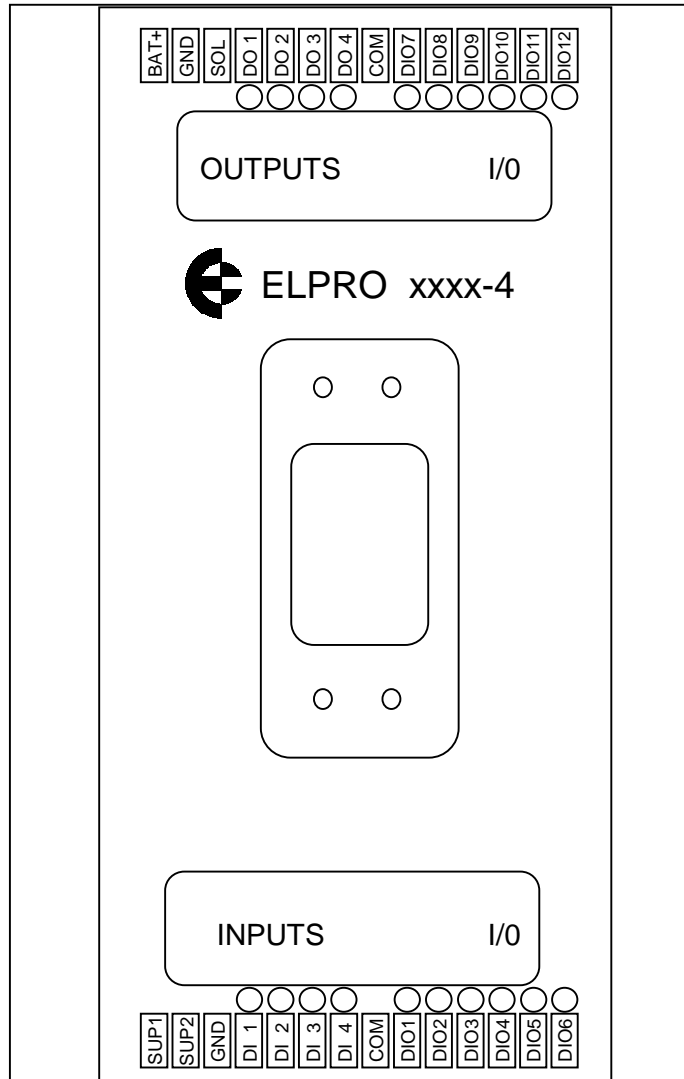
WIRING DRAWING - 105U-2, 905U-2 105S-2



WIRING DRAWING - 105U-3, 905U-3, 105S-3



WIRING DRAWING - 105U-4, 905U-4, 105S-4



19. Signal Isolator



Halmac Services (Qld) Pty. Ltd.
A.C.N. 098 852 923
A.B.N. 40 741 712 113

SIGNAL ISOLATOR

1. ECT SIGNAL ISOLATOR TECHNICAL DETAILS

June 2009

Description

ECT DIN-style signal isolators, converters, repeaters, boosters and splitters feature solid metal housings that stand up to the continuous, daily rigors of process control and factory automation applications.

Rugged and reliable, the ECT is available in 2-wire (loop) and 4-wire (line/mains) powered models. The complete family delivers economical solutions for an expansive range of signal interface applications.

- **Isolate Signals** to stop erratic measurements caused by ground loops.
- **Convert Signals** so field instruments can interface directly with an indicator, recorder, DCS, PLC or PC-based SCADA system.
- **Split One Signal** to allow one primary measurement to be sent to two separate systems.
- **Get two isolators in one.** The ECT is available in dual channel I/O models that provide application flexibility while reducing space requirements and costs.
- **Protect Equipment and Signals (Area Isolation)** by eliminating common electrical paths.
- **Amplify (Boost) Signals** so that more instruments can be added to an overburdened loop.
- **Solve “Bucking” Power Supplies** by stopping a conflict caused by a 4-wire transmitter and a DCS both trying to power the same process loop.
- **Step Down Dangerous,** high voltage signals to safer levels to protect plant personnel.
- **Solve DCS Start-Up Problems** caused by non-isolated transmitters by installing an ECT in each troublesome loop.

To choose the right ECT for your application, first determine the power supply characteristics:

Power Supply Type	Page
2-Wire, Output-Loop Powered (12-42Vdc)	2-3
2-Wire, Input-Loop Powered (5.5Vlp)	4-5
4-Wire, Line/Mains Powered (117Vac, 230Vac, 24Vdc)	6-7



Featuring metal DIN-style housings, the ECT snaps securely onto standard G-type and Top Hat rails.

Features

- **Current and voltage inputs.** Available models handle Current and Voltage Signals.
- **2-wire (loop) and 4-wire (line/mains) powered.** Versatile choices allow you to match the ECT to the type of AC or DC power available at each location.
- **Superior signal isolation (up to 1500Vrms).** Industrial-strength protection stops ground loops, motor noise, and other electrical interferences from affecting process signals.
- **RF/EMI protection.** The ECT provides an effective barrier against the unpredictable, harmful effects of radio frequency and electromagnetic interference. When ordered with the -RF option, the ECT delivers enhanced protection for especially noisy environments.

Certifications



Underwriter's Laboratories: General Location*



CE: Conformant to EMC 89/336/EEC EN 61326

*Certification not applicable to ECT-DIN models equipped with the RF option.

ECT-DIN

Signal Isolator, Converter, Repeater, Booster and Splitter

2-Wire, Output-Loop Powered Models

This ECT model derives operating power from its output side where loop power is typically made available by the receiving device, such as a DCS.

Stop Ground Loop Noise

Differences in potential between a grounded transmitter and a grounded receiving device may result in unpredictable ground loop problems, which can lead to signal drift. Use the ECT to break the galvanic path between the field instrument and receiving device (Figure 1).

Convert Signals

The ECT takes one process signal type (such as 1-5V) and converts it to a standard, isolated 4-20mA, allowing devices with incompatible signal types to interface with one another (Figure 1).

Divert and Protect (Area Isolation) Signals

Using the ECT, you can send the output from one transmitter to a second location; protect expensive monitoring/control equipment by eliminating common electrical paths; or create a buffer between devices to allow interruption of one leg of a loop without impacting the other (Figure 2).

Amplify (Boost) Signals

If you need to add an instrument to an overloaded loop, use the ECT. It features a high drive capability of 600 ohms (with a 24V power supply) and a low input impedance of just 50 ohms (Figure 3).

Solve “Bucking” Power Supplies

When two devices (such as a 4-wire transmitter and a DCS) are trying to source power to a loop, the result is a non-functioning loop. When neither of the devices can be eliminated, the solution is the ECT. It can operate with powered inputs from both sides, thus restoring normal operations to the loop (Figure 4).

Figure 1. Input/output loop isolation and signal conversion.

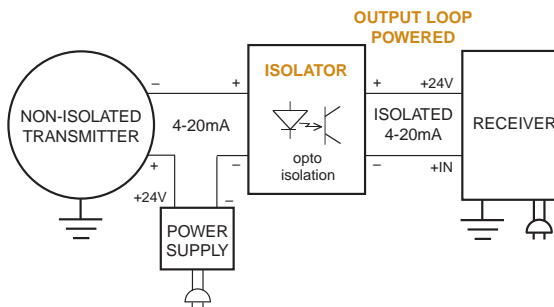


Figure 2. Divert a process signal, or protect expensive equipment by eliminating a common electrical path.

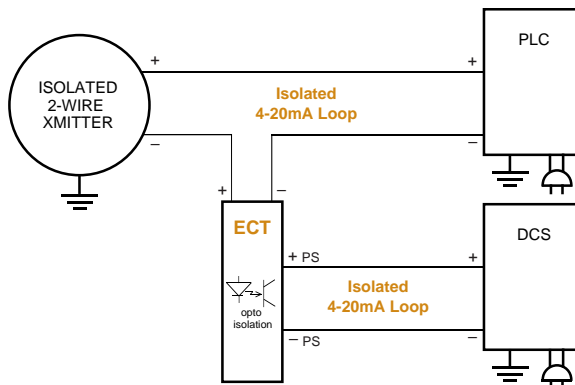


Figure 3. Boost process signals to allow another instrument to be added to an otherwise overloaded loop.

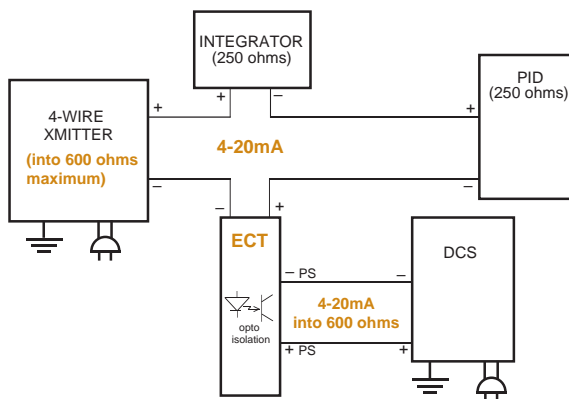
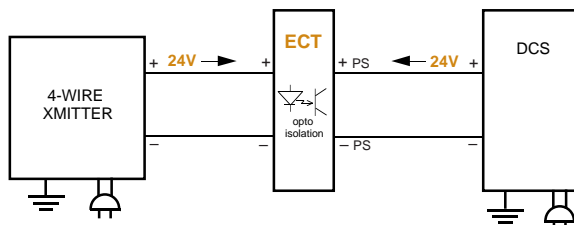


Figure 4. Restore a loop experiencing “bucking” power supplies to normal operation.



ECT-DIN

Signal Isolator, Converter, Repeater, Booster and Splitter

Specifications

<p>Performance Accuracy: ±0.1% of span (±0.2% for 0-150 AC inputs) Stability: ±0.2% of reading per year Isolation: WITHOUT -RF OPTION: 1500Vrms between input and output; WITH -RF OPTION: 500Vrms between input and output Output Response Time: DC Inputs, 100msec to 99% of output maximum; AC Inputs, 400msec to 99% of output Ripple: 10mV peak-to-peak maximum measured across a 250 ohm resistor Over-Voltage Protection: 48V, maximum on output; 48V reverse polarity protection on output</p>	<p>Performance (continued) Maximum Input Overrange: Current Inputs 250% of full scale; DC Voltage Inputs, 150% of full scale Burden: 1V maximum with 4-20mA input; 0.01V maximum with 0-5A input Load Capability: $\frac{V_s - 12V_{dc}}{0.02A} = \text{ohms}$ Output Current Limiting: 25mA typical; 30mA maximum</p> <p>Ambient Conditions Operating Range: -40°C to +85°C (-40°F to +185°F) Storage Range: -40°C to +85°C (-40°F to +185°F)</p>	<p>Ambient Conditions (Continued) Ambient Temperature Effect: ±0.007% of span/°C typical; ±0.015% of span/°C maximum Relative Humidity: 0-95% non-condensing RFI/EMI Protection: Less than ±0.1% of span error when tested at 10V/m @ 20-1000MHz WITH -RF OPTION: Less than ±0.1% of span error when tested at 30V/m @ 20-1000MHz Common Mode Rejection: Exceeds 95dB @ 60Hz with a limit of 1500Vrms</p> <p>Adjustments Type: Front panel pots Span: ±10% Zero: ±5% (non-interactive when span is set first)</p> <p>Weight 145g (5 oz)</p>
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Ordering Information

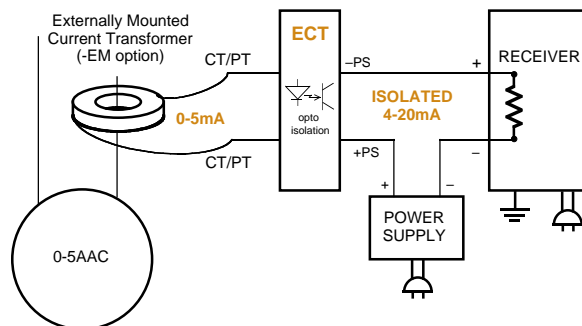
Unit	Input	Output	Power	Options	Housing
ECT 2-wire (Output-Loop Powered) Isolator/Converter	4-20MA into 50 ohms 1-5V into 1 Mohm 0-10V into 1 Mohm 0-150AC into 100 kohms 0-5AAC into 0.002 ohms	4-20MA into 600 ohms with 24Vdc power supply	12-42DC	-RF Enhanced RFI/EMI filtering provides 30V/m @ 20-1000MHz protection with less than ±0.1% of span error -EM Externally-mounted input transformer for current input (available with 0-5Aac input type only)	DIN Aluminum DIN-style housing mounts on 32mm G-type (EN50035) and 35mm Top Hat (EN50022) rails FLB2 Externally-mounted flange provides a secure mount and ensures resistance to vibration

When ordering, specify: Unit / Input / Output / Power / Options [Housing]
 Model number example: ECT / 4-20MA / 4-20MA / 12-42DC / -RF [DIN]

Step Down Unsafe High Level Signals

To protect plant personnel, the ECT comes with an optional external input transformer (-EM option) to step down high level AC current inputs to a low level signal. This permits safer servicing without opening the secondary of a current transformer (Figure 5).

Figure 5. To protect plant personnel, step down potentially dangerous high level AC current signals to lower level signals.



ECT-DIN

Signal Isolator, Converter, Repeater, Booster and Splitter

2-Wire, Input-Loop Powered Models

The 2-wire, input-loop powered ECT derives its operating power from the input side of the process loop (Figure 6). This model provides loop isolation when line power or output-loop power is not available. Its simple hook-up method provides a cost-effective interface between field signals and a computer, DCS or other multiple-input system.

IMPORTANT NOTE: When choosing this type of isolator, notice the total load imposed on the input loop. Because it derives all operating power from the input loop, that loop must be able to handle the isolator's input impedance and output load (maximum output load is 250 ohms).

Single and Multiple Unit Instrument Enclosures

Designed to meet NEMA 4X and IP66 ratings, the R-BOX is the perfect solution for protecting the ECT in field and control room applications. Rugged and versatile, it delivers a high impact structure and resistance to ultraviolet rays and chemicals.

The R-BOX mounts on a pipe, panel or surface, and comes in a variety of widths to economically accommodate just one, or up to 10, ECTs. It features a pre-installed mounting rail; customizable conduit entry options; a clear cover; and a secure locking mechanism.

For more information, see the R-BOX Field-Mount Enclosure for DIN Instruments data sheet.

Figure 6. The input-loop powered ECT provides loop isolation when line power or output-loop power is not available.

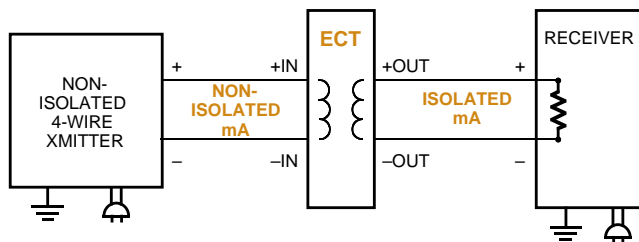
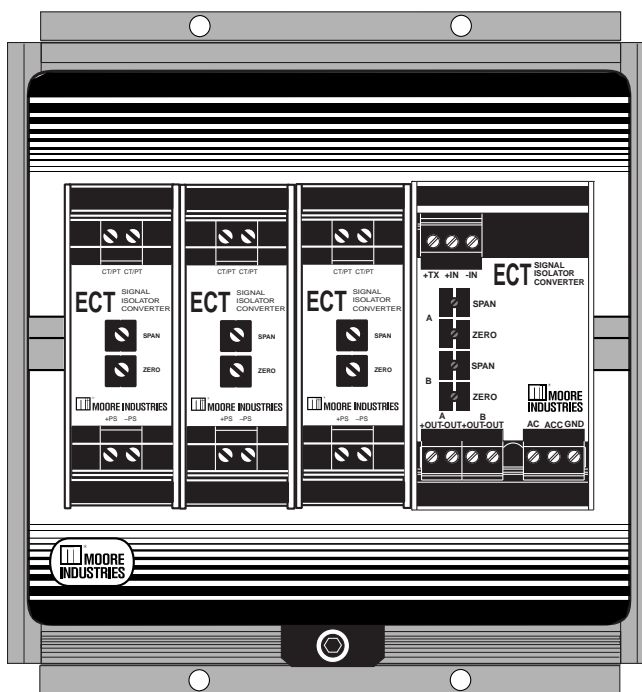


Figure 7. Available in a variety of widths, our R-BOX field-mount instrument enclosure is designed to protect DIN-rail instruments in even the most rugged environments.



ECT-DIN

Signal Isolator, Converter, Repeater, Booster and Splitter

Specifications

<p>Performance Accuracy: ±0.075% of span Stability: ±0.2% of reading per year Isolation: 500Vrms between input and output Output Response: 20msec maximum to 99% of output Ripple: 10mV peak-to-peak maximum measured across a 250 ohm resistor Over-Voltage Protection: 48V, maximum on output; 48V, reverse polarity protection on output Maximum Input Overrange: 200% of full scale Burden: 5.5V when out-</p>	<p>Performance (continued) puts are shorted for 4-20mA inputs, 10.5V with 250 ohm load (Output load voltage is reflected on input. Output should be trimmed for anticipated output load) Output Current Limiting: 30mA with 250 ohm output load</p> <p>Ambient Conditions Operating Range: -29°C to +82°C -20°F to +180°F Storage Range: -40°C to +85°C (-40°F to +185°F)</p>	<p>Ambient Conditions (Continued) Ambient Temperature Effect: ±0.018% of span/°C; ±0.005% of span/°C gain change Relative Humidity: 0-95% non-condensing RFI/EMI Protection: Less than ±0.1% of span error when tested at 10V/m @ 20-1000MHz WITH -RF OPTION: Less than ±0.1% of span error when tested at 30V/m@20-1000MHz Common Mode Rejection: Exceeds 95dB @ 60Hz with a limit of 1500Vrms</p> <p>Adjustments Type: Front panel pots Trim: ±1%</p> <p>Weight 145g (5 oz)</p>
---	---	---

Ordering Information

Unit	Input	Output	Power	Options	Housing
ECT 2-wire (Input-Loop Powered) Isolator/ Converter	4-20MA into 275 ohms	4-20MA into 0-250 ohms	Current Loop Excitation at 4mA: 5.5VLP 5.5 volts loop powered with 4-20mA (plus voltage across output load)	-RF Enhanced RFI/EMI filtering provides 30V/m @ 20-1000MHz protection with less than ±0.1% of span error	DIN Aluminum DIN-style housing mounts on 32mm G-type (EN50035) and 35mm Top Hat (EN50022) rails FLB2 Externally-mounted flange provides a secure mount and ensures resistance to vibration

When ordering, specify: Unit / Input / Output / Power / Options [Housing]
Model number example: ECT / 4-20MA / 4-20MA / 5.5VLP / -RF [DIN]

Need Enhanced Features?

PC-Programmable Universal Interface

Our model SIY signal isolator, converter, and repeater is the ideal plant standard. This 2-wire (loop-powered), microprocessor-based instrument programs in less than a minute to handle a wide range of current and voltage inputs. It even allows creation of custom input linearization curves. For detailed information, see the SIY data sheet.

Unusual Input and Outputs

We have instruments that handle a wide array of non-standard inputs and outputs.

Custom Signal Isolators

We have engineers on hand to modify our instrument to meet your unique needs.

RTD, T/C, mV, Potentiometer, I/P, P/I, Strain Gage, and Frequency Signals

We are the Interface Solution Experts. When you need to interface field processes with computer-based systems, readout equipment, and other instrumentation... our technology, services, and experience help you do it efficiently, safely, and cost-effectively.

ECT-DIN

Signal Isolator, Converter, Repeater, Booster and Splitter

4-Wire, Line/Mains Powered Models

These ECT models are powered by standard 117Vac, 230Vac, and 24Vdc power supplies (Figure 8). They are designed for applications where line/mains power is readily available, such as the back of a panel or in a control room.

Step Down Unsafe, High Level Signals

To protect plant personnel, the 4-wire ECT comes with an optional external input transformer (-EM option) to step down high level AC current inputs to a low level signal. This permits safer servicing without opening the secondary of a current transformer (Figure 9).

Power a 2-Wire Transmitter

With the -TX option, our 4-wire ECTs provide 24V power to a 2-wire, output-loop powered instrument. This eliminates the need for an additional power supply (Figure 10). **IMPORTANT:** Our 2X4-20MA dual input model provides a transmitter excitation of 16V. Refer to Figure 12 for an illustration of dual input model operation.

“Sharing” or “Splitting” a Process Signal

The ECT with dual outputs will take one input and deliver two identical, completely isolated outputs to two separate monitoring or control devices (Figure 11). This is valuable for viewing one process variable at two locations, such as in custody transfer, where two parties require identical information for accountability or billing purposes. Maintenance of one system does not disturb the information being collected at the second location. In addition, a failure at one receiver will not affect the second loop.

One Isolator Does the Work of Two

When ordered with dual input and output channels, the ECT will perform the functions of two isolators (Figure 12). Each of the ECT’s two input-to-output channels is independent and completely isolated from the other.

Figure 8. 4-wire ECT models are ideal for use where line (mains) power is readily available.

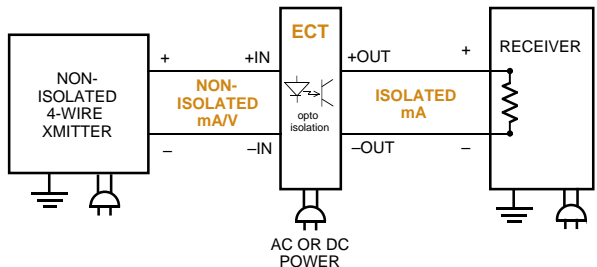


Figure 9. When ordered with the -EM option, the ECT comes with an externally-mounted current transformer to “step down” high level signals.

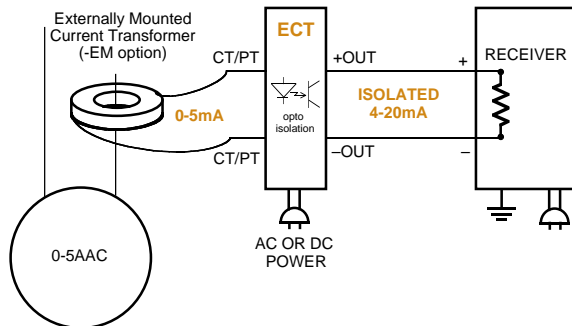


Figure 10. With the -TX Transmitter Excitation option, the ECT will supply loop power to a 2-wire transmitter.

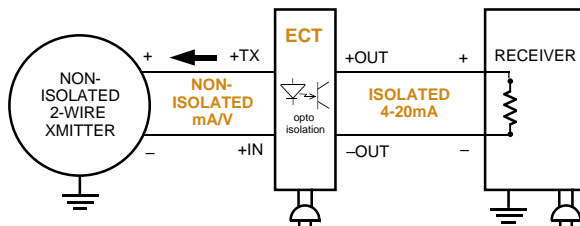


Figure 11. The ECT takes one process input and delivers two completely isolated signal outputs.

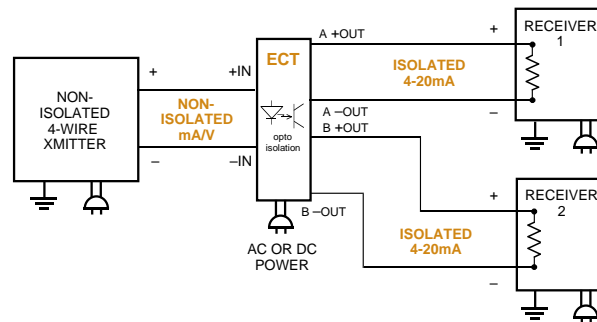
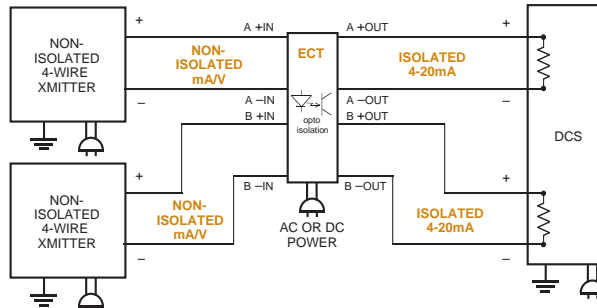


Figure 12. The ECT takes two process inputs and delivers two completely isolated signal outputs.



NOTE: ONLY 16V TX EXCITATION PROVIDED ON 2X4-20MA DUAL INPUT MODEL

ECT-DIN

Signal Isolator, Converter,
Repeater, Booster and Splitter

Specifications

<p>Performance</p> <p>Accuracy: ±0.1% of span Stability: ±0.2% of reading per year Isolation: WITHOUT -RF OPTION: 1500Vrms between input and output and power; WITH -RF OPTION: 500Vrms between input and output, 1500Vrms power terminals; DUAL I/O WITHOUT -RF OPTION: 1500Vrms Output Response Time: DC Input: 100msec, maximum to 99% of output; AC Input: 400msec, maximum, from 0-99% of output DC Input Resistance: 50 ohms Ripple: 10mV peak-to-peak maximum measured across 250 ohm resistor Load Effect: 0.01% of span from 0-100% of rated output (current only)</p>	<p>Performance (continued)</p> <p>Power Supply Rejection: Exceeds 90dB for current input unit Maximum Input Overrange: Current inputs, 250% of full scale DC Voltage inputs 150% of full scale Burden: 1V maximum with 4-20mA input; 0.01V maximum with 0-5A input Output Current Limiting: 25mA, typical; 30mA, maximum</p> <p>Ambient Conditions</p> <p>Operating Range: -40°C to +85°C -40°F to +185°F Storage Range: -40°C to +85°C (-40°F to +185°F) Ambient Temperature Effect: ±0.007% of span/°C, typical; ±0.015% of span/°C, maximum Relative Humidity: 0-95% non-condensing</p>	<p>Ambient Conditions (Continued)</p> <p>RFI/EMI Protection: Less than ±0.1% of span error when tested at 10V/m@20-1000MHz WITH -RF OPTION: Less than ±0.1% of span error when tested at 30V/m@20-1000MHz; DUAL I/O WITHOUT -RF OPTION: Output unaffected by more than ±0.5% of span@10V/M 20-1000MHz Common Mode Rejection: Exceeds 95dB@60Hz with a limit of 1500Vrms</p> <p>Adjustments</p> <p>Front panel pots Span: ±10% Zero: ±5% (non-interactive when span is set first)</p> <p>Weight</p> <p>Single I/O Channel: 384g (13.7 oz) Dual I/O Channels: 431g (15.4 oz)</p>
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Ordering Information

Unit	Input	Output	Power	Options	Housing
ECT 4-Wire (Line/Mains) Powered Isolator/ Converter	<p>SINGLE INPUT CHANNEL: 4-20MA into 50 ohms 1-5V into 1 Mohm 0-10V into 1 Mohm 0-150AC into 100 kohms 0-5AAC into 0.002 ohms</p> <p>DUAL INPUT CHANNELS: 2X4-20MA into 25 ohms 2x1-5V into 1 Mohm 2X0-10V into 1 Mohm (Other AC ranges also available)</p>	<p>SINGLE OUTPUT CHANNEL: 4-20MA into 1000 ohms 0-10V into 5 kohms minimum</p> <p>DUAL OUTPUT CHANNELS: 600 ohms 2X1-5V into 5 kohms minimum 2X0-10V into 5 kohms minimum</p> <p>DUAL OUTPUT CHANNELS (Signal Splitter): 2X4-20MA into 600 ohms (available with 4-20mA input only)</p>	<p>24DC, ±10% 117AC, 50/60Hz, ±10% 230AC, 50/60Hz, ±10% (3 watts maximum for single channel models; 5 watts maximum for dual output channel models)</p>	<p>-EM Externally-mounted input transformer for current input (available with 0-5AAC input only) -TX 24V transmitter excitation (16V for 2X4-20MA DUAL INPUT model) for powering a 2-wire transmitter (available on 4-20mA input models only; standard on models with 2X4-20mA output) -RF Enhanced RFI/EMI filtering provides 30V/m@ 20-1000MHz protection with less than ±0.1% of span error (-EM option required for AC current input) -EP External power, output stage powered by external source (only available on signal splitter in DIN housing)</p>	<p>DIN Aluminum DIN-style housing mounts on 32mm G-type (EN50035) and 35mm Top Hat (EN50022) rails FLB2 Externally-mounted flange provides a secure mount and ensures resistance to vibration</p>

When ordering, specify: Unit / Input / Output / Power / Options [Housing]
Model number example: ECT / 1-5V / 4-20MA / 117AC / -RF [DIN]

ECT-DIN

Signal Isolator, Converter, Repeater, Booster and Splitter

Figure 13. Dimensions for 2-Wire and 4-Wire ECT-DIN models

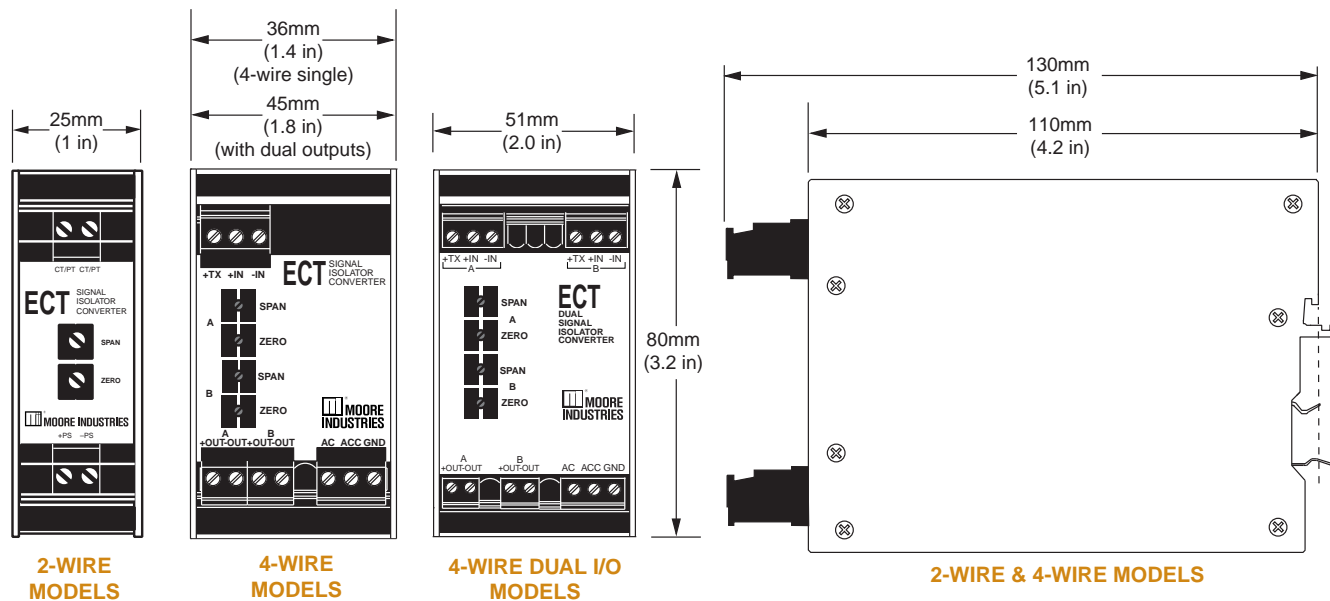


Table 1. Terminal Designations for 2-Wire Units

2-Wire Output-Loop Powered Models	Top Terminals (left to right)		Bottom Terminals (left to right)	
	Output-Loop Powered	+IN	-IN	+PS
Output-Loop Powered with -EM Option	CT/PT	CT/PT	+PS	-PS
2-Wire Input-Loop Powered Models	Top Terminals (left to right)			
	Input-Loop Powered	+IN	-IN	+OUT

Table 2. Terminal Designations for 4-Wire Units

4-Wire (Line/Mains-Powered) Models	Top Terminals (left to right)			Bottom Terminals (left to right)							
	T1	T2	T3	B1	B2	B3	B4	B5	B6	B7	B8
AC Power Single Input/Dual Outputs & -TX	+TX	+IN	-IN	A +OUT	A -OUT	B +OUT	B -OUT		AC	ACC	GND
DC Power Single Input/Dual Outputs & -TX	+TX	+IN	-IN	A +OUT	A -OUT	B +OUT	B -OUT		DC	DCC	GND
	T1	T2	T3	B1	B2	B3	B4	B5	B6		
Power with AC Inputs or -EM Option		CT/PT	CT/PT	+OUT	-OUT		AC	ACC	GND		
AC Power with -TX Option	+TX	+IN	-IN	+OUT	-OUT		AC	ACC	GND		
Power with DC Inputs or -EM Option		CT/PT	CT/PT	+OUT	-OUT		DC	DCC	GND		
DC Power with -TX Option	+TX	+IN	-IN	+OUT	-OUT		DC	DCC	GND		

Table 3. Terminal Designations for 4-Wire Dual I/O Units

4-Wire (Line/Mains-Powered) Dual I/O Models	Top Terminals (left to right)									Bottom Terminals (left to right)								
	T1	T2	T3	T4	T5	T6	T7	T8	T9	B1	B2	B3	B4	B5	B6	B7	B8	B9
AC Power & Dual Inputs/Dual Outputs	A +TX	A +IN	A -IN				B +TX	B +IN	B -IN	A +OUT	A -OUT		B +OUT	B -OUT		AC	ACC	GND
DC Power & Dual Inputs/Dual Outputs	A +TX	A +IN	A -IN				B +TX	B +IN	B -IN	A +OUT	A -OUT		B +OUT	B -OUT		DC	DCC	GND



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20. Surge Diverter & Surge Reduction Filter



Halmac Services (Qld) Pty. Ltd.
A.C.N. 098 852 923
A.B.N. 40 741 712 113

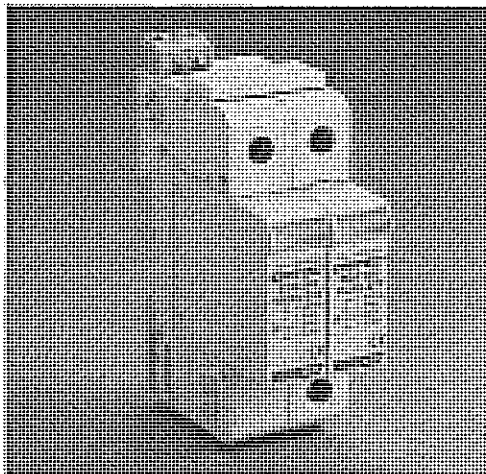
SURGE DIVERTER & SURGE REDUCTION FILTER

1. TDS1100 SURGE DIVERTER TECHNICAL
DETAILS
2. DAR ALARM RELAY TECHNICAL DETAILS
3. TDF SURGE REDUCTION FILTER TECHNICAL
DETAILS

CRITEC® TDS1100

Asia/Australia
Europe
Latin America
North America

TDS Surge Diverter - TDS1100 Series



- CRITEC® TD Technology with thermal disconnect protection
- Compact design fits into DIN distribution panel boards and motor control centers
- 35 mm DIN rail mount – DIN 43 880 profile matches common circuit breakers
- Indication flag and voltage-free contacts provide remote status monitoring
- Separate plug and base design facilitates replacement of a failed surge module
- 100kA 8/20 maximum surge rating provides protection suitable for sub-distribution panels and a long operational life
- Available in various operating voltages to suit most common power distribution systems

Surges and voltage transients are a major cause of expensive electronic equipment failure and business disruption. Damage may result in the loss of capital outlays, such as computers and communications equipment, as well as consequential loss of revenue and profits due to unscheduled system down-time.

The TDS1100 series of surge suppressors provide economical and reliable protection from voltage transients on power distribution systems. They are conveniently packaged for easy installation on 35 mm DIN rail within main distribution panelboards.

CRITEC® TD technology helps ensure reliable and continued operation during sustained and abnormal over-voltage events. Internal thermal disconnect devices help ensure safe or at end-of-life. A visual indicator flag provides user-feedback in the event of such operation. As standard, the TDS1100 provides a set of voltage-free contacts for remote signaling that maintenance is due.

The convenient plug-in module and separate base design facilitates replacement of a failed surge module without needing to undo installation wiring.

Model	TDS11002SR150	TDS11002SR240	TDS11002SR277	TDS11002SR560
Nominal Voltage U _n	120-150V~	220-240V~	240-277V~	480-560V~
Max. Cont. Operating Voltage U _c	170V~	275V~	320V~	610V~
Stand off Voltage	240V~	440V~	480V~	700V~
Frequency	0 - 100Hz			
Short Circuit Current Rating I _{sc}	25kAIC			
Required Back-up Fuse	125Agl, if supply > 100A			
Technology Used	TD with thermal disconnect			
Protection				
Maximum Discharge Current I _{max}	100kA 8/20µs			
Nominal Discharge Current I _n	50kA 8/20µs	40kA 8/20µs	40kA 8/20µs	40kA 8/20µs
Protection Modes	Single mode (L-G, L-N or N-G)			
Voltage Protection Level Up @ 3kA	< 400V	< 700V	< 800V	< 1.6kV
Voltage Protection Level Up @ 20kA	< 650	< 1000	< 1.1kV	< 2kV
Alarms and Indicators				
Status Indication	Mechanical flag / remote contacts (R model only) Change-over, 250V~ / 0.5A, max 1.5 mm ² (#14AWG) terminals			
Physical Data				
Dimensions	2 modules wide, 90 mm x 68 mm x 35 mm			
Weight	0.24 kg approx.			
Enclosure	DIN 43 880, UL94V-0 thermoplastic, IP 20 (NEMA-1)			
Connection	≤35 mm ² (#2AWG) solid ≤25 mm ² (#4AWG) stranded			
Mounting	35 mm top hat DIN rail			
Temperature	-40°C to +80°C (-40°F to +176°F)			
Humidity	0 to 90%			
Test Standards				
Approvals	CE, IEC™ 61643-1, UL® 1449 Pending			
Surge Rated to Meet	IEC 61643-1 Class I and II ANSI/IEEE C62.41-1991 Cat A, Cat B, Cat C			

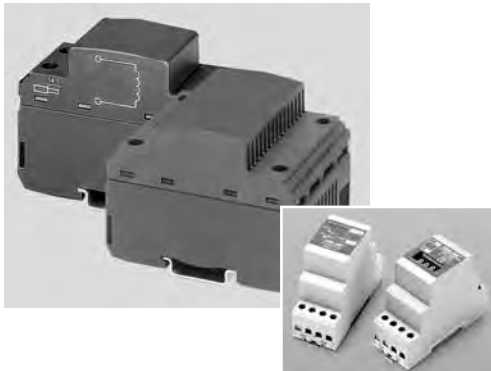
Due to a policy of continual product development, specifications are subject to change without notice.



CRITEC® DDI/DAR/TDS SC

Asia/Australia
Europe
Latin America

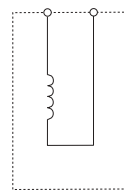
DIN Decoupling Inductor/ DINLINE Alarm Relay & Surge Counter



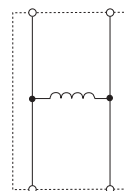
- Use for decoupling of spark gaps and MOVs – allows correct coordination of different SPD technologies
- 35 mm² tunnel terminals – accepts large cable size
- 63A model features top and bottom terminals – flexible installation
- The DINLINE Alarm Relay (DAR) is used with TDF products where alarm contacts are required for remote signaling
- The TDS-SC Surge Counter provides a non-resettable record of the number of surges diverted

Decoupling inductors are installed between spark gap and MOV protection devices to ensure correct coordination. As the decoupling inductors are installed in series with the load, two units are available, a compact unit for circuits up to 35A and a larger unit for 63A circuits.

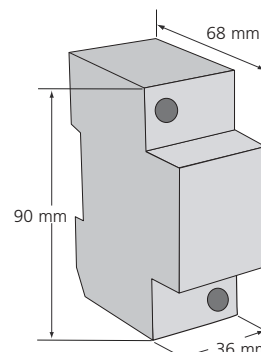
The DAR (DINLINE Alarm Relay) can be connected to TDF units to provide potential free change-over alarm contacts. The TDS SC (Surge Counter) unit is designed to provide visual indication of the number of surges registered. It uses a current transformer through which the ground conductor connecting to one, or all, of the surge protection modules is fed. Current diverted by the operation of the surge module, which exceeds a 300A trip threshold, will be registered on the counter.



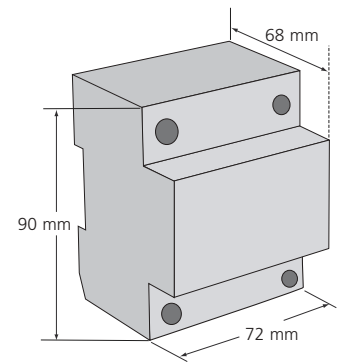
DDI 35



DDI 63



DDI 35



DDI 63

Model	DDI 35	DDI 63	DAR275V	TDS SC
Item Number for Europe	700465	700475	700900	701250
Nominal Voltage U _n	-	-	20-110V---, 100-240V~	-
System Compatibility(1)	-	-	TN-C, TN-S, TN-C-S & TT	-
Max. Cont. Operating Voltage U _c	500V~ 200V---	-	275V	-
Stand-off Voltage	-	-	275V	-
Operating Current @ U _n	-	-	20mA	-
Frequency	0 to 60Hz	-	-	-
Max. Line Current I _l	35A @ 40°C	63A @ 40°C	-	-
Temperature Increase	45° C @ max line current (I _l)	-	-	-
Inductance	7.5µH	15µH	-	-
Resistance	4.5mΩ	1.7mΩ	-	-
Technology	-	-	CT - trip threshold 300A 8/20µs	-
Status	-	-	Red/Green LEDs Change-over contact ⁽¹⁾	Maximum count 9999 Non-resettable
Dimensions	2 M. 90 mm x 68 mm x 36 mm (3.5" x 2.6" x 1.4") approx.	4 M. 90 mm x 68 mm x 72 mm (3.5" x 2.6" x 2.8") approx.	2 M. 90 mm x 68 mm x 36 mm (3.5" x 2.6" x 1.4") (excluding CT)	-
Weight	0.45 kg (1 lb) approx.	1 kg (2.2 lb) approx.	0.2 kg (0.44 lb)	-
Enclosure	DIN 43 880, UL94V-0 thermoplastic, IP 20 (NEMA-1)			
Connection	≤35 mm ² (#2AWG) solid ≤25 mm ² (#4AWG) stranded		1 mm ² to 6 mm ² (#18AWG to #10)	
Mounting	35 mm top hat DIN rail			
Back-up Overcurrent Protection	35A	63A	-	-
Temperature	-40°C to +70°C (-40°F to +158°F)		-35°C to +55°C (-31°F to +131°F)	
Humidity	0% to 90%			
Warranty	5 years		CSA22.2	-
Approvals	CE		C-Tick, AS 3260, CE	-

(1) Form C = Change-over contact (Form C dry contact), 400V~/3A 1 mm² to 6 mm² (#18AWG to #10AWG) connecting wire

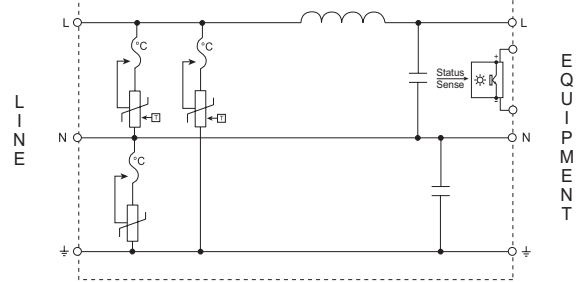
Transient Discriminating Filter



- In-line series protection
- High efficiency low pass sine wave filtering – ideal for the protection of switched mode power supplies
- Three modes of protection: L-N, L-PE & N-PE
- 35 mm DIN rail mount – simple installation
- Transient Discriminating (TD) Technology – provides increased service life
- LED status indication and opto-isolated output – for remote status monitoring

The TDF series has been specifically designed for process control applications to protect the switched mode power supply units on devices such as PLC controllers, SCADA systems and motor controllers. Units are UL Recognized and available for 3A, 10A and 20A loads and suitable for 110-120V ac/dc and 220-240Vac circuits.

The TDF is a series connected, single phase surge filter providing an aggregate surge capacity of 50kA (8/20µs) across L-N, L-PE, and N-PE. The low pass filter provides up to 65dB of attenuation to voltage transients. Not only does this reduce the residual let-through voltage, but it also helps further reduce the steep voltage rate-of-rise providing superior protection for sensitive electronic equipment.



Model	TDF3A 120V	TDF3A 240V	TDF10A 120V	TDF10A 240V	TDF20A 120V	TDF20A 240V
Item Number for Europe	700001	700002	700003	700004	700005	700006
Nominal Voltage U _n	120V	240V	120V	240V	120V	240V
Distribution System	1Ph 2W+G, TN-S & TN-C-S					
Max. Cont. Operating Voltage U _c	170V	340V	170V	340V	170V	340V
Stand-off Voltage	240V	400V	240V	400V	240V	400V
Frequency	0 to 60Hz		0 to 60Hz		0 to 60Hz	
Max. Line Current I _L	3A		10A		20A	
Operating Current @ U _n	135mA	250mA	240mA	480mA	240mA	480mA
Max. Discharge Current I _{max}	20kA 8/20 µs L-N 20kA 8/20 µs L-PE 10kA 8/20 µs N-PE					
Protection Modes	All modes protected					
Technology	TD Technology In-line series low pass sine wave filter					
Voltage Protection Level U _p @ 500A, 8/20µs (UL SVR) @ Cat B3, 3kA 8/20µs	500V <250V	700V <600V	500V <250V	700V <600V	500V <250V	700V <600V
Filtering @100kHz	-62dB		-65dB		-53dB	
Status	Green LED. On=Ok. Isolated opto-coupler output ⁽¹⁾					
Dimensions	4 M. 90 mm x 68 mm x 72 mm (3.5" x 2.6" x 2.8")		8 M. 90 mm x 68 mm x 144 mm (3.5" x 2.6" x 5.6")			
Weight	0.35 kg (0.77 lb)		0.75 kg (0.77 lb)		0.8 kg (1.7 lb)	
Enclosure	DIN 43 880, UL94V-0 thermoplastic, IP 20 (NEMA-1)					
Connection	1 mm ² to 6 mm ² (#18AWG to #10)					
Mounting	35 mm top hat DIN rail					
Back-up Overcurrent Protection	3A		10A		20A	
Temperature	-35°C to +55°C (-31°F to +131°F)					
Humidity	0% to 90%					
Warranty	5 years					
Approvals	UL 1449, UL 1283, CSA 22.2, C-Tick, CE (NOM 3A, 120V)					
Surge Rated to Meet	ANSI/IEEE C62.41.2 Cat A, Cat B, Cat C					

(1) Opto-coupler output can be connected to DAR275V to provide Form C dry contacts, Page 35

21. Timer



Halmac Services (Qld) Pty. Ltd.
A.C.N. 098 852 923
A.B.N. 40 741 712 113

TIMER

1. IDEC DIGITAL TIMER TECHNICAL DETAILS
2. ELECTRONIC TIMING RELAY TECHNICAL DETAILS

GT3D – Digital Timers

Key features of the GT3D series include:

- Precise time setting using digital thumbwheel switches
- Elapsed or time remaining LCD display
- 6 time ranges, 16 timing functions
- Time delays up to 99.9 hours



UL Recognized
File No. E55996



CSA Certified
File No. LR58183
File No. LR96764
File No. LR83814



Cert. No. BL9801133323911 (LVD)
Cert. No. E9971113332388 (EMC)

Specifications

		GT3D-2	GT3D-3	GT3D-4	GT3D-8
Operation System		Solid state CMOS circuitry			
Operation		Multi-mode			Multi-mode one-shot output
Time Range		0.01s to 99.9 hours			
Rated Voltage		100 to 240V AC (50/60Hz), 24V AC (50/60Hz)/24V DC			
Contact Ratings		125V AC/250V AC, 3A; 30V DC/1A (resistive load)	125V AC/250V AC, 5A; 30V DC/5A (resistive load)		
Contact Form		Delayed SPDT + instantaneous SPDT	Delayed DPDT	Delayed DPDT	Delayed DPDT
Minimum Applicable Load		5V, 10mA (reference value)			
Voltage Tolerance		AF20 (100–240V AC): 85 to 264V AC AD24 (AC): 20.4 to 26.4V AC AD24 (DC): 21.6 to 26.4V DC			
Error		±0.3% ±50ms (voltage, repeat, and temperature)			
Setting Error		±0.5% ±50ms			
Reset Time		60ms maximum			
Insulation Resistance		100MΩ minimum			
Dielectric Strength		Between power and output terminals: 2,000V AC, 1 minute Between contacts of different poles: 2,000V AC, 1 minute Between contacts of the same pole: 750V AC, 1 minute			
Power Consumption (approximate)	AF20	11.8VA	11.6VA	3.7VA (100V AC, 60Hz) 11.6VA (200V AC, 60Hz)	
	AD24 AC/DC	1VA/0.8W	2.1VA/0.9W	2.1VA /0.9W	
Mechanical Life		10,000,000 operations minimum	5,000,000 operations minimum		
Electrical Life (at rated load)		50,000 operations minimum	100,000 operations minimum		
Outputs	Relay	250V AC, 3A, 30V DC, 1A (resistive load)	240V AC/, 24V DC, 5A (resistive load)		
Vibration Resistance		100N (approximate 10G)			
Shock Resistance		Operating extremes: 100N (approximate 10G) Damage limits: 500N (approximate 50G)			
Operating Temperature		–10 to +50°C			
Storage Temperature		–30 to +80°C			
Operating Humidity		45 to 85% RH			
Weight (approximate)		70g	75g	76g	
Housing Color		Gray			

Switches & Prior Lights

Display Lights

Relays & Sockets

Timers

Terminal Blocks

Circuit Breakers

Part Number List

Part Numbers: GT3D-1/GT3D-2/GT3D-3

Mode of Operation	Time Range	Output	Contact	Rated Voltage Code	Complete Part No.	
					8-Pin	11-Pin
1-A: ON-delay 1 1-B: Interval 1 first 1-C: Cycle 1 (OFF first) 1-D: Cycle 3 (ON first)	0.01s to 99.9 hours	250V AC, 3A, 30V DC, 1A (resistive load)	Delayed SPDT + instantaneous SPDT	100 to 240V AC (50/60Hz)	GT3D-2AF20	GT3D-2EAF20
				24V AC/DC	GT3D-2AD24	—
		100 to 240V AC (50/60Hz)		GT3D-3AF20	GT3D-3EAF20	
		24V AC/DC		GT3D-3AD24	—	

Part Numbers: GT3D-4

Mode of Operation	Time Range	Output	Contact	Rated Voltage Code	Complete Part No.	
					A (11-Pin)	B (11-Pin)
1-A: ON-delay 1 1-B: Interval 1 first 1-C: Cycle 1 (OFF first) 1-D: Cycle 3 (ON first) 2-A: ON-delay 2 2-B: Cycle 2 2-C: Signal ON/OFF-delay 1 2-D: Signal OFF-delay 1 2-E: Interval 2 2-F: One-shot cycle 3-A: Signal ON/OFF-delay 2 3-B: Signal OFF-delay 2 3-C: One-shot 1 3-D: One-shot ON-delay 3-E: One-shot 2 3-F: Signal ON/OFF-delay 3	0.01s to 99.9 hours	240V AC/24V DC, 5A (resistive load)	Delayed DPDT	100 to 240V AC (50/60Hz)	GT3D-4AF20	GT3D-4EAF20
				24V AC/DC	GT3D-4AD24	—

Part Numbers: GT3D-8

Mode of Operation	Time Range	Output	Contact	Rated Voltage Code	Complete Part No. (11-Pin)
1: ON-delay one-shot 1 2: Cycle one-shot 3: ON-delay one-shot 2	0.01s to 99.9 hours	240V AC/24V DC, 5A (resistive load)	Delayed DPDT	100 to 240V AC (50/60Hz)	GT3D-8AF20
				24V AC/DC	GT3D-8AD24

- 1. For wiring schematics and timing diagrams GT3D, see pages 815 to 822.
- 2. For more details about time ranges, see instructions on page 823.
- 3. A (11-pin) and B (11-pin) differ in the way inputs are wired.
- 4. For socket and accessory part numbers, see page 838.
- 5. For timing diagrams overview, see page 794.

Switches & Pilot Lights

Display Lights

Relays & Sockets

Timers

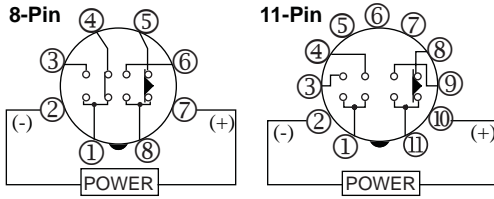
Terminal Blocks

Circuit Breakers

Timing Diagrams/Schematics

GT3D-2 Timing Diagrams Delayed SPDT + Instantaneous SPDT

Operation Mode Selection



ON-Delay 1



Item	Terminal Number	Operation
Set Time		Set Time
Power	2 - 7 (8p) 2 - 10 (11p)	
Delayed Contact	1 - 4, 5 - 8 (8p)	(NC)
	1 - 4, 8 - 11 (11p)	(NC)
	1 - 3, 6 - 8 (8p) 1 - 3, 9 - 11 (11p)	(NO)
Instantaneous Contact	1 - 4	(NC)
	1 - 3	(NO)
Indicator	OUT	
Digital Time Display	DOWN	
	UP	

Interval 1



Item	Terminal Number	Operation
Set Time		Set Time
Power	2 - 7 (8p) 2 - 10 (11p)	
Delayed Contact	1 - 4, 5 - 8 (8p)	(NC)
	1 - 4, 8 - 11 (11p)	(NC)
	1 - 3, 6 - 8 (8p) 1 - 3, 9 - 11 (11p)	(NO)
Instantaneous Contact	1 - 4	(NC)
	1 - 3	(NO)
Indicator	OUT	
Digital Time Display	DOWN	
	UP	

Cycle 1

(OFF first)



Item	Terminal Number	Operation
Set Time		Set Time
Power	2 - 7 (8p) 2 - 10 (11p)	
Delayed Contact	1 - 4, 5 - 8 (8p)	(NC)
	1 - 4, 8 - 11 (11p)	(NC)
	1 - 3, 6 - 8 (8p) 1 - 3, 9 - 11 (11p)	(NO)
Instantaneous Contact	1 - 4	(NC)
	1 - 3	(NO)
Indicator	OUT	
Digital Time Display	DOWN	
	UP	

Cycle 3

(ON first)



Item	Terminal Number	Operation
Set Time		Set Time
Power	2 - 7 (8p) 2 - 10 (11p)	
Delayed Contact	1 - 4, 5 - 8 (8p)	(NC)
	1 - 4, 8 - 11 (11p)	(NC)
	1 - 3, 6 - 8 (8p) 1 - 3, 9 - 11 (11p)	(NO)
Instantaneous Contact	1 - 4	(NC)
	1 - 3	(NO)
Indicator	OUT	
Digital Time Display	DOWN	
	UP	

Switches & Pilot Lights

Display Lights

Relays & Sockets

Timers

Terminal Blocks

Circuit Breakers

GT3D-3 Timing Diagrams
Delayed DPDT

Switches & Pilot Lights

Display Lights

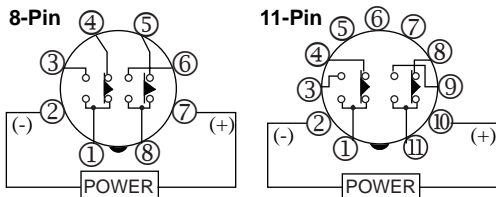
Relays & Sockets

Timers

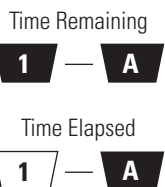
Terminal Blocks

Circuit Breakers

Operation Mode Selection

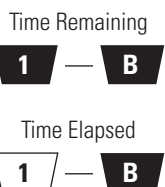


ON-Delay 1



Item	Terminal Number	Operation
Set Time		Set Time
Power	2 - 7 (8p) 2 - 10 (11p)	
Delayed Contact	1 - 4, 5 - 8 (8p) (NC) 1 - 4, 8 - 11 (11p) (NO)	
Indicator	OUT	
Digital Time Display	DOWN UP	

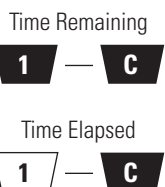
Interval 1



Item	Terminal Number	Operation
Set Time		Set Time
Power	2 - 7 (8p) 2 - 10 (11p)	
Delayed Contact	1 - 4, 5 - 8 (8p) (NC) 1 - 4, 8 - 11 (11p) (NO)	
Indicator	OUT	
Digital Time Display	DOWN UP	

Cycle 1

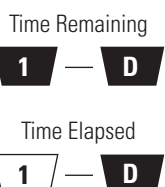
(OFF first)



Item	Terminal Number	Operation
Set Time		Set Time
Power	2 - 7 (8p) 2 - 10 (11p)	
Delayed Contact	1 - 4, 5 - 8 (8p) (NC) 1 - 4, 8 - 11 (11p) (NO)	
Indicator	OUT	
Digital Time Display	DOWN UP	

Cycle 3

(ON first)

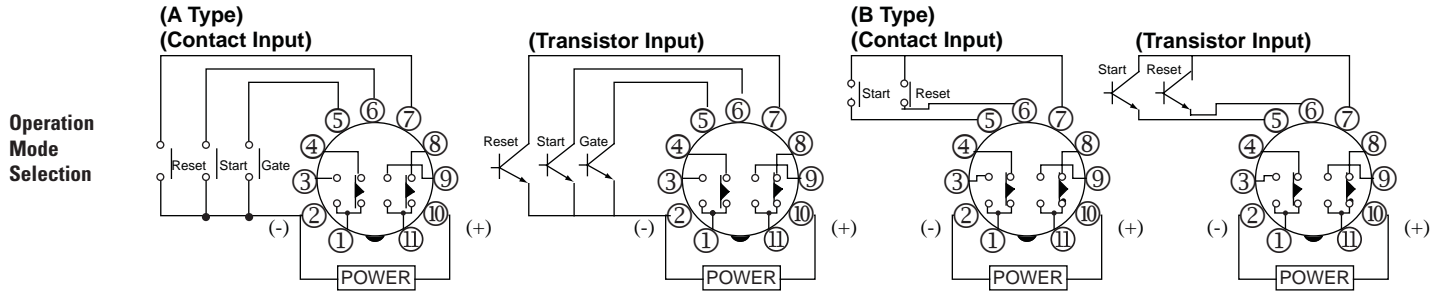


Item	Terminal Number	Operation
Set Time		Set Time
Power	2 - 7 (8p) 2 - 10 (11p)	
Delayed Contact	1 - 4, 5 - 8 (8p) (NC) 1 - 4, 8 - 11 (11p) (NO)	
Indicator	OUT	
Digital Time Display	DOWN UP	

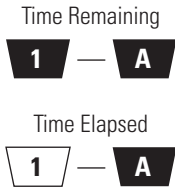
GT3D-4 Timing Diagrams

These timers require a start input. A gate and reset input are optional. Inputs are controlled by external pushbuttons. Reset occurs when the power is removed or when the reset input is supplied. The gate signal can be used to interrupt (freeze) timer functions. Timer functions resume when the gate input is removed. B type timers are not equipped for gate input.

Delayed DPDT

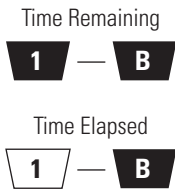


ON-Delay 1



Item	Terminal Number	Operation
Power	2 - 10	[Timing bar]
Delayed Contact	(NC) 1 - 4 8 - 11	[Timing bar]
	(NO) 1 - 3 9 - 11	[Timing bar]
Indicator	OUT	[Timing bar]
Digital Time Display	DOWN	[Timing bar]
	UP	[Timing bar]
Set Time		[Timing bar]

Interval 1



Item	Terminal Number	Operation
Power	2 - 10	[Timing bar]
Delayed Contact	(NC) 1 - 4 8 - 11	[Timing bar]
	(NO) 1 - 3 9 - 11	[Timing bar]
Indicator	OUT	[Timing bar]
Digital Time Display	DOWN	[Timing bar]
	UP	[Timing bar]
Set Time		[Timing bar]

Switches & Pilot Lights

Display Lights

Relays & Sockets

Timers

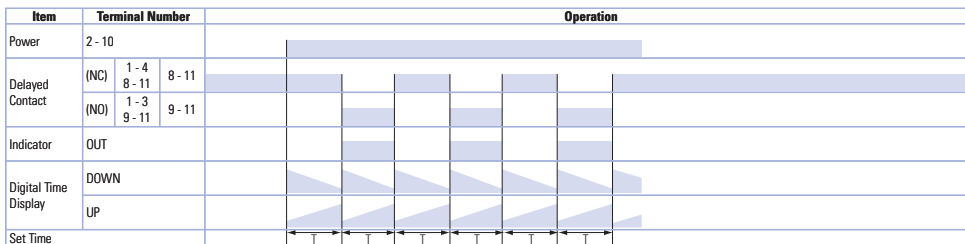
Terminal Blocks

Circuit Breakers

GT3D-4 Timing Diagrams

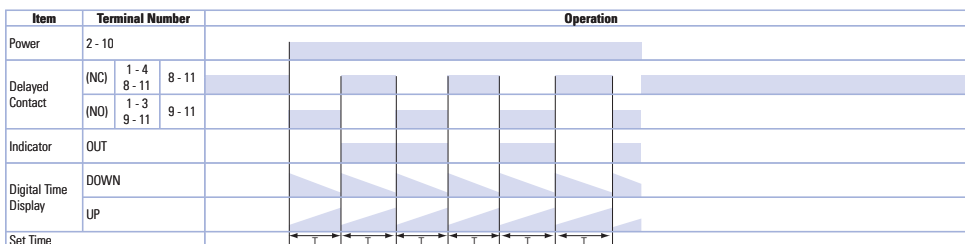
Switches & Pilot Lights

Cycle 1
(OFF first)



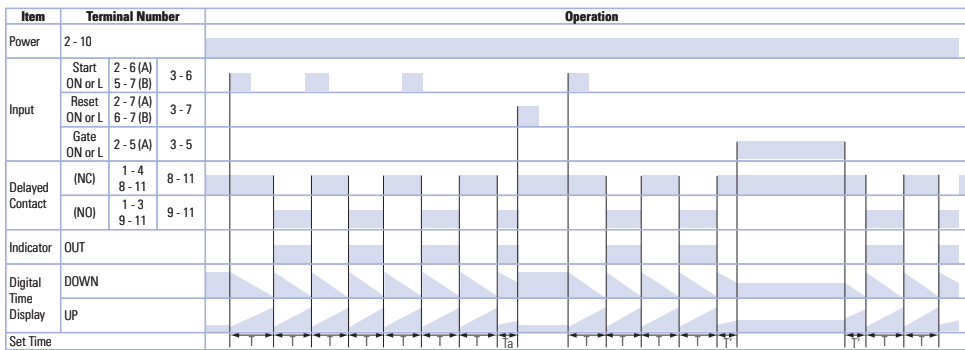
Display Lights

Cycle 3
(ON first)



Relays & Sockets

ON-Delay 2



Timers

Terminal Blocks

Circuit Breakers

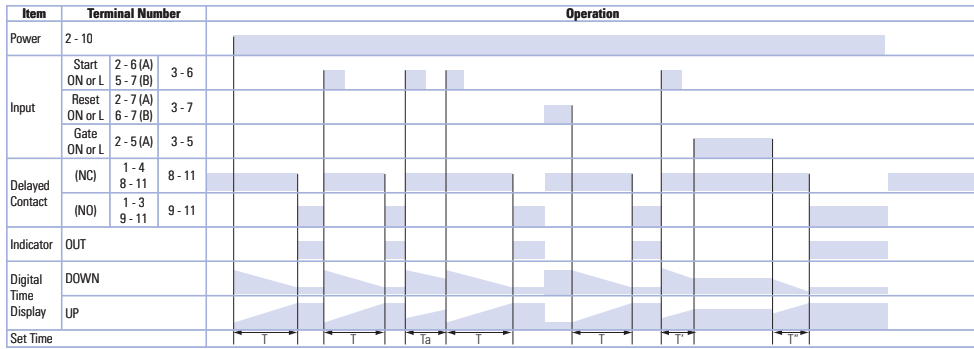
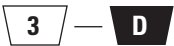
GT3D-4 Timing Diagrams

One-Shot ON-Delay

Time Remaining



Time Elapsed

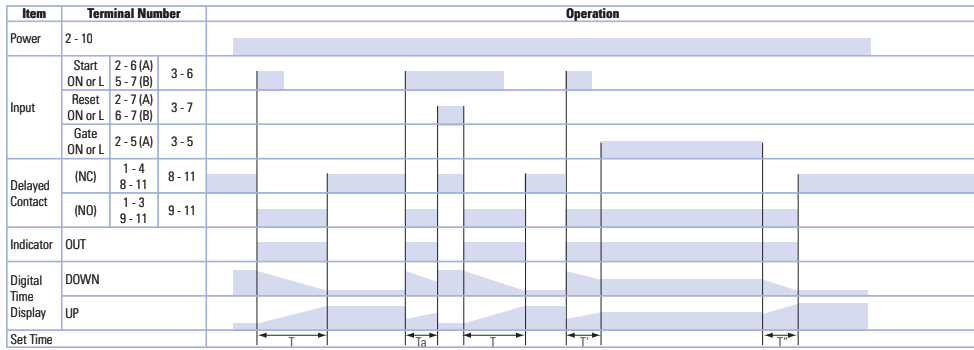
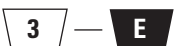


One-Shot 2

Time Remaining

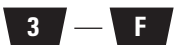


Time Elapsed

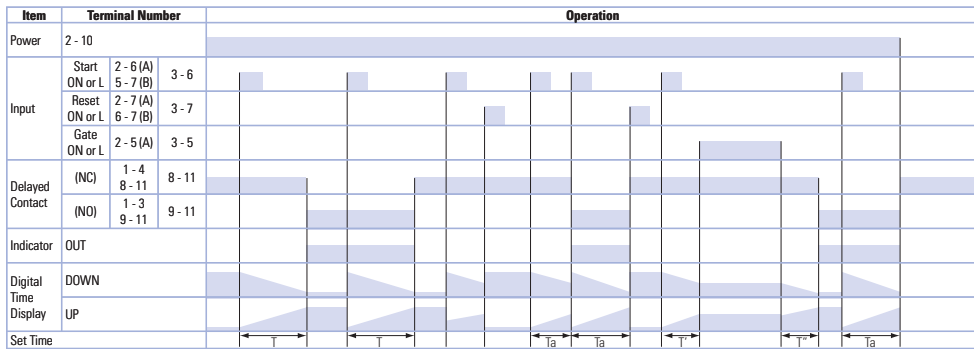
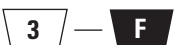


Signal ON/OFF-Delay 3

Time Remaining



Time Elapsed



Switches & Prior Lights

Display Lights

Relays & Sockets

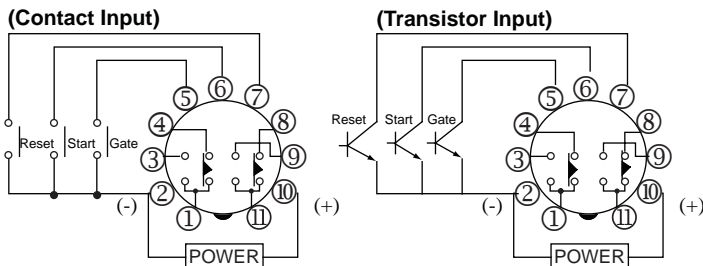
Timers

Terminal Blocks

Circuit Breakers

GT3D-8 Timing Diagrams
Delayed DPDT

Operation
Mode Selection



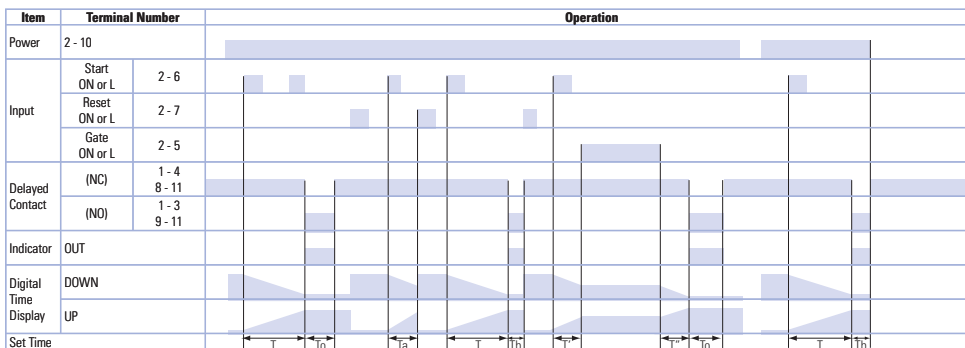
Switches & Pilot Lights

Display Lights

ON-Delay One-Shot 1

Time Remaining **1**

Time Elapsed **1**

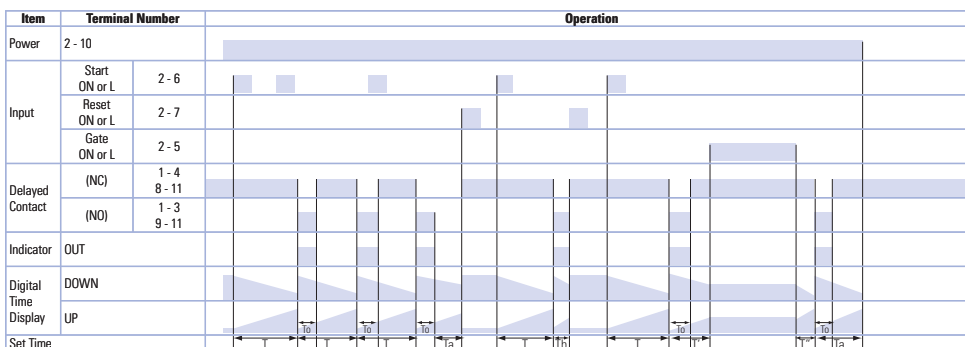


Relays & Sockets

Cycle One-Shot

Time Remaining **2**

Time Elapsed **2**

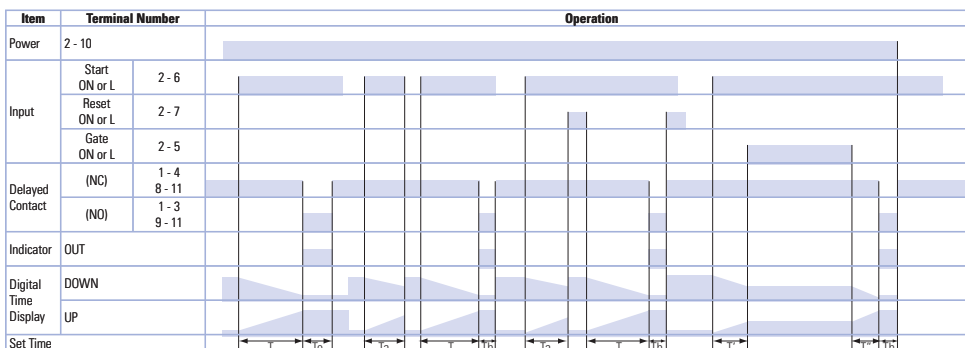


Timers

ON-Delay One-Shot 2

Time Remaining **3**

Time Elapsed **3**



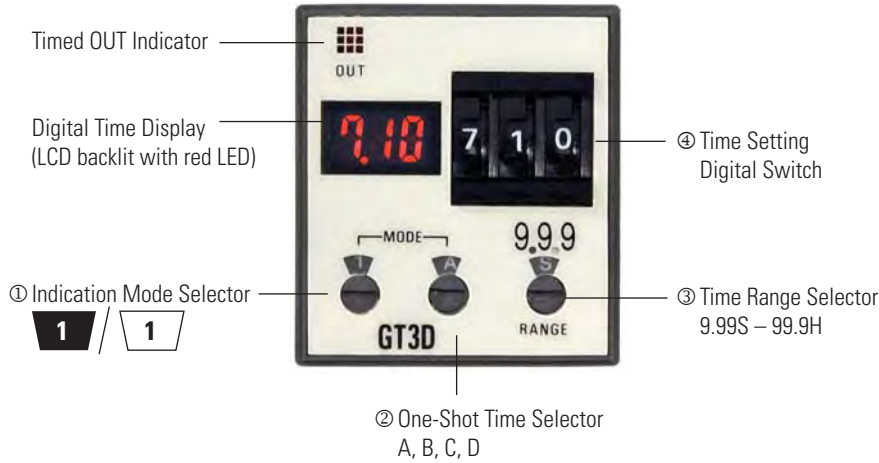
Terminal Blocks



- T = Set time
- T_a = Shorter than set time
- T_b = Shorter than single-shot output time
- T = T' + T"
- T₀ = Single-shot output time (selected from A, B, C, D, E or F)

Circuit Breakers

Instructions: Setting GT3D-2, GT3D-3 Timers



Step 1	Desired Mode/Selection				Remarks
	Time Display Mode	① Indicator Mode Selector	Operation Mode	② Operation Mode Selector	
Select the desired time display and operation modes.	Time elapsed		ON-delay 1	A	1. Use the flat screwdriver to set the selectors. Since selectors do not turn all the way around, both clockwise and counterclockwise rotation may be necessary. 2. The ① Indicator Mode Selector determines whether the Digital Time Display shows the time elapsed or time remaining. The ② Operation Mode Selector determines the desired operation mode. Decide which display and mode is desired, then use these two selectors ①② to set the operation mode. 3. The ② Operation Mode Selector has two blank modes which are not intended for use. Always have this selector set to A, B, C, or D.
	Time remaining				
	Time elapsed		Interval	B	
	Time remaining				
	Time elapsed		Cycle 1	C	
	Time remaining				
	Time elapsed		Cycle 3	D	
	Time remaining				
Step 2	Desired Operation	Selection		Remarks	
Select a time range that contains the desired period of time.	Base Time Ranges	③ Time Range Selector		1. The ③ Time Range Selector controls both the decimal point indicator (9.99, 99.9, 999) and the time increment indicators S (seconds), M (minutes), and H (hours). 2. Chose which base time range contains the targeted timer setting. Then use the ③ Time Range Selector to set the decimal point indicator and time increment indicator to its corresponding pair of settings. 3. Since these configurations offer a complete range of settings from 0.01 seconds to 99.9 hours, the setting of 9.99 for minutes and the 9.99 and 999 settings for hours are not listed and should not be used.	
		Decimal Point Indicator	Time Increment Indicator		
	0.01 seconds to 9.99 seconds	9.99			
	0.1 seconds to 99.9 seconds	99.9			
	1 second to 999 seconds	999			
	0.1 minutes to 99.9 minutes	99.9			
	1 minute to 999 minutes	999			
0.1 hours to 99.9 hours	99.9				
Step 3	Desired Operation	Selection		Remarks	
Set the precise period of time desired by using the ④ Time Setting Digital Switch.				Use the ④ Time Setting Digital Switch to set the desired period of time. It is important to remember that the setting of the ③ Time Range Selector determines the units of time measurement as well as the implied decimal point location.	

It is important to remember that the ③ Time Range Selector not only selects the time range but also influences the interpretation of the Digital Time Display. Changing the ③ Time Range Selector setting changes the units of time measurement (seconds, minutes, hours) as well as the decimal point location.

Switches & Pilot Lights

Display Lights

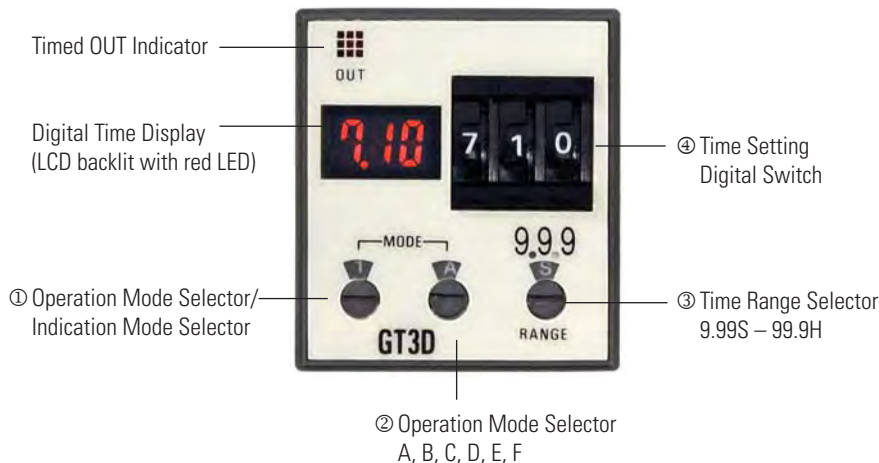
Relays & Sockets

Timers

Terminal Blocks

Circuit Breakers

Instructions: Setting GT3D-4 Timers



Step 1	Desired Mode/Selection				Remarks
	Time Display Mode	① Indicator Mode Selector	Operation Mode	② Operation Mode Selector	
Select the desired time display and operation modes.	Time elapsed		ON-delay 1 Interval 1 Cycle 1 D: Cycle 3	A B C D	1. Use a flat screwdriver to set the selectors. Since selectors do not turn all the way around, both clockwise and counterclockwise rotation is necessary. 2. The ① Indicator Mode Selector determines whether the Digital Time Display shows the time elapsed or time remaining. The ② Operation Mode Selector determines the desired operation mode. Decide which display and mode is desired; then use these two selectors ① ② to set the operation mode. 3. When using the indicator mode setting "1," the ② Operation Mode Selector has two blank modes which are not intended for use. When using mode setting "1," always have the operation mode selector set to A, B, C, or D.
	Time remaining				
	Time elapsed		ON-delay 2 Cycle 2 Signal ON/OFF-delay 2 Signal OFF-delay 1 Interval 2 One-shot cycle	A B C D E F	
	Time remaining				
	Time elapsed		Signal ON/OFF-delay 2 Signal OFF-delay 2 One-shot 1 One-shot ON-delay One-shot 2 Signal ON/OFF-delay 3	A B C D E F	
	Time remaining				
Step 2	Desired Operation	Selection		Remarks	
Select a time range that contains the desired period of time.	Base Time Ranges	③ Time Range Selector		1. The ③ Time Range Selector controls both the decimal point indicator (9.99, 99.9, 999) and the time increment indicators S (seconds), M (minutes), and H (hours). 2. Chose which base time range contains the targeted timer setting. Then use the ③ Time Range Selector to set the decimal point indicator and time increment indicator to its corresponding pair of settings. 3. Since these configurations offer a complete range of settings from 0.01 seconds to 99.9 hours, the setting of 9.99 for minutes and the 9.99 and 999 settings for hours are not listed and should not be used.	
		Decimal Point Indicator	Time Increment Indicator		
	0.01 seconds to 9.99 seconds	9.99			
	0.1 seconds to 99.9 seconds	99.9			
	1 second to 999 seconds	999			
	0.1 minutes to 99.9 minutes	99.9			
1 minute to 999 minutes	999				
0.1 hours to 99.9 hours	99.9				
Step 3	Desired Operation	Selection		Remarks	
Set the precise period of time desired by using the ④ Time Setting Digital Switch.				Use the ④ Time Setting Digital Switch to set the desired period of time. It is important to remember that the setting of the ③ Time Range Selector determines the units of time measurement as well as the implied decimal point location.	

It is important to remember that the ③ Time Range Selector not only selects the time range but also influences the interpretation of the Digital Time Display. Changing the ③ Time Range Selector setting changes the units of time measurement (seconds, minutes, hours) as well as the decimal point location.

Switches & Pilot Lights

Display Lights

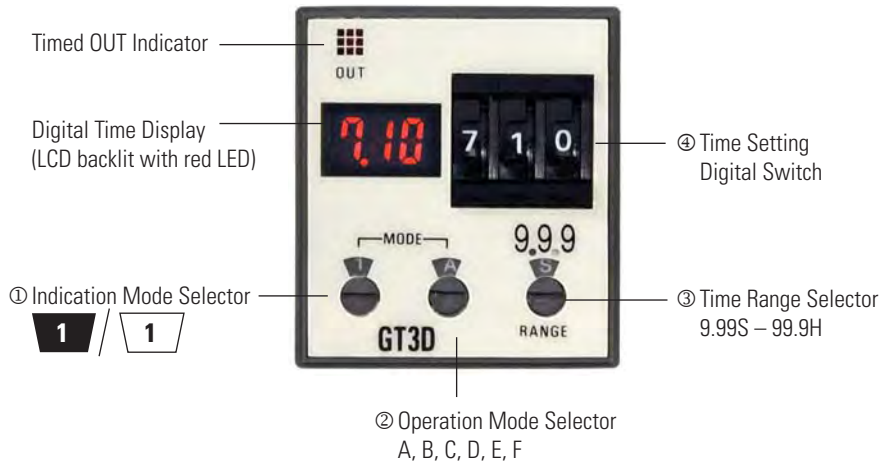
Relays & Sockets

Timers

Terminal Blocks

Circuit Breakers

Instructions: Setting GT3D-8 Timers



Step 1	Desired Mode of Operation		Selection		Remarks
Select the time display and operation modes.	Operation Mode	Time elapsed	① Indicator Mode Selector		1. Use a flat screwdriver to set the selectors. Since selectors do not turn all the way around, both clockwise and counterclockwise rotation is necessary. 2. The GT3D-8 ① Indicator Mode Selector selects both whether the Digital Time Display displays the time elapsed or time remaining and also the mode of operation. Decide which display and mode is desired. Then use this selector to set the operation mode.
		Time remaining	① Indicator Mode Selector		
	Cycle One-Shot	Time elapsed	① Indicator Mode Selector		
		Time remaining	① Indicator Mode Selector		
	ON-Delay One-Shot 2	Time elapsed	① Indicator Mode Selector		
		Time remaining	① Indicator Mode Selector		
Step 2	Desired Mode of Operation		Selection		Remarks
Select the single shot output time.	Desired Single-Shot Output Time		② Single-Shot Output Time Selector		On the GT3D-8 timers, the desired single-shot output time can be selected from the A, B, C, D, E, and F modes using the ② One-Shot Output Time Selector.
	0.1 seconds		A		
	0.5 seconds		B		
	1 second		C		
	5 seconds		D		
	10 seconds		E		
50 seconds		F			
Step 3	Desired Operation		Selection		Remarks
Select a time range that contains the desired period of time.	Base Time Ranges		③ Time Range Selector		1. The ③ Time Range Selector controls both the decimal point indicator (9.99, 99.9, 999) and the time increment indicators S (seconds), M (minutes), and H (hours). 2. Chose which base time range contains the targeted timer setting. Then use the ③ Time Range Selector to set the decimal point indicator and time increment indicator to its corresponding pair of settings. 3. Since these configurations offer a complete range of settings from 0.01 seconds to 99.9 hours, the setting of 9.99 for minutes and the 9.99 and 999 settings for hours are not listed and should not be used.
	0.01 seconds to 9.99 seconds	9.99	③ Time Range Selector		
	0.1 seconds to 99.9 seconds	99.9	S		
	1 second to 999 seconds	999	③ Time Range Selector		
	0.1 minutes to 99.9 minutes	99.9	M		
	1 minute to 999 minutes	999	③ Time Range Selector		
	0.1 hours to 99.9 hours	99.9	H		
Step 4	Desired Operation		Selection		Remarks
Set the precise period of time desired by using the ④ Time Setting Digital Switch.					Use the ④ Time Setting Digital Switch to set the desired period of time. It is important to remember that the setting of the ③ Time Range Selector determines the units of time measurement as well as the implied decimal point location.

It is important to remember that the ③ Time Range Selector not only selects the time range but also influences the interpretation of the Digital Time Display. Changing the ③ Time Range Selector setting changes the units of time measurement (seconds, minutes, hours) as well as the decimal point location.

Switches & Pilot Lights

Display Lights

Relays & Sockets

Timers

Terminal Blocks

Circuit Breakers

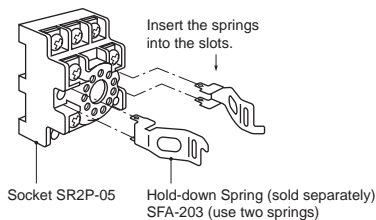
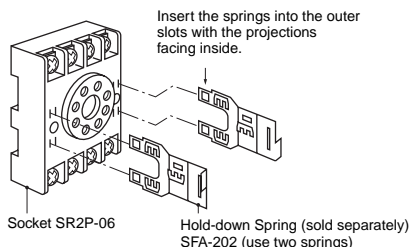
**GT3 Series
Accessories**

DIN Rail Mounting Accessories

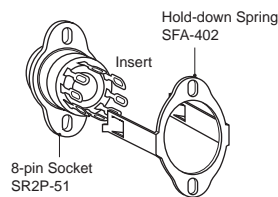
DIN Rail/Surface Mount Sockets and Hold-Down Springs

DIN Rail Mount Socket				Applicable Hold-Down Springs	
Style	Appearance	Use with Timers	Part No.	Appearance	Part No.
8-Pin Screw Terminal (dual tier)		GT3A-1, 2, 3 (8-pin) GT3D-1, 2, 3 (8-pin) GT3F-1, 2 (8-pin) GT3W (8-pin) GT3S	SR2P-05		SFA-203
11-Pin Screw Terminal (dual tier)		GT3A-1, 2, 3 (11-pin) GT3A-4, 5, 6 GT3D-1, 2, 3 (11-pin) GT3D-4, 8 GT3F-1, 2 (11-pin) GT3W (11-pin)	SR3P-05		
8-Pin Fingersafe Socket		GT3A-1, 2, 3 (8-pin) GT3D-1, 2, 3 (8-pin) GT3F-1, 2 (8-pin) GT3W (8-pin) GT3S	SR2P-05C		
11-Pin Fingersafe Socket		GT3A-1, 2, 3 (11-pin) GT3A-4, 5, 6 GT3D-1, 2, 3 (11-pin) GT3D-4, 8 GT3F-1, 2 (11-pin) GT3W (11-pin)	SR3P-05C		
8-Pin Screw Terminal		GT3A-1, 2, 3 (8-pin) GT3D-1, 2, 3 (8-pin) GT3F-1, 2 (8-pin) GT3W (8-pin) GT3S	SR2P-06		SFA-202
11-Pin Screw Terminal		GT3A-1, 2, 3 (11-pin) GT3A-4, 5, 6 GT3D-1, 2, 3 (11-pin) GT3D-4, 8 GT3F-1, 2 (11-pin) GT3W (11-pin)	SR3P-06		
DIN Mounting Rail Length 1000mm		—	BNDN1000		

**Installation of Hold-Down Springs
DIN Rail Mount Socket**



Panel Mount Socket



Circuit Breakers

Timers

Relays & Sockets




Display Lights

Switches & Pilot Lights

Terminal Blocks

Panel Mounting Accessories

Panel Mount Sockets and Hold-Down Springs

Panel Mount Socket				Applicable HD Springs	
Style	Appearance	Use with Timers	Part No.	Appearance	Part No.
8-Pin Solder Terminal		GT3A- (8-pin) GT3D- (8-pin) GT3W- (8-pin) GT3F- (8-pin) GT3S	SR2P-51		SFA-402
11-Pin Solder Terminal		GT3A- (11-pin) GT3D- (11-pin) GT3W- (11-pin) GT3F- (11-pin)	SR3P-51		





Switches & Pilot Lights

Display Lights



For information on installing the hold-down springs, see page 838.

Flush Panel Mount Adapter and Sockets that use an Adapter

Accessory	Description	Appearance	Use with Timers	Part No.
Panel Mount Adapter	Adaptor for flush panel mounting GT3 timers		All GT3 timers	RTB-G01
Sockets for use with Panel Mount Adapter	8-pin screw terminal		All 8-pin timers	SR6P-M08G
	11-pin screw terminal		(Shown: SR6P-M08G for Wiring Socket Adapter)	All 11-pin timers
	8-pin solder terminal		All 8-pin timers	SR6P-S08
	11-pin solder terminal		All 11-pin timers	SR6P-S11

Relays & Sockets

Timers

Terminal Blocks

Circuit Breakers



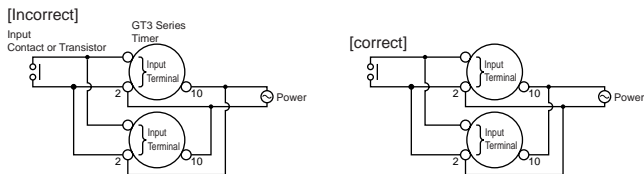
No hold down springs are available for flush panel mounting.

Instructions: Wiring Inputs for GT3 Series

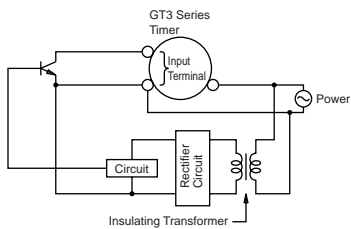
Inputs Inputs

To avoid electric shock, do not touch the input signal terminal during power voltage application.

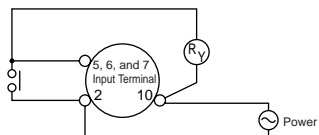
When connecting the input signal terminals of two or more GT3A timers to the same contact or transistor, the input terminals of the same number should be connected. (Connect Terminals No.2 in common.)



In a transistor circuit for controlling input signals, with its primary and secondary power circuits isolated, do not ground the secondary circuit.



Connect the input signal terminals of the GT3A timers to Terminal No.2 only. Never apply voltage to other terminals; otherwise, the internal circuit may be damaged.



Input signal lines must be made as short as possible and installed away from power cables and power lines. Use shielded wires or a separate conduit for input wiring.

Switches & Pilot Lights

Display Lights

Relays & Sockets

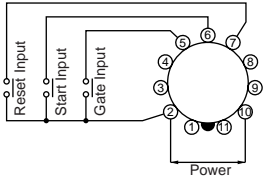
Timers

Terminal Blocks

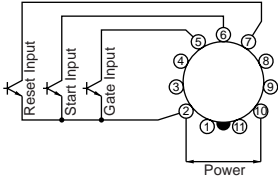
Circuit Breakers

Inputs Instructions, continued

For contact input, use gold-plated contacts to make sure that the residual voltage is less than 1V when the contacts are closed.

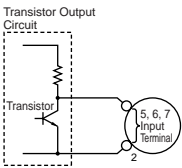


For transistor input, use transistors with the following specifications; VCE = 40V, VCES = 1V or less, IC = 50 mA or more, and ICBO = 50μA or less. The resistance should be less than 1kΩ when the transistor is on. When the output transistor switches on, a signal is input to the timer.



Inputs: GT3A-1, -2, -3

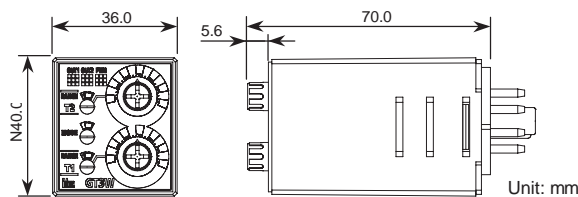
Transistor output equipment such as proximity switches and photoelectric switches can input signals if they are voltage/current output type, with power voltage ranges from 18 to 30V and have 1V. When the signal voltage switches from H to L, a signal is input to the timer



Inputs: GT3A-4, -5, -6

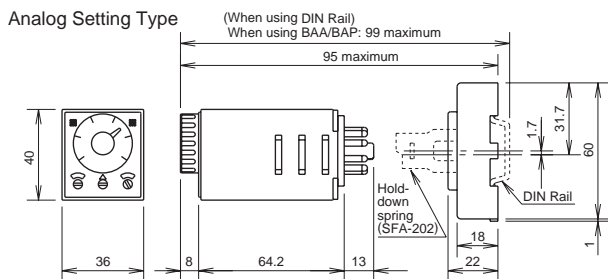
Start Input	The start input initiates a time-delay operation and controls output status.	No-voltage contact inputs and NPN open collector transistor inputs are applicable. 24V DC, 1mA maximum Input response time: 50msec maximum
Reset Input	When the reset input is activated, the time is reset, and contacts return to original state.	
Gate Input	The time-delay operation is suspended while the gate input is on (pause).	

Dimensions

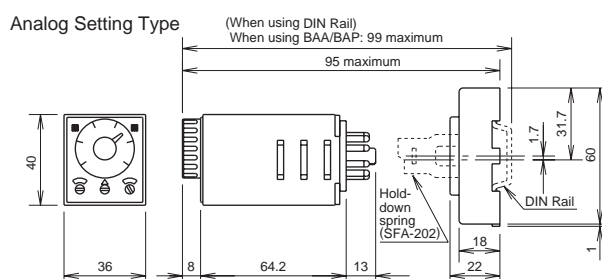


NOTE: GT3W series are UL Listed when used in combination with following IDEC's sockets:
 GT3W-A11, A33: SR2P-06* pin type socket.
 GT3W-A11E: SR3P-05* pin type socket.
 (*-May be followed by A,B,C or U)
 The socket to be used with these timers are rated:
 -Conductor Temperature Rating 60°C min.
 -Use 14AWG max.(2mm²max.) Copper conductors only
 -Terminal Torque 1.0 to 1.3 N-m

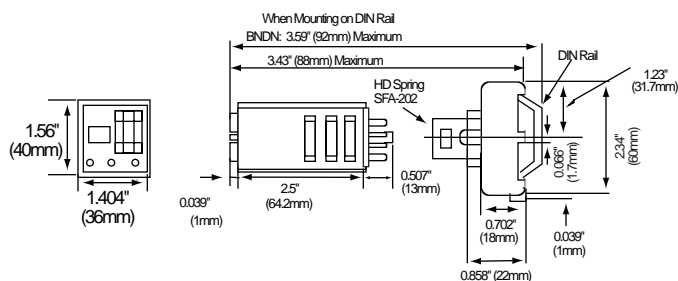
Analog GT3 Timer, 8-Pin with SR2P-06



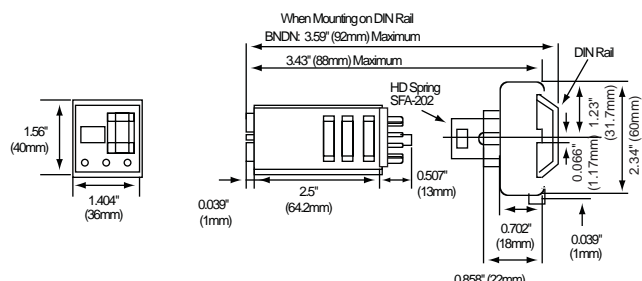
Analog GT3 Timer, 11-Pin with SR3P-06



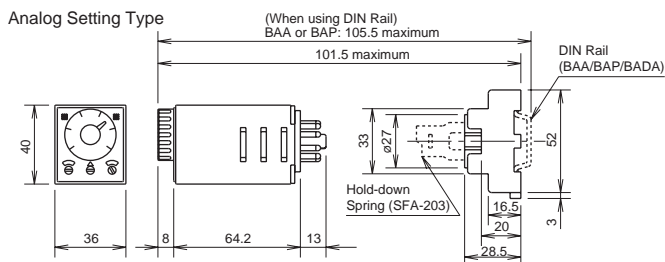
Digital GT3 Timer, 8-Pin with SR2P-06



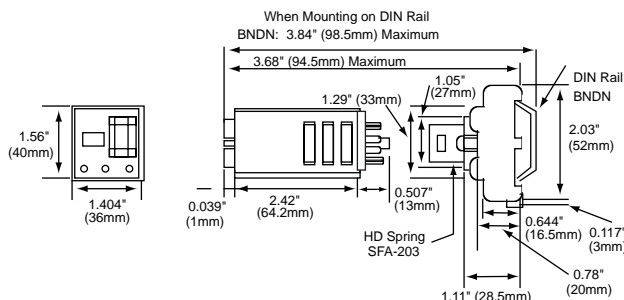
Digital GT3 Timer, 11-Pin with SR3P-06



Analog GT3 Timer, 11-Pin with SR3P-05



Digital GT3 Timer, 11-Pin with SR3P-05



Switches & Pilot Lights

Display Lights

Relays & Sockets

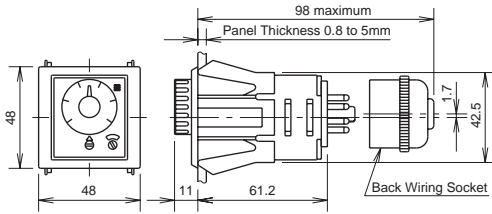
Timers

Terminal Blocks

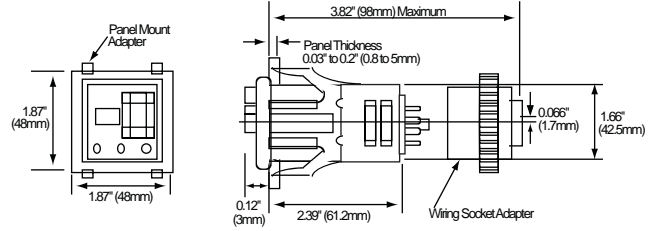
Circuit Breakers

Panel Mount Adapter

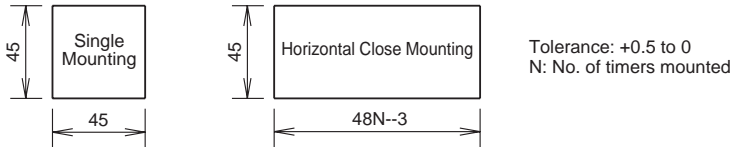
Analog GT3 Timer, 8-Pin and 11-Pin with SR6P-S08 or SR6P-S11



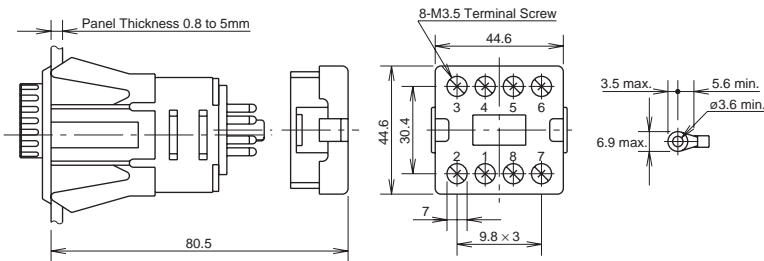
Digital GT3 Timer, 8-Pin and 11-Pin with SR6P-S08 or SR6P-S11



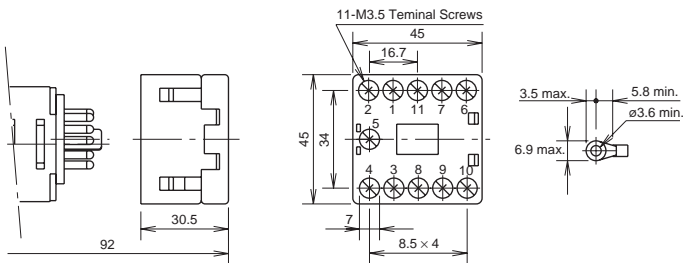
Mounting Hole Layout



Analog and Digital GT3 Timer, 8-Pin with SR6P-M08G



Analog and Digital GT3 Timer, 11-Pin with SR6P-M11G



General Instructions for All Timer Series

Load Current

With inductive, capacitive, and incandescent lamp loads, inrush current more than 10 times the rated current may cause welded contacts and other undesired effects. The inrush current and steady-state current must be taken into consideration when specifying a timer.

Contact Protection

Switching an inductive load generates a counter-electromotive force (back EMF) in the coil. The back EMF will cause arcing, which may shorten the contact life and cause imperfect contact. Application of a protection circuit is recommended to safeguard the contacts.

Temperature and Humidity

Use the timer within the operating temperature and operating humidity ranges and prevent freezing or condensation. After the timer has been stored below its operating temperature, leave the timer at room temperature for a sufficient period of time to allow it to return to operating temperatures before use.

Environment

Avoid contact between the timer and sulfurous or ammonia gases, organic solvents (alcohol, benzine, thinner, etc.), strong alkaline substances, or strong acids. Do not use the timer in an environment where such substances are prevalent. Do not allow water to run or splash on the timer.

Vibration and Shock

Excessive vibration or shocks can cause the output contacts to bounce, the timer should be used only within the operating extremes for vibration and shock resistance. In applications with significant vibration or shock, use of hold down springs or clips is recommended to secure a timer to its socket.

Time Setting

The time range is calibrated at its maximum time scale; so it is desirable to use the timer at a setting as close to its maximum time scale as possible. For a more accurate time delay, adjust the control knob by measuring the operating time with a watch before application.

Input Contacts

Use mechanical contact switch or relay to supply power to the timer. When driving the timer with a solid-state output device (such as a two-wire proximity switch, photoelectric switch, or solid-state relay), malfunction may be caused by leakage current from the solid-state device. Since AC types comprise a capacitive load, the SSR dielectric strength should be two or more times the power voltage when switching the timer power using an SSR.

Generally, it is desirable to use mechanical contacts whenever possible to apply power to a timer or its signal inputs. When using solid state devices, be cautious of inrushes and back-EMF that may exceed the ratings on such devices. Some timers are specially designed so that signal inputs switch at a lower voltage than is used to power the timer (models designated as "B" type).

Timing Accuracy Formulas

Timing accuracies are calculated from the following formulas:

Repeat Error = $\pm \frac{1 \times \text{Maximum Measured Value} - \text{Minimum Measured Value} \times 100\%}{2 \text{ Maximum Scale Value}}$

Voltage Error = $\pm \frac{T_v - T_r \times 100\%}{T_r}$

Tv: Average of measured values at voltage V
Tr: Average of measured values at the rated voltage

Temperature Error = $\pm \frac{T_t - T_{20} \times 100\%}{T_{20}}$

Tt: Average of measured values at °C
T20: Average of measured values at 20°C

Setting Error = $\pm \frac{\text{Average of Measured Values} - \text{Set Value} \times 100\%}{\text{Maximum Scale Value}}$

Switches & Pilot Lights

Display Lights

Relays & Sockets

Timers

Terminal Blocks

Circuit Breakers

Technical Data

Timing Characteristics (according to VDE 0435, Part 2021)		
Timing ranges for		
RZ7-FSM-A, B, C, D, E, F, I, & L	(1s)	0.05...1 sec
RZ7-FSH	(3s)	0.15...3 sec
	(10s)	0.5...10 sec
	(1mn)	0.05...1 min
	(3mn)	0.15...3 min
	(10mn)	0.5...10 min
	(1h)	0.05...1 hour
	(3h)	0.15...3 hours
	(10h)	0.5...10 hours
	(60h)	3...60 hours
RZ7-FSQ	(2.5s)	0.15...2.5 sec
	(10s)	0.5...10 sec
	(80s)	4...80 sec
	(10mn)	0.5...10 min
Setting accuracy	±5% of full scale value	
Repeatability	±0.2% of the setting values	
Tolerance	Voltage: ±0.001%/°ΔU Temperature: ±0.025%/°C	
Power Supply		
Supply voltages	24...48VDC and 24...240VAC, 50/60Hz (dual voltage) 12VDC 24...240V AC or DC (universal voltage) 346...440VAC, 50/60Hz	
Voltage tolerance	AC: -15%... +10% DC: -20%... +20%	
Power consumption	AC: 5VA at 240V DC: 0.5W at 24V	
Time energized	100%	
Reset time	50ms	
Voltage interruption	≤20ms without reset (supply voltage)	
Input Impedance	Relay On: 3k-13k ohms Relay Off: 0.7k-4k ohms	
Cable length (supply voltage control)	250 meters (800 ft.) max.	
Pulse Control (B1)		
Impulse duration	≥50ms (AC), ≥30ms (DC)	
Input voltage	Supply voltage range	
Input current	1 mA	
Max. Leakage Current	400 micro Amps	
Cable length	max. 250 m (800 ft.) without parallel load between B1 & A2 max. 50 m (160 ft.) with load (<3kΩ) between B1 & B2	
Outputs		
Type of outputs	Relay contacts: hard silver	
Maximum admissible operating voltage	Alternating current: 440VAC	
Dielectric Coil to contact Withstand Voltage	5,000 V	
Switching capacity	Current I_m : (AC1) Power:	
	8A (5A for RZ7-FSQ) 2000VA according to IEC947-5-1: 3A/440VAC (inductive load, AC14) 3A/250VAC (inductive load, AC15) 1A/24VDC (inductive load, DC13) according to UL 508: 1.5A/250VAC (B300) 3A/120VAC (B300)	
Short circuit resistance	10 A gL (fast blow fuse)	

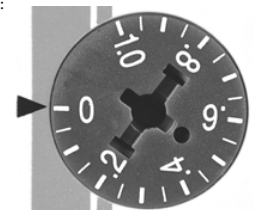
Life expectancy (electrical)	4 million ops. at 1A/250VAC, $\cos\phi = 1$ 0.2 million ops. at 6A/250VAC, $\cos\phi = 1$ 1.5 million ops. at 1A/250VAC, $\cos\phi = 0.3$ 0.3 million ops. at 3A/250VAC, $\cos\phi = 0.3$ 0.5 million ops. at 6A/24VDC, resistive 2 million ops. at 4A/24VDC, resistive 2 million ops. at 0.2A/230VDC, resistive 1 million ops. at 0.4A/24VDC, L/R = 20ms 1 million ops. at 0.2A/110VDC, L/R = 20ms 1 million ops. at 0.1A/230VDC, L/R = 20ms
Life expectancy (mechanical)	30 million operations

General Data	2 kVAC/50 Hz test voltage according to VDE 0435 and 6 kV 1.2/50 μs surge voltage according to IEC 947-1 between all inputs and outputs
Insulation Characteristics	
EMC/Interference Immunity	Performance of following requirements: - Surge capacity of the supply voltage according to IEC1000-4-5: 4 kV 1.2/50 μs - Burst according to IEC 1000-4-4: 6 kV/ 6/50ns - ESD discharge according to IEC 1000-4-2: - Contact 8 kV, air 8 kV - Electromagnetic HF field according to IEC 801-3 and conducted electromagnetic HF signal according to IEC 801-6: Level 3
EMC/Emission	Electromagnetic fields according to EN 55 022: Class B
Safe isolation	According to VDE 106, part 101
Climatic withstand	56 cycles (24h) at 25...40°C and 95% relative humidity according to IEC 68-2-30 and IEC 68-2-3.
Vibration resistance	4 g in 3 axis at 10...500 Hz, test FC according
Shock resistance	50 g according to IEC 68-2-27
Protection class	Enclosure: IP40 IP30 (single function) Terminal: IP20 according to IEC 947-1
Weight	100g
Approvals/Standards	UL, C-UL up to 240VAC, Germanischer Lloyd, CE
Ambient temperature	Open: -25°C...+60°C Enclosed: -25°C...+45°C Storage: -25°C...+85°C
Connections	Screw terminal - M3.5 for Pozidrive No.2, Phillips and slotted screws No.2 suitable for power screwdriver. Rated tightening torque - 0.8 Nm (max. 1.2 Nm) - [8.8 lb-in] Wire Size - Dual-chamber system for terminal cross-sections of 1 x 0.5mm ² (solid) or 2 x 2.5mm ² (flexible with sleeve), AWG 20...14. Finger Protection - According to VDE 0106
Mounting	- Snap-on mounting (35mm DIN-rail) - Side mounting on CA7/CA4 contactors and CS7/CS4 with dovetail joint [surface mounting in any position]
Relays	- Screw fixing by Panel Mount Adapter and two screws (M4) [surface mounting in any position]
Disposal	Synthetic material without dioxin according to EC/EFTA notification No. 93/0141/D. Electrical contacts contain cadmium.
Standards	EN 60947-1, EN 60947-5-1, EN 50081-1, IEC 947, UL 508, CSA 22.2

RZ7 Relative Scale Setting Knob

Series RZ7 Timing Relays have a "relative scale" setting knob numbered 0 to 1.0. Think about this as 0 to 100% of the relay's built-in time range. Example: To set an RZ7-FS timing relay (with a 0.05 to 1 minute range) to activate after 25 seconds:

- 1) Divide the desired activation time (25 seconds) by the maximum time limit of the relay (60 seconds).
 $25 \div 60 = .416$
- 2) Rotate the setting knob to just past the .4 mark.

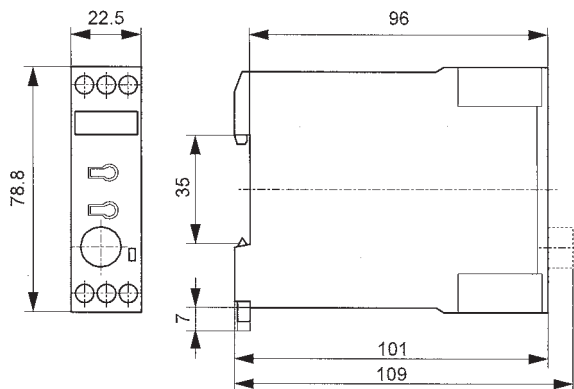


Dimensions

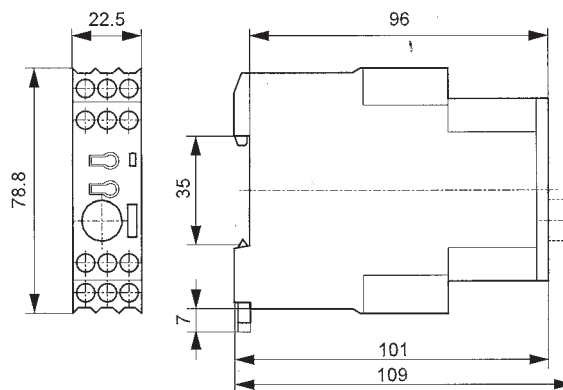
G
Control & Timing Relays
RZ7-FS

Series RZ7-FS Timing Relays (one and two pole)

- Dimensions are in millimeters
- Dimensions not intended for manufacturing purposes



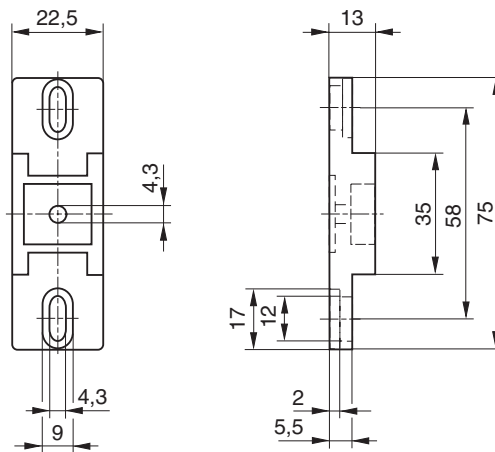
RZ7-FS (1 SPDT contact)



RZ7-FS (2 SPDT contacts)

Panel Mount Adaptor (26.506.221-01)

- Dimensions are in millimeters
- Dimensions not intended for manufacturing purposes



22. Variable Speed Drive



Halmac Services (Qld) Pty. Ltd.
A.C.N. 098 852 923
A.B.N. 40 741 712 113

VARIABLE SPEED DRIVE

1. VARIABLE SPEED DRIVE TECHNICAL DETAILS



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1 How to Read these Operating Instructions

1

VLT AQUA Drive FC 200 Series Software version: 1.33



This guide can be used with all FC 200 frequency converters with software version 1.33 or later.
The actual software version number can be read from par. 15-43 *Software Version*.

1

1.1.1 Copyright, limitation of liability and revision rights

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1.1.2 Available literature for VLT® AQUA Drive FC 200

- VLT® AQUA Drive Operating Instructions MG.20.Mx.yy provide the necessary information for getting the drive up and running.
- VLT® AQUA Drive High Power Operating Instructions MG.20.Px.yy provide the necessary information for getting the HP drive up and running.
- VLT® AQUA Drive Design Guide MG.20.Nx.yy entails all technical information about the drive and customer design and applications.
- VLT® AQUA Drive Programming Guide MN.20.Ox.yy provides information on how to programme and includes complete parameter descriptions.
- VLT® AQUA Drive FC 200 Profibus MG.33.Cx.yy
- VLT® AQUA Drive FC 200 DeviceNet MG.33.Dx.yy
- Output Filters Design Guide MG.90.Nx.yy
- VLT® AQUA Drive FC 200 Cascade Controller MI.38.Cx.yy
- Application Note MN20A102: Submersible Pump Application
- Application Note MN20B102: Master/Follower Operation Application
- Application Note MN20F102: Drive Closed Loop and Sleep Mode
- Instruction MI.38.Bx.yy: Installation Instruction for Mounting Brackets Enclosure type A5, B1, B2, C1 and C2 IP21, IP55 or IP66
- Instruction MI.90.Lx.yy: Analog I/O Option MCB109
- Instruction MI.33.Hx.yy: Panel through mount kit

x = Revision number

yy = Language code

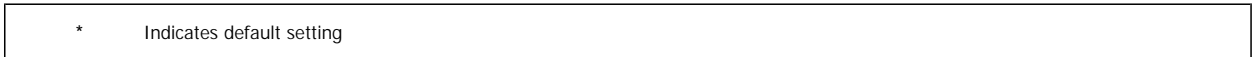
Danfoss technical literature is also available online at
www.danfoss.com/BusinessAreas/DrivesSolutions/Documentations/Technical+Documentation.htm.

1.1.3 Approvals



1.1.4 Symbols

Symbols used in these Operating Instructions.





2

2 Safety

2.1.1 Safety note



The voltage of the frequency converter is dangerous whenever connected to mains. Incorrect installation of the motor, frequency converter or fieldbus may cause damage to the equipment, serious personal injury or death. Consequently, the instructions in this manual, as well as national and local rules and safety regulations, must be complied with.

2

Safety Regulations

1. The frequency converter must be disconnected from mains if repair work is to be carried out. Check that the mains supply has been disconnected and that the necessary time has passed before removing motor and mains plugs.
2. The [STOP/RESET] key on the control panel of the frequency converter does not disconnect the equipment from mains and is thus not to be used as a safety switch.
3. Correct protective earthing of the equipment must be established, the user must be protected against supply voltage, and the motor must be protected against overload in accordance with applicable national and local regulations.
4. The earth leakage currents are higher than 3.5 mA.
5. Protection against motor overload is set by par. 1-90 *Motor Thermal Protection*. If this function is desired, set par. 1-90 to data value [ETR trip] (default value) or data value [ETR warning]. Note: The function is initialised at 1.16 x rated motor current and rated motor frequency. For the North American market: The ETR functions provide class 20 motor overload protection in accordance with NEC.
6. Do not remove the plugs for the motor and mains supply while the frequency converter is connected to mains. Check that the mains supply has been disconnected and that the necessary time has passed before removing motor and mains plugs.
7. Please note that the frequency converter has voltage inputs other than L1, L2 and L3, when load sharing (linking of DC intermediate circuit) and external 24 V DC have been installed. Check that all voltage inputs have been disconnected and that the necessary time has passed before commencing repair work.

Installation at High Altitudes



Installation at high altitude:

380 - 480 V: At altitudes above 3 km, please contact Danfoss Drives regarding PELV.
 525 - 690 V: At altitudes above 2 km, please contact Danfoss Drives regarding PELV.

Warning against Unintended Start

1. The motor can be brought to a stop by means of digital commands, bus commands, references or a local stop, while the frequency converter is connected to mains. If personal safety considerations make it necessary to ensure that no unintended start occurs, these stop functions are not sufficient.
2. While parameters are being changed, the motor may start. Consequently, the stop key [RESET] must always be activated; following which data can be modified.
3. A motor that has been stopped may start if faults occur in the electronics of the frequency converter, or if a temporary overload or a fault in the supply mains or the motor connection ceases.



Warning:

Touching the electrical parts may be fatal - even after the equipment has been disconnected from mains.

Also make sure that other voltage inputs have been disconnected, such as external 24 V DC, load sharing (linkage of DC intermediate circuit), as well as the motor connection for kinetic back up.

2.1.2 General warning



Leakage Current

The earth leakage current from the VLT AQUA Drive FC 200 exceeds 3.5 mA. According to IEC 61800-5-1 a reinforced Protective Earth connection must be ensured by means of: a min. 10mm² Cu or 16mm² Al PE-wire or an additional PE wire - with the same cable cross section as the Mains wiring - must be terminated separately.

Residual Current Device

This product can cause a D.C. current in the protective conductor. Where a residual current device (RCD) is used for extra protection, only an RCD of Type B (time delayed) shall be used on the supply side of this product. See also RCD Application Note MN.90.GX.02. Protective earthing of the VLT AQUA Drive FC 200 and the use of RCD's must always follow national and local regulations.

2

2.1.3 Before commencing repair work

1. Disconnect the frequency converter from mains
2. Disconnect DC bus terminals 88 and 89
3. Wait at least the time mentioned in section General Warning above
4. Remove motor cable

2.1.4 Special conditions

Electrical ratings:

The rating indicated on the nameplate of the frequency converter is based on a typical 3-phase mains power supply, within the specified voltage, current and temperature range, which is expected to be used in most applications.

The frequency converters also support other special applications, which affect the electrical ratings of the frequency converter. Special conditions which affect the electrical ratings might be:

- Single phase applications
- High temperature applications which require derating of the electrical ratings
- Marine applications with more severe environmental conditions.

Consult the relevant clauses in these instructions and in the **VLT® AQUA Drive Design Guide** for information about the electrical ratings.

Installation requirements:

The overall electrical safety of the frequency converter requires special installation considerations regarding:

- Fuses and circuit breakers for over-current and short-circuit protection
- Selection of power cables (mains, motor, brake, loadsharing and relay)
- Grid configuration (IT, TN, grounded leg, etc.)
- Safety of low-voltage ports (PELV conditions).

Consult the relevant clauses in these instructions and in the **VLT® AQUA Drive Design Guide** for information about the installation requirements.

2.1.5 Caution



The frequency converter DC link capacitors remain charged after power has been disconnected. To avoid an electrical shock hazard, disconnect the frequency converter from the mains before carrying out maintenance. Wait at least as follows before doing service on the frequency converter:

Voltage (V)	Min. Waiting Time (Minutes)				
	4	15	20	30	40
200 - 240	0.25 - 3.7 kW	5.5 - 45 kW			
380 - 480	0.37 - 7.5 kW	11 - 90 kW	110 - 250 kW		315 - 1000 kW
525-600	0.75 kW - 7.5 kW	11 - 90 kW			
525-690		11 - 90 kW	45 - 400 kW	450 - 1200 kW	

Be aware that there may be high voltage on the DC link even when the LEDs are turned off.

2.1.6 Avoid un-intended start

NB!
 While the frequency converter is connected to mains, the motor can be started/stopped using digital commands, bus commands, references or via the Local Control Panel.

- Disconnect the frequency converter from mains whenever personal safety considerations make it necessary to avoid unintended start.
- To avoid unintended start, always activate the [OFF] key before changing parameters.
- Unless terminal 37 is turned off, an electronic fault, temporary overload, a fault in the mains supply, or lost motor connection may cause a stopped motor to start.

2.1.7 IT mains

IT mains
 Do not connect frequency converters with RFI-filters to mains supplies with a voltage between phase and earth of more than 440 V for 400 V converters and 760 V for 690 V converters.
 For 400 V IT mains and delta earth (grounded leg), mains voltage may exceed 440 V between phase and earth.
 For 690 V IT mains and delta earth (grounded leg), mains voltage may exceed 760 V between phase and earth.

par. 14-50 *RFI Filter* can be used to disconnect the internal RFI capacitors from the RFI filter to ground.

2.1.8 Disposal instruction

Equipment containing electrical components must not be disposed of together with domestic waste. It must be separately collected with electrical and electronic waste according to local and currently valid legislation.

2.1.9 Safe Stop of the frequency converter (optional)

For versions fitted with a Safe Stop terminal 37 input, the frequency converter can perform the safety function *Safe Torque Off* (As defined by draft CD IEC 61800-5-2) or *Stop Category 0* (as defined in EN 60204-1).

It is designed and approved suitable for the requirements of Safety Category 3 in EN 954-1. This functionality is called Safe Stop. Prior to integration and use of Safe Stop in an installation, a thorough risk analysis on the installation must be carried out in order to determine whether the Safe Stop functionality and safety category are appropriate and sufficient. In order to install and use the Safe Stop function in accordance with the requirements of Safety Category 3 in EN 954-1, the related information and instructions of the VLT AQUA Drive Design Guide MG.20.NX.YY must be followed! The information and instructions of the Operating Instructions are not sufficient for a correct and safe use of the Safe Stop functionality!

2

Prüf- und Zertifizierungsstelle
 im BG-PRÜFZERT



BGIA
Berufsgenossenschaftliches
Institut für Arbeitsschutz

Hauptverband der gewerblichen
 Berufsgenossenschaften

Translation
 In any case, the German
 original shall prevail.

Type Test Certificate

05 06004

No. of certificate

Name and address of the holder of the certificate: (customer) Danfoss Drives A/S, Ulnaes 1 DK-6300 Graasten, Dänemark

Name and address of the manufacturer: Danfoss Drives A/S, Ulnaes 1 DK-6300 Graasten, Dänemark

Ref. of customer:	Ref. of Test and Certification Body: Apf/Köh VE-Nr. 2003 23220	Date of Issue: 13.04.2005
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Product designation: Frequency converter with integrated safety functions

Type: VLT® Automation Drive FC 302

Intended purpose: Implementation of safety function „Safe Stop“

Testing based on: EN 954-1, 1997-03,
 DKE AK 226.03, 1998-06,
 EN ISO 13849-2; 2003-12,
 EN 61800-3, 2001-02,
 EN 61800-5-1, 2003-09,

Test certificate: No.: 2003 23220 from 13.04.2005

Remarks: The presented types of the frequency converter FC 302 meet the requirements laid down in the test bases.
 With correct wiring a category 3 according to DIN EN 954-1 is reached for the safety function.

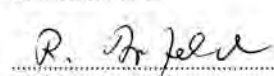
The type tested complies with the provisions laid down in the directive 98/37/EC (Machinery).

Further conditions are laid down in the Rules of Procedure for Testing and Certification of April 2004.

Head of certification body


 (Prof. Dr. rer. nat. Dielmar Reinert)

Certification officer


 (Dipl.-Ing. R. Apfeld)

130BA373.11

PZB10E
 01.05



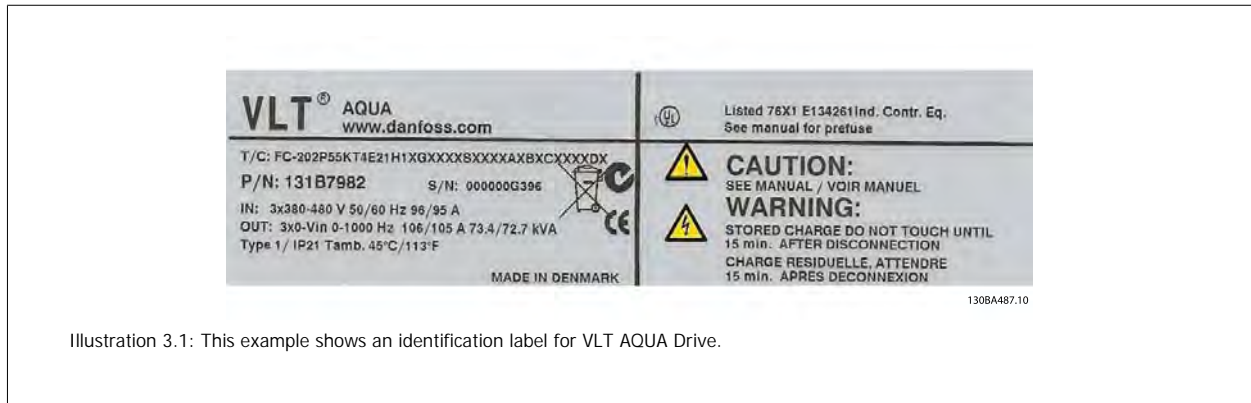
Postal address:
 53754 Sankt Augustin

Office:
 Alte Heerstraße 111
 53757 Sankt Augustin

Phone: 0 22 41/2 31-02
 Fax: 0 22 41/2 31-22 34

3.1.2 Frequency converter identification

Below is an example of an identification label. This label is situated on the frequency converter and shows the type and options fitted to the unit. See table 2.1 for details of how to read the Type code string (T/C).



Please have T/C (type code) number and serial number ready before contacting Danfoss.

3.1.3 Abbreviations and standards

Abbreviations:	Terms:	SI-units:	I-P units:
a	Acceleration	m/s ²	ft/s ²
AWG	American wire gauge		
Auto Tune	Automatic Motor Tuning		
°C	Celsius		
I	Current	A	Amp
I _{LIM}	Current limit		
Joule	Energy	J = N•m	ft-lb, Btu
°F	Fahrenheit		
FC	Frequency Converter		
f	Frequency	Hz	Hz
kHz	Kilohertz	kHz	kHz
LCP	Local Control Panel		
mA	Milliampere		
ms	Millisecond		
min	Minute		
MCT	Motion Control Tool		
M-TYPE	Motor Type Dependent		
Nm	Newton Metres		in-lbs
I _{M,N}	Nominal motor current		
f _{M,N}	Nominal motor frequency		
P _{M,N}	Nominal motor power		
U _{M,N}	Nominal motor voltage		
par.	Parameter		
PELV	Protective Extra Low Voltage		
Watt	Power	W	Btu/hr, hp
Pascal	Pressure	Pa = N/m ²	psi, psf, ft of water
I _{INV}	Rated Inverter Output Current		
RPM	Revolutions Per Minute		
SR	Size Related		
T	Temperature	C	F
t	Time	s	s,hr
T _{LIM}	Torque limit		
U	Voltage	V	V

Table 3.2: Abbreviation and standards table .

4 Mechanical installation

4.1 Before starting

4.1.1 Checklist

When unpacking the frequency converter, ensure that the unit is undamaged and complete. Use the following table to identify the packaging:












Enclosure type:	A2 (IP 20/ 21)	A3 (IP 20/21)	A5 (IP 55/ 66)	B1/B3 (IP20/ 21/ 55/ 66)	B2/B4 (IP20/ 21/ 55/66)	C1/C3 (IP20/21/ 55/66)	C2/C4 (IP20/21/ 55/66)
Unit size (kW):							
200-240 V	0.25-3.0	3.7	0.25-3.7	5.5-11/ 5.5-11	15/ 15-18.5	18.5-30/ 22-30	37-45/ 37-45
380-480 V	0.37-4.0	5.5-7.5	0.37-7.5	11-18.5/ 11-18.5	22-30/ 22-37	37-55/ 45-55	75 - 90/ 75-90
525-600 V		0.75-7.5	0.75-7.5	11-18.5/ 11-18.5	22-37/ 22-37	45-55/ 45-55	75 - 90/ 75-90
525-690 V	-	-	-	-/ -	11-30/ -	-/ -	37-90/ -

Table 4.1: Unpacking table

Please note that a selection of screwdrivers (philips or cross-thread screwdriver and torx), a side-cutter, drill and knife is also recommended to have handy for unpacking and mounting the frequency converter. The packaging for these enclosures contains, as shown: Accessories bag(s), documentation and the unit. Depending on options fitted there may be one or two bags and one or more booklets.

4

4.2.1 Mechanical front views

A2		IP20/21*																					
A3		IP20/21*																					
A5		IP55/66																					
B1		IP21/55/66																					
B2		IP21/55/66																					
B3		IP20/21*																					
B4		IP20/21*																					
C1		IP21/55/66																					
C2		IP21/55/66																					
C3		IP20/21*																					
C4		IP20/21*																					

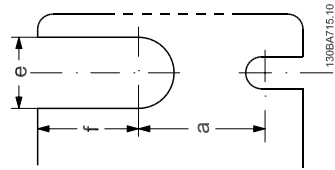


Illustration 4.2: Top and bottom mounting holes. (B4+C3+C4 only)

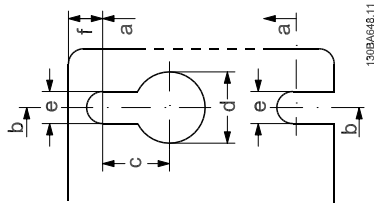


Illustration 4.1: Top and bottom mounting holes.

Accessory bags containing necessary brackets, screws and connectors are included with the drives upon delivery.

All measurements in mm.
 * IP21 can be established with a kit as described in the section: IP 21/ IP 4X/ TYPE 1 Enclosure Kit in the Design Guide.

4.2.2 Mechanical dimensions

Frame size (kW):		Mechanical dimensions											
		A2	A3	A5	B1	B2	B3	B4	C1	C2	C3	C4	
200-240 V	T2	0.25-3.0	3.7	0.25-3.7	5.5-11	15	5.5-11	15-18.5	18.5-30	37-45	22-30	37-45	
380-480 V	T4	0.37-4.0	5.5-7.5	0.37-7.5	11-18.5	22-30	11-18.5	22-37	37-55	75-90	45-55	75-90	
525-600 V	T6	-	0.75-7.5	0.75-7.5	11-18.5	22-30	11-18.5	22-37	37-55	75-90	45-55	75-90	
525-690 V	T7	-	-	-	-	11-30	-	-	-	37-90	-	-	
IP		20	21	55/66	21/ 55/66	21/55/66	20	20	21/55/66	21/55/66	20	20	
NEMA		Chassis	Type 1	Type 12	Type 1/12	Type 1/12	Chassis	Chassis	Type 1/12	Type 1/12	Chassis	Chassis	
Height (mm)													
Enclosure	A**	246	246	420	480	650	350	460	680	770	490	600	
.with de-coupling plate	A2	374	374	-	-	-	419	595	-	-	630	800	
Back plate	A1	268	268	420	480	650	399	520	680	770	550	660	
Distance between mount. holes	a	257	257	402	454	624	380	495	648	739	521	631	
Width (mm)													
Enclosure	B	90	130	242	242	242	165	231	308	370	308	370	
With one C option	B	130	170	242	242	242	205	231	308	370	308	370	
Back plate	B	90	130	242	242	242	165	231	308	370	308	370	
Distance between mount. holes	b	70	110	215	210	210	140	200	272	334	270	330	
Depth (mm)													
Without option A/B	C	205	205	200	260	260	248	242	310	335	333	333	
With option A/B	C*	220	220	200	260	260	262	242	310	335	333	333	
Screw holes (mm)													
	c	8.0	8.0	8.2	12	12	8	-	12	12	-	-	
Diameter ø	d	11	11	12	19	19	12	-	19	19	-	-	
Diameter ø	e	5.5	5.5	6.5	9	9	6.8	8.5	9.0	9.0	8.5	8.5	
	f	9	9	9	9	9	7.9	15	9.8	9.8	17	17	
Max weight (kg)		4.9	5.3	14	23	27	12	23.5	45	65	35	50	

* Depth of enclosure will vary with different options installed.
 ** The free space requirements are above and below the bare enclosure height measurement A. See section 3.2.3 for further information.

4.2.3 Mechanical mounting

All IP20 enclosure sizes as well as IP21/ IP55 enclosure sizes except A2 and A3 allow side-by-side installation.

If the IP 21 Enclosure kit (130B1122 or 130B1123) is used on enclosure A2 or A3, there must be a clearance between the drives of min. 50 mm.

For optimal cooling conditions allow a free air passage above and below the frequency converter. See table below.

4

Air passage for different enclosures		Enclosure:	A2	A3	A5	B1	B2	B3	B4	C1	C2	C3	C4
a (mm):			100	100	100	200	200	200	200	200	225	200	225
b (mm):			100	100	100	200	200	200	200	200	225	200	225

1. Drill holes in accordance with the measurements given.
2. You must provide screws suitable for the surface on which you want to mount the frequency converter. Re-tighten all four screws.

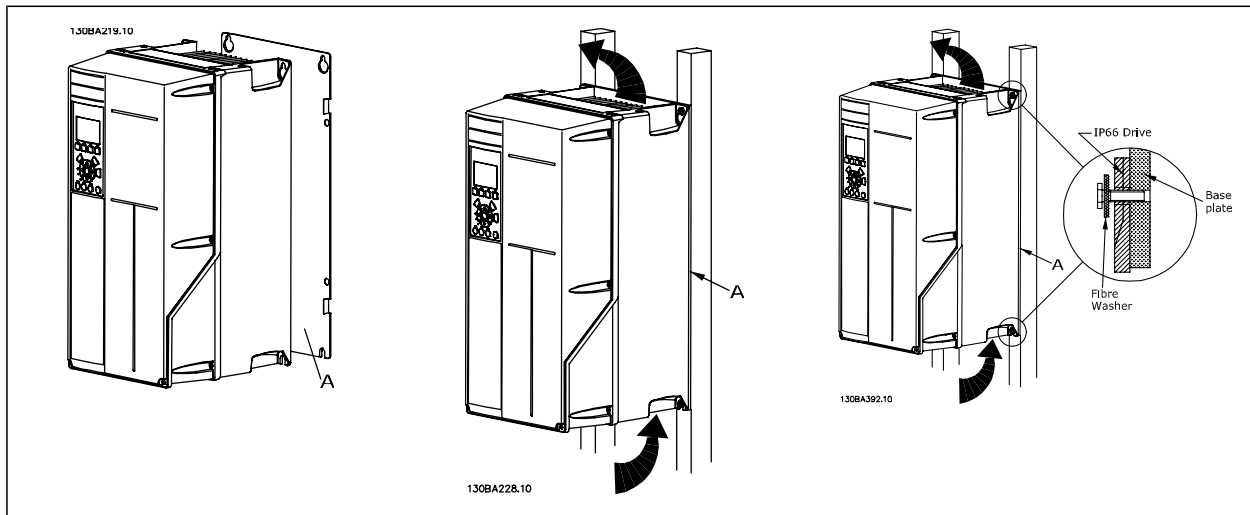


Table 4.2: Mounting frame sizes A5, B1, B2, B3, B4, C1, C2, C3 and C4 on a non-solid back wall, the drive must be provided with a back plate A due to insufficient cooling air over the heat sink.

With heavier drives (B4, C3, C4) use a lift. First wall-mount the 2 lower bolts - then lift the drive onto the lower bolts - finally fasten the drive against the wall with the 2 top bolts.

4.2.4 Safety requirements of mechanical installation



Pay attention to the requirements that apply to integration and field mounting kit. Observe the information in the list to avoid serious damage or injury, especially when installing large units.

The frequency converter is cooled by means of air circulation.

To protect the unit from overheating, it must be ensured that the ambient temperature *does not exceed the maximum temperature stated for the frequency converter* and that the 24-hour average temperature *is not exceeded*. Locate the maximum temperature and 24-hour average in the paragraph *Derating for Ambient Temperature*.

If the ambient temperature is in the range of 45 °C - 55 ° C, derating of the frequency converter will become relevant, see *Derating for Ambient Temperature*.

The service life of the frequency converter is reduced if derating for ambient temperature is not taken into account.

4.2.5 Field Mounting

For field mounting the IP 21/IP 4X top/TYPE 1 kits or IP 54/55 units are recommended.

4.2.6 Panel through mounting

A Panel Through Mount Kit is available for frequency converter series , VLT Aqua Drive and.

In order to increase heatsink cooling and reduce panel depth, the frequency converter may be mounted in a through panel. Furthermore the in-built fan can then be removed.

The kit is available for enclosures A5 through C2.



NB!

This kit cannot be used with cast front covers. No cover or IP21 plastic cover must be used instead.

Information on ordering numbers is found in the *Design Guide*, section *Ordering Numbers*.

More detailed information is available in the *Panel Through Mount Kit instruction*, *MI.33.H1.YY*, where yy=language code.



5

5 Electrical Installation

5.1 How to Connect

5.1.1 Cables general



NB!

Always comply with national and local regulations on cable cross-sections.

Details of terminal tightening torques.

Enclosure	Power (kW)			Torque (Nm)					
	200-240 V	380-480 V	525-600 V	Mains	Motor	DC connection	Brake	Earth	Relay
A2	0.25 - 3.0	0.37 - 4.0		1.8	1.8	1.8	1.8	3	0.6
A3	3.7	5.5 - 7.5	0.75 - 7.5	1.8	1.8	1.8	1.8	3	0.6
A5	0.25 - 3.7	0.37 - 7.5	0.75 - 7.5	1.8	1.8	1.8	1.8	3	0.6
B1	5.5 - 11	11 - 18.5	-	1.8	1.8	1.5	1.5	3	0.6
B2	-	22	-	4.5	4.5	3.7	3.7	3	0.6
	15	30	-	4.5 ²⁾	4.5 ²⁾	3.7	3.7	3	0.6
B3	5.5 - 11	11 - 18.5	11 - 18.5	1.8	1.8	1.8	1.8	3	0.6
B4	15 - 18.5	22 - 37	22 - 37	4.5	4.5	4.5	4.5	3	0.6
C1	18.5 - 30	37 - 55	-	10	10	10	10	3	0.6
C2	37	75	-	14	14	14	14	3	0.6
	45	90	-	24	24	14	14	3	0.6
C3	22 -	45 -	45 -	10	10	10	10	3	0.6
	30	55	55						
C4	37 -	75 -	75 -	14	14	14	14	3	0.6
	45	90	90						

Table 5.1: Tightening of terminals

1. For different cable dimensions x/y where $x \leq 95 \text{ mm}^2$ and $y \geq 95 \text{ mm}^2$.
2. Cable dimensions above 18.5 kW $\geq 35 \text{ mm}^2$ and below 22 kW $\leq 10 \text{ mm}^2$

5.1.2 Earthing and IT mains



The earth connection cable cross section must be at least 10 mm² or 2 rated mains wires terminated separately according to *EN 50178* or *IEC 61800-5-1* unless national regulations specify differently. Always comply with national and local regulations, on cable cross-sections.

The mains is connected to the main disconnect switch if this is included.



NB!
 Check that mains voltage corresponds to the mains voltage of the frequency converter name plate.

5

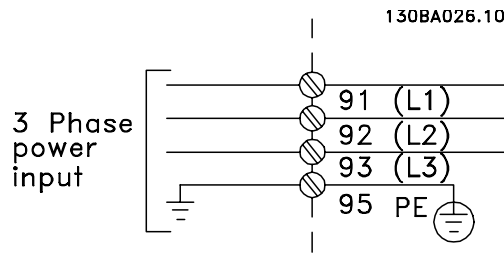


Illustration 5.1: Terminals for mains and earthing.



IT Mains

Do not connect 400 V frequency converters with RFI-filters to mains supplies with a voltage between phase and earth of more than 440 V.
 For IT mains and delta earth (grounded leg), mains voltage may exceed 440 V between phase and earth.



5.1.3 Mains wiring overview




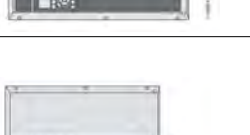
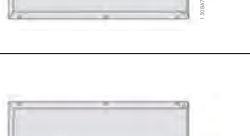






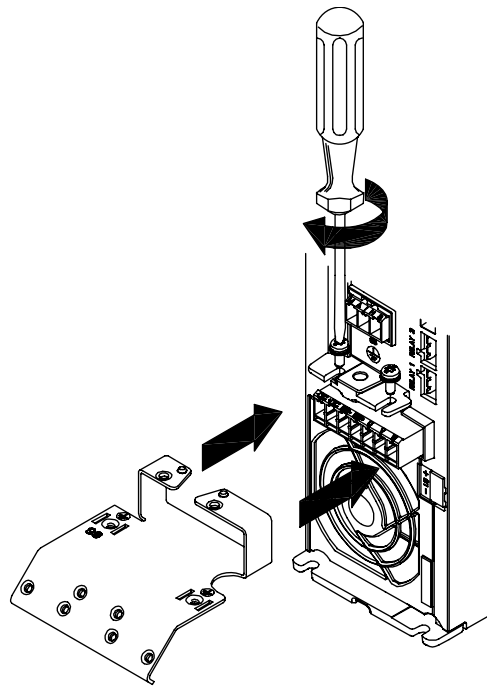
Enclosure:	A2 (IP 20/IP 21)	A3 (IP 20/IP 21)	A5 (IP 55/IP 66)	B1 (IP 21/IP 55/IP 66)	B2 (IP 21/IP 55/IP 66)	B3 (IP 20)	B4 (IP 20)	C1 (IP 21/IP 55/66)	C2 (IP 21/IP 55/66)	C3 (IP 20)	C4 (IP20)
											
Motor size (kW):											
200-240 V	0.25-3.0	3.7	1.1-3.7	5.5-11	15	5.5-11	15-18.5	18.5-30	37-45	22-30	37-45
380-480 V	0.37-4.0	5.5-7.5	1.1-7.5	11-18.5	22-30	11-18.5	22-37	37-55	75-90	45-55	75-90
525-600 V	.	1.1-7.5	1.1-7.5	11-18.5	22-30	11-18.5	22-37	37-55	75-90	45-55	75-90
525-690 V					11-30				37-90		
Goto:			5.1.7		5.1.8			5.1.9			5.1.10

Table 5.2: Mains wiring table.

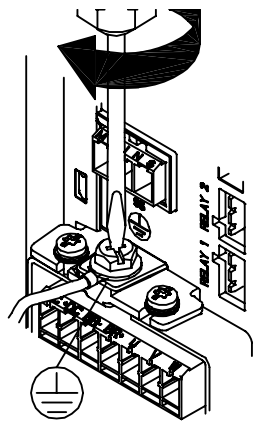
5.1.4 Mains connection for A2 and A3

5



130BA261.10

Illustration 5.2: First mount the two screws on the mounting plate, slide it into place and tighten fully.

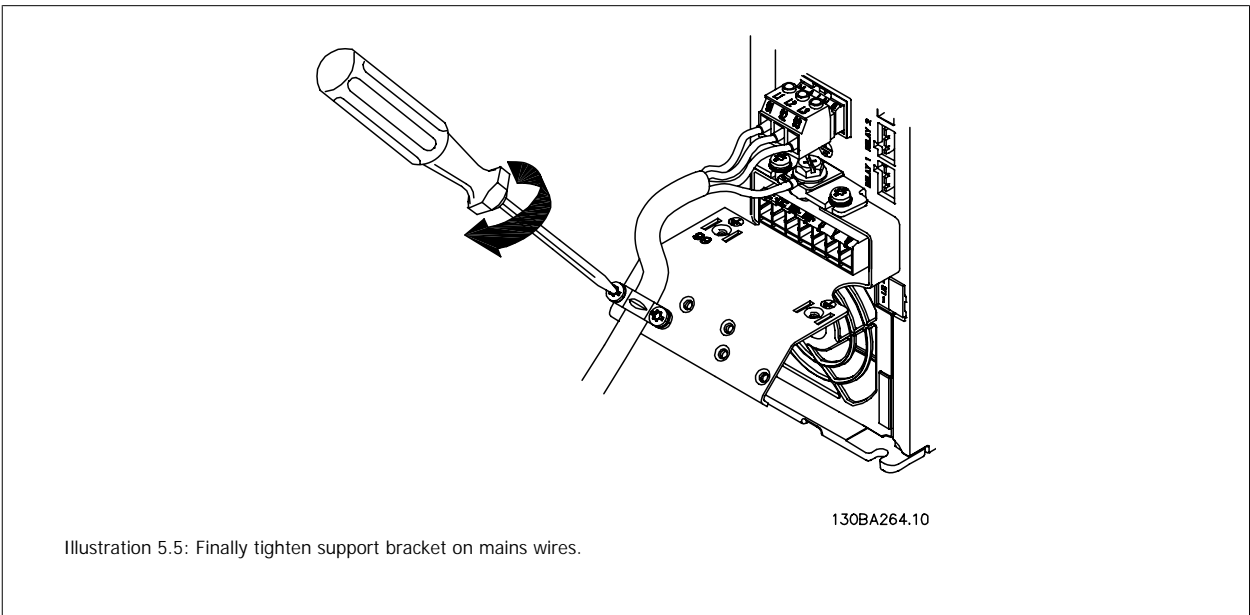
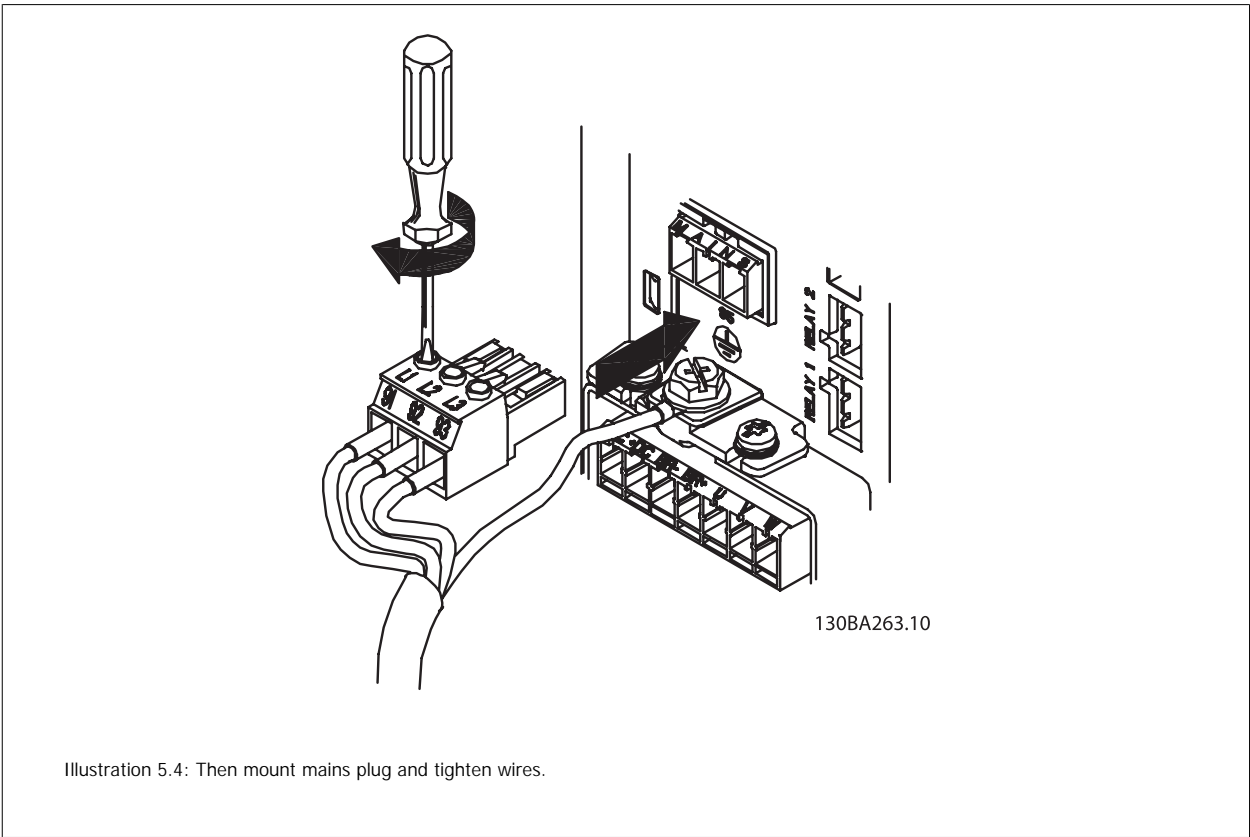


130BA262.1C

Illustration 5.3: When mounting cables, first mount and tighten earth cable.



The earth connection cable cross section must be at least 10 mm² or 2 rated mains wires terminated separately according to *EN 50178/ IEC 61800-5-1*.



NB!
With single phase A3 use L1 and L2 terminals.

5.1.5 Mains connection for A5

5

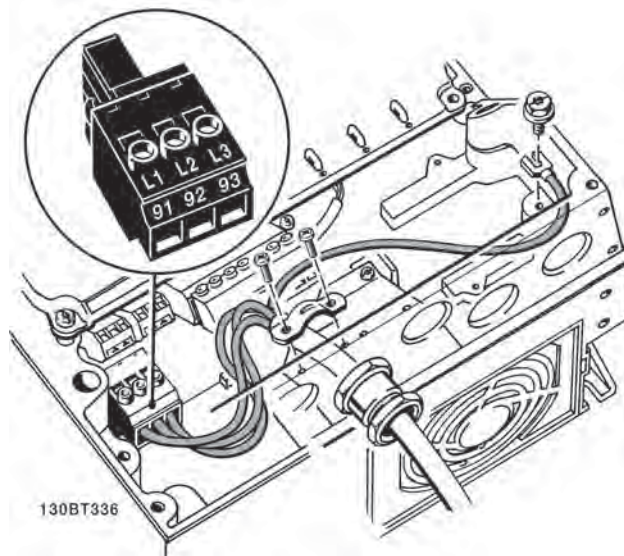


Illustration 5.6: How to connect to mains and earthing without mains disconnect switch. Note that a cable clamp is used.

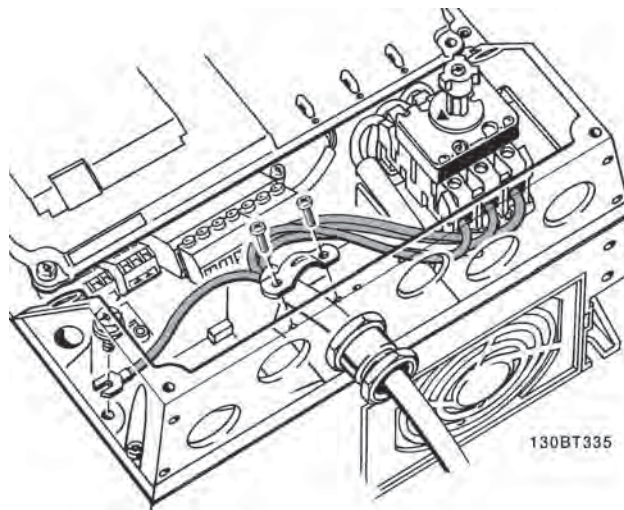


Illustration 5.7: How to connect to mains and earthing with mains disconnect switch.

NB!

With single phase A5 use L1 and L2 terminals.

5.1.6 Mains connection for B1, B2 and B3

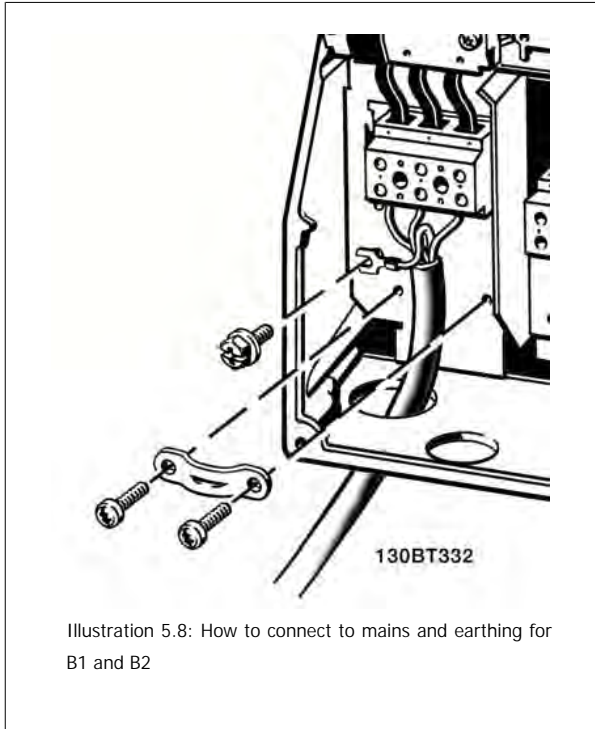


Illustration 5.8: How to connect to mains and earthing for B1 and B2

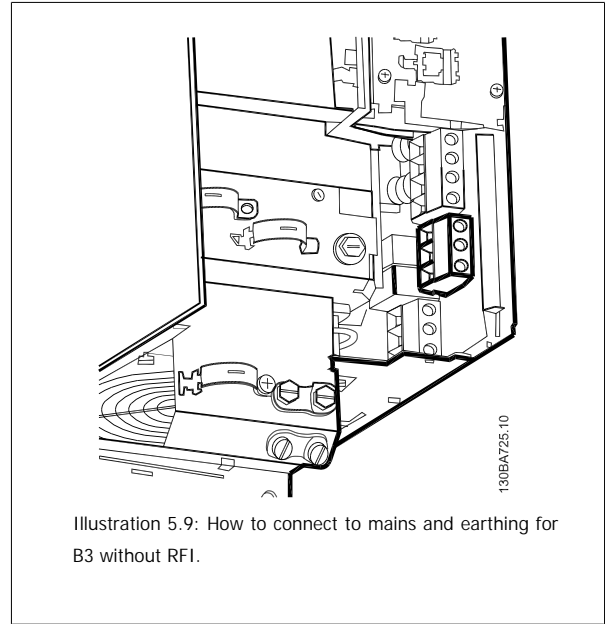


Illustration 5.9: How to connect to mains and earthing for B3 without RFI.

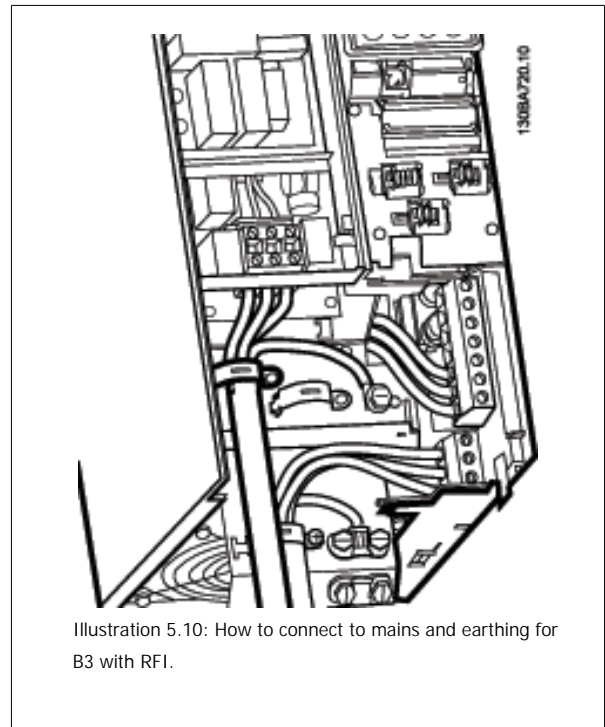



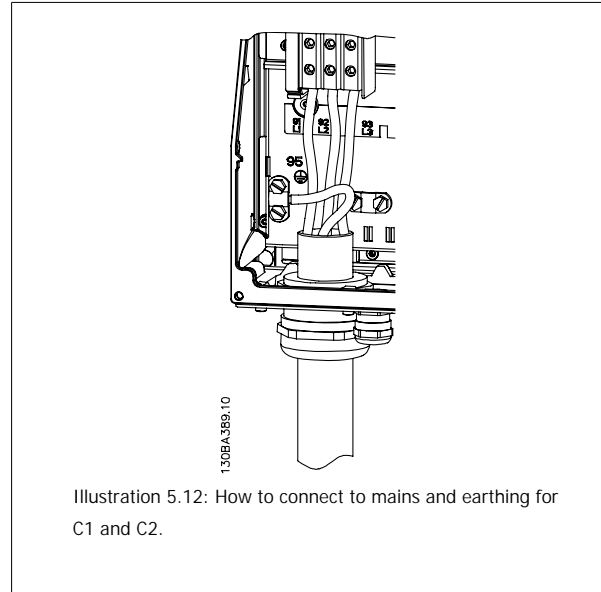
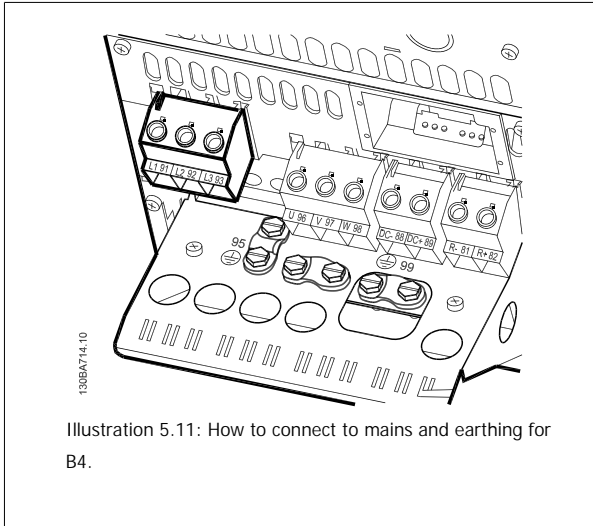
Illustration 5.10: How to connect to mains and earthing for B3 with RFI.

NB!
 With single phase B1 use L1 and L2 terminals.

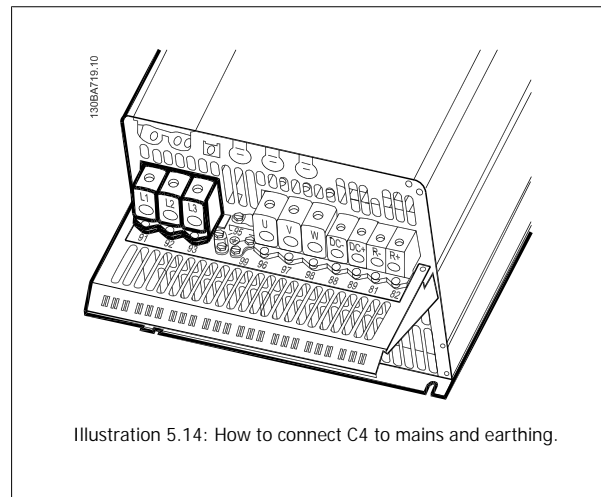
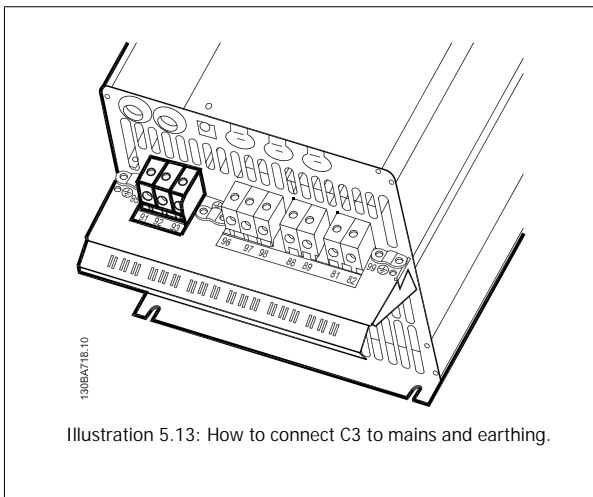
 **NB!**
 For correct cable dimensions please see the section *General Specifications* at the back of this manual.

5

5.1.7 Mains connection for B4, C1 and C2



5.1.8 Mains connection for C3 and C4



5.1.9 How to connect motor - introduction

See section *General Specifications* for correct dimensioning of motor cable cross-section and length.

- Use a screened/armoured motor cable to comply with EMC emission specifications (or install the cable in metal conduit).
- Keep the motor cable as short as possible to reduce the noise level and leakage currents.
- Connect the motor cable screen/armour to both the decoupling plate of the frequency converter and to the metal of the motor. (Same applies to both ends of metal conduit if used instead of screen.)
- Make the screen connections with the largest possible surface area (cable clamp or by using an EMC cable gland). This is done by using the supplied installation devices in the frequency converter.
- Avoid terminating the screen by twisting the ends (pigtailed), as this will spoil high frequency screening effects.
- If it is necessary to break the continuity of the screen to install a motor isolator or motor relay, the continuity must be maintained with the lowest possible HF impedance.

Cable length and cross-section

The frequency converter has been tested with a given length of cable and a given cross-section of that cable. If the cross-section is increased, the cable capacitance - and thus the leakage current - may increase, and the cable length must be reduced correspondingly.

Switching frequency

When frequency converters are used together with sine wave filters to reduce the acoustic noise from a motor, the switching frequency must be set according to the sine wave filter instruction in par. 14-01 *Switching Frequency*.

Precautions while using Aluminium conductors

Aluminium conductors are not recommended for cable cross sections below 35 mm². Terminals can accept aluminium conductors but the conductor surface has to be clean and the oxidation must be removed and sealed by neutral acid free Vaseline grease before the conductor is connected. Furthermore, the terminal screw must be retightened after two days due to the softness of the aluminium. It is crucial to ensure the connection makes a gas tight joint, otherwise the aluminium surface will oxidize again.

All types of three-phase asynchronous standard motors can be connected to the frequency converter. Normally, small motors are star-connected (230/400 V, D/Y). Large motors are delta-connected (400/690 V, D/Y). Refer to the motor name plate for correct connection mode and voltage.

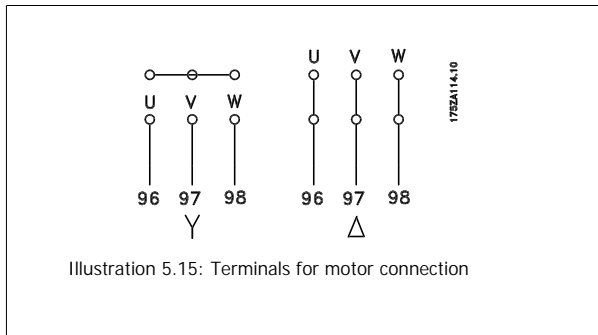


Illustration 5.15: Terminals for motor connection

NB! In motors without phase insulation paper or other insulation reinforcement suitable for operation with voltage supply (such as a frequency converter), fit a sine-wave filter on the output of the frequency converter. (Motors that comply with IEC 60034-17 do not require a Sine-wave filter).

No.	96	97	98	Motor voltage 0-100% of mains voltage.
	U	V	W	3 cables out of motor
	U1	V1	W1	6 cables out of motor, Delta-connected
	W2	U2	V2	
	U1	V1	W1	6 cables out of motor, Star-connected
				U2, V2, W2 to be interconnected separately (optional terminal block)
No.	99			Earth connection
	PE			

Table 5.3: 3 and 6 cable motor connection.

5

5.1.10 Motor wiring overview












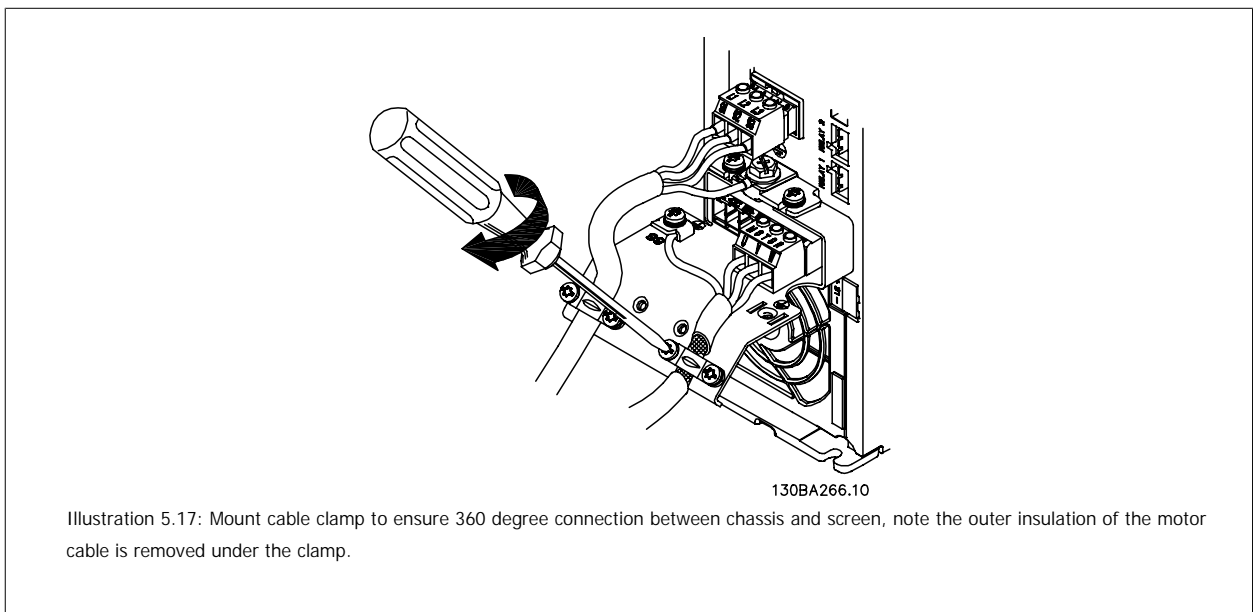
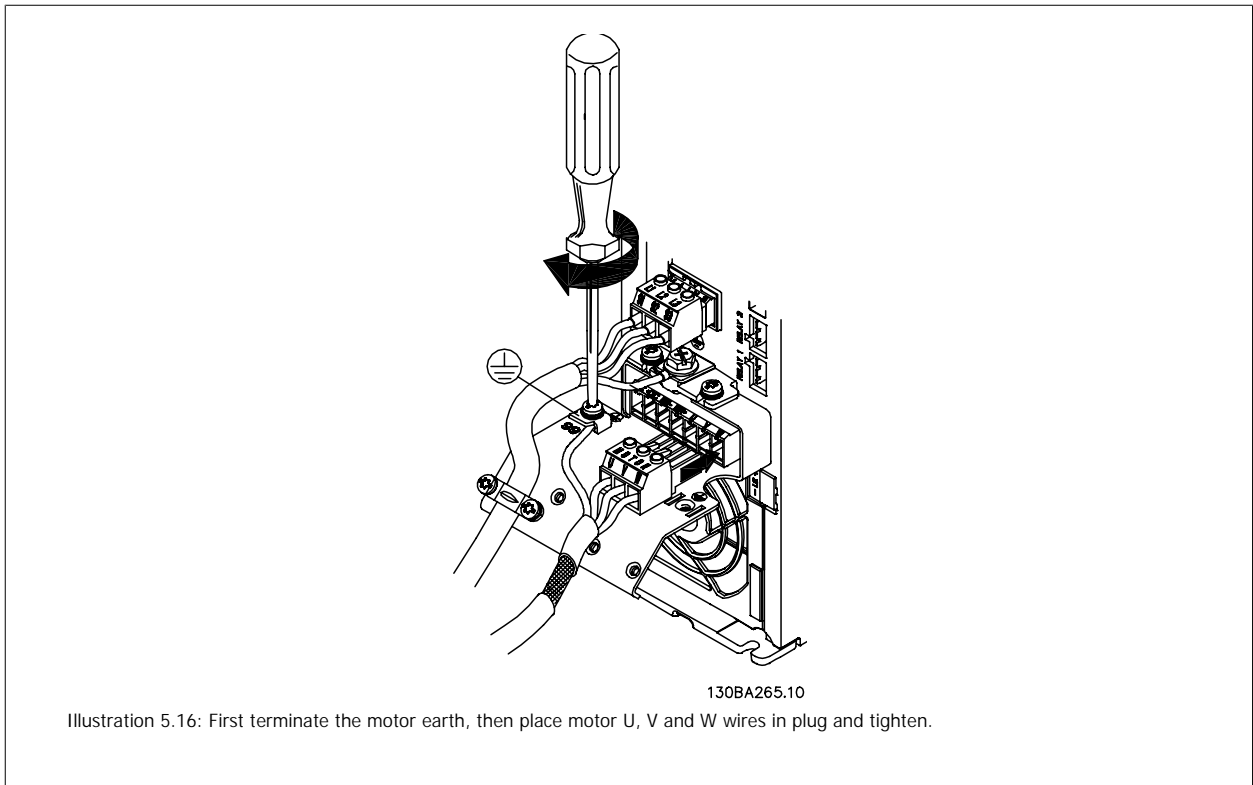
Enclosure:	A2 (IP 20/IP 21)	A3 (IP 20/IP 21)	A5 (IP 55/IP 66)	B1 (IP 21/IP 55/ IP 66)	B2 (IP 21/IP 55/ IP 66)	B3 (IP 20)	B4 (IP 20)	C1 (IP 21/IP 55/66)	C2 (IP 21/IP 55/66)	C3 (IP 20)	C4 (IP20)
											
Motor size (kW):	0.25-3.0	3.7	1.1-3.7	5.5-11	15	5.5-11	15-18.5	18.5-30	37-45	22-30	37-45
200-240 V	0.37-4.0	5.5-7.5	1.1-7.5	11-18.5	22-30	11-18.5	22-37	37-55	75-90	45-55	75-90
380-480 V		1.1-7.5	1.1-7.5	11-18.5	22-30	11-18.5	22-37	37-55	75-90	45-55	75-90
525-600 V		1.1-7.5	1.1-7.5	11-18.5	22-30	11-18.5	22-37	37-55	75-90	45-55	75-90
525-690 V		1.1-7.5	1.1-7.5	11-18.5	22-30	11-18.5	22-37	37-55	75-90	45-55	75-90
Goto:		5.1.13	5.1.14	5.1.15	5.1.16	5.1.17	5.1.18				

Table 5.4: Motor wiring table.

5.1.11 Motor connection for A2 and A3

Follow these drawings step by step for connecting the motor to the frequency converter.



5.1.12 Motor connection for A5

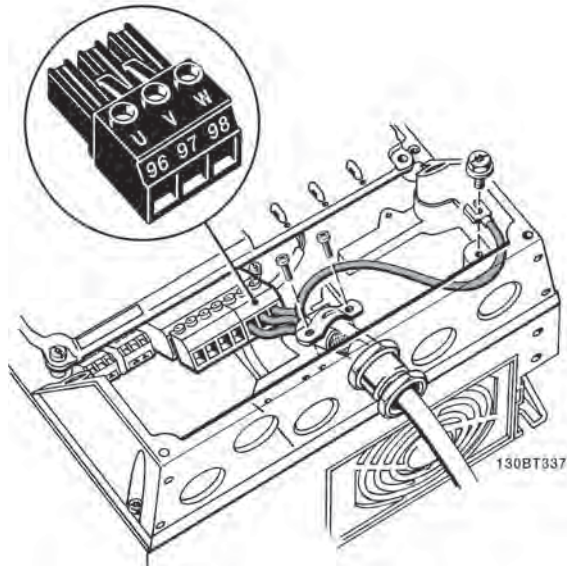


Illustration 5.18: First terminate the motor earth, then place motor U, V and W wires in terminal and tighten. Please ensure that the outer insulation of the motor cable is removed under the EMC clamp.

5.1.13 Motor connection for B1 and B2

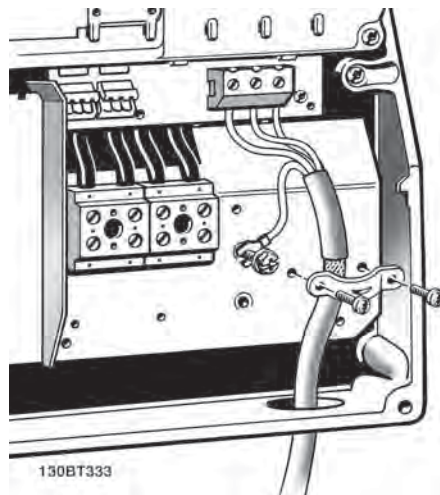


Illustration 5.19: First terminate the motor earth, then Place motor U, V and W wires in terminal and tighten. Please ensure that the outer insulation of the motor cable is removed under the EMC clamp.

5.1.14 Motor connection for B3 and B4

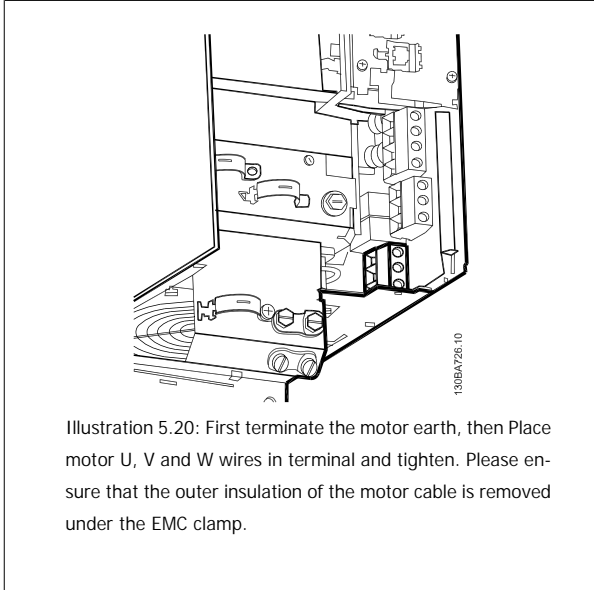


Illustration 5.20: First terminate the motor earth, then Place motor U, V and W wires in terminal and tighten. Please ensure that the outer insulation of the motor cable is removed under the EMC clamp.

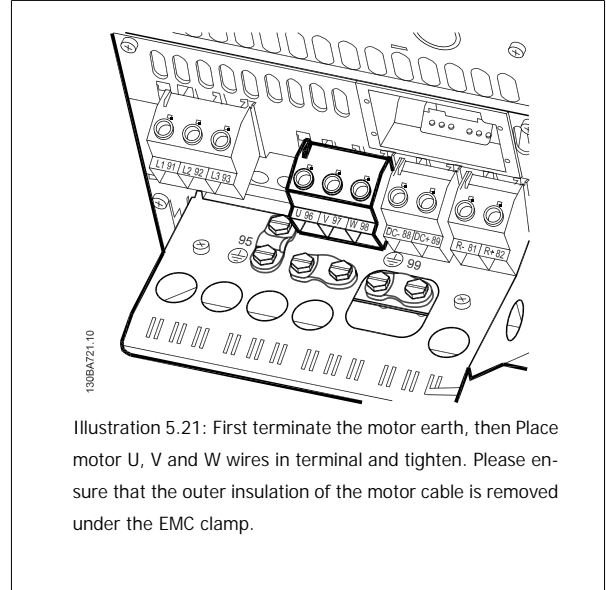


Illustration 5.21: First terminate the motor earth, then Place motor U, V and W wires in terminal and tighten. Please ensure that the outer insulation of the motor cable is removed under the EMC clamp.

5.1.15 Motor connection for C1 and C2

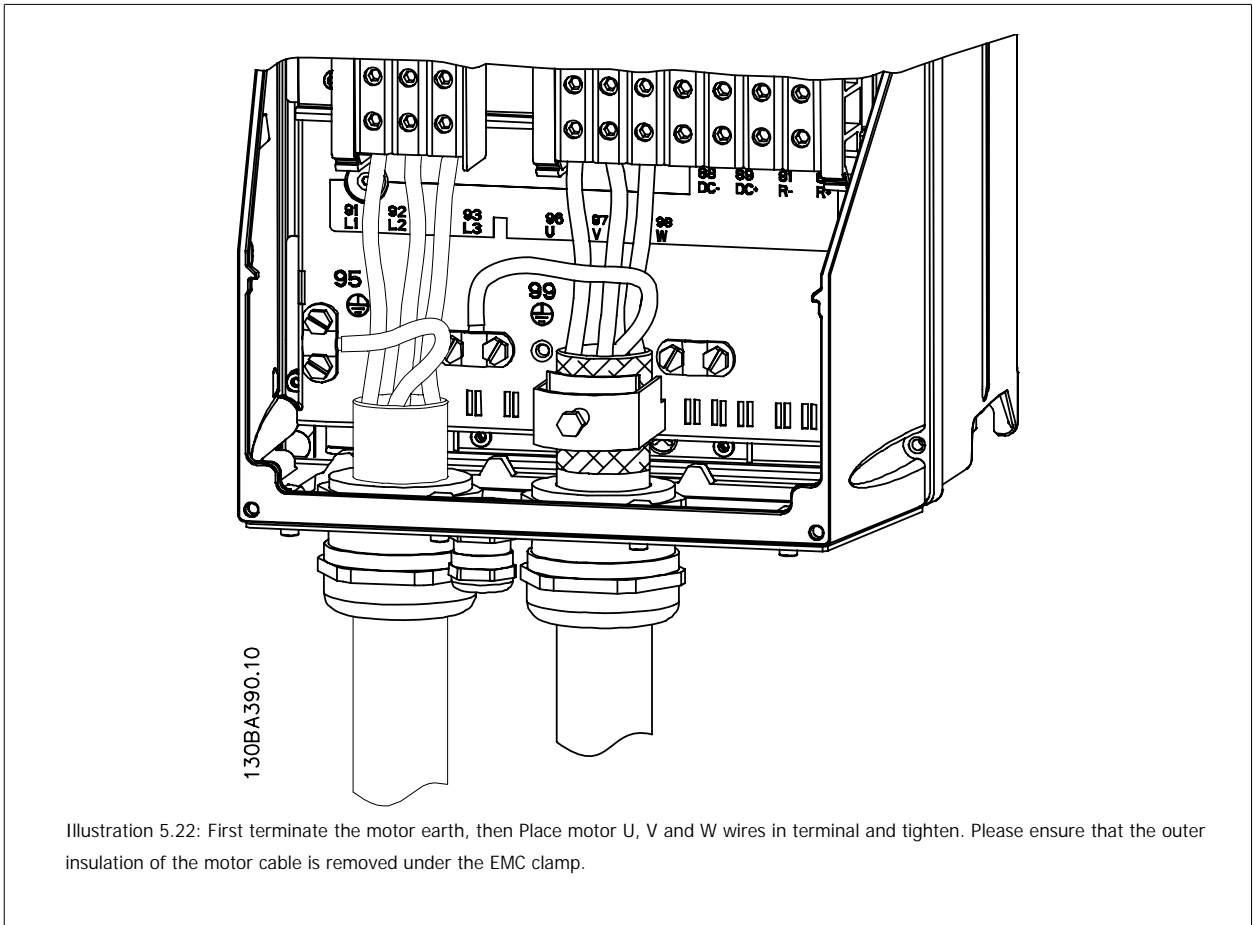


Illustration 5.22: First terminate the motor earth, then Place motor U, V and W wires in terminal and tighten. Please ensure that the outer insulation of the motor cable is removed under the EMC clamp.

5.1.16 Motor connection for C3 and C4

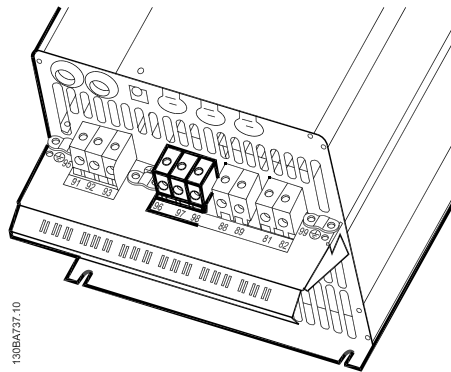


Illustration 5.23: First terminate the motor earth, then place motor U, V and W wires into the appropriate terminals and tighten. Please ensure that the outer insulation of the motor cable is removed under the EMC clamp.

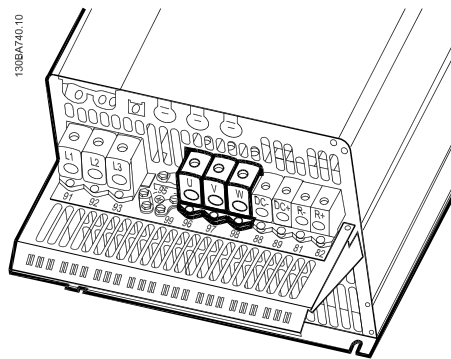


Illustration 5.24: First terminate the motor earth, then place motor U, V and W wires into the appropriate terminals and tighten. Please ensure that the outer insulation of the motor cable is removed under the EMC clamp.

5.1.17 DC bus connection

The DC bus terminal is used for DC back-up, with the intermediate circuit being supplied from an external source.

Terminal numbers used: 88, 89

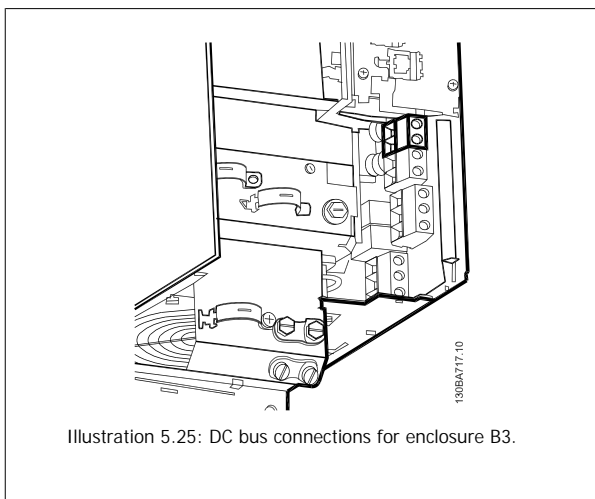


Illustration 5.25: DC bus connections for enclosure B3.

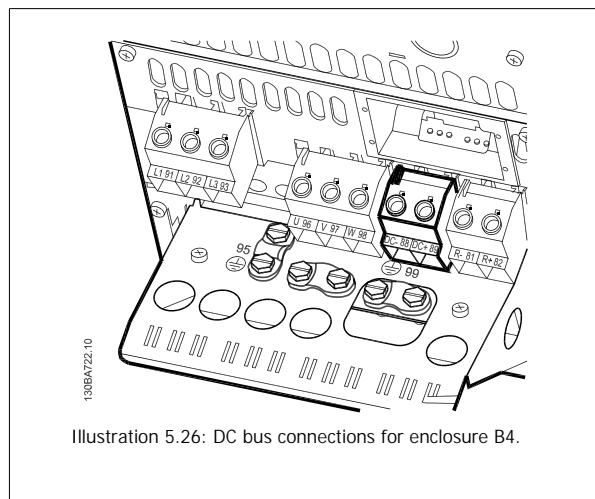


Illustration 5.26: DC bus connections for enclosure B4.

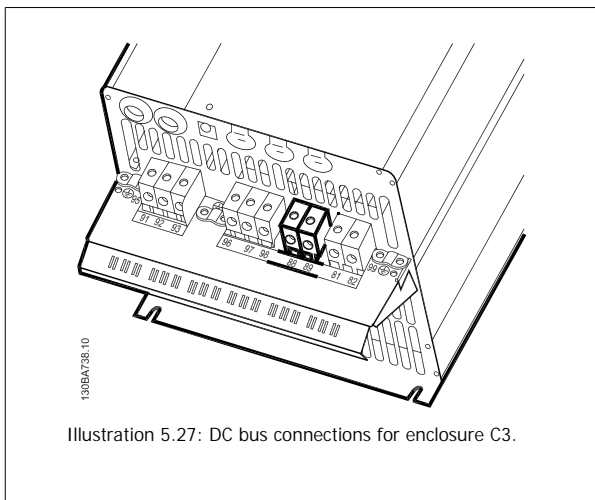


Illustration 5.27: DC bus connections for enclosure C3.

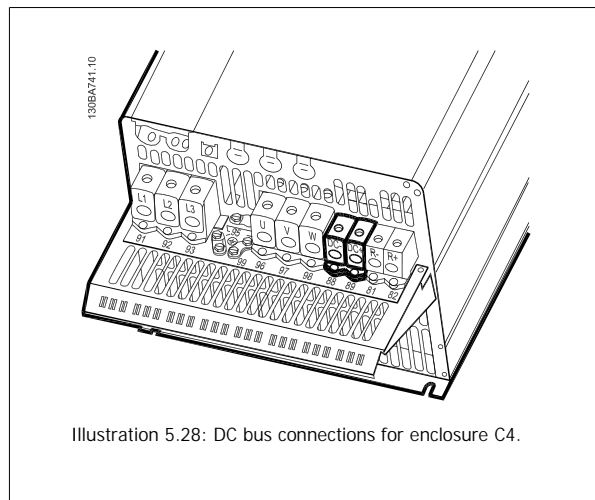


Illustration 5.28: DC bus connections for enclosure C4.

Please contact Danfoss if you require further information.

5.1.18 Brake connection option

The connection cable to the brake resistor must be screened/armoured.

Brake resistor		
Terminal number	81	82
Terminals	R-	R+

NB! Dynamic brake calls for extra equipment and safety considerations. For further information, please contact Danfoss.

1. Use cable clamps to connect the screen to the metal cabinet of the frequency converter and to the decoupling plate of the brake resistor.
2. Dimension the cross-section of the brake cable to match the brake current.

NB! Voltages up to 975 V DC (@ 600 V AC) may occur between the terminals.

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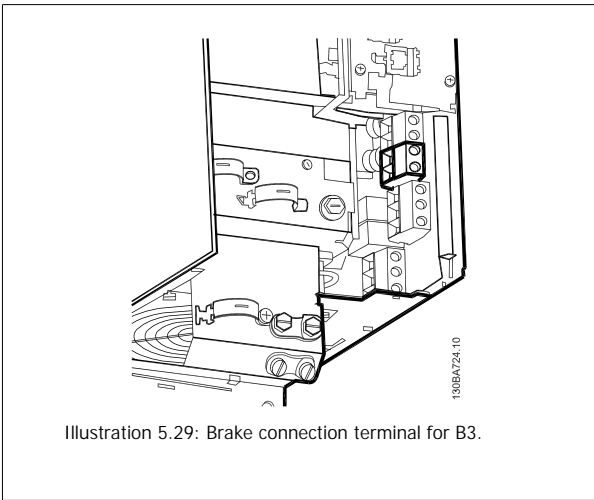


Illustration 5.29: Brake connection terminal for B3.

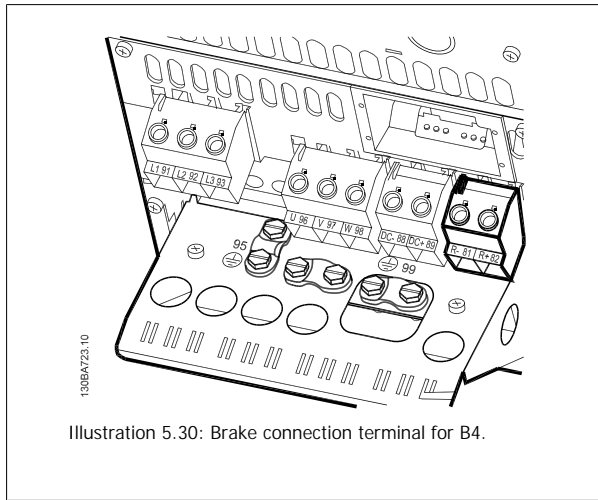


Illustration 5.30: Brake connection terminal for B4.

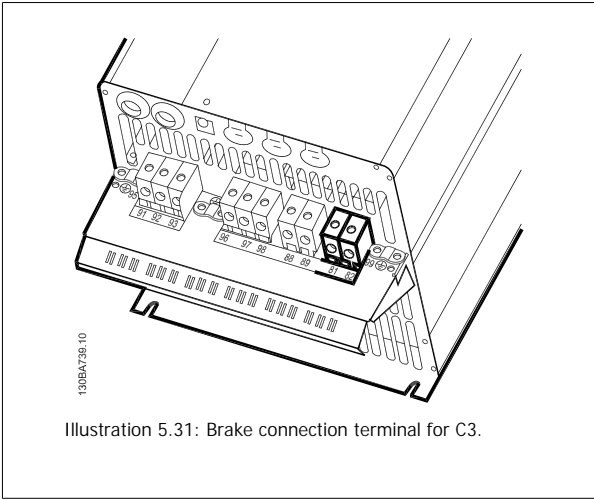


Illustration 5.31: Brake connection terminal for C3.

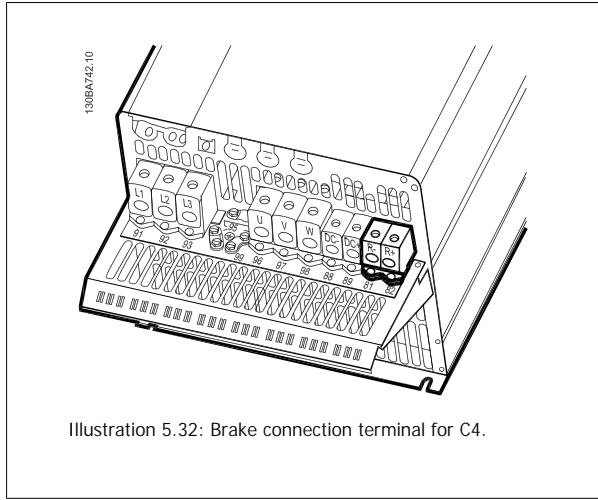


Illustration 5.32: Brake connection terminal for C4.

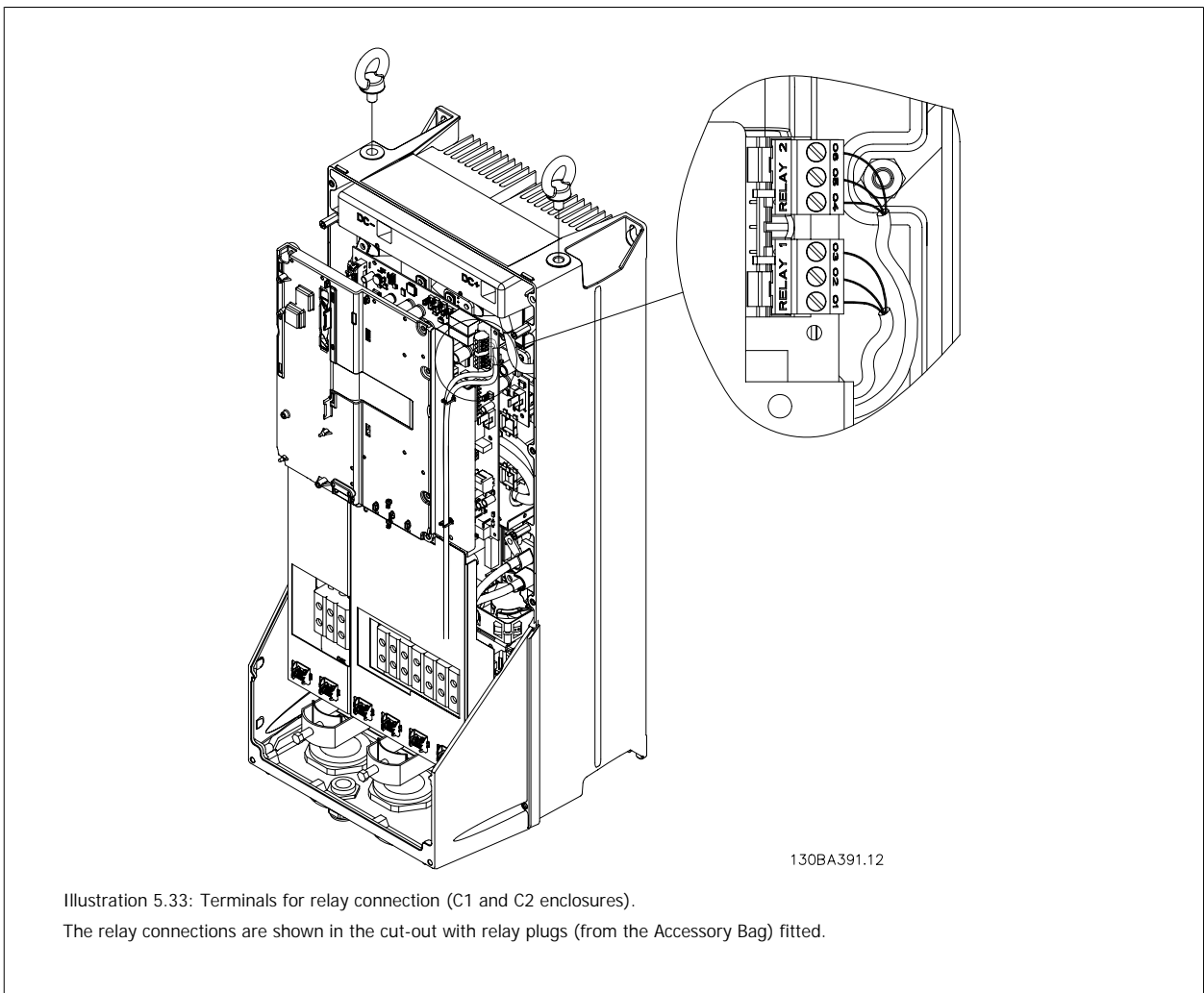
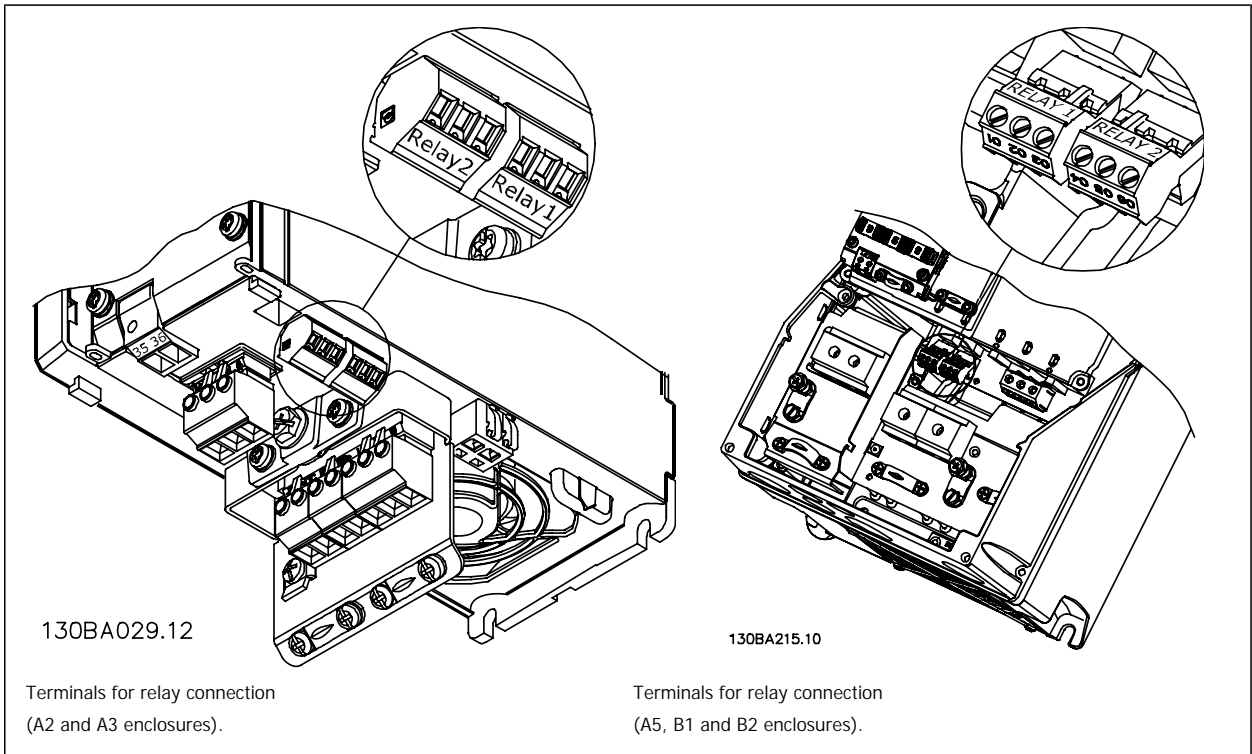
NB!
 If a short circuit in the brake IGBT occurs, prevent power dissipation in the brake resistor by using a mains switch or contactor to disconnect the mains for the frequency converter. Only the frequency converter shall control the contactor.

NB!
 Place the brake resistor in an environment free of fire risk and ensure that no external objects can fall into the brake resistor through ventilation slots.
 Do not cover ventilation slots and grids.

5.1.19 Relay connection

To set relay output, see par. group 5-4* Relays.

No.	01 - 02	make (normally open)
	01 - 03	break (normally closed)
	04 - 05	make (normally open)
	04 - 06	break (normally closed)



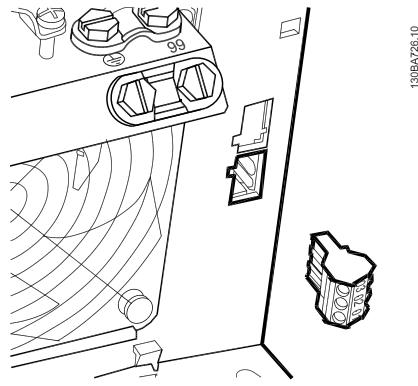


Illustration 5.34: Terminals for relay connections for B3. Only one relay input is fitted from the factory. When the second relay is needed remove knock-out.

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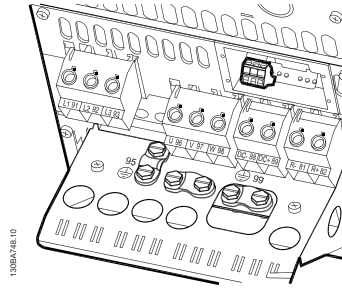


Illustration 5.35: Terminals for relay connections for B4.

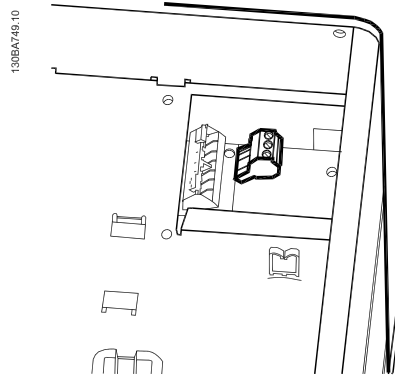


Illustration 5.36: Terminals for relay connections for C3 and C4. Located in the upper right corner of the frequency converter.

5.1.20 Relay output

Relay 1

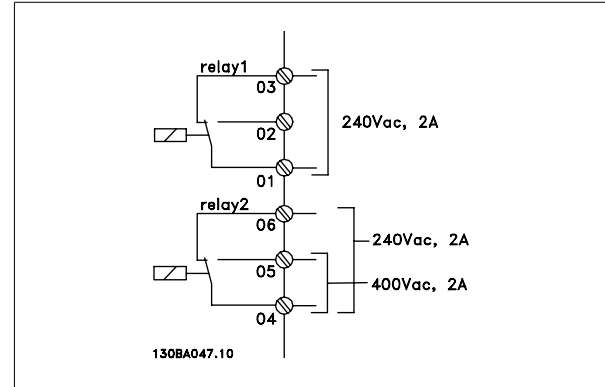
- Terminal 01: common
- Terminal 02: normal open 240 V AC
- Terminal 03: normal closed 240 V AC

Relay 1 and relay 2 are programmed in par. 5-40 *Function Relay*, par. 5-41 *On Delay, Relay*, and par. 5-42 *Off Delay, Relay*.

Additional relay outputs by using option module MCB 105.

Relay 2

- Terminal 04: common
- Terminal 05: normal open 400 V AC
- Terminal 06: normal closed 240 V AC



5

5.1.21 Wiring example and testing

The following section describes how to terminate control wires and how to access them. For an explanation of the function, programming and wiring of the control terminals, please see chapter, *How to programme the frequency converter*.

5.1.22 Access to control terminals

All terminals to the control cables are located underneath the terminal cover on the front of the frequency converter. Remove the terminal cover with a screwdriver.



Illustration 5.37: Access to control terminals for A2, A3, B3, B4, C3 and C4 enclosures

Remove front-cover to access control terminals. When replacing the front-cover, please ensure proper fastening by applying a torque of 2 Nm.

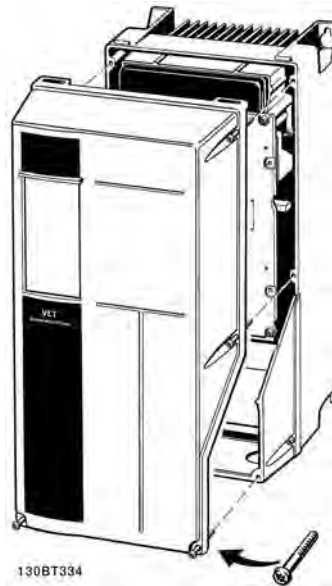


Illustration 5.38: Access to control terminals for A5, B1, B2, C1 and C2 enclosures

5.1.23 Control terminals

Drawing reference numbers:

1. 10-pole plug digital I/O.
2. 3-pole plug RS-485 Bus.
3. 6-pole analog I/O.
4. USB connection.

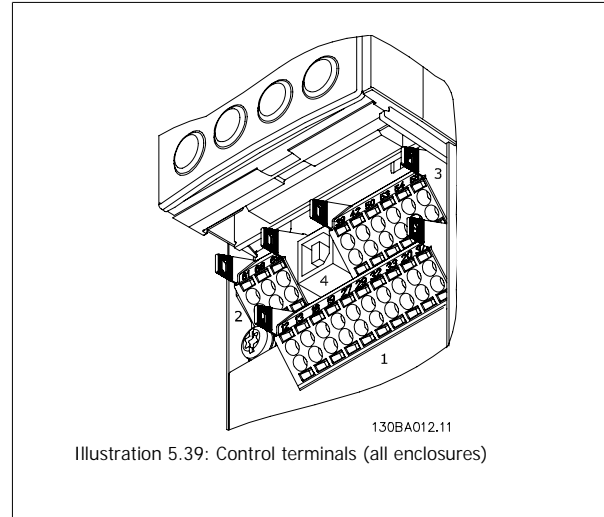


Illustration 5.39: Control terminals (all enclosures)

5.1.24 Control cable clamp

1. Use a clamp from the accessory bag to connect screen to frequency converter decoupling plate for control cables.

See section entitled *Earthing of Screened/Armoured Control Cables* for the correct termination of control cables.

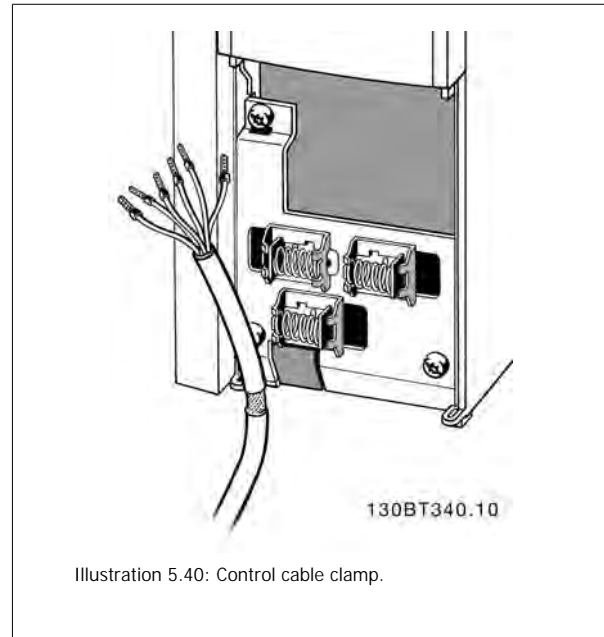


Illustration 5.40: Control cable clamp.

5.1.25 Electrical installation and control cables

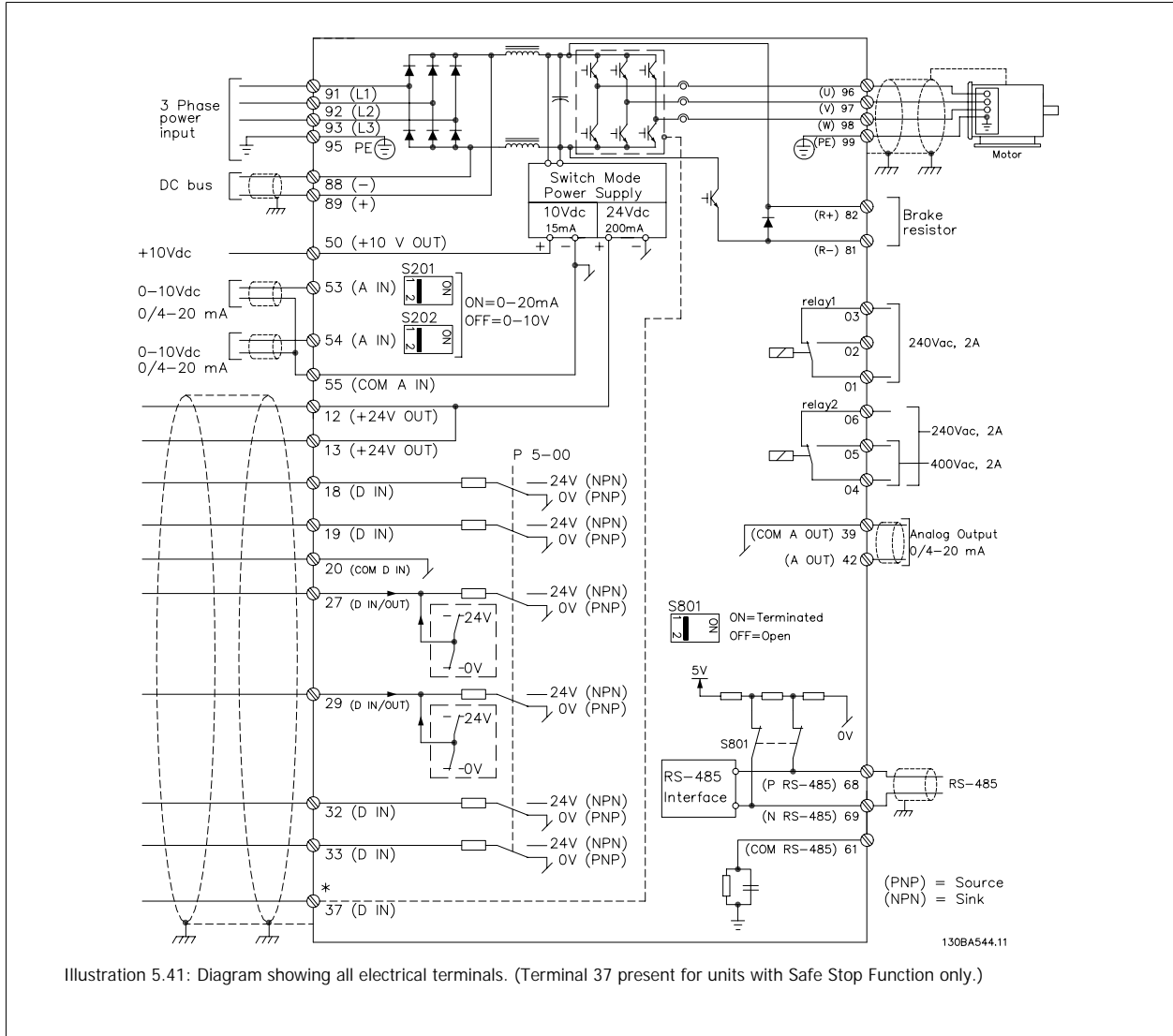



Illustration 5.41: Diagram showing all electrical terminals. (Terminal 37 present for units with Safe Stop Function only.)

Terminal number	Terminal description	Parameter number	Factory default
1+2+3	Terminal 1+2+3-Relay1	5-40	No operation
4+5+6	Terminal 4+5+6-Relay2	5-40	No operation
12	Terminal 12 Supply	-	+24 V DC
13	Terminal 13 Supply	-	+24 V DC
18	Terminal 18 Digital Input	5-10	Start
19	Terminal 19 Digital Input	5-11	No operation
20	Terminal 20	-	Common
27	Terminal 27 Digital Input/Output	5-12/5-30	Coast inverse
29	Terminal 29 Digital Input/Output	5-13/5-31	Jog
32	Terminal 32 Digital Input	5-14	No operation
33	Terminal 33 Digital Input	5-15	No operation
37	Terminal 37 Digital Input	-	Safe Stop
42	Terminal 42 Analog Output	6-50	Speed 0-HighLim
53	Terminal 53 Analog Input	3-15/6-1*/20-0*	Reference
54	Terminal 54 Analog Input	3-15/6-2*/20-0*	Feedback

Table 5.5: Terminal connections

Very long control cables and analog signals may, in rare cases and depending on installation, result in 50/60 Hz earth loops due to noise from mains supply cables.

If this occurs, break the screen or insert a 100 nF capacitor between screen and chassis.




NB!
 The common of digital / analog inputs and outputs should be connected to separate common terminals 20, 39, and 55. This will avoid ground current interference among groups. For example, it avoids switching on digital inputs disturbing analog inputs.



NB!
 Control cables must be screened/armoured.

5.1.26 How to test motor and direction of rotation



Note that unintended motor start can occur, ensure no personnel or equipment is in danger!

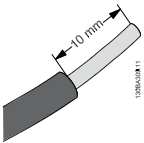


Illustration 5.42:
Step 1: First remove the insulation on both ends of a 50 to 70 mm piece of wire.

Please follow these steps to test the motor connection and direction of rotation. Start with no power to the unit.

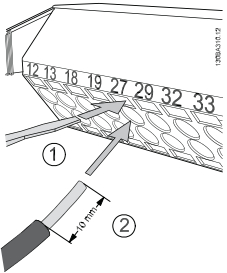


Illustration 5.43:
Step 2: Insert one end in terminal 27 using a suitable terminal screwdriver. (Note: For units with Safe Stop function, the existing jumper between terminal 12 and 37 should not be removed for the unit to be able to run!)

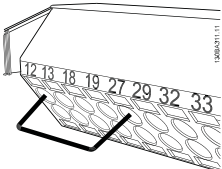



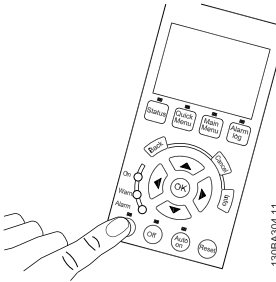
Illustration 5.44:
Step 3: Insert the other end in terminal 12 or 13. (Note: For units with Safe Stop function, the existing jumper between terminal 12 and 37 should not be removed for the unit to be able to run!)

5



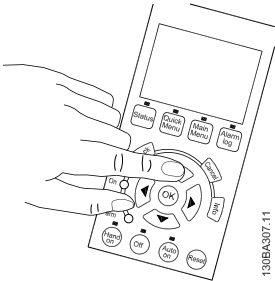
130BA305.11

Illustration 5.45:
Step 4: Power-up the unit and press the [Off] button. In this state the motor should not rotate. Press [Off] to stop the motor at any time. Note the LED at the [OFF] button should be lit. If alarms or warnings are flashing, please see chapter 7 regarding these.



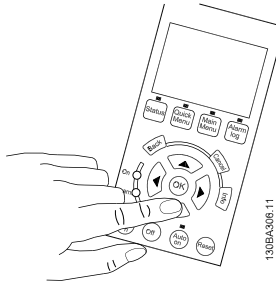
130BA304.11

Illustration 5.46:
Step 5: By pressing the [Hand on] button, the LED above the button should be lit and the motor may rotate.



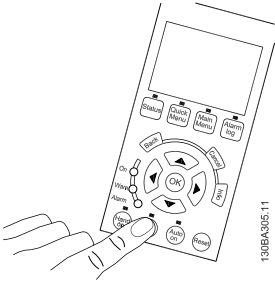
130BA307.11

Illustration 5.47:
Step 6: The speed of the motor can be seen in the LCP. It can be adjusted by pushing the up ▲ and down ▼ arrow buttons.



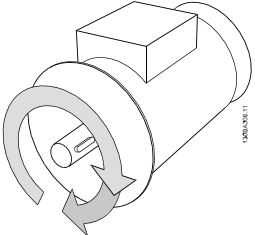
130BA306.11

Illustration 5.48:
Step 7: To move the cursor, use the left ◀ and right ▶ arrow buttons. This enables changing the speed in larger increments.




130BA305.11

Illustration 5.49:
Step 8: Press the [Off] button to stop the motor again.



130BA306.11

Illustration 5.50:
Step 9: Change two motor wires if the desired rotation of direction is not achieved.



Remove mains power from the frequency converter before changing motor wires.

5.1.27 Switches S201, S202, and S801

Switches S201 (AI 53) and S202 (AI 54) are used to select a current (0-20 mA) or a voltage (0 to 10 V) configuration of the analog input terminals 53 and 54 respectively.

Switch S801 (BUS TER.) can be used to enable termination on the RS-485 port (terminals 68 and 69).

Please note that the switches may be covered by an option, if fitted.

Default setting:

S201 (AI 53) = OFF (voltage input)

S202 (AI 54) = OFF (voltage input)

S801 (Bus termination) = OFF

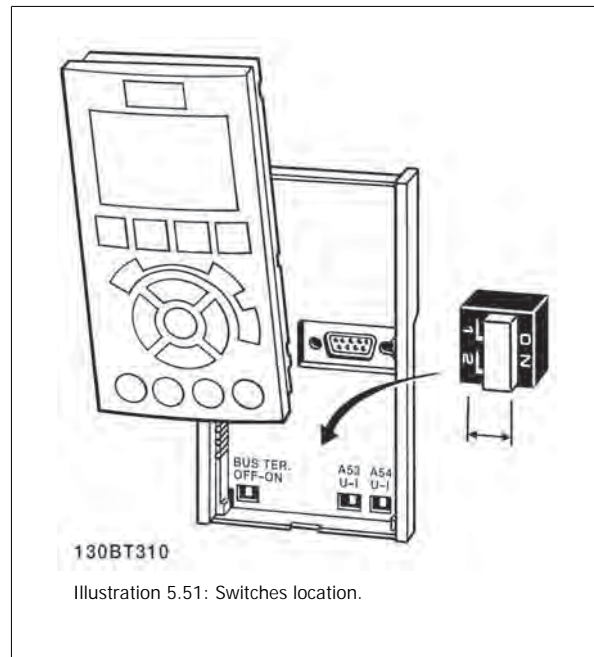


Illustration 5.51: Switches location.

5.2 Final Optimization and Test

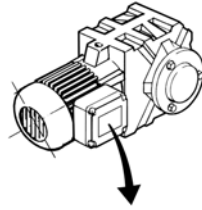
5.2.1 Final optimization and test

To optimize motor shaft performance and optimize the frequency converter for the connected motor and installation, please follow these steps. Ensure that frequency converter and motor are connected, and power is applied to frequency converter.

NB!
 Before power up ensure that connected equipment is ready for use.

Step 1. Locate motor name plate

NB!
 The motor is either star- (Y) or delta- connected (Δ). This information is located on the motor name plate data.



3 ~ MOTOR NR. 1827421		2003
S/E005A9		
1,5 kW		
n ₁	31,5 /min.	400 V V
n ₂	1400 /min.	50 Hz
cos φ	0,80	3,8 A
1,7L		
B	IP 65	H1/1A
130BT307		

Illustration 5.52: Motor name plate example

5

Step 2. Enter motor name plate data in following parameter list.

To access list first press [QUICK MENU] key then select "Q2 Quick Setup".

1.	Motor Power [kW] or Motor Power [HP]	par. 1-20 par. 1-21
2.	Motor Voltage	par. 1-22
3.	Motor Frequency	par. 1-23
4.	Motor Current	par. 1-24
5.	Motor Nominal Speed	par. 1-25

Table 5.6: Motor related parameters

Step 3. Activate Automatic Motor Adaptation (AMA)

Performing AMA ensures best possible performance. AMA automatically takes measurements from the specific motor connected and compensates for installation variances.

1. Connect terminal 27 to terminal 12 or use [MAIN MENU] and set Terminal 27 par. 5-12 to *No operation* (par. 5-12 [0])
2. Press [QUICK MENU], select "Q2 Quick Setup", scroll down to AMA par. 1-29.
3. Press [OK] to activate the AMA par. 1-29.
4. Choose between complete or reduced AMA. If sine wave filter is mounted, run only reduced AMA, or remove sine wave filter during AMA procedure.
5. Press [OK] key. Display should show "Press [Hand on] to start".
6. Press [Hand on] key. A progress bar indicates if AMA is in progress.

Stop the AMA during operation

1. Press the [OFF] key - the frequency converter enters into alarm mode and the display shows that the AMA was terminated by the user.

Successful AMA

1. The display shows "Press [OK] to finish AMA".
2. Press the [OK] key to exit the AMA state.

Unsuccessful AMA

1. The frequency converter enters into alarm mode. A description of the alarm can be found in the *Troubleshooting* section.
2. "Report Value" in the [Alarm Log] shows the last measuring sequence carried out by the AMA, before the frequency converter entered alarm mode. This number along with the description of the alarm will assist troubleshooting. If contacting Danfoss Service, make sure to mention number and alarm description.



NB!

Unsuccessful AMA is often caused by incorrectly entered motor name plate data or too big difference between the motor power size and the frequency converter power size.



Step 4. Set speed limit and ramp time

Set up the desired limits for speed and ramp time.

Minimum Reference	par. 3-02
Maximum Reference	par. 3-03

Motor Speed Low Limit	par. 4-11 or 4-12
Motor Speed High Limit	par. 4-13 or 4-14

Ramp 1 Ramp Up Time [s]	par. 3-41
Ramp 1 Ramp Down Time 1 [s]	par. 3-42

6

6 Commissioning and Application Examples

6.1 Quick Setup

6.1.1 Quick Menu Mode

The GLCP provides access to all parameters listed under the Quick Menu. To set parameters using the [Quick Menu] button:

Pressing [Quick Menu] the list indicates the different areas contained in the Quick menu.

Efficient parameter set-up for water applications

The parameters can easily be set up for the vast majority of the water and wastewater applications only by using the [Quick Menu].

The optimum way to set parameters through the [Quick Menu] is by following the below steps:

1. Press [Quick Setup] for selecting basic motor settings, ramp times, etc.
2. Press [Function Setups] for setting up the required functionality of the frequency converter - if not already covered by the settings in [Quick Setup].
3. Choose between *General Settings*, *Open Loop Settings* and *Closed Loop Settings*.

It is recommended to do the set-up in the order listed.

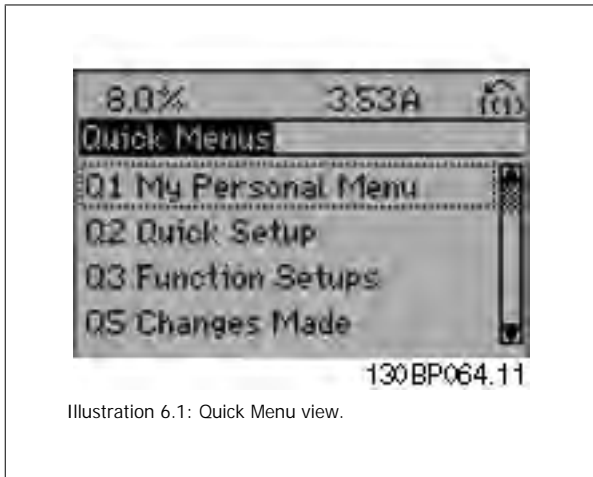


Illustration 6.1: Quick Menu view.

Par.	Designation	[Units]
0-01	Language	
1-20	Motor Power	[kW]
1-22	Motor Voltage	[V]
1-23	Motor Frequency	[Hz]
1-24	Motor Current	[A]
1-25	Motor Nominal Speed	[RPM]
3-41	Ramp 1 Ramp up Time	[s]
3-42	Ramp 1 Ramp down Time	[s]
4-11	Motor Speed Low Limit	[RPM]
4-13	Motor Speed High Limit	[RPM]
1-29	Automatic Motor Adaptation (AMA)	

Table 6.1: Quick Setup parameters. Please see section *Commonly Used Parameters - Explanations*

If *No Operation* is selected in terminal 27 no connection to +24 V on terminal 27 is necessary to enable start.

If *Coast Inverse* (factory default value) is selected in Terminal 27, a connection to +24V is necessary to enable start.

NB!

For detailed parameter descriptions, please see the following section on *Commonly Used Parameters - Explanations*.

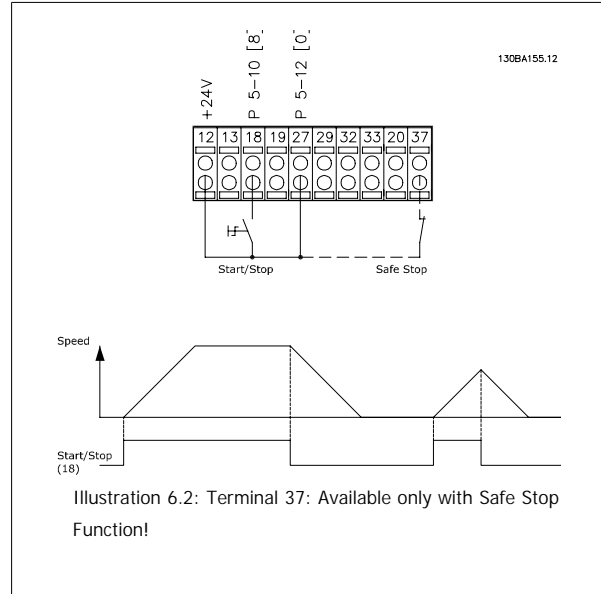
6.2.1 Start/Stop

Terminal 18 = start/stop par. 5-10 [8] *Start*

Terminal 27 = No operation par. 5-12 [0] *No operation* (Default *coast inverse*)

Par. 5-10 *Digital Input*, Terminal 18 = *Start* (default)

Par. 5-12 *Digital Input*, Terminal 27 = *coast inverse* (default)



6.2.2 Closed loop wiring

Terminal 12 /13: +24V DC

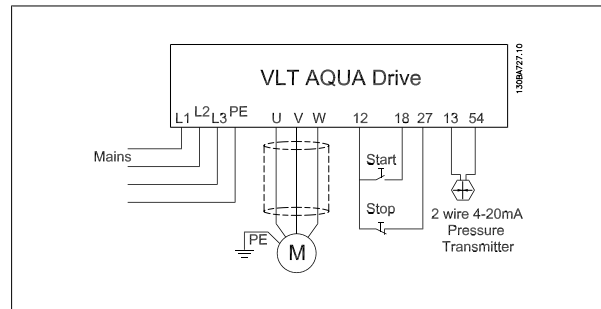
Terminal 18: Start par. 5-18 [8] Start (Default)

Terminal 27: Coast par. 5-12 [2] coast inverse (Default)

Terminal 54: Analog input

L1-L3: Mains terminals

U,V and W: Motor terminals



6.2.3 Submersible pump application

The system consists of a submersible pump controlled by a Danfoss VLT AQUA Drive and a pressure transmitter. The transmitter gives a 4-20 mA feedback signal to the VLT AQUA Drive, which keeps a constant pressure by controlling the speed of the pump. To design a drive for a submersible pump application, there are a few important issues to take into consideration. Therefore the drive used must be chosen according to motor current.

1. The motor is a so called "Can motor" with a stainless steel can between the rotor and stator. There is a larger and a more magnetic resistant air-gap than on a normal motor hence a weaker field which results in the motors being designed with a higher rated current than a norm motor with similar rated power.
2. The pump contains thrust bearings which will be damaged when running below minimum speed which normally will be 30 Hz.
3. The motor reactance is nonlinear in submersible pump motors and therefore Automatic Motor Adaption (AMA) may not be possible. However, normally submersible pumps are operated with very long motor cables that might eliminate the nonlinear motor reactance and enable the drive to perform AMA. If AMA fails, the motor data can be set from parameter group 1-3* (see motor datasheet). Be aware that if AMA has succeeded the drive will compensate for voltage drop in the long motor cables, so if the Advanced motor data are set manually, the length of the motor cable must be taken into considerations to optimize system performance.
4. It is important that the system is operated with a minimum of wear and tear of the pump and motor. A Danfoss Sine-Wave filter can lower the motor insulation stress and increase lifetime (check actual motor insulation and the frequency converter du/dt specification). It is recommended to use a filter to reduce the need for service.
5. EMC performance can be difficult to achieve due to the fact that the special pump cable which is able to withstand the wet conditions in the well normally is unshielded. A solution could be to use a screened cable above the well and fix the screen to the well pipe if it is made of steel (can also be made of plastic). A Sine-Wave filter will also reduce the EMI from unshielded motor cables.



The special "can motor" is used due to the wet installation conditions. The drive needs to be designed for the system according to output current to be able to run the motor at nominal power.

To prevent damage to the thrust bearings of the pump, it is important to ramp the pump from stop to min. speed as quick as possible. Well-known manufacturers of submersible pumps recommend that the pump is ramped to min. speed (30 Hz) in max. 2 -3 seconds. The new VLT® AQUA Drive is designed with initial and final Ramp for these applications. The initial and final ramps are 2 individual ramps, where Initial Ramp, if enabled, will ramp the motor from stop to min. speed and automatically switch to normal ramp, when min. speed is reached. Final ramp will do the opposite from min. speed to stop in a stop situation.

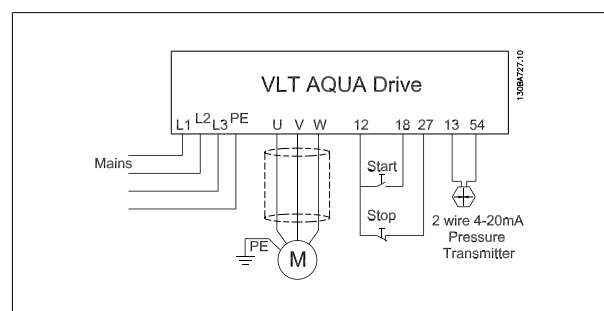
Pipe-Fill mode can be enabled to prevent water hammering. The Danfoss frequency converter is capable of filling vertical pipes using the PID controller to slowly ramp up the pressure with a user specified rate (units/sec). If enabled the drive will, when it reaches min. speed after startup, enter pipe fill mode. The pressure will slowly be ramped up until it reaches a user specified Filled Set Point, where after the drive automatically disables Pipe Fill Mode and continues in normal closed loop operation.

This feature is designed for irrigation applications.

Electrical Wiring

Typical parameter settings (Typical/recommended settings in brackets.)	
Parameters:	
Motor Rated Power	Par. 1-20 / par. 1-21
Motor Rated Voltage	Par. 1-22
Motor Current	Par. 1-24
Motor Rated Speed	Par. 1-28
Enable Reduced Automatic Motor Adaptation (AMA in par. 1-29)	

NB!
 Note the analog input 2, (terminal (54) format must be set to mA. (switch 202).

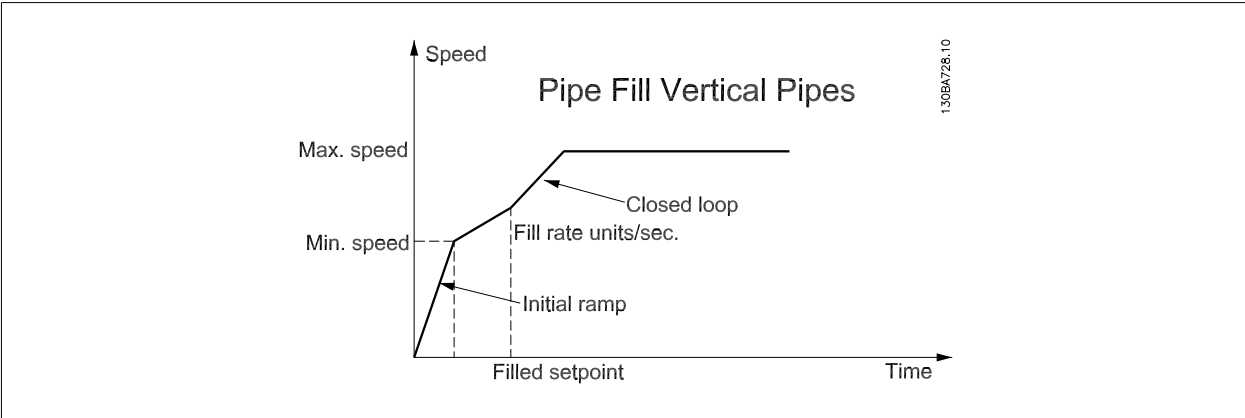


Min. Reference	Par. 3-01	(30 Hz)
Max. Reference	Par. 3-02	(50/60 Hz)
Initial Ramp Up Time	Par. 3-84	(2 sec.)
Final Ramp Down Time	Par. 3-88	(2 sec.)
Normal Ramp Up Time	Par. 3-41	(8 sec. depending on size)
Normal Ramp Down Time	Par. 3-42	(8 sec. depending on size)
Motor Min. Speed	Par. 4-11	(30 Hz)
Motor Max. Speed	Par. 4-13	(50/60 Hz)

Use the "Closed Loop" wizard under "Quick Menu_Funtion_Setup", to easily set up the feedback settings in the PID controller.

Pipe Fill Mode		
Pipe Fill Enable	Par. 29-00	
Pipe Fill Rate	Par. 29-04	(Feedback units/sec.)
Filled Set Point	Par. 29-05	(Feedback units)

6



7 How to Operate the Frequency Converter

7.1 Ways of Operation

7.1.1 Ways of operation

The frequency converter can be operated in 3 ways:

1. Graphical Local Control Panel (GLCP), see 6.1.2
2. Numeric Local Control Panel (NLCP), see 6.1.3
3. RS-485 serial communication or USB, both for PC connection, see 6.1.4

If the frequency converter is fitted with fieldbus option, please refer to relevant documentation.

7.1.2 How to operate graphical LCP (GLCP)

The following instructions are valid for the GLCP (LCP 102).

The GLCP is divided into four functional groups:

1. Graphical display with Status lines.
2. Menu keys and indicator lights (LED's) - selecting mode, changing parameters and switching between display functions.
3. Navigation keys and indicator lights (LEDs).
4. Operation keys and indicator lights (LEDs).

Graphical display:

The LCD-display is back-lit with a total of 6 alpha-numeric lines. All data is displayed on the LCP which can show up to five operating variables while in [Status] mode.

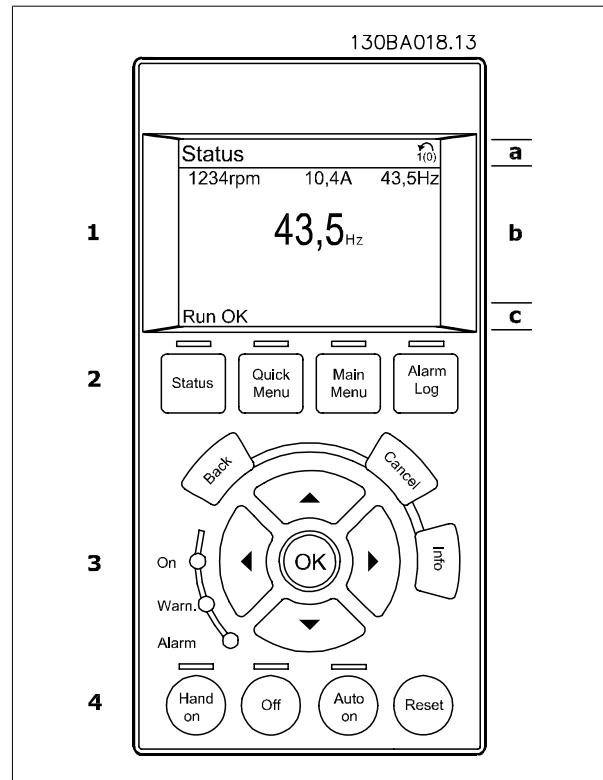
Display lines:

- a. **Status line:** Status messages displaying icons and graphics.
- b. **Line 1-2:** Operator data lines displaying data and variables defined or chosen by the user. By pressing the [Status] key, up to one extra line can be added.
- c. **Status line:** Status messages displaying text.

The display is divided into 3 sections:

Top section (a)

shows the status when in status mode or up to 2 variables when not in status mode and in the case of Alarm/Warning.



The number of the Active Set-up (selected as the Active Set-up in par. 0-10) is shown. When programming in another Set-up than the Active Set-up, the number of the Set-up being programmed appears to the right in brackets.

Middle section (b)

shows up to 5 variables with related unit, regardless of status. In case of alarm/warning, the warning is shown instead of the variables.

It is possible to toggle between three status read-out displays by pressing the [Status] key.
 Operating variables with different formatting are shown in each status screen - see below.

Several values or measurements can be linked to each of the displayed operating variables. The values / measurements to be displayed can be defined via par. 0-20, 0-21, 0-22, 0-23, and 0-24, which can be accessed via [QUICK MENU], "Q3 Function Setups", "Q3-1 General Settings", "Q3-11 Display Settings".

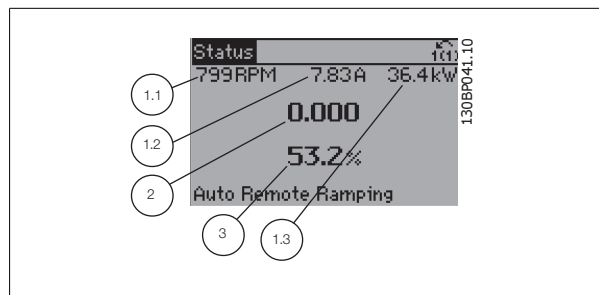
Each value / measurement readout parameter selected in par. 0-20 to par. 0-24 has its own scale and number of digits after a possible decimal point. Larger numeric values are displayed with few digits after the decimal point.

Ex.: Current readout
 5.25 A; 15.2 A 105 A.

7

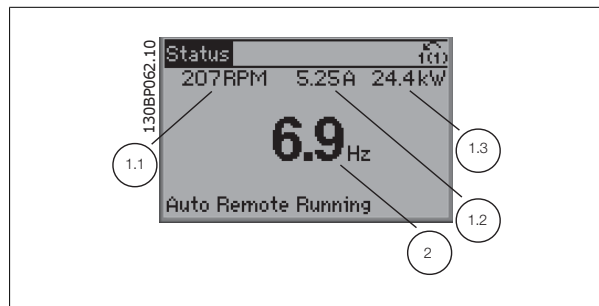
Status display I

This read-out state is standard after start-up or initialization.
 Use [INFO] to obtain information about the value/measurement linked to the displayed operating variables (1.1, 1.2, 1.3, 2, and 3).
 See the operating variables shown in the display in this illustration. 1.1, 1.2 and 1.3 are shown in small size. 2 and 3 are shown in medium size.



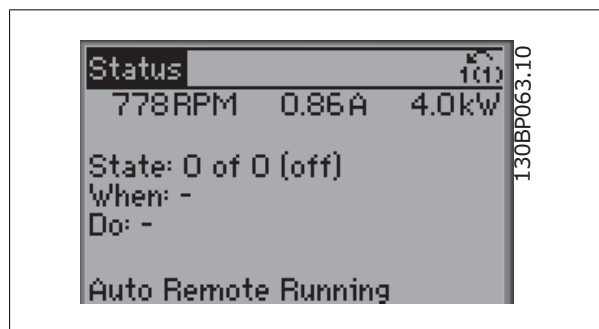
Status display II

See the operating variables (1.1, 1.2, 1.3, and 2) shown in the display in this illustration.
 In the example, Speed, Motor current, Motor power and Frequency are selected as variables in the first and second lines.
 1.1, 1.2 and 1.3 are shown in small size. 2 is shown in large size.



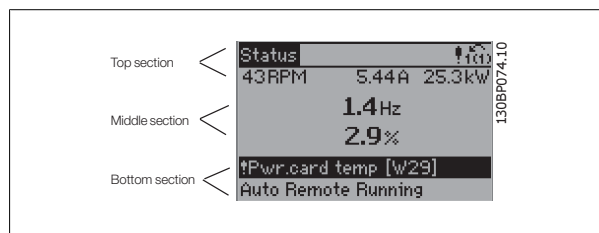
Status display III:

This state displays the event and action of the Smart Logic Control. For further information, see section *Smart Logic Control*.



Bottom section

always shows the state of the frequency converter in Status mode.



Display contrast adjustment

Press [status] and [▲] for darker display

Press [status] and [▼] for brighter display

Indicator lights (LEDs):

If certain threshold values are exceeded, the alarm and/or warning LED lights up. A status and alarm text appear on the control panel.

The On LED is activated when the frequency converter receives power from mains voltage, a DC bus terminal, or an external 24 V supply. At the same time, the back light is on.

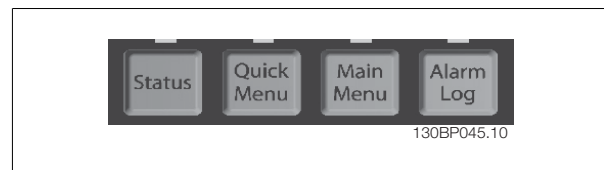
- Green LED/On: Control section is working.
- Yellow LED/Warn.: Indicates a warning.
- Flashing Red LED/Alarm: Indicates an alarm.



GLCP keys

Menu keys

The menu keys are divided into functions. The keys below the display and indicator lamps are used for parameter set-up, including choice of display indication during normal operation.



[Status]

Indicates the status of the frequency converter and/or the motor. 3 different readouts can be chosen by pressing the [Status] key:

5 line readouts, 4 line readouts or Smart Logic Control.

Use [Status] for selecting the mode of display or for changing back to Display mode from either the Quick Menu mode, the Main Menu mode or Alarm mode. Also use the [Status] key to toggle single or double read-out mode.

[Quick Menu]

Allows quick set-up of the frequency converter. **The most common functions can be programmed here.**

The [Quick Menu] consists of:

- **Q1: My Personal Menu**
- **Q2: Quick Setup**
- **Q3: Function Setups**
- **Q5: Changes Made**
- **Q6: Loggings**

The Function set-up provides quick and easy access to all parameters required for the majority of water and wastewater applications including variable torque, constant torque, pumps, dosing pumps, well pumps, booster pumps, mixer pumps, aeration blowers and other pump and fan applications. Amongst other features it also includes parameters for selecting which variables to display on the LCP, digital preset speeds, scaling of analog references, closed loop single zone and multi-zone applications and specific functions related to water and wastewater applications.

The Quick Menu parameters can be accessed immediately unless a password has been created via par. 0-60, 0-61, 0-65 or 0-66.

It is possible to switch directly between Quick Menu mode and Main Menu mode.

[Main Menu]

is used for programming all parameters.

The Main Menu parameters can be accessed immediately unless a password has been created via par. 0-60, 0-61, 0-65 or 0-66. For the majority of water and wastewater applications it is not necessary to access the Main Menu parameters but instead the Quick Menu, Quick Setup and Function Setups provides the simplest and quickest access to the typical required parameters.

It is possible to switch directly between Main Menu mode and Quick Menu mode.

Parameter shortcut can be carried out by pressing down the [Main Menu] key for 3 seconds. The parameter shortcut allows direct access to any parameter.

[Alarm Log]

displays an Alarm list of the five latest alarms (numbered A1-A5). To obtain additional details about an alarm, use the arrow keys to manoeuvre to the alarm number and press [OK]. Information is displayed about the condition of the frequency converter before it enters the alarm mode.

[Back]

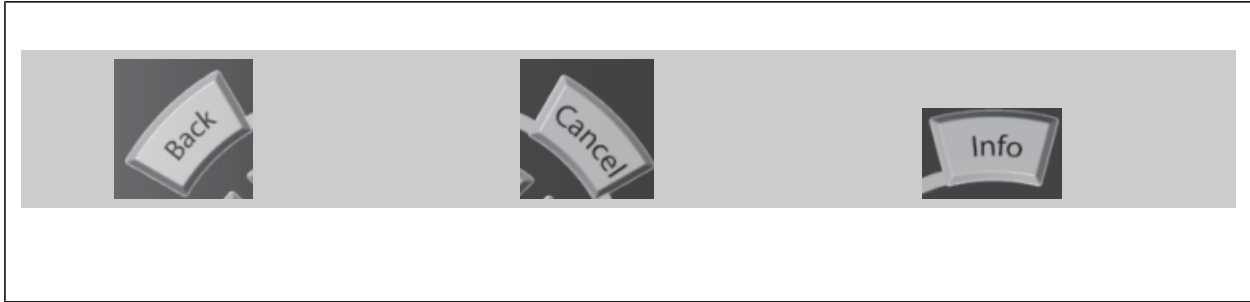
reverts to the previous step or layer in the navigation structure.

[Cancel]

last change or command will be cancelled as long as the display has not been changed.

[Info]

displays information about a command, parameter, or function in any display window. [Info] provides detailed information when needed. Exit Info mode by pressing either [Info], [Back], or [Cancel].



7

Navigation keys

The four navigation arrows are used to navigate between the different choices available in [Quick Menu], [Main Menu] and [Alarm Log]. Use the keys to move the cursor.

[OK]

is used for choosing a parameter marked by the cursor and for enabling the change of a parameter.



Operation keys

for local control are found at the bottom of the control panel.



[Hand on]

enables control of the frequency converter via the GLCP. [Hand on] also starts the motor, and it is now possible to give the motor speed reference by means of the arrow keys. The key can be *Enabled* [1] or *Disabled* [0] via par. 0-40 [Hand on] Key on LCP.

The following control signals will still be active when [Hand on] is activated:

- [Hand on] - [Off] - [Auto on]
- Reset
- Coasting stop inverse (motor coasting to stop)
- Reversing
- Set-up select lsb - Set-up select msb
- Stop command from serial communication
- Quick stop
- DC brake

NB!
 External stop signals activated by means of control signals or a serial bus will override a “start” command via the LCP.

[Off]

stops the connected motor. The key can be *Enabled* [1] or *Disabled* [0] via par. 0-41 [Off] key on LCP. If no external stop function is selected and the [Off] key is inactive the motor can only be stopped by disconnecting the mains supply.

[Auto on]

enables the frequency converter to be controlled via the control terminals and/or serial communication. When a start signal is applied on the control terminals and/or the bus, the frequency converter will start. The key can be *Enabled* [1] or *Disabled* [0] via par. 0-42 [Auto on] key on LCP.

NB!
 An active HAND-OFF-AUTO signal via the digital inputs has higher priority than the control keys [Hand on] – [Auto on].

[Reset]

is used for resetting the frequency converter after an alarm (trip). The key can be *Enabled* [1] or *Disabled* [0] via par. 0-43 Reset Keys on LCP.

The parameter shortcut

can be carried out by holding down the [Main Menu] key for 3 seconds. The parameter shortcut allows direct access to any parameter.

7.1.3 How to operate numeric LCP (NLCP)

The following instructions are valid for the NLCP (LCP 101).

The control panel is divided into four functional groups:

1. Numeric display.
2. Menu key and indicator lights (LEDs) - changing parameters and switching between display functions.
3. Navigation keys and indicator lights (LEDs).
4. Operation keys and indicator lights (LEDs).

Select one of the following modes:

Status Mode: Displays the status of the frequency converter or the motor.

If an alarm occurs, the NLCP automatically switches to status mode. A number of alarms can be displayed.

Quick Setup or Main Menu Mode: Display parameters and parameter settings.

NB!
 Parameter copy is not possible with Numeric Local Control Panel (LCP101).

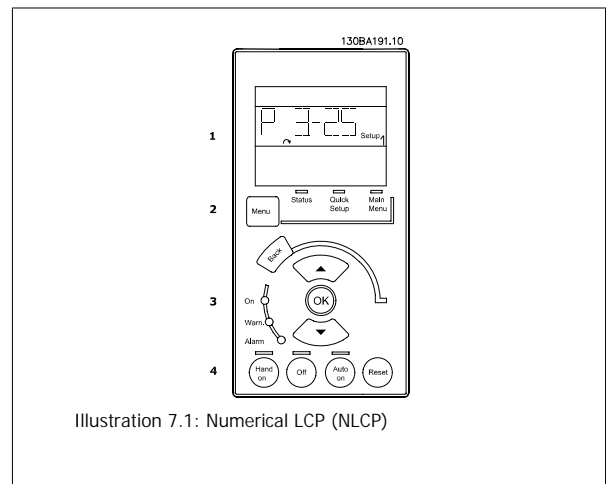


Illustration 7.1: Numerical LCP (NLCP)

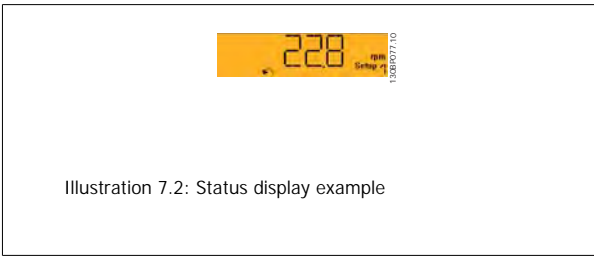


Illustration 7.2: Status display example

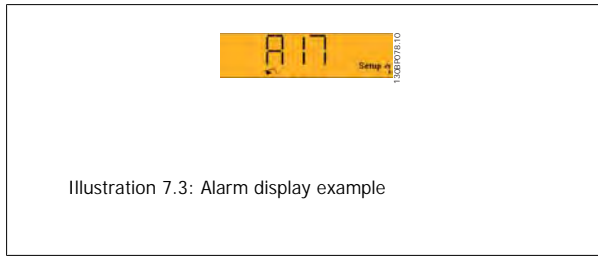


Illustration 7.3: Alarm display example

Indicator lights (LEDs):

- Green LED/On: Indicates if control section is on.
- Yellow LED/Wrn.: Indicates a warning.
- Flashing red LED/Alarm: Indicates an alarm.

Menu key

Select one of the following modes:

- Status
- Quick Setup
- Main Menu

Main Menu

is used for programming all parameters.

The parameters can be accessed immediately unless a password has been created via par. 0-60 *Main Menu Password*, par. 0-61 *Access to Main Menu w/o Password*, par. 0-65 *Personal Menu Password* or par. 0-66 *Access to Personal Menu w/o Password*.

Quick Setup is used to set up the frequency converter using only the most essential parameters.

The parameter values can be changed using the up/down arrows when the value is flashing.

Select Main Menu by pressing the [Menu] key a number of times until the Main Menu LED is lit.

Select the parameter group [xx-__] and press [OK]

Select the parameter [__-xx] and press [OK]

If the parameter is an array parameter select the array number and press [OK]

Select the wanted data value and press [OK]

Navigation keys

[Back]

for stepping backwards

Arrow [▲] [▼]

keys are used for manoeuvring between parameter groups, parameters and within parameters

[OK]

is used for choosing a parameter marked by the cursor and for enabling the change of a parameter.

Operation keys

Keys for local control are found at the bottom of the control panel.

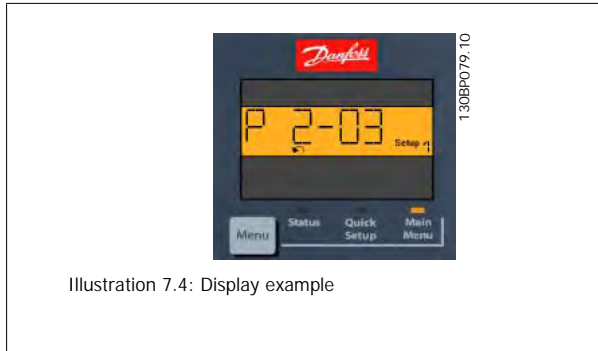


Illustration 7.4: Display example

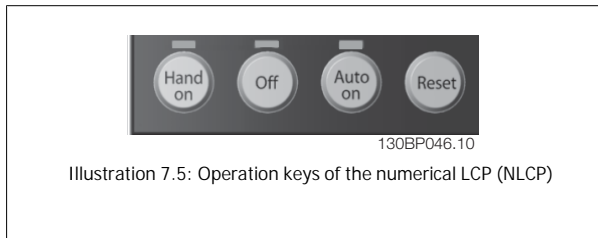


Illustration 7.5: Operation keys of the numerical LCP (NLCP)

[Hand on]

enables control of the frequency converter via the LCP. [Hand on] also starts the motor and it is now possible to enter the motor speed data by means of the arrow keys. The key can be *Enabled* [1] or *Disabled* [0] via par. 0-40 *[Hand on] Key on LCP*.

External stop signals activated by means of control signals or a serial bus will override a 'start' command via the LCP.

The following control signals will still be active when [Hand on] is activated:

- [Hand on] - [Off] - [Auto on]
- Reset
- Coasting stop inverse
- Reversing
- Set-up select lsb - Set-up select msb
- Stop command from serial communication
- Quick stop
- DC brake


[Off]

stops the connected motor. The key can be *Enabled* [1] or *Disabled* [0] via par. 0-41 *[Off] Key on LCP*.

If no external stop function is selected and the [Off] key is inactive the motor can be stopped by disconnecting the mains supply.

[Auto on]

enables the frequency converter to be controlled via the control terminals and/or serial communication. When a start signal is applied on the control terminals and/or the bus, the frequency converter will start. The key can be *Enabled* [1] or *Disabled* [0] via par. 0-42 *[Auto on] Key on LCP*.



NB!

An active HAND-OFF-AUTO signal via the digital inputs has higher priority than the control keys [Hand on] [Auto on].

[Reset]

is used for resetting the frequency converter after an alarm (trip). The key can be *Enabled* [1] or *Disabled* [0] via par. 0-43 *[Reset] Key on LCP*.

7.1.4 Changing data

1. Press [Quick Menu] or [Main Menu] key.
2. Use [▲] and [▼] keys keys to find parameter group to edit.
3. Press [OK] key.
4. Use [▲] and [▼] keys to find parameter to edit.
5. Press [OK] key.
6. Use [▲] and [▼] keys to select correct parameter setting. Or, to move to digits within a number, use keys. Cursor indicates digit selected to change. [▲] key increases the value, [▼] key decreases the value.
7. Press [Cancel] key to disregard change, or press [OK] key to accept change and enter new setting.

7.1.5 Changing a text value

If the selected parameter is a text value, change the text value by means of the up/down navigation keys.
 The up key increases the value, and the down key decreases the value.
 Place the cursor on the value to be saved and press [OK].

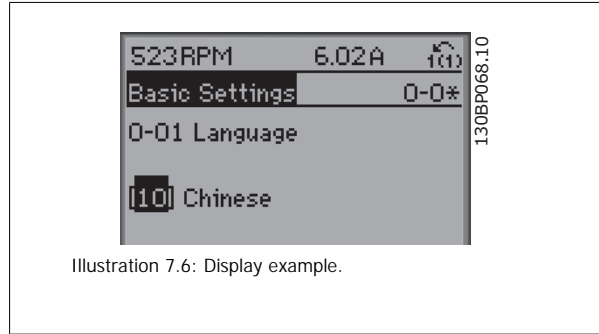


Illustration 7.6: Display example.

7.1.6 Changing a group of numeric data values

If the chosen parameter represents a numeric data value, change the chosen data value by means of the [◀] and [▶] navigation keys as well as the up/down [▲] [▼] navigation keys. Use the [◀] and [▶] navigation keys to move the cursor horizontally.

7

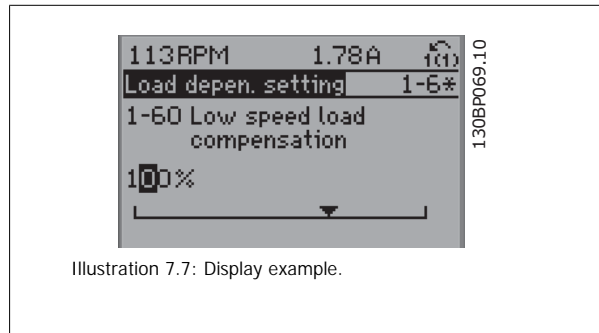


Illustration 7.7: Display example.

Use the up/down navigation keys to change the data value. The up key enlarges the data value, and the down key reduces the data value. Place the cursor on the value to be saved and press [OK].

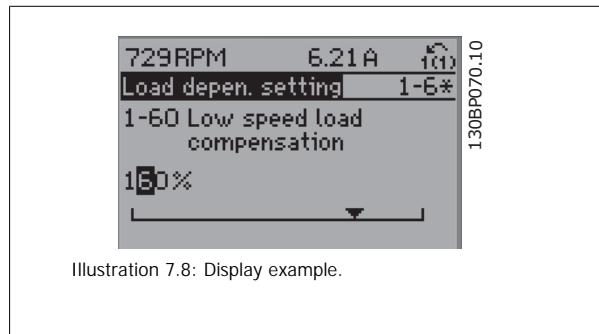


Illustration 7.8: Display example.

7.1.7 Changing of data value, Step-by-Step

Certain parameters can be changed step by step or infinitely variably. This applies to par. 1-20 *Motor Power [kW]*, par. 1-22 *Motor Voltage* and par. 1-23 *Motor Frequency*.
 The parameters are changed both as a group of numeric data values and as numeric data values infinitely variably.

7.1.8 Read-out and programming of indexed parameters

Parameters are indexed when placed in a rolling stack.
 Par. 15-30 *Alarm Log: Error Code* to par. 15-32 *Alarm Log: Time* contain a fault log which can be read out. Choose a parameter, press [OK], and use the up/down navigation keys to scroll through the value log.

Use par. 3-10 *Preset Reference* as another example:
 Choose the parameter, press [OK], and use the up/down navigation keys to scroll through the indexed values. To change the parameter value, select the indexed value and press [OK]. Change the value by using the up/down keys. Press [OK] to accept the new setting. Press [Cancel] to abort. Press [Back] to leave the parameter.


7.1.9 Tips and tricks

*	For the majority of water and wastewater applications the Quick Menu, Quick Setup and Function Setups provides the simplest and quickest access to all the typical parameters required.
*	Whenever possible, performing an AMA, will ensure best shaft performance
*	Contrast of the display can be adjusted by pressing [Status] and [▲] for darker display or by pressing [Status] and [▼] for brighter display
*	Under [Quick Menu] and [Changes Made] all parameters that have been changed from factory settings are displayed
*	Press and hold [Main Menu] key for 3 seconds for access to any parameter
*	For service purposes it is recommended to copy all parameters to the LCP, see par 0-50 for further information

Table 7.1: Tips and tricks

7.1.10 Quick transfer of parameter settings when using GLCP

Once the set-up of a frequency converter is complete, it is recommended to store (backup) the parameter settings in the GLCP or on a PC via MCT 10 Set-up Software Tool.



NB!
Stop the motor before performing any of these operations.

Data storage in LCP:

1. Go to par. 0-50 *LCP Copy*
2. Press the [OK] key
3. Select "All to LCP"
4. Press the [OK] key

All parameter settings are now stored in the GLCP indicated by the progress bar. When 100% is reached, press [OK].

The GLCP can now be connected to another frequency converter and the parameter settings copied to this frequency converter.

Data transfer from LCP to Frequency converter:

1. Go to par. 0-50 *LCP Copy*
2. Press the [OK] key
3. Select "All from LCP"
4. Press the [OK] key

The parameter settings stored in the GLCP are now transferred to the frequency converter indicated by the progress bar. When 100% is reached, press [OK].

7.1.11 Initialisation to default settings

There are two ways to initialise the frequency converter to default: Recommended initialisation and manual initialisation. Please be aware that they have different impact according to the below description.

Recommended initialisation (via par. 14-22 *Operation Mode*)

- | | |
|--|---|
| <ol style="list-style-type: none"> 1. Select par. 14-22 <i>Operation Mode</i> 2. Press [OK] 3. Select "Initialisation" (for NLCP select "2") 4. Press [OK] | <ol style="list-style-type: none"> 5. Remove power to unit and wait for display to turn off. 6. Reconnect power and the frequency converter is reset. Note that first start-up takes a few more seconds 7. Press [Reset] |
|--|---|

par. 14-22 *Operation Mode* initialises all except:
 par. 14-50 *RFI Filter*
 par. 8-30 *Protocol*
 par. 8-31 *Address*
 par. 8-32 *Baud Rate*
 par. 8-35 *Minimum Response Delay*
 par. 8-36 *Max Response Delay*
 par. 8-37 *Maximum Inter-Char Delay*
 par. 15-00 *Operating Hours* to par. 15-05 *Over Volt's*
 par. 15-20 *Historic Log: Event* to par. 15-22 *Historic Log: Time*
 par. 15-30 *Alarm Log: Error Code* to par. 15-32 *Alarm Log: Time*

NB!
 Parameters selected in par. 0-25 *My Personal Menu*, will stay present, with default factory setting.

Manual initialisation

7

NB!
 When carrying out manual initialisation, serial communication, RFI filter settings and fault log settings are reset.
 Removes parameters selected in par. 0-25 *My Personal Menu*

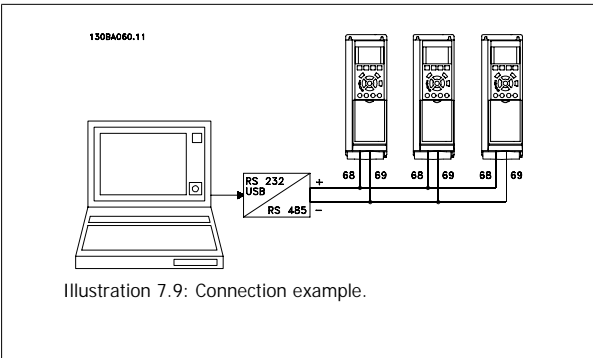
1. Disconnect from mains and wait until the display turns off.
- 2a. Press [Status] - [Main Menu] - [OK] at the same time while power up for Graphical LCP (GLCP)
- 2b. Press [Menu] while power up for LCP 101, Numerical Display
3. Release the keys after 5 s
4. The frequency converter is now programmed according to default settings

This parameter initialises all except:
 par. 15-00 *Operating Hours*
 par. 15-03 *Power Up's*
 par. 15-04 *Over Temp's*
 par. 15-05 *Over Volt's*

7.1.12 RS-485 bus connection

One or more frequency converters can be connected to a controller (or master) using the RS-485 standard interface. Terminal 68 is connected to the P signal (TX+, RX+), while terminal 69 is connected to the N signal (TX-, RX-).

If more than one frequency converter is connected to a master, use parallel connections.



In order to avoid potential equalizing currents in the screen, earth the cable screen via terminal 61, which is connected to the frame via an RC-link.

Bus termination


The RS-485 bus must be terminated by a resistor network at both ends. If the drive is the first or the last device in the RS-485 loop, set the switch S801 on the control card for ON.

For more information, see the paragraph *Switches S201, S202, and S801*.

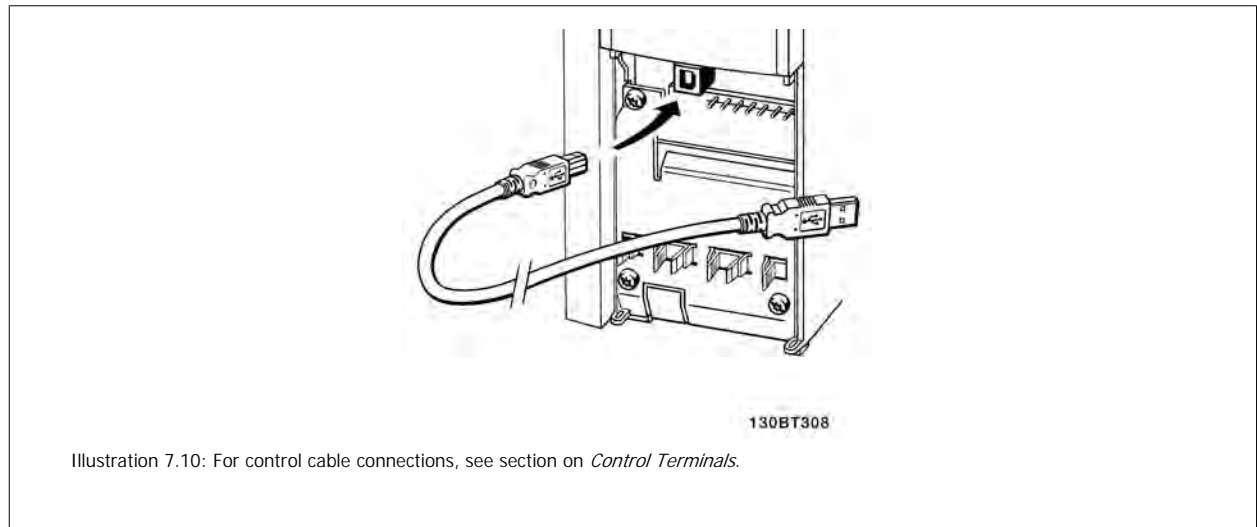
7.1.13 How to connect a PC to the frequency converter

To control or program the frequency converter from a PC, install the PC-based Configuration Tool MCT 10.

The PC is connected via a standard (host/device) USB cable, or via the RS-485 interface as shown in the *Design Guide, chapter How to Install > Installation of misc. connections.*



NB! The USB connection is galvanically isolated from the supply voltage (PELV) and other high-voltage terminals. The USB connection is connected to protection earth on the frequency converter. Use only isolated laptop as PC connection to the USB connector on the frequency converter.



7.1.14 PC software tools

PC-based Configuration Tool MCT 10

All Frequency converters are equipped with a serial communication port. Danfoss provides a PC tool for communication between PC and frequency converter, PC-based Configuration Tool MCT 10. Please check the section on *Available Literature* for detailed information on this tool.

MCT 10 set-up software

MCT 10 has been designed as an easy to use interactive tool for setting parameters in our frequency converters. The software can be downloaded from the Danfoss internet site <http://www.Danfoss.com/BusinessAreas/DrivesSolutions/SoftwareDownload/DDPC+Software+Program.htm>.

The MCT 10 set-up software will be useful for:

- Planning a communication network off-line. MCT 10 contains a complete frequency converter database
- Commissioning frequency converters on line
- Saving settings for all frequency converters
- Replacing a frequency converter in a network
- Simple and accurate documentation of frequency converter settings after commissioning.
- Expanding an existing network
- Future developed frequency converters will be supported

MCT 10 set-up software supports Profibus DP-V1 via a Master class 2 connection. It makes it possible to on line read/write parameters in a frequency converter via the Profibus network. This will eliminate the need for an extra communication network.

Save frequency converter settings:

1. Connect a PC to the unit via USB com port. (Note: Use a PC, which is isolated from the mains, in conjunction with the USB port. Failure to do so may damage equipment.)
2. Open MCT 10 Set-up Software
3. Choose "Read from drive"
4. Choose "Save as"

All parameters are now stored in the PC.

Load frequency converter settings:

1. Connect a PC to the frequency converter via USB com port
2. Open MCT 10 Set-up software
3. Choose "Open"– stored files will be shown
4. Open the appropriate file
5. Choose "Write to drive"


All parameter settings are now transferred to the frequency converter.

A separate manual for MCT 10 Set-up Software is available: *MG.10.Rx.yy*.

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The MCT 10 Set-up software modules

The following modules are included in the software package:

	<p>MCT Set-up 10 Software</p> <p>Setting parameters Copy to and from frequency converters Documentation and print out of parameter settings incl. diagrams</p>
	<p>Ext. user interface</p> <p>Preventive Maintenance Schedule Clock settings Timed Action Programming Smart Logic Controller Set-up</p>

Ordering number:

Please order the CD containing MCT 10 Set-up Software using code number 130B1000.

MCT 10 can also be downloaded from the Danfoss Internet: *WWW.DANFOSS.COM, Business Area: Motion Controls.*

8 How to Programme the Frequency Converter

8.1 How to Programme

8.1.1 Parameter set-up

Overview of parameter groups

Group	Title	Function
0-	Operation / Display	Parameters related to the fundamental functions of the frequency converter, function of the LCP buttons and configuration of the LCP display.
1-	Load / Motor	Parameter group for motor settings.
2-	Brakes	Parameter group for setting brake features in the frequency converter.
3-	Reference / Ramps	Parameters for reference handling, definitions of limitations, and configuration of the reaction of the frequency converter to changes.
4-	Limits / Warnings	Parameter group for configuring limits and warnings.
5-	Digital In/Out	Parameter group for configuring the digital inputs and outputs.
6-	Analog In/Out	Parameter group for configuration of the analog inputs and outputs.
8-	Communication and Options	Parameter group for configuring communications and options.
9-	Profibus	Parameter group for Profibus-specific parameters.
10-	DeviceNet Fieldbus	Parameter group for DeviceNet-specific parameters.
13-	Smart Logic	Parameter group for Smart Logic Control
14-	Special Functions	Parameter group for configuring special frequency converter functions.
15-	Drive Information	Parameter group containing frequency converter information such as operating data, hardware configuration and software versions.
16-	Data Readouts	Parameter group for data read-outs, e.g. actual references, voltages, control, alarm, warning and status words.
18-	Info and Readouts	This parameter group contains the last 10 Preventive Maintenance logs.
20-	Drive Closed Loop	This parameter group is used for configuring the closed loop PID Controller that controls the output frequency of the unit.
21-	Extended Closed Loop	Parameters for configuring the three Extended Closed Loop PID Controllers.
22-	Application Functions	These parameters monitor water applications.
23-	Time-based Functions	These parameters are for actions needed to be performed on a daily or weekly basis, e.g. different references for working hours/non-working hours.
25-	Basic Cascade Controller Functions	Parameters for configuring the Basic Cascade Controller for sequence control of multiple pumps.
26-	Analog I/O Option MCB 109	Parameters for configuring the Analog I/O Option MCB 109.
27-	Extended Cascade Control	Parameters for configuring the Extended Cascade Control.
29-	Water Application Functions	Parameters for setting water specific functions.
31-	Bypass Option	Parameters for configuring the Bypass Option

Table 8.1: Parameter groups

Parameter descriptions and selections are displayed on the graphic (GLCP) or numeric (NLCP) in the display area. (See Section 5 for details.) Access the parameters by pressing the [Quick Menu] or [Main Menu] key on the control panel. The quick menu is used primarily for commissioning the unit at start-up by providing those parameters necessary to start operation. The main menu provides access to all parameters for detailed application programming.

All digital input/output and analog input/output terminals are multifunctional. All terminals have factory default functions suitable for the majority of water applications but if other special functions are required, they must be programmed in parameter group 5 or 6.

8.1.2 Q1 My Personal Menu

Parameters defined by the user can be stored in Q1 My Personal Menu.

Select *My Personal Menu* to display only the parameters, which have been pre-selected and programmed as personal parameters. For example, a pump or equipment OEM may have pre-programmed these to be in My Personal Menu during factory commissioning to make on site commissioning / fine tuning simpler.. These parameters are selected in par. 0-25 *My Personal Menu*. Up to 20 different parameters can be defined in this menu.

Q1 My Personal Menu
20-21 Setpoint 1
20-93 PID Proportional Gain
20-94 PID Integral Time

8.1.3 Q2 Quick Setup

The parameters in Q2 Quick Setup are the basic parameters which are always needed to set-up the frequency converter to operation.

Q2 Quick Setup	
Parameter number and name	Unit
0-01 Language	
1-20 Motor Power	kW
1-22 Motor Voltage	V
1-23 Motor Frequency	Hz
1-24 Motor Current	A
1-25 Motor Nominal Speed	RPM
3-41 Ramp 1 Ramp Up Time	s
3-42 Ramp 1 Ramp Down Time	s
4-11 Motor Speed Low Limit	RPM
4-13 Motor Speed High Limit	RPM
1-29 Automatic Motor Adaptation (AMA)	

8.1.4 Q3 Function Setups

The Function Setup provides quick and easy access to all parameters required for the majority of water and wastewater applications including variable torque, constant torque, pumps, dosing pumps, well pumps, booster pumps, mixer pumps, aeration blowers and other pump and fan applications. Amongst other features it also includes parameters for selecting which variables to display on the LCP, digital preset speeds, scaling of analog references, closed loop single zone and multi-zone applications and specific functions related to water and wastewater applications.

How to access Function Set-up - example:

Illustration 8.1: Step 1: Turn on the frequency converter (On LED lights)

Illustration 8.5: Step 5: Use the up/down navigation keys to scroll down to i.e. 03-12 *Analog Outputs*. Press [OK].

Illustration 8.2: Step 2: Press the [Quick Menus] button (Quick Menu choices appear).

Illustration 8.6: Step 6: Choose parameter 6-50 *Terminal 42 Output*. Press [OK].

Illustration 8.3: Step 3: Use the up/down navigation keys to scroll down to Function Setups. Press [OK].

Illustration 8.7: Step 7: Use the up/down navigation keys to select between the different choices. Press [OK].

Illustration 8.4: Step 4: Function Setups choices appear. Choose 03-1 *General Settings*. Press [OK].

The Function Setup parameters are grouped in the following way:

Q3-1 General Settings			
Q3-10 Clock Settings	Q3-11 Display Settings	Q3-12 Analog Output	Q3-13 Relays
0-70 Set Date and Time	0-20 Display Line 1.1 Small	6-50 Terminal 42 Output	Relay 1 ⇒ 5-40 Function Relay
0-71 Date Format	0-21 Display Line 1.2 Small	6-51 Terminal 42 Output Min Scale	Relay 2 ⇒ 5-40 Function Relay
0-72 Time Format	0-22 Display Line 1.3 Small	6-52 Terminal 42 Output Max Scale	Option relay 7 ⇒ 5-40 Function Relay
0-74 DST/Summertime	0-23 Display Line 2 Large		Option relay 8 ⇒ 5-40 Function Relay
0-76 DST/Summertime Start	0-24 Display Line 3 Large		Option relay 9 ⇒ 5-40 Function Relay
0-77 DST/Summertime End	0-37 Display Text 1		
	0-38 Display Text 2		
	0-39 Display Text 3		

Q3-2 Open Loop Settings	
Q3-20 Digital Reference	Q3-21 Analog Reference
3-02 Minimum Reference	3-02 Minimum Reference
3-03 Maximum Reference	3-03 Maximum Reference
3-10 Preset Reference	6-10 Terminal 53 Low Voltage
5-13 Terminal 29 Digital Input	6-11 Terminal 53 High Voltage
5-14 Terminal 32 Digital Input	6-14 Terminal 53 Low Ref/Feedb. Value
5-15 Terminal 33 Digital Input	6-15 Terminal 53 High Ref/Feedb. Value

Q3-3 Closed Loop Settings	
Q3-30 Feedback Settings	Q3-31 PID Settings
1-00 Configuration Mode	20-81 PID Normal/Inverse Control
20-12 Reference/Feedb.Unit	20-82 PID Start Speed [RPM]
3-02 Minimum Reference	20-21 Setpoint 1
3-03 Maximum Reference	20-93 PID Proportional Gain
6-20 Terminal 54 Low Voltage	20-94 PID Integral Time
6-21 Terminal 54 High Voltage	
6-24 Terminal 54 Low Ref/Feedb Value	
6-25 Terminal 54 High Ref/Feedb Value	
6-00 Live Zero Timeout Time	
6-01 Live Zero Timeout Function	

8

8.1.5 Q5 Changes Made

Q5 Changes Made can be used for fault finding.

Select *Changes made to get information about:*

- the last 10 changes. Use the up/down navigation keys to scroll between the last 10 changed parameters.
- the changes made since default setting.

Select *Loggings* to get information about the display line read-outs. The information is shown as graphs.

Only display parameters selected in par. 0-20 and par. 0-24 can be viewed. It is possible to store up to 120 samples in the memory for later reference.

Please notice that the parameters listed in the below tables for Q5 only serve as examples as they will vary depending on the programming of the particular frequency converter.

Q5-1 Last 10 Changes
20-94 PID Integral Time
20-93 PID Proportional Gain

Q5-2 Since Factory Setting
20-93 PID Proportional Gain
20-94 PID Integral Time

Q5-3 Input Assignments
Analog Input 53
Analog Input 54

8.1.6 Q6 Loggings

Q6 Loggings can be used for fault finding.

Please notice that the parameters listed in the below table for Q6 only serve as examples as they will vary depending on the programming of the particular frequency converter.

Q6 Loggings	
Reference	
Analog Input 53	
Motor Current	
Frequency	
Feedback	
Energy Log	
Trending Cont Bin	
Trending Timed Bin	
Trending Comparison	

8.1.7 Main Menu mode

Both the GLCP and NLCP provide access to the main menu mode. Select the Main Menu mode by pressing the [Main Menu] key. Illustration 6.2 shows the resulting read-out, which appears on the display of the GLCP. Lines 2 through 5 on the display show a list of parameter groups which can be chosen by toggling the up and down buttons.

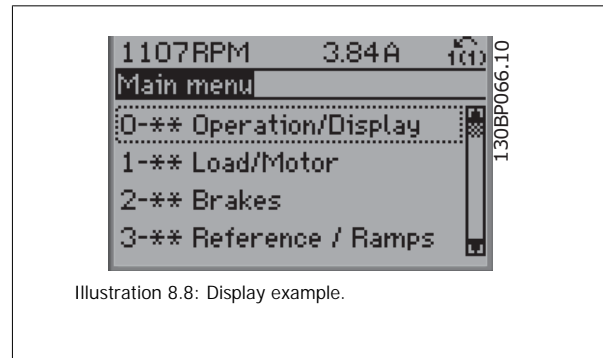


Illustration 8.8: Display example.

Each parameter has a name and number which remain the same regardless of the programming mode. In the Main Menu mode, the parameters are divided into groups. The first digit of the parameter number (from the left) indicates the parameter group number.

All parameters can be changed in the Main Menu. The configuration of the unit (par. 1-00 *Configuration Mode*) will determine other parameters available for programming. For example, selecting Closed Loop enables additional parameters related to closed loop operation. Option cards added to the unit enable additional parameters associated with the option device.

8.1.8 Parameter selection

In the Main Menu mode, the parameters are divided into groups. Select a parameter group by means of the navigation keys.

The following parameter groups are accessible:

Group no.	Parameter group:
0	Operation/Display
1	Load/Motor
2	Brakes
3	References/Ramps
4	Limits/Warnings
5	Digital In/Out
6	Analog In/Out
8	Comm. and Options
9	Profibus
10	CAN Fieldbus
11	LonWorks
13	Smart Logic
14	Special Functions
15	Drive Information
16	Data Readouts
18	Data Readouts 2
20	Drive Closed Loop
21	Ext. Closed Loop
22	Application Functions
23	Time-based Functions
24	Fire Mode
25	Cascade Controller
26	Analog I/O Option MCB 109

Table 8.2: Parameter groups.

After selecting a parameter group, choose a parameter by means of the navigation keys.

The middle section on the GLCP display shows the parameter number and name as well as the selected parameter value.

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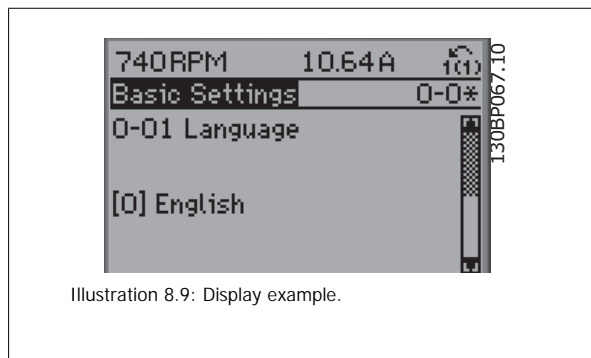


Illustration 8.9: Display example.

8.2 Commonly Used Parameters - Explanations

8.2.1 Main Menu

The Main Menu includes all available parameters in the VLT® AQUA Drive FC 200 frequency converter.

All parameters are grouped in a logic way with a group name indicating the function of the parameter group.

All parameters are listed by name and number in the section *Parameter Options* in these Operating Instructions.

All parameters included in the Quick Menu (Q1, Q2, Q3, Q5 and Q6) can be found in the following.

Some of the most used parameters for VLT® AQUA Drive applications are also explained in the following section.

For a detailed explanation of all parameters, please refer to the VLT® AQUA Drive Programming Guide MG.20.OX.YY which is available on www.danfoss.com or by ordering at the local Danfoss office.

8.2.2 0-** Operation / Display

Parameters related to the fundamental functions of the frequency converter, function of the LCP buttons and configuration of the LCP display.

0-01 Language

Option:

Function:

Defines the language to be used in the display.

The frequency converter can be delivered with 4 different language packages. English and German are included in all packages. English cannot be erased or manipulated.

[0] *	English	Part of Language packages 1 - 4
[1]	German	Part of Language packages 1 - 4
[2]	French	Part of Language package 1
[3]	Danish	Part of Language package 1
[4]	Spanish	Part of Language package 1
[5]	Italian	Part of Language package 1
[6]	Swedish	Part of Language package 1
[7]	Dutch	Part of Language package 1
[10]	Chinese	Language package 2
[20]	Finnish	Part of Language package 1
[22]	English US	Part of Language package 4
[27]	Greek	Part of Language package 4
[28]	Portuguese	Part of Language package 4
[36]	Slovenian	Part of Language package 3
[39]	Korean	Part of Language package 2
[40]	Japanese	Part of Language package 2
[41]	Turkish	Part of Language package 4
[42]	Traditional Chinese	Part of Language package 2
[43]	Bulgarian	Part of Language package 3
[44]	Serbian	Part of Language package 3
[45]	Romanian	Part of Language package 3
[46]	Hungarian	Part of Language package 3
[47]	Czech	Part of Language package 3
[48]	Polish	Part of Language package 4
[49]	Russian	Part of Language package 3
[50]	Thai	Part of Language package 2
[51]	Bahasa Indonesian	Part of Language package 2

0-20 Display Line 1.1 Small

Option:

Function:

Select a variable for display in line 1, left position.

[0]	None	No display value selected
[37]	Display Text 1	Present control word
[38]	Display Text 2	Enables an individual text string to be written, for display in the LCP or to be read via serial communication.
[39]	Display Text 3	Enables an individual text string to be written, for display in the LCP or to be read via serial communication.
[89]	Date and Time Readout	Displays the current date and time.
[953]	Profibus Warning Word	Displays Profibus communication warnings.
[1005]	Readout Transmit Error Counter	View the number of CAN control transmission errors since the last power-up.

[1006]	Readout Receive Error Counter	View the number of CAN control receipt errors since the last power-up.
[1007]	Readout Bus Off Counter	View the number of Bus Off events since the last power-up.
[1013]	Warning Parameter	View a DeviceNet-specific warning word. One separate bit is assigned to every warning.
[1115]	LON Warning Word	Shows the LON-specific warnings.
[1117]	XIF Revision	Shows the version of the external interface file of the Neuron C chip on the LON option.
[1118]	LON Works Revision	Shows the software version of the application program of the Neuron C chip on the LON option.
[1500]	Operating Hours	View the number of running hours of the frequency converter.
[1501]	Running Hours	View the number of running hours of the motor.
[1502]	kWh Counter	View the mains power consumption in kWh.
[1600]	Control Word	View the Control Word sent from the frequency converter via the serial communication port in hex code.
[1601] *	Reference [Unit]	Total reference (sum of digital/analog/preset/bus/freeze ref./catch up and slow-down) in selected unit.
[1602]	Reference %	Total reference (sum of digital/analog/preset/bus/freeze ref./catch up and slow-down) in percent.
[1603]	Status Word	Present status word
[1605]	Main Actual Value [%]	One or more warnings in a Hex code
[1609]	Custom Readout	View the user-defined readouts as defined in par. 0-30, 0-31 and 0-32.
[1610]	Power [kW]	Actual power consumed by the motor in kW.
[1611]	Power [hp]	Actual power consumed by the motor in HP.
[1612]	Motor Voltage	Voltage supplied to the motor.
[1613]	Motor Frequency	Motor frequency, i.e. the output frequency from the frequency converter in Hz.
[1614]	Motor Current	Phase current of the motor measured as effective value.
[1615]	Frequency [%]	Motor frequency, i.e. the output frequency from the frequency converter in percent.
[1616]	Torque [Nm]	Present motor load as a percentage of the rated motor torque.
[1617]	Speed [RPM]	Speed in RPM (revolutions per minute) i.e. the motor shaft speed in closed loop based on the entered motor nameplate data, the output frequency and the load on the frequency converter.
[1618]	Motor Thermal	Thermal load on the motor, calculated by the ETR function. See also parameter group 1-9* Motor Temperature.
[1622]	Torque [%]	Shows the actual torque produced, in percentage.
[1630]	DC Link Voltage	Intermediate circuit voltage in the frequency converter.
[1632]	BrakeEnergy/s	Present brake power transferred to an external brake resistor. Stated as an instantaneous value.
[1633]	BrakeEnergy/2 min	Brake power transferred to an external brake resistor. The mean power is calculated continuously for the most recent 120 seconds.
[1634]	Heatsink Temp.	Present heat sink temperature of the frequency converter. The cut-out limit is 95 ±5 oC; cutting back in occurs at 70 ±5° C.
[1635]	Thermal Drive Load	Percentage load of the inverters
[1636]	Inv. Nom. Current	Nominal current of the frequency converter
[1637]	Inv. Max. Current	Maximum current of the frequency converter
[1638]	SL Control State	State of the event executed by the control
[1639]	Control Card Temp.	Temperature of the control card.
[1650]	External Reference	Sum of the external reference as a percentage, i.e. the sum of analog/pulse/bus.
[1652]	Feedback [Unit]	Signal value in units from the programmed digital input(s).
[1653]	Digi Pot Reference	View the contribution of the digital potentiometer to the actual reference Feedback.
[1654]	Feedback 1 [Unit]	View the value of Feedback 1. See also par. 20-0*.
[1655]	Feedback 2 [Unit]	View the value of Feedback 2. See also par. 20-0*.
[1656]	Feedback 3 [Unit]	View the value of Feedback 3. See also par. 20-0*.
[1658]	PID Output [%]	Returns the Drive Closed Loop PID controller output value in percent.

[1659]	Adjusted Setpoint	Displays the actual operating set-point after it is modified by flow compensation. See parameters 22-8*.
[1660]	Digital Input	Displays the status of the digital inputs. Signal low = 0; Signal high = 1. Regarding order, see par. 16-60. Bit 0 is at the extreme right.
[1661]	Terminal 53 Switch Setting	Setting of input terminal 53. Current = 0; Voltage = 1.
[1662]	Analog Input 53	Actual value at input 53 either as a reference or protection value.
[1663]	Terminal 54 Switch Setting	Setting of input terminal 54. Current = 0; Voltage = 1.
[1664]	Analog Input 54	Actual value at input 54 either as reference or protection value.
[1665]	Analog Output 42 [mA]	Actual value at output 42 in mA. Use par. 6-50 to select the variable to be represented by output 42.
[1666]	Digital Output [bin]	Binary value of all digital outputs.
[1667]	Freq. Input #29 [Hz]	Actual value of the frequency applied at terminal 29 as a pulse input.
[1668]	Freq. Input #33 [Hz]	Actual value of the frequency applied at terminal 33 as a pulse input.
[1669]	Pulse Output #27 [Hz]	Actual value of pulses applied to terminal 27 in digital output mode.
[1670]	Pulse Output #29 [Hz]	Actual value of pulses applied to terminal 29 in digital output mode.
[1671]	Relay Output [bin]	View the setting of all relays.
[1672]	Counter A	View the present value of Counter A.
[1673]	Counter B	View the present value of Counter B.
[1675]	Analog input X30/11	Actual value of the signal on input X30/11 (General Purpose I/O Card. Option)
[1676]	Analog input X30/12	Actual value of the signal on input X30/12 (General Purpose I/O Card. Optional)
[1677]	Analog output X30/8 [mA]	Actual value at output X30/8 (General Purpose I/O Card. Optional) Use Par. 6-60 to select the variable to be shown.
[1680]	Fieldbus CTW 1	Control word (CTW) received from the Bus Master.
[1682]	Fieldbus REF 1	Main reference value sent with control word via the serial communications network e.g. from the BMS, PLC or other master controller.
[1684]	Comm. Option STW	Extended fieldbus communication option status word.
[1685]	FC Port CTW 1	Control word (CTW) received from the Bus Master.
[1686]	FC Port REF 1	Status word (STW) sent to the Bus Master.
[1690]	Alarm Word	One or more alarms in a Hex code (used for serial communications)
[1691]	Alarm Word 2	One or more alarms in a Hex code (used for serial communications)
[1692]	Warning Word	One or more warnings in a Hex code (used for serial communications)
[1693]	Warning Word 2	One or more warnings in a Hex code (used for serial communications)
[1694]	Ext. Status Word	One or more status conditions in a Hex code (used for serial communications)
[1695]	Ext. Status Word 2	One or more status conditions in a Hex code (used for serial communications)
[1696]	Maintenance Word	The bits reflect the status for the programmed Preventive Maintenance Events in parameter group 23-1*
[1830]	Analog Input X42/1	Shows the value of the signal applied to terminal X42/1 on the Analog I/O card.
[1831]	Analog Input X42/3	Shows the value of the signal applied to terminal X42/3 on the Analog I/O card.
[1832]	Analog Input X42/5	Shows the value of the signal applied to terminal X42/5 on the Analog I/O card.
[1833]	Analog Out X42/7 [V]	Shows the value of the signal applied to terminal X42/7 on the Analog I/O card.
[1834]	Analog Out X42/9 [V]	Shows the value of the signal applied to terminal X42/9 on the Analog I/O card.
[1835]	Analog Out X42/11 [V]	Shows the value of the signal applied to terminal X42/11 on the Analog I/O card.
[2117]	Ext. 1 Reference [Unit]	The value of the reference for extended Closed Loop Controller 1
[2118]	Ext. 1 Feedback [Unit]	The value of the feedback signal for extended Closed Loop Controller 1
[2119]	Ext. 1 Output [%]	The value of the output from extended Closed Loop Controller 1
[2137]	Ext. 2 Reference [Unit]	The value of the reference for extended Closed Loop Controller 2
[2138]	Ext. 2 Feedback [Unit]	The value of the feedback signal for extended Closed Loop Controller 2
[2139]	Ext. 2 Output [%]	The value of the output from extended Closed Loop Controller 2

[2157]	Ext. 3 Reference [Unit]	The value of the reference for extended Closed Loop Controller 3
[2158]	Ext. 3 Feedback [Unit]	The value of the feedback signal for extended Closed Loop Controller 3
[2159]	Ext. Output [%]	The value of the output from extended Closed Loop Controller 3
[2230]	No-Flow Power	The calculated No Flow Power for the actual operating speed
[2580]	Cascade Status	Status for the operation of the Cascade Controller
[2581]	Pump Status	Status for the operation of each individual pump controlled by the Cascade Controller
[2791]	Cascade Reference	Reference output for use with follower drives.
[2792]	% Of Total Capacity	Readout parameter to show the system operating point as a % capacity of total system capacity.
[2793]	Cascade Option Status	Readout parameter to show the status of the cascade system.

0-21 Display Line 1.2 Small

Option:	Function:
	Select a variable for display in line 1, middle position.
[1662] * Analog input 53	The options are the same as those listed for par. 0-20 <i>Display Line 1.1 Small</i> .

0-22 Display Line 1.3 Small

Option:	Function:
	Select a variable for display in line 1, right position.
[1614] * Motor Current	The options are the same as those listed for par. 0-20 <i>Display Line 1.1 Small</i> .

8

0-23 Display Line 2 Large

Option:	Function:
	Select a variable for display in line 2.
[1615] * Frequency	The options are the same as those listed for par. 0-20 <i>Display Line 1.1 Small</i>

0-24 Display Line 3 Large

Option:	Function:
[1652] * Feedback [Unit]	The options are the same as those listed for par. 0-20 <i>Display Line 1.1 Small</i> .
	Select a variable for display in line 2.

0-37 Display Text 1

Range:	Function:
0 N/A* [0 - 0 N/A]	In this parameter it is possible to write an individual text string for display in the LCP or to be read via serial communication. If to be displayed permanently select Display Text 1 in par. 0-20 <i>Display Line 1.1 Small</i> , par. 0-21 <i>Display Line 1.2 Small</i> , par. 0-22 <i>Display Line 1.3 Small</i> , par. 0-23 <i>Display Line 2 Large</i> or par. 0-24 <i>Display Line 3 Large</i> . Use the ▲ or ▼ buttons on the LCP to change a character. Use the ◀ and ▶ buttons to move the cursor. When a character is highlighted by the cursor, it can be changed. Use the ▲ or ▼ buttons on the LCP to change a character. A character can be inserted by placing the cursor between two characters and pressing ▲ or ▼.

0-38 Display Text 2

Range:	Function:
0 N/A* [0 - 0 N/A]	In this parameter it is possible to write an individual text string for display in the LCP or to be read via serial communication. If to be displayed permanently select Display Text 2 in par. 0-20 <i>Display Line 1.1 Small</i> , par. 0-21 <i>Display Line 1.2 Small</i> , par. 0-22 <i>Display Line 1.3 Small</i> , par. 0-23 <i>Display Line 2 Large</i> or par. 0-24 <i>Display Line 3 Large</i> . Use the ▲ or ▼ buttons on the LCP to change a character. Use the ◀ and ▶ buttons to move the cursor. When a character is highlighted by the cursor, this character can be changed. A character can be inserted by placing the cursor between two characters and pressing ▲ or ▼.

0-39 Display Text 3

Range:

0 N/A* [0 - 0 N/A]

Function:

In this parameter it is possible to write an individual text string for display in the LCP or to be read via serial communication. If to be displayed permanently select Display Text 3 in par. 0-20 *Display Line 1.1 Small*, par. 0-21 *Display Line 1.2 Small*, par. 0-22 *Display Line 1.3 Small*, par. 0-23 *Display Line 2 Large* or par. 0-24 *Display Line 3 Large*. Use the ▲ or ▼ buttons on the LCP to change a character. Use the ◀ and ▶ buttons to move the cursor. When a character is highlighted by the cursor, this character can be changed. A character can be inserted by placing the cursor between two characters and pressing ▲ or ▼.


0-70 Set Date and Time

Range:

2000-01-01 [2000-01-01 00:00]
 00:00 –
 2099-12-01
 23:59 *

Function:

Sets the date and time of the internal clock. The format to be used is set in par. 0-71 and 0-72.



NB!
 This parameter does not display the actual time. This can be read in par. 0-89. The clock will not begin counting until a setting different from default has been made.

0-71 Date Format

Option:

[0] * YYYY-MM-DD
 [1] DD-MM-YYYY
 [2] MM/DD/YYYY

Function:

Sets the date format to be used in the LCP.
 Sets the date format to be used in the LCP.
 Sets the date format to be used in the LCP.

0-72 Time Format

Option:

[0] * 24 h
 [1] 12 h

Function:

Sets the time format to be used in the LCP.

0-74 DST/Summertime

Option:

[0] * Off
 [2] Manual

Function:

Choose how Daylight Saving Time/Summertime should be handled. For manual DST/Summertime enter the start date and end date in par. 0-76 *DST/Summertime Start* and par. 0-77 *DST/Summertime End*.

0-76 DST/Summertime Start

Range:

0 N/A* [0 - 0 N/A]

Function:

Sets the date and time when summertime/DST starts. The date is programmed in the format selected in par. 0-71 *Date Format*.

0-77 DST/Summertime End

Range:

0 N/A* [0 - 0 N/A]

Function:

Sets the date and time when summertime/DST ends. The date is programmed in the format selected in par. 0-71 *Date Format*.

8.2.3 General Settings, 1-0*

Define whether the frequency converter operates in open loop or closed loop.

1-00 Configuration Mode

Option:

Function:

[0] *	Open Loop	Motor speed is determined by applying a speed reference or by setting desired speed when in Hand Mode. Open Loop is also used if the frequency converter is part of a closed loop control system based on an external PID controller providing a speed reference signal as output.
[3]	Closed Loop	Motor Speed will be determined by a reference from the built-in PID controller varying the motor speed as part of a closed loop control process (e.g. constant pressure or flow). The PID controller must be configured in par. 20-** or via the Function Setups accessed by pressing the [Quick Menus] button.



NB!

This parameter cannot be changed when motor is running.



NB!

When set for Closed Loop, the commands Reversing and Start Reversing will not reverse the direction of the motor.

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1-20 Motor Power [kW]

Range:

Function:

4.00 kW*	[0.09 - 3000.00 kW]	Enter the nominal motor power in kW according to the motor nameplate data. The default value corresponds to the nominal rated output of the unit. This parameter cannot be adjusted while the motor is running. Depending on the choices made in par. 0-03 <i>Regional Settings</i> , either par. 1-20 <i>Motor Power [kW]</i> or par. 1-21 <i>Motor Power [HP]</i> is made invisible.
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1-22 Motor Voltage

Range:

Function:

400. V*	[10. - 1000. V]	Enter the nominal motor voltage according to the motor nameplate data. The default value corresponds to the nominal rated output of the unit. This parameter cannot be adjusted while the motor is running.
---------	-----------------	--

1-23 Motor Frequency

Range:

Function:

50. Hz*	[20 - 1000 Hz]	Select the motor frequency value from the motor nameplate data. For 87 Hz operation with 230/400 V motors, set the nameplate data for 230 V/50 Hz. Adapt par. 4-13 <i>Motor Speed High Limit [RPM]</i> and par. 3-03 <i>Maximum Reference</i> to the 87 Hz application.
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NB!

This parameter cannot be adjusted while the motor is running.

1-24 Motor Current

Range:

7.20 A* [0.10 - 10000.00 A]

Function:

Enter the nominal motor current value from the motor nameplate data. This data is used for calculating motor torque, motor thermal protection etc.



NB!

This parameter cannot be adjusted while the motor is running.

1-25 Motor Nominal Speed

Range:

1420. RPM* [100 - 60000 RPM]

Function:

Enter the nominal motor speed value from the motor nameplate data. This data is used for calculating automatic motor compensations.



NB!

This parameter cannot be changed while the motor is running.

1-29 Automatic Motor Adaptation (AMA)

Option:

Function:

The AMA function optimizes dynamic motor performance by automatically optimizing the advanced motor parameters par. 1-30 *Stator Resistance (Rs)* to par. 1-35 *Main Reactance (Xh)* while the motor is stationary.

[0] * Off

No function

[1] Enable complete AMA

performs AMA of the stator resistance R_s , the rotor resistance R_r , the stator leakage reactance X_1 , the rotor leakage reactance X_2 and the main reactance X_h .

[2] Enable reduced AMA

performs a reduced AMA of the stator resistance R_s in the system only. Select this option if an LC filter is used between the frequency converter and the motor.

Activate the AMA function by pressing [Hand on] after selecting [1] or [2]. See also the section *Automatic Motor Adaptation*. After a normal sequence, the display will read: "Press [OK] to finish AMA". After pressing the [OK] key the frequency converter is ready for operation.

Note:

- For the best adaptation of the frequency converter, run AMA on a cold motor
- AMA cannot be performed while the motor is running



NB!

It is important to set motor par. 1-2* Motor Data correctly, since these form part of the AMA algorithm. An AMA must be performed to achieve optimum dynamic motor performance. It may take up to 10 min., depending on motor power rating.



NB!

Avoid generating external torque during AMA



NB!

If one of the settings in par. 1-2* Motor Data is changed, par. 1-30 *Stator Resistance (Rs)* to par. 1-39 *Motor Poles*, the advanced motor parameters, will return to default setting.

This parameter cannot be adjusted while the motor is running



NB!

Full AMA should be run without filter only while reduced AMA should be run with filter.

See section: *Application Examples > Automatic Motor Adaptation* in the Design Guide.

8.2.4 3-0* Reference Limits

Parameters for setting the reference unit, limits and ranges.

3-02 Minimum Reference

Range:

0.000 Ref- [-999999.999 - par. 3-03 ReferenceFeed-ceFeedbackUnit] backUnit*

Function:

Enter the Minimum Reference. The Minimum Reference is the lowest value obtainable by summing all references. The Minimum Reference value and unit matches the configuration choice made in par. 1-00 *Configuration Mode* and par. 20-12 *Reference/Feedback Unit*, respectively.



NB!

This parameter is used in open loop only.

3-03 Maximum Reference

Range:

50.000 Ref- [par. 3-02 - 999999.999 ReferenceFeed-ceFeedbackUnit] backUnit*

Function:

Enter the maximum acceptable value for the remote reference. The Maximum Reference value and unit matches the configuration choice made in par. 1-00 *Configuration Mode* and par. 20-12 *Reference/Feedback Unit*, respectively.



NB!

If operating with par. 1-00, Configuration Mode set for Closed Loop [3], par. 20-14, Maximum Reference/Feedb. must be used.

3-10 Preset Reference

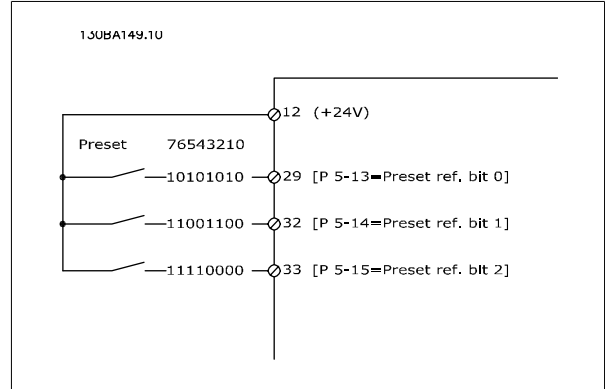
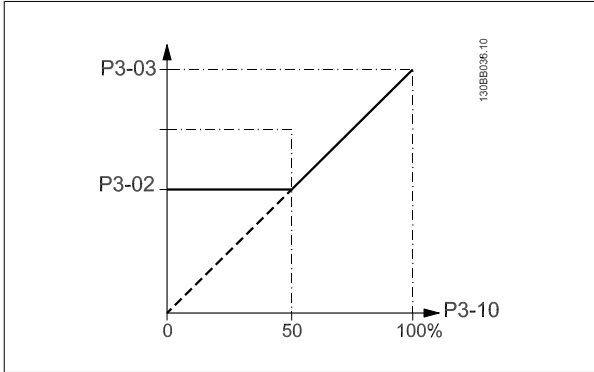
Array [8]

Range:

0.00 %* [-100.00 - 100.00 %]

Function:

Enter up to eight different preset references (0-7) in this parameter, using array programming. The preset reference is stated as a percentage of the value Ref_{MAX} (par. 3-03 *Maximum Reference*, for closed loop see par. 20-14 *Maximum Reference/Feedb.*). When using preset references, select Pre-set ref. bit 0 / 1 / 2 [16], [17] or [18] for the corresponding digital inputs in parameter group 5-1* Digital Inputs.



3-41 Ramp 1 Ramp Up Time

Range:

10.00 s* [1.00 - 3600.00 s]

Function:

Enter the ramp-up time, i.e. the acceleration time from 0 RPM to par. 1-25 *Motor Nominal Speed*. Choose a ramp-up time such that the output current does not exceed the current limit in par. 4-18 *Current Limit* during ramping. See ramp-down time in par. 3-42 *Ramp 1 Ramp Down Time*.

$$par.3 - 41 = \frac{tacc \times nnorm [par.1 - 25]}{ref [rpm]} [s]$$

3-42 Ramp 1 Ramp Down Time

Range:

20.00 s* [1.00 - 3600.00 s]

Function:

Enter the ramp-down time, i.e. the deceleration time from par. 1-25 *Motor Nominal Speed* to 0 RPM. Choose a ramp-down time such that no over-voltage arises in the inverter due to regenerative operation of the motor, and such that the generated current does not exceed the current limit set in par. 4-18 *Current Limit*. See ramp-up time in par. 3-41 *Ramp 1 Ramp Up Time*.

$$par.3 - 42 = \frac{tdec \times nnorm [par.1 - 25]}{ref [rpm]} [s]$$

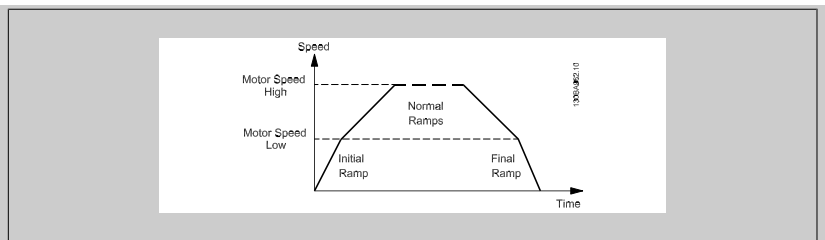
3-84 Initial Ramp Time

Range:

0 s* [0 - 60 s]

Function:

Enter the initial ramp up time from zero speed to Motor Speed Low Limit, par. 4-11 or 4-12. Submersible deep well pumps can be damaged by running below minimum speed. A fast ramp time below minimum pump speed is recommended. This parameter may be applied as a fast ramp rate from zero speed to Motor Speed Low Limit.



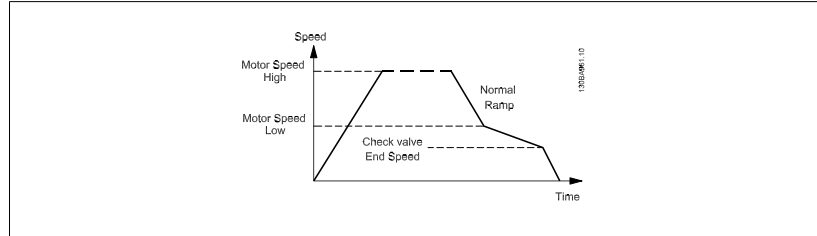
3-85 Check Valve Ramp Time

Range:

0 s* [0 – 60 s]

Function:

In order to protect ball check valves in a stop situation, the check valve ramp can be utilized as a slow ramp rate from par. 4-11 *Motor Speed Low Limit [RPM]* or par. 4-12 *Motor Speed Low Limit [Hz]*, to Check Valve Ramp End Speed, set by the user in par. 3-86 or par. 3-87. When par. 3-85 is different from 0 seconds, the Check Valve Ramp Time is effectuated and will be used to ramp down the speed from Motor Speed Low Limit to the Check Valve End Speed in par. 3-86 or par. 3-87.



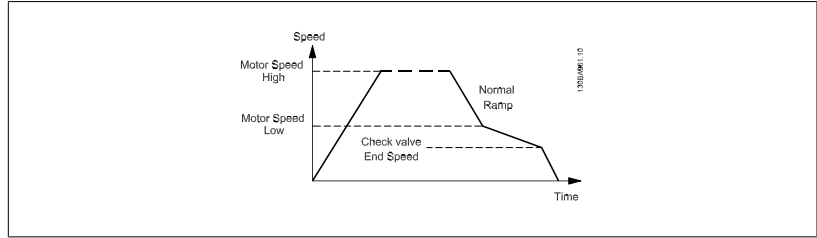
3-86 Check Valve Ramp End Speed [RPM]

Range:

0 [RPM]* [0 – Motor Speed Low Limit [RPM]]

Function:

Set the speed in [RPM] below Motor Speed Low Limit where the Check Valve is expected to be closed and the Check Valve no longer shall be active.



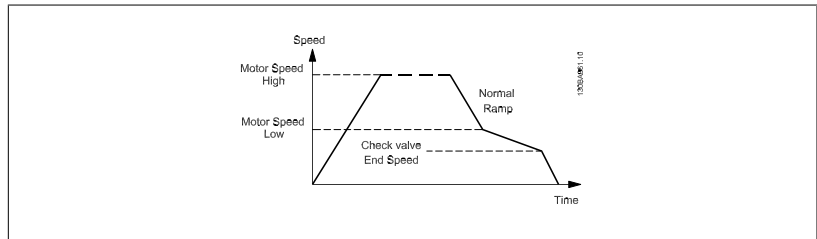
3-87 Check Valve Ramp End Speed [Hz]

Range:

0 [Hz]* [0 – Motor Speed Low Limit [Hz]]

Function:

Set the speed in [Hz] below Motor Speed Low Limit where the Check Valve Ramp will no longer be active.



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3-88 Final Ramp Time

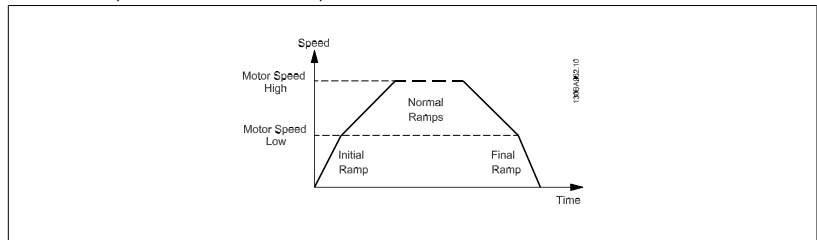
Range:

0 [s]* [0 – 60 [s]]

Function:

Enter the Final Ramp Time to be used when ramping down from Motor Speed Low Limit, par. 4-11 or 4-12, to zero speed.

Submersible deep well pumps can be damaged by running below minimum speed. A fast ramp time below minimum pump speed is recommended. This parameter may be applied as a fast ramp rate from Motor Speed Low Limit to zero speed.



8.2.5 4-** Limits and Warnings

Parameter group for configuring limits and warnings.

4-11 Motor Speed Low Limit [RPM]

Range:

0 RPM* [0 - par. 4-13 RPM]


Function:


Enter the minimum limit for motor speed. The Motor Speed Low Limit can be set to correspond to the manufacturer's recommended minimum motor speed. The Motor Speed Low Limit must not exceed the setting in par. 4-13 *Motor Speed High Limit [RPM]*.



4-13 Motor Speed High Limit [RPM]

Range:	Function:
1500. RPM* [par. 4-11 - 60000. RPM]	Enter the maximum limit for motor speed. The Motor Speed High Limit can be set to correspond to the manufacturer's maximum rated motor. The Motor Speed High Limit must exceed the setting in par. 4-11 <i>Motor Speed Low Limit [RPM]</i> . Only par. 4-11 <i>Motor Speed Low Limit [RPM]</i> or par. 4-12 <i>Motor Speed Low Limit [Hz]</i> will be displayed depending on other parameters in the Main Menu and depending on default settings dependant on global location.

 **NB!**
Max. output frequency cannot exceed 10% of the inverter switching frequency (par. 14-01 *Switching Frequency*).

 **NB!**
Any changes in par. 4-13 *Motor Speed High Limit [RPM]* will reset the value in par. 4-53 *Warning Speed High* to the same value as set in par. 4-13 *Motor Speed High Limit [RPM]*.

8.2.6 5-** Digital In/Out

Parameter group for configuring the digital input and output.

5-01 Terminal 27 Mode

Option:	Function:
[0] * Input	Defines terminal 27 as a digital input.
[1] Output	Defines terminal 27 as a digital output.

Please note that this parameter cannot be adjusted while the motor is running.

8.2.7 5-1* Digital Inputs

Parameters for configuring the input functions for the input terminals.
The digital inputs are used for selecting various functions in the frequency converter. All digital inputs can be set to the following functions:


Digital input function	Select	Terminal
No operation	[0]	All *term 32, 33
Reset	[1]	All
Coast inverse	[2]	All
Coast and reset inverse	[3]	All
DC-brake inverse	[5]	All
Stop inverse	[6]	All
External interlock	[7]	All
Start	[8]	All *term 18
Latched start	[9]	All
Reversing	[10]	All *term 19
Start reversing	[11]	All
Jog	[14]	All *term 29
Preset reference on	[15]	All
Preset ref bit 0	[16]	All
Preset ref bit 1	[17]	All
Preset ref bit 2	[18]	All
Freeze reference	[19]	All
Freeze output	[20]	All
Speed up	[21]	All
Speed down	[22]	All
Set-up select bit 0	[23]	All
Set-up select bit 1	[24]	All
Pulse input	[32]	term 29, 33
Ramp bit 0	[34]	All
Mains failure inverse	[36]	All
Run Permissive	[52]	

Hand start	[53]	
Auto start	[54]	
DigiPot Increase	[55]	All
DigiPot Decrease	[56]	All
DigiPot Clear	[57]	All
Counter A (up)	[60]	29, 33
Counter A (down)	[61]	29, 33
Reset Counter A	[62]	All
Counter B (up)	[63]	29, 33
Counter B (down)	[64]	29, 33
Reset Counter B	[65]	All
Sleep Mode	[66]	
Reset Maintenance Word	[78]	
Lead Pump Start	[120]	
Lead Pump Alternation	[121]	
Pump 1 Interlock	[130]	
Pump 2 Interlock	[131]	
Pump 3 Interlock	[132]	

All = Terminals 18, 19, 27, 29, 32, X30/2, X30/3, X30/4. X30/ are the terminals on MCB 101.

Functions dedicated to only one digital input are stated in the associated parameter.

All digital inputs can be programmed to these functions:

[0]	No operation	No reaction to signals transmitted to terminal.
[1]	Reset	Resets frequency converter after a TRIP/ALARM. Not all alarms can be reset.
[2]	Coast inverse	Leaves motor in free mode. Logic '0' => coasting stop. (Default Digital input 27): Coasting stop, inverted input (NC).
[3]	Coast and reset inverse	Reset and coasting stop Inverted input (NC). Leaves motor in free mode and resets the frequency converter. Logic '0' => coasting stop and reset.
[5]	DC-brake inverse	Inverted input for DC braking (NC). Stops motor by energizing it with a DC current for a certain time period. See par. 2-01 to par. 2-03. The function is only active when the value in par. 2-02 is different from 0. Logic '0' => DC braking.
[6]	Stop inverse	Stop Inverted function. Generates a stop function when the selected terminal goes from logical level '1' to '0'. The stop is performed according to the selected ramp time (par. 3-42 and par. 3-52).
 NB! When the frequency converter is at the torque limit and has received a stop command, it may not stop by itself. To ensure that the frequency converter stops, configure a digital output to <i>Torque limit & stop</i> [27] and connect this digital output to a digital input that is configured as coast.		
[7]	External Interlock	Same function as Coasting stop, inverse, but External Interlock generates the alarm message 'external fault' on the display when the terminal which is programmed for Coast Inverse is logic '0'. The alarm message will also be active via digital outputs and relay outputs, if programmed for External Interlock. The alarm can be reset using a digital input or the [RESET] key if the cause for the External Interlock has been removed. A delay can be programmed in par. 22-00, External Interlock Time. After applying a signal to the input, the reaction described above will be delayed with the time set in par. 22-00.
[8]	Start	Select start for a start/stop command. Logic '1' = start, logic '0' = stop. (Default Digital input 18)
[9]	Latched start	Motor starts, if a pulse is applied for min. 2 ms. Motor stops when Stop inverse is activated
[10]	Reversing	Changes direction of motor shaft rotation. Select Logic '1' to reverse. The reversing signal only changes the direction of rotation. It does not activate the start function. Select both directions in par. 4-10 <i>Motor Speed Direction</i> . (Default Digital input 19).
[11]	Start reversing	Used for start/stop and for reversing on the same wire. Signals on start are not allowed at the same time.
[14]	Jog	Used for activating jog speed. See par. 3-11. (Default Digital input 29)

8

[15] Preset reference on Used for shifting between external reference and preset reference. It is assumed that *External/preset* [1] has been selected in par. 3-04. Logic '0' = external reference active; logic '1' = one of the eight preset references is active.

[16] Preset ref bit 0 Enables a choice between one of the eight preset references according to the table below.


[17] Preset ref bit 1 Enables a choice between one of the eight preset references according to the table below.

[18] Preset ref bit 2 Enables a choice between one of the eight preset references according to the table below.

Preset ref. bit	2	1	0
Preset ref. 0	0	0	0
Preset ref. 1	0	0	1
Preset ref. 2	0	1	0
Preset ref. 3	0	1	1
Preset ref. 4	1	0	0
Preset ref. 5	1	0	1
Preset ref. 6	1	1	0
Preset ref. 7	1	1	1

[19] Freeze ref Freezes actual reference. The frozen reference is now the point of enable/condition for Speed up and Speed down to be used. If Speed up/down is used, the speed change always follows ramp 2 (par. 3-51 and 3-52) in the range 0 - par. 3-03 *Maximum Reference*.

[20] Freeze output Freezes actual motor frequency (Hz). The frozen motor frequency is now the point of enable/condition for Speed up and Speed down to be used. If Speed up/down is used, the speed change always follows ramp 2 (par. 3-51 and 3-52) in the range 0 - par. 1-23 *Motor Frequency*.



NB!
 When Freeze output is active, the frequency converter cannot be stopped via a low 'start [13]' signal. Stop the frequency converter via a terminal programmed for Coasting inverse [2] or Coast and reset, inverse [3].

[21] Speed up For digital control of the up/down speed is desired (motor potentiometer). Activate this function by selecting either Freeze reference or Freeze output. When Speed up is activated for less than 400 msec. the resulting reference will be increased by 0.1 %. If Speed up is activated for more than 400 msec. the resulting reference will ramp according to Ramp 1 in par. 3-41.

[22] Speed down Same as Speed up [21].

[23] Set-up select bit 0 Selects one of the four set-ups. Set par. 0-10 *Active Set-up* to Multi Set-up.

[24] Set-up select bit 1 Same as Set-up select bit 0 [23].
(Default Digital input 32)

[32] Pulse input Select Pulse input when using a pulse sequence as either reference or feedback. Scaling is done in par. group 5-5*.

[34] Ramp bit 0 Select which ramp to use. Logic "0" will select ramp 1 while logic "1" will select ramp 2.

[36] Mains failure inverse Activates par. 14-10 *Mains Failure*. Mains failure inverse is active in the Logic "0" situation.

[52] Run Permissive The input terminal, for which the Run permissive has been programmed must be logic "1" before a start command can be accepted. Run permissive has a logic 'AND' function related to the terminal which is programmed for *START* [8], *Jog* [14] or *Freeze Output* [20], which means that in order to start running the motor, both conditions must be fulfilled. If Run Permissive is programmed on multiple terminals, Run permissive needs only be logic '1' on one of the terminals for the function to be carried out. The digital output signal for Run Request (*Start* [8], *Jog* [14] or *Freeze output* [20]) programmed in par. 5-3* Digital outputs, or par. 5-4* Relays, will not be affected by Run Permissive.

[53] Hand start A signal applied will put the frequency converter into Hand mode as if button *Hand On* on the LCP has been pressed and a normal stop command will be overridden. If disconnecting the signal, the motor will stop. To make any other start commands valid, another digital input must be assign to *Auto Start* and a signal applied to this. The *Hand On* and *Auto On* buttons on the LCP has no impact. The *Off* button on the LCP will override *Hand Start* and *Auto Start*. Press either the *Hand On* or *Auto On* button to make *Hand Start* and *Auto Start* active again. If no signal on neither *Hand Start* nor *Auto Start*, the motor will stop regardless of any normal Start command applied. If signal applied to both *Hand Start* and *Auto Start*, the function will be *Auto Start*. If pressing the *Off* button on the LCP the motor will stop regardless of signals on *Hand Start* and *Auto Start*.

[54]	Auto start	A signal applied will put the frequency converter into Auto mode as if the LCP button <i>Auto On</i> has been pressed. See also <i>Hand Start</i> [53]
[55]	DigiPot Increase	Uses the input as an INCREASE signal to the Digital Potentiometer function described in parameter group 3-9*
[56]	DigiPot Decrease	Uses the input as a DECREASE signal to the Digital Potentiometer function described in parameter group 3-9*
[57]	DigiPot Clear	Uses the input to CLEAR the Digital Potentiometer reference described in parameter group 3-9*
[60]	Counter A (up)	(Terminal 29 or 33 only) Input for increment counting in the SLC counter.
[61]	Counter A (down)	(Terminal 29 or 33 only) Input for decrement counting in the SLC counter.
[62]	Reset Counter A	Input for reset of counter A.
[63]	Counter B (up)	(Terminal 29 and 33 only) Input for increment counting in the SLC counter.
[64]	Counter B (down)	(Terminal 29 and 33 only) Input for decrement counting in the SLC counter.
[65]	Reset Counter B	Input for reset of counter B.
[66]	Sleep Mode	Forces frequency converter into Sleep Mode (see par. 22-4*, Sleep Mode). Reacts on the rising edge of signal applied!
[78]	Reset Preventive Maintenance Word	Resets all data in par. 16-96, Preventive Maintenance Word, to 0.

The below setting options are all related to the Cascade Controller. Wiring diagrams and settings for parameter, see group 25-** for more details.

[120]	Lead Pump Start	Starts/Stops the Lead Pump (controlled by the frequency converter). A start requires that also a System Start signal has been applied e.g. to one of the digital inputs set for <i>Start</i> [8]!
[121]	Lead Pump Alternation	Forces alternation of the lead pump in a Cascade Controller. <i>Lead Pump Alternation</i> , par. 25-50, must be set to either <i>At Command</i> [2] or <i>At Staging or At Command</i> [3]. <i>Alternation Event</i> , par. 25-51, can be set to any of the four options.

[130 - 138] Pump1 Interlock - Pump9 Interlock The function will depend on the setting in par. 25-06, Number of Pumps. If set to *No* [0], then Pump1 refers to the pump controlled by relay RELAY1 etc. If set to *Yes* [1], Pump1 refers to the pump controlled by the frequency converter only (without any of the build in relays involved) and Pump2 to the pump controlled by the relay RELAY1. Variable speed pump (lead) cannot be interlocked in the basic Cascade Controller.
 See below table:

Setting in Par. 5-1*	Setting in Par. 25-06	
	[0] No	[1] Yes
[130] Pump1 Interlock	Controlled by RELAY1 (only if not lead pump)	Frequency Converter controlled (cannot be interlocked)
[131] Pump2 Interlock	Controlled by RELAY2	Controlled by RELAY1
[132] Pump3 Interlock	Controlled by RELAY3	Controlled by RELAY2
[133] Pump4 Interlock	Controlled by RELAY4	Controlled by RELAY3
[134] Pump5 Interlock	Controlled by RELAY5	Controlled by RELAY4
[135] Pump6 Interlock	Controlled by RELAY6	Controlled by RELAY5
[136] Pump7 Interlock	Controlled by RELAY7	Controlled by RELAY6
[137] Pump8 Interlock	Controlled by RELAY8	Controlled by RELAY7
[138] Pump9 Interlock	Controlled by RELAY9	Controlled by RELAY8

5-13 Terminal 29 Digital Input

Option:

[0] * No Operation

Function:

Same options and functions as par. 5-1* *Digital Inputs*.

5-14 Terminal 32 Digital Input

Same options and functions as par. 5-1*, except for *Pulse input*.

Option:

[0] * No operation

Function:

5-15 Terminal 33 Digital Input

Same options and functions as par. 5-1* Digital Inputs.

Option:	Function:
[0] *	No operation

5-30 Terminal 27 Digital Output

Same options and functions as par. 5-3*.

Option:	Function:
[0] *	No operation

5-40 Function Relay

Array [8]	(Relay 1 [0], Relay 2 [1], Relay 7 [6], Relay 8 [7], Relay 9 [8])
-----------	---

Select options to define the function of the relays.
 The selection of each mechanical relay is realized in an array parameter.

[0] *	No Operation
[1]	Control Ready
[2]	Drive Ready
[3]	Drive Ready/Remote
[4]	Stand-by/No Warning
[5]	Running
[6]	Running/No Warning
[8]	Run on Ref./No Warning
[9]	Alarm
[10]	Alarm or Warning
[11]	At Torque Limit
[12]	Out of Current Range
[13]	Below Current, low
[14]	Above Current, high
[15]	Out of Speed Range
[16]	Below Speed, low
[17]	Above Speed, high
[18]	Out of Feedb. Range
[19]	Below Feedback, low
[20]	Above Feedback, high
[21]	Thermal Warning
[25]	Reverse
[26]	Bus OK
[27]	Torque Limit & Stop
[28]	Brake, No Warning
[29]	Brake Ready, No Fault
[30]	Brake Fault (IGBT)
[35]	External Interlock
[36]	Control Word Bit 11
[37]	Control Word Bit 12
[40]	Out of Ref. Range
[41]	Below Reference, low

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[42]	Above Ref. high
[45]	Bus ctrl
[46]	Bus ctrl, 1 if timeout
[47]	Bus ctrl, 0 if timeout
[60]	Comparator 0
[61]	Comparator 1
[62]	Comparator 2
[63]	Comparator 3
[64]	Comparator 4
[65]	Comparator 5
[70]	Logic Rule 0
[71]	Logic Rule 1
[72]	Logic Rule 2
[73]	Logic Rule 3
[74]	Logic Rule 4
[75]	Logic Rule 5
[80]	SL Digital Output A
[81]	SL Digital Output B
[82]	SL Digital Output C
[83]	SL Digital Output D
[84]	SL Digital Output E
[85]	SL Digital Output F
[160]	No Alarm
[161]	Running Reverse
[165]	Local Ref. Active
[166]	Remote Ref. Active
[167]	Start Cmd. Active
[168]	Drive in Hand Mode
[169]	Drive in Auto Mode
[180]	Clock Fault
[181]	Prev. Maintenance
[190]	No-Flow
[191]	Dry Pump
[192]	End of Curve
[193]	Sleep Mode
[194]	Broken Belt
[195]	Bypass Valve Control
[199]	Pipe Filling
[211]	Cascade Pump1
[212]	Cascade Pump2
[213]	Cascade Pump3
[223]	Alarm, Trip Locked
[224]	Bypass Mode Active

5-53 Term. 29 High Ref./Feedb. Value

Range:	Function:
100.000 N/ [-999999.999 - 999999.999 N/A] A*	Enter the high reference value [RPM] for the motor shaft speed and the high feedback value, see also par. 5-58 <i>Term. 33 High Ref./Feedb. Value.</i>

8.2.8 6- Analog In/Out**

Parameter group for configuration of the analog input and output.

6-00 Live Zero Timeout Time

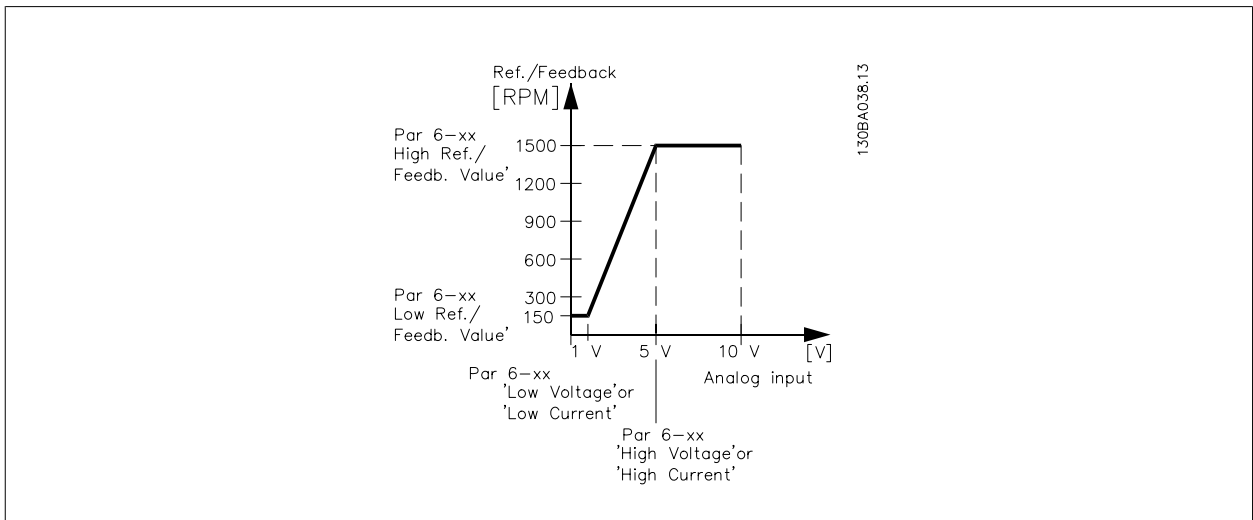
Range:	Function:
10 s* [1 - 99 s]	Enter the Live Zero Time-out time period. Live Zero Time-out Time is active for analog inputs, i.e. terminal 53 or terminal 54, used as reference or feedback sources. If the reference signal value associated with the selected current input falls below 50% of the value set in par. 6-10 <i>Terminal 53 Low Voltage</i> , par. 6-12 <i>Terminal 53 Low Current</i> , par. 6-20 <i>Terminal 54 Low Voltage</i> or par. 6-22 <i>Terminal 54 Low Current</i> for a time period longer than the time set in par. 6-00 <i>Live Zero Timeout Time</i> , the function selected in par. 6-01 <i>Live Zero Timeout Function</i> will be activated.

6-01 Live Zero Timeout Function

Option:	Function:
	<p>Select the time-out function. The function set in par. 6-01 <i>Live Zero Timeout Function</i> will be activated if the input signal on terminal 53 or 54 is below 50% of the value in par. 6-10 <i>Terminal 53 Low Voltage</i>, par. 6-12 <i>Terminal 53 Low Current</i>, par. 6-20 <i>Terminal 54 Low Voltage</i> or par. 6-22 <i>Terminal 54 Low Current</i> for a time period defined in par. 6-00 <i>Live Zero Timeout Time</i>. If several time-outs occur simultaneously, the frequency converter prioritises the time-out functions as follows:</p> <ol style="list-style-type: none"> 1. par. 6-01 <i>Live Zero Timeout Function</i> 2. par. 8-04 <i>Control Timeout Function</i> <p>The output frequency of the frequency converter can be:</p> <ul style="list-style-type: none"> • [1] frozen at the present value • [2] overruled to stop • [3] overruled to jog speed • [4] overruled to max. speed • [5] overruled to stop with subsequent trip

[0] *	Off
[1]	Freeze output
[2]	Stop
[3]	Jogging
[4]	Max. speed
[5]	Stop and trip

8



6-10 Terminal 53 Low Voltage

Range:

0.07 V* [0.00 - par. 6-11 V]

Function:

Enter the low voltage value. This analog input scaling value should correspond to the low reference/feedback value set in par. 6-14 *Terminal 53 Low Ref./Feedb. Value*.

6-11 Terminal 53 High Voltage

Range:

10.00 V* [par. 6-10 - 10.00 V]

Function:

Enter the high voltage value. This analog input scaling value should correspond to the high reference/feedback value set in par. 6-15 *Terminal 53 High Ref./Feedb. Value*.

6-14 Terminal 53 Low Ref./Feedb. Value

Range:

0.000 N/A* [-999999.999 - 999999.999 N/A]

Function:

Enter the analog input scaling value that corresponds to the low voltage/low current set in par. 6-10 *Terminal 53 Low Voltage* and par. 6-12 *Terminal 53 Low Current*.

6-15 Terminal 53 High Ref./Feedb. Value

Range:

50.000 N/A* [-999999.999 - 999999.999 N/A]

Function:

Enter the analog input scaling value that corresponds to the high voltage/high current value set in par. 6-11 *Terminal 53 High Voltage* and par. 6-13 *Terminal 53 High Current*.

6-20 Terminal 54 Low Voltage

Range:

0.07 V* [0.00 - par. 6-21 V]

Function:

Enter the low voltage value. This analog input scaling value should correspond to the low reference/feedback value, set in par. 6-24 *Terminal 54 Low Ref./Feedb. Value*.

6-21 Terminal 54 High Voltage

Range:

10.00 V* [par. 6-20 - 10.00 V]

Function:

Enter the high voltage value. This analog input scaling value should correspond to the high reference/feedback value set in par. 6-25 *Terminal 54 High Ref./Feedb. Value*.

6-24 Terminal 54 Low Ref./Feedb. Value

Range:

0.000 N/A* [-999999.999 - 999999.999 N/A]

Function:

Enter the analog input scaling value that corresponds to the low voltage/low current value set in par. 6-20 *Terminal 54 Low Voltage* and par. 6-22 *Terminal 54 Low Current*.

6-25 Terminal 54 High Ref./Feedb. Value

Range:	Function:
100.000 N/ [-999999.999 - 999999.999 N/A] A*	Enter the analog input scaling value that corresponds to the high voltage/high current value set in par. 6-21 <i>Terminal 54 High Voltage</i> and par. 6-23 <i>Terminal 54 High Current</i> .

6-50 Terminal 42 Output

Option:	Function:
	Select the function of Terminal 42 as an analog current output. A motor current of 20 mA corresponds to I_{max} .

[0] *	No operation	
[100]	Output freq. 0-100	: 0 - 100 Hz, (0-20 mA)
[101]	Reference Min-Max	: Minimum reference - Maximum reference, (0-20 mA)
[102]	Feedback +-200%	: -200% to +200% of par. 20-14, (0-20 mA)
[103]	Motor cur. 0-I _{max}	: 0 - Inverter Max. Current (par. 16-37), (0-20 mA)
[104]	Torque 0-Tlim	: 0 - Torque limit (par. 4-16), (0-20 mA)
[105]	Torque 0-Tnom	: 0 - Motor rated torque, (0-20 mA)
[106]	Power 0-Pnom	: 0 - Motor rated power, (0-20 mA)
[107] *	Speed 0-HighLim	: 0 - Speed High Limit (par. 4-13 and par. 4-14), (0-20 mA)
[113]	Ext. Closed Loop 1	: 0 - 100%, (0-20 mA)
[114]	Ext. Closed Loop 2	: 0 - 100%, (0-20 mA)
[115]	Ext. Closed Loop 3	: 0 - 100%, (0-20 mA)
[130]	Out frq 0-100 4-20mA	: 0 - 100 Hz
[131]	Reference 4-20mA	: Minimum Reference - Maximum Reference
[132]	Feedback 4-20mA	: -200% to +200% of par. 20-14 <i>Maximum Reference/Feedb.</i>
[133]	Motor cur. 4-20mA	: 0 - Inverter Max. Current (par. 16-37 <i>Inv. Max. Current</i>)
[134]	Torq.0-lim 4-20 mA	: 0 - Torque limit (par. 4-16)
[135]	Torq.0-nom 4-20mA	: 0 - Motor rated torque
[136]	Power 4-20mA	: 0 - Motor rated power
[137]	Speed 4-20mA	: 0 - Speed High Limit (4-13 and 4-14)
[139]	Bus ctrl.	: 0 - 100%, (0-20 mA)
[140]	Bus ctrl. 4-20 mA	: 0 - 100%
[141]	Bus ctrl t.o.	: 0 - 100%, (0-20 mA)
[142]	Bus ctrl t.o. 4-20mA	: 0 - 100%
[143]	Ext. CL 1 4-20mA	: 0 - 100%
[144]	Ext. CL 2 4-20mA	: 0 - 100%
[145]	Ext. CL 3 4-20mA	: 0 - 100%

NB!
 Values for setting the Minimum Reference is found in open loop par. 3-02 *Minimum Reference* and for closed loop par. 20-13 *Minimum Reference/Feedb.* - values for maximum reference for open loop is found in par. 3-03 *Maximum Reference* and for closed loop par. 20-14 *Maximum Reference/Feedb.*

6-51 Terminal 42 Output Min Scale

Range:

0.00 %* [0.00 - 200.00 %]

Function:

Scale for the minimum output (0 or 4 mA) of the analogue signal at terminal 42.
 Set the value to be the **percentage** of the full range of the variable selected in par. 6-50 *Terminal 42 Output*.

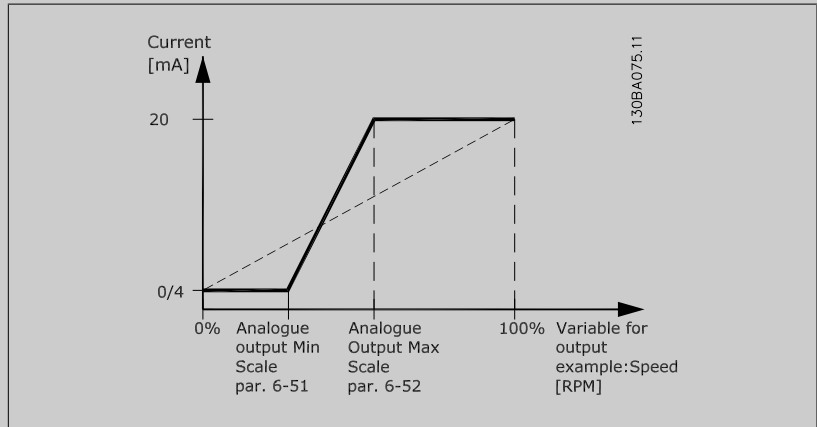
6-52 Terminal 42 Output Max Scale

Range:

100.00 %* [0.00 - 200.00 %]

Function:

Scale for the maximum output (20 mA) of the analog signal at terminal 42.
 Set the value to be the percentage of the full range of the variable selected in par. 6-50 *Terminal 42 Output*.



It is possible to get a value lower than 20 mA at full scale by programming values >100% by using a formula as follows:

$$20 \text{ mA} \mid \text{desired maximum current} \times 100 \%$$

$$\text{i.e. } 10 \text{ mA} : \frac{20 \text{ mA}}{10 \text{ mA}} \times 100 \% = 200 \%$$

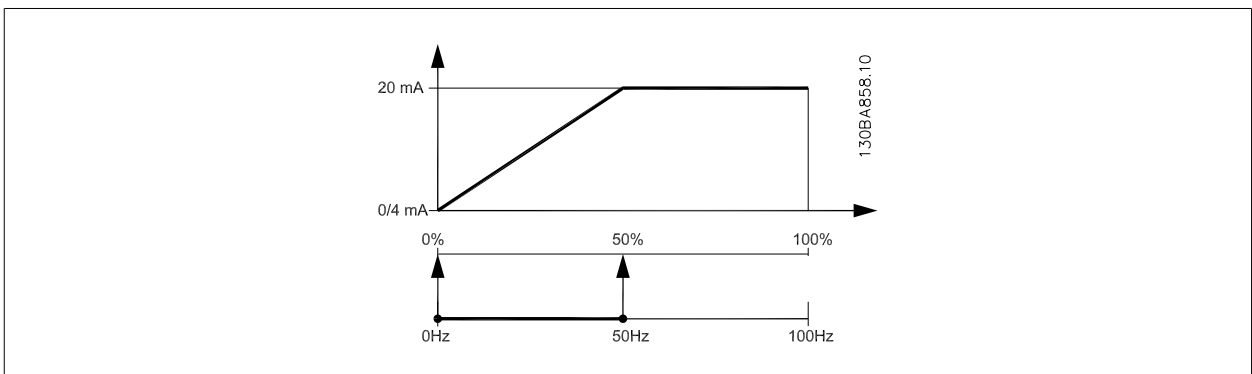
EXAMPLE 1:

Variable value= OUTPUT FREQUENCY, range = 0-100 Hz

Range needed for output = 0-50 Hz

Output signal 0 or 4 mA is needed at 0 Hz (0% of range) - set par. 6-51 *Terminal 42 Output Min Scale* to 0%

Output signal 20 mA is needed at 50 Hz (50% of range) - set par. 6-52 *Terminal 42 Output Max Scale* to 50%



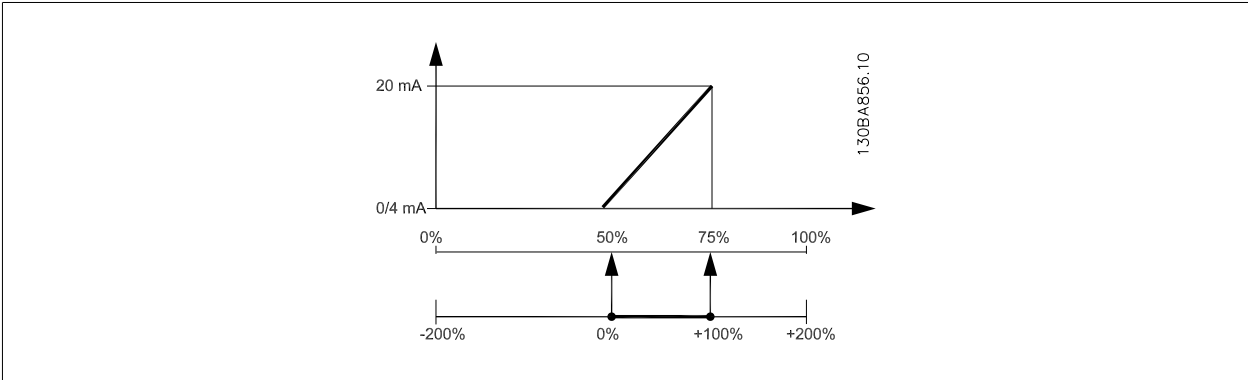
EXAMPLE 2:

Variable= FEEDBACK, range= -200% to +200%

Range needed for output= 0-100%

Output signal 0 or 4 mA is needed at 0% (50% of range) - set par. 6-51 Terminal 42 Output Min Scale to 50%

Output signal 20 mA is needed at 100% (75% of range) - set par. 6-52 Terminal 42 Output Max Scale to 75%



EXAMPLE 3:

Variable value= REFERENCE, range= Min ref - Max ref

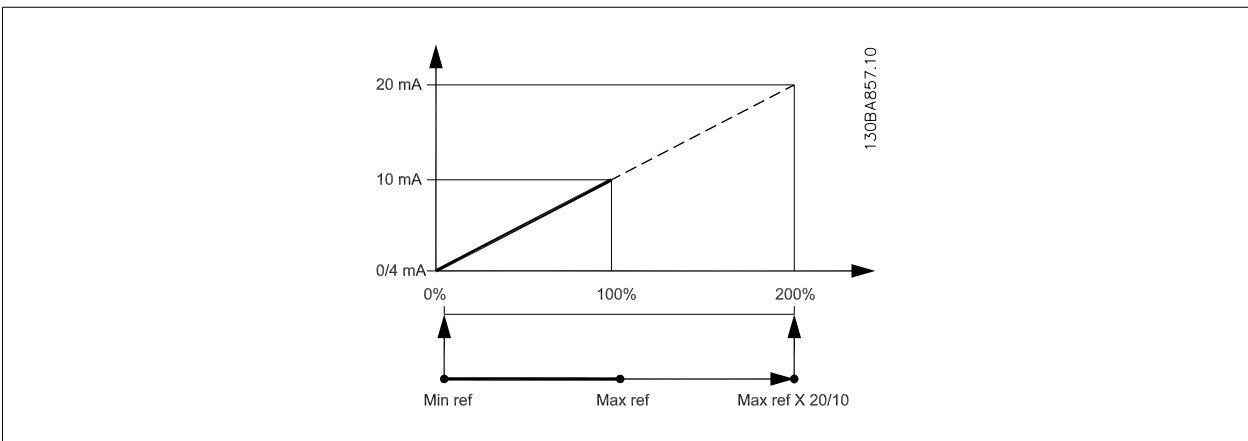
Range needed for output= Min ref (0%) - Max ref (100%), 0-10 mA

Output signal 0 or 4 mA is needed at Min ref - set par. 6-51 Terminal 42 Output Min Scale to 0%

Output signal 10 mA is needed at Max ref (100% of range) - set par. 6-52 Terminal 42 Output Max Scale to 200%

(20 mA / 10 mA x 100%=200%).

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8.2.9 Drive Closed Loop, 20-**

This parameter group is used for configuring the closed loop PID Controller, that controls the output frequency of the frequency converter.

20-12 Reference/Feedback Unit

Option:

Function:

[0] None

[1] *

[5] PPM

[10] 1/min

[11] RPM

[12] Pulse/s

[20] l/s

[21] l/min

[22]	l/h
[23]	m ³ /s
[24]	m ³ /min
[25]	m ³ /h
[30]	kg/s
[31]	kg/min
[32]	kg/h
[33]	t/min
[34]	t/h
[40]	m/s
[41]	m/min
[45]	m
[60]	°C
[70]	mbar
[71]	bar
[72]	Pa
[73]	kPa
[74]	m WG
[75]	mm Hg
[80]	kW
[120]	GPM
[121]	gal/s
[122]	gal/min
[123]	gal/h
[124]	CFM
[125]	ft ³ /s
[126]	ft ³ /min
[127]	ft ³ /h
[130]	lb/s
[131]	lb/min
[132]	lb/h
[140]	ft/s
[141]	ft/min
[145]	ft
[160]	°F
[170]	psi
[171]	lb/in ²
[172]	in WG
[173]	ft WG
[174]	in Hg
[180]	HP

This parameter determines the unit that is used for the setpoint reference and feedback that the PID Controller will use for controlling the output frequency of the frequency converter.

20-21 Setpoint 1

Range:

0.000 Proc- [-999999.999 - 999999.999 Proc-
 essCtrlU- essCtrlUnit]
 nit*

Function:

Setpoint 1 is used in Closed Loop Mode to enter a setpoint reference that is used by the frequency converter's PID Controller. See the description of par. 20-20 *Feedback Function*.



NB!

Setpoint reference entered here is added to any other references that are enabled (see par. group 3-1*).

20-81 PID Normal/Inverse Control

Option:

[0] * Normal
 [1] Inverse

Function:

Normal [0] causes the frequency converter's output frequency to decrease when the feedback is greater than the setpoint reference. This is common for pressure-controlled supply fan and pump applications.
Inverse [1] causes the frequency converter's output frequency to increase when the feedback is greater than the setpoint reference.

20-82 PID Start Speed [RPM]

Range:

0 RPM* [0 - par. 4-13 RPM]

Function:

When the frequency converter is first started, it initially ramps up to this output speed in Open Loop Mode, following the active Ramp Up Time. When the output speed programmed here is reached, the frequency converter will automatically switch to Closed Loop Mode and the PID Controller will begin to function. This is useful in applications in which the driven load must first quickly accelerate to a minimum speed when it is started.



NB!

This parameter will only be visible if par. 0-02 *Motor Speed Unit* is set to [0], RPM.

20-93 PID Proportional Gain

Range:

0.50 N/A* [0.00 - 10.00 N/A]

Function:

If (Error x Gain) jumps with a value equal to what is set in par. 20-14 *Maximum Reference/Feedb*, the PID controller will try to change the output speed equal to what is set in par. 4-13 *Motor Speed High Limit [RPM]*/par. 4-14 *Motor Speed High Limit [Hz]* but in practice of course limited by this setting. The proportional band (error causing output to change from 0-100%) can be calculated by means of the formula:

$$\left(\frac{1}{\text{Proportional Gain}} \right) \times (\text{Max Reference})$$

NB!

Always set the desired for par. 20-14 *Maximum Reference/Feedb* before setting the values for the PID controller in par. group 20-9*.

20-94 PID Integral Time

Range:

20.00 s* [0.01 - 10000.00 s]

Function:

Over time, the integrator accumulates a contribution to the output from the PID controller as long as there is a deviation between the Reference/Setpoint and feedback signals. The contribution is proportional to the size of the deviation. This ensures that the deviation (error) approaches zero. Quick response on any deviation is obtained when the integral time is set to a low value. Setting it too low, however, may cause the control to become unstable.

The value set, is the time needed for the integrator to add the same contribution as the proportional part for a certain deviation.

If the value is set to 10,000, the controller will act as a pure proportional controller with a P-band based on the value set in par. 20-93 *PID Proportional Gain*. When no deviation is present, the output from the proportional controller will be 0.

8.2.10 22-** Miscellaneous

This group contains parameters used for monitoring water/ wastewater applications.

22-20 Low Power Auto Set-up


Option:

[0] * Off
 [1] Enabled


Function:

When set for *Enabled*, an auto set up sequence is activated, automatically setting speed to approx. 50 and 85% of rated motor speed (par. 4-13 *Motor Speed High Limit [RPM]*, par. 4-14 *Motor Speed High Limit [Hz]*). At those two speeds, the power consumption is automatically measured and stored. Before enabling Auto Set Up:


1. Close valve(s) in order to create a no flow condition
2. The frequency converter must be set for Open Loop (par. 1-00 *Configuration Mode*). Note that it is important also to set par. 1-03 *Torque Characteristics*.



NB!
Auto Set Up must be done when the system has reached normal operating temperature!



NB!
It is important that the par. 4-13 *Motor Speed High Limit [RPM]* or par. 4-14 *Motor Speed High Limit [Hz]* is set to the max. operational speed of the motor!
It is important to do the Auto Set-up before configuring the integrated PI Controller as settings will be reset when changing from Closed to Open Loop in par. 1-00 *Configuration Mode*.



NB!
Carry out the tuning with the same settings in par. 1-03 *Torque Characteristics*, as for operation after the tuning.

22-21 Low Power Detection

Option:

[0] * Disabled
 [1] Enabled

Function:

If selecting Enabled, the Low Power Detection commissioning must be carried out in order to set the parameters in group 22-3* for proper operation!

22-22 Low Speed Detection		
Option:		Function:
[0] *	Disabled	
[1]	Enabled	Select Enabled for detecting when the motor operates with a speed as set in par. 4-11 <i>Motor Speed Low Limit [RPM]</i> or par. 4-12 <i>Motor Speed Low Limit [Hz]</i> .
22-23 No-Flow Function		
Option:		Function:
		Common actions for Low Power Detection and Low Speed Detection (Individual selections not possible).
[0] *	Off	
[1]	Sleep Mode	
[2]	Warning	Messages in the Local Control Panel display (if mounted) and/or signal via a relay or a digital output.
[3]	Alarm	The frequency converter trips and motor stays stopped until reset.
22-24 No-Flow Delay		
Range:		Function:
10 s*	[1 - 600 s]	Set the time Low Power/Low Speed must stay detected to activate signal for actions. If detection disappears before run out of the timer, the timer will be reset.
22-26 Dry Pump Function		
Option:		Function:
		<i>Low Power Detection</i> must be Enabled (par. 22-21 <i>Low Power Detection</i>) and commissioned (using either parameter group 22-3*, <i>No Flow Power Tuning</i> , or par. 22-20 <i>Low Power Auto Set-up</i>) in order to use Dry Pump Detection.
[0] *	Off	
[1]	Warning	Messages in the Local Control Panel display (if mounted) and/or signal via a relay or a digital output.
[2]	Alarm	The frequency converter trips and motor stays stopped until reset.
22-27 Dry Pump Delay		
Range:		Function:
10 s*	[0 - 600 s]	Defines for how long the Dry Pump condition must be active before activating Warning or Alarm
22-30 No-Flow Power		
Range:		Function:
0.00 kW*	[0.00 - 0.00 kW]	Read out of calculated No Flow power at actual speed. If power drops to the display value the frequency converter will consider the condition as a No Flow situation.
22-31 Power Correction Factor		
Range:		Function:
100 %*	[1 - 400 %]	Make corrections to the calculated power at par. 22-30 <i>No-Flow Power</i> . If No Flow is detected, when it should not be detected, the setting should be decreased. However, if No Flow is not detected, when it should be detected, the setting should be increased to above 100%.
22-32 Low Speed [RPM]		
Range:		Function:
0 RPM*	[0 - par. 22-36 RPM]	To be used if par. 0-02 <i>Motor Speed Unit</i> has been set for RPM (parameter not visible if Hz selected). Set used speed for the 50% level. This function is used for storing values needed to tune No Flow Detection.

22-33 Low Speed [Hz]

Range:

0 Hz* [0.0 - par. 22-37 Hz]

Function:

To be used if par. 0-02 *Motor Speed Unit* has been set for Hz (parameter not visible if RPM selected).
 Set used speed for the 50% level.
 The function is used for storing values needed to tune No Flow Detection.

22-34 Low Speed Power [kW]

Range:

0 kW* [0.00 - 0.00 kW]

Function:

To be used if par. 0-03 *Regional Settings* has been set for International (parameter not visible if North America selected).
 Set power consumption at 50% speed level.
 This function is used for storing values needed to tune No Flow Detection.

22-35 Low Speed Power [HP]

Range:

0 hp* [0.00 - 0.00 hp]

Function:

To be used if par. 0-03 *Regional Settings* has been set for North America (parameter not visible if International selected).
 Set power consumption at 50% speed level.
 This function is used for storing values needed to tune No Flow Detection.

22-36 High Speed [RPM]

Range:

0 RPM* [0 - par. 4-13 RPM]

Function:

To be used if par. 0-02 *Motor Speed Unit* has been set for RPM (parameter not visible if Hz selected).
 Set used speed for the 85% level.
 The function is used for storing values needed to tune No Flow Detection.

22-37 High Speed [Hz]

Range:

0.0 Hz* [0.0 - par. 4-14 Hz]

Function:

To be used if par. 0-02 *Motor Speed Unit* has been set for Hz (parameter not visible if RPM selected).
 Set used speed for the 85% level.
 The function is used for storing values needed to tune No Flow Detection.

22-38 High Speed Power [kW]

Range:

0 kW* [0.00 - 0.00 kW]

Function:

To be used if par. 0-03 *Regional Settings* has been set for International (parameter not visible if North America selected).
 Set power consumption at 85% speed level.
 This function is used for storing values needed to tune No Flow Detection.

22-39 High Speed Power [HP]

Range:

0 hp* [0.00 - 0.00 hp]

Function:

To be used if par. 0-03 *Regional Settings* has been set for North America (parameter not visible if International selected).
 Set power consumption at 85% speed level.
 This function is used for storing values needed to tune No Flow Detection.

22-40 Minimum Run Time

Range:

10 s* [0 - 600 s]

Function:

Set the desired minimum running time for the motor after a start command (digital input or Bus) before entering Sleep Mode.

22-41 Minimum Sleep Time

Range: 10 s* [0 - 600 s] **Function:** Set the desired Minimum Time for staying in Sleep Mode. This will override any wake up conditions.

22-42 Wake-up Speed [RPM]


Range: 0 RPM* [par. 4-11 - par. 4-13 RPM] **Function:** To be used if par. 0-02 *Motor Speed Unit* has been set for RPM (parameter not visible if Hz selected). Only to be used if par. 1-00 *Configuration Mode* is set for Open Loop and speed reference is applied by an external controller. Set the reference speed at which the Sleep Mode should be cancelled.

22-43 Wake-up Speed [Hz]

Range: 0 Hz* [par. 4-12 - par. 4-14 Hz] **Function:** To be used if par. 0-02 *Motor Speed Unit*, has been set for Hz (parameter not visible if RPM selected). Only to be used if par. 1-00 *Configuration Mode*, is set for Open Loop and speed reference is applied by an external controller controlling the pressure. Set the reference speed at which the Sleep Mode should be cancelled.

22-44 Wake-up Ref./FB Difference

Range: 10%* [0-100%] **Function:** Only to be used if par. 1-00, *Configuration Mode*, is set for Closed Loop and the integrated PI controller is used for controlling the pressure. Set the pressure drop allowed in percentage of set point for the pressure (Pset) before cancelling the Sleep Mode.

 **NB!** If used in application where the integrated PI controller is set for inverse control in par. 20-71, *PID, Normal/Inverse Control*, the value set in par. 22-44 will automatically be added.

22-45 Setpoint Boost

Range: 0 %* [-100 - 100 %] **Function:** Only to be used if par. 1-00 *Configuration Mode*, is set for Closed Loop and the integrated PI controller is used. In systems with e.g. constant pressure control, it is advantageous to increase the system pressure before the motor is stopped. This will extend the time in which the motor is stopped and help to avoid frequent start/stop. Set the desired over pressure/temperature in percentage of set point for the pressure (Pset)/temperature before entering the Sleep Mode. If setting for 5%, the boost pressure will be Pset*1.05. The negative values can be used for e.g. cooling tower control where a negative change is needed.

22-46 Maximum Boost Time

Range: 60 s* [0 - 600 s] **Function:** Only to be used if par. 1-00 *Configuration Mode* is set for Closed Loop and the integrated PI controller is used for controlling the pressure. Set the maximum time for which boost mode will be allowed. If the set time is exceeded, Sleep Mode will be entered, not waiting for the set boost pressure to be reached.



22-50 End of Curve Function

Option:

Function:

[0] *	Off	End of Curve monitoring not active.
[1]	Warning	A warning is issued in the display [W94].
[2]	Alarm	An alarm is issued and the frequency converter trips. A message [A94] appears in the display.



NB!

Automatic restart will reset the alarm and start the system again.

22-51 End of Curve Delay

Range:

Function:

10 s*	[0 - 600 s]	When an End of Curve condition is detected, a timer is activated. When the time set in this parameter expires, and the End of Curve condition has been steady in the entire period, the function set in par. 22-50 <i>End of Curve Function</i> will be activated. If the condition disappears before the timer expires, the timer will be reset.
-------	-------------	---

22-80 Flow Compensation

Option:

Function:

[0] *	Disabled	[0] <i>Disabled</i> : Set-Point compensation not active.
[1]	Enabled	[1] <i>Enabled</i> : Set-Point compensation is active. Enabling this parameter allows the Flow Compensated Setpoint operation.

22-81 Square-linear Curve Approximation

Range:

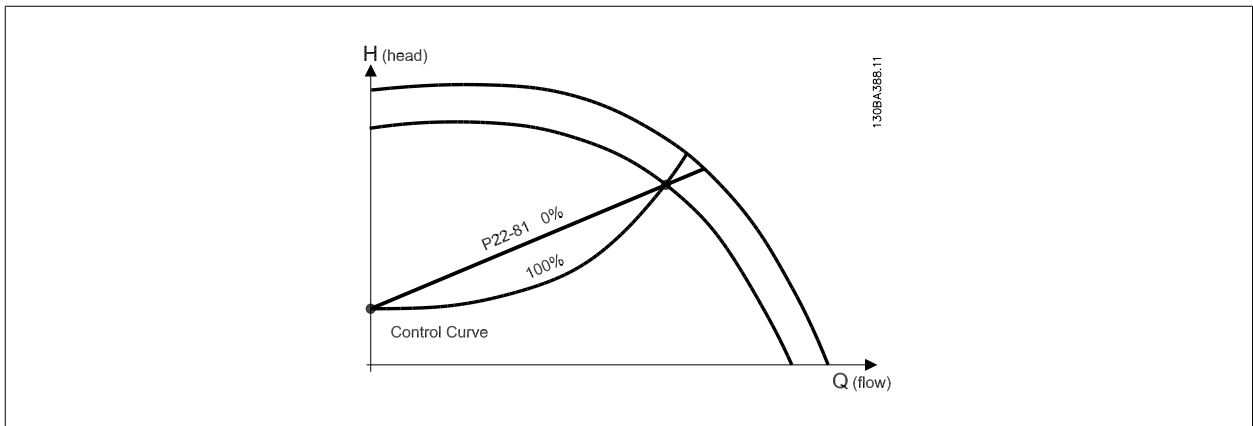
Function:

100 %*	[0 - 100 %]	Example 1: Adjustment of this parameter allows the shape of the control curve to be adjusted. 0 = Linear 100% = Ideal shape (theoretical).
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NB!

Please note: Not visible when running in cascade.

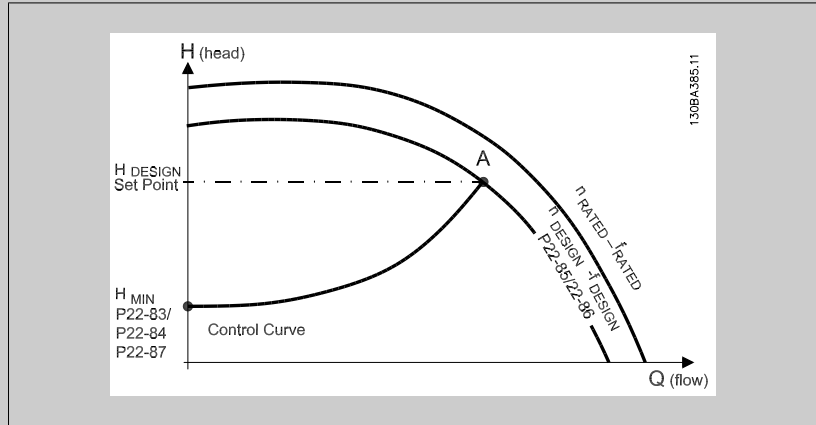


22-82 Work Point Calculation

Option:

Function:

Example 1: Speed at System Design Working Point is known:

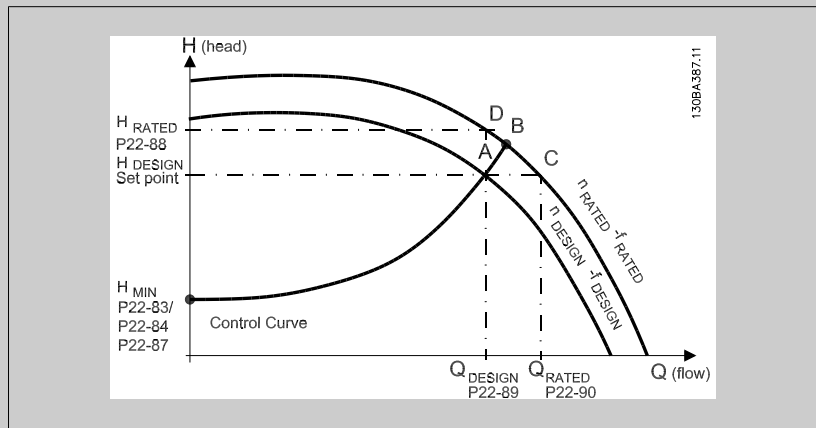


From the data sheet showing characteristics for the specific equipment at different speeds, simply reading across from the H_{DESIGN} point and the Q_{DESIGN} point allows us to find point A, which is the System Design Working Point. The pump characteristics at this point should be identified and the associated speed programmed. Closing the valves and adjusting the speed until H_{MIN} has been achieved allows the speed at the no flow point to be identified.

Adjustment of par. 22-81 *Square-linear Curve Approximation* then allows the shape of the control curve to be adjusted infinitely.

Example 2:

Speed at System Design Working Point is not known: Where the Speed at System Design Working Point is unknown, another reference point on the control curve needs to be determined by means of the data sheet. By looking at the curve for the rated speed and plotting the design pressure (H_{DESIGN} , Point C) the flow at that pressure Q_{RATED} can be determined. Similarly, by plotting the design flow (Q_{DESIGN} , Point D), the pressure H_D at that flow can be determined. Knowing these two points on the pump curve, along with H_{MIN} as described above, allows the frequency converter to calculate the reference point B and thus to plot the control curve which will also include the System design Working Point A.



[0] * Disabled *Disabled [0]:* Work Point Calculation not active. To be used if speed at design point is known (see table above).

[1] Enabled *Enabled [1]:* Work Point Calculation is active. Enabling this parameter allows the calculation of the unknown System Design Working Point at 50/60 Hz speed, from the input data set in par. 22-83 *Speed at No-Flow [RPM]* par. 22-84 *Speed at No-Flow [Hz]*, par. 22-87 *Pressure at No-Flow Speed*, par. 22-88 *Pressure at Rated Speed*, par. 22-89 *Flow at Design Point* and par. 22-90 *Flow at Rated Speed*.

22-83 Speed at No-Flow [RPM]

Range:

300. RPM* [0 - par. 22-85 RPM]

Function:

Resolution 1 RPM.

The speed of the motor at which flow is zero and minimum pressure H_{MIN} is achieved should be entered here in RPM. Alternatively, the speed in Hz can be entered in par. 22-84 *Speed at No-Flow [Hz]*. If it has been decided to use RPM in par. 0-02 *Motor Speed Unit* then par. 22-85 *Speed at Design Point [RPM]* should also be used. Closing the valves and reducing the speed until minimum pressure H_{MIN} is achieved will determine this value.

22-84 Speed at No-Flow [Hz]

Range:

50.0 Hz* [0.0 - par. 22-86 Hz]

Function:

Resolution 0.033 Hz.

The speed of the motor at which flow has effectively stopped and minimum pressure H_{MIN} is achieved should be entered here in Hz. Alternatively, the speed in RPM can be entered in par. 22-83 *Speed at No-Flow [RPM]*. If it has been decided to use Hz in par. 0-02 *Motor Speed Unit* then par. 22-86 *Speed at Design Point [Hz]* should also be used. Closing the valves and reducing the speed until minimum pressure H_{MIN} is achieved will determine this value.

22-85 Speed at Design Point [RPM]

Range:

1500. RPM* [par. 22-83 - 60000. RPM]

Function:

Resolution 1 RPM.

Only visible when par. 22-82 *Work Point Calculation* is set to *Disable*. The speed of the motor at which the System Design Working Point is achieved should be entered here in RPM. Alternatively, the speed in Hz can be entered in par. 22-86 *Speed at Design Point [Hz]*. If it has been decided to use RPM in par. 0-02 *Motor Speed Unit* then par. 22-83 *Speed at No-Flow [RPM]* should also be used.

22-86 Speed at Design Point [Hz]

Range:

50/60.0 Hz* [par. 22-84 - par. 4-19 Hz]

Function:

Resolution 0.033 Hz.

Only visible when par. 22-82 *Work Point Calculation* is set to *Disable*. The speed of the motor at which the System Design Working Point is achieved should be entered here in Hz. Alternatively, the speed in RPM can be entered in par. 22-85 *Speed at Design Point [RPM]*. If it has been decided to use Hz in par. 0-02 *Motor Speed Unit*, then par. 22-83 *Speed at No-Flow [RPM]* should also be used.

22-87 Pressure at No-Flow Speed

Range:

0.000 N/A* [0.000 - par. 22-88 N/A]

Function:

Enter the pressure H_{MIN} corresponding to Speed at No Flow in Reference/Feedback Units.

22-88 Pressure at Rated Speed

Range:

999999.999 N/A* [par. 22-87 - 999999.999 N/A]

Function:

Enter the value corresponding to the Pressure at Rated Speed, in Reference/Feedback Units. This value can be defined using the pump datasheet.

22-90 Flow at Rated Speed

Range:

0.000 N/A* [0.000 - 999999.999 N/A]


Function:

Enter the value corresponding to Flow at Rated Speed. This value can be defined using the pump datasheet.


8.2.11 23-0* Timed Actions

Use *Timed Actions* for actions needing to be performed on a daily or weekly basis, e.g. different references for working hours / non-working hours. Up to 10 Timed Actions can be programmed in the frequency converter. The Timed Action number is selected from the list when entering parameter group 23-0* from the LCP. par. 23-00 *ON Time* – par. 23-04 *Occurrence* then refer to the selected Timed Action number. Each Timed Action is divided into an ON time and an OFF time, in which two different actions may be performed.

The actions programmed in Timed Actions are merged with corresponding actions from digital inputs, control work via bus and Smart Logic Controller, according to merge rules set up in 8-5*, Digital/Bus.



NB!
The clock (parameter group 0-7*) must be correctly programmed for Timed Actions to function correctly.



NB!
When mounting an Analog I/O MCB109 option card, a battery back up of the date and time is included.

NB!
The PC-based Configuration Tool MCT 10 comprise a special guide for easy programming of Timed Actions.

8

23-00 ON Time


Array [10]

Range:

0 N/A* [0 - 0 N/A]

Function:

Sets the ON time for the Timed Action.



NB!
The frequency converter has no back up of the clock function and the set date/ time will reset to default (2000-01-01 00:00) after a power down unless a Real Time Clock module with back up is installed. In par. 0-79 *Clock Fault* it is possible to program for a Warning in case clock has not been set properly, e.g. after a power down.

23-01 ON Action

Arra [10]

Option:

Function:

Select the action during ON Time. See par. 13-52 *SL Controller Action* for descriptions of the options.

- [0] * Disabled
- [1] No action
- [2] Select set-up 1
- [3] Select set-up 2
- [4] Select set-up 3
- [5] Select set-up 4
- [10] Select preset ref 0
- [11] Select preset ref 1
- [12] Select preset ref 2
- [13] Select preset ref 3
- [14] Select preset ref 4
- [15] Select preset ref 5

- [16] Select preset ref 6
- [17] Select preset ref 7
- [18] Select ramp 1
- [19] Select ramp 2
- [22] Run
- [23] Run reverse
- [24] Stop
- [26] DC Brake
- [27] Coast
- [28] Freeze output
- [29] Start timer 0
- [30] Start timer 1
- [31] Start timer 2
- [32] Set digital out A low
- [33] Set digital out B low
- [34] Set digital out C low
- [35] Set digital out D low
- [36] Set digital out E low
- [37] Set digital out F low
- [38] Set digital out A high
- [39] Set digital out B high
- [40] Set digital out C high
- [41] Set digital out D high
- [42] Set digital out E high
- [43] Set digital out F high
- [60] Reset Counter A
- [61] Reset Counter B
- [70] Start Timer 3
- [71] Start Timer 4
- [72] Start Timer 5
- [73] Start Timer 6
- [74] Start Timer 7

NB!

For choices [32] - [43], see also par. group 5-3*, *Digital Outputs* and 5-4*, *Relays*.

23-02 OFF Time

Array [10]

Range:

0 N/A* [0 - 0 N/A]

Function:

Sets the OFF time for the Timed Action.



NB!

The frequency converter has no back up of the clock function and the set date/time will reset to default (2000-01-01 00:00) after a power down unless a Real Time Clock module with back up is installed. In par. 0-79 *Clock Fault* it is possible to program for a Warning in case clock has not been set properly, e.g. after a power down.

23-03 OFF Action

Array [10]

Option:

Function:

Select the action during OFF Time. See par. 13-52 *SL Controller Action* for descriptions of the options.

[0] * Disabled

[1] No action

[2] Select set-up 1

[3] Select set-up 2

[4] Select set-up 3

[5] Select set-up 4

[10] Select preset ref 0

[11] Select preset ref 1

[12] Select preset ref 2

[13] Select preset ref 3

[14] Select preset ref 4

[15] Select preset ref 5

[16] Select preset ref 6

[17] Select preset ref 7

[18] Select ramp 1

[19] Select ramp 2

[22] Run

[23] Run reverse

[24] Stop

[26] DC Brake

[27] Coast

[28] Freeze output

[29] Start timer 0

[30] Start timer 1

[31] Start timer 2

[32] Set digital out A low

[33] Set digital out B low

[34] Set digital out C low

[35] Set digital out D low

[36] Set digital out E low

[37] Set digital out F low

[38] Set digital out A high

[39] Set digital out B high

[40] Set digital out C high

[41] Set digital out D high

[42] Set digital out E high

[43] Set digital out F high

[60] Reset Counter A

[61] Reset Counter B

[70] Start Timer 3

[71] Start Timer 4

[72] Start Timer 5

[73] Start Timer 6

[74] Start Timer 7

23-04 Occurrence

Array [10]

Option:

Function:

Select which day(s) the Timed Action applies to. Specify working/non-working days in par. 0-81 *Working Days*, par. 0-82 *Additional Working Days* and par. 0-83 *Additional Non-Working Days*.

[0] * All days

[1] Working days

[2] Non-working days

[3] Monday

[4] Tuesday

[5] Wednesday

[6] Thursday

[7] Friday

[8] Saturday

[9] Sunday

8.2.12 Water Application Functions, 29-**

The group contains parameters used for monitoring water / wastewater applications.

29-00 Pipe Fill Enable

Option:

Function:

[0] * Disabled

Select Enabled to fill pipes at a user specified rate.

[1] Enabled

Select Enabled to fill pipes with a user specified rate.

29-01 Pipe Fill Speed [RPM]

Range:

Function:

Speed Low [Speed Low Limit - Speed High Limit* it]

Set the filling speed for filling horizontal pipe systems. The speed can be selected in Hz or RPM depending on the choices made in par. 4-11 / par. 4-13 (RPM) or in par. 4-12 / par. 4-14 (Hz).

29-02 Pipe Fill Speed [Hz]

Range:

Function:

Motor [Speed Low Limit - Speed High Limit* it]
 Speed Low
 Limit*

Set the filling speed for filling horizontal pipe systems. The speed can be selected in Hz or RPM depending on the choices made in par. 4-11 / par. 4-13 (RPM) or in par. 4-12 / par. 4-14 (Hz).

29-03 Pipe Fill Time

Range:

Function:

0 s* [0 - 3600 s]

Set the specified time for pipe filling of horizontal pipe systems.

29-04 Pipe Fill Rate

Range:

Function:

0.001 units/ [0.001 – 999999.999 units/s]
 s*

Specifies the filling rate in units/second using the PI controller. Filling rate units are feedback units/second. This function is used for filling-up vertical pipe systems but will be active when the filling-time has expired, no matter what , until the pipe fill-set-point set in par. 29-05 is reached.

29-05 Filled Setpoint

Range:	Function:
0 s* [0 – 999999,999 s]	Specifies the Filled Set-point at which the Pipe Fill Function will be disabled and the PID controller will take control. This function can be used both for horizontal and vertical pipe systems.

8.3 Parameter Options

8.3.1 Default settings

Changes during operation:

"TRUE" means that the parameter can be changed while the frequency converter is in operation and "FALSE" means that the frequency converter must be stopped before a change can be made.

4-Set-up:

'All set-up': the parameter can be set individually in each of the four set-ups, i. e. one single parameter can have four different data values.

'1 set-up': data value will be the same in all set-ups.

SR:

Size related

N/A:

No default value available.

Conversion index:

This number refers to a conversion figure used when writing or reading by means of a frequency converter.

Conv. index	100	67	6	5	4	3	2	1	0	-1	-2	-3	-4	-5	-6
Conv. factor	1	1/60	1000000	100000	10000	1000	100	10	1	0.1	0.01	0.001	0.0001	0.00001	0.000001

Data type	Description	Type
2	Integer 8	Int8
3	Integer 16	Int16
4	Integer 32	Int32
5	Unsigned 8	UInt8
6	Unsigned 16	UInt16
7	Unsigned 32	UInt32
9	Visible String	VisStr
33	Normalized value 2 bytes	N2
35	Bit sequence of 16 boolean variables	V2
54	Time difference w/o date	TimD



8.3.2 Operation/Display 0--**

Par. No. #	Parameter description	Default value	4-set-up	Change during operation	Conversion index	Type
0-0* Basic Settings						
0-01	Language	[0] English	1 set-up	TRUE	-	Uint8
0-02	Motor Speed Unit	[0] RPM	2 set-ups	FALSE	-	Uint8
0-03	Regional Settings	[0] International	2 set-ups	FALSE	-	Uint8
0-04	Operating State at Power-up	[0] Resume	All set-ups	TRUE	-	Uint8
0-05	Local Mode Unit	[0] As Motor Speed Unit	2 set-ups	FALSE	-	Uint8
0-1* Set-up Operations						
0-10	Active Set-up	[1] Set-up 1	1 set-up	TRUE	-	Uint8
0-11	Programming Set-up	[9] Active Set-up	All set-ups	TRUE	-	Uint8
0-12	This Set-up Linked to	[0] Not linked	All set-ups	FALSE	-	Uint8
0-13	Readout: Linked Set-ups	0 N/A	All set-ups	FALSE	0	Uint16
0-14	Readout: Prog. Set-ups / Channel	0 N/A	All set-ups	TRUE	0	Int32
0-2* LCP Display						
0-20	Display Line 1.1 Small	1601	All set-ups	TRUE	-	Uint16
0-21	Display Line 1.2 Small	1662	All set-ups	TRUE	-	Uint16
0-22	Display Line 1.3 Small	1614	All set-ups	TRUE	-	Uint16
0-23	Display Line 2 Large	1613	All set-ups	TRUE	-	Uint16
0-24	Display Line 3 Large	1652	All set-ups	TRUE	-	Uint16
0-25	My Personal Menu	SR	1 set-up	TRUE	0	Uint16
0-3* LCP Custom Readout						
0-30	Custom Readout Unit	[1] %	All set-ups	TRUE	-	Uint8
0-31	Custom Readout Min Value	SR	All set-ups	TRUE	-2	Int32
0-32	Custom Readout Max Value	100.00 CustomReadoutUnit	All set-ups	TRUE	-2	Int32
0-37	Display Text 1	0 N/A	1 set-up	TRUE	0	VisStr[25]
0-38	Display Text 2	0 N/A	1 set-up	TRUE	0	VisStr[25]
0-39	Display Text 3	0 N/A	1 set-up	TRUE	0	VisStr[25]
0-4* LCP Keypad						
0-40	[Hand on] Key on LCP	[1] Enabled	All set-ups	TRUE	-	Uint8
0-41	[Off] Key on LCP	[1] Enabled	All set-ups	TRUE	-	Uint8
0-42	[Auto on] Key on LCP	[1] Enabled	All set-ups	TRUE	-	Uint8
0-43	[Reset] Key on LCP	[1] Enabled	All set-ups	TRUE	-	Uint8
0-44	[Off/Reset] Key on LCP	[1] Enabled	All set-ups	TRUE	-	Uint8
0-45	[Drive Bypass] Key on LCP	[1] Enabled	All set-ups	TRUE	-	Uint8
0-5* Copy/Save						
0-50	LCP Copy	[0] No copy	All set-ups	FALSE	-	Uint8
0-51	Set-up Copy	[0] No copy	All set-ups	FALSE	-	Uint8



Par. No. #	Parameter description	Default value	4-set-up	Change during operation	Conversion Index	Type
0-6* Password						
0-60	Main Menu Password	100 N/A	1 set-up	TRUE	0	Uint16
0-61	Access to Main Menu w/o Password	[0] Full access	1 set-up	TRUE	-	Uint8
0-65	Personal Menu Password	200 N/A	1 set-up	TRUE	0	Uint16
0-66	Access to Personal Menu w/o Password	[0] Full access	1 set-up	TRUE	-	Uint8
0-7* Clock Settings						
0-70	Date and Time	SR	All set-ups	TRUE	0	TimeOfDay
0-71	Date Format	[0] YYYY-MM-DD	1 set-up	TRUE	-	Uint8
0-72	Time Format	[0] 24 h	1 set-up	TRUE	-	Uint8
0-74	DST/Summertime	[0] Off	1 set-up	TRUE	-	Uint8
0-76	DST/Summertime Start	SR	1 set-up	TRUE	0	TimeOfDay
0-77	DST/Summertime End	SR	1 set-up	TRUE	0	TimeOfDay
0-79	Clock Fault	null	1 set-up	TRUE	-	Uint8
0-81	Working Days	null	1 set-up	TRUE	-	Uint8
0-82	Additional Working Days	SR	1 set-up	TRUE	0	TimeOfDay
0-83	Additional Non-Working Days	SR	1 set-up	TRUE	0	TimeOfDay
0-89	Date and Time Readout	0 N/A	All set-ups	TRUE	0	VisStr[25]

8.3.3 Load/Motor 1--**

Par. No. #	Parameter description	Default value	4-set-up	Change during operation	Conversion index	Type
1-0* General Settings						
1-00	Configuration Mode	null	All set-ups	TRUE	-	Uint8
1-01	Motor Control Principle	null	All set-ups	FALSE	-	Uint8
1-03	Torque Characteristics	[3] Auto Energy Optim. VT	All set-ups	TRUE	-	Uint8
1-1* Motor Selection						
1-10	Motor Construction	[0] Asynchron	All set-ups	FALSE	-	Uint8
1-2* Motor Data						
1-20	Motor Power [kW]	SR	All set-ups	FALSE	1	Uint32
1-21	Motor Power [HP]	SR	All set-ups	FALSE	-2	Uint32
1-22	Motor Voltage	SR	All set-ups	FALSE	0	Uint16
1-23	Motor Frequency	SR	All set-ups	FALSE	0	Uint16
1-24	Motor Current	SR	All set-ups	FALSE	-2	Uint32
1-25	Motor Nominal Speed	SR	All set-ups	FALSE	67	Uint16
1-28	Motor Rotation Check	[0] Off	All set-ups	FALSE	-	Uint8
1-29	Automatic Motor Adaptation (AMA)	[0] Off	All set-ups	FALSE	-	Uint8
1-3* Adv. Motor Data						
1-30	Stator Resistance (Rs)	SR	All set-ups	FALSE	-4	Uint32
1-31	Rotor Resistance (Rr)	SR	All set-ups	FALSE	-4	Uint32
1-32	Stator Reactance (Xs)	SR	All set-ups	FALSE	-4	Uint32
1-33	Stator Leakage Reactance (X1)	SR	All set-ups	FALSE	-4	Uint32
1-34	Rotor Leakage Reactance (X2)	SR	All set-ups	FALSE	-4	Uint32
1-35	Main Reactance (Xh)	SR	All set-ups	FALSE	-4	Uint32
1-36	Iron Loss Resistance (Rfe)	SR	All set-ups	FALSE	-3	Uint32
1-39	Motor Poles	SR	All set-ups	FALSE	0	Uint8
1-5* Load Indep. Setting						
1-50	Motor Magnetisation at Zero Speed	100 %	All set-ups	TRUE	0	Uint16
1-51	Min Speed Normal Magnetising [RPM]	SR	All set-ups	TRUE	67	Uint16
1-52	Min Speed Normal Magnetising [Hz]	SR	All set-ups	TRUE	-1	Uint16
1-55	V/f Characteristic - V	SR	All set-ups	TRUE	-1	Uint16
1-56	V/f Characteristic - f	SR	All set-ups	TRUE	-1	Uint16
1-6* Load Depen. Setting						
1-60	Low Speed Load Compensation	100 %	All set-ups	TRUE	0	Int16
1-61	High Speed Load Compensation	100 %	All set-ups	TRUE	0	Int16
1-62	Slip Compensation	0 %	All set-ups	TRUE	0	Int16
1-63	Slip Compensation Time Constant	SR	All set-ups	TRUE	-2	Uint16
1-64	Resonance Dampening	100 %	All set-ups	TRUE	0	Uint16
1-65	Resonance Dampening Time Constant	5 ms	All set-ups	TRUE	-3	Uint8
1-7* Start Adjustments						
1-71	Start Delay	0.0 s	All set-ups	TRUE	-1	Uint16
1-73	Flying Start	[0] Disabled	All set-ups	FALSE	-	Uint8
1-74	Start Speed [RPM]	SR	All set-ups	TRUE	67	Uint16
1-75	Start Speed [Hz]	SR	All set-ups	TRUE	-1	Uint16
1-76	Start Current	0.00 A	All set-ups	TRUE	-2	Uint32

Par. No. #	Parameter description	Default value	4-set-up	Change during operation	Conversion index	Type
1-8* Stop Adjustments						
1-80	Function at Stop	[0] Coast	All set-ups	TRUE	-	Uint8
1-81	Min Speed for Function at Stop [RPM]	SR	All set-ups	TRUE	67	Uint16
1-82	Min Speed for Function at Stop [Hz]	SR	All set-ups	TRUE	-1	Uint16
1-86	Trip Speed Low [RPM]	0 RPM	All set-ups	TRUE	67	Uint16
1-87	Trip Speed Low [Hz]	0 Hz	All set-ups	TRUE	-1	Uint16
1-9* Motor Temperature						
1-90	Motor Thermal Protection	[4] ETR trip 1	All set-ups	TRUE	-	Uint8
1-91	Motor External Fan	[0] No	All set-ups	TRUE	-	Uint16
1-93	Thermistor Source	[0] None	All set-ups	TRUE	-	Uint8

8.3.4 Brakes 2-**

Par. No. #	Parameter description	Default value	4-set-up	Change during operation	Conversion index	Type
2-0* DC-Brake						
2-00	DC Hold/Preheat Current	50 %	All set-ups	TRUE	0	Uint8
2-01	DC Brake Current	50 %	All set-ups	TRUE	0	Uint16
2-02	DC Braking Time	10.0 s	All set-ups	TRUE	-1	Uint16
2-03	DC Brake Cut In Speed [RPM]	SR	All set-ups	TRUE	67	Uint16
2-04	DC Brake Cut In Speed [Hz]	SR	All set-ups	TRUE	-1	Uint16
2-1* Brake Energy Funct.						
2-10	Brake Function	[0] Off	All set-ups	TRUE	-	Uint8
2-11	Brake Resistor (ohm)	SR	All set-ups	TRUE	0	Uint16
2-12	Brake Power Limit (KW)	SR	All set-ups	TRUE	0	Uint32
2-13	Brake Power Monitoring	[0] Off	All set-ups	TRUE	-	Uint8
2-15	Brake Check	[0] Off	All set-ups	TRUE	-	Uint8
2-16	AC brake Max. Current	100.0 %	All set-ups	TRUE	-1	Uint32
2-17	Over-voltage Control	[2] Enabled	All set-ups	TRUE	-	Uint8

8.3.5 Reference / Ramps 3-**-**

Par. No. #	Parameter description	Default value	4-set-up	Change during operation	Conversion index	Type
3-0* Reference Limits						
3-02	Minimum Reference	SR	All set-ups	TRUE	-3	Int32
3-03	Maximum Reference	SR	All set-ups	TRUE	-3	Int32
3-04	Reference Function	[0] Sum	All set-ups	TRUE	-	UInt8
3-1* References						
3-10	Preset Reference	0.00 %	All set-ups	TRUE	-2	Int16
3-11	Jog Speed [Hz]	SR	All set-ups	TRUE	-1	UInt16
3-13	Reference Site	[0] Linked to Hand / Auto	All set-ups	TRUE	-	UInt8
3-14	Preset Relative Reference	0.00 %	All set-ups	TRUE	-2	Int32
3-15	Reference 1 Source	[1] Analog input 53	All set-ups	TRUE	-	UInt8
3-16	Reference 2 Source	[0] No function	All set-ups	TRUE	-	UInt8
3-17	Reference 3 Source	[0] No function	All set-ups	TRUE	-	UInt8
3-19	Jog Speed [RPM]	SR	All set-ups	TRUE	67	UInt16
3-4* Ramp 1						
3-41	Ramp 1 Ramp Up Time	SR	All set-ups	TRUE	-2	UInt32
3-42	Ramp 1 Ramp Down Time	SR	All set-ups	TRUE	-2	UInt32
3-5* Ramp 2						
3-51	Ramp 2 Ramp Up Time	SR	All set-ups	TRUE	-2	UInt32
3-52	Ramp 2 Ramp Down Time	SR	All set-ups	TRUE	-2	UInt32
3-8* Other Ramps						
3-80	Jog Ramp Time	SR	All set-ups	TRUE	-2	UInt32
3-81	Quick Stop Ramp Time	SR	2 set-ups	TRUE	-2	UInt32
3-84	Initial Ramp Time	0.00 s	All set-ups	TRUE	-2	UInt16
3-85	Check Valve Ramp Time	0.00 s	All set-ups	TRUE	-2	UInt16
3-86	Check Valve Ramp End Speed [RPM]	SR	All set-ups	TRUE	67	UInt16
3-87	Check Valve Ramp End Speed [Hz]	SR	All set-ups	TRUE	-1	UInt16
3-88	Final Ramp Time	0.00 s	All set-ups	TRUE	-2	UInt16
3-9* Digital Pot.Meter						
3-90	Step Size	0.10 %	All set-ups	TRUE	-2	UInt16
3-91	Ramp Time	1.00 s	All set-ups	TRUE	-2	UInt32
3-92	Power Restore	[0] Off	All set-ups	TRUE	-	UInt8
3-93	Maximum Limit	100 %	All set-ups	TRUE	0	Int16
3-94	Minimum Limit	0 %	All set-ups	TRUE	0	Int16
3-95	Ramp Delay	SR	All set-ups	TRUE	-3	TimD

8.3.6 Limits / Warnings 4-**

Par. No. #	Parameter description	Default value	4-set-up	Change during operation	Conversion index	Type
4-1* Motor Limits						
4-10	Motor Speed Direction	[0] Clockwise	All set-ups	FALSE	-	Uint8
4-11	Motor Speed Low Limit [RPM]	SR	All set-ups	TRUE	67	Uint16
4-12	Motor Speed Low Limit [Hz]	SR	All set-ups	TRUE	-1	Uint16
4-13	Motor Speed High Limit [RPM]	SR	All set-ups	TRUE	67	Uint16
4-14	Motor Speed High Limit [Hz]	SR	All set-ups	TRUE	-1	Uint16
4-16	Torque Limit Motor Mode	SR	All set-ups	TRUE	-1	Uint16
4-17	Torque Limit Generator Mode	100.0 %	All set-ups	TRUE	-1	Uint16
4-18	Current Limit	SR	All set-ups	TRUE	-1	Uint32
4-19	Max Output Frequency	SR	All set-ups	FALSE	-1	Uint16
4-5* Adj. Warnings						
4-50	Warning Current Low	0.00 A	All set-ups	TRUE	-2	Uint32
4-51	Warning Current High	ImaxVLT (P1637)	All set-ups	TRUE	-2	Uint32
4-52	Warning Speed Low	0 RPM	All set-ups	TRUE	67	Uint16
4-53	Warning Speed High	outputSpeedHighLimit (P413)	All set-ups	TRUE	67	Uint16
4-54	Warning Reference Low	-999999.999 N/A	All set-ups	TRUE	-3	Int32
4-55	Warning Reference High	999999.999 N/A	All set-ups	TRUE	-3	Int32
4-56	Warning Feedback Low	-999999.999 ReferenceFeedbackUnit	All set-ups	TRUE	-3	Int32
4-57	Warning Feedback High	999999.999 ReferenceFeedbackUnit	All set-ups	TRUE	-3	Int32
4-58	Missing Motor Phase Function	[2] Trip 1000 ms	All set-ups	TRUE	-	Uint8
4-6* Speed Bypass						
4-60	Bypass Speed From [RPM]	SR	All set-ups	TRUE	67	Uint16
4-61	Bypass Speed From [Hz]	SR	All set-ups	TRUE	-1	Uint16
4-62	Bypass Speed To [RPM]	SR	All set-ups	TRUE	67	Uint16
4-63	Bypass Speed To [Hz]	SR	All set-ups	TRUE	-1	Uint16
4-64	Semi-Auto Bypass Set-up	[0] Off	All set-ups	FALSE	-	Uint8

8.3.7 Digital In/Out 5-**-

Par. No. #	Parameter description	Default value	4-set-up	Change during operation	Conversion index	Type
5-0* Digital I/O mode						
5-00	Digital I/O Mode	[0] PNP - Active at 24V	All set-ups	FALSE	-	Uint8
5-01	Terminal 27 Mode	[0] Input	All set-ups	TRUE	-	Uint8
5-02	Terminal 29 Mode	[0] Input	All set-ups	TRUE	-	Uint8
5-1* Digital Inputs						
5-10	Terminal 18 Digital Input	[8] Start	All set-ups	TRUE	-	Uint8
5-11	Terminal 19 Digital Input	[0] No operation	All set-ups	TRUE	-	Uint8
5-12	Terminal 27 Digital Input	null	All set-ups	TRUE	-	Uint8
5-13	Terminal 29 Digital Input	[0] No operation	All set-ups	TRUE	-	Uint8
5-14	Terminal 32 Digital Input	[0] No operation	All set-ups	TRUE	-	Uint8
5-15	Terminal 33 Digital Input	[0] No operation	All set-ups	TRUE	-	Uint8
5-16	Terminal X30/2 Digital Input	[0] No operation	All set-ups	TRUE	-	Uint8
5-17	Terminal X30/3 Digital Input	[0] No operation	All set-ups	TRUE	-	Uint8
5-18	Terminal X30/4 Digital Input	[0] No operation	All set-ups	TRUE	-	Uint8
5-3* Digital Outputs						
5-30	Terminal 27 Digital Output	[0] No operation	All set-ups	TRUE	-	Uint8
5-31	Terminal 29 Digital Output	[0] No operation	All set-ups	TRUE	-	Uint8
5-32	Term X30/6 Digi Out (MCB 101)	[0] No operation	All set-ups	TRUE	-	Uint8
5-33	Term X30/7 Digi Out (MCB 101)	[0] No operation	All set-ups	TRUE	-	Uint8
5-4* Relays						
5-40	Function Relay	null	All set-ups	TRUE	-	Uint8
5-41	On Delay, Relay	0.01 s	All set-ups	TRUE	-2	Uint16
5-42	Off Delay, Relay	0.01 s	All set-ups	TRUE	-2	Uint16
5-5* Pulse Input						
5-50	Term. 29 Low Frequency	100 Hz	All set-ups	TRUE	0	Uint32
5-51	Term. 29 High Frequency	100 Hz	All set-ups	TRUE	0	Uint32
5-52	Term. 29 Low Ref./Feedb. Value	0.000 N/A	All set-ups	TRUE	-3	Int32
5-53	Term. 29 High Ref./Feedb. Value	100.000 N/A	All set-ups	TRUE	-3	Int32
5-54	Pulse Filter Time Constant #29	100 ms	All set-ups	FALSE	-3	Uint16
5-55	Term. 33 Low Frequency	100 Hz	All set-ups	TRUE	0	Uint32
5-56	Term. 33 High Frequency	100 Hz	All set-ups	TRUE	0	Uint32
5-57	Term. 33 Low Ref./Feedb. Value	0.000 N/A	All set-ups	TRUE	-3	Int32
5-58	Term. 33 High Ref./Feedb. Value	100.000 N/A	All set-ups	TRUE	-3	Int32
5-59	Pulse Filter Time Constant #33	100 ms	All set-ups	FALSE	-3	Uint16
5-6* Pulse Output						
5-60	Terminal 27 Pulse Output Variable	[0] No operation	All set-ups	TRUE	-	Uint8
5-62	Pulse Output Max Freq #27	5000 Hz	All set-ups	TRUE	0	Uint32
5-63	Terminal 29 Pulse Output Variable	[0] No operation	All set-ups	TRUE	-	Uint8
5-65	Pulse Output Max Freq #29	5000 Hz	All set-ups	TRUE	0	Uint32
5-66	Terminal X30/6 Pulse Output Variable	[0] No operation	All set-ups	TRUE	-	Uint8
5-68	Pulse Output Max Freq #X30/6	5000 Hz	All set-ups	TRUE	0	Uint32
5-9* Bus Controlled						
5-90	Digital & Relay Bus Control	0 N/A	All set-ups	TRUE	0	Uint32
5-93	Pulse Out #27 Bus Control	0.00 %	All set-ups	TRUE	-2	N2
5-94	Pulse Out #27 Timeout Preset	0.00 %	1 set-up	TRUE	-2	Uint16
5-95	Pulse Out #29 Bus Control	0.00 %	All set-ups	TRUE	-2	N2
5-96	Pulse Out #29 Timeout Preset	0.00 %	1 set-up	TRUE	-2	Uint16
5-97	Pulse Out #X30/6 Bus Control	0.00 %	All set-ups	TRUE	-2	N2
5-98	Pulse Out #X30/6 Timeout Preset	0.00 %	1 set-up	TRUE	-2	Uint16

8.3.8 Analog In/Out 6-**

Par. No. #	Parameter description	Default value	4-set-up	Change during operation	Conversion index	Type
6-0* Analog I/O Mode						
6-00	Live Zero Timeout Time	10 s	All set-ups	TRUE	0	UInt8
6-01	Live Zero Timeout Function	[0] Off	All set-ups	TRUE	-	UInt8
6-1* Analog Input 53						
6-10	Terminal 53 Low Voltage	0.07 V	All set-ups	TRUE	-2	Int16
6-11	Terminal 53 High Voltage	10.00 V	All set-ups	TRUE	-2	Int16
6-12	Terminal 53 Low Current	4.00 mA	All set-ups	TRUE	-5	Int16
6-13	Terminal 53 High Current	20.00 mA	All set-ups	TRUE	-5	Int16
6-14	Terminal 53 Low Ref./Feedb. Value	0.000 N/A	All set-ups	TRUE	-3	Int32
6-15	Terminal 53 High Ref./Feedb. Value	SR	All set-ups	TRUE	-3	Int32
6-16	Terminal 53 Filter Time Constant	0.001 s	All set-ups	TRUE	-3	UInt16
6-17	Terminal 53 Live Zero	[1] Enabled	All set-ups	TRUE	-	UInt8
6-2* Analog Input 54						
6-20	Terminal 54 Low Voltage	0.07 V	All set-ups	TRUE	-2	Int16
6-21	Terminal 54 High Voltage	10.00 V	All set-ups	TRUE	-2	Int16
6-22	Terminal 54 Low Current	4.00 mA	All set-ups	TRUE	-5	Int16
6-23	Terminal 54 High Current	20.00 mA	All set-ups	TRUE	-5	Int16
6-24	Terminal 54 Low Ref./Feedb. Value	0.000 N/A	All set-ups	TRUE	-3	Int32
6-25	Terminal 54 High Ref./Feedb. Value	100.000 N/A	All set-ups	TRUE	-3	Int32
6-26	Terminal 54 Filter Time Constant	0.001 s	All set-ups	TRUE	-3	UInt16
6-27	Terminal 54 Live Zero	[1] Enabled	All set-ups	TRUE	-	UInt8
6-3* Analog Input X30/11						
6-30	Terminal X30/11 Low Voltage	0.07 V	All set-ups	TRUE	-2	Int16
6-31	Terminal X30/11 High Voltage	10.00 V	All set-ups	TRUE	-2	Int16
6-34	Term. X30/11 Low Ref./Feedb. Value	0.000 N/A	All set-ups	TRUE	-3	Int32
6-35	Term. X30/11 High Ref./Feedb. Value	100.000 N/A	All set-ups	TRUE	-3	Int32
6-36	Term. X30/11 Filter Time Constant	0.001 s	All set-ups	TRUE	-3	UInt16
6-37	Term. X30/11 Live Zero	[1] Enabled	All set-ups	TRUE	-	UInt8
6-4* Analog Input X30/12						
6-40	Terminal X30/12 Low Voltage	0.07 V	All set-ups	TRUE	-2	Int16
6-41	Terminal X30/12 High Voltage	10.00 V	All set-ups	TRUE	-2	Int16
6-44	Term. X30/12 Low Ref./Feedb. Value	0.000 N/A	All set-ups	TRUE	-3	Int32
6-45	Term. X30/12 High Ref./Feedb. Value	100.000 N/A	All set-ups	TRUE	-3	Int32
6-46	Term. X30/12 Filter Time Constant	0.001 s	All set-ups	TRUE	-3	UInt16
6-47	Term. X30/12 Live Zero	[1] Enabled	All set-ups	TRUE	-	UInt8
6-5* Analog Output 42						
6-50	Terminal 42 Output	[100] Output freq. 0-100	All set-ups	TRUE	-	UInt8
6-51	Terminal 42 Output Min Scale	0.00 %	All set-ups	TRUE	-2	Int16
6-52	Terminal 42 Output Max Scale	100.00 %	All set-ups	TRUE	-2	Int16
6-53	Terminal 42 Output Bus Control	0.00 %	All set-ups	TRUE	-2	N2
6-54	Terminal 42 Output Timeout Preset	0.00 %	1 set-up	TRUE	-2	UInt16
6-6* Analog Output X30/8						
6-60	Terminal X30/8 Output	[0] No operation	All set-ups	TRUE	-	UInt8
6-61	Terminal X30/8 Min. Scale	0.00 %	All set-ups	TRUE	-2	Int16
6-62	Terminal X30/8 Max. Scale	100.00 %	All set-ups	TRUE	-2	Int16
6-63	Terminal X30/8 Output Bus Control	0.00 %	All set-ups	TRUE	-2	N2
6-64	Terminal X30/8 Output Timeout Preset	0.00 %	1 set-up	TRUE	-2	UInt16

8.3.9 Comm. and Options 8-**-*

Par. No. #	Parameter description	Default value	4-set-up	Change during operation	Conversion index	Type
8-0* General Settings						
8-01	Control Site	null	All set-ups	TRUE	-	Uint8
8-02	Control Source	null	All set-ups	TRUE	-	Uint8
8-03	Control Timeout Time	SR	1 set-up	TRUE	-1	Uint32
8-04	Control Timeout Function	[0] Off	1 set-up	TRUE	-	Uint8
8-05	End-of-Timeout Function	[1] Resume set-up	1 set-up	TRUE	-	Uint8
8-06	Reset Control Timeout	[0] Do not reset	All set-ups	TRUE	-	Uint8
8-07	Diagnosis Trigger	[0] Disable	2 set-ups	TRUE	-	Uint8
8-1* Control Settings						
8-10	Control Profile	[0] FC profile	All set-ups	TRUE	-	Uint8
8-13	Configurable Status Word STW	[1] Profile Default	All set-ups	TRUE	-	Uint8
8-14	Configurable Control Word CTW	[1] Profile default	All set-ups	TRUE	-	Uint8
8-3* FC Port Settings						
8-30	Protocol	null	1 set-up	TRUE	-	Uint8
8-31	Address	SR	1 set-up	TRUE	0	Uint8
8-32	Baud Rate	null	1 set-up	TRUE	-	Uint8
8-33	Parity / Stop Bits	null	1 set-up	TRUE	-	Uint8
8-35	Minimum Response Delay	SR	1 set-up	TRUE	-3	Uint16
8-36	Max Response Delay	SR	1 set-up	TRUE	-3	Uint16
8-37	Maximum Inter-Char Delay	SR	1 set-up	TRUE	-5	Uint16
8-4* FC MC protocol set						
8-40	Telegram Selection	[1] Standard telegram 1	2 set-ups	TRUE	-	Uint8
8-5* Digital/Bus						
8-50	Coasting Select	[3] Logic OR	All set-ups	TRUE	-	Uint8
8-52	DC Brake Select	[3] Logic OR	All set-ups	TRUE	-	Uint8
8-53	Start Select	[3] Logic OR	All set-ups	TRUE	-	Uint8
8-54	Reversing Select	null	All set-ups	TRUE	-	Uint8
8-55	Set-up Select	[3] Logic OR	All set-ups	TRUE	-	Uint8
8-56	Preset Reference Select	[3] Logic OR	All set-ups	TRUE	-	Uint8
8-7* BACnet						
8-70	BACnet Device Instance	1 N/A	1 set-up	TRUE	0	Uint32
8-72	MS/TP Max Masters	127 N/A	1 set-up	TRUE	0	Uint8
8-73	MS/TP Max Info Frames	1 N/A	1 set-up	TRUE	0	Uint16
8-74	"I-Am" Service	[0] Send at power-up	1 set-up	TRUE	-	Uint8
8-75	Initialisation Password	SR	1 set-up	TRUE	0	VisStr[20]
8-8* FC Port Diagnostics						
8-80	Bus Message Count	0 N/A	All set-ups	TRUE	0	Uint32
8-81	Bus Error Count	0 N/A	All set-ups	TRUE	0	Uint32
8-82	Slave Message Rcvd	0 N/A	All set-ups	TRUE	0	Uint32
8-83	Slave Error Count	0 N/A	All set-ups	TRUE	0	Uint32
8-9* Bus Jog / Feedback						
8-90	Bus Jog 1 Speed	100 RPM	All set-ups	TRUE	67	Uint16
8-91	Bus Jog 2 Speed	200 RPM	All set-ups	TRUE	67	Uint16
8-94	Bus Feedback 1	0 N/A	1 set-up	TRUE	0	N2
8-95	Bus Feedback 2	0 N/A	1 set-up	TRUE	0	N2
8-96	Bus Feedback 3	0 N/A	1 set-up	TRUE	0	N2



8.3.10 Profibus 9-**

Par. No. #	Parameter description	Default value	4-set-up	FC.302 only	Change during operation	Conversion index	Type
9-00	Setpoint	0 N/A	All set-ups		TRUE	0	Uimt16
9-07	Actual Value	0 N/A	All set-ups		FALSE	0	Uimt16
9-15	PCD Write Configuration	ExpressionLimit	2 set-ups		TRUE	-	Uimt16
9-16	PCD Read Configuration	ExpressionLimit	2 set-ups		TRUE	-	Uimt16
9-18	Node Address	126 N/A	1 set-up		TRUE	0	Uimt8
9-22	Telegram Selection	[108] PPO 8	1 set-up		TRUE	-	Uimt8
9-23	Parameters for Signals	0	All set-ups		TRUE	-	Uimt16
9-27	Parameter Edit	[1] Enabled	2 set-ups		FALSE	-	Uimt16
9-28	Process Control	[1] Enable cyclic master	2 set-ups		FALSE	-	Uimt8
9-44	Fault Message Counter	0 N/A	All set-ups		TRUE	0	Uimt16
9-45	Fault Code	0 N/A	All set-ups		TRUE	0	Uimt16
9-47	Fault Number	0 N/A	All set-ups		TRUE	0	Uimt16
9-52	Fault Situation Counter	0 N/A	All set-ups		TRUE	0	Uimt16
9-53	Profibus Warning Word	0 N/A	All set-ups		TRUE	0	Uimt16
9-63	Actual Baud Rate	0 N/A	All set-ups		TRUE	0	V2
9-64	Device Identification	[255] No baudrate found	All set-ups		TRUE	-	Uimt8
9-65	Profile Number	0 N/A	All set-ups		TRUE	0	Uimt16
9-67	Control Word 1	0 N/A	All set-ups		TRUE	0	OctStr[2]
9-68	Status Word 1	0 N/A	All set-ups		TRUE	0	V2
9-71	Profibus Save Data Values	[0] Off	All set-ups		TRUE	-	Uimt8
9-72	ProfibusDriveReset	[0] No action	1 set-up		FALSE	-	Uimt8
9-80	Defined Parameters (1)	0 N/A	All set-ups		FALSE	0	Uimt16
9-81	Defined Parameters (2)	0 N/A	All set-ups		FALSE	0	Uimt16
9-82	Defined Parameters (3)	0 N/A	All set-ups		FALSE	0	Uimt16
9-83	Defined Parameters (4)	0 N/A	All set-ups		FALSE	0	Uimt16
9-84	Defined Parameters (5)	0 N/A	All set-ups		FALSE	0	Uimt16
9-90	Changed Parameters (1)	0 N/A	All set-ups		FALSE	0	Uimt16
9-91	Changed Parameters (2)	0 N/A	All set-ups		FALSE	0	Uimt16
9-92	Changed Parameters (3)	0 N/A	All set-ups		FALSE	0	Uimt16
9-93	Changed Parameters (4)	0 N/A	All set-ups		FALSE	0	Uimt16
9-94	Changed Parameters (5)	0 N/A	All set-ups		FALSE	0	Uimt16

8.3.11 CAN Fieldbus 10-**

Par. No. #	Parameter description	Default value	4-set-up	Changes during operation	Conversion index	Type
10-0* Common Settings						
10-00	CAN Protocol	null	2 set-ups	FALSE	-	Uint8
10-01	Baud Rate Select	null	2 set-ups	TRUE	-	Uint8
10-02	MAC ID	SR	2 set-ups	TRUE	0	Uint8
10-05	Readout Transmit Error Counter	0 N/A	All set-ups	TRUE	0	Uint8
10-06	Readout Receive Error Counter	0 N/A	All set-ups	TRUE	0	Uint8
10-07	Readout Bus Off Counter	0 N/A	All set-ups	TRUE	0	Uint8
10-1* DeviceNet						
10-10	Process Data Type Selection	null	All set-ups	TRUE	-	Uint8
10-11	Process Data Config Write	SR	2 set-ups	TRUE	-	Uint16
10-12	Process Data Config Read	SR	2 set-ups	TRUE	-	Uint16
10-13	Warning Parameter	0 N/A	All set-ups	TRUE	0	Uint16
10-14	Net Reference	[0] Off	2 set-ups	TRUE	-	Uint8
10-15	Net Control	[0] Off	2 set-ups	TRUE	-	Uint8
10-2* COS Filters						
10-20	COS Filter 1	0 N/A	All set-ups	FALSE	0	Uint16
10-21	COS Filter 2	0 N/A	All set-ups	FALSE	0	Uint16
10-22	COS Filter 3	0 N/A	All set-ups	FALSE	0	Uint16
10-23	COS Filter 4	0 N/A	All set-ups	FALSE	0	Uint16
10-3* Parameter Access						
10-30	Array Index	0 N/A	2 set-ups	TRUE	0	Uint8
10-31	Store Data Values	[0] Off	All set-ups	TRUE	-	Uint8
10-32	DeviceNet Revision	SR	All set-ups	TRUE	0	Uint16
10-33	Store Always	[0] Off	1 set-up	TRUE	-	Uint8
10-34	DeviceNet Product Code	130 N/A	1 set-up	TRUE	0	Uint16
10-39	DeviceNet F Parameters	0 N/A	All set-ups	TRUE	0	Uint32

8.3.12 Smart Logic 13--***

Par. No. #	Parameter description	Default value	4-set-up	Change during operation	Conversion index	Type
13-0* SLC Settings						
13-00	SL Controller Mode	null	2 set-ups	TRUE	-	Uint8
13-01	Start Event	null	2 set-ups	TRUE	-	Uint8
13-02	Stop Event	null	2 set-ups	TRUE	-	Uint8
13-03	Reset SLC	[0] Do not reset SLC	All set-ups	TRUE	-	Uint8
13-1* Comparators						
13-10	Comparator Operand	null	2 set-ups	TRUE	-	Uint8
13-11	Comparator Operator	null	2 set-ups	TRUE	-	Uint8
13-12	Comparator Value	SR	2 set-ups	TRUE	-3	Int32
13-2* Timers						
13-20	SL Controller Timer	SR	1 set-up	TRUE	-3	TimD
13-4* Logic Rules						
13-40	Logic Rule Boolean 1	null	2 set-ups	TRUE	-	Uint8
13-41	Logic Rule Operator 1	null	2 set-ups	TRUE	-	Uint8
13-42	Logic Rule Boolean 2	null	2 set-ups	TRUE	-	Uint8
13-43	Logic Rule Operator 2	null	2 set-ups	TRUE	-	Uint8
13-44	Logic Rule Boolean 3	null	2 set-ups	TRUE	-	Uint8
13-5* States						
13-51	SL Controller Event	null	2 set-ups	TRUE	-	Uint8
13-52	SL Controller Action	null	2 set-ups	TRUE	-	Uint8

8.3.13 Special Functions 14-**

Par. No. #	Parameter description	Default value	4-set-up	Change during operation	Conversion index	Type
14-0* Inverter Switching						
14-00	Switching Pattern	null	All set-ups	TRUE	-	Uint8
14-01	Switching Frequency	null	All set-ups	TRUE	-	Uint8
14-03	Overmodulation	[1] On	All set-ups	FALSE	-	Uint8
14-04	PWM Random	[0] Off	All set-ups	TRUE	-	Uint8
14-1* Mains On/Off						
14-10	Mains Failure	[0] No function	All set-ups	FALSE	-	Uint8
14-11	Mains Voltage at Mains Fault	SR	All set-ups	TRUE	0	Uint16
14-12	Function at Mains Imbalance	[3] Derate	All set-ups	TRUE	-	Uint8
14-2* Reset Functions						
14-20	Reset Mode	[10] Automatic reset x 10	All set-ups	TRUE	-	Uint8
14-21	Automatic Restart Time	10 s	All set-ups	TRUE	0	Uint16
14-22	Operation Mode	[0] Normal operation	All set-ups	TRUE	-	Uint8
14-23	Typecode Setting	null	2 set-ups	FALSE	-	Uint8
14-25	Trip Delay at Torque Limit	60 s	All set-ups	TRUE	0	Uint8
14-26	Trip Delay at Inverter Fault	SR	All set-ups	TRUE	0	Uint8
14-28	Production Settings	[0] No action	All set-ups	TRUE	-	Uint8
14-29	Service Code	0 N/A	All set-ups	TRUE	0	Int32
14-3* Current Limit Ctrl.						
14-30	Current Lim Ctrl, Proportional Gain	100 %	All set-ups	FALSE	0	Uint16
14-31	Current Lim Ctrl, Integration Time	0.020 s	All set-ups	FALSE	-3	Uint16
14-32	Current Lim Ctrl, Filter Time	27.0 ms	All set-ups	FALSE	-4	Uint16
14-4* Energy Optimising						
14-40	VT Level	66 %	All set-ups	FALSE	0	Uint8
14-41	AEO Minimum Magnetisation	SR	All set-ups	TRUE	0	Uint8
14-42	Minimum AEO Frequency	10 Hz	All set-ups	TRUE	0	Uint8
14-43	Motor Cosphi	SR	All set-ups	TRUE	-2	Uint16
14-5* Environment						
14-50	RFI Filter	[1] On	1 set-up	FALSE	-	Uint8
14-52	Fan Control	[0] Auto	All set-ups	TRUE	-	Uint8
14-53	Fan Monitor	[1] Warning	All set-ups	TRUE	-	Uint8
14-55	Output Filter	[0] No Filter	1 set-up	FALSE	-	Uint8
14-59	Actual Number of Inverter Units	SR	1 set-up	FALSE	0	Uint8
14-6* Auto Derate						
14-60	Function at Over Temperature	[1] Derate	All set-ups	TRUE	-	Uint8
14-61	Function at Inverter Overload	[1] Derate	All set-ups	TRUE	-	Uint8
14-62	Inv. Overload Derate Current	95 %	All set-ups	TRUE	0	Uint16
14-8* Options						
14-80	Option Supplied by External 24VDC	[0] No	2 set-ups	FALSE	-	Uint8

8.3.14 FC Information 15--***

Par. No. #	Parameter description	Default value	4-set-up	Change during operation	Conversion index	Type
15-0* Operating Data						
15-00	Operating Hours	0 h	All set-ups	FALSE	74	UInt32
15-01	Running Hours	0 h	All set-ups	FALSE	74	UInt32
15-02	kWh Counter	0 kWh	All set-ups	FALSE	75	UInt32
15-03	Power Up's	0 N/A	All set-ups	FALSE	0	UInt32
15-04	Over Temp's	0 N/A	All set-ups	FALSE	0	UInt16
15-05	Over Volt's	0 N/A	All set-ups	FALSE	0	UInt16
15-06	Reset kWh Counter	[0] Do not reset	All set-ups	TRUE	-	UInt8
15-07	Reset Running Hours Counter	[0] Do not reset	All set-ups	TRUE	-	UInt8
15-08	Number of Starts	0 N/A	All set-ups	FALSE	0	UInt32
15-1* Data Log Settings						
15-10	Logging Source	0	2 set-ups	TRUE	-	UInt16
15-11	Logging Interval	SR	2 set-ups	TRUE	-3	TimD
15-12	Trigger Event	[0] False	1 set-up	TRUE	-	UInt8
15-13	Logging Mode	[0] Log always	2 set-ups	TRUE	-	UInt8
15-14	Samples Before Trigger	50 N/A	2 set-ups	TRUE	0	UInt8
15-2* Historic Log						
15-20	Historic Log: Event	0 N/A	All set-ups	FALSE	0	UInt8
15-21	Historic Log: Value	0 N/A	All set-ups	FALSE	0	UInt32
15-22	Historic Log: Time	0 ms	All set-ups	FALSE	-3	UInt32
15-23	Historic Log: Date and Time	SR	All set-ups	FALSE	0	TimeOfDay
15-3* Alarm Log						
15-30	Alarm Log: Error Code	0 N/A	All set-ups	FALSE	0	UInt16
15-31	Alarm Log: Value	0 N/A	All set-ups	FALSE	0	Int16
15-32	Alarm Log: Time	0 s	All set-ups	FALSE	0	UInt32
15-33	Alarm Log: Date and Time	SR	All set-ups	FALSE	0	TimeOfDay
15-34	Alarm Log: Setpoint	0.000 ProcessCtrlUnit	All set-ups	FALSE	-3	Int32
15-35	Alarm Log: Feedback	0.000 ProcessCtrlUnit	All set-ups	FALSE	-3	Int32
15-36	Alarm Log: Current Demand	0 %	All set-ups	FALSE	0	UInt8
15-37	Alarm Log: Process Ctrl Unit	[0]	All set-ups	FALSE	-	UInt8
15-4* Drive Identification						
15-40	FC Type	0 N/A	All set-ups	FALSE	0	VisStr[6]
15-41	Power Section	0 N/A	All set-ups	FALSE	0	VisStr[20]
15-42	Voltage	0 N/A	All set-ups	FALSE	0	VisStr[20]
15-43	Software Version	0 N/A	All set-ups	FALSE	0	VisStr[5]
15-44	Ordered Typecode String	0 N/A	All set-ups	FALSE	0	VisStr[40]
15-45	Actual Typecode String	0 N/A	All set-ups	FALSE	0	VisStr[40]
15-46	Frequency Converter Ordering No	0 N/A	All set-ups	FALSE	0	VisStr[8]
15-47	Power Card Ordering No	0 N/A	All set-ups	FALSE	0	VisStr[8]
15-48	LCP Id No	0 N/A	All set-ups	FALSE	0	VisStr[20]
15-49	SW ID Control Card	0 N/A	All set-ups	FALSE	0	VisStr[20]
15-50	SW ID Power Card	0 N/A	All set-ups	FALSE	0	VisStr[20]
15-51	Frequency Converter Serial Number	0 N/A	All set-ups	FALSE	0	VisStr[10]
15-53	Power Card Serial Number	0 N/A	All set-ups	FALSE	0	VisStr[19]

Par. No. #	Parameter description	Default value	4-set-up	Change during operation	Conversion index	Type
15-6* Option Ident						
15-60	Option Mounted	0 N/A	All set-ups	FALSE	0	VisStr[30]
15-61	Option SW Version	0 N/A	All set-ups	FALSE	0	VisStr[20]
15-62	Option Ordering No	0 N/A	All set-ups	FALSE	0	VisStr[8]
15-63	Option Serial No	0 N/A	All set-ups	FALSE	0	VisStr[18]
15-70	Option in Slot A	0 N/A	All set-ups	FALSE	0	VisStr[30]
15-71	Slot A Option SW Version	0 N/A	All set-ups	FALSE	0	VisStr[20]
15-72	Option in Slot B	0 N/A	All set-ups	FALSE	0	VisStr[30]
15-73	Slot B Option SW Version	0 N/A	All set-ups	FALSE	0	VisStr[20]
15-74	Option in Slot C0	0 N/A	All set-ups	FALSE	0	VisStr[30]
15-75	Slot C0 Option SW Version	0 N/A	All set-ups	FALSE	0	VisStr[20]
15-76	Option in Slot C1	0 N/A	All set-ups	FALSE	0	VisStr[30]
15-77	Slot C1 Option SW Version	0 N/A	All set-ups	FALSE	0	VisStr[20]
15-9* Parameter Info						
15-92	Defined Parameters	0 N/A	All set-ups	FALSE	0	Uint16
15-93	Modified Parameters	0 N/A	All set-ups	FALSE	0	Uint16
15-98	Drive Identification	0 N/A	All set-ups	FALSE	0	VisStr[40]
15-99	Parameter Metadata	0 N/A	All set-ups	FALSE	0	Uint16

8.3.15 Data Readouts 16-**

Par. No. #	Parameter description	Default value	4-set-up	Change during operation	Conversion index	Type
16-0* General Status						
16-00	Control Word	0 N/A	All set-ups	TRUE	0	V2
16-01	Reference [Unit]	0.000 ReferenceFeedUnit	All set-ups	TRUE	-3	Int32
16-02	Reference [%]	0.0 %	All set-ups	TRUE	-1	Int16
16-03	Status Word	0 N/A	All set-ups	TRUE	0	V2
16-05	Main Actual Value [%]	0.00 %	All set-ups	TRUE	-2	N2
16-09	Custom Readout	0.00 CustomReadoutUnit	All set-ups	TRUE	-2	Int32
16-1* Motor Status						
16-10	Power [kW]	0.00 kW	All set-ups	TRUE	1	Int32
16-11	Power [hp]	0.00 hp	All set-ups	TRUE	-2	Int32
16-12	Motor Voltage	0.0 V	All set-ups	TRUE	-1	Unit16
16-13	Frequency	0.0 Hz	All set-ups	TRUE	-1	Unit16
16-14	Motor Current	0.00 A	All set-ups	TRUE	-2	Int32
16-15	Frequency [%]	0.00 %	All set-ups	TRUE	-2	N2
16-16	Torque [Nm]	0.0 Nm	All set-ups	TRUE	-1	Int32
16-17	Speed [RPM]	0 RPM	All set-ups	TRUE	67	Int32
16-18	Motor Thermal	0 %	All set-ups	TRUE	0	Unit8
16-22	Torque [%]	0 %	All set-ups	TRUE	0	Int16
16-3* Drive Status						
16-30	DC Link Voltage	0 V	All set-ups	TRUE	0	Unit16
16-32	Brake Energy /s	0.000 kW	All set-ups	TRUE	0	Unit32
16-33	Brake Energy /2 min	0.000 kW	All set-ups	TRUE	0	Unit32
16-34	Heatsink Temp.	0 °C	All set-ups	TRUE	100	Unit8
16-35	Inverter Thermal	0 %	All set-ups	TRUE	0	Unit8
16-36	Inv. Nom. Current	SR	All set-ups	TRUE	-2	Unit32
16-37	Inv. Max. Current	SR	All set-ups	TRUE	-2	Unit32
16-38	SL Controller State	0 N/A	All set-ups	TRUE	0	Unit8
16-39	Control Card Temp.	0 °C	All set-ups	TRUE	100	Unit8
16-40	Logging Buffer Full	[0] No	All set-ups	TRUE	-	Unit8
16-5* Ref. & Feedb.						
16-50	External Reference	0.0 N/A	All set-ups	TRUE	-1	Int16
16-52	Feedback [Unit]	0.000 ProcessCtrlUnit	All set-ups	TRUE	-3	Int32
16-53	Digi Pot Reference	0.00 N/A	All set-ups	TRUE	-2	Int16
16-54	Feedback 1 [Unit]	0.000 ProcessCtrlUnit	All set-ups	TRUE	-3	Int32
16-55	Feedback 2 [Unit]	0.000 ProcessCtrlUnit	All set-ups	TRUE	-3	Int32
16-56	Feedback 3 [Unit]	0.000 ProcessCtrlUnit	All set-ups	TRUE	-3	Int32
16-58	PID Output [%]	0.0 %	All set-ups	TRUE	-1	Int16
16-59	Adjusted Setpoint	0.000 ProcessCtrlUnit	All set-ups	TRUE	-3	Int32

Par. No. #	Parameter description	Default value	4-set-up	Change during operation	Conversion index	Type
16-6* Inputs & Outputs						
16-60	Digital Input	0 N/A	All set-ups	TRUE	0	Uint16
16-61	Terminal 53 Switch Setting	[0] Current	All set-ups	TRUE	-	Uint8
16-62	Analog Input 53	0.000 N/A	All set-ups	TRUE	-3	Int32
16-63	Terminal 54 Switch Setting	[0] Current	All set-ups	TRUE	-	Uint8
16-64	Analog Input 54	0.000 N/A	All set-ups	TRUE	-3	Int32
16-65	Analog Output 42 [mA]	0.000 N/A	All set-ups	TRUE	-3	Int16
16-66	Digital Output [bin]	0 N/A	All set-ups	TRUE	0	Int16
16-67	Pulse Input #29 [Hz]	0 N/A	All set-ups	TRUE	0	Int32
16-68	Pulse Input #33 [Hz]	0 N/A	All set-ups	TRUE	0	Int32
16-69	Pulse Output #27 [Hz]	0 N/A	All set-ups	TRUE	0	Int32
16-70	Pulse Output #29 [Hz]	0 N/A	All set-ups	TRUE	0	Int32
16-71	Relay Output [bin]	0 N/A	All set-ups	TRUE	0	Uint16
16-72	Counter A	0 N/A	All set-ups	TRUE	0	Int32
16-73	Counter B	0 N/A	All set-ups	TRUE	0	Int32
16-75	Analog In X30/11	0.000 N/A	All set-ups	TRUE	-3	Int32
16-76	Analog in X30/12	0.000 N/A	All set-ups	TRUE	-3	Int32
16-77	Analog Out X30/8 [mA]	0.000 N/A	All set-ups	TRUE	-3	Int16
16-8* Fieldbus & FC Port						
16-80	Fieldbus CTW 1	0 N/A	All set-ups	TRUE	0	V2
16-82	Fieldbus REF 1	0 N/A	All set-ups	TRUE	0	N2
16-84	Comm. Option STW	0 N/A	All set-ups	TRUE	0	V2
16-85	FC Port CTW 1	0 N/A	All set-ups	TRUE	0	V2
16-86	FC Port REF 1	0 N/A	All set-ups	TRUE	0	N2
16-9* Diagnosis Readouts						
16-90	Alarm Word	0 N/A	All set-ups	TRUE	0	Uint32
16-91	Alarm Word 2	0 N/A	All set-ups	TRUE	0	Uint32
16-92	Warning Word	0 N/A	All set-ups	TRUE	0	Uint32
16-93	Warning Word 2	0 N/A	All set-ups	TRUE	0	Uint32
16-94	Ext. Status Word	0 N/A	All set-ups	TRUE	0	Uint32
16-95	Ext. Status Word 2	0 N/A	All set-ups	TRUE	0	Uint32
16-96	Maintenance Word	0 N/A	All set-ups	TRUE	0	Uint32



8.3.16 Data Readouts 2 18-**

Par. No. #	Parameter description	Default value	4-set-up	Change during operation	Conversion index	Type
18-0* Maintenance Log						
18-00	Maintenance Log: Item	0 N/A	All set-ups	FALSE	0	Uint8
18-01	Maintenance Log: Action	0 N/A	All set-ups	FALSE	0	Uint8
18-02	Maintenance Log: Time	0 s	All set-ups	FALSE	0	Uint32
18-03	Maintenance Log: Date and Time	SR	All set-ups	FALSE	0	TimeOfDay
18-3* Inputs & Outputs						
18-30	Analog Input X42/1	0.000 N/A	All set-ups	FALSE	-3	Int32
18-31	Analog Input X42/3	0.000 N/A	All set-ups	FALSE	-3	Int32
18-32	Analog Input X42/5	0.000 N/A	All set-ups	FALSE	-3	Int32
18-33	Analog Out X42/7 [V]	0.000 N/A	All set-ups	FALSE	-3	Int16
18-34	Analog Out X42/9 [V]	0.000 N/A	All set-ups	FALSE	-3	Int16
18-35	Analog Out X42/11 [V]	0.000 N/A	All set-ups	FALSE	-3	Int16

8.3.17 FC Closed Loop 20-**

Par. No. #	Parameter description	Default value	4-set-up	Change during operation	Conversion index	Type
20-0* Feedback						
20-00	Feedback 1 Source	[2] Analog input 54	All set-ups	TRUE	-	Uint8
20-01	Feedback 1 Conversion	[0] Linear	All set-ups	FALSE	-	Uint8
20-02	Feedback 1 Source Unit	null	All set-ups	TRUE	-	Uint8
20-03	Feedback 2 Source	[0] No function	All set-ups	TRUE	-	Uint8
20-04	Feedback 2 Conversion	[0] Linear	All set-ups	FALSE	-	Uint8
20-05	Feedback 2 Source Unit	null	All set-ups	TRUE	-	Uint8
20-06	Feedback 3 Source	[0] No function	All set-ups	TRUE	-	Uint8
20-07	Feedback 3 Conversion	[0] Linear	All set-ups	FALSE	-	Uint8
20-08	Feedback 3 Source Unit	null	All set-ups	TRUE	-	Uint8
20-12	Reference/Feedback Unit	null	All set-ups	TRUE	-	Uint8
20-2* Feedback/Setpoint						
20-20	Feedback Function	[4] Maximum	All set-ups	TRUE	-	Uint8
20-21	Setpoint 1	0.000 ProcessCtrlUnit	All set-ups	TRUE	-3	Int32
20-22	Setpoint 2	0.000 ProcessCtrlUnit	All set-ups	TRUE	-3	Int32
20-23	Setpoint 3	0.000 ProcessCtrlUnit	All set-ups	TRUE	-3	Int32
20-7* PID Autotuning						
20-70	Closed Loop Type	[0] Auto	2 set-ups	TRUE	-	Uint8
20-71	PID Performance	[0] Normal	2 set-ups	TRUE	-	Uint8
20-72	PID Output Change	0.10 N/A	2 set-ups	TRUE	-2	Uint16
20-73	Minimum Feedback Level	-999999.000 ProcessCtrlUnit	2 set-ups	TRUE	-3	Int32
20-74	Maximum Feedback Level	999999.000 ProcessCtrlUnit	2 set-ups	TRUE	-3	Int32
20-79	PID Autotuning	[0] Disabled	All set-ups	TRUE	-	Uint8
20-8* PID Basic Settings						
20-81	PID Normal/ Inverse Control	[0] Normal	All set-ups	TRUE	-	Uint8
20-82	PID Start Speed [RPM]	SR	All set-ups	TRUE	67	Uint16
20-83	PID Start Speed [Hz]	SR	All set-ups	TRUE	-1	Uint16
20-84	On Reference Bandwidth	5 %	All set-ups	TRUE	0	Uint8
20-9* PID Controller						
20-91	PID Anti Windup	[1] On	All set-ups	TRUE	-	Uint8
20-93	PID Proportional Gain	2.00 N/A	All set-ups	TRUE	-2	Uint16
20-94	PID Integral Time	8.00 s	All set-ups	TRUE	-2	Uint32
20-95	PID Differentiation Time	0.00 s	All set-ups	TRUE	-2	Uint16
20-96	PID Diff. Gain Limit	5.0 N/A	All set-ups	TRUE	-1	Uint16

8.3.18 Ext. Closed Loop 21--***

Par. No. #	Parameter description	Default value	4-set-up	Change during operation	Conversion index	Type
21-0* Ext. CL Autotuning						
21-00	Closed Loop Type	[0] Auto	2 set-ups	TRUE	-	Uint8
21-01	PID Performance	[0] Normal	2 set-ups	TRUE	-	Uint8
21-02	PID Output Change	0.10 N/A	2 set-ups	TRUE	-2	Uint16
21-03	Minimum Feedback Level	-999999.000 N/A	2 set-ups	TRUE	-3	Int32
21-04	Maximum Feedback Level	999999.000 N/A	2 set-ups	TRUE	-3	Int32
21-09	PID Auto Tuning	[0] Disabled	All set-ups	TRUE	-	Uint8
21-1* Ext. CL 1 Ref./Fb.						
21-10	Ext. 1 Ref./Feedback Unit	[0]	All set-ups	TRUE	-	Uint8
21-11	Ext. 1 Minimum Reference	0.000 ExtPID1Unit	All set-ups	TRUE	-3	Int32
21-12	Ext. 1 Maximum Reference	100.000 ExtPID1Unit	All set-ups	TRUE	-3	Int32
21-13	Ext. 1 Reference Source	[0] No function	All set-ups	TRUE	-	Uint8
21-14	Ext. 1 Feedback Source	[0] No function	All set-ups	TRUE	-	Uint8
21-15	Ext. 1 Setpoint	0.000 ExtPID1Unit	All set-ups	TRUE	-3	Int32
21-17	Ext. 1 Reference [Unit]	0.000 ExtPID1Unit	All set-ups	TRUE	-3	Int32
21-18	Ext. 1 Feedback [Unit]	0.000 ExtPID1Unit	All set-ups	TRUE	-3	Int32
21-19	Ext. 1 Output [%]	0 %	All set-ups	TRUE	0	Int32
21-2* Ext. CL 1 PID						
21-20	Ext. 1 Normal/Inverse Control	[0] Normal	All set-ups	TRUE	-	Uint8
21-21	Ext. 1 Proportional Gain	0.50 N/A	All set-ups	TRUE	-2	Uint16
21-22	Ext. 1 Integral Time	20.00 s	All set-ups	TRUE	-2	Uint32
21-23	Ext. 1 Differentiation Time	0.00 s	All set-ups	TRUE	-2	Uint16
21-24	Ext. 1 Dif. Gain Limit	5.0 N/A	All set-ups	TRUE	-1	Uint16
21-3* Ext. CL 2 Ref./Fb.						
21-30	Ext. 2 Ref./Feedback Unit	[0]	All set-ups	TRUE	-	Uint8
21-31	Ext. 2 Minimum Reference	0.000 ExtPID2Unit	All set-ups	TRUE	-3	Int32
21-32	Ext. 2 Maximum Reference	100.000 ExtPID2Unit	All set-ups	TRUE	-3	Int32
21-33	Ext. 2 Reference Source	[0] No function	All set-ups	TRUE	-	Uint8
21-34	Ext. 2 Feedback Source	[0] No function	All set-ups	TRUE	-	Uint8
21-35	Ext. 2 Setpoint	0.000 ExtPID2Unit	All set-ups	TRUE	-3	Int32
21-37	Ext. 2 Reference [Unit]	0.000 ExtPID2Unit	All set-ups	TRUE	-3	Int32
21-38	Ext. 2 Feedback [Unit]	0.000 ExtPID2Unit	All set-ups	TRUE	-3	Int32
21-39	Ext. 2 Output [%]	0 %	All set-ups	TRUE	0	Int32
21-4* Ext. CL 2 PID						
21-40	Ext. 2 Normal/Inverse Control	[0] Normal	All set-ups	TRUE	-	Uint8
21-41	Ext. 2 Proportional Gain	0.50 N/A	All set-ups	TRUE	-2	Uint16
21-42	Ext. 2 Integral Time	20.00 s	All set-ups	TRUE	-2	Uint32
21-43	Ext. 2 Differentiation Time	0.00 s	All set-ups	TRUE	-2	Uint16
21-44	Ext. 2 Dif. Gain Limit	5.0 N/A	All set-ups	TRUE	-1	Uint16

Par. No. #	Parameter description	Default value	4-set-up	Change during operation	Conversion index	Type
21-5*	Ext. 3 Ref./Fb.					
21-50	Ext. 3 Ref./Feedback Unit	[0]	All set-ups	TRUE	-	Uint8
21-51	Ext. 3 Minimum Reference	0.000 ExtPID3Unit	All set-ups	TRUE	-3	Int32
21-52	Ext. 3 Maximum Reference	100.000 ExtPID3Unit	All set-ups	TRUE	-3	Int32
21-53	Ext. 3 Reference Source	[0] No function	All set-ups	TRUE	-	Uint8
21-54	Ext. 3 Feedback Source	[0] No function	All set-ups	TRUE	-	Uint8
21-55	Ext. 3 Setpoint	0.000 ExtPID3Unit	All set-ups	TRUE	-3	Int32
21-57	Ext. 3 Reference [Unit]	0.000 ExtPID3Unit	All set-ups	TRUE	-3	Int32
21-58	Ext. 3 Feedback [Unit]	0.000 ExtPID3Unit	All set-ups	TRUE	-3	Int32
21-59	Ext. 3 Output [%]	0 %	All set-ups	TRUE	0	Int32
21-6*	Ext. 3 PID					
21-60	Ext. 3 Normal/Inverse Control	[0] Normal	All set-ups	TRUE	-	Uint8
21-61	Ext. 3 Proportional Gain	0.50 N/A	All set-ups	TRUE	-2	Uint16
21-62	Ext. 3 Integral Time	20.00 s	All set-ups	TRUE	-2	Uint32
21-63	Ext. 3 Differentiation Time	0.00 s	All set-ups	TRUE	-2	Uint16
21-64	Ext. 3 Dif. Gain Limit	5.0 N/A	All set-ups	TRUE	-1	Uint16

8.3.19 Application Functions 22-.*

Par. No. #	Parameter description	Default value	4-set-up	Change during operation	Conversion index	Type
22-0* Miscellaneous						
22-00	External Interlock Delay	0 s	All set-ups	TRUE	0	Uint16
22-2* No-Flow Detection						
22-20	Low Power Auto Set-up	[0] Off	All set-ups	FALSE	-	Uint8
22-21	Low Power Detection	[0] Disabled	All set-ups	TRUE	-	Uint8
22-22	Low Speed Detection	[0] Disabled	All set-ups	TRUE	-	Uint8
22-23	No-Flow Function	[0] Off	All set-ups	TRUE	-	Uint8
22-24	No-Flow Delay	10 s	All set-ups	TRUE	0	Uint16
22-26	Dry Pump Function	[0] Off	All set-ups	TRUE	-	Uint8
22-27	Dry Pump Delay	10 s	All set-ups	TRUE	0	Uint16
22-28	No-Flow Low Speed [RPM]	SR	All set-ups	TRUE	67	Uint16
22-29	No-Flow Low Speed [Hz]	SR	All set-ups	TRUE	-1	Uint16
22-3* No-Flow Power Tuning						
22-30	No-Flow Power	0.00 kW	All set-ups	TRUE	1	Uint32
22-31	Power Correction Factor	100 %	All set-ups	TRUE	0	Uint16
22-32	Low Speed [RPM]	SR	All set-ups	TRUE	67	Uint16
22-33	Low Speed [Hz]	SR	All set-ups	TRUE	-1	Uint16
22-34	Low Speed Power [kW]	SR	All set-ups	TRUE	1	Uint32
22-35	Low Speed Power [HP]	SR	All set-ups	TRUE	-2	Uint32
22-36	High Speed [RPM]	SR	All set-ups	TRUE	67	Uint16
22-37	High Speed [Hz]	SR	All set-ups	TRUE	-1	Uint16
22-38	High Speed Power [kW]	SR	All set-ups	TRUE	1	Uint32
22-39	High Speed Power [HP]	SR	All set-ups	TRUE	-2	Uint32
22-4* Sleep Mode						
22-40	Minimum Run Time	60 s	All set-ups	TRUE	0	Uint16
22-41	Minimum Sleep Time	30 s	All set-ups	TRUE	0	Uint16
22-42	Wake-up Speed [RPM]	SR	All set-ups	TRUE	67	Uint16
22-43	Wake-up Speed [Hz]	SR	All set-ups	TRUE	-1	Uint16
22-44	Wake-up Ref./FB Difference	10 %	All set-ups	TRUE	0	Int8
22-45	Setpoint Boost	0 %	All set-ups	TRUE	0	Int8
22-46	Maximum Boost Time	60 s	All set-ups	TRUE	0	Uint16
22-5* End of Curve						
22-50	End of Curve Function	[0] Off	All set-ups	TRUE	-	Uint8
22-51	End of Curve Delay	10 s	All set-ups	TRUE	0	Uint16
22-6* Broken Belt Detection						
22-60	Broken Belt Function	[0] Off	All set-ups	TRUE	-	Uint8
22-61	Broken Belt Torque	10 %	All set-ups	TRUE	0	Uint8
22-62	Broken Belt Delay	10 s	All set-ups	TRUE	0	Uint16
22-7* Short Cycle Protection						
22-75	Short Cycle Protection	[0] Disabled	All set-ups	TRUE	-	Uint8
22-76	Interval between Starts	start_to_start_min_on_time (P2277)	All set-ups	TRUE	0	Uint16
22-77	Minimum Run Time	0 s	All set-ups	TRUE	0	Uint16



Par. No. #	Parameter description	Default value	4-set-up	Change during operation	Conversion index	Type
22-8* Flow Compensation						
22-80	Flow Compensation	[0] Disabled	All set-ups	TRUE	-	Uint8
22-81	Square-linear Curve Approximation	100 %	All set-ups	TRUE	0	Uint8
22-82	Work Point Calculation	[0] Disabled	All set-ups	TRUE	-	Uint8
22-83	Speed at No-Flow [RPM]	SR	All set-ups	TRUE	67	Uint16
22-84	Speed at No-Flow [Hz]	SR	All set-ups	TRUE	-1	Uint16
22-85	Speed at Design Point [RPM]	SR	All set-ups	TRUE	67	Uint16
22-86	Speed at Design Point [Hz]	SR	All set-ups	TRUE	-1	Uint16
22-87	Pressure at No-Flow Speed	0.000 N/A	All set-ups	TRUE	-3	Int32
22-88	Pressure at Rated Speed	999999.999 N/A	All set-ups	TRUE	-3	Int32
22-89	Flow at Design Point	0.000 N/A	All set-ups	TRUE	-3	Int32
22-90	Flow at Rated Speed	0.000 N/A	All set-ups	TRUE	-3	Int32

8.3.20 Timed Actions 23-**

Par. No. #	Parameter description	Default value	4-set-up	Change during operation	Conversion index	Type
23-0* Timed Actions						
23-00	ON Time	SR	2 set-ups	TRUE	0	TimeOfDay- WoDate
23-01	ON Action	[0] Disabled	2 set-ups	TRUE	-	Uint8
23-02	OFF Time	SR	2 set-ups	TRUE	0	TimeOfDay- WoDate
23-03	OFF Action	[0] Disabled	2 set-ups	TRUE	-	Uint8
23-04	Occurrence	[0] All days	2 set-ups	TRUE	-	Uint8
23-1* Maintenance						
23-10	Maintenance Item	[1] Motor bearings	1 set-up	TRUE	-	Uint8
23-11	Maintenance Action	[1] Lubricate	1 set-up	TRUE	-	Uint8
23-12	Maintenance Time Base	[0] Disabled	1 set-up	TRUE	-	Uint8
23-13	Maintenance Time Interval	1 h	1 set-up	TRUE	74	Uint32
23-14	Maintenance Date and Time	SR	1 set-up	TRUE	0	TimeOfDay
23-1* Maintenance Reset						
23-15	Reset Maintenance Word	[0] Do not reset	All set-ups	TRUE	-	Uint8
23-16	Maintenance Text	0 N/A	1 set-up	TRUE	0	VisStr[20]
23-5* Energy Log						
23-50	Energy Log Resolution	[5] Last 24 Hours	2 set-ups	TRUE	-	Uint8
23-51	Period Start	SR	2 set-ups	TRUE	0	TimeOfDay
23-53	Energy Log	0 N/A	All set-ups	TRUE	0	Uint32
23-54	Reset Energy Log	[0] Do not reset	All set-ups	TRUE	-	Uint8
23-6* Trending						
23-60	Trend Variable	[0] Power [kW]	2 set-ups	TRUE	-	Uint8
23-61	Continuous Bin Data	0 N/A	All set-ups	TRUE	0	Uint32
23-62	Timed Bin Data	0 N/A	All set-ups	TRUE	0	Uint32
23-63	Timed Period Start	SR	2 set-ups	TRUE	0	TimeOfDay
23-64	Timed Period Stop	SR	2 set-ups	TRUE	0	TimeOfDay
23-65	Minimum Bin Value	SR	2 set-ups	TRUE	0	Uint8
23-66	Reset Continuous Bin Data	[0] Do not reset	All set-ups	TRUE	-	Uint8
23-67	Reset Timed Bin Data	[0] Do not reset	All set-ups	TRUE	-	Uint8
23-8* Payback Counter						
23-80	Power Reference Factor	100 %	2 set-ups	TRUE	0	Uint8
23-81	Energy Cost	1.00 N/A	2 set-ups	TRUE	-2	Uint32
23-82	Investment	0 N/A	2 set-ups	TRUE	0	Uint32
23-83	Energy Savings	0 kWh	All set-ups	TRUE	75	Int32
23-84	Cost Savings	0 N/A	All set-ups	TRUE	0	Int32

8.3.21 Cascade Controller 25-**-**

Par. No. #	Parameter description	Default value	4-set-up	Change during operation	Conversion index	Type
25-0* System Settings						
25-00	Cascade Controller	null	2 set-ups	FALSE	-	Uint8
25-02	Motor Start	[0] Direct on Line	2 set-ups	FALSE	-	Uint8
25-04	Pump Cycling	null	All set-ups	TRUE	-	Uint8
25-05	Fixed Lead Pump	null	2 set-ups	FALSE	-	Uint8
25-06	Number of Pumps	2 N/A	2 set-ups	FALSE	0	Uint8
25-2* Bandwidth Settings						
25-20	Staging Bandwidth	SR	All set-ups	TRUE	0	Uint8
25-21	Override Bandwidth	100 %	All set-ups	TRUE	0	Uint8
25-22	Fixed Speed Bandwidth	casco_staging_bandwidth (P2520)	All set-ups	TRUE	0	Uint8
25-23	SBW Staging Delay	15 s	All set-ups	TRUE	0	Uint16
25-24	SBW Destaging Delay	15 s	All set-ups	TRUE	0	Uint16
25-25	OBW Time	10 s	All set-ups	TRUE	0	Uint16
25-26	Destage At No-Flow	[0] Disabled	All set-ups	TRUE	-	Uint8
25-27	Stage Function	null	All set-ups	TRUE	-	Uint8
25-28	Stage Function Time	15 s	All set-ups	TRUE	0	Uint16
25-29	Destage Function	null	All set-ups	TRUE	-	Uint8
25-30	Destage Function Time	15 s	All set-ups	TRUE	0	Uint16
25-4* Staging Settings						
25-40	Ramp Down Delay	10.0 s	All set-ups	TRUE	-1	Uint16
25-41	Ramp Up Delay	2.0 s	All set-ups	TRUE	-1	Uint16
25-42	Staging Threshold	SR	All set-ups	TRUE	0	Uint8
25-43	Destaging Threshold	SR	All set-ups	TRUE	0	Uint8
25-44	Staging Speed [RPM]	0 RPM	All set-ups	TRUE	67	Uint16
25-45	Staging Speed [Hz]	0.0 Hz	All set-ups	TRUE	-1	Uint16
25-46	Destaging Speed [RPM]	0 RPM	All set-ups	TRUE	67	Uint16
25-47	Destaging Speed [Hz]	0.0 Hz	All set-ups	TRUE	-1	Uint16
25-5* Alternation Settings						
25-50	Lead Pump Alternation	null	All set-ups	TRUE	-	Uint8
25-51	Alternation Event	[0] External	All set-ups	TRUE	-	Uint8
25-52	Alternation Time Interval	24 h	All set-ups	TRUE	74	Uint16
25-53	Alternation Timer Value	0 N/A	All set-ups	TRUE	0	VisStr[7]
25-54	Alternation Predefined Time	SR	All set-ups	TRUE	0	WoDate
25-55	Alternate if Load < 50%	[1] Enabled	All set-ups	TRUE	-	Uint8
25-56	Staging Mode at Alternation	[0] Slow	All set-ups	TRUE	-	Uint8
25-58	Run Next Pump Delay	0.1 s	All set-ups	TRUE	-1	Uint16
25-59	Run on Mains Delay	0.5 s	All set-ups	TRUE	-1	Uint16

Par. No. #	Parameter description	Default value	4-set-up	Change during operation	Conversion index	Type
25-8* Status						
25-80	Cascade Status	0 N/A	All set-ups	TRUE	0	VisStr[25]
25-81	Pump Status	0 N/A	All set-ups	TRUE	0	VisStr[25]
25-82	Lead Pump	0 N/A	All set-ups	TRUE	0	Uint8
25-83	Relay Status	0 N/A	All set-ups	TRUE	0	VisStr[4]
25-84	Pump ON Time	0 h	All set-ups	TRUE	74	Uint32
25-85	Relay ON Time	0 h	All set-ups	TRUE	74	Uint32
25-86	Reset Relay Counters	[0] Do not reset	All set-ups	TRUE	-	Uint8
25-9* Service						
25-90	Pump Interlock	[0] Off	All set-ups	TRUE	-	Uint8
25-91	Manual Alternation	0 N/A	All set-ups	TRUE	0	Uint8

8.3.22 Analog I/O Option MCB 109 26--***

Par. No. #	Parameter description	Default value	4-set-up	Change during operation	Conversion index	Type
26-0* Analog I/O Mode						
26-00	Terminal X42/1 Mode	[1] Voltage	All set-ups	TRUE	-	Uint8
26-01	Terminal X42/3 Mode	[1] Voltage	All set-ups	TRUE	-	Uint8
26-02	Terminal X42/5 Mode	[1] Voltage	All set-ups	TRUE	-	Uint8
26-1* Analog Input X42/1						
26-10	Terminal X42/1 Low Voltage	0.07 V	All set-ups	TRUE	-2	Int16
26-11	Terminal X42/1 High Voltage	10.00 V	All set-ups	TRUE	-2	Int16
26-14	Term. X42/1 Low Ref./Feedb. Value	0.000 N/A	All set-ups	TRUE	-3	Int32
26-15	Term. X42/1 High Ref./Feedb. Value	100.000 N/A	All set-ups	TRUE	-3	Int32
26-16	Term. X42/1 Filter Time Constant	0.001 s	All set-ups	TRUE	-3	Uint16
26-17	Term. X42/1 Live Zero	[1] Enabled	All set-ups	TRUE	-	Uint8
26-2* Analog Input X42/3						
26-20	Terminal X42/3 Low Voltage	0.07 V	All set-ups	TRUE	-2	Int16
26-21	Terminal X42/3 High Voltage	10.00 V	All set-ups	TRUE	-2	Int16
26-24	Term. X42/3 Low Ref./Feedb. Value	0.000 N/A	All set-ups	TRUE	-3	Int32
26-25	Term. X42/3 High Ref./Feedb. Value	100.000 N/A	All set-ups	TRUE	-3	Int32
26-26	Term. X42/3 Filter Time Constant	0.001 s	All set-ups	TRUE	-3	Uint16
26-27	Term. X42/3 Live Zero	[1] Enabled	All set-ups	TRUE	-	Uint8
26-3* Analog Input X42/5						
26-30	Terminal X42/5 Low Voltage	0.07 V	All set-ups	TRUE	-2	Int16
26-31	Terminal X42/5 High Voltage	10.00 V	All set-ups	TRUE	-2	Int16
26-34	Term. X42/5 Low Ref./Feedb. Value	0.000 N/A	All set-ups	TRUE	-3	Int32
26-35	Term. X42/5 High Ref./Feedb. Value	100.000 N/A	All set-ups	TRUE	-3	Int32
26-36	Term. X42/5 Filter Time Constant	0.001 s	All set-ups	TRUE	-3	Uint16
26-37	Term. X42/5 Live Zero	[1] Enabled	All set-ups	TRUE	-	Uint8
26-4* Analog Out X42/7						
26-40	Terminal X42/7 Output	[0] No operation	All set-ups	TRUE	-	Uint8
26-41	Terminal X42/7 Min. Scale	0.00 %	All set-ups	TRUE	-2	Int16
26-42	Terminal X42/7 Max. Scale	100.00 %	All set-ups	TRUE	-2	Int16
26-43	Terminal X42/7 Bus Control	0.00 %	All set-ups	TRUE	-2	N2
26-44	Terminal X42/7 Timeout Preset	0.00 %	1 set-up	TRUE	-2	Uint16
26-5* Analog Out X42/9						
26-50	Terminal X42/9 Output	[0] No operation	All set-ups	TRUE	-	Uint8
26-51	Terminal X42/9 Min. Scale	0.00 %	All set-ups	TRUE	-2	Int16
26-52	Terminal X42/9 Max. Scale	100.00 %	All set-ups	TRUE	-2	Int16
26-53	Terminal X42/9 Bus Control	0.00 %	All set-ups	TRUE	-2	N2
26-54	Terminal X42/9 Timeout Preset	0.00 %	1 set-up	TRUE	-2	Uint16
26-6* Analog Out X42/11						
26-60	Terminal X42/11 Output	[0] No operation	All set-ups	TRUE	-	Uint8
26-61	Terminal X42/11 Min. Scale	0.00 %	All set-ups	TRUE	-2	Int16
26-62	Terminal X42/11 Max. Scale	100.00 %	All set-ups	TRUE	-2	Int16
26-63	Terminal X42/11 Bus Control	0.00 %	All set-ups	TRUE	-2	N2
26-64	Terminal X42/11 Timeout Preset	0.00 %	1 set-up	TRUE	-2	Uint16

8.3.23 Parameter Lists - Group 27--****

Par. No. #	Parameter description	Default value	4-set-up	Change during operation	Conversion Index	Type
27-0* Control & Status						
27-01	Pump Status	[0] Ready	All set-ups	TRUE	-	Unit8
27-02	Manual Pump Control	[0] No Operation	2 set-ups	TRUE	-	Unit8
27-03	Current Runtime Hours	0 h	All set-ups	TRUE	74	Unit32
27-04	Pump Total Lifetime Hours	0 h	All set-ups	TRUE	74	Unit32
27-1* Configuration						
27-10	Cascade Controller	[0] Disabled	2 set-ups	FALSE	-	Unit8
27-11	Number Of Drives	1 N/A	2 set-ups	FALSE	0	Unit8
27-12	Number Of Pumps	SR	2 set-ups	FALSE	0	Unit8
27-14	Pump Capacity	100 %	2 set-ups	FALSE	0	Unit16
27-16	Runtime Balancing	[0] Balanced Priority 1	2 set-ups	TRUE	-	Unit8
27-17	Motor Starters	[0] Direct Online	2 set-ups	FALSE	-	Unit8
27-18	Spin Time for Unused Pumps	SR	All set-ups	TRUE	0	Unit16
27-19	Reset Current Runtime Hours	[0] Do not reset	All set-ups	TRUE	-	Unit8
27-2* Bandwidth Settings						
27-20	Normal Operating Range	SR	All set-ups	TRUE	0	Unit8
27-21	Override Limit	100 %	All set-ups	TRUE	0	Unit8
27-22	Fixed Speed Only Operating Range	SR	All set-ups	TRUE	0	Unit8
27-23	Staging Delay	15 s	All set-ups	TRUE	0	Unit16
27-24	Destaging Delay	15 s	All set-ups	TRUE	0	Unit16
27-25	Override Hold Time	10 s	All set-ups	TRUE	0	Unit16
27-27	Min Speed Destage Delay	SR	All set-ups	TRUE	0	Unit16
27-3* Staging Speed						
27-30	Auto Tune Staging Speeds	[1] Enabled	All set-ups	TRUE	-	Unit8
27-31	Stage On Speed [RPM]	SR	All set-ups	TRUE	67	Unit16
27-32	Stage On Speed [Hz]	SR	All set-ups	TRUE	-1	Unit16
27-33	Stage Off Speed [RPM]	SR	All set-ups	TRUE	67	Unit16
27-34	Stage Off Speed [Hz]	SR	All set-ups	TRUE	-1	Unit16
27-4* Staging Settings						
27-40	Auto Tune Staging Settings	[0] Disabled	All set-ups	TRUE	-	Unit8
27-41	Ramp Down Delay	10.0 s	All set-ups	TRUE	-1	Unit16
27-42	Ramp Up Delay	2.0 s	All set-ups	TRUE	-1	Unit16
27-43	Staging Threshold	SR	All set-ups	TRUE	0	Unit8
27-44	Destaging Threshold	SR	All set-ups	TRUE	0	Unit8
27-45	Staging Speed [RPM]	0 RPM	All set-ups	TRUE	67	Unit16
27-46	Staging Speed [Hz]	0.0 Hz	All set-ups	TRUE	-1	Unit16
27-47	Destaging Speed [RPM]	0 RPM	All set-ups	TRUE	67	Unit16
27-48	Destaging Speed [Hz]	0.0 Hz	All set-ups	TRUE	-1	Unit16

Par. No. #	Parameter description	Default value	4-set-up	Change during operation	Conversion index	Type
27-5* Alternate Settings						
27-50	Automatic Alternation	[0] Disabled	All set-ups	FALSE	-	Uint8
27-51	Alternation Event	null	All set-ups	TRUE	-	Uint8
27-52	Alternation Time Interval	0 min	All set-ups	TRUE	70	Uint16
27-53	Alternation Timer Value	0 min	All set-ups	TRUE	70	Uint16
27-54	Alternation At Time of Day	[0] Disabled	All set-ups	TRUE	-	Uint8
27-55	Alternation Predefined Time	SR	All set-ups	TRUE	0	TimeOfDayWobDate
27-56	Alternate Capacity is <	0 %	All set-ups	TRUE	0	Uint8
27-58	Run Next Pump Delay	0.1 s	All set-ups	TRUE	-1	Uint16
27-6* Digital Inputs						
27-60	Terminal X66/1 Digital Input	[0] No operation	All set-ups	TRUE	-	Uint8
27-61	Terminal X66/3 Digital Input	[0] No operation	All set-ups	TRUE	-	Uint8
27-62	Terminal X66/5 Digital Input	[0] No operation	All set-ups	TRUE	-	Uint8
27-63	Terminal X66/7 Digital Input	[0] No operation	All set-ups	TRUE	-	Uint8
27-64	Terminal X66/9 Digital Input	[0] No operation	All set-ups	TRUE	-	Uint8
27-65	Terminal X66/11 Digital Input	[0] No operation	All set-ups	TRUE	-	Uint8
27-66	Terminal X66/13 Digital Input	[0] No operation	All set-ups	TRUE	-	Uint8
27-7* Connections						
27-70	Relay	[0] Standard Relay	2 set-ups	FALSE	-	Uint8
27-9* Readouts						
27-91	Cascade Reference	0.0 %	All set-ups	TRUE	-1	Int16
27-92	% Of Total Capacity	0 %	All set-ups	TRUE	0	Uint16
27-93	Cascade Option Status	[0] Disabled	All set-ups	TRUE	-	Uint8
27-94	Cascade System Status	0 N/A	All set-ups	TRUE	0	VisStr[25]

8.3.24 Water Application Functions 29-**

Par. No. #	Parameter description	Default value	4-set-up	Change during operation	Conversion index	Type
29-00	Pipe Fill					
29-00	Pipe Fill Enable	[0] Disabled	2 set-ups	FALSE	-	Uint8
29-01	Pipe Fill Speed [RPM]	SR	All set-ups	TRUE	67	Uint16
29-02	Pipe Fill Speed [Hz]	SR	All set-ups	TRUE	-1	Uint16
29-03	Pipe Fill Time	0.00 s	All set-ups	TRUE	-2	Uint32
29-04	Pipe Fill Rate	0.001 ProcessCtrlUnit	All set-ups	TRUE	-3	Int32
29-05	Filled Setpoint	0.000 ProcessCtrlUnit	All set-ups	TRUE	-3	Int32

8.3.25 Bypass Option 31-**

Par. No. #	Parameter description	Default value	4-set-up	Change during operation	Conversion index	Type
31-00	Bypass Mode	[0] Drive	All set-ups	TRUE	-	Uint8
31-01	Bypass Start Time Delay	30 s	All set-ups	TRUE	0	Uint16
31-02	Bypass Trip Time Delay	0 s	All set-ups	TRUE	0	Uint16
31-03	Test Mode Activation	[0] Disabled	All set-ups	TRUE	-	Uint8
31-10	Bypass Status Word	0 N/A	All set-ups	FALSE	0	V2
31-11	Bypass Running Hours	0 h	All set-ups	FALSE	74	Uint32
31-19	Remote Bypass Activation	[0] Disabled	2 set-ups	TRUE	-	Uint8



9

9 Troubleshooting

9.1 Alarms and Warnings


A warning or an alarm is signalled by the relevant LED on the front of the frequency converter and indicated by a code on the display.

A warning remains active until its cause is no longer present. Under certain circumstances operation of the motor may still be continued. Warning messages may be critical, but are not necessarily so.

In the event of an alarm, the frequency converter will have tripped. Alarms must be reset to restart operation once their cause has been rectified.

This may be done in four ways:

1. By using the [RESET] control button on the LCP control panel.
2. Via a digital input with the "Reset" function.
3. Via serial communication/optional fieldbus.
4. By resetting automatically using the [Auto Reset] function, which is a default setting for VLT AQUA Drive. see par. 14-20 *Reset Mode* in **VLT AQUA Drive Programming Guide**



NB!

After a manual reset using the [RESET] button on the LCP, the [AUTO ON] or [HAND ON] button must be pressed to restart the motor.

If an alarm cannot be reset, the reason may be that its cause has not been rectified, or the alarm is trip-locked (see also table on following page).

Alarms that are trip-locked offer additional protection, means that the mains supply must be switched off before the alarm can be reset. After being switched back on, the frequency converter is no longer blocked and may be reset as described above once the cause has been rectified.

Alarms that are not trip-locked can also be reset using the automatic reset function in par. 14-20 *Reset Mode* (Warning: automatic wake-up is possible!)

If a warning and alarm is marked against a code in the table on the following page, this means that either a warning occurs before an alarm, or it can be specified whether it is a warning or an alarm that is to be displayed for a given fault.

This is possible, for instance, in par. 1-90 *Motor Thermal Protection*. After an alarm or trip, the motor carries on coasting, and the alarm and warning flash on the frequency converter. Once the problem has been rectified, only the alarm continues flashing.



9

No.	Description	Warning	Alarm/Trip	Alarm/Trip Lock	Parameter Reference
1	10 Volts low	X			
2	Live zero error	(X)	(X)		6-01
3	No motor	(X)			1-80
4	Mains phase loss	(X)	(X)	(X)	14-12
5	DC link voltage high	X			
6	DC link voltage low	X			
7	DC over voltage	X	X		
8	DC under voltage	X	X		
9	Inverter overloaded	X	X		
10	Motor ETR over temperature	(X)	(X)		1-90
11	Motor thermistor over temperature	(X)	(X)		1-90
12	Torque limit	X	X		
13	Over Current	X	X	X	
14	Earth fault	X	X	X	
15	Hardware mismatch		X	X	
16	Short Circuit		X	X	
17	Control word timeout	(X)	(X)		8-04
23	Internal Fan Fault	X			
24	External Fan Fault	X			14-53
25	Brake resistor short-circuited	X			
26	Brake resistor power limit	(X)	(X)		2-13
27	Brake chopper short-circuited	X	X		
28	Brake check	(X)	(X)		2-15
29	Drive over temperature	X	X	X	
30	Motor phase U missing	(X)	(X)	(X)	4-58
31	Motor phase V missing	(X)	(X)	(X)	4-58
32	Motor phase W missing	(X)	(X)	(X)	4-58
33	Inrush fault		X	X	
34	Fieldbus communication fault	X	X		
35	Out of frequency range	X	X		
36	Mains failure	X	X		
37	Phase Imbalance	X	X		
39	Heatsink sensor		X	X	
40	Overload of Digital Output Terminal 27	(X)			5-00, 5-01
41	Overload of Digital Output Terminal 29	(X)			5-00, 5-02
42	Overload of Digital Output On X30/6	(X)			5-32
42	Overload of Digital Output On X30/7	(X)			5-33
46	Pwr. card supply		X	X	
47	24 V supply low	X	X	X	
48	1.8 V supply low		X	X	
49	Speed limit	X			
50	AMA calibration failed		X		
51	AMA check U _{nom} and I _{nom}		X		
52	AMA low I _{nom}		X		
53	AMA motor too big		X		
54	AMA motor too small		X		
55	AMA parameter out of range		X		
56	AMA interrupted by user		X		
57	AMA timeout		X		
58	AMA internal fault	X	X		
59	Current limit	X			
60	External Interlock	X			
62	Output Frequency at Maximum Limit	X			
64	Voltage Limit	X			
65	Control Board Over-temperature	X	X	X	
66	Heat sink Temperature Low	X			
67	Option Configuration has Changed		X		
68	Safe Stop Activated		X ¹⁾		
69	Pwr. Card Temp		X	X	
70	Illegal FC configuration			X	
71	PTC 1 Safe Stop	X	X ¹⁾		
72	Dangerous Failure			X ¹⁾	
73	Safe Stop Auto Restart				
76	Power Unit Setup	X			
79	Illegal PS config		X	X	
80	Drive Initialised to Default Value		X		
91	Analog input 54 wrong settings			X	
92	NoFlow	X	X		22-2*
93	Dry Pump	X	X		22-2*
94	End of Curve	X	X		22-5*
95	Broken Belt	X	X		22-6*
96	Start Delayed	X			22-7*
97	Stop Delayed	X			22-7*
98	Clock Fault	X			0-7*

Table 9.1: Alarm/Warning code list



No.	Description	Warning	Alarm/Trip	Alarm/Trip Lock	Parameter Reference
220	Overload Trip		X		
243	Brake IGBT	X	X		
244	Heatsink temp	X	X	X	
245	Heatsink sensor		X	X	
246	Pwr.card supply		X	X	
247	Pwr.card temp		X	X	
248	Illegal PS config		X	X	
250	New spare part			X	
251	New Type Code		X	X	

Table 9.2: Alarm/Warning code list

(X) Dependent on parameter

1) Can not be Auto reset via par. 14-20 *Reset Mode*

A trip is the action when an alarm has appeared. The trip will coast the motor and can be reset by pressing the reset button or make a reset by a digital input (Par. 5-1* [1]). The origin event that caused an alarm cannot damage the frequency converter or cause dangerous conditions. A trip lock is an action when an alarm occurs, which may cause damage to frequency converter or connected parts. A Trip Lock situation can only be reset by a power cycling.

LED indication	
Warning	yellow
Alarm	flashing red
Trip locked	yellow and red

Alarm Word and Extended Status Word					
Bit	Hex	Dec	Alarm Word	Warning Word	Extended Status Word
0	00000001	1	Brake Check	Brake Check	Ramping
1	00000002	2	Pwr. Card Temp	Pwr. Card Temp	AMA Running
2	00000004	4	Earth Fault	Earth Fault	Start CW/CCW
3	00000008	8	Ctrl.Card Temp	Ctrl.Card Temp	Slow Down
4	00000010	16	Ctrl. Word TO	Ctrl. Word TO	Catch Up
5	00000020	32	Over Current	Over Current	Feedback High
6	00000040	64	Torque Limit	Torque Limit	Feedback Low
7	00000080	128	Motor Th Over	Motor Th Over	Output Current High
8	00000100	256	Motor ETR Over	Motor ETR Over	Output Current Low
9	00000200	512	Inverter Overld.	Inverter Overld.	Output Freq High
10	00000400	1024	DC under Volt	DC under Volt	Output Freq Low
11	00000800	2048	DC over Volt	DC over Volt	Brake Check OK
12	00001000	4096	Short Circuit	DC Voltage Low	Braking Max
13	00002000	8192	Inrush Fault	DC Voltage High	Braking
14	00004000	16384	Mains ph. Loss	Mains ph. Loss	Out of Speed Range
15	00008000	32768	AMA Not OK	No Motor	OVC Active
16	00010000	65536	Live Zero Error	Live Zero Error	
17	00020000	131072	Internal Fault	10V Low	
18	00040000	262144	Brake Overload	Brake Overload	
19	00080000	524288	U phase Loss	Brake Resistor	
20	00100000	1048576	V phase Loss	Brake IGBT	
21	00200000	2097152	W phase Loss	Speed Limit	
22	00400000	4194304	Fieldbus Fault	Fieldbus Fault	
23	00800000	8388608	24 V Supply Low	24V Supply Low	
24	01000000	16777216	Mains Failure	Mains Failure	
25	02000000	33554432	1.8V Supply Low	Current Limit	
26	04000000	67108864	Brake Resistor	Low Temp	
27	08000000	134217728	Brake IGBT	Voltage Limit	
28	10000000	268435456	Option Change	Unused	
29	20000000	536870912	Drive Initialised	Unused	
30	40000000	1073741824	Safe Stop	Unused	

Table 9.3: Description of Alarm Word, Warning Word and Extended Status Word

The alarm words, warning words and extended status words can be read out via serial bus or optional fieldbus for diagnosis. See also par. 16-90 *Alarm Word*, par. 16-92 *Warning Word* and par. 16-94 *Ext. Status Word*.

WARNING 23, Internal fans:

External fans have failed due to defect hardware or fans not mounted.

WARNING 24, External fan fault:

The fan warning function is an extra protection function that checks if the fan is running / mounted. The fan warning can be disabled in par. 14-53 *Fan Monitor*, [0] Disabled.

WARNING 25, Brake resistor short-circuited:

The brake resistor is monitored during operation. If it short-circuits, the brake function is disconnected and the warning appears. The frequency converter still works, but without the brake function. Turn off the frequency converter and replace the brake resistor (see par. 2-15 *Brake Check*).


ALARM/WARNING 26, Brake resistor power limit:

The power transmitted to the brake resistor is calculated as a percentage, as a mean value over the last 120 s, on the basis of the resistance value of the brake resistor (par. 2-11 *Brake Resistor (ohm)*) and the intermediate circuit voltage. The warning is active when the dissipated braking power is higher than 90%. If *Trip* [2] has been selected in par. 2-13 *Brake Power Monitoring*, the frequency converter cuts out and issues this alarm, when the dissipated braking power is higher than 100%.

WARNING/ALARM 27, Brake chopper fault:

The brake transistor is monitored during operation and if it short-circuits, the brake function disconnects and the warning comes up. The frequency converter is still able to run, but since the brake transistor has short-circuited, substantial power is transmitted to the brake resistor, even if it is inactive.

Turn off the frequency converter and remove the brake resistor.



Warning: There is a risk of substantial power being transmitted to the brake resistor if the brake transistor is short-circuited.

ALARM/WARNING 28, Brake check failed:

Brake resistor fault: the brake resistor is not connected/working.

WARNING/ALARM 29, Drive over temperature:

If the enclosure is IP00 or IP20/Nema1 the cut-out temperature of the heat-sink is 90 °C. If IP54 is used, the cut-out temperature is 80 °C.

The fault could be:

- Ambient temperature too high
- Too long motor cable

ALARM 30, Motor phase U missing:

Motor phase U between the frequency converter and the motor is missing.

Turn off the frequency converter and check motor phase U.

ALARM 31, Motor phase V missing:

Motor phase V between the frequency converter and the motor is missing. Turn off the frequency converter and check motor phase V.

ALARM 32, Motor phase W missing:

Motor phase W between the frequency converter and the motor is missing.

Turn off the frequency converter and check motor phase W.

ALARM 33, Inrush fault:

Too many powerups have occurred within a short time period. See the chapter *General Specifications* for the allowed number of power-ups within one minute.

WARNING/ALARM 34, Fieldbus communication fault:

The fieldbus on the communication option card is not working.

WARNING/ALARM 35, Option Fault:

Option fault. Please contact your supplier.

WARNING/ALARM 36, Mains failure:

This warning/alarm is only active if the supply voltage to the frequency converter is lost and parameter 14-10 is NOT set to OFF. Possible correction: check the fuses to the frequency converter

WARNING/ALARM 37, Phase Imbalance:

There is a current imbalance between the power units.

ALARM 39, Heatsink Sensor:

No feedback from the heatsink sensor.

WARNING 40, Overload of Digital Output Terminal 27

Check the load connected to terminal 27 or remove short-circuit connection. Check parameters 5-00 and 5-01.

WARNING 41, Overload of Digital Output Terminal 29:

Check the load connected to terminal 29 or remove short-circuit connection. Check parameters 5-00 and 5-02.

WARNING 42, Overload of Digital Output On X30/6 :

Check the load connected to X30/6 or remove short-circuit connection. Check parameter 5-32.

WARNING 42, Overload of Digital Output On X30/7 :

Check the load connected to X30/7 or remove short-circuit connection. Check parameter 5-33.

ALARM 46, Pwr. card supply:

The supply on the power card is out of range.

WARNING 47, 24 V supply low:

The external 24 V DC backup power supply may be overloaded, otherwise contact your Danfoss supplier.

ALARM 48, 1.8 V supply low:

Contact your Danfoss supplier.

WARNING 49, Speed limit:

The speed has been limited by range in par. 4-11 *Motor Speed Low Limit [RPM]* and par. 4-13 *Motor Speed High Limit [RPM]*.

ALARM 50, AMA calibration failed:

Contact your Danfoss supplier.

ALARM 51, AMA check Unom and Inom:

The setting of motor voltage, motor current, and motor power is presumably wrong. Check the settings.

ALARM 52, AMA low Inom:

The motor current is too low. Check the settings.

ALARM 53, AMA motor too big:

The motor is too big for the AMA to be carried out.

ALARM 54, AMA motor too small:

The motor is too small for the AMA to be carried out.

ALARM 55, AMA par. out of range:

The par. values found from the motor are outside acceptable range.

ALARM 56, AMA interrupted by user:

The AMA has been interrupted by the user.

ALARM 57, AMA timeout:

Try to start the AMA again a number of times, until the AMA is carried out. Please note that repeated runs may heat the motor to a level where the resistance R_s and R_r are increased. In most cases, however, this is not critical.

WARNING/ALARM 58, AMA internal fault:

Contact your Danfoss supplier.

WARNING 59, Current limit:

The current is higher than the value in par. 4-18 *Current Limit*.

WARNING 60, External Interlock:

External Interlock has been activated. To resume normal operation, apply 24 VDC to the terminal programmed for External Interlock and reset the frequency converter (via Bus, Digital I/O or by pressing [Reset]).

WARNING 62, Output Frequency at Maximum Limit:

The output frequency is limited by the value set in par. 4-19 *Max Output Frequency*

WARNING/ALARM/TRIP 65, Control Card Over Temperature:

Control card over temperature: The cut-out temperature of the control card is 80° C.

WARNING 66, Low Temp.:

The heat sink temperature is measured to be low. This could indicate that the temperature sensor is defective and thus the fan speed is increased to the maximum in case the power part or control card is very hot.

ALARM 67, Option Configuration has Changed:

One or more options has either been added or removed since the last power-down.

ALARM 68, Safe Stop:

Safe Stop has been activated. To resume normal operation, apply 24 VDC to terminal 37 then send a Reset signal (via Bus, Digital I/O or by pressing [Reset]).

ALARM 69, Pwr. Card Temp:

Power card over temperature.

WARNING 76, Power Unit Setup:

The required number of power units does not match the detected number of active power units.

ALARM 70, Illegal Frequency Converter Configuration:

Actual combination of control board and power board is illegal.

ALARM 90, Feedback Mon.:

ALARM 92, NoFlow:

A no load situation has been detected for the system. See parameter group 22-2*.

ALARM 93, Dry Pump:

A no flow situation and high speed indicates that the pump has run dry. See parameter group 22-2*

ALARM 94, End of Curve:

Feed back stays lower than the set point, which may be indicates a leakage in the pipe system. See parameter group 22-5*

ALARM 95, Broken Belt:

Torque is below the torque level set for no load indicating a broken belt. See parameter group 22-6*

ALARM 96, Start Delayed:

Start of the motor has been delayed due to short cycle protection is active. See parameter group 22-7*.

ALARM 220, Overload Trip:

Motor overload has tripped. Indicates excess motor load. Check motor and driven load. To reset press the "Off Reset" key. Then, to restart the system, press the "Auto On" or "Hand On" key.

WARNING/ALARM 243, Brake IGBT:

The brake transistor is short-circuited or the brake function is disconnected. Turn off the frequency converter as a fire precaution. Report value indicates source of alarm (from left): 1-4 Inverter 5-8 Rectifier.

WARNING/ALARM 244, Heatsink Temp:

Drive heatsink over temperature: Report value indicates source of alarm (from left): 1-4 Inverter 5-8 Rectifier.

ALARM 245, Heatsink Sensor:

No feedback from the heatsink sensor Report value indicates source of alarm (from left): 1-4 Inverter 5-8 Rectifier.

ALARM 246, Pwr. Card Supply:

The supply on the power card is out of range Report value indicates source of alarm (from left): 1-4 Inverter 5-8 Rectifier.

ALARM 247, Pwr. Card Temp:

Power card over temperature Report value indicates source of alarm (from left): 1-4 Inverter 5-8 Rectifier.

ALARM 248, Illegal PS Config:

Power size configuration fault on the power card Report value indicates source of alarm (from left): 1-4 Inverter 5-8 Rectifier.

ALARM 250, New Spare Part:

The power or Switch Mode Power Supply has been exchanged. The frequency converter type code must be restored in the EEPROM. Select the correct type code in Par 14-23 according to the label on unit. Remember to select 'Save to EEPROM' to complete.

ALARM 251, New Type Code:

The frequency converter has got a new type code.



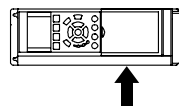
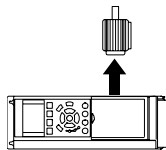
10 Specifications

10.1 General Specifications

10.1.1 Mains Supply 1 x 200 - 240 VAC

Mains Supply 1 x 200 - 240 VAC - Normal overload 110% for 1 minute

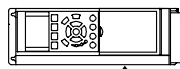
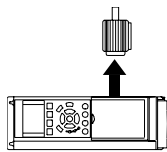
Frequency converter Typical Shaft Output [kW]	P1K1	P1K5	P2K2	P3K0	P3K7	P5K5	P7K5	P15K	P22K
IP 20 / Chassis	1.1	1.5	2.2	3.0	3.7	5.5	7.5	15	22
IP 21 / NEMA 1	1.5	2.0	2.9	4.0	4.9	7.5	10	20	30
IP 55 / NEMA 12	A3	-	-	-	-	-	-	-	-
IP 66	-	B1	B1	B1	B1	B1	B2	C1	C2
	A5	B1	B1	B1	B1	B1	B2	C1	C2
	A5	B1	B1	B1	B1	B1	B2	C1	C2
Output current									
Continuous (3 x 200-240 V) [A]	6.6	7.5	10.6	12.5	16.7	24.2	30.8	59.4	88
Intermittent (3 x 200-240 V) [A]	7.3	8.3	11.7	13.8	18.4	26.6	33.4	65.3	96.8
Continuous kVA (208 V AC) [kVA]						5.00	6.40	12.27	18.30
Max. cable size: (mains, motor, brake) [[mm ² / AWG] ²⁾			0.2-4 / 4-10			10/7	35/2	50/1/0	95/4/0
Max. input current									
Continuous (1 x 200-240 V) [A]	12.5	15	20.5	24	32	46	59	111	172
Intermittent (1 x 200-240 V) [A]	13.8	16.5	22.6	26.4	35.2	50.6	64.9	122.1	189.2
Max. pre-fuses ³⁾ [A]	20	30	40	40	60	80	100	150	200
Environment									
Estimated power loss at rated max. load [W] ⁴⁾	44	30	44	60	74	110	150	300	440
Weight enclosure IP 20 [kg]	4.9	-	-	-	-	-	-	-	-
Weight enclosure IP 21 [kg]	-	23	23	23	23	23	27	45	65
Weight enclosure IP 55 [kg]	-	23	23	23	23	23	27	45	65
Weight enclosure IP 66 [kg]	-	23	23	23	23	23	27	45	65
Efficiency ³⁾	0.968	0.98	0.98	0.98	0.98	0.98	0.98	0.98	0.98



10

Mains supply 3 x 200 - 240 VAC - Normal overload 110% for 1 minute

	B3	B3	B3	B4	B4	B4	B4	C3	C3	C3	C4	C4
IP 20 / NEMA Chassis (B3+4 and C3+4 may be converted to IP21 using a conversion kit (Please contact Danfoss))	B1	B1	B1	B2	B2	B2	B2	C1	C1	C1	C2	C2
IP 21 / NEMA 1	B1	B1	B1	B2	B2	B2	B2	C1	C1	C1	C2	C2
IP 55 / NEMA 12	B1	B1	B1	B2	B2	B2	B2	C1	C1	C1	C2	C2
IP 66	B1	B1	B1	B2	B2	B2	B2	C1	C1	C1	C2	C2
Frequency converter	P5K5	P7K5	P11K	P15K	P18K	P22K	P30K	P37K	P45K	P55K	P66K	P80K
Typical Shaft Output [kW]	5.5	7.5	11	15	18.5	22	30	37	45	55	66	80
Typical Shaft Output [HP] at 208 V	7.5	10	15	20	25	30	40	50	60	75	90	110
Output current												
Continuous (3 x 200-240 V) [A]	24.2	30.8	46.2	59.4	74.8	88.0	115	143	170	210	252	300
Intermittent (3 x 200-240 V) [A]	26.6	33.9	50.8	65.3	82.3	96.8	127	157	187	234	281	340
Continuous kVA (208 V AC) [kVA]	8.7	11.1	16.6	21.4	26.9	31.7	41.4	51.5	61.2	76.5	91.8	111.2
Max. cable size: (mains, motor, brake) [mm ² /AWG] ²⁾	10/7		35/2		50/1/0		95/4/0		120/250 MCM			
Max. input current												
Continuous (3 x 200-240 V) [A]	22.0	28.0	42.0	54.0	68.0	80.0	104.0	130.0	154.0	190	228	280
Intermittent (3 x 200-240 V) [A]	24.2	30.8	46.2	59.4	74.8	88.0	114.0	143.0	169.0	210	252	300
Max. pre-fuses ¹⁾ [A]	63	63	63	80	125	125	160	200	250	315	315	400
Environment:												
Estimated power loss at rated max. load [W] ⁴⁾	269	310	447	602	737	845	1140	1353	1636	2045	2454	3000
Weight enclosure IP20 [kg]	12	12	12	23.5	23.5	35	35	50	50	65	65	80
Weight enclosure IP21 [kg]	23	23	23	27	45	45	65	65	65	80	80	100
Weight enclosure IP55 [kg]	23	23	23	27	45	45	65	65	65	80	80	100
Weight enclosure IP 66 [kg]	23	23	23	27	45	45	65	65	65	80	80	100
Efficiency ³⁾	0.96	0.96	0.96	0.96	0.96	0.97	0.97	0.97	0.97	0.97	0.97	0.97

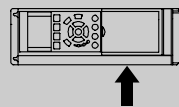
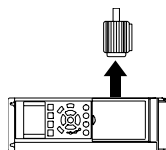




10.1.3 Mains Supply 1 x 380 - 480 VAC

Mains Supply 1x 380 VAC - Normal overload 110% for 1 minute

Frequency converter	P7K5	P11K	P18K	P37K
Typical Shaft Output [kW]	7.5	11	18.5	37
Typical Shaft Output [HP] at 460 V	10	15	25	50
IP 21 / NEMA 1	B1	B2	C1	C2
IP 55 / NEMA 12	B1	B2	C1	C2
IP 66	B1	B2	C1	C2
Output current				
Continuous (3 x 380-440 V) [A]	16	24	37.5	73
Intermittent (3 x 380-440 V) [A]	17.6	26.4	41.2	80.3
Continuous (3 x 441-480 V) [A]	14.5	21	34	65
Intermittent (3 x 441-480 V) [A]	15.4	23.1	37.4	71.5
Continuous kVA (400 V AC) [kVA]	11.0	16.6	26	50.6
Continuous kVA (460 V AC) [kVA]	11.6	16.7	27.1	51.8
Max. cable size: (mains, motor, brake) [[mm ² / AWG] ²⁾	10/7	35/2	50/1/0	120/4/0
Max. input current				
Continuous (1 x 380-440 V) [A]	33	48	78	151
Intermittent (1 x 380-440 V) [A]	36	53	85.8	166
Continuous (1 x 441-480 V) [A]	30	41	72	135
Intermittent (1 x 441-480 V) [A]	33	46	79.2	148
Max. pre-fuses ¹⁾ [A]	63	80	160	250
Environment				
Estimated power loss at rated max. load [W] ⁴⁾	300	440	740	1480
Weight enclosure IP 21 [kg]	23	27	45	65
Weight enclosure IP 55 [kg]	23	27	45	65
Weight enclosure IP 66 [kg]	23	27	45	65
Efficiency ³⁾	0.96	0.96	0.96	0.96

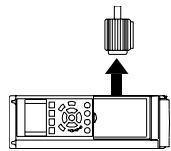


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10.1.4 Mains Supply 3 x 380 - 480 VAC

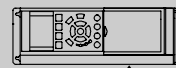
Mains Supply 3 x 380 - 480 VAC - Normal overload 110% for 1 minute

Frequency converter Typical Shaft Output [kW]	PK37	PK55	PK75	PK1K5	PK1K1	PK1K5	P2K2	P3K0	P4K0	P5K5	P7K5
Typical Shaft Output [HP] at 460 V	0.37	0.55	0.75	1.1	1.5	2.0	2.2	3	4	5.5	7.5
IP 20 / NEMA Chassis	0.5	0.75	1.0	1.5	2.0	2.9	2.9	4.0	5.3	7.5	10
IP 21 / NEMA 1	A2	A2	A2	A2	A2	A2	A2	A2	A2	A3	A3
IP 55 / NEMA 12	A5	A5	A5	A5	A5	A5	A5	A5	A5	A5	A5
IP 66	A5	A5	A5	A5	A5	A5	A5	A5	A5	AA	A5
Output current											
Continuous (3 x 380-440 V) [A]	1.3	1.8	2.4	3	4.1	5.6	6.2	7.2	10	13	16
Intermittent (3 x 380-440 V) [A]	1.43	1.98	2.64	3.3	4.5	6.2	7.9	9.9	11	14.3	17.6
Continuous (3 x 441-480 V) [A]	1.2	1.6	2.1	2.7	3.4	4.8	5.3	6.3	8.2	11	14.5
Intermittent (3 x 441-480 V) [A]	1.32	1.76	2.31	3.0	3.7	5.3	6.9	9.0	10	12.1	15.4
Continuous kVA (400 V AC) [kVA]	0.9	1.3	1.7	2.1	2.8	3.9	4.8	5.9	8.1	10.9	14.3
Continuous kVA (460 V AC) [kVA]	0.9	1.3	1.7	2.4	3.1	4.3	5.5	7.0	9.4	12.5	16.6
Max. cable size: (mains, motor, brake) [[mm ² / AWG] ²⁾	4/10										



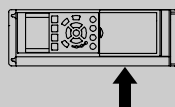
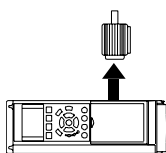
Max. input current

Continuous (3 x 380-440 V) [A]	1.2	1.6	2.2	2.7	3.7	5.0	6.5	9.0	11.7	14.4
Intermittent (3 x 380-440 V) [A]	1.32	1.76	2.42	3.0	4.1	5.5	7.2	9.9	12.9	15.8
Continuous (3 x 441-480 V) [A]	1.0	1.4	1.9	2.7	3.1	4.3	5.7	7.4	9.9	13.0
Intermittent (3 x 441-480 V) [A]	1.1	1.54	2.09	3.0	3.4	4.7	6.3	8.1	10.9	14.3
Max. pre-fuses ¹⁾ [A]	10	10	10	10	10	20	20	20	30	30
Environment										
Estimated power loss at rated max. load [W] ⁴⁾	35	42	46	58	62	88	116	124	187	255
Weight enclosure IP20 [kg]	4.7	4.7	4.8	4.8	4.9	4.9	4.9	4.9	6.6	6.6
Weight enclosure IP 21 [kg]	13.5	13.5	13.5	13.5	13.5	13.5	13.5	13.5	14.2	14.2
Weight enclosure IP 55 [kg]	13.5	13.5	13.5	13.5	13.5	13.5	13.5	13.5	14.2	14.2
Weight enclosure IP 66 [kg]	0.93	0.95	0.96	0.96	0.97	0.97	0.97	0.97	0.97	0.97
Efficiency ³⁾										





Mains Supply 3 x 380 - 480 VAC - Normal overload 110% for 1 minute												
Frequency converter Typical Shaft Output [kW]	P11K 11	P15K 15	P18K 18.5	P22K 22	P30K 30	P37K 37	P45K 45	P55K 55	P75K 75	P90K 90	P125 125	
Typical Shaft Output [HP] at 460 V	15	20	25	30	40	50	60	75	100	100	125	
IP 20 / NEMA Chassis (B3+4 and C3+4 may be converted to IP21 using a conversion kit (Please contact Danfoss))	B3	B3	B3	B4	B4	B4	C3	C3	C4	C4	C4	
IP 21 / NEMA 1	B1	B1	B1	B2	B2	C1	C1	C1	C2	C2	C2	
IP 55 / NEMA 12	B1	B1	B1	B2	B2	C1	C1	C1	C2	C2	C2	
IP 66	B1	B1	B1	B2	B2	C1	C1	C1	C2	C2	C2	
Output current												
Continuous (3 x 380-440 V) [A]	24	32	37.5	44	61	73	90	106	147	147	177	
Intermittent (3 x 380-440 V) [A]	26.4	35.2	41.3	48.4	67.1	80.3	99	117	162	162	195	
Continuous (3 x 441-480 V) [A]	21	27	34	40	52	65	80	105	130	130	160	
Intermittent (3 x 441-480 V) [A]	23.1	29.7	37.4	44	61.6	71.5	88	116	143	143	176	
Continuous kVA (400 V AC) [kVA]	16.6	22.2	26	30.5	42.3	50.6	62.4	73.4	102	102	123	
Continuous kVA (460 V AC) [kVA]	16.7	21.5	27.1	31.9	41.4	51.8	63.7	83.7	104	104	128	
Max. cable size: (mains, motor, brake) [[mm ² / AWG] ²⁾	10/7			35/2			50/1/0			120/4/0		
Max. input current												
Continuous (3 x 380-440 V) [A]	22	29	34	40	55	66	82	96	133	133	161	
Intermittent (3 x 380-440 V) [A]	24.2	31.9	37.4	44	60.5	72.6	90.2	106	146	146	177	
Continuous (3 x 441-480 V) [A]	19	25	31	36	47	59	73	95	118	118	145	
Intermittent (3 x 441-480 V) [A]	20.9	27.5	34.1	39.6	51.7	64.9	80.3	105	130	130	160	
Max. pre-fuses ¹⁾ [A]	63	63	63	63	80	100	125	160	250	250	250	
Environment												
Estimated power loss at rated max. load [W] ⁴⁾	278	392	465	525	698	739	843	1083	1384	1384	1474	
Weight enclosure IP20 [kg]	12	12	12	23.5	23.5	23.5	35	35	50	50	50	
Weight enclosure IP 21 [kg]	23	23	23	27	27	27	45	45	65	65	65	
Weight enclosure IP 55 [kg]	23	23	23	27	27	27	45	45	65	65	65	
Weight enclosure IP 66 [kg]	23	23	23	27	27	27	45	45	65	65	65	
Efficiency ³⁾	0.98	0.98	0.98	0.98	0.98	0.98	0.98	0.98	0.98	0.98	0.99	



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Normal overload 110% for 1 minute

Frequency converter Typical Shaft Output [kW] at 400V Typical Shaft Output [HP] at 460V IP 00 IP 21 / Nema 1 IP 54 / Nema 12	P110 110 150 D3 D1 D1	P132 132 200 D3 D1 D1	P160 160 250 D4 D2 D2	P200 200 300 D4 D2 D2	P250 250 350 D4 D2 D2	P315 315 450 E2 E1 E1	P355 355 500 E2 E1 E1	P400 400 550 E2 E1 E1	P450 450 600 E2 E1 E1	P500 500 700 F1/F3 F1/F3 F1/F3	P560 560 900 F1/F3 F1/F3 F1/F3	P630 630 900 F1/F3 F1/F3 F1/F3	P710 710 1000 F1/F3 F1/F3 F1/F3	P800 800 1200 F2/F4 F2/F4 F2/F4	P1M0 1000 1350 F2/F4 F2/F4 F2/F4
Continuous (3 x 380-440 V) [A]	212	260	315	395	480	600	658	745	800	880	990	1120	1260	1460	1720
Intermittent (3 x 380-440 V) [A]	233	286	347	435	528	660	724	820	880	968	1089	1232	1386	1606	1892
Continuous (3 x 441-480V) [A]	190	240	302	361	443	540	590	678	730	780	890	1050	1160	1380	1530
Intermittent (3 x 441-480V) [A]	209	264	332	397	487	594	649	746	803	858	979	1155	1276	1518	1683
Continuous kVA (400 VAC) [kVA]	147	180	218	274	333	416	456	516	554	610	686	776	873	1012	1192
Continuous kVA (460 VAC) [kVA]	151	191	241	288	353	430	470	540	582	621	709	837	924	1100	1219

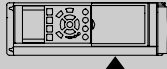


Max. cable size:

(motor), [mm ² / AWG ²⁾]	2x70 2x2/0	2x185 2x300 mcm	4x240 4x500 mcm	8x150 8x300 mcm	12x150 12x300 mcm
(mains.), [mm ² / AWG ²⁾]	2x70 2x2/0	2x185 2x300 mcm	4x240 4x500 mcm	8x240 8x500 mcm	
(loadsharing), [mm ² / AWG ²⁾]	2x70 2x2/0	2x185 2x300 mcm	4x240 4x500 mcm	4x120 4x250 mcm	
(brake), [mm ² / AWG ²⁾]	2x70 2x2/0	2x185 2x300 mcm	2x185 2x350 mcm	4x185 4x350 mcm	6x185 6x350 mcm

Max. input current

Continuous (3 x 380-440 V) [A]	204	251	304	381	463	590	647	733	787	857	964	1090	1227	1422	1675
Continuous (3 x 441-480V) [A]	183	231	291	348	427	531	580	667	718	759	867	1022	1129	1344	1490
Max. pre-fuses ¹⁾ [A]	300	350	400	500	630	700	900	900	900	1600	1600	2000	2000	2500	2500
Environment:															
Estimated power loss at 400 VAC at rated max. load [W] ⁴⁾	3234	3782	4213	5119	5893	6790	7701	8879	9670	10647	12338	13201	15436	18084	20358
Estimated power loss at 460 VAC at rated max. load [W] ⁴⁾	2947	3665	4063	4652	5634	6082	6953	8089	8803	9414	11006	12353	14041	17137	17752
Weight enclosure IP00 [kg]	82	91	112	123	138	221	234	236	277	-	-	-	-	-	-
Weight enclosure IP 21 [kg]	96	104	125	136	151	263	270	272	313	1004	1004	1004	1004	1246	1246
Weight enclosure IP 54 [kg]	96	104	125	136	151	263	270	272	313	1299	1299	1299	1299	1541	1541
Efficiency ³⁾	0.98	0.98	0.98	0.98	0.98	0.98	0.98	0.98	0.98	0.98	0.98	0.98	0.98	0.98	0.98



¹⁾ For type of fuse see section Fuses

²⁾ American Wire Gauge

³⁾ Measured using 5 m screened motor cables at rated load and rated frequency

⁴⁾ The typical power loss is at normal load conditions and expected to be within +/- 15% (tolerance relates to variety in voltage and cable conditions).

Values are based on a typical motor efficiency (eff2/eff3 border line). Lower efficiency motors will also add to the power loss in the frequency converter and vice versa. If the switching frequency is raised from nominal the power losses may rise significantly.

LCP and typical control card power consumptions are included. Further options and customer load may add up to 30 Watts to the losses. (Though typically only 4 Watts extra for a fully loaded control card or options for slot A or slot B, each).

Although measurements are made with state of the art equipment, some measurement inaccuracy must be allowed for (+/- 5%).



10.1.5 Mains Supply 3 x 525 - 600 VAC

Normal overload 110% for 1 minute

Size:	PK75	P1K1	P1K5	P2K2	P3K0	P4K0	P5K5	P7K5	P11K	P15K	P18K	P22K	P30K	P37K	P45K	P55K	P75K	P90K
Typical Shaft Output [kW]	0.75	1.1	1.5	2.2	3	4	5.5	7.5	11	15	18.5	22	30	37	45	55	75	90
IP 20 / NEMA Chassis	A2	A2	A2	A2	A2	A2	A3	A3	B3	B3	B3	B4	B4	B4	C3	C3	C4	C4
IP 21 / NEMA 1	A2	A2	A2	A2	A2	A2	A3	A3	B1	B1	B1	B2	B2	B2	C1	C1	C2	C2
IP 55 / NEMA 12	A5	A5	A5	A5	A5	A5	A5	A5	B1	B1	B1	B2	B2	B2	C1	C1	C2	C2
IP 66	A5	A5	A5	A5	A5	A5	A5	A5	B1	B1	B1	B2	B2	B2	C1	C1	C2	C2
Output current																		
Continuous (3 x 525-550 V) [A]	1.8	2.6	2.9	4.1	5.2	6.4	9.5	11.5	19	23	28	36	43	54	65	87	105	137
Intermittent (3 x 525-550 V) [A]		2.9	3.2	4.5	5.7	7.0	10.5	12.7	21	25	31	40	47	59	72	96	116	151
Continuous (3 x 525-600 V) [A]	1.7	2.4	2.7	3.9	4.9	6.1	9.0	11.0	18	22	27	34	41	52	62	83	100	131
Intermittent (3 x 525-600 V) [A]		2.6	3.0	4.3	5.4	6.7	9.9	12.1	20	24	30	37	45	57	68	91	110	144
Continuous kVA (525 V AC) [kVA]	1.7	2.5	2.8	3.9	5.0	6.1	9.0	11.0	18.1	21.9	26.7	34.3	41	51.4	61.9	82.9	100	130.5
Continuous kVA (575 V AC) [kVA]	1.7	2.4	2.7	3.9	4.9	6.1	9.0	11.0	17.9	21.9	26.9	33.9	40.8	51.8	61.7	82.7	99.6	130.5
Max. cable size (mains, motor, brake) [AWG] 2) [mm ²]				24 - 10 AWG 0.2 - 4					6 16				2 35		1 50			3/0 95.5)
Max. input current																		
Continuous (3 x 525-600 V) [A]	1.7	2.4	2.7	4.1	5.2	5.8	8.6	10.4	17.2	20.9	25.4	32.7	39	49	59	78.9	95.3	124.3
Intermittent (3 x 525-600 V) [A]		2.7	3.0	4.5	5.7	6.4	9.5	11.5	19	23	28	36	43	54	65	87	105	137
Max. pre-fuses ¹⁾ [A]	10	10	10	20	20	20	32	32	40	40	50	60	80	100	150	160	225	250
Environment:																		
Estimated power loss at rated max. load [W] ⁴⁾	35	50	65	92	122	145	195	261	225	285	329	460	560	740	860	890	1020	1130
Weight [kg]:																		
Enclosure IP20	6.5	6.5	6.5	6.5	6.5	6.5	6.6	6.6	12	12	12	23.5	23.5	23.5	35	35	50	50
Efficiency ⁴⁾	0.97	0.97	0.97	0.97	0.97	0.97	0.97	0.97	0.98	0.98	0.98	0.98	0.98	0.98	0.98	0.98	0.98	0.98

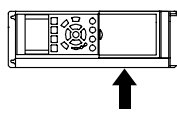
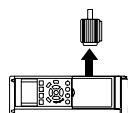


Table 10.1: ⁵⁾ Motor and mains cable: 300MCM/150mm²

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10.1.6 Mains Supply 3 x 525 - 690 VAC

Normal overload 110% for 1 minute												
Size:	P11K	P15K	P18K	P22K	P30K	P37K	P45K	P55K	P75K	P90K		
Typical Shaft Output [kW]	11	15	18.5	22	30	37	45	55	75	90		
Typical Shaft Output [HP] at 575 V	10	16.4	20.1	24	33	40	50	60	75	100		
IP 21 / NEMA 1	B2	B2	B2	B2	B2	C2	C2	C2	C2	C2		
IP 55 / NEMA 12	B2	B2	B2	B2	B2	C2	C2	C2	C2	C2		
Output current												
Continuous (3 x 525-550 V) [A]	14	19	23	28	36	43	54	65	87	105		
Intermittent (3 x 525-550 V) [A]	15.4	20.9	25.3	30.8	39.6	47.3	59.4	71.5	95.7	115.5		
Continuous (3 x 551-690 V) [A]	13	18	22	27	34	41	52	62	83	100		
Intermittent (3 x 551-690 V) [A]	14.3	19.8	24.2	29.7	37.4	45.1	57.2	68.2	91.3	110		
Continuous kVA (550 V AC) [kVA]	13.3	18.1	21.9	26.7	34.3	41	51.4	61.9	82.9	100		
Continuous kVA (575 V AC) [kVA]	12.9	17.9	21.9	26.9	33.8	40.8	51.8	61.7	82.7	99.6		
Continuous kVA (690 V AC) [kVA]	15.5	21.5	26.3	32.3	40.6	49	62.1	74.1	99.2	119.5		
Max. cable size (mains, motor, brake) [mm ²]/[AWG] ²⁾			35 1/0					95 4/0				
Max. input current												
Continuous (3 x 525-690 V) [A]	15	19.5	24	29	36	49	59	71	87	99		
Intermittent (3 x 525-690 V) [A]	16.5	21.5	26.4	31.9	39.6	53.9	64.9	78.1	95.7	108.9		
Max. pre-fuses ¹⁾ [A]	63	63	63	63	80	100	125	160	160	160		
Environment:												
Estimated power loss at rated max. load [W] ⁴⁾	201	285	335	375	430	592	720	880	1200	1440		
Weight:												
IP21 [kg]	27	27	27	27	27	65	65	65	65	65		
IP55 [kg]	27	27	27	27	27	65	65	65	65	65		
Efficiency ⁴⁾	0.98	0.98	0.98	0.98	0.98	0.98	0.98	0.98	0.98	0.98		

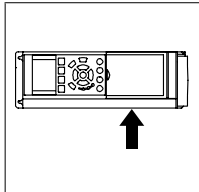
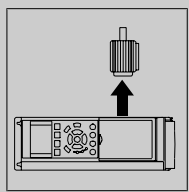


Table 10.2: ⁵⁾ Motor and mains cable: 300MCM/150mm²

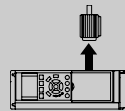
10.1.7 Mains Supply 3 x 525 - 690 VAC

Normal overload 110% for 1 minute

Frequency converter Typical Shaft Output [kW]	P45K	P55K	P75K	P90K	P110	P132	P160	P200	P250	P315	P400	P450	P500	P560	P630	P710	P800	P900	P1M0	P1M2
Typical Shaft Output [HP] at 575 V	45	55	75	90	110	132	160	200	250	315	400	450	500	560	630	710	800	900	1000	1200
IP 00	D3	D3	D3	D3	D3	D3	D3	D4	D4	D4	D4	E2	E2	E2	E2	-	-	-	-	-
IP 21 / Nema 1	D1	D1	D1	D1	D1	D1	D1	D2	D2	D2	D2	E1	E1	E1	E1	F1/F3 ⁶⁾	F1/ F3 ⁶⁾	F1/F3 ⁶⁾	F2/ F4 ⁶⁾	F2/F4 ⁶⁾
IP 54 / Nema 12	D1	D1	D1	D1	D1	D1	D1	D2	D2	D2	D2	E1	E1	E1	E1	F1/F3 ⁶⁾	F1/ F3 ⁶⁾	F1/F3 ⁶⁾	F1/ F3 ⁶⁾	F1/ F3 ⁶⁾
Continuous (3 x 550 V) [A]	56	76	90	113	137	162	201	253	303	360	418	470	523	596	630	763	889	988	1108	1317
Intermittent (3 x 550 V) [A]	62	84	99	124	151	178	221	278	333	396	460	517	575	656	693	839	978	1087	1219	1449
Continuous (3 x 690V) [A]	54	73	86	108	131	155	192	242	290	344	400	450	500	570	630	730	850	945	1060	1260
Intermittent (3 x 690 V) [A]	59	80	95	119	144	171	211	266	319	378	440	495	550	627	693	803	935	1040	1166	1386
Continuous kVA (550 VAC) [kVA]	53	72	86	108	131	154	191	241	289	343	398	448	498	568	600	727	847	941	1056	1255
Continuous kVA (575 VAC) [kVA]	54	73	86	108	130	154	191	241	289	343	398	448	498	568	627	727	847	941	1056	1255
Continuous kVA (690 VAC) ¹⁾ [kVA]	65	87	103	129	157	185	229	289	347	411	478	538	598	681	753	872	1016	1129	1267	1506

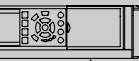
Max. cable size:

(Mains) [mm ² / AWG] ²⁾	2x70	2x2/0	2x185	2x300 mcm	4x240	4x500 mcm	8x240	8x500 mcm
(Motor) [mm ² / AWG] ²⁾	2x70	2x2/0	2x185	2x300 mcm	4x240	4x500 mcm	8x240	8x500 mcm
(Brake) [mm ² / AWG] ²⁾	2x70	2x2/0	2x185	2x300 mcm	2x185	2x350 mcm	4x185	6x185
	2x2/0	2x2/0	2x300 mcm	2x350 mcm	2x350 mcm	2x350 mcm	4x350 mcm	6x350 mcm



Max. input current

Continuous (3 x 550 V) [A]	60	77	89	110	130	158	198	245	299	355	408	453	504	574	607	743	866	962	1079	1282
Continuous (3 x 575 V) [A]	58	74	85	106	124	151	189	224	286	339	390	434	482	549	607	711	828	920	1032	1227
Continuous (3 x 690 V) [A]	58	77	87	109	128	155	197	240	296	352	400	434	482	549	607	711	828	920	1032	1227
Max. mains pre-fuses ¹⁾ [A]	125	160	200	200	250	315	350	350	400	500	550	700	700	900	900	2000	2000	2000	2000	2000



Environment:

Estimated power loss at 690 VAC at rated max. load [W] ⁴⁾	1458	1717	1913	2262	2662	3430	3612	4292	5156	5821	6149	6440	7249	8727	9673	11315	12903	14533	16375	19207
Estimated power loss at 575 VAC at rated max. load [W] ⁴⁾	1398	1645	1827	2157	2533	2963	3430	4051	4867	5493	5852	6132	6903	8343	9244	10771	12272	13835	15592	18281
Weight enclosure IP00 [kg]	82	82	82	82	82	82	91	112	123	138	151	221	221	236	277	-	-	-	-	-
Weight enclosure IP 21 [kg] ⁶⁾	96	96	96	96	96	96	104	125	136	151	165	263	263	272	313	1004	1004	1004	1246	1246
Weight enclosure IP 54 [kg] ⁶⁾	96	96	96	96	96	96	104	125	136	151	165	263	263	272	313	1004	1004	1004	1246	1246
Efficiency ³⁾	0.97	0.97	0.98	0.98	0.98	0.98	0.98	0.98	0.98	0.98	0.98	0.98	0.98	0.98	0.98	0.98	0.98	0.98	0.98	0.98

¹⁾ For type of fuse see section Fuses

²⁾ American Wire Gauge

³⁾ Measured using 5 m screened motor cables at rated load and rated frequency

⁴⁾ The typical power loss is at normal load conditions and expected to be within +/- 15% (tolerance relates to variety in voltage and cable conditions). Values are based on a typical motor efficiency (eff2/eff3 border line). Lower efficiency motors will also add to the power loss in the frequency converter and vice versa.

If the switching frequency is raised from nominal the power losses may rise significantly. LCP and typical control card power consumptions are included. Further options and customer load may add up to 30 [W] to the losses. (Though typically only 4 [W] extra for a fully loaded control card, or options for slot A or slot B, each).

Although measurements are made with state of the art equipment, some measurement inaccuracy must be allowed for (+/- 5%).

⁶⁾ Adding the F-enclosure option cabinet (resulting in the F3 and F4 enclosure sizes) adds 295 kg to the estimated weight.

Protection and Features:

- Electronic thermal motor protection against overload.
- Temperature monitoring of the heatsink ensures that the frequency converter trips if the temperature reaches $95\text{ }^{\circ}\text{C} \pm 5^{\circ}\text{C}$. An overload temperature cannot be reset until the temperature of the heatsink is below $70\text{ }^{\circ}\text{C} \pm 5^{\circ}\text{C}$ (Guideline - these temperatures may vary for different power sizes, enclosures etc.). VLT AQUA Drive has an auto derating function to avoid it's heatsink reaching 95 deg C.
- The frequency converter is protected against short-circuits on motor terminals U, V, W.
- If a mains phase is missing, the frequency converter trips or issues a warning (depending on the load).
- Monitoring of the intermediate circuit voltage ensures that the frequency converter trips if the intermediate circuit voltage is too low or too high.
- The frequency converter is protected against earth faults on motor terminals U, V, W.

Mains supply (L1, L2, L3):

Supply voltage	200-240 V $\pm 10\%$
Supply voltage	380-480 V $\pm 10\%$
Supply voltage	525-600 V $\pm 10\%$
Supply voltage	525-690 V $\pm 10\%$

Mains voltage low / mains drop-out:

During low mains voltage or a mains drop-out, the FC continues until the intermediate circuit voltage drops below the minimum stop level, which corresponds typically to 15% below the FC's lowest rated supply voltage. Power-up and full torque cannot be expected at mains voltage lower than 10% below the FC's lowest rated supply voltage.

Supply frequency	50/60 Hz +4/-6%
------------------	-----------------

The frequency converter power supply is tested in accordance with IEC61000-4-28, 50 Hz +4/-6%.

Max. imbalance temporary between mains phases	3.0 % of rated supply voltage
True Power Factor (λ)	≥ 0.9 nominal at rated load
Displacement Power Factor ($\cos\phi$) near unity	(> 0.98)
Switching on input supply L1, L2, L3 (power-ups) \leq enclosure type A	maximum 2 times/min.
Switching on input supply L1, L2, L3 (power-ups) \geq enclosure type B, C	maximum 1 time/min.
Switching on input supply L1, L2, L3 (power-ups) \geq enclosure type D, E, F	maximum 1 time/2 min.
Environment according to EN60664-1	overvoltage category III/pollution degree 2

The unit is suitable for use on a circuit capable of delivering not more than 100.000 RMS symmetrical Amperes, 240/480 V maximum.

Motor output (U, V, W):

Output voltage	0 - 100% of supply voltage
Output frequency	0 - 1000 Hz*
Switching on output	Unlimited
Ramp times	1 - 3600 sec.

** Dependent on power size.*

Torque characteristics:

Starting torque (Constant torque)	maximum 110% for 1 min.*
Starting torque	maximum 135% up to 0.5 sec.*
Overload torque (Constant torque)	maximum 110% for 1 min.*

**Percentage relates to VLT AQUA Drive's nominal torque.*

Cable lengths and cross sections:

Max. motor cable length, screened/armoured	VLT AQUA Drive: 150 m
Max. motor cable length, unscreened/unarmoured	VLT AQUA Drive: 300 m
Max. cross section to motor, mains, load sharing and brake *	
Maximum cross section to control terminals, rigid wire	1.5 mm ² /16 AWG (2 x 0.75 mm ²)
Maximum cross section to control terminals, flexible cable	1 mm ² /18 AWG
Maximum cross section to control terminals, cable with enclosed core	0.5 mm ² /20 AWG
Minimum cross section to control terminals	0.25 mm ²

** See Mains Supply tables for more information!*

Control card, RS-485 serial communication:

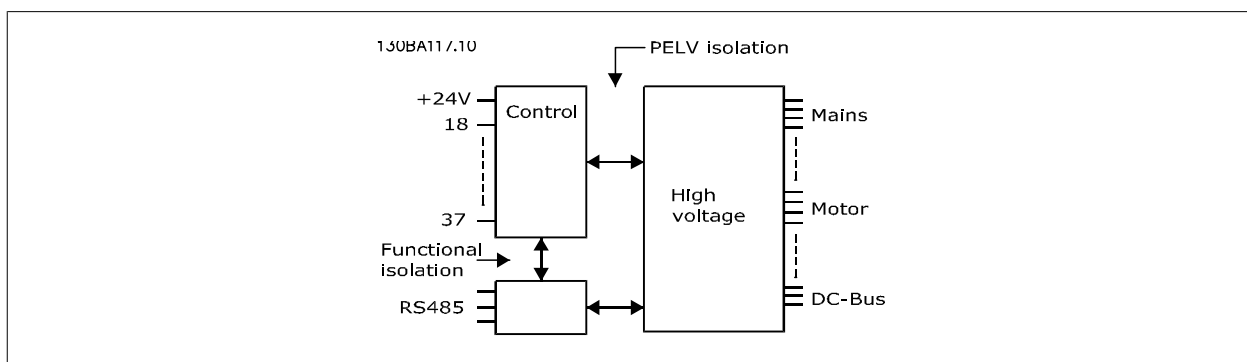
Terminal number	68 (P,TX+, RX+), 69 (N,TX-, RX-)
Terminal number 61	Common for terminals 68 and 69

The RS-485 serial communication circuit is functionally seated from other central circuits and galvanically isolated from the supply voltage (PELV).

Analog inputs:

Number of analog inputs	2
Terminal number	53, 54
Modes	Voltage or current
Mode select	Switch S201 and switch S202
Voltage mode	Switch S201/switch S202 = OFF (U)
Voltage level	: 0 to + 10 V (scaleable)
Input resistance, R_i	approx. 10 k Ω
Max. voltage	\pm 20 V
Current mode	Switch S201/switch S202 = ON (I)
Current level	0/4 to 20 mA (scaleable)
Input resistance, R_i	approx. 200 Ω
Max. current	30 mA
Resolution for analog inputs	10 bit (+ sign)
Accuracy of analog inputs	Max. error 0.5% of full scale
Bandwidth	: 200 Hz

The analog inputs are galvanically isolated from the supply voltage (PELV) and other high-voltage terminals.



Analog output:

Number of programmable analog outputs	1
Terminal number	42
Current range at analog output	0/4 - 20 mA
Max. resistor load to common at analog output	500 Ω
Accuracy on analog output	Max. error: 0.8 % of full scale
Resolution on analog output	8 bit

The analog output is galvanically isolated from the supply voltage (PELV) and other high-voltage terminals.

Digital inputs:

Programmable digital inputs	4 (6)
Terminal number	18, 19, 27 ¹⁾ , 29 ¹⁾ , 32, 33,
Logic	PNP or NPN
Voltage level	0 - 24 V DC
Voltage level, logic '0' PNP	< 5 V DC
Voltage level, logic '1' PNP	> 10 V DC
Voltage level, logic '0' NPN	> 19 V DC
Voltage level, logic '1' NPN	< 14 V DC
Maximum voltage on input	28 V DC
Input resistance, R_i	approx. 4 k

All digital inputs are galvanically isolated from the supply voltage (PELV) and other high-voltage terminals.

1) Terminals 27 and 29 can also be programmed as output.

Control characteristics:

Resolution of output frequency at 0 - 1000 Hz	: +/- 0.003 Hz
System response time (terminals 18, 19, 27, 29, 32, 33)	: ≤ 2 ms
Speed control range (open loop)	1:100 of synchronous speed
Speed accuracy (open loop)	30 - 4000 rpm: Maximum error of ±8 rpm

All control characteristics are based on a 4-pole asynchronous motor

Surroundings:

Enclosure type A	IP 20/Chassis, IP 21kit/Type 1, IP55/Type12, IP 66
Enclosure type B1/B2	IP 21/Type 1, IP55/Type12, IP 66
Enclosure type B3/B4	IP20/Chassis
Enclosure type C1/C2	IP 21/Type 1, IP55/Type 12, IP66
Enclosure type C3/C4	IP20/Chassis
Enclosure type D1/D2/E1	IP21/Type 1, IP54/Type12
Enclosure type D3/D4/E2	IP00/Chassis
Enclosure kit available ≤ enclosure type A	IP21/TYPE 1/IP 4X top
Vibration test enclosure A/B/C	1.0 g
Vibration test enclosure D/E/F	0.7 g
Max. relative humidity	5% - 95%(IEC 721-3-3; Class 3K3 (non-condensing) during operation
Aggressive environment (IEC 721-3-3), uncoated	class 3C2
Aggressive environment (IEC 721-3-3), coated	class 3C3
Test method according to IEC 60068-2-43 H2S (10 days)	
Ambient temperature	Max. 50 °C

Derating for high ambient temperature, see section on special conditions

Minimum ambient temperature during full-scale operation	0 °C
Minimum ambient temperature at reduced performance	- 10 °C
Temperature during storage/transport	-25 - +65/70 °C
Maximum altitude above sea level without derating	1000 m
Maximum altitude above sea level with derating	3000 m

Derating for high altitude, see section on special conditions

EMC standards, Emission	EN 61800-3, EN 61000-6-3/4, EN 55011, IEC 61800-3 EN 61800-3, EN 61000-6-1/2,
EMC standards, Immunity	EN 61000-4-2, EN 61000-4-3, EN 61000-4-4, EN 61000-4-5, EN 61000-4-6

See section on special conditions

Control card performance:

Scan interval	: 5 ms
Control card, USB serial communication:	
USB standard	1.1 (Full speed)
USB plug	USB type B "device" plug



Connection to PC is carried out via a standard host/device USB cable.
 The USB connection is galvanically isolated from the supply voltage (PELV) and other high-voltage terminals.
 The USB connection is not galvanically isolated from protection earth. Use only isolated laptop/PC as connection to the USB connector on VLT AQUA Drive or an isolated USB cable/converter.



10.2 Special Conditions

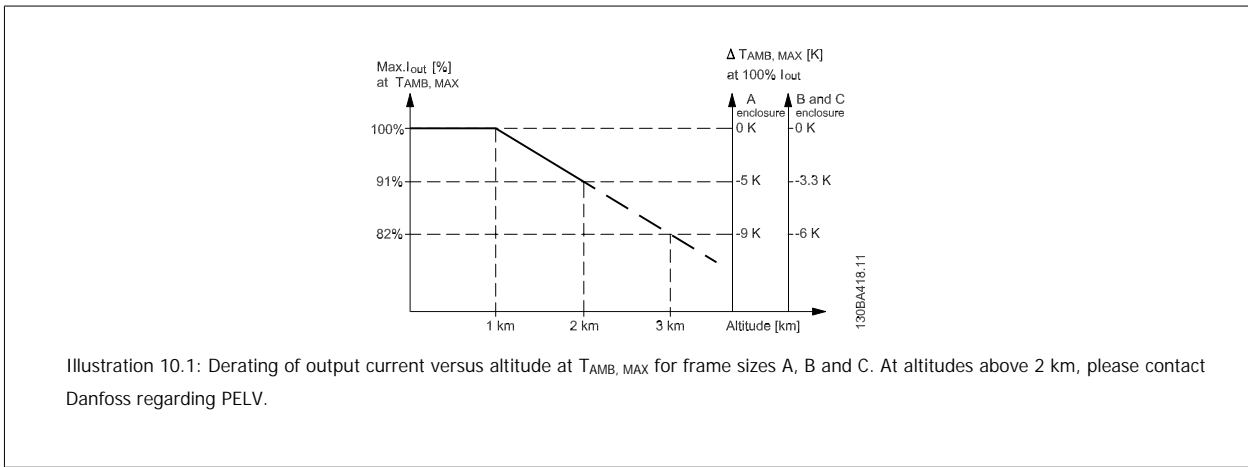
10.2.1 Purpose of Derating

Derating must be taken into account when using the frequency converter at low air pressure (heights), at low speeds, with long motor cables, cables with a large cross section or at high ambient temperature. The required action is described in this section.

10.2.2 Derating for low air pressure

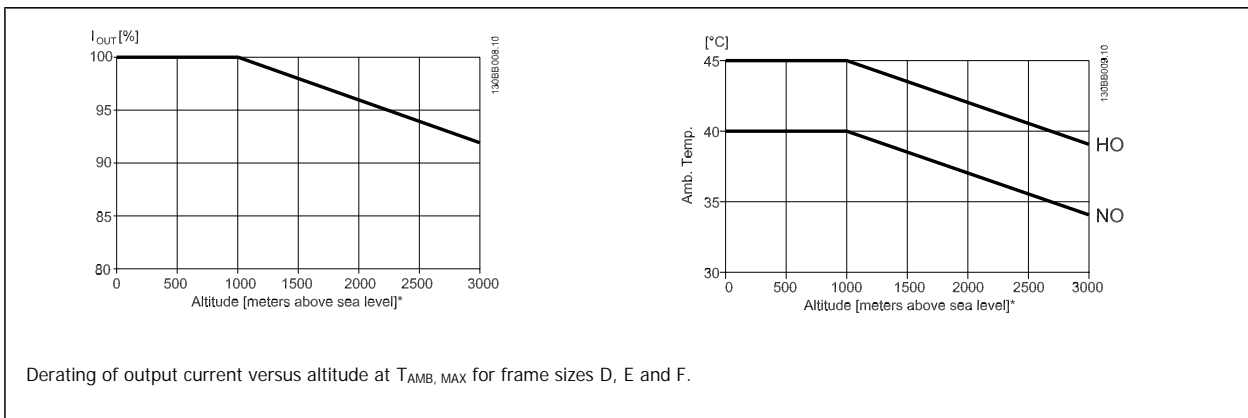
The cooling capability of air is decreased at lower air pressure.

Below 1000 m altitude no derating is necessary but above 1000 m the ambient temperature (T_{AMB}) or max. output current (I_{out}) should be derated in accordance with the shown diagram.



10

An alternative is to lower the ambient temperature at high altitudes and thereby ensure 100% output current at high altitudes. As an example of how to read the graph, the situation at 2 km is elaborated. At a temperature of 45° C ($T_{AMB, MAX} - 3.3$ K), 91% of the rated output current is available. At a temperature of 41.7° C, 100% of the rated output current is available.



10.2.3 Derating for running at low speed

When a motor is connected to a frequency converter, it is necessary to check that the cooling of the motor is adequate. The level of heating depends on the load on the motor, as well as the operating speed and time.

Constant torque applications (CT mode)

A problem may occur at low RPM values in constant torque applications. In a constant torque application a motor may over-heat at low speeds due to less cooling air from the motor integral fan.

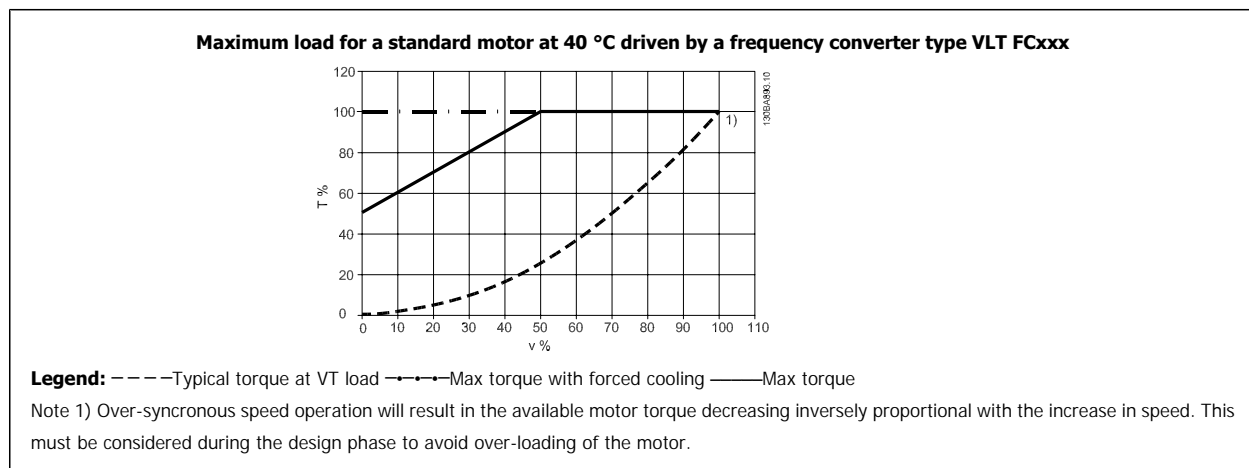
Therefore, if the motor is to be run continuously at an RPM value lower than half of the rated value, the motor must be supplied with additional air-cooling (or a motor designed for this type of operation may be used).

An alternative is to reduce the load level of the motor by choosing a larger motor. However, the design of the frequency converter puts a limit to the motor size.

Variable (Quadratic) torque applications (VT)

In VT applications such as centrifugal pumps and fans, where the torque is proportional to the square of the speed and the power is proportional to the cube of the speed, there is no need for additional cooling or de-rating of the motor.

In the graphs shown below, the typical VT curve is below the maximum torque with de-rating and maximum torque with forced cooling at all speeds.



10.2.4 Automatic adaptations to ensure performance

The frequency converter constantly checks for critical levels of internal temperature, load current, high voltage on the intermediate circuit and low motor speeds. As a response to a critical level, the frequency converter can adjust the switching frequency and / or change the switching pattern in order to ensure the performance of the frequency converter. The capability to automatically reduce the output current extends the acceptable operating conditions even further.

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23. Test Sheets



Halmac Services (Qld) Pty. Ltd.
A.C.N. 098 852 923
A.B.N. 40 741 712 113

TEST SHEET

1. PUMP STATION SP281 TEST SHEET

DESIGN & INSPECTION ROUTE SCHEDULE

CUSTOMER: BRISBANE WATER	PROJECT NAME: REPLACEMENT SWITCHBOARDS	PROJECT OFFICER: DJ
JOB NO: A4214	SWITCHBOARD NAME: SP 281	DRAWING NO: SUPPLIED

IS THIS SWITCHBOARD IDENTICAL, OR SIMILAR, TO A PREVIOUS DESIGN? YES (DELETE AS APPLICABLE)
 IF "NO" COMPLETE SWITCHBOARD DESIGN REVIEW. IF "YES" PROVIDE PREVIOUS DRAWING NO. REFERENCE

(TICK APPLICABLE SECTION BELOW: YES / NO / N/A (Not Applicable))

DESCRIPTION	INSPECTION/TEST			INSP.	DATE	IF BUSBARS ARE APPLICABLE COMPLETE DETAIL BELOW																																			
	YES	NO	N/A																																						
SHEET METALWORK - UNPAINTED	X			DJ	30/11	• Sizing as per approved shop drawings • Accessible terminations and fixings • Adequate supports and spacing • Bolts correct type and torque tension • Compartment segregation • Phase-Phase & Phase-Earth Clearance INSULATION TEST 1. Megger between phases, phase to N/L phases to earth, with MEN link removed. Note details below in Table "Megger 1" 2. Megger N/L to earth with MEN link removed. 3. Apply 2.5kV for (1) min., phase to phase, phase to NL, and 3-phases to earth. 4. Remove HI VOLT tester and repeat item (1). Note details below in Table "Megger 2". HV TEST Set Details: "MEGGER" Detail: KYORITSU 3111V Serial 1180891 No. "HI POT" TEST VOLTAGE: kV Duration mins "MEGGER" TEST VOLTAGE: 500 Volts D.C. INSTRUMENT CALIBRATION: DUE 29/5/10 <table border="1" style="width: 100%; border-collapse: collapse;"> <thead> <tr> <th>TEST</th> <th>MEGGER 1</th> <th>"HI POT"</th> <th>MEGGER 2</th> </tr> </thead> <tbody> <tr> <td>Red-White</td> <td>750... M Ohm</td> <td>..... mA</td> <td>..... M Ohm</td> </tr> <tr> <td>White-Blue</td> <td>750... M Ohm</td> <td>..... mA</td> <td>..... M Ohm</td> </tr> <tr> <td>Red-Blue</td> <td>750... M Ohm</td> <td>..... mA</td> <td>..... M Ohm</td> </tr> <tr> <td>Red-Neutral</td> <td>750... M Ohm</td> <td>..... mA</td> <td>..... M Ohm</td> </tr> <tr> <td>White-Neutral</td> <td>750... M Ohm</td> <td>..... mA</td> <td>..... M Ohm</td> </tr> <tr> <td>Blue-Neutral</td> <td>750... M Ohm</td> <td>..... mA</td> <td>..... M Ohm</td> </tr> <tr> <td>R.W.B.-Earth</td> <td>750... M Ohm</td> <td>..... mA</td> <td>..... M Ohm</td> </tr> </tbody> </table>				TEST	MEGGER 1	"HI POT"	MEGGER 2	Red-White	750... M Ohm mA M Ohm	White-Blue	750... M Ohm mA M Ohm	Red-Blue	750... M Ohm mA M Ohm	Red-Neutral	750... M Ohm mA M Ohm	White-Neutral	750... M Ohm mA M Ohm	Blue-Neutral	750... M Ohm mA M Ohm	R.W.B.-Earth	750... M Ohm mA M Ohm
TEST	MEGGER 1	"HI POT"	MEGGER 2																																						
Red-White	750... M Ohm mA M Ohm																																						
White-Blue	750... M Ohm mA M Ohm																																						
Red-Blue	750... M Ohm mA M Ohm																																						
Red-Neutral	750... M Ohm mA M Ohm																																						
White-Neutral	750... M Ohm mA M Ohm																																						
Blue-Neutral	750... M Ohm mA M Ohm																																						
R.W.B.-Earth	750... M Ohm mA M Ohm																																						
WIRING BUILDING WIRE		X		DJ	12/12																																				
FLEX	X			DJ	12/12																																				
CRIMP LUGS	X			DJ	12/12																																				
BUSBARS AFTER MANUFACTURE			X	D.J.	12/12																																				
BUSBARS - AFTER ASSEMBLY			X	D.J.	12/12																																				
FITTING OUT - BEFORE WIRING	X			JB	14/12																																				
FITTING OUT - AFTER WIRING	X			JB	14/12																																				
NAME PLATES - BEFORE FITTING	X			JB	17/12																																				
NAME PLATES - AFTER FITTING	X			JB	19/12																																				
MEGGER &/OR H.V. TEST	X			JB	21/12																																				
FUSES/C-B'S - CORRECT SIZE	X			JB	21/12																																				
WIRE & TERMINALS NUMBERED	X			JB	21/12																																				
CONTROL & POWER CONN. TIGHT	X			JB	21/12																																				
POINT TO POINT TEST	X			DJ	24/12																																				
FUNCTIONAL TEST	X			DJ	7/1																																				
COMPLETE S/BOARD TESTING	X			DJ	7/1																																				
PLC/PROGRAMMING		X		DJ	12/12																																				
FULL DOCUMENTATION IN DWG POCKET	X			DJ	23/12																																				
CORRECT DRAWING IN BOARD		X		DJ	12/12																																				
PACKING		X		DJ	12/12																																				
REQUEST FOR RELEASE																																									
'As Built' Dwgs-Completed	X			D.J.	23/12																																				
Test Reports - O.K.	X			DJ	23/12																																				
Delivery Docket - Completed			X	DJ	12/12																																				
Packaging - Completed			X	DJ	12/12																																				

I certify that the electrical switchboard has been tested in accordance with the prescribed procedure and is suitable for connection to supply.

Certificate of Competency No : ...C16507.....

Signature of Electrical Mechanic : *[Signature]*

WIRE COLOURS	240V ACTIVE: RED	240V NEUTRAL: BLACK
ELV-AC ACTIVE:	ELV-AC COMMON:	ELV DEVICES: SALMON
ELV-DC POSITIVE: GREY	ELV-DC NEGATIVE: GREY	TELEMETRY: VIOLET

NOTES: BRISBANE WATER DESIGN . 24VDC IS ORANGE & VIOLET TO FIRST FUSE OR C/B.

Inspected by: J. CLAYTON of QUU DATE: 21/1/10
 Accepted by: _____ of _____ DATE: _____
 Release Authorized by: _____ of _____ DATE: _____

