751-SG

User Manual

Windmill Software Ltd

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For updates see http://www.windmill.co.uk/help.html

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Table of Contents

Introduction

Thank you for purchasing the 75l-SG Strain Measurement and Control Package. This Manual tells you:

* About the 751-SG system and how to connect your signals (Chapter 2)
* How to install the Windmill software (Chapter 3)
* How to use Windmill software with the 751-SG (Chapter 4)

To use the 751-SG system you need a PC with a USB port. It should be running Windows 7 (64- or 32-bit), XP, 2000 or 98SE.

With the 751-SG you can

* Monitor voltages, strain and balanced bridges like pressure transducers. With additional 59x units you can also monitor current and thermocouples.
* Zero or balance bridges, nulling the offset of the initial voltage and thus taking more precise measurements.
* Record readings in microstrain or the engingeering units of your choice.
* Switch digital inputs individually or several at once.
* Count up to 65535.
* Choose input range and resolution.

Installing the 751-SG System

2.1 Introduction

The 751-SG system comprises:

* A 751 data acquisition unit
* A 594 strain gauge connection box
* Windmill software

The 751 unit lets you connect 16 analogue inputs, 32 digital inputs/outputs and 8 counters to your PC.

It has two 37-way connectors: 1 for analogue connections and one for digital and counter connections.

When measuring strain, connect the 594 strain gauge box to the 751's analogue connector with the ribbon cable. You can then wire your strain signals to the 594's screw terminals.

This chapter tells you how to connect your signals to the 751. After making your connections, see the next chapter for details of installing the Windmill software. Make sure that you connect your hardware to the computer before starting Windmill.

2.2 Using Several 751 Units

As you can connect up to eight 75x units to one PC, each one must have some way of identifying itself: an ID code.

1. If you have just one 751: its ID code is 0 and you can ignore this section.

2. If you add a 751 to your system: you can set its ID code using 3 pins on the digital connector

The pins in question are numbers 28, 9 and 10. You set an ID code by connecting these pins to 0 V, as follows.

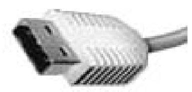
ID Code	Pin 10	Pin 9	Pin 28
0	no	no	no
1	no	no	yes
2	no	yes	no
3	no	yes	yes
4	yes	no	no
5	yes	no	yes
6	yes	yes	no
7	yes	yes	yes

See the Pin Connections Table on page 2.7 for the location of the pins and 0 V.

Make a note of the ID Codes, you'll need them when using Windmill ConfIML to install the driver software. For quick identification, you may find it helpful to label your 751s with their codes.

Set the ID code before connecting the Microlinks to the PC.

2.3 Plugging the 751 into the Computer



Plugging the into your PC could not be easier: just use the USB cable provided. You don't have to switch off your computer first—or even restart Windows.

The 751 is powered from the USB port: if you are not measuring strain, you don't need an extra power supply box. For strain measurements see Section 2.9.

2.4 The 751's Lights

The 751 has two red lights labelled ENUM and BUSY. Neither of these will come on until you have installed the Windmill software.

ENUM — ENUM stands for Enumerated. This is lit when the 751 has been powered on by the USB plug and play controller. It is a good indication that the Windmill USB driver software has been correctly loaded.

BUSY — This is lit for the duration of each USB communication. It is not active until the has been enumerated.

2.5 Analogue Input Connection Notes

The 751 provides 16 differential analogue inputs. It also has an auxiliary channel which, when used with the 594 box, is reserved for bridge excitation monitoring. It uses an integrating analogue-to-digital converter, where the integration time and resolution are under software control (set in the Windmill ConfIML program, Section 3.4).

At regular intervals Windmill uses a stable on-board reference voltage for recalibration. Use ConfIML to set this recalibration interval.

2.5.1 Differential Inputs

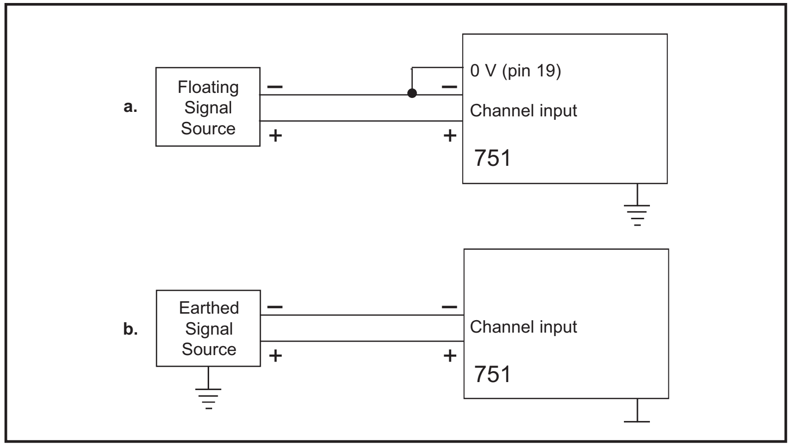
All the inputs are differential: for each input signal there are two signal wires. The measurement is the difference in voltage between the two wires. The two signals go into separate high-impedance amplifiers which monitor the voltage between the input and ground. The outputs of the two amplifiers are then subtracted to give the difference between the + and – inputs. For small signals differential inputs are much better than single-ended inputs, because the subtraction of the voltages on each of the input wires means that any voltage common to both wires is removed, so reducing noise.

It is important to remember that the voltages at both inputs must be within the amplifier operating range. A classic error is to connect a battery between positive and negative inputs with no other connection. Although the difference between the inputs is well defined, the actual voltage at each input could be anything. Connecting one end of the battery to the 0 V input, either direct or via a resistor, would solve the problem.

The 0 V of the 751 is connected to computer earth, which is usually connected to the mains earth. When making your connections you should follow this policy.

a. If your signal source is "floating", i.e. has no reference to mains earth, then you must provide a reference by connecting one end of it to the 0 V input, either direct or via a resistor. The resistor could have any value up to several MΩ. However large values could cause 50 Hz problems if your signal source has much leakage to earth.

b. If your signal source is itself earthed then you should connect only positive and negative inputs. You should make no connection to 751 earth.



For floating signals you need to connect one end of the signal to the 0 V input on pin 19

2.5.2 Input Voltage Range

The 751 operates correctly with input voltages in the range ±11 V. The inputs will reject voltages which are common to both positive and negative inputs. These common mode voltages could be as big as 13 V.

2.5.3 Maximum Input Voltage

The input multiplexers are protected against dc voltages of 33 V above the power supply. This means ±48 V if the computer is switched on, ±33 V if it is switched off. If the over-voltage is transient then protection extends as far as ±300 V. When a voltage above the power supply is applied to the unit its protection mechanism comes into action, and this draws some current from the signal source. This effect can be a problem when the computer is switched off as it now draws current from any signal. This current is limited by 4K7 resistors. Extra series resistors can be added to reduce this fault current.

2.5.4 Unconnected Inputs

You can leave unused inputs unconnected, but if you attempt to read from these unconnected inputs do not expect to get 0 V. They could be any value. If another connected channel has recently been read, the unconnected input will return a similar value. This is not crosstalk. It occurs because the input capacitance of the amplifier is charged to the voltage of the previous channel and has little incentive to change when connected to an open circuit.

2.5.5 Auxiliary Input

This input has all the facilities of the other sixteen. In Windmill software it is used for measuring excitation voltage in bridge circuits. When using a 594 bridge input unit, the auxiliary input is automatically connected as required by the software.

2.5.6 Analogue Input Pin Numbers

Analogue inputs not being used for strain measurement are connected to the analogue 37-way D connector as detailed in the table on page 2.7.

751 - 16 Analogue Inputs

		19	0 V
+15 V	37	18	–15 V
+ Auxiliary	36	17	– Auxiliary
+ Input 15	35	16	– Input 15
+ Input 14	34	15	– Input 14
+ Input 13	33	14	– Input 13
+ Input 12	30	13	– Input 12
+ Input 11	31	12	– Input 11
+ Input 10	30	11	– Input 10
+ Input 9	29	10	– Input 9
+ Input 8	28	9	– Input 8
+ Input 7	27	8	– Input 7
+ Input 6	26	7	– Input 6
+ Input 5	25	6	– Input 5
+ Input 4	24	5	– Input 4
+ Input 3	23	4	– Input 3
+ Input 2	22	3	– Input 2
+ Input 1	21	2	– Input 1
+ Input 0	20	1	– Input 0

Please read the Connection Notes on the previous pages before making your connections.

2.6 Digital Input and Output Connection Notes

The 751 provides digital input to the computer and output control by the computer. Its 32 general purpose input and output lines are arranged in 4 groups or ports. Each port can be either input or output (set using the Windmill SetupIML program). All ports power-up as inputs. The ports are referred to as Port 0 to Port 3. Port 3 also functions as 8 event counters, detailed in the next section.

2.6.1 Input Voltages

All inputs are high impedance CMOS type. They are TTL and 5 V CMOS compatible. Input Voltages should be within the range 0 to 5 V. Higher Voltages can be dealt with by the addition of resistor networks. This can be conveniently done on a 590 unit. Input protection can be provided in a similar manner.

2.6.2 Contact Closures

You can interface to contact closures using a resistor to tie the input to either 5 or 0 V. The contact then switches the line to either 0 or 5 V. The resistor can be fitted to a 590 unit.

2.6.3 Noisy Inputs

Input Filters can be fitted to a 590 unit if required.

2.6.4 Output Drive

The outputs are TTL and 5 V CMOS compatible. They can drive 15 LSTTL loads. You can increase the output drive by using additional transistors, which can be fitted to the 590 unit. Currents of 1 amp can easily be switched.

2.6.5 Power-Up State

The 751 unit will power-up as all inputs. If you intend to use the card to control outputs then you may want to define logic states at power-up. This can be done by resistors which tie the lines to either 0 or 5 V, mounted on a 590 unit.

2.6.6 Pin Numbers

Make the I/O connections to the digital 37-way connector. See the Pin Connections Table on page 2.10.

2.7 Counter Connection Notes

The 751 provides eight 16-bit totalise (event) counters which can each count up to 65535. These are located on Port 3 of the digital I/O connector. If you are using counters, set Port 3 as an input only, using the Windmill SetupIML software.

The 751 unit monitors the state of the 8 input lines once every millisecond and maintains a count for each of them. It does this whether or not you intend to use the lines as counters. You can still read Port 3 as a normal digital input, even if you are also using it to count.

2.7.1 Input Voltages

See Section 6.12.6.1 for safe voltage levels.

2.7.2 Count Inputs

A valid count is declared if the input is low for 2 milliseconds then high for two milliseconds. This gives a theoretical maximum count speed of 250 Hz.

2.7.3 Pin Numbers

Make the counter connections to Port 3 of the Digital Connector. The counter pin numbers are on page 2.10.

2.8 Digital Input/Output and Counter Pin Connections Table

The pin numbers given on the next page are those for the digital 37-way D socket.

The analogue input pin numbers are on page 2.7.

751 - Pin Connections for
Digital Inputs/Outputs and Counters

		19	0V
Port 3 Bit 0	37	18	Port 3 Bit 1
Port 3 Bit 2	36	17	Port 3 Bit 3
Port 3 Bit 4	35	16	Port 3 Bit 5
Port 3 Bit 6	34	15	Port 3 Bit 7
Port 2 Bit 0	33	14	Port 2 Bit 1
Port 2 Bit 2	32	13	Port 2 Bit 3
Port 2 Bit 4	31	12	Port 2 Bit 5
Port 2 Bit 6	30	11	Port 2 Bit 7
Not used	29	10	ID Code 2
ID Code 0	28	9	ID Code 1
Port 1 Bit 0	27	8	Port 1 Bit 1
Port 1 Bit 2	26	7	Port 1 Bit 3
Port 1 Bit 4	25	6	Port 1 Bit 5
Port 1 Bit 6	24	5	Port 1 Bit 7
Port 0 Bit 0	23	4	Port 0 Bit 1
Port 0 Bit 2	22	3	Port 0 Bit 3
Port 0 Bit 4	21	2	Port 0 Bit 5
Port 0 Bit 6	20	1	Port 0 Bit 7

Please read the Connection Notes on the previous pages before making your connections.

2.9 Measuring Strain

To measure strain, plug the 594 into the 751 unit's analogue connector using its ribbon cable.

The 594 is a boxed 16 bridge inputs card, which enables the 751 unit to monitor strain gauge bridges and balanced bridges such as pressure transducers. Extra facilities are available when components are fitted, such as protection from high voltages.

For strain gauges you need an external excitation voltage that can supply sufficient current to keep all the bridge circuits energised. Four sets of 16 screw terminals give + and – excitation and + and – signals for each of 16 bridges. Two 1 kΩ termination resistors are mounted in half bridge configuration whilst high quality 350 and 120 Ω resistors can be provided for the completion of quarter bridges.

The auxiliary channel of the 751 unit monitors the excitation voltage. The A-D converter is suitable for direct measurement of voltage imbalance provided you choose a high resolution.

When monitoring a bridge input, the Windmill software automatically reads excitation voltage and performs the bridge calculation to produce a reading in microstrain. You can set a zero reference level and monitor changes relative to that level.

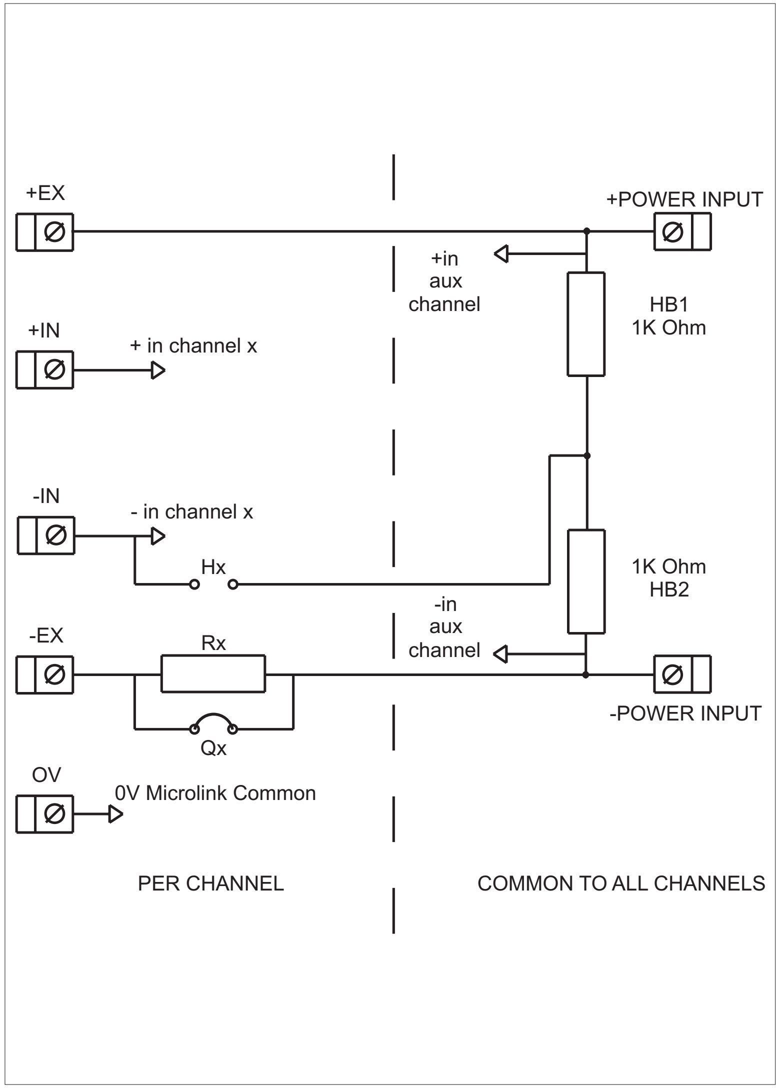
With the 594 unit you can configure each input channel for any of the following inputs. This can also be done at the factory for you.

voltage input	
quarter bridge	single strain gauge
half bridge	tensile + compressive strain gauge
half bridge	normal + transverse strain gauge
full bridge	2 tensile + 2 compressive gauges
full bridge	2 normal + 2 transverse gauges
full bridge	tensile normal + compressive normal + tensile transverse + compressive transverse gauges

The figure on the next page shows the general arrangement of the 594. For each input channel (0–15) there are 5 screw terminals. These are arranged in 5 rows labelled, 0V, +EX , —EX, +IN, –IN, with channel number printed by each terminal. Common to all channels are the POWER INPUT terminals and two precision resistors connected across the power supply to form a half bridge. The power input terminals are directly connected to the auxiliary channel of the 751.

Windmill software reads the auxiliary channel to measure the excitation voltage for use in the bridge equations. Each channel has associated with it 2 link mounting positions and one resistor position. These are:

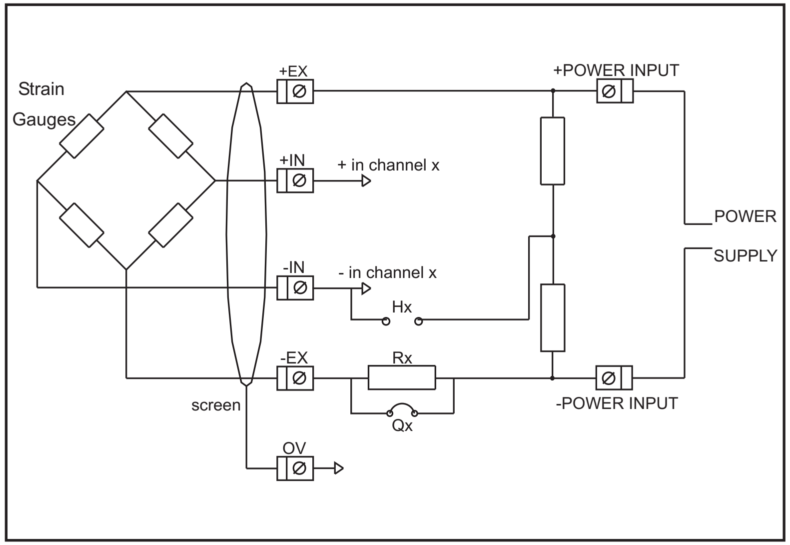
RX Position for mounting a quarter bridge completion resistor
QX Link to short out the quarter bridge completion resistor
HX Link to connect the half bridge to the –IN of channel X



General Arrangement of the 594 bridge inputs unit

Full Bridge Connection

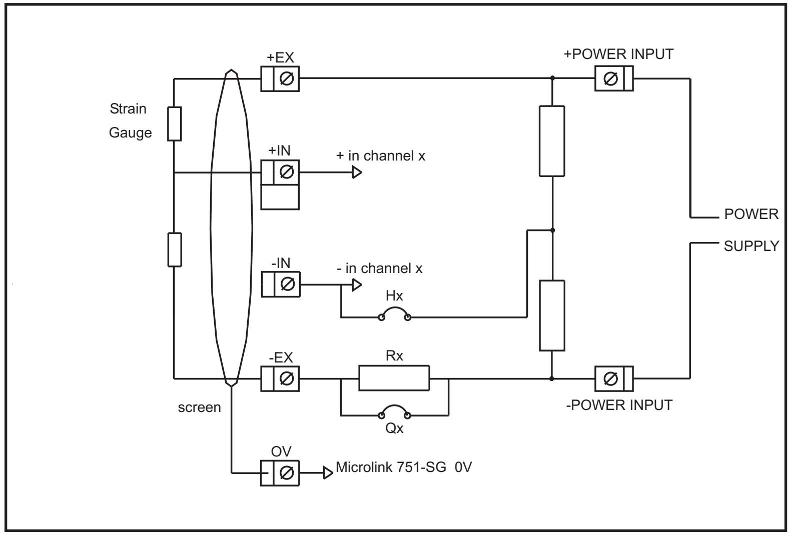
The figure below shows a full bridge connection. The QX quarter bridge link must be fitted to connect the –POWER INPUT to the –EX. Four wires are needed to connect your bridge and the earth is available for a cable screen.



594 Full Bridge Connection

Half Bridge Connection

This figure shows a half bridge connection. The HX and QX links must both be fitted. The HX link connects the half bridge to the –IN of the channel, whilst the QX link connects the –POWER INPUT to the –EX. Three wires are needed to connect your bridge and the earth is available for a cable screen.

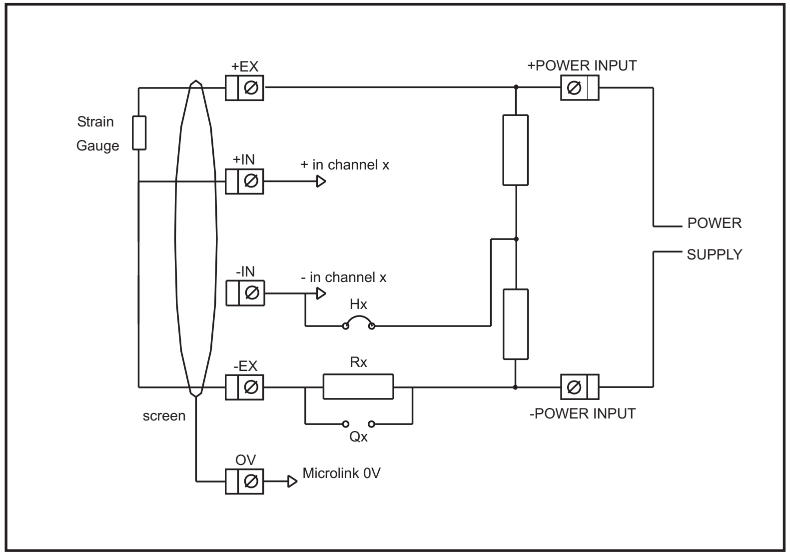


594 Half Bridge Connection

Quarter Bridge Connection

The figure below shows a quarter bridge connection. The HX link connects the half bridge to the –IN. The RX bridge completion resistor must be fitted. This resistor should be a high precision, low temperature coefficient device. Its value should be the same as the nominal resistance of your strain gauge, 120 and 350 Ω being the commonest values. In other applications it should be chosen to balance the bridge near the centre of your measurement range. For instance if you are making precise RTD measurements around ambient temperature then 100 Ω would be suitable. If however you were monitoring higher temperatures a suitably larger value would be chosen.

It is normal practice when making a quarter bridge connection to take all 3 wires to the transducer. This balances out the effects of lead resistance.



594 Quarter Bridge Connection

Power Supply

The bridges must be powered by an external power supply. The voltage used should be chosen by the user to suit his application. The current requirement can then be calculated as follows:

Full Bridge	current	=	voltage / Rg
where	Rg	=	gauge resistance usually 120 or 350 Ω
Half or Quarter Bridge	current	=	voltage / (2*Rg)

Typical Examples

16 * 120 Ω quarter bridges with 10 V excitation. These use 42 mA per bridge making a total of 0.67 amps.

16 * 350 Ω full bridges with 10 V excitation. These use 28 mA per bridge making a total of 0.45 A.

Connection of Power Supplies

Power supplies are often floating devices, i.e. they are not referenced to mains earth. If this is the case a connection must be made from 751 0 V to the power supply negative. This can easily be done on the 594. If this is not done, the bridge output voltages may be beyond the range of the 751 input amplifiers and false readings will result.

If several 594 units are used on a common power supply, each should be given its own connection to the power supply. This minimises the current flowing in any particular power supply wire, and so reduces voltage drop in the wires.

2.10 Specifications

2.10.1 751 Unit

Dimensions (mm)	180 x 120 x 40
Maximum number of 751s	8
Maximum length of cable	5 m per cable

Maximum distance from PC can be increased by use of USB hubs

2.10.2 Analogue Inputs

Number of inputs	16
Maximum safe input voltage	
Computer on	±48 V
Computer off	±33 V
Transient	±300 V
Ranges (set from software)	±10 V, ±1 V, ±100 mV, ±10 mV
Common mode range	±13 V
Relative accuracy of ranges	
gain = 1000	±0.1%
gain = 1, 10, 100	±0.05%
A-D performance (set from software)	
Resolution (bits)	Integration Time (msec)
12	2.5
13	5
14	10
15	20
16	40
18	160
Maximum speed of sampling	10 samples per second per channel
up to a maximum of	80 samples per second
Maximum linearity error	±0.02%
Input impedance	100 MΩ

2.10.3 Digital Inputs and Outputs

Maximum number of inputs	32
Maximum number of outputs	32
Power-up state	all inputs
Maximum speed	160 channels per second
Voltage Inputs	
Compatibility	TTL and 5 V CMOS
Range	0 to 5 V
Voltage Outputs	
Compatibility	TTL and 5 V CMOS
Drive	15 LSTTL loads

2.10.4 Counters

Maximum number of counters	8
Resolution	16 bits
Type of counters	Event (totalise)
Maximum count speed	160 counts per second
Compatibility	TTL and 5 V CMOS
Input voltage range	0 to 5 V

Installing and Configuring Windmill Software

3.1 Introduction

There are two steps to installing and configuring the Windmill measurement and control software.

1. Install the software onto the hard disk.
2. Tell the software about your measurement hardware.

For installation you will need a personal computer with a USB port that is running Windows 98SE or later.

3.2 What is Windmill Software?

Windmill is a ready-to-run suite of applications for data acquisition and control. You can be up and running in very little time as no programming is required. The standard suite includes data logging, charting and output control applications. You can also transfer data into third-party applications like Microsoft Excel, Access or Matlab. Other Windmill modules are available—see the Windmill Software Internet catalogue for details http://www.windmillsoft.com/.

3.3 Installing Windmill Software

1. Connect the 751 data acquisition unit to your computer, as detailed in Chapter 2.

2. Install the Windmill software:
   Insert the CD. The Installation software should run automatically. If not select Run from the Start menu and type d:setup (where d: is your CD drive).

3. When installation is complete the Windmill Configuration program, ConfIML, automatically starts. This asks for details of your hardware. See Section 3.4 for details.

3.3.1 Upgrading From Earlier Versions of Windmill

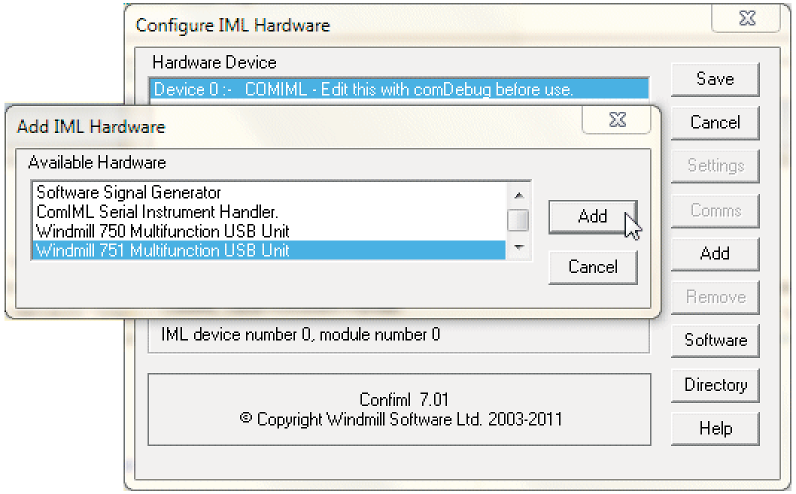
You can run Windmill alongside earlier versions of the software. Once you are happy that you no longer need a previous copy of Windmill simply run its “Uninstall” program to delete it.

3.3.2 Running Several Copies of Windmill

Unless you have bought a multiple licence, you are only permitted to run one copy of the software at any one time. Please contact your supplier or sales@windmill.co.uk if you require a multiple licence.

3.4 Configuring Your System

The Windmill Configuration program, ConfIML, records the details of your data acquisition hardware. It will run at the end of the installation process, and you should run it again from Windows whenever your acquisition hardware changes—for example when you install additional units.



Adding the 751 Unit

The first thing you need to do is press the Add button to include your 751 unit.

3.4.1 Adding New Hardware

The Add IML Hardware dialogue lists the acquisition and control devices for which you have installed drivers. Select the 751 Multifunction USB unit and press the Add button. This will take you to the Hardware Settings dialogue (Section 3.4.2).

3.4.2 Changing Hardware Settings

ConfIML needs to know some information about your 751 unit. Press the Help button or see below if in doubt about the answers.

Which Type of Card do you have?

Choose the 751.

ID Code of the 751 Unit?

As you can connect several 751 units to your PC, you need to tell ConfIML which one you are currently configuring. Do this by selecting the correct ID Code. If you have only one 751 its ID Code is 0. (There should be as many ID codes as there are 751 units connected, and each code should be different. If not, change the codes on individual units as detailed in Section 2.2.)

Which Type of Transducer Connection Unit is Attached?

There are three options—choose Strain Bridges.

Your 594 box monitors an external bridge excitation supply so that strain gauge outputs can be converted into readings in microstrain. You can use channels not required for strain for general voltage measurement.

Select the Integration Time (Resolution)

This allows you to select the trade off between speed, precision and noise rejection. Seven settings are available—the slower the speed, the better the precision and the more random noise is averaged out. The exact speeds and resolutions vary with the computer, transducer type and so on, but the following table gives some typical figures.

Setting	Typical Speed	Voltage Resolution
12-bit	80 reads/sec	5 mV in ±10 V
13-bit	64 reads/sec	3 mV in ±10 V
14-bit	48 reads/sec	1.5 mV in ±10 V
15-bit	32 reads/sec	0.8 mV in ±10 V
16-bit	16 reads/sec	0.4 mV in ±10 V
18-bit	6 reads/sec	0.1 mV in ±10 V

Settings from 15-bit to 18-bit will be effective at removing 50 Hz mains noise as these integrate over one or more complete mains cycles. For strain measurement choose a high resolution.

The resolution figures show the ability to detect small changes. The absolute accuracy will depend on several factors including your transducers.

Interval Between Automatic Recalibrations (in Minutes)?

This selects how frequently the software pauses to perform a recalibration of the 751 using its stable on-board reference voltages. This will cancel any errors introduced by temperature or power supply changes since the last recalibration, but can take up to a second to complete. During this time, no readings may be taken. You can vary the interval from 1 to 1440 minutes (24 hours), but every 20 minutes is generally sufficient.

3.4.3 751 Devices

After making your choices and pressing OK, the ConfIML Summary window appears showing your 751 as three hardware devices: 751 analogue inputs, 751 digital ports and 751 event counters.

3.4.4 Setting the Default Folders: the Working Directory

When you use Windmill you will create two types of files, those which hold data and those which hold the Windmill programs' settings. You can specify a default folder in which to store these files— known as the Working Directory. Initially the working directory is set to wherever you installed Windmill. To change this, press the Directory button.

Choose a new directory (folder) and press Save. Windmill will create two sub-directories under this choice, called setup and data. All the Windmill settings will be stored in “setup” and all the data you collect stored in “data”.

3.4.5 Saving the Settings

Save your settings and they will be used every time you run Windmill. You do not need to run ConfIML again, unless you add more units or want to change the settings.

After closing ConfIML start the SetupIML program and choose how you wish to use the hardware. Refer to the next chapter and SetupIML’s Help file (setupiml.hlp) for details.

3.4.6 The Software Signal Generator

In addition to data acquisition and control hardware, ConfIML lists the Software Signal Generator. This is a special driver which simulates a device with seven channels, each channel producing a different signal. No special hardware is required—the data values are produced by calculation. The Software Signal Generator lets you experiment and practise with Windmill, without being concerned about the hardware

To install the signal generator you first need to add it to the list of devices. In the ConfIML Summary window press the Add button (Section 3.4.1). Select Software Signal Generator and again press the Add button. You’re taken to the Hardware Settings dialogue (Section 3.4.2) where you can choose options for five of the channels. Press the Help button in this dialogue for more information on the signal generator.

3.4.7 The IML Device Icon

Whenever you run a Windmill program one or more IML Device icons will appear. Different icons identify different hardware drivers, software signal generators and so on. The Windmill applications can’t run without these, so don’t close them whilst using Windmill.

Using Windmill Software with the 751-SG

4.1 Introduction

This chapter explains which settings in the Windmill SetupIML program apply to the 751-SG, and about the rest of the Windmill software suite.

You can use the 751-SG system to monitor voltages, strain and blanced bridges like pressure transducers. With additional 59x units, you can also monitor currents and thermocouples.

Before starting Windmill make sure your 751 is plugged into the computer’s USB port, and, if you are using a 593 strain measurement box, that it is plugged into the 751’s analogue connector.

4.2 Options in SetupIML

SetupIML is the Windmill program that lets you save libraries of setup files, each holding details about how you want to use individual channels. A Windmill 751 is shown as three devices in SetupIML: Analogue Inputs, Digital Inputs and Event Counters. Choose one from SetupIML's Device menu. Now double-click a channel to configure it. Full details of using SetupIML are in its Help file.

4.2.1 General Purpose Analogue Input Connector

The input channels are numbered 0 to 15. Using SetupIML you can configure each channel as follows:

* enable or disable
* re-name
* set to a specific input range or allowing the software to pick the range automatically
* give a new units name, scale factor and offset
* set alarm levels

4.2.2 Strain Gauge Bridge Connector

The signal inputs are numbered 0 to 15. Using SetupIML you can configure each channel as follows:

* enable or disable
* set to one of six bridge configurations (see below) or set to read raw voltage
* re-name
* set to a fixed range or allowing the software to pick the range automatically
* set to a gauge factor
* if transverse strain is being measured, specify Poisson's ratio for the material under test
* set alarm levels.

See also the Special commands described on page 4.4.

The supported bridge configurations are:

Quarter bridge
One active gauge and three fixed resistors.

Half bridge
One gauge measuring tensile strain (+E), one measuring compressive strain (–E), and two fixed resistors.

Half bridge
One gauge measuring normal strain (+E), one measuring transverse strain (–vE), and two fixed resistors. Poisson's ratio must be specified.

Full bridge
Two gauges measuring tensile strain (+E) and two measuring compressive strain (–E).

Full bridge
Two gauges measuring normal strain (+E) and two measuring transverse strain (–vE). Poisson's ratio must be specified.

Full bridge
One gauge measuring normal tensile strain (+E), one measuring normal compressive strain (–E), one transverse tensile strain (+vE), and one compressive transverse strain (–vE). Poisson's ratio must be specified.

In all these cases the reading is reported directly in microstrain.

Channel 16 is used to read the bridge excitation voltage, which must be the same for all channels, and is used in the calculations.

4.2.3 Special Hardware Commands

The channel dialogue boxes will have the "Special" button enabled. This allows access to the following commands:

Recalibrate
Forces an immediate recalibration of the whole board. This is in addition to the periodic calibration cycles which happen automatically.

Cal_Interval
Displays the time between automatic calibration cycles, as selected in ConfIML (described in Section 3.4).

Resolution
Displays the resolution and integration time for this card, as selected in ConfIML (described in Section 3.4).

Show_Cal_Data
Used only during manufacturer's test procedures.

When a strain gauge bridge is in use, three additional commands are available:

Set_Zero_Now
This reads the bridge output ratio and uses it as the zero strain reference level. All subsequent readings will be changes in strain relative to that point, until another special command is issued or the software is closed down.

Describe_Offset
This shows the bridge output level which is currently being used as the zero strain reference level (as a fraction of excitation voltage).

Disable_Offset
Resets the zero strain reference to zero volts, so absolute readings are obtained. This is the default state each time the software starts running.

4.2.4 Digital Ports

The 751 unit provides four digital ports, each with 8 lines. You can use each port for input or output. You can explicitly control the choice, or it can be deduced automatically by the software. All ports start as inputs, but if any data is sent to a port by a Windmill program it immediately switches to output mode. Output lines can also be controlled by the alarm detection features of the input channels. This will cause the whole port to switch to output mode.

You can also use port 3 for event counting—in which case you must set it as an input.

The channels are numbered as follows:

0100	Line 0 of port 0
0101	Line 1 of port 0
0102	Line 2 of port 0
..	...
0107	Line 7 of port 0
0108	Direction control signal for port 0
0109	not used
0110	Line 0 of port 1
0111	Line 1 of port 1
...	...
0117	Line 7 of port 1
0118	Direction control signal for port 1
0119	not used
0120	Line 0 of port 2
etc	

In SetupIML you can replace the numbers with **meaningful names.**

By default, each channel is linked to a single line and the two digital states are called ON and OFF. You can change these names to more suitable ones, for example FAST and SLOW or OPEN and SHUT.

SetupIML lets you group the lines within each port into multi-bit channels which are displayed or controlled as single values transferred via the first channel in the group. Multi-bit values can be chosen as binary, decimal or hexadecimal, e.g.

Binary	Decimal	Hexadecimal
11	3	3
1010	10	A
10001	17	11
11111111	255	FF

Channels 0108, 0118, 0128 and 0138 are the direction control signals for ports 0 to 3. When set to 0, the whole port is used for input; when 1, the port is used for output. These channels can be viewed and also altered, but they are normally disabled and must be explicitly enabled from SetupIML before use. As noted above, direction control can usually be sensed automatically by the software.

Channel 0109, 0119 and 0129 are not used and cannot be enabled.

4.2.5 Event Counters

The 751 unit provides eight 16-bit event counters. The default names are 0200, 0201 to 0207.

Each counter starts at zero and counts pulses on the corresponding input lines, to a maximum of 65535. They can be reset to zero at any time by sending “0” to the channel using the AnalogOut, Graphics or Test-Seq programs. No other values can be sent to the counters.

Use SetupIML to change the names, enable or disable each channel, and choose one of two operating modes—accumulating count or resetting count.

Accumulating Count

Simply keeps counting until explicitly reset.

Resetting Count

Starts again from zero after each reading. This shows the number of pulses since the last reading, but it can only be used where a single program is reading the counter. If several different programs were accessing the counter simultaneously, they would all be resetting it at different times, so the results would be unpredictable.

SetupIML also lets you apply a scale factor and offset to the count. For example, if the pulses came from a flow meter which produced one pulse for each 50 millilitres, then a scale factor of 0.05 would give a reading in litres.

4.3 The Rest of the Windmill Software Suite

The Windmill suite of software that comes with the 751 comprises: ConfIML; SetupIML; the display and control panels—AnalogOut, DigitalOut & DDE Panel; Logger and Chart.

The display and control panels let you send data to, or display data from, any number of analogue and digital channels. Logger logs data to disk from up to 100 channels whilst Chart displays moving charts of data from up to 8 channels. For more channels, or different logging and charting speeds, simply run more instances of Logger and Chart. Full details of all these programs are given in their on-line Help files and the *Windmill User Manual*.

Should you need more sophisticated analysis or presentation, you can share data with other Windows applications using dynamic data exchange (DDE). For example, you can process data as it's collected using Microsoft Excel. See the DDE Panel Help file for more details.

There are many other optional programs in the Windmill range. **Graphics** lets you design and create your own Windmill displays—process mimics, wiring diagrams, bar charts, annunicator panels…whatever you wish. **Test-Seq** interprets a file of commands, and controls a test-rig accordingly. **Replay** replays a data file graphically. For details of other optional programs see http://www.windmill.co.uk/programs.html.

To be informed when new Windmill products are launched, be given data acquisition hints and tips, and read articles on measurement and control; subscribe to the free *Monitor* newsletter (ISSN 1472-0221) at http://www.windmill.co.uk/newsletter.html.