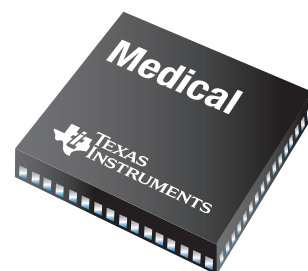


Consumer Medical Applications Guide



Blood Pressure and
Heart Rate/Fitness Monitoring Systems

Blood Glucose and Other
Diagnostic Meters

Digital Thermometers

Portable Medical
System Support Products

Power Management for
Portable Devices

Connectivity Solutions



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TI's Medical Applications Guides available for individual download:

- Consumer Medical
- Diagnostic, Patient Monitoring and Therapy
- Medical Imaging
- Medical Instruments

Visit:

www.ti.com/medicalguides



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→ Overview

Five common system blocks are used when designing everything from blood glucose, digital blood pressure and blood cholesterol meters to health and fitness monitors such as digital pulse/heart rate monitors and digital thermometers. These blocks are:

- Power/battery management
- Control and data processing
- Sensor interface, amplification and analog-to-digital conversion
- User interface and display
- Wireless connectivity
(see chapter on connectivity solutions)

While all battery-operated, microcontroller-based handheld devices take measurements using various bio-sensors, the block implementation topology differs greatly with the sensing, processing and information demands of the meter type and feature set.

For more information on TI's offering for Consumer Medical, please visit www.ti.com/consumermedical

The design goals for extended battery life, high precision and fast response times are driven by the user's desire to quickly know their health status. Additional requirements may drive the need for more memory to allow for historical profiling, cabled or wireless interfaces for data upload or for access to the sensor. Audio feedback for simple good/not good indication or more complex step-by-step utilization instructions may be required as well. Adding these features without increasing power consumption is a significant challenge.

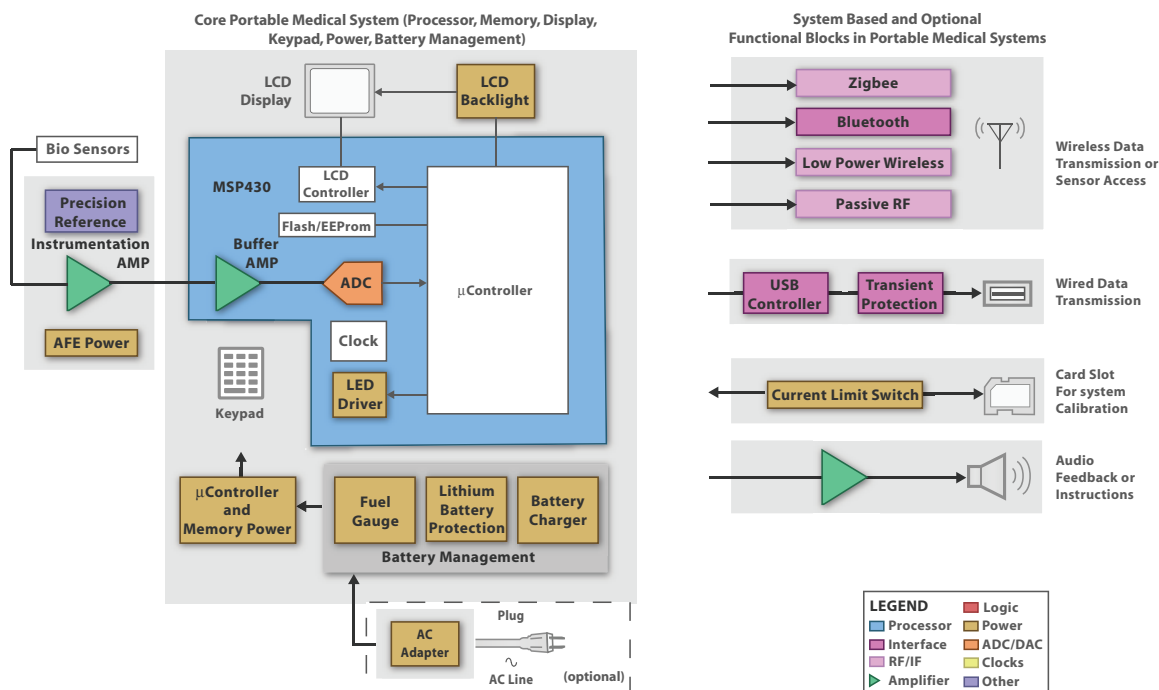
TI can help you create the solutions. We offer a broad portfolio of processors, ranging from the high performance OMAP™ platform-based application processors, to digital signal processors (DSPs), ARM-based Sitara™ MPUs and ultra-low-power MSP430™ microcontrollers (MCUs) as well as

the full range of high performance analog solutions with instrumentation, operational and buffer amplifiers, data converters, power and battery management components, audio amplifiers, and both wired and wireless interface components.

Connectivity for portable medical applications has become critical as consumers and caregivers are requiring data to move from medical devices to data hubs such as computers and mobile phones. TI is a promoting member of the Continua Health Alliance and now offers the first Continua-certified USB platform for Agent Devices. See page 23 for more information.



For more information on the Continua Health Alliance, visit <http://www.continuaalliance.org>.



Product Availability and Design Disclaimer – The system block diagram depicted above and the devices recommended are designed in this manner as a reference. Please contact your local TI sales office or distributor for system design specifics and product availability.

Portable medical meters system block diagram.

→ Blood Pressure and Heart Rate/Fitness Monitoring Systems

Blood Pressure Monitors

These monitoring systems use Korotkoff, oscillometry or pulse transit time methods to measure blood pressure. A pressure cuff and pump, along with a transducer, are used to measure blood pressure and heart rate in three phases: inflation, measurement and deflation. Also included are LCDs, selection buttons, memory recall, power management and USB interface.

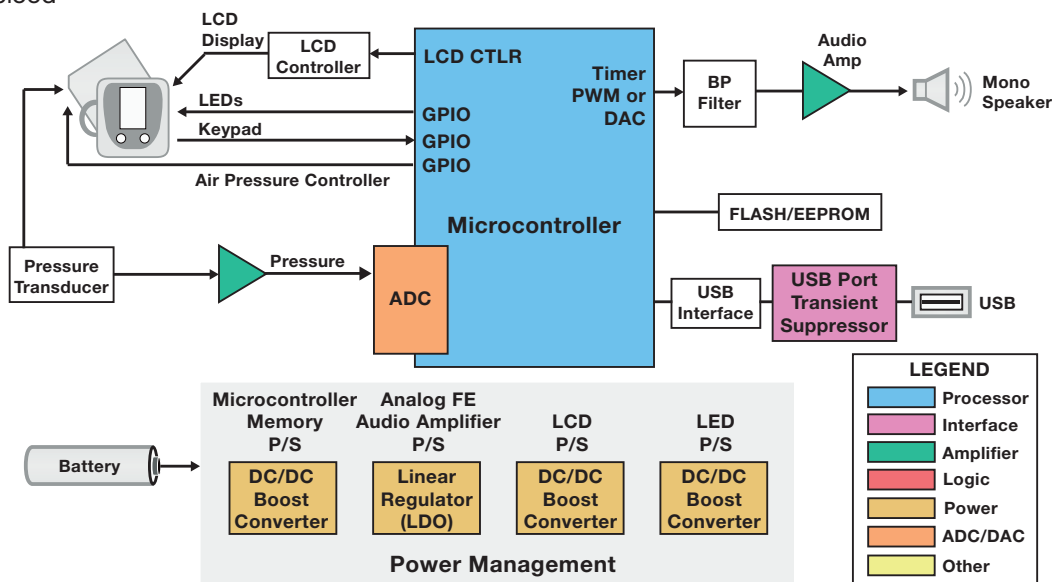
The core subsystems include:

- Processor/Memory** — Digital pressure measurement and heart rate are performed by the microcontroller. Measurement results are stored in flash memory as a data log that can be uploaded to a computer via USB or wireless connection.

User Interface — Allows the user to control the pressure measurement process and read the results on an LCD display.

Sensor Interface — Allows the processor to control the cuff inflation/deflation and sense blood pressure that is amplified by instrumentation amplifiers and digitized by the ADC.

Power Management — Converts input power from the alkaline or rechargeable batteries to run various functional blocks.



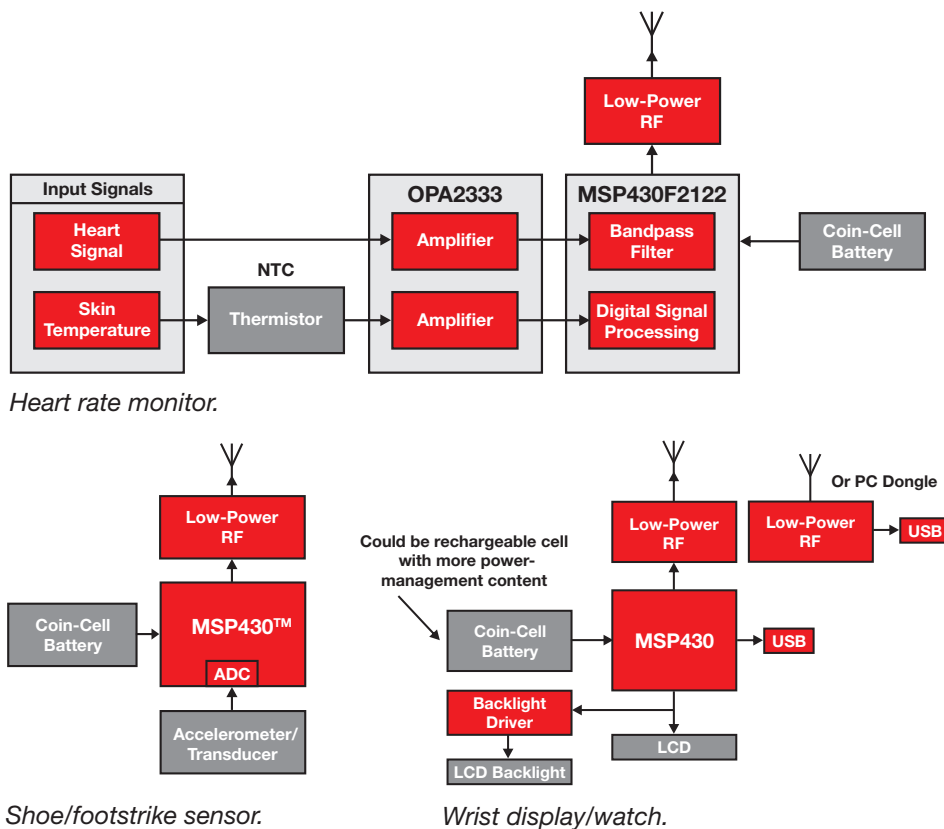
Product Availability and Design Disclaimer — The system block diagram depicted above and the devices recommended are designed in this manner as a reference. Please contact your local TI sales office or distributor for system design specifics and product availability.

Example application block diagram — blood pressure monitor.

Heart Rate/Fitness Monitors

Fitness monitors measure both a person's amount and rate of exercise (e.g. miles and pace run) as well as effort expended (e.g. through monitoring heart rate). Typically, a wristwatch or wrist-worn display is used for control and providing feedback. Stored data can be downloaded to a computer via USB or a wireless USB dongle. All parts of the system require ultra-low-power embedded controllers and low-power RF for communications. Heart rate monitoring and exercise output monitoring (e.g. running pace sensor or power sensor) require additional signal conditioning.

Note: "Heart Rate and EKG Monitor using the MSP430FG439" (slaa280)
www-s.ti.com/sc/techlit/slaa280



→ Blood Glucose and Other Diagnostic Meters

New innovations in diagnostic equipment are making it easier than ever to test quickly for a number of critical care assays in blood such as blood gases, glucose, electrolytes, coagulation, chemistries, hematology and cardiac markers (cTnI). With the advent of new digital technologies, invasive blood analyzers have become portable and are used to measure the two major assays of metabolic disorders in blood system: glucose and cholesterol.

The two methods used for blood analyte measurement are the color reflectance method and the amperometric method (electrochemical sensor technology).

The analog front-end of the reflectance method uses topical sensors (LED, photo transistors) and a transimpedance amplifier. Measurements made using the color reflectance method are based on reaction color intensity in

the reaction layer of the test strip by reflectance photometry. The meter quantifies the color change and generates a numerical value that represents the concentration of cholesterol/glucose in blood.

Using the amperometric method, the biosensor (test strip) is connected directly to the transimpedance amplifier. Cholesterol/glucose present in the blood, while undergoing chemical reaction with the test strip, generates charge and is measured by the amperometric method. An ambient temperature measurement is also necessary for test strip characteristic compensation.

The measurement sequence is usually controlled by a microcontroller (MCU). The MCU also processes the conversion results, storing the measurements in an EEPROM or Flash memory and controlling other functions such as the keypad, real-time clock, sound/speech

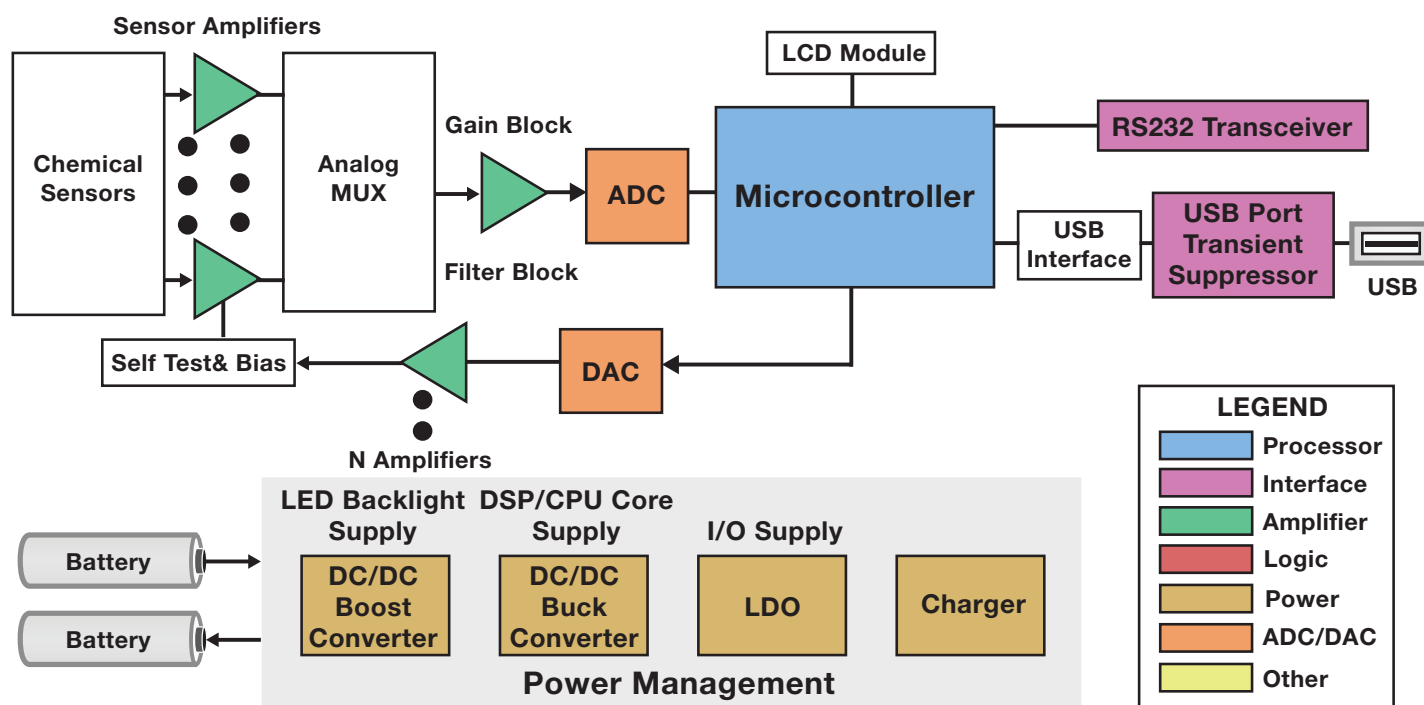
compression and serial communication to a connected computer.

The audio output is provided by either a PWM circuit or from the DAC. Both can be used to generate beeping sounds to signal when measurement results are available. They also generate voice instructions from the speech-synthesizer software using ADPCM compression algorithms. Measurement results are stored with the measurement time and date in the EEPROM or Flash memory as a data log that can be uploaded to a computer via wireless interface.

See example block diagram on pg. 4.



Awarded for the True2go portable glucose monitor by Home Diagnostics Inc.



Product Availability and Design Disclaimer – The system block diagram depicted above and the devices recommended are designed in this manner as a reference. Please contact your local TI sales office or distributor for system design specifics and product availability.

Portable blood gas analyzer block diagram.

→ Digital Thermometers

Digital Thermometers

Digital thermometers are quickly replacing traditional mercury thermometers because they are fast, accurate and effective, without the environmental risk. With newer technologies, different types of digital thermometers are classified based on the location where they are used, such as oral, rectal, under-arm, ear, etc. The ear thermometer measures infrared eardrum heat, which reflects hypothalamus temperature — the temperature-controlling system of the brain. Infrared sensors are used in ear thermometers for measurement, while thermopiles or thermistors may be used in other thermometer types.

High-end thermometers have a number of thermopiles or thermistors whose resistance changes with temperature. The resistance change is measured as a change in voltage. This analog voltage is converted digitally by an analog-to-digital converter (ADC). The ADC's speed and resolution depends on the accuracy and time at which information is needed.

If an ADC module is not available, it is possible to digitize the analog signal using a comparator and a timer for slope analog-to-digital conversion. This method is generally used in low-cost digital thermometers. The single slope conversion measures temperature. Capacitance, supply voltage and frequency changes caused by aging or temperature drift can be compensated using a ratiometric measurement principle.

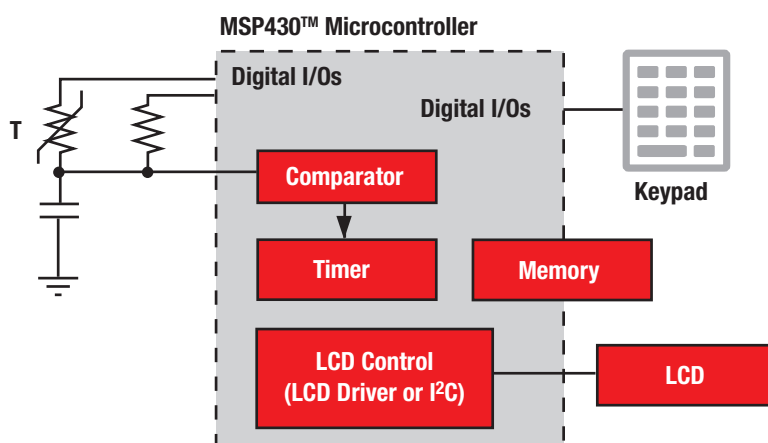
Note: "Implementing an Ultra-Low-Power Thermostat with Slope A/D Conversion" (slaa129B)

www-s.ti.com/sc/techlit/slaa129b

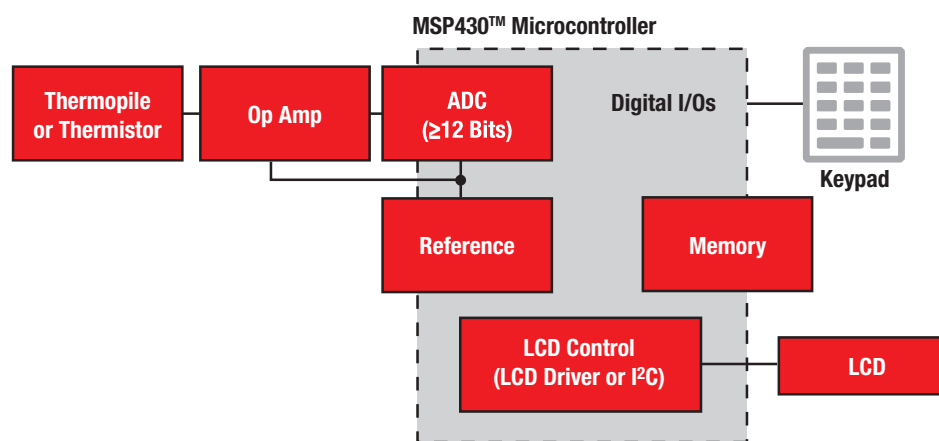
The block diagrams represent low-end general-purpose and high-end digital thermometers. Typical ADC resolution used in general-purpose digital thermometers may be 12-bit and above depending on the required accuracy level. Good ADC reference is required for better accuracy. A microcontroller may be used for control purposes. Low-cost solutions employ a low-cost, low-power microcontroller like the MSP430, which has the integrated

comparator and timer needed to digitize the analog signal using the slope analog-to-digital conversion technique.

Features like high-temperature alarm, beep after measurement, auto shut-off and a data log of previous temperatures are optional. Most thermometers have easy-to-read displays, usually a LCD display and low-battery indicator. Other peripherals include digital I/Os and LCD drivers.



A general block diagram of a low-cost digital thermometer.



A general block diagram of a digital thermometer with high accuracy.

→ Consumer Medical General

Ultra-Low-Power PaLFI (Passive Low Frequency Interface)

TMS37157

Get samples and datasheets at: www.ti.com/sc/device/TMS37157

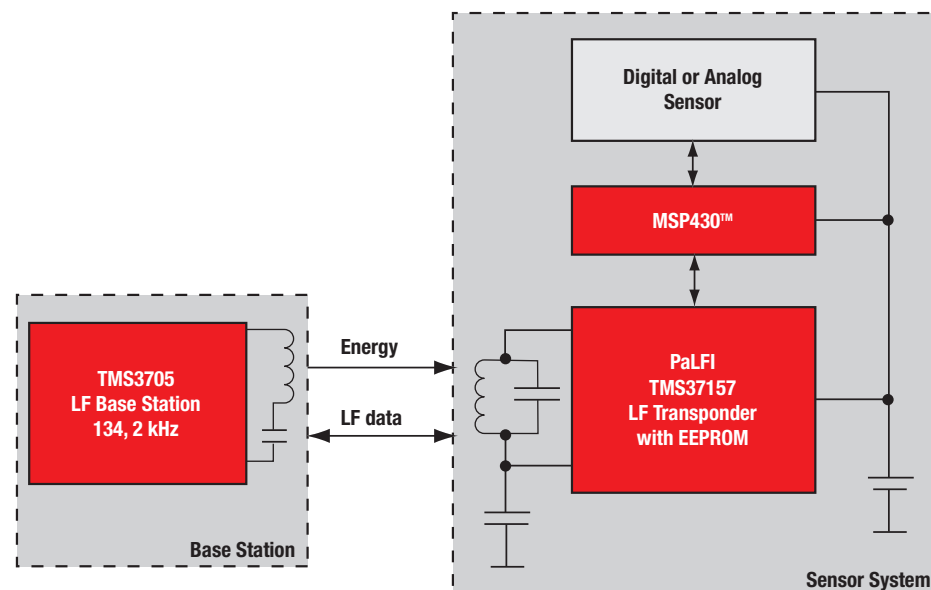
Key Features

- Wide supply voltage range 2V to 3.6V
- Ultra-low power consumption
 - Active mode max. 150µA
 - Power down mode 60nA
- Battery check and battery charge function
- Resonance frequency: 134.2kHz
- Integrated resonance frequency trimming

Applications

- Portable medical devices
- Implantable devices
- Measurement instruments
- Energy harvesting

The PaLFI combines a low-frequency transponder with an SPI interface and power management to a connected MSP430™ microcontroller. It is the ideal device for any data logger, sensor or remote control application enabling operation without the need of a battery.



PaLFI functional block diagram.

TMS37157

PaLFI – Passive Low Frequency Interface	
Communication Interfaces	SPI, RFID, direct microcontroller access via RFID
Operating Frequency	134.2kHz
Wired Communication Interface	3-wire SPI
Operating Voltage	2V to 3.6Vdc
Current Consumption	Active mode max: 150µA Power down mode: 60nA
Battery Charge Current	Max: 2mA
Memory	32-bit unique serial number 968-bit EEPROM user memory 8-bit selective address
Operating Temperature	–40°C to 85°C
Storage Temperature	–40°C to 125°C
Package	16-Pin VQFN (4mm × 4mm)
Packing/Delivery	Tape-on reel, 3000 per reel

→ Consumer Medical General

16-Bit, Ultra-Low-Power Microcontrollers

MSP430FG477, MSP430FG478, MSP430FG479

Get samples and datasheets at: www.ti.com/sc/device/PARTnumber (Replace **PARTnumber** with **MSP430FG477**, **MSP430FG478** or **MSP430FG479**)

View our video on MSP430™ 16-bit ultra-low-power MCU for portable medical devices at www.ti.com/430medical

Key Features

- Low supply-voltage range: 1.8V to 3.6V
- Ultra-low power consumption:
 - Active mode: 280µA at 1MHz, 2.2V
 - Standby mode: 1.1µA
 - Off mode (RAM retention): 0.1µA
- Five power-saving modes
- Wakes up from standby mode in less than 6µs
- 16-bit RISC architecture
- 125ns instruction cycle

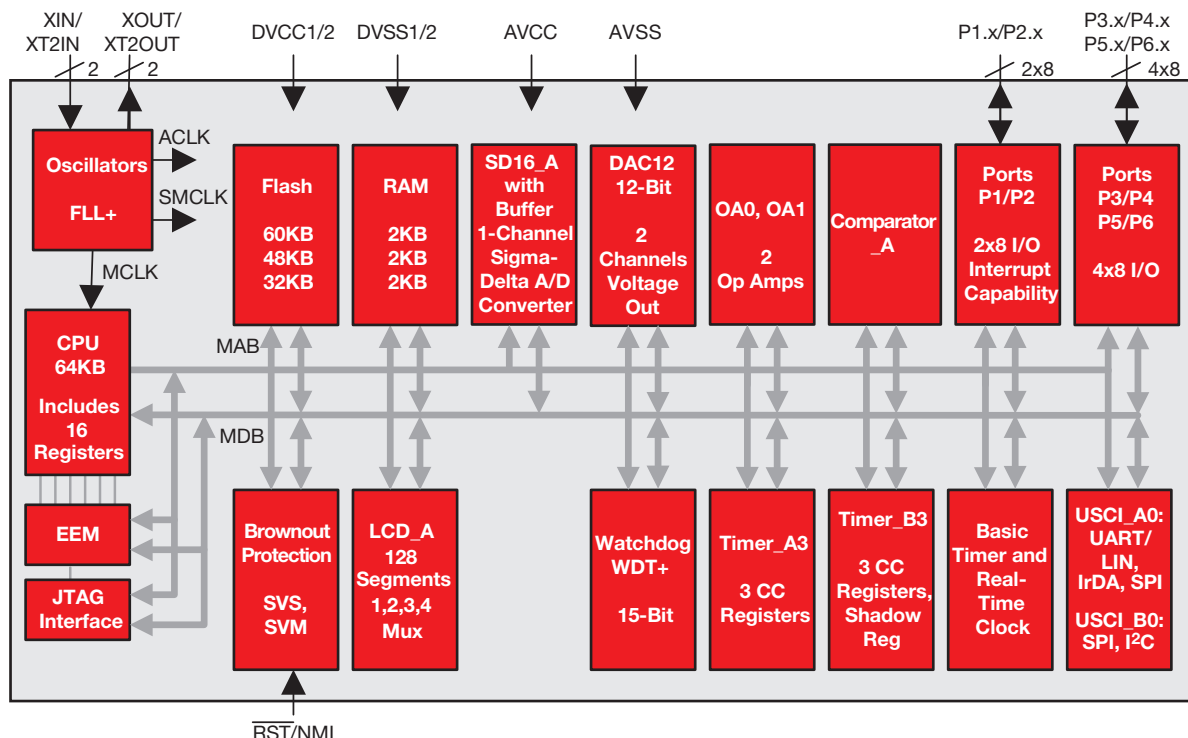
Applications

- Portable medical meters, such as blood glucose meters, pulse oximeters
- Insulin pumps
- Digital thermometers
- Heart rate monitors

TI's MSP430™ family of ultra-low-power microcontrollers consists of several devices featuring different sets of peripherals targeted for various applications. The architecture, combined with five low-power modes, is optimized to achieve extended battery life in portable measurement applications. The device features a powerful 16-bit RISC CPU, 16-bit registers, and constant generators that contribute to maximum code efficiency. The digitally controlled oscillator (DCO) allows wake-up from low-power modes to active mode in less than 6µs.

The MSP430FG47x is a microcontroller configuration with two 16-bit timers, a basic timer with a real-time clock, a high performance 16-bit sigma-delta A/D converter, dual 12-bit D/A converters, two configurable operational amplifiers, two universal serial communication interface, 48 I/O pins, and a liquid crystal display driver with contrast control.

The MSP430FG47x is one of the SoC (System on Chip) series in the MSP430 portfolio. Because this device series has integrated the entire signal chain on-chip, it greatly simplifies the design of medical devices. In addition to enabling more compact products, this device series also reduces BOM (Bill of Materials) costs because of the need for fewer discrete components.



MSP430FG47x functional block diagram.

→ Consumer Medical General

16-Bit, Ultra-Low-Power Microcontrollers

MSP430F5418A, MSP430F5419A, MSP430F5435A, MSP430F5436A, MSP430F5437A, MSP430F5438A

Get samples and datasheets at: www.ti.com/sc/device/PARTnumber (Replace **PARTnumber** with **MSP430F5418A**, **MSP430F5419A**, **MSP430F5435A**, **MSP430F5436A**, **MSP430F5437A** or **MSP430F5438A**)

Key Features

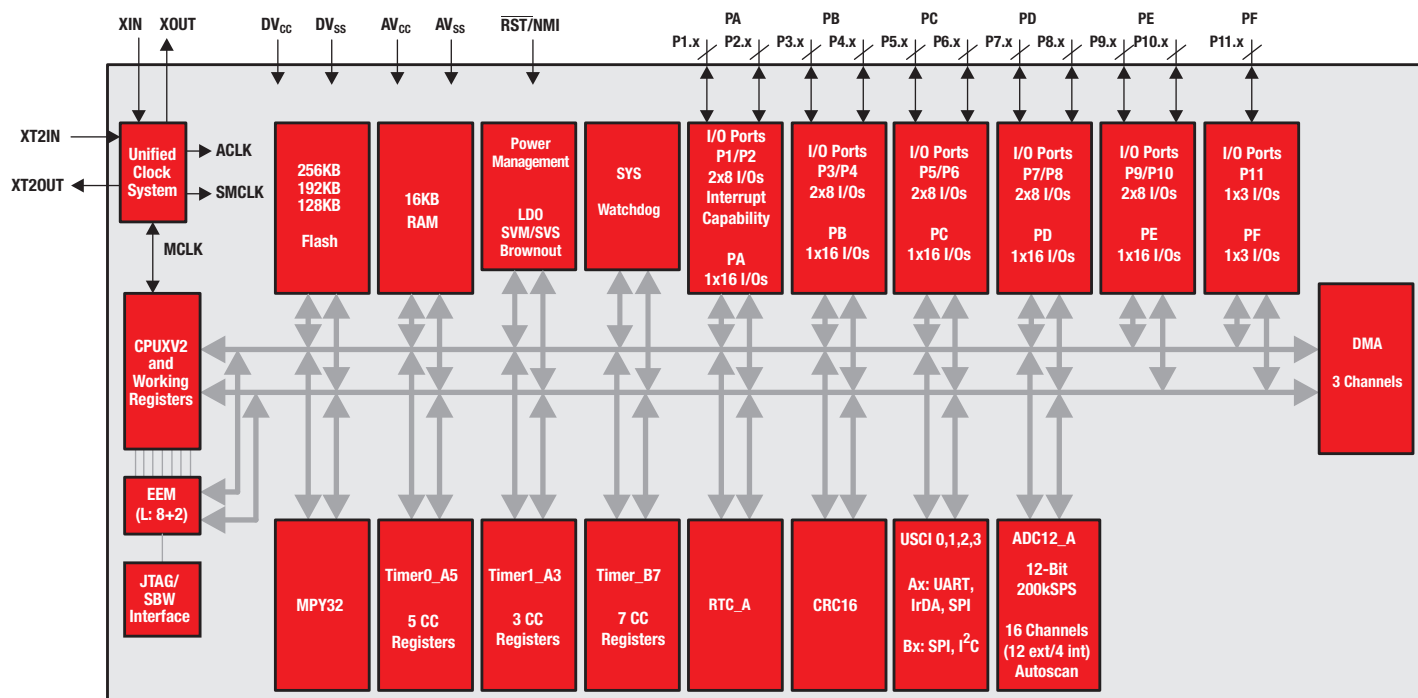
- Low supply-voltage range: 1.8V to 3.6V
- Ultra-low power consumption:
 - Active mode: 230µA/MHz
 - Standby mode (LPM3 RTC mode): 2.6µA
 - Off mode (LPM4 RAM retention): 1.6µA
 - Shutdown mode (LPM5): 0.1µA
- Wakes up from standby mode in less than 5µs
- 16-bit RISC architecture:
 - Extended memory
 - Up to 25MHz system clock

The MSP430F541x and MSP430F543x series of microcontroller configurations includes three 16-bit timers, a high-performance 12-bit ADC, up to four universal serial communication interfaces, a hardware multiplier, DMA, a real-time clock module with alarm capabilities, and up to 87 I/O pins. The architecture, combined with five low-power modes, is optimized to achieve extended battery life in portable measurement applications.

These device series are ideally suited for portable medical and fitness applications. With up to 256kB flash and 16kB RAM, they are capable of hosting the application as well as wireless protocols for medical devices with wireless capabilities. For example, the BlueMSPTM platform, which is comprised of the MSP430F5438 Experimenter's Board (MSP-EXP430F5438) and the BL6450 *Bluetooth*® Connectivity Card, can use the MSP430F5438 to host the *Bluetooth*® stack's Health Device Profile.

Applications

- Portable medical meters
- Blood pressure monitors
- Patient sensor system



MSP430F54xx functional block diagram.

Low-Power Precision Instrumentation Amplifier

INA333

Get samples and datasheets at: www.ti.com/sc/device/INA333

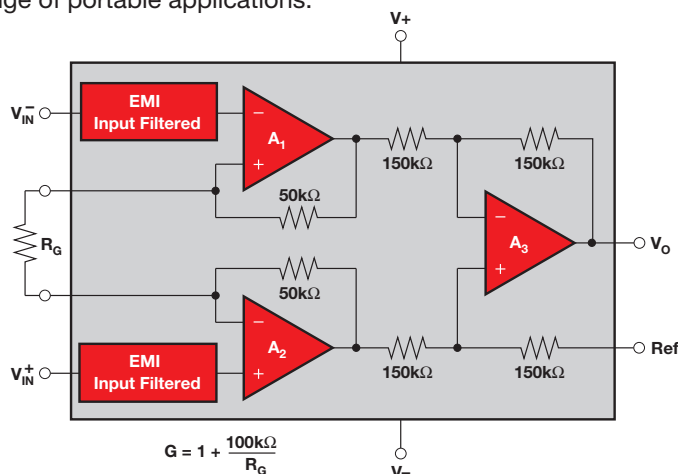
Key Features

- Low offset voltage: 20μV (max)
- Low drift: 50nV/°C
- Low input bias current: 200pA (max)
- Low noise: 50nV/√Hz
- Supply voltage: +1.8V to +5.5V
- Quiescent current: 50μA (max)
- EMI input filtered
- Packaging: MSOP-8, DFN-10

Applications

- Bridge amplifier
- Weigh scales
- Thermocouple amplifier
- RTD sensor amplifier
- Medical instruments
- Data acquisition

The INA333 is a low-power precision instrumentation amplifier offering excellent accuracy. A single external resistor sets any gain from 1 to 1000 and provides the industry-standard gain equation $G = 1 + (100k\Omega/R_G)$. With three op amps, low quiescent current, and operation with power supplies as low as +0.9V, it is ideal for a wide range of portable applications.



INA333 functional block diagram.

3.9μA, SC70-3, 30ppm/°C Drift Voltage References

REF3312, REF3318, REF3320, REF3325, REF3330, REF3333

Get samples, datasheets, evaluation modules and application reports at: www.ti.com/sc/device/PARTnumber
(Replace **PARTnumber** with **REF3312**, **REF3318**, **REF3320**, **REF3325**, **REF3330**, or **REF3333**)

Key Features

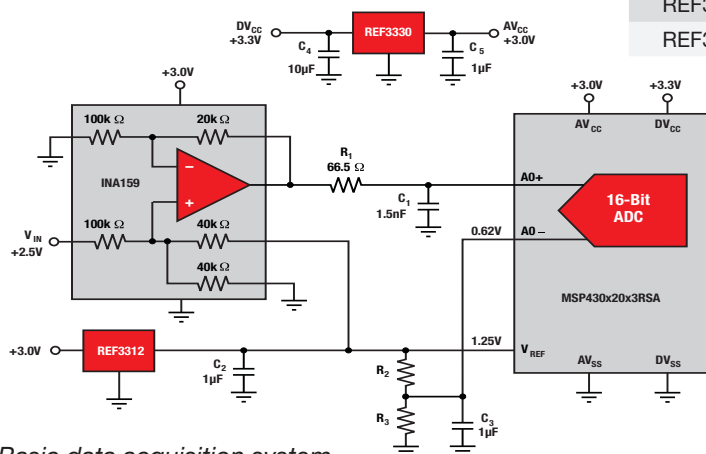
- Low power: $I_q = 3.9\mu A$ (typ)
- High initial accuracy: 0.15% (max)
- Low dropout (25mV at 25°C and 1mA I_{OUT})
- Robust output current drive: ±5mA
- ±30ppm/°C temp drift (max)
- Extended industril temp range: -40°C to 125°C

Applications

- Blood glucose meter
- Digital stethoscope
- Portable ECG/EEG

The REF33xx is a low-power, precision, low-dropout voltage reference family available in the tiny SC70-3 and SOT23-3 packages. Small size and low power consumption (5μA max) make the REF33xx ideal for a wide variety of portable applications.

Product	Voltage (V)
REF3312	1.25
REF3318	1.8
REF3320	2.048
REF3325	2.5
REF3330	3.0
REF3333	3.3
REF3340	4.096



Basic data acquisition system.

→ Consumer Medical General

1.8V, microPower CMOS Operational Amplifier Zero-Drift Series

OPA333, OPA2333

Get samples, datasheets, evaluation modules and application reports at: www.ti.com/sc/device/OPA333
or www.ti.com/sc/device/OPA2333

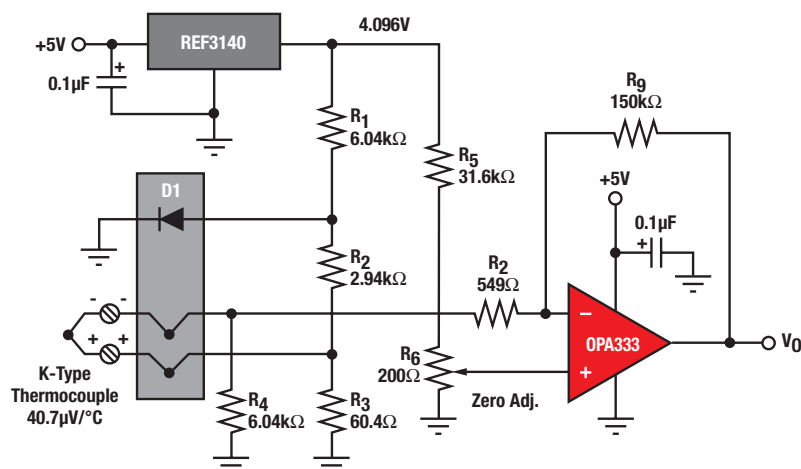
Key Features

- Low offset voltage: 10 μ V (max)
- Zero drift: 0.05 μ V/°C (max)
- 0.01Hz to 10Hz noise: 1.1 μ V_{PP}
- Quiescent current: 17 μ A
- Supply voltage: 1.8V to 5.5V
- Rail-to-rail input/output
- Packaging: SC70, SOT23
- EMI input-filtered

Applications

- Medical instruments
- Temperature measurements
- Battery-powered medical instruments
- Electronic weigh scales
- Patient monitoring

The OPA333 series of CMOS operational amplifiers uses a proprietary auto-calibration technique to simultaneously provide very low offset voltage (10 μ V max) and near-zero drift over time and temperature. These miniature, high-precision, low quiescent current amplifiers offer high-impedance inputs that have a common-mode range 100mV beyond the rails and rail-to-rail output that swings within 50mV of the rails. Single or dual supplies as low as +1.8V (\pm 0.9V) and up to +5.5V (\pm 2.75V) may be used. The OPA333 family offers excellent CMRR without the crossover associated with traditional complementary input stages. This design results in superior performance for driving analog-to-digital converters (ADCs) without degradation of differential linearity.



OPA333 in temperature measurement circuit.

→ System Support Products

Voltage Level Translation

Applications

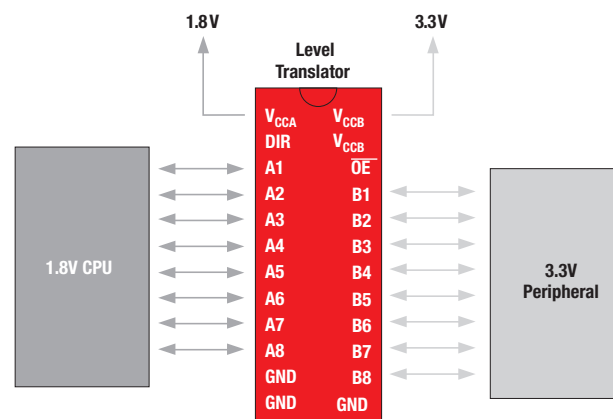
- LCD interface
- Interface devices with different supply voltages

As operating voltage levels in microcontrollers continue to drop, a void that disrupts device interfacing may be created between peripheral devices and processors. TI's translators enable communication between incompatible I/Os with level translation between the 1.2V, 1.5V, 1.8V, 2.5V and 3V nodes. The MSP430™ microcontroller has a 3.6V (max) I/O tolerance, allowing translators to be used to protect the inputs and interface to higher voltage peripherals.

Suggested Components

Component	Description	V _{CC} Range (V)	Power Max I _{CC} (μA)	Smallest Footprint Pins/Packages
SN74AVC1T45*	Single-bit Dual-Supply Bus Transceiver	1.2 to 3.6	10	6/WCSP (NanoStar™)
SN74LVC1T45	Single-bit Dual-Supply Bus Transceiver	1.65 to 5.5	4	6/WCSP (NanoStar)
SN74AVC2T45*	Dual-bit Dual-Supply Transceiver	1.2 to 3.6	10	8/WCSP (NanoStar)
SN74LVC2T45	Dual-bit Dual-Supply Transceiver	1.65 to 5.5	10	8/WCSP (NanoStar)
SN74AUP1T57	Single-Supply Voltage Translator	2.3 to 3.6	0.9	6/WCSP (NanoStar)
SN74AUP1T58	Single-Supply Voltage Translator	2.3 to 3.6	0.9	6/WCSP (NanoStar)
SN74AUP1T97	Single-Supply Voltage Translator	2.3 to 3.6	0.9	6/WCSP (NanoStar)
SN74AUP1T98	Single-Supply Voltage Translator	2.3 to 3.6	0.9	6/WCSP (NanoStar)
PCA9306	Dual Bidirectional I ² C-bus and SMBus Voltage-Level Translator	—	—	8/US

*Bus-hold option available.



Example application block diagram.

Audio Signal Routing

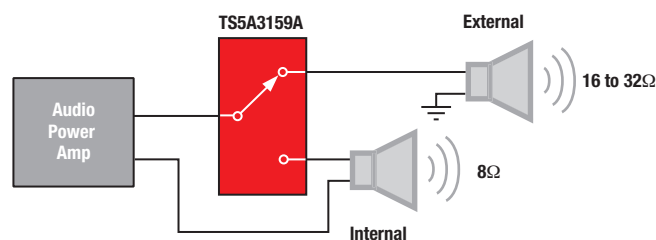
Applications

- DeMUX internal/external speakers
- MUX audio power amplifier
- Low-power routing (<100mA)
- Amplifier gain adjustment

One of the most common applications for analog switches is signal routing. Routing may come from one source to multiple destinations or from several sources to a single destination. A single-pole, double-throw analog switch can be used for either situation. The switch could be used to reroute the output of the audio power amplifier to two different speakers. Another common application is switching from an audio amplifier in the baseband of a mobile handset to an audio power amplifier for higher power output.

Suggested Components

Component	Configuration	V ₊ (V)	r _{on} (Ω)	Smallest Footprint Pins/Packages
TS5A3159A	1 x SPDT	1.65 to 5.5	0.9	6/WCSP
TS5A3166	1 x SPST	1.65 to 5.5	0.9	6/WCSP
TS5A23166	2 x SPST	1.65 to 5.5	0.9	6/WCSP
TS5A3153	1 x SPDT	1.65 to 5.5	0.9	8/WCSP
TS5A6542	1 x SPDT	1.65 to 5.5	0.75	8/WCSP
TS5A23159	2 x SPDT	1.65 to 5.5	0.9	10/Micro QFN
TS5A26542	2 x SPDT	1.65 to 5.5	0.75	12/WCSP
TS5A3359	1 x SP3T	1.65 to 5.5	0.9	8/WCSP



Example application block diagram.

→ System Support Products

I²C Bus I/O Expansion and LED Drivers

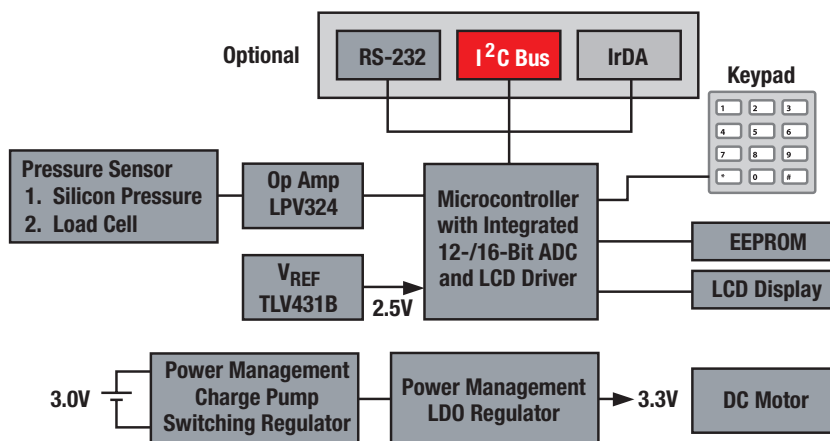
Benefits

- Processor pin savings
- Improved board routing
- Reduced board space

Applications

- Keypad control
- LED control
- Temperature sensing

I²C I/O expanders and LED drivers supplement application functionality. They free the processor from less critical functions and serve to create a more efficient design. Often there are not enough GPIOs available on the microcontroller to control all of the desired peripherals, such as interfacing to a keypad. An I²C bus expander can increase the number of GPIOs in the application while taking up minimal board space. I²C LED drivers free the processor from LED blink operations.



Example application block diagram.

Suggested Components

Device	Max freq. (kHz)	No. of I/Os	I ² C address	V _{CC} range (V)
Low-Voltage I/O Expanders				
TCA6408A	400	8	0100 00x	1.65 to 5.5
TCA6416A	400	16	0100 00x	1.65 to 5.5
TCA6424	400	24	0100 00x	1.65 to 5.5
TCA9535	400	16	0100 xxx	1.65 to 5.5
TCA9539	400	16	1110 1xx	1.65 to 5.5
TCA9555	400	16	0100 xxx	1.65 to 5.5
I/O Expanders				
PCA6107	400	8	0011 xxx	2.3 to 5.5
PCA9534	400	8	0100 xxx	2.3 to 5.5
PCA9534A	400	8	0111 xxx	2.3 to 5.5
PCA9535	400	16	0100 xxx	2.3 to 5.5
PCA9536	400	4	1000 001	2.3 to 5.5
PCA9538	400	8	1110 0xx	2.3 to 5.5
PCA9539	400	16	1110 1xx	2.3 to 5.5
PCA9554	400	8	0100 xxx	2.3 to 5.5
PCA9554A	400	8	0111 xxx	2.3 to 5.5
PCA9555	400	16	0100 xxx	2.3 to 5.5
PCA9557	400	8	0011 xxx	2.3 to 5.5
PCF8574	100	8	0100 xxx	2.5 to 6.0
PCF8574A	100	8	0111 xxx	2.5 to 6.0
PCF8575	400	16	0100 xxx	2.5 to 5.5
PCF8575C	400	16	0100 xxx	4.5 to 5.5
LED Driver				
TCA6507	400	7	1000 101	1.65 to 3.6
Keypad / Keyboard Controller				
TCA8418	1000	18	110100	1.65 to 3.6

→ System Support Products

System-Level ESD/EMI Protection for High-Speed Applications

Benefits

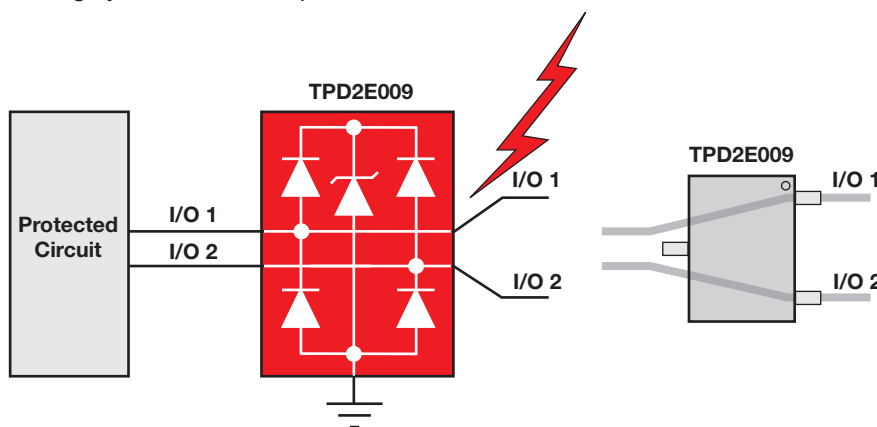
- System-level ESD protection for high-speed interconnects
- Space-saving package and flow-through layout enable glitch-free layout for the high-speed portable applications
- Ultra-low 1nA leakage current enables precision analog measurements like those of glucose meters
- The optional V_{CC} pin allows the device to work as a transient suppressor

Applications

- USB, HDMI, DisplayPort, eSATA, GigEthernet, 1394, Interface
- Analog precision interface

For any external interface connector port, an ESD strike is a constant threat to system reliability. Many low-voltage core chip or system ASICs offer only device-level human-body model (HBM) ESD protection, which does not address system-level ESD. A stand-alone ESD solution is a space- and cost-effective solution to protect the system interconnects from external ESD strikes.

TI's TPDxE series ESD devices provide an IEC-61000-4-2 (Level 4) system-level ESD solution while maintaining signal integrity at the high-speed interfaces. The TPDxF series EMI filter provides immunity against conducted EMI noise while providing system-level ESD protection.



TPD2E009 ESD circuit and board layout.

ESD/EMI Solutions

Device	Number of Channels	V_{DD} (V)	I/O Level (V)	Cap, Resistor	V_{BR} (min) (V)	Package(s)
ESD Solutions						
TPD2E009	2-Channel ESD	0.9 to 5.5/No V_{DD} pin	0 to V_{DD}	0.7pF	6	DRY, DRT, DBZ
TPD4S009	4-Channel ESD	0.9 to 5.5	0 to 5.5	0.8pF	9	DRY, DCK, DBV
TPD4S010	4-Channel ESD	No V_{DD} pin	0 to 5.5	0.8pF	9	QFN
TPD8S009	8-Channel ESD	0.9 to 5.5	0 to 5.5	0.8pF	9	DSM
TPD12S520	12-Channel, HDMI Receiver	0.9 to 5.5	0 to 5.5	0.9pF	9	DBT
TPD12S521	12-Channel, HDMI Driver	0.9 to 5.5	0 to 5.5	0.9pF	9	DBT
TPD4S012	4-Channel ESD with V_{BUS} Clamp	No V_{DD} pin	0 to 5.5	1.0pF, 9pF	7, 20	DRY
TPD2E001	2-Channel ESD	0.9 to 5.5	0 to V_{DD}	1.5pF	11	DRL, DRY, DRS
TPD3E001	3-Channel ESD	0.9 to 5.5	0 to V_{DD}	1.5pF	11	DRL, DRY, DRS
TPD4E001	4-Channel ESD	0.9 to 5.5	0 to V_{DD}	1.5pF	11	DRL, DRS
TPD6E001	6-Channel ESD	0.9 to 5.5	0 to V_{DD}	1.5pF	11	RSE, RSF
TPD6E004	6-Channel ESD	0.9 to 5.5	0 to V_{DD}	1.6pF	6	RSE
TPD4E004	4-Channel ESD	0.9 to 5.5	0 to V_{DD}	1.6pF	6	DRY
TPD4E002	4-Channel ESD	No V_{DD} pin	0 to 6	11pF	6	DRL
EMI Filters						
TPD6F002	6-Channel EMI	0.9 to 5.5	0 to 5.5	17pF, 100Ω, 17pF	6	DSV
TPD6F003	6-Channel EMI	0.9 to 5.5	0 to 5.5	8.5pF, 100Ω, 8.5pF	6	DSV

*For additional product information see designated page number.

To view more system block diagram compatible products, visit www.ti.com/medical

→ Power Management for Consumer Medical

Low- I_Q LDO with Dual-Level Outputs

TPS78001

Get samples, datasheets and evaluation modules at: www.ti.com/sc/device/TPS78001

Key Features

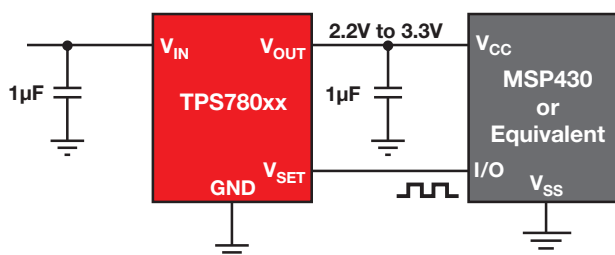
- Rated output current: 150mA
- Ultra-low I_Q : 500nA typ (TPS780xx)
- Input-voltage range: 2.2V to 5.5V
- Output voltages: Fixed (1.5V to 4.2V) and adjustable (1.22V to 5.25V)
- V_{SET} pin allows V_{OUT} to toggle between two factory EEPROM preset values
- Stable with 1 μ F ceramic output capacitor
- Packaging: TSOT23-5, 2 x 2mm SON

Applications

- TI MSP430™ attach applications
- Wireless handsets
- Portable media players

The TPS780xx family of low-dropout (LDO) regulators offers the benefits of ultra-low power ($I_Q = 500$ nA), miniaturized packaging (2 x 2mm SON-6), and selectable dual-level output-voltage levels. An adjustable version is also available but does not have the capability to shift voltage levels.

The V_{SET} pin allows the end user to switch between two voltage levels on the fly through a microprocessor-compatible input. This LDO is designed specifically for battery-powered applications where dual-level voltages are needed. With ultra-low I_Q (500nA), this device is ideal for applications such as microprocessors, memory cards and smoke detectors.



TPS780xx with integrated dynamic voltage scaling.

0.7V_{IN} Boost Converter with 5 μ A I_Q

TPS61220

Get samples and datasheets at: www.ti.com/sc/device/TPS61220

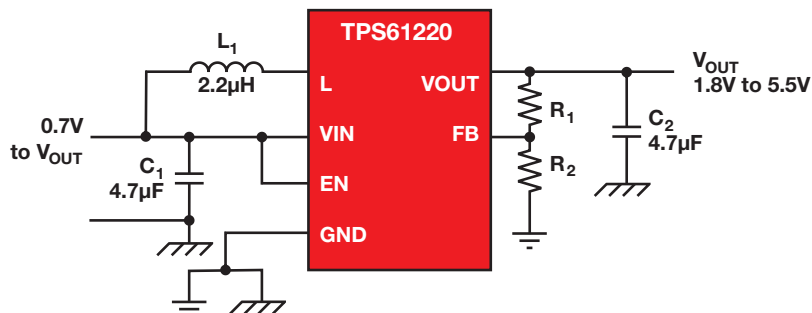
Key Features

- Extended battery run time due to extreme low quiescent current of <5 μ A
- Ideal for low-current applications due to low switch-current limit
- Works well with low-power micro-controllers like TI's MSP430™ family
- Switching frequency: 2MHz
- Packaging: SC-70

Applications

- Microcontroller power supply
- Any portable application

TI's TPS6122x boost converters manage the power conversion to applications powered by a single-cell, two-cell, or three-cell alkaline, NiCd or NiMH, or one-cell Li-Ion or Li-Polymer battery. The devices provide an output current up to 50mA at a 5V output while using a single-cell Li-Ion or Li-Polymer battery, and discharge it down to 2.5V. The TPS6122x family is based on a hysteretic, fixed off-time controller using synchronous rectification to obtain maximum efficiency at the lowest possible quiescent current level. Maximum input current is limited to a value of 250mA. Output voltage can be programmed by an external resistor divider or can be fixed internally on the chip. The TPS6122x converters are available in a 6-pin, 2 x 2mm SC-70 package.



TPS61220 boost converter with low I_Q .

→ Power Management for Consumer Medical

White LED Driver with Digital and PWM Brightness Control

TPS61160, TPS61161

Get samples, datasheets, evaluation modules and application reports at: www.ti.com/sc/device/TPS61160 or www.ti.com/sc/device/TPS61161

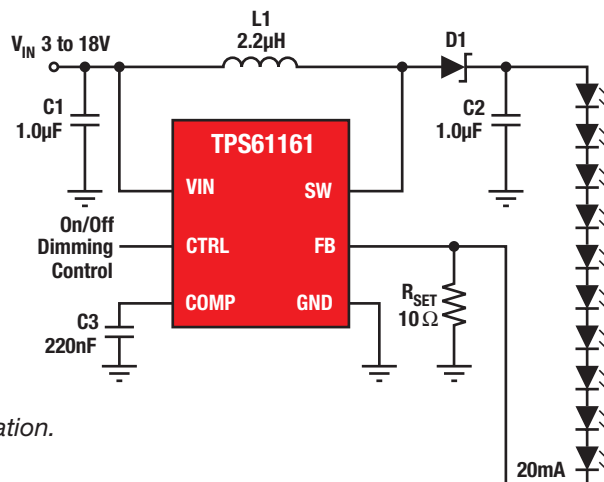
Key Features

- 2.7 to 18V input-voltage range
- 26V open LED protection for 6 LEDs (TPS61160)
- 38V open LED protection for 10 LEDs (TPS61161)
- 0.7A switch current-limit protection
- 600kHz switching frequency
- 200mV ref voltage with 2% accuracy
- EasyScale™ one-wire dimming interface
- PWM brightness control (5 to 100kHz)
- Built-in soft start
- Packaging: 2 x 2 x 0.8mm QFN-6

Applications

- 2.5 to 4.0" displays
- PDAs, cell phones, handheld computers
- GPS receivers
- General white LED backlighting for media form-factor displays

With a 40-V rated integrated switch FET, the TPS61160 and TPS61161 are boost converters that drive up to 10 LEDs in series. The boost converters run at 600kHz fixed switching frequency to reduce output ripple, improve conversion efficiency and allow for the use of small external components.



Typical application.

USB-Compliant Li-Ion Charger in 2mm x 2mm QFN

bq24040

Get samples and datasheets at: www.ti.com/sc/device/bq24040

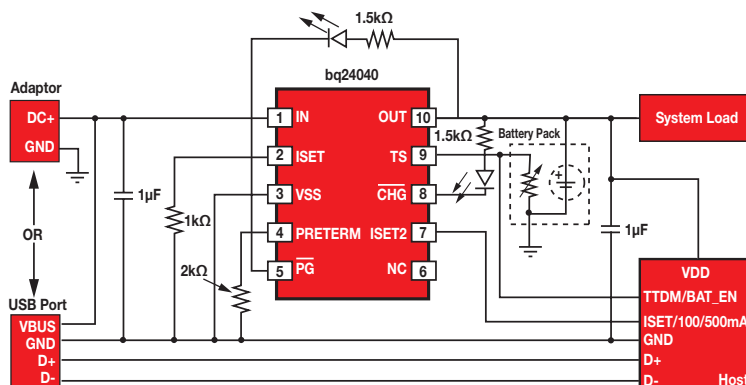
Key Features

- 30-V input rating and 6.6-V overvoltage protection
- Integrated 800-mA FET and current sensor
- USB compliance: USB current limiting and input voltage dynamic power management
- JEITA compliance: reduced charge current at cold and reduced charge voltage at hot
- Packaging: small 10-lead, 2-mm x 2-mm QFN

Applications

- Portable devices powered by 1-cell Li-Ion or Li-Pol batteries

The bq24040 operates from either a USB port or AC adapter. The 100mA /500mA current limit in USB mode fully complies with USB standard. The Input Dynamic Power Management feature reduces the charge current when the input voltage drops to an internal threshold, protecting the source from excessive loads. In addition, the bq24040 comes with more safety features: JEITA compliance, over-voltage protection, safety timers, and ISET short protection.



Functional block diagram.

→ Power Management for Consumer Medical

Pack-Side Impedance Track™ Fuel Gauge

bq27541

Get samples and application reports at: www.ti.com/sc/device/bq27541

Key Features

- Battery fuel gauge for 1-series Li-Ion applications
- Microcontroller peripheral provides:
 - Accurate battery fuel gauging
 - Internal temperature sensor for system temperature reporting
 - SHA-1/HMAC authentication
 - 96 bytes of nonvolatile scratch pad flash
- Battery fuel gauging based on patented Impedance Track™ technology
 - Models battery-discharge curve for accurate time-to-empty predictions
 - Automatically adjusts for battery aging, battery self-discharge and temperature/rate inefficiencies
 - Low-value sense resistor (10mΩ or less)
- SDQ, HDQ and I²C interface formats for communication with host system
- Packaging: Small 12-pin, 2.5 x 4mm SON

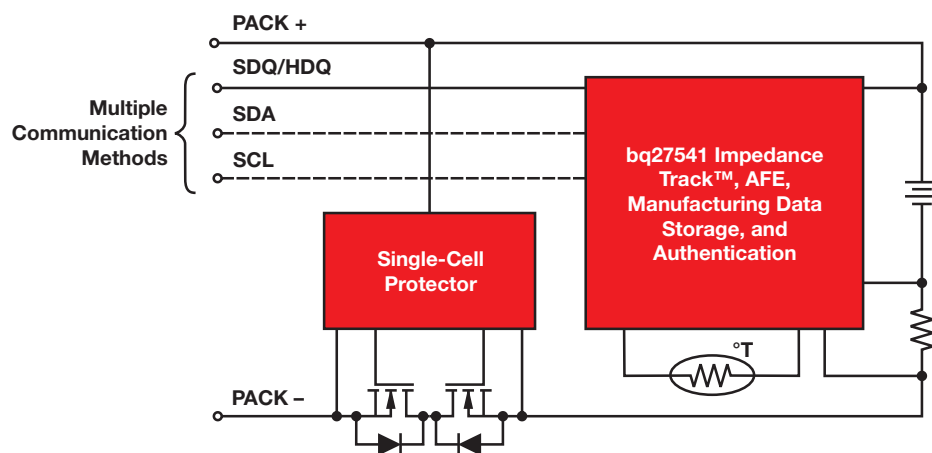
Applications

- Smartphones
- PDAs
- Digital still and video cameras
- Handheld terminals
- MP3 or multimedia players

TI's bq27541 Li-Ion battery fuel gauge is a microcontroller peripheral that provides fuel gauging for single-cell Li-Ion battery packs. The device requires little system microcontroller firmware development for accurate battery fuel gauging. The bq27541 resides within the battery pack or on the system's main board with an embedded (nonremovable) battery.

The bq27541 uses the patented Impedance Track™ algorithm for fuel gauging and provides information such as remaining battery capacity (mAh), state-of-charge (percent), run time to empty (min), battery voltage (mV) and temperature (°C).

The bq27541 also features integrated support for secure battery-pack authentication using the SHA-1/HMAC authentication algorithm.



Typical application.

→ Component Recommendations

Amplifiers

Component	Description	Key Features	Benefits	Other TI Solutions
INA118	Instrumentation Amp	55µV offset, 0.7µV/°C drift, 10nV/√(Hz) noise	Low drift, low noise, wide supply	INA128, INA326, INA333
INA122	Instrumentation Amp	±50µV (max) input offset, 83dB CMRR, 0.06mA (typ) I _Q	Low power, wide supply, CM to Gnd	INA122: INA121, INA126, INA128
INA333 <i>*Page 10</i>	Instrumentation Amp	25µV (max) offset, 50nV/°C drift, 50µA (typ) I _Q	Best offset/noise combination, supply down to 1.8V, low power	INA321, INA326, INA118
OPA141	Precision Op Amp	10MHz, 6.5nV/√Hz, ±4.5V to ±18V, 1.8mA typical, FET input: I _B = 20pA max	Common mode voltage range includes GND	OPA827
OPA333/2333 <i>*Page 11</i>	Precision Op Amp	1.8V min supply, 0.017mA/ch (max), 10µV offset (max), 0.05 µV/°C drift (max)	Zero drift, high precision, low power, EMI input	OPA335, OPA378, OPA330
OPA364	CMOS Amplifier	1.8V, 7MHz, 90dB CMRR, 5V/µs slew rate, 750µA/ch I _Q	Sensor amplification in battery-powered systems	OPA363, OPA2363, OPA2364, OPA4364
OPA369	Nanopower Zero-Crossover Op Amp	1.8V to 5.5V, 700nA I _Q , CMRR 114dB RRIO, 0.4µV/°C, V _{OS} drift	Zero-crossover input offers excellent CMRR over entire input range	OPA379, OPA349
OPA378	Low Noise Precision Op Amp	0.1µV/°C V _{OS} drift, 125µA, 900kHz, 0.4µV _{PP} (0.1Hz to 10Hz) 0.4µ V _{PP} (0.1Hz to 10Hz), 0.9MHz	Lowest noise, power, price, precision zero-drift option	OPA330 , OPA333
OPA2889	Low-Power High-Speed Amp	Typical quiescent current of 460µA/channel	Supports portable and power-sensitive applications	OPAx890, OPAx684, OPAx683, THS4281
THS4524	Very Low-Power Differential Amp	SAR and ΔΣ drivers, 145MHz, 490V/µs slew rate	Accurate output common-mode	
TLV276x	microPower Op Amp	1.8V, RRIO, 500µV input offset voltage, 500kHz BW	Available in S, D, Q, 20µA/ch I _Q	
TPA2011D1	Analog-Input Class-D Amp	Variable gain, 3.2W mono Class-D with integrated DAC noise filter in 0.4mm pitch WCSP	The TPA2011D1 Class-D speaker amplifier is smaller, has fewer external components, consumes less power and has no pop	TPA2010D1
TPA2013D1	Analog-Input Class-D Amp	2.7W constant output power, mono, Class D, integrated boost converter	Louder audio at low battery levels	TPA2014D1
TPA2026D2	Analog-Input Class-D Amp with AGC/DRC	3.2-W/channel, stereo Class-D audio amplifier with fast gain ramp, SmartGain™ AGC and DRC	Provides louder and clearer audio while protecting speakers using DRC and AGC compared to competitive products using just the AGC limiter option	TPA2016D2, TPA2017D2
TPA2028D1	Analog-Input Class-D Amp with AGC/DRC	3.0-W mono Class-D audio amplifier with fast gain ramp, SmartGain™ AGC and DRC	Provides louder and clearer audio while protecting speakers using DRC and AGC compared to competitive products using just the AGC limiter option	
TPA6205A1	Class-AB Audio Amp	1.25W mono, fully differential, Class AB, 1.8V shutdown	Loud audio, low cost	TPA751
TPA6211A1	Class-AB Audio Amp	3.1W mono, fully differential, Class AB	Loud audio	

Data Converters

ADS1115	Delta-Sigma ADC, I ² C	16-bit, 860SPS, 4 SE, 2 diff input, PGA, MUX, comparator, V _{REF}	Smallest 16-bit ADC, 2.0 x 1.5 x .04 mm leadless WFN pkg; reduces system size/component count	ADS1113/4 , ADS1013/14/15
ADS7866 ADS7924	SAR ADC, Serial microPower SAR ADC	1.2V, 12-bit, 200kSPS (max), 85dB SFDR 12-bit, 100kSPS, 4 channel, <1µA power down current, I ² C interface, QFN package	Very small, low power Intelligent system power management and self monitoring	ADS7888
ADS8201	Low-Power SAR ADC	8 channel, 12-bit, 100kSPS, 1.32mW power consumption at 100kSPS	Full on-chip data acquisition system	ADS7870
ADS8317	SAR ADC, Serial	16-bit, 250kSPS, 2.7V to 5.5V, pseudo-bipolar, diff inputs	Excellent linearity, microPower, high speed	ADS8422
ADS8326	SAR ADC, Serial	16-bit, 250kSPS, 2.7V to 5.5V, pseudo-bipolar, diff inputs	Low noise, low power, high speed	ADS8325
ADS8331/32	SAR ADC	16-bit, 500kSPS, 4/8 channels, with serial interface	Mux out feature can be used to reduce system part count and overall cost	ADS8342
DAC7551	V _{OUT} DAC	12-bit, 500kSPS, ±0.5LSB DNL, ±1LSB INL, 0.27mW power	Ultra-low glitch	DAC7554
DAC8534	V _{OUT} DAC	16-bit, 0.093MSPS, ±1LSB DNL, ±64LSB INL, 2.7mW power	Quad	
DAC8554	Low-Power DAC	16-bit, 1-4 chs, ±3 LSB (typ) INL, 0.1 to 0.15nV-s glitch	Excellent AC/DC performance	DAC8564, DAC8534
DAC8551	V _{OUT} DAC	16-bit, 140µA at 2.7V operation, 0.1nV-s glitch energy	Very low power, ultra-low glitch	DAC8531
DAC8560	V _{OUT} DAC	16-bit, 2ppm/°C temp drift, 2.5V int reference	Tiny package, single channel	DAC8564, DAC8565
DACx311	Low-Power DAC	14-and 16-bit, 1.8V to 5.5V, 80mA, 14- and 16-bit, low-power, single-channel in SC70 package	Easy resolution upgrade and downgrade capability; decrease board space and power requirements	
TLV320DAC3120	Low-Power Audio DAC	Mono DAC with 2.5W mono Class-D speaker amplifier; miniDSP for audio processing	Longer battery life, better audio quality, lower cost	TLV320AIC3104, TLV320AIC3120

References

REF29xx	Low-Power, Low-Cost Series Reference	50µA, 2% initial accuracy, 100ppm/°C max drift, ±25mA output, 1.25V, 2.048V, 2.5V, 3.0V, 3.3V, 4.096V		REF30xx, REF31xx, REF33xx
REF30xx	Low-Power, Low-Drift Series Reference	50µA, 0.2% initial accuracy, 50ppm/°C max drift, ±25mA output, 1.25V, 2.048V, 2.5V, 3.0V, 3.3V, 4.096V		REF31xx, REF33xx, REF29xx

*For additional product information see designated page number

To view more system block diagram compatible products, visit www.ti.com/medical

New products are listed in **bold red**. Preview products are listed in **bold blue**.

→ Component Recommendations

Component	Description	Key Features	Benefits	Other TI Solutions
References (Continued)				
REF31xx	Voltage Reference	15ppm/°C (max) drift, 5mV low dropout, 115µA (max) I _Q , 0.2% (max) accuracy, 1.25V, 2.048V, 2.5V, 3.0V, 3.3V, 4.096V	No load capacitor required	REF32xx, REF33xx
REF32xx	Ultra-Low-Drift Series Reference	100µA, 0.2% initial accuracy, 7ppm/°C max drift, ±10mA output, 1.25V, 2.048V, 2.5V, 3.0V, 3.3V, 4.096V	Improves system accuracy	
REF33xx *Page 10	Very-Low-Power Series Reference	5µA, 0.15% initial accuracy, 30ppm/°C max drift, ±5mA output, 1.25V, 1.8V, 2.048V, 2.5V, 3.0V, 3.3V	Preserves battery life, fits into physically constrained systems	REF30xx, REF31xx, REF29xx
REF50xx	Precision Reference	0.05% accuracy, 3ppm/°C (max) drift, 3µV _{pp} /V low noise, 2.048V, 2.5V, 3.0V, 4.096V, 4.5V, 5V, 10V	Outstanding accuracy	REF02, REF102
Processors				
AM3517	Applications Processor	ARM® Cortex-A8, graphics accelerators, Ethernet, CAN	High performance at handheld power levels	AM3505
MSP430F20xx	Ultra-Low-Power 16-Bit MCU	1KB/2KB Flash, 128B RAM, SPI+I ² C	8 ch. 12-bit ADC or 4 ch. 16-bit SD ADC, 4 x 4mm package	
MSP430F22x4	Ultra-Low-Power 16-Bit MCU	8 to 32KB Flash, 512B/1KB RAM, SPI + I ² C + UART/LIN + IrDA	12 ch. 10-bit ADC, 2 op.amps	
MSP430F23x0	Ultra-Low-Power 16-Bit MCU	8 to 32KB Flash, 1KB/2KB RAM, SPI + I ² C + UART/LIN + IrDA	Analog comparator, HW multiplier	
MSP430F24xx	Ultra-Low-Power 16-Bit MCU	32 to 120KB Flash, 2 to 8KB RAM, SPI + I ² C + UART, DMA, SVS	8 ch. 12-bit ADC, 2 ch.12-bit DAC, analog comp, HW multiplier	
MSP430F26xx	Ultra-Low-Power 16-Bit MCU	92 to 120KB Flash, 4KB/8KB RAM, SPI + I ² C + UART, DMA, SVS	8 ch. 12-bit ADC, 2 ch.12-bit DAC, analog comp, HW multiplier	
MSP430F41x	Ultra-Low-Power 16-Bit MCU	4 to 32KB Flash, 256B to 1KB RAM, SVS, 96 segment LCD	Analog comparator	
MSP430F42x	Ultra-Low-Power 16-Bit MCU	8 to 32KB Flash, 256B to 1KB RAM, SPI + UART, SVS, 128 segment LCD	3 x 16-bit SD ADC	
MSP430F42x0	Ultra-Low-Power 16-Bit MCU	16 to 32KB Flash, 256B RAM, 56 segment LCD, 2 op amps	5 ch. 16-bit SD ADC, 12-bit DAC	
MSP430FG42x0	Ultra-Low-Power 16-Bit MCU	16 to 32KB Flash, 256B RAM, 56 segment LCD 2 op amps	5 ch. 16-bit SD ADC, 12-bit DAC	
MSP430F43x	Ultra-Low-Power 16-Bit MCU	16 to 32KB Flash, 512B/1KB RAM, SPI + UART, SVS, 160 segment LCD	8 ch. 12-bit ADC, analog comparator	
MSP430FG43x	Ultra-Low-Power 16-Bit MCU	32 to 60KB Flash, 1KB/2KB RAM, SPI + UART, SVS, 128 segment LCD, 3 op amps	12 ch. 12-bit ADC, 2 ch. 12-bit DAC, DMA, 3 op amps	
MSP430F44x	Ultra-Low-Power 16-Bit MCU	32 to 60KB Flash, 1KB/2KB RAM, 2x SPI + UART, SVS, 160 segment LCD	8 ch. 12-bit ADC, HW multiplier	
MSP430FG461x	Ultra-Low-Power 16-Bit MCU	92 to 120KB Flash, 4KB/8KB RAM, SPI + I ² C + UART/LIN + IrDA, 160 LCD, 3 op amps	12 ch.12-bit ADC, 2 ch.12-bit DAC, A-comp, 3 op amp, HW multiplier	
MSP430FG47x *Page 8	Ultra-Low-Power 16-Bit MCU	32 to 60KB Flash, 2KB RAM, 16-bit ΔΣ A/D, 12-bit D/A, op amp, 128Seg LCD	Two 16-bit timers, a basic timer with a real-time clock, a high performance 16-bit ΔΣ ADC, dual 12-bit DACs, two configurable op amps	
MSP430F54xxA *Page 9	Ultra-Low-Power 16-Bit MCU	128 to 256KB Flash, 16KB RAM, (4) USCI, PMM, DMA, temp. sensor	16 ch. 12-bit ADC, analog comparator, RTC, internal voltage regulator for power optimization	
MSP430F552x	Applications Processor	Up to 128KB Flash, 8+2KB RAM, USB, SPI + I ² C	Integrated USB, 12-bit ADC	
OMAP-L137	Low-Power Applications Processor	300MHz ARM9™ w/MMU + 300MHz C674x™ floating-point DSP core, rich peripheral set including 10/100 Ethernet MAC, LCD controller, USB 2.0 HS OTG, USB 1.1 full speed, SPI and MMC/SD	Highly integrated, dual-core solution drives low system cost and maximum flexibility for connectivity, GUI and high-level OS options. Extends product battery life by providing greater than 60% power reduction over existing solutions in the market.	OMAP-L138
TMS320C5000™	DSP	Power efficient, high performance	Fixed-point DSP with industry's best combination of standby and dynamic power consumption	
TMS320F2802x/3x Piccolo™	32-Bit Microcontroller	Up to 60MHz C28x™ core with optional control law accelerator. Up to 128KB Flash, high resolution (150ps) PWMs, 4.6MSPS ADC, CAN/LIN, QEP.	With dedicated, high precision peripherals, Piccolo microcontrollers are the ultimate combination of performance, integration, size, and low cost. Ideal for precision sensing and control applications.	TMS320F283x Delfino, TMS320F280x
TMS320F283x Delfino™	32-Bit Floating-point Microcontroller	Up to 300MHz C28x™ core. Up to 512KB Flash, high resolution (150ps) PWMs, 12MSPS ADC, CAN/LIN, QEP, external memory bus, DMA.	Delfino brings floating point and unparalleled performance to MCUs. Native floating point brings increased performance and quicker development. Ideal for precision sensing and control applications.	TMS320F2802x/3x Piccolo, TMS320F280x
TMS320VC5506	DSP	200MHz, dual MAC, very low standby power of 0.12mW	Supported by eXpressDSP™ and many other software packages and tools	TMS320VC5509A, TMS320VC5502
Interface				
TPD3E001 *Page 14	3-Bit/Single-Channel USB OTG ESD	1.5pF cap, 1nA leakage	Low capacitance, small package	TPD2E001, TPD4E001
TPD4S012 *Page 14	4-Bit/Single-Channel ESD with V _{BUS} Clamp	USB HS ESD with additional V _{BUS} clamp	Replace one additional component for USB charger application	TPD4S014

*For additional product information see designated page number. To view more system block diagram compatible products, visit www.ti.com/medical

New products are listed in **bold red**.

→ Component Recommendations

Component	Description	Key Features	Benefits	Other TI Solutions
Interface (Continued)				
TPD4E004 <i>*Page 14</i>	4-Bit/2-Channel	1.6pF cap, low DC breakdown voltage	Low capacitance, small package	TPD6E004
TPD4E002 <i>*Page 14</i>	4-Bit/2-Channel	USB FS	Very robust ESD (15kV contact)	
TUSB3410	USB 2.0 Full-Speed to Enhanced Serial Port Bridge	USB 2.0 compliance, enhanced UART port		
TUSB1106	USB 2.0 Full-Speed Trans.	USB 2.0 compliance, level shifting, system-level ESD	Smaller package, no external ESD needed	TUSB1105, TUSB2551A
Power Management				
bq77PL900	5-10 Series Li-Ion Battery Protection & AFE	Integrated I ² C communications interface allows the bq77PL900 also to be as an analog front end (AFE) for a host controller	Provides full safety for overvoltage, under voltage, over current in discharge overvoltage and short circuit in discharge conditions	
bq2406x	Battery Charger	Linear 1-cell Li-Ion charger with thermal regulation, 6.5V OVP, temp sense	Good for space-limited designs with need for battery safety	bq2410x
bq24040 <i>*Page 16</i>	USB-Compliant Li-Ion Charger	30-V input rating and 6.6V overvoltage protection; integrated 800mA FET and current sensor; USB and JEITA compliant	The bq24040 comes with more safety features: JEITA compliance, over-voltage protection, safety timers, and ISET short protection.	
bq24081	Battery Charger	One-cell Li-Ion charger with 1-A FET, timer enable and temperature sensing	Great for space-limited charger applications	
bq27010	Battery Fuel Gauge	Li-Ion and Li-Pol battery gas gauge	Reports accurate time-to-empty of battery	bq27200, bq27500
bq27541 <i>*Page 17</i>	Battery Fuel Gauge	Li-Ion battery gas gauge with Impedance Track™ fuel-gauge technology	Reports accurate time-to-empty of battery	bq27510
TPS2041B	USB Power Switch	USB compliant power source, short circuit protection	USB switch with adjustable precision OC	TPS2550
TPS22902	Load Switch with Controller Turn-On	Low on resistance, controlled turn-on, ultra small 0.64mm ² package, quick output discharge	Ultra-small, fully integrated solution	TPS22901, TPS22922, TPS22924C, TPS22960
TPS22946	Current Limited Load Switch	Configurable current limit, ultra-small package, 1μA quiescent current at 1.8 V	Ultra-small, low quiescent current current limited switch	TPS22949, TPS22945
TPS2550	USB Power Switch	USB compliant power source, short circuit protection	USB switch with adjustable precision OC	TPS2551
TPS2551	Power Switch	Adjustable current limit, 100mA to 1100mA	Allows designer to precisely set current limit	TPS2051B, TPS2061
TPS61081	LED Boost Converter	Input to output isolation	Protection from short between any pins and between any pin to ground	TPS61161
TPS61093	OLED Boost Converter	Wide V _{IN} range, input-output disconnect	Flexible, fail safe solution	TPS61080
TPS61097-33	Boost Converter with Bypass Switch	Highly efficient, operates down to 0.3V; bypass switch; 5nA shutdown current; SOT-23	Super efficient boost, works over entire battery range, low quiescent current, integrate the bypass switch, small package	
TPS61160/61 <i>*Page 16</i>	Boost Converter	2.7V to 18V input voltage, up to 90% efficiency, built-in soft start	The boost converter runs at 600kHz fixed switching frequency to reduce output ripple, improve conversion efficiency, and allows for the use of small external components.	
TPS61200	Boost Converter	High efficient, operates down to 0.3V	Super efficient boost, works over entire battery range	TPS61010
TPS61220 <i>*Page 15</i>	Boost Converter	Low Input Voltage, 0.7V boost converter with 5.5μA quiescent current	Can be switched off to minimize battery drain; small package solution	
TPS62230	Step-Down Converter	Up to 90dB PSRR, excellent AC and transient load regulation	Low noise regulation, 12mm ² solution size	TPS62260
TPS62300	Step-Down Converter	500mA, 3MHz synchronous step-down converter	Very small inductor and high efficiency	TPS62040
TPS63030	Buck-Boost Converter	1-A switch, automatic transition between step down and boost mode	Extending application run time, small solution	TPS61020
TPS717xx	Low-Noise Single-Channel LDO	High bandwidth, very high rejection of power-source noise	Low-noise power rails for sensitive analog components	TPS799xx
TPS718xx-yy	Dual-Channel LDO	Very high rejection of power-source noise	Low-noise power rails for sensitive analog components	TPS719xx-yy
TPS780xx	LDO with DVS	Dynamic voltage scaling (DVS) with low I _Q 500nA	DVS voltage designed to operate with MSP430™ to increase power savings	TPS781xx
TPS78001 <i>*Page 15</i>	Single-Channel LDO	Dual-level, fixed output voltages, ultra-low I _Q	Adjustable V _{OUT} for optimal performance, longer battery life	TPS717xx, TPS739xx
RF ICs				
RF Transceivers				
CC1101	Sub-1GHz RF Transceiver	Wake-on-radio functionality; integrated packet handling with 64B data FIFOs; high RF flexibility: FSK, MSK, OOK, 1.2-500kbps; extremely fast PLL turn-on/hop time	Ideal for low-power systems; any low-end MCU can be used; backwards compatible with existing systems; suitable for fast frequency-hopping systems	CC2500
CC2520	2.4GHz ZigBee®/IEEE 802.15.4 RF Transceiver	Best-in-class coexistence and selectivity properties; excellent link budget (103dBm); extended temperature range; AES-128 security module	Reliable RF link with interference present; 400m line-of-sight range with the development kit; ideal for industrial applications; no external processor needed for secure communication	CC2530

**For additional product information see designated page number.*

To view more system block diagram compatible products, visit www.ti.com/medical

→ Component Recommendations

Component	Description	Key Features	Benefits	Other TI Solutions
RF ICs (Continued)				
RF Transceivers (Continued)				
TMS37157 *Page 7	Passive Low Frequency Interface Device (PaLFI) With EEPROM and 134.2 kHz Transponder Interface	Ultra-low-power consumption, 2V to 3.6V supply voltage, low frequency HDX interface	It is the ideal device for any data logger, sensor or remote control application enabling operation without the need of a battery.	
RF Systems-on-Chip				
CC2560	2.4GHz <i>Bluetooth</i> ® 2.1 chipset	Single-chip <i>Bluetooth</i> ® solution using TI's digital radio processor technology.	Sophisticated low-power technology ideal for battery operated solutions	
CC1110/1111	Sub-1GHz System-on-Chip	MCU, USB 2.0, Flash and RAM in one package; four flexible power modes for reduced power consumption; includes CC1101 transceiver frequency synthesizer; built-in AES-128 encryption coprocessor	Complete low-cost solution on single chip; ideal for low-power battery-operated systems; robust and secure link with good noise immunity; no external processor needed for secure communication; can connect directly to a PC	CC2510, CC2511
CC2530/31	Second Generation System-on-Chip Solution for 2.4GHz IEEE 802.15.4/RF4CE/ ZigBee®	Excellent RX sensitivity, low power, easy to use development tools	RF design System-on-Chip for quick time to market. Provides a robust and complete ZigBee USB dongle or firmware-upgradable network node	CC2590/91, CC2530ZNP
CC2540	2.4 GHz <i>Bluetooth</i> ® low energy compliant RF System-on-Chip	Excellent link budget enabling long range applications without external frontend, receiver sensitivity, selectivity and blocking performance	Fast-to-market <i>Bluetooth</i> ® low energy compliant solution	
WL1271	2.4GHz 802.11b/g/n and <i>Bluetooth</i> ® 2.1 Chipset	Single-chip 802.11b/g/n WLAN and <i>Bluetooth</i> ® solution using TI's digital radio processor technology using a single antenna.	Sophisticated low-power technology ideal for battery operated solutions; coexistence features enable simultaneous WLAN and <i>Bluetooth</i> ® operations; supports ANT+ standard.	WL1273
WL1273	2.4/5GHz 802.11a/b/g/n and <i>Bluetooth</i> ® 2.1 Chipset	Single-chip 802.11a/b/g/n WLAN and <i>Bluetooth</i> ® solution using TI's digital radio processor technology using a single antenna.	Sophisticated low-power technology ideal for battery operated solutions; coexistence features enable simultaneous WLAN and <i>Bluetooth</i> ® operations; supports ANT+ standard.	WL1271
RF Network Processor				
CC2530ZNP	Second Generation Z-Stack™ Network Processor	ZigBee® stack and radio in one chip; implements ZigBee certified stack; configurable device type and network settings; excellent selectivity and blocking performance	Add CC2530ZNP and your system is ZigBee enabled; ideal for battery operated systems; excellent coexistence with <i>Bluetooth</i> ® technology and Wi-Fi.	

*For additional product information see designated page number.

To view more system block diagram compatible products, visit www.ti.com/medical

New products are listed in **bold red**. Preview products are listed in **bold blue**.

→ Overview

Connectivity plays an important role in clinical, patient monitoring, and consumer medical devices. While wired (USB) connections continue to be used, emphasis is being placed on wireless capabilities that enable connected or networked devices. Portability requirements call for these devices to be small in size, consume minimal power and include the ability to efficiently and accurately feed data to remote sources.

TI has long-time experience providing a wide range of innovative wireless technologies. Some of these technologies include ZigBee®, radio frequency identification (RFID), low-power wireless (ISM), *Bluetooth*® technology and WLAN.

USB for Medical Applications

Connectivity for portable medical applications has become critical as consumers and caregivers are requiring data to move from medical devices to data hubs such as computers and mobile phones. TI is a promoting member of the Continua Health Alliance and now offers the first Continua-certified USB platform for Agent Devices. See page 23 for more information.

For more information on the Continua Health Alliance, visit

<http://www.continuaalliance.org>



ZigBee® and Bluetooth® Low Energy Solutions for Medical Applications

More and more medical devices, especially in patient monitoring and home healthcare, can benefit from wireless technologies such as ZigBee and Bluetooth Low Energy.

The ZigBee standard enables companies to have a simple, reliable, low-cost and low-power standard-based wireless platform for their medical application development.

As an example, with the use of ZigBee wireless sensors, patients can move around in the hospital, or even in their homes, and the sensors will still monitor and send critical health data to the hospital or doctor.

Bluetooth Low-Energy solutions are designed for low-cost, low-power and short range connectivity. The technology enables direct communication to cellular phones, laptops and other Bluetooth enabled devices such as sports and fitness watches, GPS / handhelds, and other personal monitoring devices.



Texas Instruments supports the ZigBee Personal Health (PH) profile as well as the Continua Alliance/ EN11073 profile.

For more information, visit:

www.ti.com/zigbee

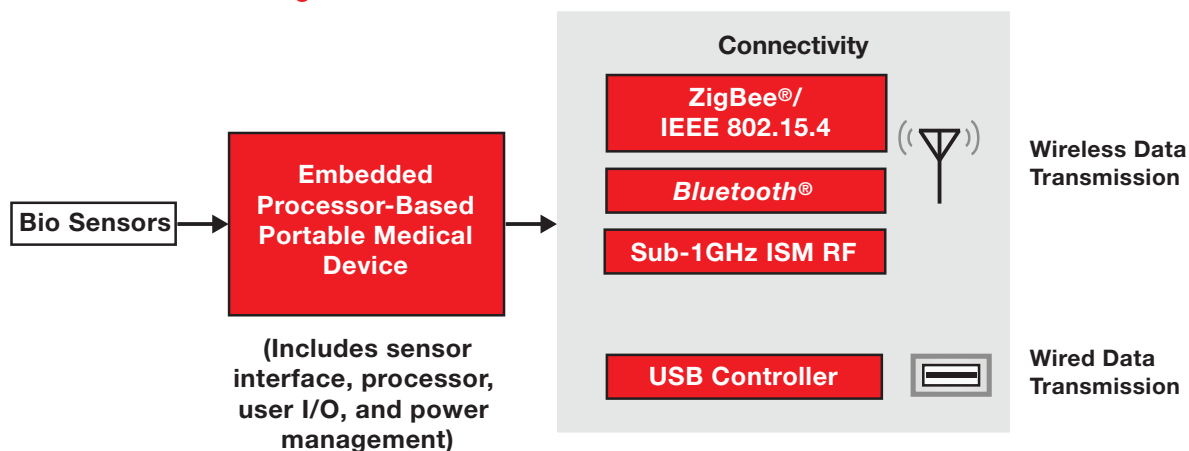
www.ti.com/bluetoothlowenergy

Radio Frequency Identification (RFID)

TI's high-frequency RFID product family consists of 13.56MHz high-frequency (HF) transponders and low-power RFID readers that are compliant with ISO/IEC 15693 and ISO/IEC 18000-3 global open standards.

Typical RFID medical applications include blood bag and medical supply tracking, patient/staff authentication, pharmaceutical authentication, medical imaging, product authentication and remote digital healthcare management applications.

TI's Tag-it™ HF-1 family of transponder inlays consists of 13.56MHz HF transponders that are compliant with ISO/IEC 15693 and ISO/IEC 18000-3 global open standards. These products are available in six different antenna shapes with frequency offset for integration into paper, PVC or other substrates manufactured with TI's patented laser-tuning process to provide consistent read performance.



TI has considerable experience designing connectivity solutions for interoperability and coexistence.

➔ Overview (Continued)

Low-Power Wireless (ISM)

TI offers a wide selection of cost-effective, low-power RF solutions for both proprietary and standard-based wireless applications. The portfolio includes RF transceivers, RF transmitters and Systems-on-Chip for short-range applications in the sub-1GHz and 2.4GHz frequency bands.

To choose the right radio for specific applications, designers need to determine at what frequency band to operate. TI's radios operate in either the global 2.4GHz or the sub-1GHz Industrial

Scientific Medical (ISM) bands. The 2.4GHz is available for license-free operation in most countries around the world and enables the same solution to be sold in several markets without software/hardware alterations.

The ISM bands below sub-1GHz have limitations that vary from region to region, but their strength is a better range than 2.4GHz with the same output power and current consumption. In addition, there is less interference present in the band. Since different

sub-1GHz bands are used in different markets, custom solutions become a necessity.

The trade-off between the need for interoperability and the cost of software design and development will, to a large extent, determine the choice of software platform. TI's software portfolio ranges from proprietary solutions with a high degree of design freedom and low complexity to fully interoperable ZigBee® solutions.

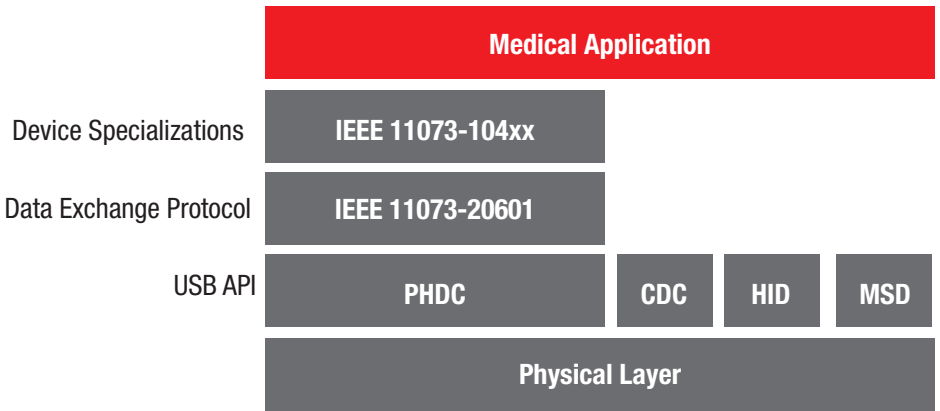
➔ Medical USB Platform

TI offers a Continua-certified USB hardware-software platform that implements the Personal Healthcare Device Class (PHDC) along with IEEE 11073. As personal healthcare devices become more ubiquitous, companies are developing products with connectivity that allow data to be exchanged easily. PHDC (Personal Healthcare Device Class), which is part of the USB standard, is designed for portable medical and wellness devices to be able to send measurements to USB hosts such as personal computers, cell phones, etc. The Continua Health Alliance has released guidelines for interoperability between various types of devices implementing the USB standard. Texas Instruments offers a hardware-software platform that has been certified by the Continua Health Alliance after having passed a rigorous testing procedure. Customers can use

the software stacks of this platform to reduce development time for devices that will comply with the medical industry standards such as the Continua Health Alliance. These stacks are available for use on TI's industry-leading, ultra-low-power MSP430™ MCUs.

For more information on the medical USB platform, visit <http://www.ti.com/usbplatform>.

For more information on the Continua Health Alliance, visit <http://www.continuaalliance.org>.



→ Wired Solutions

USB-to-Serial Bridge

TUSB3410

Get samples, datasheets, application reports and evaluation modules at: www.ti.com/sc/device/TUSB3410

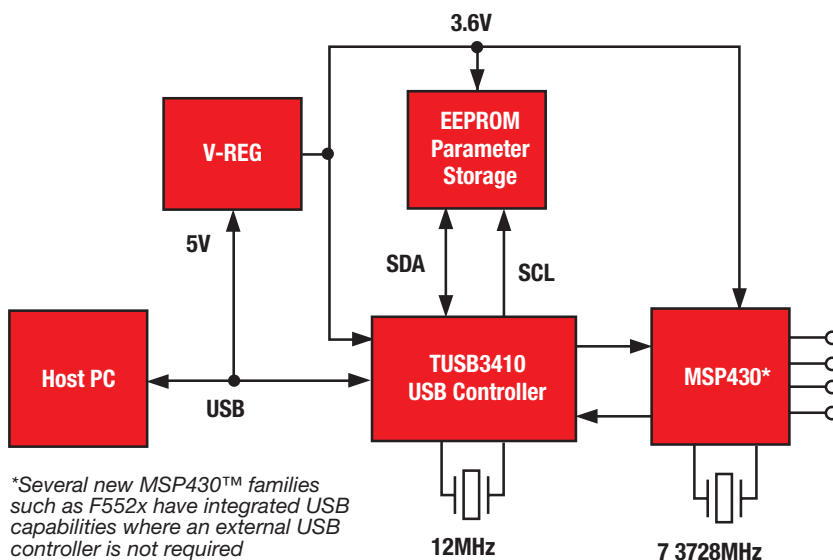
Key Features

- USB full-speed (12Mbps) compliant
- Integrated 8052 microcontroller with 16K bytes of RAM that can be loaded from the host or external memory via an I²C bus
- Integrated, enhanced UART features include:
 - Programmable software/hardware flow control
 - Automatic RS-485 bus transceiver control, with and without echo
 - Software-selectable baud rate from 50 to 921.6K baud
 - Built-in, 2-channel DMA controller for USB/UART bulk I/O
- TUSB3410UARTPDK product development kit can jump-start USB-to-serial development

Applications

- Handheld meters
- Health metrics/monitors
- Legacy-free PC COM port replacement

TUSB3410 and TUSBWINVCP software provides an easy way to move serial-based legacy devices to a fast, flexible USB interface by bridging a USB port and an enhanced UART serial port. The TUSB3410 contains all of the logic needed to communicate with the host computer using the USB bus. The TUSBWINVCP software package enables the TUSB3410 to act as a virtual COM port and appear as legacy COM ports on the back of older model computers. This enables the use of existing devices and application software without making any changes.



TUSB3410/MSP430™ implementation block diagram.

→ Wireless Interface, RFID and Tag-it™

Radio Frequency Identification (RFID)

TI's high-frequency RFID product family consists of 13.56MHz high-frequency (HF) transponders and low-power RFID readers that are compliant with ISO/IEC 15693 and ISO/IEC 18000-3 global open standards. Typical RFID implementations include asset tracking, access control, blood bag tracking, medical supply tracking, patient/staff authentication, pharmaceutical authentication, medical imaging, product authentication, remote digital healthcare management applications and many non-medical related applications.

Tag-it HF-I Transponder Inlays

TI's Tag-it HF-I family of transponder inlays consists of 13.56MHz HF transponders that are compliant with ISO/IEC 15693 and ISO/IEC 18000-3 global

open standards. These products are available in six different antenna shapes with frequency offset for integration into paper, PVC or other substrates manufactured with TI's patented laser-tuning process to provide consistent read performance. Prior to delivery, the transponders undergo complete functional and parametric testing to provide the high quality customers have come to expect.

Tag-it HF-I Family

Product Specifications

- Supported standards: ISO/IEC 15693-2, -3; ISO/IEC 18000-3
- Recommended operating frequency: 13.56MHz
- Factory programmed read-only numbers: 64-bit
- Typical programming cycles (at +25°C): 100,000

- Data retention time (at +55°C): >10 years

Key Features

- User and factory lock per block
- Application Family Identifier (AFI)

Standard

- 256-bit user memory, 8 x 32-bit
- FastSID

Pro

- 256-bit user memory, 8 x 32-bit
- Password-protected write command
- Command to disable IC functionality
- FastSID

Plus

- 2Kbit user memory, 64 x 32 6-bit
- Data Storage Format Identifier (DSFID)
- Combined inventory read block

Tag-it™ HF-I Plus Inlay Shapes

Part Number	RI-I11-112A-03	RI-I11-112B-03	RI-I02-112A-03	RI-I02-112B-03	RI-I03-112A-03	RI-I15-112B-03	RI-I16-112A-03	RI-I17-112A-03
Available Memory	2K bits organized in 64 x 32-bit blocks							
Antenna Size (mm)	45 x 45	45 x 45	45 x 76	45 x 76	22.5 x 38	34 x 65	Ø 24.2	Ø 32.5
Foil Pitch (mm)	50.8 + 0.1/ -0.4 (2 in)	50.8 + 0.1/ -0.4 (2 in)	96 + 0.1/ -0.4 (~3.78 in)	96 + 0.1/ -0.4 (~3.78 in)	58 + 0.1/ -0.4 (~1.89 in)	101.6 + 0.1/ -0.4 (4 in)	50.8 + 0.1/ -0.4 (2 in)	50.8 + 0.1/ -0.4 (2 in)
Frequency Offset for Lamination Material	Paper	PVC	Paper	PVC	Paper/PVC	PVC	Paper/PVC	Paper/PVC
Delivery	Single tape row with 48mm foil width wound on cardboard reel							

Tag-it™ HF-I Pro Transponder Inlays

Part Number	RI-I11-114A-S1	RI-I11-114B-S1	RI-I02-114A-S1	RI-I02-114B-S1	RI-I03-114-S1	RI-I16-114-S1	RI-I17-114-S1
Available Memory	256 bits organized in 8 x 32-bit blocks						
Foil Width (mm)	48mm ±0.5mm						
Antenna Size (mm)	45 x 45	45 x 45	45 x 76	45 x 76	22.5 x 38	Ø 24.2	Ø 32.5
Foil Pitch (mm)	50.8 + 0.1/ -0.4 (2 in)	50.8 + 0.1/ -0.4 (2 in)	96 + 0.1/ -0.4 (~3.78 in)	96 + 0.1/ -0.4 (~3.78 in)	48 + 0.1/ -0.4 (~1.89 in)	50.8 + 0.1/ -0.4 (2 in)	50.8 + 0.1/ -0.4 (2 in)
Frequency Offset for Lamination Material	Paper	PVC	Paper	PVC	Paper/PVC	Paper/PVC	Paper/PVC
Delivery	Single row tape wound on cardboard reel						

Tag-it™ HF-I Standard Transponder Inlays

Part Number	RI-I11-114A-01	RI-I11-114B-01	RI-I02-114A-01	RI-I02-114B-01	RI-I03-114-01	RI-I16-114-01	RI-I17-114-01
Available Memory	256 bits organized in 8 x 32-bit blocks						
Foil Width (mm)	48mm ±0.5mm						
Antenna Size (mm)	45 x 45	45 x 45	45 x 76	45 x 76	22.5 x 38	Ø 24.2	Ø 32.5
Foil Pitch (mm)	50.8 + 0.1/ -0.4 (2 in)	50.8 + 0.1/ -0.4 (2 in)	96 + 0.1/ -0.4 (~3.78 in)	96 + 0.1/ -0.4 (~3.78 in)	48 + 0.1/ -0.4 (~1.89 in)	50.8 + 0.1/ -0.4 (2 in)	50.8 + 0.1/ -0.4 (2 in)
Frequency Offset for Lamination Material	Paper	PVC	Paper	PVC	Paper/PVC	Paper/PVC	Paper/PVC
Delivery	Single row tape wound on cardboard reel						

→ Wireless Interface, RFID and Tag-it™

Low-Power, Multi-Standard HF RFID Readers

TRF7960, TRF7961

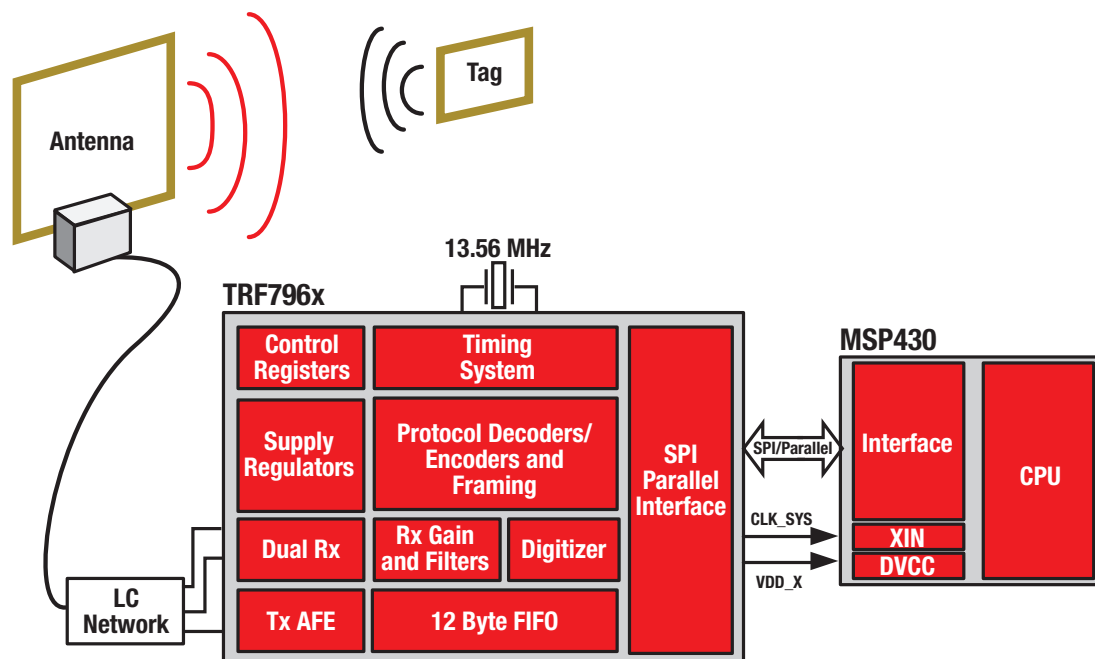
Get samples and datasheets at: www.ti.com/sc/device/TRF7960 or www.ti.com/sc/device/TRF7961

Key Features

- Supports ISO14443A/B, ISO15693 and Tag-it
- High level of integration reduces total cost, BOM and board area
 - Completely integrated protocol handling
 - Separate, internal high-PSRR LDOs for analog, digital and PA sections provide noise isolation for superior read range and reliability
 - Integrated LDO regulator output for MCU
 - Single Xtal system with available output clock for MCU
- Eleven user-accessible and programmable registers
- Low-power device with wide operating voltage range: 2.7V to 5.5V

Complementing the Tag-it™ HF-I family of transponder inlays is TRF7960, a highly integrated analog front end and data framing system for any 13.56MHz RFID reader system. Built-in programming options make TRF7960 useful for a wide range of applications, both in proximity and vicinity RFID systems. A high level of integration, excellent performance, miniature size and multiple low-power modes allow TRF7960 to be used for battery-power-constrained medical applications.

- Programmable output power: 100mW or 200mW
- Parallel 8-bit or serial 4-pin SPI interface with 12-byte FIFO
- Seven user-selectable, ultra-low-power modes
 - Power down: <1µA
 - Standby: 120mA (typical)
 - Active: 10mA (RX only)
- Available MSP430™ software libraries
- Packaging: Ultra-small, 5 x 5mm, 32-pin QFN



Functional block diagram.

→ Wireless Interface, RFID and Tag-it™

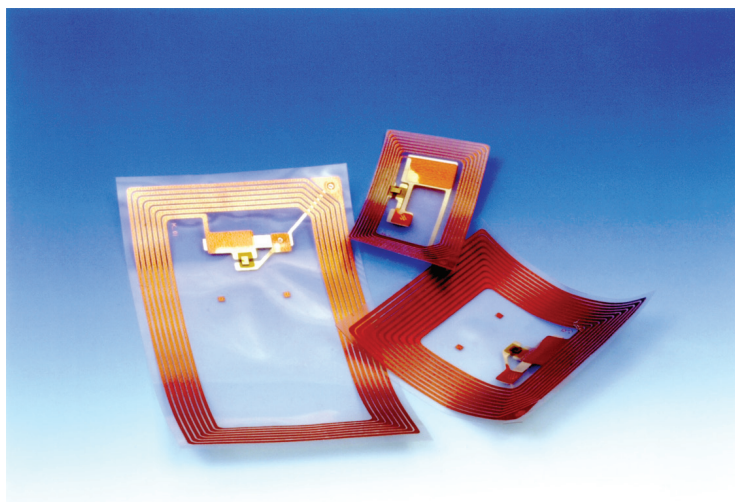
Low-Power, Multi-Standard HF RFID Readers (Continued)

TRF7960, TRF7961

Get samples and datasheets at: www.ti.com/sc/device/TRF7960 or www.ti.com/sc/device/TRF7961

Applications

- Medical
 - Patient and staff authentication
 - Pharmaceutical authentication
 - Product authentication and calibration
 - Remote digital healthcare management
- Asset tracking
- Access control
- Contactless payments
- Prepaid eMetering
- eGovernment



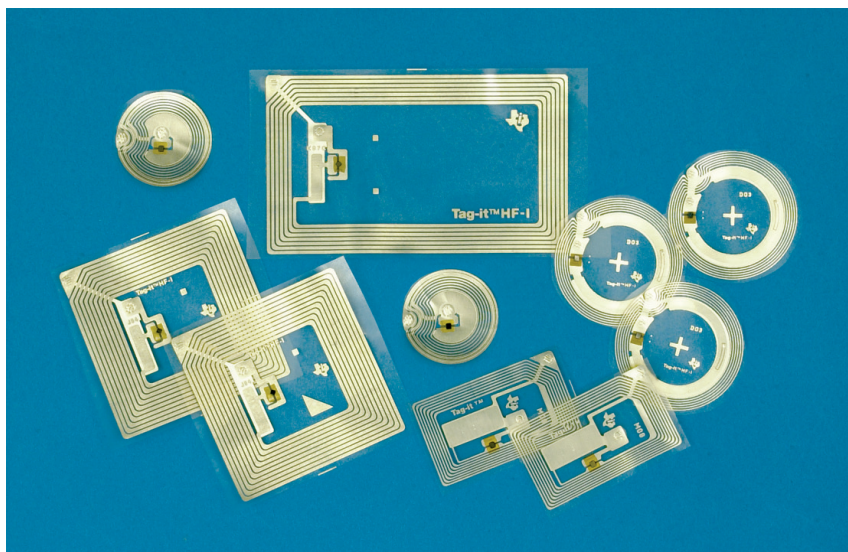
Tag-it™ smart labels bring affordable RFID technology to a wide range of new applications.

TRF7960 Evaluation Module (EVM)

The TRF7960 evaluation tool allows for quicker and simplified system design. The TRF7960 multiple-protocol RFID transceiver incorporates an analog front end, protocol handling, framing, error checking and multiple integrated voltage regulators with other features that allow the reader to be customized/configured to the end application.

TRF7960 EVM features include:

- Fully functional RFID reader with on-board and (optional) off-board antenna capabilities
- GUI that support the ISO14443A, ISO14443B, ISO15693 and Tag-it commands
- Separate LEDs that indicate tag detection—operates in stand-alone mode without GUI



Tag-it™ HF-I family transponder inlays are available in a variety of package options, including square, circular and rectangular (regular and mini).

→ Low-Power RF Products

Integrated Multi-Channel RF Transceiver

CC1101

Get samples, datasheets, evaluation modules and application reports at: www.ti.com/sc/device/CC1101

Key Features

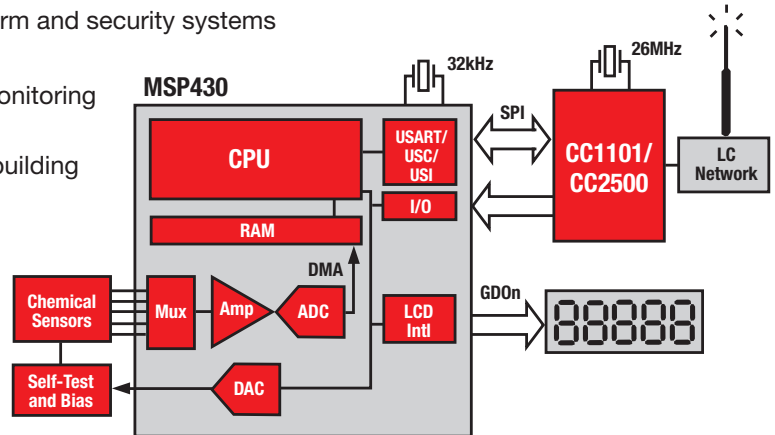
- Sub-1GHz FSK/GFSK/MSK/ASK/OOK RF transceiver
- 1.2 to 500Kbaud data rate
- Low power, low system cost
- Sleep current: –200nA
- 90µs PLL lock time: –240µs from sleep to RX/TX
- On-chip support for sync word detection, address check, flexible packet length and automatic CRC checking
- Separate 64-byte RX and TX data FIFOs enable burst-mode data transmission
- Suitable for systems targeting compliance with EN 300, 200 (Europe) and FCC CFR Part 15 (U.S.)

Need longer RF range? Try the CC2590/CC1190 2.4GHz and sub 1GHzRF range extender for low-power RF ICs.

The CC1101 is a highly integrated, multi-channel RF transceiver designed for low-power wireless applications in the 315/433/868/915MHz ISM bands. The CC1101 is an upgrade of the CC1100 transceiver with improvements for spurious response, close-in phase noise, input saturation level, output power ramping and extended frequency range.

Applications

- Wireless alarm and security systems
- AMR
- Industrial monitoring and control
- Home and building automation



Example application block diagram – wireless blood gas analyzer.

Sub-1GHz System-on-Chip RF Solution

CC1110/F8/F16/F32

Get samples and datasheets at: www.ti.com/sc/device/CC1110

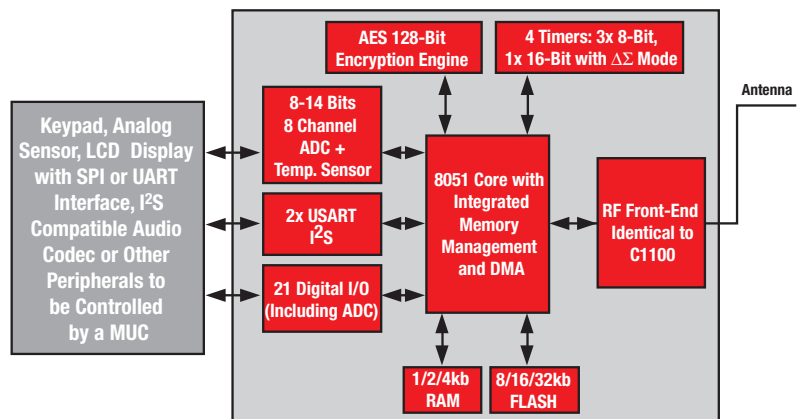
Key Features

- Low current consumption
- High-performance RF transceiver core (same as in the CC1100)
- 8- to 14-bit ADC with up to eight inputs
- 21 general I/O pins
- Real-time clock and several timers
- 8/16/32KB in-system programmable Flash
- 1/2/4KB RAM
- Packaging: 6 x 6mm QLP-36

See also the CC2510 and CC2511 – 2.4GHz, System-on-Chip RF solutions.

Need longer RF range? Try the CC2590/CC2591 2.4GHz RF range extender for low-power RF ICs.
Visit: www.ti.com/cc2591

The CC1110 is a low-cost System-on-Chip (SoC) IC designed for low-power and low-voltage wireless communication applications. The CC1110 combines the excellent performance of the CC1100 RF transceiver with an industry-standard enhanced MCU, 8/16/32KB of in-system programmable Flash memory, 1/2/4KB of RAM and many other useful peripherals. Because of several advanced low-power operating modes, the CC1110 is designed for systems where very low power consumption is required.



General-purpose medical device using CC1110. Supports secure RF link with embedded 128-bit AES hardware encryption.

→ ZigBee® / Bluetooth® Low Energy

ZigBee® and Bluetooth® Low Energy Solutions for Medical Applications

The world is going wireless and medical applications are no exception. More and more medical devices, especially patient monitoring, can benefit from wireless technology. ZigBee and *Bluetooth* Low Energy can be utilized in the consumer health, wellness, and medical space across a range of applications.

With the use of ZigBee wireless sensors, the patients can move around in the hospital, or even in their homes, and the sensors will still monitor and send critical health data to the hospital or doctor. Being independent of a patient's exact geographical location has a positive impact on both the patient and the hospital. The ZigBee standard enables companies to have a simple, reliable, low-cost and low-power standard-based wireless platform for their application development.

Bluetooth Low-Energy solutions are designed for low-cost, low-power and short range connectivity. The technology enables direct communication to cellular

phones, laptops and other *Bluetooth* enabled devices such as sports and fitness watches, GPS / handhelds, and other personal monitoring devices.

TI is part of the Continua Health Alliance and an active contributor to the evolution of ZigBee and Bluetooth Low Energy, the wireless standards for medical applications selected by the alliance.

TI's low-power RF portfolio of high-performance RF ICs offers robust and cost-effective wireless connectivity solutions for a variety of medical devices.

IEEE 802.15.4/ZigBee compliant RF ICs

- CC2520: Second-generation 2.4GHz ZigBee/IEEE 802.15.4 RF transceiver
- CC2530/31: True System-on-Chip (SoC) with integrated microcontroller
- CC2530ZNP: ZigBee network processor that communicates with any MCU via an SPI or UART interface
- Reference designs downloadable for all RF ICs

ZigBee Software and Development Tools

- Z-Stack™: ZigBee and ZigBee Pro compliant protocol stack. TI offers this

full ZigBee stack free of charge. Z-Stack supports over-the air download (OAD) for firmware upgrades in the field.

- Z-Tool (debug tool)
- Development kits: CC2520DK, CC2530DK and CC2530ZDK
- TIMAC: IEEE 802.15.4 Medium Access Control (MAC) software stack for TI IEEE 802.15.4 transceivers and SoCs

Applications

- Patient monitoring
- Hospital equipment tracking

For more information, visit:
www.ti.com/zigbee

Bluetooth Low Energy IC

- CC2540: 2.4 GHz system-on-chip for Bluetooth low energy applications
- Available in the third quarter of 2010

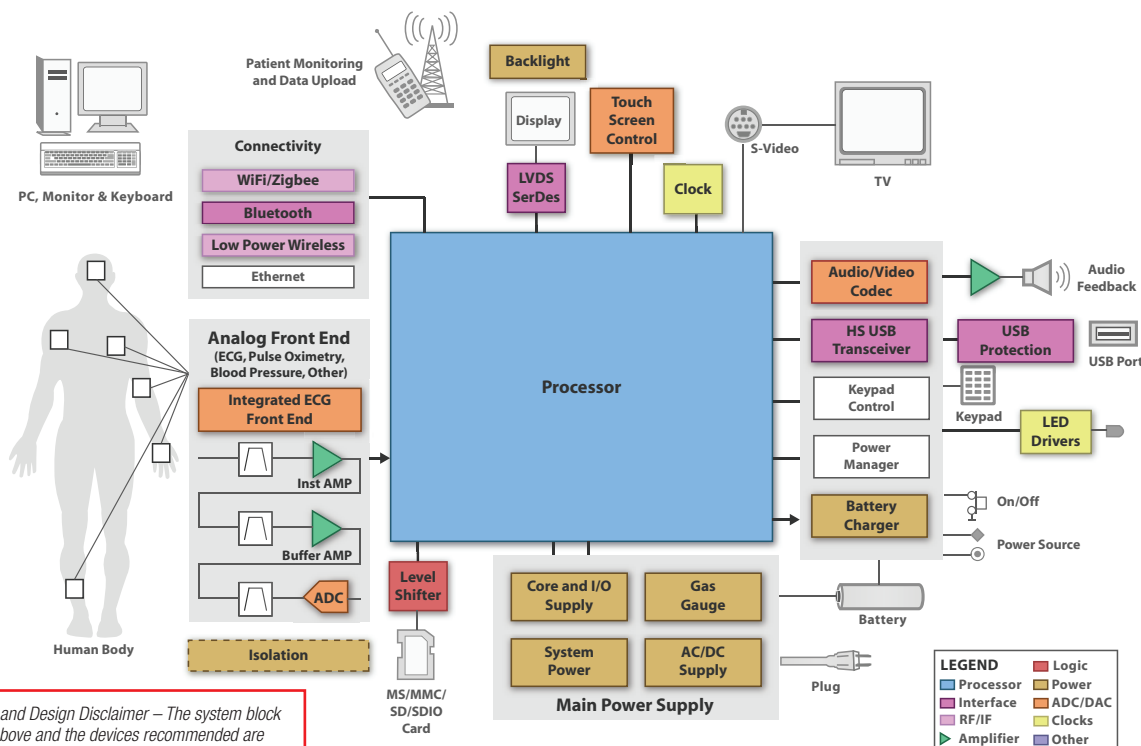
Bluetooth Low Energy Development Tools

- CC2540DK-MINI
- CC2540DK

Applications

- Consumer Health / Medical
- Bluetooth Low Energy Systems
- Wireless Sensor Systems

For more information, visit:
www.ti.com/bluetoothlowenergy



Product Availability and Design Disclaimer – The system block diagram depicted above and the devices recommended are designed in this manner as a reference. Please contact your local TI sales office or distributor for system design specifics and product availability.

Multi-parameter patient monitor system block diagram.

→ Enhanced Products/Die and Wafer Sales Solutions

Enhanced Products

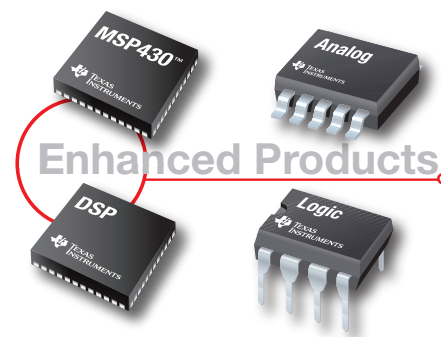
TI's Enhanced Product (EP) line offers design flexibility while still meeting HiRel and Medical standards for operating environments where high reliability and long service life are a requirement. The EP line offering can benefit avionic, defense, aerospace, medical, and industrial designers as well as designers in other rugged operating environments and long service life application fields. TI's Enhanced Product line is a commercial off-the-shelf (COTS) solution with the following key benefits:

- Fabrication/assembly controlled baseline
- Extended product change notification (PCN)
- Extended temperature performance (typically -55°C to +125°C)
- Standalone data sheet
- Qualification pedigree
- Product traceability
- Long life cycles

TI's EP products perform to data sheet specifications in environments that require extended temperatures (typically -55°C to +125°C). To ensure that a device exhibits the highest quality and reliability possible for targeted applications, TI performs the

following qualification procedures before the device is released:

- All EP devices undergo extensive requalification
- Qualification data is reviewed and audited for accuracy and compliance
- Reliability and electromigration monitoring is performed at maximum recommended operating conditions in the targeted package.
- Certified test programs & test hardware
- Electrical characterization is performed across specified temperature range
- Package performance is confirmed over extended temperatures (some mold compounds are not suitable for extended temperatures).
- Nickel/palladium/gold/lead finish eliminates "tin whisker" reliability issues
- Knowledgeable expertise in medical related ISO requirements (ISO13485 and ISO14971)
- Certificate of compliance to datasheet electrical specifications
- Available in military (-55°C/125°C), industrial (-40°C/85°C), commercial (0°C/70°C) and custom temperature ranges



Expected from TI's EP line:

- Qualification summary report
- Access to leading-edge commercial technology
- Commitment to the Industrial, Medical, Avionic and Defense markets
- Customer-driven portfolio
- Enhanced obsolescence management

In addition TI will evaluate the release of other TI's catalog devices in an EP versions based on customer requirements.

Get more information about TI's enhanced products at: www.ti.com/ep

TI Die/Wafer Solutions

Texas Instruments offers bare die/wafer solutions for applications that require higher levels of integration to reduce board space. TI provides a wide range of products in bare die and wafer form. A variety of testing and qualification options are available based on product maturity and complexity, as well as customer requirements. Typical screening options include DC probe or AC/DC probe at temperature.

TI offers three categories of die screening:

- Commercial wafers and die
 - Standard TI wafer fabrication
- Known Good Die (KGD)
 - Stand alone datasheet and warranted over temperature
- Customer defined qualification
 - QML Class Q (MIL-STD)
 - QML Class V (Space)
 - Additional options available

Typical processing and capabilities include:

- Mount and bond diagrams
- Probed die – 55°C to +210°C or special temp
- Shipping: Tape and reel, waffle packs, custom trays, Gel-Pak®
- Sidewall and visual inspections

For more information regarding TI's Die and Wafer offerings, visit www.ti.com/hirel or email: diesales@list.ti.com

→ TI Design Tools

Below you'll find a sampling of the design tools TI offers to simplify your design process. To access any of the following application reports, type the URL www-s.ti.com/sc/techlit/litnumber and replace *litnumber* with the number in the Lit Number column.

For a complete list of analog application reports, visit: analog.ti.com/appnotes

For a complete list of DSP application reports, visit: www.dspvillage.ti.com/tools

Title	Lit Number
Amplifiers	
Single-Supply Operation of Isolation Amplifiers	SBOA004
Very Low Cost Analog Isolation with Power	SBOA013
Boost Instrument Amp CMR with Common-Mode Driven Supplies	SBOA014
DC Motor Speed Controller: Control a DC Motor without Tachometer Feedback	SBOA043
PWM Power Driver Modulation Schemes	SLOA092
Thermo-Electric Cooler Control Using a TMS320F2812 DSP and a DRV592 Power Amplifier	SPRA873
Isolation Amps Hike Accuracy and Reliability	SBOA064
Make a -10V to +10V Adjustable Precision Voltage Source	SBOA052
±200V Difference Amplifier with Common-Mode Voltage Monitor	SBOA005
AC Coupling Instrumentation and Difference Amplifiers	SBOA003
Extending the Common-Mode Range of Difference Amplifiers	SBOA008
Level Shifting Signals with Differential Amplifiers	SBOA038
Photodiode Monitoring with Op Amps	SBOA035
Single-Supply Operation of Isolation Amplifiers	SBOA004
Precision IA Swings Rail-to-Rail on Single 5V Supply	SBOA033
Pressure Transducer to ADC Application	SLOA056
Buffer Op Amp to ADC Circuit Collection	SLOA098
Amplifiers and Bits: An Introduction to Selecting Amplifiers for Data Converters	SLOA035B
Diode-Connected FET Protects Op Amps	SBOA058
Signal Conditioning Piezoelectric Sensors	SLOA033A
Diode-Based Temperature Measurement	SBOA019
Single-Supply, Low-Power Measurements of Bridge Networks	SBOA018
Thermistor Temperature Transducer to ADC Application	SLOA052
Signal Conditioning Wheatstone Resistive Bridge Sensors	SLOA034
Low-Power Signal Conditioning for a Pressure Sensor	SLAA034
Interfacing the MSP430 and TMP100 Temperature Sensor	SLAA151
Data Converters	
Configuring I ² S to Generate BCLK from Codec Devices & WCLK from McBSP Port	SLAA413
Interfacing the ADS8361 to the TMS320F2812 DSP	SLAA167
Interfacing the TLC2552 and TLV2542 to the MSP430F149	SLAA168
MSC1210 In-Application Flash Programming	SBAA087
Pressure Transducer to ADC Application	SLOA056
Measuring Temperature with the ADS1216, ADS1217, or ADS1218	SBAA073
SPI-Based Data Acquisition/Monitor Using the TLC2551 Serial ADC	SLAA108A
Implementing a Direct Thermocouple Interface with MSP430x4xx and ADS1240	SLAA125A
Using the ADS7846 Touch-Screen Controller with the Intel SA-1110 StrongArm Processor	SBAA070
Complete Temp Data Acquisition System from a Single +5V Supply	SBAA050
Interfacing the ADS1210 with an 8xC51 Microcontroller	SBAA010
Programming Tricks for Higher Conversion Speeds Utilizing Delta Sigma Converters	SBAA005
Retrieving Data from the DDC112	SBAA026
Selecting an ADC	SBAA004
Synchronization of External Analog Multiplexers with the	SBAA013
The DDC112's Test Mode	SBAA025
Understanding the DDC112's Continuous and Non-Continuous Modes	SBAA024
Thermistor Temperature Transducer to ADC Application	SLOA052

→ TI Design Tools (Continued)

Title	Lit Number
Low-Power Signal Conditioning for a Pressure Sensor	SLAA034
Data Converters (Continued)	
Signal Acquisition and Conditioning with Low Supply Voltages	SLAA018
An Optical Amplifier Pump Laser Reference Design Based on the AMC7820	SBAA072
Processors/Microcontrollers	
Programming a Flash-Based MSP430 Using the JTAG Interface	SLAA149
Mixing C and Assembler with the MSP430	SLAA140
Implementing an Ultra-Low-Power Keypad Interface with the MSP430	SLAA139
Heart Rate Monitor and EKG Monitor Using the MSP430FG439	SLAA280
A Single-Chip Pulsoximeter Design Using the MSP430	SLAA274
MSP430 Interface to CC1100/2500 Code Library	SLAS325
Choosing an Ultra-Low-Power MCU	SLAA207
ECG, Pulse Oximeter, Digital Stethoscope Development Kits based on C5505 Processor	SPRT523
MSP430 USB Connectivity Using TUSB3410	SLAA276A
MSP430 Flash Memory Characteristics	SLAA334
Wave Digital Filtering Using the MSP430	SLAA331
Implementing a Real-Time Clock on the MSP430	SLAA076A
Interface	
CAN	
A System Evaluation of CAN Transceivers	SLLA109
Introduction to the Controller Area Network	SLOA101
Using CAN Arbitration for Electrical Layer Testing	SLLA123
RS-485	
Interface Circuits for TIA/EIA-485 (RS-485)	SLLA036B
422 and 485 Standards Overview and System Configurations	SLLA070C
RS-485 for E-Meter Applications	SLLA112
TIA/EIA-485 and M-LVDS, Power and Speed Comparison	SLLA106
USB	
VIDs, PIDs and Firmware: Design Decisions When Using TI USB Device Controllers	SLLA154
USB/Serial Applications Using TUSB3410/5052 and the VCP Software	SLLA170
CardBus	
PCI1520 Implementation Guide	SCPA033
LVDS	
LVDS Design Notes	SLLA014A
Reducing EMI with LVDS	SLLA030C
Performance of LVDS Over Cables	SLLA053B
M-LVDS	
Introduction to M-LVDS	SLLA108
M-LVDS Speed Versus Distance	SLLA119
Serdes	
Gigabit Transmission Across Cables	SLLA091
Power Controllers	
DC Brush Motor Control using the TPIC2101	SLIT110
Power Management	
Technical Review of Low Dropout Voltage Regulator Operation and Performance	SLVA072
ESR, Stability, and the LDO Regulator	SLVA115
Extending the Input Voltage Range of an LDO Regulator	SLVA119
High Current LDO Linear Regulators (UCCx81-ADJ, UCCx82-ADJ, UCCx83-ADJ, UCCx85-ADJ)	SLUA256
PowerPAD™ Thermally Enhanced Package	SLMA002



TI's Medical guides feature technical and product information for a variety of medical applications no matter your need.

- Diagnostic, Patient Monitoring and Therapy Applications Guide
- Medical Imaging Applications Guide
- Medical Instruments Applications Guide

To download these product selection guides, please visit www.ti.com/medicalguides

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Product Information Centers

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Mexico	Phone	0800-670-7544
	Fax	+1(972) 927-6377
	Internet/Email	support.ti.com/sc/pic/americas.htm

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European Free Call	00800-ASK-TEXAS (00800 275 83927)
International	+49 (0) 8161 80 2121
Russian Support	+7 (4) 95 98 10 701
Note: The European Free Call (Toll Free) number is not active in all countries. If you have technical difficulty calling the free call number, please use the international number above.	

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	Korea	080-551-2804
	Malaysia	1-800-80-3973
	New Zealand	0800-446-934
	Philippines	1-800-765-7404
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