Connected Sensors Building Automation Systems Guide

Texas Instruments

www.ti.com/buildingAutomation

2015

Connected Sensors Building Automation Systems Guide
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Introduction

Monitoring devices or nodes in building control systems, fire safety systems, lighting control, and other building automation and Internet of Things (IoT) applications are becoming more prevalent in today's world.

The use of connected sensors has a wide range of uses in building automation applications, from monitoring human safety and security, controlling the environment and ambience specified by the comfort preferences of the end user, or either periodic or continuous data logging of environmental and system data to detect irregular system conditions.

Texas Instruments (TI) has a broad portfolio of products that cater to connected sensing in building automation applications. This portfolio ranges from innovative sensor analog front-end products to low-power wireless connectivity solutions.

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Sensor Solutions

TI has a rich, five-decade history of sensing innovation and, combined with best-in-class sensing technologies, tools, and resources, we continue to deliver better solutions today and new possibilities for tomorrow.

Learn more about sensor solutions at: **www.ti.com/sensing**

Temperature Sensing

Part No.	Type	Local Sensor Accuracy (Max) At Given Temp Range (±°C)	Supply Current (Max) (µA)	Supply Range (V)	Interface	Infrared Sensor Accuracy (Max) (±°C)	Operating Temp. (°C)	Pin / Package	Approx. Price (US$ I 1ku)
LMT70/70A	Analog	±0.2°C from 20 to 90	12	2.0 to 5.5	Analog Out	–	–55 to 150	4DSBGA	0.54 / 0.65
LMT84	Analog	±2.7°C from –50 to 150	8.1	1.5 to 5.5	Analog Out	–	–50 to 150	5SC70	0.18
TMP112	Digital	±0.5°C from 0 to 65	10	1.4 to 3.6	I^2C, SMBus, 2-wire	–	–40 to 125	6SOT	0.90
TMP75	Digital	±2°C from –25 to 85	85	2.7 to 5.5	I^2C, SMBus, 2-wire	–	–40 to 125	8SOIC, 8VSSOP	0.45
TMP007	Contactless	±1°C from –40 to 125	350	2.2 to 5.5	I^2C, SMBus	3	–40 to 125	8DSBGA	1.90

Humidity and Temperature Sensing

Part No.	Relative Humidity Accuracy (Typ) (%RH)	RH Operating Range (Typ) (%RH)	Temperature Accuracy (Typ) (°C)	Supply Range (V)	Average Supply Current (Typ) (µA)	Interface	Operating Temp. (°C)	Pin / Package	Approx. Price (US$ I 1ku)
HDC1000/1050	±3	0 - 100	±0.2	3 to 5	1.2 @ 1 sps	I^2C	–40 to 125	8DSBGA, 6DFN	2.20
HDC1008	±4	0 - 100	±0.2	3 to 5	1.2 @ 1 sps	I^2C	–40 to 125	8DSBGA	1.76

**Quantities of 1,000 begin at this suggested resale price in U.S. dollars.*

*Preview products are listed in **bold teal.***

Sensor Solutions

Ambient Light Sensing

Part No.	Supply Range (Nom) (V)	Iq (Max) (µA)	Lux Range (Nom)	Dark Response @ 0 Lux (Max)	Gain Selection	Interface	Benefits	Operating Temp. (°C)	Pin / Package	Approx. Price (US$ I 1ku)
OPT3001	1.6 to 3.6	2	0.01 to 83K	1 Code	11 Gains with Auto-ranging	I²C	Matches photopic response of the human eye Rejects > 99% (Typ) of IR	–40 to 85	USON	0.99

Inductance Sensing

Part No.	Key Applications	Special Features	Input Channels	L (Inductance) Resolution (Bits)	Supply Range	Active State Current (mA)	Interface	Sensor Frequency (Hz)	Operating Temp. (°C)	Pin / Package	Approx. Price (US$ I 1ku)
LDC1312/4	• Position Sensing • Angle/Rotation sensing	• Contactless sensing • Ultralow cost sensors (coils, PCB coils) • Immune to dust, dirt etc.	2 / 4	12	2.7 to 3.6	2.1	I²C	1k to 10M	–40 to 125	WSON, WQFN	2.38 / 3.50
LDC1612/4	• Position Sensing • Angle/Rotation sensing	• Contactless sensing • Ultralow cost sensors (coils, PCB coils) • Immune to dust, dirt etc.	2 / 4	28	2.7 to 3.6	2.1	I²C	1k to 10M	–40 to 125	WSON, WQFN	3.25 / 4.75

Capacitance Sensing

Part No.	Input Channels	Special Features	Shield Drive Channels	Special Features	Supply Range	Supply Current (mA)	Interface	Prog. Sampling Rate (Typ) (SPS)	Operating Temp. (°C)	Pin / Package	Approx. Price (US$ I 1ku)
FDC1004	4	• Liquid level sensing (with interferers)	2	Integrated Shield Drivers	3 to 3.6	0.75	I²C	100 / 200 / 400	–40 to 125	WSON	2.50
FDC2114/12	4 / 2	• Proximity Sensing • Liquid Level Sensing	–	EMI resistant core	2.7 to 3.6	2.1	I²C	40 to 4080	–40 to 125	WQFN	2.38 / 3.50
FDC2214/12	4 / 2	• Proximity Sensing • Liquid Level Sensing	–	EMI resistant core	2.7 to 3.6	2.1	I²C	40 to 13300	–40 to 125	WQFN	3.25 / 4.75

Hall Effect Sensor

Part No.	Type	Type	Supply Range	Output	Output Bandwidth (Typ) (kHz)	Operating Temp. (°C)	Pin / Package	Approx. Price (US$ I 1ku)
DRV5013/23/33	Digital	Latch / Switch / Omnipolar Switch	2.5 to 38	Open Drain	–	–40 to 125	SOT-23, TO-92	0.29
DRV5053	Analog	Analog Bipolar	2.5 to 38	0.2 to 1.8 V	10	–40 to 125	SOT-23, TO-92	0.31

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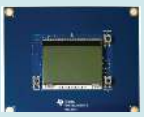
*New products are listed in **bold red.***

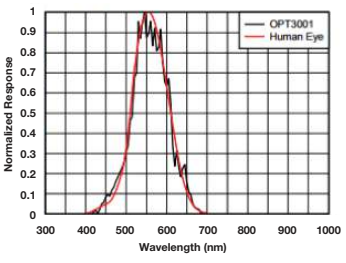
Find the Perfect Sensor Reference Design to Get Started

	**16-Button Keypad using the LDC1314 Inductive-to-Digital Converter** Reference Design - **TIDA-00509**	**Key Features** • Contactless buttons with superior reliability over electrical/mechanical contact solutions • Support simultaneous button presses	**TI Devices** LDC1314 LP2985-N MSP430F5528
	**Backlight and Smart Lighting Control by Ambient Light and Proximity Sensor** Reference Design - **TIDA-00373**	**Key Features** • Good Human Eye Spectral Matching • Dynamically Adjusts Backlight Brightness • UV Filter for Outdoor Using	**TI Devices** OPT3001 FDC1004 HDC1000 MSP430FR5969

Ambient Light Sensor with Human Eye Visibility

The OPT3001 is a single-chip lux meter, measuring the intensity of light as visible by the human eye. The precision spectral response and strong IR rejection of the device enables the OPT3001 to accurately meter the intensity of light as seen by the human eye regardless of light source. The strong IR rejection also aids in maintaining high accuracy when industrial design calls for mounting the sensor under dark glass for aesthetics.

Spectral Response: The OPT3001 and Human Eye



Amplifier and Comparator Solutions

Texas Instruments delivers a broad portfolio of amplifier and linear solutions including precision and high speed op amps, instrumentation and differential amplifers along with comparators. TI has an amplifier suited for any application.

Learn more about Amplifier solutions at: **www.ti.com/amplifier**

Low Power Amplifiers

Part No.	Supply Range (V)	Channels	Iq per ch. (Max) (mA)	GBW (Typ) (MHz)	Slew Rate (Typ) (V/µs)	CMRR (Typ) (dB)	Offset Voltage @ 25°C (Max) (mV)	Offset Drift (Typ) (µV/°C)	Rail-Rail	Operating Temp. (°C)	Approx. Price (US$ I 1ku)
LMV611/2/4	1.8 to 5.5	1 / 2 / 4	0.21	1.5	0.42	60	4	5.5	RRIO	–40 to 125	0.22 / 0.25 / 0.30
LPV521	1.6 to 5.5	1	0.0004	0.0062	0.0024	102	1	0.4	RRIO	–40 to 125	0.49
OPA369	1.8 to 5.5	1	0.0012	0.012	0.005	100	0.75	0.4	RRIO	–40 to 85	0.65
OPA349	1.8 to 5.5	1	0.002	0.065	0.02	52	10	15	RRIO	0 to 70	0.50

General Purpose Amplifiers

Part No.	Supply Range (V)	Channels	Iq per ch. (Max) (mA)	GBW (Typ) (MHz)	Slew Rate (Typ) (V/µs)	CMRR (Typ) (dB)	Offset Voltage @ 25°C (Max) (mV)	Offset Drift (Typ) (µV/°C)	Operating Temp. (°C)	Approx. Price (US$ I 1ku)
TLC271/2/4	3 to 16	1 / 2 / 4	1.6	1.7	3.6	65	10	1.8	–40 to 85	0.31 / 0.41 / 0.60
LM2904	3 to 26	2	0.6	0.7	0.3	50	7	7	–40 to 125	0.07
LM358	3 to 32	2	0.6	0.7	0.3	65	7	7	0 to 70	0.07
OPAx313	1.8 to 5.5	1, 2, 4	0.06	1	0.5	70	2.5	2	-40 to 125	0.26 / 0.38 / 0.55
OPAx314	1.8 to 5.5	1, 2, 4	0.21	3	1.5	75	2.5	1	-40 to 125	0.30 / 0.45 / 0.65
OPAx316	1.8 to 5.5	1, 2, 4	0.5	10	6	76	2.5	2	-40 to 125	0.48 / 0.72 / 1.08
OPAx170	2.7 to 36	1, 2, 4	0.145	1.2	0.5	104	1.8	0.3	-40 to 125	0.40 / 0.60 / 0.90
OPAx171	2.7 to 36	1, 2, 4	0.595	3	1.5	104	1.8	0.3	-40 to 125	0.40 / 0.60 / 0.90
OPAx172	2.7 to 36	1, 2, 4	1.8	10	10	90	1	0.3	-40 to 125	0.65 / 0.99 / 1.49

Comparators

Part No.	Type	Supply Range (V)	Channels	tRESP Low-to-High (µs)	Iq per ch. (Max) (mA)	Input Bias Current (±) (Max) (nA)	VICR (V)	Offset Voltage @ 25°C (Max) (mV)	Operating Temp. (°C)	Approx. Price (US$ I 1ku)
TLV3691	Push-Pull	0.9 to 6.5	1	24	0.00015	0.1	-0.1 to 6.6	15	–40 to 85	0.40
TLV3012	Push-Pull	1.8 to 5.5	1	6	0.005	0.01	-0.2 to 5.7	12	–40 to 85	0.75
TLC3702	Push-Pull	3 to 16	2	1.1	0.02	0.03	0 to 15	5	–40 to 85	0.36
TLV1701/2/4	Open Collector	2.2 to 36	1, 2, 4	0.56	0.075	15	2.2 to 36	2.5	-40 to 125	0.38 / 0.61 / 0.97

Analog-to-Digital Converters

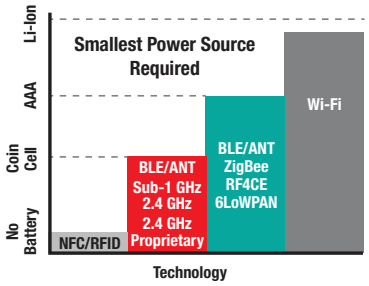
Part No.	Type	Resolution (bits)	Sample Rate (SPS)	Input Channels	Interface	Supply Range (V)	Features	Operating Temp. (°C)	Approx. Price (US$ I 1ku)
ADS7040/1/2/3/4	SAR	8 to 12	1000	1	SPI	0 to 3.6	Nanowatt Power Consumption	-40 to 125	1.00 / 1.60 / 2.10
ADS1018	ΣΔ	12	3300	4	SPI	2 to 5.5	Temp. Sensor (0.5°C accurate)	-40 to 125	1.15
ADS1120/1220	ΣΔ	16, 24	2000	4	SPI	2.3 to 5.5	Single cycle setting, sensor, IDACs	-40 to 125	3.15 / 3.95

**Quantities of 1,000 begin at this suggested resale price in U.S. dollars.*

Wireless Connectivity

With the industry's broadest wireless connectivity portfolio TI offers cost-effective, low-power solutions for short-range, long-range, mesh, and IP networks

Learn more about Wireless Connectivity solutions at:
www.ti.com/wireless



Wi-Fi

Part No.	Benefits	TI Designs and Development Tools
CC3200	SimpleLink Wi-Fi Wireless MCU with ARM Cortex®-M4, Integrated Wi-Fi Connectivity, security, low power, ease of use: Certified Wi-Fi modules available	CC3200MODLAUNCHXL, TIDA-00372, TIDC-CC3200SMARTPLUG, TIDC-CC3200CAMBOOST
CC3100	SimpleLink Wi-Fi Wireless Network Processor: provides easy Wi-Fi connectivity for building automation applications. Fully integrated 802.11 b/b/n radio, baseband, and MAC. Connect serialy Interface to any 8, 16, or 32-bit micro-controllers. Certified Wi-Fi modules available	CC3100MODBOOST
WL1837MOD	High performance, low power, certified combo modules integrating Wi-Fi + Bluetooth + Bluetooth Low Energy. Connects to any Linux Processor with SDIO interface, available up to 85°C, 2.4GHz and 5GHz	WL1837MODCOM8I

Sub-1GHz

Part No.	Benefits	TI Designs and Development Tools
CC1200	High performance, long distance, low power radio transceiver: optimized for wide band applications	CC1200DK, CC1200EMK-868-930, TIDC-CHN
CC1120	High performance, long distance, low power radio transceiver: optimized for Narrowband	CC1120DK, CC1120EMK-169, CC1120EMK-420-470, CC1120EMK-868-915, TIDC-MULTIBAND-WMBUS
CC1101	Ultra-low power radio transceiver	CC1101DK433, CC1101DK868-915, TIDM-SUB1GHZ-MESH-NETWORK
CC1310	SimpleLink Ultra-low power ARM® Cortex®-M Based Wireless MCU	TIDA-00484

Bluetooth®

Part No.	Benefits	TI Designs and Development Tools
CC2650	SimpleLink Wi-Fi Ultra-Low power ARM® Cortex®-M Based Wireless MCU: multi-standard supported Bluetooth Low-Energy, 6LowPAN and ZigBee. Ideal for end point sensors	CC2650DK, CC2650STK, TIDA-00374
CC2640	SimpleLink Wi-Fi Ultra-Low power ARM® Cortex®-M Based Wireless MCU supporting Bluetooth Low-Energy: ultra-low power, small size and ease of use. Ideal for end point sensors	CC2650DK, CC2650STK, TIDA-00374
CC2540T	Extreme temperature Bluetooth Low Energy (up to 125 degree C) wireless MCU combined with low power and ease of use	CC2541DK-MINI, TIDC-BLUETOOTH-LOW-ENERGY-LONG-RANGE, TIDC-BLUETOOTH-SMART-TO-RS-485-GATEWAY
CC2564MODA	Dual Mode Bluetooth (Bluetooth Low energy + Bluetooth Classic) transceivers module with antenna integrated: low-power, stable and robust SW stack	CC256XQFNEM CC2564MODAEM (RTM September)

ZigBee®

Part No.	Benefits	TI Designs and Development Tools
CC2630	SimpleLink Wi-Fi Ultra-Low power ARM® Cortex®-M Based Wireless MCU : ideal for end point sensors	CC2650DK, CC2650STK, TIDA-00374
CC2530	ZigBee Wireless MCU: enables robust network nodes to be built with very low total bill-of-material costs	CC2530DK, CC2530EMK, CC2531EM-IOT-HOME-GATEWAY-RD, CC2530-CC2592EM-RD
CC2538	512kB ARM® Cortex®-M Based Wireless MCU: handle complex network stacks with security, demanding applications, and over-the-air download	CC2538DK, CC2538EMK, TIDC-ZNP-HOST-SW3

NFC

Part No.	Benefits	TI Designs and Development Tools
RF430FRL152H	13.56-MHz transponder chip with a programmable 16-bit MSP430 low-power microcontroller. Optimized for operation in fully passive (battery-less) or single-cell battery-powered (semi-active) mode.	TIDM-RF430-TEMPSENSE, TIDM-RF430FRLSENSE
RF430CL330H	NFC Tag Type 4 device which combines a wireless NFC interface and a wired SPI/I2C interface to connect the device to a host	TIDA-00217

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

Wireless Connectivity

Find the Perfect Connectivity Reference Design to Get Started			
	**SimpleLink™ *Bluetooth* Smart®/ Multi-Standard SensorTag** Reference Design - **CC2650STK-RD**	**Key Features** • More Sensors! 10 Sensors including light, humidity, pressure, magnetic, accelerometer, gyroscope, and others • Flexibility for IoT applications; Enable ZigBee or 6LoWPAN through a firmware upgrade	**TI Devices** CC2650 TMP007 OPT3001 HDC1000
	**Wired (UART or RS-485) to Wi-Fi® Bridge with 24-VAC Power** Reference Design - **TIDA-00375, TIDA-00485, TIDA-00486**	**Key Features** • Add Wi-Fi® Connectivity to an existing wired network • Wide Input Voltage Range of 18- to 30-VAC, 12- to 48-VDC • Galvanically Isolated or Non-Isolated variations	**TI Devices** CC3200MOD CC3100MOD LM5160 LMR16006
	**Battery-less NFC/RFID Temperature Sensing Patch** Reference Design - **TIDM-RF430-TEMPSENSE**	**Key Features** • No batteries required • "Over the air" configuration of the ADC • Different antenna configurations allow many form factors	**TI Devices** RF430FRL152H
	**Dynamic Field Powered NFC Reference Design for Data Logging and Security Applications** Reference Design - **TIDA-00217**	**Key Features** • User can receive updated information from a field unit • Battery-less sensor interface; NFC reader provides	**TI Devices** TMP103 RF430CL330H MSP430FR5969
	**SimpleLink™ Wi-Fi® CC3200 Smart Plug** Reference Design - **TIDC-CC3200SMARTPLUG**	**Key Features** • Single-Phase energy measurement that calculates Current, Voltage, Power, and Energy • SimpleLink™ Wi-Fi® connectivity over 802.11 b/g/n networks from any mobile device • Isolated flyback power supply to provide Constant-Voltage and Constant-Current output regulation without optical coupler"	**TI Devices** CC3200 UCC28910 TPS61097A-33

Embedded Processing Solutions

Microcontrollers and processors from Texas Instruments offer a broad range of performance and power consumption options. From MSP430 MCU with ultra-low power consumption to the Sitara™ AM335x family with integrated multi-protocol industrial communications support to connect various kinds of sensors in real-time for better automation; TI is tailored to meet your design challenges.

Learn more about Microcontroller solutions at: **www.ti.com/msp430** and **www.ti.com/msp432.**

Learn more about processor solutions at: **www.ti.com/processors**.

MSP430 Low Power FRAM MCUs

Part No.	Frequency (MHz)	Non-volatile Memory (KB)	SRAM (KB)	GPIO	I2C	SPI	UART	DMA	ADC	Comparator (Channels)	Timers 16-Bit	Multipliers	AES	Additional Features	Operating Temp. (°C)	Package	Approx.Price (US$ | 1ku)
MSP430FR4133	16	15.5	2	60	1	2	1	0	ADC10-10ch	0	2	N/A	N/A	LCD, RTC, BOR, Temp Sensor	–40 to 85	LQFP, TSSOP	1.55
MSP430FR5969	16	64	2	40	1	3	2	3	ADC12-16ch	16	5	32x32	AES256	RTC, BOR, IrDA, Temp Sensor	–40 to 85	VQFN	2.35
MSP430FR6972	16	64	2	51	2	4	2	3	ADC12-8ch	8	5	32x32	AES256	LCD, RTD, BOR, IrDA, Temp Sensor	–40 to 85	LQFP	2.55
MSP430FR6989	16	128	2	83	2	4	2	3	ADC12-16ch	16	5	32x32	AES256	LCD, RTC, Scan I/F, BOR, IrDA, Temp Sensor	–40 to 85	LQFP	4.50

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

Embedded Processing Solutions

MSP430 Low Power MCUs

Part No.	Frequency (MHz)	Non-volatile Memory (KB)	SRAM (KB)	GPIO	I²C	SPI	UART	ADC	Comparator (Channels)	Timers 16-Bit	Multipliers	Additional Features	Operating Temp. (°C)	Package	Approx.Price (US$ 1 ku)
MSP430G2553	16	16	0.5	24	1	1	1	ADC10-8ch	8	2	N/A	Temp Sensor, BOR, IrDA	–40 to 85	TSSOP, VQFN	0.90
MSP430G2955	16	56	4	32	1	2	1	ADC10-12ch	8	3	N/A	Temp Sensor, BOR, IrDA	–40 to 85	TSSOP, VQFN	1.30
MSP430F2274	16	32	1	32	1	1	1	ADC10-12ch	0	2	N/A	Temp Sensor, BOR, OpAmp	–40 to 105 –40 to 85	DSBGA, TSSOP, VQFN	1.80
MSP430I2041	16	32	2	16	1	2	1	SigmaDelta 24-4ch	0	2	16 x16	Temp Sensor, BOR, IrDA	-40 to 105	TSSOP, VQFN	1.75

ARM Based MCUs and MPUs

Part No.	ARM CPU	Benefits	TI Designs and Dev. Tools
MSP432P401R	ARM Cortex-M4F	MSP432P4x microcontrollers are the ideal combination of TI's MSP430 low-power DNA, advanced mixed-signal features, and the high-performance processing capabilities of ARM®'s 32-bit Cortex®-M4F RISC engine.	MSP-EXP432P401R
AM3352	ARM Cortex-A8	Sitara™ AM335x ARM Cortex-A8 Processors deliver the right balance of performance (300 MHz to 1 GHz of processing power), Interfaces (DDR3, LCD, Touch Screen Controller), and Connectivity (UART and Industrial Protocols)	Beaglebk, TMDXEVM3358

**Quantities of 1,000 begin at this suggested resale price in U.S. dollars.*

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

Find the Perfect MCU Reference Design to Get Started			
	**Thermostat Implementation with FRAM Microcontroller** Reference Design - **TIDM-FRAM-THERMOSTAT**	**Key Features** • 0°C to 35°C Temperature Measurement with 0.1°C Resolution • 3.4 inch LCD Display • Ultra-Low Power: 1.8 µA Standby Current	**TI Devices** MSP430FR4133 SN65HVD75 TPS782
	**Smoke Detector with Ultra Low Power MCU** Reference Design - **TIDM-G2xxSMOKEDETECTOR**	**Key Features** • Passive infrared (PIR) smoke chamber with discrete Amplification circuitry to ADC input • Low power (2.07 µA) and small code size (<1 KB Flash) • One timer and multiple GPIOs for proprietary comms	**TI Devices** OPT3001 FDC1004 HDC1000 MSP430FR5969

FRAM Technology

Ferroelectric Random Access Memory (FRAM) is a memory technology that combines the best of Flash and SRAM. It is non-volatile like Flash, but offers fast and low power writes, write endurance of 10^{15} cycles, code and data security that is less vulnerable to attackers than Flash/EEPROM, resistance to radiation and electromagnetic fields, and unmatched flexibility. This memory technology has been around for decades, but is now being integrated in MSP430 ultra-low-power microcontrollers (MCUs) to bring its unique advantages to real-world applications such as energy harvesting, data security, remote sensing or data logging, and many others.

All-in-one: FRAM MCU delivers max benefits				
Specifications	FRAM	SRAM	EEPROM	Flash
Non-volatile Retains data w/o power	Yes	No	Yes	Yes
Write speed (13 KB)	10ms	<10ms	2 secs	1 sec
Average active Power [µA/MHz] 16 bit word access by the CPU	100	<60	50,000+	230
Write endurance	10^{15}	Unlimited	100,000	10,000
Soft Errors	Below Measurable Limits	Yes	Yes	Yes
Bit-wise programmable	Yes	Yes	No	No
Unified Memory Flexible code and data partitioning	Yes	No	No	No

Power Management

Texas Instruments offers complete power solutions with a full line of high-performance products. These products, which range from standard linear regulators to highly efficient DC/DC converters and battery management, are tailored to meet your design challenges.

Learn more about Power Management solutions at: **www.ti.com/power** and **www.ti.com/powerlab**

DC/DC Switching Regulators

Part No.	Topology	Supply Range (V)	Output Voltage (V)	Output Current (Max) (A)	Switching Frequency (Max) (kHz)	Duty Cycle (Max) (%)	Iq (Typ) (mA)	Operating Temp. (°C)	Pin / Package	Approx. Price (US$ I 1ku)
Vin < 24V										
TPS82740A	Buck Module	2.2 to 5.5	1.8 to 2.5	0.2	2000	100	0.00036	–40 to 85	9uSIP	1.50
TPS62730	Buck	1.9 to 3.9	1.9, 2.1, 2.3	0.1	3000	100	0.025	–40 to 85	6SON	0.55
TPS62080	Buck	2.3 to 6	0.5 to 6	1.2	2000	100	0.0045	–40 to 85	8WSON	0.75
TPS62160	Buck	3 to 17	0.9 to 6	1	2500	100	0.017	–40 to 85	8VSSOP, 8WSON	0.80
TPS61291	Boost	0.9 to 5.0	2.5, 3.0, 3.3	0.2	–	–	0.005	–40 to 85	6SON	0.68
TPS61098	Boost	0.7 to 4.5	2.2 to 4.3	0.1	–	–	0.0003	-40 to 85	6WSON	0.72
TPS61220	Boost	0.7 to 5.5	1.8 to 5.5	0.1	2000	90	0.005	–40 to 85	6SC70	0.43
Wide Vin (Vin ≥ 24V)										
TPS62175	Buck	4.7 to 28	1 to 6	0.5	1000	100	0.0048	-40 to 85	10WSON	0.70
LM25017/8/9	Buck	7.5 to 48	1.25 to 40	0.65 / 0.3 / 0.1	1000	90	1.75	–40 to 125	8WSON, 8SO PowerPAD	1.25 / 1.12 / 0.81
TPS54160A	Buck	3.5 to 60	0.8 to 58	1.5	2500	98	0.138	–40 to 125	10MSOP/10SON	1.58
TPS54060A	Buck	3.5 to 60	0.8 to 58	0.5	2500	98	0.116	–40 to 150	10MSOP/10SON	1.27
TPS54061	Buck	4.7 to 60	0.8 to 58	0.2	1100	98	0.09	–40 to 150	8SON	1.04

Linear Regulators

Part No.	Supply Range (V)	Output Voltage (V)	Output Current (Max) (A)	Iq (Typ) (mA)	Output Options	Accuracy (Max) (%)	PSRR @ 100kHz (dB)	Operating Temp. (°C)	Pin / Package	Approx. Price (US$ I 1ku)
Vin < 24V										
TPS799	2.7 to 6.5	1.2 to 4.5	0.2	0.04	Adj. or Fixed	2	38	–40 to 125	5DSBGA, 5SOT, 6SON	0.28
TLV1117	2.7 to 15	1.25 to 13.7	0.8	0.08	Adjustable	1	28	–40 to 125	3TO, 4SOT, 8SON	0.18
TPS7A37	2.2 to 5.5	1.2 to 5.4	1	0.4	Adj. or Fixed	1	32	–40 to 125	6SON	0.66
LP5907	2.2 to 5.5	1.2 to 4.5	0.25	0.012	Fixed	2	60	–40 to 125	4DSBGA, 4X2SON, 5SOT-23	0.14
Wide Vin (Vin ≥ 24V)										
TPS709	2.7 to 30	1.2 to 6	0.15	0.001	Fixed	2	26	–40 to 125	5SOT-23, 6SON	0.39
LP2951/LP2951-N	2 to 30	1.2 to 29	0.1	0.075	Adjustable	2	53	–40 to 125	8SOIC	0.18
TPS7A16	3 to 60	1.2 to 18.5	0.1	0.005	Adj. or Fixed	2	26	–40 to 125	8SON, 8MSOP-PowerPAD	1.39
LM317	3 to 40	1.25 to 37	1.5	0.05	Adjustable	4	–	0 to 125	4SOT, 3TO, 2PFM	0.18
LM2936	5.5 to 60	3 to 5	0.05	0.015	Fixed	3	35	–40 to 125	3TO-92, 4SOT-223, 8SOIC, 8VSSOP, 3TO-252	0.62

Voltage Reference

Part No.	Supply Range (V)	Output Voltage (V)	Iout/Iz (Max) (mA)	Iq (Typ) (µA)	Initial Accuracy (%)	0.1-10Hz Noise (Max) (µVpp)	Temp. Coeff (Typ) (ppm/°C)	Operating Temp. (°C)	Pin / Package	Approx. Price (US$ I 1ku)
REF3312	2.7 to 5.5	2.5	5	3.9	0.15	70	9	–40 to 125	3SC70, 5SOT-23, 8UQFN	0.85
REF5030	3.2 to 18	3	10	800	0.05	9	3	–40 to 125	8SOIC, 8VSSOP	1.35
ATL431	2.5 to 36	2.5 to 36	100	20	0.5 1	–	–	–40 to 125 –40 to 85	3SOT-23	0.19

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

Power Management

AC/DC Converters

Part No.	Power Level (Typ) (W)	Current Mode	Topologies	Maximum Practical Frequency	Soft Start	700-V Start-Up Circuit	110-V Start-Up Circuit	Operating Temp. (°C)	Pin / Package	Approx. Price (US$	1ku)
Green Mode PWM Controllers											
UCC28722	Up to 25	✓	Flyback w/PSR for Bipolar Power Device	80 kHz	✓		✓	-40 to 125	6SOT-23	0.25	
UCC28700/1/2/3	Up to 30	✓	Flyback w/PSR	130 kHz	✓			-20 to 125	6SOT-26	0.35	
Switchers with Integrated FETs											
UCC28880	<5		High Voltage Switcher for Non-Isolated AC/DC Conversion	66 kHz	✓	✓		-40 to 125	7SOIC	0.55	
UCC28910	<10	✓	High Voltage Flyback Switcher w/PSR	115 kHz	✓	✓		-40 to 125	7SOIC	0.75	

Ultra Low Power Harvester Power Management IC

Part No.	Description	Benefits	TI Designs
BQ25570	Power Management IC which efficiently extracts microwatts (uW) to milliwatts (mW) of power generated from high output impedance DC Sources like photo voltaic (solar) or thermal electric generators (TEG).	Integrates nanopower buck converter and high efficient boost charger	TIDA-00242
BQ25505		A high efficiency nano-boost charger that charges a rechargeable energy resevoir, and also provides battery back-up though a nonrechargeable battery to extend run-time.	TIDA-00100

System Timer

Part No.	Supply Current (Typ) (µA)	Supply Range	Prog. Delay Range	Manual Reset	Additional Notes	Programmable Timer Interval (s)	Timekeeping Accuracy (Typ) (%)	Operating Temp. (°C)	Pin / Package	Approx. Price (US$	1ku)
TPL5100	0.030	1.8 to 5	Yes	No	MOS-Driver	0.1 to 7200	1	–40 to 105	6SOT	0.40	
TPL5110	0.035	1.8 to 5	Yes	Yes	MOS-Driver	0.1 to 7200	1	–40 to 105	6SOT	0.40	
TPL5111	0.035	1.8 to 5	Yes	Yes	Active Low MOS-Driver, Active High LDO Enable	0.1 to 7200	1	–40 to 105	6SOT	–	

Load Switches

Part No.	Vin (Max) (V)	Imax (A)	Ron @ 3.6V (Typ) (mΩ)	Leakage Current (µA) (Typ)	Channels	Special Features	Operating Temp. (°C)	Pin / Package	Approx. Price (US$	1ku)
Single Channel Devices										
TPS22860	1.65 to 5.5	0.1	1300	0.02	1	–	–40 to 85	6SC70, 6SOT-23	0.25	
TPS22907	1.1 to 3.6	1	44	0.5	1	–	–40 to 85	4CSP (0.5 pitch)	0.22	
TPS22918	1.05 to 5.5	2	46	2	1	–	–40 to 85	6SOT-23	–	
TPS22954	0.7 to 5.5	5	14	5	1	Voltage Monitor (PG Pin)	–40 to 105	10SON	0.36	
Multi-channel Devices										
TPS22960	1.62 to 5.5	0.5/ch	435	0.47	2	–	–40 to 85	8SOT-23, 8µQFN	0.36	

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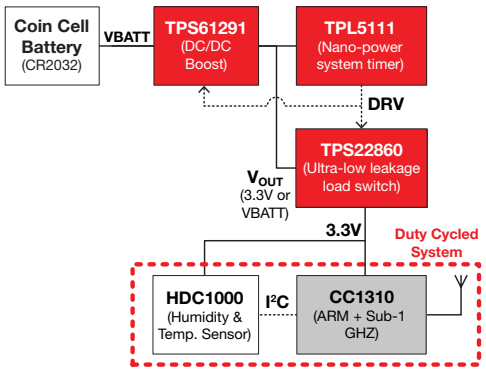
*New products are listed in **bold red.** Preview products are listed in **bold teal.***

Duty-Cycled Power Design Theory for Star Networks

One method to achieve extremely long battery life is through the use of a nano-power system timer. This type of device is intended to replace the internal timer of any standard microcontroller with a discrete analog system timer that consumes much less power than the MCUs internal timer. The nano-power timer can also bring an MCU out of sleep mode by means of a pin interrupt, or to completely shut off power to the system, in whole, or in part. This reduces the system off-state current draw to the tens or hundreds of nanoamps.



TIDA-00484 Block Diagram which Demonstrates a Duty-Cycled Sensor Node

Power Management

Find the Perfect Low Power Reference Design to Get Started			
	**Humidity & Temp Sensor Node for 2.4-GHz Star Networks Enabling 10+ Year Coin Cell Battery Life** Reference Design - **TIDA-00374**	**Key Features** • Use of nano-power system timer results in 10+ years of battery life on a coin cell battery • ±3% relative humidity accuracy, ±0.2°C temperature accuracy	**TI Devices** TPL5110 TS5A3160 CC2650 HDC1000
	**Humidity & Temp Sensor Node for Sub 1-GHz Star Networks Enabling 10+ Year Coin Cell Battery Life** Reference Design - **TIDA-00484**	**Key Features** • Use of nano-power system timer results in 10+ years of battery life on a coin cell battery • ±3% relative humidity accuracy, ±0.2°C temperature accuracy	**TI Devices** TPL5111 TPS22860 TPS61291 CC1310
	**Energy Buffering for Long-Life Battery Applications** Reference Design - **PMP9753**	**Key Features** • Efficient Super Capacitor Charging • Peak Power Assistance • Longer Battery Runtime	**TI Devices** TPL5110 TS5A3160 CC2650 HDC1000
	**110-VAC to 5-VDC @ 30-mA Non-Isolated Power Supply Reference Design** Reference Design - **TIDA-00379**	**Key Features** • Solution does not require a custom transformer • Optimized, low-cost BOM • Output ripple of less than 10-mV	**TI Devices** UCC28880 LP2985-50

Haptic

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Learn more about Haptic Feedback solutions at: **www.ti.com/haptics**

Piezo Driver

Part No.	Maximum Differential Output Voltage (Vpp)	Maximum Single-Ended Output Voltage (Vp)	Supply Voltage (V)	Small-signal Bandwidth (kHz)	Gain-Bandwidth (kHz)	Load Capacitance (µF)	Slew Rate (V/µs)	Operating Temp. (°C)	Pin / Package	Approx. Price (US$ I 1ku)
DRV2700	±100	1000	3 to 5.5	20	550	4.7	0.6	–40 to 85	QFN	4.95

Haptic Driver

Part No.	Haptic Acutator Type	Input Signal	Supply Voltage (V)	Startup Time (ms)	Vout (Max) (V)	Iq (Typ) (mA)	Shutdown Current (Typ) (uA)	Operating Temp. (°C)	Pin / Package	Approx. Price (US$ I 1ku)
DRV2605L	ERM, LRA	PWM, Analog, I²C	2 to 5.2	0.7	5.5	0.5	4	–40 to 85	10VSSOP, 9DSBGA	1.65
DRV2667	Piezo	PWM, Analog, I²C	3 to 5.5	2	200	0.13	–	–40 to 85	20QFN	2.95

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

Find the Perfect Haptic Reference Design to Get Started			
	**Touch on Metal Buttons with Integrated Haptic Feedback** Reference Design - **TIDA-00314**	**Key Features** • Replaces Mechanical Buttons with Inductive-Sensing Based Touch on Metal Detection • Customizable Haptic Feedback and Waveforms Provide High Quality User Experience • Programmable Button Sensitivity (from Light Touch to Hard Press)	**TI Devices** DRV2605L DRV2667 LDC1614 MSP430F5528
	**Piezo Speaker Strobe Notification Reference Design** Reference Design - **TIDA-00376**	**Key Features** • 86.5 dBA @ 3m (520 Hz Square Wave) • 80.5 dBA @ 3m (2.84 kHz Sine Wave) • 77.5 dBA @ 3m (Pre-Recorded Speech) • 300 candela @ 3m (Flash Mode)	**TI Devices** DRV2700 LMV344 LM3550 MSP430FR5969

Interface and Protection

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Integrated ESD Protection

Part No.	Interface	Channels	IO Capacitance (Typ) (pF)	Breakdown Voltage (Min) (V)	IEC 61000-4-2 Contact (+/- kV)	IEC 61000-4-2\ Air-Gap (+/- kV)	Special Features	Current Limit Rating (Min) (mA)	Operating Temperature Range(C)	Pin / Package	Approx. Price (US$ I 1ku)
TPD4F003	LCD Display, Memory / SIM Card	4	17	6	12	20	EMI Filter	–	–40 to 85	WSON	0.18

High Performance TVS Diodes

Part No.	Interface	Channels	IO Capacitance (Typ) (pF)	Breakdown Voltage (Min) (V)	IEC 61000-4-2 Contact (+/- kV)	IEC 61000-4-2 Air-Gap (+/- kV)	Bi-/ Uni-Directional	Operating Temp. (°C)	Pin / Package	Approx. Price (US$ I 1ku)
TPD1E10B06	Audio, General Purpose	1	12	6	30	30	Bi-Directional	–40 to 125	X1SON	0.05
TPD2E007	RS-232/485, CAN, Audio	2	15	14	8	15	Bi-Directional	–40 to 85	DSLGA, SC70	0.20

Peripheral Drivers

Part No.	Type	Peak Output Current (mA)	Output Voltage (Max) (V)	Delay Time (Typ) (ns)	Input Compatibility	Drives per Package	Gate	Output Clamp Diodes	Operating Temp. (°C)	Pin / Package	Approx. Price (US$ I 1ku)
TPL7407L	NMOS Array	600	40	250	CMOS, TTL	7	INVERT	Yes	–40 to 125	16SOIC, 16TSSOP	0.20
ULN2003A	Darlington Transistor Array	500	50	250	CMOS, TTL	7	INVERT	Yes	–20 to 70	16SO, 16SOIC, 16TSSOP	0.14

RS-485

Part No.	TX/RX	Duplex	Supply Voltage (V)	Features	Signaling Rate (Mbps)	HBM ESD (kV)	Receiver Fail-Safe	Nodes	Pin / Package	Approx. Price (US$ I 1ku)
SN65HVD72	1/1	Half	3.3	High Hysteresis, ±12kV IEC 61000-4-2 ESD, ±4kV EFT	0.25	15	Short, Open, Idle	256	8SOIC, 8SON, *VSSOP	0.70
SN65HVD82	1/1	Half	5	Low Power, ±12kV IEC 61000-4-2 ESD, ±4kV EFT	0.25	16	Short, Open, Idle	256	8SOIC	1.00
SN65HVD3082E/5E/8E	1/1	Half	5	Ultra-Low Power, Optimized for Low, Medium, & High Speeds	0.2, 1, 20	15	Short, Open, Idle	256	8SOIC, 8MSOP, 8PDIP	0.90, 1.00, 1.10

eFuses

Part No.	Supply Range (V)	Vabsmax_ cont (V)	Current Limit Threshold (A)	Current Limit Accuracy	Internal FET RON (mOhm)	Fault Response	On_Off Control Input(s)	Special Features	Pin / Package	Approx. Price (US$ I 1ku)
TPS25921A	4.5 to 18	20	0.4 to 1.6	±2% @ 1A	90	Auto Retry	ENUV, OV	No Rsense Required	8SOIC	0.50
TPS25926	4.5 to 13.8	20	2 to 5	±8% @ 3.7A	30	Auto Retry	ENUV	BLK FET Driver, Output Clamp, No Rsense Required	10VSON	0.55
TPS25927	4.5 to 18	20	1 to 5	±15% @ 2.1A	30	Auto Retry	ENUV	BLK FET Driver, No Rsense Required	10VSON	0.55

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