Smart Grid Solutions

Let's Build The Grid Together.

TI is your global partner for smart grid systems that are secure, economical and future proof.

Compliant system solutions for

- Grid infrastructure
- Utility metering
- Home and building automation
- Communication systems

www.ti.com/smartgrid

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Let's Build The Grid Together.

TI is your global partner for smart grid systems that are secure, economical and future proof. Our smart grid solutions include grid infrastructure, smart meters and home/building automation.

The power of TI saves you time to market.
- Globally deployed metering know-how and products
- Comprehensive end-to-end system-on-chip (SoC) solutions
- Innovation and expertise across a robust portfolio, covering all the major functions of the meter

Speed your design cycle with TI's flexible solutions.
- Complete portfolio of hardware, software and SoCs tailored to functional requirements
- Future-proof solutions
- Upgradable, in-system programmable flash memory to support evolving worldwide standards
- Available standards include IEC, ANSI, ZigBee®, Wireless M-Bus (wM-Bus), PLC and 6LoWPAN
- TI grid solutions are scalable to allow optimization of system requirements

Outsmart the competition with smarter solutions.
- Optimized electricity-meter SoC (MSP430™)
- Flexible applications-processor SoC (LM4F1x)
- Dedicated ultra-low-power MCU peripheral for flow-meter rotation detection
- High performance for graphical user interfaces (AM18xx/AM335x Sitara™ ARM® MPU and LM4F1x)
- Optimized, low-power radio SoC (CC1101/CC1120 ISM)
- Flexible power line communication processors (TMS320F28PLCxx)
- Secure RFID prepayment (TRF79xx, TMS37xx)
- Complementary interface and power management
- Cost-effective integration and volume manufacturing
- Compliance with wM-Bus and 802.15.4g
- Compliance with future worldwide security requirements

TI offers smart grid solutions now and for the future.

Across the smart grid application spectrum, TI supports every stage of the design process, from device selection and software development to tools and system solutions.

Hardware: Dedicated Silicon

Metrology: MSP430™
Ultra-low-power consumption, high-performance analog front end (sigma-deltas, comparators, ADCs), RTC and LCD driver –
- 1-phase, MSP430FE42xx, MSP430F47x3, MSP430AFE2xx, MSP430F672x/F673x
- 2-phase, MSP430F47x4
- 3-phase, MSP430F471xx (see app note SLAA409) or lowest-cost F6736; 3-phase high-end SoC + security, MSP430F6779/677x

Applications Processor
Stellaris® ARM® Cortex™-M microcontrollers have security, connectivity and up to 1MB flash memory – LM4F series

Sitara™ ARM MPU – Provides increased performance for advanced user interface: ARM926 and Cortex-A8 core, connectivity (UARTs, SPIs, I²C, GPIOs, USB, Ethernet), AM18xx/AM335x Sitara ARM MPU series

C6000™ DSP floating-point performance – TMS320C674x series

C6000 DSP+ARM performance + OS support – OMAP™-L13x series

Power Line Communication (PLC): C2000™
CPU performance (MHz), high-resolution PWMs, fast ADC – Piccolo™, Concerto™

Power Line AFE: PA
Current drive, integration, zero-crossing detection, Rx-Tx filtering – PGA112, OPA564, AFE030, AFE031

Low-Power RF Offering
Link budget, selectivity, low power consumption – CC1101, CC1120, CC1125, CC2520, CC2530, CC2533, CC2538, CC2590/CC2591

RFID
Multi-protocol, LDO integration, low-power modes – TRF7960A, TRF7970A, TMS3705, TMS37157

Power Management
High efficiency, low power consumption, integration and flexibility – UCC28600, TPS5401, TPS54260, TPS54231, TLV704

Software: Optimized Offering

Metrology: MSP430
Reference designs provide software building blocks for a quick start –
- 1-phase and 3-phase SoC; 1-phase front end
- 3-phase Rogowski coil and THD software

Application Processor
StellarisWare® peripheral driver library, ZigBee® Stack, RFID MIFARE, Sitara ARM MPU – Significant code base and high-quality development software available from TI and ARM third-party ecosystem:
- Base port to multiple industry-leading operating systems (Linux® kernel 2.6.33 BSP, Windows® Embedded CE BSP), full peripheral driver library.
- Monitoring and power analytics libraries.
- Rogowski support with 3-phase monitoring and analytics including harmonic distortion.
- Communications, OS and power monitoring and analytics libraries.
- Sitara ARM MPU high-quality development software from TI and ARM third-party ecosystem. Supports Linux, Android® and Windows Embedded CE.

Power Line Communication (PLC) C2000 MCU
High-performance and low-power VCU (Viterbi, Complex-Math and CRC Unit) instructions for PLC PHY acceleration. AFE test library supports CENELEC band A, B, C and D. The plcSUITE™ software package contains multiple OFDM standards software components: Fully certified PRIME stack and G3 complete stack, IEEE P1901.2, ITU-G.9955/9956, TI-defined FlexOFDM™ and PLC-Lite, IEC61334 S-FSK for both eMeter/service node and data concentrator side. Zero-configuration GUI allows user to monitor and control PLC system with ease.

Power Line AFE: PA
Integration with the C2000 PLC solutions – Universal Hardware Abstraction Layer supports AFE031/AFE030 or OPA564/PGA112 under single software framework. AFE test libraries and test vectors for performance calibration.

Wireless Connectivity Offering
Metering protocol stacks and dedicated profiles (ZigBee-SE, wM-Bus, ZigBeeIP, 6LoWPAN) – Royalty-free, fully certified and interoperable protocol stacks.

RFID/NFC
Prepayment code examples available (14443A/B, MIFARE) – Examples available for multiple platforms (MSP430, Stellaris)

Global Support: The Power of TI

People
Dedicated application support team for metering customers – Hardware and software, analog and digital, with complete coverage of metrology, PLC, RF

External Representation
TI presence at the regulatory bodies (governmental and private) – PRIME Alliance (PLC-EMEA), G3-PLC, Euridis, ETSI, IEEE 802.15.4g, ZigBee, P1901.2

Development Tools
Robust and fully tested solutions, one-to-many approach – Smart-meter board development, ZigBee large-node network test

Logistics
Expertise with big production ramps – TI production, assembly and test sites can be audited

Quality
Metering requires high volume, high quality – Expertise in manufacturing (dies, packaging), CQA process

The worldwide electric-power infrastructure is a set of interconnected assets for power generation, transmission, conversion and distribution commonly referred to as "the Grid." As demand for energy accelerates, governments, power producers, distributors, equipment providers and other stakeholders are working together to modernize this outdated and taxed infrastructure to add intelligence, communications, and decentralized control.

The automated metering infrastructure (AMI) and automated meter reading (AMR) provide the necessary means to measure, analyze and communicate energy usage to a central database for billing, troubleshooting and analyzing. Since it would not be practical for all meters to directly communicate with utility servers, data-concentrator applications are an important node in the AMI network. Data concentrators at several points in the infrastructure securely aggregate data from a manageable number of meters and send the information to the utility servers.

TI Data-Concentrator Solutions Block Diagram: Super Set
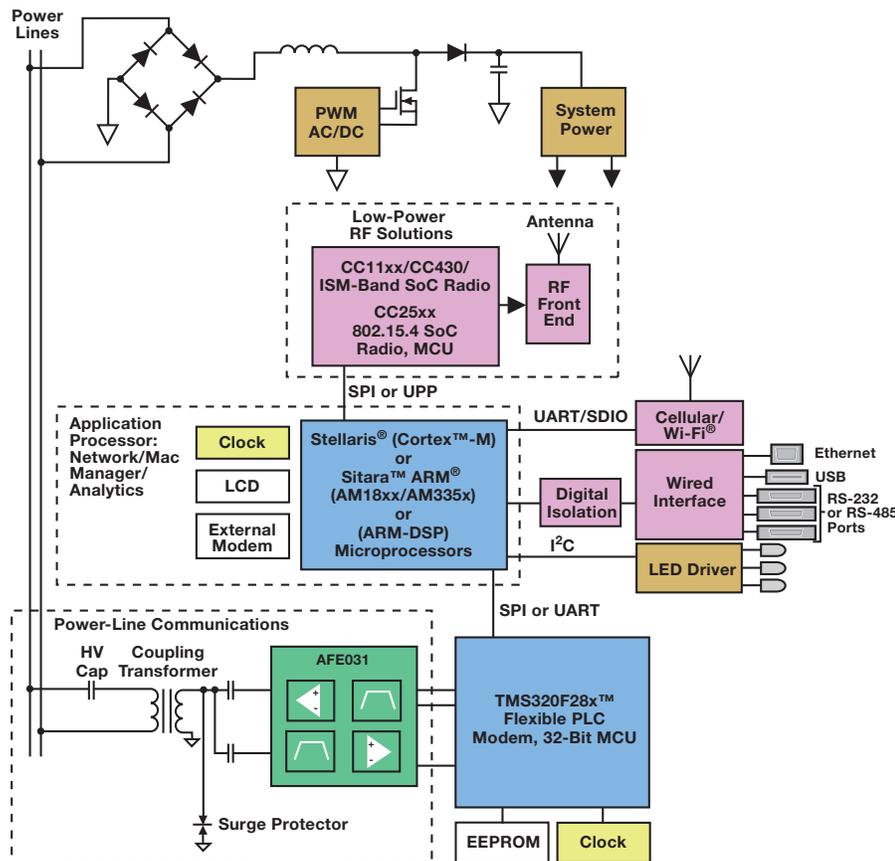
Smart Grid Infrastructure Evaluation Module (TMDSSGI-EVML138)
Grid Infrastructure

- 3-phase power system: 3 current and voltage inputs plus neutral
- Isolation to prevent damage from high voltages and currents
- Host processor: OMAP™-L138 or AM18xx/AM335x ARM® MPU for control, communications and signal processing; full Linux® BSP support by TI
- High-performance AIC provides 16-bit sampling at low SNR
- Supports control and data communications: 2x Ethernet, PLC, <1-GHz RF, 2.4-GHz RF, RS-232, CAN
- Designed with best practices for high-speed systems: Good reference design for passing ESD system tests

Application Processors for Grid Infrastructure	
AM18xx ARM9™	Sitara™ ARM9 AM18xx microprocessors, a set of code-compatible devices with industry-specific peripherals and interfaces for embedded industrial, medical and consumer designs
AM335x Cortex™-A8	Sitara ARM® Cortex-A8 microprocessors, a set of code-compatible devices with industry-specific peripherals and security engine for industrial automation designs
TMS320C674x	Combines the fixed-point C64x+™ instruction set and the floating-point C67x+™ instruction set to bring floating-point precision and fixed-point performance to energy-efficient, connected applications
OMAP™-L1x	OMAP-L1x applications processors include ARM9 + DSP architectures, which offer a variety of peripherals for networking, secure boot and multi-level encryption, and run Linux® or the DSP/BIOS™ real-time kernel for operating system flexibility

Learn more at www.ti.com/dataconcentrator

BeagleBone Development Board
This board is based on TI's Sitara™ AM335x ARM® Cortex™-A8 processor, is a low-cost, open source development tool for hobbyists, developers and engineers. It delivers bare bones hardware with access to interface signals for sensors and controls, while eliminating the need for additional equipment with a single cable development environment.

www.beagleboard.org/bone

Smart Grid Security and Safety

TI is current with worldwide smart grid NIST, BSI and FIPS 140-2 security requirements. From existing security software libraries to hardware modules and associated roadmaps, TI smart grid security solutions ensure that developers invest in future-proof solutions today.

For more information on security features per product, please visit the TI security kiosk at **www.ti.com/grid-security**

Current and Future TI Smart Grid Security Products

Grid	Now	Future Needs
Gateway/BSI	AM35xx	AM35xx + external third-party security module (Sitara™ redesign, certification three years)
e-Meter	MSP430™ Energy Meter ICs (1-phase, 3-phase), Stellaris® Cortex™-M, CC2538 ZigBee® SoC	Roadmap solutions for secured end point – contact TI representative
Water/Gas/Heat Meter	MSP430	Wolverine, MSP430 class of security with roadmap add-ons – contact TI representative
Heat Cost Allocator	MSP430	Wolverine, MSP430 class of security with roadmap add-ons – contact TI representative

Active Participation in Smart Grid Standards

Texas Instruments is proud to be an active member and contributor in these leading smart grid standards bodies and committees:

- PRIME Alliance
- G3-PLC Alliance
- ZigBee® Alliance
- Wi-Fi® Alliance
- SAE PHEV Committee
- ISO/IEC JWG CI (PEV)
- IEEE P1901.2 narrowband PLC standard
- IPSO Alliance (6LoWPAN)

- KNX Alliance
- IEEE 802.15.4/IEEE 802.15.4g Smart Utility Network (SUN) wireless standard
- ITU-T G.9955/G.9956 (G.hnem) narrowband PLC standard
- EU-US Smart Grid Coordination Group
- Smart Grid Interoperability Panel (NIST)
- ITU-T Focus Group on Smart Grid
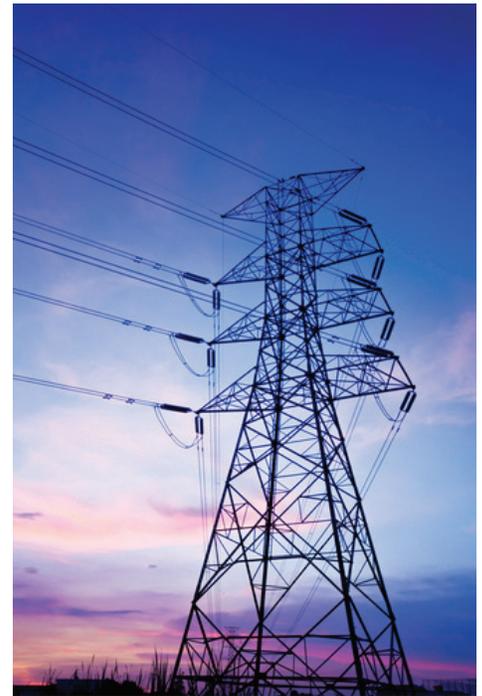
Analog Signal Chain Solutions for Smart Grid		
AMC1100	Isolation amplifier, 4.25-kV peak	e-meters/Smart Meters/Circuit Breakers
ADS131Exx/130Exx	Analog front end for power monitoring, control and protection	e-meters/Power Monitoring
ADS1292	Low-power integrated analog front end for metering applications	e-meters/Power Monitoring
ISO7520/1	Low-power 5-kV$_{rms}$ dual digital isolators	e-meters/Power Monitoring
ISO7240	Quad channel, 4/0, 25 Mbps, digital isolator	Data Concentrators/Grid Infrastructure
AFE030/1	Powerline communications analog front end	e-meters/Smart Grid Infrastructure
ISO3086T/ISO35T	Isolated RS485 transceiver with integrated transformer driver	e-meters/Smart Grid Infrastructure
SN6501	Transformer driver for isolated power supplies	e-meters/Smart Grid Infrastructure
LM1851	Ground-fault interrupter	Ground-Fault Interrupter (GFCI)/CCID
TMP275	Digital-out temperature sensor with 0.5°C accuracy	Smart Meters/Circuit Breakers
TMP112	Low-power digital temperature sensor with SMBus interface	Smart Meters/Circuit Breakers
REF2912	1.25-V voltage (bandgap) reference, 100 ppm/°C, 50 µA in SOT23-3	Metering/Circuit Breakers
SM73307	Dual-precision, 17-MHz, low-noise, CMOS-input amplifier	DC Arc Fault Detection/CCID
SM73308	Single, low-offset, low-noise, RRO op amp	DC Arc Fault Detection/CCID
SM73201	16-bit, 50- to 250-kSPS, differential-input, micropower ADC	DC Arc Fault Detection/CCID
TMP006	Contact-less infrared thermopile sensor	Smart Meters/Circuit Breakers
PGA112	Zero-drift, programmable gain amplifier with MUX	Smart Meters/Circuit Breakers
OPA356	2.5-V, 200-MHz GBW, CMOS single op amp	Data Concentrators/Grid Infrastructure
OPA835/6	Ultra-low-power, rail-to-rail out, negative rail in, VFB amplifier	Flow Meters
INA333	Low-power, precision instrumentation amplifier	Circuit Breakers
OPA4330	1.8-V, 35-µA, micropower, precision, zero-drift CMOS op amp	Circuit Breakers
TL431	Adjustable precision shunt regulator	Circuit Breakers

TI E2E™ Community

engineer.to.engineer, solving problems

www.ti.com/smartgrid-blog

MSP430™ Energy Meter ICs

Is the line voltage single-phase or multi-phase?
- 1-phase, use MSP430FE42xx, MSP430F47x3, MSP430AFE2xx, MSP430F672x/F673x
- 2-phase, use MSP430F47x4
- 3-phase, use MSP430F471xx (see app note SLAA409), or lowest-cost F6736
- 3-phase high-end SoC + security, use MSP430F6779/677x

ESP engine or software library for metrology?
- ESP engine has built-in calculation algorithms
- MSP430 Energy Library has programmable metrology code and provides additional flexibility

Is tamper detection required?
- Use MSP430FE42xA, MSP430F47x3 and MSP430F673x for single-phase electric meter with tamper detection, and MSP430F471x7 for three-phase

Key Features of MSP430
- Integrated ADC, LCD driver, RTC and flash memory
- High-performance simultaneous ADC with differential input
- Low active current while sampling the SD24
- Ultra-low-power for long backup-battery life
- Flash memory solutions from 8KB to 512KB

Featured Products

MSP430F471xx
- Up to 7xSD16, 16 MHz, 32x32 MPY, 160-seg LCD, RTC, up to 120KB/8KB
- DMA less than 0.1% accuracy (60° shift, room temperature, 2400:1)

MSP430FE42xx
- ESP energy calculation engine with up to 3xSD16, 128-seg LCD, up to 32KB flash and 1KB RAM

MSP430F672x/F673x
- Up to 3xSD24, 25 MHz, 320-seg LCD, RTC with battery backup, up to 128KB flash and 8KB RAM

MSP430F674x/F677x
- Up to 7xSD24, 25 MHz, 320-seg LCD, RTC with battery backup, up to 512KB flash, 32KB RAM, AES128

Learn more at www.ti.com/430metering

Application Processors Sitara™ ARM® MPU

Need for operating system?
- Linux® SDK

Key Features of Sitara ARM MPU Solutions
- Performance and system integration
- Multiple connectivity and flexible interfaces
- Operating-system compatibility
- Hardware security engine
- Software support infrastructure

Featured Products

AM1808/6 Sitara ARM9™ MPU
- 375/456 MHz, 128KB RAM, 65KB ROM, 361-ball BGA
- ARM926EJ-S™ RISC core, programmable
- Real-time unit subsystem, multiple connectivity interfaces

AM3352/6/7 Sitara Cortex™-A8 MPU
- 275 to 720 MHz, 256KB RAM, 176KB ROM, 298/324-S-PBGA
- Cortex-A8 32-bit RISC core with Neon™ SIMD coprocessor
- Crypto hardware accelerator for security authorization
- Two real-time unit subsystems, multiple connectivity interfaces

Learn more at www.ti.com/sitara

Stellaris® ARM Cortex-M4F MCU

How many I/Os?
- LM4F1x0QC – 100-pin LQFP with up to 69 GPIOs
- LM4F1x0QR – 64-pin LQFP with up to 49 GPIOs

Key Features of Stellaris MCU Solutions
- Flash and applications security features
- Wide range of connectivity options
- Upgrade roadmap to 1MB flash/256KB SRAM
- Extensive StellarisWare® driver library in ROM

Featured Products

LM4F1x0QC
- 80 MHz, up to 256KB flash, 32KB SRAM, 32- and 64-bit timers,12-bit ADC, 100-pin LQFP

LM4F1x0QR
- 80 MHz, up to 256KB flash, 32KB SRAM, 32- and 64-bit timers,12-bit ADC, 64-pin LQFP

Learn more at www.ti.com/stellaris

Microcontrollers for Electricity Meters		
MSP430AFE2xx	Single-phase programmable metrology front end; 24-pin TSSOP (PW); anti-tampering capabilities with an additional sigma-delta converter; more robust performance and software development with simultaneous sampling	Electricity Meters
MSP430FE42xA	Cost-optimized ultra-low-power microcontroller for Class 0.1 single-phase electricity meter with anti-tamper capabilities; up to 32K flash; 128-seg LCD	Electricity Meters
MSP430FE42x2	Cost-optimized ultra-low-power microcontroller for Class 0.1 single-phase electricity meter; up to 32K flash; 128-seg LCD	Electricity Meters
MSP430F47x4	Ultra-low-power microcontroller for Class 0.1 two-phase electricity meter; up to 60K flash; 160-seg LCD	Electricity Meters
MSP430F47x3	Ultra-low-power microcontroller for Class 0.1 single-phase electricity meter with anti-tamper capabilities; up to 60K flash; 160-seg LCD	Electricity Meters
MSP430F471xx	Ultra-low-power microcontroller for Class 0.1 for up to three-phase electricity meter with anti-tamper capabilities; up to 120K flash; 160-seg LCD	Electricity Meters
MSP430F672x/F673x	New! Optimized for single-phase electricity metering applications with RTC battery backup, auxiliary power supply and 320-seg LCD; integrated 24-bit sigma-delta converter	Electricity Meters
MSP430F674x/F677x	New! Optimized for single-phase electricity metering applications with RTC battery backup, auxiliary power supply and 320-seg LCD; integrated 24-bit sigma-delta converter, up to 512KB flash, 32KB RAM, AES128	Electricity Meters
LM4F1x0QR	ARM® Cortex™-M4F digital signal controllers for metering; 64-pin LQFP with multi-type serial connectivity; 32- and 64-bit timers; 12-bit ADCs; pin-to-pin compatible roadmap from 32 to 256KB flash and beyond	Electricity Meters
LM4F1x0QC	ARM Cortex-M4F digital signal controllers for metering; 100-pin LQFP with multi-type serial connectivity; 32- and 64-bit timers; 12-bit ADCs; pin-to-pin compatible roadmap from 32 to 256KB flash and beyond	Electricity Meters
LM4F29x	ARM Cortex-M4F digital signal controllers for metering; 128-pin TQFP with integrated Ethernet MAC+PHY; 120-MHz CPU; 1MB Flash; 256KB SRAM; 6KB EEPROM; multi-type serial connectivity; 2-MSPS 12-bit ADCs	Electricity Meters
RFID/NFC		
TRF7970A	ISO 14443A/B, ISO 15693, NFC reader/writer, card emulation and peer-to-peer modes supported; 7 user-selectable power modes; fully-integrated protocol handling: encoding, decoding, packetization and error checking with support for high data rates (106/212/424/848 kbps)	Secure Prepayment
TRF796x	ISO 14443A/B, ISO 15693 supported; 7 user-selectable power modes; fully integrated protocol handling: encoding, decoding, packetization and error checking with support for high data rates (106/212/424/848 kbps)	Secure Prepayment
TMS37157	Passive low-frequency interface transponder IC with SPI interface	Passive RF Configuration Access
TMS3705	Low-frequency base-station reader/writer IC	Passive RF Configuration Access

Wireless Connectivity

What frequency band?
- 169 MHz, 433 MHz, 868 MHz, 915 MHz: CC1xxx
- 2.4 GHz: CC2xxx

Which wireless connectivity protocol will be used?
- ZigBee®, proprietary, IEEE 802.15.4, wM-Bus, 6LoWPAN

Key Features of TI RF ICs
- All have best-in-class blocking, selectivity and coexistence properties

Featured Products

CC2520 and CC2530
- Second-generation 2.4-GHz ZigBee/IEEE 802.15.4 RF transceiver
- Ready for ZigBee AMI
- 103-dB link budget and 50-dB adjacent-channel rejection

CC2538
- CC2538 Cortex™-M3 ZigBee system on chip for SE1.0 and SE2.0 with up to 512K flash and 32K RAM plus HW security accellerators for fast commissioning

CC2591
- 2.4-GHz RF front end
- Seamless interface to TI low-power RF devices
- Up to +22-dBm output power
- 6-dB typical: Improved sensitivity on CC24xx and CC2500, CC2510 and CC2511
- Very few external components: Integrated PA, LNA, switches, inductors, balun and matching network

CC1120
- Highly configurable sub-1-GHz RF transceiver
- Supports FSK, GFSK, MSK, OOK, 0.6 to 200 kbps **CC1110 and CC1111**
- SoCs with 8051 core, options for wM-Bus and 6LoWPAN protocols

CC1180
- Sub-1-GHz 6LoWPAN network processor
- CC1190 range extender (integrated RF front end) for 868-MHz and 915-MHz ISM frequency bands

CC430
- Supports wM-Bus and 6LoWPAN protocols
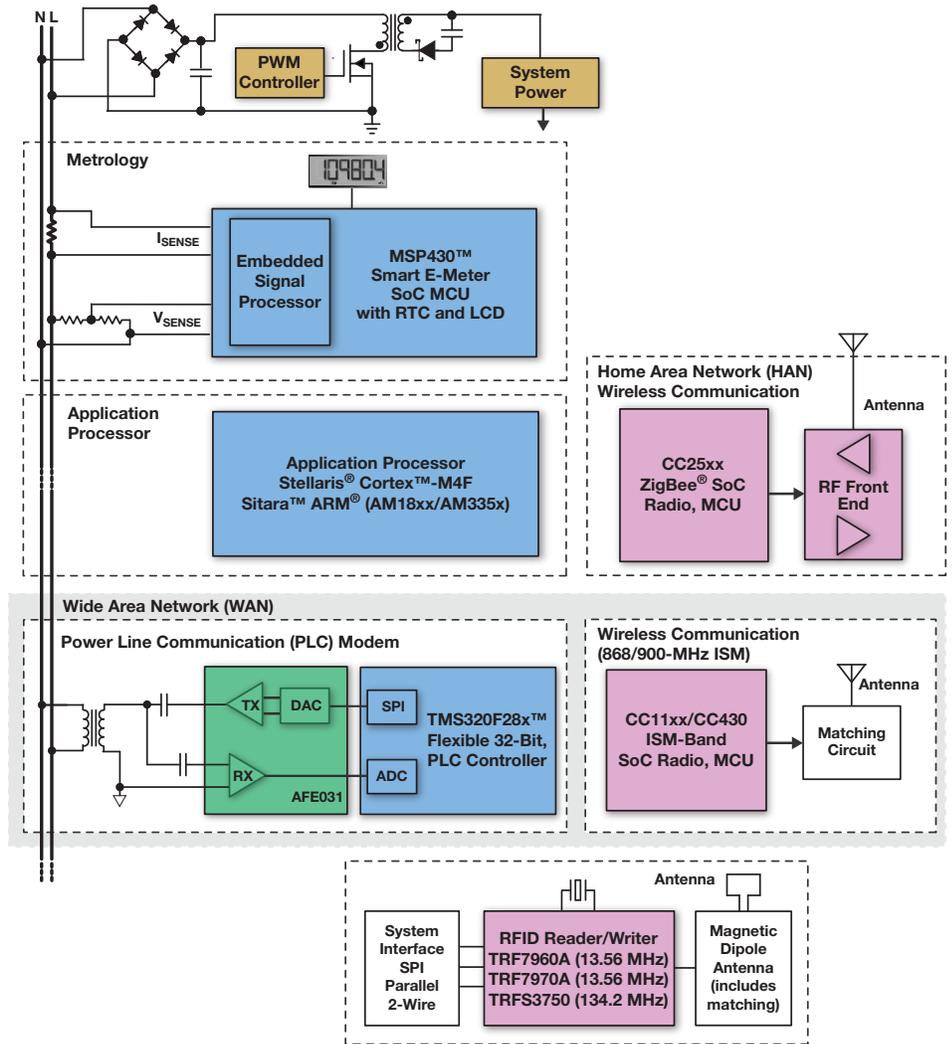
RFID Prepayment

TRF7960A/TRF7970A
- ISO 14443A/B, ISO 15693 supported
- 7 user-selectable power modes
- Fully integrated protocol handling: Encoding, decoding, packetization and error checking with high-data-rate support (106, 212, 424 and 848 kbps)

Passive RF Configuration Access

TMS3705 (Reader/Writer)
TMS37157 (Transponder IC with SPI interface)
- Short-range configuration of meter
- Counter values can be read even if battery is empty or mains is switched off
- Half-duplex (HDX) communication at 134.2 kHz
- 121-byte user EEPROM
- 3-wire SPI interface

Why Partner with TI Smart Grid Solutions?
Choose from the broadest selection of low-power solutions that optimize your gas, water and heat meter systems.

TI Smart Grid Solutions deliver:
- Innovation, expertise, and support covering all the major functions of the flow meter
- Comprehensive hardware and software portfolios to meet specific system requirements
- Solutions that are compliant with standards such as IEC, ANSI, WMBus and ZigBee®

www.ti.com/flowmeter

Recommended Devices for Gas, Water and Heat Meters

Function	Part Number	Key Features	Category
Ultra-Low-Power Microcontrollers			
Metrology MCU	MSP430F2274	32KB flash (no LCD)	General Purpose
	MSP430F417	32KB flash, 96-seg LCD	General Purpose
	MSP430F448	48KB flash, 160-seg LCD, 2 USARTs, HW multiplier, temp sensor	General Purpose
	MSP430FW429	60KB flash, LCD, scan interface peripheral for rotation detection under low-power mode (supports multiple types of sensors)	Dedicated Flow-Meter Devices
	MSP430FR5739	16KB FRAM, unified memory, 10^{15} write cycle endurance, industry-leading write speeds; 1.5-µA standby power consumption (with RTC)	Embedded FRAM
	Wolverine	Next-generation MCU platform with embedded FRAM	Embedded FRAM
Apps Processor	MSP430F5438A	256KB flash, ideal for apps processor	High Performance
	MSP430F6638	256KB flash, 160-seg LCD, RTC with battery backup	High Performance
	MSP430F6736	128KB flash, 320-seg LCD, RTC with battery backup, power management	High Performance
MCU + RF System-on-Chip (SoC)	CC430F5137	Sub-1-GHz SoC (no LCD); CC1101 transceiver, MSP430 MCU	MCU + RF SoC
	CC430F6147	Sub-1-GHz SoC, LCD; CC1101 transceiver, MSP430 MCU	MCU + RF SoC
Communications			
Sub-1 GHz	CC1101	Transceiver; low cost, low power; −116-dBm sensitivity	Proprietary RF
	CC1120	Transceiver; high performance, narrowband, −123-dBm sensitivity	Proprietary RF
	CC1121	Transceiver; high performance, narrowband, −117-dBm sensitivity	Proprietary RF
	CC1125	Transceiver; high performance, narrowband, −129-dBm sensitivity	Proprietary RF
	CC1175	Transmitter; high performance, narrowband, 16-dBm TX power	Proprietary RF
	CC110L	Transceiver; cost-optimized, −116-dBm sensitivity	Proprietary RF
	CC1190	RF front end; 27-dBm (0.5-W) TX power	Range Extender
2.4 GHz	CC2510	Low-cost SoC; 8051 MCU (up to 32KB flash), −103-dBm sensitivity	Proprietary RF
	CC2520	Transceiver; 8051 MCU (up to 256KB flash), −98-dBm sensitivity	ZigBee®/IEEE 802.15.4
	CC2530	SoC; 8051 MCU (up to 256KB flash), −97-dBm sensitivity	ZigBee®/IEEE 802.15.4
	CC2538	SoC; Cortex™-M3 MCU (up to 512K flash, 32K RAM)	ZigBee®/IEEE 802.15.4
	CC2590	RF front end; cost-effective, for low-power apps, 14-dBm TX power	Range Extender
	CC2591	RF front end; cost-effective, for low-power apps, 22-dBm TX power	Range Extender
Wired M-Bus	TSS721A	Meter-Bus (M-Bus) transceiver; meets EN1434-3 standard	Wired M-Bus
Power Management			
See "Power Management Solutions for Smart Grid" on page 14			
Additional Smart Functionalities			
Prepayment (RFID/NFC)	TRF7960A	RFID/NFC reader/writer IC; fully integrated protocol handling	RFID/NFC
	TRF7970A	RFID/NFC transceiver IC (supports reader/writer, peer-to-peer and card-emulation modes); fully integrated protocol handling; compliant to NFC standards NFCIP-1 and NFCIP-2	RFID/NFC
Valve Control (Motor Driver)	DRV8830	I^2C interface and speed regulation; up to 9 devices on a single bus	Brushed
	DRV8832	Speed regulation: Constant speed over lifetime of battery	Brushed
	DRV8833	Up to 3-A continuous current; 1.6-µA sleep current	Brushed/Stepper
	DRV8835	Tiny 2 x 3-mm package; split V_M and V_{CC} supplies; 10-nA sleep current	Brushed/Stepper
	DRV8836	Tiny 2 x 3-mm package; dedicated sleep pin; 40-nA sleep current	Brushed/Stepper
	DRV8837	Tiny 2 x 2-mm package; split V_M and V_{CC} supplies; 35-nA sleep current	Brushed

For more information on products for gas, water and heat meter solutions, visit: http://www.ti.com/flow

Flow Metering System Block Diagram
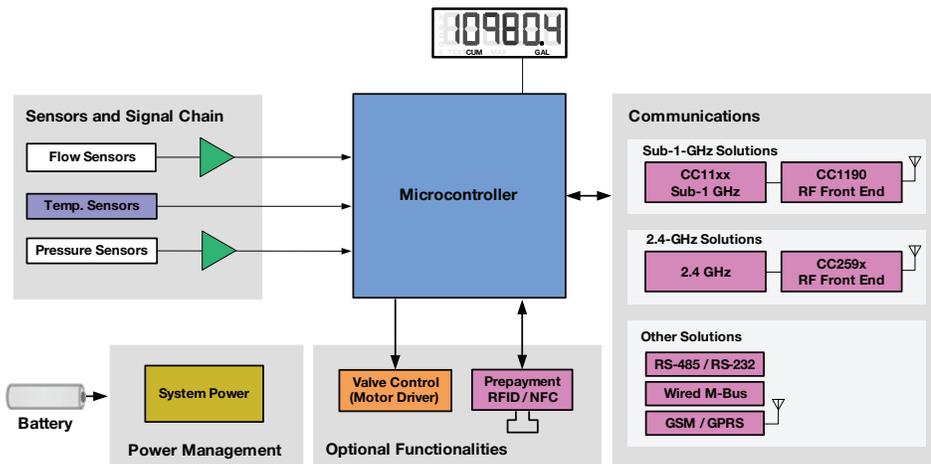
Signal Chain

The mechanical forces in meters are measured and detected by various sensors. Because voltages are very low, precise low-noise amplifiers (for flow and temperature), and instrumentation amps (for pressure) are needed to process the signal.

Microcontrollers

With TI's MSP430™ ultra-low-power microcontrollers, designers are given several design options to differentiate and to drive innovation with their meter designs. In addition to sensing, data-logging, processing and communications support, the MSP430 family enables rapid development for next-generation gas, water and heat meter systems.

Communications—Wireless Solutions

With the industry's broadest wireless connectivity portfolio, TI offers cost-effective, low-power solutions for gas, water or heat meter designs. Select from a wide range of RF ICs and proprietary protocols for the sub-1-GHz and 2.4-GHz frequency bands. Solutions include best-in-class performance-line and value-line devices that meet stringent ETSI and FCC regulations.

Paired with an extensive selection of support collateral such as development tools, technical documentation, reference designs, application expertise and third-party programs, TI's solutions simplify design and speed time to market.

Learn more about wireless solutions for the Smart Grid: www.ti.com/smartgrid-connect

Power Management

Decrease system power consumption and increase system efficiency with solutions designed specifically for battery-powered applications. From simple to complex meter designs, TI's power management solutions address needs for various topologies and various power requirements.

Solutions range from standard ICs such as DC/DC converters and linear regulators to integrated power solutions such as PMIC devices. (See page 14 for details.)

Additional Functionalities

Motor Drivers

TI's integrated motor-driver solutions enable remote valve control for smart meters. Choose TI for broadest motor expertise, breadth of selection, and comprehensive support for efficient, reliable, cost-effective drive and control solutions. Solutions for low-voltage, battery-powered requirements include stepper motors and brushed motors.

Learn more about TI's motor drive and control solutions: www.ti.com/motor

Prepayment

Prepayment meters are deployed in certain regions of the world. TI's TRF796x/TRF797x solutions offer RFID and near field communication (NFC) functionality for prepayment meters.

NFC is based on existing contactless/RFID standards where loosely coupled inductive circuits share power and data across a few centimeters. It combines the protocols and expands the communication possibilities above the standard RFID reader/writer capability with peer-to-peer communication and card emulation.
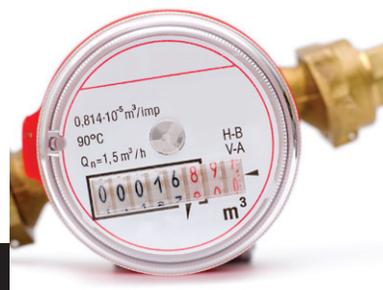
Learn more about NFC for prepayment: www.ti.com/nfc

TI E2E™ Community
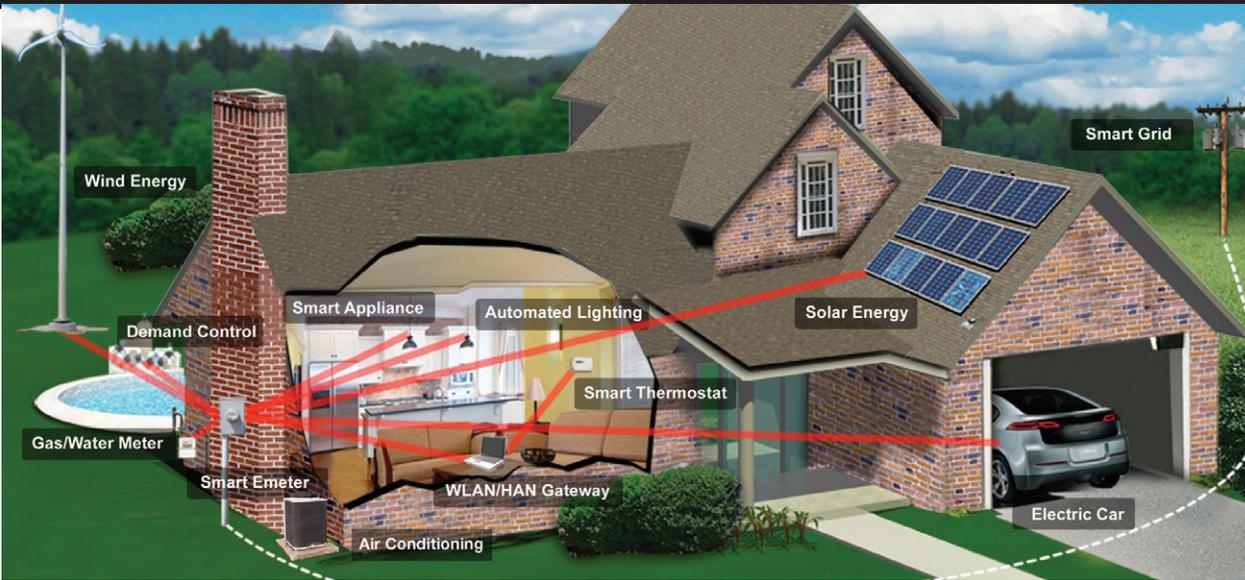engineer.to.engineer, solving problems
www.ti.com/smartgrid-blog

The home area network (HAN) refers to the ecosystem of devices within the home that are connected to the smart grid through a smart meter, through a home energy gateway, or directly in some cases. Some examples of these devices are in-home displays (IHDs) for power-consumption monitoring (see block diagram), smart appliances that respond to time-of-use pricing signals, smart thermostats that cycle the air conditioning in response to peak-load-reduction signaling from the utilities, or smart plugs that can monitor power consumption and control appliances.

Activities in the HAN can be broadly split into three categories: Measurement, communication and control. TI has comprehensive solutions to address each of these three categories. Measurement refers to the metrology or power-measurement piece that is addressed by a suite of our solutions based on the MSP430™ microcontroller. Communications between the smart meter and devices can be via a wireless standard such as ZigBee®. Devices in the HAN might communicate with each other via power line communications (PLC), ZigBee or other wireless standards such as Wi-Fi®. TI has proven software and hardware solutions supporting each of these communication interfaces. The last piece of the HAN is controlling the components based on the measurement and communication. This can be done by using IHDs or via a web portal. It can also be done by sending signals directly to load controllers or smart plugs.

Now and for the future:
- Grid-connected appliances
- Smart thermostats
- Energy gateway
- Smart plugs

In-Home Display
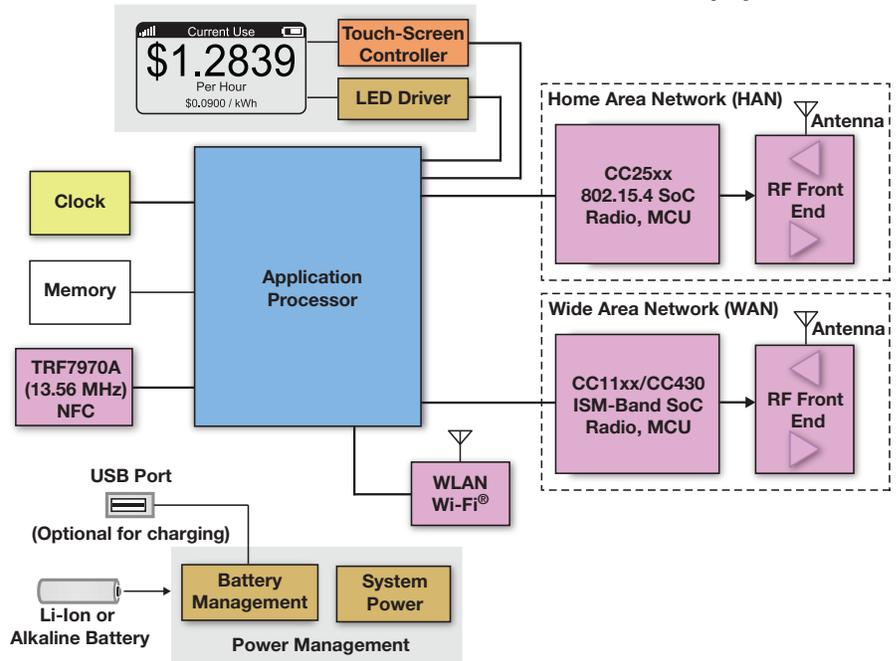
Energy Watchdog Tool
(MSP-NRGWTCHDG) *Power Monitor*

This smart plug reference design features the MSP430AFE253 and monitors electricity consumption for any household electrical appliance. Incoming AC voltage, current, frequency, active power, reactive power, apparent power, power factor and energy consumption in kWh is measured and displayed on the LCD.

Sub-1-GHz SoC Wireless Development Tool
(EM430F6137RF900) *Wide Area Network*

Complete development tool for an entire wireless project featuring the CC430 system-on-chip RF transceiver. Kit includes two sub-1-GHz wireless target boards with antennas (868/915 MHz) and the highly integrated MSP430F6137IRGC RF system-on-chip. SimpliciTI™ software stack available.

Sub-1-GHz Performance Line Development Kit
(CC1120DK) *Home Automation*

Kit provides a complete hardware performance testing and software development platform for TI's sub-1-GHz performance line devices. Test power consumption and RF range/robustness with different settings (supports 868/915 MHz). Additional kits can be purchased separately to support other frequencies.

In-Home-Display with Wi-Fi® Evaluation Module
(TMDXEVMWIFI1808L) *Home Automation*

Full-featured application development kit for evaluating the functionality of TI's highly integrated, energy-efficient Sitara™ ARM® AM1808, AM1806 and AM1802 application processors. Also features *Bluetooth*® and Wi-Fi connectivity with integrated LCD, touch and backlight display.

ZigBee®/IEEE 802.15.4 Development Kit
(CC2530DK) *ZigBee Home Area Network*

Kit includes all necessary hardware to properly evaluate, demonstrate, prototype and develop software targeting not only ZigBee- or 802.15.4-compliant applications but also proprietary applications requiring a DSSS radio. Also features TI's second-generation ZigBee/IEEE 802.15.4 RF transceiver for 2.4-GHz band.

ZigBee Network Processor Mini Development Kit
(CC2530ZDK-ZNP-MINI) *ZigBee Home Area Network*

This kit provides the perfect introduction to 2.4-GHz ZigBee wireless sensor networks. Designed for engineers who want to get familiar with this technology without having to port a lot of software to get up and running.

In-Home-Display Reference Design Kit
(RDK-IDM-SBC) *Home Automation*

This intelligent-display, single-board computer is a reference design for a complete 3.5" QVGA touch-screen user interface for control, automation and instrumentation applications. It is based on the feature-rich Stellaris® LM3S9B92 microcontroller featuring Ethernet, USB OTG/host/device and CAN.

6LoWPAN Development Kit
(CC-6LOWPAN-DK-868) *Home Automation*

The CC-6LOWPAN-DK-868 is a complete development kit for a sub-1-GHz 6LoWPAN system. It supports the 868-MHz frequency band and can quickly be reconfigured in software for operation in the 915-MHz ISM band. Additional evaluation module kits can be purchased separately to support other frequencies.

Smart Grid Wireless Sensor Node

Wireless sensor nodes (WSNs) have a broad range of applications in smart grid infrastructures. WSNs can be distributed widely across the network to remotely monitor status and report faulty conditions. WSNs can measure any number of physical parameters such as temperature, pressure, vibration, position, motion, orientation and light in different parts of the spectrum (visible, IR).

A good solution when WSN demands low system-power consumption and a "(nearly) self-powering" capability to extend the lifetime of the sensor node. TI's bq25504 power-management IC with MPPT, 16-bit MSP430™ microcontroller and CC25xx radio enable customers to design a complete solution for smart grid wireless sensor nodes.

Target Applications
- Residential and industrial monitoring for temperature, pressure, vibration, etc.
- Asset tracking

TI Devices
- bq25504
- CC2530
- CC2538
- MSP430F22x4
- TMP006
- TMP112
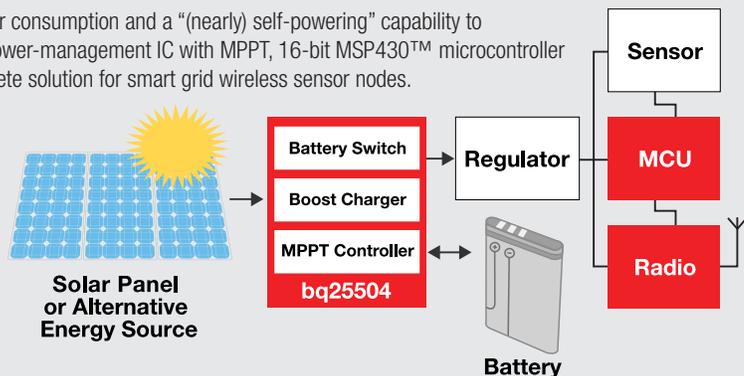
Wireless Connectivity Solutions for Smart Grid

Includes RF ICs, metering protocol stacks and dedicated profiles: Proprietary sub-1-GHz, ZigBee®-SE, wM-Bus, ZigBee-IP from 2010, 6LoWPAN. Royalty-free, fully certified and interoperable protocol stacks. Learn more at **www.ti.com/wirelessconnectivity**

Sub-1-GHz Solutions

- **CC1120**
  High-performance RF transceiver for narrowband systems
- **CC430**
  Enable smarter, low-power RF applications with more flexibility via the latest MSP430™ MCU and leading low-power RF IC

Learn more at www.ti.com/sub-1ghz

ZigBee Solutions

- Complete hardware and software ZigBee Compliant Platform (ZCP) certified by a ZigBee Alliance-approved test house
- Free IEEE 802.15.4 MAC software and golden unit status Z-Stack™ protocol stack
- High-performance CC253x radio featuring excellent coexistence with WLAN, Bluetooth® and other 2.4-GHz solutions
- Smart Energy and Home Automation public-application profiles and support
- Development kits and tools

Learn more at www.ti.com/zigbee

6LoWPAN Solutions

- Gateway for remote, low-cost wireless sensors to connect to the Internet and a wireless extension of wired IPv6 infrastructures
- Sub-1-GHz product family includes the CC1180 network processor, CC430 complete system-on-chip (SoC) microcontrollers, CC1101/MSP430F5xxx platform and 6LoWPAN software stacks
- Supports large-scale mesh networks. Suitable for applications such as smart grid, security, home and building automation, street lighting and other wireless sensor networks.

Learn more at www.ti.com/6lowpan

NFC/RFID Solutions

Learn more at www.ti.com/nfc

TI's Complete wM-Bus Solution

Multiple MSP430+CC11xx hardware platforms with wM-Bus stack. Easy-to-use TI evaluation kits with TI's ULP MSP430 MCU and CC11xx devices immediately available for wM-Bus development.

- Multiple TI EVM kits supporting wM-Bus are available today:
  - MSP-EXP430F5438 + CC1120EM kit
  - MSP-EXP430FG4618 + CC1101EM kit
  - EM430F6137RF900 for CC430 single-chip device
- CC1101+CC1190 evaluation kits for high transmit power in 868/915-MHz bands
- TPS62730 EVM for efficient power supply from primary batteries supporting all the MCU+RF kits above
- wM-Bus stack with TI hardware platform is the first complete wM-Bus product on the market, just like TI was the first semiconductor company to provide ZigBee stack for the mass market

Learn more at www.ti.com/wmbus

Wi-Fi® Solutions

- **CC3000**
  Self-contained 802.11 b/g solution enables easy-to-implement Internet connectivity. Embedded Wi-Fi and networking software including drivers, stack and supplicant. Allows Wi-Fi implementation quickly without previous Wi-Fi or RF experience.
- **WL1271**
  802.11 b/g/n and Bluetooth platform on a single chip with best-in-class coexistence technology. TI's sixth-generation WLAN technology allows secure, high-throughput and reliable Wi-Fi connectivity of electronic devices to each other, the Internet and wired networks. TI's seventh-generation Bluetooth technology supports low-power applications in personal area networks.

Learn more at www.ti.com/wifi

Recommended Development Tools		
CC1120DK	Sub-1-GHz RF performance-line development kit	Wireless Communication/ Wireless Mbus (wM-Bus)
CC2530ZDK-ZNP-Mini	ZigBee® network processor development kit	Wireless Communication
CC2531EMK	ZigBee USB dongle development kit	Wireless Communication
CC-6LOWPAN-DK-868	Sub-1-GHz 6LoWPAN development kit	Wireless Communication
TRF7970AEVM	NFC development kit	NFC
DK-EM2-2520Z	Stellaris® 2.4-GHz ZigBee wireless networking kit (requires Stellaris DK-LM3S9B96 base kit)	Wireless Communication
EZ430-TMS37157	Passive low-frequency interface device kit	Wireless Communication
MSP-EXP430F5438/ CC1120EMK-868-915	High-performance system solution	wM-Bus
MSP-EXP430FG4618/ CC1101EMK868-915	Cost-optimized system solution	wM-Bus
EM430F6137RF900	EVM for CC430 single-chip device	wM-Bus
CC1101CC1190EMK868/ CC1101CC1190EMK915	Evaluation kit for high transmit power in 868/915-MHz bands	wM-Bus
TPS62730 EVM	EVM efficient power supply from primary batteries supporting all the MCU+RF kits above	wM-Bus
BQ25504EVM-674	Evaluation module for BQ25504 ultra-low-power boost converter with battery management	Metering/Smart Grid/RFID/ Wireless Communication
CC3000FRAMEMK	Kit with CC3000 Wi-Fi® modules, FRAM experimenter board and access point and USB hub for out-of-box experience	Wireless Communication
TMDXEVMWIFI1808L	Full-featured application development kit for evaluating the WL1271 Wi-Fi/Bluetooth® functionality combined with TI's highly integrated, energy-efficient AM1808, AM1806 and AM1802 application processors	Wireless Communication

Power Line Communications Modem Solutions from Texas Instruments: SFSK/PRIME/G3/FlexOFDM™/PLC-Lite

Developing an efficient PLC implementation is not without its challenges. Power lines are inherently noisy and require a robust architecture to ensure data reliability. In addition, each application and operating environment is different, requiring developers to optimize designs across a variety of factors. With the many protocol standards and modulation schemes available, developers need a **flexible development platform** which simplifies design, allows for optimization to environmental conditions, supports local regulations, and can be easily adjusted to conform to evolving standards.

In addition to providing flexible solutions to the industry, TI is performing field tests all around the world to validate PLC performance, while collecting and building invaluable grid experience and knowledge. Learn more at www.ti.com/plc
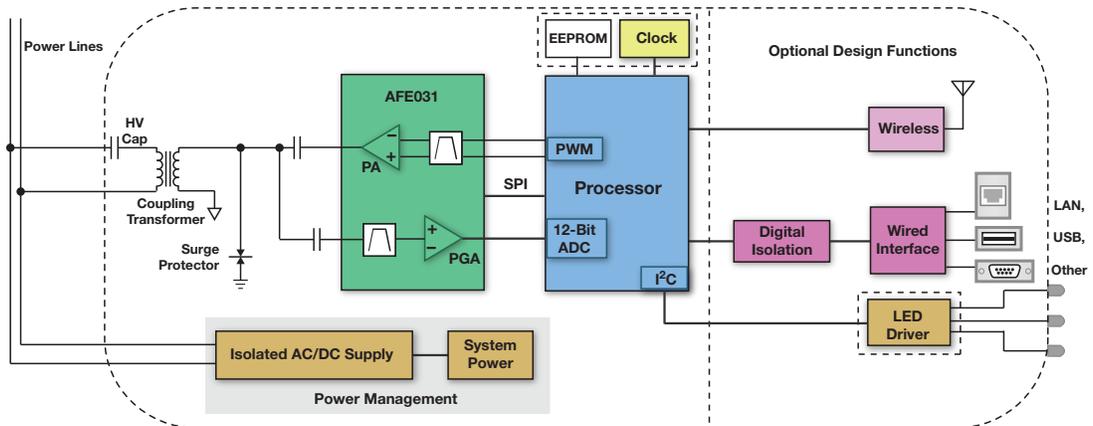
TMDSPLCKIT-V3 C2000™ Power Line Modem Developer's Kit
- Two PLC modems
- PLC software supporting OFDM (PRIME, G3, FlexOFDM™ and PLC-Lite) and SFSK communication
- Built-in USB JTAG emulation
- Two F28069 controlCARD™ devices included
- All necessary power and connection cables included
- 32KB limited Code Composer Studio™ (CCS) includes integrated development environment

TI PLC Featured Products
- TMS320F28PLC35 Piccolo™ – 60 MHz + accelerator, 128KB flash, 20KB RAM
- TMS320F28027 Piccolo – 60 MHz, 64KB flash, 12KB RAM,
- TMS320F28PLCxx Piccolo – 80 MHz + accelerators, 256KB flash, 100KB RAM
- AFE031 – Fully integrated Tx and Rx PLC AFE, FSK, SFSK, OFDM, PRIME, G3 compliant; direct digital interface to TI PLC processor, up to 20-V_{PP} output at 1.5 A

What is the communication rate?
- Up to 128-kbps PRIME standard available from TI
- Scalable bit rate with FlexOFDM, roadmap in FCC band

What modulation type?
- PRIME and G3 and FlexOFDM (OFDM) available from TI
- SFSK from TI third party

Part	Features	Comments
BQ24210	800-mA, single-input, single-cell Li-Ion solar battery charger	
BQ24650	High-efficiency synchronous switch-mode charger controller for solar battery charger	
BQ25504	Ultra-low-power boost converter with battery management for energy-harvester applications	
LM2841	300 mA, up to 42-V input step-down DC/DC regulator	e-meters
LM25011	DC/DC buck regulator: 42-V current-limit adjustable to 2 A, 2-MHz switching frequency	e-meter
LM34923	DC/DC buck regulator: 6- to 75-V input-voltage range, no loop compensation required	e-meter
LM5006/7/10A	DC/DC buck regulator: 75-V maximum input capability, synchronous or nonsynchronous rectification. Up to 1-A output current.	e-meter
LM5017	DC/DC buck regulator: 100-V maximum input capability, synchronous rectification, no loop compensation required	e-meter, PLC
SN1106046	DC/DC switching regulator: High light-load efficiency, suitable for single-layer PCB, 3.5- to 28-V input, 1 A; targets 7805 replacement	
TLV70430	LDO linear regulator: 24 V, 150 mA; ultra-low 3.2-µA I_Q	
TPS3700	UV, OV voltage monitor; wide input voltage	
TPS3839	Ultra-low-power, 150-nA, ultra-small voltage supervisor	
TPS5401	Cost-optimized 42-V, 0.5-A step-down DC/DC converter; cap-drop off-line power supplies – Refer to app note SLVA491	Low-cost cap-drop solution
TPS5402/03/05	3.5-V~28-V V_{IN}, 2-A output current, non-sync buck	e-meters
TPS54040/140/240	DC/DC switching power supply: 42-V, 0.5-A/1.5-A/2.5-A step-down DC/DC converters with Eco-mode™ for light-load efficiency and very low I_Q	
TPS54060/160/260	DC/DC switching power supply: 60-V, 0.5-A/1.5-A/2.5-A step-down DC/DC converters with Eco-mode for light-load efficiency and very low I_Q	Cost-effective 60-V cap-drop solutions
TPS54061	60-V, 200-mA synchronous step-down DC/DC converter with sub-100-µA I_Q	Highly efficient three-phase meters needing <200 mA; 3-wire 4- to 20-mA loop sensors
TPS54062	60-V, 50-mA synchronous step-down DC/DC converter with sub-100-µA I_Q	Highly efficient single-phase meters needing <50 mA; 2-wire 4- to 20-mA loop sensors
TPS54218	DC/DC switching power supply: 2.95-V to 6-V input, 2-A output, 2 MHz, synchronous step down	e-meter and Grid Infrastructure Processor Power
TPS5423x/33x	DC/DC switching power supply: 24-V, 2-A/3-A/3.5-A DC/DC converters	
TPS54320	DC/DC switching power supply: 4.5-V to 17-V input, 3-A synchronous step down SWIFT™ converter	e-meter and Grid Infrastructure Processor Power
TPS54478	DC/DC switching power supply: 2.95-V to 6-V Input, 4-A Output, 2-MHz, synchronous step-down switcher	e-meter and Grid Infrastructure Processor Power
TPS54623	DC/DC switching power supply: 4.5-V to 17-V input, 6-A synchronous step-down converter with light-load efficiency	e-meter and Grid Infrastructure Processor Power
TPS62125	DC/DC step-down converter: Up to 17-V supply; 0.3-A output current; adjustable ENABLE threshold and hysteresis; DCS-Control™ topology provides fast AC line and transient load response; Power Good indicator	System Supply (Harvesting operated)
TPS62130/140/150	DC/DC step-down converter: Up to 17-V supply, 1-A to 3-A output current; DCS-Control™ topology provides very high efficiency over load range, fast AC line and transient load response on a small-solution footprint (<95 mm^2); Power Good indicator	General System Supply
TPS62160/170	DC/DC step-down converter: Up to 17-V supply, 0.5-A or 1-A output current; DCS-Control™ topology provides very high efficiency over load range, fast AC line and transient load response on a small-solution footprint (<45 mm^2); soft-start/tracking; pin-selectable switching frequency; Power Good indicator	General System Supply
TPS62175	DC/DC step-down converter: Up to 28-V supply; 0.5-A output current; DCS-Control™ topology provides fast AC line and transient load response on a small-solution footprint; Power Good indicator	General System Supply
TPS62730	DC/DC step-down converter: Companion power supply for LP RF devices; bypass mode saves 20-30% battery current without compromising on transmit power; DCS-Control™ topology provides low output voltage ripple	RF Supply
TPS6303x	DC/DC buck-boost regulators: 0.8 A, low I_Q with up to 96% efficiency	System Supply (Battery operated)
TPS6306x	DC/DC buck-boost regulators: 2.5- to 12-V input voltage with 93% efficiency and 2.25-A switch-current limit	
TPS65250	Power-management IC for e-meters	e-meters
TPS65290	Power-management IC for gas/water meters: Ultra-low I_Q, buck/boost, LDO, power switch, I^{2}C/SPI	Gas/Water Meters
TPS650250	Low-cost PMU for AM335x	Grid Infrastructure
TPS782x	LDO linear regulator: Ultra-low 0.5-µA I_Q, 150 mA, low noise	
TPS7A1601	LDO linear regulator: 60 V, 100 mA; ultra-low 5-µA I_Q; PG pin	
TPS7A4001	LDO linear regulator: 100 V, 50 mA; low I_Q	
UCC28700/610/600	AC/DC switching power supply: Quasi-resonant flyback controller, optimized for high efficiency	e-meters, Data Concentrators

Learn more at www.ti.com/power

Featured Smart Meter Development Tools

Three-Phase E-Meter (Anti-Tamper) Evaluation Module
(EVM430-F47197) *E-Meter*

Features a system-on-chip MSP430F47197 and 16-MHz metrology with up to seven sigma-delta converters that allow measurement of three phases with anti-tamper. The 160-segment LCD displays energy, voltage, current and more for all three phases.

Single-Phase E-Meter Evaluation Module
(EVM430-F6736) *E-Meter*

Single-phase electricity meter EVM features the 25-MHz MSP430F6736 with three 24-bit sigma-delta converters for 50% lower power consumption in metering applications. Includes LCD display for easy readout.

Single-Phase E-Meter (Analog Front End) Evaluation Module
(EVM430-AFE253) *E-Meter*

Single-phase electricity meter (with anti-tamper) EVM features the MSP430AFE253, which is the industry's first programmable microcontroller with an analog front end. Quickly understand calibration, anti-tamper and precise measurements that achieve >99.9% accuracy across a dynamic range of 2400:1.

RFID/NFC Transceiver Evaluation Module Kit for Prepaid Meters
(TRF7960AEVM/TRF7970AEVM) *Secure Prepayment*

Self-contained development platform that can be used to independently evaluate/test the performance of the TRF7960A or TRF7970A RFID/near-field-communications transceiver IC, custom firmware, customer designed antennas and/or potential transponders for a customer-defined RFID/NFC application.

Development Tools for Smart Meters

Part	Features
EK-LM4F120XL	Stellaris® LM4F120 LaunchPad evaluation kit with BoosterPack XL interface, software examples and schematics
EK-LM4F232	Stellaris ARM® Cortex™-M4F application processor kit, software examples and schematics
EVM430-F47197	3-phase electricity-meter evaluation board with application notes, software and schematics
EVM430-FE4272	Single-phase electricity-meter evaluation board with application notes, software and schematics
EVM430-FE427A	Single-phase electricity-meter (with anti-tamper) evaluation board with application notes, software and schematics
MSP-TS430PW24	Stand-alone target board for MSP430AFE2xx
MSP-TS430PZ100B	Stand-alone target board for MSP430F672x/F673x series
BQ24210EVM-678	Evaluation module for BQ24210; 800-mA, single-input, single-cell Li-Ion battery solar charger
BQ24650EVM-639	BQ24650 evaluation module; synchronous, switch-mode, battery charge controller for solar power
BQ25504EVM-674	Evaluation module for BQ25504; ultra-low-power boost converter with battery management
ADS131E08EVM-PDK	ADS131E08 performance demonstration kit for power monitoring in e-meters, data concentrators
MSP-EXP430F5438	Dot-matrix LCD, 3-axis accelerometer, microphone, audio output, USB communication, joystick, 2 buttons, 2 LEDs for MSP430F5438
MSP-EXP430FG4618	LCD, capacitive-sensitive input, audio output, buzzer, RS-232 communication, 2 buttons, 3 LEDs for MSP430FG4618, MSP430F2013
MSP-EXP430F5529	Complete USB development board, dot-matrix LCD, microSD card, 3-axis accelerometer, 5-pad capacitive touch slider, RF module connectors, LEDs, integrated flash emulation tool for MSP430F5529
MSP-EXP430FR5739	FRAM-based experimenter's board, accelerometer, thermistor, LEDs, switches, connections for RF modules, integrated flash emulation tool for MSP430FR5739

Suggested TI Resources

- C2000™ high-performance Piccolo™ MCU for power line communications – **www.ti.com/plc**
- MSP430™ ultra-low-power MCU for water, gas, and 1- to 3-phase e-metering and RF systems – **www.ti.com/430metering**
- Cost-effective, low-power and high-performance sub-1-GHz and 2.4-GHz wireless connectivity solutions – **www.ti.com/wirelessconnectivity**
- Isolated and non-isolated power-supply solutions for AC/DC power conversion tailored for powering your smart meter – **www.ti.com/power**
- Stellaris® ARM® Cortex™-M real-time microcontrollers – **www.ti.com/stellaris**

- Sitara™ high-performance, embedded microprocessors based on ARM with Cortex-A8 or ARM9™ with speeds ranging from 300 MHz to 1.35 GHz – **www.ti.com/sitara**
- TI-RFid™ tags, smart labels and RFID readers for contactless payments and secure ID – **www.ti.com/rfid**
- Smart lighting solutions and LED drivers – **www.ti.com/lighting**
- To review all TI industrial solutions – **www.ti.com/industrial**
- Learn more about signal-chain design options at **www.ti.com/analog**

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TI Semiconductor Product Information Center Home Page
support.ti.com
TI E2E™ Community Home Page
e2e.ti.com

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Americas	Phone	+1(512) 434-1560
Brazil	Phone	0800-891-2616
Mexico	Phone	0800-670-7544
	Fax	+1(972) 927-6377
	Internet/Email	support.ti.com/sc/pic/americas.htm

Europe, Middle East, and Africa
Phone

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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Internet	www.ti.com/asktexas
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Japan

Phone	Domestic	0120-92-3326
Fax	International	+81-3-3344-5317
	Domestic	0120-81-0036
Internet/Email	International	support.ti.com/sc/pic/japan.htm
	Domestic	www.tij.co.jp/pic

Asia
Phone

International	+91-80-41381665
Domestic	Toll-Free Number

Note: Toll-free numbers do not support mobile and IP phones.

Australia	1-800-999-084
China	800-820-8682
Hong Kong	800-96-5941
India	1-800-425-7888
Indonesia	001-803-8861-1006
Korea	080-551-2804
Malaysia	1-800-80-3973
New Zealand	0800-446-934
Philippines	1-800-765-7404
Singapore	800-886-1028
Taiwan	0800-006800
Thailand	001-800-886-0010

Fax	+8621-23073686
Email	tiasia@ti.com or ti-china@ti.com
Internet	support.ti.com/sc/pic/asia.htm

TI E2E™ Community

engineer.to.engineer, solving problems

www.ti.com/smartgrid-blog

TEXAS INSTRUMENTS

SLYM071J

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In some cases, TI components may be promoted specifically to facilitate safety-related applications. With such components, TI's goal is to help enable customers to design and create their own end-product solutions that meet applicable functional safety standards and requirements. Nonetheless, such components are subject to these terms.

No TI components are authorized for use in FDA Class III (or similar life-critical medical equipment) unless authorized officers of the parties have executed a special agreement specifically governing such use.

Only those TI components which TI has specifically designated as military grade or "enhanced plastic" are designed and intended for use in military/aerospace applications or environments. Buyer acknowledges and agrees that any military or aerospace use of TI components which have *not* been so designated is solely at the Buyer's risk, and that Buyer is solely responsible for compliance with all legal and regulatory requirements in connection with such use.

TI has specifically designated certain components which meet ISO/TS16949 requirements, mainly for automotive use. Components which have not been so designated are neither designed nor intended for automotive use; and TI will not be responsible for any failure of such components to meet such requirements.

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