Communications

Overview

An electricity grid without adequate communications is simply a power "broadcaster." It is through the addition of two-way communications that the power grid is made "smart."

Communications enables utilities to achieve three key objectives: intelligent monitoring, security, and load balancing. Using two-way communications, data can be collected from sensors and meters located throughout the grid and transmitted directly to the grid operator's control room. This added communications capability provides enough bandwidth for the control room operator to actively manage the grid.

The communications must be reliable, secure, and low cost. The sheer scale of the electrical grid network makes cost a critical consideration when implementing a communications technology. Selecting a solution that minimizes the number of modems and concentrators needed to cover the entire system can dramatically reduce infrastructure costs. At the same time, the selected technology must have enough bandwidth to handle all data traffic being sent in both directions over the grid network.

Communications networks and protocols

Communications in the smart grid can be broken into three segments.

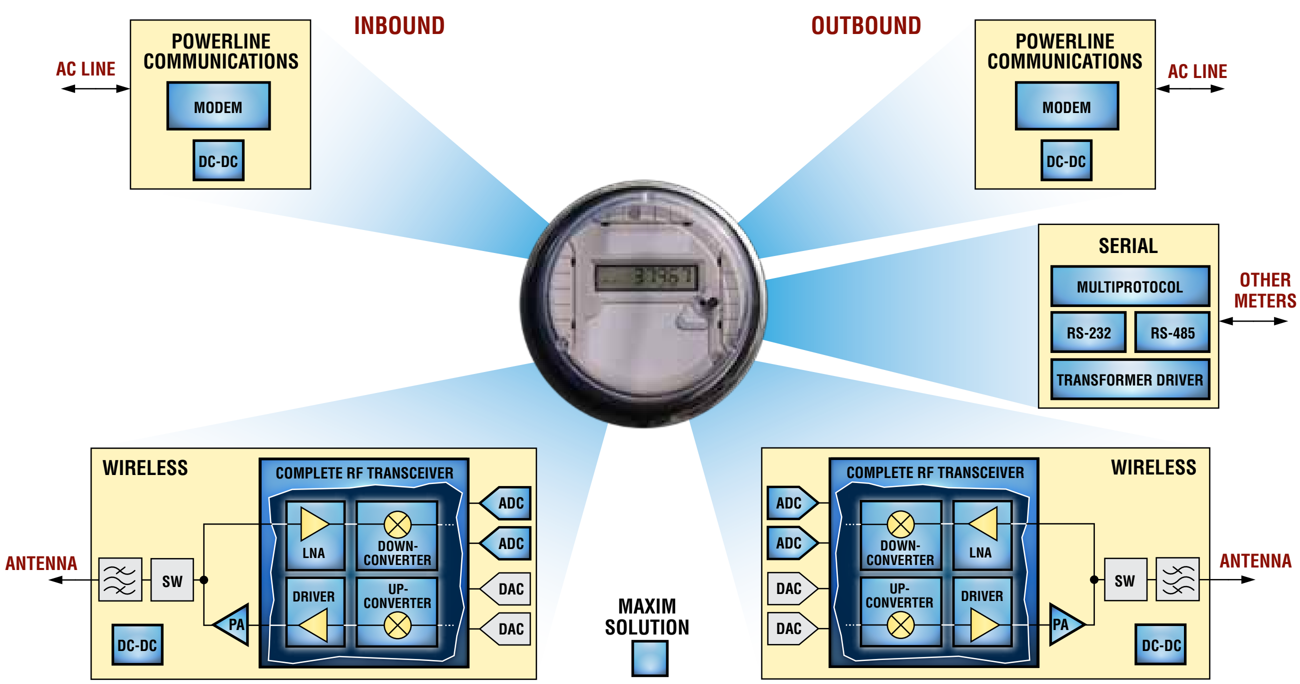
Wide area network (WAN) covers long-haul distances from the command center to local neighborhoods downstream.

Neighborhood area network (NAN) manages all information between the WAN and the home area network using medium-voltage lines.

Home area network (HAN) extends communication to endpoints within the end-user home or business.

Each segment is interconnected through a node or gateway: a concentrator between the WAN and NAN and an e-meter between the NAN and HAN. Each of these nodes communicates through the network with adjacent nodes. The concentrator aggregates the data from the meters and sends that information to the grid operator. The e-meter collects the power-usage data of the home or business by communicating with the home network gateway or functioning as the gateway itself.

Each segment can utilize different communications technologies and protocols depending on the transmission environments and amount of data being transmitted. In addition to the architecture choice between wireless and powerline communications (PLC), there are a variety of wireless and PLC protocols to choose among (**Table 1**).



Maxim offers solutions for powerline, wireless, and serial communications. For a list of Maxim's recommended solutions, please go to: www.maxim-ic.com/communications.

Table 1: Smart grid communications protocols

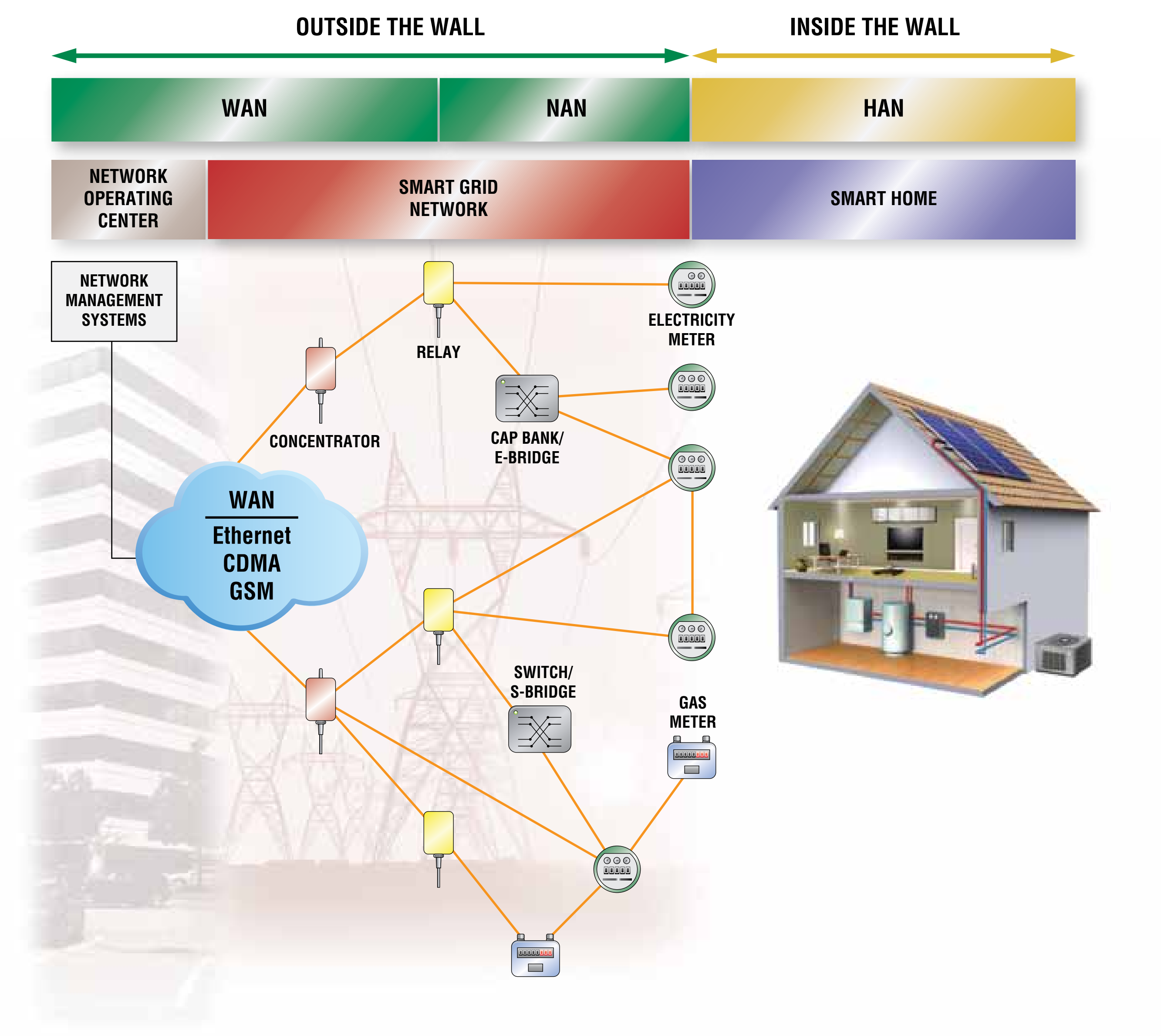
Network	Protocol	Advantages	Disadvantages	Recommendation
WAN	Wireless (2G/3G/LTE cellular, GPRS)	Extensive cellular infrastructure is readily available; large amount of aggregated data can be communicated over a long haul	Utility must rent the infrastructure from a cellular carrier for a monthly access fee; utility does not own infrastructure	Wireless usually works best
NAN	Wireless ISM	Long range; leaps transformers	Currently proprietary; dead spots complicate installation and maintenance	Useful in some topologies, such as in the U.S.
	IEEE® 802.15.4g	Long range; leaps transformers	Not yet an accepted standard	Useful in some topologies
	ZigBee®	Low cost; low power consumption allows battery operation; well-known standard	Low data rate; very short range; does not penetrate structures well	Unlikely to be used in NANs
	First-generation PLC (FSK, Yitran, Echelon®)	Low cost	Unreliable; low bandwidth	Bandwidth and reliability inadequate for the smart grid
	Early-generation narrowband OFDM	Better range, bandwidth, and reliability than FSK	Does not cross transformers; does not coexist with first-generation PLC	Not recommended for new designs due to cost and compatibility concerns
	Broadband PLC	High data rate	Does not cross transformers	Increases infrastructure cost, making it too costly for most large-scale deployments
	G3-PLC	Highly reliable long-range transmission; crosses transformers, reducing infrastructure costs; data rate supports frequent two-way communications; coexists with FSK; open standard; supports IPv6	Not yet an accepted standard	Excellent for NAN worldwide
HAN	ZigBee	Well-known standard that offers low cost and low power	Very short range; does not penetrate structures well	Well suited for communication between water and gas meters
	Wi-Fi®	Popular technology with high data rates	Medium range; does not penetrate cement buildings or basements	Good for consumer applications, but no provisions for meeting utility objectives
	First-generation PLC (FSK, Yitran, Echelon)	Low cost	Not reliable in home environments	Unlikely to be used in homes due to high levels of interference
	Early-generation narrowband OFDM	Better range, bandwidth, and reliability than FSK	Does not cross transformers; does not coexist with first-generation PLC	Not recommended for new designs due to cost and compatibility concerns
	Broadband PLC	High bandwidth	Short range is not sufficient for NAN	Good for consumer applications, but no provisions for meeting utility objectives
	G3-PLC	Highly reliable; sufficient data rate; IPv6 enables networking with many devices	Not yet an accepted standard	Excellent for HAN worldwide

The WAN is the communications path between the grid operator and the concentrator. The WAN can be implemented over fiber or wireless media using Ethernet or cellular protocols, respectively. Cellular or WiMAX® is most commonly used between the grid operator and the concentrator.

The NAN is the path between the concentrator and the meter. It uses either wireless or PLC. Typically, the concentrator communicates with anywhere from a few to hundreds of meters, depending on the grid topology and the communications protocol used. Today, there is no standard for this portion of the network, so most implementations use proprietary wireless or PLC technologies. Several standards bodies are currently working with utilities and technology providers to define standards for wireless and PLC protocols. The IEEE 802.15.4g standard targets wireless; the IEEE P1901, OPEN meter, and ITU-T G.hnem standards are being developed for PLC (**Table 2**).

The HAN is used by utilities to extend the reach of their communication path to devices inside the home. This network can support functions such as cycling air conditioners off during peak load conditions, sharing consumption data with in-home displays, or enabling a card-activated prepayment scheme. The arrival of electric/plug-in hybrid electric vehicles (EV/PHEVs) presents a special communications scenario for HANs. Standards bodies are defining PLC protocols for communicating with vehicle charging systems.

In addition to supporting the data requirements for smart grid activities, a HAN might also include: peer-to-peer (P2P) communications between devices inside the home; communications with handheld remote-control devices, lighting controls, and gas or water meters; as well as broadband



The smart grid communications architecture.

Table 2: Communication protocols under consideration around the world

Region	WAN	NAN	HAN
North America	Cellular, WiMAX	G3-PLC, HomePlug®, IEEE 802.15.4g, IEEE P1901, ITU-T G.hnem, proprietary wireless, Wi-Fi	G3-PLC, HomePlug, ITU-T G.hn, Wi-Fi, ZigBee, Z-Wave
Europe	Cellular	G3-PLC, IEEE P1901, ITU-T G.hnem, PRIME, Wi-Fi	G3-PLC, HomePlug, ITU-T G.hn, Wi-Fi, Wireless M-Bus, ZigBee
China	Cellular, band-translated WiMAX	G3-PLC, RS-485, wireless to be determined	G3-PLC, RS-485, Wi-Fi, to be determined
Rest of the World	Cellular, WiMAX	G3-PLC, HomePlug, IEEE 802.15.4g, IEEE P1901, ITU-T G.hnem, PRIME, RS-485, Wi-Fi	G3-PLC, HomePlug, ITU-T G.hn, RS-485, Wi-Fi, Wireless M-Bus, ZigBee, Z-Wave

traffic. Protocols such as RS-485, ZigBee, Z-Wave®, and HomePlug are used for this network. If there is a separate home gateway, it is possible that additional protocols could be used to communicate with appliances, thermostats, and other devices.

Communications alternatives in the HAN can often coexist, but utility support will probably be limited to technologies needed to support the utility's primary objectives.

RF communications

Wireless communications is used in some areas for automated meter reading (AMR). Several proprietary and standardized wireless protocols are available today. Frequency bands of interest range from 200MHz to 3.9GHz.

Several blocks are used to implement RF communications (**Figure 3**). The signal is received through an antenna and goes through a bandpass filter, which rejects frequencies beyond the one of interest. The signal is then switched to the receive signal chain, where one or more downconverters translate from the carrier frequency to an intermediate frequency (IF), then to the in-phase/quadrature-phase (I/Q) stage, and then to the baseband.

More recent architectures eliminate one or more of the IF downconversion stages with a low-IF or zero-IF sampling architecture. These designs use either a single ADC to digitize a high- or low-IF signal or, typically, two ADCs to digitize a complex I/Q baseband signal. The ADC output is fed into a DSP or digital ASIC where the baseband is processed. Sometimes a microprocessor is also used to handle the higher layers of the protocol. For transmission, the processing path and signal chain are reversed, and the signal is sent out to the antenna.

The system can be partitioned in several ways. ZigBee or Maxim's Simplelink radios, for instance, can provide a complete system-on-chip (SoC) solution. In other cases, such as proprietary protocols, a digital ASIC and an RF transceiver are used to build the complete radio link. Maxim has both standard RF transceivers as well as custom ASICs that can be configured as transceivers.

Powerline communications

Overview of modulation schemes

Powerline communications uses AC power lines as the transmission medium. Some systems, such as Maxim's, work over DC and cold wires as well. There are several powerline protocols in the market today. These protocols break down into one of two basic modulation schemes: frequency-shift keying (FSK) and orthogonal frequency-division multiplexing (OFDM).

FSK is an older modulation scheme that has been used by the utility industry in the past for rudimentary purposes, such as infrequent one-way communications from meters to a concentrator. However, FSK suffers from a significant drawback: if an interferer coincides with one of the transmit frequencies, the receiver loses reception. As FSK only switches between two frequencies, bandwidth is not used efficiently, resulting in low data rates. This low data rate is insufficient for smart grid applications that demand bidirectional control.

Real-world PLC rollouts frequently require up to several hundred meters to be connected to a single data concentrator over the medium-voltage (MV) portion of the network. This requires data communication across low-voltage/medium-voltage (LV/MV) transformers. Since these transformers can cause several tens of decibels of (frequency-selective) signal attenuation to FSK signals, more advanced and robust communication methods than FSK are needed.

OFDM has been used in many modern communication systems such as digital radio and TV, Wi-Fi, and WiMAX, as well as early-generation narrowband protocols such as PRIME. Today, OFDM technology is enabling exciting new functions and capabilities for PLC networks. Among the most significant benefits, it gives the utility industry the bandwidth needed to build intelligence into the power grid while meeting aggressive cost targets.

Advancements offered by G3-PLC technology

G3-PLC employs OFDM to optimize bandwidth utilization. Since OFDM uses multiple carriers to transmit data, interference at a specific frequency or frequency-selective attenuation can now effectively be eliminated. In addition to increased reliability, this capability allows considerably more data to be sent.

Additionally, OFDM's spectral efficiency allows the use of advanced channel-coding techniques. In Maxim's powerline solutions, advanced channel coding is used along with OFDM to maximize communication robustness in adverse channel conditions. Two layers of error-correction coding (convolutional and Reed Solomon) are used to ensure reliable data transmission. In addition, data is interleaved in both time and frequency domains across OFDM carriers to decrease the sensitivity to impulse noise and protect against burst errors.

Maxim's next-generation G3-PLC technology includes additional capabilities:

- MAC-level security using an AES-128 cryptographic engine
- Mesh routing protocol to determine the best path between remote network nodes

- Adaptive tone mapping for optimal bandwidth utilization
- A robust mode of operation to improve communication under noisy channel conditions
- Channel estimation to select the optimal modulation scheme between neighboring nodes
- Coexistence with older S-FSK systems

G3-PLC is so robust that transmission across transformers is achievable with an inexpensive coupler. This reduces the number of concentrators needed in smart grid installations, saving system implementation cost and making PLC cost competitive with, or even superior to, wireless advanced meter infrastructure (AMI) systems. Distances up to 6km have been achieved on low- and medium-voltage lines, allowing remote sites to be monitored as well. The complete G3-PLC profile specification, as well as specifications for the PHY and MAC layers, can be downloaded from: www.maxim-ic.com/G3-PLC.

Maxim provides both high-frequency and low-frequency PLC chipsets for smart grid applications. Maxim recommends using narrow-band OFDM to transmit data in a spectrum consistent with world-wide spectral power-density standards for PLC (below ~500kHz in CENELEC®, FCC, and ARIB).

Serial communications

Achieve long cable runs in noisy environments

In harsh and noisy environments, such as multi-unit residential buildings or industrial settings, an RS-485 bus architecture can be used to implement a low-cost, yet robust communications network. The differential nature of RS-485 signaling makes it less susceptible to external interference. Moreover, the RS-485 specification supports multidrop configurations, thus allowing the connection of multiple meters to a single bus.

For instance, RS-485 can be used in an apartment building to transmit data from meters in each apartment to a central unit that aggregates the data from the individual meters, which can then be read through a wireless or PLC link. A similar approach can be used in industrial systems that require multiple cost centers to be metered.

Selecting an RS-485 transceiver

To maintain signal quality over long cable lengths through noisy environments, designers should look for transceivers with the following features.

ESD protection to prevent damage from handling and connection of the transceivers.

Fail-safe circuitry to protect the design from open- and short-circuit conditions.

Slew-rate limiting to reduce radiated emissions and data errors.

Hot-swap capability to eliminate false transitions on the bus during power-up or live insertion of the transceiver.

Isolation to protect against voltage spikes, ground loops, electrical storms, etc.

AutoDirection control to save an optocoupler by eliminating the need for an isolated control channel.

±80V fault protection to eliminate the need for external components such as polyswitch limiters and zener diodes.

Add a point-to-point link with RS-232 transceivers

The RS-232 protocol is intended for short-distance communication between two devices. Meter designers typically use RS-232 for implementing a point-to-point link between a utility meter and a computer, remote display, or modem.

Because the RS-232 port is only used a fraction of the time, it should include automatic shutdown circuitry to conserve power. Additionally, designers should look for devices with extended ESD protection to prevent damage during handling.

Maxim's RS-232 family combines proprietary AutoShutdown™ technology with robust ESD protection, fast data rates, and small footprints—basically, everything that you need in an RS-232 transceiver.

Multiprotocol transceivers provide design flexibility

In cases where the protocols are either not known in advance or where there needs to be flexibility, Maxim's multiprotocol transceivers allow you to use a single board layout to support either RS-232 or RS-485 communication. This saves time because one design can support different market requirements, and each board can simply be programmed to the desired protocol during production.

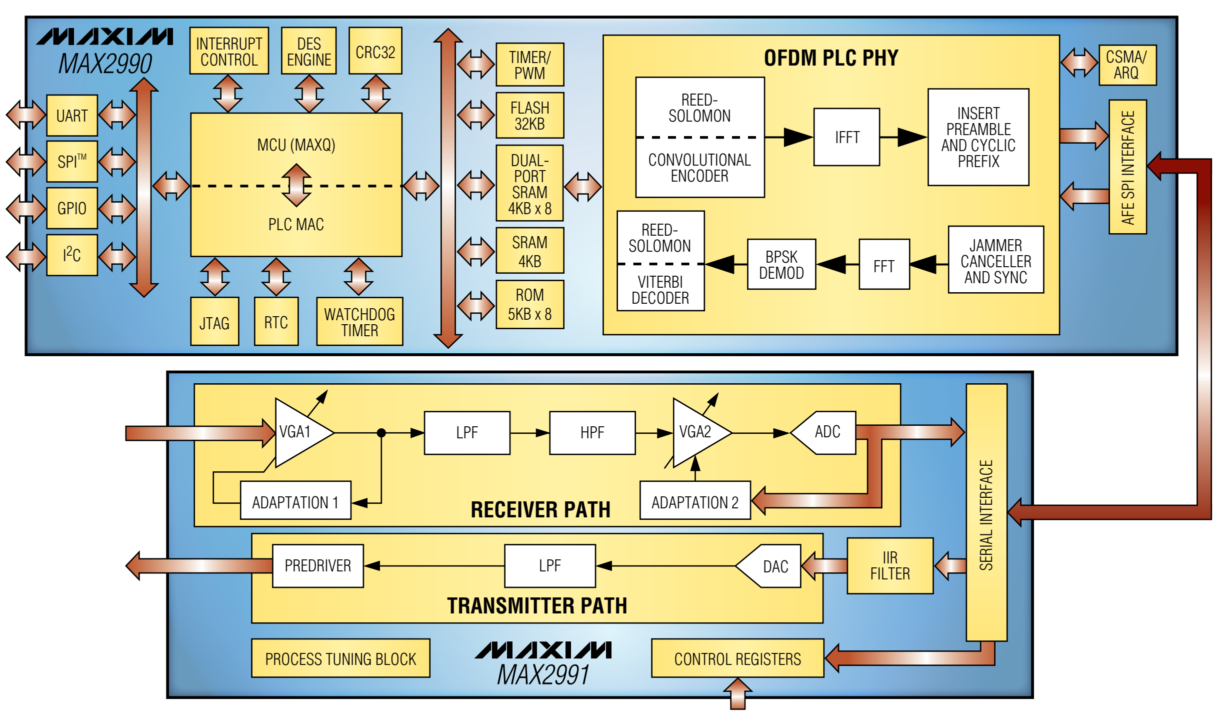
OFDM-based PLC chipset dramatically improves reliability and network data rate

MAX2990/MAX2991 (G3-PLC Lite)

The MAX2990 modem and the MAX2991 analog front-end (AFE) comprise a PLC chipset that achieves reliable long-range data communications. The MAX2990 is a highly integrated SoC that combines the PHY and MAC layers using Maxim's 16-bit MAXQ® microcontroller core. The MAX2991 is a state-of-the-art, stand-alone IC that features two-stage automatic gain control (AGC) with a 62dB dynamic range and on-chip programmable filters. Both devices operate in the CENELEC, FCC, and ARIB frequency bands.

Benefits

- **Robust long-distance transmission**
  - Up to 100kbps data rate at 10kHz to 490kHz; 32kbps at 10kHz to 95kHz
  - Built-in AGC with 62dB dynamic range and DC offset cancellation
  - Includes forward error correction (FEC), CRC16, and CRC32
  - CSMA/CA controls traffic in multinode networks
  - ARQ enhances data transmission reliability
- **High integration lowers BOM cost and speeds design**
  - On-chip band-select filter, VGA, and 10-bit ADC for the Rx path
  - On-chip band-waveform-shaping filter, programmable predriver, and 10-bit DAC for the Tx path
- **Built-in security protocols prevent tampering**
  - Fast DES/3DES engine



Block diagrams of the MAX2990 and MAX2991.

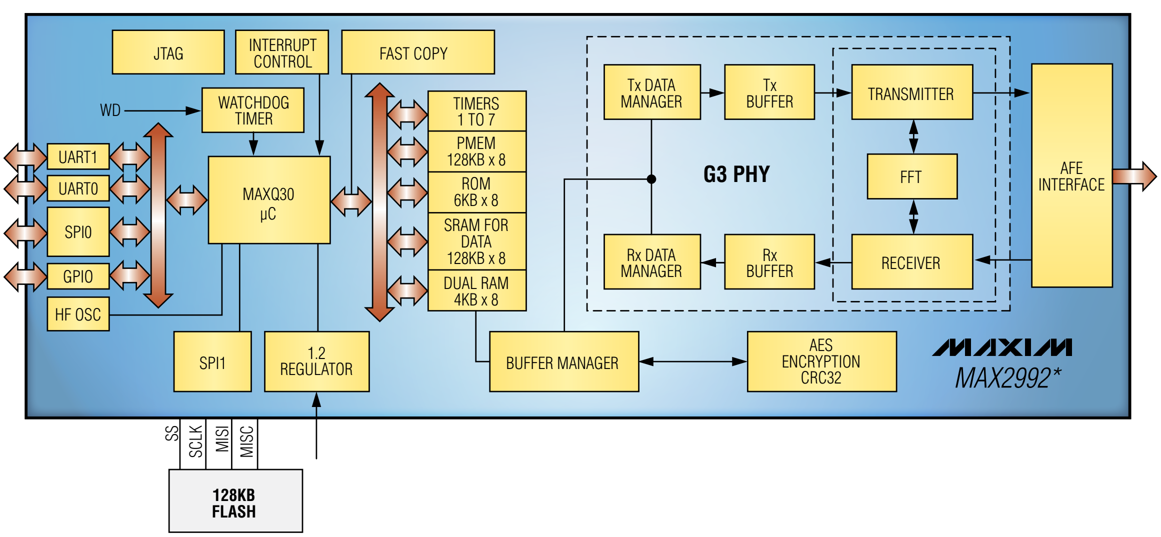
Next-generation OFDM-based PLC modem improves network reliability and coverage over earlier generations

MAX2992* (G3-PLC)

The MAX2992 modem improves long-range data communications by extending network capabilities to transmission over transformers. This highly integrated SoC combines the PHY and MAC layers using Maxim's 32-bit MAXQ microcontroller core. Two forms of FEC are added to further improve communication reliability over earlier generations and add backwards compatibility with older FSK-based PLC technologies. This device operates in the CENELEC, FCC, and ARIB frequency bands. When combined with the MAX2991, a full PLC modem can be realized.

Benefits

- **Reliable long-distance transmission**
  - Up to 225kbps effective data rate at 10kHz to 490kHz; 44kbps effective data rate at 10kHz to 95kHz with a maximum data rate of 298kbps
  - Adaptive tone mapping monitors sub-channel conditions and automatically selects the optimal transmission parameters
  - FEC, CRC16, and CRC32
  - CSMA/CA controls traffic in multinode networks
  - ARQ enhances data transmission reliability
  - Fast AES-128 engine for high data security
- **Reduces system cost**
  - Long-distance (6km) transmission means fewer repeaters
  - Communication across transformers requires fewer data concentrators
  - Backwards compatibility with FSK-based solutions improves interoperability
- **Full IPv6 addressing extends system addressability all the way into the home**
  - Implements 6LoWPAN adaptation layer supporting IPv6



Block diagram of the MAX2992.

*Future product—contact the factory for availability.

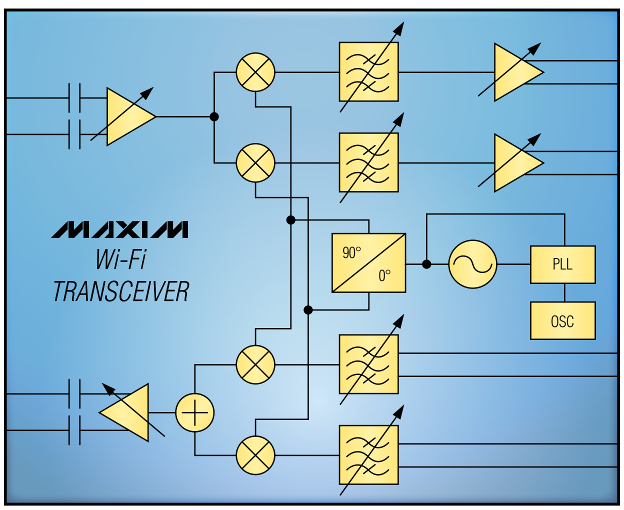
Wi-Fi transceivers enable communication over the longest distances

MAX2830/MAX2831/MAX2832

The MAX2830/MAX2831/MAX2832 Wi-Fi RF transceivers support wireless communication standards in the unlicensed 2.4GHz frequency band. Maxim's line of Wi-Fi products are direct-conversion, zero-IF OFDM transceivers providing best-in-class performance to support the longest distances. Custom frequency bands for nonstandard and multimode applications are also available.

Benefits

- **Transceivers support industry standards for easier, faster design**
  - Support for the IEEE 802.11b/g standards to leverage a large ecosystem of HAN devices
- **Low noise and high sensitivity enable larger networks**
  - Low noise figure (2.6dB) and receive sensitivity (-76dBm) enable the longest range
- **On-chip filters eliminate external SAW filter and reduce BOM count and cost**
  - Integrated PA with +18.5dBm transmit power reduces BOM count and PCB area

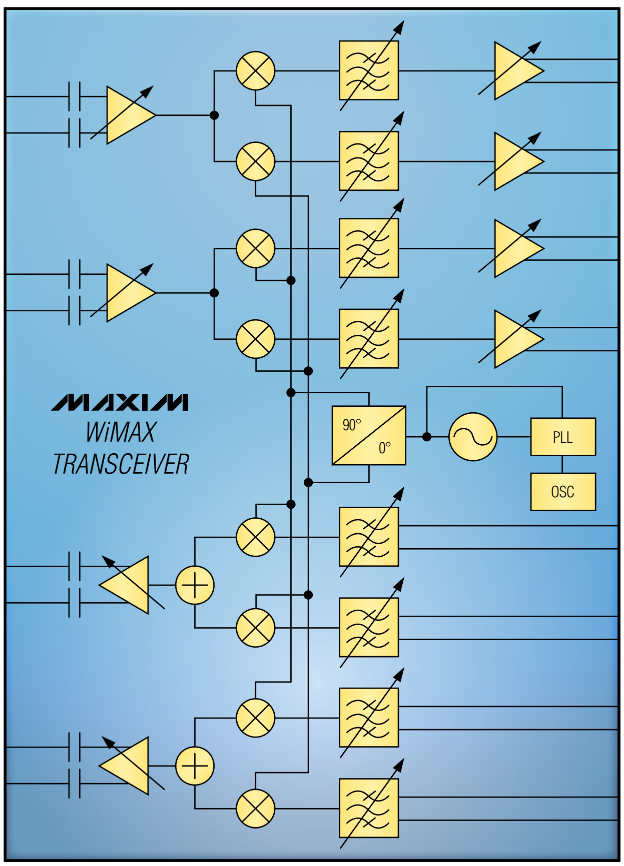


Block diagram of Maxim's Wi-Fi transceivers.

WiMAX transceivers boost range and throughput for faster data access

MAX2839/MAX2842

The MAX2839/MAX2842 WiMAX RF transceivers provide the flexibility to support wireless communication standards in the licensed 2GHz and 3GHz frequency bands. Maxim's WiMAX products are direct-conversion, zero-IF, MIMO OFDM transceivers that use a dual-receiver architecture to maximize data throughput and link range. Custom frequency bands for nonstandard and multimode applications are also available.



Block diagram of Maxim's WiMAX transceivers.

Benefits

- **Best-in-class performance extends link range**
  - Lowest noise figure (2.3dB) provides longest range—18% farther than closest competitor
- **Smallest WiMAX transceiver fits the tightest designs**
  - Tiny 3.6mm x 5.1mm wafer-level package (MAX2839AS)
- **Complete frequency coverage with MIMO support to reach customers worldwide**
  - 2.3GHz to 2.7GHz with 1x2 MIMO support (MAX2839)
  - 3.3GHz to 3.9GHz with 2x2 MIMO support (MAX2842)

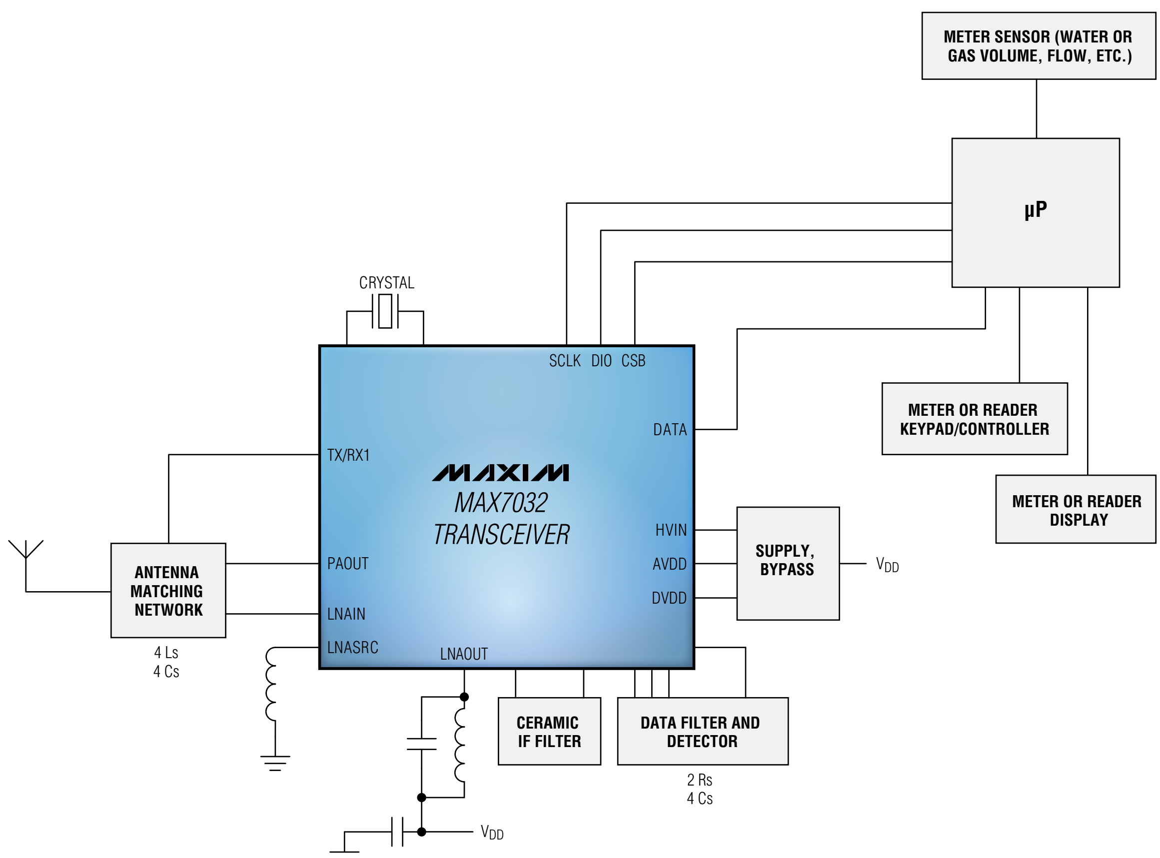
260MHz to 470MHz ISM radio for HANs and NANs extends battery life up to seven years

MAX7032

The MAX7032 transceiver offers an inexpensive, low-power solution for one-way and two-way reporting from meters in HANs and some NANs. The transceiver uses the license-free low-frequency radio bands in the U.S. (260MHz to 470MHz) and Europe (433.05MHz to 434.79MHz). The radio's simple ASK or FSK modulation technique, outstanding sensitivity, wide selection of data rates, and low current drain make it the perfect choice for local radio links and networks in these frequency ranges. The transceiver can achieve link margins better than 120dB, which means that it can reach 1km over open flat terrain or maintain a link between an underground water meter and a local concentrator. The MAX7032 is flexible enough to work with multiple smart grid communication standards.

Benefits

- **Extends battery life**
  - Low active (< 7mA Rx, < 12mA Tx) and shutdown (< 1µA) current extends battery life
  - Programmable receiver shutdown/wake-up cycle for additional current savings
- **Compact radio module for space-constrained metering applications**
  - Small 5mm x 5mm TQFN package
- **Good penetration in buildings**



System diagram for the MAX7032.

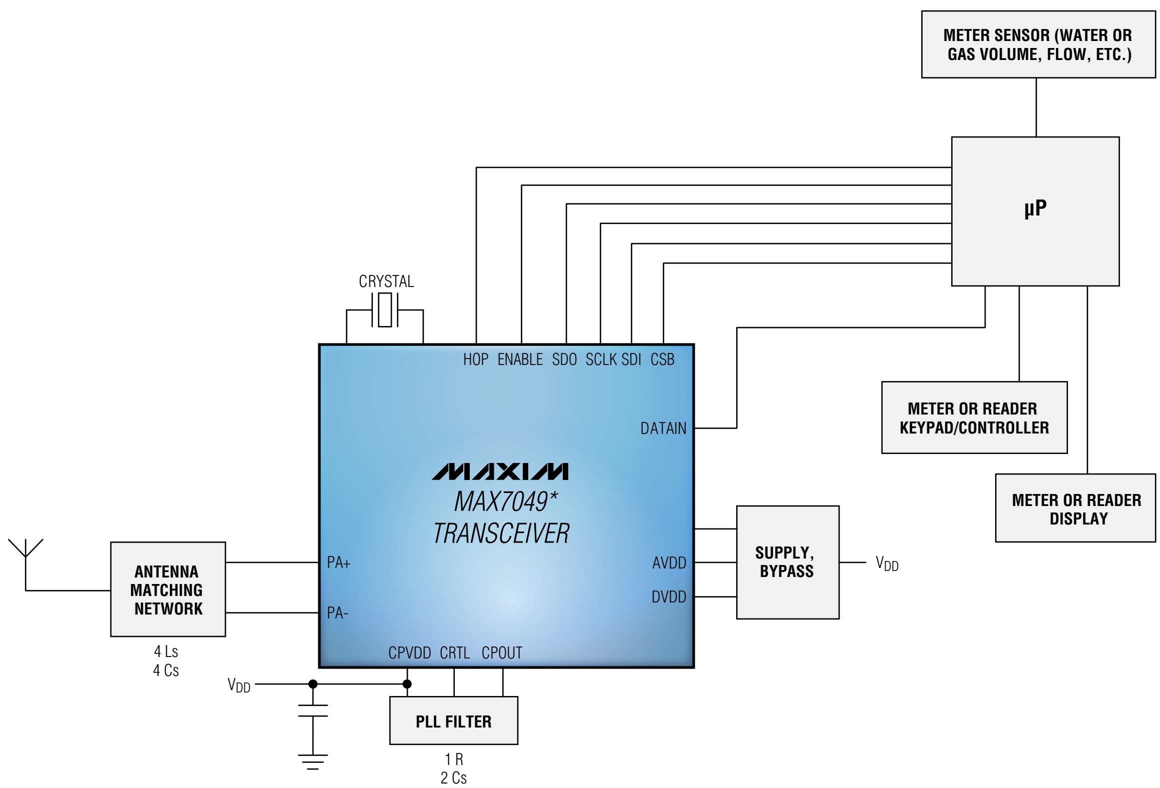
Low-/high-band transmitter for HANs/NANs extends battery life up to seven years

MAX7049*

The MAX7049 ASK/FSK transmitter offers an inexpensive, low-power solution for one-way reporting from meters in HANs and some NANs. The transmitter uses the license-free low- and high-frequency bands in the U.S. and Europe, making it a very flexible solution. The shaped ASK or FSK modulation technique reduces the transmitted frequency bandwidth so that more frequency channels can be used. The wide selection of data rates and low current drain make it well suited for local radio links and networks. This IC is flexible enough to work with multiple smart grid communication standards and is compatible with modes S and T of the European M-Bus standard.

Benefits

- **Extends battery life**
  - Low active (< 35mA) and shutdown (< 0.5µA) current conserves battery life
- **Low BOM cost**
  - Only crystal and matching components are needed
- **Good penetration in buildings**
  - Maximum allowable Tx power (25mW) for European ETSI standard



System diagram for the MAX7049.

*Future product—contact the factory for availability.

RF expertise to deliver custom-tailored solutions for your specific smart grid needs

ASIC Services

Maxim's ASIC services are available to meet your specific application requirements. Maxim offers flexible engagement options from foundry sales through turnkey design to joint-development projects. Our smart grid solutions include:

- **Wireless backhaul; distribution asset management**
  - WiMAX and rebanded WiMAX transceivers
- **AMR; fault diagnostics**
  - FSK, ASK, OFDM, DSSS transceivers
- **AMI**
  - WiFi, ZigBee/802.15.4 transceivers
- **Proprietary solutions**
  - 400MHz to 5GHz RF/wireless transceivers

Benefits

- **Maxim's expertise gives you a high first-silicon success rate**
  - Over 15 years of experience in the ASIC business
  - Rich analog and RF IP catalog speeds your time to market
- **In-house process technologies provide optimal performance-cost tradeoff**

www.maxim-ic.com/ASICs

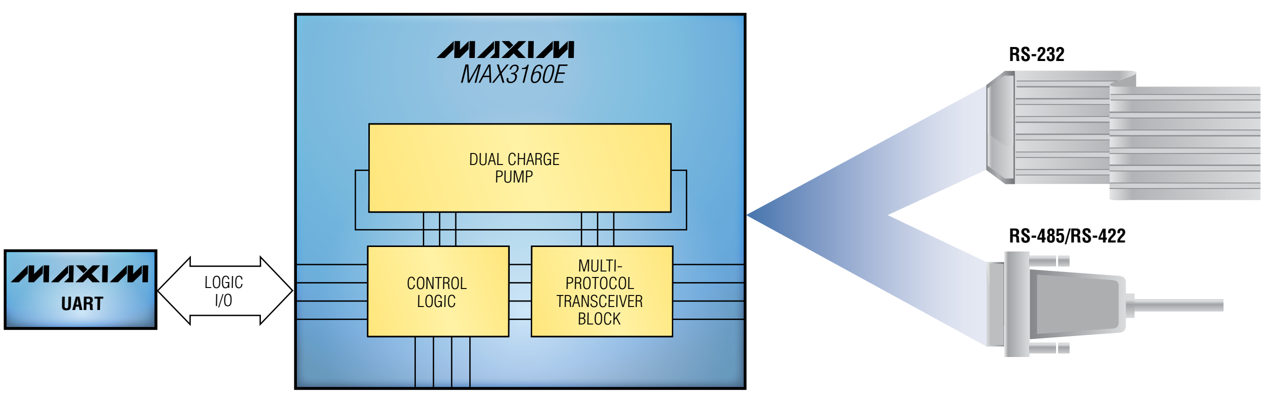
Multiprotocol transceivers enable on-the-fly protocol selection for power-meter communications

MAX3160E/MAX3161E/MAX3162E

The MAX3160E/MAX3161E/MAX3162E are multiprotocol transceivers that allow designers to use a single device to support both RS-232 and RS-485 serial communications in power-meter applications. These devices offer flexibility and convenience through a pin-selectable interface, which makes it easy to program each board to the desired protocol during production. In addition, the transceivers have extra protection against static electricity; true fail-safe circuitry that guarantees a logic-high receiver output when the receiver inputs are open or shorted; a 10nA shutdown mode; short-circuit limiting; and thermal shutdown circuitry to protect against excessive power dissipation.

Benefits

- **Provide adaptability without additional parts or design work**
  - Pin-programmable half- or full-duplex communication
  - Pin-selectable RS-232 or RS-485/RS-422 operation
- **Save board space and cost**
  - Integrated ±15kV ESD protection eliminates external protection circuitry
  - Allow up to 256 transceivers on the bus without requiring an extra serial bus, UART, or microprocessor
- **Reduce power consumption**
  - First 3V multiprotocol solution in the industry
  - 5x lower supply current than the competition—significantly reduces power dissipation



Block diagram of Maxim's multiprotocol transceivers.

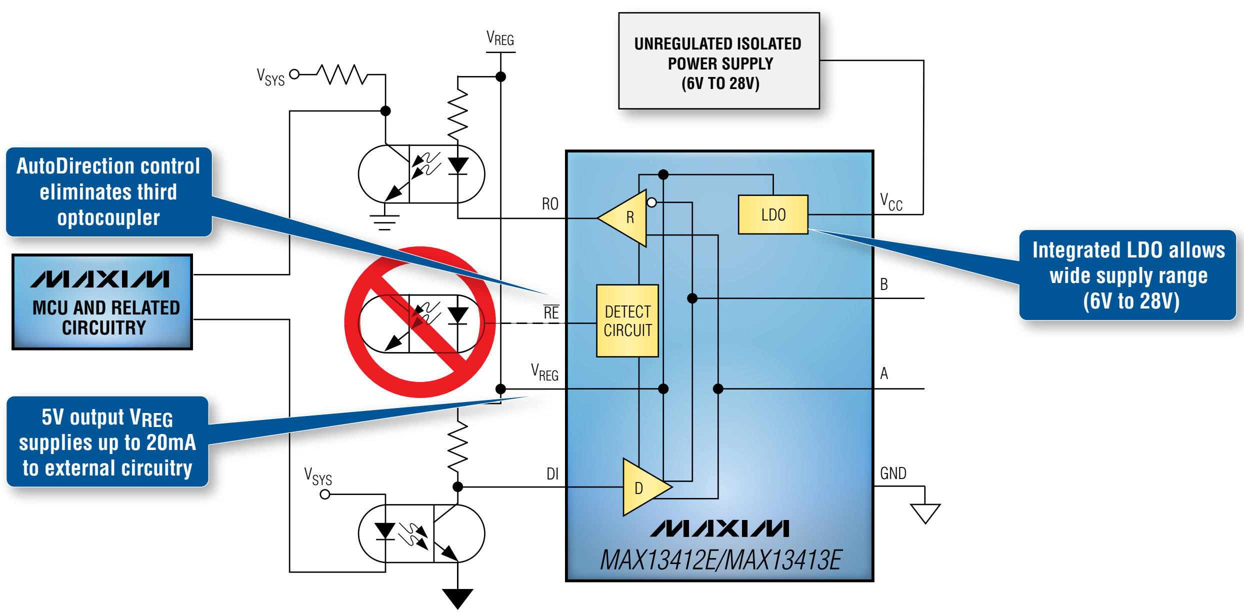
Highly integrated RS-485 transceivers simplify power-meter interface designs

MAX13412E/MAX13413E

The MAX13412E/MAX13413E are half-duplex RS-485/RS-422 transceivers optimized for isolated power meters. These devices reduce design complexity by integrating a low-dropout regulator (LDO) and a sensing circuit for AutoDirection control. The internal LDO allows the devices to operate from a wide, unregulated voltage range (6V to 28V), simplifying power-supply designs. AutoDirection control reduces cost and board space by eliminating an optocoupler in isolated power-meter applications. Other features include enhanced ESD protection, fail-safe circuitry, slew-rate limiting, and full-speed operation.

Benefits

- **AutoDirection control saves cost and board space**
  - Reduces the number of optical isolators needed in isolated applications
- **Built-in LDO offers convenience without the worry of providing a regulated voltage level**
  - Operates from an unregulated 6V to 28V power supply and provides 5V/20mA of power to external circuits
- **Extended ESD level of ±15kV (Human Body Model) eliminates external ESD protection circuitry**
- **1/8-unit load receiver input impedance enables up to 256 peripheral sensors in the system**



System block diagram of the MAX13412E/MAX13413E.

Recommended solutions

Part	Description	Features	Benefits
RF transceivers			
MAX2830/31/32	Direct-conversion, zero-IF RF transceivers for 2.4GHz 802.11g/b	Integrated PA, antenna diversity switch, and crystal oscillator; best-in-class receive sensitivity (-76dBm)	Low-cost, low-BOM implementation for 802.11b/g standards
MAX2839	Direct-conversion, zero-IF RF transceiver for 2.3GHz to 2.7GHz MIMO WiMAX	1x2 MIMO RF transceiver with best-in-class noise figure (2.3dB) and linearity specifications; 8mm x 8mm TQFN package	Best-in-class performance supports longer range; small package enables compact designs
MAX2842	Direct-conversion, zero-IF RF transceiver for 3.3GHz to 3.9GHz MIMO WiMAX	2x2 MIMO RF transceiver with best-in-class noise figure (3.8dB) and linearity specifications	Best-in-class performance supports longer range
MAX7032	300MHz to 450MHz ASK/FSK transceiver with low current drain	Under 7mA active receiver current; SPI programmable; programmable sleep/wake mode	Good in-building range with long battery life
MAX7031	300MHz to 450MHz FSK transceiver with low current drain	Under 7mA active receiver current; hardwired or microprocessor controllable; factory-preset frequencies	Good in-building range with long battery life
MAX7030	300MHz to 450MHz ASK transceiver with low current drain	Under 7mA active receiver current; hardwired or microprocessor controllable; factory-preset frequencies	Good in-building range with long battery life
RF transmitter			
MAX7049*	288MHz to 945MHz ASK/FSK transmitter with low current drain	Up to 25mW Tx power; SPI programmable; less than 500nA shutdown current	Good in-building range (including 800MHz/900MHz) with long battery life
Powerline communications ICs			
MAX2981/82*	Broadband HomePlug 1.0 chipset	Up to 14Mbps data transmission	Robust, high-data-rate transmission with guaranteed latency for industrial environments
MAX2990/91 (G3-PLC Lite)	Narrowband OFDM PLC chipset	Up to 100kbps data transmission or lower-data-rate robust mode for extremely noisy environments; DES/3DES encryption engine	Lower network implementation cost from ability to cross transformers
MAX2991/92* (G3-PLC)	Narrowband OFDM PLC chipset	AES-128 encryption engine; adaptive tone mapping allows coexistence with FSK protocols; 6LoWPAN compression enables IPv6	Lower network implementation cost from ability to cross transformers
Multiprotocol transceivers			
MAX3160E	Programmable 2Tx/2Rx RS-232 or 1Tx/1Rx RS-485/RS-422	Supports RS-232, RS-422, and RS-485; handles up to 128 devices on the bus; 20-pin SSOP	Eases system configuration while saving space
MAX3161E	Programmable 2Tx/2Rx RS-232 or 1Tx/1Rx RS-485/RS-422	Supports RS-232, RS-422, and RS-485; handles up to 256 devices on the bus; 24-pin SSOP	Eases system configuration while saving space
MAX3162E	Dedicated 2Tx/2Rx RS-232 and 1Tx RS-485/RS-422	Supports RS-232, RS-422, and RS-485; handles up to 256 devices on the bus; 28-pin SSOP	Eases system configuration while saving space
UART			
MAX3107	Single-channel SPI/I^{2}C UART	Integrated oscillator; 24Mbps data rate; PLL; shutdown modes	Reduces solution cost and size; offloads µC

(Continued on next page)

*Future product—contact the factory for availability.

Recommended solutions *(continued)*

Part	Description	Features	Benefits
RS-485 transceivers			
MAX13442E	Fault-protected RS-485 transceiver	±80V fault protection; ±15kV ESD protection	Eliminates external circuitry
MAX13485E	RS-485 transceiver with enhanced ESD protection	±15kV ESD protection; fail-safe circuitry; hot-swappable	Saves space and provides robust protection
MAX3535E	Isolated RS-485 transceiver with enhanced ESD protection	Robust ±2.5kV capacitive isolation	Eliminates external optocoupler and power supply
MAX13412E/13E	RS-485 transceivers optimized for isolated applications	AutoDirection circuitry; integrated LDO	Minimize solution size
MAX13430E	RS-485 transceiver for multivoltage systems	Integrated low-voltage logic interface	Interfaces directly to low-voltage FPGAs and ASICs, eliminating level translator
Transformer drivers			
MAX253	1W primary-side transformer H-bridge driver for isolated supplies	Simple solution for producing an isolated power supply up to 1W	Simple open-loop circuit speeds PSU design, allowing faster time to market
MAX256	3W primary-side transformer H-bridge driver for isolated supplies	Simple solution for producing an isolated power supply up to 3W	Simple open-loop circuit speeds PSU design, allowing faster time to market
Power amplifier			
MAX2235	1W autoramping power amplifier for 900MHz applications	+30dBm (1W) typical output power from a 3.6V supply or +28dBm from a 2.7V supply	Maximizes read range; operates directly from a single 2.7V to 5.5V supply, making it suitable for use with 3-cell NiCd or 1-cell Li+ batteries
DC-DC regulator			
MAX15062*	36V, 300mA DC-DC regulator with integrated MOSFET	Low quiescent current; 2mm x 2mm TDFN package	High integration with small footprint saves up to 50% total board area compared to competing solutions
Analog-to-digital converters (ADCs)			
MAX11103/05	12-bit, 3Msps/2Msps SAR ADCs	73dB SNR; SPI interface; high 1.7MHz full linear bandwidth; 1-channel (SOT23) and 2-channel (µMAX®, TDFN) options	Tiny SOT23, µMAX, and TDFN packages save space; serial interface simplifies data transmission
MAX1379/83	12-bit, 1.25Msps, 4-channel, simultaneous-sampling SAR ADCs	0 to 5V, 0 to 10V, or ±10V inputs; 70dB SNR; four single-ended or two differential inputs; SPI interface	Serial interface saves cost and space on digital isolators

For a list of Maxim's recommended smart grid communications solutions, please go to: www.maxim-ic.com/communications.