Wireless Technologies for Smart Meters

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IDEA IN BRIEF

Progress in technology is making possible the replacement of mechanical and electromechanical meters for energy, water, and gas with digital meters showing advanced functionalities. With these new tools in their hands, users are evolving from a purely passive role to a more active one, in which everyone can take control of their consumer habits and define their own strategy to save resources. The key word is "communication". With the new technology, utilities and users can communicate, paving the way for new scenarios of smart usage of primary resources.

Smart Meters

There are several advantages in using smart meters. Utility companies can benefit from the automated data collection, avoiding human errors due to manual readings and, ultimately, reducing labor costs. Also, statistic data collection becomes easier, allowing optimal sizing and utilization of the distribution network. Diagnosis and instantaneous fault detection allow predictive maintenance, resulting in a more efficient and reliable distribution network. Moreover, utilities can offer additional services such as real-time pricing, based on different time slots during the day. Some operations can be postponed in time, when the cost of the service is lower, allowing users to save money and utilities to effectively manage peak demands.

Once connected to the home network, the smart meters can provide useful information on the consumer's habits. It will be possible to know the energy consumption of a washer cycle, the water required to water the garden, the daily gas consumption for heating. Several studies show that simple awareness can produce savings of 20% or more. Given the
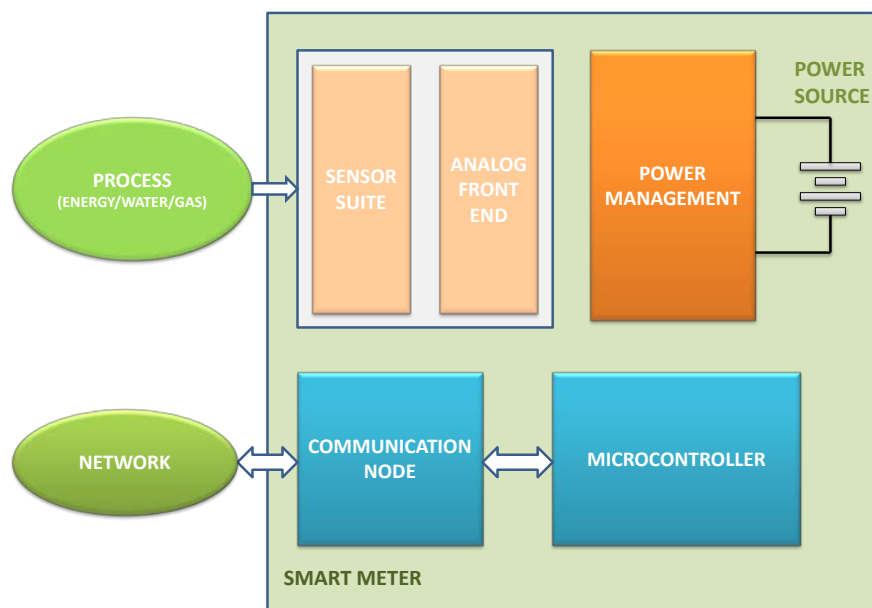

Figure 1. Smart Meter Block Diagram

opportunity to save money by curbing resource use and given the technology to take action to reduce it, consumers will take the action, with savings up to 50%.

Smart meters will allow a reduction of the primary resources on the user side, savings on the losses on the utility side, ultimately helping in the goal to reduce carbon emissions making the Earth a greener place to live.

Smart Meter Structure

The general block diagram of a smart meter is shown in Figure 1. Depending on the application, energy, gas, or water metering, you may have one or more sensors interfaced to front end electronics, an energy source with the associated power management circuitry, a communication node, and a microcontroller for system management.

Several technologies are available when implementing a networked metering system. However, two of them are emerging as dominant: wireless short range (SRD) and power-line communication (PLC). PLC is especially suited for energy metering, being the power-line carrier available for free; for water and gas meters, SRD is becoming the obvious choice due to the lack of a suitable power-line carrier. Also, gas and water meters are battery powered, making power consumption a very critical aspect.

To achieve the best trade-off between power consumption and communication range, meter designers are choosing radios in the sub-GHz bands, like 915 MHz in North America, while in Europe the bands of interest are 868 MHz and 433 MHz, with a growing interest in the 169 MHz band. Also, most meter manufacturers are considering the 2.4 GHz worldwide free frequency band; however, for a given power consumption, radios communicating at these frequencies have a shorter range than sub-GHz radios. Wider range is vital for gas and water meters, which can be placed in hostile environments for RF propagation, like basements and underground pits.

Water Metering—The MultiReader System Developed by Smart Metering

Advances in wireless short range transmission are making possible the monitoring of water distribution networks. Once water use was monitored using mathematical models and sporadic measurement at the input of the distribution network and user connections. Today, with suitable hardware, it is possible to perform synchronized, multiple measurements that allow proper management of the distribution network.

The meter allows AMR (automatic meter reading), which can be used for billing but also to detect losses in the network. Having synchronized and frequent measures on inputs and outputs, utilities can perform a water budget on a monthly, weekly, or even daily basis. In this way, it will be easier to detect losses in the network due to failures or illegal water usage. Utilities can also offer additional services to their customers, like loss detection in the user network by monitoring consumption during nighttime or off-peak hours.

A battery powered wireless network for water monitoring is a difficult task. The meters are requested to work for several years, 10 or even 15 years, with a limited source of energy, in a hostile environment. Electromagnetic interferences due to outband interferers like radio and TV broadcasting, GSM base stations, or inband interferers like remote controls can reduce the receiver sensitivity and in some cases can cause the blocking of the receiver itself. Also, weather conditions and metallic objects like drain pipes or parked cars can compromise antenna performances and radio waves propagation. High humidity levels and thermal cycling can induce mechanical stresses or affect battery performances.

All these factors can affect the overall reliability of the system and impact maintenance costs that must be kept very low.

Given these operating conditions it is clear that the device shall have very high sensitivity, robustness to interferers, and low power consumption. Smart Metering conducted a benchmark between available short range devices and decided to go with the Analog Devices ADF702x family of wireless transceivers demonstrated to be the best on the market in meeting these high demanding requirements.

The MultiReader System

Smart Metering has developed The MultiReader System (Figure 2), based on ADF702x family, to meet the needs of the utilities for water monitoring. It is composed of the water meter MultiReader-C, the repeater MultiReader-R, and the concentrator MultiReader – G.

The MultiReader-C is a battery powered counter that can be connected to up to three pulse emitter devices. The meter can provide real-time water consumption, stored data based on a fixed calendar, and measurements processed applying specific algorithms. All these capabilities allow several services like synchronous measurements on different points, water consumption in a specified time interval, and reporting of other useful information like reflux, counter shut down, and end user losses.

Figure 2. The MultiReader System

Figure 4. MultiReader-R Repeater

The MultiReader-R is a battery powered repeater, typically installed on a pole, and is used to extend the range of the single meters. It is able to communicate with meters, other repeaters, and concentrators.

The MultiReader-G collects the data from meters and is able to communicate with a central office via the GSM network.

Installation and maintenance of a reliable wireless network for water metering requires HW, SW, and system management capabilities, which have been developed by Smart Metering over time.

Figure 3 shows MultiReader-C units installation where each unit is connected to three pulse emitter devices. A repeater installed on a pole can be seen in Figure 4.

Figure 3. Three Inputs MultiReader-C Units

Analog Devices ISM Band Transceiver Technology

Analog Devices SRD transceivers can cover the frequency band from 75 MHz up to 1 GHz. The most popular devices are the ADF7020 medium band (100 kHz to 200 kHz, up to 200 kbps), the ADF7021 narrow-band (9 kHz to 25 kHz, up to 32 kbps), and their derivatives. Flexibility is one of the main characteristics of these devices. Several parameters can be programmed in order to achieve the best trade-off between performance and power consumption. The transceivers allow ASK, FSK, OOK, GFSK, MSK modulation schemes, programmable output power in the range -16 dBm to +13 dBm, and many programming options for the LNA to trade off sensitivity, linearity, and current consumption. The differential LNA input stage, the PA ramp control, and the Gaussian and raised cosine data filtering all help the device work properly in a complex electromagnetic environment.

Of the same family, the ADF7023 embeds an 8-bit communication processor for the packet handling, radio control, and smart wake mode functionality. The communication processor eases the processing burden of the companion processor by integrating the lower layers of a typical communication protocol stack.

RESOURCES

Visit energy.analog.com for more information on ADI energy solutions.

Products Mentioned in This Article

Product	Description
ADF7020	ISM Band Transceiver IC
ADF7021	High Performance Narrow-Band ISM Transceiver IC
ADF7023	High Performance, Low Power, ISM Band FSK/GFSK/OOK/MSK/GMSK Transceiver IC

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