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TODAY'S HOMES SEEM more modern than ever, with knobs and dials replaced by buttons and digital displays. But outside, electricity meters use electromechanical Ferraris technology developed 100 years ago. These meters register the amount of energy consumed in kilowatt-hours (kWh) yet offer little additional information to you or the utility. Behind the scenes, there is a new revolution in residential energy metering. As the technology rapidly falls into place, it won't be long before your utility can provide much more information about your household consumption.

Events like the California energy crisis are forcing utilities to realize that the grid they manage isn't operating as efficiently as necessary under modern demands. Deregulation and energy conservation initiatives are fueling interest in revenue protection, loss analysis, automatic meter reading, multitariff billing, and better customer service. In this environment, the electronic metering solution is inevitable.

Electronic solutions are harder to tamper with and offer superior accuracy with higher functionality than their electromechanical predecessors. According to the *Handbook For Electricity Metering* (Edison Electric Institute, 1992), each 0.1% improvement in metering resolution can make a significant impact on revenues for the utility. The wheel-cranking mechanical meters can't achieve the dynamic range and accuracy of lower-cost electronic meters, which are approaching 10,000:1 current dynamic range with 0.1% accuracy.

Energy-measurement ICs are the core of electronic meters and combine analog-to-digital converter technology with DSP algorithms. They multiply voltage and current signals to accumulate power for kWh billing while filtering unwanted noise. Advanced ICs have antitamper and power quality features. Other components inside these meters include the power supply, regulator, current/voltage sensor, voltage reference, crystal oscillator, nonvolatile memory, microcontroller, real-time clock, and LCD driver and display. As this high-volume application takes shape, innovation will occur at every level inside the new meters.

Current sensors demand innovation with household loads approaching 200 A. This current must be translated into a small voltage signal for the metering IC. The popular low-cost, low-resistance shunt doesn't provide line isolation, and its self-inductance results in noticeable error at low power factor. A current transformer and burden resistor creates the appropriate low-voltage signal and provides line isolation but saturates at high current. Removing the ferrite core sends the high current limit close to infinity.

This "air-core" current sensor, or Rogowski coil, offers the benefits of traditional current transformers without hysteresis and dc saturation problems. The output signal is proportional to the time derivative of the current, and a stable integrator can be implemented inside the metering IC. The drawback is sensitivity of the air-core CT to external electromagnetic interference (EMI). ANSI's metering specification limits EMI sensitivity. Current sensor manufacturers that address this issue could see their solution become the standard inside millions of electronic meters.

The electronic meter component list may expand to encompass the communication technology needed for automatic meter reading (AMR). Despite its growing popularity, AMR adoption is met with some hesitation. AMR technology lacks a defined standard, and each solution is the topic of heated debate. Radio frequency (RF) enables short-range transmission for drive-by meter readings, or it can connect to the phone line or GSM network for transmission to the utility. However, there's an associated cost with the utilities not owning the infrastructure. Power-line carrier (PLC) solves this problem, but some fear that it's not "robust" enough to handle volumes of data.

Developing a new protocol for secure transmission is a daunting task using these media. So DSL, cable, and Ethernet also are being examined as contenders. Once a standard is set, it will be tough for utilities to resist capturing the benefits of AMR. The electronics required for metering will then begin to merge with the communications hardware, and AMR will no longer be an add-on technology. ●