Power Monitoring

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Power monitoring can help to reduce energy demand regardless of whether the energy used is from conventional or alternative sources.

The government legislation which will force utility companies to install smart meters by 2014, will also encourage end-users to take more control over their own energy consumption and costs. For power-hungry applications, such as industrial equipment, heating and boiler controls and street lighting, power monitoring can be a key differentiator, either as a standalone function, or when combined with existing sensors. A temperature sensor can, for example, be upgraded to monitor both temperature and power consumption, simply by incorporating a meter or data logger. As well as being a differentiator for new alternative-energy designs, power monitors can be retro-fitted to products and equipment running on conventional energy sources.

Demand-side Management

Power monitoring allows utility companies to use a range of demand-side management (DSM) techniques which go beyond the conventional approach of restricting or controlling supply through power outages. Techniques such as load shaping, load shedding and peak lopping will enable them to employ complex optimization and control schemes as part of pre-defined supply programs.

These programs also include indirect demand management, using financial incentives and penalties to manipulate the end-users' energy-usage patterns. Peak cutting, for example, encourages users to reduce their peak energy demand: Peak demand dominates overall energy costs, particularly for heavy industry, and even a slight reduction in the peak demand can provide significant cost savings. The price that utility companies and industrial users pay to their energy suppliers is also sensitive to peaks in demand. The cost typically includes a risk premium for exceeding their agreed peak demand. Increasing the accuracy of load prediction, therefore, reduces the risk of exceeding the maximum agreed demand and incurring heavy financial penalties. If load prediction accuracy is +/-3%, the risk premium may be 2%, whereas an accuracy of only +/-5% could result in an 8% risk premium.

All direct and indirect demand-side management programs rely on accurate monitoring. Designers faced with adding power-monitoring functionality to their products, have a number of options ranging from the simple to the sophisticated. The critical design choices rest on cost, of around $24 to $180 per unit, as well as accuracy and accessibility.

Technology choices

For new designs, with a maximum current of less than 1A, the lowest-cost option is to integrate a shunt. This allows the measurement of the voltage drop across the resistance to provide the most basic level of power monitoring. (Shunts are not restricted to AC, they can be used to measure DC as well.) Although low cost, this method is restricted to the measurement of currents with a relatively low load and must be integrated into the circuit at the design stage. Power loss and overheating issues must also be carefully considered.

The second option for low-current applications is a Hall Effect sensor. This has the advantage that it does not need to be designed into the open circuit, and can be used to measure both AC and DC supplies. However, it has the significant drawback that it is not a passive device and requires an external power supply to operate.

Another option is to use a current-sense transformer or a Rogowski coil. Both are capable of handling AC currents of up to 5000A and neither requires a dedicated power supply. They provide an isolated connection to power cables, either by being integrated during assembly, or retro-fitted where installed equipment cannot be removed or turned off, or where access or space is restricted. New designs would typically use a solid-core version, whereas the snap-on mounting of the split-core transformers , and the flexibility of Rogowski coils, work well in retro-fit applications.

Accuracy and output

Most current-sense transformers provide a straight output of between 1A and 5A, however, by integrating a burden resistor Magnelab current-sense transformers achieve a fixed, low-voltage output of 0.333V. This not only reduces the energy consumed by the monitoring equipment itself, but also eliminates potential safety issues associated with working with a 5A circuit. Factory-setting of the transformer’s output to a constant and accurate 0.333V, also eliminates the need to trim the transformer during the assembly stage.

The choice of whether to use a solid or split-core current transformer, or a Rogowski coil, may also depend on accuracy, as well as whether the application is a new design, or a retrofit upgrade. The commonly accepted benchmark for accuracy is ±1%, although variations in the phase angle also play a part in the accuracy of the measurements. Magnelab snap-on split-core current-sense transformers, for example, feature less than 2 degree phase angle, whereas the solid-core versions achieve 0.5-1 degree and their Rogowski coils less than 0.5 of a degree. This is reflected in the cost, with solid and split-core sensors priced at around $50-80, and Rogowski coils costing upwards of $150.

Beyond smart metering

Smart meters are just the tip of the power-monitoring iceberg. Demand for power monitors is already growing, with consumers, industrial users, businesses and local government all focussing on cutting costs and carbon emissions by taking control of their energy usage.

Technology	**Phase Angle**	**Cost**	**MAX Current**
Shunt	<1 degree	$24-180	<1A AC
Split-core current-sense transformer	2 degrees	$50-80	<3000A AC
Solid-core current-sense transformer	0.5 - 1 degree	$50-80	<600A AC
Hall Effect Transformers	1 degree	$100	<1A AC/DC
Rogowski coils	<0.5 degree	$150-180	<5000A AC