Power Monitoring for Modern Data Centers

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By their nature, mission critical facilities such as Internet data centers are prime candidates for power monitoring systems. By employing monitoring systems to analyze system-wide historical and real-time power data, facility managers can reduce the cost of electricity and improve its quality and reliability.

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The Evolution of Power Monitoring Systems

Modern power monitoring systems look nothing like the basic electricity meters from which they evolved. Today's systems comprise sophisticated metering devices, communication networks and software (Figure 1).

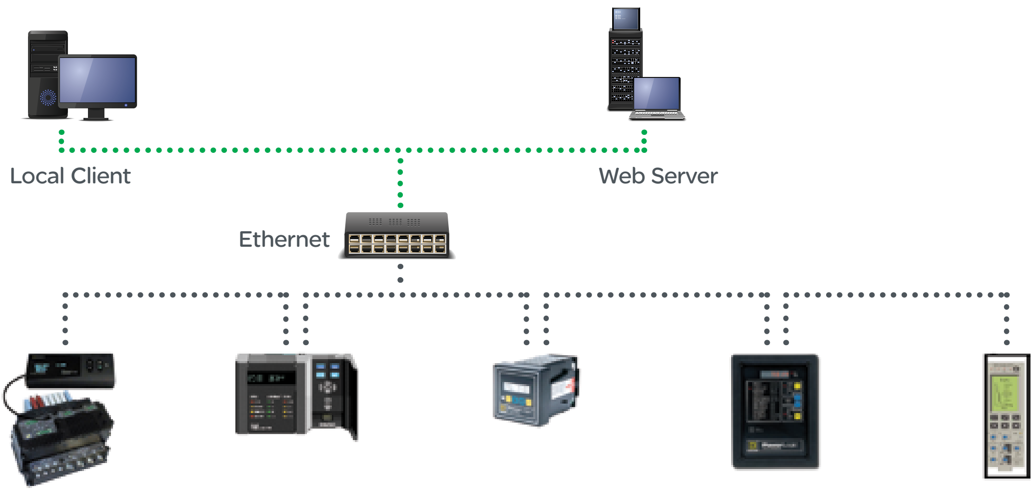

Figure 1: Basic Architecture of Data Center Power Monitoring

As microprocessor technologies become cheaper and more reliable, manufacturers have been embedding power monitoring functionality and communications technology into panelboards, transformers and circuit breakers. This "smart" equipment can obtain and communicate information about the state of their health as well as the health of the entire power system. Circuit breakers can communicate their status, the time of the last trip and the magnitude of the fault current. Transformers can communicate their winding temperatures.

One might think that these advanced, intelligent devices will eliminate the need for separate power monitoring and control equipment. Or, that trip units and circuit monitors are interchangeable. However, the reality is that trip units and circuit monitors compliment each other and fill different roles in the power distribution system. In fact, microprocessor technologies have given us a host of new power monitor features, such as the ability to re-construct sequence of events to determine the true cause of power system anomalies.

Instrument Classes and Functions

Before the microprocessor revolution, power system engineers recognized three, well defined classes of instruments:

- Digital Fault Recorders were used to obtain oscillograms of fault currents and voltages to evaluate the effect of voltage sags and to construct sequence of events.
- Transient Recorders and Oscilloscopes captured oscillatory and impulsive voltage transients.
- Power Monitors were used primarily to report steady state currents and voltages and to provide basic energy and power calculations.

Each class of equipment was very different, designed and optimized around a specific application. But with microprocessor-based technologies, the three classes are slowly merging. The power monitor is becoming a universal measurement and recording instrument. Figure 2 illustrates the basic building blocks of a power monitor. The analog to digital converter provides a stream of digitized data. The digital signal processor and microprocessor are at the heart of the computations. All these components have been subject to continuous and unprecedented advancement within the past few years.

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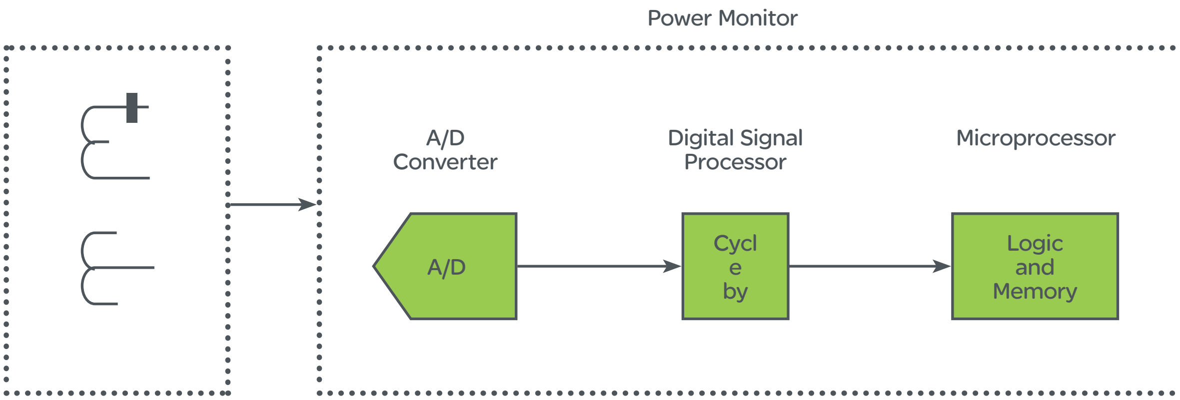

Figure 2: Power Monitor Building Blocks

Power monitors now do much of what digital fault recorders and transient recorders did. In the near future, it is likely that power monitors will take over most of the functionality of these devices.

For voltage transient measurement, selection of the sensing devices is very important. In order to obtain an accurate recording of a transient event, sensors are required that can provide accurate replica of voltages at very high frequencies.

At low voltages (below 600V) voltage transients can be captured with good accuracy by connecting the instrument directly to the voltage source. This requires that the power monitor be rated for the full system voltage.

Circuit Breaker Trip Unit as a Power Monitoring Device

Modern circuit breaker trip units employ microprocessor and communication technologies as well, and many have power monitoring capability. The main difference between circuit breaker trip units and power monitors is in the method of sensing currents.

In circuit breaker trip units, the protection and monitoring functions are kept separate, but the current sensors are common. While trip units are optimized for protection, the sensors are designed to provide a reasonable level of accuracy for currents that are several times the normal current of the circuit breaker. Therefore, for normal currents, we cannot expect revenue accuracy metering from trip units.

In contrast, power monitors are optimized for metering accuracy and perfect duplication of waveforms, and thus provide revenue level accuracy at currents close to the normal current of the system.

Another key difference is that trip units are optimized for collecting information about the circuit breaker itself. Power monitors are designed to collect information about the connected circuit. For example, if you are interested in power flow in a feeder at the 2% accuracy level, circuit breaker trip units are ideal. There are many applications where 2% accuracy is more than sufficient. But, if you need to perform an IEEE-519 harmonic analysis on the power system, power monitors are the right choice. They provide high accuracy individual harmonic data and perform many of the necessary computations automatically.

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Deploying Power Monitors

Where high accuracy metering, disturbance recording, transient detection or harmonic analysis is needed, there is no substitute for power monitors. So if you're going to deploy power monitors in a data center, there are several key guidelines to keep in mind:

1.) Use full function power monitors on all medium voltage mains and feeders. The full function monitor must include disturbance recording and transient detection capability.

2.) Provide a full function power monitor on the main device of each low voltage switchboard.

3.) Specify low voltage feeder circuit breakers with metering features. For most applications at the feeder level, circuit breaker trip units provide sufficient accuracy.

4.) Deploy power monitors at low voltage feeder level where there is a need for:

- High accuracy – revenue level – metering
- Transient detection and disturbance recording
- High level data analysis such as IEEE-519 harmonic analysis

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