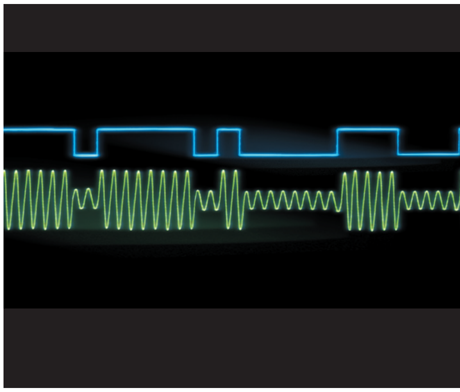
Symmetricom®

The Role of Time and Frequency Systems in the Power Industry



APPLICATION NOTE

2003 Power Outage

The massive 2003 power outage that left over 50 million people in the dark did indeed shed light on one critical issue facing power companies — the role of synchronized timekeeping.

During nine seconds on the afternoon of August 14^{th} thousands of events occurred across 34,000 miles of high-voltage transmission lines, the ultimate result of which was to shut off power in eight states and Ontario. According to *EC&M*, a power industry journal, "the first breakdown occurred at 3:06 p.m., when a 345 KV transmission line west of Cleveland shut down .... Not too long after ... a second 345-KV line in the same area, probably one helping to carry the load from the first failed line, sagged into a tree [and also] shut down. Over the next hour, systems throughout the eastern US and Canada began to see huge swings in voltage and direction of power flow, more lines went down, and power plants began to shut themselves off."

How could a single shutdown near Cleveland cascade to thousands of shutdowns across thousands of square miles? Defining the timeline of exactly what happened and when is necessary to prevent future cascades from occurring. That requires clocks synchronized to UTC (universal coordinated time, the world standard). If the clocks connected to grid switches, voltage monitors and other equipment are out of synch by more than a millisecond then the reason for these damaging cascades may be impossible to determine.

Timelining the causes and effects of shutdowns is critical to the industry and its customers. Less than a month before the August 14^{th} outage, the Economic Policy Research Institute, reported that U.S. economic losses due to unreliable electric power were 1% of GDP, or $100 billion per year.

Besides *tracing* outages, power companies also need synchronized timekeeping to *prevent* outages. In today's deregulated market, power companies buy and sell electricity to each other thousands of times each day — and schedule delivery across a network of interconnected grids comprised of 6,000 power stations and 3,000 utilities. But because electricity cannot be stored, supply and demand must always be kept in balance everywhere. All the energy and only the energy needed for each customer must be provided in real time. It's a job akin to an FAA flight controller. System operators viewing computer screens in windowless rooms switch power to circuits on or off at the correct instant. They must also monitor circuits to maintain a consistent 60 cycles-per-second frequency. If the frequency drifts higher or lower, it can indicate an under- or over-voltage condition — and it can damage plant generators.

Timelining events, scheduling power flows, and monitoring line frequencies — these are all applications that demand time synchronized to UTC. Another application is power line fault detection. Very much like radar, this is done by sending signals down a transmission line and waiting for an echo to return from a fault. The time it takes for the echo to be received must be precisely measured in order to determine exactly where the fault exists. Once again, precise timekeeping is required.

The Power Industry Responds

Increasingly, power companies and system operators are responding to these timekeeping requirements. They are installing time and frequency systems throughout their infrastructures that meet six criteria:

- The timing system is accurate to within one millisecond. One millisecond is chosen because this is the resolution of the modern Sequence of Events Recorders.
- The timing system is absolute rather than relative. This means that the time standard is related to a UTC source such as those maintained by the National Institute of Standards and Technology (NIST) and the U.S. Naval Observatory (USNO).
- The system can be operated unattended. After installation, workers are not required to recalibrate the clock (in fact, they never need to calibrate the clock in the first place).
- The system is reliable. The most accurate system does little good if it is not working, especially during a disturbance.
- The system uses standard hardware for easier and less costly implementation and management.
- The cost per installation is reasonable.

The Symmetricom XL family of GPS time receivers satisfies all six criteria. The outputs (IRIG Code standard) can be used to synchronize local station clocks or time code generators and provide either the reference time code for network transmission or for local time code generation. These outputs are *all* standard on any Symmetricom Synchronized Clock and they are *all* traceable to UTC (GPS) to ±1 millisecond.

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