Synchrophasor Fact Sheet

Synchrophasors and SEL

For more than 25 years, Schweitzer Engineering Laboratories, Inc. (SEL) has delivered reliable, high-quality solutions that lead the electric power industry in price, features, innovation, and service. Furthermore, we have developed synchrophasor solutions and deployed them in utility systems for nearly a decade.

The following document highlights a few of our synchrophasor solutions and system designs. In addition to these historical examples, our synchrophasor team continues to develop new products and help utilities, regional transmission operators (RTOs), independent transmission operators (ITOs), and industrial customers build practical systems that solve real problems.

SEL Provides Industry-Leading Relays and Meters With PMU Functionality

In 2002, SEL introduced the SEL-421 Protection, Automation, and Control System, the first protective relay with phasor measurement unit (PMU) functionality [1]. Since that time, we have offered PMU functionality standard, free of charge. We do this to accelerate the application of synchrophasors for safer, more reliable, and more economical electric power. Other PMU solutions include adding PMU capability to the SEL-734 Advanced Metering System (2003), retrofitting into existing utility relay installations with the SEL-351 Protection System and SEL-311 Distance Relay (2006), adding to the SEL-487E Transformer Protection Relay (2009), adding to motor relays (2010), and releasing standalone PMUs (2009). Additionally, we created the only PMU available today that receives synchrophasors and combines them with a relay-internal phasor data concentrator (PDC) so synchrophasors with relay logic can be used for real-time control applications (2007). This real-time control functionality is now standard in the SEL-421, SEL-451 Protection, Automation, and Control System, SEL-487E, and SEL-487V Capacitor Protection and Control System.

SEL and Phasor Data Concentrators – Five Years and Going Strong

SEL synchrophasor solutions extend beyond the PMU. In 2005, we released a software PDC called SEL-5077 SYNCHROWAVE® Server Software, and in 2006, we released the SEL-3306 Sychrophasor Processor hardware PDC. The SEL-3378 Synchrophasor Vector Processor (SVP) went into production in 2008. The SVP combines PDC functionality with programmable logic controller (PLC) capabilities that allow the user to write customer-synchronized control schemes and power system algorithms, such as modal analysis and distributed state calculation. The result enables real-time, wide-area distributed control based on time-synchronized phasors. In 2007, we included synchrophasor data with Modbus® TCP (Transmission Control Protocol). In 2009, we further combined PDC functionality with protocols such as DNP3 and Modbus in the SEL-3530 Real-Time Automation Controller (RTAC) to bring synchrophasors to the supervisory control and data acquisition (SCADA) world.

Archiving, Analysis, and Visualization Solutions From SEL

In addition to measurement and control, it is important for operators to see and understand the power system in real time. In 2005, SEL launched a visualization application called SEL-5078 SYNCHROWAVE® Console Software. We have added enhancements since the original release, such as synchroscope capability. SYNCHROWAVE Console displays high-speed, oscilloscope-style synchrophasors. It is small enough to run on a laptop computer. This software was followed by SEL-5076 SYNCHROWAVE® Archiver Software in 2008, which is a distributed archiving software.

Synchrophasor System Implementations by SEL in Partnership With Utilities

The experience of the SEL synchrophasor team extends beyond providing products to electric power customers. Our team has participated in many synchrophasor system implementations.

In 2004, we created a North American synchrophasor data acquisition and display system [2]. We placed SEL PMUs in Pullman, Washington; Boerne, Texas; Philadelphia, Pennsylvania; Monterrey, Mexico; Belleville, Illinois; and Tampa, Florida. The result was a pioneering network of wide-area synchrophasor data visualized in central and distributed locations.

In 2005, SEL worked with Salt River Project (SRP) on a system using time-synchronized phasors to start generation units and synchronize them without using any grid power for auxiliary functions [3]. The project used SEL relays, clocks, PDCs, and SYNCHROWAVE Software.

In 2006, the first utility system integrity protection scheme (SIPS) using synchrophasors for wide-area control was designed and tested by SEL in cooperation with Comisión Federal de Electricidad (CFE) [4]. The new system shed generation based on time-synchronized angle difference measurements across a critical 400 kV transmission network. The system used SEL clocks and PMU relays.

Also in 2006, SEL worked with Long Island Power Authority (LIPA) on a system to collect synchrophasor data in the New York area to improve power system reliability by better understanding voltage stability [5]. The system used SEL clocks, relays, and PDCs.

In 2007, SEL and Southern California Edison (SCE) implemented the first application in which synchronized phasor measurements are used in a closed-loop dynamic control scheme [6]. The project successfully maintains voltage stability through the use of the static var compensator (SVC) without creating an overvoltage condition at the generation station.

In 2008, SEL and New Zealand engineers applied SEL synchrophasor solutions to test system response after a major generation capacity loss [7]. Synchrophasor data were archived while removing 120 MW of generation. The frequency response of the generators was time-aligned and plotted to help the engineers understand the governor response to this contingency.

Also in 2008, American Electric Power (AEP) built a distributed synchrophasor archiving system with synchrophasor measurements and SEL products [8]. Synchrophasor data are collected by SEL relays with PMU capability, concentrated with PDCs, and then recorded with SYNCHROWAVE Archiver.

In 2009, SEL and PV Powered, a solar inverter manufacturer, engineered a system using synchrophasor measurements to control islanding of distributed solar generation systems [9]. In May 2010, this application was successfully demonstrated with Portland General Electric. The system uses SEL clocks, PMU relays, archiving software, and the SVP. The SVP is a PDC that also includes power system analysis algorithms and real-time control capability.

SEL designed an anti-islanding distributed generation control solution with Florida Power and Light in 2009 [10]. Time-synchronized measurements are applied to calculate slip frequency and acceleration between two systems. SEL PMU relays and the SVP provide the real-time measurement and control capability for this solution.

SEL has helped engineer many other real-world synchrophasor systems. These include system protection with a combination of IEEE C37.118 and IEC 61850 [11], SCADA verification and backup, and communications channel analysis with synchrophasors, which improves state estimation, wide-area disturbance recording, substation voltage measurement refinement, and signal phasing verification [7].

The Future of Synchrophasors at SEL

All of these examples demonstrate the SEL commitment to applying synchrophasor systems worldwide. SEL fundamentally believes that synchrophasors will play an important role in improving the control and stability of power systems. Furthermore, the examples represent many years of synchrophasor experience within the SEL organization.

We have a group dedicated to further extend the usefulness of synchrophasor products. This group is responsible for research, development, and customer support. We support these products directly from Pullman and in coordination with engineering offices throughout the world. Outstanding customer support is a high priority for the synchrophasor team.

All of the products listed in this fact sheet have been installed in utility applications worldwide. Customer feedback and our commitment to innovation are leading us towards many new products and product improvements.

New products are in development. We are presently finalizing the SEL-3373 Station PDC and SEL-5073 SYNCHROWAVE® PDC System Software. We are also in the process of improving the SVP and our wide-area situational awareness visualization solution. For more details, see the substation PDC white paper, “Expand Synchrophasor Capabilities With the Substation Phasor Data Concentrator,” available at www.selinc.com.

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Contact Information

If you have questions or comments, please contact us at:

Schweitzer Engineering Laboratories, Inc.
2350 NE Hopkins Court
Pullman, WA 99163 USA
Tel: +1.509.332.1890
Fax: +1.509.332.7990
Email: info@selinc.com