

Visualize Your Power System With Synchrophasors

Greg Zweigle

INTRODUCTION

Time-synchronized phasors enable a new perspective into the power grid. They provide a direct view of the power system state and a means to display this information to the power system operators. You can observe quantities such as phase, magnitude, frequency, and power at a high resolution. This gives immediate feedback on what is happening in the system.

PROBLEM

SCADA (supervisory control and data acquisition) systems have served the electric power industry for over forty years. However, they include several limitations. For example, the data are slowly scanned across many devices. The scan not only limits the overall acquisition rate but also skews the implied acquisition time stamp of the data. This blurs the information. Also, the acquisition method means that data are not uniformly sampled. This presents an issue during subsequent postprocessing using standard digital signal processing algorithms. Finally, the data lack angle measurements.

The result of these limitations is that the details of power system dynamics are not observable. Situational awareness is reduced because operators cannot see the precise real-time response of the system to various events. Also, without angle measurements, the state estimation approach becomes nonlinear, which lowers its reliability and increases its computation time.

SEL SOLUTION

SEL SYNCHROWAVE® is a set of software applications that include data concentration, archiving, and visualization. The SEL-5078 SYNCHROWAVE Console Software provides streaming plots and charts based on real-time synchrophasor data. Use SYNCHROWAVE Console to display the line angle across a critical section of the transmission system or to plot frequency at sample rates up to 60 per second. This enables seeing details of oscillations in the power system frequency. A standard synchroscope function provides the ability to use synchrophasors for observing phase angle differences. Another idea is to check your state estimator results against the streaming, real-time phase angles that are displayed in SYNCHROWAVE Console.

Data are received by SYNCHROWAVE Console via the IEEE C37.118-2005 protocol. The data include phasors, digitals, and sampled analogs. The phasors are represented as either a magnitude/angle pair or real/imaginary pair. SEL relays, such as SEL-400 or SEL-300 series relays, provide the phasor, digital, and analog measurements. These devices enable sending nearly any relay-derived quantity. Therefore, in addition to time-synchronized phasors, breaker status, power flows, and many other quantities can be received and displayed using SYNCHROWAVE Console.

Figure 1 shows an example SYNCHROWAVE Console display.

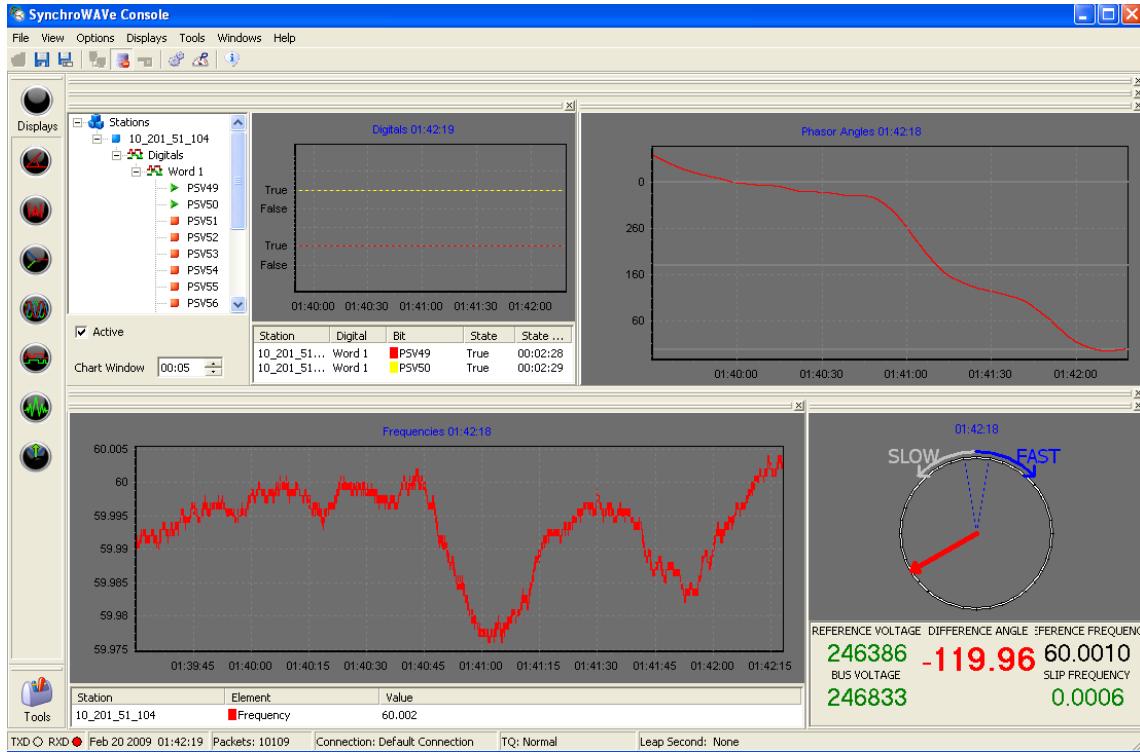


Figure 1 Example SYNCHROWAVE Console Display

SYNCHROWAVE Console provides a flexible method of organizing real-time synchrophasor data for display. In the upper left quadrant of Figure 1, a display of digital information was selected for viewing. The upper right shows a phase angle plot. The lower left portion of the screen is the line frequency. The lower right is a synchroscope based on time-synchronized phasors. Many other plots are also available, such as magnitudes, sampled analogs, and status.