Acacia
Power Solutions

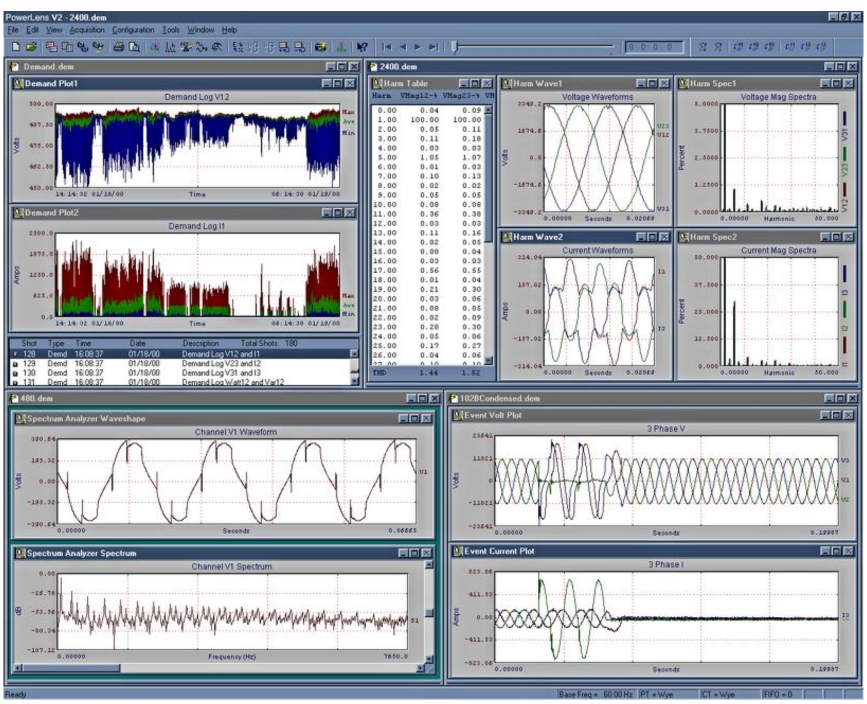
PowerLens

Designed with Purpose

PowerLens was developed by power system engineers for the purpose of analyzing, commissioning, and troubleshooting power systems. By providing unmatched graphical, numeric, and analysis displays, this measurement tool fills a void in the industry. Not only does PowerLens provide real-time power quality and three-phase power measurements, but its recording capabilities allow you to capture, analyze, and play back data at any time.

Measurement Tools

Cycle-By-Cycle
Detailed Harmonics
Event Demand Capture
Phasor Diagram
Spectrum Analyzer
Flicker
Machine Measurements
IEEE 519 Harmonics



"A thoughtful set of power measurement and analysis tools built with a purposeful flow."

Measurement Tools

Phasor Diagram

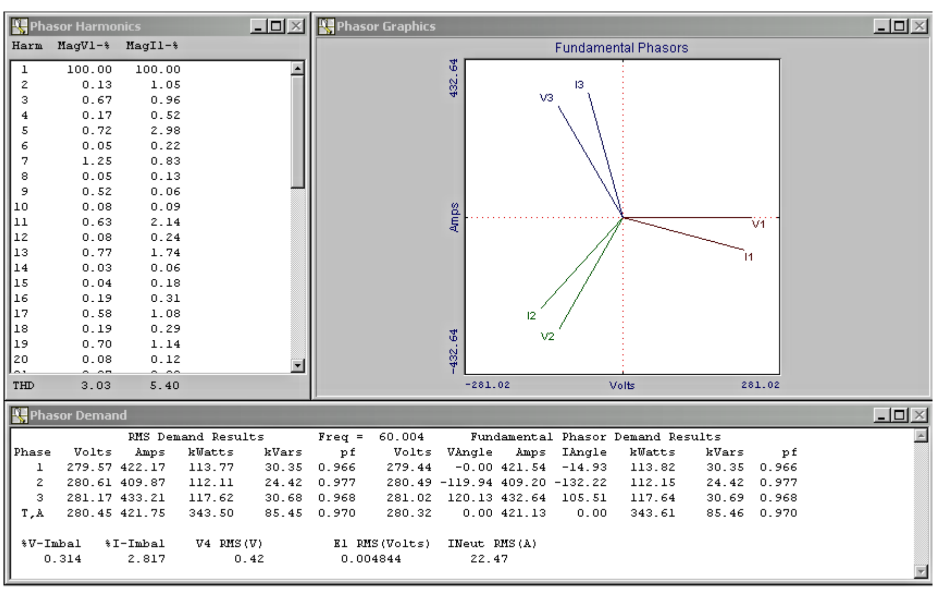
An all-in-one presentation of three-phase power vital signs.

The Phasor Diagram tool provides the best way to quickly diagnose first-tier power problems in any electrical system. Connect the hardware and watch as windows update in real-time and actively plot the changes in voltage, current, power, and harmonic distortion. Graphical updates occur at 10 times per second with a base frequency of 60 Hz.

The phasor diagram plot itself is a power engineer's window into the overall balance and stability of the electrical equipment being measured. It gives you real-time feedback so you can visualize changes in voltage and current over time. And while this is happening, you can also correlate harmonic content and electrical power variations.

Calculated quantities include:

- Fundamental voltage magnitude and angle (three phases)
- Fundamental current magnitude and angle (three phases)
- RMS voltage and current (three phases)
- Voltage and current imbalance
- RMS neutral voltage and current magnitude
- Watts (three phases plus total)
- Vars (three phases plus total)
- Frequency
- Power factor
- Voltage and current spectral content and total harmonic distortion

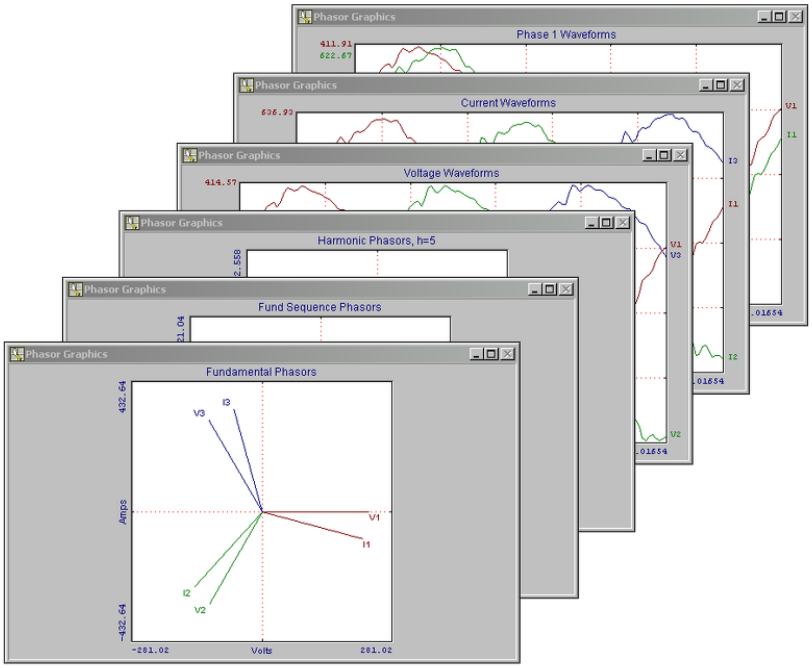


Phasor Diagram Screen

The phasor diagram on the left presents all key vital signs of your electrical power system in one presentation: vector diagram, harmonic distortion, and calculated power.

In this example we see a typical three-phase wye-grounded 480 V system. The vectors show a positive sequence rotation where current is lagging voltage by roughly 15 degrees. This produces a power factor of 0.97 while serving 343 kW. Voltage distortion is acceptable at 3.03 %.

"See the pulse of your power system."



Display Options

The phasor diagram screen can optionally show waveforms and other vectors in the graphical display:

- Voltage and current fundamental phase vectors
- Voltage and current sequence vectors
- Any single harmonic voltage and current phase vectors
- Voltage and current waveforms
- Neutral voltage and current waveforms

Similarly, the harmonics table also has several display options.

Cycle-by-Cycle

The quintessential presentation of a power system's dynamic response.

This feature demodulates voltage and current waveforms into the common RMS quantities most power engineers are familiar with. However, the data is captured every cycle continuously and can be collected uninterrupted for extreme durations - from days to weeks. All cycles include digitally calculated frequency, thus eliminating response time and limited frequency range in a hardware phase-locked loop. This allows for precise calculation of RMS quantities using PowerLen's proprietary Digital Phase Locking (DPL) algorithm.

Optionally, fundamental phasor magnitudes or average DC values can be captured instead of RMS.

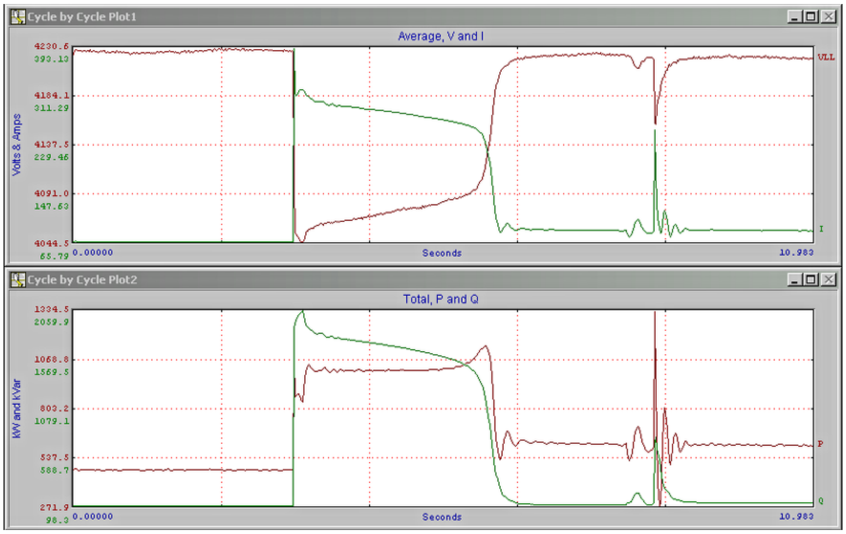
DPL Algorithm

The PowerLens software includes a proprietary and industry exclusive Digital Phase Locking (DPL) algorithm to ensure accuracy of calculations. No specialty hardware is needed; all following of the fundamental frequency is performed by the software on fixed sample rate data. This robust algorithm also handles loss of the synchronizing phase and can be easily switched on or off according to your needs.

Calculated quantities include:

- RMS voltage magnitude and angle (three phases)
- RMS current magnitude and angle (three phases)
- Watts (three phases plus total)
- Vars (three phases plus total)
- kW-Hr (total three phase)
- Frequency
- kVA
- Power factor
- Neutral voltage and current magnitude
- Optional phasor magnitude and DC average for RMS

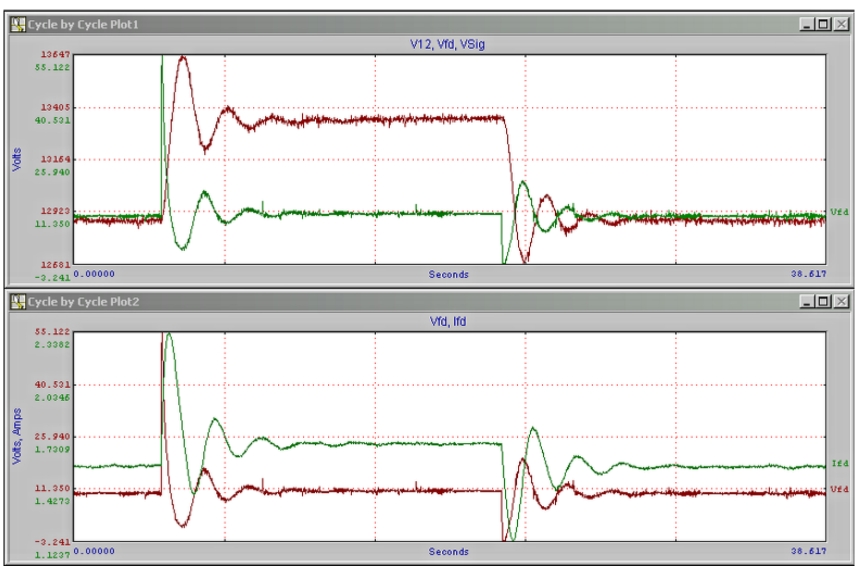
"Plots of all calculated quantities are quickly accessed through selectable display options."



Motor Start

In this example motor start, notice the instantaneous drop in voltage and the detail of the power oscillation when the motor comes up to speed. We also see an additional event impacting the motor after starting and causing a large power excursion and dynamic response.

"An ideal tool for any issue involving problematic load impacting."



Exciter Step Test

One of the key uses of Cycle-By-Cycle data capture is capturing the dynamic response of a generator's excitation system. In the capture to the left, we see a generator's open circuit step-test where the voltage overshoot (red curve) is exceeding the IEEE recommended overshoot of 20%. We can also see the AVR response in green.

Acacia Power Solutions, LTD
1424 Regan Ave
Coquitlam, British Columbia, V3J 3B5
604-328-1200

Acacia Power Solutions, LLC
14700 SE Megan Way
Clackamas, OR 97015
504-473-6331

acaciapowersolutions.com

Detailed Harmonics

Voltage and current spectral content updated in real time to reveal any power system distortion issue.

PowerLens' Detailed Harmonics tool calculates both integer and non-integer harmonics utilizing an eight-cycle window of captured data. This gives an average sense to the spectral content. Including non-integer frequencies is especially important when monitoring harmonic-producing equipment that switches at non-synchronous intervals. With the eight-cycle window and default sampling rate, the tool achieves a 0.125 harmonic (7.5 Hz at 60 Hz and 50 Hz at 400 Hz) resolution. The plots easily switch between integer bar chart and non-integer line graph displays, and show all three-phase voltage and current waveforms with their spectra.

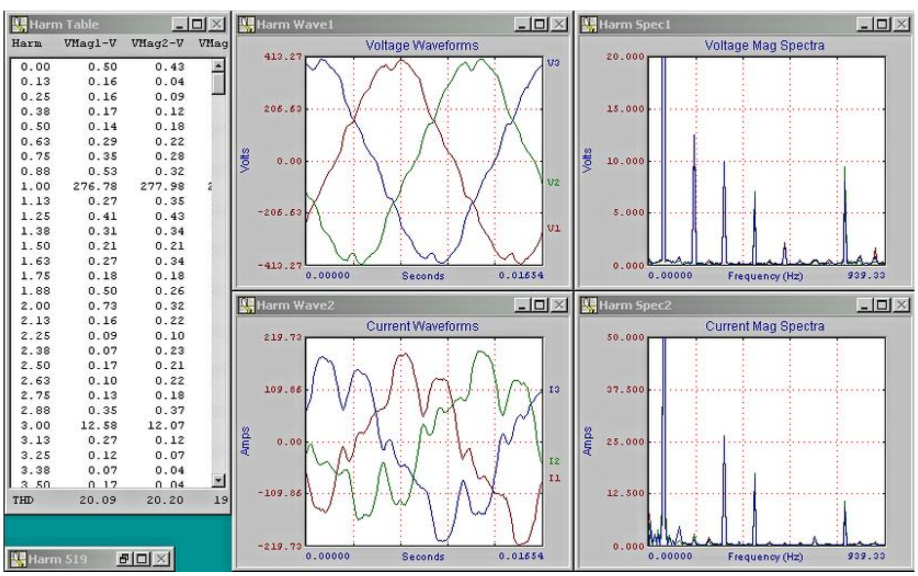
Phase-locking Advantage

Phase-locking to the fundamental frequency (accomplished using PowerLens' DPL algorithm) causes all integer harmonics to sit directly on calculated single-frequency points in the spectrum. Without phase-locking, the spectral content at integer harmonics would spread across nearby frequencies, significantly reducing the accuracy of the measurement. Phase-locking removes this problem, supplying the most accurate measurement possible.

Calculated quantities include:

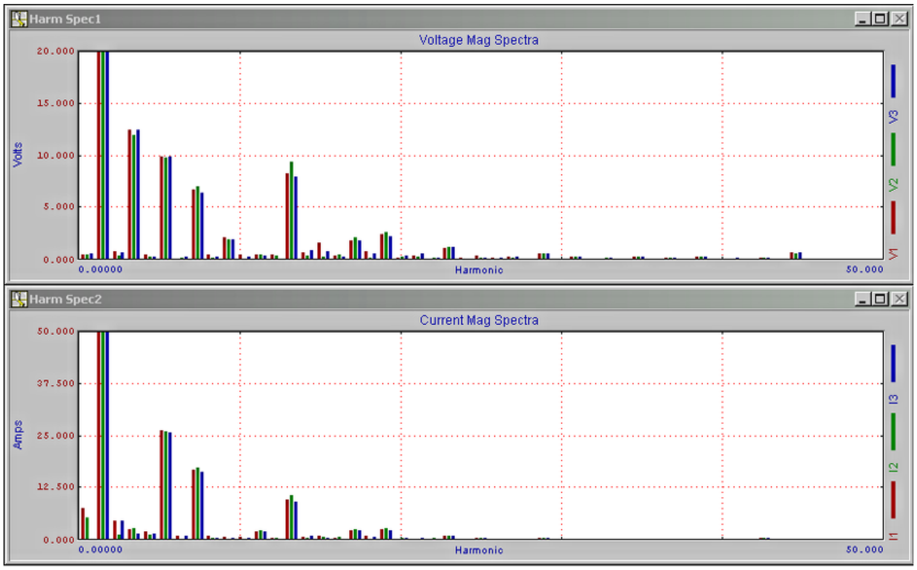
- Non-integer harmonics of all voltage and current waveforms
- Integer harmonics of all voltage and current waveforms
- Spectral content up to the 63rd harmonic
- Magnitudes and angles of all spectral content
- Magnitudes displayed in physical (Volts and Amps) or percent of fundamental

"All plot data can be easily and quickly copied into any spread sheet."



Non-Integer Harmonics

In this capture of a motor control center we see characteristic current distortion and harmonic content of several 6-pulse drives. We also see the non-integer display of harmonic content shown in both graphical and tabulated form. Voltage distortion is clearly discerned here from both the voltage waveform plot and the spectral graph.



Integer Harmonics

This is the integer harmonic bar chart display of the non-integer plot shown in the figure above. Notice that all three phases of voltage and current are displayed in red, green, and blue bars at each harmonic.

Event/Demand Capture

An enhanced event capture tool with concurrent demand logging.

PowerLens' Event Demand Capture enables you to capture power anomalies automatically by setting trigger thresholds in a simple event table interface. Events that exceed these thresholds are chronologically stored in PowerLens' fast access binary database. The database utilizes large block-size writing and saves fast access pointers for later retrieval. Databases can exceed 2GB in size. A convenient trigger table and waveform plot window provides real-time feedback while monitoring is taking place. This feature is so data efficient that triggers can be set to stream waveforms continuously to the fast database. If you are performing a critical test, this feature alone will ensure you do not miss anything.

Demand Capture

While event capture is taking place, you may optionally include the logging of all values described in the Cycle-by-Cycle tool at a user-specified interval, from once per second to once every 24 hours. During the interval every cycle is analyzed to create a minimum, average, and maximum value.

Calculated demand quantities include:

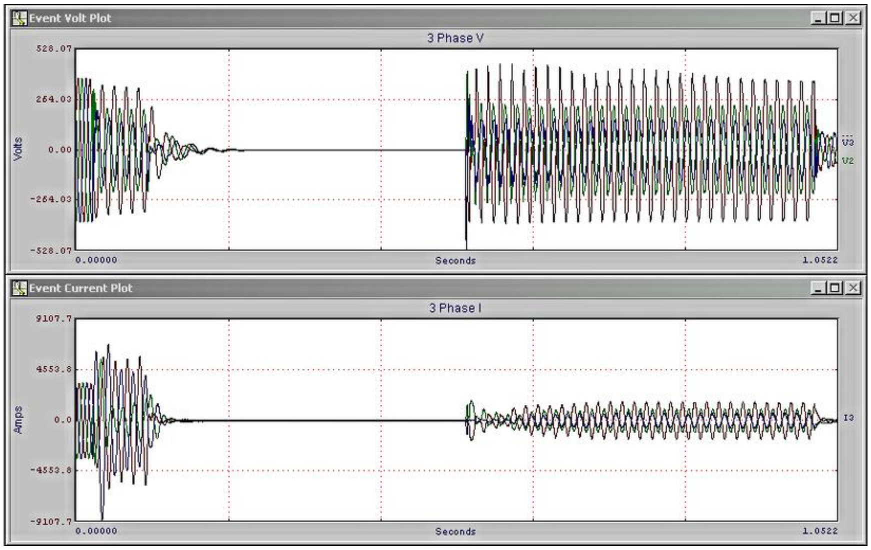
- Voltage magnitude and angle (three phases)
- Current magnitude and angle (three phases)
- Watts (three phases plus total)
- Vars (three phases plus total)
- kW-Hr (total three phase)
- Frequency
- kVA
- Power factor
- Neutral voltage and current magnitude

Captured event quantities include:

All three-phase voltage and current waveforms

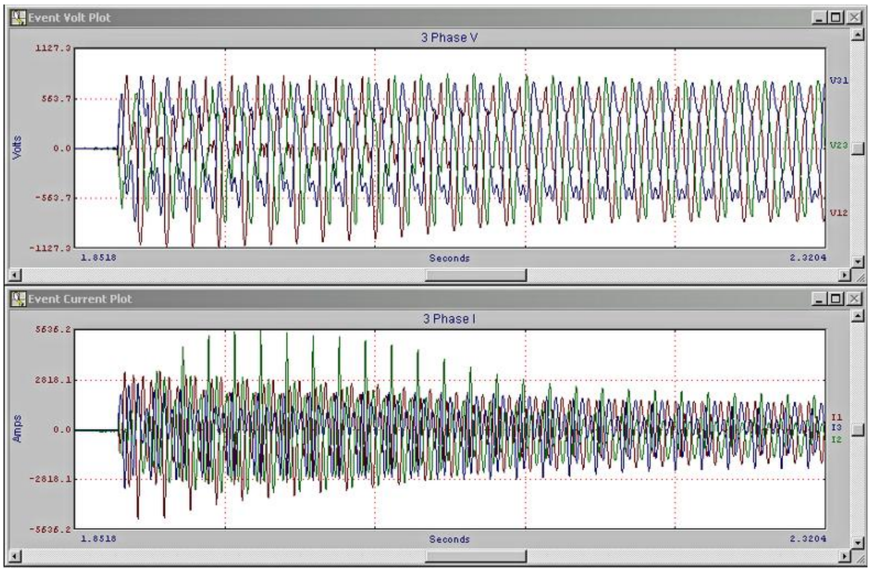
Sample Rate

The sample rate for all PowerLens tools is set in the system settings by specifying the base frequency (from 25 - 400 Hz). When set at 400 Hz the sample rate becomes 51.2 kHz to allow high detail in captured events. At the same time, the DPL algorithm can still synchronize any fundamental frequency between 25 and 400 Hz.



Fault with Recloser Action

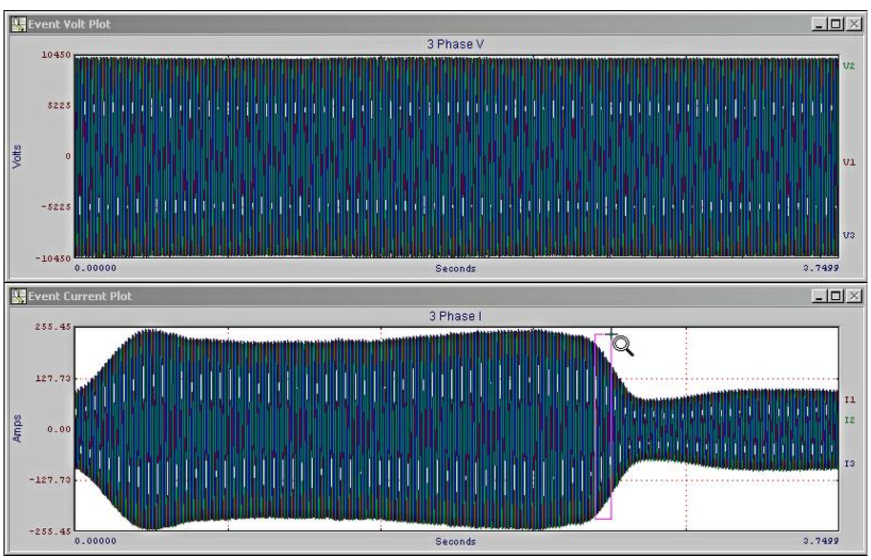
In this capture of a restricted line-to-line fault, we see voltage depression during the fault followed by breaking opening (the quick decay of voltage seen). After 30 cycles an automatic recloser closes back into the fault and takes an additional 30 cycles to clear. Notice that the event length extended automatically to capture a clear picture of the recloser action without having to piece together two separate events. In this case, the event length (post-trig cycles) was preset for a minimum of 30 cycles.



Transformer Inrush with Resonance

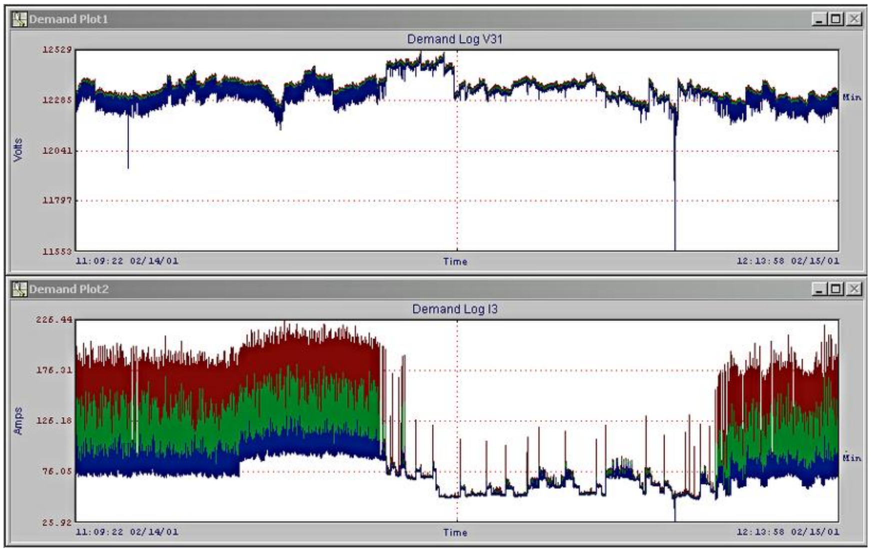
In this critical one-time test, Event Demand Logging was set to trigger events continuously. Thus, no information was lost due to unrefined trigger settings. This plot is a zoomed-in view of a transient over-voltage event occurring during transformer energization.

Notice how phase A voltage (red line in top plot) has a peak voltage of approximately 1127 volts (166%) on a 480 volt system. This test subsequently caused over-voltage failures on several drive systems. Continuous triggering allowed us to capture the full extent of this event the first time, without any further testing.



Drive Load Impact

In this event, so many cycles have been captured (greater than 120) that we only see the profile of the current waveform peaks in the bottom plot. The extended event length capability allows this capture to show drive load impact in its full detail.



Demand Logging

Long-term demand logging at a one-second interval is shown in this plot pair. The red, blue, and green curves are the maximum, average, and minimum values recorded over the one-second interval for each second.

The tight overlay of these curves in the voltage plot indicates that they are approximately the same, while the wide variation in the current plot illustrates significant moment-by-moment load variations. In the voltage plot we are able to identify a voltage sag of 93% (11.55 kV) occurring roughly three quarters of the way through the measurement.

Spectrum Analyzer

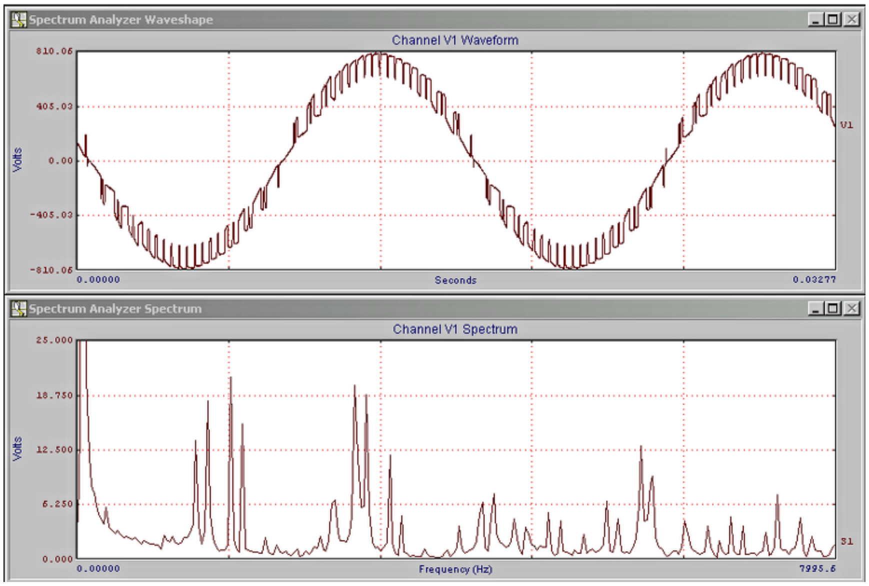
Look deeper into high frequency issues.

For a detailed look at the frequency spectrum of any voltage or current, the Spectrum Analyzer tool provides two graphic windows: a time waveform plot and a spectrum plot. The tool includes user-selectable sample rates up to 500 kHz, a user-selectable window size from 256 to 16,384 points, and an optional Hamming window applied to the time waveform. It works on a single channel that is also user-selectable. Similar to all graphic windows in PowerLens, you can use the mouse to zoom in and out, scroll, and drag cursers to show numeric results for both the waveform and the spectrum. This tool makes use of the widely known Fast Fourier Transform (FFT) to calculate results as quickly as possible. All spectral results are presented in physical units (Volts or Amps) and in dB.

Calculated quantities include:

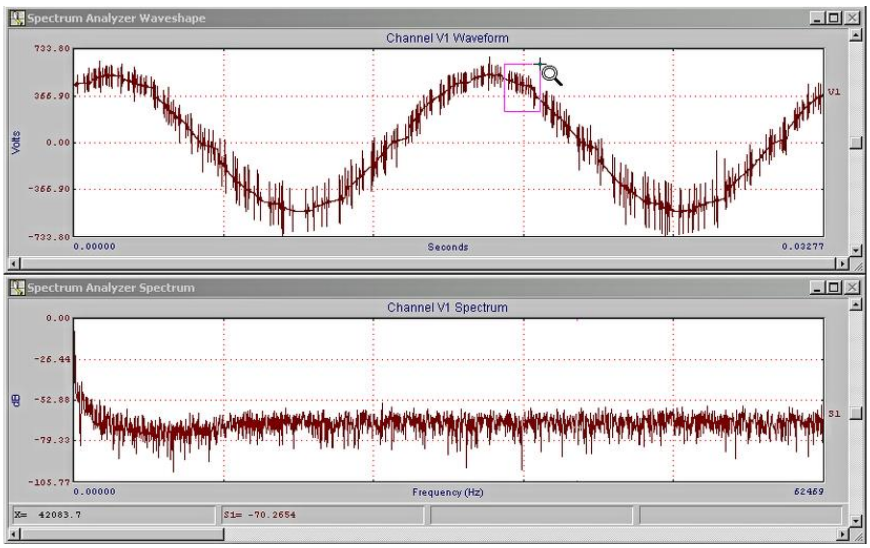
The waveform and spectrum for any voltage and current

"No longer wait for an event to see high frequency waveform detail."



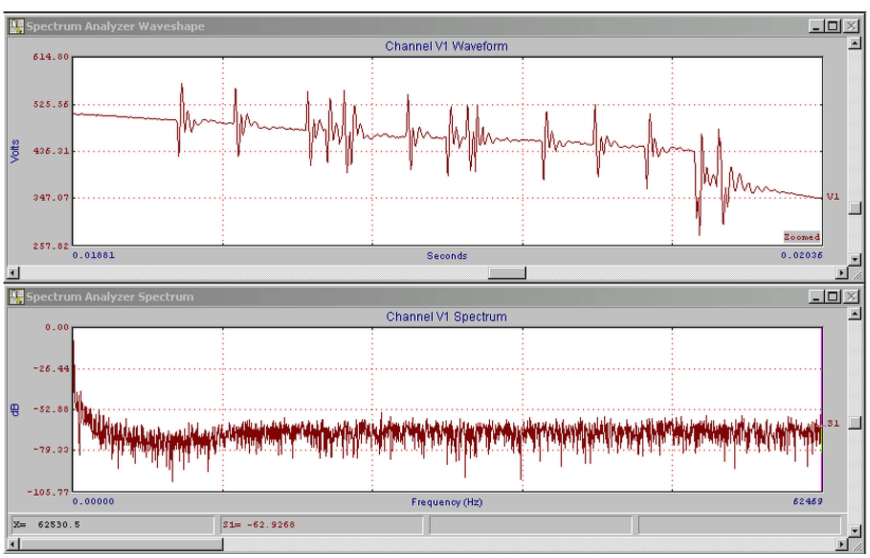
Source Inverter

This capture shows the detailed waveform and spectral content of a source inverter output. Notice the fine resolution of the waveform data, and that we have zoomed in on the spectrum to review the most important spectral frequencies.



Drive Switching Noise

In this capture we are able to see extreme drive switching noise that has coupled back onto the AC system. A zoom in of the small section shown by the magnifying glass is shown in the next figure.



Zoom In On Drive Switching Noise

After zooming in on the time waveform, we can clearly see the ringing in the switching noise. This type of detail is only possible with a very large sampling window and high frequency sampling.

Flicker

Not just a number, SEE flicker response.

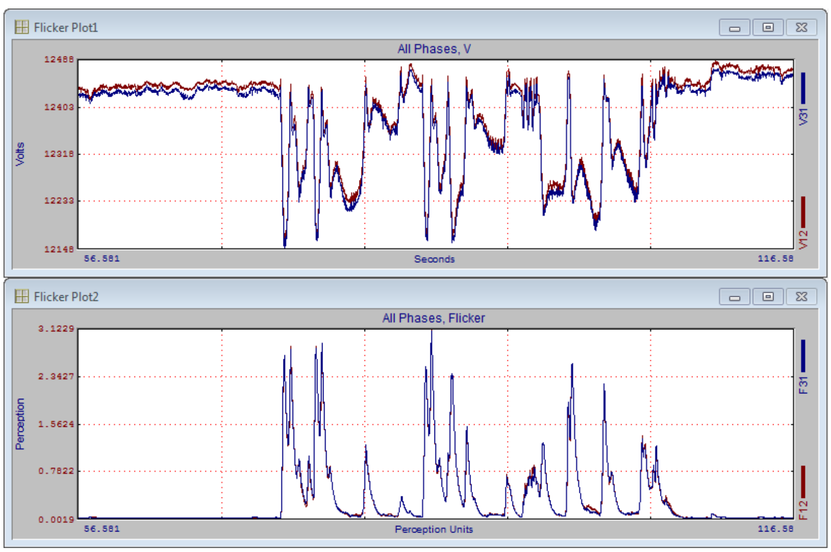
The IEC Flicker meter method is well documented. But the result of most meters is typically a few numbers like PST and PLT. But what do these figures really mean, and what is the meter doing in its algorithm?

For those who desire not only the final results, but an indication as to what is causing the flicker issue, PowerLen's Flicker tool is what you need. Visualize the increase in PST by monitoring the perception output of the meter. See how the lamp-eye-brain response in the meter's simulation method fades over time with an exponential decay. If a greater level of IEC flicker meter methods is desired, it can be achieved with PowerLens' implementation of the IEC Flicker meter.

"If flicker is a visible light fluctuation index, then we should be able to SEE how we get that value"

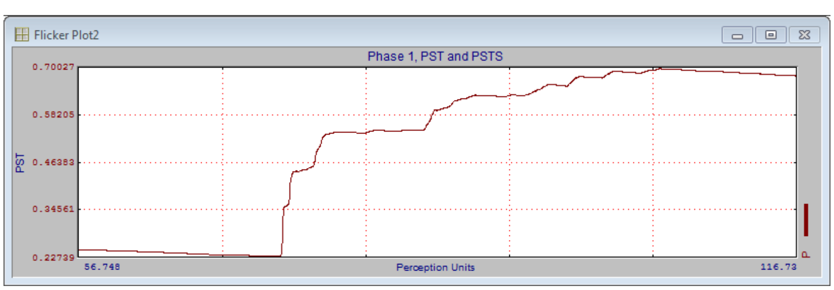
Calculated quantities include:

- Cycle-by-cycle RMS voltage
- Cycle-by-cycle flicker perception
- PST (short term flicker index)
- PLT (long term flicker index)
- Flicker perception density function
- Flicker perception distribution function



Flicker Perception from Load Impacting

In this plot we see cycle-by-cycle voltage dips due to load impacting, causing sudden increases in flicker meter perception. The values of perception then respond according to the lamp-eye-brain simulation and decay after each impact.



PST Over Time

Though PST is a value determined at the end of a 10 minute interval, it is revelatory to see how it is affected by the "come-and-go" behavior of voltage disturbances. Notice in this real-time cycle-by-cycle update of PST how PST stair-steps and grows as the sequence of voltage dips pass by. PST then starts dropping as the disturbances stop. If no additional disturbances occur after this group, PST would drop continuously until the end of the interval where it would then be logged.

Machine Measurement

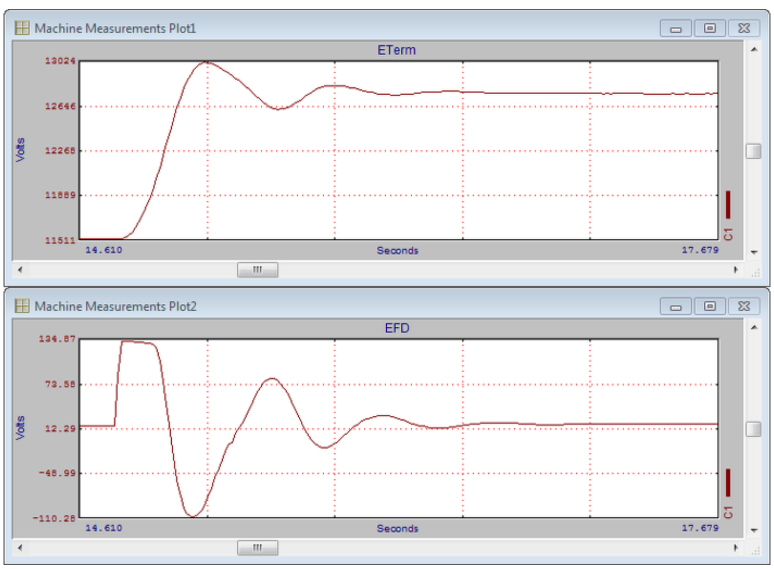
Machine measurements made easy.

When performing any type of generator testing to determine parameters for dynamic stability simulations, certain key features are needed:

- Ability to calculate RMS and DC Average values
- Cycle-by-Cycle capture
- Phase locking with fast response
- Accurate frequency measurement
- Ability to define what you desire to see, ignoring other elements

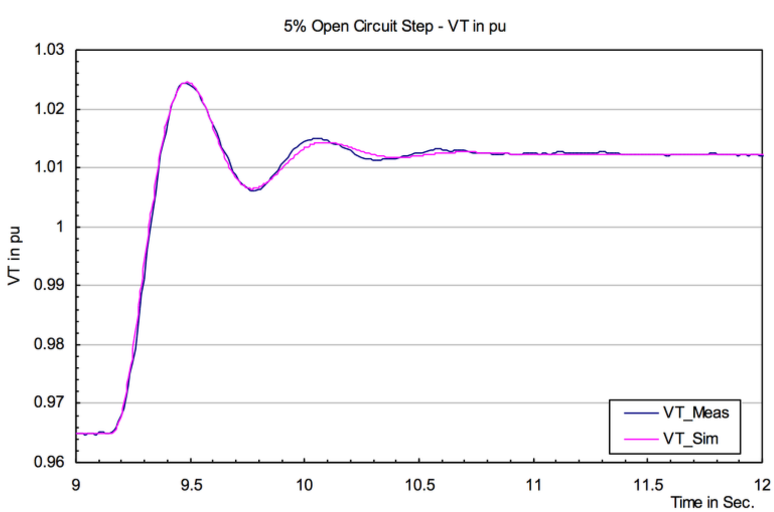
PowerLen's Machine Measurments tool supplies this power and flexibility so that captured responses can be overlaid and compared directly against simulated responses of a dynamic simulation.

"A tool made for WECC machine testing."



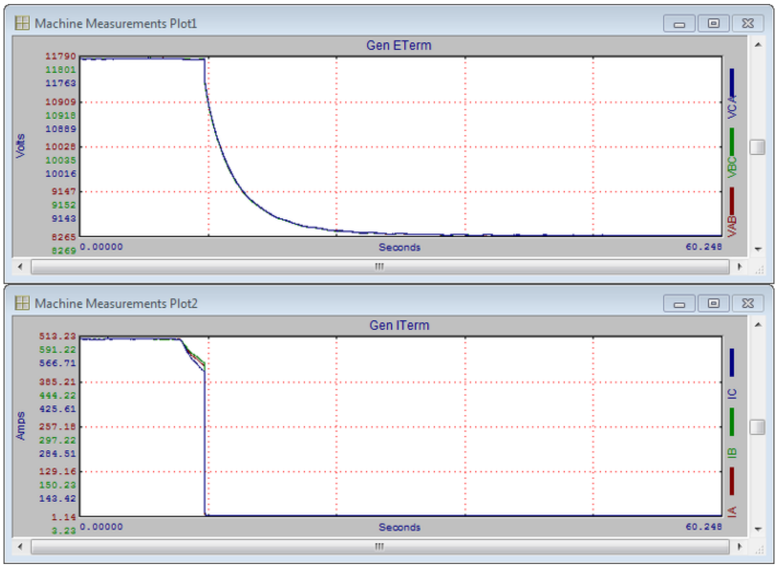
10% Open Circuit Step Test

Notice how each plot window in this machine test example is titled specifically to match measured data. The top plot shows the RMS terminal voltage (ETerm) and the bottom plot show the DC Average field voltage (EFD); both for a 10% open circuit step test. Field voltage limiting is clearly evident in EFD at approximately 134 V.



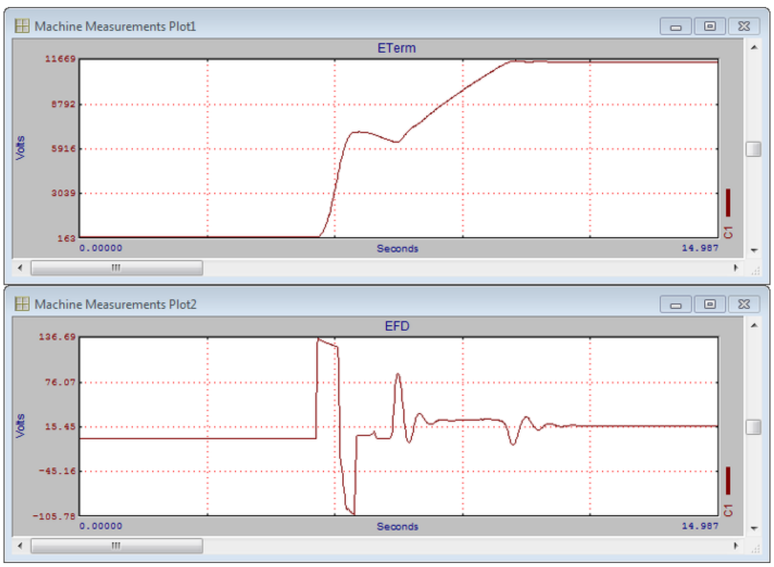
5% Open Circuit Step Test Overlay

This figure supplies an actual overlay of measured data from PowerLens with a simulated exciter step test using a dynamic stability simulation tool. This was a reported result in an actual WECC test.



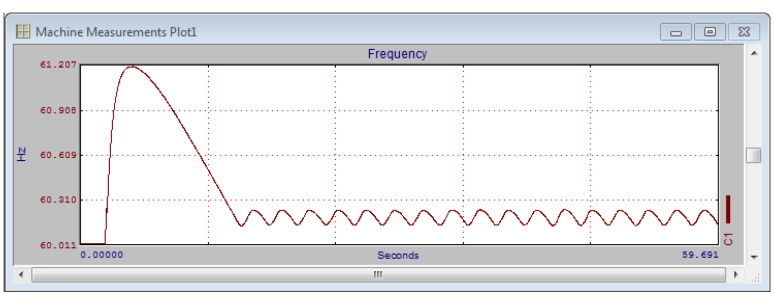
D-Axis Trip Test

One of the key tests for determining synchronous machine impedances and time constants is the D-Axis trip test. This test shows the characteristic drop in terminal voltage due to a reactive power rejection when the automatic voltage regulator is on manual control.



Generator Spin Up

During machine testing, it is always a good idea to monitor the generator as it is spinning up. This helps to validate instrument connections and verify proper field application. Here we see field flashing at max EFD and the subsequent field voltage application bringing the terminal voltage up to 11.7 kV.



Partial Load Rejection

Partial load rejection is necessary to determine machine inertia and governor response. Here we see a typical load rejection test where the machine speed increases to 61.2 Hz. After the steam valve has closed, the speed turns around and ramps down until the governor holds a rather oscillatory but stable frequency. The ramp down is attributed to machine friction and windage losses.

IEEE 519 Harmonics

IEEE 519 2014 Harmonic Limit Compliance

The 2014 update to the IEEE 519 Standard requires a statistical approach to harmonic measurements. This new and enhanced feature supplies a single graphic presentation of statistically analyzed harmonic measurements vs. required limits. Enter the three critical IEEE 519 settings, and the tool is completely automatic, saving shots of 10 Minutes values and each of the required limit graphics.

Calculated quantities include:

- Voltage harmonics to the 50th
- Current harmonics to the 50th

Calculated statistical quantities include:

For Voltage Distortion:

- Daily 99th percentile very short time (3s) voltages
- Weekly 95th percentile short time (10 min) voltages

For Current Distortion (120 V through 69 kV):

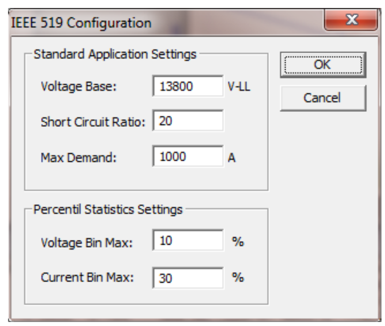
- Daily 99th percentile very short time (3s) currents
- Weekly 99th percentile short time (10 min) currents
- Weekly 95th percentile short time (10 min) currents

For Current Distortion (69 kV through 161 kV):

- Daily 99th percentile very short time (3s) currents
- Weekly 99th percentile short time (10 min) currents
- Weekly 95th percentile short time (10 min) currents

For Current Distortion (above 161 kV):

- Daily 99th percentile very short time (3s) currents
- Weekly 99th percentile short time (10 min) currents
- Weekly 95th percentile short time (10 min) currents

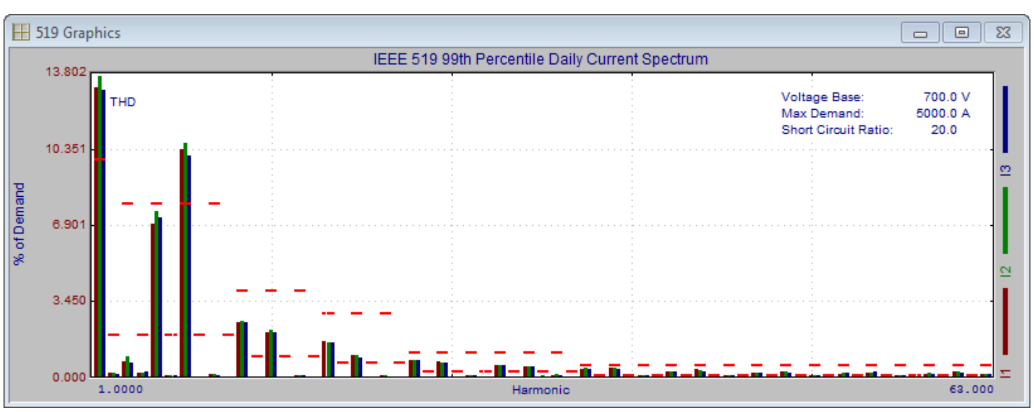


Easy Setup

Just enter the Standard Application Settings and start your measurement to perform a 519 compliance check.

Definitive Results Presentation

The plot below shows how both limits (the red horizontal bars) and voltage and current harmonic results for each phase (the bar chart red, blue and green bars) are presented for a single page compliance check.

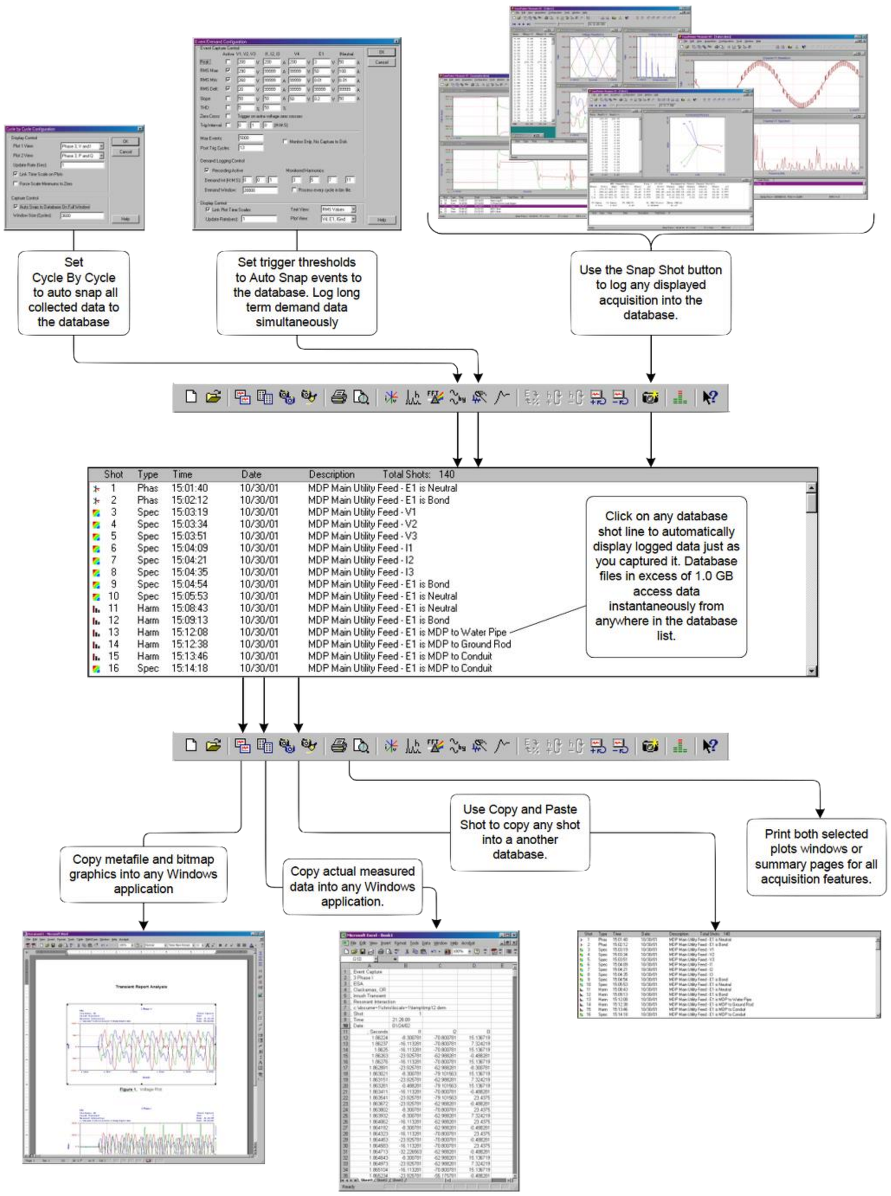


Software Features

Data Flow

A measurement database should work for you.

All saving of captured data is handled by PowerLens' fast binary database. The figure below shows how instrument settings are used to capture data into the database and how you can access the stored measurements. Quickly save, retrieve, view, and copy your measured data. The amount of data you collect is only limited by the instrument's hard drive size. PowerLens' ultra fast plot windows allow you to quickly view data captures that are up to 28,800 points in length.



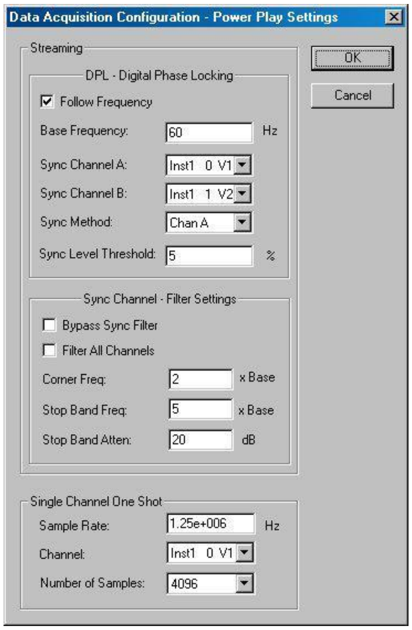
"Fast access pointers let you access captured data with no delay."

"Copy tab delimited data right from a plot or table to the clipboard."

25 and 400 Hz

Freedom to capture synchronized data for any power system.

Power systems operate at a base frequency that is typically 50 or 60 Hz. For 400 Hz military and avionic systems and for older 25 Hz railway systems, most power quality monitors and panel meters cannot phase lock. In PowerLens, base frequency is user-set between 10 Hz and 400 Hz. And even when set at a frequency of 400 Hz, the software can synchronize with a 50 or 60 Hz system. This supplies the ultimate flexibility to capture data on any electrical power supply system in use today.



Acquisition Configuration

The acquisition configuration dialog in PowerLens is used to set the base sample rate and several DPL algorithm settings. The sample rate for data capture is set to 128 times the base frequency (10 to 400 Hz), thus supporting 128 point-per-cycle RMS and phasor calculations, and Detailed Harmonic analysis to the 63rd harmonic.

Any instrument channel may be used as the synchronizing signal. For example, this feature can be used to synchronize with current instead of voltage when the voltage (in cases of a drive output) has extreme switching noise. The method of sync can be either Chan A (a single channel) or Chan A - B (channel difference) for a line-to-line desired synchronizing method.

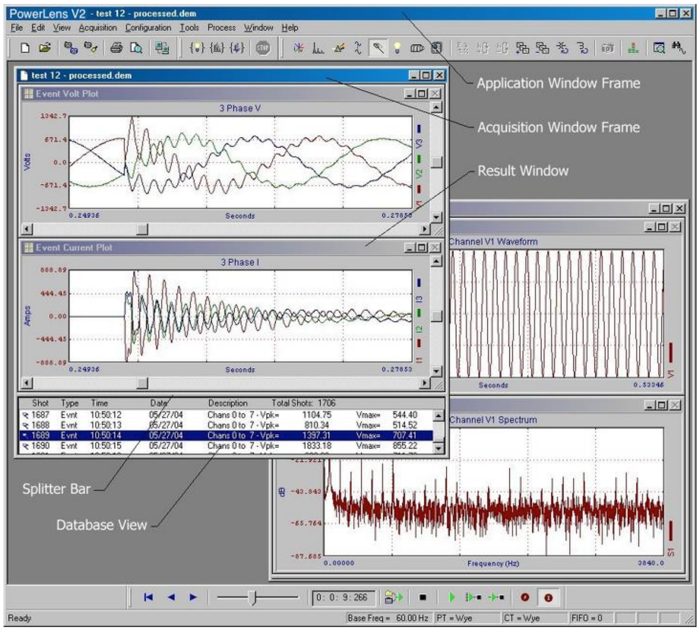
If the settings above are not adequate to achieve synchronization on a difficult signal, PowerLens allows you to apply a FIR (finite impulse response) filtering of the synchronizing channel. This filter can be optionally disabled or applied to all channels of data.

One Tool

One interface for all your data capture and analysis.

PowerLens is a tool built for flexibility and versatility. Though this instrument can easily be used to perform long-term monitoring, like a typical power quality meter, it also has the greater ability to supply fast results and real-time graphical feedback while taking measurements.

PowerLens is developed in a Windows friendly environment, and is easy and familiar to use. The software's interface is not only used in the field, but translates directly to your desktop or notebook PC for reviewing and analyzing your captured data. The same tool and interface used to capture your data is what you use to review and analyze your data. In fact, the desktop version for analysis is literally the same software with the hardware access removed. No longer do you have to learn two interfaces to gather and analyze data.



Example PowerLens Application Display

In this example, PowerLens is open with two database windows in view. Each acquisition window can link with the data stream and capture data simultaneously and update its display in real-time.

Do you desire to capture events and monitor and capture cycle-by-cycle results at the same time? No problem with PowerLens.

How about monitoring in real-time with the Phasor Diagram, monitoring and saving cycle-by-cycle results and capturing events? No problem with PowerLens.

Applications

What can PowerLens do for you?

If a power system measurement is needed, PowerLens can help you gather the data while revealing the pulse of your system. The following list of applications is by no means exhaustive, but gives an indication of the many ways PowerLens can be applied:

- Power quality measurements
- Harmonic filter commissioning
- Static var commissioning
- Harmonic studies
- Checking IEEE 519 compliance
- Energy measurements and studies
- Test lab needs
- Generator measurements and testing
- WECC testing
- Power factor studies
- Verify acceptable equipment operation
- Measurements for equipment modeling
- Power system stabilizer tuning
- Excitation system tuning
- General power system trouble shooting
- Checking IEC flicker compliance
- Measure fault currents for arc flash testing
- Capture distribution system faults
- Check performance of zero-cross switch closing
- Capture fast capacitive fault discharge
- Motor starting measurements
- Load impacting measurements
- Obtaining drive system harmonic content

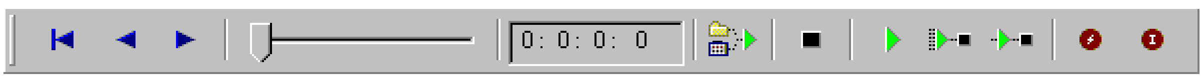
Power Record
&
Power Play

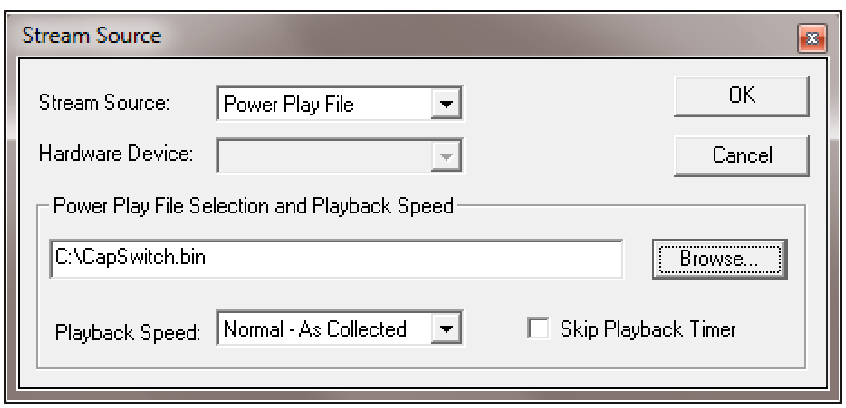
Don't miss anything in your next critical one-time-only test.

There are a host of data-loggers that capture streamed data. However, that data is simple sampled voltages and currents in waveform format. Power Record not only streams data while taking measurements, but stores it for later playback. Never again miss any part of a critical test.

Power Record saves all sampled data in the background while real-time trending and phasor response can be viewed with full functionality. Then after the critical test is complete, and streamed data is stored in a Power Play file, simply play it back through each analysis tool as needed. Analyze your data over and over to make sure that nothing is missed.

"The Time Toolbar lets you Power Record and Power Play with One-Button ease."





Data Stream Selection

Choose any previously recorded Power Play file to play through PowerLens' analysis tools.

Play back data at its normal speed, a faster rate, or skip the play-back timer to post-process data as fast as your computer can.

Specifications
&
Hardware Options

Specification and Hardware Options.

PowerLens runs on Dewetron data acquisition platforms. This equipment includes full-featured high voltage isolated input modules (fully differential, programmable gain and programmable filters). Combined with the tools and features of the PowerLens software, the result is a power system test instrument without equal in the industry.

Dewetron 8-Channel Unit

Dewetron 16-Channel Unit

DAQP Module

8-Channel Unit

(4) High Voltage Inputs

Option 1: DC to 300 kHz
Programmable Lo-Pass Filter: 10, 30, 100, 300 1k, 3k, 10k, 30k, 100k, 300k Hz

Option 2: DC to 2 MHz
Programmable Lo-Pass Filter: 100, 300, 1k, 3k, 10k, 30k, 100k, 300k, 1M, 2M Hz

Max Range: +/- 1400 V peak differential
Programmable Gain: +/- 20, 50, 100, 200, 400, 800, 1400 V
Accuracy: .1% FS through 100 kHz
Isolation 1.8 kV Line-to-Line, 1.4 kV Line-to-Ground

(4) Low Voltage Inputs for Current Clamps and Shunts

Option 1: DC to 300 kHz
Programmable Lo-Pass Filter: 10, 30, 100, 300 1k, 3k, 10k, 30k, 100k, 300k Hz

Option 2: DC to 2 MHz
Programmable Lo-Pass Filter: 100, 300, 1k, 3k, 10k, 30k, 100k, 300k, 1M, 2M Hz

Max Range: +/- 50 V peak differential
Programmable Gain: +/- .01, .05, .2, 1, 5, 10, 50 V
Accuracy*: +.1% FS through 100 kHz
Isolation 1.0 kV

Data Acquisition

Channel-to-Channel Skew: Approximately 5 ns
Measurement Resolution: 16 bit
Streaming Sample Frequency: 128 samples per cycle nominal
Single Channel Max Sample Rate: 2 MS
Accuracy: 1.66 mV for +/- 10 V input range
RMS and Frequency Measurement Response Time: 1 cycle
Frequency Measurement: 10 to 500 Hz; resolution 0.01 Hz
Harmonic Measurement: 0-63rd harmonic, integer and non-integer frequencies
Capture Memory: Instruments hard drive (non-volatile)
Operating Power: 90 to 240 V, 50/60 Hz
Environment: 0 - 40 Degrees C; 100% RH non-condensing

* Does not include inaccuracies in clamp or other current transducers

16-Channel Unit

A 16-Channel unit simply doubles the numbers of inputs and is equivalent to two separate 8-Channel instruments in one box.