Featured Product:

Ground Resistance Tester Model 3640

Inside this Issue:

- Featured Product:
  Fall-of-Potential Testing with the Ground Resistance Tester Model 3640

- Introduction to DataView® Template Frames

- Customer Support Tip: Ensure Correct Connections with Phasor Diagrams!

- DataView® PEL Control Panel Event Log Messages

- AEMC® Interview: Dick McCarrick, Technical Writer

Featured Product:

Fall-of-Potential Testing with the Ground Resistance Tester Model 3640

Grounding is a critical component of electrical systems. Effective grounding provides a low-resistance path for lightning and other phenomena that might otherwise damage electrical systems and injure personnel.

A common method for measuring the resistance of a grounding system is the *Fall-of-Potential* test, also known as the 3-point or 3-pole test. This involves injecting a current into the ground at a distance from the grounding system under test, and then measuring potential at different points between the grounding system and injector electrode.

In this article, we demonstrate how to perform a Fall-of-Potential test, using the AEMC® Ground Resistance Tester Model 3640, the simplest and easiest to use member of our Ground Resistance Tester product family. This direct reading instrument measures ground resistances from 10 milliohms up to approximately 2000 ohms at the push of a button – no manual adjustments or settings necessary. Among its features is auto-ranging, which automatically seeks out optimum measurement range for the test being conducted. In addition to 3-point Fall-of-Potential testing, the Model 3640 is also designed for 2-point continuity testing. The instrument ships with all the color-coded leads and electrodes necessary for ground testing.

Before you begin, verify that the grounding system under test is de-energized and isolated from other grounding systems. In addition to safety considerations, this ensures that the measurements truly reflect the resistivity of the grounding system.

We'll start by connecting the leads. Insert the provided spade lugs into the ends of the leads, and attach the lugs to the instrument terminals. The green lead connects the instrument to the grounding system. The red lead connects to the injector terminal, and the blue to the measurement terminal.

Notice the jumper strap attached to the red terminal. This is for connecting the red and blue terminals together for continuity testing, and is not used in Fall-of-Potential tests.

Attach the end of the green lead to the grounding system under test. Fall-of-Potential testing is often performed on rods that have been disconnected from the grounding system in preparation for the test. Another typical subject is a newly installed rod that needs to be qualified before being connected to a grounding system.

Now let's place the electrodes. For Fall-of-Potential testing, the injector electrode should be placed at a distance at least 8 to 10 times the depth of the grounding system. For example, if you're testing a grounding rod that has been inserted into the soil to a depth of 10 feet, place the injector electrode at least 80 to 100 feet away from the rod. It's good practice to place the electrode further away than is minimally necessary. Placing the electrode further than is necessary has no negative impact on the measurement; but placing the electrode too close can render the measurement invalid.

Note that if you are measuring a ground ring or grid, the longest diagonal length should be used as the rod depth in calculating the injector electrode distance.

When taking the initial measurement, the depth of the auxiliary electrode is not critical. In some locations with very moist soil, the electrode can simply be placed on the ground.

When the injector electrode is installed, attach it to the instrument with the red lead.

Next, place the potential electrode. This is the electrode through which the instrument will obtain its measurements. In full Fall-of-Potential testing, we would take measurements at 10% increments of the distance between the grounding system and the injector electrode. However, today we'll demonstrate a simplified version of the test known as the *62% method*. This uses three test points at 52%, 62%, and 72% of the distance between the grounding system and injector electrode. If these measurements are close – in other words, if plotted on a graph they produce a more or less flat line as shown in the illustration below – we can be confident that the injector electrode is inserted sufficiently far from the grounding system, and that our results are valid. If the results vary significantly, move the injector electrode further away and retake the measurements.
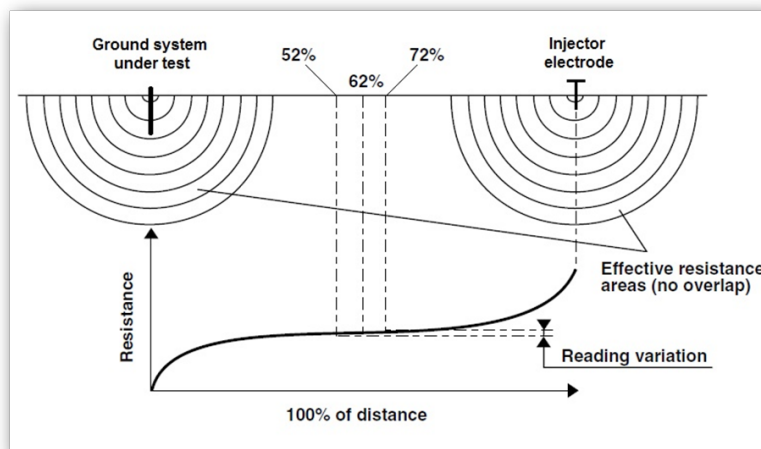
Our first measurement will be at 62% of the distance between the grounding system and injector electrode, so insert the potential electrode at this point and connect it to the instrument with the blue lead.

To take the measurement, simply press the button and wait a few seconds for the reading on the display to stabilize. The Model 3640 is auto-ranging, so no other manual setup is necessary. As you can see in the following illustration, our measurement at the 62% point is 11 ohms.
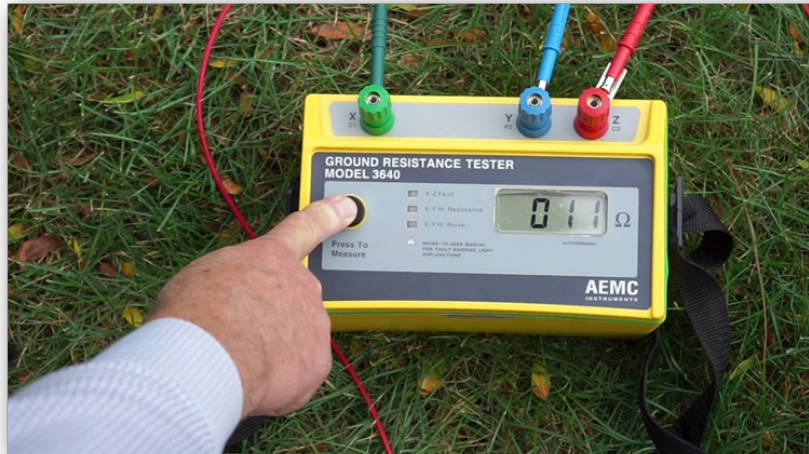
The Model 3640 has three fault indicators:

- **X-Z Fault** generally indicates the ground resistance at the injector electrode is too high. If this light flashes, you can insert the electrode deeper into the ground, add additional electrodes in parallel with the first, or moisten the ground around the electrode to improve conductivity. Note that this indicator also flashes when the instrument's fuse is blown, or when the lead is not connected and the circuit is open.

- **X-Y Hi Resistance** is similar to X-Z fault, except that it indicates the resistance at the potential measurement electrode is too high. The same fixes described for X-Z Fault applies.

- **X-Y High Noise** indicates stray voltage is in the soil. This could be due to a source of electromagnetic interference (EMI), for example high tension lines right above the instrument or along the run of the leads, being present in this location. This can be addressed by using shielded leads. Or you can apply a quick fix by twisting the blue and red leads together along their runs.

In addition to these indicators, the LCD displays a reading of 1 if the resistance exceeds the instrument's measurement range. Overrange is also indicated by blinking on the LCD.

After we obtain a valid reading, we now move the potential measurement electrode to a point 52% of the distance between the grounding system and injector electrode, and take another measurement. For our final measurement, we move the potential electrode to 72% of the distance.

We now compare our measurements. If all three are close, the injector electrode has been placed far enough away from the grounding system to produce reliable results. In this case, we simply add the three measurements together and divide by three to obtain the effective resistance of the grounding system. If the readings vary significantly, move the injector electrode further away and repeat the three measurements.

This concludes our quick demonstration of Fall-of-Potential testing. For more information about the Model 3640, consult the documentation that comes with the instrument. You can also visit the Model 3640 Product Page (http://www.aemc.com) for additional specifications.

DataView Report Frames

All data in a DataView report is displayed through frames. These are rectangular boxes in which numerical and graphical data, explanatory text, and other visual components are displayed. Frames determine which data is included in a report, and how this data is presented.

There are a wide variety of frames. You can create, modify, and move frames within a report or template. Frames can also be linked, so that the data displayed in the parent frame determines which data appears in the linked child frame.
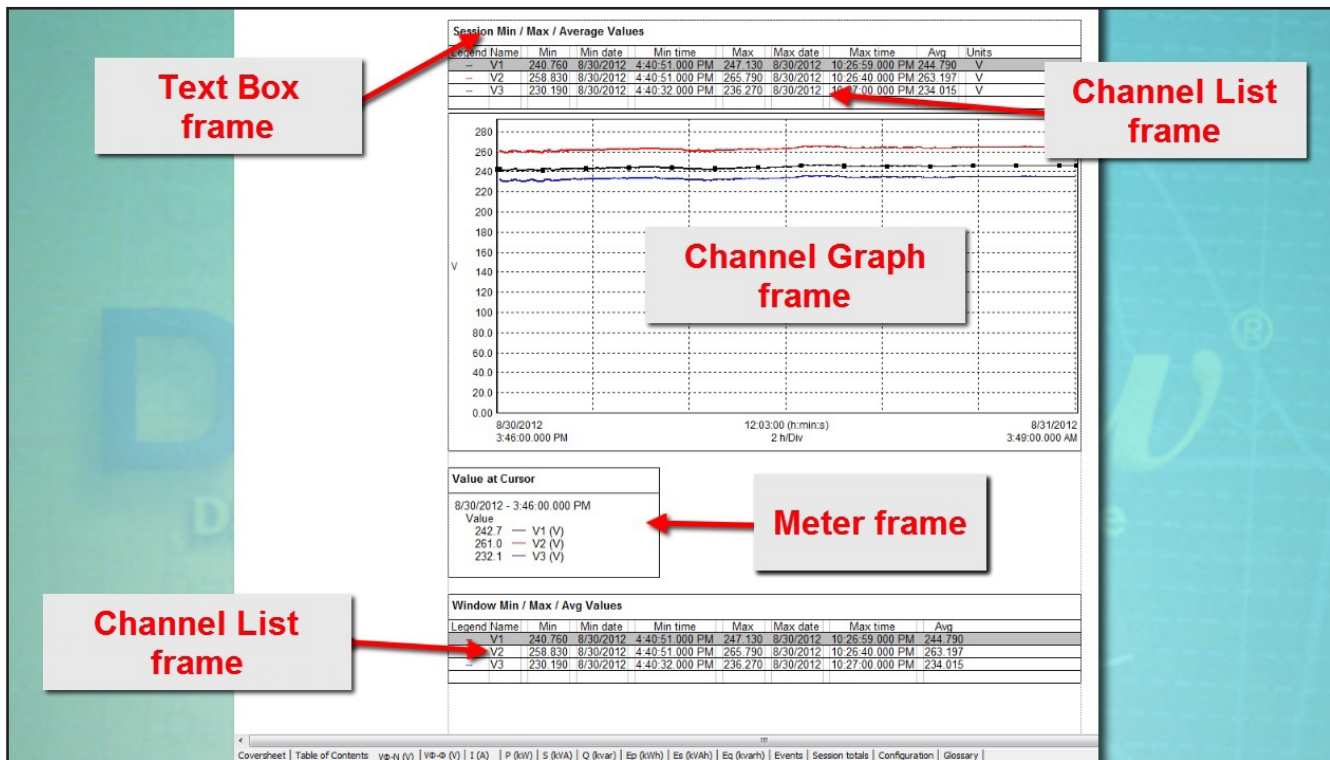
In this article we briefly introduce the types of frames available in DataView. We demonstrate how to create a frame. And we also show how to link frames.

Creating a Frame

To create a frame, click the DataView icon on your desktop. Close the Quick Start dialog box, and then select File from the menu bar. You can add a frame to either a template or a report. For demonstration purposes we will add a frame to a template, so select Open Template from the File menu. This displays the Open dialog box. Locate and select the template file to be modified. Template files are identified by the extension .dvt. In this example, we will choose the PEL basic report template. Note that if we later decide to save the changes we make to this template, we must save it under a different name. DataView does not allow you to modify and save a standard template under its original name. Also be sure to name the new template with the .dvt extension, to ensure it is recognized as a template by DataView. (In addition to modifying and saving an existing template, you can create a template by modifying a report and selecting the Save as Template option from the File menu.)

When the template is open and displayed on the screen, the icons in the toolbar are activated. These include a set of icons designed for creating specific types of frames.

- Draw Box ⬜ creates a box frame
- Draw Line ◥ creates a line frame
- Draw Arrow ➤ creates an arrow frame
- Place Word OLE �W creates a Word OLE frame
- Insert Data $^{O}L_E$ creates an Object Linking and Embedding frame
- Insert Text **A** creates a text frame
- Place Table of Contents ▤ creates a Table of Contents frame
- Place Graph ⌐⌐ creates a waveform or trend frame, depending on the selected data
- New Frame ▣ creates any frame type, including those for which no dedicated icon exists
- Link Frame ⌀ creates a new frame linked to the currently selected frame

Notice that when you select a frame creation icon, the cursor changes to reflect the type of frame you are creating.
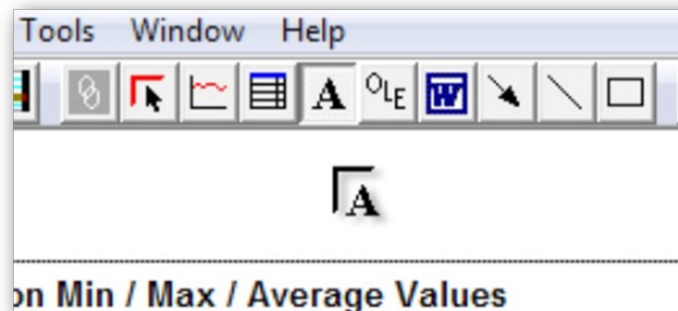
You can also create a frame by clicking Frame in the menu bar and selecting New Frame. The cursor changes to the generic Create Frame cursor.

In our example, we will place a simple text frame into the template. To do this, click the Insert Text icon, and move the cursor to the location where the upper left corner of the frame will be placed. Click and hold the left mouse button, then drag the cursor to the location where the lower right corner of the frame is to be located. A dotted box shows the size and location of the frame being created (see below).
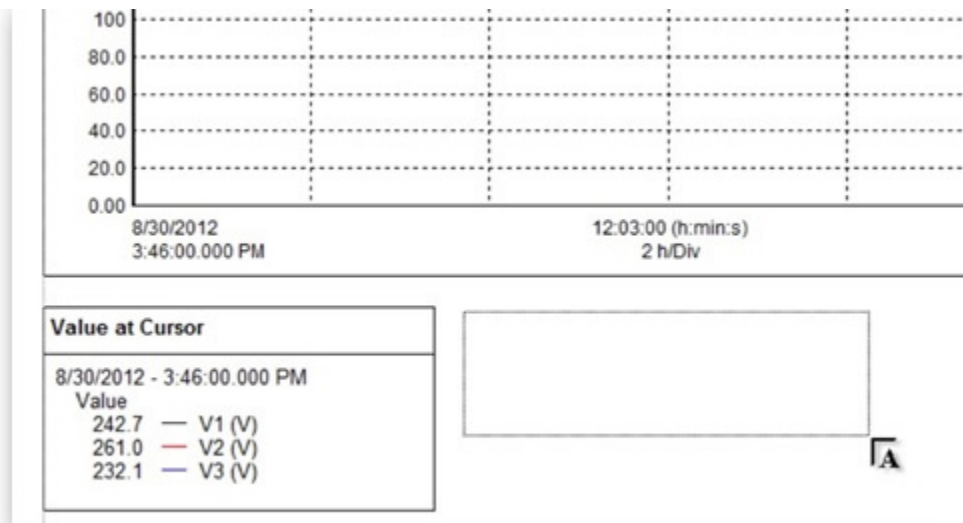
Release the mouse button to display the Text Box Properties dialog box. Type in the text, and use the buttons to select options for text font, size, and effects. When finished, click OK. The text frame now appears in the template, where you can make any final adjustments to its size and position.
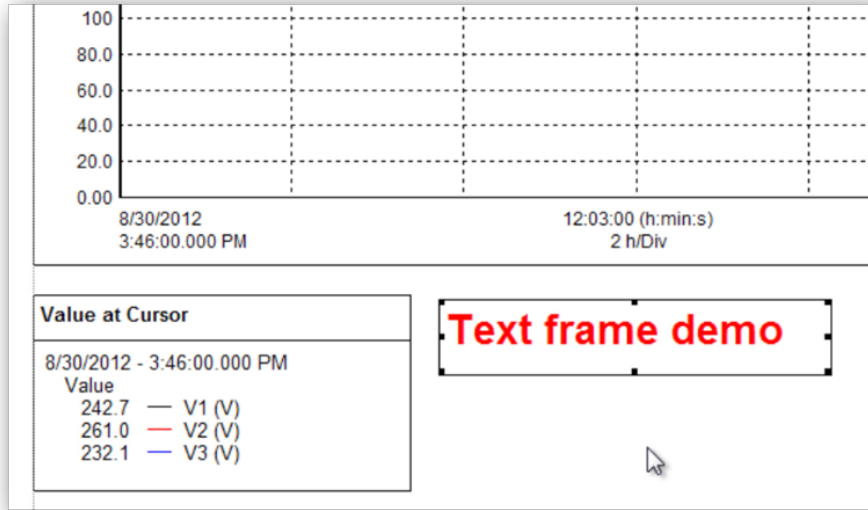
Linking Frames

As we mentioned earlier, frames can be linked. This enables you to define one frame by the contents of another frame. For example, a Meter frame can be linked to a Channel Graph frame. As you move the cursor in the Channel Graph frame, the data displayed in the Meter frame is updated to display the values at the cursor position. In this example, the Channel Graph is referred to as the parent frame, while the Meter frame is called the child frame.
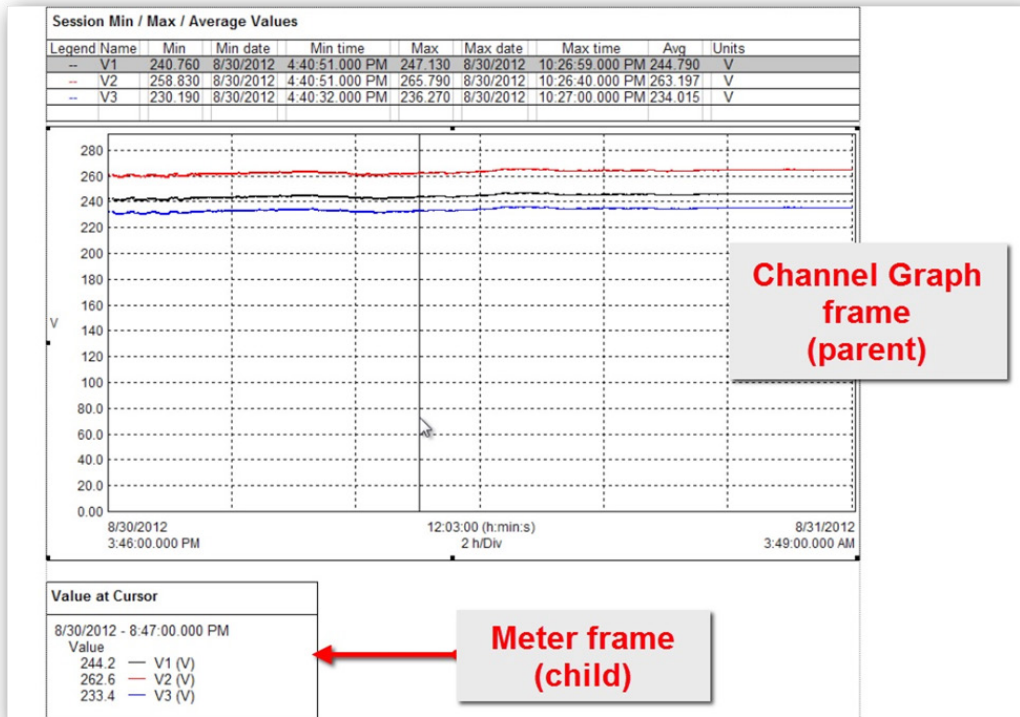
Note that a single parent frame can have multiple child frames. Also, not all frame types support child frames. If the selected frame type does not support child frames, the Link Frame icon and option are grayed out. Consult the DataView Help for a complete list of which frames can serve as parent and/or child frames.

To link a frame to another, click the parent frame to select it. Then click the Link Frame icon, or choose Frame in the menu bar and select the Link Frame option. Either action displays the Child Frame Type dialog box. This lists all the frame types that can be linked to the selected frame. In our example we will select Graph Legend and click OK. The cursor changes to the Link Frame cursor; use it to define the size and location of the frame. Release the mouse button to display the dialog box appropriate for the child frame type, which in this case is Graph Legend Properties. Complete the selections and click OK. The child frame now appears at the selected location.

This concludes our quick introduction to DataView report frames. Consult the Help system that comes with DataView for detailed information about working with all types of frames.

Customer Support Tip:

Ensure Correct Connections with Phasor Diagrams!

By Guy Belliveau

A measurement campaign may be completely wrong if the measurements are not performed correctly. One of the most frequent mistakes is incorrect connections of the voltage leads and current clamps.

The simplest way to check that our Power Quality Analyzers (PowerPads) are correctly connected is the phasor diagram. Once the instrument has been fully configured, this verification can be used to ensure that the voltage leads and current clamps are positioned correctly.

This article assumes that the phases are identified as L1-L2-L3 and that different colors are assigned to the phases.

The phasor diagram can be accessed simply by pressing the waveforms button ⌇ located on the front of the PowerPad casing, and then pressing the phasor key ∠⊗.

If the wiring is correct, the phasor diagram will look similar to the following:
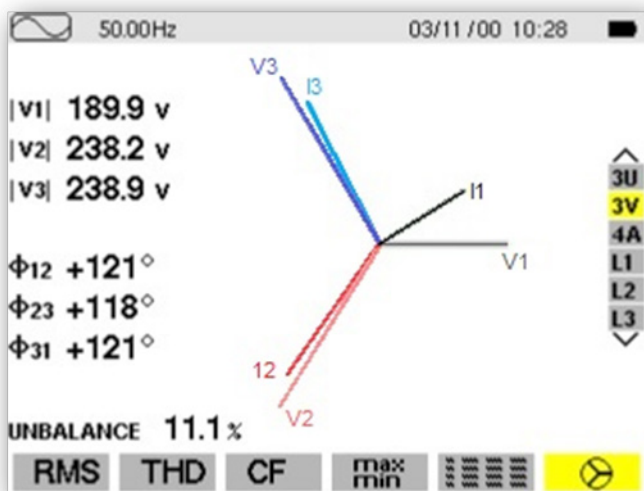
NOTE: Directional arrows are marked on all of our PowerPad® current clamps and sensors. These arrows should point towards the load. The illustrations below show the directional arrows located on the top of the SR193-BK and MN93-BK clamps. Both clamps are compatible with our PowerPads:

Top of SR193-BK clamp

Top of MN93-BK clamp

This diagram shows that the respective voltages and currents of each phase are associated correctly: V1 and I1, V2 and I2, V3 and I3.

If there is a connection error, the diagram will resemble the examples below. In the first example, one of the current clamps (I1) has been connected in the wrong direction. So I1 trace is out of phase:
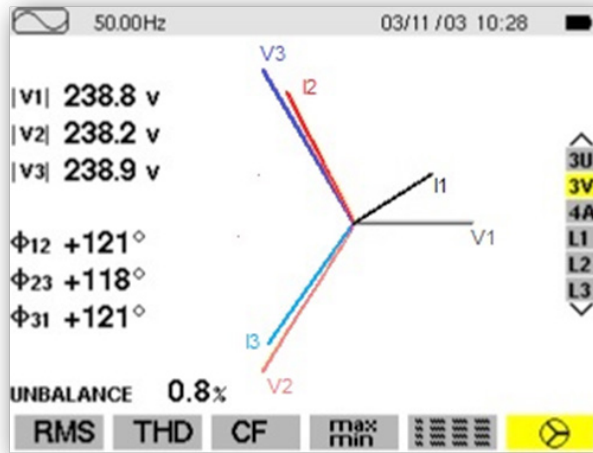
In the second example, two current clamps (I2 and I3) are connected to the wrong phase. For example, the diagram shows I2 trace associated with V3 and I3 trace associated with V2:
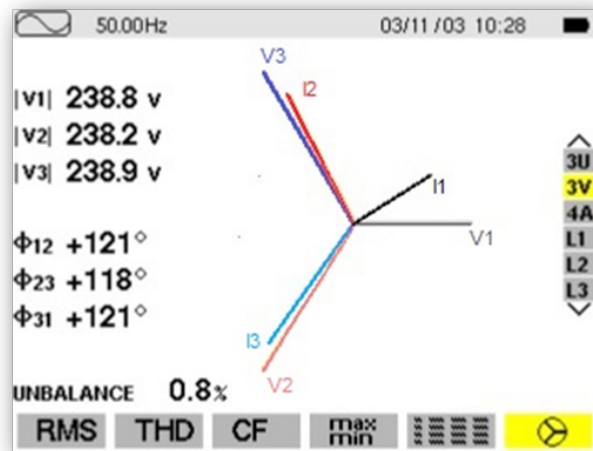
The use of phasor diagrams is an effective way of ensuring that the right connections are set up for reliable measurements and a successful recording campaign. This can ultimately save you time and money when working for your client. It also avoids the embarrassment of having to repeat the campaign due to initially incorrect wiring.

We welcome your feedback and can be reached at:
techsupport@aemc.com or by calling 1-800-343-1291 (x351) for our Technical Support Help line.

About the Author:

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DataView® PEL Control Panel Event Log Messages

AEMC® Instruments Model PEL 100 series data loggers store a wide variety of measurement data. When data from a recording session is downloaded to a computer using the DataView® PEL Control Panel, it is stored in an .icp file. Each .icp file includes a folder called Event Log, which you can view by opening the file in the PEL Control Panel and clicking Event Log in the navigation frame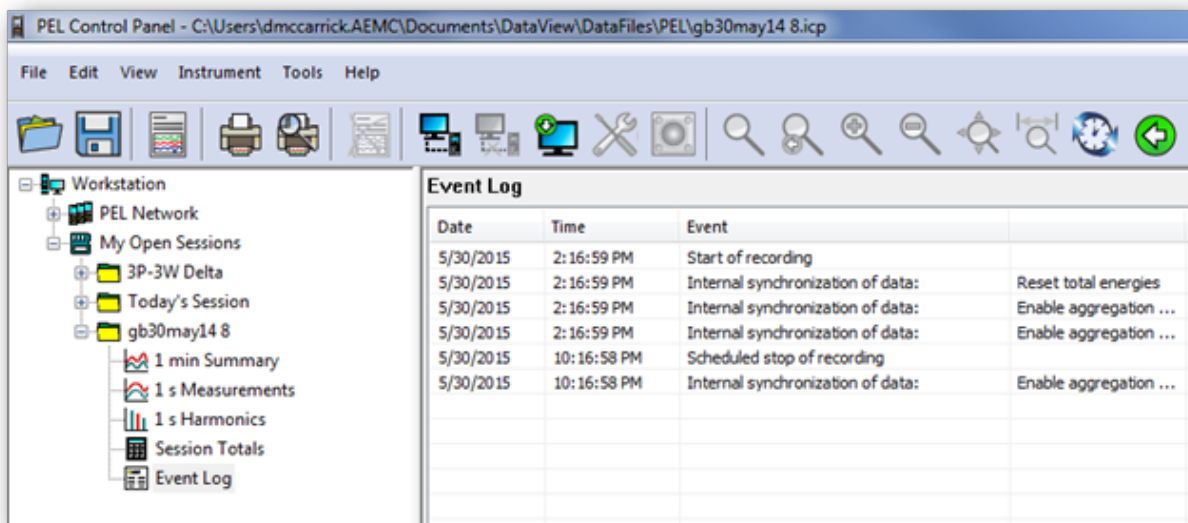. All events that occurred during the recording session are then listed in the data frame. Some of these, such as the start of the recording, are relatively routine. Others may indicate an error condition or other issue that may require contacting AEMC® Technical Support.

Each event message contains up to four fields:

- **Date** indicates the date the event occurred.
- **Time** indicates the local time the event occurred.
- **Event** defines the type of event.
- For some messages, a fourth column appears to the right of Event. This provides additional explanatory information.

When viewing event messages, note the following:

- **DSP** (Digital Signal Processor) is a specialized processor within the PEL instrument that handles the acquisition of measurement data and measurement calculations.

- **Ride through** is the period of time a data recording session will continue when external power is lost. This is defined through the option "Auto power off (ride through)" in the General tab of the Configure dialog box in the PEL Control Panel. If this option is disabled, the instrument will continue recording until the battery power runs out and the instrument turns OFF.

Events are grouped into the six categories: Recording, Power Supply, SD-Card, Sensor, DSP, and Other.

Recording Event Messages

- **Start of recording** indicates when the recording session began.
- **Scheduled stop of recording** indicates the recording reached its scheduled stop time/date.
- **The recording resumed** indicates that a recording that was interrupted before completion was re-started.
- **The user stopped (canceled) the recording before the scheduled time** indicates that a scheduled recording was stopped manually by the user before the scheduled end date/time was reached.

Power Supply Event Messages

- **The power supply has been lost, instrument on battery** indicates that the instrument was running on external power (either through a voltage terminal adapter or through auxiliary AC power) but the external power was interrupted, causing the instrument to switch to battery power.

- **The recording was suspended after the loss of the power supply** indicates that the instrument's external power supply was lost, causing the instrument to run on battery power until it either (1) reached the end of the "Auto power off (ride through)" period, or (2) the battery power ran too low to continue operation. In the first case, this message is followed by the message "Instrument turned off due to expiration of ride through." In the second case, this message is followed by the message "Instrument turned off due to low battery." Both messages are described below.

- **Instrument turned off due to low battery** indicates that the instrument did not have sufficient battery power to continue operation.

- **Instrument turned off due to expiration of ride through** indicates the instrument automatically turned OFF because it reached the end of the period defined by "Auto power off (ride through)." When enabled, this option causes the instrument to turn OFF after a user-selectable period of time (3, 10, or 15 minutes) when it is running on battery power (either by user choice or due to an interruption in the external power supply).

- **Instrument turned on, power supply restored** indicates that power has been restored to the instrument after a shutdown due to low battery power.

- **Instrument turned on, power supply not restored, running on battery** indicates that when the instrument was turned ON, there was no external power available so it operated on battery power. This is usually the result of a user pressing the Power button when the instrument is unplugged; for example: (1) the instrument was recording, (2) power was lost, (3) the instrument turned OFF after the ride through period expired, then (4) the instrument was turned back ON by the user.

SD-Card Event Messages

- **The recording was suspended when the SD-Card memory became full** indicates (1) the instrument's SD-Card reached its maximum data storage capacity during the recording session, or (2) the 1 s harmonics or 1 s trend data reached 4GB in size. When either happens, the instrument stops recording data. If the SD-Card is full, you will need to erase the SD-Card's memory to start another recording. If you schedule long recording sessions and see this message repeatedly, consider replacing the SD-Card with another card with more storage capacity. Excluding 1 s harmonics and trend measurements from the recording may also help avoid this situation.

- **The recording was suspended when the SD-Card was extracted** indicates the SD-Card was removed from the instrument during the recording session. If this was not done intentionally, check the instrument to ensure the SD-Card has not been accidentally dislodged. When the card is re-inserted, the recording session will resume.

- **The recording resumed when the SD-Card was inserted** indicates the SD-Card was re-inserted into the instrument after being extracted. The recording session resumes when the card is re-inserted into the instrument.

- **SD-Card interface reset** indicates the instrument cannot communicate with its SD-Card. Replace the SD-Card; if this condition still persists and/or occurs frequently, contact AEMC® Technical Support.

The following two messages are associated with the rate at which data is recorded to the SD-Card:

- **The SD-Card began to saturate. Recording of 1 s harmonics terminated to preserve integrity of recorded data**.

- **The SD-Card began to saturate. Recording of 1 s trend terminated to preserve integrity of recorded data**.

As the size of a data recording increases, the time required to access the SD-Card lengthens. When the write time for harmonic data reaches a threshold, the PEL Control Program stops recording 1 s harmonics data. This prevents loss of 1 s trend or aggregate data. This threshold is dependent on the PEL model and firmware revision.

For example, for version 1.17 of the PEL 102/103 logger firmware, the threshold is 54 seconds in a 64 second interval. The PEL 102/103 has a 64 second buffer for 1 s trend data and 1 s harmonics. When it requires 54 seconds to store 64 sample sets, there is the potential of a buffer over-run; in which case the instrument stops recording 1 s harmonics.

If this condition occurs again, the instrument stops recording 1 s trend data. The first message above indicates the recording of 1 s harmonics data has been terminated; the second indicates 1 s trend data has been terminated.

Sensor Event Messages

- **Current sensor has been removed** indicates a sensor was disconnected from the instrument during the recording session. The terminal to which the sensor was connected is listed in the message. If you see this message but the sensor is still connected to the instrument, it may indicate a problem with the sensor or the input terminal to which the sensor is connected.

- **Current sensors changed** indicates one or more sensors were disconnected from the instrument during the recording session and replaced with different sensors. The terminal(s) to which the sensor(s) were connected are listed in the message.

DSP Event Messages

- **The acquisition of measurements has been interrupted in the instrument** indicates the instrument stopped communicating with the DSP. If this condition persists and/or occurs frequently, contact AEMC® Technical Support.

- **The acquisition of measurements by the instrument has resumed** indicates that after an unscheduled interruption, the instrument resumed receiving and recording measurement data.

- **Internal synchronization of data** indicates the instrument has reset an internal data setting. The message includes the type of synchronization operation performed:

- **Enable DSP MAX detection** is written to the DSP when the aggregation MAX detection mode is set to "Aggregated MAX values updated while recording only." When the recording ends, the DSP will be instructed to disable aggregation MAX detection.

- **Set nominal frequency** indicates "Auto" was selected for the nominal frequency and the instrument reset it during the recording. In general, this message rarely if ever appears since the nominal frequency should be set before the recording starts.

- **Reset partial energies**. If the "Reset partial energy meters at the start of each new session" option in the Meters tab of the Configure dialog box is checked, this command is sent to the DSP to reset the partial energy meters when a recording starts.

- **Reset total energies**. If the "Reset total and partial energy meters at the start of each new session" option in the Meters tab of the Configure dialog box is checked, this command is sent to the DSP to reset the total energy meters when a recording starts.

- **Reset DSP aggregation MAX registers**. If the instrument is configured to only detect aggregated MAX data when recording, this message indicates that the DSP aggregation MAX registers have been reset.

- **DSP write failure** indicates the DSP did not respond to a write request. The write request will be retried and should succeed if the failure was caused by a random condition. If the failure is due to a problem with the DSP, this condition will persist and prevent normal instrument operation. In this case, contact AEMC® Technical Support.

Other

- **Event Code: x** indicates an event occurred for which no description is available. The event code number is included in the message. If you see this message, please record the event code number and contact AEMC® Technical Support.

AEMC® Interview:

Dick McCarrick, Technical Writer
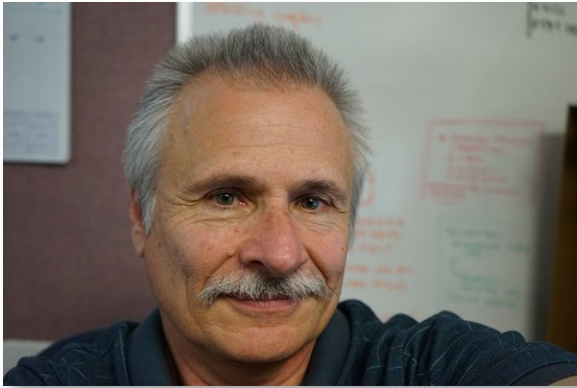
If you're an AEMC® customer, chances are you've used content produced by Dick McCarrick – whether it's the user manuals that accompany our products, the Help systems for DataView® and its Control Panels, the videos on AEMC's YouTube channel, or even this Technical Bulletin. In this interview Dick explains the function and purpose of the various forms of AEMC® content.

Q. **What is the purpose of the AEMC® YouTube channel?**

A. Not a lot of people may know this, but the AEMC® YouTube channel has been online for almost six years. For the first few years, we really didn't post a lot of videos on it. When I joined AEMC® in 2013, one of my first responsibilities was to work with Technical Support Specialist Guy Belliveau *[See the Spring 2014 issue of the Watts Current Technical Bulletin]* to help populate the channel with a steady stream of fresh content. The goal is to provide short instructional videos that explain how to perform a certain task, or highlight the capabilities of our instruments.

From the beginning, we made the decision not to attempt splashy, big-production commercial-style videos. Instead, we try to provide simple easy-to-understand explanations of specific topics – real people talking to real customers, as we like to say.

Q. **How do you decide which topics to cover in these videos?**

A. We get our "inspiration" from a number of sources. Sometimes we'll produce a video to address a question that has resulted in multiple Technical Support calls, such as how to connect a Simple Logger® to a computer or how the various DataView® file types are used. Other videos are more general and explain concepts such as RMS and the Kelvin method for measuring resistance. And many of our videos are product-specific, explaining the capabilities of an instrument or how to perform a particular task with it. Our ultimate goal is to provide videos for each product offered by AEMC®.

We're well aware that none of our videos will ever "go viral," but that's not our intent. Instead, we hope users will think of our channel as the go-to place where they can spend a few minutes to learn something useful and important to them. To do that, we want to be sure each video is addressing a real customer need. So if anyone reading this has a suggestion for a future video topic, please let us know. *[Editor's note: Visit the AEMC YouTube Channel.]*

Q. **What are the challenges producing documentation for a global company?**

A. An obvious issue is translation. Most of our user manuals and Help content are translated into multiple languages, over a dozen in some instances. This can be expensive and time-consuming, so we need to be sure the original material is clear and concise – while simultaneously being thorough and complete.

We also need to be mindful of terminology. For example, a word such as "default" can have very different meanings depending on context; and if mistranslated can be highly confusing to users. So translated content is reviewed by someone who's both a native speaker of the language and is familiar with our products on a technical level.

Q. What are the main differences between writing user manuals and writing Help?

A. User manuals are expected to have a formal structure, with topics in a specific order. Usually this follows a task-oriented flow, with information presented in the same sequence a typical user is likely to need it – introduction, setup, configuration, operation, and so on. Not everyone reads manuals cover-to-cover of course; many users (especially experienced ones) will go straight to the section they need and skip the rest. But the expectation is that topics are ordered in a way that's both logical and useful.

Help systems tend to be more "free form," with users jumping in from many different entry points, such as pressing F1 or the Help button on the screen. It's probably relatively uncommon for a user to open the Help system and then read all the topics from beginning to end. We still order the topics in a logical sequence, for users who feel comfortable navigating a Table of Contents. But it's not as rigidly structured as user manuals tend to be.

And we try to make each Help topic as complete and standalone as is reasonably possible, since there's no guarantee the user has read any other part of Help. They may have just come across some feature they didn't understand, pressed F1, and went straight to that topic. We don't want them to have to jump around Help and follow a bunch of links to find the answer.

Q. What is your target audience for the *Technical Bulletin*?

A. Pretty much the same as the videos: users who want to learn more about an instrument's capability, or how to perform a particular task. In fact, there's a lot of overlap between topics covered in the *Bulletin* and our YouTube channel. Visually-oriented users can visit our channel, and users more comfortable with written material can consult the *Bulletin*.

In upcoming issues of the *Bulletin*, we hope to provide more real-world examples of how to use our products to solve problems in specific situations. Over the years, we've accumulated a large reservoir of experiences working with customers in a wide variety of industries and environments. We want to share these experiences with users in similar situations. And as with videos, we're very open to suggestions for topics upon which to base future articles.

Q. How does producing content at AEMC® differ from other companies?

A. I've been a Technical Writer for over 35 years, working for companies that ranged from small startups to giant multi-national corporations. One common theme among those companies was what I call a "calendar-driven" approach to product development. Basically, they'd pick a date to deliver a product and then stick to that date at all costs. If the product wasn't quite ready by the deadline, they'd often find a way to ship it anyway – maybe some features would be dropped, or the product would be released with known issues. Needless to say, this created a somewhat chaotic environment in which to produce documentation, since so many changes would be occurring right as the product was about to go out the door.

At AEMC®, we follow what I consider to be a more "criteria-driven" philosophy. As with any company in a competitive industry, we naturally want our products to be released in a timely fashion. But we're also willing to hold off release until we're convinced the product is complete, thoroughly tested, and fully functional. This makes for a considerably more stable environment in which to produce documentation, since major last-minute changes are relatively rare. Far more important, this approach ensures our customers can be confident all our products provide the versatility, reliability, and quality they've come to expect from AEMC®.