AEMC® INSTRUMENTS
CHAUVIN ARNOUX GROUP

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Issue 17 **"WATTS CURRENT" TECHNICAL BULLETIN** *Winter 2019*

NEW PRODUCT

Portable Oscilloscope
MODEL OX 5042

Inside This Issue:

Ideal Replacement for the discontinued
Fluke® Model 43B
Power Quality Analyzer

Featured Products:

PowerPad III® vs PEL® Feature Comparison

AEMC's Power and Energy Loggers Model PEL® instruments provide all the necessary functions and features for power and energy data logging for most 50Hz, 60Hz, 400Hz, and DC distribution systems worldwide. Primary uses include performing power system evaluation and monitoring.

The AEMC PowerPad® family combines data logging with sophisticated power quality analysis. These portable three-phase network analyzers enable utility company personnel to measure single and three-phase networks, and perform diagnostics.

Although PEL and PowerPad instruments share a number of the same capabilities, there are also significant differences between the two product lines. These differences are important considerations when deciding which instrument is better suited for your applications and requirements.

Common features

Before we examine the differences between the PEL and PowerPad families, let's take a look at areas in which these instruments are similar. Both are designed to provide mobile, easy to use data analysis and logging, although different models emphasize different features and functionality. Both measure a variety of 50 and 60Hz distribution systems. And both are supported by AEMC's DataView software with a dedicated Control Panel for configuring the instrument, viewing real-time measurement data, and generating reports.

In addition, both the PEL and PowerPad families include a rugged model that provides IP67-level protection.

PowerPad features

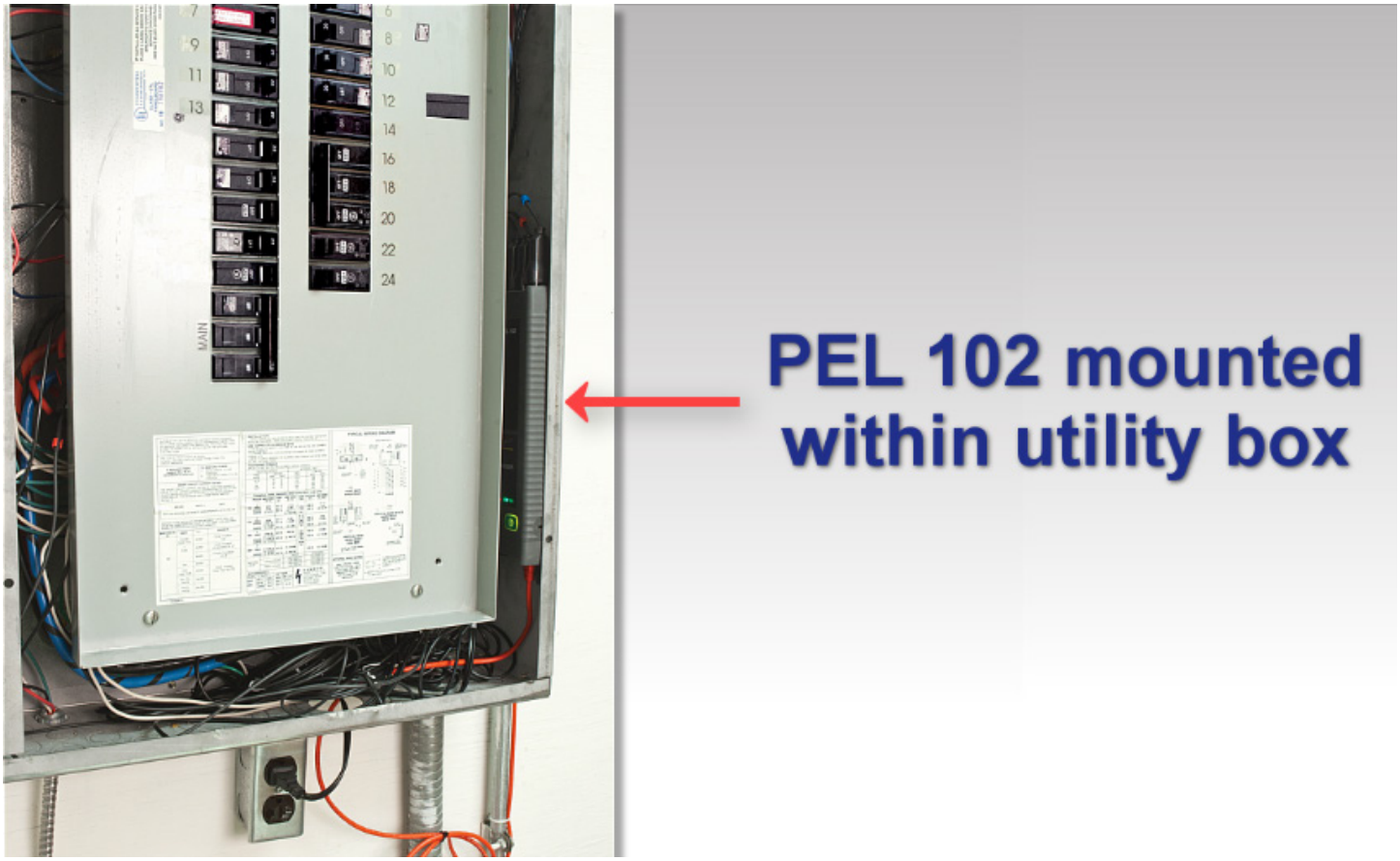
At first glance, one of the more obvious characteristics of the PowerPad is its user interface. The front panel features a variety of function, mode, configuration, and selection buttons. Combined with the bright, backlit display screen and sophisticated graphics, these buttons provide an extensive suite of advanced standalone capabilities.

For example, you can view data as tables, bar charts, waveforms, or phasor diagrams. You can save a snapshot of the displayed data in the instrument's memory.

The PowerPad can detect and record short-term anomalies such as transients and inrush current. You can also configure alarms to identify when a measurement falls outside defined parameters. The PowerPad takes 256 samples per cycle, resulting in over 15 thousand samples per second on 60Hz networks. This allows the instrument to calculate highly detailed sub-cycle data. PowerPad can also measure neutral voltage and current, and supports 5-wire networks.

PEL features

Now let's turn our attention to the PEL. The economical PEL 102 and 103 are smaller with a slimmer profile than PowerPad instruments, so they can be unobtrusively mounted in locations where space is limited.



They provide a wider range of connection options, including Bluetooth, Ethernet, Wi-Fi, and IRD server, depending on model. This allows you to set up PEL networks consisting of many instruments widely scattered throughout the world, all centrally managed from a single location. This enables an operator to configure, monitor, and download data from a global PEL network, and then generate reports that includes data from all or a select subset of these instruments. Typical applications for the PEL include demand metering and curtailment programs that often entail protracted recording sessions.

Each instrument can store up to 32GB of trend data for recording sessions that can run for many months or even years, depending on configuration. PEL instruments work with 400Hz distribution networks.

Conclusion

In summary, a general rule of thumb is that PowerPad instruments are optimal for applications involving detailed power quality analysis, especially those that require capturing short-duration anomalies. If your primary focus is performing on-site analysis and diagnostics in real time, the PowerPad is the best choice.

The PEL, on the other hand, is ideal for recording large amounts of power and energy data while operating unattended for long durations, in environments with limited space and access. A wide range of connectivity options enable you to build global networks of centrally controlled instruments. You can perform long-term data logging and monitoring of trend data, which can then be downloaded to a computer for analysis and troubleshooting.

PowerPad vs PEL

- Advanced UI
- More robust standalone features
- Data snapshots
- Transients and inrush
- Measure neutral voltage and current
- Supports 5-wire networks
- Faster operation

PowerPad: Detailed power quality analysis and diagnostics performed on-site in real-time.

- Smaller and slimmer
- More communication options, including Bluetooth, Ethernet, Wi-Fi, and IRD server (model dependent)
- Can be configured in global networks and centrally managed using an identical set of settings
- Larger storage capacity
- Supports 400Hz distribution networks

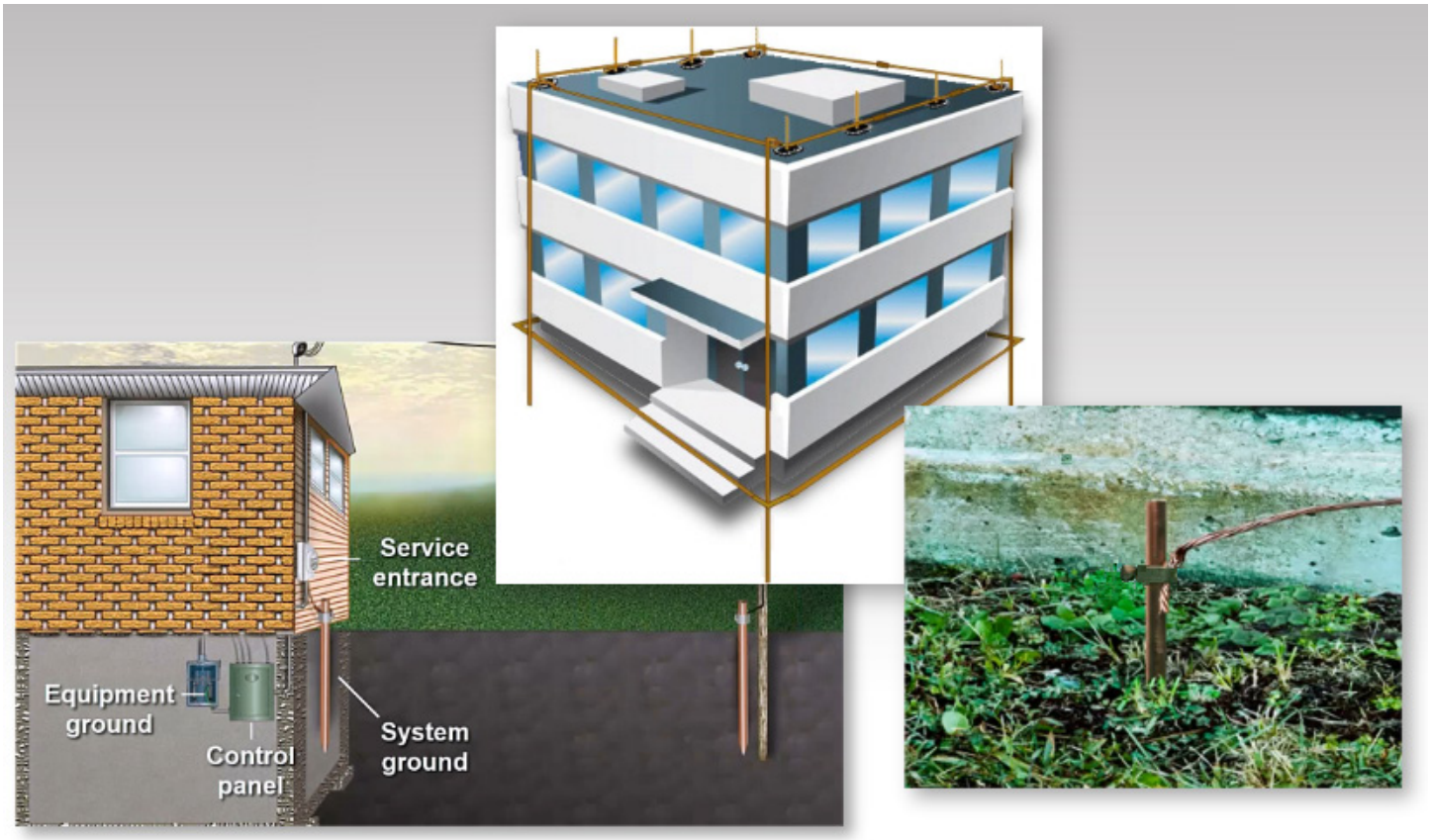
PEL: Power and energy logging over extended periods, for example demanding metering and curtailment programs.

Again, bear in mind that both PowerPad and PEL are versatile and share a number of capabilities. For instance, PEL does offer limited power quality analysis capabilities, while PowerPad can perform data logging. There are many applications in which either instrument would be well-suited. However, if you need to select one instrument over the other, the functionality and feature differences discussed in this article can help you decide which model is ideally matched to your specific requirements.

For more information about AEMC PowerPad and PEL instruments, please visit our web site. And be sure to visit our YouTube channel for instructional videos on a wide variety of topics in electronics.

Understanding Ground Resistance Testing Seminar

In today's rapidly changing world of technological advances, good grounding of electrical systems is more important than ever. Grounding provides low-resistance paths for discharging fault currents, protecting personnel from injury and system components from damage. Low ground resistance is required to meet NEC, OSHA, and other electrical safety standards.



Whether you're performing regular ground testing on existing systems, troubleshooting power quality problems, or designing grounding systems for new installations, it's essential to have a solid understanding of ground and soil resistivity testing procedures, and the equipment used for conducting these tests.

AEMC, the world leader in ground testing instruments, proudly offers Understanding Ground Resistance Testing, a one day technical training seminar presented by our staff of engineers and technical personnel. This course provides all the information you need to understand proper sizing and testing of grounding systems.

Through a combination of classroom instruction and hands-on field demonstrations, you will learn the various types of ground resistance tests, the proper application for each test, and how to correctly operate the equipment used in conducting these tests. This course provides all the information you need to perform accurate and efficient ground resistance testing.

The classroom session discusses all aspects of testing soil resistivity, ground resistance, and bonding. The 4-Point soil resistivity test and 3-Point Fall-of-Potential ground resistance test are presented along with the revolutionary clamp-on method. We cover the standards and codes that affect ground testing, including sections of the IEEE Green Book, IEEE standard 81, and article 250 of the National Electrical Code.

The course also provides hands-on field use of the different ground resistance testing methods discussed during the classroom session. All participants will have the opportunity to gain hands-on experience with proper testing procedures, including measurement of soil resistivity, correct placement of test rods, using the 3-Point method, and proper use of the clamp-on test method.

Class materials include a binder and USB drive full of useful tools and information. You also receive calculator clipboards, a personalized training certificate, and a free digital multimeter.

Classes are held throughout the year, at various locations across the U.S. To check the latest schedule and sign up for a class near you, visit our web site. You can also register by phone. Early bird and quantity discounts are available.

Hope to see you there!

Battery Basics, Part 2:

Determining Battery Capacity

In Part 1 of our review on battery basics, we presented a brief explanation of how a battery works, the difference between disposable and rechargeable batteries, and the various designs used for each.

In Part 2, we take a look at how to interpret battery specifications (such as capacity, performance, and life) and how to match them to your specific application to help ensure you select the most appropriate battery for your requirements.

To ensure you're comparing apples-to-apples when selecting a battery, let's take a moment to discuss specifications.

Amp-Hour (Ah)

In addition to voltage and current, an important measure for judging a battery's capacity is the ***amp-hour***, abbreviated as Ah. This represents the discharge current a battery can ideally deliver over time. For example, a battery rated at 2000 milliamp-hours can provide one milliamp for 2000 hours, 2000 milliamps (in other words, 2 amps) for one hour, and so on. (Note that this represents "ideal" battery operation; real-world factors can impact the actual battery capacity as explained below.)

Amp-hour provides a quick way for estimating how long the battery can deliver power for a specific application: simply divide amp-hours by the load.

There is a lower limit to this calculation, however, due to the battery's internal impedance. Amp-hours can also be affected by the load. Higher loads can cause the battery to lose energy in the form of heat, reducing its effective life. It can also lower the battery's voltage. Therefore the amp-hour rating only applies under specific conditions. Consult the battery's specifications to determine how higher loads affects amp-hours.

Note that amp-hour does not represent the final word on the amount of energy stored in the battery. Batteries with the same amp-hour rating may have different voltages. The battery with the higher voltage can provide more power than the lower voltage battery over the same time period for a specific current. So to ensure a more meaningful comparison, we can multiply voltage by amp-hours to calculate each battery's watt-hour value.

C-rating

Another important variable to consider is the so-called ***C-rating***. This measures the battery's discharge rate, and is used to calculate the maximum continuous discharge current. This is the highest current the battery can safely deliver. To do this, multiply the C-rating by the amp-hour rating. The C-rating is also used for the charge rate for rechargeable batteries

For example, consider the 2000 milliamp-hour battery we discussed earlier. If this battery is rated 1C, the maximum continuous discharge current is 2 amps. If the C-rating is 5C, the maximum current is 10 amps. This is an important factor when choosing a battery for electronics with variable loads. The C-rating allows you to determine whether or not your battery is capable of handling the application's peak loads.

Note that the voltage discharge curve is not always identical between chemistries. The curve for alkaline batteries is more or less linear, and therefore is a good indicator for how much charge remains in the battery. On the other hand, nickel-metal hydride units initially discharge relatively slowly over time, and then discharge rapidly. This makes it difficult to estimate remaining battery power from the discharge rate.

Bear in mind that the rated amperage for a battery represents the amount of current it *can* supply, not necessarily the current it *will* supply. The current provided by the battery depends on the load. For example, a 1 amp battery connected to a 500 milliamp load will provide 500 milliamps of current. Increasing the load increases the amount of current being supplied, up to the battery's 1 amp limit.

Battery sizes

A well-known fact about batteries is that they come in a broad range of sizes and shapes. Some of these, such as AA and C-cells, are extremely common and familiar to most consumers. Others are more special-purpose and designed for specific devices and applications. Some sizes come in a single chemistry type; others are available in a choice of chemistries.

As a rough rule of thumb, the larger the battery the higher its capacity, although there are numerous exceptions to this rule, particularly for batteries designed for applications that require both high energy and limited size and weight.

The following table compares a few of the more common standard battery sizes.

Size (illustrations to scale)	Dimensions (mm)	Nominal Voltage	Capacity (mA)	Chemistry (typical)	Uses/Comments
 AAAA	8.3 x 42.5	1.5	625	alkaline	Small devices such as pen lights
 AAA	10.5 x 44.5	1.5, 1.2	800-1200	alkaline, NiMH	Many household devices. Available in both disposable and rechargeable types.
 AA	14.5 × 50.5	1.5, 1.2	600-3000	alkaline, NiMH	Many household devices. Available in both disposable and rechargeable types.

 ½ AA	14 × 25 (nom) 14.5 × 25 (max)	3 - 3.6	850-1200	lithium	Small devices, military applications.
 C	26.2 × 50	1.5, 1.2	3800-8000	alkaline, NiMH	Flashlights and other household electronics. Available in both disposable and rechargeable types.
 D	34.2 × 61.5	1.5, 1.2	2200-12,000	alkaline, NiMH	Flashlights and other household electronics. Available in both disposable and rechargeable types.
 A23	10.3 × 28.5	12	55	alkaline	Small RF devices that require only infrequent pulse current.
 A27	8.0 x 28.2	12	22	alkaline	Small RF devices such as car alarm remote controls.
 E (9-volt)	48.5 × 26.5 x 17.5	9, 7.2	120-1200	alkaline, lithium, NiMH	Many electronic devices. Typically consists of 6 separate cells. Available in both disposable and rechargeable types.
Lantern (spring)	115 x 68.2 x 68.2	6	10,500-26,000	alkaline	Larger household items such as backup lighting. Typically contains 4 separate cells.
 CR123A	34.5 x 17	3	700-1500	lithium, lithium-ion	Cameras. Available in both disposable and rechargeable types.
Button (numerous sizes)				lithium, silver oxide	Button batteries come in a variety of sizes and capacities. They are used in small devices, such as digital watches.

Safety

Nickel-metal hydride and lithium-ion battery packs can rapidly release high levels of energy. As a result, safety devices are often incorporated within the battery to help minimize risk during battery operation, transport, and storage, to protect the battery and the device in which it is installed. This can be a simple fuse that opens on high current. In some cases, the fuse renders the battery inoperative. Other fuses can be reset. Note that CE certification for some devices requires a protection capability for the battery power source.

Lithium-ion batteries sometimes employ a more sophisticated safety measure consisting of a solid-state switch that measures the current and voltage and disconnects the circuit if the values are too high.

Other safety devices include resistive temperature devices, or RTDs, designed to disconnect the battery when its internal temperature exceeds threshold levels.

At the higher end of battery safety features is the smart battery. This is a rechargeable battery pack that includes an internal microchip, circuits and sensors. This battery management system monitors voltage, current, temperature, and other parameters that comprise the battery's overall state of health. This data is then communicated to external devices to issue requests such as starting and stopping a recharging session. Battery management systems add to the purchase price, but help ensure the battery is used safely and efficiently.

These and other safety measures are important considerations when choosing a battery for electronic devices used in hazardous areas.

This concludes Part 2 of our review of battery basics. In Part 3, we complete our series with a review of battery recharging, storage, cleaning, and disposal.

Measuring Humidity (and Why it's Important!)

Most people are all too aware of the effects humidity can have on human comfort and health, especially when combined with high temperatures. Perhaps less well known is how humidity can impact electrical systems. For example, high humidity can cause droplets of liquid water to condense on circuits, producing problems such as shorting and corrosion.

Many geographic regions are prone to humid conditions, particularly the tropics. But even in relatively temperate climates, high humidity can occur depending on altitude, proximity to bodies of water, and seasonal effects. In addition, the "microclimate" inside and immediately around an electrical cabinet can result in condensation-related issues. As a result, standards bodies such as the InterNational Electrical Testing Association (NETA) often require that humidity data be included in test reports.

Absolute vs Relative

Simply stated, humidity is the amount of water vapor in the air. This is commonly measured either of two ways:

- ***Absolute humidity (AH)*** is the mass of water vapor present in a given volume of air. This is usually expressed in grams per cubic meter (g/m^3) and changes as the volume of air changes.
- ***Relative humidity (RH)*** is the ratio of water vapor density (mass per unit volume) to the water vapor density at the saturation vapor pressure (the point at which the air can hold no more water vapor and liquid droplets begin to precipitate out; this is also known as the ***dew point***). This is typically expressed as a percentage, and changes with air pressure and temperature.

In this article, humidity will be expressed as RH.

Humidity and People

Maintaining an appropriate level of humidity is important for ensuring a comfortable and healthy indoor environment. Excessive humidity can make working difficult, especially if physical activity is involved. Less directly (but equally important), high humidity promotes the growth of mold that can cause respiratory issues. It can also cause peeling paint, rust on iron objects, and slippery surfaces slick with condensation. These and other factors can significantly affect your health and safety.

In general, a humidity level between 30 and 40% is considered ideal for maximum comfort. To ensure the humidity remains within this range, facilities employ a variety of HVAC systems, including air conditioning, controlled mechanical ventilation, and dehumidifiers. To test their efficiency, it is important to periodically check the humidity level with hygrometers and other moisture measuring instruments. In many cases, it also can be useful to monitor humidity continuously over an extended interval, to identify potential trends and spikes.

Electronics

As noted at the beginning of this article, humidity can have a detrimental effect on electrical systems and components. The most obvious issue is condensation, which results when RH reaches 100%. For example, droplets of water forming on a heatsink can wick into the housings of power modules. In live conductors, liquid can compromise insulation. The damage may remain even after the RH falls and the droplets evaporate, making it very difficult to troubleshoot and identify the cause of the problem.

A number of factors can cause RH to reach the saturation point. One of the more common is temperature disparity. As air cools, the amount of water vapor it can hold decreases. Thus a sudden cooling causes RH to rise rapidly.

For instance, an electrical system can be warmed by the waste heat of its components. A sudden change in operating state (for instance a power failure) can cause the system to cool. Components such as the heatsink may cool far more rapidly than the air temperature in the enclosure, creating a condition where the heatsink temperature falls below the dew point. Therefore it is critical to be aware of any changes from operation from full to reduced power, such as equipment entering standby mode or an unexpected downtime.

Changes in air temperature can also cause internal condensation in electrical systems. Many heatsinks are cooled by outside ambient air. As the inlet air temperature drops in the evening the heatsink may be cooled to below the dew point. We therefore recommend monitoring both the interior and exterior RH over a period of days or weeks to understand how weather and system operation interact.

In addition to electrical conductance, humidity can also have a corrosive effect on many materials. Corrosion progresses rapidly when humidity exceeds 60%. And since corrosion also progresses as temperature increases, facilities in high humidity locations must carefully monitor (and prepare countermeasures for) the amount of water vapor in the air.

Organic components

A recent trend is to fabricate electronic components from organic materials, due to their reduced costs and ease of manufacture. Unfortunately, these materials present special humidity-related issues. This is due to the fact that they tend to be water-permeable, slowly absorbing moisture until its internal water concentration matches the ambient air.

Excessive levels of moisture in organic materials can severely impact performance and reliability. One obvious example is so-called "popcorn" cracking, caused when saturated organic materials are suddenly heated to a high temperature. Other longer-term effects include swelling of components, which can compromise electrical connections.

AEMC Thermo-Hygrometer Data Logger Model 1246

To help you monitor humidity in your facility, AEMC provides the Thermo-Hygrometer Data Logger Model 1246. This is a portable, compact digital meter designed for simplicity and one-hand operation. The instrument enables you to perform a variety of recording tasks with easy and intuitive setup from a computer using supplied DataView® software. The meter uses an NTC as the temperature sensor, providing excellent response time to changes in temperature, good repeatability and accurate readings. The Model 1246 also utilizes a thin film polymer capacitive type relative humidity sensor, offering excellent recovery from 100% moisture, and fast response time and durability.

Features include:

- Monitor and record temperature, humidity, and dew point
- Dual line display toggles between any two measurements
- User selectable temperature units (°F, °C)
- Built in sensor with removable protective cap
- Min and Max measurements stored
- Hold function freezes the display
- Spot or continuous recording up to 1 million measurements
- Blue luminescent backlit display
- Programmable alarms for temperature and humidity through software
- USB and Bluetooth communication
- Magnetic mount
- Battery or USB powered
- DataView® graphing and analysis software included

The Model 1246 can store up to 1,000,000 measurements on each channel (4MB). Recorded data is stored in non-volatile memory and will be retained even if the battery is removed. The instrument can measure from 3 to 98% RH, with an accuracy of ± 2% RH + 1 count when measuring between 10 to 90% RH.

For more information about the Model 1246, see https://www.aemc.com/products/environmental-testers/environmental-thermohygrometer-1246.

New Product:

Portable Handscope Model OX5042

AEMC® Instruments, a world leader in electrical test and measurement instruments, proudly introduces the Handscope Model OX5042, one of the few hand-held oscilloscopes on the market with isolated channels. This combines three instruments into one: 40MHz oscilloscope, double 8000-count TRMS multimeter/power analyzer, and harmonic analyzer.

The Handscope measures two channels of individual harmonic content up to the 31st harmonic. It instantly displays measurements in multimeter mode at the press of a button. The instrument also automatically displays measurements for both isolated channels from your choice of 19 measurement types. You can view real-time measurements on your computer configure the Handscope, export data to spreadsheets using the SX-Metro included software. This makes the instrument the ideal replacement for the discontinued Fluke Model 43B

The Model OX5042 features:

- Two fully isolated inputs
- Simultaneous voltage and current measurements display
- Auto scaling
- Full color 3.5 inch display
- Scope, Multimeter and Harmonic modes at the press of a button
- Hold function
- Ability to store up to 100 screenshots recallable to the display
- 2MB recording data
- 8 hours of battery life
- Rechargeable batteries
- Stores 2700 measurements (5 minutes up to 1 month)
- Isolated USB communication
- Analysis software and communication cable
- Integrated interactive multilingual Help function

The Handscope includes all the necessary probes and test leads to perform electrical measurements.

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