AEMC® INSTRUMENTS
CHAUVIN ARNOUX GROUP

Chauvin Arnoux® Inc.

15 Faraday Drive • Dover, NH 03820 USA • (603) 749-6434 • Fax (603) 742-2346 • www.aemc.com

*Issue 15* **"WATTS CURRENT" TECHNICAL BULLETIN** *Summer 2018*

# Special Environmental Issue: Testing Air, Light, and Earth


## Inside This Issue:

# Indoor Air Quality

Indoor air quality has become a significant public health concern in recent years. Numerous studies show that environmental conditions in the office, classroom, and home can have a detrimental impact on physical comfort and mental performance. Understanding and controlling common pollutants within a building can help reduce health risks for its occupants -- while often providing the additional benefit of improving productivity and reducing energy consumption.


## Health Concerns

In many large cities with severe air pollution, office buildings with sealed windows are now the norm. Unfortunately, this often creates an indoor environment that degrades air quality. When unfiltered indoor air is continuously recycled without exchange with fresh outdoor air, volatile organic compounds, emitted from furniture and carpets, can raise the level of potentially dangerous pollutants. These gasses, combined with the carbon dioxide we exhale, can make occupants less alert, productive, or healthy.

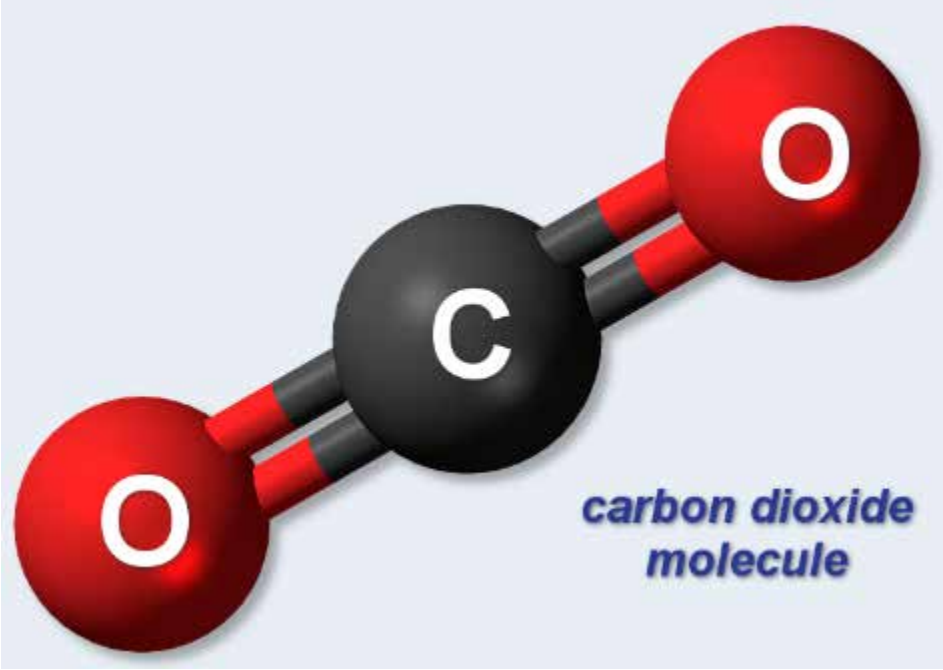
Symptoms caused by indoor air pollutants may appear shortly after a single exposure, or repeated exposures, to a pollutant. These include irritation to the eyes, nose, and throat; headaches, dizziness, and fatigue.

Other effects may show up years after exposure has occurred, or only after long or repeated periods of exposure. These health issues, which can include respiratory problems, heart disease, and cancer, can be severely debilitating or even fatal. It is therefore critical to carefully monitor the air quality in your facility or home, even if physical symptoms are not yet apparent.

## Carbon Dioxide

Among the various types of indoor pollutants, carbon dioxide typically attracts a great deal of attention, both as an indicator of the efficacy of a building's ventilation system, and for the adverse impact carbon dioxide itself can have on human health.

Carbon dioxide is a colorless, odorless gas that is a natural component of the atmosphere. It is also a byproduct of human breathing. The amount of carbon dioxide in a given air sample is commonly expressed in terms of parts per million. The ambient air in most outdoor locations around the world contains approximately 400 parts per million of carbon dioxide, while each exhaled breath by an average adult contains 35,000 or more parts per million. As a result, indoor levels can be considerably higher than outdoors, especially in facilities such as workplaces and schools, where large numbers of people spend the day in close proximity.




Without adequate ventilation to dilute and remove the carbon dioxide being continuously generated by building occupants, it can accumulate well beyond the 1000 parts per million level, and in some cases far higher. The amount found within an indoor environment is often used as a marker for whether other gaseous pollutants are likely to become a nuisance or hazard.

And although carbon dioxide is not usually considered toxic, recent research is raising concerns about the detrimental effects heightened levels of this gas may have on people. For example, a survey conducted by Lawrence Berkeley National Laboratory found that moderately high indoor concentrations of carbon dioxide can significantly impair a person's decision-making capabilities. Test subjects showed significant reductions in performance at carbon dioxide levels around 1,000 parts per million, and large reductions at 2,500 parts per million. This shows that even moderately elevated levels of indoor carbon dioxide can adversely affect us

## AEMC Products

Indoor air quality can also have an economic factor. Absenteeism, discomfort, and lowered productivity can directly impact employee performance. And elevated levels of pollutants may indicate that your ventilation system is running inefficiently and wasting energy.

Fortunately, as environmental sensors become widely available, indoor air quality is no longer an academic pursuit, but something building managers and others can track and manage.

For example, AEMC offers a variety of data loggers that can help you monitor indoor environments for occupant health and comfort. One such instrument is the Air Quality Logger Model 1510, which monitors carbon dioxide, temperature, and humidity in the local air. This compact, easy-to-use instrument provides quick and accurate readings, and can store up to a million separate measurements.


The Model 1510 features adjustable alarm settings for indicating when measurements fall outside a specified range. The display blinks with red backlighting when any of the measured parameters exceeds user selected thresholds.

The instrument includes USB and Bluetooth communication for downloading recorded data to a computer. It is also supported by AEMC's DataView data analysis software for viewing real-time data, configuring and running recording sessions, and creating reports. These reports can then be saved and reviewed for identifying and analyzing long-term trends. The instrument is also accessible via a free Android app. This allows you to view measurements in real time, display recorded data, configure the instrument, and perform other tasks directly on your Android smartphone or tablet.

Other AEMC instruments can also help you monitor and improve the efficiency of your facility's heating and ventilation.


For instance, the AEMC Environmental series of data loggers record a variety of environmental quantities, including air flow, humidity, dew point, temperature, and other environmental factors (including light, as explained in the next article in this Bulletin). These instruments are especially useful for assessing whether or not your HVAC systems are functioning efficiently, and what types of fine-tuning may be required to ensure optimal performance

## Conclusion

Let's take a moment to review:

- Indoor air quality has become an increasingly important issue in recent years.
- One particular area of focus is carbon dioxide, which can impact human health and performance, while also serving as an indicator of your ventilation system's efficiency.
- To help monitor the air quality in your facility, AEMC provides a variety of data loggers, including the Air Quality Logger Model 1510 for measuring carbon dioxide, humidity, and temperature.
- Other AEMC instruments can help monitor air flow, dew point, and other environmental parameters.

For more information about these and all other AEMC products, please visit our web site. And be sure to check our YouTube channel for instructional videos about other topics in electronics.

# Lightmeters and Office Lighting

Along with indoor air quality, office lighting has attracted a great deal of recent scrutiny. Clinicians are raising questions about the effects of working in environments that are too bright, too dark, or inconsistently lit. Others are concerned that the recent trend to replace traditional incandescent bulbs with energy-efficient LED and fluorescent lights may be increasing the risk of eye strain and related symptoms. While new lighting can significantly reduce energy costs, its long-term visual effects have prompted some to explore ways to limit worker exposure to this type of illumination.


Beyond health issues, researchers have studied the psychological impact of different lighting levels. Findings indicate bright lights tend to make employees feel more alert, which helps them concentrate on the task at hand. Conversely, dimming the lights can make people more creative, especially useful for brainstorming sessions. Therefore adjusting illumination to the level appropriate for the activity may (at least in theory) promote worker performance.

This article is a brief review of some measures you can take to help minimize the effects of poor quality lighting. And we briefly review AEMC lightmeters that enable you to monitor illumination in your facility, to ensure your employees are provided with a well-lit and healthy environment.

## Lighting Measurement Primer

When discussing lighting, it's important to understand the distinction between the terms illuminance, luminous flux, and luminous intensity:

- ***Luminous flux*** is the total amount of energy emitted from a light source in all directions. Luminous flux is measured in units called lumens.
- ***Luminous intensity*** is the amount of light emitted by a light source in a specific direction. This is measured in candelas.
- ***Illuminance*** is the amount of incident light spread over a given area. This is measured in lux (equal to one lumen per square meter) or footcandles (one lumen per square foot).

To help visualize the relationship between these terms, it may be useful to compare a light source to a lawn sprinkler that sprays water in all directions. Luminous flux is analogous to the total amount of water the sprinkler sprays. Luminous intensity corresponds to the amount of water that flows out of a single hole in the sprinkler head. And illuminance is the amount of water that falls on a given area of the lawn.

## Recommended Lighting Levels

The U.S. Department of Labor's Occupational Safety and Health Administration (OSHA) standard calls for minimum illumination levels for the following venues:

**Table D-3. Minimum Illumination Intensities in Footcandles (fc)**

| fc | Area of Operation |
|---|---|
| 5 | General construction area lighting. |
| 3 | General construction areas, concrete placement, excavation, waste areas, access ways, active storage areas, loading platforms, refueling, and field maintenance areas. |
| 5 | Indoor warehouses, corridors, hallways, and exit ways. |
| 5 | Tunnels, shafts, and general underground work areas. (Exception: minimum of 10fc is required at tunnel and shaft heading during drilling, mucking, and scaling. Bureau of Mines approved cap lights shall be acceptable for use in the tunnel heading.) |
| 10 | General construction plant and shops (e.g., batch plants, screening plants, mechanical and electrical equipment rooms, carpenters shops, rigging lofts and active store rooms, barracks or living quarters, locker or dressing rooms, mess halls, indoor toilets, and workrooms). |
| 30 | First-aid stations, infirmaries, and offices. |

In addition to these minimum levels, it can be equally important to be mindful of the appropriate *maximum* illumination for environments such as workplaces, as explained in the following sections.

## Health Effects of LED and Fluorescent Lighting

Although research is still ongoing, evidence appears to be mounting about the potential health risks associated with LED and fluorescent lighting.

For example, medical researchers have found that prolonged exposure to LED lights may cause irreparable damage to the retinas of the human eye. LEDs typically produce light in the high-energy blue and violet end of the visible light spectrum. Light from this spectral region can be particularly damaging to structures within the eye. In addition, LEDs do not produce near-infrared radiation, which many medical professionals believe is necessary for overall health.

Fluorescent lighting is also being studied for its potential detrimental health effects. For instance, some fluorescent lights emit high levels of ultraviolet (UV) radiation, which has been cited as potentially damaging to vision. One study estimates that fluorescent lighting may increase UV-related eye diseases by up to 12%. And as with LEDs, fluorescent lights oduce a rather limited spectrum.

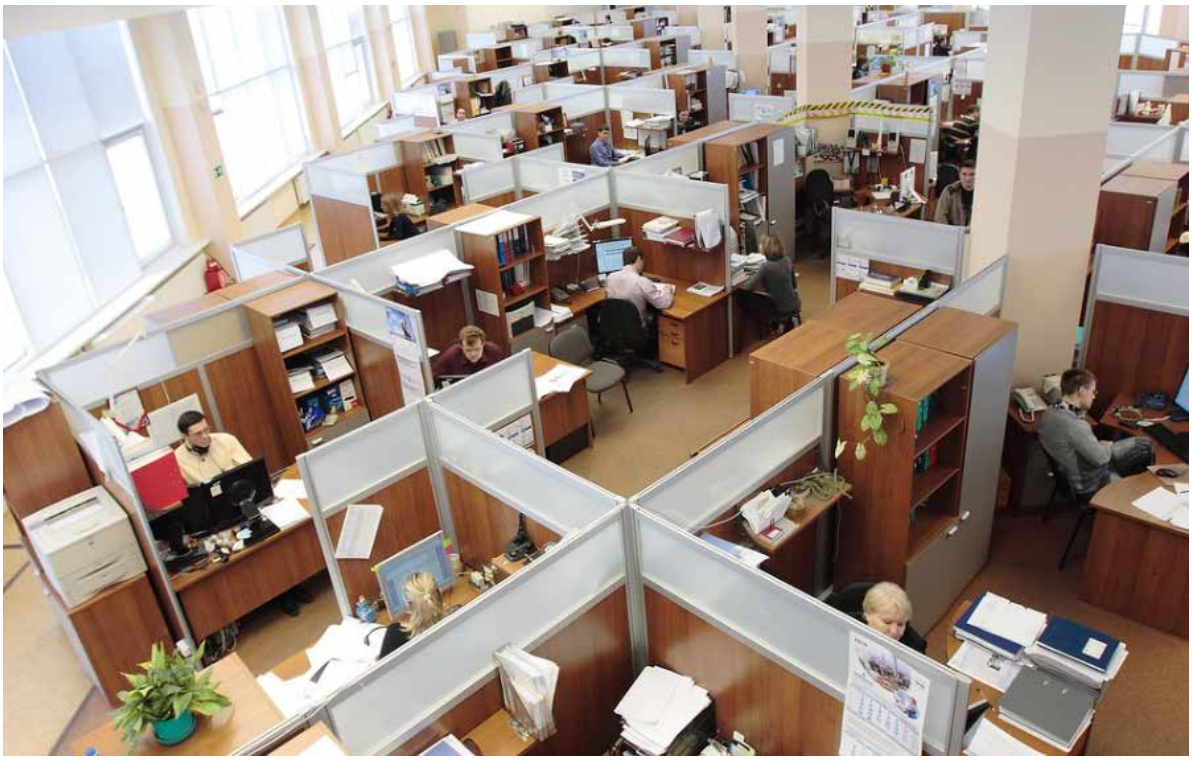
As a result of these and other potential health issues, many are paying special attention to the levels of LED and fluorescent lighting in their facilities.

## Office Lighting and Computer Screens

The typical office environment where employees spend hours on computers presents special lighting challenges. The average office illumination ranges between 75 and 150fc. This is significantly higher than the recommended levels for working with computers.

For instance, the suggested illumination for working with a computer display with a dark background is 18 to 46fc, while the recommendation for displays with white backgrounds is 50 to 75fc (all measurements should be made at desktop level). When the room is too bright for the computer, users often experience visual discomfort and related symptoms.

Perhaps even more important than brightness level is intensity evenness – in other words, maintaining an environment in which all objects in your field of view are more or less of equal brightness. Bright LEDs can often illuminate objects unevenly, causing high contrast images that can produce eye strain.



There are a number of measures you can take to help maintain illumination at an appropriate and consistent level:

- Use smaller desk lamps with incandescent bulbs rather than bright overhead lights. If you use auxiliary desk lighting, use low wattage and aim the light in a direction that does not directly enter your eyes or illuminate the computer display screen.
- Add blinds or drapes on windows. Adjust these throughout the day to admit the appropriate level of light.
- Orient workstations to avoid direct viewing of bright lights, while minimizing screen glare and reflections.
- Avoid white reflective surfaces in favor of matte desktops, furnishings, ceilings, and walls.
- If bright overhead lights cannot be dimmed or eliminated, advise employees to wear a visor to shield their eyes.
- When working with a computer, adjust its screen brightness and contrast to maximize character definition and resolution. Brightness should match the general background brightness of the room. If the screen appears to flicker, turn down its brightness level.

Finally, advise your employees to take regular breaks from their computer and mobile screens. Some clinicians suggest "20/20/20" breaks: every 20 minutes, take 20 seconds and look 20 feet away.

# AEMC Lightmeters Models 1110, C.A 811, and C.A 813

To help measure and monitor light in your facility, AEMC offers portable, easy-to-use lightmeters that incorporate optical sensors designed to match the response of the human eye. This makes them ideal for workspace analysis and planning.

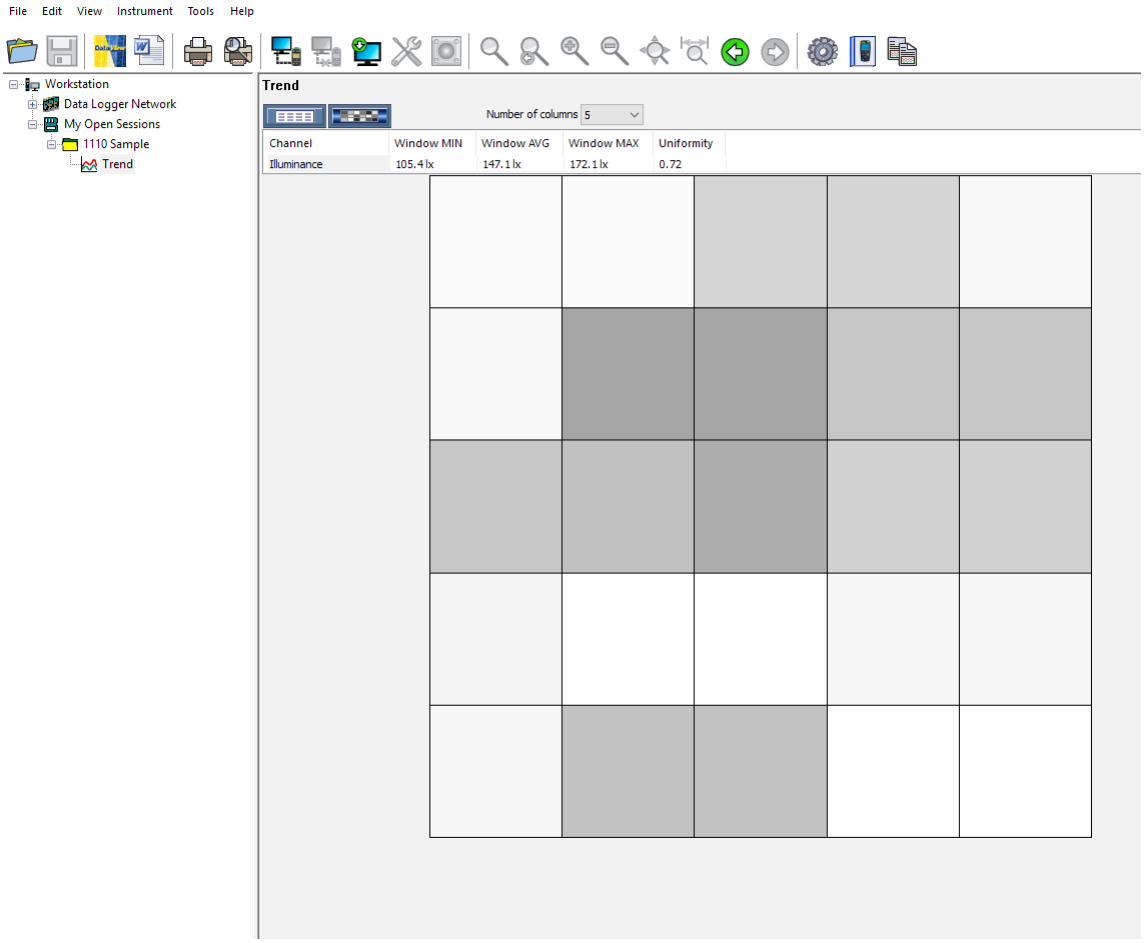
Each instrument features one-hand operation with an ergonomically designed case, large 3 1/2 digit backlit LCD display, and intuitive function selection including LCD, HOLD, and MAX. Other features are model-dependent, including PEAK, MAP, and data logging.


The following table compares the features of the AEMC lightmeters Models C.A 811, C.A 813, and 1110:

| Instrument | C.A 811 | C.A 813 | Model 1110 |
|---|---|---|---|
| Range | 20fc, 200fc, 2000fc, 20kfc | | 0.01 to 18,580fc |
| Display resolution | 0.01fc | | 0.01 to 10fc beyond |
| Sensor | Silicon photodiode | | |
| Spectral response | CIE photoptic curve | | Optical filter |
| Accuracy:<br>2856K light source<br>Common light source | ±5% R (reading) ±10cts<br>±18% R ±2cts | ±5% R ±10cts<br>±11% R ±2cts | ±3% R on incandescent sources (default)<br>±6% R on LEDs (3333k to 6666k)<br>±9% R on fluorescent sources |
| Sample rate | 2.5 times per second nominal | | 1 second |
| Display | 3 1/2 digit LCD 2000 count | | custom digital |
| Operating temperature | 32° to 122°F (0° to 50°C), RH without battery | | 14° to 140°F (-10 to 60°C) |
| Polarity | Automatic | | |
| Power source | One 9V alkaline | | Three 1.5AA alkaline |
| Low Battery indication | ✓ | ✓ | ✓ |
| Dimensions | 6.81 x 2.38 x 1.5"<br>(173 x 60.5 x 38mm) | | 5.9 x 2.8 x 1.26"<br>(150 x 70 x 32mm) |
| Measures fc & lux | ✓ | ✓ | ✓ |
| Range button | ✓ | ✓ | |
| HOLD function button | ✓ | ✓ | ✓ |
| MAX function button | ✓ | | ✓ |
| Peak function button | | ✓ | ✓ |
| Measures incandescent | ✓ | ✓ | ✓ |
| Cosine corrected | ✓ | ✓ | |
| Backlight button | ✓ | ✓ | ✓ |
| Spectral compensation for LED and fluorescent lighting | | | ✓ |
| User-selectable light source | | | ✓ |
| Auto power OFF | | | ✓ |
| MAP mode | | | ✓ |
| Data logging | | | ✓ |
| Removable light sensor | ✓ | ✓ | ✓ |
| Wall power adapter | | | ✓ |

Note that the Lightmeter Data Logger Model 1110 can perform a variety of recording tasks with easy and intuitive setup from a computer using AEMC's DataView® software (provided free with the instrument in the Americas and Australia).

The Model 1110 also includes the MAP feature. This lets you plot the illumination for a 2-dimensional space or surface. For example, in MAP mode you can measure the illumination at specific points within a room. You can then download the recording to a computer running DataView, and display the measurements as a 2-dimensional matrix, creating a "map" of the illumination within the room. This helps you quickly identify areas of dark, overly bright, and uneven lighting as indicated by the shading in the blocks (see below). Hovering your mouse or pointing device over one of the blocks will display the actual measurements.




The Model 1110 can also be set up to measure specific types of lighting sources, including LED and fluorescent.

For more information about AEMC lightmeters, please visit our web site at www.aemc.com.

## Customer Support Tip:

# Simple Logger II Containers from Mailing Tubes


Looking for an easy and low-cost way to store your Simple Logger II instruments? Consider using mailing tubes! These are readily accessible and inexpensive. For example, most Simple Logger II models can fit comfortably within a 3" diameter tube; while larger instruments such as the Model CL601 can fit in a 4" tube.

Several Simple Logger II containers can be made from a single tube. The length of each container can be adapted to accommodate the requirements of the specific instrument along with its leads and accessories. Use a hacksaw or similar tool to cut the tube.

To make the container more rugged, you can purchase tubes with thicker walls. You can also wrap the tube in duct tape to improve its resistance to water and other contaminants. When finished, write the name of the instrument on the end cap for quick identification. These containers can then be stacked and stored a variety of ways, providing both protection and quick access for your Simple Logger II instruments.

Feel free to customize the container design to your needs and location. For example, you can drill a hole in the top of the container and run a loop of wire through it, enabling you to hang instruments on a wall. You can also use a hook or other type of fastener in place of the wire.

Note that mailing tubes also make excellent low-cost containers for other AEMC products, including flexible probes, phase rotation instruments, sensors, and others.

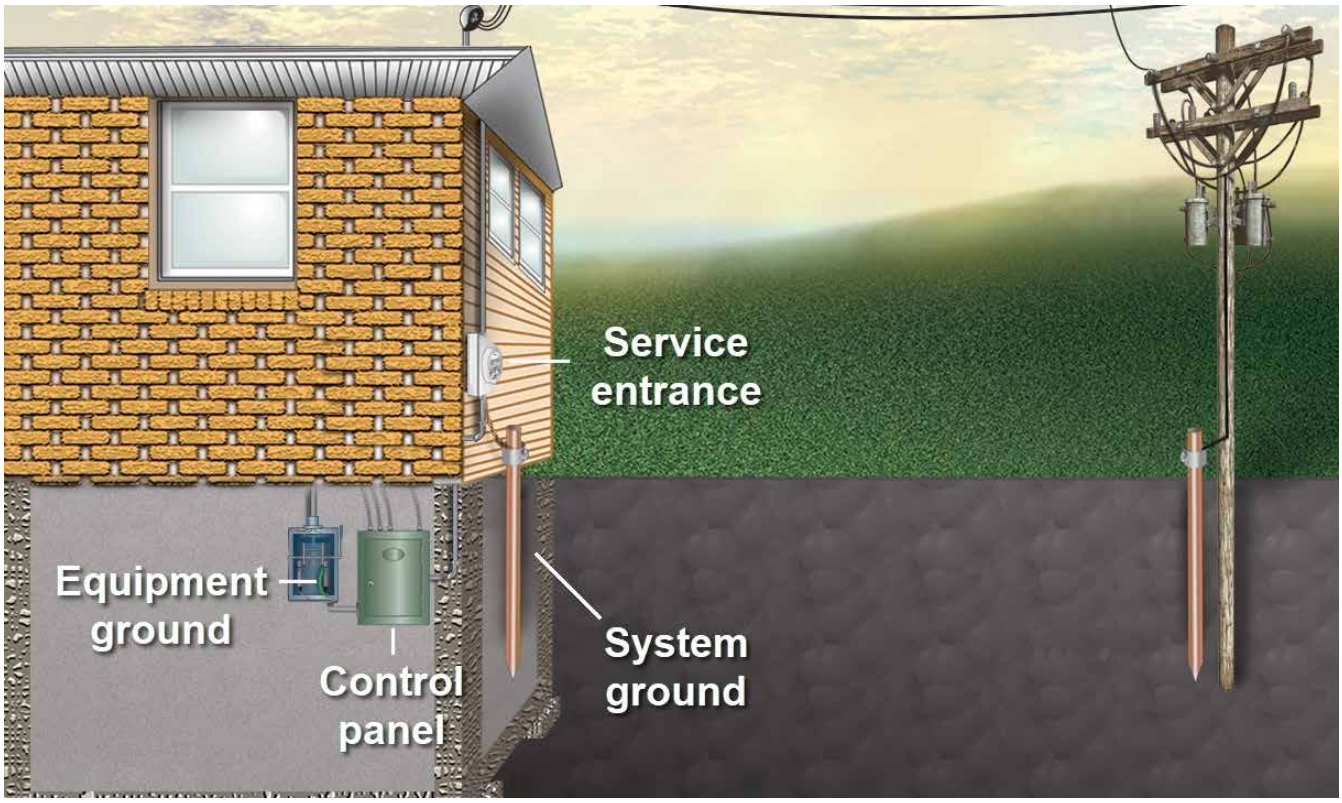
### *About the Author:*

Ray Brady is an Application Engineer for AEMC® Instruments, Foxborough MA

# Grounding System Primer

In an electrical system, effective grounding ensures a safe working environment as well as proper equipment performance. A "ground" is a conducting connection by which an electrical circuit or equipment is connected to earth. This connection is used to establish and maintain as closely as possible the potential of the earth on the circuit or equipment connected to it. This connection to the earth provides a low impedance path for electrical currents to travel under fault conditions.

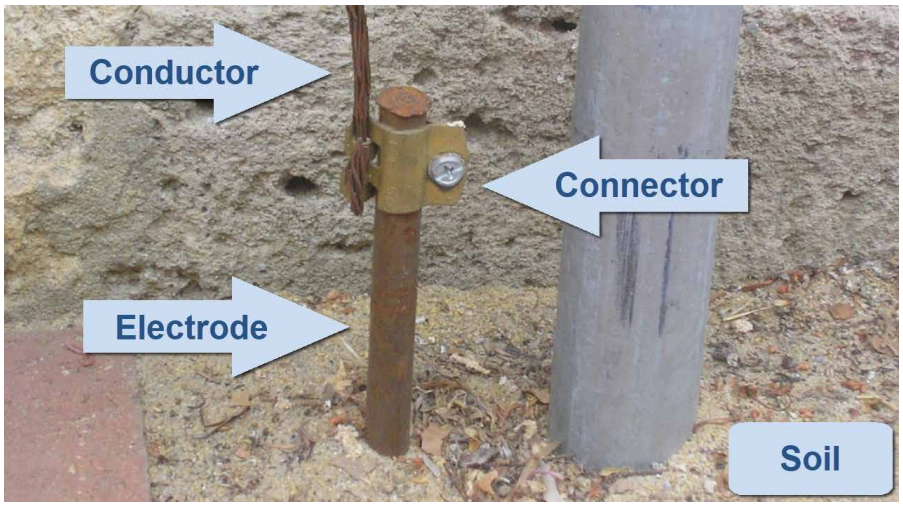
For example, most people know that the third pin on the line cord of an electric appliance is the ground connection. When a piece of electrical equipment is plugged into a wall receptacle, the ground terminal connects all exposed metal surfaces of the equipment to a common connection, called the "equipment ground," in the building's electric service panel. From this point the ground connection typically exits the building and is connected to the system ground at the building service entrance.



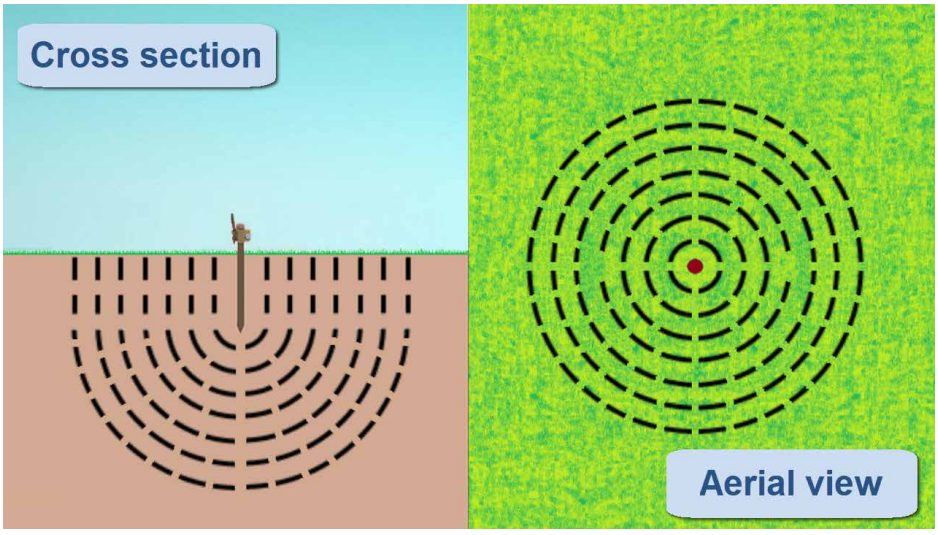

The system ground can be a simple metal rod driven into the ground as shown above, a grid consisting of multiple electrodes, or another type of grounding system

## Grounding System Components

A grounding system typically consists of a grounding conductor, a bonding connector, its grounding electrode (typically a rod or grid system), and the soil in contact with the electrode.




An electrode can be thought of as being surrounded by concentric shells of earth or soil, all the same thickness, with each successive shell having a larger cross-sectional value. Each successive shell offers less and less resistance until a point is reach that it adds negligible resistance. Current from the grounding electrode radiates in all directions in the earth through these concentric shells. The lower the soil resistivity, the lower the effective grounding electrode resistance will be as measured by a ground resistance tester.




Grounding systems can range in complexity from a single rod driven into the ground, to complex grids consisting of multiple rods connected with wire mesh, to other types of grounding systems incorporating plates, concrete, chemicals, and soil conductivity enhancers.

## Rods

The most common electrical grounding system consists of a single rod. These are familiar sights for providing grounding for homes, utility poles, and similar structures.

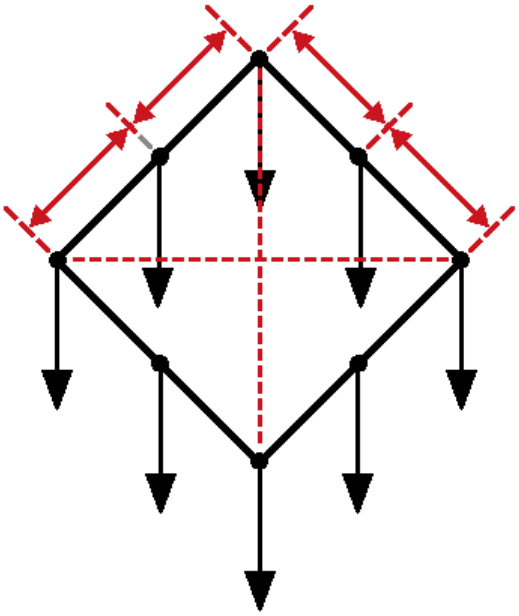
The rod is typically made of copper, stainless steel, or other highly conductive metal, often in combination. The composition, size, and length of the rod (along with the characteristics of the local soil) determine the efficacy of the grounding system.

Note that increasing the diameter of the grounding electrode does not significantly reduce its resistance. For instance, doubling the diameter reduces the resistance by less than 10%.

However, driving the ground rod deeper into the earth does substantially reduce resistance. As a general rule, doubling the depth to which the rod is driven into the ground reduces its resistance by up to 40%. However, this has its practical limits.

## Grids

Grounding systems can be grids consisting of multiple rods connected together. Grids are commonly designed for substations and similar facilities to provide the lowest possible earth resistance values, as well as to create an equipotential zone throughout the entire station. The fence surrounding the substation is usually included in this zone for safety reasons.



Multiple rod grids are typically constructed with ground rods exothermically welded to copper mesh, creating a large area of zero potential earth when installed properly

## Other Grounding Options

In addition to single rods and grid systems, other grounding design options are available. These include:

- ***Grounding plates.*** These are typically thin copper plates buried in direct contact with the earth. Grounding plates are often placed under poles or similar structures.
- There are also concrete-encased systems, often called ***"ufers"*** within the industry. These can be one or more copper rods, rebar, wire, or mesh encased in concrete, often incorporated as part of the building's foundation.

Also used are ***chemical rods*** consisting of a hollow electrode filled with electrolytic salts (see below). This option can provide an efficient ground system in locations where poor soil conditions are present and spacing for electrodes is limited.

- Chemical rods are often used in conjunction with ***soil enhancement materials*** that improve grounding effectiveness. These materials can also be used in other grounding systems located in soils with poor conductivity.

For more information on grounding system design and testing, consult the AEMC workbook "Understanding Ground Resistance Testing" (https://www.aemc.com/userfiles/files/resources/workbooks/950-WKBK-GROUND-WEB.pdf).

## New Product:

# Pocket Multimeter Model 5115

The AEMC Pocket Multimeter Model 5115 is a low-cost, professional, CE tested digital multimeter designed to a 600V CAT III rating. This compact instrument provides capabilities typically found only in much larger meters costing several times as much. The Model 5115 is sized to fit into your pocket – yet versatile enough to handle many electrical measurement tasks with attached leads and large, easy-to-use rotary switch.

Features include:

- Voltage to 600$V_{AC/DC}$
- Resistance to 20MΩ
- Continuity with audible alarm below 30Ω
- Full auto-range
- Flashlight
- Non-contact voltage (NCV) detection
- MAX function
- Attached leads (2mm)
- IEC 61010-2-033 compliant
- Diode test


For more information about the AEMC Pocket Multimeter Model 5115, please visit https://www.aemc.com/store/products/multimeters/multimeter-5115.

**Chauvin Arnoux®, Inc. d.b.a. AEMC® Instruments**
15 Faraday Drive • Dover, NH 03820 USA
Tel: (800) 343-1391 • (603) 749-6434 • Fax: (603) 742-2346
www.aemc.com • techsupport@aemc.com