The Power of Zap

The first installment of a series:

How to Find, Troubleshoot and Remedy Power Problems

By Chuck Crowley and Jim Daggon

Jim Daggon, senior product manager, and Chuck Crowley, senior technical support, wear static control wrist straps and use a (left) dissipative work surface to protect sensitive components and circuits from ESD. These items are available in our Rice Lake Master Catalog and at www.ricelake.com under "Hardware and Accessories."

ZAP! UNSEEN, UNFELT AND UNHEARD, electrostatic discharge (ESD), commonly known as static electricity, is damaging millions of dollars' worth of electronic components every year. What's more shocking is that you and your technicians are probably accomplices.

Electrostatic discharge is an electrical charge transferred between bodies at different electrostatic potential. "Static" electricity is the buildup of a charge on one object without a circuit for the current to flow through. When the charge builds up to the point where the voltage can "jump" the distance to a lesser charged object, it discharges with a spark. Once that spark occurs, the circuit is completed and current flows along the path of the spark. Lightning is the largest static electricity charge most of us will ever see. But we'll discuss lightning more later.

That ZAP! you get when you shuffle across the rug in the winter and touch the TV can be annoying, but the voltages that build up can be deadly to today's electronics. Quite often that damage is unseen. A zapped electronic device may work when it leaves your hands, but more than likely, its length of service has been reduced significantly.

You cannot feel ESD below 3,000 volts, hear it below 5,000 volts, or see the spark below 10,000 volts. Many electronic devices can be damaged by ESD of well under 1,000 volts—EPROMs can be damaged by only 100 volts!

If this sounds hard to believe, look at the following stats:

- In low humidity, walking with rubber-soled shoes across a vinyl floor can build up 12,000 volts.
- Pulling tape off a dispenser just 6 inches can build up 4,000 volts.
- Walking across carpet can build up 35,000 volts.

Without a ground path to dissipate the charge, nonconductors like papers, plastics, foam coffee cups, clothing, and people can carry thousands of volts.

While moist air allows charged bodies to slowly drain off an excess charge to ground, dry air inhibits that charge dissipation. Simply adding moisture to indoor air may stop painful charges arcing to your fingertips from light switches in carpeted rooms, but it is not sufficient protection for sensitive electronic components. For this protection, a total system that prevents all damage by static must be in place.

Electronic Equipment Damage—Power Related

Today's electronic equipment relies heavily on the power supplied to it to maintain its reliability, yet sometimes the power itself causes its downfall. Power for today's high speed, fast-computing, and full-featured designs are very susceptible to power anomalies that, less than a decade ago, would have been insignificant. In the reel-to-reel tape recorder days gone by, the higher tape speeds were used for higher fidelity, since any noise was then spread over a wider section of tape. This higher speed works against us in today's microprocessor clock speeds. A single extraneous pulse lasting a mere millionth of a second can disrupt 1,000 clock pulses in a 1 Ghz microprocessor.

Power anomalies come in a variety of types. Four of the more common ones are surges, sags, transients, and faulty wiring.

Surges

A surge is a prolonged increase in the voltage applied to a circuit that lasts at least one half cycle or more. In today's common household AC voltage of 120 volts at 60 Hz, that becomes any significant overvoltage that lasts more than 1/120th of a second. These surges can be due to a load that has been on the same line being disconnected (especially in the case of a purely inductive load such as a large motor) or a change in the supplied voltage from the source or utility. An external source, such as a lightning strike in the vicinity or along a power line, or a power pole event such as a traffic collision or equipment failure, can also cause a surge.

Power surges can affect electronic equipment catastrophically if the surge is high enough in overvoltage and duration. This can be as simple as blown fuses or internal power supply damage. However, smaller surges, or faster ones, can also cause damage that is not immediately apparent but that shortens the life of the equipment or leads to intermittent behavior. This effect is sometimes referred to as "electronic rust." An important point to remember when dealing with surges is that they do not always result in immediate equipment failure.

Sags

A voltage sag is the opposite of a surge. It is significant reduction in voltage that lasts for one half cycle or more. Although it might be assumed that low voltage would not have an adverse effect, the lower voltage can also put a strain on electronic equipment, particularly internal power supplies and other voltage-sensitive circuits, because they try to compensate with voltage that is not there by increasing the current to make up for the loss in power. Sags are not limited to catastrophic failures and also contribute to electronic rust.

Transients

Transients are much shorter in duration and more varied in nature. Rather than a simple over or under voltage, transients can also carry different voltage potentials within them and are the most common cause of electronic equipment power-related maladies.

Transients can be very fast and can be caused by any number of events including the ones listed above. In addition, the introduction of any additional voltage, directly coupled or induced, can produce transients, such as the use of portable two-way radios, microwaves, cordless telephones, cell phones, motors, fluorescent ballast transformers, dimmer switches, and computers. In addition, the voltage spikes found in transients can be much higher than those found in surges and sags, so they can contribute greatly to electronic rust and degradation of circuits in a short time. Often transients are hard to identify, and it is also difficult to pinpoint their origins.

Faulty wiring

A trained and licensed electrician may need to be involved in troubleshooting and correcting some of these problems. Some power problems masquerade as one of the above categories, but are rooted in faulty wiring. This can include neutral wires that are not grounded at the distribution box, ground wires that develop a low (or high) resistance to ground, and ground wires that are connected to the neutral but not grounded. Any of the above conditions can be caused by simple deterioration of a connection due to weather, temperature swings, rodents, or other outside influences. Some of these conditions not only cause damage to the equipment, but can also pose hazardous, even lethal, conditions for operators or personnel that come in contact with the equipment. Always be sure to check local electrical codes and laws concerning electrical installations before undertaking any of these tasks.

Power anomalies conclusion

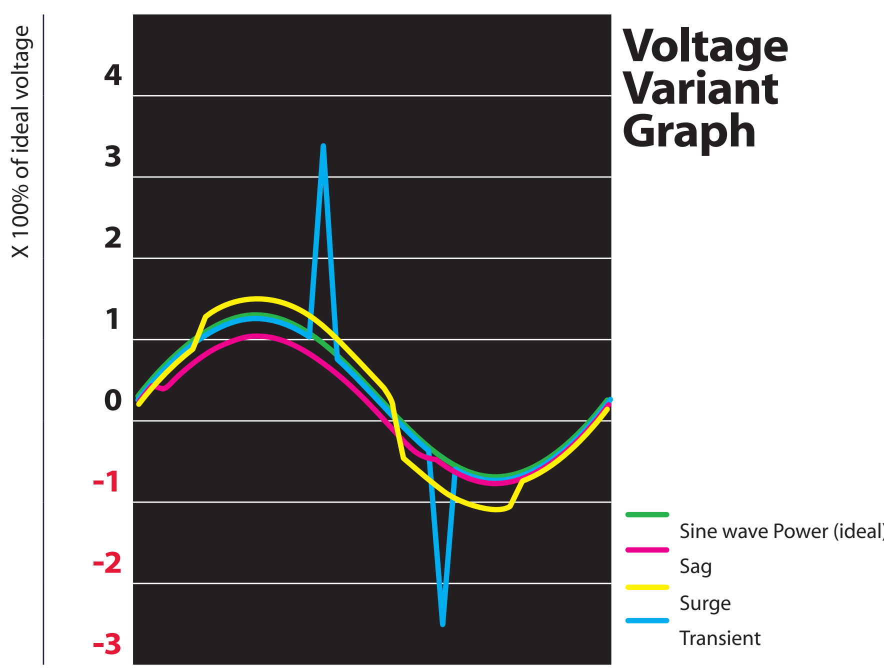
Many power-related problems can cause immediate or cumulative damage to today's high speed sophisticated electronic devices including weighing systems. In the next installment, we will look at how to troubleshoot these problems and take corrective (and preventative) actions to prolong and protect the operation of these devices.

Lightning—Dangerous static electricity!

A little static electricity can shorten the life of electronic equipment, but a lot of lightning can drastically shorten the life of a person. About 60 people every year are killed by lightning. Lightning takes a number of forms, including the common cloud-to-ground and cloud-to-cloud lightning. However, in cloud-to-ground lightning, the actual bolt goes from the ground up to the cloud!

Here's how it works:

When large thunderhead clouds form before a storm, they develop a charge of excess electrons in the bottom of the cloud and therefore have an opposite positive charge at the top of the cloud. These cumulonimbus clouds can be anywhere from



¼ to 12 miles above the ground. As they develop this charge, the excess negatively charged electrons begin to descend to the positively charged ground in a seemingly random, but "staircase" pattern, called a leader. This leader is not visible to the naked eye but can be monitored using specialized equipment.

Once the leader reaches a few hundred feet above the earth, a more positively charged region develops between the leader and the earth. This region includes the "tallest object" – which can be you, if you are not careful!

Once these two regions meet a few hundred feet in the air, the circuit is complete and the lightning bolt travels from the ground up into the cloud (at approximately 90,000 miles per second!), relieving it of *some* of the excess charge. The cloud still retains some charge, and the path of the first bolt, made by the leader and the positively charged ground region, can be used again and again. This is what we see when lightning "flickers." Many lightning strikes consist of three or four bolts, or discharge paths, along the same path. So, yes, lightning not only CAN but many times DOES strike in the same place twice! (The Empire State Building in New York City is struck by lightning on average 23 times each year and was once struck eight times in 24 minutes.)

Lightning can take a number of forms and all of the details are still not fully understood. The common cloud-to-ground lightning can consist of a 1-million-volt bolt, from ½ to 2 inches in diameter, traveling at approximately half the speed of light. The current in that bolt can be 40,000 amps or 200 times all the current available in the average household!

Cloud-to-cloud or "heat" lightning is simply the discharge of electrons within the same cloud or to an adjoining one. It is called heat lightning by tradition, but heat really has nothing to do with it.

The thunder that accompanies a lightning bolt results from the expansion of the air around the bolt. A lightning bolt heats the air through which it travels to about three times the temperature of the sun (about 20,000 degrees F) and does it almost instantly. The air immediately around the bolt is pushed by this rapidly expanding air which produces a shock wave, that we hear (later) as thunder. The delay occurs since light travels at approximately 300,000 km/second (186,000 miles per second) and sound travels at approximately .346 km/sec or 1/1,000,000 of that speed. So, when you see the lightning, count the number of seconds until you hear the thunder and divide by 5 to get the distance that the strike is away from you, in miles. ■

The Day Hollywood Called

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re-recorded and sent to the prop team for its second viewing.

"No different from any other custom solution we build," said Mark, Jr., "Rice Lake excels in custom program development by keeping customer feedback and programming results flexible in order to achieve optimal results. Although software can be modified in the field, our goal is to build in enough structure to the program while still allowing flexibility so the system can be adapted to the application after installation."

After uploading the requested additions to the 920i®, Gary delivered the indicator to Rice Lake's Testing Engineer Keith Kaiser to ensure the indicator was ready to be calibrated with the scale platform. As the deadline loomed, the scale and indicator were packed off to Hollywood.

As the cameras were placed and the lighting checked, Roger Kimber, western regional director, stepped through the target weight settings and weighing modes so the props team would be familiar with the programming established earlier through the video demo. While standing on the scale and adding more weight, the props team requested that the displayed weight be set up to simulate the needs of the script. Roger quickly created realistic set points in the user-defined mode which aided the props team during its training and filming and provided the Hollywood-style illusion of specific weight changes.

Soon the props team was ready to present the scale to the director of the premiere. It was important that everything on the scale, from bumper guards to indicator text, was authentic to a warehouse. Form and functionality for the RoughDeck® and 920i system were on the mark.

Scene 5 – Taping the Episode

The stand-in rehearsal allowed Roger to assist with a few more set changes. "I had picked up two cables the night before thinking they may want to operate the scale out of the shot," he explained. Indeed, the props team requested the option to target the scale out of sight. Within 45 minutes, Roger was able to communicate the necessary changes to Gary in Rice Lake.

The command changes were added to the custom programming, and the scale was now equipped with keyboard shortcut key commands to display the desired target. One last modification to the programming allowed the indicator to display a target weight and then decrease as one of the cast members de-scaled from the group weight. It worked great!

As the final credits rolled on NBC's *The Office*® season five opening episode, Rice Lake's legendary attention to customer service and flexibility in meeting customers' custom requirements shined brightly. Rice Lake provided the same celebrity treatment it provides every customer.

Maybe we'll receive an Emmy for our dramatic role on a hit television series. ■