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6 Common Bonding Problems and Solutions

Confusing terminology and a lack of formal education or training can cause problems with bonding in the electrical industry. By R. Scott Peabody

The telecommunications industry and the larger electrical industry have a ubiquitous problem, namely grounding, or more commonly, bonding. Every location, with only the rarest of exceptions, is plagued by interior and exterior bonding problems. Several factors contribute to this persistent

problem, including an industrywide lack of formal education and training on grounding for engineers, technicians, manufacturers, systems integrators, designers and installers. Haphazard on-the-job training based on a plethora of myths makes matters worse. People want to do the right

thing; they just don't know how.

Confusing Terminology

Unfortunately, the term grounding has been used as a synonym for bonding for 100 years, and old habits are hard to break. In 99 percent of telecommunications installations,



Photo courtesy R. Scott Peabody

The bare ground conductor should be replaced with green-jacketed 2 AWG ground wire and detached from the metal conduit.

bonding, rather than grounding, is involved. The National Electrical Code (NEC) defines bonding as, “the permanent joining of metal parts to form an electrically conductive path that ensures electrical continuity and the capacity to conduct safely any current likely to be imposed.” In communications systems, bonding eliminates the electric potential difference, known as voltage, and static discharge between pieces of equipment. The current resulting from the voltage difference and the static discharge may damage the equipment in its path.

Grounding is defined in the NEC as, “Establishing a connection, whether intentional or accidental, between an electrical circuit or equipment and the earth or some conducting body that serves in place of the earth.” For instance, the installation of a ground rod or a more complex grounding electrode system is grounding. Typically, the installation of a grounding electrode system occurs one time for an equipment enclosure, and bonding occurs with the installation of every piece of equipment.

The grounding electrode system is

a buried system of grounding elements providing a bonding point to the soil at the site. A ground rod or electrode driven into the earth for a residential alternating current (AC) power service is a simple grounding electrode system. Grounding electrode systems for communications sites are typically more complicated with multiple electrodes, buried conductors, rings, ground plates, concrete-encased electrodes or rebar, and more. Grounding electrode conductors are the wire, typically 2 American wire gauge (AWG), connecting the grounding electrode system to a ground bus bar.

The first step in solving any problem is recognizing there is a problem. Each of the six most common problems are listed, along with straightforward and usually inexpensive remedial actions.

1. No Equipment Bonds (Grounds)

The most common grounding problem is a lack of equipment bonds. Proper equipment bonds are easy to spot with green or green and yellow striped jackets. The wire size

is typically 6 AWG, although larger wire to 2 AWG is used for longer runs. To add more confusion, larger wire sizes have smaller numbers and vice versa. The grounding conductors used for power applications — 12 AWG solid conductor wire with bare or green jackets — are not proper for this application.

The fix: Install green-jacketed 6 AWG stranded ground wire.

Although not a grounding/bonding issue per se, the most common cabling problem is attaching communications cables to an electrical metallic tubing (EMT) conduit with wire ties. The cable straps or clamps used to secure the EMT are designed for the conduit and its content, not the mechanical demands from the cables strapped to the conduit.

The fix: Remove the attachments to the conduit and secure the cables with proper-sized cable supports.

2. Stacked Lugs

Stacked lugs are another telltale sign of improper installation and usually a result of poor job planning from a lack of mounting hardware or bus bar capacity. Stacked lugs are not permitted because they reduce the area of contact between the lug and bus bar. Two-hole lugs are preferred over one-hole lugs because they cannot be rotated or slip off the mounting bolt. Fork tongue lugs suffer from both of these symptoms and should not be used.

The fix: Unstack the lugs. Replace fork lugs with one- or two-hole lugs. Two-hole lugs are preferred.

3. No Rack Ground Conductor or Bar

It’s hard to bond the rack and the equipment in it without a rack grounding conductor or bus bar. Best practices include the installation of the rack bus bar, rack bonds and the rack grounding conductors as a part of the rack installation. Chassis connections, with or without the paint removed, between the equipment and racks are not a substitute for equipment bonds. The choice of rack ground bus (RGB) is generally a matter of cable management. The bonds from the rack and equipment should be dressed horizontally to the rack ground bus with

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smooth bends. In general, series or “daisy chain” connections in all grounding and bonding conductors are unacceptable. Racks without a rack ground bus are also installed without isolation mounting hardware. To prevent multiple ground paths, the racks should be mounted to the floor with visible insulating washers.

The fix: Install an RGB bar or rack grounding conductor, and bond the rack and each piece of equipment to the RGB. If the rack is not isolated from the floor, install a rack isolation kit.

Another common problem with equipment racks is a lack of seismic bracing. The equipment in racks can be heavy, and sometimes the racks are heavier at the top than the bottom. During a seismic event, the equipment, racks, cables and their support systems could fall and injure people or block exits. Further, the equipment could become damaged and inoperable. Seismic bracing is beyond the scope of this article, but the same approach of recognizing the problem so it can be corrected applies to seismic bracing.

4. No Master Ground Bus Bar

Arguably the most critical component of a ground system, the master ground bus bar (MGB) is the single grounding point inside an equipment enclosure. All interior ground wires are ultimately bonded to the MGB, and the MGB is connected to the earth through the grounding electrode system. Any telecommunications shelter, equipment building or room without an MGB bar has significant grounding issues. The MGB must be bonded to the AC power service in one and only one place, such as the equipment grounding bar in the service panel, at the same location as the main bonding jumper.

The fix: Locate the grounding electrode system, a location for the MGB and a cable route for the grounding electrode conductor. Install the MGB, grounding electrode conductor and the bonding jumper to the AC neutral-ground bar. Bond the equipment, racks and cable supports to the MGB.



Photo courtesy R. Scott Peabody

Unstack one-hole lugs and dress cabling.

5. No Interior Perimeter Ground Bus

The interior perimeter ground bus (IPGB) has a tongue twister name so it's usually called the IPGB, halo or ring. Unfortunately, the terms halo and ring connote a loop and are misleading. The IPGB has a separation to prevent loop currents, so it's not a ring. The IPGB provides a bus for bonding ancillary support equipment, such as DC power plants, cabinets, racks, cable trays, metallic conduit, metallic building structures and piping systems, and surge protection devices. Not all enclosures require an IPGB; it's not required in rooms in a large building or when it's more practical to bond the ancillary support equipment directly to the MGB. An IPGB is recommended for tower sites. The IPGB is a 2 AWG conductor located 1 foot from the ceiling around the perimeter of the enclosure with support standoffs every 2 feet.

The fix: Determine if an IPGB is required. Install an IPGB if needed and bond all ancillary support equipment to it.

6. No Exterior Bonds to Metallic Objects

The number of unlicensed exterior point-to-point and point-to-multi-point Wi-Fi installations has

increased exponentially during the past decade. Very few of these installations are properly bonded. It's not just Wi-Fi sites. Metallic objects such as antenna pipe mounts, roof sled antenna mounts and metallic objects within 6 feet of an external ground electrode system or within 6 feet of a grounded metallic object should be bonded to the external grounding electrode system. This requirement applies to a long list of metallic objects including antenna mounts, fences, fence posts and gates, ice bridges, generator frames, metallic components of incoming telecommunications cables, metallic entry points, metallic conduits and raceways, metallic pipes, heaters, air conditioning units, storage tanks and external light fixtures or support masts. The exterior connections to heavy metal objects such as tower legs, support posts, exterior ground bus bars and grounding conductors use exothermic welding, a permanent connection using a chemical reaction to heat the welding materials — or irreversible compression.

Rather than memorize the list of metal parts, remember the 6-foot distance in the context of touch voltage or its synonym touch potential. Touch voltage is the potential difference

between two points on the human body in contact with metal parts or the earth. The body completes a circuit between the two points — one hand to the other hand or one hand to one foot produces a current flow. Bonding these metal parts to the grounding electrode system removes the touch voltage to protect from lethal shock.

The fix: Bond all metal parts within 6 feet of an external ground electrode system or grounded metal

part. For heavy metal parts, use exothermic welds or irreversible compressions.

Look for these common bonding problems; they are everywhere. Be aware of the confusing terminology and try to use the correct language when explaining the issues. Discuss bonding problems with colleagues at training and safety meetings and develop a plan to fix them. Working together, the communications and large electrical industries can solve

grounding and bonding problems. ■

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