NI01
Telecommunications
Bonding and Grounding - Commercial
Telecommunications
Bonding and Grounding

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A Grounding & Bonding System is most often associated with the protection of personnel, equipment and property from electrical disturbances caused by lightning, Electrostatic Discharge (ESD), surge or fault currents and transient voltages.
What Does Grounding Do?

- Provides a reference to earth to stabilize the system voltage for the Power Distribution System.
- Provide paths for fault current to get back to its source without damaging equipment and facilitate operation of over current devices (breakers and fuses).
- Promote equalization of electric potentials (voltages) between equipment, earth and personnel by bonding conductive paths together
  - Lightning
  - Electrostatic discharge
What are the effects of Improper Grounding?

**Lower Reliability**

- An improperly designed grounding (and bonding) system may be a primary source of interference and emission.
- According to the IEEE, the typical AC third-prong ground circuit is almost never sufficient to prevent damage to network equipment susceptible to ground-fault related potentials.
- Poorly designed or improperly applied grounding, bonding, and shielding techniques often adversely affect the performance of electronic equipment – from the circuit board to the network system.
- Approximately 70% of all anomalies, dysfunctions, or problems associated with power distribution systems are directly or indirectly related to bonding and grounding issues.
Safety
  - Shocks
  - Fire hazards

Lightning
  - Insurance data: $500 million/year due to lightning damage

Equipment failure
  - Industry experts estimate 27-33% of damaged equipment due to ESD (Electrostatic Discharge)

The risk of electrical noise
  - The performance of shielded data cable requires proper bonding & grounding.
To have a good conversation about Grounding Systems we need to establish a vocabulary to use to describe different areas of the system.

We need to learn 3 terms:

- Earthing
- Grounding
- Bonding
Understanding these three things will alleviate MOST grounding issues within any facility.

Earthing → Grounding → Bonding
Design is Critical

A properly designed grounding and bonding system is:

– Intentional,
– Visually verifiable,
– and Adequately Sized

...to handle expected currents safely and without undue effect on susceptible electronic equipment.
Integrated bonding and grounding enhances long-term equipment reliability and safety

Data center

Telecommunications room

Entrance and direct burial
How does telecommunications grounding and bonding work?

• Provide paths for current to get back to its source without damaging equipment

• Equalize potentials (voltages) by bonding conductive paths together – minimizes current flow
Best Practice: Start at the Source and work your way down.

- To prevent ground loops always route grounds down and out.
- Never daisy chain.
- Avoid multiple grounds.
Defining grounding and bonding

NFPA 70-2011 (National Electrical Code, a.k.a. “NEC”)

- Grounded (Grounding). Connected (connecting) to ground or to a conductive body that extends the ground connection.
- Bonded (Bonding). Connected to establish electrical continuity and conductivity.
Does the National Electrical Code require telecom grounding?

645.15 Grounding.

All exposed non–current-carrying metal parts of an information technology system shall be bonded to the equipment grounding conductor in accordance with Article 250 or shall be double insulated…. Where signal reference structures are installed, they shall be bonded to the equipment grounding conductor provided for the information technology equipment.

(NEC: NFPA 70-2011)
Does the National Electrical Code specify an acceptable path for Fault Current?

250.5(4) Grounding and Bonding

Electrical equipment, wiring, and other electrically conductive material likely to become energized shall be installed in a manner that creates a low impedance circuit from any point on the wiring system to the electrical supply source to facilitate the operation of overcurrent devices should a second ground fault from a different phase occur on the wiring system. The earth shall not be considered as an effective fault-current path.

(NEC: NFPA 70-2011)
Grounding Systems as Defined by BICSI

The ITS designer must recognize that three separate and distinct grounding (earthing) systems should be in place at every site.

They are the:
- ac grounding electrode system (e.g., in some countries it may also be known as the earthing system).
- Equipment grounding system (e.g., in some countries it may also be known as the equipment bonding system).
- Telecommunications bonding infrastructure.

Because the purpose of each of these systems is unique, one cannot be used in place of the other two. Also, the installation requirements, improvement methods, and test methods of the three systems vary greatly.
Grounding Systems as Defined by BICSI

- Equipment Grounding System
- Telecommunications Bonding Infrastructure
- Grounding Electrode System (GES)
Telecom Bonding Updates
What is driving the need? (based on R&M Research)

- Tolerance windows have shrunk as data rates have increased
- Susceptibility to noise is higher for high speed Ethernet (1G, 10G)
- Noise disturbances cannot be compensated by electronics
- Good quality cable and properly engineered grounding and bonding system can help mitigate noise
Purpose of TIA-607-B

The purpose of this Standard is to enable and encourage the planning, design, and installation of generic telecommunications bonding and grounding systems within premises with or without prior knowledge of the telecommunications systems that will subsequently be installed. While primarily intended to provide direction for the design of new buildings, this Standard may be used for existing building renovations or retrofit treatment. Design requirements and choices are provided to enable the designer to make informed design decisions.

Scope of TIA-607-B

TIA-607-B grounding is normative and applies to entire building, not just data center.

TIA-607-B, “Generic Telecommunications Bonding and Grounding (Earthing) for Customer Premises”, is now approved!
**Scope:** Specifies requirements for a generic telecommunications bonding and grounding infrastructure, and its interconnection to other systems, for locations where telecommunications equipment will be or are installed.

**Major revision of J-STD-607-A:**
- Includes G&B of telecommunications spaces (distributors and computer rooms)
- Continued harmonization efforts (as practicable) on terminology and practices with international standards
How does the telecommunications bonding system work?

- Provide paths for current to get back to its source without damaging equipment
  - e.g. faults
  - Primary path for “dead metal”
  - Supplemental path for powered equipment
- Promote equalization of electric potentials (voltages) by bonding conductive paths together
  - Lightning
  - Electrostatic discharge
Implementation of a telecommunications grounding and bonding system

- Provide electrostatic discharge (ESD) protection
- Bond the equipment to the racks/cabinets
- Ensure that the racks/cabinets have electrical continuity
- Bond the racks/cabinets back to the electrical panel
- Bond nearby conductive items to the telecommunications grounding and bonding system

TIA-607-B does not talk about ESD
The 5 Steps document - GRFL02--SA-ENG
ESD protection (best practice – not in TIA-607-B)

- Manufacturers ESD resistance is designed to work under normal operational scenarios
- All built-in ESD protection is worthless when the product is opened – must use external ESD protection
  - Service call – swap components

USB/1394 ports
Modem port
Serial port
VGA port

Notebook:
DC power input

Desktop:
AC power line
DVI/HDMI port

Source Littelfuse
Example ESD protection wrist strap and docking options

Banana jack on ESD protection wrist strap fits ESD port provided on equipment (Cisco 6500 shown)

Bent 45° port acts as a hook to hold wrist strap

Panduit part RGESDWS
“Rather than relying on the ac power cord ground wire, it is desirable that equipment be grounded in a verifiable manner as described in this Standard.”

Figure 7—Example of three methods to bond equipment and racks to ground
Implementing the equipment grounding requirement

Bond equipment with a jumper when possible

Bonding screws have thread-forming threads and serrations under the head that remove the paint off mounting flanges and patch panels (RGTBSG-C)

Bonding cage nuts have teeth that cut paint when installed (CBN4K)
Some equipment isn’t designed for a supplemental bonding system

- Can’t add a jumper
- Can’t add a bonding screw or a bonding cage nut

That’s OK. So long as the AC power system and the telecom bonding system are bonded together, no safety issues result

Most servers cannot be grounded directly to the telecommunications grounding system.
Ground strip kits

- Ground strips have same x-sectional area as #6 AWG wire
- Strips also future-proof against a future installer bonding to the rack without thread-forming screws

BICSI 002 will call for grounding strips or a grounding busbar in the cabinet. When the final standard is approved, the Grounding 5 Steps document will be updated to be consistent with the standard.

Install the strip on the vertical rail and bond all other jumpers to it.
TIA-607-B requires racks and cabinets to be electrically continuous

- Electrical continuity must be confirmed through the use of bonding jumpers, bonding hardware, or the removal of paint
- Bonding jumpers must be a minimum of #12 AWG

All Panduit racks and cabinets are electrically continuous, eliminating the need for jumpers

Panduit telecom bonding products are not impacted by Cabinet 2.0

Integral bonding means that no additional jumpers are required to create electrical continuity within the rack or cabinet, which saves costs, speeds installation, and removes a variable that could otherwise cause problems later.
If the rack/cabinet is not electrically continuous, use a busbar

- Bond busbar to rack/cabinets with thread-forming screws to create electrical continuity between the equipment mounting rails
- Bond to busbar with 2-hole lug tongues for long-term connection reliability
New terminology introduced by TIA-607-B: Telecommunications Equipment Bonding Conductor (TEBC)

Example TEBCs routed along auxiliary cable brackets (which help to maintain 50 mm separation)

- “The TEBC connects the TMGB/TGB to equipment racks/cabinets”
- Minimum separation from power and telecom cables is 50 mm (2 in)
Acceptable telecommunications equipment bonding conductor topologies for the telco closet, per TIA-607-B

- Rack bonding conductor (RBC)
- Telecommunications equipment bonding conductor (TEBC)
Use two-hole lugs to bond to busbars and racks & cabinets. Compression is required on busbars.

- Two hole compression lug
- One hole mechanical lug
Mechanical connectors are allowed for bonding the TEBC/RGB to racks, but Panduit recommends compression to prevent loosening.

The intent of the standard is that only double set screw mechanicals can be used on racks. Not clearly stated in TIA-607-B.

We will add this after we have finished characterizing the vibration and stress relaxation characteristics.
Mesh-BN: a collection of components (As per CENELEC documents, includes TIA-942’s Data Center Grounding Infrastructure as the “Supplemental Bonding Network” and IEEE Std 1100 calls the MCBN), per TIA-607-B

- Building steel
- Conduits
- Cabling pathways (not shown)
- Information technology equipment (ITE)
- Racks and cabinets
- Supplemental bonding grid (SBG)
- Rack bonding conductor (RBC)
Watch for this common problem

Common Bonding Network Jumper Kit (RGCBNJ660P22)

When you see a supplemental bonding grid (SBG) with nothing attached to it, the customer intended to have grounding but got nothing!!! Making this bond was in no one’s scope of work...

(20% of the data centers have this problem)

Specify who bonds the racks to the SBG!
• HTCT HTAPs require 12 tons of compression
• CT-2930/L is recommended
• Can use other manufacturers’ tools and retain UL Listing/CSA Certification
• Must use Panduit locator dies

Patented locating rib guarantees full-width crimp 1st time, every time!
Conductor sizing isn’t only about electrical issues...

Standards call for a minimum #6 AWG for mechanical strength

Size matters!

Source: Picture from Internet
Supplemental bonding grid construction per TIA-607-B

Make aisle grounds convenient to racks and cabinets

Cross aisle grounds at least every 10 feet (Unless column in way)

• Use #6 AWG wire
• Use pedestal grounding clamps at conductor intersections
• 1/0 bond to TGB
• Bond to AC power ground through a local TGB
When do we make an SBG on every-other-pedestal?

- When we do not know where the racks and cabinets are going to go
- When there is a stringerless access floor system (bonds each tile at one point)

Example supplemental bonding grid
GPQC family of access floor grounding (Mesh-BN) products

- Up to two each of #6 AWG-2/0 conductors
- Rated for fault current (not all commonly installed access floor connectors are)
- Models for access floor pedestals from ¾” to 2” diameters

Hinged U-bolt design allows for “no look” installation—saving 67% of installation time
Preventing loose busbar connections

Two-hole compression lugs required on TGB & TMGB

Telecommunications Grounding Busbar (TGB), BICSI/TIA-607 hole pattern

BICSI-607 stainless steel TGB hardware stack-up

(Parts HDW1/4-KT, HDW3/8-KT)

(Type LCC-W)

(Type GB2B, or Part GB2B0306TPI-1)
Panduit tooling options

- or -

Panduit lugs can be crimped with select competitors’ tools and dies and still retain UL/CSA approvals and performance
What else needs to be bonded?

• IEEE studies have indicated that the point of diminishing financial returns with respect to lightning strikes is 2 meters (6 feet)
• Bond anything that could become charged that a person could bump while working on a rack/cabinet for safety
• Therefore, bond any conductive path within six feet of your racks/cabinets
Split bolts – use tin plated if outdoors (Panduit SBC & SBCT, respectively)

#6 AWG conductor, green w/yellow jacket

— OR —

Specify systems that automatically bond to reduce chances of error

PANDUIT® Wyr-Grid™ and GRIDRUNNER™ hardware automatically bonds sections, eliminating the need for jumper wires
ANSI/TIA-607-B

7 DESIGN REQUIREMENTS

7.1 General

All exposed cables in a telecommunications facility shall be bonded to ground as close as practical to the point of entrance. This includes bonding to ground the cable shields and metallic sheath members according to manufacturer’s installation instructions.

Where the building backbone telecommunications cabling incorporates a shield or metallic member, this shield or metallic member shall be bonded to the telecommunications main grounding busbar (TMGB) or the telecommunications grounding busbar (TGB) where the cables are terminated or where pairs are “broken out” from the cable sheath.
Armored fiber grounding cable clamp

- Mechanical clamp design is entirely external to armor—no risk of damage to fibers
- Clamp assembly has more current-carrying capability than the armor it attaches to

Cover protects clamp and provides neat appearance

Mechanical clamp assembly
• Purpose of TBB is to reduce potential differences between interconnected telecommunications systems on different floors
• Originates at TMGB and extends throughout building using telecom pathways
• Connects TGBs that exist in each distributor
### 6.3.2 Sizing the telecommunications bonding backbone (TBB)

The minimum TBB conductor size shall be a No. 6 American Wire Gauge (AWG). The TBB should be sized at 2 kcmil per linear foot of conductor length up to a maximum size of 750 kcmil.

**NOTE** – The previous edition of this Standard sized the TBB conductor up to 3/0 AWG. This Standard allows the TBB conductor to be sized up to 750 kcmil. Bonding conductors used for telecommunications should be sized using engineered calculations.

<table>
<thead>
<tr>
<th>TBB/GE linear length (m) (ft)</th>
<th>TBB/GE size (AWG)</th>
</tr>
</thead>
<tbody>
<tr>
<td>less than 4 (13)</td>
<td>6</td>
</tr>
<tr>
<td>4 – 6 (14 – 20)</td>
<td>4</td>
</tr>
<tr>
<td>6 – 8 (21 – 26)</td>
<td>3</td>
</tr>
<tr>
<td>8 – 10 (27 – 33)</td>
<td>2</td>
</tr>
<tr>
<td>10 – 13 (34 – 41)</td>
<td>1</td>
</tr>
<tr>
<td>13 – 16 (42 – 52)</td>
<td>1/0</td>
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<tr>
<td>16 – 20 (53 – 66)</td>
<td>2/0</td>
</tr>
<tr>
<td>20 – 26 (67 – 84)</td>
<td>3/0</td>
</tr>
<tr>
<td>26 – 32 (85 – 105)</td>
<td>4/0</td>
</tr>
<tr>
<td>32 – 38 (106 – 125)</td>
<td>250 kcmil</td>
</tr>
<tr>
<td>38 – 46 (126 – 150)</td>
<td>300 kcmil</td>
</tr>
<tr>
<td>46 – 53 (151 – 175)</td>
<td>350 kcmil</td>
</tr>
<tr>
<td>53 – 78 (176 – 250)</td>
<td>500 kcmil</td>
</tr>
<tr>
<td>76 – 91 (251 – 300)</td>
<td>600 kcmil</td>
</tr>
<tr>
<td>Greater than 91 (301)</td>
<td>750 kcmil</td>
</tr>
</tbody>
</table>

**Table 1 – TBB conductor size vs length**
Use of structural metal is permitted in lieu of a copper conductor for the TBB and GE (grounding equalizer, which connects TBBs to one another)

- Bond to structural metal using a Listed connector (compression, mechanical, or weld)
- Size bonding conductor according to rules in table in previous slide

What metal qualifies?
- Electrically continuous
  - 2-point measurements
  - Architectural drawings/as-builds, when measurement not possible
- Metal must be earthed (grounded) in at least one place

Published August 21, 2013
Connectors for structural metal

- Today: “GM” family of parts available for conductors from #4 AWG to 250 kcmil
- Available around November: “GM” parts for conductors from #8 SOL to 1,000 kcmil

Drill hole in structural metal, put stud through hole, fasten to structural metal surface with nut (provided)

Insert wire you want to bond to structural metal here

GUBC shown in product roadmaps today
Article 250.70 Methods of Grounding and Bonding Conductor Connection to Electrodes.

“The grounding or bonding conductor shall be connected to the grounding electrode by exothermic welding, listed lugs, listed pressure connectors, listed clamps, or other listed means.”

Types of Connectors allowed by Code and Standards

- Mechanical Connections
- Compression
- Exothermic Welding
Grounding and Bonding Systems
Depth of Product Lines

Power Connectors

Terminals

Compression Taps

Data Center Kits

Direct Burial

Mechanical Grounding
Grounding and Bonding Systems
Installation Tooling
Technical Support
  Design Consultation
  Product Selection
  Specification Template
  Tool Selection
Knowledgeable Staff
Product Literature
White Papers
Articles
Part Drawings
Questions?

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Thank You!

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