

SCTE | **STANDARDS**

Interface Practices Subcommittee

AMERICAN NATIONAL STANDARD

ANSI/SCTE 275 2021

**Electrical Grounding and Bonding for Cable
Broadband Network Critical Facilities**

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Document Types and Tags

Document Type: Specification

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☐ Test or Measurement

☐ Checklist

☒ Facility

☐ Architecture or Framework

☐ Metric

☐ Access Network

☐ Procedure, Process or Method

☐ Cloud

☐ Customer Premises

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1. Introduction

1.1. Executive Summary

This standard provides a description of basic practices to obtain a reliable, low impedance grounding and bonding system in communication networks.

There are five principal objectives for providing a dependable low impedance grounding and bonding system. These include:

1. **Personal Safety:** Minimize the development of electrical potential that could create a shock hazard to personnel, within and between metallic frames and structures.
2. **Equipment Protection:** Provide adequate fault current paths so any installed overcurrent devices can disconnect faulted circuits to reduce the possibility of fire and limit damage to the critical equipment.
3. **Equipment Operation:** Provide an equalized ground reference to electronic communication circuits connected to the ground plane.
4. **Electrical Noise Reduction:** Assist in the reduction of electrical interference by maintaining low impedance paths between ground points throughout the communication system.
5. **Reliability:** Provide a grounding system that resists deterioration and requires minimal maintenance.

1.2. Scope

This document includes practices for exterior system grounding and bonding, interior grounding systems, surge protection, roof mounted lightning protection, environmental handling for electric static discharge (ESD) sensitive equipment, commissioning, and maintenance.

1.3. Benefits

Broadband networks can become more dependable when appropriate standardized grounding and bonding procedures are followed. The recommendations herein also ensure operational safety.

1.4. Intended Audience

Cable operators, contractors, and cable industry equipment manufacturers should familiarize themselves with this publication.

1.5. Areas for Further Investigation or to be Added in Future Versions

Possible topics that could be added include shielding and ground fault detection.

2. Normative References

The following documents contain provisions, which, through reference in this text, constitute provisions of this document. At the time of Subcommittee approval, the editions indicated were valid. All documents are subject to revision; and while parties to any agreement based on this document are encouraged to investigate the possibility of applying the most recent editions of the documents listed below, they are reminded that newer editions of those documents might not be compatible with the referenced version.

2.1. SCTE References

- [SCTE 226] ANSI/SCTE 226 2015, Cable Facility Classification Definitions and Requirements, https://scte-cms-resource-storage.s3.amazonaws.com/Standards/ANSI_SCTE%20226%202015.pdf

2.2. Standards from Other Organizations

- [IEEE 3003.1] IEEE STANDARD 3003.1 — IEEE Recommended Practice for System Grounding of Industrial and Commercial Power, https://standards.ieee.org/standard/3003_12019.html
- [IEEE 3003.2] IEEE STANDARD 3003.2 — IEEE Recommended Practice for Equipment Grounding and Bonding in Industrial and Commercial Power Systems, https://standards.ieee.org/standard/3003_2-2014.html
- [IEEE 81] IEEE 81-2012 - IEEE Guide for Measuring Earth Resistivity, Ground Impedance, and Earth Surface Potentials of a Grounding System, <https://standards.ieee.org/standard/81-2012.html>
- [Ericsson] Ericsson GR-295 Mesh and Isolated Bonding Networks: Definition and Application to Telephone Central Offices, 2004
- [NFPA 780] NFPA 780 2020, Standard for the Installation of Lightning Protection Systems
- [ATIS] ATIS 0600313: Telecommunications – Electrical Protection for Telecommunications Central offices and Similar Type Facilities, 2013
- [CSA] CSA b72 Installation Code for Lightning Protection Systems, 2020
- [NFPA 70] NFPA 70 National Electrical Code, 2020
- [CSA C222.1] CSA C22.1 2021 – Canadian Electrical Code. Part I, Safety Standard for Electrical Installations
- [ANSI TL] ANSI TL313-2003 Electrical Protection for Telecommunications Central Offices and Similar Type Facilities

3. Informative References

The following documents might provide valuable information to the reader but are not required when complying with this document.

3.1. SCTE References

No informative references are applicable.

3.2. Standards from Other Organizations

No informative references are applicable.

3.3. Published Materials

No informative references are applicable.

4. Compliance Notation

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<i>deprecated</i>	Use is permissible for legacy purposes only. Deprecated features may be removed from future versions of this document. Implementations should avoid use of deprecated features.

5. Abbreviations and Definitions

5.1. Abbreviations

AC	alternating current
AHJ	authority having jurisdiction
ANSI	American National Standards Institute
ASHRAE	American Society of Heating, Refrigerating and Air-Conditioning Engineers
ATS	automatic transfer switch
AWG	American wire gauge
BDCBB	battery distribution circuit break bay
BDFB	battery distribution fuse bay
BN	building network
BRSB	battery room safety bar
CBN	common building network
CCEGB	coax cable entrance ground bar
CEGB	cable entrance ground bar
CF	critical facilities
CRGB	computer room ground bar
CSA	CSA Group (formerly the Canadian Standards Association)
DC	direct current
DCGB	DC positive bus ground bar

ENT	electrical non-metallic tubing
ESD	electrostatic discharge
FCEGB	fiber cable entrance ground bar
FEC	fiber entry cabinet
FGB	frame ground bar
HEGB	headend equipment ground bar
IEEE	Institute of Electrical and Electronics Engineers
IGZ	isolated ground zone
kcmil	thousand circular mils
MCM	thousand circular mils, see kcmil
MGB	master ground bar
MSS	main AC service switchboard
NEC	National Electrical Code
NFPA	National Fire Protection Association
OSP	outside plant
PANI	producer absorber non-isolated isolated
PM	preventative maintenance
PVC	polyvinyl chloride
RH	relative humidity
SCTE	Society of Cable Telecommunications Engineers
SGB	secondary ground bar
SPD	surge protective device
SSGB	sub-system ground bar
TCEGB	telco cable entrance ground bar
THHN	thermoplastic high heat-resistant nylon-coated
TVSS	transient voltage surge suppressor
UPS	uninterruptible power supply

5.2. Definitions

American wire gauge	A US standard specifying diameter of a round wire usually made of copper and aluminum. The larger the AWG number, the smaller the diameter (gauge).
air terminals	Devices that are located at specific building sections, primarily the roof, that are likely to be struck by lightning. Their purpose is to intercept a lightning strike.
aisle feeder	An aisle feeder is an equipment grounding conductor that connects a secondary ground bar (SGB) to an equipment frame ground bar (FGB); typically, 2/0 AWG or larger in size, it connects to an equipment FGB via a 'tapped' #6 AWG.
cabinet/rack frame ground conductor	A #6 AWG conductor that runs from the row aisle feeder ground conductor to the cabinet/rack.
cable entrance ground bar	The ground bar where telecommunication cables that enter the building are terminated.
counterpoise ground	Electrical grounding of a system that is a closed loop shape (triangle, square, etc.) versus a radial system (spokes of a wheel without the ends being connected)
down (or main) conductors	Stranded copper lightning protection conductors that provide a path for lightning currents down the exterior sides of a building.

exothermic welding	A weld that is used for electrical connections that minimizes introduction of resistance due to the weld.
ground	The earth.
grounded (grounding)	Connected (connecting) to ground or to a conductive body that extends the ground connection.
grounded conductor	A system or circuit conductor that is intentionally grounded.
grounding conductor equipment	The conductive path(s) that provides a ground-fault current path and connects normally non-current-carrying metal parts of equipment together and to the system grounded conductor or to the grounding electrode conductor, or both.
grounding electrode	A conducting object through which a direct connection to earth is established.
grounding electrode conductor	A conductor used to connect the system grounded conductor or the equipment to a grounding electrode or to a point on the grounding electrode system.
halo ground ring	A type of ring ground that, instead of being installed outside and underground, is installed inside, near the top of a building or structure. The ground reference for all equipment inside the area being protected is separate from the halo. The halo is connected to the main building ground. Electrical equipment is also often placed in fully enclosed metal cabinets, which function as Faraday cages to further protect the equipment. A typical halo ground is constructed of #2 insulated copper wire and is installed six inches below the ceiling, and entirely encircles the area that it is protecting.
isolated ground zone	The isolated ground zone or IGZ is a dedicated zone or area inside a facility that contains any equipment that needs to have an isolated ground. All equipment located within this IGZ shall be electrically isolated from all external grounds except for those equalized through a connection to other specifically isolated ground bars.
main aisle feeder ground conductor	Runs from the SGB, (a 2/0 AWG or 4/0 AWG conductor) perpendicular to the rows of cabinets/racks, usually taps down to a 2/0 AWG row aisle feeder conductor.
PANI	P - surge producers (typically, conductors coming from cable entrance ground bars, as well as generators, UPSs, and transformer enclosures) A - surge absorbers (typically contains connections to building steel, the exterior ground ring, the cold-water pipe, if metallic, and the incoming main AC service ground bar – the multi-ground neutral bond) N - non-isolated ground zone equipment grounds (typically includes secondary ground bars for equipment ‘aisle feeder ground conductor’ cabinet/rack grounds, ladder rack, etc.) I - isolated ground zone equipment grounds (typically equipment associated with the legacy electronic telephone switch, some logic grounds and the DC plant reference ground)
secondary ground bar	Any ground bar that is downstream of the master ground bar that collects aisle feeder and other grounds. This is not a cable entrance ground bar. Also known as foreign object ground (FOG) or auxiliary ground bar (AGB).

row aisle feeder ground conductor	Runs from the main aisle feeder ground conductor, parallel to the rows of cabinets/racks, usually a #2 to 2/0 AWG conductor that taps down to a #6 AWG cabinet/rack frame ground conductor.
single point ground system	The single point ground system refers to the design of a grounding system where all internal SGBs, grounding electrode conductors and other necessary local ground conductors are all terminated to the master ground bar (MGB), which becomes the 'single point' of the single point ground system.
uninterruptible power supply	An AC power supply used to provide reliable, conditioned AC power to electronic equipment and systems that typically operate 24 hours per day and that cannot tolerate a momentary power outage. An uninterruptible power supply maintains AC power, typically from storage batteries, in the event of an outage in the AC mains.

6. Intended Application

The recommendations presented herein are intended for cable and similar telecommunication operators. The reader of this document is reminded to comply with all applicable regulatory and safety requirements. These include but are not limited to requirements related to basic personnel safety and fire prevention and national (electric) codes when these requirements exceed those described in this document. Any authority having jurisdiction (AHJ) might have additional requirements.

7. Exterior Grounding and Bonding System

This section of the document describes exterior grounding and bonding systems.

7.1. Definition

The exterior grounding system establishes a direct path of known low impedance for all power, communication, and signal systems. The exterior grounding system also provides a path to earth for the discharge of lightning strikes, restricts step and touch potential gradient in the area accessible to persons, and assists in the control of electrical noise in signal and control circuits by minimizing voltage differentials. Currents associated with power faults and noise typically use this path to return to their source, whereas currents associated with lightning use this path to equalize the charge established on the earth's surface during storms.

7.2. Design Considerations

Service providers target a range of earth resistance values, varying from 5 ohms to 25 ohms, depending on company policy, applications, and specific conditions. In general, the lower the resistance, the better, but 25 ohms *should* be considered a maximum.

7.3. Soil

The composition of local soil will affect grounding. Test soil resistivity to achieve a targeted ground system resistance value. Use enhanced grounding methods (counterpoise, chemical/electrolytic rods, backfill materials) if necessary. The following issues *should* be considered:

1. Determine the specific conductive properties of the local soil by measurement of the soil resistivity at the existing (for expansions) or proposed site location.
2. Review soil boring measurement reports to determine soil classifications and water content at various depths and determine the seasonal variations in the water table.

3. Review exposure to transferred ground potentials by electric power companies during phase to ground faults on their distribution system.
4. Some soils, (sandy) have a high resistivity so that conventional ground rods or ground electrode systems might not be able to obtain the desired ground resistance.
5. Enhanced ground electrodes or ground enhancement materials (list general methods/materials) *may* be required to meet grounding specifications.

7.4. Resistivity

Best practices for measuring soil resistivity are described in the latest IEEE Std 142, IEEE Recommended Practice for Grounding of Industrial and Commercial Power Systems (Green Book) and IEEE Standard 81, Guide for Measuring Earth Resistivity, Ground Impedance, and Earth Surface Potentials of a Ground System.

7.5. Tower Grounding

All earth stations and tower systems including legs, and posts ***shall*** be grounded to a tower ground ring with a minimum of #2 copper with exothermic welds. The tower ground ring ***shall*** be bonded to the facility ground ring. On decommissioning of tower and earth stations, all transmission cables ***shall*** be disconnected from the headend ground system.

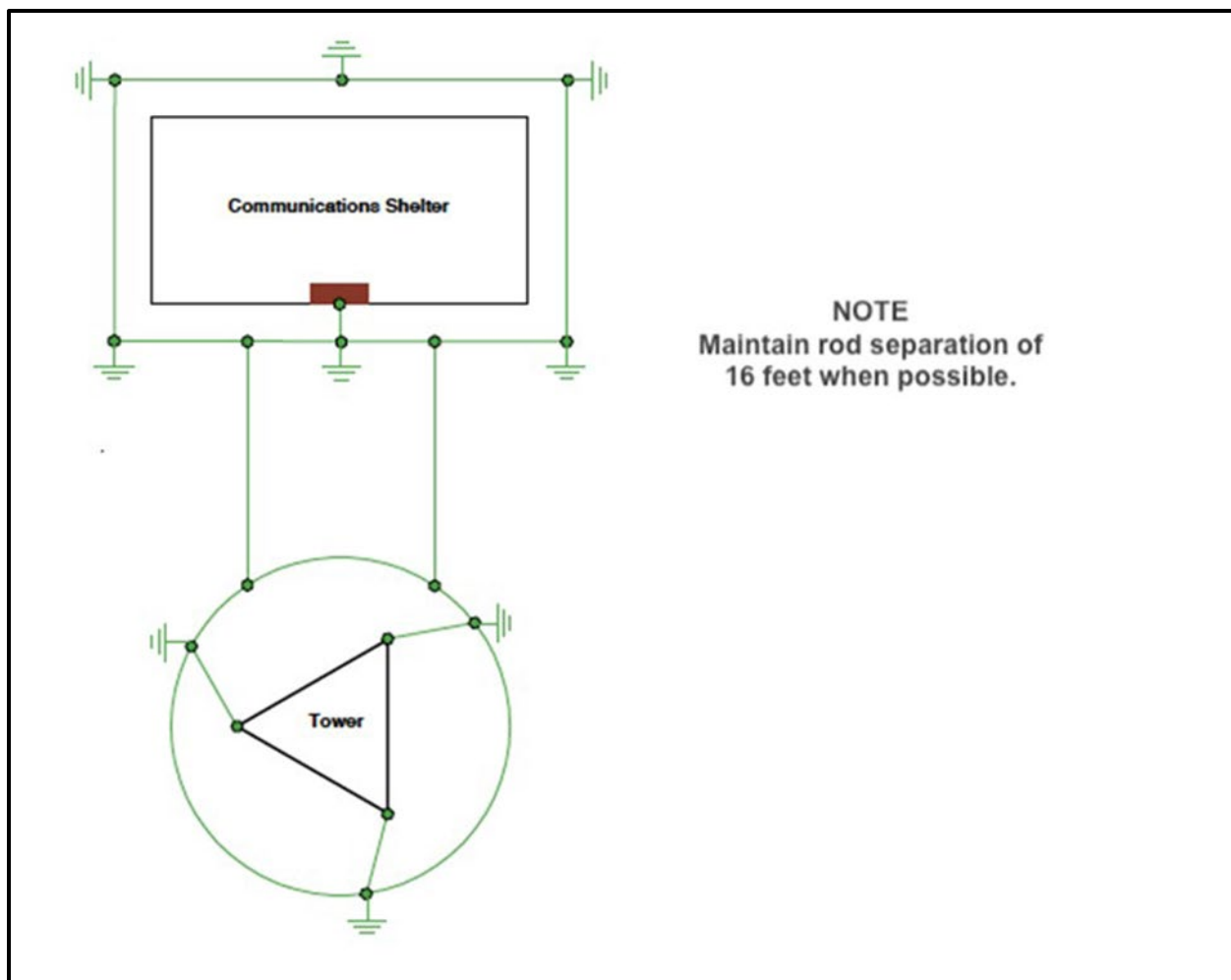


Figure 1 - Typical Tower Ground Ring Bonded to Facility Ground Ring

7.6. Ground Rings

As a minimum, the exterior ground ring installed around the facility *should* consist of a minimum #2 copper conductor buried at a depth of 30 inches below grade or below the local frost line, whichever is greater. At intervals of 20 feet, copper clad ground rods, $\frac{3}{4}$ inch x 10 feet long, *should* be connected to this ring along its entire length. These ground rods *should* be exothermically connected to the ground ring and driven vertically into the earth with the top of the rods driven to a depth equal to the depth of the ground ring conductor. If determined through design calculations that this minimum system will not produce a system having a resistance to remote earth of a maximum of 25 ohms with every reasonable effort to achieve 5 ohms or less, then additional grounding provisions *should* be incorporated into the design and depicted on the construction drawings.

Ground rod inspection sleeves, test wells or hand holes *should* be installed at critical locations along the ground ring. These locations will differ depending on the type of facility being built, but as a minimum, *should* include connection points between the ground ring and the master ground bar (MGB) and connection points between the ground ring and the tower ground ring, where applicable. In addition to the connections described in the preceding sections, the building exterior ground ring *should* have connections to the master ground bar (2, at opposite locations along the facility ground ring with both conductors being the same length), interior halo ground ring (at each corner), the frame of each generator