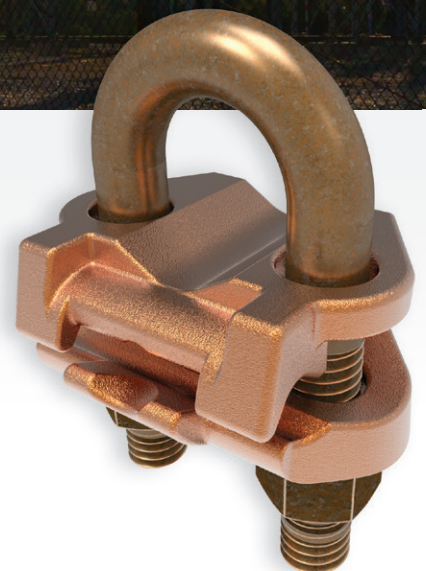




Critical Infrastructure Grounding Guide

A complete grounding connection
guide for project specification



Introduction to Critical Infrastructure Grounding

What is Critical Infrastructure?

Per the **Federal Energy Regulatory Commission**, **Critical infrastructure** can be defined as “**existing and proposed systems and assets**, whether physical or virtual, the incapacity or destruction of which would negatively affect security, economic security, public health or safety, or any combination of those matters” (**Energy Department and the Federal Energy Regulatory, 81 FR 93749 2016**).

What elements can be included in critical infrastructure grounding?

- ✓ **Perimeter Fencing – Permanent and Temporary**
- ✓ **Ground Grid and Ring**
- ✓ **Structure – Pipes and H or I Beams**
- ✓ **Equipment – Transformers & Cabinets**

Why is Grounding and Bonding important?

There are several main reasons for providing a well-designed ground system; safety of personnel tops the list, followed by equipment protection, signal reference quality, return path for faults and/or surges allowing over-current protection devices to work properly, and static dissipation.

In order to meet these objectives, ground system interconnections must maintain a low contact resistance, often under adverse conditions, for the expected life of the grounding system. Connections in a ground network are subject to severe corrosion, high mechanical stress due to electromagnetic forces, and rapid thermal heating due to high current magnitudes during fault conditions. (Reference the Connector Theory and Application - A Guide to Connection Design and Specification - Revised 5th Edition.)



Technical Standards

Guidelines utilized within the electrical industry are referred to as Codes, Standards, Specifications and Regulations.

Codes are a set of rules that dictate requirements. Standards are the guiding principles of how to comply with codes. Specifications are requirements set by individual companies. Regulations implement codes and standards into law.

Common Industry Standards

UL Solutions

- UL467 - UL Standard for Safety Grounding and Bonding Equipment
- UL96 - UL Standard for Safety Lightning Protection Components
- UL486A-486B - UL Standard for Safety Wire Connectors
- <https://www.ul.com/>

Institute of Electrical and Electronics Engineers (IEEE)

- IEEE80 - IEEE Guide for Safety in AC Substation Grounding
- IEEE837 - IEEE Standard for Qualifying Permanent Connections Used in Substation Grounding
- IEEE1402 - IEEE Guide for Physical Security of Electric Power Substations
- <https://www.ieee.org/>

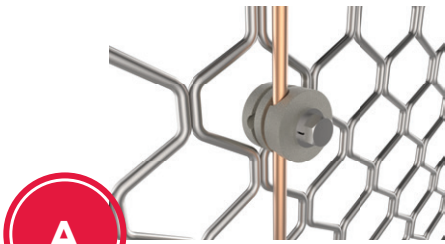
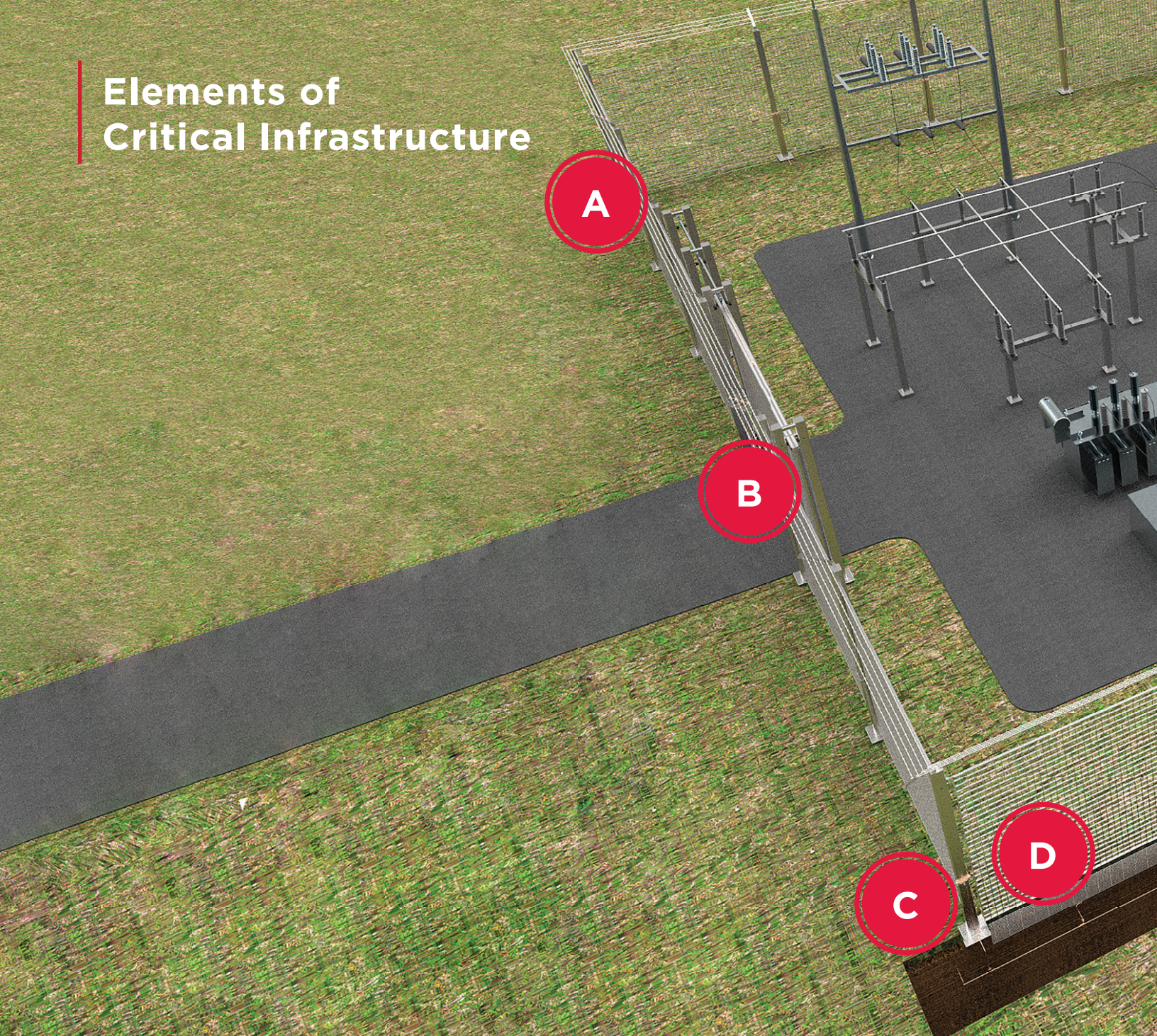
ASTM International

- ASTM F855 - Standard Specifications for Temporary Protective Grounds to Be Used on De-energized Electric Power Lines and Equipment
- <https://www.astm.org/>

Code

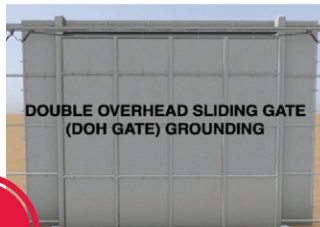
- NFPA 70, National Electrical Code (NEC) <https://www.nfpa.org/>
- National Electrical Safety Code® (NESC®) <https://www.ieee.org/>
- CSA C22.2 - Canadian Electrical Code <https://www.csagroup.org/>

Elements of Critical Infrastructure



A

Fence Fabric and Barbed Wire Grounding: Allows for proper conductor alignment and the grounding of fence mesh and razor wire.



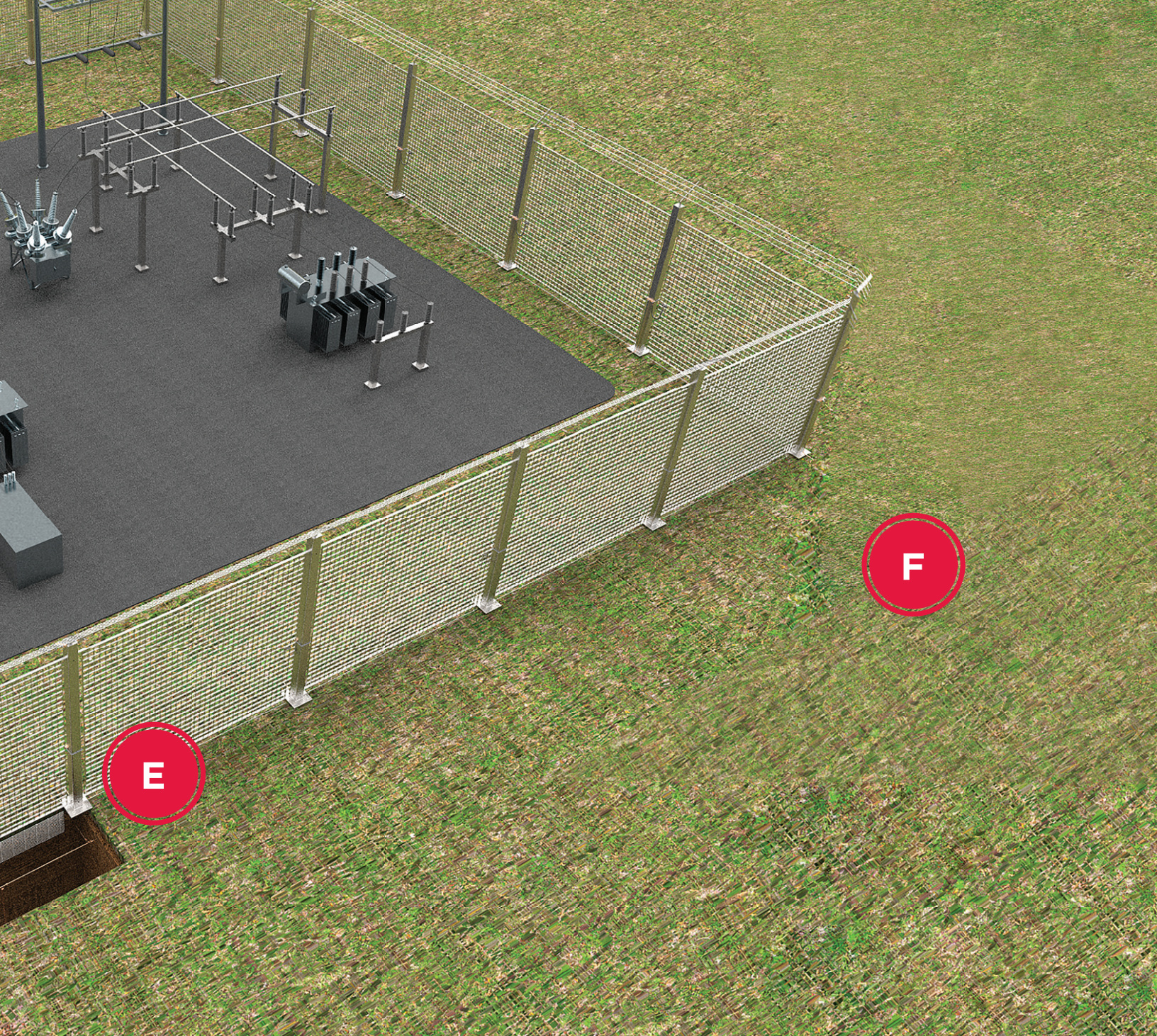
B

Rolling Gate Grounding System: Allows for the grounding of moving components of rolling/sliding gates.



C

High Security Fence Grounding: Allows for the grounding of square terminal and line fence posts to the ground grid. Clamps up to 8" square posts.



D

Below Grade Barrier Grounding: Connectors used to ground the dig guards, anti-tunneling theft deterrent.



E

High Security Fence Grounding: Allows for the grounding of round terminal, line and gate fence posts to the ground grid. Clamps up to 8" round posts.



F

Ground Grid: Compression, Exothermic, and Mechanical connectors to construct ground grids.

Critical Assets

- Utility Substations or Switchyards
- Power Plants – Solar, Oil & Gas and other power generating facilities
- Treatment Plants – Waste Water
- Data Centers



Mechanical

BURNDY® has a broad line of mechanical connectors and are the most widely used in the industry. Mechanical connectors use bolts &/or other hardware to apply clamping force.

Mechanical connectors are designed to accommodate the current carrying capacity of the conductor and provide ease of installation, resulting in a safe, reliable electrical connection especially when installed at the manufacturer's recommended torque.



Compression

BURNDY® HYGROUND® Compression Grounding is a safe, cost-effective, and consistent grounding system that can be installed in all weather conditions. Compression connectors are part of a BURNDY® Engineered System that utilizes specific installation tools and dies for installing permanent, high quality connections. Compression grounding connectors are an excellent solution for connecting fence and other metallic structures that are bonded together to the ground grid.



Exothermic

The **thermOweld®** exothermic grounding process utilizes a high temperature reaction of powdered copper oxide and aluminum resulting in an irreversible connection. No outside power is required for installation. The reaction takes place in a semi-permanent graphite mold. **thermOweld®** connections have a current carrying capacity equal to or greater than that of the conductors.



Tin-Plating

When tin plating is recommended:

Anti-theft Prevention: If using any anti-theft conductors such as copper clad steel or newer steel over copper, a tin-plated connector will aid in the camouflage effort. This is a very inexpensive way to combat theft.

Structural Staining: Many substation designers do not want to see the stains that bare copper connectors leave on their structures over the years. The tin will greatly reduce or eliminate the chance of the connector staining over a period of time.

Corrosion Protection: For outdoor environments, specifically in coastal areas and petrochemical plants, tin plated connectors are recommended or may be required. Projects located in high sulfur or corrosive areas, tin plating is highly recommended as the sulfur residue or corrosive elements will degrade bare copper over time. When bare connectors are connected to a differing or dissimilar metals to decrease the effects of galvanic action.



Material Considerations

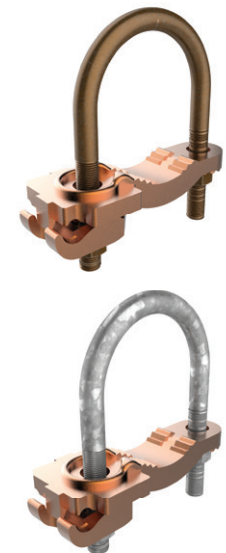
General requirements for connector use are explained in **Article 110 of the NEC**. It is important to understand the connectors intended use, installation method, product listing, approved functional environment (i.e., indoor, or outdoor).

Dissimilar Metals - Consideration for conductor, connector, and mounting material is required, the material construction should not negatively impact the conductors, installation, or equipment. Per **NEC Article 110.14 Electrical Connections**, dissimilar metals shall not be intermingled or in physical contact.

Dissimilar metals can increase the potential for galvanic corrosion. Galvanic corrosion can take place when two or more metals of different electrochemical activity are in direct contact and in the presence of an electrolyte.

Connector Material - Only products that are rated for Direct Burial can be encased in earth or concrete. The **NEC Article 250.64(A)**, states Aluminum or Copper-Clad Aluminum Conductors or connectors are required to be at least 18" from earth. Make sure to confirm the connector or conductor material construction is correct for your application.

Hardware/Fasteners - Silicon bronze, a copper-based alloy with the addition of silicon, has superior corrosion resistance, high tensile strength, hardness, conductive, and less resistance. Stainless steel is susceptible to galling (cold weld), less conductive, and has a higher resistance. Galvanized steel is not rated for direct burial and not recommended for corrosive environments.



Oxide Inhibitors

Oxide inhibiting compound (e.g., **BURNDY PENETROX™**) provides low initial contact resistance, seal out air and contaminants, prevent oxidation or corrosion, exhibit superior weathering characteristics, are usable over wide temperature ranges, and provide a high conductivity “gas-tight” joint. Mechanical and compression connections generally require coating contact surfaces with an oxide inhibiting compound for long term outdoor exposure. These compounds have many attributes that ensure good contact and enhance the longevity of the connection.



Benefits

- Penetration of oxide layers helps produce low initial contact resistance, resulting in improved connection conductivity.
- Prevention of oxidation and other corrosion by sealing the joint from air and contaminants.
- Assistance in increasing pullout strength of the connection, when needed.
- Continuance of properties to maintain connection integrity over wide temperature ranges.

Main Types and Ratings

UL listed Oxide inhibitors include limits for the application based on their use on Insulated Conductors in Power applications. This particular guide is focused on bare conductors in outdoor applications and the UL listing is not explicitly called for by NEC articles or our product listings for their use.

BURNDY recommendations are as follows:

Penetrox A – petroleum based with zinc particles or Penetrox - A13 non-petroleum based with zinc particles

- for above ground, outdoor, for aluminum to aluminum, aluminum to copper, or for galvanized connections.

Penetrox E – Non-petroleum based with copper granules

- for below ground, outdoor, for bare copper to copper grounding applications

NEC Article 300.6 outlines additional considerations and requirements for **Protection Against Corrosion and Deterioration**.

Compression Connectors

Preparing a connector – Most connectors come in plastic sealed packaging. Remove the connector from the packaging and remove any tape or other packaging materials from the connector. For example, lugs are shipped with blue inspection hole plugs, covered in tape, along with a plug at the wire insertion point. Remove all of those packaging contents prior to making the connection.



Inspecting a connector – Make sure that you have the correct connector by checking the stamping on the part and verifying the part number. Visually inspect to make sure the part has Penetrox™ oxide inhibitor (unless it was special ordered without it) and that the Penetrox oxide inhibitor is applied to most of the surface of the connector that will be coming into contact with the wire, ground rod, etc.

Aligning the die sets – Always make sure the connector is aligned into die set as close to center as possible. You do not want any part of the connector hanging out of the die set. A best practice is to make sure that the entire surface area of the connector is in complete contact with the die set throughout the entire crimp.

Overlapping Crimps – Some connectors require 2 or more crimps. In these cases, spread the crimps out over the surface of the connector as evenly as possible without crimping off of the edge of the connector as noted above. It is very common and perfectly acceptable to overlap crimps when needed.

Precrimping – It is recommended that all smooth surfaces be precrimped prior to installation unless specified otherwise. This practice is most popular on ground rods and steel surfaces. Precrimps are made by selecting the appropriate precrimp die, and crimping the surface. Knurling the surface insures that the connector will crimp to the surface even stronger, adding rotational strength and vibration resistance from the environment.

Ground Rod Precrimping

- Precrimp the ground rod surface in a way that most of the surface that the connector will come into contact with is knurled. In most cases this is 2 crimps. Use the recommend die based on the diameter of the ground rod.

PRECRIMP DIES	GROUND ROD DIAMETER
UPRECRIMP12	1/2"
UPRECRIMP58	5/8"
UPRECRIMP34	3/4"

- Another option is to use a U2CABT die that will work on any ground rod size. When using this die it makes slotted grooves on the ground rod. Crimp it several times so that the slots cover most of the area where the connector will be placed, but do not overlap any of the precrimps.

Flat Steel Precrimping

- When crimping flat steel such as an I-Beam, it is recommended to precrimp the surface.

PIEBEAMKIT		GROUND ROD DIAMETER	
For flange thickness 0.690" - 0.750"		For flange thickness 0.250" - 0.675"	
P1105	Flat Crimp	U1105	Flat Crimp
PIBEUP1	Universal Precrimp	UIBEUP1	Universal Precrimp
PIBESP1	Standard Flange Precrimp	UIBESP1	Standard Flange Precrimp
PIBEWP1	Wide Flange Precrimp	UIBEWP1	Wide Flange Precrimp

Mechanical Connectors

Verifying Torque – A critical aspect when installing hardware is the torque used to tighten the components. Every field termination, from a low voltage screw terminal to the largest lug, has an optimum value of torque that produces the most reliable, low resistance joint. Per NEC110.14D, connectors shall be installed to the manufacturer's tightening torque specification.

Shear Hardware/Fasteners – Utilize Tamper Resistant (TR) & Breakaway (BA) hardware shears at the connector specified torque level to mitigate theft and field torque issues.



Connector and Surface Considerations

Copper to Galvanized Steel Connections – Be sure to clean rust from the structure or cable, apply Penetrox A (oxide inhibitor) to the structure or cable, and install connectors using proper torque values.

Surface Preparation – According to NEC Article 250.12 Clean Surfaces, non-conductive coatings need to be removed from surfaces and structures (i.e., powder coated fence posts, paint, etc.) before installing connectors to ensure sufficient electrical continuity. Oxide Inhibitors should be used to protect the now uncoated surface. An alternative to removing the coating would be the WEEB® Bonding Washer. In certain applications the WEEB Bonding Washer teeth can pierce through non-conductive coated surfaces to establish conductivity and prevent surface oxidation.

The WEEB Bonding Washers can also be used to prevent rotation in single hole lug applications with external forces – vibration, wind, etc.

Corrosion Protection – Mechanical Connectors are available tin-plated. Tinsplating can help mitigate the effects of corrosive environments. Oxide inhibitors (e.g., BURNDY PENETROX™) prevent oxidation and other corrosion by sealing the connection points from air and contaminants.



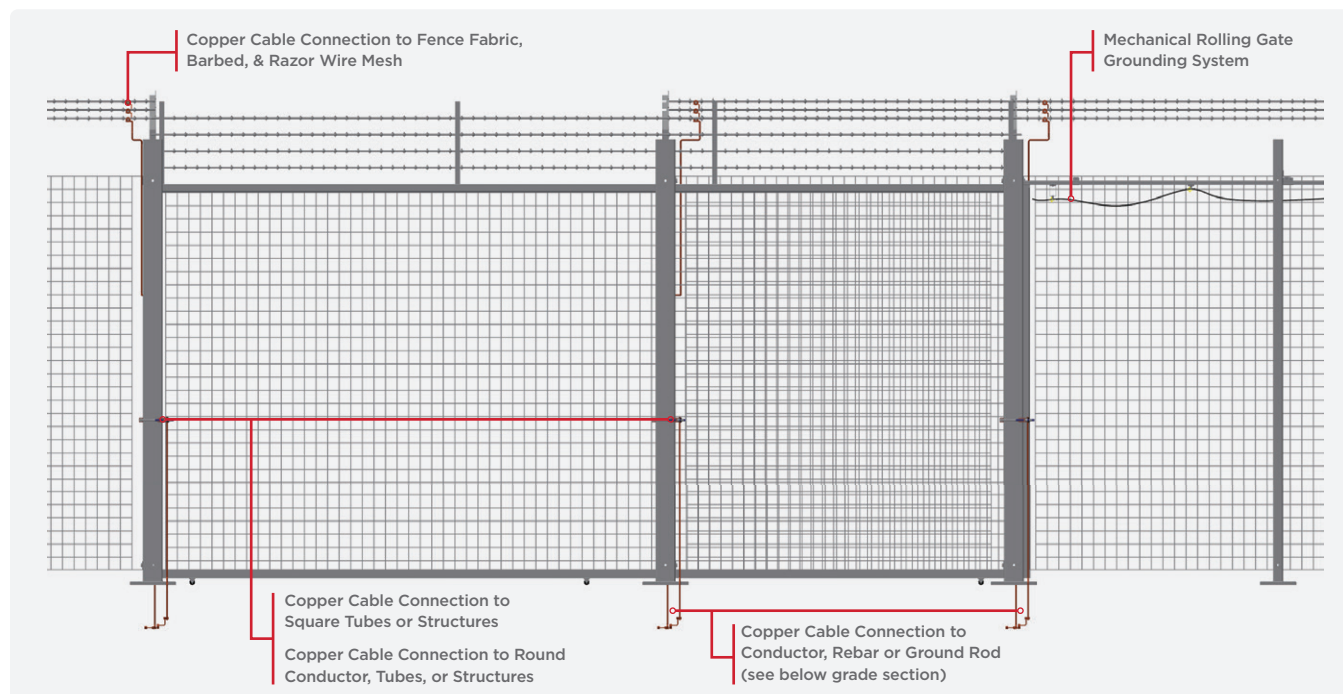
Exothermic Molds

- Wear appropriate personal protective equipment (PPE)
- Preparing the mold – make sure you heat mold before using for the first time, using a propane torch to eliminate any moisture in the mold
- After making the connection make sure you clean mold after every use with a soft bristle brush

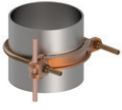
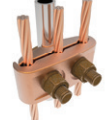
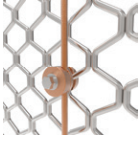


ABOVE GRADE APPLICATIONS & CONNECTORS

Above grade refers to the application and installation of connectors located in whole above the surface of the ground or earth. Typical above ground applications can include fence, structure, and/or equipment bonding or grounding.



ABOVE GRADE APPLICATIONS & CONNECTORS

Fence & Structure Grounding			
GAR 	GAR-BU 	GAR-39 	GD 
GP 	GK 	GAR-TC 	GG 
Braid 	BCR Rolling Gate 	GA-H 	GCS-HEX 
GCS-YA 	YGIB 	GB 	GC 
GBH 	GCH 	FFGC 	GNAH 

Mechanical Grounding Clamps

Copper Cable Connection to Round Conductor, Tubes, or Structures

Product Family	Material	Application	Available Ranges within Product Family			
			Wire Range	Rod or OD Range	IPS Range	Rebar Range
GAR	Cast Copper Alloy Connector Bodies; Silicon Bronze Hardware	One wire in parallel or perpendicular	#8 AWG - 500 kcmil	0.5" - 4.5"	0.5" - 6"	#5 - #11
GAR-BU	Cast Copper Alloy Connector Bodies; Silicon Bronze Hardware	One wire in parallel or perpendicular	#4 - 4/0 AWG	0.5" - 12.75"	0.5" - 12"	-
GAR-39	Cast Copper Alloy Connector Bodies; Galvanized Hardware	One wire in parallel or perpendicular	#4 - 4/0 AWG	0.5" - 12.75"	0.5" - 12"	-
GD	Cast Copper Alloy Connector Bodies; Silicon Bronze Hardware	Two wires in parallel	#4 AWG - 500 kcmil	0.5" - 12.75"	1" - 4"	-
GP	Cast Copper Alloy Connector Bodies; Silicon Bronze Hardware	Two wires in perpendicular	#8 - 2/0 AWG	0.5" - 4.5"	0.25" - 4"	-
GK	Cast Copper Alloy Connector Bodies; Silicon Bronze Hardware	Three wires in parallel	#8 AWG - 500 kcmil	0.5" - 2.875"	0.25" - 2.5"	-
GAR-TC	Cast Copper Alloy Connector Bodies; Silicon Bronze Hardware	Two-Hole (3/8") Lug Pad; Termination in parallel, 45° or 90° degrees	Up to 750 kcmil	0.84" - 12.75	0.5" - 12"	-

ABOVE GRADE APPLICATIONS & CONNECTORS

Mechanical Grounding Clamps

Copper Cable Connection to Square Tubes or Structures

Product Family	Material	Application	Available Ranges within Product Family	
			Wire Range	Square OD Range
GA-25H	Cast Copper Alloy Connector Bodies; Silicon Bronze Hardware	One wire in parallel	#4 AWG - 250 kcmil	1.875" - 2.5" x 2.5"
GA-H	Cast Copper Alloy Connector Bodies; Silicon Bronze Hardware	One or two wires in parallel	Small Clamp #6 - #4 AWG; Large Clamp 1/0 - 4/0 AWG	4"
GA-H30SS	Cast Copper Alloy Connector Bodies; Stainless Steel Hardware	One or two wires in parallel	#4 AWG - 300 kcmil	6" - 8"

Copper Cable Connection to Structure Flanges

Product Family	Material	Application	Available Ranges within Product Family	
			Wire Range	Flange Thickness Range
GCS-HEX	Cast Copper Alloy Connector Bodies; Stainless Steel Hardware	One or two wires in parallel or perpendicular	#6 AWG - 500 kcmil	1/8" - 1"
GCS-YA	Cast Copper Alloy Connector Bodies; Stainless Steel Hardware	Two-Hole or One-Hole termination in parallel or perpendicular	#8 - #1 AWG	1/8" - 5/8"

Copper Cable Connection to Bar, Equipment, Tower Leg, or Flat Structures

Product Family	Material	Application	Available Ranges within Product Family	
			Wire Range	Structure Thickness Range*
GB	Cast Copper Alloy Connector Bodies; Silicon Bronze Hardware	One wire	#8 AWG - 500 kcmil	1/4"
GC	Cast Copper Alloy Connector Bodies; Silicon Bronze Hardware	Two wires	#8 AWG - 500 kcmil	1/4"
GBH	Cast Copper Alloy Connector Bodies; Silicon Bronze Hardware	One wire; IEEE837	#8 AWG - 500 kcmil	1/4"
GCH	Cast Copper Alloy Connector Bodies; Silicon Bronze Hardware	Two wires; IEEE837	#8 AWG - 500 kcmil	1/4"
GNAH	Cast Copper Alloy Connector Bodies; Silicon Bronze Hardware	One wire; 1/2"-13 Hardware with 1.75" NEMA spacing; IEEE837	One wire; 1/2"-13 Hardware with 1.75" NEMA spacing; IEEE837	N/A

*Optional bolt lengths are available to accommodate up to 1" thick bar. For bar thicknesses from 1/4" to 1/2", add the suffix "T4" to the catalog number in the table. For bar thicknesses from 1/2" to 1", add the suffix "T8" to the catalog number in the table.

Copper Cable Connection to Fence Fabric, Barbed, & Razor Wire Mesh

Product Family	Material	Application	Available Wire Ranges within Product Family
FFGC	Tin-Plated Cast Copper Alloy; Stainless Steel Hardware	Wires in parallel, perpendicular or any degree in between	#8 - 2/0 AWG

Copper Bar, Strap, Braid Connection to Round Tubes, or Structures

Product Family	Material	Application	Available Ranges within Product Family	
			Wire Range	Structure Thickness Range*
GG	Cast Copper Alloy Connector Bodies; Silicon Bronze Hardware	One wire	#8 AWG - 500 kcmil	1/4"

Flexible Braid Jumper For Use with GG Grounding Clamp

Product Family	Material	Application	Available Ranges within Product Family	
			Wire Equivalent Range	Length Range*
TYPE B	Braided Copper Wire; Copper Ferrules	Flexible Conductor to compensate for misalignment and absorb vibratory movement	#6 AWG - 300 kcmil	6" - 36"

ABOVE GRADE APPLICATIONS & CONNECTORS

Mechanical Grounding Clamps

Mechanical Rolling Gate Grounding System

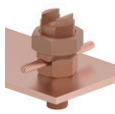
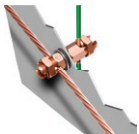
Product Family	Material	Application	Available Gate Lengths Ranges within Product Family
BCR	Zinc-Plated Steel; Galvanized Steel	Allows Conductor to move with Rolling Gates	12'-8" - 39'-11"

Irreversible Grounding Connectors

Copper Cable Connection to Vertical or Horizontal Steel Structure

Connector Type	Product Family or Catalog	Type	Application	Available Ranges within Product Family Wire Range	Flange Thickness Range
Exothermic	M-593	CS-3	Wire to Vertical Steel	4/0 AWG	-
Exothermic	M-647	CS-1	Wire to Horizontal Steel	#2 AWG - 500 kcmil	0.250" - 1.060"
Exothermic	M-8718	CS-23	Wire to Vertical Steel	4/0 AWG	
Compression	YGIB	-	Two-Hole (1/2-13") Lug Pad; Termination in parallel		

Equipment Grounding

WEEB-DSK Washer	WEEB-LUG	KC - J	EQC	YGHC-CN	KCKF
					

WEEB® Washers (Washer Electrical Equipment Bond)

Bonding and Grounding Connectors for Non-Conductive Coated Surfaces

Product Family	Material	Application	Available Ranges within Product Family Wire Range	Mounting Hardware Range
WEEB- LUG	Tin-Plated Copper; Stainless Steel Hardware	Grounding Lug; One or Two Wires	One Wire #14 - #6 AWG or Two Wires #12 - #10 AWG	1/4" - 3/8"
WEEB-DSK	Stainless Steel	Bonding Washer	Equivalent to #6 AWG	1/4" - 1/2"

Mechanical Grounding Clamps

Copper Cable Connection to Transformer, Cabinets, or Bulkhead

Product Family	Material	Application	Available Ranges within Product Family Wire Range	Stud Size Range
KC-J	Copper	Transformer Ground Connectors	#8 AWG - 500 kcmil	1/2-13"
EQC	Copper	Transformer Ground Connectors	#8 - #2 AWG	1/2-13"
KCKF	Copper; Stainless Steel; Neoprene	Bulkhead Ground Connector	#10 - 4/0 AWG	7/16" - 11/16"

Irreversible Grounding Connectors

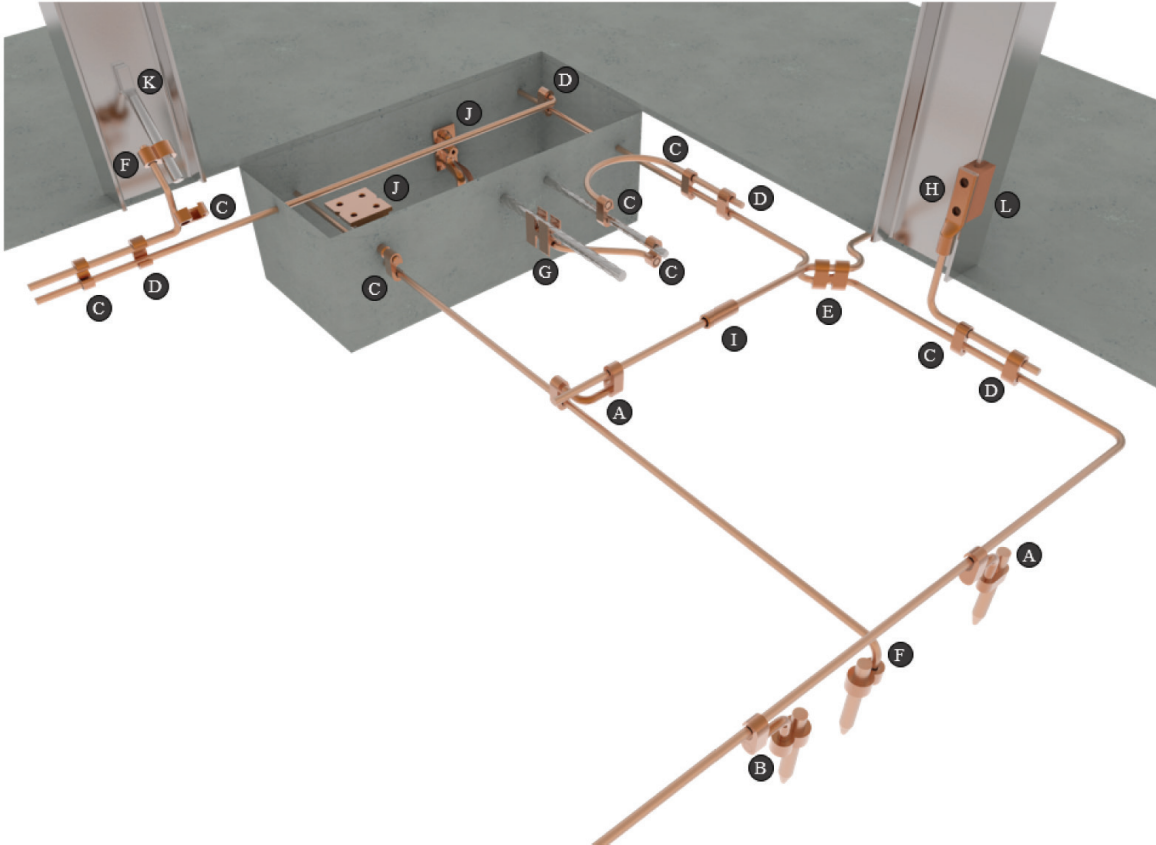
Copper Cable to Copper Cable in Medium Voltage Cabinets or Enclosures

Product Family	Material	Application	Available Ranges within Product Family Round Concentric Range	Flat Strap Concentric Neutral Range
YGHC-CN	Copper Alloy	Concentric Neutral Grounding	#6 - 250 kcmil	#6 - 250 kcmil

BELOW GRADE APPLICATIONS & CONNECTORS

Below grade refers to the application and installation of connectors underneath the surface of the ground or earth. Typical below ground applications can include ground grids or rings.

HYGROUND® Irreversible Compression System



Letter	Product Family	Application	Available Ranges within Product Family		
			Wire Range	Ground Rod Range	Rebar Range
A	YGL	Cross Grid (perpendicular)	#6 AWG - 500 kcmil	1/2" - 3/4"	#3 - #6
B	YGLR	Ground Rod to Grid	#2 AWG - 500 kcmil	1/2" - 1'	N/A
C	YGHP	Figure 6	#6 AWG - 500 kcmil	1/2" - 3/4"	#3 - #6
D	YGHC	Figure C	#6 AWG - 500 kcmil	1/4" - 3/4"	N/A
E	YGHHC	Double Figure C	#6 AWG - 500 kcmil	3/8" - 3/4"	N/A
F	YGHR	Ground Rod Tap	#2 AWG - 500 kcmil	1/2" - 1'	N/A
G	YSHG	Double H-Tap Connector	#2 AWG - 500 kcmil	3/4"	#6 - #9
H	YGHA	Heavy Duty Terminal	#2 AWG - 500 kcmil	N/A	N/A
H	YGA	Standard Duty Terminal	#8 AWG - 500 kcmil	N/A	N/A
I	YGHS	Heavy Duty Splice	#2 AWG - 500 kcmil	N/A	N/A
I	YGS	Standard Duty Splice	#8 AWG - 500 kcmil	N/A	N/A
J	YGF	Grounding Plate	#2 AWG - 500 kcmil	N/A	N/A
K	GSTUD-HY	Structural Steel Connector	#6 - 4/0AWG Equivalent	1/4" - 3/4"	N/A
L	YGIB	Structural Steel Connector	See YGA or YGHA	N/A	N/A

BELOW GRADE APPLICATIONS & CONNECTORS

HYGROUND® Compression Connector Grid

Hygrid™ Cross Connector (YGL-C)

- Designed for cross connections as well as “ells” and “tees”
- Rotating elements facilitate positioning prior to crimp
- IEEE837



Gridlok™ Ground Rod to Grid Connector (YGLR-C)

- Provides high-torque connection to ground rod
- Rotating elements facilitate installation
- IEEE837



Figure “6” Hytap™ Connector (YGHP-C)

- Can be used as a tap connector or a tap splice connector
- IEEE837



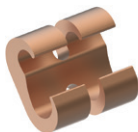
Figure “C” Hytap™ Connector (YGHC-C)

- Can be used for tap or cross connections
- “C”-shaped opening permits placing two parallel cables into conductor groove
- Wire to ground rod applications
- IEEE837



Double Figure “C” Hytap™ Connector (YGHC-C)

- Double wide version of the YGHC-C
- IEEE837



Hytail™ Ground Rod Tap Connector (YGHR-C)

- Provides a tap or pigtail-type connection from ground rods to grounding counterpoise or grid
- IEEE837



Double H-Tap Connector (YSHG)

- Can be used on any secondary splice or tap application
- Wire to ground rod or rebar applications



Hylug™ Heavy-Duty Terminals (YGHA)

- Designed to carry a short-circuit load and withstand high mechanical stress
- IEEE837



Hylug™ Terminals (YGA)

- Designed for ground applications
- Inspection hole ensures proper cable insertion
- Standard NEMA hole spacing



Hylink™ Heavy-Duty Splice (YGHS)

- Designed to carry a short-circuit load and withstand high mechanical stress
- IEEE837



Hylink™ Splice (YGS)

- Designed to carry a short-circuit load and withstand high mechanical stress



Grounding Plate (YGF)

- Withstands the rigors of concrete construction
- Pre-tapped two- or four-hole NEMA spacing
- Tapped hole on underside for ease of repositioning
- Plugged holes keep dirt out
- IEEE837



Versitail Structural Steel Connector (GSTUD-HY)

- Welds to steel surfaces quickly with regular equipment
- Eliminates costly disk grinding
- Copper-plated knurled area for excellent gripping and electrical integrity



GroundLink™ Connector (YGIB)

- Unique design allows for ground attachment to structural steel
- Available for straight or angled steel
- Includes thread protection studs to prevent hole deformation
- IEEE837



Static Grounding Receptacle (YGT and YTTAG)

- Connects to ground grid and finished flush
- YTTAG for aircraft applications



Hytap™ Ground Electrode Tap Connector (YGHP-C)

- A ground rod connector with an open groove for continuous run and tapping applications (second groove for tap only)
- “Third hand” constrains conductors while installer completes crimp
- IEEE837



Bus Bar/Flat Steel Connector (YG-B)

- Designed to attach tap conductor(s) to 1/8”-1/4” thick copper bus bar or flat steel
- Suitable for 1 or 2 conductors for power or grounding and bonding applications



Tooling

PATRIOT® T3 Technology

- Track** crimp locations with onboard GPS - BURNDY exclusive!
- Trace** individual crimps with comments, photos, and output force validation
- Transmit** via Bluetooth technology and sync to the cloud
- T3 Technology and the Burndy Engineered System ensures 5-Year Warranty

T3 TRACK
TRACE
TRANSMIT

PATRIOT® 12 Ton with T3 Technology (Tool Series: PAT750T3)

- C-head with 1.65” jaw opening and 355° head rotation
- Used with U dies
- Patented T-Track alignment guide for HYGROUND® as well as other asymmetrical connectors

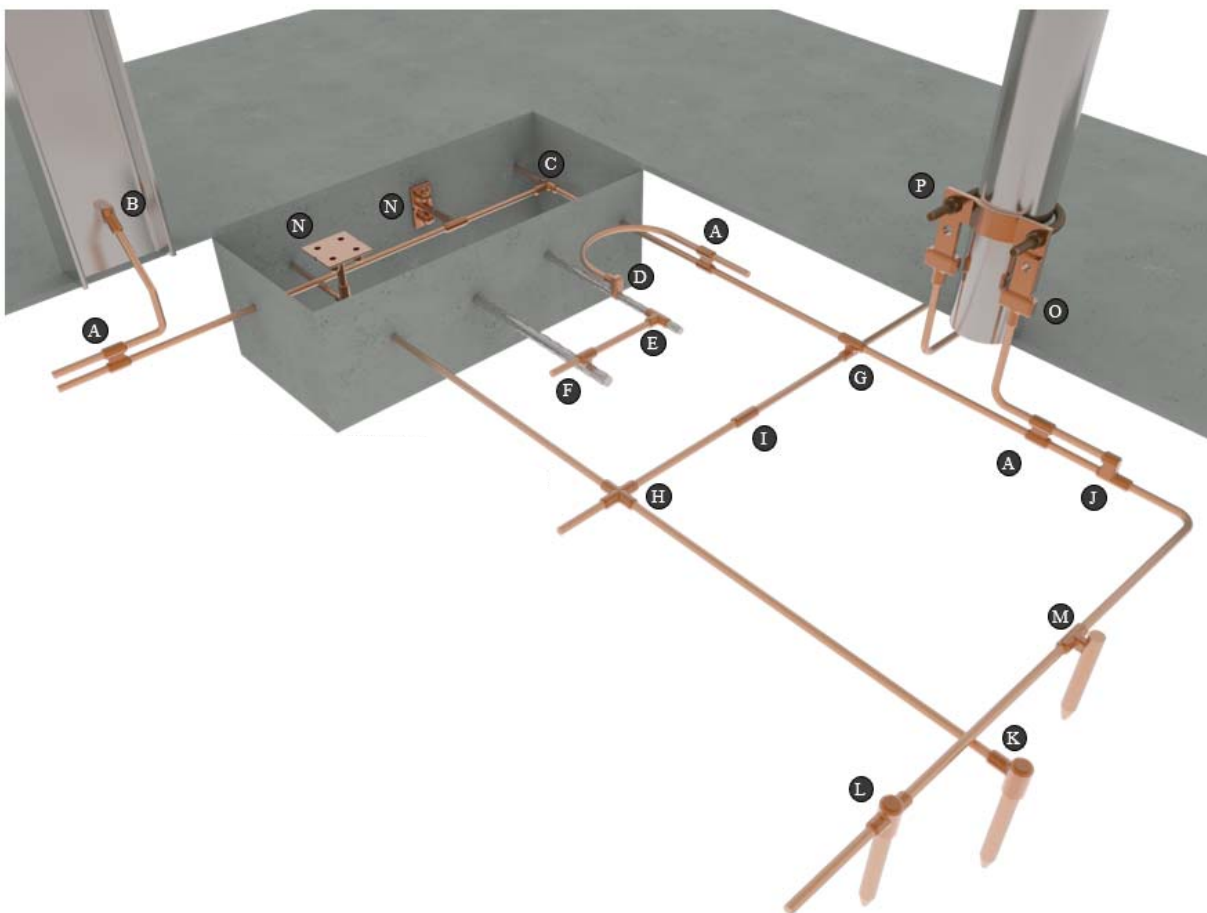


PATRIOT® 15 Ton with T3 Technology (Tool Series: PAT46T3)

- C-head or Latch head with 2.00” jaw opening or ram travel and 355° head rotation
- Used with P dies; U dies with PUADP1 Adapter (sold separately)



thermOweld® Exothermic Connections



EXOTHERMIC

Letter	Description	Product Family
A	CABLE TO CABLE PARALLEL WELD CONNECTOR	CC-7
B	ANGULAR CABLE TO VERTICAL STEEL PLATE WELD CONNECTOR	CS-3
C	CABLE TO CABLE T-TYPE WELD CONNECTOR	CC-2
D	CABLE TO REBAR TAP WELD CONNECTOR	CRE-1
E	CABLE TO REBAR T-TYPE WELD CONNECTOR	CRE-2
F	CABLE TO REBAR CROSS WELD CONNECTOR	CRE-4
G	CABLE TO CABLE UNCUT CROSS WELD CONNECTOR	CC-11
H	CABLE TO CABLE CUT CROSS WELD CONNECTOR	CC-4
I	CABLE END TO END WELD CONNECTOR	CC-1
J	CABLE TO CABLE PARALLEL TAP WELD CONNECTOR	CC-6
K	CABLE END TO GROUND ROD WELD CONNECTOR	CR-1
L	CABLE TO GROUND ROD CUT T-TYPE WELD CONNECTOR	CR-2
M	CABLE TO GROUND ROD UNCUT T-TYPE WELD CONNECTOR	CR-3
N	THRU CABLE TO GROUND PLATE T-TYPE WELD CONNECTOR	CR-32
O	CABLE TO LUG TERMINAL WELD CONNECTOR	CB-11

thermOweld® Exothermic Connections

Molds

CATALOG #	TYPE	DESCRIPTION
M-232	CC-2	2/0 to 2/0
M-241	CC-2	4/0 to 4/0
M-2707	CC-11	4/0 to 4/0
M-548	CR-2	2/0 to 5/8" rod
M-550	CR-2	4/0 to 5/8" rod
M-559	CR-2	2/0 to 3/4" rod
M-561	CR-2	4/0 to 3/4" rod
M-593	CS-3	4/0 to vertical steel
M-647	CS-1	4/0 to horizontal steel
M-8718	CS-23	4/0 to vertical steel
M-208	CC-1	4/0 to 4/0
M-593	CS-3	4/0 to vertical steel
M-647	CS-1	4/0 to horizontal steel
M-8718	CS-23	4/0 to vertical steel



Electronic Ignition

CATALOG #	DESCRIPTION
38-EZLT-RU	Battery Ignition System
38-EZLT-IG	Ignitor Sticks
38-EZLT	Battery Ignition System & 20 QIKSTIK Ignitor Sticks



Accessories

CATALOG #	DESCRIPTION
B106	Handle Clamp
38030900	Flint Ignitor
38392200	Natural Bristle Brush
38032900	Shimstock
38406100	Ceramic Fiber Packing Material
37032001	3/4" disc for Weld Metal Cartridge sizes 15-65
37032002	1" disc for Weld Metal Cartridge sizes 90-115

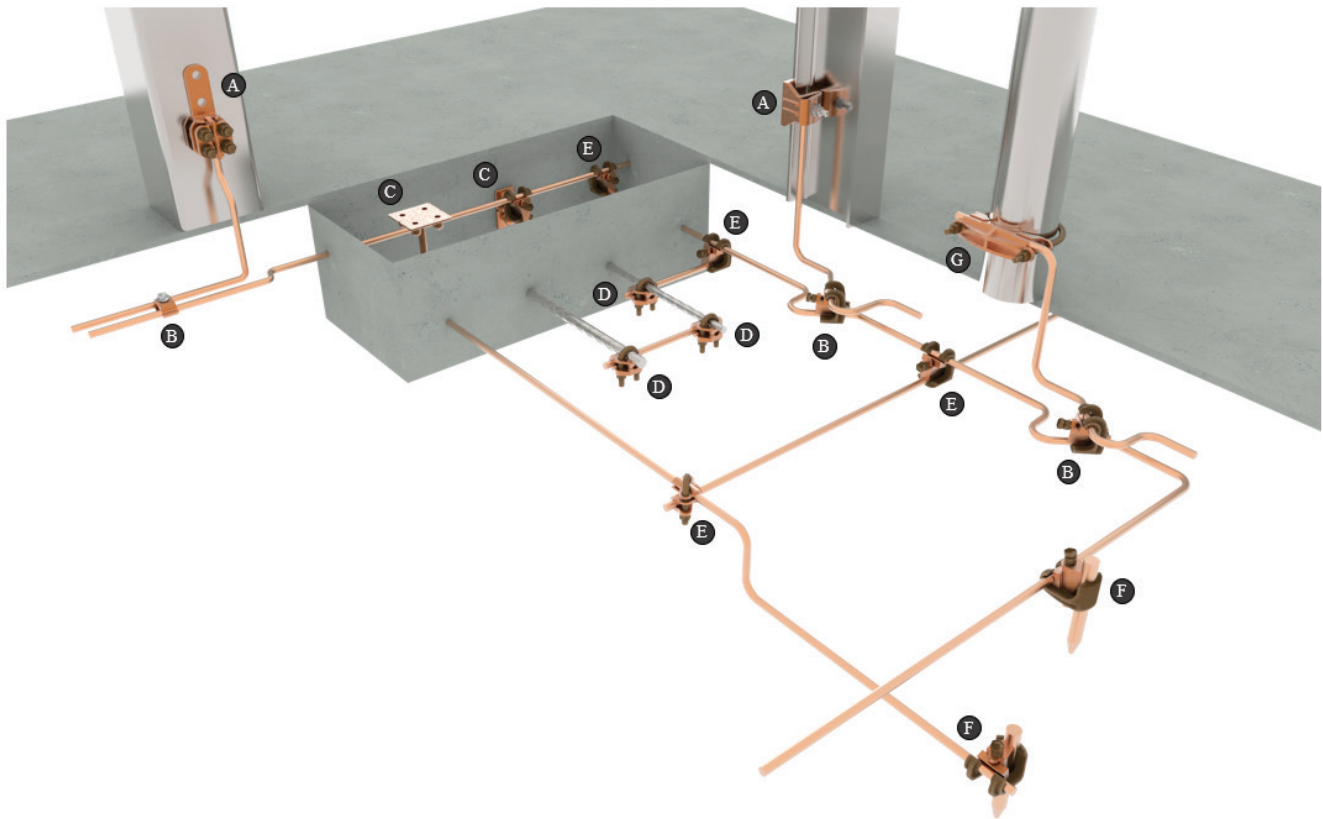


Weld Metal/Cartridge Size

WELD METAL/CARTRIDGE SIZE	WELD METAL W/IGNITOR STICKS	PACKAGE QTY
45	TW45EZ	20
65	TW65EZ	20
90	TW90EZ	10
115	TW115EZ	10
150	TW150EZ	10
250	TW250EZ	10



Mechanical



MECHANICAL		
Letter	Description	Product Family
A	STRUCTURAL FRAME TO GRID CONNECTOR	G-AH, GNAH or GCS
B	GRID TO GRID PARALLEL CONNECTOR	GB-RB or GC
C	GROUND PLATE TO GRID CONNECTOR	YGF
D	REBAR TO GRID CONNECTOR	GAR, GP, or GB-RB
E	GRID TO GRID PERPENDICULAR CONNECTOR	GX or GXP
F	GROUND ROD TO GRID CONNECTOR	GP or GRC
G	ROUND POST TO GRID CONNECTOR	GAR, GP, GD, or GK

Mechanical

Mechanical					
GX (wire to wire cross grid)	GXP	GP (wire to rod)	GAR (wire to rebar or rod)	GC-RB (wire to rebar)	GNAH
					

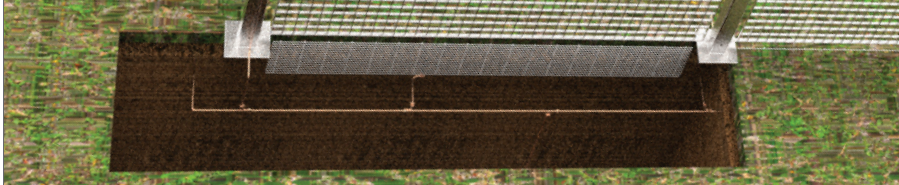
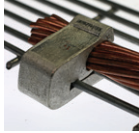
Mechanical Grounding Clamps

Copper Cable Connection to Round Conductor

Product Family	Material	Application	Available Ranges within Product Family		
			Wire Range	Rod or OD Range	Rebar Range
GX	Cast Copper Alloy Connector Bodies; Silicon Bronze Hardware	Two wires in cross grid	#8 AWG - 500 kcmil		
GXP	Cast Copper Alloy Connector Bodies; Stainless Steel Hardware	Two wires to Pedestal/ Pipe / Rebar in cross grid, parallel or perpendicular	#6 - 4/0 AWG		#7 - #12
GAR	Cast Copper Alloy Connector Bodies; Silicon Bronze Hardware	One wire in parallel or perpendicular	#8 AWG - 500 kcmil	1/2 - 4 1/2	#5 - #11
GP	Cast Copper Alloy Connector Bodies; Silicon Bronze Hardware	Two wires in perpendicular	#8 AWG - 500 kcmil	1/2 - 4 1/2	
GC-RB	Cast Copper Alloy Connector Bodies; Silicon Bronze Hardware	Two wires in perpendicular	#6 - 4/0 AWG		#3 - 11
GNAH	Cast Copper Alloy Connector Bodies; Silicon Bronze Hardware	One wire; 1/2"-13 Hardware with 1.75" NEMA spacing; IEEE837	#6 SOL - 250 kcmil	N/A	

Dig Guard or Ground Barriers

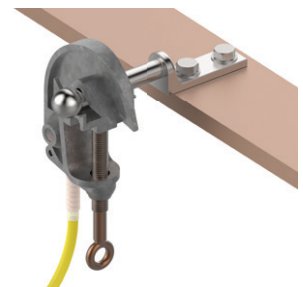
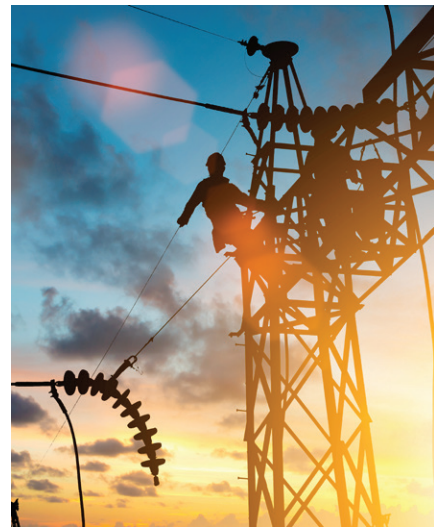
Below grade barriers are commonly used as an anti-trenching theft deterrent.

HYGROUND® Irreversible Compression and Mechanical		
FFGC		YG-G
		
		

Product Family	Material	Application	Available Ranges within Product Family
FFGC	Tin-Plated Cast Copper Alloy; Stainless Steel Hardware	Wires in parallel, perpendicular or any degree in between	#8 - 2/0 AWG
YG-B	Copper	Wire to guard wire or flat structure	1/0 AWG - 4/0 AWG

TEMPORARY PROTECTIVE GROUNDING

The building of high-powered electrical systems has resulted in a continuous increase in the power capability of the national electric grid and the need for higher-rated grounding components and accessories. The ASTM F855 standard, which outlines the specifications for temporary protective grounding, contains updates to reflect these changing requirements.



Burndy Temporary Protective Ground Studs

Temporary Protective Ground Studs are single point ground connections for Temporary Ground Sets. The H-Rated Ground Studs are designed and tested to meet the requirements of ASTM F855 Table 2.

- Constructed of Tin-Plated Cast Copper
- NEMA spaced terminal pad
- Animal mitigation/Stud Protector Cover Available
- Ball and Socket design accommodates industry standard Ground Set Clamps
- Third-party laboratory test results available



CHANCE® Grounding Set Configurator Tool

Type GSC88

35mm Ground Ball Stud with 90° NEMA Pad

Catalog Number	Description	Mounting Details & Orientation	Pad Angle	Ball Diameter	Rating
GSC882NH35B7H	Ground Stud	1/2" holes with 1.75" NEMA Spacing; 90° Pad	Straight	35 mm (1.38")	Grade 7H
GSC882NH35BCOVER	Ground Stud Cover		Not Applicable for Cover		

Type GSC75

30mm Ground Ball Stud with Inline NEMA Pad

Catalog Number	Description	Mounting Details & Orientation	Pad Angle	Ball Diameter	Rating
GSC752N30B5H	Ground Stud	1/2" holes with 1.75" NEMA Spacing; Inline Pad	Straight	30 mm (1.18")	Grade 5H
GSC752N30B	Ground Stud	1/2" holes with 1.75" NEMA Spacing; Inline Pad	Straight	30 mm (1.18")	Grade 5
GSC752N30B45	Ground Stud	1/2" holes with 1.75" NEMA Spacing; Inline Pad	45°	30 mm (1.18")	
GSC752N30B90	Ground Stud	1/2" holes with 1.75" NEMA Spacing; Inline Pad	90°	30 mm (1.18")	
GSC7530BCOVER	Ground Stud Cover		Not Applicable for Cover		

Type GSC63

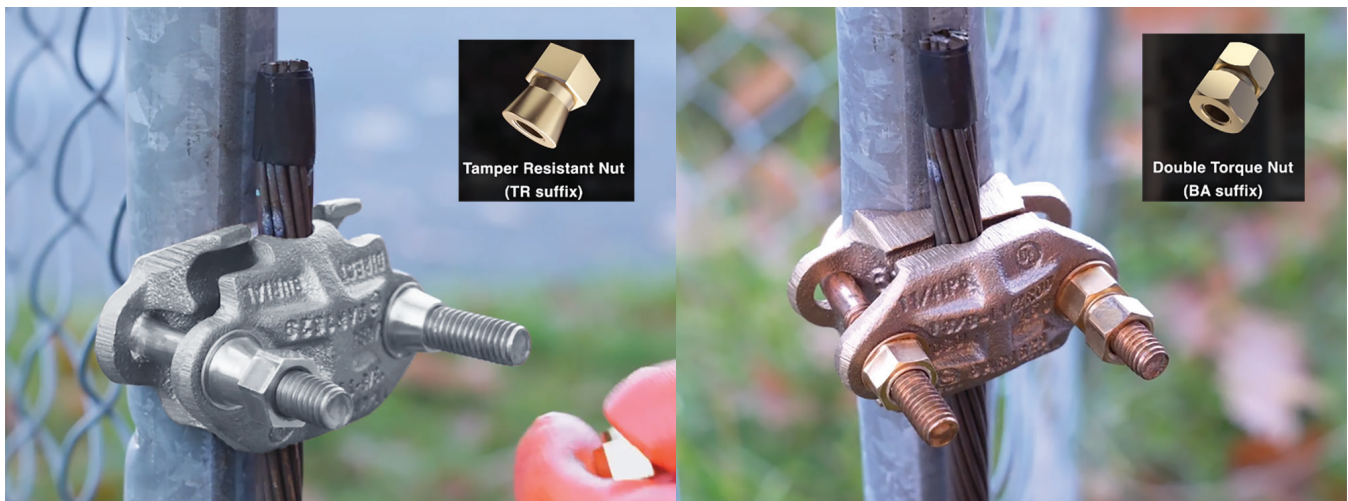
25mm Ground Ball Stud 90° and Inline NEMA Pad

Catalog Number	Description	Mounting Details & Orientation	Pad Angle	Ball Diameter	Rating
GSC632NH1B	Ground Stud (90°)	1/2" holes with 1.75" NEMA Spacing; 90° Pad	Straight	25mm (1")	Grade 4
GSC632NH25B5H	Ground Stud (90°)	1/2" holes with 1.75" NEMA Spacing; 90° Pad	Straight	25mm (1")	Grade 5H
GSC632N25B5H	Ground Stud (inline)	1/2" holes with 1.75" NEMA Spacing; Inline Pad	Straight	25mm (1")	Grade 5H
GSC632NH1BCOVER1	Ground Stud Cover		Not Applicable for Cover		

The Grounding Superstore™ has a full product offering that covers a variety of unique grounding applications.

Unprotected, visible copper conductor and connectors are vulnerable to theft. Damage from copper theft is rarely limited to just conductor loss and often includes equipment damage, connector damage or theft. **BURNDY** offers a variety of options to help customers deter copper theft.

- **Tin-Plated Connectors** - by changing the appearance, connections are less attractive to potential copper thieves.
 - Mechanical or Compression Connectors with a TN suffix have tin-plated connector bodies
- **Alternative Hardware** - **BURNDY** offers the option of alternative hardware on our mechanical grounding connectors, as well as tin plated hardware, all of which assist in the deterrence of theft and prevent damage.
 - Mechanical Connectors with a W suffix are fully tin-plated products
- **Longer Bolts** - Some mechanical connectors offer a longer bolt option as a way to hide conductor inside a channel or back of structural steel reducing its visibility.
 - Mechanical Connectors with a T suffix have longer than standard bolts
- Compatible with **COPPERWELD®** Copper-clad Steel Conductor. Copper-clad Steel Conductor is difficult to cut and nets a low scrap value.
- **Specialized Hardware** - In areas with high foot traffic, or where theft is an inherent issue, **BURNDY** offers multiple hardware options that utilizes special tooling for installation, deterring potential thefts.
 - Mechanical Connectors with a TR suffix have tamper-resistant shear nuts and a BA suffix for breakaway nuts





TAKE OFF SERVICES

At **BURNDY**, we are more than just a supplier, we are your technical partner. Our exclusive take off program can arm you with part number level detail for BOM preparation.

Our expert BURNDY® Take Off Team can offer product suggestions and a devoted BURNDY Sales Representative is on hand for seamless communication throughout the process.

- We provide you with expert knowledge of BURNDY and competitor products.
- Receive the best possible solutions for all types of connections such as ground grids, substation fencing, moving gates, swimming pools and lightning protection.
- Our product solutions meet all requirements for telecommunication, aerospace and military (FAA) projects as well as those for the federal government.
- Enjoy quick turn around time.
- There is absolutely no cost to you.
- Includes marked up project drawings and BOM spreadsheet

Hardware & Torque

Some years ago, the electrical industry established optimum torque values for the most common materials and sizes of hardware used for electrical connections. It is often asked whether bolted connections require periodic retightening. The simple answer is NO. Once the connector is installed with the proper torque, repeated tightening could damage the connector and/or the conductor and eventually lead to a failure. (Reference the Connector Theory and Application - A Guide to Connection Design and Specification - Revised 5th Edition.)

Recommended Tightening Torque

The hardware used in connectors must be compatible with the connector material, have high mechanical strength and be corrosion resistant.

Copper alloy connectors have hardware made of DURIMUM™, which is the BURNDY trade name for silicon bronze alloy ASTM B99. This material was first introduced by BURNDY in 1927 for use in outdoor construction and today is the standard throughout the industry.

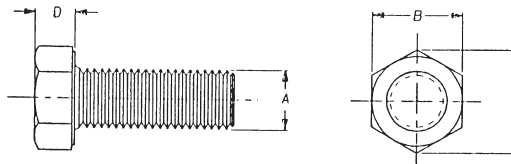
Aluminum connectors generally have aluminum alloy hardware. The bolts are 2024T4 and anodized to resist corrosion. The nuts are 6061T6, which is resistant to corrosion and does not require anodizing. Bolts are lubricated to eliminate galling and to provide consistent clamping forces.

The size material for clamping hardware are selected to provide the required force when tightened to the recommended torque. To reduce or greatly exceed the recommended torque can adversely affect the performance of the connector.

STEEL HARDWARE	
Bolt Size	Recommended Torque (Inch Pounds)
1/4 - 20	80
5/16 - 18	180
3/8 - 16	240
1/2 - 13	480
5/8 - 11	660
3/4 - 10	1050

ALUMINUM HARDWARE	
Bolt Size	Recommended Torque (Inch Pounds)
1/2 - 13	300
5/8 - 11	480
3/4 - 10	650

DURIMUM™ (Silicon Bronze) Hexagonal Bolt Data



ALUMINUM HARDWARE							
Catalog Number Series*	"A" Bolt Size	"B"	"C"	"D"	Recommended Torque (in-lb)**	Min. Breaking Force (lb)	Min. Shearing Force (lb)
25X__HEB	1/4 - 20	7/16	0.5	0.16	80	1,780	990
31X__HEB	5/6 - 18	1/2	0.56	0.21	180	2,930	1,640
38X__HEB	3/8 - 16	9/16	0.65	0.24	240	4,350	2,430
50X__HEB	1/2 - 13	3/4	0.87	0.32	480	7,950	4,460
62X__HEB	5/8 - 11	15/16	1.08	0.4	660	12,700	7,100
75X__HEB	3/4 - 10	1-1/8	1.3	0.48	1050	17,510	10,540

__ is substituted for bolt length; Consult sales representative for available lengths

**These torque values develop maximum bolt preload

This drawing is based on BURNDY engineering specification

Plating

Various plating materials and processes are used on electrical connection products. Table 3.1-5 contains a short list of possible reasons for plating and the corresponding types of plated connectors suitable for meeting that objective.

TABLE 3. 1-5 PLATING APPLICATIONS				
Objective	Electro-tin	Electro-tin	Nickel	Silver*
Reduce galvanic corrosion (bimetallic)	X	X	-	-
Resist corrosive elements	X	X	-	-
Increase conductivity/lower contact resistance	-	-		X
Provide high, continuous service temperatures (maximum)	-	-	X (650F/343C)	X (650F/343C)

*Joining aluminum to a silver plated surface will result in a highly corrosive high resistance connection.

Conductor

See Reference Section of the Burndy Master Catalog for more comprehensive cable and conductor data.

COPPER PRODUCT			COPPER CLAD STEEL 40% DSA		
Size	Diameter	Circular Mills	Size	Diameter	Circular Mills
Solid No. 6 AWG	0.162	26250	Solid No. 6 AWG*	0.162	26250
Solid No. 4 AWG	0.204	41738	Solid No. 4 AWG*	0.204	41738
No. 2 AWG Strand	0.292	66407	7 No. 9 AWG	0.343	91651
Solid No. 1 AWG	0.289	83683	7 No. 8 AWG	0.385	115568
1/0 Strand	0.368	105521	7 No. 7 AWG	0.433	145726
2/0 Strand	0.414	133057	7 No. 6 AWG	0.486	183754
3/0 Strand	0.464	167779	7 No. 5 AWG	0.546	231706
4/0 Strand	0.552	211563	19 No. 9 AWG	0.572	248767
250 MCM	0.574	250000	19 No. 8 AWG	0.642	313684
300 MCM	0.629	300000	19 No. 7 AWG	0.721	395542
400 MCM	0.726	400000	19 No. 6 AWG	0.81	498762
500 MCM	0.813	500000	19 No. 5 AWG	0.91	628917

GROUND ROD AND REBAR DIAMETER CHART				
Size	Ground Rod		Reinforcing Bar (Rebar)	
	Material*	Diameter	Size	Diameter
1/2"	Steel	0.500	#3 (3/8")	0.375
	Copperclad	0.475	#4 (1/2")	0.500
5/8"	Steel	0.625	#5 (5/8")	0.625
	Copperclad	0.563	#6 (3/4")	0.750
3/4"	Steel	0.750	#7 (7/8)	0.875
	Copperclad	0.682	#8 (1"0)	1.000
1"	Steel	1.000	#9 (1-1/8")	1.128
	Copperclad	0.914		

Sources

FERC Regulation



Burndy Connector Theory



NFPA 70 National Electric Code 2023



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