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How To Attach Ground Wires to RF Coaxial Surge Arrestors

White Paper

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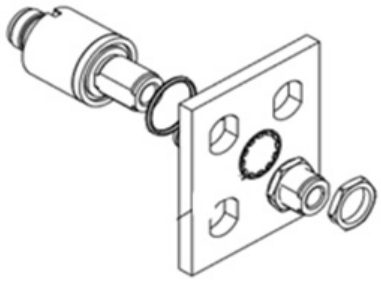
Surge Protector Grounding is Foundational:

First, grounding the surge arrestor is required. The surge arrestor body is part of the surge current path to ground, but that body must be connected to ground through a dedicated ground wire. Absent that connection, the surge arrestor will be ineffective, and the circuit will remain susceptible to surge damage.

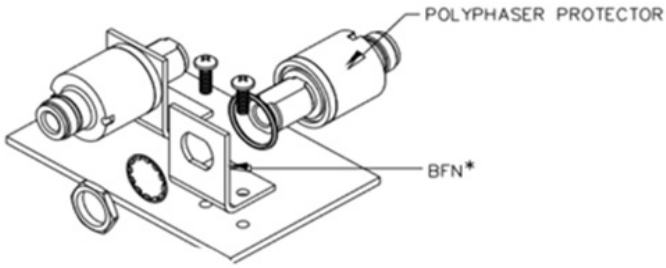
Here are the three basic methods to attach a ground wire to a surge protector without a built-in ground connection:

1. If bulkhead mounting the RF surge arrestor to a metal ground plate or ground bar, attach the ground wire to the metal ground plate/bar. Use a #4 or #2 stranded (not solid) ground wire.



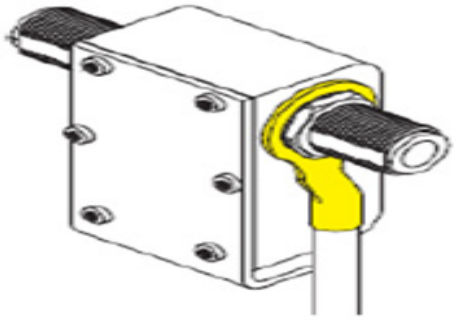
Bulkhead Mount to Ground Plate or Enclosure

2. If flange mounting the RF surge protector, attach the ground wire to the flange bracket.



Flange Mounting to a Flat Surface with a Bulkhead-to-Flange Adapter Plate (like the BFN AdapterBracket (for N Type Female Connectors) for example)

3. If hanging the surge arrestor on a coax cable (not attaching it to a ground plate or to a flange bracket), use a ring terminal with the correct inner diameter for the Female Connector type used. Crimp the ring terminal to one end of the ground wire, and slip it over the surge arrestor's female connector, securing it with the provided washer and nut. Use #6 AWG stranded ground wire.



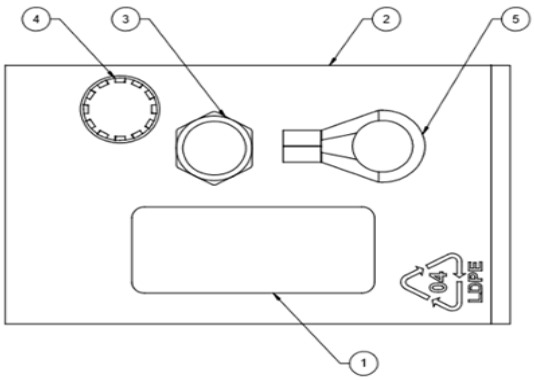
Ring Terminal Grounding to Female Connector

Below are the female connector outer-diameters for a few of the more popular RF coaxial connectors used by many RF surge arrestors:

- 4.3-10 Female Connector: 0.82-inch diameter (20.83mm)
- N Female Connector: 5/8-inch diameter or 0.64 inch (16.3mm)
- 7/16 DIN Female Connector: 1.15-inch diameter (29.21mm)

For female coax connector dimensions not identified above, use calipers or a ruler to measure the female coax connector outer diameter. Use the measured diameter to select a ring terminal with the same inner-diameter appropriate for the just measured female connector and that crimps to a #6AWG stranded (not solid) ground wire.

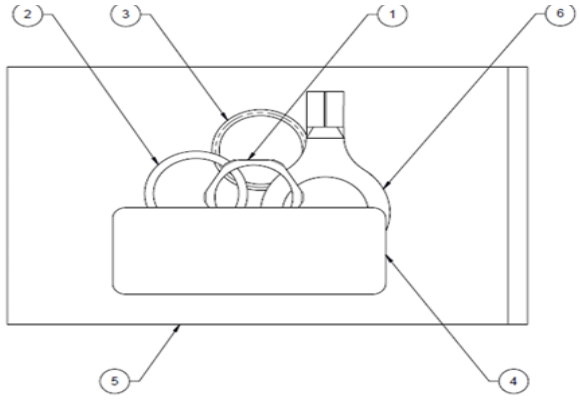
Below are three ring terminal hardware kits offered by PolyPhaser for 4.3-10, N and 7/16 DIN female connectors. These kits include washer, nut, and a ring terminal for the appropriate connector and are meant to crimp to a #6 AWG (or 16mm² for international wire diameters) stranded ground wire.



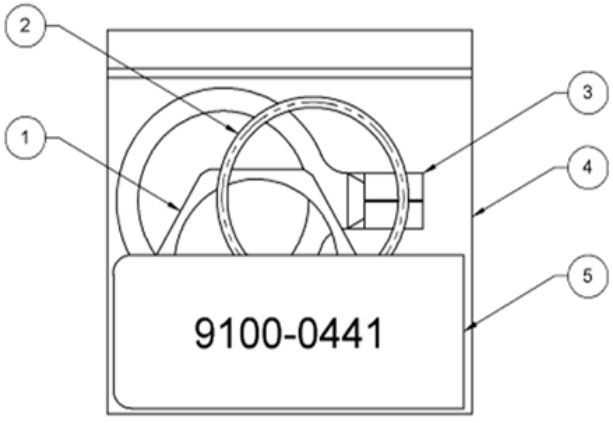
#1 = LABEL BAR CODE PRINTED
#2 = POLYBAG 3x5 2MIL
#3 = NUT 5/8-24 303 HEX SS
#4 = WASHER 5/8 410 SS
#5 = RING TERM 5/8" STUD 6AWG

PolyPhaser SKU#: 9100-0350 (N female connectors)

Item #1 = NUT M20 X 1 SS
Item #2 = WASHER .82ID FLAT SS
Item #3 = SILICONE O-RING 019
Item #4 = LABEL BAR CODE PRINTED
Item #5 = POLYBAG 3X5 2MIL
Item #6 = RING TERM 6 AWG DIN .82" ID



PolyPhaser SKU#: 9100-0522 (4.3-10 female connectors)



Item #1 = NUT M29 X 1.5 SST DIN
Item #2 = O-RING 025 SILICONE
Item #3 = RING TERM 6AWG DIN 1.5"ID
Item #4 = POLYBAG 2.5 X 2.5 IN 1.5 MIL ROLL
Item #5 = LABEL BAR CODE PRINTED

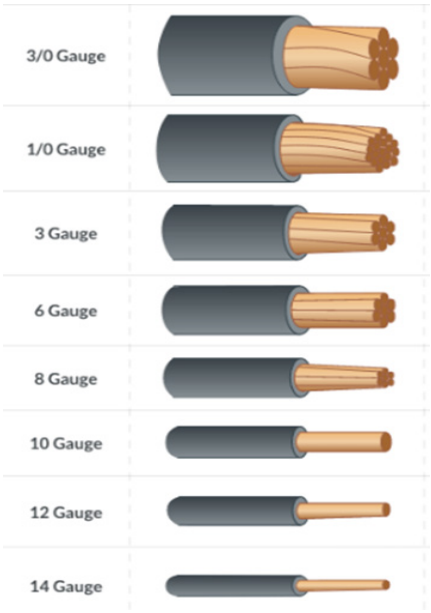
PolyPhaser SKU#: 9100-0441 (7/16 DIN female connectors)

Note: The three ring terminal kits identified above are not available on www.polyphaser.com, but are active hardware kits available via PolyPhaser manufacturers' representatives and authorized distributors. They are also available from PolyPhaser directly by contacting PolyPhaser at Sales@polyphaser.com

When searching for a ring terminal to attach to the surge arrestor's female connector, identify a ring terminal that accepts and crimps to a #6 AWG stranded ground wire.

PolyPhaser's RF engineering team researched what the minimum amount of copper which should be attached to a single surge arrestor for best grounding results. Results found that either a 1 ½-inch wide solid copper strap or its equivalent, a #6 AWG stranded ground wire, should be the minimum size ground conductor for single surge arrestor grounding.

Regarding wire gauge, the smaller the gauge number or AWG number, the larger the wire diameter. For example, a #12 AWG wire is much smaller than a #6 AWG wire diameter. North America uses the American Wire Gauge (AWG) standard. International Wire Gauge is described in square millimeters (MM2). There are online AWG to MM2 wire gauge charts available if needed.



American Wire Gauge (AWG) wire size comparison chart.
Use #6 AWG stranded ground wire

Stranded vs. Solid Ground Wire & Wire Diameter Basics

Why are stranded ground wires recommended and not solid ground wires? Surge current flows on the conductor surface. There is more surface area or skin effect with a stranded wire than with a solid wire. Therefore, more surge current can transfer to ground through a stranded ground wire than through a solid ground wire.

When attaching a ground wire or strap to a metal ground plate, use a larger diameter wire or a larger copper strap to properly shunt combined surge arrestor surge grounds. This assumes multiple surge arrestors or additional ground wires from multiple equipment are attached to the ground bar. For ground bars or ground plates, use #2 AWG stranded ground wire or a 6-inch-wide solid copper strap.

Keep the ground wire or strap as straight and short as possible (from the plate or surge arrestor to earth ground). Surge current finds the path of least resistance to earth ground. Bends or kinks in the ground wire add impedance, which causes the surge current to find a lesser path to ground, potentially through electronic equipment. If a bend is unavoidable, use a gentle 8-inch arc.

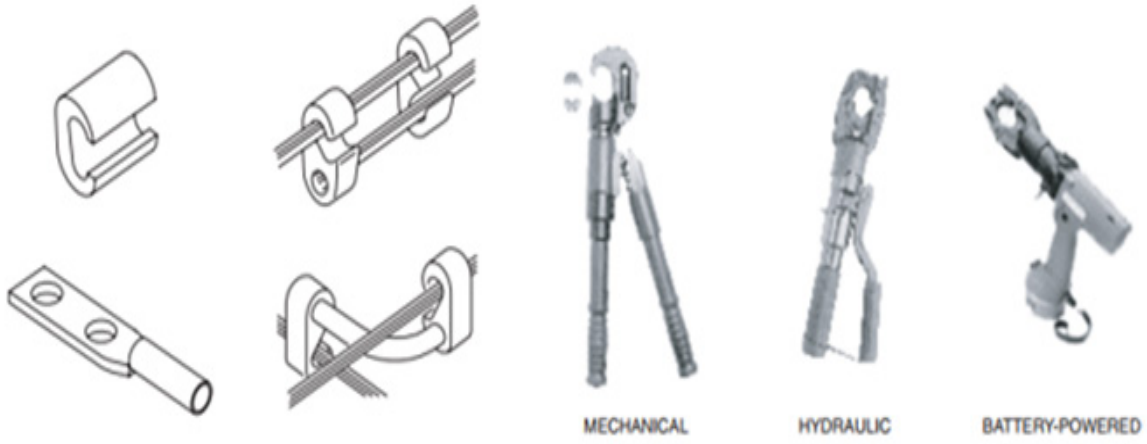
Using a larger ground wire or strap with a ground plate is required to allow the combined surge currents from multiple surge arrestors and other equipment ground wires to find ground through.

For single surge arrestor grounding, a single #6 AWG stranded ground wire or 1 ½" wide copper strap is sufficient, again, keeping the ground wire or strap as straight and short as possible. There are several methods to attach or bond the ground cable or ground strap to an earthed ground rod. The three best practice methods all assume the use of a ground rod.

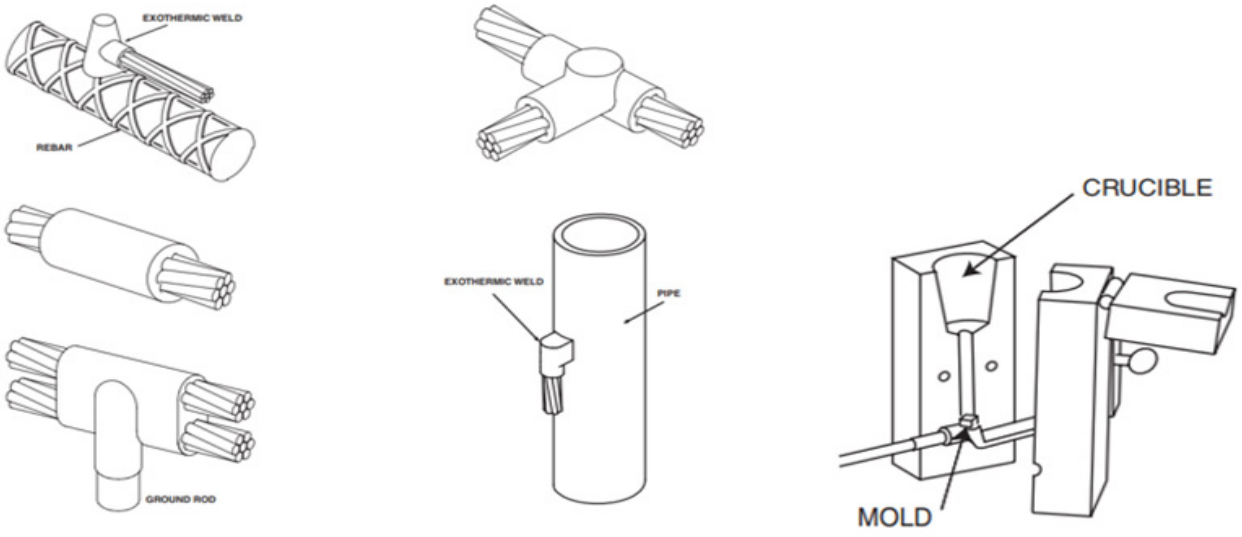
The three bonding methods, bonding the ground wire or strap to a ground rod, in order of good, better, best (from top to bottom in that order) are:

1. Compression clamp

2. Permanent crimp



3. Exothermic welding



Some installation and grounding standards, such as Motorola R56, accept permanent crimp or exothermic weld only (for land mobile radio or public safety communications applications). Using ground rods is typical, and more than one ground rod is common. However, all ground rods used must tie together to form the single point ground system at the location per National Electric Code and the National Fire Protection Agency and other standards.

Single Point Ground Systems – Essentials and Codes Required

Single point ground systems prevent the unwanted 'ground loop' scenario, which is damaging to equipment and facilitates, and is a potential human electrical touch safety issue. In the United States, the National Electric Code (NEC) and the National Fire Protection Agency (NFPA 70) are just two standards that define and regulate facility grounding, requiring single point grounding systems.

If the RF coax surge arrestor is installed inside the facility, a common consideration is how to safely attach the unit and ground wire to ground within the facility. . As every facility is unique, it is strongly recommended to consult with a licensed and bonded journeyman or master electrician who can use their experience and knowledge of the NEC and NFPA standards to identify a suitable, safe, and code-compliant location to attach the RF surge arrestor ground wire to, inside and/or outside the facility.

When attaching the RF coaxial surge arrestor to a metal ground plate (bulkhead mount) or to a flange plate, prepare the metal surfaces first. Prepare the ground plate, surge arrestor, and the ground terminal or ring terminal metal surfaces by removing paint, oils and greases, and other conformal coatings, exposing bare metal surfaces.

Any conformal coatings, paint, or other material that covers the bare metal of the plate needs to be sanded down and removed, exposing bare metal at the location where the surge arrestor will be connected to the metal plate.

Cleaning Metal Ground Plate and Surge Arrestor Metal Surfaces Before Attaching Ground Wires – Use Conductive Joint Compound

Clean the bare metal of any grease or other dirt using safe solvents or alcohol wipes. Follow proper hazardous materials safety procedures and appropriate personal protective equipment as appropriate for the chemicals and coatings used. Once the metal surfaces are prepared, apply a conductive joint compound or conducive anti-seize to the plate bare metal and surge arrestor surfaces before securing the surge arrestor to the ground plate or flange plate.

The PolyPhaser CCK copper cleaning kit can be used to clean copper and other metal surfaces before Surge Arrestor installation to Metal Surfaces.

The conductive joint compound provides three functions:

1. Provides and maintains excellent conductivity between the two metal surfaces.
2. Prevents dust and water from settling between the metal surfaces and causing corrosion.
3. Helps mitigate dissimilar metals (electrolysis) issues, such as those between an aluminum surge arrestor and a copper ground plate, for example.

Also, apply conductive joint compound between a ring terminal and the surge arrestor, or from the ring terminal to the metal ground plate or flange plate for the same reasons as mentioned above.

Regarding dissimilar metal or electrolysis issues, it is best to mate two metal surfaces of the same type, such as an aluminum surge arrestor to an aluminum ground plate. However, this is not always possible. In such cases, using tinned copper ground plates and surge arrestors with tri-metal coatings (consisting of copper, tin, and zinc) helps diminish corrosion due to electrolysis. Furthermore, using a conductive joint compound between the metal surfaces further helps mitigate electrolysis.

Summary:

Determining where to attach a ground wire to an RF coaxial surge arrestor without a ground screw is just one of the many steps required to properly ground the surge arrestor. The grounding process includes:

- Identify the surge arrestor mounting method (bulkhead, flange, or hanging on the coax line).
- Identify the appropriate-sized ground conductor (stranded wire or flat strap) using the appropriate stranded ground wire diameter or strap size for the application.