Selecting and Installing Lightning Protection Devices

A Whitepaper

Revision 0

DXE-UE-1P Shown with Optional Equipment Mounted

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Selecting and Installing Lightning Protection Devices

The primary goal in any lightning protection system is to control the massive energy generated during a lightning strike so it will dissipate before it can enter our homes. Lightning contains awesome levels of energy in a wide range of frequencies, and travels fast (1ns per foot) with very fast rise times. It can travel through the power lines, coax feedline, control lines, telephone, CATV or satellite coax and our equipment looking for the easiest path to ground unless we can provide a better path for it to follow.

To control this energy, we have to provide a better path to ground than anything else around. A single point, low inductance ground system can ensure a simultaneous rise and fall of the currents across all of our equipment, so no current will flow across the equipment in search of ground potential. Build a ground system that uses conductors with low inductance and impedance across a wide frequency spectrum to provide a good path for the energy to follow. A wide and thin conductor like copper strap is better than wire or cable for longer runs. A heavy solid, rather than stranded, wire will work if the connection is direct and short.

Even with a well designed ground system, some of the current generated during a lightning event may flow along feedlines, control and equipment grounds and AC power lines. Lightning protectors should therefore be used on all of these lines before they enter our house. Lightning protectors work by diverting the surge to a low inductance, ground path we must provide.

Many articles and papers have been written about the danger of lightning and how to protect ourselves and our equipment from it. In the Tech Info section of our web-site, www.dxengineering,com, there is a series of articles about how to protect your station. PolyPhaser (www.polyphaser.com), one of the industry leaders in lightning protection, has also written a variety of technical papers on the topic. In the Technical Documents section, #TD1016 refers specifically to Amateur Radio. The ARRL web-site has additional information on the topic as well at www.arrl.org. Search for "Lightning Protection" in the Technical Information Pages.

What is not discussed in these and other technical documents are installation procedures and examples. The purpose of this document is to detail the proper installation procedures for many of the items typically used for lightning protection in and around an Amateur Radio Station.

DX Engineering offers a wide variety of PolyPhaser protection devices for coax, rotor control, telephone and the AC power source. Accessories such as clamps, copper strap and Single Point Ground Plates are also available. Our part numbers have been added to each section to make selection easier. We stock most items.

Let's start at the tower or ground-mounted antenna and work our way toward the equipment.

Tower Grounding System

Statistically, a tower has the highest probability of attracting a lightning event. As tower height increases, your chance of having a close encounter of the worst kind improves! By controlling the lightning energy at the tower, we can greatly reduce or eliminate the surge that could find its way to our equipment. We also need to protect any equipment on or close to the tower, including feed lines, rotor control cables or antenna switches.

For amateur use, it's best to have the tower located at least 50 feet from the home. This distance puts more earth between the tower and the house which will help dissipate the magnetic fields generated during a strike event. It also allows the natural inductance of the feedline to limit the amount of the surge and allow more time for the tower grounding system to absorb the strike energy. If possible, the tower ground system should be connected to the rest of the ground system. In some installations, the distance between the tower and the house is far enough that this is not possible or feasible. So having a properly grounded tower installation is important.

Note: Prior to making any bonds or connections, all surfaces must be thoroughly cleaned to remove any oxidation, and then coated with a conductive copper joint compound to prevent moisture penetration. The **PPC-CCK-1** Copper Cleaning Kit contains the proper joint compound and cleaning materials to correctly prepare copper surfaces for bonding. You may need several CCK kits for an entire installation. Be sure to use different sections of the cleaning pad for the various materials you will be cleaning to avoid contamination.

Wide copper strap should extend away from each tower leg in a star type configuration. These straps should be a minimum of 50 feet long, but not more than 75 feet long. They should be buried 6 to 18 inches below the surface. Ideally, they should have ground rods along their length, separated by twice the length of the ground rod. So, if you are going to use 5 ft ground rods, they should be placed every 10 feet along the strap. Use the **PPC-58R-112S** grounding adapters to bond 5/8 inch ground rods to the copper strap. See **Figure 2**. Some ground rods may need to use an extra piece of copper strap as a shim to ensure sufficient clamp tightness.

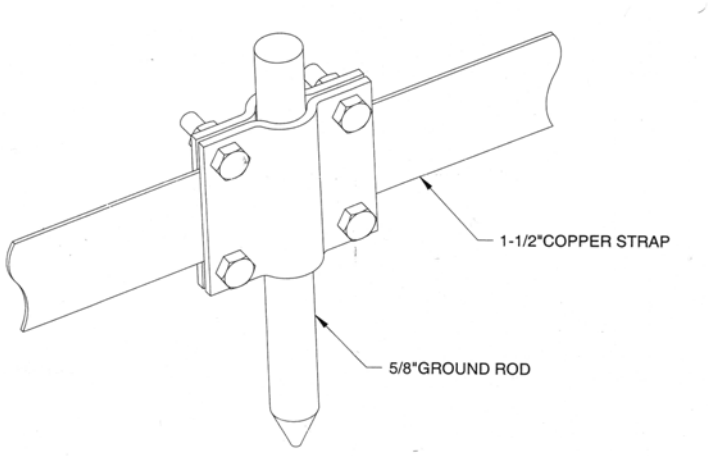


Figure 2: PPC-58R-112S Ground Rod to Strap clamp

Each copper strap from the ground radial system should then be bonded to the tower leg. When bonding copper to a galvanized steel or aluminum tower, a transition material must be used to prevent galvanic corrosions and to assure a permanent connection. PolyPhaser has series of clamps to do the job. The **PPC-TK-2** clamp is for tower legs from 1-1/4 to 2-1/4 inch diameter, which will work on the most common sizes used for amateur towers. Other **TK** series grounding clamps fit tower legs from 5/8 to 5 inches in diameter. Made from stainless steel, they feature an inner metal leaf to buffer the copper strap from touching the galvanized tower leg. See **Figure 3.** The TK-1 and TK-2 clamps require a narrowing of the copper strap in order to fit under the stainless buffer leaf. We recommend folding-over the edges of the strap rather than trimming. All bends in the copper strap should be gradual.

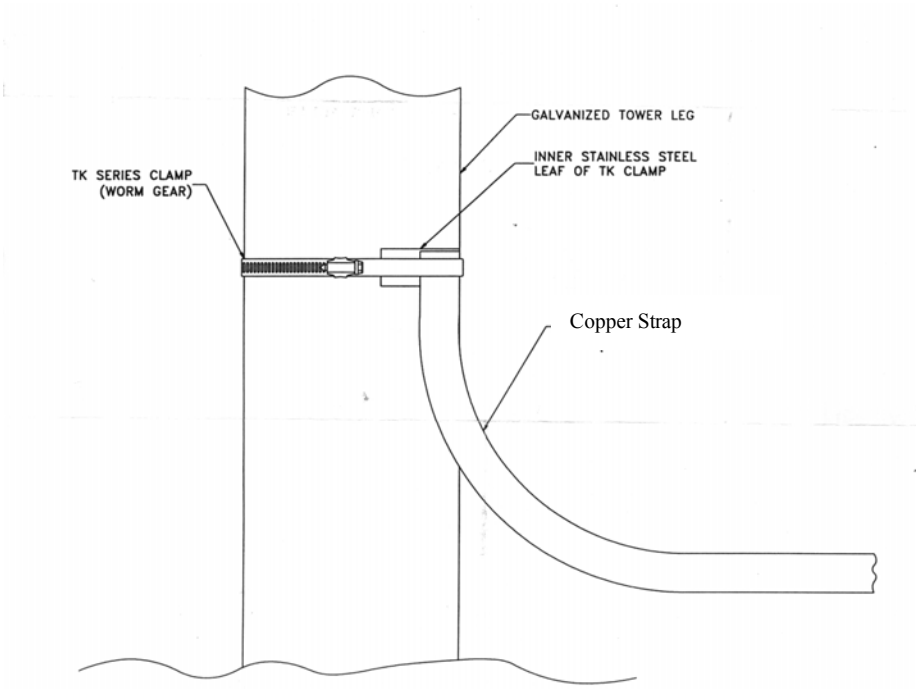


Figure 3: TK Series Clamp Transition from Tower Leg to Copper Strap

Be sure to clean both surfaces of the TK clamps to ensure a quality connection. A light coating of Penetrox-A (part number **DXE-P8A**)on both sides of the clamp should be used to prevent moisture ingress and oxidation of the bond.

If you use a cleaning pad such as is found in the **PPC-CCK** cleaning kit to clean the tower surfaces, the clamp and the strap, care should be taken to use different sections of the pad for different materials being cleaned so as to avoid contaminating one with the other.

The ground straps from each tower leg should be bonded together using 3 or 4 **PPC-MSC-3** Grounding Adapters which can bond the 1.5 to 3 inch strap together while maintaining low inductance. All bonding points should be cleaned and coated with copper joint compound. Strap larger than 1.5 inches will need holes punched or drilled in it to accommodate the mounting hardware location in the MSC-3. See **Figure 4.** If possible, a strap should be also run from the tower ground system to the Single Point Ground point at the service entrance of the home. Use wide copper strap with the same ground rod spacing used in the tower grounding system to connect to the SPG. Remember the strap should be kept 6 to 8 inches under the soil.

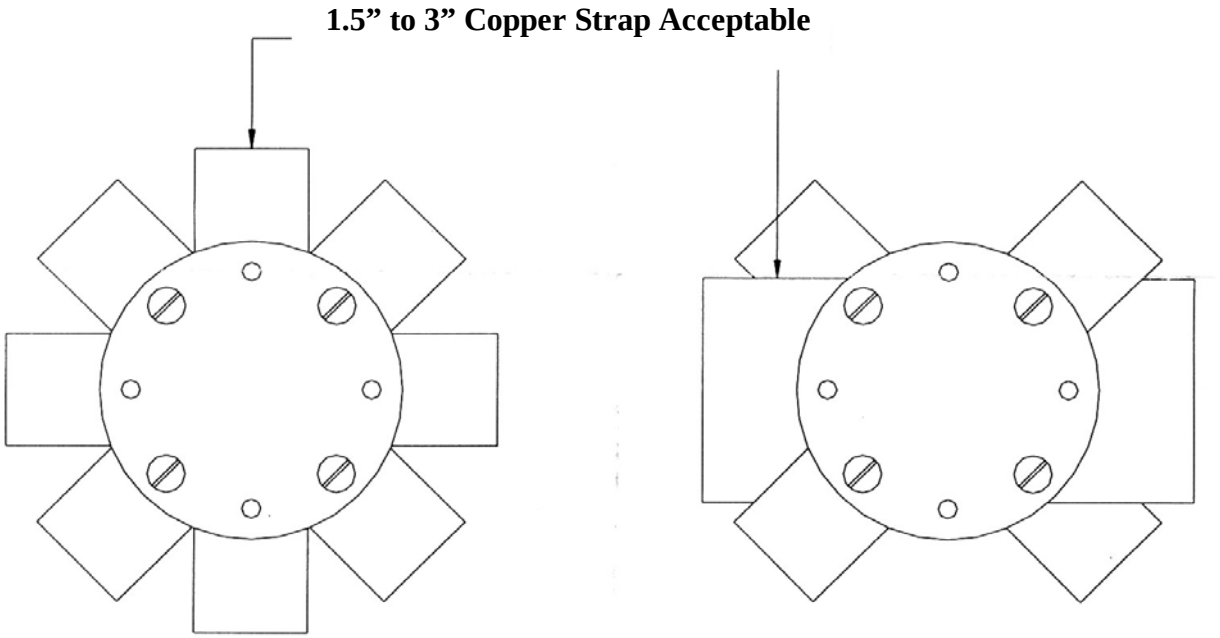


Figure 4: MSC-3 Copper Strap Bonding Clamp

Note: If the ground radial system comes within 4 feet of any metal object, it must be bonded to that object. The four foot rule applies to metal above, below or in any plane from the radial, including fences, buried tanks, children’s metal swing sets, in-ground metal pools, etc

Grounding the Feedline to the Tower

After a lightning strike to the tower, as the energy travels down the tower towards ground potential, much of the energy can be induced into any feedlines within 4 feet of the tower. There can be significant voltage potential differences between the top and bottom of a tower during a lightning event and we want to keep the tower and feedline at the same potential, so the feedlines should be bonded to the tower.

If your tower is less than 75 feet high, the shield should be bonded to the top and bottom. For a taller tower, the shield should be bonded to the tower every 75 feet. The feedline shield bond at the bottom of the tower should be as close to ground-level as possible, but above the attachment point of the tower ground system. This will ensure the maximum amount of energy is dissipated from the feedline directly through the tower ground system.

PolyPhaser has a series of feedline grounding kits that provide a compatible bonding connection between the feedline shield and aluminum or galvanized towers. Most coax in amateur service uses either bare copper or a tinned copper shield. The **PPC-UNI-KIT-2CT** kit is for bare copper shields, such as found on RG-213, to aluminum or galvanized towers. RG8 and hardline type feedline use tinned copper for the shield, so part number **PPC-UNI-KIT-2TT** would be used to provide the grounding connections between the shield and aluminum or galvanized towers. Use of these kits avoids corrosion caused by bonding dissimilar metals. Either kit can accommodate shield diameters from ¼ inch to 2-1/8 inches, which includes most coax in amateur use. Other kits are available for larger feedline sizes or alternate shield materials. A copper to copper kit is available to bond the feedline shield directly to a ground system.

Installing a UNI-KIT Feedline Grounding Kit

All UNI-KIT versions include stainless hardware, an appropriate metal strap that forms around the shield and a 24 inch copper or tin to stainless tail strap to make the bond from the feedline to the tower. Waterproofing mastic and tape are also included.

Figure 5: PPC-UNI-KIT-2CT for Copper Shield to Galvanized or Aluminum Towers

We will use the **PPC-UNI-KIT-2CT** kit to show how to properly prepare the coax and assemble a shield grounding kit. For this example, we used RG213 coax, which has a bare copper shield, bonding to an aluminum tower.

Note: It is highly recommended that all copper connections be cleaned and a conductive copper joint compound is used to ensure a low impedance and watertight connection. The PPC-CCK cleaning kit contains enough material to do several connections.

First, locate a suitable place along the coax to attach the ground strap. The strap will connect this spot in the coax to the tower leg, so make sure the strap will be long enough to reach the tower leg before you cut into the feedline. The shield ground strap nearest the bottom of the tower should be bonded to the tower leg as close as possible to ground level, but above the connection to the tower ground system. The strap has limited positioning once connected to the clamps and sharp bends should be avoided. The square end of the strap attaches to the tower with clamps.

Preparing the Feedline

Using the small bracket with the slot as a template, mark the coax on both sides of the bracket. You will be removing approximately 2 inches of jacket from the coax as shown in **Figure 6**. Be careful not to cut through the braid on the coax, it is somewhat soft and can be damaged easily. Use a sharp utility knife, making the cuts around the coax first, then length-wise. Carefully peel the jacket from the coax.

Figure 6: Remove 2" of Jacket From Coax.

Clean the exposed shield with an abrasive pad and apply some of the conductive copper joint compound to the shield area. Use enough to ensure a good seal against water and contaminants.
Take the flat copper perforated strap, center the exposed coax shield on the portion of the strap with no holes and carefully fold the strap around the coax shield, keeping the holes in the strap aligned. You might want to pre-form the perforated strap using a 3/8 inch socket extension or rod prior to fitting the strap around the coax shield. This will reduce the distortion of strap as it is wrapped around the shield and ensures maximum contact between the strap and shield.

Slip the perforated strap through the slotted bracket as shown in **Figure 7**. Note the orientation of the bracket. The dimples above and below the slot should protrude facing the coax side of the bracket as shown. Push the bracket toward the coax firmly to form the strap around the coax.

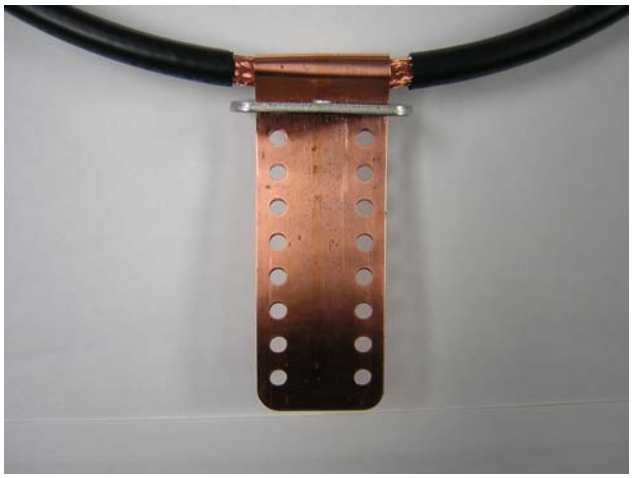


Figure 7: Strap Wrapped Around the Shield with Bracket In-Place

Using **Figure 8** for reference, locate two L brackets, one with threaded studs and the other with matching holes. Take the rounded end of the grounding strap with the slotted holes and slide it between the folded-over perforated strap. Most of the amateur coax should use the two holes in the strap closest to the coax to allow proper tightening as shown in Figure 3 and 4. The L bracket with the threaded studs should be routed through to the lower strap, through the ground strap, then through the upper strap with the L portion towards the slotted bracket. You may have to push firmly on the slotted bracket to get enough slack to allow use of the first set of holes. Assemble the remaining L bracket using the star washer and nuts. Adjust the grounding strap to the position needed to facilitate attachment to the tower leg and tighten firmly.
Notice the slotted holes in the grounding strap align with the bracket holes when oriented to either side of the L brackets and not in the middle. Make sure the ground strap orientation is correct for your application prior to tightening of the clamp.

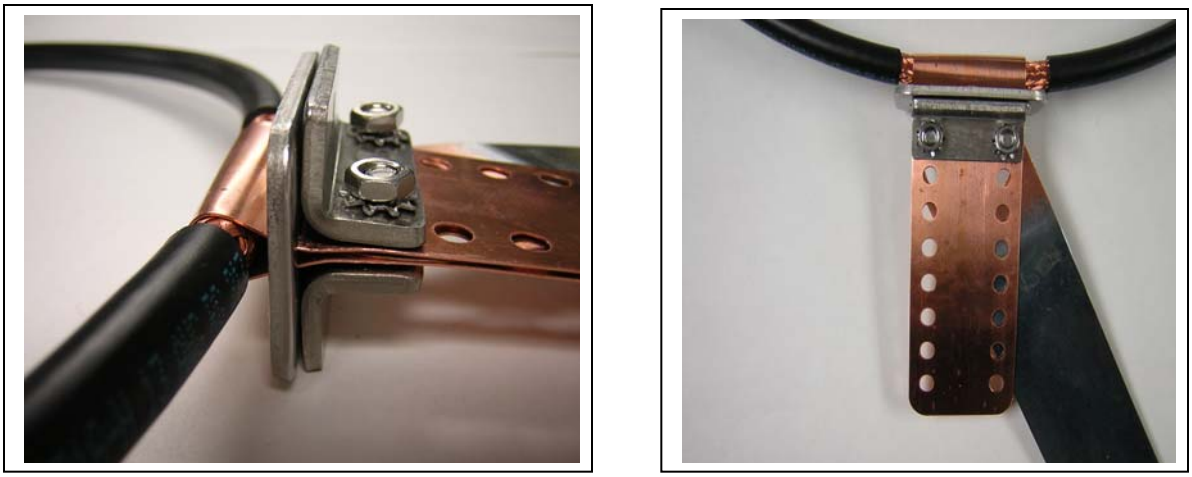


Figure 8 A & B: Grounding clamp assembly ready to be tightened.

Locate two #10 bolts. Insert the bolts into the threaded holes in the upper and lower L brackets as shown in **Figure 9**. Note that the bolts sit in the recessed dimple in the slotted bracket as shown in **Figure 10**.

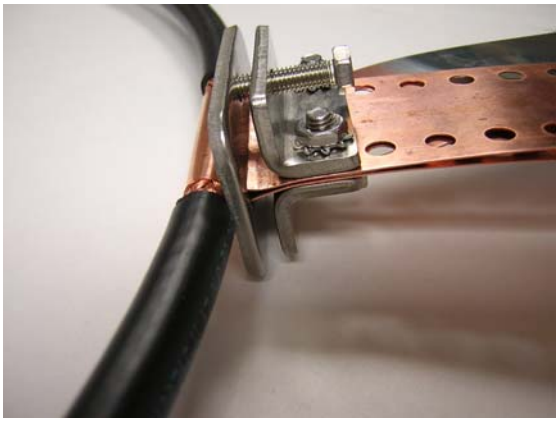


Figure 9: Completed grounding assembly

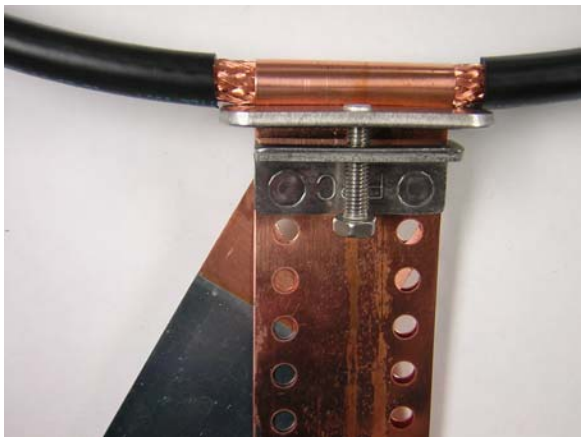


Figure 10: Bolts fit to inside of the dimple

Tighten down the #10 bolts against the slotted bracket carefully. Tighten them evenly side-to-side using no more than 15-25in/lbs. If you run out of thread before the strap is securely fastened to the coax, you will have to disassemble and reposition the brackets closer to the cable. The goal is to just form the strap around the coax shield so that it is secure and will not move. You should see some of the copper conductive joint compound squeeze out between the shield and strap as it's tightened. Do not over tighten the bolts as this can cause the strap to distort the coax shield and center dielectric causing an impedance bump in the feedline and a possible failure point. **Figure 11** shows the completed shield ground kit.

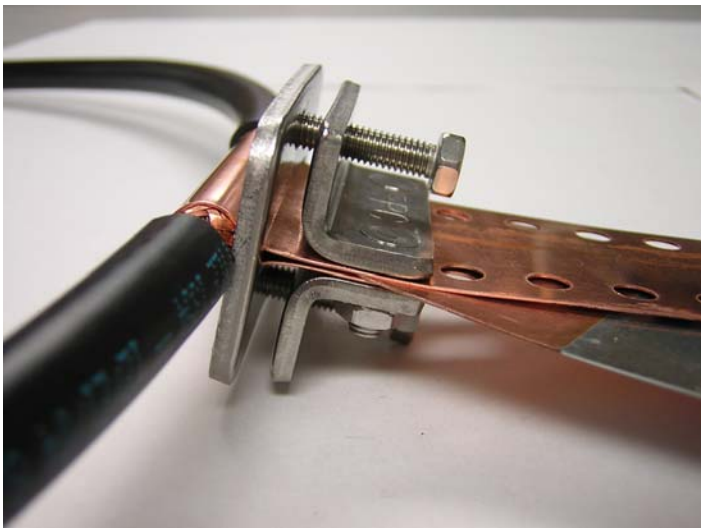


Figure 11: Completed Strap Assembly.

Figure 12: **WK-1 Weatherproofing kit.**

Once completed, this assembly should be completely weatherproofed using a **PPC-WK-1** as shown in **Figure 12**.

Bonding the Feedline Ground to the Tower Leg

The grounding strap has two holes used to attach directly to the tower. If your tower has L-shaped legs, these holes should line up with existing hardware. If your tower has round legs, you will have to be a bit creative to ensure maximum contact patch between the tower leg and grounding strap. The grounding strap is made from stainless steel, so bonding it directly to the tower leg is acceptable. Be sure to clean both surfaces using the abrasive pad included in the **PPC-CCK** cleaning kit, being careful to use a clean section of the pad to avoid contamination, then use an anti-oxidant like Penetrox-A, part number **DXE-P8A**, on the strap and tower surfaces before bonding.

One or two stainless steel band clamps around the tower leg will provide an effective bond between the strap and tower. Typical Rohn towers have 1-1/4" O.D. legs, so the DX Engineering **DXE-ECL-24SS** band clamp should be used as seen in **Figure 14.** The DX Engineering band clamps utilize both a stainless steel band and worm screw.

Figure 14: Tower Bonding With Band Clamp

Grounding the coax shield to an ungrounded tower is, of course, futile. Since the tower is the most-likely to attract lightning, care should be taken to install a sufficient grounding system as outlined above.

Protecting the Rotor Control Cable

The **PPC-IS-RCT** can protect rotor control cables up to 8 conductors. It is a shunt type protector that conducts current to ground when it receives a surge exceeding 82 Vdc in either polarity. It reacts much faster than a gas-tube device and can sustain multiple strikes. Like all protection devices, proper operation depends on a low impedance ground system.

It mounts to the tower leg using a **PPC-J-2** clamp or directly to a ground rod using a **PPC-J-1** clamp. The **PPC-J-2** clamp fits 1-1/4 to 2-1/4 inch tower legs. The **PPC-J-1** clamp is used with ground rods from 1/2 to 1" diameter. You can reverse one side of the clamp to fit the smaller sizes like is shown in **Figure 15**. We recommend using an additional stainless ¼-20 locking nut on the **PPC-IS-RCT** mounting stud to ensure a tight fit to the clamp threads as shown. If tower mounted, it should be attached just above the connection of the tower ground system.

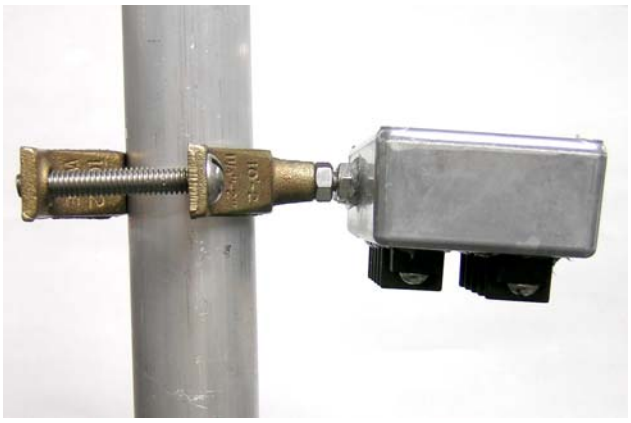


Figure 15: IS-RCT Mounted to Tower Leg using a J-2 Clamp.

Summary

So far, we have installed a tower ground system and connected our feedline shields and the rotor cable protector to it. If other items are connected to the tower, such as an antenna switch, should be properly grounded and the control cable needs to have similar protection as the rotor cable. We can recommend the correct device if we know the operating voltages. Contact us for applications assistance.

If the tower is located too far from the equipment, consider the tower and its associated equipment as a protected cluster with its own grounding system. Providing everything associated with the tower is grounded and employs the proper lightning protection, any surge should be nearly dissipated by the time it reaches the next stage of protection where the feedlines and control cable enter the home. We will install protectors on each feedline before they enter the house to ensure the remaining energy is shorted to ground before it reaches our equipment.

Establishing a good ground system at the house is equally as important as the tower ground system, maybe even more so. We have to consider the existing utility ground, usually found at the AC service entrance panel and the distance, if any, between it and the feedline entrance panel. We'll start by developing a Single Point Ground system at the house.

Single Point Ground

The most effective way to control the massive current flow present after a strike event is to employ a low-impedance Single Point Ground (SPG) for our home and equipment. A good SPG system ensures a simultaneous rise and fall of the ground currents across our equipment, preventing voltage potential differences through the grounds in our equipment.

Surge protectors can only function if they are properly connected to a low impedance ground. Excessive impedance in the ground system can cause the surge energy to take an alternate path to ground, which we don't want. Lightning protectors are designed for series or parallel (shunt) connection to the load we are protecting, depending on the application. Either way, the surge is directed to ground once the rated turn-on voltage has been reached.

Ideally, the ground at our electrical service entrance and all other grounds serving telephone, cable service, satellite, antennas and our radio equipment should be tied together. If the tower ground system is not too far away from the equipment, the ground systems should be tied together using wide copper strap and appropriate bonding clamps. Our feedlines and control lines should enter the home at the service entrance and have their respective protectors bonded to this ground as well. This forms the basis of a single point ground system, since the single origin point of the ground system is the service entrance location and ground.

The PolyPhaser **PPC-CU-SPGP** Single Point Ground Plate, shown in **Figure 16** with optional protectors, can be used to mount a variety of protectors at the service entrance. It is not waterproof, so must be protected from weather if it is mounted outdoors. It includes mounting hardware for 16" on-center studs or masonry mounting, a roll of copper strap, copper joint compound and copper bars for bonding the strap to the plate. The SPGP panel should be mounted as close as possible to the service entrance ground so a short copper strap can be run from the panel directly to it.

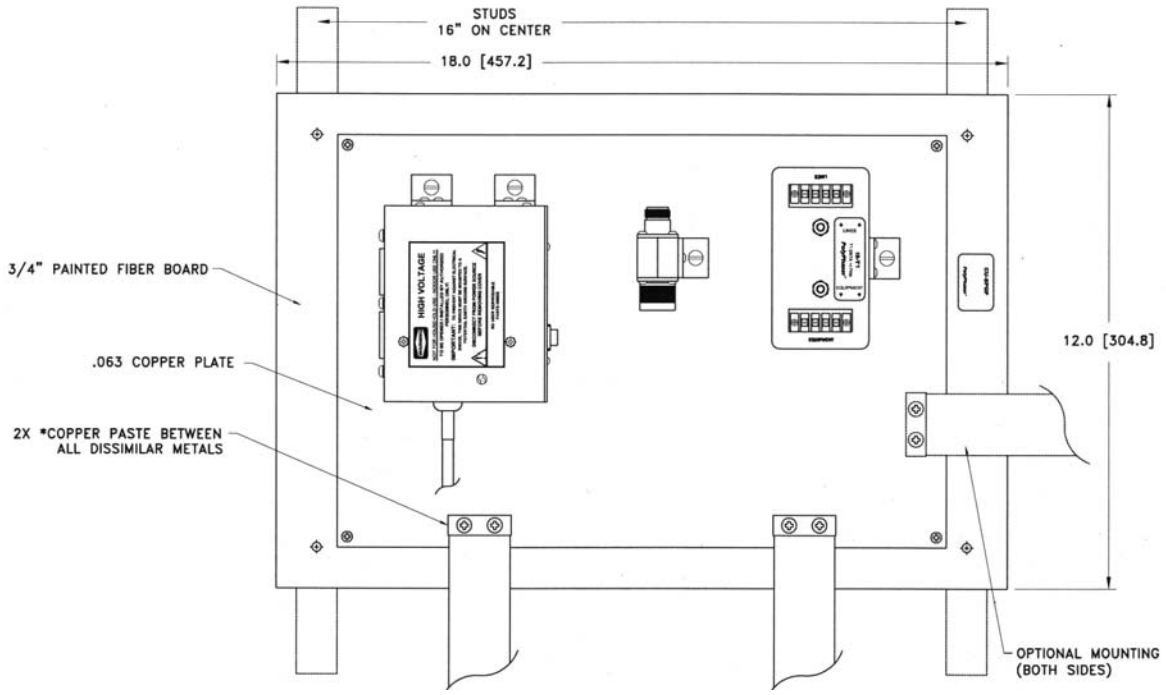


Figure 16: Service Entrance Ground Plate (Protectors Optional)

In **Figure 16**, an SPGP is shown with optional PolyPhaser protectors. From left to right, a plug-in style AC protector, a 50 series coax protector and a T1 telephone line protector.

In this example, with the AC protector mounted on the panel located at the service entrance, all power to the equipment should be plugged into this AC protector. For smaller installations, extension cords and outlet strips can be used if the equipment is not too far away. Feedlines should be run through the protectors to the equipment. Telephone lines that enter the house should be protected here. The ground blocks for CATV or satellite should be connected here as well.

Hard-Wired AC Protection

For larger installations, a whole-house protector can be installed on the main breaker panel. PolyPhaser offers a direct-wired AC protector designed to be installed at the service entrance breaker panel. The **PPC-IS-PM240-BP** unit is the most widely used for home installations. It has dual circuit breakers and a series of dry contacts for status monitoring. Other models are available for different voltages and phase configurations. These units should be installed by a qualified electrician.

In the US, most homes have 240 volt, Single phase service, which consists of two hot wires, a Neutral wire and a Ground wire as depicted in **Figure 17**. The **PM240-BP** protects both hot lines by shunting surge energy to ground, therefore it is important to provide any protector with a short, low inductance path to ground. The single ground rod used at many service entrance panels is not sufficient. A series of ground rods or a perimeter ground system should be used. See the Section on Single Point Grounds for more information.

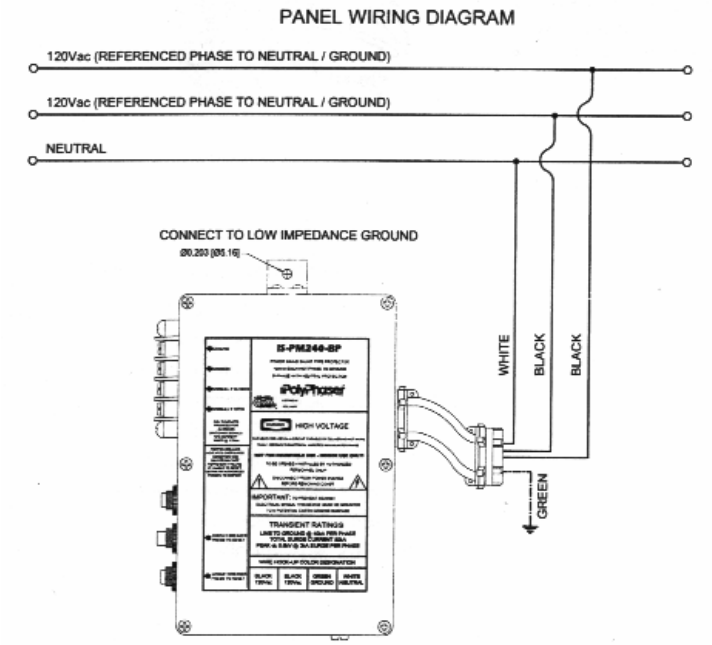


Figure 17: PM240-BP Whole House Protector Wiring Example

Larger equipment installations have an electrical sub-panel located near their equipment. This sub-panel is normally run from the main panel and should be installed per the latest NEC code. The ground wire and the neutral wire (White) should be kept isolated from each other in the sub-panel. A whole house protector can also be installed on the sub-panel. It is important to have the ground at the sub-panel common to the ground at the service entrance panel. In some cases where the distance between the two panels was large, both grounds were connected to a perimeter or "halo" ground system, extending around the home.

In situations where the feedlines and other control cables cannot be routed through the same place as the utility service entrance, we should construct a common point or bulkhead where these cables enter the home. The distance between the service entrance and the bulkhead should be kept to minimum as we want the very fast lightning surge to arrive at all our grounding locations simultaneously. As the surge travels on longer runs, it could arrive at our equipment later than a separate run that is shorter.

Entrance Bulkhead

Often it is not possible to have the antenna feedlines and control cables enter the home at the same point as the electric service and its ground. We can still provide some protection by having a "bulkhead" connection where the feedline and other cables enter the home. This simplifies the mounting of various types of lightning arrestors and provides a convenient way to bond to a ground system using copper strap. The arrestors must be protected from weather by using a **WK-1** Weatherproofing kit or by mounting them in a weather tight enclosure.

A plastic watertight enclosure, like the DX Engineering **DXE-OE-1P**, is shown in **Figure 18** with optional suppressors mounted to the aluminum mounting plate. A copper clamp to mount the copper strap to the plate can be made from several pieces of the strap material layered and drilled to accept common stainless machine screws. You could also use an additional **PPC-1C-112S** strap clamp by cutting it into ¾ inch wide strips and drilling extra holes in the strips to accommodate stainless #10 x 5/8 self-tapping metal screws.

Be sure to clean all connections and use copper joint compound under the clamps to avoid corrosion.

Figure 18: The DXE-OE-1P Weathertight Enclosure (Shown with Optional Equipment Mounted)

An SPG Example

As an example installation, assume the coax feedline and control lines have to enter the home 20 feet or more from the utility service entrance. We have mounted a weatherproof "bulkhead" box for mounting the lightning protectors where the cables will enter the home. The first thing we need to do is connect the ground plate in the bulkhead box to the service entrance ground using low inductance copper strap. Measure the distance between the two. Allow extra for the connection to the bulkhead and service entrance ground rod or panel.

We want to bury the copper strap 6 to 18 inches underground along its path to the service entrance panel. Try to keep the strap away from the foundation walls to put as much earth as possible around the strap. The strap should have ground rods along its length, separated by twice the length of the ground rod. So, if you are going to use 5 ft ground rods, they should be placed every 10 feet. If you have to splice the copper strap, use the **PPC-MSC-3** clamp shown in **Figure 4** in the Tower Grounding section.

At the service entrance, bond the existing ground rod to the copper strap that runs to the bulkhead ground panel. Use a PolyPhaser **PPC-58R-112S** grounding adapter which will bond copper strap to the 5/8" ground rod used in most installations. **See Figure 19**. Some ground rods may need to use an extra piece of copper strap as a shim to ensure sufficient clamp tightness.

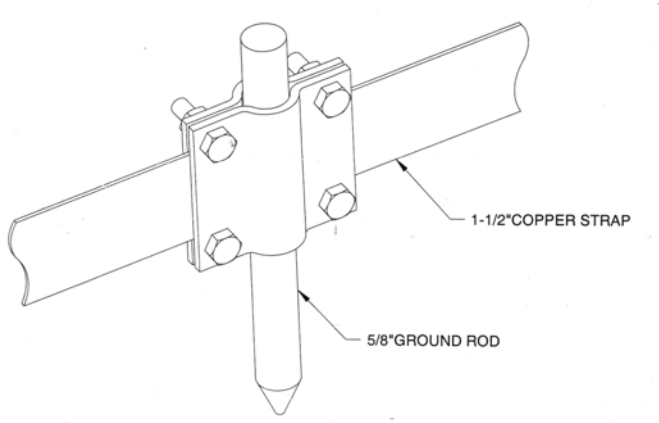


Figure 19: A PPC-58R-112S Ground Rod to Copper Strap Bonding Clamp

The ground rod adapter accepts 1-1/2 to 3 inch strap. Strap wider than 1-1/2 inches requires holes to be punched in the strap for the mounting hardware. Do not disturb the existing ground wire connection, which is usually a 6 or 8 gauge solid copper wire that is connected to the circuit breaker panel in the home. If you wish to upgrade this connection to larger wire-or ground rod size, contact a licensed electrician.

If you need to bond the strap to stranded copper wire, use the **PPC-1C-112S** clamps as shown in **Figure 20**, which are available for wire sizes up to 6/0 AWG.

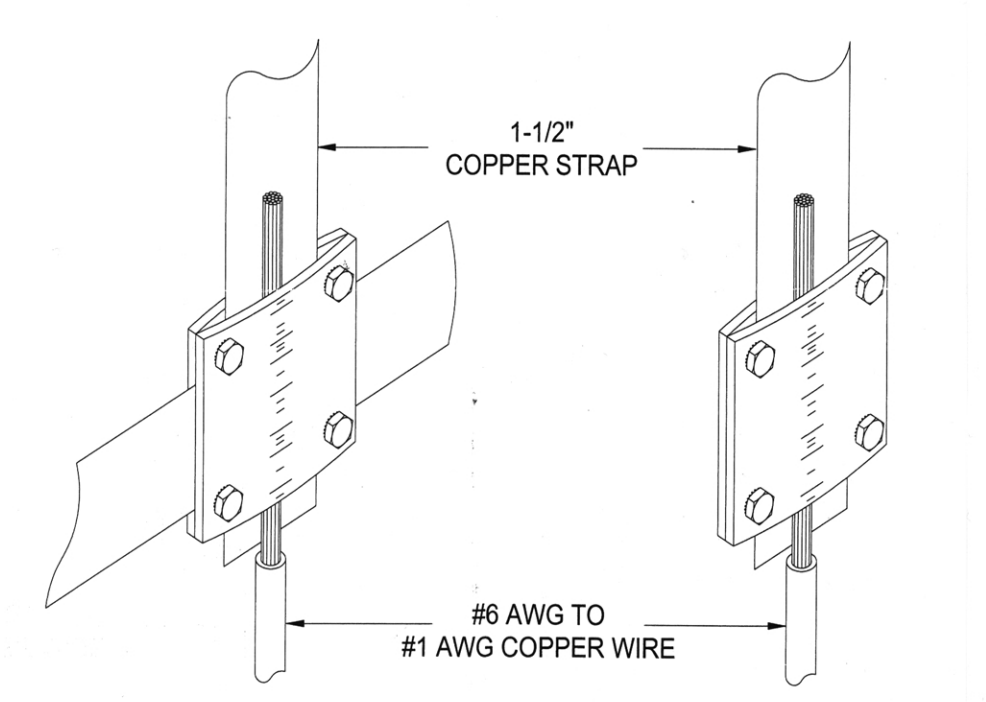


Figure 20: PPC-1C-112S Transition from copper wire to copper strap.

Note: All connections should be cleaned using the **PPC-CCK** copper cleaning kit prior to making the connection. The CCK kit contains cleaning materials and the copper joint compound necessary to ensure a corrosion-free, long-lasting bond.

Coaxial Feedline Protectors
Coax protectors are installed in series on the feedline before it enters the home, ideally at the bulkhead entrance plate previously discussed. See **Figure 18** for an example.

The PolyPhaser IS-50 series protectors are 50 Ω, bulkhead or flange mount, with either N or UHF style connectors. Models are available for HF to 400 MHz and VHF/UHF to 1 GHz in two power levels. Note that the coaxial feedline protectors are directional. The antenna and equipment ports are clearly marked. A backwards installation will **not** protect your equipment.

The most common unit used in amateur service is the flange mount unit with UHF connectors, usable from 1.5 to 400 MHz., for up 2 kW, part number **PPC-IS-50UX-C0**. A 3 kW unit is also available.

Figure 21: PPC-IS-50UX-C0, Flange Mount with UHF connectors

For 75Ω, the **PPC-IS-75FB/18** protector is used for 75 Ω receiving applications where DC is required on the feedline for control purposes, such as a Reversible Beverage system or Receive Four-Square System, both offered by DX Engineering. Other units are available to protect CATV and satellite feedlines, call us for applications assistance.

In the event the tower is some distance from the operating position, feedline protectors should be used at the tower and again at the entrance panel. Use a bulkhead style protector at the tower, such as the **PPC-IS-B50LN-C0**, rated at 2kw, and a **PPC-T-1** tower mount kit which will mount the protector on tower legs up to 2-1/4 inches in diameter. A 3kw version is also available, part number **PPC-IS-B50HN-C0**. The protectors must be connected to a low impedance ground system to provide effective protection.

These units must be mounted in a protective enclosure like the **DXE-UE-1P** as seen in **Figure 18** or completely waterproofed using a **PPC-WK-1** waterproofing kit.

So far we have the tower ground system installed, with coaxial and rotor control protectors mounted. The ground at the service entrance and the bulkhead entrance panel are connected with a combination of copper strap and ground rods and the coaxial protectors are mounted on the bulkhead panel. Let move inside and see what needs to be done to complete our lightning protection project.

Equipment Grounding

Wherever our equipment is located; the ground connection from each piece of equipment to a common grounding point should be short and of **equal length**. In addition, we need to provide protection against lightning energy surges coming from the utility power grid through our home AC service. Standard circuit breakers offer no protection from lightning surges. We should also consider other paths that a high energy surge can take on its way to ground such telephone, cable TV or satellite lines.

Single-Point Equipment Ground

PolyPhaser makes a copper grounding plate that can be used as common grounding point in the equipment area. It is intended for indoor use only and is large enough to be mounted directly to framework that is 16" on-center, or on masonry. The part number is **PPC-CU-SPGP** which includes the mounting hardware, the plate, copper joint compound 10' of copper strap and bonding clamps used to secure the copper strap to the plate. The preferred mounting position is behind the equipment where the connections to the equipment grounds can be as short and equal length as possible. The panel should be connected to the Single Point Ground system using a copper strap as shown. The panel in **Figure 22** features three protectors mounted to take advantage of the single point ground potential provided by the copper plate.

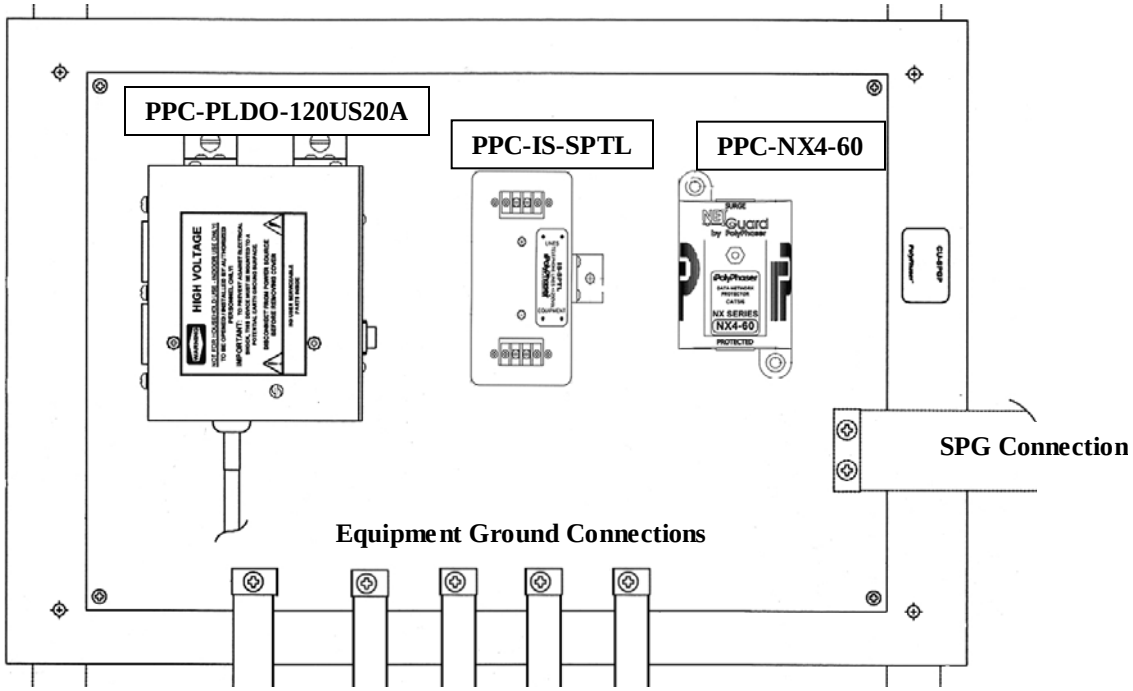


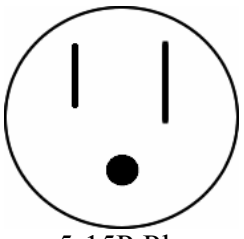
Figure 22: Single Point Ground Plate with Optional Protectors Mounted

The panel in **Figure 22** shows, from left to right, a PLDO series AC plug-in protector, an **PPC IS-SPTL** 2 wire telephone line protector and a NX4 Network protector for DSL, POE and others. These protectors are not included with the SPGP panel and must be purchased separately.

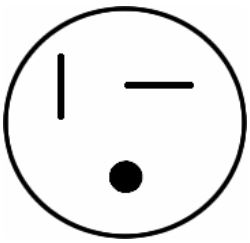
AC Protection

An alternative to using a hard-wired, whole house protector as seen on Page 16 is a plug-in unit that can be used at the service entrance panel or in the equipment area. Most amateur equipment areas do not have dedicated electric service to them, so the use of a plug-in style suppressor will offer good protection. The PLDO series of plug-in suppressors offer good protection from surges because they install in series with the equipment, rather than in parallel with the equipment like a shunt-type device.

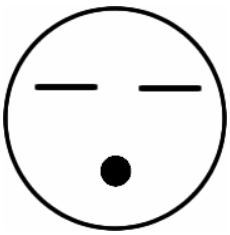
Various models are available to suite most operating situations. The **PPC-PLDO-120US15A** is for 120 Vac, 15A circuits. The **PPC-PLDO-120US20A** is a 120 Vac, 20A unit. Both have dual outlets and an ON/OFF switch with added circuit breaker protection. A 240 Vac model, which has an ON/OFF switch, but no circuit breaker, is also available, part number **PPC-PLDO-240US15A**. These protectors have the appropriate plug configuration for their amperage rating as depicted in the diagrams below.



Common 5-15P Plug used for 120v, 15A circuits. Used by the **PPC-PLDO-120US15A**



5-20P Plug used for 120V, 20A circuits. Used by the **PPC-PLDO-120US20A**



6-15P Plug used for 240V, 15A circuits. Used by the **PPC-PLDO-240US15A**

Figure 23: Plugs Used on the Noted PLDO Protectors

The outlets found on the 120V models are upward compatible, that is, 5-15P 15A plugs can be used with both the 15A and the 20A models. The 20A model will require a 5-20R, 20A outlet and branch circuit for safe operation. The 240V model operates at that voltage and plugs in to a 6-15R outlet. It includes 2 protected 6-15R outlets.

Care should be taken not to exceed the rated capacity of the units, or of the electrical branch circuit to which the units are plugged in. The most common outlets in modern homes are the 5-15R type rated for 15A. If you have any concerns about compatibility with existing wiring, consult an electrician.

The PLDO units should be mounted to a panel like the **PPC-CU-SPGP** Single Point Ground Panel where copper strap is used to connect the panel to the same SPG ground system used by your equipment as shown in **Figure 22**. At minimum, the PLDO unit should be grounded and have a common ground connection to whatever is plugged in to it.

Telephone Protection

Telephone lines that enter the house should also be protected. The **PPC-IS-SPTL** can be used for two-wire telephone lines that are used in most residential single line installations. Four and six wire units are also available. Although the telephone company provides some protection for their lines, they are not always connected to a high current carrying or fast transient response ground system. The **PPC-IS-SPTL** is shown installed on a SPGP panel in **Figure 22**.

The SPTL unit is a series type protector, which offers the best protection during a surge, but only if connected to a low inductance ground system. This unit can be mounted on a single point ground panel as shown in Figure X, or individually mounted. If you are using the grounding stud to connect to the ground system, do not over-torque the nut used to secure the wire. Keep the wire as short as possible with no sharp bends. The Lines terminals are for the incoming line, the Equipment terminals connect to the equipment to be protected.

Note that like most protectors, the SPTL is directional. The Lines and Equipment ports are clearly marked. A backwards installation will **not** protect your equipment.

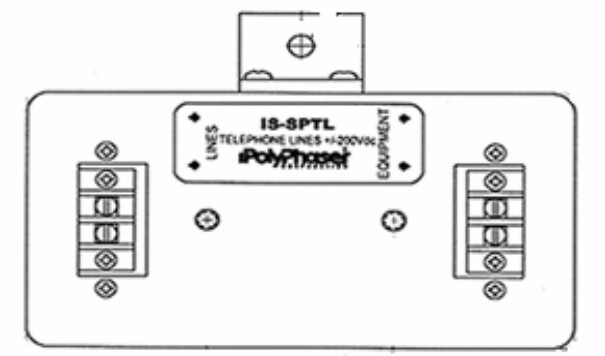


Figure 24: PPC-IS-SPTL Telephone Protector

Network Protection
Cable modems, DSL modems and other networking interfaces can also be protected by using the NX4 series of protectors. These protectors are a series-type and feature convenient RJ45 plugs on the input and output. These units must be connected to a low inductance ground system using the threaded connection on top of the unit. The two mounting tabs do not provide a path to ground. Even if you are mounting this unit to an SPG panel as shown above, a ground wire must be run from the center terminal to the copper plate. The correct model number for protecting DSL, ISDN, E1/T1, and 10/100 BASET Ethernet is **PPC-NX4-60**.

Figure 25: PPC-NX4-60 Network Protector

Every installation is different. It is better to be safe than sorry.

Application Assistance

If you have questions about which device to use for the best protection or have other installation questions, please review the information on our web-site at **www.dxengineering.com** in the Lightning Protection and Grounding section. You can also contact our Tech Line at 330-572-3200 or by E-mail: dxengineering@dxengineering.com

Our hours are from 8:30 am to 4:30 pm Eastern Time.

Warranty

All products manufactured by DX Engineering are warranted to be free from defects in material and workmanship for a period of one (1) year from date of shipment. DX Engineering's sole obligation under these warranties shall be to issue credit, repair or replace any item or part thereof which is proved to be other than as warranted; no allowance shall be made for any labor charges of Buyer for replacement of parts, adjustment or repairs, or any other work, unless such charges are authorized in advance by DX Engineering.

If DX Engineering's products are claimed to be defective in material or workmanship, DX Engineering shall, upon prompt notice thereof, issue shipping instructions for return to DX Engineering (transportation-charges prepaid by Buyer). Every such claim for breach of these warranties shall be deemed to be waived by Buyer unless made in writing.

++The above warranties shall not extend to any products or parts thereof which have been subjected to any misuse or neglect, damaged by accident, rendered defective by reason of improper installation, damaged from severe weather including floods, or abnormal environmental conditions such as prolonged exposure to corrosives or power surges, or by the performance of repairs or alterations outside of our plant, and shall not apply to any goods or parts thereof furnished by Buyer or acquired from others at Buyer's specifications. In addition, DX Engineering's warranties do not extend to other equipment and parts manufactured by others except to the extent of the original manufacturer's warranty to DX Engineering.

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