March 13 - 15

2018 ATIS-PEG Conference
Huntsville, AL

"Lightning Protection for PoE Powered Ethernet Radio Systems"

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2018 ATIS-PEG Conference

Lightning Protection for PoE Powered Ethernet Radio Systems

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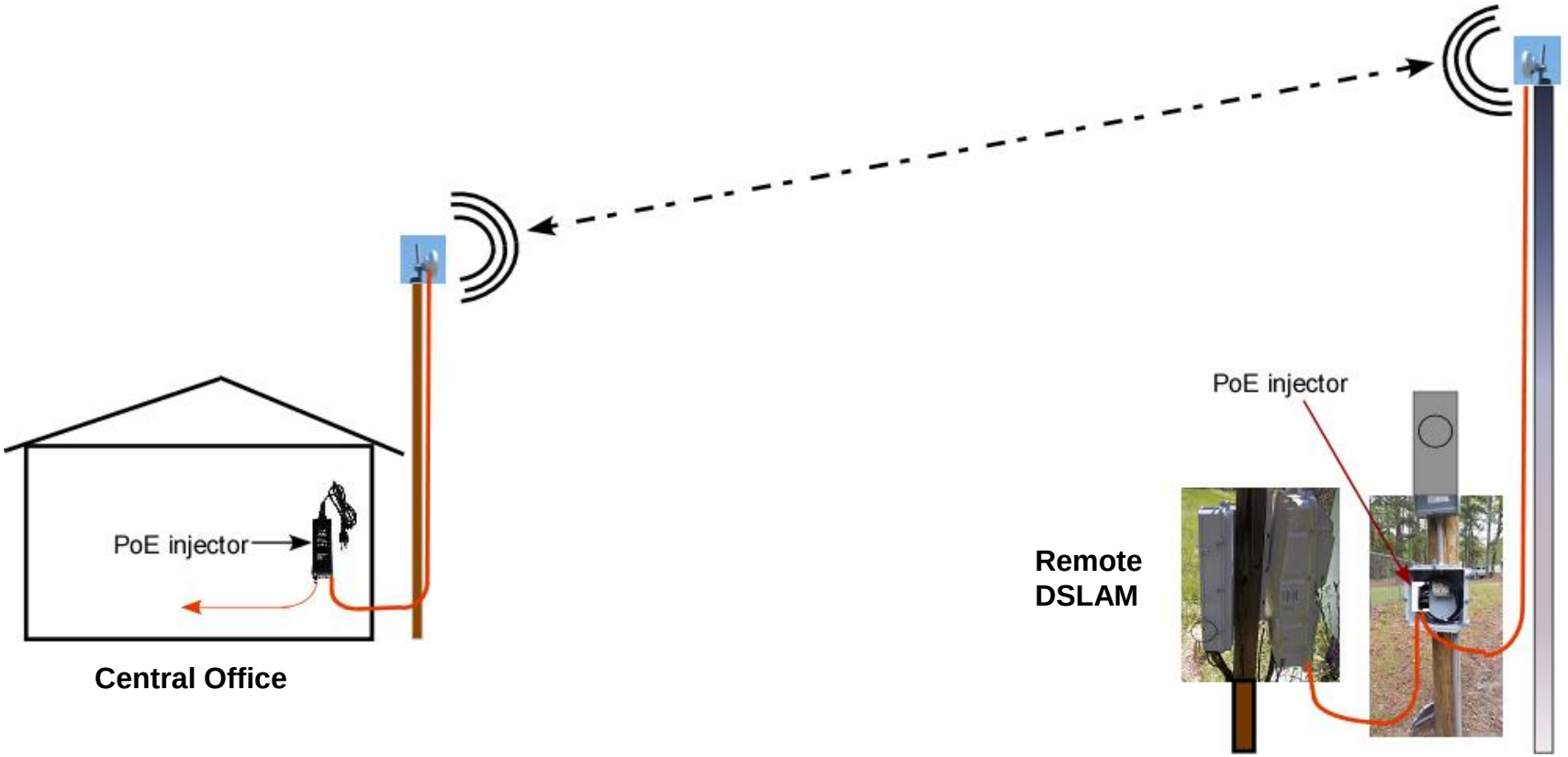
Ethernet radio systems, utilizing power over ethernet (PoE) technology, are being deployed by multiple telecommunication service providers as a low cost means to extend the network for xDSL deployments. Two of these systems require an external radio/antenna that may need to be mounted on the roofs or eaves of residential homes. Due to the mounting location of the radios/antennas, there is a risk of a proximity lightning striking or a direct strike to the ethernet radios/antennas which could introduce lightning energy inside the structure through the CAT5/6 cabling.

One Additional Example

Point to Point ethernet radio backhaul system for remote DSLAMs which may include repeater locations. Existing standards such as Motorola R56© provide good guidance for tower grounding/bonding and protection for these types of systems.



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Residential service delivery using UHF bandwidth

Residential service delivery using the 4G LTE Cellular network

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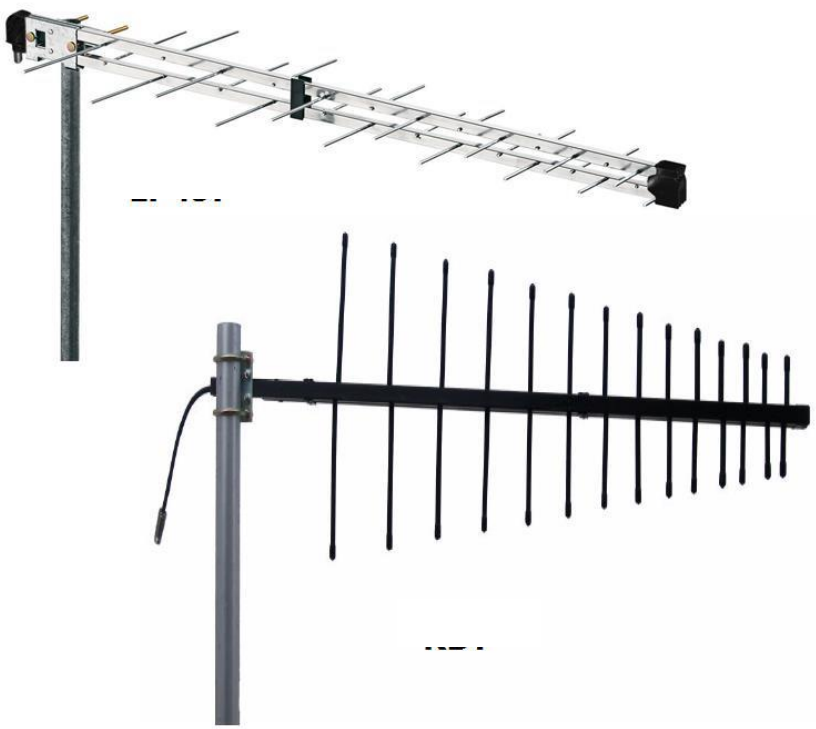
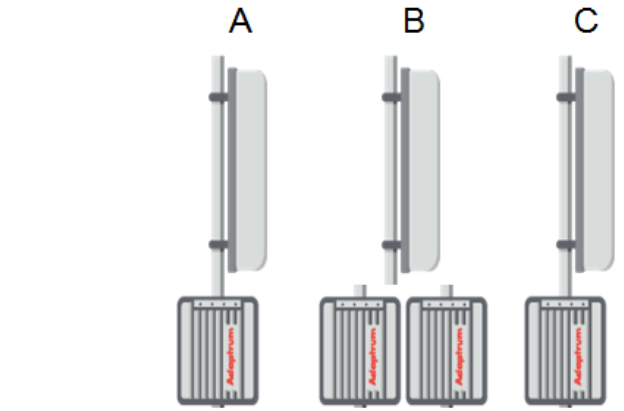
More about the UHF delivery system

UHF antennas



- Various databases show a total of 29 UHF channels available between channels 14 and 51 for fixed devices @ 30m height.
- 4 pairs of UHF channels (total of 8 channels) are required for operation per the proposed network deployment.
- Actual channel availability and quality requires on ground spectrum scan measurements.

UHF antennas at transmitter location (fiber node)



Frequency spectrum

UHF TELEVISION FREQUENCIES

CH #	FREQUENCY	CH #	FREQUENCY	CH #	FREQUENCY
14	470-476 MHz	38	614-620 MHz	62	758-764 MHz
15	476-482 MHz	39	620-626 MHz	63	764-770 MHz
16	482-488 MHz	40	626-632 MHz	64	770-776 MHz
17	488-494 MHz	41	632-638 MHz	65	776-782 MHz
18	494-500 MHz	42	638-644 MHz	66	782-788 MHz
19	500-506 MHz	43	644-650 MHz	67	788-794 MHz
20	506-512 MHz	44	650-656 MHz	68	794-800 MHz
21	512-518 MHz	45	656-662 MHz	69	800-806 MHz
22	518-524 MHz	46	662-668 MHz	70	806-812 MHz
23	524-530 MHz	47	668-674 MHz	71	812-818 MHz
24	530-536 MHz	48	674-680 MHz	72	818-824 MHz
25	536-542 MHz	49	680-686 MHz	73	824-830 MHz
26	542-548 MHz	50	686-692 MHz	74	830-836 MHz
27	548-554 MHz	51	692-698 MHz	75	836-842 MHz
28	554-560 MHz	52	698-704 MHz	76	842-848 MHz
29	560-566 MHz	53	704-710 MHz	77	848-854 MHz
30	566-572 MHz	54	710-716 MHz	78	854-860 MHz
31	572-578 MHz	55	716-722 MHz	79	860-866 MHz
32	578-584 MHz	56	722-728 MHz	80	866-872 MHz
33	584-590 MHz	57	728-734 MHz	81	872-878 MHz
34	590-596 MHz	58	734-740 MHz	82	878-884 MHz

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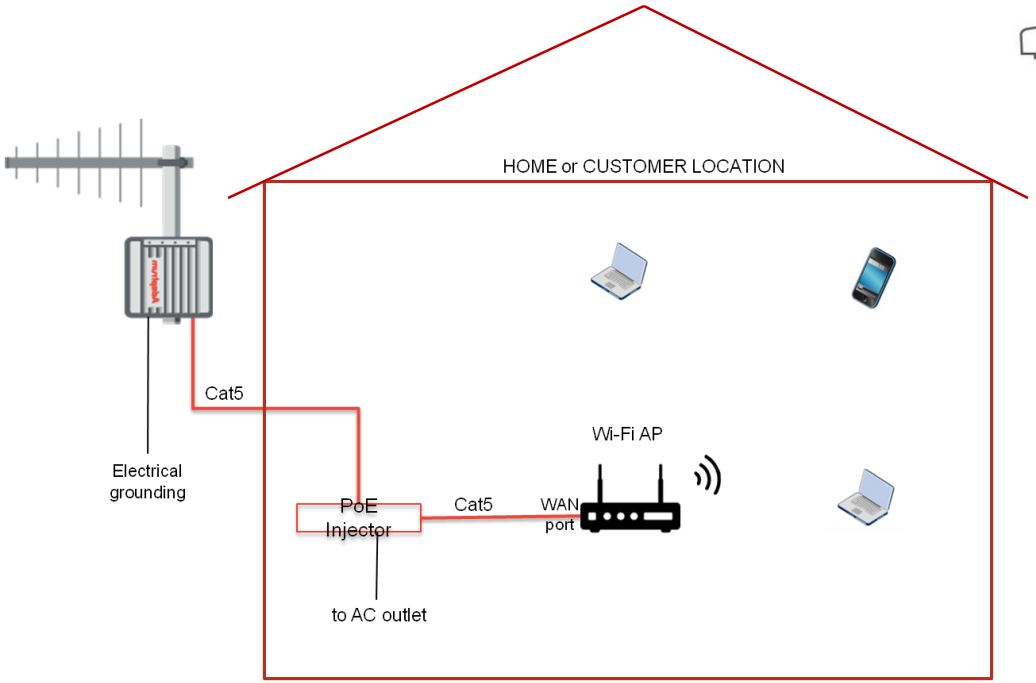
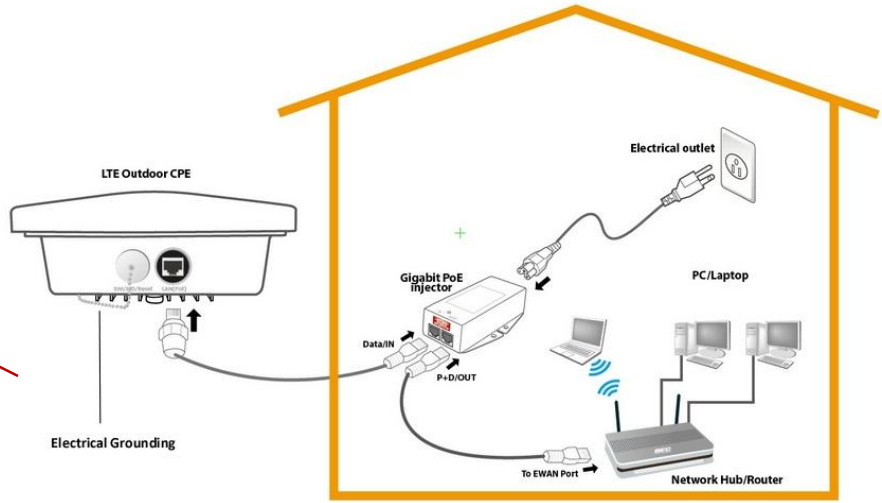
Typical diagrams from installation documents





UHF and 4G radio mountings

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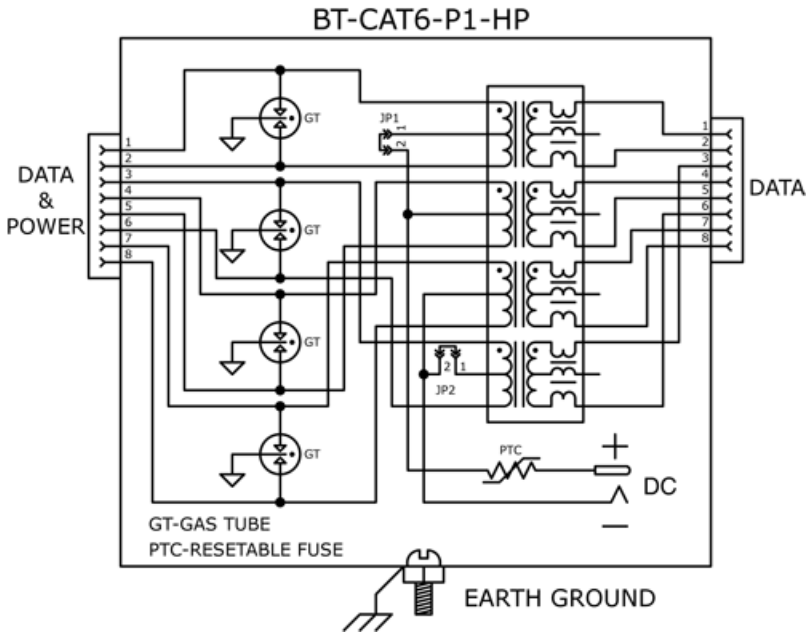
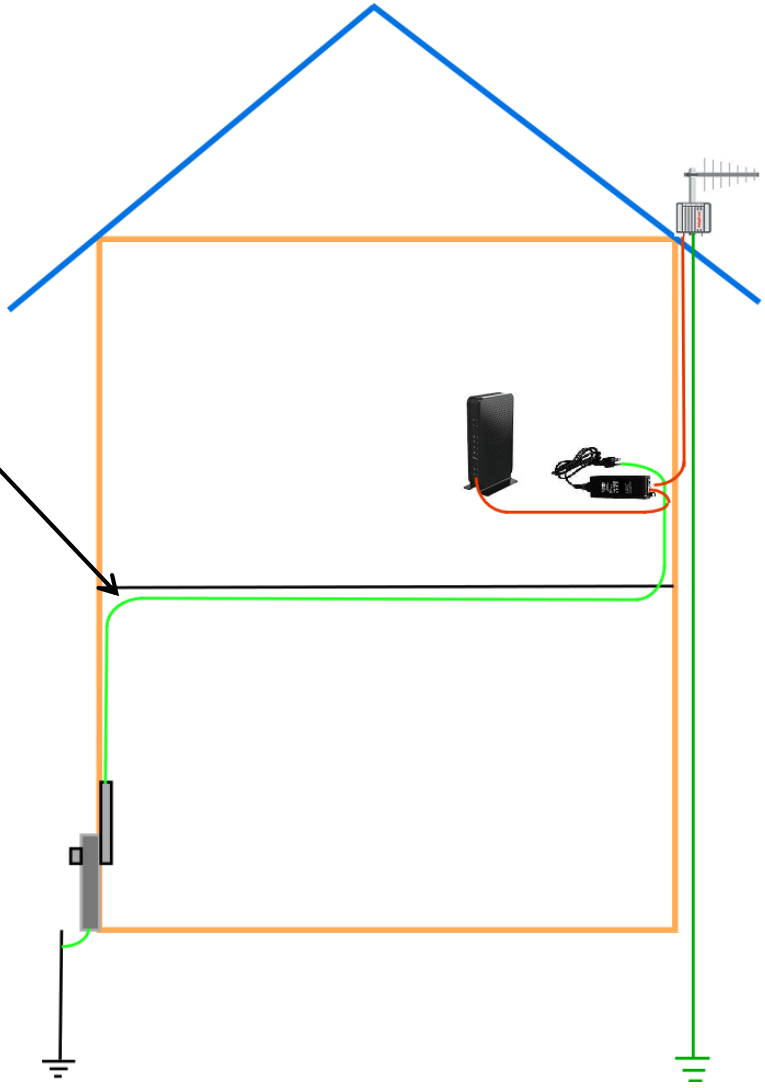
Lightning Protection for PoE Powered Ethernet Radio Systems

PoE with GDT protection





Standard 14AWG grounding conductor in 12/2 residential wiring, designed for 60Hz AC fault protection, is now being used as the discharge path for primary protection installed in PoE injectors during a lightning strike.

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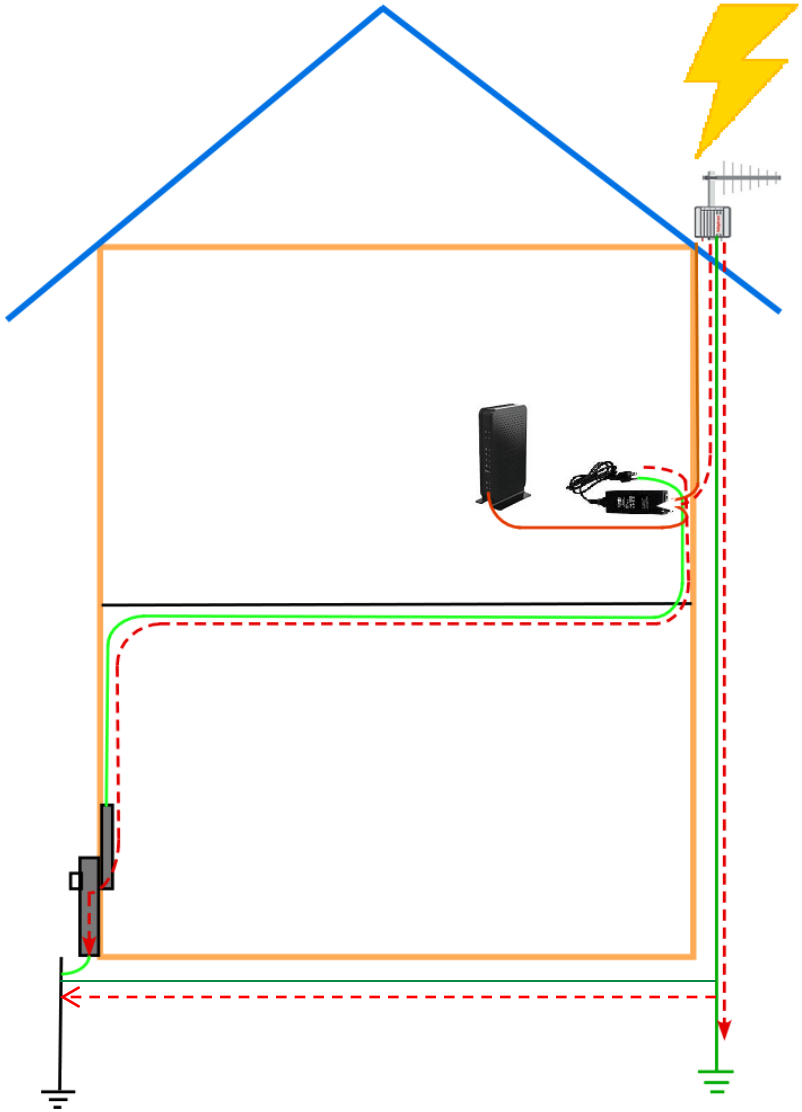
Lightning Protection for PoE Powered Ethernet Radio Systems

When lightning strikes the external antenna, a portion of the lightning discharge may propagate into the CAT5/6 cable. When the PoE injector primary protectors fire, this will direct the electrical energy through the cord and into the grounding conductor of the residential house wiring.



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What do the Standards Say?

NFPA 780® Standards for the Installation of Lightning Protection Systems

4.20.2.2* SPDs shall be installed at entrances of conductive communications systems (including, but not limited to, CATV, alarm, and data) and antenna systems.

4.20.6 Communications Surge Protection.

4.20.6.1* SPDs shall be provided for all communications systems (including, but not limited to, CATV, alarm, and data) and antenna systems at facility entrances.

4.20.6.4.1* SPDs protecting communications systems shall be grounded in accordance with *NFPA 70*® , Chapter 8. (**800.100**)

4.20.6.4.2 If the point of grounding in 4.20.6.4.1 is more than 20 ft (6 m) away, a supplementary ground reference point shall be installed at the SPD location. Acceptable supplementary ground reference points shall be permitted as follows:

(1) Equipotential ground bus bar

(2) Structural metal framework in accordance with 4.19.1

(3) Ground reference at a secondary power distribution panel

4.20.6.4.3 SPDs shall not be grounded through a down conductor of the lightning protection system.

4.20.6.4.4* SPDs for data and signal line protection shall provide common mode protection.

4.20.8* Earth Grounding Electrode. Resistance of the earth electrode system used in the grounding of SPDs shall comply with *NFPA 70*® . [**Section 250 Part III**]

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4.8 GROUNDING (EARTHING) ROOF-MOUNTED ANTENNA

MASTS AND METAL SUPPORT STRUCTURES

All roof-mounted antenna masts and metal support structures **shall** be grounded (earthed) NFPA 70® Article 810.15.

810.15 Grounding. Masts and metal structures supporting

antennas shall be grounded in accordance with 810.21,

NOTE: When a lightning protection system is not available, roof-mounted antenna masts and metal support structure **shall** be grounded by directly bonding to the building's grounding electrode system, or to a supplemental grounding electrode system (FAA STD-019d-2002, section 3.7.9.4). Bonding to the grounding electrode system **shall** use effectively grounded structural building steel when available. When effectively grounded structural building steel is not available, bonding to the grounding electrode system **shall** use at least two down conductors whenever practical (ANSI T1.334-2002, section 8.2). When effectively grounded structural building steel is not available and the use of two down conductors is not practical, the use of a single down conductor should be approved by an engineer. Available water piping systems may also be used as a grounding down-conductor, but should only be used under the advice of an engineer.

Down-conductors **shall** be routed to the grounding electrode system from opposite sides of the roof whenever practical (ANSI T1.334-2002, section 8.2). Down-conductors **shall** be physically separated from one another as much as practical (ANSI T1.334-2002, section 8.2). Additional requirements for down-conductors are as follows:

- Grounding down-conductors **shall** be sized as follows:
- The conductor **shall** be a 35 mm2 csa **(#2 AWG**) or coarser, bare, copper or equivalent, for buildings not exceeding 22.9 m (75 ft.) in height (NFPA 780-2004, Table 4.1.1.1(A)).
- Grounding down-conductors **shall not** be required to be insulated (NFPA 70-2005, Article 810.21(b)). Insulated conductors are recommended when the grounding conductor may come into incidental contact with other metallic objects. Incidental contact with other metallic object may be a point for RF interference.
- Grounding down-conductor **shall** be run in as straight a line as is practical (NFPA 70-2005, Article 810.21(e)).
- Grounding down-conductors **shall** have a minimum bend radius of 203 mm (8 in.), and the included angle **shall not** exceed 90 degrees as shown in Figure 4-22 on page 4-29 (ANSI T1.313-2003, section 11.3; MIL-STD-188-124B; and NFPA 780-2004, section 4.9.5).

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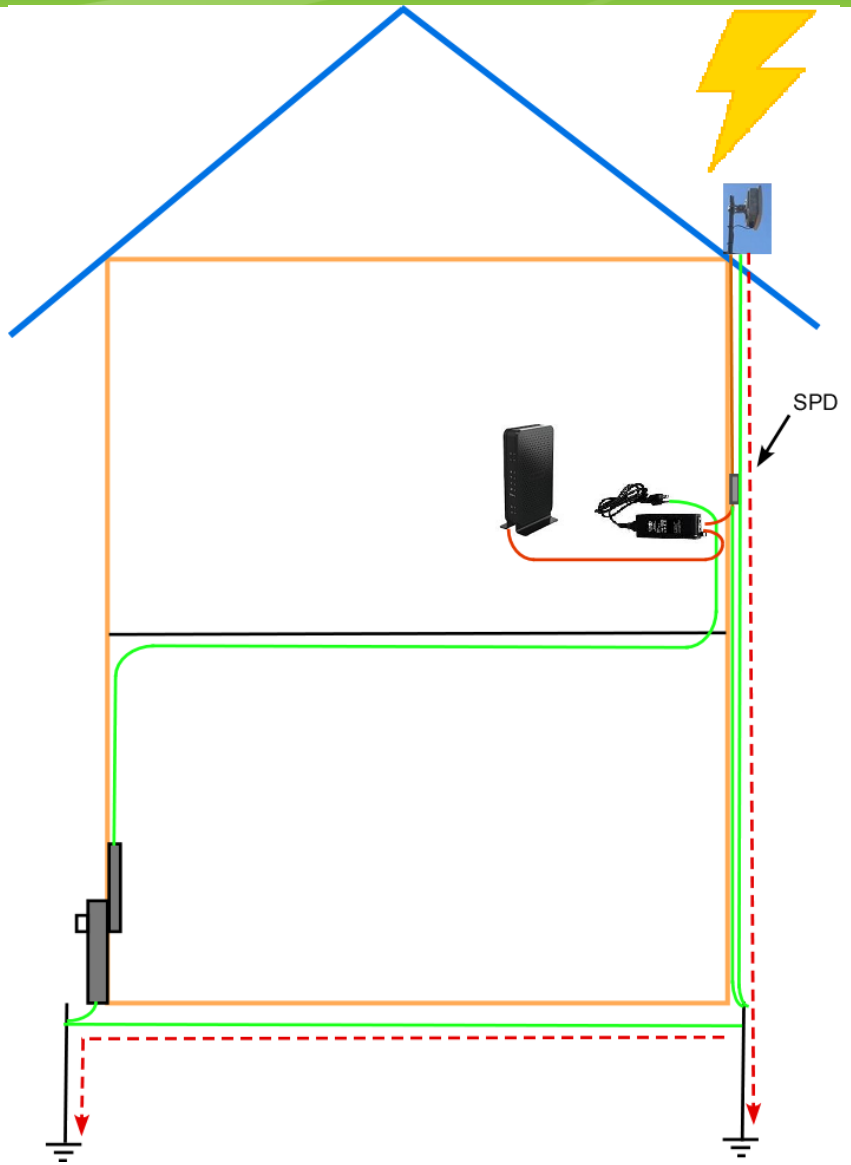
4.8.1 SIDE MOUNTED ANTENNA GROUNDING (EARTHING)

Typically, a side mounted antenna may be grounded (earthed) with a single grounding conductor. The use of two grounding down-conductors may not always be practical. However, two down-conductors should be used whenever practical; this is especially important at buildings that are normally occupied, such as dispatch centers. When two grounding down-conductors are not installed, it is recommended to either use a copper strap or a larger sized grounding down-conductor.

With external grounding and SPD installation, lightning energy can be better managed on the exterior of the structure and minimize the let through voltage that could propagate into the building, wiring and electronics.



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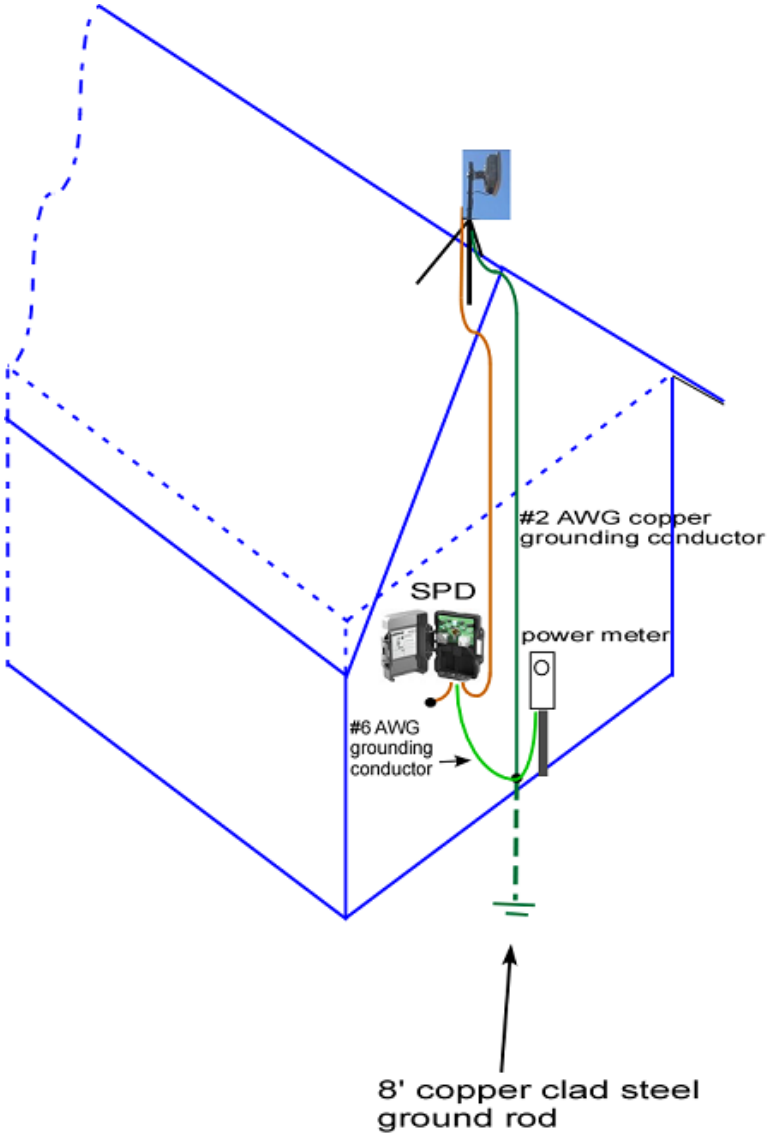
Lightning Protection for PoE Powered Ethernet Radio Systems

Recommended grounding and protection for a roof top antenna where the existing building grounding electrode is in close proximity to the antenna and SPD location.

A supplemental grounding electrode may be added if the impedance of the existing grounding electrode can not be determined or measures over 25 ohms earth resistance. *(NEC® 250.53 (2)(3))*



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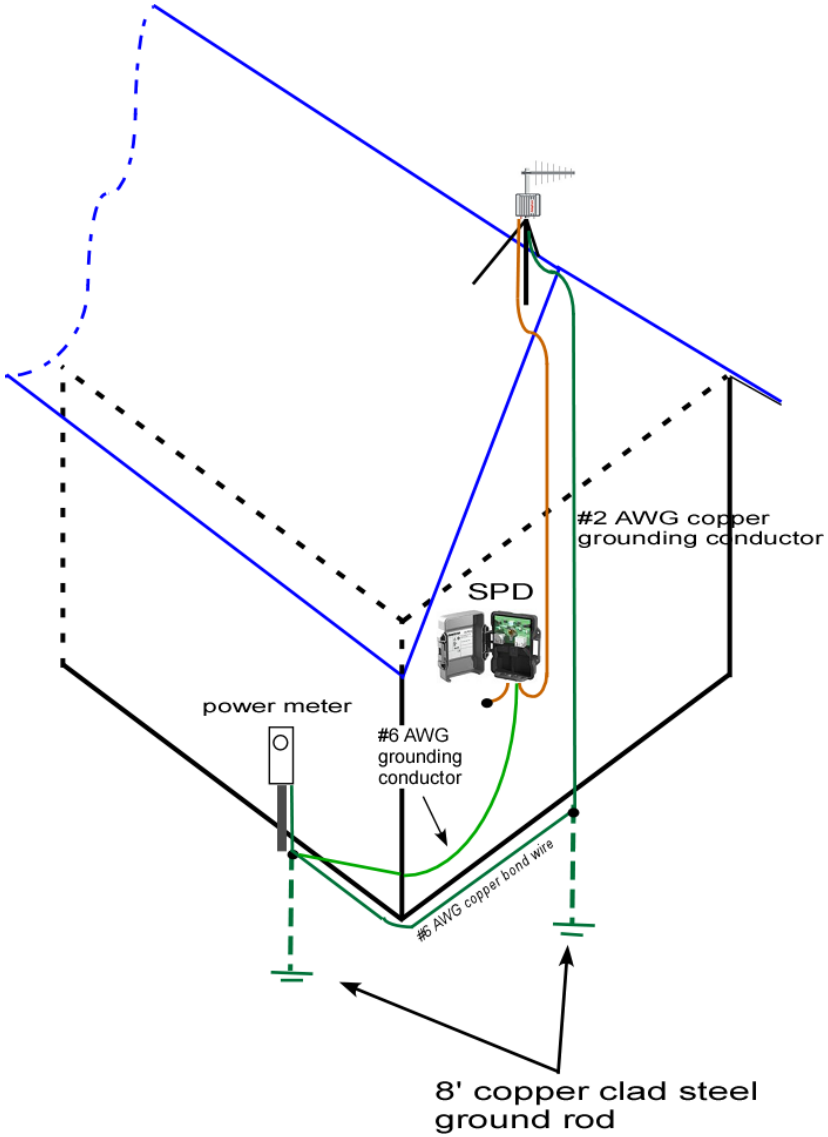
Lightning Protection for PoE Powered Ethernet Radio Systems

Recommended grounding and protection for a roof top antenna where the existing building grounding electrode is greater than 20 feet horizontally from the antenna and SPD location.

A supplemental grounding electrode should be added if the SPD is greater than 20 feet (grounding conductor length) from the existing building grounding electrode.

A supplemental grounding electrode should be added for antenna grounding and a minimum solid #6 AWG wire be placed to bond all grounding electrodes together.



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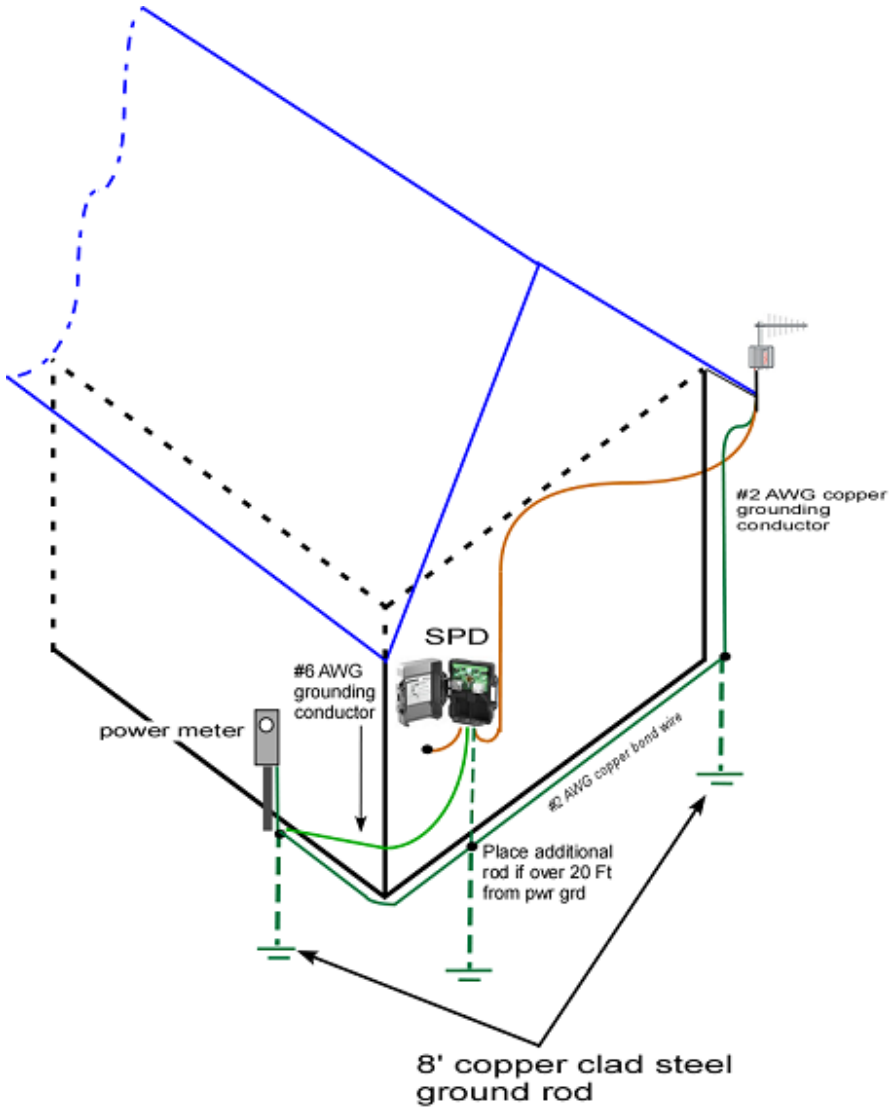
Lightning Protection for PoE Powered Ethernet Radio Systems

Recommended grounding and protection for an eave mounted antenna where the existing building grounding electrode is greater than 20 feet horizontally from the antenna and SPD location.

A supplemental grounding electrode should be added if the SPD is greater than 20 feet (grounding conductor length) from the existing building grounding electrode.

A supplemental grounding electrode should be added for antenna grounding and a minimum solid #6 AWG wire be placed to bond all grounding electrodes together.



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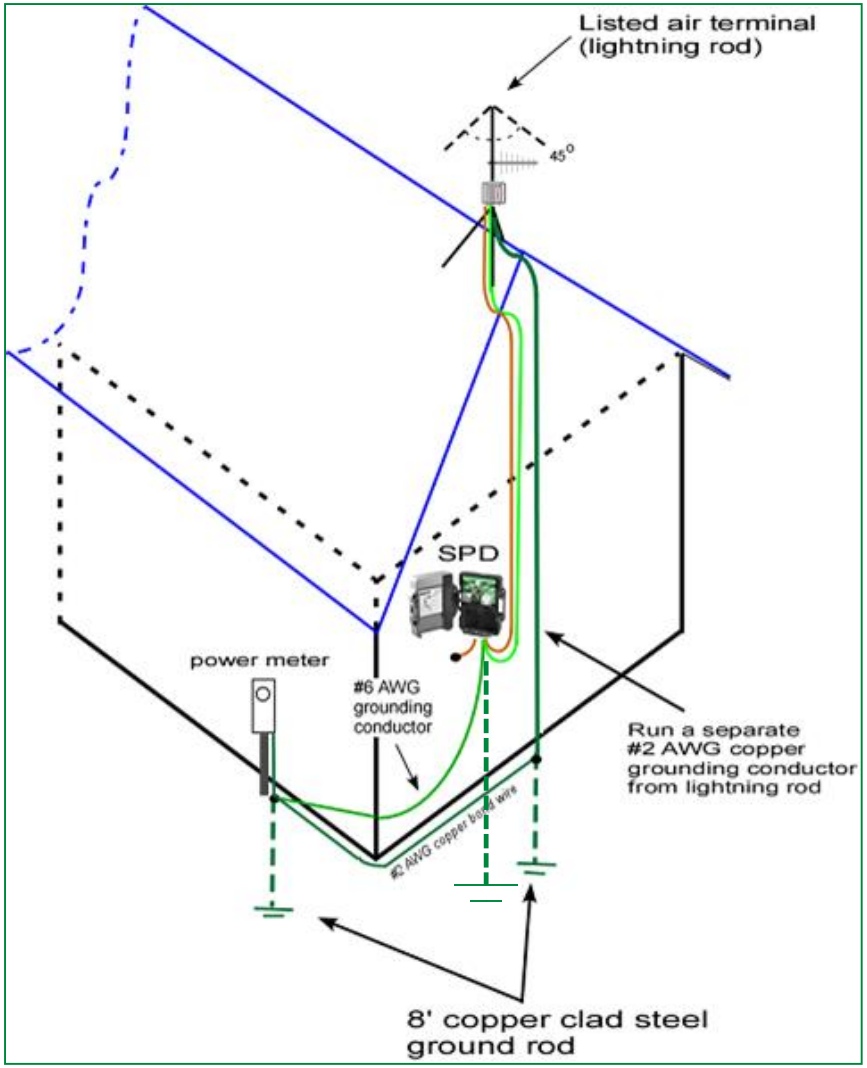
Lightning Protection for PoE Powered Ethernet Radio Systems

Where the Antenna is installed above the roof line of the residence in lightning prone regions, a listed air terminal (lightning rod) may be installed above the radio/antenna so that the top of the terminal provides a 45 degree down angle cone of protection over the antenna.

A separate main down conductor (minimum AWG #2) should be installed between the air terminal and the grounding electrode system.



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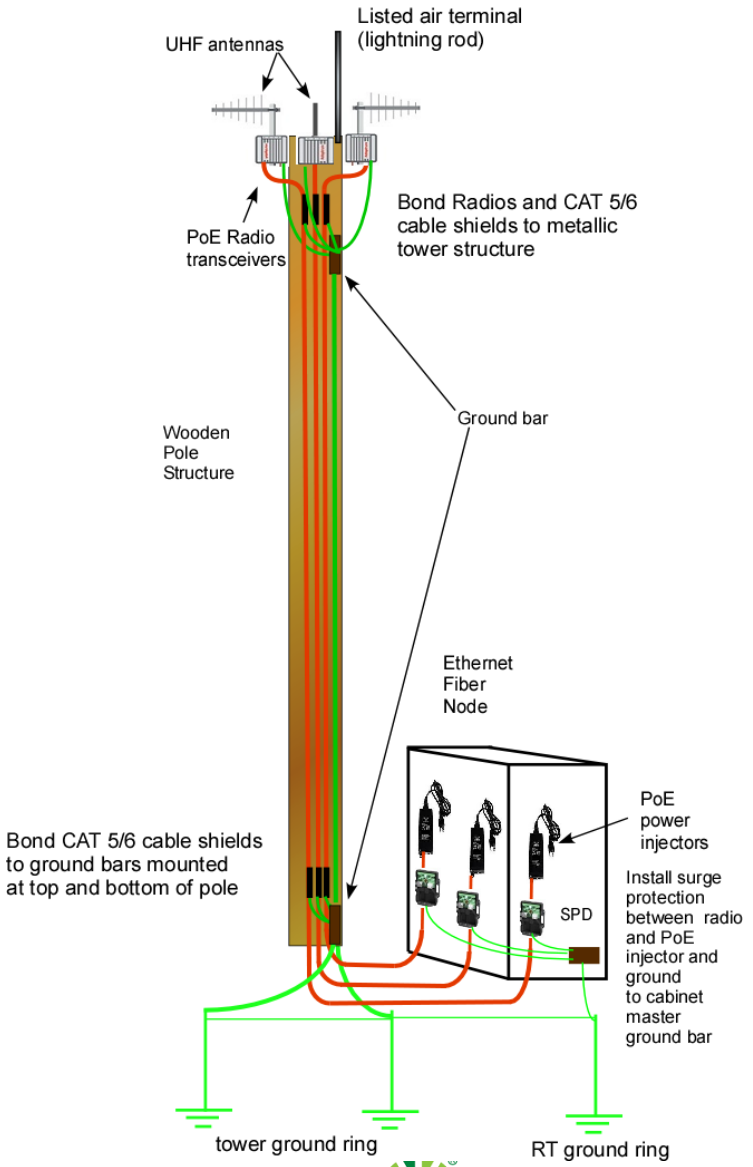
Point to Multi Point Systems

More Motorola R56©

7.6.4 BROADBAND - WIRELESS ACCESS POINT NETWORKS

SPD considerations for broadband **shall** include the use of SPDs to protect pole-mounted access points and ground-based cabinet architecture. It is important to install proper SPD applications on both ends of Ethernet, Power-Over Ethernet (POE), Giga-Ethernet (GigE) and AC cable runs. SPDs **shall** be located within the node or cabinet, or as close to the entrance as possible, and properly installed into load centers, control panels and utility power cabinets. While RF protection is a consideration, it **shall** only be required when antennas are connected to the node with coaxial cables greater than 610 mm (2 ft.) in length.



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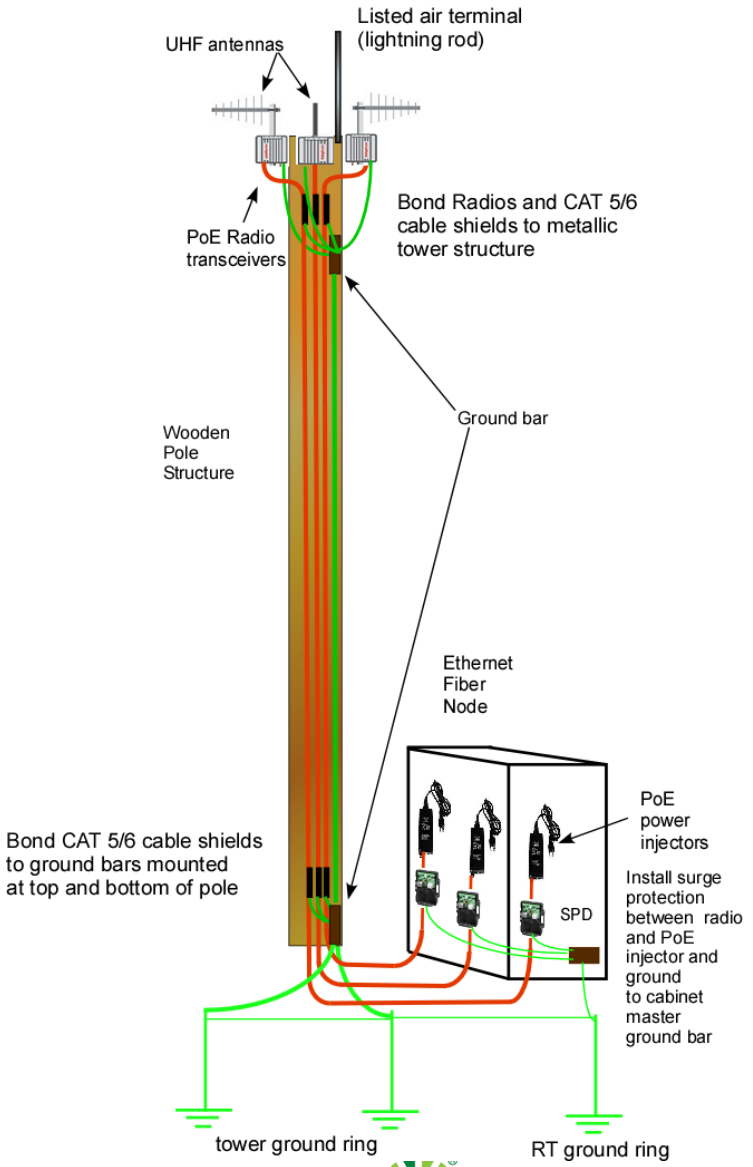
Lightning Protection for PoE Powered Ethernet Radio Systems

Recommended grounding and protection for antennas mounted on a wood pole structure including:

- •Separate grounding electrode system bonded to the grounding system of the remote fiber node.
- •Ground bars at base and top of tower bonded together with (one minimum two is better) #2 AWG solid tinned copper conductors.
- •Shield bonding of the CAT 5/6 cables at top and bottom of structure.
- •Radio antennas bonded to the ground bar at the top of the wooden structure.
- •Air terminal installed above the top of the wooden pole structure.
- •SPD's installed in fiber node cabinet between radio transmitters and PoE power injectors.



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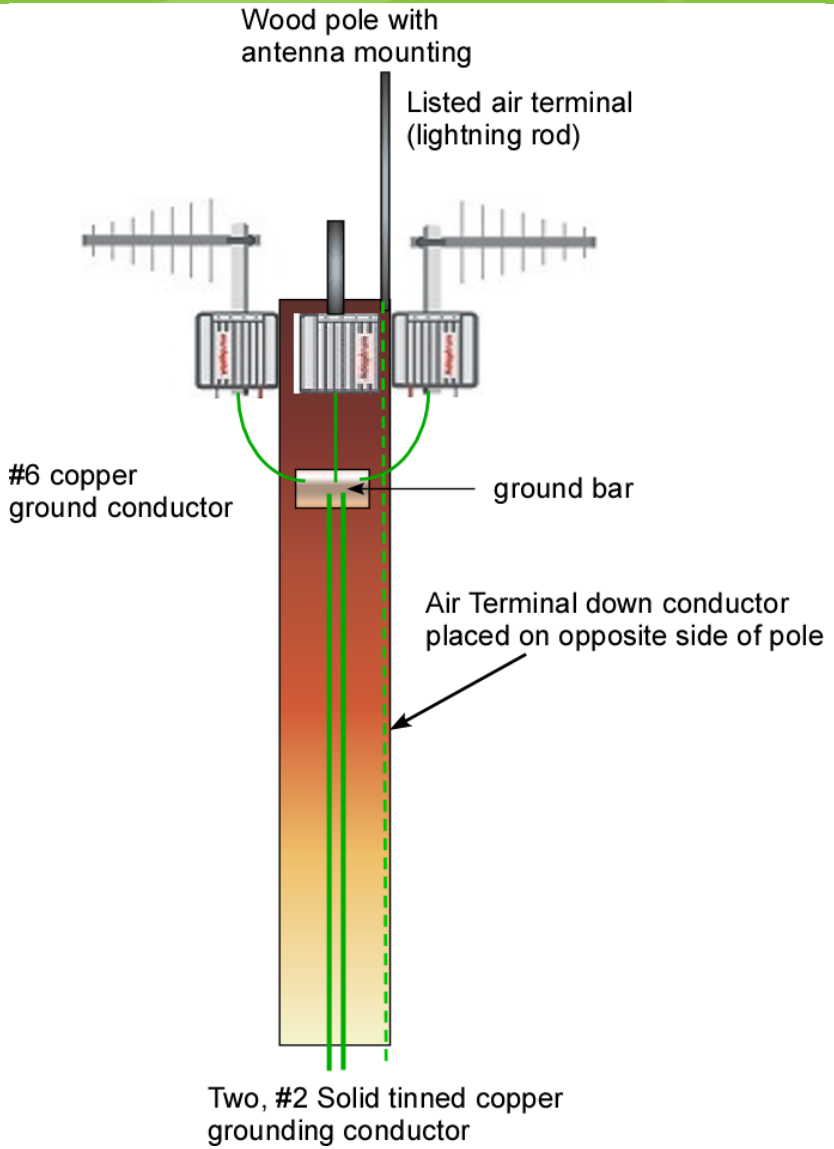
Lightning Protection for PoE Powered Ethernet Radio Systems

Recommended grounding and protection for antennas mounted on a wood pole structure (additional):

- Air terminal installed above the top of the wooden pole structure. Run a separate main down conductor (minimum #2 AWG solid copper) on the opposite side of the wooden pole from the grounding conductor(s).
- Bond Lightning rod down conductor separately to made ground electrode system.



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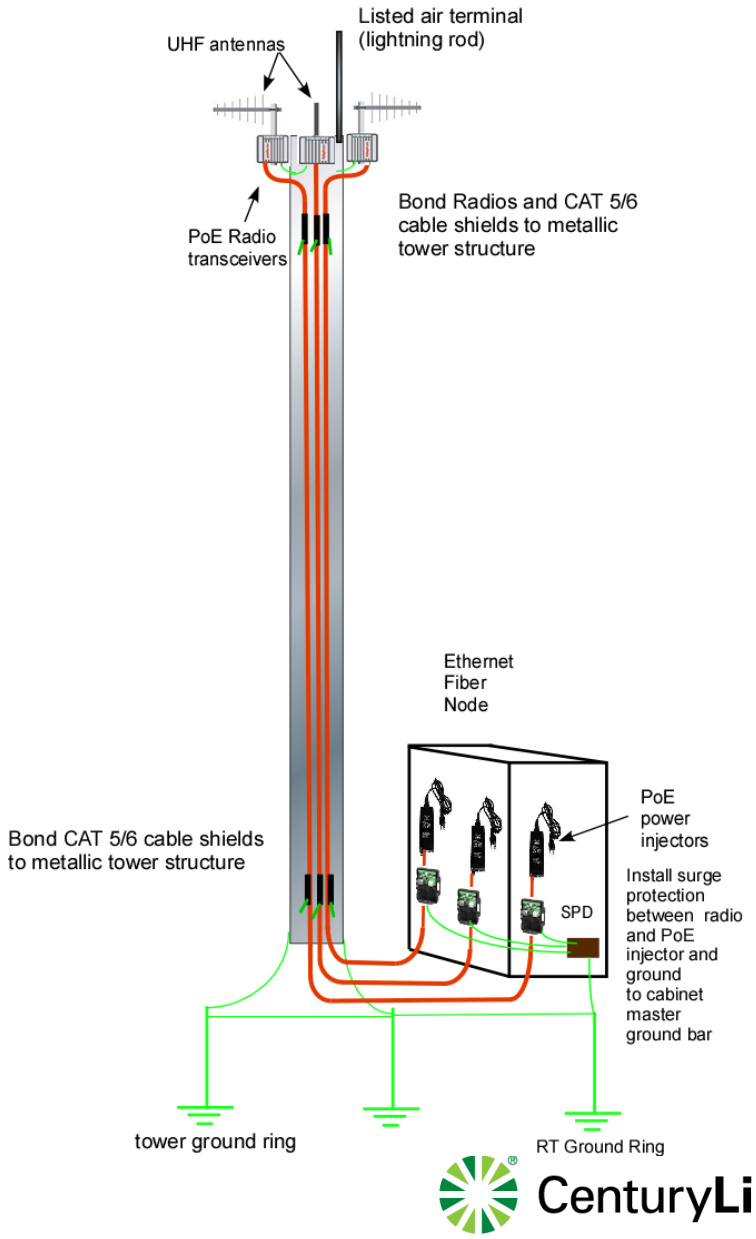
Lightning Protection for PoE Powered Ethernet Radio Systems

Recommended grounding and protection for antennas mounted on a steel pole/ tower structure including Version-1:

- •Separate tower grounding electrode system bonded to the grounding system of the remote fiber node.
- •Radio antennas bonded to the steel tower.
- •Shield bonding of the CAT 5/6 cables at top and bottom of structure and at least every 50 feet for towers ≤100 feet.
- •Air terminals located on steel towers shall be bonded directly to the steel tower.
- •SPD's installed in fiber node cabinet between radio transmitters and PoE power injectors.



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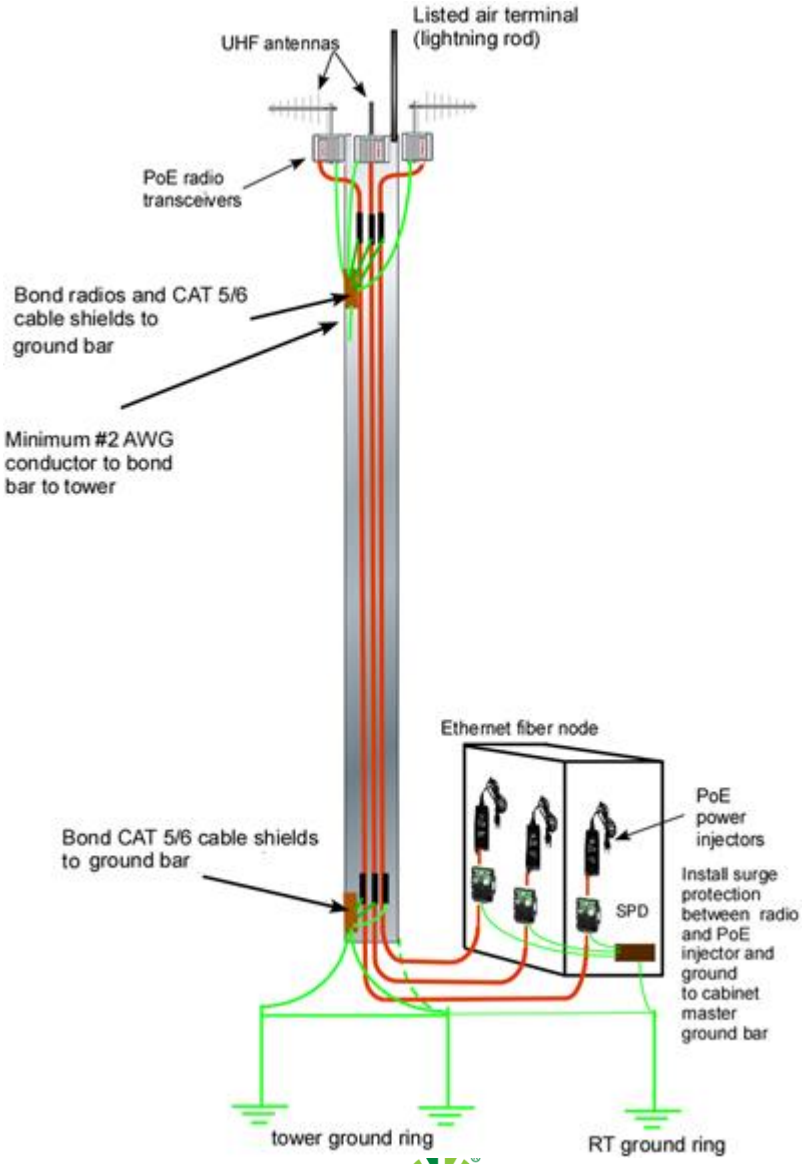
Lightning Protection for PoE Powered Ethernet Radio Systems

Recommended grounding and protection for antennas mounted on a steel pole/ tower structure including Version-2:

- Separate tower grounding electrode system bonded to the grounding system of the remote fiber node.
- All ground bars isolated from direct tower contact with minimum #2 AWG bonding conductors to tower steel for grounding the radio/ antennas and CAT 5/6 cable shields.
- Air terminals located on steel towers shall be bonded directly to the steel tower.
- There shall be a separate grounding conductor placed between the steel tower and the tower MGE.
- SPD's installed in fiber node cabinet between radio transmitters and PoE power injectors.



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4.7.9 RF TRANSMISSION LINE AND PREAMPLIFIER GROUNDING (EARTHING)

Tower mounted antenna preamplifiers **shall** be bonded to the tower using 16 mm2 csa (#6 AWG) or coarser, solid or stranded, tinned, copper conductor.

Transmission lines **shall** be bonded to the tower in order to prevent lightning from creating a difference of potential between the tower and the transmission lines and to help drain lightning energy to earth.

Transmission line ground kits **shall** be installed at the first point of contact, near the antenna.

Transmission line ground kits **shall** be installed at the bottom of the tower near the vertical to horizontal transition point.

If the tower is greater than 61 m (200 ft.) in height, an additional ground kit **shall** be installed at the

tower midpoint.

Due to the size and nature of the CAT 5/6 wire and shield, it may be advisable to have cable bonding at the tower midpoint on towers 100 feet and taller

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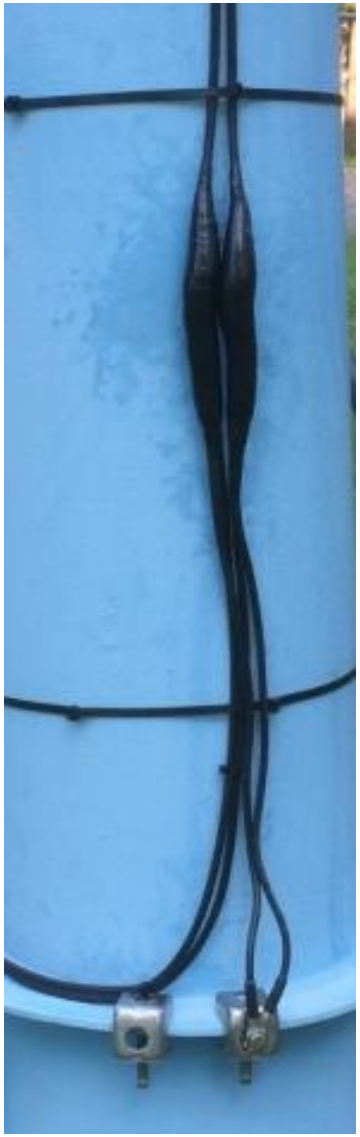

Cable shield grounding kits for CAT 5/6 cables incorporate a foil wrap type clamp that keeps 100% of the cable shield intact. The kits come with weather proofing materials to seal the cables from moisture ingress.

Conclusion:

By using the applicable portions of existing standards, ethernet radio systems can be installed in a manner that will reduce their susceptibility to damage from lightning, *along with the structures they are mounted on*.

However, additional attention should be paid to these types of systems by Industry Standards and Code Bodies.

Questions??

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