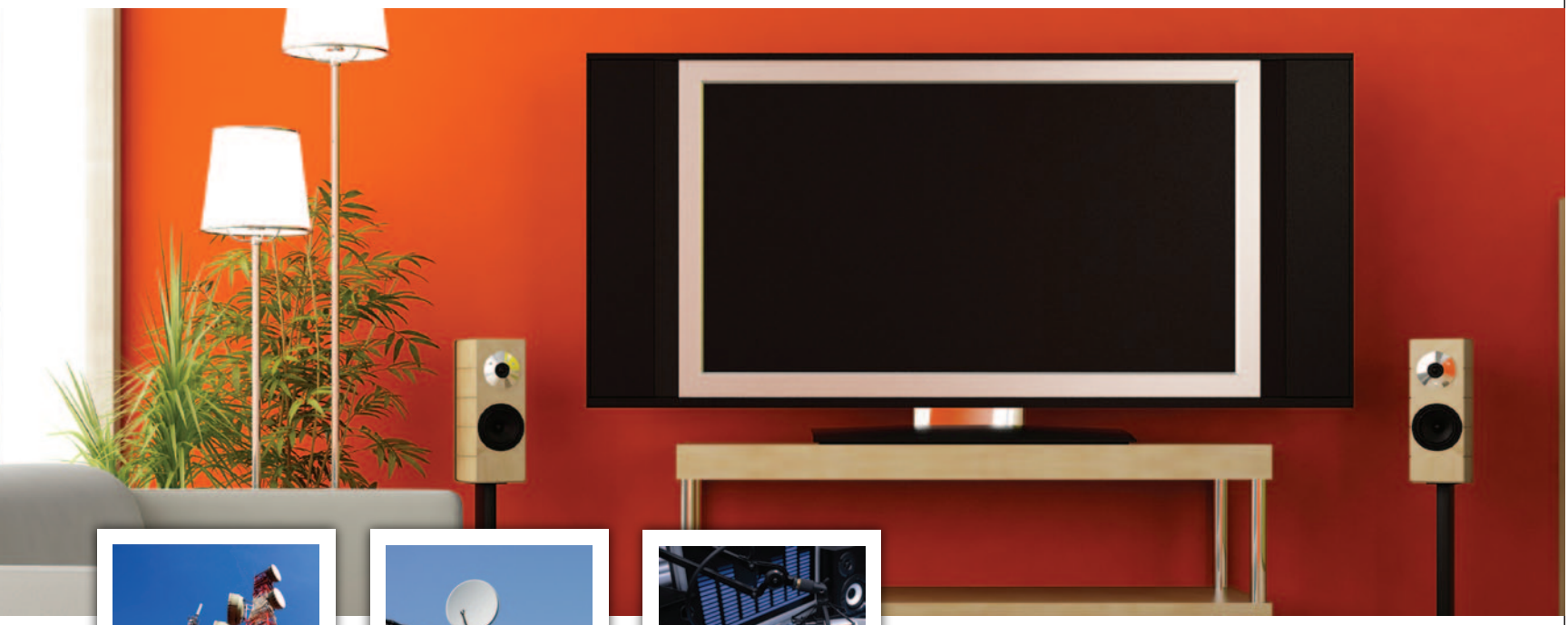
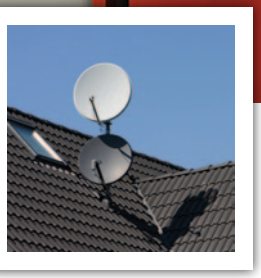
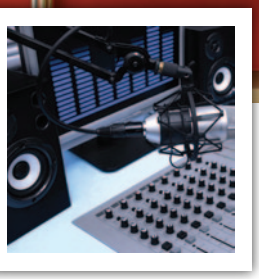
Mike Holt's Illustrated Guide to

Understanding NEC® Requirements for **RADIO AND TELEVISION EQUIPMENT**







Based on the 2011 NEC®

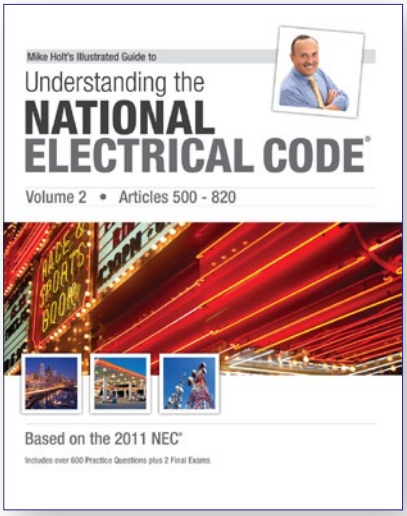
7.14.11

Mike Holt's Illustrated Guide to

Understanding the NEC® Requirements for

Radio and Television Equipment

Extracted from Mike Holt's Illustrated Guide to
Understanding the 2011 National Electrical Code, Volume 2



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Notes

ARTICLE

810

Radio and Television Equipment

INTRODUCTION TO ARTICLE 810—RADIO AND TELEVISION EQUIPMENT

This article covers transmitter and receiver equipment—and the wiring and cabling associated with that equipment. Here are a few key points to remember about Article 810:

- Avoid contact with conductors of other systems.
- Don't attach antennas or other equipment to the service-entrance power mast.
- If the mast isn't grounded properly, voltage surges caused by nearby lightning strikes can destroy it.
- Keep the bonding conductor or grounding electrode conductor as straight as practicable, and protect it from physical damage.
- If the mast isn't bonded properly, you risk flashovers and possible electrocution.
- Keep in mind that the purpose of bonding is to prevent a difference of potential between metallic objects and other conductive items, such as swimming pools.
- Clearances are critical, and Article 810 contains detailed clearance requirements. For example, it provides separate clearance requirements for indoor and outdoor locations.

PART I. GENERAL

Note: The term "Grounding Conductor" previously used in this article has been replaced by either "Bonding Conductor" or "Grounding Electrode Conductor (GEC)" where applicable to more accurately reflect the application and function of the conductor. Figures 810–1 and 810–2

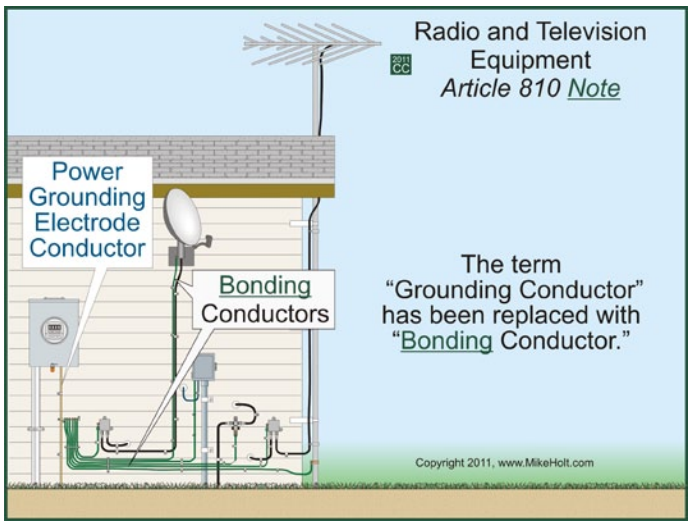


Figure 810–1

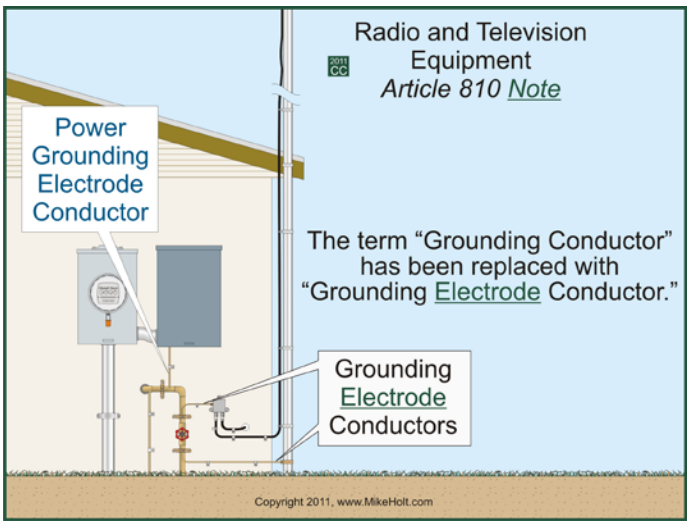


Figure 810–2

810.1 Scope. Article 810 contains the installation requirements for the wiring of television and radio receiving equipment, such as digital satellite receiving equipment for television signals and amateur/citizen band radio equipment antennas. Figure 810–3

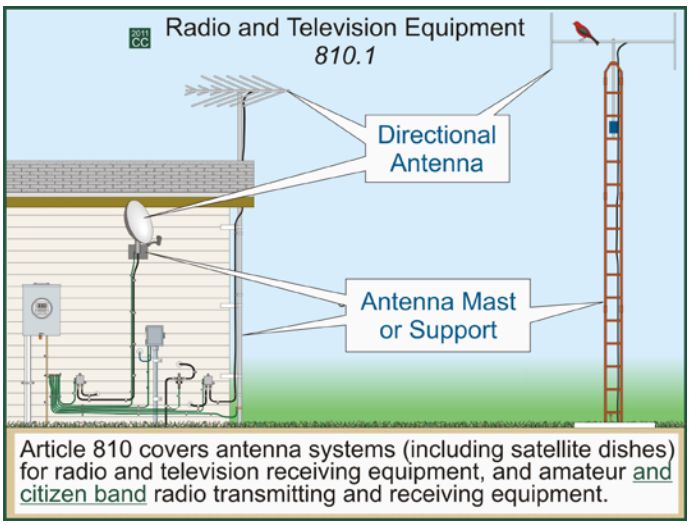


Figure 810–3

Author's Comment: Article 810 covers:

- VHF/UHF antennas, which receive local television signals.
- Satellite antennas, which are often referred to as satellite dishes. Large satellite dish antennas (often about 6 ft in diameter) usually have a motor that moves the dish to focus on different satellites. The smaller satellite dish antennas (18 in. in diameter) are usually aimed at a single satellite.
- Roof-mounted antennas for AM/FM/XM radio reception.
- Amateur radio transmitting and receiving equipment, including HAM radio equipment (a noncommercial [amateur] communications system).

810.3 Other Articles. Wiring from the power supply to Article 810 equipment must be installed in accordance with Chapters 1 through 4. Wiring for audio equipment must comply with Article 640 and coaxial cables that connect antennas to equipment must be installed in accordance with Article 820. Figure 810–4

Author's Comment: The grounding requirements for antenna cables are contained in 810.20(C) and 810.21, not Article 820.

810.4 Community Television Antenna. The antenna for community television systems must be installed in accordance with this article, but the coaxial cable beyond the point of entrance must be installed in accordance with Article 820. Figure 810–5

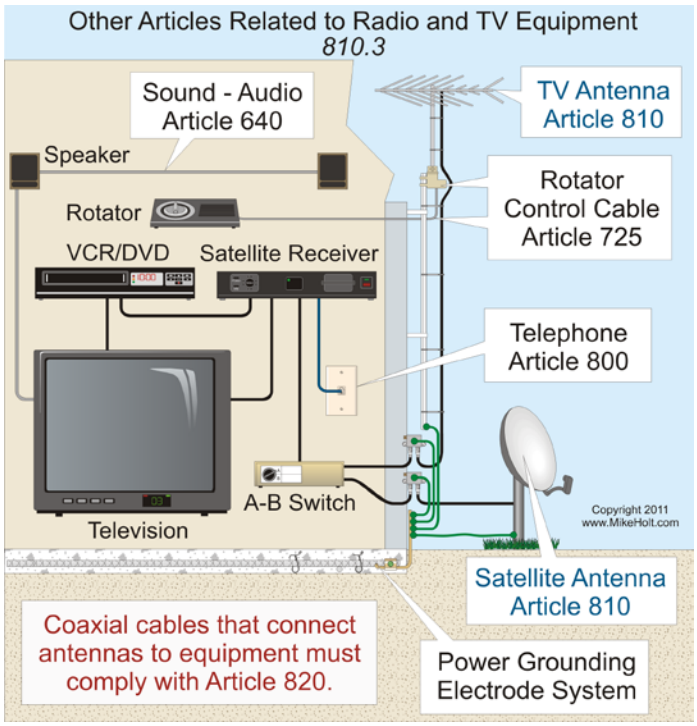


Figure 810–4

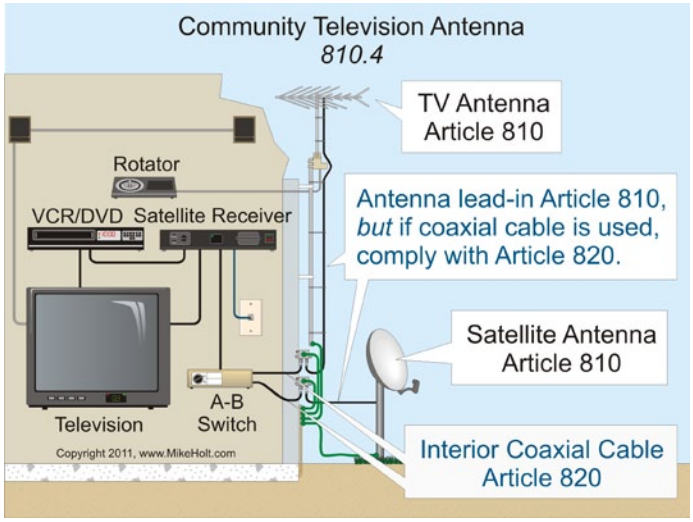


Figure 810–5

Author's Comment: A community TV antenna is used for multiple-occupancy facilities, such as apartments, condominiums, motels, and hotels.

PART II. RECEIVING EQUIPMENT—ANTENNA SYSTEMS

810.12 Support of Lead-In Cables. Outdoor antennas and lead-in conductors must be securely supported, and the lead-in conductors must be securely attached to the antenna.

Author's Comment: Outdoor antennas aren't permitted to be attached to the electric service mast [230.28]. Figure 810–6

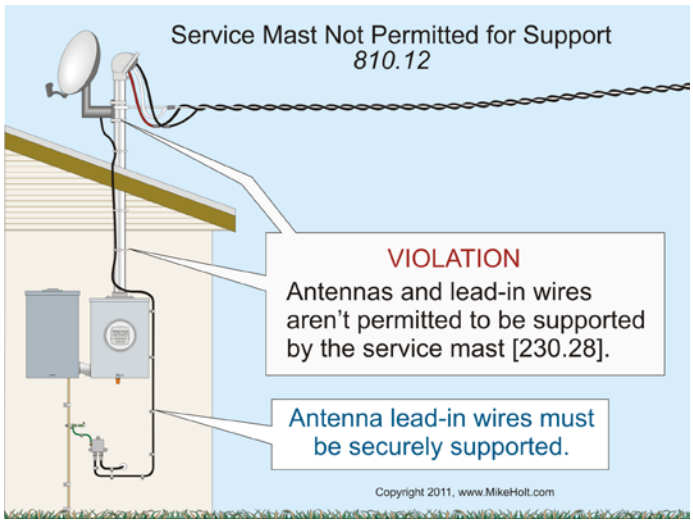


Figure 810–6

810.13 Avoid Contact with Conductors of Other Systems. Outdoor antennas and lead-in conductors must be kept at least 2 ft from exposed electric power conductors to avoid the possibility of accidental contact.

Author's Comment: According to the *National Electrical Code Handbook*, "One of the leading causes of electrical shock and electrocution is the accidental contact of radio, television, and amateur radio transmitting and receiving antennas, and equipment with light or power conductors. Extreme caution should therefore be exercised during this type of installation, and periodic visual inspections should be conducted thereafter."

810.15 Metal Antenna Supports—Grounding. Outdoor masts and metal structures that support antennas must be grounded in accordance with 810.21. Figure 810–7

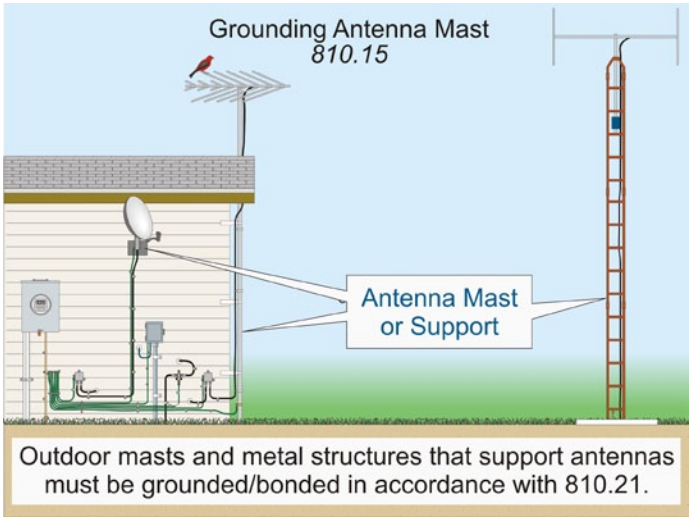


Figure 810–7

810.18 Clearances.

(A) Outside of Buildings. Lead-in conductors attached to buildings must be installed so that they can't swing closer than 2 ft to the conductors of circuits of 250V or less, or closer than 10 ft to the conductors of circuits of over 250V. Lead-in conductors must be kept at least 6 ft from the lightning protection system and underground antenna lead-in conductors must maintain a separation not less than 12 in. from electric power conductors. Figure 810–8

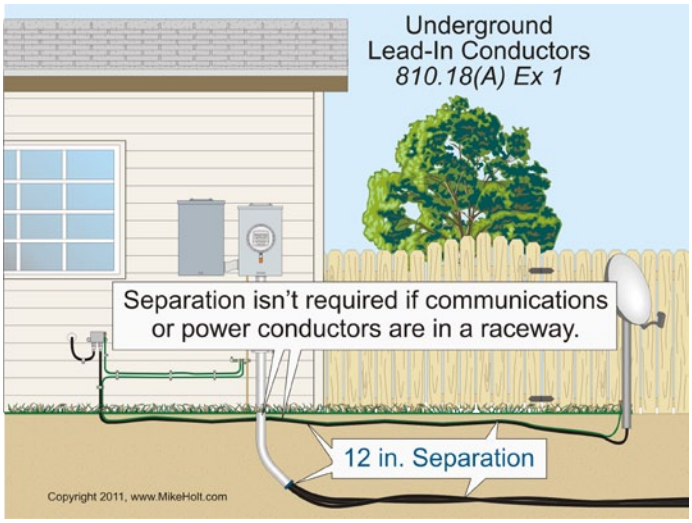


Figure 810–8

Ex: Separation isn't required where the underground antenna lead-in conductors or the electric power conductors are installed in a raceway or cable armor.

Author's Comment: The *NEC* doesn't specify a burial depth for antenna lead-in wires.

Note 1: The grounding electrode for a lightning protection system must not be used for the building/structure grounding electrode [250.60].

Note 2: Metal raceways, enclosures, frames, and metal parts of electric equipment must be bonded or spaced from the lightning protection system in accordance with NFPA 780, *Standard for the Installation of Lightning Protection Systems.*

Author's Comments:

- Separation from lightning protection conductors is typically 6 ft through air or 3 ft through dense materials such as concrete, brick, or wood.
- If a lightning protection system is installed, it must be bonded to the building/structure grounding electrode system [250.106].

(B) Indoors. Indoor antenna and lead-in conductors must not be less than 2 in. from electrical power conductors.

Ex 1: Separation isn't required if the antenna lead-in conductors or the electrical power conductors are installed in a raceway or cable armor.

(C) Enclosures. Indoor antenna lead-in conductors can be in the same enclosure with electric power conductors where separated by an effective, permanently installed barrier. Figure 810–9

810.20 Antenna Discharge Unit.

(A) Required. Each lead-in conductor from an outdoor antenna must be provided with a listed antenna discharge unit. Figure 810–10

(B) Location. The antenna discharge unit must be located outside or inside the building, nearest the point of entrance, but not near combustible material.

(C) Grounding. The antenna discharge unit must be grounded in accordance with 810.21.

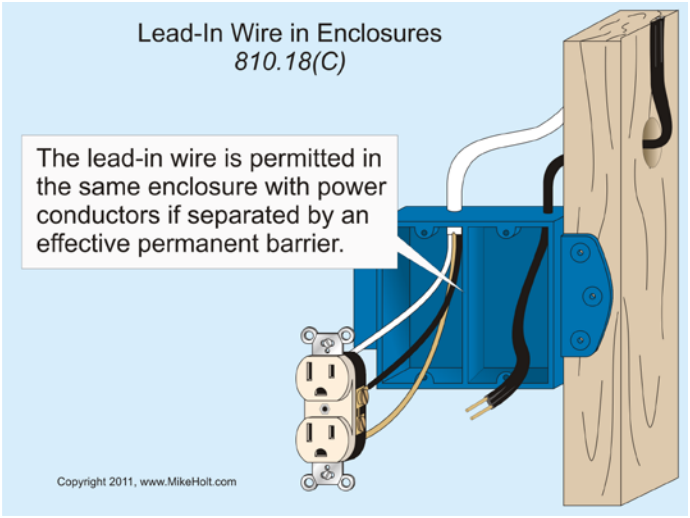


Figure 810–9

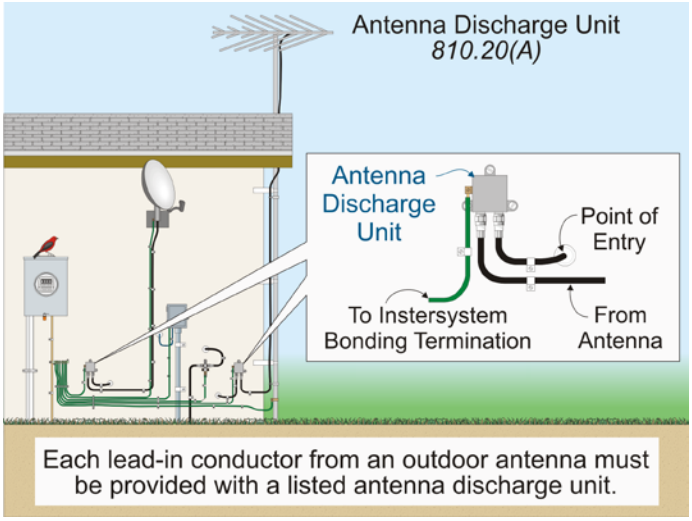


Figure 810–10

810.21 Bonding Conductor or Grounding Electrode Conductors. The antenna mast [810.15] and antenna discharge unit [810.20(C)] must be grounded as follows. Figure 810–11

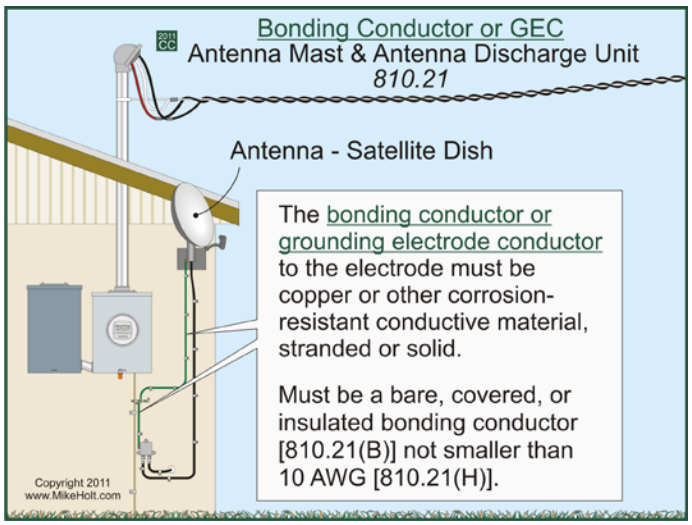


Figure 810–11

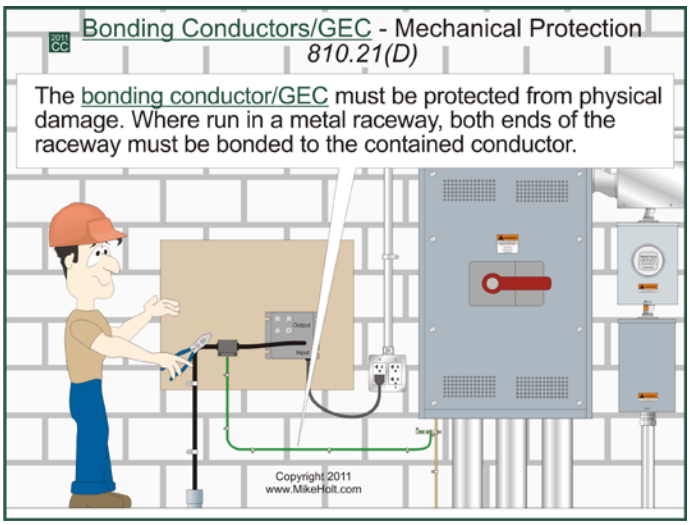


Figure 810–12

Author's Comment: Grounding the lead-in antenna cables and the mast helps prevent voltage surges caused by static discharge or nearby lightning strikes from reaching the center conductor of the lead-in coaxial cable. Because the satellite dish sits outdoors, wind creates a static charge on the antenna as well as on the cable attached to it. This charge can build up on both the antenna and the cable until it jumps across an air space, often passing through the electronics inside the low noise block down converter feedhorn (LNBF) or receiver. Connecting the coaxial cable and dish to the building grounding electrode system (grounding) helps to dissipate this static charge.

Nothing can prevent damage from a direct lightning strike, but grounding with proper surge protection can help reduce damage to the satellite dish and other equipment from nearby lightning strikes.

(A) Material. The bonding conductor or grounding electrode conductor to the electrode [810.21(F)] must be copper or other corrosion-resistant conductive material, stranded or solid.

(B) Insulation. Insulated, covered, or bare.

(C) Supports. The bonding conductor or grounding electrode conductor must be securely fastened in place.

(D) Mechanical Protection. The bonding conductor or grounding electrode conductor must be mechanically protected where subject to physical damage, and where installed in a metal raceway both ends of the raceway must be bonded to the bonding conductor or grounding electrode conductor. Figure 810–12

Author's Comment: Installing the bonding conductor or grounding electrode conductor in PVC conduit is a better practice.

(E) Run in Straight Line. The bonding conductor or grounding electrode conductor must be run in as straight a line as practicable.

Author's Comment: Lightning doesn't like to travel around corners or through loops, which is why the bonding conductor or grounding electrode conductor must be run as straight as practicable.

(F) Electrode. The bonding conductor or grounding electrode conductor must terminate in accordance with (1), (2), or (3).

(1) Buildings or Structures With an Intersystem Bonding Termination. The bonding conductor for the antenna mast and antenna discharge unit must terminate to the intersystem bonding termination as required by 250.94 [Article 100 and 250.94]. Figure 810–13

Note: According to the Article 100 definition, an Intersystem Bonding Termination is a device that provides a means to connect bonding conductors for communications systems to the grounding electrode system, in accordance with 250.94. Figure 810–14

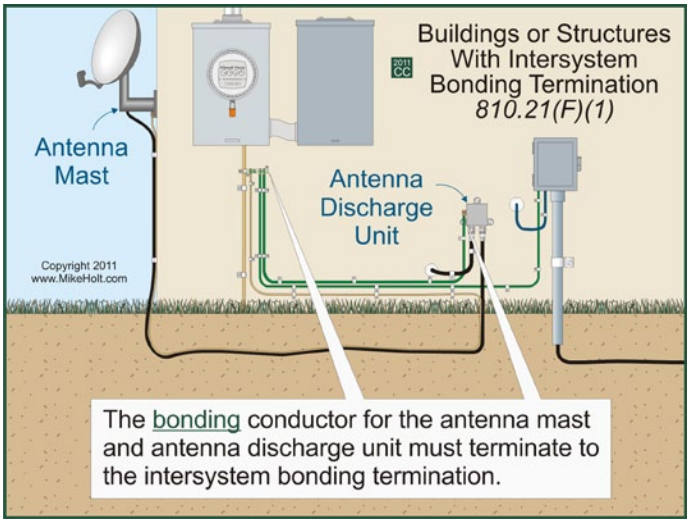


Figure 810–13

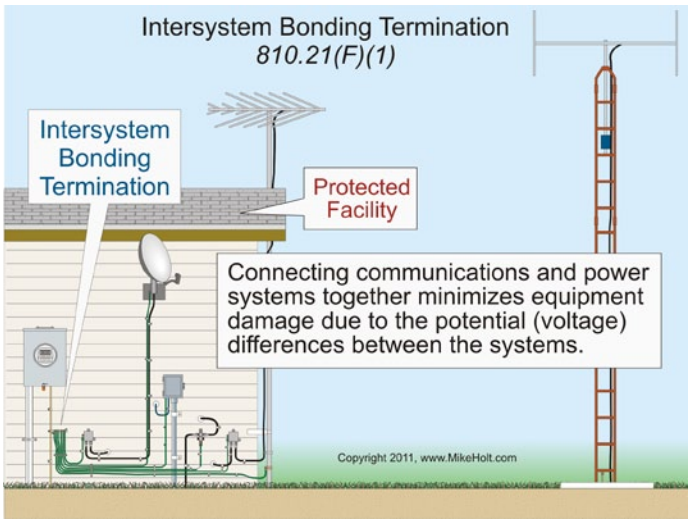


Figure 810–15

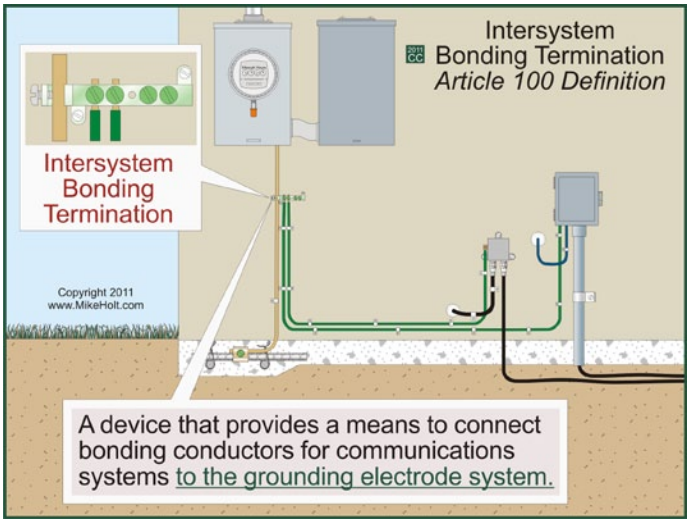


Figure 810–14

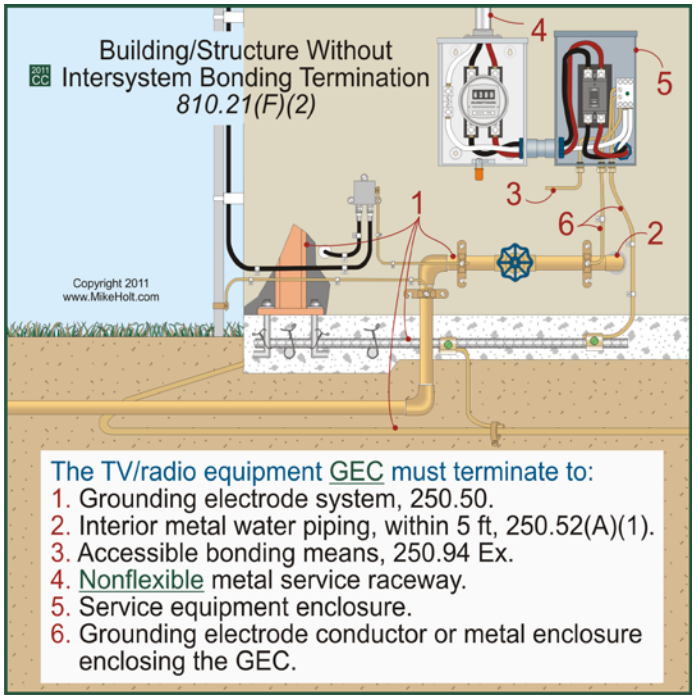


Figure 810–16

Author's Comment: Bonding all systems to the intersystem bonding termination helps reduce induced potential (voltage) differences between the power and the radio and television systems during lightning events. Figure 810–15

(2) In Buildings or Structures Without Intersystem Bonding Termination. The bonding conductor or grounding electrode conductor for the antenna mast and antenna discharge unit must terminate to the nearest accessible location on the following: Figure 810–16

(1) Building/structure grounding electrode system [250.50].

(2) Interior metal water piping system, within 5 ft from its point of entrance [250.52(A)(1)]. Figure 810–17

(3) Accessible means external to the building, as covered in 250.94.

(4) Nonflexible metallic service raceway.

(5) Service equipment enclosure.

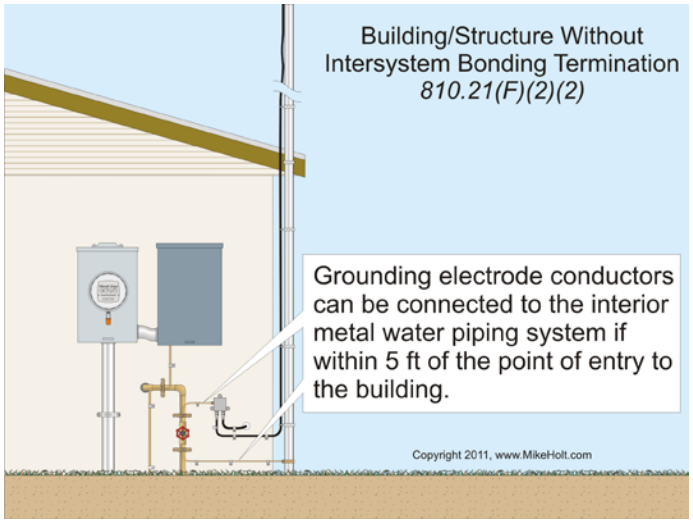


Figure 810–17

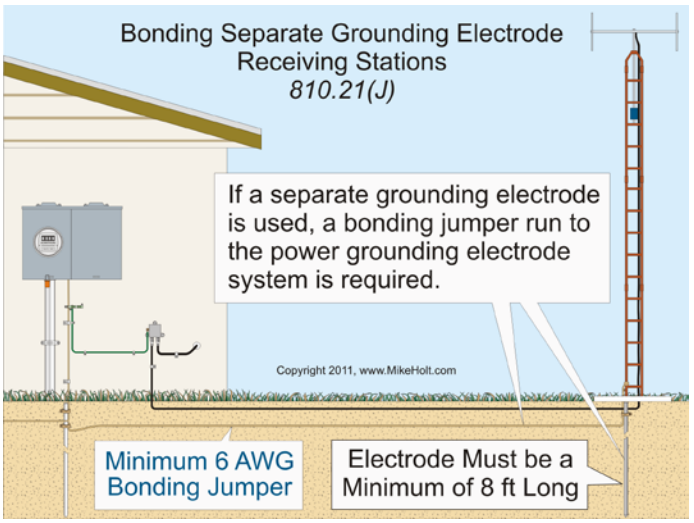


Figure 810–18

(6) Grounding electrode conductor or the grounding electrode conductor metal enclosure.

(3) In Buildings or Structures Without a Grounding Means. The grounding electrode conductor for the antenna mast and antenna discharge unit must be connected to any grounding electrode as described in 250.52.

(G) Inside or Outside Building. The bonding conductor or grounding electrode conductor can be installed either inside or outside the building.

(H) Size. The bonding conductor or grounding electrode conductor must not be smaller than 10 AWG copper or 17 AWG copper-clad steel or bronze.

> **Author's Comment:** Copper-clad steel or bronze wire (17 AWG) is often molded into the jacket of the coaxial cable to simplify the grounding of the lead-in conductor from an outdoor antenna to the discharge unit [810.21(F)].

(J) Bonding of Electrodes. If a ground rod is installed to serve as the grounding electrode for the radio and television equipment, it must be connected to the building's power grounding electrode system with a minimum 6 AWG conductor. Figure 810–18

(K) Electrode Connection. Termination of the bonding conductor or grounding electrode conductor must be by exothermic welding, listed lugs, listed pressure connectors, or listed clamps. Grounding fittings that are concrete-encased or buried in the earth must be listed for direct burial [250.70]. Figure 810–19

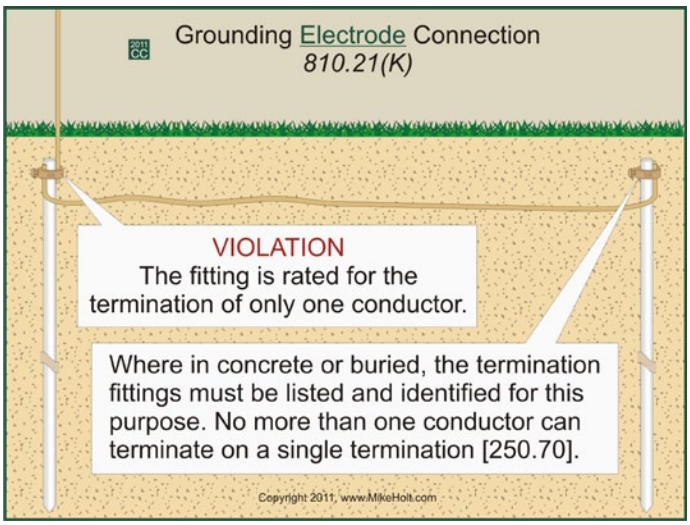


Figure 810–19

PART III. AMATEUR AND CITIZEN BAND TRANSMITTING AND RECEIVING ANTENNA SYSTEMS

810.51 Other Sections. Antenna systems for amateur and citizen band transmitting and receiving stations must also comply with the following requirements:

- **Support of Lead-In Cables.** Antennas and lead-in conductors must be securely supported, and the lead-in conductors must be securely attached to the antenna [810.12].
- **Avoid Contact with Conductors of Other Systems.** Outdoor antennas and lead-in conductors must be kept at least 2 ft from exposed electric power conductors to avoid the possibility of accidental contact [810.13].
- **Metal Antenna Supports—Grounding.** Outdoor masts and metal structures that support antennas must be grounded in accordance with 810.21 [810.15].

810.54 Clearance on Building. Antenna lead-in conductors must be firmly mounted at least 3 in. away from the surface of the building.

810.57 Antenna Discharge Units. Each lead-in conductor from an outdoor antenna must be provided with a listed antenna discharge unit or other suitable means that drain static charges from the antenna system.

Ex 1: If protected by a continuous metallic shield that's grounded according to 810.58.

Ex 2: If the antenna is grounded according to 810.58.

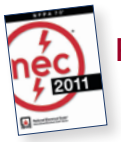
810.58 Bonding Conductor or Grounding Electrode Conductors.

(A) Other Sections. The antenna mast [810.15] and antenna discharge unit [810.57] must be grounded as specified in 810.21.

(B) Size of Protective Bonding Conductor or Grounding Electrode Conductor. The bonding conductor or grounding electrode conductor must be the same size as the lead-in conductors, but not smaller than 10 AWG copper, bronze, or copper-clad steel.

(C) Size of Operating Bonding Conductor or Grounding Electrode Conductor. The bonding conductor or grounding electrode conductor for transmitting stations must not be smaller than 14 AWG copper or its equivalent.

CHAPTER 810 Practice Questions



Please use the 2011 *Code* book to answer the following questions.

Article 810. Radio and Television Equipment

1. Article _____ contains the installation requirements for the wiring of television and radio receiving equipment, such as digital satellite receiving equipment for television signals and amateur/citizen band radio equipment antennas.

   (a) 680
   (b) 700
   (c) 810
   (d) 840

2. Soft-drawn or medium-drawn copper lead-in conductors for receiving antenna systems shall be permitted where the maximum span between points of support is less than _____.

   (a) 10 ft
   (b) 20 ft
   (c) 30 ft
   (d) 35 ft

3. Outdoor antennas and lead-in conductors shall be securely supported and the lead-in conductors shall be securely attached to the antenna, but they shall not be attached to the electric service mast.

   (a) True
   (b) False

4. A receiving station outdoor wire-strung antenna conductor with a span of 75 ft shall be at least _____ if a copper-clad steel conductor is used.

   (a) 17 AWG
   (b) 14 AWG
   (c) 12 AWG
   (d) 10 AWG

5. An outdoor wire-strung antenna conductor of a receiving station with a 75 ft span using a hard-drawn copper conductor shall not be less than _____.

   (a) 17 AWG
   (b) 14 AWG
   (c) 12 AWG
   (d) 10 AWG

6. Underground antenna conductors for radio and television receiving equipment shall be separated at least _____ from any light, power, or Class 1 circuit conductors.

   (a) 12 in.
   (b) 18 in.
   (c) 5 ft
   (d) 6 ft

7. Indoor antenna and lead-in conductors for radio and television receiving equipment shall be separated by at least _____ from conductors of any electric light, power, or Class 1 circuit conductors, unless otherwise permitted.

   (a) 2 in.
   (b) 12 in.
   (c) 18 in.
   (d) 6 ft

8. Indoor antenna lead-in conductors for radio and television receiving equipment can be in the same enclosure with conductors of other wiring systems where separated by an effective, permanently installed barrier.

   (a) True
   (b) False

9. Each lead-in conductor from an outdoor antenna shall be provided with a listed antenna discharge unit, unless enclosed in a continuous metallic shield that is either grounded or protected by an antenna discharge unit.

   (a) True
   (b) False

10. Antenna discharge units shall be located outside the building only.

(a) True
(b) False

11. The grounding conductor for an antenna mast shall be _____ protected where subject to physical damage.

(a) electrically
(b) mechanically
(c) arc-fault
(d) none of these

12. Radio and television receiving antenna systems must have bonding or grounding electrode conductors that _____.

(a) are copper or other corrosion-resistant conductive material
(b) are insulated, covered, or bare
(c) are securely fastened in place and mechanically protected where subject to physical damage
(d) all of these

13. The bonding conductor or grounding electrode conductor for a radio/television antenna system must be mechanically protected where subject to physical damage, and where installed in a metal raceway both ends of the raceway must be bonded to the _____ conductor.

(a) contained
(b) grounded
(c) ungrounded
(d) b or c

14. The bonding conductor or grounding electrode conductor for an antenna mast or antenna discharge unit shall be run to the grounding electrode in as straight a line as practicable.

(a) True
(b) False

15. If the building or structure served has an intersystem bonding termination, the bonding conductor for an antenna mast shall be connected to the intersystem bonding termination.

(a) True
(b) False

16. The grounding conductor for an antenna mast or antenna discharge unit, if copper, shall not be smaller than 10 AWG.

(a) True
(b) False

17. If a separate grounding electrode is installed for the radio and television equipment, it shall be bonded to the building's electrical power grounding electrode system with a bonding jumper not smaller than _____AWG.

(a) 10
(b) 8
(c) 6
(d) 1/0

18. An open span length of 200 ft for antenna conductors of hard-drawn copper located at an amateur transmitting and receiving station requires a minimum conductor size of _____.

(a) 14 AWG
(b) 12 AWG
(c) 10 AWG
(d) 8 AWG

19. Antenna conductors for amateur transmitting stations attached to buildings shall be firmly mounted at least _____ clear of the surface of the building on nonabsorbent insulating supports.

(a) 1 in.
(b) 2 in.
(c) 3 in.
(d) 4 in.

Article
810

Answer Key

1. (c) 810.1
2. (d) 810.11 Ex
3. (a) 810.12
4. (a) 810.16(A) Table
5. (b) 810.16(A) Table
6. (a) 810.18(A)
7. (a) 810.18(B)
8. (a) 810.18(C)
9. (a) 810.20(A)
10. (b) 810.20(B)
11. (b) 810.21(D)
12. (d) 810.21(A),(B),(C), and (D)
13. (a) 810.21(D)
14. (a) 810.21(E)
15. (a) 810.21(F)(1)
16. (a) 810.21(H)
17. (c) 810.21(J)
18. (c) 810.52 Table
19. (c) 810.54

Notes

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