Mike Holt's Illustrated Guide to

COMMUNICATIONS SYSTEMS

Extracted from Understanding the National Electrical Code® Volume 2

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BASED ON THE
2020 NEC®

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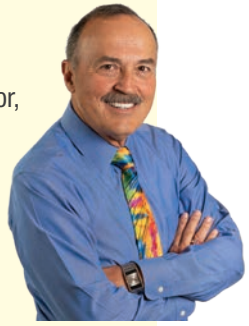

Mike Holt is an author, businessman, educator, speaker, publisher and *NEC®* expert. He has written hundreds of electrical training books and articles, founded three successful businesses, and has taught thousands of electrical *Code* seminars across the United States and internationally.

Mike's approach to electrical training is based on his own experience as an electrician, contractor, inspector and teacher. He's always felt a responsibility to his students and to the electrical industry to provide education beyond the scope of just passing an exam. This commitment, coupled with the lessons he learned at the University of Miami's MBA program, have helped him build one of the largest electrical training and publishing companies in the United States.

Mike's one-of-a-kind presentation style and his ability to simplify and clarify technical concepts explain his unique position as one of the premier educators and *Code* experts in the country. His passion for the electrical field drives his goal to increase electrical safety and improve lives.

Mike's commitment to pushing boundaries and setting high standards extends into his personal life. He's an eight-time Overall National Barefoot Waterski Champion with more than 20 gold medals, many national records, and he has competed in three World Barefoot Tournaments. In 2015, at the tender age of 64, he started a new adventure—competitive mountain bike racing. Every day he continues to find ways to motivate himself, both mentally and physically.

Mike and his wife, Linda, reside in New Mexico and Florida, and are the parents of seven children and six grandchildren. As his life has changed over the years, a few things have remained constant: his commitment to God, his love for his family, and doing what he can to change the lives of others through his products and seminars.

I dedicate this book to the
Lord Jesus Christ,
my mentor and teacher.
Proverbs 16:3

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CHAPTER

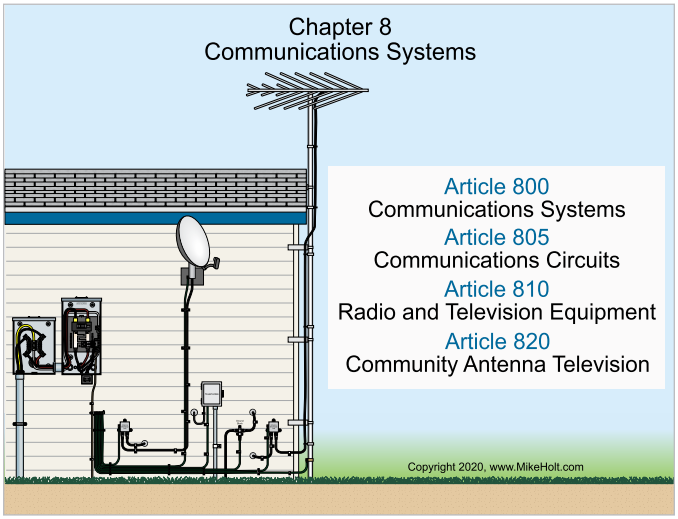
8

COMMUNICATIONS SYSTEMS

Introduction to Chapter 8—Communications Systems

Chapter 8 of the *National Electrical Code* covers the wiring requirements for communications systems such as telephones, radio and TV antennas, satellite dishes, closed-circuit television (CCTV), coaxial cable systems, and network- and premises-powered broadband systems for use of voice, audio, video and data. ▸Figure 1

Communications systems are not subject to the general requirements contained in Chapters 1 through 4 or the special requirements of Chapters 5 through 7, except where a Chapter 8 rule specifically refers to one of those chapters [90.3]. Also, installations of communications equipment under the exclusive control of communications utilities located outdoors, or in building spaces used exclusively for such installations, are exempt from the *NEC* [90.2(B)(4)].



▸Figure 1

- **Article 800—General Requirements for Communications Systems.** This article covers general requirements for the installation of communications circuits, community antenna television and radio distribution systems, network-powered broadband communications systems, and premises-powered broadband communications systems, unless modified by Articles 805 or 820.
- **Article 805—General Requirements for Communications Circuits.** Article 805 covers the installation requirements for circuits and equipment related to telephone wiring and other telecommunications purposes such as computer local area networks (LANs), and outside wiring for fire and burglar alarm systems connected to central monitoring stations.
- **Article 810—Radio and Television Antenna Equipment.** This article covers antenna systems for radio and television receiving equipment, amateur radio transmitting and receiving equipment, and certain features of transmitter safety. It also includes antennas such as multi-element, vertical rod and dish, and the wiring and cabling that connects them to the equipment.
- **Article 820—Community Antenna Television (CATV) and Radio Distribution Systems (Coaxial Cable).** Article 820 covers the installation of coaxial cables to distribute limited-energy high-frequency signals for television, cable TV, and closed-circuit television (CCTV) which is often used for security purposes. It also covers the premises wiring of satellite TV systems where the dish antenna is outside and covered by Article 810.

ARTICLE

800

GENERAL REQUIREMENTS FOR COMMUNICATIONS SYSTEMS

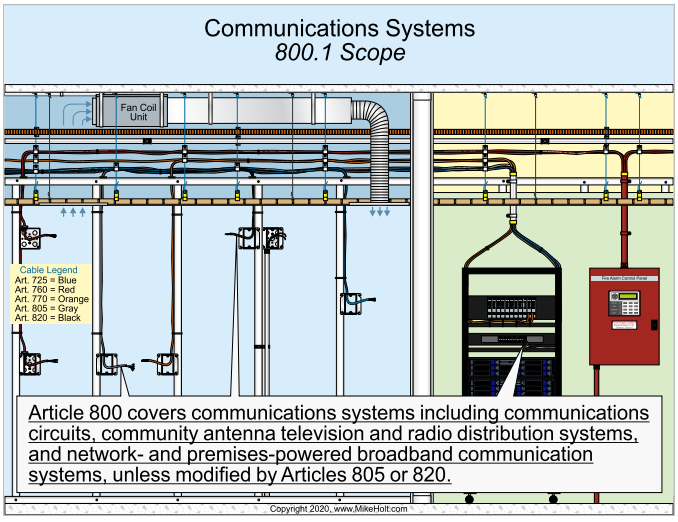
Introduction to Article 800—General Requirements for Communications Systems

Article 800 contains the general rules for, and apply to, installations of those systems covered by Articles 805 and 820. Note that the scope of this article does not include Article 810, Radio and Television Equipment. That article still stands alone from the rest of the *Code*, including the Chapter 8 Articles. The specific rules in Articles 805, 820, 830, and 840 supplement or modify the requirements in Article 800. This is similar to the language in 90.3 that says the general rules in Chapters 1 through 4 may be modified by the specific rules in Chapters 5 through 7.

Part I. General

800.1 Scope

Article 800 covers general requirements for communications systems. They apply to communications circuits, community antenna television and radio distribution systems, and network- and premises-powered broadband communications systems, unless modified by Articles 805 or 820. ▸Figure 800–1



▸Figure 800–1

800.2 Definitions

The definitions for more common items that appear in Article 100 and those that are contained here in 800.2 apply throughout Chapter 8.

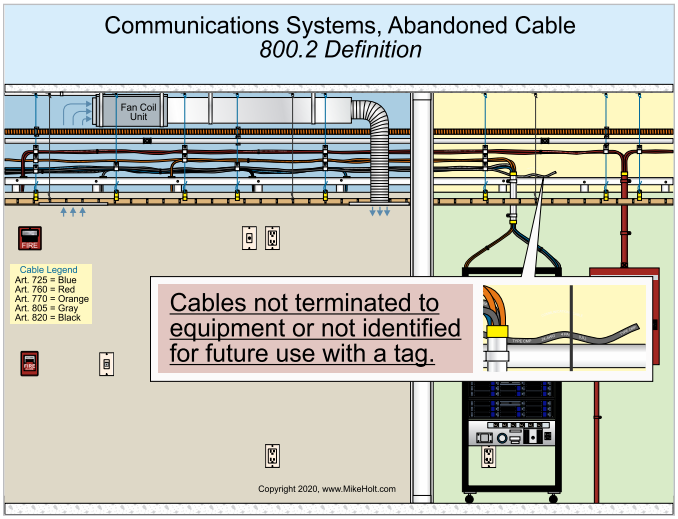
Author's Comment:

- Throughout articles in the *NEC*, definitions specific to that article generally appear in the xxx.2 section of the individual article. What is unique about Chapter 8 is that definitions applicable throughout all of the articles in that chapter are listed in section 800.2.
- Another unique feature of Chapter 8 is that common wiring methods, bonding methods, and other installation requirements that apply throughout the chapter are also consolidated in Article 800.

Abandoned Cable. Cable that is not terminated to equipment or not identified for future use with a tag. ▸Figure 800–2

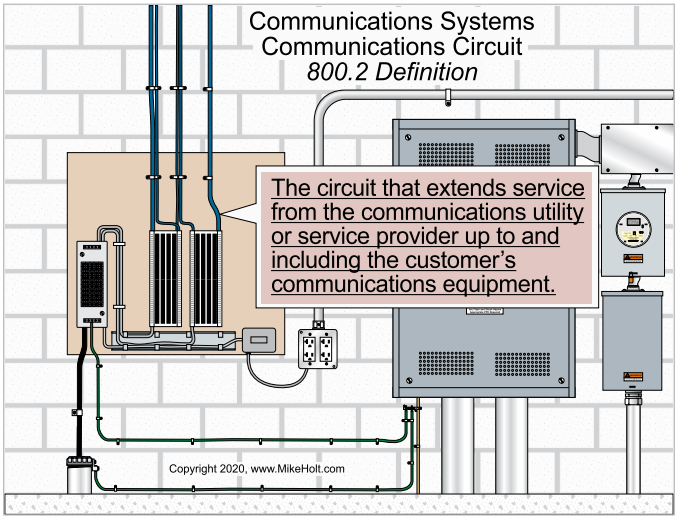
Author's Comment:

- Section 800.25 requires the accessible portion of abandoned cables to be removed.



▸Figure 800–2

Communications Circuit. The circuit that extends service from the communications utility or service provider up to and including the customer's communications equipment. ▸Figure 800–3



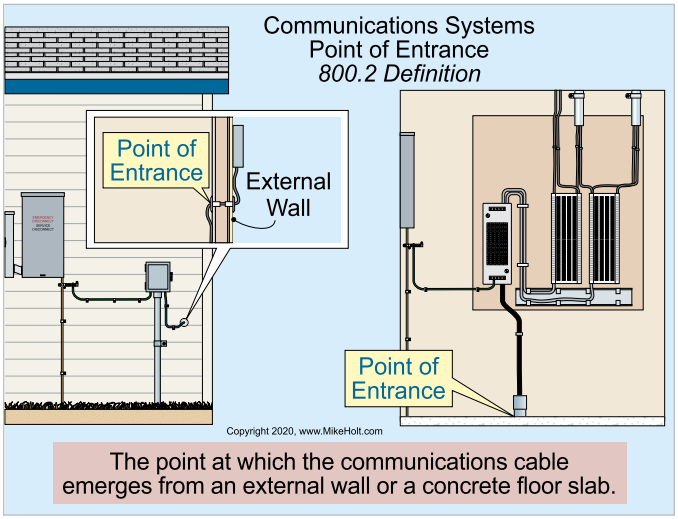
▸Figure 800–3

Exposed (to Accidental Contact). A condition where failure of support or insulation can result in the circuit contacting another circuit.

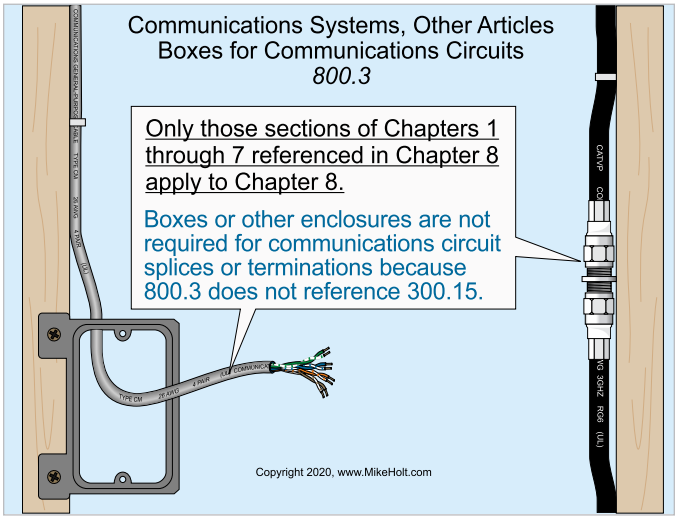
Point of Entrance. The point within a building at which the cable emerges from an external wall or concrete floor slab. ▸Figure 800–4

800.3 Other Articles

Only those sections of Chapters 1 through 7 referenced in Chapter 8 apply to Chapter 8. ▸Figure 800–5



▸Figure 800–4



▸Figure 800–5

(A) Hazardous (Classified) Locations. For circuits and equipment installed in a location that is classified in accordance with 500.5 and 505.5, the applicable requirements of Chapter 5 apply.

(B) Wiring in Ducts for Dust, Loose Stock, or Vapor Removal. The requirements of 300.22(A) apply.

(C) Equipment in Plenum Spaces. Equipment installed in plenum spaces must comply with 300.22(C)(3).

Author's Comment:

- According to 300.22(C)(3), electrical equipment with a metal enclosure, or a nonmetallic enclosure listed for use in an air-handling space, can be installed in a plenum space. ▸Figure 800–6

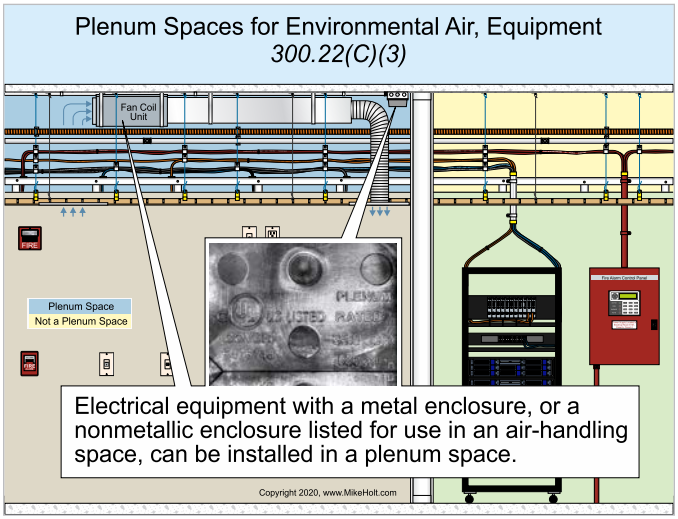


Figure 800–6

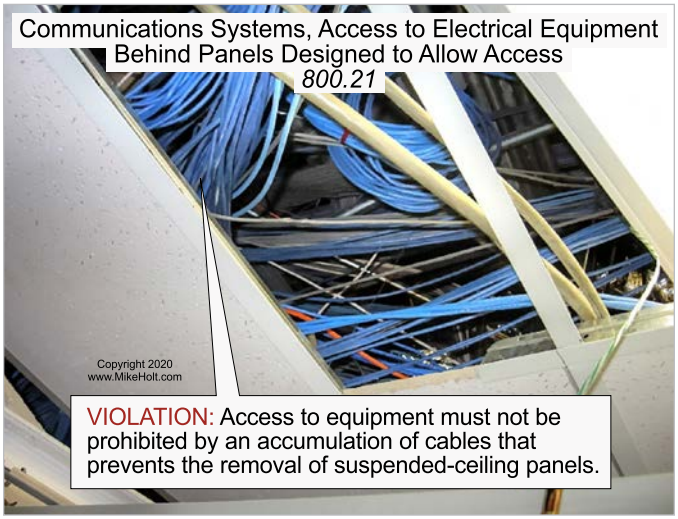


Figure 800–7

(D) Installation and Use. Communications equipment must be installed and used according to manufacturers' instructions in accordance with of 110.3(B).

(E) Optical Fiber Cable. Where optical fiber cable is used to provide a communications circuit within a building, Article 770 applies.

(F) Other Communications Systems. Communications systems must comply with the following requirements:

(1) Communications Circuits—Article 805

(2) Antennas—Article 810

(3) Coaxial Cable Systems—Article 820

800.21 Access to Electrical Equipment Behind Panels Designed to Allow Access

Access to equipment must not be prohibited by an accumulation of cables that prevents the removal of suspended-ceiling panels ▸Figure 800–7

800.24 Mechanical Execution of Work

Equipment and cabling must be installed in a neat and workmanlike manner. ▸Figure 800–8

Exposed cables must be supported by the structural components of the building so the cable will not be damaged by normal building use. Support must be by straps, staples, hangers, cable ties, or similar fittings designed and installed in a manner that will not damage the cable. ▸Figure 800–9

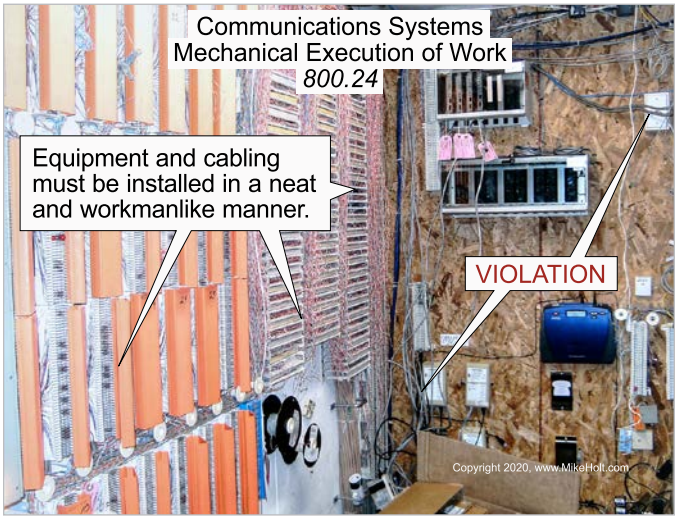


Figure 800–8

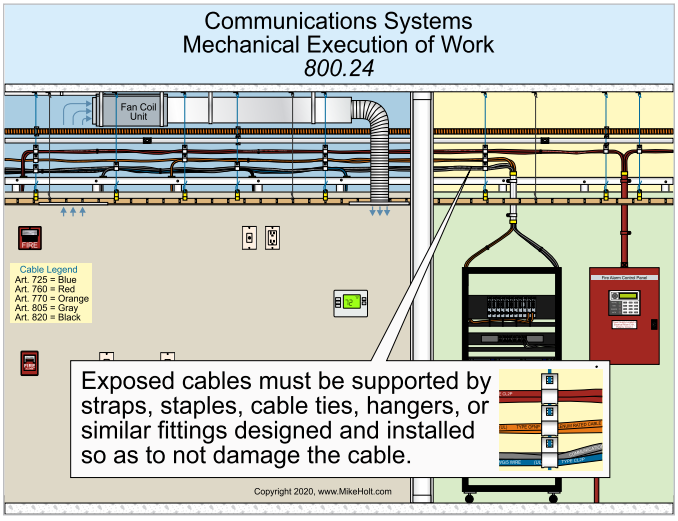
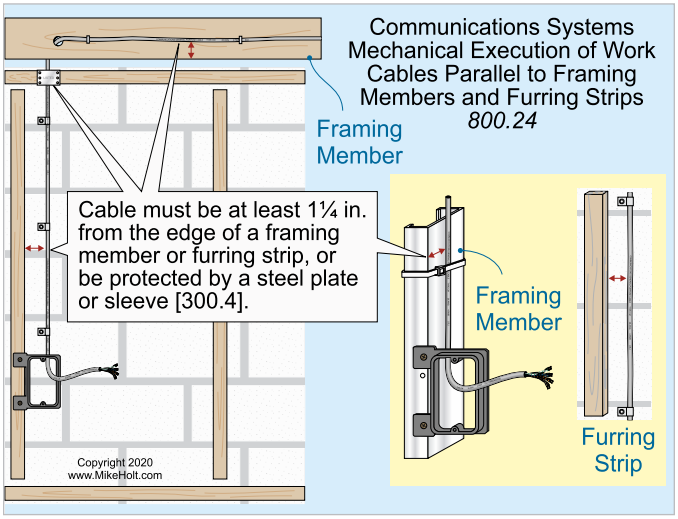
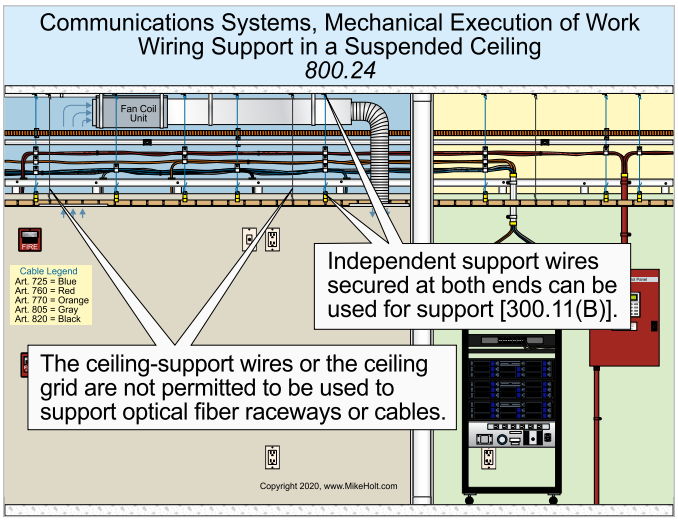


Figure 800–9

Exposed cables must comply with 300.4 and 300.11. Nonmetallic cable ties in plenum spaces must comply with 805.170(C). ▸Figure 800–10 and ▸Figure 800–11



▸Figure 800–10



▸Figure 800–11

Author's Comment:

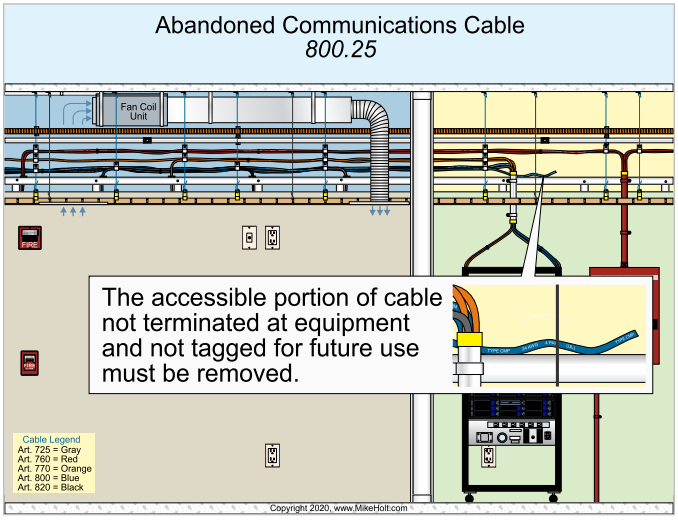
- Section 300.4 contains the rules for protection against physical damage when cables and raceways pass through wood and metal members, and when they are run in parallel with framing members. Section 300.11 addresses the securing and supporting requirements of wiring methods.

Note 1: Accepted industry practices are described in ANSI/TIA-568, *Commercial Building Telecommunications Infrastructure Standard*; ANSI/TIA-569-D, *Telecommunications Pathways and Spaces*; ANSI/TIA-570-C, *Residential Telecommunications Infrastructure Standard*; ANSI/TIA-1005-A, *Telecommunications Infrastructure Standard for Industrial Premises*; ANSI/TIA-1179, *Healthcare Facility Telecommunications Infrastructure Standard*; ANSI/TIA-4966, *Telecommunications Infrastructure Standard for Educational Facilities*; and other ANSI-approved installation standards.

Note 3: Paint, plaster, cleaners, abrasives, corrosive residues, or other contaminants may result in an undetermined alteration of wire and cable properties.

800.25 Abandoned Cable

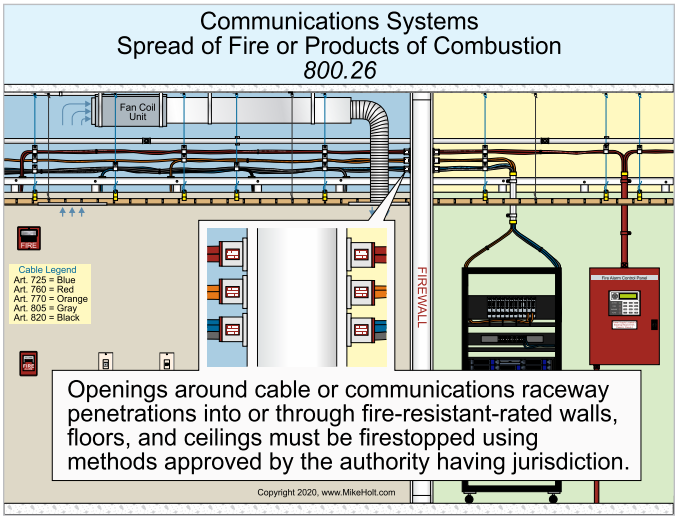
To limit the spread of fire or products of combustion within a building, the accessible portion of cable that is not terminated at equipment and not identified for future use with a tag must be removed [800.2]. Tags identifying cables for future use must be able to withstand the environment involved. ▸Figure 800–12



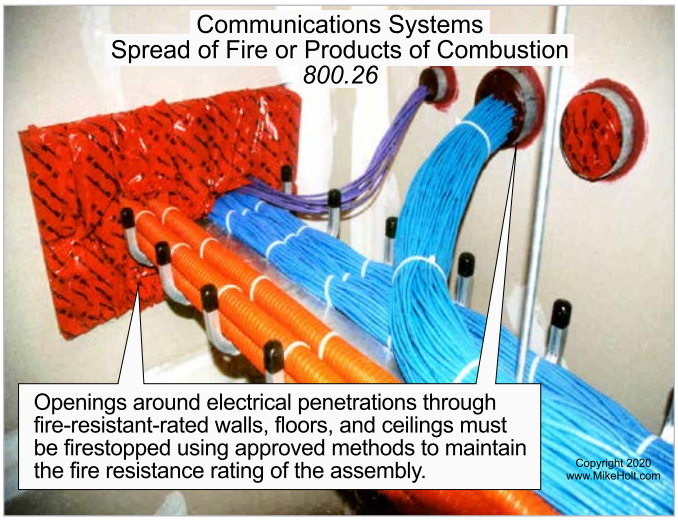
▸Figure 800–12

800.26 Spread of Fire or Products of Combustion

Communications circuits and equipment must be installed in such a way that the spread of fire or products of combustion will not be substantially increased. Openings into or through fire-resistant-rated walls, floors, and ceilings for electrical equipment must be firestopped using methods approved by the authority having jurisdiction to maintain the fire-resistance rating of the fire-rated assembly. ▸Figure 800–13 and ▸Figure 800–14



▶Figure 800–13



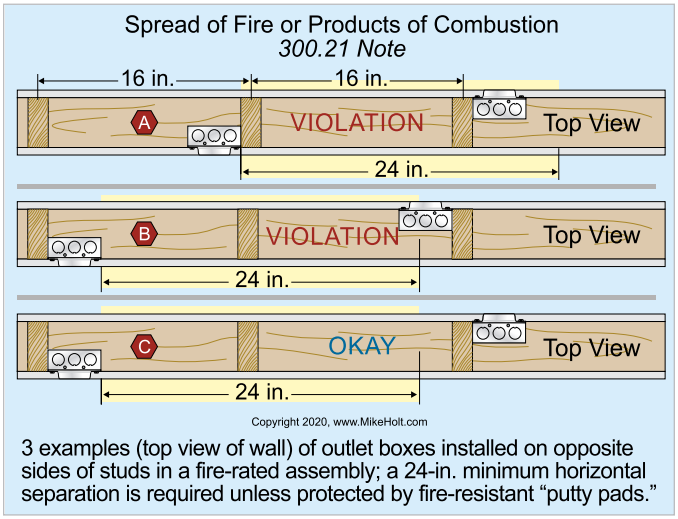
▶Figure 800–14

Author's Comment:

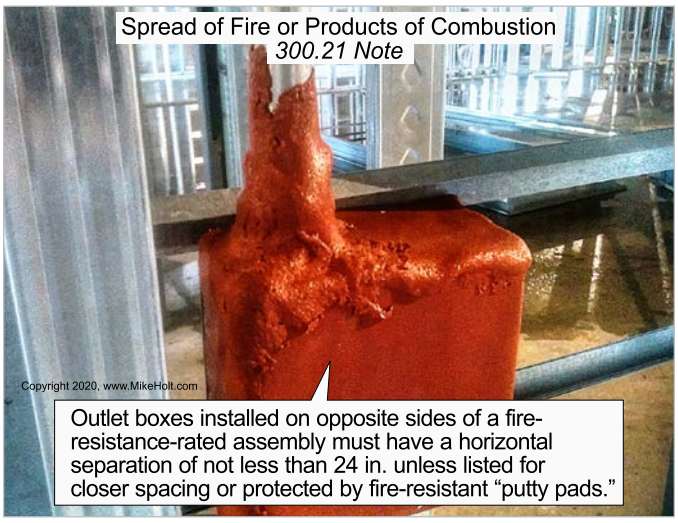
- Firestopping materials are listed for the specific types of wiring methods and the construction of the assembly they penetrate. ▶Figure 800–15

Note: Directories of electrical construction materials published by recognized testing laboratories contain listing and installation restrictions necessary to maintain the fire-resistive rating of assemblies. Building codes also have restrictions on penetrations on opposite sides of a fire-resistance-rated wall. Outlet boxes must have a horizontal separation of not less than 24 in. when installed on opposite sides in a fire-rated assembly, unless an outlet box is listed for closer spacing or protected by fire-resistant "putty pads" in accordance with manufacturer's instructions. ▶Figure 800–16 and ▶Figure 800–17

▶Figure 800–15



▶Figure 800–16



▶Figure 800–17

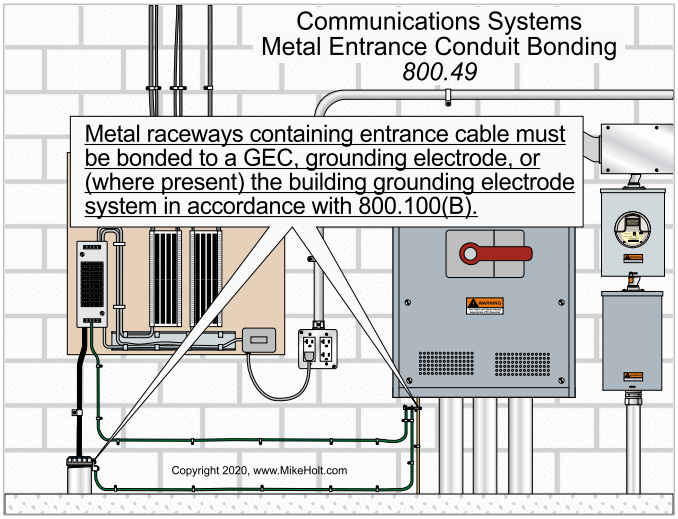
Author's Comment:

- Boxes installed in fire-resistance rated assemblies must be listed for the purpose. If steel boxes are used, they must be secured to the framing member, so cut-in type boxes are not permitted (UL White Book, *Guide Information for Electrical Equipment*). "Putty pads" are typically installed on the exterior of the box, but many manufactures have listed inserts for the interior of the box.

Part II. Wires and Cables Outside and Entering Buildings

800.49 Metal Entrance Conduit Bonding

Metal raceways containing entrance cable must be bonded to a grounding electrode conductor, grounding electrode, or (where present) the building grounding electrode system in accordance with 800.100(B). ▸Figure 800–18



▸Figure 800–18

800.53 Separation from Lightning Conductors

Where practicable, a separation of at least 6 ft must be maintained between communications circuits and lightning protection conductors.

Part III. Bonding Methods

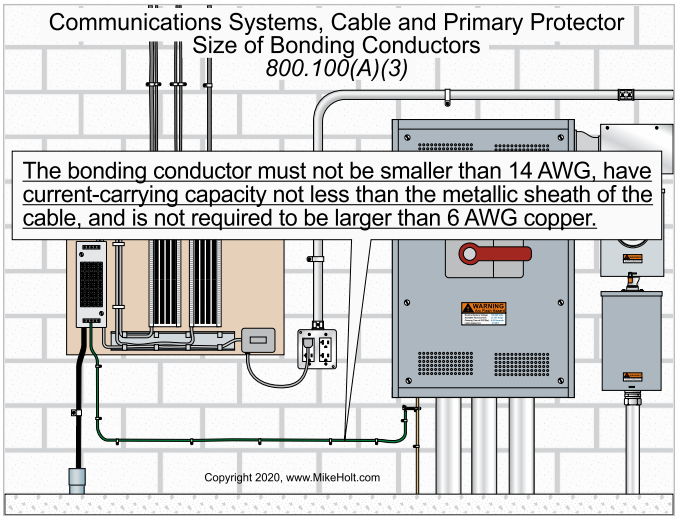
800.100 Cable and Primary Protector Bonding

(A) Bonding Conductor.

(1) Insulation. The bonding conductor must be listed and can be insulated, covered, or bare.

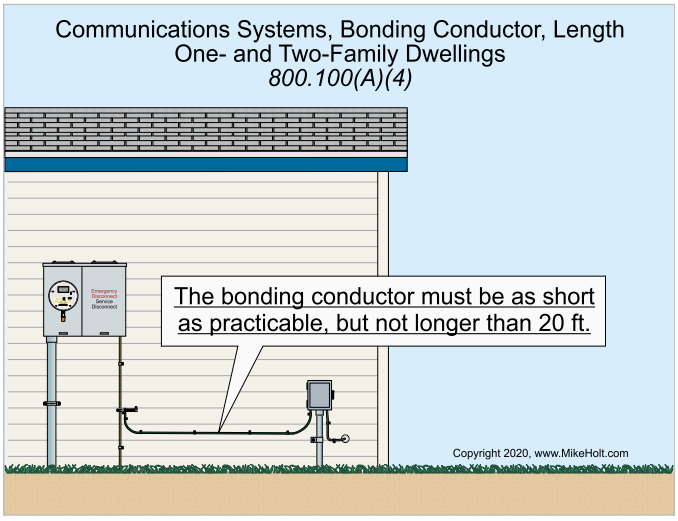
(2) Material. The bonding conductor must be copper or other corrosion-resistant conductive material and can be stranded or solid.

(3) Size. The bonding conductor must not be smaller than 14 AWG, have current-carrying capacity not less than the metallic sheath of the cable, and is not required to be larger than 6 AWG copper. ▸Figure 800–19



▸Figure 800–19

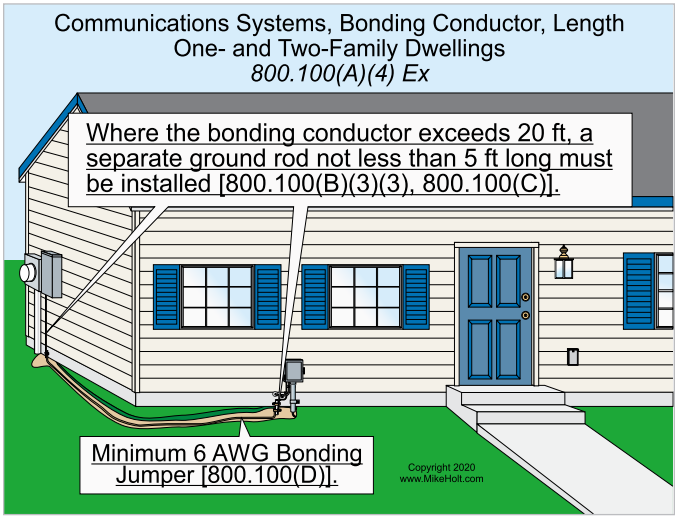
(4) Length. The bonding conductor must be as short as practicable. For one- and two-family dwellings, the bonding conductor is not permitted to exceed 20 ft in length. ▸Figure 800–20



▸Figure 800–20

Note: Limiting the length of the bonding conductor helps limit induced voltage differences between the building's power and communications systems during lightning events.

Ex: If the bonding conductor is over 20 ft in length for one- and two-family dwellings, a separate ground rod not less than 5 ft long [800.100(B)(3)(3)] with fittings suitable for the application [800.100(C)] must be installed. The additional ground rod must be bonded to the power grounding electrode system with a minimum 6 AWG [800.100(D)]. ▸Figure 800–21



▸Figure 800–21

(5) Run in Straight Line. The bonding conductor must be run in as straight a line as practicable.

Author's Comment:

- Lightning does not like to travel around corners or through loops, which is why the bonding jumper must be run as straight as practicable.

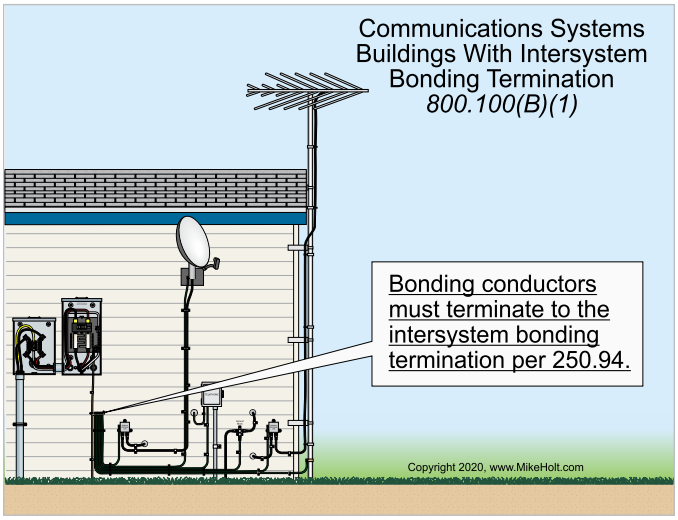
(6) Physical Protection. The bonding conductor is not permitted to be subject to physical damage. If installed in a metal raceway, both ends of the raceway must be bonded to the bonding conductor or connected to the same terminal or electrode to which the bonding conductor is connected.

Author's Comment:

- Installing the bonding conductor in PVC conduit is a better practice.

(B) Electrode. The bonding conductor must be connected in accordance with (B)(1), (B)(2), or (B)(3).

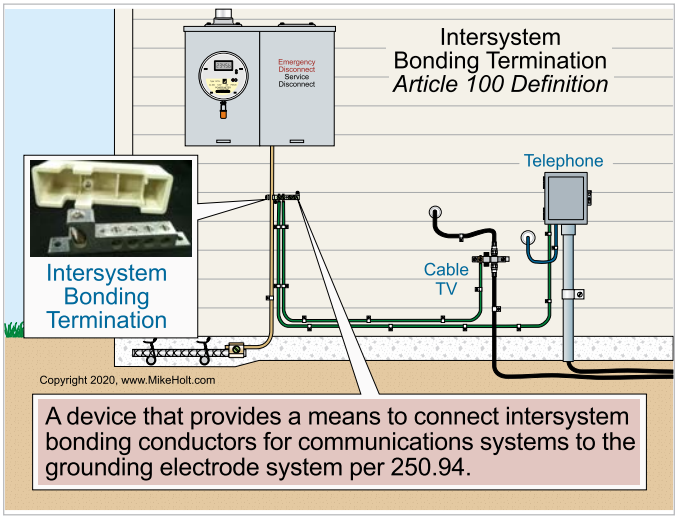
(1) Buildings with an Intersystem Bonding Termination. The bonding conductor must terminate to the intersystem bonding termination as required by 250.94. ▸Figure 800–22



▸Figure 800–22

Author's Comment:

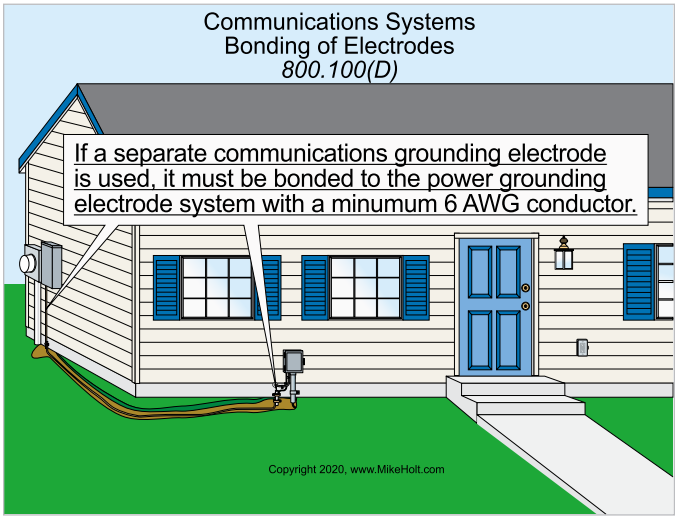
- According to the Article 100 definition, an "Intersystem Bonding Termination" is a device that provides a means to connect intersystem bonding conductors for communications systems to the grounding electrode system. ▸Figure 800–23



▸Figure 800–23

Note: Figure 800.100(B)(1) in the *NEC* illustrates the connection of the bonding conductor in buildings or structures equipped with an intersystem bonding termination.

(D) Bonding of Electrodes. If a separate grounding electrode (such as a rod) is installed for a communications system, it must be bonded to the building's power grounding electrode system with a minimum 6 AWG copper conductor. ▸Figure 800–24



▸Figure 800–24

Note 2: Bonding separate electrodes together helps reduce induced voltage differences between the power and communications systems during lightning events.

Part IV. Installation Methods Within Buildings

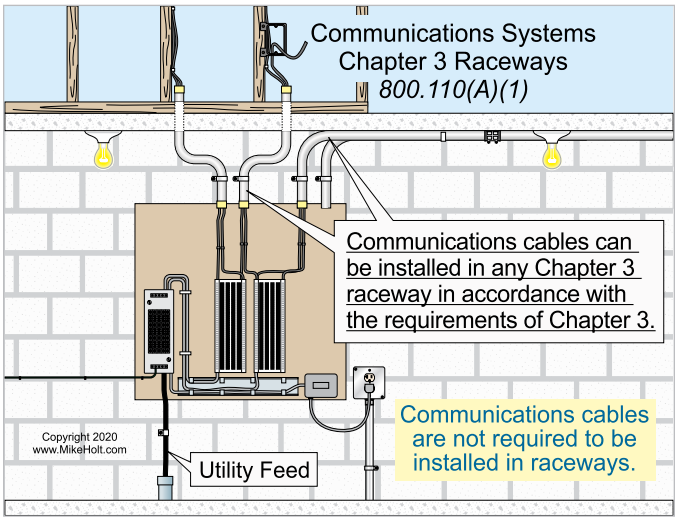
800.110 Raceways and Cable Routing Assemblies

(A) Types of Raceways.

(1) Chapter 3 Raceways. Communications cables can be installed in any Chapter 3 raceway in accordance with the requirements of Chapter 3. ▸Figure 800–25

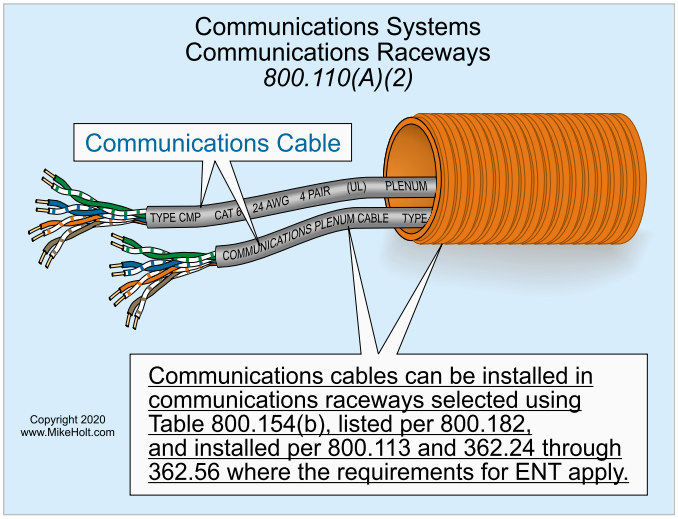
Author's Comment:

- Communications cable is not required to be installed in a Chapter 3 raceway, but when it is, it must be installed in accordance with the Chapter 3 requirements for that raceway.



▸Figure 800–25

(2) Communications Raceways. Communications cables can be installed in communications raceways selected using Table 800.154(b), listed in accordance with 800.182, and installed in accordance with 800.113 and 362.24 through 362.56 where the requirements for electrical nonmetallic tubing (ENT) apply. ▸Figure 800–26



▸Figure 800–26

(3) Innerduct for Communications Wires and Cables, or Coaxial Cables. Listed plenum communications raceways, listed riser communications raceways, and listed general-purpose communications raceways selected in accordance with Table 800.154(b) are permitted to be installed as innerduct in any type of listed raceway permitted in Chapter 3.

(B) Raceway Fill for Communications Wires and Cables. The raceway fill limitations of 300.17 do not apply to communications cables installed within a raceway.

(C) Cable Routing Assemblies. Communications cables can be installed in cable routing assemblies selected in accordance with Table 800.154(c), listed in accordance with 800.182, and installed in accordance with 800.110(C)(1) and (C)(2) and 800.113.

(1) Horizontal Support. Where installed horizontally, cable routing assemblies must be supported every 3 ft, and at each end or joint, unless listed otherwise. The distance between supports can never exceed 10 ft.

(2) Vertical Support. Where installed vertically, cable routing assemblies must be supported every 4 ft, unless listed otherwise, and are not permitted to have more than one joint between supports.

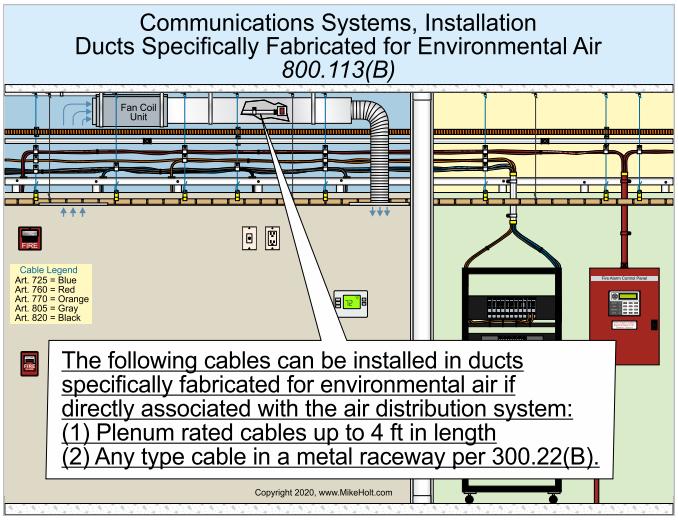
800.113 Installation of Communications Wires, Cables, Raceways, and Cable Routing Assemblies

The installation of cables, cable routing assemblies, and communications raceways must comply with 800.110 and the following:

(A) Listing. Cables, cable routing assemblies, and communications raceways installed in buildings must be listed.

Ex: Outside plant cables installed per 805.48 and 820.48 are not be required to be listed.

(B) Ducts Specifically Fabricated for Environmental Air. The following cables are permitted in ducts specifically fabricated for environmental air as described in 300.22(B) if they are directly associated with the air distribution system: ▸Figure 800–27



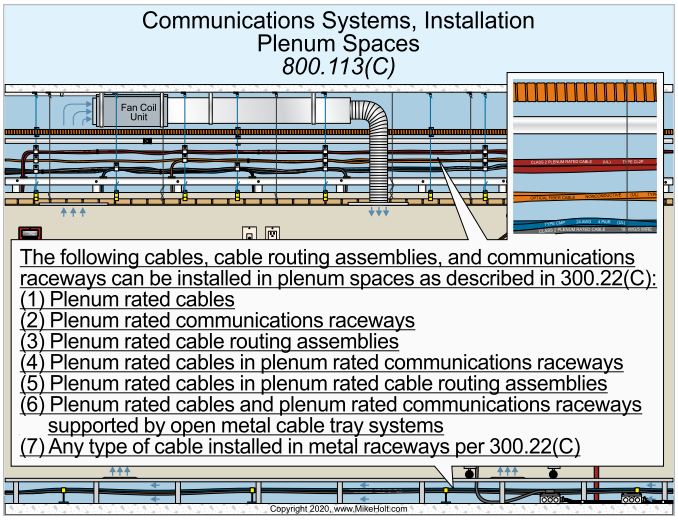
▸Figure 800–27

(1) Plenum-rated cables up to 4 ft in length

(2) Any type of cable in a metal raceway in accordance with 300.22(B)

Note: For information on fire protection of wiring installed in fabricated ducts, see NFPA 90A, *Standard for the Installation of Air-Conditioning and Ventilating Systems*.

(C) Plenum Spaces. The following cables, cable routing assemblies, and communications raceways can be installed in plenum spaces as described in 300.22(C): ▸Figure 800–28



▸Figure 800–28

(1) Plenum-rated cables

(2) Plenum-rated communications raceways

(3) Plenum-rated cable routing assemblies

(4) Plenum-rated cables installed in plenum-rated communications raceways

(5) Plenum-rated cables installed in plenum-rated cable routing assemblies

(6) Plenum-rated cables and plenum-rated communications raceways supported by open metal cable tray systems

(7) Any type of cable installed in metal raceways in compliance with 300.22(C)

800.154 Applications of Listed Communications Wires, Cables, and Raceways, and Listed Cable Routing Assemblies

Permitted and nonpermitted applications of listed communications wires, cables, coaxial cables and raceways, and listed cable routing assemblies must be in accordance with one of the following:

(1) Listed communications wires and cables as indicated in Table 800.154(a)

(2) Listed communications raceways as indicated in Table 800.154(b)

(3) Listed cable routing assemblies as indicated in Table 800.154(c)

The permitted applications are subject to the installation requirements of 800.110 and 800.113.

800.179 Plenum, Riser, General-Purpose, and Limited Use Cables

Plenum, riser, general-purpose, and limited-use cables must be listed in accordance with 800.179(A) through (D). The cable voltage rating must not be marked on the cable.

(A) Plenum Cables. Type CMP (communications plenum cables) and Type CATVP (community antenna television plenum coaxial cables must be listed as being suitable for use in ducts, plenums, and other spaces used for environmental air and also be listed as having adequate fire-resistant and low smoke-producing characteristics.

(C) General-Purpose Cables. Type CM (communications general-purpose cables) and Type CATV (community antenna television coaxial general-purpose cables) must be listed as being suitable for general-purpose use, with the exception of risers and plenums, and also be listed as being resistant to the spread of fire.

ARTICLE

805

GENERAL REQUIREMENTS FOR COMMUNICATIONS CIRCUITS

Introduction to Article 805—General Requirements for Communications Circuits

The general rules for Chapter 8 installations, other than Article 810 installations, are consolidated within Article 800 while the specific requirements for communications circuits are found here in Article 805. These rules supplement or modify the requirements in Article 800. This is similar to the language in 90.3 that says the general rules in Chapters 1 through 4 may be modified by the specific rules in Chapters 5 through 7.

Article 805 has its roots in telephone technology. Consequently, it addresses telephone, fax, voice, and related systems. Here are a few key points to remember about Article 805:

- Do not attach incoming communications cables to the service-entrance power mast.
- Keep the bonding conductor for the primary protector as straight and as short as possible.
- If you locate communications cables above a suspended ceiling, route and support them to allow access via ceiling panel removal.
- Keep these cables separated from lightning protection circuits.
- If you install communications cables in a Chapter 3 raceway, you must do so in accordance with the *NEC* requirements for the raceway system.
- Special labeling and marking provisions apply—follow them carefully.

Part I. General

805.1 Scope

Article 805 covers communications circuits and equipment. ▸Figure 805–1

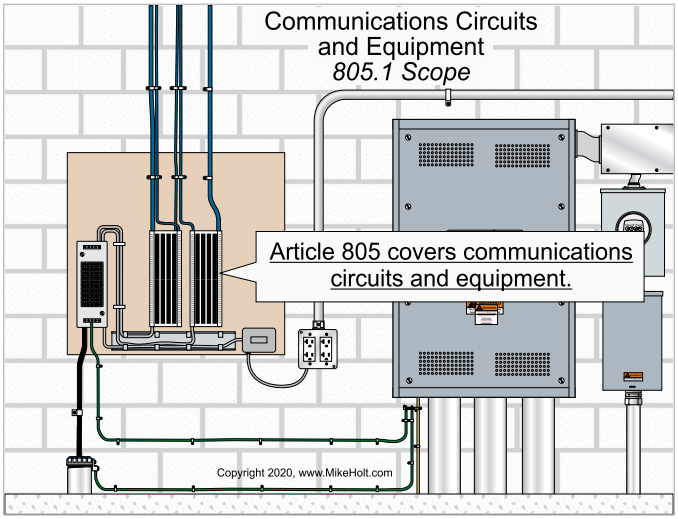
805.2 Definitions

This definition applies only to Article 805.

Communications Circuit Integrity (CI) Cable. Cable used in communications systems to ensure continued operation of critical circuits during a specified time under fire conditions.

805.18 Installation of Equipment

Communications equipment must be listed in accordance with 805.170.

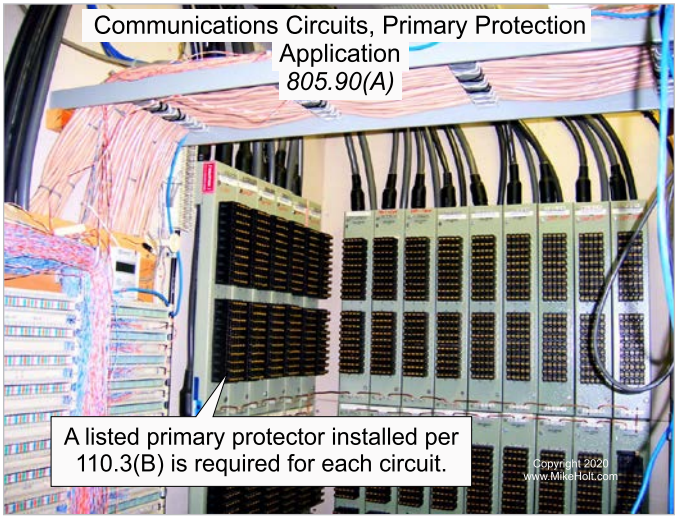


▸Figure 805–1

Part III. Protection

805.90 Primary Protection

(A) Application. A listed primary protector installed in accordance with 110.3(B) is required for each circuit. ▸Figure 805–2



▸Figure 805–2

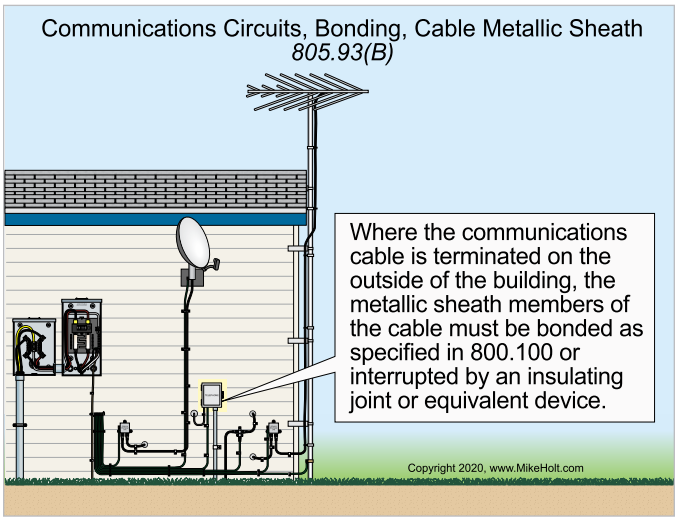
Author's Comment:

- Select a location for the primary protector so the shortest bonding conductor can be used. Doing so will reduce differences in voltage between circuits and other metallic systems during lightning events.

805.93 Bonding or Interruption

(A) Entering Buildings. In installations where the communications cable enters a building, the metallic sheath members of the cable must be bonded as specified in 800.100 or interrupted by an insulating joint or equivalent device. The bonding or interruption must be as close as practicable to the point of entrance.

(B) Terminating on the Outside of Buildings. In installations where the communications cable is terminated on the outside of the building, the metallic sheath members of the cable must be bonded as specified in 800.100 or interrupted by an insulating joint or equivalent device. The bonding or interruption must be as close as practicable to the point of termination of the cable. ▸Figure 805–3



▸Figure 805–3

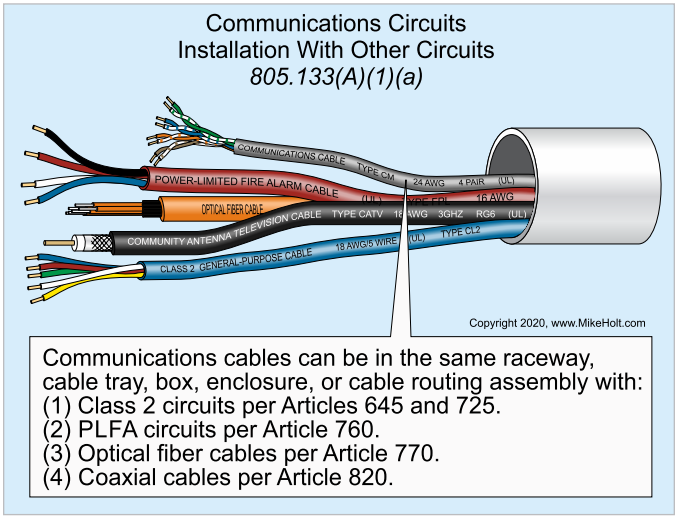
Part IV. Installation Methods Within Buildings

805.133 Installation of Communications Wires, Cables, and Equipment

(A) Separation from Power Conductors.

(1) In Raceways, Cable Trays, Boxes, Enclosures, and Cable Routing Assemblies.

(a) With Other Circuits. Communications cables can be in the same raceway, cable tray, cable routing assembly, box, or enclosure with cables of any of the following: ▸Figure 805–4



▸Figure 805–4

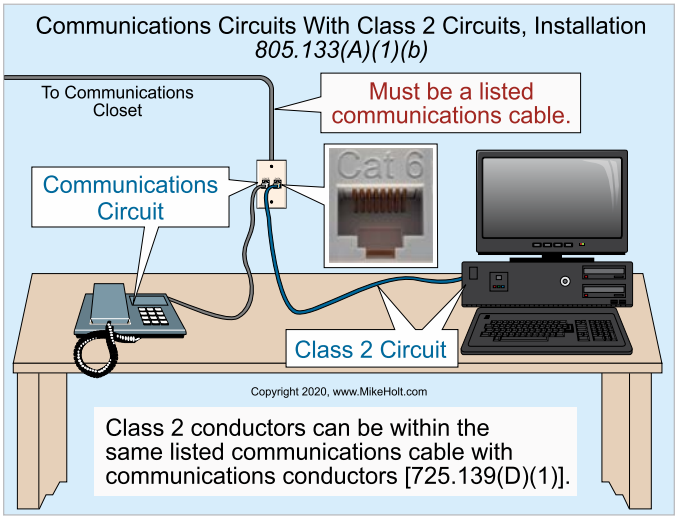
(1) Class 2 circuits in accordance with Articles 645 and 725.

(2) Power-limited fire alarm circuits in accordance with Article 760.

(3) Optical fiber cables in accordance with Article 770.

(4) Coaxial cables in accordance with Article 820.

(b) Class 2 Circuits. Class 2 conductors can be within the same listed communications cable with communications conductors [725.139(D)(1)]. ▸Figure 805–5



▸Figure 805–5

Author's Comment:

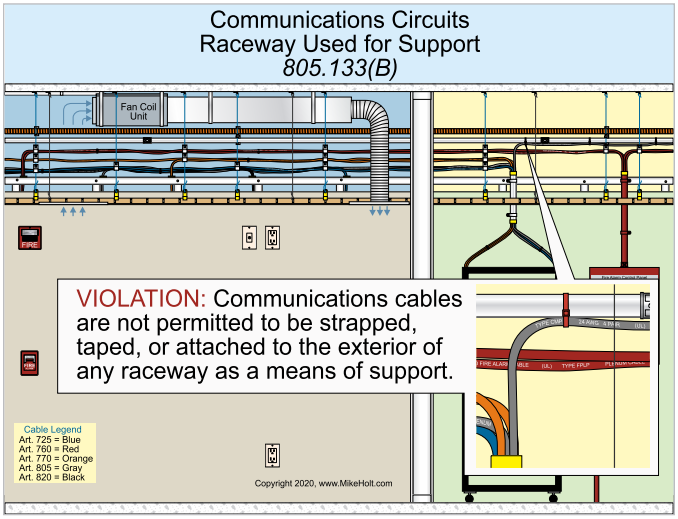
- A common application of this requirement is when a single cable is used for both voice communications and data.
- Listed Class 2 cables have a voltage rating of not less than 150V [725.179(G)], whereas communications cables have a voltage rating of at least 300V [800.179].

(c) With Power Conductors in Same Raceway or Enclosure. Communications conductors are not permitted to be placed in any raceway, compartment, outlet box, junction box, or similar fitting with conductors of electric power or Class 1 circuits.

Ex 1: Power conductors can be in the same enclosure with communication conductors if separated by a barrier.

Ex 2: Power conductors that supply communication equipment shall maintain a ¼ in. separation from communications conductors within the enclosure.

(B) Support of Communications Cables. Communications cables are not permitted to be strapped, taped, or attached to the exterior of any raceway as a means of support. ▸Figure 805–6



▸Figure 805–6

Author's Comment:

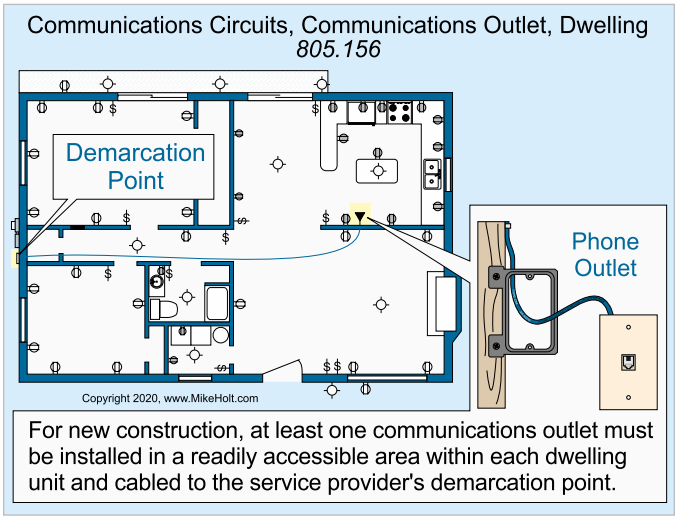
- Exposed cables must be supported by the structural components of the building so the cable will not be damaged by normal building use. The cables must be secured by straps, staples, cable ties, hangers, or similar fittings designed and installed in a manner that will not damage the cable [800.24].

805.154 Communications Cable(s) Substitutions

Cable substitutions are permitted provided that the substitute is more fire resistant than the original as indicated in the Cable Substitution Hierarchy in *NEC* figure 805.154.

805.156 Dwelling Unit Communications Outlet

For new construction, at least one communications outlet must be installed in a readily accessible area within each dwelling unit and cabled to the service provider's demarcation point. ▸Figure 805–7


Communications Circuits, Communications Outlet, Dwelling
805.156
Demarcation Point
Phone Outlet
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For new construction, at least one communications outlet must be installed in a readily accessible area within each dwelling unit and cabled to the service provider's demarcation point.

Figure 805–7

ARTICLE

810

RADIO AND TELEVISION ANTENNA EQUIPMENT

Introduction to Article 810—Radio and Television Antenna Equipment

Unlike other articles in this chapter, Article 810 is not covered by the general rules in Article 800, as a result, it stands completely alone in the *Code* unless a rule in 810 references a specific rule elsewhere in the *NEC*.

This article covers transmitter and receiver (satellite dish and antenna) 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.
- Do not attach satellite dishes, antennas, or other equipment to the service-entrance power mast.
- Keep the bonding conductor as straight as practicable and protect it from physical damage.
- If the mast is not bonded properly, you risk flashovers and possible electrocution.
- Remember that the purpose of bonding is to prevent a difference of voltage 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.

See Figure 800.100(B)(1) and Figure 800.100(B)(2) in the *NEC* for examples of bonding conductors and grounding electrode conductors.

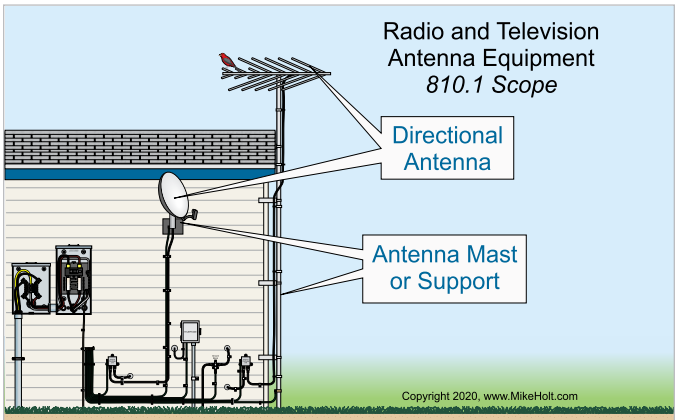
Part I. General

810.1 Scope

Article 810 contains the installation requirements for television and radio receiving (antenna) equipment such as satellite dishes and amateur/citizen band radio antennas. ▸Figure 810–1

Author's Comment:

- Article 810 covers:
  - Antennas that receive local television signals.
  - Satellite antennas, which are often referred to as satellite dishes.
  - Roof-mounted antennas for AM/FM/XM radio reception.
  - Amateur radio transmitting and receiving equipment, including HAM radio equipment (a noncommercial [amateur] communications system). ▸Figure 810–2



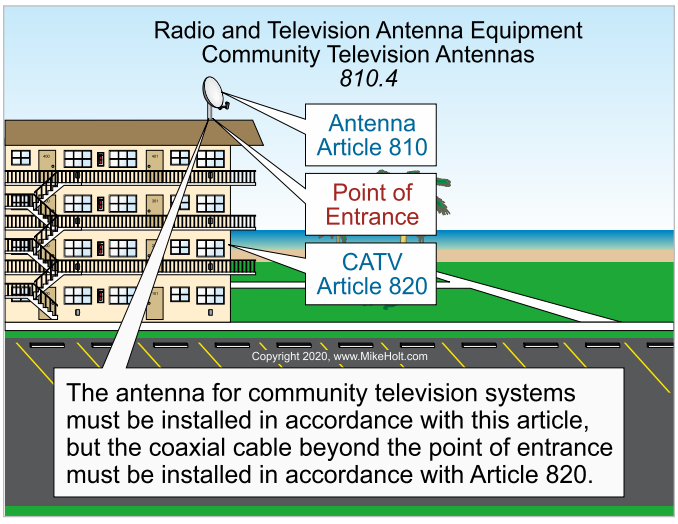
Article 810 contains the installation requirements for television and radio receiving (antenna) equipment such as satellite dishes and amateur/citizen band radio antennas.

▸Figure 810–1

▸Figure 810–2

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 810–3



▸Figure 810–3

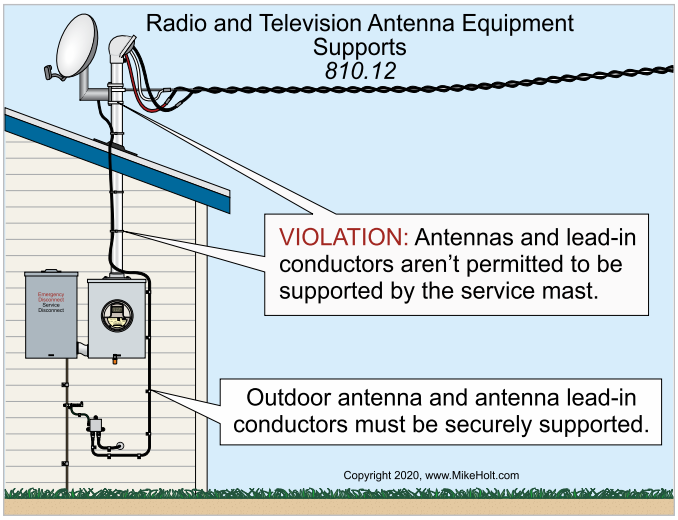
Author's Comment:

- 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 Supports

Outdoor antennas and lead-in conductors must be securely supported, and the lead-in conductors must be securely attached to the antenna. The antennas or lead-in conductors are not permitted to be attached to the electric service mast. ▸Figure 810–4



▸Figure 810–4

810.13 Avoid Contact with Conductors of Other Systems

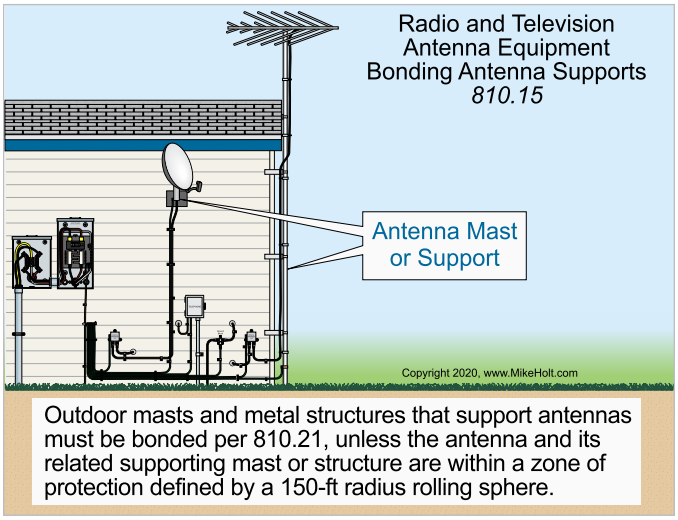
Outdoor antennas and lead-in conductors must be kept at least 2 ft away from exposed electric power conductors to avoid the possibility of accidental contact.

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—Bonding

Outdoor masts and metal structures that support antennas must be bonded in accordance with 810.21, unless the antenna and its related supporting mast or structure are within a zone of protection defined by a 150-ft radius rolling sphere. ▸Figure 810–5



▸Figure 810–5

Note: See NFPA 780, *Standard for the Installation of Lightning Protection Systems* [4.8.3.1], for the application of the term "Rolling Sphere."

810.18 Clearances

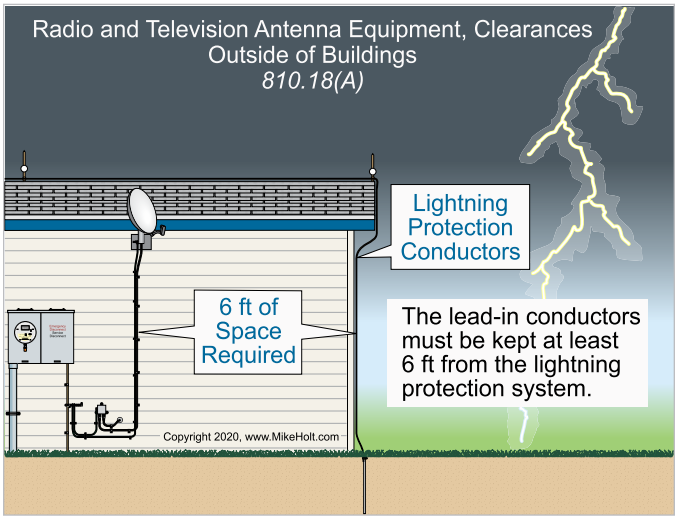
(A) Outside of Buildings. Lead-in conductors attached to buildings must be installed so they cannot swing closer than 2 ft to the conductors of circuits of 250V or less, or closer than 10 ft to the conductors of circuits of over 250V.

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 810–6

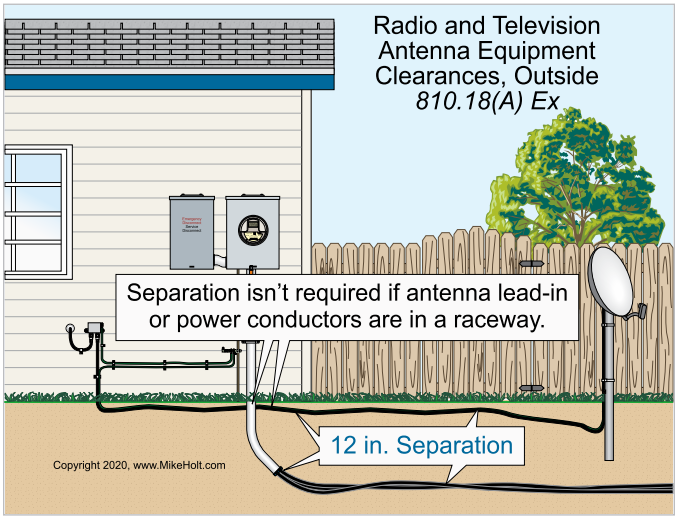
Ex: Separation is not required where the underground antenna lead-in conductors or the electric power conductors are installed in raceways or metal cable armor. ▸Figure 810–7

(B) Indoors. Indoor antenna and lead-in conductors are not permitted to be less than 2 in. from electric power conductors.

Ex 1: Separation is not required if the antenna lead-in conductors or the electric power conductors are installed within a metal raceway or metal cable armor.



▸Figure 810–6



▸Figure 810–7

(C) Boxes and Enclosures. Indoor antenna lead-in conductors can be in the same box or enclosure with electric power conductors where separated by an effective, permanently installed barrier. ▸Figure 810–8

810.20 Antenna Discharge Unit

(A) Listed. Each lead-in conductor from an outdoor antenna must be provided with a listed antenna discharge unit. ▸Figure 810–9

(B) Location. The antenna discharge unit must be located outside or inside the building, nearest the point of entrance, but not near combustible material or in a hazardous (classified) location as defined in Article 500.

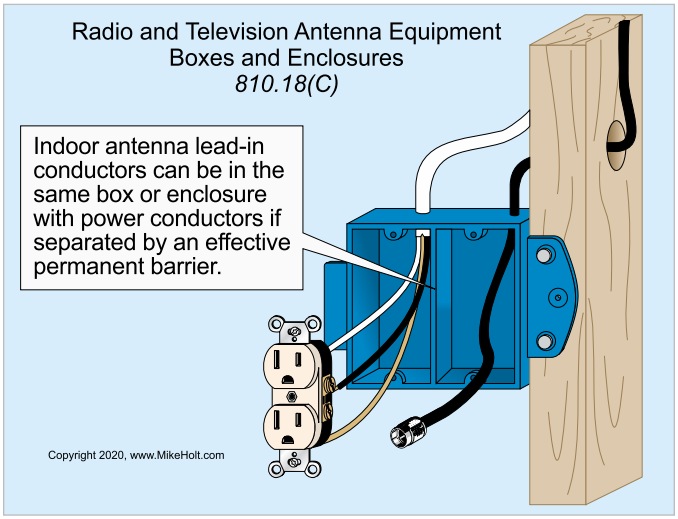


Figure 810–8

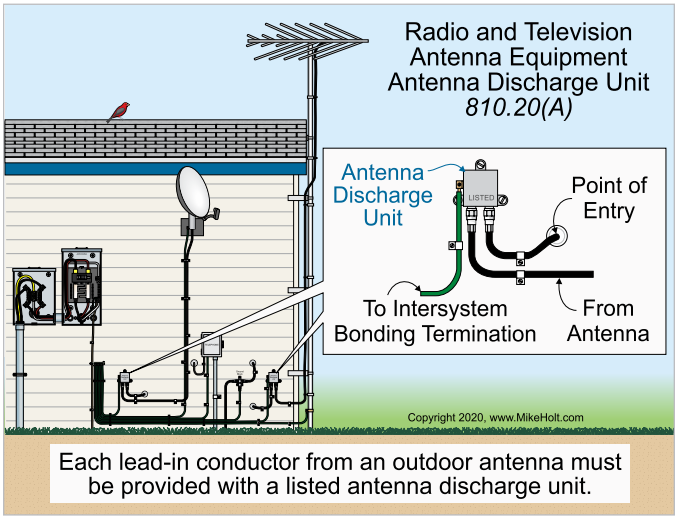


Figure 810–9

(C) Bonding. The antenna discharge unit must be bonded in accordance with 810.21.

810.21 Bonding Conductors and Grounding Electrode Conductors

Bonding conductors must meet the following requirements:

(A) Material. The bonding conductor to the intersystem bonding termination must be copper, copper-clad aluminum, copper-clad steel, aluminum, bronze, or other corrosion-resistant conductive material. Figure 810–10

Where aluminum or copper-clad aluminum is used, it must not be installed outside within 18 in. from the Earth or where subject to corrosive conditions.

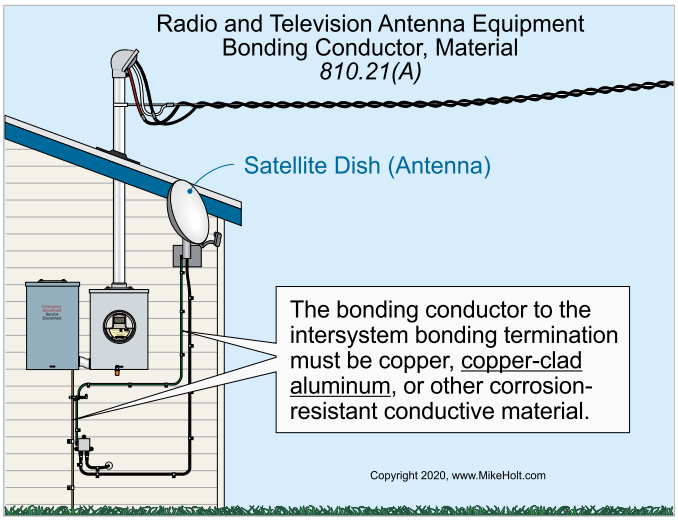


Figure 810–10

(B) Insulation. Insulation on bonding conductors is not required.

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

(D) Physical Protection. Bonding conductors 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.

Author's Comment:

- Installing the bonding conductor in PVC conduit is a better practice.

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

Author's Comment:

- Lightning does not like to travel around corners or through loops, which is why the bonding conductor must be run as straight as practicable.

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

(1) Buildings with an Intersystem Bonding Termination. The bonding conductor for the antenna mast and antenna discharge unit must terminate to the intersystem bonding termination [Article 100] as required by 250.94. Figure 810–11

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

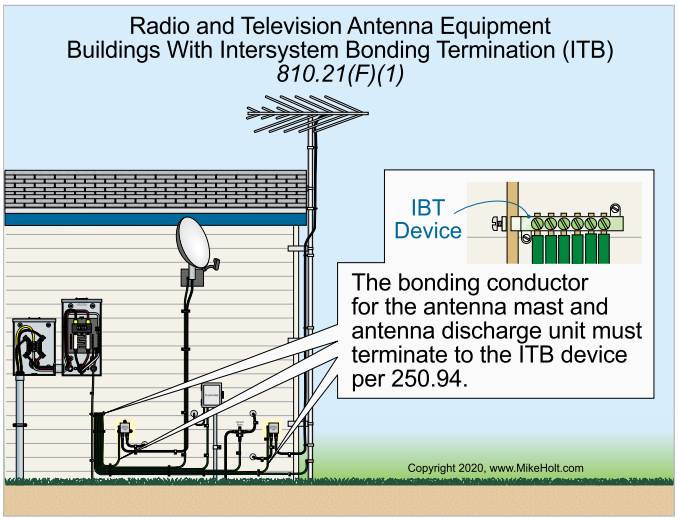


Figure 810–11

(H) Size. The bonding conductor is not permitted to be smaller than 10 AWG copper, 8 AWG aluminum, or 17 AWG copper-clad steel or bronze. Figure 810–12

Figure 810–12

(J) Bonding of Electrodes. A ground rod installed for the radio and television equipment must be bonded to the building's power grounding electrode system with a minimum 6 AWG copper conductor. Figure 810–13

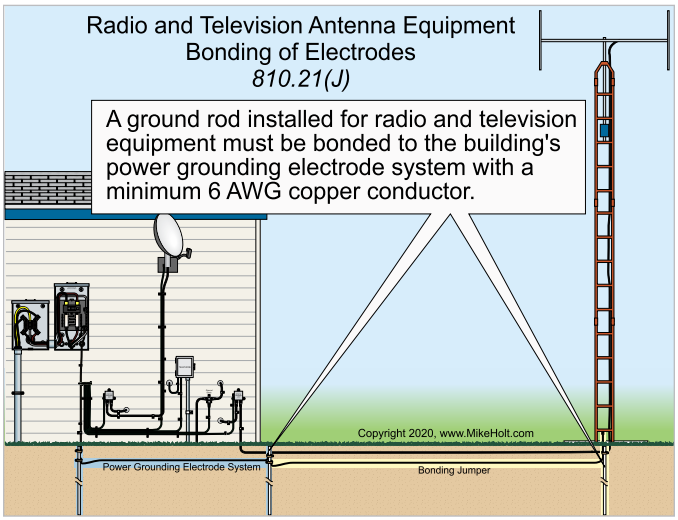


Figure 810–13

Author's Comment:

- A separate grounding electrode is not required for radio and TV equipment, but if it is installed, then it must be bonded to the building's power grounding electrode system with a minimum 6 AWG copper conductor.
- Bonding of electrodes helps reduce induced voltage differences between the power and communications systems during lightning events.

(K) Electrode Connection. Termination of the bonding 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 in accordance with 250.70. Figure 810–14

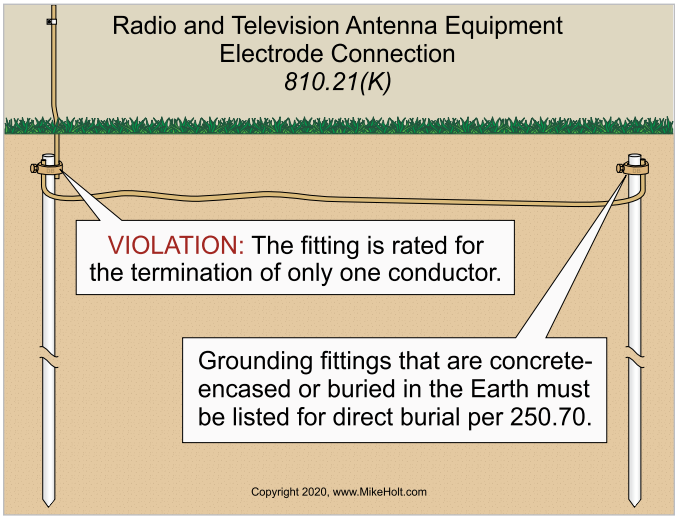


Figure 810–14

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 to which it is attached. 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 antenna and/or satellite dish to the building's grounding electrode system (grounding) helps 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.

Part III. Amateur and Citizen Band Transmitting and Receiving Stations—Antenna Systems

810.51 Other Sections

In addition to complying with Part III, antenna systems for amateur and citizen band transmitting and receiving stations must comply with 810.11 through 810.15.

810.57 Antenna Discharge Units—Transmitting Stations

Each conductor of a lead-in for outdoor antennas must be provided with an antenna discharge unit or other suitable means to drain static charges from the antenna system.

Ex 1: Where the lead-in is protected by a continuous metallic shield that is bonded in accordance with 810.58, an antenna discharge unit or other suitable means is not required.

Ex 2: Where the antenna is bonded in accordance with 810.58, an antenna discharge unit or other suitable means is not required.

810.58 Bonding Conductors and Grounding Electrode Conductors—Amateur and Citizen Band Transmitting and Receiving Stations

Bonding conductors must comply with 810.58(A) through 810.58(C).

(A) Other Sections. Bonding conductors for amateur and citizen band transmitting and receiving stations must comply with 810.21(A) through 810.21(C).

(B) Size of Protective Bonding Conductor. The protective bonding conductor for transmitting stations must be as large as the lead-in but not smaller than 10 AWG copper, bronze, or copper-clad steel.

ARTICLE
820

COMMUNITY ANTENNA TELEVISION (CATV) AND RADIO DISTRIBUTION SYSTEMS (COAXIAL CABLE)

Introduction to Article 820—Community Antenna Television (CATV) and Radio Distribution Systems (Coaxial Cable)

This article focuses on the distribution of television and radio signals within a facility or on a property via cable rather than their transmission or reception via antenna. These signals are limited energy, but they are high frequency.

- Article 800 defines the "Point of Entrance" for these circuits and the general requirements regarding installation methods of all types of communications wiring.
- Ground the incoming coaxial cable as close as practicable to the point of entrance.
- If coaxial cables are located above a suspended ceiling, route and support them to allow access via ceiling panel removal.
- Clearances are critical, and Article 800 contains detailed clearance requirements. For example, it requires at least 6 ft of clearance between coaxial cable and lightning conductors.
- The bonding conductor must be connected to the intersystem bonding termination if there is one in (or at) the building.
- If you use a separate grounding electrode, you must run a bonding jumper to the power grounding system.

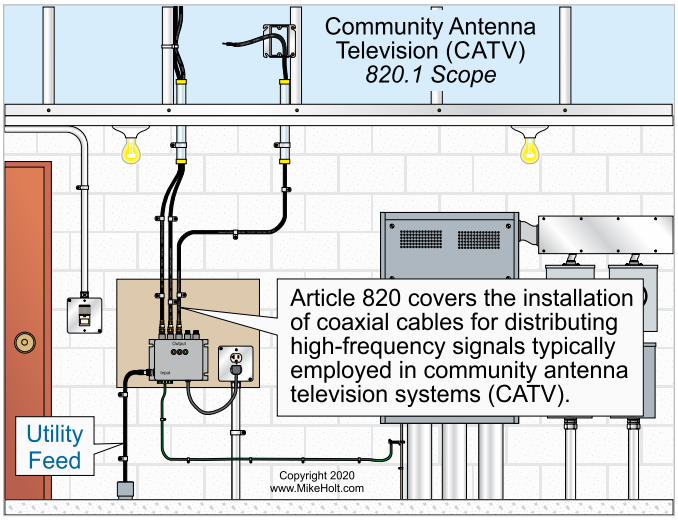
Part I. General

820.1 Scope

Article 820 covers the installation of coaxial cables for distributing high-frequency signals typically employed in community antenna television systems (CATV). ▸Figure 820–1

Author's Comment:

- Article 820 covers the installation of coaxial cable for cable television, closed-circuit television, security cameras, and radio and television receiving equipment.
- Coaxial cables that connect antennas to television and radio receiving equipment [810.3] and community television systems [810.4] must be installed in accordance with this article. ▸Figure 820–2



▸Figure 820–1

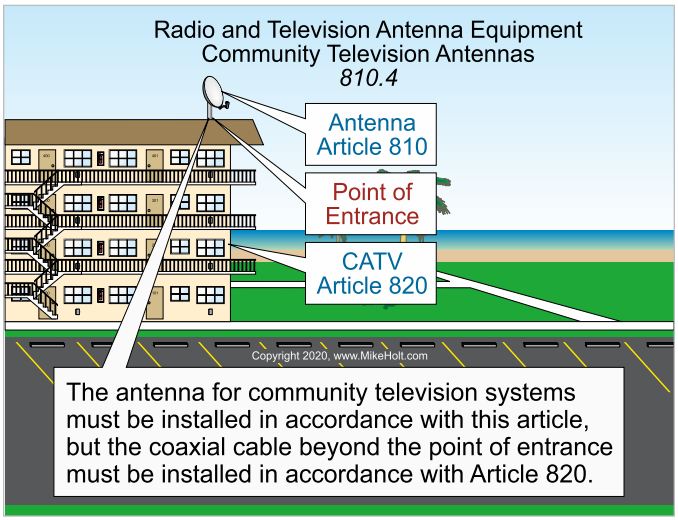


Figure 820–2

Part III. Protection

820.93 Grounding of the Outer Conductive Shield of Coaxial Cables

(A) Coaxial Cables Entering Building. Coaxial cables supplied to a building must have the metallic sheath members bonded as close as practicable to the point of entrance in accordance with 820.100. Figure 820–3

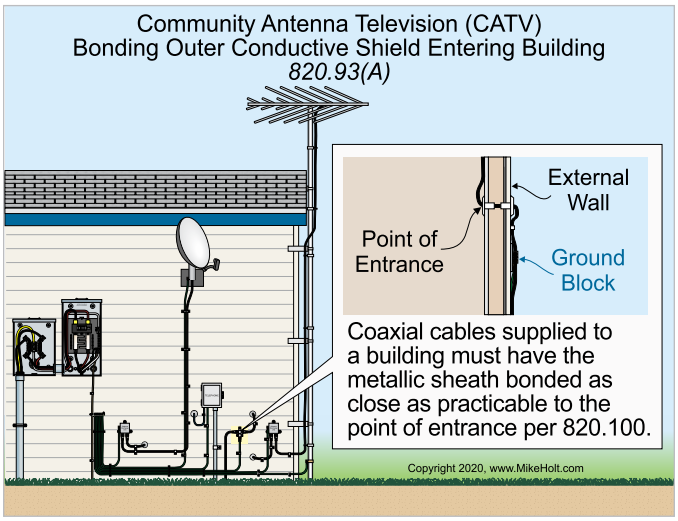


Figure 820–3

Part IV. Grounding Methods

820.100 Bonding and Grounding Methods

The outer conductive shield of a coaxial cable must be bonded in accordance with 800.100. Figure 820–4

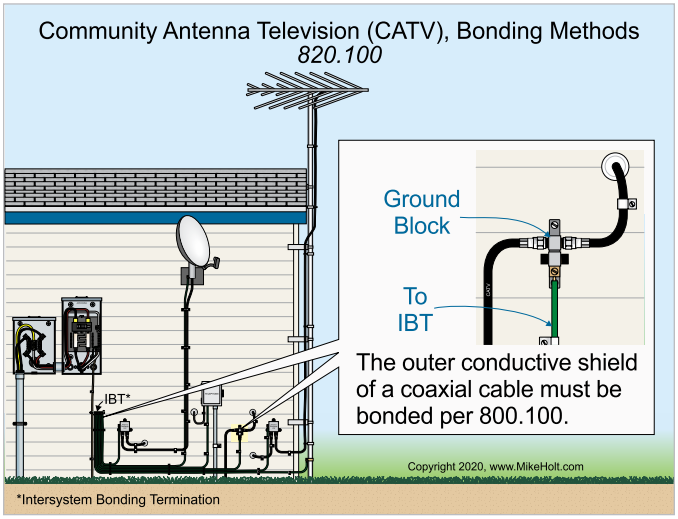


Figure 820–4

Part V. Installation Methods Within Buildings

820.133 Installation of Coaxial Cables and Equipment

(A) Separation from Power Conductors.

(1) In Raceways, Cable Trays, Boxes, Enclosures, and Cable Routing Assemblies.

(a) Other Circuits. Coaxial cables are permitted in the same raceway, cable tray, box, enclosure, or cable routing assembly with jacketed cables of any of the following: Figure 820–5

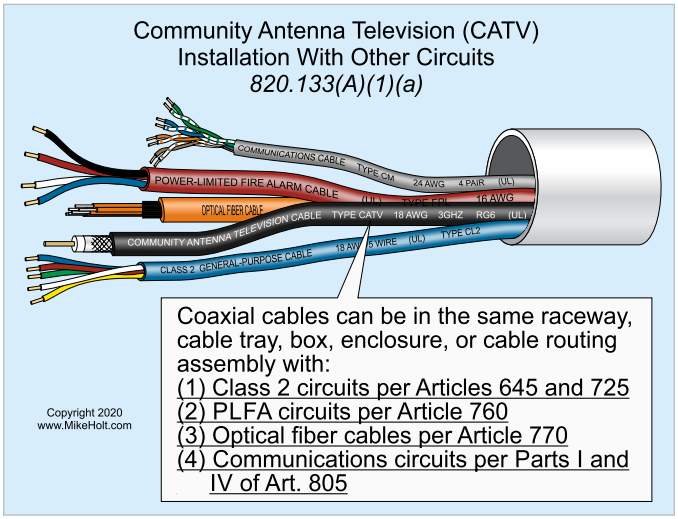


Figure 820–5

(1) Class 2 remote control, signaling, and power-limited circuits in compliance with Article 645 or Parts I and III of Article 725

(2) Power-limited fire alarm systems in compliance with Parts I and III of Article 760

(3) Nonconductive and conductive optical fiber cables in compliance with Parts I and V of Article 770

(4) Communications circuits in compliance with Parts I and IV of Article 805

(5) Low-power network-powered broadband communications circuits in compliance with Parts I and V of Article 830

(b) With Power Conductors in Same Raceway or Enclosure. Coaxial cables are not permitted to be placed in any raceway, compartment, outlet box, junction box, or similar fitting with conductors of electric power or Class 1 circuits.

Ex 1: Power conductors are permitted in the same enclosure with coaxial cables if separated by a barrier.

Ex 2: Power conductors that supply coaxial cable distribution equipment must maintain ¼ in. separation from coaxial cables within the enclosure.

(2) Other Applications. Coaxial cable must be separated at least 2 in. from conductors of any electric light, power, Class 1, nonpower-limited fire alarm, or medium-power network-powered broadband communications circuits.

Ex 1: Separation is not required where either (1) all of the conductors of electric light, power, Class 1, nonpower-limited fire alarm, and medium-power network-powered broadband communications circuits are in a raceway, or in metal-sheathed, metal-clad, nonmetallic-sheathed, Type AC or Type UF cables, or (2) all of the coaxial cables are encased in a raceway. Figure 820–6

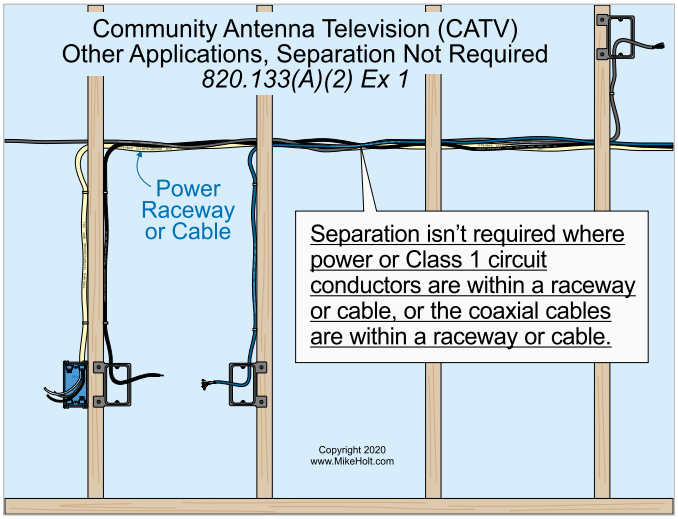


Figure 820–6

Ex 2: Separation is not required where the coaxial cables are permanently separated from the conductors of electric light, power, Class 1, nonpower-limited fire alarm, and medium-power network-powered broadband communications circuits by a continuous and firmly fixed nonconductor, such as porcelain tubes or flexible tubing, in addition to the insulation on the wire.

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