without barriers where all of the conductors are installed with separate multiconductor Type AC, Type MC, Type MI, or Type TC cables and all the conductors in the cables are insulated at 600 volts or greater.

N 724.49 Class 1 Circuit Conductors.

N (A) Sizes and Use. Conductors that are 18 AWG and 16 AWG shall be permitted to be used if they supply loads that do not exceed the ampacities specified in 402.5 and are installed in a raceway, an approved enclosure, or a listed cable. Conductors larger than 16 AWG shall not supply loads greater than the ampacities specified in 310.14. Flexible cords shall comply with the requirements of Article 400.

N (B) Insulation. Insulation on conductors shall be rated for the system voltage and not less than 600 volts. Conductors larger than 16 AWG shall comply with the requirements of Article 310. Conductors that are 18 AWG and 16 AWG shall be Type FFH-2, Type KF-2, Type KFF-2, Type PAF, Type PAFF, Type PF, Type PFF, Type PGF, Type PGFF, Type PTF, Type PTFF, Type RFH-2, Type RFHH-2, Type RFHH-3, Type SF-2, SFF-2, Type TF, Type TFF, Type TFFN, Type TFN, Type ZF, or Type ZFF. Conductors with other types and thicknesses of insulation shall be permitted if listed for Class 1 circuit use.

Class 1 circuit conductor insulation is required to be rated not less than 600 volts, which effectively requires Class 1 circuits to be wired using the wiring methods found in Chapter 3 or to use conductors specifically listed for Class 1 circuits.

N 724.51 Number of Conductors in Cable Trays and Raceways, and Ampacity Adjustment.

N (A) Class 1 Circuit Conductors. Where only Class 1 circuit conductors are in a raceway, the number of conductors shall be determined in accordance with 300.17. The ampacity adjustment factors specified in 310.15(C)(1) shall apply only if such conductors carry continuous loads in excess of 10 percent of the ampacity of each conductor.

N (B) Power-Supply Conductors and Class 1 Circuit Conductors. Where power-supply conductors and Class 1 circuit conductors are permitted in a raceway in accordance with 724.48, the number of conductors shall be determined in accordance with 300.17. The ampacity adjustment factors specified in 310.15(C)(1) shall apply as follows:

(1) To all conductors where the Class 1 circuit conductors carry continuous loads in excess of 10 percent of the ampacity of each conductor and where the total number of conductors is more than three

(2) To the power-supply conductors only, where the Class 1 circuit conductors do not carry continuous loads in excess of 10 percent of the ampacity of each conductor and where the number of power-supply conductors is more than three

N (C) Class 1 Circuit Conductors in Cable Trays. Where Class 1 circuit conductors are installed in cable trays, they shall comply with the requirements of 392.22 and 392.80(A).

N 724.52 Circuits Extending Beyond One Building. Class 1 circuits that extend aerially beyond one building shall also meet the requirements of Part I of Article 225.

Δ ARTICLE 725

Class 2 and Class 3 Power-Limited Circuits

Part I. General

Δ 725.1 Scope. This article covers power-limited circuits, including power-limited remote-control and signaling circuits, that are not an integral part of a device or of utilization equipment.

Informational Note No. 1: The circuits described herein are characterized by usage and electrical power limitations that differentiate them from electric light and power circuits; therefore, alternative requirements are given regarding minimum wire sizes, ampacity adjustment and correction factors, overcurrent protection, insulation requirements, and wiring methods and materials.

Informational Note No. 2: See 300.26 for classifications of remote-control and signaling circuits.

Article 725 can include systems such as security system circuits, access control circuits, nurse call circuits, some computer network systems, some control circuits for lighting dimmer systems, and some low-voltage control circuits that originate from listed appliances or from listed computer equipment.

The installation requirements for the wiring of information technology equipment (electronic data processing and computer equipment) located within the confines of a room that is constructed according to the requirements of NFPA 75, *Standard for the Fire Protection of Information Technology Equipment*, are not covered by Article 725. The wiring within those specially constructed rooms is covered by Article 645.

In addition, if listed computer equipment is interconnected and all the interconnected equipment is in close proximity, the wiring is considered an integral part of the equipment and, therefore, not subject to the requirements of Article 725. If the wiring leaves the group of equipment to connect to other devices in the same room or elsewhere in the building, the wiring is considered "wiring within buildings" and is subject to the requirements of Article 725.

According to 90.3, the general wiring methods found in Chapters 1 through 4 of the *NEC*® apply to Class 2 and Class 3 power-limited circuits and power-limited remote-control and signaling circuits, except as amended by Article 725 for specified conditions.

Conductors and equipment on the supply side of overcurrent protection, transformers, or current-limiting devices of

Class 2 and Class 3 circuits must be installed according to the applicable requirements of Chapter 3. Load-side conductors and equipment must comply with Article 725. Class 2 and Class 3 conductors are required to be separated from and not occupy the same raceways, cable trays, cables, or enclosures as electric light, power, and Class 1 conductors, except as noted in 725.136.

Many batteries can be considered Class 2 power supplies if the voltage is 30 volts or less and listed and identified as Class 2. See 725.60(A)(5).

725.3 Other Articles. In addition to the requirements of this article, circuits and equipment shall comply with the articles or sections listed in 725.3(A) through (E). Only those sections of Article 300 referenced in this article shall apply to Class 2 and Class 3 circuits.

(A) Spread of Fire or Products of Combustion. Installation of Class 2 and Class 3 circuits shall comply with 300.21.

Δ **(B) Ducts, Plenums, and Other Air-Handling Spaces.** Class 2 and Class 3 circuits installed in ducts, plenums, or other space used for environmental air shall comply with 300.22.

(C) Motor Control Circuits. Motor control circuits tapped from the load side of the motor branch-circuit protective device(s) as specified in 430.72(A) shall comply with Part IV of Article 430.

Δ **(D) Identification of Equipment Grounding Conductors.** Equipment grounding conductors shall be identified in accordance with 250.119.

N **(E) Cables for Class 2 and Class 3 Circuits.** The listing and installation of cables for Class 2 and Class 3 circuits shall comply with Part I and Part II of Article 722.

N **725.10 Hazardous (Classified) Locations.** Cables and equipment shall be permitted to be used in hazardous (classified) locations where specifically permitted by other articles in this *Code*.

725.21 Access to Electrical Equipment Behind Panels Designed to Allow Access. Access to electrical equipment shall not be denied by an accumulation of wires and cables that prevents removal of panels, including suspended ceiling panels.

An excess accumulation of wires and cables can limit access to electrical equipment by preventing the removal of access panels. To safely service, rearrange, or install electrical equipment, the worker must have an accessible work space. See Exhibit 725.1.

See also

300.11(B), which permits the use of support wires and approved fittings that are independent of the suspended ceiling support wires

Δ **725.24 Mechanical Execution of Work.** Class 2 and Class 3 equipment shall be installed in a neat and workmanlike manner. The installation shall also comply with 300.4 and 300.11.

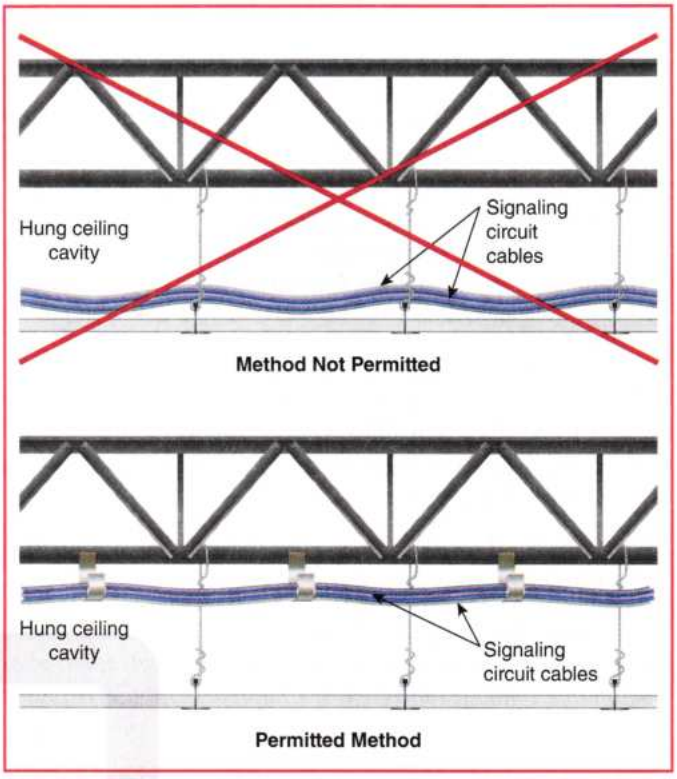


EXHIBIT 725.1 Incorrect cable installation *(upper diagram)* and correct method *(lower diagram)*.

Cable must be attached to or supported by the building structure by cable ties, straps, clamps, hangers, and so forth. See Exhibit 725.1. The installation method must not damage the cable. In addition, the location of the cable should be carefully evaluated to ensure that activities and processes within the building do not cause damage to the cable. See 300.11(C).

Section 300.4(D) requires protection of cables that are installed on framing members. Such cables are required to be installed in a manner that protects them from nail or screw penetration. This section permits attachment to baseboards and non-load-bearing walls, which are not structural components.

725.30 Class 2 and Class 3 Circuit Identification. Class 2 and Class 3 circuits shall be identified at terminal and junction locations in a manner that prevents unintentional interference with other circuits during testing and servicing.

725.31 Safety-Control Equipment. Where damage to power-limited circuits can result in a failure of safety-control equipment that would introduce a direct fire or life hazard, the power-limited circuits shall be installed in accordance with 724.31. Room thermostats, water temperature regulating devices, and similar controls used in conjunction with electrically controlled household heating and air conditioning shall not be considered safety-control equipment.

Part II. Class 2 and Class 3 Circuits

725.60 Power Sources for Class 2 and Class 3 Circuits.

Δ **(A) Power Source.** The power source for a Class 2 or a Class 3 circuit shall be as follows:

Informational Note No. 1: Informational Note Figure 725.60 illustrates the relationships between Class 2 or Class 3 power sources, their supply, and the Class 2 or Class 3 circuits.

Informational Note No. 2: See Chapter 9, Table 11(A) and Table 11(B), for requirements for listed Class 2 and Class 3 power sources.

(1) A listed Class 2 or Class 3 transformer
(2) A listed Class 2 or Class 3 power supply
(3) Other listed equipment marked to identify the Class 2 or Class 3 power source

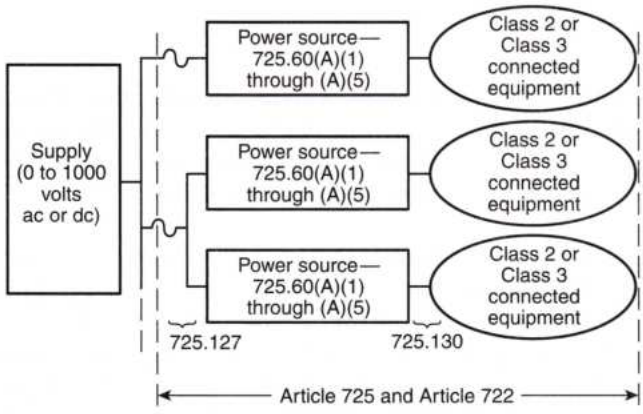
Exception No. 1 to (3): Thermocouples shall not require listing as a Class 2 power source.

Exception No. 2 to (3): Limited power circuits of listed equipment where these circuits have energy levels rated at or below the limits established in Chapter 9, Table 11(A) and Table 11(B).

Informational Note No. 3: Examples of other listed equipment are as follows:

(1) A circuit card listed for use as a Class 2 or Class 3 power source where used as part of a listed assembly
(2) A current-limiting impedance, listed for the purpose, or part of a listed product, used in conjunction with a non-power-limited transformer or a stored energy source, for example, storage battery, to limit the output current
(3) A thermocouple
(4) Limited voltage/current or limited impedance secondary communications circuits of listed industrial control equipment

(4) Listed audio/video, information technology (computer), communications, and industrial equipment limited-power circuits



Δ ***INFORMATIONAL NOTE FIGURE 725.60*** *Class 2 and Class 3 Circuits.*

Informational Note No. 4: One way to determine applicable requirements for listing of information technology (computer) equipment is to refer to UL 60950-1-2011, *Standard for Safety of Information Technology Equipment*. Another way to determine applicable requirements for listing of audio/video, information technology, and communications equipment is to refer to UL 62368-1-2014, *Safety of audio/video, information and communication technology equipment*. Typically such circuits are used to interconnect data circuits for the purpose of exchanging information data. One way to determine applicable requirements for listing of industrial equipment is to refer to UL 61010-2-201, *Safety requirements for electrical equipment for measurement, control, and laboratory use — Part 2-201: Particular requirements for control equipment*, and/or UL 61800-5-1, *Adjustable speed electrical power drive systems — Part 5-1: Safety requirements — Electrical, thermal and energy.*

(5) A battery source or battery source system that is listed and identified as Class 2

(B) Interconnection of Power Sources. Class 2 or Class 3 power sources shall not have the output connections paralleled or otherwise interconnected unless listed for such interconnection.

Δ **(C) Marking.** The equipment supplying the circuits shall be durably marked where plainly visible to indicate each circuit that is a Class 2 or Class 3 circuit. The power sources for limited power circuits in 725.60(A)(3), limited power circuits for listed audio/video equipment, listed information technology equipment, listed communications equipment, and listed industrial equipment in 725.60(A)(4) shall have a label indicating the maximum voltage and rated current output per conductor for each connection point on the power source. Where multiple connection points have the same rating, a single label shall be permitted to be used.

Informational Note No. 1: Rated current for power sources covered in 725.144 is the output current per conductor the power source is designed to deliver to an operational load at normal operating conditions, as declared by the manufacturer.

Informational Note No. 2: An example of a label is "52V @ 0.433A, 57V MAX" for an IEEE 802.3 compliant Class 8 power source.

Δ **725.127 Wiring Methods on Supply Side of the Class 2 or Class 3 Power Source.** Conductors and equipment on the supply side of the power source shall be installed in accordance with the appropriate requirements of Chapters 1 through 4.

Exception: The input leads of a transformer or other power source supplying Class 2 and Class 3 circuits shall be permitted to be smaller than 14 AWG but not smaller than 18 AWG if they are protected by an overcurrent device rated not over 20 amperes, are not over 305 mm (12 in.) long, and have insulation that complies with 724.49(B).

Δ **725.130 Wiring Methods and Materials on Load Side of the Class 2 or Class 3 Power Source.** Class 2 and Class 3 circuits on the load side of the power source shall be permitted to be installed using wiring methods and materials in accordance with

725.130(A), (B), or a combination of both. Parts I and II of Article 722 shall apply.

Δ **(A) Class 1 Wiring Methods and Materials.** Use of Class 1 wiring methods for Class 2 and Class 3 circuits shall be permitted. Separation from electric light, power, Class 1, non-power-limited fire alarm circuit conductors, and medium-power network-powered broadband communications cables shall comply with 725.136.

Exception: The ampacity adjustment factors given in 310.15(C)(1) shall not apply.

Δ **(B) Class 2 and Class 3 Wiring Methods and Materials.** Conductors on the load side of the power source shall be insulated in accordance with 722.179 and be installed in accordance with 722.135 and 725.136 through 725.144.

Exception No. 1: As provided for in 620.21 for elevators and similar equipment.

Exception No. 2: Other wiring methods and materials installed in accordance with 725.3 shall be permitted to extend or replace the conductors and cables described in 722.179(A) and permitted by 725.130(B).

Exception No. 3: Bare Class 2 conductors shall be permitted as part of a listed intrusion protection system where installed in accordance with the listing instructions for the system.

• **N 725.136 Separation from Electric Light, Power, Class 1, Non-Power-Limited Fire Alarm Circuit Conductors, and Medium-Power Network-Powered Broadband Communications Cables.**

N **(A) General.** Cables and conductors of Class 2 and Class 3 circuits shall not be placed in any cable, cable tray, compartment, enclosure, manhole, outlet box, device box, raceway, or similar fitting with conductors of electric light, power, Class 1, non-power-limited fire alarm circuits, and medium-power network-powered broadband communications circuits unless permitted by 725.136(B) through (I).

Generally, the lower voltage ratings of listed Class 2 and Class 3 cables do not allow them to be installed with electric light, power, Class 1, non-power-limited fire alarm circuits, and medium-power network-powered broadband communications cables. Failure of the cable insulation due to a fault could lead to hazardous voltages being imposed on the Class 2 or Class 3 circuit conductors. However, see 725.136(I) for methods to provide separation.

N **(B) Separated by Barriers.** Class 2 and Class 3 circuits shall be permitted to be installed together with the conductors of electric light, power, Class 1, non-power-limited fire alarm, and medium-power network-powered broadband communications circuits where they are separated by a barrier.

N **(C) Raceways Within Enclosures.** In enclosures, Class 2 and Class 3 circuits shall be permitted to be installed in a raceway to separate them from Class 1, non-power-limited fire alarm, and medium-power network-powered broadband communications circuits.

N **(D) Associated Systems Within Enclosures.** Class 2 and Class 3 circuit conductors in compartments, enclosures, device boxes, outlet boxes, or similar fittings shall be permitted to be installed with electric light, power, Class 1, non-power-limited fire alarm, and medium-power network-powered broadband communications circuits where they are introduced solely to connect the equipment connected to Class 2 and Class 3 circuits, and where one of the following applies:

(1) The electric light, power, Class 1, non-power-limited fire alarm, and medium-power network-powered broadband communications circuit conductors are routed to maintain a minimum of 6 mm (0.25 in.) separation from the conductors and cables of Class 2 and Class 3 circuits.

(2) The circuit conductors operate at 150 volts or less to ground and comply with one of the following:

a. The Class 2 and Class 3 circuits are installed using Type CL3, Type CL3R, or Type CL3P or permitted substitute cables if these Class 3 cable conductors extending beyond the jacket are separated by a minimum of 6 mm (0.25 in.) or by a nonconductive sleeve or nonconductive barrier from all other conductors.

b. The Class 2 and Class 3 circuit conductors are installed as a Class 1 circuit in accordance with 724.40.

An example of associated systems is a Class 2 circuit source that is the secondary of a control transformer installed in the same motor-starter enclosure. In such an installation, the Class 2 conductor insulation is not required to have the same voltage rating as the insulation on the power conductors in the same enclosure, provided the installation complies with 725.136(D)(1) or (2).

N **(E) Enclosures with Single Opening.** Class 2 and Class 3 circuit conductors entering compartments, enclosures, device boxes, outlet boxes, or similar fittings shall be permitted to be installed with Class 1, non-power-limited fire alarm, and medium-power network-powered broadband communications circuits where they are introduced solely to connect the equipment connected to Class 2 and Class 3 circuits. Where Class 2 and Class 3 circuit conductors must enter an enclosure that is provided with a single opening, they shall be permitted to enter through a single fitting (such as a tee) if the conductors are separated from the conductors of the other circuits by a continuous and firmly fixed nonconductor, such as flexible tubing.

N **(F) Manholes.** Underground Class 2 and Class 3 circuit conductors in a manhole shall be permitted to be installed with Class 1,

non-power-limited fire alarm, and medium-power network-powered broadband communications circuits where one of the following conditions is met:

(1) The electric light, power, Class 1, non-power-limited fire alarm, and medium-power network-powered broadband communications circuit conductors are in a metal-enclosed cable or Type UF cable.
(2) The Class 2 and Class 3 circuit conductors are permanently and effectively separated from the conductors of other circuits by a continuous and firmly fixed nonconductor, such as flexible tubing, in addition to the insulation or covering on the wire.
(3) The Class 2 and Class 3 circuit conductors are permanently and effectively separated from conductors of the other circuits and securely fastened to racks, insulators, or other approved supports.

N **(G) Cable Trays.** Class 2 and Class 3 circuit conductors shall be permitted to be installed in cable trays where the conductors of the electric light, Class 1, and non-power-limited fire alarm circuits are separated by a solid fixed barrier of a material compatible with the cable tray or where the Class 2 or Class 3 circuits are installed in Type MC cable.

N **(H) Where Protected.** Class 2 and Class 3 circuits shall be permitted to be installed together with the conductors of electric light, power, Class 1, non-power-limited fire alarm, and medium-power network-powered broadband communications circuits where they are installed using Class 1 wiring methods in accordance with 724.46 and where they are protected by an approved raceway.

N **(I) Other Applications.** For other applications, conductors of Class 2 and Class 3 circuits shall be separated by at least 50 mm (2 in.) from conductors of any electric light, power, Class 1, non-power-limited fire alarm, or medium-power network-powered broadband communications circuits unless one of the following conditions is met:

(1) Either all of the electric light, power, Class 1, non-power-limited fire alarm, and medium-power network-powered broadband communications circuit conductors or all of the Class 2 and Class 3 circuit conductors are in a raceway or in metal-sheathed, metal-clad, nonmetallic-sheathed, Type TC, or Type UF cables.
(2) All of the electric light, power, Class 1, non-power-limited fire alarm, and medium-power network-powered broadband communications circuit conductors are permanently separated from all of the Class 2 and Class 3 circuit conductors by a continuous and firmly fixed nonconductor, such as porcelain tubes or flexible tubing, in addition to the insulation on the conductors.

N **725.139 Installation of Conductors of Different Circuits in the Same Cable, Enclosure, Cable Tray, Raceway, or Cable Routing Assembly.**

N **(A) Two or More Class 2 Circuits.** Conductors of two or more Class 2 circuits shall be permitted within the same cable, enclosure, raceway, or cable routing assembly.

N **(B) Two or More Class 3 Circuits.** Conductors of two or more Class 3 circuits shall be permitted within the same cable, enclosure, raceway, or cable routing assembly.

N **(C) Class 2 Circuits with Class 3 Circuits.** Conductors of one or more Class 2 circuits shall be permitted within the same cable, enclosure, raceway, or cable routing assembly with conductors of Class 3 circuits if the insulation of the Class 2 circuit conductors in the cable, enclosure, raceway, or cable routing assembly is at least that required for Class 3 circuits.

N **(D) Class 2 and Class 3 Circuits with Communications Circuits.**

N **(1) Communications Cables.** Conductors of one or more Class 2 or Class 3 circuits shall be permitted in the same cable with conductors of communications circuits if the cable is a listed communications cable installed in accordance with Part V of Article 800. The cables shall be listed as communications cables.

N **(2) Composite Cables.** Cables constructed of individually listed Class 2, Class 3, and communications cables under a common jacket shall be permitted to be classified as communications cables. The fire resistance rating of the composite cable shall be determined by the performance of the composite cable.

N **(E) Class 2 or Class 3 Cables with Other Circuit Cables.** Jacketed cables of Class 2 or Class 3 circuits shall be permitted in the same enclosure, cable tray, raceway, or cable routing assembly with jacketed cables of any of the following:

(1) Power-limited fire alarm systems in compliance with Parts I and III of Article 760
(2) Nonconductive and conductive optical fiber cables in compliance with Parts I and IV of Article 770
(3) Communications circuits in compliance with Parts I and IV of Article 805
(4) Community antenna television and radio distribution systems in compliance with Parts I and IV of Article 820
(5) Low-power, network-powered broadband communications in compliance with Parts I and IV of Article 830

N **(F) Class 2 or Class 3 Conductors or Cables and Audio System Circuits.** Audio system circuits described in 640.9(C) and installed using Class 2 or Class 3 wiring methods in compliance with 722.135 shall not be installed in the same cable, raceway, or cable routing assembly with Class 2 or Class 3 conductors or cables.

N **725.144 Bundling of Cables Transmitting Power and Data.** Sections 725.144(A) and (B) shall apply to Class 2 and Class 3 circuits that transmit power and data to a powered device over listed cabling. Section 300.11 and Parts I and III of Article

725 shall apply to Class 2 and Class 3 circuits that transmit power and data. The conductors that carry power for the data circuits shall be copper. The current in the power circuit shall not exceed the current limitation of the connectors.

Informational Note No. 1: One example of the use of cables that transmit power and data is the connection of closed-circuit TV cameras (CCTV).

Informational Note No. 2: The 8P8C connector is in widespread use with powered communications systems. IEC 60603-7-2008, *Connectors for electronic equipment — Part 7-1: Detail specification for 8-way, unshielded, free and fixed connectors,* specifies these connectors to have a current-carrying capacity per contact of 1.0 amperes maximum at 60°C (149°F). See IEC 60603-7 for more information on current-carrying capacity at higher and lower temperatures.

Informational Note No. 3: The requirements of Table 725.144 were derived for carrying power and data over 4-pair copper balanced twisted pair cabling. This type of cabling is described in ANSI/TIA 568-C.2-2009, *Commercial Building Telecommunications Cabling Standard — Part 2: Balanced Twisted-Pair Telecommunications Cabling and Components.*

Informational Note No. 4: See TIA-TSB-184-A-2017, *Guidelines for Supporting Power Delivery Over Balanced Twisted-Pair Cabling,* for information on installation and management of balanced twisted pair cabling supporting power delivery.

Informational Note No. 5: See ANSI/NEMA C137.3-2017, *American National Standard for Lighting Systems — Minimum Requirements for Installation of Energy Efficient Power over Ethernet (PoE) Lighting Systems,* for information on installation of cables for PoE lighting systems.

Informational Note No. 6: Rated current for power sources covered in 725.144 is the output current per conductor the power source is designed to deliver to an operational load at normal operating conditions, as declared by the manufacturer. In the design of these systems, the actual current in a given conductor might vary from the rated current per conductor by as much as 20 percent. An increase in current in one conductor is offset by a corresponding decrease in current in one or more conductors of the same cable.

This section provides requirements for cables that are used for transmission of data and power. This is commonly referred to as Power over Ethernet (PoE). Common applications include telephones, wireless access points, and security cameras powered from a Class 2 power supply that also uses conductors in the same cable for data transmission. These devices may be identified as complying to IEEE 802.3 networking standards, including IEEE 802.3af, *Data Terminal Equipment (DTE) Power via Media Dependent Interface (MDI)*; IEEE 802.3at, *Data Terminal Equipment (DTE) Power via Media Dependent Interface (MDI) Enhancements*; or IEEE 802.3bt, *Physical Layer and Management Parameters for Power over Ethernet over 4 pairs*. In all but the highest power classes of the IEEE 802.3 standards, the rated current output per conductor is less than 0.3 amperes.

Section 725.144 protects against situations in which current flow in a large number of bundled cables could cause an increased temperature in a conductor or cable that can degrade the insulation. The ampacities in Table 725.144 are based on a fact-finding report by Underwriters Laboratories and were updated for the 2020 edition of the *NEC* to provide greater precision.

By far, the most common installations are designed in accordance with IEEE 802.3 networking standards, for which power sources are rated as less than 0.433 amperes per conductor, usually 0.3 amperes per conductor or less. The 4-pair local area network (LAN) cabling typically is 24 AWG or larger.

N **TABLE 725.144** *Ampacities of Each Conductor in Amperes in 4-Pair Class 2 or Class 3 Balanced Twisted-Pair Cables Based on Copper Conductors at an Ambient Temperature of 30°C (86°F) with All Conductors in All Cables Carrying Current, 60°C (140°F), 75°C (167°F), and 90°C (194°F) Rated Cables*

	Number of 4-Pair Cables in a Bundle																	
	1–7			8–19			20–37			38–61			62–91			92–192		
	Temperature Rating			Temperature Rating			Temperature Rating			Temperature Rating			Temperature Rating			Temperature Rating		
AWG	60°C	75°C	90°C	60°C	75°C	90°C	60°C	75°C	90°C	60°C	75°C	90°C	60°C	75°C	90°C	60°C	75°C	90°C
26	1.00	1.23	1.42	0.71	0.87	1.02	0.55	0.68	0.78	0.46	0.57	0.67	0.45	0.55	0.64	NA	NA	NA
24	1.19	1.46	1.69	0.81	1.01	1.17	0.63	0.78	0.91	0.55	0.67	0.78	0.46	0.56	0.65	0.40	0.48	0.55
23	1.24	1.53	1.78	0.89	1.11	1.28	0.77	0.95	1.10	0.66	0.80	0.93	0.58	0.71	0.82	0.45	0.55	0.63
22	1.50	1.86	2.16	1.04	1.28	1.49	0.77	0.95	1.11	0.66	0.82	0.96	0.62	0.77	0.89	0.53	0.63	0.72

Notes:

1. For bundle sizes over 192 cables, or for conductor sizes smaller than 26 AWG, ampacities shall be permitted to be determined by qualified personnel under engineering supervision.
2. Where only half of the conductors in each cable are carrying current, the values in the table shall be permitted to be increased by a factor of 1.4.

Informational Note No. 1: Elevated cable temperatures can reduce a cable's data transmission performance. For information on practices for 4-pair balanced twisted pair cabling, see TIA-TSB-184-A and 6.4.7, 6.6.3, and Annex G of ANSI/TIA-568-C.2, which provide guidance on adjustments for operating temperatures between 20°C and 60°C.

Informational Note No. 2: The per-contact current rating of connectors can limit the maximum allowable current below the ampacity shown in Table 725.144.

COMMENTARY TABLE 725.1 Performance Characteristics for Each IEEE Class of PoE

IEEE Class	PSE Power (W)	PD Power (W)	Maximum Cable Current (mA)	Maximum Rated Current per Conductor (mA)	
				2-Pair	4-Pair
1	4	3.84	91	45	20
2	7	6.49	159	80	35
3	15.4	13	350	175	77
4	30	25.5	600	300	150
5	45	40	900	N/A	225
6	60	51	1200	N/A	300
7	75	62	1442	N/A	361
8	90	71.3	1731	N/A	433

Table Notes:
PSE = power sourcing equipment (the power supply).
PD = powered device (the load).
Maximum Cable Current = combined one-way current through all conductors.
Maximum Rated Current per Conductor = single conductor current for use with Table 725.144.

PoE installations designed to IEEE 802.3 are comprised of power sourcing equipment (PSE) and a powered device (PD). The PSE is an *NEC* Class 2 power supply. The PD is the load that is being supplied the power. The PSEs and PDs are connected via an eight-conductor category cable. The PD can use four or eight of the conductors to draw current from and return current to the PSE. PSEs and PDs are defined by one of eight IEEE 802.3 classes, ranging from 3.84 watts to 90 watts, detailed in Commentary Table 725.1. Above a certain IEEE class (above Class 4), the PD must use all eight conductors. The category cable between the PSE and the PD can be 328 feet long. As a result, the PSE power and the PD power are not equivalent, to account for cable losses. This can be seen as the difference between the PSE power and the PD power in Commentary Table 725.1. The maximum cable current (i.e., the combined one-way current through all the conductors) can be calculated from the PSE power and voltage. The calculated worst-case cable current is in the fourth column of the commentary table.

Table 725.144 provides the rated current per conductor for a PSE, which is the maximum one-way cable current draw divided either between two conductors or among four conductors. The divisor is chosen depending on whether the PD is drawing and then returning current over a total of only four conductors or all eight conductors. Commentary Table 725.1 shows the worst-case rated current for each IEEE class, one for four conductors (the 2-Pair column) and one for eight conductors (the 4-Pair column). The currents in the last column, Maximum Rated Current per Conductor (mA), are the currents to be used in reference to Table 725.144.

For the common IEEE standard PoE described above, the following items provide a simple path to qualify an installation according to 725.144:

1. When cabling is 24 AWG or larger and the rated current is less than 0.3 ampere per conductor, the installation meets 725.144.
2. If the plans call for higher current (above 0.3 amperes per conductor but below 0.433 amperes per conductor), the installation meets 725.144 if the answer to any of the following questions is YES:
   a. Is the cabling rated as limited power (LP) 0.6 or greater?
   b. Are fewer than 37 ports of PoE provided?
   c. Are the cables bundled in groups of 37 or fewer?

   If neither item 1 nor 2 applies, then the bundle size and temperature rating of the cable will have to be checked.
3. Is 75°C cabling of 23 AWG or larger being used in bundles of 192 or fewer?

   Note: TIA-568.2-D Category 6A cabling ("Cat 6a") is typically 23 AWG; other categories of cabling may be in 23 AWG variants.
4. Is 60°C cabling of 23 AWG or larger being used in bundles of 61 or fewer?
5. Is 75°C cabling of 24 AWG or larger being used in bundles of 91 or fewer?

   Note: TIA-568.2-D Category 5E cabling ("Cat 5e") is typically 24 AWG.

The values in Table 725.144 are specified at an ambient temperature of 30°C. The cable bundles are referred to as "horizontal cables" in the TIA/EIA 568 standards, which specify an ambient

COMMENTARY TABLE 725.2 *NEC* Table 725.144 Adjusted for Ambient Temperature of 45°C (113°F)

AWG	Number of 4-Pair Cables in a Bundle																	
	1–7			8–19			20–37			38–61			62–91			92–192		
	Temperature Rating			Temperature Rating			Temperature Rating			Temperature Rating			Temperature Rating			Temperature Rating		
	60°C	75°C	90°C	60°C	75°C	90°C	60°C	75°C	90°C	60°C	75°C	90°C	60°C	75°C	90°C	60°C	75°C	90°C
26	0.71	1.00	1.23	0.50	0.71	0.88	0.39	0.56	0.68	0.33	0.47	0.58	0.32	0.45	0.55	NA	NA	NA
24	0.84	1.19	1.46	0.57	0.82	1.01	0.45	0.64	0.79	0.39	0.55	0.68	0.33	0.46	0.56	0.28	0.39	0.48
23	0.88	1.25	1.54	0.63	0.91	1.11	0.54	0.78	0.95	0.47	0.65	0.81	0.41	0.58	0.71	0.32	0.45	0.55
22	1.06	1.52	1.87	0.74	1.05	1.29	0.54	0.78	0.96	0.47	0.67	0.83	0.44	0.63	0.77	0.37	0.51	0.62

temperature of 45°C. Commentary Table 725.2 is Table 725.144 adjusted to an ambient temperature of 45°C using equation 310.15(B).

(A) Use of 4-Pair Class 2 or Class 3 Cables to Transmit Power and Data. Where Type CL3P, Type CL2P, Type CL3R, Type CL2R, Type CL3, or Type CL2 4-pair cables transmit power and data, the rated current per conductor of the power source shall not exceed the ampacities in Table 725.144 at an ambient temperature of 30°C (86°F). For ambient temperatures above 30°C (86°F), the correction factors in Table 310.15(B)(1)(1) or in Equation 310.15(B) shall apply.

Exception: Compliance with Table 725.144 shall not be required for installations where conductors are 24 AWG or larger and the rated current per conductor of the power source does not exceed 0.3 amperes.

Informational Note: One example of the use of Class 2 cables is a network of closed-circuit TV cameras using 24 AWG, 60°C rated, Type CL2R, Category 5e balanced twisted-pair cabling.

Δ **(B) Use of Class 2-LP or Class 3-LP Cables to Transmit Power and Data.** Type CL3P-LP, Type CL2P-LP, Type CL3R-LP, Type CL2R-LP, Type CL3-LP, or Type CL2-LP cables shall be permitted to supply power to equipment from a power source with a rated current per conductor up to the marked current limit located immediately following the suffix "-LP" and shall be permitted to transmit data to the equipment. Where the number of bundled LP cables is 192 or less and the selected ampacity of the cables in accordance with Table 725.144 exceeds the marked current limit of the cable, the ampacity determined from the table shall be permitted to be used. For ambient temperatures above 30°C (86°F), the correction factors of Table 310.15(B)(1)(1) or Equation 310.15(B) shall apply. The Class 2-LP and Class 3-LP cables shall comply with the following, as applicable:

(1) Cables with the suffix "-LP" shall be permitted to be installed in bundles, raceways, cable trays, communications raceways, and cable routing assemblies.
(2) Cables with the suffix "-LP" and a marked current limit shall follow the substitution hierarchy of 722.135(E) for the cable type without the suffix "-LP" and without the marked current limit.
(3) System design shall be permitted by qualified persons under engineering supervision.

Informational Note: An example of the marking on a 23 AWG, 4-pair, Class 2 cable rated 75°C with an LP current rating of 0.6 amperes per conductor is "CL2-LP(0.6A) 75°C 23 AWG 4-pair". See 722.179(A)(9).

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Part III. Listing Requirements

725.160 Listing and Marking of Equipment for Power and Data Transmission. The listed power source for circuits intended to provide power and data over Class 2 cables to remote equipment shall be as specified in 725.60(A)(1), (A)(2), (A)(3), or (A)(4). In accordance with 725.60(B), the power sources shall not have the output connections paralleled or otherwise interconnected, unless listed for such interconnection. Powered devices connected to a circuit supplying data and power shall be listed. Marking of equipment output connections shall be in accordance with 725.60(C).

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N ARTICLE 726 Class 4 Fault-Managed Power Systems

N Part I. General

N 726.1 Scope. This article covers the installation of wiring systems and equipment, including utilization equipment, of Class 4 fault-managed power (FMP) systems.

Informational Note No. 1: Class 4 fault-managed power systems consist of a Class 4 power transmitter and a Class 4 power receiver connected by a Class 4 cabling system. These systems are characterized by monitoring the circuit for faults and controlling the source current to ensure the energy delivered into any fault is limited. Class 4 systems differ from Class 1, Class 2, and Class 3 systems in that they are not limited for power delivered to an appropriate load. They are current limited for faults between the Class 4 transmitter and Class 4 receiver.

Informational Note No. 2: The circuits described in this article are characterized by monitoring and control systems that differentiate them from electric light and power circuits; therefore, alternative requirements to those of Chapters 1 through 4 are given.

Class 4, or fault-managed power (FMP), systems are not Power over Ethernet (PoE) systems, which are Class 2 or Class 3 systems. Class 4 systems are designed to enable high-voltage power, not over 450-volts peak ac or dc, to be delivered with enhanced safety, as both line-to-line and line-to-ground faults are mitigated within milliseconds of occurrence resulting in no harm to people or property. Class 4 system transmitters (TX) and receivers (RX) must be listed and from the same manufacturer to function properly. The TX and RX are interconnected with listed Class 4 cables. See UL 1400-2, *Outline of Investigation for Fault-Managed Power Systems — Part 2 Requirements for Cables*, at https://iq.ulprospector.com/en/. Class 4 circuits must be durably marked where plainly visible with the maximum voltage and current output.

N 726.3 Other Articles. The listing and installation of cables for Class 4 circuits shall comply with Article 722. Only those sections of Article 300 referenced in Article 722 shall apply to Class 4 circuits.

N 726.10 Hazardous (Classified) Locations. Class 4 power systems shall be permitted to be used in hazardous (classified) locations where specifically permitted by other articles in this *Code*.