

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)(I) 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)(I) 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).

### 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).

## 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.



**N 726.12 Uses Not Permitted.** Class 4 power systems shall not be permitted in dwelling units.

**N 726.24 Mechanical Execution of Work.** Class 4 equipment shall be installed in a neat and workmanlike manner. The installation shall also comply with 300.4 and 300.11.

## N Part II. Class 4 Circuits

**N 726.121 Power Sources for Class 4 Circuits.** The power source shall be a listed Class 4 power transmitter or a listed Class 4 power transmitter as part of a transmitter/receiver system and shall provide the protections in accordance with 726.121(A). Class 4 circuits shall be supplied from a power source (transmitter) that has a voltage output of not more than 450 volts peak or dc.

Informational Note No. 1: Informational Note Figure 726.121 illustrates the relationships between Class 4 power transmitters (power sources), Class 4 circuits, Class 4 power receivers, and utilization equipment.

Informational Note No. 2: See UL 1400-1, *Outline for Fault-Managed Power Systems — Part 1: General Requirements*, for information on determining applicable requirements for the listing of Class 4 power systems.

**N (A) Fault Management.** For listing purposes, a transmitter shall interrupt an energized circuit when any of the following conditions occur on the circuit between the transmitter and receiver:

- (1) A short circuit
- (2) A line-to-line fault condition that presents an unacceptable risk of fire or electric shock
- (3) A ground-fault condition that presents an unacceptable risk of fire or electric shock

- (4) An overcurrent condition
- (5) A malfunction of the monitoring or control system that presents an unacceptable risk of fire or electric shock
- (6) Any other condition that presents an unacceptable risk of fire or electric shock

Informational Note: See UL 1400-1, *Outline for Fault-Managed Power Systems — Part 1: General Requirements*, for information on determining applicable requirements for the listing of Class 4 power systems, including safe operation and limiting the risk of fire and electric shock.

**N 726.122 Class 4 Loads.** Outputs of a Class 4 receiver and power outputs of Class 4 utilization equipment shall be considered a separately derived system if the outputs are used as a supply for a feeder or branch circuit.

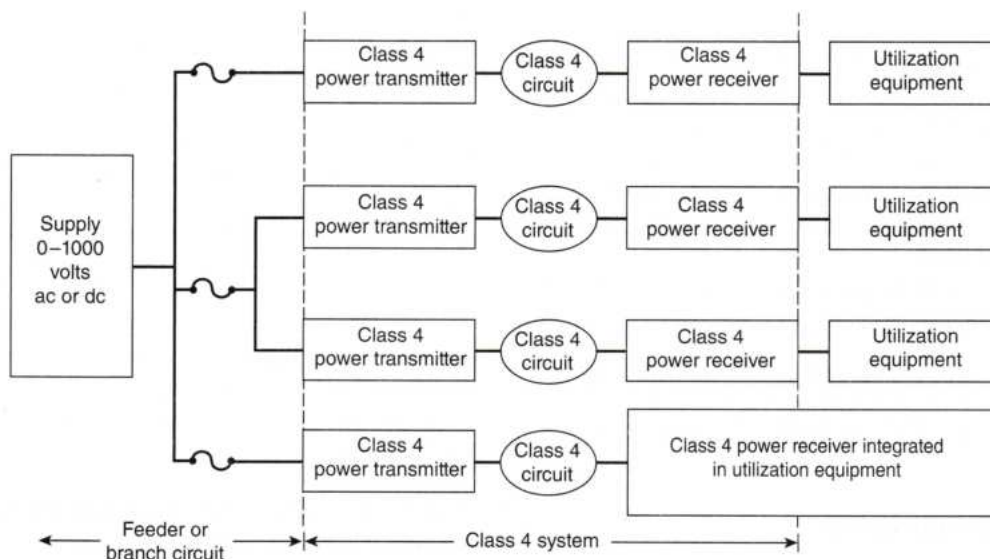
Informational Note: Class 4 utilization equipment that does not provide power outputs is not subject to these requirements.

*Exception: A Class 4 receiver with limited-power circuit outputs shall be permitted to meet the requirements of Part II of Article 725.*

## N 726.124 Class 4 Marking.

**N (A) Class 4 Transmitter Marking.** The equipment supplying the Class 4 circuits shall be durably marked where plainly visible to indicate each circuit that is a Class 4 circuit. The marking shall also include the maximum voltage and current output for each connection point. Where multiple connection points have the same rating, a single label shall be permitted to be used.

Informational Note: An example of marking is “Class 4: +/-190V, 5A” for a Class 4 transmitter capable of delivering 1.9 kW from 380 volts line to line.



**N INFORMATIONAL NOTE FIGURE 726.121** Class 4 Circuits.



**N (B) Class 4 Receiver Marking.**

**N (1) Class 4 Circuits.** A Class 4 receiver or Class 4 utilization equipment shall be durably marked where plainly visible to indicate each circuit that is a Class 4 circuit. The marking shall include the maximum input voltage and current for each connection point.

**N (2) Output Terminals and Socket Outlets.** Where the Class 4 receiver or Class 4 utilization equipment has outputs, terminals, or socket outlets for providing power to other equipment, each output shall be durably marked where plainly visible. The marking shall include the maximum output voltage and current for each connection point. Where multiple connection points have the same rating, a single label shall be permitted to be used. Class 1, Class 2, and Class 3 circuits shall be identified in accordance with 724.30 or Part II of Article 725.

**N 726.130 Terminals and Connectors.**

**N (A) Listing.** Connecting hardware used on Class 4 distribution systems shall be listed.

**N (B) Noninterchangeability.** Connectors for Class 4 circuits shall be designed such that they are not interchangeable with non-power-limited sources located on the same premises.

**N (C) Guarding.** Any junctions and mating connectors shall be constructed and installed to guard against inadvertent contact with live parts by persons.

**N 726.136 Separation from Electric Light, Power, Class 1, Non-Power-Limited Fire Alarm Circuit, and Medium-Power Network-Powered Broadband Communications Cables.**

**N (A) General.** Cables and conductors of Class 4 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, and medium-power network-powered broadband communications circuits unless permitted by 726.136(B) through (H).

In general, because of the potential higher voltage and strict monitoring of Class 4 circuits, the cables are not allowed to be installed with electric light, power, Class 1, non-power-limited fire alarm circuits, and medium-power network-powered broadband communications cables. Class 4 circuit power and current are continually monitored by the transmitters (TX) and receivers (RX) to clear any line-to-line or line-to-ground faults. However, 726.136(B) through (H) does provide for approved methods of separation.

**N (B) Separated by Barriers.** Class 4 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 4 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 4 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 4 circuits, and where either 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 4 circuits.
- (2) The non-Class 4 circuit conductors operate at 150 volts or less to ground and the Class 4 circuits are installed using Type CL4, Type CL4R, or Type CL4P cables if any CL4 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.

An example of associated systems is a programmable circuit breaker or alarm system. In such an installation, the Class 4 conductor insulation is not required to have the same voltage rating as the insulation on the power conductors in the same enclosure. They do require a 6 millimeter or ¼ inch separation at all points.

**N (E) Enclosures with Single Openings.** Class 4 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 4 circuits. Where Class 4 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 4 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 4 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 4 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 4 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 4 circuits are installed in Type MC cable.

**N (H) Other Applications.** For other applications, conductors of Class 4 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 4 circuit conductors are in a raceway or in metal-sheathed, metal-clad, non-metallic-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 4 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 726.139 Installation of Conductors of Different Circuits in the Same Cable, Enclosure, Cable Tray, Raceway, or Cable Routing Assembly.**

**N (A) Two or More Class 4 Circuits.** Conductors of two or more Class 4 circuits shall be permitted within the same cable, enclosure, raceway, or cable routing assembly.

**N (B) Class 4 Circuits With Class 2, Class 3, or Communications Circuits.** Conductors of one or more Class 4 circuits shall be permitted within the same cable assembly as conductors of Class 2, Class 3, or communications circuits if the insulation of the Class 2, Class 3, or communications circuit conductors in the cable is at least that required for Class 4 circuits. Class 4 cables shall be permitted within the same enclosure, raceway, or cable routing assembly as Class 2, Class 3, or communications circuits.

**N (C) Class 4 Cables With Other Circuit Cables.** Jacketed cables of Class 4 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 726.144 Ampacity.** The ampacity of Class 4 cables shall comply with 300.15 based on the temperature rating of the Class 4 cable for conductors sized 16 AWG to 6 AWG. For conductors sized 24 AWG to 17 AWG, the Class 4 cable shall be rated for the intended ampacity as evidenced by the marking FMP-XXA, where XX is the maximum allowable ampacity permitted.

Informational Note No. 1: See 722.179(A)(16) for additional Class 4 cable requirements.

Informational Note No. 2: See UL 1400-1, *Outline of Investigation for Fault-Managed Power Systems — Part 1: General Requirements*, and UL 1400-2, *Outline of Fault-Managed Power Systems — Part 2: Requirements for Class 4 Cables*, for information on determining maximum allowable ampacities.

### **N Part III. Listing Requirements**

**N 726.170 Listing of Equipment for Class 4 Systems.** The active components of a Class 4 system shall be listed as a Class 4 device. The listing information shall include compatible devices if a listed Class 4 device depends on specific system devices for interoperability, monitoring, or control.

Informational Note No. 1: See UL 1400-1, *Outline for Fault-Managed Power Systems — Part 1: General Requirements*, for information on determining applicable requirements for the listing of Class 4 power systems.

Informational Note No. 2: An example of a dependent active device in a Class 4 system is a transmitter that relies on a particular receiver or receivers as part of the monitoring and control system.

## **ARTICLE**

## **728**

## **Fire-Resistive Cable Systems**

**728.1 Scope.** This article covers the installation of fire-resistive cables, fire-resistive conductors, and other system components used for survivability of critical circuits to ensure continued operation during a specified time under fire conditions as required in this *Code*.

**728.3 Other Articles.** Wherever the requirements of other articles of this *Code* and Article 728 differ, the requirements of Article 728 shall apply.



This article does not require the use of fire-resistive cable systems. It provides requirements if such systems are required to be installed. Some of the common applications of fire-resistive cable systems are fire pump installations and critical operations power systems (COPS). Often, the use of fire-resistive cable systems will be a design consideration to ensure circuit integrity.

**Δ 728.4 General.** Fire-resistive cables and conductors and their components shall be tested and listed as a complete system, shall be designated for use in a specific system, and shall not be interchangeable between systems.

*Informational Note:* One method of defining the fire rating is by testing the system in accordance with UL 2196, *Fire Test for Circuit Integrity of Fire-Resistive Power, Instrumentation, Control and Data Cables*.

**728.5 Installations.** Fire-resistive cable systems installed outside the fire-rated rooms that they serve, such as the electrical room or the fire pump room, shall comply with the requirements of 728.5(A) through (H) and all other installation instructions provided in the listing.

**(A) Mounting.** The fire-resistive cable system shall be secured to the building structure in accordance with the listing and the manufacturer's installation instructions.

**(B) Supports.** The fire-resistive cable system shall be supported in accordance with the listing and the manufacturer's installation instructions.

*Informational Note:* The supports are critical for survivability of the system. Each system has its specific support requirements.

**Δ (C) Raceways and Couplings.** Where fire-resistive cable is listed to be installed in a raceway, the raceway enclosing the cable, any couplings, and any connectors shall be listed as part of the fire-resistive cable system.

The raceway fill for each system shall comply with the listing requirements for the system and shall not be greater than the fill permitted in Chapter 9, Table 1.

*Informational Note:* Raceway fill might not be the same for all listed fire-resistive cable systems.

**(D) Cable Trays.** Cable trays used as part of a fire-resistive cable system shall be listed as part of the fire-resistive cable system.

**(E) Boxes.** Boxes or enclosures used as part of a fire-resistive cable system shall be listed as part of the fire-resistive cable system and shall be secured to the building structure independently of the raceways or cables listed in the system.

**Δ (F) Pulling Lubricants.** Fire-resistive cable installed in a raceway shall only use pulling lubricants listed as part of the fire-resistive cable system.

**(G) Vertical Supports.** Cables and conductors installed in vertical raceways shall be supported in accordance with the listing of the fire-resistive cable system and in accordance with 300.19.

**(H) Splices.** Only splices that are part of the listing for the fire-resistive cable system shall be used. Splices shall have manufacturer's installation instructions.

**Δ 728.60 Equipment Grounding Conductor.** Fire-resistive cables installed in a raceway requiring an equipment grounding conductor shall use the same fire-resistive cable described in the system unless alternative equipment grounding conductors are listed with the system. Any alternative equipment grounding conductors shall be marked with the system number. The system shall specify a permissible equipment grounding conductor. If not specified, the equipment grounding conductor shall be the same as the fire-resistive cable described in the system.

**728.120 Marking.** In addition to the marking required in 310.8, system cables and conductors shall be surface marked with the suffix "FRR" (fire-resistive rating), along with the circuit integrity duration in hours, and with the system identifier.

## ARTICLE 750

## Energy Management Systems

**750.1 Scope.** This article applies to the installation and operation of energy management systems.

*Informational Note:* Performance provisions in other codes establish prescriptive requirements that may further restrict the requirements contained in this article.

This article addresses the installation and operation of energy management systems. Energy management systems have become integral elements of the electrical infrastructure through the control of utilization equipment, energy storage, and power protection. Energy management has two basic aspects: monitoring the system and controlling some part of the system. These two elements must be separated in order to allow the system to monitor and possibly restrict those areas of control that would adversely affect the electrical system. The requirements ensure that an energy management system does not overload a branch circuit, feeder, or service or override a load-shedding system for an alternate power source for fire pumps and other emergency systems.

**• N 750.6 Listing.** Energy management systems shall be one of the following:

- (1) Listed as a complete energy management system
- (2) Listed as a kit for field installation in switch or overcurrent device enclosures
- (3) Listed individual components assembled as a system

**750.20 Alternate Power Sources.** An energy management system shall not override any control necessary to ensure continuity of an alternate power source for the following:

- (1) Fire pumps
- (2) Health care facilities