

N **TABLE 722.179(B)** Cable Type Markings

Cable Type	Cable Marking
Class 4 plenum cable	CL4P
Class 3 plenum cable	CL3P
Class 2 plenum cable	CL2P
Power-limited fire alarm plenum cable	FPLP
Nonconductive optical fiber plenum cable	OFNP
Conductive optical fiber plenum cable	OFCP
Class 4 riser cable	CL4R
Class 3 riser cable	CL3R
Class 2 riser cable	CL2R
Power-limited fire alarm riser cable	FPLR
Nonconductive optical fiber riser cable	OFNR
Conductive optical fiber riser cable	OFCR
Class 4 general-purpose cable	CL4
Class 3 general-purpose cable	CL3
Class 2 general-purpose cable	CL2
Power-limited fire alarm cable	FPL
Nonconductive general-purpose optical fiber cable	OFN
Conductive general-purpose optical fiber cable	OFC
Alternative nonconductive general-purpose optical fiber cable	OFNG
Alternative conductive general-purpose optical fiber cable	OFCG
Class 3 cable — limited use	CL3X
Class 2 cable — limited use	CL2X
Undercarpet cable	CMUC

Note: All types of CL2, CL3, and FPL cables containing optical fibers are provided with the suffix “-OF.”

Exception: Voltage markings shall be permitted where the cable has multiple listings and a voltage marking is required for one or more of the listings.

Informational Note No. 3: Voltage markings on cables could be misinterpreted to suggest that the cables may be suitable for Class 1 electric light and power applications.

Informational Note No. 4: Cable types are listed in descending order of fire resistance rating.

N (C) Optional Markings. Cables shall be permitted to be surface marked to indicate special characteristics of the cable materials.

Informational Note No. 1: Examples of these characteristics include, but are not limited to, limited smoke, halogen free, low smoke and halogen free, and sunlight resistant.

Informational Note No. 2: Some examples of optional markings are ST1 to indicate limited smoke characteristics. See UL 2556, *Wire and Cable Test Methods*; HF to indicate halogen free. See in UL 2885, *Outline of Investigation for Acid Gas, Acidity and Conductivity of Combusted Materials*; and LSHF to indicate halogen free and low-smoke characteristics. See IEC 61034-2, *Measurement of smoke density of cables burning under defined conditions — Part 2: Test procedure and requirements*.

ARTICLE 724

Class 1 Power-Limited Circuits and Class 1 Power-Limited Remote-Control and Signaling Circuits

N 724.1 Scope. This article covers Class 1 circuits, including power-limited Class 1 remote-control and signaling circuits, that are not an integral part of a device or utilization equipment.

Informational Note: See 300.26 for classifications of remote-control and signaling circuits.

Article 724 may 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 724. 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 724. 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 724.

According to 90.3, the general wiring methods found in Chapters 1 through 4 of the NEC® apply to remote-control, signaling, and power-limited circuits, except as amended by Article 724 for specified conditions.

A remote-control, signaling, or power-limited circuit is the portion of the wiring system between the load side of the over-current device or the power-limited supply and all connected equipment.

Class 1 circuits are not permitted to exceed 30 volts and 1000 volt-amperes. In many cases, Class 1 circuits are extensions of power systems and are subject to the requirements of the power systems, except under the following conditions:

1. Conductors size 16 AWG and 18 AWG may be used. (See 724.43.)
2. Where damage to the circuit would introduce a hazard, the circuit must be mechanically protected. (See 724.31.)
3. The adjustment factors of 310.15(C) apply only if such conductors carry a continuous load exceeding 10 percent of the ampacity of the conductor. (See 724.51.)

Class 1 remote-control circuits are commonly used to operate motor controllers in conjunction with moving equipment or mechanical processes, elevators, conveyors, and other such

equipment. Class 1 remote-control circuits also can be used as shunt-trip circuits for circuit breakers.

N 724.3 Other Articles. In addition to the requirements of this article, circuits and equipment shall comply with 724.3(A) through (J).

N (A) Number and Size of Conductors in Raceway. The number and size of conductors shall comply with 300.17.

N (B) Spread of Fire or Products of Combustion. Installation of Class 1 circuits shall comply with 300.21.

N (C) Ducts, Plenums, and Other Air-Handling Spaces. Class 1 circuits installed in ducts, plenums, and other spaces used for environmental air shall comply with 300.22.

N (D) Hazardous (Classified) Locations. Class 1 circuits shall not be installed in any hazardous (classified) locations except as permitted by other articles of this *Code*.

N (E) Cable Trays. Cable tray installations shall comply with Parts I and II of Article 392.

N (F) Raceways Exposed to Different Temperatures. Installation of raceways shall comply with 300.7(A).

Condensation often forms in conduits that are exposed to different temperatures, such as a walk-in refrigerator or an air-conditioned area to a space that is warmer. Section 724.3(F) brings the requirements of 300.7(A) into Article 724.

See also

300.7(A) and its associated commentary

N (G) Vertical Support for Fire-Rated Cables and Conductors. Vertical installations of circuit integrity (CI) cables and conductors installed in a raceway or conductors and cables of electrical circuit protective systems shall comply with 300.19.

N (H) Bushings. Bushings shall be installed where cables emerge from raceways used for mechanical support or protection in accordance with 300.15(C).

N (I) Installation of Conductors With Other Systems. Installation of conductors with other systems shall comply with 300.8.

N (J) Identification of Equipment Grounding Conductors. Equipment grounding conductors shall be identified in accordance with 250.119.

N 724.21 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 preventing the 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 or ceiling panels. To safely service, rearrange, or install electrical equipment, the worker must have accessible workspace. See Exhibit 724.1.

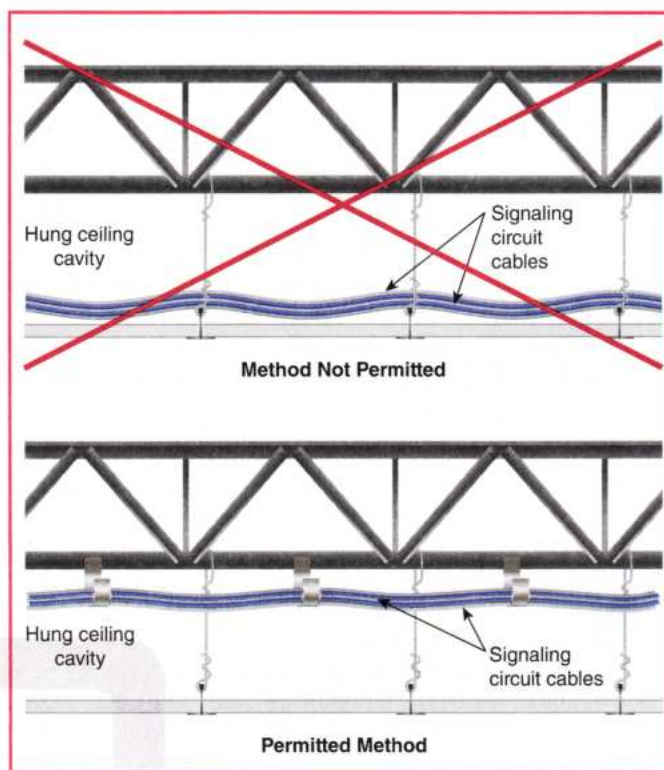


EXHIBIT 724.1 Incorrect cable installation (upper diagram) and correct method (lower diagram).

See also

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

N 724.24 Mechanical Execution of Work. Class 1 circuits shall be installed in a neat and workmanlike manner. Cables and conductors installed exposed on the surfaces of ceilings and sidewalls shall be supported by the building structure such that the cable will not be damaged by normal building use. Such cables shall be supported by straps, staples, hangers, cable ties, or similar fittings that are designed and installed to not damage the cable. The installation shall also comply with the requirements of 300.4 and 300.11.

Informational Note: Paint, plaster, cleaners, abrasives, corrosive residues, or other contaminants can result in an undetermined alteration of Class 1 cable properties.

Cable must be attached to or supported by the building structure by cable ties, straps, clamps, hangers, and so forth. 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 Exhibit 724.1.)

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.

N 724.30 Class 1 Circuit Identification. Class 1 circuits shall be identified at terminal and junction locations in a manner that prevents unintentional interference with other circuits during testing and servicing.

N 724.31 Safety-Control Equipment. If controlling safety-control equipment, Class 1 circuits shall be provided with physical protection if the failure of such equipment to operate introduces a direct fire or life hazard. All conductors of such circuits shall be installed in rigid metal conduit, intermediate metal conduit, rigid nonmetallic conduit, electrical metallic tubing, Type MI cable, or Type MC cable, or be otherwise suitably protected from physical damage.

The remote-control circuits to safety-control devices are required to be classified as Class 1 if failure of the safety-control circuit could cause a direct fire or life hazard. One example of the direct link between a failure and the initiation of a fire hazard is a boiler explosion caused by failure of the low-water cutoff circuit. See Exhibit 724.2.

Generally, signaling systems such as a nurse call system do not fit this category. Those systems do not have a direct link to the initiation of fire or the initiation of a life hazard but, rather, serve as the reporting or warning link of a hazard initiated by some other (indirect) cause.

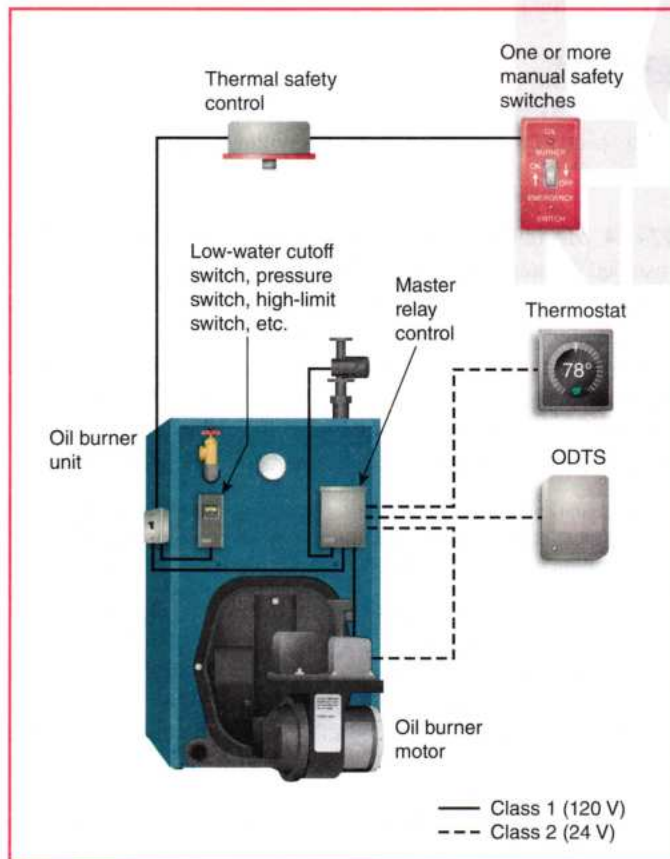


EXHIBIT 724.2 Typical installation of an automatic oil burner unit for a boiler employing a safety shutdown circuit required to be Class 1.

N 724.40 Class 1 Circuits. Class 1 circuits shall be supplied from a source with a rated output of not more than 30 volts and 1000 volt-amperes.

N (A) Class 1 Transformers. Transformers shall be permitted to supply Class 1 circuits.

Informational Note: See Parts I and II of Article 450 for information on transformers used to supply a Class 1 circuit.

N (B) Other Class 1 Power Sources. Power sources other than transformers shall be protected by overcurrent devices rated at not more than 167 percent of the volt-ampere rating of the source divided by the rated voltage. The overcurrent devices shall not be interchangeable with overcurrent devices of higher ratings. The overcurrent device shall be permitted to be an integral part of the power supply.

To comply with the 1000 volt-ampere limitation of 724.40, the maximum output (VA_{max}) of power sources other than transformers shall be limited to 2500 volt-amperes, and the product of the maximum current (I_{max}) and maximum voltage (V_{max}) shall not exceed 10,000 volt-amperes. These ratings shall be determined with any overcurrent-protective device bypassed.

VA_{max} is the maximum volt-ampere output after one minute of operation regardless of load and with overcurrent protection bypassed, if used. Current-limiting impedance shall not be bypassed when determining VA_{max} .

I_{max} is the maximum output current under any noncapacitive load, including short circuit, and with overcurrent protection bypassed, if used. Current-limiting impedance should not be bypassed when determining I_{max} . Where a current-limiting impedance listed for the purpose or as part of a listed product is used in combination with a stored energy source, such as a storage battery, to limit the output current, I_{max} limits apply after 5 seconds.

V_{max} is the maximum output voltage regardless of load with rated input applied.

N 724.43 Class 1 Circuit Overcurrent Protection. Overcurrent protection for conductors 14 AWG and larger shall be provided in accordance with the conductor ampacity, without applying the ampacity adjustment and correction factors specified in 310.15 to the ampacity calculation. Overcurrent protection shall not exceed 7 amperes for 18 AWG conductors and 10 amperes for 16 AWG.

Exception: Where other articles of this Code permit or require other overcurrent protection.

N 724.45 Class 1 Circuit Overcurrent Device Location. Overcurrent devices shall be located as specified in 724.45(A) through (E).

N (A) Point of Supply. Overcurrent devices shall be located at the point where the conductor to be protected receives its supply.

N (B) Feeder Taps. Class 1 circuit conductors shall be permitted to be tapped, without overcurrent protection at the tap, where the overcurrent device protecting the circuit conductor is sized to protect the tap conductor.

N (C) Branch-Circuit Taps. Class 1 circuit conductors 14 AWG and larger that are tapped from the load side of the overcurrent protective device(s) of a controlled light and power circuit shall require only short-circuit and ground-fault protection and shall be permitted to be protected by the branch-circuit overcurrent protective device(s) where the rating of the protective device(s) is not more than 300 percent of the ampacity of the Class 1 circuit conductor.

N (D) Primary Side of Transformer. Class 1 circuit conductors supplied by the secondary of a single-phase transformer having only a 2-wire (single-voltage) secondary shall be permitted to be protected by overcurrent protection provided on the primary side of the transformer if the protection is in accordance with 450.3 and does not exceed the value determined by multiplying the secondary conductor ampacity by the secondary-to-primary transformer voltage ratio. Transformer secondary conductors other than 2-wire shall not be considered to be protected by the primary overcurrent protection.

N (E) Input Side of Electronic Power Source. Class 1 circuit conductors supplied by the output of a single-phase, listed electronic power source other than a transformer having only a 2-wire (single-voltage) output for connection to Class 1 circuits shall be permitted to be protected by overcurrent protection provided on the input side of the electronic power source if the protection does not exceed the value determined by multiplying the Class 1 circuit conductor ampacity by the output-to-input voltage ratio. Electronic power source outputs other than 2-wire (single voltage) shall not be considered to be protected by the primary overcurrent protection.

N 724.46 Class 1 Circuit Wiring Methods. Class 1 circuits shall be installed in accordance with 300.2 through 300.26.

Exception No. 1: The requirements of 724.48 through 724.51 shall be permitted to apply in installations of Class 1 circuits.

Exception No. 2: Methods permitted or required by other articles of this Code shall apply to installations of Class 1 circuits.

N 724.48 Conductors of Different Circuits in the Same Cable, Cable Tray, Enclosure, or Raceway. Class 1 circuits shall be permitted to be installed with other circuits as specified in 724.48(A) and (B).

N (A) Two or More Class 1 Circuits. Class 1 circuits shall be permitted to occupy the same cable, cable tray, enclosure, or raceway regardless of whether the individual circuits are alternating current or direct current if all conductors are insulated for the maximum voltage of any conductor in the cable, cable tray, enclosure, or raceway.

N (B) Class 1 Circuits with Power-Supply Circuits. Class 1 circuits shall be permitted to be installed with power-supply conductors as specified in 724.48(B)(1) through (B)(4).

N (1) In Cables, Enclosures, or Raceways. Class 1 circuits and power-supply circuits shall be permitted to occupy the same cable, enclosure, or raceway without a barrier only where the equipment powered is functionally associated. Class 1 circuits shall be permitted to be installed together with the conductors of electric light, power, non-power-limited fire alarm systems, and medium-power network-powered broadband communications circuits where separated by a barrier.

N (2) In Factory- or Field-Assembled Control Centers. Class 1 circuits and power-supply circuits shall be permitted to be installed in factory- or field-assembled control centers.

N (3) In Manholes. Class 1 circuits and power-supply circuits shall be permitted to be installed as underground conductors in manholes in accordance with one of the following:

- (1) The power-supply or Class 1 circuit conductors are in metal-enclosed cable or Type UF cable.
- (2) The conductors are permanently separated from power-supply conductors by continuous firmly fixed nonconductors, such as flexible tubing, in addition to insulation on the wire.
- (3) The conductors are permanently and effectively separated from power-supply conductors and securely fastened to racks, insulators, or other approved supports.

Class 1 power-limited circuit conductors are permitted to be installed in manholes with wiring of power-supply conductors where one of the permanent separation requirements that follow are used:

1. Power-supply or Class 1 circuits are in metal-enclosed cable or Type UF cable.
2. Conductors are permanently separated by continuous firmly fixed nonconductors, such as flexible tubing.
3. Conductors are permanently separated by securely fastening to racks, insulators, or other approved supports.

Section 724.48(B)(1) permits Class 1 conductors to occupy the same cable, enclosure, or raceway with power supply conductors if they are functionally associated.

N (4) In Cable Trays. Installations in cable trays shall comply with the requirements of one of the following:

- (1) Class 1 circuit conductors and power-supply conductors not functionally associated with the Class 1 circuit conductors shall be separated by a solid fixed barrier of a material compatible with the cable tray.
- (2) Class 1 circuit conductors and power-supply conductors not functionally associated with the Class 1 circuit conductors shall be permitted to be installed in a cable tray

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.

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