210.4 Multiwire Branch Circuits.

(A) General. Branch circuits recognized by this article shall be permitted as multiwire circuits. A multiwire circuit shall be permitted to be considered as multiple circuits. All conductors of a multiwire branch circuit shall originate from the same panelboard or similar distribution equipment.

FPN: A 3-phase, 4-wire, wye-connected power system used to supply power to nonlinear loads may necessitate that the power system design allow for the possibility of high harmonic currents on the neutral conductor.

The power supplies for equipment such as computers, printers, and adjustable-speed motor drives can introduce harmonic currents in the system neutral conductor. The resulting total harmonic distortion current could exceed the load current of the device itself. See the commentary following 310.15(B)(4)(c) for a discussion of neutral conductor ampacity.

(B) Disconnecting Means. Each multiwire branch circuit shall be provided with a means that will simultaneously disconnect all ungrounded conductors at the point where the branch circuit originates.

Multiwire branch circuits can be dangerous when not all the ungrounded circuit conductors are de-energized and equipment supplied from a multiwire circuit is being serviced. For this reason, all ungrounded conductors of a multiwire branch circuit must be simultaneously disconnected to reduce the risk of shock to personnel working on equipment supplied by a multiwire branch circuit. The simultaneous disconnecting means requirement takes the guesswork out of ensuring safe conditions for maintenance. In former editions of the *NEC*, this requirement applied only where the multiwire branch circuit supplied equipment mounted to a common yoke or strap.

For a single-phase installation, the simultaneous disconnection can be achieved by two single-pole circuit breakers with an identified handle tie, as shown in Exhibit 210.1 (top), or by a 2-pole switch or circuit breaker, as shown in Exhibit 210.1 (bottom). For a 3-phase installation, a 3-pole circuit breaker or three single-pole circuit breakers with an identified handle tie provides the required simultaneous disconnection of the ungrounded conductors. Where fuses are used for the branch-circuit overcurrent protection, a 2-pole or 3-pole switch is required.

The simultaneous opening of both “hot” conductors at the panelboard effectively protects personnel from inadvertent contact with an energized conductor or device terminal during servicing. The simultaneous disconnection can be achieved by a 2-pole switch or circuit breaker, as shown in Exhibit 210.1 (bottom), or by two single-pole circuit breakers with an identified handle tie, as shown in Exhibit 210.1 (top). Where fuses are used for the branch circuit overcurrent protection, a 2-pole disconnect switch is required.

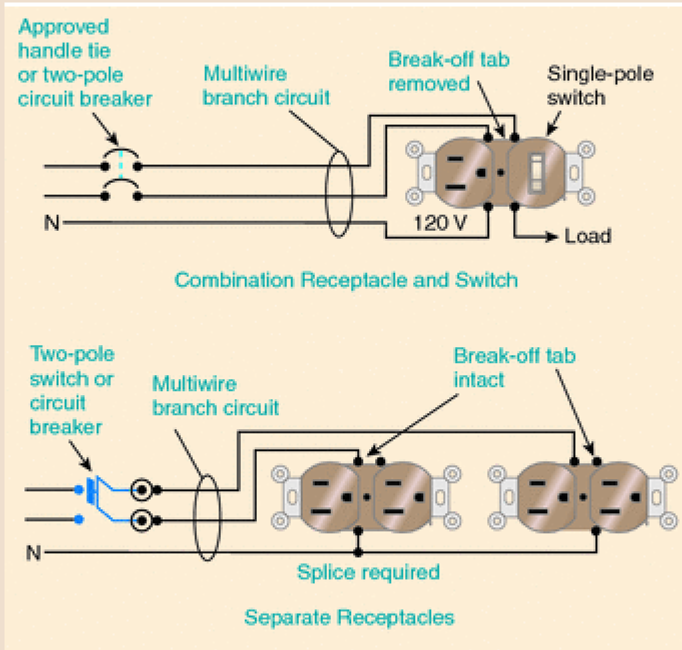


Exhibit 210.1 Examples where 210.4(B) requires the simultaneous disconnection of all ungrounded conductors to multiwire branch circuits supplying more than one device or equipment.

(C) Line-to-Neutral Loads. Multiwire branch circuits shall supply only line-to-neutral loads.

Exception No. 1: A multiwire branch circuit that supplies only one utilization equipment.

Exception No. 2: Where all ungrounded conductors of the multiwire branch circuit are opened simultaneously by the branch-circuit overcurrent device.

FPN: See 300.13(B) for continuity of grounded conductor on multiwire circuits.

The term *multiwire branch circuit* is defined in Article 100 as “a branch circuit that consists of two or more ungrounded conductors that have a voltage between them, and a grounded conductor that has equal voltage between it and each ungrounded conductor of the circuit and that is connected to the neutral or grounded conductor of the system.” Although defined as “a” branch circuit, 210.4(A) permits a multiwire branch circuit to be considered as multiple circuits and could be used, for instance, to satisfy the requirement for providing two small-appliance branch circuits for countertop receptacle outlets in a dwelling-unit kitchen.

The circuit most commonly used as a multiwire branch circuit consists of two ungrounded conductors and one grounded conductor supplied from a 120/240-volt, single-phase, 3-wire system. Such multiwire circuits supply appliances that have both line-to-line and line-to-neutral connected loads, such as electric ranges and clothes dryers, and also supply loads that are line-to-neutral connected only, such as the split-wired combination device shown in Exhibit 210.1 (bottom). A multiwire branch circuit is also permitted to supply a device with a 250-volt receptacle and a 125-volt receptacle, as shown in Exhibit 210.2, provided the branch-circuit overcurrent device simultaneously opens both of the ungrounded conductors.

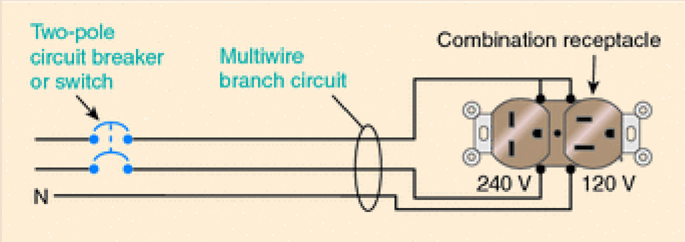


Exhibit 210.2 An example of 210.4(C), Exception No. 2, which permits a multiwire branch circuit to supply line-to-neutral and line-to-line connected loads, provided the ungrounded conductors are opened simultaneously by the branch-circuit overcurrent device.

Multiwire branch circuits have many advantages, including using three wires to do the work of four (in place of two 2-wire circuits), less raceway fill, easier balancing and phasing of a system, and less voltage drop. See the commentary following 215.2(A)(3), FPN No. 3, for further information on voltage drop for branch circuits.

Multiwire branch circuits may be derived from a 120/240-volt, single-phase; a 208Y/120-volt and 480Y/277-volt, 3-phase, 4-wire; or a 240/120-volt, 3-phase, 4-wire delta system. Section 210.11(B) requires multiwire branch circuits to be properly balanced. If two ungrounded conductors and a common neutral are used as a multiwire branch circuit supplied from a 208Y/120-volt, 3-phase, 4-wire system, the neutral carries the same current as the phase conductor with the highest current and, therefore, should be the same size. The neutral for a 2-phase, 3-wire or a 2-phase, 5-wire circuit must be sized to carry 140 percent of the ampere rating of the circuit, as required by 220.61(A) Exception. See the commentary following 210.4(A), FPN, for further information on 3-phase, 4-wire system neutral conductors.

If loads are connected line-to-line (i.e., utilization equipment connected between 2 or 3 phases), 2-pole or 3-pole circuit breakers are required to disconnect all ungrounded conductors simultaneously. In testing 240-volt equipment, it is quite possible not to realize that the circuit is still energized with 120 volts if one pole of the overcurrent device is open. See 210.10 and 240.15(B) for further information on circuit breaker overcurrent protection of ungrounded conductors. Other precautions concerning device removal on multiwire branch circuits are found in the commentary following 300.13(B).

(D) Grouping. The ungrounded and grounded conductors of each multiwire branch circuit shall be grouped by wire ties or similar means in at least one location within the panelboard or other point of origination.

Exception: The requirement for grouping shall not apply if the circuit enters from a cable or raceway unique to the circuit that makes the grouping obvious.

PART I. GENERAL PROVISIONS

210.1 Scope. Article 210 contains the requirements for conductor sizing, overcurrent protection, identification, and GFCI protection of branch circuits, as well as receptacle outlets and lighting outlet requirements.

Author's Comment: Article 100 defines a "branch circuit" as the conductors between the final overcurrent device and the receptacle outlets, lighting outlets, or other outlets. Figure 210–1

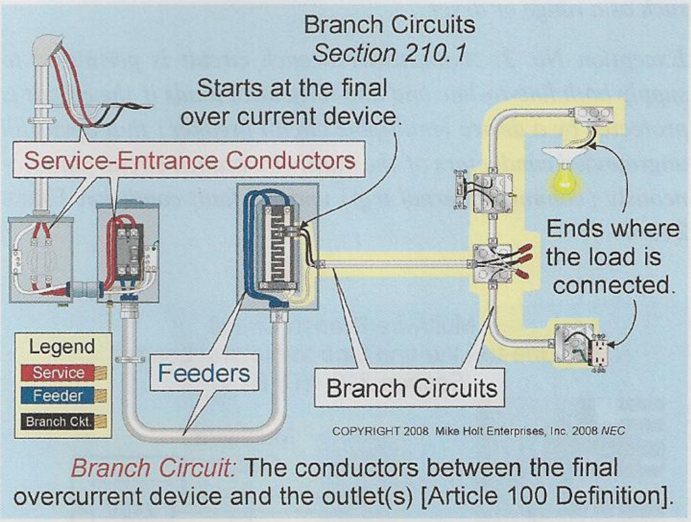


Figure 210–1

210.2 Other Articles. Other *NEC* sections that have specific requirements for branch circuits include:

- Air-Conditioning and Refrigeration, 440.6, 440.31, and 440.32
- Appliances, 422.10
- Data Processing (Information Technology) Equipment, 645.5
- Electric Space-Heating Equipment, 424.3(B)
- Motors, 430.22
- Signs, 600.5

210.3 Branch-Circuit Rating. The rating of a branch circuit is determined by the rating of the branch-circuit overcurrent device, not the conductor size.

Author's Comment: For example, the branch-circuit ampere rating of 10 THHN conductors on a 20A circuit breaker is 20A. Figure 210–2

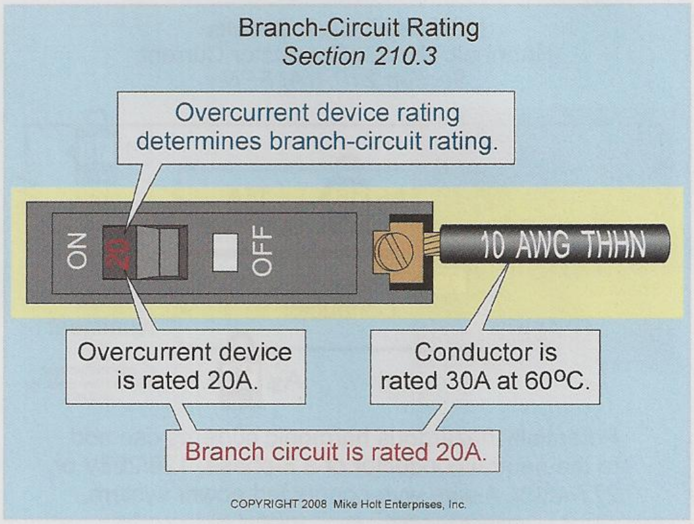


Figure 210–2

210.4 Multiwire Branch Circuits.

(A) General. A multiwire branch circuit can be considered a single circuit or a multiple circuit.

Author's Comments:

- See the definition of "Multiwire Branch Circuit" in Article 100.
- Two small-appliance circuits are required for receptacles that serve countertops in dwelling unit kitchens [210.11(C)(1) and 210.52(B)]. One 3-wire, single-phase, 120/240V multiwire branch circuit can be used for this purpose.

To prevent inductive heating and to reduce conductor impedance for fault currents, all conductors of a multiwire branch circuit must originate from the same panelboard.

Author's Comment: For more information on the inductive heating of metal parts, see 300.3(B), 300.5(I), and 300.20.

FPN: Unwanted and potentially hazardous harmonic neutral currents can cause additional heating of the neutral conductor of a 4-wire, three-phase, 120/208V or 277/480V wye-connected system, which supplies nonlinear loads.

Author's Comment: To prevent fire or equipment damage from excessive harmonic neutral currents, the designer should consider: (1) increasing the size of the neutral conductor, or (2) installing a separate neutral for each phase. Also see 220.61(C)(2) FPN No. 2, and 310.15(B)(4)(c) in this textbook. Figure 210–3

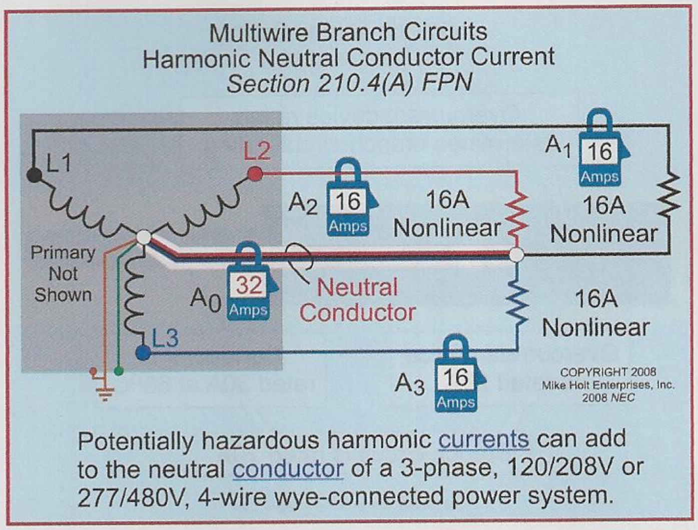


Figure 210–3

Author's Comments:

- See the definition of "Nonlinear Load" in Article 100.
- For more information, please visit www.MikeHolt.com. Click on "Technical Information" on the left side of the page, then select "Power Quality."

(B) Disconnecting Means. Each multiwire branch circuit must have a means to simultaneously disconnect all ungrounded conductors at the point where the branch circuit originates. Figure 210–4

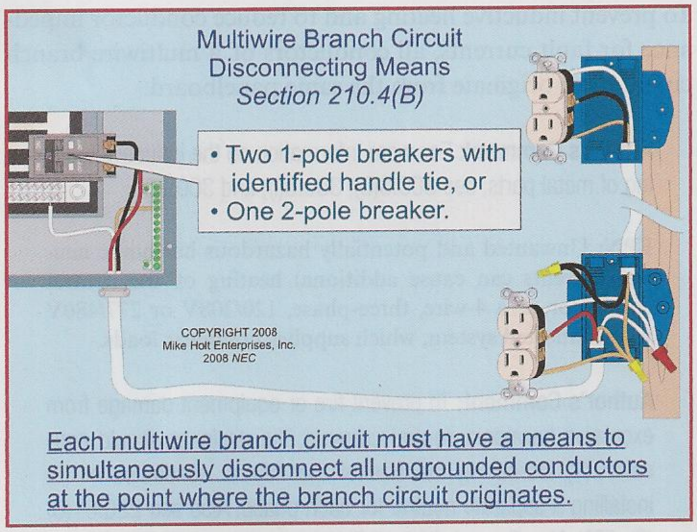


Figure 210–4

Author's Comment: Individual single-pole circuit breakers with handle ties identified for the purpose, or a breaker with common internal trip, can be used for this application [240.15(B)(1)].

CAUTION: *This rule is intended to prevent people from working on energized circuits they thought were disconnected.*

(C) Line-to-Neutral Loads. Multiwire branch circuits must supply only line-to-neutral loads.

Exception No. 1: A multiwire branch circuit is permitted to supply an individual piece of line-to-line utilization equipment, such as a range or dryer.

Exception No. 2: A multiwire branch circuit is permitted to supply both line-to-line and line-to-neutral loads if the circuit is protected by a device (multipole circuit breaker) that opens all ungrounded conductors of the multiwire branch circuit simultaneously (common internal trip) under a fault condition. Figure 210–5

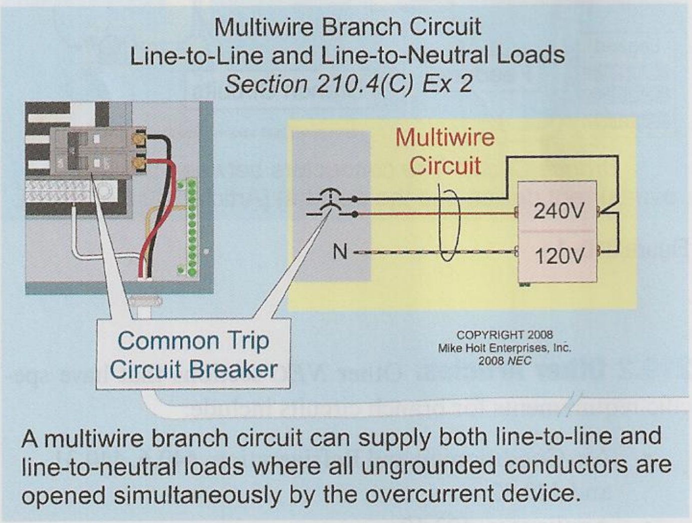


Figure 210–5

FPN: See 300.13(B) for the requirements relating to the continuity of the neutral conductor on multiwire branch circuits.

CAUTION: *If the continuity of the neutral conductor of a multiwire circuit is interrupted (open), the resultant over- or undervoltage can cause a fire and/or destruction of electrical equipment. For details on how this occurs, see 300.13(B) in this textbook.* Figure 210–6

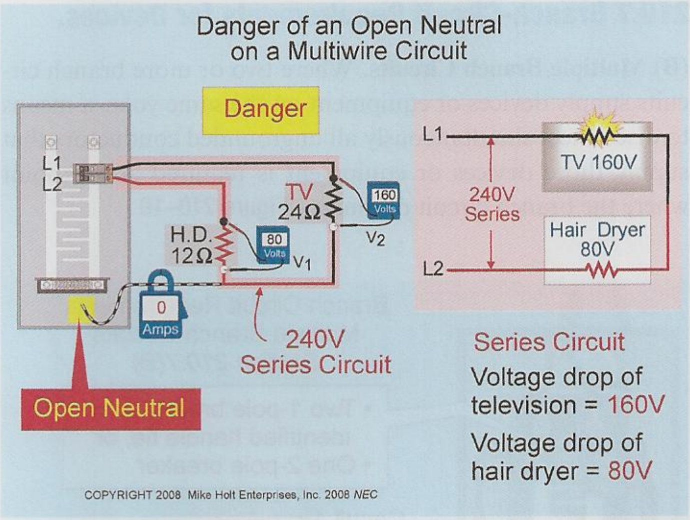


Figure 210–6

(D) Grouping. The ungrounded and neutral conductors of a multiwire branch circuit must be grouped together in at least one location by wire ties or similar means at the point of origination. Figure 210–7

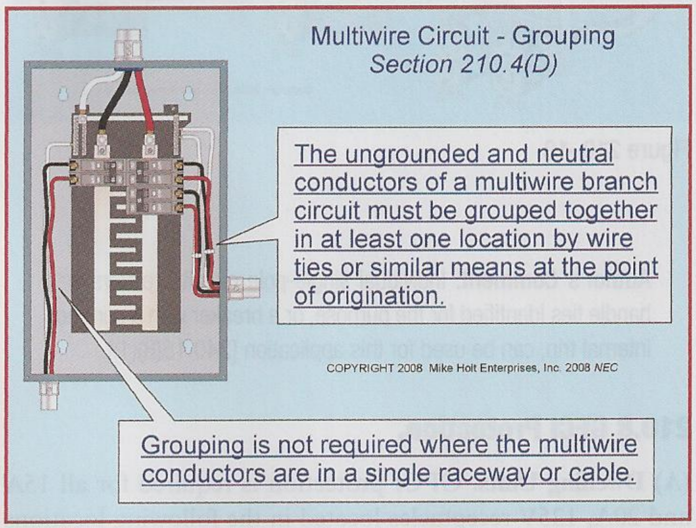


Figure 210–7

Exception: Grouping is not required where the circuit conductors are contained in a single raceway or cable that makes the grouping obvious.

Author's Comment: Grouping all associated conductors of a multiwire branch circuit together by wire ties or other means within the panel or origination point of the circuit makes it easier to visually identify the conductors of the multiwire branch circuit. The grouping will assist in connecting multiwire branch circuit conductors to circuit breakers correctly, particularly where twin breakers are used. If proper diligence is not exercised when making these connections, two circuit conductors could be accidentally connected to the same phase conductor.

CAUTION: *If the ungrounded conductors of a multiwire circuit are not terminated to different phases or lines, the currents on the neutral conductor will not cancel, but will add, which can cause an overload on the neutral conductor.* Figure 210–8

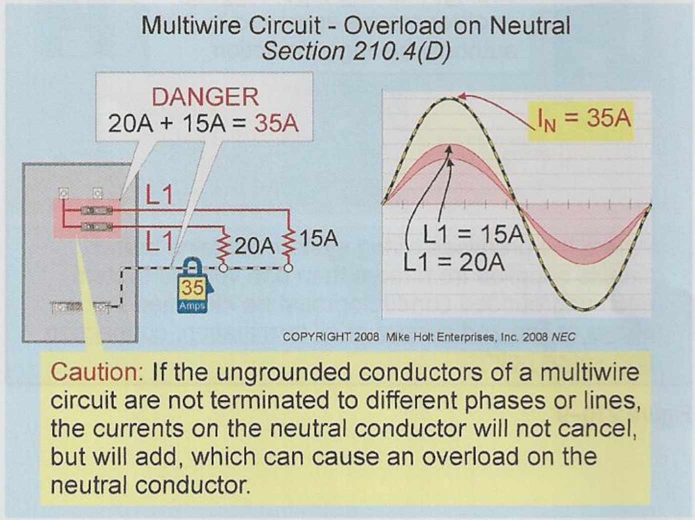


Figure 210–8

210.5 Identification for Branch Circuits.

(A) Neutral Conductor. The neutral conductor of a branch circuit must be identified in accordance with 200.6.

(B) Equipment Grounding Conductor. Equipment grounding conductors can be bare, covered, or insulated. Insulated equipment grounding conductors size 6 AWG and smaller must have a continuous outer finish either green or green with one or more yellow stripes [250.119].

On equipment grounding conductors larger than 6 AWG, insulation can be permanently reidentified with green marking at the time of installation at every point where the conductor is accessible [250.119(A)].

210.4 Multiwire Branch Circuits.

(A) General. Branch circuits recognized by this article shall be permitted as multiwire circuits. A multiwire circuit shall be permitted to be considered as multiple circuits. All conductors of a multiwire branch circuit shall originate from the same panelboard or similar distribution equipment.

FPN: A 3-phase, 4-wire, wye-connected power system used to supply power to nonlinear loads may necessitate that the power system design allow for the possibility of high harmonic currents on the neutral conductor.

The power supplies for equipment such as computers, printers, and adjustable-speed motor drives can introduce harmonic currents in the system neutral conductor. The resulting total harmonic distortion current could exceed the load current of the device itself. See the commentary following 310.15(B)(4)(c) for a discussion of neutral conductor ampacity.

(B) Disconnecting Means. Each multiwire branch circuit shall be provided with a means that will simultaneously disconnect all ungrounded conductors at the point where the branch circuit originates.

Multiwire branch circuits can be dangerous when not all the ungrounded circuit conductors are de-energized and equipment supplied from a multiwire circuit is being serviced. For this reason, all ungrounded conductors of a multiwire branch circuit must be simultaneously disconnected to reduce the risk of shock to personnel working on equipment supplied by a multiwire branch circuit. The simultaneous disconnecting means requirement takes the guesswork out of ensuring safe conditions for maintenance. In former editions of the *NEC*, this requirement applied only where the multiwire branch circuit supplied equipment mounted to a common yoke or strap.

For a single-phase installation, the simultaneous disconnection can be achieved by two single-pole circuit breakers with an identified handle tie, as shown in Exhibit 210.1 (top), or by a 2-pole switch or circuit breaker, as shown in Exhibit 210.1 (bottom). For a 3-phase installation, a 3-pole circuit breaker or three single-pole circuit breakers with an identified handle tie provides the required simultaneous disconnection of the ungrounded conductors. Where fuses are used for the branch-circuit overcurrent protection, a 2-pole or 3-pole switch is required.

The simultaneous opening of both “hot” conductors at the panelboard effectively protects personnel from inadvertent contact with an energized conductor or device terminal during servicing. The simultaneous disconnection can be achieved by a 2-pole switch or circuit breaker, as shown in Exhibit 210.1 (bottom), or by two single-pole circuit breakers with an identified handle tie, as shown in Exhibit 210.1 (top). Where fuses are used for the branch circuit overcurrent protection, a 2-pole disconnect switch is required.

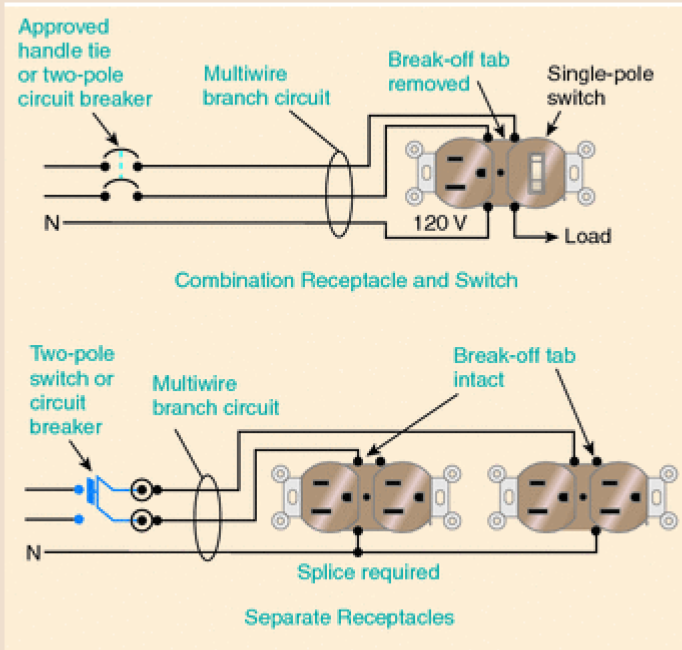


Exhibit 210.1 Examples where 210.4(B) requires the simultaneous disconnection of all ungrounded conductors to multiwire branch circuits supplying more than one device or equipment.

(C) Line-to-Neutral Loads. Multiwire branch circuits shall supply only line-to-neutral loads.

Exception No. 1: A multiwire branch circuit that supplies only one utilization equipment.

Exception No. 2: Where all ungrounded conductors of the multiwire branch circuit are opened simultaneously by the branch-circuit overcurrent device.

FPN: See 300.13(B) for continuity of grounded conductor on multiwire circuits.

The term *multiwire branch circuit* is defined in Article 100 as “a branch circuit that consists of two or more ungrounded conductors that have a voltage between them, and a grounded conductor that has equal voltage between it and each ungrounded conductor of the circuit and that is connected to the neutral or grounded conductor of the system.” Although defined as “a” branch circuit, 210.4(A) permits a multiwire branch circuit to be considered as multiple circuits and could be used, for instance, to satisfy the requirement for providing two small-appliance branch circuits for countertop receptacle outlets in a dwelling-unit kitchen.

The circuit most commonly used as a multiwire branch circuit consists of two ungrounded conductors and one grounded conductor supplied from a 120/240-volt, single-phase, 3-wire system. Such multiwire circuits supply appliances that have both line-to-line and line-to-neutral connected loads, such as electric ranges and clothes dryers, and also supply loads that are line-to-neutral connected only, such as the split-wired combination device shown in Exhibit 210.1 (bottom). A multiwire branch circuit is also permitted to supply a device with a 250-volt receptacle and a 125-volt receptacle, as shown in Exhibit 210.2, provided the branch-circuit overcurrent device simultaneously opens both of the ungrounded conductors.

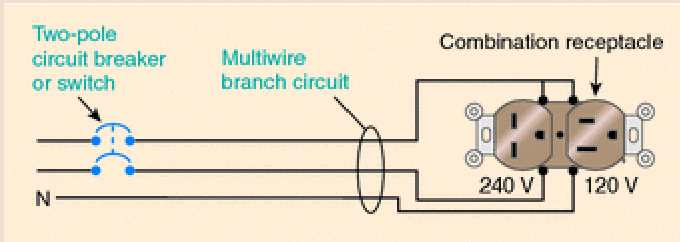


Exhibit 210.2 An example of 210.4(C), Exception No. 2, which permits a multiwire branch circuit to supply line-to-neutral and line-to-line connected loads, provided the ungrounded conductors are opened simultaneously by the branch-circuit overcurrent device.

Multiwire branch circuits have many advantages, including using three wires to do the work of four (in place of two 2-wire circuits), less raceway fill, easier balancing and phasing of a system, and less voltage drop. See the commentary following 215.2(A)(3), FPN No. 3, for further information on voltage drop for branch circuits.

Multiwire branch circuits may be derived from a 120/240-volt, single-phase; a 208Y/120-volt and 480Y/277-volt, 3-phase, 4-wire; or a 240/120-volt, 3-phase, 4-wire delta system. Section 210.11(B) requires multiwire branch circuits to be properly balanced. If two ungrounded conductors and a common neutral are used as a multiwire branch circuit supplied from a 208Y/120-volt, 3-phase, 4-wire system, the neutral carries the same current as the phase conductor with the highest current and, therefore, should be the same size. The neutral for a 2-phase, 3-wire or a 2-phase, 5-wire circuit must be sized to carry 140 percent of the ampere rating of the circuit, as required by 220.61(A) Exception. See the commentary following 210.4(A), FPN, for further information on 3-phase, 4-wire system neutral conductors.

If loads are connected line-to-line (i.e., utilization equipment connected between 2 or 3 phases), 2-pole or 3-pole circuit breakers are required to disconnect all ungrounded conductors simultaneously. In testing 240-volt equipment, it is quite possible not to realize that the circuit is still energized with 120 volts if one pole of the overcurrent device is open. See 210.10 and 240.15(B) for further information on circuit breaker overcurrent protection of ungrounded conductors. Other precautions concerning device removal on multiwire branch circuits are found in the commentary following 300.13(B).

(D) Grouping. The ungrounded and grounded conductors of each multiwire branch circuit shall be grouped by wire ties or similar means in at least one location within the panelboard or other point of origination.

Exception: The requirement for grouping shall not apply if the circuit enters from a cable or raceway unique to the circuit that makes the grouping obvious.

240.15 Ungrounded Conductors.

(A) Overcurrent Device Required. A fuse or an overcurrent trip unit of a circuit breaker shall be connected in series with each ungrounded conductor. A combination of a current transformer and overcurrent relay shall be considered equivalent to an overcurrent trip unit.

FPN: For motor circuits, see Parts III, IV, V, and XI of Article 430.

(B) Circuit Breaker as Overcurrent Device. Circuit breakers shall open all ungrounded conductors of the circuit both manually and automatically unless otherwise permitted in 240.15(B)(1), (B)(2), and (B)(3).

(1) Multiwire Branch Circuit. Except where limited by 210.4(B), individual single-pole circuit breakers, with or without identified handle ties, shall be permitted as the protection for each ungrounded conductor of multiwire branch circuits that serve only single-phase line-to-neutral loads.

(2) Grounded Single-Phase and 3-Wire dc Circuits. In grounded systems, individual single-pole circuit breakers with identified handle ties shall be permitted as the protection for each ungrounded conductor for line-to-line connected loads for single-phase circuits or 3-wire, direct-current circuits.

(3) 3-Phase and 2-Phase Systems. For line-to-line loads in 4-wire, 3-phase systems or 5-wire, 2-phase systems having a grounded neutral point and no conductor operating at a voltage greater than permitted in 210.6, individual single-pole circuit breakers with identified handle ties shall be permitted as the protection for each ungrounded conductor.

Before discussing handle ties, it is important to understand the Article 100 definition of the term *multiwire branch circuit*, as well as 210.4(C) and its two exceptions. Multiwire branch circuits are permitted to supply line-to-line connected loads where the loads are associated with a single piece of utilization equipment or where all of the ungrounded conductors are opened simultaneously by the branch-circuit overcurrent device (automatic opening in response to overcurrent). See the commentary following 210.4(C) for additional information.

The basic rule in 240.15(B) requires circuit breakers to open all ungrounded conductors of the circuit when it trips (automatic operation in response to overcurrent) or is manually operated as a disconnecting means. For 2-wire circuits with one conductor grounded, this rule is simple and needs no further explanation. For multiwire branch circuits of 600 volts or less, however, there are three acceptable methods of complying with this rule.

The first, and most widely used, method is to install a multipole circuit breaker with an internal common trip mechanism. The use of such multipole devices ensures compliance with all of the *Code* requirements for overcurrent protection and disconnecting of multiwire branch circuits. This breaker is operated by an external single lever internally attached to the two or three poles of the circuit breaker, or the external lever may be attached to multiple handles operated as one, provided the breaker is a factory-assembled unit in accordance with 240.8. Underwriters Laboratories refers to these devices as *multipole common trip circuit breakers*. This type of circuit breaker is required to be used for branch circuits that comprise multiple ungrounded conductors supplied by ungrounded 3-phase and single-phase systems. Where circuit breakers are used on ungrounded systems, it is important to verify compliance with the application requirements in 240.85. Of course, multipole common trip circuit breakers are permitted to be installed on any branch circuit supplied from a grounded system where used within their ratings.

The second option permitted for multiwire branch circuits is to use two or three single-pole circuit breakers and add an identified handle tie to function as a common operating handle. This multipole circuit breaker is field assembled by externally attaching an identified common lever (handle tie) onto the two or three individual circuit breakers. It is important to understand that handle ties do not cause the circuit breaker to function as a common trip device; rather, they only allow common operation as a disconnecting means. Handle tie mechanism circuit breakers are permitted as a substitute for internal common trip mechanism circuit breakers only for limited applications. Unless specifically prohibited elsewhere, circuit breakers with identified handle ties are permitted for multiwire branch circuits only where the circuit is supplied from grounded 3-phase or grounded single-phase systems. The single-pole circuit breakers used together in this fashion must be rated for the dual voltage encountered, such as 120/240 volts. It is important to note that the term *approved* was revised to *identified* for the 2005 *Code*, to require the use of hardware designed specifically to perform this common disconnecting means function. The use of approved, homemade hardware to perform this function is no longer permitted.

It is important to correlate the requirements of 240.15 with those in 210.4(B) covering disconnection of multiwire branch circuits. The revision to 210.4(B) in the 2008 *Code* requires a means to simultaneously disconnect all ungrounded conductors of the multiwire branch circuit. The use of a multipole switch or circuit breaker satisfies the 210.4(B) requirement, as does the use of single-pole circuit breakers with identified handle ties. The use of a multipole circuit breaker or single-pole circuit breakers joined with handle ties to comply with 210.4(B) also satisfies the requirements of 240.15 on the use of circuit breakers to provide overcurrent protection of multiwire branch circuits.

Exhibits 240.4 through 240.6 illustrate the application of 240.15(B). In Exhibit 240.4, where multipole common trip circuit breakers are required, handle ties are not permitted because the circuits are supplied from ungrounded systems. In Exhibit 240.5, where the supply systems are grounded, single-pole circuit breakers are permitted and handle ties or common trip operation is not required because the circuits supply line-to-neutral loads. In Exhibit 240.6, in which line-to-line loads are supplied from single-phase or 4-wire, 3-phase systems, identified handle ties or multipole common trip circuit breakers are permitted.

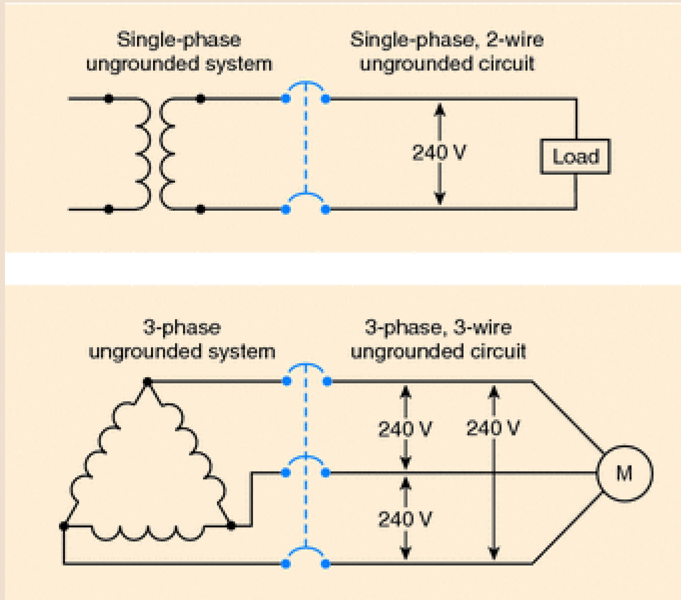


Exhibit 240.4 Examples of circuits that require multipole common trip–type circuit breakers, in accordance with 240.15(B).

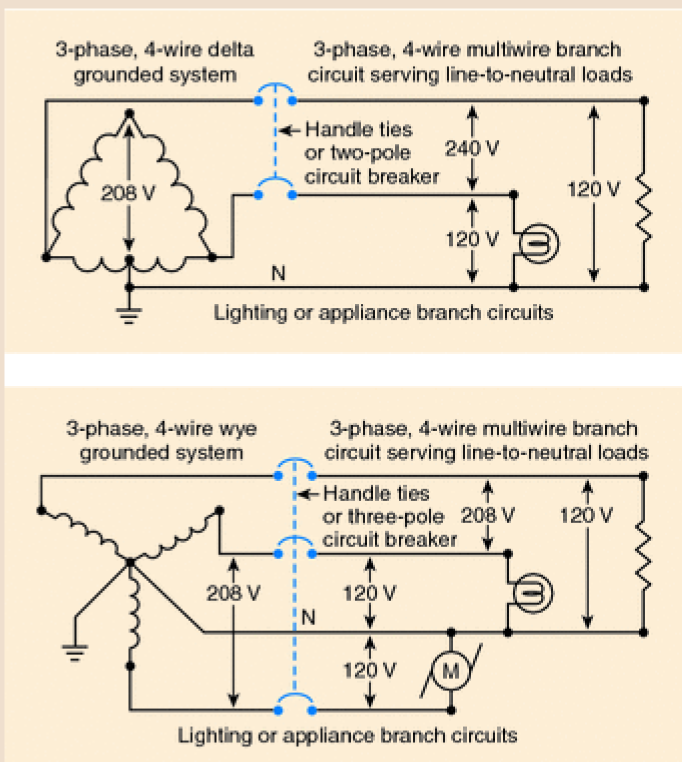


Exhibit 240.5 Examples of circuits in which single-pole circuit breakers are permitted, in accordance with 240.15(B)(1), because they open the ungrounded conductor of the circuit.

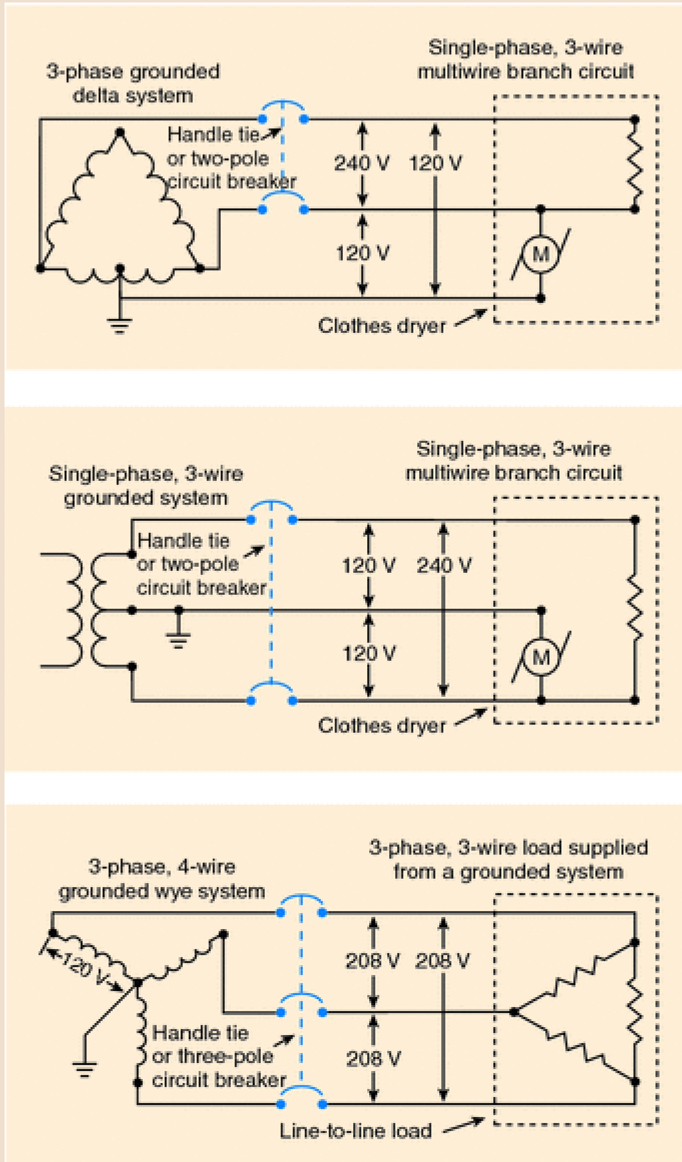
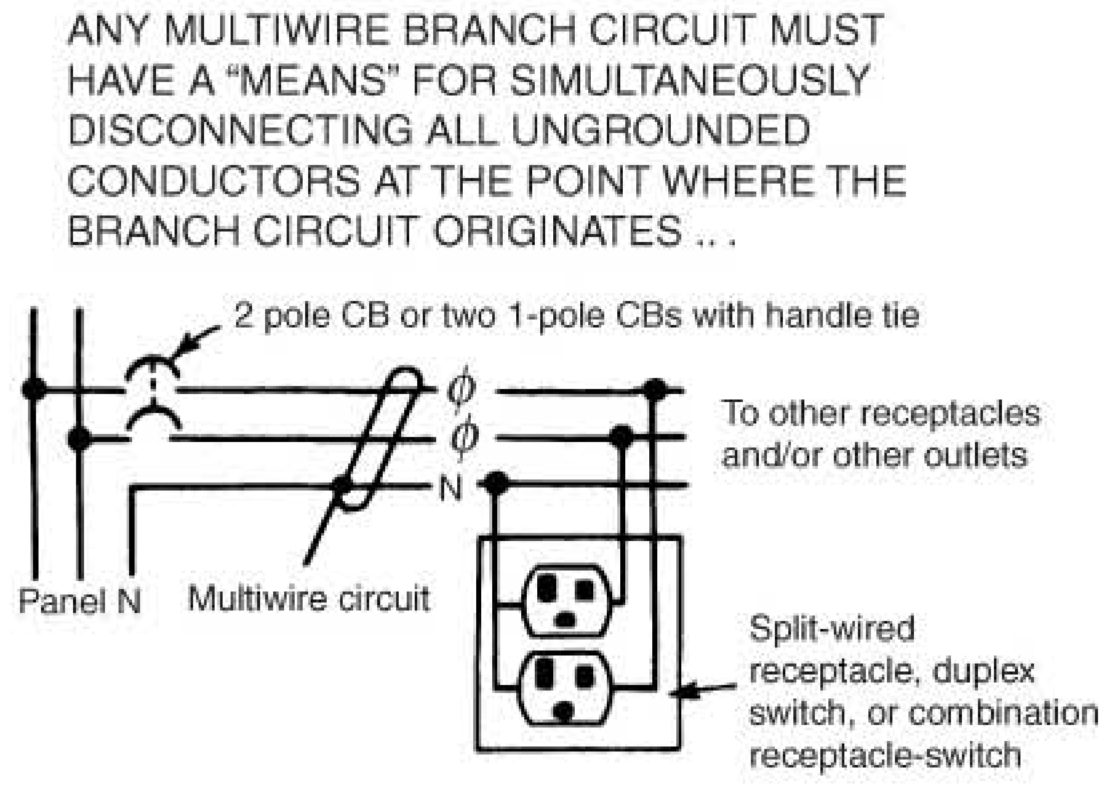
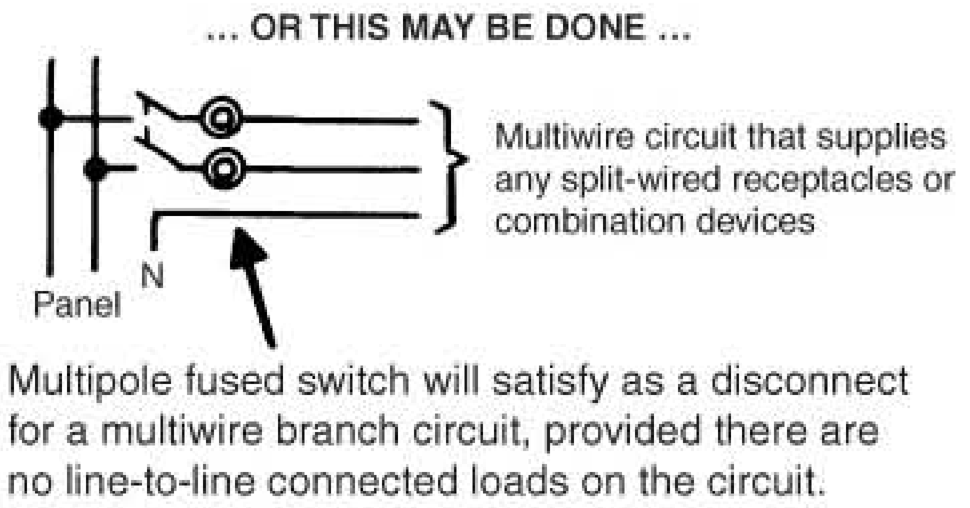


Exhibit 240.6 Examples of circuits in which identified handle ties are permitted to provide the simultaneous disconnecting function in accordance with 240.15(B)(2) or 240.15(B)(3).

(C) Closed-Loop Power Distribution Systems. Listed devices that provide equivalent overcurrent protection in closed-loop power distribution systems shall be permitted as a substitute for fuses or circuit breakers.

opened.





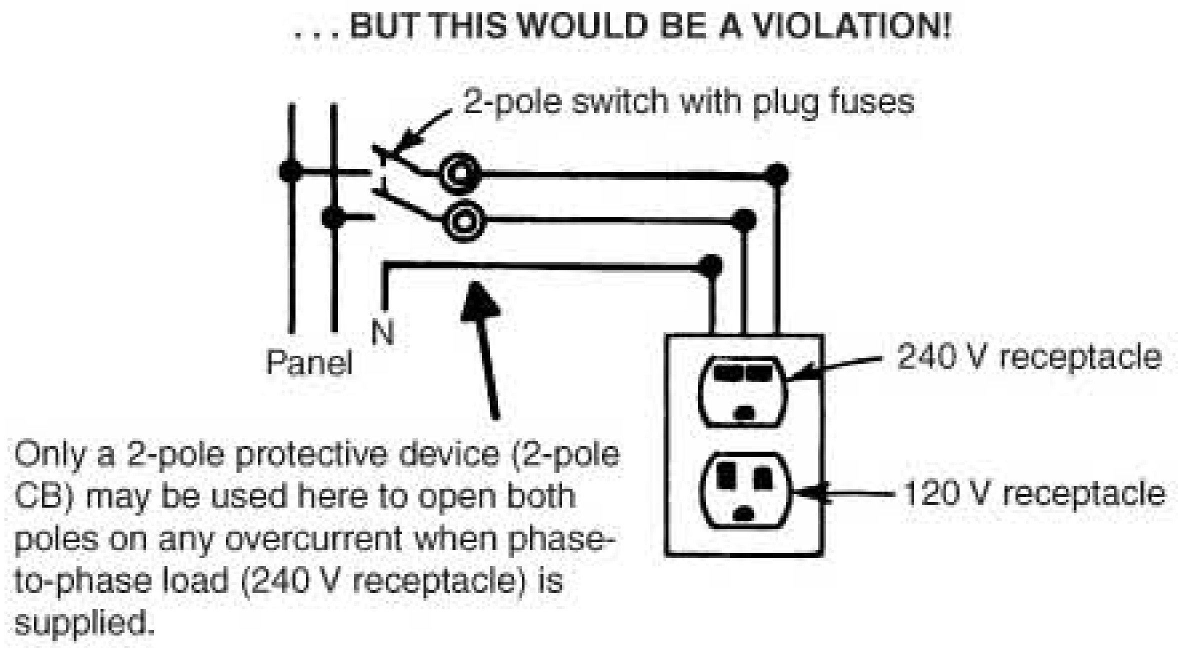


Fig. 210-7.

It should also be noted that although a 2-pole switch ahead of fuses may satisfy as the simultaneous disconnect required ahead of split-wired receptacles, such a switch does not satisfy as the simultaneous multipole "branch-circuit protective device" that is required by Exception No. 2 of 210.4 when a multi-wire circuit supplies any loads connected phase-to-phase. In such a case, a 2-pole CB must be used because fuses are single-pole devices and do not ensure simultaneous opening of all hot legs on overcurrent or ground fault.

It should be noted that the threat of motor burnout, shown in the diagram of Fig. 210-6, may exist just as readily where the 230-V resistance device and the 115-V motor are fed from a dual-voltage (240-V, 120-V) duplex receptacle as where loads are fixed wired. As shown in Fig. 210-8, the rule of 210.4 does clearly call for a 2-pole CB (and not single-pole CBs or fuses) for a circuit supplying a dual-voltage receptacle. In such a case, a line-to-line load and a line-to-neutral load could be connected and subjected to the condition shown in Fig. 210-6.

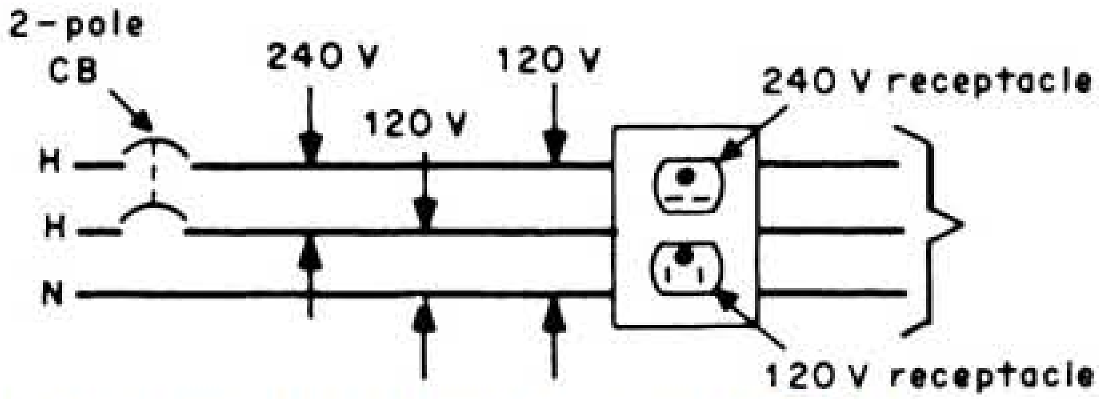


Fig. 210-8. A dual-voltage receptacle requires a 2-pole CB on its circuit. (Sec. 210.4.)

At the end of part **(C)**, a fine-print note calls attention to 300.13(B), which requires maintaining the continuity of the grounded neutral wire in a multiwire branch circuit by pigtailing the neutral to the neutral terminal of a receptacle. Exception No. 2 of 210.4(C) and 300.13(B) are both aimed at the same safety objective—to prevent damage to electrical equipment that can result when two loads of unequal impedances are series-connected from hot leg to hot leg as a result of opening the neutral of an energized multiwire branch circuit or are series-connected from hot leg to neutral. 300.13(B) prohibits dependency upon device terminals (such as internally connected screw terminals of duplex receptacles) for the splicing of neutral conductors in multiwire (3- or 4-wire) circuits. Grounded neutral wires must not depend on device connection (such as the break-off tab between duplex-receptacle screw terminals) for continuity. White wires can be spliced together, with a pigtail to the neutral terminal on the receptacle. If the receptacle is removed, the neutral will not be opened.

This rule is intended to prevent the establishment of unbalanced voltages should a neutral conductor be opened first when a receptacle or similar device is replaced on energized circuits. In such cases, the line-to-neutral connections downstream from this point (farther from the point of supply) could result in a considerably higher-than-normal voltage on one part of a multiwire circuit and damage equipment, because of the "open" neutral, if the downstream line-to-neutral loads are appreciably unbalanced. Refer to the description given in 300.13 of this book.

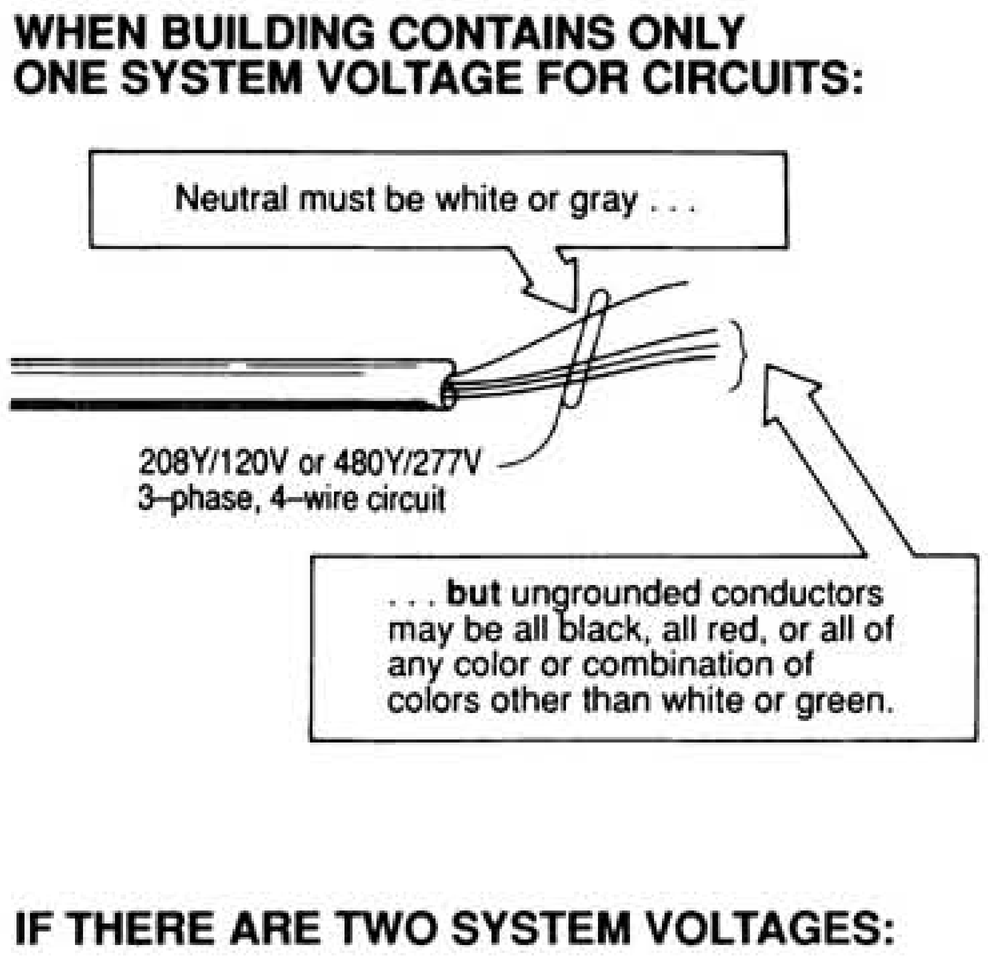
Part **(D)** of this section, new in the 2008 **NEC**, requires that all conductors of a multiwire branch circuit, including the associated neutral conductor, be grouped in the panelboard or other point of circuit origination. If the conductors enter in a cable assembly that makes the grouping obvious, or in a raceway containing only to one multiwire circuit so that the grouping is obvious, then the rule is satisfied. However, if multiple multiwire circuits enter through a common raceway, then you must keep track of which white (or gray) wire goes with which ungrounded conductors, and group those wires together at least once using wire ties or similar methods. Note that if two cable assemblies enclosing multiwire circuits enter a panel through a duplex cable connector, additional grouping within the panel would probably be required because the cable grouping would no longer qualify as "obvious."

210.5. Identification for Branch Circuits. For grounding and grounded conductors this section simply directs the reader to comply with other Code rules that cover conductor color-coding or color-identification schemes. It directs that "grounded" and "grounding" conductors in branch circuits utilize the specific color identification given in 200.6 and 250.119. Those rules generally reserve the color green for equipment grounding conductors and white, gray, or three continuous white stripes on other than green-colored insulation for the grounded conductors in branch circuits.

It should be noted that rules on color coding of conductors given in Art. 210 apply only to branch-circuit conductors and do not directly require color coding of feeder conductors. But the rules given in 200.6 and 250.119 must generally be observed, and would apply to feeder and service conductors. 215.12 also requires identification of phase legs of feeders to panelboards, switchboards, and so forth—and that requires some technique for marking the phase legs; those provisions are now harmonized with the ones here for branch circuits. Note that many design engineers have insisted on color coding of feeder conductors all along to afford effective balancing of loads on the different phase legs.

Color identification for branch-circuit conductors is divided into three categories:

Grounded conductor As indicated, grounded conductors must satisfy 200.6. That rule generally requires that the grounded conductor of a branch circuit (the neutral of a wye system or a grounded phase of a delta) must be identified by a continuous white or gray color for the entire length of the conductor, or have three continuous white stripes for its entire length on other than green insulation. Where wires of different systems (such as 208/120 and 480/277) are installed in the same raceway, box, or other enclosure, the neutral or grounded wire of one system must be white or gray or have the three continuous white stripes on other than green insulation; and the neutral of the other system must be white with a color stripe, or be gray if the first one is white, etc., or it must be otherwise distinguished—such as by painting or taping. The point is that neutrals of different systems must be distinguished from each other when they are in the same enclosure [200.6(D) and Fig. 210-9]. For more, See 200.6.



nonlinear loads that are connected line-to-neutral, it may be necessary to use an oversized neutral (up to two sizes larger), or each phase conductor could be run with an individual full-size neutral. Either way, a derating of 80 percent would be required for the number of conductors [see 310.15(B)(4)(c)].

Part **(B)** of this section requires a "means" to simultaneously disconnect all ungrounded conductors of a multiwire branch circuit "at the point where the branch circuit originates." Although at one time this was a dwelling unit provision for split-wired receptacles, and then it applied in all occupancies to multiple devices on one yoke, *it now applies to all multiwire circuits serving any loads in all occupancies*. There is a long and unfortunate history of unqualified persons creating havoc when working on multiwire circuits without protecting against the consequences of open neutrals and of voltage backfeeding into an outlet from a different leg than the one thought to be at issue. Now a common disconnecting means will be in an obvious and prominent location when the branch circuit is being disconnected.

A multipole circuit breaker (CB) certainly complies with this rule, as would a multipole fused switch. Single-pole circuit breakers connected together with approved handle ties presumably qualify, although this is not perfectly clear from the Code text. Remember that handle ties are for operation by hand; they are not rated to automatically open the companion breaker if only one leg trips. Even less clear is a multipole switch located immediately adjacent to the panel where the circuit originates. This would be the only practical option on an existing fusible panelboard.

The objective is to assure that when someone goes to deenergize an ungrounded conductor of some equipment being maintained or replaced, that person will open all the conductors and thereby preclude line voltage from appearing on the load-side neutral conductor through loads connected on another leg of the circuit. In other words, this rule serves a maintenance function. If the purpose were electrical, even fuses in a multipole fused switch, would have been disallowed because they are inherently single-pole devices and if one opens, the others still provide power to the other legs. In this regard, note that the wording here differs from the requirement in 210.4(C) Exception No. 2, which serves an electrical function and clearly does require a multipole circuit breaker for other reasons. On this basis a good case can be made for the multipole switch adjacent to the panel, but this is certainly subject to local interpretation.

The basic rule of part **(C)** addresses the need for personnel safety. To help minimize the possibility of shock or electrocution during maintenance or repair, this section states that multiwire branch circuits (such as 240/120-V, 3-wire, single-phase and 3-phase, 4-wire circuits at 208/120 or 480/277 V) may be used only with loads connected from a hot or phase leg to the neutral conductor (Fig. 210-4). However, while generally prohibited, where additional measures are taken to protect personnel, the two exceptions to this rule permit supplying "other than line-to-neutral loads" from multiwire branch circuits. The two exceptions to that rule are shown in Fig. 210-5.

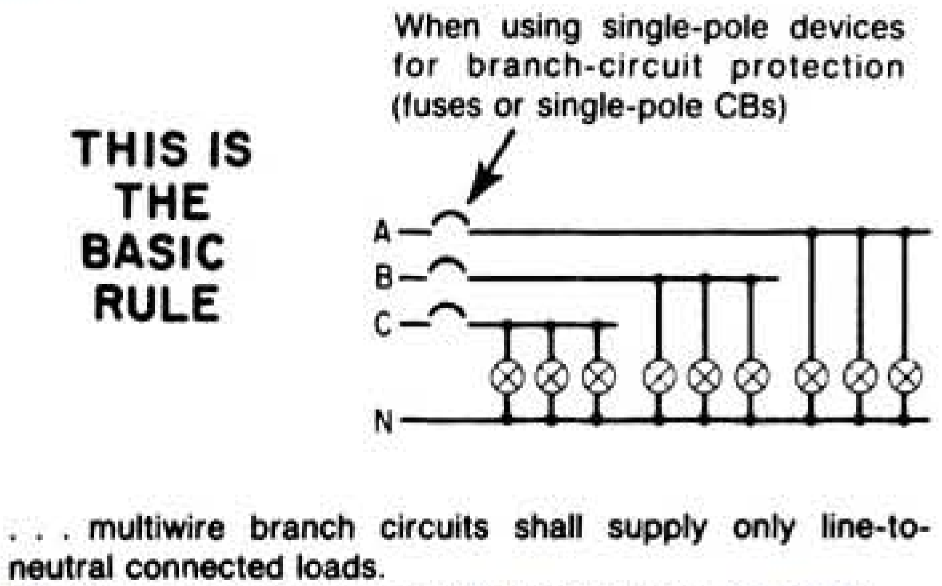


Fig. 210-4. With single-pole protection only line-to-neutral loads may be fed. (Sec. 210.4.)

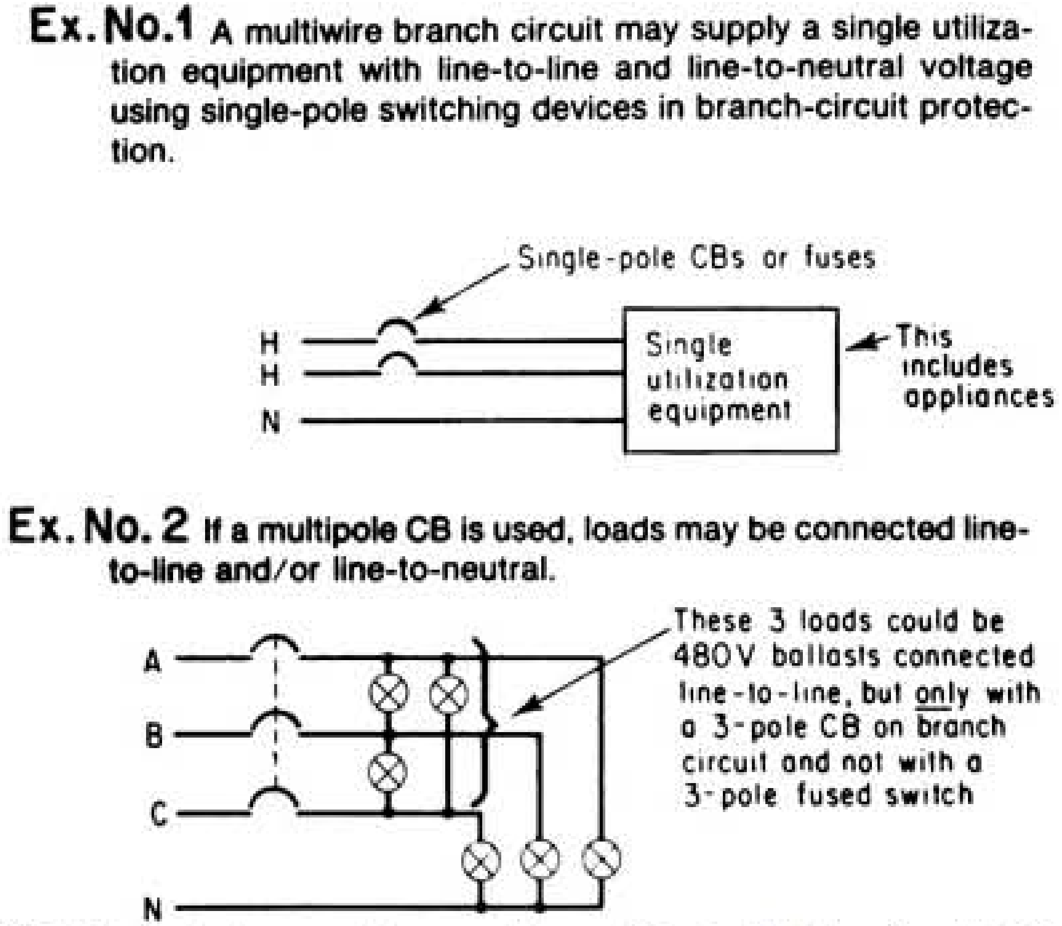


Fig. 210-5. Line-to-line loads may only be connected on multiwire circuits that conform to the Exceptions given. (Sec. 210.4.)

Exception No. 1 permits use of single-pole protective devices for an individual circuit to "only one utilization equipment"—in which the load may be connected line-to-line as well as line-to-neutral. "Utilization equipment," as defined in Art. 100, is "equipment which utilizes electric energy for electronic, electromechanical, chemical, heating, lighting, or similar purposes." The definition of "appliance," in Art. 100, notes that an *appliance* is "utilization equipment, generally other than industrial, that is normally built in standardized sizes or types and is installed or connected as a unit to perform one or more functions such as washing clothes, air conditioning, food mixing, deep frying, and so forth." Because of those definitions, the wording of Exception No. 1 opens its application to commercial and industrial equipment as well as residential. It should be noted that 210.4(B) applies in these cases, and therefore means must still be provided, such as handle ties, to provide for simultaneous opening of a set of single-pole breakers installed for this equipment.

Exception No. 2 permits a multiwire branch-circuit to supply line-to-line connected loads, but only when it is protected by a multipole circuit breaker (CB). The intent of Exception No. 2 is that line-to-line connected loads may be used (other than in Exception No. 1) only where the poles of the circuit protective device operate together, or simultaneously. A multipole CB satisfies the rule, but a fused multipole switch would not comply because the hot circuit conductors are not "opened simultaneously by the branch-circuit overcurrent device." This rule requiring a multipole CB for any circuit that supplies line-to-line connected loads as well as line-to-neutral loads was put in the Code to prevent equipment loss under the conditions shown in Fig. 210-6. Use of a 2-pole CB in the sketch would cause opening of both hot legs on any fault and prevent the condition shown.

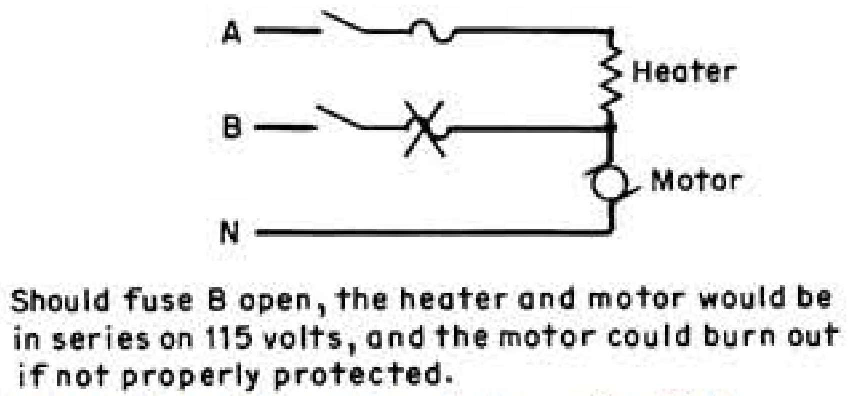
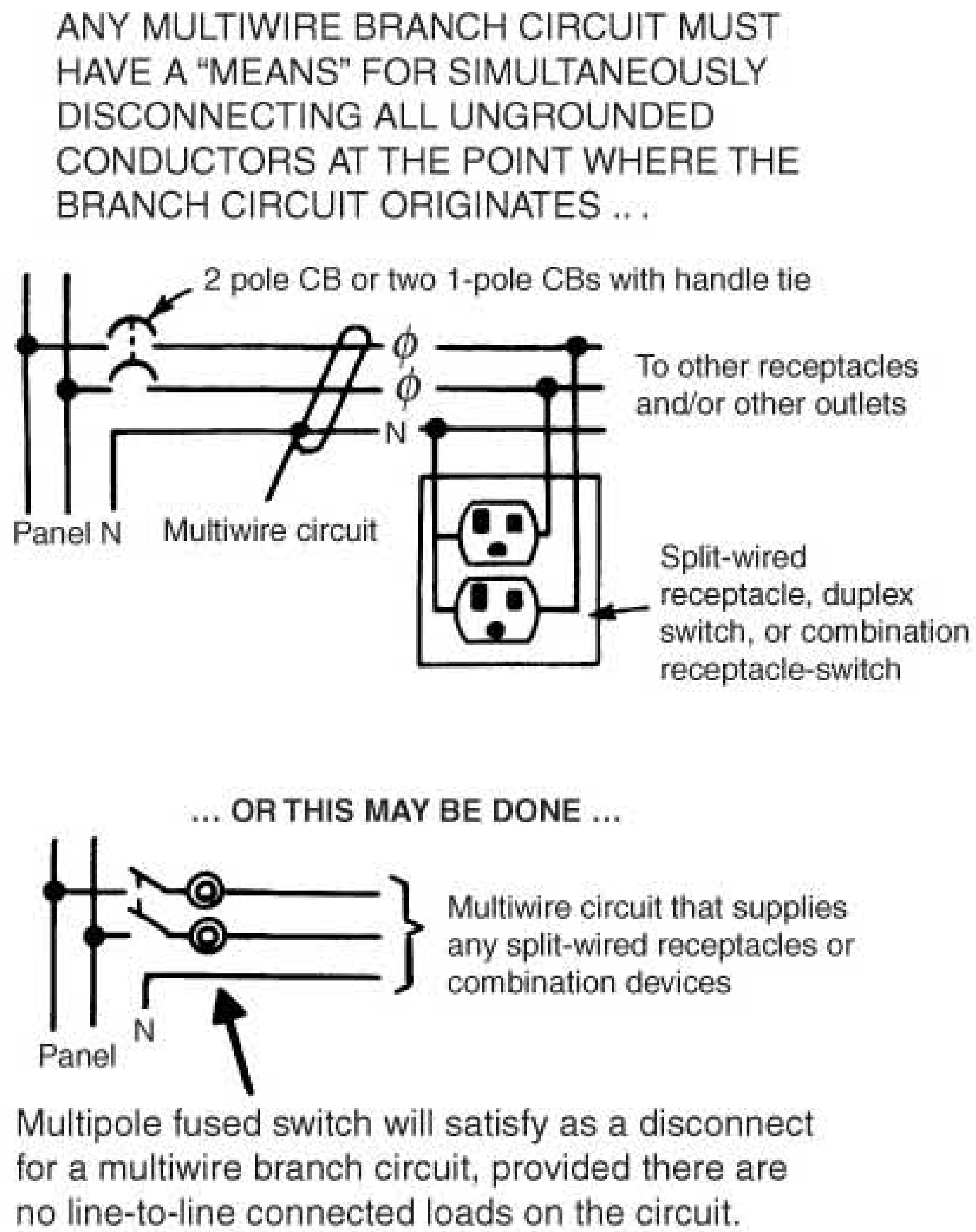


Fig. 210-6. Single-pole protection can expose equipment to damage. (Sec. 210.4.)

Figure 210-7 shows that a 2-pole CB, two single-pole CBs with a handle tie that enables them to be used as a 2-pole disconnect, or a 2-pole switch ahead of branch-circuit fuse protection will satisfy the requirement that both hot legs must be interrupted when the disconnect means is opened to deenergize a multiwire circuit to a split-wired receptacle. This Code rule provides the greater safety of disconnecting both hot conductors simultaneously to prevent shock hazard in replacing or maintaining any piece of electrical equipment where only one of two hot supply conductors has been opened.



EXCEPTION —

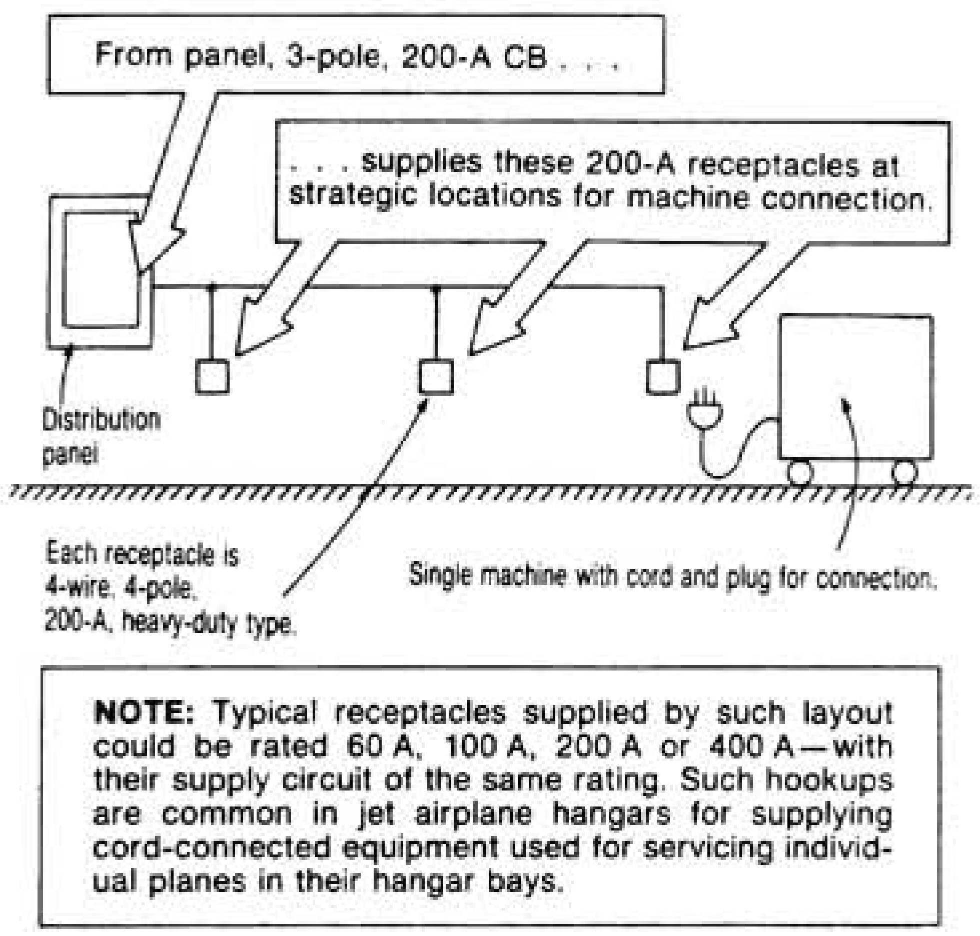


Fig. 210-1. A multioutlet branch circuit must usually have a rating (of its overcurrent protective device) at one of the five values set by 210.3. (Sec. 210.3.)

Under the definition for "receptacle" in NE Code Art. 100, it clearly provides that a duplex receptacle is two receptacles and not one—even though there is only one box and therefore one outlet. However, a circuit that supplies only one duplex receptacle is still usually not an "individual branch circuit" because it normally will be likely to supply more than one utilization equipment through its separate receptacles, and therefore flunk the definition of "individual branch circuit" in Art. 100. If an individual branch circuit is required for any reason, and the purpose is to supply cord-and-plug connected utilization equipment, a single receptacle must be installed. One example is the individual branch-circuit required in 422.16(B)(4)(5) for a cord-and-plug connected range hood.

The Exception to the rule of 210.3 gives limited permission to use multioutlet branch circuits rated over 50 A—but only to supply nonlighting loads and only in industrial places where maintenance and supervision ensure that only qualified persons will service the installation. This Exception recognizes a real need in industrial plants where a machine or other electrically operated equipment is going to be provided with its own dedicated branch circuit of adequate capacity—in effect, an individual branch circuit—but where such machine or equipment is required to be moved around and used at more than one location, requiring multiple points of outlet from the individual branch circuit to provide for connection of the machine or equipment at any one of its intended locations (see Fig. 210-2). For instance, there could be a 200-A branch circuit to a special receptacle outlet or a 300-A branch circuit to a single machine. In fact, the wording used here actually recognizes the use of such a circuit to supply more than one machine at a time, but other realities of application make such an approach impractical.

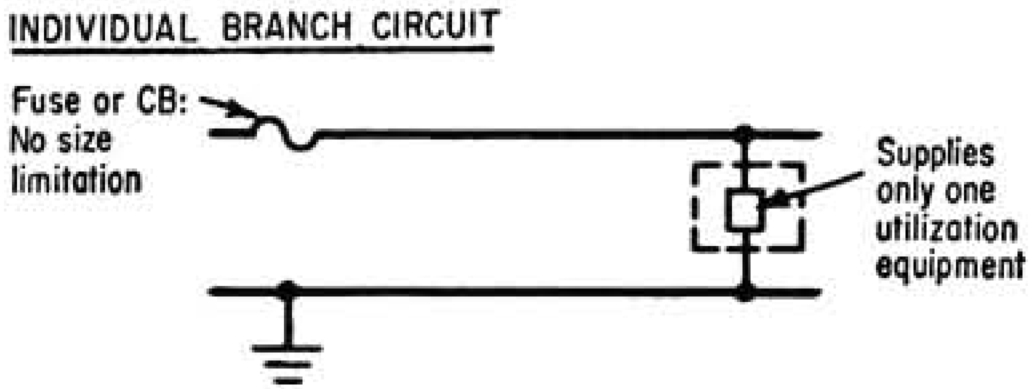


Fig. 210-2. A circuit to a single load device or equipment may have any rating. (Sec. 210.3.)

It is important to note that it is the size of the overcurrent device that actually determines the rating of any circuit covered by Art. 210, even when the conductors used for the branch circuit have an ampere rating higher than that of the protective device. In a typical case, for example, a 20-A circuit breaker in a panelboard might be used to protect a branch circuit in which 10 AWG conductors are used as the circuit wires. Although the load on the circuit does not exceed 20 A, and 12 AWG conductors would have sufficient current-carrying capacity to be used in the circuit, the 10 AWG conductors with their rating of 30 A were selected to reduce the voltage drop in a long homerun. The rating of the circuit is 20 A because that is the size of the overcurrent device. The current rating of the wire does not enter into the ampere classification of the circuit.

210.4. Multiwire Branch Circuits. A "branch circuit," as covered by Art. 210, may be a 2-wire circuit or may be a "multiwire" branch circuit. A "multiwire" branch circuit consists of two or more ungrounded conductors having a potential difference between them and an identified grounded conductor having equal potential difference between it and each of the ungrounded conductors and which is connected to the neutral conductor of the system. Thus, a 3-wire circuit consisting of two opposite-polarity ungrounded conductors and a neutral derived from a 3-wire, single-phase system or a 4-wire circuit consisting of three different phase conductors and a neutral of a 3-phase, 4-wire system is a single multiwire branch circuit. This is only one circuit, even though it involves two or three single-pole protective devices in the panelboard (Fig. 210-3). This is important, because other sections of the Code refer to conditions involving "one branch circuit" or "the single branch circuit." (See 250.32 Exception and 410.65.)

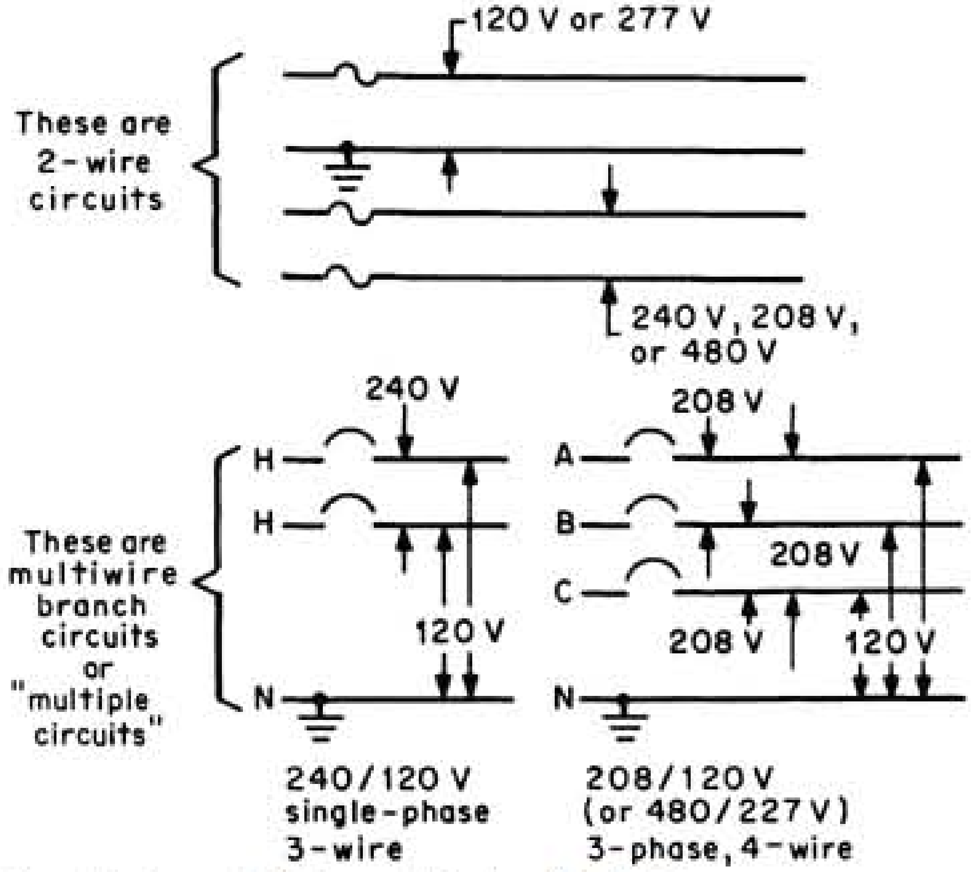


Fig. 210-3. Branch circuits may be 2-wire or multiwire type. (Sec. 210.4.)

The wording of part **(A)** of this section makes clear that a multiwire branch circuit may be considered to be either "a single circuit" or "multiple circuits." This coordinates with other Code rules that refer to multiwire circuits as well as rules that call for two or more circuits. For instance, 210.11(C)(1) requires that at least two 20-A small appliance branch circuits be provided for receptacle outlets in those areas specified in 210.52(B)—that is, the kitchen, dining room, pantry, and breakfast room of a dwelling unit. The wording of this rule recognizes that a single 3-wire, single-phase 240/120-V circuit run to the receptacles in those rooms is equivalent to two 120-V circuits and satisfies the rule of 210.11(C)(1).

In addition, a "multiwire" branch circuit is considered to be a single circuit of multiple-wire makeup. That will satisfy the rule in 410.65, which recognizes that a multiwire circuit is a single circuit when run through end-to-end connected lighting fixtures that are used as a raceway for the circuit conductors. Only one principal circuit—either a 2-wire circuit or a multiwire (3- or 4-wire) circuit—may be run through fixtures connected in a line.

The FPN following part **(A)** of 210.4 warns of the potential for "neutral overload" where line-to-neutral nonlinear loads are supplied. This results from the additive harmonics that will be carried by the neutral in multiwire branch circuits. In some cases, where the load to be supplied consists of, or is expected to consist of, so-called nonlinear loads that are connected line-to-neutral, it may be necessary to use an oversized neutral (up to two sizes larger), or each phase conductor could be run with an individual full-size neutral. Either way, a derating of 80 percent would be required for the number of conductors [see 310.15(B)(4)(c)].

Part **(B)** of this section requires a "means" to simultaneously disconnect all ungrounded conductors of a multiwire branch circuit "at the point where the branch circuit originates." Although at one time this was a dwelling unit provision for split-wired receptacles, and then it applied in all occupancies to multiple devices on one yoke, *it now applies to all multiwire circuits serving any loads in all occupancies*. There is a long and unfortunate history of unqualified persons creating havoc when working on multiwire circuits without protecting against the consequences of open neutrals and of voltage backfeeding into an outlet from a different leg than the one thought to be at issue. Now a common disconnecting means will be in an obvious and prominent location when the branch circuit is being disconnected.

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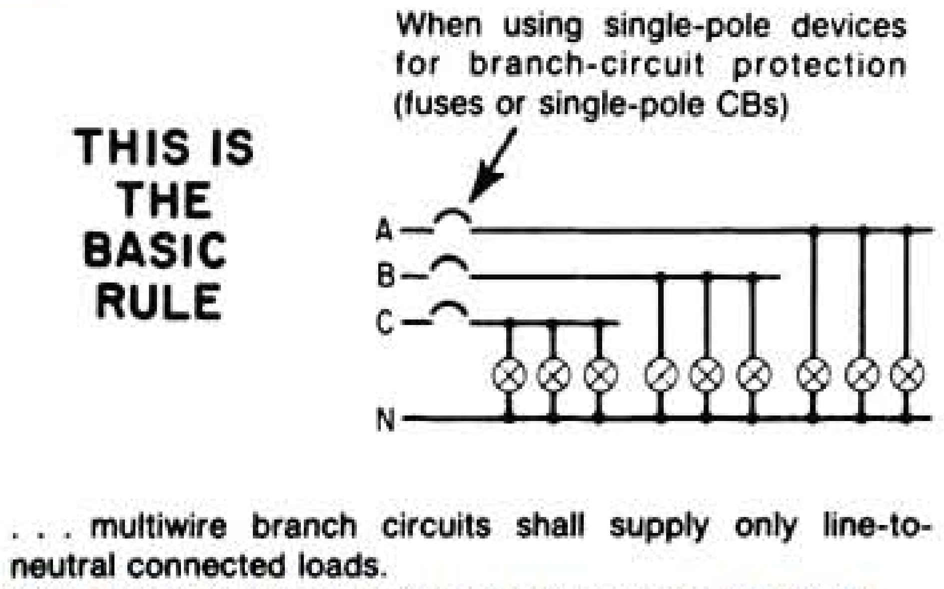

Fig. 210-4. With single-pole protection only line-to-neutral loads may be fed. (Sec. 210.4.)