ARTICLE
310
Conductors for General Wiring

Introduction to Article 310—Conductors for General Wiring

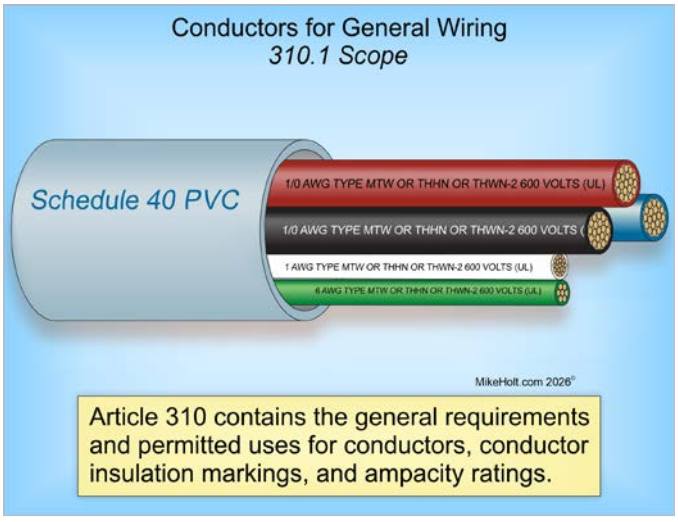
Article 310 covers general requirements and permitted uses for conductors—including insulation types, identification markings, and ampacity ratings. Article 310 does not apply to conductors that are part of flexible cords, fixture wires, or conductors that are an integral part of equipment [90.7 and 310.1]. A special section also provides guidance for sizing service and feeder conductors in single-family dwellings and individual units of multifamily dwellings.

Understanding Article 310 is key to ensuring safe, *Code*-compliant conductor installations.

Part I. General

310.1 Scope

Article 310 contains the general requirements and permitted uses for conductors, conductor insulation markings, and ampacity ratings. ▸Figure 310–1



▸Figure 310–1

Note: For flexible cords, see Article 400; for fixture wires, see Article 402.

310.2 Listing Requirements

The following must be listed:

(1) Insulated conductors

(2) Copper-clad aluminum conductor material

Part II. Construction Specifications

310.4 Conductor Construction and Application

Table 310.4(1) provides information on conductor insulation properties such as letter type, maximum operating temperature, application, insulation, and outer cover properties. ▸Figure 310–2

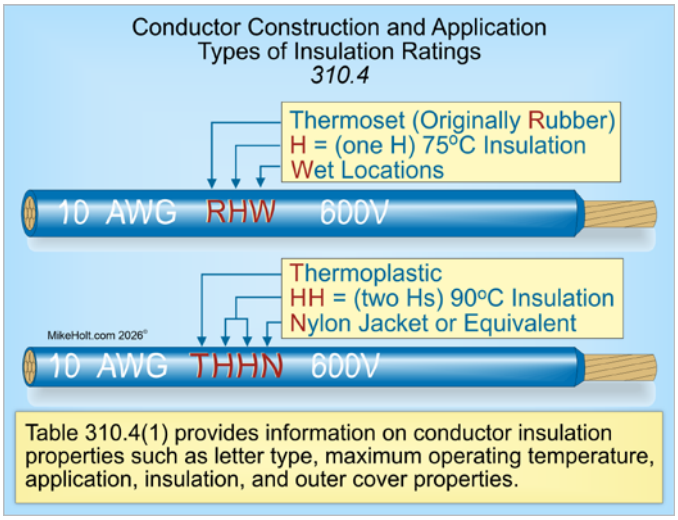


Figure 310–2

Author's Comment:

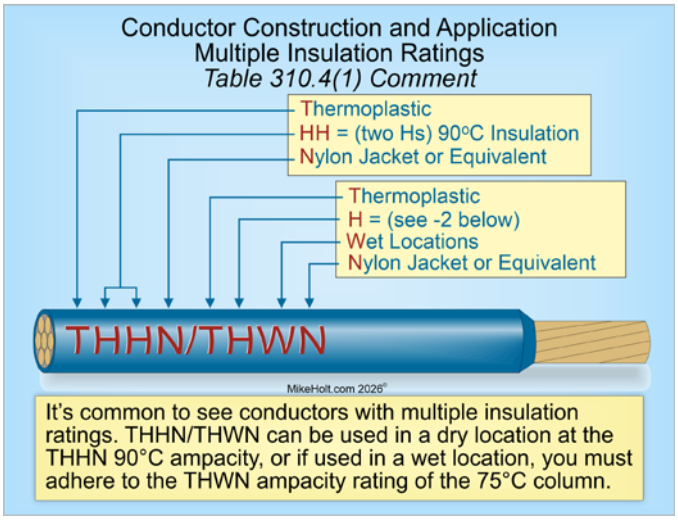
- The following explains the lettering on conductor insulation [Table 310.4(1)]:
  - No H 60°C insulation rating
  - H 75°C insulation rating
  - HH 90°C insulation rating permitted in dry locations
  - -2 90°C insulation rating permitted in wet locations
  - N Nylon outer cover
  - T Thermoplastic insulation
  - U Underground
  - W Permitted in wet or damp locations
  - X Thermoset insulation
  - R Rubber insulation

Table 310.4(1) Conductor Applications and Insulations

Type Letter	Column 2 Insulation	Column 3 Max. Operating Temperature	Column 4 Application	Column 5 Sizes Available AWG or kcmil	Column 6 Outer Covering
RHH	Flame-retardant thermoset	90°C	Dry and damp locations	16 AWG–2000 kcmil	Moisture-resistant, flame-retardant, nonmetallic
RHW	Flame-retardant, moisture-resistant thermoset	75°C	Dry and wet locations	16 AWG–2000 kcmil	Moisture-resistant, flame-retardant, nonmetallic
RHW-2	Flame-retardant, moisture-resistant thermoset	90°C	Dry and wet locations	16 AWG–2000 kcmil	Moisture-resistant, flame-retardant, nonmetallic
THHN	Flame-retardant, heat-resistant thermoplastic	90°C	Dry and damp locations	16 AWG–1000 kcmil	Nylon jacket or equivalent
THHW	Flame-retardant, moisture- and heat-resistant thermoplastic	75°C 90°C	Dry and wet locations	16 AWG–1000 kcmil	None
THW	Flame-retardant, moisture- and heat-resistant thermoplastic	75°C	Dry, damp, and wet locations	16 AWG–2000 kcmil	None
THW-2	Flame-retardant, moisture- and heat-resistant thermoplastic	90°C	Dry, damp, and wet locations	16 AWG–1000 kcmil	None
THWN	Flame-retardant, moisture- and heat-resistant thermoplastic	75°C	Dry, damp, and wet locations	16 AWG–1000 kcmil	Nylon jacket or equivalent
THWN-2	Flame-retardant, moisture- and heat-resistant thermoplastic	90°C	Dry, damp, and wet locations	16 AWG–1000 kcmil	Nylon jacket or equivalent
TW	Flame-retardant, moisture-resistant thermoplastic	60°C	Dry, damp, and wet locations	16 AWG–2000 kcmil	None
USE	Heat- and moisture-resistant	75°C	See Article 338	16 AWG–2000 kcmil	Moisture-resistant nonmetallic
USE-2	Heat- and moisture-resistant	90°C	See Article 338	16 AWG–2000 kcmil	Moisture-resistant nonmetallic

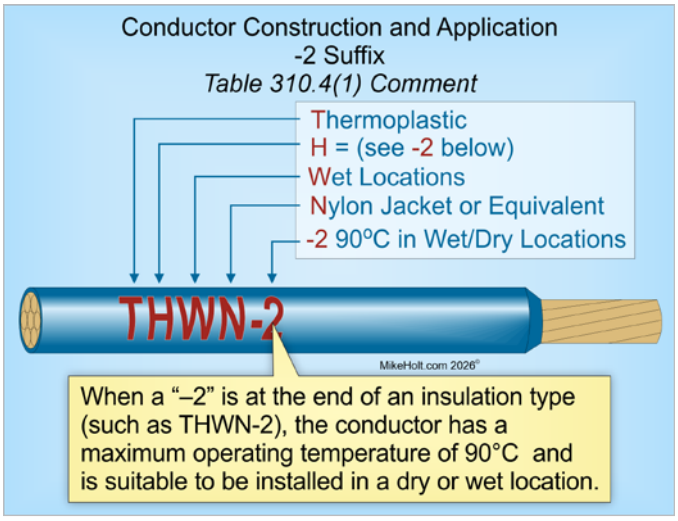
Author's Comment:

- It is common to see conductors with a multiple insulation rating (such as THHN/THWN). This type of conductor can be used in a dry location at the THHN 90°C ampacity. If it is used in a wet location, you must adhere to the THWN ampacity rating of the 75°C column of Table 310.16 for THWN insulation types. ▸Figure 310–3



▸Figure 310–3

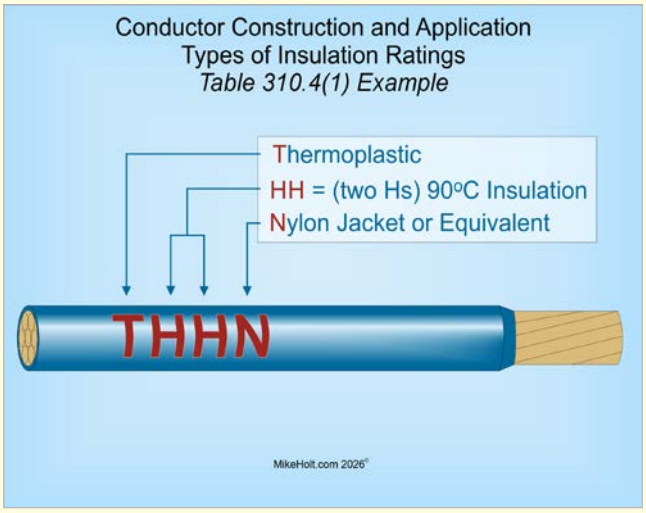
- When a "–2" is at the end of an insulation type (such as THWN-2), the conductor has a maximum operating temperature of 90°C and is suitable to be installed in a dry or wet location. ▸Figure 310–4



▸Figure 310–4

▸ Table 310.4(1) Conductor Insulation Example

Question: *Which of the following describes Type THHN insulation?* ▸Figure 310–5



▸Figure 310–5

(a) thermoplastic insulation
(b) suitable for dry or damp locations
(c) maximum operating temperature of 90°C
(d) all of these

Answer: *(d) all of these*

310.5 Conductors, Minimum Size and Material

(A) Minimum Size Conductor. The minimum size conductor is 16 AWG copper, 14 AWG copper-clad aluminum, or 12 AWG aluminum, except as permitted elsewhere in this *Code*.

Author's Comment:

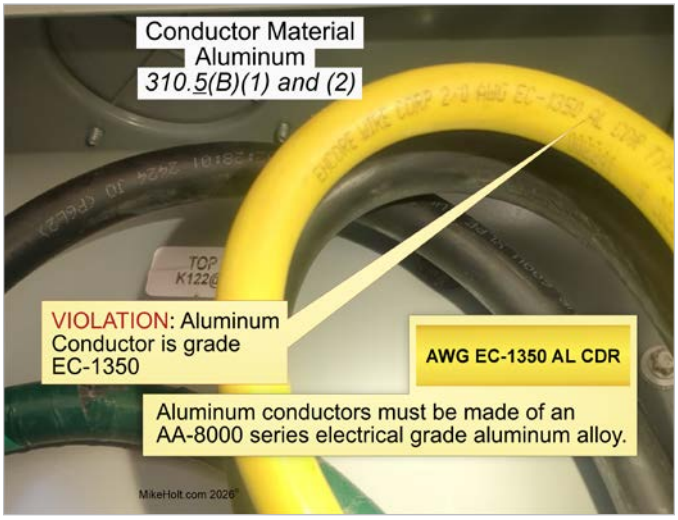
- There is a misconception that 12 AWG copper is the smallest conductor permitted for commercial or industrial facilities. Although it is not true based on *NEC* rules, it might be a job specification or local code requirement.

(B) Conductor Material. Conductors must be copper, aluminum, or copper-clad aluminum as follows:

(1) The 8, 10, and 12 AWG solid aluminum conductors must be made of an AA-8000 series electrical grade aluminum alloy

(2) The 8 AWG through 1000 kcmil stranded aluminum conductors must be made of an AA-8000 series electrical grade aluminum alloy ▸Figure 310–6 and ▸Figure 310–7

▸Figure 310–6

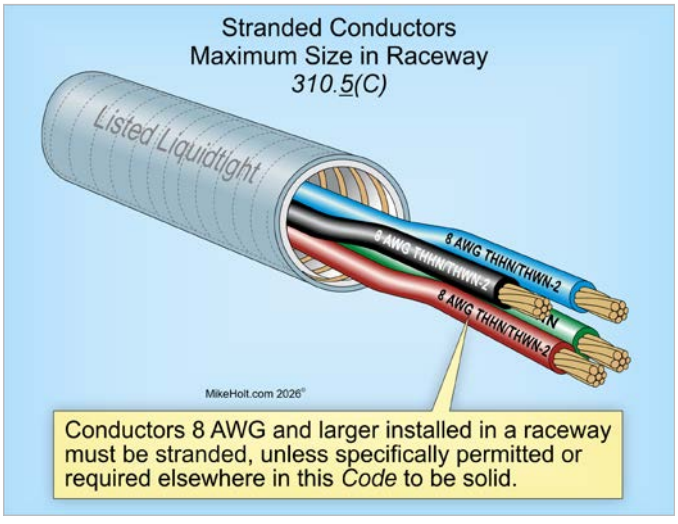


▸Figure 310–7

(3) Copper in copper-clad aluminum conductors must form a minimum 10 percent of the cross-sectional area, and the aluminum core must be made of an AA-8000 series electrical grade aluminum alloy ▸Figure 310–8

(C) Stranded Conductors. Conductors 8 AWG and larger installed in a raceway must be stranded, unless specifically permitted or required elsewhere in this *Code* to be solid. ▸Figure 310–9

▸Figure 310–8



▸Figure 310–9

Author's Comment:

- A grounding electrode conductor is an example of where a solid conductor 8 AWG and larger can be installed in a raceway when it is required to be protected from physical damage [250.64(B)].

310.6 Conductor Identification

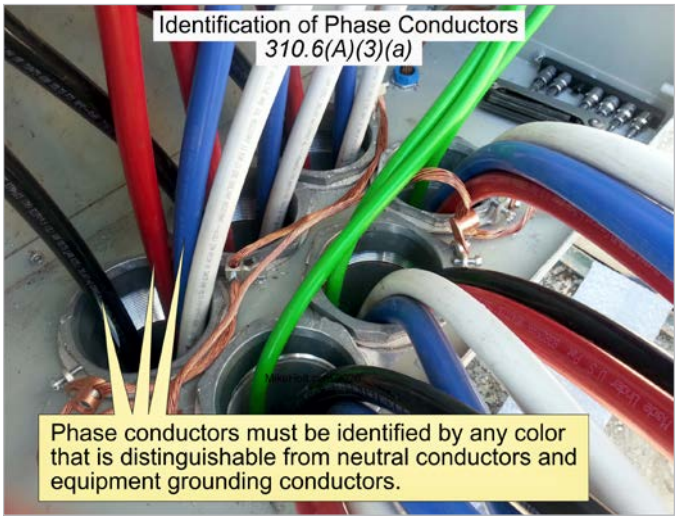
(A) Conductors Not Exceeding 1000V.

(1) Neutral Conductor. Insulated neutral conductors must be identified white or gray in accordance with 200.7.

(2) Equipment Grounding Conductor. Insulated equipment grounding conductors must be identified green or green with yellow stripe in accordance with 250.119.

(3) Identification of Phase Conductors.

(a) General. Phase conductors must be identified by any color that is distinguishable from neutral conductors [200.7] and equipment grounding conductors [250.119]. ▸Figure 310–10



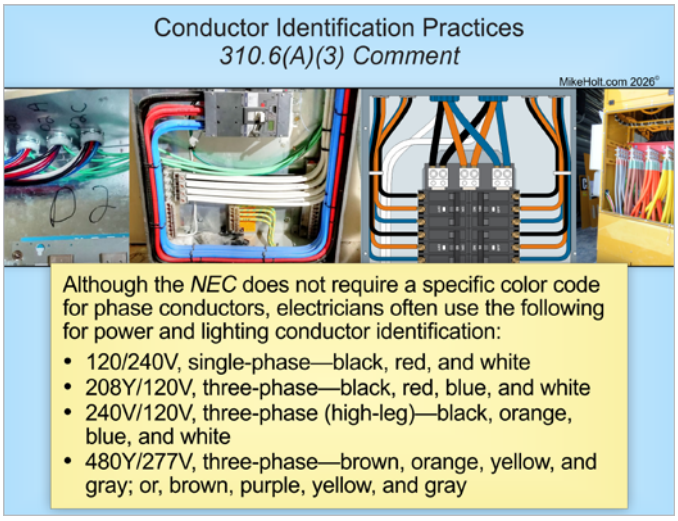
▸Figure 310–10

(b) Branch Circuit. Where premises wiring is supplied from more than one nominal voltage system, branch-circuit phase conductors must be identified in accordance with 210.5(C).

(c) Feeders. Where premises wiring is supplied from more than one nominal voltage system, feeder phase conductors must be identified in accordance with 215.12(C).

Author's Comment:

- Although the *NEC* does not require a specific color code for phase conductors, electricians often use the following color system: ▸Figure 310–11
  - 120/240V, single-phase–black, red, and white
  - 208Y/120V, three-phase–black, red, blue, and white
  - 240V/120V, three-phase–(high-leg) black, orange, blue, and white
  - 480Y/277V, three-phase–brown, orange, yellow, and gray; or, brown, purple, yellow, and gray



▸Figure 310–11

Part III. Installation

310.10 Uses Permitted

Conductors described in Table 310.4(1) are permitted for use in any of the wiring methods covered in Chapter 3.

(A) Dry Locations. Conductors used in dry locations can be any of the types identified in Table 310.4.

(C) Wet Locations. Conductors in wet locations must be listed for wet locations (such as THWN-2 or XHHW-2). Cables in wet locations must be listed for wet locations (such as UF or USE).

Author's Comment:

- The letter "W" found on the insulation types indicates it is suitable for wet locations.

(D) Conductors Exposed to Direct Sunlight. Conductors exposed to the rays of the sun must be:

(1) Insulated and listed as being sunlight resistant ▸Figure 310–12

(3) Bare

(E) Direct-Burial Conductors. Conductors used for direct-burial applications must be of a type identified for such use.

Author's Comment:

- Single-conductor UF cable is permitted for direct burial, see 340.10(1) and single-conductor USE cable is permitted for direct burial, see 338.10(B)(4)(b)(2).

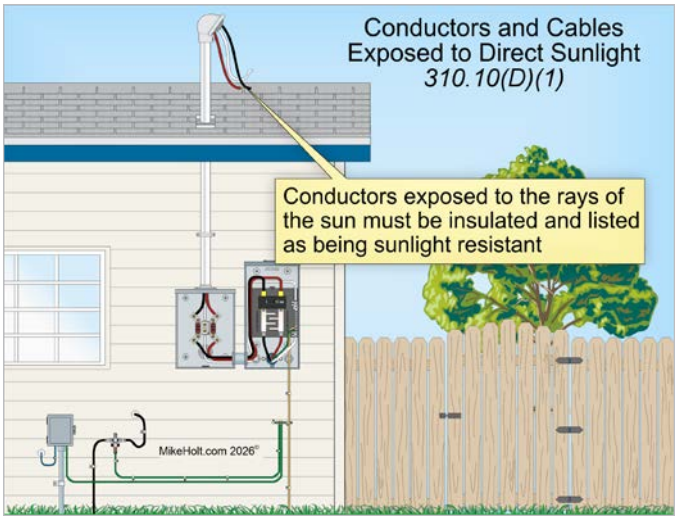


Figure 310–12

(G) Conductors Connected in Parallel.

(1) 1/0 AWG and Larger Conductors. Phase, neutral, and equipment grounding conductors are permitted to be connected in parallel (electrically joined at both ends). Phase and neutral conductors connected in parallel must be sized 1/0 AWG and larger. Figure 310–13

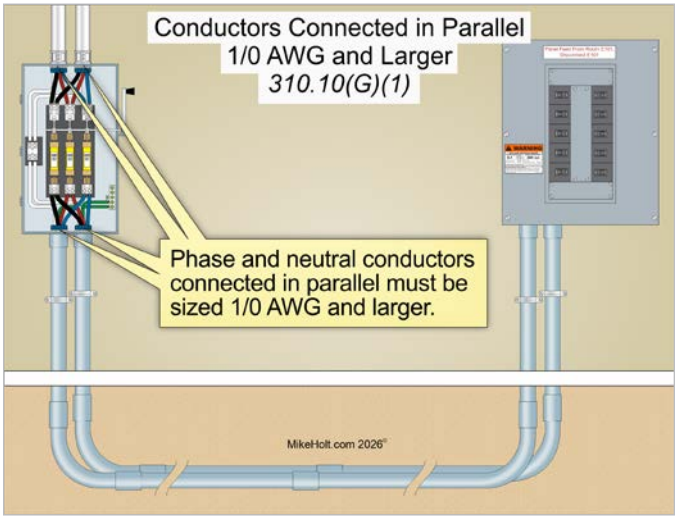


Figure 310–13

Author's Comment:

- When conductors are installed in parallel (electrically joined at both ends), the current flow will be evenly distributed between the individual parallel conductors.

(2) Conductor and Installation Characteristics. All parallel phase conductors, neutral conductors, equipment grounding conductors, and supply-side bonding jumpers must comply with the following: Figure 310–14

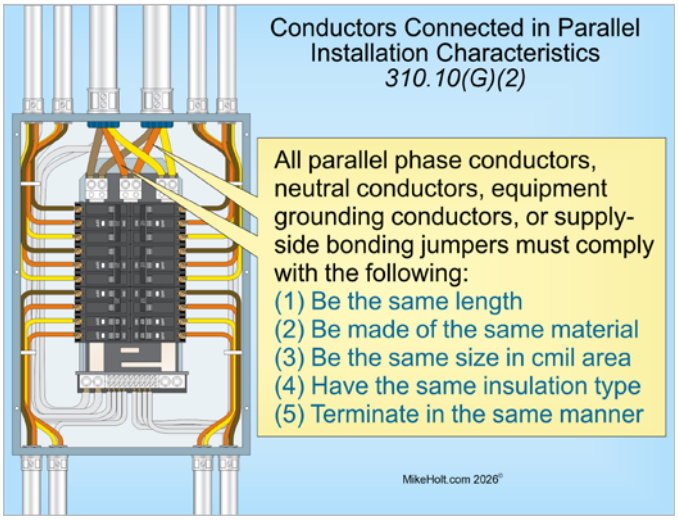


Figure 310–14

(1) Be the same length

(2) Be the same conductor material (copper, aluminum, or copper-clad aluminum)

(3) Be the same size in circular mil area

(4) Have the same type of conductor insulation

(5) Terminate in the same manner (set screw versus compression fitting)

(3) Separate Raceways and Cables.

(a) Raceways and Cables. The raceways or cables for parallel circuits must have the same number of conductors and the raceways or cables must have the same electrical characteristics (metallic versus nonmetallic). Figure 310–15

(b) Conductors. Conductors composing one parallel set are not required to have the same physical characteristics as those of another paralleled set. Figure 310–16

(4) Conductor Ampacity Correction or Adjustment. Conductors in parallel must comply with 310.15(B) and (C).

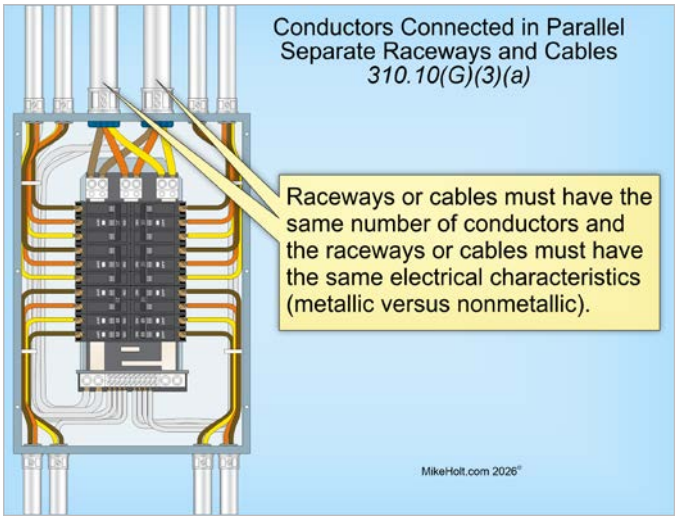


Figure 310–15

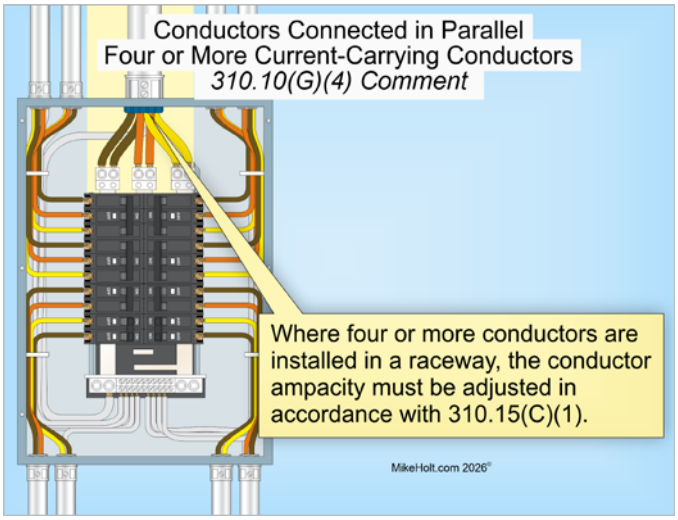


Figure 310–17

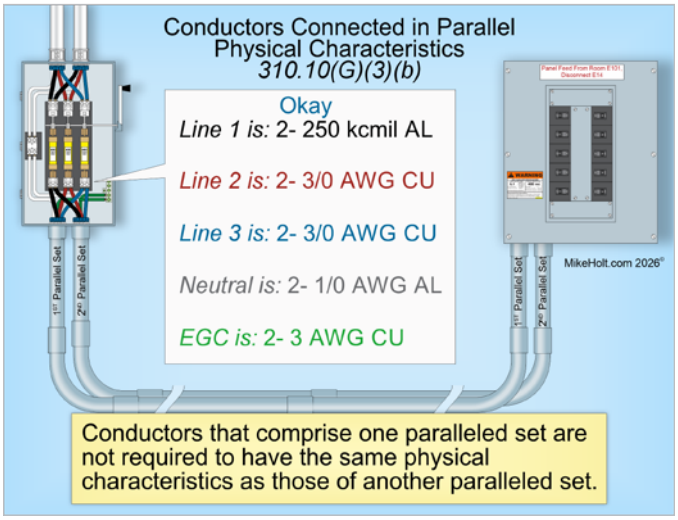


Figure 310–16

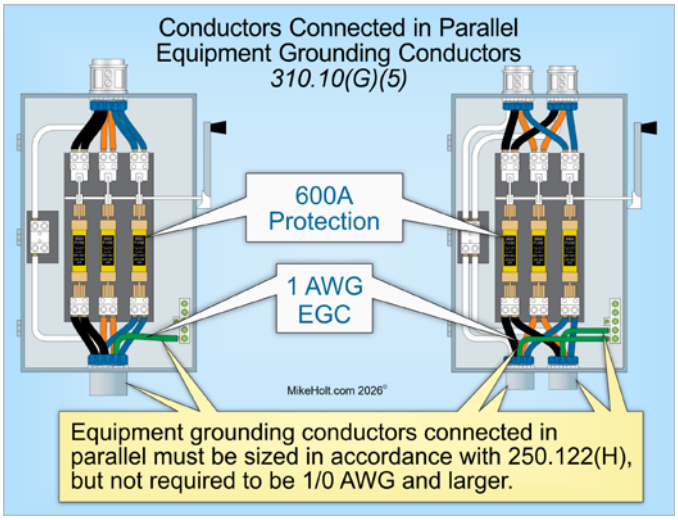


Figure 310–18

Author's Comment:

- Where conductors are in an ambient temperature greater than 86°F, the conductor ampacity (based on the 90°C column of Table 310.16 must be corrected in accordance with 310.15(B)(1).
- Where four or more current-carrying conductors are in a raceway or cable, the conductor ampacity (based on the 90°C column of Table 310.16), must be adjusted in accordance with 310.15(C)(1). Figure 310–17

(5) Equipment Grounding Conductors. Equipment grounding conductors connected in parallel must be sized in accordance with 250.122(H), but they are not required to be 1/0 AWG and larger. Figure 310–18

(6) Bonding Jumpers. Supply-side bonding jumpers must be sized in accordance with 250.102(C) and load-side bonding jumpers must be sized in accordance with 250.102(D), but they are not required to be 1/0 AWG and larger.

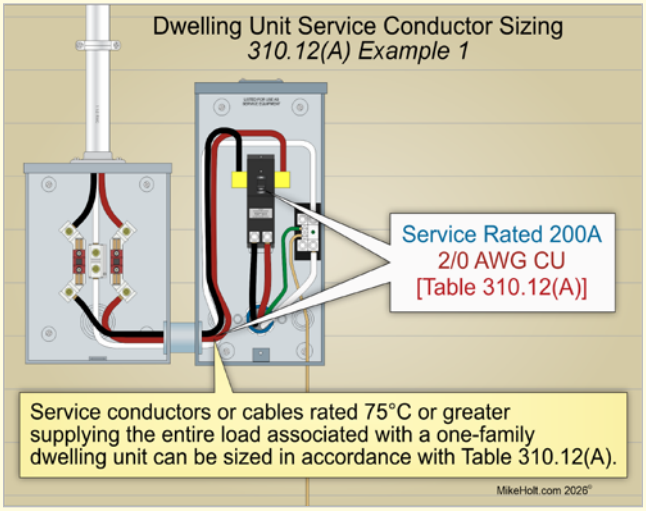
310.12 Dwelling Services and Feeders

(A) Services. For a service rated 100A through 400A, service conductors or cables rated 75°C or greater supplying the entire load associated with a one-family dwelling unit can be sized in accordance with Table 310.12(A).

▶ Dwelling Unit Service Conductor Size [310.12(A)] Example

Question: *What is the minimum size copper service conductor for a single-family dwelling unit with a service disconnect rated 200A?* ▸Figure 310–19

(a) 1/0 AWG (b) 2/0 AWG (c) 3/0 AWG (d) 4/0 AWG

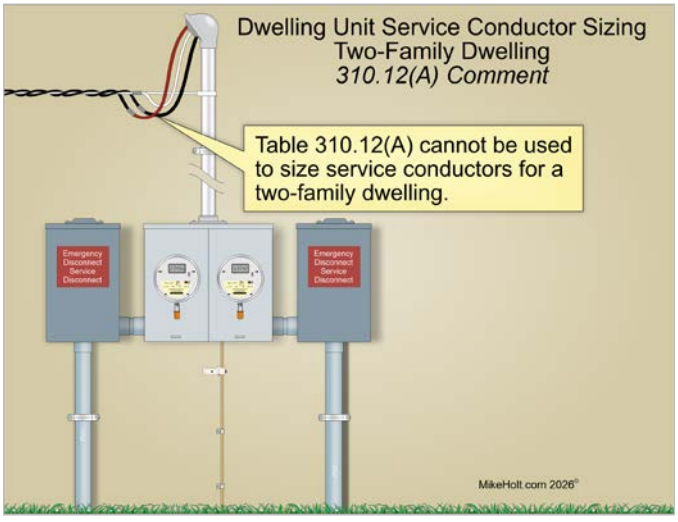


▸Figure 310–19

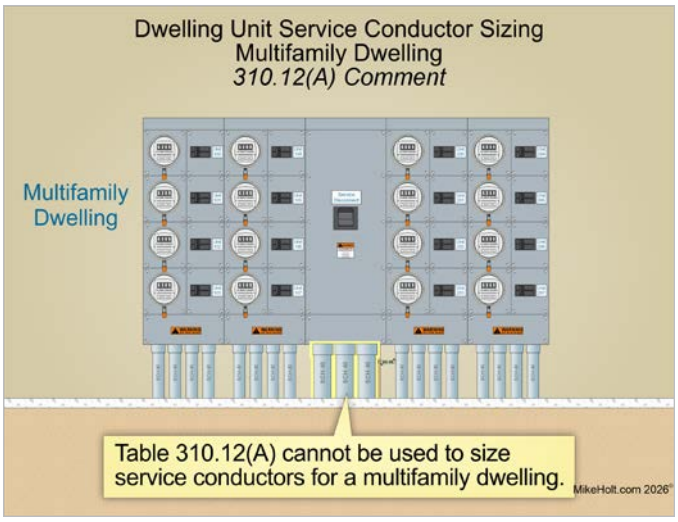
Answer: *(b) 2/0 AWG [Table 310.12(A)]*

Author's Comment:

- Table 310.12(A) cannot be used to size service conductors for two-family or multifamily dwelling buildings. ▸Figure 310–20 and ▸Figure 310–21

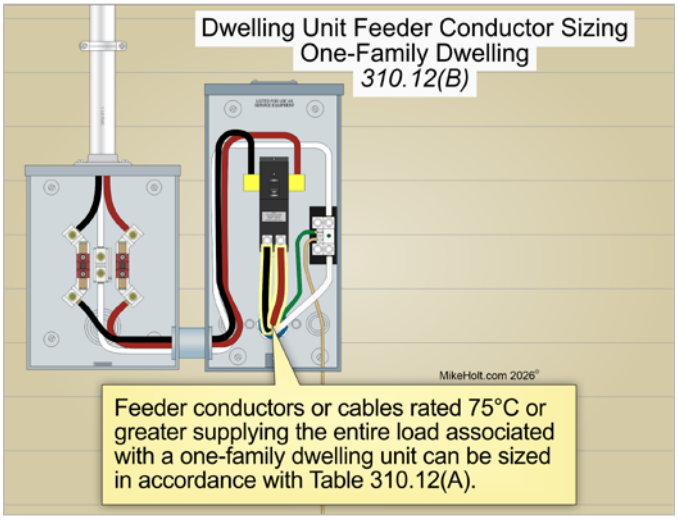


▸Figure 310–20



▸Figure 310–21

(B) Feeders. For a feeder rated 100A through 400A, feeder conductors or cables rated 75°C or greater supplying the entire load associated with a one-family dwelling or individual dwelling unit (in a two-family dwelling and multifamily dwelling) can be sized in accordance with Table 310.12(A). ▸Figure 310–22, ▸Figure 310–23, and ▸Figure 310–24



▸Figure 310–22

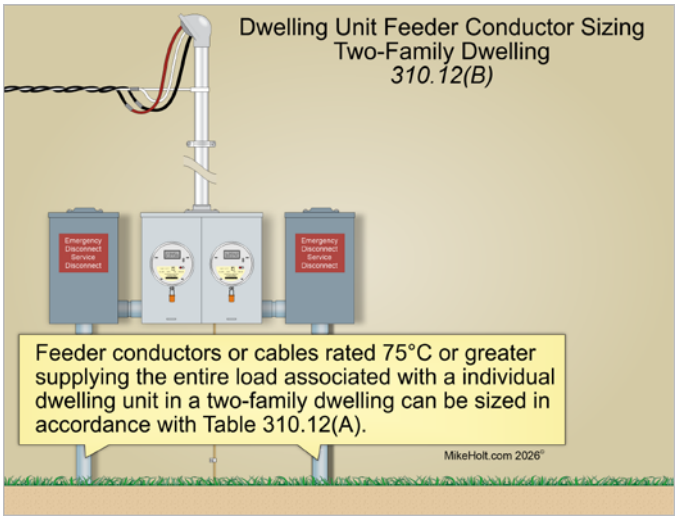


Figure 310–23

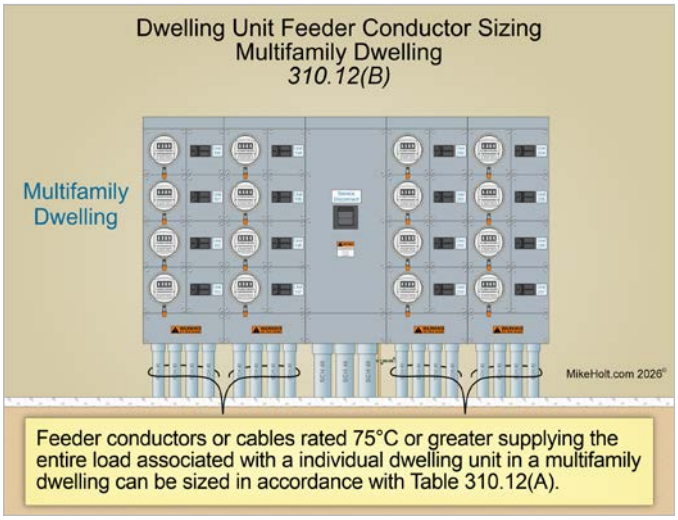


Figure 310–24

▶ Dwelling Unit Feeder Conductor Size [310.12(B)] Example

Question: *What is the minimum size copper feeder conductors for a single-family dwelling unit that has overcurrent protection of 200A and the feeder conductors carry the entire load of the dwelling unit?* Figure 310–25

(a) 1/0 AWG (b) 2/0 AWG (c) 3/0 AWG (d) 4/0 AWG

Answer: *(b) 2/0 AWG [Table 310.12(A)]*

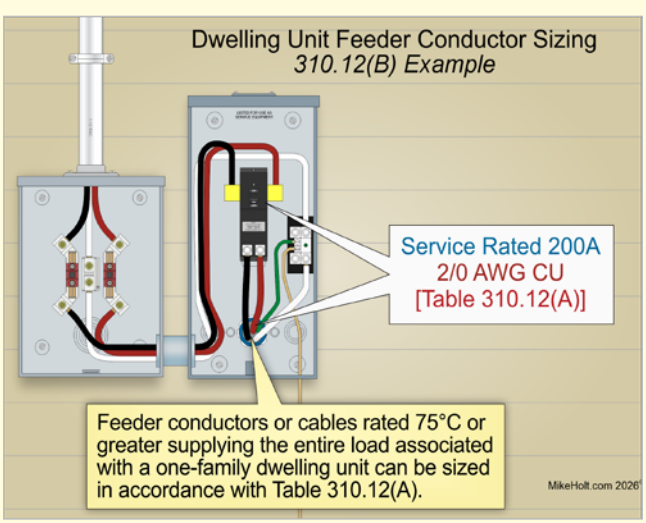


Figure 310–25

(C) Feeder Conductors Not Greater Than Service Conductors. In no case is the feeder conductor for an individual dwelling unit required to have an ampacity greater than the service, as specified in 310.12(A) or (B).

Feeder conductors are not required to be larger than the service conductor. Figure 310–26

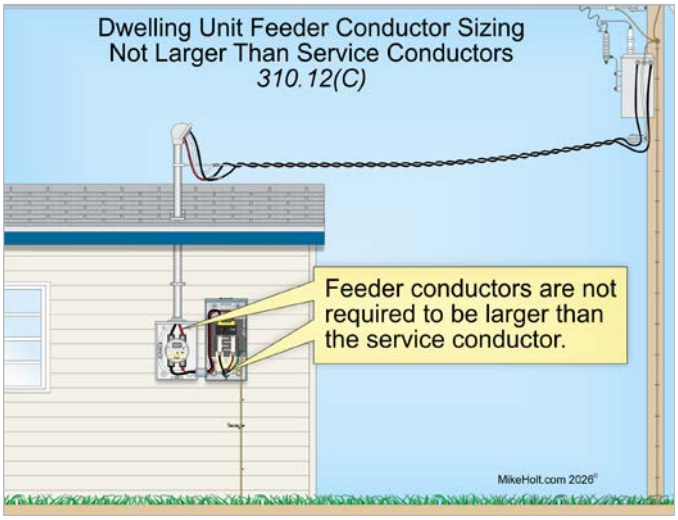


Figure 310–26

Table 310.12(A) Single-Phase Dwelling Services and Feeders		
Service or Feeder Rating	Copper	Aluminum or Copper-Clad Aluminum
100A	4 AWG	2 AWG
110A	3 AWG	1 AWG
125A	2 AWG	1/0 AWG
150A	1 AWG	2/0 AWG
175A	1/0 AWG	3/0 AWG
200A	2/0 AWG	4/0 AWG
225A	3/0 AWG	250 kcmil
250A	4/0 AWG	300 kcmil
300A	250 kcmil	350 kcmil
350A	350 kcmil	500 kcmil
400A	400 kcmil	600 kcmil

310.14 Ampacities for Conductors

(A) General Requirements.

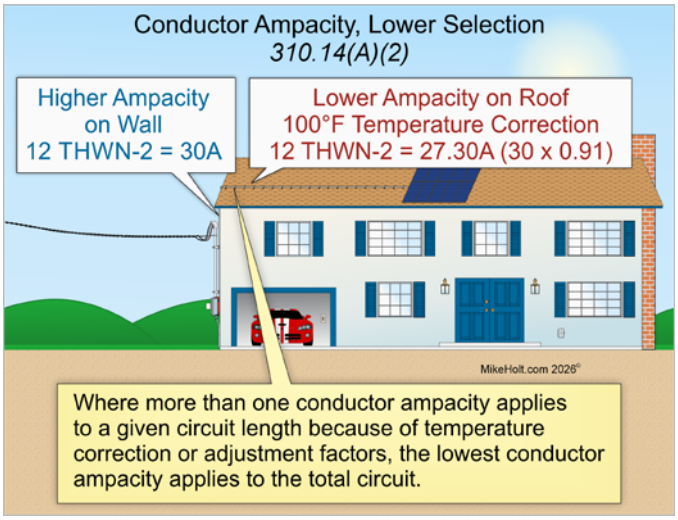
(1) Tables or Engineering Supervision. Conductor ampacity is determined by the *NEC* tables as corrected and adjusted in accordance with 310.15, or under engineering supervision as provided in 310.14(B).

(2) Lower Rating Conductor Ampacity. Where more than one conductor ampacity applies to a given circuit length because of temperature correction [Table 310.15(B)(1)(1)] or adjustment factors [Table 310.15(C)(1)], the lowest conductor ampacity applies to the total circuit. ▸Figure 310–27

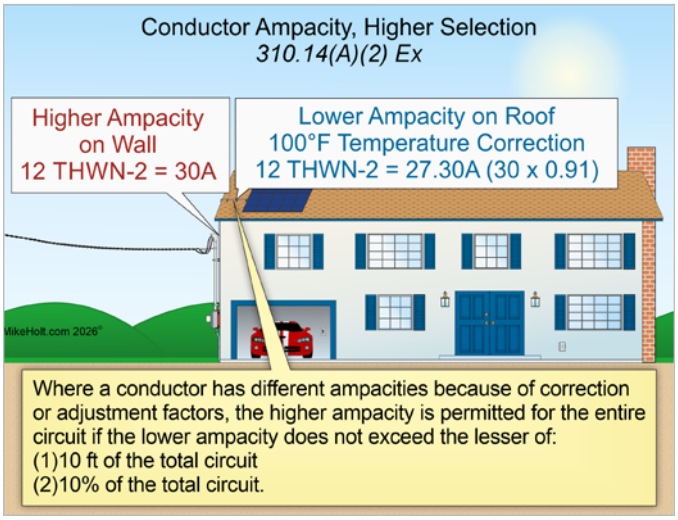
Ex: Where a conductor has different ampacities because of ambient temperature correction [310.15(B)] or adjustment factors [310.15(C)], the higher ampacity is permitted for the entire circuit if the lower ampacity does not exceed the lesser of:

(1) 10 ft of the total circuit

(2) 10 percent of the total circuit ▸Figure 310–28



▸Figure 310–27



▸Figure 310–28

310.15 Ampacity Tables

(A) General. ***Ampacities*** for conductors are contained in Table 310.16.

Ampacity. The maximum current, in amperes, a conductor can carry continuously under its conditions of use without exceeding its temperature rating. ▸Figure 310–29

The temperature ampacity correction [310.15(B)(1)] and ampacity adjustment factors [310.15(C)(1)] are applied to the ampacities listed in Table 310.16 based on the conductor's insulation temperature rating.

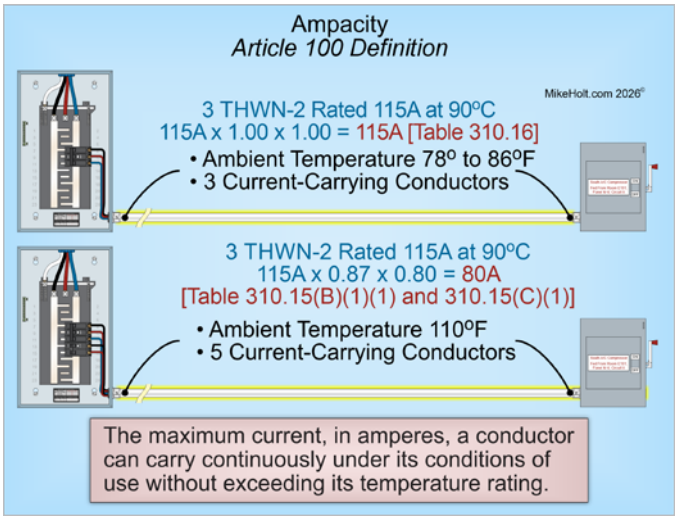


Figure 310–29

Author's Comment:

- The Table 310.16 ampacity must be corrected when the ambient temperature is not between 78°F and 86°F and must be adjusted when more than three current-carrying conductors are bundled together. The temperature correction multiplier [310.15(B)(1)] and adjustment multiplier [310.15(C)(1)] are applied to the conductor ampacity based on the temperature rating of the conductor insulation in Table 310.16 (typically in the 90°C column). Figure 310–30

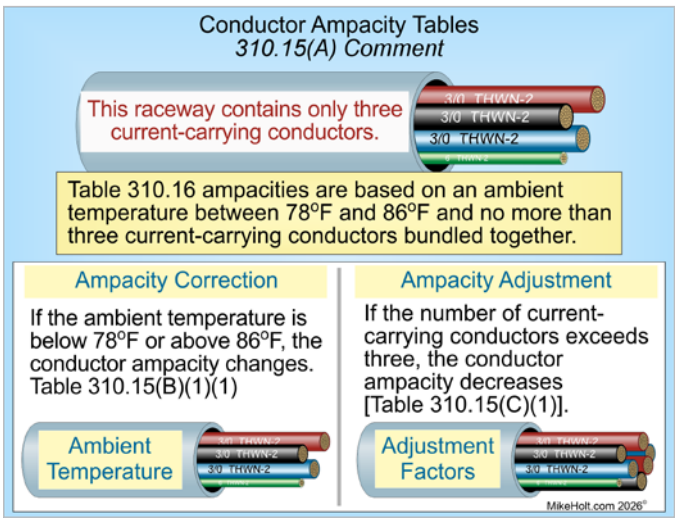


Figure 310–30

(B) Conductor Ampacity Correction.

(1) General. Where the ambient temperature is greater than 86°F or less than 78°F, the conductor ampacities contained in Table 310.16 in the 90°C column must be corrected in accordance with Table 310.15(B)(1)(1). Figure 310–31

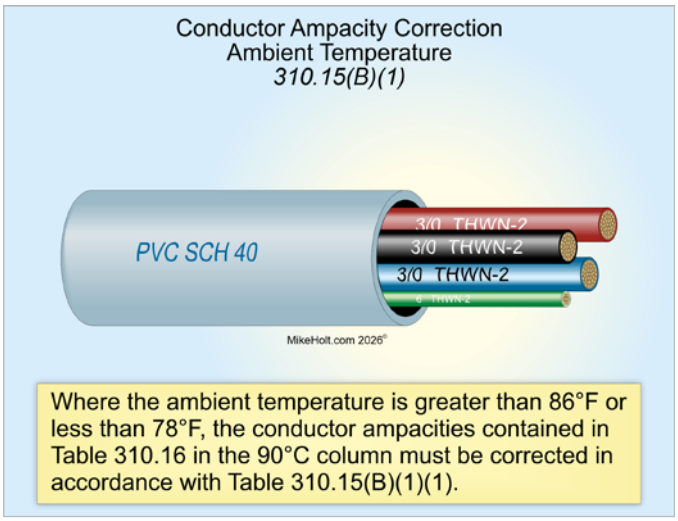


Figure 310–31

Author's Comment:

- Conductor ampacity reduction is required when the ambient temperature is greater than 86°F. This is because heat generated by the current flow in the conductor plus the added ambient temperature can exceed the conductor insulation temperature rating. Figure 310–32

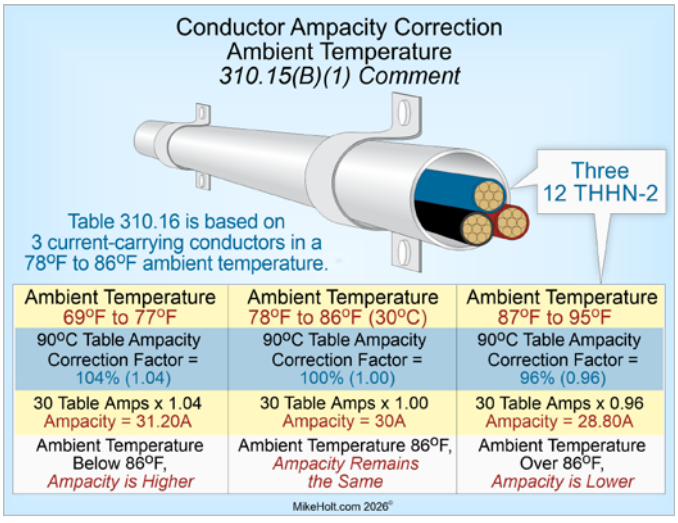


Figure 310–32

Table 310.15(B)(1)(1) Ambient Temperature Correction Factors Based on 30°C (86°F) and 90°C Insulation

Ambient Temperature °F	Ambient Temperature °C	Correction Factor 90°C Conductors
50°F or less	10°C or less	1.15
51–59°F	11–15°C	1.12
60–68°F	16–20°C	1.08
69–77°F	21–25°C	1.04
78–86°F	26–30°C	1.00
87–95°F	31–35°C	0.96
96–104°F	36–40°C	0.91
105–113°F	41–45°C	0.87
114–122°F	46–50°C	0.82

Corrected Conductor Ampacity—Ambient Temperature Correction Formula:

Corrected Ampacity = Table 310.16 Ampacity × Ambient Correction Factor

▶ Conductor Ampacity Temperature Correction [310.15(B)(1)(1)] Example 1

Question: *What is the ampacity of a 12 AWG, THWN-2 copper conductor in an ambient temperature of 50°F?* ▸Figure 310–33

(a) 30.50A (b) 32.50A (c) 34.50A (d) 36.50A

Solution:

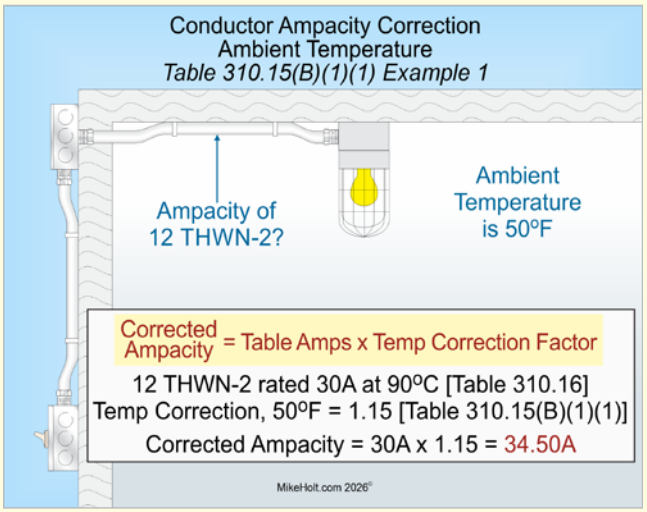
The conductor ampacity for 12 AWG, THWN-2 is 30A at 90°C [Table 310.16].

The correction factor for a 90°C conductor in an ambient temperature of 50°F is 1.15 [Table 310.15(B)(1)(1)].

Corrected Ampacity = 30A × 115%
Corrected Ampacity = 34.50A

Note: *Ampacity increases when the ambient temperature is less than 86°F.*

Answer: *(c) 34.50A*

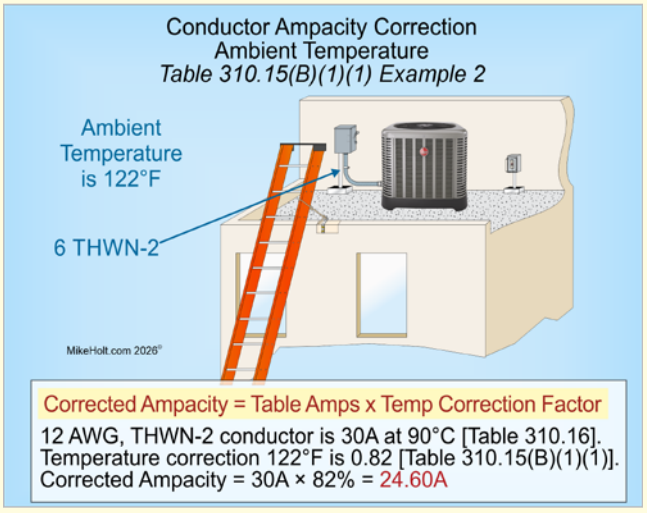


▸Figure 310–33

▶ Conductor Ampacity Temperature Correction [310.15(B)(1)(1)] Example 2

Question: *What is the ampacity of a 6 AWG, THWN-2 copper conductor in an ambient temperature of 122°F?* ▸Figure 310–34

(a) 59.50A (b) 60.50A (c) 61.50A (d) 62.50A



▸Figure 310–34

Solution:

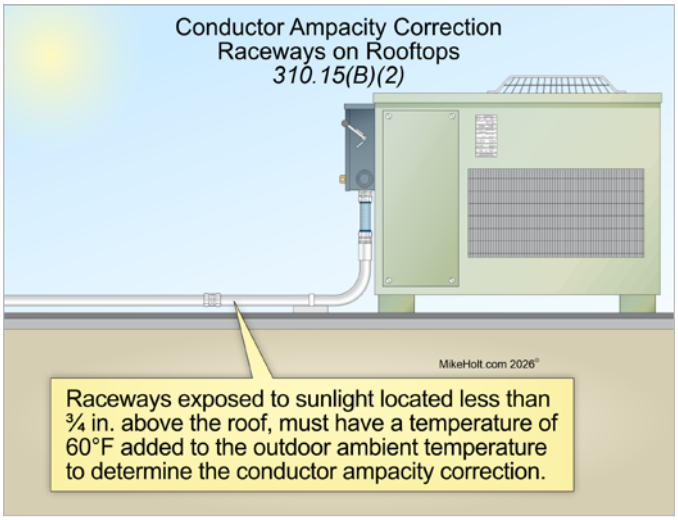
The conductor ampacity for 6 AWG, THWN-2 conductor is 75A at 90°C [Table 310.16].

The correction factor for a 90°C conductor in an ambient temperature of 122°F is 0.82 [Table 310.15(B)(1)(1)].

Corrected Ampacity = 75A × 82%
Corrected Ampacity = 61.50A

Answer: *(c) 61.50A*

(2) Raceways and Cables Exposed to Sunlight on Rooftops. Where raceways or cables are exposed to direct sunlight and located less than ¾ in. above the roof, a temperature of 60°F (33°C) must be added to the outdoor ambient temperature to determine the ambient temperature correction in accordance with Table 310.15(B)(1)(1). ▸Figure 310–35



▸Figure 310–35

Author's Comment:

- The reason for the temperature adder is because the air inside raceways and cables that are in direct sunlight is significantly hotter than the surrounding air.

▶ Conductor Ampacity Temperature Rooftop Adder [310.15(B)(2)] Example

Question: *What is the ampacity of a 6 AWG, THWN-2 copper conductor in a raceway ½ in. above the roof, in an ambient temperature of 90°F?* ▸Figure 310–36

(a) 38A (b) 40A (c) 42A (d) 44A

Solution:

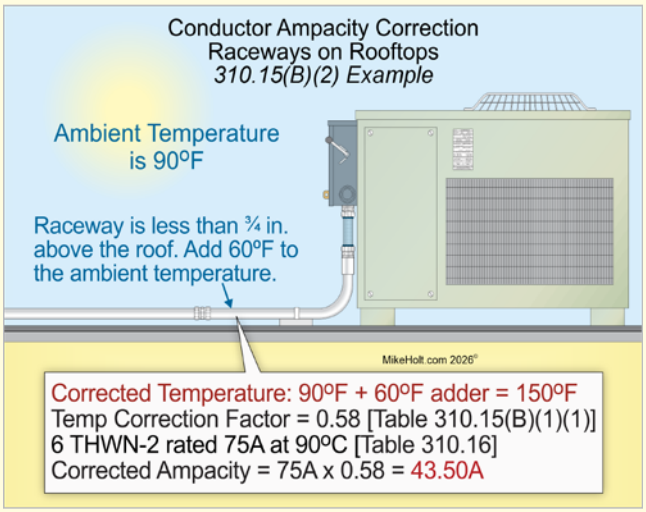
Corrected Temperature = 90°F + 60°F adder [310.15(B)(2)]
Corrected Temperature = 150°F

The temperature correction factor for 150°F = 0.58 [Table 310.15(B)(1)(1)]

6 AWG, THWN-2 conductor is rated 75A at 90°C [Table 310.16]

Corrected Ampacity = 75A × 58%
Corrected Ampacity = 43.50A, round to 44A

Answer: *(d) 44A*



▸Figure 310–36

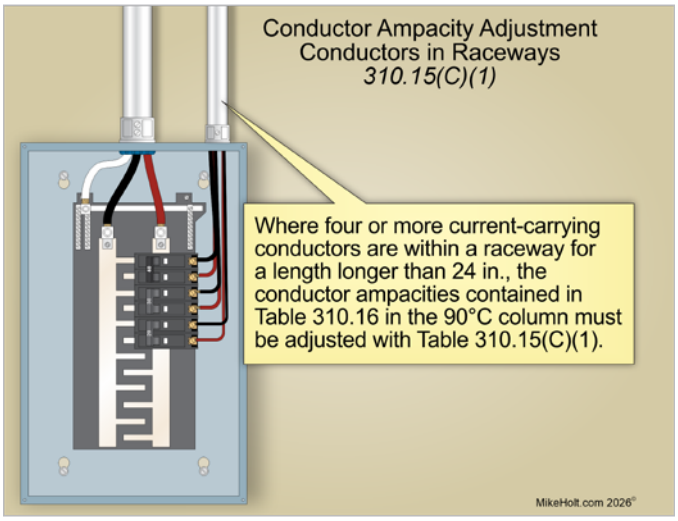
Ex: XHHW-2 insulated conductors are not subject to the rooftop temperature correction adder.

Note 1: The *ASHRAE Handbook–Fundamentals* (www.ashrae.org) is one source for the ambient temperatures in various locations.

(C) Conductor Ampacity Adjustment.

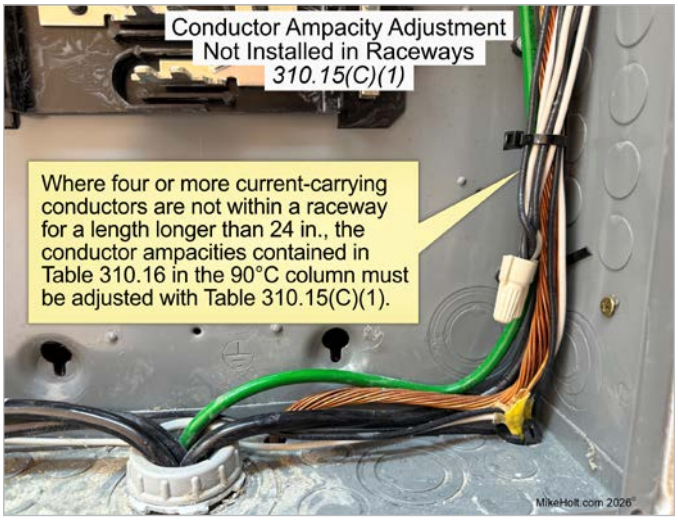
(1) Four or More Current-Carrying Conductors.

Conductors Within Raceways or Cables. Where four or more current-carrying conductors are within a raceway or cable for a length longer than 24 in., the conductor ampacities contained in Table 310.16 in the 90°C column must be adjusted in accordance with Table 310.15(C)(1). ▸Figure 310–37



▸Figure 310–37

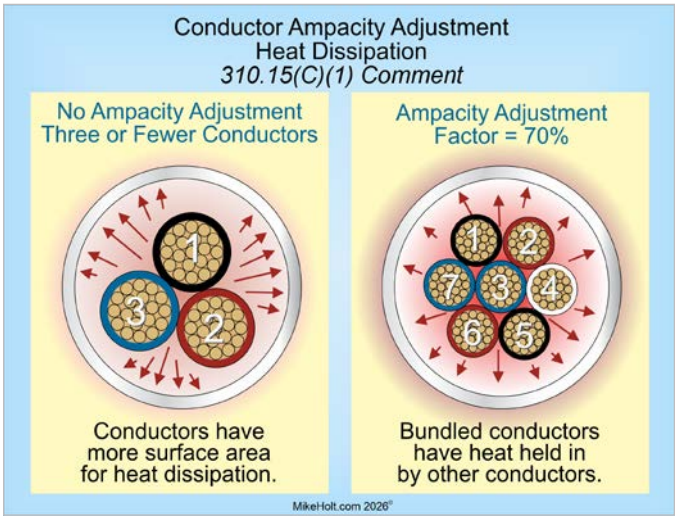
Conductors Not Within Raceways or Cables. Where four or more current-carrying conductors are not within a raceway or cable for a length longer than 24 in., the conductor ampacities contained in Table 310.16 in the 90°C column must be adjusted in accordance with Table 310.15(C)(1). ▸Figure 310–38



▸Figure 310–38

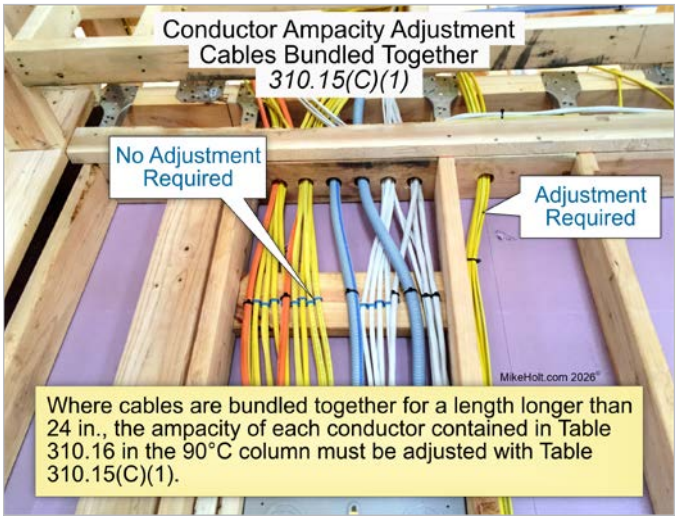
Author's Comment:

- Conductor ampacity reduction is required when four or more current-carrying conductors are bundled together because heat generated by current flow cannot dissipate as quickly as when there are fewer current-carrying conductors. ▸Figure 310–39



▸Figure 310–39

Cables Bundled Together. Where cables are bundled together for a length longer than 24 in., the ampacity of each conductor contained in Table 310.16 in the 90°C column must be adjusted in accordance with Table 310.15(C)(1). ▸Figure 310–40



▸Figure 310–40

Author's Comment:

- The neutral conductor is considered a current-carrying conductor for the purposes of conductor ampacity adjustment [310.15(C)(1)] under the conditions specified in 310.15(E)(1).
- Equipment grounding conductors are never considered current carrying. See 310.15(F).

Table 310.15(C)(1) Conductor Ampacity Adjustment for More Than Three Current-Carrying Conductors

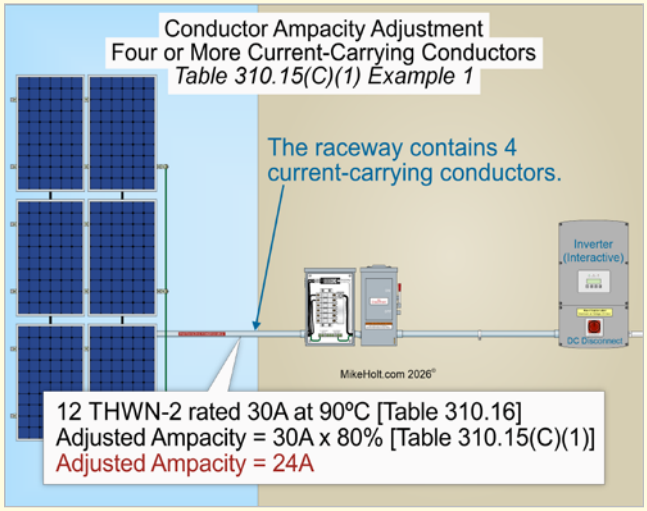
Number of Conductors[1]	Adjustment
4–6	80%
7–9	70%
10–20	50%
21–30	45%
31–40	40%
41 and above	35%

[1] Does not include conductors that cannot be energized at the same time.

▶ Conductor Ampacity Adjustment [310.15(C)(1)] Example 1

Question: *What is the adjusted ampacity of four current-carrying 12 AWG, THWN-2 copper conductors in a raceway longer than 24 in.?* ▸Figure 310–41

(a) 20A (b) 24A (c) 28A (d) 32A



▸Figure 310–41

Solution:

Adjusted Ampacity = Table 310.16 Ampacity × Bundled Ampacity Adjustment Factor from Table 310.15(C)(1)

12 AWG, THWN-2 is rated 30A at 90°C [Table 310.16].

The adjustment factor for four current-carrying conductors is 80 percent [Table 310.15(C)(1)].

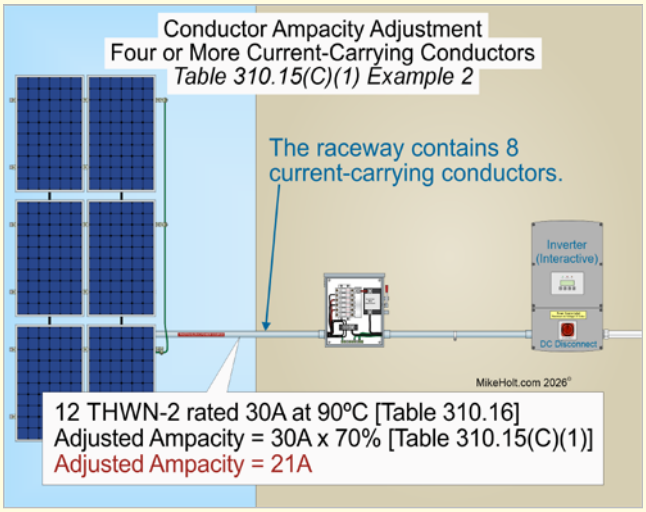
Adjusted Ampacity = 30A × 80%
Adjusted Ampacity = 24A

Answer: *(b) 24A*

▶ Conductor Ampacity Adjustment [310.15(C)(1)] Example 2

Question: *What is the adjusted ampacity of eight current-carrying 12 AWG, THWN-2 copper conductors in a raceway longer than 24 in.?* ▸Figure 310–42

(a) 18A (b) 21A (c) 24A (d) 27A



▸Figure 310–42

Solution:

Adjusted Ampacity = Table 310.16 Ampacity × Bundled Ampacity Adjustment Factor from Table 310.15(C)(1)

12 AWG, THWN-2 is rated 30A at 90°C [Table 310.16].

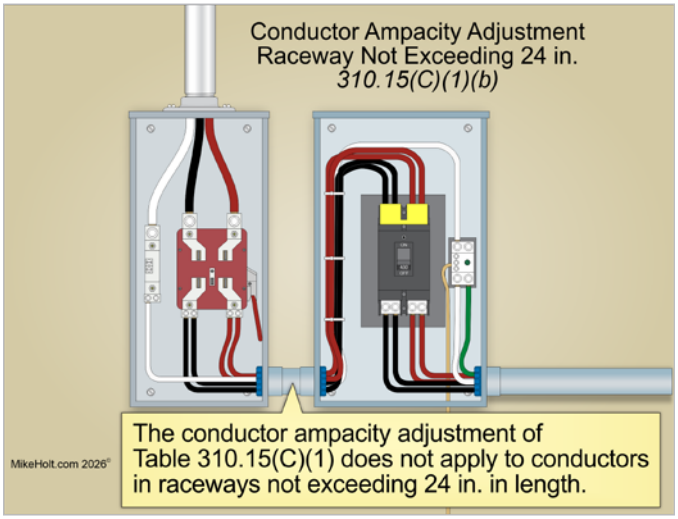
The adjustment factor for eight current-carrying conductors is 70 percent [Table 310.15(C)(1)].

Adjusted Ampacity = 30A × 70%
Adjusted Ampacity = 21A

Answer: *(b) 21A*

(a) Where conductors are in cable trays, 392.80 applies

(b) In raceways not exceeding 24 in., conductor ampacity adjustment from Table 310.15(C)(1) does not apply ▸Figure 310–43

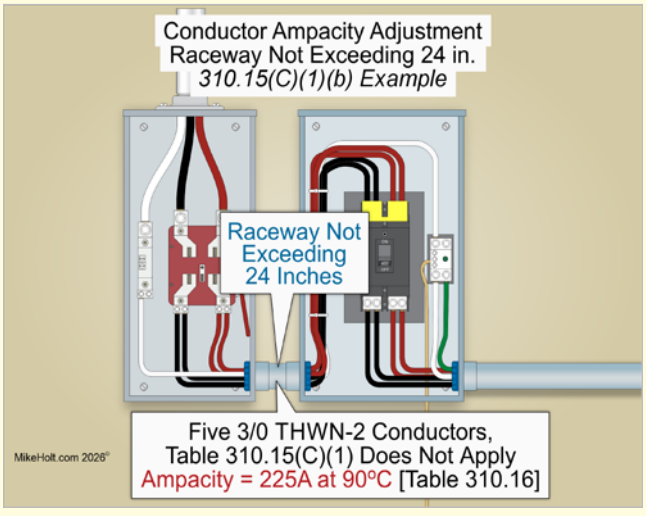


▸Figure 310–43

▶ Conductor Ampacity Adjustment—Raceway Not Exceeding 24 in. Example

Question: *What is the ampacity of five 3/0 AWG, THWN-2 copper conductors in a raceway that does not exceed 24 in. in length?* ▸Figure 310–44

(a) 175A (b) 195A (c) 205A (d) 225A



▸Figure 310–44

Solution:

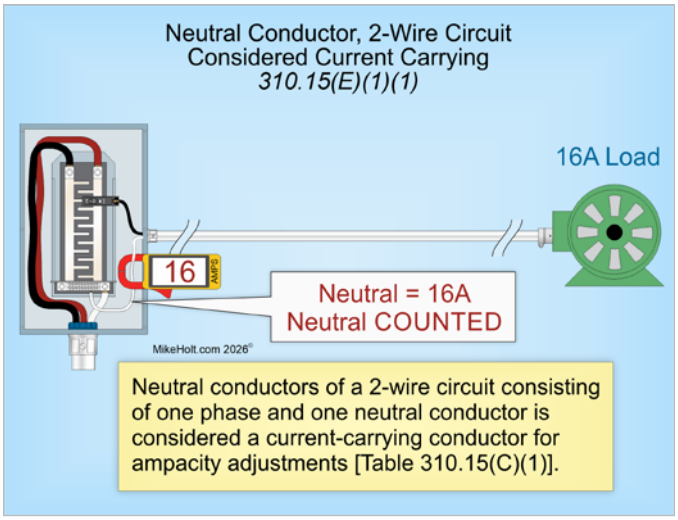
3/0 AWG, THWN-2 is rated 225A at 90°C [Table 310.16].

Answer: *(d) 225A*

(E) Neutral Conductor. When applying 310.15(C), neutrals are considered current-carrying or considered not current-carrying in accordance with the following:

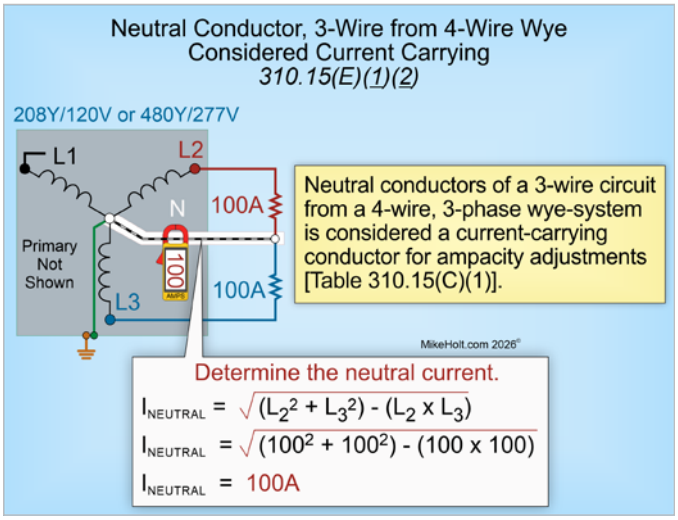
(1) Considered Current Carrying. A neutral conductor is considered a current-carrying conductor for ampacity adjustments in accordance with Table 310.15(C)(1) for the following circuits:

(1) 2-wire circuit consisting of one phase and one neutral conductor ▸Figure 310–45



▸Figure 310–45

(2) 3-wire circuit from a 4-wire, three-phase wye-connected system ▸Figure 310–46



▸Figure 310–46

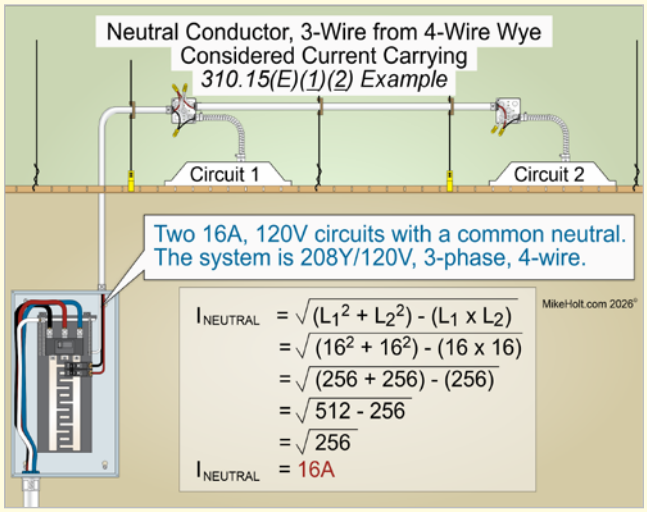
Unbalanced 3-Wire Wye Secondary Neutral Current Formula:

$$I_{Neutral} = \sqrt{[(I_{Line1}^2 + I_{Line2}^2) - (I_{Line1} \times I_{Line1})]}$$

▶ Neutral Conductor Current Carrying [310.15(E)(1)(2)] Example

Question: *What is the neutral current for two 16A, 120V circuits in a 208Y/120V, three-phase, 4-wire, wye-connected system?* ▸Figure 310–47

(a) 8A (b) 16A (c) 24A (d) 32A



▸Figure 310–47

Solution:

$I_{Neutral} = \sqrt{(I_{Line1}^2 + I_{Line2}^2) - (I_{Line1} \times I_{Line2})}$
$I_{Neutral} = \sqrt{(16^2 + 16^2) - (16 \times 16)}$
$I_{Neutral} = \sqrt{(512 - 256)}$
$I_{Neutral} = \sqrt{256}$
$I_{Neutral} = 16A$

Answer: *(b) 16A*

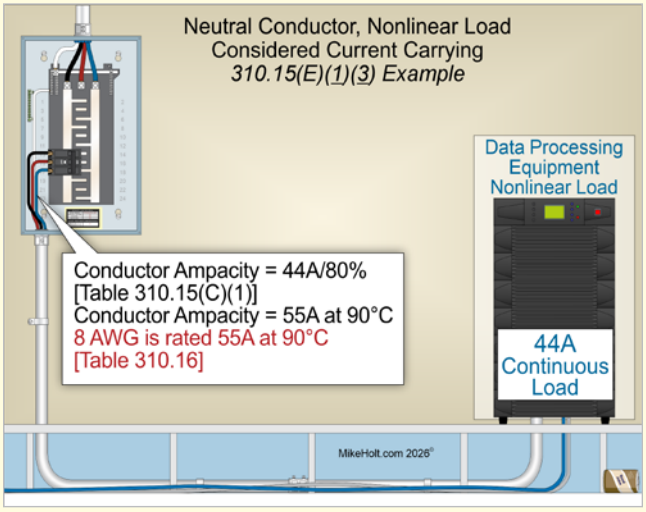
(3) 4-wire, three-phase, wye circuit where the majority of the line-to-neutral loads consists of ***nonlinear loads*** ▸Figure 310–48

Nonlinear Load. A load where the shape of the current waveform does not follow the shape of the voltage waveform.

▸Figure 310–48

▶ Neutral Conductor Nonlinear Load [310.15(E)(1)(3)] Example

Question: *What size conductor is required for a circuit supplying a 44A nonlinear load where the equipment is rated for 75°C conductor?* ▸Figure 310–49



▸Figure 310–49

(a) 10 AWG (b) 8 AWG (c) 6 AWG (d) 4 AWG

Solution:

Conductor Ampacity at 90°C = Actual Load/Adjustment

...

Actual Load = 44A

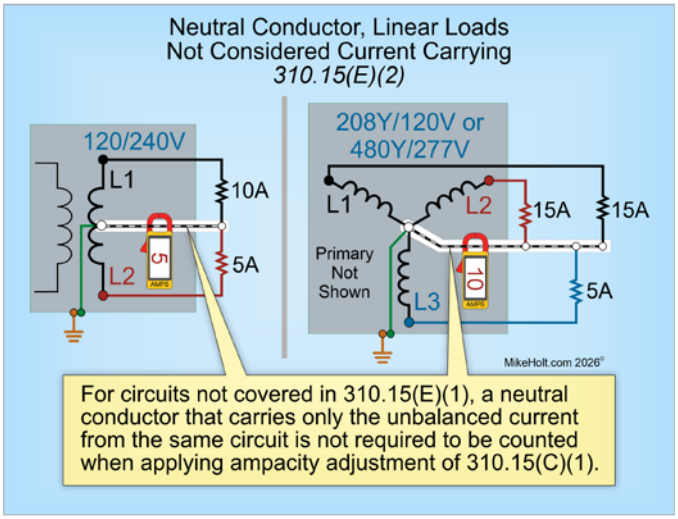
Adjustment [Table 310.15(C)(1)] = 80% (four current-carrying conductors)

Conductor Ampacity at 90°C Column = 44A/80%
Conductor Ampacity at 90°C Column = 55A

8 AWG copper is rated 55A at 90°C based on Table 310.16.

Answer: *(b) 8 AWG*

(2) Not Considered Current Carrying. For circuits not covered in 310.15(E)(1), a neutral conductor that carries only the unbalanced current from other conductors of the same circuit is not required to be counted when applying ampacity adjustment provisions of 310.15(C)(1). ▸Figure 310–50

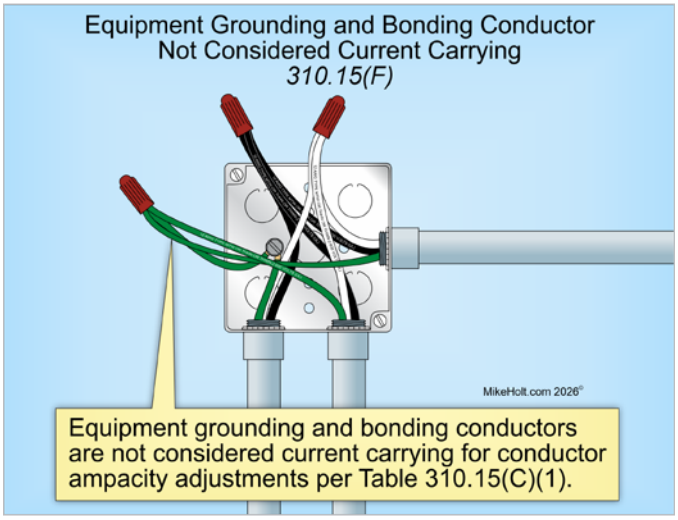


▸Figure 310–50

Author's Comment:

- The neutral conductor of a 3-wire, 120/240V circuit, or a 4-wire 208Y/120V or 480Y/277V circuit is not considered a current-carrying conductor for ampacity adjustments in accordance with Table 310.15(C)(1).
- The neutral conductor of a 2-wire circuit supplied from a 3-wire, single-phase, 120/240V system, or a 4-wire, three-phase, 208Y/120V or 480Y/277V system, is considered a current-carrying conductor for the application of conductor ampacity adjustments in accordance with Table 310.15(C)(1).

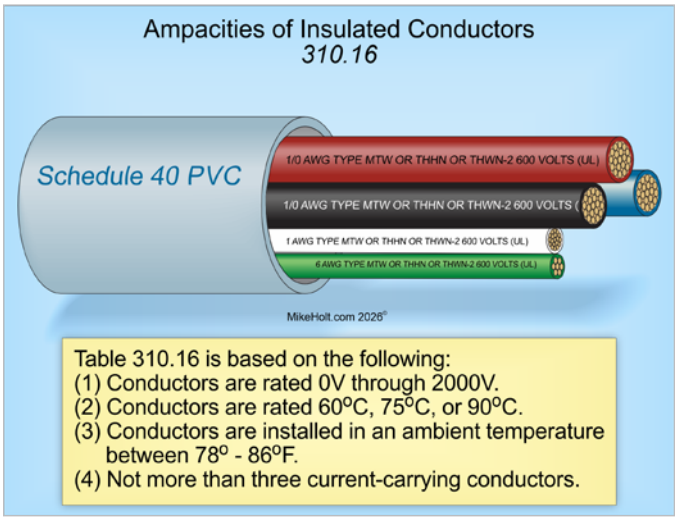
(F) Grounding and Bonding Conductor. Equipment grounding and bonding conductors are not considered current carrying for ampacity adjustments in accordance with Table 310.15(C)(1). ▸Figure 310–51



▸Figure 310–51

310.16 Insulated Conductors

Conductor ampacity is based on the following conditions: ▸Figure 310–52



▸Figure 310–52

(1) Conductors are rated 0V through 2000V

(2) Conductors are rated 60°C, 75°C, or 90°C

(3) Conductors in an ambient temperature between 78–86°F

(4) There are not more than three current-carrying conductors

Table 310.16 Ampacities of Insulated Conductors Not More Than Three Current-Carrying Conductors in Raceway, Cable, or Earth (Directly Buried)

Copper				Aluminum			
Size AWG kcmil	60°C (140°F)	75°C (167°F)	90°C (194°F)	60°C (140°F)	75°C (167°F)	90°C (194°F)	Size AWG kcmil
	TW UF	RHW THHW THW THWN XHHW USE	RHH RHW-2 THHN THHW THW-2 THWN-2 USE-2 XHHW XHHW-2	TW UF	THHN THW THWN XHHW	THHN THW–2 THWN–2 THHW XHHW XHHW–2	
16*[1]	10	15*[2]	20*[2]				
14*[1]	15	20	25	10*[2]	15*[2]	20*[2,3]	14*[1]
12*[1]	20	25	30	15	20	25	12*[1]
10*[1]	30	35	40	25	30	35	10*[1]
8	40	50	55	35	40	45	8
6	55	65	75	40	50	55	6
4	70	85	95	55	65	75	4
3	85	100	115	65	75	85	3
2	95	115	130	75	90	100	2
1	110	130	145	85	100	115	1
1/0	125	150	170	100	120	135	1/0
2/0	145	175	195	115	135	150	2/0
3/0	165	200	225	130	155	175	3/0
4/0	195	230	260	150	180	205	4/0
250	215	255	290	170	205	230	250
300	240	285	320	195	230	260	300
350	260	310	350	210	250	280	350
400	280	335	380	225	270	305	400
500	320	380	430	260	310	350	500

Notes:

1. See 310.15(B) for ampacity correction factors where the ambient temperature is other than 30°C (86°F).

2. See 310.15(C)(1) for ampacity adjustment factors when more than three current-carrying conductors.

**1 See 240.4(D) for overcurrent protection of small conductors*

**2 Ampacity is applicable only to copper-clad aluminum conductors.*

**3 Ampacity can only be used for adjustment or correction.*