

Article 310 Conductors for General Wiring

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310.1 Scope

Article 310 is to be used for general requirements for wiring, but not in areas where it is part of an integral device such as a motor, motor controller, or where covered in another part of the NEC®.

310.2 Conductors

Conductors must be insulated and made of copper, copper-clad aluminum, or aluminum unless otherwise specified in the NEC®.

310.3 Stranded Conductors

Any conductor installed in a raceway must be stranded if it is 8 AWG or larger. This is not required if it is permitted or required in another part of the NEC®.

310.4 Conductors in Parallel

Conductors 1/0 AWG or larger and having each phase, polarity, neutral, or grounded circuit conductor can be run in parallel if they are the same length, the same size, and of the same material with the same insulation and terminated the same way. They must be electrically joined at both ends. The cables or raceways must have the same physical characteristics if the conductors are run in separate cables or raceways. The same numbers of conductors have to be used in each raceway or cable. The conductors of one phase, neutral, or ground do not have to have the same physical characteristics as those of another to achieve balance. There are four exceptions to this:

1. Section 620.12(A)(1), Exception.
2. If smaller than 1/0 AWG, used for control power to indicating instruments, relays, and similar devices, and in the same raceway, each individual conductor can carry the entire load and the overcurrent rating is not larger than the ampacity of any single conductor.
3. Sizes smaller than 1/0 AWG are allowed for frequencies of 360 Hz and higher provided that Exception 2 is met.
4. With engineering supervision 2 AWG or larger grounded neutral conductors can be run parallel in existing installations.

310.5 Minimum Size of Conductors

Minimum sizes are shown in Table 310.5 except as permitted in other sections of the Code®. For voltages up to 2000, it is 14 AWG for copper and 12 AWG for aluminum or copper-clad aluminum.

310.6 Shielding

310.7 Direct Burial Conductors

310.8 Locations

In dry locations any type of insulated conductor or cable noted in the Code can be used. Use only Type RHW, TW, THW, MTW, RHW-2, THW-2, THHW, THHW-2, THWN, THWN-2, XHHW, XHHW-2, ZW, or a type listed as such for a wet location, or a moisture impervious metal-sheathed conductor. For dry and damp locations use Types FEP, FEPB, MTW, PFA, RHW, RHH, RHW-2, SA, XHH, XHHW, XHHW-2, THHN, THW-2, THW, THHW, THHW-2, THWN, THWN-2, TW, Z, or ZW. If conductors are exposed to direct sunlight the cables must be listed as sunlight resistant; or conductors must be listed and identified as sunlight resistant; or insulated conductors can be covered with tape, sleeving, or similar material that is listed for the application and identified as sunlight resistant.

310.9 Corrosive Conditions

310.10 Temperature Limitations of Conductors

310.11 Marking

All conductors and cables must have marked on them the maximum rated voltage, the proper letter type, the manufacturer's name or trademark, the AWG size or circular mil area, and cable assemblies where the neutral conductor is smaller than the ungrounded conductor. The size markings should be on the surface and spaced not more than 610 mm (24 in.) for eight types of cables. Other markings may be spaced 1.0 m (40 in.) apart. Certain cables can use marker tape inside the cable. Refer to this section in the NEC® for specific types where marker tape is permitted, which cables can have the size located elsewhere, and suffix designations for number of conductors. Special characteristics can be surface-marked on conductors listed in Chapter 3.

310.12 Conductor Identification

(A) Grounded Conductors. Insulated grounded conductors must be identified as noted in Section 200.6.

(B) Equipment Grounding Conductors. Equipment grounding conductors must be as noted in Section 250.119.

(C) Ungrounded Conductors. These must be distinguished from grounded and grounding conductors.

310.13 Conductor Constructions and Applications

Insulated conductors must be in accordance with Tables 310.13 and 310.61 through 310.64.

310.14 Aluminum Conductor Material

310.15 Ampacities for Conductors Rated 0-2000 Volts

(A) General

(1) Tables or Engineering Supervision. Ampacities can be determined by tables as provided in (B) or under engineering supervision as noted in 310.15(C).

(2) Selection of Ampacity. If more than one ampacity is determined from the tables or calculations, the lowest value must be used. There is one exception for adjacent portions of a circuit under certain circumstances.

(B) Tables. Ampacities are noted in the Allowable Ampacities Tables 310.16 through 310.19 and 310.20 through 310.23 for conductors rated 0 to 2000 volts. They can be modified by paragraphs (1) through (6).

Temperature Rating of Conductor (See Table 310.13)

	60°C (140°F)	75°C (167°F)	90°C (194°F)	60°C (140°F)	75°C (167°F)	90 °C (194°F)	
							Types TBS, SA, SIS, THHN, THHW, THW-2, THWN-2, RHH, RHW-2, USE-2, XHH, XHHW, XHHW-2, ZW-2
	Types TW, UF	Types RHW, THHW, THW, THWN, XHHW, USE, ZW	Types TBS, SA, SIS, FEP, FEPB, MI, RHH, RHW-2, THHN, THHW, THW-2, THWN- 2 USE-2, XHH, XHHW, XHHW- 2, ZW-2	Types TW, UF	Types RHW, THHW, THW, THWN, XHHW, USE,		
Size AWG or kcmil	Copper			Aluminum or Copper-Clad Aluminum			Size AWG or kcmil
18	....	....	14	....	....	....	....
16	....	....	18	....	....	....	....
14[*]	20	20	25	....	....	....	....
12[*]	25	25	30	20	20	25	12[*]
10[*]	30	35	40	25	30	35	10[*]
8	40	50	55	30	40	45	8
6	55	65	75	40	50	60	6
4	70	85	95	55	65	75	4
3	85	100	110	65	75	85	3

2	95	115	130	75	90	100	2
1	110	130	150	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	190	230	255	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
600	355	420	475	285	340	385	600
700	385	460	520	310	375	420	700
750	400	475	535	320	385	435	750
800	410	490	555	330	395	450	800
900	435	520	585	355	425	480	900
1000	455	545	615	375	445	500	1000
1250	495	590	665	405	485	545	1250

1500	520	625	705	435	520	585	1500
1750	545	650	735	455	545	615	1750
2000	560	665	750	470	560	630	2000
Correction Factors							
Ambient Temp. °C	For ambient temperatures other than 30°C (86°F), multiply the allowable ampacities shown above by the appropriate factor shown below.						Ambient Temp. °F
21-25	1.08	1.05	1.04	1.08	1.05	1.04	70-77
26-30	1.00	1.00	1.00	1.00	1.00	1.00	78-86
31-35	0.91	0.94	0.96	0.91	0.94	0.96	87-95
36-40	0.82	0.88	0.91	0.82	0.88	0.91	96-104
41-45	0.71	0.82	0.87	0.71	0.82	0.87	105-113
46-50	0.58	0.75	0.82	0.58	0.75	0.82	114-122
51-55	0.41	0.67	0.76	0.41	0.67	0.76	123-131
56-60	....	0.58	0.71	....	0.58	0.71	132-140
61-70	....	0.33	0.58	....	0.33	0.58	141-158
71-80	....	....	0.41	....	....	0.41	159-176

For table headings see page 94.

Table 310.16. Allowable Ampacities of Insulated Conductors, Rated 0 through 2000 Volts, 60° through 90°C (140° through 194°F) Not More than Three Current Conductors in Raceway, Cable, or Earth (Directly Buried) Based on Ambient Temperature of 30°C (86°F)

[*] See Section 240.4(D).

Temperature Rating of Conductor (See Table 310.13)

Size AWG or kcmil	75°C (167°F)	90°C (194°F)	75°C (167°F)	90°C (194°F)	Size AWG or kcmil
	TYPES RHW, THHW, THW, THWN, XHHW, ZW	TYPES MI, THHN, THHW, THW-2, THWN-2, RHH, RWH-2, USE-2, XHHW, XHHW-2, ZW-2	TYPES RHW, THW, THWN, THHW, XHHW	TYPES THHN, THHW, RHH, XHHW, RHW-2, XHHW-2, THW-2, THWN-2 USE-2, ZW-2	
	Copper		Aluminum or Copper-Clad Aluminum		
8	57	66	44	51	8
6	76	89	59	69	6
4	101	117	78	91	4
3	118	138	92	107	3
2	135	158	106	123	2
1	158	185	123	144	1
1/0	183	214	143	167	1/0
2/0	212	247	165	193	2/0
3/0	245	287	192	224	3/0
4/0	287	335	224	262	4/0

250	320	374	251	292	250
300	359	419	282	328	300
350	397	464	312	364	350
400	430	503	339	395	400
500	496	580	392	458	500
600	553	647	440	514	600
700	610	714	488	570	700
750	638	747	512	598	750
800	660	773	532	622	800
900	704	826	572	669	900
1000	748	879	612	716	1000

CORRECTION FACTORS

Ambient Temp. (°C)	For ambient temperatures other than 40° (104°F), multiply the ampacities shown above by the appropriate factor shown below.				Ambient Temp. (°F)
2125	1.20	1.14	1.20	1.14	7077
2630	1.13	1.10	1.13	1.10	7986
3135	1.07	1.05	1.07	1.05	8895
3640	1.00	1.00	1.00	1.00	97104

4145	0.93	0.95	0.93	0.95	106113
4650	0.85	0.89	0.85	0.89	115122
5155	0.76	0.84	0.76	0.84	124131
5660	0.65	0.77	0.65	0.77	133140
6170	0.38	0.63	0.38	0.63	142158
7180		0.45		0.45	160176

Table 310.20. Ampacities of Not More than Three Single-Insulated Conductors, Rated 0 through 2000 Volts, Supported on a Messenger, Based on Ambient Air Temperature of 40°C (104°F)

(1) General. For explanation of Type Letters, and for recognized size of conductors for the various conductor insulations, see Section 310.13. For installation requirements, see Sections 310.1 through 310.10, and the various articles of this Code. For flexible cords, see Tables 400.4, 400.5(A), and 400.5(B).

(2) Adjustment Factors

(a) More than Three Current-Carrying Conductors in a Raceway or Cable. Where the number of current-carrying conductors in a raceway or cable exceeds three, or where multi-conductor cables or single conductors are bundled or stacked longer than 600 mm (24 in.) without proper spacing and not in a raceway, the ampacities shall be reduced as shown in the following table Table 310.15(B)(2)(a). In a parallel set of conductors each conductor is counted as a current-carrying conductor. The exceptions to this are listed on the bottom of the table.

Number of Current-Carrying Conductors	Percent of Values in Tables Number of 310.16 through 310.19 Current-Carrying as Adjusted for Ambient Conductors Temperature if Necessary
4 through 6	80
7 through 9	70

Number of Current-Carrying Conductors	Percent of Values in Tables Number of 310.16 through 310.19 Current-Carrying as Adjusted for Ambient Conductors Temperature if Necessary
10 through 20	50
21 through 30	45
31 through 40	40
41 and above	35

Table 310.15(B)(2)(a). Adjustment Factors for More than Three Current-Carrying Conductors in a Raceway or Cable

FPN Note 1: See Appendix B, Table B.310.11 for adjustment factors for more than three current-carrying conductors in a raceway or cable with load diversity.

FPN Note 2: For correction factors for conductors in sheet metal auxiliary gutters see 366.23(A) and 376.22 for conductors in metal raceways.

Exception No. 1. When conductors of different systems, as provided in Section 300.3, are installed in a common raceway or cable the derating factors shown in Table 310.15(B)(2)(a) shall apply to the number of power and lighting (Articles 210, 215, 220, and 230) conductors only.

Exception No. 2. For conductors installed in cable trays, the provisions of Section 392.11 shall apply.

Exception No. 3. Derating factors shall not apply to conductors in nipples having a length not exceeding 610 mm (24 in.).

Exception No. 4. Derating factors shall not apply to underground conductors entering or leaving an outdoor trench if those conductors have physical protection in the form of rigid metal conduit, intermediate metal conduit or rigid nonmetallic conduit having a length not exceeding 3 mm (10 ft.) and the number of conductors does not exceed 4.

Exception No. 5. Adjustment factors shall not apply to Type AC cable or to Type MC cable without an overall outer jacket under the following conditions:

- (a) Each cable has not more than three current carrying conductors.
- (b) The conductors are 12 AWG copper.
- (c) Not more than 20 current carrying conductors are bundled, stacked, or supported on "bridle rings."

A 60 percent adjustment factor shall be applied where the current carrying conductors in these cables that are stacked or bundled longer than 600 mm (24 in.) without maintaining spacing exceeds 20.

(b) More than One Conduit, Tube, or Raceway. Spacing between conduits, tubing, or raceways shall be maintained.

(3) Bare Conductors or Covered Conductors

Where bare or covered conductors are used with insulated conductors, their allowable ampacities shall be limited to that permitted for the adjacent insulated conductors.

Copper Conductors				AAC Aluminum Conductors			
Bare		Covered		Bare		Covered	
AWG or kcmil	Amperes	AWG or kcmil	Amperes	AWG or kcmil	Amperes	AWG or kcmil	Amperes
8	98	8	103	8	76	8	80
6	124	6	130	6	96	6	101
4	155	4	163	4	121	4	127
2	209	2	219	2	163	2	171
1/0	282	1/0	297	1/0	220	1/0	231
2/0	329	2/0	344	2/0	255	2/0	268
3/0	382	3/0	401	3/0	297	3/0	312

Copper Conductors				AAC Aluminum Conductors			
Bare		Covered		Bare		Covered	
AWG or kcmil	Amperes	AWG or kcmil	Amperes	AWG or kcmil	Amperes	AWG or kcmil	Amperes
4/0	444	4/0	466	4/0	346	4/0	364
250	494	250	519	266.8	403	266.8	423
300	556	300	584	336.4	468	336.4	492
500	773	500	812	397.5	522	397.5	548
750	1000	750	1050	477.0	588	477.0	617
1000	1193	1000	1253	556.5	650	556.5	682
				636.0	709	636.0	744
				795.0	819	795.0	860
				954.0	920		
				1033.5	968	1033.5	1017
				1272	1103	1272	1201
				1590	1267	1590	1381
				2000	1454	2000	1527

Table 310.21. Ampacities of Bare or Covered Conductors in Free Air, Based on 40°C (104°F) Ambient, 80°C (176°F) Total Conductor Temperature, 610 mm/sec (2 ft/sec) Wind Velocity

(4) Neutral Conductor

1. A neutral conductor that carries only the unbalanced current from other conductors of the same circuit need not be counted when applying the provisions of Section 310.15(B)(2)(a).
2. In a three-wire circuit consisting of two-phase wires and the neutral of a four-wire, three-phase wye-connected system, a common conductor carries approximately the same current as the line to neutral load currents of the other conductors and shall be counted when applying the provisions of Section 310.15(B)(2)(a).
3. On a four-wire, three-phase wye circuit where the major portion of the load consists of nonlinear loads there are harmonic currents present in the neutral conductor and the neutral shall be considered to be a current-carrying conductor.

(5) Grounding or Bonding Conductor

A grounding or bonding conductor shall not be counted when applying the provisions of Section 310.15(B)(2)(a).

(6) 120/240 Volts, Three-Wire, Single-Phase Dwelling Services and Feeders

For individual dwelling units of one family, two-family, and multifamily dwellings, conductors, as listed in Table 310.15(B)(6), shall be permitted to be utilized as 120/240-V, three-wire, single-phase service-entrance conductors, service lateral conductors, and feeder conductors that serve as the main power feeder to a dwelling unit and are installed in raceway or cable with or without an equipment grounding conductor. For applications of this section, the main power feeder shall be the feeder(s) between the main disconnect and the lighting and appliance branch circuit panelboard(s). The feeder conductors to a dwelling unit shall not be required to be larger than its service-entrance conductors. The grounded conductor shall be permitted to be smaller than the ungrounded conductors, provided that the requirements of Sections 215.2, 220.61, and 230.42 are met.

Conductor (AWG or kcmil)

Copper	Aluminum or Copper-Clad Aluminum	Service or Feeder Ratings (Amperes)
4	2	100
3	1	110
2	1/0	125

Conductor (AWG or kcmil)

Copper	Aluminum or Copper-Clad Aluminum	Service or Feeder Ratings (Amperes)
1	2/0	150
1/0	3/0	175
2/0	4/0	200
3/0	250	225
4/0	300	250
250	350	300
350	500	350
400	600	400

Table 310.15(B)(6). Conductor Types and Sizes for 120/240-Volt, Three-Wire, Single-Phase Dwelling Services and Feeders

(C) Engineering Supervision.

With engineering supervision the following formula can be used to calculate ampacities:

where

TC = conductor temperature in degrees Celsius (°C)

TA = ambient temperature in degrees Celsius (°C)

DELTA TD = dielectric loss temperature rise

$$I = \sqrt{\frac{TC - (TA + \text{DELTA TD})}{RDC(1 + YC)RCA}}$$

RDC = dc resistance of conductor at temperature TC

YC = component ac resistance resulting from skin effect and proximity effect

RCA = effective thermal resistance between conductor and surrounding ambient

FPN: See Annex B for examples of formula application.

310.60 Conductors Rated 2001 to 35,000 Volts.

(A) Definitions.

(B) Ampacities of Conductors Rated 2001 to 35,000 Volts.