

Commercial and Industrial Wiring and Raceway Chart

Overcurrent Protection Size	Copper Wire 75°C Terminal	Maximum Continuous Ampere Load	Raceway (3)	Equipment Ground Wire	Maximum Continuous Single-Phase VA Load (2)					Maximum Continuous Three-Phase VA Load (2)		
					120V	208V	240V	277V	480V	208V	240V	480V
15	14	12	1/2"	14	1,440	2,496	2,880	3,324	5,760	4,323	4,988	9,976
20	12	16	1/2"	12	1,920	3,328	3,840	4,432	7,680	5,764	6,651	13,302
25	10	20	3/4"	10	2,400	4,160	4,800	5,540	9,600	7,205	8,314	16,627
30	10	24	3/4"	10	2,880	4,992	5,760	6,648	11,520	8,646	9,976	19,953
35	8	28	1"	10	3,360	5,824	6,720	7,756	13,440	10,087	11,639	23,278
40	8	32	1"	10	3,840	6,656	7,680	8,864	15,360	11,528	13,302	26,604
45	8	36	1"	10	4,320	7,488	8,640	9,972	17,280	12,969	14,964	29,929
50	8	40	1"	10	4,800	8,320	9,600	11,080	19,200	14,410	16,627	33,254
60	6	48	1"	10	5,760	9,984	11,520	13,296	23,040	17,292	19,953	39,905
70	4	56	1 1/4"	8	6,720	11,648	13,440	15,512	26,880	20,174	23,278	46,556
80	4	64	1 1/4"	8	7,680	13,312	15,360	17,728	30,720	23,056	26,604	53,207
90	3	72	1 1/4"	8	8,640	14,976	17,280	19,944	34,560	25,938	29,929	59,858
100	3	80	1 1/4"	8	9,600	16,640	19,200	22,160	38,400	28,820	33,254	66,509
110	2	88	1 1/2"	6	10,560	18,304	21,120	24,376	42,240	31,703	36,580	73,160
125	1	100	2"	6	12,000	20,800	24,000	27,700	48,000	36,026	41,568	83,136
150	1/0	120	2"	6	14,400	24,960	28,800	33,240	57,600	43,231	49,882	99,763
175	2/0	140	2"	6	16,800	29,120	33,600	38,780	67,200	50,436	58,195	116,390
200	3/0	160	2 1/2"	6	19,200	33,280	38,400	44,320	76,800	57,641	66,509	133,018
225	4/0	180	2 1/2"	4	21,600	37,440	43,200	49,860	86,400	64,846	74,822	149,645
250	250 kcmil	200	3"	4	24,000	41,600	48,000	55,400	96,000	72,051	83,136	166,272
300	350 kcmil	240	3 1/2"	4	28,800	49,920	57,600	66,480	115,200	86,461	99,763	199,526
350	400 kcmil	268(5)	3 1/2"	3	32,160	55,744	64,320	74,236	128,640	96,549	111,402	222,804
400	500 kcmil	304(5)	4"	3	36,480	63,232	72,960	84,208	145,920	109,518	126,367	252,733
400	600 kcmil	320	4"	3	38,400	66,560	76,800	88,640	153,600	115,282	133,108	266,035

(1) Conductor size based on 75°C terminal rating [110.14(C)(1)]. Ampacity based on four 90°C current-carrying conductors [Table 310.15(B)(3)(a) and Table 310.15(B)(16)].

(2) Maximum continuous nonlinear load in an ambient temperature of 30°C limited to 80 percent of the overcurrent device rating or the conductor ampacity, whichever is less [210.19(A), 240.6(A), 215.2(A)(1)].

(3) To ensure ease of installation, raceways are sized to six THHN conductors in PVC conduit [Annex C.10].

(4) Copper equipment grounding conductor is sized in accordance with Table 250.122.

(5) Maximum continuous load is limited to 80 percent of 75°C conductor ampacity because the conductor ampacity is lower than the overcurrent protection device rating.

Formulas

Conversion Formulas

Area of Circle = πr^2
 Break-even Dollars = Overhead Cost \$/Gross Profit %
 Busbar Ampacity AL = 700A sq. in. and CU = 1,000A sq. in.
 Centimeters = Inches/2.54
 Inch = 0.0254 Meters
 Inch = 2.54 Centimeters
 Inch = 25.40 Millimeters
 Kilometer = 0.6213 Miles
 Length of Coiled Wire =
 Diameter of Coil (average) x Number of Coils x π
 Lightning Distance in Miles =
 Seconds between flash and thunder/4.68
 Meter = 39.37 Inches
 Mile = 5,280 ft, 1,760 yards, 1,609 meters, 1.609 km
 Millimeter = 0.03937 Inch
 Selling Price = Estimated Cost \$(1 - Gross Profit %)
 Speed of Sound (Sea Level) = 1,128 fps or 769 mph
 Temp C = (Temp F - 32)/1.80
 Temp F = (Temp C x 1.80) + 32
 Yard = 0.9144 Meters

Electrical Formulas Based on 60 Hz

Capacitive Reactance (Xc) in Ohms = $1/(2\pi f C)$
 Effective (RMS) ac Amperes = Peak Amperes x 0.707
 Effective (RMS) ac Volts = Peak Volts x 0.707
 Efficiency (percent) = Output/Input x 100
 Efficiency = Output/Input
 Horsepower = Output Watts/746
 Inductive Reactance (Xl) in Ohms = $2\pi f L$
 Input = Output/Efficiency

Neutral Current (Wye) =

$$\sqrt{[(L_1^2 + L_2^2 + L_3^2) - (L_1 \times L_2) + (L_2 \times L_3) + (L_1 \times L_3)]}$$

Output = Input x Efficiency

Peak AC Volts = Effective (RMS) AC Volts x $\sqrt{2}$

Peak Amperes = Effective (RMS) Amperes x $\sqrt{2}$

Power Factor (PF) = Watts/VA

VA (apparent power) = Volts x Ampere or Watts/Power Factor

VA single-Phase = Volts x Amperes

VA three-Phase = Volts x Amperes x $\sqrt{3}$

Watts (real power) Single-Phase = Volts x Amperes x Power Factor

Watts (real power) Three-Phase = Volts x Amperes x Power Factor x $\sqrt{3}$

Parallel Circuits

Note 1: Total resistance is always less than the smallest resistor

$$RT = 1/(1/R1 + 1/R2 + 1/R3 + \dots)$$

Note 2: Total current is equal to the sum of the currents of all parallel resistors

Note 3: Total power is equal to the sum of power of all parallel resistors

Note 4: Voltage is the same across each of the parallel resistors

Series Circuits

Note 1: Total resistance is equal to the sum of all the resistors

Note 2: Current in the circuit remains the same through all the resistors

Note 3: Voltage source is equal to the sum of voltage drops of all resistors

Note 4: Power of the circuit is equal to the sum of the power of all resistors

Transformer Amperes

Secondary Amperes single-Phase = VA/Volts

Secondary Amperes three-Phase = VA/(Volts x $\sqrt{3}$)

Secondary Available Fault single-Phase =

$$VA/(\text{Volts} \times \% \text{impedance})$$

Transformer Amperes (continued)

Secondary Available Fault three-Phase =

$$VA/(\text{Volts} \times \sqrt{3} \times \% \text{impedance})$$

Delta 4-Wire: Line Amperes =

$$\text{Phase (one winding) Amperes} \times \sqrt{3}$$

Delta 4-Wire: Line Volts = Phase (one winding) Volts

Delta 4-Wire: High-Leg Voltage (L-to-G) =

$$\text{Phase (one winding) Volts} \times 0.50 \times \sqrt{3}$$

Wye: Line Volts = Phase (one winding) Volts x $\sqrt{3}$

Wye: Line Amperes = Phase (one winding) Amperes

Voltage Drop

VD (single-Phase) = 2KID/Cmil

VD (three-Phase) = $\sqrt{3}$ KID/Cmil

Cmil (single-Phase) = 2KID/VD

Cmil (three-Phase) = $\sqrt{3}$ KID/VD

Code Rules

Breaker/Fuse Ratings - 240.6(A)

Conductor Ampacity - 310.15 and Table 310.15(B)(16)

Equipment Grounding Conductor - 250.122

Grounding Electrode Conductor - 250.66

Motor Conductor Size - 430.22 (Single)

430.24 (Multiple)

Motor Short-Circuit Protection - 430.52

Transformer Overcurrent Protection - 450.3

Legend

π (Pi) = 3.142 (approximately)

$\sqrt{2}$ = 1.414 (approximately)

$\sqrt{3}$ = 1.732 (approximately)

f = frequency

r = radius

d = diameter

C = Capacitance (farads)

L = Inductance (henrys)

Cmil = Circular Mills

VD = Volts Drop

I = Amperes of load

D = Distance one way

K75°C = (12.90 ohms CU)

(21.20 ohms AL)



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