GROUNDED CONDUCTOR, MAIN BONDING JUMPER, SYSTEM BONDING JUMPER, AND SUPPLY-SIDE BONDING JUMPER FOR ALTERNATING-CURRENT SYSTEMS

Size of Largest Ungrounded Conductor or Equivalent Area for Parallel Conductors (AWG/kcmil)		Size of Grounded Conductor or Bonding Jumper (AWG/kcmil)	
Copper	Aluminum or Copper-Clad Aluminum	Copper	Aluminum or Copper-Clad Aluminum
2 or Smaller	1/0 or Smaller	8	6
1 or 1/0	2/0 or 3/0	6	4
2/0 or 3/0	4/0 or 250	4	2
Over 3/0 through 350	Over 250 through 500	2	1/0
Over 350 through 600	Over 500 through 900	1/0	3/0
Over 600 through 1100	Over 900 through 1750	2/0	4/0
Over 1100	Over 1750	See Notes 1 and 2.	

Notes:

1. If the circular mil area of ungrounded supply conductors that are connected in parallel is larger than 1100 kcmil copper or 1750 kcmil aluminum, the grounded conductor or bonding jumper shall have an area not less than 12½% of the area of the largest ungrounded supply conductor or equivalent area for parallel supply conductors. The grounded conductor or bonding jumper shall not be required to be larger than the largest ungrounded conductor or set of ungrounded conductors.
2. The grounded conductor or bonding jumper shall not be required to be larger than the largest ungrounded conductor or set of ungrounded conductors.
3. If the circular mil area of ungrounded supply conductors that are connected in parallel is larger than 1100 kcmil copper or 1750 kcmil aluminum and if the ungrounded supply conductors and the bonding jumper are of different materials (copper, aluminum, or copper-clad aluminum), the minimum size of the grounded conductor or bonding jumper shall be based on the assumed use of ungrounded supply conductors of the same material as the grounded conductor or bonding jumper that has an ampacity equivalent to that of the installed ungrounded supply conductors.
4. If there are no service-entrance conductors, the supply conductor size shall be determined by the equivalent size of the largest service-entrance conductor required for the load to be served.

Source: NFPA 70®, *National Electrical Code®*, 2026 edition, NFPA, Quincy, MA, 2025, Table 250.102(C)(1), as modified.

GENERAL LIGHTING LOADS BY NON-DWELLING OCCUPANCY

Type of Occupancy	Volt-Amperes/ Square Foot	Type of Occupancy	Volt-Amperes/ Square Foot
Automotive facility	1.5	Museum	1.6
Convention center	1.4	Office[4]	1.3
Courthouse	1.4	Parking garage[5]	0.3
Dormitory	1.5	Penitentiary	1.2
Exercise center	1.4	Performing arts theater	1.5
Fire station	1.3	Police station	1.3
Gymnasium[1]	1.7	Post office	1.6
Health care clinic	1.6	Religious facility	2.2
Hospital	1.6	Restaurant[6]	1.5
Hotel or motels, or apartment houses without provisions for cooking by tenants[2]	1.7	Retail[7, 8]	1.9
		School/university	1.5
Library	1.5	Sports arena	1.5
Manufacturing facility[3]	2.2	Town hall	1.4
Motion picture theater	1.6	Transportation	1.2
		Warehouse	1.2
		Workshop	1.7

See *NEC* 120.41 for dwelling units.
See *NEC* 120.14(J) for receptacle outlets in office buildings.
[1]Armories and auditoriums are considered gymnasium-type occupancies.
[2]Lodge rooms are similar to hotels and motels.
[3]Industrial commercial loft buildings are considered manufacturing-type occupancies.
[4]Banks are office-type occupancies.
[5]Commercial (storage) garages are considered parking garage occupancies.
[6]Clubs are considered restaurant occupancies.
[7]Barber shops and beauty parlors are considered retail occupancies.
[8]Stores are considered retail occupancies.

Source: NFPA 70®, *National Electrical Code®*, 2026 edition, NFPA, Quincy, MA, 2025, Table 120.42(A), as modified.

LIGHTING LOAD DEMAND FACTORS

Type of Occupancy	Portion of Lighting Load to Which Demand Factor Applies (Volt-Amperes)	Demand Factor (%)
Dwelling units	First 3000	100
	From 3001 to 120000 at	35
	Remainder over 120000 at	25
Hotels and motels, including apartment houses without provision for cooking by tenants*	First 20000 or less at	60
	From 20001 to 100000 at	50
	Remainder over 100000 at	35
Warehouses (storage)	First 12500 or less at	100
	Remainder over 12500 at	50
All others	Total volt-amperes	100

* The demand factors of this table shall not apply to the calculated load of feeders or services supplying areas in hotels and motels where the entire lighting is likely to be used at one time, as in ballrooms or dining rooms.

Source: NFPA 70®, *National Electrical Code®*, 2026 edition, NFPA, Quincy, MA, 2025, Table 120.45, as modified.

DEMAND FACTORS FOR RECEPTACLE LOADS—OTHER THAN DWELLING UNITS

Portion of Receptacle Load to Which Demand Factor Applies (Volt-Amperes)	Demand Factor (%)
First 10 kVA or less at	100
Remainder over 10 kVA at	50

Source: NFPA 70®, *National Electrical Code®*, 2026 edition, NFPA, Quincy, MA, 2025, Table 120.47, as modified.

DEMAND FACTORS FOR HOUSEHOLD ELECTRIC CLOTHES DRYERS

Number of Dryers	Demand Factor (%)
1–2	100
3–5	80
6	75
7	65
8	60
9	55
10	50
11	47
12–23	47 minus 1 for each dryer exceeding 11
24–42	35 minus 0.5 for each dryer exceeding 23
43 and over	25

Source: NFPA 70®, *National Electrical Code®*, 2026 edition, NFPA, Quincy, MA, 2025, Table 120.54, as modified.

DEMAND FACTORS FOR INSTANTANEOUS WATER HEATERS AND KITCHEN EQUIPMENT—OTHER THAN DWELLING UNIT(S)

Number of Units of Equipment	Demand Factor (%)
1	100
2	100
3	90
4	80
5	70
6 and over	65

Note: In no case shall the feeder or service calculated load be less than the sum of the largest two kitchen equipment loads.

Source: NFPA 70®, *National Electrical Code®*, 2026 edition, NFPA, Quincy, MA, 2025, Table 120.56, as modified.

DEMAND LOADS FOR HOUSEHOLD ELECTRIC RANGES, WALL-MOUNTED OVENS, COUNTER-MOUNTED COOKING UNITS, AND OTHER HOUSEHOLD COOKING APPLIANCES OVER 1¾ KW RATING

(Column C to be used in all cases except as otherwise permitted in Note 3)

Number of Appliances	Demand Factor (%) (See Notes) Column A (Less than 3½ kW Rating)	Column B (3½ kW Through 8¾ kW Rating)	Column C Maximum Demand (kW) (See Notes) (Not over 12 kW Rating)
1	80	80	8
2	75	65	11
3	70	55	14
4	66	50	17
5	62	45	20
6	59	43	21
7	56	40	22
8	53	36	23
9	51	35	24
10	49	34	25
11	47	32	26
12	45	32	27
13	43	32	28
14	41	32	29
15	40	32	30
16	39	28	31
17	38	28	32
18	37	28	33
19	36	28	34
20	35	28	35
21	34	26	36
22	33	26	37
23	32	26	38
24	31	26	39
25	30	26	40
26–30	30	24	15 kW + 1 kW for each range
31–40	30	22	
41–50	30	20	25 kW + 3/4 kW for each range
51–60	30	18	
61 and over	30	16	

(continued on next page)

DEMAND LOADS FOR HOUSEHOLD ELECTRIC RANGES, WALL-MOUNTED OVENS, COUNTER-MOUNTED COOKING UNITS, AND OTHER HOUSEHOLD COOKING APPLIANCES OVER 1¾ KW RATING

Notes:

1. Over 12 kW through 27 kW ranges all of same rating. For ranges individually rated more than 12 kW but not more than 27 kW, the maximum demand in Column C shall be increased by 5% for each additional kilowatt of rating or major fraction thereof by which the rating of individual ranges exceeds 12 kW.
2. Over 8¾ kW through 27 kW ranges of unequal ratings. For ranges individually rated more than 8¾ kW and of different ratings, but none exceeding 27 kW, an average value of rating shall be computed by adding together the ratings of all ranges to obtain the total connected load (using 12 kW for any range rated less than 12 kW) and dividing the total number of ranges. Then the maximum demand in Column C shall be increased by 5% for each kilowatt or major fraction thereof by which this average value exceeds 12 kW.
3. Over 1¾ kW through 8¾ kW. In lieu of the method provided in Column C, adding the nameplate ratings of all household cooking appliances rated more than 1¾ kW but not more than 8¾ kW and multiplying the sum by the demand factors specified in Column A or B for the given number of appliances shall be permitted. Where the rating of cooking appliances falls under both Column A and Column B, the demand factors for each column shall be applied to the appliances for that column and the results are added together.
4. Calculating the branch-circuit load for one range in accordance with Table 120.55 shall be permitted.
5. The branch-circuit load for one wall-mounted oven or one counter-mounted cooking unit shall be the nameplate rating of the appliance.
6. The branch-circuit load for a counter-mounted cooking unit and not more than two wall-mounted ovens, all supplied from a single branch circuit and located in the same room, shall be computed by adding the nameplate rating of the individual appliances and treating this total as equivalent to one range.
7. This table also applies to household cooking appliances rated over 1¾ kW and used in instructional programs.

NFPA 70®, National Electrical Code®, 2026 edition, NFPA, Quincy, MA, 2025. Table 120.55, as modified.

CALCULATING COST OF OPERATING AN ELECTRICAL APPLIANCE

What is the monthly cost of operating a 240-volt, 5-kilowatt (kW) central electric heater that operates 12 hours per day when the cost is 15 cents per kilowatt-hour (kWhr)?

Cost = Watts × Hours Used × Rate per kWhr/1000

5 kW = 5000 Watts

Hours = 12 Hours × 30 Days = 360 Hours per Month

= 5000 × 360 × 0.15/1000

= 270000/1000 = **$270 Monthly Cost**

The above example is for a resistive load. Air-conditioning loads are primarily inductive loads. However, if ampere and voltage values are known, this method will give an approximate cost. Kilowatt-hour rates vary for different power companies, and for residential use, graduated-rate scales are usually used (the more power used, the lower the rate). Commercial and industrial rates are generally based on kilowatt usage, maximum demand and power factor. Other costs are often added such as fuel cost adjustments.

CHANGING INCANDESCENT LAMP TO ENERGY-SAVING LAMP

A 100-watt incandescent lamp is to be replaced with a 15-watt, energy-saving lamp that has the same light output (lumens). If the cost per kilowatt-hour (kWhr) is 15 cents, how many hours would the new lamp need to operate to pay for itself?

Lamp cost is 4 dollars. Energy saved is 85 watts.

Hours = Lamp Cost × 1000/Watts Saved × kWhr

(4 × 1000)/(85 × 0.15) = 4000/12.75 = 313.73 hours

The energy-saving lamp will pay for itself with 313.73 hours of operation.

The comparative operating cost of these two lamps based on 313.73 hours is found by:

Cost = Watts × Hours Used × Rate per kWhr/1000

100-watt incandescent lamp = $4.71 for 313.73 hours of operation

15-watt energy saving lamp = $0.71 for 313.73 hours of operation

PARTIAL 2026 NATIONAL ELECTRICAL CODE SUMMARY

The 2026 edition of the National Electrical Code (NEC) contains 13 new articles and several relocated articles. Six existing articles were deleted, but the requirements from these deleted articles were moved into other new and existing articles. Article 220 was relocated to Chapter 1 and is now Article 120. Article 235 was deleted and separated into four new articles. Article 750 was renamed, and the rules for energy management systems were moved to Article 130. The requirements found in Article 395 for outdoor overhead conductors over 1000 volts were relocated to Article 267. The requirements for fire-resistive cable systems, which were found in the now-deleted Article 728, have been moved to Article 772.

Article 120—Branch-Circuit, Feeder, and Service Load Calculations (Moved)

Article 120 provides requirements for calculating branch-circuit, feeder, and service loads. This article was revised and relocated from Article 220 in the 2023 NEC to Article 120 in the 2026 NEC.

Article 130—Energy Management Systems (Moved)

Article 130 applies to the installation and operation of energy management systems. The requirements found in Article 130 were previously located in Article 750 in the 2023 NEC.

Article 206—Non-Power-Limited Remote-Control and Signaling Circuits (New)

Article 206 covers the general requirements for non-power-limited remote-control and signaling circuits. This new article contains new content as well as existing rules that were previously found in Article 300 of the 2023 NEC.

Article 265—Branch Circuits Over 1000 Volts ac, 1500 Volts dc, Nominal (New)

Article 235 in the 2023 NEC, which covered branch circuits, feeders, and services over 1000 volts ac, and 1500 volts dc was deleted and broken down into four separate articles for the 2026 NEC. The first

of these four new articles is Article 265 which solely covers branch circuits over 1000 volts ac and 1500 volts dc nominal.

Article 266—Feeders Over 1000 Volts ac, 1500 Volts dc, Nominal (New)

Article 266 is the second new article that contains requirements from the deleted Article 235 found in the 2023 NEC. Article 266 contains the rules for feeders over 1000 volts ac and 1500 volts dc.

Article 267—Outside Branch Circuits and Feeders Over 1000 Volts ac, 1500 Volts dc, Nominal (New)

Article 267 covers outside branch circuits and feeders over 1000 volts ac and 1500 volts dc. This article is the third of four new articles relocated from the 2023 NEC Article 235.

Article 268—Services Over 1000 Volts ac, 1500 Volts dc, Nominal (New)

The fourth article relocated from Article 235 in the 2023 NEC is Article 268. This article covers services over 1000 volts ac and 1500 volts dc, nominal.

Article 270—Grounding and Bonding of Systems Over 1000 Volts ac, 1500 Volts dc, Nominal (New)

Article 270 provides the requirements for grounding and bonding of systems over 1000 volts ac and 1500 volts dc. This new article contains text that was previously found in Part X of Article 250 in the 2023 NEC.

Article 624—Electric Self-Propelled Vehicle Power Transfer Systems (ESVSEs) (New)

Article 624 contains new requirements and existing requirements for conductors and equipment connecting an electric self-propelled vehicle to premises wiring for the purposes of charging, power export, or bidirectional current flow. Many of the sections contained in Article 624 were relocated from Article 625 in the 2023 NEC and several new sections were added.

PARTIAL 2026 NATIONAL ELECTRICAL CODE SUMMARY

Article 720—General Requirements for Limited-Energy System Wiring Methods and Materials (New)

Article 720 covers the wiring methods and materials for Class 1 power-limited circuits, Class 2, 3, and 4 circuits, as well as optical fiber systems, communications systems, antenna systems, CATV systems, network-powered broadband communications systems, premises-powered broadband communications systems, and power-limited fire alarm systems.

Article 721—Power Sources for Limited-Energy Systems (New)

Article 721 provides rules for power sources for limited-energy circuits.

Article 722—Limited-Energy Cables for Power-Limited Circuits, Fault-Managed-Power Circuits, Optical Fiber Circuits, and Communications Circuits (New)

Article 722 received a new title for the 2026 NEC and now covers the general requirements for the installation of single- and multiple-conductor cables used in Class 2, 3, and 4 circuits, power-limited fire alarm circuits, optical fiber cables, and communications systems power-limited, remote-control, and signaling circuits that are not an integral part of a device or utilization equipment installed inside of buildings.

Article 723—Raceways, Cable-Routing Assemblies, and Cable Trays for Limited-Energy Systems (New)

Article 723 provides the requirements for raceways and cable assemblies for limited-energy systems.

Article 742—Overvoltage Protection of Limited-Energy Systems (New)

Article 742 covers the overvoltage protection requirements for Class 1 power-limited circuits, Class 2, 3, and 4 circuits, optical fiber systems, communications systems, antenna systems, community antenna systems, network-powered broadband communications systems, premises-powered broadband communications systems, and power-limited fire alarm systems.

PARTIAL 2026 NATIONAL ELECTRICAL CODE SUMMARY

Article 750—Grounding and Bonding of Limited-Energy Systems (New)

Article 750 covers the grounding and bonding for Class 1 power-limited circuits, Class 2, 3, and 4 circuits, optical fiber systems, communications systems, antenna systems, community antenna systems, network-powered broadband communications systems, premises-powered broadband communications systems, and power-limited fire alarm systems.

Article 772—Fire-Resistive Cable Systems (Moved)

Article 772 provides the requirements for the installation of fire-resistive cables, conductors, and other system components used for survivability of critical circuits to ensure continued operation during a specified time under fire conditions as required by the NEC. These rules were relocated from Article 728 in the 2023 NEC.

Code Arrangement [90.3]

Chapter 8 is no longer a "stand-alone" chapter. In previous editions of the NEC, Chapter 8 was not subject to the requirements found in Chapters 1 through 7. In the 2026 NEC, revised Figure 90.3 shows that Chapter 8 supplements or modifies Chapters 1 through 8 and is subject to the rules found in Chapters 1 through 8.

Definitions [Article 100]

A new definition of "Limited-Energy Cable" has been added. A limited-energy cable is defined as a factory assembly of one or more conductors or optical fibers used for Class 2, 3, or 4 circuits, optical fiber systems, communications circuits, CATV circuits, network-powered broadband low-power communications circuits, premises communications circuits, and power-limited fire alarm circuits.

Arc-Flash Hazard Marking [110.16]

In other than dwelling units, a permanent arc flash marking is now required to be field or factory applied to service equipment and feeder-supplied equipment such as switchboards, switchgear, enclosed

panelboards, industrial control panels, meter socket enclosures, and motor-control centers. In previous editions of the NEC, this rule simply required a label warning of the potential of an arc flash. The 2026 edition of the NEC requires permanent markings showing the nominal system voltage, the arc flash boundary, the available incident energy or minimum required level of PPE, and the date the assessment was completed.

GFCI Protection for Personnel [210.8]

201.8(F) requires GFCI protection for all outdoor outlets at dwelling units supplied by single-phase branch circuits rated 150 volts or less to ground and 60 amperes or less. Effective September 1, 2026, GFCI or SPGFCI protection shall be provided for listed HVAC equipment. This section was added to the 2020 NEC and requires GFCI protection for all specified outlets located outdoors at dwelling units but was modified in the 2026 NEC by raising the current limit from 50 amperes to 60 amperes. By definition, listed HVAC equipment is an outlet and GFCI or SPGFCI protection is required. There are a few limited exceptions to this rule including most lighting outlets and electric snow-melting and deicing equipment. The requirement for protecting listed HVAC equipment has been postdated to September 1, 2026.

10-Ampere Branch Circuits [210.23(A)]

10-ampere branch circuits were introduced in the 2023 NEC with limited use. This section has been revised and now allows 10-ampere branch circuits to be used for lighting outlets and dwelling unit exhaust fans on bathroom and laundry room lighting circuits only. Section 310.5(A) has also been revised for the 2026 NEC and now allows 16 AWG copper, 14 AWG copper-clad aluminum, and 12 AWG aluminum conductors to be used on 10-ampere branch circuits.

Dwelling Unit Receptacle Outlets [210.52]

210.52(C)(4) states that required and permitted receptacle outlets in dwelling unit kitchens, pantries, breakfast rooms, dining rooms, and similar areas installed in a location that is accessible outside cabinets or wall surfaces that are below countertop and work surfaces shall not

be installed on adjacent walls within 24 inches of the base cabinets. If installed beneath countertops, the receptacle outlets shall not be located within 24 inches of the countertop or work surface. Previous editions of the NEC allowed receptacle outlets to be installed on the sides of island and peninsular countertop spaces within this zone. This new section prohibits receptacle outlets from being installed below the countertops in kitchens, dining rooms, and similar areas of dwelling units if located within 24 inches of the countertop or base cabinets.

Minimum Size of Conductors [310.5(A)]

Since 10-ampere branch circuits are now permitted when complying with 210.23(A), the minimum size of conductors has also been revised. The minimum size of conductors for voltage ratings up to and including 2000 volts shall be 16 AWG copper, 14 AWG copper-clad aluminum, or 12 AWG aluminum, except as permitted elsewhere in the NEC.

Wiring Devices [Article 406]

The title of Article 406 has changed "Receptacles, Cord Connectors, and Attachment Plugs (Caps)" to "Wiring Devices". The revised title illustrates that this article no longer solely covers receptacle outlets but now includes requirements for switches and other wiring devices. Much of the text in Article 404 in the 2023 NEC, related to switches, has been moved to Article 406 in the 2026 NEC.

Annex L—Proposed Organization of the 2029 National Electrical Code

Annex L was added to the 2026 NEC and gives us a look at what is being proposed for the structure of the 2029 edition. The NEC has contained 9 chapters for many decades. The 2029 edition is poised to undergo vast changes and will potentially contain 30 chapters. Annex L gives a preview of this proposed reorganization and allows for Public Input to be submitted during that stage of the NFPA Standards Development Process. For more information, please visit www.nfpa.org/70next. Public Input for the 2029 NEC must be submitted by April 9, 2026.

FIELD TERMS VERSUS *NEC* TERMS

• BX	Armored cable (*NEC* 320)
• Romex	Nonmetallic sheathed cable (*NEC* 334)
• Green field	Flexible metal conduit (*NEC* 348)
• Thin wall	Electrical metallic tubing (*NEC* 358)
• Smurf tube	Electrical nonmetallic tubing (*NEC* 362)
• 1900 box	4-inch square box (*NEC* 314)
• 333 box	Device box (*NEC* 314)
• EYS	Explosion proof seal off (*NEC* 500)
• Neutral**	Grounded conductor (*NEC* 200)**
• Ground wire	Equipment grounding conductor (*NEC* 250.118)
• Ground wire	Grounding electrode conductor (*NEC* 250.66)
• Hot, live	Ungrounded conductor (*NEC* 100)

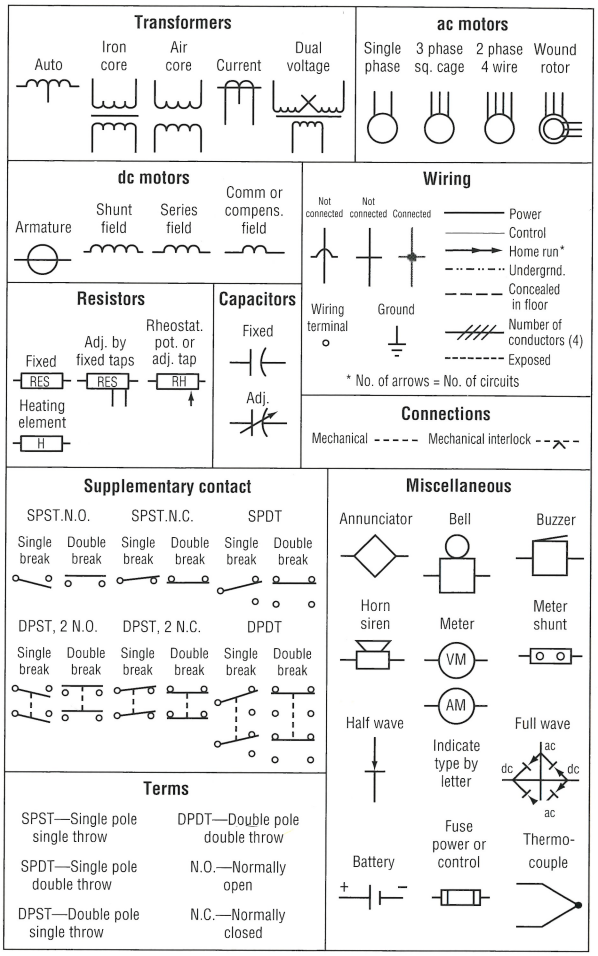
** Some systems do not have a neutral, and the grounded conductor may be a phase conductor. (See *NEC* Article 100 definition of *neutral conductor.*)

ELECTRICAL SYMBOLS

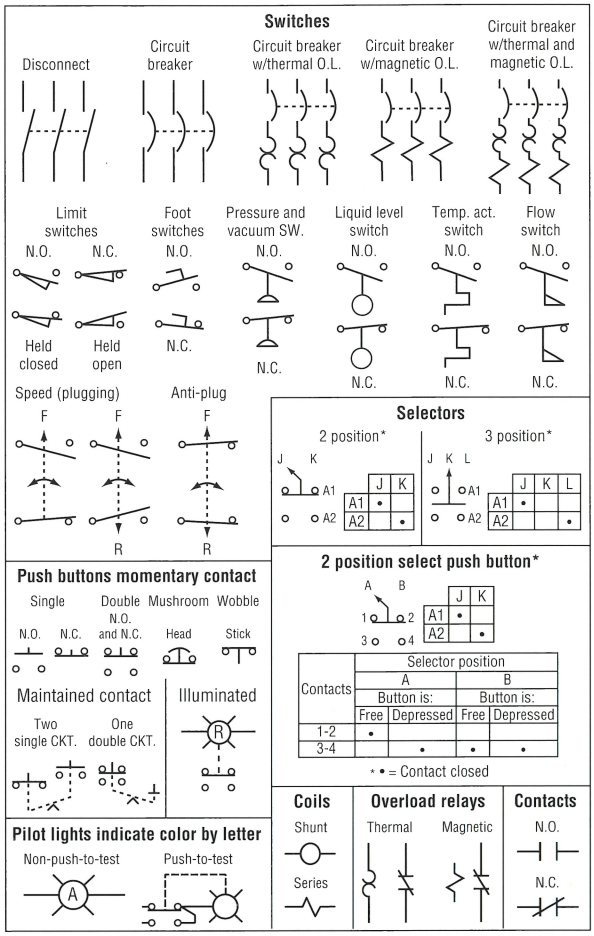
Wall	Ceiling	
		Outlet
D	D	Drop Card
F	F	Fan Outlet
J	J	Junction Box
L	L	Lampholder
L_{PS}	L_{PS}	Lampholder With Pull Switch
S	S	Pull Switch
V	V	Vapor Discharge Lamp Outlet
X	X	Exit Outlet
C	C	Clock Outlet
B	B	Blanked Outlet
		Duplex Convenience Outlet
1.3		Single, Triplex, etc.
		Range Outlet
S		Duplex Receptacle and Switch
		Special Purpose Outlet
		Floor Outlet

Switch Outlets	
S	Single-Pole Switch
S_2	Double-Pole Switch
S_3	Three-Way Switch
S_4	Four-Way Switch
S_D	Door Switch
S_E	Electrolier Switch
S_P	Switch and Pilot Lamp
S_K	Key-Operated Switch
S_{CB}	Circuit Breaker
S_{WCB}	Weather-Proof Circuit Breaker
S_{MC}	Momentary-Contact Switch
S_{RC}	Remote-Control Switch
S_{WP}	Weather-Proof Switch
S_F	Fused Switch
S_{WPF}	Weather-Proof Fused Switch
	Lighting Switch
	Power Panel

ELECTRICAL SYMBOLS



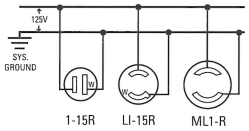
ELECTRICAL SYMBOLS



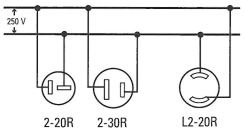
Note: N.O. = normally open; N.C. = normally closed

WIRING DIAGRAMS FOR NEMA CONFIGURATIONS

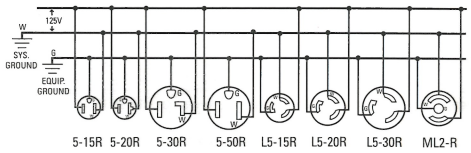
2 Pole,2 Wire Nongrounding 125V



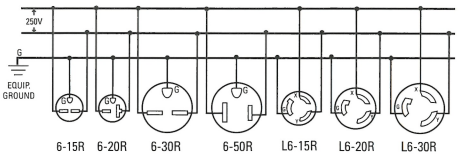
2 Pole,2 Wire Nongrounding 250V



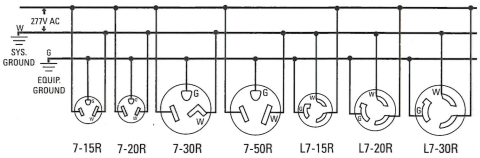
2 Pole,3 Wire Grounding 125V



2 Pole,3 Wire Grounding 250V



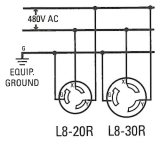
2 Pole,3 Wire Grounding 277V ac



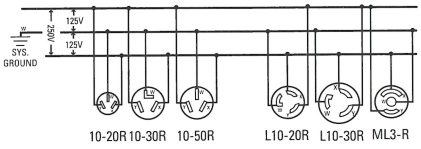
Courtesy of
COOPER Wiring Devices
The New Power in Wiring Devices

WIRING DIAGRAMS FOR NEMA CONFIGURATIONS

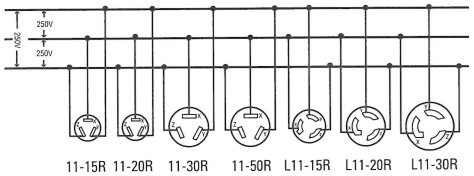
2 Pole, 3 Wire Grounding 480V ac



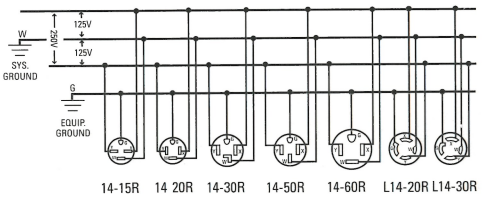
3 Pole, 3 Wire Nongrounding 125/250V



3 Pole, 3 Wire Nongrounding 3ø 250V



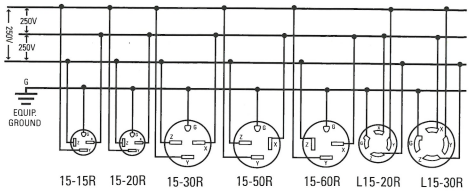
3 Pole, 4 Wire Grounding 125/250V



Courtesy of
COOPER Wiring Devices
The New Power In Wiring Devices

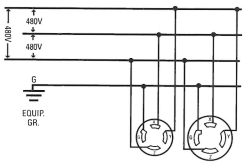
WIRING DIAGRAMS FOR NEMA CONFIGURATIONS

3 Pole, 4 Wire Grounding 3ø 250V



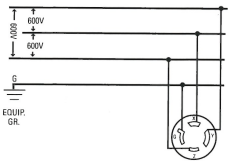
15-15R 15-20R 15-30R 15-50R 15-60R L15-20R L15-30R

3 Pole, 4 Wire Grounding 3ø 480V



L16-20R L16-30R

3 Pole, 4 Wire Grounding 3ø 600V



L17-30R

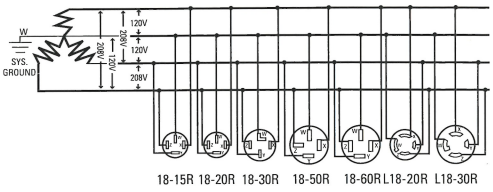
Courtesy of

COOPER Wiring Devices

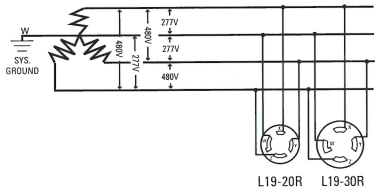
The New Power in Wiring Devices

WIRING DIAGRAMS FOR NEMA CONFIGURATIONS

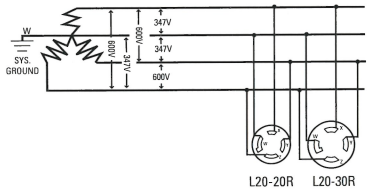
4 Pole, 4 Wire Nongrounding 3ø 120/208V



4 Pole, 4 Wire Nongrounding 3ø 277/480V



4 Pole, 4 Wire Nongrounding 3ø 347/600V



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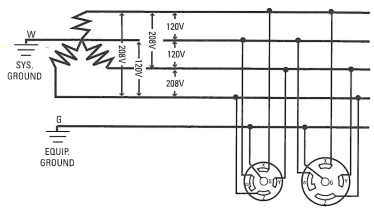
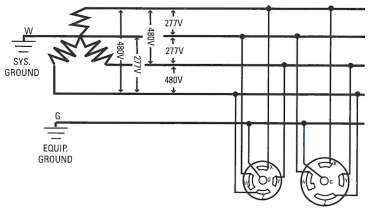
WIRING DIAGRAMS FOR NEMA CONFIGURATIONS

4 Pole, 5 Wire Grounding 3ø 120/208V



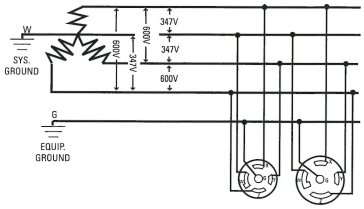
L21-20R L21-30R

4 Pole, 5 Wire Grounding 3ø 277/480V



L22-20R L22-30R

4 Pole, 5 Wire Grounding 3ø 347/600V



L23-20R L23-30R

Courtesy of

COOPER Wiring Devices

The New Power in Wiring Devices

NEMA ENCLOSURE TYPES

The specific enclosure types, their applications, and the environmental conditions they are designed to provide a degree of protection against are as follows:

Type 1—Enclosures constructed for indoor use to provide a degree of protection to personnel against access to hazardous parts and to provide a degree of protection of the equipment inside the enclosure against ingress of solid foreign objects (falling dirt).

Type 2—Enclosures constructed for indoor use to provide a degree of protection to personnel against access to hazardous parts; to provide a degree of protection of the equipment inside the enclosure against ingress of solid foreign objects (falling dirt); and to provide a degree of protection with respect to harmful effects on the equipment due to the ingress of water (dripping and light splashing).

Type 3—Enclosures constructed for either indoor or outdoor use to provide a degree of protection to personnel against access to hazardous parts; to provide a degree of protection of the equipment inside the enclosure against ingress of solid foreign objects (falling dirt and windblown dust); to provide a degree of protection with respect to harmful effects on the equipment due to the ingress of water (rain, sleet, snow); and that will be undamaged by the external formation of ice on the enclosure.

Type 3R—Enclosures constructed for either indoor or outdoor use to provide a degree of protection to personnel against access to hazardous parts; to provide a degree of protection of the equipment inside the enclosure against ingress of solid foreign objects (falling dirt); to provide a degree of protection with respect to harmful effects on the equipment due to the ingress of water (rain, sleet, snow); and that will be undamaged by the external formation of ice on the enclosure.

Type 3S—Enclosures constructed for either indoor or outdoor use to provide a degree of protection to personnel against access to hazardous parts; to provide a degree of protection of the equipment inside the enclosure against ingress of solid foreign objects (falling dirt and windblown

dust); to provide a degree of protection with respect to harmful effects on the equipment due to the ingress of water (rain, sleet, snow); and for which the external mechanism(s) remain(s) operable when ice laden.

Type 3X—Enclosures constructed for either indoor or outdoor use to provide a degree of protection to personnel against access to hazardous parts; to provide a degree of protection of the equipment inside the enclosure against ingress of solid foreign objects (falling dirt and windblown dust); to provide a degree of protection with respect to harmful effects on the equipment due to the ingress of water (rain, sleet, snow); that provides an increased level of protection against corrosion and that will be undamaged by the external formation of ice on the enclosure.

Type 3RX—Enclosures constructed for either indoor or outdoor use to provide a degree of protection to personnel against access to hazardous parts; to provide a degree of protection of the equipment inside the enclosure against ingress of solid foreign objects (falling dirt); to provide a degree of protection with respect to harmful effects on the equipment due to the ingress of water (rain, sleet, snow); that will be undamaged by the external formation of ice on the enclosure that provides an increased level of protection against corrosion.

Type 3SX—Enclosures constructed for either indoor or outdoor use to provide a degree of protection to personnel against access to hazardous parts; to provide a degree of protection of the equipment inside the enclosure against ingress of solid foreign objects (falling dirt and windblown dust); to provide a degree of protection with respect to harmful effects on the equipment due to the ingress of water (rain, sleet, snow); that provides an increased level of protection against corrosion; and for which the external mechanism(s) remain(s) operable when ice laden.

Type 4—Enclosures constructed for either indoor or outdoor use to provide a degree of protection to personnel against access to hazardous parts; to provide a degree of protection of the equipment inside the enclosure against ingress of solid foreign objects (falling dirt

and windblown dust); to provide a degree of protection with respect to harmful effects on the equipment due to the ingress of water (rain, sleet, snow, splashing water, and hose-directed water); and that will be undamaged by the external formation of ice on the enclosure.

Type 4X—Enclosures constructed for either indoor or outdoor use to provide a degree of protection to personnel against access to hazardous parts; to provide a degree of protection of the equipment inside the enclosure against ingress of solid foreign objects (falling dirt and windblown dust); to provide a degree of protection with respect to harmful effects on the equipment due to the ingress of water (rain, sleet, snow, splashing water, and hose-directed water); that provides an increased level of protection against corrosion; and that will be undamaged by the external formation of ice on the enclosure.

Type 5—Enclosures constructed for indoor use to provide a degree of protection to personnel against access to hazardous parts; to provide a degree of protection of the equipment inside the enclosure against ingress of solid foreign objects (falling dirt and settling airborne dust, lint, fibers, and flyings); and to provide a degree of protection with respect to harmful effects on the equipment due to the ingress of water (dripping and light splashing).

Type 6—Enclosures constructed for either indoor or outdoor use to provide a degree of protection to personnel against access to hazardous parts; to provide a degree of protection of the equipment inside the enclosure against ingress of solid foreign objects (falling dirt); to provide a degree of protection with respect to harmful effects on the equipment due to the ingress of water (hose-directed water and the entry of water during occasional temporary submersion at a limited depth); and that will be undamaged by the external formation of ice on the enclosure.

Type 6P—Enclosures constructed for either indoor or outdoor use to provide a degree of protection to personnel against access to hazardous parts; to provide a degree of protection of the equipment inside the

enclosure against ingress of solid foreign objects (falling dirt); to provide a degree of protection with respect to harmful effects on the equipment due to the ingress of water (hose-directed water and the entry of water during prolonged submersion at a limited depth); that provides an increased level of protection against corrosion; and that will be undamaged by the external formation of ice on the enclosure.

Type 12—Enclosures constructed (without knockouts) for indoor use to provide a degree of protection to personnel against access to hazardous parts; to provide a degree of protection of the equipment inside the enclosure against ingress of solid foreign objects (falling dirt and circulating dust, lint, fibers, and flyings); to provide a degree of protection with respect to harmful effects on the equipment due to the ingress of water (dripping and light splashing); and to provide a degree of protection against light splashing and seepage of oil and non-corrosive coolants.

Type 12K—Enclosures constructed (with knockouts) for indoor use to provide a degree of protection to personnel against access to hazardous parts; to provide a degree of protection of the equipment inside the enclosure against ingress of solid foreign objects (falling dirt and circulating dust, lint, fibers, and flyings); to provide a degree of protection with respect to harmful effects on the equipment due to the ingress of water (dripping and light splashing); and to provide a degree of protection against light splashing and seepage of oil and non-corrosive coolants.

Type 13—Enclosures constructed for indoor use to provide a degree of protection to personnel against access to hazardous parts; to provide a degree of protection of the equipment inside the enclosure against ingress of solid foreign objects (falling dirt and circulating dust, lint, fibers, and flyings); to provide a degree of protection with respect to harmful effects on the equipment due to the ingress of water (dripping and light splashing); and to provide a degree of protection against the spraying, splashing, and seepage of oil and non-corrosive coolants.

U.S. WEIGHTS AND MEASURES

Linear Measures

		1 Inch	= 2.540 Centimeters
12	Inches	= 1 Foot	= 3.048 Decimeters
3	Feet	= 1 Yard	= 9.144 Decimeters
5.5	Yards	= 1 Rod	= 5.029 Meters
40	Rods	= 1 Furlong	= 2.018 Hectometers
8	Furlongs	= 1 Mile	= 1.609 Kilometers

Mile Measurements

1 Statute Mile	=	5280	Feet
1 Scots Mile	=	5952	Feet
1 Irish Mile	=	6720	Feet
1 Russian Verst	=	3504	Feet
1 Italian Mile	=	4401	Feet
1 Spanish Mile	=	15084	Feet

Other Linear Measurements

1 Hand	=	4	Inches	1 Link	=	7.92	Inches
1 Span	=	9	Inches	1 Fathom	=	6	Feet
1 Chain	=	22	Yards	1 Furlong	=	10	Chains
				1 Cable	=	608	Feet

Square Measures

144	Square Inches	=	1	Square Foot
9	Square Feet	=	1	Square Yard
30¼	Square Yards	=	1	Square Rod
40	Rods	=	1	Rood
4	Roods	=	1	Acre
640	Acres	=	1	Square Mile
1	Square Mile	=	1	Section
36	Sections	=	1	Township

Cubic or Solid Measures

1	Cubic Foot	=	1728	Cubic Inches
1	Cubic Yard	=	27	Cubic Feet
1	Cubic Foot	=	7.48	Gallons
1	Gallon (Water)	=	8.34	Pounds
1	Gallon (U.S.)	=	231	Cubic Inches of Water
1	Gallon (Imperial)	=	277¼	Cubic Inches of Water

U.S. WEIGHTS AND MEASURES

Liquid Measurements

1	Pint	= 4	Gills
1	Quart	= 2	Pints
1	Gallon	= 4	Quarts
1	Firkin	= 9	Gallons (Ale or Beer)
1	Barrel	= 42	Gallons (Petroleum or Crude Oil)

Dry Measure

1	Quart	= 2	Pints
1	Peck	= 8	Quarts
1	Bushel	= 4	Pecks

Weight Measurement (Mass)

A. Avoirdupois Weight

1	Ounce	= 16	Drams
1	Pound	= 16	Ounces
1	Hundredweight	= 100	Pounds
1	Ton	= 2000	Pounds

B. Troy Weight

1	Carat	= 3.17	Grains
1	Pennyweight	= 20	Grains
1	Ounce	= 20	Pennyweights
1	Pound	= 12	Ounces
1	Long Hundred-Weight	= 112	Pounds
1	Long Ton	= 20	Long Hundredweights
		= 2240	Pounds

C. Apothecaries Weight

1	Scruple	= 20	Grains	= 1.296	Grams
1	Dram	= 3	Scruples	= 3.888	Grams
1	Ounce	= 8	Drams	= 31.1035	Grams
1	Pound	= 12	Ounces	= 373.2420	Grams

D. Kitchen Weights and Measures

1	U.S. Pint	= 16	Fluid Ounces
1	Standard Cup	= 8	Fluid Ounces
1	Tablespoon	= 0.5	Fluid Ounces (15 Cubic Centimeters)
1	Teaspoon	= 0.16	Fluid Ounces (5 Cubic Centimeters)

METRIC SYSTEM

Prefixes

A. Mega	= 1000000	E. Deci	= 0.1
B. Kilo	= 1000	F. Centi	= 0.01
C. Hecto	= 100	G. Milli	= 0.001
D. Deka	= 10	H. Micro	= 0.000001

Linear Measure

(The Unit is the Meter = 39.37 Inches)

1 Centimeter	= 10	Millimeters	= 0.3937011	Inch
1 Decimeter	= 10	Centimeters	= 3.9370113	Inches
1 Meter	= 10	Decimeters	= 1.0936143	Yards
			= 3.2808429	Feet
1 Dekameter	= 10	Meters	= 10.936143	Yards
1 Hectometer	= 10	Dekameters	= 109.36143	Yards
1 Kilometer	= 10	Hectometers	= 0.62137	Mile
1 Myriameter	= 10000 Meters			

Square Measure

(The Unit is the Square Meter = 1549.9969 SQ. Inches)

1 SQ. Centimeter	= 100 SQ. Millimeters	=	0.1550	Square Inch
1 SQ. Decimeter	= 100 SQ. Centimeters	=	15.550	Square Inches
1 SQ. Meter	= 100 SQ. Decimeters	=	10.7639	Square Feet
1 SQ. Dekameter	= 100 SQ. Meters	=	119.60	Square Yards
1 SQ. Hectometer	= 100 SQ. Dekameters			
1 SQ. Kilometer	= 100 SQ. Hectometers			

(The Unit is the "Are" = 100 SQ. Meters)

1 Centiare	= 10 Milliares	=	10.7643	Square Feet
1 Deciare	= 10 Centiares	=	11.96033	Square Yards
1 Are	= 10 Deciares	=	119.6033	Square Yards
1 Decare	= 10 Ares	=	0.247110	Acres
1 Hectare	= 10 Decares	=	2.471098	Acres
1 SQ. Kilometer	= 100 Hectares	=	0.38611	Square Mile

Cubic Measure

(The Unit is the "Stere" = 61025.38659 CU. INs.)

1 Decistere	= 10 Centisteres	= 3.531562	Cubic Foot
1 Stere	= 10 Decisteres	= 1.307986	Cubic Yards
1 Dekastere	= 10 Steres	= 13.07986	Cubic Yards

METRIC SYSTEM

Cubic Measure *(continued)*

(The Unit is the Meter = 39.37 Inches)

1 CU. Centimeter	= 1000 CU. Millimeters	= 0.06102	Cubic Inches
1 CU. Decimeter	= 1000 CU. Centimeters	= 61.02374	Cubic Inches
1 CU. Meter	= 1000 CU. Decimeters	= 35.31467	Cubic Feet
	= 1 Stere	= 1.30795	Cubic Yards
1 CU. Centimeter (Water)		= 1 Gram	
1000 CU. Centimeters (Water) = 1 Liter		= 1 Kilogram	
1 CU. Meter (1000 Liters)		= 1 Metric Ton	

Measures of Weight

(The Unit is the Gram = 0.035274 Ounces)

1 Milligram	=		= 0.015432	Grains
1 Centigram	=	10 Milligrams	= 0.15432	Grains
1 Decigram	=	10 Centigrams	= 1.5432	Grains
1 Gram	=	10 Decigrams	= 15.4323	Grains
1 Dekagram	=	10 Grams	= 5.6438	Drams
1 Hectogram	=	10 Dekagrams	= 3.5274	Ounces
1 Kilogram	=	10 Hectograms	= 2.2046223	Pounds
1 Myriagram	=	10 Kilograms	= 22.046223	Pounds
1 Quintal	=	10 Myriagrams	= 1.986412	Hundredweight
1 Metric Ton	=	10 Quintal	= 22045.622	Pounds
1 Gram	=	0.56438 Drams		
1 Dram	=	1.77186 Grams		
	=	27.3438 Grains		
1 Metric Ton	=	2204.6223 Pounds		

Measures of Capacity

(The Unit is the Liter = 1.0567 Liquid Quarts)

1 Centiliter	=	10 Milliliters	= 0.338	Fluid Ounces
1 Deciliter	=	10 Centiliters	= 3.38	Fluid Ounces
1 Liter	=	10 Deciliters	= 33.8	Fluid Ounces
1 Dekaliter	=	10 Liters	= 0.284	Bushel
1 Hectoliter	=	10 Dekaliters	= 2.84	Bushels
1 Kiloliter	=	10 Hectoliters	= 264.2	Gallons

Note: $\frac{\text{Kilometers}}{8} \times 5 = \text{Miles}$ or $\frac{\text{Miles}}{5} \times 8 = \text{Kilometers}$

METRIC SYSTEM

Metric Designator and Trade Sizes

Metric Designator												
12	16	21	27	35	41	53	63	78	91	103	129	155
Trade Size												
3/8	1/2	3/4	1	1 1/4	1 1/2	2	2 1/2	3	3 1/2	4	5	6

Source: NFPA 70, *National Electrical Code*®, NFPA, Quincy, MA, 2023, Table 300.1(C), as modified.

U.S. Weights and Measures/Metric Equivalent Chart

	In.	Ft	Yd.	Mile	mm	cm	m	km
1 Inch =	1	.0833	.0278	1.578×10^{-5}	25.4	2.54	.0254	2.54×10^{-3}
1 Foot =	12	1	.333	1.894×10^{-4}	304.8	30.48	.3048	3.048×10^{-4}
1 Yard =	36	3	1	5.6818×10^{-4}	914.4	91.44	.9144	9.144×10^{-4}
1 Mile =	63360	5280	1760	1	1609344	160934.4	1609.344	1609344
1 mm =	.03937	.00032808	1.0936×10^{-3}	6.2137×10^{-7}	1	0.1	0.001	0.000001
1 cm =	.3937	.0328084	.0109361	6.2137×10^{-6}	10	1	0.01	0.00001
1 m =	39.37	3.280.84	1.093.61	6.2137×10^{-4}	1000	100	1	0.001
1 km =	39370	3280.84	1093.61	0.62137	1000000	100000	1000	1

In. = inches Ft = foot Yd. = yard mm = millimeter cm = centimeter m = meter km = kilometer

Explanation of Scientific Notation

Scientific notation (powers of 10) is simply a way of expressing very large or very small numbers in a more compact format. Any number can be expressed as a number between 1 and 10, multiplied by a power of 10 (which indicates the correct position of the decimal point in the original number). Numbers greater than 10 have positive powers of 10, and numbers less than 1 have negative powers of 10.

Example: $186000 = 1.86 \times 10^{5}$ $0.000524 = 5.24 \times 10^{-4}$

Useful Conversions/Equivalents

1 BTU . . . . . Raises 1 lb of water 1°F
1 Gram Calorie . . . . . Raises 1 gram of water 1°C
1 Circular Mil . . . . . Equals 0.7854 sq. mil
1 SQ. Mil . . . . . Equals 1.2732 cir. mils
1 Mil . . . . . Equals 0.001 in.

To determine circular mil (cmil) of a conductor:

Round Conductor . . . . . $\text{cmil} = (\text{Diameter in mils})^2$

Rectangle Bus Bar . . . . . $\text{cmil} = \dfrac{\text{Width} \times \text{Thickness} \times 1{,}000{,}000}{0.7854}$

Notes: 1 millimeter = 39.37 mils 1 cir. millimeter = 1550 cir. mils
1 sq. millimeter = 1974 cir. mils

DECIMAL EQUIVALENTS

Fraction					Decimal	Fraction					Decimal
1/64					.0156	33/64					.5156
2/64	1/32				.0313	34/64	17/32				.5313
3/64					.0469	35/64					.5469
4/64	2/32	1/16			.0625	36/64	18/32	9/16			.5625
5/64					.0781	37/64					.5781
6/64	3/32				.0938	38/64	19/32				.5938
7/64					.1094	39/64					.6094
8/64	4/32	2/16	1/8		.125	40/64	20/32	10/16	5/8		.625
9/64					.1406	41/64					.6406
10/64	5/32				.1563	42/64	21/32				.6563
11/64					.1719	43/64					.6719
12/64	6/32	3/16			.1875	44/64	22/32	11/16			.6875
13/64					.2031	45/64					.7031
14/64	7/32				.2188	46/64	23/32				.7188
15/64					.2344	47/64					.7344
16/64	8/32	4/16	2/8	1/4	.25	48/64	24/32	12/16	6/8	3/4	.75
17/64					.2656	49/64					.7656
18/64	9/32				.2813	50/64	25/32				.7813
19/64					.2969	51/64					.7969
20/64	10/32	5/16			.3125	52/64	26/32	13/16			.8125
21/64					.3281	53/64					.8281
22/64	11/32				.3438	54/64	27/32				.8438
23/64					.3594	55/64					.8594
24/64	12/32	6/16	3/8		.375	56/64	28/32	14/16	7/8		.875
25/64					.3906	57/64					.8906
26/64	13/32				.4063	58/64	29/32				.9063
27/64					.4219	59/64					.9219
28/64	14/32	7/16			.4375	60/64	30/32	15/16			.9375
29/64					.4531	61/64					.9531
30/64	15/32				.4688	62/64	31/32				.9688
31/64					.4844	63/64					.9844
32/64	16/32	8/16	4/8	2/4	.5	64/64	32/32	16/16	8/8	4/4	1.000

Decimals are rounded to the nearest 10000th.

TWO-WAY CONVERSION TABLE

To convert from the unit of measure in Column B to the unit of measure in Column C, multiply the number of units in Column B by the multiplier in Column A. To convert from Column C to B, use the multiplier in Column D.

Example: To convert 1000 BTUs to Calories, find the "BTU - Calorie" combination in Columns B and C. "BTU" is in Column B and "Calorie" is in Column C; so we are converting from B to C. Therefore, we use Column A multiplier. 1000 BTUs x 251.996 = 251996 Calories.

To convert 251996 Calories to BTUs, use the same "BTU - Calorie" combination. But this time you are converting from C to B. Therefore, use Column D multiplier. 251996 Calories x 0.0039683 = 1000 BTUs.

A x B = C **&** **D x C = B**

To Convert from B to C, Multiply B x A:			To Convert from C to B, Multiply C x D:
A	**B**	**C**	**D**
43560	**Acre**	**Sq. foot**	2.2956×10^{-5}
1.5625×10^{-3}	**Acre**	**Sq. mile**	640
6.4516	**Ampere per sq. cm.**	**Ampere per sq. in.**	0.155003
1.256637	**Ampere (turn)**	**Gilberts**	0.79578
33.89854	**Atmosphere**	**Foot of H_2O**	0.029499
29.92125	**Atmosphere**	**Inch of Hg**	0.033421
14.69595	**Atmosphere**	**Pound force/sq. in.**	0.06804
251.996	**BTU**	**Calorie**	3.96832×10^{-3}
778.169	**BTU**	**Foot pound force**	1.28507×10^{-3}
3.93015×10^{-4}	**BTU**	**Horsepower hour**	2544.43
1055.056	**BTU**	**Joule**	9.47817×10^{-4}
2.9307×10^{-4}	**BTU**	**Kilowatt hour**	3412.14
3.93015×10^{-4}	**BTU/hour**	**Horsepower**	2544.43
2.93071×10^{-4}	**BTU/hour**	**Kilowatt**	3412.1412
0.293071	**BTU/hour**	**Watt**	3.41214
4.19993	**BTU/minute**	**Calorie/second**	0.23809
0.0235809	**BTU/minute**	**Horsepower**	42.4072
17.5843	**BTU/minute**	**Watt**	0.0568

(*continued on next page*)

TWO-WAY CONVERSION TABLE

To Convert from B to C, Multiply B x A:			To Convert from C to B, Multiply C x D:
A	**B**	**C**	**D**
4.1868	Calorie	Joule	0.238846
0.0328084	Centimeter	Foot	30.48
0.3937	Centimeter	Inch	2.54
0.00001	Centimeter	Kilometer	100000
0.01	Centimeter	Meter	100
6.2137×10^{-6}	Centimeter	Mile	160934.4
10	Centimeter	Millimeter	0.1
0.010936	Centimeter	Yard	91.44
7.85398×10^{-7}	Circular mil	Sq. inch	1.273239×10^{6}
0.000507	Circular mil	Sq. millimeter	1973.525
0.06102374	Cubic centimeter	Cubic inch	16.387065
0.028317	Cubic foot	Cubic meter	35.31467
1.0197×10^{-3}	Dyne	Gram force	980.665
1×10^{-5}	Dyne	Newton	100000
1	Dyne centimeter	Erg	1
7.376×10^{-8}	Erg	Foot pound force	1.355818×10^{7}
2.777×10^{-14}	Erg	Kilowatt hour	3.6×10^{13}
1.0×10^{-7}	Erg/second	Watt	1.0×10^{7}
12	Foot	Inch	0.0833
3.048×10^{-4}	Foot	Kilometer	3280.84
0.3048	Foot	Meter	3.28084
1.894×10^{-4}	Foot	Mile	5280
304.8	Foot	Millimeter	0.00328
0.333	Foot	Yard	3
10.7639	Foot candle	Lux	0.0929
0.882671	Foot of H_2O	Inch of Hg	1.13292
5.0505×10^{-7}	Foot pound force	Horsepower hour	1.98×10^{6}
1.35582	Foot pound force	Joule	0.737562
3.76616×10^{-7}	Foot pound force	Kilowatt hour	2.655223×10^{6}
3.76616×10^{-4}	Foot pound force	Watt hour	2655.22
3.76616×10^{-7}	Foot pound force/hour	Kilowatt	2.6552×10^{6}
3.0303×10^{-5}	Foot pound force/minute	Horsepower	33000

TWO-WAY CONVERSION TABLE

To Convert from B to C, Multiply B x A:		To Convert from C to B, Multiply C x D:	
A	**B**	**C**	**D**
2.2597×10^{-5}	Foot pnd. force/minute	Kilowatt	44253.7
0.022597	Foot pnd. force/minute	Watt	44.2537
1.81818×10^{-3}	Foot pnd. force/second	Horsepower	550
1.355818×10^{-3}	Foot pnd. force/second	Kilowatt	737.562
0.7457	Horsepower	Kilowatt	1.34102
745.7	Horsepower	Watt	0.00134
0.0022046	Gram	Pound mass	453.592
2.54×10^{-5}	Inch	Kilometer	39370
0.0254	Inch	Meter	39.37
1.578×10^{-5}	Inch	Mile	63360
25.4	Inch	Millimeter	0.03937
0.0278	Inch	Yard	36
0.07355	Inch of H_2O	Inch of Hg	13.5951
2.7777×10^{-7}	Joule	Kilowatt hour	3.6×10^{6}
2.7777×10^{-4}	Joule	Watt hour	3600
1	Joule	Watt second	1
1000	Kilometer	Meter	0.001
0.62137	Kilometer	Mile	1.609344
1000000	Kilometer	Millimeter	0.000001
1093.61	Kilometer	Yard	9.144×10^{-4}
0.000621	Meter	Mile	1609.344
1000	Meter	Millimeter	0.001
1.0936	Meter	Yard	0.9144
1609344	Mile	Millimeter	6.2137×10^{-7}
1760	Mile	Yard	5.681×10^{-4}
1.0936×10^{-3}	Millimeter	Yard	914.4
0.224809	Newton	Pound force	4.44822
0.03108	Pound	Slug	32.174
0.0005	Pound	Ton (short)	2000
0.155	Sq. centimeter	Sq. inch	6.4516
0.092903	Sq. foot	Sq. meter	10.76391
0.386102	Sq. kilometer	Sq. mile	2.589988

METALS

Metal	Symb.	Spec. Grav.	Melt Point °C	Melt Point °F	Elec. Cond. % Copper	Pounds/ Cu In
Aluminum	Al	2.71	660	1220	64.9	.0978
Antimony	Sb	6.62	630	1167	4.42	.2390
Arsenic	As	5.73	—	—	4.9	.2070
Beryllium	Be	1.83	1280	2336	9.32	.0660
Bismuth	Bi	9.80	271	520	1.50	.3540
Brass (70-30)		8.51	900	1652	28.0	.3070
Bronze (5% SN)		8.87	1000	1832	18.0	.3200
Cadmium	Cd	8.65	321	610	22.7	.3120
Calcium	Ca	1.55	850	1562	50.1	.0560
Cobalt	Co	8.90	1495	2723	17.8	.3210
Copper	Cu					
Rolled		8.89	1083	1981	100.0	.3210
Tubing		8.95	—	—	100.0	.3230
Gold	Au	19.30	1063	1945	71.2	.6970
Graphite		2.25	3500	6332	10^{-3}	.0812
Indium	In	7.30	156	311	20.6	.2640
Iridium	Ir	22.40	2450	4442	32.5	.8090
Iron	Fe	7.20	1200–1400	2192–2552	17.6	.2600
Malleable		7.20	1500–1600	2732–2912	10	.2600
Wrought		7.70	1500–1600	2732–2912	10	.2780
Lead	Pb	11.40	327	621	8.35	.4120
Magnesium	Mg	1.74	651	1204	38.7	.0628

METALS

Metal	Symb.	Spec. Grav.	Melt Point °C	Melt Point °F	Elec. Cond. % Copper	Pounds/ Cu In
Manganese	Mn	7.20	1245	2273	0.9	.2600
Mercury	Hg	13.65	–38.9	–37.7	1.80	.4930
Molybdenum	Mo	10.20	2620	4748	36.1	.3680
Monel (63–37)		8.87	1300	2372	3.0	.3200
Nickel	Ni	8.90	1452	2646	25.0	.3210
Phosphorous	P	1.82	44.1	111.4	10^{-17}	.0657
Platinum	Pt	21.46	1773	3221	17.5	.7750
Potassium	K	0.860	62.3	144.1	28	.0310
Selenium	Se	4.81	220	428	14.4	.1740
Silicon	Si	2.40	1420	2588	10^{-5}	.0866
Silver	Ag	10.50	960	1760	106	.3790
Steel (Carbon)		7.84	1330–1380	2436–2516	10	.2830
Stainless						
(18-8)		7.92	1500	2732	2.5	.2860
(13-CR)		7.78	1520	2768	3.5	.2810
Tantalum	Ta	16.60	2900	5414	13.9	.599
Tellurium	Te	6.20	450	846	10^{-5}	.224
Thorium	Th	11.70	1845	3353	9.10	.422
Tin	Sn	7.30	232	449	15.00	.264
Titanium	Ti	4.50	1800	3272	2.10	.162
Tungsten	W	19.30	3410	—	31.50	.697
Uranium	U	18.70	1130	2066	2.80	.675
Vanadium	V	5.96	1710	3110	6.63	.215
Zinc	Zn	7.14	419	786	29.10	.258
Zirconium	Zr	6.40	1700	3092	4.20	.231

METALS

Specific Resistance (K)

The specific resistance (K) of a material is the resistance offered by a wire of this material that is 1 foot long with a diameter of 1 mil.

Material	K	Material	K
Brass	43.0	Aluminum	17.0
Constantan	295	Monel	253
Copper	10.8	Nichrome	600
German silver 18%	200	Nickel	947
Gold	14.7	Tantalum	93.3
Iron (pure)	60.0	Tin	69.0
Magnesium	276	Tungsten	34.0
Manganin	265	Silver	9.7

Note: 1. The resistance of a wire is directly proportional to the specific resistance of the material.

2. "K" = Specific Resistance

3. Resistance varies with temperature. See *NEC* Chapter 9, Table 8, Note 1.

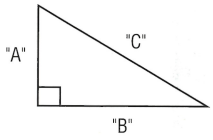
CENTIGRADE AND FAHRENHEIT THERMOMETER SCALES

°C	°F	°C	°F	°C	°F	°C	°F
0	32						
1	33.8	26	78.8	51	123.8	76	168.8
2	35.6	27	80.6	52	125.6	77	170.6
3	37.4	28	82.4	53	127.4	78	172.4
4	39.2	29	84.2	54	129.2	79	174.2
5	41	30	86	55	131	80	176
6	42.8	31	87.8	56	132.8	81	177.8
7	44.6	32	89.6	57	134.6	82	179.6
8	46.4	33	91.4	58	136.4	83	181.4
9	48.2	34	93.2	59	138.2	84	183.2
10	50	35	95	60	140	85	185
11	51.8	36	96.8	61	141.8	86	186.8
12	53.6	37	98.6	62	143.6	87	188.6
13	55.4	38	100.4	63	145.4	88	190.4
14	57.2	39	102.2	64	147.2	89	192.2
15	59	40	104	65	149	90	194
16	60.8	41	105.8	66	150.8	91	195.8
17	62.6	42	107.6	67	152.6	92	197.6
18	64.4	43	109.4	68	154.4	93	199.4
19	66.2	44	111.2	69	156.2	94	201.2
20	68	45	113	70	158	95	203
21	69.8	46	114.8	71	159.8	96	204.8
22	71.6	47	116.6	72	161.6	97	206.6
23	73.4	48	118.4	73	163.4	98	208.4
24	75.2	49	120.2	74	165.2	99	210.2
25	77	50	122	75	167	100	212

1. Temp. °C = $^{5}/_{9}$ x (Temp. °F – 32)
2. Temp. °F = ($^{9}/_{5}$ x Temp. °C) + 32
3. Ambient temperature is the temperature of the surrounding cooling medium.
4. Rated temperature rise is the permissible rise in temperature above ambient when operating under load.

USEFUL MATH FORMULAS

Right triangle



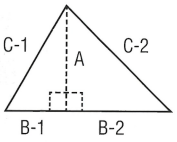
$A = \sqrt{C^2 - B^2}$

$B = \sqrt{C^2 - A^2}$

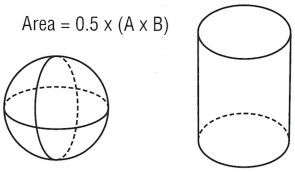
$C = \sqrt{A^2 + B^2}$

Area = 0.5 x (A x B)

Oblique triangle



Solve as two right triangles

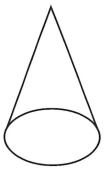


Sphere

Surface Area = D^2 x 3.1416
Volume = D^3 x 0.5236

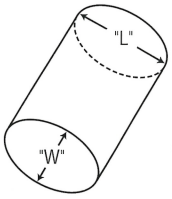
Cylindrical

Volume =
Area of end
x height



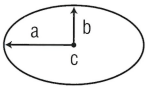
Cone

Volume =
Area of end x height ÷ 3



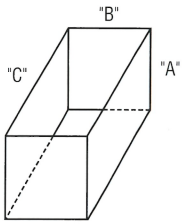
Elliptical

Solve the same
as cylindrical



Ellipse

Area = a x b x 3.1416
(assuming C is center)



Rectangular prism

Volume = A x B x C
Area = 2(AB + AC + BC)