TO FIND REACTANCE

Reactance (X)

Reactance in a circuit is the opposition to an alternating current caused by inductance and capacitance, equal to the difference between capacitive and inductive reactance. Reactance is expressed in ohms.

A. Inductive Reactance X_L
Inductive reactance is the element of reactance in a circuit caused by self-inductance.

$$X_L = 2 \times 3.1416 \times \text{Frequency} \times \text{Inductance}$$
$$= 6.28 \times F \times L$$

Determine the reactance of a 4-Henry coil on a 60-cycle ac circuit.

$$X_L = 6.28 \times F \times L = 6.28 \times 60 \times 4 = 1507 \text{ Ohms}$$

B. Capacitive Reactance X_C
Capacitive reactance is the element of reactance in a circuit caused by capacitance.

$$X_C = \frac{1}{2 \times 3.1416 \times \text{Frequency} \times \text{Capacitance}}$$

$$= \frac{1}{6.28 \times F \times C}$$

Determine the reactance of a 4-microfarad condenser on a 60-cycle ac circuit.

$$X_C = \frac{1}{6.28 \times F \times C} = \frac{1}{6.28 \times 60 \times 0.000004}$$

$$= \frac{1}{0.0015072} = 663 \text{ Ohms}$$

A Henry is a unit of inductance equal to the inductance of a circuit in which the variation of a current at the rate of 1 amp per second induces an electromotive force of 1 volt.

FULL-LOAD CURRENT IN AMPERES: DIRECT-CURRENT (dc) MOTORS

	Armature Voltage Rating*					
HP	90 V	120 V	180 V	240 V	500 V	550 V
¼	4.0	3.1	2.0	1.6	—	—
⅓	5.2	4.1	2.6	2.0	—	—
½	6.8	5.4	3.4	2.7	—	—
¾	9.6	7.6	4.8	3.8	—	—
1	12.2	9.5	6.1	4.7	—	—
1½	—	13.2	8.3	6.6	—	—
2	—	17	10.8	8.5	—	—
3	—	25	16	12.2	—	—
5	—	40	27	20	—	—
7½	—	58	—	29	13.6	12.2
10	—	76	—	38	18	16
15	—	—	—	55	27	24
20	—	—	—	72	34	31
25	—	—	—	89	43	38
30	—	—	—	106	51	46
40	—	—	—	140	67	61
50	—	—	—	173	83	75
60	—	—	—	206	99	90
75	—	—	—	255	123	111
100	—	—	—	341	164	148
125	—	—	—	425	205	185
150	—	—	—	506	246	222
200	—	—	—	675	330	294

These values of full-load currents* are for motors running at base speed.

**These are average dc quantities.*

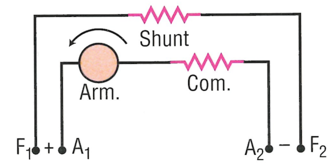
DIRECT-CURRENT MOTORS

Terminal Markings

Terminal markings are used to tag terminals to which connections are to be made from outside circuits.

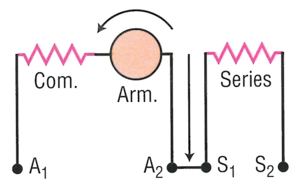
Facing the end opposite the drive (commutator end), the standard direction of shaft rotation is counterclockwise.

A_1 and A_2 indicate armature leads.
S_1 and S_2 indicate series-field leads.
F_1 and F_2 indicate shunt-field leads.



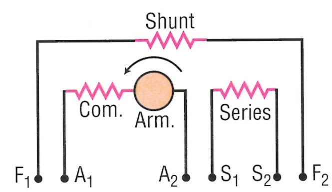
Shunt-Wound Motors

To change rotation, reverse either armature leads or shunt leads. **Do not** reverse both armature and shunt leads.



Series-Wound Motors

To change rotation, reverse either armature leads or series leads. **Do not** reverse both armature and series leads.



Compound-Wound Motors

To change rotation, reverse either armature leads or both the series and shunt leads. **Do not** reverse all three sets of leads.

Note: Standard rotation for a dc generator is clockwise.

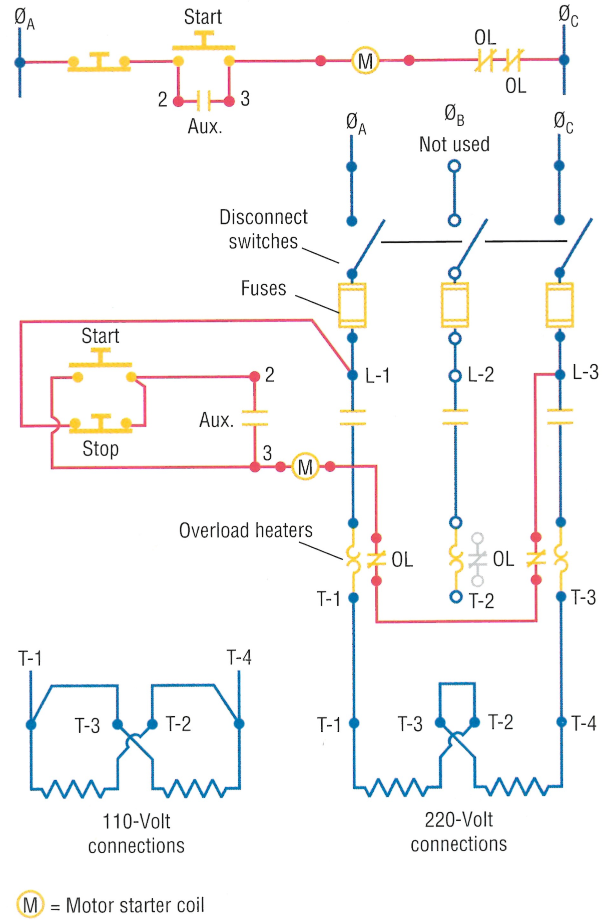
FULL-LOAD CURRENT IN AMPERES: SINGLE-PHASE ALTERNATING-CURRENT (ac) MOTORS

HP	115 V	200 V	208 V	230 V
⅙	4.4	2.5	2.4	2.2
¼	5.8	3.3	3.2	2.9
⅓	7.2	4.1	4.0	3.6
½	9.8	5.6	5.4	4.9
¾	13.8	7.9	7.6	6.9
1	16	9.2	8.8	8.0
1½	20	11.5	11	10
2	24	13.8	13.2	12
3	34	19.6	18.7	17
5	56	32.2	30.8	28
7½	80	46	44	40
10	100	57.5	55	50

The voltages listed are rated motor voltages. The currents listed shall be permitted for system voltage ranges of 110 to 120 and 220 to 240 volts.

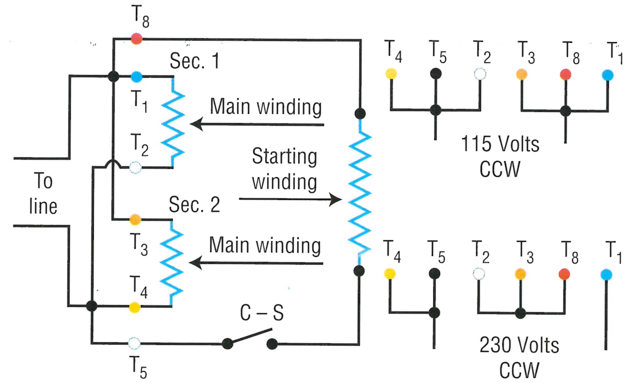
Source: NFPA 70®, *National Electrical Code®*, 2026 edition, NFPA, Quincy, MA, 2025, Table 430.248.

SINGLE-PHASE MOTOR USING STANDARD THREE-PHASE STARTER



SINGLE-PHASE MOTORS

Split-Phase, Squirrel-Cage, Dual-Voltage Motor



To reverse, interchange 5 and 8

Classes of Single-Phase Motors

1. Split-phase
   - A. Capacitor start
   - B. Repulsion start
   - C. Resistance start
   - D. Split capacitor
2. Commutator
   - A. Repulsion
   - B. Series

Terminal Color Marking

T_1 Blue •	T_3 Orange •	T_5 Black •
T_2 White	T_4 Yellow •	T_8 Red •

Note: Split-phase motors are usually fractional horsepower. The majority of electric motors used in washing machines, refrigerators, etc. are of the split-phase type.

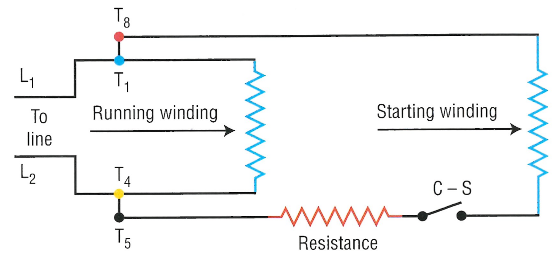
To change the speed of a split-phase motor, the number of poles must be changed.

1. Addition of running winding
2. Two starting windings and two running windings
3. Consequent pole connections

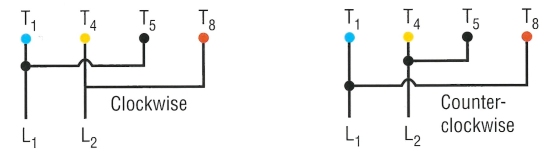
SINGLE-PHASE MOTORS

Split-Phase, Squirrel-Cage Motor

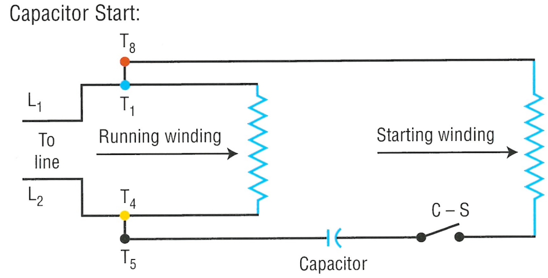
A. Resistance Start:



Centrifugal switch o (cs) opens after reaching 75% of normal speed.



B. Capacitor Start:



Note: 1. A resistance start motor has a resistance connected in series with the starting winding.
2. The capacitor start motor is employed where a high starting torque is required.

RUNNING OVERLOAD UNITS

Kind of Motor	Supply System	Number and Location of Overload Units Such as Trip Coils or Relays
1-phase ac or dc	2-wire, 1-phase ac or dc, ungrounded	1 in either conductor
1-phase ac or dc	2-wire, 1-phase ac or dc, one conductor grounded	1 in ungrounded conductor
1-phase ac or dc	3-wire, 1-phase ac or dc, grounded neutral conductor	1 in either ungrounded conductor
1-phase ac	Any 3-phase	1 in ungrounded conductor
2-phase ac	3-wire, 2-phase ac, ungrounded	2, one in each phase
2-phase ac	3-wire, 2-phase ac, one conductor grounded	2 in ungrounded conductors
2-phase ac	4-wire, 2-phase ac, grounded or ungrounded	2, one for each phase in ungrounded conductors
2-phase ac	Grounded neutral or 5-wire, 2-phase ac, ungrounded	2, one for each phase in any ungrounded phase wire
3-phase ac	Any 3-phase	3, one in each phase*

*Exception: An overload unit in each phase shall not be required where overload protection is provided by other approved means.
Source: NFPA 70®, *National Electrical Code®*, NFPA, 2026 edition, Quincy, MA, 2025, Table 430.37.

MOTOR BRANCH-CIRCUIT PROTECTIVE DEVICES: MAXIMUM RATING OR SETTING

	Percent of Full-Load Current			
Type of Motor	Nontime Delay Fuse[1]	Dual Element (Time-Delay) Fuse[1]	Instantaneous Trip Breaker	Inverse Time Breaker[2]
Single-phase motors	300	175	800	250
Alternating-current (ac) polyphase motors other than wound rotor	300	175	800	250
Squirrel cage — other than Design B or C energy-efficient — and Design B or C premium efficiency	300	175	800	250
Design B energy-efficient, Design B premium efficiency, Design BE, and Design CE	300	175	1100	250
Synchronous[3]	300	175	800	250
Wound rotor	150	150	800	150
Direct-current (dc) (constant voltage)	150	150	250	150

Note: See 430.54 for certain exceptions to the values specified.
1 The values in the Nontime Delay Fuse column apply to time-delay Class CC fuses.
2 The values given in the Inverse Time Breaker column also cover the ratings of nonadjustable inverse time types of circuit breakers that can be modified as in 430.52(C)(1)(a) and 430.52(C)(1)(b).
3 Synchronous motors of the low-torque, low-speed type (usually 450 rpm or lower), such as those used to drive reciprocating compressors, pumps, and so forth, that start unloaded, do not require a fuse rating or circuit-breaker setting in excess of 200% of full-load current.
Source: NFPA 70®, *National Electrical Code®*, 2026 edition, NFPA, Quincy, MA, 2025, Table 430.52(C)(1).
Note: Where the result of the calculation for the branch circuit protective device does not correspond with a standard size fuse or circuit breaker, see 430.52(C)(1)(a).
Note: Where the rating specified in Table 430.52(C)(1), or the rating modified by 430.52(C)(1)(a), is not sufficient for the starting current of the motor, see 430.52(C)(1)(b).

FULL-LOAD CURRENT: THREE-PHASE ALTERNATING-CURRENT (ac) MOTORS

	Induction-Type Squirrel Cage and Wound Rotor (Amperes)							Synchronous-Type Unity Power Factor* (Amperes)			
HP	115 V	200 V	208 V	230 V	460 V	575 V	2300 V	230 V	460 V	575 V	2300 V
½	4.4	2.5	2.4	2.2	1.1	0.9	—	—	—	—	—
¾	6.4	3.7	3.5	3.2	1.6	1.3	—	—	—	—	—
1	8.4	4.8	4.6	4.2	2.1	1.7	—	—	—	—	—
1½	12.0	6.9	6.6	6.0	3.0	2.4	—	—	—	—	—
2	13.6	7.8	7.5	6.8	3.4	2.7	—	—	—	—	—
3	—	11.0	10.6	9.6	4.8	3.9	—	—	—	—	—
5	—	17.5	16.7	15.2	7.6	6.1	—	—	—	—	—
7½	—	25.3	24.2	22	11	9	—	—	—	—	—
10	—	32.2	30.8	28	14	11	—	—	—	—	—
15	—	48.3	46.2	42	21	17	—	—	—	—	—
20	—	62.1	59.4	54	27	22	—	—	—	—	—
25	—	78.2	74.8	68	34	27	—	53	26	21	—
30	—	92	88	80	40	32	—	63	32	26	—
40	—	120	114	104	52	41	—	83	41	33	—
50	—	150	143	130	65	52	—	104	52	42	—
60	—	177	169	154	77	62	16	123	61	49	12
75	—	221	211	192	96	77	20	155	78	62	15
100	—	285	273	248	124	99	26	202	101	81	20
125	—	359	343	312	156	125	31	253	126	101	25
150	—	414	396	360	180	144	37	302	151	121	30
200	—	552	528	480	240	192	49	400	201	161	40
250	—	—	—	—	302	242	60	—	—	—	—
300	—	—	—	—	361	289	72	—	—	—	—
350	—	—	—	—	414	336	83	—	—	—	—
400	—	—	—	—	477	382	95	—	—	—	—
450	—	—	—	—	515	412	103	—	—	—	—
500	—	—	—	—	590	472	118	—	—	—	—

*For 90% and 80% power factor, the figures shall be multiplied by 1.1 and 1.25, respectively.

Source: NFPA 70®, *National Electrical Code®*, NFPA, 2026 edition, Quincy, MA, 2025, Table 430.250.

The voltages listed are rated motor voltages. The currents listed shall be permitted for system voltage ranges of 110 to 120, 220 to 240, 440 to 480, and 550 to 600 volts.

FULL-LOAD CURRENT AND OTHER DATA: THREE-PHASE ac MOTORS

Motor Horsepower		Motor Ampere	Size Breaker *	Size Starter	Heater Ampere **	Size Wire	Size Conduit ***
½	230 V	2.2	15	00	2.530	12	¾"
	460	1.1	15	00	1.265	12	¾
¾	230	3.2	15	00	3.680	12	¾
	460	1.6	15	00	1.840	12	¾
1	230	4.2	15	00	4.830	12	¾
	460	2.1	15	00	2.415	12	¾
1½	230	6.0	15	00	6.900	12	¾
	460	3.0	15	00	3.450	12	¾
2	230	6.8	15	0	7.820	12	¾
	460	3.4	15	00	3.910	12	¾
3	230	9.6	20	0	11.040	12	¾
	460	4.8	15	0	5.520	12	¾
5	230	15.2	30	1	17.480	12	¾
	460	7.6	15	0	8.740	12	¾
7½	230	22	45	1	25.300	10	¾
	460	11	20	1	12.650	12	¾
10	230	28	60	2	32.200	10	¾
	460	14	30	1	16.100	12	¾
15	230	42	70	2	48.300	6	1
	460	21	40	2	24.150	10	¾
20	230	54	100	3	62.100	4	1
	460	27	50	2	31.050	10	¾
25	230	68	100	3	78.200	4	1½
	460	34	50	2	39.100	8	1
30	230	80	125	3	92.000	3	1½
	460	40	70	3	46.000	8	1
40	230	104	175	4	119.600	1	1½
	460	52	100	3	59.800	6	1
50	230	130	200	4	149.500	00	2
	460	65	150	3	74.750	4	1½
60	230	154	250	5	177.10	000	2
	460	77	200	4	88.55	3	1½

(continued on next page)

FULL-LOAD CURRENT AND OTHER DATA: THREE-PHASE ac MOTORS

Motor Horsepower		Motor Ampere	Size Breaker *	Size Starer	Heater Ampere **	Size Wire	Size Conduit ***
75	230 V	192	300	5	220.80	250 kcmil	2½"
	460	96	200	4	110.40	1	1½
100	230	248	400	5	285.20	350 kcmil	3
	460	124	200	4	142.60	2/0	2
125	230	312	500	6	358.80	600 kcmil	3½
	460	156	250	5	179.40	3/0	2
150	230	360	600	6	414.00	700 kcmil	4
	460	180	300	5	207.00	4/0	2½

* Overcurrent device may have to be increased due to starting current and load conditions. See *NEC* 430.52, Table 430.52(C)(1). Wire size based on 75°C (167°F) terminations and 75°C (167°F) insulation.

** Overload heater must be based on motor nameplate and sized per *NEC* 430.32 for continuous-duty motors and *NEC* 430.33 for intermittent and similar duty motors.

*** Conduit size based on rigid metal conduit with some spare capacity. For minimum size and other conduit types, see *NEC* Annex C or *Ugly's* pages 84–97.

MOTOR AND MOTOR CIRCUIT CONDUCTOR PROTECTION

Motors can have large starting currents three to five times or more than that of the actual motor current. In order for motors to start, the motor and motor circuit conductors are allowed to be protected by circuit breakers and fuses at values that are higher than the actual motor and conductor ampere ratings. These larger overcurrent devices do not provide overload protection and will only open upon short circuits or ground faults. Overload protection must be used to protect the motor based on the actual nameplate amperes of the motor. This protection is usually in the form of heating elements in manual or magnetic motor starters. Small motors such as waste disposal motors have a red overload reset button built into the motor.

General Motor Rules

- Use full-load current from tables instead of nameplate.
- Branch circuit conductors: Use 125% of full-load current to find conductor size.
- Branch circuit OCP size: Use percentages given in tables for full-load current. (*Ugly's* pages 32, 34, and 39)
- Feeder conductor size: 125% of largest motor and sum of the rest.
- Feeder OCP: Use largest OCP plus rest of full-load currents.

(See examples on Ugly's *page 42.)*

MOTOR BRANCH CIRCUIT AND FEEDER EXAMPLE

General Motor Applications

Branch circuit conductors:

Use full-load, three-phase currents, from the table on *Ugly's* page 39 or 2026 *NEC* Table 430.250, 50-HP, 480-volt, 3-phase, motor Design B, 75-degree terminations = 65 Amps
125% of full-load current [*NEC* 430.22] (*Ugly's* page 41)
125% of 65 Amps = **81.25 Amps** conductor selection ampacity

Branch circuit overcurrent device: *NEC* 430.52(C)(1)

(Branch circuit short-circuit and ground fault protection)
Use percentages given in *Ugly's* page 38 or *NEC* Table 430.52(C)(1) for **Type** of circuit breaker or fuse used.
50-HP, 480-volt, 3-phase motor = 65 Amps (*Ugly's* page 39)
Nontime delay fuse = 300% (*Ugly's* page 38)
300% of 65 Amps = 195 Amps. *NEC* 430.52(C)(1)(a) Next size allowed *NEC* Table 240.6(A) = **200-amp fuse**.

Feeder connectors:

For 50-HP and 30-HP, 480-volt, 3-phase, Design B motors on same feeder:
Use 125% of the largest full-load current and 100% of the rest. (*NEC* 430.24)
50-HP, 480-volt, 3-phase motor = 65 Amps; 30-HP, 480-volt, 3-phase motor = 40 Amps (125% of 65 Amps) + 40 Amps = **121.25 Amps** conductor selection ampacity

Feeder overcurrent device: *NEC* 430.62(A) (specific load)

(Feeder short-circuit and ground-fault protection)
Use largest overcurrent protection device **plus** full-load currents of the rest of the motors.
50 HP = 200-Amp fuse (65 FLC)
30 HP = 125-Amp fuse (40 FLC)
200-Amp fuse + 40 Amp (FLC) = 240 Amp. Do not exceed this value on feeder. The next standard size fuse below 240 is a **225-amp** fuse.

LOCKED-ROTOR INDICATING CODE LETTERS

Code Letter	Kilovolt-Amperes per Horsepower with Locked Rotor	Code Letter	Kilovolt-Amperes per Horsepower with Locked Rotor
A	0–3.14	L	9.0–9.99
B	3.15–3.54	M	10.0–11.19
C	3.55–3.99	N	11.2–12.49
D	4.0–4.49	P	12.5–13.99
E	4.5–4.99	R	14.0–15.99
F	5.0–5.59	S	16.0–17.99
G	5.6–6.29	T	18.0–19.99
H	6.3–7.09	U	20.0–22.39
J	7.1–7.99	V	22.4 and up
K	8.0–8.99		

Source: NFPA 70®, *National Electrical Code®*, NFPA, 2026 edition, Quincy, MA, 2025, Table 430.7(B), as modified.

The *National Electrical Code®* requires that all alternating-current (ac) motors rated ½ HP or more (except for polyphase wound-rotor motors) must have code letters on their nameplates indicating motor input with locked rotor (in kilovolt-amperes per horsepower). The motor's horsepower, voltage, and locked-rotor code letter are needed to calculate the motor's locked-rotor current. Use the following formulas:

Single-Phase Motors:

$$\text{Locked-Rotor Current} = \frac{HP \times KVA_{hp} \times 1000}{E}$$

Three-Phase Motors:

$$\text{Locked-Rotor Current} = \frac{HP \times KVA_{hp} \times 1000}{E \times 1.73}$$

Example: What is the maximum locked-rotor current for a 480-volt, 25-HP, code letter F motor?
(From the above table, code letter F = 5.59 kVA_{hp})

$$I = \frac{HP \times kVA_{hp} \times 1000}{E \times 1.73} = \frac{25 \times 5.59 \times 1000}{480 \times 1.73} = \mathbf{168.29\ Amps}$$

MAXIMUM MOTOR LOCKED-ROTOR CURRENT IN AMPERES, SINGLE PHASE

HP	115 V	208 V	230 V	HP	115 V	208 V	230 V
½	58.8	32.5	29.4	3	204	113	102
¾	82.8	45.8	41.4	5	336	186	168
1	96	53	48	7½	480	265	240
1½	120	66	60	10	1000	332	300
2	144	80	72				

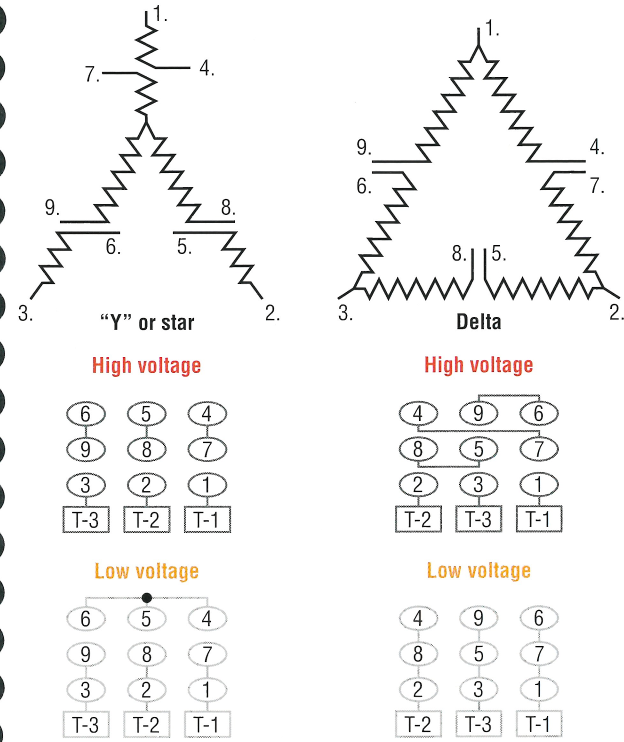
Note: For use only with 430.110, 440.12, 440.41, and 455.8(C).
Source: NFPA 70®, *National Electrical Code®*, 2026 edition, NFPA, Quincy, MA, 2025, Table 430.251(A), as modified.

MAXIMUM MOTOR LOCKED-ROTOR CURRENT IN AMPERES, TWO AND THREE PHASE, DESIGN B, C, AND D*

HP	115 V	200 V	208 V	230 V	460 V	575 V
½	40	23	22.1	20	10	8
¾	50	28.8	27.6	25	12.5	10
1	60	34.5	33	30	15	12
1½	80	46	44	40	20	16
2	100	57.5	55	50	25	20
3	—	73.6	71	64	32	25.6
5	—	105.8	102	92	46	36.8
7½	—	146	140	127	63.5	50.8
10	—	186.3	179	162	81	64.8
15	—	267	257	232	116	93
20	—	334	321	290	145	116
25	—	420	404	365	183	146
30	—	500	481	435	218	174
40	—	667	641	580	290	232
50	—	834	802	725	363	290
60	—	1001	962	870	435	348
75	—	1248	1200	1085	543	434
100	—	1668	1603	1450	725	580
125	—	2087	2007	1815	908	726
150	—	2496	2400	2170	1085	868
200	—	3335	3207	2900	1450	1160

* Design A motors are not limited to a maximum starting current or locked-rotor current.
Note: For use only with 430.110, 440.12, 440.41, and 455.8(C).
Source: NFPA 70®, *National Electrical Code®*, 2026 edition, NFPA, Quincy, MA, 2025, Table 430.251(B), as modified.

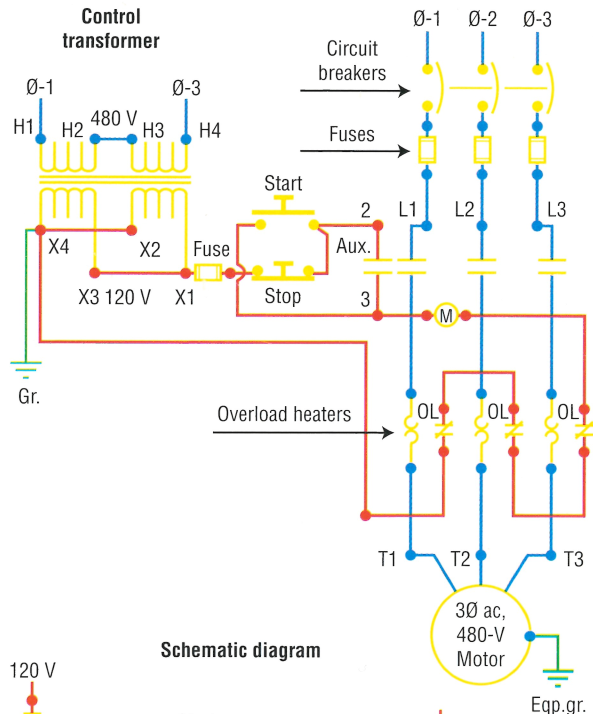
THREE-PHASE ac MOTOR WINDINGS AND CONNECTIONS



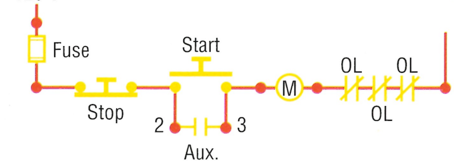
Note:
1. The most important part of any motor is the nameplate. Check the data given on the plate before making the connections.
2. To change rotation direction of 3-phase motor, swap any two T-leads.

THREE-WIRE STOP-START STATION

Wiring diagram



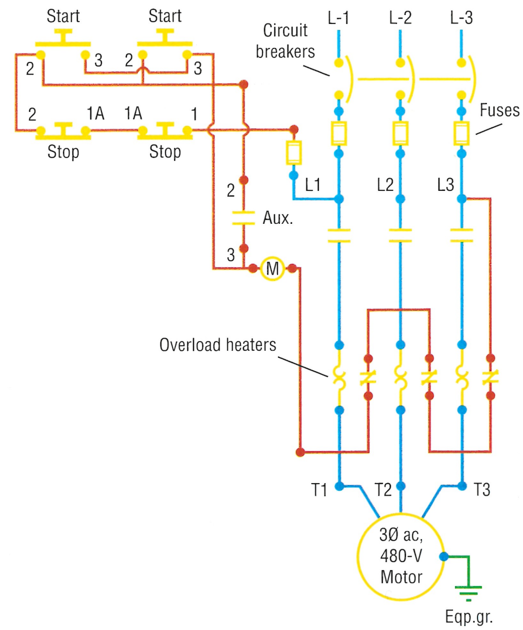
Schematic diagram

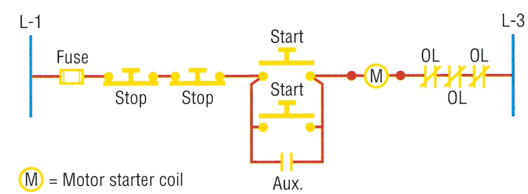


(M) = Motor starter coil

Note: Controls and motor are of different voltages.

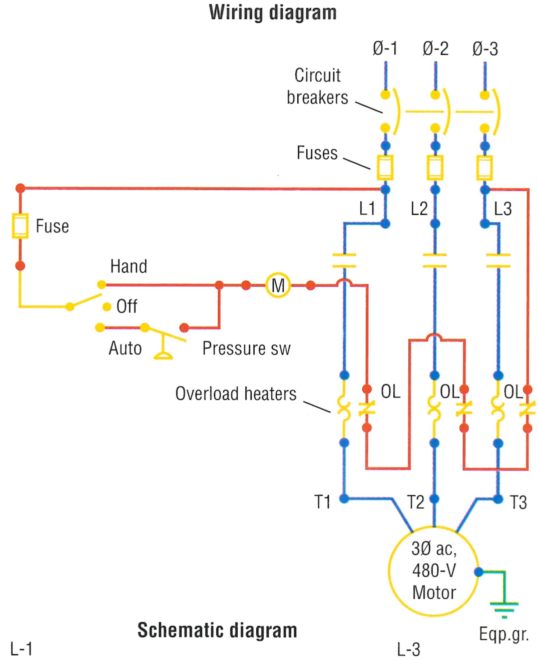
TWO THREE-WIRE STOP-START STATIONS

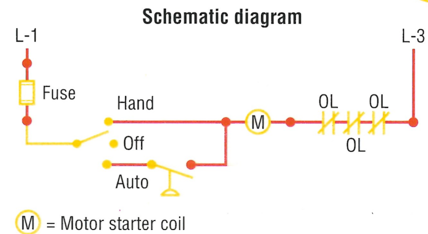




Note: Controls and motor are of the same voltage.
If low-voltage controls are used, see *Ugly's* page 46 for control transformer connections.

HAND-OFF AUTOMATIC CONTROL

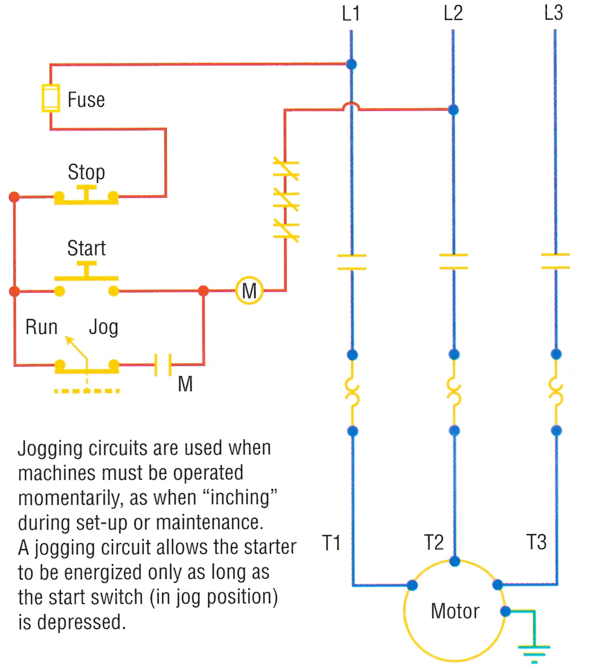




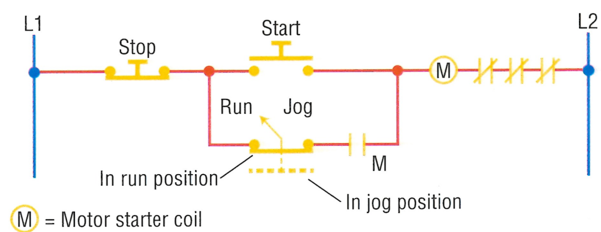
Note: Controls and motor are of the same voltage.
If low-voltage controls are used, see *Ugly's* page 46 for control transformer connections.

JOGGING WITH SELECTOR SWITCH

Jogging control



Jogging circuits are used when machines must be operated momentarily, as when “inching” during set-up or maintenance. A jogging circuit allows the starter to be energized only as long as the start switch (in jog position) is depressed.



VOLTAGE DROP CALCULATIONS: INDUCTANCE NEGLIGIBLE

Vd = Voltage Drop
I = Current in Conductor (Amperes)
L = One-way Length of Circuit (Feet)
Cm = Cross-Sectional Area of Conductor (Circular Mils) (page 71)
K = Resistance in Ohms of 1 Circular Mil Foot of Conductor
K = 12.9 for Copper Conductors @ 75°C (167°F)
K = 21.2 for Aluminum Conductors @ 75°C (167°F)

Note: K value changes with temperature and other factors. See *NEC* Chapter 9, Table 8, Note 1.

Single-Phase Circuits

$$Vd = \frac{2K \times L \times I}{Cm} \quad \text{or} \quad {}^{*}Cm = \frac{2K \times L \times I}{Vd}$$

Three-Phase Circuits

$$Vd = \frac{1.73K \times L \times I}{Cm} \quad \text{or} \quad {}^{*}Cm = \frac{1.73K \times L \times I}{Vd}$$

**Note:* Always check ampacity tables to ensure conductor's ampacity is equal to load after voltage drop calculation.

Refer to *Ugly's* pages 71–82 for conductor size, type, and ampacity.
See *Ugly's* pages 51–52 for examples.

VOLTAGE DROP EXAMPLES

Distance (One Way) for 2% Voltage Drop for 120 Volts Single Phase

AMPS	VOLTS	12 AWG	10 AWG	8 AWG	6 AWG	4 AWG	3 AWG	2 AWG	1 AWG	1/0 AWG
20	120	30	48	77	122	194	245	309	389	491
	240	60	96	154	244	388	490	618	778	982
30	120		32	51	81	129	163	206	260	327
	240		64	102	162	258	326	412	520	654
40	120			38	61	97	122	154	195	246
	240			76	122	194	244	308	390	492
50	120				49	78	98	123	156	196
	240				98	156	196	246	312	392
60	120					65	82	103	130	164
60	240					130	164	206	260	328
70	240					111	140	176	222	281
80	240						122	154	195	246
90	240							137	173	218
100	240								156	196

(See Footnotes on Page 51 Concerning Circuit Load Limitations.)

VOLTAGE DROP EXAMPLES

Typical Voltage Drop Values Based on Conductor Size and One-Way Length* (60°C [140°F] Termination and Insulation)

	25 Feet							
	12 AWG	10 AWG	8 AWG	6 AWG	4 AWG	3 AWG	2 AWG	1 AWG
20 A	1.98	1.24	0.78	0.49	0.31	0.25	0.19	0.15
30		1.86	1.17	0.74	0.46	0.37	0.29	0.23
40			1.56	0.98	0.62	0.49	0.39	0.31
50				1.23	0.77	0.61	0.49	0.39
60					0.93	0.74	0.58	0.46

	50 Feet							
	12 AWG	10 AWG	8 AWG	6 AWG	4 AWG	3 AWG	2 AWG	1 AWG
20 A	3.95	2.49	1.56	0.98	0.62	0.49	0.39	0.31
30		3.73	2.34	1.47	0.93	0.74	0.58	0.46
40			3.13	1.97	1.24	0.98	0.78	0.62
50				2.46	1.55	1.23	0.97	0.77
60					1.85	1.47	1.17	0.92

	75 Feet							
	12 AWG	10 AWG	8 AWG	6 AWG	4 AWG	3 AWG	2 AWG	1 AWG
20 A	5.93	3.73	2.34	1.47	0.93	0.74	0.58	0.46
30		5.59	3.52	2.21	1.39	1.10	0.87	0.69
40			4.69	2.95	1.85	1.47	1.17	0.92
50				3.69	2.32	1.84	1.46	1.16
60					2.78	2.21	1.75	1.39

	100 Feet							
	12 AWG	10 AWG	8 AWG	6 AWG	4 AWG	3 AWG	2 AWG	1 AWG
20 A	7.90	4.97	3.13	1.97	1.24	0.98	0.78	0.62
30		7.46	4.69	2.95	1.85	1.47	1.17	0.92
40			6.25	3.93	2.47	1.96	1.56	1.23
50				4.92	3.09	2.45	1.94	1.54
60					3.71	2.94	2.33	1.85

	125 Feet							
	12 AWG	10 AWG	8 AWG	6 AWG	4 AWG	3 AWG	2 AWG	1 AWG
20 A	9.88	6.21	3.91	2.46	1.55	1.23	0.97	0.77
30		9.32	5.86	3.69	2.32	1.84	1.46	1.16
40			7.81	4.92	3.09	2.45	1.94	1.54
50				6.15	3.86	3.06	2.43	1.93
60					4.64	3.68	2.92	2.31

	150 Feet							
	12 AWG	10 AWG	8 AWG	6 AWG	4 AWG	3 AWG	2 AWG	1 AWG
20 A	11.85	7.46	4.69	2.95	1.85	1.47	1.17	0.92
30		11.18	7.03	4.42	2.78	2.21	1.75	1.39
40			9.38	5.90	3.71	2.94	2.33	1.85
50				7.37	4.64	3.68	2.92	2.31
60					5.56	4.41	3.50	2.77

A 2-wire, 20-amp circuit using 12 AWG with a one-way distance of 25 feet will drop 1.98 volts.
120 Volts − 1.98 Volts = 118.02 Volts as the load voltage.
240 Volts − 1.98 Volts = 238.02 Volts as the load voltage.

*Better economy and efficiency will result using the voltage drop method on page 50.
A continuous load cannot exceed 80% of the circuit rating.
A motor or heating load cannot exceed 80% of the circuit rating.
For motor overcurrent devices and conductor sizing, see *Ugly's* pages 40–42.

VOLTAGE DROP CALCULATION EXAMPLES

Single-Phase Voltage Drop

What is the voltage drop of a 240-volt, single-phase circuit consisting of #8 THWN copper conductors feeding a 30-amp load that is 150 feet in length?

Voltage Drop Formula (see *Ugly's* page 50)

$$Vd = \frac{2K \times L \times I}{Cm} = \frac{2 \times 12.9 \times 150 \times 30}{16510} = \frac{116100}{16510} = 7 \text{ Volts}$$

Percentage voltage drop = 7 Volts/240 Volts = 0.029 = **2.9%**
Voltage at load = 240 Volts – 7 Volts = **233 Volts**

Three-Phase Voltage Drop

What is the voltage drop of a 480-volt, 3-phase circuit consisting of 250-kcmil THWN copper conductors that supply a 250-amp load that is 500 feet from the source?

250 kcmil = 250000 circular mils

Voltage Drop Formula (see *Ugly's* page 50)

$$Vd = \frac{1.73K \times L \times I}{Cm} = \frac{1.73 \times 12.9 \times 500 \times 250}{250000} = \frac{2789625}{250000} = 11 \text{ Volts}$$

Percentage voltage drop = 11 Volts/480 Volts = 0.0229 = **2.29%**
Voltage at load = 480 Volts – 11 Volts = **469 Volts**

Note: Always check ampacity tables for conductors selected.

Refer to *Ugly's* pages 71–82 for conductor size, type, and ampacity.

SHORT-CIRCUIT CALCULATION

(Courtesy of Cooper Bussmann)

Basic Short-Circuit Calculation Procedure

1. Determine transformer full-load amperes from either:
   a) Nameplate
   b) Formula:

$$3\text{Ø transformer} \quad I_{l.l.} = \frac{KVA \times 1000}{E_{L\text{-}L} \times 1.732}$$

$$1\text{Ø transformer} \quad I_{l.l.} = \frac{KVA \times 1000}{E_{L\text{-}L}}$$

2. Find transformer multiplier.

$$\text{Multiplier} = \frac{100}{{*}\%Z_{trans}}$$

3. Determine transformer let-through short-circuit current.**

$$I_{S.C.} = I_{l.l.} \times \text{Multiplier}$$

4. Calculate "f" factor.

3Ø faults

$$f = \frac{1.732 \times L \times I_{3Ø}}{C \times E_{L\text{-}L}}$$

1Ø line-to-line (L-L) faults on 1Ø Center Tapped Transformer

$$f = \frac{2 \times L \times I_{L\text{-}L}}{C \times E_{L\text{-}L}}$$

1Ø line-to-neutral (L-N) faults on 1Ø Center Tapped Transformer

$$f = \frac{2 \times L \times I_{L\text{-}N}^{***}}{C \times E_{L\text{-}N}}$$

L = Length (feet) of conductor to the fault
C = Constant from Table C (page 55) for conductors and busway. For parallel runs, multiply C values by the number of conductors per phase.
I = Available short-circuit current in amperes at beginning of circuit.

5. Calculate "M" (multiplier)

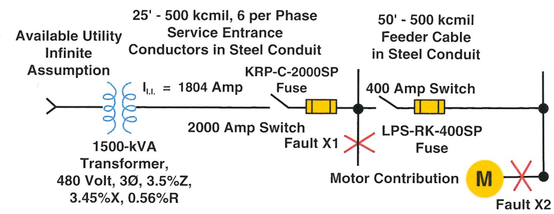
$$M = \frac{1}{1 + f}$$

6. Calculate the available short-circuit symmetrical RMS current at the point of fault.

$$I_{S.C.\ sym\ RMS} = I_{S.C.} \times M$$

SHORT-CIRCUIT CALCULATION

(Courtesy of Cooper Bussmann)



Example: Short-Circuit Calculation

(Fault #1)

1. $$I_{I.L.} = \frac{KVA \times 1000}{E_{L\text{-}L} \times 1.732} = \frac{1500 \times 1000}{480 \times 1.732} = 1804 \text{ Amps}$$

2. $$\text{Multiplier} = \frac{100}{{}^{*}\,\%Z_{trans}} = \frac{100}{3.5} = 28.57$$

3. $$I_{S.C.} = 1804 \times 28.57 = 51540 \text{ Amps}$$

4. $$f = \frac{1.732 \times L \times I_{3Ø}}{C \times E_{L\text{-}L}} = \frac{1.73 \times 25 \times 51540}{6 \times 22185 \times 480} = 0.0349$$

5. $$M = \frac{1}{1 + f} = \frac{1}{1 + 0.0349} = 0.9663$$

6. $$I_{S.C.\ sym\ RMS} = I_{S.C.} \times M = 51540 \times 0.9663 = 49803 \text{ Amps}$$
$$I_{S.C.\ motor\ contrib} = 4 \times 1804 = 7216 \text{ Amps}$$
$$I_{total\ S.C.\ sym\ RMS} = 49803 + 7216 = 57019 \text{ Amps}$$

(Fault #2)

1. Use $I_{S.C.\ sym\ RMS}$ @ Fault X_1 to calculate "f"
$$f = \frac{1.73 \times 50 \times 49803}{22185 \times 480} = 0.4050$$

2. $$M = \frac{1}{1 + 0.4050} = 0.7117$$

3. $$I_{S.C.\ sym\ RMS} = 49803 \times 0.7117 = 35445 \text{ Amps}$$
$$I_{sym\ motor\ contrib} = 4 \times 1804 = 7216 \text{ Amps}$$
$$I_{total\ S.C.\ sym\ RMS} = 35445 + 7216 = 42661 \text{ Amps}$$

"C" Values for Conductors (Courtesy of Cooper Bussmann)

AWG or MCM	Copper Three Single Conductors						Copper Three Conductor Cable					
	Steel Conduit			Nonmagnetic Conduit			Steel Conduit			Nonmagnetic Conduit		
	600 V	5 kV	15 kV	600 V	5 kV	15 kV	600 V	5 kV	15 kV	600 V	5 kV	15 kV
12	617	617	617	617	617	617	617	617	617	617	617	617
10	981	981	981	981	981	981	981	981	981	981	981	981
8	1557	1551	1557	1558	1555	1558	1559	1557	1559	1559	1558	1559
6	2425	2406	2389	2430	2417	2406	2431	2424	2414	2433	2428	2420
4	3806	3750	3695	3825	3789	3752	3830	3811	3778	3837	3823	3798
3	4760	4760	4760	4802	4802	4802	4760	4790	4760	4802	4802	4802
2	5906	5736	5574	6044	5926	5809	5989	5929	5827	6087	6022	5957
1	7292	7029	6758	7493	7306	7108	7454	7364	7188	7579	7507	7364
1/0	8924	8543	7973	9317	9033	8590	9209	9086	8707	9472	9372	9052
2/0	10755	10061	9389	11423	10877	10318	11244	11045	10500	11703	11528	11052
3/0	12843	11804	11021	13923	13048	12360	13656	13333	12613	14410	14118	13461
4/0	15082	13605	12542	16673	15351	14347	16391	15890	14813	17482	17019	16012
250	16483	14924	13643	18593	17120	15865	18310	17850	16465	19779	19352	18001
300	18176	16292	14768	20867	18975	17408	20617	20051	18318	22524	21938	20163
350	19703	17385	15678	22736	20526	18672	22646	21914	19821	24904	24126	21982
400	20565	18235	16365	24296	21786	19731	24253	23371	21042	26915	26044	23517
500	22185	19172	17492	26706	23277	21329	26980	25449	23125	30028	28712	25916
600	22965	20567	17962	28033	25203	22097	28752	27974	24896	32236	31258	27766
750	24136	21386	18888	28303	25430	22690	31050	30024	26932	32404	31338	28303
1000	25278	22539	19923	31490	28083	24887	33864	32688	29320	37197	35748	31959

(continued on next page)

SHORT-CIRCUIT CALCULATION

(Courtesy of Cooper Bussmann)

Notes:

*Transformer impedance (Z) helps to determine what the short circuit current will be at the transformer secondary. Transformer impedance is determined as follows:

The transformer secondary is short circuited. Voltage is applied to the primary, which causes full-load current to flow in the secondary. This applied voltage divided by the rated primary voltage is the impedance of the transformer.

Example:

For a 480-volt rated primary, if 9.6 volts causes secondary full-load current to flow through the shorted secondary, the transformer impedance is 9.6 ÷ 480 = 0.02 = 2%Z.

In addition, U.L. listed transformers 25 kVA and larger have a ± 10% impedance tolerance. Short-circuit amperes can be affected by this tolerance.

**Motor short-circuit contribution, if significant, may be added to the transformer secondary short-circuit current value as determined in Step 3. Proceed with this adjusted figure through Steps 4, 5, and 6. A practical estimate of motor short-circuit contribution is to multiply the total motor current in amperes by 4.

***The L-N fault current is higher than the L-L fault current at the secondary terminals of a single-phase center-tapped transformer. The short-circuit current available (I) for this case in Step 4 should be adjusted at the transformer terminals as follows:

At L-N center tapped transformer terminals,

$I_{L-N} = 1.5 \times I_{L-L}$ at Transformer Terminals.

COMPONENT PROTECTION

(Courtesy of Cooper Bussmann)

How to Use Current-Limitation Charts

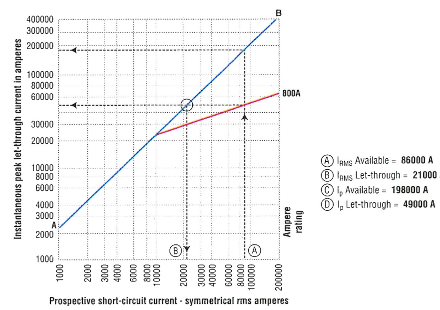
Example: An 800-amps circuit and an 800-amps, low-peak, current-limiting, time-delay fuse

How to Use the Let-Through Charts:

Using the example above, one can determine the pertinent let-through data for the KRP-C-800SP ampere, low-peak fuse. The let-through chart pertaining to the 800-amps, low-peak fuse is illustrated.

A. Determine the PEAK let-through CURRENT.
   1. Enter the chart on the Prospective Short-Circuit Current scale at 86000 amp and proceed vertically until the 800-amps fuse curve is intersected.
   2. Follow horizontally until the Instantaneous Peak Let-Through Current scale is intersected.
   3. Read the PEAK let-through CURRENT as 49000 amps. (If a fuse had not been used, the peak current would have been 198000 amps.)

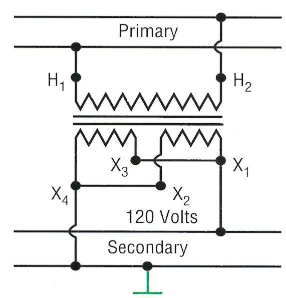
B. Determine the APPARENT PROSPECTIVE RMS SYMMETRICAL let-through CURRENT.
   1. Enter the chart on the Prospective Short-Circuit current scale at 86000 amps and proceed vertically until the 800-amps fuse curve is intersected.
   2. Follow horizontally until line A–B is intersected.
   3. Proceed vertically down to the Prospective Short-Circuit Current.
   4. Read the APPARENT PROSPECTIVE RMS SYMMETRICAL let-through CURRENT as 21000 amps. (The RMS SYMMETRICAL let-through CURRENT would be 86000 amps if there were no fuse in the circuit.)



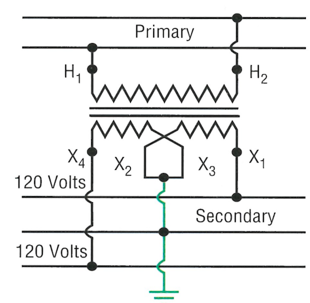
The data that can be obtained from the Fuse Let-Through Charts and their physical effects are:

1) Peak let-through current: Mechanical forces
2) Apparent prospective RMS symmetrical let-through current: Heating effect
3) Clearing time: Less than $\frac{1}{2}$ cycle when fuse is in its current-limiting range (beyond where fuse curve intersects A–B line)

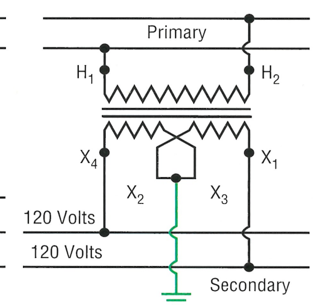
SINGLE-PHASE TRANSFORMER CONNECTIONS



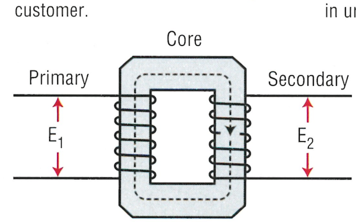
Single phase to supply 120-volt lighting load. Often used for single customer.



Single phase to supply 120/240-volt, 3-wire lighting and power load. Used in urban distribution circuits.



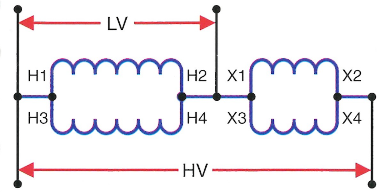
Single phase for power. Used for small industrial applications.

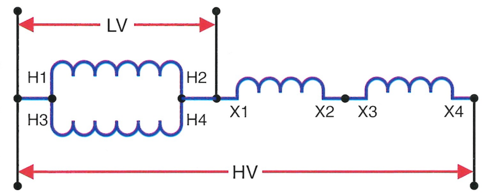


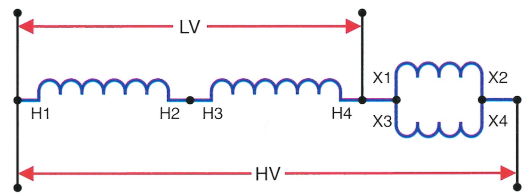
Single Ø transformer circuit

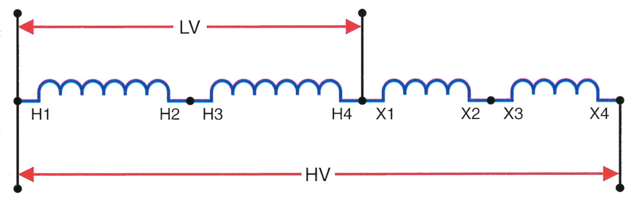
A transformer is a stationary induction device for transferring electrical energy from one circuit to another without change of frequency. A transformer consists of two coils or windings wound upon a magnetic core of soft iron laminations and insulated from one another.

BUCK-AND-BOOST TRANSFORMER CONNECTIONS









FULL-LOAD CURRENTS

Three-Phase Transformer's Voltage (Line to Line)						Single-Phase Transformer's Voltage					
kVA Rating	208	240	480	2400	4160	kVA Rating	120	208	240	480	2400
3	8.3	7.2	3.6	.72	.416	1	8.33	4.81	4.17	2.08	.42
6	16.7	14.4	7.2	1.44	.83	3	25.0	14.4	12.5	6.25	1.25
9	25.0	21.7	10.8	2.17	1.25	5	41.7	24.0	20.8	10.4	2.08
15	41.6	36.1	18.0	3.6	2.08	7.5	62.5	36.1	31.3	15.6	3.13
30	83.3	72.2	36.1	7.2	4.16	10	83.3	48.1	41.7	20.8	4.17
45	124.9	108.3	54.1	10.8	6.25	15	125.0	72.1	62.5	31.3	6.25
75	208.2	180.4	90.2	18.0	10.4	25	208.3	120.2	104.2	52.1	10.4
100	277.6	240.6	120.3	24.1	13.9	37.5	312.5	180.3	156.3	78.1	15.6
112.5	312.5	270.6	135.3	27.1	15.6	50	416.7	240.4	208.3	104.2	20.8
150	416.4	360.9	180.4	36.1	20.8	75	625.0	360.6	312.5	156.3	31.3
225	624.6	541.3	270.6	54.1	31.2	100	833.3	480.8	416.7	208.3	41.7
300	832.7	721.7	360.9	72.2	41.6	125	1041.7	601.0	520.8	260.4	52.1
500	1387.9	1202.8	601.4	120.3	69.4	167.5	1395.8	805.3	697.9	349.0	69.8
750	2081.9	1804.3	902.1	180.4	104.1	200	1666.7	961.5	833.3	416.7	83.3
1000	2775.8	2405.7	1202.8	240.6	138.8	250	2083.3	1201.9	1041.7	520.8	104.2
1500	4163.7	3608.5	1804.3	360.9	208.2	333	2775.0	1601.0	1387.5	693.8	138.8
2000	5551.6	4811.4	2405.7	481.1	277.6	500	4166.7	2403.8	2083.3	1041.7	208.3
2500	6939.5	6014.2	3007.1	601.4	347.0						
5000	13879.0	12028.5	6014.2	1202.8	694.0						
7500	20818.5	18042.7	9021.4	1804.3	1040.9						

$I = \frac{kVA \times 1000}{E \times 1.73}$ or $kVA = \frac{E \times I \times 1.73}{1000}$

$I = \frac{kVA \times 1000}{E}$ or $kVA = \frac{E \times I}{1000}$

TRANSFORMER CALCULATIONS

To better understand the following formulas, review the rule of transposition in equations.

A multiplier may be removed from one side of an equation by making it a divisor on the other side; or a divisor may be removed from one side of an equation by making it a multiplier on the other side.

1. Voltage and Current: Primary (p) and Secondary (s)

Power (p) = Power (s) or $Ep \times Ip = Es \times Is$

A. $Ep = \frac{Es \times Is}{Ip}$ B. $Ip = \frac{Es \times Is}{Ep}$

C. $\frac{Ep \times Ip}{Es} = Is$ D. $\frac{Ep \times Ip}{Is} = Es$

2. Voltage and Turns in Coil:

Voltage (p) x Turns (s) = Voltage (s) x Turns (p)

or

$Ep \times Ts = Es \times Tp$

A. $Ep = \frac{Es \times Tp}{Ts}$ B. $Ts = \frac{Es \times Tp}{Ep}$

C. $\frac{Ep \times Ts}{Es} = Tp$ D. $\frac{Ep \times Ts}{Tp} = Es$

3. Amperes and Turns in Coil:

Amperes (p) x Turns (p) = Amperes (s) x Turns (s)

or

$Ip \times Tp = Is \times Ts$

A. $Ip = \frac{Is \times Ts}{Tp}$ B. $Tp = \frac{Is \times Ts}{Ip}$

C. $\frac{Ip \times Tp}{Is} = Ts$ D. $\frac{Ip \times Tp}{Ts} = Is$

SIZING TRANSFORMERS

Single-Phase Transformers

Size a 480-volt, primary, or 240/120-volt, secondary, single-phase transformer for the following single-phase incandescent lighting load consisting of 48 recessed fixtures each rated 2 amps, 120 volts. Each fixture has a 150-watt lamp.
*(These fixtures can be evenly balanced on the transformer.)

Find total volt-amperes using fixture ratings—***do not use lamp watt rating.***

2 Amps x 120 Volts = 240 Volt-Amperes
240 VA x 48 = 11520 VA
11520 VA/1000 = 11.52 kVA

The single-phase transformer that meets or exceeds this value is **15 kVA**.

*24 lighting fixtures would be connected line one to the common neutral, and 24 lighting fixtures would be connected line two to the common neutral.

Three-Phase Transformers

Size a 480-volt, primary, or 208/120-volt, secondary, 3-phase transformer (polyphase unit) to supply one 280-volt, 3-phase, 25-kVA process heater and one 120-volt, 5-kW unit heater.

The 5-kW unit heater cannot be balanced across all three phases. The 5 kW will be on one phase only. Adding the loads directly will undersize the transformer. Common practice is to put an imaginary load equal to the single-phase load on the other two phases.
5 kW x 3 = 15 kW*
The 25 kVA is three phase; use 25 kVA.
25 kVA + 15 kVA* = 40 kVA
The nearest 3-phase transformer that meets or exceeds this value is a **45 kVA**.
*(kVA = kW at unity power factor) (Transformers are rated in kVA.)

SINGLE-PHASE TRANSFORMER

Primary and Secondary Amperes

A 480/240-volt, single-phase, 50-kVA transformer (Z = 2%) is to be installed. Calculate primary and secondary amperes and short-circuit amperes.

Primary amperes:

$$I_p = \frac{\text{kVA} \times 1000}{E_p} = \frac{50 \times 1000}{480} = \frac{50000}{480} = \textbf{104 Amps}$$

Secondary amperes:

$$I_s = \frac{\text{kVA} \times 1000}{E_s} = \frac{50 \times 1000}{240} = \frac{50000}{240} = \textbf{208 Amps}$$

Short-circuit amperes:*

$$I_{SC} = \frac{I_s}{\%Z} = \frac{208}{0.02} = \textbf{10400 Amps}$$

THREE-PHASE TRANSFORMER

Primary and Secondary Amperes

A 480/208-volt, 3-phase, 100-kVA transformer (Z = 1%) is to be installed. Calculate primary and secondary amperes and short-circuit amperes.

Primary amperes:

$$I_p = \frac{\text{kVA} \times 1000}{E_p \times 1.73} = \frac{100 \times 1000}{480 \times 1.73} = \frac{100000}{831} = \textbf{120 Amps}$$

Secondary amperes:

$$I_s = \frac{\text{kVA} \times 1000}{E_s \times 1.73} = \frac{100 \times 1000}{208 \times 1.73} = \frac{100000}{360} = \textbf{278 Amps}$$

Short-circuit amperes:*

$$I_{SC} = \frac{I_s}{\%Z} = \frac{278}{0.01} = \textbf{27800 Amps}$$

*Short-circuit amperes is the current that would flow if the transformers' secondary terminals were shorted phase to phase. See *Ugly's* pages 53–56 for calculating short-circuit amperes point to point using the Cooper Bussmann method.

THREE-PHASE CONNECTIONS

Wye (Star)

Voltage from "A," "B," or "C" to Neutral = E_{PHASE} (E_P)

Voltage between A and B, B and C, or C and A = E_{LINE} (E_L)

I_L = I_P, if balanced.

If unbalanced,

$$I_N = \sqrt{I_A^2 + I_B^2 + I_C^2 - (I_A \times I_B) - (I_B \times I_C) - (I_C \times I_A)}$$

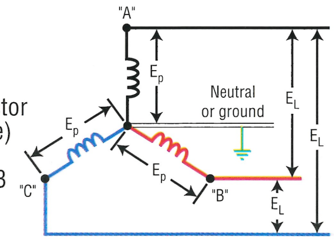
$E_L = E_P \times 1.73$

$E_P = E_L \div 1.73$

(True Power)
Power =

$I_L \times E_L \times 1.73 \times$ Power Factor (cosine)

(Apparent Power)
Volt-Amperes = $I_L \times E_L \times 1.73$



Delta

E_{LINE} (E_L) = E_{PHASE} (E_P)

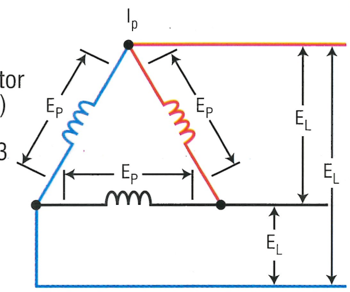
$I_{LINE} = I_P \times 1.73$

$I_{PHASE} = I_L \div 1.73$

(True Power)
Power =

$I_L \times E_L \times 1.73 \times$ Power Factor (cosine)

(Apparent Power)
Volt-Amperes = $I_L \times E_L \times 1.73$

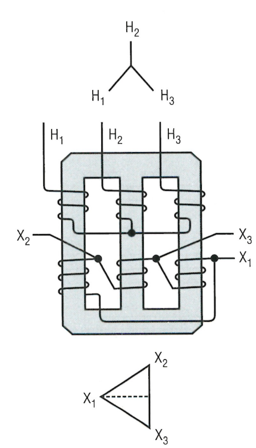


*Neutral could be ungrounded. Also see *NEC* Article 250, Grounding and Bonding.

THREE-PHASE STANDARD PHASE ROTATION

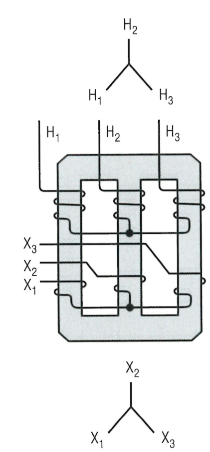
Transformers

Star-Delta



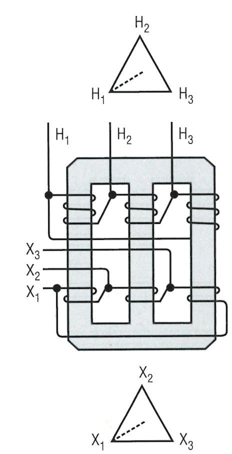
Additive Polarity
30° Angular Displacement

Star-Star



Subtractive Polarity
0° Phase Displacement

Delta-Delta

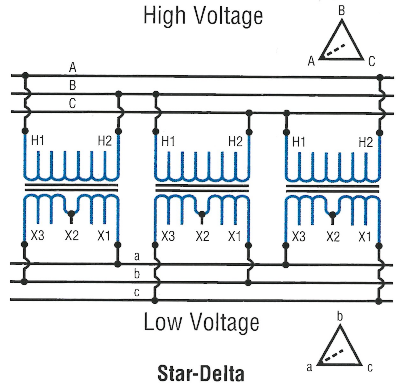


Subtractive Polarity
0° Phase Displacement

Series Connections of Low-Voltage Windings

Delta-Delta

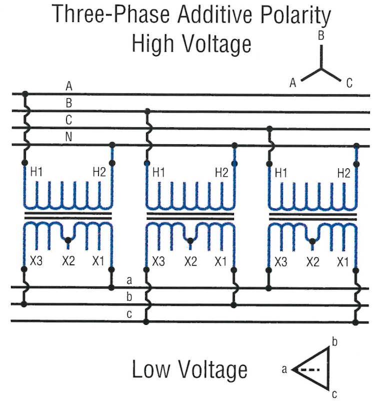
Three-Phase Additive Polarity
High Voltage



Low Voltage

Star-Delta

Three-Phase Additive Polarity
High Voltage



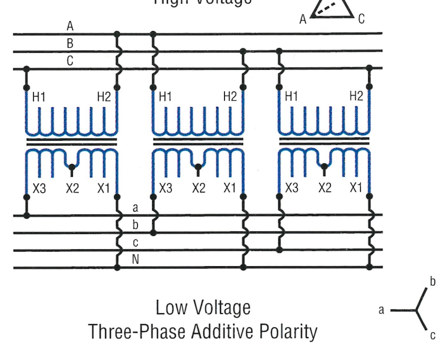
Low Voltage

Note: Single-phase transformers should be thoroughly checked for impedance, polarity, and voltage ratio before installation.

Series Connections of Low-Voltage Windings *(continued)*

Delta-Star

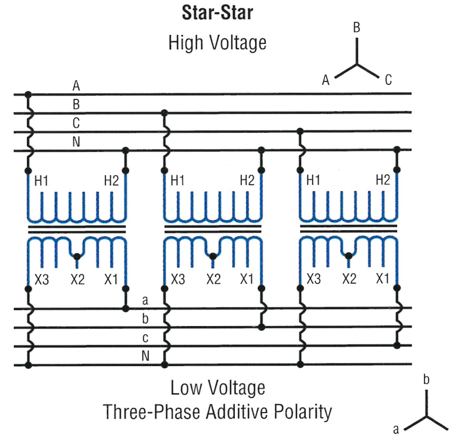
High Voltage



Low Voltage
Three-Phase Additive Polarity

Star-Star

High Voltage



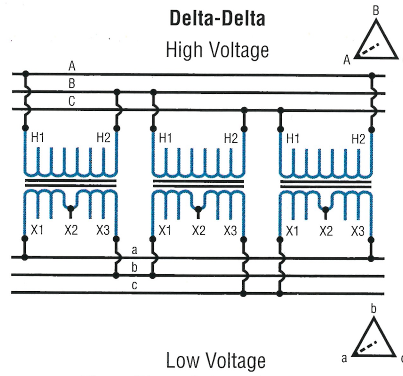
Low Voltage
Three-Phase Additive Polarity

Note: For additive polarity, the H1 and the X1 bushings are diagonally opposite to each other.

Series Connections of Low-Voltage Windings *(continued)*

Delta-Delta

High Voltage

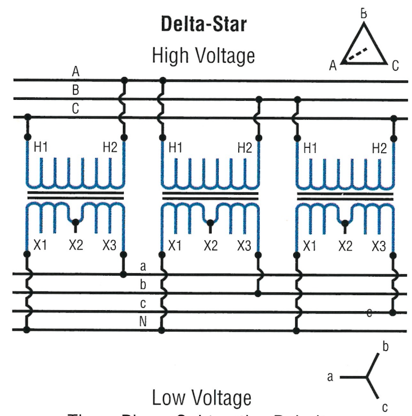


Low Voltage

Three-Phase Subtractive Polarity

Delta-Star

High Voltage



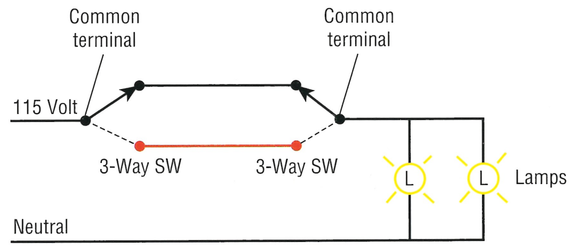
Low Voltage

Three-Phase Subtractive Polarity

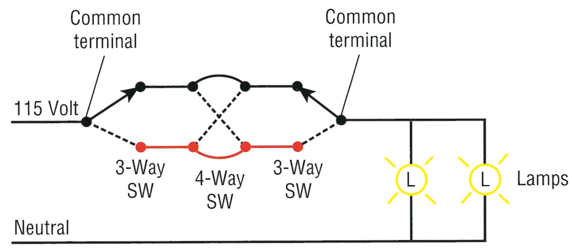
Note: For subtractive polarity, the H1 and the X1 bushings are directly opposite to each other.

MISCELLANEOUS WIRING DIAGRAMS

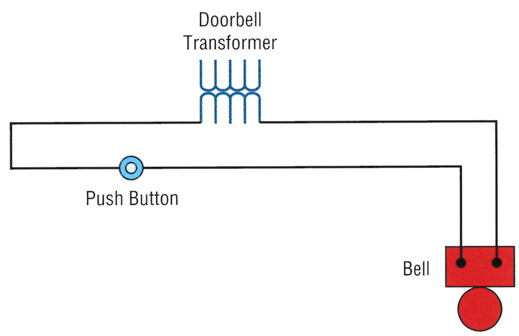
Two Three-Way Switches



Two Three-Way Switches and One Four-Way Switch

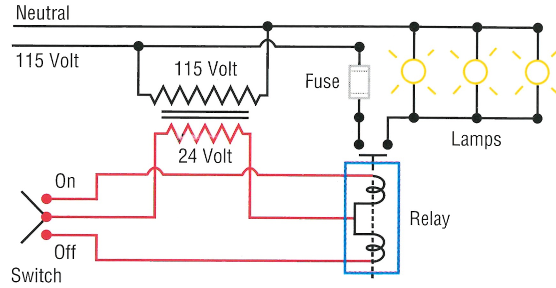


Bell Circuit



MISCELLANEOUS WIRING DIAGRAMS

Remote-Control Circuit: One Relay and One Switch



SUPPORTS FOR RIGID METAL CONDUIT

Conduit Size	Maximum Distance Between Supports
½"–¾"	10 Feet
1"	12 Feet
1¼"–1½"	14 Feet
2"–2½"	16 Feet
3" and larger	20 Feet

Source: NFPA 70®, *National Electrical Code*®, 2026 edition, NFPA, Quincy, MA, 2025, Table 344.30(B), as modified.

SUPPORTS FOR RIGID PVC CONDUIT CONDUIT

Conduit Size	Maximum Distance Between Supports
½"–1"	3 Feet
1¼"–2"	5 Feet
2½"–3"	6 Feet
3½"–5"	7 Feet
6	8 Feet

For SI units: (Supports) 1 foot = 0.3048 meter.
Source: NFPA 70®, *National Electrical Code*®, 2026 edition, NFPA, Quincy, MA, 2025, Table 352.30(B), as modified.