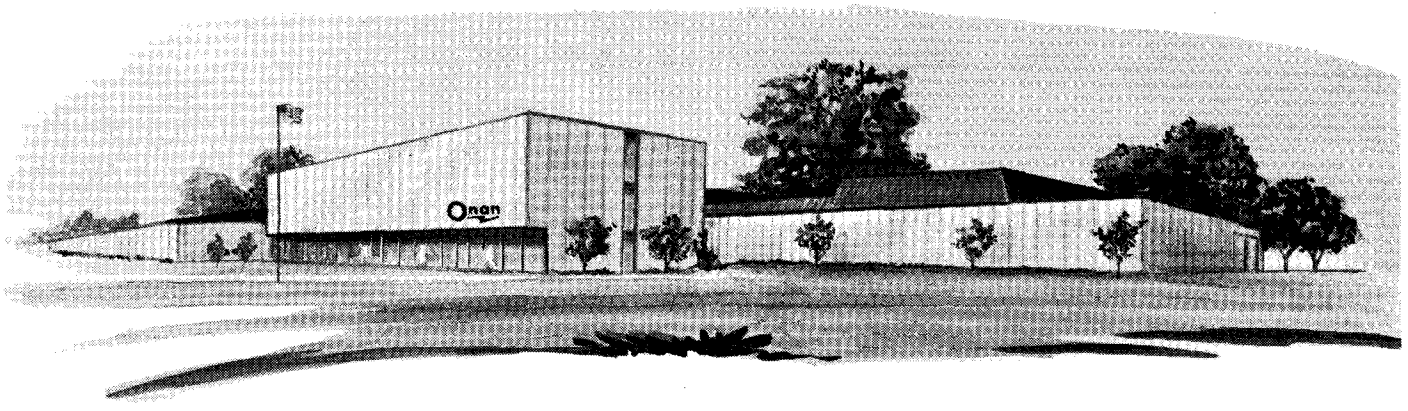
T-001

technical bulletin

MISCELLANEOUS ELECTRICAL TABLES AND INFORMATION



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Introduction

Some of the material in this technical bulletin is intended to provide various electrical information for installations of Onan equipment, other material explains electrical terminology, common symbols used in wiring diagrams and schematics, etc. Characteristics of conductors, effects of voltage drops, nominal ampere ratings of AC and DC generating sets and correct wire sizes are factors to be considered for almost all installations.

Most of the information such as conductor characteristics, typical running current requirements of motors, wire sizes, has been standardized through the years and can be found in most electrical handbooks. Onan does not mean to design or restrict installations through its technical bulletins, but rather to perform as an aid. Each installation must be planned carefully, be acceptable to electrical inspectors and comply with applicable codes and regulations.

MOTOR CIRCUIT AMPERE RATING AND INTERRUPTING CAPACITY

The ampacity (current carrying capacity) of torque motor circuits and the disconnecting means (over current protection circuit breaker capacities) must be at least 115 percent of the motor nameplate capacities or a summation of all circuit currents at the full-load condition.

To determine the equivalent horsepower for the disconnecting means to be used in a circuit, select the horsepower rating or the next higher value from Table 3 which corresponds to the motor current for the voltage in use.

To determine the ampere and horsepower ratings for the disconnecting means to be used with combination loads, a summation of all currents (including resistance loads at the full-load condition) is used and considered as a single motor. The full-load current equivalent is then selected from Table 3.

The locked rotor current equivalent to the horsepower rating is selected from Table 4. For a combined load, the locked rotor current must be added to the ampere rating of the other loads in the circuit to obtain the equivalent locked rotor current. For small motors not covered by Table 3, the locked rotor current should be six times the full-load current.

For additional information, refer to the latest edition of the National Electrical Code (NFPA 70-1975) and to your local electrical code requirements.

TABLE 3. FULL-LOAD CURRENT * THREE-PHASE ALTERNATING-CURRENT MOTORS

	Induction Type Squirrel-Cage and Wound Rotor Amperes				Synchronous Type † Unity Power Factor Amperes		
HP	200V	230V	460V	575V	220V	440V	550V
1/2	2.3	2	1	.8			
3/4	3.2	2.8	1.4	1.1			
1	4.1	3.6	1.8	1.4			
1-1/2	6.0	5.2	2.6	2.1			
2	7.8	6.8	3.4	2.7			
3	11.0	9.6	4.8	3.9			
5	17.5	15.2	7.6	6.1			
7-1/2	25.3	22	11	9			
10	32	28	14	11			
15	48	42	21	17			
20	62	54	27	22			
25	78	68	34	27	54	27	22
30	92	80	40	32	65	33	26
40	119	104	52	41	86	43	35
50	150	130	65	52	108	54	44
60	177	154	77	62	128	64	51
75	221	192	96	77	161	81	65
100	285	248	124	99	211	106	85
125	359	312	156	125	264	132	106
150	414	360	180	144		158	127
200	552	480	240	192		210	168

* - These values of full-load current are for motors running at speeds usual for belted motors and motors with normal torque characteristics. Motors built for especially low speeds or high torques may require more running current, and the nameplate current rating shall be used.

† - For 90 and 80 percent power factor, the above figures shall be multiplied by 1.1 and 1.25 respectively.

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.

TABLE 1. CHARACTERISTICS OF CONDUCTORS

WIRE SIZE	AREA CIRCULAR MILLS	OHMS PER 1000 FT. 25° C or 77° F.	BARE COPPER POUNDS PER 1000 FT.	ALLOWABLE AMPACITIES OF INSULATED COPPER CONDUCTORS - Based on Ambient Temperature of 30° C (86° F). For additional details, refer to the National Electrical Code (NEC) Tables 310-16 through 310-19.		
				3 Conductors or less in raceway or cable Type T, TW, ot UF.	Copper conductor in free air Type T, ot TW	4 through 6 in raceway or cable Type T, TW, . ot UF
14	4,109	2.575	12.43	15	20	12
12	6,520	1.619	19.77	20	25	16
10	10,380	1.018	31.43	30	40	24
8	16,510	.641	49.98	40	55	32
6	26,240	.410	79.46	55	80	44
4	41,740	.259	126.4	70	105	56
2	66,360	.162	205.0	95	140	76
1	83,690	.129	258.0	110	165	88
0	105,560	.102	326.0	125	195	100
00	133,080	.0811	411.0	145	225	116
000	167,770	.0642	518.0	165	260	132
0000	211,600	.0509	640.5	195	300	156

TABLE 2. TYPICAL RUNNING CURRENT REQUIREMENTS OF MOTORS AND RECOMMENDED WIRE SIZE

H.P.	115 V 1 PHASE AC		230 V 1 PHASE AC		120 VDC		240 VDC	
	A	W	A	W	A	W	A	W
1/6	4.4	14	2.2	14				
1/4	5.8	14	2.9	14	3.1	14	1.6	14
1/3	7.2	14	3.6	14	4.1	14	2.0	14
1/2	9.8	14	4.9	14	5.4	14	2.7	14
3/4	13.8	12	6.9	14	7.6	14	3.8	14
1	16.0	12	8.0	14	9.5	14	4.7	14
1-1/2	20.0	10	10.0	14	13.2	12	6.6	14
2	24	10	12.0	14	17.0	10	8.5	14
3	34	6	17.0	10	25.0	8	12.2	12
5	56	4	28.0	8	40.0	6	20.0	10
7-1/2	80	1	40.0	6	58.0	3	29.0	8
10	100	0	50.0	4	76.0	2	38.0	6
	NEC 430-148				NEC 430-147			

A - Full rated load current in amperes (amperes while starting are much higher).
W - Minimum wire size permitted by code; larger sizes often required - check distance for voltage drop.

TABLE 4. LOCKED-ROTOR CURRENT CONVERSION TABLE FOR MOTOR CIRCUITS AND CONTROLLERS

MAX. HP RATING	Typical Motor Locked-Rotor Current Amperes						
	Single Phase		Two or Three Phase				
	115V	230V	115V	200V	230V	460V	575V
1/2	58.8	29.4	24	14	12	6	4.8
3/4	82.8	41.4	33.6	19	16.8	8.4	6.6
1	96	48	42	24	21	10.8	8.4
1-1/2	120	60	60	34	30	15	12
2	144	72	78	45	39	19.8	15.6
3	204	102	–	62	54	27	24
5	336	168	–	103	90	45	36
7-1/2	480	240	–	152	132	66	54
10	600	300	–	186	162	84	66
15	–	–	–	276	240	120	96
20	–	–	–	359	312	156	126
25	–	–	–	442	384	192	156
30	–	–	–	538	468	234	186
40	–	–	–	718	624	312	246
50	–	–	–	862	750	378	300
60	–	–	–	1035	900	450	360
75	–	–	–	1276	1110	558	444
100	–	–	–	1697	1476	738	588
125	–	–	–	2139	1860	930	744
150	–	–	–	2484	2160	1080	864
200	–	–	–	3312	2880	1440	1152

TABLE 5. *RECOMMENDED WIRE SIZE FOR A SINGLE 3-PHASE MOTOR HORSEPOWER

Volts	1-3	5	7-1/2	10	15	20	25	30	40	50	60	75
200	14	10	8	6	4	3	1	0	000	000	300	400
230	14	12	10	8	6	4	3	1	0	000	000	300
460	14	14	14	12	10	8	6	6	4	3	2	0
575	14	14	14	14	12	10	8	6	6	4	3	2

Volts	100	125	150	200	250	300	350	400	450	500
200 230	600 500									
460	000	0000	300	500	700	900	1500	600(1)	750(1)	900(1)
575	0	000	0000	250	500	600	800	1000	1500	600(1)

* - Branch circuit conductors supplying a single motor shall have an ampacity not less than 125 percent of the motor full load current rating.

STANDARD VOLTAGES

Direct Current:

For charging 6-volt battery, battery voltage 6-8 volts.
For charging 12-volt battery, battery voltage 12-14 volts.
For charging 24-volt battery, battery voltage 24-30 volts.
For charging 32-volt battery, battery voltage 32-40 volts.
For charging 110-volt battery, battery voltage 110-140 volts.

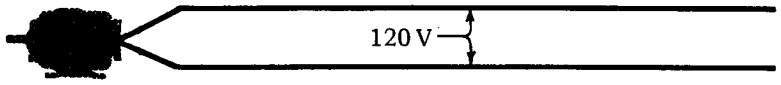
For battery-less systems, generator voltage 115.
For battery-less systems, generator voltage 230.

Alternating Current: Usually 60-hertz in U.S.A. (In foreign countries, 50-hertz current is common).

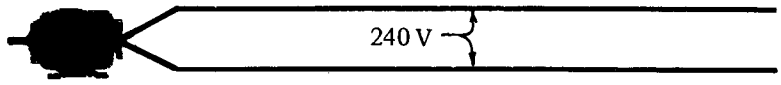
For a more complete explanation, see technical bulletin T-005.

SINGLE PHASE

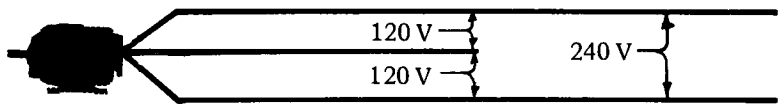
120 volt, 2 wire, 1 phase



240 volt, 2 wire, 1 phase

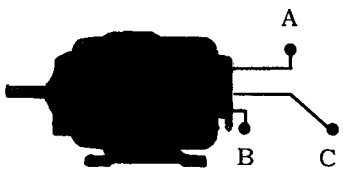


120/240 volt, 3 wire, 1 phase



THREE PHASE

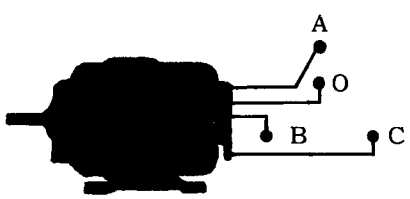
240 Volt
3 Wire, 3 Phase



Between A & B, 240 V single-phase
Between B & C, 240 V single-phase
Between A & C, 240 V single-phase
All three wires together produce 240 V, 3 phase voltage.

480 Volt, 3 wire, 3 phase. Connected as above, but higher voltage.

120/208 Volt
4 Wire, 3 Phase



Between O & A, 120 V single-phase
Between O & B, 120 V single-phase
Between O & C, 120 V single-phase
Between A & B, 208 V single-phase
Between B & C, 208 V single-phase
Between A & C, 208 V single-phase
All three wires A, B, C together produce 208 volt, 3 phase voltage.

220/380 Volt, 4 Wire, 3 Phase (usually 50 hertz).
Connected as above, except higher voltages.

VOLTAGE DROP

A voltage drop exists in any wire carrying an electric current. It is the loss in pressure (volts) when a current (amperes) flows through a conductor which has resistance (ohms). This voltage drop is wasted electricity as it does nothing productive at the other end of the conductor. It is advisable to keep the voltage drop as low as possible to maintain the efficiency of the system. This is done by using wire of sufficient size; the larger the wire, the less the drop. See tables 5 through 9 on wire sizes.

FIGURE 1. EFFECTS OF VARYING VOLTAGE ON LIGHT PRODUCED BY BULB

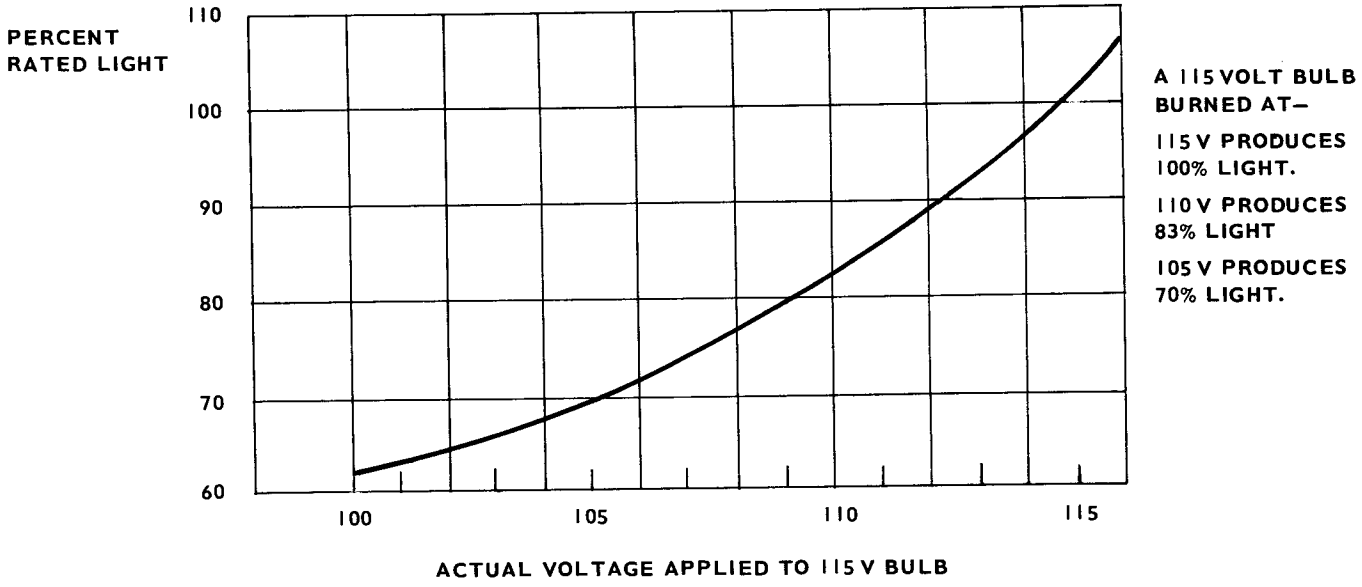
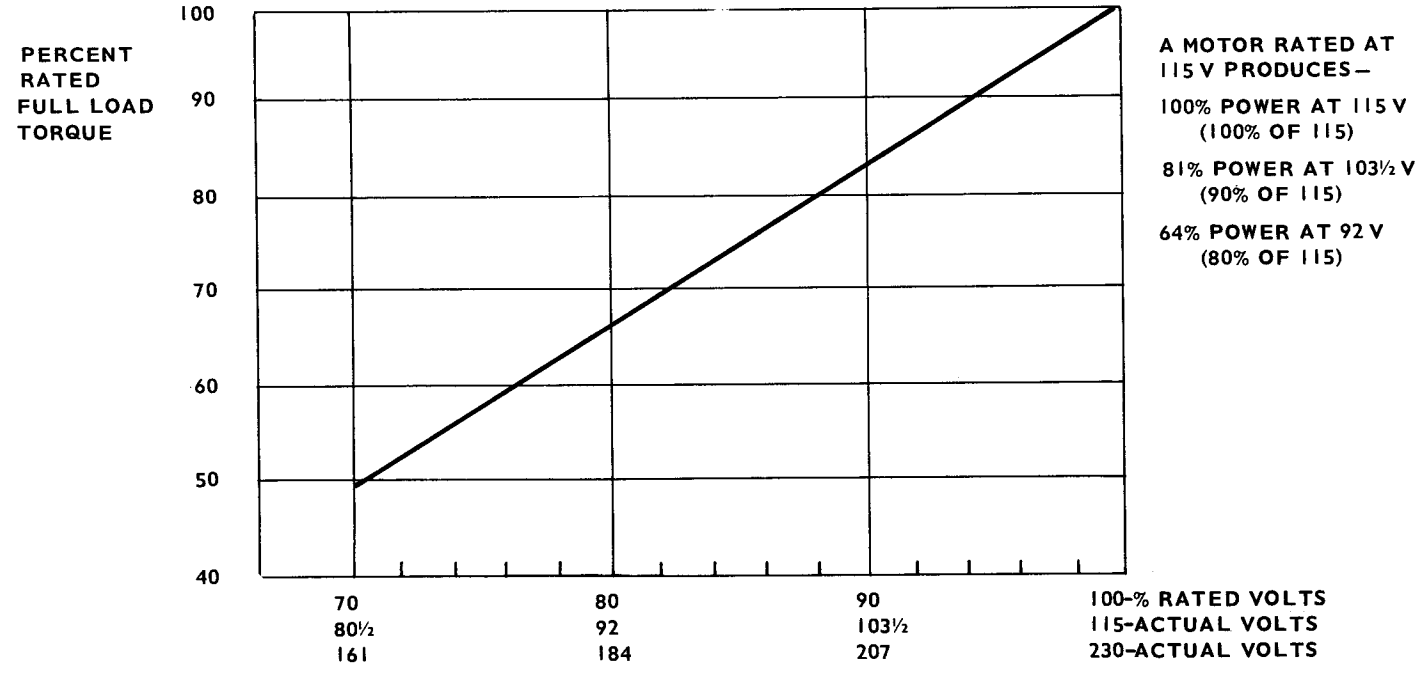


FIGURE 2. EFFECTS OF VARYING VOLTAGE ON POWER DELIVERED BY MOTOR



WIRE SIZES

Low Voltage DC Systems: Wire sizes in Tables 6, 7, 8 apply to the largest wattage available from Onan DC battery charging generating sets for that voltage. Distances are based on an allowable 4% voltage drop. If only a 2% voltage drop is allowable, cut the distances in half. None of the amperages given for the various wire lengths exceed the maximum amperage (ampacity) of that particular wire size. For other sizes, consult an electrical handbook.

TABLE 6. WIRE SIZES FOR 12-VOLT CIRCUIT WITH 4% (0.48 VOLT) VOLTAGE DROP

	*WIRE SIZE	10	8	6	4	2	1
WATTS AT 12 VOLTS	AMPERES AT 12 VOLTS	**DISTANCE IN FEET					
25	2.08	105	170	275	435	695	875
50	4.17	50	85	135	215	345	435
100	8.33	25	40	65	105	170	215
150	12.50	15	25	45	70	115	145
200	16.67	--	20	30	50	85	105
250	20.83	--	15	25	40	65	85
300	25.00	--	--	20	35	55	70
400	33.33	--	--	15	25	40	50
500	41.67	--	--	--	20	30	40
600	50.00	--	--	--	15	25	35

* - Minimum wire size recommended is number 10.
** - One-way distance for a 2-wire run.

TABLE 7. WIRE SIZES FOR 24-VOLT CIRCUIT WITH 4% (0.96) VOLTAGE DROP

	*WIRE SIZE	12	10	8	6	4	2	1
WATTS AT 24 VOLTS	AMPERES AT 24 VOLTS	**DISTANCE IN FEET						
50	2.08	135	215	345	550	875	1390	1755
100	4.17	65	105	170	270	435	690	875
150	6.25	45	70	115	180	290	460	580
200	8.33	30	50	85	135	215	345	435
250	10.42	25	40	65	105	170	275	350
300	12.50	20	35	55	90	145	230	290
400	16.67	--	27	30	65	105	170	215
500	20.83	--	20	25	50	85	135	175
600	25.00	--	--	20	45	70	115	145
800	33.33	--	--	--	30	50	85	105
1000	41.67	--	--	--	25	40	65	85
1200	50.00	--	--	--	20	35	55	70
1400	58.33	--	--	--	--	30	50	60
1500	62.50	--	--	--	--	25	45	55

* - Minimum wire size recommended is number 12.
** - One-way distance for a 2-wire run.

TABLE 8. WIRE SIZES FOR 32-VOLT CIRCUIT WITH 4% (1.28 VOLT) VOLTAGE DROP

	* WIRE SIZE	12	10	8	6	4	2
WATTS AT 32 VOLTS	AMPERES AT 32 VOLTS	**DISTANCE IN FEET					
50	1.56	240	385	615	975	1555	2475
100	3.13	120	190	305	485	775	1230
150	4.69	80	125	200	325	515	820
200	6.25	60	95	150	240	385	615
250	7.81	45	75	120	195	310	490
300	9.38	40	60	100	160	255	410
400	12.50	30	45	75	120	190	305
500	15.63	20	35	60	95	155	245
600	18.75	--	30	50	80	125	205
800	25.00	--	20	35	60	95	150
1000	31.25	--	--	30	45	75	120
1200	37.50	--	--	25	40	60	100
1400	43.85	--	--	--	35	55	85
1500	46.88	--	--	--	30	50	80

* - Minimum wire size recommended is number 12.
** - One-way distance for a 2-wire run.

TABLE 9. WIRE SIZES FOR 120 VOLT DC OR AC, UNITY POWER FACTOR, 2% VOLTAGE DROP (2.4 VOLTS)

	WIRE SIZE	14	12	10	8	6	4	2
WATTS ★	AMPERES AT 120 VOLTS	* DISTANCE (FEET)						
	.84	550	880	1330	2080	3400	5500	8500
	1.67	275	440	665	1060	1690	2750	4300
	2.50	183	290	450	710	1130	1850	2840
	3.33	137	220	330	530	840	1380	2150
500	4.16	110	175	265	430	680	1100	1700
750	6.25	73	115	177	285	450	740	1140
1000	8.33	55	83	130	214	340	550	850
1500	12.50	36	57	88	146	225	365	575
2000	16.66	27	42	68	104	166	275	430
2500	20.80	22	37	52	83	135	220	365
3000	25.00	18	26	42	68	115	188	285
3500	29.20	--	23	37	63	94	155	245
4000	33.30	--	21	31	52	83	134	217
4500	37.50	--	15	29	46	73	119	176
5000	41.80	--	--	26	42	67	108	166
6000	50.00	--	--	21	36	57	88	140
7000	58.30	--	--	--	29	46	78	119
8000	66.60	--	--	--	26	42	67	104
9000	75.00	--	--	--	--	36	57	93
10000	83.30	--	--	--	--	31	52	83

* - Above figures represent a one-way distance in feet for a 2-wire run. If a 4% voltage drop is permissible, double the distances listed.
★ - For other voltages (120, 240, etc.), use amperes column - disregard watts. If only 1% voltage drop is allowable, divide the distances listed by 2.

AC, Single Phase: For 120 volt - use Table 9; 120/240 volt, 3 wire - use Table 9 for each 120-volt circuit; 240 volt - use watts column in Table 9, multiply distances by 4 or use amperes column and multiply distances by 2; 480-volt circuit, use watts column in Table 9 and multiply distances by 16 or use amperes column and multiply distances by 4.

AC, Three-Phase Systems: For a 240-volt circuit, multiply the distances in the 120-volt Table 9 by 4 for a load of the number of amperes indicated. Use the amperes column. For a 480-volt circuit, multiply the distances in the 120-volt Table 9 by 8 for the same load. Use the amperes column.

Formula for Determining Wire Size Under Any Other Condition:

A. Direct-current and single-phase systems:

$$CM = \frac{D \times I \times 22}{Ed}$$

B. Three-phase, three-wire systems:

$$CM = \frac{D \times I \times 19}{Ed}$$

CM = circular mills - Wire Size (see Table 1)

I = current in amperes (In the case of three phase, it is the current in each wire.)

D = single distance on one way length of the circuit in feet.

Ed = allowable voltage drop in volts (2% of 115 volts is 2.3 volt, etc.)

Shown below are the diameters of the various wire sizes without the insulation.

No. 14 No. 12 No. 10 No. 8 No. 6 No. 4 No. 2 No. 1/0

DEFINITIONS

Ampacity: Current carrying capacity of electric conductors expressed in amperes.

Alternating Current: Alternating current (AC) is current which reverses direction rapidly, flowing back and forth in the system with regularity. This reversal of current is due to reversal of voltage which occurs at the same frequency. In alternating current, any one wire is first positive, then negative, then positive and so on. With commercial power, the change from positive to negative to positive occurs 60 times per second resulting in 60 hertz current.

Alternator: An electric generator designed to supply alternating current. Some types have a revolving armature and in other types a revolving field.

Ampere: The ampere is the unit of measurement for electric current. It represents the rate at which current flows through a resistance of one ohm by a pressure of one volt.

Capacitor or Condenser: A capacitor is an electrical device which causes the current to lead the voltage, opposite in effect to inductive reactance. Capacitors are used to neutralize the objectional effect of lagging current (inductive reactance) which overloads the power source. It also acts as a low resistance path to ground for currents of radio frequency thus effectively reducing radio disturbance.

Conductor: Substances which offer little resistance to the flow of electric current (such as metals). Silver, copper, and aluminum are especially good conductors although no material is a perfect conductor. Each of the wires lying in the armature slots of an electric generator is referred to as a conductor.

Current: The flow of electricity in a circuit (similar to the flow of water in a pipe). It is expressed in amperes and represents an amount of electricity, similar to gallons per minute of water flow, regardless of the pressure (voltage).

Cycle: One complete period of flow of alternating current in both directions. One cycle represents 360°. See *Frequency*.

Direct Current: Current (DC) which flows in one direction only. One wire is always positive, the other negative.

Electrical Generator: An electrical generator is a machine so constructed that when its rotor is driven by an engine or other prime mover, a voltage is generated.

Exciter: An exciter is a direct-current generator which supplies direct current to excite or magnetize the fields of an alternator. An exciter may be a separate machine or be combined with the alternator.

Farad: The farad is a measure of electrical capacity of condensers. A microfarad is one-millionth of a farad and is abbreviated "mfd".

Frequency: Frequency of alternating current is the number of cycles per second. A 60-hertz alternating current makes 60 complete cycles of flow back and forth (120 alternations) per second. A conventional alternator has an even number of field poles arranged in alternate north and south polarities.

Current flows in one direction in an AC armature conductor while the conductor is passing a north pole and in the other direction while passing a south pole. The conductor passes two poles during each cycle. A frequency of 60 hertz requires the conductor to pass 120 poles per second. In a 6-pole alternator, the equivalent speed would be 20 revolutions per second or 1200 revolutions per minute. In a 4-pole alternator, the equivalent speed would be 30 revolutions per second or 1800 revolutions per minute.

Hertz: A unit of frequency, one cycle per second. Written as 50-hertz or 60-hertz current, etc.

Impedance: Effects placed on alternating current by inductive capacitance (current lags voltage), capacitive reactance (current leads voltage) and resistance (opposes current but doesn't lag or lead voltage) or any combination of two. It's measured in ohms like resistance.

Insulator: Substances which offer great resistances to the flow of electric current such as glass, procelain, paper, cotton, enamel and paraffin are called insulators because they are practically non-conducting. However, no material is a perfect insulator.

KVA: The abbreviation of kilovolt-amperes which is the product of the volts times the amperes divided by 1000. This term is used in rating alternating current machinery because with alternating currents, the product of the volts times the amperes usually does not give the true average power. See *Reactance* and *Power Factor*.

KVAR: The abbreviation of kilovolt-ampere reactance which is a measurement of reactive power that generates power within induction equipment (motors, transformers, holding coils, lighting ballasts, etc.).

KW: The abbreviation for kilowatt which is a unit of measurement of electrical power. A kilowatt (KW) equals 1000 watts and is the product of the volts times the amperes divided by 1000 when used in rating direct current machinery. It is also the term used to indicate true power in an AC circuit.

Kilowatt Hour: A kilowatt hour is the amount of electrical power represented by 1000 watts for a period of 1 hour. Thus a generator which delivered 1000 watts for a period of 1 hour would have delivered 1 kilowatt hour of electricity.

Ohm: The ohm is the unit of measurement of electrical resistance and represents the amount of resistance that permits current to flow at the rate of one ampere under a pressure of one volt. The resistance (in ohms) equals the pressure (in volts) divided by the current (in amperes).

Power Factor: When the current waves in an alternating-current circuit coincide exactly in time with the voltage waves, the product of volts times amperes gives volt amperes which is true power in watts (or in KW if divided by 1000). When the current waves lag behind the voltage, due to inductive reactance (or lead due to capacitive reactance), they do not reach their respective peak values at the same time. Under such conditions, the product of volts and amperes does not give true average watts. Such a product is called volt amperes or apparent watts. The factor by which apparent watts must be multiplied to give the true watts is known as the power factor (PF).

Power factor depends on the amount of lag or lead, and is the percentage of apparent watts which represents true watts. With a power factor of 80%, a fully loaded 5KVA (80% PF) alternator will produce 4KW (true watts). When the rating of a power unit is stated in KVA at 80% PF, it means that with an 80% PF load, the generator will generate its rated voltage providing the load does not exceed the KVA rating.

An engine-driven alternator with automatic voltage regulation, the KVA rating usually is determined by the maximum current which can flow through the windings without injurious overheating or by the ability of the engine or other prime mover to maintain the normal operating speed. A resistance load such as lamp bulbs, irons, toasters and similar devices is a unity power factor load. Motors, transformers and various other devices cause a current wave lag which is expressed in the power factor of the load.

Reactance: Reactance is opposition to the change of current flow in an AC circuit. The rapid reversing of alternating current tends to induce voltages that oppose the flow of current in such a manner that the current waves do not coincide in time with the voltage waves. The opposition of self inductance to the flow of current is called "inductive reactance" and causes the current to lag behind the voltage which produces it. The opposition of a condenser or of capacitance to the change of alternating current voltage causes the current wave to lead the voltage wave. This is called "capacitive reactance." The unit of measurement for either inductive reactance or capacitive reactance is the ohm.

Resistance: Electrical resistance is opposition to the flow of electric current and may be compared to the resistance of a pipe to the flow of water. All substances have some resistance but the amount varies with different substances and with the same substances under different conditions.

Resistor: A resistor is a poor conductor used in a circuit to create resistance which limits the amount of current flow. It may be compared to a valve in a water system.

See technical bulletin T-005 on phase.

Single Phase: A single phase, alternating-current system has a single voltage in which voltage reversals occur at the same time and are of the same alternating polarity throughout the system.

Three Phase: A three phase, alternating-current system has three individual circuits or phase. Each phase is timed so the current alternations of the first phase is 1/3 cycle (120°) ahead of the second and 2/3 cycle (240°) ahead of the third.

Voltage: Voltage is the force, pressure or electromotive force (EMF) which causes electric current to flow in an electric circuit. Its unit of measurement is the volt, which represents the amount of electrical pressure that causes current to flow at the rate of one ampere through a resistance of one ohm. Voltage in an electric circuit may be considered as being similar to water pressure in a pipe or water system.

Voltage Drop: The voltage drop in an electrical circuit is the difference between the voltage at the power source and the voltage at the point at which electricity is to be used. The voltage drop or loss is created by the resistance of the connecting conductors.

Watt: The watt is the unit of measurement of electrical power or rate of work. 746 watts is equivalent to 1 horsepower. The watt represents the rate at which power is expended when a pressure of one volt causes current to flow at the rate of one ampere. In a DC circuit or in an AC circuit at unity (100%) power factor, the number of watts equals the pressure (in volts) multiplied by the current (in amperes).

ELECTRICAL FORMULAS FOR DETERMINING WATTS, KILOWATTS, AMPERES, KILOVOLT-AMPERES AND HORSEPOWER

(NEW SYMBOLS)

FACTOR	ALTERNATING CURRENT	DIRECT CURRENT
Watts	A x V x PF (1-phase) A x V x 1.73 x PF (3-phase)	A x V
Kilowatts	$\frac{A \times V \times PF}{1000}$ (1-phase) $\frac{A \times V \times 1.73 \times PF}{1000}$ (3-phase)	$\frac{A \times V}{1000}$
Amperes	$\frac{kW \times 1000}{V \times PF}$	$\frac{kW \times 1000}{}$
Kilovolt-amperes (kVA)	$\frac{A \times V}{1000}$ (1-phase) $\frac{A \times V \times 1.73}{1000}$ (3-phase)	_____
Frequency (hertz) Hz	$\frac{P \times RPM}{120}$	_____
Revolutions per minute	$\frac{Hz \times 120}{P}$	_____
Number of poles	$\frac{Hz \times 120}{RPM}$	_____
Power factor	$\frac{\text{Actual watts}}{A \times V}$	_____
Horsepower (kilowatts)	$\frac{A \times V \times PF}{746\text{-}W \times \% \text{ Eff}}$	$\frac{A \times V}{746 \times \% \text{ Eff}}$
Amperes when kilowatts is known	$\frac{kW \times 1000}{V \times PF}$	$\frac{kW \times 1000}{V}$
Amperes when kilovolt-amperes is known	$\frac{kVA \times 1000}{V}$	_____
Amperes when horsepower is known	$\frac{kW \times \% \text{ Eff}}{V \times PF}$	$\frac{kW \times \% \text{ Eff}}{V}$
Voltage tolerance	$\% = \frac{\text{No-load—Full-load voltage}}{2 \times \text{rated voltage}} \times 100$	
Voltage regulation	$\% = \frac{\text{No-load—Full-load voltage}}{\text{Full load volts}} \times 100$	
Voltage drop	$V = A \times \Omega$	$V = A \times R\ (\Omega)$
Speed regulation	$\% = \frac{\text{No-load—Full-load}}{\text{Full load speed}} \times 100$	

ELECTRICAL FORMULAS FOR DETERMINING WATTS, KILOWATTS, AMPERES, KILOVOLT-AMPERES AND HORSEPOWER

(OLD SYMBOLS)

	ALTERNATING CURRENT	DIRECT CURRENT
Watts	I x E x PF (single phase) I x E x 1.73 x PF (3 phase)	I x E
Kilowatts	$\frac{I \times E \times PF}{1000}$ (single phase) $\frac{I \times E \times 1.73 \times PF}{1000}$ (3 phase)	$\frac{I \times E}{1000}$
Amperes	$\frac{KW \times 1000}{E \times PF}$	$\frac{KW \times 1000}{E}$
Kilovolt - amperes (KVA)	$\frac{I \times E}{1000}$ (single phase) $\frac{I \times E \times 1.73}{1000}$ (3 phase)	_____ _____
Frequency (hertz)	$\frac{P \times RPM}{120}$	_____
Revolutions per minute	$\frac{F \times 120}{P}$	_____
Number of poles	$\frac{F \times 120}{RPM}$	_____
Power factor	$\frac{\text{Actual watts}}{I \times E}$	_____
Horsepower	$\frac{I \times E \times PF}{746 \times \% \text{ Eff}}$	$\frac{I \times E}{746 \times \% \text{ Eff}}$
Amperes when kilowatts is known	$\frac{KW \times 1000}{E \times PF}$	$\frac{KW \times 1000}{E}$
Amperes when kilovolt-amperes is known	$\frac{KVA \times 1000}{E}$	_____
Amperes when horsepower is known	$\frac{HP \times 746 \times \% \text{ Eff}}{E \times PF}$	$\frac{HP \times 746 \times \% \text{ Eff}}{E}$
Voltage tolerance	$\% = \frac{\text{No-load - Full-load voltage}}{2 \times \text{rated voltage}} \times 100$	
Voltage regulation	$\% = \frac{\text{No-load - Full-load voltage}}{\text{Full load volts}} \times 100$	
Voltage drop	$E = I \times R$	$E = I \times R$
Speed regulation	$\% = \frac{\text{No-load - Full-load}}{\text{Full load speed}} \times 100$	

OHM'S LAW: Ohm's law states that the current in an electric circuit is equal to the pressure divided by the resistance.

The equations may be written:

OHM 'S LAW:

$A = \frac{V}{\Omega}$ Amperes = $\frac{\text{Volts}}{\text{Ohms}}$

$V = A\Omega$ Volts = Amperes x Ohms

$\Omega = \frac{V}{A}$ Ohms = $\frac{\text{Volts}}{\text{Amperes}}$

OLD	FACTOR	NEW
E	volts	V
F	frequency	Hz
P	watts	W
HP	horsepower	kW
I	amperes	A
R	resistance (ohms)	Ω
Z	impedance (ohms)	AC Ω
KW	kilowatts	kW
KVA	kilovolt amperes	kVA
P	number of poles	P
PF	power factor	PF
RPM	revolutions per minute	RPM
%Eff	percent efficiency	%Eff

NOTE: *See nominal ampere ratings of AC and DC units at the end of this bulletin.*

ELECTRICAL SYMBOLS

A graphic symbol represents the function of a part in the circuit. They are used on schematic diagrams and wiring diagrams. They are correlated with parts lists, descriptions and instructions.

A schematic diagram shows, by means of graphic symbols, the electrical connections and functions of a specific circuit arrangement. It aids tracing the circuit and its functions without regard to the actual physical size, shape or location of the component device or parts.

A wiring diagram is used for wiring and tracing out the connection in the circuit. The placement of parts or assemblies shall usually show the general physical arrangement of the control. It may cover internal or external connections or both.

The standard symbol for a terminal (○) may be added to each point of attachment to the connecting lines to any one of the symbols.

The polarity symbol, + for positive, – for negative, is used as necessary and if clarity is required to understand a circuit function.

The ground symbol ⏚ is a direct conducting connection to the earth or body of water or a conducting connection to a structure that serves as an earth ground (such as the frame of an air, space, or land vehicle).

For simplification of a schematic diagram, parts of a symbol for a device such as a relay, or contactor may be separated. If this is done, suitable designations are used to show proper relationship of the parts.

LIST OF SYMBOLS

A

ASSEMBLY, SUBASSEMBLY

It is an assembly of items that is mounted and prewired as a unit, which can not be identified in a specific group or which may contain items made up of other parts.

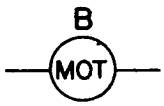
AR

AMPLIFIER

B

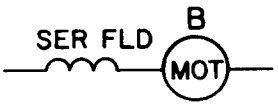
MOTOR

1. General (fan, blower)



2. Series Field

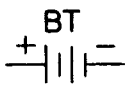
3. Application: Engine Starting Motor



BT

BATTERY

The long line is always positive, polarity must be identified in addition (shown as multicell).

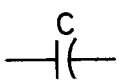


C

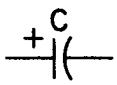
CAPACITOR

If it is necessary to identify the capacitor electrodes, the curved element shall represent the outside electrode in fixed paper-dielectric and ceramic dielectric capacitors, and the low potential element in feed through capacitor.

1. General



2. Polarized, Electrolytic Capacitor



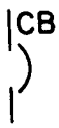
3. Feed-through Capacitor (with terminals shown on feed-through element for clarity.)

Commonly used for bypassing high frequency current to chassis.

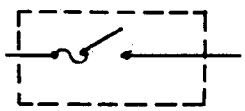
CB

CIRCUIT BREAKER

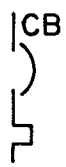
1. General



old drawings)



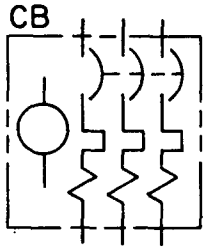
2. Circuit Breaker with thermal overload device.



3. Circuit Breaker with magnetic overload device.

4. Circuit Breaker with thermal magnetic overload device.

5. Application: 3-pole circuit breaker with thermal magnetic overload device in each pole and trip coil (shown with boundary lines)

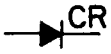


CR

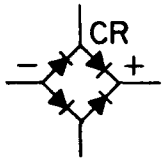
RECTIFIER, DIODE

Triangle points in direction in which rectifier conducts current easily.

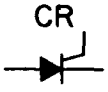
1. Diode, Metallic Rectifier, Electrolytic Rectifier, Asymmetrical Varisitor.



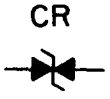
2. Application: Full-Wave Bridge Type Rectifier.



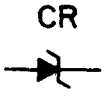
3. Controlled Rectifier (SCR)



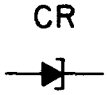
4. Bidirectional Diode (Suppressor)



5. Zener Diode



6. Tunnel Diode

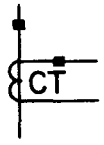


CT

CURRENT TRANSFORMER

1. General

2. Current Transformer with polarity marking.
Instantaneous direction of current into one polarity mark corresponds to current out of the other polarity mark.

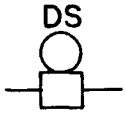


DS

SIGNALING DEVICE except meter or thermometer.

1. Audible Signaling device.

1.1 bell



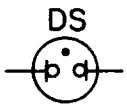
1.2. buzzer

1.3. howler

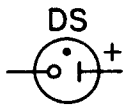
2. Visual Signaling Device (indicating, pilot, signal or illuminating lamp)

2.1. incandescant lamp

2.2. neon lamp
2.2.1 alternating-current type



2.2.2. direct-current type
NOTE: Polarity mark is not part of the symbol.



E

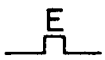
ELECTRICAL SHIELDING, PERMANENT MAGNET, SPARK PLUG, MISCELLANEOUS ELECTRICAL PARTS.

1. Electrical shield (short dashes) normally used for eletric or magnetic shielding. When used for other shielding, a note should so indicate.

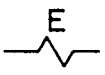
2. Permanent magnet

3. Spark plug

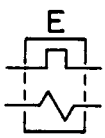
4. Miscellaneous Electrical part
4.1. engine choke
4.1.1. thermal



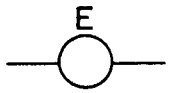
4.1.2. magnetic



4.1.3. thermal magnetic



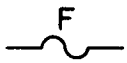
4.2. fuel pump



4.3 sending units (oil, water, etc.)

F

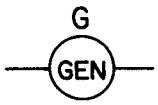
FUSE



G

GENERATORS

1. General



2. Field, Generator
2.1. compensating or commutating

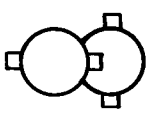
2.2 series

2.3. shunt or separately excited.

3. Winding Symbols
3.1. 1-Phase

3.2. 3-Phase wye

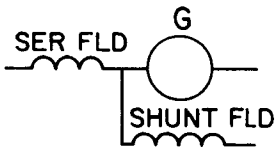
(old drawings



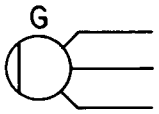
Indicates slip rings
or collector rings.)

3.3 3-Phase delta

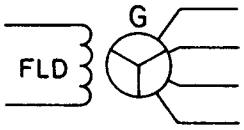
4. Application: charger generator and cranker.



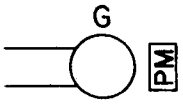
5. Application: revolving armature generator (shown as single phase, 3 wire)



6. Application: revolving field generator (shown as 3-phase wye, 4 wire



7. Application: Magneto



H

HARDWARE (bolts, nuts, screws, etc.) if applicable.

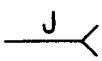
HR

HEATER, manifold, glow plug, general.

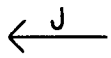
J

RECEPTACLE-fixed or stationary connector.
The connector symbol is not an arrow head. It is larger and the lines are drawn at a 90° angle.

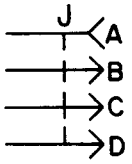
1. Female Contact



2. Male contact

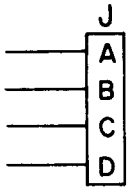


3. Application: 4-conductor connector with 3-male contacts and 1-female contact with individual contact designations.



or

if no confusion results from its use by disregarding the type of contacts in the receptacle, it may be shown as

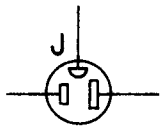


4. Receptacles of the type commonly used for power-supply purposes (convenience outlets)

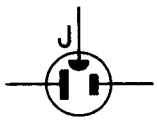
4.1. female contact

4.2. male contact

5. Application: 3-conductor polarized connector with female contacts.



6. Application: 3-conductor polarized connector with male contacts.

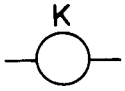


K

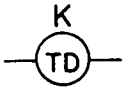
RELAY, CONTACTOR, SOLENOID (electrically or thermally operated)

1. Coil

1.1. basic operating



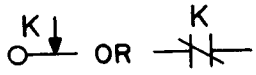
1.2. time delay



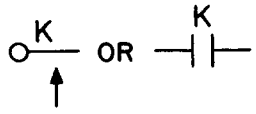
2. Contacts

2.1. basic contact assemblies

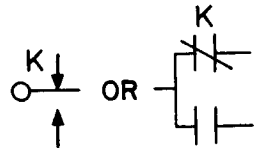
2.1.1. closed contact (break)



2.1.2. open contact (make)

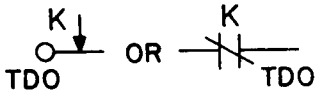


2.1.3 transfer

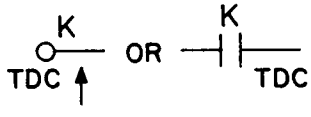


2.2. contacts with time delay feature.

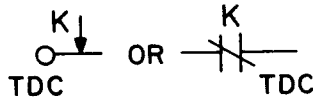
2.2.1. closed contact, time delay opening



2.2.2. open contact, time delay closing

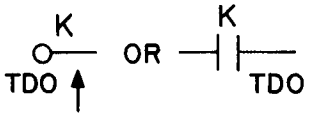


2.2.3 closed contact, time delay closing

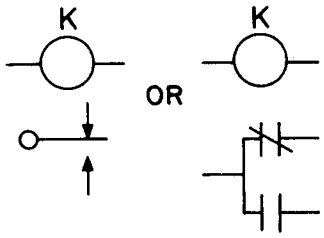


Note: contacts at left are for wiring diagrams. Contacts at right for schematic diagrams & wiring diagrams of contactors.

2.2.4 open contact, time delay opening



3. Application: Relay with transfer contacts

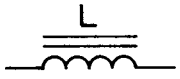


L

INDUCTOR, REACTOR

1. Air core

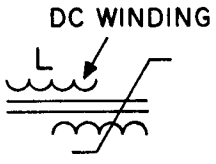
2. Iron Core (if desired to distinguish magnetic-core inductors)



3. Saturating core

4. Saturable-core inductor (reactor)

NOTE: explanatory words & arrow are not part of the symbol shown

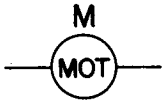


M

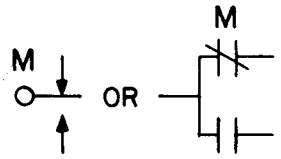
METERS, GAUGES, CLOCKS with calibrated dials

1. clock, electric timer

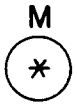
1.1. motor



1.2. transfer contacts



2. Indicating meters, gauges, etc.



*replace the asterisk by one of the following letter combinations, depending on the function of the meter.

A	**Ammeter**
AH	**Ampere-hour**
F	**Frequency meter**
MA	**Milliammeter**
OP	**Oil Pressure**
PF	**Power Factor**
T	**Temperature**
TT	**Total Time (Running Time)**
V	**Voltmeter**
W	**Wattmeter**
WH	**Watthour meter**

MP

MECHANICAL PARTS including nameplates - if applicable

P

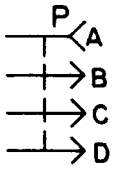
PLUG- affixed to a cable, cord or wire

The connector symbol is not an arrowhead. It is larger and the lines are drawn at a 90° angle.

1. Female contact

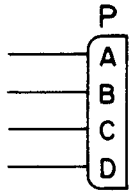
2. Male contact

3. Application: 4-conductor connector with 3-male contacts and 1-female contact with individual contact designations.



or

if no confusion results from its use by disregarding the type of contacts in the plug, it may be shown as

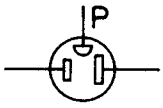


4. Plugs of the type commonly used for power-supply purposes (mating connectors)

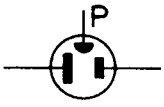
4.1. female contact

4.2. male contact

5. Application: 3-conductor polarized connector with female contacts.



6. Application: 3-conductor polarized connector with male contacts

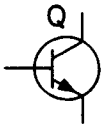


Q

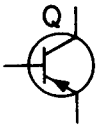
TRANSISTOR

1. General

1.1. NPN



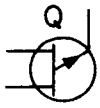
1.2. PNP



2. Unijunction

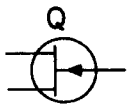
2.1. N-type base

2.2. P-type base

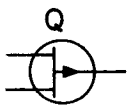


3. Field-effect

3.1. N-type base



3.2. P-type base

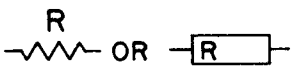


R

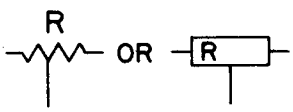
RESISTOR

do not use both styles of symbols on the same diagram

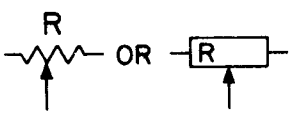
1. General (fixed)



2. Tapped



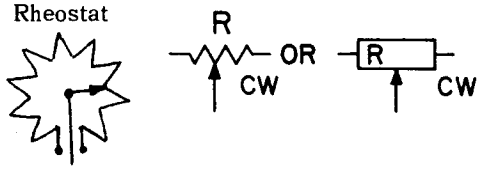
3. Adjustable contact



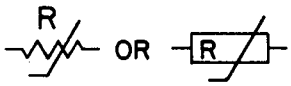
4. Rotary type adjustable

The preferred method of terminal indentification is to designate with the letters "CW" the terminal adjacent to the movable contact when it is in an extreme clockwise position as viewed from the knob end.

Rheostat



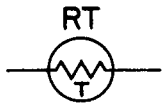
5. Non linear



RT

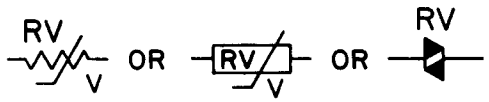
THERMISTOR; THERMAL RESISTOR

"T" indicates that the primary characteristic of the element within the circle is a function of temperature



VARISTOR, SYMMETRICAL

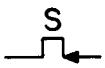
resistor, voltage sensitive (silicon carbide, etc)



S

SWITCH

1. Thermal cutout, thermal flasher



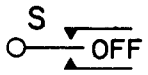
2. Switch

2.1. momentary-fixed contact on momentary switch

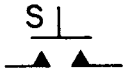
2.1.1. open contact (make) (ignition points)

2.1.2. closed contact (break)

2.1.3. 2-open contacts (make)



2.1.4. push button, open contact (make)



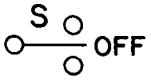
2.1.5. push button, closed contact (break)

2.2. locking or maintained-fixed contact for maintained switch.

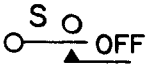
2.2.1 open contact (make)

2.2.2. closed contact (break)

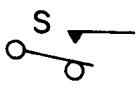
2.2.3. 2-open contact (make)



2.3. application: 3-position, 1-pole; circuit closing (make), off, momentary circuit closing (make).

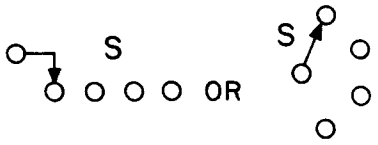


2.4. application: 2-position, 1-pole; momentary circuit closing (make), circuit closing.

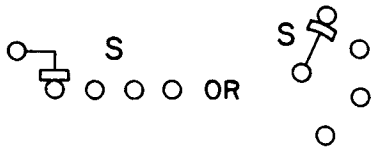


2.5. selector switch

2.5.1. 4-position with non-shorting contacts



2.5.2. 4-position with shorting contacts



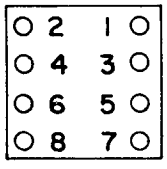
2.6. master or control switch

A table of contact operation must be shown on the diagram. A typical table is shown below.

DETACHED CONTACTS SHOWN ELSEWHERE ON DIAGRAM

CONTACT	POSITION		
	A	B	C
1 – 2			X
3 – 4	X		
5 – 6			X
7 – 8	X		

X indicates contact closed



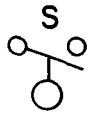
FOR WIRING DIAGRAM

2.7. flow actuated switch

2.7.1. closing on increase in flow

2.7.2. opening on increase in flow

2.8. liquid level actuated switch
2.8.1 closing on rising level



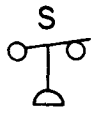
2.8.2 open on rising level

2.9. temperature actuated switch
(thermostat)
2.9.1. closing on rising temperature

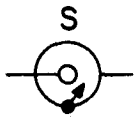
2.9.2 opening on rising temperature

2.10. pressure or vacuum actuated switch
2.10.1. closing on rising pressure

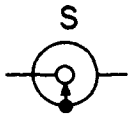
2.10.2 opening on rising pressure



2.11. centrifugal actuated switch (overspeed)
2.11.1. closing on speed



2.11.2. opening on speed



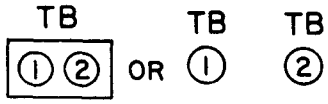
T

TRANSFORMER - ignition coil
1. Iron core

2. Air core

TB

TERMINAL BLOCK-MARKER STRIP



TC

THERMOCOUPLE

VR

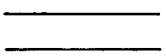
VOLTAGE REGULATOR, CHARGE, CURRENT

W

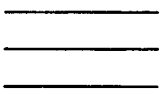
CONDUCTORS, CABLE, WIRING, BUSBAR, ETC.

1. Conductive path or conductor; wire

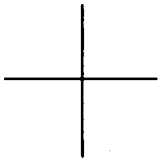
2. Two conductors or conductive paths



3. Three conductors or conductive paths

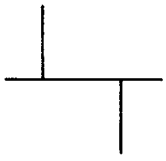


4. Crossing of paths or conductors not connected. The crossing is not necessarily at a 90° angle.



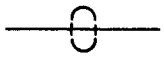
5. Splice

6. Junction of connected paths, conductors, or wires (other than a terminal)

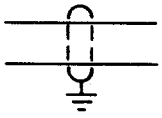


7. Terminal
may be added to each point of attachment to the connecting lines to any one of the graphic symbols.

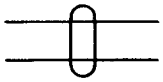
8. Shielded single conductor



9. Shielded 2-conductor cable with shield grounded

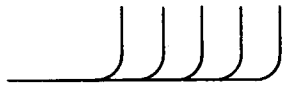


10. 2-conductor cable



11. Grouping of leads
Normally, bend of line indicates direction of conductor joining cable

OR



12. Associated or future (short dashes)

X

FUSEHOLDER, SOCKET, LAMPHOLDER

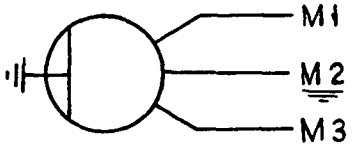
Z

NETWORK, General
Where specific letters do not fit, when considered a part.

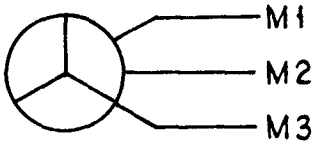
TYPICAL SYMBOL APPLICATIONS

GENERATOR WINDING DIAGRAM

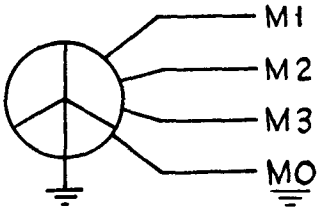
SINGLE PHASE (SHOWN AS CODE 3)



3 PHASE WYE (UNGROUNDED)

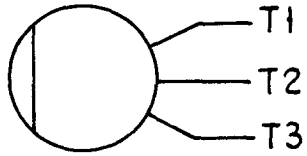


3 PHASE WYE (GROUNDED)
(SHOWN AS CODE 4)

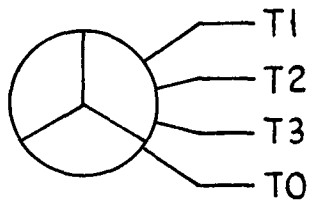


GENERATOR WINDING DIAGRAM

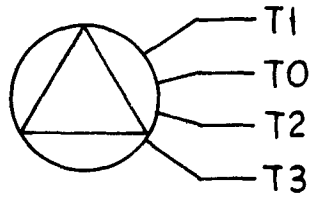
1-PHASE



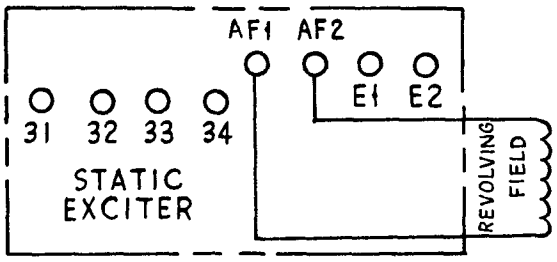
3-PHASE WYE

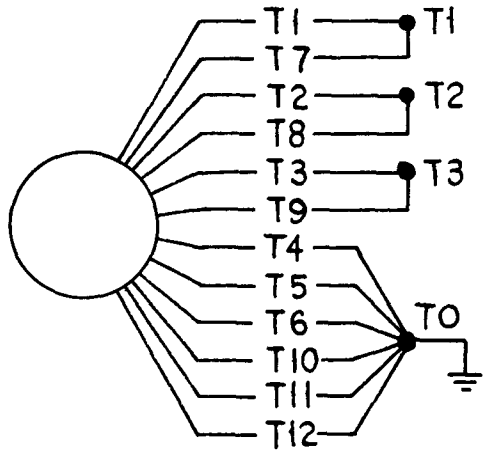


3 PHASE DELTA



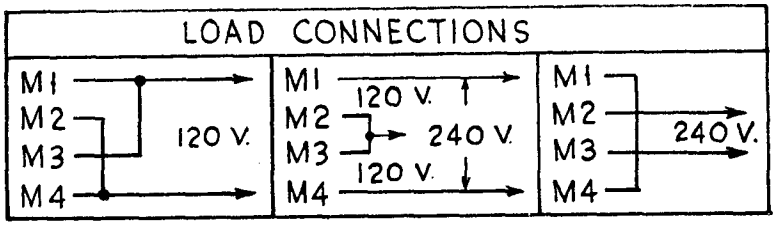
revolving field generators (AC Output)





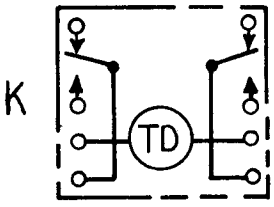
12 lead reconnectable shown connected for 120/208 V, 3 PH, 4 W. leadwire order may be changed according to specific output.

RECONNECTION BLOCK 120/240V. 1-Phase, 4-Wire

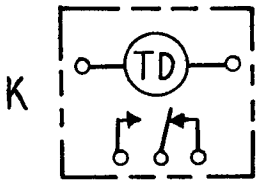


TYPICAL SYMBOL APPLICATIONS

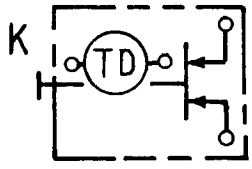
Relay with D.P.D.T. contacts



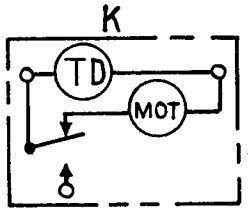
Time delay relay with S.P.D.T. contact

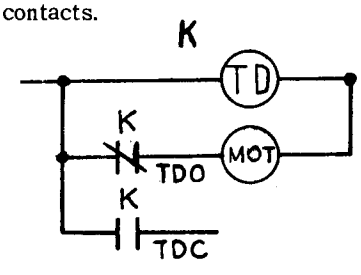


Relay with time delay feature by means of thermal element with S.P.S.T. contact (manual reset)



Relay with time delay feature by means of motor with SPDT contacts.

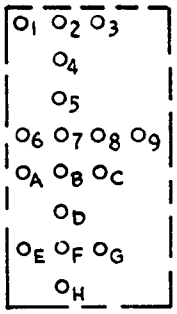


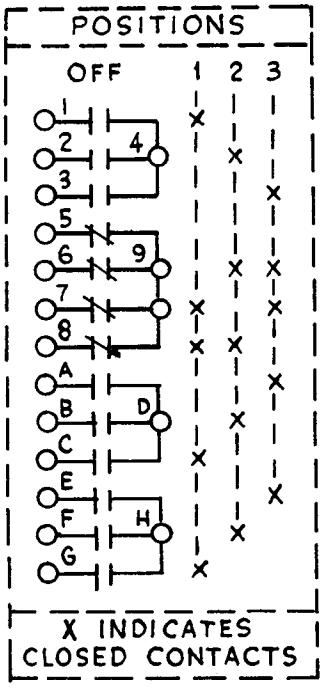


TYPICAL SYMBOL APPLICATIONS

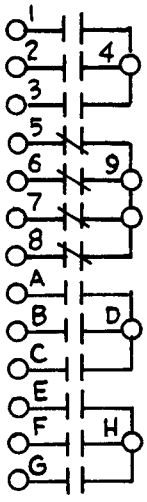
4-position cam operated 13-circuit switch (voltmeter and ammeter selector switch No. 308B22).

WIRING DIAGRAM





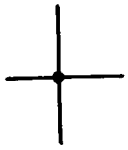
SCHEMATIC DIAGRAM



ELECTRICAL SYMBOLS AS SHOWN ON OLD STYLE DRAWINGS

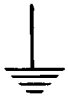
CROSSOVER
Used to designate where two wires cross but are not electrically connected. Any one of the symbols may be used.

CONNECTED CROSS
Used to designate where two wires cross and are electrically connected. A dot is shown at the point of connection.



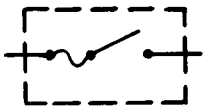
TAP
Used to designate where one wire is electrically connected to another wire. A dot is placed at the point of connection.

GROUND
Used to indicate that the circuit is completed through the generator frame or engine. Connections which are not insulated from the frame are called grounded connections. Used also when it is desired to use the earth as a return circuit.

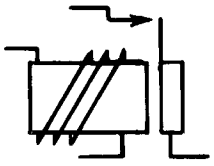


SWITCH
Used to indicate a simple switch.

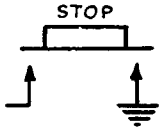
CIRCUIT BREAKER
Used to designate an automatic safety switch. The amperage at which it opens automatically is usually printed near the symbol.



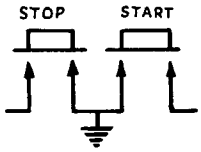
RELAY
Used to designate a relay, where the current of one electrical circuit is used to control one or more other electrical circuits.



STOP BUTTON
Used to show the stop button of the power plant. Notice that one terminal is grounded.



STOP-START BUTTONS
Used to show the start and stop buttons mounted together on the power plant or remote station. One terminal of each button is grounded to a common ground connection.

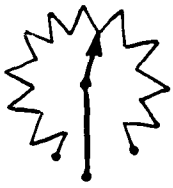


POSITIVE SIGN
Used to designate the positive post of a battery, the positive brush of a generator or the positive side of the circuit in general.

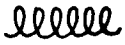
NEGATIVE SIGN
Used to designate the negative post of a battery, the negative brush of a generator or the negative side of the circuit in general.

BATTERY
Used to designate either a storage or dry cell battery.

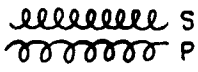
RHEOSTAT
Used to designate a rheostat. The resistance of a rheostat can readily be varied by means of a knob or lever.



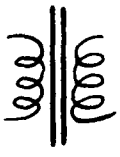
COIL
Used to designate a coil of wire such as the field circuit of a generator or a relay coil.



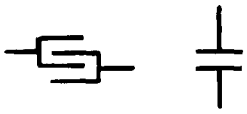
INDUCTION COIL
Used to designate an induction coil having a primary winding (P) and a secondary winding (S). It usually has a soft iron core. This symbol is used for showing the ignition coil in the magneto and battery ignition systems.



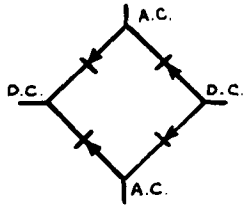
TRANSFORMER
Used to designate a transformer for changing the voltage or current in an alternating current system.



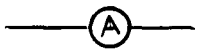
CONDENSER
Two ways used to designate a condenser. The one on the right generally is used.



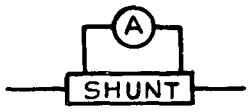
RECTIFIER
Used to designate a rectifier for changing the current in an alternating current system to direct current.



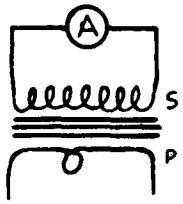
AMMETER
Used to designate the ammeter in a circuit. An ammeter is used to measure the current flow in the circuit.



Ammeter with Shunt, used only on DC circuits carrying high amperages. Only a very small portion of the current passes through the meter.

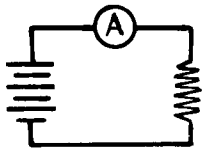


Ammeter with Current Transformer, used only in AC circuits carrying high amperages. Only a small portion of the current flows through the ammeter and secondary circuit.

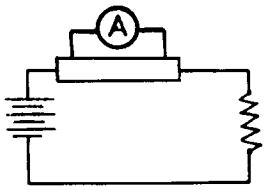


Ammeter in Circuit, series connection. Notice the direct reading ammeter is connected in the circuit to measure

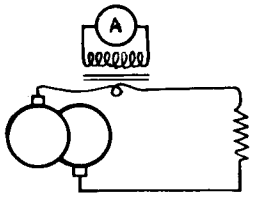
the amperes.



Ammeter in Circuit, with shunt. Notice the shunt is connected in the circuit. The shunt is connected in series with the battery and resistor, and the ammeter is connected parallel with the shunt. Only used in DC circuits.

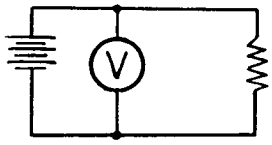


Ammeter in Circuit, with transformer. Notice the primary winding of the current transformer is connected in the circuit. Only a small amount of induced current passes through the secondary winding and the ammeter. Used on AC circuits only.

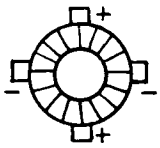


VOLTMETER
Used to designate a voltmeter. A voltmeter measures the pressure in the circuit.

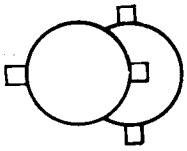
Voltmeter in Circuit, parallel connection. The voltmeter is always connected across the circuit to measure the voltage.



COMMUTATOR AND BRUSHES
Used to designate the commutator and brushes on DC generators and motors.



SLIP RINGS OR COLLECTOR RINGS AND BRUSHES
Designates slip rings and brushes on AC generator. Alternating current is collected from them in the revolving armature type generator. Direct current is passed through them into the field coils of the rotating field type generator.



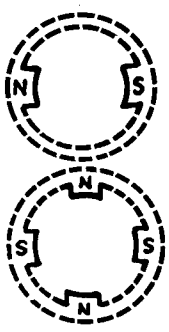
NORTH
Used to designate the north pole of a permanent magnet or electromagnet.

N

SOUTH
Designates the south pole of a permanent magnet or electromagnet.

S

FIELD POLES
Used to designate the field poles of a generator. The poles may be either electromagnets or permanent magnets.



SPARK PLUG

Two ways used to designate spark plugs. The essential feature consists of a break (or gap) in the wire and then a connection to ground.

CONTACT POINTS

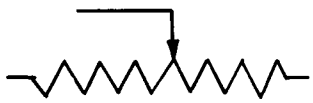
Two methods used to designate contact points of distributors, magnetos or relays.

RESISTOR

Designates a resistor. Usually the resistance in ohms will be given near it.

VARIABLE RESISTOR

Designates a resistor arranged so effective resistance can be varied.



NOMINAL AMPERE RATINGS OF AC GENERATING UNITS

ALWAYS USE KVA RATINGS WHEN SHOWN OR KNOWN		SINGLE PHASE			THREE PHASE					
POWER FACTOR						139/240-V			240/480-V	
80%		UNITY	120-V	120/240-V	120/208-V	240-V 120/240-V	220/380-V	240/416-V	277/480-V	347/600-V
KW	KVA	KW=KVA	AMP	AMP	AMP	AMP	AMP	AMP	AMP	AMP
		0.5	4.2	2.1						
		0.75	6.25	3.2						
		1.0	8.3	4.2						
		1.25	10.4	5.2						
		1.5	12.5	6.2						
		2.0	16.7	8.3						
		2.5	20.8	10.4						
		3.0	25.0	12.5	8.3	7.2	4.6	4.2		
		3.5	29.2	14.6	9.7	8.4	5.3	4.9		
		4.0	33.3	17	11.0	9.6	6.0	5.6		
		4.5	38	19	13	11	7.2	6.3	5.4	4.3
4.0	5.0	5.0	42.0	21.0	14	12	8	7.0	6	5
		6.0	50	25	16	14	9	8.0	7	6
6.0	7.5	7.5	63	32	21	18	11	10.5	9	7
		9.0	75	38	25	22	14	12.5	11	9
		10.0	83	42	28	24	15	14.0	12	10
10.0	12.5	12.5	104	52	35	30	19	17.5	15	12
12.5	15.6	15.6	130	65	43	38	23	21.5	19	15
		15.0	125	63	42	36	23	21.0	18	14
15.0	18.75	18.75	156	78	53	45	29	26.5	23	18
		17.5	146	73	49	42	27	24.5	21	17
17.5	21.87	21.87	182	91	61	53	33	30.5	26	21
		20.0	167	84	56	48	30	28.0	24	19
20.0	25.0	25.0	208	104	70	60	38	35.0	30	24
25.0	31.25		260	130	87	75	48	43.5	38	30
				125	83	72	46	41.5	36	29
30.0	37.5			156	104	90	57	52.0	45	36
35.0	43.75			182	122	105	67	61.0	53	42
40.0	50.0			208	139	120	76	69.5	60	48
45.0	56.25			234	156	135	86	78.0	68	54
50.0	62.5			260	174	151	95	87.0	75	60
55.0	68.75			286	191	166	105	95.5	83	66
60.0	75.0			313	209	181	114	104.5	90	72
65.0	81.25			339	226	196	124	113.0	98	78
70.0	87.5			365	244	210	133	122.0	105	84
75.0	93.75			390	261	226	143	130.5	113	90
80.0	100.0			417	278	240	152	139.0	120	96
85.0	106.25			443	295	256	162	147.5	128	103
90.0	112.5			468	312	271	171	156.0	135	108
100.0	125.0			520	348	300	190	174.0	150	120
110.0	137.50			573	382	332	210	191.0	166	132
115.0	143.75			595	400	346	218	200.0	173	138
125.0	156.25			651	435	376	238	217.5	188	150
140.0	175.0			729	486	421	266	243.0	211	169
150.0	187.5				521	452	285	260.5	226	181
155.0	193.75				538	468	295	269.0	234	187
165.0	206.25				575	498	314	287.5	248	199
170.0	212.5				591	513	324	295.5	256	204
175.0	218.75				609	527	333	304.5	263	211
190.0	237.5				660	573	361	330.0	286	229
200.0	250.0				696	602	380	348.0	300	241
230	287.5				799	693	438	399.5	346	277
250	312.5				867	751	475	433.5	376	301
300	375				1042	903	570	521.0	452	361
350	437.5				1215	1054	666	607.5	527	421
400	500				1390	1204	761	695.0	602	482
450	562.5				1560	1354	855	780.0	676	542
500	625.0				1734	1500	950	867.0	751	600

NOMINAL AMPERE RATINGS - DC GENERATORS

DIRECT CURRENT CODE AND VOLTAGE				BATTERY CHARGING CODE AND VOLTAGE			
CODE	115	123	150	212	224	232	210
Nominal Volts				14.1-V	28.2-V	37.6-V	129.25-V
VOLTAGE	115-V	230-V	250-V	12-15-V	24-30-V	32-40-V	110-140-V
KW	AMP	AMP	AMP	AMP	AMP	AMP	AMP
.4	3.5	1.74	1.6	28.4	14.2	10.6	3
.5	4.4	2.2	2.0	35.4	17.7	13.3	4
.6	5.2	2.6	2.4	42.5	21.3	15.95	5
.75	6.5	3.2	3.0	53.2	26.6	19.9	6
1.0	8.7	4.3	4.0	71.0	35.5	26.6	8
1.25	10.9	5.4	5.0	88.6	44.3	33.3	10
1.5	13.0	6.5	6.0	106.4	53.2	40.0	12
2.0	17.4	8.7	8.0	142.0	71.0	53.2	16
2.5	21.8	10.9	10.0	177.3	88.6	66.5	19
3.0	26.0	13.0	12.0	213.0		80.0	23.0
3.5	30.4	15.2	14.0	248.0		93.0	27.0
5.0	43.5	21.8	20.0	355.0		133.0	39
6.0	52.2	26.1	24.0				47
10.0	87.0	43.5	40.0				78
15.0	130.0	65.0	60.0				116.0

Onan manufactures a complete line of electric power systems from 1 to 500 KW (generator sets • automatic transfer switches • industrial engines), gas-, gasoline- or diesel-driven. For standby power in homes, industrial plants, commercial buildings and institutions. For auxiliary or portable power in boats, recreational vehicles, service trucks and construction equipment.