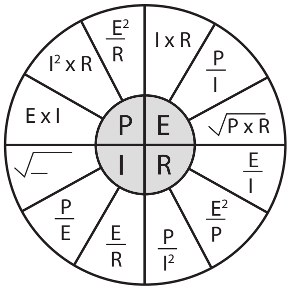
MOTOR ENGINEERING FORMULAS

Legend: E = volts   I = amps   W = watts   PF = power factor   Eff = efficiency   HP = horsepower

Ohm's Law

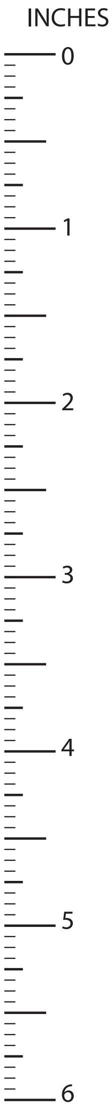


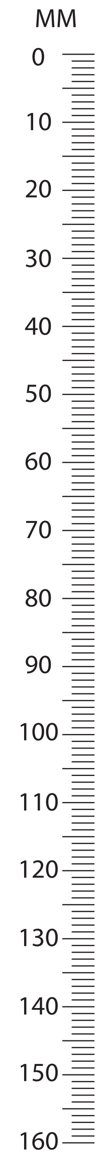
Three Phase Values

For 208 volts x 1.732, use 360
For 230 volts x 1.732, use 398
For 240 volts x 1.732, use 416
For 415 volts x 1.732, use 719
For 440 volts x 1.732, use 762
For 460 volts x 1.732, use 797
For 480 volts, x 1.732, use 831

AC/DC Formulas

To Find	Direct Current	AC / 1phase	AC 3 phase
Amps when Horsepower is Known	HP x 746 / E x Eff	HP x 746 / E x Eff x PF	HP x 746 / 1.73 x E x Eff x PF
Amps when Kilowatts is known	kW x 1000 / E	kW x 1000 / E x PF	kW x 1000 / 1.73 x E x PF
Amps when kVA is known		kVA x 1000 / E	kVA x 1000 / 1.73 x E
Kilowatts	I x E / 1000	I x E x PF / 1000	I x E x 1.73 x PF / 1000
Kilovolt-Amps		I x E / 1000	I x E x 1.73 / 1000
Horsepower (output)	I x E x Eff / 746	I x E x Eff x PF / 746	I x E x Eff x 1.73 x PF / 746





IEC-Style Contactors and Starters Selection Guide
Average Amperages for Given Horsepower Motor Ratings

The table below provides the average full-load currents of squirrel cage motors based on NEC (National Electrical Code) Tables 430-148, 149, and 150. These values are given only as a guide - they may vary depending on the type of motor and manufacturer. Refer to the actual motor nameplate for full-load current values.

HP	110 to 120 VAC			220 to 240 VAC			440 to 480 VAC		
	Single Phase	Two Phase	Three Phase	Single Phase	Two Phase	Three Phase	Single Phase	Two Phase	Three Phase
1/10	3.0	-	-	1.5	-	-	-	-	-
1/8	3.8	-	-	1.9	-	-	-	-	-
1/6	4.4	-	-	2.2	-	-	-	-	-
1/4	5.8	-	-	2.9	-	-	-	-	-
1/3	7.2	-	-	3.6	-	-	-	-	-
1/2	9.8	4.0	4.4	4.9	2.0	2.2	2.5	1.0	1.1
3/4	13.8	4.8	6.4	6.9	2.4	3.2	3.5	1.2	1.6
1	16.0	6.4	8.4	8.0	3.2	4.2	4.0	1.6	2.1
1 1/2	20.0	9.0	12.0	10.0	4.5	6.0	5.0	2.3	3.0
2	24.0	11.8	13.6	12.0	5.9	6.8	6.0	3.0	3.4
3	34.0	16.6	19.2	17.0	8.3	9.6	8.5	4.2	4.8
5	56.0	26.4	30.4	28.0	13.2	15.2	14.0	6.6	7.6
7 1/2	80.0	38.0	44.0	40.0	19.0	22.0	21.0	9.0	11.0
10	100.0	48.0	56.0	50.0	24.0	28.0	26.0	12.0	14.0
15	135.0	72.0	84.0	68.0	36.0	42.0	34.0	18.0	21.0
20	-	94.0	108.0	88.0	47.0	54.0	44.0	23.0	27.0
25	-	118.0	136.0	110.0	59.0	68.0	55.0	29.0	34.0
30	-	138.0	160.0	136.0	69.0	80.0	68.0	35.0	40.0
40	-	180.0	208.0	176.0	90.0	104.0	88.0	45.0	52.0
50	-	226.0	260.0	216.0	113.0	130.0	108.0	56.0	65.0
60	-	-	-	-	133.0	154.0	-	67.0	77.0
75	-	-	-	-	166.0	192.0	-	83.0	96.0
100	-	-	-	-	218.0	248.0	-	109.0	124.0
125	-	-	-	-	-	312.0	-	135.0	156.0
150	-	-	-	-	-	360.0	-	156.0	180.0
200	-	-	-	-	-	480.0	-	208.0	240.0
250	-	-	-	-	-	602.0	-	-	302.0
300	-	-	-	-	-	-	-	-	361.0
350	-	-	-	-	-	-	-	-	414.0
400	-	-	-	-	-	-	-	-	477.0
500	-	-	-	-	-	-	-	-	590.0

AC Efficiency and Power Factor Formulas

To Find	Single Phase	Three Phase
Efficiency	746 x HP / E x I x PF	746 x HP / E x I x PF x 1.732
Power Factor	Input Watts / V x A	Input Watts / E x I x PF x 1.732

Centrifugal Applications

AFFINITY LAWS

$$\frac{Flow_2}{Flow_1} = \frac{RPM_2}{RPM_1}$$

$$\frac{Pres_2}{Pres_1} = \frac{(RPM_2)^2}{(RPM_1)^2}$$

$$\frac{HP_2}{HP_1} = \frac{(RPM_2)^3}{(RPM_1)^3}$$

Where:
Pres = Pressure
RPM = Revolutions per minute

FANS AND BLOWERS

$$HP = \frac{CFM \times PSF}{33000 \times \text{Efficiency of Fan}}$$

$$HP = \frac{CFM \times PIW}{6356 \times \text{Efficiency of Fan}}$$

$$HP = \frac{CFM \times PSI}{229 \times \text{Efficiency of Fan}}$$

Where:
CFM = Cubic feet per minute
PIW = Inches of water gauge
PSF = Pounds per square foot
PSI = Pounds per square inch

PUMPS

$$HP = \frac{GPM \times FT \times \text{Specific Gravity}}{3960 \times \text{Efficiency of Pump}}$$

$$HP = \frac{GPM \times PSI \times \text{Specific Gravity}}{1713 \times \text{Efficiency of Pump}}$$

Where:
FT = Head in feet*
GPM = Gallons per minute
PSI = Pounds per square inch
*Head in feet = 2.31 x lbs. per sq. in. gravity

VOLUME OF LIQUID IN A TANK

Gallons = 5.875 x D^2 x H
1 gallon (US) of water weighs 8.33 lb.
Specific gravity of water = 1.0
Where:
D = Tank diameter (ft)
H = Height of liquid (ft)

Motor Application Formulas

$$\text{Horsepower} = \frac{\text{Torque (lb-ft)} \times RPM}{5252} \qquad \text{Kilowatts} = \frac{\text{Torque (N-m)} \times RPM}{9550}$$

$$\text{Torque (lb-ft)} = \frac{\text{Horsepower} \times 5252}{RPM} \qquad \text{Torque (N-m)} = \frac{\text{Kilowatts} \times 9550}{RPM}$$

"Guesstimating" Motor Current Draw*

At 575 volts, a 3-phase motor draws 1 amp per horsepower.
At 460 volts, a 3-phase motor draws 1.27 amps per horsepower.
At 230 volts, a 3-phase motor draws 2.5 amps per horsepower.
At 230 volts, a single-phase motor draws 5 amps per horsepower.
At 115 volts, a single phase motor draws 10 amps per horsepower.
*These will vary by motor type and application

1 HP = 746 watts

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