## Electrical Formulas for Finding Amperes, Horsepower, Kilowatts and kVA

| To Find | Single Phase | Alternating Current Two Phase[1], Four Wire | Three Phase | Direct Current |
|---|---|---|---|---|
| Kilowatts | $\dfrac{I \times E \times pf}{1000}$ | $\dfrac{I \times E \times 2 \times pf}{1000}$ | $\dfrac{I \times E \times 1.73 \times pf}{1000}$ | $\dfrac{I \times E}{1000}$ |
| kVA | $\dfrac{I \times E}{1000}$ | $\dfrac{I \times E \times 2}{1000}$ | $\dfrac{I \times E \times 1.73}{1000}$ | —— |
| Horsepower (Output) | $\dfrac{I \times E \times \% \, EFF \times pf}{746}$ | $\dfrac{I \times E \times 2 \times \% \, EFF \times pf}{746}$ | $\dfrac{I \times E \times 1.73 \times \% \, EFF \times pf}{746}$ | $\dfrac{I \times E \times \% \, EFF}{746}$ |
| Amperes when Horsepower is Known | $\dfrac{HP \times 746}{E \times \% \, EFF \times pf}$ | $\dfrac{HP \times 746}{2 \times E \times \% \, EFF \times pf}$ | $\dfrac{HP \times 746}{1.73 \times E \times \% \, EFF \times pf}$ | $\dfrac{HP \times 746}{E \times \% \, EFF}$ |
| Amperes when Kilowatts is Known | $\dfrac{KW \times 1000}{E \times pf}$ | $\dfrac{KW \times 1000}{2 \times E \times pf}$ | $\dfrac{KW \times 1000}{1.73 \times E \times pf}$ | $\dfrac{KW \times 1000}{E}$ |
| Amperes when kVA is Known | $\dfrac{kVA \times 1000}{E}$ | $\dfrac{kVA \times 1000}{2 \times E}$ | $\dfrac{kVA \times 1000}{1.73 \times E}$ | —— |

## Average Efficiency and Power Factor Values of Motors

When the actual efficiencies and power factors of the motors to be controlled are not known, the following approximations may be used.

Efficiencies:
DC motors, 35 horsepower
and less                                80% to 85%
DC motors, above
35 horsepower                           85% to 90%
Synchronous motors
(at 100% power factor)                  92% to 95%
"Apparent" Efficiencies
( = Efficiency x Power Factor);
Three phase induction motors,
25 horsepower and less                  70%
Three phase induction motors
above 25 horsepower                     80%

These figures may be decreased slightly for single phase and two phase induction motors.

## Fault-Current Calculation on Low-Voltage AC Systems

In order to determine the maximum interrupting rate of the circuit breakers in a distribution system it is necessary to calculate the current which could flow under a three phase bolted short circuit condition. For a three phase system the maximum available fault current at the secondary side of the transformer can be obtained by use of the formula:

$$I_{sc} = \frac{kVA \times 100}{KV \times \sqrt{3} \times \% \, Z}$$

where:

$I_{sc}$ = Symmetrical RMS amperes of fault current.
kVA = Kilovolt-ampere rating of transformers.
KV = Secondary voltage in kilovolts.
% Z = Percent impedance of primary line and transformer.

Table 5 on page 18-20 has been prepared to list the symmetrical RMS fault current which is available at the secondary terminals of the transformer.

## Minimum Size Grounding Conductors for Grounding Raceways and Equipment (From NEC Table 250–122)

| Rating or Setting of Automatic Overcurrent Device in Circuit Ahead of Equipment, Conduit etc., Not Exceeding (Amperes) | Size | |
|---|---|---|
| | Copper Wire Number | Aluminum or Copper Clad Aluminum Wire Number |
| 15 | 14 | 12 |
| 20 | 12 | 10 |
| 30 | 10 | 8 |
| 40 | 10 | 8 |
| 60 | 10 | 8 |
| 100 | 8 | 6 |
| 200 | 6 | 4 |
| 300 | 4 | 2 |
| 400 | 3 | 1 |
| 500 | 2 | 1/0 |
| 600 | 1 | 2/0 |
| 800 | 1/0 | 3/0 |
| 1000 | 2/0 | 4/0 |
| 1200 | 3/0 | 250 kcmil |
| 1600 | 4/0 | 350 kcmil |
| 2000 | 250 kcmil | 400 kcmil |
| 2500 | 350 kcmil | 600 kcmil |
| 3000 | 400 kcmil | 600 kcmil |
| 4000 | 500 kcmil | 800 kcmil |
| 5000 | 700 kcmil | 1200 kcmil |
| 6000 | 800 kcmil | 1200 kcmil |

**Note:** Where necessary to comply with 250.4(A)(5) or (B)(4), the equipment grounding conductor shall be sized larger than given in this table.

## Grounding Electrode Conductor for AC Systems (From NEC Table 250–66)

| Size of Largest Service Entrance Conductor or Equivalent Area for Parallel Conductors | | Size of Grounding Electrode Conductor | |
|---|---|---|---|
| Copper | Aluminum or Copper Clad Aluminum | Copper | Aluminum or Copper Clad Aluminum |
| 2 or smaller | 1/0 or smaller | 8 | 6 |
| 1 or 1/0 | 2/0 or 3/0 | 6 | 4 |
| 2/0 or 3/0 | 4/0 or 250 kcmil | 4 | 2 |
| Over 3/0 to 350 kcmil | Over 250 kcmil to 500 kcmil | 2 | 1/0 |
| Over 350 kcmil to 600 kcmil | Over 500 kcmil to 900 kcmil | 1/0 | 3/0 |
| Over 600 kcmil to 1100 kcmil | Over 900 kcmil to 1750 kcmil | 2/0 | 4/0 |
| Over 1100 kcmil | Over 1750 kcmil | 3/0 | 250 kcmil |

[1]In three wire, two phase circuits the current in the common conductor is 1.41 times that in either other conductor.

[2]Additional information and exceptions are stated in Article 250 — Grounding, National Electric Code.

E = Volts    I = Amperes
% EFF = Per Cent Efficiency    pf = Power Factor