LOAD REFERENCE

Motors	Kilowatts KW		Kilovolt amps KVA	Power Factor PF
USE NEC 430-148 and 430-150 to find current for given HP	KW	<	KVA	.6-.95
Indancescant Lighting				
USE actual wattage	KW	=	KVA	1.0
Fluorescent Lighting				
USE 50VA per 4 foot F40 T12 Tube	KW	<	KVA	.95
Metal Discharge Lamps				
Mercury, Metal Halide, HPS Use actual input KVA or current from manufacturers data	KW	<	KVA	.8-.95
Heating				
Resistance Heat - Stoves toasters, unit heaters, base board heat use actual wattage	KW	=	KVA	1.0

Basic Electrical Fundamentals Voltage, current kilowatts, kilovolt amps.

1. Voltage - the electrical pressure needed to force current through any load.

   Units - Volts, V: Measured line to line or line to neutral with a voltmeter.

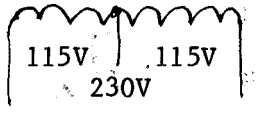
Nominal System Voltage

Actual System Voltage (use for calculations)

Single Phase

120/240 volts, 1 phase

115/230 volts =.115/.230 KV

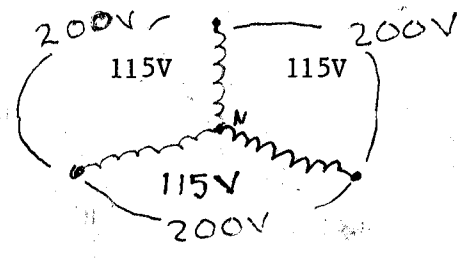


Single phase transformer

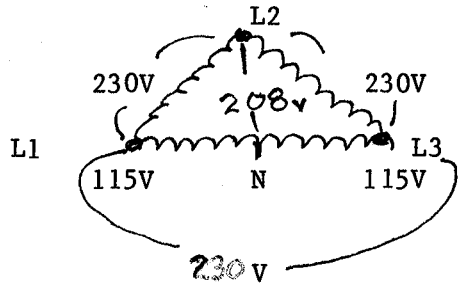
Three Phase

120/208 volts 3 phase
120/240 volts 3 phase
277/480 volts 3 phase

115/200 volts = .115/.200 KV
115/230 volts = .115/.230 KV
265/460 volts = .265/.460 KV



115/200V WYE SYSTEM, "Y"

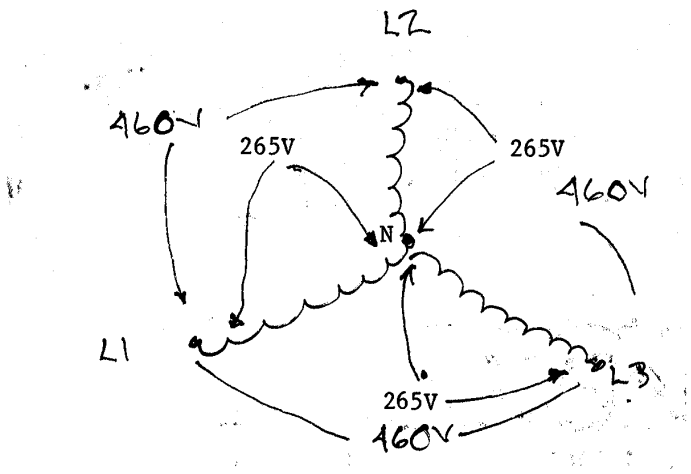


Wild Leg-

208 volts to neutral

Do not use L2 to neutral for 1 pole breakers, will supply 208 volts. Only L1 and L3 can be used for 115 volts.

115/230 V, 3 phase DELTA SYSTEM, Y



265V / 460 V, 3 Phase, WYE, Y

2. Current (I) Current is the flow of electrons through a load, the units are ampers or amps. Current is measured inductively with a clamp-on ammeter.

   Single Phase

   Current $(I) = \frac{\text{(Kilovolt Amps)}}{\text{Kilovolts}} = \frac{\text{KVA}}{\text{KV}}$

Example: Load = Unit heater 5 KW, 230V 1 phase. Since unit heater is resistive, power factor is 1 so KW = PF (KVA)

PF = 1 KW = KVA

$$I = \frac{KVA}{KV} = \frac{5KW}{.23\ KV} \quad 21.7\ Amp$$

Example: 5-4 tube 4' fluorescent fixtures. Find current, (I) at 115 VAC. F40T12 Lamp.

Fluorescent fixture loading per lamp = 50 VA
(5 fixtures) (4 lamps/fixture) (50VA/ Lamp) = 1000 VA = 1.0 KVA

$$I = \frac{KVA}{KV} = \frac{1.0\ KVA}{.115KVA} = 8.69\ Amp$$

Example: 4 KW water Heater 230V, 1 phase find I

PF = 1

$$I = \frac{KVA}{KV} = KW = KVA \quad I = \frac{KW}{KV}$$

$$I = \frac{4\ KW}{.23KV} = 17.39\ Amp.$$

Example: 50 KW electric furnace, 230V, 1 phase
find I PF = 1 KW = KVA

$$I = \frac{KVA}{KV} = \frac{50KW}{.23KV} \quad 217.3 \text{ Amp.}$$

Example: 5 HP motor 230V, 1 phase; find I

Use NEC 430-148, 5 HP@230V, I=28Amp

Example: 1/2 HP motor, 115V, find I

Use NEC 430-148 l/2 HP = 9.8A

Three Phase Current

$$\text{Current (I)} = \frac{\text{Kilovolt Amps}}{\text{Kilovolts } \sqrt{3}} = \frac{KVA}{KV\sqrt{3}}$$

Example: Unit Heater 5 KW, 230V, 3 phase find I

Heater PF = 1 KW = KVA

$$I = \frac{KW}{KV\ 3} = \frac{5KW}{.23KV\sqrt{3}} = 12.55 \text{ Amp}$$

Example: Motor 20 HP, 208V,3 phase ,find I

USE NEC 430-150 @ 230V = 20 HP, I = 54 Amp

See note at bottom of table for 200 volt motors

Increase current 10% S0:

I = 1.10(54 Amp) = 61.1 Amp.

Example: Electric furnace 50 KW, 208 V, 3 phase

$$I = \frac{KVA}{KW} = (P.F.=1.0) = \frac{50KW}{.20KV\sqrt{3}} = 144.3 \text{Amp}$$

Example: Motor 10 HP, 460V, 3 phase, find I

NEC 430-150, 10 HP @ 460V, 3 phase I = 14 Amp

3. KW, KVA

KW is real consumed power turned into heat, and is the product of volts x current x power factor.

KVA is apparent power, is always greater than or equal to KW and is the product of volts x amps 1 phase, volts x amps x , √3, 3 phase.

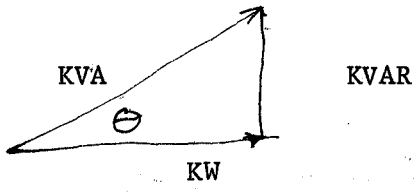
USE KVA for calculations unless load is resistive, (ie. unit heaters, furnaces) then KVA = KW.

KVA is larger than KW because loads are inductive such as motors, discharge lighting, reactors and more current is required to keep the magnetic field energized than is -turned into heat (KW).

Inductive devices or loads such'. as tansformers and motors having power factor less than 1.0 are generally rated in KVA.

Resistive devices or loads such as heaters, incandescent lamps are rated in KW.

Power triangle



Cos θ = Power factor = $\frac{KW}{KVA}$

KVA are used to size panel boards and wires not KW.

Add KVA up algebraically, this will be a conservative answer because KVA's are not all in phase.

Single Phase KW, KVA

KW = I (KV)(P.F.); KVA =1(KV)

Example: KVA = I(KV)

Given I = 30A, KV = .23 P.F. = .8 find KW, KVA

KW = (30 Amp)(.23 KV)(.8 P.F.) = 5.52 KW
KVA = (30 Amp)(.23 KV) = 6.9 KVA

Example: Unit Heater I = 34A, V = .23 KV
find KW Unit Heater P.F. = 1.0

KW = I(KV)(P.F.) = (34A)(.23 KV)(1.0 P.F.)=7.82KW

KVA = I(KV) = (34A)(.23 KV) = 7.82 KW

KVA = KW for resistive loads

Example: Motor 2 HP, 230V find KW, KVA

NEC 430-148 2 HP = 12A

P.F. from motor table .80 page 6- 5

KW = I(KV)(P.F.) = (12A)(.23KV)(.80 P.F.) = 2.20 KW

KVA = I(KV) = (12A)(.23 KV) = 2.76 KVA

Three Phase KW, KVA

KW = I(KV)(√3)(P.F.)

KVA = I(KV)(√3)

Example Motor 15 HP, 230V, 3 phase find KW,' KVA,

NEC 430-150, 15 HP, 230V, I = 21A ..

P.F. .868 from Table 1 Motor starting data page 6-5

KVA = I(KV) √3 = (21A)(.23KV) √3 = 8.36 KVA

KW = I(KV)(√3)(P.F.)=(21A)(.23KV)(√3)(.868P.F.) = 7.2 KW

Example: Unit Heater I = 56A; 230V 3 phase P.F. = 1

KVA = I(KV)(√ 3) = (56A)(.23KV)(√ 3) = 22.3 KVA

KW = I(KVA)(√3)(P.F.) =(56A)(.23KV)(√3)(1.OP.F.)= 22.3

22.3 KVA = 22.3 KW because P.F. = 1