

Steps for Selecting the Proper Transformer

SINGLE PHASE LOADS

1. Determine electrical load

- A. Voltage required by load.
- B. Amperes or kVA capacity required by load.
- C. Frequency in Hz (cycles per second).
- D. Verify load is designed to operate on a single phase supply.

All of the above information is standard data normally obtained from equipment nameplates or instruction manuals.

2. Determine supply voltage

- A. Voltage of supply (source).
- B. Frequency in Hz (cycles per second).

The frequency of the line supply and electrical load must be the same. Select single phase transformer designed to operate at this frequency, having a primary (input) equal to the supply voltage and a secondary (output) equal to the voltage required by the load.

3. If the load nameplate expresses a rating in kVA, a transformer can be directly selected from the charts. Choose from a group of transformers with primary and secondary voltages matching those you have just determined.

- A. Select a transformer with a standard kVA capacity equal to or greater than

that needed to operate the load.

- B. Primary taps are available on most models to compensate for line voltage variations. (Refer to question #2 in the Transformer Questions and Answers Section on page 6.)
- C. When load ratings are given only in amperes, tables 1 and 2 or the following formulas may be used to determine proper kVA size for the required transformer.

- (1) To determine **kVA** when volts and amperes are known:

$$\text{kVA} = \frac{\text{Volts} \times \text{Amps}}{1000}$$

- (2) To determine **Amperes** when kVA and volts are known:

$$\text{Amps} = \frac{\text{kVA} \times 1000}{\text{Volts}}$$

Single Phase Example

Question: Select a transformer to meet the following conditions. Load is single phase lighting using incandescent lamps. Each fixture requires 1.3 amps @ 120 volts, 1 phase, 60 Hz, power factor of unity. The installation requires 52-100 watt fixtures. The desired circuit distributing power to the light fixtures is 120/240 volt, three wire, single phase. The supply voltage is 460 volt, 3 phase.

Answer: Compute the kVA required.

$$\frac{1.3 \text{ amps} \times 120 \text{ volts}}{1000} = .156 \text{ kVA}$$

For each lighting fixture

Always use amps x volts to compute VA, never use lamp wattage. .156 kVA/ Fixture x 52 Fixture = 8.11 kVA. The two sizes (kVA) nearest 8.11 kVA are 7.5 kVA and 10 kVA. Use the 10 kVA. This will not overload the transformer and allows some capacity, 1.89 kVA, for future loads. Since the supply is 460 V (not 480 V) use the 456 V tap. This will produce approximately 120 volts on output. If the tap is not used, the output will be 115 V compared to the desired 120 V. Note the transformer selected is single phase but the supply is 480 V, 3 phase. Single phase is obtained by using any 2 wires of the 3 phase supply.

TABLE 1

Full Load Current in Amperes—
Single Phase Circuits

kVA	120V	208V	240V	277V	380V	440V	480V	600V
.050	0.4	0.2	0.2	0.2	0.1	0.1	0.1	0.1
.100	0.8	0.5	0.4	0.3	0.2	0.2	0.2	0.2
.150	1.2	0.7	0.6	0.5	0.4	0.3	0.3	0.3
.250	2.0	1.2	1.0	0.9	0.6	0.5	0.5	0.4
.500	4.2	2.4	2.1	1.8	1.3	1.1	1.0	0.8
.750	6.3	3.6	3.1	2.7	2.0	1.7	1.6	1.3
1	8.3	4.8	4.2	3.6	2.6	2.3	2.1	1.7
1.5	12.5	7.2	6.2	5.4	3.9	3.4	3.1	2.5
2	16.7	9.6	8.3	7.2	5.2	4.5	4.2	3.3
3	25	14.4	12.5	10.8	7.9	6.8	6.2	5.0
5	41	24.0	20.8	18.0	13.1	11.3	10.4	8.3
7.5	62	36	31	27	19.7	17	15.6	12.5
10	83	48	41	36	26	22.7	20.8	16.7
15	125	72	62	54	39	34	31	25
25	208	120	104	90	65	57	52	41
37.5	312	180	156	135	98	85	78	62
50	416	240	208	180	131	114	104	83
75	625	360	312	270	197	170	156	125
100	833	480	416	361	263	227	208	166
167	1391	802	695	602	439	379	347	278
250	2083	1201	1041	902	657	568	520	416

TABLE 2

Full Load Amperes
Single Phase A.C. Motors ①

HORSE-POWER	115 V	208 V	230 V	MIN. TRANS-FORMER KVA
1/6	4.4	2.4	2.2	.53
1/4	5.8	3.2	2.9	.70
1/3	7.2	4.0	3.6	.87
1/2	9.8	5.4	4.9	1.18
3/4	13.8	7.6	6.9	1.66
1	16	8.8	8	1.92
1.5	20	11.0	10	2.40
2	24	13.2	12	2.88
3	34	18.7	17	4.10
5	56	30.8	28	6.72
7.5	80	44	40	9.6
10	100	55	50	12.0

① When motor service factor is greater than 1, increase full load amps proportionally. Example: If service factor is 1.15, increase above amp values by 15%.

$$\text{1 Phase kVA} = \frac{\text{Volts} \times \text{Amps}}{1000}$$

NOTE: If motors are started more than once per hour, increase minimum transformer kVA by 20%.

THREE PHASE LOADS

1. Determine electrical load

- A. Voltage required by load.
- B. Amperes or kVA required by load.
- C. Frequency in Hz (cycles per second).
- D. Verify load is designed to operate on three phase.

All the above information is standard data normally obtained from equipment nameplates or instruction manuals.

2. Determine supply voltage

- A. Voltage of supply (source).
- B. Frequency in Hz (cycles per second).

The frequency of the line supply and electrical load must be the same. A three phase transformer is selected which is designed to operate at this frequency having a primary (input) equal to the supply voltage and a secondary (output) equal to the voltage required by the load.

3. If the load nameplate expresses a rating in kVA, a transformer can be directly selected from the charts. Choose from the group of transformers with primary and secondary voltages matching that which you have just determined.

- A. Select a transformer with a standard kVA capacity **equal to or greater than** that needed to operate the load.
- B. Primary taps are available on most models to compensate for line voltage variations. (Refer to question #2 in the Transformer Questions and Answers Section on page 6.)
- C. When load ratings are given only in amperes, tables 3 and 4 or the following formulas may be used to determine proper kVA size for the required transformer.

(1) To determine three phase **kVA** when volts and amperes are known:

$$\text{Three Phase kVA} = \frac{\text{Volts} \times \text{Amps} \times 1.73}{1000}$$

(2) To determine **Amperes** when kVA and volts are known:

$$\text{Amps} = \frac{3 \text{ Phase kVA} \times 1000}{\text{Volts} \times 1.73}$$

Three Phase Example

Question: Select a transformer to fulfill the following conditions. Load is a three phase induction motor, 25 horsepower @ 240 volts, 60 Hz and a heater load of 4 kilowatts @ 240 volts single phase. The supply voltage is 480Y/277, three phase, 4 wire.

Answer: Compute the kVA required. **Motor** — From table 4 the current is 68 amps.

$$\frac{240 \text{ volts} \times 68 \text{ amps} \times 1.73}{1000} = 28.2 \text{ kVA}$$

(The kVA can also be obtained from table 4).

Heater — 4 kVA

A three phase transformer must be selected so that any one phase is not overloaded. Each phase should have the additional 4 kVA rating required by the heater even though the heater will operate on one phase only. So, the transformer should have a minimum kVA rating of 28.2 + 4 + 4 + 4 or 40.2 kVA. Refer to the appropriate selection chart. A 480 delta primary — 240 delta secondary transformer may be used on a 4 wire, 480Y/277 volt supply. The fourth wire (neutral) is not connected to the transformer. To not overload the transformer, a 45 kVA transformer should be selected.

NOTE: Any two wires of the 240 volts, 3 phase developed by the secondary of the transformer may be used to supply the heater. Any 2 wires of a 3 phase system is single phase.

TABLE 3

Full Load Current in Amperes—
Three Phase Circuits

kVA	208 V	240 V	380 V	440 V	480 V	600 V
3	8.3	7.2	4.6	3.9	3.6	2.9
4.5	12.5	10.8	6.8	5.9	5.4	4.3
6	16.6	14.4	9.1	7.8	7.2	5.8
9	25	21.6	13.7	11.8	10.8	8.6
15	41	36	22.8	19.6	18.0	14.4
22.5	62	54	34.2	29	27	21.6
30	83	72	45.6	39	36	28
45	124	108	68.4	59	54	43
75	208	180	114	98	90	72
112.5	312	270	171	147	135	108
150	416	360	228	196	180	144
225	624	541	342	294	270	216
300	832	721	456	392	360	288
500	1387	1202	760	655	601	481
750	2081	1804	1139	984	902	721
1000	2775	2405	1519	1312	1202	962

TABLE 4

Full Load Amperes
Three Phase A.C. Motors ①

HORSE-POWER	208 V	230 V	460 V	575 V	MIN. TRANSFORMER KVA
1/2	2.2	2.0	1.0	0.8	0.9
3/4	3.1	2.8	1.4	1.1	1.2
1	4.0	3.6	1.8	1.4	1.5
2	7.5	6.8	3.4	2.7	2.7
3	10.7	9.6	4.8	3.9	3.8
5	16.7	15.2	7.6	6.1	6.3
10	31	28	14	11	11.2
15	46	42	21	17	16.6
20	59	54	27	22	21.6
25	75	68	34	27	26.6
30	88	80	40	32	32.4
40	114	104	52	41	43.2
50	143	130	65	52	52
60	170	154	77	62	64
75	211	192	96	77	80
100	273	248	124	99	103
125	342	312	156	125	130
150	396	360	180	144	150
200	528	480	240	192	200

① When motor service factor is greater than 1, increase full load amps proportionally.

Example: If service factor is 1.15, increase above amp values by 15%.

$$\text{3 Phase kVA} = \frac{\text{Volts} \times \text{Amps} \times 1.73}{1000}$$

NOTE: If motors are started more than once per hour, increase minimum transformer kVA by 20%.