Where Are Buck-Boost Transformers Used?

A typical buck-boost application is 120 volts in, 12 volts out for low voltage lighting or control circuitry. In most applications, this low voltage transformer is field connected as an autotransformer. (See question 2 for the definition of an autotransformer). Buck-boost transformers provide tremendous capabilities and flexibility in kVA sizes and input/output voltage combinations. **Basically you get 75 different transformers... all in one convenient package.**

Other buck-boost applications are, where (A) low supply voltage exists because equipment is installed at the end of a bus system; (B) the supply system is operating at or over its design capacity; and (C) where overall consumer demands may be so high the utility cuts back the supply voltage to the consumer causing a "brownout."

Why Use Buck-Boost Instead of Another Type Transformer ?

Take a look at the advantages and disadvantages of using a buck-boost transformer (autotransformer) compared to a standard isolation transformer of the proper size and voltage combination.

As you can see, the advantages are many, the economies great. Buck-boost transformers are readily available from the stock of your nearest Power Distribution Products Distributor.

ADVANTAGES	DISADVANTAGES
More efficient	No circuit isolation
Smaller & lighter	Cannot create a neutral
5-10 times increase in kVA	Application voltages and kVA don't match the nameplate voltages and kVA
Versatile, many applications	
Lower cost	

T211688 T111683

Proper Voltage Is Critical

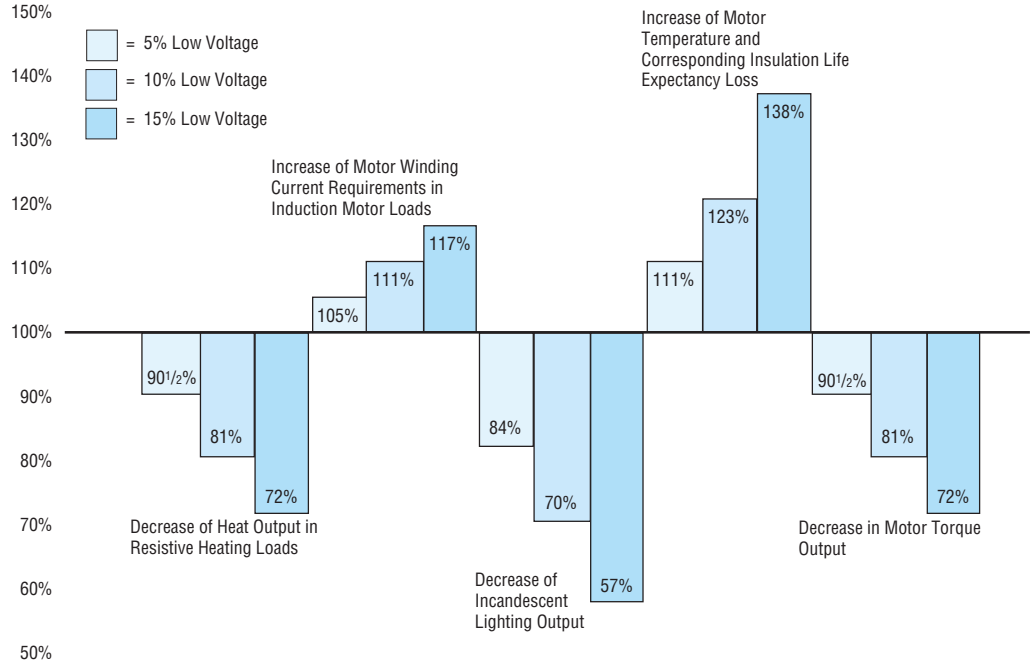
With nearly two-thirds of all electrical loads being A.C. motor loads, maintenance of the proper voltage to that motor is very important. If the supply line voltage is not maintained, motor winding current is increased causing reduced motor torque and escalating motor temperature, all of which results in the rapid loss of insulation life expectancy.

In addition to motor loads, the detrimental effects of low voltage on both resistive heating loads and incandescent lighting output is illustrated in the chart.

Anytime you have a lower than standard voltage, equipment damage and failure can result.

Buck-boost transformers are an economical way to correct this potentially very serious problem. **Anytime** a line voltage change in the 5-20% range is required, a buck-boost transformer should be considered as your first line of defense.

How Low Voltage Affects Various Equipment Operations and Functions



Questions & Answers About Buck-Boost Transformers

1. What is a buck-boost transformer?

Buck-boost transformers are small single phase transformers designed to reduce (buck) or raise (boost) line voltage from 5-20%. The most common example is boosting 208 volts to 230 volts, usually to operate a 230 volt motor such as an air-conditioner compressor, from a 208 volt supply line.

Buck-boosts are a standard type of single phase distribution transformers, with primary voltages of 120, 240 or 480 volts and secondaries typically of 12, 16, 24, 32 or 48 volts. They are available in sizes ranging from 50 volt amperes to 10 kilo-volt amperes.

Buck-boost transformers are shipped ready to be connected for a number of possible voltage combinations.

2. How does a buck-boost transformer differ from an insulating transformer?

A buck-boost transformer **IS** an insulating type transformer when it is shipped from the factory. When it is connected at the job site, a lead wire on the primary is connected to a lead wire on the secondary – thereby changing the transformer's electrical characteristics to those of an autotransformer. The primary and secondary windings are no longer "insulated" and secondary windings are no longer "insulated" and its kVA capacity is greatly increased. Refer to figures 1, 2 and 3.

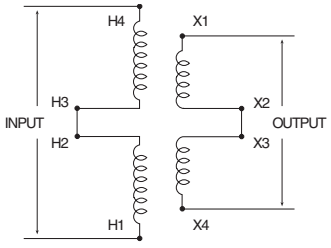


Figure 1. Buck-boost transformer connected as a low voltage insulating transformer (primary and secondary windings shown series connected).

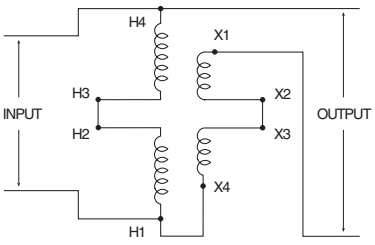


Figure 2. Same buck-boost transformer connected as a boosting autotransformer. The connection from H1 to X4 "converted" the unit to an autotransformer.

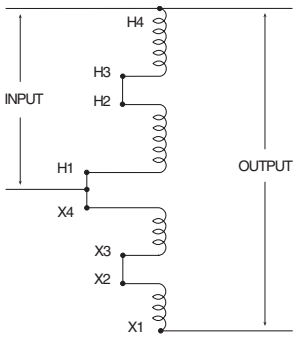


Figure 3. Illustration No. 2 shown with the primary and secondary windings "straightened".

3. What is the difference between a buck-boost transformer and an autotransformer?

When a primary lead wire and secondary lead wire of a buck-boost transformer are connected together electrically, in a recommended voltage bucking or boosting connection, the transformer is in all respects, an autotransformer. However, if the interconnection between the primary and secondary winding is not made, then the unit is an insulating type transformer.

Applications

4. Why are they used?

Electrical and electronic equipment is designed to operate on standard supply voltage. When the supply voltage is constantly too high or too low, (usually more than 55%), the equipment fails to operate at maximum efficiency. A buck and boost transformer is a simple and ECONOMICAL means of correcting this off-standard voltage.

5. What are the most common applications for buck-boost transformers?

Boosting 208V to 230V or 240V and vice versa for commercial and industrial air conditioning systems; boosting 110V to 120V and 240V to 277V for lighting systems; voltage correction for heating systems and induction motors of all types. Many applications exist where supply voltages are constantly above or below normal.

6. Can buck-boost transformers be used to power low voltage circuits?

Yes, low voltage control, lighting circuits, or other low voltage applications requiring either 12V, 16V, 24V, 32V or 48V. The unit is connected as an insulating transformer and the nameplate kVA rating is the transformer's capacity.

(1 kVA) T111683 **(7.5 kVA) T2535153S**

Operation and Construction

7. Why do buck-boost transformers have 4 windings?

To make them versatile! A four winding buck-boost transformer (2 primary and 2 secondary windings) can be connected eight different ways to provide a multitude of voltage and kVA outputs. A two winding (1 primary & 1 secondary) buck-boost transformer can be connected only one way.

8. Will a buck-boost transformer stabilize voltage?

No. The output voltage is a function of the input voltage. If the input voltage varies, then the output voltage will also vary by the same percentage.

Load Data

9. Are there any restrictions on the type of load that can be operated from a buck-boost transformer?

No, there are no restrictions.

10. Why can a buck-boost transformer operate a kVA load many times larger than the kVA rating on its nameplate?

Since the transformer has been auto-connected in such a fashion that the 22V secondary voltage is added to the 208V primary voltage, it produces 230V output.

The autotransformer kVA is calculated:

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

$$kVA = \frac{230\ V \times 41.67\ \text{Amps}}{1000} = 9.58\ kVA$$

The picture to the left illustrates the difference in physical size between the autotransformer of 1 kVA, capable of handling a 9.58 kVA load, and an isolation transformer capable of handling a 7.5 kVA load.

To cite an example... a model T111683 buck-boost transformer has a nameplate kVA rating of 1 kVA, but when it's connected as an autotransformer boosting 208V to 230V, its kVA capacity increases to 9.58 kVA. The key to understanding the operation of buck-boost transformers lies in the fact that the secondary windings are the only parts of the transformer that do the work of transforming voltage and current. In the example above, only 22 volts are being transformed (boosted) — i.e. 208V + 22V = 230V. This 22V transformation is carried out by the secondary windings which are designed to operate at a maximum current of 41.67 amps (determined by wire size of windings).

$$\text{Maximum Secondary Amps} = \frac{\text{nameplate kVA} \times 1000}{\text{secondary volts}}$$

$$\text{Maximum Secondary Amps} = \frac{1.0\ \text{kVA} \times 1000}{24\ V} = \frac{1000\ VA}{24\ V} = 41.67\ \text{amps}$$

11. Can buck-boost transformers be used on motor loads?

Yes, either single or three phase. Refer to the motor data charts in Section I for determining kVA and Amps required by NEMA standard motors.

12. How are single phase and three phase load Amps and load kVA calculated?

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

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

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

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

Three-Phase

13. Can buck-boost transformers be used on three-phase systems as well as single phase systems?

Yes. A single unit is used to buck or boost single phase voltage — two or three units are used to buck or boost three phase voltage. The number of units to be used in a three-phase installation depends on the number of wires in the supply line. If the three-phase supply is 4 wire Y, use three buck-boost transformers. If the 3-phase supply is 3 wire Y (neutral not available), use two buck-boost transformers. Refer to three-phase selection charts.

14. Should buck-boost transformers be used to develop a three-phase 4 wire Y circuit from a three-phase 3 wire delta circuit?

No. A three phase "wye" buck-boost transformer connection should be used only on a 4 wire source of supply. A delta to wye connection does not provide adequate current capacity to accommodate unbalanced currents flowing in the neutral wire of the 4 wire circuit.

3 PHASE CONNECTIONS

INPUT (SUPPLY SYSTEM)	DESIRED OUTPUT CONNECTION	
DELTA 3 wire	WYE 3 or 4 wire	DO NOT USE
OPEN DELTA 3 wire	WYE 3 or 4 wire	DO NOT USE
WYE 3 or 4 wire	CLOSED DELTA 3 wire	DO NOT USE
WYE 4 wire	WYE 3 or 4 wire	OK
WYE 3 or 4 wire	OPEN DELTA 3 wire	OK
CLOSED DELTA 3 wire	OPEN DELTA 3 wire	OK

15. Why isn't a closed delta buck-boost connection recommended?

A closed delta buck-boost auto transformer connection requires more transformer kVA than a "wye" or open delta connection and phase shifting occurs on the output. Consequently the closed delta connection is more expensive and electrically inferior to other three-phase connections.

Connection and Frequency

16. How does the installer or user know how to connect a buck-boost transformer?

The connection chart packed with each unit shows how to make the appropriate connections. These same connection charts are also shown in this section (page 118).

17. Can 60 Hertz buck-boost transformers be used on a 50 Hertz service?

No. Acme buck-boost transformers should be operated only at the frequencies recommended. However, units recommended for 50 cycle operation are suitable for 60 cycle operation but not vice versa.

Selection

18. How do you select a buck-boost transformer?

Refer to the selection steps on page 101 for easy 4-step selection, then go to the charts. Also, pages 12 and 13 are helpful for determining buck-boost kVA when only the H.P. rating of a motor is available.

Nameplate Data

19. Why are buck-boost transformers shipped from the factory as insulating transformers and not preconnected at the factory as autotransformers?

A four winding buck-boost transformer can be auto connected eight different ways to provide a multitude of voltage and kVA output combinations. The proper transformer connection depends on the user's supply voltage, load voltage and load kVA. Consequently, it is more feasible for the manufacturer to ship the unit as an insulating transformer and allow the user to connect it on the job site in accordance with the available supply voltage and requirements of his load.

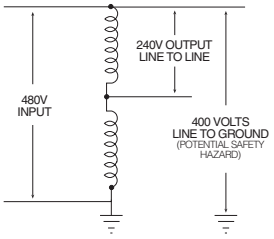
20. Why is the isolation transformer kVA rating shown on the nameplate instead of the autotransformer kVA rating?

The kVA rating of a buck-boost transformer when auto connected depends on the amount of voltage buck or boost. Since the amount of voltage buck or boost is different for each connection, it is physically impossible to show all of the various voltage combinations and attainable kVA ratings on the nameplate. A connection chart showing the various attainable single phase and three-phase connections is packed with each unit.

Safety

21. Do buck-boost transformers present a safety hazard usually associated with autotransformers?

No. Most autotransformers, if they are not of the buck-boost variety, change voltage from one voltage class to another. (Example 480V to 240V) In a system where one line is grounded, the user thinks he has 240V; yet due to the primary and secondary being tied together, it is possible to have 480V to ground from the 240V output. A buck-boost transformer only changes the voltage a small amount, such as 208V to 240V. This small increase does not represent a safety hazard, as compared to a buck of 480V to 240V. Refer to Figure on the following page.



Sound Levels

22. Are buck-boost transformers as quiet as standard isolation transformers?

Yes. However, an auto-connected buck-boost transformer will be quieter than an isolation transformer capable of handling the same load. The isolation transformer would have to be physically larger than the buck-boost transformer, and small transformers are quieter than larger ones. (Example) 1 kVA — 40 db; 75 kVA — 50 db. (db is a unit of sound measure).

Cost and Life Expectancy

23. How does the cost of a buck-boost transformer compare to that of an insulating transformer — both capable of handling the same load?

For the most common buck-boost applications, the dollar savings are generally greater than 75% compared to the use of an insulating type distribution transformer for the same application.

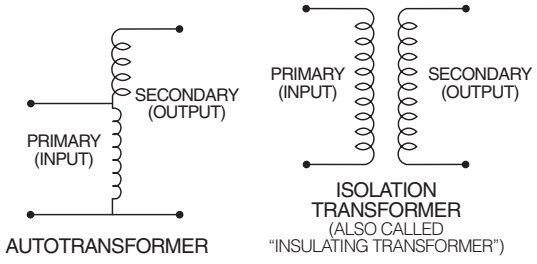
24. What is the life expectancy of a buck boost transformer?

The life expectancy of a buck-boost transformer is the same as the life expectancy of other dry type transformers.

National Electrical Code

25. Your catalog indicates that a buck-boost transformer is suitable for connecting as an AUTOTRANS-FORMER. What is the definition of an autotransformer and how does it differ from an isolation transformer?

An autotransformer is a transformer in which the primary (input) and the secondary (output) are electrically connected to each other. An isolation transformer, also known as an insulating transformer, has complete electrical separation between the primary (input) and the secondary (output). This is illustrated in the drawing below.



An autotransformer changes or transforms only a portion of the electrical energy it transmits. The rest of the electrical energy flows directly through the electrical connections between the primary and secondary. An isolation transformer (insulating transformer) changes or transforms all of the electrical energy it transmits.

Consequently, an autotransformer is smaller, lighter in weight, and less costly than a comparable kVA size insulating transformer.

Please refer to Question 27 for additional information on auto-transformers.

Buck-boost transformers are frequently field-connected as autotransformers.

26. Buck-boost transformers are almost always installed as auto-transformers. Does the N.E.C. (National Electrical Code) permit the use of autotransformers?

Yes. Please refer to N.E.C. Article 450-4, "Autotransformers 600 Volts, Nominal, or Less." Item **(a)** explains how to overcurrent protect an autotransformer; item **(b)** explains that an insulating transformer such as a buck-boost transformer may be field connected as an autotransformer.

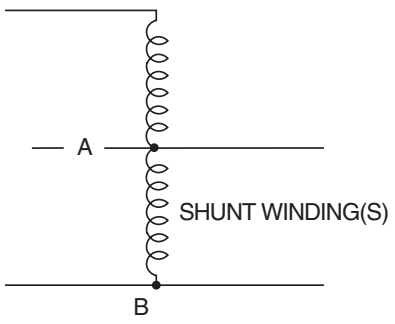
27. When a buck-boost transformer is connected as an autotransformer such as boosting 208V to 230V, the kVA is greatly increased. What is the procedure for determining the size (ampere rating) of the overcurrent protective device such as a fuse or circuit breaker?

The National Electrical Code Article 450-4 addresses overcurrent protection of autotransformers. A copy is reproduced below for easy reference.

450-4. Autotransformers 600 Volts, Nominal, or Less.

(a) Overcurrent Protection. Each autotransformer 600 volts, nominal, or less shall be protected by an individual overcurrent device installed in series with each ungrounded input conductor. Such overcurrent device shall be rated or set at not more than 125 percent of the rated full-load input current of the autotransformer. An overcurrent device shall not be installed in series with the shunt winding (the winding common to both the input and the output circuits) of the autotransformer between Points A and B as shown in Diagram 450-4.

Diagram 450-4



GROUP III

SINGLE PHASE		BOOSTING										BUCKING			
Line Voltage (Available)		230	380	416	425	430	435	440	440	450	460	277	480	480	504
Load Voltage (Output)		277	420	457	467	473	457	462	484	472	483	230	436	456	480
CAT. NO.															
T181061	Load kVA	0.29	0.44	0.48	0.49	0.49	0.95	0.96	0.50	0.98	1.01	0.29	0.50	1.05	1.10
	Load Amps	1.04	1.04	1.04	1.04	1.04	2.08	2.08	1.04	2.08	2.08	1.25	1.15	2.29	2.29
	Max. Size of Fuse or Breaker	3	3	3	3	3	6	6	3	6	6	3	3	6	6
T181062	Load kVA	0.58	0.87	0.95	0.97	0.99	1.90	1.93	1.01	1.97	2.01	0.58	1.00	2.09	2.20
	Load Amps	2.08	2.08	2.08	2.08	2.08	4.17	4.17	2.08	4.17	4.17	2.50	2.29	4.58	4.58
	Max. Size of Fuse or Breaker	6	6	6	6	6	10	10	6	10	10	6	6	10	10
T181063	Load kVA	0.87	1.31	1.43	1.46	1.48	2.86	2.89	1.51	2.95	3.02	0.86	1.50	3.14	3.30
	Load Amps	3.13	3.13	3.13	3.13	3.13	6.25	6.25	3.13	6.25	6.25	3.75	3.44	6.88	6.88
	Max. Size of Fuse or Breaker	10	6	6	6	6	15	15	6	15	15	6	6	15	15
T181064	Load kVA	1.44	2.19	2.38	2.43	2.46	4.76	4.81	2.52	4.92	5.03	1.44	2.50	5.23	5.50
	Load Amps	5.21	5.21	5.21	5.21	5.21	5.21	10.42	5.21	10.42	10.42	6.25	5.73	11.46	11.46
	Max. Size of Fuse or Breaker	15	10	10	10	10	15	15	10	15	15	10	10	15	15
T181065	Load kVA	2.89	4.38	4.76	4.86	4.93	9.52	9.62	5.04	9.83	10.06	2.88	5.00	10.45	11.00
	Load Amps	10.42	10.42	10.42	10.42	10.42	20.83	20.83	10.42	20.83	20.83	12.50	11.46	22.92	22.92
	Max. Size of Fuse or Breaker	20	15	15	15	15	30	30	15	30	30	15	15	30	30
T181066	Load kVA	4.33	6.56	7.14	7.30	7.39	14.28	14.44	7.56	14.75	15.09	4.31	7.49	15.68	16.50
	Load Amps	15.63	15.63	15.63	15.63	15.63	31.25	31.25	15.63	31.25	31.25	18.75	17.19	34.38	34.38
	Max. Size of Fuse or Breaker	25	25	25	25	25	45	45	25	45	45	20	20	45	45
T137920	Load kVA	5.77	8.57	9.52	9.73	9.85	19.04	19.25	10.08	19.67	20.13	5.75	9.99	20.90	22.00
	Load Amps	20.83	20.83	20.83	20.83	20.83	41.67	41.67	20.83	41.67	41.67	25.00	22.92	45.83	45.83
	Max. Size of Fuse or Breaker	35	30	30	30	30	60	60	30	60	60	30	30	60	60
T137921	Load kVA	8.66	13.13	14.28	14.59	14.78	28.56	28.88	15.13	29.50	30.19	8.63	14.99	31.35	33.00
	Load Amps	31.25	31.25	31.25	31.25	31.25	62.50	62.50	31.25	62.50	62.50	37.50	34.38	68.75	68.75
	Max. Size of Fuse or Breaker	50	50	45	45	45	90	90	45	90	90	40	40	90	90
T137922	Load kVA	11.54	17.50	19.04	19.46	19.71	38.08	38.50	20.17	39.33	40.25	11.50	19.98	41.80	44.00
	Load Amps	41.67	41.67	41.67	41.67	41.67	83.33	83.33	41.67	83.33	83.33	50.00	45.83	91.67	91.67
	Max. Size of Fuse or Breaker	70	60	60	60	60	110	110	60	110	110	60	60	110	110
T137923	Load kVA	17.31	26.25	28.56	29.19	29.56	57.13	57.75	30.25	59.00	60.38	17.25	29.98	62.70	66.00
	Load Amps	62.50	62.50	62.50	62.50	62.50	125.00	125.00	62.50	125.00	125.00	75.00	68.80	137.50	137.50
	Max. Size of Fuse or Breaker	100	90	90	90	90	175	175	90	175	175	80	80	175	175
T137924	Load kVA	28.90	43.80	47.60	48.60	49.30	95.20	96.20	50.40	98.30	100.60	28.80	50.00	104.50	110.00
	Load Amps	104.20	104.20	104.20	104.20	104.20	208.30	208.30	104.20	208.30	208.30	125.00	114.60	229.20	229.20
	Max. Size of Fuse or Breaker	175	150	150	150	150	300	300	150	300	300	150	150	300	300
T243570	Load kVA	43.30	65.60	71.40	73.00	73.90	142.80	144.40	75.60	147.50	150.90	43.10	74.90	156.80	165.00
	Load Amps	156.30	156.30	156.30	156.30	156.30	312.50	312.50	156.30	312.50	312.50	187.50	171.90	343.80	343.80
	Max. Size of Fuse or Breaker	250	225	225	225	225	450	450	225	450	450	200	200	450	450
T243571 ①	Load kVA	57.70	87.50	95.20	97.30	98.50	190.40	192.50	100.80	196.70	201.30	57.50	99.90	209.00	220.00
	Load Amps	208.30	208.30	208.30	208.30	208.30	416.70	416.70	208.30	416.70	416.70	250.00	229.20	458.30	458.30
	Max. Size of Fuse or Breaker	350	300	300	300	300	600	600	300	600	600	300	300	600	600
See Page 110 For Connection Diagrams		D	H	H	H	H	G	G	H	G	G	J	I	E	E

① See chart on page 101.

NOTE: Inputs and Outputs may be reversed; kVA capacity remains constant. All applications above bold face line are suitable for 50/60 Hz. All applications below bold face line are suitable for 60 Hz only.

SELECTION CHARTS

THREE PHASE

GROUP I

THREE PHASE		BOOSTING							BUCKING				
Line Voltage (Available)		189Y 109	196Y 113	201Y 116	208Y 120	189	208	220	219	230	250	255	264
Load Voltage (Output)		208	234	240	230	208	230	242	208	208	227	232	240
CAT. NO.													
T181047	Load kVA	1.50	0.84	0.87	1.66	0.75	0.83	0.87	1.58	0.83	0.90	0.92	0.95
	Load Amps	4.17	2.08	2.08	4.17	2.08	2.08	2.08	4.39	2.30	2.29	2.29	2.29
	Max. Size of Fuse or Breaker	10	6	6	10	6	6	6	10	6	6	6	6
T181048	Load kVA	3.00	1.69	1.73	3.32	1.50	1.66	1.75	3.16	1.66	1.80	1.84	1.91
	Load Amps	8.33	4.17	4.17	8.33	4.17	4.17	4.17	8.77	4.61	4.59	4.58	4.58
	Max. Size of Fuse or Breaker	15	10	10	15	10	10	10	15	10	10	10	10
T181049	Load kVA	4.50	2.53	2.60	4.98	2.25	2.49	2.62	4.74	2.49	2.71	2.76	2.86
	Load Amps	12.50	6.25	6.25	12.50	6.25	6.25	6.25	13.16	6.91	6.88	6.87	6.88
	Max. Size of Fuse or Breaker	20	15	15	20	15	15	15	20	15	15	15	15
T181050	Load kVA	7.51	4.22	4.33	8.30	3.75	4.15	4.37	7.90	4.15	4.51	4.60	4.76
	Load Amps	20.83	10.42	10.42	20.83	10.42	10.42	10.42	21.94	11.52	11.47	11.45	11.46
	Max. Size of Fuse or Breaker	30	20	20	30	15	15	15	30	15	15	15	15
T181051	Load kVA	15.01	8.44	8.66	16.60	7.51	8.30	8.73	15.80	8.30	9.02	9.20	9.53
	Load Amps	41.67	20.83	20.83	41.67	20.83	20.83	20.83	43.87	23.04	22.94	22.90	22.92
	Max. Size of Fuse or Breaker	60	35	35	60	30	30	30	60	30	30	30	30
T181052	Load kVA	22.52	12.67	12.99	24.90	11.26	12.45	13.10	23.71	12.45	13.53	13.80	14.29
	Load Amps	62.50	31.25	31.25	62.50	31.25	31.25	31.25	65.81	34.56	34.42	34.35	34.38
	Max. Size of Fuse or Breaker	90	50	50	90	45	45	45	80	40	40	40	40
T111683	Load kVA	30.02	16.89	17.32	33.20	15.01	16.60	17.46	31.61	16.60	18.04	18.40	19.05
	Load Amps	83.33	41.67	41.67	83.33	41.67	41.67	41.67	87.74	46.07	45.89	45.80	45.83
	Max. Size of Fuse or Breaker	125	70	70	125	60	60	60	110	60	60	60	60
T111684	Load kVA	45.03	25.33	25.98	49.80	22.52	24.90	26.20	47.41	24.90	27.06	27.60	28.58
	Load Amps	125.00	62.50	62.50	125.00	62.50	62.50	62.50	131.61	69.11	68.83	68.70	68.75
	Max. Size of Fuse or Breaker	175	100	100	175	90	90	90	175	80	80	80	80
T111685	Load kVA	60.04	33.77	34.64	66.40	30.02	33.20	34.93	63.22	33.20	36.08	36.81	38.11
	Load Amps	166.67	83.33	83.33	167.67	83.33	83.33	83.33	175.48	92.15	91.78	91.59	91.67
	Max. Size of Fuse or Breaker	250	125	125	250	125	125	125	225	110	110	110	110
T111686	Load kVA	90.07	50.66	51.96	99.59	45.03	49.80	52.39	94.83	49.80	54.13	55.21	57.16
	Load Amps	250.00	125.00	125.00	250.00	125.00	125.00	125.00	263.22	138.22	137.67	137.39	137.50
	Max. Size of Fuse or Breaker	350	200	200	350	175	175	175	350	175	175	175	175
T111687	Load kVA	150.11	84.44	86.60	165.99	75.06	82.99	87.32	158.05	82.99	90.21	92.02	95.26
	Load Amps	416.67	208.33	208.33	416.67	208.33	208.33	208.33	438.70	230.37	229.44	228.99	229.17
	Max. Size of Fuse or Breaker	600	350	350	600	300	300	300	600	300	300	300	300
T211688①	Load kVA	225.17	126.66	129.90	248.98	112.58	124.49	130.99	237.07	124.49	135.32	138.02	142.89
	Load Amps	625.00	312.50	312.50	625.00	312.50	312.50	312.50	658.05	345.55	344.16	343.48	343.75
	Max. Size of Fuse or Breaker	1000	500	500	1000	450	450	450	800	400	400	400	400
T211689①	Load kVA	300.22	168.87	173.21	331.98	150.11	165.99	174.65	316.10	165.99	180.42	184.03	190.53
	Load Amps	833.33	416.67	416.67	833.33	416.67	416.67	416.67	877.40	460.74	458.88	457.97	458.33
	Max. Size of Fuse or Breaker	1200	700	700	1200	600	600	600	1200	600	600	600	600
Quantity Required		3	3	3	3	2	2	2	2	2	2	2	2
See Page 102 For Connection Diagrams		A-A	F-F	F-F	A-A	B-B	B-B	B-B	C-C	E-E	E-E	E-E	E-E

① See chart on page 101.

GROUP II

THREE PHASE		BOOSTING					BUCKING					
Line Voltage (Available)		183Y 106	208Y 120	195	208	225	240	245	250	256	265	272
Load Voltage (Output)		208	236	208	240	240	208	230	234	240	234	240
CAT. NO.												
T181054	Load kVA	1.13	1.28	1.13	0.63	1.30	0.56	1.33	1.35	1.39	0.72	0.74
	Load Amps	3.13	3.13	3.13	1.56	3.13	1.56	3.33	3.34	3.33	1.77	1.77
	Max. Size of Fuse or Breaker	6	6	6	3	6	3	6	6	6	3	3
T181055	Load kVA	2.25	2.55	2.25	1.27	2.60	1.13	2.65	2.71	2.77	1.43	1.47
	Load Amps	6.25	6.25	6.25	3.13	6.25	3.13	6.66	6.68	6.67	3.54	3.54
	Max. Size of Fuse or Breaker	15	15	15	6	15	6	15	15	15	6	6
T181056	Load kVA	3.38	3.83	3.38	1.90	3.90	1.69	3.98	4.06	4.16	2.15	2.21
	Load Amps	9.38	9.38	9.38	4.69	9.38	4.69	9.99	10.02	10.00	5.31	5.31
	Max. Size of Fuse or Breaker	15	15	15	10	15	10	15	15	15	10	10
T181057	Load kVA	5.63	6.39	5.63	3.17	6.50	2.81	6.63	6.77	6.93	3.59	3.68
	Load Amps	15.63	15.63	15.63	7.81	15.63	7.81	16.64	16.69	16.67	8.85	8.85
	Max. Size of Fuse or Breaker	25	25	25	15	25	15	20	20	20	15	15
T181058	Load kVA	11.26	12.77	11.26	6.33	12.99	5.63	13.26	13.53	13.86	7.17	7.36
	Load Amps	31.25	31.25	31.25	15.63	31.25	15.63	33.29	33.39	33.33	17.69	17.71
	Max. Size of Fuse or Breaker	45	45	45	25	45	20	40	40	40	20	20
T181059	Load kVA	16.89	19.16	16.89	9.50	19.49	8.44	19.89	20.30	20.78	10.76	11.04
	Load Amps	46.88	46.88	46.88	23.44	46.88	23.44	49.93	50.08	50.00	26.54	26.56
	Max. Size of Fuse or Breaker	70	70	70	35	70	30	60	60	60	30	30
T113073	Load kVA	22.52	25.55	22.52	12.67	25.98	11.26	26.52	27.06	27.71	14.34	14.72
	Load Amps	62.50	62.50	62.50	31.25	62.50	31.25	66.58	66.67	66.67	35.39	35.42
	Max. Size of Fuse or Breaker	90	90	90	45	90	35	80	80	80	40	40
T113074	Load kVA	33.77	38.32	33.77	19.00	38.97	16.89	39.87	40.59	41.57	21.52	22.08
	Load Amps	93.75	93.75	93.75	46.88	93.75	46.88	99.86	100.16	100.00	53.08	53.13
	Max. Size of Fuse or Breaker	150	150	125	70	125	60	125	125	125	60	60
T113075	Load kVA	45.03	51.10	45.03	25.33	51.96	22.52	53.04	54.13	55.43	28.69	29.44
	Load Amps	125.00	125.00	125.00	62.50	125.00	62.50	133.15	133.55	133.33	70.78	70.83
	Max. Size of Fuse or Breaker	200	200	175	90	175	70	175	175	175	80	80
T113076	Load kVA	67.55	76.64	67.55	38.00	77.94	33.77	79.57	81.19	83.14	43.03	44.17
	Load Amps	187.50	187.50	187.50	93.75	187.50	93.75	199.73	200.32	200.00	106.17	106.25
	Max. Size of Fuse or Breaker	300	300	250	150	250	110	250	250	250	125	125
T113077	Load kVA	112.58	127.74	112.58	63.33	129.90	56.29	132.61	135.32	138.56	71.72	73.50
	Load Amps	312.50	312.50	312.50	156.25	312.50	156.25	332.88	333.87	333.33	176.95	176.80
	Max. Size of Fuse or Breaker	450	450	450	225	450	175	400	400	400	200	200
T213078①	Load kVA	166.87	191.61	168.87	94.99	194.86	84.44	198.92	202.97	207.85	107.58	110.42
	Load Amps	468.75	468.75	468.75	234.38	468.75	234.38	499.32	500.80	500.00	265.42	265.63
	Max. Size of Fuse or Breaker	700	700	700	350	700	300	600	600	600	300	300
T213079①	Load kVA	225.17	255.48	225.17	126.66	259.81	112.58	265.22	270.63	277.13	143.44	147.22
	Load Amps	625.00	625.00	625.00	312.50	625.00	312.50	665.76	667.74	666.67	353.90	354.17
	Max. Size of Fuse or Breaker	1000	1000	1000	450	1000	350	800	800	800	400	400
Quantity Required		3	3	2	2	2	2	2	2	2	2	2
See Page 110 For Connection Diagrams		A-A	A-A	G-G	B-B	G-G	D-D	C-C	C-C	C-C	E-E	E-E

①See chart on page 101.

NOTE: (1) Inputs and Outputs may be reversed; kVA capacity remains constant. All applications above bold face line are suitable for 50/60 Hz. All applications below bold face line are suitable for 60 Hz only. (2) Connection Diagrams A-A and F-F cannot be reverse connected.

GROUP III

THREE PHASE		BOOSTING								BUCKING							
	Line Voltage (Available)	399Y 230	380	430	440	460	460	480	480	440	440	460	460	480	480	500	500
	Load Voltage (Output)	480Y 277	420	473	462	506	483	528	504	400	419	438	418	457	436	455	477
CAT. NO.																	
T181061	Load kVA	0.86	0.76	0.85	1.66	0.91	1.74	0.95	1.82	0.79	1.58	1.66	0.83	1.73	0.86	0.90	1.80
	Load Amps	1.04	1.04	1.04	2.08	1.04	2.08	1.04	2.08	1.14	2.18	2.18	1.14	2.18	1.14	1.14	2.18
	Max. Size of Fuse or Breaker	3	3	3	6	3	6	3	6	3	6	6	3	6	3	3	6
T181062	Load kVA	1.73	1.51	1.70	3.33	1.82	3.48	1.90	3.63	1.59	3.17	3.31	1.66	3.46	1.73	1.80	3.61
	Load Amps	2.08	2.08	2.08	4.16	2.08	4.16	2.08	4.16	2.29	4.37	4.37	2.29	4.37	2.29	2.29	4.37
	Max. Size of Fuse or Breaker	6	6	6	10	6	10	6	10	6	10	10	6	10	6	6	10
T181063	Load kVA	2.60	2.27	2.56	4.99	2.73	5.22	2.85	5.45	2.38	4.75	4.97	2.48	5.19	2.59	2.70	5.41
	Load Amps	3.12	3.12	3.12	6.24	3.12	6.25	3.12	6.24	3.43	6.55	6.55	3.43	6.55	3.43	3.43	6.55
	Max. Size of Fuse or Breaker	10	6	6	15	6	15	6	15	6	15	15	6	15	6	6	15
T181064	Load kVA	4.33	3.78	4.26	8.32	4.56	8.70	4.76	9.08	3.96	7.92	8.28	4.14	8.64	4.32	4.51	9.02
	Load Amps	5.20	5.20	5.20	10.40	5.20	10.40	5.20	10.40	5.72	10.92	10.92	5.72	10.92	5.72	5.72	10.92
	Max. Size of Fuse or Breaker	15	10	10	15	10	15	10	15	10	15	15	10	15	10	10	15
T181065	Load kVA	8.60	7.56	8.52	16.64	9.11	17.40	9.51	18.16	7.93	15.85	16.57	8.28	17.29	8.64	9.02	18.04
	Load Amps	10.40	10.40	10.40	20.80	10.40	20.80	10.40	20.80	11.44	21.84	21.84	11.44	21.84	11.44	11.44	21.84
	Max. Size of Fuse or Breaker	20	15	15	30	15	30	15	30	15	30	30	15	30	15	15	30
T181066	Load kVA	12.90	11.34	12.77	24.97	13.67	26.10	14.27	27.24	11.89	23.77	24.85	12.42	25.93	12.96	13.52	27.07
	Load Amps	15.60	15.60	15.60	31.20	15.60	31.20	15.60	31.20	17.16	32.76	32.76	17.16	32.76	17.16	17.16	32.76
	Max. Size of Fuse or Breaker	25	25	25	45	25	45	25	45	20	40	40	20	40	20	20	40
T137920	Load kVA	17.30	15.12	17.03	33.29	18.23	34.80	19.02	36.31	15.85	31.70	33.14	16.57	34.57	17.28	18.03	36.09
	Load Amps	20.80	20.80	20.80	41.60	20.80	41.60	20.80	41.60	22.88	43.68	43.68	22.88	43.68	22.88	22.88	43.68
	Max. Size of Fuse or Breaker	35	30	30	60	30	60	30	60	30	60	60	30	60	30	30	60
T137921	Load kVA	25.90	22.69	25.55	49.93	27.34	52.20	28.53	54.47	23.78	47.55	49.71	24.85	51.86	25.92	27.05	54.13
	Load Amps	31.20	31.20	31.20	62.40	31.20	62.40	31.20	62.40	34.32	65.52	65.52	34.32	65.52	34.32	34.32	65.52
	Max. Size of Fuse or Breaker	50	45	45	90	45	90	45	90	40	80	80	40	80	40	40	80
T137922	Load kVA	34.60	30.25	34.07	66.58	36.46	69.60	38.04	72.63	31.70	63.40	66.27	33.13	69.15	34.56	36.06	72.18
	Load Amps	41.60	41.60	41.60	83.20	41.60	83.20	41.60	83.20	45.76	87.36	87.36	45.76	87.36	45.76	45.76	87.36
	Max. Size of Fuse or Breaker	70	60	60	110	60	110	60	110	60	110	110	60	110	60	60	110
T137923	Load kVA	52.00	45.45	51.18	100.03	54.69	104.57	57.07	109.12	47.63	95.25	99.57	49.77	103.89	51.92	54.18	108.44
	Load Amps	62.50	62.50	62.50	125.00	62.50	125.00	62.50	125.00	68.75	131.25	131.25	68.75	131.25	68.75	68.75	131.25
	Max. Size of Fuse or Breaker	100	90	90	175	90	175	90	175	80	175	175	80	175	80	80	175
T137924	Load kVA	86.10	75.62	85.17	166.44	91.15	174.01	95.11	181.57	79.26	158.50	165.69	82.83	172.87	86.39	90.16	180.44
	Load Amps	104.00	104.00	104.00	208.00	104.00	208.00	104.00	208.00	114.40	218.40	218.40	114.40	218.40	114.40	114.40	218.40
	Max. Size of Fuse or Breaker	175	150	150	300	150	300	150	300	150	300	300	150	300	150	150	300
T243570	Load kVA	129.30	113.43	127.75	249.66	136.72	261.01	142.67	272.36	118.89	237.75	248.53	124.24	259.31	129.59	135.23	270.66
	Load Amps	156.00	156.00	156.00	312.00	156.00	312.00	156.00	312.00	171.60	327.60	327.60	171.60	327.60	171.60	171.60	327.60
	Max. Size of Fuse or Breaker	250	225	225	450	225	450	225	450	200	400	400	200	400	200	200	400
T243571①	Load kVA	173.10	151.25	170.33	332.89	182.29	348.02	190.22	363.15	158.52	317.00	331.37	165.65	345.75	172.78	180.31	360.88
	Load Amps	208.00	208.00	208.00	416.00	208.00	416.00	208.00	416.00	228.80	436.80	436.80	228.80	436.80	228.80	228.80	436.80
	Max. Size of Fuse or Breaker	350	300	300	600	300	600	300	600	300	600	600	300	600	300	300	600
Quantity Required		3	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2
See Page 110 For Connection Diagrams		F-F	B-B	B-B	G-G	B-B	G-G	B-B	G-G	E-E	C-C	C-C	E-E	C-C	E-E	E-E	C-C

①See chart on page 101.

NOTE: (1) Inputs and Outputs may be reversed; kVA capacity remains constant. All applications above bold face line are suitable for 50/60 Hz. All applications below bold face line are suitable for 60 Hz only. (2) Connection Diagrams A-A and F-F cannot be reverse connected.

SPECIFICATIONS ①

GROUP I

120 X 240 PRIMARY VOLTS — 12/24 SECONDARY VOLTS — 60 Hz

CATALOG NUMBER	INSULATING TRANSFORMER RATING	SECONDARY MAXIMUM CURRENT OUTPUT 12 V	SECONDARY MAXIMUM CURRENT OUTPUT 24 V	APPROX. DIMENSIONS INCHES (CM.) HEIGHT	APPROX. DIMENSIONS INCHES (CM.) WIDTH	APPROX. DIMENSIONS INCHES (CM.) DEPTH	APPROX. NET WEIGHT LBS. (KG.)	DIMENSIONAL DRAWINGS
T181047	0.05 kVA	4.16	2.08	6.41 (16.3)	3.14 (8.0)	3.05 (7.7)	4 (1.8)	A
T181048	0.10 kVA	8.32	4.16	7.16 (18.2)	3.89 (9.9)	3.67 (9.3)	5 (2.3)	A
T181049	0.15 kVA	12.52	6.25	7.16 (18.2)	3.89 (9.9)	3.67 (9.3)	7 (3.2)	A
T181050	0.25 kVA	20.80	10.40	8.68 (22.0)	4.08 (10.4)	3.88 (9.9)	10 (4.5)	B
T181051	0.50 kVA	41.60	20.80	9.06 (23.0)	4.37 (11.1)	4.20 (10.7)	15 (6.8)	B
T181052	0.75 kVA	62.50	31.25	9.68 (24.6)	4.75 (12.1)	4.51 (11.5)	19 (8.6)	B
T111683	1.00 kVA	83.20	41.60	10.50 (26.7)	5.50 (14.0)	5.13 (13.0)	24 (10.9)	B
T111684	1.50 kVA	125.00	62.50	11.62 (29.5)	5.50 (14.0)	5.13 (13.0)	30 (13.6)	B
T111685	2.00 kVA	166.00	83.20	13.00 (33.0)	5.50 (14.0)	5.13 (13.0)	38 (17.2)	B
T111686	3.00 kVA	250.00	125.00	11.50 (29.2)	10.31 (26.2)	7.13 (18.1)	55 (24.9)	C
T111687	5.00 kVA	416.60	208.00	14.38 (36.5)	10.31 (26.2)	7.13 (18.1)	75 (34.0)	C
T211688	7.50 kVA	625.00	312.50	20.81 (52.9)	11.12 (28.2)	10.84 (27.5)	125 (56.7)	D
T211689	10.00 kVA	833.00	416.60	20.81 (52.9)	11.75 (29.8)	11.59 (29.4)	160 (72.6)	D

GROUP II

120 X 240 PRIMARY VOLTS — 16/32 SECONDARY VOLTS — 60 Hz

CATALOG NUMBER	INSULATING TRANSFORMER RATING	SECONDARY MAXIMUM CURRENT OUTPUT 16 V	SECONDARY MAXIMUM CURRENT OUTPUT 32 V	APPROX. DIMENSIONS INCHES (CM.) HEIGHT	APPROX. DIMENSIONS INCHES (CM.) WIDTH	APPROX. DIMENSIONS INCHES (CM.) DEPTH	APPROX. NET WEIGHT LBS. (KG.)	DIMENSIONAL DRAWINGS
T181054	0.05 kVA	3.12	1.56	6.41 (16.3)	3.14 (8.0)	3.05 (7.7)	4 (1.8)	A
T181055	0.10 kVA	6.25	3.12	7.16 (18.2)	3.89 (9.9)	3.67 (9.3)	5 (2.3)	A
T181056	0.15 kVA	9.38	4.69	7.16 (18.2)	3.89 (9.9)	3.67 (9.3)	7 (3.2)	A
T181057	0.25 kVA	15.60	7.80	8.68 (22.0)	4.08 (10.4)	3.88 (9.9)	10 (4.5)	B
T181058	0.50 kVA	31.20	15.60	9.06 (23.0)	4.37 (11.1)	4.20 (10.7)	15 (6.8)	B
T181059	0.75 kVA	46.90	23.40	9.68 (24.6)	4.75 (12.1)	4.51 (11.5)	19 (8.6)	B
T113073	1.00 kVA	62.50	31.20	10.50 (26.7)	5.50 (14.0)	5.13 (13.0)	24 (10.9)	B
T113074	1.50 kVA	93.70	46.90	11.62 (29.5)	5.50 (14.0)	5.13 (13.0)	30 (13.6)	B
T113075	2.00 kVA	125.00	62.50	13.00 (33.0)	5.50 (14.0)	5.13 (13.0)	38 (17.2)	B
T113076	3.00 kVA	187.50	93.80	11.50 (29.2)	10.31 (26.2)	7.13 (18.1)	55 (24.9)	C
T113077	5.00 kVA	312.00	156.00	14.38 (36.5)	10.31 (26.2)	7.13 (18.1)	75 (34.0)	C
T213078	7.50 kVA	468.00	234.00	20.81 (52.9)	11.12 (28.2)	10.84 (27.5)	125 (56.7)	D
T213079	10.00 kVA	625.00	312.00	20.81 (52.9)	11.75 (29.8)	10.84 (27.5)	160 (72.6)	D

GROUP III

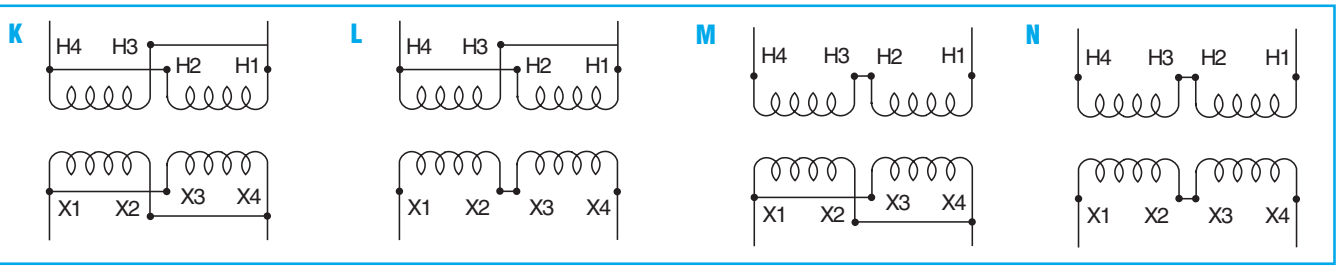
240 X 480 PRIMARY VOLTS — 24/48 SECONDARY VOLTS — 60 Hz

CATALOG NUMBER	INSULATING TRANSFORMER RATING	SECONDARY MAXIMUM CURRENT OUTPUT 24 V	SECONDARY MAXIMUM CURRENT OUTPUT 48 V	APPROX. DIMENSIONS INCHES (CM.) HEIGHT	APPROX. DIMENSIONS INCHES (CM.) WIDTH	APPROX. DIMENSIONS INCHES (CM.) DEPTH	APPROX. NET WEIGHT LBS. (KG.)	DIMENSIONAL DRAWINGS
T181061	0.05 kVA	2.08	1.04	6.41 (16.3)	3.14 (8.0)	3.05 (7.7)	4 (1.8)	A
T181062	0.10 kVA	4.16	2.08	7.16 (18.2)	3.89 (9.9)	3.67 (9.3)	5 (2.3)	A
T181063	0.15 kVA	6.24	3.12	7.16 (18.2)	3.89 (9.9)	3.67 (9.3)	7 (3.2)	A
T181064	0.25 kVA	10.40	5.20	8.68 (22.0)	4.08 (10.4)	3.88 (9.9)	10 (4.5)	B
T181065	0.50 kVA	20.80	10.40	9.06 (23.0)	4.37 (11.1)	4.20 (10.7)	15 (6.8)	B
T181066	0.75 kVA	31.20	15.60	9.68 (24.6)	4.75 (12.1)	4.51 (11.5)	19 (8.6)	B
T137920	1.00 kVA	41.60	20.80	10.50 (26.7)	5.50 (14.0)	5.13 (13.0)	24 (10.9)	B
T137921	1.50 kVA	62.40	31.20	11.62 (29.5)	5.50 (14.0)	5.13 (13.0)	30 (13.6)	B
T137922	2.00 kVA	83.20	41.60	13.00 (33.0)	5.50 (14.0)	5.13 (13.0)	38 (17.2)	B
T137923	3.00 kVA	125.00	62.50	11.50 (29.2)	10.31 (26.2)	7.13 (18.1)	55 (24.9)	C
T137924	5.00 kVA	208.00	104.00	14.38 (36.5)	10.31 (26.2)	7.13 (18.1)	75 (34.0)	C
T243570	7.50 kVA	312.00	156.00	20.81 (52.9)	11.12 (28.2)	10.84 (27.5)	135 (61.2)	D
T243571	10.00 kVA	416.00	208.00	20.81 (52.9)	11.75 (29.8)	11.59 (29.4)	160 (72.6)	D

① All units have ground studs for use with non-metallic conduit. All sizes of 0.75 kVA and less are suitable for 50/60 Hertz. Additional field wiring box may be required when using units as autotransformers.

LOW VOLTAGE LIGHTING WIRING DIAGRAMS

SINGLE PHASE



GROUP I

Units Rated 120 x 240 V Input: 12/24 V Output		
INPUT	OUTPUT	CONNECTION DIAGRAM
120	12	K
120	24	L
240	12	M
240	24	N

GROUP II

Units Rated 120 x 240 V Input: 16/32 V Output		
INPUT	OUTPUT	CONNECTION DIAGRAM
120	16	K
120	32	L
240	16	M
240	32	N

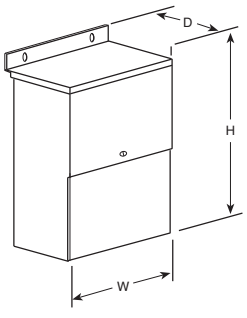
GROUP III

Units Rated 240 x 480 V Input: 24/48 V Output		
INPUT	OUTPUT	CONNECTION DIAGRAM
240	24	K
240	48	L
480	24	M
480	48	N

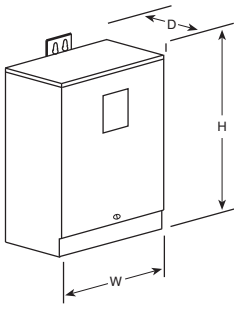
Number of Leads per Termination								
	H1	H2	H3	H4	X1	X2	X3	X4
T213078	1	1	1	1	2	2	2	2
T213079	1	1	1	1	2	2	2	2
T243571	1	1	1	1	2	2	2	2
T211688	1	1	1	1	2	2	2	2
T211689	1	1	1	1	2	2	2	2

All leads with same designation (ex. X1, X1) MUST be joined together for proper operation.

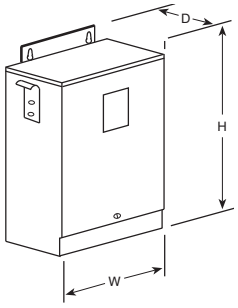
BUCK-BOOST DIMENSIONAL DRAWINGS



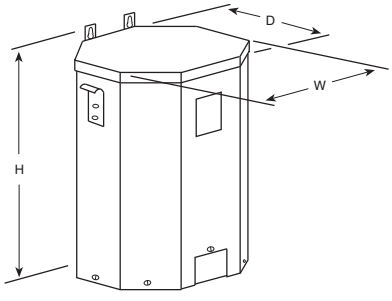
DESIGN A



DESIGN B



DESIGN C



DESIGN D

NOTE: All designs listed above are totally enclosed and suitable for UL 3R outdoor service.

BUCK-BOOST WIRING DIAGRAMS ① — SINGLE PHASE

FIG. C

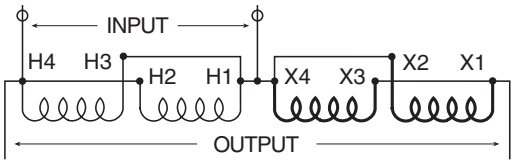


FIG. D

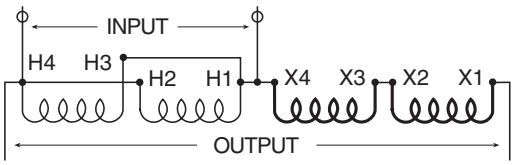


FIG. E

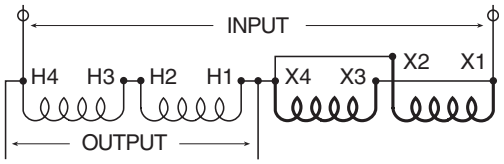


FIG. F

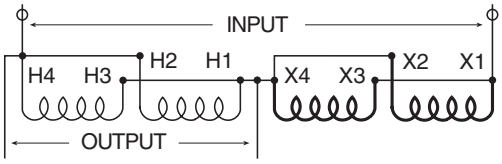


FIG. G

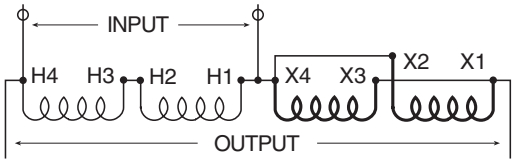


FIG. H

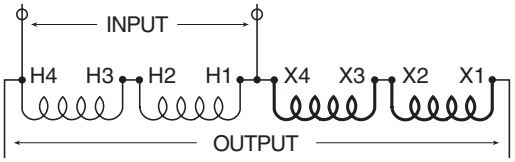


FIG. I

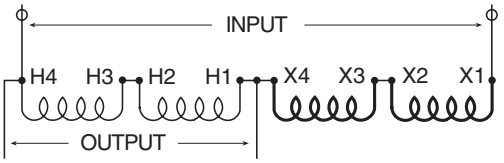
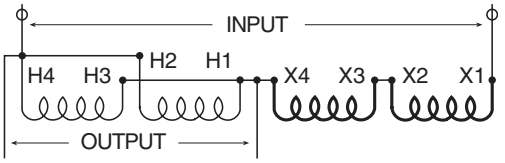


FIG. J



BUCK-BOOST WIRING DIAGRAMS ① — THREE PHASE

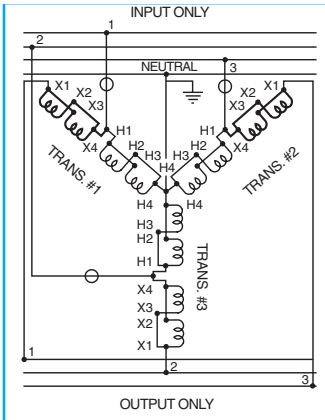


FIG. AA ▯ **WYE**

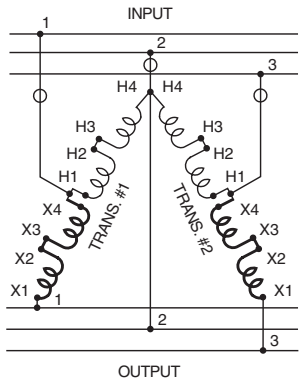


FIG. BB **OPEN DELTA**

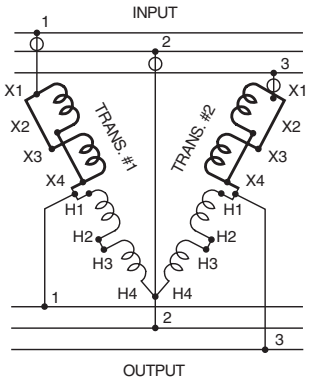


FIG. CC **OPEN DELTA**

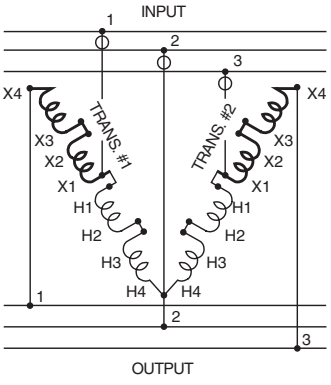


FIG. DD **OPEN DELTA**

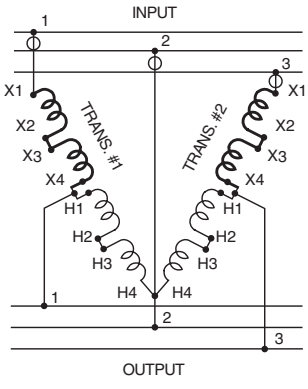


FIG. EE **OPEN DELTA**

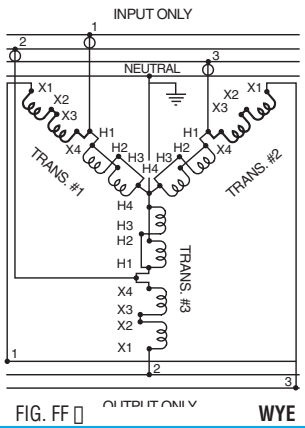


FIG. FF ▯ **WYE**

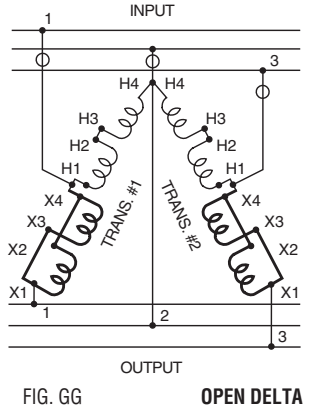


FIG. GG **OPEN DELTA**

① The symbol O used in these connection diagrams indicates where to field install the over-current protective device, typically a fuse or circuit breaker.

② Cannot be reverse connected.

IMPORTANT: Refer to the N.E.C. (National Electrical Code) Article 450-4 for overcurrent protection of an autotransformer. These connection diagrams are packed with each buck-boost transformer. Do not use connections other than those shown above.