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

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).

$$\text{Maximum Secondary Amps} = \frac{\text{Volts x Amps x 1.73}}{\text{Secondary Volts}}$$

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

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?

$$\text{Single Phase Amps} = \frac{\text{kVA x 1000}}{\text{Volts}}$$

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

$$\text{Single Phase kVA} = \frac{\text{Volts x Amps}}{1000}$$

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

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 135-136).

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 126 for easy 4-step selection, then go to the charts. Also, pages 15 and 17 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.

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 autotransformers.

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

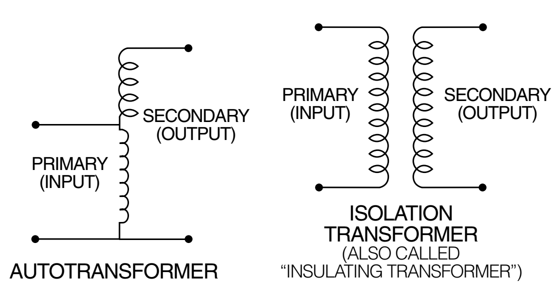
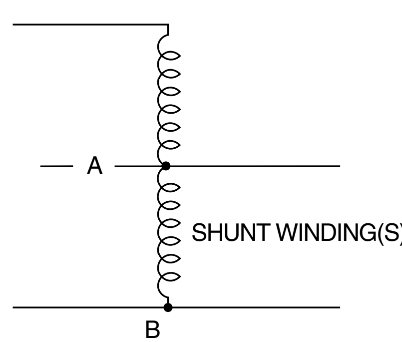


Diagram 450-4



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.

Exception: Where the rated input current of an autotransformer is 9 amperes or more and 125 percent of this current does not correspond to a standard rating of a fuse or non-adjustable circuit breaker, the next higher standard rating described in Section 240-6 shall be permitted. When the rated input current is less than 9 amperes, an overcurrent device rated or set at not more than 167 percent of the input current shall be permitted.

(b) Transformer Field-Connected as an Autotransformer. A transformer field-connected as an autotransformer shall be identified for use at elevated voltage.

28. I have noted the reprint of the N.E.C. (National Electrical Code), Article 450-4 shown in the previous question covering autotransformer overcurrent protection. Could you explain this article in detail by citing an example?
An example of an everyday application is always a good way to explain the intent of the "Code." Example: A 1 kVA transformer Catalog No. T111683 has a primary of 120 x 240V and a secondary of 12 x 24V. It is to be connected as an autotransformer at the time of installation to raise 208V to 230V single phase.

When this 1 kVA unit is connected as an autotransformer for this voltage combination, its kVA rating is increased to 9.58 kVA (may also be expressed as 9,580 VA). This is the rating to be used for determining the full load input amps and the sizing of the overcurrent protect device (fuse or breaker) on the input.

$$\text{Full Load Input Amps} = \frac{\text{9,580 Volt Amps}}{\text{208 Volts}} = \text{46 Amps}$$

When the full load current is greater than 9 amps, the overcurrent protective device (usually a fuse or non-adjustable breaker) amp rating can be up to 125 percent of the full load rating of the autotransformer input amps.

Max. amp rating of the overcurrent device = 46 amps x 125% = 57.5 amps

The National Electrical Code, Article 450-4 (a) Exception, permits the use of the next higher standard ampere rating of the overcurrent device. This is shown in Article 240-6 of the N.E.C.

Max. size of the fuse or circuit breaker = 60 amps

SELECTING A BUCK-BOOST TRANSFORMER

You should have the following information before selecting a buck-boost transformer.

Line Voltage — The voltage that you want to buck (decrease) or boost (increase). This can be found by measuring the supply line voltage with a voltmeter.

Load Voltage — The voltage at which your equipment is designed to operate. This is listed on the nameplate of the load equipment.

Load kVA or Load Amps — You do not need to know both — one or the other is sufficient for selection purposes. This information usually can be found on the nameplate of the equipment that you want to operate.

Frequency — The supply line frequency must be the same as the frequency of the equipment to be operated — either 50 or 60 cycles.

Phase — The supply line should be the same as the equipment to be operated — either single or three phase.

Four Step Selection

1. A series of LINE VOLTAGE and LOAD VOLTAGE combinations are listed across the top of each selection chart. Select a LINE VOLTAGE and LOAD VOLTAGE combination from ANY of the charts that comes closest to matching the LINE VOLTAGE and LOAD VOLTAGE of your application.

2. Read down the column you have selected until you reach either the LOAD kVA or LOAD AMPS of the equipment you want to operate. You probably will not find the exact value of LOAD kVA or LOAD AMPS so go to the next higher rating.

3. From this point, read across the column to the far left-hand side and you have found the catalog number of the exact buck-boost transformer you need. Refer to the catalog number listing on page 133 and 135 for dimensions.

4. CONNECT the transformer according to the connection diagram specified at the bottom of the column where you selected YOUR LINE VOLTAGE and LOAD VOLTAGE combination. Connection diagrams are found at the end of this section.

This same connection information is packed with each buck-boost transformer.

240 X 480 PRIMARY VOLTS — 24/48 SECONDARY VOLTS — 60 Hz (CONT.)

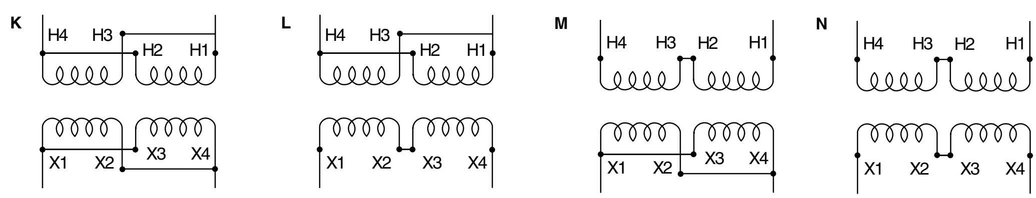
Catalog Number	Insulating Transformer Rating	Secondary Maximum Current Output 24 V	Secondary Maximum Current Output 48 V	Height (Inches)(Cm.)	Width (Inches)(Cm.)	Depth (Inches)(Cm.)	Weight (Lbs.)(Kg.)	Dimensional Drawings
T137922	2.00 kVA	83.20	41.60	13.0 (33.0)	5.5 (14.0)	5.1 (13.0)	38 (17.2)	B
T137923	3.00 kVA	125.00	62.50	11.5 (29.2)	10.3 (26.2)	7.1 (18.1)	55 (24.9)	C
T137924	5.00 kVA	208.00	104.00	14.3 (36.5)	10.3 (26.2)	7.1 (18.1)	75 (34.0)	C
T243570	7.50 kVA	312.00	156.00	20.8 (52.9)	11.1 (28.2)	10.8 (27.5)	135 (61.2)	D
T243571	10.00 kVA	416.00	208.00	20.8 (52.9)	11.7 (29.8)	11.5 (29.4)	160 (72.6)	D

240 X 480 PRIMARY VOLTS — 24/48 SECONDARY VOLTS — 60 Hz NEW NEMA 4X

Catalog Number	Insulating Transformer Rating	Secondary Maximum Current Output 24 V	Secondary Maximum Current Output 48 V	Height (Inches)(Cm.)	Width (Inches)(Cm.)	Depth (Inches)(Cm.)	Weight (Lbs.)(Kg.)	Dimensional Drawings
B1250V0300X	0.25 kVA	10.40	5.20	8.7 (22.0)	4.1 (10.4)	3.9 (9.9)	10 (4.5)	J
B1500V0300X	0.50 kVA	20.80	10.40	9.7 (24.6)	4.7 (12.0)	4.5 (11.4)	15 (6.8)	J
B1750V0300X	0.75 kVA	31.20	15.60	9.7 (24.6)	4.7 (12.0)	4.5 (11.4)	19 (8.6)	J
B1001K0300X	1.00 kVA	41.60	20.80	12.5 (31.7)	5.5 (13.9)	5.1 (13.0)	24 (10.9)	J
B1105K0300X	1.50 kVA	62.40	31.20	12.5 (31.7)	5.5 (13.9)	5.1 (13.0)	30 (13.6)	J
B1002K0300X	2.00 kVA	83.20	41.60	12.5 (31.7)	5.5 (13.9)	5.1 (13.0)	38 (17.2)	J
B1003K0300X	3.00 kVA	125.00	62.50	14.0 (35.5)	10.3 (26.1)	7.1 (18.1)	55 (24.9)	J
B1005K0300X	5.00 kVA	208.00	104.0	14.0 (35.5)	10.3 (26.1)	7.1 (18.1)	75 (34.0)	J
B1007K0300X	7.50 kVA	312.00	156.0	21.1 (53.8)	13.5 (34.2)	10.8 (27.5)	135 (61.2)	J
B1010K0300X	10.00 kVA	416.00	208.00	21.1 (53.8)	13.5 (34.2)	10.8 (27.5)	160 (72.6)	J

Dimensional Drawings page 136.

LOW VOLTAGE LIGHTING WIRING DIAGRAMS



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

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

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