

Jefferson Electric Buck-Boost Transformers

What is a buck-boost transformer?

Buck-boost transformers are designed to maximize the performance and life of electrical equipment. They are typically used to power loads with specific voltage requirements that differ from the available line voltage.

The 2008 NEC Handbook Section 210.9 provides the following definition for a buck-boost transformer:

A buck-boost transformer is classified as an autotransformer. A buck-boost transformer provides a means of raising (boosting) or lowering (bucking) a supply line voltage by a small amount (usually no more than 20 percent).

A buck-boost is a transformer with two primary windings (H1-H2 and H3-H4) and two secondary windings (X1-X2 and X3-X4). Its primary and secondary windings are connected so that the electrical characteristics are changed from a transformer that has its primary and secondary windings isolated from each other to one that has primary and secondary windings connected to buck or boost the voltage as an autotransformer, correcting voltage by up to 20 percent.

A single unit is used to boost or buck single-phase voltage. Two or three units are used to boost or buck three-phase voltage. An autotransformer requires little physical space, is economical, and above all, is efficient.

A Buck-Boost transformer can have two main applications:

1. When connected as an autotransformer, you can buck (lower) or boost (raise) available line voltage anywhere from 5 to 20 percent.
2. When connected as an isolation transformer, they can be used to step-down supply power to low voltage circuits at the nameplate rating listed.

Standards/Approvals

Built in accordance with UL1446, CAN/CSA - C22.2 No. 0

Agency Approval UL File #E4466



Applications*

- Air conditioners
- Heating elements
- Motor applications (not motor control circuits per NFPA 79 9.1.1.1)
- 77 volt supply for lighting systems

Features

- Encapsulated with electrical grade resin
- Cores of high-quality electrical steel
- Aluminum/copper windings (see nameplate for product specific information)
- 60Hz operation
- NEMA 3R-rated enclosures
- 135°C temperature rise, 180°C insulation class or 95°C temperature rise, 130°C insulation class depending on kVA size
- Heat-cured ASA-61 gray powder coat finish
- Slotted mounting holes for quick and easy mounting
- Permanently affixed wiring diagram
- 10-year limited warranty (limited to mfg. defects)
- Single-phase encapsulated isolation transformer ratings 50VA to 2kVA
- Ambient temperature 0 - 25°C (32 - 77°F) (Per UL506, UL5085-1, 2 General Purpose Transformers)

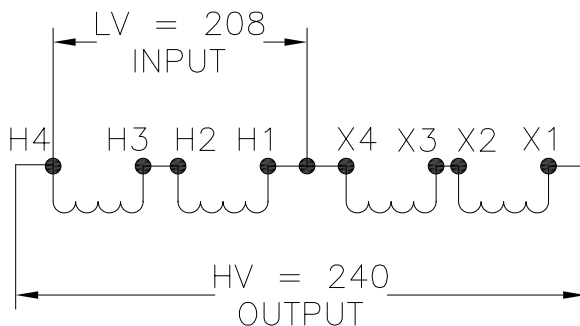


* Note: Buck-boost transformers do not compensate for fluctuating line voltages. They should only be used when line voltage is relatively constant.

Buck-Boost Single-phase Connections

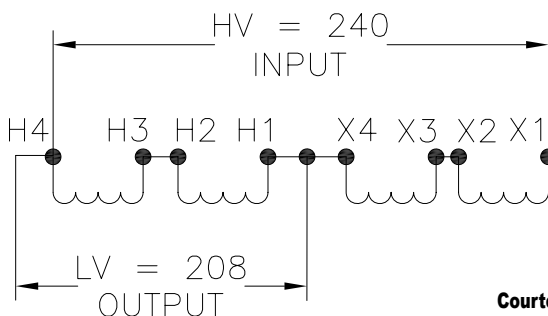
NEC Handbook 2008 Exhibit 210.18 Typical single-phase connection diagrams for buck or boost transformers connected as autotransformers to change 240 volts single-phase to 208 volts and vice versa.

Boost (increase)



HV = High Voltage
LV = Low Voltage

Buck (decrease)



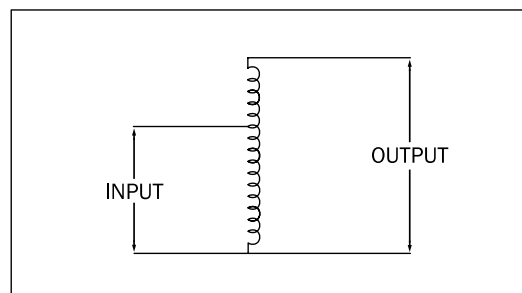
Courtesy of NFPA, from 2008 Handbook

Difference between an autotransformer and an isolation transformer

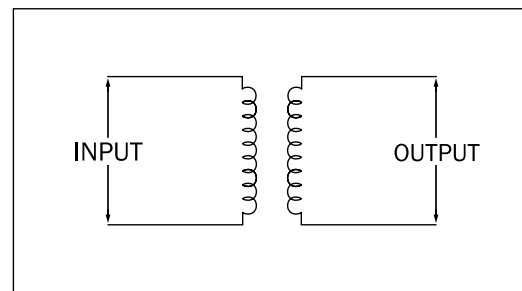
The principal difference between an autotransformer and an isolation transformer is the separation of secondary windings. In an autotransformer, the input (or primary) and the output (or secondary) are electrically connected, while in an isolation transformer they are completely separated, as shown to the right.

Because autotransformers require fewer windings and smaller cores, they are typically lighter and less costly than conventional isolation transformers with the same ratings. Autotransformers do have some performance advantages too. They have increased power handling capability, flatter frequency response, lower insertion loss and lower distortion than conventional transformers of similar size and cost. They do not, however, provide electrical isolation or stabilize fluctuating supply line voltages.

Autotransformers are best suited for applications where the line voltage needs to be matched to a protected piece of equipment, for example to adapt a piece of equipment manufactured in one country to operate in another where the line voltage is slightly different. Autotransformers are a smart choice if the difference between the input and desired output voltages is nominal.



Autotransformer ("Autoformers")



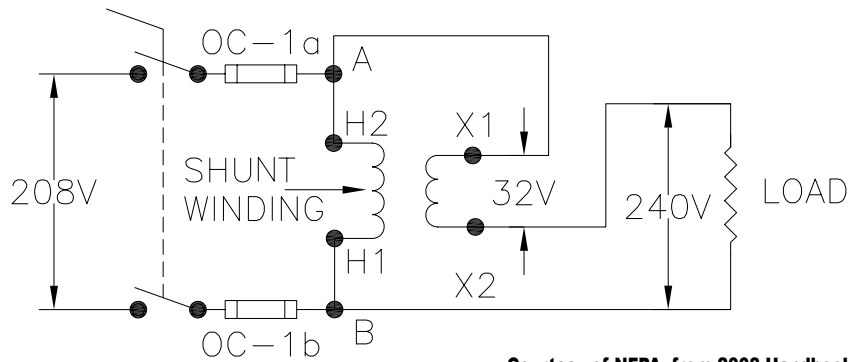
Isolation (or Insulating) Transformer

Fusing Buck-Boost Transformers

The method for determining the correct size overcurrent protection for an autotransformer is covered in the 2008 National Electric Code (NEC) 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. Where this calculation does not correspond to a standard rating of a fuse or nonadjustable circuit breaker and the rated input current is 9 amperes or more, the next higher standard rating described in 240.6 shall be permitted. 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 Exhibit 450.6 (below).

Exhibit 450.6 provides an example of overcurrent protection for an autotransformer. It shows a two-winding, single-phase transformer connected to boost a 208-volt supply to 240 volts. The autotransformer is provided with a two-pole disconnect switch with both overcurrent devices (OC-1a and OC-1b) located on the supply side of the autotransformer.



Courtesy of NFPA, from 2008 Handbook

Buck-Boost Transformer Selection Information

How to select the proper transformer

To select the proper transformer for buck-boost applications, determine the following first:

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 is sufficient for selection purposes. This information usually can be found on the nameplate of the equipment that you want to operate.

Supply Line and Equipment Frequencies

The supply line frequency must be the same as the frequency of the equipment to be operated. This will be 60 Hz for buck-boost transformers.

Number of Phases

Single-phase or three-phase line and load should match because a transformer is not capable of converting single-phase to three-phase.

The Type of Electrical Configuration

Delta or Wye.

How to use the selection charts on the following pages

1. Find the appropriate single-phase, three-phase delta or three-phase wye table.
2. Read across the appropriate input/output voltage rows and find the nearest ratio of required load voltage to line voltage for the application desired. (High voltage (HV) and low voltage (LV) may be either input or output voltage depending on the circumstances.)
3. Reading vertically down the column beginning with your application voltage ratio, locate in one of the kVA rows a kVA capacity equal to or larger than your load requirement.
4. Now move left across the kVA row to locate the appropriate transformer catalog number for your application.

Example:

(Assume the following information)

1. A reasonably constant line voltage of 200 volts.
2. A required equipment voltage of 236 volts.
3. 1.6 kVA load capacity needed.
4. Single-phase line and equipment.

In the voltage rows, 208 is closest to our line voltage of 200. The 236 high voltage meets our requirements.

Reading vertically down this column, find 1.8 kVA, the closest larger kVA to our required 1.6 load kVA.

Moving left across this row, you will find the transformer catalog number to be 416-1221-000.

Buck-Boost Single-Phase Selection Chart

Single-Phase Connection										
Part Number	Input or Output	LV	100	109	120	120	208	218	240	240
		HV	120	120	132	144	230	240	252	264
416-1100-000	LV Amps		2.5	4.6	4.6	2.5	2.3	2.3	4.4	2.3
	kVA		0.3	0.5	0.6	0.3	0.5	0.5	1.1	0.6
	HV Amps		2.1	4.2	4.2	2.1	2.1	2.1	4.2	2.1
416-1101-000	LV Amps		5.0	9.2	9.2	5.0	4.6	4.6	8.8	4.6
	kVA		0.5	1.0	1.1	0.6	1.0	1.0	2.1	1.1
	HV Amps		4.2	8.3	8.3	4.2	4.2	4.2	8.3	4.2
416-1121-000	LV Amps		12.5	22.9	22.9	12.5	11.5	11.5	21.9	11.5
	kVA		1.3	2.5	2.8	1.5	2.4	2.5	5.3	2.8
	HV Amps		10.4	20.8	20.8	10.4	10.4	10.4	20.8	10.4
Wiring Diagram			2	1	1	2	4	4	3	4
Part Number	Input or Output	LV	95	106	120	120	208	212	225	240
		HV	120	120	136	152	236	240	240	272
416-1221-000	LV Amps		9.9	17.7	17.7	9.9	8.9	8.9	16.7	8.9
	kVA		0.9	1.9	2.1	1.2	1.8	1.9	3.8	2.1
	HV Amps		7.8	15.6	15.6	7.8	7.8	7.8	15.6	7.8
416-1231-000	LV Amps		19.8	35.4	35.4	19.8	17.7	17.7	33.3	17.7
	kVA		1.9	3.8	4.3	2.4	3.7	3.8	7.5	4.3
	HV Amps		15.6	31.3	31.3	15.6	15.6	15.6	31.3	15.6
416-1271-000	LV Amps		79.0	142.0	142	79	71.0	71.0	133.0	71.0
	kVA		7.5	15.0	17.0	9.5	14.7	15.0	30.0	17.0
	HV Amps		63.0	125.0	125.0	63.0	63.0	63.0	125.0	63.0
Wiring Diagram			2	1	1	2	4	4	3	4

Buck-Boost 3-Phase Open Delta Selection Chart

Please note: Three-phase open delta connections require two transformers.

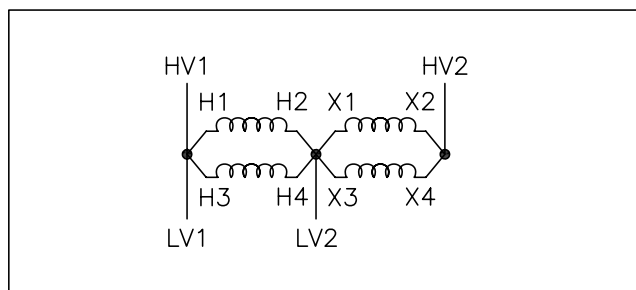
Three-Phase Open Delta Connection														
Part Number	Input or Output	LV	208	218	229	240	240	Part Number	Input or Output	LV	208	212	225	240
		HV	230	240	240	252	264			HV	236	240	240	272
<u>416-1100-000</u>	LV Amps	2.3		2.3	4.4	4.4	2.3	<u>416-1221-000</u>	LV Amps	8.9		8.9	16.7	8.9
	kVA	0.8		0.9	1.7	1.8	1.0		kVA	3.2		3.3	6.5	3.7
	HV Amps	2.1		2.1	4.2	4.2	2.1		HV Amps	7.8		7.8	15.6	7.8
<u>416-1101-000</u>	LV Amps	4.6		4.6	8.8	8.8	4.6	<u>416-1231-000</u>	LV Amps	17.7		17.7	33.3	17.7
	kVA	1.7		1.7	3.5	3.6	1.9		kVA	6.4		6.5	13.0	7.4
	HV Amps	4.2		4.2	8.3	8.3	4.2		HV Amps	15.6		15.6	31.3	15.6
<u>416-1121-000</u>	LV Amps	11.5		11.5	21.9	21.9	11.5							
	kVA	4.1		4.3	8.7	9.1	4.8							
	HV Amps	10.4		10.4	20.8	20.8	10.4							
Wiring Diagram			10	10	9	9	10	Wiring Diagram			10	10	9	10

Buck-Boost 3-Phase Wye Selection Chart

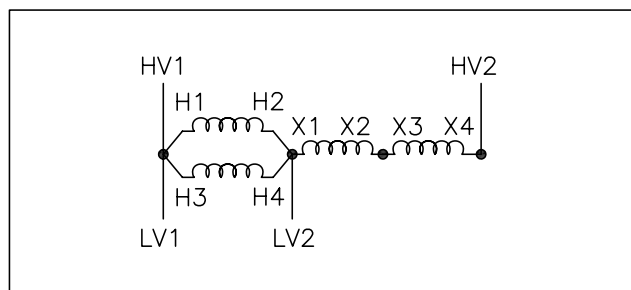
Please note: Three-phase wye delta connections require three transformers.

Three-Phase Wye Connection										
Part Number	Input or Output	LV	173	189	208	208	378	397	416	416
		HV	208	208	229	249	416	416	437	457
416-1100-000	LV Amps		2.5	1.8	4.6	2.5	2.3	4.4	4.4	2.3
	kVA		0.7	0.6	1.7	0.9	1.5	3.0	3.2	1.7
	HV Amps		2.1	1.6	4.2	2.1	2.1	4.2	4.2	2.1
416-1101-000	LV Amps		5.0	3.5	9.2	5.0	4.6	8.8	8.8	4.6
	kVA		1.5	1.2	3.3	1.8	3.0	6.0	6.3	3.3
	HV Amps		4.2	3.1	8.3	4.2	4.2	8.3	8.3	4.2
416-1121-000	LV Amps		12.5	22.9	22.9	12.5	11.5	21.9	21.9	11.5
	kVA		3.7	7.5	8.3	4.5	7.5	15.0	15.8	8.3
	HV Amps		10.4	20.8	20.8	10.4	10.4	20.8	20.8	10.4
Wiring Diagram			6	5	5	6	8	7	7	8
Part Number	Input or Output	LV	164	183	208	208	367	390	416	416
		HV	208	208	235	263	416	416	443	471
416-1221-000	LV Amps		9.9	17.7	17.7	9.9	8.9	16.7	16.7	8.9
	kVA		2.8	5.6	6.4	3.6	5.6	11.3	12.0	6.4
	HV Amps		7.8	15.6	15.6	7.8	7.8	15.6	15.6	7.8
416-1231-000	LV Amps		19.8	35.4	35.4	19.8	17.7	33.3	33.3	17.7
	kVA		5.6	11.2	12.8	7.1	11.3	22.5	24.0	12.8
	HV Amps		15.6	31.3	31.3	15.6	15.6	31.3	31.3	15.6
416-1271-000	LV Amps		79.0	142.0	142.0	79.0	71.0	133.0	133.0	71.0
	kVA		22.5	44.9	51.0	28.5	45.0	90.1	96.1	51.0
	HV Amps		63.0	125.0	125.0	63.0	63.0	125.0	125.0	63.0
Wiring Diagram			6	5	5	6	8	7	7	8

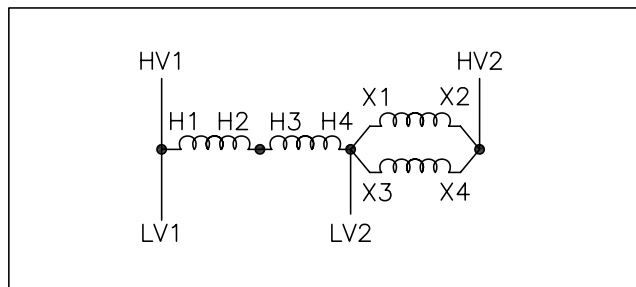
Buck-Boost Wiring Diagrams



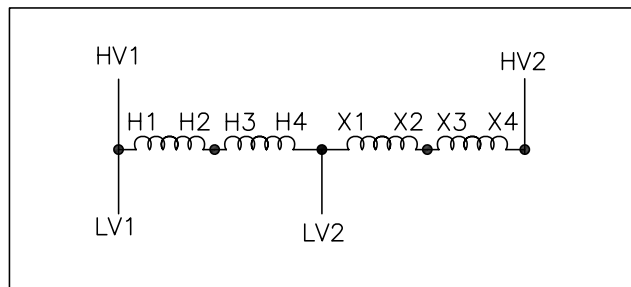
Wiring Diagram 1



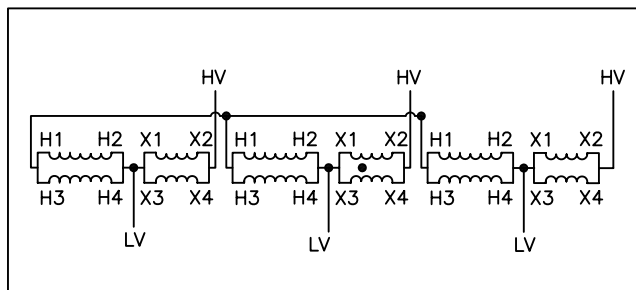
Wiring Diagram 2



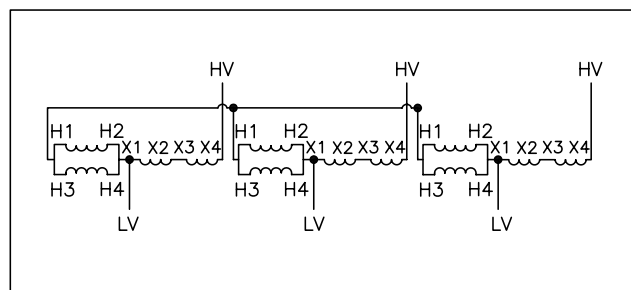
Wiring Diagram 3



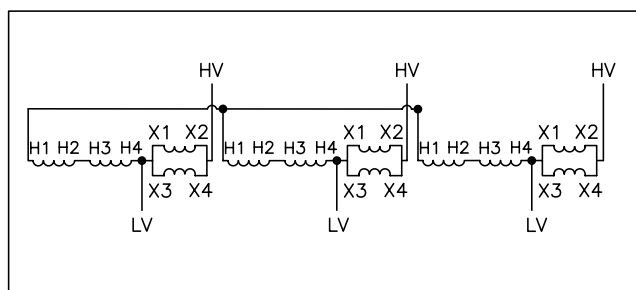
Wiring Diagram 4



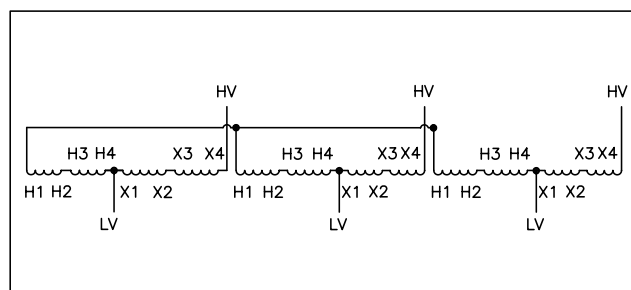
Wiring Diagram 5



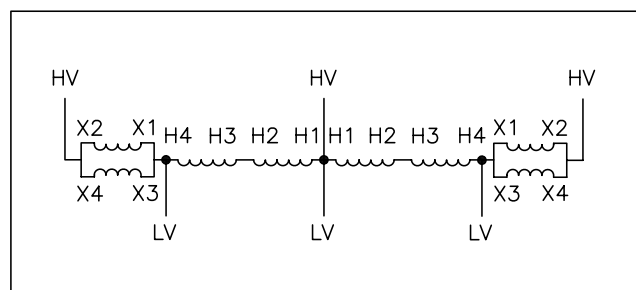
Wiring Diagram 6



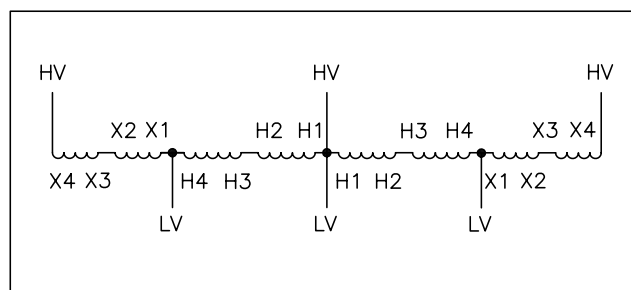
Wiring Diagram 7



Wiring Diagram 8



Wiring Diagram 9



Wiring Diagram 10

Note: Wiring diagrams 11 and 12 can be found in the product insert.

Buck-Boost Transformers

General Specifications and Terminations

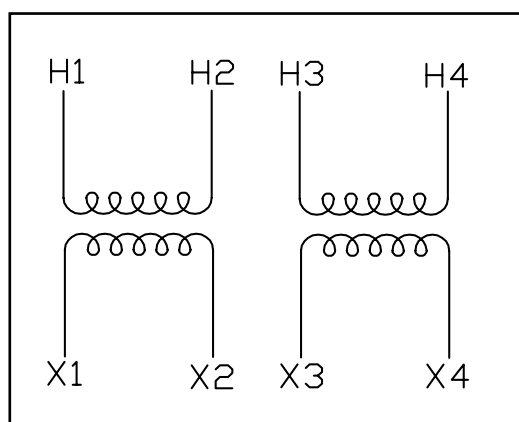
Single-Phase - 600V Class Transformers General Specifications										
	KVA	Part Number	Temp. Rise °C	Termination		Height (in.)	Width (in.)	Depth (in.)	Shipping Weight (lbs.)	Price
				HV	LV					
120 x 240 V 12/24 V 60 Hz	0.05	<u>416-1100-000</u>	95	#18 AWG Leads	#18 AWG Leads	8.03	3.31	3.08	4.4	Retired
	0.10	<u>416-1101-000</u>		#18 AWG Leads	#18 AWG Leads	8.03	3.31	3.08	4.8	Retired
	0.25	<u>416-1121-000</u>		#18 AWG Leads	#14 AWG Leads	8.03	3.31	3.08	6.7	Retired
	KVA	Part Number	Temp. Rise °C	Termination		Height (in.)	Width (in.)	Depth (in.)	Shipping Weight (lbs.)	Price
				HV	LV					
120 x 240 V 16/32 V 60 Hz	0.25	<u>416-1221-000</u>	95	#18 AWG Leads	#14 AWG Leads	8.03	3.31	3.08	6.7	Retired
	0.50	<u>416-1231-000</u>		#18 AWG Leads	#10 AWG Leads	10.19	5.06	4.59	15.0	Retired
	2	<u>416-1271-000</u>	135	#16 AWG Leads	#6 AWG Leads	12.50	6.69	5.34	41.2	Retired

Buck-Boost Transformer Connections

Used as an Isolation Transformer

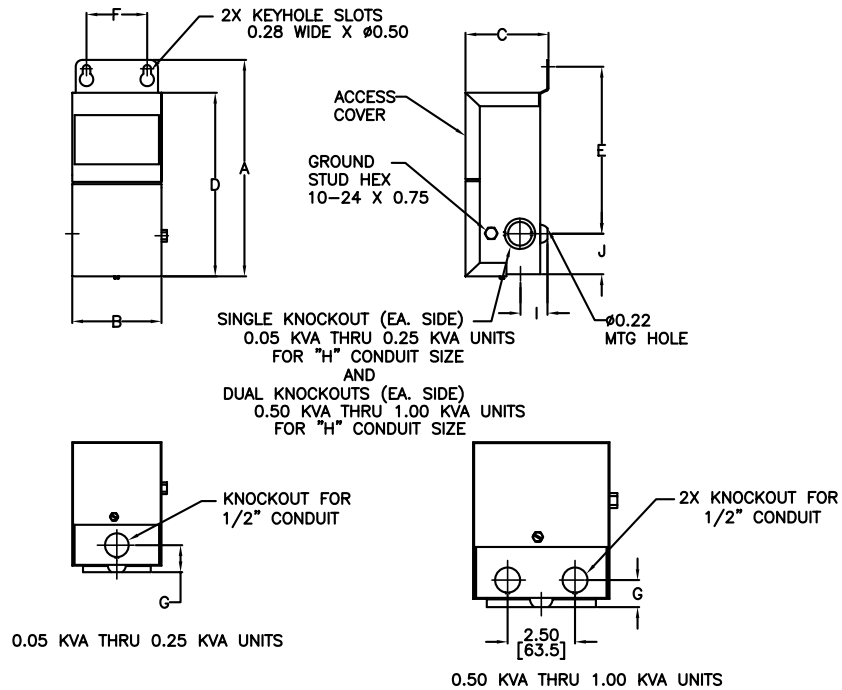
Maximum Secondary Current			
KVA	Part Number	Maximum Secondary Amperage	
		12V	24V
0.05	<u>416-1100-000</u>	4.16	2.08
0.10	<u>416-1101-000</u>	8.33	4.16
0.25	<u>416-1121-000</u>	20.8	10.4
KVA	Part Number	Maximum Secondary Amperage	
		16V	32V
0.25	<u>416-1221-000</u>	15.6	7.81
0.50	<u>416-1231-000</u>	31.2	15.6
2	<u>416-1271-000</u>	125	62.5

Isolation Transformer Connections

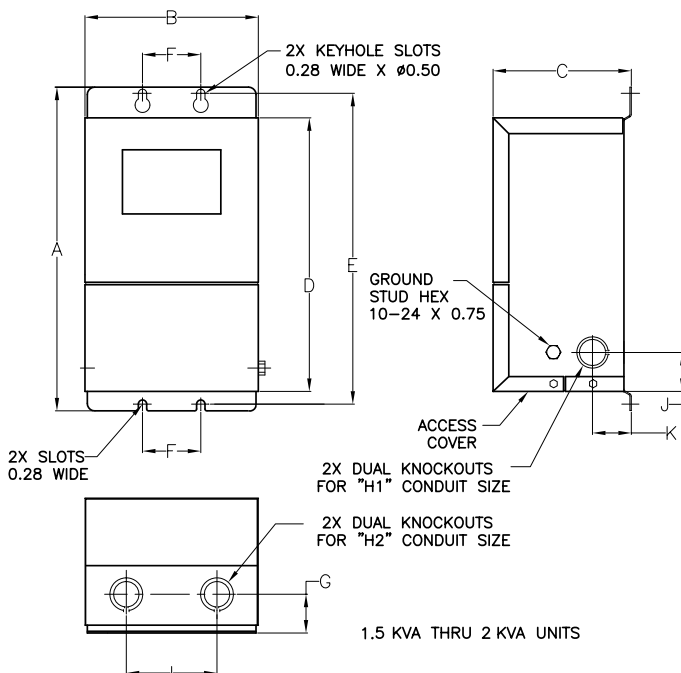


Connections				
Primary Volts		Interconnect	Primary Lines to Connect to	
240		H2 to H3	H1-H4	
120		H1 to H3	H1-H4	
		H2 to H4		
Secondary Volts		Interconnect	Secondary Lines to Connect to	
24	32	X2 to X3	X1-X4	
12	16	X1 to X3	X1-X4	
		X2 to X4		

Dimensional Diagrams



Housing Dimensions (in [mm])		
Part Numbers	416-1100-000 416-1101-000 416-1121-000 416-1221-000	416-1231-000
A	8.03 [203.96]	10.19 [258.83]
B	3.31 [80.07]	5.06 [128.52]
C	3.08 [78.23]	4.56 [115.82]
D	6.81 [172.97]	9.06 [230.12]
E	6.19 [157.23]	8.38 [212.85]
F	2.25 [57.15]	2.25 [57.15]
G	1.00 [25.4]	1.00 [25.4]
H	1/2" [12.7]	0.5 [12.7] & 0.75 [19.05]
I	1.00 [25.4]	1.25 [31.75]
J	1.50 [38.1]	1.50 [38.1]



Housing Dimensions (in [mm])	
Part Numbers	416-1271-000
A	12.50 [317.5]
B	6.69 [169.93]
C	5.34 [135.64]
D	10.56 [268.22]
E	12.00 [304.8]
F	2.25 [57.15]
G	1.50 [38.1]
H1	0.5 [12.7] & 0.75 [19.05]
H2	0.5 [12.7] & 0.75 [19.05]
I	3.5 [88.9]
J	1.50 [38.1]
K	1.50 [38.1]

Buck-Boost Transformer Cross-Reference

Automation Direct	Hammond	Acme	Federal	Square D	Siemens	Micron	GE	Sola-Hevi Duty	Cutler Hammer
<u>416-1100-000</u>	QC05ERCB	T1-81047	SB12N.050F	50SV43A	050BB1224	J050A1EA1A01	9T51B0102	HS19B50	S10N04A81N
<u>416-1101-000</u>	QC10ERCB	T1-81048	SB12N.100F	100SV43A	100BB1224	J100A1EA1A01	9T51B0104	HS19B100	S10N04A82N
<u>416-1121-000</u>	QC25ERCB	T1-81050	SB12N.250F	250SV43B	205BB1224	J250A1EA1A02	9T51B0107	HS19B250	S10N04A26N
<u>416-1221-000</u>	QC25ESCB	T1-81057	SB16N.250F	250SV46B	205BB1632	J250A1EB1A02	9T51B0127	HS20B250	S10N06A26N
<u>416-1231-000</u>	QC50ESCB	T1-81058	SB16N.500F	500SV46B	505BB1632	J500A1EB1A02	9T51B0128	HS20F500B	S10N06A51N
<u>416-1271-000</u>	Q002ESCF	T-1-13075	SB16N2F	2S46F	2BB1632	J002K1EB1A02	9T51B0132	HS20F2A	S10N06A02N

Note: All cross reference results are to the best of our knowledge. Please compare and verify all product specifications before selecting.