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Low-voltage dry-type buck-boost transformers

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Overview

Eaton's buck-boost transformers are ideally suited to applications where the available voltage needs to be slightly increased ("boosted") or decreased ("bucked") to be used in a specific application. When buck-boost transformers are wired as auto-transformers, they can be used to accomplish this bucking or boosting of voltage. Buck-boost transformers are single-phase encapsulated transformers and are available in three voltage combinations.

- 120 x 240–12/24
- 120 x 240–16/32
- 240 x 480–24/48

Buck-boost transformers are available in ratings 0.05 kVA through 7.5 kVA. These transformers can also be used at their nameplate voltages for applications such as low-voltage interior or landscape lighting.

Types EP, EPT

- Encapsulated design
- Suitable for indoor or outdoor applications
- Totally enclosed, non-ventilated enclosures
- Enclosures are NEMA® 3R rated
- Mountable in any position indoors and upright-only outdoors
- 180 °C insulation system
- 115 °C rise standard; 80 °C rise optional
- Available in single-phase ratings through 7.5 kVA
- Encapsulated transformers, such as buck-boost and low-voltage lighting transformers, are specifically excluded from the scope of U.S. DOE energy efficiency requirements

Application Description

A buck-boost transformer is used to provide an economical method of correcting a lower or higher voltage rating more suitable for efficient operation of electrical equipment. Type EP buck-boost transformers are small kVA, single-phase transformers with dual primary and dual secondary windings, and are usually connected as autotransformers by using one unit for single-phase applications and either two or three units banked for three-phase operation. They are primarily used for motor operation and should not be used for motor control circuits, to correct fluctuating line voltage or to obtain a neutral on a delta system. Buck-boost transformers are ideally suited for use with low-voltage lighting systems, such as outdoor lighting.

Features, Benefits and Functions

- 60 Hz operation
- 600 volt class insulation
- Short-term overload capability as required by ANSI
- Meet NEMA ST-20 sound levels

Standards and Certifications

- UL® listed
- CSA® certified

Listed

Industry Standards

All Eaton dry-type distribution transformers are built and tested in accordance with applicable NEMA, ANSI and IEEE® Standards. All 600 V class transformers are UL listed unless otherwise noted.

Seismically Qualified

Eaton-manufactured dry-type distribution transformers are seismically qualified, and exceed requirements of the International Building Code (IBC) and California Code Title 24.

How to Select a Buck-Boost Transformer

For quick selection data, refer to the tables on this and the following pages.

Selection Requirements

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 Amperes or Load kVA

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—Eaton's buck-boost transformers operate at 60 Hz only.

Phase

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

Transformer Interconnection

For three-phase applications, interconnections of transformers should be made in a junction box. Two or three transformers may be used depending on an open delta (2) or wye (3) connection.

5-Step Selector

The tables that follow will simplify the selection of the buck-boost transformers. There are no calculations needed; simply follow these five steps:

1. Refer to the table having the same output voltage as the equipment you want to operate. For example, if you are installing a 240 V 6 kVA single-phase load use selection table on the page.
2. Select the available line voltage across the top of the chart that is closest to the actual supply voltage. Therefore, for example, if the available line voltage is 213 V, use the 212 V column.
3. Read down the column until you reach an output kVA or amps rating equal to or greater than the load requirements. Since 6 kVA, in the example, is not listed, use the next higher rating, or 7.5 kVA.
4. Read across to the far left columns for the catalog number and quantity of transformers for your application. In this case, you will need one (1) catalog number S10N06P01P.
5. Connect the buck-boost transformer(s) you have selected in accordance with the connection diagram specified at the bottom of the available line voltage column. In this example, Diagram "F" would be used.

Note: For single-phase connections and three-phase open delta connections, inputs and outputs may be reversed. kVA capacity remains constant.

Frequency

Eaton buck-boost transformers are designed for 60 Hz operation.

Overload Capability

Short-term overload is designed into transformers as required by ANSI. Dry-type distribution transformers will deliver 200% nameplate load for one-half hour, 150% load for one hour, and 125% load for four hours without being damaged, provided that a constant 50% load precedes and follows the overload.

See ANSI C57.96-01.250 for additional limitations.

Continuous overload capacity is not deliberately designed into a transformer because the design objective is to be within the allowed winding temperature rise with nameplate loading.

Insulation System and Temperature Rise

The design life of transformers having different insulation systems is the same; the lower temperature systems are designed for the same life as the higher temperature systems.

Eaton's encapsulated transformers are manufactured using a 180 °C insulation system. Required performance is obtained without exceeding the insulation system rating at rated temperature rise in a 40 °C maximum ambient, with an average ambient temperature of 30 °C over a 24-hour period.

All insulation materials are flame-retardant and do not support combustion as defined in ASTM Standard Test Method D635.

Enclosures

Eaton encapsulated buck-boost transformers use a NEMA 3R rated enclosure.

Winding Terminations

Primary and secondary windings are terminated in the wiring compartment. Encapsulated units have copper leads or stabs brought out for connections. **Lugs are not supplied with these transformers.** Eaton recommends that external cables be rated 90 °C (sized at 75 °C ampacity) for encapsulated designs.

Series-Multiple Windings

Series-multiple windings consist of two similar coils in each winding that can be connected in series or parallel (multiple). Transformers with series-multiple windings are designated with an "x" or "/" between the voltage ratings, such as voltages of "120/240" or "240 x 480."

If the series-multiple winding is designated by an "x," the winding can be connected only for a series or parallel. With the "/" designation, a mid-point also becomes available in addition to the series or parallel connection. As an example, a 120 x 240 winding can be connected for either 120 (parallel) or 240 (series), but a 120/240 winding can be connected for 120 (parallel), 240 (series) or 240 with a 120 mid-point.

Sound Levels

All Eaton 600 volt class general-purpose dry-type distribution transformers are designed to meet NEMA ST-20 sound levels listed here. These are the sound levels measured in a soundproof environment. Actual sound levels measured at an installation will likely be higher due to electrical connections and environmental conditions. Lower sound levels are available and should be specified when the transformer is going to be installed in an area where sound may be a concern.

Table 19.4-1. Encapsulated Sound Level

kVA Range	NEMA ST-20 Average Sound Level, dB
Up to 9.0	45

Selection Tables

Table 19.4-2. Single-Phase 115 V Output Required, 60 Hz

Units Required ①	Unit kVA	Input Available Voltage										Catalog Number
		84 Output kVA	Amps	91 Output kVA	Amps	96 Output kVA	Amps	100 Output kVA	Amps	102 Output kVA	Amps	
1	0.05	—	—	—	—	0.24	2.09	—	—	—	—	**S10N04A81N**
1	0.05	0.13	1.14	0.18	1.56	—	—	0.31	2.70	0.36	3.13	**S10N06A81N**
1	0.10	—	—	—	—	0.48	4.17	—	—	—	—	**S10N04A82N**
1	0.10	0.26	2.29	0.36	3.12	—	—	0.62	5.41	0.72	6.25	**S10N06A82N**
1	0.15	—	—	—	—	0.72	6.25	—	—	—	—	**S10N04A83N**
1	0.15	0.39	3.44	0.54	4.69	—	—	0.93	8.12	1.08	9.37	**S10N06A83N**
1	0.25	—	—	—	—	1.2	10.4	—	—	—	—	**S10N04P26P**
1	0.25	0.659	5.73	0.899	7.81	—	—	1.56	13.5	1.8	15.6	**S10N06P26P**
1	0.50	—	—	—	—	2.4	20.8	—	—	—	—	**S10N04P51P**
1	0.50	1.32	11.5	1.8	15.6	—	—	3.11	27.1	3.59	31.2	**S10N06P51P**
1	0.75	—	—	—	—	3.6	31.2	—	—	—	—	**S10N04P76P**
1	0.75	1.98	17.2	2.7	23.4	—	—	4.67	40.6	5.39	46.8	**S10N06P76P**
1	1	—	—	—	—	4.79	41.7	—	—	—	—	**S10N04P01P**
1	1	2.64	22.9	3.59	31.2	—	—	6.23	54.1	7.19	62.5	**S10N06P01P**
1	1.5	—	—	—	—	7.2	62.5	—	—	—	—	**S10N04P16P**
1	1.5	3.95	34.4	5.39	46.9	—	—	9.34	81.2	10.8	93.7	**S10N06P16P**
1	2	—	—	—	—	9.58	83.3	—	—	—	—	**S10N04P02P**
1	2	5.27	45.8	7.19	62.5	—	—	12.5	108	14.4	125	**S10N06P02P**
1	3	—	—	—	—	14.37	125.1	—	—	—	—	**S10N04A03N**
1	3	7.92	68.7	10.77	93.6	—	—	18.69	162.3	21.57	187.5	**S10N06A03N**
1	5	—	—	—	—	23.95	208.5	—	—	—	—	**S10N04A05N**
1	5	13.2	115	18	156	—	—	31.15	270.5	35.95	312.5	**S10N06A05N**
1	7.5	—	—	—	—	36	312	—	—	—	—	**S10N04A07N**
1	7.5	19.8	172	27	234	—	—	46.7	406	53.9	468	**S10N06A07N**
Connection Diagram ②		D		B		B		C		A		

① Additional wiring trough may be required.
② Refer to **Page 19.4-26** for buck-boost wiring diagrams.

Output voltage for lower input voltage can be found by: $\frac{\text{Rated Output Voltage}}{\text{Rated Input Voltage}}$ x Input Actual Voltage = Output New Voltage.

Output kVA available at reduced input voltage can be found by: $\frac{\text{Actual Output Voltage}}{\text{Rated Input Voltage}}$ x Output kVA = New kVA Rating.

Frame drawings/dimensions information begins on **Page 19.4-28**.

Table 19.4-2. Single-Phase 115 V Output Required, 60 Hz, continued

Units Required ①	Unit kVA	Input Available Voltage										Catalog Number
		105 Output kVA	Amps	127 Output kVA	Amps	130 Output kVA	Amps	138 Output kVA	Amps	146 Output kVA	Amps	
1	0.05	0.48	4.17	0.54	4.58	—	—	0.29	2.5	—	—	**S10N04A81N**
1	0.05	—	—	—	—	0.41	3.54	—	—	0.23	1.98	**S10N06A81N**
1	0.10	0.96	8.33	1.1	9.17	—	—	0.58	5.0	—	—	**S10N04A82N**
1	0.10	—	—	—	—	0.82	7.08	—	—	0.46	3.95	**S10N06A82N**
1	0.15	1.44	12.5	1.6	13.7	—	—	0.87	7.5	—	—	**S10N04A83N**
1	0.15	—	—	—	—	1.3	10.6	—	—	0.69	5.93	**S10N06A83N**
1	0.25	2.39	20.8	2.63	22.9	—	—	1.44	12.5	—	—	**S10N04P26P**
1	0.25	—	—	—	—	2.03	17.7	—	—	1.14	9.88	**S10N06P26P**
1	0.50	4.79	41.6	5.27	45.8	—	—	2.87	25	—	—	**S10N04P51P**
1	0.50	—	—	—	—	4.07	35.4	—	—	2.27	19.8	**S10N06P51P**
1	0.75	7.19	62.4	7.9	68.7	—	—	4.31	37.5	—	—	**S10N04P76P**
1	0.75	—	—	—	—	6.1	53.1	—	—	3.41	29.6	**S10N06P76P**
1	1	9.58	83.3	10.5	91.7	—	—	5.75	50	—	—	**S10N04P01P**
1	1	—	—	—	—	8.14	70.8	—	—	4.55	39.5	**S10N06P01P**
1	1.5	14.4	125	15.8	137	—	—	8.62	75	—	—	**S10N04P16P**
1	1.5	—	—	—	—	12.2	106	—	—	6.82	59.3	**S10N06P16P**
1	2	19.2	16.7	21.1	183	—	—	11.5	100	—	—	**S10N04P02P**
1	2	—	—	—	—	16.3	142	—	—	9.10	79.2	**S10N06P02P**
1	3	28.7	249.9	31.5	275.1	—	—	17.3	150	—	—	**S10N04A03N**
1	3	—	—	—	—	24.4	212.4	—	—	13.6	118.5	**S10N06A03N**
1	5	47.9	416.5	52.5	458.5	—	—	28.7	250	—	—	**S10N04A05N**
1	5	—	—	—	—	40.7	354	—	—	22.7	197.5	**S10N06A05N**
1	7.5	71.9	624	79	687	—	—	43.1	357	—	—	**S10N04A07N**
1	7.5	—	—	—	—	61	531	—	—	34.1	296	**S10N06A07N**
Connection Diagram ②		A		A		A		B		B		

① Additional wiring trough may be required.
② Refer to **Page 19.4-26** for buck-boost wiring diagrams.

Output voltage for lower input voltage can be found by: $\frac{\text{Rated Output Voltage}}{\text{Rated Input Voltage}}$ x Input Actual Voltage = Output New Voltage.

Output kVA available at reduced input voltage can be found by: $\frac{\text{Actual Output Voltage}}{\text{Rated Input Voltage}}$ x Output kVA = New kVA Rating.

Frame drawings/dimensions information begins on **Page 19.4-28**

Table 19.4-3. Single-Phase 120 V Output Required, 60 Hz

Units Required ①	Unit kVA	Input Available Voltage										Catalog Number
		88 Output kVA	Amps	95 Output kVA	Amps	100 Output kVA	Amps	104 Output kVA	Amps	106 Output kVA	Amps	
1	0.05	—	—	—	—	0.25	2.09	—	—	—	—	**S10N04A81N**
1	0.05	0.14	1.15	0.19	1.56	—	—	0.33	v2.70	0.38	3.13	**S10N06A81N**
1	0.10	—	—	—	—	0.50	4.17	—	—	—	—	**S10N04A82N**
1	0.10	0.28	2.29	0.38	3.12	—	—	0.65	5.41	0.75	6.25	**S10N06A82N**
1	0.15	—	—	—	—	0.75	6.25	—	—	—	—	**S10N04A83N**
1	0.15	0.41	3.44	0.56	4.69	—	—	0.98	8.12	1.12	9.37	**S10N06A83N**
1	0.25	—	—	—	—	1.25	10.4	—	—	—	—	**S10N04P26P**
1	0.25	0.687	5.73	0.937	7.81	—	—	1.62	13.5	1.87	15.6	**S10N06P26P**
1	0.50	—	—	—	—	2.5	20.8	—	—	—	—	**S10N04P51P**
1	0.50	1.37	11.5	1.87	15.6	—	—	3.25	27.1	3.75	31.2	**S10N06P51P**
1	0.75	—	—	—	—	3.75	31.2	—	—	—	—	**S10N04P76P**
1	0.75	2.06	17.2	2.82	23.4	—	—	4.87	40.6	5.62	46.8	**S10N06P76P**
1	1	—	—	—	—	5	41.7	—	—	—	—	**S10N04P01P**
1	1	2.75	22.9	3.75	31.2	—	—	6.5	54.1	7.5	62.5	**S10N06P01P**
1	1.5	—	—	—	—	7.5	62.5	—	—	—	—	**S10N04P16P**
1	1.5	4.12	34.4	5.62	46.9	—	—	9.75	81.2	11.2	93.7	**S10N06P16P**
1	2	—	—	—	—	10	83.3	—	—	—	—	**S10N04P02P**
1	2	5.5	45.8	7.5	62.5	—	—	13	108	15	125	**S10N06P02P**
1	3	—	—	—	—	15	125.1	—	—	—	—	**S10N04A03N**
1	3	8.25	68.7	11.25	93.6	—	—	19.5	162.3	22.5	187.5	**S10N06A03N**
1	5	—	—	—	—	25	208.5	—	—	—	—	**S10N04A05N**
1	5	13.75	114.5	18.75	156	—	—	32.5	270.5	37.5	312.5	**S10N06A05N**
1	7.5	—	—	—	—	37.5	312	—	—	—	—	**S10N04A07N**
1	7.5	20.6	172	28.2	234	—	—	48.7	406	56.2	468	**S10N06A07N**
Connection Diagram ②		D		B		B		C		A		

① Additional wiring trough may be required.
② Refer to **Page 19.4-26** for buck-boost wiring diagrams.

Output voltage for lower input voltage can be found by: $\frac{\text{Rated Output Voltage}}{\text{Rated Input Voltage}}$ x Input Actual Voltage = Output New Voltage.

Output kVA available at reduced input voltage can be found by: $\frac{\text{Actual Output Voltage}}{\text{Rated Input Voltage}}$ x Output kVA = New kVA Rating.

Frame drawings/dimensions information begins on **Page 19.4-28**.

Table 19.4-3. Single-Phase 120 V Output Required, 60 Hz, continued

Units Required ①	Unit kVA	Input Available Voltage										Catalog Number
		109 Output kVA	Amps	132 Output kVA	Amps	136 Output kVA	Amps	144 Output kVA	Amps	152 Output kVA	Amps	
1	0.05	0.5	4.17	0.55	4.58	—	—	0.3	2.5	—	—	S10N04A81N
1	0.05	—	—	—	—	0.43	3.54	—	—	0.24	1.98	S10N06A81N
1	0.10	1.0	8.33	1.1	9.17	—	—	0.6	5.0	—	—	S10N04A82N
1	0.10	—	—	—	—	0.85	7.08	—	—	0.48	3.95	S10N06A82N
1	0.15	1.5	12.5	1.6	13.7	—	—	0.9	7.5	—	—	S10N04A83N
1	0.15	—	—	—	—	1.27	10.6	—	—	0.71	5.93	S10N06A83N
1	0.25	2.5	20.8	2.75	22.9	—	—	1.5	12.5	—	—	S10N04P26P
1	0.25	—	—	—	—	2.12	17.7	—	—	1.19	9.88	S10N06P26P
1	0.50	5	41.6	5.5	45.8	—	—	3	25	—	—	S10N04P51P
1	0.50	—	—	—	—	4.25	35.4	—	—	2.37	19.8	S10N06P51P
1	0.75	7.5	62.4	8.25	68.7	—	—	4.5	37.5	—	—	S10N04P76P
1	0.75	—	—	—	—	6.37	53.1	—	—	3.56	29.6	S10N06P76P
1	1	10	83.3	11	91.7	—	—	6	50	—	—	S10N04P01P
1	1	—	—	—	—	8.5	70.8	—	—	4.75	39.5	S10N06P01P
1	1.5	15	125	16.5	137	—	—	9	75	—	—	S10N04P16P
1	1.5	—	—	—	—	12.7	106	—	—	7.12	59.3	S10N06P16P
1	2	20	167	22	183	—	—	12	100	—	—	S10N04P02P
1	2	—	—	—	—	17	142	—	—	9.5	79.2	S10N06P02P
1	3	30	249.9	33	275.1	—	—	18	150	—	—	S10N04A03N
1	3	—	—	—	—	25.5	212.4	—	—	14.25	118.5	S10N06A03N
1	5	50	416.5	55	458.5	—	—	30	250	—	—	S10N04A05N
1	5	—	—	—	—	42.5	354	—	—	23.7	197.5	S10N06A05N
1	7.5	75	624	82.5	687	—	—	45	375	—	—	S10N04A07N
1	7.5	—	—	—	—	63.7	531	—	—	35.6	296	S10N06A07N
Connection Diagram ②		A		A		A		B		B		

① Additional wiring trough may be required.

② Refer to **Page 19.4-26** for buck-boost wiring diagrams.

Output voltage for lower input voltage can be found by: $\frac{\text{Rated Output Voltage}}{\text{Rated Input Voltage}}$ x Input Actual Voltage = Output New Voltage.

Output kVA available at reduced input voltage can be found by: $\frac{\text{Actual Output Voltage}}{\text{Rated Input Voltage}}$ x Output kVA = New kVA Rating.

Frame drawings/dimensions information begins on **Page 19.4-28**.

Table 19.4-4. Single-Phase 230 Volt Output Required, 60 Hz

Units Required ①	Unit kVA	Input Available Voltage										Catalog Number
		199 Output kVA	Amps	203 Output kVA	Amps	207 Output kVA	Amps	209 Output kVA	Amps	216 Output kVA	Amps	
1	0.05	—	—	—	—	0.43	1.88	0.48	2.08	—	—	**S10N04A81N**
1	0.05	0.31	1.36	0.36	1.56	—	—	—	—	0.72	3.12	**S10N06A81N**
1	0.10	—	—	—	—	0.86	3.75	0.96	4.17	—	—	**S10N04A82N**
1	0.10	0.62	2.71	0.72	3.12	—	—	—	—	1.44	6.25	**S10N06A82N**
1	0.15	—	—	—	—	1.29	5.62	1.44	6.25	—	—	**S10N04A83N**
1	0.15	0.93	4.06	1.08	4.69	—	—	—	—	2.16	9.37	**S10N06A83N**
1	0.25	—	—	—	—	2.15	9.37	2.39	10.4	—	—	**S10N04P26P**
1	0.25	1.55	6.77	1.8	7.81	—	—	—	—	3.59	15.6	**S10N06P26P**
1	0.50	—	—	—	—	4.31	18.7	4.79	20.8	—	—	**S10N04P51P**
1	0.50	3.11	13.5	3.6	15.6	—	—	—	—	7.19	31.2	**S10N06P51P**
1	0.75	—	—	—	—	6.46	28.2	7.19	31.2	—	—	**S10N04P76P**
1	0.75	4.66	20.3	5.4	23.4	—	—	—	—	10.8	46.8	**S10N06P76P**
1	1	—	—	—	—	8.62	37.5	9.58	41.7	—	—	**S10N04P01P**
1	1	6.23	27.1	7.2	31.2	—	—	—	—	14.4	62.5	**S10N06P01P**
1	1.5	—	—	—	—	12.9	56.2	14.4	62.5	—	—	**S10N04P16P**
1	1.5	9.34	40.6	10.8	46.9	—	—	—	—	21.6	93.7	**S10N06P16P**
1	2	—	—	—	—	17.2	75	19.2	83.3	—	—	**S10N04P02P**
1	2	12.5	54.2	14.4	62.5	—	—	—	—	28.7	125	**S10N06P02P**
1	3	—	—	—	—	25.8	112.5	28.7	125.1	—	—	**S10N04A03N**
1	3	18.6	81.3	21.6	93.6	—	—	—	—	43.2	187.5	**S10N06A03N**
1	5	—	—	—	—	43.1	187.5	47.9	208.5	—	—	**S10N04A05N**
1	5	31.1	135.5	36	156	—	—	—	—	72	312.5	**S10N06A05N**
1	7.5	—	—	—	—	64.6	282	71.9	312	—	—	**S10N04A07N**
1	7.5	46.6	203	54	234	—	—	—	—	108	468	**S10N06A07N**
Connection Diagram ②		G		F		G		F		E		

① Additional wiring trough may be required.
② Refer to **Page 19.4-26** for buck-boost wiring diagrams.

Output voltage for lower input voltage can be found by: $\frac{\text{Rated Output Voltage}}{\text{Rated Input Voltage}}$ x Input Actual Voltage = Output New Voltage.

Output kVA available at reduced input voltage can be found by: $\frac{\text{Actual Output Voltage}}{\text{Rated Input Voltage}}$ x Output kVA = New kVA Rating.

Frame drawings/dimensions information begins on **Page 19.4-28**.

Table 19.4-4. Single-Phase 230 V Output Required, 60 Hz, continued

Units Required ①	Unit kVA	Input Available Voltage										Catalog Number
		219 Output kVA	Amps	242 Output kVA	Amps	246 Output kVA	Amps	253 Output kVA	Amps	260 Output kVA	Amps	
1	0.05	0.96	4.16	1.0	4.38	—	—	0.53	2.29	—	—	**S10N04A81N**
1	0.05	—	—	—	—	0.77	3.34	—	—	0.41	1.77	**S10N06A81N**
1	0.10	1.92	8.33	2.01	8.75	—	—	1.05	4.58	—	—	**S10N04A82N**
1	0.10	—	—	—	—	1.53	6.67	—	—	0.82	3.54	**S10N06A82N**
1	0.15	2.87	12.5	3.02	13.1	—	—	1.58	6.87	—	—	**S10N04A83N**
1	0.15	—	—	—	—	2.3	10.0	—	—	1.22	5.31	**S10N06A83N**
1	0.25	4.79	20.8	5.03	21.9	—	—	2.63	11.5	—	—	**S10N04P26P**
1	0.25	—	—	—	—	3.83	16.7	—	—	2.04	8.85	**S10N06P26P**
1	0.50	9.58	41.6	10.1	43.7	—	—	5.27	22.9	—	—	**S10N04P51P**
1	0.50	—	—	—	—	7.67	33.3	—	—	4.07	17.7	**S10N06P51P**
1	0.75	14.4	62.4	15.1	65.6	—	—	7.9	34.4	—	—	**S10N04P76P**
1	0.75	—	—	—	—	11.5	50	—	—	6.11	26.6	**S10N06P76P**
1	1	19.2	83.3	20.1	87.5	—	—	10.5	45.8	—	—	**S10N04P01P**
1	1	—	—	—	—	15.3	66.7	—	—	8.15	35.4	**S10N06P01P**
1	1.5	28.7	125	30.2	131	—	—	15.8	68.7	—	—	**S10N04P16P**
1	1.5	—	—	—	—	23	100	—	—	12.2	53.1	**S10N06P16P**
1	2	38.3	167	40.2	175	—	—	21.1	91.7	—	—	**S10N04P02P**
1	2	—	—	—	—	30.7	133	—	—	16.3	70.8	**S10N06P02P**
1	3	57.6	249.9	60.3	262.5	—	—	31.5	137.4	—	—	**S10N04A03N**
1	3	—	—	—	—	45.9	200.1	—	—	24.4	106.2	**S10N06A03N**
1	5	96	416.5	100.5	437.5	—	—	52.5	229	—	—	**S10N04A05N**
1	5	—	—	—	—	76.5	333.5	—	—	40.7	177	**S10N06A05N**
1	7.5	144	624	151	656	—	—	79	344	—	—	**S10N04A07N**
1	7.5	—	—	—	—	115	500	—	—	61.1	266	**S10N06A07N**
Connection Diagram ②		E		E		E		F		F		

① Additional wiring trough may be required.

② Refer to **Page 19.4-26** for buck-boost wiring diagrams.

Output voltage for lower input voltage can be found by: $\frac{\text{Rated Output Voltage}}{\text{Rated Input Voltage}}$ x Input Actual Voltage = Output New Voltage.

Output kVA available at reduced input voltage can be found by: $\frac{\text{Actual Output Voltage}}{\text{Rated Input Voltage}}$ x Output kVA = New kVA Rating.

Frame drawings/dimensions information begins on **Page 19.4-28**.

Table 19.4-5. Single-Phase 240 V Output Required, 60 Hz

Units Required ①	Unit kVA	Input Available Voltage										Catalog Number
		208 Output kVA	Amps	212 Output kVA	Amps	216 Output kVA	Amps	218 Output kVA	Amps	225 Output kVA	Amps	
1	0.05	—	—	—	—	0.45	1.88	0.5	2.08	—	—	**S10N04A81N**
1	0.05	0.32	1.35	0.38	1.56	—	—	—	—	0.75	3.12	**S10N06A81N**
1	0.10	—	—	—	—	0.9	3.75	1.0	4.17	—	—	**S10N04A82N**
1	0.10	0.65	2.71	0.75	3.12	—	—	—	—	1.5	6.25	**S10N06A82N**
1	0.15	—	—	—	—	1.35	5.62	1.5	6.25	—	—	**S10N04A83N**
1	0.15	0.98	4.06	1.12	4.69	—	—	—	—	2.25	9.37	**S10N06A83N**
1	0.25	—	—	—	—	2.25	9.37	2.5	10.4	—	—	**S10N04P26P**
1	0.25	1.62	6.77	1.87	7.81	—	—	—	—	3.75	15.6	**S10N06P26P**
1	0.50	—	—	—	—	4.5	18.7	5	20.8	—	—	**S10N04P51P**
1	0.50	3.25	13.5	3.75	15.6	—	—	—	—	7.5	31.2	**S10N06P51P**
1	0.75	—	—	—	—	6.75	28.2	7.5	31.2	—	—	**S10N04P76P**
1	0.75	4.87	20.3	5.62	23.4	—	—	—	—	11.2	46.8	**S10N06P76P**
1	1	—	—	—	—	9	37.5	10	41.7	—	—	**S10N04P01P**
1	1	6.5	27.1	7.5	31.2	—	—	—	—	15	62.5	**S10N06A01**
1	1.5	—	—	—	—	13.5	56.2	15	62.5	—	—	**S10N04P16P**
1	1.5	9.75	40.6	11.2	46.9	—	—	—	—	22.5	93.7	**S10N06P16P**
1	2	—	—	—	—	18	75	20	83.3	—	—	**S10N04P02P**
1	2	13	54.2	15	62.5	—	—	—	—	30	125	**S10N06P02P**
1	3	—	—	—	—	27	112.5	30	125.1	—	—	**S10N04A03N**
1	3	19.5	81.3	22.5	93.6	—	—	—	—	45	187.5	**S10N06A03N**
1	5	—	—	—	—	45	187	50	208	—	—	**S10N04A05N**
1	5	32.5	135	37.5	156	—	—	—	—	75	312	**S10N06A05N**
1	7.5	—	—	—	—	67.5	282	75	312	—	—	**S10N04A07N**
1	7.5	48.7	203	56.2	234	—	—	—	—	112	468	**S10N06A07N**
Connection Diagram ②		G		F		G		F		E		

① Additional wiring trough may be required.
② Refer to **Page 19.4-26** for buck-boost wiring diagrams.

Output voltage for lower input voltage can be found by: $\frac{\text{Rated Output Voltage}}{\text{Rated Input Voltage}}$ x Input Actual Voltage = Output New Voltage.

Output kVA available at reduced input voltage can be found by: $\frac{\text{Actual Output Voltage}}{\text{Rated Input Voltage}}$ x Output kVA = New kVA Rating.

Frame drawings/dimensions information begins on **Page 19.4-28**.

Table 19.4-5. Single-Phase 240 V Output Required, 60 Hz, continued

Units Required ①	Unit kVA	Input Available Voltage										Catalog Number
		229 Output kVA	Amps	252 Output kVA	Amps	256 Output kVA	Amps	264 Output kVA	Amps	272 Output kVA	Amps	
1 1 1	0.05 0.05 0.10	1.0 — 2.0	4.16 — 8.33	1.05 — 2.1	4.38 — 8.75	— 0.8 —	— 3.33 —	0.55 — 1.1	2.29 — 4.58	— 0.42 —	— 1.77 —	**S10N04A81N S10N06A81N S10N04A82N**
1 1 1	0.10 0.15 0.15	— 3.0 —	— 12.5 —	— 3.15 —	— 13.1 —	1.6 — 2.4	6.67 — 10.0	— 1.65 —	— 6.87 —	0.85 — 1.27	3.54 — 5.31	**S10N06A82N S10N04A83N S10N06A83N**
1 1 1	0.25 0.25 0.50	5 — 10	20.8 — 41.6	5.25 — 10.5	21.9 — 43.7	— 4 —	— 16.7 —	2.75 — 5.5	11.5 — 22.9	— 2.12 —	— 8.85 —	**S10N04P26P S10N06P26P S10N04P51P**
1 1 1	0.50 0.75 0.75	— 15 —	— 62.4 —	— 15.7 —	— 65.6 —	8 — 12	33.3 — 50	— 8.25 —	— 34.4 —	4.25 — 6.37	17.7 — 26.6	**S10N06P51P S10N04P76P S10N06P76P**
1 1 1	1 1 1.5	20 — 30	83.3 — 125	21 — 31.5	87.5 — 131	— 16 —	— 66.7 —	11 — 16.5	45.8 — 68.7	— 8.5 —	— 35.4 —	**S10N04P01P S10N06P01P S10N04P16P**
1 1 1	1.5 2 2	— 40 —	— 167 —	— 42 —	— 175 —	24 — 32	100 — 133	— 22 —	— 91.7 —	12.7 — 17	53.1 — 70.8	**S10N06P16P S10N04P02P S10N06P02P**
1 1 1	3 3 5	60 — 100	249.9 — 416.5	63 — 105	262.5 — 437.5	— 48 —	— 200.1 —	33 — 55	137.4 — 229	— 25.5 —	— 106.2 —	**S10N04A03N S10N06A03N S10N04A05N**
1 1 1	5 7.5 7.5	— 150 —	— 624 —	— 157 —	— 656 —	80 — 120	333 — 500	— 82.5 —	— 344 —	42.5 — 63.7	177 — 266	**S10N06A05N S10N04A07N S10N06A07N**
Connection Diagram ②		E		E		E		F		F		

① Additional wiring trough may be required.
② Refer to **Page 19.4-26** for buck-boost wiring diagrams.

Output voltage for lower input voltage can be found by: $\frac{\text{Rated Output Voltage}}{\text{Rated Input Voltage}}$ x Input Actual Voltage = Output New Voltage.

Output kVA available at reduced input voltage can be found by: $\frac{\text{Actual Output Voltage}}{\text{Rated Input Voltage}}$ x Output kVA = New kVA Rating.

Frame drawings/dimensions information begins on **Page 19.4-28**.

Table 19.4-6. Three-Phase Open Delta Connection 230 V Output Required, 60 Hz

Units Required ①	Unit kVA	Input Available Voltage										Catalog Number
		199 Output kVA	Amps	203 Output kVA	Amps	207 Output kVA	Amps	209 Output kVA	Amps	216 Output kVA	Amps	
2	0.05	—	—	—	—	0.75	1.87	0.83	2.08	—	—	S10N04A81N
2	0.05	0.54	1.35	0.62	1.56	—	—	—	—	1.24	3.12	S10N06A81N
2	0.10	—	—	—	—	1.49	3.75	1.66	4.17	—	—	S10N04A82N
2	0.10	1.08	2.71	1.24	3.12	—	—	—	—	2.49	6.25	S10N06A82N
2	0.15	—	—	—	—	2.24	5.62	2.49	6.25	—	—	S10N04A83N
2	0.15	1.62	4.06	1.87	4.69	—	—	—	—	3.73	9.37	S10N06A83N
2	0.25	—	—	—	—	3.3	9.37	4.15	10.4	—	—	S10N04P26P
2	0.25	2.7	6.77	3.11	7.81	—	—	—	—	6.22	15.6	S10N06P26P
2	0.50	—	—	—	—	7.47	18.7	8.3	20.8	—	—	S10N04P51P
2	0.50	5.39	13.5	6.22	15.6	—	—	—	—	12.4	31.2	S10N06P51P
2	0.75	—	—	—	—	11.2	28.2	12.4	31.2	—	—	S10N04P76P
2	0.75	8.09	20.3	9.33	23.4	—	—	—	—	18.7	46.8	S10N06P76P
2	1	—	—	—	—	14.9	37.5	16.6	41.7	—	—	S10N04P01P
2	1	10.8	27.1	12.4	31.2	—	—	—	—	24.9	62.5	S10N06P01P
2	1.5	—	—	—	—	22.4	56.2	24.9	62.5	—	—	S10N04P16P
2	1.5	16.2	40.6	18.7	46.9	—	—	—	—	37.3	93.7	S10N06P16P
2	2	—	—	—	—	29.9	75	33.2	83.3	—	—	S10N04P02P
2	2	21.6	54.2	24.9	62.5	—	—	—	—	49.8	125	S10N06P02P
2	3	—	—	—	—	44.7	112.5	49.8	125.1	—	—	S10N04A03N
2	3	32.4	81.3	32.7	93.6	—	—	—	—	74.7	187.5	S10N06A03N
2	5	—	—	—	—	74.7	187	83	208	—	—	S10N04A05N
2	5	53.9	135	62.2	156	—	—	—	—	124	312.5	S10N06A05N
2	7.5	—	—	—	—	112	282	124	312	—	—	S10N04A07N
2	7.5	80.9	203	93.3	234	—	—	—	—	187	468	S10N06A07N
Connection Diagram ②		L		K		L		K		I		

① Additional wiring trough may be required.
② Refer to **Page 19.4-26** for buck-boost wiring diagrams.

Output voltage for lower input voltage can be found by: $\frac{\text{Rated Output Voltage}}{\text{Rated Input Voltage}}$ x Input Actual Voltage = Output New Voltage.

Output kVA available at reduced input voltage can be found by: $\frac{\text{Actual Output Voltage}}{\text{Rated Input Voltage}}$ x Output kVA = New kVA Rating.

Frame drawings/dimensions information begins on **Page 19.4-28**.

Table 19.4-6. Three-Phase Open Delta Connection 230 V Output Required, 60 Hz, continued

Units Required ①	Unit kVA	Input Available Voltage										Catalog Number
		219 Output kVA	Amps	242 Output kVA	Amps	246 Output kVA	Amps	253 Output kVA	Amps	260 Output kVA	Amps	
2	0.05	1.66	4.17	1.74	4.37	—	—	0.91	2.29	—	—	S10N04A81N
2	0.05	—	—	—	—	1.33	3.33	—	—	0.70	1.77	S10N06A81N
2	0.10	3.32	8.33	3.48	8.75	—	—	1.83	4.58	—	—	S10N04A82N
2	0.10	—	—	—	—	2.65	6.67	—	—	1.41	3.54	S10N06A82N
2	0.15	4.98	12.5	5.23	13.1	—	—	2.74	6.87	—	—	S10N04A83N
2	0.15	—	—	—	—	3.98	10.0	—	—	2.12	5.13	S10N06A83N
2	0.25	8.3	20.8	8.71	21.9	—	—	4.56	11.5	—	—	S10N04P26P
2	0.25	—	—	—	—	6.64	16.7	—	—	3.52	8.85	S10N06P26P
2	0.50	16.6	41.7	17.4	43.7	—	—	9.73	22.9	—	—	S10N04P51P
2	0.50	—	—	—	—	13.3	33.3	—	—	7.05	17.7	S10N06P51P
2	0.75	24.9	62.4	26.1	65.6	—	—	13.7	34.4	—	—	S10N04P76P
2	0.75	—	—	—	—	19.9	50	—	—	10.6	26.6	S10N06P76P
2	1	33.2	83.3	34.8	87.5	—	—	18.3	45.8	—	—	S10N04P01P
2	1	—	—	—	—	26.5	66.7	—	—	14.1	35.4	S10N06P01P
2	1.5	49.8	125	52.3	131	—	—	27.4	68.7	—	—	S10N04P16P
2	1.5	—	—	—	—	39.8	100	—	—	21.2	53.1	S10N06P16P
2	2	66.4	167	69.7	175	—	—	36.5	91.7	—	—	S10N04P02P
2	2	—	—	—	—	53.1	133	—	—	28.2	70.8	S10N06P02P
2	3	99.6	249.9	104.4	262.5	—	—	54.9	137.4	—	—	S10N04A03N
2	3	—	—	—	—	79.5	200	—	—	42.3	106.2	S10N06A03N
2	5	166	417	174	437	—	—	91.3	229	—	—	S10N04A05N
2	5	—	—	—	—	133	333	—	—	70.5	177	S10N06A05N
2	7.5	249	624	261	656	—	—	137	344	—	—	S10N04A07N
2	7.5	—	—	—	—	199	500	—	—	106	266	S10N06A07N
Connection Diagram ②		I		I		I		K		K		

① Additional wiring trough may be required.
② Refer to **Page 19.4-26** for buck-boost wiring diagrams.

Output voltage for lower input voltage can be found by: $\frac{\text{Rated Output Voltage}}{\text{Rated Input Voltage}}$ x Input Actual Voltage = Output New Voltage.

Output kVA available at reduced input voltage can be found by: $\frac{\text{Actual Output Voltage}}{\text{Rated Input Voltage}}$ x Output kVA = New kVA Rating.

Frame drawings/dimensions information begins on **Page 19.4-28**.

Table 19.4-7. Three-Phase Open Delta Connection 240 V Output Required, 60 Hz

Units Required ①	Unit kVA	Input Available Voltage										Catalog Number
		208 Output kVA	Amps	212 Output kVA	Amps	216 Output kVA	Amps	218 Output kVA	Amps	225 Output kVA	Amps	
2	0.05	—	—	—	—	0.73	1.87	0.87	2.08	—	—	S10N04A81N
2	0.05	0.56	v1.35	0.65	1.56	—	—	—	—	1.3	3.12	S10N06A81N
2	0.10	—	—	—	—	1.56	3.75	1.73	4.17	—	—	S10N04A82N
2	0.10	1.13	2.71	1.3	3.12	—	—	—	—	2.6	6.25	S10N06A82N
2	0.15	—	—	—	—	2.34	5.62	2.6	6.25	—	—	S10N04A83N
2	0.15	1.69	4.06	1.95	4.69	—	—	—	—	3.9	9.37	S10N06A83N
2	0.25	—	—	—	—	3.9	9.37	4.33	10.4	—	—	S10N04P26P
2	0.25	2.81	6.77	3.25	7.81	—	—	—	—	6.49	15.6	S10N06P26P
2	0.50	—	—	—	—	7.79	18.7	8.66	20.8	—	—	S10N04P51P
2	0.50	5.63	13.5	6.5	15.6	—	—	—	—	13	31.2	S10N06P51P
2	0.75	—	—	—	—	11.7	28.2	13	31.2	—	—	S10N04P76P
2	0.75	8.44	20.3	9.75	23.4	—	—	—	—	19.5	46.8	S10N06P76P
2	1	—	—	—	—	15.6	37.5	17.3	41.7	—	—	S10N04P01P
2	1	11.3	27.1	13	31.2	—	—	—	—	26	62.5	S10N06P01P
2	1.5	—	—	—	—	23.4	56.2	26	62.5	—	—	S10N04P16P
2	1.5	16.9	40.6	19.5	46.9	—	—	—	—	39	93.7	S10N06P16P
2	2	—	—	—	—	31.2	75	34.6	83.3	—	—	S10N04P02P
2	2	22.5	54.2	26	62.5	—	—	—	—	52	125	S10N06P02P
2	3	—	—	—	—	46.8	112.5	51.9	125.1	—	—	S10N04A03N
2	3	33.9	81.3	39	93.6	—	—	—	—	78	187.5	S10N06A03N
2	5	—	—	—	—	77.9	187	86.6	208	—	—	S10N04A05N
2	5	56.3	135	65	156	—	—	—	—	130	312	S10N06A05N
2	7.5	—	—	—	—	117	282	130	312	—	—	S10N04A07N
2	7.5	84.4	203	97.5	234	—	—	—	—	195	468	S10N06A07N
Connection Diagram ②		L		K		L		K		I		

① Additional wiring trough may be required.

② Refer to **Page 19.4-26** for buck-boost wiring diagrams.

Output voltage for lower input voltage can be found by: $\frac{\text{Rated Output Voltage}}{\text{Rated Input Voltage}}$ x Input Actual Voltage = Output New Voltage.

Output kVA available at reduced input voltage can be found by: $\frac{\text{Actual Output Voltage}}{\text{Rated Input Voltage}}$ x Output kVA = New kVA Rating.

Frame drawings/dimensions information begins on **Page 19.4-28**.

Table 19.4-7. Three-Phase Open Delta Connection 240 V Output Required, 60 Hz, continued

Units Required ①	Unit kVA	Input Available Voltage										Catalog Number
		229 Output kVA	Amps	252 Output kVA	Amps	256 Output kVA	Amps	264 Output kVA	Amps	272 Output kVA	Amps	
2	0.05	1.73	4.16	1.82	4.37	—	—	0.95	2.29	—	—	**S10N04A81N**
2	0.05	—	—	—	—	1.38	3.33	—	—	0.74	1.77	**S10N06A81N**
2	0.10	3.46	8.33	3.64	8.75	—	—	1.91	4.58	—	—	**S10N04A82N**
2	0.10	—	—	—	—	2.77	6.67	—	—	1.47	3.54	**S10N06A82N**
2	0.15	5.19	12.5	5.45	13.1	—	—	2.86	6.87	—	—	**S10N04A83N**
2	0.15	—	—	—	—	4.15	10.0	—	—	2.21	5.31	**S10N06A83N**
2	0.25	8.66	20.8	9.09	21.9	—	—	4.76	11.5	—	—	**S10N04P26P**
2	0.25	—	—	—	—	6.92	16.7	—	—	3.68	8.85	**S10N06P26P**
2	0.50	17.3	41.6	18.2	43.7	—	—	9.53	22.9	—	—	**S10N04P51P**
2	0.50	—	—	—	—	13.8	33.3	—	—	7.36	17.7	**S10N06P51P**
2	0.75	26	62.4	27.3	65.6	—	—	14.3	34.4	—	—	**S10N04P76P**
2	0.75	—	—	—	—	20.8	50	—	—	11	26.6	**S10N06P76P**
2	1	34.6	83.3	36.4	87.5	—	—	19.1	45.8	—	—	**S10N04P01P**
2	1	—	—	—	—	27.7	66.7	—	—	14.7	35.4	**S10N06P01P**
2	1.5	51.9	125	54.5	131	—	—	28.6	68.7	—	—	**S10N04P16P**
2	1.5	—	—	—	—	41.5	100	—	—	22.1	53.1	**S10N06P16P**
2	2	69.3	167	72.7	175	—	—	38.1	91.7	—	—	**S10N04P02P**
2	2	—	—	—	—	55.4	133	—	—	29.4	70.8	**S10N06P02P**
2	3	103.8	249.9	109.2	262.5	—	—	57.3	137.4	—	—	**S10N04A03N**
2	3	—	—	—	—	83.1	200	—	—	44.1	106.2	**S10N06A03N**
2	5	173	416	182	437	—	—	95.3	229	—	—	**S10N04A05N**
2	5	—	—	—	—	138	333	—	—	73.6	177	**S10N06A05N**
2	7.5	260	624	273	656	—	—	143	344	—	—	**S10N04A07N**
2	7.5	—	—	—	—	208	500	—	—	110	266	**S10N06A07N**
Connection Diagram ②		I		I		I		K		K		

① Additional wiring trough may be required.
② Refer to **Page 19.4-26** for buck-boost wiring diagrams.

Output voltage for lower input voltage can be found by: $\frac{\text{Rated Output Voltage}}{\text{Rated Input Voltage}}$ x Input Actual Voltage = Output New Voltage.

Output kVA available at reduced input voltage can be found by: $\frac{\text{Actual Output Voltage}}{\text{Rated Input Voltage}}$ x Output kVA = New kVA Rating.

Frame drawings/dimensions information begins on **Page 19.4-28**.

WARNING! Three-phase autotransformers should never be used to obtain four-wire output with three-wire input. Four-wire output requires four-wire wye input.

On all wye connections, the source neutral must be present and connected to the transformer bank. If source neutral is not present, do not use a wye connection.

Table 19.4-8. Three-Phase Wye Connection 208 V Output Required, 60 Hz

Units Required ①	Unit kVA	Input Available Voltage										Catalog Number
		152 Output kVA	Amps	164 Output kVA	Amps	173 Output kVA	Amps	180 Output kVA	Amps	184 Output kVA	Amps	
3	0.05	—	—	—	—	0.75	2.08	—	—	—	—	S10N04A81N
3	0.05	0.41	1.15	0.56	1.56	—	—	0.98	2.71	1.12	3.12	S10N06A81N
3	0.10	—	—	—	—	1.50	4.17	—	—	—	—	S10N04A82N
3	0.10	0.82	2.29	1.12	3.12	—	—	1.95	5.41	2.25	6.25	S10N06A82N
3	0.15	—	—	—	—	2.25	6.25	—	—	—	—	S10N04A83N
3	0.15	1.24	3.44	1.69	4.69	—	—	2.92	8.12	3.73	9.37	S10N06A83N
3	0.25	—	—	—	—	3.75	10.4	—	—	—	—	S10N04P26P
3	0.25	2.06	5.73	2.81	7.81	—	—	4.87	13.5	5.62	15.6	S10N06P26P
3	0.50	—	—	—	—	7.5	20.8	—	—	—	—	S10N04P51P
3	0.50	4.12	11.5	5.62	15.6	—	—	9.75	27.1	11.2	31.2	S10N06P51P
3	0.75	—	—	—	—	11.2	31.2	—	—	—	—	S10N04P76P
3	0.75	6.19	17.2	8.44	23.4	—	—	14.6	40.6	16.8	46.8	S10N06P76P
3	1	—	—	—	—	15	41.7	—	—	—	—	S10N04P01P
3	1	8.25	22.9	11.2	31.2	—	—	19.5	54.1	22.5	62.5	S10N06P01P
3	1.5	—	—	—	—	22.5	62.5	—	—	—	—	S10N04P16P
3	1.5	12.4	34.4	16.9	46.9	—	—	29.2	81.2	33.7	93.7	S10N06P16P
3	2	—	—	—	—	30	83.3	—	—	—	—	S10N04P02P
3	2	16.5	45.8	22.5	62.5	—	—	39	108	45	125	S10N06P02P
3	3	—	—	—	—	45	125	—	—	—	—	S10N04A03N
3	3	24.7	68.7	33.6	93.6	—	—	58.5	162.3	67.5	187.5	S10N06A03N
3	5	—	—	—	—	75	208	—	—	—	—	S10N04A05N
3	5	41.2	115	56.2	156	—	—	97.5	271	112	312	S10N06A05N
3	7.5	—	—	—	—	112	312	—	—	—	—	S10N04A07N
3	7.5	61.9	172	84.4	234	—	—	146	406	168	468	S10N06A07N
Connection Diagram ②		P		N		N		O		M		

① Additional wiring trough may be required.

② Refer to **Page 19.4-26** for buck-boost wiring diagrams.

Output voltage for lower input voltage can be found by: $\frac{\text{Rated Output Voltage}}{\text{Rated Input Voltage}}$ x Input Actual Voltage = Output New Voltage.

Output kVA available at reduced input voltage can be found by: $\frac{\text{Actual Output Voltage}}{\text{Rated Input Voltage}}$ x Output kVA = New kVA Rating.

Frame drawings/dimensions information begins on **Page 19.4-28**.

WARNING! Three-phase autotransformers should never be used to obtain four-wire output with three-wire input. Four-wire output requires four-wire wye input.

On all wye connections, the source neutral must be present and connected to the transformer bank. If source neutral is not present, do not use a wye connection.

Table 19.4-8. Three-Phase Wye Connection 208 V Output Required, 60 Hz, continued

Units Required ①	Unit kVA	Input Available Voltage										Catalog Number
		189 Output kVA	Amps	229 Output kVA	Amps	236 Output kVA	Amps	250 Output kVA	Amps	264 Output kVA	Amps	
3	0.05	1.5	4.16	1.65	4.58	—	—	0.9	2.5	—	—	S10N04A81N
3	0.05	—	—	—	—	1.27	3.54	—	—	0.71	1.98	S10N06A81N
3	0.10	3.0	8.33	3.3	9.17	—	—	1.8	5.0	—	—	S10N04A82N
3	0.10	—	—	—	—	2.55	7.08	—	—	1.42	3.95	S10N06A82N
3	0.15	4.5	12.5	4.95	13.7	—	—	2.7	7.5	—	—	S10N04A83N
3	0.15	—	—	—	—	3.82	10.6	—	—	2.14	5.93	S10N06A83N
3	0.25	7.5	20.8	8.25	22.9	—	—	4.5	12.5	—	—	S10N04P26P
3	0.25	—	—	—	—	6.35	17.7	—	—	3.56	9.88	S10N06P26P
3	0.50	15	41.6	16.5	45.8	—	—	9	25	—	—	S10N04P51P
3	0.50	—	—	—	—	12.7	35.4	13.5	—	7.12	19.3	S10N06P51P
3	0.75	22.5	62.4	24.7	68.7	—	—	—	37.5	—	—	S10N04P76P
3	0.75	—	—	—	—	19	53.1		—	10.7	29.3	S10N06P76P
3	1	30	83.3	33	91.7	—	—	18	50	—	—	S10N04P01P
3	1	—	—	—	—	25.5	70.8	—	—	14.2	39.5	S10N06P01P
3	1.5	45	125	49.5	137	—	—	27	75	—	—	S10N04P16P
3	1.5	—	—	—	—	38.2	106	—	—	21.4	59.3	S10N06P16P
3	2	60	167	66	183	—	—	361	100	—	—	S10N04P02P
3	2	—	—	—	—	51	142	—	—	28.5	79.2	S10N06P02P
3	3	90	249.9	99	275.1	—	—	54	150	—	—	S10N04A03N
3	3	—	—	—	—	76.5	212.4	—	—	46.2	118.5	S10N06A03N
3	5	150	416	165	458	—	—	90	250	—	—	S10N04A05N
3	5	—	—	—	—	127	354	—	—	71.2	198	S10N06A05N
3	7.5	225	624	274	687	—	—	135	375	—	—	S10N04A07N
3	7.5	—	—	—	—	190	531	—	—	107	293	S10N06A07N
Connection Diagram ②		M		M		M		N		N		

① Additional wiring trough may be required.
② Refer to **Page 19.4-26** for buck-boost wiring diagrams.

Output voltage for lower input voltage can be found by: $\frac{\text{Rated Output Voltage}}{\text{Rated Input Voltage}}$ x Input Actual Voltage = Output New Voltage.

Output kVA available at reduced input voltage can be found by: $\frac{\text{Actual Output Voltage}}{\text{Rated Input Voltage}}$ x Output kVA = New kVA Rating.

Frame drawings/dimensions information begins on **Page 19.4-28**.

WARNING! Three-phase autotransformers should never be used to obtain four-wire output with three-wire input.
Four-wire output requires four-wire wye input.

On all wye connections, the source neutral must be present and connected to the transformer bank.
If source neutral is not present, do not use a wye connection.

Table 19.4-9. Three-Phase Wye Connection 230 V Output Required, 60 Hz

Units Required ①	Unit kVA	Input Available Voltage										Catalog Number
		183 Output kVA	Amps	192 Output kVA	Amps	199 Output kVA	Amps	208 Output kVA	Amps	218 Output kVA	Amps	
3	0.05	—	—	0.83	2.08	—	—	1.65	v4.58	1.66	4.17	S10N04A81N
3	0.05	0.62	1.56	—	—	0.54	1.35	—	—	—	—	S10N06A81N
3	0.10	—	—	1.66	4.17	—	—	3.3	9.17	3.32	8.35	S10N04A82N
3	0.10	1.25	3.12	—	—	1.08	2.71	—	—	—	—	S10N06A82N
3	0.15	—	—	2.49	6.25	—	—	4.95	13.7	4.98	12.5	S10N04A83N
3	0.15	1.87	4.69	—	—	1.62	4.06	—	—	—	—	S10N06A83N
3	0.25	—	—	4.15	10.4	—	—	8.2	22.9	8.3	20.9	S10N04P26P
3	0.25	3.11	7.81	—	—	2.70	6.77	—	—	—	—	S10N06P26P
3	0.50	—	—	8.3	20.8	—	—	16.5	45.8	16.6	41.7	S10N04P51P
3	0.50	6.22	15.6	—	—	5.39	13.5	—	—	—	—	S10N06P51P
3	0.75	—	—	12.4	31.2	—	—	24.7	68.8	24.9	62.6	S10N04P76P
3	0.75	9.33	23.4	—	—	8.09	20.3	—	—	—	—	S10N06P76P
3	1	—	—	16.6	41.7	—	—	33	91.7	33.2	83.5	S10N04P01P
3	1	12.5	31.2	—	—	10.8	27.1	—	—	—	—	S10N06P01P
3	1.5	—	—	24.9	62.5	—	—	49.5	137	49.8	125	S10N04P16P
3	1.5	18.7	46.9	—	—	16.2	40.6	—	—	—	—	S10N06P16P
3	2	—	—	33.2	83.3	—	—	66	183	66.4	167	S10N04P02P
3	2	24.9	62.5	—	—	21.6	54.2	—	—	—	—	S10N06P02P
3	3	—	—	49.8	125.1	—	—	99	275	99.6	250.5	S10N04A03N
3	3	37.5	93.6	—	—	32.4	81.3	—	—	—	—	S10N06A03N
3	5	—	—	83	208	—	—	165	458	166	417	S10N04A05N
3	5	62.2	156	—	—	53.9	135	—	—	—	—	S10N06A05N
3	7.5	—	—	124	312	—	—	247	688	249	626	S10N04A07N
3	7.5	93.3	234	—	—	80.9	203	—	—	—	—	S10N06A07N
Connection Diagram ②		N		N		S		M		Q		

① Additional wiring trough may be required.
② Refer to **Page 19.4-26** for buck-boost wiring diagrams.

Output voltage for lower input voltage can be found by: $\frac{\text{Rated Output Voltage}}{\text{Rated Input Voltage}}$ x Input Actual Voltage = Output New Voltage.

Output kVA available at reduced input voltage can be found by: $\frac{\text{Actual Output Voltage}}{\text{Rated Input Voltage}}$ x Output kVA = New kVA Rating.

Frame drawings/dimensions information begins on **Page 19.4-28**.

WARNING! Three-phase autotransformers should never be used to obtain four-wire output with three-wire input. Four-wire output requires four-wire wye input.

On all wye connections, the source neutral must be present and connected to the transformer bank. If source neutral is not present, do not use a wye connection.

Table 19.4-9. Three-Phase Wye Connection 230 V Output Required, 60 Hz, continued

Units Required ①	Unit kVA	Input Available Voltage										Catalog Number
		242 Output kVA	Amps	245 Output kVA	Amps	253 Output kVA	Amps	260 Output kVA	Amps	265 Output kVA	Amps	
3	0.05	1.74	4.37	—	—	0.91	2.29	—	—	—	—	S10N04A81N
3	0.05	—	—	1.33	3.33	—	—	0.70	1.77	0.62	1.56	S10N06A81N
3	0.10	3.48	8.75	—	—	1.83	4.58	—	—	—	—	S10N04A82N
3	0.10	—	—	2.65	6.67	—	—	1.41	3.54	1.25	3.12	S10N06A82N
3	0.15	5.23	13.1	—	—	2.74	6.87	—	—	—	—	S10N04A83N
3	0.15	—	—	3.98	10.0	—	—	2.12	5.31	1.87	4.69	S10N06A83N
3	0.25	8.71	21.9	—	—	4.56	11.5	—	—	—	—	S10N04P26P
3	0.25	—	—	6.63	16.7	—	—	3.52	8.85	3.11	7.81	S10N06P26P
3	0.50	17.4	43.7	—	—	9.31	22.9	—	—	—	—	S10N04P51P
3	0.50	—	—	13.3	33.3	—	—	7.05	17.7	6.22	15.6	S10N06P51P
3	0.75	26.1	65.6	—	—	13.7	34.4	—	—	—	—	S10N04P76P
3	0.75	—	—	19.9	50	—	—	10.6	26.6	9.33	23.4	S10N06P76P
3	1	34.8	87.5	—	—	18.3	45.8	—	—	—	—	S10N04P01P
3	1	—	—	26.5	66.7	—	—	14.1	35.4	12.5	31.2	S10N06P01P
3	1.5	52.3	131	—	—	27.4	68.7	—	—	—	—	S10N04P16P
3	1.5	—	—	39.8	100	—	—	21.2	53.1	18.7	46.9	S10N06P16P
3	2	69.7	175	—	—	36.6	91.6	—	—	—	—	S10N04P02P
3	2	—	—	53.1	133	—	—	28.2	70.8	24.9	62.5	S10N06P02P
3	3	104.4	262.5	—	—	54.9	137.4	—	—	—	—	S10N04A03N
3	3	—	—	79.5	200	—	—	42.3	106.2	37.5	93.6	S10N06A03N
3	5	174	437	—	—	91.3	229	—	—	—	—	S10N04A05N
3	5	—	—	133	333	—	—	70.5	177	62.2	156	S10N06A05N
3	7.5	261	656	—	—	137	344	—	—	—	—	S10N04A07N
3	7.5	—	—	199	500	—	—	106	266	93.3	234	S10N06A07N
Connection Diagram ②		Q		Q		R		R		S		

① Additional wiring trough may be required.
② Refer to **Page 19.4-26** for buck-boost wiring diagrams.

Output voltage for lower input voltage can be found by: $\frac{\text{Rated Output Voltage}}{\text{Rated Input Voltage}}$ x Input Actual Voltage = Output New Voltage.

Output kVA available at reduced input voltage can be found by: $\frac{\text{Actual Output Voltage}}{\text{Rated Input Voltage}}$ x Output kVA = New kVA Rating.

Frame drawings/dimensions information begins on **Page 19.4-28**.

WARNING! Three-phase autotransformers should never be used to obtain four-wire output with three-wire input. Four-wire output requires four-wire wye input.

On all wye connections, the source neutral must be present and connected to the transformer bank. If source neutral is not present, do not use a wye connection.

Table 19.4-10. Three-Phase Wye Connection 240 V Output Required, 60 Hz

Units Required ①	Unit kVA	Input Available Voltage										Catalog Number
		190 Output kVA	Amps	200 Output kVA	Amps	208 Output kVA	Amps	218 Output kVA	Amps	228 Output kVA	Amps	
3	0.05	—	—	0.86	2.08	—	—	0.86	2.08	1.73	4.17	**S10N04A81N**
3	0.05	0.65	1.65	—	—	1.27	3.05	—	—	—	—	**S10N06A81N**
3	0.10	—	—	1.73	4.17	—	—	1.73	4.17	3.46	8.34	**S10N04A82N**
3	0.10	1.3	3.12	—	—	2.55	6.12	—	—	—	—	**S10N06A82N**
3	0.15	—	—	2.59	6.25	—	—	2.59	6.25	5.20	12.5	**S10N04A83N**
3	0.15	1.95	4.69	—	—	3.82	9.16	—	—	—	—	**S10N06A83N**
3	0.25	—	—	4.32	10.4	—	—	4.32	10.4	8.66	20.9	**S10N04P26P**
3	0.25	3.25	7.81	—	—	6.3	15.1	—	—	—	—	**S10N06P26P**
3	0.50	—	—	8.65	20.8	—	—	8.65	20.8	17.3	41.7	**S10N04P51P**
3	0.50	6.5	15.6	—	—	12.7	30.4	—	—	—	—	**S10N06P51P**
3	0.75	—	—	13	31.2	—	—	13	31.2	26	62.6	**S10N04P76P**
3	0.75	9.75	23.4	—	—	19.2	46	—	—	—	—	**S10N06P76P**
3	1	—	—	17.3	41.7	—	—	17.3	41.7	34.6	83.4	**S10N04P01P**
3	1	13	31.2	—	—	25.5	61.2	—	—	—	—	**S10N06P01P**
3	1.5	—	—	25.9	62.5	—	—	25.9	62.5	52	125	**S10N04P16P**
3	1.5	19.5	46.9	—	—	38.2	91.6	—	—	—	—	**S10N06P16P**
3	2	—	—	34.6	83.3	—	—	34.6	83.3	69.3	167	**S10N04P02P**
3	2	26	62.5	—	—	51	122.4	—	—	—	—	**S10N06P02P**
3	3	—	—	51.9	125.1	—	—	51.9	125.1	103.8	250.2	**S10N04A03N**
3	3	39	93.6	—	—	76.5	183.6	—	—	—	—	**S10N06A03N**
3	5	—	—	86.5	208	—	—	86.5	208	173	417	**S10N04A05N**
3	5	65	156	—	—	127.2	305.2	—	—	—	—	**S10N06A05N**
3	7.5	—	—	130	312	—	—	130	312	260	626	**S10N04A07N**
3	7.5	97.5	234	—	—	192	460	—	—	—	—	**S10N06A07N**
Connection Diagram ②		N		N		M		R		Q		

① Additional wiring trough may be required.
② Refer to **Page 19.4-26** for buck-boost wiring diagrams.

Output voltage for lower input voltage can be found by: $\frac{\text{Rated Output Voltage}}{\text{Rated Input Voltage}}$ x Input Actual Voltage = Output New Voltage.

Output kVA available at reduced input voltage can be found by: $\frac{\text{Actual Output Voltage}}{\text{Rated Input Voltage}}$ x Output kVA = New kVA Rating.

Frame drawings/dimensions information begins on **Page 19.4-28**.

WARNING! Three-phase autotransformers should never be used to obtain four-wire output with three-wire input. Four-wire output requires four-wire wye input.

On all wye connections, the source neutral must be present and connected to the transformer bank. If source neutral is not present, do not use a wye connection.

Table 19.4-10. Three-Phase Wye Connection 240 V Output Required, 60 Hz, continued

Units Required ①	Unit kVA	Input Available Voltage										Catalog Number
		252 Output kVA	Amps	256 Output kVA	Amps	264 Output kVA	Amps	272 Output kVA	Amps	277 Output kVA	Amps	
3	0.05	1.85	4.37	—	—	0.95	2.29	—	—	—	—	S10N04A81N
3	0.05	—	—	1.39	3.33	—	—	0.74	1.77	0.65	1.56	S10N06A81N
3	0.10	3.64	8.75	—	—	1.91	4.58	—	—	—	—	S10N04A82N
3	0.10	—	—	2.77	6.67	—	—	1.47	3.54	1.3	3.12	S10N06A82N
3	0.15	5.46	13.1	—	—	2.86	6.87	—	—	—	—	S10N04A83N
3	0.15	—	—	4.16	10.0	—	—	2.21	5.31	1.95	4.69	S10N06A83N
3	0.25	9.09	21.9	—	—	4.76	11.5	—	—	—	—	S10N04P26P
3	0.25	—	—	6.93	16.7	—	—	3.68	8.85	3.25	7.81	S10N06P26P
3	0.50	18.2	43.7	—	—	9.53	22.9	—	—	—	—	S10N04P51P
3	0.50	—	—	13.9	33.3	—	—	7.36	17.7	6.5	15.6	S10N06P51P
3	0.75	27.3	65.6	—	—	14.3	34.4	—	—	—	—	S10N04P76P
3	0.75	—	—	20.8	50	—	—	11	26.6	9.75	23.4	S10N06P76P
3	1	36.4	87.5	—	—	19.1	45.8	—	—	—	—	S10N04P01P
3	1	—	—	27.7	66.7	—	—	14.7	35.4	13	31.2	S10N06P01P
3	1.5	54.6	131	—	—	28.6	68.7	—	—	—	—	S10N04P16P
3	1.5	—	—	41.6	100	—	—	22.1	53.1	19.5	46.9	S10N06P16P
3	2	72.8	175	—	—	38.1	91.7	—	—	—	—	S10N04P02P
3	2	—	—	55.4	133	—	—	29.5	70.8	26	62.5	S10N06P02P
3	3	109.2	262.5	—	—	57.3	137.4	—	—	—	—	S10N04A03N
3	3	—	—	83.1	200	—	—	44.1	106.2	39	93.6	S10N06A03N
3	5	182	437	—	—	95.3	229	—	—	—	—	S10N04A05N
3	5	—	—	139	333	—	—	73.6	177	65	156	S10N06A05N
3	7.5	273	656	—	—	143	344	—	—	—	—	S10N04A07N
3	7.5	—	—	208	500	—	—	110	266	97.5	234	S10N06A07N
Connection Diagram ②		Q		Q		R		R		S		

① Additional wiring trough may be required.
② Refer to **Page 19.4-26** for buck-boost wiring diagrams.

Output voltage for lower input voltage can be found by: $\frac{\text{Rated Output Voltage}}{\text{Rated Input Voltage}}$ x Input Actual Voltage = Output New Voltage.

Output kVA available at reduced input voltage can be found by: $\frac{\text{Actual Output Voltage}}{\text{Rated Input Voltage}}$ x Output kVA = New kVA Rating.

Frame drawings/dimensions information begins on **Page 19.4-28**.

WARNING! Three-phase autotransformers should never be used to obtain four-wire output with three-wire input. Four-wire output requires four-wire wye input.

On all wye connections, the source neutral must be present and connected to the transformer bank. If source neutral is not present, do not use a wye connection.

Table 19.4-11. Three-Phase Wye Connection 460 V Output Required, 60 Hz

Units Required ①	Unit kVA	Input Available Voltage								Catalog Number
		406 Output kVA	Amps	418 Output kVA	Amps	432 Output kVA	Amps	438 Output kVA	Amps	
3	0.05	—	—	1.66	2.08	—	—	3.22	4.04	**S10N04A81N**
3	0.05	1.25	1.57	—	—	2.49	3.12	—	—	**S10N06A81N**
3	0.10	—	—	3.31	4.15	—	—	6.62	8.31	**S10N04A82N**
3	0.10	2.49	3.12	—	—	4.97	6.24	—	—	**S10N06A82N**
3	0.15	—	—	4.97	6.24	—	—	9.94	12.48	**S10N04A83N**
3	0.15	3.73	4.68	—	—	7.46	9.36	—	—	**S10N06A83N**
3	0.25	—	—	8.28	10.39	—	—	16.6	20.84	**S10N04P26P**
3	0.25	6.22	7.81	—	—	12.4	15.56	—	—	**S10N06P26P**
3	0.50	—	—	16.6	20.84	—	—	33.2	41.67	**S10N04P51P**
3	0.50	12.5	15.69	—	—	24.69	31.25	—	—	**S10N06P51P**
3	0.75	—	—	24.8	31.12	—	—	49.6	62.25	**S10N04P76P**
3	0.75	18.7	23.47	—	—	37.3	46.82	—	—	**S10N06P76P**
3	1	—	—	33.1	41.54	—	—	66.2	83.09	**S10N04P01P**
3	1	24.9	31.25	—	—	49.7	62.38	—	—	**S10N06P01P**
3	1.5	—	—	49.7	62.38	—	—	99.4	124.75	**S10N04P16P**
3	1.5	37.3	46.94	—	—	74.6	93.63	—	—	**S10N06P16P**
3	2	—	—	66.3	83.22	—	—	133	166.93	**S10N04P02P**
3	2	49.7	62.38	—	—	99.5	124.88	—	—	**S10N06P02P**
3	3	—	—	99.3	124.64	—	—	198.6	249.27	**S10N04A03N**
3	3	74.6	93.63	—	—	149	187.01	—	—	**S10N06A03N**
3	5	—	—	166	208.35	—	—	322	404.16	**S10N04A05N**
3	5	125	156.89	—	—	249	312.53	—	—	**S10N06A05N**
3	7.5	—	—	248	311	—	—	496	622	**S10N04A07N**
3	7.5	187	235	—	—	373	468	—	—	**S10N06A07N**
Connection Diagram ②		R		R		Q		Q		

① Additional wiring trough may be required.
② Refer to **Page 19.4-26** for buck-boost wiring diagrams.

Output voltage for lower input voltage can be found by: $\frac{\text{Rated Output Voltage}}{\text{Rated Input Voltage}}$ x Input Actual Voltage = Output New Voltage.

Output kVA available at reduced input voltage can be found by: $\frac{\text{Actual Output Voltage}}{\text{Rated Input Voltage}}$ x Output kVA = New kVA Rating.

Frame drawings/dimensions information begins on **Page 19.4-28**.

WARNING! Three-phase autotransformers should never be used to obtain four-wire output with three-wire input. Four-wire output requires four-wire wye input.

On all wye connections, the source neutral must be present and connected to the transformer bank. If source neutral is not present, do not use a wye connection.

Table 19.4-11. Three-Phase Wye Connection 460 V Output Required, 60 Hz, continued

Units Required ①	Unit kVA	Input Available Voltage						Catalog Number
		424 Output kVA	Amps	436 Output kVA	Amps	450 Output kVA	Amps	
3	0.05	—	1.7	2.1	—	—	—	**S10N04A81N**
3	0.05	1.3	1.56	—	—	2.6	3.13	**S10N06A81N**
3	0.10	—	—	3.5	4.2	—	—	**S10N04A82N**
3	0.10	2.6	3.12	—	—	5.2	6.25	**S10N06A82N**
3	0.15	—	—	5.2	6.25	—	—	**S10N04A83N**
3	0.15	3.9	4.68	—	—	7.8	9.38	**S10N06A83N**
3	0.25	—	—	8.7	10.4	—	—	**S10N04P26P**
3	0.25	6.5	7.82	—	—	13	15.6	**S10N06P26P**
3	0.50	—	—	17.4	20.9	—	—	**S10N04P51P**
3	0.50	13	15.6	—	—	26	31.2	**S10N06P51P**
3	0.75	—	—	26	31.2	—	—	**S10N04P76P**
3	0.75	19.5	23.4	—	—	39	46.9	**S10N06P76P**
3	1	—	—	35	42	—	—	**S10N04P01P**
3	1	26	31.2	—	—	52	62.5	**S10N06P01P**
3	1.5	—	—	52	62.5	—	—	**S10N04P16P**
3	1.5	39	46.8	—	—	78	93.8	**S10N06P16P**
3	2	—	—	69	82.9	—	—	**S10N04P02P**
3	2	52	62.5	—	—	104	125	**S10N06P02P**
3	3	—	—	104	125	—	—	**S10N04A03N**
3	3	78	93.8	—	—	156	187.6	**S10N06A03N**
3	5	—	—	174	209.2	—	—	**S10N04A05N**
3	5	130	156.3	—	—	260	312.7	**S10N06A05N**
3	7.5	—	—	260	312	—	—	**S10N04A07N**
3	7.5	195	234	—	—	390	469	**S10N06A07N**
Connection Diagram ②		R		R		Q		

① Additional wiring trough may be required.
② Refer to **Page 19.4-26** for buck-boost wiring diagrams.

Output voltage for lower input voltage can be found by: $\frac{\text{Rated Output Voltage}}{\text{Rated Input Voltage}}$ x Input Actual Voltage = Output New Voltage.

Output kVA available at reduced input voltage can be found by: $\frac{\text{Actual Output Voltage}}{\text{Rated Input Voltage}}$ x Output kVA = New kVA Rating.

Frame drawings/dimensions information begins on **Page 19.4-28**.

Transformer Selection Information

Table 19.4-12. 120 x 240 V to 12/24 V

kVA	°CTemp. Rise	Frame	Weight Lb (kg)	Catalog Number
0.05	115	FR52	7 (3)	**S10N04A81N**
0.10	115	FR54	7 (3)	**S10N04A82N**
0.15	115	FR55	8 (4)	**S10N04A83N**
0.25	115	FR57P	12 (5)	**S10N04P26P**
0.50	115	FR57P	13 (5)	**S10N04P51P**
0.75	115	FR58AP	21 (10)	**S10N04P76P**
1	115	FR67P	31 (14)	**S10N04P01P**
1.5	115	FR67P	40 (18)	**S10N04P16P**
2	115	FR68P	40 (18)	**S10N04P02P**
3	115	FR176	65 (29)	**S10N04A03N**
5	115	FR177	113 (51)	**S10N04A05N**
7.5	115	FR178	123 (55)	**S10N04A07N**

Table 19.4-13. 120 x 240 V to 16/32 V

kVA	°CTemp. Rise	Frame	Weight Lb (kg)	Catalog Number
0.05	115	FR52	7 (3)	**S10N06A81N**
0.10	115	FR54	7 (3)	**S10N06A82N**
0.15	115	FR55	8 (4)	**S10N06A83N**
0.25	115	FR57P	12 (5)	**S10N06P26P**
0.50	115	FR57P	13 (5)	**S10N06P51P**
0.75	115	FR58AP	21 (10)	**S10N06P76P**
1	115	FR67P	31 (14)	**S10N06P01P**
1.5	115	FR67P	40 (18)	**S10N06P16P**
2	115	FR68P	40 (18)	**S10N06P02P**
3	115	FR176	65 (29)	**S10N06A03N**
5	115	FR177	113 (51)	**S10N06A05N**
7.5	115	FR178	123 (55)	**S10N06A07N**

Table 19.4-14. 240 x 480 V to 24/48 V

kVA	°CTemp. Rise	Frame	Weight Lb (kg)	Catalog Number
0.05	115	FR52	7 (3)	**S20N08A81N**
0.10	115	FR54	7 (3)	**S20N08A82N**
0.15	115	FR55	8 (4)	**S20N08A83N**
0.25	115	FR57P	12 (5)	**S20N08P26P**
0.50	115	FR57P	13 (5)	**S20N08P51P**
0.75	115	FR58AP	21 (10)	**S20N08P76P**
1	115	FR67P	31 (14)	**S20N08P01P**
1.5	115	FR67P	40 (18)	**S20N08P16P**
2	115	FR68P	40 (18)	**S20N08P02P**
3	115	FR176	65 (29)	**S20N08A03N**
5	115	FR177	113 (51)	**S20N08A05N**
7.5	115	FR178	123 (55)	**S20N08A07N**

Wiring Diagrams

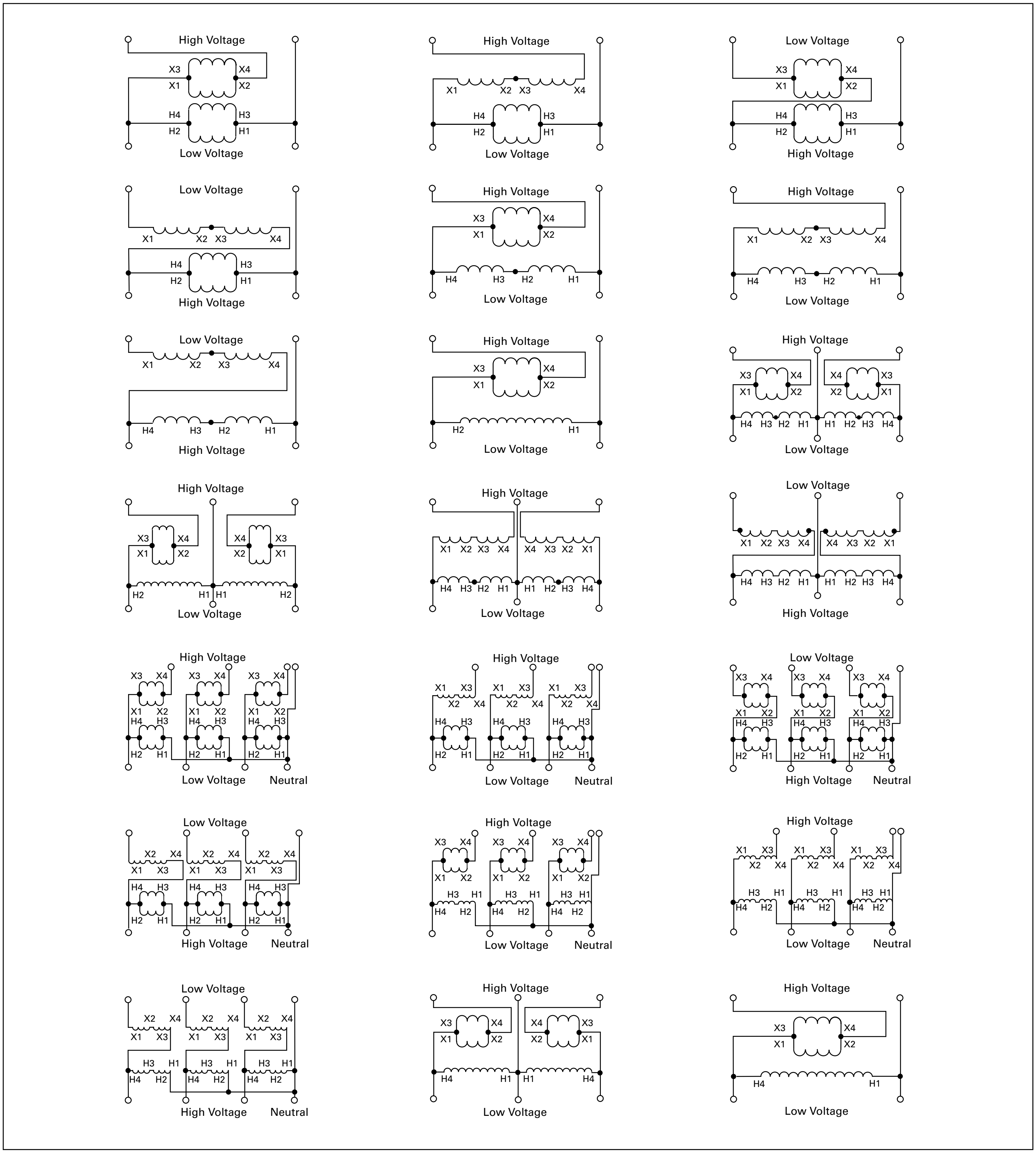

Figure 19.4-1. Buck-Boost Transformers Wiring Diagrams

① **WARNING!** If input is three-wire, "neutral" connection must be isolated and insulated! When used to supply a three-phase, four-wire load, the source must be three-phase, four-wire wye.

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Dimensions

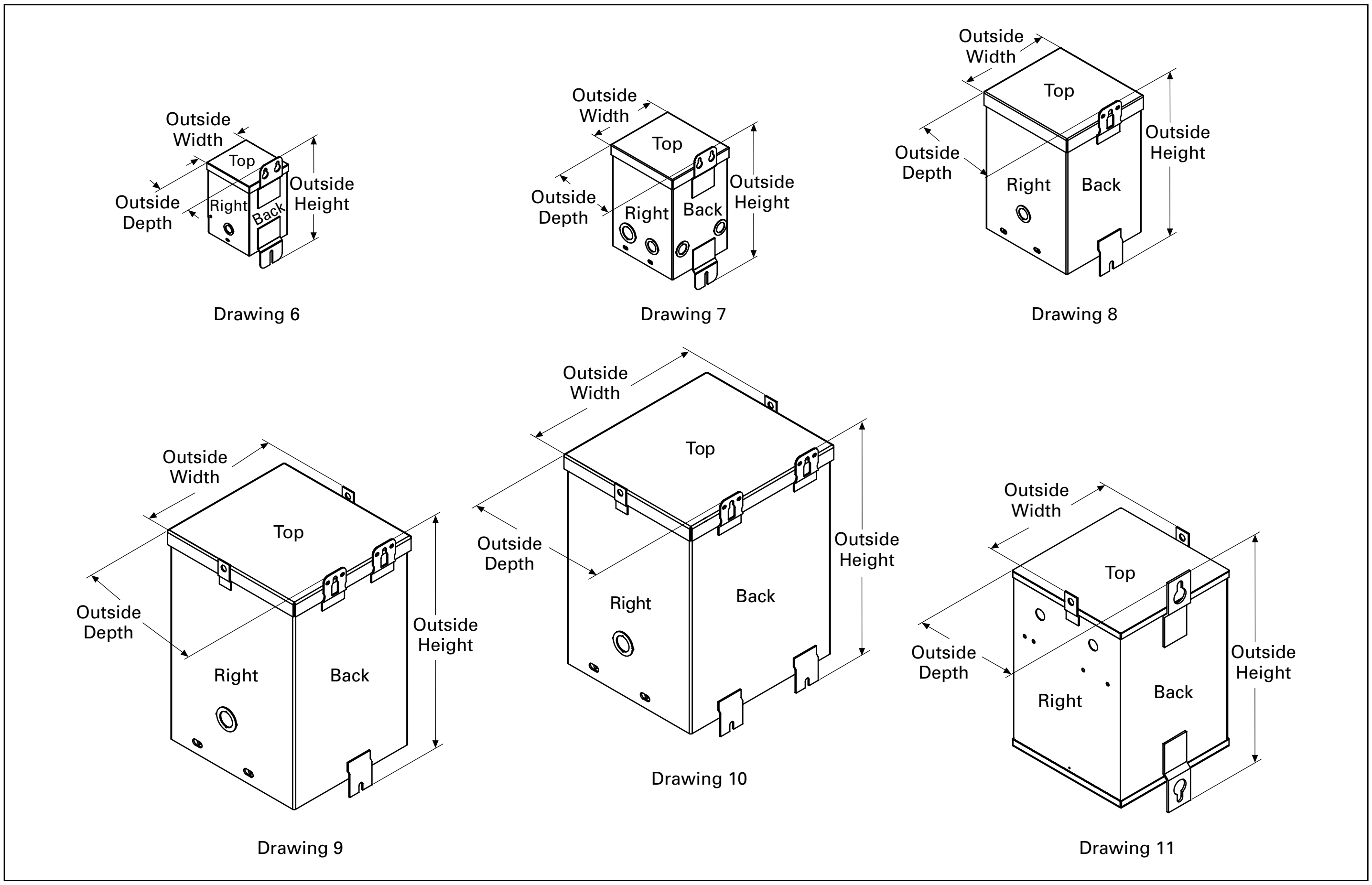

Figure 19.4-2. Enclosure Dimensional Drawings—Encapsulated Transformers (Type EP)

Table 19.4-15. Encapsulated Transformers—Approximate Dimensions in Inches (mm)

Frame	Drawing Number	Dimensions		
		Height	Width	Depth
FR52	6	8.91 (226.3)	4.11 (104.4)	4.00 (101.6)
FR54	6	8.91 (226.3)	4.11 (104.4)	4.00 (101.6)
FR55	6	8.91 (226.3)	4.11 (104.4)	4.00 (101.6)
FR56	7	8.97 (227.8)	4.87 (123.7)	4.06 (103.1)
FR57	7	8.97 (227.8)	4.87 (123.7)	4.91 (124.7)
FR58A	7	11.28 (286.5)	5.99 (152.1)	5.75 (146.1)
FR59A	7	11.28 (286.5)	5.99 (152.1)	5.75 (146.1)
FR67	7	13.41 (340.6)	6.37 (161.8)	6.52 (165.6)
FR68	7	13.41 (340.6)	6.37 (161.8)	6.52 (165.6)
FR176	8	14.25 (361.9)	7.69 (195.3)	8.00 (203.2)
FR177	9	16.00 (406.4)	10.38 (263.7)	9.89 (251.2)
FR301	11	22.26 (565.4)	12.71 (322.8)	12.79 (324.9)
FR178	9	16.00 (406.4)	10.38 (263.7)	9.89 (251.2)
FR302	11	25.26 (641.6)	12.71 (322.8)	12.79 (324.9)
FR304	11	25.26 (641.6)	14.72 (373.9)	14.82 (376.4)
FR179	9	19.00 (482.6)	13.38 (339.9)	10.52 (267.2)
FR180	9	19.00 (482.6)	13.38 (339.9)	10.52 (267.2)
FR182	10	23.31 (592.1)	16.35 (415.3)	14.12 (358.6)
FR190	10	26.31 (668.3)	16.35 (415.3)	14.12 (358.6)

Standards and Certifications

Eaton dry-type distribution transformers are approved, listed, recognized or may comply with the following standards.

Table 19.4-16. Engineering Standards

Catalog Product Name	UL Standard ①	UL/cUL File Number	UL Listed Control Number	cUL Energy Efficiency Verification File Number	CSA File Number	Insulation System Temp/°C	kVA Single-Phase	kVA Three-Phase	Applicable IEC Standard
Industrial Control Transformer									
MTE	5085	E46323	702X	—	—	105	0.025–1.5	N/A	61558
MTE	5085	E46323	702X	—	—	180	0.05–5	N/A	61558
Encapsulated Transformer									
AP	5085	E10156	591H	—	—	180	3–10	N/A	61558
AP	1561	E78389	591H	—	—	180	15	N/A	61558
EP	5085	E10156	591H	—	LR60545	180	0.05–10	N/A	61558
EP	1561	E78389	591H	—	LR60545 ②	180	15–37.5	N/A	61558 ④ / 726 ⑤
EPT	5085	E10156	591H	—	LR60545	180	N/A	3–9	61558 ⑥ / 726 ⑦
EP	1561	E78389	591H	—	LR60545 ③	180	N/A	15–75	726
MPC	1062	E53449	591H	—	LR60546	180	3–25	15–30	—
Ventilated Transformer									
DS-3	1561	E78389	591H	EV33871 ⑧	—	220	7.5–167	N/A	60726
DS-3	1561	E78389	591H	EV33871 ⑨	—	220	N/A	7.5–750	60726
KT	1561	E78389	591H	EV33871 ⑨	—	220	N/A	7.5–750	N/A

① UL 5085 replaces UL 506.
② Applies to 25 kVA.
③ Applies to 30 kVA.
④ Applies to 15–25 kVA.
⑤ Applies to 37.5 kVA.
⑥ Applies to 3 kVA.
⑦ Applies to 5–9 kVA.
⑧ Applies to 15–167 kVA.
⑨ Applies to 15–300 kVA.

In addition to the above standards, Eaton dry-type distribution transformers are also manufactured in compliance with the applicable standards listed below.

Not all of the following standards apply to every transformer.

NEC: National Electrical Code.

NEMA ST-1: Specialty Transformers (C89.1) (control transformers).

NEMA ST-20: General-Purpose Transformers.

DOE 2016 Final Rule: CFR Title 10 Chapter II Part 431, Appendix A of Subpart K 2016.

NEMA 250: Enclosures for Electrical Equipment (1000 volts maximum).

IEEE C57.12.01: General Requirements for Dry-Type Distribution and Power Transformers (including those with solidcast and/or resin-encapsulated windings).

ANSI C57.12.70: Terminal Markings and Connections for Distribution and Power Transformers.

ANSI C57.12.91: Standard Test Code for Dry-Type Distribution and Power Transformers.

CSA C22 No. 47-M90: Air-Cooled Transformers (Dry-Type).

CSA C9-M1981: Dry-Type Transformers.

CSA C22.2 No. 66: Specialty Transformers.

CSA 802-94: Maximum Losses for Distribution, Power and Dry-Type Transformers.

NEMA TP-1: Guide for Determining Energy Efficiency for Distribution Transformers (rescinded).

NEMA TP-2: Standard Test Method for Measuring the Energy Consumption of Distribution Transformers (rescinded).

NEMA TP-3: Standard for the Labeling of Distribution Transformer Efficiency (rescinded).

Glossary of Transformer Terms

Air cooled: A transformer that is cooled by the natural circulation of air around, or through, the core and coils.

Ambient noise level: The existing or inherent sound level of the area surrounding the transformer, prior to energizing the transformer. Measured in decibels.

Ambient temperature: The temperature of the air surrounding the transformer into which the heat of the transformer is dissipated.

Ampacity: The current-carrying capacity of an electrical conductor under stated thermal conditions. Expressed in amperes.

Ampere: The practical unit of electric current.

Attenuation: A decrease in signal power or voltage. Unit of measure is dB.

Autotransformer: A transformer in which part of the winding is common to both the primary and the secondary circuits.

Banked: Two or more single-phase transformers wired together to supply a three-phase load. Three single-phase transformers can be "banked" together to support a three-phase load. For example, three 10 kVA single-phase transformers "banked" together will have a 30 kVA three-phase capacity.

BIL: Basic impulse level. The ability of a transformer's insulation system to withstand high voltage surges. All Eaton 600 V-class transformers have a 10 kV BIL rating.

BTU: British thermal unit. In North America, the term "BTU" is used to describe the heat value (energy content) of fuels, and also to describe the power of heating and cooling systems, such as furnaces, stoves, barbecue grills and air conditioners. When used as a unit of power, BTU "per hour" (BTU/h) is understood, though this is often abbreviated to just "BTU."

Buck-Boost: The name of a standard, single-phase, two-winding transformer application with the low-voltage secondary windings connected as an autotransformer for boosting (increasing) or bucking (decreasing) voltages in small amounts. Applications can either be single-phase or three-phase.

CE: Mark to indicate third-party approved or self-certification to specific requirements of the European community.

Celsius (centigrade): Metric temperature measure.

°F = (1.8 x °C) + 32

°C = (°F-32) / 1.8

Center tap: A reduced capacity tap at the mid-point of a winding. The center tap on three-phase delta-delta transformers is called a lighting tap. It provides 5% of the transformer's kVA for single-phase loads.

Certified tests: Actual values taken during production tests and certified as applying to a given unit shipped on a specific order. Certified tests are serial number–specific.

Common mode: Electrical noise or voltage fluctuation that occurs between all of the line leads and the common ground, or between ground and line or neutral.

Compensated transformer: A transformer with a turns ratio that provides a higher than nameplate output (secondary) voltage at no load, and nameplate output (secondary) voltage at rated load. It is common for small transformers (2 kVA and less) to be compensated.

Conductor losses: Losses (expressed in watts) in a transformer that are incidental to carrying a load: coil resistance, stray loss due to stray fluxes in the windings, core clamps, and the like, as well as circulating currents (if any) in parallel windings. Also called load losses.

Continuous duty rating: The load that a transformer can handle indefinitely without exceeding its specified temperature rise.

Core losses: Losses (expressed in watts) caused by magnetization of the core and its resistance to magnetic flux. Also called no-load losses or excitation losses. Core losses are always present when the transformer is energized.

CSA: Canadian Standards Association. The Canadian equivalent of Underwriters Laboratories (UL).

CSL3: Candidate Standard Level 3 (CSL3) design criteria developed by the U.S. Department of Energy.

cUL: Mark to indicate UL Certification to specific CSA Standards.

Decibel (dB): Unit of measure used to express the magnitude of a change in signal or sound level.

Delta connection: A standard three-phase connection with the ends of each phase winding connected in series to form a closed loop with each phase 120 degrees from the other. Sometimes referred to as three-wire.

Dielectric tests: Tests that consist of the application of a voltage higher than the rated voltage for a specified time for the purpose of determining the adequacy against breakdowns of insulating materials and spacings under normal conditions.

DOE 2016 efficient: A revision to federal law 10 CFR Part 431 (2007) that mandates higher efficiency for distribution transformers manufactured for sale in the U.S. and U.S. Territories effective January 1, 2016. "TP-1" efficient transformers can no longer legally be manufactured for use in the U.S. as of this date.

Dry-type transformer: A transformer in which the core and coils are in a gaseous or dry compound insulating medium. A transformer that is cooled by a medium other than a liquid, normally by the circulation of air.

Eddy currents: The currents that are induced in the body of a conducting mass by the time variation of magnetic flux or varying magnetic field.

Efficiency: The ratio of the power output from a transformer to the total power input. Typically expressed as a %.

Electrostatic shield: Copper or other conducting sheet placed between primary and secondary windings, and grounded to reduce electrical interference and to provide additional protection from line-to-line or line-to-ground noise. Commonly referred to as "Faraday shield."

Encapsulated transformer: A transformer with its coils either dipped or cast in an epoxy resin or other encapsulating substance.

Enclosure: A surrounding case or housing used to protect the contained equipment against external conditions and prevent personnel from accidentally contacting live parts.

Environmentally preferable product: A product that has a lesser or reduced negative effect on human health and the environment when compared to competing products that serve the same purpose. This comparison may consider raw materials acquisition, production, manufacturing, packaging, distribution, reuse, operation, maintenance and disposal of the product. This term includes recyclable products, recycled products and reusable products.

EPACT: The Energy Policy Act of 1992 (EPAct) is an important piece of legislation for efficiency because it established minimum efficiency levels for dry-type distribution transformers manufactured or imported after December 2006. EPAct, which was based on NEMA standards, defined a number of terms, including what constitutes an energy-efficient transformer. The DOE issued a rule that defines these transformers and how manufacturers must comply. In April 2013, the DOE mandated even higher minimum efficiency levels for distribution transformers effective starting in January 2016. DOE EPAct rule (PDF): Energy Efficiency Program for Certain Commercial and Industrial Equipment: Test Procedures, Labeling, and the Certification Requirements for Electric Motors. Final Rule. 10-CFR Part 431.

Excitation current: No load current. The current that flows in any winding used to excite the transformer when all other windings are open-circuited. It is usually expressed in percent of the rated current of a winding in which it is measured. Also called magnetizing current.

FCAN: "Full Capacity Above Nominal" taps. Designates the transformer will deliver its rated kVA when connected to a voltage source which is higher than the rated primary voltage.

FCBN: "Full Capacity Below Nominal" taps. Designates the transformer will deliver its rated kVA when connected to a voltage source which is lower than the rated primary voltage.

Frequency: On AC circuits, designates the number of times that polarity alternates from positive to negative and back again per second, such as 60 cycles per second. Typically measured in Hertz (Hz).

Ground: Connecting one side of a circuit to the earth through low resistance or low impedance paths to help prevent transmitting electrical shock to personnel.

Harmonic: A sinusoidal waveform with a frequency that is an integral multiple of the fundamental frequency (60 Hz).

60 H_3 fundamental
120 H_3 2nd harmonic
180 H_3 3rd harmonic
240 H_3 4th harmonic

Harmonic distortion: Nonlinear distortion of a system characterized by the appearance of harmonic (non-sinusoidal) currents in the output, when the input is sinusoidal.

Harmonic distortion, total (THD): The square root of the sum of the squares of all harmonic currents present in a load, excluding the fundamental 60 Hz current. Usually expressed as a percent of the fundamental.

High-voltage windings: In a two-winding transformer, the winding intended to have the greater voltage. Usually marked with "H" designations.

HMT: Harmonic Mitigating Transformer (HMT) is better able to handle the harmonic currents present in today's electrical power system. thereby increasing system capacity, reducing distortion throughout a facility, help to minimize downtime and "mysterious" maintenance on equipment, and return the longevity of equipment life through reduced operational energy losses, thereby running cooler.

Hp: Horsepower. The energy required to raise 33,000 pounds a distance of one foot in one minute. 1 hp is equal to 746 watts, or 0.746 kW.

Hi pot: A standard test on dry-type transformers consisting of extra-high potentials (voltages) connected to the windings. Used to check the integrity of insulation materials and clearances.

Hottest-spot temperature: The highest temperature inside the transformer winding. Is greater than the measured average temperature of the coil conductors, when using the resistance change method.

Hysteresis: The tendency of a magnetic substance to persist in any state of magnetization.

Impedance: The retarding forces of current in an AC circuit; the current-limiting characteristics of a transformer. Symbol = Z

Inductance: In electrical circuits, the opposition to a change in the flow of electrical current. Symbol = L

Inducted potential test: A standard dielectric test of transformer insulation. Verifies the integrity of insulating materials and electrical clearances.

Inrush current: The initial high peak of current that occurs in the first few cycles of energization, which can be 30 to 40 times the rated current.

Insulating transformer: Another term for an isolating transformer.

Insulation: Material with a high electrical resistance.

Insulation materials: Those materials used to insulate the transformer's electrical windings from each other and ground.

Integral TVSS or SPD: Major standard change for surge protective devices (formerly known as transient voltage surge suppressors). The primary safety standard for transient voltage surge suppressors (TVSS) has undergone major revisions in the past three years with mandatory compliance by manufacturers required by September 29, 2009. Even the name of the standard has changed from UL Standard for Safety for Transient Voltage Surge Suppressors, UL 1449 to UL Standard for Safety for Surge Protective Devices, UL 1449. This means that TVSS listed to the UL 1449 2nd Edition standard will no longer be able to be manufactured after September 29, 2009. All Surge Protective Devices must be designed, tested, manufactured and listed to the UL 1449 3rd Edition standard after this date.

Isolating transformer: A transformer where the input (primary) windings are not connected to the output (secondary) windings (i.e., electrically isolated).

K-factor: A common industry term for the amount of harmonics produced by a given load. The larger the K-factor, the more harmonics that are present. Also used to define a transformer's ability to withstand the additional heating generated by harmonic currents.

kVA: Kilovolt-ampere. Designates the output that a transformer can deliver for a specified time at a rated secondary voltage and rated frequency without exceeding the specified temperature rise. When multiplied by the power factor, will give kilowatts or kW.

1000 VA = 1 kVA

Lamination: Thin sheets of electrical steel used to construct the core of a transformer.

Limiting temperature: The maximum temperature at which a component or material may be operated continuously with no sacrifice in normal life expectancy.

Linear load: A load where the current waveform conforms to that of the applied voltage, or a load where a change in current is directly proportional to a change in applied voltage.

Live part: Any component consisting of an electrically conductive material that can be energized under conditions of normal use.

Load losses: I^2R losses in windings. Also see conductor losses.

Low-voltage winding: In a two-winding transformer, the winding intended to have the lesser voltage. Usually marked with "X" designations.

Mid-tap: See center tap.

Noise level: The relative intensity of sound, measured in decibels (dB). NEMA Standard ST-20 outlines the maximum allowable noise level for dry-type transformers.

Nonlinear load: A load where the current waveform does not conform to that of the applied voltage, or where a change in current is not proportional to a change in applied voltage.

Non-ventilated transformer: A transformer where the core and coil assembly is mounted inside an enclosure with no openings for ventilation. Also referred to as totally enclosed non-ventilated (TENV).

No load losses: Losses in a transformer that is excited at rated voltage and frequency but that is not supplying a load. No load losses include core losses, dielectric losses and conductor losses in the winding due to the exciting current. Also referred to as excitation losses.

Overload capability: Short-term overload capacity is designed into transformers as required by ANSI. Continuous overload capacity is not deliberately designed into a transformer because the design objective is to be within the allowed winding temperature rise with nameplate loading.

Percent IR (% resistance): Voltage drop due to resistance at rated current in percent of rated voltage.

Percent IX (% reactance): Voltage drop due to reactance at rated current in percent of rated voltage.

Percent IZ (% impedance): Voltage drop due to impedance at rated current in percent of rated voltage.

Phase: Type of AC electrical circuit; usually single-phase two- or three-wire, or three-phase three- or four-wire.

Polarity test: A standard test on transformers to determine instantaneous direction of the voltages in the primary compared to the secondary.

Primary taps: Taps added to the primary (input) winding. See Tap.

Primary voltage: The input circuit voltage.

Power factor: The cosine of the phase angle between a voltage and a current.

Ratio test: A standard test of transformers to determine the ratio of the input (primary) voltage to the output (secondary) voltage.

Reactance: The effect of inductive and capacitive components of a circuit producing other than unity power factor.

Reactor: A single winding device with an air or iron core that produces a specific amount of inductive reactance into a circuit. Normally used to reduce of control current.

Regulation: Usually expressed as the percent change in output voltage when the load goes from full load to no load.

Scott T connection: Connection for three-phase transformers. Instead of using three sets of coils for a three-phase load, the transformer uses only two sets of coils.

Series/multiple winding: A winding consisting of two or more sections that can be connected for series operation or multiple (parallel) operation. Also called series-parallel winding.

Short circuit: A low resistance connection, usually accidental, across part of a circuit, resulting in excessive current flow.

Sound levels: All transformers make some sound mainly due to the vibration generated in its core by alternating flux. All Eaton general-purpose dry-type distribution transformers are designed with sound levels lower than NEMA ST-20 maximum levels.

Star connection: Same as a wye connection.

Step-down transformer: A transformer where the input voltage is greater than the output voltage.

Step-up transformer: A transformer where the input voltage is less than the output voltage.

T-T connection: See Scott T connection.

Tap: A connection brought out of a winding at some point between its extremities, usually to permit changing the voltage or current ratio. Taps are typically used to compensate for above or below rated input voltage, in order to provide the rated output voltage. See FCAN and FCBN.

Temperature class: The maximum temperature that the insulation system of a transformer can continuously withstand. The common insulation classes are 105, 150, 180 (also 185) and 220.

Temperature rise: The increase over ambient temperature of the windings due to energizing and loading the transformer.

Total losses: The sum of the no-load losses and load losses.

Totally enclosed non-ventilated enclosure: The core and coil assembly is installed inside an enclosure that has no ventilation to cool the transformer. The transformer relies on heat to radiate from the enclosure for cooling.

Transformer tests: Per NEMA ST-20, routine transformer production tests are performed on each transformer prior to shipment. These tests are: Ratio tests on the rated voltage connection; Polarity and Phase Relation tests on the rated connection; No-Load and Excitation Current tests at rated voltage on the rated voltage connection and Applied Potential and Induced Potential tests. Special tests include sound level testing.

Transverse mode: Electrical noise or voltage disturbance that occurs between phase and neutral, or from spurious signals across metallic hot line and the neutral conductor.

Turns ratio: The ratio of the number of turns in the high voltage winding to that in the low voltage winding.

Typical test data: Tests that were performed on similar units that were previously manufactured and tested.

UL (Underwriters Laboratories): An independent safety testing organization.

Universal taps: A combination of six primary voltage taps consisting of 2 at +2-1/2% FCAN and 4 at -2-1/2% FCBN.

Watt: A unit of electrical power when the current in a circuit is one ampere and the voltage is one volt.

Wye connection: A standard three-wire transformer connection with similar ends of single-phase coils connected together. The common point forms the electrical neutral point and may be grounded. Also referred to as three-phase four-wire. To obtain the line-to-neutral voltage, divide the line voltage by $\sqrt{3}$ (1.732).

Frequently Asked Questions About Transformers

Can 60 Hz transformers be used at other frequencies?

Transformers rated for 60 Hz can be applied to circuits with a higher frequency, as long as the nameplate voltages are not exceeded. The higher the frequency that you apply to a 60 Hz transformer, the less voltage regulation you will have. 60 Hz transformers may be used at lower frequencies, but only at reduced voltages corresponding to the reduction in frequency. For example, a 480–120 V 60 Hz transformer can carry rated kVA at 50 Hz but only when applied as a 400–100 V transformer (50/60 x 480 = 400).

Can single-phase transformers be used on a three-phase source?

Yes. Any single-phase transformer can be used on a three-phase source by connecting the primary terminals of the single-phase transformer to any two wires of a three-phase system. It does not matter whether the three-phase source is three-phase three-wire or three-phase four-wire. The output of the transformer will be single-phase.

Can transformers be used to create three-phase power from a single-phase system?

No. Single-phase transformers alone cannot be used to create the phase-shifts required for a three-phase system. Phase-shifting devices (reactors or capacitors) or phase converters in conjunction with transformers are required to change single-phase power to three-phase.

What considerations need to be taken into account when operating transformers at high altitudes?

At altitudes greater than 3300 ft (1000 m), the density of the air is lesser than at lower elevations. This reduces the ability of the air surrounding a transformer to cool it, so the temperature rise of the transformer is increased. Therefore, when a transformer is being installed at altitudes greater than 3300 ft (1000 m) above sea level, it is necessary to derate the nameplate kVA by 0.3% for each 330 ft (100 m) in excess of 3300 feet.

What considerations need to be taken into account when operating transformers where the ambient temperature is high?

Eaton's dry-type transformers are designed in accordance with ANSI standards to operate in areas where the average maximum ambient temperature is 40 °C. For operation in ambient temperatures above 40 °C, there are two options:

1. Order a custom-designed transformer made for the specific application.
2. Derate the nameplate kVA of a standard transformer by 8% for each 10 °C of ambient above 40 °C.

What is the normal life expectancy of a transformer?

When a transformer is operated under ANSI/IEEE basic loading conditions (ANSI C57.96), the normal life expectancy of a transformer is 20 years. The ANSI/IEEE basic loading conditions are:

A. The transformer is continuously loaded at rated kVA and rated voltages.

B. The average temperature of the ambient air during any 24-hour period is equal to 30 °C and at no time exceeds 40 °C.

C. The altitude where the transformer is installed does not exceed 3300 ft (1000 m).

What are Insulation Classes?

Insulation classes were originally used to distinguish insulating materials operating at different temperatures. In the past, letters were used for the different designations. Recently, insulation system temperatures (°C) have replaced the letters' designations.

Table 19.3-17. Insulation Classes

Previous Designation	Insulation System Rating (°C)
Class A	105
Class B	150
Class F	180
Class H	220
Class R	220

How do you know if the enclosure temperature is too hot?

UL and CSA standards strictly regulate the highest temperature that an enclosure can reach. For ventilated transformers, the temperature of the enclosure should not increase by more than 50 °C in °C ambient at full rated current. For encapsulated transformers, the temperature of the enclosure should not increase by more than 65 °C in a 25 °C ambient at full rated current. This means that it is permissible for the temperature of the enclosure to reach 90 °C (194 °F). Although this temperature is very warm to the touch, it is within the allowed standards. A thermometer should be used to measure enclosure temperatures, not your hand.

Can transformers be reverse-connected (reverse-fed)?

Yes, with limitations. Eaton's single-phase transformers rated 3 kVA and larger can be reverse-connected without any loss of kVA capacity or any adverse effects. Transformers rated 2 kVA and below, because there is a turns ratio compensation on the low voltage winding that adjusts voltage between no load and full load conditions, should not be reverse-fed.

Three-phase transformers with either delta-delta or delta-wye configurations can also be reverse-connected for step-up operation. When reverse-feeding a delta-wye connected transformer, there are two important considerations to take into account: (1) The neutral is not connected, only the three-phase wires of the wye system are connected; and (2) the ground strap between X0 and the enclosure must be removed. Due to high inrush currents that may be created in these applications, it is recommended that you do not reverse-feed transformers rated more than 75 kVA. The preferred solution is to purchase an Eaton step-up transformer designed specifically for your application.

Can transformers be connected in parallel?

Yes, with certain restrictions. For single-phase transformers being connected in parallel, the voltages and impedances of the transformers must be equal (impedances must be within 7.5% of each other). For three-phase transformers, the same restrictions apply as for single-phase transformers, plus the phase shift of t he transformers must be the same. For example, a delta-wye–connected transformer (30° phase shift) must be connected in parallel with another delta-wye–connected transformer, not a delta-delta–connected transformer (0° phase shift).

Why is the impedance of a transformer important?

The impedance of a transformer is important because it is used to determine the interrupting rating and trip rating of the circuit protection devices on the load side of the transformer. To calculate the maximum short-circuit current on the load side of a transformer, use the following formula:

$$\text{Maximum Short-Circuit Load Current (Amps)} = \frac{\text{Full Load Current (Amps)}}{\text{Transformer Impedance}}$$

Full load current for single-phase circuits is:

$$\frac{\text{Nameplate Volt-Amps}}{\text{Load (output) Voltage}}$$

and for three-phase circuits the full load current is:

$$\frac{\text{Nameplate Volt-Amps}}{\text{Load (output) Volts} \times \sqrt{3}}$$

Example: For a standard three-phase, 75 kVA transformer, rated 480 V delta primary and 208Y/120 V secondary (catalog number V48M28T75J) and impedance equal to 5.1%, the full load current is:

$$\frac{75{,}000 \text{ VA}}{208 \text{ V x } 1.732} = 208.2 \text{ A}$$

The maximum short-circuit load current is:

$$\frac{208.2 \text{ A}}{0.051} = 4082.4 \text{ A}$$

The circuit breaker or fuse on the secondary side of this transformer would have to have a minimum interrupting capacity of 4083 A at 208 V. NEMA ST-20 (1992).

A similar transformer with lower impedance would require a primary circuit breaker or fuse with a higher interrupting capacity.

What clearances are required around transformers when they are installed?

All dry-type transformers depend upon the circulation of air for cooling; therefore, it is important that the flow of air around a transformer not be impeded. Many Eaton transformers require a minimum clearance of 6 inches from panels with ventilation openings. However, small kVA DOE 2016 efficient ventilated transformers are UL approved to be installed with just 2 inches clearance, while large kVA transformers require 12 inches or more clearance. In compliance with NEC 450.9, Eaton's ventilated transformers have a note on their nameplates identifying the minimum required clearance from the ventilation openings and walls or other obstructions. This clearance only addresses the ventilation needs of the transformer. There may be additional local codes and standards that affect installation clearances.

Transformers should not be mounted in such a manner that one unit will contribute to the additional heating of another unit, beyond allowable temperature limits, for example, where two units are mounted on a wall one above the other.

How Can I Reduce Transformer Sound Levels?

All transformers emit some audible sound due mainly to the vibration generated in their core by alternating flux. NEMA ST-20 (2014) defines the maximum average sound levels for transformers.

Table 19.3-18. NEMA ST-20 (2014) Maximum Audible Sound Levels for 600 V Class Transformers (dBA)

Equivalent Winding kVA Range	Average Sound Level, Decibels			
	Self-Cooled Ventilated			Self-Cooled Sealed
	A	B	C	D
	K Factor = 1 K Factor = 4 K Factor = 9	K Factor = 13 K Factor = 20	Forced Air When Fans Running	
3.00 and below	40	40	67	45
3.01 to 9.00	40	40	67	45
9.01 to 15.00	45	45	67	50
15.01 to 30.00	45	45	67	50
30.01 to 50.00	45	48	67	50
50.01 to 75.00	50	53	67	55
75.01 to 112.50	50	53	67	55
112.51 to 150.00	50	53	67	55
150.01 to 225.00	55	58	67	57
225.01 to 300.00	55	58	67	57
300.01 to 500.00	60	63	67	59
500.01 to 700.00	62	65	67	61
700.01 to 1000.00	64	67	67	63
Greater than 1000	Consult factory			

Note: Consult factory for nonlinear requirements exceeding a K-factor rating of 20. When the fans are not running, columns A and B apply. Sound levels are measured using the A-weighted scale (dBA).

All Eaton transformers are designed to have audible sound levels lower than those required by NEMA ST-20 (2014). However, consideration should be given to the specific location of a transformer and its installation to minimize the potential for sound transmission to surrounding structures and sound reflection. The following installation methods should be considered:

1. If possible, mount the transformer away from corners of walls or ceilings. For installations that must be near a corner, use sound-absorbing materials on the walls and ceiling if necessary to eliminate reflection.
2. Provide a solid foundation for mounting the transformer and use vibration dampening mounts if not already provided in the transformer. Eaton's ventilated transformers contain a built-in vibration dampening system to minimize and isolate sound transmission. However, supplemental vibration dampening mounts installed between the floor and the transformer may provide additional sound dampening.
3. Make electrical connections to the transformer using flexible conduit.
4. Locate the transformer in an area where audible sound is not offensive to building inhabitants.
5. Install "low sound" transformers (up to 5 dB below NEMA ST-20 [2014] sound limits).

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