Dry-Type Transformers

600 Volt Class

Bulletin
7700-99

FEDERAL PACIFIC™

ISO 9002 Registered

UL LISTED

Federal Pacific

Federal Pacific History

During 1987, the Electro-Mechanical Corporation acquired the dry-type transformer division of Federal Pacific Electric in Des Plaines, Illinois. It was moved to Bristol, Virginia and the name was changed to Federal Pacific (FP). A new 100,000 square foot facility was constructed where time-proven designs and modern technology are combined and employed by the new management. Expansion in early 1993 provided an additional 36,000 square feet of manufacturing space.

FP Today

Federal Pacific is a major manufacturer of dry-type transformers which serve the industrial, construction, commercial, mining, OEM and utility markets. The product scope is 50 VA through 10,000 KVA and120 through 34,500 volts. The 600 volt class offering includes industrial control transformers, encapsulated/compound-filled general purpose and buck-boost transformers, ventilated designs for general purpose applications, electrostatically shielded transformers and a complete line of motor drive isolation transformers. The high voltage offering includes core and coil transformers, general purpose designs, padmount transformers, unit substation transformers, vacuum pressure impregnated transformers (VPI), and VPI/epoxy shielded transformers. K-Factor rated transformers are offered for the entire product scope.

Distribution

A 35,000 square foot National Distribution Center was added in 1992. Additionally, regional warehouse stocks have been implemented in 19 strategic locations across the United States.

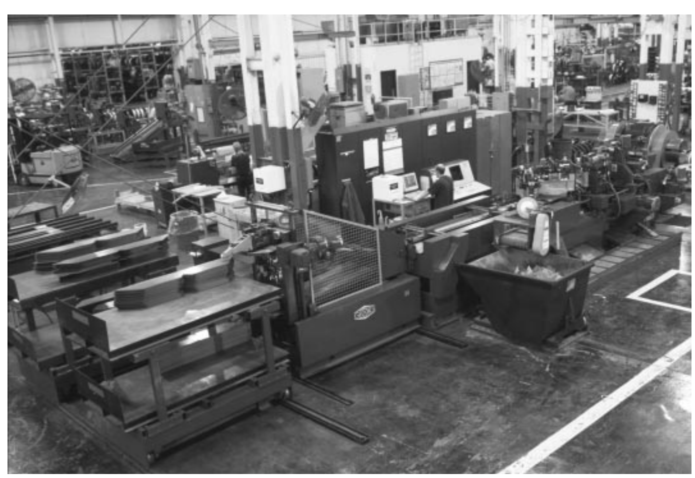


Table of Contents

Full Load Current Ratings

KVA Rating	Full Load Current (Amperes)			
	120 V	240 V	480 V	600 V
.050	0.42	0.21	0.1	0.08
.075	0.63	0.31	0.16	0.13
.100	0.83	0.42	0.21	0.17
.150	1.25	0.63	0.31	0.25
.250	2.08	1.04	0.52	0.42
.500	4.17	2.08	1.04	0.83
.750	6.25	3.13	1.56	1.25
1	8.33	4.17	2.08	1.67
1.5	12.5	6.25	3.13	2.5
2	16.7	8.33	4.17	3.33
3	25	12.5	6.25	5
5	41.7	20.8	10.4	8.33
7.5	62.5	31.3	15.6	12.5
10	83.3	41.7	20.8	16.7
15	125	62.5	31.2	25
25	208	104	52	41.7
37.5	312	156	78.1	62.5
50	417	208	104	83.3
75	625	312	156	125
100	833	417	208	167
167	1392	696	348	278
333	2775	1387	694	555

Single-Phase KVA = $\frac{\text{Volts x Load Amperes}}{1000}$

KVA Rating	Full Load Current (Amperes)			
	208 V	240 V	480 V	600 V
3	8.33	7.22	3.61	2.89
6	16.6	14.4	7.22	5.77
9	25	21.6	10.8	8.66
15	41.6	36.1	18	14.4
25	69.4	60.1	30.1	24.1
30	83.3	72.2	36.1	28.9
37.5	104	90.2	45.1	36.1
45	125	108	54.1	43.3
50	139	120	60.1	48.1
60	166	144	72.2	57.7
75	208	180	90.2	72.2
100	278	241	120	96.2
112.5	312	271	135	108
150	416	361	180	144
225	625	541	271	217
300	833	722	361	289
400	1110	962	481	385
500	1388	1203	601	481
750	2082	1804	902	722
1000	2776	2406	1203	962

Three-Phase KVA = $\frac{\text{Volts x Load Amperes x 1.73}}{1000}$

General Information

What is a Transformer?

A transformer is an electrical apparatus designed to convert alternating voltage from one voltage level to another. Transformers are completely static devices without continuously moving mechanical parts, which, by electromagnetic induction, transform electrical energy from one or more circuits to one or more other circuits at the same frequency.

In most cases, transformers change the voltage from an incoming source to its load. Transformers can be used to increase (step up) or decrease (step down) voltages. Sometimes transformers do not change voltages; that is, they are not used for step up or step down purposes. These transformers are called **isolation** transformers.

Electric power is always distributed over a wide area by means of alternating current. Direct current is not used for several reasons, the most important being that it cannot be changed from one voltage level to another without expensive conversion equipment. Alternating current however can be simply changed to any convenient voltage by the use of transformers.

Description

Federal Pacific dry-type transformers rated 600 volts and below are available in a wide variety of types and ratings to provide reliable and versatile electrical distribution for lighting and power loads in industrial and commercial applications.

Ratings are available from .050 through 333 KVA in single-phase configurations and from 3 through 1000 KVA in three-phase. All standard primary and secondary voltage ratings are provided to match load requirements to the distribution system.

The air cooled dry-type construction requires no special vaults for installation. The units may be located in almost any indoor location convenient to the load being served. Most transformers are also available for outdoor installations. Maintenance requires only periodic inspection of cable connections and removal of any dust accumulation.

Industry Standards

Federal Pacific dry-type transformers are UL Listed and are designed, tested, and manufactured in accordance with applicable industry standards:

- UL-506 & UL 1561
- ANSI C57.12
- NEMA ST-20
- CSA # C22.2 No. 47
- CUL

Tested Performance

Ratio Test is performed on rated voltage connection and tap connections to assure proper turns ratio on all connections.

Polarity Test and phase relation tests are made to ensure proper polarity and marking because of their importance in paralleling or banking two or more transformers.

No-load (excitation) Loss Test determines the losses of a transformer which is excited at rated voltage and frequency, but which is not supplying a load. Transformer excitation loss consists mainly of the iron loss in the transformer core.

Load Loss Test determines the amount of losses in the transformer when carrying full rated load. These losses consist primarily of I^2R losses in the primary and secondary winding and ensure that specifications of the transformer design are met.

Excitation Current Test determines the current necessary to maintain transformer excitation.

Resistance Test is performed on the transformer windings and is used to determine I^2R loss.

Impedance Test is made to insure that transformer design standards are attained. This is important when paralleling transformers.

Dielectric Test (applied and induced potential) checks the insulation and workmanship to demonstrate that the transformer has been designed and manufactured to meet the insulation tests required by the standards.

Applied Potential Tests are made by impressing between windings and between each winding and ground, a low frequency voltage.

Induced Potential Tests call for over-exciting the transformer by applying between the terminals on one winding a voltage of twice the normal voltage developed in the winding for a period of 7200 cycles.

Selection and Application Considerations

Selection Steps

- Determine the system supply voltage available (primary voltage).
- Determine the required load voltage rating (secondary voltage).
- Determine the KVA rating of the load. (If the load rating is given only in amperes, the proper KVA size of the transformer can be selected from the charts on page 3.) The KVA capacity of the transformer must equal or be greater than the load rating.
- Select a transformer model from the listings on the following pages.

Connections

Many single-phase transformers are provided with a series multiple winding construction and a dual voltage primary or secondary identification (i.e. 240 x 480 to 120/240). These transformers will have two windings on the primary or secondary that can be connected either in series for the higher voltage or in parallel for the lower voltage. Transformers with voltage ratings containing an "x" can only be connected for one or the other of the two voltages. On those units with voltage ratings separated by a "slant", the windings can be connected to provide either or both voltages (three wire operation).

Three-phase transformers are provided with a delta primary for three wire input and either a wye secondary for four wire output or a delta secondary for three wire output. Transformers with 240 volt delta secondaries may have a 120 volt single-phase lighting tap as a standard feature. Maximum single-phase 120 volt load should not exceed 10% of the three-phase KVA rating. The load should also be balanced at 5% maximum between terminals X1 to X4 and 5% between terminals X2 to X4. The three-phase KVA must also be reduced by 30% of the nameplate rating. For example, a 45 KVA transformer can have a 4.5 KVA maximum single-phase, 120 volt load. Of that 4.5 KVA, 2.25 KVA must be loaded between X1 - X4 and 2.25 KVA must be loaded between X2 - X4. The three-phase KVA rating must be reduced to 31.5 KVA.

Primary Taps

All Federal Pacific three-phase transformers and most single-phase models are provided with taps in the primary winding to compensate for input voltage variations. The taps will provide a range of voltage adjustment above and/or below the nominal voltage rating of the transformer. The available quantity, location, and percentage of the tap connections are shown in the transformer listings. All transformers are furnished with a nameplate showing the terminal and tap arrangements.

Sound Levels

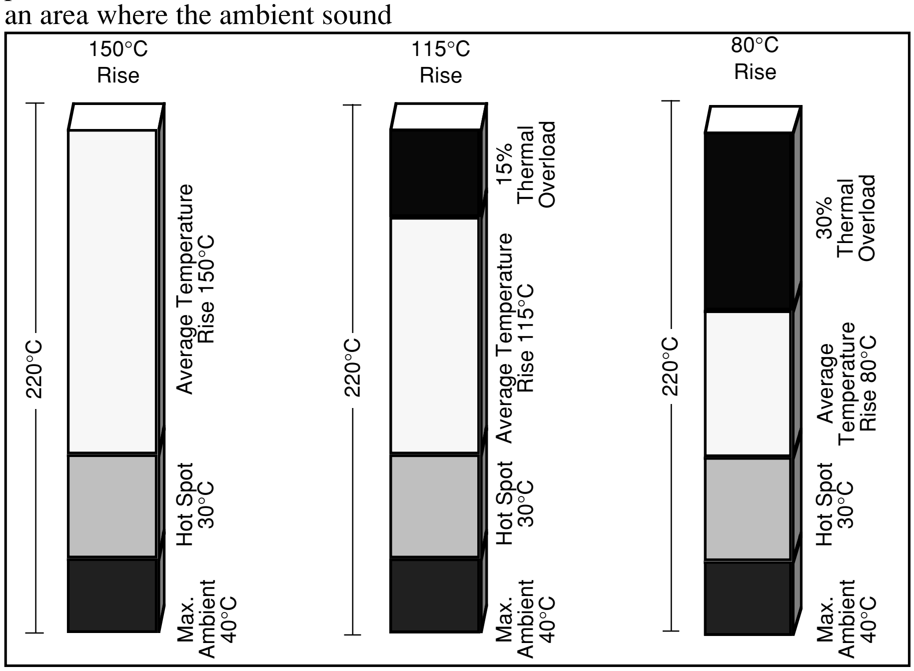
A humming sound is an inherent characteristic of transformers due to the vibration caused by alternating flux in the magnetic core. Sound levels will vary according to transformer size. Attention to installation methods can help reduce any objectionable noise. When possible, locate the transformer in an area where the ambient sound will be equal to or greater than the transformer sound level. Avoid locating units in corners. Make connections with flexible conduits and couplings to prevent transmitting vibration to other equipment. Larger units should be installed on flexible mountings to isolate the transformer from the building structure.

Federal Pacific transformers are designed, built, and comply with NEMA maximum sound level requirements as measured in accordance with NEMA ST-20.

Sound Level in Decibels	
KVA 150° C Rise K-1	NEMA ST-20 Average
0 - 9	40
10 - 50	45
51 - 150	50
151 - 300	55
301 - 500	60
501 - 700	62
701 - 1000	64

Temperature

Insulation system limiting temperatures for FH Style dry-type transformers are classified by industry standards based on a 40°C ambient, 25°C ambient for FB Styles.



Definition of Average Temperature Rise

Selection and Application Considerations

Altitude

Standard self-cooled dry-type transformers are designed for operation with normal temperature rise at altitudes up to 3300 ft. above sea level. The transformer rated KVA should be reduced by 0.3% for each 330 ft. the transformer is installed above 3300 ft.

Polarity

Transformer polarity is an indication of the direction of current flow through the high voltage terminals with respect to the direction of current flow through the low voltage terminals at any given instant in the alternating cycle.

Primary and secondary terminals are said to have the same (or additive) polarity when, at a given instant, the current enters the primary terminal in question and leaves the secondary terminal in question in the same direction as though the two terminals formed a continuous circuit.

Single-phase transformers rated 600 volts and below normally have additive polarity.

The polarity of a three-phase transformer is fixed by the internal connections between phases. It is usually designated by means of a vector diagram showing the angular displacement of the windings and a sketch showing the markings of the terminals.

Angular Displacement

The angular displacement of a three-phase transformer is the time angle expressed in degrees between the line-to-neutral voltage of a specified high voltage terminal and the line-to-neutral voltage of a specified low voltage terminal.

The angular displacement between the high voltage and low voltage terminal voltages of three-phase transformers with delta-delta connections is zero degrees.

The angular displacement for three-phase transformers with delta-wye connections is 30 degrees with the low voltage lagging the high voltage.

Parallel Operation

Transformers with the same KVA ratings can be connected in parallel if required conditions are met. Single-phase transformers must have the same voltage rating, tap settings and frequency rating. Plus, the impedance values of the transformers must be within 7-1/2% of each other. When paralleling three-phase transformers, the same conditions would apply and, in addition, the angular displacement of the transformers must be the same.

Transformer Banking

Three single-phase transformers can be properly connected to supply a three-phase load. The single-phase units can be used in a three-phase bank with delta connected primary and wye or delta connected secondary. The equivalent three-phase capacity would be three times the nameplate rating of each single-phase transformer. For example, three 15 KVA single-phase transformers will, when properly banked, accommodate a 45 KVA three-phase load.

Balanced Loading

Single-phase loads connected to the secondary of a transformer must be distributed so as not to overload any one winding of the transformer.

Single-phase transformers generally have two winding secondaries that can be connected for 120/240 volt three wire operation. When so arranged, care must be taken when connecting 120 volt loads to assure that the total connected load on each secondary winding does not exceed one-half the nameplate KVA rating.

When connecting single-phase loads on a three-phase transformer, each phase must be considered as a single-phase transformer. The single-phase loading on each phase of a three-phase transformer must not exceed one-third of the nameplate KVA rating. For example, a 45 KVA three-phase transformer with a 208Y/120 Volt secondary should not have any 120 volt single-phase loads distributed such that more than 15 KVA of single-phase load is applied to any one phase.

Transformer Protection (Reference N.E.C. Article 450)

Transformers - 600 Volts or Less Primary Protection Only

If secondary protection is not provided, a transformer must be protected by an individual overcurrent device on the primary side. The primary overcurrent device must be rated: No more than 125% of the rated primary current or the next higher standard device rating (for primary currents of 9 amperes or more); no more than 167% of the rated primary current (for 2 amperes to 9 amperes); and no more than 300 % of the rated primary current (for ratings less than 2 amperes). An individual transformer primary protective device is not necessary where the primary circuit overcurrent protective device provides the required protection.

Primary & Secondary Protection

If the transformer secondary is protected by an overcurrent protective device rated no more than 125% of the transformer rated secondary current (or the next higher standard rating device), an individual primary protective device is not required provided the primary feeder circuit overcurrent device is rated no more than 250% of the transformer rated primary current.

Type FB Transformers

Non-Ventilated • Indoor / Outdoor
Single-Phase: .050 to 15 KVA
Three-Phase: 3 to 15 KVA

Construction

The Type FB dry-type transformer is a totally enclosed, non-ventilated, compound filled, insulating transformer. The core and coil assembly is embedded in a polyester resin compound which provides a solid insulation. The embedding compound has an extremely high heat transfer rate which permits a design of minimum size and weight. The compound-filled assembly is completely encased in a sturdy steel housing and cannot be damaged by dust, moisture, or adverse atmospheric conditions.

- A low enclosure temperature rise eliminates the UL-506 requirement of special markings to indicate clearance between the enclosure and adjacent surfaces.
- Type FB transformers are made in a temperature class based on a 25°C ambient, 115°C rise, 180°C insulation system.
- Sound level problems are negligible with Type FB transformers because the core and coils are rigidly encased in the polyester resin which is mechanically strong and acts as sound deadening material. Average sound levels are consistently below NEMA standards.
- A large wiring compartment with knockouts permits fast wiring connections. Compartment temperatures can attain temperatures reaching 90°C; therefore 90°C cable should be used.
- All units are supplied with flexible cable leads marked for easy identification, and are supplied with wall-mounting brackets to help reduce installation time.

Application

Federal Pacific UL, CSA & CUL Listed Type FB dry-type transformers can be used in industrial, commercial, institutional, and residential installations for economical, efficient distribution of power.

Typical loads served include motors, lighting, heating, ranges, air conditioners, exhaust fans, control circuits, appliances, and portable tools. Other applications are found in pumping stations, mining and shipboard distribution systems.

Type FB units are ideal for dusty industrial areas and are suitable for **Indoor / Outdoor** applications.

Typical Section View - Type FB Transformer

Single-Phase
.050 to 3 KVA

Single-Phase
5 KVA to 15 KVA

Three-Phase
3 KVA to 15 KVA

Type FH Transformers

Ventilated
Single-Phase: 15 to 167 KVA
Three-Phase: 7.5 to 1000 KVA

Construction

The Type FH line of ventilated dry-type transformers incorporates wire and/or strip wound coils in a barrel wound configuration. Horizontal and vertical spacers are strategically positioned in the windings to brace the winding layers and allow maximum ventilation. The electrical grade core steel is arranged in a construction designed to accommodate the coils.

Vibration Dampening System

The core and coil assembly is anchored to the enclosure through a vibration dampening system to reduce noise levels. Units through 600 KVA are provided with neoprene isolating pads while larger units are furnished with three layer rubber and cork pads. A flexible grounding conductor is installed between the core and coil assembly and the transformer enclosure.

Rugged Enclosure

Enclosures are rigidly braced and covers are fastened with slotted hex head screws for ease of removal. A rugged steel base provides safe handling with a fork lift.

Wiring Compartments

Front accessible wiring compartments are approved for 60°-75°C cable. Terminals are sized to carry the full current capacity of the transformers.

UL Listed 220°C Insulation System

To attain UL listing, it was necessary to complete an accelerated aging test as specified by Underwriters Laboratories, Inc.

This insulation system was subjected to a series of exposures to heat, vibration, moisture, and dielectric tests. As a proven system this insulation system has received from Underwriters Laboratories, Inc. a recognized 220°C continuous rating. This total temperature of 220°C is derived from the average conductor temperature rise of 150°C, hotspot temperature gradient of 30°C, and an ambient temperature of 40°C.

The major components that allow for this 220°C rating are Nomex† paper, resin-glass laminates, silicon rubber, and polyester varnish. This combination of materials and the care taken in construction and workmanship, not only give Federal Pacific Type FH Transformers a long operating life, but helps insure their quiet operation.

Versatile Performance

The design features of the Federal Pacific Type FH family of UL Listed transformers assures versatile, economical, and reliable distribution of power. All transformers are fully tested to insure trouble-free installation and operation. The unique combination of ratings makes the FH family suitable for a wide variety of applications.

† *Dupont T.M.*

Typical Ventilated Dry-Type Transformer Construction

Optional Temperature Rise Transformers

Energy Saving Optional Temperature Rises

Transformers are specifically designed for optimum performance on systems with a continuous high loading factor. The units feature either 80°C or 115°C temperature rise utilizing a 220°C insulation system which provides extended life and inherent overload capability (15% for 115°C and 30% for 80°C.) The transformers provide lower losses and minimize operating costs. The amount of savings will depend on loading factors and local energy costs. (See page 18 for single-phase model listings and 23-28 for three-phase model listings.)

Typical Construction

Electrostatically Shielded Transformers

Electrostatically shielded transformers are designed to protect systems from unwanted high-frequency voltages that can occur due to switching and loading on distribution lines.

While all transformers with separate primary and secondary windings isolate the load circuits, transients and electrical noise can be transmitted to the load circuits through the interwinding capacitance of the transformer.

These disturbances can have a detrimental effect on sensitive electronic equipment and can cause improper operation. Electrostatic shielding brings these unwanted signals to ground thus preventing the electrical disturbances from being transmitted to the load circuits.

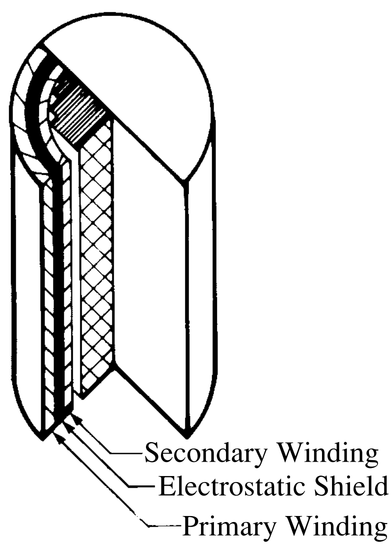
Federal Pacific UL Listed electrostatically shielded transformers provide all the quality features of the transformer plus an electrostatic shield consisting of a single turn copper or aluminum strip placed between the primary and secondary windings with a lead run to the transformer ground.

Applications

Electronic products ranging from solid state control relays to complex medical equipment are susceptible to malfunction due to transient disturbances in the power supply.

Typical applications would include:

- Hospital Operating Rooms
- X-Ray Equipment
- Computer Installations
- Data Processing
- Instrumentation
- Programmable Controllers



Cutaway Sketch, Shielded Transformer Winding

Type FB Buck-Boost Transformers

Application

The Type FB Insulating and Buck-Boost Transformer has four separate windings, two windings in the primary and two windings in the secondary. The unit is designed for use as an isolating transformer or as an auto-transformer. As an autotransformer the unit can be connected to Buck (decrease) or Boost (increase) a supply voltage. When connected in either the Buck or Boost mode, the unit is no longer an isolating transformer but is an autotransformer.

Autotransformers are more economical and physically smaller than equivalent two-winding transformers designed to carry the same load. They will perform the same function as two-winding transformers with the exception of insulating or isolating two circuits. Since autotransformers may transmit line disturbances directly, they may be prohibited in some areas by local building codes. Before applying them, care should be taken to assure that they are acceptable according to local code.

Note: Autotransformers are not used in closed delta connections as they introduce into the circuit a phase shift.

As isolating transformers, these units can accommodate a high voltage of 120x240 volts (SB12N and SB16N series) or 240x480 volts (SB24N series.) For the units with two 12 volt secondaries, the low voltage output can be 12 volts, 24 volts, or 3-wire 12/24 volts. For the units with two 16 volt secondaries, the output voltages can be 16 volts, 32 volts, or 3 wire 16/32 volts. For the units with two 24 volt secondaries, the output voltages can be 24 volts, 48 volts, or 3 wire 24/48 volts. The unit is capacity rated (KVA) as any conventional transformer.

Operation

Electrical and electronic equipment is designed to operate on a standard supply voltage. When the supply voltage is constantly too high or too low, (usually greater than ± 5%), the equipment fails to operate at maximum efficiency. A Buck-Boost transformer is a simple and economical means of correcting this off-standard voltage up to ± 20%. A Buck-Boost transformer will NOT, however, stabilize a fluctuating voltage.

Buck-Boost transformers are suitable for use in a three-phase autotransformer bank in either direction to supply 3-wire loads. They are also suitable for use in a three-phase autotransformer bank which provides a neutral return for unbalanced current. They are not suitable for use in a three-phase autotransformer bank to supply a 4-wire unbalanced load when the source is a 3-wire circuit.

Selection

To select the proper transformer for Buck-Boost applications, determine:

1. Input 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.

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

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

4. Number of Phases- single- or three-phase line and load should match because a transformer is not capable of converting single-phase to three-phase. It is, however, a common application to make a single-phase transformer connection from a three-phase supply by use of one leg of the three-phase supply circuit. Care must always be taken not to overload the leg of the three-phase supply. This is particularly true in a Buck-Boost application because the supply must provide the load KVA, not just the nameplate rating of the Buck-Boost transformer.

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

Six Step Selection

1. Choose the selection table with the correct number of phases. Tables I, III and V for single-phase applications and Tables II, IV and VI for three-phase applications. Tables I and II are for 120x240-12/24 volt units, tables III and IV are for 120x240-16/32 volt units and tables V and VI are for 240x480-24/48 volt units.

2. Line/Load voltage combinations are listed across the top of the selection table. Select a line/load voltage combination which comes closest to matching your application.

3. Follow the selected column down until you find either the load KVA or load amps of your application. If you do not find the exact value, go on to the next highest rating.

4. Follow across the table to the far left-hand side to find the catalog number of the transformer you need.

5. Follow the column of your line/load voltage to the bottom to find the connection diagram for this application. **NOTE:** Connection diagrams show low voltage and high voltage connection terminals. Either can be input or output depending on buck or boost application.

6. In the case of three-phase loads, two or three single-phase transformers are required as indicated in the "quantity required" line at the bottom of Table II, IV or VI. Select depending on whether a Wye connected bank of three transformers with a neutral is required or whether an open Delta connected bank of two transformers for a Delta connected load will be suitable.

For line/load voltages not listed on table, use the pair listed on the table that is slightly above your application for reference. Then apply the first formula at the bottom of the page to determine "New" output voltage. The new KVA rating can be found using the second formula.

Buck-Boost Technical Data

Type FB: 115° C Rise • 180° C Insulation System • Non-Ventilated • Indoor/Outdoor

Type	KVA	Catalog Number	Taps	Approximate Dimensions - Inches			Aprx. Wt. in Lbs.	Weather Shield	Connection Diagram †
				H	W	D			
120 x 240 - 12/24 Volts, 60 Hz, No Taps									
FB	0.050	SB12N.050F	No Taps	8-1/4	3-1/4	4-1/4	8	N/R	10A
	0.100	SB12N.100F	No Taps	8-1/4	3-1/4	4-1/4	10	N/R	10A
	0.150	SB12N.150F	No Taps	9-1/4	4	5	14	N/R	10A
	0.250	SB12N.250F	No Taps	9-1/4	4	5	15	N/R	10A
	0.500	SB12N.500F	No Taps	11-1/4	5-1/4	6-1/2	21	N/R	10A
	0.750	SB12N.750F	No Taps	11-1/4	5-1/4	6-1/2	25	N/R	10A
	1	SB12N1F	No Taps	11-1/4	5-1/4	6-1/2	28	N/R	10A
	1.5	SB12N1.5F	No Taps	13-1/4	6-1/4	7-3/4	45	N/R	10A
	2	SB12N2F	No Taps	13-1/4	6-1/4	7-3/4	50	N/R	10A
	3	SB12N3F	No Taps	13-1/4	6-1/4	7-3/4	60	N/R	10A
	5	SB12N5F	No Taps	15	10-3/16	10-5/8	110	N/R	10A
120 x 240 - 16/32 Volts, 60 Hz, No Taps									
FB	0.050	SB16N.050F	No Taps	8-1/4	3-1/4	4-1/4	8	N/R	10A
	0.100	SB16N.100F	No Taps	8-1/4	3-1/4	4-1/4	10	N/R	10A
	0.150	SB16N.150F	No Taps	9-1/4	4	5	14	N/R	10A
	0.250	SB16N.250F	No Taps	9-1/4	4	5	15	N/R	10A
	0.500	SB16N.500F	No Taps	11-1/4	5-1/4	6-1/2	21	N/R	10A
	0.750	SB16N.750F	No Taps	11-1/4	5-1/4	6-1/2	25	N/R	10A
	1	SB16N1F	No Taps	11-1/4	5-1/4	6-1/2	28	N/R	10A
	1.5	SB16N1.5F	No Taps	13-1/4	6-1/4	7-3/4	45	N/R	10A
	2	SB16N2F	No Taps	13-1/4	6-1/4	7-3/4	50	N/R	10A
	3	SB16N3F	No Taps	13-1/4	6-1/4	7-3/4	60	N/R	10A
	5	SB16N5F	No Taps	15	10-3/16	10-5/8	110	N/R	10A
240 x 480 - 24/48 Volts, 60 Hz, No Taps									
FB	0.050	SB24N.050F	No Taps	8-1/4	3-1/4	4-1/4	8	N/R	10A
	0.100	SB24N.100F	No Taps	8-1/4	3-1/4	4-1/4	10	N/R	10A
	0.150	SB24N.150F	No Taps	9-1/4	4	5	14	N/R	10A
	0.250	SB24N.250F	No Taps	9-1/4	4	5	15	N/R	10A
	0.500	SB24N.500F	No Taps	11-1/4	5-1/4	6-1/2	21	N/R	10A
	0.750	SB24N.750F	No Taps	11-1/4	5-1/4	6-1/2	25	N/R	10A
	1	SB24N1F	No Taps	11-1/4	5-1/4	6-1/2	28	N/R	10A
	1.5	SB24N1.5F	No Taps	13-1/4	6-1/4	7-3/4	45	N/R	10A
	2	SB24N2F	No Taps	13-1/4	6-1/4	7-3/4	50	N/R	10A
	3	SB24N3F	No Taps	13-1/4	6-1/4	7-3/4	60	N/R	10A
	5	SB24N5F	No Taps	15	10-3/16	10-5/8	110	N/R	10A

† Connection diagram when used as an isolation transformer

N/R - Not Required

Buck-Boost Selection Tables

120 x 240 Volts Primary - 12/24 Volts Secondary • Buck - Boost Dry-Type Transformers

Single-Phase

Table I

Catalog Number		BOOSTING								BUCKING					
	Line Voltage	96	100	105	109	189	208	218	220	125	132	229	245	250	252
	Load Voltage	115	120	116	120	208	229	240	242	114	120	208	223	227	240
SB12N.050F	KVA	0.24	0.25	0.48	0.50	0.43	0.48	0.50	0.50	0.52	0.55	0.48	0.51	0.52	1.05
	AMPS	2.08	2.08	4.17	4.17	2.08	2.08	2.08	2.08	4.58	4.58	2.29	2.29	2.29	4.38
SB12N.100F	KVA	0.48	0.50	0.96	1.00	0.87	0.95	1.00	1.01	1.04	1.10	0.95	1.02	1.04	2.10
	AMPS	4.17	4.17	8.33	8.33	4.17	4.17	4.17	4.17	9.17	9.17	4.58	4.58	4.58	8.75
SB12N.150F	KVA	0.72	0.75	1.44	1.50	1.30	1.43	1.50	1.51	1.56	1.65	1.43	1.53	1.56	3.15
	AMPS	6.25	6.25	12.50	12.50	6.25	6.25	6.25	6.25	13.75	13.75	6.87	6.87	6.87	13.13
SB12N.250F	KVA	1.20	1.25	2.41	2.50	2.17	2.38	2.50	2.52	2.60	2.75	2.39	2.55	2.60	5.25
	AMPS	10.42	10.42	20.83	20.83	10.42	10.42	10.42	10.42	22.92	22.92	11.46	11.46	11.46	21.88
SB12N.500F	KVA	2.40	2.50	4.81	5.00	4.33	4.77	5.00	5.04	5.21	5.50	4.77	5.10	5.21	10.50
	AMPS	20.83	20.83	41.67	41.67	20.83	20.83	20.83	20.83	45.83	45.83	22.92	22.92	22.92	43.75
SB12N.750F	KVA	3.60	3.75	7.22	7.49	6.5	7.15	7.49	7.56	7.81	8.25	7.16	7.66	7.81	15.75
	AMPS	31.25	31.25	62.50	62.50	31.25	31.25	31.25	31.25	68.75	68.75	34.37	34.37	34.37	65.63
SB12N1F	KVA	4.80	5.00	9.63	9.99	8.66	9.53	9.99	10.08	10.42	11.00	9.54	10.21	10.42	21.00
	AMPS	41.67	41.67	83.33	8.33	41.67	41.67	41.67	41.67	91.67	91.67	45.83	45.83	45.83	87.50
SB12N1.5F	KVA	7.20	7.5	14.44	14.99	12.99	14.30	14.99	15.13	15.62	16.50	14.31	15.31	15.62	31.50
	AMPS	62.50	62.50	125.00	125.00	62.50	62.50	62.50	62.50	137.50	137.50	68.75	68.75	68.75	131.25
SB12N2F	KVA	9.60	10.00	19.25	19.98	17.32	19.07	19.98	20.17	20.83	22.00	19.08	20.42	20.83	42.00
	AMPS	83.33	83.33	166.67	166.67	83.33	83.33	83.33	83.33	183.33	183.33	91.67	91.67	91.67	175.00
SB12N3F	KVA	14.40	15.00	28.88	29.98	25.99	28.60	29.98	30.25	31.25	33.00	28.62	30.62	31.25	63.00
	AMPS	125.00	125.00	250.00	250.00	125.00	125.00	125.00	125.00	275.00	275.00	137.50	137.50	137.50	262.50
SB12N5F	KVA	24.00	25.00	48.13	49.96	43.31	47.67	49.96	50.42	52.08	55.00	47.71	51.04	52.08	105.00
	AMPS	208.33	208.33	416.67	416.67	208.33	208.33	208.33	208.33	458.33	458.33	229.17	229.17	229.17	437.50
*DIAGRAM		B	B	A	A	D	D	D	D	A	A	D	D	D	C

Three-Phase

Table II

Catalog Number		BOOSTING									BUCKING				
	Line Voltage	189Y/109	195Y/113	200Y/115	208Y/120	416Y/240	416Y/240	189	208	220	218	229	250	255	264
	Load Voltage	208Y/120	234Y/135	240Y/139	229Y/132	458Y/264	437Y/252	208	229	242	208	208	227	232	240
SB12N.050F	KVA	1.50	0.84	0.87	1.65	1.65	3.15	0.75	0.83	0.87	1.57	0.83	0.90	0.92	0.95
	AMPS	4.17	2.08	2.08	4.17	2.08	4.17	2.08	2.08	2.08	4.38	2.29	2.29	2.29	2.29
SB12N.100F	KVA	3.00	1.69	1.73	3.30	3.30	6.30	1.50	1.65	1.75	3.15	1.65	1.80	1.84	1.91
	AMPS	8.33	4.17	4.17	8.33	4.17	8.33	4.17	4.17	4.17	8.75	4.58	4.58	4.58	4.58
SB12N.150F	KVA	4.5	2.53	2.60	4.95	4.95	9.46	2.25	2.48	2.62	4.72	2.48	2.71	2.76	2.86
	AMPS	12.50	6.25	6.25	12.50	6.25	12.50	6.25	6.25	6.25	13.13	6.87	6.87	6.88	6.88
SB12N.250F	KVA	7.50	4.22	4.33	8.26	8.26	15.76	3.75	4.13	4.37	7.87	4.13	4.51	4.60	4.76
	AMPS	20.83	10.42	10.42	20.83	10.42	20.83	10.42	10.42	10.42	21.88	11.46	11.46	11.46	11.46
SB12N.500F	KVA	15.00	8.44	8.66	16.51	16.51	31.52	7.50	8.26	8.73	15.73	8.26	9.02	9.20	9.53
	AMPS	41.67	20.83	20.83	41.67	20.83	41.67	20.83	20.83	20.83	43.75	22.92	22.92	22.92	22.92
SB12N.750F	KVA	22.51	12.67	12.99	24.77	24.77	47.28	11.25	12.38	13.1	23.60	12.39	13.53	13.80	14.29
	AMPS	62.50	31.25	31.25	62.50	31.25	62.50	31.25	31.25	31.25	65.63	34.37	34.37	34.37	34.38
SB12N1F	KVA	30.01	16.89	17.32	33.02	33.02	63.05	15.00	16.51	17.46	31.47	16.53	18.04	18.40	19.05
	AMPS	83.33	41.67	41.67	83.33	41.67	83.33	41.67	41.67	41.67	87.50	45.83	45.83	45.83	45.83
SB12N1.5F	KVA	45.01	25.33	25.98	49.54	49.54	94.57	22.51	24.77	26.20	47.20	24.79	27.06	27.60	28.58
	AMPS	125.00	62.50	62.50	125.00	62.50	125.00	62.50	62.50	62.50	131.25	68.75	68.75	68.75	68.75
SB12N2F	KVA	60.02	33.77	34.64	66.05	66.05	126.09	30.01	33.02	34.93	62.93	33.05	36.08	36.81	38.11
	AMPS	166.67	83.33	83.33	166.67	83.33	166.67	83.33	83.33	83.33	175.00	91.67	91.67	91.67	91.67
SB12N3F	KVA	90.02	50.66	51.96	99.07	99.07	189.14	45.01	49.54	52.39	94.40	49.58	54.13	55.21	57.16
	AMPS	250.00	125.00	125.00	250.00	125.00	250.00	125.00	125.00	125.00	262.50	137.50	137.50	137.50	137.50
SB12N5F	KVA	150.04	84.44	86.60	165.12	165.12	315.23	75.02	82.56	87.32	157.33	82.63	90.21	92.02	95.26
	AMPS	416.67	208.33	208.33	416.67	208.33	416.67	208.33	208.33	208.33	437.50	229.17	229.17	229.17	229.17
Number of Transformers		3	3	3	3	3	3	2	2	2	2	2	2	2	2
*DIAGRAM		F	E	E	F	J	K	G	G	G	H	G	G	G	G

* See Page 40 and 41

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: $\frac{\text{Actual Input Voltage}}{\text{Rated Input Voltage}}$ x Output KVA = New KVA Rating.

Buck-Boost Selection Tables

120 x 240 Volts Primary - 16/32 Volts Secondary • Buck - Boost Dry-Type Transformers

Single-Phase

Table III

Catalog Number		BOOSTING								BUCKING					
	Line Voltage	95	100	105	208	215	215	220	225	135	240	240	245	250	255
	Load Voltage	120	113	119	236	244	229	235	240	120	212	225	230	234	239
SB16N.050F	KVA	0.19	0.35	0.37	0.37	0.38	0.72	0.73	0.75	0.42	0.38	0.75	0.77	0.78	0.80
	AMPS	1.56	3.13	3.13	1.56	1.56	3.12	3.13	3.12	3.54	1.77	3.33	3.33	3.33	3.33
SB16N.100F	KVA	0.38	0.71	0.74	0.74	0.76	1.43	1.47	1.50	0.84	0.75	1.50	1.53	1.56	1.59
	AMPS	3.13	6.25	6.25	3.13	3.13	6.25	6.25	6.25	7.08	3.54	6.67	6.67	6.67	6.67
SB16N.150F	KVA	0.56	1.06	1.12	1.11	1.14	2.15	2.20	2.25	1.27	1.13	2.25	2.30	2.34	2.39
	AMPS	4.69	9.38	9.38	4.69	4.69	9.37	9.37	9.37	10.63	5.31	10.00	10.00	10.00	10.00
SB16N.250F	KVA	0.94	1.77	1.86	1.84	1.90	3.58	3.67	3.75	2.11	1.88	3.75	3.83	3.91	3.98
	AMPS	7.81	15.63	15.63	7.81	7.81	15.62	15.62	15.62	17.71	8.85	16.67	16.67	16.67	16.67
SB16N.500F	KVA	1.88	3.54	3.72	3.68	3.81	7.17	7.33	7.50	4.22	3.75	7.50	7.66	7.81	7.97
	AMPS	15.63	31.25	31.25	15.63	15.63	31.25	31.25	31.25	35.42	17.71	33.33	33.33	33.33	33.33
SB16N.750F	KVA	2.82	5.31	5.58	5.53	5.71	10.75	11.00	11.25	6.33	5.63	11.25	11.48	11.72	11.95
	AMPS	23.44	46.88	46.88	23.44	23.44	46.87	46.87	46.87	53.13	26.56	50.00	50.00	50.00	50.00
SB16N1F	KVA	3.76	7.08	7.44	7.37	7.61	14.33	14.67	15.00	8.44	7.50	15.00	15.31	15.62	15.94
	AMPS	31.25	62.50	62.50	31.25	31.25	62.50	62.50	62.50	70.83	35.42	66.67	66.67	66.67	66.67
SB16N1.5F	KVA	5.64	10.63	11.16	11.05	11.42	21.50	22.00	22.50	12.66	11.25	22.50	22.97	23.44	23.91
	AMPS	46.88	93.75	93.75	46.88	46.88	93.75	93.75	93.75	106.25	53.13	100.00	100.00	100.00	100.00
SB16N2F	KVA	7.52	14.71	14.88	14.73	15.23	28.67	29.33	30.00	16.88	15.00	30.00	30.62	31.25	31.87
	AMPS	62.50	125.00	125.00	62.50	62.50	125.00	125.00	125.00	141.67	70.83	133.33	133.33	133.33	133.33
SB16N3F	KVA	11.28	21.25	22.31	22.1	22.84	43.00	44.00	45.00	25.31	22.50	45.00	45.94	46.87	47.81
	AMPS	93.75	187.50	187.50	93.75	93.75	187.50	187.50	187.50	212.50	106.25	200.00	200.00	200.00	200.00
SB16N5F	KVA	18.80	35.42	37.19	36.83	38.07	71.67	73.33	75.00	42.19	37.50	75.00	76.56	78.12	79.69
	AMPS	156.25	312.50	312.50	156.25	156.25	312.50	312.50	312.50	354.17	177.08	333.33	333.33	333.33	333.33
	*DIAGRAM	B	A	A	D	D	C	C	C	A	D	C	C	C	C

Three-Phase

Table IV

Catalog Number		BOOSTING					BUCKING					
	Line Voltage	183Y/106	208Y/120	195	208	225	240	245	250	256	265	272
	Load Voltage	208Y/120	236Y/136	208	236	240	208	230	234	240	234	240
SB16N.050F	KVA	1.12	1.28	1.13	0.64	1.30	0.65	1.33	1.35	1.39	0.72	0.74
	AMPS	3.13	3.13	3.12	1.56	3.12	1.80	3.33	3.33	3.33	1.77	1.77
SB16N.100F	KVA	2.25	2.55	2.25	1.28	2.60	1.30	2.65	2.71	2.77	1.43	1.47
	AMPS	6.25	6.25	6.25	3.13	6.25	3.61	6.67	6.67	6.67	3.54	3.54
SB16N.150F	KVA	3.37	3.83	3.38	1.91	3.90	1.95	3.98	4.06	4.16	2.15	2.21
	AMPS	9.38	9.38	9.37	4.69	9.37	5.41	10.00	10.00	10.00	5.31	5.31
SB16N.250F	KVA	5.61	6.38	5.63	3.19	6.50	3.25	6.63	6.77	6.93	3.59	3.68
	AMPS	15.63	15.62	15.62	7.81	15.62	9.01	16.67	16.67	16.67	8.85	8.85
SB16N.500F	KVA	11.23	12.76	11.26	6.38	12.99	6.50	13.26	13.53	13.86	7.17	7.36
	AMPS	31.25	31.25	31.25	15.63	31.25	18.03	33.33	33.33	33.33	17.71	17.71
SB16N.750F	KVA	16.84	19.14	16.89	9.58	19.49	9.74	19.89	20.30	20.78	10.76	11.04
	AMPS	46.88	46.88	46.87	23.44	46.87	27.04	50.00	50.00	50.00	26.56	26.56
SB16N1F	KVA	22.45	25.52	22.52	12.76	25.98	12.99	26.52	27.06	27.71	14.34	14.72
	AMPS	62.50	62.50	62.50	31.25	62.50	36.06	66.67	66.67	66.67	35.42	35.42
SB16N1.5F	KVA	33.68	38.28	33.77	19.14	38.97	19.49	39.78	40.59	41.57	21.52	22.08
	AMPS	93.75	93.75	93.75	46.88	93.75	54.09	100.00	100.00	100.00	53.13	53.13
SB16N2F	KVA	44.90	51.04	45.03	25.52	51.96	25.98	53.04	54.13	55.43	28.69	29.44
	AMPS	125.00	125.00	125.00	62.50	125.00	72.12	133.33	133.33	133.33	70.83	70.83
SB16N3F	KVA	67.36	76.56	67.55	38.28	77.94	38.97	79.57	81.19	83.14	43.03	44.17
	AMPS	187.50	187.50	187.50	93.75	187.50	108.17	200.00	200.00	200.00	106.25	106.25
SB16N5F	KVA	112.26	127.59	112.58	63.80	129.90	64.95	132.61	135.32	138.56	71.72	73.61
	AMPS	312.50	312.50	312.50	156.25	312.50	180.29	333.33	333.33	333.33	177.08	177.08
	No. of Transformers	3	3	2	2	2	2	2	2	2	2	2
	*DIAGRAM	F	F	H	G	H	L	H	H	H	G	G

* See Page 40 and 41

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: $\frac{\text{Actual Input Voltage}}{\text{Rated Input Voltage}}$ x Output KVA = New KVA Rating.

Buck-Boost Selection Tables

240 x 480 Volts Primary - 24/48 Volts Secondary • Buck - Boost Dry-Type Transformers

Single-Phase

Table V

Catalog Number		BOOSTING									BUCKING				
	Line Voltage	230	380	416	425	430	435	440	450	460	132	277	480	480	504
	Load Voltage	276	418	458	468	473	457	462	495	483	126	231	436	457	480
SB24N.050F	KVA	0.29	0.44	0.48	0.49	0.49	0.95	0.96	0.52	1.01	0.28	0.29	0.50	1.00	1.05
	AMPS	1.04	1.04	1.04	1.04	1.04	2.08	2.08	1.04	2.08	2.19	1.25	1.15	2.19	2.19
SB24N.100F	KVA	0.58	0.87	0.95	0.97	0.99	1.90	1.93	1.03	2.01	0.55	0.58	1.00	2.00	2.10
	AMPS	2.08	2.08	2.08	2.08	2.08	4.17	4.17	2.08	4.17	4.38	2.50	2.29	4.38	4.38
SB24N.150F	KVA	0.86	1.31	1.43	1.46	1.48	2.85	2.89	1.55	3.02	0.83	0.87	1.50	3.00	3.15
	AMPS	3.13	3.13	3.13	3.13	3.13	6.25	6.25	3.13	6.25	6.56	3.75	3.44	6.56	6.56
SB24N.250F	KVA	1.44	2.18	2.38	2.43	2.46	4.76	4.81	2.58	5.03	1.38	1.44	2.50	5.00	5.25
	AMPS	5.21	5.21	5.21	5.21	5.21	10.42	10.42	5.21	10.42	10.94	6.25	5.73	10.94	10.94
SB24N.500F	KVA	2.88	4.35	4.77	4.87	4.93	9.52	9.63	5.16	10.06	2.75	2.89	5.00	10.00	10.50
	AMPS	10.42	10.42	10.42	10.42	10.42	20.83	20.83	10.42	20.83	21.88	12.50	11.46	21.88	21.88
SB24N.750F	KVA	4.31	6.53	7.15	7.30	7.39	14.27	14.44	7.73	15.09	4.13	4.33	7.50	15.00	15.75
	AMPS	15.63	15.63	15.62	15.63	15.63	31.25	31.25	15.63	31.25	32.81	18.75	17.19	32.81	32.81
SB24N1F	KVA	5.75	8.71	9.53	9.74	9.85	19.03	19.25	10.31	20.13	5.50	5.77	10.00	20.00	21.00
	AMPS	20.83	20.83	20.83	20.83	20.83	41.67	41.67	20.83	41.67	43.75	25.00	22.92	43.75	43.75
SB24N1.5F	KVA	8.63	13.06	14.30	14.61	14.78	28.55	28.88	15.47	30.19	8.25	8.66	15.00	30.00	31.50
	AMPS	31.25	31.25	31.25	31.25	31.25	62.50	62.50	31.25	62.50	65.63	37.50	34.37	65.63	65.63
SB24N2F	KVA	11.50	17.42	19.07	19.48	19.71	38.06	38.50	20.63	40.25	11.00	11.54	20.00	40.00	42.00
	AMPS	41.67	41.67	41.67	41.67	41.67	83.33	83.33	41.67	83.33	87.50	50.00	45.83	87.50	87.50
SB24N3F	KVA	17.25	26.13	28.60	29.22	29.56	57.09	57.75	30.94	60.38	16.50	17.31	30.00	60.00	63.00
	AMPS	62.50	62.50	62.50	62.50	62.50	125.00	125.00	62.50	125.00	131.25	75.00	68.75	131.25	131.25
SB24N5F	KVA	28.75	43.54	47.67	48.70	49.27	95.16	96.25	51.56	100.63	27.50	28.85	50.00	100.00	105.00
	AMPS	104.17	104.17	104.17	104.17	104.17	208.33	208.33	104.17	208.33	218.75	125.00	114.58	218.75	218.75
	*DIAGRAM	B	D	D	D	D	C	C	D	C	C	B	D	C	C

Three-Phase

Table VI

Catalog Number		BOOSTING								BUCKING							
	Line Voltage	399Y/230	380	430	440	460	460	480	480	440	440	460	460	480	480	500	500
	Load Voltage	480Y/277	418	473	462	506	483	528	504	400	419	438	418	457	436	455	476
SB24N.050F	KVA	0.86	0.75	0.85	1.67	0.91	1.74	0.95	1.82	0.79	1.59	1.66	0.83	1.73	0.87	0.90	1.80
	AMPS	1.04	1.04	1.04	2.08	1.04	2.08	1.04	2.08	1.15	2.19	2.19	1.15	2.19	1.15	1.15	2.19
SB24N.100F	KVA	1.73	1.51	1.71	3.33	1.83	3.49	1.91	3.64	1.59	3.18	3.32	1.66	3.46	1.73	1.80	3.61
	AMPS	2.08	2.08	2.08	4.17	2.08	4.17	2.08	4.17	2.29	4.38	4.38	2.29	4.38	2.29	2.29	4.38
SB24N.150F	KVA	2.59	2.26	2.56	5.00	2.74	5.23	2.86	5.46	2.38	4.76	4.98	2.49	5.20	2.60	2.71	5.41
	AMPS	3.13	3.13	3.13	6.25	3.13	6.25	3.13	6.25	3.44	6.56	6.56	3.44	6.56	3.44	3.44	6.56
SB24N.250F	KVA	4.32	3.77	4.27	8.34	4.56	8.71	4.76	9.09	3.97	7.94	8.30	4.15	8.66	4.33	4.51	9.02
	AMPS	5.21	5.21	5.21	10.42	5.21	10.42	5.21	10.42	5.73	10.94	10.94	5.73	10.94	5.73	5.73	10.94
SB24N.500F	KVA	8.64	7.54	8.53	16.67	9.13	17.43	9.53	18.19	7.94	15.88	16.60	8.30	17.32	8.66	9.02	18.04
	AMPS	10.42	10.42	10.42	20.83	10.42	20.83	10.42	20.83	11.46	21.88	21.88	11.46	21.88	11.46	11.46	21.88
SB24N.750F	KVA	12.96	11.31	12.80	25.01	13.69	26.14	14.29	27.28	11.91	23.82	24.90	12.45	25.98	12.99	13.53	27.06
	AMPS	15.62	15.63	15.63	31.25	15.63	31.25	15.63	31.25	17.19	32.81	32.81	17.19	32.81	17.19	17.19	32.81
SB24N1F	KVA	17.28	15.08	17.07	33.34	18.26	34.86	19.05	36.37	15.88	31.75	33.20	16.60	34.64	17.32	18.04	36.08
	AMPS	20.83	20.83	20.83	41.67	20.83	41.67	20.83	41.67	22.92	43.75	43.75	22.92	43.75	22.92	22.92	43.75
SB24N1.5F	KVA	25.92	22.62	25.60	50.01	27.39	52.29	28.58	54.56	23.82	47.63	49.80	24.90	51.96	25.98	27.06	54.13
	AMPS	31.25	31.25	31.25	62.50	31.25	62.50	31.25	62.50	34.38	65.63	65.63	34.38	65.63	34.37	34.37	65.63
SB24N2F	KVA	34.55	30.17	34.14	66.68	36.52	69.72	38.11	72.75	31.75	63.51	66.40	33.20	69.28	34.64	36.08	72.17
	AMPS	41.67	41.67	41.67	83.33	41.67	83.33	41.67	83.33	45.83	87.50	87.50	45.83	87.50	45.83	45.83	87.50
SB24N3F	KVA	51.83	45.25	51.20	100.03	54.78	104.57	57.16	109.12	47.63	95.26	99.59	49.80	103.92	51.96	54.13	108.25
	AMPS	62.50	62.50	62.50	125.00	62.50	125.00	62.50	125.00	68.75	131.25	131.25	68.75	131.25	68.75	68.75	131.25
SB24N5F	KVA	86.39	75.42	85.34	166.71	91.29	174.29	95.26	181.87	79.39	158.77	165.99	82.99	173.21	86.60	90.21	180.42
	AMPS	104.17	104.17	104.17	208.33	104.17	208.33	104.17	208.33	114.58	218.75	218.75	114.58	218.75	114.58	114.58	218.75
	No. of Transformers	3	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2
	*DIAGRAM	E	G	G	H	G	H	G	H	G	H	H	G	H	G	G	H

* See Page 40 and 41

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: $\frac{\text{Actual Input Voltage}}{\text{Rated Input Voltage}}$ x Output KVA = New KVA Rating.

Single-Phase General Purpose Technical Data

Type FB: 115° C Rise • 180° C Insulation System • Non-Ventilated • Indoor/Outdoor
Type FH: 150° C Rise • 220° C Insulation System • Indoor Ventilated • Floor Mounted

Type	KVA	Catalog Number	Taps	Approximate Dimensions - Inches			Aprx. Wt. in Lbs.	Weather Shield [1]	Wiring Diagram
				H	W	D			
120 x 240 - 120/240 Volts, 60 Hz.									
FB	1	SE120N1F	No Taps	11-1/4	5-1/4	6-1/2	28	N/R	5
	1.5	SE120N1.5F	No Taps	13-1/4	6-1/4	7-3/4	45	N/R	5
	2	SE120N2F	No Taps	13-1/4	6-1/4	7-3/4	50	N/R	5
	3	SE120N3F	No Taps	13-1/4	6-1/4	7-3/4	60	N/R	5
	5	SE120N5F	No Taps	15	10-3/16	10-5/8	110	N/R	5
	7.5	SE120N7.5F	No Taps	15	10-3/16	10-5/8	150	N/R	5
	10	SE120N10F	No Taps	17	13-3/16	13-1/8	175	N/R	5
	15	SE120N15F	No Taps	17	13-3/16	13-1/8	270	N/R	5
208 - 120/240 Volts, 60 Hz									
FB	1	SE201D1F	-2 x 5%	11-1/4	5-1/4	6-1/2	28	N/R	6
	1.5	SE201D1.5F	-2 x 5%	13-1/4	6-1/4	7-3/4	45	N/R	6
	2	SE201D2F	-2 x 5%	13-1/4	6-1/4	7-3/4	50	N/R	6
	3	SE201D3F	-2 x 5%	13-1/4	6-1/4	7-3/4	60	N/R	6
	5	SE201D5F	-2 x 5%	15	10-3/16	10-5/8	110	N/R	6
	7.5	SE201D7.5F	-2 x 5%	15	10-3/16	10-5/8	150	N/R	6
	10	SE201D10F	-2 x 5%	17	13-3/16	13-1/8	175	N/R	6
	15	SE201D15F	-2 x 5%	17	13-3/16	13-1/8	270	N/R	6
240 x 480 - 120/240 Volts, 60 Hz									
FB	0.050	SE2N.050F	No Taps	8-1/4	3-1/4	4-1/4	8	N/R	1
	0.075	SE2N.075F	No Taps	8-1/4	3-1/4	4-1/4	9	N/R	1
	0.100	SE2N.100F	No Taps	8-1/4	3-1/4	4-1/4	10	N/R	1
	0.150	SE2N.150F	No Taps	9-1/4	4	5	14	N/R	1
	0.250	SE2N.250F	No Taps	9-1/4	4	5	15	N/R	1
	0.500	SE2N.500F	No Taps	11-1/4	5-1/4	6-1/2	21	N/R	1
	0.750	SE2N.750F	No Taps	11-1/4	5-1/4	6-1/2	25	N/R	1
	1	SE2N1F	No Taps	11-1/4	5-1/4	6-1/2	28	N/R	1
	1.5	SE2N1.5F	No Taps	13-1/4	6-1/4	7-3/4	45	N/R	1
	2	SE2N2F	No Taps	13-1/4	6-1/4	7-3/4	50	N/R	1
	3	SE2N3FS	No Taps	13-1/4	6-1/4	7-3/4	60	N/R	10
	3	SE2T3F	+2, -4 x 2-1/2%	13-1/4	6-1/4	7-3/4	60	N/R	8
	5	SE2N5FS	No Taps	15	10-3/16	10-5/8	110	N/R	10
	5	SE2T5F	+2, -4 x 2-1/2%	15	10-3/16	10-5/8	110	N/R	8
	7.5	SE2N7.5F	No Taps	15	10-3/16	10-5/8	150	N/R	1
	7.5	SE2T7.5F	+2, -4 x 2-1/2%	15	10-3/16	10-5/8	150	N/R	8
	10	SE2N10F	No Taps	17	13-3/16	13-1/8	175	N/R	1
	10	SE2T10F	+2, -4 x 2-1/2%	17	13-3/16	13-1/8	175	N/R	8
	15	SE2N15F	No Taps	17	13-3/16	13-1/8	270	N/R	1
	15	SE2T15F	+2, -4 x 2-1/2%	17	13-3/16	13-1/8	270	N/R	8
FH	15	S2T15	+2, -4 x 2-1/2%	33	16-5/8	18-3/8	165	WS-3	9
	25	S2T25	+2, -4 x 2-1/2%	33	16-5/8	18-3/8	190	WS-3	9
	37.5	S2T37	+2, -4 x 2-1/2%	37	22-3/8	19-7/8	300	WS-4	9
	50	S2T50	+2, -4 x 2-1/2%	37	22-3/8	19-7/8	335	WS-4	9
	75	S2T75	+2, -4 x 2-1/2%	45-1/2	24-3/8	20	490	WS-5	9
	100	S2T100	+2, -4 x 2-1/2%	52	25-3/8	23	610	WS-7	9
	167	S2T167	+2, -4 x 2-1/2%	60	33-3/8	26	895	WS-9	9

[1] Addition of weather shield kit converts transformer from NEMA 2 to NEMA 3R.

N/R - Not Required

Single-Phase General Purpose Technical Data

Type FB: 115° C Rise • 180° C Insulation System • Non-Ventilated • Indoor/Outdoor
Type FH: 150° C Rise • 220° C Insulation System • Indoor Ventilated • Floor Mounted

Type	KVA	Catalog Number	Taps	Approximate Dimensions - Inches			Aprx. Wt. In Lb.s	Weather Shield [1]	Wiring Diagram
				H	W	D			
277 - 120/240 Volts, 60 Hz									
FB	1	SE271D1F	-2 x 5%	11-1/4	5-1/4	6-1/2	28	N/R	7
	1.5	SE271D1.5F	-2 x 5%	13-1/4	6-1/4	7-3/4	45	N/R	7
	2	SE271D2F	-2 x 5%	13-1/4	6-1/4	7-3/4	50	N/R	7
	3	SE271D3F	-2 x 5%	13-1/4	6-1/4	7-3/4	60	N/R	7
	5	SE271D5F	-2 x 5%	15	10-3/16	10-5/8	110	N/R	7
	7.5	SE271D7.5F	-2 x 5%	15	10-3/16	10-5/8	150	N/R	7
	10	SE271D10F	-2 x 5%	17	13-3/16	13-1/8	175	N/R	7
	15	SE271D15F	-2 x 5%	17	13-3/16	13-1/8	270	N/R	7
480 - 120/240 Volts, 60 Hz									
FB	1	SE481D1F	-2 x 5%	11-1/4	5-1/4	6-1/2	28	N/R	2
	1.5	SE481D1.5F	-2 x 5%	13-1/4	6-1/4	7-3/4	45	N/R	2
	2	SE481D2F	-2 x 5%	13-1/4	6-1/4	7-3/4	50	N/R	2
	3	SE481D3F	-2 x 5%	13-1/4	6-1/4	7-3/4	60	N/R	2
	5	SE481D5F	-2 x 5%	15	10-3/16	10-5/8	110	N/R	2
	7.5	SE481D7.5F	-2 x 5%	15	10-3/16	10-5/8	150	N/R	2
	10	SE481D10F	-2 x 5%	17	13-3/16	13-1/8	175	N/R	2
	15	SE481D15F	-2 x 5%	17	13-3/16	13-1/8	270	N/R	2
600 - 120/240 Volts, 60 Hz, Electrostatically Shielded									
FB	1	SE61D1FS	-2 x 5%	11-1/4	5-1/4	6-1/2	28	N/R	3
	1.5	SE61D1.5FS	-2 x 5%	13-1/4	6-1/4	7-3/4	45	N/R	3
	2	SE61D2FS	-2 x 5%	13-1/4	6-1/4	7-3/4	50	N/R	3
	3	SE61D3FS	-2 x 5%	13-1/4	6-1/4	7-3/4	60	N/R	3
	5	SE61D5FS	-2 x 5%	15	10-3/16	10-5/8	110	N/R	3
	7.5	SE61D7.5FS	-2 x 5%	15	10-3/16	10-5/8	150	N/R	3
	10	SE61D10FS	-2 x 5%	17	13-3/16	13-1/8	175	N/R	3
	15	SE61G15FS	-4 x 2-1/2%	17	13-3/16	13-1/8	270	N/R	4
FH	15	S61T15S	+2, -4 x 2-1/2%	33	16-5/8	18-3/8	165	WS-3	11
	25	S61T25S	+2, -4 x 2-1/2%	33	16-5/8	18-3/8	190	WS-3	11
	37.5	S61T37S	+2, -4 x 2-1/2%	37	22-3/8	19-7/8	300	WS-4	11
	50	S61T50S	+2, -4 x 2-1/2%	37	22-3/8	19-7/8	335	WS-4	11
	75	S61T75S	+2, -4 x 2-1/2%	45-1/2	24-3/8	20	490	WS-5	11
	100	S61T100S	+2, -4 x 2-1/2%	52	25-3/8	23	610	WS-7	11
	167	S61T167S	+2, -4 x 2-1/2%	60	33-3/8	26	895	WS-9	11

[1]Addition of weather shield kit converts transformer from NEMA 2 to NEMA 3R.

N/R - Not Required

Single-Phase Optional Temperature Rise Technical Data

Type FH: 115° C and 80° C Rise • 220° C Insulation System • Indoor Ventilated • Floor Mounted

Type	KVA	Catalog Number	Taps	Approximate Dimensions - Inches			Aprx. Wt. in Lbs.	Weather Shield [1]	Wiring Diagram
				H	W	D			
115° C Rise, 240 x 480 - 120/240 Volts, 60 Hz									
FH	15	S2T15F	+2, -4 x 2-1/2%	33	16-5/8	18-3/8	190	WS-3	9
	25	S2T25F	+2, -4 x 2-1/2%	37	22-3/8	19-7/8	300	WS-4	9
	37.5	S2T37F	+2, -4 x 2-1/2%	37	22-3/8	19-7/8	335	WS-4	9
	50	S2T50F	+2, -4 x 2-1/2%	45-1/2	24-3/8	20	490	WS-5	9
	75	S2T75F	+2, -4 x 2-1/2%	52	25-3/8	23	610	WS-7	9
	100	S2T100F	+2, -4 x 2-1/2%	60	33-3/8	26	895	WS-9	9
80° C Rise, 240 x 480 - 120/240 Volts, 60 Hz									
FH	15	S2T15B	+2, -4 x 2-1/2%	33	16-5/8	18-3/8	190	WS-3	9
	25	S2T25B	+2, -4 x 2-1/2%	37	22-3/8	19-7/8	300	WS-4	9
	37.5	S2T37B	+2, -4 x 2-1/2%	45-1/2	24-3/8	20	490	WS-5	9
	50	S2T50B	+2, -4 x 2-1/2%	45-1/2	24-3/8	20	490	WS-5	9
	75	S2T75B	+2, -4 x 2-1/2%	60	33-3/8	26	895	WS-9	9
	100	S2T100B	+2, -4 x 2-1/2%	60	33-3/8	26	895	WS-9	9

[1]Addition of weather shield kit converts transformer from NEMA 2 to NEMA 3R.

Three-Phase General Purpose Technical Data

Type FB: 115° C Rise • 180° C Insulation System • Non-Ventilated • Indoor/Outdoor
Type FH: 150° C Rise • 220° C Insulation System • Indoor Ventilated • Floor Mounted

Type	KVA	Catalog Number	Taps	Approximate Dimensions - Inches H	W	D	Aprx. Wt. in Lbs.	Weather Shield 1	Wiring Diagram
208 - 208Y/120 Volts, 60 Hz, Electrostatically Shielded									
FH	15	T202H15S	+2, -2 x 2-1/2%	29	17-1/8	19-3/8	185	WS-2	19
	25	T202H25S	+2, -2 x 2-1/2%	34	22-3/8	19-7/8	285	WS-4	19
	30	T202H30S	+2, -2 x 2-1/2%	34	22-3/8	19-7/8	315	WS-4	19
	45	T202H45S	+2, -2 x 2-1/2%	34	22-3/8	19-7/8	345	WS-4	19
	75	T202H75S	+2, -2 x 2-1/2%	41-1/2	32-1/4	20	555	WS-6	19A
	112.5	T202H112S	+2, -2 x 2-1/2%	45-1/2	34-3/4	20	740	WS-8	19A
	150	T202H150S	+2, -2 x 2-1/2%	49	39	23	965	WS-10	19A
	225	T202J225S	+2, -2 x 3%	57	42-1/8	26	1300	WS-12	19B
	300	T202L300S	+2, -2 x 3-1/2%	63	46-1/2	30-7/8	1625	WS-14	19C
	500	T202E500S	+1, -1 x 5%	72-3/4	53-3/8	36-7/8	2575	WS-16	19E
208 - 480Y/277 Volts, 60 Hz									
FH	15	T204H15	+2, -2 x 2-1/2%	29	17-1/8	19-3/8	185	WS-2	23
	25	T204H25	+2, -2 x 2-1/2%	34	22-3/8	19-7/8	285	WS-4	23
	30	T204H30	+2, -2 x 2-1/2%	34	22-3/8	19-7/8	315	WS-4	23
	45	T204H45	+2, -2 x 2-1/2%	34	22-3/8	19-7/8	345	WS-4	23
	75	T204H75	+2, -2 x 2-1/2%	41-1/2	32-1/4	20	555	WS-6	23A
	112.5	T204H112	+2, -2 x 2-1/2%	45-1/2	34-3/4	20	740	WS-8	23A
	150	T204H150	+2, -2 x 2-1/2%	49	39	23	965	WS-10	23A
	225	T204J225	+2, -2 x 3%	57	42-1/8	26	1300	WS-12	23B
	300	T204L300	+2, -2 x 3-1/2%	63	46-1/2	30-7/8	1625	WS-14	23C
	500	T204E500	+1, -1 x 5%	72-3/4	53-3/8	36-7/8	2575	WS-16	23E
	750	T204E750	+1, -1 x 5%	76-3/4	53-3/8	44-3/8	3525	—	23E
240 - 208Y/120 Volts, 60 Hz, Electrostatically Shielded									
FB	3	TE242D3FS	-2 x 5%	12-1/16	12-1/8	8-3/8	95	N/R	12
	6	TE242D6FS	-2 x 5%	14-9/16	20-1/8	10-5/8	225	N/R	12
	9	TE242D9FS	-2 x 5%	14-9/16	20-1/8	10-5/8	270	N/R	12
	15	TE242D15FS	-2 x 5%	16-1/16	21-1/8	15-1/8	435	N/R	12
FH	15	T242T15S	+2, -4 x 2-1/2%	29	17-1/8	19-3/8	185	WS-2	26
	30	T242T30S	+2, -4 x 2-1/2%	34	22-3/8	19-7/8	315	WS-4	26
	45	T242T45S	+2, -4 x 2-1/2%	34	22-3/8	19-7/8	345	WS-4	26
	75	T242T75S	+2, -4 x 2-1/2%	41-1/2	32-1/4	20	555	WS-6	26A
	112.5	T242T112S	+2, -4 x 2-1/2%	45-1/2	34-3/4	20	740	WS-8	26A
	150	T242T150S	+2, -4 x 2-1/2%	49	39	23	965	WS-10	26A
	225	T242J225S	+2, -2 x 3%	57	42-1/2	26	1300	WS-12	26B
	300	T242L300S	+2, -2 x 3-1/2%	63	46-1/2	30-7/8	1625	WS-14	26C
	500	T242B500S	+1, -1 x 4%	72-3/4	53-3/8	36-7/8	2575	WS-16	26D

NR - Not Required
[1]Addition of weather shield kit converts transformer from NEMA 2 to NEMA 3R.

Three-Phase General Purpose Technical Data

Type FB: 115° C Rise • 180° C Insulation System • Non-Ventilated • Indoor/Outdoor
Type FH: 150° C Rise • 220° C Insulation System • Indoor Ventilated • Floor Mounted

Type	KVA	Catalog Number	Taps	Approximate Dimensions - Inches H	W	D	Aprx. Wt. in Lbs.	Weather Shield 1	Wiring Diagram
480 - 208Y/120 Volts, 60 Hz									
FB	3	TE4D3F	-2 x 5%	12-1/16	12-1/8	8-3/8	95	N/R	13
	6	TE4D6F	-2 x 5%	14-9/16	20-1/8	10-5/8	225	N/R	13
	9	TE4D9F	-2 x 5%	14-9/16	20-1/8	10-5/8	270	N/R	13
	15	TE4D15F	-2 x 5%	16-1/16	21-1/8	15-1/8	435	N/R	13
FH	15	T4T15	+2, -4 x 2-1/2%	29	17-1/8	19-3/8	185	WS-2	22
	25	T4T25	+2, -4 x 2-1/2%	34	22-3/8	19-7/8	285	WS-4	22
	30	T4T30	+2, -4 x 2-1/2%	34	22-3/8	19-7/8	315	WS-4	22
	37.5	T4T37	+2, -4 x 2-1/2%	34	22-3/8	19-7/8	320	WS-4	22
	45	T4T45	+2, -4 x 2-1/2%	34	22-3/8	19-7/8	345	WS-4	22
	75	T4T75	+2, -4 x 2-1/2%	43	28-1/2	23-1/2	515	WS-18	22
	112.5	T4T112	+2, -4 x 2-1/2%	43	28-1/2	23-1/2	665	WS-18	22
	150	T4T150	+2, -4 x 2-1/2%	49	39	23	965	WS-10	22A
	225	T4T225	+2, -4 x 2-1/2%	57	42-1/8	26	1300	WS-12	22A
	300	T4T300	+2, -4 x 2-1/2%	63	46-1/2	30-7/8	1625	WS-14	22A
	500	T4T500	+2, -4 x 2-1/2%	72-3/4	53-3/8	36-7/8	2575	WS-16	22A
	750	T4T750	+2, -4 x 2-1/2%	76-3/4	53-3/8	44-3/8	3525	—	22A
	1000	T4J1000	+2, -2 x 3%	80	61	44-3/8	4450	—	22B
480 - 208Y/120 Volts, 60 Hz, Electrostatically Shielded									
FB	3	TE4D3FS	-2 x 5%	12-1/16	12-1/8	8-3/8	95	N/R	15
	6	TE4D6FS	-2 x 5%	14-9/16	20-1/8	10-5/8	225	N/R	15
	9	TE4D9FS	-2 x 5%	14-9/16	20-1/8	10-5/8	270	N/R	15
	15	TE4D15FS	-2 x 5%	16-1/16	21-1/8	15-1/8	435	N/R	15
FH	15	T4T15S	+2, -4 x 2-1/2%	29	17-1/8	19-3/8	185	WS-2	18
	30	T4T30S	+2, -4 x 2-1/2%	34	22-3/8	19-7/8	315	WS-4	18
	45	T4T45S	+2, -4 x 2-1/2%	34	22-3/8	19-7/8	345	WS-4	18
	50	T4T50S	+2, -4 x 2-1/2%	34	22-3/8	19-7/8	400	WS-4	18
	75	T4T75S	+2, -4 x 2-1/2%	43	28-1/2	23-1/2	515	WS-18	18
	112.5	T4T112S	+2, -4 x 2-1/2%	43	28-1/2	23-1/2	665	WS-18	18
	150	T4T150S	+2, -4 x 2-1/2%	49	39	23	965	WS-10	18A
	225	T4T225S	+2, -4 x 2-1/2%	57	42-1/8	26	1300	WS-12	18A
	300	T4T300S	+2, -4 x 2-1/2%	63	46-1/2	30-7/8	1625	WS-14	18A
	500	T4T500S	+2, -4 x 2-1/2%	72-3/4	53-3/8	36-7/8	2575	WS-16	18A
	750	T4T750S	+2, -4 x 2-1/2%	76-3/4	53-3/8	44-3/8	3525	—	18A
	1000	T4J1000S	+2, -2 x 3%	80	61	44-3/8	4450	—	18B
480 - 208Y/120 Volts, 60 Hz, Electrostatically Shielded Copper									
FH	15	T4T15CS	+2, -4 x 2-1/2%	29	17-1/8	19-3/8	190	WS-2	18
	30	T4T30CS	+2, -4 x 2-1/2%	34	22-3/8	19-7/8	335	WS-4	18
	45	T4T45CS	+2, -4 x 2-1/2%	34	22-3/8	19-7/8	385	WS-4	18
	50	T4T50CS	+2, -4 x 2-1/2%	34	22-3/8	19-7/8	440	WS-4	18
	75	T4T75CS	+2, -4 x 2-1/2%	41-1/2	32-1/4	20	595	WS-6	18A
	112.5	T4T112CS	+2, -4 x 2-1/2%	45-1/2	34-3/4	20	790	WS-8	18A
	150	T4T150CS	+2, -4 x 2-1/2%	49	39	23	1015	WS-10	18A
	225	T4T225CS	+2, -4 x 2-1/2%	57	42-1/8	26	1390	WS-12	18A
	300	T4T300CS	+2, -4 x 2-1/2%	63	46-1/2	30-7/8	1715	WS-14	18A
	500	T4T500CS	+2, -4 x 2-1/2%	72-3/4	53-3/8	36-7/8	2670	WS-16	18A
	750	T4T750CS	+2, -4 x 2-1/2%	CONSULT FACTORY					
	1000	T4J1000CS	+2, -2 x 3%						

N/R - Not Required

[1]Addition of weather shield kit converts transformer from Nema 2 to Nema 3R.

Three-Phase General Purpose Technical Data

Type FB: 115° C Rise • 180° C Insulation System • Non-Ventilated • Indoor/Outdoor

Type FH: 150° C Rise • 220° C Insulation System • Indoor Ventilated • Floor Mounted

Type	KVA	Catalog Number	Taps	Approximate Dimensions - Inches			Aprx. Wt. in Lbs.	Weather Shield [1]	Wiring Diagram
				H	W	D			
480 - 240 Volts, 60 Hz									
FB	3	TE482D3F	-2x 5%	12-1/16	12-1/8	8-3/8	95	N/R	14
	6	TE482D6F	-2x 5%	14-9/16	20-1/8	10-5/8	225	N/R	14
	9	TE482D9F	-2x 5%	14-9/16	20-1/8	10-5/8	270	N/R	14
	15	TE482D15F	-2x 5%	16-1/16	21-1/8	15-1/8	435	N/R	14
480 - 240 Volts, 60 Hz, Electrostatically Shielded									
FB	3	TE482D3FS	-2 x 5%	12-1/16	12-1/8	8-3/8	95	N/R	16
	6	TE482D6FS	-2 x 5%	14-9/16	20-1/8	10-5/8	225	N/R	16
	9	TE482D9FS	-2 x 5%	14-9/16	20-1/8	10-5/8	270	N/R	16
	15	TE482D15FS	-2 x 5%	16-1/16	21-1/8	15-1/8	435	N/R	16
480 - 240/120 Volts, LT (Lighting Tap), 60 Hz									
FH	15	T43T15	+2, -4 x 2-1/2%	29	17-1/8	19-3/8	185	WS-2	21
	30	T43T30	+2, -4 x 2-1/2%	34	22-3/8	19-7/8	315	WS-4	21
	45	T43T45	+2, -4 x 2-1/2%	34	22-3/8	19-7/8	345	WS-4	21
	75	T43T75	+2, -4 x 2-1/2%	43	28-1/2	23-1/2	515	WS-18	21
	112.5	T43T112	+2, -4 x 2-1/2%	43	28-1/2	23-1/2	665	WS-18	21
	150	T43T150	+2, -4 x 2-1/2%	49	39	23	965	WS-10	21A
	225	T43T225	+2, -4 x 2-1/2%	57	42-1/8	26	1300	WS-12	21A
	300	T43T300	+2, -4 x 2-1/2%	63	46-1/2	30-7/8	1625	WS-14	21A
	500	T43T500	+2, -4 x 2-1/2%	72-3/4	53-3/8	36-7/8	2575	WS-16	21A
	750	T43T750	+2, -4 x 2-1/2%	76-3/4	53-3/8	44-3/8	3525	—	21A
480 - 240/120 Volts, LT (Lighting Tap), 60 Hz, Electrostatically Shielded									
FH	15	T43T15S	+2, -4 x 2-1/2%	29	17-1/8	19-3/8	185	WS-2	17
	30	T43T30S	+2, -4 x 2-1/2%	34	22-3/8	19-7/8	315	WS-4	17
	45	T43T45S	+2, -4 x 2-1/2%	34	22-3/8	19-7/8	345	WS-4	17
	75	T43T75S	+2, -4 x 2-1/2%	43	28-1/2	23-1/2	515	WS-18	17
	112.5	T43T112S	+2, -4 x 2-1/2%	43	28-1/2	23-1/2	665	WS-18	17
	150	T43T150S	+2, -4 x 2-1/2%	49	39	23	965	WS-10	17A
	225	T43T225S	+2, -4 x 2-1/2%	57	42-1/8	26	1300	WS-12	17A
	300	T43T300S	+2, -4 x 2-1/2%	63	46-1/2	30-7/8	1625	WS-14	17A
	500	T43T500S	+2, -4 x 2-1/2%	72-3/4	53-3/8	36-7/8	2575	WS-16	17A
	750	T43T750S	+2, -4 x 2-1/2%	76-3/4	53-3/8	44-3/8	3525	—	17A

NR - Not Required

[1]Addition of weather shield kit converts transformer from NEMA 2 to NEMA 3R.

Three-Phase General Purpose Technical Data

Type FH: 150° C Rise • 220° C Insulation System • Indoor Ventilated • Floor Mounted

Type	KVA	Catalog Number	Taps	Approximate Dimensions - Inches H	W	D	Aprx. Wt. in Lbs.	Weather Shield [1]	Wiring Diagram
480 - 480Y/277 Volts, 60 Hz									
FH	15	T484T15	+2, -4 x 2-1/2%	29	17-1/8	19-3/8	185	WS-2	20
	25	T484T25	+2, -4 x 2-1/2%	34	22-3/8	19-7/8	285	WS-4	20
	30	T484T30	+2, -4 x 2-1/2%	34	22-3/8	19-7/8	315	WS-4	20
	45	T484T45	+2, -4 x 2-1/2%	34	22-3/8	19-7/8	345	WS-4	20
	75	T484T75	+2, -4 x 2-1/2%	43	28-1/2	23-1/2	515	WS-18	20
	112.5	T484T112	+2, -4 x 2-1/2%	45-1/2	34-3/4	20	740	WS-8	20A
	150	T484T150	+2, -4 x 2-1/2%	49	39	23	965	WS-10	20A
	225	T484T225	+2, -4 x 2-1/2%	57	42-1/8	26	1300	WS-12	20A
	300	T484T300	+2, -4 x 2-1/2%	63	46-1/2	30-7/8	1625	WS-14	20A
	500	T484T500	+2, -4 x 2-1/2%	72-3/4	53-3/8	36-7/8	2575	WS-16	20A
	750	T484T750	+2, -4 x 2-1/2%	76-3/4	53-3/8	44-3/8	3525	—	20A
600 - 208Y/120 Volts, 60 Hz, Electrostatically Shielded									
FH	15	T6T15S	+2, -4 x 2-1/2%	29	17-1/8	19-3/8	185	WS-2	24
	30	T6T30S	+2, -4 x 2-1/2%	34	22-3/8	19-7/8	315	WS-4	24
	45	T6T45S	+2, -4 x 2-1/2%	34	22-3/8	19-7/8	345	WS-4	24
	75	T6T75S	+2, -4 x 2-1/2%	41-1/2	32-1/4	20	555	WS-6	24A
	112.5	T6T112S	+2, -4 x 2-1/2%	45-1/2	34-3/4	20	740	WS-8	24A
	150	T6T150S	+2, -4 x 2-1/2%	49	39	23	965	WS-10	24A
	225	T6T225S	+2, -4 x 2-1/2%	57	42-1/8	26	1300	WS-12	24A
	300	T6T300S	+2, -4 x 2-1/2%	63	46-1/2	30-7/8	1625	WS-14	24A
	500	T6T500S	+2, -4 x 2-1/2%	72-3/4	53-3/8	36-7/8	2575	WS-16	24A

[1] Addition of weather shield kit converts transformer from NEMA 2 to NEMA 3R.

Three-Phase Optional Temperature Rise Technical Data

Type FH: 115° C Rise • 220° C Insulation System • Indoor Ventilated • Floor Mounted

Type	KVA	Catalog Number	Taps	Approximate Dimensions - Inches			Aprx. Wt. In Lbs.	Weather Shield 1	Wiring Diagram
				H	W	D			
208 - 208Y/120 Volts, 60 Hz, Electrostatically Shielded									
FH	15	T202H15FS	+2, -2 x 2-1/2%	34	22-3/8	19-7/8	285	WS-4	19
	25	T202H25FS	+2, -2 x 2-1/2%	34	22-3/8	19-7/8	315	WS-4	19
	30	T202H30FS	+2, -2 x 2-1/2%	34	22-3/8	19-7/8	320	WS-4	19
	45	T202H45FS	+2, -2 x 2-1/2%	34	22-3/8	19-7/8	400	WS-4	19
	75	T202H75FS	+2, -2 x 2-1/2%	45-1/2	34-3/4	20	740	WS-8	19A
	112.5	T202H112FS	+2, -2 x 2-1/2%	49	39	23	965	WS-10	19A
	150	T202J150FS	+2, -2 x 3%	57	42-1/8	26	1300	WS-12	19B
	225	T202L225FS	+2, -2 x 3-1/2%	63	46-1/2	30-7/8	1625	WS-14	19C
	300	T202B300FS	+1, -1 x 4%	72-3/4	53-3/8	36-7/8	2575	WS-16	19D
208 - 480Y/277 Volts, 60 Hz									
FH	15	T204H15F	+2, -2 x 2-1/2%	34	22-3/8	19-7/8	285	WS-4	23
	25	T204H25F	+2, -2 x 2-1/2%	34	22-3/8	19-7/8	315	WS-4	23
	30	T204H30F	+2, -2 x 2-1/2%	34	22-3/8	19-7/8	320	WS-4	23
	45	T204H45F	+2, -2 x 2-1/2%	34	22-3/8	19-7/8	400	WS-4	23
	75	T204H75F	+2, -2 x 2-1/2%	45-1/2	34-3/4	20	740	WS-8	23A
	112.5	T204H112F	+2, -2 x 2-1/2%	49	39	23	965	WS-10	23A
	150	T204J150F	+2, -2 x 3%	57	42-1/8	26	1300	WS-12	23B
	225	T204L225F	+2, -2 x 3-1/2%	63	46-1/2	30-7/8	1625	WS-14	23C
	300	T204B300F	+1, -1 x 4%	72-3/4	53-3/8	36-7/8	2575	WS-16	23D
	500	T204E500F	+1, -1 x 5%	76-3/4	53-3/8	44-3/8	3525	—	23E
240 - 208Y/120 Volts, 60 Hz, Electrostatically Shielded									
FH	15	T242T15FS	+2, -4 x 2-1/2%	34	22-3/8	19-7/8	285	WS-4	26
	30	T242T30FS	+2, -4 x 2-1/2%	34	22-3/8	19-7/8	320	WS-4	26
	45	T242T45FS	+2, -4 x 2-1/2%	41-1/2	32-1/4	20	555	WS-6	26A
	75	T242T75FS	+2, -4 x 2-1/2%	45-1/2	34-3/4	20	740	WS-8	26A
	112.5	T242T112FS	+2, -4 x 2-1/2%	49	39	23	965	WS-10	26A
	150	T242J150FS	+2, -2 x 3%	57	42-1/8	26	1300	WS-12	26B
	225	T242L225FS	+2, -2 x 3-1/2%	63	46-1/2	30-7/8	1625	WS-14	26C
	300	T242B300FS	+1, -1 x 4%	72-3/4	53-3/8	36-7/8	2575	WS-16	26D
480 - 208Y/120 Volts, 60 Hz									
FH	15	T4T15F	+2, -4 x 2-1/2%	34	22-3/8	19-7/8	285	WS-4	22
	25	T4T25F	+2, -4 x 2-1/2%	34	22-3/8	19-7/8	315	WS-4	22
	30	T4T30F	+2, -4 x 2-1/2%	34	22-3/8	19-7/8	320	WS-4	22
	37.5	T4T37F	+2, -4 x 2-1/2%	34	22-3/8	19-7/8	345	WS-4	22
	45	T4T45F	+2, -4 x 2-1/2%	34	22-3/8	19-7/8	400	WS-4	22
	50	T4T50F	+2, -4 x 2-1/2%	43	28-1/2	23-1/2	515	WS-18	22
	75	T4T75F	+2, -4 x 2-1/2%	43	28-1/2	23-1/2	665	WS-18	22
	112.5	T4T112F	+2, 4 x 2-1/2%	49	39	23	965	WS-10	22A
	150	T4T150F	+2, -4 x 2-1/2%	57	42-1/8	26	1300	WS-12	22A
	225	T4T225F	+2, -4 x 2-1/2%	63	46-1/2	30-7/8	1625	WS-14	22A
	300	T4T300F	+2, -4 x 2-1/2%	72-3/4	53-3/8	36-7/8	2575	WS-16	22A
	500	T4T500F	+2, -4 x 2-1/2%	76-3/4	53-3/8	44-3/8	3525	—	22A

[1]Addition of weather shield kit converts transformer from NEMA 2 to NEMA 3R.

Three-Phase Optional Temperature Rise Technical Data

Type FH: 115° C Rise • 220° C Insulation System • Indoor Ventilated • Floor Mounted

Type	KVA	Catalog Number	Taps	Approximate Dimensions - Inches H	W	D	Aprx. Wt. in Lbs.	Weather Shield 1	Wiring Diagram
480- 208Y/120 Volts, 60 Hz, Electrostatically Shielded									
FH	15	T4T15FS	+2, -4 x 2-1/2%	34	22-3/8	19-7/8	285	WS-4	18
	30	T4T30FS	+2, -4 x 2-1/2%	34	22-3/8	19-7/8	320	WS-4	18
	45	T4T45FS	+2, -4 x 2-1/2%	34	22-3/8	19-7/8	400	WS-4	18
	50	T4T50FS	+2, -4 x 2-1/2%	43	28-1/2	23-1/2	515	WS-18	18
	75	T4T75FS	+2, -4 x 2-1/2%	43	28-1/2	23-1/2	665	WS-18	18
	112.5	T4T112FS	+2, -4 x 2-1/2%	49	39	23	965	WS-10	18A
	150	T4T150FS	+2, -4 x 2-1/2%	57	42-1/8	26	1300	WS-12	18A
	225	T4T225FS	+2, -4 x 2-1/2%	63	46-1/2	30-7/8	1625	WS-14	18A
	300	T4T300FS	+2, -4 x 2-1/2%	72-3/4	53-3/8	36-7/8	2575	WS-16	18A
	500	T4T500FS	+2, -4 x 2-1/2%	76-3/4	53-3/8	44-3/8	3525	—	18A
480 Volts - 208Y/120 Volts, 60 Hz, Electrostatically Shielded Copper									
FH	15	T4T15FCS	+2, -4 x 2-1/2%	29	17-1/8	19-3/8	190	WS-2	18
	30	T4T30FCS	+2, -4 x 2-1/2%	34	22-3/8	19-7/8	355	WS-4	18
	45	T4T45FCS	+2, -4 x 2-1/2%	34	22-3/8	19-7/8	440	WS-4	18
	75	T4T75FCS	+2, -4 x 2-1/2%	41-1/2	32-1/4	;20	595	WS-6	18A
	112.5	T4T112FCS	+2, -4 x 2-1/2%	45-1/2	34-3/4	20	790	WS-8	18A
	150	T4T150FCS	+2, -4 x 2-1/2%	49	39	23	1015	WS-10	18A
	225	T4T225FCS	+2, -4 x 2-1/2%	63	46-1/2	30-7/8	1715	WS-14	18A
	300	T4T300FCS	+2, -4 x 2-1/2%	72-3/4	53-3/8	36-7/8	2670	WS-16	18A
	500	T4T500FCS	+2, -4 x 2-1/2%	CONSULT FACTORY					
480 - 240/120 Volts, LT (Lighting Tap), 60 Hz									
FH	15	T43T15F	+2, -4 x 2-1/2%	34	22-3/8	19-7/8	285	WS-4	21
	30	T43T30F	+2, -4 x 2-1/2%	34	22-3/8	19-7/8	320	WS-4	21
	45	T43T45F	+2, -4 x 2-1/2%	43	28-1/2	23-1/2	515	WS-18	21
	75	T43T75F	+2, -4 x 2-1/2%	43	28-1/2	23-1/2	665	WS-18	21
	112.5	T43T112F	+2, -4 x 2-1/2%	49	39	23	965	WS-10	21A
	150	T43T150F	+2, -4 x 2-1/2%	57	42-1/8	26	1300	WS-12	21A
	225	T43T225F	+2, -4 x 2-1/2%	63	46-1/2	30-7/8	1625	WS-14	21A
	300	T43T300F	+2, -4 x 2-1/2%	72-3/4	53-3/8	36-7/8	2575	WS-16	21A
	500	T43T500F	+2, -4 x 2-1/2%	76-3/4	53-3/8	44-3/8	3525	—	21A
480 - 240/120 Volts, LT (Lighting Tap), 60 Hz, Electrostatically Shielded									
FH	15	T43T15FS	+2, -4 x 2-1/2%	34	22-3/8	19-7/8	285	WS-4	17
	30	T43T30FS	+2, -4 x 2-1/2%	34	22-3/8	19-7/8	320	WS-4	17
	45	T43T45FS	+2, -4 x 2-1/2%	43	28-1/2	23-1/2	515	WS-18	17
	75	T43T75FS	+2, -4 x 2-1/2%	43	28-1/2	23-1/2	665	WS-18	17
	112.5	T43T112FS	+2, -4 x 2-1/2%	49	39	23	965	WS-10	17A
	150	T43T150FS	+2, -4 x 2-1/2%	57	42-1/8	26	1300	WS-12	17A
	225	T43T225FS	+2, -4 x 2-1/2%	63	46-1/2	30-7/8	1625	WS-14	17A
	300	T43T300FS	+2, 4 x 2-1/2%	72-3/4	53-3/8	36-7/8	2575	WS-16	17A

[1]Addition of weather shield kit converts transformer from NEMA 2 to NEMA 3R.

Three-Phase Optional Temperature Rise Technical Data

Type FH: 115° C Rise • 220° C Insulation System • Indoor Ventilated • Floor Mounted

Type	KVA	Catalog Number	Taps	Approximate Dimensions - Inches			Aprx. Wt. in Lbs.	Weather Shield [1]	Wiring Diagram
				H	W	D			
480 - 480Y/277 Volts, 60 Hz									
FH	15	T484T15F	+2, -4 x 2-1/2%	34	22-3/8	19-7/8	285	WS-4	20
	25	T484T25F	+2, -4 x 2-1/2%	34	22-3/8	19-7/8	315	WS-4	20
	30	T484T30F	+2, -4 x 2-1/2%	34	22-3/8	19-7/8	320	WS-4	20
	45	T484T45F	+2, -4 x 2-1/2%	43	28-1/2	23-1/2	515	WS-18	20
	75	T484T75F	+2, -4 x 2-1/2%	45-1/2	34-3/4	20	740	WS-8	20A
	112.5	T484T112F	+2, -4 x 2-1/2%	49	39	23	965	WS-10	20A
	150	T484T150F	+2, -4 x 2-1/2%	57	42-1/8	26	1300	WS-12	20A
	225	T484T225F	+2, -4 x 2-1/2%	63	46-1/2	30-7/8	1625	WS-14	20A
	300	T484T300F	+2, -4 x 2-1/2%	72-3/4	53-3/8	36-7/8	2575	WS-16	20A
	500	T484T500F	+2, -4 x 2-1/2%	76-3/4	53-3/8	44-3/8	3525	—	20A
600 - 208Y/120 Volts, 60 Hz, Electrostatically Shielded									
FH	15	T6T15FS	+2, -4 x 2-1/2%	34	22-3/8	19-7/8	285	WS-4	24
	30	T6T30FS	+2, -4 x 2-1/2%	34	22-3/8	19-7/8	320	WS-4	24
	45	T6T45FS	+2, -4 x 2-1/2%	41-1/2	32-1/4	20	555	WS-6	24A
	75	T6T75FS	+2, -4 x 2-1/2%	45-1/2	34-3/4	20	740	WS-8	24A
	112.5	T6T112FS	+2, -4 x 2-1/2%	49	39	23	965	WS-10	24A
	150	T6T150FS	+2, -4 x 2-1/2%	57	42-1/8	26	1300	WS-12	24A
	225	T6T225FS	+2, -4 x 2-1/2%	63	46-1/2	30-7/8	1625	WS-14	24A
	300	T6T300FS	+2, -4 x 2-1/2%	72-3/4	53-3/8	30-7/8	2575	WS-16	24A

[1]Addition of weather shield kit converts transformer from NEMA 2 to NEMA 3R.

Three-Phase Optional Temperature Rise Technical Data

Type FH: 80° C Rise • 220° C Insulation System • Indoor Ventilated • Floor Mounted

Type	KVA	Catalog Number	Taps	Approximate Dimensions - Inches H	W	D	Aprx. Wt. in Lbs.	Weather Shield [1]	Wiring Diagram
208 - 208Y/120 Volts, 60 Hz, Electrostatically Shielded									
FH	15	T202H15BS	+2, -2 x 2-1/2%	34	22-3/8	19-7/8	285	WS-4	19
	25	T202H25BS	+2, -2 x 2-1/2%	34	22-3/8	19-7/8	345	WS-4	19
	30	T202H30BS	+2, -2 x 2-1/2%	34	22-3/8	19-7/8	345	WS-4	19
	45	T202H45BS	+2, -2 x 2-1/2%	41-1/2	32-1/4	20	555	WS-6	19A
	75	T202H75BS	+2, -2 x 2-1/2%	45-1/2	34-3/4	20	740	WS-8	19A
	112.5	T202H112BS	+2, -2 x 2-1/2%	49	39	23	965	WS-10	19A
	150	T202J150BS	+2, -2 x 3%	57	42-1/8	26	1300	WS-12	19B
	225	T202B225BS	+1, -1 x 4%	72-3/4	53-3/8	36-7/8	2575	WS-16	19D
	300	T202B300BS	+1, -1 x 4%	72-3/4	53-3/8	36-7/8	2575	WS-16	19D
208 - 480Y/277 Volts, 60 Hz									
FH	15	T204H15B	+2, -2 x 2-1/2%	34	22-3/8	19-7/8	285	WS-4	23
	25	T204H25B	+2, -2 x 2-1/2%	34	22-3/8	19-7/8	320	WS-4	23
	30	T204H30B	+2, -2 x 2-1/2%	34	22-3/8	19-7/8	345	WS-4	23
	45	T204H45B	+2, -2 x 2-1/2%	41-1/2	32-1/4	20	555	WS-6	23A
	75	T204H75B	+2, -2 x 2-1/2%	45-1/2	34-3/4	20	740	WS-8	23A
	112.5	T204J112B	+2, -2 x 3%	49	39	23	965	WS-10	23B
	150	T204J150B	+2, -2 x 3%	57	42-1/8	26	1300	WS-12	23B
	225	T204B225B	+1, -1 x 4%	72-3/4	53-3/8	36-7/8	2575	WS-16	23D
	300	T204B300B	+1, -1 x 4%	72-3/4	53-3/8	36-7/8	2575	WS-16	23D
	500	T204E500B	+1, -1 x 5%	76-3/4	53-3/8	44-3/8	3525	—	23E
240 - 208Y/120 Volts, 60 Hz, Electrostatically Shielded									
FH	15	T242T15BS	+2, -4 x 2-1/2%	34	22-3/8	19-7/8	285	WS-4	26
	30	T242T30BS	+2, -4 x 2-1/2%	34	22-3/8	19-7/8	345	WS-4	26
	45	T242T45BS	+2, -4 x 2-1/2%	41-1/2	32-1/4	20	555	WS-6	26A
	75	T242T75BS	+2, -4 x 2-1/2%	45-1/2	34-3/4	20	740	WS-8	26A
	112.5	T242T112BS	+2, -4 x 2-1/2%	49	39	23	965	WS-10	26A
	150	T242J150BS	+2, -2 x 3%	57	42-1/8	26	1300	WS-12	26B
	225	T242B225BS	+1, -1 x 4%	72-3/4	53-3/8	36-7/8	2575	WS-16	26D
	300	T242B300BS	+1, -1 x 4%	72-3/4	53-3/8	36-7/8	2575	WS-16	26D
480 - 208Y/120 Volts, 60 Hz									
FH	15	T4T15B	+2, -4 x 2-1/2%	34	22-3/8	19-7/8	285	WS-4	22
	25	T4T25B	+2, -4 x 2-1/2%	34	22-3/8	19-7/8	320	WS-4	22
	30	T4T30B	+2, -4 x 2-1/2%	34	22-3/8	19-7/8	345	WS-4	22
	37.5	T4T37B	+2, -4 x 2-1/2%	43	28-1/2	23-1/2	515	WS-18	22
	45	T4T45B	+2, -4 x 2-1/2%	43	28-1/2	23-1/2	515	WS-18	22
	50	T4T50B	+2, -4 x 2-1/2%	43	28-1/2	23-1/2	515	WS-18	22
	75	T4T75B	+2, -4 x 2-1/2%	43	28-1/2	23-1/2	665	WS-18	22
	112.5	T4T112B	+2, 4 x 2-1/2%	49	39	23	965	WS-10	22A
	150	T4T150B	+2, -4 x 2-1/2%	57	42-1/8	26	1300	WS-12	22A
	225	T4T225B	+2, -4 x 2-1/2%	72-3/4	53-3/8	36-7/8	2575	WS-16	22A
	300	T4T300B	+2, -4 x 2-1/2%	72-3/4	53-3/8	36-7/8	2575	WS-16	22A
	500	T4T500B	+2, -4 x 2-1/2%	76-3/4	53-3/8	44-3/8	3525	—	22A

[1] Addition of weather shield kit converts transformer from NEMA 2 to NEMA 3R.

Three-Phase Optional Temperature Rise Technical Data

Type FH: 80° C Rise • 220° C Insulation System • Indoor Ventilated • Floor Mounted

Type	KVA	Catalog Number	Taps	Approximate Dimensions - Inches			Aprx. Wt. in Lbs.	Weather Shield [1]	Wiring Diagram
				H	W	D			
480 - 208Y/120 Volts, 60 Hz, Electrostatically Shielded									
FH	15	T4T15BS	+2, -4 x 2-1/2%	34	22-3/8	19-7/8	285	WS-4	18
	30	T4T30BS	+2, -4 x 2-1/2%	34	22-3/8	19-7/8	345	WS-4	18
	45	T4T45BS	+2, -4 x 2-1/2%	43	28-1/2	23-1/2	515	WS-18	18
	50	T4T50BS	+2, -4 x 2-1/2%	43	28-1/2	23-1/2	515	WS-18	18
	75	T4T75BS	+2, -4 x 2-1/2%	43	28-1/2	23-1/2	665	WS-18	18
	112.5	T4T112BS	+2, -4 x 2-1/2%	49	39	23	965	WS-10	18A
	150	T4T150BS	+2, -4 x 2-1/2%	57	42-1/8	26	1300	WS-12	18A
	225	T4T225BS	+2, -4 x 2-1/2%	72-3/4	53-3/8	36-7/8	2575	WS-16	18A
	300	T4T300BS	+2, -4 x 2-1/2%	72-3/4	53-3/8	36-7/8	2575	WS-16	18A
	500	T4T500BS	+2, -4 x 2-1/2%	76-3/4	53-3/8	44-3/8	3525	—	18A
480 Volts - 208Y/120 Volts, 60 Hz, Electrostatically Shielded Copper									
FH	15	T4T15BCS	+2, -4 x 2-1/2%	34	22-3/8	19-7/8	305	WS-4	18
	30	T4T30BCS	+2, -4 x 2-1/2%	34	22-3/8	19-7/8	385	WS-4	18
	45	T4T45BCS	+2, -4 x 2-1/2%	41-1/2	32-1/4	20	595	WS-6	18A
	75	T4T75BCS	+2, -4 x 2-1/2%	45-1/2	34-3/4	20	790	WS-8	18A
	112.5	T4T112BCS	+2, -4 x 2-1/2%	49	39	23	1390	WS-10	18A
	150	T4T150BCS	+2, -4 x 2-1/2%	57	42-1/8	26	1405	WS-12	18A
	225	T4T225BCS	+2, -4 x 2-1/2%	63	46-1/2	30-7/8	1715	WS-14	18A
	300	T4T300BCS	+2, -4 x 2-1/2%	72-3/4	53-3/8	36-7/8	2670	WS-16	18A
	500	T4T500BCS	+2, -4 x 2-1/2%	CONSULT FACTORY					
480 - 240/120 Volts, LT (Lighting Tap), 60 Hz									
FH	15	T43T15B	+2, -4 x 2-1/2%	34	22-3/8	19-7/8	285	WS-4	21
	30	T43T30B	+2, -4 x 2-1/2%	34	22-3/8	19-7/8	345	WS-4	21
	45	T43T45B	+2, -4 x 2-1/2%	43	28-1/2	23-1/2	515	WS-18	21
	75	T43T75B	+2, -4 x 2-1/2%	43	28-1/2	23-1/2	665	WS-18	21
	112.5	T43T112B	+2, -4 x 2-1/2%	49	39	23	965	WS-10	21A
	150	T43T150B	+2, -4 x 2-1/2%	57	42-1/8	26	1300	WS-12	21A
	225	T43T225B	+2, -4 x 2-1/2%	72-3/4	53-3/8	36-7/8	2575	WS-16	21A
	300	T43T300B	+2, -4 x 2-1/2%	72-3/4	53-3/8	36-7/8	2575	WS-16	21A
480 - 240/120 Volts, LT (Lighting Tap), 60 Hz, Electrostatically Shielded									
FH	15	T43T15BS	+2, -4 x 2-1/2%	34	22-3/8	19-7/8	285	WS-4	17
	30	T43T30BS	+2, -4 x 2-1/2%	34	22-3/8	19-7/8	345	WS-4	17
	45	T43T45BS	+2, -4 x 2-1/2%	43	28-1/2	23-1/2	515	WS-18	17
	75	T43T75BS	+2, -4 x 2-1/2%	43	28-1/2	23-1/2	665	WS-18	17
	112.5	T43T112BS	+2, -4 x 2-1/2%	49	39	23	965	WS-10	17A
	150	T43T150BS	+2, -4 x 2-1/2%	57	42-1/8	26	1300	WS-12	17A
	225	T43T225BS	+2, -4 x 2-1/2%	72-3/4	53-3/8	36-7/8	2575	WS-16	17A
	300	T43T300BS	+2, -4 x 2-1/2%	72-3/4	53-3/8	36-7/8	2575	WS-16	17A

[1] Addition of weather shield kit converts transformer from NEMA 2 to NEMA 3R.

Three-Phase Optional Temperature Rise Technical Data

Type FH: 80° C Rise • 220° C Insulation System • Indoor Ventilated • Floor Mounted

Type	KVA	Catalog Number	Taps	Approximate Dimensions - Inches			Aprx. Wt. in Lbs.	Weather Shield [1]	Wiring Diagram
				H	W	D			
480 - 480Y/277 Volts, 60 Hz									
FH	15	T484T15B	+2, -4 x 2-1/2%	34	22-3/8	19-7/8	285	WS-4	20
	25	T484T25B	+2, -4 x 2-1/2%	34	22-3/8	19-7/8	320	WS-4	20
	30	T484T30B	+2, -4 x 2-1/2%	34	22-3/8	19-7/8	345	WS-4	20
	45	T484T45B	+2, -4 x 2-1/2%	43	28-1/2	23-1/2	515	WS-18	20
	75	T484T75B	+2, -4 x 2-1/2%	45-1/2	34-3/4	20	740	WS-6	20A
	112.5	T484T112B	+2, -4 x 2-1/2%	49	39	23	965	WS-10	20A
	150	T484T150B	+2, -4 x 2-1/2%	57	42-1/8	26	1300	WS-12	20A
	225	T484T225B	+2, -4 x 2-1/2%	72-3/4	53-3/8	36-7/8	2575	WS-16	20A
	300	T484T300B	+2, -4 x 2-1/2%	72-3/4	53-3/8	36-7/8	2575	WS-16	20A
	500	T484T500B	+2, -4 x 2-1/2%	76-3/4	53-3/8	44-3/8	3525	—	20A
600 - 208Y/120 Volts, 60 Hz, Electrostatically Shielded									
FH	15	T6T15BS	+2, -4 x 2-1/2%	34	22-3/8	19-7/8	285	WS-4	24
	30	T6T30BS	+2, -4 x 2-1/2%	34	22-3/8	19-7/8	345	WS-4	24
	45	T6T45BS	+2, -4 x 2-1/2%	41-1/2	32-1/4	20	555	WS-6	24A
	75	T6T75BS	+2, -4 x 2-1/2%	45-1/2	34-3/4	20	740	WS-8	24A
	112.5	T6T112BS	+2, -4 x 2-1/2%	49	39	23	965	WS-10	24A
	150	T6T150BS	+2, -4 x 2-1/2%	57	42-1/8	26	1300	WS-12	24A
	225	T6T225BS	+2, -4 x 2-1/2%	72-3/4	53-3/8	36-7/8	2575	WS-16	24A
	300	T6T300BS	+2, -4 x 2-1/2%	72-3/4	53-3/8	36-7/8	2575	WS-16	24A

[1] Addition of weather shield kit converts transformer from NEMA 2 to NEMA 3R.

Type FH Motor Drive Isolation Transformers

Type FH motor drive isolation transformers are designed to meet the requirements of SCR controlled variable speed motor drives. They are specifically constructed to withstand the mechanical forces associated with SCR drive duty cycles and to isolate the line from most SCR generated voltage spikes and transient feedback. Similarly, the two-winding construction also aids in reducing some types of line transients that can cause misfiring of the SCR's.

The units are UL Listed and incorporate all the features of the FH transformer line. The transformers can also be supplied as core and coil units with UL component recognition.

Delta-wye designs are available for all commonly used primary and secondary voltages. All units include primary taps consisting of one 5% FCAN and one 5% FCBN.

7.5 KVA - 51 KVA

63 KVA - 220 KVA

275 KVA - 750 KVA

Three-Phase Motor Drive Isolation Transformer Technical Data

Type FH: 150° C Rise • 220° C Insulation System • Indoor Ventilated • Floor Mounted

HV Taps: 1 - 5% FCAN, 1 - 5% FCBN

Motor		Voltages - Primary-Delta, Secondary-Wye, 60 Hz				Aprx. Dimensions - Inches			Wt.	Weather
HP	KVA	230Δ-230Y	230Δ-460Y	460Δ-230Y	460Δ-460Y	H	W	D	Lbs.	Shield
3 & 5	7.5	FH7.5AEMD	FH7.5AFMD	FH7.5CEMD	FH7.5CFMD	29	17-1/8	19-3/8	145	WS-2
7.5	11	FH11AEMD	FH11AFMD	FH11CEMD	FH11CFMD	29	17-1/8	19-3/8	165	WS-2
10	15	FH15AEMD	FH15AFMD	FH15CEMD	FH15CFMD	29	17-1/8	19-3/8	185	WS-2
15	20	FH20AEMD	FH20AFMD	FH20CEMD	FH20CFMD	34	22-3/8	19-7/8	285	WS-4
20	27	FH27AEMD	FH27AFMD	FH27CEMD	FH27CFMD	34	22-3/8	19-7/8	315	WS-4
25	34	FH34AEMD	FH34AFMD	FH34CEMD	FH34CFMD	34	22-3/8	19-7/8	320	WS-4
30	40	FH40AEMD	FH40AFMD	FH40CEMD	FH40CFMD	34	22-3/8	19-7/8	345	WS-4
40	51	FH51AEMD	FH51AFMD	FH51CEMD	FH51CFMD	34	22-3/8	19-7/8	400	WS-4
50	63	FH63AEMD	FH63AFMD	FH63CEMD	FH63CFMD	34-1/2	27-7/8	14-1/4	480	—
60	75	FH75AEMD	FH75AFMD	FH75CEMD	FH75CFMD	34-1/2	27-7/8	14-1/4	495	—
75	93	FH93AEMD	FH93AFMD	FH93CEMD	FH93CFMD	40-1/2	30-7/8	15-1/2	600	—
100	118	FH118AEMD	FH118AFMD	FH118CEMD	FH118CFMD	46	34-3/8	16-1/2	755	—
125	145	FH145AEMD	FH145AFMD	FH145CEMD	FH145CFMD	46	34-3/8	16-1/2	810	—
150	175	FH175AEMD	FH175AFMD	FH175CEMD	FH175CFMD	50	39-7/8	19-3/4	1030	—
200	220	FH220AEMD	FH220AFMD	FH220CEMD	FH220CFMD	50	39-7/8	19-3/4	1090	—
250	275	FH275AEMD	FH275AFMD	FH275CEMD	FH275CFMD	55-1/4	44-3/8	27-1/4	1450	—
300	330	FH330AEMD	FH330AFMD	FH330CEMD	FH330CFMD	60-1/2	50-3/8	34-1/4	1720	—
400	440	FH440AEMD	FH440AFMD	FH440CEMD	FH440CFMD	60-1/2	50-3/8	34-1/4	2085	—
500	550	FH550AEMD	FH550AFMD	FH550CEMD	FH550CFMD	72	53-3/8	44-3/8	2750	—
600	660	FH660AEMD	FH660AFMD	FH660CEMD	FH660CFMD	72	53-3/8	44-3/8	3100	—
700	750	FH750AEMD	FH750AFMD	FH750CEMD	FH750CFMD	76-3/4	53-3/8	44-3/8	3150	—

Type FH: 150° C Rise • 220° C Insulation System • Indoor Ventilated • Floor Mounted

HV Taps: 1 - 5% FCAN, 1 - 5% FCBN

Motor		Voltages - Primary-Delta, Secondary-Wye, 60 Hz					Aprx. Dimensions - Inches			Wt.	Weather
H.P.	KVA	230Δ-575Y	460Δ-575Y	575Δ-230Y	575Δ-460Y	575Δ-575Y	H	W	D	Lbs.	Shield
3 & 5	7.5	FH7.5AHMD	FH7.5CHMD	FH7.5DEMD	FH7.5DFMD	FH7.5DHMD	29	17-1/8	19-3/8	145	WS-2
7.5	11	FH11AHMD	FH11CHMD	FH11DEMD	FH11DFMD	FH11DHMD	29	17-1/8	19-3/8	165	WS-2
10	15	FH15AHMD	FH15CHMD	FH15DEMD	FH15DFMD	FH15DHMD	29	17-1/8	19-3/8	185	WS-2
15	20	FH20AHMD	FH20CHMD	FH20DEMD	FH20DFMD	FH20DHMD	34	22-3/8	19-7/8	285	WS-4
20	27	FH27AHMD	FH27CHMD	FH27DEMD	FH27DFMD	FH27DHMD	34	22-3/8	19-7/8	315	WS-4
25	34	FH34AHMD	FH34CHMD	FH34DEMD	FH34DFMD	FH34DHMD	34	22-3/8	19-7/8	320	WS-4
30	40	FH40AHMD	FH40CHMD	FH40DEMD	FH40DFMD	FH40DHMD	34	22-3/8	19-7/8	345	WS-4
40	51	FH51AHMD	FH51CHMD	FH51DEMD	FH51DFMD	FH51DHMD	34	22-3/8	19-7/8	400	WS-4
50	63	FH63AHMD	FH63CHMD	FH63DEMD	FH63DFMD	FH63DHMD	34-1/2	27-7/8	14-1/4	480	—
60	75	FH75AHMD	FH75CHMD	FH75DEMD	FH75DFMD	FH75DHMD	34-1/2	27-7/8	14-1/4	495	—
75	93	FH93AHMD	FH93CHMD	FH93DEMD	FH93DFMD	FH93DHMD	40-1/2	30-7/8	15-1/2	600	—
100	118	FH118AHMD	FH118CHMD	FH118DEMD	FH118DFMD	FH118DHMD	46	34-3/8	16-1/2	755	—
125	145	FH145AHMD	FH145CHMD	FH145DEMD	FH145DFMD	FH145DHMD	46	34-3/8	16-1/2	810	—
150	175	FH175AHMD	FH175CHMD	FH175DEMD	FH175DFMD	FH175DHMD	50	39-7/8	19-3/4	1030	—
200	220	FH220AHMD	FH220CHMD	FH220DEMD	FH220DFMD	FH220DHMD	50	39-7/8	19-3/4	1090	—
250	275	FH275AHMD	FH275CHMD	FH275DEMD	FH275DFMD	FH275DHMD	55-1/4	44-3/8	27-1/4	1450	—
300	330	FH330AHMD	FH330CHMD	FH330DEMD	FH330DFMD	FH330DHMD	60-1/2	50-3/8	34-1/4	1720	—
400	440	FH440AHMD	FH440CHMD	FH440DEMD	FH440DFMD	FH440DHMD	60-1/2	50-3/8	34-1/4	2085	—
500	550	FH550AHMD	FH550CHMD	FH550DEMD	FH550DFMD	FH550DHMD	72	53-3/8	44-3/8	2750	—
600	660	FH660AHMD	FH660CHMD	FH660DEMD	FH660DFMD	FH660DHMD	72	53-3/8	44-3/8	3100	—
700	750	FH750AHMD	FH750CHMD	FH750DEMD	FH750DFMD	FH750DHMD	76-3/4	53-3/8	44-3/8	3150	—

K-Factor Dry Type Transformers - Type FHK

Application

With today's modern electronic, electrical components and circuitry constantly changing, the demand is forced upon the electrical power industry to produce and supply a clean source of electrical energy.

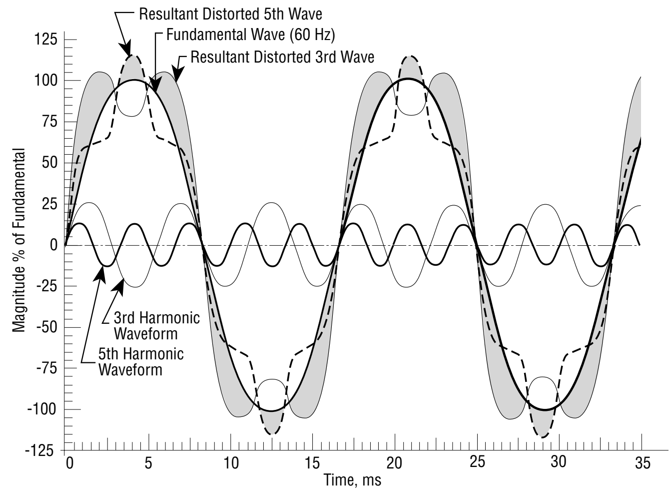
The Problem

The extensive utilization of solid state power conversion technologies has created new problems for the power industry and power engineer designer. This technology, called Switch Mode Power Systems (SMPS), consists of various types of solid state switching elements. These switching elements are solid state devices such as: SCR's, DIAC's, transistors and capacitors. These switching devices are in computers, copy machines, fax machines, telecommunications equipment, solid-state drives and controls, energy-efficient lighting ballasts, and numerous types of DC-Power Loads. These solid state elements continuously switch on and off producing non-linear or non-sinusoidal wave shapes in the current supplied from the energy source.

While a linear load uses current from the AC source continuously over the sinusoidal cycle, a non-linear load (such as the SMPS) uses current in large pulses from the AC source which creates harmonic distortion. These non-linear current pulses may exceed the nameplate ampere rating of the power source and may cause transformers to run hotter than expected, even when these transformers are supplying less than 50% of their rated nameplate capacity.

With non-linear loads, overloaded neutrals are also showing up in three-phase panel boards serving single-phase loads. In some cases the neutral conductor carries 180 Hertz currents, rather than 60 Hertz currents. This phenomenon is called triplen harmonics. Triplens are multiples of three, which do not cancel but are **additive** in the neutral conductor.

Figure 1
Distorted 3rd and 5th Resultant Harmonic Waveform



(Non-linear loads can produce additive 3rd order harmonic currents which may create overloaded neutral conductors.)

What Are Harmonics

As defined by ANSI/IEEE Std. 519-1981

Harmonic

Harmonic components are represented by a periodic wave having a frequency that is an integral multiple of the fundamental frequency.

In other words, harmonics are voltages or currents at frequencies that are integer multiples of the fundamental (60 Hz) frequency, e.g. 120 Hz, 180 Hz, 240 Hz, 300 Hz, etc. Harmonics are designated by their harmonic number, or multiple of the fundamental frequency. Thus, a harmonic with a frequency of 180 Hz (three times the 60 Hz fundamental Frequency) is called the 3rd harmonic.

Harmonics superimpose themselves on the fundamental waveform, distorting it and changing its magnitude. For instance, when a sine wave voltage source is applied to a non-linear load connected from phase-to-neutral on a 3-phase, 4-wire wye circuit, the load itself will draw a current wave made up of the 60 Hz fundamental frequency of the voltage source plus 3rd and higher order odd harmonic (multiples of the 60 Hz fundamental frequency), which are all generated by the non-linear load. **Figure 1** shows the resultants of a distorted 3rd and 5th harmonic waveform. It is not uncommon for portions of an industrial power system to have 15 to 25% of Total Harmonic Distortion (THD). THD is calculated as the **square root of the sum of the squares** of all harmonics, divided by the normal 60 hertz value as shown in **Equation 1**.

Equation 1

$$THD=\left[\frac{(I_{RMS_{60}})^2+(I_{RMS_{180}})^2+\ldots+(I_{RMS_N})^2}{(I_{RMS_{60}})^2}\right]^{1/2}$$

This yields a root-mean-square (RMS) value of distortion as a percentage of the fundamental 60 hertz waveform.

Therefore, THD is the percent of odd harmonics (3rd, 5th, 7th, ..., 25th, ...) present in the load which can affect the transformer. This condition is called a "Non-Linear Load" or "Non-Sinusoidal Load".

For dry type transformers, to determine what amount of harmonic content is present, a "K" factor calculation is made instead of using the THD formula.

The total amount of harmonics will determine the percentage of non-linear load, which can be specified with the following typical examples:

Transformers shall be sized to account for harmonic non-linear loads of 50% minimum (K-4), 100% (K-13), 125% (K-20), 150% (K-30).

The neutral connection shall be sized at 200% of the current rating of the phase connections.

The conductors of the transformer winding shall be sized to handle circulation of 3rd harmonic current and not exceed the rated temperature rise.

Transformers shall be capable of operating within the specified temperature rise while supplying 100% of the 60 Hertz fundamental rated current values plus the following harmonics as calculated by ANSI/IEEE 57.110-1986.

(A) 50% Non-Linear Load (K-4 Rating)

16.7% of the rated current at the 3rd Harmonic
10.0% of the rated current at the 5th Harmonic
7.1% of the rated current at the 7th Harmonic
5.6% of the rated current at the 9th Harmonic

Beyond the 9th Harmonic the percentages of the fundamental current through the 25th Harmonic shall be equal to the reciprocal of the odd harmonic number involved times 0.5

The FP Type FHK4 series transformer is designed for 100% linear load plus 50% non-linear load which can operate at a total I_h $(pu)^2$ h^2 K-factor load value of 4.0. See ***Table 1***.

(B) 100% Non-Linear Load (K-13 Rating)

33.3% of the rated current at the 3rd harmonic
20.0% of the rated current at the 5th harmonic
14.3% of the rated current at the 7th harmonic
11.1% of the rated current at the 9th harmonic

Beyond the 9th Harmonic the percentages of the fundamental current through the 25th Harmonic shall be equal to the reciprocal of the odd harmonic number involved times 1.0

The FP Type FHK13 series transformer is designed for 100% linear load plus 100% non-linear load which can operate at a total (I_h $(pu)^2h^2$) K-factor load value of 13.0. See ***Table 1***.

(C) 125% Non-Linear Load (K-20 Rating)

41.7% of the rated current at the 3rd harmonic
25.0% of the rated current at the 5th harmonic
17.9% of the rated current at the 7th harmonic
13.9% of the rated current at the 9th harmonic

Beyond the 9th Harmonic the percentages of the fundamental current through the 25th Harmonic shall be equal to the reciprocal of the odd harmonic number involved times 1.25

The FP Type FHK20 series transformer is designed for 100%linear load plus 125% non-linear load which can operate at a total ($I_h$$(pu)^2h^2$) K-factor load value of 20. See ***Table 1***.

(D) 150% Non-Linear Load (K-30 Rating)

50.0% of the rated current at the 3rd harmonic
30.0% of the rated current at the 5th harmonic
21.4% of the rated current at the 7th harmonic
16.7% of the rated current at the 9th harmonic

Beyond the 9th Harmonic the percentages of the fundamental current through the 25th Harmonic shall be equal to the reciprocal of the odd harmonic number involved times 1.50

The FP Type FHK30 series transformer is designed for 100%linear load plus 150% non-linear load which can operate at a total ($I_h$$(pu)^2h^2$) K-factor load value of 30. See ***Table 1***.

Note: *In these example the amount of non-linear load specified, the percentage of fundamental current, and the percentage of harmonic factor are arbitrary values; actual values may vary.*

Table 1 — Examples of K-Factor Loads

	K-4			K-13			K-20			K-30		
Harmonic (h)	Current (I_h)	I_h (pu)	Ih $(pu)_2h_2$	Current (I_h)	I_h (pu)	I_h $(pu)_2h_2$	Current (I_h)	I_h (Pu)	I_h $(Pu)_2h_2$	Current (I_h)	I_h (Pu)	I_h $(Pu)_2h_2$
1	100.000%	1,000	1.000	100.000%	1,000	1.000	100.000%	1.000	1.000	100.000%	1.000	1.000
3	16.667%	0.167	0.250	33.333%	0.333	1.000	41.667%	0.417	1.563	50.000%	0.500	2.250
5	10.000%	0.100	0.250	20.000%	0.200	1.000	25.000%	0.250	1.563	30.000%	0.300	2.250
7	7.143%	0.071	0.250	14.286%	0.143	1.000	17.857%	0.1790	1.563	21.429%	0.214	2.250
9	5.556%	0.056	0.250	11.111%	0.111	1.000	13.889%	0.139	1.563	16.667%	0.167	2.250
11	4.545%	0.045	0.250	9.091%	0.091	1.000	11.364%	0.114	1.563	13.636%	0.136	2.250
13	3.846%	0.038	0.250	7.692%	0.077	1.000	9.615%	0.096	1.563	11.538%	0.115	2.250
15	3.333%	0.033	0.250	6.667%	0.067	1.000	8.333%	0.083	1.563	10.000%	0.100	2.250
17	2.941%	0.029	0.250	5.882%	0.059	1.000	7.353%	0.074	1.563	8.824%	0.088	2.250
19	2.632%	0.026	0.250	5.263%	0.053	1.000	6.569%	0.066	1,563	7.895%	0.079	2.250
21	2.381%	0.024	0.250	4.762%	0.048	1.000	5.952%	0.060	1.563	7.143%	0.071	2.250
23	2.174%	0.022	0.250	4.348%	0.043	1.000	5.435%	0.054	1.563	6.522%	0.065	2.250
25	2.000%	0.020	0.250	4.000%	0.040	1.000	5.000%	0.050	1.563	6.000%	0.060	2.250

(Consult FP factory for your specific application or current values for each harmonic.)

K-Factor Transformer Ratings

The K-Factor rating assigned to a transformer and marked on the transformer case in accordance with the listing of Underwriters Laboratories, is an index of the transformer's ability to supply harmonic content in its load current while remaining within its operating temperature limits. A specific K-factor rating indicates that a transformer can supply its rated KVA load output to a load of specified amount of harmonic content. At present, industry literature and commentary refers to a limited number of K-factor ratings: K-1, K-4, K-9, K-13, K-20, K-30, K-40. In theory, a transformer could be designed for other K-factor ratings in-between those values, as well as for higher values. The commonly referenced ratings calculated according to ANSI/IEEE C57.110-1986 are as follows:

K-1: This is the rating of any conventional transformer that has been designed to handle only the heating effects of eddy currents and other losses resulting from 60 Hertz, sine-wave current loading on the transformer. Such a unit may or may not be designed to handle the increased heating of harmonics in its load current.

K-4: A transformer with this rating has been designed to supply rated KVA, without overheating, to a load made-up of 100% of the normal 60 Hertz, sine-wave, fundamental current plus: 16% of the fundamental as 3rd harmonic current; 10% of the fundamental as 5th; 7% of the fundamental as 7th; 5.5% of the fundamental as 9th; and smaller percentages through the 25th harmonic. The "4" indicates its ability to accommodate four times the eddy current losses of a K-1 transformer.

K-9: A K-9 transformer can accommodate 163% of the harmonic loading of a K-4 rated transformer.

K-13: A K-13 transformer can accommodate 200% of the harmonic loading of a K-4 rated transformer.

K-20, K-30, K-40: The higher number of each of these K-factor ratings indicates ability to handle successively larger amounts of harmonic load content without overheating.

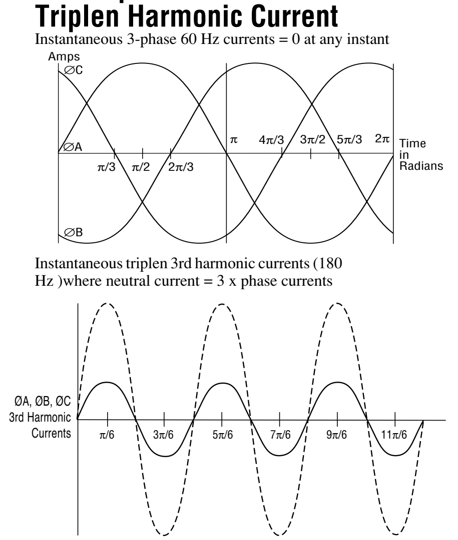
Table 1 Gives example of K-factor loads.

Triplen Harmonics

Triplen harmonic currents are phase currents which flow from each of the phases into the fourth wire neutral and have frequencies in integer multiples of three times the 60 hertz base frequency (180Hz, 360Hz, 540Hz, etc). At each of these third multiple triplen frequencies, these triplen phase currents are in phase with each other and when flowing in the neutral as zero sequence currents, are equal to three times their RMS phase values. See **Figure 2**.

In a 3-phase, 4-wire system, single-phase line-to-neutral currents flow in each phase conductor and return in the common neutral. Since the three 60 hertz currents are separated by 120°, when balanced they cancel each other. The measured resultant current is equal to zero. See **Figure 2.**

Figure 2
Development of Triplen Harmonic Current



At any given instant, the 60 Hertz currents on the three-phase legs have a vector resultant of zero and cancel in the neutral. But, the third (and other odd triplen harmonics) on the phase legs are in phase and become additive in the neutral.

Theory also states that for even harmonics, starting with the second order, when balanced the even harmonic will cancel in the common neutral.

Other odd harmonics add in the common neutral, but their magnitude is considerably less than triplens. The RMS value of the total current is the square root of the RMS value of the individual currents squared. As shown in **Equation 2**.

Equation 2

$$I_{Total}=\sqrt{I^2_{60Hz}+I^2_{180Hz}+I^2_{300Hz}+I^2_{420Hz}+...}$$

where I = RMS

The UL Approach for Transformers Supplying Non-Sinusoidal Loads

A. A transformer intended for use with loads drawing non-sinusoidal currents shall be marked "Suitable for non-sinusoidal current load with K-factor not to exceed x. (x= 4, 9, 13, 20, 30, 40 or 50)

B. Formulas to determine eddy losses and total losses where the transformer load losses (P_{LL}) are to be determined as follows:

$$P_{LL}=P_{DC}(1+K(P_{EC}))$$

where:

P_{DC} = the total I^2R losses

K= the K-factor rating at the transformer (4, 9, 13, 20, 30, 40 or 50)

P_{EC}= assumed eddy current losses calculated as follows:

$\frac{P_{AC}-P_{DC}}{P_{DC}}$ for transformers rated 300 KVA or less, and

$\frac{C\ (P_{AC}-P_{DC})}{P_{DC-I}}$ For transformers rated more than 300 KVA

in which:

P_{AC} = the impedance loss

C=0.7 for transformers having a turn ratio greater than 4:1 and having one or more windings with a current rating greater than 1000 amperes, or C=0.6 for all other transformers

P_{DC-I} =the I^2R losses for the inner winding

The impedance losses and the I^2R losses shall be determined in accordance with the Test Code for Dry Type Distribution and Power Transformers, ANSI/IEEE C57.12.91-1979.

DC Components of Load Current

As Stated in ANSI/IEEE C57.110-1986

Harmonic load currents may be accompanied by DC components in the load current which are frequently caused by the loss of a diode in a rectifier circuit. A dc component of load current will increase the transformer core loss slightly, and may increase the magnetizing current and audible sound level .

Relatively small dc components (up to the RMS magnitude of the transformer excitation current at rated voltage) are expected to have no significant effect on the load carrying capability of a transformer determined by this recommended practice. Higher dc load current components may adversely affect transformer capability and must be corrected by the user.

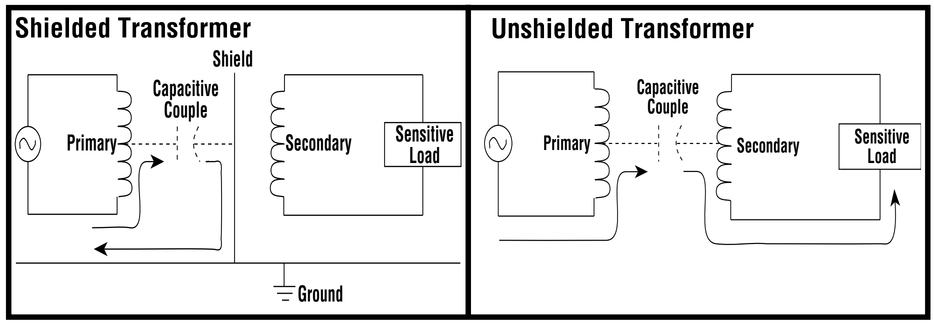
Harmonic currents flowing through transformer leakage impedance and through system impedance may also produce some small harmonic distortion in the voltage waveform at the transformer terminals. Such voltage harmonics may cause extra harmonic losses in the transformer core. However, operating experience has indicated that core temperature rise usually will not be the limiting parameter for determination of safe magnitudes of nonsinusoidal load currents.

Noise Isolation Transformers

The Noise Isolation Transformer suppresses common mode noise by introducing a grounded shield between its primary and secondary windings. The grounded shield provides a low impedance path to ground by capacitive coupling which prevents unwanted high frequency signals contained in the source voltage from reaching the transformer secondary.

The grounded shield between the primary and secondary windings is called an electrostatic shield. This shield does not perform any function with regard to harmonic current or voltage distortion wave forms. However the shield is extremely valuable in protecting sensitive equipment from common-mode electrical noise and transients generated on the line side of the transformer.

The ratio of the common mode noise attenuation (CMA) on the input to that of the output of the transformer is expressed in decibels as shown in **Equation 3**. An isolation transformer with an electrostatic shield can have a ratio of input noise voltage (V_{IN}) to output noise voltage (V_{OUT}) within the range of 10:1 to 1000:1 or even higher.



Test Circuit

Equation 3

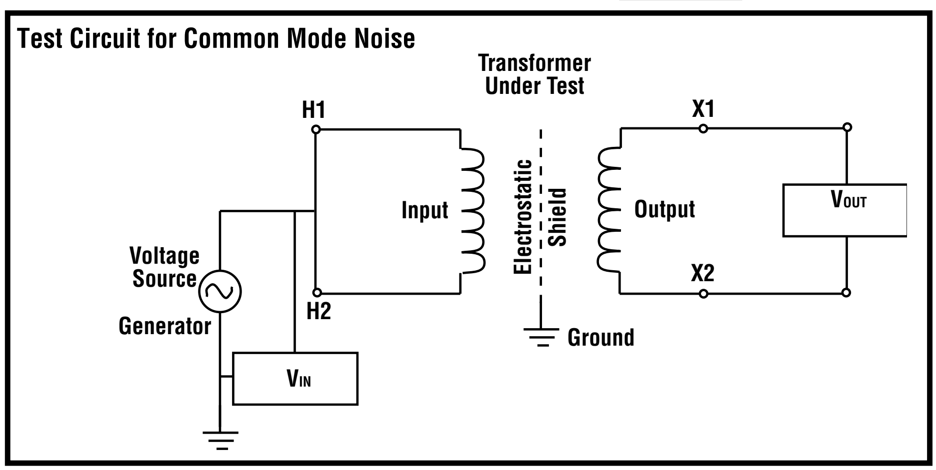
$$CMA = 20 \, Log_{10} \left[\frac{V_{IN}}{V_{OUT}} \right] dB$$

Using a Numerical Example

V_{IN} = 100.0 V at 40 kHz

V_{OUT} = 0.06 V at 40 kHz

$$CMA = 20 \, Log_{10} \left[\frac{100.0 V_{IN}}{0.06 \, V_{OUT}} \right] = 64.4 \text{ dB}$$

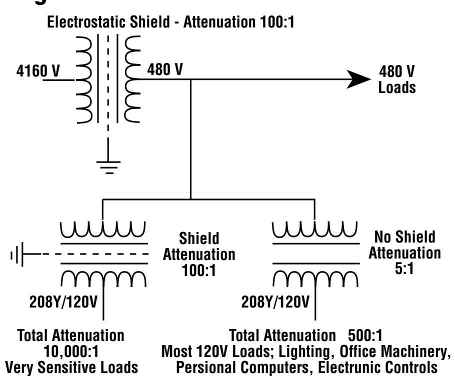


Federal Pacific Type DIT Drive Isolation Transformers are designed to meet the requirements of SCR controlled, variable speed motor drives. They are specifically constructed to withstand the mechanical forces associated with SCR drive duty cycles and to isolate the source voltage circuit from low frequency noise generated from SCR voltage spikes and transient feedback. Whereas the electrostatic shielded transformer attenuates higher frequency noise in the 10 K Hz - 100 K Hz range.

Multiplying Effect of Cascading Shielded Transformers

Having the presence of an upline transformer with an electrostatic shield may mean that other shielded transformers would not be required in the system. However, if a shielded transformer feeds another shielded transformer, there is an effect of the attenuation ratio multiplying as shown in **Figure 3**. If the attenuation ratio is 100:1 in each of the transformers, the total attenuation will be 100x100=10,000:1. Obviously, cascading inherently multiplies the attenuation effectiveness of shielded transformers. The term cascading means that two or more transformers are connected in series on the same system.

Figure 3



One line diagram shows system with shielded upline transformer and the attenuation ratios for various combinations with downline transformers. In most systems, only one shielded upline transformer is required.

Estimating K-Factor Loads

For the most part, each designer or installer must make his/her own decision regarding what K-factor to assign to any load or load category. The following table is intended to assist in that determination by presenting what we believe are realistic, yet conservative, K-factors for a number of loads and load categories based on their relative harmonic producing capabilities.

Calculating K-Factor Loads

1. List the KVA value for each load category to be supplied. Next, assign an I_{LK} value that corresponds to the relative level of harmonics drawn by each type of load. See **Table 2**.

2. Multiply the KVA of each load times the I_{LK} rating that corresponds to the assigned K-factor rating. This result is an indexed KVA-I_{LK} value:

KVA x I_{LK}=KVA -I_{LK}

3. Tabulate the total connected load KVA for all load categories to be supplied.

4. Next, add-up the KVA-I_{LK} values for all loads or load categories to be supplied by the transformer.

5. Divide the grand total KVA-I_{LK} value by the total KVA load to be supplied. This will give an average I_{LK} for that combination of loads.

(Total KVA-I_{LK}) ÷ (Total KVA) = average I_{LK}

6. From **Table 3**, find the K-factor rating whose I_{LK} is equal to or greater than the calculated I_{LK}. Corresponding to this I_{LK} is the K-factor of the transformer required.

Table 2

Load	K-Factor	I_{LK}
Incandescent Lighting	K-1	0.00
Electric Resistance Heating	K-1	0.00
Motors (without solid state drives)	K-1	0.00
Control Transformers/Electromagnetic Control Devices	K-1	0.00
Motor-Generators (without solid state drives)	K-1	0.00
Distribution Transformers	K-1	0.00
Electric-Discharge Lighting	K-4	25.82
UPS w/Optional Input Filter	K-4	25.82
Welders	K-4	25.82
Induction Heating Equipment	K-4	25.82
PLCs and Solid State Controls	K-4	25.82
Telecommunications Equipment (e.g. PBX)	K-13	57.74
Ups without Input Filtering	K-13	57.74
Multiwire Receptacle Circuits in General Care Areas of Health Care Facilities, Classrooms of Schools, etc	K-13	57.74
Multiwire Receptacle Circuits Supplying Inspection or Testing Equipment on an Assembly or Production Line	K-13	57.74
Main-Frame Computer Loads	K-20	80.94
Solid State Motor Drives (variable speed drives)	K-20	80.94
Multiwire Receptacle Circuits in Critical Care, Operating and Recovery Room Areas in Hospitals	K-20	80.94
Multiwire Receptacle Circuits in Industrial, Medical and Educational Laboratories	K-30	123.54
Multiwire Receptacle Circuits in Commercial Office Spaces	K-30	123.54
Small Main Frames (mini and micro)	K-30	123.54
Other Loads Identified as Producing Very High Amounts of Harmonics	K-40	208.17

Reprinted with permission from EDI Magazine

Table 3 Index of Load K-ratings

K-factor	K-1	K-4	K-9	K-13	K-20	K-30	K- 40
I_{LK}	0.0	25.82	44.72	57.74	80.94	123.54	208.17

Examples:

Problem 1

Calculate the overall K-factor for several non-linear loads.

Load Category	KVA Load	x	I_{LK}	=	KVA-I_{LK} Value
Discharge lighting	7.0	x	25.82	=	180.74
Receptacle circuits	2.0	x	123.54	=	247.08
Main frame computers	5.0	x	80.94	=	404.70
Motor w/drive	0.5	x	80.94	=	40.47
Motor w/o drive	1.5	x	0.00	=	0.00
Totals	16.0				872.99

Total KVA -I_{LK} / Total KVA=average I_{LK}

872.99/16 = 54.56 = average I_{LK}

From Table 3, the nearest K-factor greater than or equal to the average I_{LK} of 54.56 is K-13 with an I_{LK} of 57.74.

Problem 2

Calculate the amount of additional K-30 load that can be handled by a 25KVA, K-13 transformer with 9KVA of spare capacity.

1. Determine the available spare K-13 KVA-I_{LK}, using the I_{LK} that corresponds to the transformer's K-factor rating.

spare KVA x I_{LK} = spare KVA-I_{LK}

9 x 57.74 = 519.66 spare KVA-I_{LK}

2. Divide the spare KVA-I_{LK} by the Index of Load K-rating for the load to be supplied.

The I_{LK} for a K-30 load is 123.54

spare KVA-I_{LK} / new load I_{LK} @ K-30 =maximum additional KVA

519.66 / 123.54 = 4.2 KVA maximum additional KVA

3. Therefore, an additional 4.2 KVA of K-30 load could be added to this transformer. This additional loading represents the absolute maximum non-linear loading for that transformer.

For a transformer already partially loaded, any additional KVA loading must take into consideration the K-factor of each of the new loads to be added.

Guide Specification for 600 Volt Class Ventilated Dry Type Transformer Non-Linear, Non-Sinusoidal Loads

1. Transformer shall be UL 1561 listed, type "FHK". And be a Federal Pacific type FHK or approved equal.

2. Transformer shall be designed to supply rated current at 100% linear load plus carry the percent of non-linear odd order load up to the 25th harmonic as listed in ***Table 4***.

3. The transformer shall be three-phase with the fundamental frequency rating of 60 hertz.

Table 4
K-Factor Load Relationship

K Factor	% Linear Load	Plus	% Non Linear Load
4	100%	+	50% (1/h)
13	100%	+	100% (1/h)
20	100%	+	125% (1/h)
30	100%	+	150% (1/h)

where h= 3 through 25 for odd harmonics

4. Primary winding shall be delta connected and secondary winding shall be wye connected.

5. The transformer windings and terminals shall be aluminum. (Copper option is readily available; please specify)

6. The primary shall have two 2.5% full capacity taps above rated voltage and four 2.5% full capacity taps below rated voltage tap.

7. The temperature rise at the rated voltage and rated K-Factor load shall not exceed 150°C when measured by the resistance method as listed in ANSI/IEEE C57.12.91 with a 220°C UL Component Recognition Insulation System. (Optional: 115°C and 80°C temperature rise K-1 through K-20 Units available; please specify.)

8. The primary and secondary conductor shall be sized; shaped and transposed where necessary, to keep eddy current losses to an absolute minimum. The primary winding conductor also shall be sized to carry the triplen harmonic circulating current effect in the delta winding without overheating.

9. The secondary neutral shall be 2x (twice) the ampacity of the secondary phase conductors for triplens and unbalanced single phase loads.

10. The Basic Impulse Level of all windings shall be 10 KV.

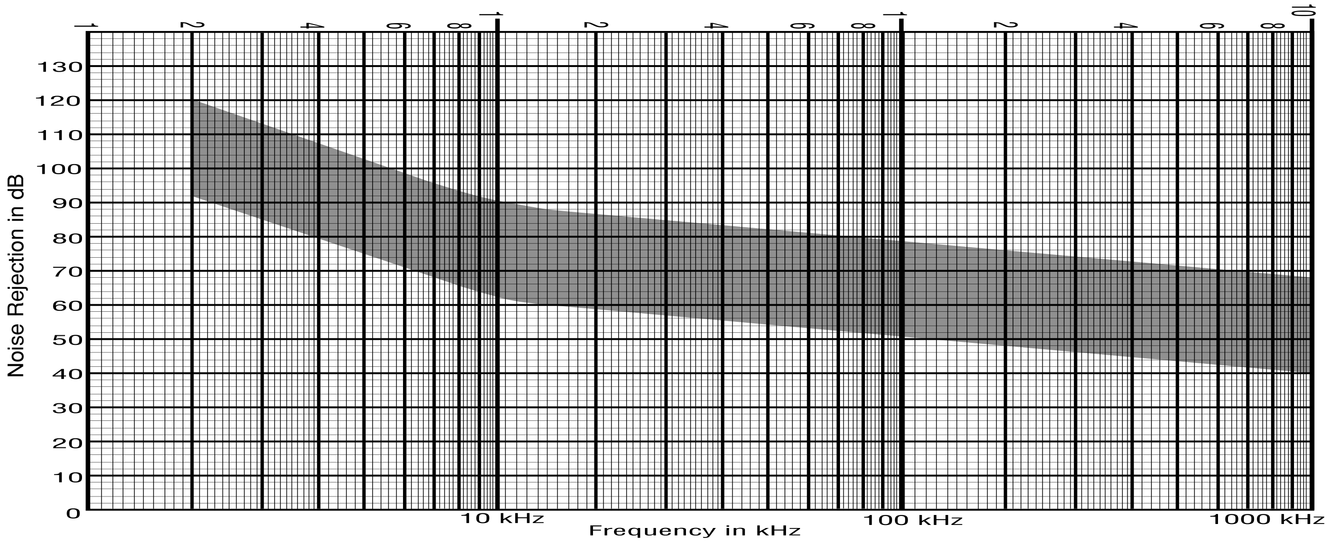
11. The enclosure shall be rated NEMA-1. (Optional: NEMA-3R units available.)

12. Optional: A full electrical width electrostatic shield shall be placed between the primary and secondary windings of each coil. With the shield grounded to a common point and the transformer connected under normal loaded conditions the attenuation of common mode line noise and transients shall be similar to values in ***Figure 4***.

13. The average audible sound level shall comply with NEMA ST-20:
10 to 50 KVA - 45 dB
51 to 150 KVA - 50 dB
151 to 300 KVA - 55 dB
301 to 500 KVA - 60 dB
501 to 700 KVA - 62 dB
701 to 1000 KVA - 64 dB
1001 to 1500 KVA - 65 dB
1501 to 2000 KVA - 66 dB

Note: Lower sound levels may be desirable for critical areas such as hospitals, schools or office areas. Contact your local FP Representative for specific recommendations.

Figure 4 Typical Common Mode Noise Rejection Curve



FPT Type FHK • K-Factor Dry-Type Transformers

Type: AA Phase: Three Frequency: 60 Hz Insulation Class: 220°C Enclosure: NEMA-1
Primary Voltage: 480 V Delta (2.5%) 2-FCAN & 4-FCBN Secondary Voltage: 208Y/ 120 V
Electrostatic Shield: Optional (Add "S" to CAT # Suffix) Windings and Bus: Aluminum (Copper Optional)

Rise	150° C			115° C			80° C		
KVA	K-4 CAT #	K-13 CAT #	K-20 CAT #	K-4 CAT#	K-13 CAT #	K-20 CAT #	K-4 CAT #	K-13 CAT #	K-20 CAT #
15	T4T15K4	T4T15K13	T4T15K20	T4T15FK4	T4T15FK13	T4T15FK20	T4T15BK4	T4T15BK13	T4T15BK20
25	T4T25K4	T4T25K13	T4T25K20	T4T25FK4	T4T25FK13	T4T25FK20	T4T25BK4	T4T25BK13	T4T25BK20
30	T4T30K4	T4T30K13	T4T30K20	T4T30FK4	T4T30FK13	T4T30FK20	T4T30BK4	T4T30BK13	T4T30BK20
37.5	T4T37K4	T4T37K13	T4T37K20	T4T37FK4	T4T37FK13	T4T37FK20	T4T37BK4	T4T37BK13	T4T37BK20
45	T4T45K4	T4T45K13	T4T45K20	T4T45FK4	T4T45FK13	T4T45FK20	T4T45BK4	T4T45BK13	T4T45BK20
75	T4T75K4	T4T75K13	T4T75K20	T4T75FK4	T4T75FK13	T4T75FK20	T4T75BK4	T4T75BK13	T4T75BK20
112.5	T4T112K4	T4T112K13	T4T112K20	T4T112FK4	T4T112FK13	T4T112FK20	T4T112BK4	T4T112BK13	T4T112BK20
150	T4T150K4	T4T150K13	T4T150K20	T4T150FK4	T4T150FK13	T4T150FK20	T4T150BK4	T4T150BK13	T4T150BK20
225	T4T225K4	T4T225K13	T4T225K20	T4T225FK4	T45225FK13	T4T225FK20	T4T225BK4	T4T225BK13	T4T225BK20
300	T4T300K4	T4T300K13	T4T300K20	T4T300FK4	T4T300FK13	T4T300FK20	T4T300BK4	T4T300BK13	T4T300BK20
500	T4T500K4	T4T500K13	T4T500K20	T4T500FK4	T4T500FK13	T4T500FK20	T4T500BK4	T4T500BK13	T4T500BK20

References:

ANSI/IEEE C57.110-1986, Recommended Practice to Establish Transformer Capability when Supplying Non-Sinusoidal Load Currents

ANSI/IEEE STD 519-1981, IEEE Guide to Harmonic Control and Reactive Compensation of Static Power Converters

McPartland, Brian J.; "Use K-Factor Transformers? Definitely! But Which K-Factor?" *EDI*, June 1991, Vol 2, No 6.

Accessories

Terminal Lug Kits for Type FH Transformers

Catalog Number	KVA Sizes	Terminal Lug Qty.	Cable Range	Hardware		Aprx. Wt. in Lbs.
				Qty.	Bolt Size	
50400	15 - 25 1Ø 15 - 25 - 30 - 37 1/2 3Ø	7	14-1/0	7	1/4 -20 x 1"	1
50401	37 1/2 - 50 1Ø 45 - 50 - 60 - 75 3Ø	3 7	14-1/0 6 - 250MCM	3 7	1/4 - 20 x 1" 5/16 - 18 x 1 1/2"	3
50402	75 - 100 1Ø 100 - 112 1/2 - 150 3Ø	6 6	(2) 6-350MCM 6 - 350MCM	6 3 6	1/2 - 13 x 2" 5/16 - 18 x 1 1/2" 3/8 - 16 x 1 1/2"	6
50403*	225 3Ø	3 4	4-500MCM (2) 2-600MCM	3 4	3/8 - 16 x 1 1/2" 1/2 - 13 x 2"	6
50404*	300 3Ø	3 12	(2) 6-350MCM 4 - 500MCM	3 9	1/2 - 13 x 2" 3/8 - 16 x 2"	8
50405*	400 - 500 3Ø	16 3	300-800MCM (2) 2-600MCM	13	1/2 - 13 x 2 1/2"	15

NOTES:
1. Screw type lugs suitable for aluminum or copper conductor.
*2. Catalog numbers 50403, 50404 and 50405 to be used with transformer voltages of 480-208Y/120 or 480-240/120 LT only.

Weather Shield Kits for Type FH Indoor Ventilated Transformers

Catalog Number	Overhang Extension (2 top & 2 bottom)	Approx. Wt.in Lbs.
WS-2	2-1/16 inches each side	10
WS-3	2-1/16 inches each side	10
WS-4	2-1/16 inches each side	15
WS-5	2-1/16 inches each side	15
WS-6	2-1/16 inches each side	16
WS-7	2-1/16 inches each side	16
WS-8	2-1/16 inches each side	17
WS-9	2-1/16 inches each side	18
WS-10	2-1/16 inches each side	20
WS-12	2-1/16 inches each side	22
WS-14	2-1/16 inches each side	28
WS-16	2-1/16 inches each side	35
WS-18	2-1/16 inches each side	15

Weathershield Note:

Weathershield catalog numbers are listed in the technical data sections for each product. Addition of a weathershield kit converts the transformer from Nema 2 to Nema 3R - UL listed product.

Wall Mount Brackets

Catalog Number	Type	Approx. Wt. in Lbs.	Use With . . .
WMB-3	Indoor/Outdoor	24	Type "FH" Transformers up to 450 pounds.
WMB-4	Indoor/Outdoor	60	Type "FH" Transformers up to 800 pounds.

Specification Guide

Lighting and Power Transformers 600 Volts and Below

Furnish and install single-phase and three-phase general purpose dry type transformers of the two winding type, self-cooled, with ratings as indicated on the electrical plans.

All transformers shall be constructed and rated in accordance with Underwriters Laboratories, Inc. Standard 506 or 1561as applicable, ANSI Standard C57, NEMA Standard ST-20 and the National Electrical Code.

Type FB

Transformers smaller than 15 KVA shall be totally enclosed non-ventilated with core and coil assemblies completely encapsulated in a polyester resin compound to provide a moisture-proof, shock-resistant, high dielectric seal.

Transformers shall be insulated with 180°C insulation system with 115°C rise.

Cores shall be constructed from non-aging electrical steels.

The case shall be constructed in accordance with UL specifications and shall include a wiring compartment to accommodate cable connections. All units shall be supplied with flexible cable leads marked for easy identification. Case design shall include knockouts and wall mounting brackets.

All external surfaces shall be provided with a durable ANSI 61 light gray paint finish. Three-phase transformers shall include NEMA standard tap arrangements and all units shall have sound levels in accordance with NEMA standards.

Transformers shall be Federal Pacific Transformer CompanyType FB or approved equal.

Type FH

Transformers rated 15 KVA and larger shall be a ventilated dry type with a UL listed 220°C insulation system. Units shall be designed to operate with a rated maximum temperature rise of 150°C (115°C) (80°C).

Cores shall be constructed from non-aging electrical steels. Core laminations shall be tightly clamped with structural steel angles. The complete core and coil assembly shall be impregnated with non-hygroscopic thermo-setting varnish to provide a high dielectric flame retardant seal.

Core and coil assemblies shall be braced to provide short circuit ratings as defined in ANSI and NEMA standards. The complete assembly shall be installed on vibration dampening pads to reduce noise and securely bolted to the enclosure base. A flexible grounding conductor shall be installed between the core and coil assembly and the transformer enclosure.

Enclosures shall be of heavy gauge steel, ventilated construction, finished with ANSI 61 light gray paint. All units shall be provided with suitable lifting means. Front and rear covers shall be removable to provide access to the terminal compartment. Terminals shall be fully sized to carry the transformer full load current and shall be arranged to accept required UL listed cable connectors. Units installed outdoors shall have a UL listed type 3R outdoor enclosure.

All units shall be supplied with NEMA standard taps in the high voltage windings.

Sound levels shall not exceed the following:

0 to 9 KVA	40 db
10 to 50 KVA	45 db
51 to 150 KVA	50 db
151 to 300 KVA	55 db
301 to 500 KVA	60 db
501 to 700 KVA	62 db
701 to 1000 KVA	64 db

Each transformer shall have a securely attached nameplate providing complete electrical ratings, wiring diagram, tap connections and catalog number.

Transformers shall be Federal Pacific Type FH or approved equal.

For K-Factor specifications, please refer to page 36.

Buck-Boost Connection Diagram

SINGLE PHASE

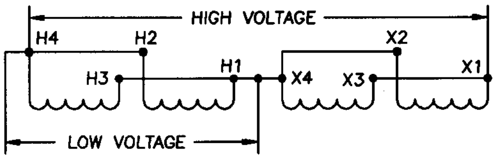


FIGURE A

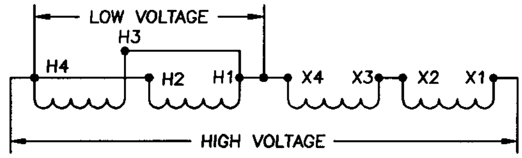


FIGURE B

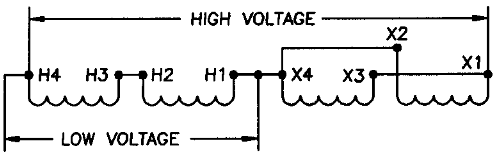


FIGURE C

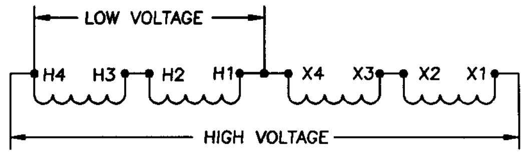


FIGURE D

THREE PHASE

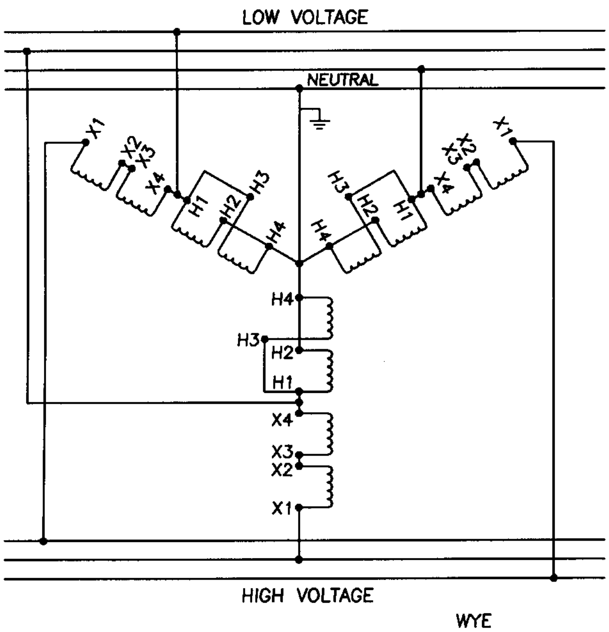


FIGURE E

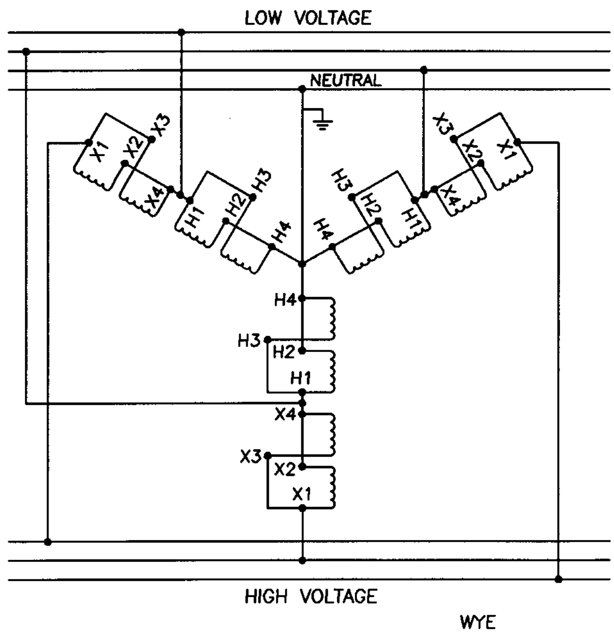


FIGURE F

NOTE: FIGURES E AND F CAN ONLY BE USED WHEN THE SOURCE IS A FOUR WIRE SUPPLY SYSTEM.

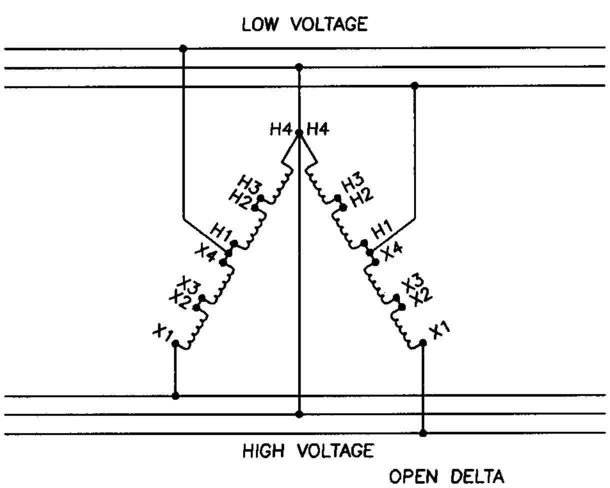


FIGURE G

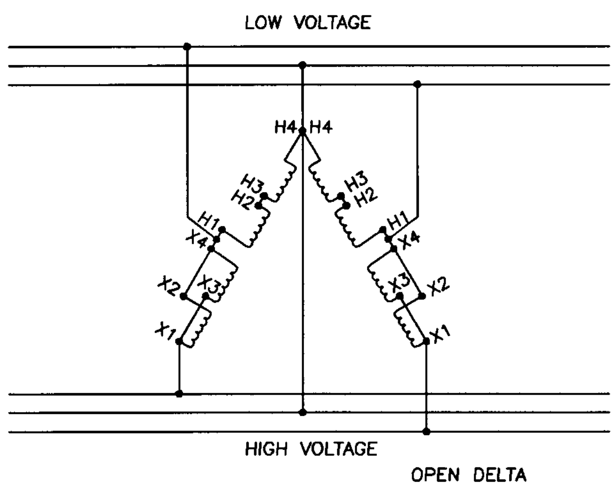


FIGURE H

Buck-Boost Connection Diagram

THREE PHASE

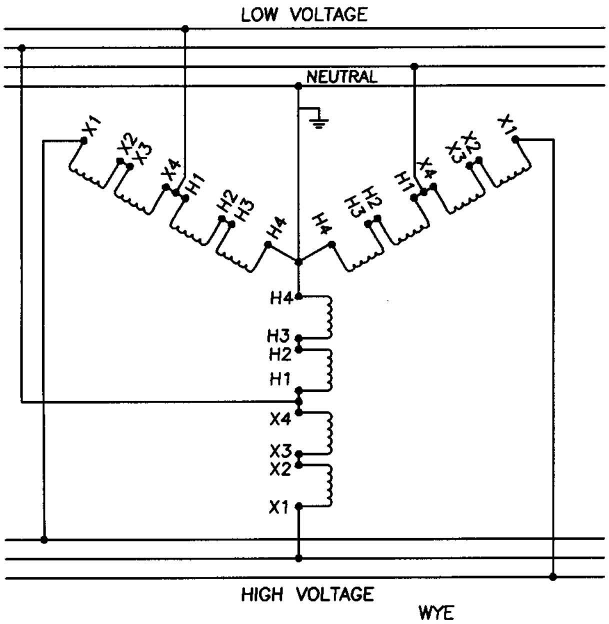


FIGURE J

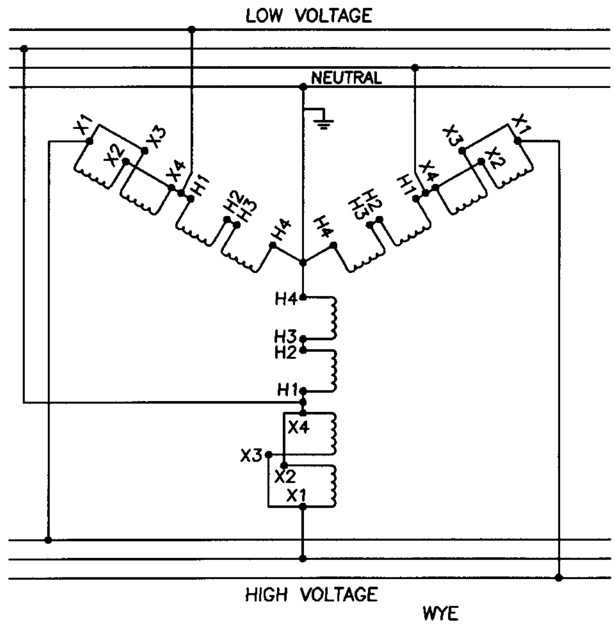


FIGURE K

NOTE: FIGURES J AND K CAN ONLY BE USED WHEN THE SOURCE IS A FOUR WIRE SUPPLY SYSTEM.

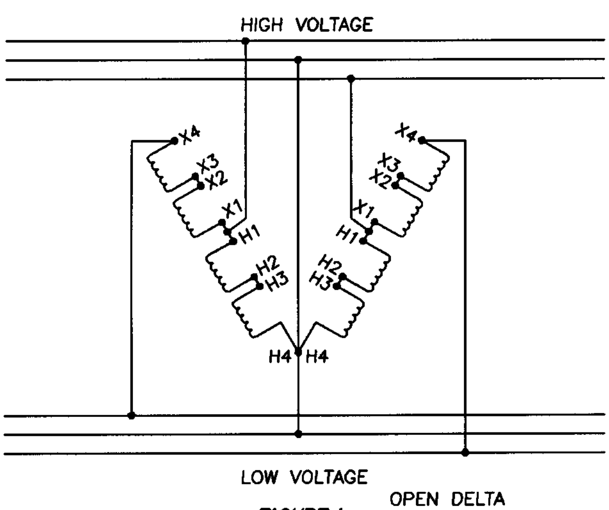
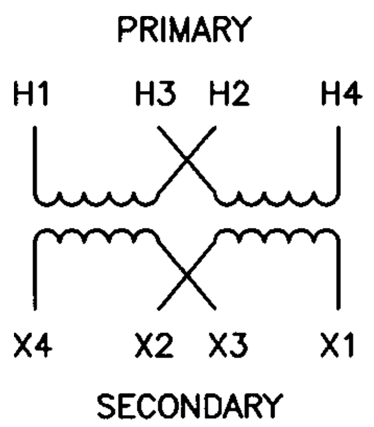


FIGURE L

Wiring Diagrams

Diagram #1

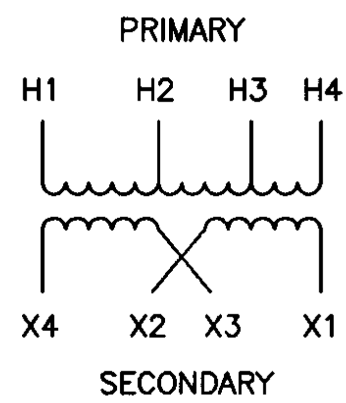
PRIMARY VOLTAGE	SECONDARY VOLTAGE	TAPS
240 X 480	120/240	NONE



VOLTS	CONNECTIONS	LINE LEADS
480	H2-H3	H1, H4
240	H1-H3, H2-H4	H1, H4
240	X2-X3	X1, X4
240/120	X2-X3	X1, X2, X4
120	X1-X3, X2-X4	X1, X4

Diagram #2

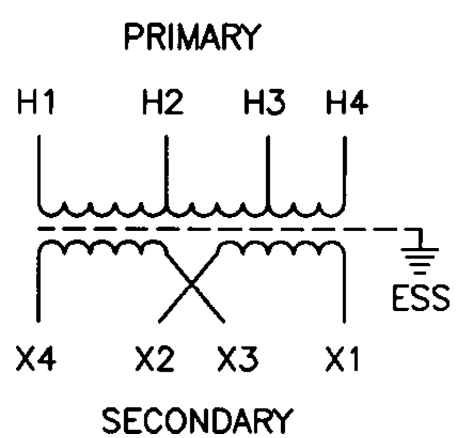
PRIMARY VOLTAGE	SECONDARY VOLTAGE	TAPS
480	120/240	2-5% FCBN



VOLTS	CONNECTIONS	LINE LEADS
480		H1, H4
456		H1, H3
432		H1, H2
240	X2-X3	X1, X4
240/120	X2-X3	X1, X2, X4
120	X1-X3, X2-X4	X1, X4

Diagram #3

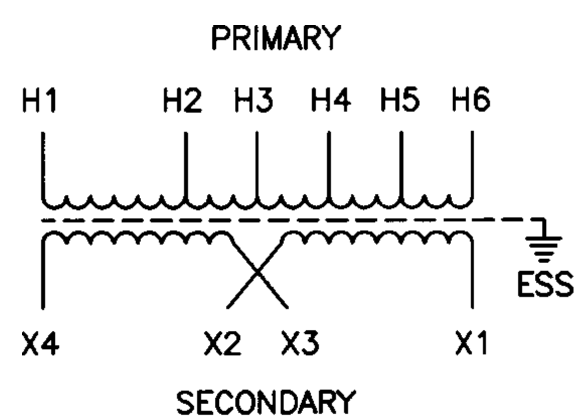
PRIMARY VOLTAGE	SECONDARY VOLTAGE	TAPS
600	120/240	2-5% FCBN



VOLTS	CONNECTIONS	LINE LEADS
600		H1, H4
570		H1, H3
540		H1, H2
240	X2-X3	X1, X4
240/120	X2-X3	X1, X2, X4
120	X1-X3, X2-X4	X1, X4

Diagram #4

PRIMARY VOLTAGE	SECONDARY VOLTAGE	TAPS
600	120/240	4-2 1/2% FCBN

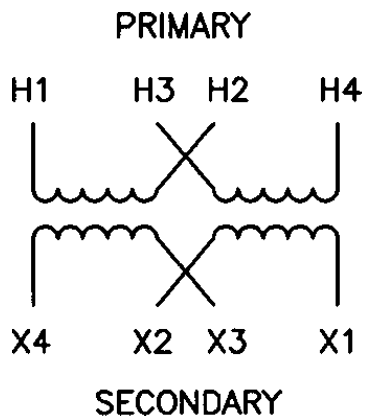


VOLTS	CONNECTIONS	LINE LEADS
600		H1, H6
585		H1, H5
570		H1, H4
555		H1, H3
540		H1, H2
240	X2-X3	X1, X4
240/120	X2-X3	X1, X2, X4
120	X1-X3, X2-X4	X1, X4

Wiring Diagrams

Diagram #5

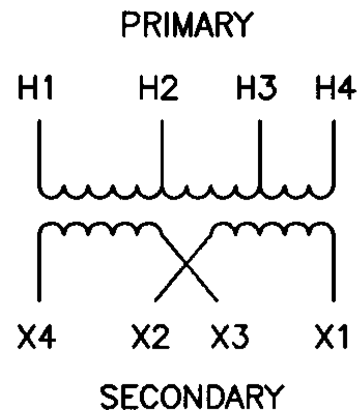
PRIMARY VOLTAGE	SECONDARY VOLTAGE	TAPS
120 X 240	120/240	NONE



VOLTS	CONNECTIONS	LINE LEADS
240	H2-H3	H1, H4
120	H1-H3, H2-H4	H1, H4
240	X2-X3	X1, X4
240/120	X2-X3	X1, X2, X4
120	X1-X3, X2-X4	X1, X4

Diagram #6

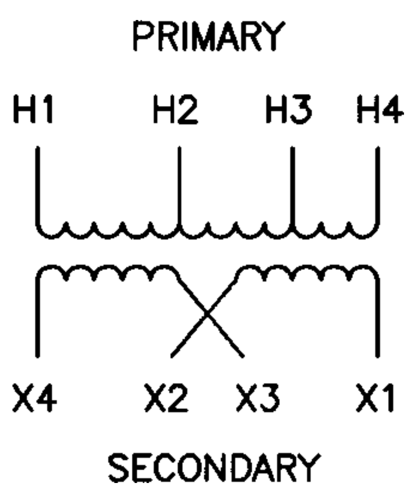
PRIMARY VOLTAGE	SECONDARY VOLTAGE	TAPS
208	120/240	2-5% FCBN



VOLTS	CONNECTIONS	LINE LEADS
208		H1, H4
198		H1, H3
187		H1, H2
240	X2-X3	X1, X4
240/120	X2-X3	X1, X2, X4
120	X1-X3, X2-X4	X1, X4

Diagram #7

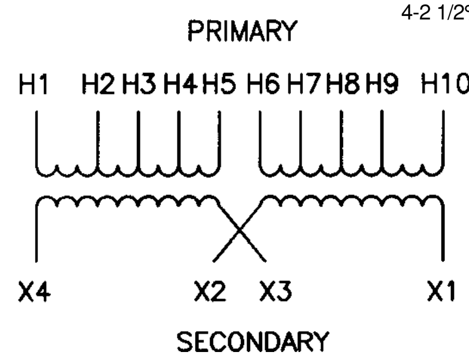
PRIMARY VOLTAGE	SECONDARY VOLTAGE	TAPS
277	120/240	2-5% FCBN



VOLTS	CONNECTIONS	LINE LEADS
277		H1, H4
263		H1, H3
249		H1, H2
240	X2-X3	X1, X4
240/120	X2-X3	X1, X2, X4
120	X1-X3, X2-X4	X1, X4

Diagram #8

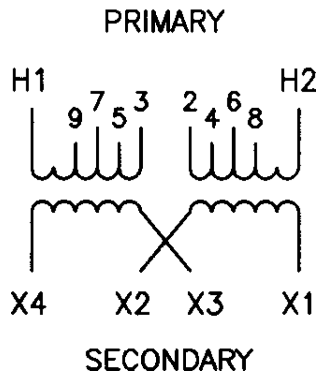
PRIMARY VOLTAGE	SECONDARY VOLTAGE	TAPS
240 X 480	120/240	2-2 1/2% FCAN & 4-2 1/2% FCBN



VOLTS	CONNECTIONS	LINE LEADS
252	H1-H6, H10-H5	H1, H10
240	H1-H7, H10-H4	H1, H10
228	H1-H8, H10-H3	H1, H10
216	H1-H9, H10-H2	H1, H10
504	H5-H6	H1, H10
492	H5-H7	H1, H10
480	H4-H7	H1, H10
468	H4-H8	H1, H10
456	H3-H8	H1, H10
444	H3-H9	H1, H10
432	H2-H9	H1, H10
240	X2-X3	X1, X4
240/120	X2-X3	X1, X2, X4
120	X1-X3, X2-X4	X1, X4

Diagram #9

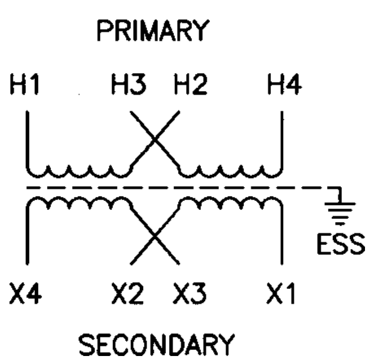
PRIMARY VOLTAGE	SECONDARY VOLTAGE	TAPS
240 X 480	120/240	2-2 1/2% FCAN & 4-2 1/2% FCBN



VOLTS	CONNECTIONS	LINE LEADS
504	2 TO 3	H1, H2
492	3 TO 4	H1, H2
480	4 TO 5	H1, H2
468	5 TO 6	H1, H2
456	6 TO 7	H1, H2
444	7 TO 8	H1, H2
432	8 TO 9	H1, H2
252	2 TO H1, 3 TO H2	H1, H2
240	4 TO H1, 5 TO H2	H1, H2
228	6 TO H1, 7 TO H2	H1, H2
216	8 TO H1, 9 TO H2	H1, H2
240	X2 TO X3	X1, X4
240/120	X2 TO X3	X1, X2, X4
120	X1 TO X3, X2 TO X4	X1, X4

Diagram #10

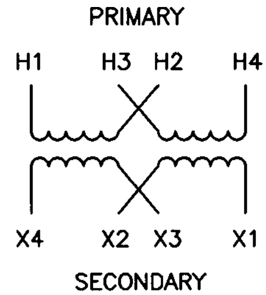
PRIMARY VOLTAGE	SECONDARY VOLTAGE	TAPS
240 X 480	120/240	NONE



VOLTS	CONNECTIONS	LINE LEADS
480	H2-H3	H1, H4
240	H1-H3, H2-H4	H1, H4
240	X2-X3	X1, X4
240/120	X2-X3	X1, X2, X4
120	X1-X3, X2-X4	X1, X4

Diagram #10A

	PRIMARY VOLTAGE	SECONDARY VOLTAGE	TAPS
(A)	120 X 240	12/24	None
(B)	120 X 240	16/32	None
(C)	240 X 480	24/48	None



(A)

VOLTS	CONNECTIONS	LINE LEADS
240	H2-H3	H1, H4
120	H1-H3, H2-H4	H1, H4
24	X2-X3	X1, X4
12	X1-X3, X2-X4	X1, X4

(B)

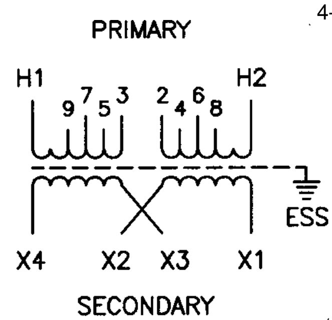
VOLTS	CONNECTIONS	LINE LEADS
240	H2-H3	H1, H4
120	H1-H3, H2-H4	H1, H4
32	X2-X3	X1, X4
16	X1-X3, X2-X4	X1, X4

(C)

VOLTS	CONNECTIONS	LINE LEADS
480	H2-H3	H1, H4
240	H1-H3, H2-H4	H1, H4
48	X2-X3	X1, X4
24	X1-X3, X2-X4	X1, X4

Diagram #11

PRIMARY VOLTAGE	SECONDARY VOLTAGE	TAPS
600	120/240	2-2 1/2% FCAN & 4-2 1/2% FCBN



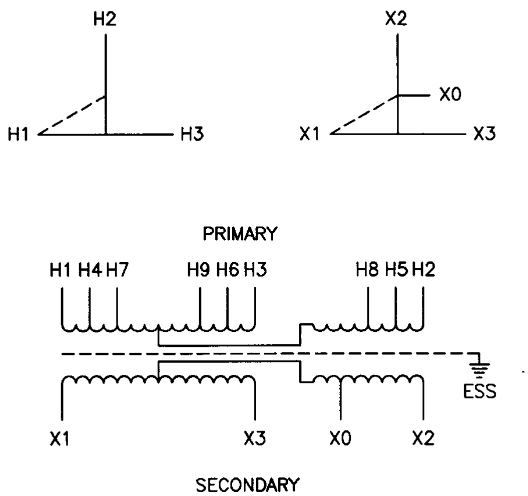
VOLTS	CONNECTIONS	LINE LEADS
630	2 TO 3	H1, H2
615	3 TO 4	H1, H2
600	4 TO 5	H1, H2
585	5 TO 6	H1, H2
570	6 TO 7	H1, H2
555	7 TO 8	H1, H2
540	8 TO 9	H1, H2
240	X2 TO X3	X1, X4
240/120	X2 TO X3	X1, X2, X4
120	X1 TO X3, X2 TO X4	X1, X4

Wiring Diagrams

Diagram #12

PRIMARY VOLTAGE	SECONDARY VOLTAGE	TAPS
240 Δ	208Y/120	2-5% FCBN

Ø DEGREE ANGULAR DISPLACEMENT

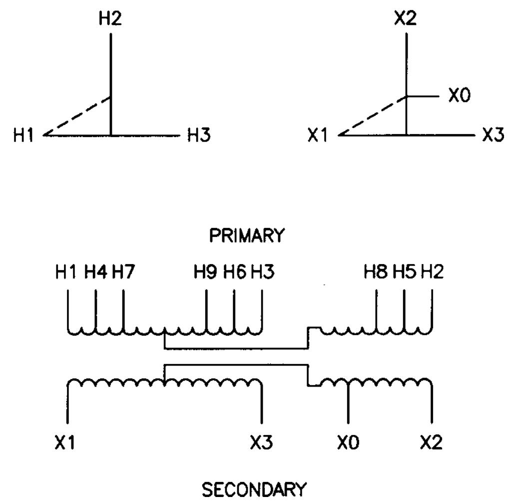


VOLTS	CONNECTIONS	LINE LEADS
240		H1, H2, H3
228		H4, H5, H6
216		H7, H8, H9
208Y/120		X0, X1, X2, X3

Diagram #13

PRIMARY VOLTAGE	SECONDARY VOLTAGE	TAPS
480 Δ	208Y/120	2-5% FCBN

Ø DEGREE ANGULAR DISPLACEMENT

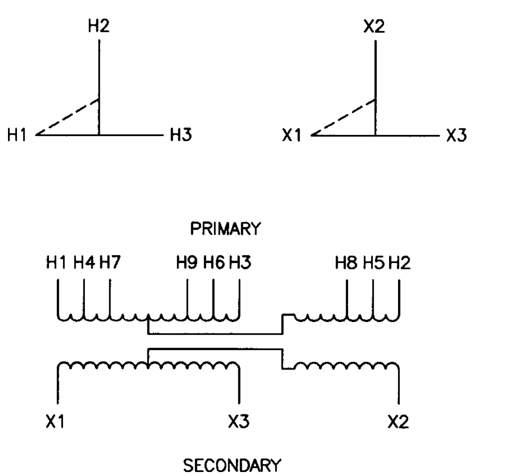


VOLTS	CONNECTIONS	LINE LEADS
480		H1, H2, H3
456		H4, H5, H6
432		H7, H8, H9
208Y/120		X0, X1, X2, X3

Diagram #14

PRIMARY VOLTAGE	SECONDARY VOLTAGE	TAPS
480 Δ	240 Δ	2-5% FCBN

Ø DEGREE ANGULAR DISPLACEMENT

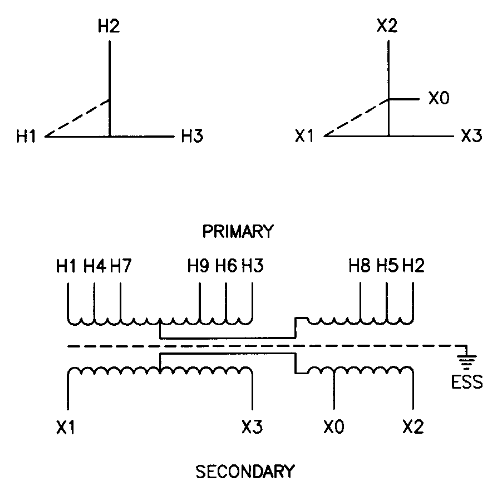


VOLTS	CONNECTIONS	LINE LEADS
480		H1, H2, H3
456		H4, H5, H6
432		H7, H8, H9
240		X1, X2, X3

Diagram #15

PRIMARY VOLTAGE	SECONDARY VOLTAGE	TAPS
480 Δ	208Y/120	2-5% FCBN

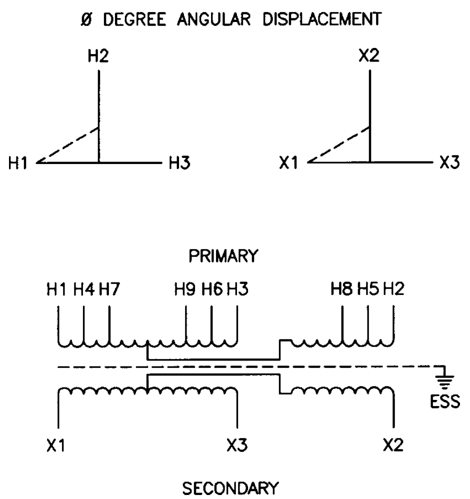
Ø DEGREE ANGULAR DISPLACEMENT



VOLTS	CONNECTIONS	LINE LEADS
480		H1, H2, H3
456		H4, H5, H6
432		H7, H8, H9
208Y/120		X0, X1, X2, X3

Diagram #16

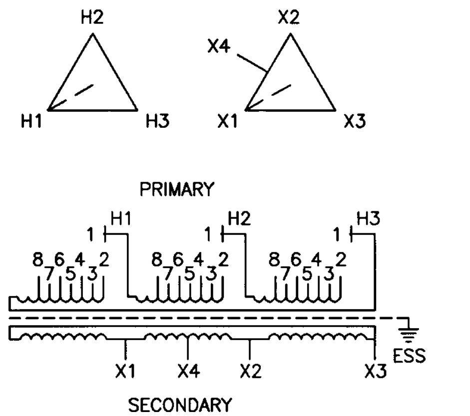
PRIMARY VOLTAGE	SECONDARY VOLTAGE	TAPS
480 Δ	240	2-5% FCBN



VOLTS	CONNECTIONS	LINE LEADS
480		H1, H2, H3
456		H4, H5, H6
432		H7, H8, H9
240		X1, X2, X3

Diagram #17

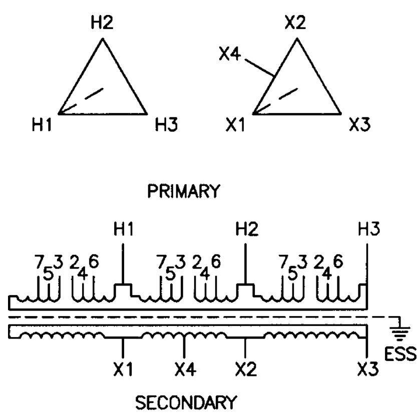
PRIMARY VOLTAGE	SECONDARY VOLTAGE	TAPS
480 Δ	240/120 LT.	2-2 1/2% FCAN & 4-2 1/2% FCBN



VOLTS	CONNECTIONS	LINE LEADS
504	1 TO 2	H1, H2, H3
492	1 TO 3	H1, H2, H3
480	1 TO 4	H1, H2, H3
468	1 TO 5	H1, H2, H3
456	1 TO 6	H1, H2, H3
444	1 TO 7	H1, H2, H3
432	1 TO 8	H1, H2, H3
240		X1, X2, X3

Diagram #17A

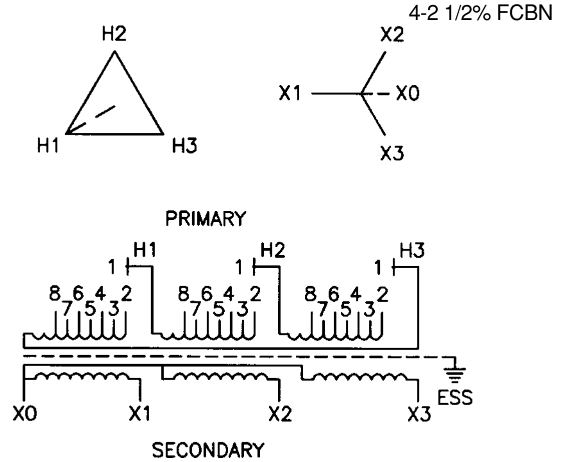
PRIMARY VOLTAGE	SECONDARY VOLTAGE	TAPS
480 Δ	240/120 LT.	2-2 1/2% FCAN & 4-2 1/2% FCBN



VOLTS	CONNECTIONS	LINE LEADS
504	2 TO 3	H1, H2, H3
492	2 TO 5	H1, H2, H3
480	3 TO 4	H1, H2, H3
468	4 TO 5	H1, H2, H3
456	5 TO 6	H1, H2, H3
444	4 TO 7	H1, H2, H3
432	6 TO 7	H1, H2, H3
240		X1, X2, X3

Diagram #18

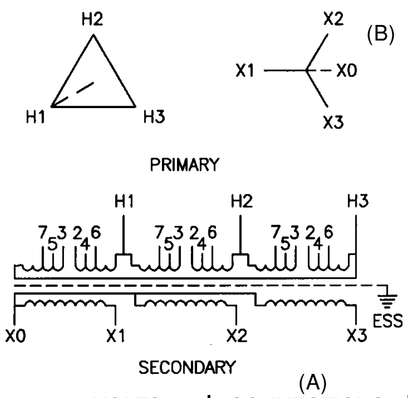
PRIMARY VOLTAGE	SECONDARY VOLTAGE	TAPS
480 Δ	208Y/120	2-2 1/2% FCAN & 4-2 1/2% FCBN



VOLTS	CONNECTIONS	LINE LEADS
504	1 TO 2	H1, H2, H3
492	1 TO 3	H1, H2, H3
480	1 TO 4	H1, H2, H3
468	1 TO 5	H1, H2, H3
456	1 TO 6	H1, H2, H3
444	1 TO 7	H1, H2, H3
432	1 TO 8	H1, H2, H3
208Y/120		X0, X1, X2, X3

Diagram #18A - 18B

PRIMARY VOLTAGE	SECONDARY VOLTAGE	TAPS
480 Δ	208Y/120	(A) 2-2 1/2% FCAN & 4-2 1/2% FCBN (B) 2-3% FCAN & 2-3 % FCBN



(A)

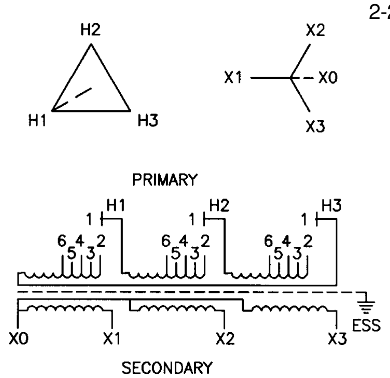
VOLTS	CONNECTIONS	LINE LEADS
504	2 TO 3	H1, H2, H3
492	2 TO 5	H1, H2, H3
480	3 TO 4	H1, H2, H3
468	4 TO 5	H1, H2, H3
456	5 TO 6	H1, H2, H3
444	4 TO 7	H1, H2, H3
432	6 TO 7	H1, H2, H3
208Y/120		X0, X1, X2, X3

(B)

VOLTS	CONNECTIONS	LINE LEADS
509	2 TO 3	H1, H2, H3
494	2 TO 5	H1, H2, H3
480	3 TO 4	H1, H2, H3
466	4 TO 5	H1, H2, H3
451	5 TO 6	H1, H2, H3
208Y/120		X0, X1, X2, X3

Diagram #19

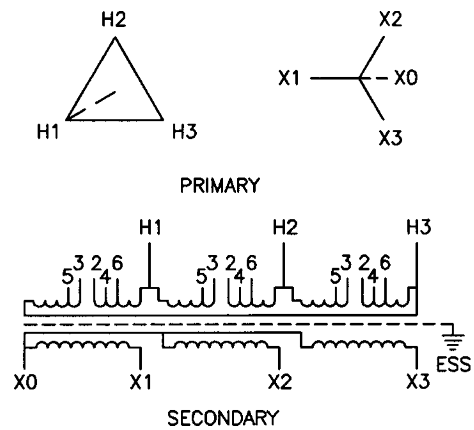
PRIMARY VOLTAGE	SECONDARY VOLTAGE	TAPS
208 Δ	208Y/120	2-2 1/2% FCAN & 2-2 1/2% FCBN



VOLTS	CONNECTIONS	LINE LEADS
218	1 TO 2	H1, H2, H3
213	1 TO 3	H1, H2, H3
208	1 TO 4	H1, H2, H3
203	1 TO 5	H1, H2, H3
198	1 TO 6	H1, H2, H3
208Y/120		X0, X1, X2, X3

Diagram #19A - 19E

PRIMARY VOLTAGE	SECONDARY VOLTAGE	TAPS
208 Δ	208Y/120	(A) 2-2 1/2% FCAN & 2-2 1/2% FCBN (B) 2-3% FCAN & 2-3% FCBN (C) 2-3 1/2% FCAN & 2-3 1/2% FCBN (D) 1-4% FCAN & 1-4% FCBN (E) 1-5% FCAN & 1-5% FCBN



(A)

VOLTS	CONNECTIONS	LINE LEADS
218	2 TO 3	H1, H2, H3
213	2 TO 5	H1, H2, H3
208	3 TO 4	H1, H2, H3
203	4 TO 5	H1, H2, H3
198	5 TO 6	H1, H2, H3
208Y/120		X0, X1, X2, X3

(B)

VOLTS	CONNECTIONS	LINE LEADS
220	2 TO 3	H1, H2, H3
214	2 TO 5	H1, H2, H3
208	3 TO 4	H1, H2, H3
202	4 TO 5	H1, H2, H3
196	5 TO 6	H1, H2, H3
208Y/120		X0, X1, X2, X3

(C)

VOLTS	CONNECTIONS	LINE LEADS
223	2 TO 3	H1, H2, H3
215	2 TO 5	H1, H2, H3
208	3 TO 4	H1, H2, H3
201	4 TO 5	H1, H2, H3
193	5 TO 6	H1, H2, H3
208Y/120		X0, X1, X2, X3

(D)

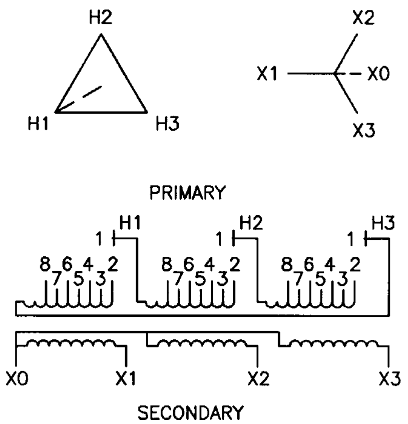
VOLTS	CONNECTIONS	LINE LEADS
216	2 TO 3	H1, H2, H3
208	3 TO 4	H1, H2, H3
200	4 TO 5	H1, H2, H3
208Y/120		X0, X1, X2, X3

(E)

VOLTS	CONNECTIONS	LINE LEADS
218	2 TO 3	H1, H2, H3
208	3 TO 4	H1, H2, H3
198	4 TO 5	H1, H2, H3
208Y/120		X0, X1, X2, X3

Diagram #20

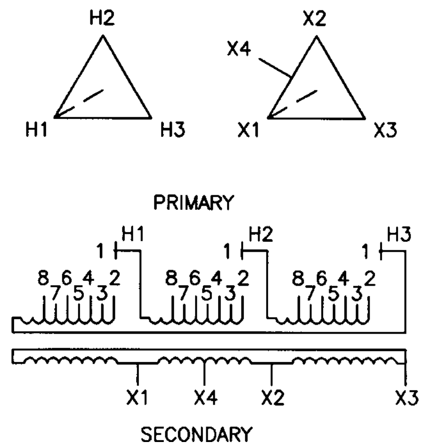
PRIMARY VOLTAGE	SECONDARY VOLTAGE	TAPS
480 Δ	480Y/277	2-2 1/2% FCAN & 4-2 1/2% FCBN



VOLTS	CONNECTIONS	LINE LEADS
504	1 TO 2	H1, H2, H3
492	1 TO 3	H1, H2, H3
480	1 TO 4	H1, H2, H3
468	1 TO 5	H1, H2, H3
456	1 TO 6	H1, H2, H3
444	1 TO 7	H1, H2, H3
432	1 TO 8	H1, H2, H3
480Y/277		X0, X1, X2, X3

Diagram #21

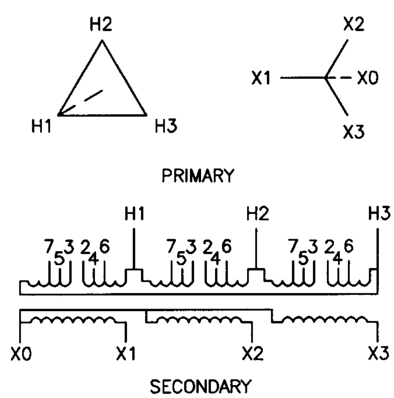
PRIMARY VOLTAGE	SECONDARY VOLTAGE	TAPS
480 Δ	240/120 LT.	2-2 1/2% FCAN & 4-2 1/2% FCBN



VOLTS	CONNECTIONS	LINE LEADS
504	1 TO 2	H1, H2, H3
492	1 TO 3	H1-, H2, H3
480	1 TO 4	H1, H2, H3
468	1 TO 5	H1, H2, H3
456	1 TO 6	H1, H2, H3
444	1 TO 7	H1, H2, H3
432	1 TO 8	H1, H2, H3
240		X1, X2, X3

Diagram #20A

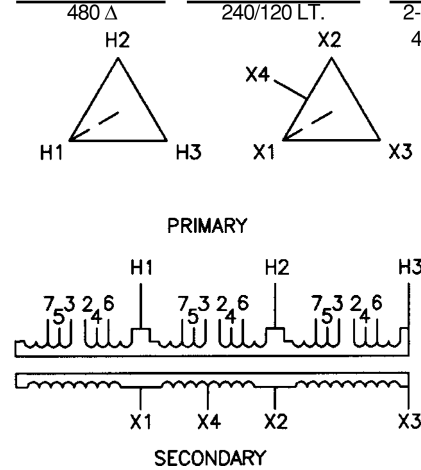
PRIMARY VOLTAGE	SECONDARY VOLTAGE	TAPS
480 Δ	480Y/277	2-2 1/2% FCAN & 4-2 1/2% FCBN



VOLTS	CONNECTIONS	LINE LEADS
504	2 TO 3	H1, H2, H3
492	2 TO 5	H1, H2, H3
480	3 TO 4	H1, H2, H3
468	4 TO 5	H1, H2, H3
456	5 TO 6	H1, H2, H3
444	4 TO 7	H1, H2, H3
432	6 TO 7	H1, H2, H3
480Y/277		X0, X1, X2, X3

Diagram #21A

PRIMARY VOLTAGE	SECONDARY VOLTAGE	TAPS
480 Δ	240/120 LT.	2-2 1/2% FCAN & 4-2 1/2% FCBN

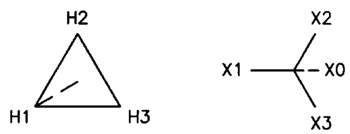


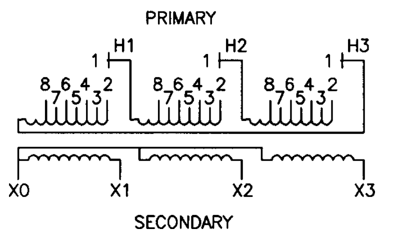
VOLTS	CONNECTIONS	LINE LEADS
504	2 TO 3	H1, H2, H3
492	2 TO 5	H1, H2, H3
480	3 TO 4	H1, H2, H3
468	4 TO 5	H1, H2, H3
456	5 TO 6	H1, H2, H3
444	4 TO 7	H1, H2, H3
432	6 TO 7	H1, H2, H3
240		X1, X2, X3

Wiring Diagrams

Diagram #22

PRIMARY VOLTAGE	SECONDARY VOLTAGE	TAPS
480 Δ	208Y/120	2-2 1/2% FCAN & 4-2 1/2% FCBN

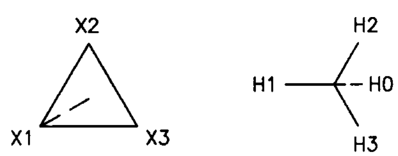


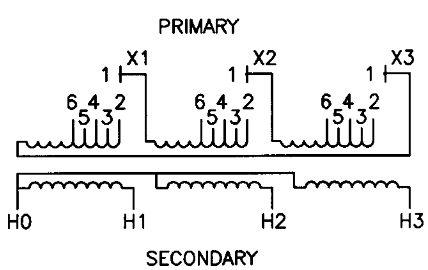


VOLTS	CONNECTIONS	LINE LEADS
504	1 TO 2	H1, H2, H3
492	1TO 3	H1, H2, H3
480	1 TO 4	H1, H2, H3
468	1 TO 5	H1, H2, H3
456	1 TO 6	H1, H2, H3
444	1 TO 7	H1, H2, H3
432	1 TO 8	H1, H2, H3
208Y/120		X0, X1, X2, X3

Diagram #23

PRIMARY VOLTAGE	SECONDARY VOLTAGE	TAPS
208 Δ	480Y/277	2-2 1/2% FCAN & 2-2 1/2% FCBN

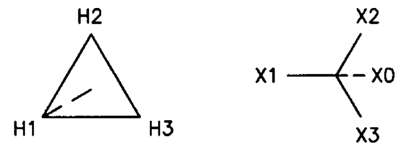


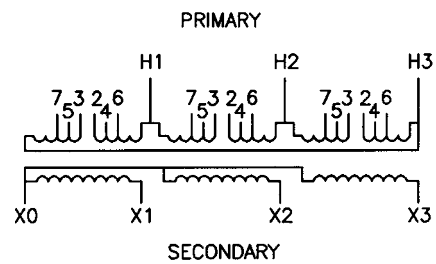


VOLTS	CONNECTIONS	LINE LEADS
218	1 TO 2	X1, X2, X3
213	1 TO 3	X1, X2, X3
208	1 TO 4	X1, X2, X3
203	1 TO 5	X1, X2, X3
198	1 TO 6	X1, X2, X3
480Y/277		H0, H1, H2, H3

Diagram #22A - 22B

PRIMARY VOLTAGE	SECONDARY VOLTAGE	TAPS
480 Δ	208Y/120	(A) 2-2 1/2 % FCAN & 4-2 1/2% FCBN (B) 2-3% FCAN & 2-3% FCBN





(A)

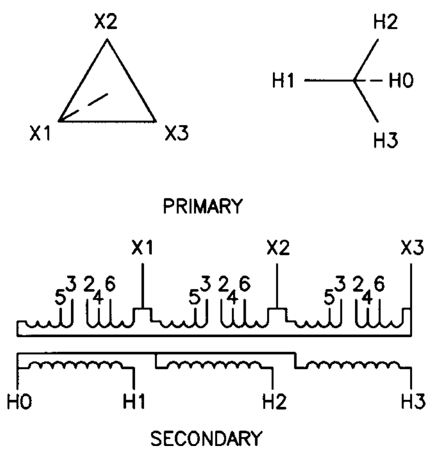
VOLTS	CONNECTIONS	LINE LEADS
504	2 TO 3	H1, H2, H3
492	2 TO 5	H1, H2, H3
480	3 TO 4	H1, H2, H3
468	4 TO 5	H1, H2, H3
456	5 TO 6	H1, H2, H3
444	4 TO 7	H1, H2, H3
432	6 TO 7	H1, H2, H3
208Y/120		X0, X1, X2, X3

(B)

VOLTS	CONNECTIONS	LINE LEADS
509	2 TO 3	H1, H2, H3
494	2 TO 5	H1, H2, H3
480	3 TO 4	H1, H2, H3
466	4 TO 5	H1, H2, H3
451	5 TO 6	H1, H2, H3
208Y/120		X0, X1, X2, X3

Diagram #23A-23E

PRIMARY VOLTAGE	SECONDARY VOLTAGE	TAPS
208	480Y/277	(A) 2-2 1/2 % FCAN & 2-2 1/2% FCBN
		(B) 2-3% FCAN & 2-3% FCBN
		(C) 2-3 1/2% FCAN & 2-3 1/2% FCBN
		(D) 1-4% FCAN & 1-4% FCBN
		(E) 1-5% FCAN & 1-5% FCBN



(A)

VOLTS	CONNECTIONS	LINE LEADS
218	2 TO 3	X1, X2, X3
213	2 TO 5	X1, X2, X3
208	3 TO 4	X1, X2, X3
203	4 TO 5	X1, X2, X3
198	5 TO 6	X1, X2, X3
480Y/277		HO, H1, H2, H3

(B)

VOLTS	CONNECTIONS	LINE LEADS
220	2 TO 3	X1, X2, X3
214	2 TO 5	X1, X2, X3
208	3 TO 4	X1, X2, X3
202	4 TO 5	X1, X2, X3
196	5 TO 6	X1, X2, X3
480Y/277		HO, H1, H2, H3

(C)

VOLTS	CONNECTIONS	LINE LEADS
223	2 TO 3	X1, X2, X3
215	2 TO 5	X1, X2, X3
208	3 TO 4	X1, X2, X3
201	4 TO 5	X1, X2, X3
193	5 TO 6	X1, X2, X3
480Y/277		HO, H1, H2, H3

(D)

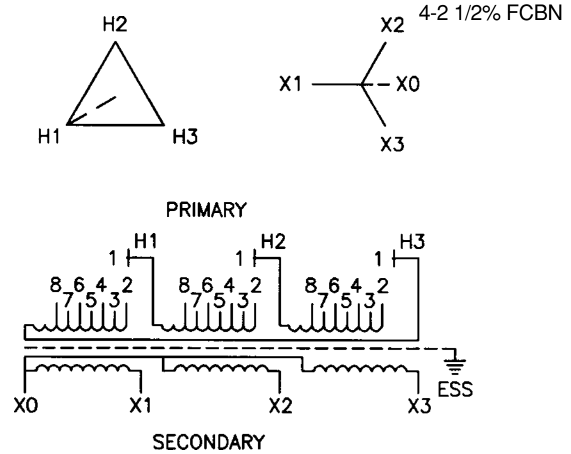
VOLTS	CONNECTIONS	LINE LEADS
216	2 TO 3	X1, X2, X3
208	3 TO 4	X1, X2, X3
200	4 TO 5	X1, X2, X3
480Y/277		HO, H1, H2, H3

(E)

VOLTS	CONNECTIONS	LINE LEADS
218	2 TO 3	X1, X2, X3
208	3 TO 4	X1, X2, X3
198	4 TO 5	X1, X2, X3
480Y/277		HO, H1, H2, H3

Diagram #24

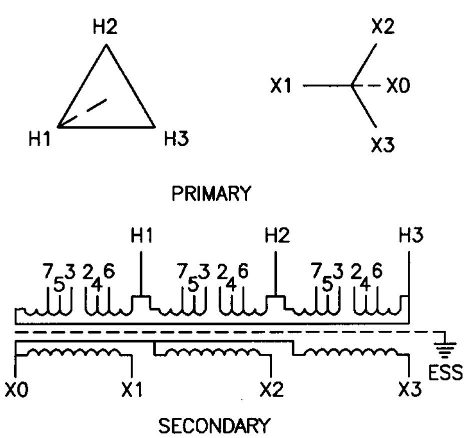
PRIMARY VOLTAGE	SECONDARY VOLTAGE	TAPS
600 Δ	208Y/120	2-2 1/2% FCAN & 4-2 1/2% FCBN



VOLTS	CONNECTIONS	LINE LEADS
630	1 TO 2	H1, H2, H3
615	1 TO 3	H1, H2, H3
600	1 TO 4	H1, H2, H3
585	1 TO 5	H1, H2, H3
570	1 TO 6	H1, H2, H3
555	1 TO 7	H1, H2, H3
540	1 TO 8	H1, H2, H3
208Y/120		X0, X1, X2, X3

Diagram #24A

PRIMARY VOLTAGE	SECONDARY VOLTAGE	TAPS
600 Δ	208Y/120	2-2 1/2% FCAN & 4-2 1/2% FCBN



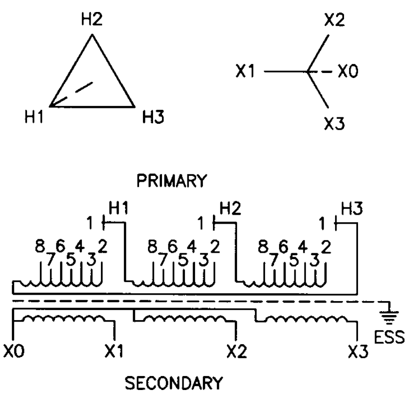
VOLTS	CONNECTIONS	LINE LEADS
630	2 TO 3	H1, H2, H3
615	2 TO 5	H1, H2, H3
600	3 TO 4	H1, H2, H3
585	4 TO 5	H1, H2, H3
570	5 TO 6	H1, H2, H3
555	4 TO 7	H1, H2, H3
540	6 TO 7	H1, H2, H3
208Y/120		X0, X1, X2, X3

Diagram #25

Not Used

Diagram #26

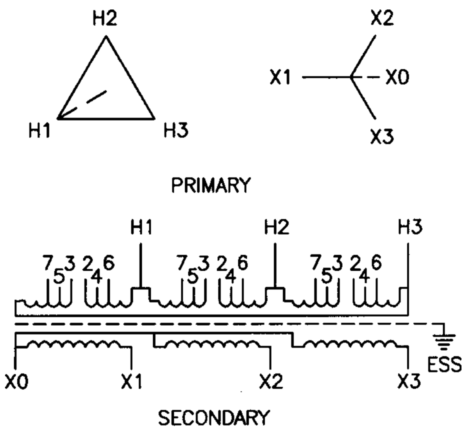
PRIMARY VOLTAGE	SECONDARY VOLTAGE	TAPS
240 Δ	208Y/120	2-2 1/2% FCAN & 4-2 1/2% FCBN



VOLTS	CONNECTIONS	LINE LEADS
252	1 TO 2	H1, H2, H3
246	1 TO 3	H1, H2, H3
240	1 TO 4	H1, H2, H3
234	1 TO 5	H1, H2, H3
228	1 TO 6	H1, H2, H3
222	1 TO 7	H1, H2, H3
216	1 TO 8	H1, H2, H3
208Y/120		X0, X1, X2, X3

Diagram #26A - 26D

PRIMARY VOLTAGE	SECONDARY VOLTAGE	TAPS
240 Δ	208Y/120	(A) 2-2 1/2 % FCAN & 4-2 1/2% FCBN (B) 2-3% FCAN & 2-3% FCBN (C) 2-3 1/2% FCAN & 2-3 1/2% FCBN (D) 1-4% FCAN & 1-4% FCBN



(A)

VOLTS	CONNECTIONS	LINE LEADS
252	2 TO 3	H1, H2, H3
246	2 TO 5	H1, H2, H3
240	3 TO 4	H1, H2, H3
234	4 TO 5	H1, H2, H3
228	5 TO 6	H1, H2, H3
222	4 TO 7	H1, H2, H3
216	6 TO 7	H1, H2, H3
208Y/120		X0, X1, X2, X3

(B)

VOLTS	CONNECTIONS	LINE LEADS
254	2 TO 3	H1, H2, H3
247	2 TO 5	H1, H2, H3
240	3 TO 4	H1, H2, H3
233	4 TO 5	H1, H2, H3
226	5 TO 6	H1, H2, H3
208Y/120		X0, X1, X2, X3

(C)

VOLTS	CONNECTIONS	LINE LEADS
256	2 TO 3	H1, H2, H3
248	2 TO 5	H1, H2, H3
240	3 TO 4	H1, H2, H3
232	4 TO 5	H1, H2, H3
224	5 TO 6	H1, H2, H3
208Y/120		X0, X1, X2, X3

(D)

VOLTS	CONNECTIONS	LINE LEADS
250	2 TO 3	H1, H2, H3
240	3 TO 4	H1, H2, H3
230	4 TO 5	H1, H2, H3
208Y/120		X0, X1, X2, X3

GLOSSARY

A

Air-Cooled - A transformer cooled by the natural circulation of air over and/or through the core and coils or forced air by using fans.
Ambient Noise Level - The sound level of the surrounding area of a transformer as measured in decibels.
Ambient Temperature - Temperature of the surrounding air which comes in contact with the transformer.
Ampere - Unit of current flow.
ANSI - American National Standards Institute.
ANSI-61 - A light grey paint used on dry type transformers.
ASTM - American Society for Testing Materials.
Autotransformer - A transformer in which at least two windings have a common section.

B

Banked Transformers - When two or more single-phase transformers are connected together to supply a three-phase load.
BIL -Acronym for basic impulse insulation levels, a specific insulation level expressed in kilovolts of the crest value of a standard lightning impulse.
Buck-Boost Transformers -An insulating transformer which has two primary windings and two secondary windings. These windings can be interconnected so that the transformer will be changed from an insulating transformer to a "bucking" or "boosting" autotransformer.

C

C° - Temperature in degrees Centigrade (Celsius).
Cast-coil Transformer - A transformer with coils cast in an epoxy resin.
Center Tap - A reduced-capacity tap at the mid-point in a winding.
Coil - A number of turns of wire wound on a form.
Conductor Losses - Losses caused by the resistance of a transformer winding, measured at 25, 50, 75, and 100 per cent of load.
Continuous Duty - A requirement of service that demands operation at a constant load for an indefinite period.
Continuous Rating - The load that a transformer can handle indefinitely without exceeding the specified temperature rise.
Control Transformer - A transformer which is designed for good voltage regulation characteristics when low power factor, large inrush currents are drawn.
Core - The steel which carries the magnetic flow.
Core Loss - Losses caused by a magnetization of the core and its resistance to magnetic flux.
Current Transformer - A transformer designed to have its primary winding connected in series with the circuit and used for transforming current into a value suitable for measurement of control.

D

Decibel - (DB) The standard unit for the measurement of sound intensity.
Delta - (Δ) A standard three-phase connection with the ends of each phase winding connected in series to form a closed loop, 120 degrees from the other.
Delta-Wye - (Δ-Y) A term used indicating the method of connection for both primary (Δ) and secondary (Y) windings of a three-phase transformer bank.
Dielectric Test - A test conducted at higher than rated nameplate voltage to determine the effectiveness of insulating materials and electrical clearances.
Distribution Transformer - A transformer for transferring electrical energy from a primary distribution circuit to a consumer service circuit.
Dry-Type Transformer - A transformer that is cooled by air as opposed to a transformer that is immersed in oil.
Dual Winding - A winding that consists of two separate windings connected in series to handle a specific voltage and KVA, or in parallel to handle the same KVA at one half the series connected voltage.

E

Electrostatic Shield - A grounded conductor sheet placed between the primary and secondary winding to reduce or eliminate line-to-line or line-to-ground noise.
Exciting Current - (No-Load Current) Current which flows in any winding used to excite the transformer when all other windings are open-circuited, expressed in per cent of the rated current of a winding.

F

FCAN - Full capacity above normal taps.
FCBN - Full capacity below normal taps.
Fan Cooled - A mechanical means of accelerating heat dissipation to lower the temperature rise of the transformer.
Frequency - The number of times an AC voltage will alternate from positive to negative and back again within a specified period of time, expressed in cycles per second and identified as Hz.
Full Capacity Tap - A tap designed to deliver the rated capacity of the transformer.

G

Ground - Connected to earth or to some conducting body that serves in place of earth.
Grounding Transformer - A special three-phase autotransformer for establishing a neutral on a three-wire delta secondary. (Also referred to as a "zig-zag transformer".)

H

Hertz - A term meaning cycles per second, abbreviated Hz.
High Voltage Windings - A term applied to two winding transformers, designates the winding with greater voltage, identified by H1, H2, etc.
Hi Pot - A standard test on dry-type transformers consisting of extra-high potentials (high voltage) impressed on the windings.

I

IEEE - Institute of Electrical and Electronic Engineers.
Impulse Tests- Dielectric tests consisting of the application of a high-frequency steep-wave-front voltage between windings and between windings and ground. (Used to determine BIL.)
Impedance - The vector sum of resistance and reactance which limits the current flow in an AC circuit. Impedance is identified in percentage and is used to determine the interrupting capacity of circuit breakers which protect the primary circuit. (Symbol Z)
Induced Potential Test - A standard dielectric test which verifies the integrity of insulating materials and electrical clearances between turns and layers of a transformer winding.
Insulating Materials - Those materials used to electrically insulate the transformer windings from each other and ground. (Rated 80° C rise, 115° C rise and 150° C rise.)
Insulating Transformer - A transformer that insulates the primary from the secondary winding. (Also called an isolating transformer.)

K

KVA - Kilovolt Ampere rating designates the output which a transformer can deliver at rated voltage and frequency without exceeding a specified temperature rise.

L

Line Conditioner - Portable or hard wire devices that will stabilize voltage, suppress electrical noise and act as surge suppressors against lightning discharges.
Liquid Transformer - A transformer with core and coils immersed in liquid (as opposed to a dry-type transformer).
Load - The KVA or VA requirement which the transformer must supply.
Load Losses - The losses which are the result of a current flowing to the load. Load losses would include all losses incurred above and beyond the no-load losses.

M

Mid-tap - A reduced-capacity tap midway in a winding, usually the secondary.
Multiple Winding - A winding which consists of two or more sections that can be paralleled for a specific mode of operation.

N

NEC- National Electric Code.
NEMA - National Electrical Manufacturers Association.
Noise Isolation Transformer - A transformer that is designed to provide both common and transverse mode noise attenuation.
Noise Level - The relative intensity of sound, measured in db.
No-Load Losses - The losses incurred when a transformer is excited but without a load connected to the secondary. These include core loss, dielectric loss, and exciting current I^2R loss.

O

OSHA - Occupational Safety and Health Act. Federal regulation setting minimum safety standards for compliance in industrial and commercial installations.

P

Parallel Operation - Transformers may be connected in parallel, provided that the electrical characteristics are suitable for such operation.
Percent IR - (%IR) Percent Resistance. The voltage drop due to conductor resistance at rated current expressed in percent of rated voltage.
Percent IX - (%IX) Percent Reactance. The voltage drop due to reactance at rated current expressed in percent of rated voltage.
Percent IZ - (%IZ) Percent Impedance. The voltage drop due to impedance at rated current expressed in percent of rated voltage.
Phase - Classification of an AC circuit. Usually, circuits are rated single-phase two wire or three wire or three-phase three wire or four wire. Single-phase transformers can be used on a three-phase source when two wires of the three-phase system are connected to the primary of the transformer. The secondary will be single-phase.
Polarity Tests - A standard test on transformers to determine instantaneous direction of the voltages in the primary compared to the secondary.
Potential Transformer - A transformer that is designed to have its primary winding connected parallel with a circuit and used for transforming voltage to a value suitable for measurement or control.
Power Conditioning - The means to correct voltage fluctuations and electrical noise problems common to incoming power sources.
Power Factor - The ratio of watts to volt amperes in a circuit. (% watts/VA)
Primary Voltage - The input circuit voltage for which the primary winding is designed.

R

Rating - The characteristics such as volt-ampere capacity, voltages, frequency and temperature rise that a transformer is designed to.
Ratio Test - A standard test of transformers to determine the ratio of the primary to the secondary voltage.
Reactance - A component of impedance produced by either inductance or capacitance in an AC circuit.
Reactor - A device for introducing inductive reactance into a circuit for motor starting, operating transformers in parallel and controlling current.
Regulation - The per cent change in output voltage from full load to no-load.

S

Scott Connection - A transformer connection usually used to get a two-phase output from the secondary of a transformer with a three-phase input to the primary or vice versa. It can also be used to provide three-phase to three-phase transformation.
Secondary Voltage Rating - Designates the load-circuit voltage for which the secondary winding is designated.
Series/multiple - A winding of two similar coils that can be connected for series operation or multiple (parallel) operation.
Star Connection - Same as WYE connection.
Step Down Transformer - High voltage winding is connected to the power source input and the low voltage winding to the output load.
Step Up Transformer - Low voltage winding is connected to the power source (input) and the high voltage winding is connected to the output load.

T

T-Connection - A Scott connected three-phase transformer utilizing two primary and two secondary coils.
Tap - A connection in a transformer winding which has the effect of changing the nominal voltage ratio of the transformer. (Taps are usually placed on the high voltage winding to correct for high or low voltage conditions found on the low voltage output side.)
Temperature Rise - The increase over ambient temperature of the winding due to energizing and loading.
Total Losses - Losses represented by the sum of the no-load and the load losses.
Transformer - A transformer is a static electrical device, which by electro-magnetic induction, transfers electrical energy from one circuit to another circuit, usually with changed values of voltage and current.

U

UL - Underwriters' Laboratories. Establishes standards for transformers.
Universal Taps - A combination of six primary voltage taps consisting of 4-2 1/2% FCBN and 2-2 1/2% FCAN.

V

Volt Amperes - The current flowing in a circuit multiplied by the voltage of that circuit. (The output rating of a transformer.)

W

WYE Connection (Y) - A three-phase connection in which similar ends of each phase winding are connected together at a common point which forms the electrical neutral and is often grounded.

Z

Zig-Zag Transformer - Commonly used term for a grounding transformer.

Old/New Numbering Cross Reference

Old Number	New Number	Page No.
50003	SE2N.250F	16
50004	SE2N.500F	16
50005	SE2N.750F	16
50006	SE2N1F	16
50007	SE2N1.5F	16
50008	SE2N2F	16
50009	SE2N3FS	16
50010	SE2N5FS	16
50011	SE2N7.5F	16
50012	SE2N10F	16
50013	SE2N15F	16
50030	SE481D1F	17
50031	SE481D1.5F	17
50032	SE481D2F	17
50033	SE481D3F	17
50034	SE481D5F	17
50035	SE481D7.5F	17
50036	SE481D10F	17
50037	SE481D15F	17
50050-M	S2T15	16
50051-M	S2T25	16
50052-M	S2T37	16
50054-M	S2T75	16
50055-M	S2T100	16
50056-M	S2T167	16
50062-M	S61T37S	17
50063-M	S61T50S	17
50064-M	S61T75S	17
50065-M	S61T100S	17
50066-M	S61T167S	17
50103	SB12N.250F	12
50104	SB12N.500F	12
50105	SB12N.750F	12
50106	SB12N1F	12
50107	SB12N1.5F	12
50108	SB12N2F	12
50109	SB12N3F	12
50110	SB12N5F	12
50203	SB16N.250F	12
50204	SB16N.500F	12
50205	SB16N.750F	12
50206	SB16N1F	12
50207	SB16N1.5F	12
50208	SB16N2F	12
50209	SB16N3F	12
50210	SB16N5F	12
50300	TE4D3F	20
50301	TE4D6F	20
50302	TE4D9F	20
50340-M	T4T15	20
50341-M	T4T25	20
50342-M	T4T30	20
50343-M	T4T37	20
50344-M	T4T45	20
50345-M	T4T50S	20
50347-M	T4T75	20
50349-M	T4T112	20
50350-M	T4T150	20
50352-M	T4T225	20
50353-M	T4T300	20
50355-M	T4T500	20
50357-M	T4T750	20
50359-M	T4J1000	20
50360-LM	T43T15	21
50361-ES	T43T30S	21
50361-LM	T43T30	21
50362-ES	T43T45S	21
50362-LM	T43T45	21
50363-ES	T43T75S	21
50363-LM	T43T75	21
50364-LM	T43T112	21
50364-ES	T43T112S	21
50365-ES	T43T150S	21
50365-LM	T43T150	21
50366-LM	T43T225	21
50367-LM	T43T300	21
50368-LM	T43T500	21
50610	SE61D1FS	17
50611	SE61D1.5FS	17
50612	SE61D2FS	17
50613	SE61D3FS	17
50614	SE61D5FS	17
50615	SE61D7.5FS	17
50616	SE61D10FS	17
50617	SE61G15FS	17
51340-F	T4T15F	23
51341-F	T4T25F	23
51342-F	T4T30F	23
51343-F	T4T37F	23
51344-F	T4T45F	23
51345-F	T4T50F	23
51347-F	T4T75F	23
51349-F	T4T112F	23
51350-F	T4T150F	23
51352-F	T4T225F	23
51353-F	T4T300F	23
51355-F	T4T500F	23
51360-F	T43T15F	24
51361-F	T43T30F	24
51362-F	T43T45F	24
51363-F	T43T75F	24
51364-F	T43T112F	24
51365-F	T43T150F	24
51366-F	T43T225F	24
51367-F	T43T300F	24
51368-F	T43T500F	24
52340-B	T4T15B	26
52341-B	T4T25B	26
52342-B	T4T30B	26
52343-B	T4T37B	26
52344-B	T4T45B	26
52345-B	T4T50B	26
52347-B	T4T75B	26
52349-B	T4T112B	26
52350-B	T4T150B	26
52352-B	T4T225B	26
52353-B	T4T300B	26
52355-B	T4T500B	26
52360-B	T43T15B	27
52361-B	T43T30B	27
52362-B	T43T45B	27
52363-B	T43T75B	27
52364-B	T43T112B	27
52365-B	T43T150B	27
52366-B	T43T225B	27
52367-B	T43T300B	27
54340-S	T204H15	19
54341-S	T204H25	19
54342-S	T204H30	19
54344-S	T204H45	19
54347-S	T204H75	19
54349-S	T204H112	19
54350-S	T204H150	19
54352-S	T204J225	19
54353-S	T204L300	19
54355-S	T204E500	19
54357-S	T204E750	19
56340-ES	T202H15S	19
56341-ES	T202H25S	19
56342-ES	T202H30S	19
56344-ES	T202H45S	19
56347-ES	T202H75S	19
56349-ES	T202H112S	19
56350-ES	T202H150S	19
56352-ES	T202J225S	19
56353-ES	T202L300S	19
56355-ES	T202E500S	19
57340-ES	T4T15S	20
57342-ES	T4T30S	20
57344-ES	T4T45S	20
57347-ES	T4T75S	20
57349-ES	T4T112S	20
57350-ES	T4T150S	20
57352-ES	T4T225S	20
57353-ES	T4T300S	20
57355-ES	T4T500S	20
57357-ES	T4T750S	20

Catalog Number Index

Catalog Number Index

Catalog Number Index

Notes

Other Products Available

600 Volt and Below Dry Type Transformers

- Industrial control transformers
- Encapsulated/compound filled transformers
- Buck-Boost transformers
- General purpose, lighting and control power transformers
- Open core and coil transformers
- Electrostatically shielded transformers
- Motor drive isolation transformers
- Energy saving 115° C and 80° C designs
- K-Factor transformers
- Wall mounting, dripshield and terminal lug accessories

High Voltage Dry Type Transformers

- Core and coil transformers
- General purpose transformers
- Outdoor designs
- Unit substation transformers
- Motor drive isolation transformers
- K-Factor transformers
- Padmounted transformers
- Vacuum pressure impregnation (VPI) transformers
- VPI/epoxy shielded transformers
- UL® listed high voltage transformers

Specialty Transformers

FP will custom engineer your specialty transformer requirements.

EPA Energy Star Compliant Transformers

- Commercial and industrial low voltage transformers compliant with EPA Energy Star Efficiency Guidelines.

FEDERAL PACIFIC™

P. O. Box 8200
Bristol, Virginia 24203-8200
(276) 669-4084 • FAX (276) 669-1869
www.federalpacific.com

FPTS-RTB-1101