

Guide to this section

This information is provided to ensure you select the unit that best suits your needs and to show you how to maintain it for a long life.

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Our full list of transformer types

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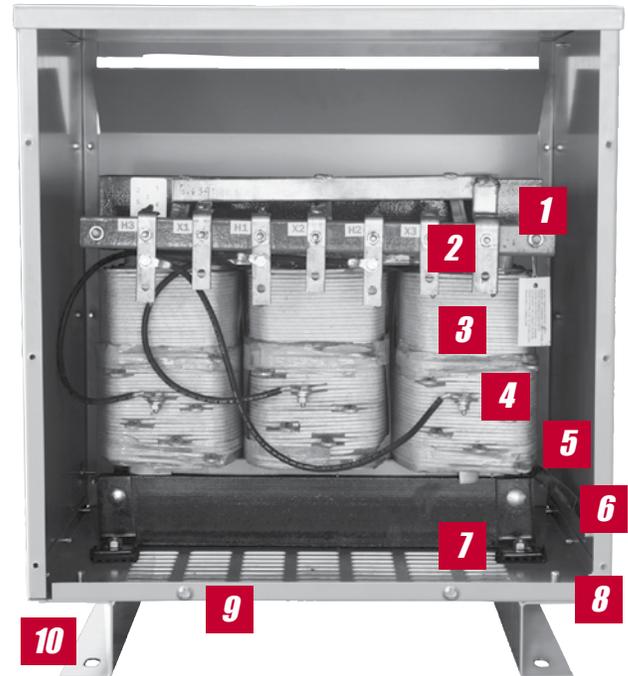
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Transformer Construction

Jefferson Electric transformers are built to the highest industry standards. Each unit is fully tested before it is shipped. We stand behind each unit we sell with a strong customer service department and Application Engineers knowledgeable in the use of transformers.



- 1** Fiberglass terminal board
- 2** Tightly stacked electrical steel core provides lower losses and low noise
- 3** Standard aluminum coils
- 4** Front loop taps are staggered for easy connection
- 5** Flexible core ground strap
- 6** Ground stud bolt
- 7** Vibration isolation pads provide quiet operation
- 8** Side or bottom conduit access for convenient mounting options
- 9** Bolt locations to hold front cover during installation loosen, don't remove
- 10** Easy access mounting holes

General Dry Type Transformers

Following is a list of our product line. For more information see the catalog section noted.

1 Single-Phase Ventilated

15 to 667 kVA

For all general loads, indoors or out, including lighting, industrial and commercial applications. Units may be banked for three phase operation.

2 Three-Phase Ventilated

15 to 2,500 kVA

For all general three phase loads, indoors or out, including lighting, industrial and commercial applications.

3 Non-Linear Three-Phase

15 to 1,000 kVA

Built to handle electronic loads to meet non-linear demands caused by modern office equipment. For indoor and outdoor applications.

4 Drive Isolation

3 to 990 kVA

For industrial and commercial applications with SCR-controlled adjustable speed motor drives, and AC adjustable frequency or DC drives.

5 Totally Enclosed Non-Ventilated

15 to 500 kVA

Single- and three-phase designed for use in challenging manufacturing environments.

6 Industrial Control

50 to 5,000 VA

For control panels, conveyor systems, machine tooling equipment, commercial sewing machines, pumping system panels, and commercial air conditioning applications.

7 Single-Phase Encapsulated

50 VA to 25 kVA

For all general loads, indoors or out, including lighting, industrial and commercial applications. Units may be banked for three phase operation.

Pool & Spa Lighting

Lamp Watts 100 through 1,000

For low voltage circuits near water or other shock hazards.

8 Three-Phase Encapsulated

3 to 75 kVA

For all general three phase loads, indoors or out, including lighting, industrial and commercial applications.

9 Buck-Boost

50 VA to 10 kVA

For correcting voltage line drops, landscape lighting, low voltage lighting, international voltage adaptation and motor applications. Buck-boost transformers do not compensate for fluctuating line voltages.

10 Class I Division 2 Encapsulated transformers

1 to 25 kVA, Single Phase

3 to 75 kVA, Three Phase

Class I Division 2 units are key in hazardous locations in maintaining a safe environment.

11 18-Pulse

15 to 500 HP

Multi-pulse units are key in designing systems to mitigate the harmonic distortion generated by variable frequency drives and other digital equipment.

12 Medium Voltage

5 kV to 25 kV Class

Designs for industrial facilities and process lines, drilling and mining installations and commercial power applications. Each unit customized to your specifications.

13 Power Quality

13a HMT / Zig-Zag 15 to 1,500 VA

These transformers cancel 3rd harmonic currents in the secondary winding eliminating them from the primary winding.

13b Harmonic Suppression System (HSS)

This system eliminates, not accommodates, the 3rd harmonic current, removing it from the distribution system.

■ Medium Voltage Industrial Control

.5 to 5 kVA

See website for more information

For the demands of industrial control applications, even rugged conditions.

Specifying the Correct Transformer

Contact an Application Engineer at 800-892-3755 if you have questions regarding performance, design or installation. You can email them at technical_services@jeffersonelectric.com

- Transformer size is determined by the kVA of the load.
- Load voltage, or secondary voltage, is the voltage needed to operate the load.
- Line voltage, or primary voltage, is the voltage from the source.
- Single-Phase has two lines of AC power.
- Three-Phase has three lines of AC power, each line 120 degrees out of phase with the other two.
- kVA is kilovolt ampere or thousand volt amperes. This is how transformers are rated.

NOTE: If motors are started more than once per hour, increase minimum transformer kVA by 20%.

To determine the size of the transformer you need, use this handy formula, or the chart at the right.

Determine the Load Voltage

Load Voltage =

Determine the Load Current (Amps)

Load Current/Amps =

Determine the Line Voltage

Line Voltage =

Size and Select a Transformer

1. Determine the proper kVA based on the required load voltage, line voltage and load current.

For an example: Load voltage = 480 volts,
Load current = 80 Amps and Line voltage = 208 volts.
Using the calculation yields a 66 kVA transformer.

Transformer Selection Formulas

Single-Phase Transformers

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

Plug your numbers into the formula:

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

Three-Phase Transformers

$$\frac{\text{Volts} \times \text{Amps} \times 1.732}{1000} = \text{kVA}$$

Plug your numbers into the formula:

$$\frac{\text{Volts } \boxed{} \times \text{Amps } \boxed{} \times 1.732}{1000} = \boxed{} \text{ kVA}$$

2. Choose the appropriate style of transformer for the application. See page 14-2. For example, if you need a transformer for a three phase industrial application you can choose the Three Phase Ventilated style.
3. Go to the appropriate section in the catalog.
4. Select the options such as mounting brackets to assist your installation.

Full Load Currents (in Amperes), Voltage (line to line)

Single-Phase Transformers

kVA	120V	208V	240V	277V	480V	600V
.50	.42	.24	.21	.18	.10	.08
.75	.63	.36	.31	.27	.16	.13
1.0	.83	.48	.42	.36	.21	.17
.15	1.25	.72	.63	.54	.31	.25
.25	2.08	1.20	1.04	.90	.52	.42
.50	4.16	2.40	2.08	1.8	1.04	.83
.75	6.25	3.60	3.13	2.7	1.56	1.25
1.0	8.3	4.8	4.2	3.6	2.1	1.7
1.5	12.5	7.2	6.2	5.4	3.1	2.5
2.0	16.7	9.6	8.3	7.2	4.2	3.3
3.0	25	14.4	12.5	10.8	6.2	5.0
5.0	41.7	24	20.8	18.0	10.4	8.3
7.5	62.5	36.1	31.2	27	15.6	12.5
10.0	83.4	48	41.6	36	20.8	16.7
15.0	125	72	62.5	54	31.2	25
25.0	208	120	104	90	52	41.7
37.5	312	180	156	135	78	62.5
50.0	417	240	208	180	104	83.5
75.0	625	361	312	270	156	125
100.0	834	480	416	361	208	167
167.0	1,396	805	698	602	349	279

Three-Phase Transformers

kVA	208V	240V	480V	600V
3	8.3	7.2	3.6	2.9
6	16.6	14.4	7.2	5.8
9	25	21.6	10.8	8.7
15	41.6	36.0	18.0	14.4
30	83	72	36	29
45	125	108	54	43
75	208	180	90	72
112.5	312	270	135	108
150	416	360	180	144
225	625	542	271	217
300	830	720	360	290
500	1,390	1,200	600	480
750	2,080	1,800	900	720

For other single-phase kVA ratings or voltages:

$$\text{Amperes} = \frac{\text{kVA} \times 1000}{\text{Volts}}$$

For other three-phase kVA ratings or voltages:

$$\text{Amperes} = \frac{\text{kVA} \times 1000}{\text{Volts} \times 1.732}$$

Source: EASA Handbook

Recommended Copper Wire and Transformer Size

HP	Transformer kVA	Distance — Motor to Transformer in Feet				
		100	150	200	300	500

Single-Phase Motors, 230V

1½	3	10	8	8	6	4
2	3	10	8	8	6	4
3	5	8	8	6	4	2
5	7-1/2	6	4	4	2	0
7½	10	6	4	3	1	0

HP	Volts	Transformer kVA	Distance — Motor to Transformer in Feet				
			150	150	200	300	500

Three-Phase Motors, 230 & 460V

1½	230	3	12	12	12	12	10
1½	460	3	12	12	12	12	12
2	230	3	12	12	12	10	8
2	460	3	12	12	12	12	12
3	230	5	12	10	10	8	6
3	460	5	12	12	12	12	10
5	230	7½	10	8	8	6	4
5	460	7½	12	12	12	10	8
7½	230	10	8	6	6	4	2
7½	460	10	12	12	12	10	8
10	230	15	6	4	4	4	1
10	460	15	12	12	12	10	8
15	230	20	4	4	4	2	0
15	460	20	12	10	10	8	6
20	230	Consult Local Power Company	4	2	2	1	000
20	460		10	8	8	6	4
25	230		2	2	2	0	000
25	460		8	8	6	6	4
30	230		2	1	1	00	0000
30	460		8	6	6	4	2
40	230		1	0	00	0000	300
40	460		6	6	4	2	0
50	230		1	0	00	0000	300
50	460		4	4	2	2	0
60	230		1	00	000	250	500
60	460		4	2	2	0	00
75	230		0	000	0000	300	500
75	460		4	2	0	00	000

Enclosures

Our standard enclosure is rated NEMA3R. Other enclosures are available. Let us help you specify the one to meet your exact needs.

NEMA Transformer Enclosure Definitions

Standard	Description
Type 1	General purpose – indoor.
Type 2	Drip-proof – indoor.
Type 3	Wind blown dust and water – indoor/outdoor.
Type 3R	Rainproof and sleet/ice resistant – outdoor.
Type 3S	Dust-tight, rain-tight, and sleet/ice proof – outdoor.
Type 4	Water-tight and dust-tight – indoor/outdoor.
Type 4X	Water-tight, dust-tight and corrosion resistant – outdoor.
Type 5	Dust-tight – indoor.
Type 6	Submersible, water-tight, dust-tight and sleet/ice resistant – indoor/outdoor.
Type 7	Class I, Group (S) A,B,C and/or D – indoor hazardous locations, air-break equipment
Type 8	Class I, Group (S) A,B,C and/or D – indoor hazardous locations
Type 9	Class II, Group (S) E,F and/or D – indoor hazardous locations - air-break equipment
Type 10	Bureau of Mines
Type 11	Drip-proof and corrosion resistant
Type 12	Industrial use dust-tight and drip-tight – indoor.
Type 13	Oil-tight and dust-tight – indoor.

Source: NEMA Pub. No. ST20

Transformer NEMA Maximum * Single- and Three-Phase db Ratings

kVA Rating	600V
0 - 9	40
10 - 50	45
51 - 150	50
151 - 300	55
301 - 500	60
501 - 700	62
701 - 1000	64

* K-Factor, low temp and special transformer sound rating = kVA of equivalent design at 150°C rise and K-1

Protective Equipment

The importance of protecting your power delivery system cannot be overstated. The system must be protected against short circuits, surges caused by lightning, switching and overheating. Equipment is available to provide this protection, but it must also be adequately sized and properly installed. Failure to do so could damage the transformer and invalidate its warranty.

Protective equipment includes circuit breakers and fuses.

The selection and placement of protective equipment within the system is the responsibility of the end user.

Circuit Breakers

When any component of a circuit fails, there is nothing to limit current flow except the resistance of the circuit conductors and the resistance of the fault itself. The currents in these situations can be extremely large and destructive, making it imperative to interrupt the circuit as quickly as possible.

Circuit breakers are designed to react to a fault by making a physical separation in the current carrying or conducting element by inserting an insulating medium. Breakers come in different types, depending on the insulating medium used. While the most common insulation is oil, air is used in some 600 Volt class circuits. For higher voltages and larger capacities, the insulating medium might be a vacuum or an inert gas such as sulphur hexafluoride.

Specifications for a circuit breaker will depend on the operating voltage of the circuit, the normal operating or maximum load current, and the maximum abnormal or fault current to be interrupted.

Circuit breakers are rated in kVA or mVA and express the ability of the breaker to withstand short circuit forces.

Circuit breakers must withstand large inrush currents that result when voltage is initially switched on. These currents can be 20 to 30 times the rated transformer current even with no-load. Therefore, breakers must have built-in time delay for the first 5 to 10 cycles to avoid tripping under “turn-on” currents.

Fuses

The most common protective device in use, the fuse is basically a circuit breaker that works only once and then must be replaced. When current exceeds the predetermined current value, a fusible link melts, opening the circuit.

When voltage is initially switched on, a large inrush current results, being greatest in the first half-cycle of operation, or approximately .01 second. This current becomes less severe over the next few cycles, or approximately .1 second until the transformer is operating normally. Because of inrush current, fuses are often selected to withstand as much as 25 times primary rated current for .01 second, and 12 times primary rated current for .1 second.

Storage should be avoided, but if this is not possible, the transformer must be protected against moisture and contaminants.

Condensation and moisture can be reduced with heaters. If the transformer has been subjected to moisture, it should be baked out before energizing. This is especially important in transformers of 5 kV or higher.

Fuse Selection

The tables provide guidance for selecting fuses when the maximum voltage in the circuit is 600 Volts or less. These tables are included in Article 450-3 of the National Electrical Code covering over-current protection of transformers.

If primary protection only is required, use Table 1. If both primary and secondary protection are required, refer to Table 2.

IMPORTANT: *These tables are to be used as a guide only. The final determination of application is the responsibility of the end user.*

Table 1—Primary Fuse Only

Transformer Primary Amperes	Maximum Primary Fuse % Rating
9 or more	125*
2 or 9	167
Less than 2	300

If 125% does not correspond to a standard ampere rating, the next higher standard rating described in NEC Article 240-6 shall be permitted.

Primary Fuse Selection

Primary fuse selection is made according to rated primary current (I_{pri}). To determine I_{pri}, the transformer rating (VA or kVA) and primary voltage (V_{pri}) must be known as well as whether the transformer is single- or three-phase. With this information, use the appropriate formula to determine I_{pri}.

Once I_{pri} is known, select fuses according to or 2 above.

Secondary Fuse Selection

Primary Fuse Formulas

Single-Phase Transformers

$$I_{pri} = \frac{\text{Transformer VA}}{V_{pri}}$$

OR

$$I_{pri} = \frac{\text{Transformer VA}}{V_{pri}} \times 1000$$

Three-Phase Transformers

$$I_{pri} = \frac{\text{Transformer VA} \times 1000}{1.73 \times V_{pri}}$$

Table 2—Primary and Secondary Fuses

Transformer Secondary Amperes	Maximum % Rating	
	Primary Fuse	Secondary Fuse
9 or more	250	125*
Less than 9	250	167

Secondary fuse selection is made according to rated secondary current (I_{sec}). To determine I_{sec}, the transformer rating (VA or kVA) and secondary voltage (V_{sec}) must be known as well as whether the transformer is single- or three-phase. With this information, use the appropriate formula to determine I_{sec}.

Once I_{sec} is known, select fuses according to Table 2 above.

Secondary Fuse Formulas

Single-Phase Transformers

$$I_{sec} = \frac{\text{Transformer VA}}{V_{sec}}$$

OR

$$I_{sec} = \frac{\text{Transformer VA}}{V_{sec}} \times 1000$$

Three-Phase Transformers

$$I_{sec} = \frac{\text{Transformer VA} \times 1000}{1.73 \times V_{sec}}$$

Temperature Considerations

Insulation and Temperature

All transformers are designed and manufactured with the best quality insulation available. There are classes of insulation systems for different temperatures as defined by NEMA and ANSI. Insulation classes are rated in °C rise above a specific ambient of 40°C maximum. A transformer having a specific class of insulation, for example Class 220, can have an average winding temperature rise of 150°C with a maximum hot spot temperature rise of 180°C. If the room ambient temperature is 40°C, then the total temperature of the hottest spot would be 220°C.

Our transformers are designed to operate at rated load and voltage in maximum room ambient temperatures of 40°C, average room ambient temperature not to exceed 30°C, and at altitudes not to exceed 3300 feet in accordance with NEMA standards.

Insulating Classifications

The designations for insulation systems are numerical classifications based on temperature ratings. Transformer ratings are based on temperature rise. The accompanying table shows the designations.

Transformer and Insulation System Ratings

Ventilated			
Insulation Class	Temperature Rise	Ambient Temperature	Hot Spot Allowance
105	55°C	40°C	10°C
150	80°C	40°C	30°C
180	110°C	40°C	30°C
220	150°C	40°C	30°C
Encapsulated			
105	70°C	25°C	10°C
130	95°C	25°C	10°C
180	135°C	25°C	20°C
Control Transformers			
105	55°C	40°C	10°C
130	80°C	40°C	10°C
135	100°C	40°C	15°C
180	120°C	40°C	20°C

Overloads

Overloads exceeding the maximum allowable insulation temperature can be tolerated, provided the overload is of short duration and is preceded and followed by a period of operation at less than rated kVA (refer to ANSI C57.96-1989, Tables 5,6,7). Overloading should be avoided unless approval is obtained from the Jefferson Electric engineering department.

High Ambient Temperatures

Ambient temperatures above 30°C average over a 24-hour period and 40°C maximum require either a larger kVA rating or a special low temperature rise transformer. A 150°C rise air cooled transformer can also be derated using the formula of .4% kVA reduction for each degree centigrade above 30°C ambient temperature.

Altitude Correction

For transformers above 3300 feet, reduce the kVA rating .3% for each 330 feet above 3300 feet.

Taps

If the transformer comes supplied with taps, they will generally have a full capacity rating. A common tap arrangement is two 2.5% taps above FCAN and four 2.5% taps below FCBN nominal voltage. Transformers are shipped with the taps connected for nominal voltage, that is, 480 volts for a 480 volt transformer. The installing electrician must change the taps if the supply voltage differs from the nominal voltage rating.

Safety and Installation

Transformers are provided with access covers to facilitate installation and service. They must be kept securely in place at all times when the transformer is operating.

CAUTION: *Normal operating voltages can be extremely hazardous. Only qualified personnel should install, inspect or service transformers. Disconnect the power before opening the cover or touching any internal parts.*

Connections and Circuits

The transformer should be connected only as described on the nameplate or the wiring diagram inside the wiring compartment cover, or as otherwise specifically authorized.

Transformers without terminal boards, usually the smaller size transformers, provide leads for connections.

IMPORTANT: *Any unused taps or leads must be insulated from each other and taped*

Encapsulated transformers, 2 kVA and smaller, have their turns ratio compensated for losses so that their open circuit voltage is somewhat higher than the load voltage. Machine tool transformers are compensated up to 5 kVA. Using transformers in the reverse direction from which it is designed would result in lower than expected output voltage.

Mounting and Spacing

Dry-type transformers depend on air for cooling, and must be placed so that room air can circulate freely around them. Cabinet style transformers must be mounted so that air can pass freely through the ventilation openings. The transformer space should be kept clear.

Transformers should be spaced at least six inches apart. Transformers rated 30 kVA and larger should be kept at least six inches from walls and ceilings.

Transformers should never be mounted near heat-generating equipment or near heat-sensitive equipment. Transformers should never be placed in a room with hazardous processes, or where flammable gasses or combustible materials are present. Particular care must be taken when mounting in unventilated plenums or in closets with no ventilation. In areas without free moving air, ambient temperatures can rise above acceptable limits, causing the transformer to overheat.

Storage

Transformers should be stored in a warm, dry location of uniform temperature and in their original packing. If the transformer has been unpacked, all ventilating openings should be covered to keep out dust. Outdoor storage should be avoided, but if this is not possible, the transformer must be protected against moisture and contaminants.

Condensation and moisture can be reduced with heaters. If the transformer has been subjected to moisture, it should be baked out before energizing. This is especially important in transformers of 5 kV or higher.

Care and Maintenance

Periodic inspection of the transformer should be made, depending on conditions. In most clean, dry installations, once a year is usually sufficient.

After disconnecting the transformer from the power, the cover should be removed and any dirt cleaned out. Screens covering the ventilating openings should be cleaned.

Inspect for loose connections, terminal and splice conditions and for signs of overheating, rust or deteriorating paint.

Troubleshooting Guide

Condition	Possible Cause	Suggested Remedy
Hot Transformer	High ambient temperature	Improve ventilation or relocate unit to cooler location.
	Overload	Reduce load; reduce amperes by improving power factor with capacitors; check for circulating currents for paralleled transformers (different ratios or impedances); check for open phase in delta bank.
	High voltage	Change circuit voltage, taps.
	Insufficient cooling	If other than naturally cooled, check fans, pumps, valves and other units in cooling systems.
	Winding failure – incipient fault	See “No voltage - unsteady voltage” below.
	Short-circuited core	Test for exciting current and no-load loss; if high, inspect core, remove and repair; check core bolt, clamps and tighten; check insulation between laminations; if welded together, return to factory for repair or replacement.
	High harmonic loads	Measure neutral current - replace with K-rated transformer.
Noisy transformer	Overload	See “Hot transformer” above.
	Metal part ungrounded, loose connection	Determine part and reason; check clamps, cores and parts normally grounded for loose or broken connections, missing bolts or nuts, etc.; tighten loose clamps, bolts, nuts; replace missing ones.
	External parts and accessories in resonant vibration	Tighten items as above; in some cases, loosen to relieve pressure causing resonance and install shims.
	Incipient fault – core or winding	See above under “Hot transformer.”
No voltage – unsteady voltage	Winding failure - lightning; overload; short-circuit from foreign object or low strength dielectric	Check winding; remove foreign object or damaged material; repair or replace parts of insulation materials.
Rust and paint deterioration	Weather, pollution, corrosive or salt atmosphere; overloads	Remove rust and deteriorated paint; clean surfaces; repaint with proper paints and sufficient coatings.
	Excessive heating discoloration	If excessive heating discoloration occurs, check sizing, input voltage, or loading amps.
Hot neutral line	Overload	Too small neutral conductor: replace. Severe unbalance between phase: rebalance and equalize loads.
	One leg of wye bank open	Check associated fuse. If blown, remove cause and replace. Check for open circuit in winding of transformer in bank. Measure odd harmonic amps with RMS meter.
Voltage unbalanced	Open neutral unbalanced loads	Check neutral connections. See “Hot neutral line” above.
Voltages high and unbalanced	Open neutral on wye bank ground in winding of one transformer in wye	Check neutral connections and load balance. Check values of voltages between phases and phase-to-ground voltages. Vector should indicate source of trouble.

Condition	Possible Cause	Suggested Remedy
Hot neutral line	Overload	Too small neutral conductor: replace. Severe unbalance between phase: rebalance and equalize loads.
	One leg of wye bank open	Check associated fuse. If blown, remove cause and replace. Check for open circuit in winding of transformer in bank. Measure odd harmonic amps with RMS meter.
Voltages unbalanced	Open neutral unbalanced loads	Check neutral connections. See "Hot neutral line" above.
No voltage – one phase of delta connected bank	Grounds on two legs of delta (delta collapse - loads "single phasing")	Remove grounds from at least one leg of delta source.
Overloads on two delta bank	Open in third transformer of bank; operating in open delta	Check fuses on supply to their bank; check winding of transformers in third transformer for continuity.
Low voltage on two phases of delta	Open in one phase of delta supply; two transformers now connected across one same phase	Check fuse on supply; check supply circuit back to source for open circuit.

Certifications



Underwriters Laboratories Listing Mark

Samples of the product have met UL's safety requirements primarily based on UL's own published Standards of Safety.



UL Recognized Component Mark

This mark means that the component alone meets the requirements for a limited, specified use.



C-UL Listing Mark

Products with this type of mark have been evaluated to Canadian safety requirements by UL, which may be somewhat different than U.S. safety requirements.



CSA International Mark (formerly Canadian Standards Association)

This mark may appear alone, or with other qualifiers. If it appears alone, it means that the product is certified for the Canadian market, to the applicable Canadian standards.



Conformité Européenne

To market electrical products within the European Union (EU), product conformity and the proper use of the CE mark on machines and control equipment is critical. As a major supplier to global companies serving customers in the EU, Jefferson Electric pays special attention to meeting the EU specification and certification requirements. These global companies need the guarantee of free trade of goods, elimination of trade restrictions and harmonization of technical regulations to sell their products to EU member countries. All Jefferson Electric products that meet or exceed the requirements of these directives are designated by the CE mark.

To request CE certified equivalents for products not already certified, please contact our Technical Support department at 800-892-3755.



ETL Intertek Verified

United States and Canada require general purpose transformers to meet specific energy efficiency standards. Jefferson Electric has contracted with Intertek ETL SEMKO an independent organization to test and certify our products. The ETL logo on our products indicates that the transformer meets the energy efficiency standards as defined by the NEMA TP-3R standard.

Seismic

In order to meet seismic qualifications, products must go through rigorous testing to meet the International Building Code and the California Building Code requirements. Each test must also be met in accordance with ICC-ES AC156 seismic qualifications.



ABS Qualified

ABS (American Bureau of Shipping) approved for use on marine vessels including off-shore oil rigs.

Glossary

A

AA An ANSI (American National Standard Institute) cooling class designation indicating open, natural draft ventilated transformer construction, usually for dry-type transformers.

Air-Cooled A transformer cooled by the natural circulation of air over and/or through the core and coils.

Alternating Current (or voltage) Current that alternates regularly in direction, is periodic and has an average value (over a period of time) of zero.

Ambient Noise Level The existing or inherent sound level of the area surrounding a transformer installation. Measured in decibels.

Ambient Temperature The temperature of the surrounding atmosphere into which the heat of the transformer is dissipated.

Ampacity The current-carrying capacity of an electrical conductor or device.

Ampere The practical unit of electric current.

ANSI American National Standards Institute. An organization that provides written standards on transformers [600v and below (ANSI C89.1), 601~ and above (ANSI C57.12)].

Attenuation Decrease in signal voltage or power.

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

B

BIL Basic Insulation Level. The crest (peak) value that the insulation is required to withstand without failure. For example, a 600 volt class transformer has a 10 kV BIL rating.

Banked Two or more single-phase transformers connected together, or banked, to supply power. Three single-phase transformers banked together will produce a kVA capacity of three times the nameplate rating of the individual single-phase transformers. For example, three 5 kVA single-phase transformers connected together for a three-phase load will have a 15 kVA capacity.

Bushing An electrical insulator (porcelain, epoxy, etc.) that is used to control the high voltage stresses that occur when an energized cable must pass through a grounded barrier.

Buck transformer Step down the Voltage from Primary Winding to Secondary Winding i.e. 460V to 230V.

Boost transformer Step up the Voltage from Primary Winding to Secondary Winding i.e. 230V to 460V.

C

Cast-coil Transformer A transformer with high-voltage coils cast in an epoxy resin. *Usually used with 5 to 15 kV transformers.*

CE Mark to indicate third party approved or self-certification to European Community requirements.

CSA Canadian Standards Association. The Canadian equivalent of Underwriter's Laboratories (UL).

CUL Mark to indicate UL certification to CSA standards.

Celsius Same as Centigrade. To convert Centigrade to Fahrenheit, use the following formula: $^{\circ}\text{F} = 1.8 \times ^{\circ}\text{C} + 32$.

Coil A number of turns of conductor wound as a coil.

Compensated Transformer A transformer with a turns ratio which provides a higher rated voltage at no-load and rated voltage at rated load. Normally used on units rated 2 kVA or smaller.

Continuous Duty The service requirement that demands operation at a constant load for an indefinite period of time.

Continuous Rating Gains the constant load that a transformer can carry at rated primary voltage and frequency without exceeding the specified temperature rise.

Control Transformer Usually referred to as an Industrial Control Transformer. Designed for good voltage regulation characteristics when low power factor and/or large inrush currents are drawn (5 to 15 times normal).

Conductor Losses Losses in the transformer winding that are incidental to the carrying of the load. These losses include those due to resistance as well as to stray and eddy currents.

Copper Losses See Load Losses.

Core The steel that carries the magnetic flux in a transformer.

Core-Form Construction A type of core construction where the winding materials completely enclose the core.

Core Loss Losses caused by a magnetization of the core and its resistance to magnetic flux.

Current Transformer A transformer generally used in instrumentation circuits that measure or control current.

Cycle One complete sequence of values of an alternating quantity, including a rise to maximum in one direction, a return to zero, a rise to a maximum in the opposite direction, and a return to zero.

D

Decibel (db) A unit used to express the magnitude of a change in signal or sound level, either an increase or a decrease.

Delta A standard three-phase connection with the ends of each phase winding connected in series to form a closed loop with each phase 120 degrees from the other. Sometimes referred to as 3-wire.

Delta Wye The method of connection for both primary and secondary windings of a three-phase transformer bank.

Dielectric Tests A series of tests conducted at a much higher than rated nameplate voltage to assure the integrity of insulating materials and electrical clearances.

Distribution Transformer Those rated 5 to 120 kV on the high-voltage side and normally used in secondary distribution systems. An applicable standard is ANSI C-57.12.

Double Wound Transformer See “Isolating Transformer”

Dripproof Constructed or protected so that successful operation is not interfered with by falling moisture or dirt. A transformer in which the transformer core and coils are not immersed in liquid.

Drive Isolation Transformer A transformer designed to withstand the additional heat and mechanical stress caused by DC drives.

Dry Type Transformer A transformer cooled by a medium other than a liquid, usually through the circulation of air.

Dual Winding A winding that consists of two separate windings which can be 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

Eddy Currents Additional currents caused by a time varying magnetic field.

Effective Voltage or Current 0.707 times the peak value of AC voltage or current. Effective value is also designated RMS value (Root Mean Square). When AC voltage is referred to, the effective value is understood unless otherwise noted. Symbols “E” and “I” without subscripts indicate effective values.

Efficiency The efficiency of a transformer is the ratio of its power output to its total power input.

Electrostatic Shield A grounded conductor placed between the primary and secondary winding to greatly reduce or eliminate line-to-line or line-to-ground noise. Often referred to as a “Faraday shield.”

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

Excitation Wattage The no-load loss of a transformer.

F

FA An ANSI cooling class designation indicating a forced air ventilated transformer, usually for dry type transformers and typically to increase the transformer’s KVA rating above the natural ventilation or AA rating.

Fan Cooled Cooled mechanically to stay within rated temperature rise by addition of fans internally and/or externally. *Normally used on large transformers only.*

FCAN and FCBN Taps Full Capacity Above Nominal and Full Capacity Below Nominal. The FCAN designation is used to indicate that a transformer will deliver rated

kVA when connected to a voltage source which is higher than rated voltage. The FCBN designation indicates that a transformer will deliver rated kVA when connected to a voltage source which is lower than rated voltage.

FOA An ANSI cooling class designation indicating forced oil cooling using pumps to circulate the oil for increased cooling capacity.

FL Full-load

FOW An ANSI cooling class designation indicating forced oil water cooling using a separate water loop in the oil to take the heat to a remote heat exchanger. Typically used where air cooling is difficult such as underground.

Frequency On AC circuits, designate number of times that polarity alternates from positive to negative and back again, *such as 60 hertz* (cycles per second).

Fuse An overcurrent protective device with a circuit-opening fusible member which is directly heated and severed by the passage of overcurrent through it, or by a fault.

G

Grounds or Grounding Connecting one side of a circuit to the earth through low-resistance or low-impedance paths. This helps prevent transmitting electrical shock to personnel. Also aids in the dissipation or mitigation of Noise (High frequency or other).

Grounded Connected to the earth or some other conductor.

Ground Strap A Flat Strap of varying density, width and length to aid in the dissipation of High frequency noise, commonly generated by Switching Power Supplies, Lighting Ballasts, Inverters or Variable Frequency Drives.

H

HP Horsepower. Energy required to raise 33,000 pounds one foot in one minute. Equals 746 watts, or .746 KW.

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

HZ	Harmonic
60	Fundamental
120	2nd Harmonic
180	3rd Harmonic
240	4th Harmonic

etc...

Current waveforms from non-linear loads appear distorted because the non-linear waveform is the result of adding harmonic components to the fundamental current.

High-voltage and Low-voltage Windings Terms used to distinguish the wind that has the greater voltage rating from that having the lesser in two-winding transformers. The terminations on the high-voltage windings are identified by H1, H2, etc., and on the low-voltage by X1, X2, etc.

I

Impedance Retarding forces of current flow in AC circuits.

Indoor transformer A transformer that, because of its construction, is not suitable for outdoor service.

Insulating Materials Those materials used to electrically insulate the transformer windings from each other and to ground. Usually classified by degree of strength or voltage rating (0, A, B, C, and H).

Inductance That property of a circuit or circuit element opposing a change in current flow (symbol L). Measured in Henrys.

Input The power or signal fed into an electrical device, or to the terminals involved.

Inrush Current The initial high peak of current during the first few cycles of energization which can be 30 to 40 times the rated current.

Isolation transformer For the purpose of isolating the Source Supply from the consumer(s), aids in prevention of noise transmission, adds impedance and can also provide an isolated Ground on the secondary.

Insulation Material with high electrical resistance.

Insulating Materials Those materials used to electrically insulate the transformer windings from each other and to ground. Usually classified by degree of strength or voltage rating (0, A, B, C, and H).

Insulator Device used for supporting or separating conductors of electricity.

Insulating Transformer Another term for isolation transformer.

K

K-Factor A numerical value taking into account both the magnitude and frequency of the component of a current waveform. Used to indicate a full-rated transformer specifically designed to handle non-linear loads.

Kilowatt (KW) 1,000 Watts.

KWH Kilowatt hour, one kilowatt for one hour.

kVA or Volt-ampere Output Rating The kVA or volt-ampere output rating designates the output that a transformer can deliver for a specified time at rated secondary voltage and rated frequency without exceeding the specified temperature rise ($1 \text{ kVA} = 1000 \text{ VA}$).

L

Linear Loads Loads where the current waveform conforms to that of the applied voltage, or loads where a change in current is directly proportional to a change in applied voltage. For example: resistance heating, incandescent lighting, water heater.

Lamination Thin sheets of steel making up the core of the transformer.

Line Voltage The voltage of the power line.

Liquid-immersed Transformer A transformer with the core and coils immersed in liquid (as opposed to a dry-type transformer).

Load The amount of electricity, in kVA or volt-amperes, supplied by the transformer. Loads are expressed as a function of the current flowing in the transformer, and not according to the watts consumed by the equipment the transformer feeds.

Load Losses Those losses in a transformer that are incident to load carrying. Load losses include the I²R loss in the winding, core clamps, etc., and the circulating currents (if any) in parallel windings.

M

Mid-tap A reduced-capacity tap midway in a winding – usually the secondary.

Moisture-resistant Constructed or treated so as to reduce harm by exposure to a moist atmosphere.

N

Natural-draft or Natural-draft Ventilated An open transformer cooled by the draft created by the chimney effect of the heated air in its enclosure.

No-load Losses (Excitation Losses) Loss in a transformer that is excited at its rated voltage and frequency, but which is not supplying load. No-load losses include core loss, dielectric loss, and copper loss in the winding due to exciting current.

Non-Linear Loads Loads where the current waveform does not conform to that of the applied voltage, or where a change in current is not proportional to change in applied voltage. For example: computer power supplies, motor drives, fluorescent lighting.

Non-Ventilated Construction The core and coil assembly is mounted inside an enclosure which has no ventilation openings.

O

OA An ANSI cooling class designation indicating an *oil filled transformer*.

P

Parallel Operation Single and three-phase transformers having appropriate terminals may be operated in parallel by connecting similarly-marked terminals, provided their ratios, voltages, resistances, reactances, and ground connections are designed to permit paralleled operation and provided their angular displacements are the same in the case of three-phase transformers.

Polarity Test A standard test performed on transformers to determine instantaneous direction of the voltages in the primary compared to the secondary (see Transformer Tests).

Poly-phase More than one phase.

Potential (Voltage) Transformer A transformer used in instrumentation circuits that measure or control voltage.

Potted The core and coil assembly is completely encapsulated (contained within protecting material) with a resin-sand compound and contained in a metal enclosure.

Power Factor (PF) The ratio of watts to volt-amps in a circuit.

Peak Voltage The voltage or current of an AC sinusoidal wave when it reaches its peak or maximum level. This occurs twice and lasts for only a fraction of the cycle. Direct current voltage is peak voltage at all times.

Primary Taps Taps added in the primary winding (see Tap).

Primary Voltage Rating Designates the input circuit voltage for which the primary winding is designed.

Primary Winding The primary winding on the energy input (supply) side.

R

Rating The output or input and any other characteristic, such as primary and secondary voltage, current, frequency, power factor and temperature rise assigned to the transformer by the manufacturer.

Ratio Test A standard test of transformers used to determine the ratio of the primary to the secondary voltage.

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

Reactor A device for introducing *inductive reactance* into a circuit for: *motor starting, operating transformers in parallel, and controlling current.*

S

Scott Connection Connection for polyphase transformers. Usually used to change from two-phase to three-phase to three-phase to two-phase.

Sealed Transformer A transformer completely sealed from outside atmosphere and usually contains an inert gas that is slightly pressurized.

Secondary Taps Taps located in the secondary winding (see Taps).

Secondary Voltage Rating Designates the load-circuit voltage for which the secondary winding (winding on the output side) is designed.

Series/Multiple A winding of two similar coils that can be connected for series operation or multiple (parallel) operation.

Shell-type Construction A type of transformer construction where the core completely surrounds the coil.

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

Sinusoidal Having the form of a sine (or cosine) wave.

Star Connection Same as wye connections.

Step-down Transformer A transformer in which the energy transfer is from the high-voltage winding to the low-voltage winding or windings.

Step-up transformer A transformer in which the energy transfer is from the low-voltage winding to a high-voltage winding or windings.

T

T-Connection Use of Scott Connection for three-phase operation. A connection brought out of a winding at some point between its extremities, usually to permit changing the voltage or current ratio.

Taps Incoming plant voltage varies according to the distance from the substation and other factors. Taps allow a distribution transformer to provide secondary voltage as close as possible to the desired operating voltage. Taps are usually supplied on the primary winding to allow matching of the supply voltage to the voltage rating of the transformer connection. A tap position above the nominal connection will lower the secondary output and vice-versa.

Temperature Rise The increase over ambient temperature of the winding due to energizing and loading the transformer.

Total Losses The losses represented by the sum of the no-load and the load losses.

Transformer An electrical device, without continuously moving parts, which, by electro-magnetic induction, transforms energy from one or more circuits to other circuits at the same frequency, usually with changed values of voltage and current.

Transformer Regulation The percentage difference between voltage at the secondary terminals under no-load condition versus voltage under full-load. This value depends on the load power factor and is usually reported at 1.0 PF and 0.8 PF.

Turns Ratio (of a transformer) The ratio of turns in the primary winding to the number of turns in the secondary winding.

U

UL Underwriter's Laboratories. A non-profit safety testing organization.

V

Ventilated Providing circulation of external air.

Ventilated Enclosure Enclosure with openings which allow air to flow directly over the core and coil assembly for cooling.

Volt-amperes Circuit volts multiplied by circuit amperes.

Voltage Ratio (of a transformer) The ratio of the RMS primary terminal voltage to the RMS secondary terminal voltage under specified conditions of load.

Voltage Regulation (of a transformer) The change in secondary voltage that occurs when the load is reduced from rated value to zero, with the values of all other quantities remaining unchanged. The regulation may be expressed in percent (or per unit) on the basis of the rated secondary voltage at full load.

W

Watt Unit of electrical power when the current in the circuit is one ampere and the voltage is one volt.

Weathershields When added to ventilated enclosures, allow indoor-rated units to be situated outdoors, changing the enclosure rating to NEMA 3R.

Winding Losses See Load Losses.

Winding Voltage Rating Designates the voltage for which the winding is designed

Wye Connection (Y) A standard three-phase connection with similar ends of the single-phase coils connected to a common point. This common point forms the electrical neutral point and may be grounded.

Reference: Power transformer maintenance and accepting testing – Department of the Army™ 5686

Limited Warranty

Jefferson Electric, Inc. (Jefferson) warrants to original Purchaser that any products provided by Jefferson hereunder shall be free from defects in material and/or workmanship under normal use and operation; matches functional specifications; and the final product meets industry standards during the warranty period, provided conditions of operation have been normal at all times, and that the product has not been subjected to abnormal stresses, including, but not limited to, such causes as incorrect primary voltage or frequency or improper ventilation. The warranty will not be extended to any product which has been subject to misuse, negligence, accident, improper installation or operation, nor does it extend to any product which has been repaired or altered by any party other than Jefferson.

The warranty provided herein is non-transferable. It is available only for the Purchaser.

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Warranty Period

Standard catalog transformers:	Ten Years – limited from date of manufacture
Custom quoted products:	One year from date of manufacture
Products manufactured by third party, including specialty transformers, and accessories	See original manufacturers warranty

