INTRODUCTION

INTRODUCTION

THE COMPANY

Established in 1917, Hammond Power Solutions Inc. (HPS), is an industry leader in magnetic transformer design and development. With our headquarters in Guelph, Canada, HPS operates out of multiple facilities globally. HPS has expanded it's manufacturing and product base to offer the broadest ranges of both standard and specialty transformers

Our engineering experience and capability has resulted in a computer database of over one million transformer designs. We offer the most cost effective, highest quality transformers in order to satisfy your requirements.

There are HPS facilities in Canada, USA, Mexico, Italy and India to service your global needs.

The products featured in this catalog are produced in facilities with the most modern manufacturing processes. All products are available through your local **Authorized HPS Distributor**.

COMPETITIVE EDGE

North American stand-alone leader for the design and manufacture of standard & custom electrical engineered dry-type transformers.

- Multi-national manufacturing presence
- Multiple channels to market
- Highly regarded for our engineering expertise
- Dominant Supplier in the transformer industry
- Globally recognized and respected

APPLICATIONS

Offering thousands of standard transformers from 25VA to 5MVA and specials up to 34MVA, HPS can meet the needs of your application.

HPS transformers are suitable for any commercial, industrial, manufacturing or production process application. In addition to conventional indoor applications, our dry-type transformers can be built for outdoor locations, including applications where airborne contaminants pose a risk to electrical equipment.

CUSTOMER SERVICE

Our inside sales team are available to answer your questions immediately. They are technically trained and are able to answer most questions on the phone. Stock checks, expediting, quotations or technical information are always readily available. Our commitment to customer service means you will be an informed, relaxed and satisfied customer as quickly as possible. Call our Inside Sales team and let us serve you.

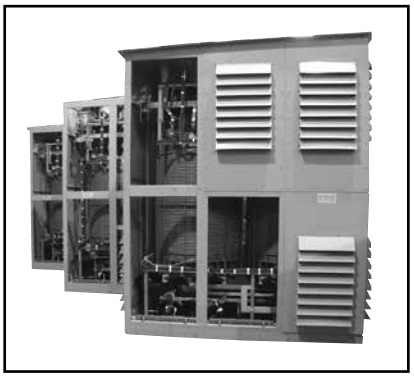
INTRODUCTION

DESIGN CAPABILITIES

Our history and experience in transformer magnetic design is the very best in the industry. Our extensive testing program, including all qualification tests and short circuit testing, plus an exemplary field service record, ensures that our products not only meet all the standards necessary, but more importantly, fulfill your expectations and requirements.

All HPS designs are cost effective and the transformers are built with modern manufacturing techniques. We particularly emphasize our 'Value Added Engineering' where our design staff will work directly with your team to produce the optimum and cost effective solution for your application. Our fully computerized design and CAD facilities permits quick and effective communication when time is vital.

A RELIABLE SOURCE



For over 95 years, HPS has continued to grow from a small family business to the industry leader in dry-type transformer technology. Our customers have come to rely on our products and services and continue to depend on us for support at the most critical stages of their need. Our stability and integrity as a supplier are paramount particularly in an industry where demands must be resolved quickly and effectively.

TECHNICAL SUPPORT

The experienced HPS technical team is available to help you with your application or design questions. Call our regional offices for assistance.

QUALITY ASSURANCE

HPS has been regarded for its quality since its very inception. With our commitment to 'Excellence' and 'Continuous Improvement', we build value and reliability into every HPS product. We feel that no other transformer company can offer comparable flexibility for service and quality in a full range of products. All our units are designed to meet ANSI, CSA, UL, IEC, RoHS and NEMA standards.

TRANSFORMER TERMINOLOGY

Air Cooled
A transformer which uses "air" as the cooling medium. This term is abbreviated with the ANSI designation AA, indicating open, natural draft ventilated construction.

Ambient Noise Level
The noise level of the surrounding area, measured in decibels (dB).

Ambient Temperature
The inherent or existing temperature of the atmosphere surrounding a transformer into which its heat is dissipated.

Ampere
Is the unit of measurement for electric current flow.

ANSI
American National Standards Institute Inc. - one of the recognized organizations which specifies the standards for transformers.

Autotransformer
A transformer which has only one winding per phase, part of which is common to both the primary and secondary circuits.

Banked
Two or more single phase transformers connected together to supply a three phase load.

BIL
Basic impulse level is a means to express the ability of the insulation system to withstand high voltage surges.

Buck Boost Transformer
Two-winding, single phase transformer with low voltage secondary windings which can be connected as an autotransformer. Used to raise or lower single and three phase line voltages by 10 - 20%.

Cast Coil Transformer
Transformer with coils solidly cast in epoxy resin under vacuum in a mold. Also called cast resin or epoxy cast coil transformers.

Center Tap
A reduced capacity tap at the midpoint in a winding.

Coil
Turns of electrical grade wire or strip conductor material wound on a form, referred to as a winding.

Coil Hot-Spot Temperature
The absolute maximum temperature present in the transformer. This number is equal to the sum of the ambient temperature, temperature rise and a variable.
T Hot Spot = T ambient + T rise + (10-20)°C.

Common Mode
Electrical noise or voltage disturbance that occurs between all of the line leads and the common ground, or between the ground plane and either line or the neutral.

Compensated Transformer
A transformer with a turns ratio which provides a higher than rated voltage at no load and rated voltage at rated load. These transformers CANNOT be used for reverse feed.

Continuous Rating
The constant load which a transformer can carry its rated primary voltage and frequency, without exceeding its specified temperature rise.

Control Transformer
A transformer which is designed to supply good voltage regulation characteristics when low power factor or high inrush current is drawn. Sometimes referred to as an Industrial Control Transformer.

Core
Electrical grade steel laminations which carry the magnetic flux.

Core Loss
Losses in watts caused by magnetization of the core and its resistance to magnetic flux when excited or energized at rated voltage and frequency. Also referred to as excitation loss or no-load loss.

Current Transformer
Transformer generally used in control or instrumentation circuits for measuring current.

Delta Connection (△)
The delta connection is 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.

Delta Wye (△ Y)
Delta wye is a term indicating the primary connected in delta and the secondary in wye when pertaining to a three phase transformer bank or three phase transformer.

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

DOE 2016
The Department of Energy (DOE) has established new and more stringent Energy Efficiency levels for transformers in the United States effective January 1, 2016.

Dry-Type Transformer
A dry-type transformer is one in which the transformer core and coils are not immersed in liquid.

Dual Winding
A winding consisting of two separate parts which can be connected in series or parallel. Also referred to as dual voltage or series-multiple winding.

Efficiency
The percentage of power transferred from the input of equipment to the output of equipment in Watts. (power out/ power in x 100)

Electrostatic Shield
Copper or other conducting material placed between the primary and secondary winding and grounded to reduce electrical interference and to provide additional protection.

Exciting Current (No-Load Current)
Current which 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.

Encapsulated
Transformer with its coils either encased or cast in an epoxy resin or other encapsulating materials.

FCAN
Full Capacity Above Normal. This designates that a transformer will deliver its rated kVA when connected to a voltage source which is higher than the rated voltage.

FCBN
Full Capacity Below Normal. Same as FCAN except that the taps are below rated voltage.

Fan Cooled
A transformer cooled mechanically to maintain its rated temperature rise, typically using auxiliary fans to accelerate heat dissipation.

Flexible Connection
A non-rigid connection used to reduce transmission of noise and vibration.

Flux Density
The magnetic field strength in the core, typically measured in Telsa or Gauss.

Frequency
On AC circuits, designates the number of times the polarity alternates from positive to negative and back again, such as 60 cycles per second. Measured in Hertz.

Full Capacity Tap

A full capacity tap is one through which the transformer can deliver its rated kVA output without exceeding the specified temperature rise.

Grounding Transformer
A special three phase autotransformer for establishing a neutral on a 3-wire delta secondary. Also referred to as a Zig-Zag transformer.

INTRODUCTION

TERMINOLOGY CONTINUED . . .

Grounds or Grounding
Connecting one side of a circuit to the earth through low resistance or low impedance paths.

Harmonic
A Harmonic is a sinusoidal component of a periodic wave having a frequency that is a multiple of the fundamental frequency. For example, a component whose frequency is twice the fundamental frequency is referred to as the second harmonic, (120 Hz is the 2nd harmonic of 60 Hz).

Hertz (Hz)
A term for AC frequency in cycles per second.

High Voltage and Low Voltage Windings
These terms are used to distinguish the winding having the greater voltage rating from that having the lesser in two winding transformers.

Hi Pot
High potential dielectric test impressed on the windings to check insulation materials and clearances.

Impedance
The apparent resistance in a circuit to the flow of an alternating current analogous to the actual resistance to a direct current.

Impulse Test
Dielectric test which determines BIL capability by applying high frequency, steep wave-front voltage between windings and ground.

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.

Inductance
A property which opposes a change in current flow.

Inrush Current
High transient current, caused by residual flux in the core, which may be drawn when a transformer is energized.

Insulating Materials
Those materials used to electrically insulate the transformer's windings; turn-to-turn or layer-to-layer, and other assemblies in the transformer such as the core and busswork.

Isolation Transformer
A transformer which insulates the primary circuit from the secondary circuit. Also referred to as a two-winding or insulating transformer.

KVA
Kilovolt ampere rating designates the output which a transformer can deliver for a specified time at rated secondary voltage and rated frequency without exceeding the specified temperature rise. (1 kVA = 1000 VA, or 1000 volt amperes)

Knockouts
Easily removable circle of metal in an enclosure which eliminates the need for punching holes for conduit.

Lamination
Thin sheets of special steel used to make the core of a transformer.

Line Reactor
A device whose primary purpose is to introduce a specific amount of inductive reactance into a circuit, usually to reduce or control current.

Load
The load of a transformer is the power in kVA or volt amperes supplied by the transformer.

Load Losses
Losses in a transformer which are incident to load carrying. Load loses include I^2R loss in the windings due to load current, stray loss due to stray fluxes in the windings, core clamps, etc., and to circulating currents (if any), in parallel windings.

Mini Power Center
A pre-wired power center that combines primary breaker, secondary power panel, and a dry-type shielded transformer.

Mid-tap
A reduced capacity tap midway in a winding. Also referred to as a 'Center tap'. Usually in the secondary winding.

Moisture Resistance
Materials or equipment constructed or treated so that it will not be harmed readily by exposure to a moist atmosphere.

NEC
National Electric Code

NEMA
National Electrical Manufacturers Association.

No-Load Losses (Excitation Losses)
Loss in a transformer which is excited at rated voltage and frequency, but without a load connected to the secondary. No-load losses include core loss, dielectric loss, and copper loss in the winding due to exciting current.

Overload
When a transformer is overloaded, excessive heat develops and the insulation system begins to breakdown. Life expectancy of the transformer is decreased due to heat exceeding the rating of the insulation system.

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

Phase
Type of AC electrical circuit, usually single phase 2 wire or 3 wire, or three phase, 3 or 4 wire.

Polarity
Designates the instantaneous direction of voltages in the primary compared to the secondary.

Potential (Voltage) Transformer
A transformer generally used in instrumentation circuits for measuring or controlling voltage.

Power Factor
The relation of watts to volt amps in a circuit.

Primary Taps
Taps added to the primary winding. (see Taps)

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

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

Rating
The design characteristics, such as primary and secondary voltage, kVA capacity, temperature rise, frequency, etc.

Ratio (Voltage)
A reference to either the primary to secondary winding turns ratio or to the voltage ratio of the transformer.

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

Reactance
The impedance component due to inductance and/or capacitance.

Reactor
A single winding device with an air or iron core which produces a specific amount of inductive reactance into a circuit, usually to reduce or control current.

Rectifier Transformer
A transformer designed to supply AC input to a rectifier to obtain the desired DC output and have the ability to withstand the heating effects caused by rectifier commutation or ripple.

RCBN - Reduced Capacity Below Normal
Taps which carry full-rated winding current only, thus reducing available power because of lower output voltage.

Terminology Continued...

Regulation
Usually expressed as the percent change output voltage when the load goes from full load to no load at a given power factor.

SCR
A silicon-controlled rectifier.

Saturation
Saturation is a natural condition in which an increase in current results in a decrease in inductance.

Scott Connection
Connection for polyphase using two special single phase transformers. Usually used to change from two phase to three phase or three phase to two phase.

Secondary Voltage Rating
Designates the no-load circuit voltage for which the secondary winding (winding on the output side) is designed.

Secondary Winding
The transformer winding connected to the load or output side.

Series/Multiple
A winding consisting of two or more sections which can be connected for series operation or multiple (parallel) operation. Also referred to as dual voltage or series-parallel.

Short Circuit
A short circuit condition occurs when an abnormal connection or relatively low impedance, whether made accidentally or intentionally, occurs between two points of different potential in a circuit.

Solid State Device
One which contains components that do not depend on electronic conduction in a vacuum or gas. The electrical function is performed by semiconductors or the use of otherwise completely static components such as resistors or capacitors.

Step-Down Transformer
A transformer that typically has the output voltage in the secondary (LV) winding lower than the input voltage in the primary (HV) winding.

Step-Up Transformer
A transformer that typically has the output voltage in the secondary (LV) winding higher than the input voltage in the primary (HV) winding.

Tap
A tap is a connection brought out of a winding at some point between its extremities, usually to permit changing the voltage or current ratio.

T-Connection
A Scott connected three phase transformer utilizing two primary and two secondary coils called the main and the teaser.

Temperature Class
The maximum temperature that the insulation can continuously withstand. Class of insulation system in a transformer, i.e.

Class 105°C
Class 150°C
Class 180°C
Class 220°C

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

Total Losses
The transformer electrical losses which include no-load losses (core losses) and load losses (winding losses).

Transformer
A static electrical device which by electromagnetic induction transforms energy at one voltage and current to another voltage and current at the same frequency.

Transient
A temporary or brief change in a given parameter. This is typically associated with input voltage or output load parameters.

Transformer Tests
Normal, routine production tests include: (1) core loss; (2) load loss - winding or copper loss; (3) impedance; (4) hi-pot - high voltage between windings and ground; (5) induced - double induced two times voltage. Optional special tests include: (a) heat run - temperature testing; (b) noise tests - sound level measurement; (c) impulse tests - BIL tests: (d) partial discharge.

Transverse Mode
Electrical noise or voltage disturbance that occurs between phase and neutral (between lines), or from spurious signals across the metallic hot line and the neutral conductor.

UL
Underwriters Laboratories

VPI Impregnation
A vacuum and pressure impregnation process using a resin which is then oven cured to completely seal and protect the surface of a transformer and provides a strong mechanical bond. This process is standard on all HPS transformer products.

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

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

Wye Connection
A standard 3-wire transformer connection with similar ends of the single phase coils connected. This common point forms the electrical neutral point and may be grounded.

Zig Zag Connection
Special transformer connection commonly used in grounded transformers. See also grounding transformers.

WHAT IS A TRANSFORMER?

A transformer is an electrical device which converts alternating current from one voltage to another. It can be designed to increase or decrease voltages and works on the magnetic induction principle. A transformer has no moving parts and is a completely static, solid state device, which insures under normal operating conditions, a long and trouble-free life. A transformer consists of two or more coils of insulated wire wound on a laminated steel core. When voltage is introduced into one coil (called the primary), it magnetizes the iron core. As a result, a voltage is induced into the secondary, or output coil. The change of voltage (voltage ratio) between the primary and secondary depends on the turns ratio of the two coils.

WHAT DOES A TRANSFORMER DO?

Principle of Operation

A transformer operates on the principle of magnetic induction. Each transformer consists of two or more coils of insulated conductor (wire) wound on a laminated steel core. When a voltage is supplied to the PRIMARY (input) coil, it magnetizes the steel core, which in turn induces a voltage on the SECONDARY (output) coil. The voltage induced from the primary to the secondary coils is directly proportional to the turns ratio between the two coils. (**FIG 1**)

For example, if a transformer's input, or primary leg has twice as many turns of wire as the secondary, then the ratio would be 2:1. Therefore, if you applied 480 volts to the primary, 240 volts would be induced in the secondary. This is an example of a two winding "step-down" transformer. (**FIG 2**). If the application requires the voltage to be increased (stepped-up), then the input side may be for example 240 volts and the output 480 volts. (**FIG 3**)

HPS does NOT recommend the back-feeding of HPS transformers. Reverse feeding HPS transformers may result in technical issues and safety aspects that could be easily avoided by using a transformer specifically designed for the required step-up application. Back-feeding may also void the HPS product warranty. Transformers rated 2 kVA and below have compensated windings and should not be used in reverse feed applications.

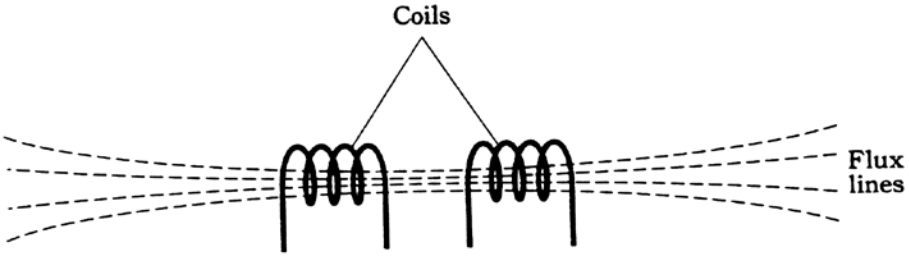


FIG (1)

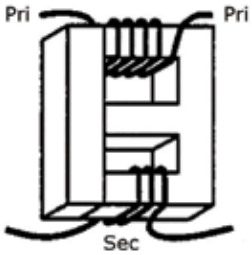


FIG (2)

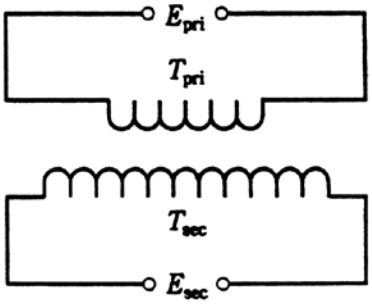


FIG (3)

TYPES OF TRANSFORMERS

Dry-type transformers are manufactured in a variety of ways to meet the requirements of different applications. The following is a list of transformer types found in this catalog with a brief explanation.

Industrial Control and General Purpose Enclosed Transformers - (see Section 1)

A control transformer is an isolation transformer designed to provide a high degree of secondary voltage stability (regulation) during a brief period of overload condition (also referred to as "Inrush Current"). Control transformers are usually rated for 600 volts or less.

Buck-Boost Transformers - (see Section 2)

Buck-Boost transformers are control transformers with low voltage secondary windings. By field connecting the primary and secondary windings in an autotransformer configuration, they offer an economical solution to the adjustment of line voltages that are slightly above or below normal.

Buck-Boost transformers can be used to adjust **stable voltages only**. Fluctuating line voltages should be regulated with a Voltage Conditioner.

Reactors - (see Section 3)

Air Core:
They are used primarily as current or voltage limiting devices, particularly where large currents can enter a system that uses small amounts of power. An example is the telephone system which uses very small voltages where the current in a fault condition needs to be kept to a minimum.

Iron Core:
An iron core reactor provides the same current or voltage control on a system as its air core counterpart. Iron core units tend to be used on smaller applications where the variables need greater or more sensitive control.

Drive Isolation Transformers - (see Section 4)

Drive isolation transformers are designed to supply power to AC and DC variable speed drives. The harmonics created by SCR type drives requires careful designing to match the rated hp of each drive system. The duty cycle included is approximately one start every 2 hours. The windings are designed for an overcurrent of 150% for 60 seconds, or 200% for 30 seconds.

Motor Starting Autotransformers - (see Section 5)

Motors have a large inrush current component that requires a special design. Motor starting autotransformers are designed to withstand an inrush of upwards of 25 times normal current. Typically, they are tapped on larger sizes to soft-start the motor until it is up to full RPM.

Low Voltage General Purpose Transformers - (see Section 6)

HPS low voltage general purpose transformers provide a safe, long lasting, highly reliable power source. They are designed for general lighting and other low voltage applications. They are UL listed and CSA certified.

Types of Transformers continued...

Energy Efficient Transformers - (see Section 7)

The energy efficiency requirements for distribution type transformers are continuously evolving, with the latest change occuring in the US, where the Department of Energy (DOE) mandates new higher energy efficiency levels for distribution transformers effective January 1st, 2016. HPS proudly supports this change offering its customers a complete line of DOE 2016 compliant transformers. More details about this product offer can be found in the HPS Sentinel® Energy Efficient Distribution Transformer Selection Guide (DOESEL15). In addition to the benefits to the environment, energy efficient transformers also will benefit users by providing substantial savings in operating costs thereby having a positive impact on the initial investment.

The energy efficient product offer described in this catalog continues to comply with the CSA C802.2 energy efficiency requirements. This product line also meets the DOE energy efficiency levels that were in effect from January 1, 2007 to December 31, 2015 known also as TP-1 energy efficiency levels.

Our NEMA Premium product offer is obsolete and is being replaced by the higher efficiency DOE 2016 product line that provides premium energy efficiency levels for Canadian users that would like to take advantage of its benefits described above.

CSA C802.2 Energy Efficient Transformers

Energy Efficient General Purpose Transformers
The HPS Sentinel® energy efficient general purpose transformers are designed for linear loads and are most frequently used for applications such as commercial buildings which will supply a variety of general loads.

Energy Efficient K-Factor Transformers
The HPS Synergy® energy efficient k-factor transformers are designed to tolerate heating due to harmonics associated with non-linear loads. Harmonics can indicate their presence in a number of ways: overheating, device malfunctions, telephone interference, equipment vibration and breakers tripping.

Energy Efficient Harmonic Mitigating Transformers
The HPS Centurion® energy efficient, harmonic mitigating transformer with zero sequence flux cancellation technology is specifically designed to treat the harmonics generated by computer equipment and other non-linear, power electronic loads. Combining zero sequence flux cancellation with phase shifting treats 3rd, 5th, 7th, 9th, 15th, 17th and 19th harmonics within its secondary windings. Typical applications of severe non-linear loading conditions include data centers, internet-service providers, telecom sites, call centers, broadcast centers, etc.

Encapsulated (Potted) Transformers - (see Section 8)

HPS offers two complete lines of encapsulated transformers to meet both a commercial and industrial environment. These units are encapsulated and completely enclosed.

Encapsulated Transformers for Commercial Use
The HPS Fortress™ is designed to provide the ideal solution for commercial applications. All units are encapsulated with electrical grade silica sand and resin compounds, which completely enclose the core and coil to seal out moisture, airborne contaminants and eliminates corrosion and deterioration.

Encapsulated Transformers for Harsh Environments and Hazardous Locations
The HPS Titan® design is especially suited for installations in harsh environments and hazardous locations which may contain dangerous gasses, liquids, dust, lint, moisture and where corrosive contaminants are present. Typical applications include: institutional, commercial, industrial, petrochemical, pulp and paper; food processing, mines, marine and shipboard installations. They are designed to meet both UL Standard 1604 entitled "Electrical Equipment for use in Class I and Class II, Division 2 and Class III Hazardous (Classified) Locations" and ABS Type Approval for "Marine Duty Service and Offshore Applications - Electrical Distribution and Propulsion".

INTRODUCTION

Types of Transformers continued...

Mini Power Centers - (see Section 9)

HPS power centers are conveniently pre-wired to save you time, money, and space. They're designed ideally for industrial locations, temporary power at construction sites, commercial buildings, test equipment, plant assembly lines, etc.

Autotransformers - (see Section 10)

Autotransformers are similar to Buck-Boost transformers in that they are also an economical means of adjusting output voltage. Autotransformers are designed to adjust the supply voltage when isolation from the line is not necessary and where local electrical codes permit. Units are designed in either a step-up or step-down application and meet motor inrush currents.

Energy Efficient Medium Voltage Distribution Transformers - (see Section 11)

HPS has a new line of energy efficient distribution transformers to meet the new DOE 10 CFR p.431 that comes in effect on January 1, 2016 also known as DOE 2016. More details about this product offer can be found in the HPS Millennium™ Medium Voltage Transformer Selection Guide (MILGMED15).

The Canadian product offering described in the current catalogue continues to comply with the CSA C802.2 energy efficiency requirements. This product line also meets the DOE energy efficiency levels that were in effect from January 1, 2010 to December 31, 2015.

HPS Millennium™ transformers are really 5kV class dry-type energy efficient distribution transformers. They are designed primarily for use in stepping down medium voltage power (i.e. 4160V or 2400V primary) to a lower voltage for commercial, institutional or industrial applications.

CONSTRUCTION FEATURES

Standard transformers are designed and constructed to meet or exceed the requirements for general applications. These transformers are provided either ventilated or totally enclosed. To meet special applications or custom requirements, modifications are available as either factory installed options or field installed accessories.

Please note that construction details for our Control Transformers and Reactors are in sections 1 and 3 respectively.

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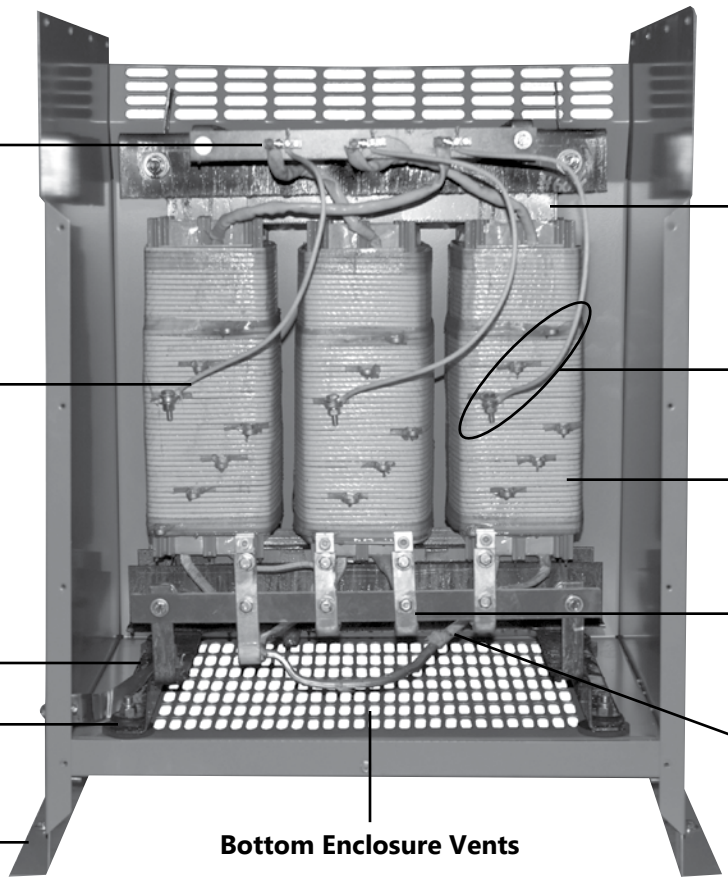
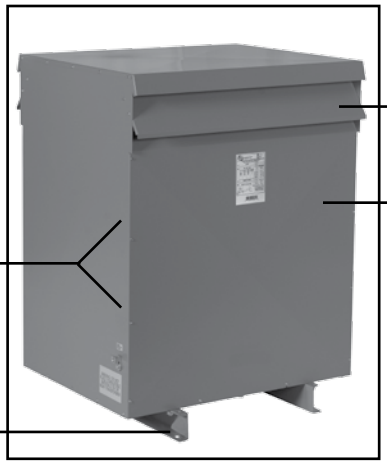




Note: For DOE 2016 construction features please see the HPS Sentinel® Energy Efficient Distribution Transformer Selection Guide (DOESEL15) or the HPS Millennium™ G Medium Voltage Transformer Selection Guide (MILGMED15)

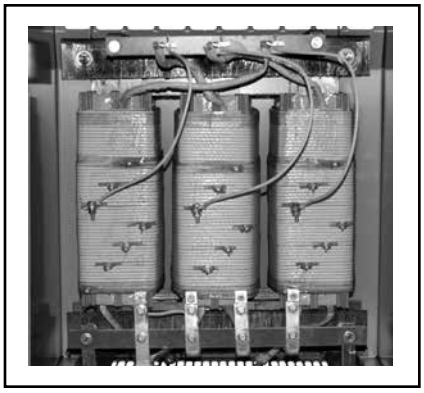
INTRODUCTION

CONSTRUCTION FEATURES continued . . .

Core Construction

HPS cores are manufactured from the highest quality non-aging, cold rolled, silicon steel laminations. Cores are precision cut to close tolerances to eliminate burrs and improve performance. Most feature fully interleaved stepped core construction for optimum energy efficiency.

Cores are carefully assembled and rigidly clamped and then either bolted or welded to minimize gaps and assure low losses and quiet operation.



Coil Construction

Coils are available in either aluminium or copper construction. Coils are precision wound with continuous copper or aluminum conductors and are electrically balanced to minimize axial short-circuit forces.

The use of duct stick permits the flow of air thus providing excellent cooling in addition to providing superior axial mechanical strength.

Terminations

HPS transformers are provided (where applicable) with both high and low terminal connectors suitable for both copper and aluminum cables. These connectors allow for easy field installation without the need to purchase connectors separately, saving the installer both time and money. For details on types and sizes of connectors provided, please refer to the features tables located within each product section.

Insulation System

The insulation rating is the maximum allowable winding (hot spot) temperature of a transformer operating at an ambient temperature of 40°C. Insulation systems are classified by the temperature rating. The following table summarizes the different insulation systems available.

Insulation Rating	Insulation Class	Average Winding Temperature Rise	Hot Spot Temperature Rise	Maximum Winding Temperature
Class 105	A	55°C	65°C	105°C
Class 150 or 130	B	80°C	110°C	150°C
Class 180	F	115°C	145°C	180°C
Class 200	N	130°C	160°C	200°C
Class 220	H	150°C	180°C	220°C

NOTE: The maximum acceptable temperature rise based on an average ambient of 30°C during any 24 hour period and a maximum ambient of 40°C at any time.

Note: For DOE 2016 construction features please see the HPS Sentinel® Energy Efficient Distribution Transformer Selection Guide (DOESEL15) or the HPS Millennium™ G Medium Voltage Transformer Selection Guide (MILGMED15)

CONSTRUCTION FEATURES continued . . .

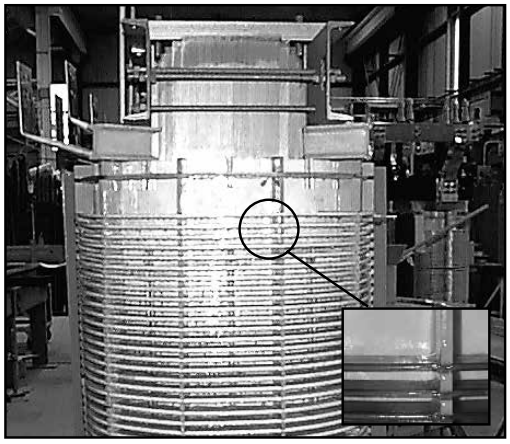
VACUUM PRESSURE IMPREGNATION (VPI)

The following briefly describes our process.

Polyester Resin Impregnation

For most applications, regardless of voltage class, HPS' polyester resin impregnation system is preferred. The polyester resin exhibits a much higher dielectric strength and bonding properties than any varnish previously used, or other encapsulations including oil modified epoxies. This polyester resin exhibits these characteristics:

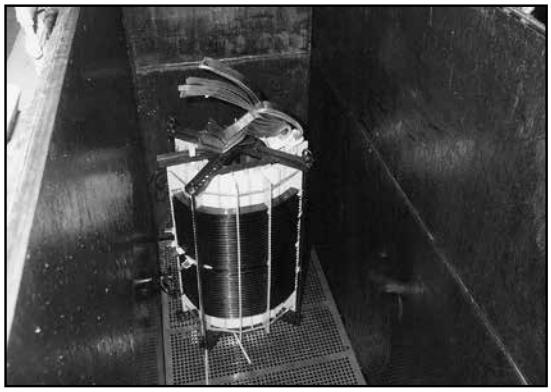
- Low moisture absorption (Non-Hydroscopic)
- High dielectric strength
- High bond strength
- Excellent mechanical properties
- Stability at high temperatures
- Excellent thermal shock properties
- Longevity of life at maximum transformer temperatures
- UL approved for 220°C insulation systems for any voltage class
- Fungus-resistant reactive components makes it environmentally superior



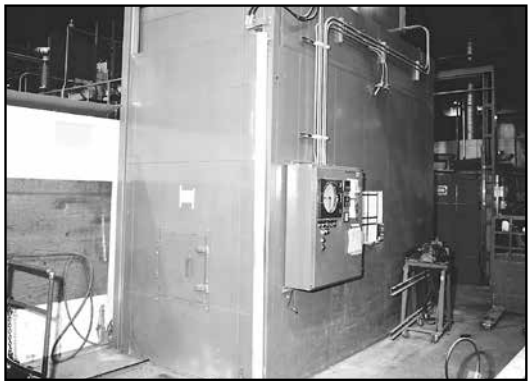
For long-term life expectancy, it is critical that transformers maintain the integrity of the dielectric properties of the insulation materials.

At HPS, transformer coils are impregnated with a complete vacuum-pressure impregnating cycle:

- Coils are placed in a sealed tank and a vacuum is drawn
- The resin is then introduced into the chamber and the assembly is completely immersed
- The tank is then pressurized to force the impregnation material to thoroughly penetrate the windings
- The coils or assembly are then removed from the chamber and oven cured
- These steps are then repeated

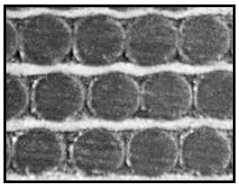


Vacuum Pressure Chamber



Baking Oven

The result is transformers whose coils exhibit virtually corona-free performance, a superior resistance to environmental conditions and a new standard of reliability even for the worst industrial, utility or commercial applications.

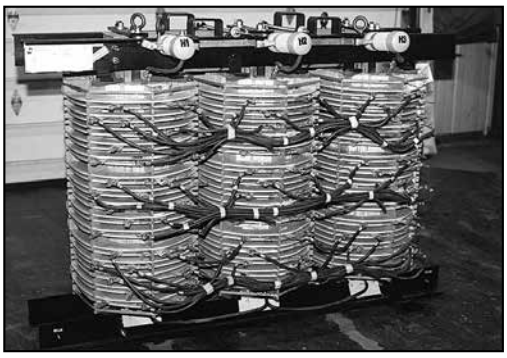


Note: For DOE 2016 construction features please see the HPS Sentinel® Energy Efficient Distribution Transformer Selection Guide (DOESEL15) or the HPS Millennium™ G Medium Voltage Transformer Selection Guide (MILGMED15)

TRANSFORMER BASICS

Banking of Transformers

Two or three single phase transformers can be connected to make a three phase bank. The primary windings of the single phase transformers can be connected in delta or wye. The secondary windings can also be connected in either a delta or wye configuration. The equivalent capacity of the bank will be equal to three times the nameplate rating of each single phase transformer. Usually this type of installation is more expensive than using a single three phase transformer.



Primary Voltage Taps

In some cases, the actual supply voltage to the primary of the transformer is either slightly higher or lower than the nameplate rating. Taps are provided on most transformers on the primary winding to correct this condition and maintain full rated output voltage and capacity. Standard taps are usually in 2 ½% or 5% increments. Example: The transformer has a 480V primary rating and the incoming voltage is at 504V. The primary connection should be made at the +5% tap in order to maintain the nominal secondary voltage.

Transformer Operation at 50 Hz

Transformers rated at 60Hz should not be used on a 50Hz supply due to higher losses and core saturation and the resultant higher temperature rise. Transformers rated for 50Hz, however, can be operated on a 60Hz supply.

Reverse Connection

HPS does NOT recommend the back-feeding of HPS transformers. Reverse feeding HPS transformers may result in technical issues and safety aspects that could be easily avoided by using a transformer specifically designed for the required step-up application. Back-feeding may also void the HPS product warranty.

HPS has the know-how and capability to assist its customers in satisfying the most demanding application needs in a time sensitive manner with the most suitable design.

Transformer Basics continued . . .

Balance Loading on Single and Three Phase Transformers

A single phase transformer with 120/240V secondary has two separate 120V secondary windings and is usually connected into a 3 wire system. Care must be exercised in distributing the load on the two 120V windings evenly, so each winding is carrying about half of the total load.

Similarly for a three phase transformer, each phase should be considered as a single phase transformer. When distributing single phase loads between the three phases, each of the three windings should be evenly loaded.

Sound Level

Sound needs to be considered when transformers are located in close proximity to occupied areas. All energized transformers emanate sound due to the alternating flux in the core. This normal sound emitted by the transformer can be a source of annoyance unless it is kept below acceptable levels.

HPS transformers are built to meet the latest ANSI, CSA and UL standards. These standards use NEMA-ST20 (see below table for outline).

HPS also offers "Low Sound" options to most of it distribution style transformers. Please contact your HPS sales representative for details.

Equivalent Two Winding kVA	Self Cooled Ventilated Voltage Line to Line		Self Cooled Non-Ventilated
	1.2kV	>1.2kV	
	dB-A	dB-A	dB-A
0-9	40	45	45
10-50	45	50	50
51-150	50	55	55
151-300	55	58	57
301-500	60	60	59
501-700	62	62	61
701-1000	64	64	63

SELECTING TRANSFORMERS

SINGLE PHASE

A single phase transformer is designed to transform single phase or three phase input (source) voltage to the single phase output (load) voltage required by your equipment. To select the correct single phase transformer you must first determine:

1. The equipment being installed operates on a **single phase** supply (see your equipment nameplate or installation manual).
2. The **Primary Voltage** of the transformer. This is the same as the line input (or source) voltage, typically 480 or 600 volts AC.
3. The **Secondary Voltage** of the transformer. The equipment being installed will have a specified supply voltage (see equipment nameplate or installation manual). The transformer you select must have a secondary voltage equal to the required supply voltage of the equipment, typically 120/240 VAC.
4. The **Frequency** in Hertz (cycles-per-second) of the input (source) voltage must be the same as the operating frequency of the equipment being supplied. The transformer selected must operate at the same frequency. Typical operating frequency is 60 Hz.
5. The **Total VA** of the load is determined by the product of the voltage supplied across the load and the current passing through it. This is normally expressed in VA (Volt-Amperes) or kVA (kilo Volt-Amperes) on the equipment nameplate. The total load is often a combination of various loads (i.e. lights, heaters, motors). You must calculate these individual loads and add them together to obtain the total load of the transformer. The transformer you select must have a kVA rating equal to or greater than the load on the transformer.

How to use the full load chart to find kVA:

1. Determine the secondary voltage of your transformer.
2. Sum up the total amperes required by the load.
3. From the full load current table below, select a transformer under the corresponding secondary voltage, with a standard kVA capacity and amperage equal to or higher than the sum required by the load.

Calculating kVA: To calculate kVA when volts and amperes are known:

$$kVA = \frac{\text{Volts X Amps (load)}}{1000}$$

Full Load Current Table Single Phase Transformer

	Current in Amperes					
kVA	**120V**	**240V**	**480V**	**600V**	**2400V**	**4160V**
0.5	4.17	2.08	1.04	0.83		
0.75	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		
3	25	12.5	6.25	5	1.25	0.72
5	41.7	20.8	10.4	8.33	2.08	1.2
7.5	62.5	31.3	15.6	12.5	3.13	1.8
10	83.3	41.7	20.8	16.7	4.17	2.4
15	125	62.5	31.3	25	6.25	3.61
25	208	104	52.1	41.7	10.4	6.01
37.5	313	156	78.1	62.5	15.6	9.01
50	417	208	104	83.3	20.8	12
75	625	313	156	125	31.3	18
100	833	417	208	167	41.7	24
150	1250	625	313	250	62.5	36
167	1392	696	348	278	69.6	40.1
250	2083	1042	521	417	104	60.1
333	2775	1388	694	555	139	80

Single Phase AC Motor Full Load Running Currents in Amperes and Recommended Transformer Ratings

	Full Load Current (Amps)			Minimum Transformer kVA
Horsepower	**110-120V**	**208V**	**220-240V***	
0.50 HP	9.8	5.4	4.9	1.5
0.75 HP	13.8	7.6	6.9	2.0
1.0 HP	16.0	8.8	8.0	3.0
1.5 HP	20.0	11.0	10.0	3.0
2.0 HP	24.0	13.2	12.0	5.0
3.0 HP	34.0	18.7	17.0	5.0
5.0 HP	56.0	30.8	28.0	7.5
7.5 HP	80.0	44.0	40.0	15.0
10 HP	100	55.0	50.0	15.0
15 HP	135	74.8	68.0	25.0
20 HP	-	-	88.0	25.0
25 HP	-	-	110	37.5
30 HP	-	-	136	37.5
40 HP	-	-	176	50.0
50 HP	-	-	216	75.0

kVA ratings include 10% overcapacity for frequent motor starts.
* For 200 volt motors increase 220-240V ratings by 15%.

INTRODUCTION

Selecting Transformers continued . . .

THREE PHASE

A three phase transformer is designed to transform a three phase input (source) voltage to the single phase and three phase output (load) voltages required by your equipment.

In order to select the correct three phase transformer you must first determine:

1. The equipment being installed operates on a **three phase** supply. Note: If both single phase and three phase equipment makes up the load, the single phase equipment is connected to only one phase of the transformer.
2. The **Primary Voltage** of the transformer. This is the same as the line input (or source) voltage, typically 480 or 600 volts AC.
3. The **Secondary Voltage** of the transformer. This is the transformer's output voltage and must be the same as the voltage required by the equipment being installed (see equipment nameplate, typically 208Y/120 volts).
4. The **Frequency** in hertz (cycles per second) of the input (source) voltage must be the same as the operating frequency of the equipment being supplied. The transformer selected must operate at the same frequency. Typical operating frequency is 60 Hz.
5. The **Total VA** of the load is determined by the product of the voltage supplied across the load and the current passing through it. This is normally expressed in VA (Volt-Amperes) or kVA (kilo Volt-Amperes) on the equipment nameplate.

The total load is often a combination of various loads (i.e. lights, heaters, motors). You must calculate these individual loads and add them together to obtain the total load of the transformer.

The transformer you select must have a kVA rating equal to or greater than the load requirement.

Note: The three phase transformer must be selected so that any one phase is not overloaded. If you are connecting a single phase load to one phase of the three phase transformer, you must calculate the load as if it were loading all three phases.

Calculating kVA

To calculate kVA when volts and amperes are known:

$$kVA = \sqrt{3} \times \frac{V_{LL} \times I_L}{1000}$$

V_{LL} = Volts line - line

I_L = Line Current

Full Load Current Table - Three Phase Transformer

kVA	Current in Amperes					
	208V	240V	480V	600V	2400V	4160V
3	8.33	7.22	3.61	2.89	0.72	0.42
6	16.7	14.4	7.22	5.77	1.44	0.83
9	25	21.7	10.8	8.66	2.17	1.25
15	41.6	36.1	18	14.4	3.61	2.08
30	83.3	72.2	36.1	28.9	7.22	4.16
45	125	108	54.1	43.3	10.8	6.25
75	208	180	90.2	72.2	18	10.4
100	278	241	120	96.2	24.1	13.9
112.5	312	271	135	108	27.1	15.6
150	416	361	180	144	36.1	20.8
225	625	541	271	217	54.1	31.2
300	833	722	361	289	72.2	41.6
450	1249	1082	541	433	108	62.4
500	1388	1203	601	481	120	69.4
600	1665	1443	722	577	144	83.3
750	2082	1804	902	722	180	104
1000	2776	2406	1203	962	241	139
1500	4164	3609	1804	1443	361	208
2000	5552	4811	2406	1925	481	278
2500	6940	6014	3007	2406	601	347
3000	8327	7217	3608	2887	722	416

Three Phase AC Motor Full Load Running Currents in Amperes and Recommended Transformer Ratings

Horsepower	Full Load Current (Amps) Minimum					Transformer kVA
	110-120V	208V	220-240V*	440-480V	550-600V	
0.50 HP	4.0	2.2	2.0	1.0	0.8	3
0.75 HP	5.6	3.1	2.8	1.4	1.1	3
1.0 HP	7.2	4.0	3.6	1.8	1.4	3
1.5 HP	10.4	5.7	5.2	2.6	2.1	3
2.0 HP	13.6	7.5	6.8	3.4	2.7	6
3.0 HP	19.2	10.7	9.6	4.8	3.9	6
5.0 HP	30.4	16.7	15.2	7.6	6.1	9
7.5 HP	44.0	24.0	22.0	11.0	9.0	15
10 HP	56.0	31.0	28.0	14.0	11.0	15
15 HP	84.0	46.0	42.0	21.0	17.0	30
20 HP	108	59.0	54.0	27.0	22.0	30
25 HP	136	75.0	68.0	34.0	27.0	45
30 HP	160	88.0	80.0	40.0	32.0	45
40 HP	208	114	104	52.0	41.0	75
50 HP	260	143	130	65.0	52.0	75
60 HP	-	170	154	77.0	62.0	75
75 HP	-	211	192	96.0	77.0	112.5
100 HP	-	273	248	124	99.0	150

kVA ratings include 10% overcapacity for frequent motor starts.
* For 200 volt motors increase 220-240V ratings by 15%.

COMPLIANCE WITH ENGINEERING STANDARDS

HPS Dry-Type Transformers are approved, listed, recognized or comply with the following Regulatory Standards. The reference files are:

UL1561 and UL1562	CSA C9-M and CSA C22.2-M	
ANSI C57.12.51	NEMA TR-1 and ST-1	IEC 76

HPS dry-type transformers can be built to comply with the following engineering standards:

- **UL 1561 :** Dry-Type General Purpose and Power Transformers
- **UL 1562 :** Transformers, Distribution, Dry-Type over 600 volts
- **IEEE-C57.12.01 :** General Requirements for Dry-Type Distribution and Power Transformers
- **NEMA ST-20 :** Dry-Type Transformers for General Applications
- **ANSI-C57.12.51 :** Requirements for Ventilated Dry-Type
- **ANSI-C57.12.70 :** Terminal Markings & Connections for Distribution & Power Transformers
- **ANSI-C57.12.91 :** Test Code for Dry-Type Distribution and Power Transformers
- **ANSI-C57.12.90 :** Guide for Short Circuit Testing of Distribution and Power Transformers
- **NEMA 250 :** Enclosures for Electrical Equipment
- **CSA-C22.2 No. 47 :** Air-Cooled (Dry-Type) Transformers
- **CSA-C9-M :** Dry-Type Transformers
- **CSA C802.2 and DOE 10 CFR Part 431:** Energy Efficiency Standards

TRANSFORMER TEST STANDARDS

All transformers are tested at the manufacturing facility prior to shipment. Transformers must meet very specific criteria to be certified acceptable for release. Tests are categorized as 'Production Tests' and 'Type Tests'. Production Tests are typically applied to every transformer, where Type Tests are required either to qualify a new product or to further certify a production product. Type tests are optional and are available at an additional cost.

Production Tests

D.C. Resistance Measurement

Current from a D.C. resistance bridge is applied to the transformers windings to determine the D.C. resistance of the coils. This test is important for the calculation of I^2R for use in the winding temperature test and as base data for future assessment in the field.
(Note: This is a standard test. Data retained on units over 500kVA only).

Polarity and Phase-Relation Test

Polarity and phase-relation tests are made to determine angular displacement and relative phase sequence to facilitate connections in a transformer. Determining polarity is also essential when paralleling or banking two or more transformers.
(Note: This is a standard test. Data retained on units over 500kVA only).

Transformer Test Standards continued ...

No-Load and Excitation Current Test

No-load losses (excitation losses) are the core losses of a transformer that are "excited" at rated voltage and frequency, but which do not supply load. No-load losses include core loss, dielectric loss and losses in the windings due to exciting current.

The transformer is excited at rated voltage with all other windings open circuited. The exciting current and no load loss is then measured.

(Note: This is a standard test to determine that energy efficiency requirements are met. Data retained on units over 500kVA only).

Voltage Ratio (turns ratio)

To confirm the voltage ratio of a transformer, the ratio of the number of turns in the high-voltage winding with respect to the number of turns in the low-voltage winding is measured.

(Note: This is a standard test. Data retained on units over 500kVA only).

Applied Potential Test

A normal power frequency, such as 60 Hz, is applied to each winding for one minute with all other windings and core grounded. These tests are in accordance with UL 1561.

Induced Voltage Test

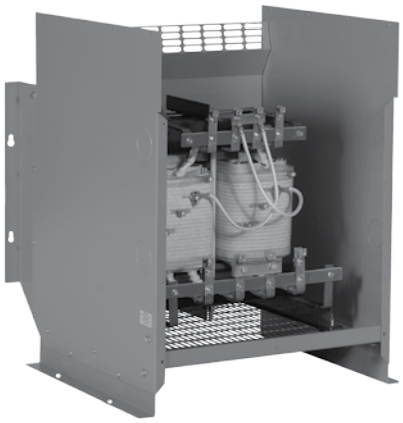
The induced voltage test is applied for 7200 cycles. The voltage applied is twice the operating voltage and confirms the integrity of the insulation.

Impedance Voltage and Load Loss Test

The voltage required to circulate the rated current under short-circuit conditions when connected on the rated voltage tap is the impedance voltage.

Rated current is circulated through the windings with the secondary short circuited. The impedance voltage and load loss is then measured. They are corrected to rise +20°C reference temperature.

(Note: This is a standard test only on units over 500kVA. It will only be carried out on lower kVA units when specifically requested. Extra charges apply below 500kVA)



Type Tests

Type tests are required either to qualify a new product or to further certify a standard product line. The following is a list of type tests performed on HPS Transformers.

(Note: Available at an additional charge)

- **Temperature Rise Test**
- **Sound Level Test**
- **Partial Discharge (corona)**
- **Basic Impulse Insulation Level (BIL)**
- **Short-Circuit Test**
- **Insulation Resistance Test**

QUALITY MANAGEMENT SYSTEMS

ISO 9001:2008

Hammond Power Solutions facilities, located in Guelph Ontario Canada, Walkerton Ontario Canada, Baraboo Wisconsin USA, Compton California USA and Monterrey Mexico, (which manufacture the transformers featured in this catalog), have implemented Quality Management Systems based on ISO 9001. ISO 9001 includes all processes affecting quality, customer satisfaction and continual improvement. Our customers can be assured of the integrity and quality in all Hammond Power Solutions transformer products.

HPS STANDARD ENCLOSURES

An enclosure is a surrounding case constructed to provide a degree of protection to personnel against access to hazardous parts and to provide a degree of protection to the enclosed equipment against specified environmental conditions.

Applicable Engineering Standards

HPS Enclosures are designed in accordance with the following standards:

- CSA 22.2 No. 47 (General Purpose)
- CSA 22.2 No. 94 (Specialty Enclosures)
- NEMA 250
- UL 50 and UL 50E

Please ensure to reference all local and national electrical codes and applicable transformer standards before selecting an enclosure for your application.

Definitions

Degree of protection: The extent of protection provided by an enclosure against access to hazardous parts, against ingress of foreign solid objects and/or against ingress of water and verified by approved standardized test methods.

Hazardous parts: A part that is hazardous to approach or to touch.

Indoor Locations: Areas which are protected from exposure to the weather.

Non-ventilated: Constructed so as to provide no intentional circulation of external air through the enclosure.

Outdoor locations: Locations that are exposed to the weather.

Ventilated: Constructed so as to provide for the circulation of external air through the enclosure to remove excess heat, fumes or vapors.

Enclosure Selection

The selection of the appropriate enclosure is vital for the long term reliability of your HPS product. The "degree of protection" an enclosure actually provides can only be determined by referencing the appropriate test methods outlined in the above mentioned standards.

The list below is just some of the typical enclosure types available for HPS products, their applications, and the environmental conditions they are designed to meet.

HPS Typical Enclosures Types

The following lists some of the standard HPS enclosures available and a brief description of their applications:

TYPE 1
This is a general purpose ventilated enclosure constructed for indoor use only to provide a degree of protection to personnel against access to hazardous parts; to provide a degree of protection of the equipment inside the enclosure against ingress of solid foreign objects (falling dirt).

TYPE 2
This is a general purpose ventilated enclosure constructed for indoor use only to provide a degree of protection to personnel against access to hazardous parts; to provide a degree of protection of the equipment inside the enclosure against the ingress of solid foreign objects (falling dirt); and to provide a degree of protection with respect to harmful effects on the equipment due to the ingress of water (dripping or light splashing).

TYPE 3RI
This is a general purpose ventilated enclosure constructed for indoor use only to provide a degree of protection to personnel against access to hazardous parts; to provide a degree of protection of the equipment inside the enclosure against the ingress of solid foreign objects (falling dirt); and to provide a degree of protection with respect to harmful effects on the equipment due to the ingress of water (sprinkler head spray, light splashing of liquids).

TYPE 3R
This is a general purpose ventilated enclosure constructed for either indoor or outdoor use to provide a degree of protection to personnel against access to hazardous parts; to provide a degree of protection of the equipment inside the enclosure against the ingress of solid foreign objects (falling dirt); and to provide a degree of protection with respect to harmful effects on the equipment due to the ingress of water (rain, sleet, snow); and that will be undamaged by the external formation of ice on the enclosure.

INTRODUCTION

HPS Standard Enclosures continued ...

TYPE 3RE
This is a general purpose ventilated enclosure constructed for either indoor or outdoor use to provide a degree of protection to personnel against access to hazardous parts; to provide a degree of protection of the equipment inside the enclosure against the ingress of solid foreign objects (falling dirt and circulating dust); and to provide a degree of protection with respect to harmful effects on the equipment due to the ingress of water (rain, sleet, circulating snow); and that will be undamaged by the external formation of ice on the enclosure.

TYPE 4
This is a general purpose non-ventilated enclosure constructed for either indoor or outdoor use to provide a degree of protection to personnel against access to hazardous parts; to provide a degree of protection of the equipment inside the enclosure against the ingress of solid foreign objects (falling dirt and windblown dust); and to provide a degree of protection with respect to harmful effects on the equipment due to the ingress of water (rain, sleet, snow, splashing water, and hose directed water); and that will be undamaged by the external formation of ice on the enclosure. (Note: not submersible)

TYPE 4X
This is a general purpose non-ventilated enclosure constructed for either indoor or outdoor use to provide a degree of protection to personnel against access to hazardous parts; to provide a degree of protection of the equipment inside the enclosure against the ingress of solid foreign objects (windblown dust); and to provide a degree of protection with respect to harmful effects on the equipment due to the ingress of water (rain, sleet, snow, splashing water, and hose directed water); that provides an additional level of protection against corrosion; and that will be undamaged by the external formation of ice on the enclosure. (Note: not submersible)

TYPE 12
This is a general purpose non-ventilated enclosure constructed (without knockouts) for indoor use only to provide a degree of protection to personnel against access to hazardous parts; to provide a degree of protection of the equipment inside the enclosure against the ingress of solid foreign objects (falling dirt and circulating dust, lint, fibers, and filings); and to provide a degree of protection with respect to harmful effects on the equipment due to the ingress of water (dripping and light splashing). (Note: not submersible)

Comparison of Enclosures for Indoor and Outdoor Non-Hazardous Locations

		Indoor						Indoor/Outdoor								Submersible	
CSA C22.2 No. 94.2 Enclosure Type		**1 [a]**	**2 [a]**	**5**	**12**	**12K**	**13**	**3**	**-**	**3R[a]**	**-**	**3S**	**-**	**4**	**4X**	**6**	**6P**
NEMA 250 Enclosure Type		**1 [a]**	**2 [a]**	**5**	**12**	**12K**	**13**	**3**	**3X**	**3R[a]**	**3RX[a]**	**3S**	**3SX**	**4**	**4X**	**6**	**6P**
Equivalent IEC 60529 IP designation [e]		**IP20**	**IP22**	**IP53**	**IP54**	**IP54**	**IP54**	**IP55**	**IP55**	**IP24**	**IP24**	**IP55**	**IP55**	**IP66**	**IP66**	**IP67**	**IP68**
Provides a degree of protection against these environmental conditions	Accidental contact with live parts	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x
	Falling dirt	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x
	Dripping and light splashing of non-corrosive liquids		x	x	x	x	x	x	x	x	x	x	x	x	x	x	x
	Circulating dust, lint, fibers and flyings				x	x	x	x	x			x	x	x	x	x	x
	Settling[d] dust, lint, fibers and flying[d]			x	x	x	x	x	x			x	x	x	x	x	x
	Wind-blown dust							x	x			x	x	x	x	x	x
	Rain, snow, and external formation of ice or sleet[b]							x	x	x	x	x	x	x	x	x	x
	External Formation of ice or sleet[c]											x	x				
	Hose down and splashing water													x	x	x	x
	Corrosion								x		x		x		x		x
	Occasional temporary submersion															x	x
	Occasional prolonged submersion																x
	Oil and coolant seepage				x	x	x										
	Oil and coolant seepage, spraying and splashing						x										

Notes:
a - These enclosures may be ventilated
b - External operating mechanism(s) is not required to operate when the enclosure is ice covered
c - External operating mechanism(s) shall be operable when the enclosure is ice covered
d - These fibers are flyings are non-hazardous and are not considered Class III type ignitable fibers or combustible flyings
e - Since IEC 60529 does not specify degrees of protection for many conditions considered within CSA C22.2 No. 94.2, the IEC classifications cannot be exactly equated to North American Type numbers. The North American Type numbers meet or exceed the test requirements for the associated IP classifications. This table cannot be used to convert from IEC classifications to North American Type designations

References: CSA C22.2 No. 94.2, CSA C22.1 (CEC), NEMA 250, NEMA document - NEMA Enclosure Types
Disclaimer: This table is for quick comparison only. Please refer to appropriate standard for enclosure selection to meet your needs.

INTRODUCTION

HAMMOND POWER SOLUTIONS INC. EXCLUSIVE LIMITED WARRANTY

Exclusive Warranty

Hammond Power Solutions Inc. ("HPS"), warrants to the original purchaser of the standard transformers listed in this catalog (the "Goods"), will be free from defects in materials and workmanship for a period commencing on the date of manufacture of the Goods and expiring at the end of the period specified below (the "Warranty Period"). THIS WARRANTY IS EXCLUSIVE AND IS IN LIEU OF ANY OTHER WARRANTY EXPRESS OR IMPLIED, INCLUDING BUT NOT LIMITED TO ANY IMPLIED WARRANTY OR MERCHANTABILITY OR FITNESS FOR A PARTICULAR PURPOSE.

Warranty Exclusions - Limitation of Damages and Claims Procedure

The above stated warranty does not cover: workmanship of installation; dissatisfaction or damage due to improper installation, vandalism, misuse, accident, excessive wear and tear, unauthorized repair, abnormal use, lack of maintenance, or other cause(s) not within HPS's control and HPS WILL NOT BE LIABLE, UNDER ANY CIRCUMSTANCES, FOR CONSEQUENTIAL OR INCIDENTAL DAMAGES, INCLUDING BUT NOT LIMITED TO LABOR COSTS OR LOST PROFITS RESULTING FROM THE USE OF OR INABILITY TO USE THE GOODS OR FROM THE GOODS BEING INCORPORATED IN OR BECOMING A COMPONENT OR ANY OTHER PRODUCT. Without limiting the generality of the foregoing, HPS will not be responsible for labor costs involved in the removal of Goods or the installation of replacement Goods.

HPS's liability and the Buyer's exclusive remedy hereunder will be limited to repair or replacement of those Goods found in HPS's reasonable judgment to be defective. HPS reserves the right to accept or reject any claim in whole or in part. HPS will not accept the return of any Goods without its prior written approval. Please consult HPS for instructions on the Return Authorization procedure.

Product Warranty Periods:

Industrial Control Transformers (Section 1)	
HPS Imperator®	**Lifetime Warranty**
HPS Spartan®	**15 Years**
Other Control	**10 Years**
HPS Fusion™ General Purpose Enclosed Transformers (Section 1)	**15 Years**
HPS Universal™ Buck-Boost/Low Voltage Lighting Transformers (Sections 2 & 6)	**10 Years**
HPS Centurion® R Reactors (Section 3)	**10 Years**
DV/DT Filters (Section 3)	**10 Years**
HPS Tribune™ and Standard Drive Isolation Transformers (Section 4)	**10 Years**
Motor Starting Auto Transformers (Section 5)	**1 Year**
Energy Efficient Distribution Transformers (Section 7)	**10 Years**
Encapsulated Dry-Type Distribution Transformers (Section 8)	**10 Years**
HPS PowerPlus™ Mini Power Center (Section 9)	
Transformer only	**15 Year**
Mini Power Center	**1 Year**
Autotransformers (Section 10)	**10 Years**
HPS Millennium Medium Voltage Distribution Transformers (Section 11)	**1 Year**
All HPS six digit Special and Custom Transformers	**1 Year**