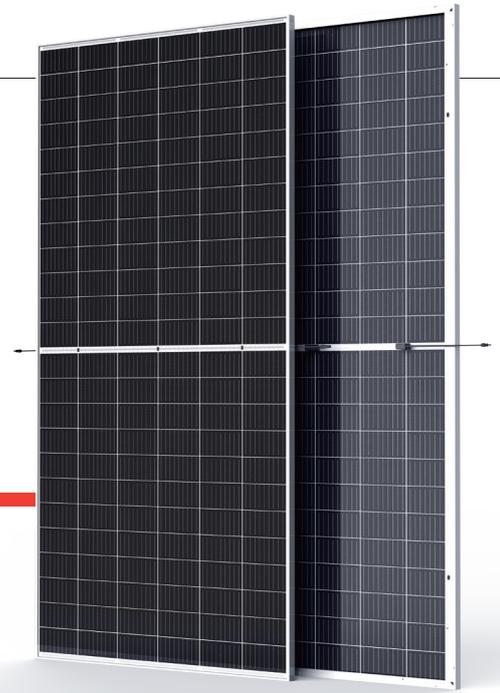


THE

DUOMAX twin

BIFACIAL DUAL GLASS 144 CELL MULTI BUSBAR MODULE



144-Cell

MONOCRYSTALLINE MODULE

390-410W

POWER OUTPUT RANGE

20.2%

MAXIMUM EFFICIENCY

0~+5W

POSITIVE POWER TOLERANCE

Founded in 1997, Trina Solar is the world's leading total solution provider for solar energy. With local presence around the globe, Trina Solar is able to provide exceptional service to each customer in each market and deliver our innovative, reliable products with the backing of Trina as a strong, bankable brand. Trina Solar now distributes its PV products to over 100 countries all over the world. We are committed to building strategic, mutually beneficial collaborations with installers, developers, distributors and other partners in driving smart energy together.

Comprehensive Products and System Certificates

IEC61215/IEC61730/IEC61701/IEC62716

ISO 9001: Quality Management System

ISO 14001: Environmental Management System

ISO14064: Greenhouse Gases Emissions Verification

OHSAS 18001: Occupation Health and Safety Management System



PRODUCTS

TSM-DEG15MC.20(II)

POWER RANGE

390-410W



High power output

- Up to 410W front power and 20.2% module efficiency with half-cut and MBB (Multi Busbar) technology enabling higher BOS savings
- Lower resistance of half-cut cells ensures higher power



Certified to perform in highly challenging environments

- High PID resistance through cell process and module material control
- Resistant to salt, acid, sand, and ammonia
- Proven to be reliable in high temperature and humidity areas
- Certified to the best fire class A
- Minimizes micro-crack and snail trails
- Certified to 5400 Pa positive load and 2400 Pa negative load



High energy generation, low LCOE

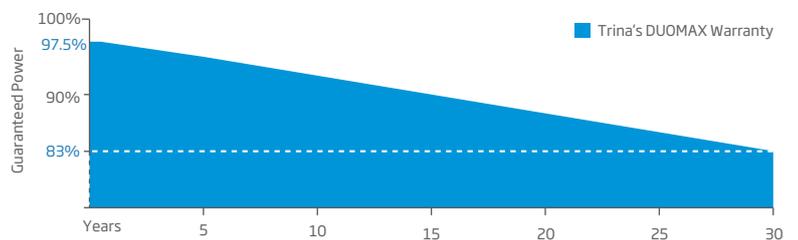
- Up to 25% additional power gain from back side, depending on the albedo
- Excellent 3rd party validated IAM and low light performance with cell process and module material optimization
- Low temp coefficient (-0.35%) and NMOT increases energy production
- Better anti-shading performance and lower operating temperature
- Higher power from same installation footprint as standard modules



Easy to install, wide application

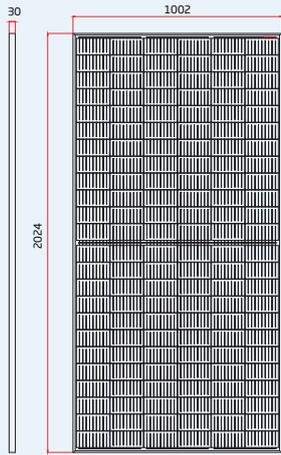
- Frame design enables compatibility with standard installation methods
- Deployable for ground mounted utility, carports, and agricultural projects
- Safe and easy to transport, handle, and install like normal framed modules

Trina Solar's DUOMAX Performance Warranty

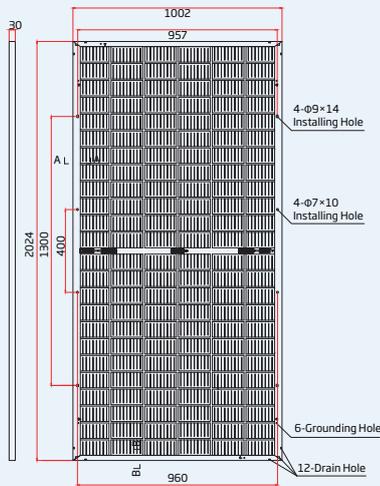


From the 2nd year to the 30th year, the average annual power decline will be no more than 0.5%.

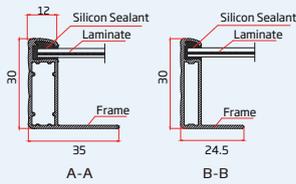
DIMENSIONS OF PV MODULE (mm)



Front View



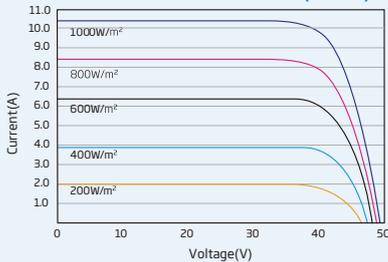
Back View



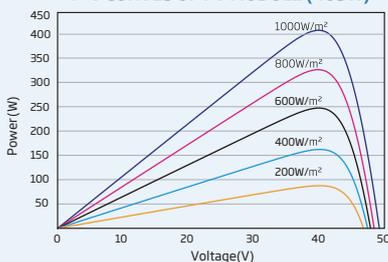
A-A

B-B

I-V CURVES OF PV MODULE (405 W)



P-V CURVES OF PV MODULE (405W)



ELECTRICAL DATA (STC)

Peak Power Watts- P_{MAX} (Wp)*	390	395	400	405	410
Power Output Tolerance- P_{MAX} (W)	0 ~ +5				
Maximum Power Voltage- V_{MPP} (V)	40.2	40.5	40.8	41.1	41.4
Maximum Power Current- I_{MPP} (A)	9.71	9.76	9.81	9.86	9.91
Open Circuit Voltage- V_{OC} (V)	48.5	48.7	48.9	49.1	49.3
Short Circuit Current- I_{SC} (A)	10.25	10.29	10.33	10.37	10.41
Module Efficiency η_m (%)	19.2	19.5	19.7	20.0	20.2

STC: Irradiance 1000W/m², Cell Temperature 25°C, Air Mass AM1.5.
*Measuring tolerance: ±3%.

ELECTRICAL DATA (NMOT)

Maximum Power- P_{MAX} (Wp)	295	299	302	306	310
Maximum Power Voltage- V_{MPP} (V)	37.7	38.0	38.3	38.6	38.9
Maximum Power Current- I_{MPP} (A)	7.82	7.86	7.90	7.93	7.97
Open Circuit Voltage- V_{OC} (V)	45.7	45.9	46.1	46.3	46.5
Short Circuit Current- I_{SC} (A)	8.26	8.29	8.33	8.36	8.39

NMOT: Irradiance at 800W/m², Ambient Temperature 20°C, Wind Speed 1m/s.

Electrical characteristics with different rear side power gains (referenced specifically to 405 Wp front)**

Maximum Power- P_{MAX} (Wp)	425	446	466	486	506
Maximum Power Voltage- V_{MPP} (V)	41.1	41.1	41.1	41.1	41.1
Maximum Power Current- I_{MPP} (A)	10.35	10.85	11.34	11.83	12.33
Open Circuit Voltage- V_{OC} (V)	49.2	49.3	49.4	49.5	49.6
Short Circuit Current- I_{SC} (A)	10.89	11.41	11.93	12.44	12.96
P_{max} gain	5%	10%	15%	20%	25%

Power Bifaciality: 70±5%.

MECHANICAL DATA

Solar Cells	Monocrystalline
Cell Orientation	144 cells (6 × 24)
Module Dimensions	2024 × 1002 × 30 mm (79.69 × 39.45 × 1.18 inches)
Weight	26.0 kg (57.3 lb)
Front Glass	2.0 mm (0.08 inches), High Transmission, AR Coated Heat Strengthened Glass
Encapsulant material	POE/EVA
Back Glass	2.0 mm (0.08 inches), Heat Strengthened Glass (White Grid Glass)
Frame	30mm (1.18 inches) Anodized Aluminium Alloy
J-Box	IP 68 rated
Cables	Photovoltaic Technology Cable 4.0 mm ² (0.006 inches ²) Portrait: 280/280 mm (11.02/11.02 inches) Landscape: 1900/1900 mm (74.80/74.80 inches)
Connector	Trina TS4

TEMPERATURE RATINGS

NMOT (Nominal Module Operating Temperature)	41°C (±3°C)
Temperature Coefficient of P_{MAX}	- 0.35%/°C
Temperature Coefficient of V_{OC}	- 0.25%/°C
Temperature Coefficient of I_{SC}	0.04%/°C

(Do not connect Fuse in Combiner Box with two or more strings in parallel connection)

MAXIMUM RATINGS

Operational Temperature	-40~+85°C
Maximum System Voltage	1500V DC (IEC)
	1500V DC (UL)
Max Series Fuse Rating	20A

WARRANTY

12 year Product Workmanship Warranty

30 year Power Warranty

(Please refer to product warranty for details)

PACKAGING CONFIGURATION

Modules per box: 35 pieces

Modules per 40' container: 665 pieces

** Back-side power gain varies depending upon the specific project albedo

HIGH PERFORMANCE BIFACIAL PERC MONOCRYSTALLINE MODULE

RSM144-6-370BMDG-390BMDG

144 CELL MONOCRYSTALLINE MODULE

370-390Wp POWER OUTPUT RANGE

1500VDC MAXIMUM SYSTEM VOLTAGE

19.5% MAXIMUM EFFICIENCY



About Risen Energy

Risen Energy is a leading, global tier 1 manufacturer of high-performance solar photovoltaic products and provider of total business solutions for residential, commercial and utility-scale power generation. The company, founded in 1986, and publicly listed in 2010, compels value generation for its chosen global customers. Techno-commercial innovation, underpinned by consummate quality and support, encircle Risen Energy's total Solar PV business solutions which are among the most powerful and cost-effective in the industry. With local market presence and strong financial bankability status, we are committed, and able, to building strategic, mutually beneficial collaborations with our partners, as together we capitalise on the rising value of green energy.



KEY SALIENT FEATURES



Global, Tier 1 bankable brand, with independently certified state-of-the-art automated manufacturing



Bifacial technology enables additional energy harvesting from rear side (up to 25%)



Industry leading lowest thermal co-efficient of power



Industry leading 12 years product warranty



Excellent low irradiance performance



Excellent PID resistance



Positive tight power tolerance



Dual stage 100% EL Inspection warranting defect-free product



Module Imp binning radically reduces string mismatch losses

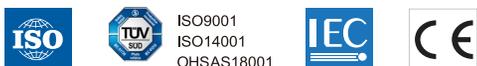


Warranted reliability and stringent quality assurances well beyond certified requirements



Certified to withstand severe environmental conditions

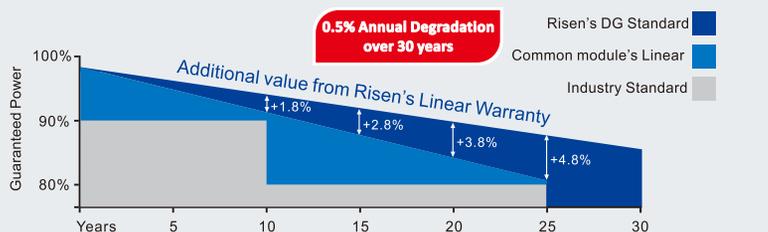
- ♦ Anti-reflective & anti-soiling surface minimise power loss from dirt and dust
- ♦ Severe salt mist, ammonia & blown sand resistance, for seaside, farm and desert environments
- ♦ Excellent mechanical load 2400Pa & snow load 5400Pa resistance



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Fax: +86-574-59953599
E-mail: info@risenenergy.com
Website: www.risenenergy.com

LINEAR PERFORMANCE WARRANTY

12 year Product Warranty / 30 year Linear Power Warranty



YASKAWA

SOLECTRIA XGI™ 1500

Premium 3-Phase Transformerless Utility-Scale Inverters

Features

- Made in the USA with global components
- Buy American Act (BAA) compliant
- Four models: 125kW/125kVA, 125kW/150kVA, 150kW/166kVA, 166kW/166kVA
- 99.0% peak efficiency
- Flexible solution for distributed and centralized system architecture
- Advanced grid-support functionality Rule 21/UL1741SA
- Robust, dependable and built to last
- Lowest O&M and installation costs
- Access all inverters on site via WiFi from one location
- Remote diagnostics and firmware upgrades
- SunSpec Modbus Certified

Options

- String combiners for distributed and centralized systems
- Web-based monitoring
- Extended warranty



Yaskawa Solectria Solar's XGI 1500 utility-scale string inverters are designed for high reliability and built of the highest quality components that were selected, tested and proven to last beyond their warranty. The XGI 1500 inverters provide advanced grid-support functionality and meet the latest IEEE 1547 and UL 1741 standards for safety. The XGI 1500 inverters are the most powerful 1500VDC string inverters in the PV market and have been engineered for both distributed and centralized system architecture. Designed and engineered in Lawrence, MA, the new SOLECTRIA XGI inverters are assembled and tested at Yaskawa America's facilities in Buffalo Grove, IL. The XGI 1500 inverters are Made in the USA with global components and are compliant with the Buy American Act.

MADE IN THE USA



With U.S. and Global Components

SOLECTRIA SOLAR

SOLECTRIA XGI 1500

Specifications

	XGI 1500-125/125	XGI 1500-125/150	XGI 1500-150/166	XGI 1500-166/166
DC Input				
Absolute Maximum Input Voltage	1500 VDC	1500 VDC	1500 VDC	1500 VDC
Maximum Power Input Voltage Range (MPPT)	860-1250 VDC	860-1250 VDC	860-1250 VDC	860-1250 VDC
Operating Voltage Range (MPPT)	860-1450 VDC	860-1450 VDC	860-1450 VDC	860-1450 VDC
Number of MPP Trackers	1 MPPT	1 MPPT	1 MPPT	1 MPPT
Maximum Operating Input Current	148.3 A	148.3 A	178.0 A	197.7 A
Maximum Operating PV Power	128 kW	128 kW	153 kW	170 kW
Maximum DC/AC Ratio Max Rated PV Power	2.0 250 kW	2.0 250 kW	1.66 250 kW	1.5 250 kW
Max Rated PV Short-Circuit Current ($\Sigma I_{sc} \times 1.25$)	320 A	320 A	320 A	320 A
AC Output				
Nominal Output Voltage	600 VAC, 3-Ph	600 VAC, 3-Ph	600 VAC, 3-Ph	600 VAC, 3-Ph
AC Voltage Range	-12% to +10%	-12% to +10%	-12% to +10%	-12% to +10%
Continuous Real Output Power	125 kW	125 kW	150 kW	166 kW
Continuous Apparent Output Power	125 kVA	150 kVA	166 kVA	166 kVA
Maximum Output Current	120 A	144 A	160 A	160 A
Nominal Output Frequency	60 Hz	60 Hz	60 Hz	60 Hz
Power Factor (Unity default)	+/- 0.80 Adjustable	+/- 0.80 Adjustable	+/- 0.80 Adjustable	+/- 0.80 Adjustable
Total Harmonic Distortion (THD) @ Rated Load	<3%	<3%	<3%	<3%
Grid Connection Type	3-Ph + N/GND	3-Ph + N/GND	3-Ph + N/GND	3-Ph + N/GND
Fault Current Contribution (1 cycle RMS)	144 A	173 A	192 A	192 A
Efficiency				
Peak Efficiency	98.9%	98.9%	99.0%	99.0%
CEC Average Efficiency	98.5%	98.5%	98.5%	98.5%
Tare Loss	<1 W	<1 W	<1 W	<1 W
Temperature				
Ambient Temperature Range	-40°F to 140°F (-40C to 60C)		-40°F to 140°F (-40C to 60C)	
De-Rating Temperature	122°F (50C)		113°F (45C)	
Storage Temperature Range	-40°F to 167°F (-40C to 75C)		-40°F to 167°F (-40C to 75C)	
Relative Humidity (non-condensing)	0 - 95%		0 - 95%	
Operating Altitude	9,840 ft (3 km)		9,840 ft (3 km)	
Communications				
Advanced Graphical User Interface	WiFi			
Communication Interface	Ethernet			
Third-Party Monitoring Protocol	SunSpec Modbus TCP/IP			
Web-Based Monitoring	Optional			
Firmware Updates	Remote and Local			
Testing & Certifications				
Safety Listings & Certifications	UL 1741, IEEE 1547, UL 1998			
Advanced Grid Support Functionality	Rule 21, UL 1741SA			
Testing Agency	ETL			
FCC Compliance	FCC Part 15, Class A			
Warranty				
Standard and Options	5 Years Standard; Option for 10 Years			
Enclosure				
Acoustic Noise Rating	56 dBA @ 3 m			
DC Disconnect	Integrated 2-Pole 250 A DC Disconnect			
Mounting Angle	Vertical only			
Dimensions	Height: 29.5 in. (750 mm) Width: 39.4 in. (1000 mm) Depth: 15.1 in. (380 mm) Specifications subject to change.			
Weight	270 lbs (122 kg)			
Enclosure Rating and Finish	Type 4X, Polyester Powder-Coated Aluminum			



SOLECTRIA SOLAR

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YASKAWA

XGI 1500 COMBINERS

Increased Design Flexibility for SOLECTRIA XGI 1500

Features

- Made in the USA with global components
- Buy American Act (BAA) compliant
- Designed exclusively for use with XGI 1500 inverters
- Both poles fused and switched
- 16, 20, 24, 26, and 28 fuse positions
- 15 and 20 A fuse options for all models; 25 and 30 A fuse options for select models only
- Connection plates for compression terminals
- 90C terminal rating

Option

- Surge arrestor, both polarities



Yaskawa Solectria Solar offers two 1500V string combiners, Attachable & Remote, each designed to pair exclusively with SOLECTRIA XGI 1500 inverters. The 1500V Attachable Combiner is designed to mate directly to the XGI 1500 inverter for use in distributed PV systems where the combiner and inverter are located together throughout the array field. The 1500V Remote Combiner has similar features, but is designed for a centralized or clustered deployment of multiple XGI 1500 inverters where the combiners are distributed throughout the PV array field. Both combiner lines feature the highest quality and durability in the industry today.

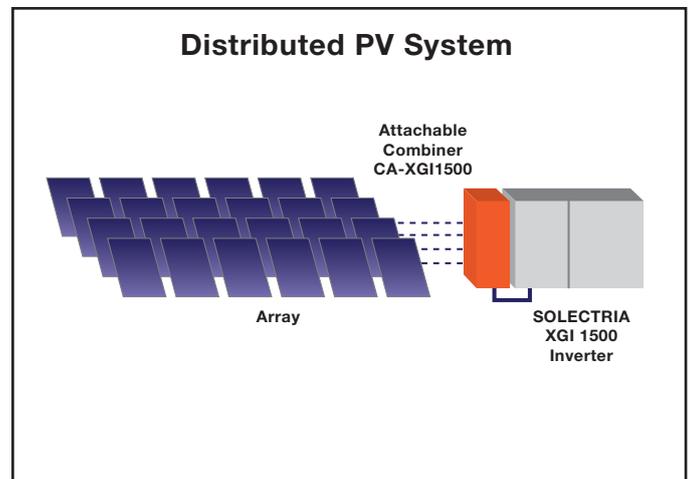
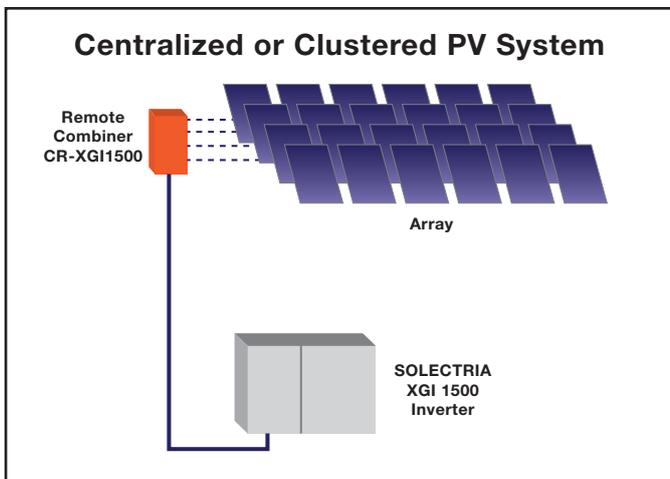
Choose from models with 16 to 28 fused positions and either 15 or 20 A fuses. Specific models also available with 25 A fuses (20 positions) and 30 A fuses (16 positions). The combiners match the XGI 1500 in quality and appearance. Both models satisfy the National Electrical Code for systems with ungrounded PV source circuits. All Yaskawa Solectria Solar XGI inverters and combiners are Made in the USA with global components and are compliant with the Buy American Act.



XGI 1500 COMBINERS

Specifications

	1500V Remote Combiner				1500V Attachable Combiner		
1500V String Combiners exclusively for use with SOLECTRIA XGI 1500							
Input Wire Compatibility	14-4 AWG				14-4 AWG		
Output Wire Compatibility	Compression Terminal: 1 conductor, 1/0 - 500 kcmil 2 conductors, 1/0 - 500 kcmil				Compression Terminal: 1 conductor, 1/0 - 500 kcmil 2 conductors, 1/0 - 500 kcmil		
Maximum Voltage	1500 VDC				1500 VDC		
Fuse Rating Options	15 A or 20 A (fuses included)	25 A	30 A	15 A or 20 A (fuses included)	25 A	30 A	
Number of Fused Positions	16 / 20 / 24 / 26 / 28	20	16	16 / 20 / 24 / 26 / 28	20	16	
Input PV Source Circuit Configurations	Ungrounded PV Source Circuits				Ungrounded PV Source Circuits		
Fuse Configurations	Both positive and negative polarities fused				Both positive and negative polarities fused		
DC Disconnect	2-pole integrated DC disconnect, positive and negative poles switched				DC Disconnect located on XGI 1500 inverter		
DC Disconnect Current Rating	250 A				250 A (located on XGI 1500)		
Temperature Range	-40°F to 122°F (-40°C to 50°C)				-40°F to 122°F (-40°C to 50°C)		
Mounting Positions	Indoor, Outdoor, Wall, Array - Vertical, Horizontal or Angled				Mechanically attaches to structure		
Safety Certification & Listing	UL 1741				UL 1741		
Standard Warranty	5 Years				5 Years		
Enclosure Material Options & Rating	Polyester Powder Coated Aluminum, NEMA Type 4X				Polyester Powder Coated Aluminum, NEMA Type 4X		
Option							
Surge Protection	Both positive and negative polarities				Both positive and negative polarities		



SOLECTRIA SOLAR

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YASKAWA



HPS Millennium™ E
Medium Voltage
Distribution Transformer
- up to 34.5kV

power to perform



HPS Millennium™ E

Medium Voltage Transformer



HPS MILLENNIUM™ E

Hammond Power Solutions (HPS) is the industry leading manufacturer of standard and custom dry-type transformers in North America. Every HPS product is built with the quality and dependability you count on.

HPS Millennium™ medium voltage distribution transformers are designed for many demanding and diverse applications, while minimizing both installation and maintenance costs. Coils are precision wound with copper or aluminum conductors using either barrel or comb wound designs with a full vacuum-pressure impregnation (VPI) insulation system.

With three phase ratings up to 15MVA, 34.5kV, 175kV BIL and single phase to 5MVA, they feature the newest technology and manufacturing processes.

To service all of your medium voltage needs, HPS Millennium™ G is also available for applications requiring voltages up to 5kV. For more information on HPS Millennium™ G (catalog no. MILGMED), please contact us or visit the HPS Website.

SUPPORT & RESOURCES

No other transformer company can offer our service and quality in a full range of products:

-  **Current Calculator:** Calculate the Amps, Volts, or kVA of a transformer. Visit the "Online Tools" area of the HPS website.
-  **Fast On-Site Response:** On-site technicians are available to assist with any technical problems or issues that cannot be resolved over the phone.
-  **Live Telephone Technical Support:** Our inside sales team is available to quickly answer your questions. They are technically trained and able to answer most questions right over the phone.
-  **Easy-To-Access Installation Manuals:** All transformer installation manuals are conveniently located on our website so you can access them anywhere, anytime.
-  **Online Technical Support:** Get answers to frequently asked questions, troubleshooting tips and instruction sheets by visiting the "Technical Support" area of the HPS website.

APPLICATIONS

HPS Millennium™ E is suitable for any commercial, industrial, manufacturing or production process application. They can be offered for a variety of environmental conditions and built to meet the most onerous duty.

- Industrial
- Commercial
- Data Centers
- Renewable Energy



Built-in enclosure fork lift capability



Low voltage bus bar



Flexible connectors



FEATURES

Core & Coil Construction:

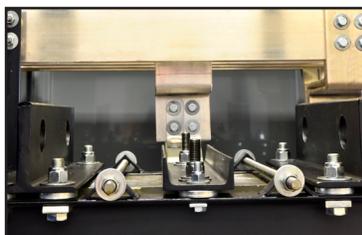
- Manufactured from quality non-aging, cold rolled, silicon steel laminations
- Cores are precision cut to close tolerances to eliminate gaps and improve performance
- Core is coated to prevent the ingress of moisture
- Precision wound with copper or aluminum conductors that are electrically balanced to minimize axial forces during short-circuit conditions
- Wire or foil conductors for optimum performance for the application
- Robust interface between core & coils for better short circuit performance
- Utilize both barrel or comb wound construction techniques
- Available with multiple termination configurations: stubs-up, coordinated bus-to-end
- Vibration isolation pads to minimize noise

BENEFITS

- Meets the minimum efficiency standards mandated in DOE 10 CFR Part 431 (levels as of Jan. 1st 2016), NRCan 2019 SOR/2018-201 Amd. 14, ON Reg. 404/12 (effective Jan. 1st, 2018) and exceeds CSA C802.2-12 resulting in increased dollar savings and positive societal/environmental payback
- Designed for indoor or outdoor applications
- VPI windings are mechanically durable for the most demanding environments typically found in mining, crane and other difficult mechanical applications.
- Minimal maintenance required beyond removing surface contaminants, such as dirt
- Can be energized immediately after installation
- Excellent resistance to short circuits
- Self-extinguishing in the unlikely event of fire
- Environmentally friendly



Lift off hinged doors



Lifting eyes for core & coil assembly



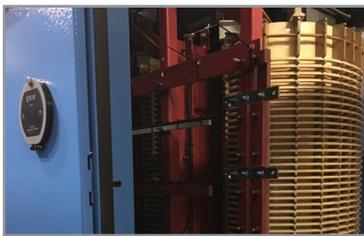
Air terminal chamber (ATC)

HPS Millennium™ E

Medium Voltage Transformer

Specifications - Copper or Aluminum

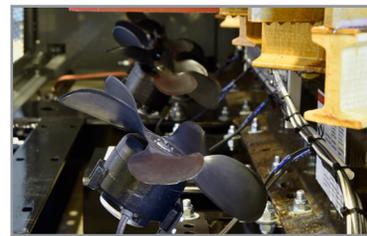
kVA:	225-2500kVA (DOE16) 225-7500kVA (NRCAN 2019) others available upon request	Temperature Rise:	150°C typical temperature rise, (optional 115°C & 80°C rise available)
High Voltage (Primary):	Up to 34.5 kV Class, up to 175 kV BIL Up to 150 kV BIL (BIL per CSA and IEEE/ANSI standards) Standard taps +/- 2.5%, +/- 5% Other options available upon request	Termination:	Front accessible separate high and low voltage terminals; connectors suitable for aluminum and copper are provided for easy cable installation.
Low Voltage (Secondary):	208Y/120V to 600Y/347V & 2.4-5kV up to 60kV BIL Higher BIL available upon request	Impedance:	3-7%, typically 5.75%
Frequency:	60 Hz, others available upon request	Seismic:	Seismically qualified according to the International Building Code (IBC) 2018, and the American Society of Civil Engineers ASCE 7-16 specifications, with the following design parameters: Spectral acceleration: $S_{DS} \leq 2.0$ g Importance factor: $I_p = 1.5$ Attachment/height ratio: $z/h = 0$ OSHPD compliance available upon request
Insulation System:	220°C (200°C for some lower kVA ratings)	Sound Level:	Meets IEEE C57.12.01 (other sound level performance available)
Enclosure Type:	Type 1, 2, 3/3R, 4/4X or 12 available (others available upon request). Enhanced Type 3R option available for improved outdoor performance. Lift off hinged doors for easy accessibility and quick removal if required. Built-in enclosure fork lift capability.	Altitude:	Standard up to 1000 meters (de-rated above 1000 meters)
Enclosure Finish:	ANSI 61 Grey Compliant with UL 50	Ambient:	-20°C to 40°C (with de-rating possible from 40°C to 60°C, consult HPS)
Neutral:	Neutral terminal for field connection (on applicable units)	Duty:	Special duty available upon request.



Infrared viewing window & custom enclosure finish



Lightning arrestors



Cooling fans

OPTIONAL ACCESSORIES

- Forced air-cooling (or provisions for later)
- Heat exchanger/cooling for TENV units
- Lightning arrestors rated for system voltage (Station, Intermediate or Distribution)
- Grounding resistor
- Neutral Ground Monitor
- Thermal sensing & indication
 - Thermocouples
 - Thermometers (analog/digital)
 - Thermostat alarm / trip (N.O. /N.C. contacts)
- Current transformers
- Potential transformers
- Key interlock to prevent unauthorized access
- Electrostatic shielding
- Rated to handle non-linear loads
- Strip heater (powered from separate source)
- Surge protection devices
- Air terminal chamber
- Low voltage panel
- Coordinated bus-to-end
- Primary fused disconnects
- Infrared viewing windows

Comparison of Enclosures for Indoor and Outdoor Non-Hazardous Locations

CSA C22.2 No. 94.2 Enclosure Type	Indoor						Indoor/Outdoor								Submersible	
	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 ^a	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
	Falling dirt	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
	Circulating dust, lint, fibres and flyings ^d				X	X	X	X	X			X	X	X	X	X
	Settling dust, lint, fibres and flyings ^d			X	X	X	X	X	X			X	X	X	X	X
	Wind-blown dust							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
	External formation of ice or sleet											X	X			
	Hose down and splashing water													X	X	X
	Corrosion												X		X	
	Occasional temporary submersion															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 fibres and flyings are non-hazardous and are not considered Class III type ignitable fibres or combustible flyings
 - e. - Since IEC 60529 does not specify degrees of protection for many conditions considered 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, 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 your needs.

TESTING

All VPI Power transformers are tested at HPS prior to shipment. They must meet specific criteria to be certified acceptable for release. The following tests are performed on each power transformer:

- Resistance Measurement*
- Voltage Ratio
- Polarity & Phase-Relation Test
- No-Load Loss and Excitation Current Test
- Induced Voltage
- Impedance, Voltage & Load Loss Test*
- Power frequency voltage-withstand each winding
- Other testing available upon customer request

* typically not performed for units ≤ 500kVA

COMPLIANCE & APPROVALS

HPS Millennium™ E is CSA Certified and UL Listed to the following standards:

- CSA C22.2 No. 47
- CSA C9-02
- U.L. 1562



Compliant to the following industry standards:

- IEEE-C57.12.01
- IEEE-C57.12.51
- IEEE-C57.12.70
- IEEE-C57.12.91
- CSA 802.2-12
- DOE 10 CFR Part 431: 2010 or 2016
- NRCAN SOR/2018-201 Amd. 14
- ON Reg. 404/12 (2018)
- IEC 60076 (upon request)
- IBC 2018/OSHPD for seismic conditions

Selection Tables

ALUMINUM WOUND

kVA	Voltage Class kV	BIL	Enclosure with Stubs Up Fig. 1				Enclosure with Bus-To-End Fig. 2			
			Width (W)	Depth (D)	Height (H)	Weight (Lbs.)	Width (W)	Depth (D)	Height (H)	Weight (Lbs.)
225	5	30	49	42	64	2000	60	50	82	2300
	15	60	54	47	72	2400	60	50	82	2700
	15	95	60	50	82	3000	72	54	91.5	3700
	25	110	72	54	91.5	4100	72	60	91.5	4400
	25	125	72	60	91.5	4500	72	60	91.5	4900
	34.5	150	90	72	91.5	5500	90	72	91.5	5900
300	5	30	49	42	64	2100	68	50	72	2400
	15	60	68	50	72	2900	68	50	72	3200
	15	95	72	54	91.5	4000	84	54	91.5	4400
	25	110	72	54	91.5	4200	84	60	91.5	4800
	25	125	84	60	91.5	4800	84	60	91.5	5200
	34.5	150	90	72	91.5	5700	90	72	91.5	6100
500	5	30	54	47	72	3100	78	48	78	3600
	15	60	68	50	72	3900	78	48	78	4400
	15	95	84	54	91.5	5300	84	54	91.5	5800
	25	110	84	54	91.5	5700	84	60	91.5	6400
	25	125	90	60	91.5	6400	96	72	91.5	7200
	34.5	150	96	72	91.5	7800	96	72	91.5	8400
750	5	30	68	50	72	5000	84	54	91.5	6100
	15	60	78	48	78	5300	90	54	91.5	6400
	15	95	84	54	91.5	6700	96	60	91.5	7600
	25	110	84	60	91.5	7000	90	60	91.5	7600
	25	125	90	60	91.5	7100	96	72	91.5	8000
	34.5	150	96	72	91.5	9000	102	72	91.5	9900
1000	5	30	78	48	78	6100	90	54	91.5	7300
	15	60	84	54	91.5	7200	96	54	91.5	8000
	15	95	90	60	91.5	8400	102	60	91.5	9400
	25	110	90	60	91.5	8500	96	60	91.5	9300
	25	125	96	60	91.5	8700	102	72	91.5	9800
	34.5	150	96	72	110	10000	102	72	110	11000
1500	5	30	78	48	78	8100	96	54	91.5	9500
	15	60	90	54	91.5	9600	102	60	91.5	10800
	15	95	96	60	91.5	10800	108	60	91.5	12100
	25	110	96	60	91.5	10900	108	72	91.5	12500
	25	125	102	72	110	11800	108	72	110	13000
	34.5	150	108	72	110	13900	120	72	110	15400
2000	5	30	90	54	91.5	10800	108	60	91.5	12400
	15	60	96	54	91.5	11500	108	60	91.5	13000
	15	95	102	60	91.5	13400	120	72	91.5	15300
	25	110	102	72	91.5	13800	120	72	91.5	15500
	25	125	108	72	110	15000	120	72	110	16600
	34.5	150	120	72	110	16200	120	72	110	17600
2500	5	30	90	54	91.5	13000	120	60	91.5	15100
	15	60	96	60	91.5	13700	120	72	91.5	15800
	15	95	108	60	91.5	15800	132	72	110	18400
	25	110	108	72	110	14900	120	72	110	16500
	25	125	108	72	110	15900	120	72	110	17600
	34.5	150	108	72	110	16900	132	72	110	19000

Weight and dimensions are typical for 150°C Average Winding Rise.
 Weights and dimensions are for DOE 2016/NRCAN 2019 compliant product.
 All dimensions are in inches.
 For Type 2 enclosure styles, add 4 inches to the enclosure depth and 20 lbs to the total weight.
 Not for construction purposes. Approval drawings can be provided as needed.

Add 20 inch for ATC up to 110kV BIL designs and 24 inch for ATC with 125/150kV BIL designs.
 Add approx. 400 lbs. per ATC.

Selection Tables

ALUMINUM WOUND



Hammond
Power Solutions

kVA	Voltage Class kV	BIL	Enclosure with Stubs Up Fig. 1				Enclosure with Bus-To-End Fig. 2			
			Width (W)	Depth (D)	Height (H)	Weight (Lbs.)	Width (W)	Depth (D)	Height (H)	Weight (Lbs.)
3000	5	30	90	60	110	15700	120	60	110	17900
	15	60	96	60	110	17300	120	72	110	19800
	15	95	102	60	110	19000	132	72	110	21700
	25	110	102	72	110	20700	120	72	110	23100
	25	125	108	72	110	22900	132	72	110	25600
	34.5	150	Consult HPS				Consult HPS			
3750	5	30	Consult HPS				Consult HPS			
	15	60	96	60	110	17800	120	72	110	20300
	15	95	102	60	110	19500	132	72	135	22800
	25	110	108	72	110	21400	132	72	135	24400
	25	125	108	72	110	23900	Consult HPS			
	34.5	150	Consult HPS				Consult HPS			
5000	5	30	Consult HPS				Consult HPS			
	15	60	102	60	110	19000	120	72	110	21400
	15	95	108	72	135	21400	132	72	135	23900
	25	110	120	72	135	23200	132	72	135	25500
	25	125	120	72	135	25700	Consult HPS			
	34.5	150	Consult HPS				Consult HPS			
7500	5	30	Consult HPS				Consult HPS			
	15	60	120	72	135	21700	132	72	135	23900
	15	95	120	72	135	23200	Consult HPS			
	25	110	120	72	135	24700	Consult HPS			
	25	125	Consult HPS				Consult HPS			
	34.5	150	Consult HPS				Consult HPS			

Weight and dimensions are typical for 150°C Average Winding Rise.
Weights and dimensions are for NRCAN 2019 compliant product.
All dimensions are in inches.

For Type 2 enclosure styles, add 4 inches to the enclosure depth and 20 lbs to the total weight.

Not for construction purposes. Approval drawings can be provided as needed.

Add 20 inch for ATC up to 110kV BIL designs and 24 inch for ATC with 125/150kV BIL designs.
Add approx. 400 lbs. per ATC.

Selection Tables

COPPER WOUND

kVA	Voltage Class kV	BIL	Enclosure with Stubs Up Fig. 1				Enclosure with Bus-To-End Fig. 2			
			Width (W)	Depth (D)	Height (H)	Weight (Lbs.)	Width (W)	Depth (D)	Height (H)	Weight (Lbs.)
225	5	30	49	42	64	2000	60	50	82	2300
	15	60	60	50	82	2700	68	50	72	2900
	15	95	68	50	72	3100	72	54	91.5	3900
	25	110	68	50	72	3300	72	54	91.5	4100
	25	125	72	54	91.5	3900	72	60	91.5	4200
300	5	30	49	42	64	2100	60	50	82	2400
	15	60	60	50	82	3100	68	50	72	3400
	15	95	68	50	72	3700	72	54	91.5	4500
	25	110	72	54	91.5	4400	84	54	91.5	4900
	25	125	84	54	91.5	4600	84	60	91.5	5200
500	5	30	49	42	64	2800	68	50	72	3200
	15	60	78	48	78	4400	78	48	78	4800
	15	95	84	54	91.5	5700	84	54	91.5	6200
	25	110	84	54	91.5	5800	84	60	91.5	6500
	25	125	84	60	91.5	6100	84	60	91.5	6600
750	5	30	49	42	64	2800	68	50	72	3200
	15	60	78	48	78	4400	78	48	78	4800
	15	95	84	54	91.5	6500	90	60	91.5	7200
	25	110	90	54	91.5	6800	96	60	91.5	7600
	25	125	90	60	91.5	7000	96	72	91.5	7900
1000	5	30	60	50	82	4800	78	48	78	5300
	15	60	78	48	78	5500	84	54	91.5	6500
	15	95	84	54	91.5	6500	90	60	91.5	7200
	25	110	90	54	91.5	6800	96	60	91.5	7600
	25	125	90	60	91.5	7000	96	72	91.5	7900
1500	5	30	68	50	72	5800	84	54	91.5	7000
	15	60	78	48	78	6500	90	54	91.5	7700
	15	95	90	54	91.5	8400	96	60	91.5	9300
	25	110	90	60	91.5	8600	96	60	91.5	9400
	25	125	90	60	91.5	8700	96	72	91.5	9700
2000	5	30	78	48	78	7900	90	54	91.5	9200
	15	60	84	54	91.5	8500	96	54	91.5	9400
	15	95	90	54	91.5	10400	102	60	91.5	11700
	25	110	96	60	91.5	10800	102	72	91.5	12100
	25	125	102	72	91.5	12200	108	72	91.5	13400
2500	5	30	84	54	91.5	11300	102	60	91.5	12800
	15	60	90	54	91.5	12100	108	60	91.5	13800
	15	95	96	54	91.5	14100	120	72	91.5	16400
	25	110	96	72	91.5	15100	120	72	91.5	17200
	25	125	102	72	110	16600	120	72	110	18500
	34.5	150	108	72	110	18400	Consult HPS			

Weight and dimensions are typical for 150°C Average Winding Rise. Weights and dimensions are for DOE 2016/NRCAN 2019 compliant product. All dimensions are in inches. For Type 2 enclosure styles, add 4 inches to the enclosure depth and 20 lbs to the total weight. Not for construction purposes. Approval drawings can be provided as needed.

Add 20 inch for ATC up to 110kV BIL designs and 24 inch for ATC with 125/150kV BIL designs. Add approx. 400 lbs. per ATC.

Selection Tables

COPPER WOUND



Hammond
Power Solutions

kVA	Voltage Class kV	BIL	Enclosure with Stubs Up Fig. 1				Enclosure with Bus-To-End Fig. 2			
			Width (W)	Depth (D)	Height (H)	Weight (Lbs.)	Width (W)	Depth (D)	Height (H)	Weight (Lbs.)
3000	5	30	90	54	91.5	15200	120	60	91.5	17500
	15	60	96	54	91.5	17300	120	60	91.5	19700
	15	95	102	54	91.5	19500	120	72	91.5	22100
	25	110	102	72	91.5	21800	120	72	91.5	24300
	25	125	102	72	110	23700	120	72	110	26400
	34.5	150	Consult HPS				Consult HPS			
3750	5	30	Consult HPS				Consult HPS			
	15	60	96	60	110.0	19800	120	60	110	22300
	15	95	102	60	110.0	22300	120	72	110.0	25000
	25	110	102	60	110	23000	120	72	110.0	25800
	25	125	108	72	110	24900	132	72	110.0	27800
	34.5	150	120	72	110	26700	Consult HPS			
5000	5	30	Consult HPS				Consult HPS			
	15	60	96	60	110	20800	108	60	110	23100
	15	95	102	60	110	23000	120	60	110.0	25600
	25	110	108	72	135	25400	120	72	135.0	28000
	25	125	108	72	135	25900	120	72	135.0	28500
	34.5	150	Consult HPS				Consult HPS			
7500	5	30	Consult HPS				Consult HPS			
	15	60	102	72	135	23700	120	72	135	26300
	15	95	108	72	135	25600	132	72	135.0	28500
	25	110	120	72	135	26400	132	72	135.0	29000
	25	125	120	72	135	27700	132	72	135.0	30500
	34.5	150	Consult HPS				Consult HPS			

Weight and dimensions are typical for 150°C Average Winding Rise.
Weights and dimensions are for NRCAN 2019 compliant product.

All dimensions are in inches.

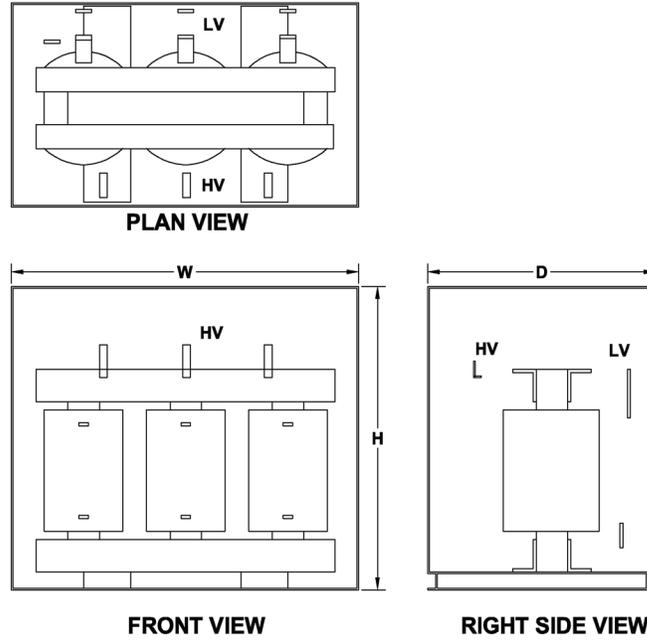
For Type 2 enclosure styles, add 4 inches to the enclosure depth and 20 lbs to the total weight.

Not for construction purposes. Approval drawings can be provided as needed.

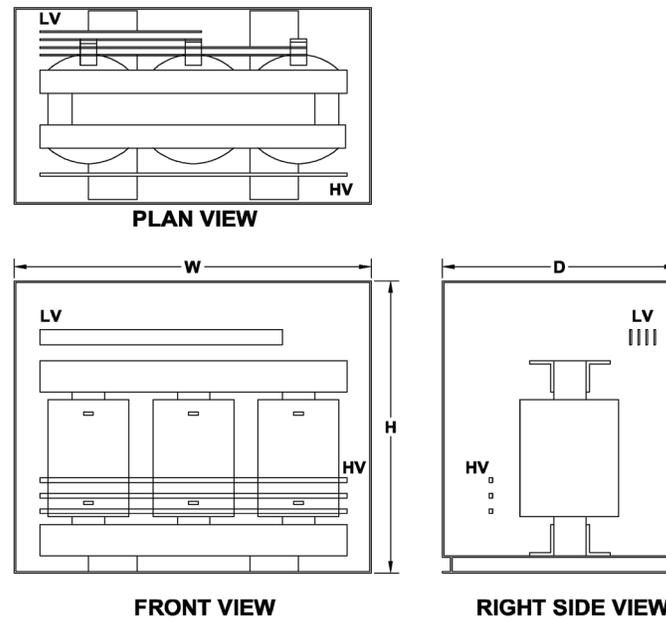
Add 20 inch for ATC up to 110kV BIL designs and 24 inch for ATC with 125/150kV BIL designs.

Add approx. 400 lbs. per ATC.

Drawings



ENCLOSURE WITH STUBS UP FIG. 1



ENCLOSURE WITH BUS-TO-END FIG. 2

Anti-Vibration Pad & Vibration Isolator Kits



ANTI-VIBRATION PAD AND VIBRATION ISOLATOR KITS

All standard transformers come with installed internal vibration absorbing pads to minimize noise during operation. Optional external "anti-vibration" pad and "vibration isolator" (for higher noise dampening) kits can be used to reduce operating noise even further. All are resistant to industrial contaminants like oil, acids and alkalines.

Anti-Vibration Pad Kits

Part No.	Description
PD1	Set of four (4) rubber anti-vibration pads which replace the standard steel enclosure washers.
PD2	



All anti-vibration pad kits contain a set of four (4) pads or isolators. Therefore only one kit is required per transformer.

Vibration Isolator Kits

Part No.	Transformer Weight (Lbs)	Description
NMP1	Up to 340 lbs	Set of four (4) molded neoprene and steel plate assemblies that virtually eliminate vibration noise between the transformer and the mounting surface.
NMP2	341 to 680 lbs	
NMP3	681 to 1040 lbs	
NMP4	1041 to 1740 lbs	
NMP5	1741 to 2330 lbs	
NMP6	2331 to 3450 lbs	
NMP7	3451 to 4690 lbs	



All vibration isolator kits and anti-vibration pad kits contain a set of four (4) pads or isolators. Therefore only one kit is required per transformer.

Typical Performance Data

5 kV, 30kV BIL - Aluminum

75°C, 4160V Delta (30 kV BIL) -
480Y/277V, 600Y/347V (10kV BIL), 60 Hz

kVA	No Load Loss (W)	Load Loss (W)	Impedance	Resistance	Reactance	X/R Ratio	Regulation				% Efficiency at different loads			
							at 50% load		at 100% load		25%	50%*	75%	100%
							pf = 1	pf = 0.8	pf = 1	pf = 0.8				
225	630	2770	5.7%	1.2%	5.6%	4.64	0.65%	2.18%	1.38%	4.40%	98.56%	98.82%	98.71%	98.50%
300	735	3420	5.7%	1.1%	5.6%	5.10	0.63%	2.16%	1.33%	4.37%	98.72%	98.93%	98.80%	98.60%
500	1020	4925	5.7%	1.0%	5.7%	5.66	0.54%	2.12%	1.17%	4.27%	98.93%	99.09%	98.98%	98.80%
750	1500	6010	5.8%	0.8%	5.7%	7.13	0.44%	2.05%	0.96%	4.15%	99.01%	99.21%	99.14%	99.01%
1000	1790	7145	5.8%	0.7%	5.7%	8.18	0.41%	2.03%	0.90%	4.11%	99.10%	99.28%	99.21%	99.09%
1500	2150	10235	5.8%	0.7%	5.7%	8.19	0.39%	2.02%	0.86%	4.08%	99.26%	99.37%	99.29%	99.17%
2000	2595	12440	5.8%	0.6%	5.7%	9.57	0.35%	1.99%	0.79%	4.03%	99.33%	99.43%	99.36%	99.25%
2500	2785	15460	5.8%	0.6%	5.7%	9.58	0.35%	1.99%	0.78%	4.03%	99.40%	99.47%	99.39%	99.28%

*Meets DOE 10 CFR Part 431 - 2016 & NRCAN 2019/ON Reg. 404/12 Energy Efficiency Regulations for MVDT Transformers

5 kV, 30kV BIL - Copper

75°C, 4160V Delta (30 kV BIL) -
480Y/277V, 600Y/347V (10kV BIL), 60 Hz

kVA	No Load Loss (W)	Load Loss* (W)	Impedance	Resistance	Reactance	X/R Ratio	Regulation				% Efficiency at different loads			
							at 50% load		at 100% load		25%	50%*	75%	100%
							pf = 1	pf = 0.8	pf = 1	pf = 0.8				
225	575	3070	5.6%	1.3%	5.4%	4.17	0.72%	2.19%	1.51%	4.40%	98.65%	98.82%	98.65%	98.41%
300	690	3720	5.6%	1.2%	5.5%	4.56	0.66%	2.15%	1.39%	4.34%	98.79%	98.93%	98.78%	98.55%
500	900	5550	5.6%	1.1%	5.5%	5.01	0.59%	2.12%	1.26%	4.27%	99.01%	99.09%	98.94%	98.73%
750	1475	6050	5.7%	0.8%	5.6%	7.00	0.44%	2.02%	0.96%	4.09%	99.02%	99.21%	99.14%	99.01%
1000	1650	7840	5.7%	0.8%	5.6%	7.01	0.43%	2.02%	0.94%	4.07%	99.15%	99.28%	99.20%	99.06%
1500	1910	11240	5.7%	0.7%	5.6%	8.02	0.41%	2.01%	0.91%	4.05%	99.31%	99.37%	99.27%	99.13%
2000	2265	13750	5.7%	0.7%	5.6%	8.05	0.38%	1.99%	0.85%	4.01%	99.38%	99.43%	99.34%	99.21%
2500	2570	16310	5.7%	0.6%	5.6%	9.40	0.37%	1.97%	0.81%	3.99%	99.43%	99.47%	99.38%	99.25%

*Meets DOE 10 CFR Part 431 - 2016 & NRCAN 2019/ON Reg. 404/12 Energy Efficiency Regulations for MVDT Transformers

15 kV, 60kV BIL - Aluminum

75°C, 12470V Delta (60 kV BIL) -
480Y/277V, 600Y/347V (10kV BIL), 60 Hz

kVA	No Load Loss (W)	Load Loss (W)	Impedance	Resistance	Reactance	X/R Ratio	Regulation				% Efficiency at different loads			
							at 50% load		at 100% load		25%	50%*	75%	100%
							pf = 1	pf = 0.8	pf = 1	pf = 0.8				
225	915	2300	5.7%	1.0%	5.6%	5.64	0.55%	2.12%	1.18%	4.28%	98.15%	98.69%	98.71%	98.59%
300	1025	3135	5.7%	1.0%	5.6%	5.64	0.56%	2.13%	1.20%	4.29%	98.40%	98.81%	98.78%	98.63%
500	1275	5085	5.7%	1.0%	5.6%	5.65	0.55%	2.12%	1.18%	4.28%	98.74%	98.99%	98.91%	98.74%
750	1700	6510	5.8%	0.9%	5.7%	6.32	0.47%	2.07%	1.03%	4.19%	98.89%	99.12%	99.06%	98.92%
1000	2075	7585	5.8%	0.8%	5.7%	7.14	0.42%	2.04%	0.92%	4.12%	98.99%	99.21%	99.16%	99.04%
1500	2775	9950	5.8%	0.7%	5.7%	8.19	0.37%	2.01%	0.83%	4.06%	99.10%	99.30%	99.26%	99.16%
2000	3285	12850	5.8%	0.6%	5.7%	9.57	0.36%	2.00%	0.81%	4.05%	99.19%	99.35%	99.30%	99.20%
2500	3825	14710	5.8%	0.6%	5.8%	9.59	0.34%	1.98%	0.75%	4.01%	99.25%	99.40%	99.36%	99.26%

*Meets DOE 10 CFR Part 431 - 2016 & NRCAN 2019/ON Reg. 404/12 Energy Efficiency Regulations for MVDT Transformers

15 kV, 60kV BIL - Copper

75°C, 12470V Delta (60 kV BIL) -
480Y/277V, 600Y/347V (10kV BIL), 60 Hz

kVA	No Load Loss (W)	Load Loss (W)	Impedance	Resistance	Reactance	X/R Ratio	Regulation				% Efficiency at different loads			
							at 50% load		at 100% load		25%	50%*	75%	100%
							pf = 1	pf = 0.8	pf = 1	pf = 0.8				
225	750	2725	5.6%	1.2%	5.5%	4.55	0.64%	2.14%	1.36%	4.32%	98.29%	98.69%	98.63%	98.45%
300	950	3425	5.6%	1.0%	5.5%	5.54	0.61%	2.13%	1.29%	4.29%	98.47%	98.81%	98.74%	98.56%
500	1240	5215	5.6%	1.0%	5.5%	5.54	0.56%	2.10%	1.20%	4.23%	98.76%	98.99%	98.90%	98.73%
750	1540	7115	5.6%	0.9%	5.6%	6.18	0.51%	2.07%	1.10%	4.17%	98.95%	99.12%	99.02%	98.86%
1000	1800	8980	5.7%	0.9%	5.6%	6.20	0.49%	2.05%	1.05%	4.14%	99.08%	99.21%	99.10%	98.94%
1500	2485	11215	5.7%	0.8%	5.6%	7.02	0.41%	2.00%	0.91%	4.05%	99.16%	99.30%	99.22%	99.09%
2000	2860	14695	5.7%	0.7%	5.6%	8.03	0.41%	2.00%	0.89%	4.04%	99.25%	99.35%	99.26%	99.13%
2500	3015	18025	5.7%	0.7%	5.6%	8.04	0.40%	2.00%	0.88%	4.04%	99.34%	99.40%	99.30%	99.17%

*Meets DOE 10 CFR Part 431 - 2016 & NRCAN 2019/ON Reg. 404/12 Energy Efficiency Regulations for MVDT Transformers

Typical Performance Data

15 kV, 95kV BIL - Aluminum

75°C, 12470V Delta (95 kV BIL) -
480Y/277V, 600Y/347V (10kV BIL), 60 Hz

kVA	No Load Loss (W)	Load Loss (W)	Impedance	Resistance	Reactance	X/R Ratio	Regulation				% Efficiency at different loads			
							at 50% load		at 100% load		25%	50%*	75%	100%
							pf = 1	pf = 0.8	pf = 1	pf = 0.8				
225	930	2240	5.7%	1.0%	5.7%	5.65	0.51%	1.28%	1.04%	2.57%	98.13%	98.69%	98.72%	98.61%
300	1050	3005	5.7%	1.0%	5.7%	5.65	0.51%	1.28%	1.04%	2.57%	98.38%	98.81%	98.80%	98.67%
500	1350	4820	5.7%	1.0%	5.7%	5.66	0.53%	1.32%	1.09%	2.65%	98.75%	98.99%	98.90%	98.72%
750	1750	6280	5.8%	0.8%	5.7%	7.12	0.45%	1.57%	0.94%	3.15%	98.89%	99.12%	99.06%	98.92%
1000	2275	7050	5.8%	0.7%	5.7%	8.18	0.37%	1.52%	0.78%	3.06%	98.93%	99.20%	99.18%	99.09%
1500	2850	9620	5.8%	0.6%	5.7%	9.57	0.35%	1.60%	0.74%	3.22%	99.09%	99.30%	99.27%	99.18%
2000	3350	12465	5.8%	0.6%	5.7%	9.57	0.37%	1.70%	0.79%	3.43%	99.23%	99.36%	99.29%	99.17%
2500	3900	14235	5.8%	0.5%	5.8%	11.51	0.33%	1.68%	0.72%	3.39%	99.26%	99.41%	99.35%	99.25%

*Meets DOE 10 CFR Part 431 - 2016 & NRCAN 2019/ON Reg. 404/12 Energy Efficiency Regulations for MVDT Transformers

15 kV, 95kV BIL - Copper

75°C, 12470V Delta (95 kV BIL) -
480Y/277V, 600Y/347V (10kV BIL), 60 Hz

kVA	No Load Loss (W)	Load Loss* (W)	Impedance	Resistance	Reactance	X/R Ratio	Regulation				% Efficiency at different loads			
							at 50% load		at 100% load		25%	50%*	75%	100%
							pf = 1	pf = 0.8	pf = 1	pf = 0.8				
225	850	2570	5.6%	1.1%	5.5%	4.83	0.60%	2.02%	1.28%	4.06%	98.23%	98.69%	98.66%	98.50%
300	1000	3235	5.6%	1.1%	5.5%	4.98	0.58%	2.11%	1.23%	4.25%	98.42%	98.81%	98.76%	98.61%
500	1425	4450	5.7%	0.9%	5.6%	6.27	0.49%	2.08%	1.05%	4.21%	98.66%	98.99%	98.96%	98.84%
750	1725	6400	5.7%	0.9%	5.6%	6.58	0.47%	2.23%	1.05%	4.50%	98.88%	99.12%	99.06%	98.93%
1000	2040	7890	5.7%	0.8%	5.6%	7.19	0.44%	2.21%	0.98%	4.46%	99.00%	99.20%	99.14%	99.02%
1500	2610	10700	5.7%	0.7%	5.6%	7.92	0.41%	2.18%	0.91%	4.41%	99.13%	99.30%	99.24%	99.12%
2000	3070	13550	5.7%	0.7%	5.6%	8.41	0.39%	2.17%	0.87%	4.39%	99.22%	99.36%	99.29%	99.18%
2500	3600	15480	5.7%	0.6%	5.6%	9.11	0.36%	2.15%	0.81%	4.35%	99.27%	99.41%	99.35%	99.24%

*Meets DOE 10 CFR Part 431 - 2016 & NRCAN 2019/ON Reg. 404/12 Energy Efficiency Regulations for MVDT Transformers

25 kV, 125kV BIL - Aluminum

75°C, 24940V Delta (125 kV BIL) -
480Y/277V, 600Y/347V (10kV BIL), 60 Hz

kVA	No Load Loss (W)	Load Loss (W)	Impedance	Resistance	Reactance	X/R Ratio	Regulation				% Efficiency at different loads			
							at 50% load		at 100% load		25%	50%*	75%	100%
							pf = 1	pf = 0.8	pf = 1	pf = 0.8				
225	950	2714	5.7%	1.2%	5.6%	4.65	0.64%	2.17%	1.36%	4.38%	98.05%	98.57%	98.55%	98.40%
300	1165	3280	5.7%	1.1%	5.6%	5.11	0.59%	2.14%	1.25%	4.32%	98.21%	98.69%	98.68%	98.54%
500	1535	5038	5.7%	1.0%	5.6%	5.65	0.54%	2.12%	1.17%	4.27%	98.54%	98.89%	98.85%	98.70%
750	2000	6868	5.7%	0.9%	5.7%	6.31	0.50%	2.09%	1.08%	4.22%	98.72%	99.02%	98.97%	98.83%
1000	2460	8045	5.8%	0.8%	5.7%	7.13	0.44%	2.05%	0.97%	4.15%	98.83%	99.11%	99.08%	98.96%
1500	3115	11312	5.8%	0.7%	5.7%	8.17	0.42%	2.04%	0.92%	4.12%	98.99%	99.21%	99.16%	99.05%
2000	4015	12822	5.8%	0.7%	5.7%	8.20	0.36%	2.00%	0.81%	4.05%	99.05%	99.28%	99.26%	99.17%
2500	4200	17000	5.8%	0.7%	5.7%	8.19	0.38%	2.01%	0.84%	4.07%	99.17%	99.33%	99.27%	99.16%

*Meets DOE 10 CFR Part 431 - 2016 & NRCAN 2019/ON Reg. 404/12 Energy Efficiency Regulations for MVDT Transformers

25 kV, 125kV BIL - Copper

75°C, 24940V Delta (125 kV BIL) -
480Y/277V, 600Y/347V (10kV BIL), 60 Hz

kVA	No Load Loss (W)	Load Loss (W)	Impedance	Resistance	Reactance	X/R Ratio	Regulation				% Efficiency at different loads			
							at 50% load		at 100% load		25%	50%*	75%	100%
							pf = 1	pf = 0.8	pf = 1	pf = 0.8				
225	900	2920	5.6%	1.3%	5.4%	4.14	0.69%	2.17%	1.45%	4.37%	98.11%	98.57%	98.52%	98.33%
300	1115	3500	5.6%	1.2%	5.5%	4.58	0.62%	2.13%	1.32%	4.30%	98.25%	98.69%	98.65%	98.48%
500	1525	5085	5.6%	1.0%	5.5%	5.55	0.55%	2.09%	1.17%	4.21%	98.55%	98.89%	98.84%	98.70%
750	1955	7100	5.6%	0.9%	5.6%	6.18	0.51%	2.07%	1.10%	4.17%	98.74%	99.02%	98.95%	98.81%
1000	2340	8520	5.6%	0.8%	5.6%	6.99	0.47%	2.04%	1.01%	4.12%	98.86%	99.11%	99.06%	98.93%
1500	3280	10730	5.7%	0.7%	5.6%	8.04	0.40%	1.99%	0.87%	4.03%	98.96%	99.21%	99.18%	99.07%
2000	3650	14600	5.7%	0.7%	5.6%	8.03	0.40%	2.00%	0.89%	4.04%	99.10%	99.28%	99.22%	99.10%
2500	4050	17740	5.7%	0.7%	5.6%	8.04	0.39%	1.99%	0.87%	4.03%	99.18%	99.33%	99.26%	99.14%

*Meets DOE 10 CFR Part 431 - 2016 & NRCAN 2019/ON Reg. 404/12 Energy Efficiency Regulations for MVDT Transformers

Technical Information

The following information is provided for reference only:

Average Audible Sound Levels

Self-Cooled		Ventilated Forced Air Cooled	
Equivalent Two-Winding (kVA)	Ventilated (Class AA Rating)	Equivalent Two-Winding (kVA)	Class FA and AFA Rating
0-9	40	0-1167	67
10-50	45	1168-1667	68
51-150	50	1668-2000	69
151-300	55	2001-3333	71
301-500	60	3334-5000	73
501-700	62	5001-6667	74
701-1000	64	6668-8333	75
1001-1500	65	8334-10000	78
1501-2000	66		
2001-3000	68		
3001-4000	70		
4001-5000	71		
5001-6000	72		
6001-7500	75		

System Voltage and Transformer BIL Ratings

Nominal L-L System Voltage (kV)	Low Frequency Voltage Insulation Level (kV rms)	Basic lightning impulse insulation levels (BIL ratings) in common use kV crest ^{a,b} (1.2 x 50 μs)													
		10	20	30	45	60	95	110	125	150	200	250	300	350	
0.25	2.5	None													
0.6	3	S	1	1											
1.2	4	S	1	1											
2.5	10		S	1	1										
5.0	12			S	1	1									
8.7	20				S	1	1								
15.0	34					S	1	1							
18.0	40						S	1	1						
25.0	50							2	S	1	1				
34.5	70									2	S	1			
46.0	95											S	1	1	
69.0	140												S	1	1
Chopped wave ^{c,d} minimum time to flashover μs		1.0	1.0	1.0	1.25	1.5	1.6	1.8	2.0	2.25	2.7	3.0	3.0	3.0	

When performing an impulse test on the low voltage windings, the high voltage windings may experience higher test voltage than the rated BIL level.

Note - The latest edition of IEEE Std. C62.22™ [B3] should be consulted for information coordination with available surge arrester protection levels.

S = Standard values

1 = Optional higher levels where exposure to overvoltages occurs and improved protective margins are required.

2 = Optional lower levels where protective characteristics of applied surge arresters have been evaluated and found to provide appropriate surge protection.

a = Low-impedance low-side windings may be tested with a much faster 0.5 x 1.5 μs impulse wave on BIL ratings less than or equal to 30 kV.

b = A positive impulse wave shall be used.

c = The voltage crest of the chopped wave should be approximately the same as the full wave magnitude.

d = No chopped waves are required on 0.6 kV systems and below.

Standard Transformer Ratings, Primary Voltage Class 2.3-46 kV

kVA 3 Phase			Secondary Voltage			
Self-Cooled	Fan-Cooled Ventilated Dry	Fan-Cooled Weather Resistant Ventilated	208Y/120 V 240 V Delta	480Y/277 V 480V Delta	4160Y/2400 V 4160 V Delta 2400 V Delta	600Y/277 V 600V Delta
225			X	X		X
300	400	400	X	X		X
500	667	667	X	X	X	X
750	1000	1000	X	X	X	X
1000	1333	1333	X	X	X	X
1500	2000	2000	X	X	X	X
2000	2666	2666		X	X	X
2500	3333	3333		X	X	X
3750	5000	5000			X	
5000	6650	6650			X	
7500	10000	10000			X	

The above combinations are based on standard designs. Other than standard designs may place further restrictions on the availability of voltage and kVA combinations. Consult factory for final determination.

Altitude Derating Factor

Altitude (FT)	kVA Correction	BIL Correction
3300	1.00	1.00
4000	0.994	0.98
5000	0.985	0.95
6000	0.975	0.92
7000	0.966	0.89
8000	0.957	0.86
9000	0.948	0.83
10,000	0.939	0.80
11,000	0.930	0.77
12,000	0.921	0.75
13,000	0.912	0.72
14,000	0.903	0.70
15,000	0.894	0.67

Per IEEE 100m = 330 ft

Other HPS Energy Efficient Products



ENERGY EFFICIENT GENERAL PURPOSE DISTRIBUTION TRANSFORMERS

Generally used for supplying appliance, lighting, heating, motorized machine and power loads from electrical distribution systems.

Standard features include:

HPS Sentinel®

- Meets C802.2 (2012) efficiencies per Canadian Energy Efficiency Regulations SOR/94-651

HPS Sentinel® G

- Meets new DOE 2016/NRCAN 2019 & ON Reg. 404/12 efficiency standards
- 10kV BIL on all transformers



ENERGY EFFICIENT K-FACTOR TRANSFORMERS

The use of K-factor distribution transformers has become a popular means of supplying power for non-linear loads such as electronic ballasts, drives, personal computers, telecommunications equipment, broadcasting equipment and other similar power electronics. These non-linear loads generate harmonic currents which can substantially increase transformer losses. Our K-rated transformers have been specifically designed to prevent failure due to overheating.

Standard features include:

HPS Synergy®

- K-Factor ratings of K4, K9, K13 and K20
- Meets C802.2 (2012) efficiencies per Canadian Energy Efficiency Regulations SOR/94-651

HPS Sentinel® K

- K-Factor ratings of K4, K9, K13 and K20
- Meets new DOE 2016/NRCAN 2019 & ON Reg. 404/12 efficiency standards
- 10kV BIL on all transformers



ENERGY EFFICIENT HARMONIC MITIGATING TRANSFORMERS

HPS Harmonic Mitigating transformers reduce voltage distortion (flat-topping) and power losses due to current harmonics created by single-phase, non-linear loads such as computer equipment. They treat sequence harmonics (3rd, 9th and 15th) within the secondary windings and 5th and 7th harmonics upstream with appropriate phase shifting. Typical applications of severe non-linear loading conditions include data centers, internet-service providers, telecom sites, call centers, broadcast centers, etc.

Standard features include:

HPS Centurion®

- Meets C802.2 (2012) efficiencies per Canadian Energy Efficiency Regulations SOR/94-651

HPS Sentinel® H

- K-Factor rating of K13 (others available on request)
- Meets new DOE 2016/NRCAN 2019 & ON Reg. 404/12 efficiency standards
- 10kV BIL on all transformers





ENERGY EFFICIENT DRIVE ISOLATION TRANSFORMERS

HPS drive isolation transformers are suitable for both AC and DC variable speed drives. They are sized to match standard motor horsepower and voltage ratings.

Standard features include:

- Three phase ratings from 7 kVA to 660 kVA
- Copper and aluminum available
- Optional shield available
- UL Listed and CSA Certified
- Type 3R enclosure (optional type 4, 12 or stainless)

HPS Tribune™

- Meets TP1 and C802.2-12 efficiencies

HPS Tribune™ E

- Meets NRCAN 2019 & ON Reg. 404/12 efficiency standards



HPS ENDURACOIL™ CAST RESIN TRANSFORMERS

HPS EnduraCoil™ is a high-performance cast resin product designed for many demanding and diverse applications. Coils are precision wound with copper or aluminum conductors that are electrically balanced to minimize axial forces during short-circuit conditions.

Standard features include:

- kVA ratings from 300 to 3000 ANN, 4000 AFN, up to 34.5 kV Class
- Enclosure options (Type 1, 2, 3R, 3RE, 4, 12; other paint colors or stainless steel)
- Multiple standard options
- UL listed and CSA certified

HPS EnduraCoil™

- Meets Canadian Energy Efficiency Regulations SOR/94-651 efficiency levels at 50% of rated load

HPS EnduraCoil™ E

- Meets new DOE 2016/NRCAN 2019 & ON Reg. 404/12 efficiency standards



HPS MILLENNIUM™ ENERGY EFFICIENT MEDIUM VOLTAGE DISTRIBUTION TRANSFORMERS

5 kV class transformers are designed to step down incoming high voltage power to utilize voltages for commercial, institutional or industrial applications.

Standard features include:

- Large variety of standard and custom single phase and three phase voltages and kVA ratings
- Standard primary voltages of 2400 and 4160 volts
- UL Listed and CSA Certified
- Type 3R and ANSI 61 enclosure (optional Type 4, 12; other paint colors or stainless steel)

HPS Millennium™

- Meets CSA C802.2-12 efficiency standards at 50% of rated load

HPS Millennium™ G

- Meets new DOE 2016/NRCAN 2019 & ON Reg. 404/12 efficiency standards





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