

Thyro-PX™ Power Controller

User Manual

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Safety and Product Compliance Guidelines

IMPORTANT SAFETY INFORMATION

To ensure safe installation and operation of the Advanced Energy Thyro-PX unit, read and understand this manual before attempting to install and operate this unit. At a minimum, read and follow the safety guidelines, instructions, and practices.

DANGER, WARNING, AND CAUTION BOXES



This symbol represents important notes concerning potential harm to people, this unit, or associated equipment. Advanced Energy includes this symbol in Danger, Warning, and Caution boxes to identify specific levels of hazard seriousness.



DANGER:

DANGER indicates an imminently hazardous situation that, if not avoided, will result in death or serious injury. **DANGER** is limited to the most extreme situations.



DANGER:

DANGER indique une situation dangereuse imminente qui, si elle n'est pas évitée, pourrait provoquer la mort ou des blessures graves. **DANGER** est réservé aux situations les plus extrêmes.



WARNING:

WARNING indicates a potentially hazardous situation that, if not avoided, could result in death or serious injury, and/or property damage.



AVERTISSEMENT:

AVERTISSEMENT indique une situation potentiellement dangereuse qui, si elle n'est pas évitée, pourrait provoquer la mort ou des blessures graves et/ou des dommages matériels.

**CAUTION:**

CAUTION indicates a potentially hazardous situation that, if not avoided, could result in minor or moderate injury, and/or property damage. CAUTION is also used for property-damage-only accidents.

**ATTENTION:**

ATTENTION indique une situation potentiellement dangereuse qui, si elle n'est pas évitée, pourrait provoquer des blessures mineures ou modérées et/ou des dommages matériels. ATTENTION est également utilisé pour des accidents causant uniquement des dommages matériels.

SAFETY GUIDELINES

Review the following information before attempting to install and operate the product.

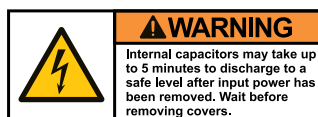
Rules for Safe Installation and Operation

Please note the following rules:

- Do not attempt to install or operate this equipment without proper training.
- Ensure that this unit is properly grounded.
- Ensure that all cables are properly connected.
- Verify that input voltage and current capacity are within specifications before turning on the unit.
- Use proper electrostatic discharge (ESD) and lockout/tagout precautions.
- Maintenance and service must be performed only by AE-trained service personnel.

INTERPRETING PRODUCT LABELS

The following labels may appear on your unit:



Capacitor discharge warning (5 minutes)



CE label

Complies with applicable European directives.



Protective conductor terminal
 This terminal must be connected first and be of proper type and size for the circuit with the highest voltage and current carrying capacity. Note that other connections may have higher requirements than that of the MAINS connection.



On or off

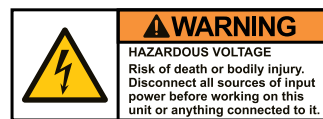


or

Phase



Power on/standby



Hazardous voltage



Hazardous voltage
 Voltage > 30 V_{rms}, 42.4 V peak, or 60 VDC



Hot surface



No user-serviceable parts



European Union RoHS compliant






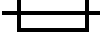






Refer to manual for more information



Short-circuit protected



Environmentally Friendly Use Period of 25 years per China RoHS—recycle responsibly at end of life

| | |
|---|--|
|  | Electrocution hazard |
|  | Heavy object—can cause muscle strain or back injury |
|  | Heavy object—do not lift manually |
|  | Electrical fuse |
|  | Alternating current |
|  | Direct current |
|  | UL® Listed to Canadian and United States safety standards |
|  | UL Listed to United States safety standards |
|  | UL Recognized to Canadian and United States safety standards |
|  | UL Recognized to United States safety standards |

PRODUCT COMPLIANCE

The following sections include information about unit compliance and certification, including the conditions of use required to be in compliance with the standards and directives.

Product Certification

Certain options of this product may be certified according to the list below.

For more information, refer to the Certificate or Letter of Conformity (US) or Declaration of Conformity (EU), available on request.

- CE Marking – Self-declaration, assessed by AE Corporate Compliance
- EMC measurements – Verified by AE Corporate Compliance
- UL registration file E135074 according to UL 508

Safety and EMC Directives and Standards

For information concerning compliance to applicable EU requirements, refer to the EU Declaration of Conformity for this unit. The Declaration of Conformity may also include a supplementary section covering compliance to non-EU regulatory requirements and/or industry standards or guidelines.

Conditions of Use

To comply with the stated directives and standards, you must meet the following conditions of use:

- Before making any other connection to this product, connect the primary Protective Earth (ground), and secondary Protective Earth (ground) if applicable, to a local earth ground using wire that is sized according to the applicable requirements.
- Install and operate this unit in an overvoltage category according to environmental specifications.
- You must install and operate this device with a circuit breaker switch on the AC input. The circuit breaker switch must be easily accessible and near the unit. The breaker must be marked as the disconnecting device for the equipment.
- Use only a shielded cable for communications and/or control connections.
- Limit the system load current to the maximum specified level for the unit.
- Dispose of this product as directed by applicable laws and regulations.
- For the input and output power connections, use wires that are suitable for at least 75°C (167°F).
- Do not allow condensation of any liquids or accumulation of conductive dust on the instrument. Doing so will have unpredictable results, possibly including, but not limited to, loss of accuracy.

INTERLOCKS AND LIMITING CONDITIONS



WARNING:

Advanced Energy products only include interlocks when required by product specification. Interlocks in Advanced Energy products are not intended to meet or satisfy safety requirements. Where interlocks exist, you must still meet and satisfy safety requirements. The presence of interlocks does not imply operator protection.

**AVERTISSEMENT:**

Les produits Advanced Energy comprennent des dispositifs de verrouillage uniquement si la spécification du produit l'exige. Les dispositifs de verrouillage d'Advanced Energy ne sont pas destinés à satisfaire aux normes de sécurité ni à s'y conformer. Lorsqu'un système comprend un dispositif de verrouillage, vous demeurez responsable de satisfaire aux normes de sécurité et de vous y conformer. La présence d'un dispositif de verrouillage n'implique pas la protection de l'opérateur.

Table 1-1. Interlocks and limiting conditions

| Mechanism | Detection Method | Equipment Condition When Interlock is Open |
|---|--|--|
| By opening the <i>PULSE LOCK</i> jumper the unit is locked. | Opening the <i>PULSE LOCK</i> jumper or external interlock circuit Terminal X51.2 connected to terminal X51.3 | The red PULSE LOCK LED is lit on the front panel. The output is disabled. |

The interlock jumper can be removed and replaced with an external interlock circuit capable of switching 24 V, 20 mA.

**Important**

By default, the unit is configured to require a customer supplied *PULSE LOCK* jumper. The unit may be customer configured to not require this jumper.

Product Overview

GENERAL DESCRIPTION

The Thyro-PX is a communication-enabled SCR power controller. The Thyro-PX power controller can be installed where voltages, currents, or power have to be controlled precisely in 1-phase or 3-phase networks. Several modes of operation and control, good coupling ability to process and automation technology, high control precision by application of a 32 bit processor, and simple handling ensure that the Thyro-PX power controller is also suitable for new applications.

The Thyro-PX power controller offers the following ways for mains load optimization:

- The optional digital mains load optimization (dASM) ensures that multiple power controller applications can be used in an optimal way for the network so that system perturbations are mainly avoided.
- For applications which have to use phase angle firing due to required high dynamic, the voltage sequence control (VSC) mode offers to significantly minimize harmonics by its VSC technology.

The Thyro-PX power controller is suitable in particular for the following:

- Direct supply of resistive loads
- Loads with large $R_{\text{warm}}/R_{\text{cold}}$ ratio
- Serving as primary power controller for a transformer with subsequent load

Due to use of high quality thyristors, the Thyro-PX power controller has a type range up to 2900 A, and the nominal design loads reach up to ~ 2860 kW.

UNIT FEATURES

The Thyro-PX unit offers several features for improved handling and operation:

- Ease of use
 - Thyro-Touch display (optional)
 - Thyro-Tool Pro PC computer user interface (optional)
- Wide application range
 - 230 V to 690 V mains voltage
 - 1-phase, 2-phase, and 3-phase units
 - Resistive and inductive loads
 - External 90 VAC to 265 VAC or 24 VDC auxiliary power supply

- Useful features
 - Resistive load and transformer load
 - Soft start function for transformer load
 - Load circuit monitoring
 - Automatic rotating field recognition for 2PX and 3PX units
 - U, U², I, I², and P control
 - Operating modes TAKT, VAR
 - Optional mains load optimization dASM module for applications with multiple power controllers in operating mode TAKT
 - Starting modes MOSI and RAMP
- Flexible connectivity
 - Standard USB interface
 - Standard analog and digital I/O
 - Optional analog and digital I/O extension modules
 - I/O bus for future extension options
 - Optional Anybus® system interface modules

Specifications

PHYSICAL SPECIFICATIONS

Table 3-1. Physical specifications

| Description | Specification |
|---|--|
| General Physical Specifications | |
| Size | For 500 V units, see Table 3-2 |
| Weight | For 690 V units, see Table 3-3 |
| Mounting | |
| Mechanical | Mounting hardware not included |
| Connectors | |
| AC auxiliary power supply input (X1) | Included 3-pin plug-in screw terminal block, 0.2 mm ² - 2.5 mm ² (24 AWG - 12 AWG) |
| RS-232 (powered) (X10) | 9-pin subminiature-D socket (for Thyro-Touch display connection) |
| Anybus module (optional) | Varies by Anybus module, according to the bus standard (not included) |
| dASM module (optional) | 2 RJ-45 sockets (connectors and cables not included) |
| USB (X6) | μ USB (connector and cable not included) |
| Analog I/O 1 (X51) | Included 9-pin, plug-in, screw terminal block, 30 AWG - 14 AWG |
| Analog and digital I/O 2 (X52) | Included 9-pin, plug-in, screw terminal block, 0.14 mm ² - 1.5 mm ² (30 AWG - 14 AWG) |
| Analog and digital I/O 3 (optional) (X53) | Included 16-pin, plug-in, screw terminal block, 0.14 mm ² - 1.5 mm ² (30 AWG - 14 AWG) |
| Analog and digital I/O 4 (optional) (X54) | Included 16-pin, plug-in, screw terminal block, 0.14 mm ² - 1.5 mm ² (30 AWG - 14 AWG) |
| I/O Bus (X4) | RJ-45 (connector and cable not included) |
| 24 V DC auxiliary power supply input (X3) | Included 2-pin, plug-in, screw terminal block, 0.14 mm ² - 1.5 mm ² (30 AWG - 14 AWG) |
| Relay K1 (X21) | Included 3-pin, plug-in, screw terminal block, 0.14 mm ² - 1.5 mm ² (30 AWG - 14 AWG) |
| Relay K2 (X22) | Included 3-pin, plug-in, screw terminal block, 0.14 mm ² - 1.5 mm ² (30 AWG - 14 AWG) |

Table 3-1. Physical specifications (Continued)

| Description | Specification |
|----------------------|--|
| Relay K3 (X23) | Included 3-pin, plug-in, screw terminal block, 0.14 mm ² - 1.5 mm ² (30 AWG - 14 AWG) |
| Protection | |
| Degree of protection | IP10B The unit meets IP20 safety of persons requirements, but not the IP20 safety of device requirements. |

Table 3-2. Type Range 500 Volts

| Model Type Current (A) | Dimensions (WxHxD) mm (in) | | | Weight kg (lb) | Dimensional Drawing |
|-----------------------------|-------------------------------|------------|------------|-------------------|------------------------|
| Thyro-PX 1PX | | | | | |
| 16 H, 37 H, 75 H, 110 H | 150 (5.9) | 320 (12.6) | 232 (9.1) | 6 (13.2) | Figure 5-1 |
| 130 H, 170 H | 200 (7.9) | 320 (12.6) | 232 (9.1) | 8 (17.6) | Figure 5-2 |
| 280 HF | 200 (7.9) | 370 (14.6) | 232 (9.1) | 9 (19.8) | Figure 5-3 |
| 350 HF, 495 HF, 650 HF | 175 (6.9) | 501 (19.7) | 340 (13.4) | 15 (33.0) | Figure 5-4 |
| 780 HF, 1000 HF, 1500 HF | 242 (9.5) | 787 (31.0) | 505 (19.9) | 35 (77.2) | Figure 5-5 |
| 2100 HF | 522 (20.5) | 577 (22.7) | 445 (17.5) | 50 (110.2) | Figure 5-6 |
| 2900 HF | 593 (23.3) | 577 (22.7) | 473 (18.6) | 62 (136.7) | Figure 5-7 |
| Thyro-PX 2PX | | | | | |
| 16 H, 37 H, 75 H, 110 H | 225 (8.9) | 320 (12.6) | 232 (9.1) | 10 (22.0) | Figure 5-8 |
| 130 H, 170H | 325 (12.8) | 320 (12.6) | 232 (9.1) | 12 (26.5) | Figure 5-9 |
| 280 HF | 325 (12.8) | 415 (16.3) | 232 (9.1) | 15 (33.0) | Figure 5-10 |
| 350 HF, 495 HF, 650 HF | 261 (10.3) | 501 (19.7) | 340 (13.4) | 22 (48.5) | Figure 5-11 |
| 780 HF, 1000 HF, 1500 HF | 410 (16.1) | 787 (31.0) | 505 (19.9) | 54 (119.0) | Figure 5-12 |
| 2000 HF, | 550 (21.6) | 837 (33.0) | 445 (17.5) | 84 (185.2) | Figure 5-13 |
| 2750 HF | 593 (23.3) | 837 (33.0) | 474 (18.6) | 107 (235.9) | Figure 5-14 |
| Thyro-PX 3PX | | | | | |
| 16 H, 37 H, 75 H, 110 H | 300 (11.8) | 320 (12.6) | 232 (9.1) | 14 (30.9) | Figure 5-15 |
| 130 H, 170 H | 450 (17.7) | 320 (12.6) | 232 (9.1) | 17 (37.5) | Figure 5-16 |
| 280 HF | 450 (17.7) | 414 (16.4) | 232 (9.1) | 20 (44.0) | Figure 5-17 |
| 350 HF ,495 HF, 650 HF | 348 (10.8) | 525 (20.7) | 340 (13.4) | 30 (66.1) | Figure 5-18 |

Table 3-2. Type Range 500 Volts (Continued)

| Model Type Current (A) | Dimensions (WxHxD) mm (in) | | | Weight kg (lb) | Dimensional Drawing |
|---------------------------|-------------------------------|-------------|------------|-------------------|-----------------------------|
| 780 HF, 1000 HF, 1500 HF | 575 (22.6) | 787 (31.0) | 505 (19.9) | 74 (163.1) | Figure 5-19 |
| 1850 HF | 550 (21.6) | 1094 (43.1) | 445 (17.5) | 119 (262.3) | Figure 5-20 |
| 2600 HF | 593 (23.3) | 1094 (43.1) | 474 (18.6) | 152 (335.1) | Figure 5-21 |

Table 3-3. Type Range 690 Volts

| Model Type Current (A) | Dimensions (WxHxD) mm (in) | | | Weight kg (lb) | Dimensional Drawing |
|---------------------------|-------------------------------|----------------|------------|-------------------|-----------------------------|
| Thyro-PX 1PX | | | | | |
| 80 H | 200 (7.9) | 320 (12.6) | 232 (9.1) | 8 (17.6) | Figure 5-2 |
| 200 HF | 200 (7.9) | 370 (14.6) | 232 (9.1) | 9 (19.8) | Figure 5-3 |
| 300 HF, 500 HF | 175 (6.9) | 501 (19.7) | 340 (13.4) | 15 (33.0) | Figure 5-4 |
| 780 HF, 1400 HF | 242 (9.5) | 787 (31.0) | 505 (19.9) | 35 (77.2) | Figure 5-5 |
| 2000 HF | 522 (20.5) | 577 (22.7) | 445 (17.5) | 50 (110.2) | Figure 5-6 |
| 2600 HF | 593 (23.3) | 577 (22.7) | 473 (18.6) | 62 (136.7) | Figure 5-7 |
| Thyro-PX 2PX | | | | | |
| 80 H | 325 (12.8) | 320 (12.6) | 232 (9.1) | 12 (26.5) | Figure 5-9 |
| 200 HF | 325 (12.8) | 415 (16.3) | 232 (9.1) | 15 (33.0) | Figure 5-10 |
| 300 HF, 500 HF | 261 (10.3) | 501 (19.7) | 340 (13.4) | 22 (48.5) | Figure 5-11 |
| 780 HF, 1400 HF | 410 (16.1) | 787 (31.0) | 505 (19.9) | 54 (119.0) | Figure 5-12 |
| 1850 HF | 550 (21.6) | 837 (33.0) | 445 (17.5) | 84 (185.2) | Figure 5-13 |
| 2400 HF | 593 (23.3) | 837 (33.0) | 474 (18.6) | 107 (235.9) | Figure 5-14 |
| Thyro-PX 3PX | | | | | |
| 80 H | 450 (17.7) | 320 (12.6) | 232 (9.1) | 17 (37.5) | Figure 5-16 |
| 200 HF | 450 (17.7) | 414 (16.4) | 232 (9.1) | 20 (44.0) | Figure 5-17 |
| 300 HF, 500 HF | 348 (10.8) | 525 (20.7) | 340 (13.4) | 30 (66.1) | Figure 5-18 |
| 780 HF, 1400 HF | 575 (22.6) | 787 (31.0) | 505 (19.9) | 74 (163.1) | Figure 5-19 |
| 1700 HF | 550 (21.6) | 1094 (43.1) | 445 (17.5) | 119 (262.3) | Figure 5-20 |
| 2200 HF | 593 (23.3) | 1094 (43.1) | 474 (18.6) | 152 (335.1) | Figure 5-21 |

ELECTRICAL SPECIFICATIONS

Table 3-4. Electrical specifications

| Description | Specification |
|--------------------------------------|---|
| Electrical Requirements | |
| AC input line voltage | Type voltage 500 V units: 184 V to 550 V Type voltage 690 V units: 400 V to 759 V |
| Auxiliary power supply input voltage | 90 VAC - 250 VAC (230 V, 150 mA), or 24 VDC at 1 A |
| Fan input voltage (type HF models) | 230 V, 50/60 Hz, for fan current and current derating see “Cooling Specifications” on page 3-7 |
| AC line frequency | 50/60 Hz nominal; 45 Hz to 65 Hz range |
| AC current | |
| Rated power | |
| Dissipation | Type voltage 500 V units, see Table 3-5 |
| Current transformer ratio | Type voltage 690 V units, see Table 3-6 |
| Burden Resistor | |
| Fuse | |
| Ground connection | Chassis ground near AC connector suitable for ring lug connection Clamp for grounding the control cable shields |
| Load description | Resistive load (minimum 100 W) Resistive load R_{warm}/R_{cold} ratio up to 20 (MOSI starting mode) Transformer load |
| External transformer | The induction of the load side transformer should not exceed 1.45T in case of mains overvoltage when using grain-oriented, cold-rolled plates. This corresponds to a nominal induction of approximately 1.3T. |
| Analog inputs | 0(4) mA - 20 mA $R_i = \text{ca. } 250 \Omega / \text{max. } 24 \text{ mA}$. Max open-circuit voltage = 24 V 0(1) V - 5 V $R_i = \text{ca. } 6.6 \text{ k}\Omega / \text{max. } 12 \text{ V}$ 0(2) V - 10 V $R_i = \text{ca. } 11.1 \text{ k}\Omega / \text{max. } 12 \text{ V}$ |
| Analog outputs | Signal level 0 V - 10 V, 0 mA - 20 mA or 4 mA - 20 mA. The maximum burden voltage is 10 V. Short-circuit proof. |
| Precision | U-control: Better than $\pm 0.5\%$ I-control: Better than $\pm 0.5\%$ P-control: Better than $\pm 1\%$ All specifications are relating to the respective final value. |

Table 3-4. Electrical specifications (Continued)

| Description | Specification |
|-------------|---|
| Limitations | Voltage limitation U_{rms} Current limitation I_{rms} = default setting Effective power limitation P Peak current limitation, MOSI starting mode |
| Relays | Rated current: 6 A Rated voltage: 277 VAC, 24 VDC General use Contact material: AgNi+Au |

Table 3-5. Type voltage 500 volts

| Model Type Current (A) | Type Power (kVA) | Dissipation (W) | Current Transformer T1 | Burden R (Ω) | Fuse F1 (A) |
|------------------------------|---------------------|--------------------|------------------------------|--------------------------|----------------|
| Thyro-PX 1PX | | | | | |
| 16 H | 8 | 71 | 400/1 | 27.4 | 50 |
| 37 H | 18 | 105 | 100/1 | 2.7 | 50 |
| 75 H | 38 | 130 | 100/1 | 1.30 | 100 |
| 110 H | 55 | 175 | 100/1 | 0.91 | 180 |
| 130 H | 65 | 190 | 150/1 | 1.10 | 200 |
| 170 H | 85 | 220 | 200/1 | 1.10 | 315 |
| 280 HF | 140 | 365 | 300/1 | 1.00 | 350 |
| 350 HF | 175 | 477 | 500/1 | 1.30 | 500 |
| 495 HF | 248 | 595 | 500/1 | 1.00 | 630 |
| 650 HF | 325 | 750 | 700/1 | 1.00 | 900 |
| 780 HF | 390 | 1180 | 1000/1 | 1.00 | 2x700 |
| 1000 HF | 500 | 1450 | 1000/1 | 1.00 | 2x1000 |
| 1500 HF | 750 | 1775 | 1500/1 | 1.00 | 4x900 |
| 2100 HF | 1050 | 2600 | 2000/1 | 0.91 | 4x1000 |
| 2900 HF | 1450 | 3400 | 3000/1 | 1.00 | 4x1500 |
| Thyro-PX 2PX | | | | | |
| 16 H | 14 | 107 | 400/1 | 27.4 | 50 |
| 37 H | 32 | 175 | 100/1 | 2.70 | 50 |
| 75 H | 65 | 220 | 100/1 | 1.30 | 100 |
| 110 H | 95 | 310 | 100/1 | 0.91 | 180 |
| 130 H | 112 | 350 | 150/1 | 1.10 | 200 |
| 170 H | 147 | 410 | 200/1 | 1.10 | 315 |

Table 3-5. Type voltage 500 volts (Continued)

| Model Type Current (A) | Type Power (kVA) | Dissipation (W) | Current Transformer T1 | Burden R (Ω) | Fuse F1 (A) |
|------------------------------|---------------------|--------------------|------------------------------|-----------------|----------------|
| 280 HF | 242 | 700 | 300/1 | 1.00 | 350 |
| 350 HF | 303 | 889 | 500/1 | 1.30 | 500 |
| 495 HF | 429 | 1150 | 500/1 | 1.00 | 630 |
| 650 HF | 563 | 1465 | 700/1 | 1.00 | 900 |
| 780 HF | 675 | 2320 | 1000/1 | 1.00 | 2x700 |
| 1000 HF | 866 | 2865 | 1000/1 | 1.00 | 2x1000 |
| 1500 HF | 1300 | 3510 | 1500/1 | 1.00 | 4x900 |
| 2000 HF | 1732 | 4800 | 2000/1 | 1.00 | 4x1000 |
| 2750 HF | 2381 | 6200 | 3000/1 | 1.00 | 4x1500 |
| Thyro-PX 3PX | | | | | |
| 16 H | 14 | 228 | 400/1 | 27.4 | 50 |
| 37 H | 32 | 330 | 100/1 | 2.70 | 50 |
| 75 H | 65 | 400 | 100/1 | 1.30 | 100 |
| 110 H | 95 | 540 | 100/1 | 0.91 | 180 |
| 130 H | 112 | 560 | 150/1 | 1.10 | 200 |
| 170 H | 147 | 650 | 200/1 | 1.10 | 315 |
| 280 HF | 242 | 1070 | 300/1 | 1.00 | 350 |
| 350 HF | 303 | 1301 | 500/1 | 1.30 | 500 |
| 495 HF | 429 | 1800 | 500/1 | 1.00 | 630 |
| 650 HF | 563 | 2265 | 700/1 | 1.00 | 900 |
| 780 HF | 675 | 3330 | 1000/1 | 1.00 | 2x700 |
| 1000 HF | 866 | 4370 | 1000/1 | 1.00 | 2x1000 |
| 1500 HF | 1300 | 5335 | 1500/1 | 1.00 | 4x900 |
| 1850 HF | 1602 | 6900 | 2000/1 | 1.00 | 4x1000 |
| 2600 HF | 2251 | 8700 | 3000/1 | 1.00 | 4x1500 |

Table 3-6. Type voltage 690 volts

| Model Type Current (A) | Type Power (kVA) | Dissipation (W) | Current Transformer T1 | Burden R (Ω) | Fuse F1 (A) |
|------------------------------|---------------------|--------------------|------------------------------|-----------------|-------------|
| Thyro-PX 1PX | | | | | |
| 80 H | 55 | 125 | 100/1 | 1.2 | 100 |
| 200 HF | 138 | 260 | 200/1 | 1.0 | 250 |
| 300 HF | 207 | 360 | 300/1 | 1.0 | 350 |

Table 3-6. Type voltage 690 volts (Continued)

| Model Type Current (A) | Type Power (kVA) | Dissipation (W) | Current Transformer T1 | Burden R (Ω) | Fuse F1 (A) |
|------------------------|------------------|-----------------|------------------------|--------------|-------------|
| 500 HF | 345 | 625 | 500/1 | 1.0 | 630 |
| 780 HF | 538 | 910 | 1000/1 | 1.2 | 2x630 |
| 1400 HF | 966 | 1900 | 1500/1 | 1.0 | 4x700 |
| 2000 HF | 1380 | 3200 | 2000/1 | 1.0 | 4x900 |
| 2600 HF | 1794 | 3450 | 3000/1 | 1.2 | 4x1400 |
| Thyro-PX 2PX | | | | | |
| 80 H | 95 | 225 | 100/1 | 1.2 | 100 |
| 200 HF | 239 | 485 | 200/1 | 1.0 | 250 |
| 300 HF | 358 | 640 | 300/1 | 1.0 | 350 |
| 500 HF | 597 | 1225 | 500/1 | 1.0 | 630 |
| 780 HF | 932 | 1700 | 1000/1 | 1.2 | 2x630 |
| 1400 HF | 1673 | 3750 | 1500/1 | 1.0 | 4x700 |
| 1850 HF | 2210 | 5700 | 2000/1 | 1.0 | 4x900 |
| 2400 HF | 2868 | 6400 | 3000/1 | 1.2 | 4x1400 |
| Thyro-PX 3PX | | | | | |
| 80 H | 95 | 350 | 100/1 | 1.2 | 100 |
| 200 HF | 239 | 740 | 200/1 | 1.0 | 250 |
| 300 HF | 358 | 1020 | 300/1 | 1.0 | 350 |
| 500 HF | 597 | 1825 | 500/1 | 1.0 | 630 |
| 780 HF | 932 | 2740 | 1000/1 | 1.2 | 2x630 |
| 1400 HF | 1673 | 5600 | 1500/1 | 1.0 | 4x700 |
| 1700 HF | 2031 | 8000 | 2000/1 | 1.0 | 4x900 |
| 2200 HF | 2619 | 9000 | 3000/1 | 1.2 | 4x1400 |

COOLING SPECIFICATIONS

Type H Thyro-PX power controllers are self cooled, while type HF units are force cooled. The fan in HF units require a separate power source at 230 V, 50/60 Hz. A 115 V fan is available by special-order for some units.

Table 3-7. Current derating

| Air Temperature | I/I _{RATED} CURRENT (A) | |
|--|----------------------------------|----------------|
| | Self Cooling | Forced Cooling |
| -10°C to +25°C (14°F to 77°F) | 1.10 | 1.10 |
| 30°C (86°F) | 1.10 | 1.05 |
| 35°C (95°F) | 1.10 | 1.00 |
| 40°C (104°F) | 1.05 | 0.96 |
| 45°C (113°F) | 1.00 | 0.91 |
| 50°C (122°F) | 0.95 | 0.87 |
| 55°C (131°F) | 0.88 | 0.81 |
| UL applications limited to +40°C (104°F) | | |

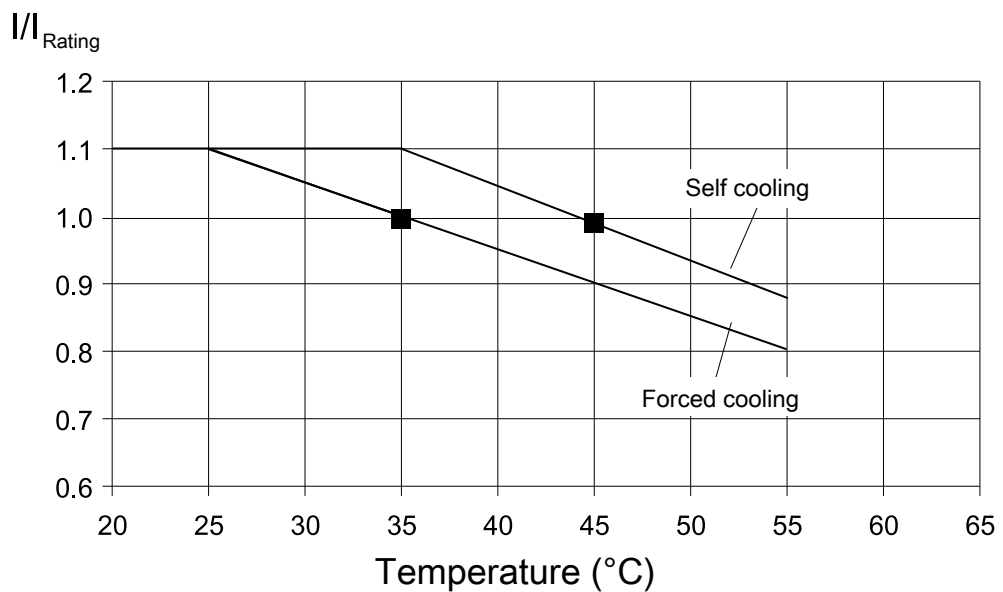


Figure 3-1. Current derating

Table 3-8. Fan current, air volume, and sound pressure

| Model | Current (A) | | Air Volume (m ³ /h) | Sound Pressure (dbA @ 1m) |
|--|-------------|-------|--------------------------------|---------------------------|
| | 50 Hz | 60 Hz | | |
| 1PX | | | | |
| 200 HF, 280 HF | 0.22 | 0.22 | 120 | 53 |
| 300 HF, 350 HF, 495 HF, 500 HF, 650 HF | 0.50 | 0.38 | 150 | 67 |
| 780 HF, 1000 HF, 1400 HF, 1500 HF | 0.55 | 0.60 | 580 | 75 |
| 2000 HF, 2100 HF, 2600 HF, 2900 HF | 1.00 | 1.20 | 2200 | 81 |

Table 3-8. Fan current, air volume, and sound pressure (Continued)

| Model | Current (A) | | Air Volume (m ³ /h) | Sound Pressure (dbA @ 1m) |
|---|-------------|-------|-----------------------------------|------------------------------|
| | 50 Hz | 60 Hz | | |
| 2PX | | | | |
| 200 HF, 280 HF | 0.50 | 0.38 | 200 | 67 |
| 300 HF, 350 HF, 495 HF, 500 HF, 650 HF | 0.50 | 0.38 | 230 | 67 |
| 780 HF, 1000 HF, 1400 HF, 1500 HF | 1.00 | 1.20 | 1200 | 81 |
| 1850 HF, 2000 HF, 2400 HF, 2750 HF | 1.00 | 1.20 | 2100 | 81 |
| 3PX | | | | |
| 200 HF, 280 HF | 0.50 | 0.38 | 260 | 67 |
| 300 HF, 350 HF, 495 HF, 500 HF, 650 HF | 1.20 | 0.85 | 450 | 72 |
| 780 HF, 1000 HF, 1400 HF, 1500 HF | 1.00 | 1.20 | 1600 | 81 |
| 1700 HF, 1850 HF, 2200 HF, 2600 HF | 1.00 | 1.20 | 2000 | 81 |
| Fans for HF units must be running when the unit is operating. Connect the fans according to connecting diagrams. When operating conditions are below +10°C (50°F), a longer fan startup time is required. Therefore, the overcurrent protection device should be rated at twice the specified continuous current. | | | | |

ENVIRONMENTAL SPECIFICATIONS

The two following tables describe the environmental specifications for the Thyro-PX unit.

Table 3-9. Environmental standard specifications

| Description | Specification |
|------------------|----------------------------|
| Overvoltage | Category III per IEC 61010 |
| Pollution degree | 2 |

Table 3-10. Climatic specifications

| | Temperature | Relative Humidity | Air Pressure |
|--|--|--|--|
| Operating | Self cooled models: +0°C to +45°C +32°F to +113°F Force cooled models: +0°C to +35°C +32°F to +95°F | 5% to 85% ^[1] 1 g/m ³ to 25 g/m ³ 1 g/m ³ to 25 g/m ³ | 78.8 kPa to 106 kPa 788 mbar to 1060 mbar Equivalent altitude: +2000 m to -500 m (+6562' to -1640') |
| Storage | -25°C to +55°C -13°F to +131°F | 5% to 95% 1 g/m ³ to 29 g/m ³ | 78.8 kPa to 106 kPa 788 mbar to 1060 mbar Equivalent altitude: +2000 m to -500 m (+6562' to -1640') |
| Transportation | -25°C to +70°C -13°F to +158°F | 95% ^[2] 60 g/m ³ ^[3] | 65.6 kPa to 106 kPa 656 mbar to 1060 mbar Equivalent altitude: +3500 m to -500 m (+11480' to -1640') |
| ¹ Non-condensing, no formation of ice ² Maximum relative humidity when the unit temperature slowly increases, or when the unit temperature directly increases from -25°C to +30°C (-13°F to +86°F) ³ Maximum absolute humidity when the unit temperature directly decreases from +70°C to +15°C (+158°F to +59°F) | | | |

TYPE DESIGNATION

The type designations of the Thyro-PX power controllers are derived from the construction of the unit power section, as shown in the following table.

Table 3-11. Type designation

| Type Range | Designation | Features |
|---------------------------|-------------|---|
| Thyro-PX power controller | 1PX | 1-phase power section, for 1-phase operation |
| | 2PX | 2-phase power section used with a 3-phase load in 3-phase economic circuit (not for phase-angle firing VAR), or with two 1-phase loads in multi-zone mode |

Table 3-11. Type designation (Continued)

| Type Range | Designation | Features |
|------------|----------------|--|
| | 3PX | 3-phase power section, for 3-phase operation, or with three 1-phase loads in multi-zone mode |
| | ..500 | Up to 500 V |
| | ..690 | Up to 690 V |
| |-37 | Type current 37 A |
| |-..... H | Integrated semiconductor fuse |
| |-..... F | Forced air cooling with integrated fan |

Communication Controls

CONTROLS AND INDICATORS

The unit can be configured using either the Thyro-Touch display, or via the Thyro-Tool Pro PC software.

The setpoint control characteristic of Thyro-PX may be easily adapted for the control output signal of the upstream process controller or automation system. The adaptation is made by changing the starting and ending points of the control characteristic. Inverted operation (ending value is smaller than the starting value in voltage or current) is also possible. The effective setpoint is the total setpoint, and it is formed by adding the three setpoints as shown in [Figure 4-1](#). In the simplest case, all the setpoint values are added algebraically. The prerequisite for a setpoint to influence the total setpoint value is that it must be enabled by the setpoint configuration.

- Analog setpoint: (X52.2 to X52.5 ground) 4 mA to 20 mA default, other configurations are possible (for example, 0 V to 5 V)
- Bus setpoint: Setpoint of the superordinate system or PC via either USB or the optional bus interface.
- Motor potentiometer setpoint: Setpoint input (motor potentiometer function) settings via USB, the optional bus interface, or the Thyro-Touch display. The motor potentiometer setpoint is stored in case of mains failure.

If a unit is operating in the multi-zone mode, there are up to three setpoints, one for each zone.

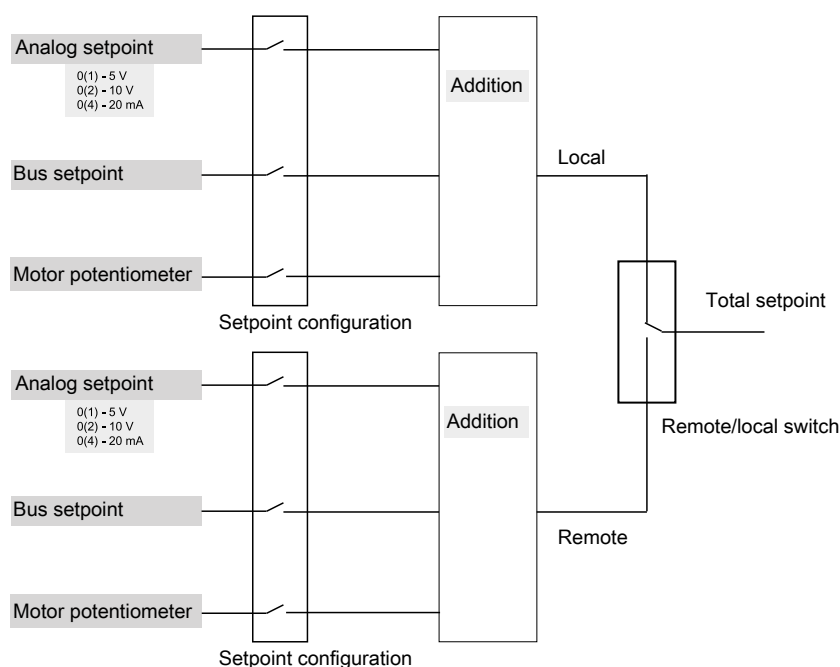


Figure 4-1. Total setpoint

The local analog setpoint, and local motor potentiometer setpoint are used by default. If an Anybus module is installed, the remote bus setpoint is used by default. Switching between the local setpoint and the remote setpoint can be controlled using the Thyro-Touch display, the Thyro-Tool Pro PC software, or the bus communication. A digital I/O line may also be configured to control the local/remote switch.

Status Indicators (LEDs)

Errors and faults are indicated by the status LEDs, the fault and limit relays, the Thyro-Touch display, the Thyro-Tool Pro PC software, and the optional bus interface.

The unit signals faults in the power controller or load circuit via the **FAULT** LED and fault relay K1. To identify the location of the fault, select the status line, and read the fault log via the Thyro-Touch display, the Thyro-Tool Pro PC software, or the bus interface.

Simultaneously with the fault signal, you can use the **Pulse Lock On/Off** (with acknowledgement), **Pulse Lock On/Off** (without acknowledgement), or **Regulator Lock On/Off** (without acknowledgement) configuration to require that pulse shutdown occur.

The Thyro-PX unit LED status indicators are located on the front panel of the unit.



Important

This manual describes the default configuration. Though these functions are fully configurable, AE recommends not changing the default configuration.



Figure 4-2. Status LEDs

Table 4-1. Thyro-PX status LEDs

| LED | Status |
|-------------------|--|
| ON/READY | Green: On, ready for operation Red: Severe hardware fault. (EEPROM fault) Red blinking: Hardware configuration incorrect. Orange blinking: Firmware is being updated. Off: No power, hardware fault. |
| LIMIT | Red: Limitation is active |
| PULSE LOCK | Red: Pulse lock active |
| FAULT | Red: Fault present |
| CONTROL 1 | Green: Blinks at rate proportional to pulse-width modulation of power controller 1 Red: Power unit 1 hardware failure |
| CONTROL 2 | Green: Blinks at rate proportional to pulse-width modulation of power controller 2 Red: Power unit 2 hardware failure |
| CONTROL 3 | Green: Blinks at rate proportional to pulse-width modulation of power controller 3 Red: Power unit 3 hardware failure |

Relay Indicators

Errors and faults are indicated by the status LEDs, the fault and limit relays, the Thyro-Touch display, the Thyro-Tool Pro PC software, and the optional bus interface.

The unit signals faults in the power controller or load circuit via the **FAULT** LED and fault relay K1. To identify the location of the fault, select the status line, and read the fault log via the Thyro-Touch display, the Thyro-Tool Pro PC software, or the bus interface.

Simultaneously with the fault signal, you can use the **Pulse Lock On/Off** (with acknowledgement), **Pulse Lock On/Off** (without acknowledgement), or **Regulator Lock On/Off** (without acknowledgement) configuration to require that pulse shutdown occur.

The Thyro-PX power controller is fitted with three relays. Each of these relays has a change-over contact. AE recommends that users keep the default settings for K1 and K2. Each relay can be reconfigured as normally-open or normally-closed using the Thyro-Touch display or the Thyro-Tool Pro PC software.



Important

This manual describes the default configuration. Though these functions are fully configurable, AE recommends not changing the default configuration.

Table 4-2. Relay indications

| Relay | Name | Description |
|-------|----------------|---|
| K1 | Fault relay | This relay is normally-closed, and opens if a fault is detected in the system. You can set which faults switch the relay. |
| K2 | Limit relay | This relay is normally-closed, and opens if a limit is detected in the system. You can set which limits switch the relay. This relay opens (in default setting) if at least one of the following values is exceeded: <ul style="list-style-type: none"> • Maximum configured effective value of the load current • Maximum configured effective value of the load voltage • Maximum. configured active power of the load |
| K3 | Optional relay | The function of this relay is customer-configured. It is possible to implement functions like a follow-up relay for ventilator control, or to bypass the fault relay at system startup. K3 can also be used as an additional fault relay or limiting relay, by re-parameterization. |

ANALOG AND DIGITAL I/O

There are four standard and two optional I/O connectors on the front of the unit:

- RS-232 (with power) connector, for the optional Thyro-Touch display
- µUSB connector, for configuration using the Thyro-Tool Pro PC software
- 9-pin digital I/O connector, with 6 digital inputs
- 9-pin analog I/O connector, with 3 analog inputs, and 3 analog outputs
- Optional 16-pin analog/digital I/O connector, with 4 digital inputs, 3 digital outputs and 3 analog inputs
- Optional 16-pin digital I/O connector, with 9 digital inputs and 3 digital outputs

Up to two of the optional 16-pin I/O ports may be installed in the unit. Each I/O port line can be reconfigured to serve any function, as needed for the application.



Important

This manual describes the default configuration. Though these functions are fully configurable, AE recommends not changing the default configuration.



Important

All digital and analog control cables must be shielded. Connect the cable shields to the shield clamp on the unit as shown in the following figure.

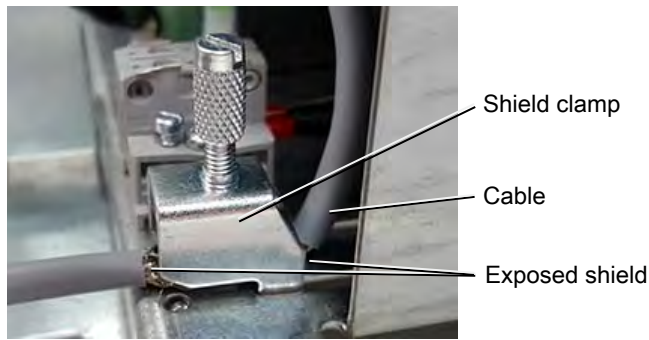


Figure 4-3. Shield clamp

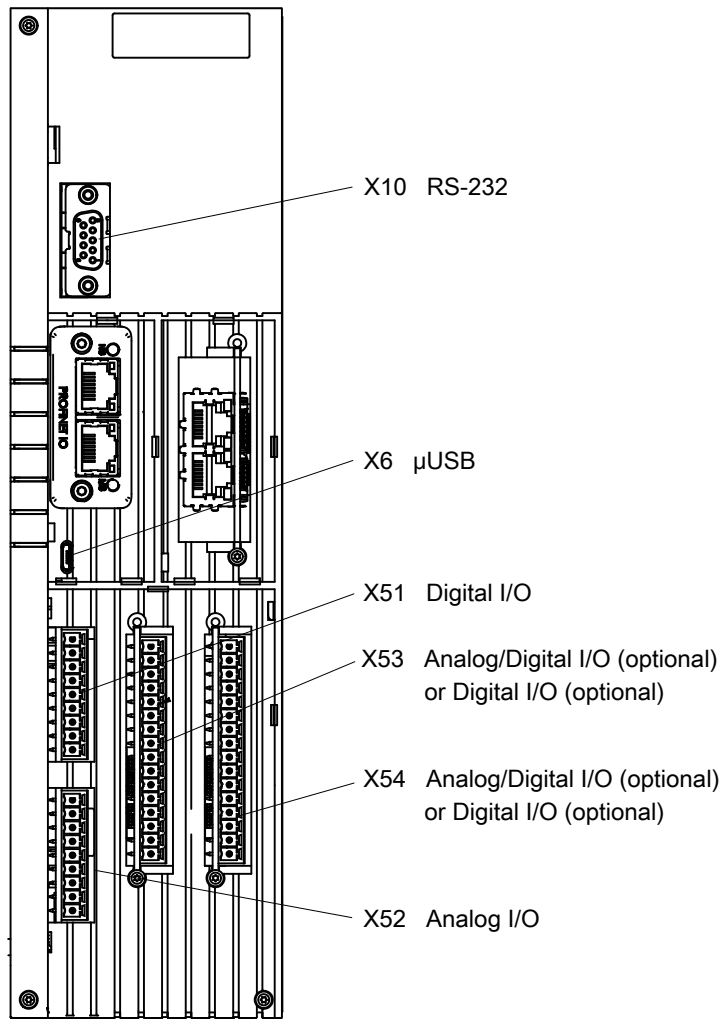


Figure 4-4. Front I/O connectors

Table 4-3. 9-pin digital I/O connector (X51)

| Pin | Signal Name | Function |
|-------|-------------------|-------------------|
| X51.1 | + 24 V | |
| X51.2 | + 24 V | |
| X51.3 | Digital input 1.1 | Pulse lock |
| X51.4 | Digital input 1.2 | Fault acknowledge |

Table 4-3. 9-pin digital I/O connector (X51) (Continued)

| Pin | Signal Name | Function |
|-------|-------------------|-----------------|
| X51.5 | Digital input 1.3 | User configured |
| X51.6 | Digital input 1.4 | User configured |
| X51.7 | Digital input 1.5 | User configured |
| X51.8 | Digital input 1.6 | User configured |
| X51.9 | Common | |

Table 4-4. 9-pin analog I/O connector (X52)

| Pin | Signal Name | Function |
|-------|-------------------|-----------------------------|
| X52.1 | + 5 V | |
| X52.2 | Analog input 1.1 | Setpoint power controller 1 |
| X52.3 | Analog input 1.2 | Setpoint power controller 2 |
| X52.4 | Analog input 1.3 | Setpoint power controller 3 |
| X52.5 | Common | |
| X52.6 | Analog output 1.1 | Output power controller 1 |
| X52.7 | Analog output 1.2 | Output power controller 2 |
| X52.8 | Analog output 1.3 | Output power controller 3 |
| X52.9 | Common | |

Table 4-5. 16-pin analog/digital I/O connector (X53 or X54)

| Pin | Signal Name | Function |
|--------|--------------------|-----------------|
| X53.1 | + 24 V | |
| X53.2 | + 24 V | |
| X53.3 | Digital input 2.1 | User configured |
| X53.4 | Digital input 2.2 | User configured |
| X53.5 | Digital input 2.3 | User configured |
| X53.6 | Digital input 2.4 | User configured |
| X53.7 | Common | |
| X53.8 | Digital output 2.1 | User configured |
| X53.9 | Digital output 2.2 | User configured |
| X53.10 | Digital output 2.3 | User configured |
| X53.11 | Common | |
| X53.12 | + 5 V | |
| X53.13 | Analog input 2.1 | User configured |
| X53.14 | Analog input 2.2 | User configured |
| X53.15 | Analog input 2.3 | User configured |

Table 4-5. 16-pin analog/digital I/O connector (X53 or X54) (Continued)

| Pin | Signal Name | Function |
|--------|-------------|----------|
| X53.16 | Common | |

Table 4-6. 16-pin digital I/O connector (X53 or X54)

| Pin | Signal Name | Function |
|--------|--------------------|-----------------|
| X54.1 | + 24 V | |
| X54.2 | + 24 V | |
| X54.3 | Digital input 3.1 | User configured |
| X54.4 | Digital input 3.2 | User configured |
| X54.5 | Digital input 3.3 | User configured |
| X54.6 | Digital input 3.4 | User configured |
| X54.7 | Digital input 3.5 | User configured |
| X54.8 | Digital input 3.6 | User configured |
| X54.9 | Digital input 3.7 | User configured |
| X54.10 | Digital input 3.8 | User configured |
| X54.11 | Digital input 3.9 | User configured |
| X54.12 | Common | |
| X54.13 | Digital output 3.1 | User configured |
| X54.14 | Digital output 3.2 | User configured |
| X54.15 | Digital output 3.3 | User configured |
| X54.16 | Common | |

The unit has six standard I/O connectors on the bottom of the unit:

- RJ-45 I/O bus
- Fault relay K1
- Limit relay K2
- Optional relay K3
- 24 V auxiliary power supply input

- AC auxiliary power supply input

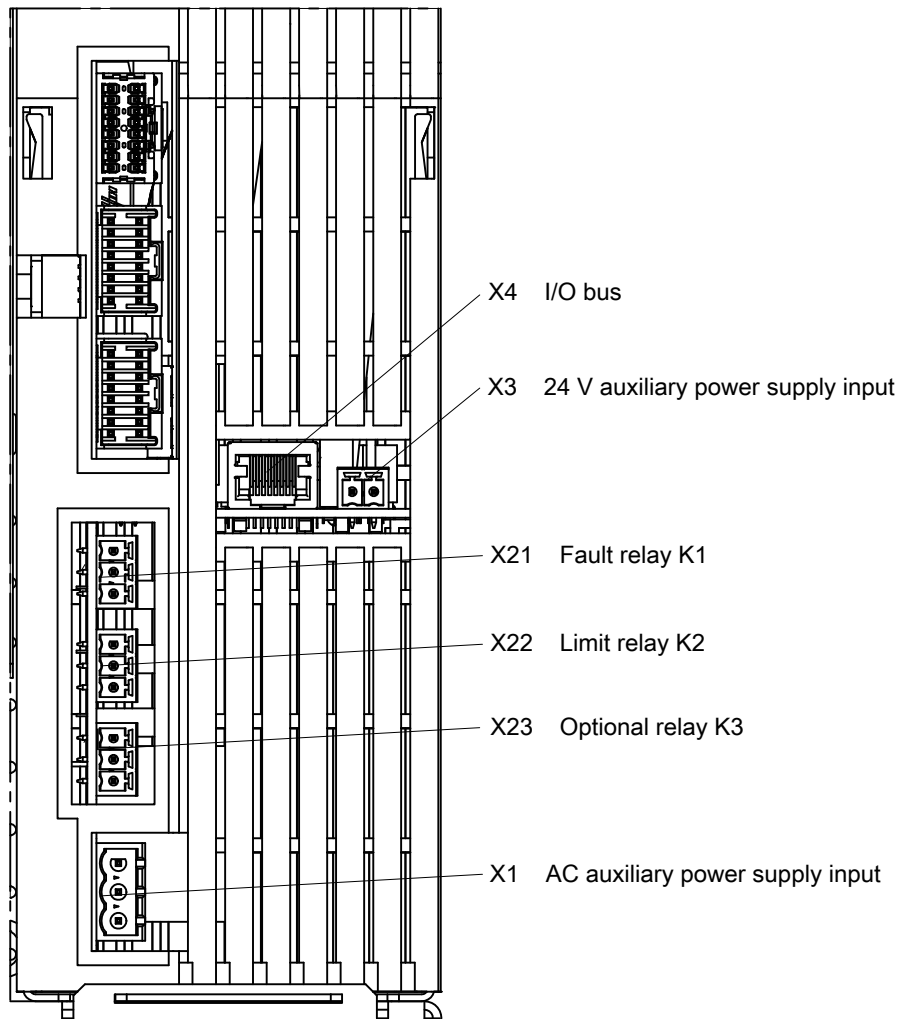


Figure 4-5. Bottom I/O connectors

Table 4-7. Relay K1, K2, and K3 connectors (X21, X22, X23)

| Pin | Function |
|-----|-----------------|
| 1 | Common |
| 2 | Normally closed |
| 3 | Normally open |

Table 4-8. AC auxiliary power supply input (X1)

| Pin | Function |
|-----|----------|
| 1 | L1 |
| 2 | N |
| 3 | Ground |

Table 4-9. DC auxiliary power supply input (X3)

| Pin | Function |
|-----|----------|
| 1 | - 24 VDC |
| 2 | + 24 VDC |

Related Links

- “Connecting I/O and Auxiliary Connectors” on page 5-25

MODULE SLOTS

The unit has two module slots. The Anybus module slot may be equipped with one of the following Anybus modules to add field bus communication capability to the Thyro-PX power controller. For additional module documentation, scan the QR code in the table below.

Table 4-10. Module documentation links








| Anybus Module | Link | QR Code |
|----------------------|---|---|
| Anybus PROFIBUS DPV1 | http://www.aei.com/en/anybus_profibus.html |  |
| Anybus PROFINET® | http://www.aei.com/en/anybus_profinet.html |  |
| Anybus DeviceNet™ | http://www.aei.com/en/anybus_devicenet.html |  |
| Anybus EtherNet/IP™ | http://www.aei.com/en/anybus_ethernet_ip.html |  |

Table 4-10. Module documentation links (Continued)

| Anybus Module | Link | QR Code |
|--------------------|---|---|
| Anybus EtherCAT® | http://www.aei.com/en/anybus_ethercat.html |  |
| Anybus Modbus® TCP | http://www.aei.com/en/anybus_modbus_tcp.html |  |
| Anybus Modbus RTU | http://www.aei.com/en/anybus_modbus_rtu.html |  |

The second module slot may be equipped with the dASM module. All modules are optional.

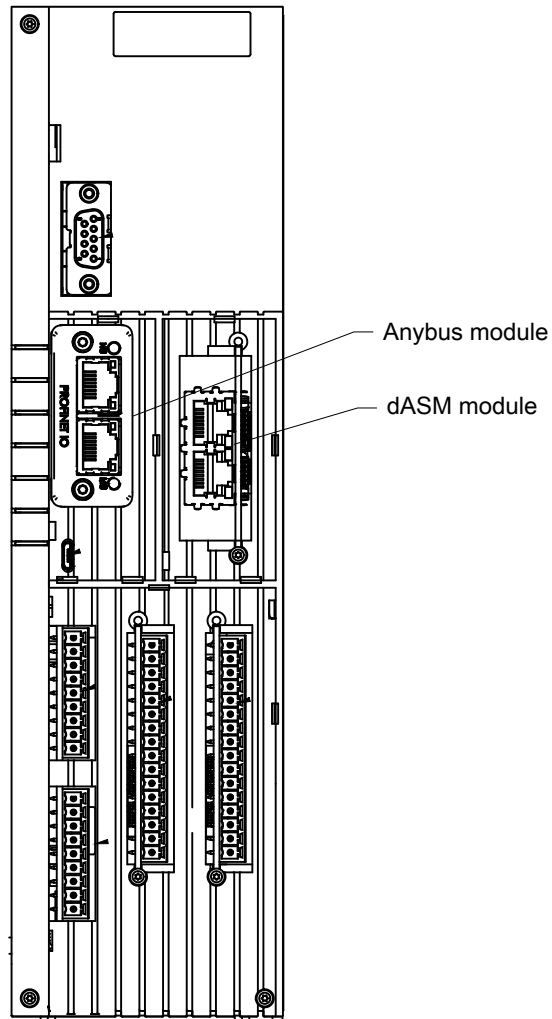


Figure 4-6. Module slots

THYRO-TOUCH DISPLAY

The Thyro-Touch display is an optional accessory for the parameterization and visualization of measured values, such as current, voltage, power, and setpoint.



Figure 4-7. Thyro-Touch display

In addition to simplifying the handling of the Thyro-PX power controller, the Thyro-Touch display also offers a quick overview of power controller status. Ongoing data can also be displayed as line or bar charts. The integrated data recorder enables a long-term recording of up to six measured values, including status messages. You can evaluate the data on a PC. The **EasyStart** feature simplifies the setting of the power controller configuration.

The Thyro-Touch display includes an SD® memory card, and supports Bluetooth low energy wireless communication.

The Thyro-PX power controller provides a communications interface through the **X10** port. This interface allows you to monitor and control the unit through an optional touch display. The display features include:

- Standard languages: German, English. Additional languages are available on request.
- Configure setpoints, actual values, parameters, and status messages.
- Display setpoints and measured process values as a line chart, bar chart, or operating-data display.
- Log process data for long-term data recording, including evaluation of min./max. data curve (easy to convert data into Excel® format).
- Load and save the power controller parameter setting to an SD Memory Card.
- The display can either be connected directly to the power controller, or connected remotely with the cabinet installation kit (SEK).

- Additional Bluetooth low energy communication between the power controller and free application for iOS® and Android™ based smartphone/tablet PC.

If a Bluetooth low energy connection is made to a smartphone or tablet PC, the Thyro-Touch display shows the status of the Bluetooth connection.

Warnings are highlighted in yellow, and error messages are highlighted in red on the display. Click on a message to see details directly in the fault log.

The following access level apply:

- Level 1 PIN: 160387, access to parameter settings
- Level 2 PIN: 311263, access to detailed power controller parameterization

Make sure to change the password after initial use to ensure that third parties cannot change the access levels. Passwords must be numeric only, and must contain at least 6 digits.

Thyro-Touch Display Menus

The Thyro-Touch display allows you to access menus and to make menu selections. When a menu selection causes the display to show a parameter, you can use the display to set the parameter value.


Accessing the Main Menu

When you connect the display, it shows top-level operation information on the display screen.

TO ACCESS THE MAIN MENU AND OTHER MENUS

1. Press a soft key to cause another level of menu choices to display.

For example, pressing the list menu icon soft key displays the next menu level: **configure the display** and **configure the power controller**.

Press the  icon to return to the main menu.

SOFTWARE USER INTERFACE

The optional Thyro-Tool Pro PC software is available for commissioning and visualization. This software can be used to:

- Update firmware
- Set and display parameters
- Display current operating conditions and events
- Create a time-stamped data record

- Create data charts

**Important**

Do not start a USB connection while the controller is controlling a critical process. A short output interruption might occur.

A complete software manual will be available in the **DOWNLOADS** section of the Thyro-PX website: http://www.advanced-energy.com/en/THYRO_PX.html.

Installation, Setup, and Operation

PREPARING TO INSTALL THE UNIT

Spacing Requirements

Install the unit in a vertical orientation to ensure that thyristors attached to heat sinks are adequately ventilated. If you intend to mount this unit in a cabinet, ensure that the cabinet itself is adequately ventilated, and that the following requirements are met.

- The minimum distance between the bottom of the unit and the bottom of the cabinet or any other object is 100 mm (4").
- The minimum distance between the top of the unit and the top of the cabinet or any other object is 150 mm (6").
- The minimum distance between the top of the unit and the bottom of another unit is 150 mm (6").
- Units may be installed side-by-side with no intervening distance.
- Ensure that the unit is not exposed to sources of heat.

Dimensional Drawings

The following figures show Thyro-PX unit dimensions, front, and side views.

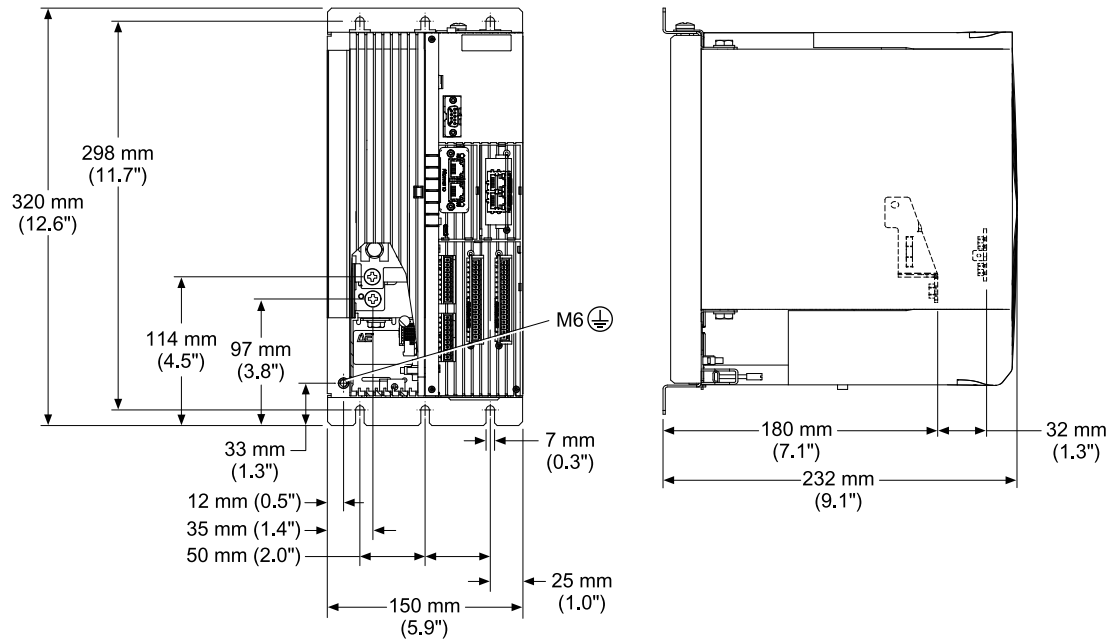


Figure 5-1. Thyro-PX 1PX 500-16 H, 37 H, 75 H, 110 H

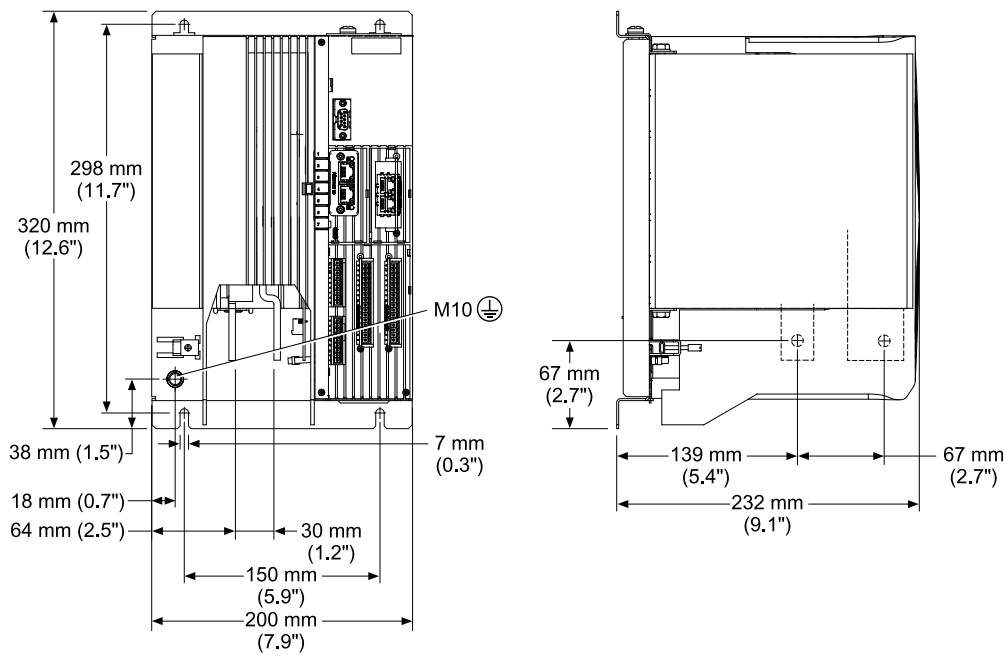


Figure 5-2. Thyro-PX 1PX 500-130 H, 170 H, Thyro-PX 1PX 690-80 H

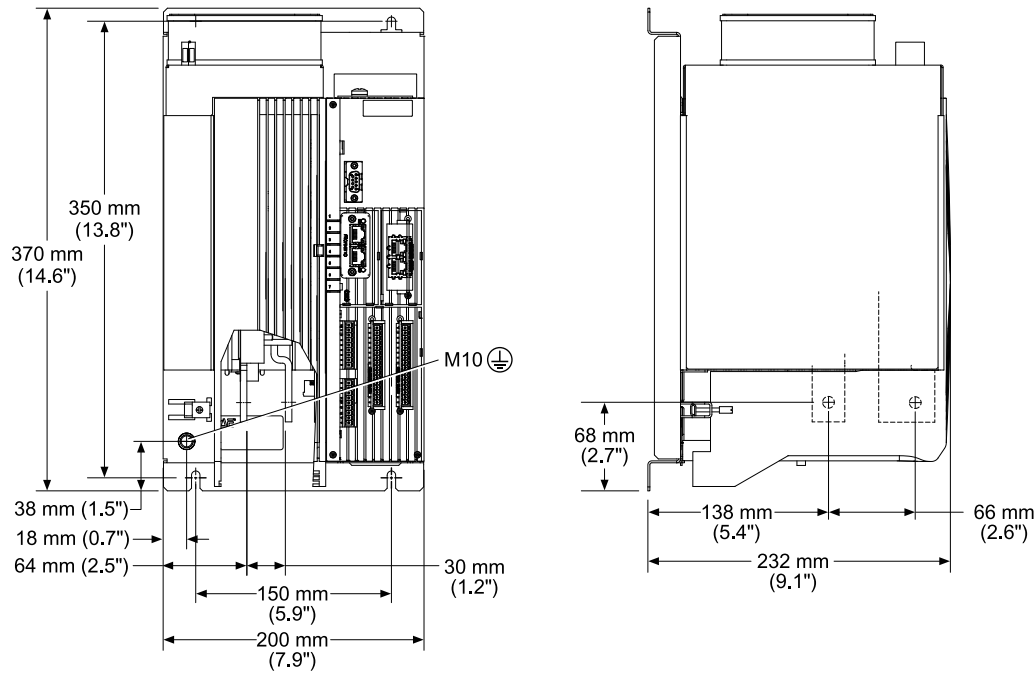


Figure 5-3. Thyro-PX 1PX 500-280 HF, Thyro-PX 1PX 690-200 HF

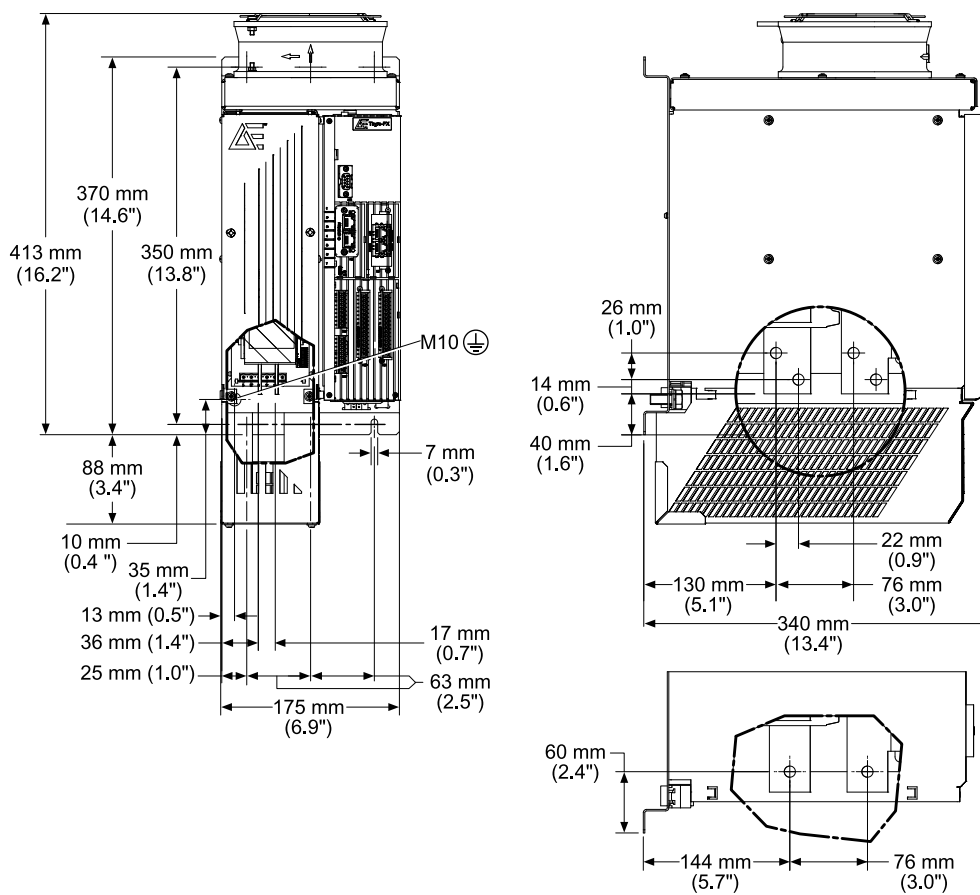


Figure 5-4. Thyro-PX 1PX 500-350 HF, 495 HF, 650 HF, Thyro-PX 1PX 690-300 HF, 500 HF

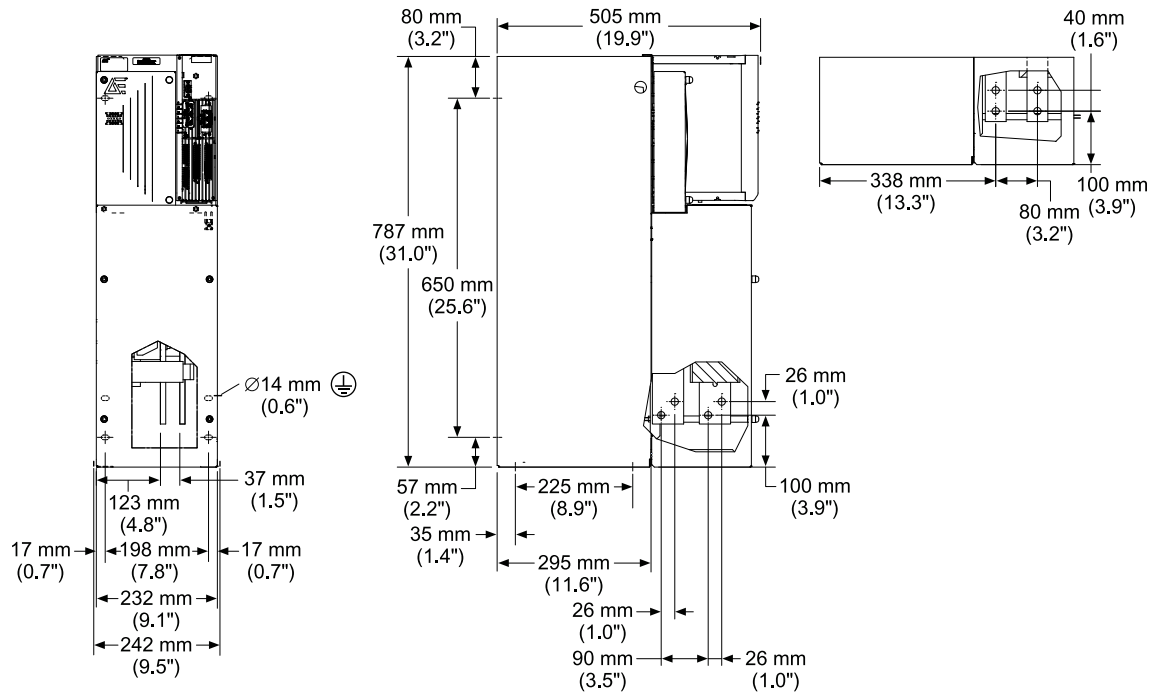


Figure 5-5. Thyro-PX 1PX 500-780 HF, 1000 HF, 1500 HF, Thyro-PX 1PX 690-780 HF, 1400 HF

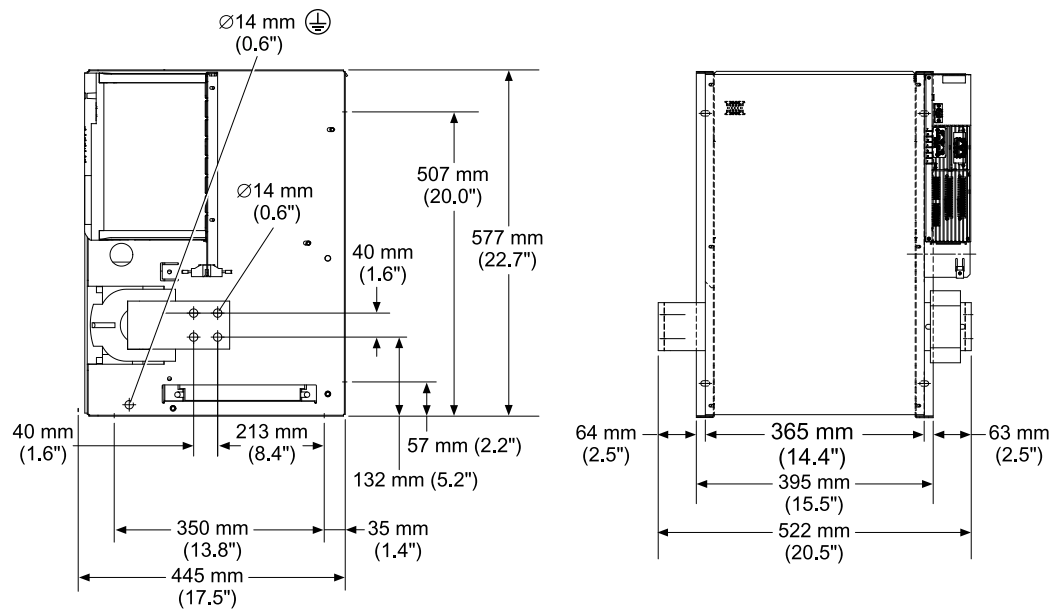


Figure 5-6. Thyro-PX 1PX 500-2100 HF, Thyro-PX 1PX 690-2000 HF

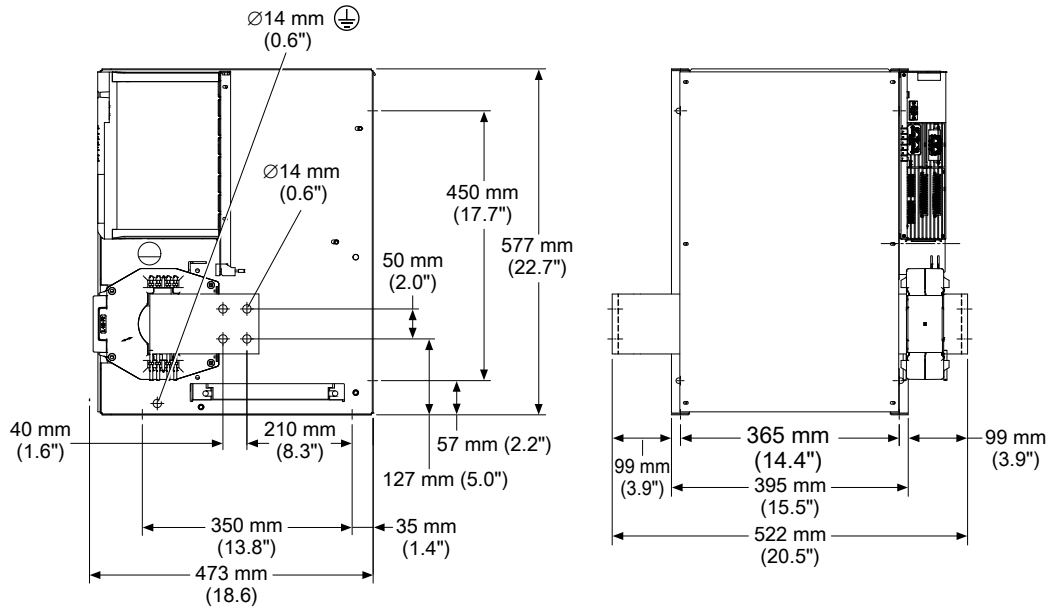


Figure 5-7. Thyro-PX 1PX 500-2900HF, Thyro-PX 1PX 690-2600 HF

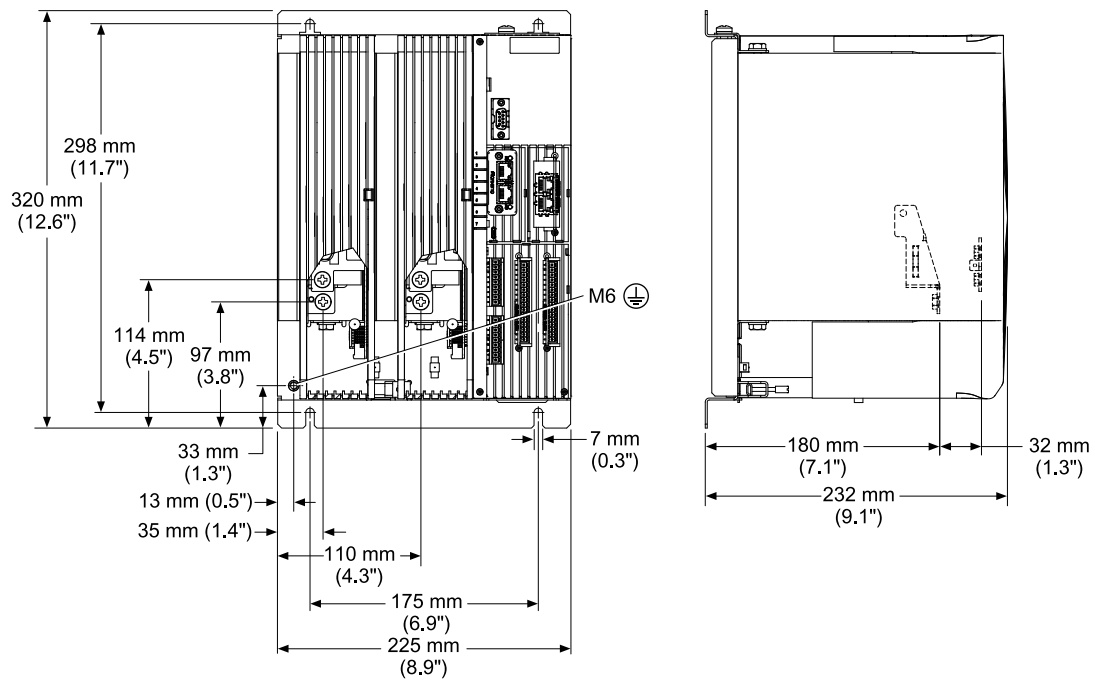


Figure 5-8. Thyro-PX 2PX 500-16 H, 37 H, 75 H, 110 H

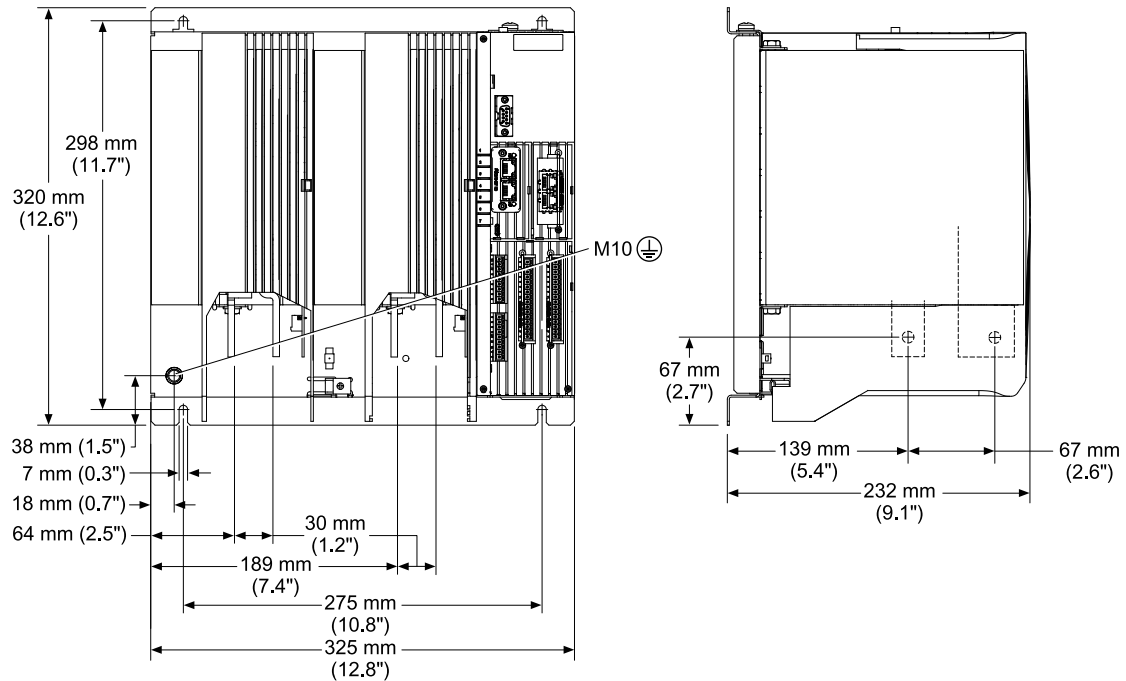


Figure 5-9. Thyro-PX 2PX 500-130 H, 170 H, Thyro-PX 2PX 690-80 H

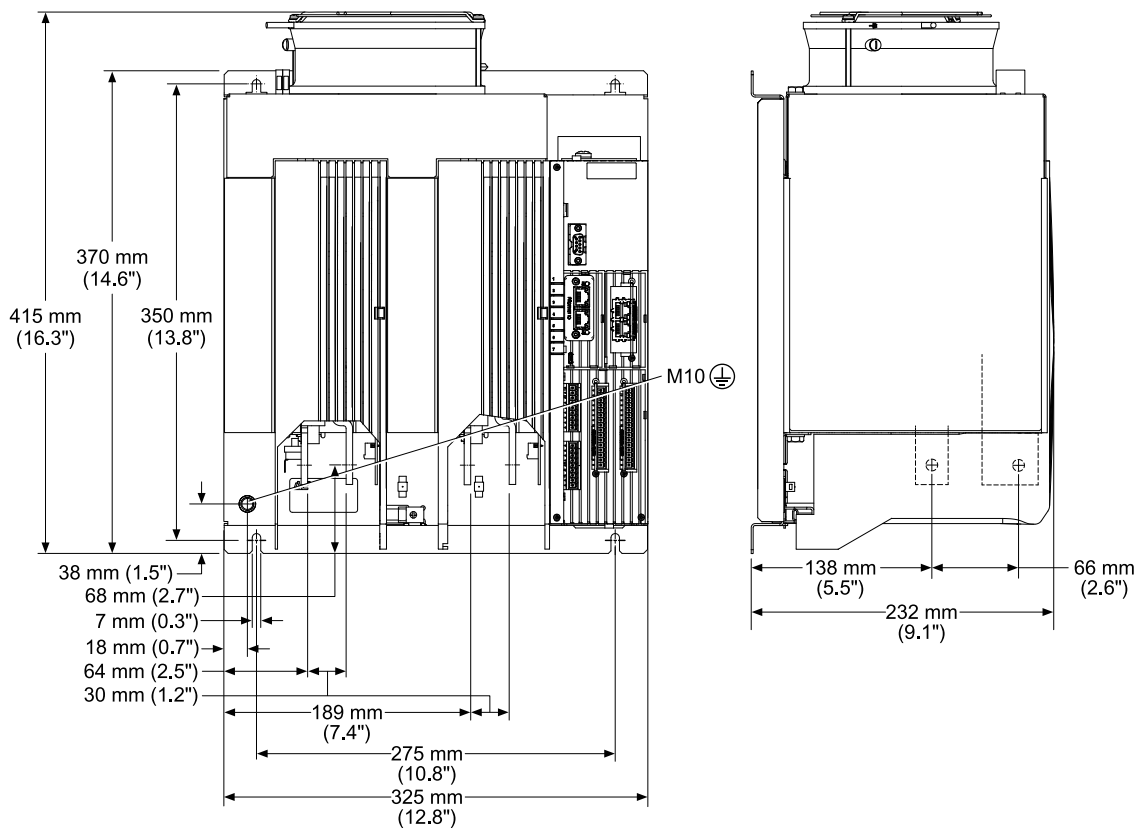


Figure 5-10. Thyro-PX 2PX 500-280 HF, Thyro-PX 2PX 690-200 HF

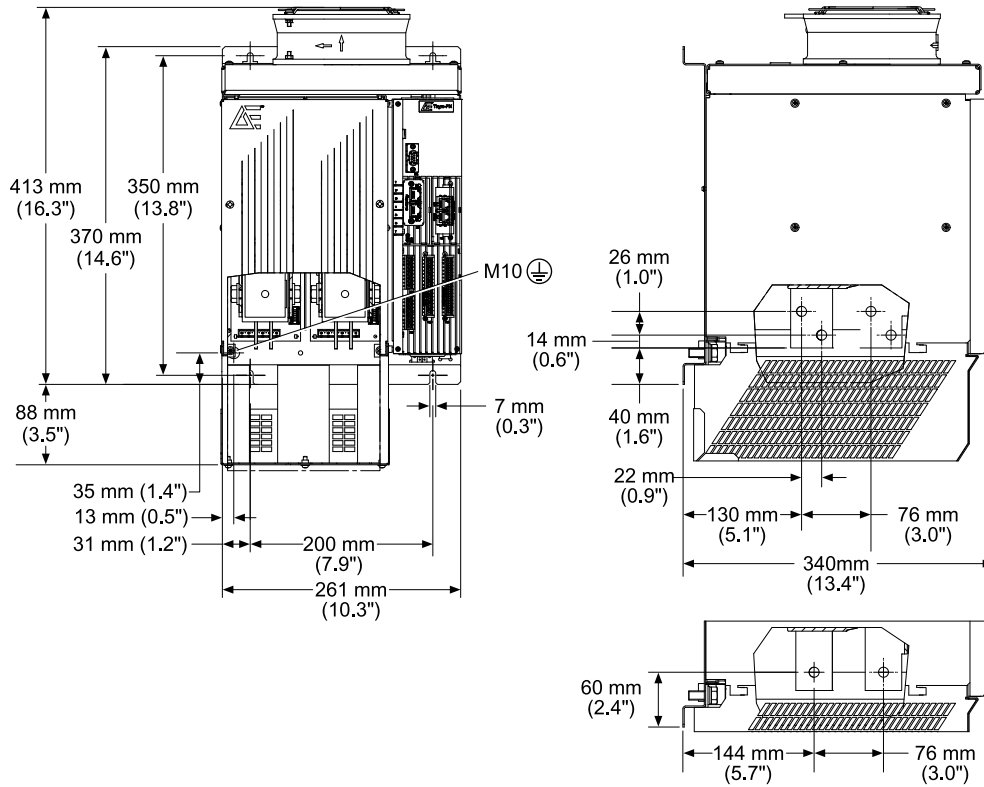


Figure 5-11. Thyro-PX 2PX 500-350HF, 495 HF, 650 HF, Thyro-PX 2PX 690-300 HF, 500 HF

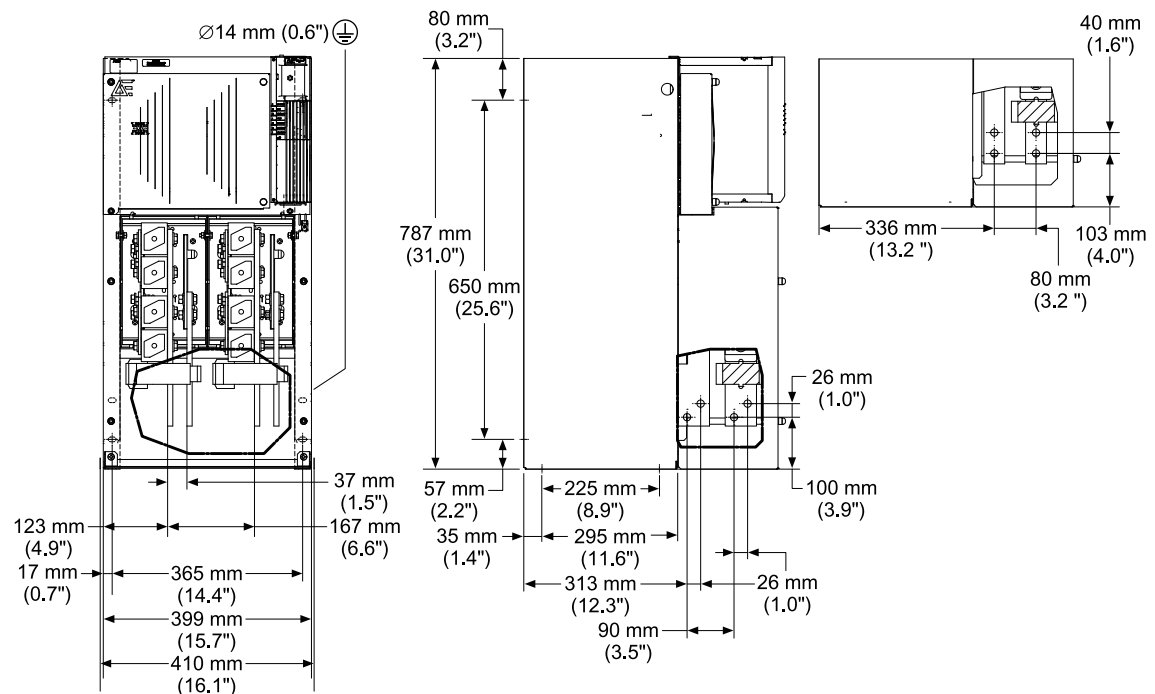


Figure 5-12. Thyro-PX 2PX 500-780 HF, 1000 HF, 1500 HF, Thyro-PX 2PX 690-780 HF, 1400 HF

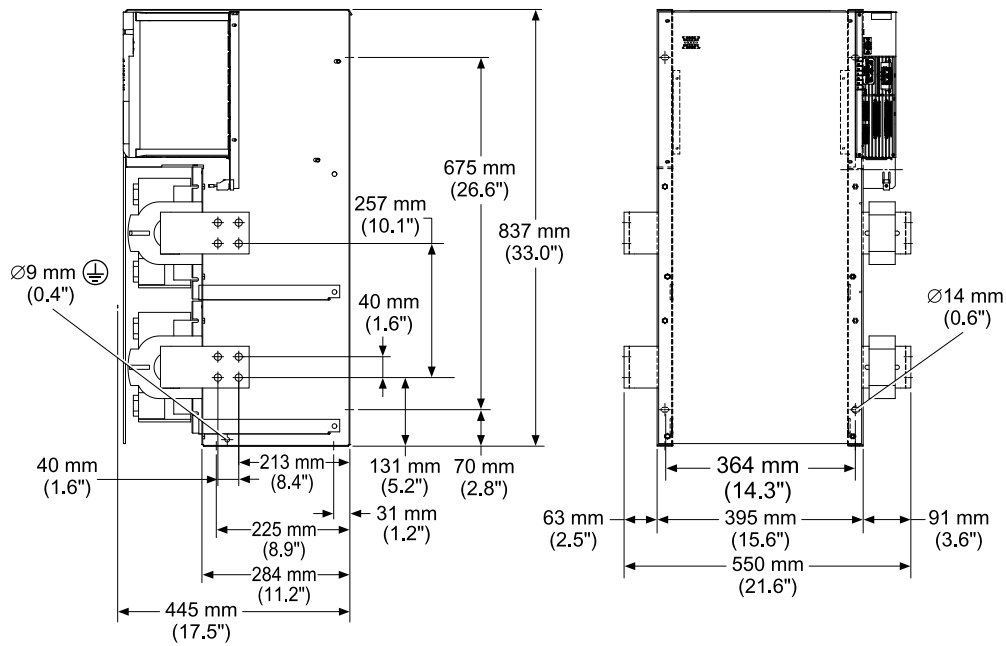


Figure 5-13. Thyro-PX 2PX 500-2000 HF, Thyro-PX 2PX 690-1850 HF

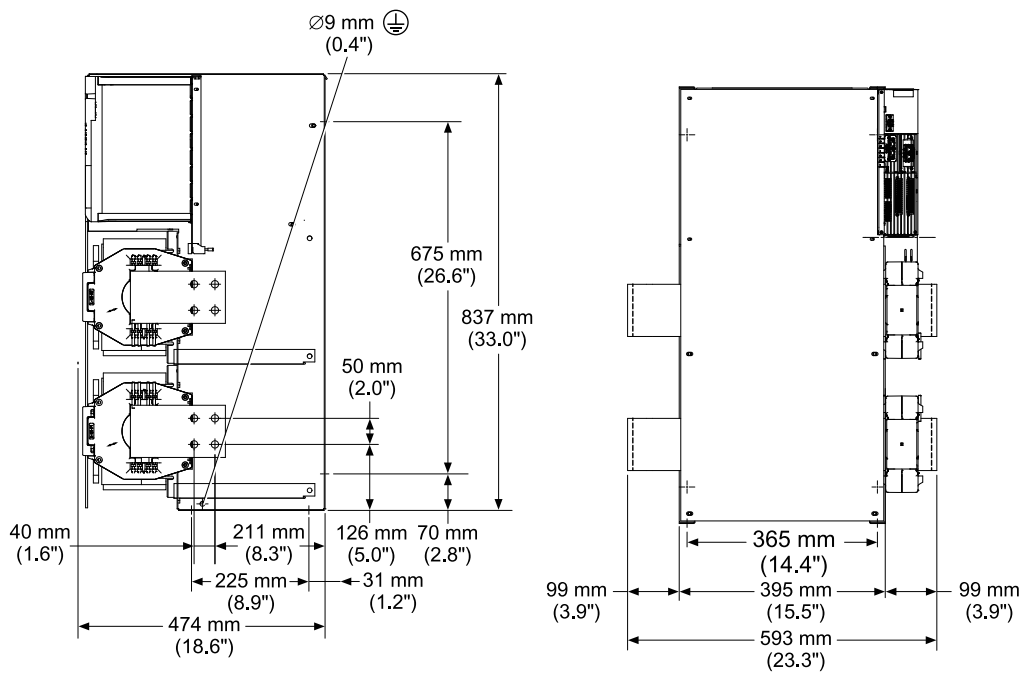


Figure 5-14. Thyro-PX 2PX 500-2750 HF, Thyro-PX 2PX 690-2400 HF

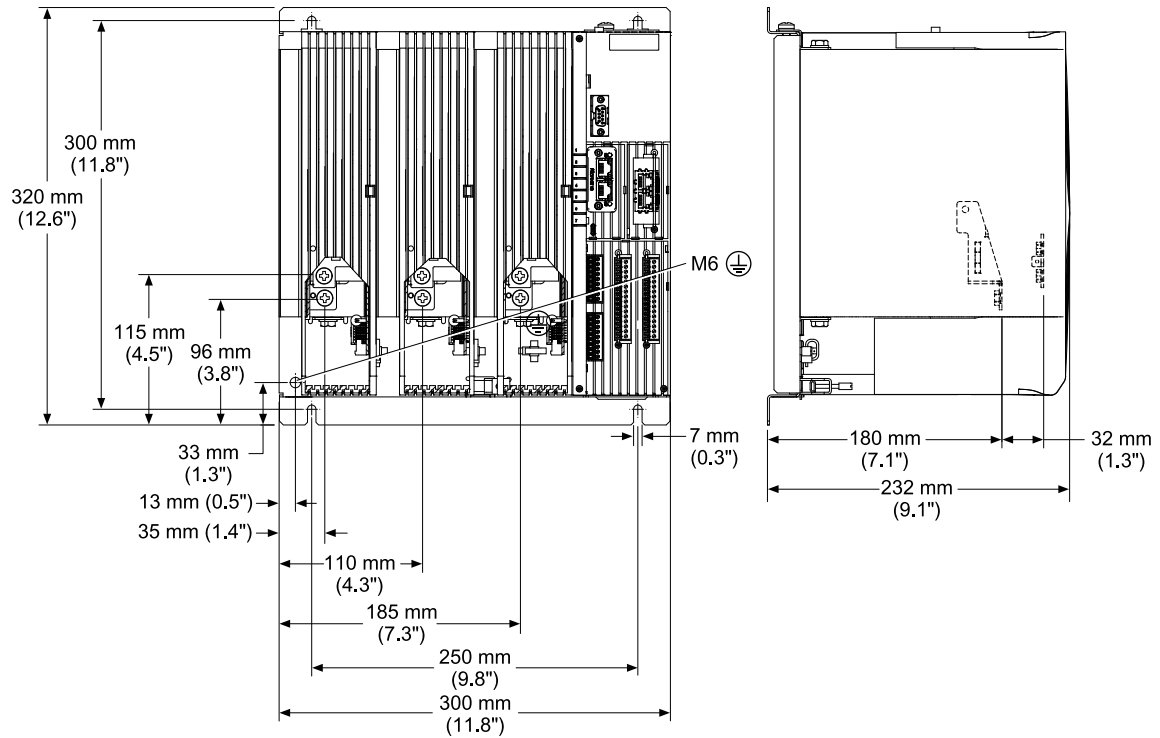


Figure 5-15. Thyro-PX 3PX 500-16 H, 37 H, 75 H, 110 H

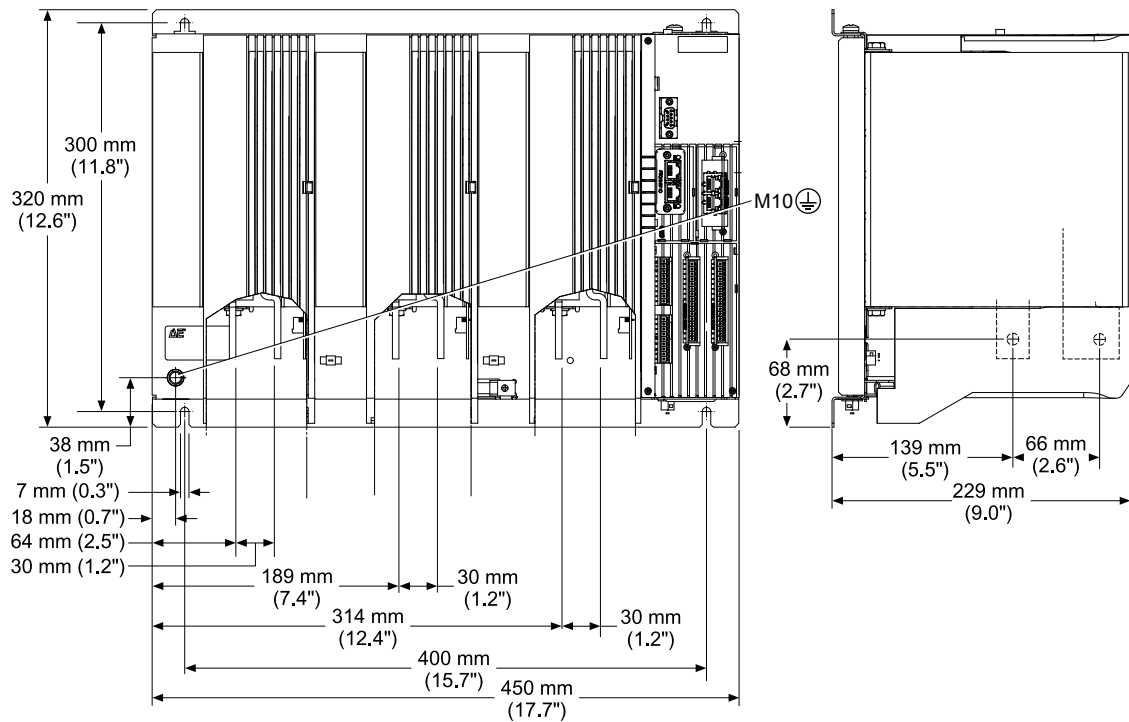


Figure 5-16. Thyro-PX 3PX 500-130 H, 170 H, Thyro-PX 3PX 690-80 H

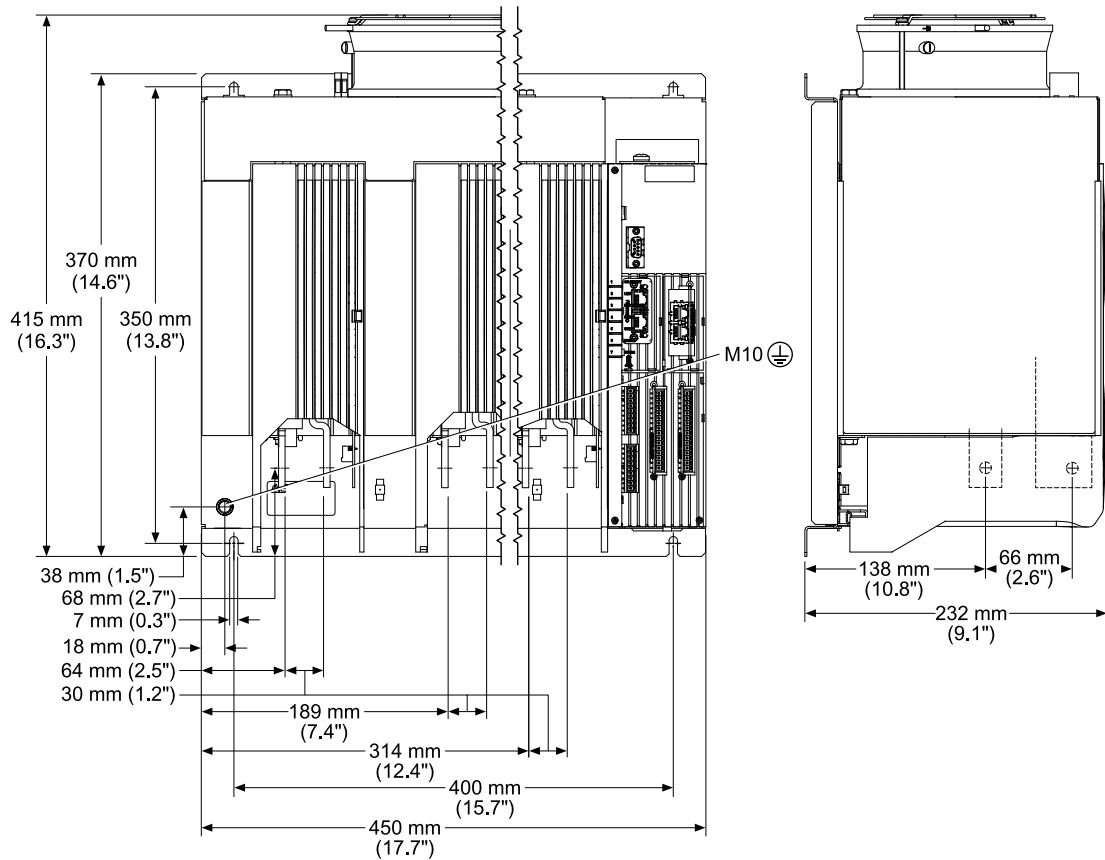


Figure 5-17. Thyro-PX 3PX 500-280 HF, Thyro-PX 3PX 690-200 HF

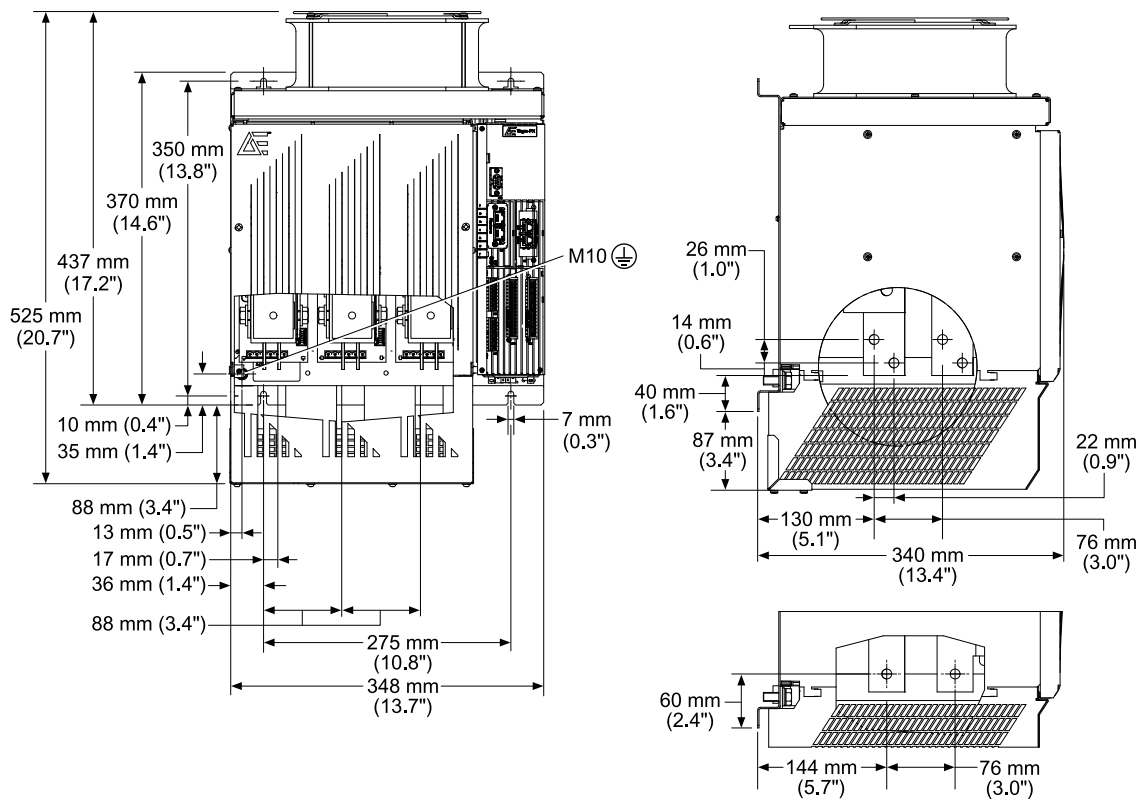


Figure 5-18. Thyro-PX 3PX 500-350HF, 495 HF, 650 HF, Thyro-PX 3PX 690-300 HF, 500 HF

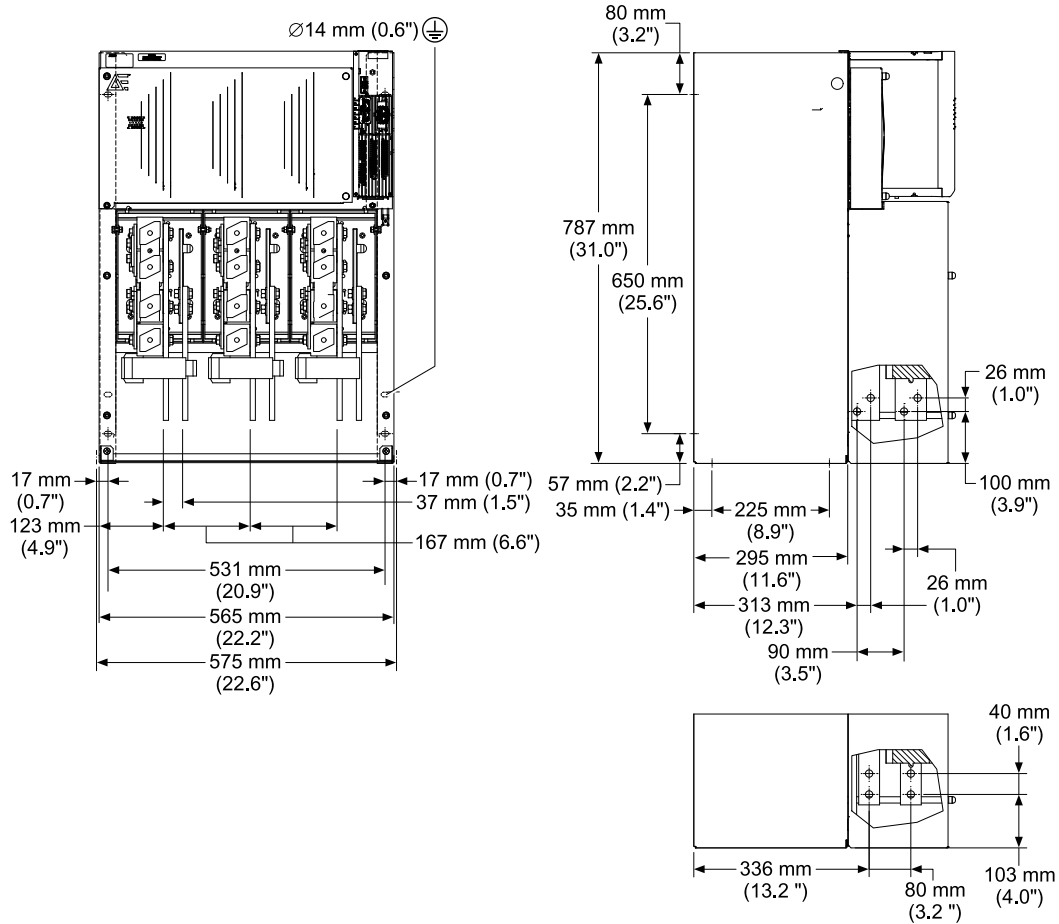


Figure 5-19. Thyro-PX 3PX 500-780 HF, 1000 HF, 1500 HF, Thyro-PX 3PX 690-780 HF, 1400 HF

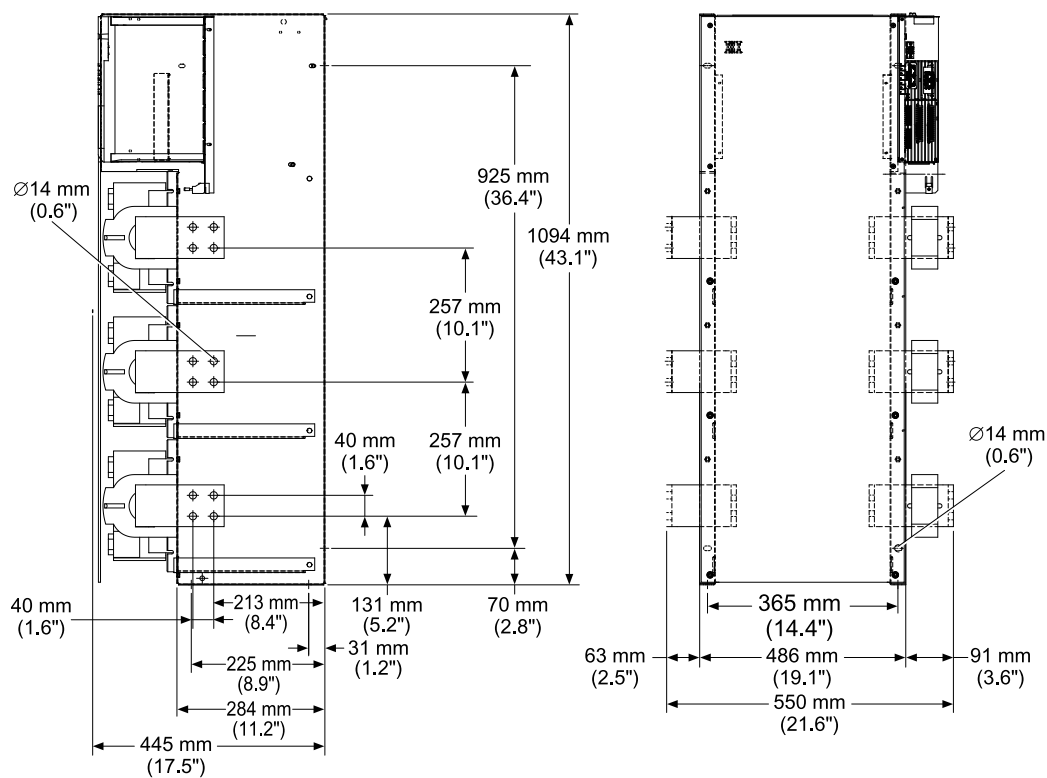


Figure 5-20. Thyro-PX 3PX 500-2000 HF, Thyro-PX 3PX 690-1700 HF

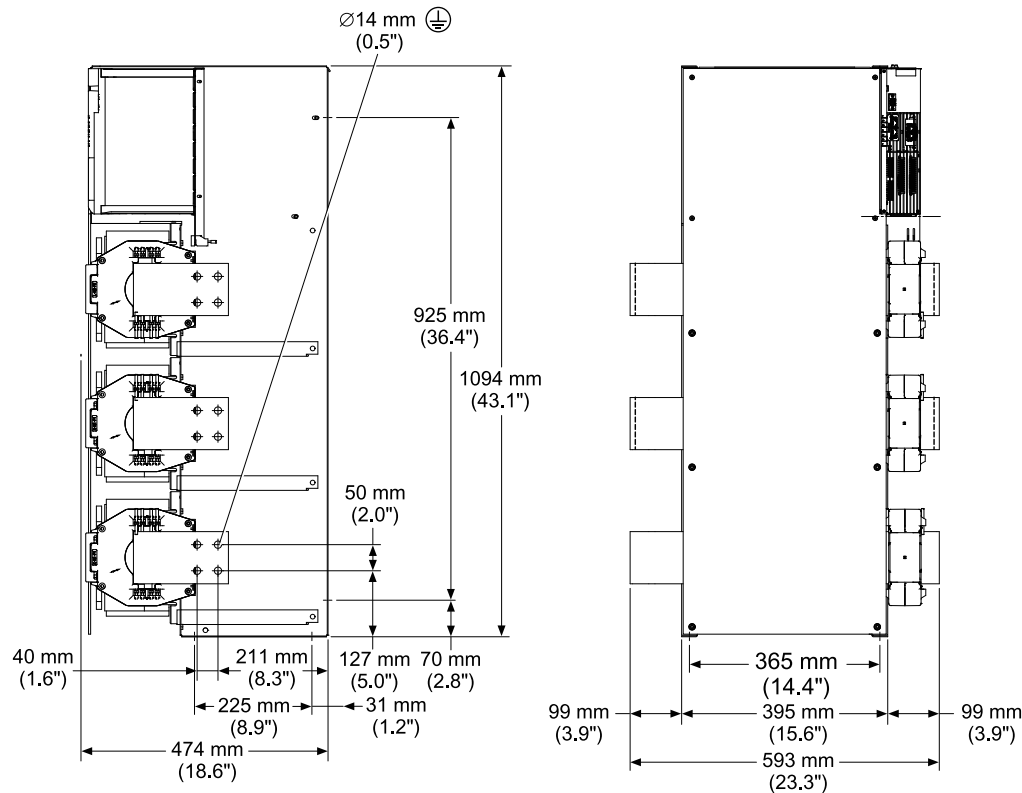


Figure 5-21. Thyro-PX 3PX 500-2600 HF, Thyro-PX 3PX 690-2200 HF

Installation Requirements

Install this unit according to the following requirements.



DANGER:

RISK OF DEATH OR BODILY INJURY. Disconnect and lockout/tagout all sources of input power before working on this unit or anything connected to it.



DANGER:

RISQUE DE MORT OU DE BLESSURES CORPORELLES. Débrancher et verrouiller/étiqueter toutes les sources de puissance d'entrée avant de travailler sur cette unité ou sur tout élément qui y est raccordé.



DANGER:

Personnel must receive proper training before installing or troubleshooting high-energy electrical equipment. Potentially lethal voltages could cause death, serious personal injury, or damage to the equipment. Ensure that all appropriate safety precautions are taken.

**DANGER:**

Le personnel devra être correctement formé avant de pouvoir installer ou dépanner des équipements électriques à haute énergie. Des tensions potentiellement létales peuvent entraîner le décès, des blessures ou des dommages à l'équipement. Assurez-vous de prendre toutes les précautions de sécurité appropriées.

Unpacking the Unit

1. Unpack and inspect the unit carefully, looking for obvious physical damage.
2. If no damage is apparent, proceed with the unit installation and setup.
3. If you do see signs of shipping damage, contact Advanced Energy and the carrier immediately.

Save the shipping container for submitting necessary claims to the carrier.

Lifting the Unit

This manual describes many Thyro-PX models. Use appropriate lifting techniques and tools based on the size and weight of the unit.

**CAUTION:**

The modules are heavy. Use two people to lift the module.

**ATTENTION:**

Les modules sont lourds. Le module doit être soulevé par deux personnes.

TO LIFT THE UNIT

- Lift the unit by holding on to the front of the unit while also supporting the rear of the unit.

INSTALLING THE UNIT

Installing Optional Modules

**DANGER:**

RISK OF DEATH OR BODILY INJURY. Disconnect and lockout/tagout all sources of input power before working on this unit or anything connected to it.

**DANGER:**

RISQUE DE MORT OU DE BLESSURES CORPORELLES. Débrancher et verrouiller/étiqueter toutes les sources de puissance d'entrée avant de travailler sur cette unité ou sur tout élément qui y est raccordé.

The optional modules may be shipped separately.

1. Verify that the unit is disconnected from all power sources.
2. Unpack each optional module at an ESD safe work space.
3. Plug each optional module into the unit.

When an Anybus module is inserted into the unit, guide the module towards the left during insertion.




4. Secure each module with the two TORX® T8 screws provided with the module.

For additional module documentation, scan the QR code that corresponds to the module (see the following table).

Table 5-1. Module documentation links

| Anybus Module | Link | QR Code |
|----------------------|---|---------|
| Anybus PROFIBUS DPV1 | http://www.aei.com/en/anybus_profibus.html | |
| Anybus PROFINET | http://www.aei.com/en/anybus_profinet.html | |
| Anybus DeviceNet | http://www.aei.com/en/anybus_devicenet.html | |
| Anybus EtherNet/IP | http://www.aei.com/en/anybus_ethernet_ip.html | |

Table 5-1. Module documentation links (Continued)

| Anybus Module | Link | QR Code |
|-------------------|---|---|
| Anybus EtherCAT | http://www.aei.com/en/anybus_ethercat.html |  |
| Anybus Modbus TCP | http://www.aei.com/en/anybus_modbus_tcp.html |  |
| Anybus Modbus RTU | http://www.aei.com/en/anybus_modbus_rtu.html |  |

If an Anybus module must be removed from the unit, loosen the TORX T8 mounting screws 3 turns, and pry out the module with a small flat-bladed screwdriver, as shown in the following figure.

*Figure 5-22. Anybus module removal*

If an I/O module must be removed from the unit, remove the TORX T8 mounting screws, insert a connector, and pull while moving the module from side to side, as shown in the following figure.



Figure 5-23. I/O module removal

Configuring as a Multi-Zone Controller



DANGER:

RISK OF DEATH OR BODILY INJURY. Disconnect and lockout/tagout all sources of input power before working on this unit or anything connected to it.



DANGER:

RISQUE DE MORT OU DE BLESSURES CORPORELLES. Débrancher et verrouiller/étiqueter toutes les sources de puissance d'entrée avant de travailler sur cette unité ou sur tout élément qui y est raccordé.



DANGER:

Personnel must receive proper training before installing or troubleshooting high-energy electrical equipment. Potentially lethal voltages could cause death, serious personal injury, or damage to the equipment. Ensure that all appropriate safety precautions are taken.



DANGER:

Le personnel devra être correctement formé avant de pouvoir installer ou dépanner des équipements électriques à haute énergie. Des tensions potentiellement létales peuvent entraîner le décès, des blessures ou des dommages à l'équipement. Assurez-vous de prendre toutes les précautions de sécurité appropriées.

**WARNING:**

These servicing instructions are for use by qualified personnel only. To reduce the risk of electric shock, do not perform any servicing other than that specified in the operating instructions.

**AVERTISSEMENT:**

Ces instructions d'entretien sont destinées uniquement à un personnel qualifié. Pour réduire le risque d'électrocution, ne pas effectuer un entretien autre que celui spécifié dans les instructions de fonctionnement.

A 2-phase or 3-phase Thyro-PX power controller can be configured to operate as a 1-phase unit controlling two or three zones.

1. Remove the covers from the unit at an ESD safe work space.
2. Disconnect and remove the factory-installed wires connecting A1.X1 to A3.X1 (3-phase only) and A5.X1.

Do not remove the jumpers.

3. Verify that the following jumpers are in place:
 - a. A1,X1,1 to A1.X1.2.
 - b. A3,X1,1 to A3.X1.2. (3-phase only).
 - c. A5,X1,1 to A5.X1.2.
 - d. A1,X1,4 to A1.X1.5 (2-phase only).
4. Install a jumper between A1.X1.4 and A1.X1.5 (3-phase only).
5. Install a jumper between A3.X1.4 and A3.X1.5 (3-phase only).
6. Install a jumper between A5.X1.4 and A5.X1.5.
7. Connect A1.X1.3 to the reference phase L2, L3, or N.
8. Connect A3.X1.3 to the reference phase L2, L3, or N (3-phase only).
9. Connect A5.X1.3 to the reference phase L2, L3, or N.
10. Connect X51.4 and X51.5 to terminal X51.2.
11. Install the covers.

To convert a 3-phase unit, see [Figure 5-24](#). To convert a 2-phase unit, see [Figure 5-25](#). The wiring changes are shown as bold lines.

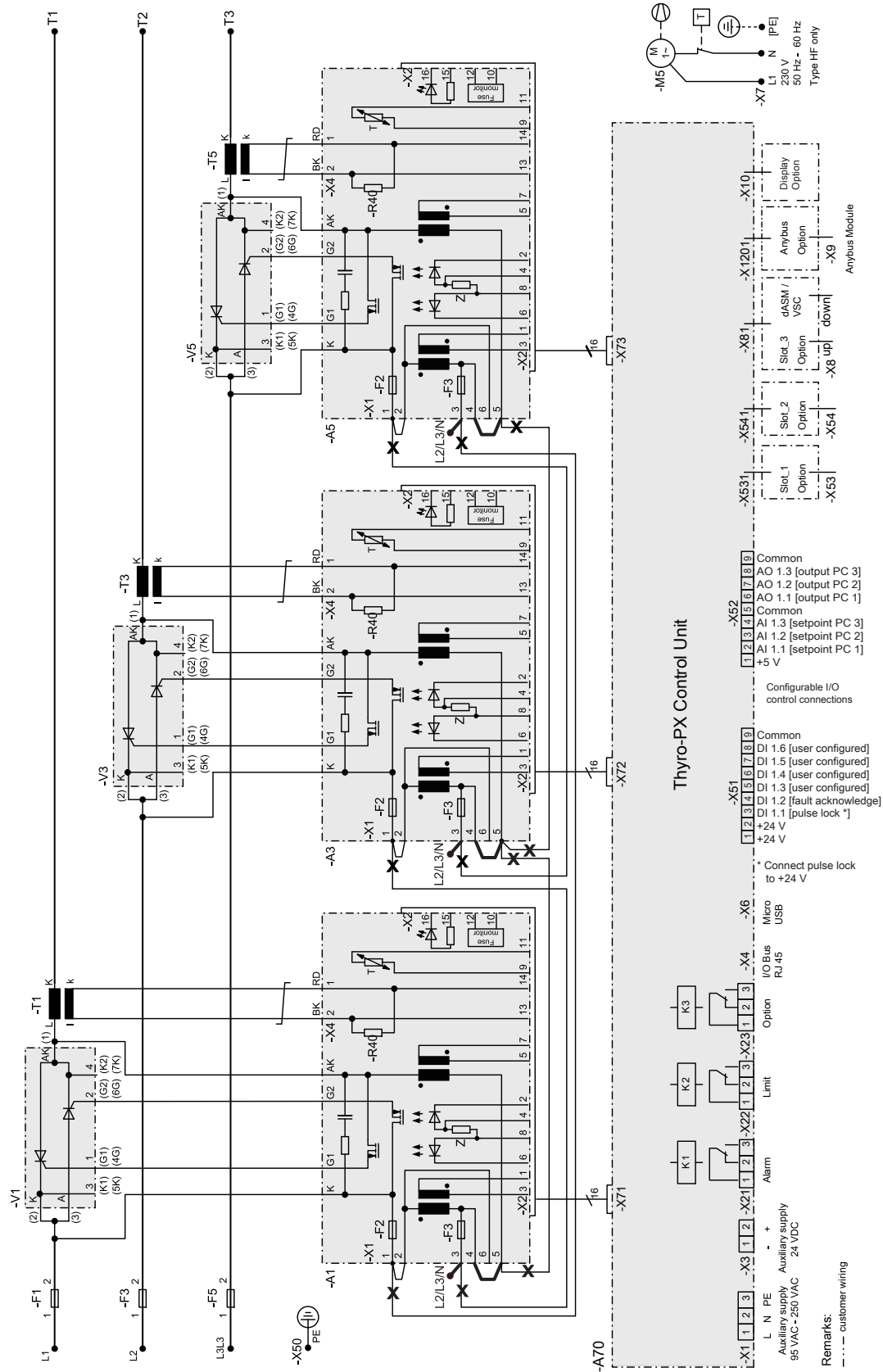


Figure 5-24. Configure 3-phase as multi-zone

Configuring as a Voltage Sequence Controller (VSC)

**DANGER:**

RISK OF DEATH OR BODILY INJURY. Disconnect and lockout/tagout all sources of input power before working on this unit or anything connected to it.

**DANGER:**

RISQUE DE MORT OU DE BLESSURES CORPORELLES. Débrancher et verrouiller/étiqueter toutes les sources de puissance d'entrée avant de travailler sur cette unité ou sur tout élément qui y est raccordé.

**DANGER:**

Personnel must receive proper training before installing or troubleshooting high-energy electrical equipment. Potentially lethal voltages could cause death, serious personal injury, or damage to the equipment. Ensure that all appropriate safety precautions are taken.

**DANGER:**

Le personnel devra être correctement formé avant de pouvoir installer ou dépanner des équipements électriques à haute énergie. Des tensions potentiellement létales peuvent entraîner le décès, des blessures ou des dommages à l'équipement. Assurez-vous de prendre toutes les précautions de sécurité appropriées.

**WARNING:**

These servicing instructions are for use by qualified personnel only. To reduce the risk of electric shock, do not perform any servicing other than that specified in the operating instructions.

**AVERTISSEMENT:**

Ces instructions d'entretien sont destinées uniquement à un personnel qualifié. Pour réduire le risque d'électrocution, ne pas effectuer un entretien autre que celui spécifié dans les instructions de fonctionnement.

For applications with single or multiple transformer-coupled heating zone, Voltage Sequence Control (VSC) technology offers the fast response, high control dynamics, and high control resolution per cycle of phase-angle mode – while reducing reactive power, decreasing harmonics, and significantly improving power factor. VSC is useful for grid load optimized, highly dynamic heating processes. Primary or secondary VSC connections in a two or three stage format can be configured.

Primary VSC is particularly suitable for large load currents ($I_{Load} > I_{Controller}$) with smaller voltages. One transformer is used for each load. The following

illustrations show the two stage and three stage VSC connections. Details can be found in the Thyro-PX VSC connection diagrams, [Figure 5-28](#) and [Figure 5-29](#).



CAUTION:

In the primary VSC configuration, the mains voltage is stepped up on the inactive power controller outputs, marked * in the following figure. The transformer must be designed so that this voltage does not exceed the type voltage (500 V or 690 V) of the unit, or the unit will be damaged.



ATTENTION:

Dans la configuration principale de VSC, la tension de l'alimentation secteur est élevée sur les sorties du contrôleur de puissance inactive, indiqué par * dans l'illustration suivante. Le transformateur doit être conçu de façon à ce que la tension n'excède par la tension type de l'appareil (500 V ou 690 V); autrement l'appareil pourrait être endommagé.

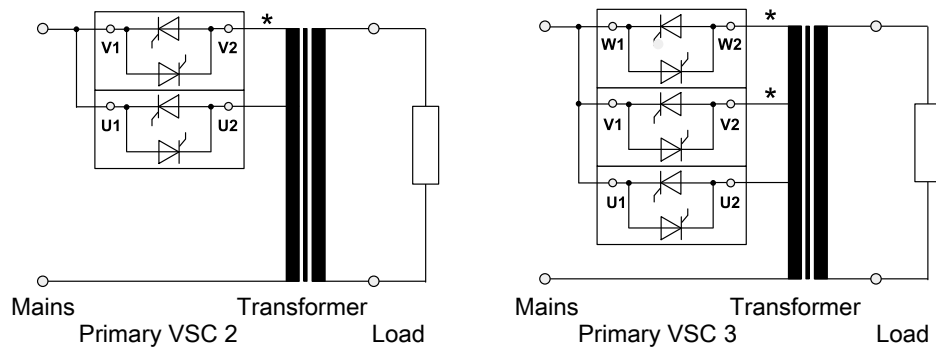


Figure 5-26. Primary VSC

Secondary VSC is particularly suitable if many heaters are being supplied from one transformer. Through the improvement of the power factor, a larger transformer can dispense more active power and supply additional loads (if required).

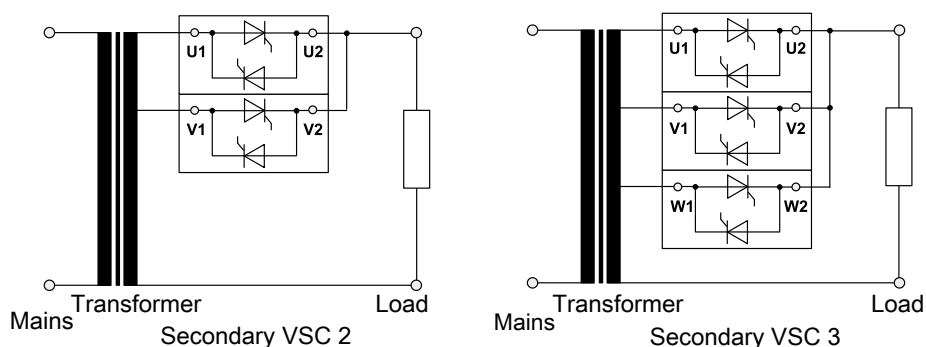


Figure 5-27. Secondary VSC

TO CONFIGURE FOR VSC

1. Remove the covers from the unit at an ESD safe work space.

2. Disconnect and remove the factory-installed wires connecting A1.X1 to A3.X1 (VSC 3 only) and A5.X1, including the connected factory-installed jumpers A1.X1.1 to A1.X1.2, A3.X1.1 to A3.X1.2 (VSC 3 only), and A5.X1.1 to A5.X1.2.
3. Install a replacement jumper between A1.X1.1 and A1.X1.2.
4. Install a jumper between A1.X1.4 and A1.X1.5.
5. Install a jumper between A3.X1.4 and A3.X1.5 (VSC 3 only).
6. Install a jumper between A5.X1.4 and A5.X1.5.
7. For VSC 3 units:
 - a. Connect A1.X1.5 to A3.X1.3
 - b. Connect A1.X1.6 to A3.X1.2
 - c. Connect A3.X1.5 to A5.X1.3
 - d. Connect A3.X1.6 to A5.X1.2

To convert a 3-phase unit to VSC 3, see [Figure 5-28](#). The wiring changes are shown as bold lines.

8. For VSC 2 units:
 - a. Connect A1.X1.5 to A5.X1.3
 - b. Connect A1.X1.6 to A5.X1.2

To convert a 2-phase unit to VSC 2, see [Figure 5-29](#). The wiring changes are shown as bold lines.

9. Install the covers.

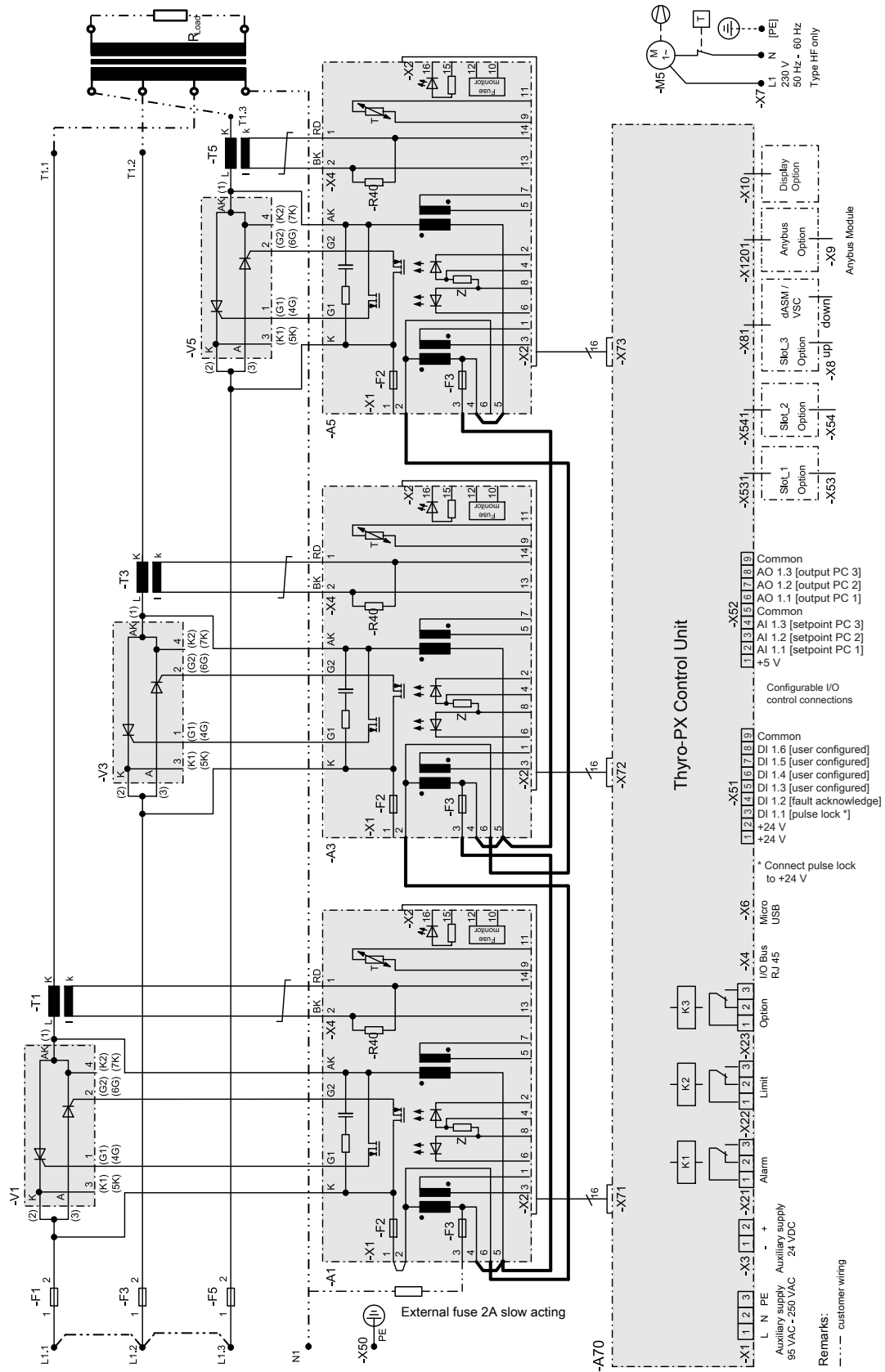


Figure 5-28. Configure 3-phase as VSC 3

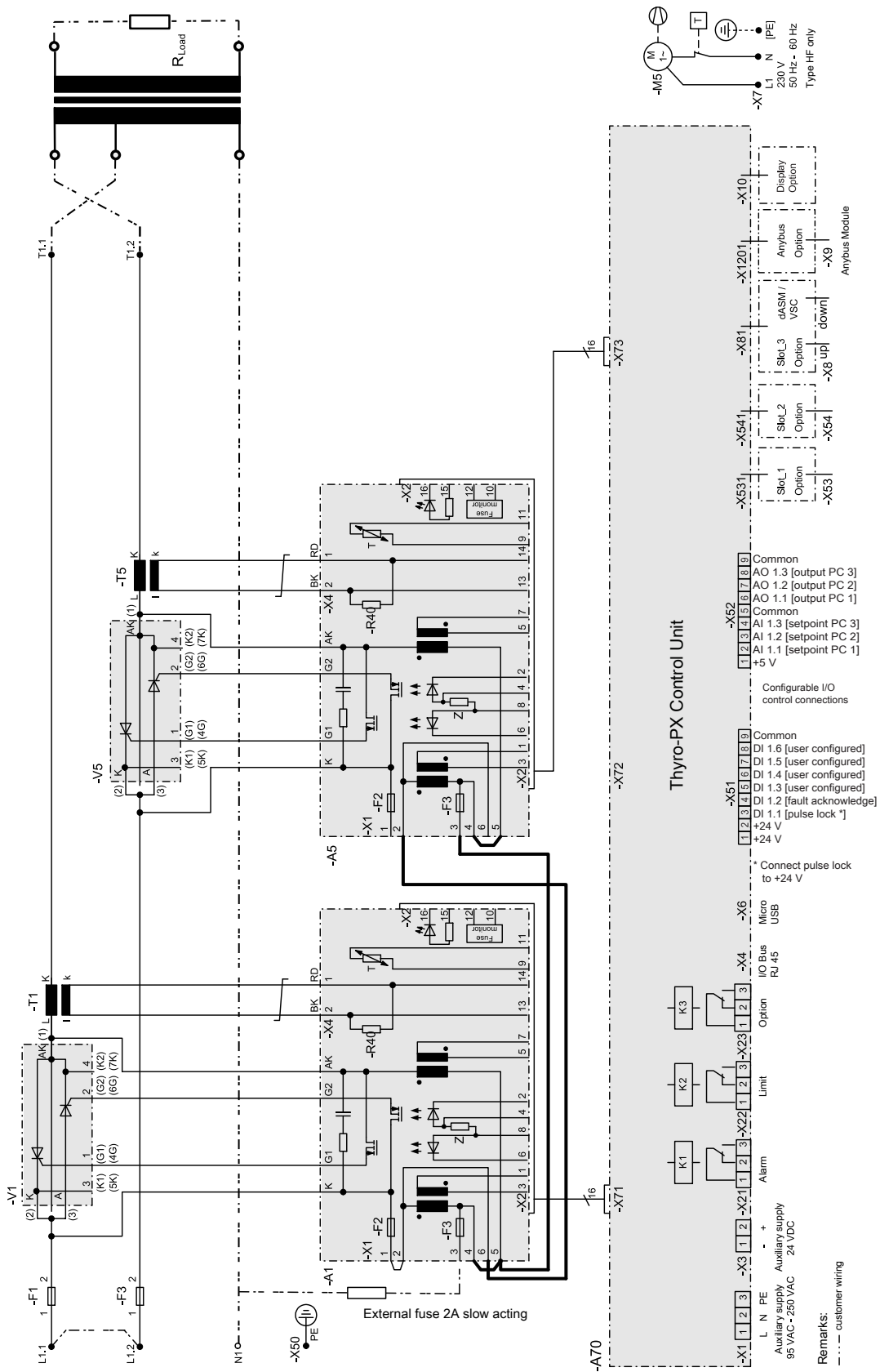


Figure 5-29. Configure 2-phase as VSC 2

Mounting the Unit

1. Install the unit on or in the mounting surface, rack, or cabinet.
2. Fasten the unit to the mounting surface, rack, or cabinet. Use suitable fasteners.

See “[Dimensional Drawings](#)” on page 5-1 for mounting hole details.

Grounding

**WARNING:**

Do not attempt to turn on power until the chassis of the unit is tied to a local earth ground through a copper grounding strap that is sized in accordance with applicable requirements.

**AVERTISSEMENT:**

Ne pas essayer de mettre l'unité sous tension avant que son ossature ne soit reliée à une mise à la terre locale à l'aide d'un bracelet de mise à la terre en cuivre dont les dimensions sont conformes aux exigences applicables.

- Make a suitable chassis ground connection to the location specified on the dimensional drawing. See “[Dimensional Drawings](#)” on page 5-1.

Connecting I/O and Auxiliary Connectors

**DANGER:**

RISK OF DEATH OR BODILY INJURY. Disconnect and lockout/tagout all sources of input power before working on this unit or anything connected to it.

**DANGER:**

RISQUE DE MORT OU DE BLESSURES CORPORELLES. Débrancher et verrouiller/étiqueter toutes les sources de puissance d'entrée avant de travailler sur cette unité ou sur tout élément qui y est raccordé.

**Important**

All digital and analog control cables must be shielded. Connect the cable shields to the shield clamp on the unit as shown in the following figure.

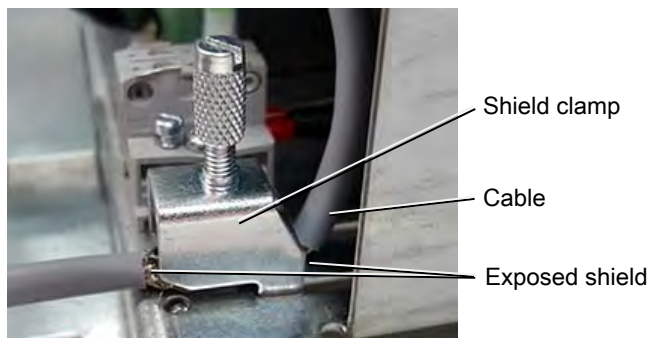


Figure 5-30. *Shield clamp*

The following signals are always required for operation of the device: *SETPOINT*, *PULSE LOCK*.

 **Important**

By default, the unit is configured to require a customer supplied *PULSE LOCK* jumper. The unit may be customer configured to not require this jumper.

Complete the following steps to connect each control cable required for your installation. A plug-in, screw-terminal block is provided for each control connector.

1. Verify that the control cable conductors are sized between 0.14 mm² and 1.5 mm² (30 AWG and 14 AWG).
2. Prepare the end of the control cable:
 - a. Strip 50 mm (2") of the cable jacket.
 - b. Expose the cable shield for connection to the shield clamp.
 - c. Strip 7 mm (0.28") of insulation from each conductor.
3. Connect each conductor to the plug-in, screw-terminal block.
4. Plug the block into the power controller.
5. Connect the cable shield to the shield clamp.

Related Links

- [“Analog and Digital I/O” on page 4-4](#)

Connecting Load and Auxiliary Power



DANGER:

RISK OF DEATH OR BODILY INJURY. Disconnect and lockout/tagout all sources of input power before working on this unit or anything connected to it.

**DANGER:**

RISQUE DE MORT OU DE BLESSURES CORPORELLES. Débrancher et verrouiller/étiqueter toutes les sources de puissance d'entrée avant de travailler sur cette unité ou sur tout élément qui y est raccordé.

**WARNING:**

This device must be installed so that the output power connection is inaccessible to the user.

**AVERTISSEMENT:**

Le dispositif doit être installé de façon à ce que l'utilisateur ne puisse accéder à la connexion de puissance de sortie.

This task applies to all units. Three-phase units will have three mains input terminals and three load terminals. Two-phase and 1-phase units will have two sets or one set of mains terminals and load terminals, and will require a reference phase connection to the A1 board as shown in the connection diagram (see “[Connection Diagrams](#)” on page 5-28).

TO CONNECT LOAD AND AUXILIARY POWER

1. Verify that the Protective Earth ground conductor is connected.
2. Connect each phase of the mains supply to the mains terminal (**L1, L2, L3**).

The mains terminals are labeled **1** on units with less than a 45 A current rating.

- a. Use the screw size specified in [Table 5-2](#).
- b. Tighten to the torque specified in [Table 5-3](#).

3. Connect each phase of the load to the load terminals (**T1, T2, T3**).

The load terminals are labeled **2** on units with less than a 45 A current rating.

- a. Use the screw size specified in [Table 5-2](#).
- b. Tighten to the torque specified in [Table 5-3](#).

4. For 1PX and 2PX units, connect the reference phase to **A1 X1.3**.
5. Connect a current-limited external power source to the auxiliary power input connector on the bottom of the unit. Connect either:
 - 90 VAC to 265 VAC (230 V, 150 mA) to connector **X1**
 - 24 VDC, 1 A to connector **X3**

Use the included plug-in, screw-terminal block to make this connection. Follow the torque recommendation for M2 terminal screws.

6. For HF units, connect the 230 VAC (or 115 VAC special option) fan power supply to connector **X7**.

Use the included plug-in, screw-terminal block to make this connection.
Follow the torque recommendation for M2 terminal screws.

Table 5-2. Terminal screw size

| Model | Connector Screw | Protective Earth Screw |
|--|-----------------|------------------------|
| 37 H, 75 H | M6 | M6 |
| 80 H | M8 | M10 |
| 110 H | M6 | M6 |
| 130 H, 170 H | M8 | M10 |
| 200 HF, 280 HF, 300 HF 495 HF, 500 HF, 650 HF | M10 | M10 |
| 780 HF, 1000 HF, 1400 HF, 1500 HF, 1700 HF, 1850 HF, 2000 HF, 2100 HF, 2200 HF, 2400 HF, 2600 HF, 2750 HF, 2900 HF | M12 | M12 |

Table 5-3. Terminal screw torque

| Screw | Torque | | |
|-------|---------------------------|-------------------------|---------------------------|
| | Minimum NM (Pound-Inches) | Rated NM (Pound-Inches) | Maximum NM (Pound-Inches) |
| M2 | 0.2 (1.9) | 0.25 (2.2) | 0.3 (2.5) |
| M6 | 3.0 (26.1) | 4.4 (38.9) | 5.9 (52.2) |
| M8 | 11.5 (101.8) | 17.0 (150.5) | 22.5 (199.1) |
| M10 | 22.0 (194.7) | 33.0 (292.1) | 44 (389.4) |
| M12 | 38.0 (336.3) | 56.0 (495.6) | 75 (663.8) |

Connection Diagrams



DANGER:

RISK OF DEATH OR BODILY INJURY. Disconnect and lockout/tagout all sources of input power before working on this unit or anything connected to it.



DANGER:

RISQUE DE MORT OU DE BLESSURES CORPORELLES. Débrancher et verrouiller/étiqueter toutes les sources de puissance d'entrée avant de travailler sur cette unité ou sur tout élément qui y est raccordé.



WARNING:

More than one live circuit. See diagram.



AVERTISSEMENT:

Plus d'un circuit est sous tension. Voir schéma.

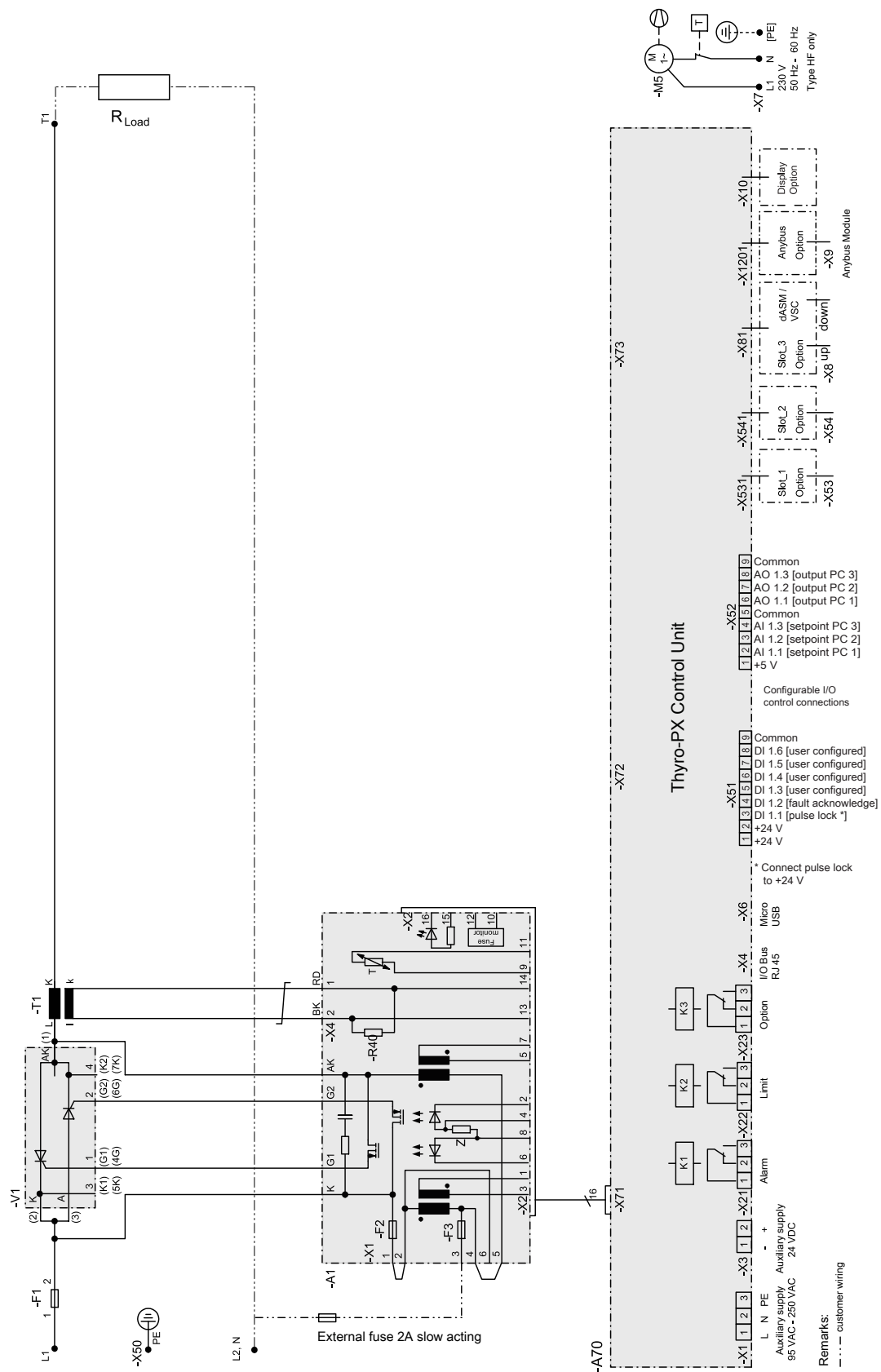


Figure 5-31. 1PX power controller connections

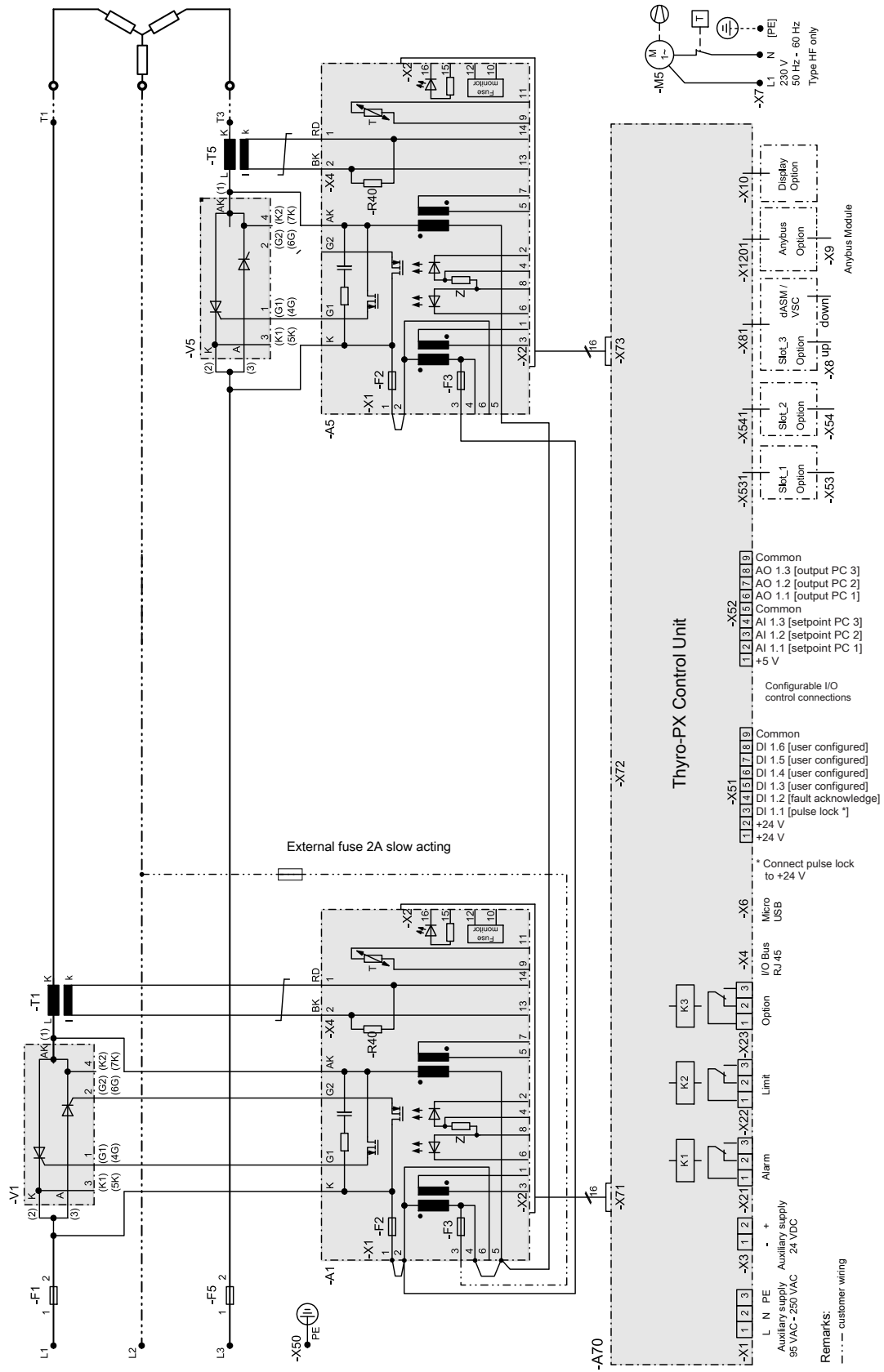


Figure 5-32. 2PX power controller connections

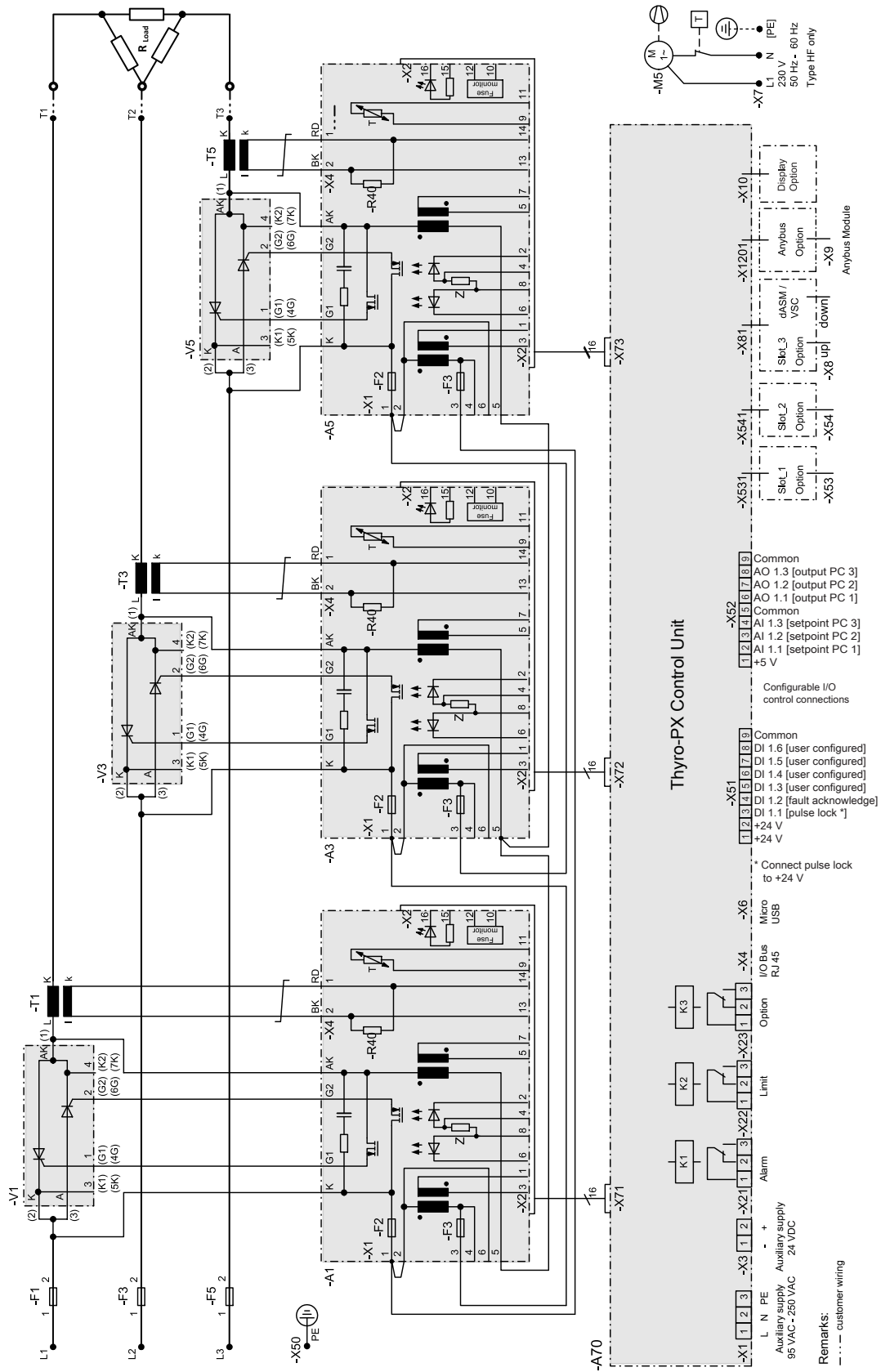


Figure 5-33. 3PX power controller connections

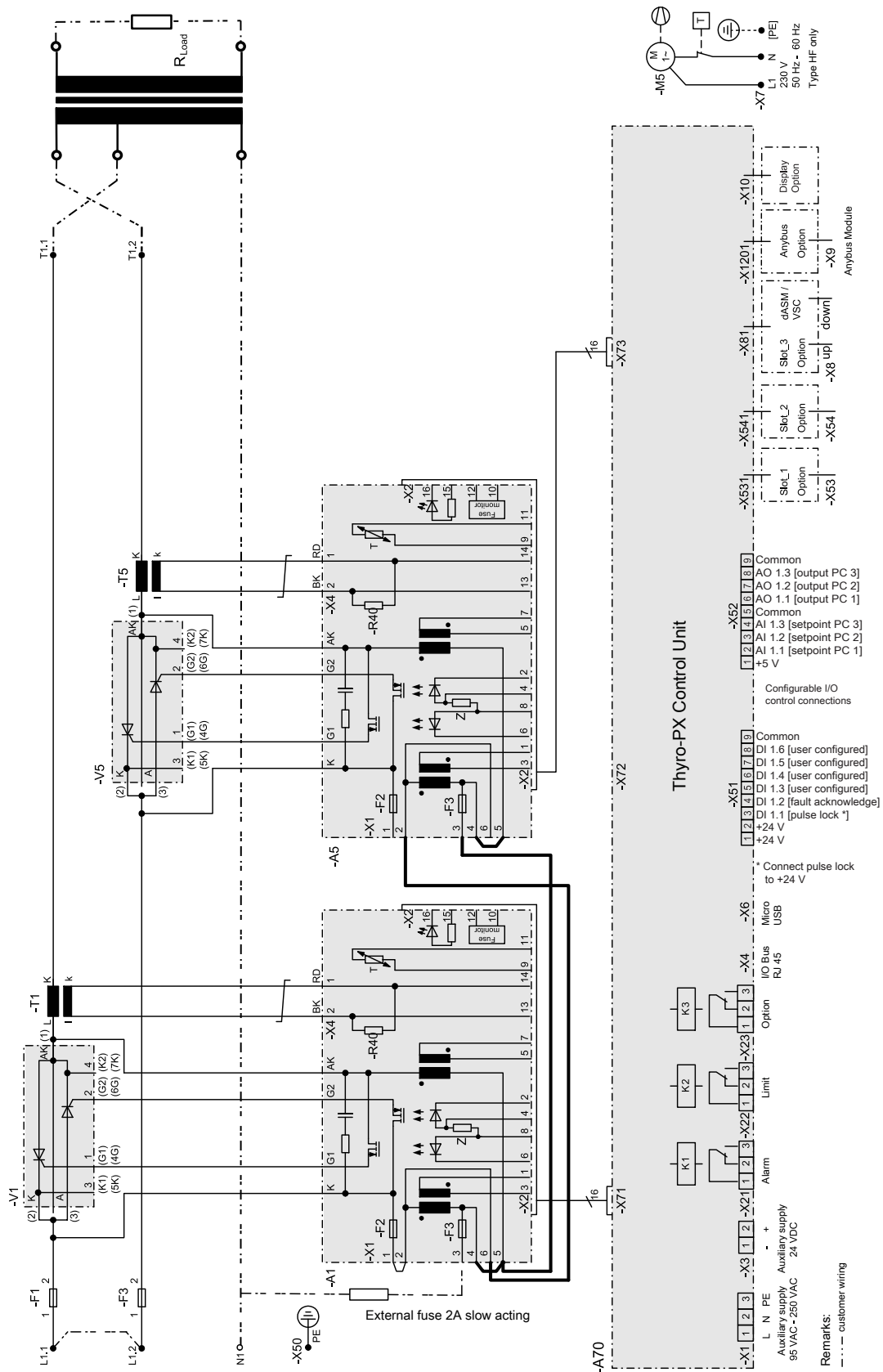


Figure 5-34. 2PX primary VSC 2 power controller connections

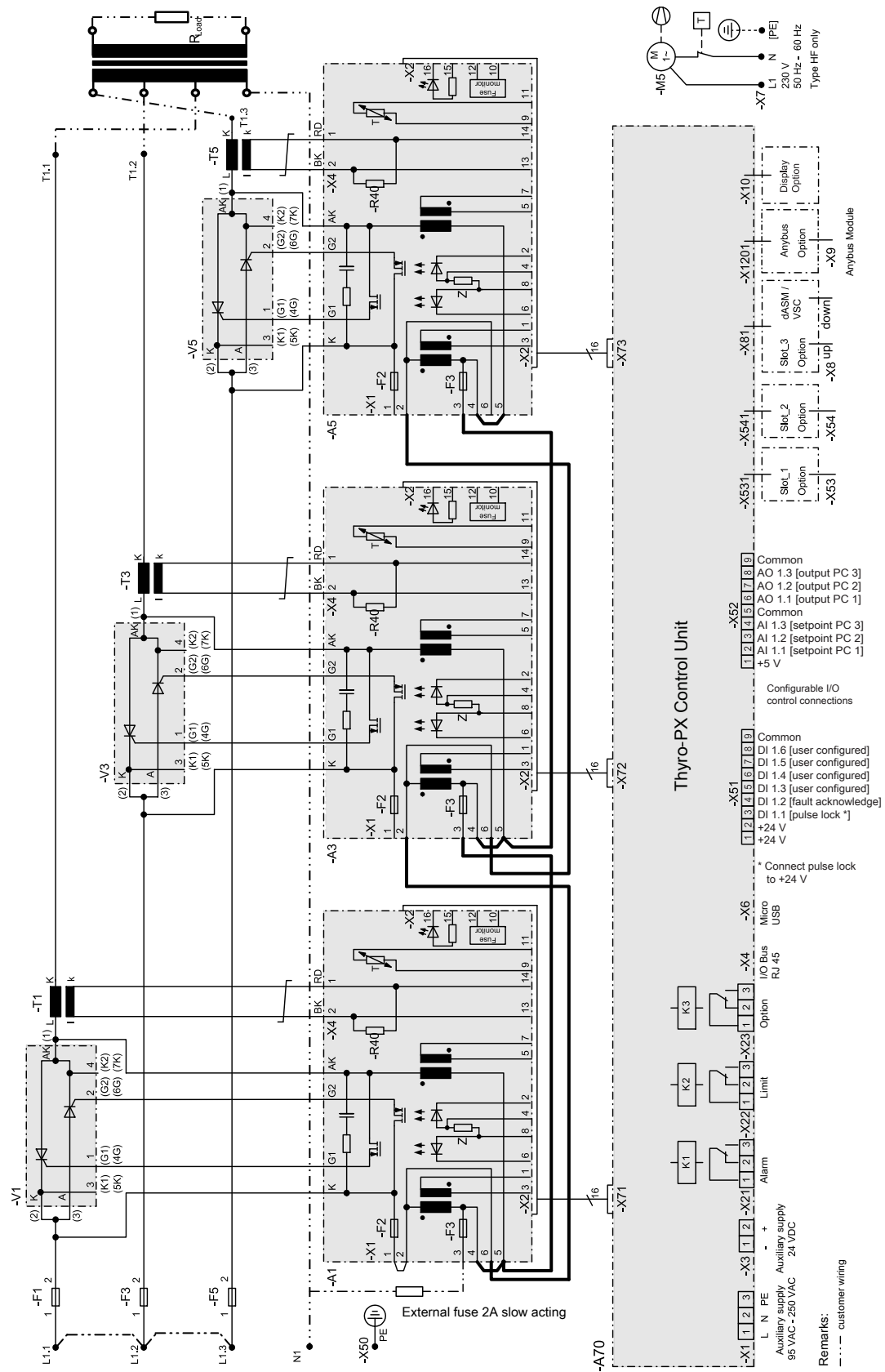


Figure 5-35. 3PX primary VSC 3 power controller connections

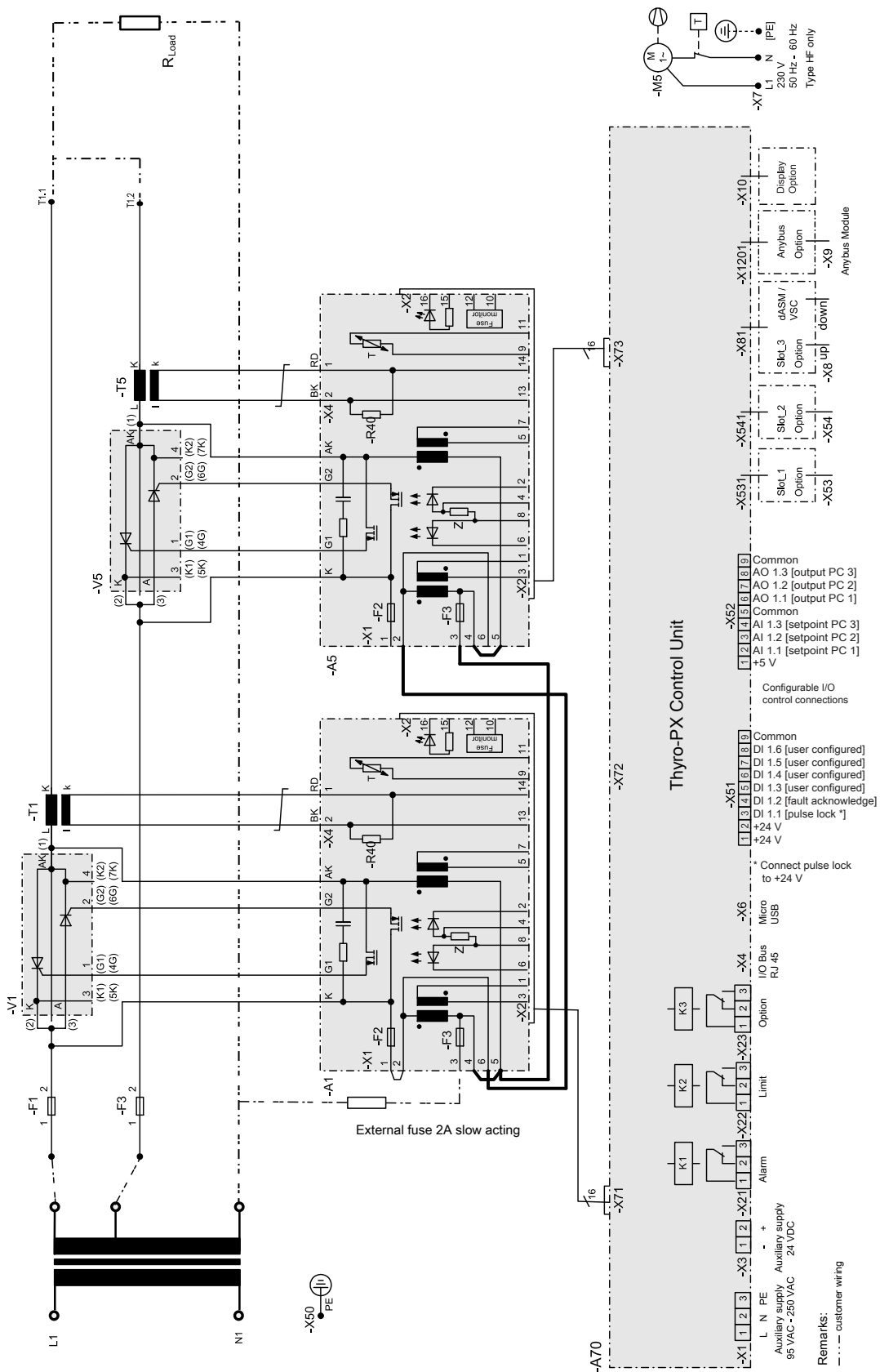


Figure 5-36. 2PX secondary VSC 2 power controller connections

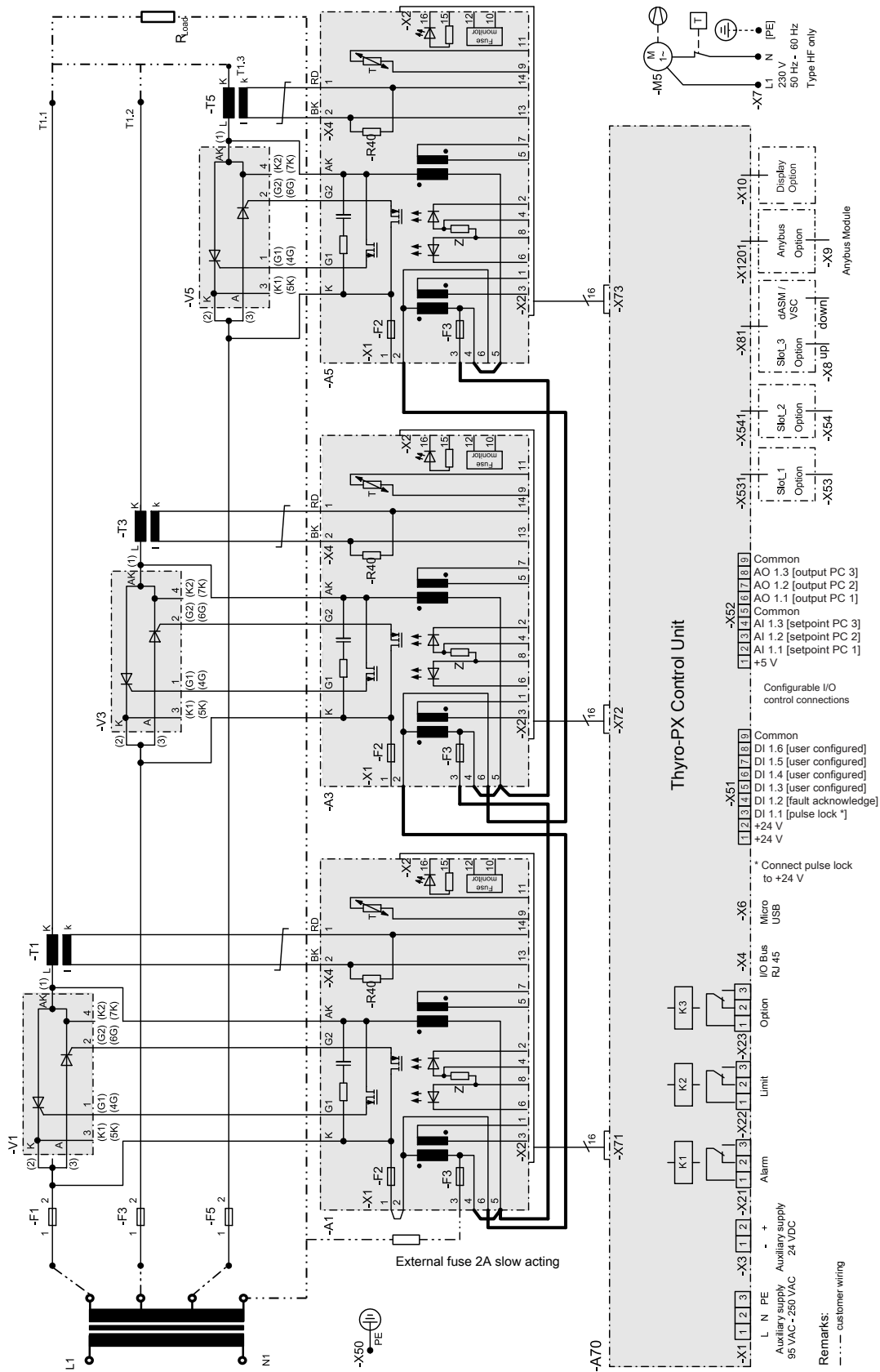


Figure 5-37. 3PX secondary VSC 3 power controller connections

FIRST TIME OPERATION

On delivery, the device is parameterized to the respective power section, and the TAKT operating mode is set. You should review these standard parameters, and, if necessary, adjust them for your application.

To Operate the Thyro-PX Unit for the First Time

1. Install the unit according to the installation procedures in this user manual.

The minimum connections are power, load, *SETPPOINT*, and *PULSE LOCK* jumper.

 **Important**

By default, the unit is configured to require a customer supplied *PULSE LOCK* jumper. The unit may be customer configured to not require this jumper.

2. Turn on the system circuit breakers and apply AC input to the unit.

When the unit receives AC input, it performs self-diagnostics. If the unit detects an error, the unit sets the respective fault bits and lights the **FAULT** LED, or the light green **ON / READY** LED if the fault is severe. You will not be able to apply power to the load until you clear the fault.

3. Verify that the light green **ON / READY** LED is lit.
4. Verify that the **LIMIT** LED is not lit.
5. Verify that the **PULSE LOCK** LED is not lit.
6. Verify that the **FAULT** LED is not lit.
7. Verify that an increase in setpoint applies power to the load.

If the Thyro-PX unit is delivering power and the **LIMIT** LED is not lit, the unit is functioning properly.

 **Important**

AE recommends that you update the firmware to the latest revision using the Thyro-Tool Pro PC software.

Related Links

- [“Operating Modes” on page 5-38](#)
- [“Thyro-Touch Display” on page 4-11](#)
- [“Software User Interface” on page 4-13](#)

NORMAL OPERATION

Each time you turn the unit on, the unit runs a self-diagnostics procedure to ensure that it is performing correctly. Follow the procedures in this user manual for first time operation the first time you operate your unit. Consult the

troubleshooting section if you have issues or problems operating your unit after you have followed the first time operation guidelines.

You can monitor your unit with a system (user-supplied) controller or a Windows®-based personal computer running Thyro-Tool Pro PC software. To order this software, contact your AE sales representative.

OPERATING MODES

Full-Wave Switch (TAKT)

In full-switch mode, whole multiples of the mains periods are always switched and harmonics are minimized.

The mains are switched on/off depending on the prescribed time period.

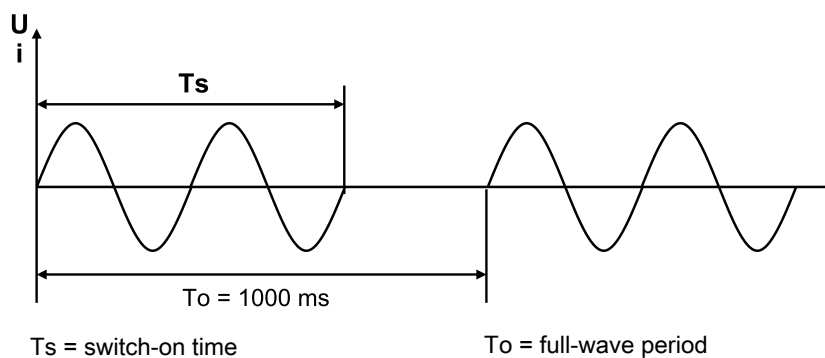


Figure 5-38. TAKT waveform

The start and stop ramp functions can be used in TAKT mode. Ramps are used with the operation of large single loads to reduce pulse-shaped mains loads and therefore to reduce voltage variations. The ramps are implemented by applying periods with phase-angle firing, using the parameters SST and SDN (see the following figure).

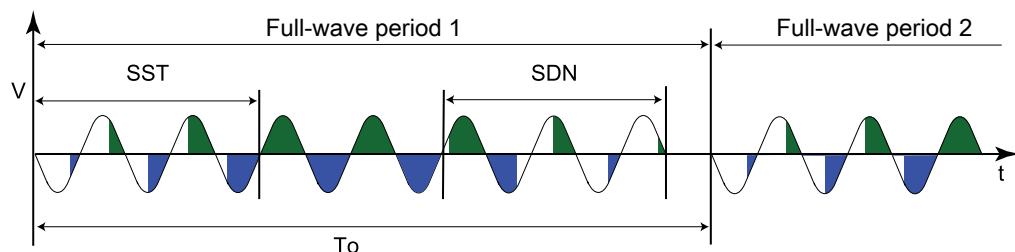


Figure 5-39. Start/stop ramp waveform

Phase-Angle Firing (VAR)

Depending on the prescribed setpoint, the sine oscillation of the mains voltage is gated using a larger or smaller control angle α . This operating mode is characterized by high control dynamics.

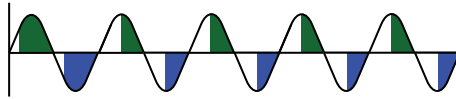


Figure 5-40. VAR waveform

STARTING MODES

The Thyro-PX power controller has enhanced starting modes that are used with special loads. These modes are used when the unit is started or restarted, and the restart behavior can be configured.

RAMP Starting Mode

This starting mode begins with a specially configured, one-time block, normally in the form of a ramp (default). It is used to symmetrize transformers during restart. It can be configured in the same manner as the standard TAKT. See also “Operating Modes” on page 5-38.

MOSI Starting Mode

The MOSI starting mode is used for sensitive heating materials with a high $R_{\text{warm}}/R_{\text{cold}}$ ratio, such as molybdenum disilicide. The power controller limits the maximum current to the load during the low-resistance heating-up phase, and then automatically switches to the set operating mode.

SETPOINT CONTROL

The setpoint control characteristic of the Thyro-PX power controller is easily adapted for the control output signal of the upstream process controller or automation system. All typical control voltage and control current signals can be used. Inverted operation (ending value is smaller than the starting value in voltage or current) is also supported.

The effective setpoint is the total setpoint. It is formed by adding the three setpoints as shown in Figure 5-41.

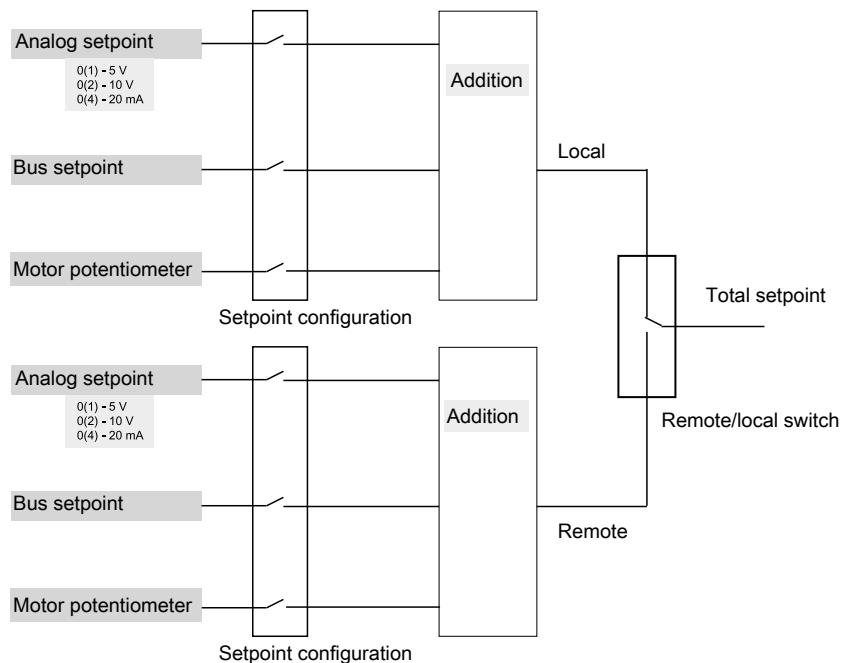


Figure 5-41. Total setpoint

The local analog setpoint, and local motor potentiometer setpoint are used by default. If an Anybus module is installed, the remote bus setpoint is used by default. Switching between the local setpoint and the remote setpoint can be controlled using the Thyro-Touch display, the Thyro-Tool Pro PC software, or the bus communication. A digital I/O line may also be configured to control the local/remote switch.

Table 5-4. Setpoint characteristics

| Input Type | Input Characteristics | |
|--------------------------------|------------------------------|---------------------------------|
| 0 mA to 20 mA 4 mA to 20 mA | Ri = ca. 250 Ω / max. 24 mA | Do not exceed 12 V open-circuit |
| 0 V to 5 V 1 V to 5 V | Ri = ca. 6.6 kΩ / max. 12 V | |
| 0 V to 10 V 2 V to 10 V | Ri = ca. 11.1 kΩ / max. 12 V | |

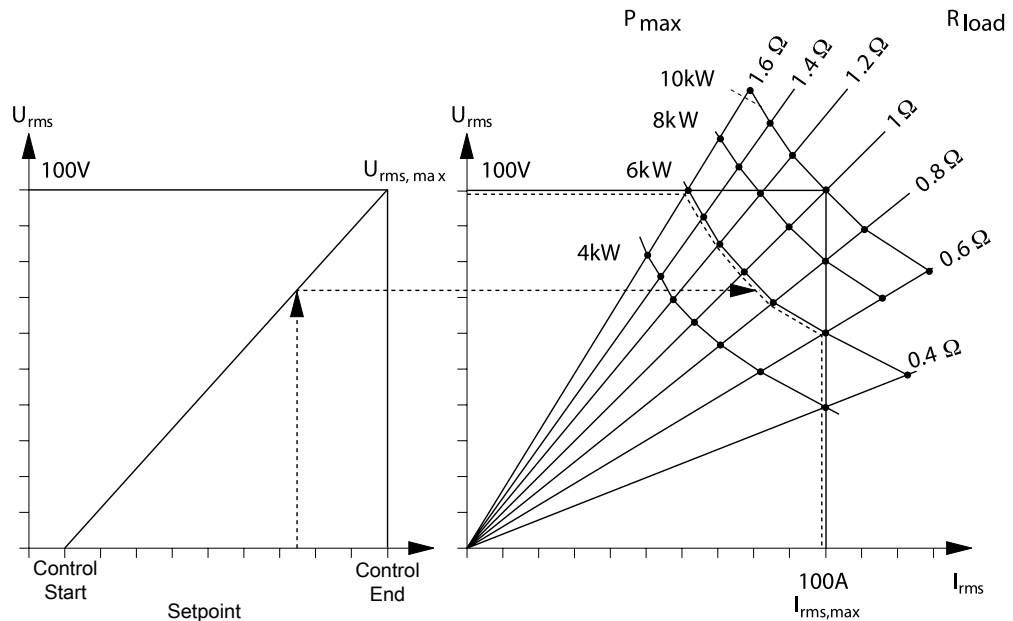


Figure 5-42. Control characteristics for U control

CONTROL TYPES

The Thyro-PX power controller has six control types effective as underlying controls. Mains voltage variations and load changes are directly and quickly adjusted by bypassing the slow temperature control system.

Before commissioning the power controller and selecting a control type, you should be familiar with the application and with the operating characteristics of the load.

Controlled Value

The controlled value effect on the load is proportional to the total setpoint, depending on the control type, as shown in the following table.

Table 5-5. Controlled values

| Control Type | Control Value (Proportional to the total setpoint) |
|---------------|---|
| P control | Output (active) power, P |
| U control | Output voltage, U_{rms} |
| U^2 control | Output voltage, U_{rms}^2 |
| I control | Output current, I_{rms} |
| I^2 control | Output current, I_{rms}^2 |
| No regulation | Output proportional to the setpoint |

Controller Response

If the load resistance changes (for example, due to temperature effect, aging, or load fault), the power controller responds as shown in the following table.

Table 5-6. Response to load changes

| Control Type | Limit | Load Resistance Decreases | | | Load Resistance Increases | | | Effective Limitations ^[1] | |
|--------------------------|---------------------|---------------------------|-------------------|-------------------|---------------------------|-------------------|-------------------|--------------------------------------|---------------------|
| | | P | U _{LOAD} | I _{LOAD} | P | U _{LOAD} | I _{LOAD} | | |
| U | U _{rmsmax} | Larger | = | Larger | Smaller | = | Smaller | I _{rmsmax} | P _{max} |
| U ² | U _{rmsmax} | Larger | = | Larger | Smaller | = | Smaller | I _{rmsmax} | P _{max} |
| I | I _{rmsmax} | Smaller | Smaller | = | Larger | Larger | = | U _{rmsmax} | P _{max} |
| I ² | I _{rmsmax} | Smaller | Smaller | = | Larger | Larger | = | U _{rmsmax} | P _{max} |
| P | P _{max} | = | Smaller | Larger | = | Larger | Smaller | U _{rmsmax} | I _{rmsmax} |
| without control | | Larger | = | Larger | Smaller | = | Smaller | U _{rmsmax} | I _{rmsmax} |
| General modulation limit | | | | | | | | T _s =T _{smax} | |
| | | | | | | | | α=α _{max} | |

¹ If one of the limits is exceeded, then the limit relay K2 and the LED Limit react (default values of parameter settings).

MONITORING

Faults occurring in the power controller or in the load circuit are signaled. Signaling is performed via the LED indicators, and via the fault relay K1. The fault log may be read via the Thyro-Touch display, or via the Thyro-Tool Pro PC software interface after selecting the status line. Simultaneously with the fault signal, you can use the **Pulse Lock On/Off** (with acknowledgement), **Pulse Lock On/Off** (without acknowledgement), or **Regulator Lock On/Off** (without acknowledgement) configuration to require that pulse shutdown occur. The number and content of occurred warnings or errors are shown in the status line of the Thyro-Touch display. Select a status line to retrieve the corresponding warning or error message.

Minimum and Maximum Monitoring

The following table shows the minimum and maximum conditions that can be monitored using the Thyro-Tool Pro PC software.

Table 5-7. Minimum and maximum conditions

| Symbol | Description |
|----------|---|
| UMainMin | Minimum mains voltage |
| UMainMax | Maximum mains voltage |
| Ueff_Min | Minimum rms voltage |
| Ueff_Max | Maximum rms voltage |
| U_min | Minimum rectified voltage (average of the absolute value) |
| U_Max | Maximum rectified voltage (average of the absolute value) |
| Ieff_Min | Minimum rms current |
| Ieff_Max | Maximum rms current |
| I_Min | Minimum rectified current (average of the absolute value) |
| I_Max | Maximum rectified current (average of the absolute value) |
| Ip_Max | Maximum peak current |
| P_Min | Minimum power |
| P_Max | Maximum power |
| R_Min | Minimum load resistance |
| R_Max | Maximum load resistance |
| T_Min | Minimum power controller temperature |
| T_Max | Maximum power controller temperature |

Fuse Monitoring

Open semiconductor fuses are detected and indicated.

Mains Voltage Monitoring

The power controller is equipped with mains voltage monitoring. You can set the limits for U mains minimum and U mains maximum. A status message will be generated when either limit is reached.

Fan Monitoring

The power controllers with fans (type designation that includes "F") are fitted with thermal monitoring. The temperature is measured on the heat sink. In case of a temperature overrange, a fault indication `Unit overtemperature` is issued.

By default, the device will be switched off and the **FAULT** LED will be lit.

**Important**

When using the device under UL conditions, this feature must be switched on.

Load Resistance Monitoring

Changes in load resistance can be caused by temperature changes or by aging. There are two ways to monitor these resistance changes. Absolute monitoring is useful for loads which do not change over time. Relative monitoring is useful if the resistance value of the load slowly changes.

Use absolute monitoring for heating elements with $R_{\text{warm}}/R_{\text{cold}} \approx 1$, and use relative monitoring for heating elements with $R_{\text{warm}}/R_{\text{cold}} \neq 1$.

Absolute Value Load Resistance Monitoring

Absolute value monitoring lends itself to one or more load resistances organized in parallel or in series. Generally, the effective load resistance value measured is continuously compared with a configurable absolute resistance minimum and maximum limit. If these limits are undercut or exceeded, an indication occurs after a configurable number of mains periods. Using the upper resistance limit, in case of resistor elements connected in parallel, it is possible to detect a partial load interruption. Using the lower resistance limit, in case of resistors connected in series, it is possible to detect short-circuiting of an element.

Relative Value Load Resistance Monitoring

Relative monitoring is useful if the resistance value of the load slowly changes. The load resistance is measured and compared period to period. A fault is generated if the change is greater than the configured % change limit. The unit establishes a new nominal resistance value after each startup, restart, or mains outage.

MAINS LOAD OPTIMIZATION WITH dASM

The digital and dynamic dASM process offers the option of dynamic mains load optimization when multiple Thyro-PX power controllers operate in the TAKT mode.

For systems in which there are multiple power controllers, individual power controllers are synchronized so that a regular mains load is achieved. This avoids random load peaks caused by multiple power controllers switching on at the same time. The upstream transformer and/or the upstream feed point can be designed for a lower load, which results in savings in investment and operating costs, and much smaller system perturbations.

dASM can be applied whenever multiple power controllers operate together on a common grid supply in the TAKT mode. Other features include:

- Grid load optimization for up to 32 power controllers in the TAKT mode
- Grid load optimization on the basis of power consumption of the connected loads

- Dynamic grid load optimization, including the observance of setpoint or of the load alterations
- Digital operation and communication
- Grid load optimization of the dASM group within up to 5 seconds
- Suitable for 1-phase or 3-phase applications
- Simple dASM wiring with shielded RJ-45 patch cables (Ethernet CAT 5 8-pole) with a cable length between two power controllers of up to 100 m (328') depending on surrounding conditions
- Simple parameterization for the master unit (including power limit and number of devices)
- Monitoring the grid load (power limit)

dASM Application Considerations

When designing and installing, ensure that the:

- Electric load is evenly distributed onto the 3-phase system
- Parameterization and initiation of the individual power controller devices are in the TAKT mode with the same TAKT cycle period (To)
- Power wiring is correct for the phases
- 1-phase and 3-phase loads are in separate dASM groups
- Power controllers and loads of a dASM group are connected to the same grid in phase
- Shielded RJ-45 patch cables connect the **dASM In** and **dASM Out** connectors of each unit
 - Remove a section of the outer cable jacket to expose the shield.
 - Place the exposed shield section of the cable under the shield clamp.
 - Plug the RJ-45 connector into the unit.



Important

All digital and analog control cables must be shielded. Connect the cable shields to the shield clamp on the unit as shown in the following figure.

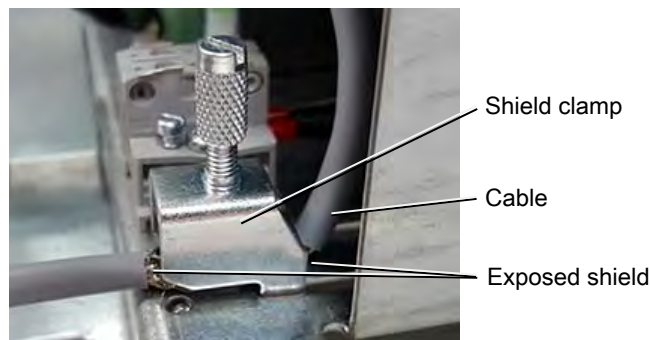


Figure 5-43. Shield clamp

dASM Commissioning

To ensure optimal functionality of the dASM grid load optimization, make sure to do the following when commissioning:

- Check the power controller for in-phase grid connection
- Check wiring of patch cables
- Select operating mode TAKT (with the same TAKT cycle period) for all power controller devices
- Verify these parameters on the master unit:
 - dASM NO. OF DEVICES
 - dASM POWER THRESHOLD [W]
- Start up each unit in the dASM group

dASM Notification

The dASM grid load optimization generates the following notifications in the master unit in the event of an error:

- `dASM device number is incorrect`: Check patch cable connections/parameter dASM device number
- `dASM power limit has been exceeded`: Reduce setpoints of the assembly as appropriate

The notifications generated can be reported via:

- Fault log
- LED
- Relay
- Thyro-Touch display
- Thyro-Tool Pro PC software

Errors in dASM Communication

If the dASM communication between units is interrupted, then a new master is automatically generated in the system beyond the point of interruption.

Notification: dASM device number is incorrect.

For example, if a cable break causes an interruption between unit 6 and unit 7, the dASM system continues to run, and unit 1 now operates as a master only for units 1 to 6 and displays that an incorrect number of units are present in the dASM network.

MAINTENANCE

Fan Maintenance

The fan is subject to wear. Complete the following visual inspection every year:

- Inspect the fan blade for abrasion, deposition, and corrosion.
- Check the fan for abnormal operating noise.

The fan has an expected lifetime of $L_{10} = 37,500$ h. Depending on working conditions, a new fan should be installed after approximately five years.

Troubleshooting and Global Services

Before calling AE Global Services, perform recommended checks and troubleshooting procedures. If you are still unable to resolve the issue and resume normal operation after following these checks and procedures, contact AE Global Services.

TROUBLESHOOTING CHECKLIST



DANGER:

RISK OF DEATH OR BODILY INJURY. Disconnect and lockout/tagout all sources of input power before working on this unit or anything connected to it.



DANGER:

RISQUE DE MORT OU DE BLESSURES CORPORELLES. Débrancher et verrouiller/étiqueter toutes les sources de puissance d'entrée avant de travailler sur cette unité ou sur tout élément qui y est raccordé.



DANGER:

Personnel must receive proper training before installing or troubleshooting high-energy electrical equipment. Potentially lethal voltages could cause death, serious personal injury, or damage to the equipment. Ensure that all appropriate safety precautions are taken.



DANGER:

Le personnel devra être correctement formé avant de pouvoir installer ou dépanner des équipements électriques à haute énergie. Des tensions potentiellement létales peuvent entraîner le décès, des blessures ou des dommages à l'équipement. Assurez-vous de prendre toutes les précautions de sécurité appropriées.

Table 6-1. Using LED states for troubleshooting

| Troubleshooting Check | Action |
|---------------------------------------|--|
| Is the green ON/READY LED lit? | If no: The auxiliary 230 VAC or 24 VDC supply is faulty. |

Table 6-1. Using LED states for troubleshooting (Continued)

| Troubleshooting Check | Action |
|---|---|
| Is the red ON/READY LED lit? | If yes: There is an EEPROM fault. |
| Is the red ON/READY LED blinking? | If yes: The hardware configuration is incorrect. |
| Is the orange ON/READY LED blinking? | If yes: The firmware is being updated. |
| Is the red LIMIT LED lit? | If yes: The unit is unable to supply enough power to match the setpoint due to a limiting condition. When an internal protection limit is exceeded, the output is limited but not shut off. <ol style="list-style-type: none"> 1. Disable the output. 2. Verify that the limitation setting is correct. 3. Verify that the unit load and load connections are correct. |
| Is the FAULT LED lit? | If yes: The unit has detected a fault. This fault will generate error data that can be viewed using the Thyro-Touch display or the Thyro-Tool Pro PC software. |
| Are any red CONTROL LEDs lit? | If yes: The unit has a fault in the corresponding power section. |

TROUBLESHOOTING UNIT OUTPUT

Use extreme caution when troubleshooting the unit output.



DANGER:

RISK OF DEATH OR BODILY INJURY. Disconnect and lockout/tagout all sources of input power before working on this unit or anything connected to it.



DANGER:

RISQUE DE MORT OU DE BLESSURES CORPORELLES. Débrancher et verrouiller/étiqueter toutes les sources de puissance d'entrée avant de travailler sur cette unité ou sur tout élément qui y est raccordé.

**DANGER:**

Personnel must receive proper training before installing or troubleshooting high-energy electrical equipment. Potentially lethal voltages could cause death, serious personal injury, or damage to the equipment. Ensure that all appropriate safety precautions are taken.

**DANGER:**

Le personnel devra être correctement formé avant de pouvoir installer ou dépanner des équipements électriques à haute énergie. Des tensions potentiellement létales peuvent entraîner le décès, des blessures ou des dommages à l'équipement. Assurez-vous de prendre toutes les précautions de sécurité appropriées.

No LEDs Lit

If no LEDs are lit, check for these errors:

- The customer-supplied power supply for the A70 control device is missing.
- Check that the voltage at terminal X1.1 and X1.2 of the A70 control device is within the range 90 VAC to 265 VAC, or that X3.1 and X3.2 are at 24 VDC.
- Check that fuses F2 and F3 on the A1, A3, and A5 controller cards are not open.
- Check that the semiconductor load fuses are not open.
- For transformer loads, the phase angle of the first half-wave might need to be optimized. Begin with a phase angle (phase angle 1) = 60 degrees, and slowly increase until the inrush current is minimized.

No Load Current

Check the following if no load current is present:

- Supply voltage of the A70 control device is within the range 90 VAC to 265 VAC, or X3.1 and X3.2 are at 24 VDC.
- Pulse lock X51.3 is jumpered to X51.2.
- Setpoint is available and active. Using the display or software, check the total setpoint (effective total), or measure setpoint on X52.2 and X52.5.
 - Setpoints are not cleared.
 - Parameterization of the setpoint inputs 20 mA, 5 V, 10 V, is matched to output of the temperature controller.
 - Parameters of the control characteristic of the respective analog input are correct.
- Parameters I_{max}, U_{max}, and P_{max} are set too small.
- Controller parameters T_i or K_p are set too large.

- The load is broken or disconnected (only for type 1PX). Check connection on A1 terminal X1.3.
- For 1PX and 2PX, units, verify that the reference phase is connected.
 - Check A1 terminal X1.3.
 - Check A3 terminal X1.3.
 - Check A5 terminal X1.3.

Thyristors Are Set To Full Scale

Check the following if the thyristors are set to full scale load current without a setpoint:

- Make sure that the motorpotentiometer setpoint is set to 0.
- Check the control characteristic of the respective analog inputs.
- Verify that parameters Ts, Uemin, Iemin, and Pmin are 0.
- Controller parameters Ti and Kp are set too small.
- Parameters Iemax, Uemax, and Pmax are set too large or the load current is too small.
- If no load is connected the voltage will be higher than 0 V. A load must be connected to troubleshoot this condition.
- Check the thyristor resistance between L1 and T1, L2 and T2, L3 and T3. If the resistance is greater than 100 Ω, the thyristor is not damaged.

Other Malfunctions

Check the following for other malfunctions:

- Evaluate the fault log entries with the Thyro-Touch display or the Thyro-Tool Pro PC software.
- Check the parameters.
- Check the wiring of the unit.
- Check the number of controlled phases (parameters).
- Eliminate the fault indicated by the fault relay.
- Visually verify correct operation by replacing the loads with appropriately rated incandescent lamps.

AE GLOBAL SERVICES

Please contact AE Global Services if you have questions or problems that cannot be resolved by working through the provided troubleshooting. When you call Global Services, make sure to have the unit serial number and part number. These numbers are available on unit labels.

**Important**

For returns and repairs, please call AE Global Services to get the correct shipping address.

Table 6-2. AE Global Services 24 X 7 contact information

| Office | Contact |
|---|--|
| AE World Headquarters | Address: 1625 Sharp Point Drive Fort Collins, CO 80525 USA Phone (24 hrs/day, 7 days/week): 800.446.9167 or +1.970.221.0108 Email: (We will respond to email by the next business day.) mailto:technical.support@aei.com |
| Sekidenko thermal product support | Contact by phone or email: +1.360.694.7871 mailto:thermalapplications@aei.com |
| Power Control Module product support | Contact by phone or email: +49 (0)2902 763 520 (technical support during German business hours) mailto:powercontroller@aei.com |
| High Voltage product support: HiTek Power, Ltd. | Contact by phone or email: +44 (0) 1903 712400 mailto:support.centre@aei.com |
| High Voltage product support: UltraVolt, Inc. | Contact by phone or email: +1.631.471.4444 mailto:sales.support-uv@aei.com |
| Local or regional sales or service office | Visit the Advanced Energy website for current contact information: http://www.advanced-energy.com |

RETURNING UNITS FOR REPAIR

Before returning any product for repair and/or adjustment, first follow all troubleshooting procedures. After following troubleshooting procedures, if your unit is unable to resume normal operation, contact AE Global Services and discuss the problem with a representative. Be prepared to give them the model number and serial number of the unit as well as the reason for the proposed return. This consultation call will allow Global Services to determine if the unit must actually be returned for the problem to be corrected. Such technical consultation is always available at no charge.

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