



# Thyro-PX<sup>®</sup> Power Controller

#### **User Manual**

October 2024 57010148-00JB



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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 source capacity are within specifications before turning on the unit.
- Use proper electrostatic discharge (ESD) precautions.
- Maintenance and service must be performed only by AE-trained service personnel.

## **Interpreting Product Labels**

The following labels might appear on the unit:



CE

Capacitor discharge warning (5 minutes)

CE label

or Complies with applicable European directives. CE UK Conformity Assessed label UK CA Complies with applicable United Kingdom regulations. Protective conductor terminal On or off Phase or Power on/standby **WARNING** HAZARDOUS VOLTAGE Hazardous voltage Risk of death or bodily injury. Disconnect all sources of input power before working on this unit or anything connected to it Hazardous voltage Voltage  $> 30 V_{RMS}$ , 42.4  $V_{peak}$ , or 60 V DC Hot surface ATTENTION There are no user serviceable parts or adjustments inside. No user-serviceable parts DO NOT REMOVE COVER RoHS European Union RoHS compliant Refer to manual for more information or



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<sup>®</sup> 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 Regulations, Directives, and Standards

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

#### Conditions of Use

Comply with the stated directives and standards by meeting 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.
- Install and operate this unit with a dedicated circuit breaker on the AC input. The circuit breaker must be easily accessible and near the unit. The circuit 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.

### **UL Markings and Requirements**

To use the unit under UL conditions, you must comply with the following additional conditions of use:

- Make electrical connections following the specified tightening torque. See "Connecting Load and Auxiliary Power" on page 5-31.
- Use 75°C copper conductors for power circuits.
- Use 60°C/75°C copper conductors for control circuits only.
- The maximum surrounding air temperature under UL conditions is 40°C (104°F).
- The unit is suitable for use on a circuit capable of delivering not more than 100 kA RMS symmetrical amperes, *xxx* volts maximum, when protected by RK5 class fuses, where *xxx* is the maximum rated voltage of the unit.
- Branch circuit protection must be provided and sized according to National Electrical Code<sup>®</sup> and any additional local codes.
- The unit is suitable for use in Pollution Degree 2 environment.

For installations according to Canadian National Standard C22.2 No. 14-13 (cUL Mark only):

Transient surge suppression devices shall be installed on the line side of this equipment and shall be rated \_\_\_\_ (phase to ground), \_\_\_\_ V (phase to phase), suitable for overvoltage category III, and shall provide protection for a rated impulse withstand voltage peak of \_\_\_\_ kV, as shown in the following table.

| Supply Voltage       | Phase to Ground<br>Voltage | Phase to Phase<br>Voltage | Impulse Withstand<br>Voltage Peak |  |
|----------------------|----------------------------|---------------------------|-----------------------------------|--|
| Corner Ground Source | ces                        | -                         | -                                 |  |
| 230 V                | 230 V                      | 230 V                     | 4 kV                              |  |
| 400 V                | 400 V                      | 400 V                     | 6 kV                              |  |
| 500 V                | 500 V                      | 500 V                     | 6 kV                              |  |
| 690 V                | 690 V                      | 690 V                     | 8 kV                              |  |
| 1000 V               | 1000 V                     | 1000 V                    | 8 kV                              |  |
| Grounded Wye Sourc   | Grounded Wye Sources       |                           |                                   |  |
| 230 V                | 133 V                      | 230 V                     | 2.5 kV                            |  |
| 400 V                | 230 V                      | 400 V                     | 4 kV                              |  |
| 500 V                | 288 V                      | 500 V                     | 4 kV                              |  |
| 690 V                | 400 V                      | 690 V                     | 6 kV                              |  |
| 1000 V               | 577 V                      | 1000 V                    | 6 kV                              |  |

Table 1-1. Transient surge suppression device ratings

#### **Environmental Compliance**

#### • EU RoHS – European Union Directive 2011/65/EU (RoHS 2)

Restriction of the Use of Certain Hazardous Substances in Electrical and Electronic Equipment

This product is EU 2011/65/EU (RoHS 2) compliant, designed to contain no more than the maximum concentration of hazardous substances listed in Annex II, with possible exemptions from Annex III or IV. Because this product is installed as a component in a large-scale fixed installation or stationary industrial tool: the product is outside the scope of this Directive, compliance is not required, and the EU RoHS Directive is not declared on the CE Declaration of Conformity.

#### European Delegated Directive (EU) 2015/863 (RoHS 3) – Amendment to Annex II of Directive 2011/65/EU (RoHS 2) Regarding the List of Restricted Substances

This product is also compliant to the 2015/863 amendment, containing no more than the maximum concentration of four additional hazardous substances (phthalates) listed in amended Annex II.

#### • EU REACH – European Union Regulation (EC) No. 1907/2006

Registration, Evaluation, Authorization and Restriction of Chemicals

Advanced Energy manufactures articles subject to Article 33 of REACH and, upon request, will provide information regarding Substances of Very High Concern (SVHC) currently identified by the European Chemical Agency (ECHA) that are contained in this product, at concentrations greater than 0.1% by weight.

# • China RoHS – People's Republic of China (PRC) Ministry of Industry and Information Technology (MIIT) Order #32 (China RoHS 2)

Management Methods for the Restriction of the Use of Hazardous Substances Electrical and Electronic Products

This product contains hazardous substances listed in PRC Standard GB/T 26572, above the maximum concentration limits stipulated. In compliance to PRC Standard SJ/T 11364, AE provides a disclosure of hazardous substance content and this product is marked with an Environmentally Friendly Use Period (EFUP) of 25 years.

## 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 1-2. Interlocks and limiting conditions

| Mechanism   | Detection Method  | Equipment Condition When<br>Interlock is Open                                    |
|---|---|--|
| By opening the <i>Pulse Lock</i> jumper the unit is locked. | Opening the <i>Pulse Lock</i><br>jumper or external interlock<br>circuit<br>Terminal X51.2 connected to<br>terminal X51.3 | The red <b>PULSE LOCK</b> 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  $R_{warm}/R_{cold}$  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 5000 A, and the nominal design loads reach up to  $\sim$ 3015 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 computer user interface (optional)
- Wide application range
  - 230 V to 1000 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 input
- 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
  - $^{\circ}$  U, U<sup>2</sup>, I, I<sup>2</sup>, 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<sup>®</sup> system interface modules

# **Specifications**

# **Physical Specifications**

| Description   | Specification  |  |  |
|---|--|--|--|
| <b>General Physical Specificatio</b>                  | ns   |  |  |
| Size  | For 500 V units, see Table 3-2   |  |  |
| Weight  | For 690 V units, see Table 3-3   |  |  |
|   | For 1000 V units, see Table 3-4  |  |  |
| Mounting  |  |  |  |
| Mechanical  | Mounting hardware not included   |  |  |
| Connectors  |  |  |  |
| AC auxiliary power supply input (X1)                  | Included 3-pin plug-in screw terminal block, 0.2 mm <sup>2</sup> - 2.5 mm <sup>2</sup> (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 ( <b>X6</b> )                                     | $\mu$ USB (connector and cable not included)   |  |  |
| Analog I/O 1 ( <b>X51</b> )                           | Included 9-pin, plug-in, screw terminal block, 30 AWG -<br>14 AWG  |  |  |
| Analog and digital I/O 2 (X52)                        | Included 9-pin, plug-in, screw terminal block, 0.14 mm <sup>2</sup> - 1.5 mm <sup>2</sup> (30 AWG - 14 AWG)  |  |  |
| Analog and digital I/O 3<br>(optional) ( <b>X53</b> ) | Included 16-pin, plug-in, screw terminal block, 0.14 mm <sup>2</sup> - 1.5 mm <sup>2</sup> (30 AWG - 14 AWG) |  |  |
| Analog and digital I/O 4<br>(optional) ( <b>X54</b> ) | Included 16-pin, plug-in, screw terminal block, 0.14 mm <sup>2</sup> - 1.5 mm <sup>2</sup> (30 AWG - 14 AWG) |  |  |
| I/O Bus ( <b>X4</b> )                                 | RJ-45 (connector and cable not included)   |  |  |
| 24 V DC auxiliary power supply input ( <b>X3</b> )    | Included 2-pin, plug-in, screw terminal block, 0.14 mm <sup>2</sup> - 1.5 mm <sup>2</sup> (30 AWG - 14 AWG)  |  |  |
| Relay K1 ( <b>X21</b> )                               | Included 3-pin, plug-in, screw terminal block, 0.14 mm <sup>2</sup> - 1.5 mm <sup>2</sup> (30 AWG - 14 AWG)  |  |  |

#### Table 3-1. Physical specifications

| Description             | Specification   |  |  |  |
|-------------------------|---|--|--|--|
| Relay K2 ( <b>X22</b> ) | Included 3-pin, plug-in, screw terminal block, 0.14 mm <sup>2</sup> - 1.5 mm <sup>2</sup> (30 AWG - 14 AWG)     |  |  |  |
| Relay K3 ( <b>X23</b> ) | Included 3-pin, plug-in, screw terminal block, 0.14 mm <sup>2</sup> - 1.5 mm <sup>2</sup> (30 AWG - 14 AWG)     |  |  |  |
| Protection              |   |  |  |  |
| Degree of protection    | IP10B<br>The unit meets IP20 safety of persons requirements, but not the<br>IP20 safety of device requirements. |  |  |  |

Table 3-1. Physical specifications (Continued)

| Table 3-2. Type range 500 vo |
|------------------------------|
|------------------------------|

| Model                       | Dimensions (WxHxD) |            |            | Weight      | Dimensional |  |  |
|-----------------------------|--------------------|------------|------------|-------------|-------------|--|--|
| Type Current (A)            | mm (in)            |            |            | kg (lb)     | 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 Н, 170 Н                | 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,<br>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 5-9  |  |  |
| 130 Н, 170Н                 | 325 (12.8)         | 320 (12.6) | 232 (9.1)  | 12 (26.5)   | Figure 5-10 |  |  |
| 280 HF                      | 325 (12.8)         | 415 (16.3  | 232 (9.1)  | 15 (33.0)   | Figure 5-11 |  |  |
| 350 HF, 495 HF, 650 HF      | 261 (10.3)         | 501 (19.7) | 340 (13.4) | 22 (48.5)   | Figure 5-12 |  |  |
| 780 HF, 1000 HF, 1500<br>HF | 410 (16.1)         | 787 (31.0) | 505 (19.9) | 54 (119.0)  | Figure 5-14 |  |  |
| 2000 HF,                    | 550 (21.6)         | 837 (33.0) | 445 (17.5) | 84 (185.2)  | Figure 5-15 |  |  |
| 2750 HF                     | 593 (23.3)         | 837 (33.0) | 474 (18.6) | 107 (235.9) | Figure 5-16 |  |  |
| Thyro-PX 3PX                |                    |            |            |             |             |  |  |
| 16 H, 37 H, 75 H, 110 H     | 300 (11.8)         | 320 (12.6) | 232 (9.1)  | 14 (30.9)   | Figure 5-18 |  |  |
| 130 H, 170 H                | 450 (17.7)         | 320 (12.6) | 232 (9.1)  | 17 (37.5)   | Figure 5-19 |  |  |
| 280 HF                      | 450 (17.7)         | 414 (16.4) | 232 (9.1)  | 20 (44.0)   | Figure 5-20 |  |  |

| Model                       | Dimensions (WxHxD) |             |            | Weight      | Dimensional |
|-----------------------------|--------------------|-------------|------------|-------------|-------------|
| Type Current (A)            | mm (in)            |             |            | kg (lb)     | Drawing     |
| 350 HF ,495 HF, 650 HF      | 348 (10.8)         | 525 (20.7)  | 340 (13.4) | 30 (66.1)   | Figure 5-21 |
| 780 HF, 1000 HF, 1500<br>HF | 575 (22.6)         | 787 (31.0)  | 505 (19.9) | 74 (163.1)  | Figure 5-22 |
| 1850 HF                     | 550 (21.6)         | 1094 (43.1) | 445 (17.5) | 119 (262.3) | Figure 5-23 |
| 2600 HF                     | 593 (23.3)         | 1094 (43.1) | 474 (18.6) | 152 (335.1) | Figure 5-24 |

Table 3-2. Type range 500 volts (Continued)

#### Table 3-3. Type range 690 volts

| Model                  | Dimensions (WxHxD) |             |            | Weight      | Dimensional |  |
|------------------------|--------------------|-------------|------------|-------------|-------------|--|
| Type Current (A)       | mm (in)            |             |            | kg (lb)     | 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, 600 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  |  |
| 4500 HF                | 593 (23.3)         | 837 (33.0)  | 474 (18.6) | 107 (235.9) | Figure 5-16 |  |
| Thyro-PX 2PX           |                    |             |            |             |             |  |
| 80 H                   | 325 (12.8)         | 320 (12.6)  | 232 (9.1)  | 12 (26.5)   | Figure 5-10 |  |
| 200 HF                 | 325 (12.8)         | 415 (16.3   | 232 (9.1)  | 15 (33.0)   | Figure 5-11 |  |
| 300 HF, 500 HF         | 261 (10.3)         | 501 (19.7)  | 340 (13.4) | 22 (48.5)   | Figure 5-12 |  |
| 600 HF                 | 261 (10.3)         | 525 (20.7)  | 340 (13.4) | 22 (48.5)   | Figure 5-13 |  |
| 780 HF, 1400 HF        | 410 (16.1)         | 787 (31.0)  | 505 (19.9) | 54 (119.0)  | Figure 5-14 |  |
| 1850 HF                | 550 (21.6)         | 837 (33.0)  | 445 (17.5) | 84 (185.2)  | Figure 5-15 |  |
| 2400 HF                | 593 (23.3)         | 837 (33.0)  | 474 (18.6) | 107 (235.9) | Figure 5-16 |  |
| Thyro-PX 3PX           |                    |             |            |             |             |  |
| 80 H                   | 450 (17.7)         | 320 (12.6)  | 232 (9.1)  | 17 (37.5)   | Figure 5-19 |  |
| 200 HF                 | 450 (17.7)         | 414 (16.4)  | 232 (9.1)  | 20 (44.0)   | Figure 5-20 |  |
| 300 HF, 500 HF, 600 HF | 348 (10.8)         | 525 (20.7)  | 340 (13.4) | 30 (66.1)   | Figure 5-21 |  |
| 780 HF, 1400 HF        | 575 (22.6)         | 787 (31.0)  | 505 (19.9) | 74 (163.1)  | Figure 5-22 |  |
| 1700 HF                | 550 (21.6)         | 1094 (43.1) | 445 (17.5) | 119 (262.3) | Figure 5-23 |  |
| 2200 HF                | 593 (23.3)         | 1094 (43.1) | 474 (18.6) | 152 (335.1) | Figure 5-24 |  |

| Table 3-4. | Type range | 1000 volts |
|------------|------------|------------|
|------------|------------|------------|

| Model                        | Dimensions (WxHxD) |            |            | Weight     | Dimensional |  |
|------------------------------|--------------------|------------|------------|------------|-------------|--|
| Type Current (A)             | mm (in)            |            |            | kg (lb)    | Drawing     |  |
| Thyro-PX 1PX                 |                    |            |            |            |             |  |
| 600 HF, 1000 HF (on request) | 242 (9.5)          | 787 (31.0) | 505 (19.9) | 35 (77.2)  | Figure 5-8  |  |
| Thyro-PX 2PX                 |                    |            |            |            |             |  |
| 600 HF, 1000 HF (on request) | 410 (16.1)         | 787 (31.0) | 505 (19.9) | 54 (119.0) | Figure 5-17 |  |
| Thyro-PX 3PX                 | •                  | •          | •          | •          | •           |  |
| 600 HF, 1000 HF              | 575 (22.6)         | 787 (31.0) | 505 (19.9) | 74 (163.1) | Figure 5-25 |  |

# **Electrical Specifications**

| Table 3-5. Electrical specifi | ications |
|-------------------------------|----------|
|-------------------------------|----------|

| Description                           | Specification  |
|---------------------------------------|--|
| <b>Electrical Requirements</b>        |  |
| AC input line voltage                 | Type voltage 500 V units: 184 V to 550 V   |
|                                       | Type voltage 690 V units: 400 V to 759 V   |
|                                       | Type voltage 1000 V units: 580 V to 1100 V   |
| Auxiliary power supply input voltage  | 90 VAC - 250 VAC (230 V, 150 mA), or 24 VDC at 1 A   |
| Fan input voltage (type<br>HF models) | 230 V, 50/60 Hz, for fan current and current derating see "Cooling Specifications" on page 3-9 |
| AC line frequency                     | 50/60 Hz nominal; 45 Hz to 65 Hz range   |
| AC current                            |  |
| Rated power                           | Type voltage 500 V units, see Table 3-6  |
| Dissipation                           | Type voltage 600 V units see Table 3.7   |
| Current transformer ratio             |  |
| Burden resistor                       | Type voltage 1000 V units, see Table 3-8   |
| Semiconductor 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)   |

| Description          | Specification   |  |  |  |  |
|----------------------|---|--|--|--|--|
|                      | 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 Ri = ca. 250 $\Omega$ / max. 24 mA. Max open-circuit voltage = 24 V   |  |  |  |  |
|                      | $0(1)$ V - 5 V Ri = ca. 6.6 k $\Omega$ / max. 12 V  |  |  |  |  |
|                      | $0(2)$ V - 10 V Ri = ca. 11.1 k $\Omega$ / max. 12 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.  |  |  |  |  |
| Limitations          | Voltage limitation U <sub>rms</sub>   |  |  |  |  |
|                      | 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. Electrical specifications (Continued)

| Table 3-6.  | Tvpe    | voltage | 500 | volts |
|-------------|---------|---------|-----|-------|
| 1 0010 0 01 | . , p c | renage  | 000 | 10/10 |

| Model<br>Type Current<br>(A) | Type Power<br>(kVA) | Dissipation<br>(W) | Current<br>Transformer<br>T1 | Burden<br>R (Ω) | Fuse F1<br>(A) |
|------------------------------|---------------------|--------------------|------------------------------|-----------------|----------------|
| Thyro-PX 1PX                 | X                   | _                  |                              | _               |                |
| 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            |

| Model        |              | Dissinction | Current     | Burdon | Euro E1 |  |
|--------------|--------------|-------------|-------------|--------|---------|--|
| Type Current | Type Power   | Dissipation | Transformer | Burden |         |  |
| (A)          | (KVA)        | (VV)        | 11          | R (Ω)  | (A)     |  |
| 110 H        | 110 H 55     |             | 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 | X            |             |             |        |         |  |
| 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     |  |
| 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 | 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     |  |

Table 3-6. Type voltage 500 volts (Continued)

| Model<br>Type Current<br>(A) | Type Power<br>(kVA) | Dissipation<br>(W) | Current<br>Transformer<br>T1 | Burden<br>R (Ω) | Fuse F1<br>(A) |
|------------------------------|---------------------|--------------------|------------------------------|-----------------|----------------|
| 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 500 volts (Continued)

Table 3-7. Type voltage 690 volts

| Model<br>Type Current<br>(A) | Type Power<br>(kVA) | Dissipation<br>(W) | Current<br>Transformer<br>T1 | Burden R<br>(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         |  |  |
| 500 HF                       | 345                 | 625                | 500/1                        | 1.0             | 630         |  |  |
| 600 HF                       | 414                 | 781                | 700/1                        | 1.1             | 800         |  |  |
| 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      |  |  |
| 4500 HF                      | 3105                | 5100               | 5000/1                       | 1.1             | 8x1400      |  |  |
| Thyro-PX 2PX                 | X                   |                    |                              |                 |             |  |  |
| 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         |  |  |

| Model<br>Type Current<br>(A) | Type Power<br>(kVA) | Dissipation<br>(W) | Current<br>Transformer<br>T1 | Burden R<br>(Ω) | Fuse F1 (A) |
|------------------------------|---------------------|--------------------|------------------------------|-----------------|-------------|
| 500 HF                       | 597                 | 1225               | 500/1                        | 1.0             | 630         |
| 600 HF                       | 717                 | 1570               | 700/1                        | 1.1             | 800         |
| 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                 | K                   |                    |                              |                 |             |
| 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         |
| 600 HF                       | 717                 | 2360               | 700/1                        | 1.1             | 800         |
| 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      |

Table 3-7. Type voltage 690 volts (Continued)

| Table 3-8. | Туре | voltage | 1000 | volts |
|------------|------|---------|------|-------|
|------------|------|---------|------|-------|

| Model<br>Type Current<br>(A) | Type Power<br>(kVA) | Dissipation<br>(W) | Current<br>Transformer<br>T1 | Burden R<br>(Ω) | Fuse F1 (A) |  |
|------------------------------|---------------------|--------------------|------------------------------|-----------------|-------------|--|
| Thyro-PX 1PX (on request)    |                     |                    |                              |                 |             |  |
| 600 HF                       | 538                 | 910                | 700/1                        | 1.1             | 2x550       |  |
| 1000 HF                      | 966                 | 1915               | 1000/1                       | 1.1             | 2x800       |  |
| Thyro-PX 2PX                 | K (on request)      |                    |                              |                 |             |  |
| 600 HF                       | 932                 | 1700               | 700/1                        | 1.1             | 4x550       |  |
| 1000 HF                      | 1673                | 3830               | 1000/1                       | 1.1             | 4x800       |  |
| Thyro-PX 3PX                 |                     |                    |                              |                 |             |  |
| 600 HF                       | 932                 | 2740               | 700/1                        | 1.1             | 6x550       |  |
| 1000 HF                      | 1673                | 5745               | 1000/1                       | 1.1             | 6x800       |  |

## **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.

| Air Temperature                          | I/I <sub>RATED CURRENT</sub> (A) |                |  |  |  |
|--|----------------------------------|----------------|--|--|--|
|  | Self Cooling                     | Forced Cooling |  |  |  |
| 0°C to +25°C (32°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) |                                  |                |  |  |  |

Table 3-9. Current derating



Figure 3-1. Current derating

| Model  | Current (A)             |                       | Air Volume                                    | Sound Pressure                      |
|--|-------------------------|-----------------------|---|-------------------------------------|
|  | 50 Hz                   | 60 Hz                 | (m <sup>3</sup> /h)                           | (dbA @ 1 m)                         |
| 1PX  |                         |                       |   |                                     |
| 200 HF, 280 HF                                       | 0.22                    | 0.22                  | 120   | 53                                  |
| 300 HF, 350 HF,<br>495 HF, 500 HF,<br>600 HF, 650 HF | 0.50                    | 0.38                  | 150   | 67                                  |
| 780 HF, 1000 HF,<br>1400 HF, 1500 HF                 | 0.55                    | 0.60                  | 580   | 75                                  |
| 1000 V: 600 HF,<br>1000 HF                           |                         |                       |   |                                     |
| 2000 HF, 2100 HF,<br>2600 HF, 2900 HF                | 1.00                    | 1.20                  | 2200  | 81                                  |
| 4500 HF  | 1.00                    | 1.20                  | 2100  | 81                                  |
| 2PX  |                         |                       |   |                                     |
| 200 HF, 280 HF                                       | 0.50                    | 0.38                  | 200   | 67                                  |
| 300 HF, 350 HF,<br>495 HF, 500 HF,<br>600 HF, 650 HF | 0.50                    | 0.38                  | 230   | 67                                  |
| 780 HF, 1000 HF,<br>1400 HF, 1500 HF                 | 1.00                    | 1.20                  | 1200  | 81                                  |
| 1000 V: 600 HF,<br>1000 HF                           |                         |                       |   |                                     |
| 1850 HF, 2000 HF,<br>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,<br>495 HF, 500 HF,<br>600 HF, 650 HF | 1.20                    | 0.85                  | 450   | 72                                  |
| 780 HF, 1000 HF,<br>1400 HF, 1500 HF                 | 1.00                    | 1.20                  | 1600  | 81                                  |
| 1000 V: 600 HF,<br>1000 HF                           |                         |                       |   |                                     |
| 1700 HF, 1850 HF,<br>2200 HF, 2600 HF                | 1.00                    | 1.20                  | 2000  | 81                                  |
| Fans for HF units must according to connectin        | t be runni<br>g diagran | ng when t<br>ns. When | he unit is operating.<br>operating conditions | Connect the fans<br>are below +10°C |

Table 3-10. Fan current, air volume, and sound pressure

|   | -           | -     |                     |                |  |
|---|-------------|-------|---------------------|----------------|--|
| Model   | Current (A) |       | Air Volume          | Sound Pressure |  |
|   | 50 Hz       | 60 Hz | (m <sup>3</sup> /h) | (dbA @ 1 m)    |  |
| (+50°F), a longer fan startup time is required. Therefore, the overcurrent protection device should be rated at twice the specified continuous current. |             |       |                     |                |  |

Table 3-10. Fan current, air volume, and sound pressure

## **Environmental Specifications**

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

Table 3-11. Environmental standard specifications

| Description      | Specification                |  |
|------------------|------------------------------|--|
| Overvoltage      | Category III per IEC 62477-1 |  |
| Pollution degree | 2                            |  |

Table 3-12. Climatic specifications

|  | Temperature   | Relative Humidity  | Air Pressure   |
|--|---|--|--|
| <b>Operating</b> Self cooled models: 5 |   | 5% to 85% <sup>[1]</sup>   | 89.9 kPa to 106 kPa  |
|  | +0°C to +45°C<br>+32°F to +113°F<br>Force cooled models:<br>+0°C to +35°C | 1 g/m <sup>3</sup> to 25 g/m <sup>3</sup><br>1 g/m <sup>3</sup> to 25 g/m <sup>3</sup> | 899 mbar to<br>1060 mbar<br>Equivalent altitude:<br>+1000 m to -500 m<br>(+3281' to -1640') <sup>[2]</sup>         |
|  | +32°F to +95°F  |  |  |
| Storage                                | -25°C to +55°C<br>-13°F to +131°F   | 5% to 95%<br>1 g/m <sup>3</sup> to 29 g/m <sup>3</sup>                                 | 78.8 kPa to 106 kPa<br>788 mbar to<br>1060 mbar<br>Equivalent altitude:<br>+2000 m to -500 m<br>(+6562' to -1640') |

|                | Temperature     | Relative Humidity                  | Air Pressure   |
|----------------|-----------------|------------------------------------|--|
| Transportation | -25°C to +70°C  | 95% [3]                            | 65.6 kPa to 106 kPa  |
|                | -13°F to +158°F | 60 g/m <sup>3</sup> <sup>[4]</sup> | 656 mbar to<br>1060 mbar   |
|                |                 |                                    | Equivalent altitude:<br>+3500 m to -500 m<br>(+11480' to -1640') |

 Table 3-12. Climatic specifications (Continued)

<sup>1</sup> Non-condensing, no formation of ice

<sup>2</sup> Operation at higher altitudes is possible with reduced current limits. From +1000 m to +2000 m (+3281' to +6562'), the rated current is decreased by 1.5%/100 m (1.5%/328'). Contact AE Technical Support for operating at >+2000 m (+6562').

<sup>3</sup> 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)

<sup>4</sup> Maximum absolute humidity when the unit temperature directly decreases from  $+70^{\circ}$ C to  $+15^{\circ}$ 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.

| Type Range                      | Designation | Features   |
|---------------------------------|-------------|--|
| Thyro-PX<br>power<br>controller | 1PX         | 1-phase power section, for 1-phase operation   |
|                                 | 2PX         | 2-phase power section used with a 3-phase<br>load in 3-phase economic circuit (not for<br>phase-angle firing VAR), or with two 1-phase<br>loads in multi-zone mode |
|                                 | 3PX         | 3-phase power section, for 3-phase operation,<br>or with three 1-phase loads in multi-zone<br>mode   |
|                                 | 500         | Up to 500 V  |
|                                 | 1000        | Up to 1000 V   |
|                                 | 37          | Type current 37 A  |
|                                 |             | Integrated semiconductor fuse  |
|                                 |             | Forced air cooling with integrated fan   |

Table 3-13. Type designation



# **Communication Controls**

## **Controls and Indicators**

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

#### Important

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

| 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:  |  |
|       |                | 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. |  |

Table 4-2. Relay indications

# 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 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

#### Important

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

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

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

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

 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 |  |  |  |
| 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 |  |  |

| Pin    | Signal Name        | Function        |  |  |
|--------|--------------------|-----------------|--|--|
| 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             |                 |  |  |

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

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

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

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

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

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

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

#### **Related Links**

• "Connecting I/O and Auxiliary Connectors" on page 5-30

# **Module Slots**

The unit has two module slots. The Anybus module slot can be equipped with one of several Anybus modules to add field bus communication capability to the Thyro-PX power controller. For additional module documentation, visit https://www.advancedenergy.com and select **Products SCR Power Controllers**.

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



# **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  $SD^{(R)}$  memory card. It also 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 the 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<sup>®</sup> 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.

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

The following access levels apply:

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

#### **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 the information determined by the start screen configuration.

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.

#### 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 soft key ( $\equiv$ ) displays the next menu level: **configure the display** and **configure the power controller**.

<sup>2.</sup> Press the home key  $(\triangle)$  to return to the main menu.

## Software User Interface

The optional Thyro-Tool Pro 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.

To view software manuals, go to https://www.advancedenergy.com, select Products→ SCR Power Controllers→ Thyro Family, and scroll to the Technical Documentation section.

#### Using the Software

#### Installation

To install the Thyro-Tool Pro software, double-click the .exe file provided by AE. During installation, a server (Windows<sup>®</sup> service: ThyroWindowsService) and client are installed. The server and client start in parallel when the software is started.



Figure 4-8. Connection to local installed server

The left side of the window offers a file explorer for opening files and directly connected devices. On the right side, tabs are shown for each subsection that has been selected by double-clicking it. You can switch between the open windows by:

- Double-clicking the file explorer
- Clicking the appropriate tab
- Selecting the desired option from a drop-down menu (overview with icons)

#### **Manage Devices and Files**

Click the **Port Explorer** tab to show all the Thyro-PX devices connected to the computer. USB connected devices list their virtual COM port. Network connected devices list their IP address. Devices can be connected before and after the software is started.

#### Important

The first time the specific USB port is connected, the computer must configure the port and load the device driver. This will take up to several minutes.

You can select files with a .thyro file extension using the file explorer or the open

icon icon from the tool bar. All open files display in the lower pane. The middle pane displays the .thyro files from the selected folder of the upper window.



Figure 4-9. Open .thyro files in file explorer

The following tabs display when an open device is expanded:

- Parameters (to change and adjust the settings)
- Actual Values (to display the current available data and event messages)
- Data Logger (to record messages with time stamp)
- **Diagrams** (to show time-stamped data as characteristic lines)

The .thyro files include parameters, time, data logger entries, and diagrams.

#### **Parameters**

Double-click a parameter to open its editable window.



Figure 4-10. Change name of device

The features are sorted by groups and are changeable via one click on each heading on the right side. A tooltip for each feature describes the effect of the feature and, if appropriate, the default value and valid value range. If you change a value and then select another field, the changed value displays as red.

- A changed value is effective immediately when the device is connected; by default, a changed value reverts to the last saved value on system startup.
- Click the save 🛅 icon to save the changed value.

Click the save-as 🖪 icon to save parameters to your computer as a .thyro file.

To transfer a local file to the device, the device must be connected and the relevant .thyro file must be open (file will appear in the lower window of the file explorer). A drop-down menu opens with a list of all open files and connections under **Tools** $\rightarrow$  **Transfer parameter set**.

| Customer description Source Description<br>Thyro-PX 1PX500-37 H COM5 1PX500-37 H |  |
|--|--|
| Thyro-PX 1PX500-37 H COM5 1PX500-37 H  |  |
|  |  |
|  |  |
| Target instance(s)   |  |
| Customer description Source Description  |  |
| Thyro-PX 1PX500-37 H COM5 1PX500-37 H  |  |
|  |  |
|  |  |
|  |  |
|  |  |

Figure 4-11. Parameter transfer

The source file displays under **Source instance** and the describe device is displays under **Target instance**. Click the **Transfer** button to start the file transfer. Subsequently the values have to be saved. There are three entry methods used for parameters:

- Drop-down menus
- Numeric fields
- Check boxes

With drop-down menu parameters, entries are summarized in a list, as shown in the following figure. Select the desired parameter from the drop-down menu.

| Operatin | g Mode                              |                      |
|----------|-------------------------------------|----------------------|
| Symbol   | Name                                | Selection            |
| Mode     | Operating mode                      | VAR                  |
| Symbol   | Name                                | ТАКТ                 |
| ConfOM   | Configuration (regulator behaviour) | No option activated! |

Figure 4-12. Drop-down menu parameter

With numeric-field parameters, a number is entered into a field, as shown in the following figure. In those fields, values are displayed to the second decimal place. For internal purposes, additional decimal places can be entered which will be used for calculation. With mouse-over the precise value of each field can be seen without any limitations. This is of particular importance to control parameters.

| PID pro | cess co | ntroller |         |      |         |
|---------|---------|----------|---------|------|---------|
| Symbol  | Name    | Value    | Minimur | n    | Maximum |
| Кр      | Кр      | 0.15     |         | 0.00 | 1.00    |
| Ki      | Кі      | C 0.1    | 501235  | 0.00 | 1.00    |
| Kd      | Kd      | 0.00     |         | 0.00 | 1.00    |

Figure 4-13. Numeric-field parameter

With check-box parameters, a list of possible entries is displayed, as shown in the following figure. Multiple selection is possible and active entries are marked in light green. Active entries are grouped in the overview and non-selected are hidden. These lists are used for selection of messages (events), which should lead to certain actions, or for selection of setpoints, which are added in two switchable, customized configurations and therefore are captured simultaneously in sets.

| TAKT of | perating mode |  |  |
|---------|---------------|--|--|
| Symbol  | Name          | Code   |  |
| Config  | Configuration | <ul> <li>Activate cutting of 1st half-wave (AN1) and deactivate soft-start (SST</li> <li>Activate minimum off-time and deactivate soft-down (SDN)</li> </ul> |  |

Figure 4-14. Check-box parameter



# 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, or front, side, and back 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, 600 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 1PX 1000-600 HF, 1000 HF



Figure 5-9. Thyro-PX 2PX 500-16 H, 37 H, 75 H, 110 H



Figure 5-10. Thyro-PX 2PX 500-130 H, 170 H, Thyro-PX 2PX 690-80 H



Figure 5-11. Thyro-PX 2PX 500-280 HF, Thyro-PX 2PX 690-200 HF



Figure 5-12. Thyro-PX 2PX 500-350 HF, 495 HF, 650 HF, Thyro-PX 2PX 690-300 HF, 500 HF



*Figure 5-13. Thyro-PX 2PX 690-600 HF* 



*Figure 5-14.* Thyro-PX 2PX 500-780 HF, 1000 HF, 1500 HF, Thyro-PX 2PX 690-780 HF, 1400 HF



Figure 5-15. Thyro-PX 2PX 500-2000 HF, Thyro-PX 2PX 690-1850 HF



Figure 5-16. Thyro-PX 2PX 500-2750 HF, Thyro-PX 2PX 690-2400 HF



Figure 5-17. Thyro-PX 2PX 1000-600 HF, 1000 HF



Figure 5-18. Thyro-PX 3PX 500-16 H, 37 H, 75 H, 110 H



Figure 5-19. Thyro-PX 3PX 500-130 H, 170 H, Thyro-PX 3PX 690-80 H



Figure 5-20. Thyro-PX 3PX 500-280 HF, Thyro-PX 3PX 690-200 HF



*Figure 5-21.* Thyro-PX 3PX 500-350HF, 495 HF, 650 HF, Thyro-PX 3PX 690-300 HF, 500 HF, 600 HF



*Figure 5-22.* Thyro-PX 3PX 500-780 HF, 1000 HF, 1500 HF, Thyro-PX 3PX 690-780 HF, 1400 HF



Figure 5-23. Thyro-PX 3PX 500-1850 HF, Thyro-PX 3PX 690-1700 HF



Figure 5-24. Thyro-PX 3PX 500-2600 HF, Thyro-PX 3PX 690-2200 HF



Figure 5-25. Thyro-PX 3PX 1000-600 HF, 1000 HF

## Installation Requirements

Install this unit according to the following requirements.

#### 1 DANGER:

RISK OF DEATH OR BODILY INJURY. Follow your local jurisdiction requirements for lockout/tagout prior to connecting or disconnecting all input power sources and output connections.

## 1 DANGER:

RISQUE DE MORT OU DE BLESSURES. Respectez les exigences de votre juridiction locale en matière de verrouillage/étiquetage avant de connecter ou de déconnecter toutes les sources d'alimentation d'entrée et les connexions de sortie.

## **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**

#### Important

The labels on the packaging provide important safety and handling information. Follow company procedures when 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 signs of shipping damage are found, contact AE Technical Support and the carrier immediately.

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

#### Lifting the Unit

Use appropriate lifting techniques and tools based on the size and weight of the unit.

#### **CAUTION:**

The module is heavy. Use two people to lift the module.

#### **ATTENTION:**

Le module est lourd. Il doit être soulevé par deux personnes.

- 1. Review your company procedures before lifting the Thyro-PX power controller.
- 2. Lift the Thyro-PX power controller 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. Follow your local jurisdiction requirements for lockout/tagout prior to connecting or disconnecting all input power sources and output connections.

#### **DANGER:**

RISQUE DE MORT OU DE BLESSURES. Respectez les exigences de votre juridiction locale en matière de verrouillage/étiquetage avant de connecter ou de déconnecter toutes les sources d'alimentation d'entrée et les connexions de sortie.

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<sup>®</sup> T8 screws provided with the module.

For additional module documentation, go to https://www.advancedenergy.com, select **Products**  $\rightarrow$  **SCR Power Controllers**  $\rightarrow$  **Thyro Family**, and scroll to the **Technical Documentation** section.

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 5-26. 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 5-27. I/O module removal

## Configuring as a Multi-Zone Controller

#### **DANGER:**

RISK OF DEATH OR BODILY INJURY. Follow your local jurisdiction requirements for lockout/tagout prior to connecting or disconnecting all input power sources and output connections.

## **DANGER:**

RISQUE DE MORT OU DE BLESSURES. Respectez les exigences de votre juridiction locale en matière de verrouillage/étiquetage avant de connecter ou de déconnecter toutes les sources d'alimentation d'entrée et les connexions de sortie.

## **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. Modify the factory-installed wiring:
  - For 2-phase units, disconnect and remove the factory-installed wires connecting A1.X1 to A5.X1.

• For 3-phase units, disconnect and remove the factory-installed wires connecting A1.X1 to A3.X1 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
- 4. Install a jumper between A1.X1.4 and A1.X1.5.
- 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 L1, L3, or N (3-phase only).
- 9. Connect A5.X1.3 to the reference phase L1, L2, or N.

#### Important

A multi-zone controller can be operated from a single power phase, with each reference phase connected to another phase. For example, if the unit is connected to phase 1, then phase 2, phase 3, or neutral are used as the reference phase.

- 10. Connect X51.4 and X51.5 to terminal X51.2.
- 11. Install the covers.
- 12. Update the unit hardware configuration.
  - Using the Thyro-Touch display.
    - Press → Settings→ Thyro-Controller→ Thyro-PX Device→ Hardware config (gen.)→ Basic configur.
    - 2) Enter the level 1 pin: 160387.
    - 3) Scroll to the appropriate multi-zone configuration.
    - 4) Press the green-check icon to save the new configuration.
    - 5) Press  $\stackrel{\frown}{\frown}$  to return to the home screen.
  - Using the Thyro-Tool Pro software.
    - 1) Connect to the unit via USB.
    - 2) Open the unit in the port explorer.
    - 3) Select Parameters  $\rightarrow$  Hardware config. (gen.)  $\rightarrow$  Basic configuration .
    - 4) Select the appropriate multi-zone configuration from the drop-down list.
    - 5) Click the save icon.

| Thyro-PX 3PX500-350 HF.thyro             |   |                         |                                 |                                   |  |  |  |
|--|---|-------------------------|---------------------------------|-----------------------------------|--|--|--|
| <ul> <li>Parameters Explorer </li> </ul> | <ul> <li>Thyro-PX Device</li> <li>Info</li> </ul>             | Hardware config. (gen.) |                                 |                                   |  |  |  |
|  | iÖi Hardware config. (gen.)                                   | Symbol                  | Name                            | Selection                         |  |  |  |
|  | Hardware config. (PUs)  | Conf_PU                 | Basic configuration             | 3x 1-phase (power units #1,#2,#3) |  |  |  |
|  | 🖻 🏹 Math  | Card_L1                 | I/O extension card slot 1 (X53) | None 👻                            |  |  |  |
|  | Acknowledgement   | Card_L2                 | I/O extension card slot 2 (X54) | None 👻                            |  |  |  |
|  | Fault log config.   | Module1                 | External I/O extension          | None 👻                            |  |  |  |
|  | Thyro-PX Power Controller #1                                  | Card_S1                 | dASM module slot                | None 🗸                            |  |  |  |
|  | Thyro-PX Power Controller #2                                  | Anybus                  | Anybus module slot              | None 👻                            |  |  |  |
|  | Thyro-PX Power Controller #3     Thyro-PX I/Os, LEDs & Relays | Symbol                  | Name                            | Code                              |  |  |  |
|  | Info  | Config                  | Show unused measurements        | No option activated!              |  |  |  |
|  | 🕨 🔽 LEDs  |                         |                                 |                                   |  |  |  |

Figure 5-28. Software configuration

To convert a 3-phase unit, see Figure 5-29. To convert a 2-phase unit, see Figure 5-30. The wiring changes are shown as bold lines.



Figure 5-29. Configure 3-phase as multi-zone



Figure 5-30. Configure 2-phase as multi-zone

## Configuring as a Voltage Sequence Controller (VSC)

#### 1 DANGER:

RISK OF DEATH OR BODILY INJURY. Follow your local jurisdiction requirements for lockout/tagout prior to connecting or disconnecting all input power sources and output connections.

## 1 DANGER:

RISQUE DE MORT OU DE BLESSURES. Respectez les exigences de votre juridiction locale en matière de verrouillage/étiquetage avant de connecter ou de déconnecter toutes les sources d'alimentation d'entrée et les connexions de sortie.

#### **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 5-34 and Figure 5-35.

## **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.





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).



#### 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 5-34. 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 5-35. The wiring changes are shown as bold lines.

- 9. Install the covers.
- 10. Update the unit hardware configuration.
  - Using the Thyro-Touch display.

    - 2) Enter the level 1 pin: 160387
    - 3) Scroll to the appropriate VSC configuration
    - 4) Press the green check icon to save the new configuration.
    - 5) Press  $\stackrel{\frown}{\frown}$  to return to the home screen.
  - Using the Thyro-Tool Pro software.
    - 1) Connect to the unit via USB.
    - 2) Open the unit in the port explorer.
    - 3) Select Parameters→ Hardware config. (gen.)→ Basic configuration.

- 4) Select the appropriate VSC configuration from the drop-down list.
- 5) Click the save icon.

|   | T       | hyro-PX 3PX500-350 HF.thyro      |                         |                                 |                                       |  |  |
|---|---------|----------------------------------|-------------------------|---------------------------------|---------------------------------------|--|--|
| ( | <)<br>ه | Thyro-PX Device  Info            | Hardware config. (gen.) |                                 |                                       |  |  |
|   | ameter  | i Hardware config. (gen.)        | Symbol                  | Name                            | Selection                             |  |  |
|   | F       | Hardware config. (PUs)           | Conf_PU                 | Basic configuration             | 1x 1-phase VSC (power units #1,#2,#3) |  |  |
|   |         | 🛛 💦 Math                         | Card_L1                 | I/O extension card slot 1 (X53) | None                                  |  |  |
| 1 | Ċ)      | Acknowledgement                  | Card_L2                 | I/O extension card slot 2 (X54) | None                                  |  |  |
|   |         | Fault log config.                | Module1                 | External I/O extension          | None 👻                                |  |  |
|   |         | Thyro-PX Power Controller #1     | Card_S1                 | dASM module slot                | None 👻                                |  |  |
|   |         | 4 🐗 Thyro-PX I/Os, LEDs & Relays | Anybus                  | Anybus module slot              | None 🗸                                |  |  |
|   |         | Info                             |                         | -                               |                                       |  |  |
|   |         | EDs                              | Symbol                  | Name                            | Code                                  |  |  |
|   |         | 🛚 🧱 Relays                       | Config                  | Show unused measurements        | No option activated!                  |  |  |
|   |         | Analogue inputs                  |                         |                                 |                                       |  |  |
|   |         | Analogue outputs                 | Symbol                  | Name                            | Selection                             |  |  |
|   |         | Digital inputs                   | VSC_STEP                | Configuration VSC               | 3 stages 🔹                            |  |  |

Figure 5-33. Software configuration



Figure 5-34. Configure 3-phase as VSC 3



Figure 5-35. 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 wire that is sized in accordance with applicable requirements.

#### AVERTISSEMENT:

N'essayez pas d'allumer l'alimentation jusqu'à ce que le châssis de l'unité soit attaché à un sol de terre local au moyen d'un fil de mise à la terre en cuivre dimensionné conformément 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. Follow your local jurisdiction requirements for lockout/tagout prior to connecting or disconnecting all input power sources and output connections.

## **A** DANGER:

RISQUE DE MORT OU DE BLESSURES. Respectez les exigences de votre juridiction locale en matière de verrouillage/étiquetage avant de connecter ou de déconnecter toutes les sources d'alimentation d'entrée et les connexions de sortie.

#### 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 5-36. 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.

- Verify that the control cable conductors are sized between 0.14 mm<sup>2</sup> and 1.5 mm<sup>2</sup> (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. Follow your local jurisdiction requirements for lockout/tagout prior to connecting or disconnecting all input power sources and output connections.

#### **DANGER:**

RISQUE DE MORT OU DE BLESSURES. Respectez les exigences de votre juridiction locale en matière de verrouillage/étiquetage avant de connecter ou de déconnecter toutes les sources d'alimentation d'entrée et les connexions de sortie.

#### 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 5-34).

#### Important

If the unit is operated without an output load at over 600 V, the output voltage can exceed the maximum input voltage, damaging the unit. In this case, an optional 690 V snubber board (part number 2000003203) must be connected to each output. One snubber board is required for 1-phase and 2-phase units; two snubber boards are required for 3-phase units wired in an open delta configuration.

#### To Connect Load and Auxiliary Power

- 1. Press on the retaining clip on the front of the unit(s), and slide the plastic cover(s) forward to remove.
- 2. Verify that the Protective Earth ground conductor is connected.
- 3. Connect each phase of the mains supply to the mains terminal (L1, L2, L3).

#### Important

A clockwise rotating field is required. The mains terminals are labeled **1** on units with less than a 45 A current rating.

- a. Use the screw size specified in Table 5-1.
- b. Tighten to the torque specified in Table 5-2.
- 4. Connect each phase of the load to the load terminals (T1, T2, T3).

#### Important

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

- a. Use the screw size specified in Table 5-1.
- b. Tighten to the torque specified in Table 5-2.
- 5. For 1PX and 2PX units, connect the reference phase to A1 X1.3.
- 6. Connect a current-limited external power source to the auxiliary power input connector on the bottom of the unit. Connect either:
  - $\circ~$  90 VAC to 250 VAC (230 V, 150 mA) to connector X1
  - $\circ~$  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.

7. 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.

8. Reinstall the plastic cover(s) removed for step 1.

Table 5-1. Terminal screw size

| Model  | Connector<br>Screw | Protective<br>Earth Screw |
|--|--------------------|---------------------------|
| 37 H, 75 H   | M6                 | M6                        |
| 80 H   | M8                 | M10                       |
| 110 H  | M6                 | M6                        |
| 130 Н, 170 Н   | 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                       |

| Screw | Torque         |                |                |  |
|-------|----------------|----------------|----------------|--|
|       | Minimum NM     | Rated NM       | Maximum NM     |  |
|       | (Pound-Inches) | (Pound-Inches) | (Pound-Inches) |  |
| M2    | 0.2 (1.8)      | 0.25 (2.2)     | 0.3 (2.7)      |  |
| M4    | 1.0 (8.9)      | 1.3 (11.5)     | 1.7 (15.0)     |  |
| M6    | 3.0 (26.6)     | 4.4 (38.9)     | 5.9 (52.2)     |  |

| Screw | Torque         |                |                |  |
|-------|----------------|----------------|----------------|--|
|       | Minimum NM     | Rated NM       | Maximum NM     |  |
|       | (Pound-Inches) | (Pound-Inches) | (Pound-Inches) |  |
| M8    | 11.5 (101.8)   | 17.0 (150.5)   | 22.5 (199.1)   |  |
| M10   | 22.0 (194.7)   | 33.0 (292.1)   | 44.0 (389.4)   |  |
| M12   | 38.0 (336.3)   | 56.0 (495.6)   | 75.0 (663.8)   |  |

Table 5-2. Terminal screw torque (Continued)

## **Connection Diagrams**

#### **DANGER:**

RISK OF DEATH OR BODILY INJURY. Follow your local jurisdiction requirements for lockout/tagout prior to connecting or disconnecting all input power sources and output connections.

#### A DANGER:

RISQUE DE MORT OU DE BLESSURES. Respectez les exigences de votre juridiction locale en matière de verrouillage/étiquetage avant de connecter ou de déconnecter toutes les sources d'alimentation d'entrée et les connexions de sortie.

#### **WARNING:**

More than one live circuit. See diagram.

#### AVERTISSEMENT:

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



*Figure 5-37. 1PX power controller connections* 



*Figure 5-38.* 2PX power controller connections



*Figure 5-39. 3PX power controller connections* 



*Figure 5-40.* 2PX primary VSC 2 power controller connections



Figure 5-41. 3PX primary VSC 3 power controller connections



Figure 5-42. 2PX secondary VSC 2 power controller connections



Figure 5-43. 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, Setpoint, 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 software.

#### **Related Links**

- "Operating Modes" on page 5-43
- "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 Windowsbased personal computer running Thyro-Tool Pro 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.



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 5-45. 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  $\alpha$ . This operating mode is characterized by high control dynamics.



# **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 5-43.

## **MOSI Starting Mode**

The MOSI starting mode is used for sensitive heating materials with a high  $R_{warm}/R_{cold}$  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 5-47.



Figure 5-47. 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 software, or the bus communication. A digital I/O line may also be configured to control the local/remote switch.

| Table 5 | <b>-3</b> . Set | point ch | aracteristics |
|---------|-----------------|----------|---------------|
|---------|-----------------|----------|---------------|

| Input Type    | Input Characteristics               |                          |
|---------------|-------------------------------------|--------------------------|
| 0 mA to 20 mA | $Ri = ca. 250 \Omega / max. 24 mA$  | Do not exceed 12 V open- |
| 4 mA to 20 mA |                                     | cırcuit                  |
| 0 V to 5 V    | $Ri = ca. 6.6 k\Omega / max. 12 V$  |                          |
| 1 V to 5 V    |                                     |                          |
| 0 V to 10 V   | $Ri = ca. 11.1 k\Omega / max. 12 V$ |                          |
| 2 V to 10 V   |                                     |                          |



Figure 5-48. 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.

| Control Type           | Control Value                                 |  |  |
|------------------------|---|--|--|
|                        | (Proportional to the Total Setpoint)          |  |  |
| P control              | Output (active) power, P                      |  |  |
| U control              | Output voltage, U <sub>RMS</sub>              |  |  |
| U <sup>2</sup> control | Output voltage, U <sup>2</sup> <sub>RMS</sub> |  |  |
| I control              | Output current, I <sub>RMS</sub>              |  |  |
| I <sup>2</sup> control | Output current, I <sup>2</sup> <sub>RMS</sub> |  |  |

Table 5-4. Controlled values

| Control Type  | Control Value                        |
|---------------|--------------------------------------|
|               | (Proportional to the Total Setpoint) |
| No regulation | Output proportional to the setpoint  |

Table 5-4. Controlled values (Continued)

## **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.

| Control<br>Type   | Limit  | Loa<br>[ | d Resista<br>Decrease | ance<br>es        | Loa     | d Resista<br>Increase | ance<br>s         | Effe<br>Limitat  | ctive<br>tions <sup>[1]</sup> |
|---|--|----------|-----------------------|-------------------|---------|-----------------------|-------------------|--|-------------------------------|
|   | -  | Р        | U <sub>LOAD</sub>     | I <sub>LOAD</sub> | Р       | U <sub>LOAD</sub>     | I <sub>LOAD</sub> |  |                               |
| U   | U <sub>RMSm</sub><br>ax  | Larger   | =                     | Larger            | Smaller | =                     | Smaller           | I <sub>RMSmax</sub>                                    | P <sub>max</sub>              |
| U <sup>2</sup>  | U <sub>RMSm</sub><br>ax  | Larger   | =                     | Larger            | Smaller | =                     | Smaller           | I <sub>RMSmax</sub>                                    | P <sub>max</sub>              |
| Ι   | I <sub>RMSmax</sub>  | Smaller  | Smaller               | =                 | Larger  | Larger                | =                 | U <sub>RMSm</sub><br>ax                                | P <sub>max</sub>              |
| I <sup>2</sup>  | I <sub>RMSmax</sub>  | Smaller  | Smaller               | =                 | Larger  | Larger                | =                 | U <sub>RMSm</sub><br>ax                                | P <sub>max</sub>              |
| Р   | P <sub>max</sub>   |          | Smaller               | Larger            | =       | Larger                | Smaller           | U <sub>RMSm</sub><br>ax                                | I <sub>RMSmax</sub>           |
| Without<br>control  |  | Larger   | =                     | Larger            | Smaller | =                     | Smaller           | U <sub>RMSm</sub><br><sup>ax</sup><br>P <sub>max</sub> | I <sub>RMSmax</sub>           |
| General m   | General modulation limit $T_s=T_{smax}$<br>$\alpha=\alpha_{max}$ |          |                       |                   |         |                       | x                 |  |                               |
| <sup>1</sup> If one of the limits is exceeded, then the limit relay K2 and the <b>Limit</b> LED react (default values of parameter settings). |  |          |                       |                   |         |                       |                   |  |                               |

Table 5-5. Response to load changes

# 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 can be read via the Thyro-Touch display, or via the Thyro-Tool Pro 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 occurs. 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 software.

| 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                      |

Table 5-6. Minimum and maximum conditions

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

#### **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 of monitoring features in the Main unit (including configurable total 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 5-49. 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 Main 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 Main 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 software

## Errors in dASM Communication

If the dASM communication between units is interrupted, then a new Main 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 Main 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 L10 = 37,500 h. Depending on working conditions, a new fan should be installed after approximately five years.



# Troubleshooting and Technical Support

Before requesting support, perform the recommended checks and the troubleshooting procedures in this chapter. If you are still unable to resolve the issue and resume normal operation of the equipment, contact Technical Support. You can find the contact information for "Technical Support" on page 6-5.

# **Troubleshooting Checklist**

#### **DANGER:**

RISK OF DEATH OR BODILY INJURY. Follow your local jurisdiction requirements for lockout/tagout prior to connecting or disconnecting all input power sources and output connections.

## **DANGER:**

RISQUE DE MORT OU DE BLESSURES. Respectez les exigences de votre juridiction locale en matière de verrouillage/étiquetage avant de connecter ou de déconnecter toutes les sources d'alimentation d'entrée et les connexions de sortie.

## **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.

## **A** 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.

| Troubleshooting<br>Check                                   | Action   |
|--|--|
| Is the green <b>ON</b> /<br><b>READY</b> LED lit?          | If no: The auxiliary 230 VAC or 24 VDC supply is faulty.   |
| Is the red <b>ON</b> /<br><b>READY</b> LED lit?            | If yes: There is an EEPROM fault.  |
| Is the red <b>ON</b> /<br><b>READY</b> LED<br>blinking?    | If yes: The hardware configuration is incorrect.   |
| Is the orange <b>ON</b> /<br><b>READY</b> LED<br>blinking? | If yes: The firmware is being updated.   |
| Is the red <b>LIMIT</b><br>LED lit?                        | If yes: The unit is unable to supply enough power to match<br>the setpoint due to a limiting condition. When an internal<br>protection limit is exceeded, the output is limited but not shut<br>off. |
|  | 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<br>error data that can be viewed using the Thyro-Touch display<br>or the Thyro-Tool Pro software.                                    |
| Are any red<br>CONTROL LEDs<br>lit?                        | If yes: The unit has a fault in the corresponding power section.   |

Table 6-1. Using LED states for troubleshooting

# **Troubleshooting Unit Output**

Use extreme caution when troubleshooting the unit output.

#### **DANGER:**

RISK OF DEATH OR BODILY INJURY. Follow your local jurisdiction requirements for lockout/tagout prior to connecting or disconnecting all input power sources and output connections.

#### 1 DANGER:

RISQUE DE MORT OU DE BLESSURES. Respectez les exigences de votre juridiction locale en matière de verrouillage/étiquetage avant de connecter ou de déconnecter toutes les sources d'alimentation d'entrée et les connexions de sortie.

## **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.

#### **A** 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 Iemax, Uemax, and Pmax are set too small.
- Controller parameters Ti or Kp 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  $100 \Omega$ , 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 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.

# **Technical Support**

For help using or troubleshooting products, contact the Advanced Energy Technical Support Organization (TSO). Proceed as follows:

- 1. Make a note of the serial number (SN) and part number (PN) listed on the product label.
- To contact the TSO by email, address the message to Technical.Support@aei.com. In the body of the email, include the serial number (SN) and part number (PN) of the product and a description of the issue.
- 3. To contact the TSO by telephone, dial +1.866.865.5180 (toll-free in the United States of America).
- To contact the TSO at its business address, write to: AE World Headquarters 1625 Sharp Point Drive Fort Collins, CO 80525 USA

## **Power Control Modules**

For Power Control Module product support, contact by phone or email:

+49 (0) 2902 910370 10 (technical support during German business hours)

mailto:powercontroller@aei.com

# Service, Repairs, and Upgrades

Before returning equipment for service, refurbishment, calibration, upgrade, or repair, obtain a Return Material Authorization (RMA) number. Request an RMA number using one of the methods explained in the following sections.

## Obtaining an RMA Number Using an Existing MyAE Account

For customers who have a MyAE account, proceed as follows:

- 1. Make a note of the serial number (SN) and part number (PN) listed on the product label.
- 2. Go to advancedenergy.com and click MyAE → MyAE Dashboard located at the top of the screen.
- 3. Enter the user credentials and click Log in.
- 4. Click Submit RMA, Submit Multiple RMAs, or Upload RMAs via CSV.
- 5. Follow the instructions to complete the form(s).
- 6. Click the appropriate button(s) to complete the request.

## Obtaining an RMA Number Using the Online Form

To obtain an RMA number using the online form, proceed as follows:

- 1. Make a note of the serial number (SN) and part number (PN) listed on the product label.
- 2. To display the RMA Request Form, go to advancedenergy.com and click **Services** located at the top of the screen.
- 3. On the Services screen, click Submit an RMA Form.
- 4. Follow the instructions to complete the form, and then click **Submit**. Required fields are marked with asterisks.

A Technical Support representative will respond with an RMA number and shipping instructions.

## Obtaining an RMA Number by Email

To obtain an RMA number by email, proceed as follows:

- 1. Make a note of the serial number (SN) and part number (PN) listed on the product label.
- 2. Address an email to TECHSUPPORT@aei.com.
- 3. In the email subject line, include "RMA request", followed by the product serial number (SN) found on the product label. If there is prepopulated information in the subject line, replace it.
- 4. In the body of the email, include the serial number (SN) and part number (PN) found on the product label and a description of the reason for returning the equipment.

## Obtaining an RMA Number by Telephone

To obtain an RMA by telephone, proceed as follows:

- 1. Make a note of the serial number (SN) and part number (PN) listed on the product label.
- 2. Dial +1.866.865.5180 (toll-free in the United States of America).

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