Thyro-A+® Power Controller

User Manual

September 2020 57010220-00B

COPYRIGHT

This manual and the information contained herein are the proprietary property of Advanced Energy Industries, Inc.

No part of this manual may be reproduced or copied without the express written permission of Advanced Energy Industries, Inc. Any unauthorized use of this manual or its contents is strictly prohibited. Copyright © 2019 - 2020 Advanced Energy Industries, Inc. All Rights Reserved.

DISCLAIMER AND LIMITATION OF LIABILITY

The information contained in this manual is subject to change by Advanced Energy Industries, Inc. without prior notice. Advanced Energy Industries, Inc. makes no warranty of any kind whatsoever, either expressed or implied, with respect to the information contained herein. Advanced Energy Industries, Inc. shall not be liable in damages, of whatever kind, as a result of the reliance on or use of the information contained herein.

PRODUCT USAGE STATEMENT

WARNING:

Read this entire manual and all other publications pertaining to the work to be performed before you install, operate, or maintain this equipment. Practice all plant and product safety instructions and precautions. Failure to follow instructions can cause personal injury and/or property damage. If the equipment is used in a manner not specified by the manufacturer, the protection provided by the equipment might be impaired. All personnel who work with or who are exposed to this equipment must take precautions to protect themselves against serious or possibly fatal bodily injury.

Advanced Energy Industries, Inc., (AE) provides information on its products and associated hazards, but it assumes no responsibility for the after-sale operation of the equipment or the safety practices of the owner or user. NEVER DEFEAT INTERLOCKS OR GROUNDS.

AVERTISSEMENT:

Lire ce manuel au complet ainsi que toutes les autres publications portant sur le travail à effectuer avant d'installer, d'utiliser ou d'entretenir cet équipement. Suivre toutes les consignes de sécurité et appliquer toutes les mesures de précautions de l'usine et du produit. Ne pas suivre ces consignes peut entraîner des blessures corporelles et/ou des dommages matériels. Si l'équipement est utilisé de manière non spécifiée par le fabricant, la protection fournie par l'équipement peut être compromise. Tous les membres du personnel travaillant sur cet équipement ou qui y sont exposés doivent prendre des mesures de précaution pour se protéger contre des blessures graves, voire mortelles.

Advanced Energy Industries, Inc. (AE) fournit des renseignements sur ses produits et les dangers qui y sont liés, mais elle ne peut être tenue responsable du fonctionnement après-vente de l'équipement ou des pratiques de sécurité du propriétaire ou de l'utilisateur. NE JAMAIS METTRE EN ÉCHEC OU CONTOURNER LES DISPOSITIFS DE PROTECTION DE VERROUILLAGE OU DE MISE À LA TERRE.

TRADEMARKS

All Advanced Energy trademarks are the property of Advanced Energy Industries, Inc. For the list of Advanced Energy trademarks, visit: http://www.advanced-energy.com/en/Trademarks.html. Any unauthorized use of Advanced Energy trademarks is prohibited.

All other trademarks are the property of their respective owners.

CUSTOMER FEEDBACK

Advanced Energy's technical writing staff has carefully developed this manual using research-based document design principles. However, improvement is ongoing, and the writing staff welcomes and appreciates customer feedback. Please send any comments on the content, organization, or format of this user manual to:

- tech.writing@aei.com

To order a manual, please contact Technical Support:

- technical.support@aei.com

Table of Contents

Chapter 1. Safety and Product Compliance Guidelines

Important Safety Information 1-1
Danger, Warning, and Caution Boxes 1-1
Safety Guidelines 1-2
    Rules for Safe Installation and Operation 1-2
Interpreting Product Labels 1-2
Product Compliance 1-4
    Product Certification 1-4
    Safety and EMC Directives and Standards 1-5
    Conditions of Use 1-5
    UL Markings and Requirements 1-5
    Environmental Compliance 1-6
Interlocks and Limiting Conditions 1-7

Chapter 2. Product Overview

General Description 2-1
Unit Features 2-1

Chapter 3. Specifications

Physical Specifications 3-1
Electrical Specifications 3-3
Cooling Specifications 3-5
Environmental Specifications 3-7
Type Designation 3-8
    Validity 3-8
    Type Code 3-8

Chapter 4. Communication Controls

Controls and Indicators 4-1
    Status Indicators (LEDs) 4-1
    Relay Indicator 4-3
Analog and Digital I/O 4-4
Thyro-A+ Display 4-6
Software User Interface 4-7

Chapter 5. Installation, Setup, and Operation

Preparing to Install the Unit 5-1
Spacing Requirements 5-1
Dimensional Drawings 5-1
Installation Requirements 5-8
Unpacking the Unit 5-9
Lifting the Unit 5-9
Installing the Unit 5-9
Mounting the Unit 5-9
Grounding 5-10
Connecting I/O and Auxiliary Connectors 5-10
Connecting Load and Auxiliary Power 5-11
Connection Diagrams 5-13
First Time Operation 5-17
Normal Operation 5-17
Operating Modes 5-18
Full-Wave Switch (TAKT) 5-18
Phase-Angle Firing (VAR) 5-18
Half-Wave Switch QTM (Quick TAKT Mode) 5-18
Switch Mode (SWITCH) 5-19
Setpoint Control 5-19
Switch Mode Setpoint 5-19
Control Types 5-20
Controlled Value 5-20
Control Characteristic Curves 5-20
Controller Response 5-21
Monitoring 5-22
Mains Voltage Monitoring 5-22
Device Temperature and Fan Monitoring 5-23
Monitoring Parallel Loads 5-23
Thyro-A+ 1A and Thyro-A+ 2A With Separate Star Point 5-24
Thyro-A+ 2A With Star and Delta Loads 5-25
Thyro-A+ 3A With Star and Delta Loads 5-27
Extended Functions 5-30
Extended Operating Modes/Circuit Types 5-30
Analog Output Averaging 5-30
Control Limits 5-30
Controller Parameters 5-31
Mains Load Optimization 5-31
Mains Load Optimization 5-31
Internal Mains Load Optimization 5-32
Synchronization With Optional Thyro-Power Manager Accessory 5-32
Basic Bus Module 5-32
Maintenance 5-33
Fan Maintenance 5-33

Chapter 6. Troubleshooting and Global Services

Troubleshooting Checklist 6-1

AE Global Services 6-4
Primary Contact Information 6-4
Alternate Contact Information 6-4
Returning Units for Repair 6-4

List of Tables

Table 1-1. Transient surge suppression device ratings 1-6
Table 1-2. Interlocks and limiting conditions 1-8
Table 3-1. Physical specifications 3-1
Table 3-2. Type range 230 V, 400 V, 500 V 3-2
Table 3-3. Terminal size 3-2
Table 3-4. Electrical specifications 3-3
Table 3-5. Standard voltage range 3-4
Table 3-6. Model-specific specifications 3-4
Table 3-7. Current derating 3-6
Table 3-8. Fan current, air volume, and sound pressure 3-6
Table 3-9. Environmental standard specifications 3-7
Table 3-10. Climatic specifications 3-7
Table 3-11. Type designation 3-9
Table 4-1. Thyro-A+ status LEDs 4-2
Table 4-2. LED blink codes 4-3
Table 4-3. AC phase connection (X1) 4-5
Table 4-4. AC phase connection (X10) (present only on some 3-phase units) 4-5
Table 4-5. AC/DC auxiliary power input (X11) 4-5
Table 4-6. 11-pin analog I/O connector (X2) 4-5
Table 4-7. 7-pin bus module connector (X22) 4-6
Table 4-8. Relay K1 connectors (X3) 4-6
Table 5-1. Terminal screw size 5-12
Table 5-2. Terminal screw torque 5-13
Table 5-3. Control modes 5-20
Table 5-4. Response to load changes 5-22
Table 5-5. Limit values for mains voltage monitoring 5-23
Table 5-6. Load with separate star point and without neutral conductor 5-24
Table 5-7. Load with common star point and without neutral conductor 5-25
Table 5-8. Load in delta connection 5-26
Table 5-9. Load with common star point and without neutral conductor 5-27
Table 5-10. Load in delta connection 5-28
Table 5-11. Other possibilities of load monitoring 5-29
Table 6-1. Using LED states for troubleshooting 6-2

List of Figures

Figure 3-1. Current derating 3-6
Figure 4-1. Total setpoint 4-1
Figure 4-2. Status LEDs 4-2
Figure 4-3. Front I/O connector 4-4
Figure 4-4. Bottom connectors 4-5
Figure 4-5. Thyro-A+ display 4-7
Figure 5-1. Thyro-A+ 1A 16 H, 30 H 5-1
Figure 5-2. Thyro-A+ 1A 45 H, 60 H 5-2
Figure 5-3. Thyro-A+ 1A 100 H 5-2
Figure 5-4. Thyro-A+ 1A 130 H, 170 H 5-2
Figure 5-5. Thyro-A+ 1A 280 HF 5-3
Figure 5-6. Thyro-A+ 2A 16 H, 30 H 5-3
Figure 5-7. Thyro-A+ 2A 45 H, 60 H 5-4
Figure 5-8. Thyro-A+ 2A 100 H 5-4
Figure 5-9. Thyro-A+ 2A A 130 H, 170 H 5-5
Figure 5-10. Thyro-A+ 2A 280 HF 5-5
Figure 5-11. Thyro-A+ 3A 16 H, 30 H 5-6
Figure 5-12. Thyro-A+ 3A 45 H, 60 H 5-6
Figure 5-13. Thyro-A+ 3A 100 H 5-7
Figure 5-14. Thyro-A+ 3A 130 H, 170 H 5-7
Figure 5-15. Thyro-A+ 3A 280 HF 5-8
Figure 5-16. 1A power controller connections 5-14
Figure 5-17. 2A power controller connections 5-15
Figure 5-18. 3A power controller connections 5-16
Figure 5-19. TAKT waveform 5-18
Figure 5-20. VAR waveform 5-18
Figure 5-21. QTM waveform 5-18
Figure 5-22. Setpoint inputs 5-19
Figure 5-23. U control 5-21
Figure 5-24. I control 5-21
Figure 5-25. P control 5-21
Figure 5-26. Load with separate star point and without neutral conductor 5-24
Figure 5-27. Load with common star point and without neutral conductor 5-25
Figure 5-28. Load in delta connection 5-26
Figure 5-29. Load with common star point and without neutral conductor 5-27
Figure 5-30. Load in delta connection 5-28
Figure 5-31. Other possibilities of load monitoring 5-29
Figure 5-32. Basic Bus Module 5-33

Safety and Product Compliance Guidelines

IMPORTANT SAFETY INFORMATION

To ensure safe installation and operation of the Advanced Energy Thyro-A+ 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.

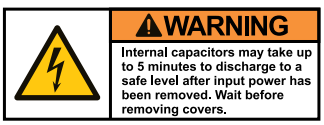
Rules for Safe Installation and Operation

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 your unit:



Capacitor discharge warning (5 minutes)

CE label

or

Complies with applicable European directives.

Protective conductor terminal

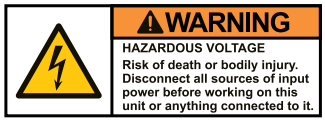
This terminal must be connected first and be of proper type and size for the circuit with the highest voltage and current carrying capacity. Note that other connections might have higher requirements than that of the mains connection.

On or off

or

Phase

Power on/standby



Hazardous voltage

Hazardous voltage

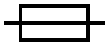
Voltage > 30 V_{RMS}, 42.4 V peak, or 60 VDC

Hot surface

No user-serviceable parts

European Union RoHS compliant

Refer to manual for more information

	Short-circuit protected
	Environmentally Friendly Use Period of 25 years per China RoHS—recycle responsibly at end of life
	Electrocution hazard
	Heavy object—can cause muscle strain or back injury
	Heavy object—do not lift manually
	Electrical fuse
	Alternating current
	Direct current
	UL® Listed to Canadian and United States safety standards
	UL Listed to United States safety standards
	UL Recognized to Canadian and United States safety standards
	UL Recognized to United States safety standards

PRODUCT COMPLIANCE

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

Product Certification

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

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

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

Safety and EMC Directives and Standards

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

Conditions of Use

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

- Before making any other connection to this product, connect the primary Protective Earth (ground), and secondary Protective Earth (ground) if applicable, to a local earth ground using wire that is sized according to the applicable requirements.
- Install and operate this unit in an overvoltage category according to environmental specifications.
- You must install and operate this unit with a 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 5-11.
- Use 75°C copper conductors for power circuits.

- 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® 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.

Table 1-1. Transient surge suppression device ratings

Supply Voltage	Phase to Ground Voltage	Phase to Phase Voltage	Impulse Withstand Voltage Peak
Corner Ground Sources			
115 V	120 V	120 V	2.5 kV
230 V	230 V	230 V	4 kV
400 V	400 V	400 V	6 kV
500 V	500 V	500 V	6 kV
Grounded Wye Sources			
115 V	70 V	120 V	1.5 kV
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

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 Interlock is Open
By opening the *PULSE LOCK* jumper the unit is locked.	Opening the *PULSE LOCK* jumper or external interlock circuit Terminal X2.1 connected to terminal X2.2	The red **PULSE LOCK** LED on the front panel is blinking. The output is disabled.

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

Product Overview

GENERAL DESCRIPTION

The Thyro-A+ power controller is a communication-capable thyristor power controller. It can be used wherever alternating voltages, alternating currents or outputs in thermal process technology need to be controlled. The Thyro-A+ power controller has several different control and regulation modes, can easily be connected to process and automation technology, has a high degree of control accuracy and is simple to handle.

UNIT FEATURES

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

- Integrated semiconductor fuse
- Type range 230 V to 500 V, 16 A to 280 A, 1-phase, 2-phase, and 3-phase
- Resistive load and transformer load in operating mode VAR
- Soft start function for transformer load
- Channel separation, necessary with countervoltage
- Control modes P, I, I^2, U, U^2
- Operating modes TAKT, VAR
- Operating mode QTM (with Thyro-A+ 1A)
- Synchronization option, available for the following operating modes:
  - TAKT with optional Thyro-Power Manager
  - QTM with internal mains load optimization
- Control with analog setpoint, via PC using optional Thyro-Tool Pro software, or with an optional bus module
- Micro USB system interface
- Safe isolation in accordance with EN 62477-1
- External auxiliary power supply input, allowing operation with mains voltages up to 0.43 x U_{nom}
- Load with high R_{warm} /R_{cold} (≤ 6), peak current limitation of 3 x I_{nom}
- Load current monitoring
- Signaling relay

- Analog output
- Modbus® RTU using included RS-485 interface

Options include:

- Thyro-Tool Pro computer user interface
- Thyro-A+ display
- Bus connection via bus adapters for:
  - PROFIBUS
  - PROFINET
  - Ethernet/IP™
  - Modbus RTU
  - Other bus systems on request

Specifications

PHYSICAL SPECIFICATIONS

Table 3-1. Physical specifications

Description	Specification
General Physical Specifications	
Size	See Table 3-2
Weight	
Mounting	
Mechanical	Mounting hardware not included
Connectors	
AC phase connection (**X1**)	Included 2-pin plug-in screw terminal block, 0.2 mm^2 - 2.5 mm^2 (24 AWG - 12 AWG)
USB (**X5**)	µ USB (connector and cable not included)
Display (**X6**)	Connector for optional Thyro-A+ display.
Analog I/O (**X2**)	Included 11-pin, plug-in, screw terminal block, 0.14 mm^2 - 1.5 mm^2 (30 AWG - 14 AWG)
24 V AC or DC auxiliary power input (**X11**)	Included 2-pin, plug-in, screw terminal block, 0.14 mm^2 - 1.5 mm^2 (30 AWG - 14 AWG)
Relay K1 (**X3**)	Included 3-pin, plug-in, screw terminal block, 0.14 mm^2 - 1.5 mm^2 (30 AWG - 14 AWG)
Bus module (**X22**)	Included 7-pin, plug-in, screw terminal block, 0.14 mm^2 - 1.5 mm^2 (30 AWG - 14 AWG)
Degree of protection	IP10

Table 3-2. Type range 230 V, 400 V, 500 V

Model Type Current (A)	Dimensions (WxHxD) mm (in)			Weight kg (lb)	Dimensional Drawing
Thyro-A+ 1A					
16, 30	45 (1.76)	136 (5.35)	129 (5.08)	0.7 (1.5)	Figure 5-1
45, 60	52 (2.0)	203 (8.0)	184 (7.3)	1.7 (3.7)	Figure 5-2
100	75 (3.0)	203 (8.0)	193 (7.6)	1.7 (3.7)	Figure 5-3
130, 170	125 (4.9)	320 (12.6)	241 (9.5)	4 (8.8)	Figure 5-4
280	125 (4.9)	370 (14.6)	241 (9.5)	5 (11.0)	Figure 5-5
Thyro-A+ 2A					
16, 30	89 (3.5)	136 (5.4)	129 (5.1)	1.4 (3.1)	Figure 5-6
45, 60	104 (4.1)	203 (8.0)	184 (7.3)	3.4 (7.5)	Figure 5-7
100	150 (5.9)	203 (8.0)	193 (7.6)	3.8 (8.4)	Figure 5-8
130, 170	250 (9.8)	320 (12.6)	241 (9.5)	8 (17.6)	Figure 5-9
280	250 (9.8)	393 (15.5)	241 (9.5)	11 (24.3)	Figure 5-10
Thyro-A+ 3A					
16, 30	135 (5.3)	136 (5.4)	129 (5.1)	2.1 (4.6)	Figure 5-11
45, 60	156 (6.1)	203 (8.0)	184 (7.3)	5.1 (11.2)	Figure 5-12
100	225 (8.9)	203 (8.0)	193 (7.6)	5.7 (12.5)	Figure 5-13
130, 170	375 (14.8)	320 (12.6)	241 (9.5)	12 (26.5)	Figure 5-14
280	375 (14.8)	393 (15.5)	241 (9.5)	15 (33.1)	Figure 5-15

Use 75°C copper conductors in UL applications.

Table 3-3. Terminal size

Type Current	AC Connection Screw Size	Ground Screw Size	Conductor Area	Wire Gauge
16 A, 30 A	Lug or M4	Lug or M4	6 mm^2	10 AWG
45 A, 60 A, 100 A	M6	M6 maximum	50 mm^2	0 (1/0) AWG
130 A, 170 A	M8	M10	95/120 mm^2	0000 (4/0) AWG
280 A	M10	M10	150/185 mm^2	

ELECTRICAL SPECIFICATIONS

Table 3-4. Electrical specifications

Description	Specification
Electrical Requirements	
AC input voltage	Type HRL4, HRLP4: 230 V, 400 V, 500 V –57% to +10% See Table 3-5.
24 V auxiliary power supply input	24 VAC +10% /-20% 24 VDC +18 V to +32 V The auxiliary voltage supply can be AC or DC (2 W per device/5 VA/not grounded) ☞ **Important** The 24 V auxiliary power supply is required for all installations.
Fan input voltage (type designation F)	230 V, 50/60 Hz, 115 V fans are available special order for some units. For fan current and current derating see "Cooling Specifications" on page 3-5
AC line frequency	50/60 Hz nominal; 47 Hz to 63 Hz range
AC current Rated power Dissipation Semiconductor fuse	See Table 3-6.
Ground connection	Chassis ground near AC connector suitable for ring lug connection
Load description	Resistive load (minimum 100 W) Resistive load R_{warm}/R_{cold} ratio up to 6 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.
Setpoint inputs	0(4) mA - 20 mA Ri = 250 Ω / max 24 mA. Max open-circuit voltage = 24 V 0(1) V - 5 V Ri = 44 kΩ / max 12 V 0(2) V - 10 V Ri = 88 kΩ / max 12 V

Table 3-4. Electrical specifications (Continued)

Description	Specification
Analog outputs	Signal level 0 V - 10 V, 0 mA - 20 mA or 4 mA - 20 mA. The maximum burden voltage is 10 V.
Precision	U-control: Better than ± 1.5% (only valid from -15% to +10% of the type voltage) I-Control: ± 1.5% P-Control: Better than ± 3% [1] All specifications are relating to the respective final value.
Limitations	Voltage limitation U_{rms} Current limitation I^{rms} = default setting Effective power limitation P Peak current limitation
Relay	AC max: 250 V/6 A (1500 VA) AC min: >10 VA DC max: 300 V/0.25 A (62.5 W) DC min : 5 V/20 mA Contact material: AgCdO With UL applications AC max: 250 V/4 A
[1] Type HRLP4 only.	

Table 3-5. Standard voltage range

Type Voltage	Range	Voltage Range
230 V	–57% to +10%	99 V < U mains ≤ 253 V
400 V	–57% to +10%	172 V < U mains ≤ 440 V
500 V	–57% to +10%	215 V < U mains ≤ 550 V

Table 3-6. Model-specific specifications

Current (A)	Type Power (kW)			Dissipation	Fuse
	230 V	400 V	500 V	(W)	(A)
Thyro-A+ 1A ... HRL4, HRLP4					
16	3.7	6.4	8	30	20
30	6.9	12	15	47	40
45	10	18	22.5	52	63

Table 3-6. Model-specific specifications (Continued)

Current (A)	Type Power (kW)			Dissipation (W)	Fuse (A)
	230 V	400 V	500 V		
60	14	24	30	80	80
100	23	40	50	105	200
130	30	52	65	150	200
170	39	68	85	210	315
280	64	112	140	330	350
Thyro-A+ 2A ... HRL4, HRLP4					
16		11	14	60	20
30		21	26	94	40
45		31	39	96	63
60		42	52	160	80
100		69	87	210	200
130		90	112	300	200
170		118	147	420	315
280		194	242	660	350
Thyro-A+ 3A ... HRL4, HRLP4					
16		11	14	90	20
30		21	26	141	40
45		31	39	144	63
60		42	52	240	80
100		69	87	315	200
130		90	112	450	200
170		118	147	630	315
280		194	242	990	350

COOLING SPECIFICATIONS

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

Table 3-7. Current derating

Air Temperature	$I/I_{RATED\ CURRENT}$ (A)	
	Self Cooling	Forced Cooling
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)		

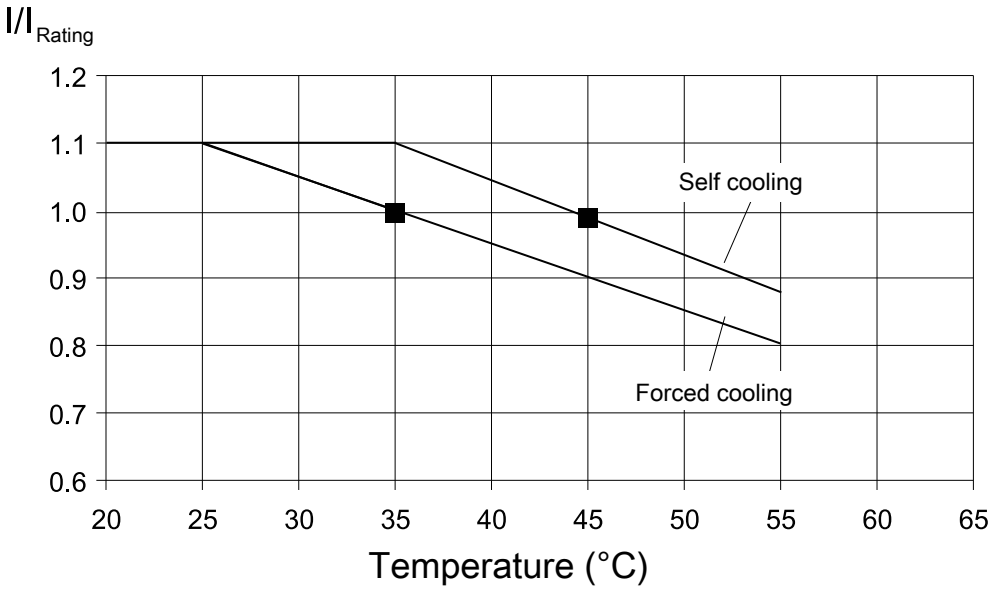


Figure 3-1. Current derating

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

Model	Current (A) [1]		Air Volume	Sound Pressure
	50 Hz	60 Hz	(m^3/h)	(dbA @ 1 m)
1A				
280 F	0.22	0.22	120	67
2A				
280 F	0.5	0.38	200	70

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

Model	Current (A) [1]		Air Volume	Sound Pressure
	50 Hz	60 Hz	(m^3/h)	(dbA @ 1 m)
3A				
280 F	0.5	0.38	260	70
[1] For 230 V fans.				

ENVIRONMENTAL SPECIFICATIONS

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

Table 3-9. Environmental standard specifications

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

Table 3-10. Climatic specifications

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

Table 3-10. Climatic specifications (Continued)

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

[1] Non-condensing, no formation of ice

[2] 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 Global Services for operating at >+2000 m (+6562′).

[3] 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)

[4] Maximum absolute humidity when the unit temperature directly decreases from +70°C to +15°C (+158°F to +59°F)

TYPE DESIGNATION

Validity

This manual describes the Thyro-A+ power controller series versions HRL4 and HRLP4.

These operating instructions comply with the current technical specifications of the device at the time of publication. The contents do not constitute a subject matter of the contract, but serve for information purposes only.

AE reserves the right to alter any specifications given in this manual, especially with regard to technical data, operation, weights, and dimensions. Advanced Energy reserves the right to make modifications with regard to the content and technical data in these operating instructions.

Type Code

The type designation of the thyristor-power controller is derived from the configuration of the power unit as well as from other features.

Thyro-A+ 1A

Thyristor controller with 1-phase power unit, suited for 1-phase loads in operating modes TAKT, VAR, and QTM.

Thyro-A+ 2A

Thyristor controller with 2-phase power unit, suited for symmetrical loads in 3-phase operation in 3-phase economical circuit in operating mode TAKT. The unit calculates the values of load current on phase L2, based on the measured values of phase L1 and L3.

Thyro-A+ 3A

Thyristor controller with 3-phase power unit, suited for 3-phase loads in operating modes TAKT and VAR.

Table 3-11. Type designation

Type range	Designation	Features
Thyro-A+	1A	1-phase power section, for 1-phase operation
	2A	2-phase power section used with a 3-phase load in 3-phase economic circuit (not for phase-angle firing VAR)
	3A	3-phase power section, for 3-phase operation
	... 400-	With 400 V type voltage
	... 280	With 280 A type current
	H	With integrated semiconductor fuse
	F	With fan
	R	With signaling relay
	L	With load monitoring
	P	With power measurement and control
	4	Upgraded Thyro-A+ series

Thyro-A+ ... HRLP4

Thyristor power controller with integrated semiconductor fuse, system bus interface, additional 24 VDC/AC electronic power supply, signaling relay, load monitoring and analog output, channel separation, synchronization option, and control modes U, U^2, I, I^2, and P. The power controller is suitable for visualization and commissioning software using the Thyro-Tool Pro software.

Communication Controls

CONTROLS AND INDICATORS

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

The setpoint control characteristics of the Thyro-A+ power controller can 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.

- Setpoint 1: (X2.4 to X2.3 ground) 0 mA to 20 mA default, configurable as 4 mA to 20 mA, 0(1) V to 5 V, or 0(2) V to 10 V
- Setpoint 2: Setpoint of the superordinate system or PC via either USB or the optional bus interface

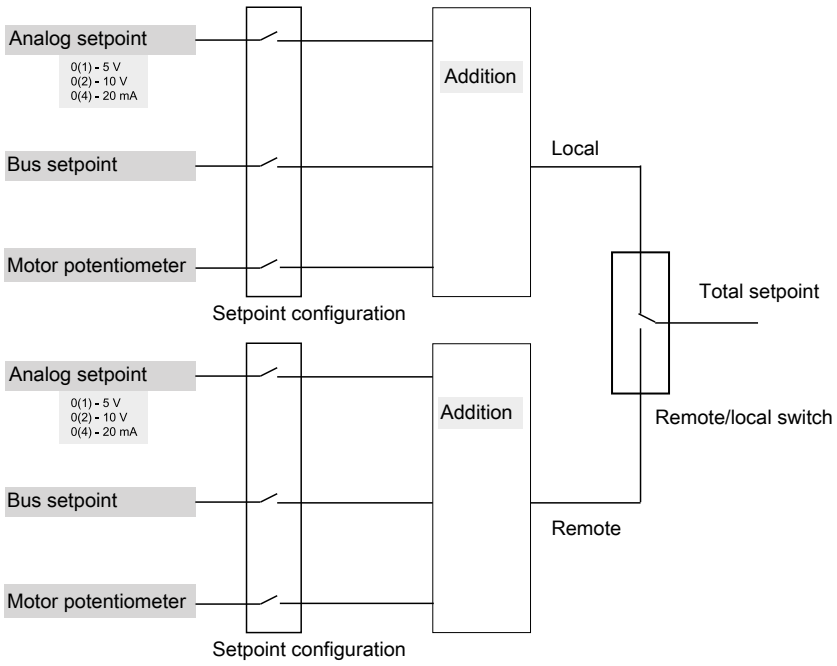


Figure 4-1. Total setpoint

The setpoint input is selected by configuring terminal X22.1. Setpoint 2 is selected when X22.1 is grounded, setpoint 1 is selected when X22.1 is ungrounded.

Status Indicators (LEDs)

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

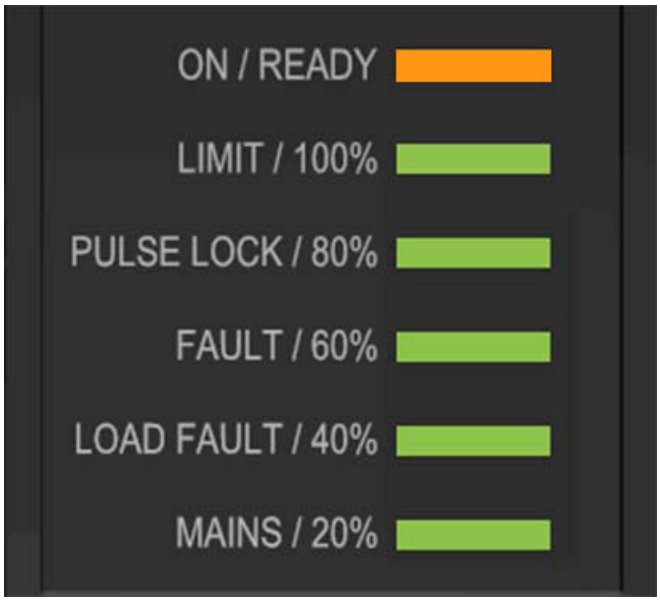


Figure 4-2. Status LEDs

Table 4-1. Thyro-A+ status LEDs

LED	Status
ON / READY	Orange: On, ready for operation Red: On, not ready for operation, check other LEDs Off: No power, hardware fault
LIMIT / 100%	Red blinking: Limitation is active, see following table Green: Output is at 100%
PULSE LOCK / 80%	Red blinking: Pulse lock active, see following table Green: Output is at 80%
FAULT / 60%	Red blinking: Fault present, see following table Green: Output is at 60%
LOAD FAULT / 40%	Red blinking: Load fault, see following table Green: Output is at 40%
MAINS / 20%	Red blinking: Mains fault, see following table Green: Output is at 20%

Red fault LEDs also signal the type of fault using a blink code, as shown in the following table.

Table 4-2. LED blink codes

Fault LED	Blink Number			
	1	2	3	4
LIMIT / 100%	Voltage limit	Current limit	Power limit	
PULSE LOCK / 80%	Jumper open, or other condition causing pulse lock			
FAULT / 60%	Master/slave fault	Flash memory fault or configuration fault	Temperature fault	Thyristor short circuit
LOAD FAULT / 40%	Load voltage out of limits	Load current out of limits	Load power out of limits	Load fault
MAINS / 20%	Overvoltage	Undervoltage	Phase sequence/phase fault	Frequency/sync

Relay Indicator

Errors and faults are indicated by the status LEDs, the optional fault and limit relay, and the optional bus interface. The presence of the optional relay is indicated by the letter **R** in the type code.

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, check the LED blink code, or check the fault register using the bus interface.

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

Fault signaling relay K1 has a changeover contact. Messages that cause the fault signaling relay to switch can be set with Thyro-Tool Pro software. In the default state, fault signaling relay K1 functions on the closed circuit principle.

In the event of the following errors, the fault signaling relay de-energizes and the power controller switches off:

- SYNC error
- Internal error
- Undervoltage in the mains
- Master/slave error
- Error rotating field/phase
- Overtemperature

In the event of the following error, the fault signaling relay de-energizes, the power controller remains on, and the **LOAD FAULT** LED blinks:

- Undercurrent in the load circuit

ANALOG AND DIGITAL I/O

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

- µUSB connector X5, for configuration using a PC
- Display connector X6 (under a removable cover)

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

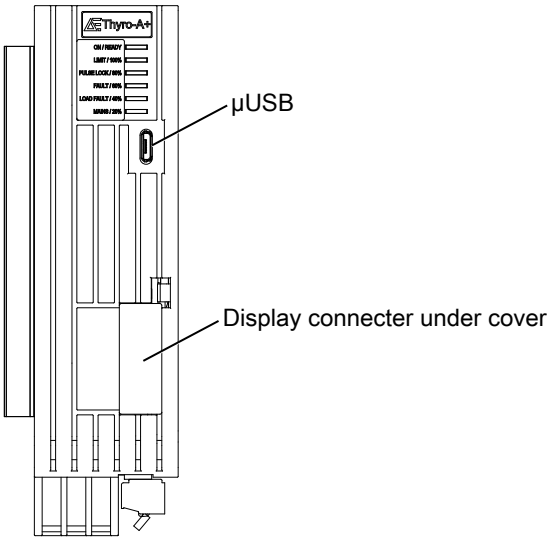
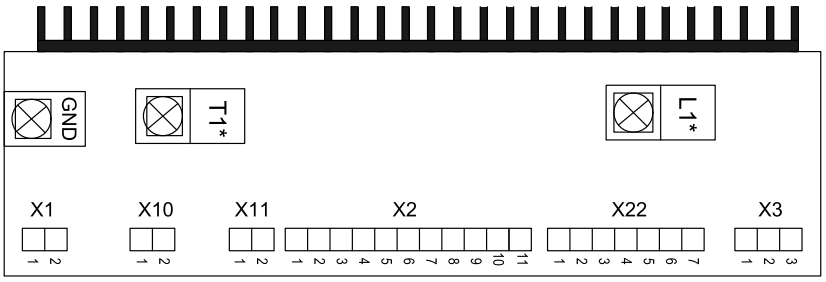


Figure 4-3. Front I/O connector

The unit has six connectors on the bottom of the unit:

- AC phase connection **X1**
- AC phase connection **X10** (present only on some 3-phase units)
- 24 V auxiliary power input **X11**
- Analog I/O connector **X2**
- Bus module connector **X22**
- Fault relay K1 connector **X3**



*For units < 45 A, L1 is labeled 1, T1 is labeled 2

Figure 4-4. Bottom connectors

Important

All digital and analog control cables must be shielded. Connect the cable shields to the shield terminal on the unit.

Table 4-3. AC phase connection (X1)

Pin	Function
X1.1	For 1-phase and 2-phase units, add L2 or N connection according to the connection diagram (see "Connection Diagrams" on page 5-13). Do not alter the factory wiring.
X1.2	For 1-phase and 2-phase units, add L2 or N connection according to the connection diagram (see "Connection Diagrams" on page 5-13). Do not alter the factory wiring.

Table 4-4. AC phase connection (X10) (present only on some 3-phase units)

Pin	Function
X10.1	Factory wired, do not alter
X10.2	Factory wired, do not alter

Table 4-5. AC/DC auxiliary power input (X11)

Pin	Function
X11.1	24 VAC or +24 VDC (required connection)
X11.2	24 VAC or –24 VDC (required connection)

Table 4-6. 11-pin analog I/O connector (X2)

Pin	Function
X2.1	Control ground
X2.2	Pulse lock
X2.3	Control ground
X2.4	Analog setpoint, 10 V maximum or 20 mA maximum

Table 4-6. 11-pin analog I/O connector (X2) (Continued)

Pin	Function
X2.5	Control ground
X2.6	Sync out
X2.7	Sync in
X2.8	+5 V
X2.9	Analog output (setpoint potentiometer power 0 V to 10 V, or 0 (4) mA to 20 mA)
X2.10	Control cable shield
X2.11	Feedback input 0 (4) mA to 20 mA

Table 4-7. 7-pin bus module connector (X22)

Pin	Function
X22.1	Bus module detection/setpoint selection
X22.2	TxD
X22.3	RxD
X22.4	Control ground
X22.5	Slave connection
X22.6	Slave connection
X22.7	Control ground

Table 4-8. Relay K1 connectors (X3)

Pin	Function
X3.1	Common
X3.2	Normally open
X3.3	Normally closed

Related Links

- “Connecting I/O and Auxiliary Connectors” on page 5-10

THYRO-A+ DISPLAY

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

Figure 4-5. Thyro-A+ display

In addition to simplifying the handling of the Thyro-A+ power controller, the Thyro-A+ 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-A+ display includes an SD® memory card.

The Thyro-A+ power controller provides a communications interface through the **X6** port. This interface allows you to monitor and control the unit through the display. The display features include:

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

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.

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.

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-A+ unit dimensions, front, and side views.

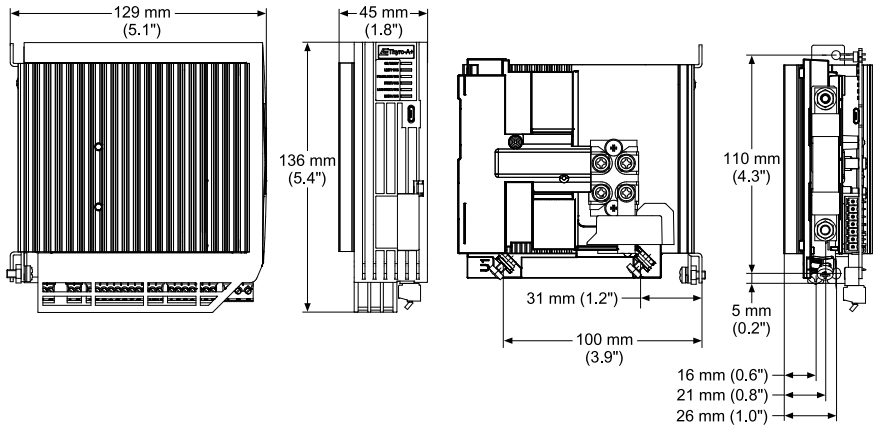


Figure 5-1. *Thyro-A+ 1A 16 H, 30 H*

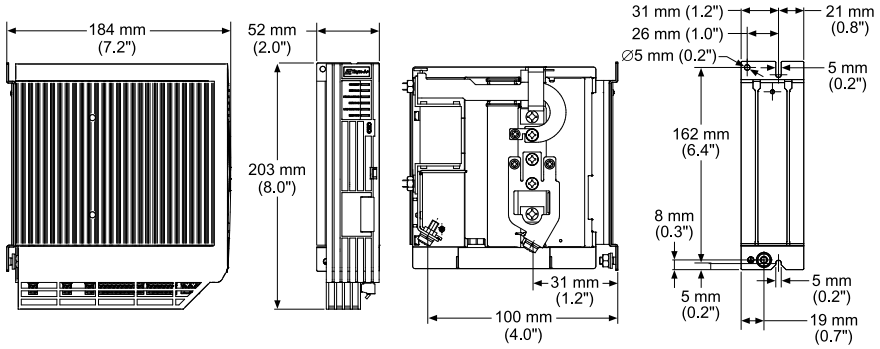


Figure 5-2. *Thyro-A+ 1A 45 H, 60 H*

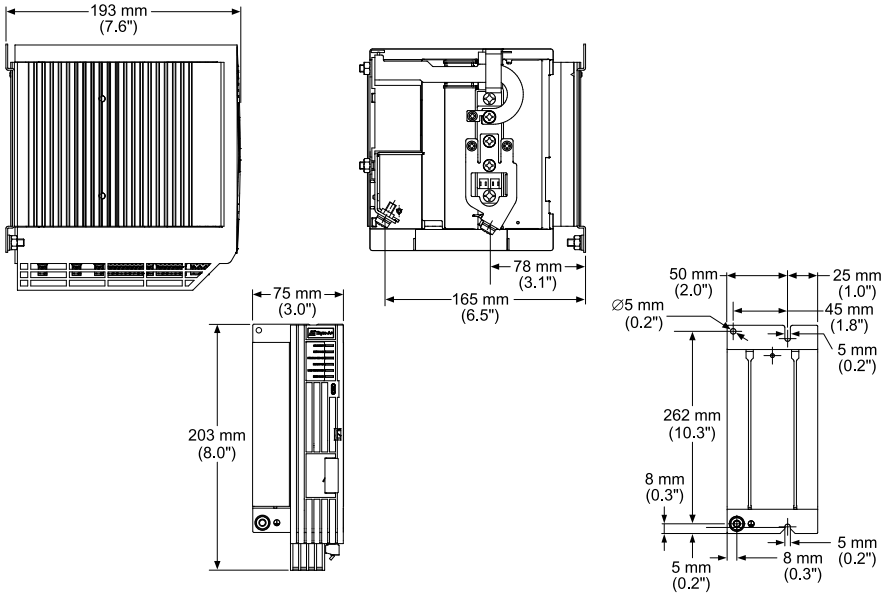


Figure 5-3. *Thyro-A+ 1A 100 H*

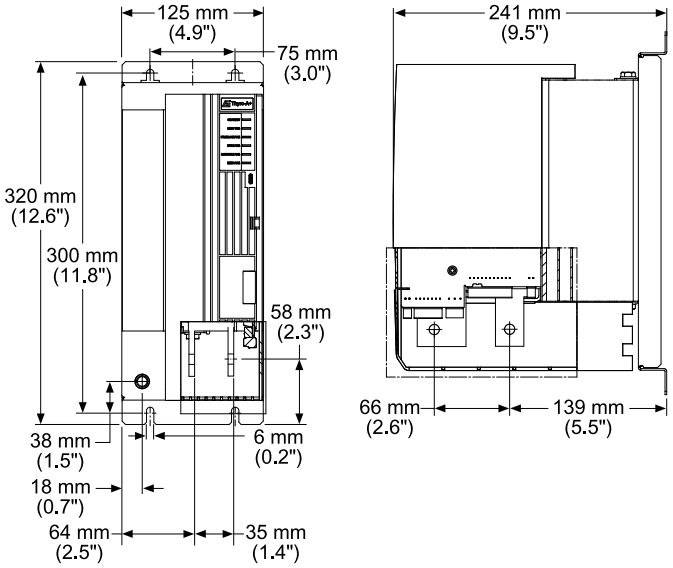


Figure 5-4. *Thyro-A+ 1A 130 H, 170 H*

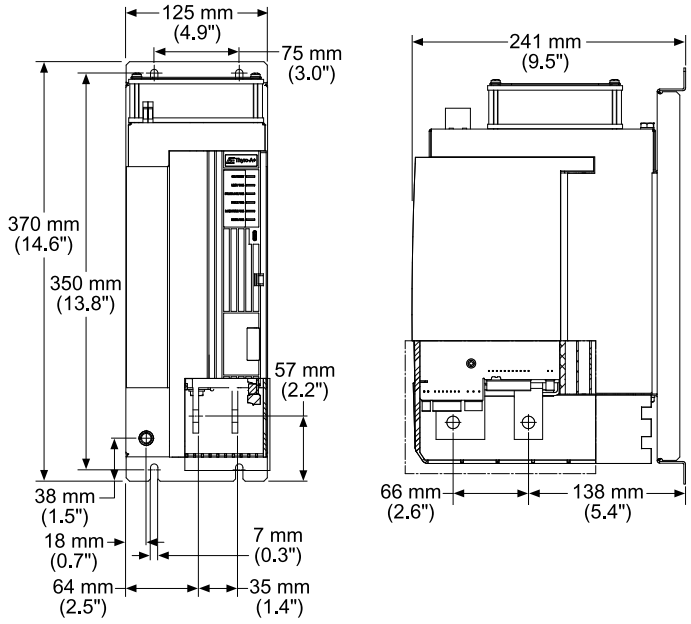


Figure 5-5. *Thyro-A+ 1A 280 HF*

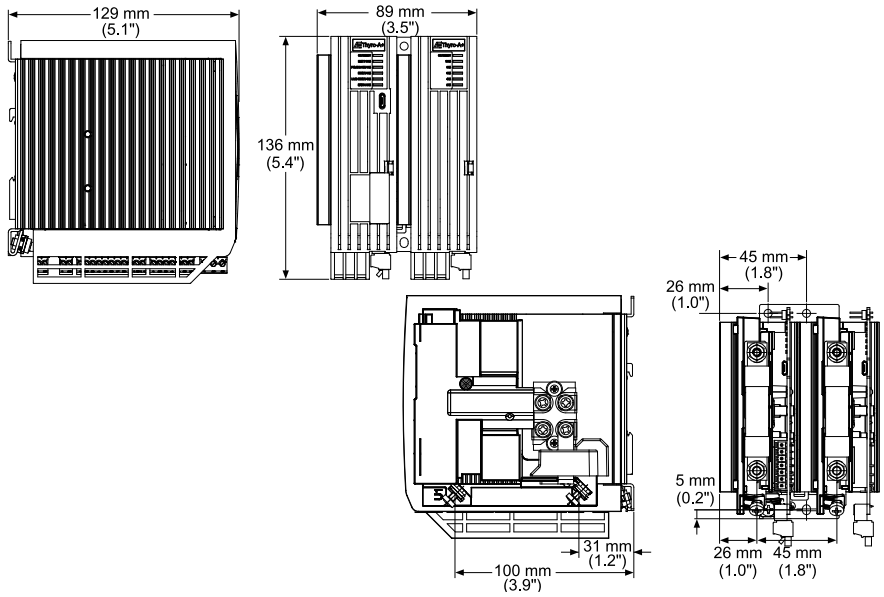


Figure 5-6. *Thyro-A+ 2A 16 H, 30 H*

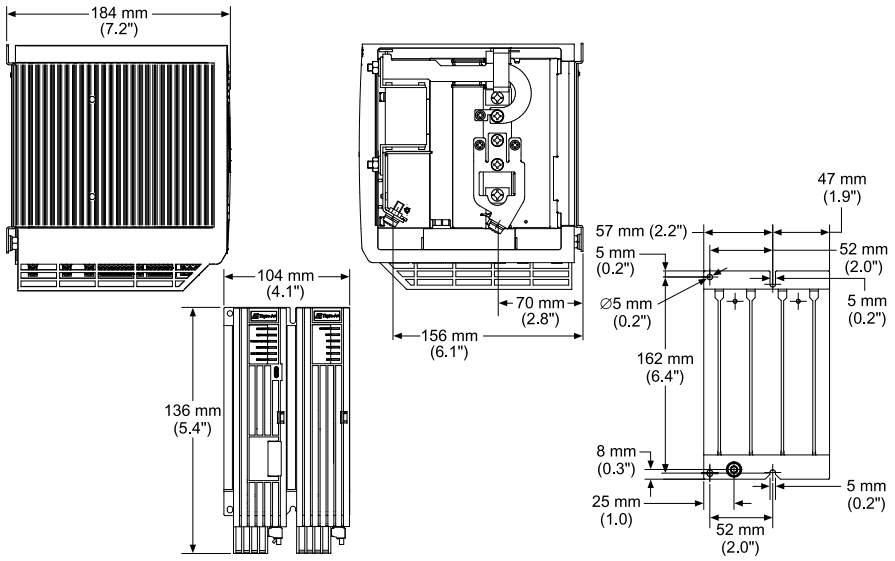


Figure 5-7. *Thyro-A+ 2A 45 H, 60 H*

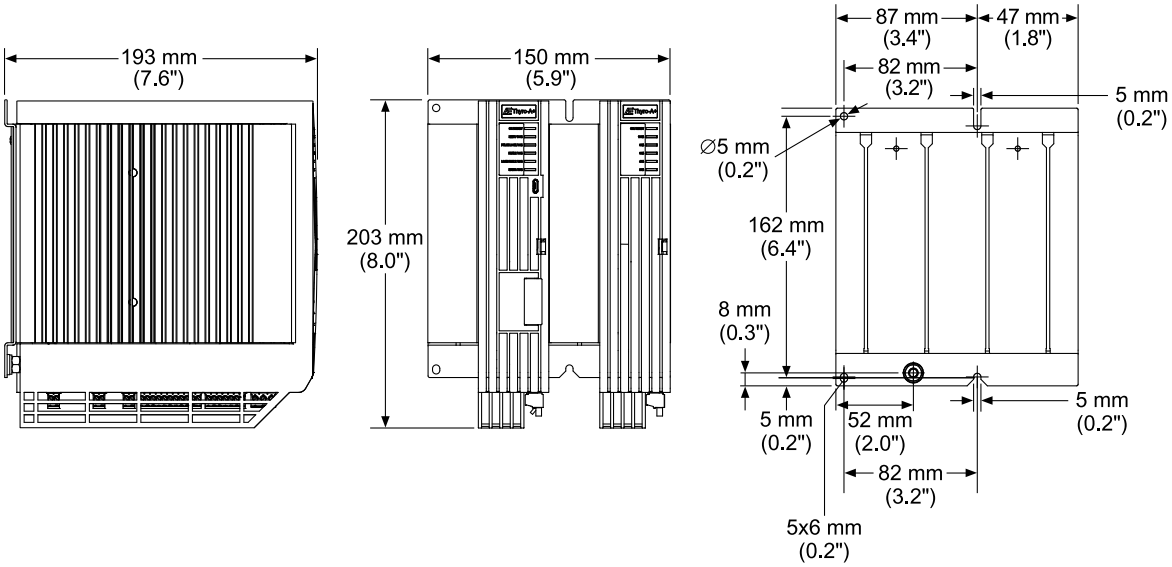


Figure 5-8. *Thyro-A+ 2A 100 H*

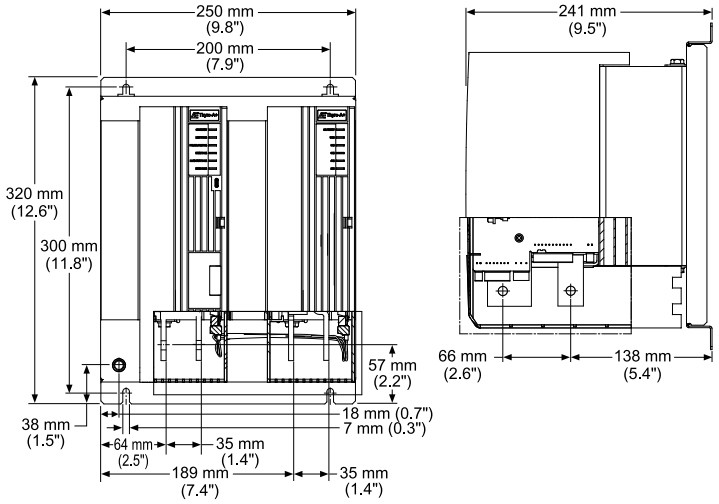


Figure 5-9. *Thyro-A+ 2A A 130 H, 170 H*

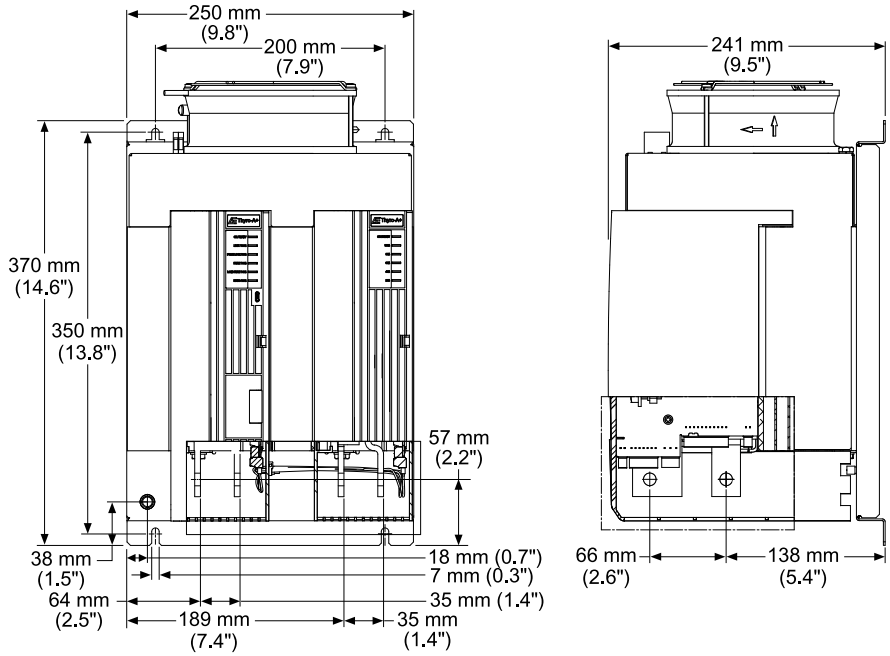


Figure 5-10. *Thyro-A+ 2A 280 HF*

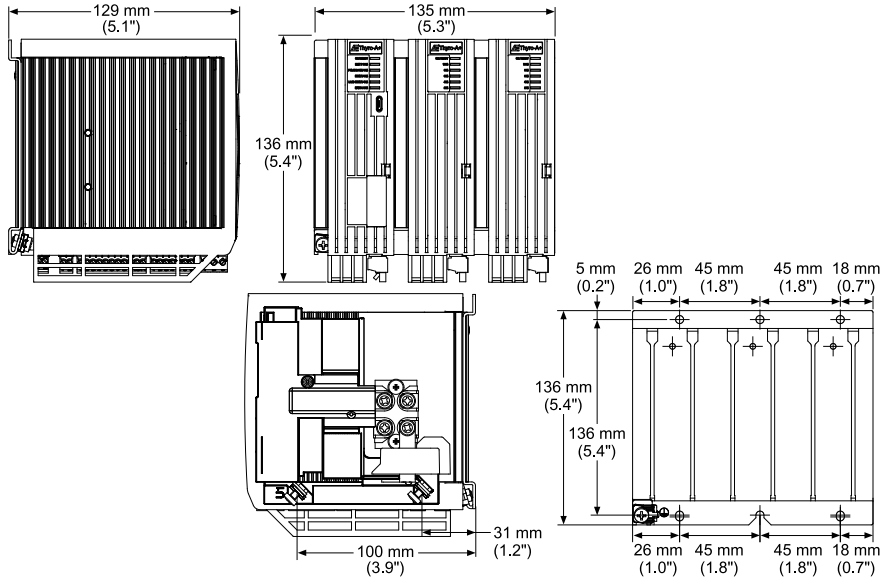


Figure 5-11. *Thyro-A+ 3A 16 H, 30 H*

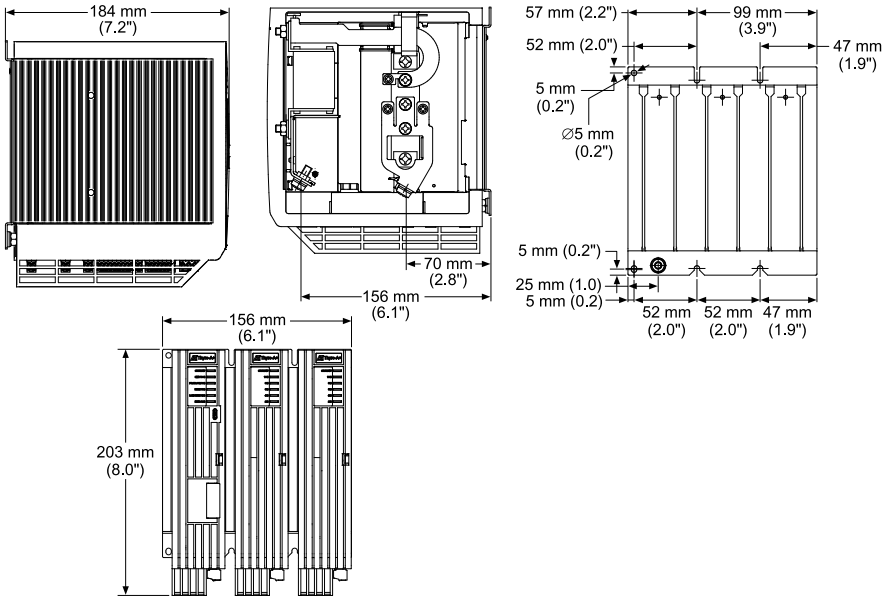


Figure 5-12. *Thyro-A+ 3A 45 H, 60 H*

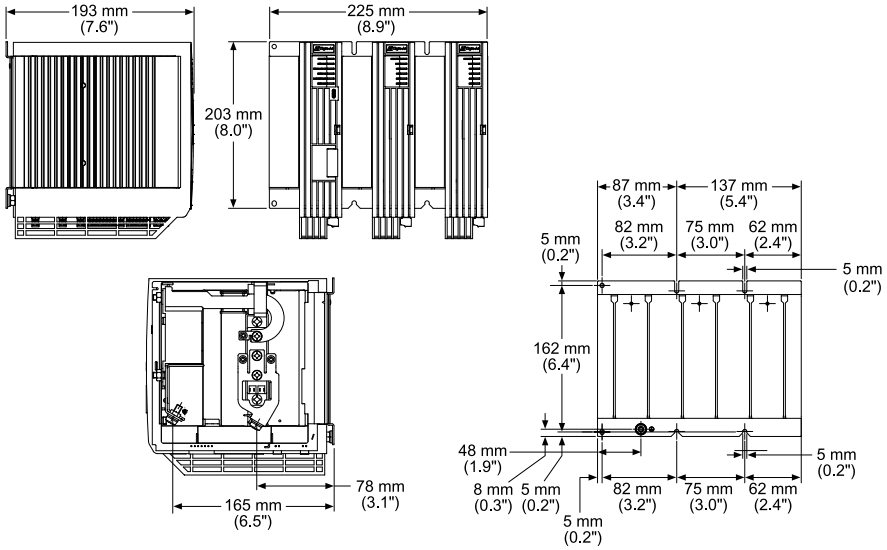


Figure 5-13. *Thyro-A+ 3A 100 H*

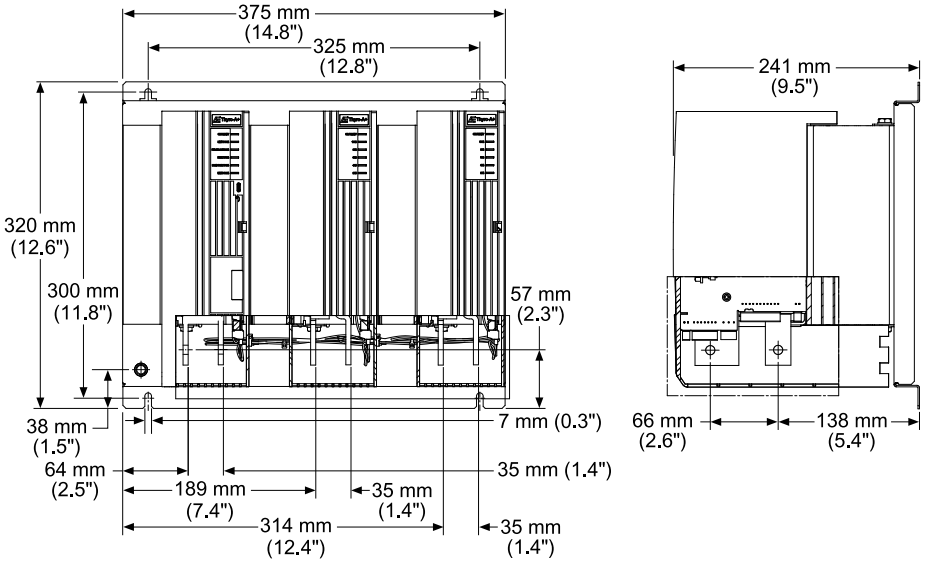


Figure 5-14. *Thyro-A+ 3A 130 H, 170 H*

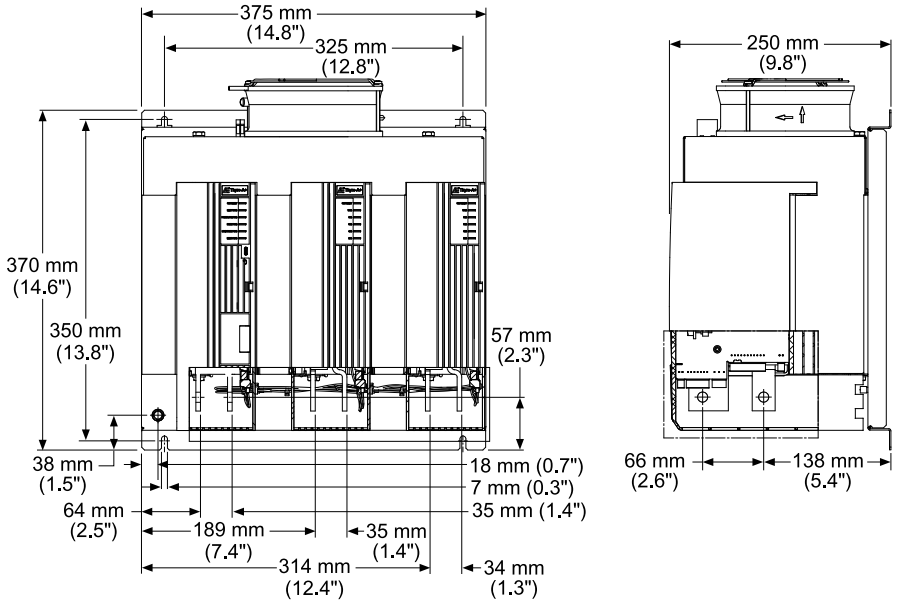


Figure 5-15. Thyro-A+ 3A 280 HF

Installation Requirements

Install this unit according to the following requirements.

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.

Unpacking the Unit

Important

The labels on the packaging provide important safety and handling information. Follow your 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 you do see signs of shipping damage, contact Advanced Energy and the carrier immediately.

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

Lifting the Unit

This manual describes many Thyro-A+ models. 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.

TO LIFT THE UNIT

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

INSTALLING THE UNIT

Mounting the Unit

1. Install the unit on or in the mounting surface, rack, or cabinet.

2. Fasten the unit to the mounting surface, rack, or cabinet. Use suitable fasteners.

See "Dimensional Drawings" on page 5-1 for mounting hole details.

Grounding

WARNING:

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

AVERTISSEMENT:

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

- Make a suitable chassis ground connection to the location specified on the dimensional drawing. See "Dimensional Drawings" on page 5-1.

Connecting I/O and Auxiliary Connectors

DANGER:

RISK OF DEATH OR BODILY INJURY. 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.

Important

All digital and analog control cables must be shielded. Connect the cable shields to the shield terminal on the unit.

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

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

1. Verify that the control cable conductors are sized between 0.14 mm^2 and 1.5 mm^2 (30 AWG and 14 AWG).
2. Prepare the end of the control cable:

a. Strip 50 mm (2″) of the cable jacket.
b. Prepare the cable shield for connection to the shield terminal.
c. Strip 7 mm (0.28″) of insulation from each conductor.

3. Connect each conductor to the plug-in, screw-terminal block.
4. Connect the cable shield to the shield terminal, X2.10.
5. Plug the block into the power controller.

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 connector **X1**, as shown in the connection diagram (see "Connection Diagrams" on page 5-13).

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. Connect a current-limited 24 V DC or AC external power source to the auxiliary power input connector, **X11**, on the bottom of the unit.
6. For 1-phase and 2-phase units only, connect terminal **X1.1** on the bottom of the unit:
   - To the neutral conductor (1-phase units)
   - To the mains side of L2 through an external 2 A fuse (1-phase or 2-phase units)

   An external 2 A fuse might be required. Use the included plug-in, screw-terminal block to make this connection. Do not alter any existing factory wiring connected to this terminal block.
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 Screw	Protective Earth Screw
16 A, 30 A	Lug, M4	Lug, M4
45 A, 60 A, 100 A	M6	M6
130 A, 170 A	M8	M10
280 A	M10	M10

Table 5-2. Terminal screw torque

Screw	Torque		
	Minimum NM (Pound-Inches)	Rated NM (Pound-Inches)	Maximum NM (Pound-Inches)
M2	0.2 (1.9)	0.25 (2.2)	0.3 (2.5)
M4	1.0 (8.9)	1.3 (11.5)	1.7 (15.0)
M6	3.0 (26.1)	4.4 (38.9)	5.9 (52.2)
M8	11.5 (101.8)	17.0 (150.5)	22.5 (199.1)
M10	22.0 (194.7)	33.0 (292.1)	44.0 (389.4)
M12	38.0 (336.3)	56.0 (495.6)	75.0 (663.8)

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.

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.

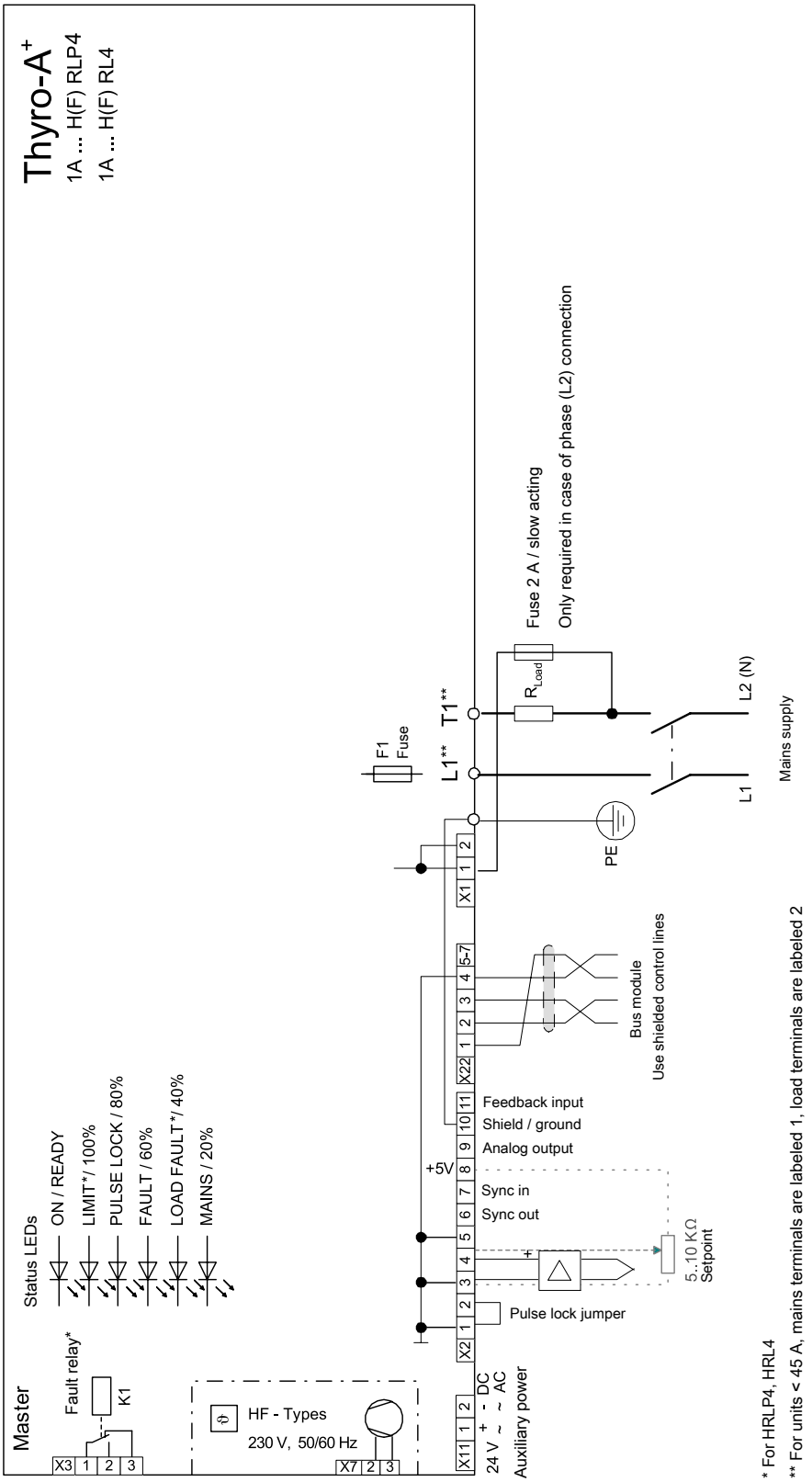


Figure 5-16. *1A power controller connections*

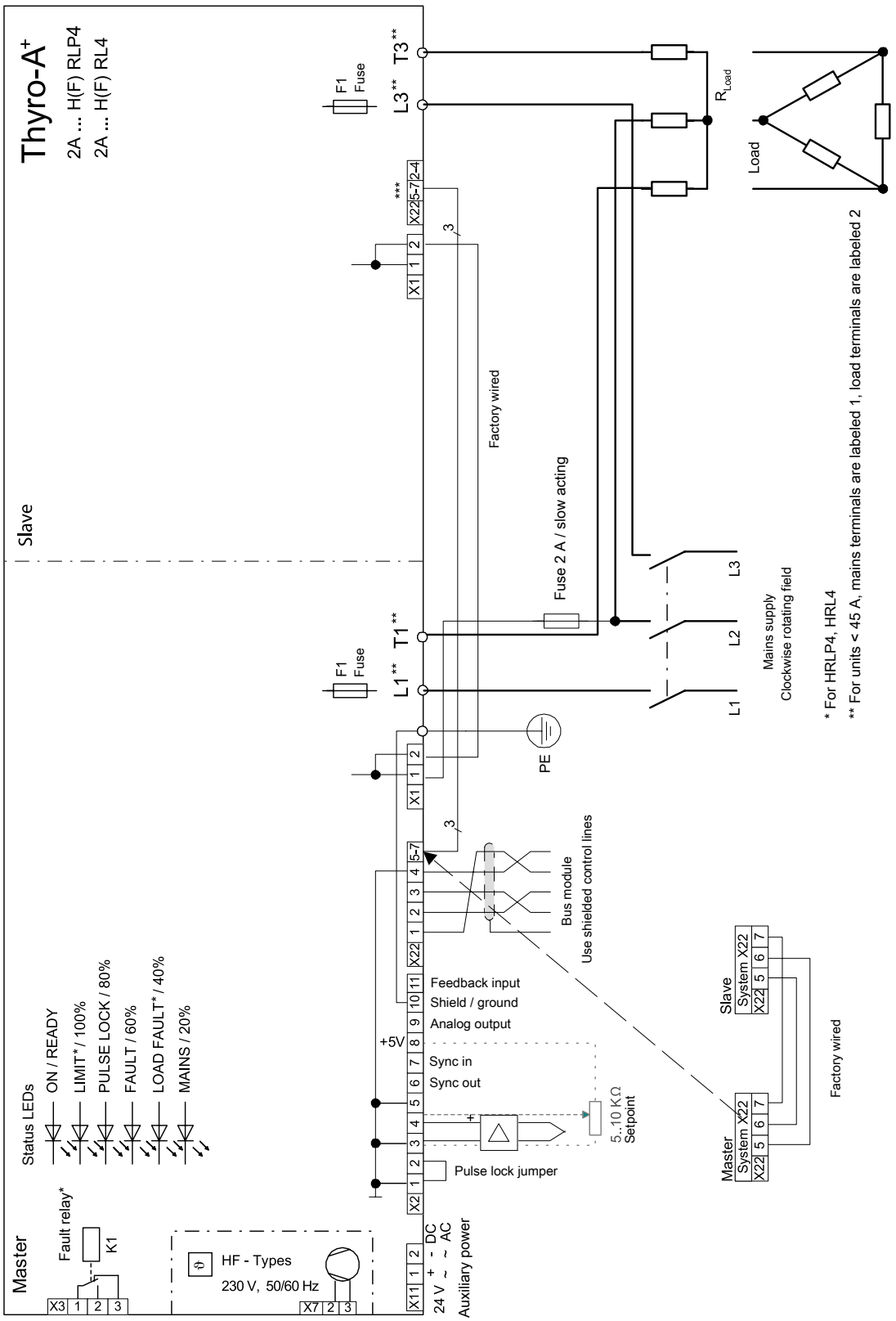


Figure 5-17. *2A power controller connections*

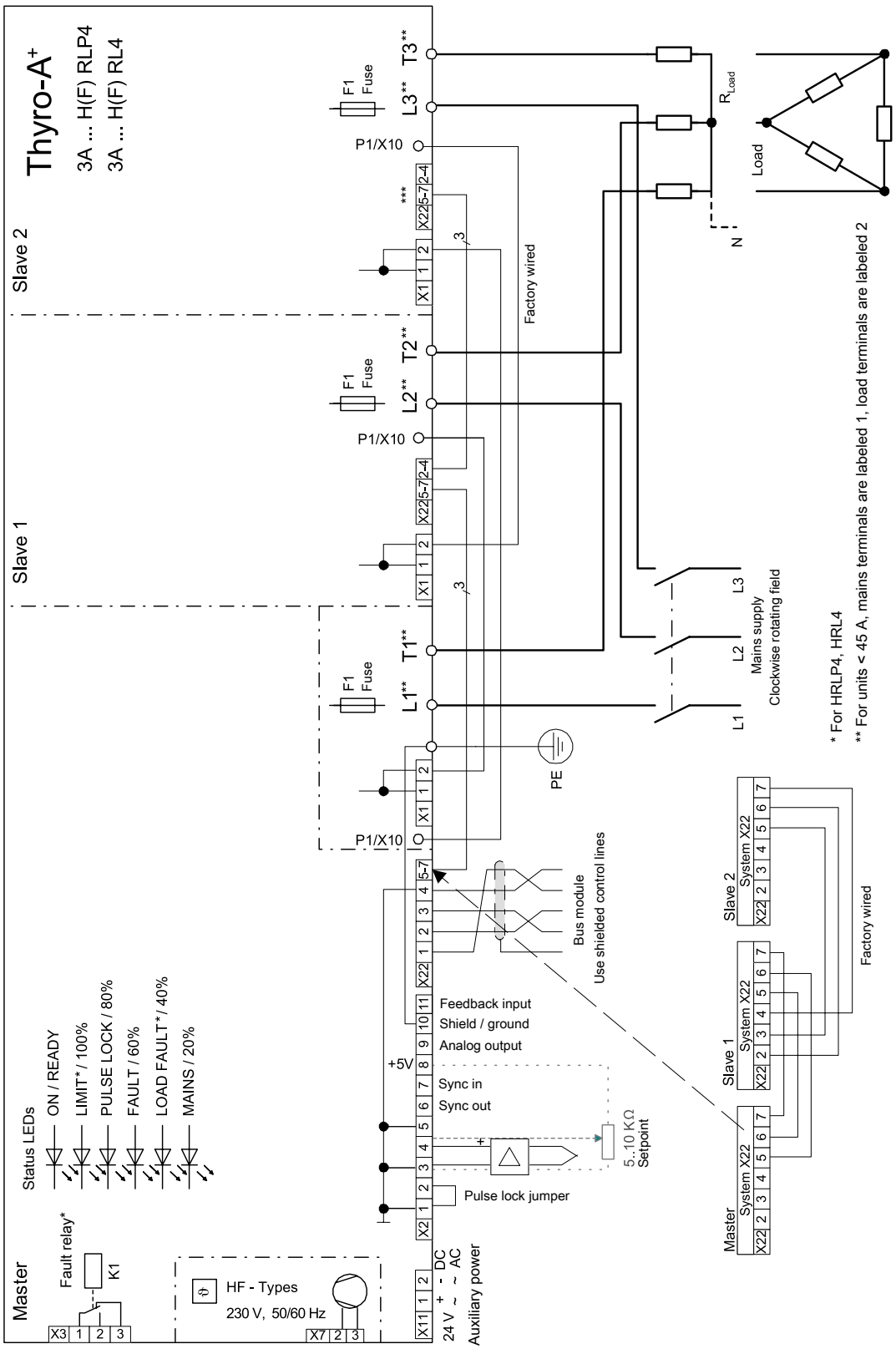


Figure 5-18. *3A power controller connections*

FIRST TIME OPERATION

On delivery, the device is parameterized to the respective power section. The TAKT operating mode is set on 1-phase and 2-phase units, and the VAR operating mode is set on 3-phase units. You should review these standard parameters, and, if necessary, adjust them for your application.

To Operate the Thyro-A+ Unit for the First Time

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

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

2. Turn on the system circuit breakers and apply AC input to the unit.
3. Verify that the orange **ON / READY** LED is lit.

   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 appropriate LED (see Table 4-2 on page 4-3). You will not be able to apply power to the load until you clear the fault.

4. Verify that an increase in setpoint applies power to the load.

If the Thyro-A+ unit is delivering power, 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 5-18
- "Thyro-A+ Display" on page 4-6
- "Software User Interface" on page 4-7

NORMAL OPERATION

Each time you turn the unit on, the unit runs a self-diagnostics procedure to ensure that it is performing correctly. Follow the procedures in this user manual for first time operation the first time you operate your unit. Consult the troubleshooting section if you have issues or problems operating your unit after you have followed the first time operation guidelines.

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

OPERATING MODES

Full-Wave Switch (TAKT)

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

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

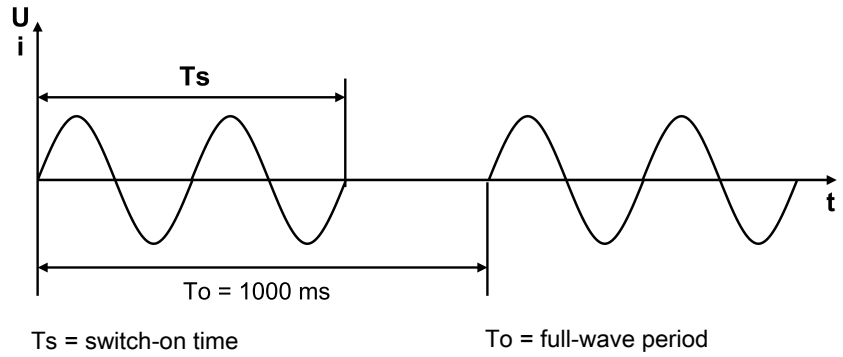


Figure 5-19. TAKT waveform

Phase-Angle Firing (VAR)

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

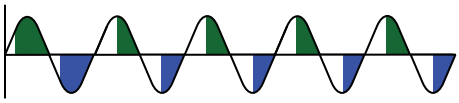


Figure 5-20. VAR waveform

Half-Wave Switch QTM (Quick TAKT Mode)

QTM is an operating mode which works on the half wave switch principle, and is only available on single-phase units. QTM is suitable for resistive loads and is particularly suited for IR heaters as an alternative to phase-angle control. Whole mains half-wave periods are switched so that harmonics are minimized.

Figure 5-21. QTM waveform

Switch Mode (SWITCH)

In switch mode, the mains voltage is switched on when the setpoint exceeds 50%, or the *SYNC IN* (X2.7) signal is on. This means that on-off control can be realized. Whole multiples of the mains periods are always switched and harmonics are minimized. The switch mode is suitable for resistive load and transformer load.

SETPOINT CONTROL

The user can adapt the setpoint signal to either process controllers or to the automation system. This is done by altering the starting and finishing points of the control characteristic curve. All common control signal types can be used. LEDs indicate when the power controller reaches a limit value (U_Max, I_Max, P_Max)..

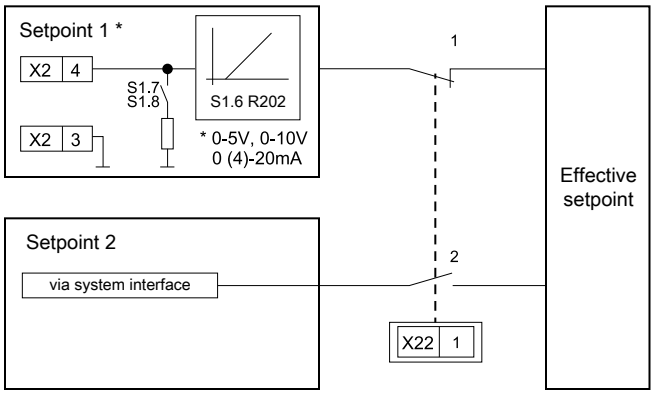


Figure 5-22. *Setpoint inputs*

The power controller has two setpoint inputs that are electrically isolated from the mains and of which only one is ever active.

- Setpoint 1: Analog signal X2.4 (+); X2.3 (ground)
- Setpoint 2: Via system interface (bus module, Thyro-Tool Pro software)

The setpoint input to be used is defined by configuring terminal X22.1. Setpoint 1 is selected when X22.1 is open. Setpoint 2 is selected when X22.1 is connected to X22.4 (ground).

Switch Mode Setpoint

When operating in switch mode, a setpoint above 50% causes the load to be switched on; a setpoint below 50% causes the load to be switched off. A digital signal (5 V to 24 V) to terminal X2.7 (*SYNC IN*) can also be used to switch the load on and off.

CONTROL TYPES

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

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

Controlled Value

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

Table 5-3. Control modes

Control Mode	Control Value
Type HRLP4	
U control	Output voltage, U_{RMS}
U^2 control	Output voltage, U^2_{RMS}
I control	Output current, I_{RMS}
I^2 control	Output current, I^2_{RMS}
P control	Output (active) power, P
No regulation	Output proportional to the setpoint

Control Characteristic Curves

The control variable influencing the load is proportional to the effective setpoint in the case of control modes U, I, and P. In control modes U^2 and I^2, the control variable influencing the load is a square of the effective setpoint.

The control characteristic curves are shown in the following three figures.

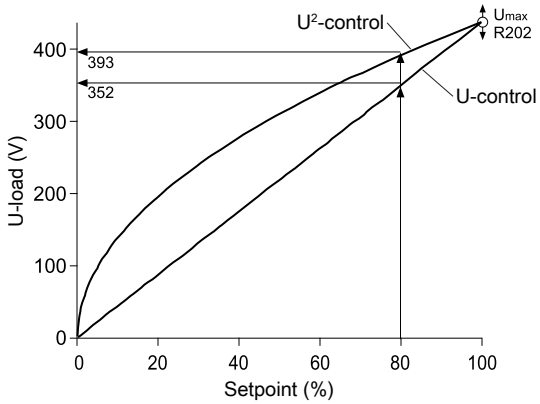


Figure 5-23. U control

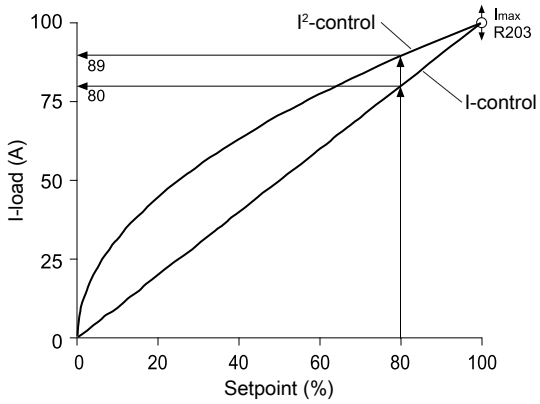


Figure 5-24. I control

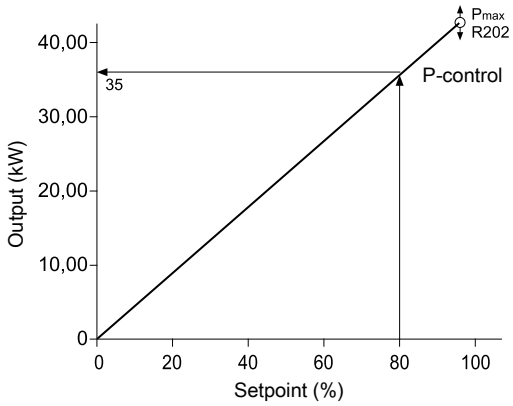


Figure 5-25. P control

Controller Response

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

Table 5-4. Response to load changes

Control Type	Limit	Load Resistance Decreases			Load Resistance Increases			Effective Limitations [1]	
		P	U_{LOAD}	I_{LOAD}	P	U_{LOAD}	I_{LOAD}		
U	U_{RMSmax}	Larger	=	Larger	Smaller	=	Smaller	I_{RMSmax}	P_{max}
U^2	U_{RMSmax}	Larger	=	Larger	Smaller	=	Smaller	I_{RMSmax}	P_{max}
I	I_{RMSmax}	Smaller	Smaller	=	Larger	Larger	=	U_{RMSmax}	P_{max}
I^2	I_{RMSmax}	Smaller	Smaller	=	Larger	Larger	=	U_{RMSmax}	P_{max}
P	P_{max}	=	Smaller	Larger	=	Larger	Smaller	U_{RMSmax}	I_{RMSmax}
Without control		Larger	=	Larger	Smaller	=	Smaller	U_{RMSmax} P_{max}	I_{RMSmax}
General modulation limit								$T_s=T_{smax}$ $\alpha=\alpha_{max}$	

[1] If one of the limits is exceeded, then the **Limit** LED reacts (default values of parameter settings).

MONITORING

Faults occurring in the power controller or in the load circuit are signaled. Signaling is performed via the LED indicators, and via the fault relay K1. See LED table Table 4-2 on page 4-3.

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.

☞ **Important**

The following limit values apply for voltage monitoring:

- Undervoltage monitoring: -57% of type voltage
- Overvoltage monitoring: +10% of type voltage

This results in absolute limit values for the monitoring of the mains voltage.

Table 5-5. Limit values for mains voltage monitoring

Type	Undervoltage Limit	Overvoltage Limit
230 V	99 V	253 V
400 V	172 V	440 V
500 V	215 V	550 V

In default state, *PULSE LOCK* is switched internally when the undervoltage limit is exceeded, and fault relay K1 de-energizes. Both can be set with the Thyro-Tool Pro software.

Device Temperature and Fan Monitoring

The Thyro-A+ has temperature monitoring. If the temperature exceeds 90°C (194°F), a message is sent via LED, via the bus module, or via fault relay K1. The *PULSE LOCK* is actuated but can be deactivated. Note that if you deactivate the *PULSE LOCK*, you run the risk of overheating and/or damaging the unit.

For units with fans, the device temperature monitoring indirectly monitors the fan.

In case of a temperature overrange, the device will be switched off and the **FAULT** LED will be blinking with blink code 3.

☞ **Important**

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

Monitoring Parallel Loads

This function enables a freely selectable absolute current limit to be monitored. The value can be set using the Thyro-Tool Pro software.

During the configuration process, the monitoring value will be indicated at the analog output and by the LED bar graph. This monitoring of absolute values is suitable for one or several load resistors set up in parallel. The effective value of the current measured is continually compared with a configurable absolute current limit for undercurrent. If the current drops below this limit, a message is sent. In the case of resistors set up in parallel, a partial load break can be detected by setting the appropriate undercurrent limit.

A measuring instrument connected to the analog output and the LED bar graph can be used as a setting aid. If the actual value has fallen below the set value, a message is sent (LED, by bus, and fault signaling relay K1).

☞ **Important**

Settings less than 10% and over 90% are not practical. If the load currents are considerably less than the nominal currents of the power controller, consider using a smaller power controller.

- In operating mode VAR, monitoring is blocked for large control angles (for load with neutral conductor α >140° electrical phase angle and for load without neutral conductor α >117° electrical phase angle.
- The signaling delays can be up to 15 seconds in operating mode VAR and up to 30 seconds in operating mode TAKT.
- Convert deviating values as a percentage. The set monitoring value should always be an average of the value for load nominal current and the value after failure.

THYRO-A+ 1A AND THYRO-A+ 2A WITH SEPARATE STAR POINT

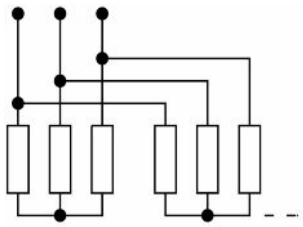


Figure 5-26. Load with separate star point and without neutral conductor

For Thyro-A+ 1A and Thyro-A+ 2A (load with separate star point without N), a setting for load monitoring can be made according to the following table:

Table 5-6. Load with separate star point and without neutral conductor

Number of Parallel Load Resistors	$I_{LOAD\ NOM}$ / $I_{TYPE\ CONTROLLER}$	Current in Case of Fault	Setting Aid LED Bar Graph	Setting Aid at Actual Value Output X2.9 (0 V to 5 V)	Setting Aid at Actual Value Output X2.9 (0 mA to 20 mA)
1	100%	0%	50.0%	2.5 V	5 mA
	80%		40.0%	2 V	4 mA
	60%		30.0%	1.5 V	3 mA
	40%		20.0%	1 V	2 mA
	20%		10.0%	0.5 V	1 mA
2	100%	50%	75.0%	3.75 V	7.5 mA
	80%		60.0%	3 V	6 mA
	60%		45.0%	2.25 V	4.5 mA
	40%		30.0%	1.5 V	3 mA

Table 5-6. Load with separate star point and without neutral conductor (Continued)

Number of Parallel Load Resistors	$I_{LOAD\ NOM}$ / $I_{TYPE\ CONTROLLER}$	Current in Case of Fault	Setting Aid LED Bar Graph	Setting Aid at Actual Value Output X2.9 (0 V to 5 V)	Setting Aid at Actual Value Output X2.9 (0 mA to 20 mA)
	20%		15.0%	0.75 V	1.5 mA
3	100%	66%	83.3%	4.15 V	8.35 mA
	80%		66.7%	3.35 V	6.65 mA
	60%		50.0%	2.5 V	5 mA
	40%		33.3%	1.65 V	3.35 mA
4	100%	75%	87.5%	4.4 V	8.75 mA
	80%		70.0%	3.5 V	7 mA
	60%		52.5%	2.65 V	5.25 mA
	40%		35.0%	1.75 V	3.5 mA
5	100%	80%	90.0%	4.5 V	9 mA
	80%		72.0%	3.6 V	7.2 mA
	60%		54.0%	2.7 V	5.4 mA
	40%		36.0%	1.8 V	3.6 mA

THYRO-A+ 2A WITH STAR AND DELTA LOADS

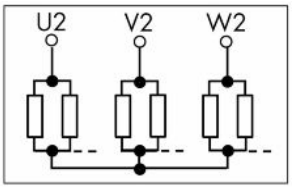


Figure 5-27. Load with common star point and without neutral conductor

Table 5-7. Load with common star point and without neutral conductor

Number of Parallel Load Resistors	$I_{LOAD\ NOM}$ / $I_{TYPE\ CONTROLLER}$	Current in Case of Fault	Setting Aid LED Bar Graph	Setting Aid at Actual Value Output X2.9 (0 V to 5 V)	Setting Aid at Actual Value Output X2.9 (0 mA to 20 mA)
1	100%	0%	50.0%	2.5 V	5 mA
	80%		40.0%	2 V	4 mA

Table 5-7. Load with common star point and without neutral conductor (Continued)

Number of Parallel Load Resistors	$I_{LOAD\ NOM}$ / $I_{TYPE\ CONTROLLER}$	Current in Case of Fault	Setting Aid LED Bar Graph	Setting Aid at Actual Value Output X2.9 (0 V to 5 V)	Setting Aid at Actual Value Output X2.9 (0 mA to 20 mA)
	60%		30.0%	1.5 V	3 mA
	40%		20.0%	1 V	2 mA
	20%		10.0%	0.5 V	1 mA
2	100%	60%	80.0%	4 V	8 mA
	80%		63.0%	3.15 V	6.3 mA
	60%		48.0%	2.4 V	4.8 mA
	40%		32.0%	1.6 V	3.2 mA
	20%		16.0%	0.8 V	1.6 mA
3	100%	75%	87.0%	4.35 V	8.7 mA
	80%		70.0%	3.5 V	7 mA
	60%		52.0%	2.6 V	5.2 mA
	40%		35.0%	1.75 V	3.5 mA
4	100%	82%	90.0%	4.5 V	9 mA
	80%		72.0%	3.6 V	7.2 mA
	60%		(54.0%)	2.7 V	5.4 mA

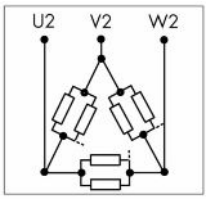


Figure 5-28. Load in delta connection

Table 5-8. Load in delta connection

Number of Parallel Load Resistors	$I_{LOAD\ NOM}$ / $I_{TYPE\ CONTROLLER}$	Current in Case of Fault	Setting Aid LED Bar Graph	Setting Aid at Actual Value Output X2.9 (0 V to 5 V)	Setting Aid at Actual Value Output X2.9 (0 mA to 20 mA)
1	100%	57%	79%	3.95 V	7.9 mA
	80%		63%	3.15 V	6.3 mA

Table 5-8. Load in delta connection (Continued)

Number of Parallel Load Resistors	$I_{LOAD\ NOM}$ / $I_{TYPE\ CONTROLLER}$	Current in Case of Fault	Setting Aid LED Bar Graph	Setting Aid at Actual Value Output X2.9 (0 V to 5 V)	Setting Aid at Actual Value Output X2.9 (0 mA to 20 mA)
	60%		48%	2.4 V	4.8 mA
	40%		32%	1.6 V	3.2 mA
	20%		16%	0.8 V	1.6 mA
2	100%	76%	88%	4.4 V	8.8 mA
	80%		66%	3.3 V	6.6 mA
	60%		50%	2.5 V	5 mA
	40%		33%	1.65 V	3.3 mA
	20%		17%	0.85 V	1.7 mA
3	100%	84%	90%	4.5 V	9 mA
	80%		72%	3.6 V	7.2 mA
	60%		54%	2.7 V	5.4 mA

THYRO-A+ 3A WITH STAR AND DELTA LOADS

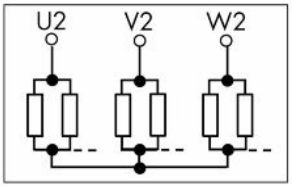


Figure 5-29. Load with common star point and without neutral conductor

Table 5-9. Load with common star point and without neutral conductor

Number of Parallel Load Resistors	$I_{LOAD\ NOM}$ / $I_{TYPE\ CONTROLLER}$	Current in Case of Fault	Setting Aid LED Bar Graph	Setting Aid at Actual Value Output X2.9 (0 V to 5 V)	Setting Aid at Actual Value Output X2.9 (0 mA to 20 mA)
1	100%	0%	50.0%	2.5 V	5 mA
	80%		40.0%	2 V	4 mA
	60%		30.0%	1.5 V	3 mA
	40%		20.0%	1 V	2 mA

Table 5-9. Load with common star point and without neutral conductor (Continued)

Number of Parallel Load Resistors	$I_{LOAD\ NOM}$ / $I_{TYPE\ CONTROLLER}$	Current in Case of Fault	Setting Aid LED Bar Graph	Setting Aid at Actual Value Output X2.9 (0 V to 5 V)	Setting Aid at Actual Value Output X2.9 (0 mA to 20 mA)
	20%		10.0%	0.5 V	1 mA
2	100%	60%	80.0%	4 V	8 mA
	80%		64.0%	3.2 V	6.4 mA
	60%		48.0%	2.4 V	4.8 mA
	40%		32.0%	1.6 V	3.2 mA
	20%		16.0%	0.8 V	1.6 mA
3	100%	75%	87.5%	4.375 V	8.75 mA
	80%		70.0%	3.5 V	7 mA
4	100%	82%	91.0%	4.55 V	9.1 mA

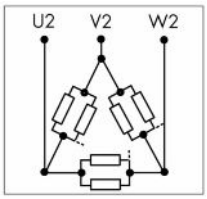


Figure 5-30. Load in delta connection

Table 5-10. Load in delta connection

Number of Parallel Load Resistors	$I_{LOAD\ NOM}$ / $I_{TYPE\ CONTROLLER}$	Current in Case of Fault	Setting Aid LED Bar Graph	Setting Aid at Actual Value Output X2.9 (0 V to 5 V)	Setting Aid at Actual Value Output X2.9 (0 mA to 20 mA)
1	100%	57%	78.5%	3.925 V	7.85 mA
	80%		62.8%	3.14 V	6.28 mA
	60%		47.1%	2.355 V	4.71 mA
	40%		31.4%	1.57 V	3.14 mA
	20%		15.7%	0.785 V	1.57 mA
2	100%	76%	88.0%	4.4 V	8.8 mA
	80%		70.4%	3.52 V	7.04 mA

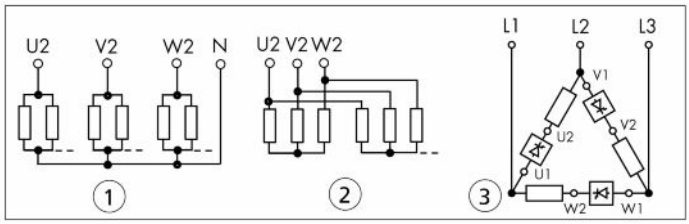


Figure 5-31. Other possibilities of load monitoring

The preceding figure shows other possible load configurations:

1. Load with common star point with neutral conductor
2. Load with separate star point without neutral conductor
3. Load in open delta connection

Table 5-11. Other possibilities of load monitoring

Number of Parallel Load Resistors	$I_{LOAD\ NOM}$ / $I_{TYPE\ CONTROLLER}$	Current in Case of Fault	Setting Aid LED Bar Graph	Setting Aid at Actual Value Output X2.9 (0 V to 5 V)	Setting Aid at Actual Value Output X2.9 (0 mA to 20 mA)
1	100%	0%	50.0%	2.5 V	5 mA
	80%		40.0%	2 V	4 mA
	60%		30.0%	1.5 V	3 mA
	40%		20.0%	1 V	2 mA
	20%		10.0%	0.5 V	1 mA
2	100%	50%	75.0%	3.75 V	7.5 mA
	80%		60.0%	3 V	6 mA
	60%		45.0%	2.25 V	4.5 mA
	40%		30.0%	1.5 V	3 mA
	20%		15.0%	0.75 V	1.5 mA
3	100%	66%	83.0%	4.15 V	8.3 mA
	80%		66.4%	3.32 V	6.64 mA
	60%		49.8%	2.49 V	4.98 mA
	40%		33.2%	1.66 V	3.32 mA
	20%		16.6%	0.83 V	1.66 mA
4	100%	75%	87.5%	4.375 V	8.75 mA
	80%		70.0%	3.5 V	7 mA
	60%		52.5%	2.625 V	5.25 mA
	40%		35.0%	1.75 V	3.5 mA

Table 5-11. Other possibilities of load monitoring (Continued)

Number of Parallel Load Resistors	$I_{LOAD\ NOM}$ / $I_{TYPE\ CONTROLLER}$	Current in Case of Fault	Setting Aid LED Bar Graph	Setting Aid at Actual Value Output X2.9 (0 V to 5 V)	Setting Aid at Actual Value Output X2.9 (0 mA to 20 mA)
	20%		17.5%	0.875 V	1.75 mA
5	100%	80%	90.0%	4.5 V	9 mA

EXTENDED FUNCTIONS

A bus module (for example, PROFIBUS® DP or DeviceNet®) or a PC can be connected at the system interface X22. This makes it possible to access additional parameters, setpoints, actual values, and error messages.

Extended Operating Modes/Circuit Types

With the aid of the Thyro-Tool Pro software, it is possible to set the operating mode and circuit type independently of one another.

- Operating modes
  - TAKT
  - VAR
- Load circuit types
  - Star with neutral conductor
  - Delta without neutral conductor
  - Star without neutral conductor
  - Open delta

Analog Output Averaging

In order to attain a finer line thickness for line recorders, the output signal can be smoothened, if needed, to suit the application. The default setting uses the mean of 100 mains periods.

Control Limits

For operating modes TAKT and VAR, it is possible to set control limits (end position limits).

- For TAKT:
  - Tsmax Maximum switch-on period
  - Tsmin Minimum switch-on period
- For VAR:
  - V_IE Front pulse end position
  - H_IE Rear pulse end position

Controller Parameters

The Thyro-A+ unit contains a PID controller. The parameters of the PID controller can be modified if needed to suit the application.

Parameter	Default Setting	Description
T_I	20	Controller I share
K_P	60	Controller P share
K_R	5	Controller amplification

Mains Load Optimization

The time for software synchronization can be set.

- 50 Hz ≥ Delay period after mains returns 10 ms * 100 = 1000 ms
- 60 Hz ≥ Delay period after mains returns 8.33 ms * 100 = 833 ms

(Default setting: 100)

MAINS LOAD OPTIMIZATION

Mains load optimization offers considerable benefits by reducing mains load peaks and system disturbances. Mains load optimization is possible under the following conditions:

- When more than one power controller is used
- Operating mode TAKT

The mains load is optimized by cascading the switching on of the individual devices. There are two different processes for mains load optimization, described in the following sections.

Internal Mains Load Optimization

In the operating modes QTM and TAKT, the synchronization of 2-12 controllers is possible. The operating mode QTM works in a quick half wave switch principle with a pattern of switched and blocked half waves at a set time interval < 1 second, also known as T0. In order to create a balance in the mains, from the start the individual controllers synchronize by offsetting themselves by a network period. The first of the controllers connected has the SYT input X2.7 bridged to +5 V X2.8.

The controllers which follow the first controller get their signal to X2.7 from the synchronization output (X2.6) of the previous controller. At the last controller X2.6 is not connected.

Synchronization With Optional Thyro-Power Manager Accessory

If power controllers are operating in the full wave switch mode (TAKT), then this can lead to an increased mains load through an unfavorable spread of switching on and off times. This has negative effects such as higher power loss and flicker effects. If load elements whose resistances increase over time (ageing) are used, then potentially a transformer with increased power output might need to be implemented.

All of these negative effects can be avoided or reduced to a minimum level by using the Thyro-Power Manager. The Thyro-Power Manager has a total of 10 digital outputs at terminals **X3** and **X4**. These digital outputs are set up as potential free optical coupler outputs. When optimizing the network load, the digital outputs are used as synchronization outputs (SYT) for the connected power controllers or power controller groups. All cables are to be laid shielded with the shield grounded at the output switch. For more information, see the Thyro-Power Manager operating instructions, available separately.

Characteristics:

- Minimal mains peak load and related mains feedback rates
- Changes to the setpoint and load do not automatically feed into the mains load optimization
- Can also be used in connection with already existing Advanced Energy power controllers

Basic Bus Module

The Basic Bus Module is an optional accessory for the Thyro-A+ series power controllers. It can control up to eight power controllers, and connects to your network using a Thyro Anybus® module, which is available for many bus protocols. The module allows the power controller to be integrated into complex installations via the field network.

With the optional digital Automatic Synchronization for Multiple power controllers feature (dASM), up to 4 Basic Bus Module accessories can be interconnected to optimize the mains load for very large installations.

Figure 5-32. Basic Bus Module

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 Global Services

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

TROUBLESHOOTING CHECKLIST

DANGER:

RISK OF DEATH OR BODILY INJURY. 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.

Table 6-1. Using LED states for troubleshooting

<table>
<tr><th>Troubleshooting Check</th><th>Action</th></tr>
<tr><td>Turn off AC power and make these checks.</td><td>1. Check for visible damage to the unit, cables, and connectors.
2. Ensure that all unit connectors are installed correctly and are fastened tightly.
3. Verify that no system-related circuit breakers have been tripped.
4. Ensure that ground connections are adequate and secure.</td></tr>
<tr><td>Is the ON / READY LED lit?</td><td>If no: There could be an external line fault.
1. Make sure that there are no loose wires or unreliable connections in the AC input line.
2. Make sure that the AC disconnect switch is closed.
3. Make sure that all three phases on the AC voltage line are present and meet specifications.
4. Verify that the F1 fuse(s) are OK.
5. If this LED remains unlit, call AE Global Services.</td></tr>
<tr><td>Is the ON / READY LED lit in red?</td><td>If yes: The unit is on, but not ready for operation. Check the other LEDs.</td></tr>
<tr><td>Is the LIMIT LED blinking in red?</td><td>If yes: The unit is unable to supply enough power to match the setpoint due to a limiting condition. When an internal protection limit is exceeded, the output is limited, but not shut off.
1. Disable the output.
2. Inspect and evaluate the unit load connections. Look for signs of heat stress.
3. Check the limit parameters.
<table>
<tr><th colspan="4">Blink Number</th></tr>
<tr><th>1</th><th>2</th><th>3</th><th>4</th></tr>
<tr><td>Voltage limit</td><td>Current limit</td><td>Power limit</td><td></td></tr>
</table>
</td></tr>
</table>

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

<table>
<tr><th>Troubleshooting Check</th><th>Action</th></tr>
<tr><td>Is the PULSE LOCK LED blinking in red?</td><td>If yes: The pulse lock jumper is open, or pulse lock has been set via a bus module or the Thyro-Tool Pro software.
<table>
<tr><th colspan="4">Blink Number</th></tr>
<tr><th>1</th><th>2</th><th>3</th><th>4</th></tr>
<tr><td>Jumper open or other condition causing pulse lock.</td><td></td><td></td><td></td></tr>
</table></td></tr>
<tr><td>Is the FAULT LED lit in red?</td><td>If yes: The unit has detected a fault. This fault will generate error data that is provided through the serial port.
<table>
<tr><th colspan="4">Blink Number</th></tr>
<tr><th>1</th><th>2</th><th>3</th><th>4</th></tr>
<tr><td>Master/slave fault</td><td>Flash memory fault</td><td>Temperature fault</td><td>Thyristor short circuit</td></tr>
</table></td></tr>
<tr><td>Are any LOAD FAULT LEDs lit in red?</td><td>If yes: The unit has a fault in the corresponding load. Check the load and load monitoring parameters.
<table>
<tr><th colspan="4">Blink Number</th></tr>
<tr><th>1</th><th>2</th><th>3</th><th>4</th></tr>
<tr><td>Load voltage out of limits</td><td>Load current out of limits</td><td>Load power out of limits</td><td>Load fault</td></tr>
</table></td></tr>
<tr><td>Is the MAINS LED blinking in red?</td><td>If yes: A mains fault has occurred.
<table>
<tr><th colspan="4">Blink Number</th></tr>
<tr><th>1</th><th>2</th><th>3</th><th>4</th></tr>
<tr><td>Overvoltage [1]</td><td>Undervoltage [1]</td><td>Phase sequence/ phase fault [2]</td><td>Frequency/sync [3]</td></tr>
<tr><td colspan="4">[1] Check mains voltage. Check threshold parameters using Thyro-Tool Pro software.
[2] Check that all phases are present. Verify right-hand phase rotation.
[3] Check that all phases are present. Verify that frequency is within range and mains voltage is stable.</td></tr>
</table></td></tr>
</table>

AE GLOBAL SERVICES

Please contact AE Global Services if you have questions or problems, or if you need customer support. Before contacting AE Global Services, please work through the provided troubleshooting. When you contact Global Services, please include the unit serial number and part number. These numbers are available on unit labels.

☞ **Important**

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

Primary Contact Information

Visit the Advanced Energy website for local service and support contact information:

http://www.advancedenergy.com

Click on the service link at the top of the page.

Alternate Contact Information

If you do not have access to the Advanced Energy website, then use one of the following:

- Phone (24 hrs/day, 7 days/week):
  800.446.9167
  or
  +1.970.221.0108
- Email: (We will respond to email by the next business day.)

  mailto:technical.support@aei.com
- AE World Headquarters

  1625 Sharp Point Drive

  Fort Collins, CO 80525 USA

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

RETURNING UNITS FOR REPAIR

Before returning any product for repair and/or adjustment, first follow all troubleshooting procedures. After following troubleshooting procedures, if your unit is unable to resume normal operation, contact AE Global Services and discuss the problem with a representative. Be prepared to provide the model number and serial

number of the unit, as well as the reason for the proposed return. This consultation call will allow AE Global Services to determine if the unit must actually be returned for the problem to be corrected. Such technical consultation is always available at no charge.

Index

A

AE customer service contact information 6-4
authorized returns 6-4

B

basic bus module 5-32

C

certification 1-4
communication 4-4
compliance
    directives and standards 1-5
    environmental 1-6
    unit 1-4
conditions of use 1-5
conformity, letter and declaration 1-4
connections
    diagrams 5-13
connectors
    I/O and auxiliary 5-10
control types
    operation 5-20
cooling specifications 3-5
customer service contact information 6-4

D

diagrams
    connection 5-13
dimensional drawings 5-1
directives and standards 1-5
display 4-6

E

electrical specifications 3-3
electromagnetic compatibility
    directives and standards 1-5
environmental specifications 3-7
extended functions
    operation 5-30

F

fan maintenance 5-33
features 2-1

G

general description 2-1
Global Services contact information 6-4
grounding 5-10
guidelines
    safety 1-2

I

icons
    in user manual 1-1
    on unit 1-2
industry guidelines, compliance with 1-5
installation
    connecting I/O 5-10
    connecting the load 5-11
    grounding 5-10
    lifting 5-9
    mounting 5-9
    preparing to install 5-1
    requirements 5-8
    spacing requirements 5-1
    unpacking 5-9
interlock
    overview 1-7

L

labels on unit 1-2
LEDs 4-1
    troubleshooting 6-1
lifting 5-9
limiting conditions
    operation 1-7
load
    connecting 5-11

M

mains load optimization 5-31
maintenance
    fan 5-33
monitoring
    operation 5-22
    parallel loads 5-23

mounting 5-9

N

normal operation 5-17

O

operating modes 5-18
operation
    control types 5-20
    extended functions 5-30
    first time 5-17
    monitoring 5-22
    normal 5-17
    operating modes 5-18
    relay indicators 4-3
    setpoint 5-19

P

physical specifications 3-1
product
    certification 1-4
    compliance 1-4
    labels 1-2

R

relay indicators
    operation 4-3

S

safety
    conditions of use 1-5
    directives and standards 1-5
    guidelines 1-2
software user interface 4-7
spacing requirements 5-1
specifications
    cooling 3-5
    electrical 3-3
    environmental 3-7
    physical 3-1
    type designation 3-8
standards, directives and standards 1-5
status indicators
    LEDs 4-1
    relays 4-3
symbols
    in user manual 1-1
    on unit 1-2

T

troubleshooting
    checklist 6-1
    LEDs 6-1

U

UL 1-5
unit
    compliance 1-4
    dimensional drawings 5-1
    features 2-1
    general description 2-1
    grounding 5-10
    icons and symbols used 1-2
    lifting 5-9
    mounting 5-9
    preparing to install 5-1
    software user interface 4-7
    unpacking 5-9
unpacking 5-9
user manual
    alert boxes in 1-1
    symbols and icons used 1-1

W

warranty
    authorized returns 6-4