Thyro-S® Power Controller

Thyro-S ... H3 / HRLP3

User Manual

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Safety and Product Compliance Guidelines

IMPORTANT SAFETY INFORMATION

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

DANGER, WARNING, AND CAUTION BOXES

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

DANGER:

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

DANGER:

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

WARNING:

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

AVERTISSEMENT:

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

CAUTION:

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

ATTENTION:

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

SAFETY GUIDELINES

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

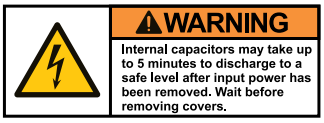
Rules for Safe Installation and Operation

Please note the following rules:

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

INTERPRETING PRODUCT LABELS

The following labels might appear on your unit:



Capacitor discharge warning (5 minutes)

CE label

Complies with applicable European directives.

Protective conductor terminal

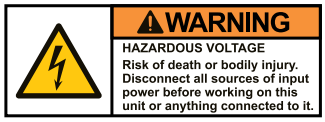
This terminal must be connected first and be of proper type and size for the circuit with the highest voltage and current carrying capacity. Note that other connections might have higher requirements than that of the mains connection.

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

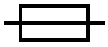
Short-circuit protected

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 device with a circuit breaker switch on the AC input. The circuit breaker switch must be easily accessible and near the unit. The breaker must be marked as the disconnecting device for the equipment.
- Use only a shielded cable for communications and/or control connections.
- Limit the system load current to the maximum specified level for the unit.
- Dispose of this product as directed by applicable laws and regulations.
- For the input and output power connections, use wires that are suitable for at least 75°C (167°F).
- Do not allow condensation of any liquids or accumulation of conductive dust on the instrument. Doing so will have unpredictable results, possibly including, but not limited to, loss of accuracy.

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 5-13.
- Use 60°C, 60°C/75°C, or 75°C copper conductors, as specified by model. See Table 3-3 on page 3-2.
- 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 outside the scope of this Directive, because it is installed as a component in a large-scale fixed installation or large-scale stationary industrial tool. Therefore, conformity is not required and conformance to this Directive is not declared on the CE Declaration of Conformity for this product.

However, this product is EU RoHS compliant. This product has been designed per specification to meet this Directive to contain no more than the maximum concentration of hazardous substances listed in Annex II, but might utilize application exemptions in Annex III or IV.

- **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-S 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 switched. The Thyro-S power controller can easily be connected to process and automation technology.

UNIT FEATURES

Thyro-S has a wide range of distinguishing features, including:

- Integrated semiconductor fuse
- Type range 230 V to 500 V, 8 A to 350 A, 1-phase, 2-phase, and 3-phase
- Resistive load and transformer load
- Operating mode: Full-wave switch
- Digital control with 24 V signal (> 3 V) or via optional bus module
- Micro USB system interface
- Safe isolation in accordance with EN 62477-1

Units with type designation HRLP3 have these additional features:

- External auxiliary power supply input, allowing operation with mains voltages up to 0.43 x U_{nom}
- Load current monitoring
- Signaling relay
- Analog output

Options include:

- Thyro-Tool Pro computer user interface
- Bus connection via bus adapters for:
  - PROFIBUS
  - PROFINET
  - Ethernet/IP™

- Modbus® TCP
- Modbus RTU
- DeviceNet™
- CANopen®
- 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)
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**) [1]	Included 2-pin, plug-in, screw terminal block, 0.14 mm^2 - 1.5 mm^2 (30 AWG - 14 AWG)
Relay K1 (**X3**) [1]	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
[1] Type HRLP3 only.	

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-S 1S					
8, 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
350	125 (4.9)	400 (15.8)	261 (10.3)	8.4 (18.5)	Figure 5-6
Thyro-S 2S					
8, 16, 30	89 (3.5)	136 (5.4)	129 (5.1)	1.4 (3.1)	Figure 5-7
45, 60	104 (4.1)	203 (8.0)	184 (7.3)	3.4 (7.5)	Figure 5-8
100	150 (5.9)	203 (8.0)	193 (7.6)	3.8 (8.4)	Figure 5-9
130, 170	250 (9.8)	320 (12.6)	241 (9.5)	8 (17.6)	Figure 5-10
280	250 (9.8)	393 (15.5)	241 (9.5)	11 (24.3)	Figure 5-11
350	250 (9.8)	430 (16.9)	261 (10.3)	16.7 (36.8)	Figure 5-12
Thyro-S 3S					
8, 16, 30	135 (5.3)	136 (5.4)	129 (5.1)	2.1 (4.6)	Figure 5-13
45, 60	156 (6.1)	203 (8.0)	184 (7.3)	5.1 (11.2)	Figure 5-14
100	225 (8.9)	203 (8.0)	193 (7.6)	5.7 (12.5)	Figure 5-15
130, 170	375 (14.8)	320 (12.6)	241 (9.5)	12 (26.5)	Figure 5-16
280	375 (14.8)	393 (15.5)	241 (9.5)	15 (33.1)	Figure 5-17
350	375 (14.8)	430 (16.9)	261 (10.3)	25.5 (56.2)	Figure 5-18

Unless otherwise noted in the following table, in UL applications use 60°C or 60°C/75°C copper conductors.

Table 3-3. Terminal size

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

Table 3-3. Terminal size (Continued)

Type Current	AC Connection Screw Size	Ground Screw Size	Conductor Area	Wire Gauge
280 A	M10	M10	150/185 mm^2	
350 A	M10	M10	185 mm^2	
[1] In UL applications, use only 75°C copper conductors (except for control circuits).				

ELECTRICAL SPECIFICATIONS

Table 3-4. Electrical specifications

Description	Specification
Electrical Requirements	
AC input voltage	Type H3: 230 V, 400 V, 500 V –57% to +10% [1] See Table 3-5.
	Type HRL3, HRLP3: 230 V, 400 V, 500 V -15% +10% Extended range –57% to +10% (with separate 24 V auxiliary power supply) See Table 3-5.
24 V auxiliary power supply input [2]	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)
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 3-7
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) 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 input	0 VDC - 24 VDC, R_I > 3.3kΩ , on > 3 VDC
Analog outputs [2]	Signal level 0 V - 10 V, 0 mA - 20 mA or 4 mA - 20 mA. The maximum burden voltage is 10 V.

Table 3-4. Electrical specifications (Continued)

Description	Specification
Relay [2]	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] The X2.8 setpoint potentiometer power supply on type H3 units can be used only when the AC input voltage is within the –15% to +10% range.

[2] Type HRLP3 only.

Table 3-5. Standard and extended voltage range

Type Voltage	Range	Voltage Range
Thyro-S H3 [1]		
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
Thyro-S HRLP3		
230 V	–15% to +10%	196 V < U mains ≤ 253 V
400 V	–15% to +10%	340 V < U mains ≤ 440 V
500 V	–15% to +10%	425 V < U mains ≤ 550 V
Thyro-S HRLP3 with external 24 V auxiliary power supply		
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

[1] The X2.8 setpoint potentiometer power supply on type H3 units can be used only when the AC input voltage is within the -15% to +10% range.

Table 3-6. Model-specific specifications

Current (A)	Type Power (kW)			Dissipation (W)	Fuse (A)
	230 V	400 V	500 V		
Thyro-S 1S ... H3, ... HRLP3					
8	3.2	3.2	4	9	10
16	3.7	6.4	8	30	20

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

Current (A)	Type Power (kW)			Dissipation (W)	Fuse (A)
	230 V	400 V	500 V		
30	6.9	12	15	47	40
45	10	18	22.5	52	63
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
350	80	140	175	390	500
Thyro-S 2S ... H3, ... HRLP3					
8		6	7	18	10
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
350		242	303	780	500
Thyro-S 3S ... H3, ... HRLP3					
8		6	7	27	10
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
350		242	303	1170	500

COOLING SPECIFICATIONS

Type H Thyro-S 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)		

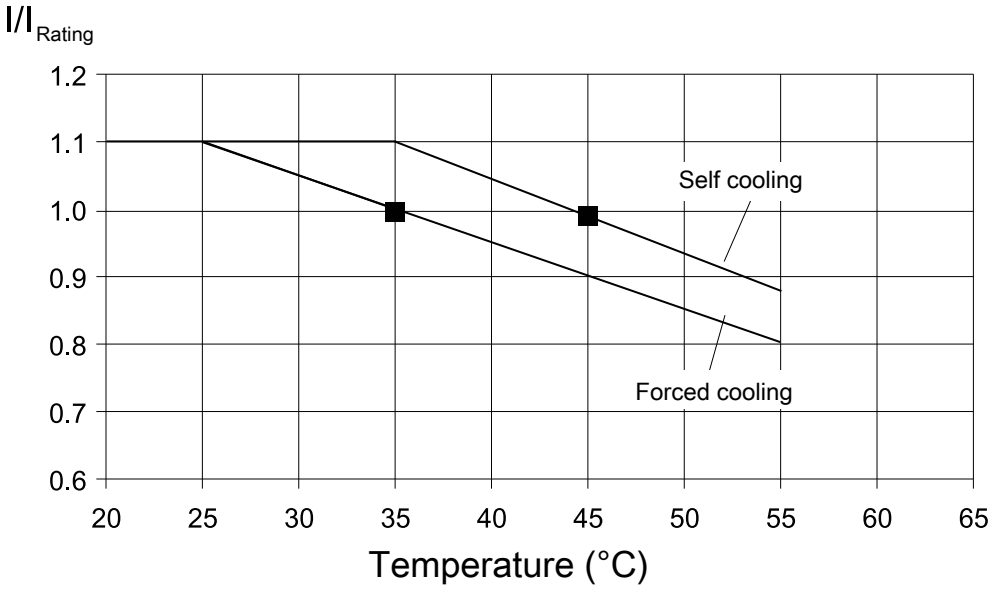


Figure 3-1. Current derating

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

Model	Current (A) [1]		Air Volume (m^3/h)	Sound Pressure (dbA @ 1 m)
	50 Hz	60 Hz		
1S				
280 F, 350 F	0.22	0.22	120	67
2S				
280 F, 350 F	0.5	0.38	200	70
3S				
280 F, 350 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-S 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	78.8 kPa to 106 kPa 788 mbar to 1060 mbar Equivalent altitude: +2000 m to -500 m (+6562′ to -1640′)
Storage	-25°C to +55°C -13°F to +131°F	5% to 95% 1 g/m^3 to 29 g/m^3	78.8 kPa to 106 kPa 788 mbar to 1060 mbar Equivalent altitude: +2000 m to -500 m (+6562′ to -1640′)

Table 3-10. Climatic specifications (Continued)

	Temperature	Relative Humidity	Air Pressure
Transportation	-25°C to +70°C -13°F to +158°F	95% [2] 60 g/m³ [3]	65.6 kPa to 106 kPa 656 mbar to 1060 mbar Equivalent altitude: +3500 m to -500 m (+11480′ to -1640′)

[1] Non-condensing, no formation of ice

[2] Maximum relative humidity when the unit temperature slowly increases, or when the unit temperature directly increases from -25°C to +30°C (-13°F to +86°F)

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

TYPE DESIGNATION

Validity

This manual describes the Thyro-S power controller series versions ... H3 and ... HRLP3. Product characteristics that are only provided by the Thyro-S ... HRLP3 series are marked in the text.

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-S 1S

Thyristor controller with 1-phase power unit, suited for 1-phase loads.

Thyro-S 2S

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

Thyro-S 3S

Thyristor controller with 3-phase power unit, suited for 3-phase loads.

Table 3-11. Type designation

Designation	Feature
... 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
3	Upgraded Thyro-S series

Thyro-S ... H3

Thyristor switch with integrated semiconductor fuse, system bus interface, synchronization option, and channel separation.

Thyro-S … HRLP3

Thyristor switch with integrated semiconductor fuse, system bus interface, additional 24 DC/AC electronic power supply, signaling relay, load monitoring and analog output, channel separation.

Communication Controls

CONTROLS AND INDICATORS

The unit can be configured using either the internal DIP switches, or via the Thyro-Tool Pro software.

- Setpoint 1: (X2.7 to X2.8 +5 V) +3 VDC to +24 VDC to X2.7 turns the output on
- Setpoint 2: Setpoint of the superordinate system or PC via either USB or the optional bus interface

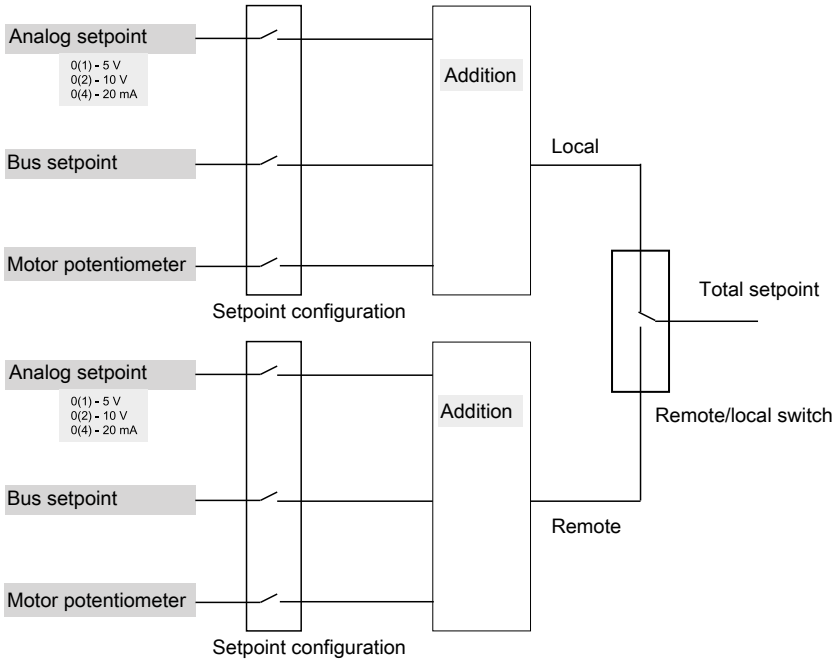


Figure 4-1. Total setpoint

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-S unit LED status indicators are located on the front panel of the unit.

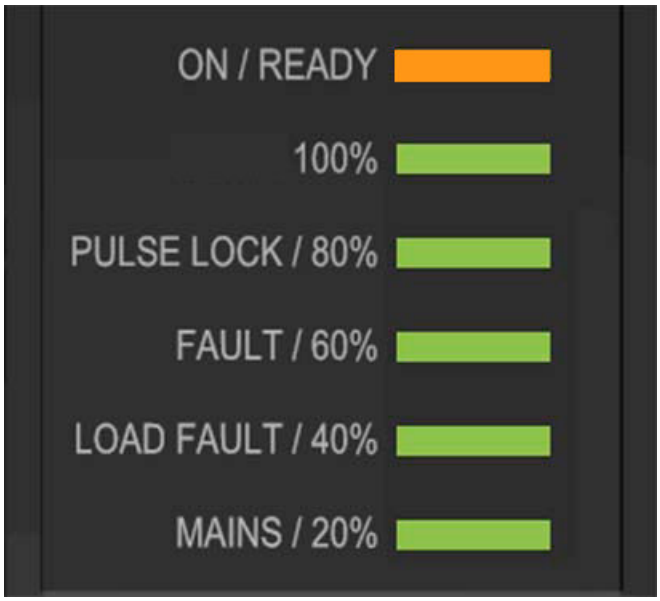


Figure 4-2. Status LEDs

Table 4-1. Thyro-S 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
100%	Green: Output is on Orange fast blinking: Setting aid active, parameter is at 100%
PULSE LOCK / 80%	Red blinking: Pulse lock active, see following table Green: Output is on Orange fast blinking: Setting aid active, parameter is at 80%
FAULT / 60%	Red blinking: Fault present, see following table Green: Output is on Orange fast blinking: Setting aid active, parameter is at 60%
LOAD FAULT / 40%	Red blinking: Load fault, see following table Green: Output is on Orange fast blinking: Setting aid active, parameter is at 40%
MAINS / 20%	Red blinking: Mains fault, see following table Green: Output is on Orange fast blinking: Setting aid active, parameter 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
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 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

DIP Switch Settings

There is a 10-pin DIP switch behind the cover of the master power unit for device configuration. The DIP switch is only read in once by the control device at switch-on or when the mains returns. Before commissioning, the DIP switch must be set to suit the application.

- Switch off mains supply and secure against accidentally being switched back on.
- Remove the cover of the master power unit.
- Set configuration on the DIP switch.

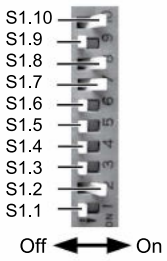


Figure 4-3. DIP switch

Table 4-3. S1 default settings

Type	1	2	3	4	5	6	7	8	9	10	Function
	1	0									Operating mode: Full-wave switch
			0	0	0						DIP switch configured, analog output Uload
						0	1	1			Not used
									0		Live zero analog output (HRLP3 only)
										1	Analog output 10 V range (HRLP3 only)

Table 4-4. Operating mode

Type	1	2	3	4	5	6	7	8	9	10	Function
1S											
Default	1	0	0	0	0	0	1	1	0	1	Full-wave switch
	1	0									Operation mode: Full-wave switch

Table 4-4. Operating mode (Continued)

Type	1	2	3	4	5	6	7	8	9	10	Function
2S											
	1	0									Operation mode: Full-wave switch with delta, or star without neutral conductor
3S											
	1	0									Full-wave switch with delta, or star without neutral conductor
	Can be set with Thyro-Tool Pro software.										Full-wave switch with open delta, or star with neutral conductor

Table 4-5. Analog output function

Type	1	2	3	4	5	6	7	8	9	10	Function
HRLP3											
			0	0	0						Analog output Uload
			0	1	0						Analog output Iload
			1	0	1						Analog output Pload
H3/HRLP3											
			1	1	1						Thyro-Tool Pro software mode

Table 4-6. Analog output mode

Type	1	2	3	4	5	6	7	8	9	10	Function
HRLP3											
									0	1	0 V to 10 V analog output
									1	1	2 V to 10 V analog output
									0	0	0 mA to 20 mA analog output
									1	0	4 mA to 20 mA analog output

The analog output can be used as a setting aid for the potentiometers.

Potentiometer Settings

There are potentiometers below the LEDs, with each potentiometer having a setting range of approximately 18 turns. Turning a potentiometer clockwise increases the value. Turning the potentiometer counterclockwise lowers the value.

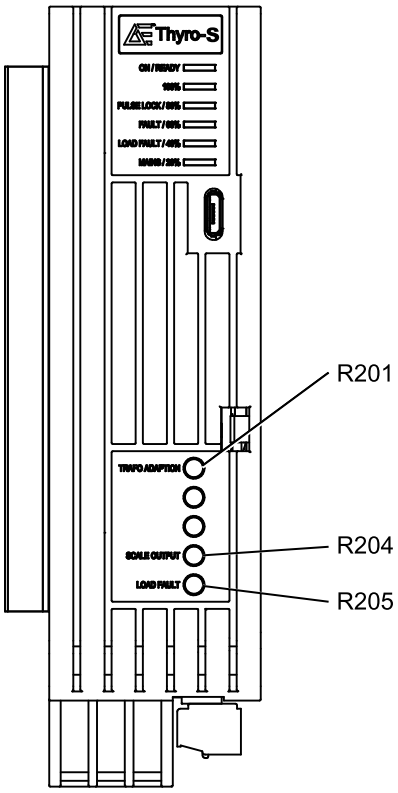


Figure 4-4. Potentiometer locations

Table 4-7. Potentiometer locations

Location	Function	Default
R201	Transformer adaptation (Phase angle of first half wave)	Thyro-S 1S 60° electrical phase angle Thyro-S 2S 90° electrical phase angle Thyro-S 3S 90° electrical phase angle
R204	Scale output [1]	U_{type}, I_{type}, P (depending on output variable of analog output)
R205	Load monitoring [1]	Off (left stop)
[1] For HRLP3 only.		

SETTING AIDS

The LED bar graph or the analog output may be used as an aid to setting the parameter potentiometers. When a potentiometer is changed, the LED bar graph enters the setting mode. The LED bar graph changes to an orange color, and flashes rapidly.

Table 4-8. Setting aids

LED Bar Graph	Analog Output	Setting %	Corresponding Phase Angle
100%	10.0 mA/5 V	100%	100° electrical phase angle
100% dimmed [1]	9.0 mA/4.5 V	90%	90° electrical phase angle (default Thyro-S 2S & 3S)
80%	8.0 mA/4.0 V	80%	80° electrical phase angle
80% dimmed	7.0 mA/3.5 V	70%	70° electrical phase angle
60%	6.0 mA/3.0 V	60%	60° electrical phase angle (default Thyro-S 1S)
60% dimmed	5.0 mA/2.5 V	50%	50° electrical phase angle (default Thyro-S 1S)
40%	4.0 mA/2.0 V	40%	40° electrical phase angle
40% dimmed	3.0 mA/1.5 V	30%	30° electrical phase angle
20%	2.0 mA/1.0 V	20%	20° electrical phase angle
20% dimmed	1.0 mA/0.5 V	10%	10° electrical phase angle

[1] At 90%, the 100% LED is dimmed.

SETTING THE TRANSFORMER LOAD

In order to minimize the rush current for transformers, it is possible to alter the angle of the first half wave on potentiometer R201 **TRAFO ADAPTION**.

Before adapting the transformer load:

- Set transformer load and SST on potentiometer R201 **TRAFO ADAPTION** (default setting: 60° electrical phase angle with the Thyro-S 1S, 90° electrical phase angle with the Thyro-S 2S and Thyro-S 3S)

To control a transformer load with the Thyro-S 1S controller, typically increase the phase angle by turning R201 **TRAFO ADAPTION** to the right. With the Thyro-S 2S and Thyro-S 3S controllers, typically decrease the phase angle by turning R201 **TRAFO ADAPTION** to the left. An optimal setting is achieved when the rush current is minimal.

ADAPTING ANALOG OUTPUT (SCALE)

For ... HRLP3

The scale of the analog output is adapted with potentiometer R204 **SCALE OUTPUT**, if, for example, the scale of the display does not correspond to the nominal data.

Default = 0 mA to 20 mA, corresponds to type value (current/voltage/power).

Table 4-9. Analog output scaling for voltage and current

Setting	U-, I Display Potentiometer R204 SCALE OUTPUT
Potentiometer turns (from left stop)	3.6 turns * (type value power / controller / scale end value)
Analog output setting aid mA (Switch S1.10 = **OFF**)	4 mA * (type value power controller / scale end value
Analog output setting aid V (Switch S1.10 = **ON**)	2 V * (type value power controller / scale end value)
LED bar graph	40% * (type value power controller / scale end value)

Table 4-10. Analog output scaling for power

Setting	P Display [1] - Potentiometer R204 SCALE OUTPUT		
	Thyro-S 1S	**Thyro-S 2S**	**Thyro-S 3S**
Potentiometer turns (from left stop)	3.6 turns * (type value power/ controller / scale end value)	4.16 turns * (Ptype power controller / scale end value)	6.24 turns * (Ptype power controller / scale end value)
Analog output setting aid mA (Switch S1.10 = **OFF**)	4 mA * (type value power controller / scale end value	4.62 mA * (Ptype power controller / scale end value)	6.93 mA * (Ptype power controller / scale end value)
Analog output setting aid V (Switch S1.10 = **ON**)	2 V * (type value power controller / scale end value)	2.13 V * (Ptype power controller / scale end value)	3.46 V * (Ptype power controller / scale end value)
LED bar graph	40% * (type value power controller / scale end value)	46.2% * (type value power controller / scale end value)	69.3% * (type value power controller / scale end value)
[1] Only with ... HRLP3			

For example, to scale the analog output of a Thyro-S 3S 400-30 HRLP3 (Utype = 400 V, Itype = 30 A, Ptype = 20.7 kW), for a measuring instrument range of 4 mA to 20 mA, with full scale at 20 kW:

- Setting aid in turns, R204: 6.24 * (20.7 kW / 20 kW) = 6.5 turns (from left stop)
- Setting aid in mA: 6.93 mA * (20.7 kW / 20 kW) = 7.17 mA
- Setting aid in V: 3.46 V * (20.7 kW / 20 kW) = 3.58 V

- Setting aid LED bar graph: 69.3% * (20.7 kW / 20 kW) = 72% ≈ 80% LED dimmed

SETTING LOAD MONITORING (UNDERCURRENT MONITORING)

For ... HRLP3

This function enables a freely selectable absolute current limit to be monitored. The value can be set using the R205 **LOAD FAULT** potentiometer or the Thyro-Tool Pro software.

During the configuration process via potentiometer, 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.

- Set load monitoring on potentiometer R205 **LOAD FAULT**.

The default setting of this monitoring is OFF (= left stop of potentiometer R205 **LOAD FAULT**). 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.

- The signaling delays can be up to 30 seconds.
- 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.

See “Monitoring Parallel Loads” on page 5-22 for more information.

ANALOG AND DIGITAL I/O

There is one standard I/O connector on the front of the unit:

- µUSB connector X5, for configuration using a PC

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

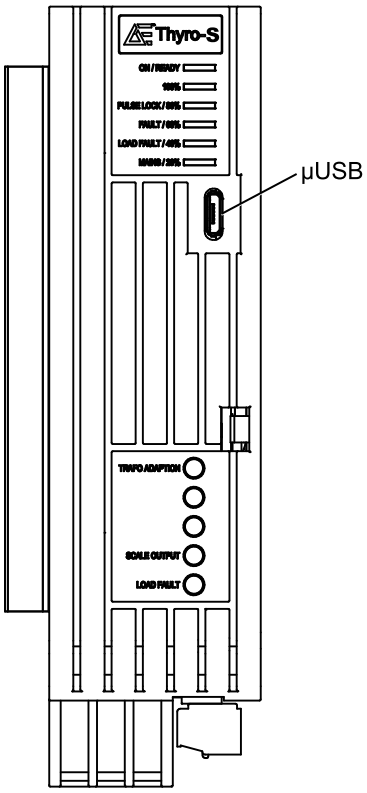
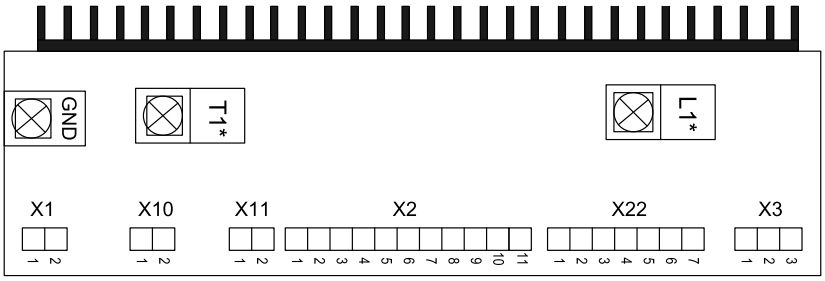


Figure 4-5. Front I/O connector

The type HRLP3 units have six connectors on the bottom of the unit:

- AC phase connection X1
- 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 4-6. Bottom connectors

Important

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

Table 4-11. AC phase connection (X1)

Pin	Function
X1.1	Add L2 or N connection according to the connection diagram (see "Connection Diagrams" on page 5-16).
X1.2	Add L2 or N connection according to the connection diagram (see "Connection Diagrams" on page 5-16).

Table 4-12. AC/DC auxiliary power input (X11)

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

Table 4-13. 11-pin analog I/O connector (X2)

Pin	Function
X2.1	Control ground
X2.2	Pulse lock
X2.3	Control ground
X2.4	Not used
X2.5	Control ground
X2.6	Not used
X2.7	Digital setpoint
X2.8	+5 V
X2.9	Analog output (setpoint potentiometer power 0 V to 10 V, or 0 (4) mA to 20 mA) [1]
X2.10	Control cable shield
X2.11	Not used
[1] Only with ... HRLP3	

Table 4-14. 7-pin bus module connector (X22)

Pin	Function
X22.1	Bus module detection/setpoint selection
X22.2	TxD
X22.3	RxD

Table 4-14. 7-pin bus module connector (X22) (Continued)

Pin	Function
X22.4	Control ground
X22.5	Slave connection
X22.6	Slave connection
X22.7	Control ground

Table 4-15. 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 5-12

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-S unit dimensions, front, and side views.

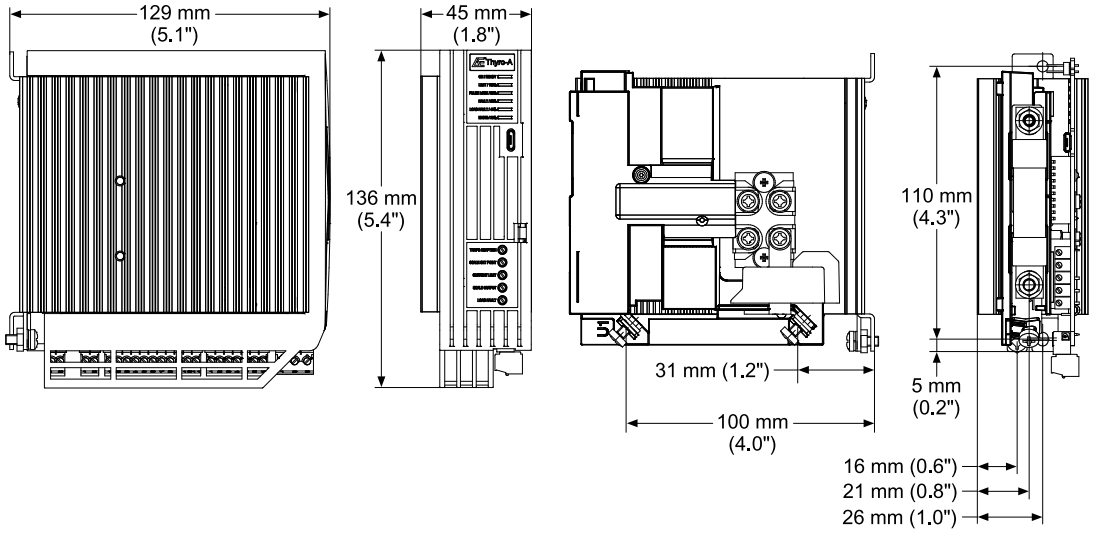


Figure 5-1. *Thyro-S 1S 8 H, 16 H, 30 H*

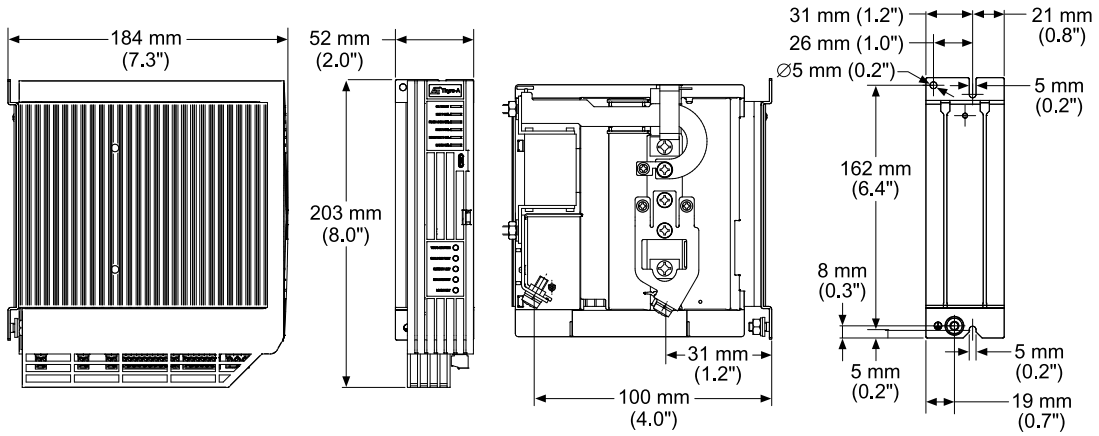


Figure 5-2. *Thyro-S 1S 45 H, 60 H*

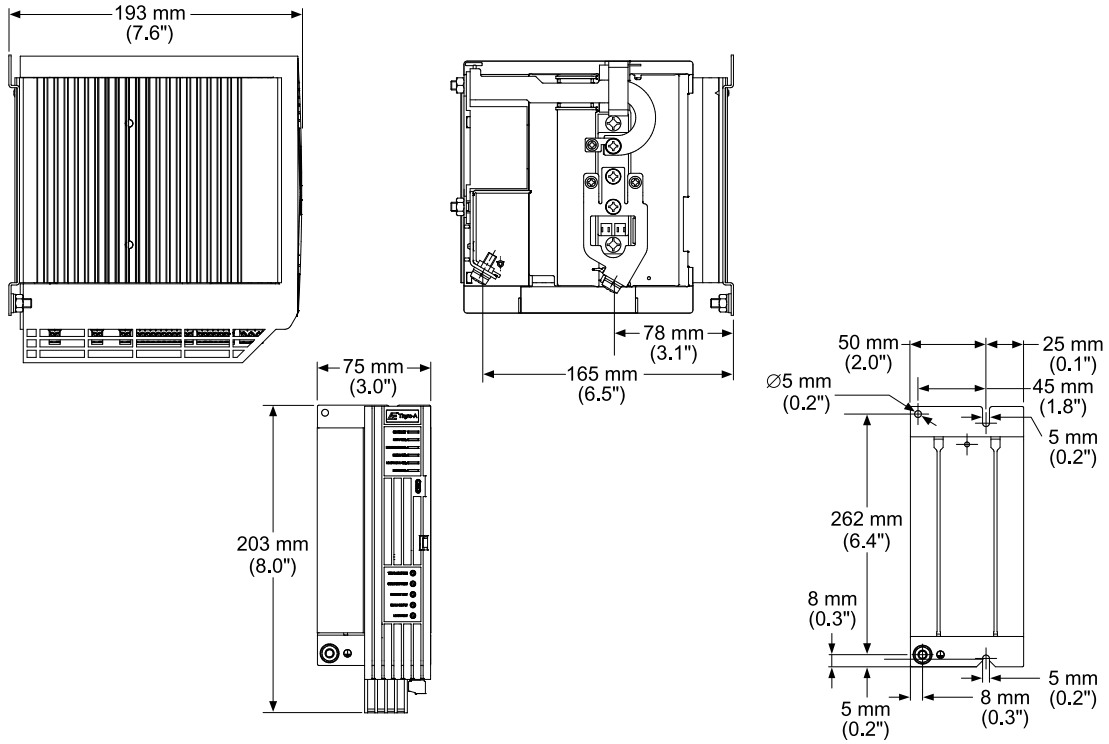


Figure 5-3. *Thyro-S 1S 100 H*

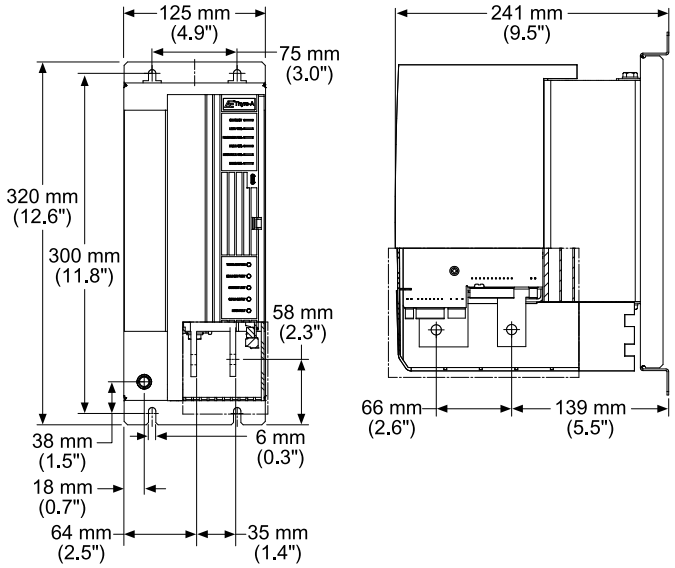


Figure 5-4. *Thyro-S 1S 130 H, 170 H*

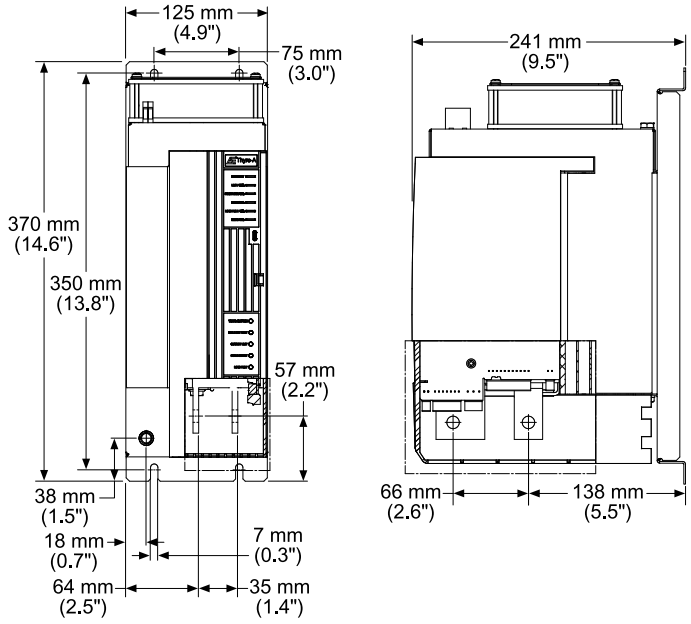


Figure 5-5. *Thyro-S 1S 280 HF*

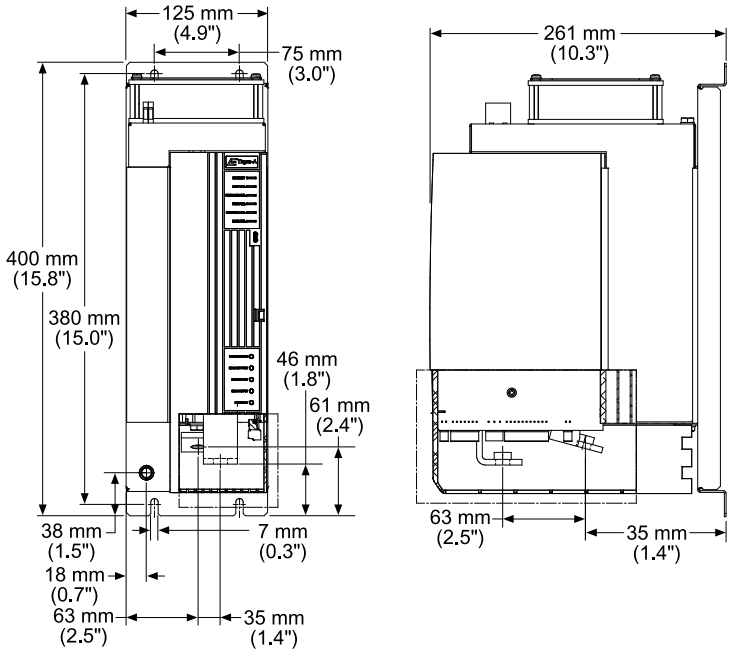


Figure 5-6. *Thyro-S 1S 350 HF*

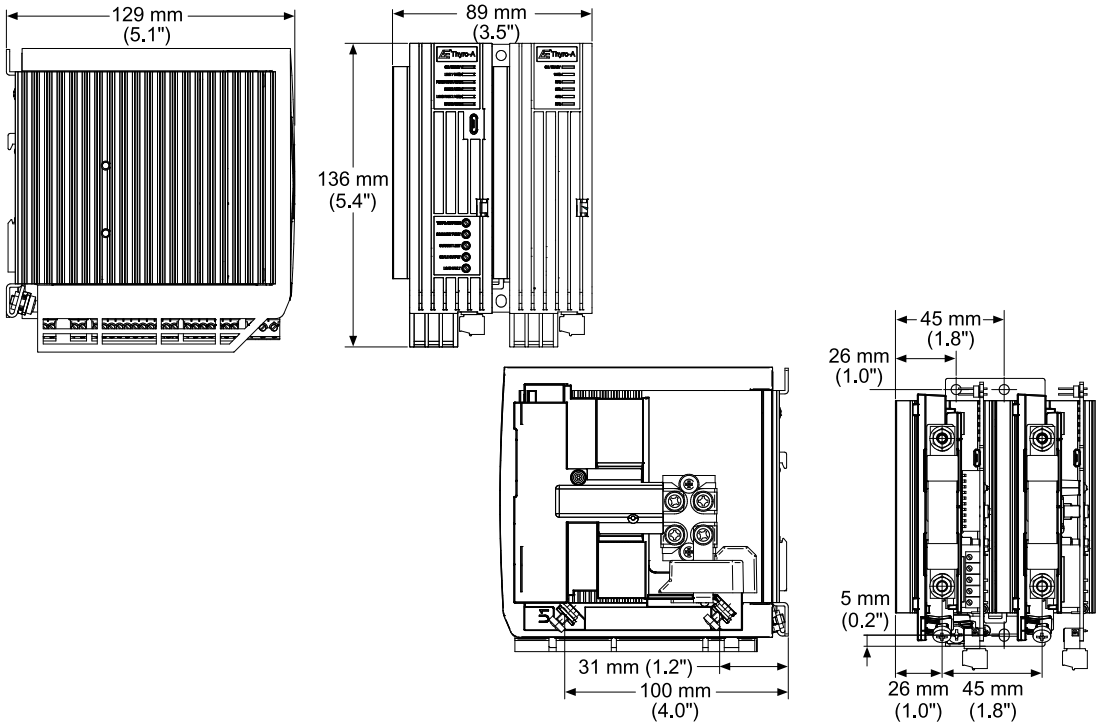


Figure 5-7. Thyro-S 2S 8 H, 16 H, 30 H

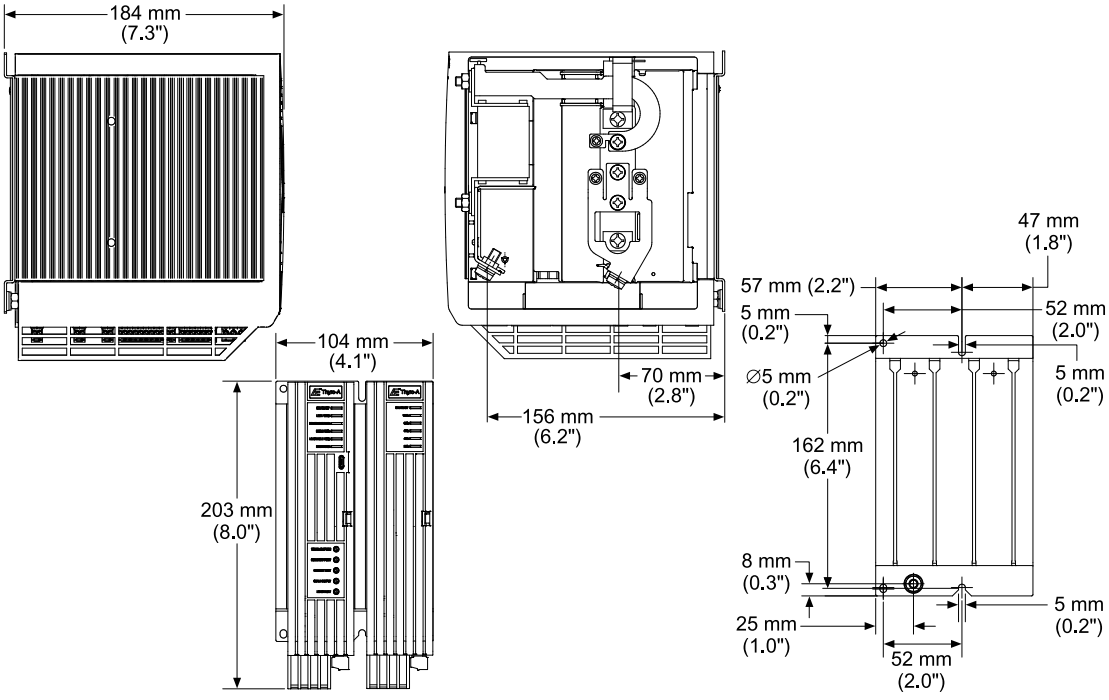


Figure 5-8. Thyro-S 2S 45 H, 60 H

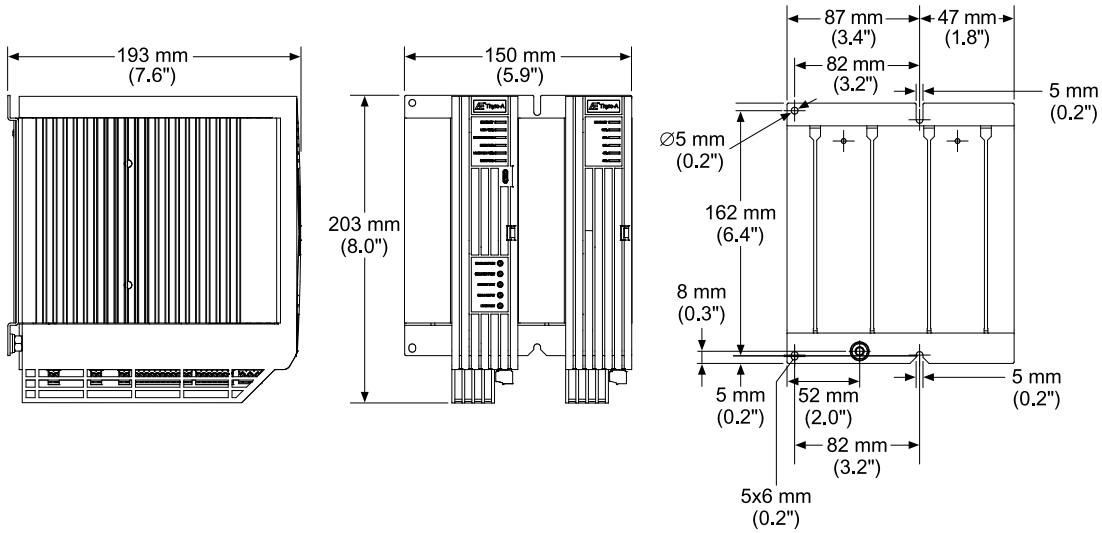


Figure 5-9. *Thyro-S 2S 100 H*

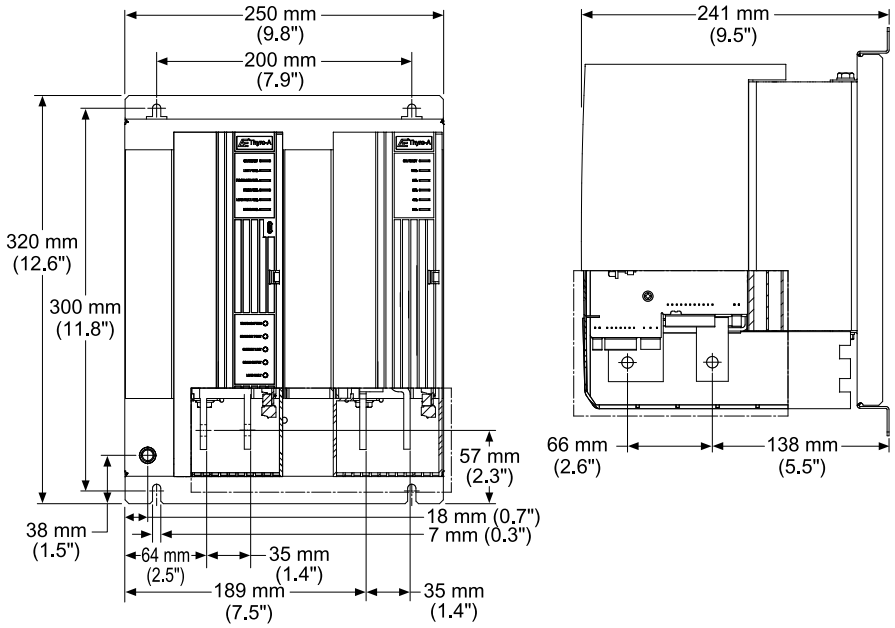


Figure 5-10. *Thyro-S 2S S 130 H, 170 H*

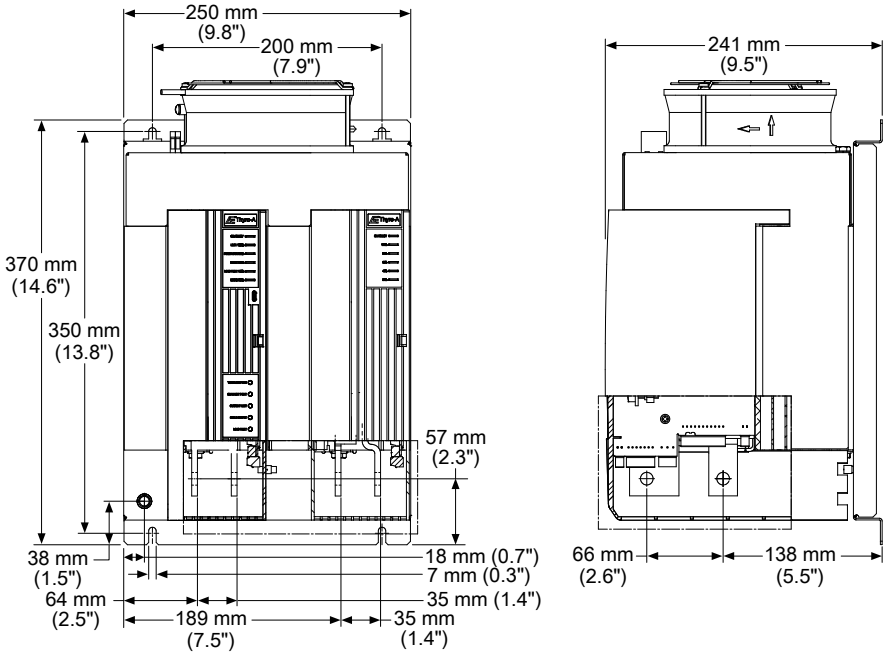


Figure 5-11. Thyro-S 2S 280 HF

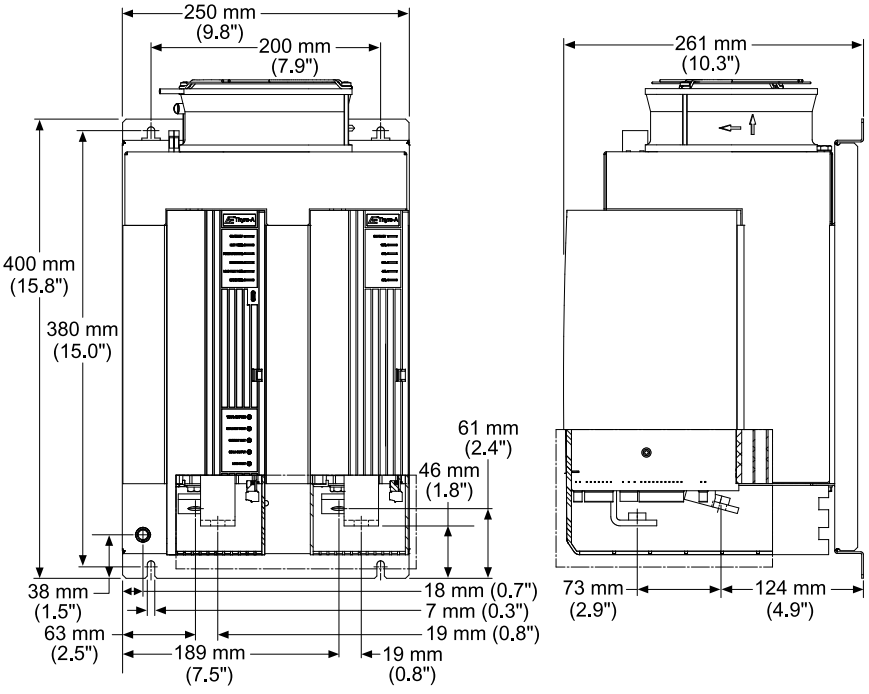


Figure 5-12. Thyro-S 2S 350 HF

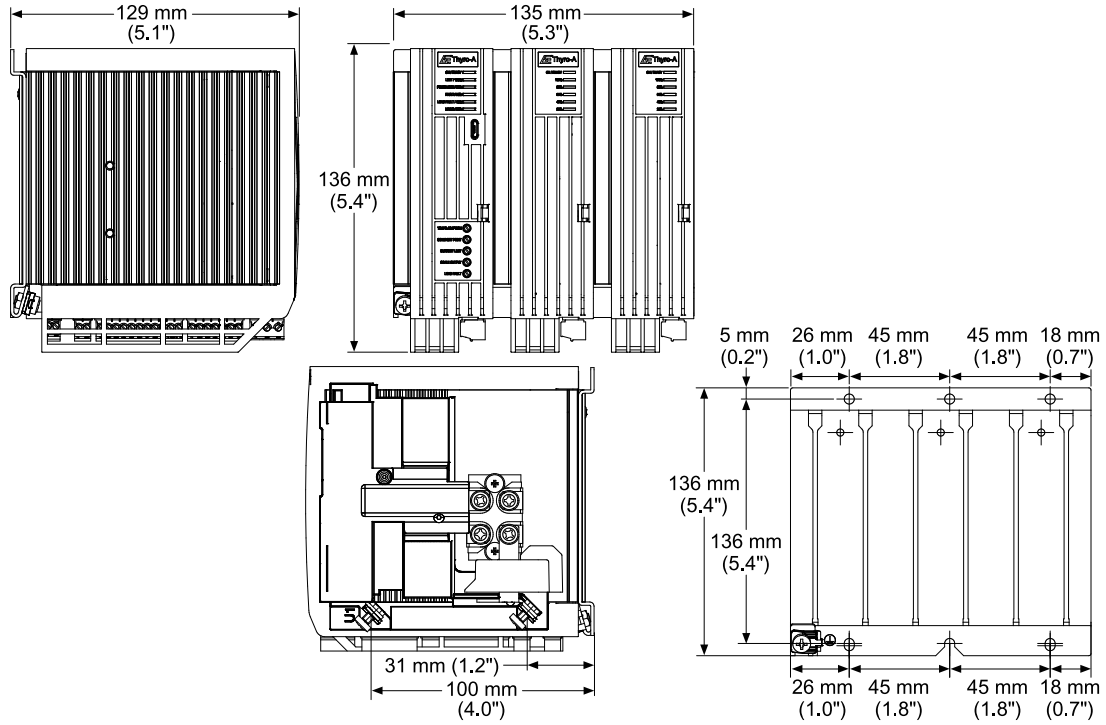


Figure 5-13. *Thyro-S 3S 8 H, 16 H, 30 H*

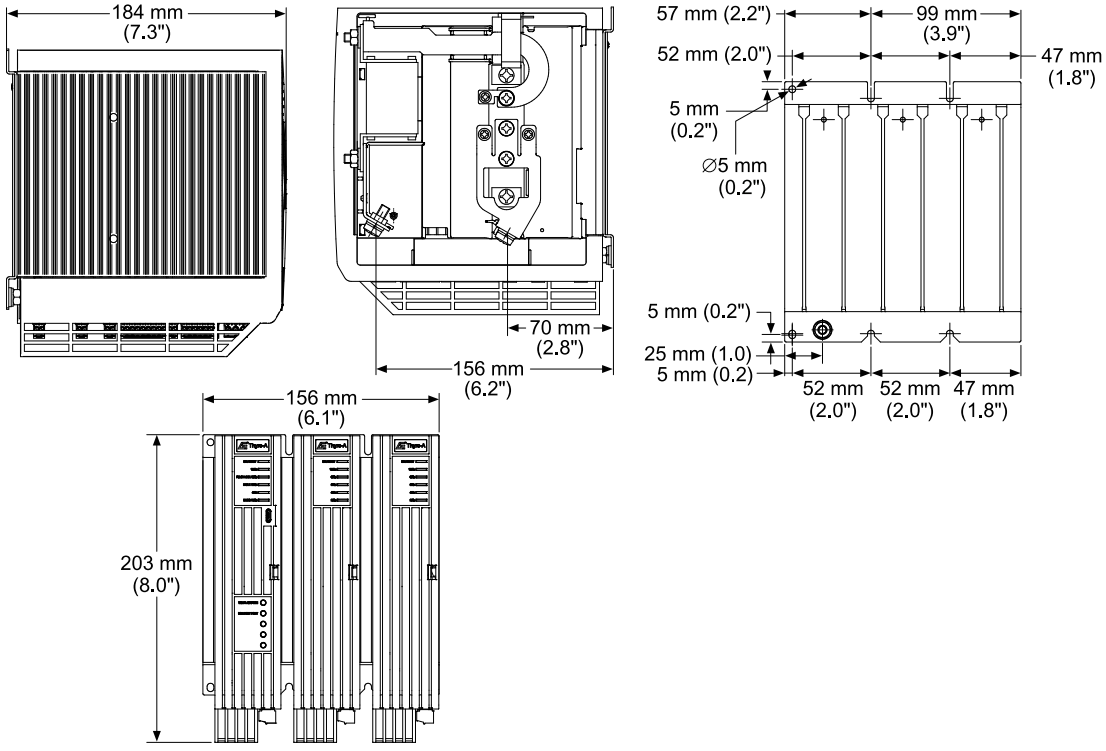


Figure 5-14. *Thyro-S 3S 45 H, 60 H*

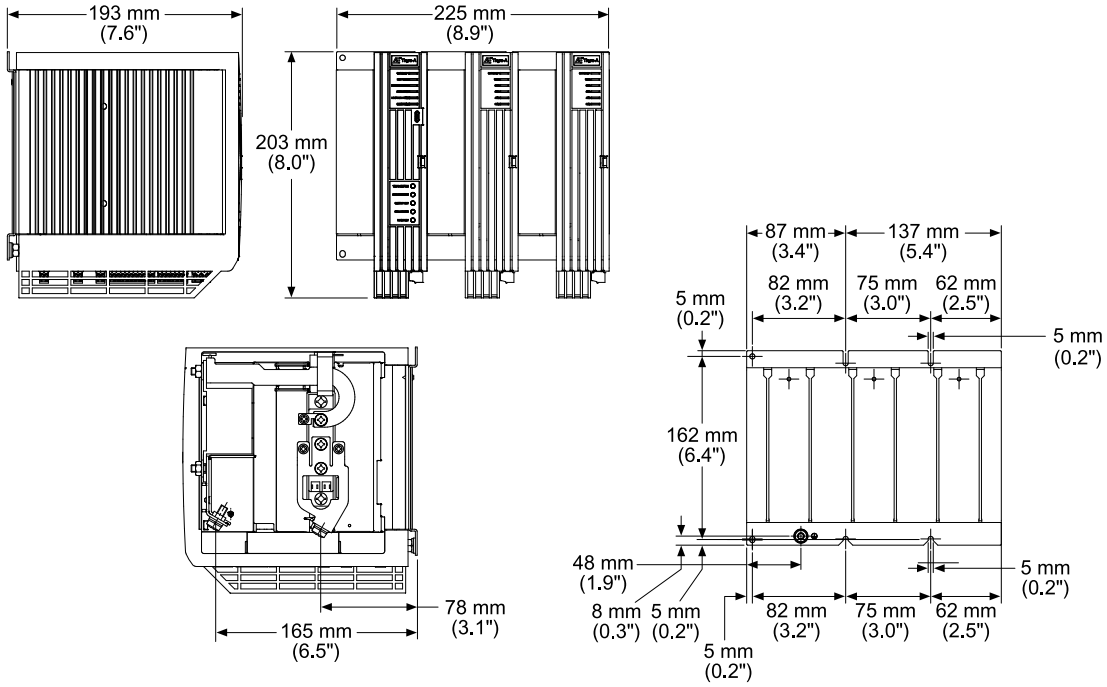


Figure 5-15. *Thyro-S 3S 100 H*

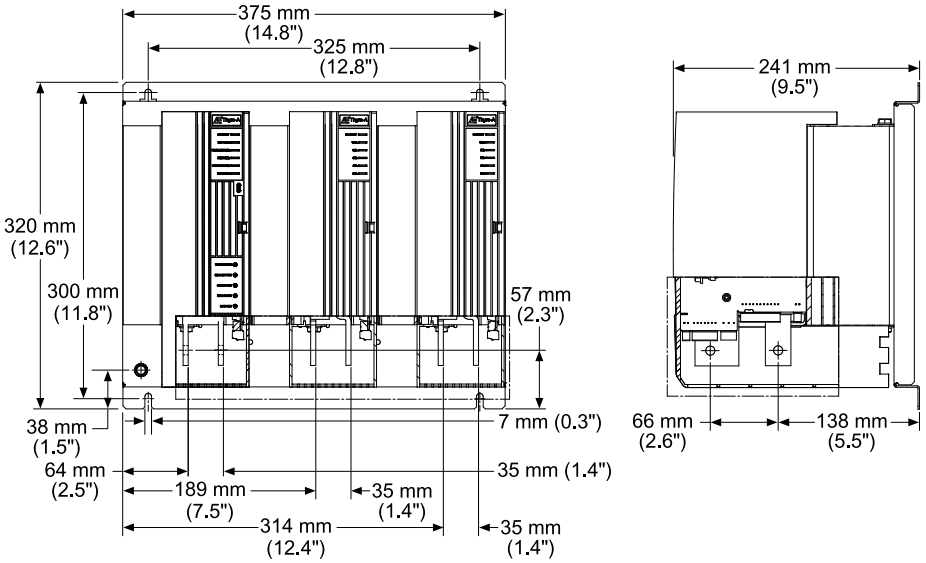


Figure 5-16. *Thyro-S 3S 130 H, 170 H*

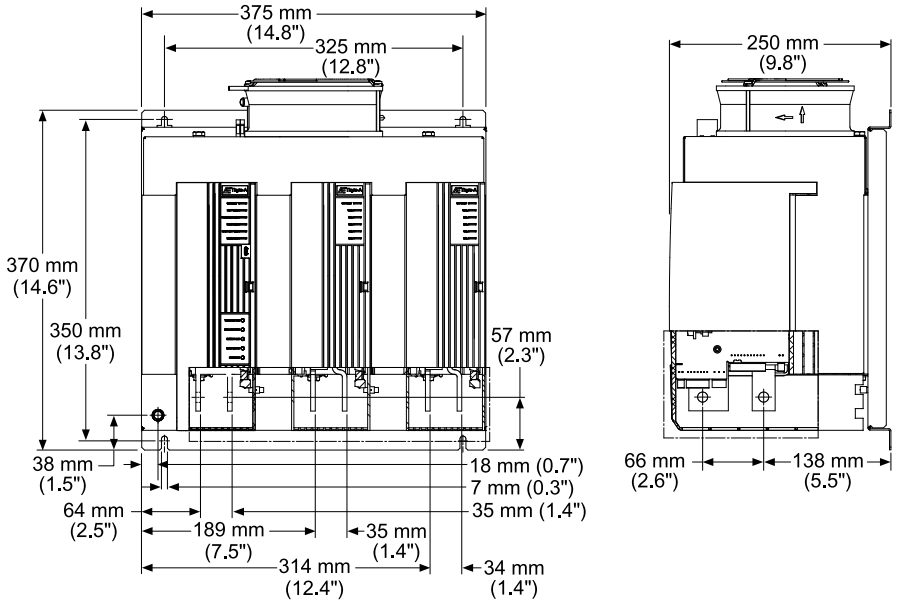


Figure 5-17. Thyro-S 3S 280 HF

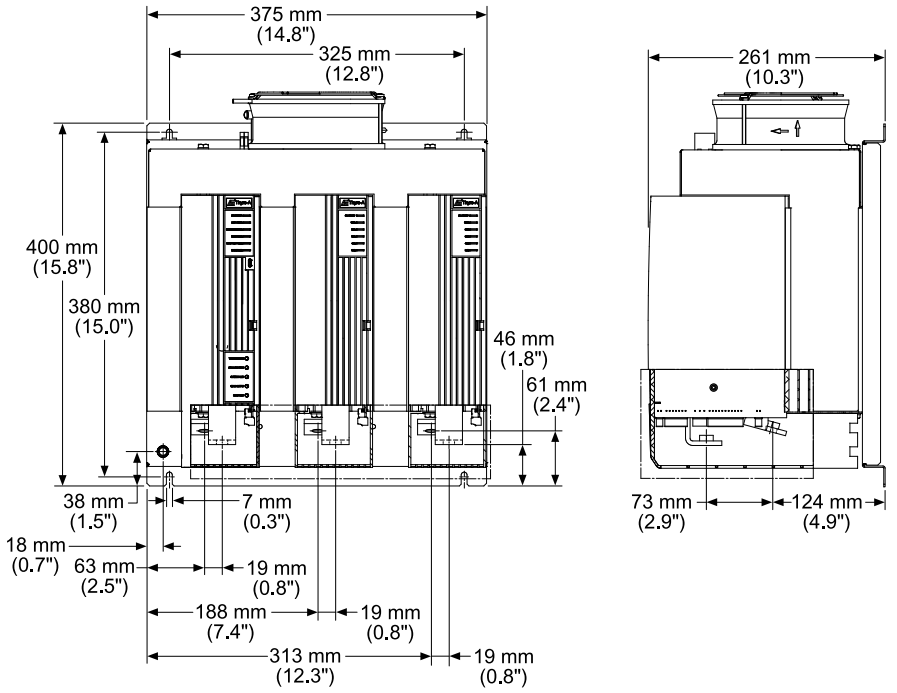


Figure 5-18. Thyro-S 3S 350 HF

Installation Requirements

Install this unit according to the following requirements.

DANGER:

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

DANGER:

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

DANGER:

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

DANGER:

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

Unpacking the Unit

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

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

Lifting the Unit

This manual describes many Thyro-S 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. Disconnect and lockout/tagout all sources of input power before working on this unit or anything connected to it.

DANGER:

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

Important

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

The following signal is always required for operation of the device: *DIGITAL 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 4-9

Connecting Load and Auxiliary Power

DANGER:

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

DANGER:

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

WARNING:

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

AVERTISSEMENT:

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

This task applies to all units. Three-phase units will have three mains input terminals and three load terminals. Two-phase and 1-phase units will have two sets or one set of mains terminals and load terminals, and will require a reference phase connection to connector **X1**, as shown in the connection diagram (see "Connection Diagrams" on page 5-16).

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 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.

6. To use the unit beyond the normal voltage range, connect a current-limited external 24 V power source to the power input connector **X11** on the bottom of the unit.

   External 24 V auxiliary power allows bus communication operation during mains faults.

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
8 A, 16 A, 30 A	Lug, M4	Lug, M4
45 A, 60 A, 100 A	M6	M6
130 A, 170 A	M8	M10
280 A, 350 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. Disconnect and lockout/tagout all sources of input power before working on this unit or anything connected to it.

DANGER:

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

WARNING:

More than one live circuit. See diagram.

AVERTISSEMENT:

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

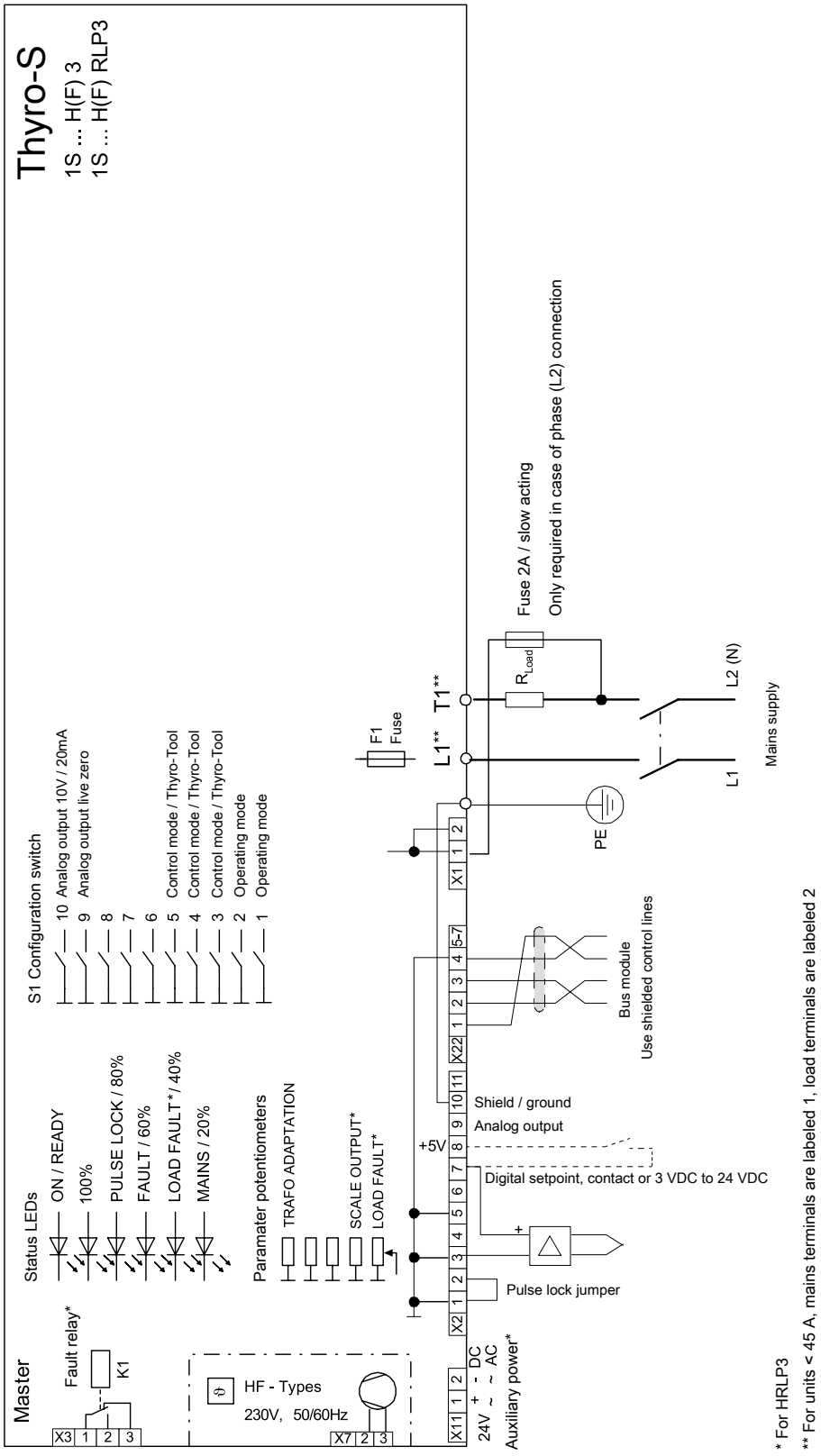


Figure 5-19. *1S power controller connections*

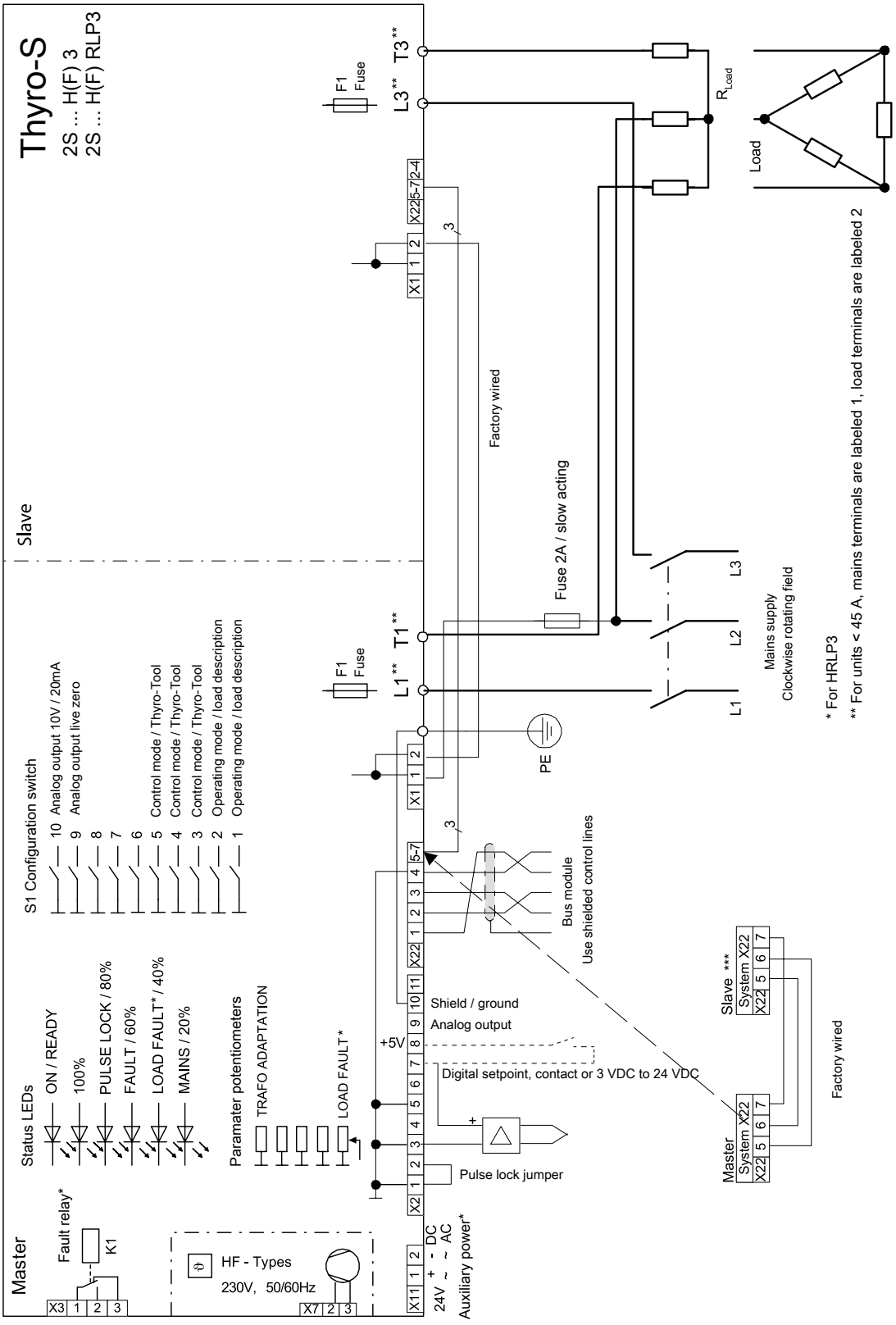


Figure 5-20. 2S power controller connections

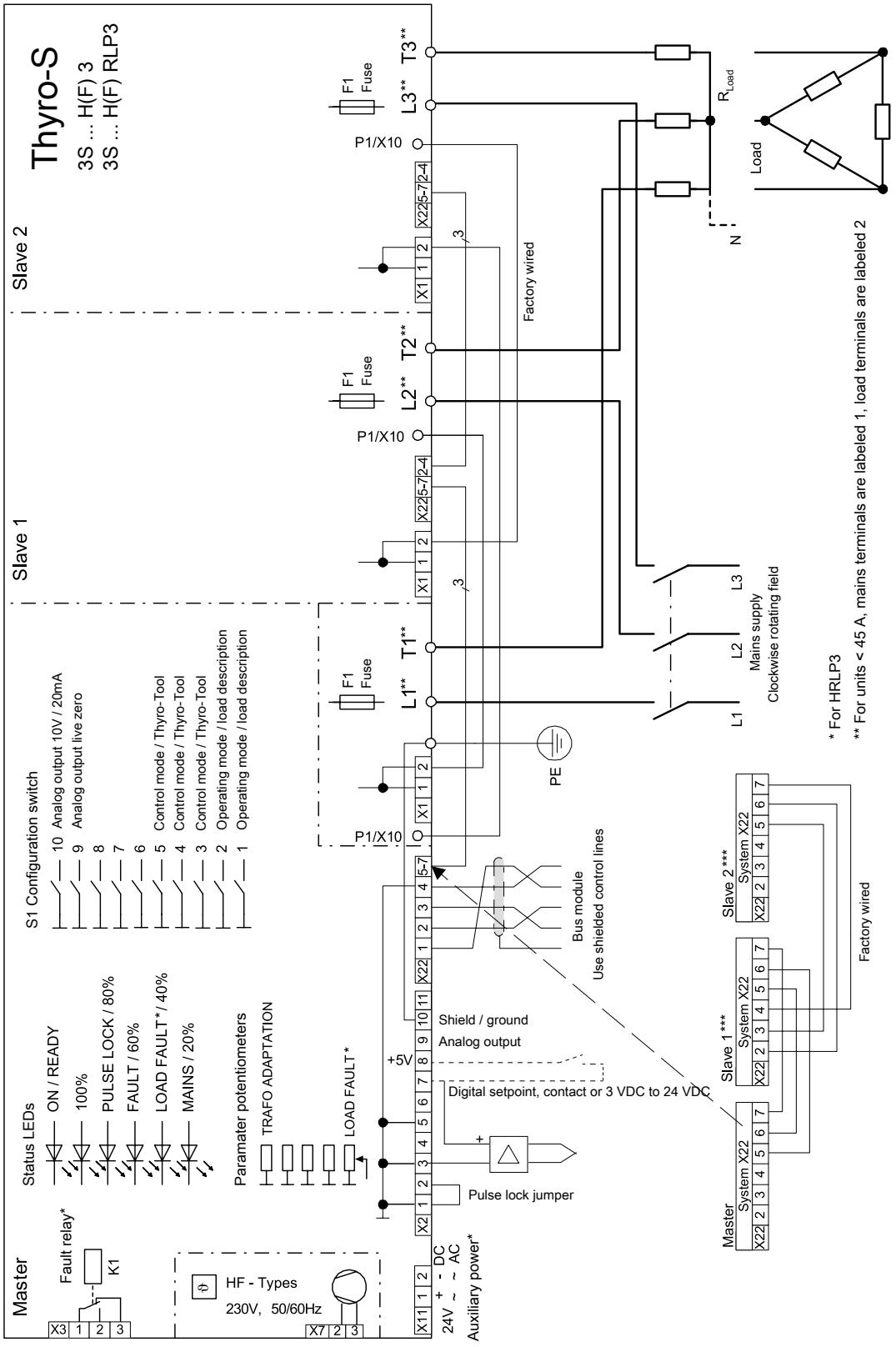


Figure 5-21. 3S power controller connections

FIRST TIME OPERATION

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

To Operate the Thyro-S Unit for the First Time

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

   The minimum connections are power, load, *DIGITAL SETPOINT*, and *PULSE LOCK* jumper (preconfigured).

2. Turn on the system circuit breakers and apply AC input to the unit.
3. Verify that the light green **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 a *DIGITAL SETPOINT* > 3 V applies power to the load, and a *DIGITAL SETPOINT* < 3 V removes power to the load.

If the Thyro-S 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

- "Software User Interface" on page 4-12

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

In full-wave switch mode, the mains voltage is switch on when the *DIGITAL SETPOINT* signal is on. Whole multiples of the mains periods are always switched and harmonics are minimized.

SETPOINT CONTROL

The power controller has two setpoint inputs that are electrically isolated from the mains. Only one setpoint input is active at one time.

- Setpoint 1: Digital Setpoint X2.7 (input); X2.3 (ground)
- Setpoint 2: Via system interface (bus module, Thyro-Tool Pro software)

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 5-3. 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
600 V	258 V	660 V

For ... HRLP3 only: In the event of more than 15% below the type voltage, the devices can only be operated up to the undervoltage limit if the electronics are supplied from an external 24 V source.

Device Temperature and Fan Monitoring

The Thyro-S 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

For ... HRLP3

This function enables a freely selectable absolute current limit to be monitored. The value can be set using the R205 **LOAD FAULT** potentiometer or the Thyro-Tool Pro software.

During the configuration process via potentiometer, 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.

- Set load monitoring on potentiometer R205 **LOAD FAULT**.

The default setting of this monitoring is OFF (= left stop of potentiometer R205 **LOAD FAULT**). 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.

- The signaling delays can be up to 30 seconds.
- 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.

See "Setting Load Monitoring (Undercurrent Monitoring)" on page 4-9 for more information.

THYRO-S 1S AND THYRO-S 2S WITH SEPARATE STAR POINT

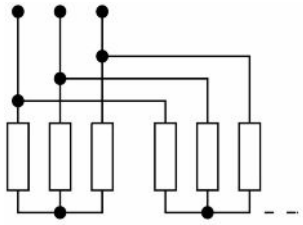


Figure 5-22. Load with separate star point and without neutral conductor

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

Table 5-4. Load with separate star point and without neutral conductor

Number of Parallel Load Resistors	$I_{LOAD\ NOM}$ / $I_{TYPE\ CONTROL-LER}$	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]	Number of Poten-tiometer Turns From Left Stop
1	100%	0%	50.0%	2.5 V	5 mA	8.5
	80%		40.0%	2 V	4 mA	7

Table 5-4. Load with separate star point and without neutral conductor (Continued)

Number of Parallel Load Resistors	$I_{LOAD\ NOM}$ / $I_{TYPE\ CONTROL-LER}$	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]	Number of Poten-tiometer Turns From Left Stop
	60%		30.0%	1.5 V	3 mA	6
	40%		20.0%	1 V	2 mA	4.5
	20%		10.0%	0.5 V	1 mA	2.5
2	100%	50%	75.0%	3.75 V	7.5 mA	12
	80%		60.0%	3 V	6 mA	9.5
	60%		45.0%	2.25 V	4.5 mA	7.5
	40%		30.0%	1.5 V	3 mA	6
	20%		15.0%	0.75 V	1.5 mA	3.5
3	100%	66%	83.3%	4.15 V	8.35 mA	13
	80%		66.7%	3.35 V	6.65 mA	10.5
	60%		50.0%	2.5 V	5 mA	8.5
	40%		33.3%	1.65 V	3.35 mA	6
4	100%	75%	87.5%	4.4 V	8.75 mA	13.5
	80%		70.0%	3.5 V	7 mA	11.5
	60%		52.5%	2.65 V	5.25 mA	9
	40%		35.0%	1.75 V	3.5 mA	6
5	100%	80%	90.0%	4.5 V	9 mA	14
	80%		72.0%	3.6 V	7.2 mA	11.5
	60%		54.0%	2.7 V	5.4 mA	9
	40%		36.0%	1.8 V	3.6 mA	6.5

THYRO-S 2S WITH STAR AND DELTA LOADS

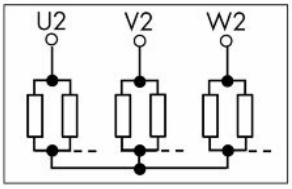


Figure 5-23. Load with common star point and without neutral conductor

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

Number of Parallel Load Resistors	$I_{LOAD\ NOM}$ / $I_{TYPE\ CONTROL-LER}$	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]	Number of Poten-tiometer Turns From Left Stop
1	100%	0%	50.0%	2.5 V	5 mA	8.5
	80%		40.0%	2 V	4 mA	7
	60%		30.0%	1.5 V	3 mA	6
	40%		20.0%	1 V	2 mA	4.5
	20%		10.0%	0.5 V	1 mA	2.5
2	100%	60%	80.0%	4 V	8 mA	12
	80%		63.0%	3.15 V	6.3 mA	10
	60%		48.0%	2.4 V	4.8 mA	8
	40%		32.0%	1.6 V	3.2 mA	5.5
	20%		16.0%	0.8 V	1.6 mA	3.5
3	100%	75%	87.0%	4.35 V	8.7 mA	13.5
	80%		70.0%	3.5 V	7 mA	11.5
	60%		52.0%	2.6 V	5.2 mA	8.5
	40%		35.0%	1.75 V	3.5 mA	6
4	100%	82%	90.0%	4.5 V	9 mA	14
	80%		72.0%	3.6 V	7.2 mA	11.5
	60%		(54.0%)	2.7 V	5.4 mA	9

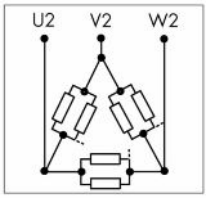


Figure 5-24. Load in delta connection

Table 5-6. Load in delta connection

Number of Parallel Load Resistors	$I_{LOAD\ NOM}$ / $I_{TYPE\ CONTROL-LER}$	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]	Number of Potentiometer Turns From Left Stop
1	100%	57%	79%	3.95 V	7.9 mA	12
	80%		63%	3.15 V	6.3 mA	10
	60%		48%	2.4 V	4.8 mA	8
	40%		32%	1.6 V	3.2 mA	5.5
	20%		16%	0.8 V	1.6 mA	3.5
2	100%	76%	88%	4.4 V	8.8 mA	13.5
	80%		66%	3.3 V	6.6 mA	0.5
	60%		50%	2.5 V	5 mA	8.5
	40%		33%	1.65 V	3.3 mA	6
	20%		17%	0.85 V	1.7 mA	4
3	100%	84%	90%	4.5 V	9 mA	14
	80%		72%	3.6 V	7.2 mA	11.5
	60%		54%	2.7 V	5.4 mA	9

THYRO-S 3S WITH STAR AND DELTA LOADS

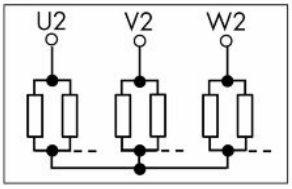


Figure 5-25. Load with common star point and without neutral conductor

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

Number of Parallel Load Resistors	$I_{LOAD\ NOM}$ / $I_{TYPE\ CONTROL-LER}$	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]	Number of Poten-tiometer Turns From Left Stop
1	100%	0%	50.0%	2.5 V	5 mA	7.8
	80%		40.0%	2 V	4 mA	6.6
	60%		30.0%	1.5 V	3 mA	5.4
	40%		20.0%	1 V	2 mA	4.2
	20%		10.0%	0.5 V	1 mA	2.9
2	100%	60%	80.0%	4 V	8 mA	11.4
	80%		64.0%	3.2 V	6.4 mA	9.5
	60%		48.0%	2.4 V	4.8 mA	7.5
	40%		32.0%	1.6 V	3.2 mA	5.7
	20%		16.0%	0.8 V	1.6 mA	3.7
3	100%	75%	87.5%	4.375 V	8.75 mA	12.3
	80%		70.0%	3.5 V	7 mA	10.3
4	100%	82%	91.0%	4.55 V	9.1 mA	12.8

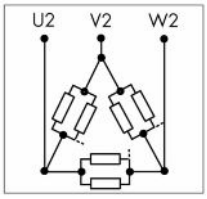


Figure 5-26. Load in delta connection

Table 5-8. Load in delta connection

Number of Parallel Load Resistors	$I_{LOAD\ NOM}$ / $I_{TYPE\ CONTROL-LER}$	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]	Number of Potentiom eter Turns From Left Stop
1	100%	57%	78.5%	3.925 V	7.85 mA	11.3
	80%		62.8%	3.14 V	6.28 mA	9.4

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

Number of Parallel Load Resistors	$I_{LOAD\ NOM}$ / $I_{TYPE\ CONTROL-LER}$	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]	Number of Potentiometer Turns From Left Stop
	60%		47.1%	2.355 V	4.71 mA	7.5
	40%		31.4%	1.57 V	3.14 mA	5.6
	20%		15.7%	0.785 V	1.57 mA	3.7
2	100%	76%	88.0%	4.4 V	8.8 mA	4
	80%		70.4%	3.52 V	7.04 mA	10.3

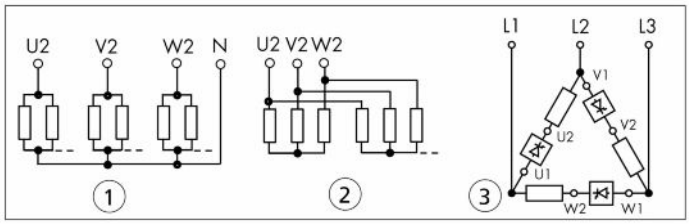


Figure 5-27. Other possibilities of load monitoring

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 5-9. TAB. 10 Other possibilities of load monitoring

Number of Parallel Load Resistors	$I_{LOAD\ NOM}$ / $I_{TYPE\ CONTROL-LER}$	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]	Number of Poten-tiometer Turns From Left Stop
1	100%	0%	50.0%	2.5 V	5 mA	7.8
	80%		40.0%	2 V	4 mA	6.7
	60%		30.0%	1.5 V	3 mA	5.4
	40%		20.0%	1 V	2 mA	4.2

Table 5-9. TAB. 10 Other possibilities of load monitoring (Continued)

Number of Parallel Load Resistors	$I_{LOAD\ NOM}$ / $I_{TYPE\ CONTROL-LER}$	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]	Number of Poten-tiometer Turns From Left Stop
	20%		10.0%	0.5 V	1 mA	3
2	100%	50%	75.0%	3.75 V	7.5 mA	10.9
	80%		60.0%	3 V	6 mA	9
	60%		45.0%	2.25 V	4.5 mA	7.2
	40%		30.0%	1.5 V	3 mA	5.4
	20%		15.0%	0.75 V	1.5 mA	3.6
3	100%	66%	83.0%	4.15 V	8.3 mA	11.8
	80%		66.4%	3.32 V	6.64 mA	9.8
	60%		49.8%	2.49 V	4.98 mA	7.8
	40%		33.2%	1.66 V	3.32 mA	5.9
	20%		16.6%	0.83 V	1.66 mA	3.8
4	100%	75%	87.5%	4.375 V	8.75 mA	12.3
	80%		70.0%	3.5 V	7 mA	10.3
	60%		52.5%	2.625 V	5.25 mA	8.1
	40%		35.0%	1.75 V	3.5 mA	6
	20%		17.5%	0.875 V	1.75 mA	3.9
5	100%	80%	90.0%	4.5 V	9 mA	12.7

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. Disconnect and lockout/tagout all sources of input power before working on this unit or anything connected to it.

DANGER:

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

DANGER:

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

DANGER:

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

Table 6-1. Using LED states for troubleshooting

<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 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>
</table>

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

<table>
<tr><th>Troubleshooting Check</th><th>Action</th></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 that cannot be resolved by working through the provided troubleshooting. When you call Global Services, make sure to have the unit serial number and part number. These numbers are available on unit labels.

☞ **Important**

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

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

Office	Contact
AE World Headquarters	Address: 1625 Sharp Point Drive Fort Collins, CO 80525 USA Phone (24 hrs/day, 7 days/week): 800.446.9167 or +1.970.221.0108 Email: (We will respond to email by the next business day.) mailto:technical.support@aei.com
Thermal product support	Contact by phone or email: +1.360.694.7871 mailto:thermalapplications@aei.com
Power Control Module product support	Contact by phone or email: +49 (0) 2902 910370 10 (technical support during German business hours) mailto:powercontroller@aei.com
High Voltage product support: HiTek Power, Ltd.	Contact by phone or email: +44 (0) 1903 712400 mailto:support.centre@aei.com
High Voltage product support: UltraVolt, Inc.	Contact by phone or email: +1.631.471.4444 mailto:sales.support-uv@aei.com
Local or regional sales or service office	Visit the Advanced Energy website for current contact information: http://www.advanced-energy.com

RETURNING UNITS FOR REPAIR

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

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