Power controller

THYRITOP 300

English

User's Manual

PYRO® CONTROLE
CHAUVIN ARNOUX GROUP

CONTENTS

LIST OF TABLES AND ILLUSTRATIONS

ABBREVIATIONS

AN1 - phase angle of the 1st half wave
SST - soft-start time
SYT - synchronized clock
T0 - cycle period
TS - switch-on time
TAKT - full wave mode
VAR - phase angle firing
QTM - quick takt mode
SWITCH - switch mode

SPECIAL FEATURES

- Integrated semiconductor fuse
- Type range 230-600 V~, 16-1500 A, single phase, two phase and three phase
- Load voltage from 24 V~
- Touch display capable of full graphics
- Electronic supply with 230V~/110V~ (85 V-265 V permissible)
- Ohmic load and transformer load as well as load with large R_{warm} /R_{cold} (≤6) and configurable peak current limitation up to 3 x I_{nom} in operating mode VAR.
- Soft-start function for transformer load
- Channel separation, needed in case of counter voltage
- Load current monitoring
- Measurement of real phase value (current, voltage, power and resistance)
- Fuse monitoring
- 1 signaling relay
- 3 analog outputs
- Flexible connection: supply and outflow from above or below as selected
- Control modes U, U^2, I, I^2, P
- Operating modes TAKT, VAR, SWITCH and QTM (QTM only in the case of the single phase device, VAR only in the case of the single and three phase device)
- Mains load optimization: internal for operating modes QTM and TAKT, connection for external mains load optimization e.g. Thyritop Power Manager (QTM only in the case of single phase device)
- Values display via Ethernet through integrated web server with browser interface
- Control by analog or digital setpoint, via PC, touch display or via optional bus adapter
- Data logger
- Operating hours counter
- Energy counter
- Internal/external measuring transformer
- USB interface
- Safe isolation in accordance with DIN EN 50 178
- UL approval (for standard devices 16 - 350A)
- Connection for optional visualization and commissioning software Thyritop-Tool 300 via USB

Options:

- Coupling to different bus systems e.g. PROFIBUS DPV1, Modbus RTU, DeviceNet, CANopen, PROFINET, EtherNet/IP and Modbus TCP. Other bus systems on request.
- Thyritop-Tool 300 (visualization and commissioning software)

1 SAFETY NOTES

The safety notes and the operating instructions are to be read carefully before installing and commissioning.

1.1 OBLIGATORY INSTRUCTION

These safety notes and operating instructions shall carefully be read by all persons deployed for work using and employing the Thyritop 300 prior to assembly, installation and the initial start-up of the Thyritop 300. These operating instructions are part of the Thyritop 300. The operator of the device is committed to provide these operating instructions without limitation to all persons, who transport the Thyritop 300, start it up, maintain it, or perform other work tasks to it. In accordance with the Product Liability Act the manufacturer of this product is obligated to inform about and warn against

- Other than the intended use of a product
- The residual hazards of a product as well as
- Incorrect usages and their consequences

The following information is intended for this purpose. This information should warn the product user and protect him and his appliances.

1.2 APPROPRIATE USAGE

The Thyritop 300 is a power controller which is capable of communication. It can be used anywhere where alternating voltages, alternating currents or power need to be regulated in thermal process engineering. The Thyritop 300 has several different operation and control modes, good connectivity with the process and automation technology, high regulation accuracy and simple handling.

- The Thyritop 300 is a component which may only be used to control and regulate electric energies in industrial alternating or three-phase networks.
- The Thyritop 300 may at most be operated with the maximum permissible connection values in accordance with the details on the type plate.
- The Thyritop 300 may only be operated in connection with an appropriate upstream mains disconnecting device (e.g. switch, take note of DIN EN 50110-1)
- The Thyritop 300 is not functional on its own and must be project planned for its appropriate usage in order to minimize the residual hazards of the product.
- The Thyritop 300 may only be used for the purpose for which it was intended, as persons may otherwise be exposed to dangers (e.g. electric shock, burns) and systems also (e. g. overload).
- It is not permitted to make any unauthorized modifications to the device or to use any spare parts or replacement parts not approved by Pyrocontrole, or to use the device for any other purpose.
- The warranty obligations of the manufacturer are only applicable if these operating instructions are observed and complied with.
- It must be ensured that in the case of an error no uncontrolled large currents, voltages of power can occur in the circuit.
- In the case of an error even with appropriate usage it is possible that the currents, voltages or power in the load circuit are no longer affected by the device (example: in the case of the destruction of the power components (fully alloyed or high resistance) the following reactions may result: current interruption, half wave operation, continual flow of energy).

1.3 RESIDUAL HAZARDS OF THE PRODUCT

Even with intended use it is possible, in the case of an error, that the currents, voltages or power in the load circuit are no longer affected by the Thyritop 300. If the power components are destroyed, for example, the following cases are possible: current interruption, continual flow of energy.

If such a case occurs, then the occurring load voltages and currents result from the physical sizes of the overall circuit. Throughout the project planning of the system it must be ensured, that no uncontrolled large currents, voltages or power can occur.

1.4 INCORRECT OPERATION AND THEIR CONSEQUENCES

In the case of incorrect operations, higher power, voltages or currents than intended can reach the thyristor power controller or the load. This can cause damage to the thyristor power controller or the load. In particular, factory-set parameters may not be altered in such a way that the Thyritop 300 is overloaded.

1.5 SCOPE OF SUPPLY

The supply consists of the following parts:

- Thyritop 300
- Accessory bag with screw/push terminals
- Operating instructions
- Safety note stickers

1.6 STORAGE

The devices may be stored originally OEM packaged in rooms, which are dry and ventilated.

- Permissible ambient temperature: -25 °C to +55 °C
- Permissible relative air humidity: max. 85%
- For longer storage durations, the devices should be contained in airtight plastic skins with the addition of commercially available drying agents.

1.7 ASSEMBLY

- If stored in cold environments it must be ensured that the device is absolutely dry before commissioning. Therefore allow at least 2 hours acclimatization time before commissioning.
- Ensure sufficient ventilation and aeration of the cabinet if mounted in a cabinet.
- Observe minimum spacing.
- Ensure that the device cannot be heated up by heat sources below it. (see Technical data).
- Ground the device in accordance with the local regulations.
- Connect the device in accordance with the connection diagrams.
- For further details see the chapter "Installation".

1.8 CONNECTION

Before connection, the indicated voltage on the type plate is to be compared with the mains voltage to make sure they match. The electrical connection is made at the points labeled on the Thyritop 300.

1.9 MAINTENANCE, SERVICE, FAULTS

The symbols used in the following are explained in the chapter on safety requirements.
In order to avoid damage to personnel or property the user must note the following points before all work:

CAUTION
In the case of smoke or smell development, as well as in the case of fire, the power controller shall immediately be disconnected from the power supply.

CAUTION
For maintenance and repair works the power controller must be disconnected from all external voltage sources and safeguarded against it being switched on again. After switching off wait at least two minutes for the snubber capacitors to discharge. The absence of voltage is to be ascertained using appropriate measurement instruments. The device is to be grounded and short-circuited. Adjacent components under voltage are to be covered or separated off. These activities may only be carried out by an electrically qualified person. The local electro-technical regulations are to be adhered to.

CAUTION
The thyristor controller contains voltages which are hazardous. Repairs are strictly only to be carried out by qualified and trained maintenance personnel.

CAUTION
Hazard of electric shocks. Even after the separation from the mains, capacitors can still contain dangerously high levels of energy.

CAUTION
Hazard of electric shocks. Even with a non-activated thyristor controller the load circuit is not separated from the mains by the thyristor controller.

ATTENTION
Different power components are screwed in place with exact torques according to their function. For safety reasons repairs to power components are to be carried out by Pyrocontrole or Manumesure.
Repairs by personnel of the operator require a written confirmation of the manufacturer.

1.10 REPLACEMENT OF THE INTEGRATED SEMICONDUCTOR FUSE

The device has got an integrated semiconductor fuse F1 for each power unit which is designed protection reasons for the thyristor. If it has to be replaced, the device shall immediately be disconnected from the power supply. Before resumption of operation it is responsible for seeing that all screws are fastened and no unfasten screw are in the cabinet.

1.11 SHUT DOWN, DIS-ASSEMBLY

If shutting down and dis-assembling the device for the reason of venue change or for disposal purposes the following safety rules must be complied with prior to the beginning of all work performed:

ATTENTION MAINS VOLTAGE!
Safety rules for work performed to electrical facilities:
1. Disconnect the device from the power supply (establish a voltage free status)
2. Secure against re-activation
3. Verify by measurement that there is no voltage present
4. Ground and short-circuit equipment
5. Cover or separate adjacent parts which are under voltage

For dis-assembly, perform the following steps:
1. Separate the device from the 230VAC, respectively 110VAC, power supply.
2. Separate all other connections. Electrical connections are thus dis-assembled and now, the device can be removed by dis-assembly from the overhead rail.

2 SAFETY REQUIREMENTS

2.1 IMPORTANT INSTRUCTIONS AND EXPLANATIONS

For the protection of personnel and the maintenance of good working order, usage and repairs must be in line with the guidelines, and the safety requirements listed must be adhered to. The personnel who set up/disassemble the devices, start them up, operate them, maintain them, must know and adhere to these safety requirements. All works may only be carried out by specialist personnel trained for the purpose and equipped with the tools, appliances, means of testing and materials required and intended for that purpose. In these operating instructions, there are important warnings before dangerous actions. These warnings are divided into the following classes of hazards:

DANGER
Hazards that can lead to serious injuries or fatal injuries.

WARNING
Hazards that can lead to serious injuries or considerable damage to property.

CAUTION
Hazards that can lead to injuries and damage to property.

CAUTION
Hazards that can lead to minor damage to property.

The warnings can also be supplemented with a special danger symbol (e.g. "Electric current" or "Hot device"), e.g.

 in case of risk of electric current or

 in case of risk of burns.

In addition to the warnings, there is also a general note for useful information.

NOTE
Content of note

2.2 GENERAL DANGER INFORMATION

DANGER
ELECTRIC CURRENT
Hazards that can lead to serious injuries or fatal injuries.

WARNING
ELECTRIC CURRENT
Risk of injury from current carrying parts
• Never operate the device without covering.

CAUTION
HOT DEVICE
Risk of burns from heat sinks and adjacent plastic parts (> 70 °C possible)
Do not touch the hot parts of the device.
Affix the warning sign "Risk of burns" in the immediate vicinity of the device.

DANGER
HAZARDS DURING INSTALLING
Not adhering to the safety requirements in the operating instructions of the power controllers being used can lead to danger of injury/danger of damaging the device or system.
- Adhere to all safety requirements in the chapter "Safety" of the operating instructions of the power controllers being used.

DANGER
UNSAFE SYSTEM DUE TO INCORRECT INSTALLATION
Incorrect installation can lead to unsafe operation of the system. Therefore it is essential to maintain the following specifications:
- Only install the device in an upright position.
- Ensure sufficient ventilation and deaeration of the cabinet if mounted in a cabinet.
- Observe minimum spacing (self-ventilated: clearance: 150 mm above, 100 mm below). The devices can be installed next to one another without spacing between.
- Ensure that the device cannot heat up as a result of heat sources from below (the power loss is listed in the type overview table, see chapter Technical data).
- Ground the device in accordance with the local regulations (ground screw/bolt for protective conductor connection on the heat sink). The grounding also serves for EMC means (Y - capacitor 4.7 nF + 12 MΩ).
- Cover energized parts

CAUTION
USE OF INCORRECT CONNECTION CABLES
Incorrect connection cables can lead to functional faults. Use shielded control cables to connect the control signals. For use in UL conditions: for power connections only use 60 °C or 75 °C copper conductors (in accordance with the information in the Technical data).

2.3 QUALIFIED PERSONNEL

Only qualified personnel who are familiar with the pertinent safety and installation regulations may perform the following with the Thyritop 300:

- Transport
- Installation
- Connection
- Commissioning
- Maintenance
- Testing
- Operation

These operating instructions must be read carefully by all persons working with or on the device prior to installation and initial start-up.

2.4 REQUIREMENTS TO THE OPERATOR

The person responsible for the system must ensure that

- Safety notes and operating instructions are available and adhered to.
- Operating conditions and technical data are heeded.
- Protective devices are used.

- Maintenance personnel are informed immediately or the Thyritop 300 is taken out of action immediately if abnormal voltages or noises, higher temperatures, waves or similar occur, in order to identify the cause.
- The accident prevention regulations valid in the respective country of use and the general safety regulations are observed.
- All safety devices (covers, warning signs etc.) are present, in perfect condition and are used correctly.
- The national and regional safety regulations are observed.
- The personnel have access to the operating instructions and safety regulations at all times.

2.5 INTENDED USE

CAUTION
The Thyritop 300 may only be used for the purpose for which it was intended, as persons may otherwise be exposed to dangers (e.g. electric shock, burns) and systems also (e. g. overload).

It is not permitted to make any unauthorized modifications to the Thyritop 300 or to use any spare parts or replacement parts not approved by Pyrocontrole, or to use the Thyritop 300 for any other purpose.
These operating instructions contain all the information required by skilled personnel using the Thyritop 300. Additional information and notes for non-qualified persons and for the use of the Thyritop 300 outside of industrial assemblies are not contained in these operating instructions.

The warranty obligations of the manufacturer are only applicable if these operating instructions are observed and complied with.

2.6 LIABILITY

No liability is burdened for non-intended by the manufacturer use of the Thyritop 300. The operator or user, respectively, shall burden the responsibility for possibly necessary measures for the prevention of people and asset damage. In case of complaints, please contact us immediately and include the following information:

- Type designation
- Fabrication number /serial number
- Complaint description
- Duration in operations
- Ambient temperature
- Mode of operation

2.7 GUIDELINES

The devices of the type series Thyritop 300 comply with the currently applicable EN 50178 and EN 60146-1-1. BGV A3 is considered by the compliance with EN 50274.

The CE sign attached to the device confirms compliance with the EC directives for 2006/95/EEC for low voltage and 2004/108/EEC for electro-magnetic compatibility, if the installation and commissioning instructions described within the operating instructions are followed.

Regulations and definitions for specialists are included in DIN EN 50110-1.

Safe separation in accordance with EN 50178.

3 NOTES ON THESE OPERATING INSTRUCTIONS

3.1 VALIDITY

These operating instructions correspond with the technical status of the Thyritop 300 in the versions ...H RLP2 at the time of issue.
The content is not the subject of the contract, but rather serves to provide information. We reserve the right to make amendments to the details in these operating instructions, in particular to technical data, operation, measurements and weights. Pyrocontrole reserves the right to make content amendments and technical alterations to the details in these operating instructions unannounced. Pyrocontrole cannot be held responsible for any inaccuracies or incorrect details in these operating instructions as there is no obligation to make ongoing updates to these operating instructions. These operating instructions only apply to the Pyrocontrole power controller Thyritop 300 in the versions of the types indicated on the cover sheet. The safety notes contained are to be noted in particular.

3.2 TYPE DESIGNATIONS

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

Thyritop 300 1A: Thyristor controller with single phase power unit, suited for single phase loads

Thyritop 300 2A: Thyristor controller with two phase power unit, suited for symmetrical loads in three phase operation in the three phase economy circuit (connection to L1 and L3). Thyritop 300 calculates the values of load current, load voltage, power and resistance on phase L2 by measured values of phase L1 and L3.

Thyritop 300 3A: Thyristor controller with three phase power unit, suited for three phase loads

DESIGNATION (EXAMPLE)	CHARACTERISTICS	DIFFERENT VERSIONS OF THE POWER CONTROLLER
Thyritop 300 3A	Three phase power controller with three phase power unit	
...400-	with 400V type voltage	230 V, 400 V, 500 V, 600 V
...280	with 280A type current	16 ... 1500 A
H	with integrated semiconductor fuse	
F	with fan	*
R	with signaling relay	
L	with load monitoring	
P	with additional power control	
2	Identification 2, Thyritop 300 series	

* device-specific

Thyritop 300 ...H RLP2
Thyristor power controller with

- integrated semiconductor fuse,
- system bus interface,
- fully graphically capable touch display,
- additional 230 V~/110 V~ electronic supply input,
- signaling relay,
- load current monitoring
- analog output,
- channel separation
- operating modes TAKT, VAR, QTM and SWITCH,
- synchronization option for mains load optimization,
- control modes U, U^2, I, I^2 and P
- suitable for the visualization and commissioning software Thyritop-Tool 300.

3.3 HANDLING

These operating instructions for the Thyritop 300 are structured in a manner so that according expert personnel may perform all work necessary for commissioning, maintenance, and repair. If threats to personnel and material cannot be ruled out for certain work, such tasks are marked with a pictogram, from which the according content may be extracted from the before mentioned chapter "Safety requirements".

3.4 LOSS OF WARRANTY

Our supplies and services are subject to the general conditions of supply for products of the electrical industry, as well as our general sales conditions. Claims in connection with supplied goods must be submitted within eight days upon receipt, along with the packing slip.
Claims made later cannot receive consideration.
Pyrocontrole will rescind all possible obligations such as warranty agreements, service contracts, etc. entered into by Pyrocontrole or its distributors without prior notice if maintenance and repair work is carried out using anything other than original Pyrocontrole spare parts or spare parts purchased from Pyrocontrole.

3.5 COPYRIGHT

3.6 FURTHER INFORMATION ON COPYRIGHT

4 CONTACT

4.1 TECHNICAL QUERIES

If you have any technical queries regarding the subjects dealt with in these operating instructions, please get in touch with our team for power controllers:

Tel. +33(0)4 72 14 15 40
automation@pyro-controle.tm.fr

4.2 COMMERCIAL QUERIES

If you have any commercial queries on power controllers, please get in touch with:

Tel. +33(0)4 72 14 15 40
info@pyro-controle.tm.fr

4.3 SERVICE-HOTLINE

Our team is at your service on the following hotline:

+33(0)4 72 14 15 52
automation@pyro-controle.tm.fr

4.4 REPAIR

For maintenance and repair of products with or without guaranty, please contact your local Manumesure office.

Information: Tel. +33(0)2 31 64 51 43

4.5 INTERNET

Further information about our company or products please see

http://www.pyro-controle.com

5 COMMISSIONING

The Thyritop 300 may only be started when there is absolutely no danger to persons or system.

- Protect the device against dust and damp.
- Ensure that the ventilation openings are not blocked.

5.1 CONNECTIONS

The device has to be connected to the power supply and to further external components or devices (PLC, Thyritop Power Manager or PC), which are contingent to the application, in accordance with the connection diagrams.

5.1.1 GROUNDING

The grounding of the device shall be performed in accordance with the local regulations (grounding screw/nut for connecting the protective conductor to the heat sink). Grounding also serves for EMC means (Y capacitor 4.7 nF + 12MΩ).

5.1.2 POWER SUPPLY AND LOAD

The connection of the power supply takes place in accordance with the illustrations.

1. Switch off power supply and ensure it cannot be switched back on again.
2. Ground the power controller.
3. Connect the load to the terminals (T1 + T3 in the case of the Thyritop 300 2A, T1 + T2 + T3 in the case of 3A devices, or only T1 in the case of the Thyritop 300 1A device)
4. Connect the terminals L1, L2 and L3 to the circuit breaker. In the case of Thyritop 300 2A and 3A devices the connection must be made to a clockwise rotating field in the power circuit.
5. Only in the case of Thyritop 300 1A and 2A devices: connect terminal X1.1 to N or the other / middle phase. When connecting to a phase a 2A slow acting fuse is required, at N the connection can be made directly. The terminals (X1.1 and X1.2, 1.5mm2, grid 3.5) are bridged internally.
6. Make any other necessary connections.

The input voltage is used simultaneously for mains synchronization.
Using flexible connection the terminals for the power can be used from above or from below. Contacts with the same designation are connected with one another internally so that the connections can be divided up to enable various combinations.

WARNING
HAZARDS DURING INSTALLATION
Danger of injury/damage to the device or system
Take note of the labeling for the connections, as contacts with the same designation are connected internally and if confused there is a risk of a short-circuit occurring.

5.1.3 ELECTRONIC SUPPLY

The electronics of the control device is supplied by a separate connection with 230V~ / 110V~ (85V - 265V 47Hz - 63Hz). The connection is made at terminals X4.1 and X4.3 (1.5mm2, grid 3.5). Terminals X4.1 and X4.2, along with X4.3 and X4.4 are internally bridged and offer an alternative connection option.
The connection cables are to be fused in accordance with the applicable regulations. An internal 2A fuse protects the device in the case of internal short-circuits. In the case of Thyritop 300 2A and 3A each power unit must be connected separately to the electronic supply, this is wired up correspondingly at delivery.

5.1.4 FANS

Devices with a rated current from 230A and more require a power supply of 230V~ for fan at terminal X7. Devices with a rated current of 30A and 100A come with a fan which is feed in by the device. In this case no extra connection is required. The connection is wired up correspondingly at delivery.

5.1.5 CONTROL SIGNALS

The control signals influence the functional mode of the device. Shielded control cables must be used for the connection of the control signals. The following control signals are required for the operation of the device:

- Connect setpoint (setpoint 1 to X2.4 (signal) and X2.3 (ground) or connect setpoint 2 to X2.11 (signal) and X2.3 (ground). Alternatively via bus module or PC)
- Pulse inhibition (connect terminal X2.2 with ground X2.1)

If the pulse inhibition bridge is not connected then the device is blocked and will not function. Communication via the interfaces continues to be possible.
Please read carefully the information given in chapter 5.1.6. when using the USB interface.

5.1.6 USB INTERFACE

When using the USB interface, e.g. for the use of the Thyritop-Tool 300, the special Pyrocontrole USB cable has to be used between the PC and Thyritop 300 to avoid malfunctions.

The shorter part of the wiring cable (plug - filter, approx. 30 cm) has to be connected to Thyritop 300 while the longer part of the wiring cable (filter - plug) has to be connected to the USB plug of the PC.

5.1.7 CONNECTING TERMINALS (OVERVIEW)

TERMINAL		DESCRIPTION	GRID DIMENSION
X3	.1	root, common connection	5.08
	.2	N/O contact, open when there is a fault (closed circuit principle)	
	.3	N/C contact, closed when there is a fault	
X22	.1	bus setpoint activation (factory setting)/ setpoint switchover	3.5
	.2	TxD / connection to bus module	
	.3	RxD / connection to bus module	
	.4	control ground	
	.5	connection to slave power section	
	.6	connection to slave power section	
	.7	control ground	
	.8	analog output 3 0-10 V or 0(4)-20 mA	
	.9	multi I/O	
	.10	external voltage transformer	
	.11	control ground	
	.12	external current transformer	
	.13	external current transformer	
X2	.1	control ground	3.5
	.2	pulse inhibition	
	.3	control ground	
	.4	analog - setpoint input 1, max. 10 V, max. 20 mA	
	.5	control ground	
	.6	sync. Out (internal mains load optimization)	
	.7	sync. In (digital In, internal mains load optimization)	
	.8	+ 5V output, e.g. for a setpoint potentiometer (5 kΩ ≤ R_{Poti} ≤ 10 kΩ)	
	.9	analog output 1, 0-10 V or 0(4)-20 mA	
	.10	ground potential, as may be shielded control cable	
	.11	analog - setpoint input 2, max. 10 V, max. 20 mA	
	.12	analog output 2, 0-10 V or 0(4)-20 mA	
	.13	control ground	
X1	.1	auxiliary phase L2 / N	3.5
	.2	auxiliary phase L2 / N	
X4	.1	phase for additional electronics supply	3.5
	.2	phase for additional electronics supply	
	.3	N for additional electronics supply	
	.4	N for additional electronics supply	
X7	.2	phase for fan	3.5
	.3	ground for fan	

Tab. 1 : Connecting terminals (Overview)

5.1.8 CONNECTING DIAGRAMS

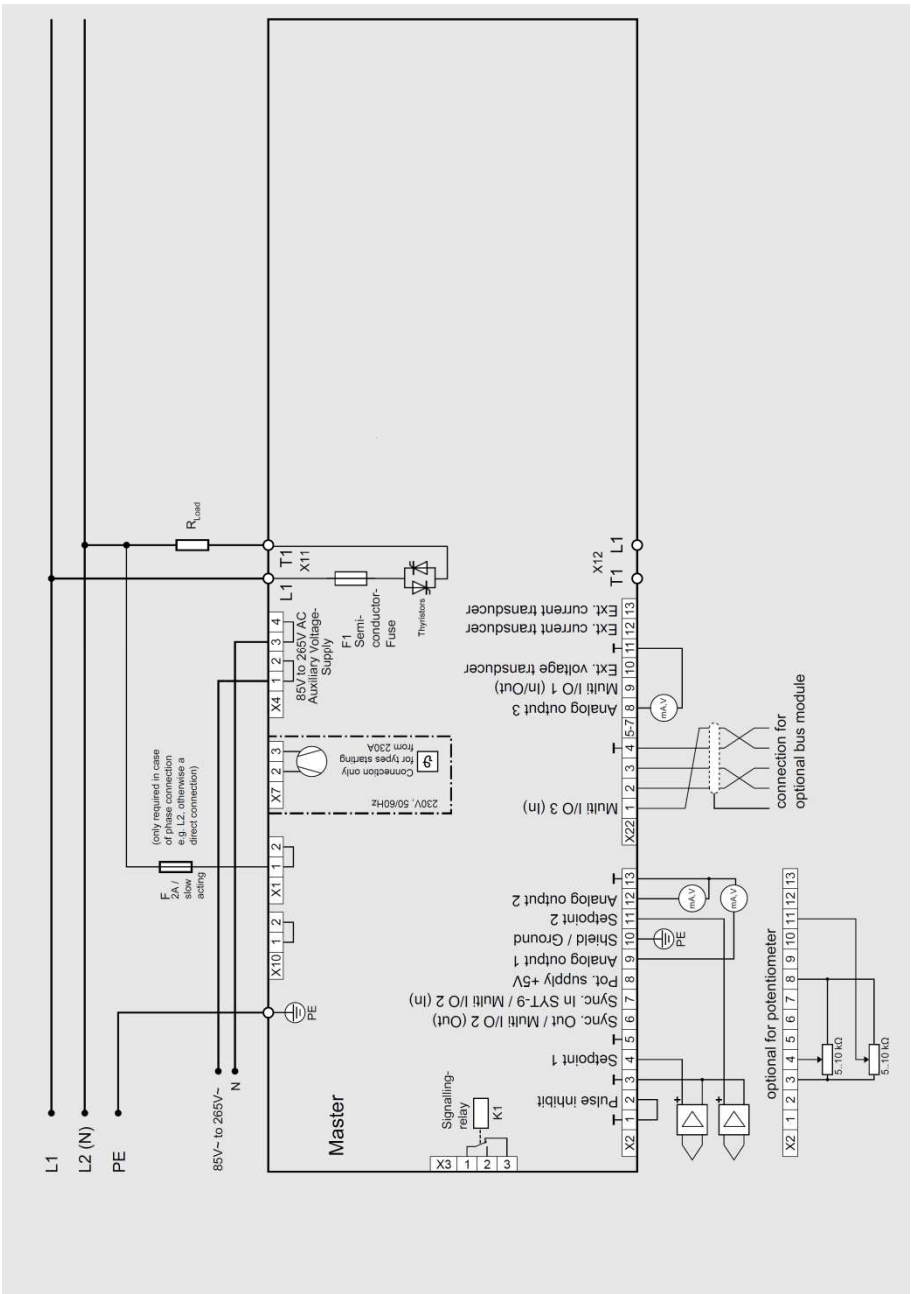


Fig. 1 : Connection Diagram Thyritop 300-1A

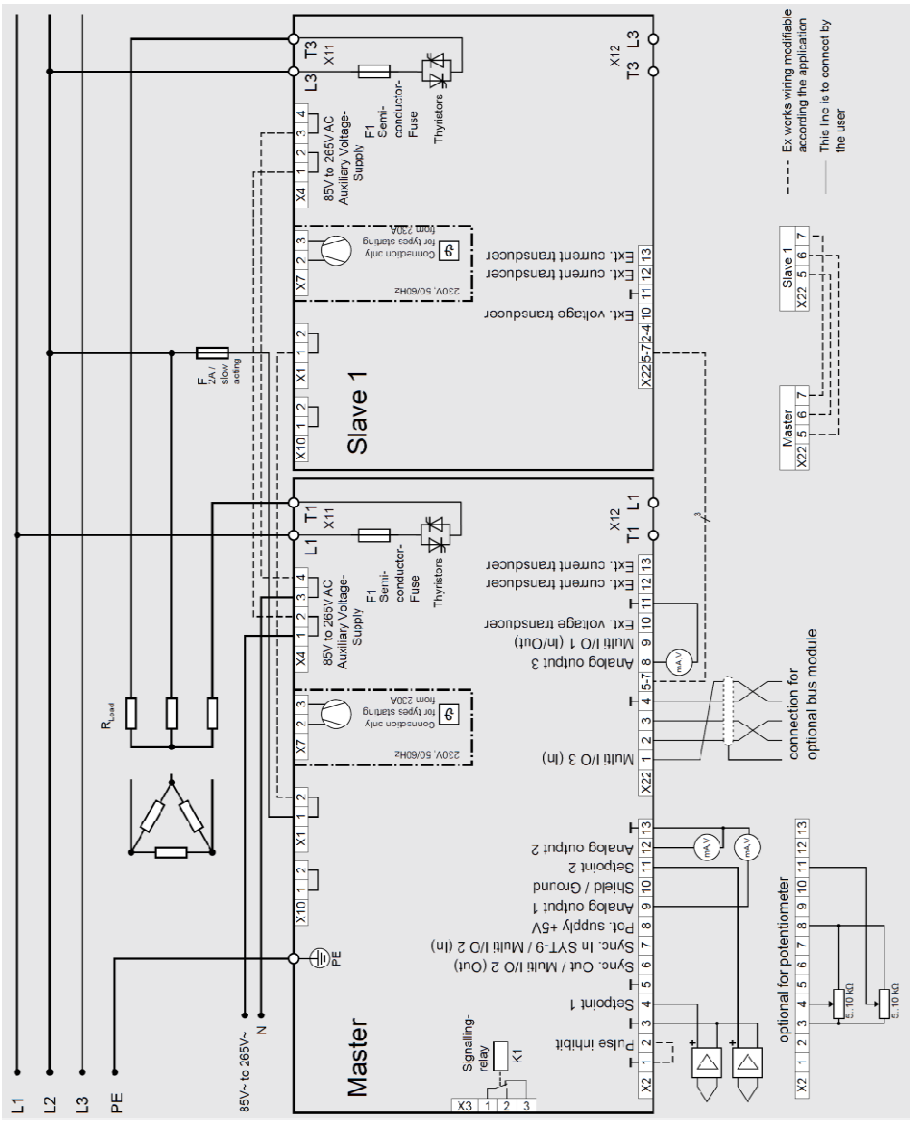


Fig. 2 : Connection Diagram Thyritop 300-2A

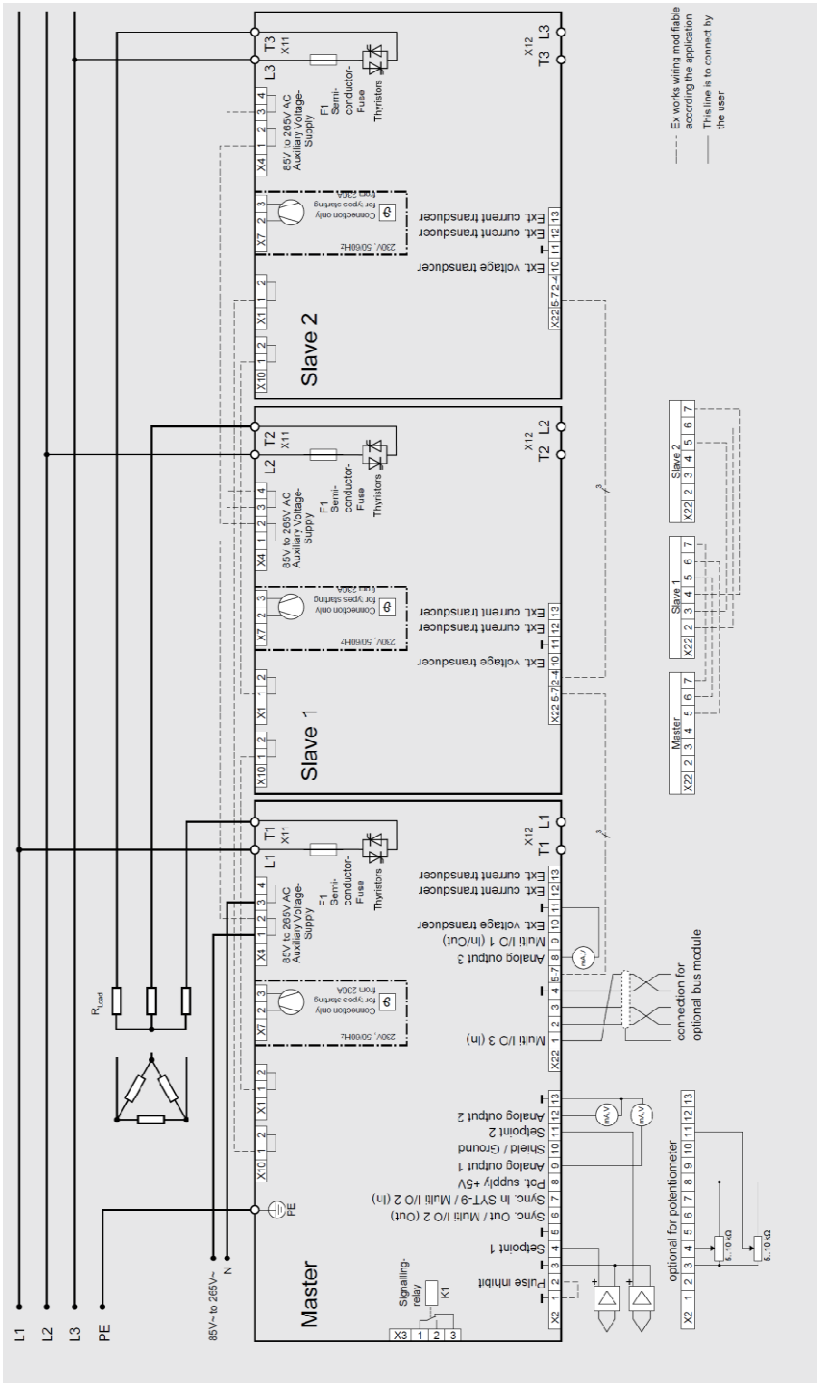


Fig. 3 : Connection Diagram Thyritop 300-3A with load in delta or star connection without neutral

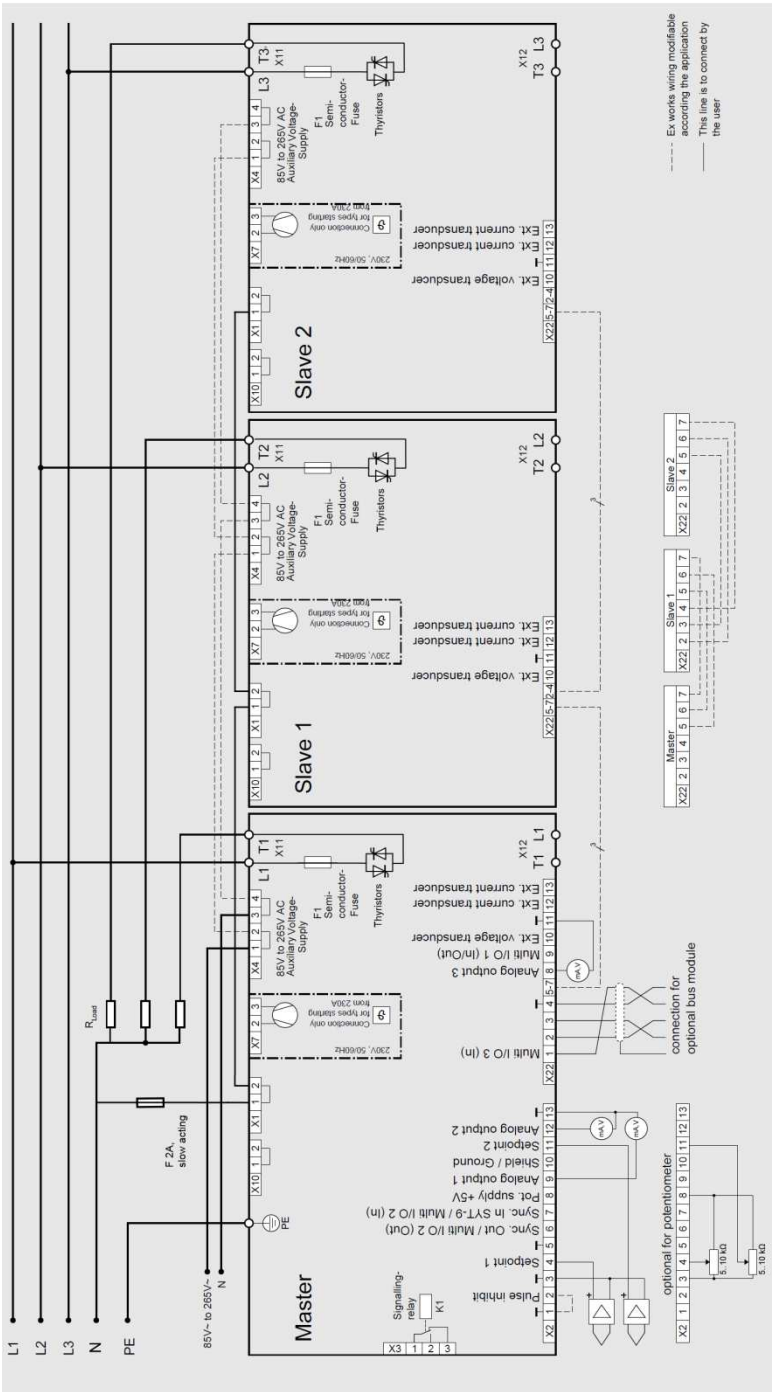


Fig. 4 : Connection Diagram Thyritop 300-3A with load in star connection with neutral

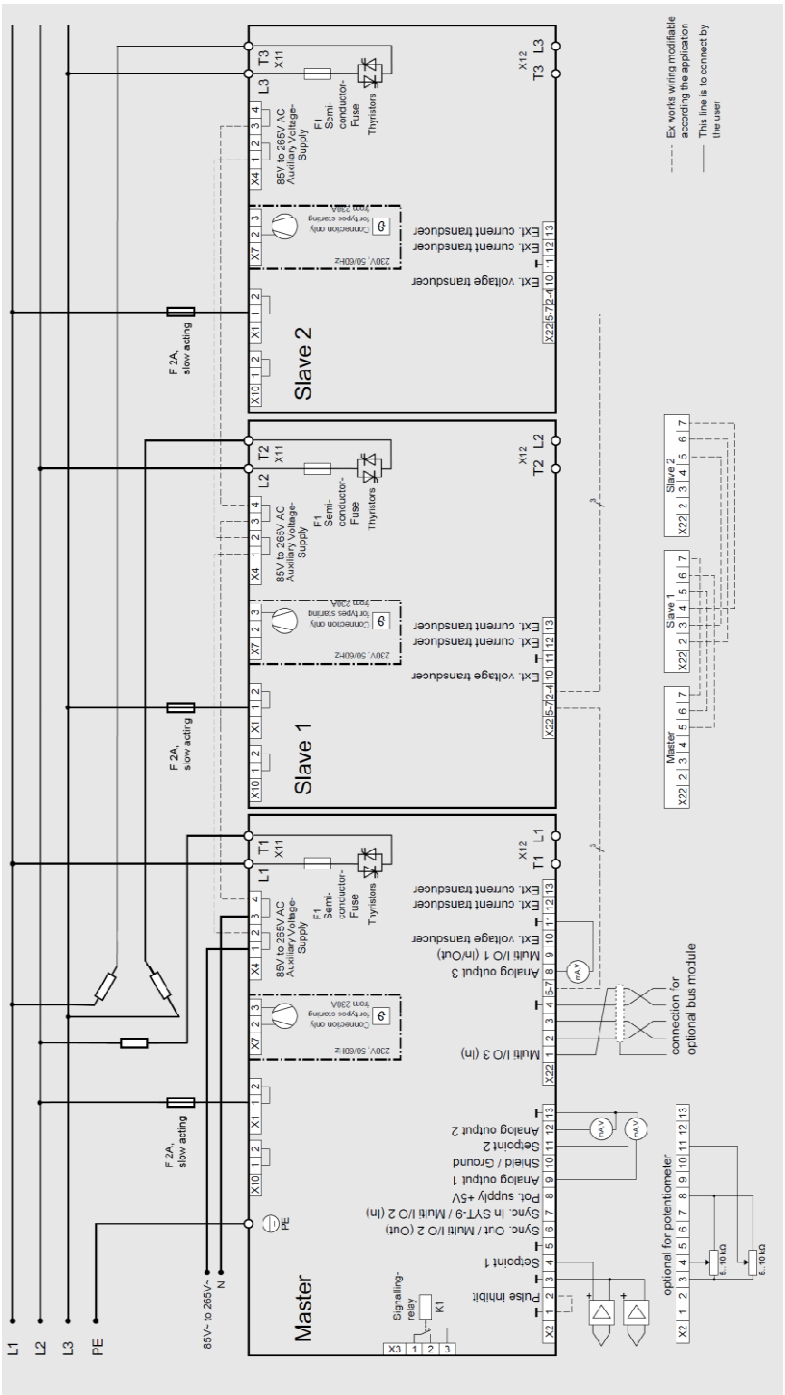


Fig. 5 : Connection Diagram Thyritop 300-3A with load in open delta

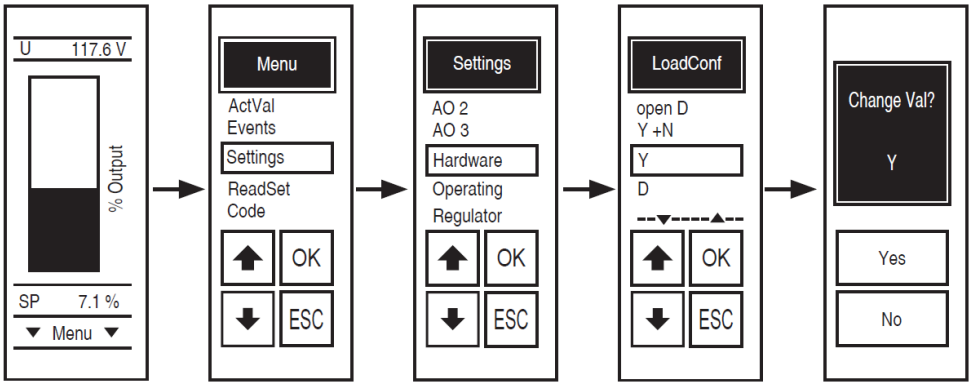
5.2 LOAD CONFIGURATION

For load connection if applicable the wiring has to be adjusted for terminals X1 and X10. This depends on the connection option and has to be done in accordance to the respective connection diagram, see chapter 5.1.7 Connection diagrams.

- Star or delta connection without N: Factory setting, no changes necessary
- Star connection with N: **Changes of wiring of X1 and X10 necessary**
- Open delta connection: **Changes of wiring of X1 and X10 necessary**

When changing the load connection is has to be adjusted via parameters.
This setting can be done by touch display, Thyritop-Tool 300 software or acyclic communication of a bus protocol.

Touch display
The general functionality of the touch display is explained in chapter 7 Display and operational elements. If the connection option has not previously been set up via EasyStart configuration or has not yet been changed, the modification can be done in accordance to the following structure:



Thyritop-Tool 300
Load configuration can be found under the same parameter name (symbol: LoadConf). The modification has to be saved in the unit for permanent usage.

Settings -> Hardware -> LoadConf ->	Star connection with N (only Thyritop 300-3A version) Star or delta connection without N (factory setting) Open delta connection.

5.3 IP20 PROTECTION

DANGER
Energized parts.
The device shall immediately be disconnected from the power supply before installation.

The Thyritop 300 is designed according to IP20 protection code. To ensure protection during operation, the correct mounting is necessary of the added protection devices at each electric connection. In the following pictures the mounting of the protection devices is shown, this handling also applies to 2- or 3- phase units of Thyritop 300.

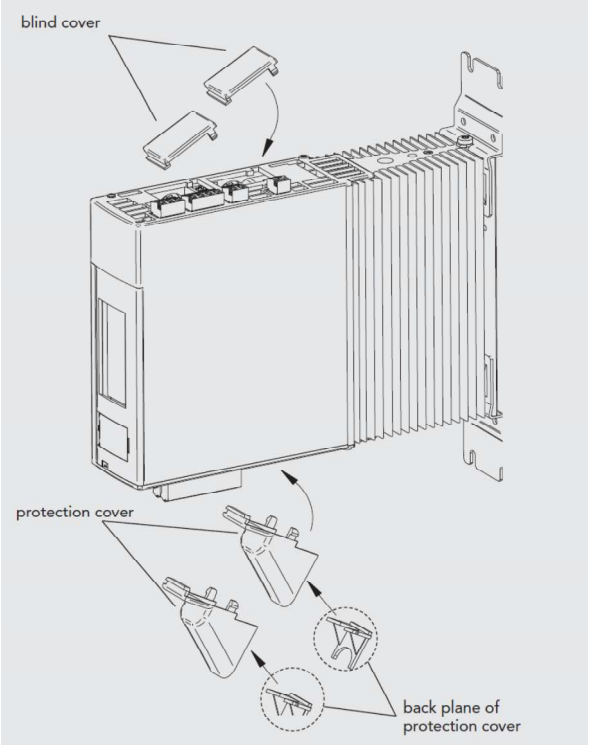
Devices of 45A / 60A / 100A :

For non-used connections:

- The blind cover for non-used connections has to be inserted into the plug-in edge at the front top of the device
- The back part of the blind cover has to be pressed into the device cover until it snaps into place

For used connections (cable is connected):

- The protection cover has to be placed with its plug-in edge in the direction of the device and be placed at the cable with its semicircle gap
- Push the whole backplane over the sideways rails towards the cover
- Protection cover has to be hooked with its plug-in edge into the front hole
- Press the back part of the cover into the device cover until it snaps into place



NOTE
In the case of both connections from top or from bottom are used at the same time, both backplanes of protection covers (see dotted line in the figure) have not to be mounted.
For devices of 100A please consider additionally that the rear backplane of protection cover (see dotted line in the figure) has always not to be mounted due to the close-by fuse cover. This is only the case when the device is connected from below.

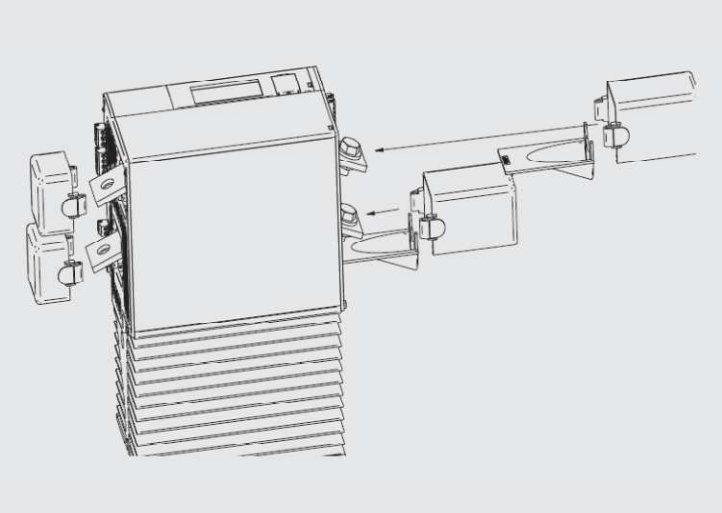
Devices of 130A / 170A / 240A / 280A / 350A:

For non-used connections:

- The blind cover for non-used connections has to be inserted into the plug-in edge of the device

For used connections (cable is connected):

- The protection covers have to be mounted according to the direction arrows in the figure.
- If the customer used connections are wider than the standard gaps used for these protection covers, then the cover have to be adjusted by the customer in accordance to the given gaps.



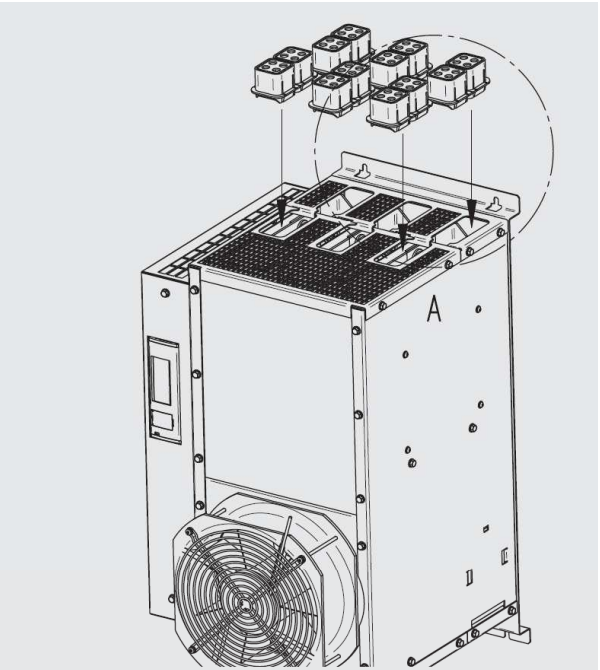
Devices 495A / 650A:

For non-used connections:

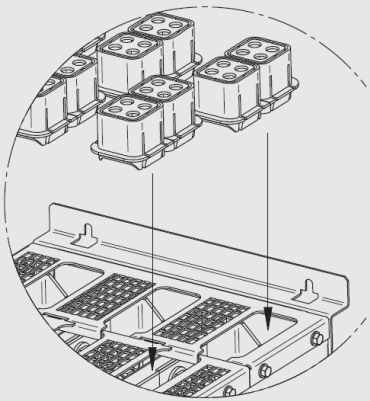
- The blind cover for non-used connections has to be inserted into the plug-in edge of the device

For used connections (cable is connected):

- The protection covers have to be mounted according to the direction arrows in the figure.
- If the customer used connections are wider than the standard gaps used for these protection covers, then the cover have to be adjusted by the customer in accordance to the given gaps.

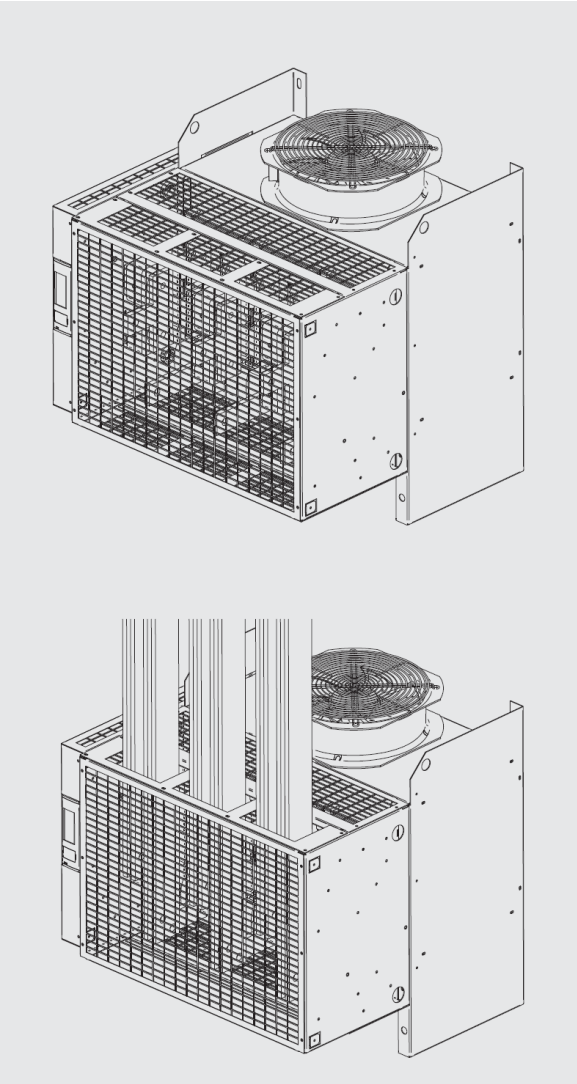


In Detail:



For devices 1000A / 1400A / 1500A:

Before connecting the device all coverages (above and / or below as well as in the front) have to be removed. The connections coming from the customer side have to be connected to the copper bars of the device. Afterwards the according parts have to be removed with a side cutter so that the area around the copper bars to free for connection. Please be consider that an adequate IP20 protection can only exist when the area around the copper bars has only be removed as may be necessary. Then the according coverages have to be fixed again on the device.
The following pictures illustrate a potential position of the coverages:



6 DESCRIPTION OF FUNCTIONALITY

So that the Thyritop 300 can be fitted to the desired application optimally it is equipped with a variety of functions.

NOTE
OPTIMAL ADAPTATION OF THE THYRITOP 300 TO THE LOAD
With the selection of the operating and control mode the Thyritop 300 can be optimally adapted to the load.

NOTE
INDICATED TIMES
The times indicated in the following (duration), e.g. T_0 or SST are given as the number of full waves. In this way the exact times for the frequency actually used can be indicated.

6.1 OPERATING MODES

For optimal adaptation to different applications and manufacturing procedures or varying electrical loads the appropriate operating mode is selected by the user.

6.1.1 FULL WAVE MODE TAKT

The mains voltage is switched periodically depending on the defined setpoint. In this operating mode almost no harmonics of the mains frequency occurs. Whole multiples of network periods are always switched, which avoids continuous current elements. The full wave mode is particularly suited to loads with heat inertia. Nevertheless, any occurring feedback to mains (e.g. flickering) can be reduced to a negligible amount with the aid of mains load optimization (see chapter Mains load optimization).

6.1.2 PHASE ANGLE FIRING VAR (ONLY 1A AND 3A)

Depending on the defined setpoint the sinus wave of the mains voltage is shifted with a larger or smaller trigger delay angle α. This operating mode is characterized by its high control dynamics. In the case of phase angle firing, harmonics of the mains voltage occur. These can be minimized or considerably reduced by using various circuit types.

6.1.3 SST RAMP

On a unit working in TAKT mode, a SoftStart ramp up occurs at the first start up of the unit or after a pulse inhibition. The Thyritop 300 drives the load with a ramp up / ramp down of phase angle firing, respectively defined by the parameters SST / SSD. This allows the power controller to check the load status, and to protect itself, for example in case the load is short circuit.

6.1.4 QUICK TAKT MODE QTM (ONLY 1A)

Depending on the defined setpoint network half waves are switched. Quick takt mode is a quick operating mode which offers a higher dynamic than TAKT through its functioning in half wave switch principle. QTM is suitable for Ohmic loads. Continuous current elements are avoided through the cycle duration. The quick cycle control is particularly suited to infra-red projectors as an alternative to phase angle firing. When using multiple controllers there is the option of keeping feedback to mains minimal through synchronization.

6.1.5 SWITCH MODE SWITCH

Depending on the defined setpoint whole network periods are always switched. Then a signal can be used as control input for switch mode operation. This means that on-off control can be realized. The feedback to mains is very slight in this functionality. The switch mode is suitable for Ohmic load and transformer load.

6.2 SETPOINT PROCESSING

The Thyritop 300 power controller has four setpoint inputs. All setpoint inputs are electrically isolated from the mains. For the analog setpoints 1 and 2 individual control characteristics can be configured via the parameters control begin and control end.
All setpoints are added up taking into consideration any preceding modifying symbols. The prerequisite for the influence of a setpoint on the overall setpoint is that it is approved through the setpoint enable register.

- Setpoint 1 analog signal: (X2.4, X2.3 ground) 0-20 mA as default settings
- Setpoint 2 analog signal: (X2.11, X2.3 ground) 0-5 V as default settings
- Setpoint 3 digital signal: setpoint from higher-level system such as a PC with USB or via the optional bus interface.
- Setpoint 4 digital signal: setpoint from digital potentiometer of the control panel

The setpoint inputs 1 and 2 are two electrically identical analog inputs for current or voltage signals with a downstream A/D transformer (resolution 0.025% of end value). The following signal ranges can be configured using the touch display, Thyritop-Tool 300 and bus:

- 0(4) - 20 mA (R_i = 250 Ω) maximum 24 mA
- 0 - 5 V (R_i = 8,8 kΩ) maximum 12 V
- 0 - 10 V (R_i = 5 kΩ) maximum 12 V

The setpoint signal can be adjusted by the user to the procedure controller or automation system. To do this the start and end points of the control characteristics are altered. All COTS signals can be used. If the power controller finds itself in a limitation (U_{max}, I_{max}, P_{max}) this is shown on the display (see chapter Events).

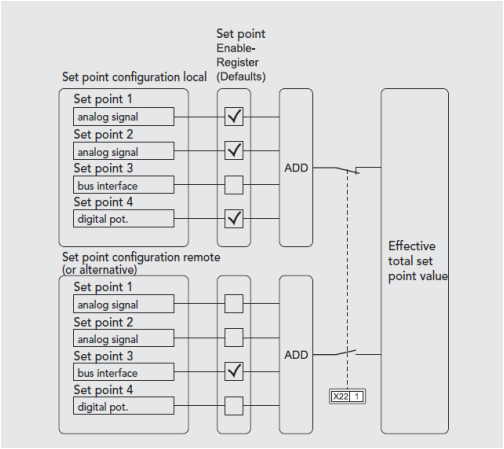


Fig. 6 : Setpoint inputs and effective setpoints

CONFIGURE OVERALL SETPOINTS

Two configurations for the overall setpoint are possible which each allow optional combinations of setpoints. In this way an alternative configuration can be selected quickly by connecting X22.1 to ground.
This allows a manual/automatic switching to be realized
The values of the default settings are:

- setpoint configuration 1 (no ground to terminal X22.1)
  - o analog signal 1
  - o analog signal 2
  - o digital signal from digital potentiometer
- setpoint configuration 2 (alternative - ground to terminal X22.1)
  - o digital signal from USB or bus interface

INPUTS FOR SWITCH MODE SWITCH
For the switch mode SWITCH it is possible to switch via a 24 V signal (5-24 V) as a digital signal to terminal X2.7 (Sync. In Digital In) or via the setpoint on the basis of a threshold. A digital switching signal or an overall setpoint from 50% causes a switching on, below this a switching off.

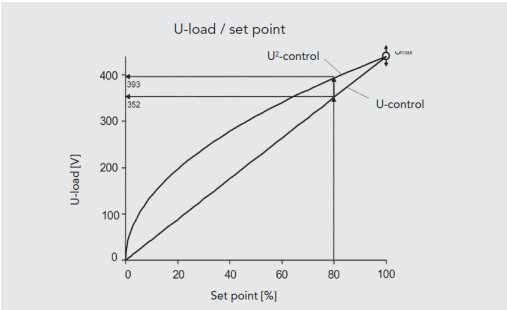
6.3 CONTROL MODES

Thyritop 300 provides various types of control. The control has an influence on the size of the output of the power controller. Before commissioning the power controller and selection of a control mode the mode of functionality and effect on the application should be known.

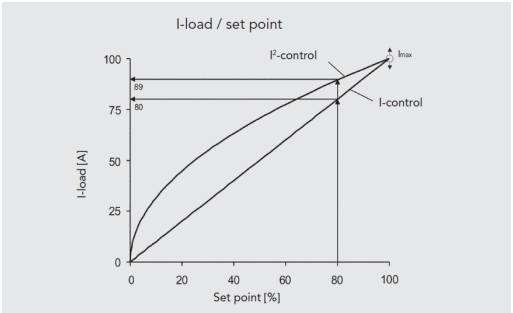
CONTROL MODES...H RLP2	Control Variable
U, U^2	Output voltage
I, I^2	Output current
P	Effective Power

Mains voltage variations and load alterations are compensated directly and, as a result, quickly by bypassing the inert temperature regulation circuit (secondary control).

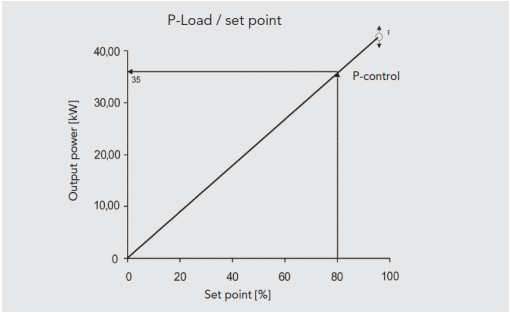
CONTROL CHARACTERISTICS AND CONTROL VARIABLE
The control variable influencing the load is proportional to the effective setpoint in the case of control modes U, I, P. In control modes U_2, I_2, the control variable influencing the load is a square of the effective setpoint.



Load voltage U/U^2



Load current I / I^2



P output power

If the load resistance changes e.g. through the influence of temperature, ageing or load interruption, the variables influencing the load change.

CONTROL MODE	LOAD RESISTANCE GETS SMALLER			LOAD RESISTANCE GETS LARGER		
	P	ULoad	ILoad	P	ULoad	ILoad
U	↗	=	↗	↘	=	↘
U^2	↗	=	↗	↘	=	↘
I	↘	↘	=	↗	↗	=
I^2	↘	↘	=	↗	↗	=
P	=	↘	↗	=	↗	↘

Tab. 2 : Effects in the case of load resistance change

6.4 LIMITATIONS

In addition to the configured control mode the following variables can be limited:

- voltage limitation (U)
- current limitation (I)
- power limitation (P)

SECONDARY MODE OF CONTROL	END VALUE OF THE CONTROLLER	LIMITATIONS
U	Urms max	Irms max Pmax
U^2	Urms max	Irms max Pmax
I	Irms max	Urms max Pmax
I^2	Irms max	Urms max Pmax
P	Pmax	Irms max Urms max

Tab. 3 : Effective limitations

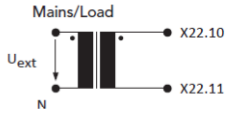
Besides this the Thyritop 300 1A/3A … HRLP2 is equipped with a peak current limitation ($\hat{i} = 3 \times I_{typ}$) in phase angle.

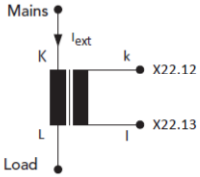
6.5 PULSE INHIBITION

The pulse inhibition (terminals X2.1 – X2.2) is activated by opening the pulse inhibition bridge, which means that current no longer flows. When the pulse inhibition is activated the touch display turns red and in the data logger "Pulse on" is listed. After switching on or after pulse inhibition the first Takt pulse (in TAKT operation) runs through with the soft start function. This is important for transformer load if it was switched off in an undefined way (remanence). In the case of the Thyritop 300 2A or Thyritop 300 3A the pulse inhibition is only wired to the master (L1, left).

6.6 CURRENT AND VOLTAGE TRANSFORMER

The power controller has a current and voltage transformer on the load side per power unit which is internally wired. In addition each controller also has an external current and voltage transformer terminal which can be used via internal link plugs as an alternative to the internally built-in parts. This can increase the measurement accuracy in the case of very small voltages. For details on how to convert over please use the contact information indicated above.
External current and/or voltage transformer are to be connected in phase, see connection diagram:





The output value of the voltage transformer is 10V~ (at rated voltage) and the output value of the current transformer is 1V~ (at rated current).
The corresponding load resistor has to be connected externally as well.

6.7 DISPLAY VIA ANALOG OUTPUT

The following variables are given at the analog output (e.g. when connecting an external measurement instrument):

- load current (highest phase current from L1, L2, L3)
- load voltage (highest conductor voltage)
- effective power (overall power)
- additional variables (can be selected via PC/Bus, e.g. mains voltage, setpoint etc.)

The variable to be given at the analog output can be configured by the user (see chapter control mode/analog output).

DEFAULT SETTINGS:

ANALOG OUTPUT	OUTPUT VARIABLE
Analog output 1	load voltage
Analog output 2	load current
Analog output 3	power on the load

6.8 FAULT AND STATUS MESSAGES

The Thyritop 300 has internal fault and status messages. Their effects can be configured with the Thyritop-Tool 300 software. The reactions on the occurrence of a message can be determined by the user. As a reaction, the inhibition of the load current (pulse inhibition), as well as the display at the fault signaling relay K1 and the color of the display lights (red) can be configured. Besides this the mode of operation (open or closed circuit principle) can be configured at the fault signaling relay K1. Fundamental fault messages which make the operation of the device impossible in general switch the pulse inhibition or the fault signaling relay K1.

6.8.1 OVERVIEW

FAULT DESCRIPTION	THYRO-TOOL AX TEXT	DISPLAY EVENT MESSAGE	DISPLAY LIGHTNING RED	RELAY	PULSE INHIBITION	DATA LOGGER
MAINS NOT OK (SYNC ERROR)	SYNC ERROR	SYNC ERROR	X	X	NOT CONFIG.	X
HARDWARE FAULT	HARDWARE FAULT	HW FAULT	X	X	NOT CONFIG.	X
MINIMUM FREQUENCY	FREQUENCY TOO LOW	FMIN	X	X	NOT CONFIG.	X
MAXIMUM FREQUENCY	FREQUENCY TOO HIGH	FMAX	X	X	NOT CONFIG.	X
ADMISSIBLE FREQUENCY TOLERANCE	FREQUENCY TOLERANCE	FTOLERANCE	X	X	NOT CONFIG.	X
NO ROTATING FIELD/ COUNTER-CLOCKWISE ROTATING FIELD (WITH AX)	NO ROTATING FIELD	NO ROTFIELD	X	X	NOT CONFIG.	X
PHASE L1 MISSING	PHASE L1 MISSING	NO PHASE1	X	X	NOT CONFIG.	X
PHASE L2 MISSING	PHASE L2 MISSING	NO PHASE2	X	X	NOT CONFIG.	X
PHASE L3 MISSING	PHASE L3 MISSING	NO PHASE3	X	X	NOT CONFIG.	X
SETPOINT FAILURE (<4mA)	SETPOINT < 4MA (OPEN LOOP)	SETPOINT	X	X	X	X
NO SUPPLY VOLTAGE	NO SUPPLY VOLTAGE	NO POWER	X	X	NOT CONFIG.	X
POWER UNIT CONNECTION	POWER UNIT DISCONNECTED	NOCONNPART	X	X	NOT CONFIG.	X
TEMPERATURE SENSOR FAULT	TEMPERATURE PROBE DEFECT	TEMPSENS	X	X		X
FUSE FAILURE	OPEN FUSE	FUSE	X	X	NOT CONFIG.	X
THYRISTOR SHORT CIRCUIT	THYRISTOR SHORT CIRCUIT	THYRISTOR	X	X	X	X
EEPROM FAULT	MEMORY ERROR	EEPROM	X	X	X	X
I2C FAULT	2C ERROR	I2C				
ETHERNET FAULT	ETHERNET ERROR	ETH				
USB FAULT	USB ERROR	USB		X		X
FIRMWARE FAULT	FIRMWARE ERROR POWER UNIT INCOMPATIBLE	FIRMWARE	X	X	NOT CONFIG.	X
U MEASURING RANGE EXCEEDED	U MEASURING RANGE EXCEEDED	U RANGE	X	X		X
I MEASURING RANGE EXCEEDED	I MEASURING RANGE EXCEEDED	I RANGE	X	X		X
NEGATIVE POWER	NEGATIVE POWER	NEG POWER	X	X		X
LCD FAULT	LCD ERROR	LCD	X	X		X
PARAMETER FAULT	PARAMETER ERROR	PARAMETER	X	X	NOT CONFIG.	X
UMAINS MIN	U MAINS < MINIMUM	UN MIN				X
UMAINS MAX	U MAINS > MAXIMUM	UN MAX				X
ULOAD MIN	U < MINIMUM	UL MIN				X
ULOAD MAX	U > MAXIMUM	UL MAX				X
ILOAD MIN	I < MINIMUM	IL MIN				X
ILOAD MAX	I > MAXIMUM	IL MAX				X
PLOAD MIN	P < MINIMUM	PL MIN				X
PLOAD MAX	P > MAXIMUM	PL MAX				X
RLOAD MIN	R < MINIMUM	RL MIN				X
RLOAD MAX	R > MAXIMUM	RL MAX	X	X		X
IPEAK MAX	I PEAK > MAXIMUM	I_PEAK MAX				X
THEAT SINK MIN	TEMPERATURE HEAT SINK < MINIMUM	T_HEAT MIN				
THEAT SINK MAX	TEMPERATURE HEAT SINK > MAXIMUM	T_HEAT MAX	X	X		X

Tab. 4 : Events Overview

The events, which are captured by the Thyritop 300, are shown on the touch display in abbreviated form in a list. They correspond with the full forms in their meaning and can be discerned using the table above.

6.8.2 FAULT SIGNALING RELAY K1

NOTE
DEFAULT SETTING
Fault signaling relay K1 has a default closed circuit principle
This setting can be altered with the control panel, with a bus module, or with the Thyritop-Tool 300.

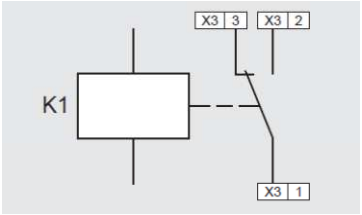


Fig. 7 : Contact assignment fault signaling relay K1

The fault signaling relay K1 is fitted with a changeover. Messages which lead to the switching of the fault signaling relay can be configured with the control panel, with a bus module, or with the Thyritop-Tool 300 software. With the default setting the fault signaling relay K1 works in accordance with the closed circuit principle. In the case of the following errors the fault signaling relay de-energizes and the power controller switches off:

- SYNC error
- internal error
- undervoltage in mains
- master/slave error
- error rotating field/phase

In the case of the following errors the fault signaling relay drops out, the power controller continues to run and a notification is sent (touch display):

- excess temperature
- undercurrent in the load circuit

6.9 MONITORING

Power controller and load circuit are monitored for errors. Messages are sent via the touch display, via a bus, or through the fault signaling relay K1 (see chapter Fault signaling relay K1).

6.9.1 MONITORING THE MAINS VOLTAGE

NOTE
LIMITS OF THE VOLTAGE MONITORING
There are the following limits to the voltage monitoring:
- undervoltage monitoring: < 24 V
- overvoltage monitoring: +10% of the type voltage
This results in absolute limits for the monitoring of the mains voltage.

TYPE VOLTAGE	UNDERVOLTAGE LIMIT	OVERVOLTAGE LIMIT
230 V	24 V	253 V
400 V	24 V	440 V
500 V	24 V	550 V
600 V	24 V	660 V

Tab. 5 : Limits of mains voltage monitoring

In the default setting the pulse inhibition is switched internally if voltage drops below the undervoltage limit and the fault signaling relay K1 de-energizes (both can be configured).

6.9.2 DEVICE TEMPERATURE MONITORING

NOTE
DEFAULT SETTING
The function explained here is described in its default setting.
This setting can be altered with the control panel, with a bus module, or with the Thyritop-Tool 300.

The Thyritop 300 is fitted with temperature monitoring. If the power controller dependent temperature is exceeded an event message is sent (see chapter Fault and status messages). The pulse inhibition is not triggered as configured by the factory.

7 DISPLAY AND OPERATIONAL ELEMENTS

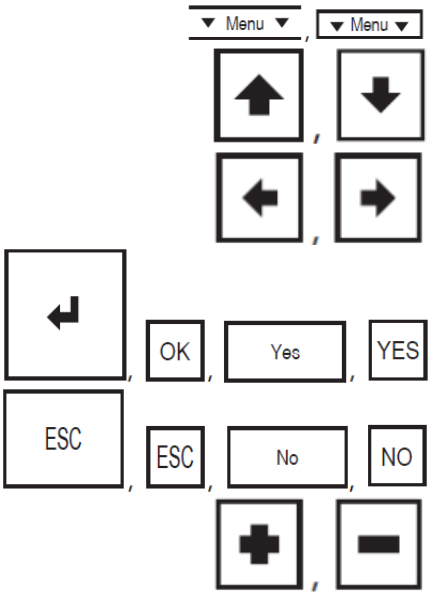
The parameters of the power controller can be altered via the integrated touch display.
In addition it shows the current values of the Thyritop 300.

CAUTION
Do not use any pointed or sharp-edged objects to operate. They can damage the surface of the screen.

The touch display is a pressure sensitive screen which can be operated with the finger. It contains fields which react to light pressure in order to register buttons being pressed. Depending on the menu displayed the areas which can be pressed vary in accordance with the contents displayed. There is a large actual value button and requirement specific buttons displayed in the lower section of the screen. After a period of 30 seconds without a button being pressed the screen display reverts to the actual value view.
If there are more entries available than can be displayed on the screen a separating line appears when approaching the first or last entry. This marks the transition from the start to the end of the list and can be skipped over with the arrow buttons.

7.1 OPERATING THE TOUCH DISPLAY

All supported screens can be operated with a few buttons. The function of the button depends on the entry displayed. The current selection of the parameters in the list to be altered is indicated by a frame outline and can be altered with the OK button. Depending on the parameter variable a screen follows correspondingly in which alternative values for the parameter are offered. In the following the symbols and their various possible depictions are displayed.



Call up menu.

- Set the marking of an entry (frame outline) higher or lower in the list.
- Increase/decrease a numerical value or add/delete a decimal place.

Place a character position to left/right

Confirm current selection and back to last screen.

Reject current selection and back to last screen

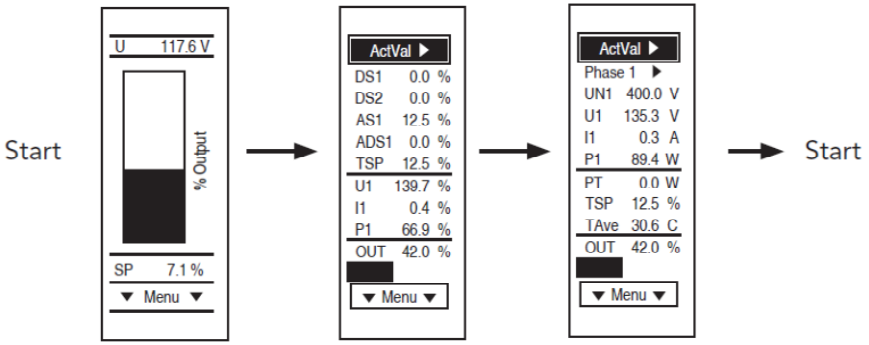
Increase/decrease digital setpoint 2

The actual value button is described in chapter 7.2.

EXAMPLE OF ENTERING A NUMBER
The example shows the entry of numerical values via the screen buttons using the setting of I_{max}, which can occur in the course of EasyStart.

7.2 ACTUAL VALUE VIEW AND ACTUAL VALUE BUTTON

When pressing the actual value button several times the current values of the Thyritop 300 are displayed over several screens. By pressing several times the screens are alternately displayed and start from the beginning again if pressed again. Depending on the number of phases of the power controller the actual value view is displayed for all phases. The screen which appears at the end gives the type information of the Thyritop 300. The last line on the screen gives the EasyStart identification The actual value view can also be reached via *Menu -> ActVal*.



Using the actual value button you can leave the current menu at any time in order to get back to the actual value view. In doing so the current menu is aborted without being saved permanently in EEPROM, however, the current alteration remains active and can be saved manually. The actual value button extends over the top half of the screen. This means that regardless of what is displayed in the upper half of the screen, the upper area, when pressed, functions as the actual value button, even when the text is displayed. This enables a quick change of the display for the values following an alteration of parameters.
During EasyStart changing to the actual value view via the button is not possible.

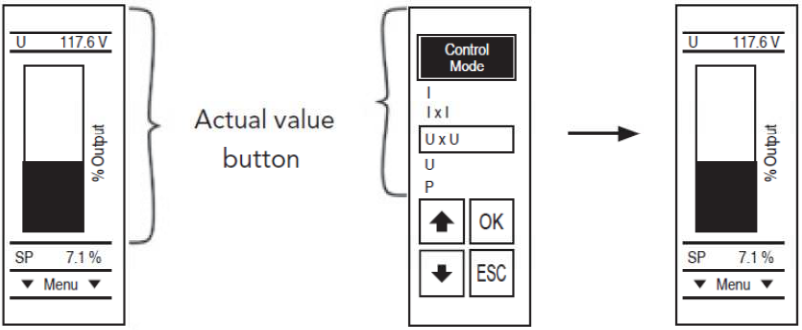
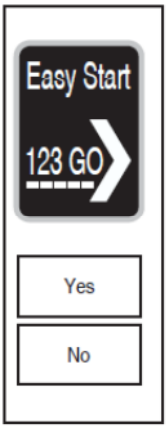


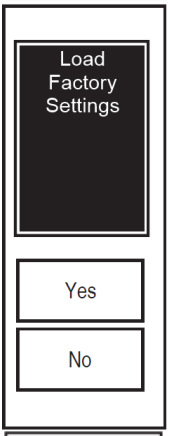
Fig. 8 : Examples of the area of the actual value button which can be pressed

7.3 EASYSTART

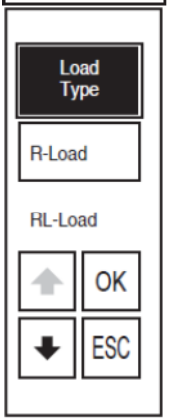
In the case of the initial start of the device the managed parameterization EasyStart is called up with the help of which the fundamental parameterization is configured. The following screens are depicted in the displayed sequences. The ESC button calls up the previous page and as such allows alterations to be made to settings already inputted. During the configuration with EasyStart the pulse inhibition is active and prevents power being emitted at the load side.



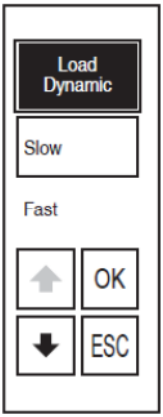
Start screen:
The parameterization of the fundamental values starts with the button Yes. With No EasyStart is aborted, in order, for example, to transfer an already saved parameter file to the device using the Thyritop-Tool 300.



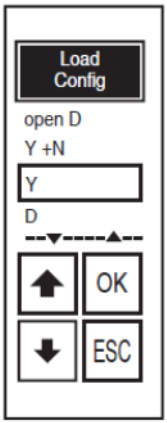
Load factory settings:
The button Yes sets the Thyritop 300 back to its default settings. When pressing the button No, the Thyritop 300 continues EasyStart feature on basis of its current settings.



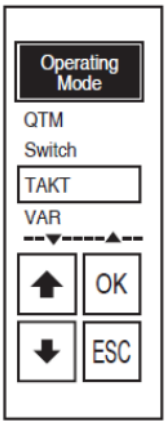
Load type:
Here, adjustment to a purely ohmic load or an inductive load, like transformers, is possible. In case of a purely ohmic load the power controller can clock more quickly than with the R-Load setting and provides a larger dynamic on the output side. Configuring a transformer load with RL-Load causes an angle of the first half wave (Alpha 1st) each time it switches through and an optimization of the necessary time intervals for the controlled magnetization of the transformer coils.



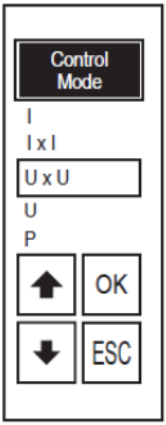
Load type, dynamic of the load:
This screen appears only if the configuration R-Load has been selected beforehand. When configuring a load with heat inertia load with Slow (T_0 = 1 s) the distance between the ignition cycles increases so that the switch on and switch off duration lasts longer. In the case of loads which are more influenceable by external effect, the switching time can be shortened by configuring Fast (T_0 = 0.1 s) to achieve a more even warm up.



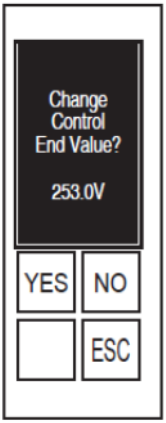
Load type, connection:
Depending on the connection option the adequate entry has to be chosen from the list. This is important for the accurate processing and displaying of data. Potential necessary changes of the connection can be taken from chapter Load configuration.



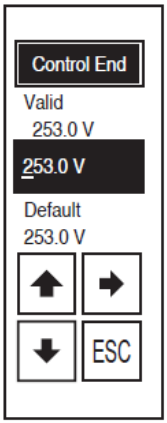
Operating mode:
The operating mode can be set as QTM, Switch, TAKT or VAR. At this the settings for the load type are taken into consideration. Notes on operating modes can be taken from the chapter Operating modes.



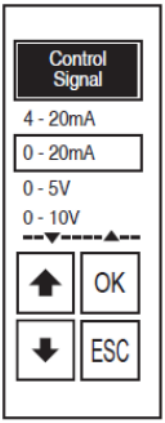
Control mode:
The mode of control can be set, from which one control mode can be selected. The selection includes I, I^2, U, U^2, P and Off. Notes on control mode can be taken from the chapter Control modes.



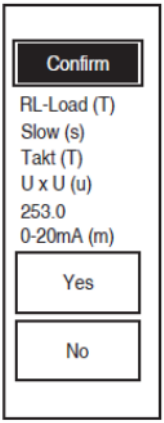
Control end value:
This screen only appears if the control mode has been selected beforehand, not if Off is selected.
The control end value is the maximum value for control and limitation. In the case of full control through the setpoint this value defines the maximum which can be reached at the output. The unit is dependent on the control mode. In the case of voltage based control it is U_{max} in V, with current based control it is I_{max} in A, and with power based control it is P_{max} in W.
In most cases the preconfigured value is sufficient and can be confirmed with the NO button.



Control end value, value input:
This screen only appears when the YES button has been selected beforehand.
Similar to the unit from the previous screen an input field appears for the desired value of the control end value. After inputting all positions of the value the OK button appears to confirm.

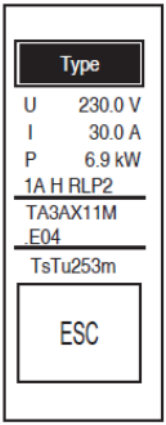


Control signal:
The correct input variable must be selected corresponding to the signal for the setpoint definition. The selected value is related to the 1st analog setpoint. The 2nd analog setpoint remains set to 0-5V in order to enable an offset through the addition of the setpoints using an external potentiometer. The 3 analog outputs also receive the variable of the setpoint selected here. The configuration for the 2nd analog setpoint can be changed afterwards in EasyStart. The electrical limits of the levels must be heeded.



Confirmation of the settings:
When Yes is pressed all settings are saved in the internal EEPROM and the pulse inhibition is ended again. Pressing the No button returns to the last screen. The characters in brackets each form an initial for the setting and are used for the EasyStart identification.

7.4 EASYSTART IDENTIFICATION



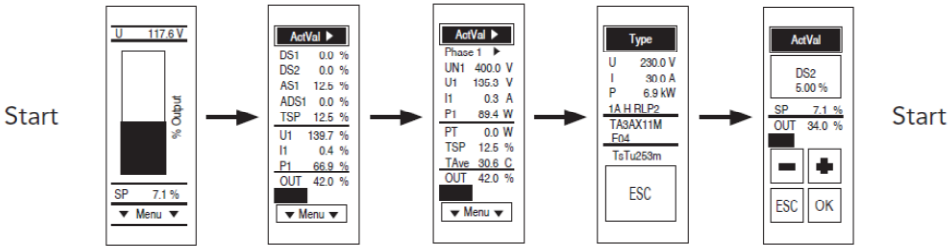
The EasyStart identification makes the comparison of the configurations of multiple devices easier. Depending on the settings selected a series of characters is generated which corresponds to the selected settings. If additional settings have been made outside of those covered by EasyStart, then a + (plus symbol) is added at the end of the identification code. This is an indication of additional alterations which have not been created by EasyStart.
The EasyStart identification can be reached from the main screen through pressing the actual value button multiple times. The last line gives the identification code.
In the example: TsTu253m

7.5 RESTRICTION CODES FOR PARAMETERIZATION AND DIGITAL SETPOINT 2

The access via the touch display can be disabled and enabled for the following contents:

- parameter alteration: setting menu is displayed or hidden (factory setting: on)
- digital setpoint 2: DS2 is alterable via buttons following the screens of the actual value view (factory setting: off).

If the actual value view is not already called up, this can be reached via *Menu →ActVal*. The screen for the DS2 follows the other actual value screens and appears last. An alteration of the setpoint is possible with the button + and -. The factory setting for this value is to be added to the other setpoints and as such can be used as an offset.



The functions can be hidden or displayed by entering the restriction code under *Menu →Code*.

- DS2 restriction code: enable 234, disable 432 (restricted by default settings).
- Parameter restriction code: enable 345, disable 543 (restricted by default settings).

8 MAINS LOAD OPTIMIZATION

HAZARDS WHEN CARRYING OUT ADJUSTMENT WORKS
Danger of injury / danger of damage of the device or system

> Adhere to all safety requirements of the chapter Safety. Mains load optimization provides considerable advantages, e.g. the reductions of mains load peaks and feedback to mains. Mains load optimization is possible under the following conditions:

- applications with multiple power controllers
- operating mode TAKT or QTM

The mains load is optimized by cascading the switching ON of the individual devices. There are two different processes for doing so.

8.1 INTERNAL MAINS LOAD OPTIMIZATION

Operating modes: QTM (Thyritop 300 1A)
In the operating mode QTM a synchronization of 2-12 controllers is possible. The operating mode QTM works in a quick half wave mode with a pattern of switched and inhibited half waves at an interval of a fixed time < 1 sec, also known as T_0. In order to create a balance within the network if possible from the start (not only following T_0), the individual controllers synchronize themselves by offsetting by one network period. The first of the connected controllers should have the Sync. In Digital Input X2.7 bridged to +5V X2.8. The subsequent controllers receive their pulse to X2.7 from Sync. Out terminal X2.6 of the previous controller. The last controller X2.6 remains free (Connection in series). The illustration bellow has to be considered when changing the internal mains load optimization.

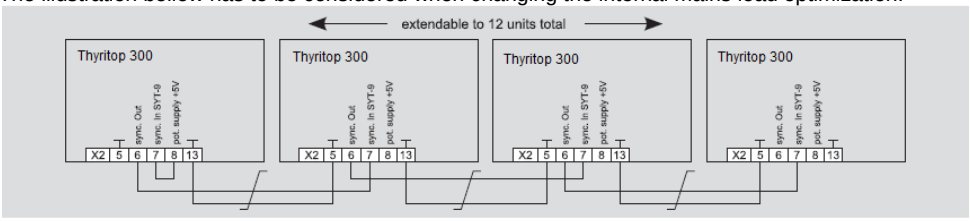


Fig. 9 : Internal mains load optimization

8.2 SYNCHRONIZATION WITH THE THYRITOP POWER MANAGER

If power controllers are working in accordance with the full wave mode (TAKT) then this can lead to an increased burden on the mains caused by an unfavorable distribution of the switching on and switching off times. This then has negative effects such as higher power loss, flicker effects etc.
If load elements are used whose resistance increases over the course of time (ageing) then under certain circumstances a transformer with increased power output may even need to be used.
All of these negative effects can be avoided or reduced to a minimum through the use of the Thyritop Power Manager.
The Thyritop Power Manager has a total of 10 digital outputs at the terminals X3 and X4. These are set up as potential-free optical coupler outputs. In the case of mains load optimization they are used as synchronization outputs (SYT) for the connected power controllers or groups of power controllers. All cables are to be laid shielded; the shield is grounded at the power controller. (Details can be found in the operating instructions of the Thyritop Power Manager available separately).
In addition the illustration bellow has to be considered when changing the wiring diagram of Thyritop Power Manager.
Important features:

- Minimizes mains load peaks and related mains feedback rates.
- Setpoint and load alterations are not automatically taken into account for mains load optimization.
- Can also be used with already existing power controllers from Pyrocontrole.

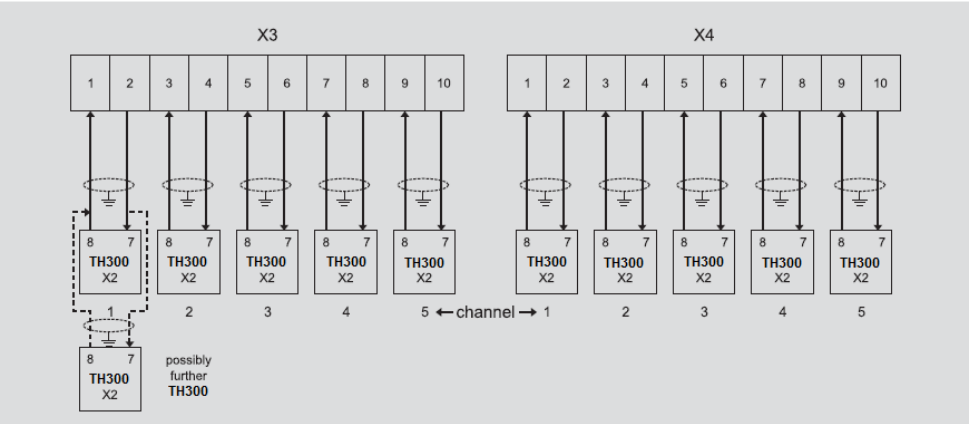


Fig. 10 : Thyritop Power Manager wiring diagram

8.3 SOFTWARE SYNCHRONIZATION WITH SOLID DELAY

Software synchronization is a method of mains load optimization which can be configured via an optional bus module or via the Thyritop-Tool 300.
The software synchronization is configured by inputting a parameter (parameter 36) and causes a delay of the initial ignition following the Thyritop 300 being switched on.

- Configure cycle period T_0 to the same value for all power controllers (recommended: T_0 = 50 periods (at 50Hz = 1 sec.).

When configuring via bus module:

- Input value via INDEX 38.

When configuring with the Thyritop-Tool 300:

- Input SYNC value "Synchronized clock address". Select a different value for each power controller.

All devices used must then be switched on at the load supply simultaneously, ideally with the aid of a corresponding switch/contactor.
A delay time up to the first switching on is set. The numerical value is given in periods. As a result the time until the first switching on is different for each power controller.
This procedure enables a slow switching ON of the load, e.g. with a slow cycle time of 1 sec. The values at an interval of 100 lead to a switching on phase delayed by a cycle period T_0 (group formation). This formation, for example, allows the activation of an emergency power generator to be realized.

9 LOAD MONITORING

Load monitoring is the identification of a breakdown of one or more resistors connected in parallel or series at the time of an error. Therefore the parameter has to be set within the monitoring to R_Max, which are calculated by the measured load resistance, e.g. plus 15% (guide value).
The table below shows adjustment options for R_Max depending on the load circuit.
Alternatively the TeachIn-function can be used for an automatically adjustment of the parameter R_Max. TeachIn determines the value for R_Max by measuring the current and voltage plus a variable addition (parameter RAutoTol, default value: 10%, parameter RAutoTol can be changed with Thyritop-Tool 300). While TeachIn determines the value for R_Max, the limits are still in use (I_Max, U_Max and P_Max).

NOTE
The following limitations apply for the settings of load resistance and for the following tables.

- Settings below 15% do not make sense and should be avoided.
- In operating mode VAR, monitoring is blocked for large control angles (for load with neutral conductor alpha>140°el., for load without neutral conductor alpha>117°el.).
- In the operating mode TAKT the monitoring is blocked for low setting times (Ts) (by 2-phase devices Ts< 2 periods).
- When the resistance value is monitored, in general the adjusted monitoring value Rmax should be in the middle between the resistance value without error and the resistance value at an error. Although it should not fall below 15%.
- In the tables below attention should be paid to minimal load nominal current (I-load-nominal / I-type controller) and minimal load nominal voltage (U-load-nominal / U-type controller). If the values are by far better as the ones in the tables, a better monitoring could be achieved by more parallel load resistances.

LOAD RESISTANCE MONITORING Thyritop 300 (R_MAX):

Thyritop 300 1A and Thyritop 300 2A (load with separate star point without neutral conductor):

NUMBER OF PARALLEL LOAD RESISTANCES	ILOAD NOMINAL / ITYPE CONTROLLER*	ULOAD NOMINAL / UTYPE CONTROLLER*	RESISTANCE CHANGE IN FAULT**	RECOMMENDED SETTINGS FOR R_MAX
1	20%	40%	unlimited	R_{Load} +50%
2	20%	40%	+100%	R_{Load} +50%
3	40%	40%	+50%	R_{Load} +25%
4	40%	40%	+33%	R_{Load} +18%
5	40%	40%	+25%	R_{Load} +15%

Thyritop 300 2A (load with common star point without neutral conductor):

NUMBER OF PARALLEL LOAD RESISTANCES	ILOAD NOMINAL / ITYPE CONTROLLER*	ULOAD NOMINAL / UTYPE CONTROLLER*	RESISTANCE CHANGE IN FAULT**	RECOMMENDED SETTINGS FOR R_MAX
1	20%	40%	unlimited	R_{Load} +50%
2	20%	40%	+67%	R_{Load} +33%
3	40%	40%	+33%	R_{Load} +18%
4	40%	40%	+22%	R_{Load} +15%

Thyritop 300 2A (load in delta connection):

NUMBER OF PARALLEL LOAD RESISTANCES	ILOAD NOMINAL / ITYPE CONTROLLER*	ULOAD NOMINAL / UTYPE CONTROLLER*	RESISTANCE CHANGE IN FAULT**	RECOMMENDED SETTINGS FOR R_MAX
1	20%	40%	+73%	R_{Load} +36%
2	20%	40%	+31%	R_{Load} +16%
3	60%	40%	+20%	R_{Load} +15%

* min value for 100% setpoint
** partial load fault

10 DIMENSION DRAWINGS

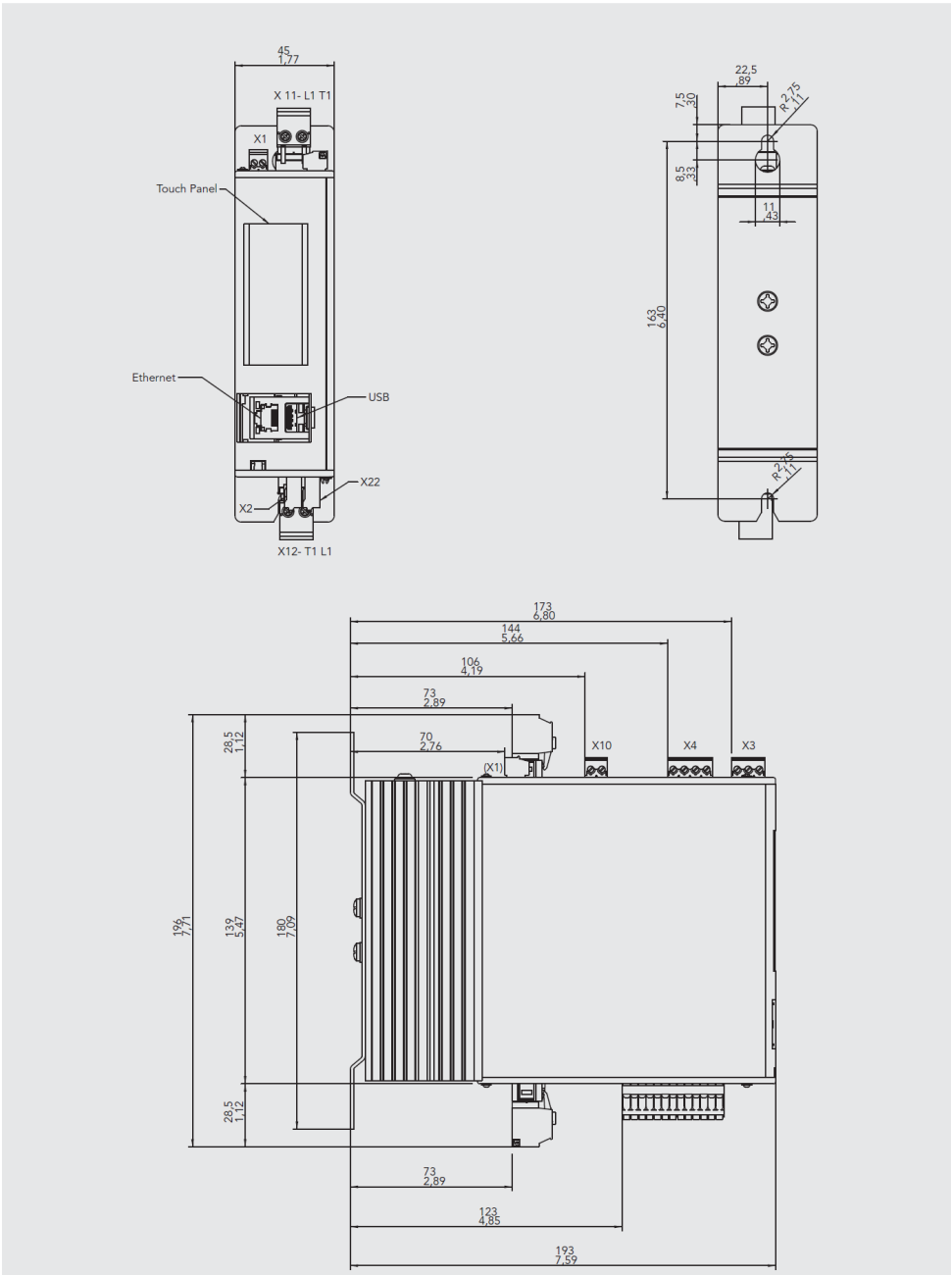


Fig. 11 : Thyritop 300-1A…16A

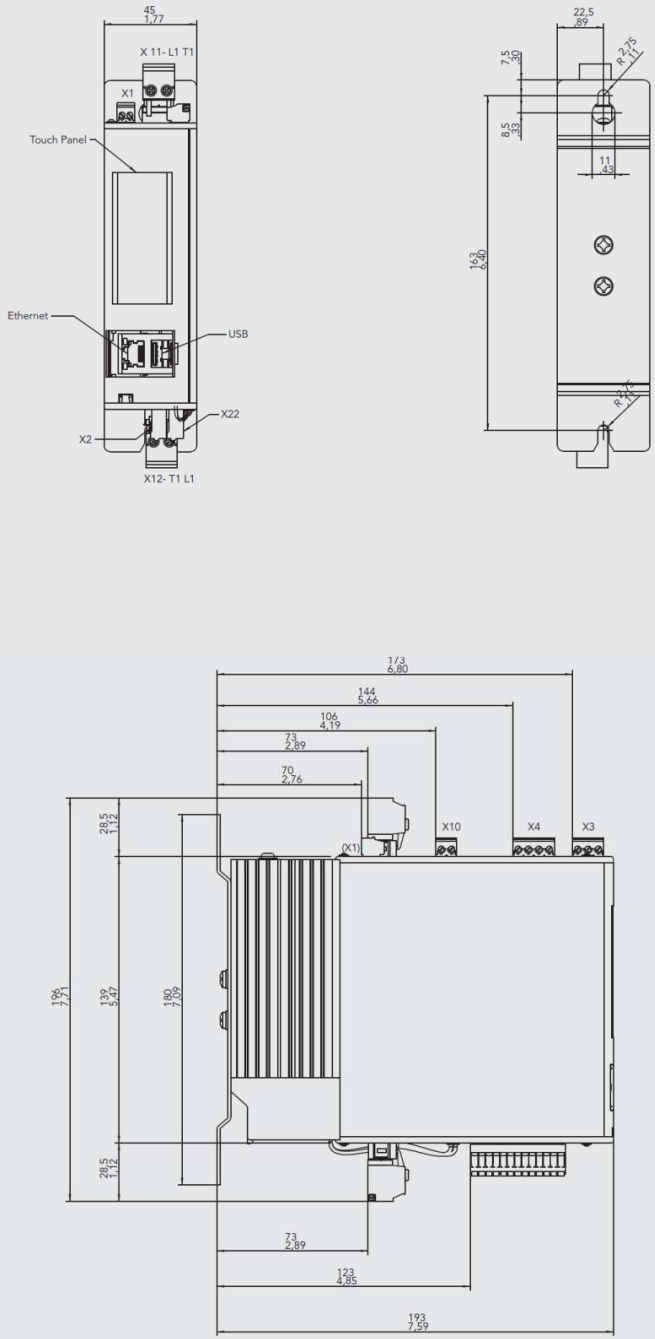


Fig. 12 : Thyritop 300-1A…30A

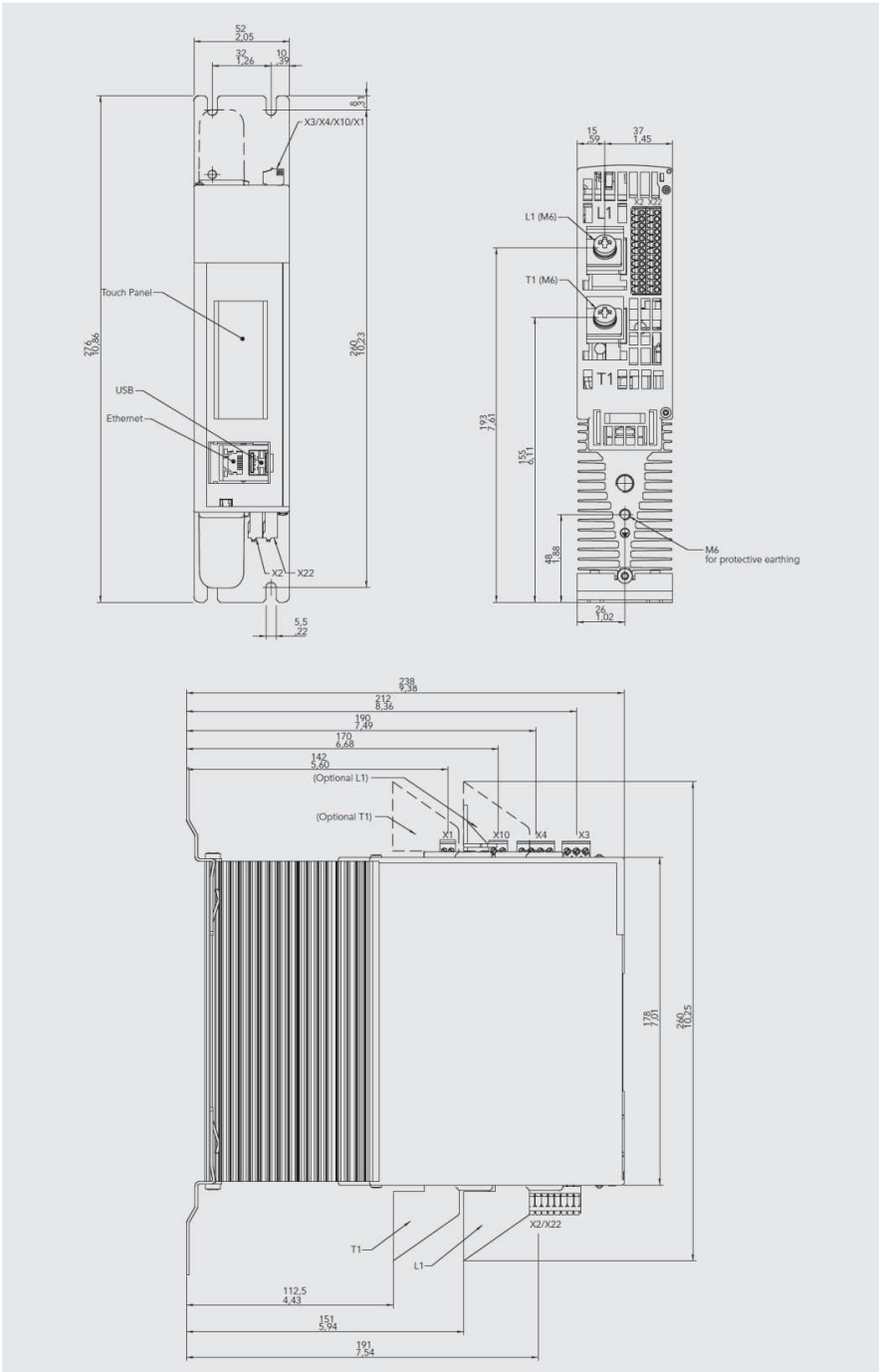


Fig. 13 : Thyritop 300-1A…45A,…60A

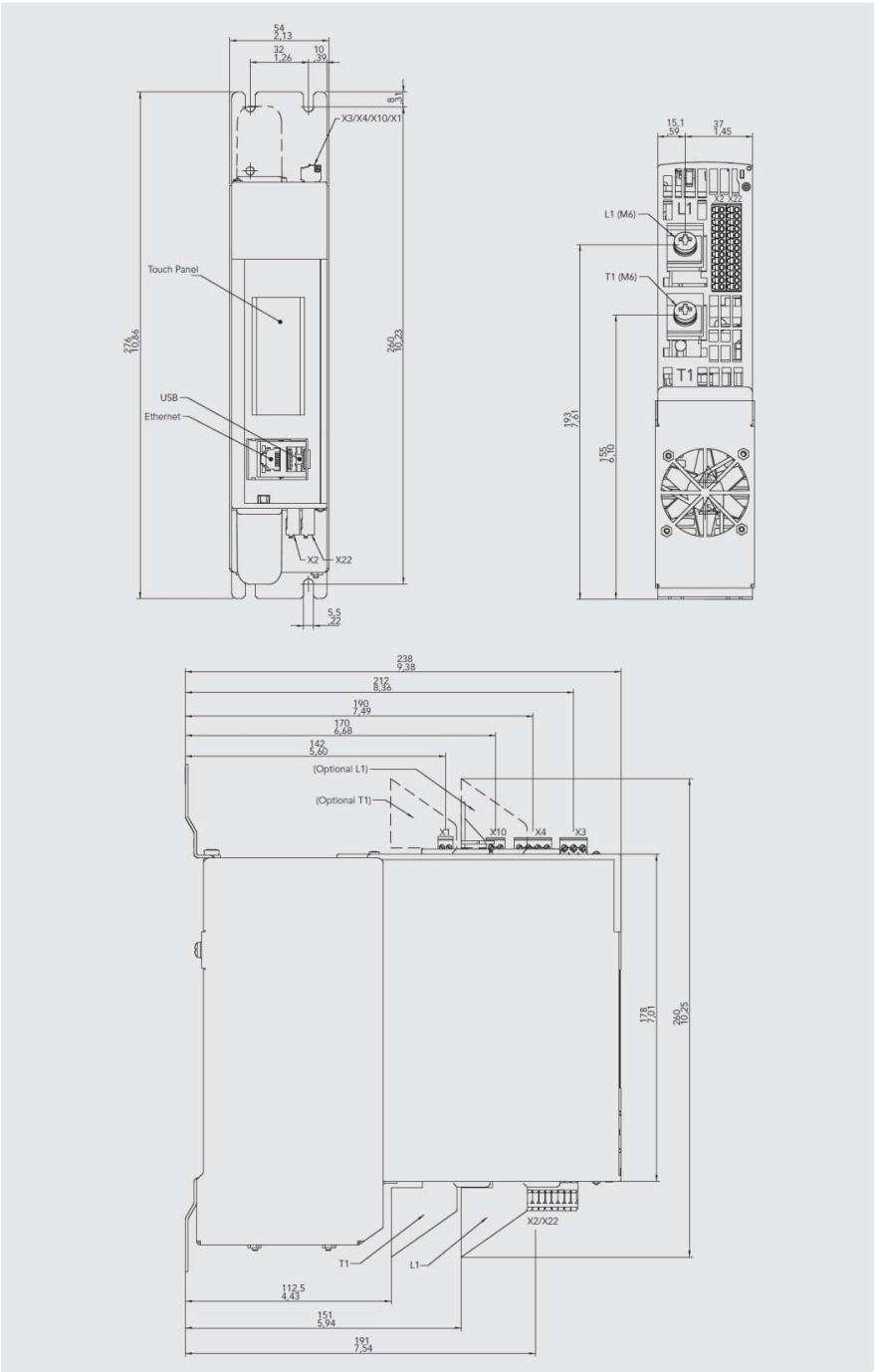


Fig. 14 : Thyritop 300-1A…100A

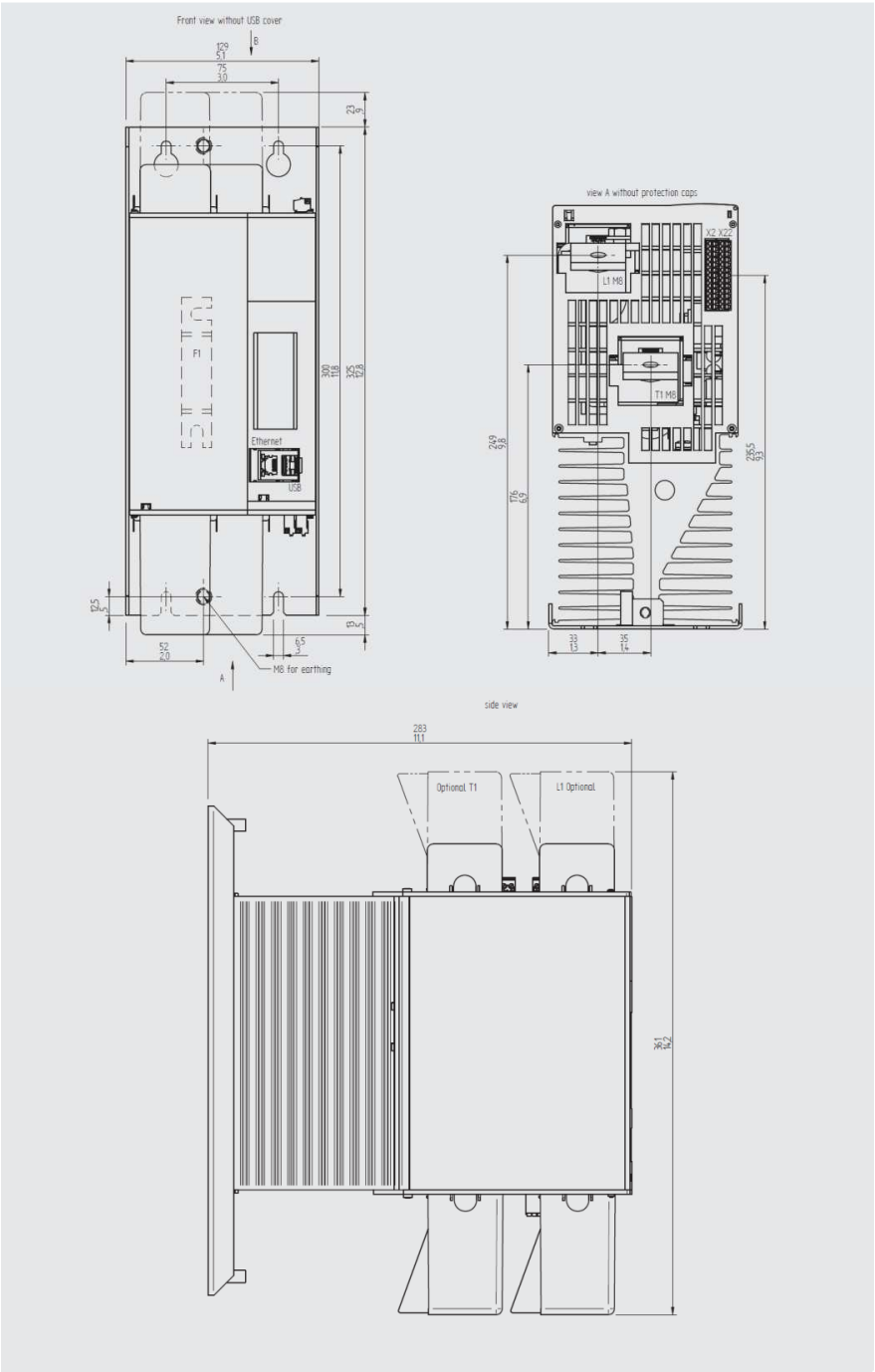


Fig. 15 : Thyritop 300-1A…130A, …170A

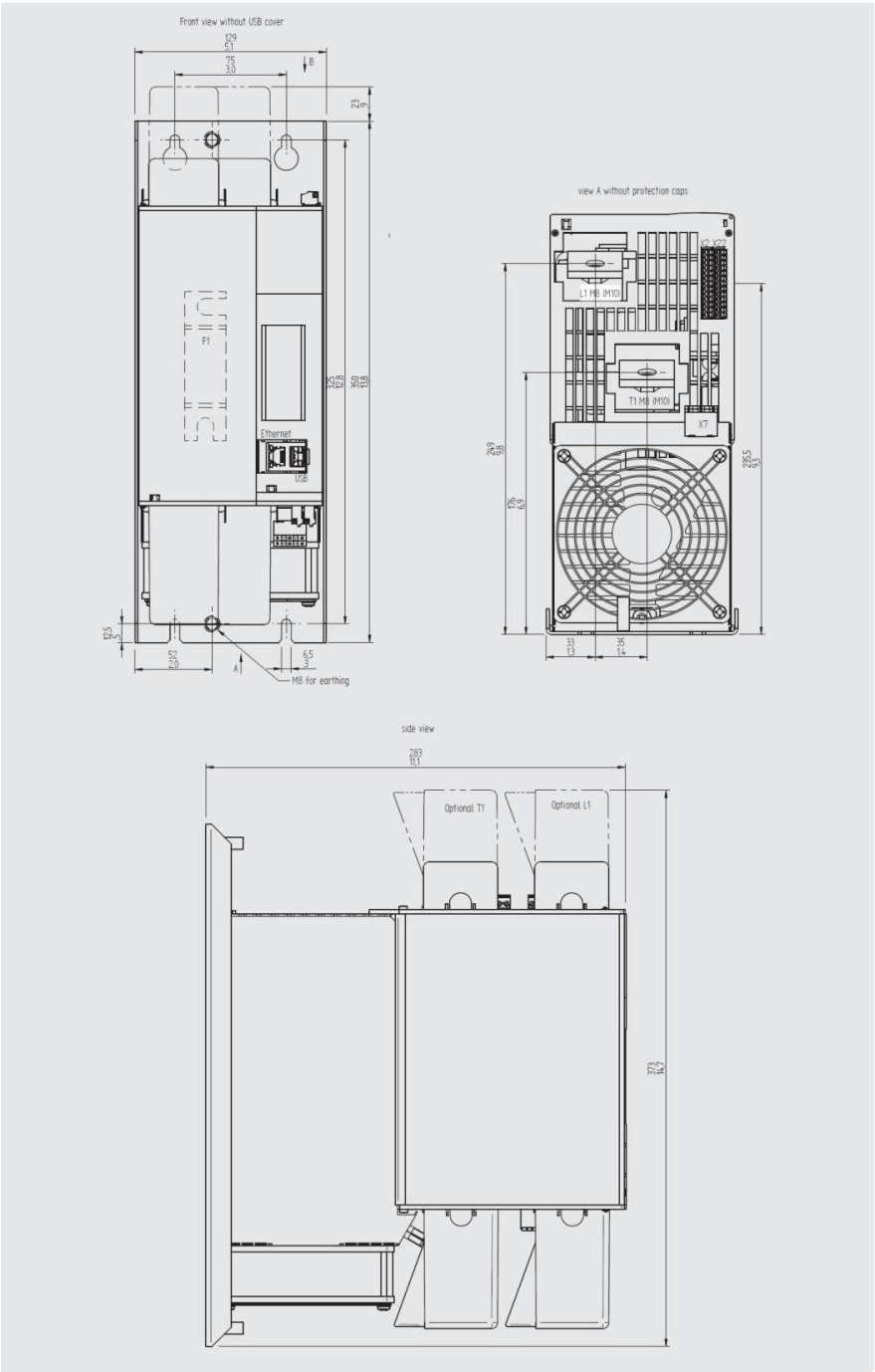


Fig. 16 : Thyritop 300-1A…230A, …240A,…280A,…350A

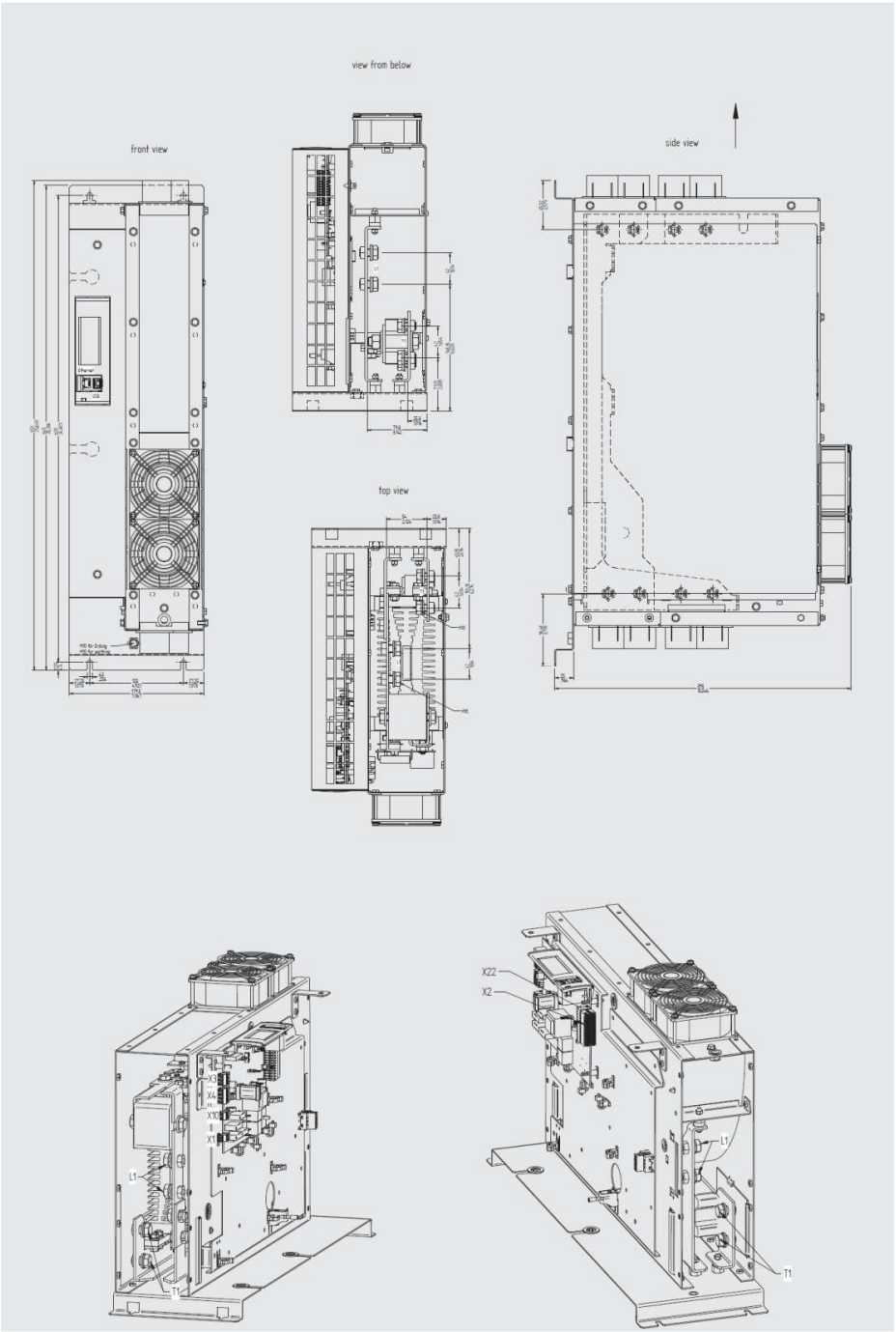


Fig. 17 : Thyritop 300-1A…495A, …650A

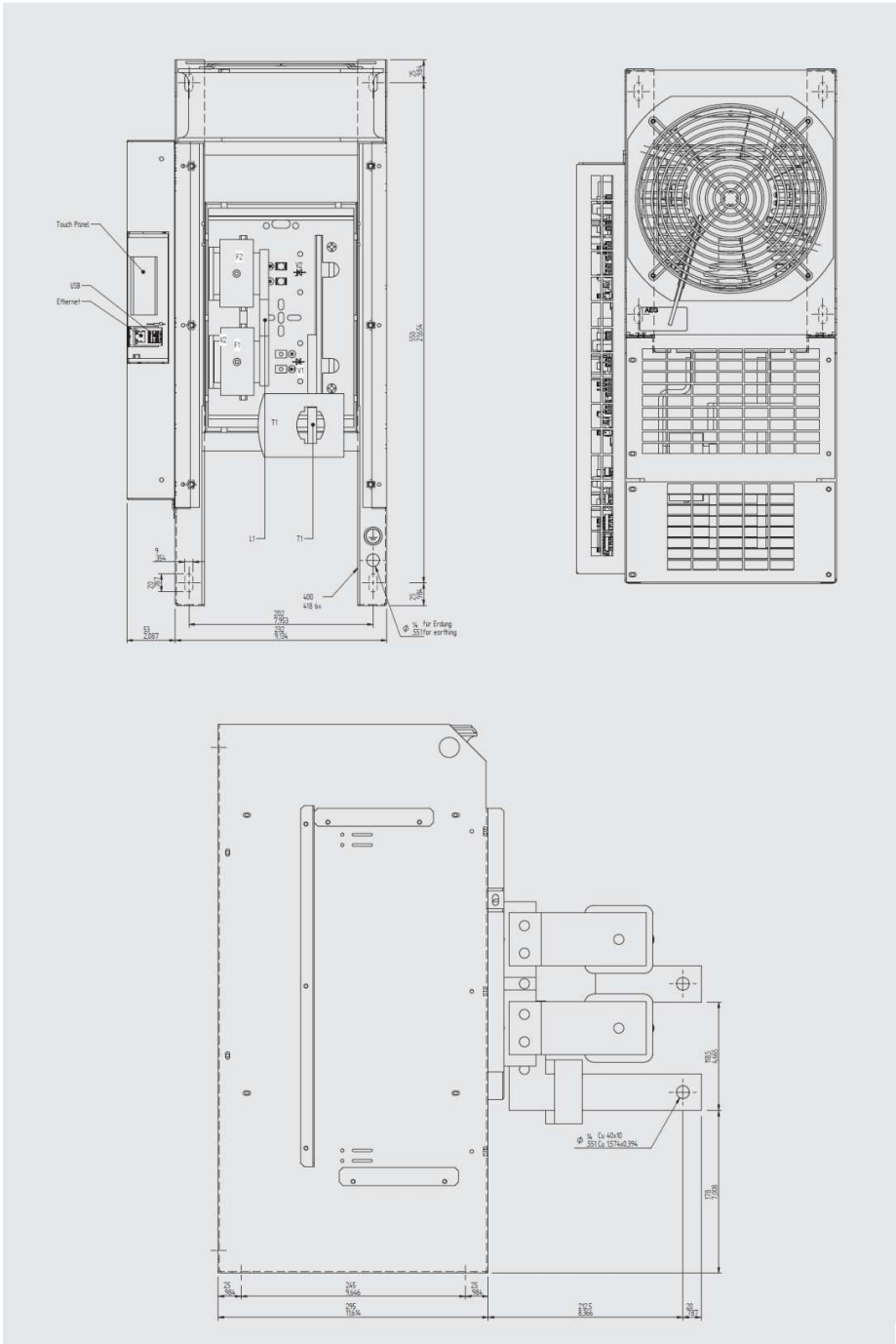


Fig. 18 : Thyritop 300-1A…1000A

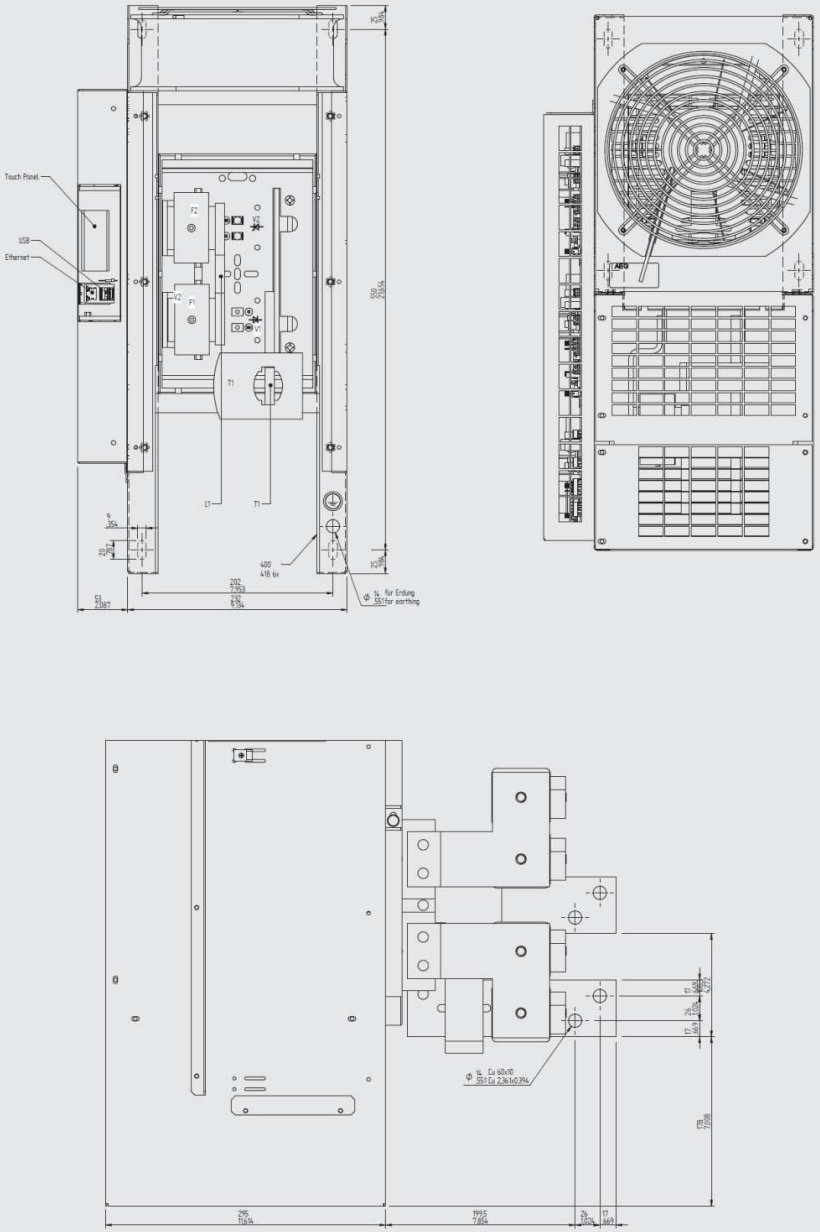


Fig. 19 : Thyritop 300-1A…1400A, …1500A

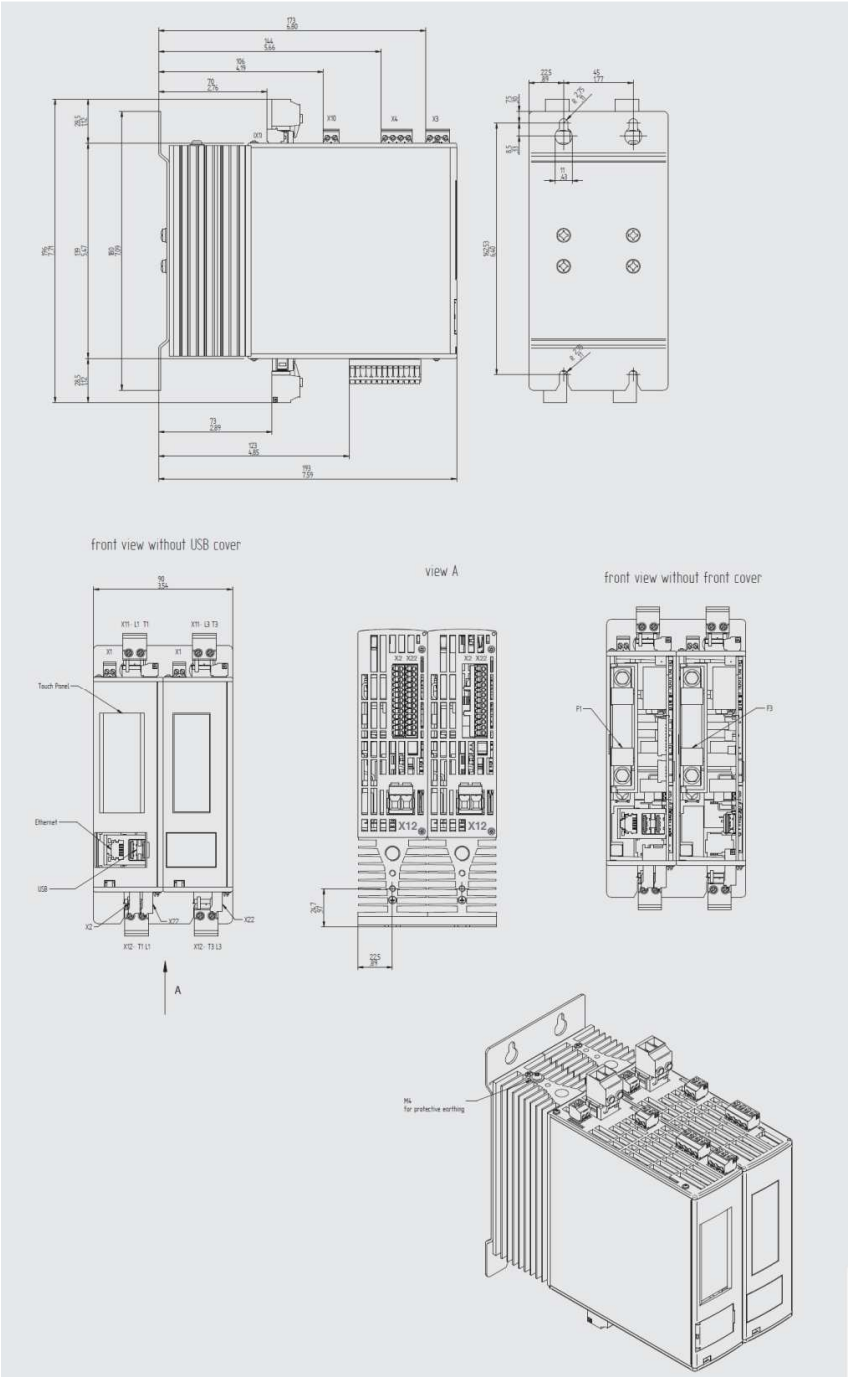


Fig. 20 : Thyritop 300-2A…16A

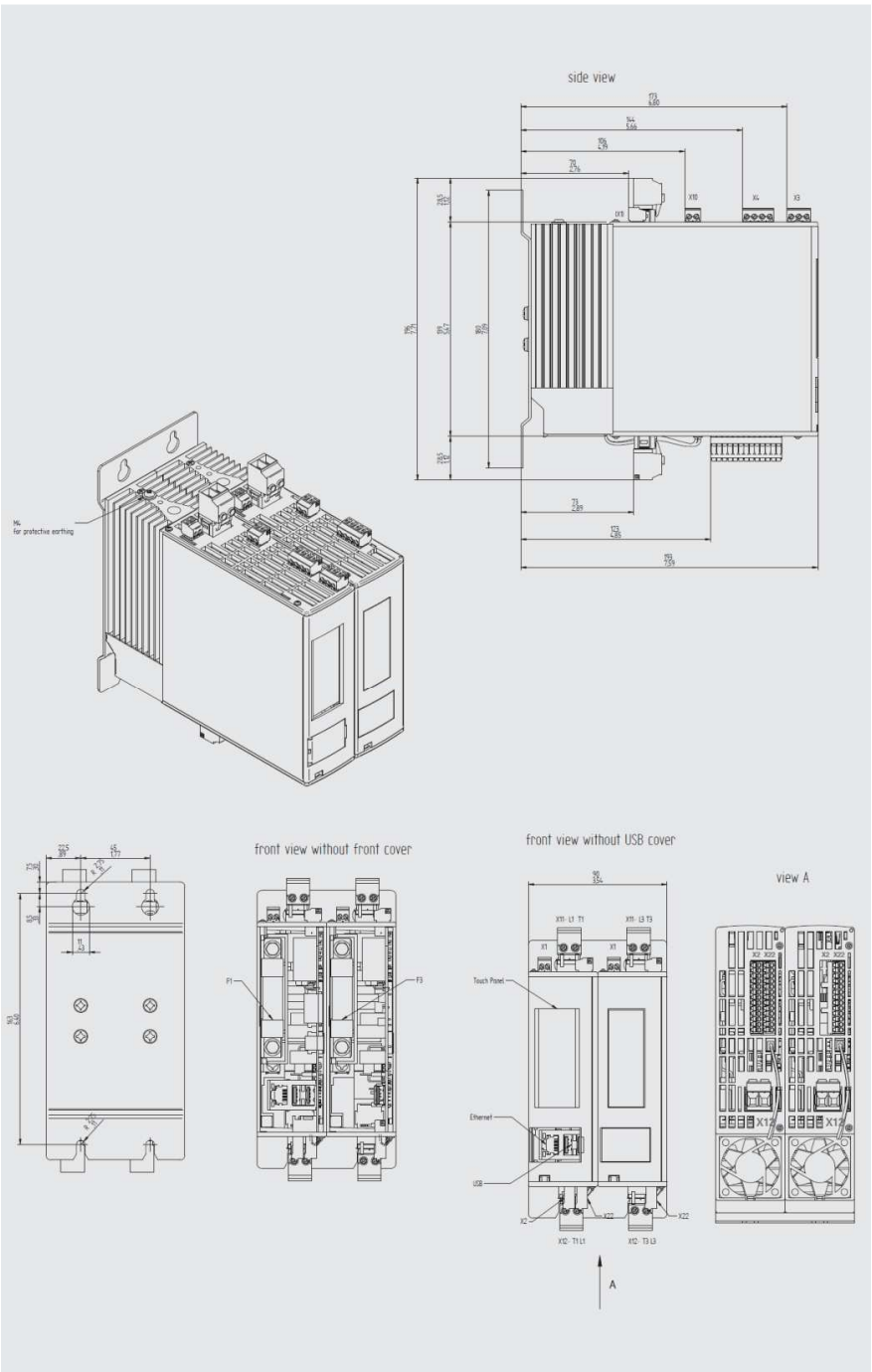


Fig. 21 : Thyritop 300-2A…30A

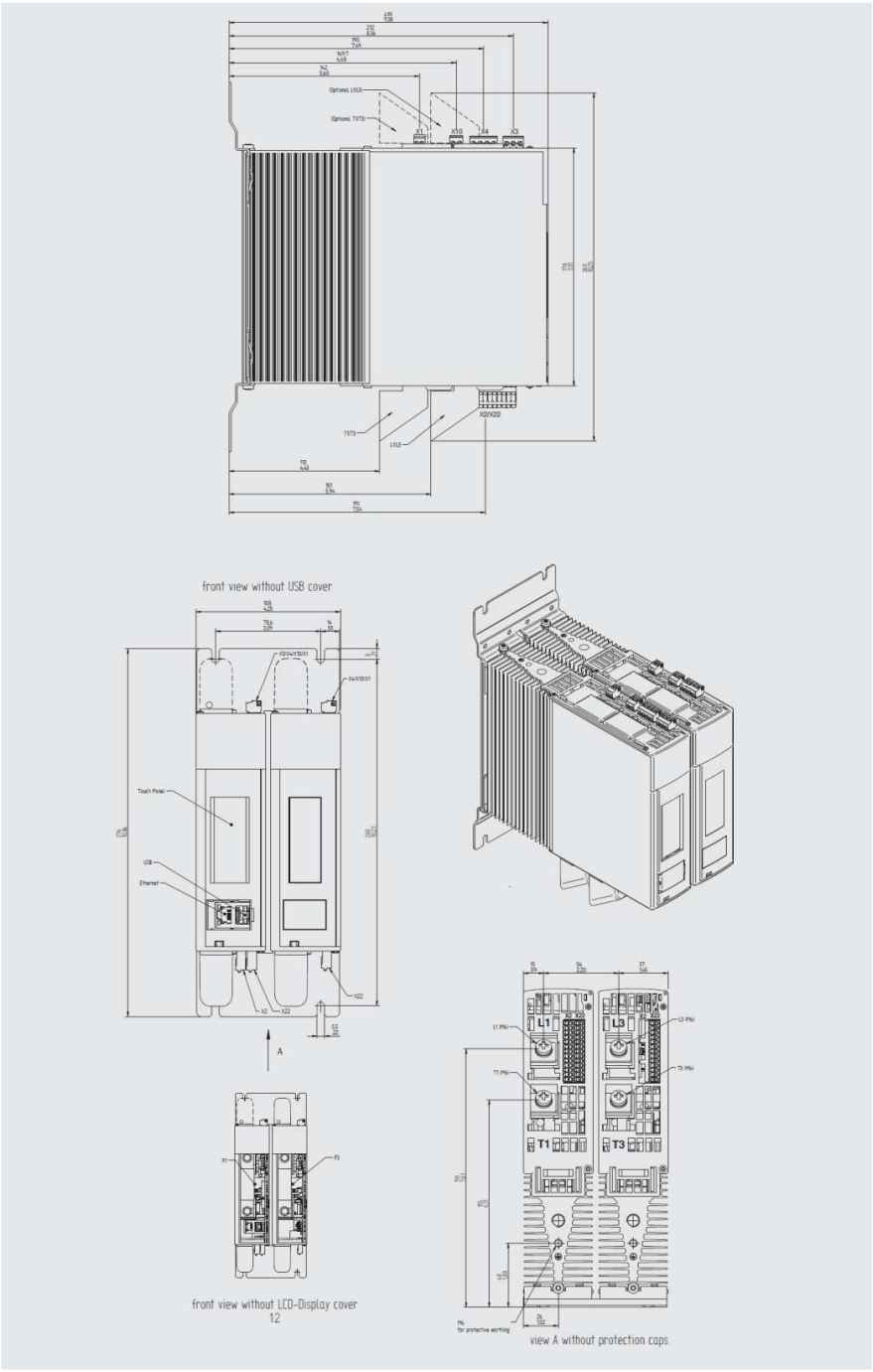


Fig. 22 : Thyritop 300-2A…45A,…60A

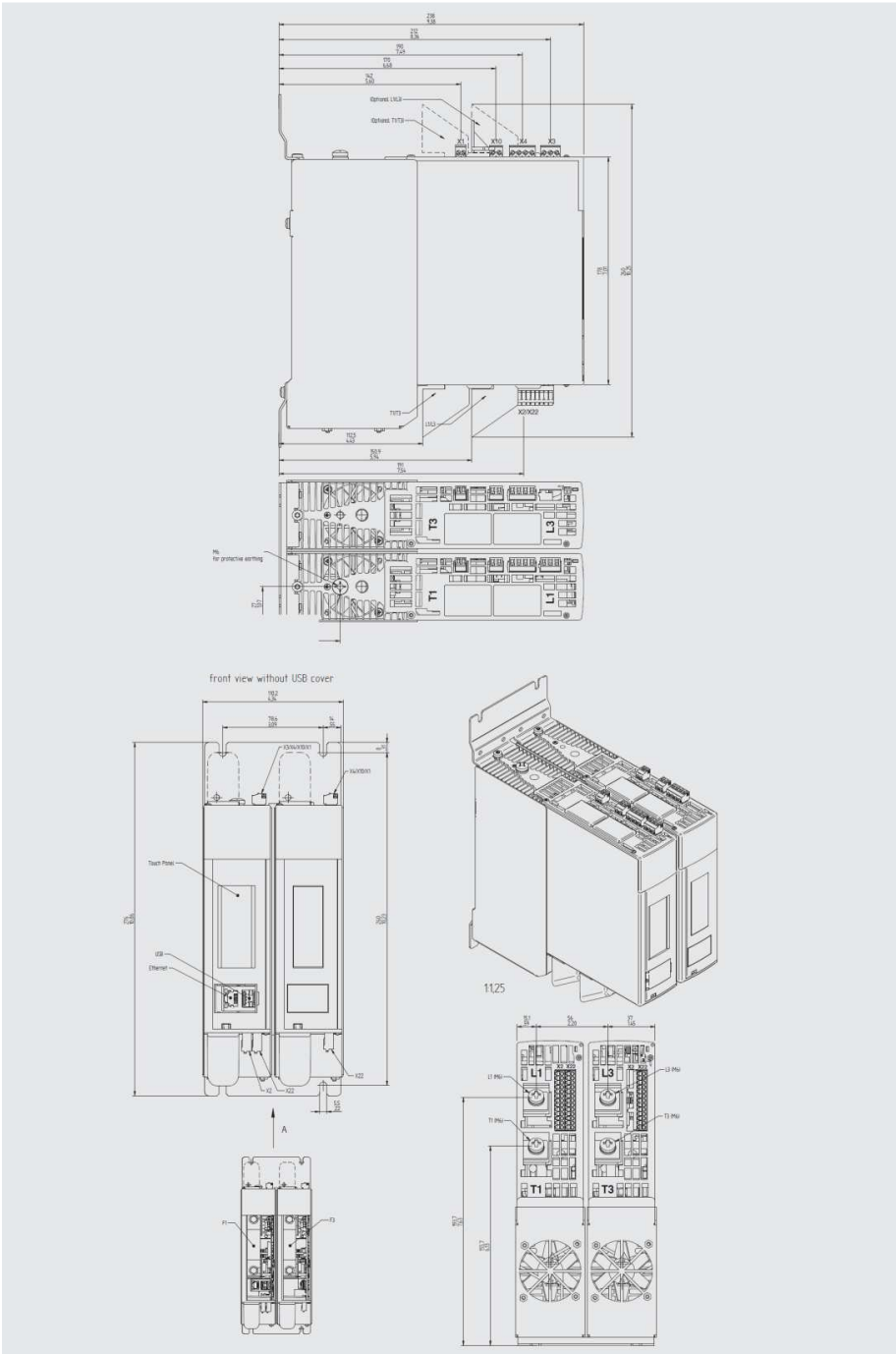


Fig. 23 : Thyritop 300-2A…100A

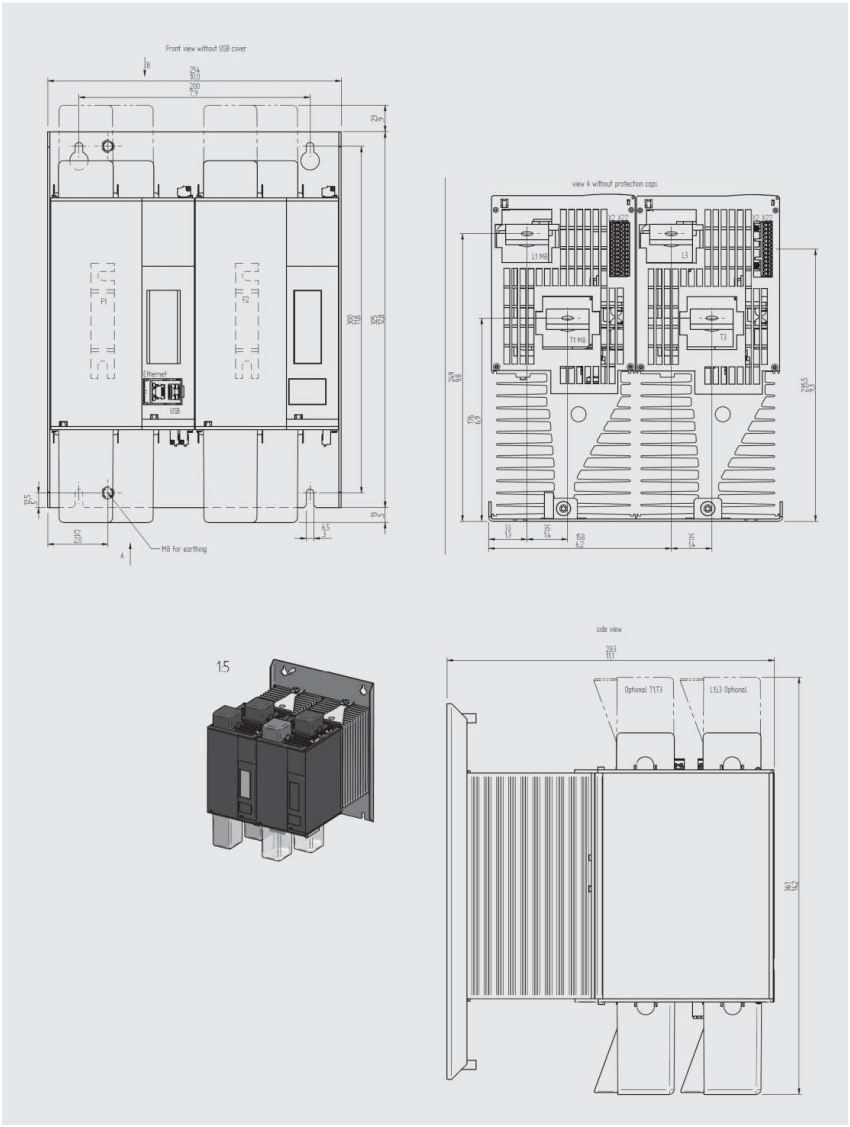


Fig. 24 : Thyritop 300-2A…130A, …170A

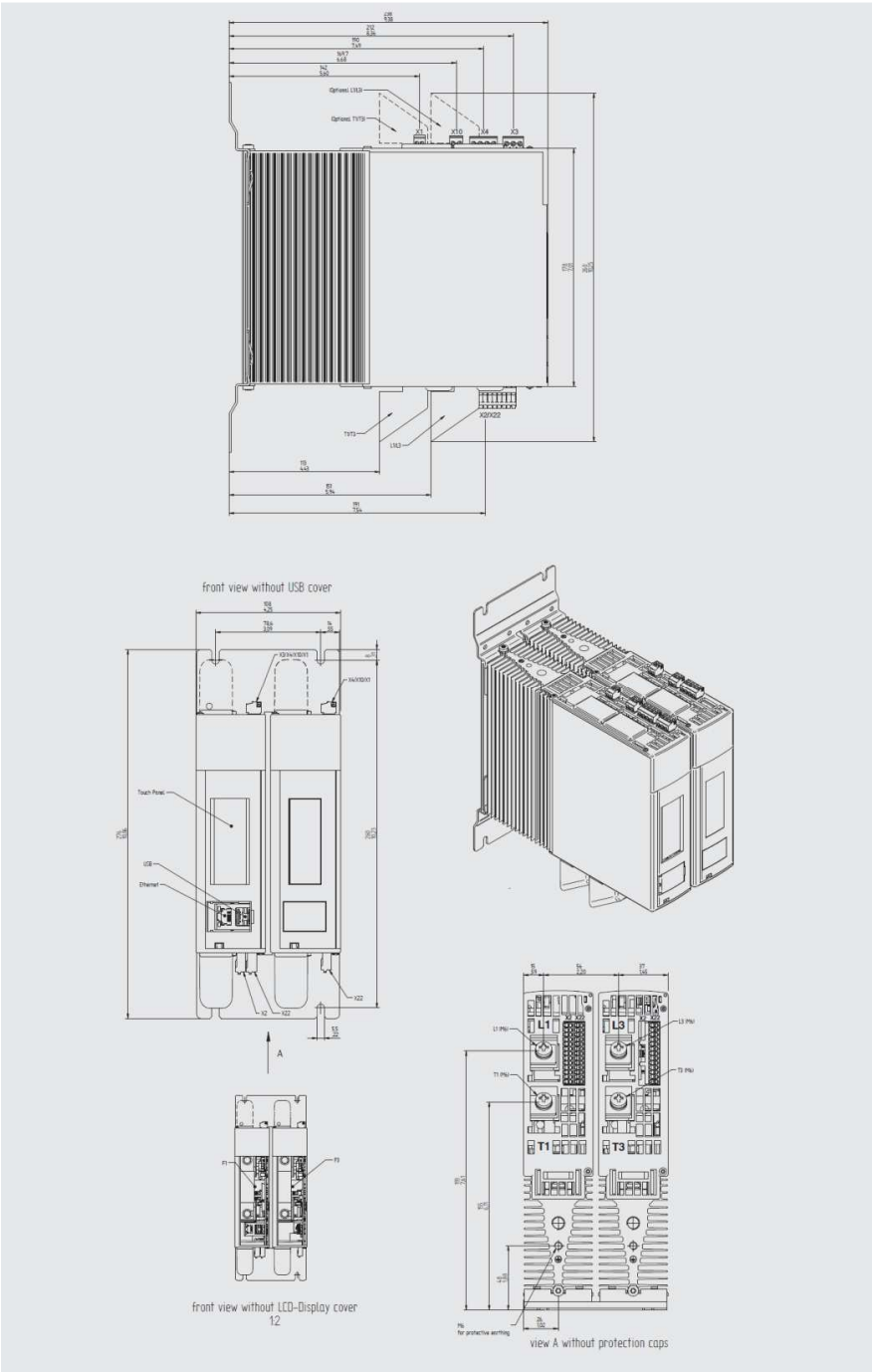


Fig. 25 : Thyritop 300-2A…45A, …60A

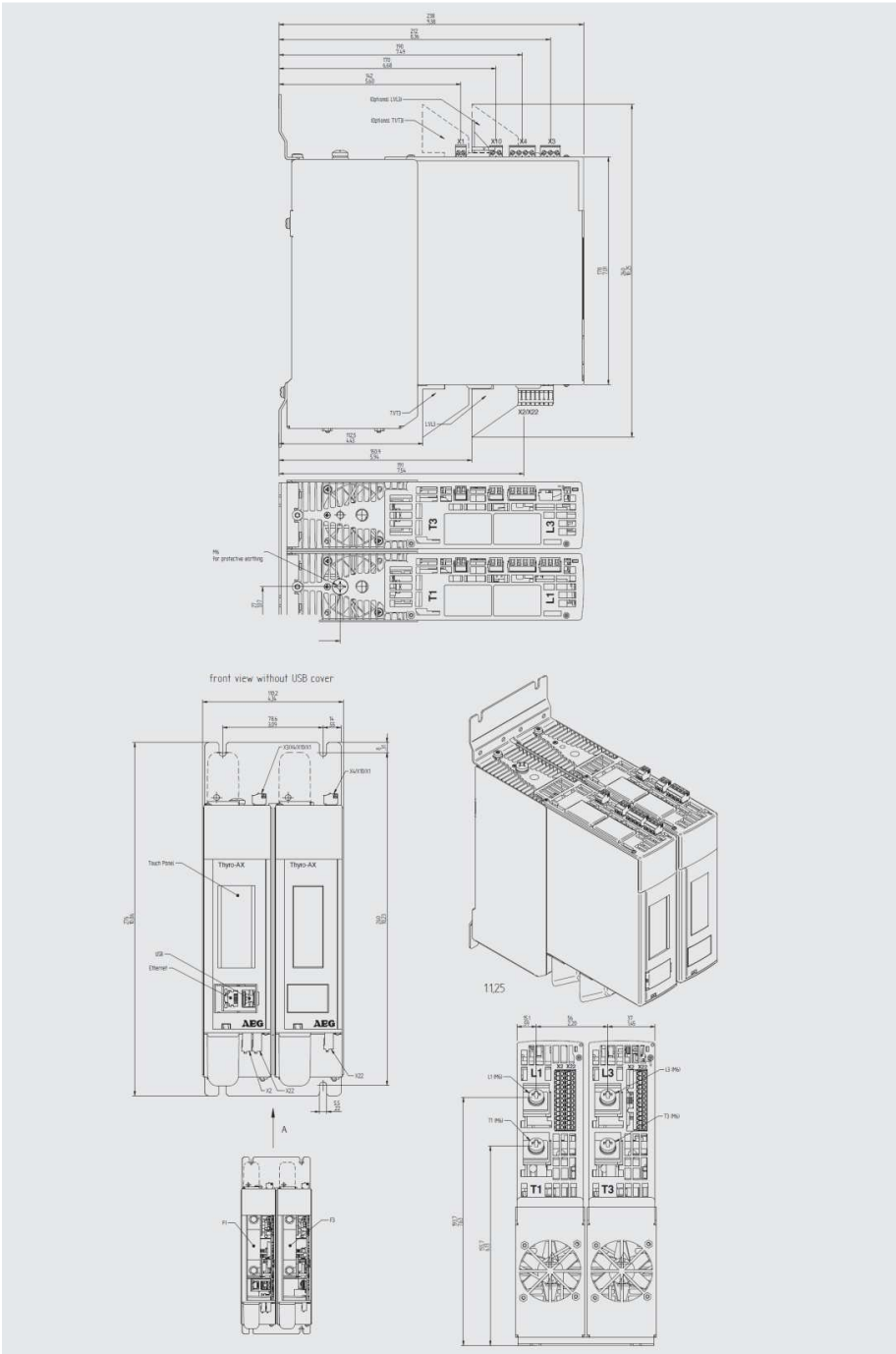


Fig. 26 : Thyritop 300-2A…100A

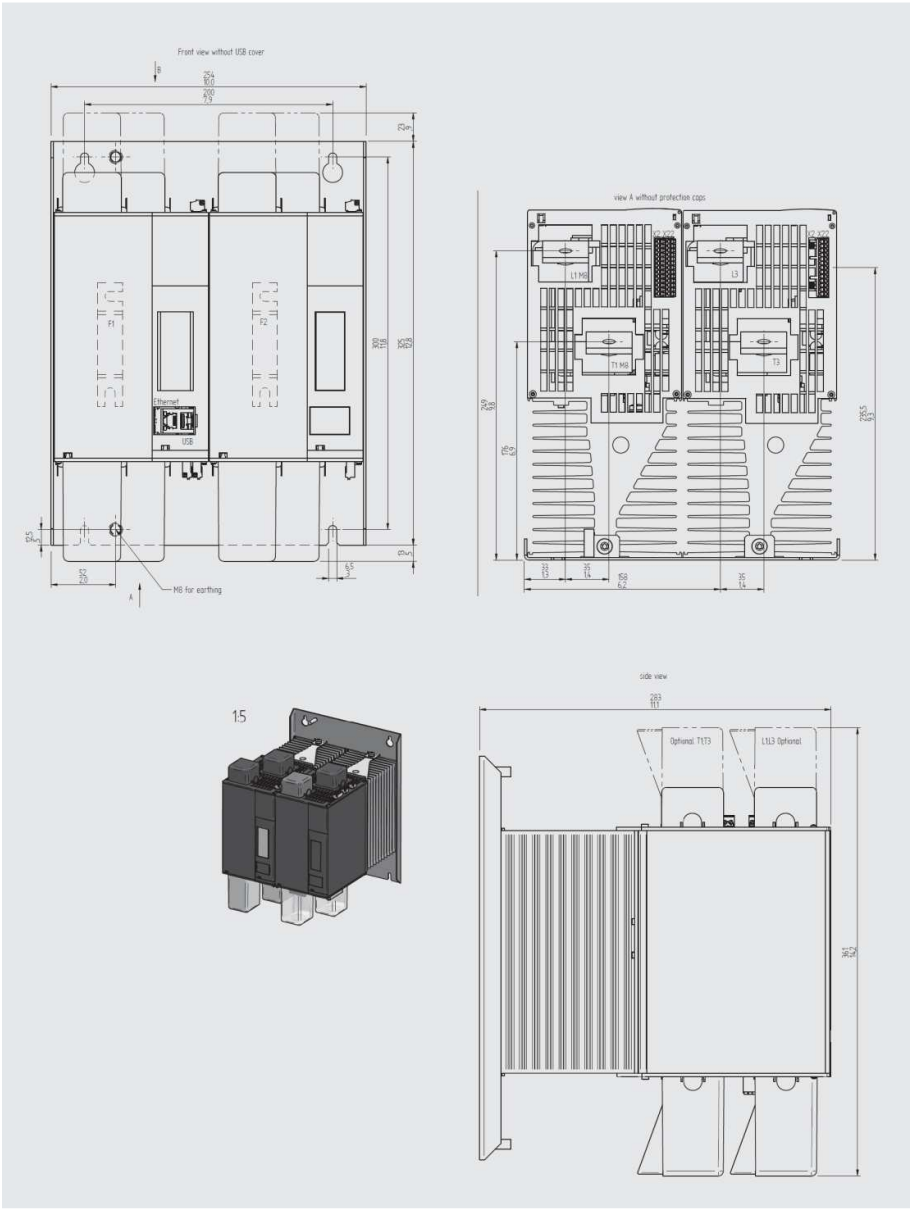


Fig. 27 : Thyritop 300-2A…130A, …170A

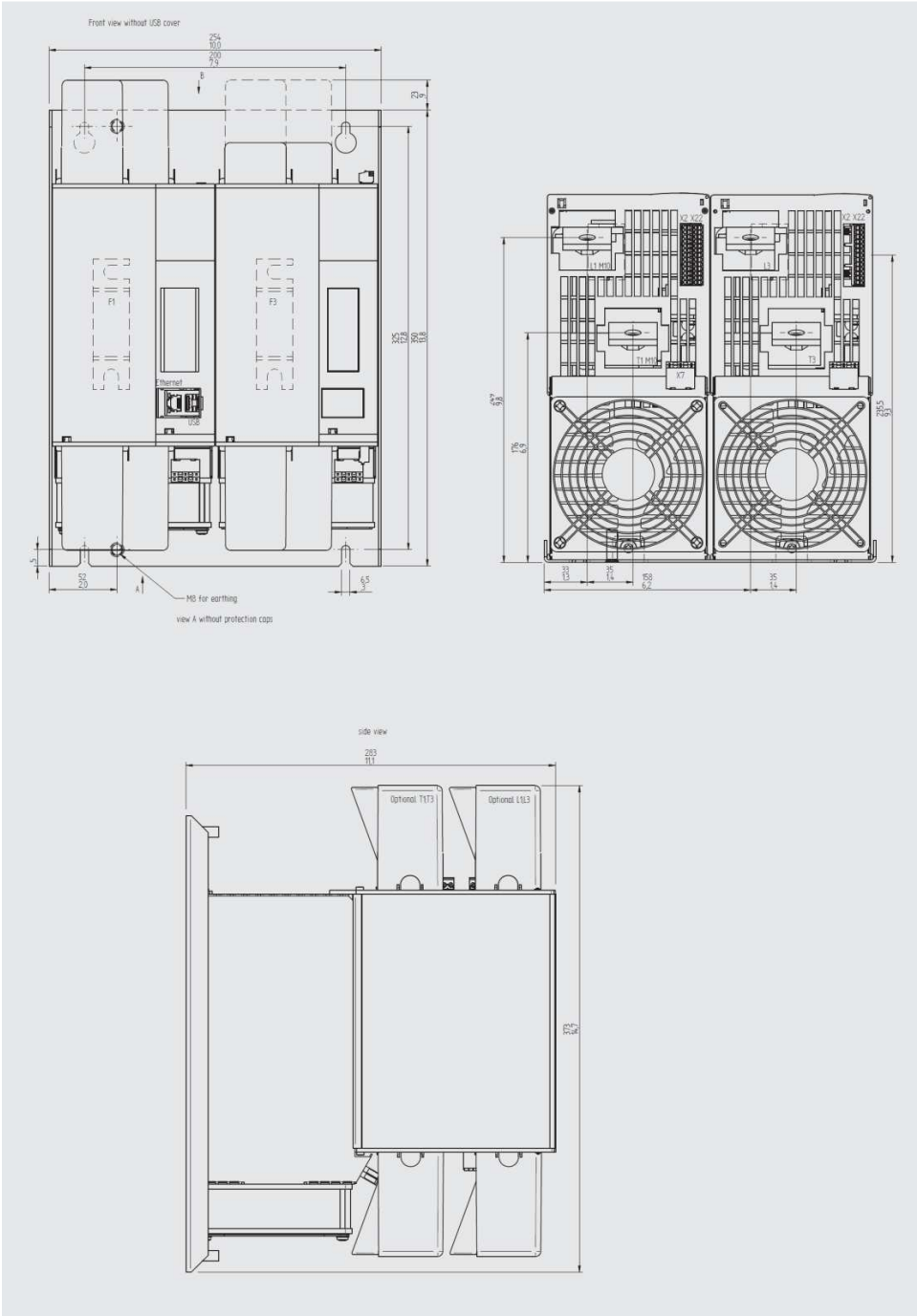


Fig. 28 : Thyritop 300-2A…230A, …240A, …280A, …350A

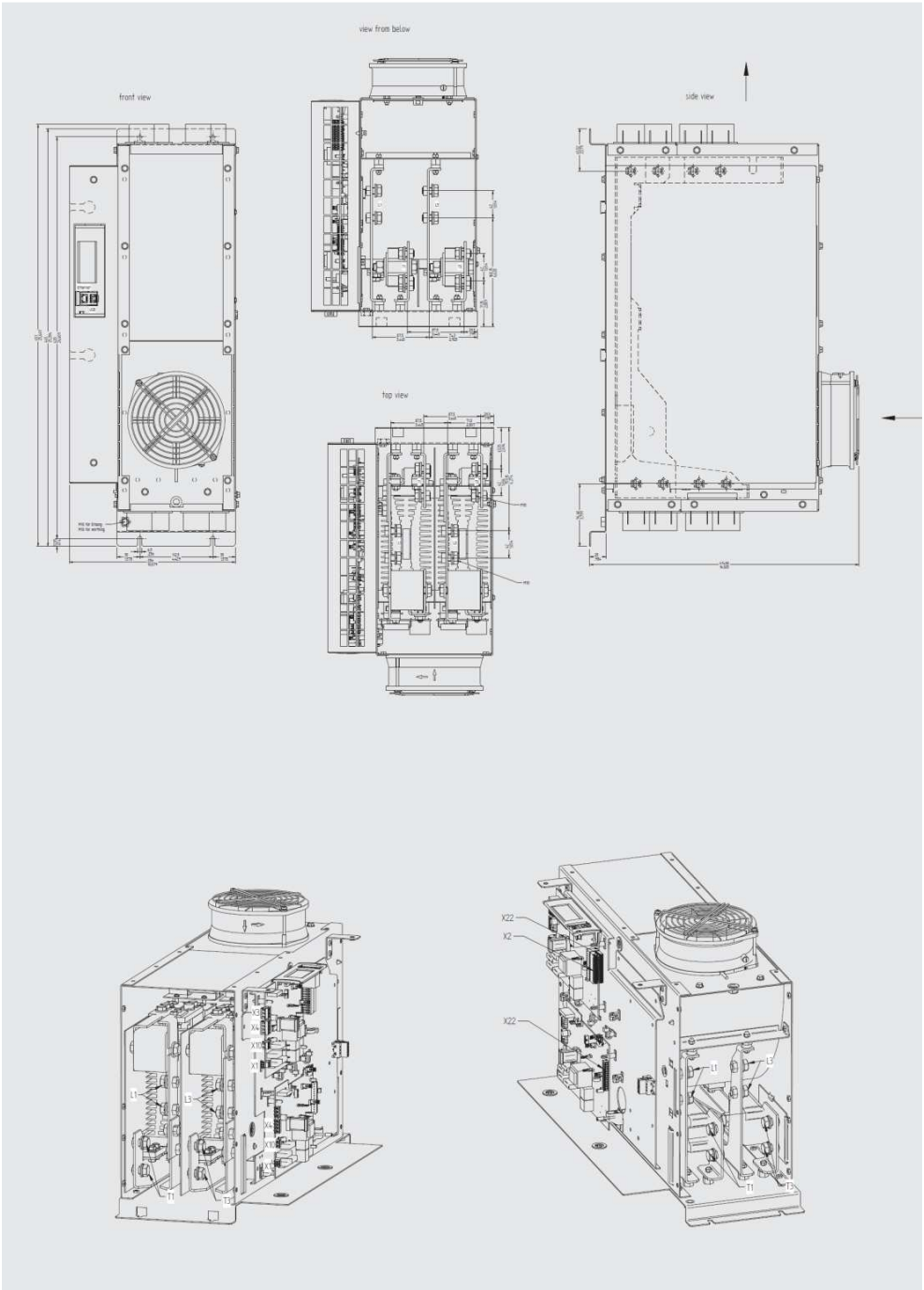


Fig. 29 : Thyritop 300-2A…495A, …650A

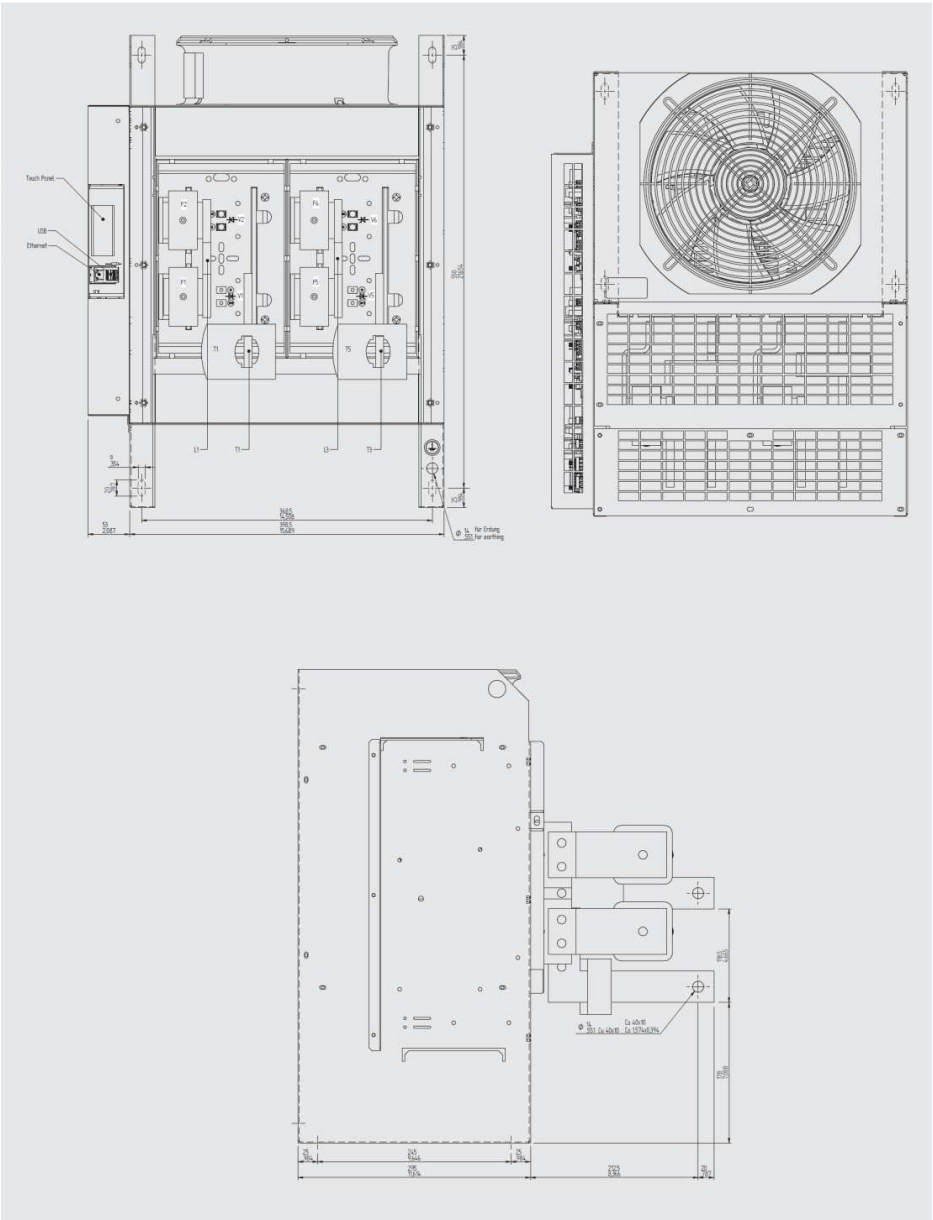


Fig. 30 : Thyritop 300-2A…1000A

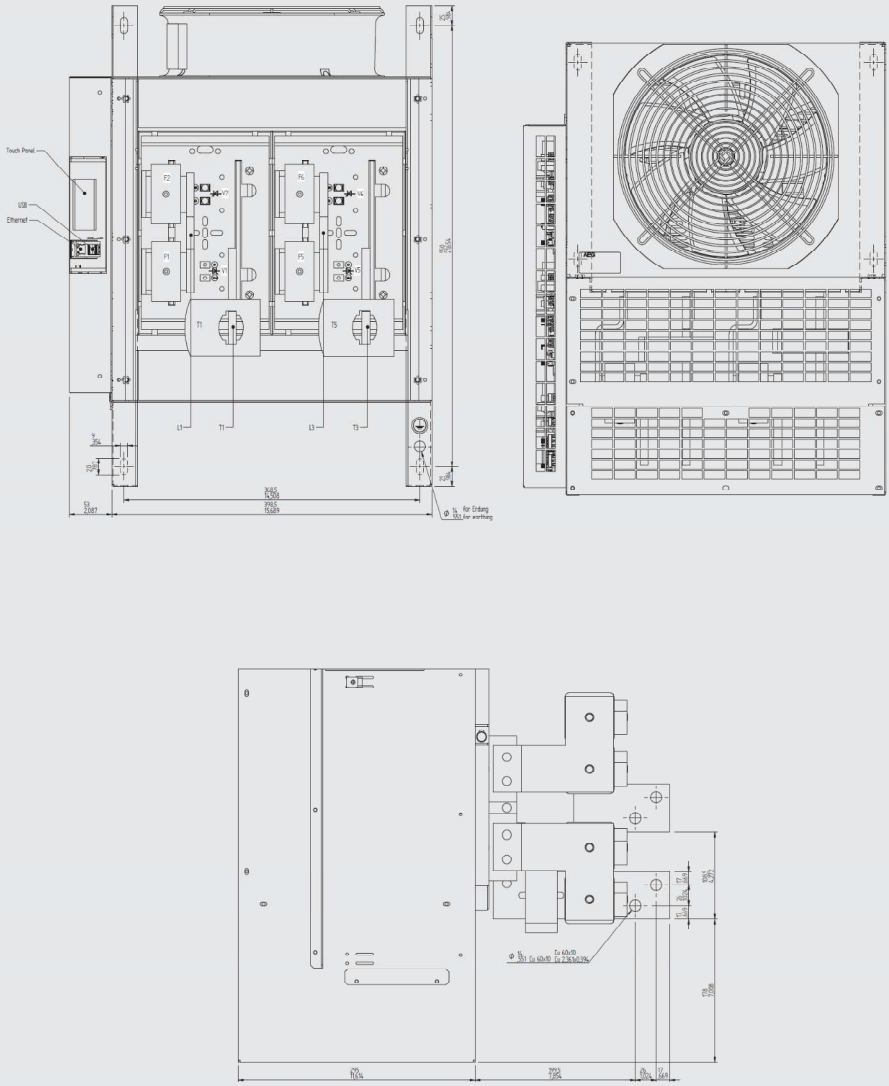


Fig. 31 : Thyritop 300-2A…1400A, …1500A

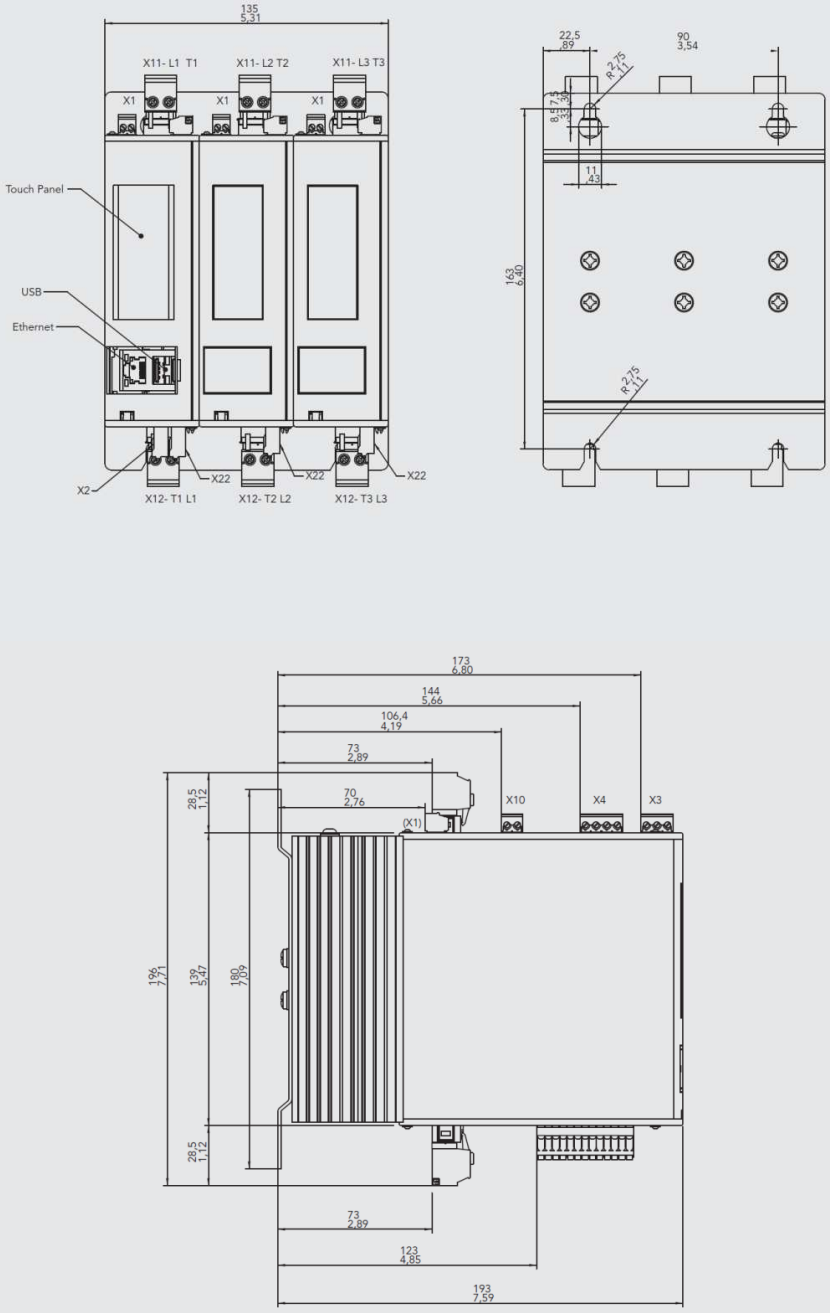


Fig. 32 : Thyritop 300-3A…16A

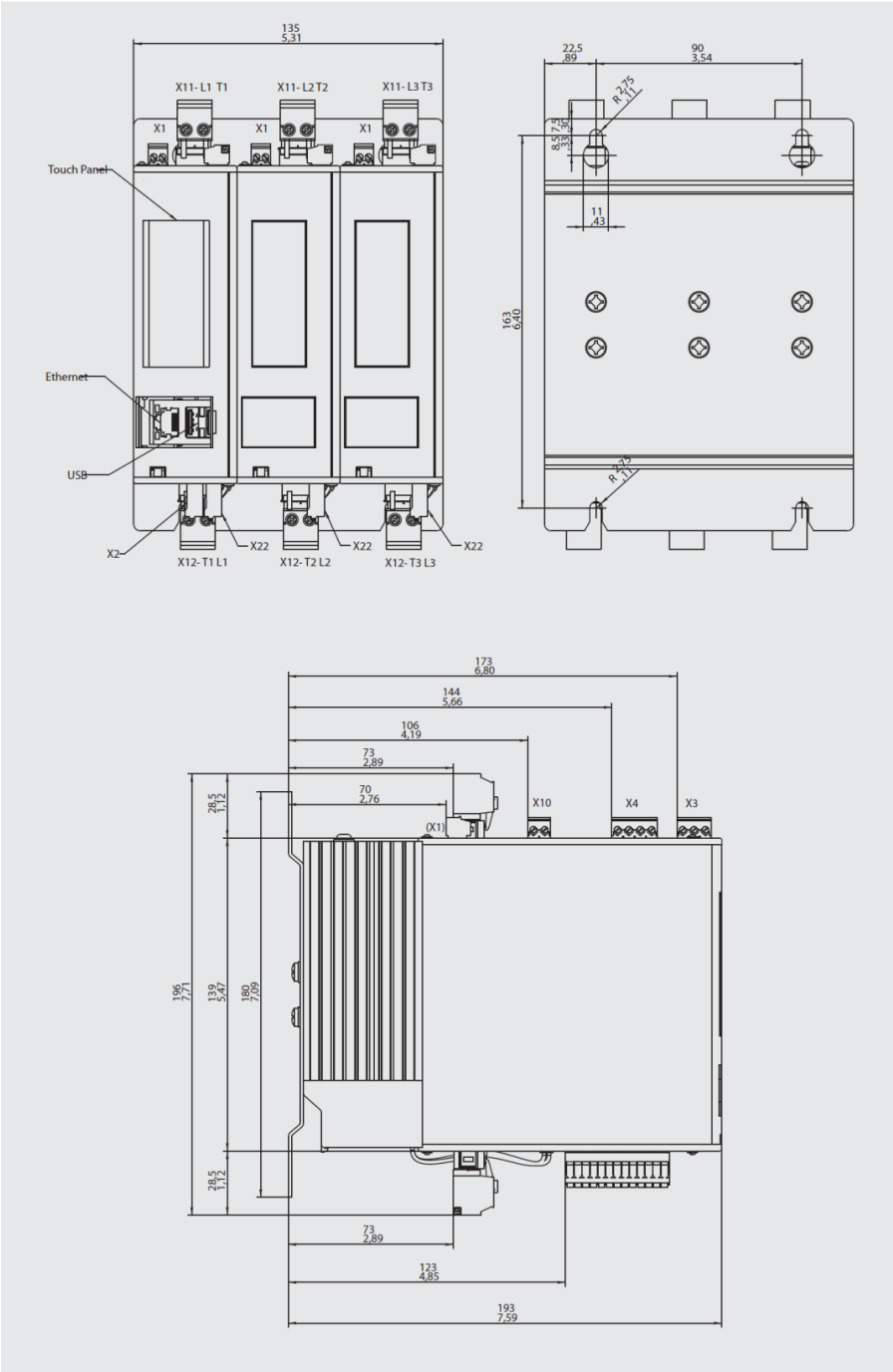


Fig. 33 : Thyritop 300-3A…30A

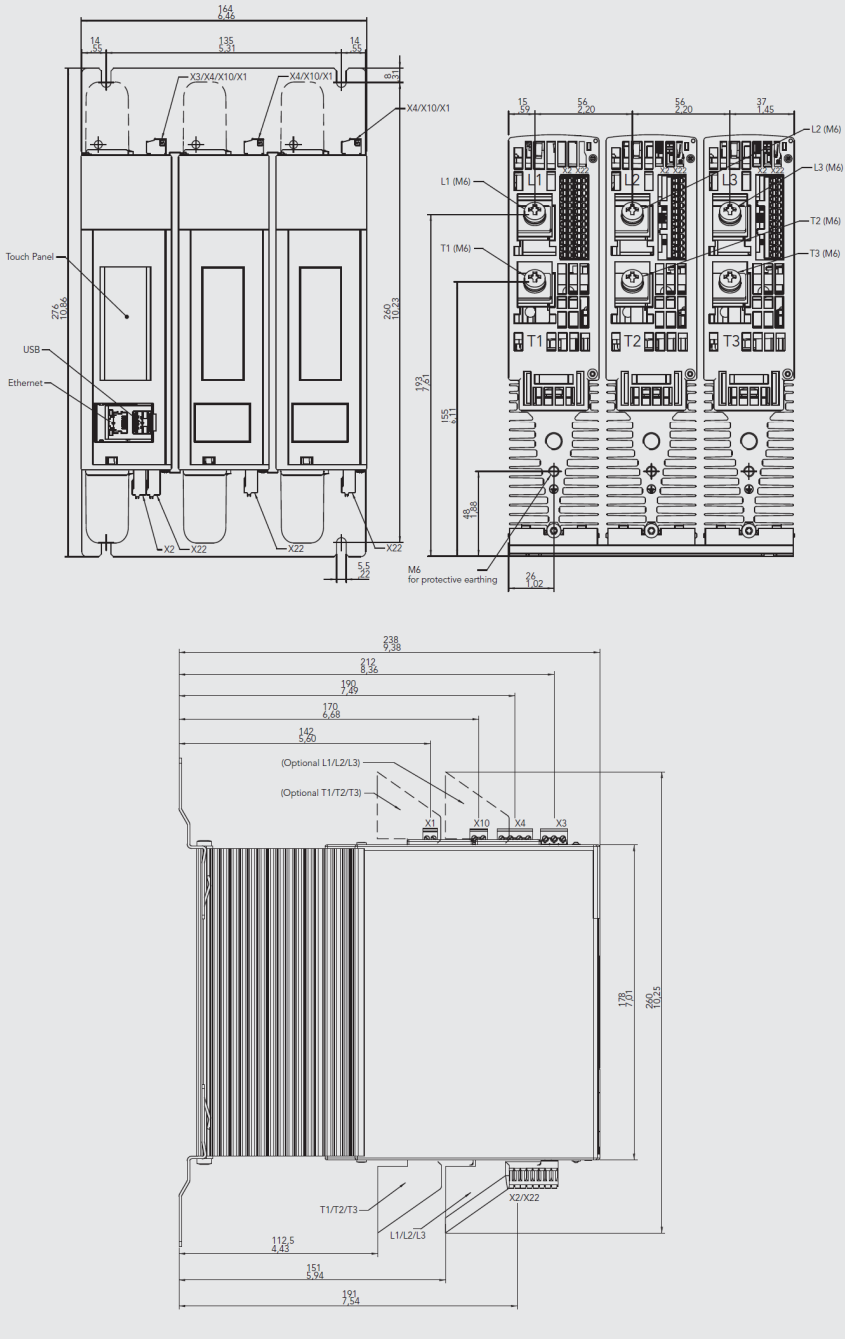


Fig. 34 : Thyritop 300-3A…45A, …60A

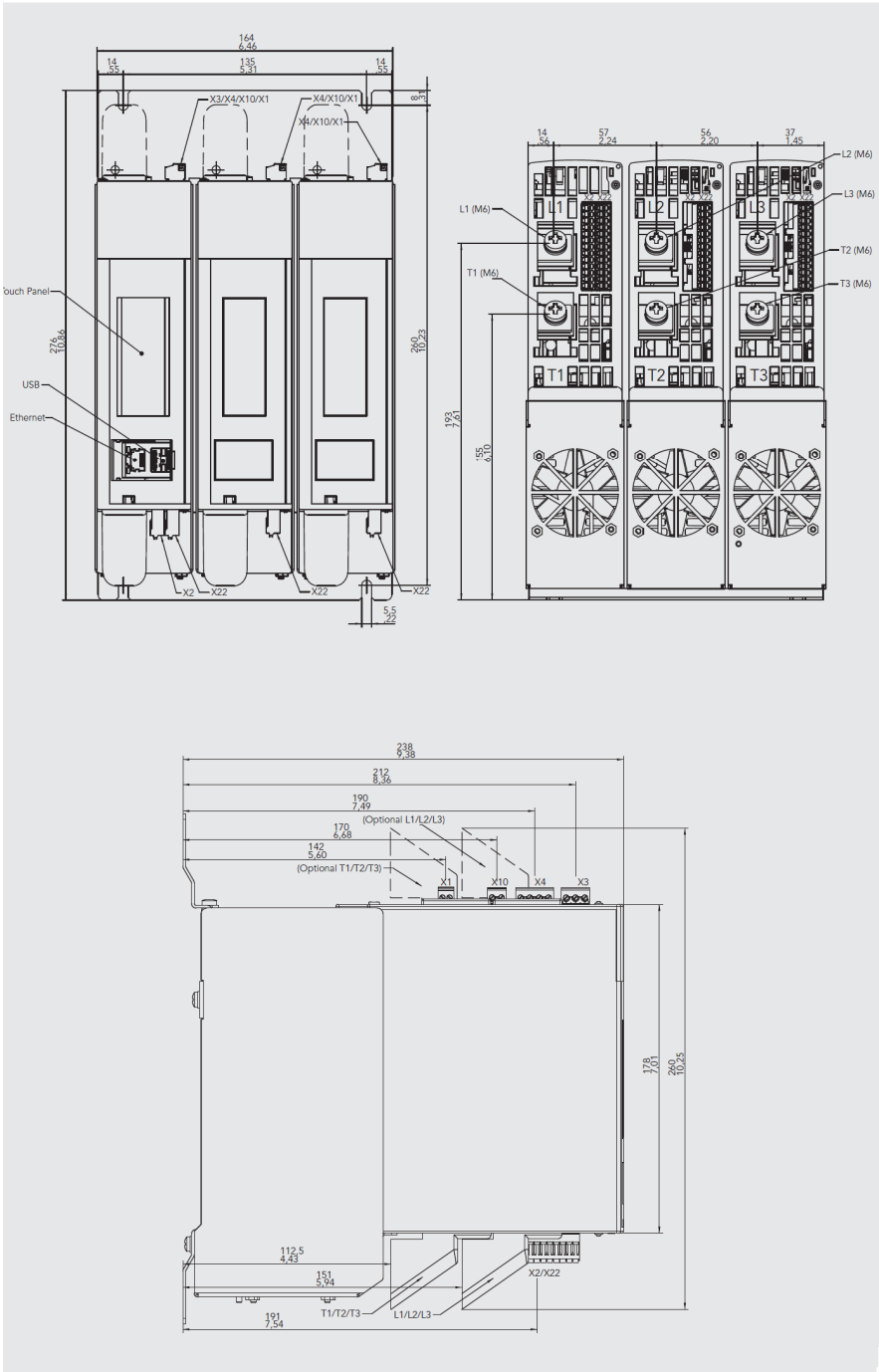


Fig. 35 : Thyritop 300-3A…100A

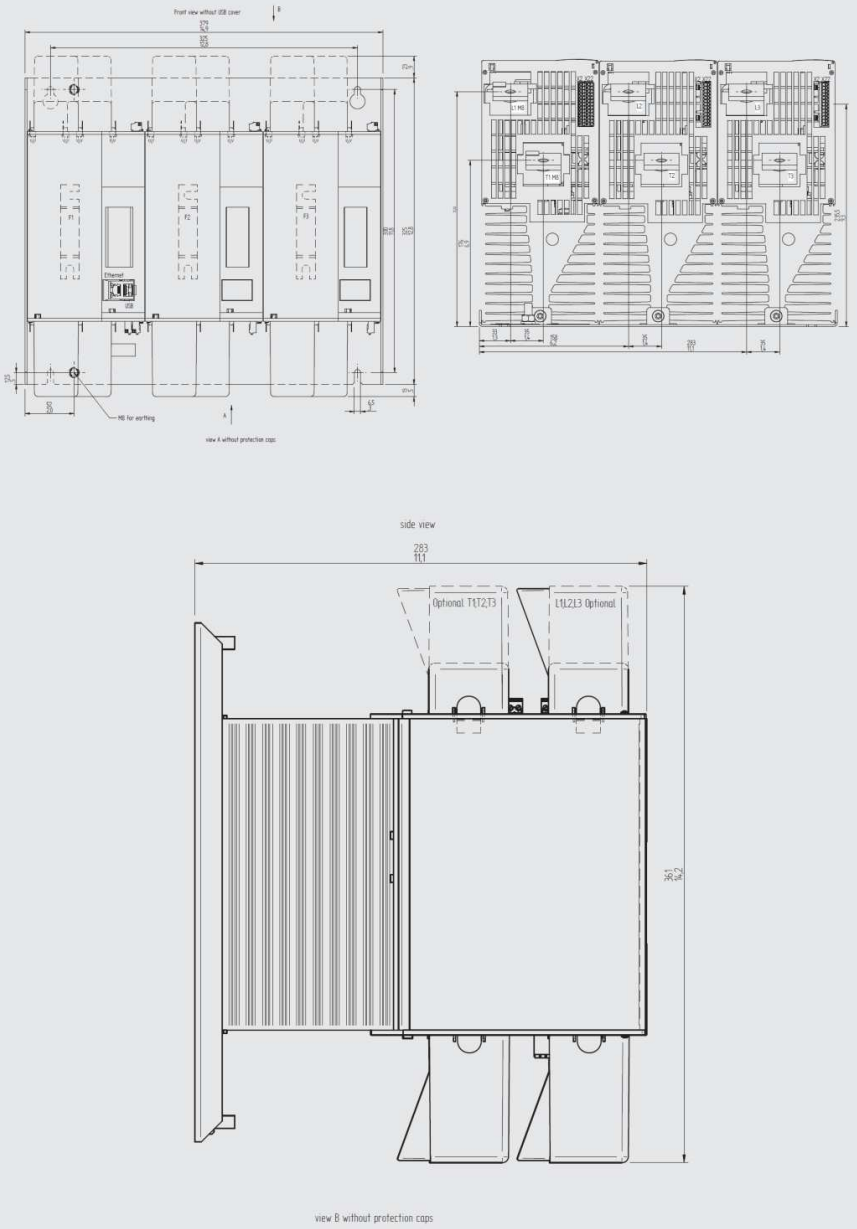


Fig. 36 : Thyritop 300-3A…130A, …170A

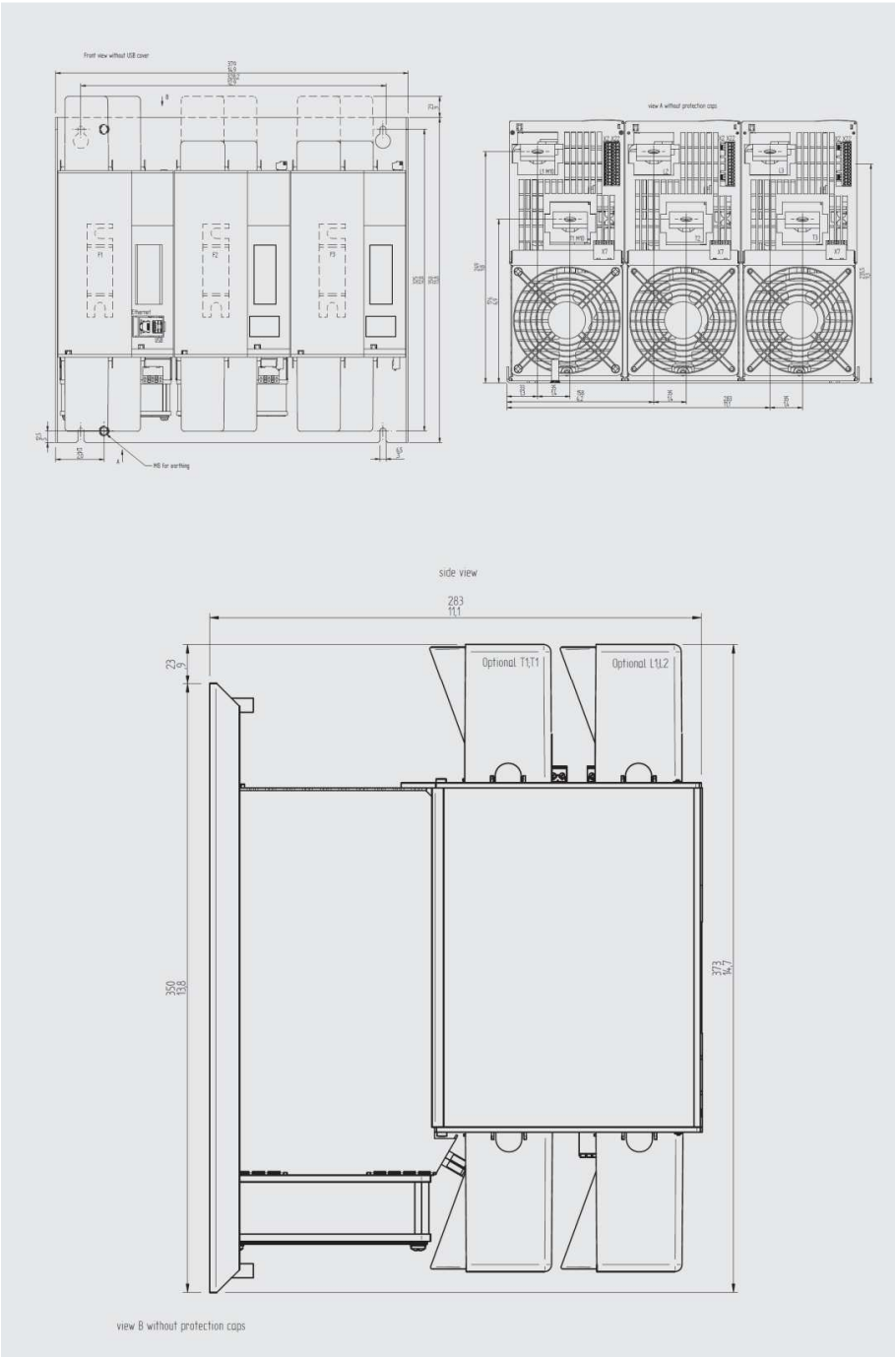


Fig. 37 : Thyritop 300-3A…230A, …240A, …280A, …350A

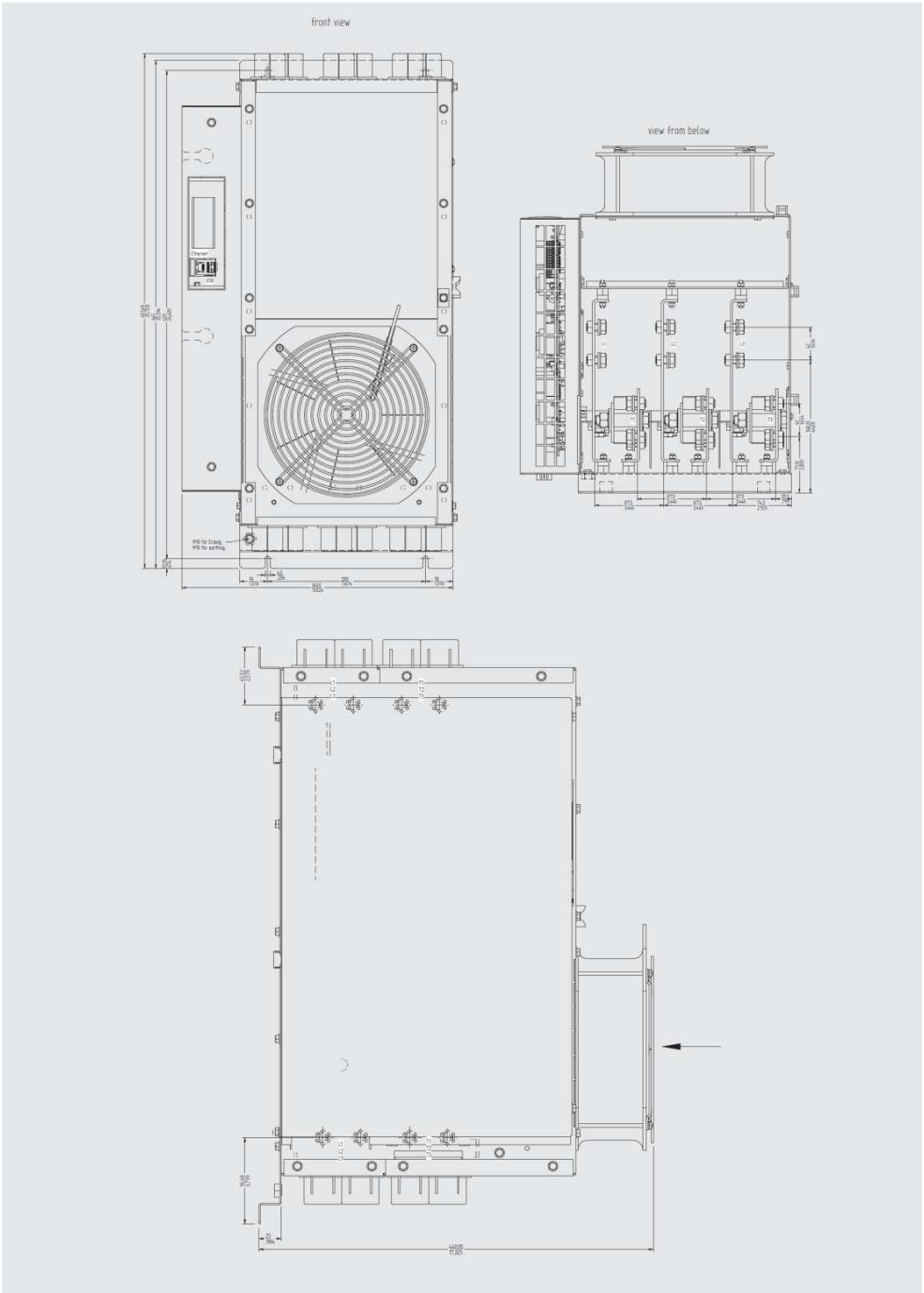


Fig. 38 : Thyritop 300-3A…495A, …650A

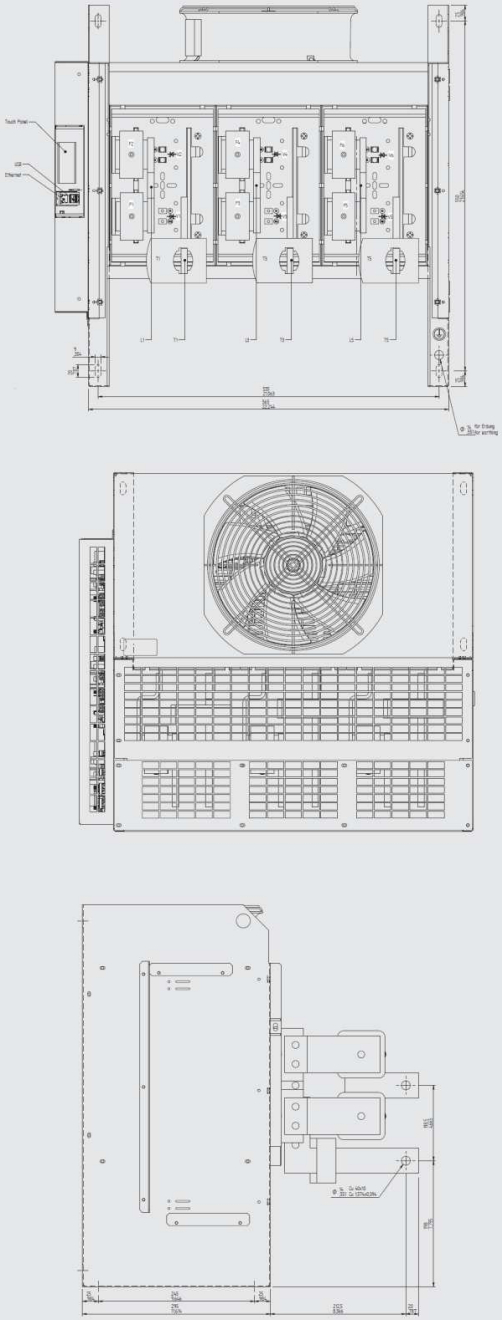


Fig. 39 : Thyritop 300-3A…1000A

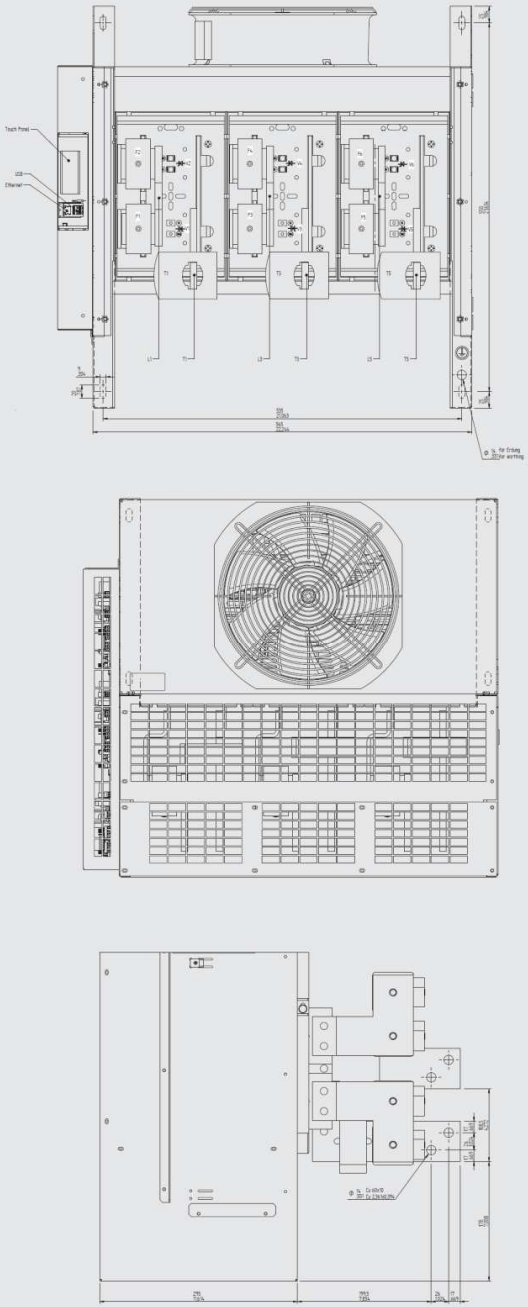


Fig. 40 : Thyritop 300-3A…1400A, …1500A

11 TECHNICAL DATA

11.1 TYPE PLATE

HAZARDS WHEN OPENING ISOLATING COVERS
Danger of injury/danger of damaging the device or system

> Adhere to all safety requirements of the chapter Safety. The type plate is located on the inside of the front door, which means on the rear side of the touch display. The device must be free of current before opening. During operation the power controller type can be displayed via the menu. The front door is secured against accidental opening and may need to be unlocked with a small object.

11.2 TECHNICAL DATA

Type voltage

24V to 230V + 10%
24V to 400V + 10%
24V to 500V + 10%
24V to 600V + 10%

IP20 Protection

DANGER:
Energized parts.
The device shall immediately be disconnected from the power supply before installation.
The Thyritop 300 is designed according to IP20 protection code. To ensure protection during operation, the correct mounting is necessary of the added protection devices at each electric connection.

Please see chapter 5.2 "IP20 Protection" for detailed information.

Electronic supply
The (additional) control voltage supply serves to supply the internal electronics max. 10W or 27VA respectively (typically 5.5W or 16VA respectively) for each supplying power unit (Please consider that for 2-phase device the information has to applied 2-times and for 3-phase operation respectively 3-times), 230 V~/110 V~ (85 V - 265 V).

Mains frequency
All types : 47 Hz to 63 Hz; maximum frequency alteration 55% per half wave

Load type

- Ohmic load
- Ohmic load with R_{warm}/R_{cold} relation to 6, peak current limitation to $\hat{i}=3xI_{Nom}$ (in VAR)
- Transformer load

CAUTION
The induction of the downstream transformer should not exceed 1.45 T in case of mains overvoltage in use (grain-oriented, cold rolled sheets) = 1.2 T nominal induction.

Operating modes
TAKT = full wave mode
VAR = phase angle firing (only for types Thyritop 300 1A and Thyritop 300 3A)
QTM = quick half wave cycle operation (only for type Thyritop 300 1A)
SWITCH = switch mode

Setpoint inputs
4 setpoint inputs (SELV, PELV), separated from the mains.

- setpoint 1 and 2: analog setpoint input signal ranges:
  - 0(4) - 20 mA Ri = 250 Ω
  - 0(1) - 5 V Ri = 44 kΩ
  - 0(2) - 10 V Ri = 88 kΩ
- setpoint 3: digital potentiometer
- setpoint 4: optional bus interface, connection of overriding PC or automation system.

Control characteristics
Any controller (e.g. temperature controller), whose output signal lies in the range 0-20 mA/0-5 V/0-10 V, is adaptable to the power controller.

Control input for switch mode operation
Maximum switching frequency 5 Hz

- $t_{on\ min}$ = 100 ms
- $t_{off\ min}$ = 100 ms

Analog outputs
Signal level 0-10 V, 2-10 V 0-20 mA, 4-20 mA
Maximum output load voltage 10 V

Control modes
… H RLP2: Voltage control U_{eff}, U_{eff}^2
Current control I_{eff}, I_{eff}^2
Power control P

Accuracy of the control:
Voltage ± 1,5%* in range -15% to +10% of the type voltage.
Current ± 1,5%*
* in relation to the respective end value(based on the digital set point)

Data logging
Phase power and phase resistances are measured. Therefore also asymmetrical loads and changes are recorded precisely. As an option for pure inductive loads, the measurement can be set to a virtual star point.

Limitations
Voltage limitation U_{eff}
Current limitation I_{eff}
Power limitation P
Peak current limitation to $\hat{i}=3xI_{Nom}$ in phase angle firing

Relay outputs
Changeover, contact material: $AgSnO_2$/Au coated
The relay can be used for low load circuits (> 5 V 20 mA), however, not if it is preloaded with 230 V~.
Maximum values: 250 V, 4 A, 180 W, 1500 VA

Ambient temperature
40 °C at ...F... (With forced cooling)
40 °C in case of natural air cooling (without fans)
If the maximum ambient temperature is reduced the maximum load current can be increased up to 110% of the nominal current. Here the following applies: 1% more current requires a temperature reduction of 1 °C.

The maximum ambient temperature can be increased up to a maximum of 55 °C if the maximum load current is reduced. Here the following applies: 1°C more ambient temperature requires a current reduction of 2%. Device usage for UL applications up to a maximum ambient temperature of 40 °C.

Connection data of the power connection
Grounding screw/bolt for protective conductor connection to the heat sink. The grounding also serves EMC means (Y - capacitor 4.7 nF).

	CONNECTION L1, T1, L2, T2, L3,T3	GROUNDING SCREW	CONDUCTOR CROSS SECTION
16 / 30 A	lug / M4	lug / M4	maximum 6 mm²
45 A*	M 6	M 6 maximum	50 mm²
60* / 100 A*	M 6	M 6 maximum	50 mm²
130 / 170 / 230 A	M 8	M 10	95 / 120 mm²
240 / 280 A	M 10	M 10	150 / 185 mm²
350 A	M 10	M 10	185 mm²
495 A	M 10	M 10	Cu 48x3; 2xø11
650 A	M 10	M 10	Cu 48x3; 2xø11
1000 A	M12	M12	Cu 60x10; 2xø14
1400 A	M12	M12	Cu 60x10; 2xø14
1500 A	M12	M12	Cu 60x10; 2xø14

Tab. 6 : Connection data of the power connection

With UL applications only use 60°C or 60°C/75°C copper conductors (with the exception of control cables).
* With UL applications only use 75°C copper conductors (with the exception of control cables).

SCREW	MIN. VALUE [NM]	NOM. VALUE [NM]	MAX. VALUE [NM]	POWER CONNECTION	GROUND CONNECTION	FUSE	CONTROL WIRE
				TYPE IN [A]			
M2	0.2	0.25	0.3				Phoenix terminals
M3	0.6	0.75	0.9	16;30			Phoenix terminals
M4	1.0	1.2	1.4		16;30		
M5	1.7	2.0	2.3			16;30	
M6	2.6	3.0	3.5	45;60;100	45;60;100	45;60;100	
M8	5.1	6.0	6.9	130;170;230	130;170;230 240;280;350	130;170;230	
M10	8.5	10.0	11.5	240;280;350		240;280;350	
M12	13.2	15.5	17.8				

Tab. 7 : Tightening torques for electric connections in Nm

SCREW	MIN. VALUE [NM]	NOM. VALUE [NM]	MAX. VALUE [NM]	POWER CONNECTION	GROUND CONNECTION	FUSE	CONTROL WIRE
				TYPE IN [A]			
M2	1.9	2.2	2.5				Phoenix terminals
M3	5.6	6.6	7.	16;30			Phoenix terminals
M4	9.0	10.6	12.2		16;30		
M5	15.0	17.7	20.4			16;30	
M6	22.6	26.6	30.5	45;60;100	45;60;100	45;60;100	
M8	45.1	53.1	61.1	130;170;230	130;170;230 240;280;350	130;170;230	
M10	75.2	88.5	101.8	240;280;350		240;280;350	
M12	116.6	137.2	157.8				

Tab. 8 : Tightening torques for electric connections in Pound Inches

11.3 APPROVALS AND CONFORMITY

The standards are subject to an adaptation and renumbering process which will continue for years as a result of European harmonization and international alignment. That is why in the detail listings norms to date are stated even if their expiry date has already been decided.
There is no product norm for thyristor power controllers so that a sensible norm framework must be created from the corresponding fundamental norms in order to facilitate safe application and comparison possibilities.

Thyristor power controllers are not devices to be used for disconnecting purposes in the sense of DIN EN 50110-1 and as a result may only be operated in connection with an appropriate upstream mains disconnecting device (e.g. breaker, observe VDE 0105 T1).

The Thyritop 300 has the following approvals and conformities:

- Quality standard in accordance with EN ISO 9001
- Approval in accordance with UL 508, File No. E 135074 Investigated under consideration of the Canadian National Standard C22.2 No.14-95
- UL Markings:
  - Tightening torque (in pound inches) see Chapter 11.2. (only for devices rated 16A or 30A)
  - Wiring details: "Use 60/75°C wires" and specified tightening torque (pound inches) (only for devices rated 45A, 60A or 100A)
  - "Max. surrounding air temperature 40°C"
  - Suitable For Use On A Circuit Capable Of Delivering Not More Than 100kA rms Symmetrical Amperes, xxx Volts Maximum, When Protected by RK5 Class Fuses"
  - "Branch circuit protection must be provided and sized according National Electrical Code and any additional local codes"

- CE conformity
  - Low voltage directive 2006/95/EEC; EMC directive 2004/108/EEC

DEVICE APPLICATION CONDITIONS

Built-in device			DIN EN 50 178
General requirements			DIN EN 60146-1-1
Installation position		vertical	
Operating location		industry sector	
Storage temperature		-25 °C - +55 °C	
Transport temperature		-25 °C - +70 °C	
Operating temperature		-10 °C - +40 °C with forced cooling	
		-10 °C - +40 °C with natural air cooling	
		-10 °C - +55 °C with reduced type current -2%/°C	
		with UL applications up to +40 °C	
Load category	I	100% permanent operation	DIN EN 60 146-1-1
Damp heat		EN 600721-3-3	93%
Overvoltage category	III		DIN EN 50 178
Degree of pollution	2		DIN EN 50 178
Altitude		≤1000 m above sea level	
Safe isolation up to 600 V mains voltage			DIN EN 50 178
EMC interference immunity			EN 61000-6-2
Test in acc. with			DIN EN 60 146-1-1
EMC emission standard			EN 61000-6-4
Compatibility level	Class 3		EN 61000-2-4

11.4 TYPE OVERVIEW

type current (A)	Type Voltage (V)				Power loss (W)	Fuse (A)	Dimensions (mm)			Weight (kg)
	230V	400V	500V	600V						
	type power (kW)	type power (kW)	type power (kW)	type power (kW)			W	H	D	
16	**3,7**	**6,4**	**8**	-	25	20	45	196	193	1,1
30 F	**6,9**	**12**	**15**	-	40	40	45	196	193	1,1
45	**11**	**18**	**23**	**27**	60	63	52	276	238	2,2
60	**14**	**24**	**30**	**36**	70	100	52	276	238	2,2
100 F	**23**	**40**	**50**	**60**	130	180	54	276	238	2,8
130	**30**	**52**	**65**	**78**	180	200	125	361	283	7,8
170	**39**	**68**	**85**	**102**	210	315	125	361	283	7,8
230 F	**53**	**92**	**115**	-	280	315	125	373	283	8,3
240 F	-	-	-	**138**	330	315	125	373	283	8,3
280 F	**64**	**112**	**140**	-	350	350	125	373	283	8,3
350 F	**81**	**140**	**175**	**210**	400	500	125	373	283	8,3
495 F	-	**198**	**248**	**297**	610	630	180	640	395	20
650 F	-	**260**	**325**	**390**	740	900	180	640	395	20
1000 F	-	**400**	**500**	**600**	1400	2x1000	285	550	565	33,5
1400 F	-	-	**700**	**840**	1700	4x900	285	550	565	33,5
1500 F	-	**600**	-	-	1770	4x900	285	550	565	33,5

Tab. 9 : Thyritop300 1A …H RLP2

type current (A)	Type Voltage (V)				Power loss (W)	Fuse (A)	Dimensions (mm)			Weight (kg)
	230V	400V	500V	600V						
	type power	type power	type power	type power			W	H	D	
16	-	**11**	**14**	-	50	20	90	196	193	2,2
30 F	-	**21**	**26**	-	80	40	90	196	193	2,2
45	-	**31**	**39**	**47**	120	63	108	276	238	4,4
60	-	**42**	**52**	**62**	150	100	108	276	238	4,4
100 F	-	**69**	**87**	**104**	260	180	110	276	238	5,6
130	-	**90**	**112**	**135**	360	200	250	361	283	15,6
170	-	**118**	**147**	**177**	420	315	250	361	283	15,6
230 F	-	**159**	**199**	-	560	315	250	373	283	16,6
240 F	-	-	-	**240**	670	315	250	373	283	16,6
280 F	-	**194**	**243**	-	700	350	250	373	283	16,6
350 F	-	**243**	**303**	**364**	800	500	250	373	283	16,6
495 F	-	**342**	**429**	**514**	1200	630	256	640	395	28,5
650 F	-	**450**	**563**	**676**	1460	900	256	640	395	28,5
1000 F	-	**693**	**866**	**1040**	2820	2x1000	452	550	565	53
1400 F	-	-	**1212**	**1455**	3470	4x900	452	550	565	53
1500 F	-	**1040**	-	-	3550	4x900	452	550	565	53

Tab. 10 : Thyritop300 2A … H RLP2

type current (A)	Type Voltage (V)				Power loss (W)	Fuse (A)	Dimensions (mm)			Weight (kg)
	230V	400V	500V	600V						
	type power (kW)	type power (kW)	type power (kW)	type power (kW)			W	H	D	
16	-	**11**	**14**	-	75	20	135	196	193	3,3
30 F	-	**21**	**26**	-	120	40	135	196	193	3,3
45	-	**31**	**39**	**47**	180	63	164	276	238	6,6
60	-	**42**	**52**	**62**	220	100	164	276	238	6,6
100 F	-	**69**	**87**	**104**	390	180	164	276	238	8,4
130	-	**90**	**112**	**135**	540	200	375	361	283	23,4
170	-	**118**	**147**	**177**	550	315	375	361	283	23,4
230 F	-	**159**	**199**	-	840	315	375	373	283	24,9
240 F	-	-	-	**240**	1000	315	375	373	283	24,9
280 F	-	**194**	**243**	-	1050	350	375	373	283	24,9
350 F	-	**243**	**303**	**364**	1200	500	375	373	283	24,9
495 F	-	**342**	**429**	**514**	1840	630	344	640	395	37
650 F	-	**450**	**563**	**676**	2200	900	344	640	395	37
1000 F	-	**693**	**866**	**1040**	4150	2x1000	618	550	565	72
1400 F	-	-	**1212**	**1455**	5100	4x900	618	550	565	72
1500 F	-	**1040**	-	-	5200	4x900	618	550	565	72

Tab. 11 : Thyritop300 3A …H RLP2

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