
Thyristor power units and Solid state contactors

TC2000 series

Two-phase control of a three-phase load or control of two single-phase loads

User Manual

© Copyright Eurotherm Automation 1995

All rights reserved. All reproduction or transmission in any form or using any procedure (electronic or mechanical, including photocopying and recording) without the written permission of EURO THERM AUTOMATION is strictly prohibited. EURO THERM AUTOMATION have taken particular care to ensure the accuracy of these specifications. However, in order to maintain our technological lead, we are dedicated to the continual improvement of our products and this may lead to modifications or omissions in the current specifications. We cannot be held responsible for any material or bodily damage, losses or costs incurred.



EUROPEAN DIRECTIVES

SAFETY

The **TC2000** products installed and used in accordance with this User Manual are designed to comply with the essential protection requirements of the European Low Voltage Directive 73/23/EEC dated 19/02/73 (amended by Directive 93/68/EEC dated 22/07/93).

CE MARK

The CE Mark of **TC2000** products implies that the essential protection requirements of the European Low Voltage Directive are observed.

The **TC2000** Technical Construction File is approved by a Notified Body, **LCIE** (Laboratoire Central des Industries *f*lectriques).

CE DECLARATION OF CONFORMITY

A CE Declaration of Conformity is available on request.

For further information on CE Mark, please contact your nearest Eurotherm office.

ELECTROMAGNETIC COMPATIBILITY (EMC)

For industrial environments, excluding residential environments

The **TC2000** products are considered as components without any direct function as defined in the EMC Directive. The system or installation in which these products are incorporated must comply with the essential protection requirements of the EMC Directive.

However, Eurotherm certifies that the **TC2000** products, when installed and used in accordance with their User Manual, meets the following EMC test standards and enables the system or installation in which there are installed to comply with the EMC Directive in regards to the **TC2000** products.

EMC STANDARDS

Immunity	Generic Standard	: EN 50082-2	
	Test Standards	: EN 61000-4-2, EN 61000-4-4, ENV 50140, ENV 50141	
Emissions	Generic Standard	: EN 50081-2	
	Test Standard	: EN 55011	
	Product Standard	: IEC1800-3	

The choice of the Conducted Emission applicable standard depends on the application

- ¥ EN 50081-2 :
 - With a internal standard filter for 60 A and 75 A nominal
 - With a internal optional filter (FILT option) for 100 A and 150 A nominal
- ¥ IEC 1800-3 :
 - Without filter. Applies for the second environment.

EMC FILTER

To reduce the conducted emissions that occur when using thyristor units, the EMC internal filter is added (standard for 60 A and 75 A; optional for 100 A and 150 A).

VALIDATION BY COMPETENT BODY

In order to guarantee the best service, Eurotherm has validated the compliance of the **TC2000** products with EMC test standards through design and laboratory tests that have been validated with a Technical Construction File by a Competent Body, **LCIE** (Laboratoire Central des Industries *f*lectriques).

EMC INSTALLATION GUIDE

In order to help you reduce risks related to the effects of electromagnetic interference depending on the installation of the product, Eurotherm can supply you with the "**EMC Installation Guide**" (Part No. HA025464).

This guide gives the rules generally applicable for Electromagnetic compatibility.

MANUALS IN USE

This **TC2000 User Manual Part No HA 174757 ENG** intended for the TC2000 series power thyristor units manufactured beginning **September 1996**.

The TC2000 User Manual (Part No HA174758) is valid for products manufactured from November 1995 to September 1996.

The TC2000 User Manual (Part No HA174514) is valid for products manufactured before November 1995.

PRECAUTIONS

Important precautions and special information are indicated in the manual by two symbols:



DANGER

This symbol means that failure to take note of the information may have serious consequences for the safety of personnel and may even result in the risk of electrocution.



ATTENTION

This symbol means that failure to take note of the information may
• **have serious consequences for the installation**
• **result in the incorrect functioning of the power unit.**

These marks must indicate specific points. The entire manual remains applicable.

PERSONNEL

The installation, configuration, commissioning and maintenance of the power unit must only be performed by a person **qualified and authorised to perform work in an industrial low voltage electrical environment**.

INDEPENDENT SAFETY

It is the responsibility of the user and it is highly recommended, given the value of the equipment controlled using TC2000, to install **independent safety** devices. This alarm must be tested regularly.
Eurotherm can supply suitable equipment.

FURTHER INFORMATION

For any further information and if in doubt, please contact your EURO THERM office where technicians are at your disposal should you require advice or assistance with the commissioning of your installation.

TC2000 USER MANUAL

Contents

Chapter 1	IDENTIFYING THE UNIT	Page
	General introduction to the TC2000 series	1-2
	Technical data	1-7
	Coding	1-10
	Serial number labels	1-12
Chapter 2	INSTALLATION	
	Safety during installation	2-2
	Dimensions	2-3
	Mechanical mounting	2-5
	Installation details	2-6
Chapter 3	CABLING	
	Safety during cabling	3-2
	Fixing power cables	3-3
	Power wiring diagrams	3-6
	Auxiliary power supply	3-9
	Control cables	3-10
	Driver terminal block	3-12
	Input signal connection	3-13
	PLU alarm signalling (optional)	3-17
Chapter 4	CONFIGURATION	
	Safety during configuration	4-2
	Possible configurations	4-3
	Operation type	4-4
	Configuration type	4-6
	Input type and level	4-7
	PLU board (optional)	4-9

Contents (Continued)

	Page
Chapter 5 OPERATION	
Thyristor firing mode	5-2
PLU detection	5-6
Chapter 6 COMMISSIONING PROCEDURE	
Commissioning procedure safety	6-2
Checking the characteristics	6-3
PLU detection adjustment (optional)	6-5
Chapter 7 MAINTENANCE	
Thyristor protection	7-2
Thyristor protection fuses	7-3
Fuse blown indication micro-switch	7-5
Protection fuses for auxiliary power supply connection	7-6
Servicing	7-7
Tools	7-8
Configuration recapitulatory tables	7-9

INDEX

Chapter 1

IDENTIFYING THE UNIT

Contents	page
General introduction to the TC2000 series	1-2
Technical data	1-7
Coding	1-10
Serial number labels	1-12

Chapter 1 IDENTIFYING THE UNIT

GENERAL INTRODUCTION TO THE TC2000 SERIES

The **TC2000** thyristor unit series is designed for the electrical power control of industrial three-phase or single-phase loads.

Depending on the type of operation, the **TC2000** series is composed of two types of unit:

- **Solid state contactors** (logic operation).

Units driven by a logic signal, operating in **ON/OFF** mode, emitting the maximum power to the load during the presence of the control signal.

- **Power thyristor units** (analogue operation).

Units driven by an analogue signal emitting an output power proportional to the input signal for thyristor firing and in **Burst firing** mode including a whole number of alternations.

For the solid state contactors and the power thyristor units, the thyristor firing and non-firing are synchronised at zero voltage for each phase, eliminating the steep current fronts which generate supply interference.

TC2000 series units are composed of **two thyristor channels**, which allows the following two types of configuration:

- three-phase configuration
- single-phase configuration.

In the **three-phase configuration**, the **TC2000** series units control **two phases** of a three-phase load connected in a closed delta or a star without neutral (3-wire configuration). In this configuration, **only one** control signal is used.

In the **single-phase configuration**, the **TC2000** series units behave in the same way as two single-phase units incorporated in the same unit, controlling **two** independent single-phase **loads** by two different control signals.

By simply modifying the positions of the jumpers on the driver board, the **TC2000** series unit can be configured to control a three-phase in a three-wire configuration or to control two single-phase loads.

The range of nominal currents of the **TC2000** series power units is from **60 to 500 A** (in **3** unit models) at nominal voltages of **120 to 500 V**.

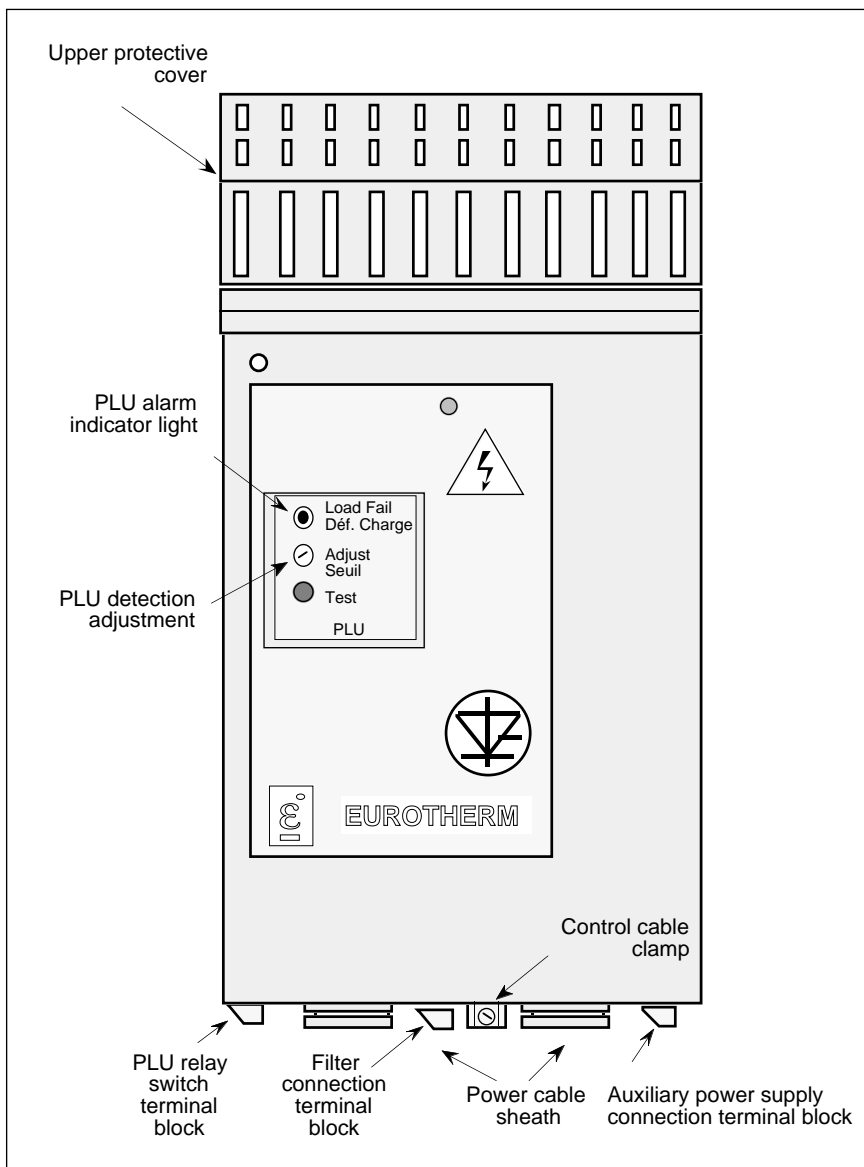


Figure 1-1 Overall view of the TC2000 power unit (PLU or IPU option)

The standard version of the TC2000 series unit (**basic version**) is equipped with a **driver board** which performs the feedback, measurement and thyristor firing functions.

As an **option**, a TC2000 unit in a three-phase configuration is equipped with a partial load unbalance board ("**PLU board**"), which can be plugged into the driver board. With the PLU/ IPU, options, TC2000 series units in a three-phase configuration detect any current unbalance greater than **10%**.

The partial load **unbalance** detection is signalled by the indicator light on the front fascia and by a **PLU alarm relay** switch (switch N/O or N/C depending on, the control code). The user terminal block of the alarm relay switch is located below the unit, to the left. In the PLU / IPU options, the front fascia of the unit comprises:

- a "**Load Fail**" indicator light when the partial load unbalance of the three-phase load is detected
- an "**Adjust**" potentiometer to adjust the detection
- a "**Test**" push button.

The partial load unbalance detection system also triggers the alarm for the following cases:

- non-firing of a thyristor
- blowing of a fuse of one of the phases
- absence of a phase or significant drop in voltage of the phases of the three-phase supply.

The simultaneous failure of the 2 fuses, installed inside the unit on the controlled phases, is detected by the fuse blown indication micro-switches (optional).

The **supply** side power cables pass through the **opening of the protective cover**. The power cables to the **load** pass through the **cable sheath** under the unit.

The control wires are connected on the user terminal block of the driver board. They must be **shielded** and grounded at **both ends**.

The control cable passes through the **cable clamp** which **secures** the cable and **grounds** the shielding simultaneously.

The thermal switch inhibits the fan-cooled unit (from **100 A** of the nominal current) in the event of thyristor **overheating**.

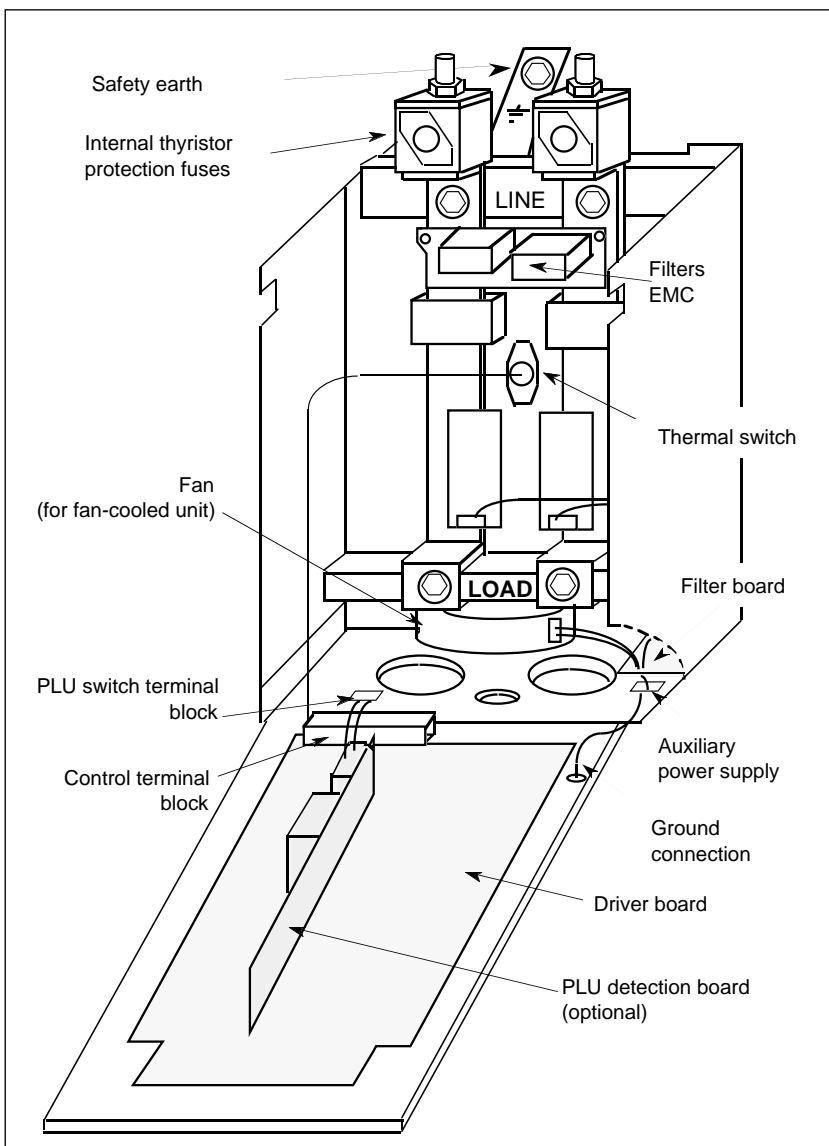


Figure 1-2 Overall view of the TC2000 unit with the access door open (PLU option installed)

The inputs of channels **A** and **B** are located on the user terminal block of the driver board.

In the **three-phase** configuration, only one control signal is applied to input **A**.

In the **single-phase** configuration, two signals are applied to inputs **A** and **B**.

Solid state contactors.

The input signals of the TC2000 series static contactors must be **logic**.

- dc signals
 - single-phase and three-phase configuration without PLU option:
 - 10 V
 - three-phase configuration with PLU option:
 - 5 V
 - 10 V
 - 20 mA
- ac signals (three-phase configuration only):
 - 100 to 240 Vac

With the ac signal, the PLU/IPU option is not available.

Power thyristor units.

The input signals of the TC2000 series power thyristor units must be **analogue**.

- dc voltage signals (single-phase and three-phase configuration):
 - 0 - 5 V
 - 0 - 10 V
 - 1 - 5 V
 - 2 - 10 V
- dc current signals (single-phase and three-phase configuration):
 - 0 - 20 mA
 - 4 - 20 mA.

The TC2000 series **power thyristor units** possess a supply voltage variation **compensation** within the range **+10%** to **-15%** of the nominal voltage.

This instantaneous compensation is used to maintain the power transmitted to the load constant in spite of the supply voltage variations, thus preventing fluctuations of the controlled value.

TECHNICAL DATA

The TC2000 series is a series of solid state contactors and power thyristor units designed to control the electrical power of industrial three-phase and single-phase loads.



Attention !

It is the user's responsibility to ensure that the unit is compatible with the conditions of installation before commissioning the unit.

Power

Nominal current (per channel)	60 A, 75 A, 100 A, 150 A, 250 A, 300 A 400 A, 500 A
Nominal voltage	120 to 500 Vac line to line (+10% -15%)
Frequency	50 or 60 Hz
Operation type	<ul style="list-style-type: none"> • Solid state contactors Thyristor firing in Logic (ON/OFF) mode Logic signals • Power thyristor units Thyristor firing in Burst firing mode Analogue signals
Configuration type	<ul style="list-style-type: none"> • Three-phase Two phase control (only one control signal). • Single-phase Control of two independent single-phase loads (2 control signals).
Three-phase phase rotation	Insensitive (except for the PLU option)
Thyristor firing	Burst firing mode: firing ON/OFF when zero voltage crossing is reached for each of the 2 phases.

Load

Load type	Resistive loads with low temperature coefficient
Configuration type	Three-phase configuration: closed delta or star without Neutral (3 wires) Single-phase configuration: two independent single-phase loads.

Protection

Thyristors	Internal high-speed fuses . RC snubbers and Varistor at thyristor terminals. Fuse blown trip indicator. As an option, fuse blown indication micro-switches.
Auxiliary power supply	1 A external fuse (not supplied)
Mechanical protection	Covers guaranteeing IP20 protection (in front fascia).
Thermal protection	Thermal safety switch (stops thyristor firing if the maximum thyristor temperature is exceeded).

Insulation

Unit	Insulated irrespective of the configuration type. Must be connected to earth
Coolers	Insulated for models up to 250 A
Control signals	Insulated from the control circuit. In the single-phase configuration, the 2 dc signals are connected to the same common 0V.

Control

Solid state contactors Logic signal which can be selected in the factory
Firing type ON/OFF (Logic)

- dc signal in standard version
 - Voltage **10 V** V max = 25 V
 - ON status V > 5 V (4 mA min)
 - OFF status V < 1 V
- dc signal with PLU option
 - Voltage **5 V** V max = 12 V
 - ON status V > 1.5 V (4 mA min)
 - OFF status V < 0.5 V
 - Voltage **10 V** V max = 25 V
 - ON status V > 5 V (4 mA min)
 - OFF status V < 1 V
 - Current **20 mA** I max = 40 mA
 - ON status I > 4 mA
 - OFF status I < 0.2 mA
- ac signal (PLU not available)
 - Voltage **100 to 240 V** V max = 264 V
 - ON status V > 85 V
 - OFF status V < 10 V

Power thyristor units

Analogue signal which can be selected by the user using jumpers

Firing type Burst firing, the typical modulation period at 50 % power is **0.6 s** (for another period contact as)

- dc signal
 - Voltage **0-5 V; 0-10 V; 1-5 V; 2-10 V**
 - Current **0-20 mA; 4-20 mA**
- Manual control External **5 kΩ** potentiometer
Input configured in **0-5 V**
+ **15 V** voltage available on the user terminal block

Power supply

- Power thyristor units: **115 V** or **230 V** (+10 %-15 %).
The exact definition of the power supply voltage is used to adjust the supply variation compensation accurately.
- Solid state contactors with the PLU/IPU options:
115 V or **230 V** (+10 %-15 %).

Thermal characteristics

Operating temperature	0 to 50°C in vertical position (40°C for the 500 A current)
Storage temperature	- 10°C to 70°C
Heat dissipation	The thyristor units dissipate on average 1.3 W per A and per phase
Cooling	Convection cooling, power supply consumption 5 VA
• 60 and 75 A	Built-in fan, power supply and fan consumption 35 VA
• 100 to 150 A	Two built-in fans, power supply and fan consumption 70 VA
• 250 to 500 A	115 V or 230 V
Fan supply	For power thyristor units and for static contactors with the PLU/IPU options, the power supply is used to power the fans.

Environment

Operating altitude	2000 m maximum
Operating atmosphere	Non explosive, non corrosive and non conductive.
Pollution	Degree 2 (IEC 664)
Humidity	RH 5% to 95% non condensing.

Options

PLU / IPU options (three-phase operation only)

Partial load unbalance (PLU) detection system. An alarm for:	<ul style="list-style-type: none"> • a 10 % unbalance of line currents • a thyristor short circuit • a fuse blow-out • the absence of a phase.
Alarm output	Relay deactivated in alarm status. Alarm stored in memory (requiring acknowledge) or not stored in memory according to user cabling. Relay switch N/O open in alarm status (PLU option) or relay switch N/C (closed in alarm status (IPU option))
Switch cut-off capacity	0.25 A at 250 Vac or 30 Vdc
Power supply required	115 V or 230 V .

Fuse blown indication micro-switches

Internal high-speed fuses	Fuse blown indication micro-switches (thyristor protection).
---------------------------	--

Internal CEM filters

Conducted emissions	To reduce the conducted emissions that occur when using thyris- tor units, the EMC internal filters is added (standard for 60 A and 75 A; optional for 100 A and 150 A).
---------------------	--

UNIT CODING

Series / Config- / Nominal / Nominal / Auxiliary / Input / Input / Options / 00
 uration current voltage power supply A B

Series	Code
Solid state contactors and power thyristor units	TC2000

Configuration	Code
Three-phase. 2 controlled phases	02
Single-phase. 2 independent phases	21

Nominal current	Code
60 amperes	60A
75 amperes	75A
100 amperes	100A
150 amperes	150A
250 amperes	250A
300 amperes	300A
400 amperes	400A
500 amperes	500A

Nominal line to line voltage	Code
120 volts	120V
240 volts	240V
277 volts	277V
440 volts	440V
480 volts	480V
500 volts	500V

For other voltages , contact your Eurotherm office

Auxiliary power supply	Code
Without auxiliary power supply (60 A and 75 A solid state contactors without PLU option)	000
230 /115 V single-phase supply:	
100 volts	100V
110 volts	110V
115 volts	115V
120 volts	120V
200 volts	200V
220 volts	220V
230 volts	230V
240 volts	240V

Input A	Code	Input B	Code
Three-phase configuration or single-phase config. channel A		Three-phase configuration	000
Power thyristor units: "Burst mode" thyristor firing Analogue signal		Power thyristor units: "Burst mode" thyristor firing Single-phase config. channel B Analogue signal	
0-5 volts	0V5	0-5 volts	0V5
1-5 volts	1V5	1-5 volts	1V5
0-10 volts	0V10	0-10 volts	0V10
2-10 volts	2V10	2-10 volts	2V10
0-20 milli-amperes	0mA20	0-20 milli-amperes	0mA20
4-20 milli-amperes	4mA20	4-20 milli-amperes	4mA20
Solid state contactors: "ON/OFF" thyristor firing dc logic signal 100 to 240 Vac logic signal (three-phase only)		Solid state contactors: "ON/OFF" thyristor firing Single-phase config. channel B dc logic signal	
	LGC		LGC
	ACL		

Options	Code
PLU detection (only in three-phase configurations; analogue or dc logic signal) <ul style="list-style-type: none"> • relay switch open in alarm status • relay switch closed in alarm status 	PLU IPU
Fuse blown indication micro-switches No internal fuses	FUMS NOFUSE
Internal EMC filters (100 A and 150 A nominal)	FILT

CODING EXAMPLE

Installation and TC2000 series unit parameters

A power thyristor unit for a three-phase load in a delta configuration.

- Three-phase configuration on 440 V supply
- Nominal current of a phase of the 120 A load
- 240 V auxiliary power supply and 0-5 V analogue control
- Partial load unbalance detection system, relay switch open in alarm status
- Fuse blown indication micro-switches
- Internal EMC filters to reduce the conducted emissions.

Coding : TC2000 / 02 / 150A / 440V / 240V / 0V5 / 00 / PLU / FUMS / FILT / 00

SERIAL NUMBER LABELS

Two **identification** labels (specifying the **coding** of the unit) and a **configuration** label provide all the information relating to the factory settings of the unit.

An identification label is **externally** located on the right-hand side panel of the unit.

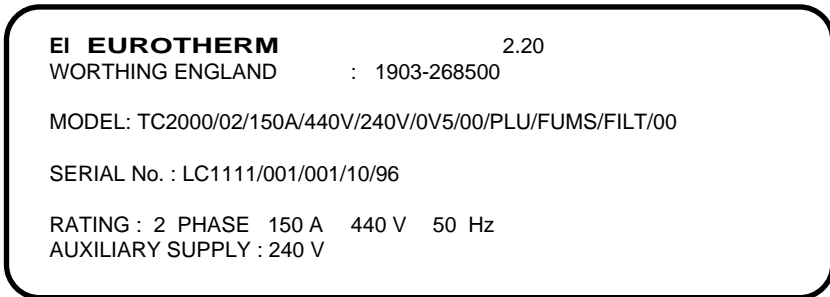


Figure 1-3 Example of identification label for a TC2000 model unit
The information corresponds to the coding example.

The second identification label and a configuration label are located **inside** the thyristor unit.

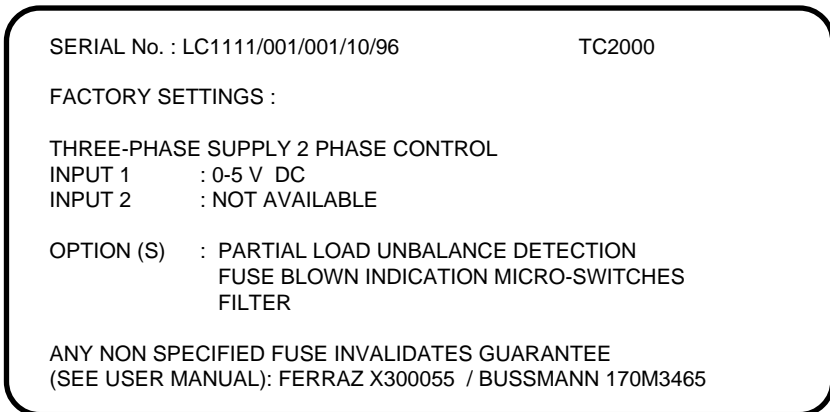


Figure 1-4 Example of configuration label for a TC2000 unit

Attention!



Following any reconfiguration on the part of the user, there is no guarantee that the thyristor unit and this information corresponds to the information related to the unit coding.

Chapter 2

INSTALLATION

Contents	page
Safety during installation	2-2
Dimensions	2-3
Mechanical mounting	2-5
Installation details	2-6

Chapter 2 INSTALLATION

Read this chapter completely before installation.

SAFETY DURING INSTALLATION



Danger !

TC2000 units must be installed by a qualified person.

Units must be installed in fan-cooled electric cabinets, guaranteeing the absence of condensation and pollution.

The cabinet must be closed and connected to the safety ground in accordance with the standards IEC 364 or the current national standards.

For installations in fan-cooled cabinets, it is recommended to place a fan failure detection device or a thermal safety control in the cabinet.

Bulkhead mountings are possible with **TC2000** series units.

The units must be mounted with the heatsink positioned vertically and with no obstructions either above or below which could block the passage of the ventilation air.

If multiple units are installed in the same cabinet, they should be arranged in such a way that the air expelled by one unit cannot be admitted into the unit located above it.

Attention !

The units are designed to be used at an ambient temperature less than or equal to **50°C** (40°C for 500 A nominal units)

Leave a minimum space of **5 cm** between two units placed beside each other.



Excessive overheating of the unit may cause incorrect operation of the unit, which in turn may cause damage the components.

60 to 75 A units are **convection**-cooled.

100 to 500 A units have **permanent** fan cooling.

DIMENSIONS

The dimensions, values and weights of the **TC2000** series thyristor units are given in figure 2-1 and in table 2-1.

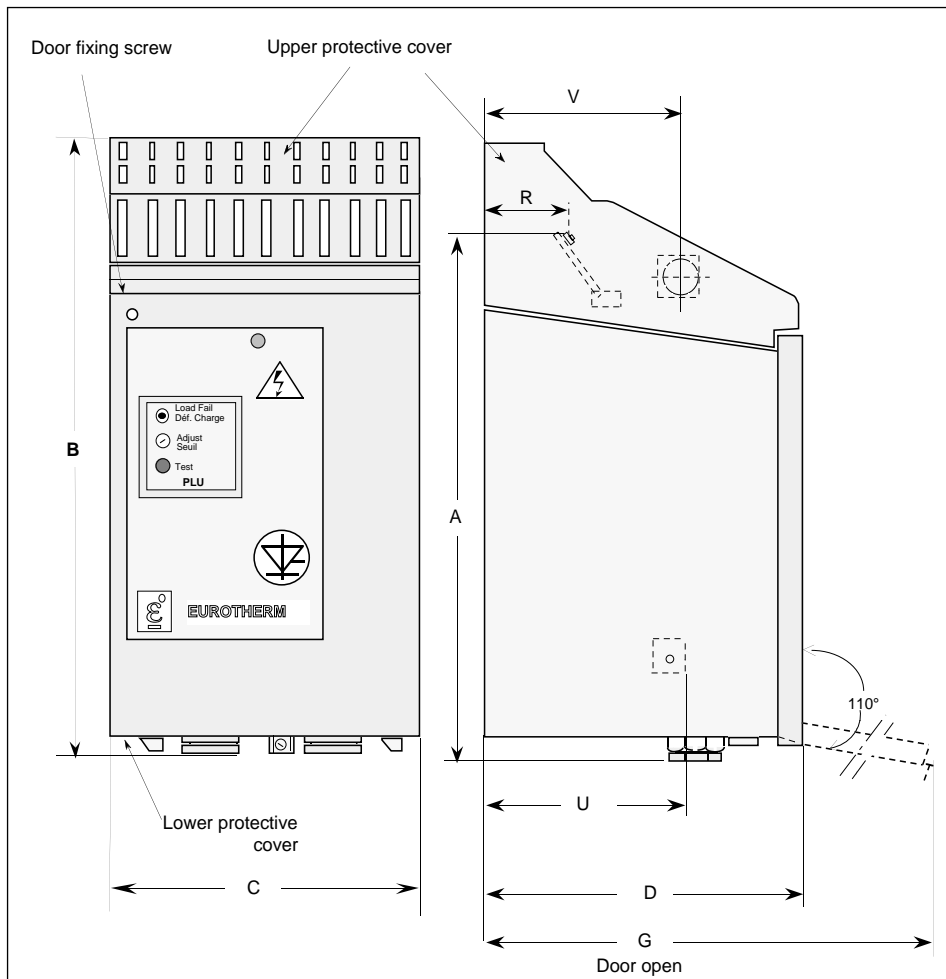


Figure 2-1 Overall dimensions with and without upper protective cover

Values	Nominal current			Description
	60 to 150 A	250 A	300 to 500 A	
A	415 mm	415 mm	425 mm	Height without protective cover
B	480 mm	480 mm	570 mm	Height with cover
C	133 mm	248 mm	248 mm	Width
D	268 mm	268 mm	268 mm	Depth
E	88 mm	203 mm	203 mm	Width between the fixing holes
F	328 mm	328 mm	328 mm	Height between the fixing holes
G	557 mm	557 mm	557 mm	Depth with the door open
K	350 mm	350 mm	350 mm	Height of lateral fascias
R	30 mm	50 mm	20 mm	Distance between "Earth" busbar and panel
U	138 mm	147 mm	150 mm	Depth between "LOAD" terminal and panel
V	125 mm	148 mm	170 mm	Depth between "LINE" terminal and panel
Poids	10 kg	16 kg	16.5 kg	-

Table 2-1 Dimensions, fixing values and weights of TC2000 series units

MECHANICAL MOUNTING

TC2000 units have two protective covers (upper and lower).

The units can be fixed with the protective covers in place.
However, for the connection, the upper protective cover must be removed.

After drilling the support panel at the dimensions and values given above, insert the fixing screws half-way in the partition holes or mounting plate.

Position the thyristor unit by first inserting the upper screw heads in the respective holes of the upper section.

Lower the unit making sure that the lower screws planned can be inserted correctly.

Then lower the unit completely until it is in position.

Fasten the 4 screws correctly.

INSTALLATION DETAILS

TC2000 series units are designed to be mounted directly on panels at the fixing points located on the rear of the unit.

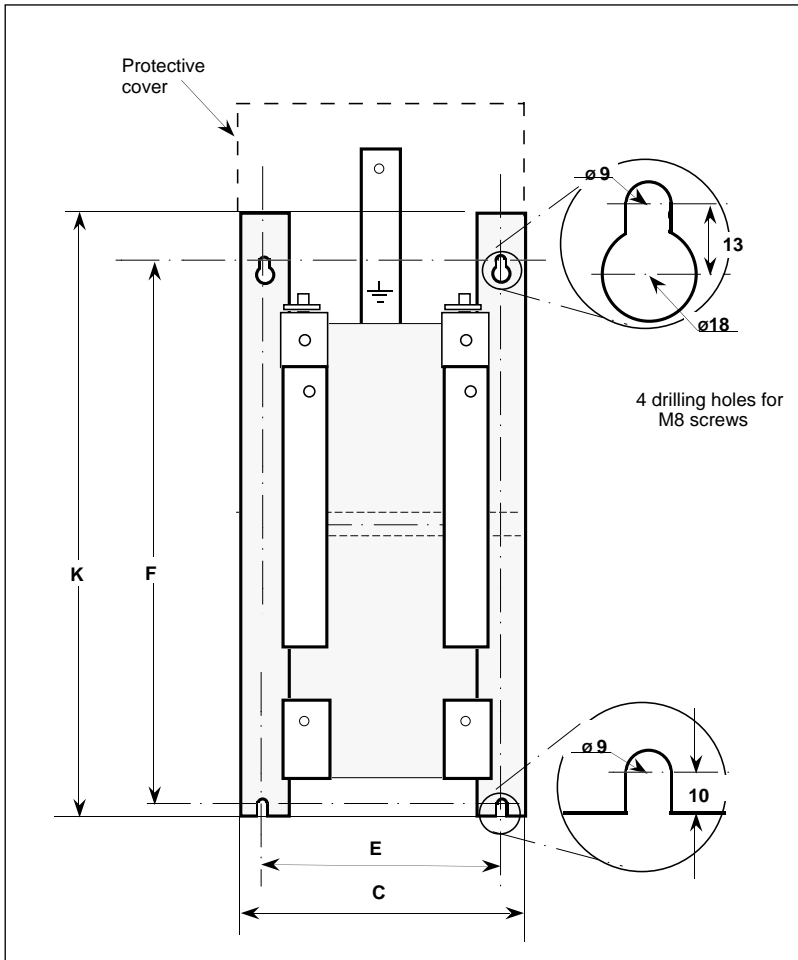


Figure 2-2 Fixing details

Chapter 3

CABLING

Contents	page
Safety during cabling	3-2
Fixing power cables	3-3
Power wiring diagrams	3-6
Three-phase configuration	3-6
Single-phase configuration	3-7
Auxiliary power supply	3-9
Control cables	3-10
Fixing	3-10
Shield connecting to the ground	3-11
Driver terminal block	3-12
Input signal connection	3-13
Solid state contactors	3-13
Power thyristor units	3-15
Analogue inputs	3-15
Manual inputs	3-16
PLU alarm signalling (optional)	3-17
User terminal block	3-17
PLU board	3-18

Chapter 3 CABLING

SAFETY DURING CABLING

Danger !



Cabling must be performed by personnel who are qualified to work with low voltage electrical equipment. It is the user's responsibility to cable and protect the installation in accordance with current professional standards. A suitable device guaranteeing electrical separation of the equipment and the supply must be installed in order to perform the operation in complete safety.

TC2000 series units possess **two protective covers**: upper and lower. The upper cover should be raised to facilitate cabling. After connection and before power-up, put the upper protective cover back in place to ensure the specified **degree of protection**.

Danger !



Before any connection or disconnection, make sure that the power and control cables and wires are insulated from the voltage sources.

For safety reasons, the safety earth cable must be connected before any other connection during cabling and the last cable to be disconnected.

The **safety earth** is connected to the screw located on the strip provided for this purpose in the top part of the unit, behind the phase terminal and labelled as follows:



Attention !



To ensure that the TC2000 unit is grounded correctly, make sure that it is attached to the **reference ground plane** (panel or bulkhead). If this is not the case it is necessary to add a ground connection **no more than 10 cm long** between the ground connection and the reference ground plane.

Danger !



The purpose of this connection is to guarantee correct **ground continuity**. It is **not**, in any circumstances, a **substitute** for the **safety earth connection**.

FIXING POWER CABLES

The **supply side** power cables pass through the opening of the upper protective cover of the TC2000 unit. The upper covers of the units are raised in order to facilitate the connection of these cables.

For connection, this cover, which is fixed to the unit, must be raised. In order to do this:

- open the door by unfastening the front screw on the top left-hand corner of the door
- raise the door in order to release it from its notches
- open the door completely by pulling it towards you
- remove the upper cover by unfastening its two fixing nuts by sliding it one cm forwards to release the two catches located at the rear and raising it.

The supply side connection is performed on the terminals of each fuse at the upper part of the unit, labelled **LINE** (see figures 3-2 and 3-3).

The **load side** power cables are placed inside the unit through cable sheaths below the unit. The loads are cabled on screws located in the bottom part of the unit and labelled **LOAD** (see figures 3-2).

The capacities of the power terminals and cabling screws are given in table 3-1.

Tightening must not exceed the limit values according to the same table.

Nominal current	60 to 150 A	250 A	300 to 500 A
Supply and load Earth cable	4 to 70 mm ² 16 to 35 mm ²	120 mm ² 70 mm ²	185 to 2x150 mm ² 95 to 185 mm ²
Fuse terminals Tightening torque	M8 13.5 N.m	M8 13.5 N.m	M10 26 N.m
Load screw Tightening torque	M8 12.5 N.m	M10 16.4 N.m	M12 28.8 N.m
Earth screw Tightening torque	M10 16.4 N.m	M10 16.4 N.m	M12 28.8 N.m

Table 3-1 Details of power cabling for TC2000 thyristor units

The cross-section of the connection wires to be used must correspond to the Standard **IEC 943**

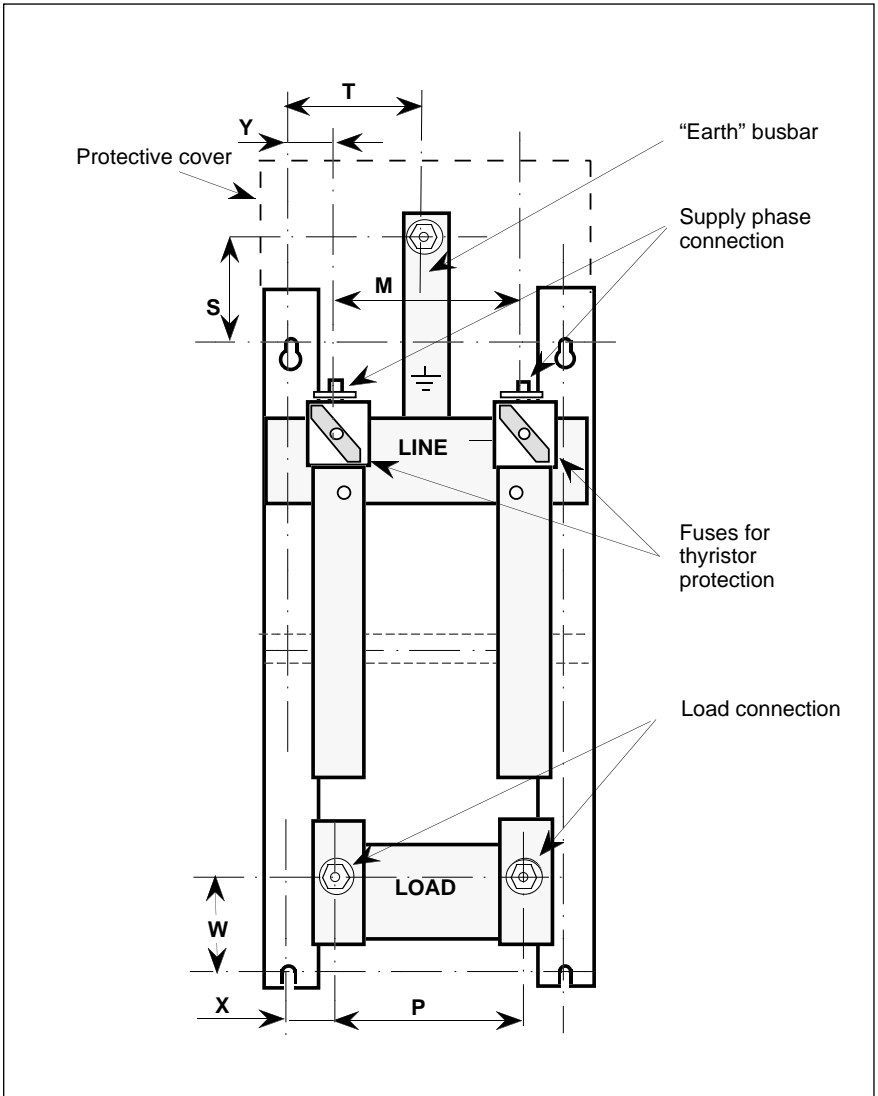


Figure 3-1 Power cable fixing points (60 to 250 A units)

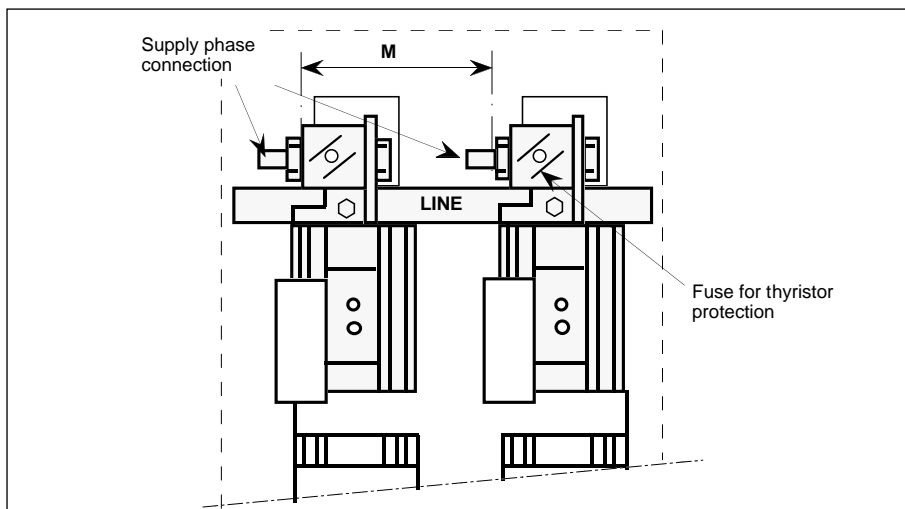


Figure 3-2 Specific power cable connection for 300 to 500 A units

Values	Nominal current			Description of distance
	60 to 150 A	250 A	300 to 500 A	
M	58 mm	135 mm	110 mm	"LINE" terminals 1 and 2
P	44 mm	150 mm	110 mm	"LOAD" terminals 1 and 2
S	50 mm	60 mm	30 mm	"Earth" busbar and upper fixing hole
T	45 mm	65 mm	96 mm	"Earth" busbar and left fixing hole
W	68 mm	70 mm	70 mm	"LOAD" terminal and lower fixing hole
X	20 mm	25 mm	20 mm	"LOAD" terminal and left fixing hole
Y	15 mm	32 mm	20 mm	"LINE" terminal and upper fixing hole

Table 3-2 Power cabling details



The power cables to a load pass through **cable sheaths** which must be tightened correctly after cabling.

POWER WIRING DIAGRAMS

If there are several TC2000 units on the same power supply, cable the units by producing a **circular permutation** of the supply phases.

The TC2000 thyristor units have **internal EMC filters** to reduce the conducted emissions to comply with the EN 50081-2.

These filters are the **standard** for the **60 A** and **75 A** units and **optional** for the **100 A** and **150 A** units. The one wire filter connection is made on the user terminal block under the unit.

Three-phase configuration (two-phase control)

The **order** of the phases must be observed if the unit includes the PLU option.

In two-phase control of a three-phase 3 wires load (star without neutral or a closed delta) the filter connection terminal (marked **L3/36**) must be connected to the non-controlled phase.

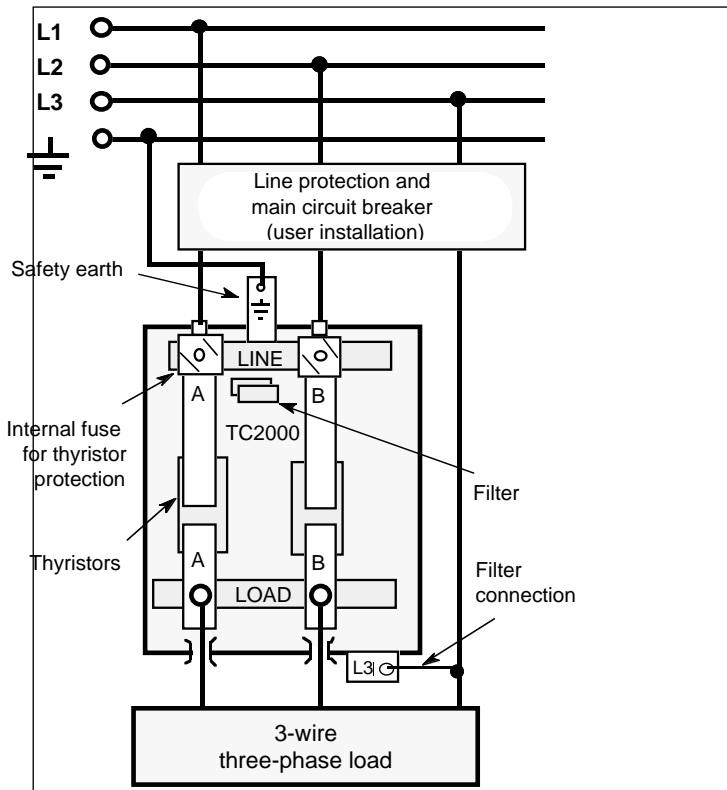


Figure 3-3 Example of TC2000 series unit three-phase wiring

Single-phase configuration (two independent single-phase loads)

The single-phase configuration of the TC2000 series unit can be performed:

- between one of the phases of the supply and neutral (in parallel)
- between two phases of the supply (in parallel)
- between two phases of the supply and neutral
- distributed between three supply phases.

Single-phase supply

In single-phase configuration the filter connection terminal (marked **L3/36**) must be connected to neutral. Filtering can only be used if loads supplied from a same single supply network.

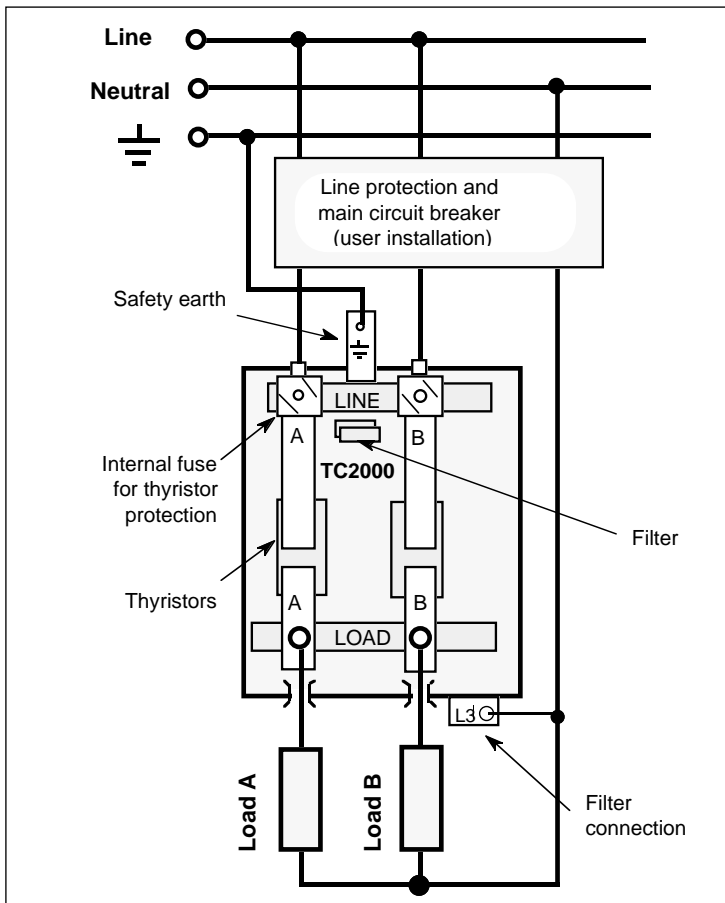


Figure 3-4 Example of power cabling of the TC2000 series unit
Single-phase configuration between one supply phase and the neutral

Three-phase supply

Filtering can only be used if one phase is common to two channels.

In single-phase configuration (three-phase supply) the filter connection terminal (marked **L3/36**) must be connected to common phase

- for the 60 A and 75 A units (standard)
- for 100 A and 150 A units with FILT option,

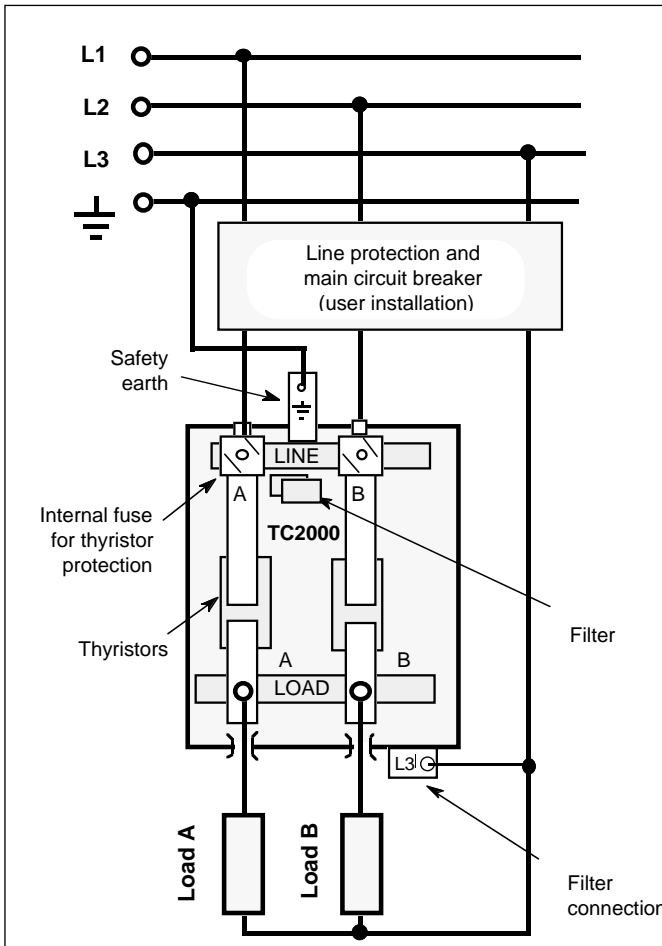


Figure 3-5 Example of power cabling of the TC2000 series unit
Single-phase configuration between 3 phases of the three-phase supply

AUXILIARY POWER SUPPLY

The auxiliary power supply is connected to a 2 terminal pluggable user terminal block, located to the right below the unit.

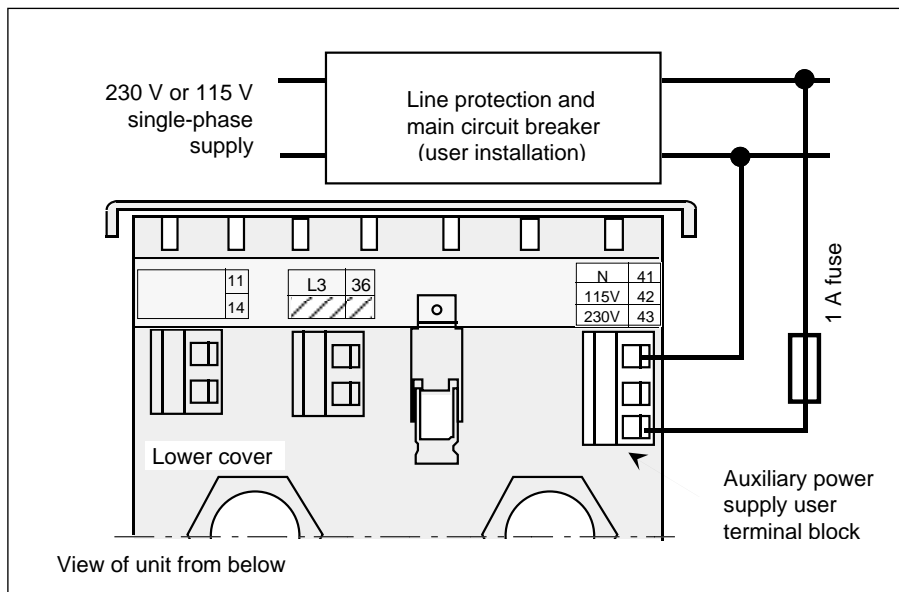


Figure 3-6 Auxiliary power supply configuration (230 V supply)

The auxiliary power supply is required in the following cases:

- permanent fan-cooling units (100 A to 500 A nominal current)
- power thyristor units (analogue control)
- static contactors with the PLU / IPU option (dc logic control in three-phase configuration).

Attention !



The auxiliary voltage is set at **100-110-115 -120 Vac** or **200-220-230-240 Vac** and must be connected to a **115 V** or **230 V single-phase** supply.

The auxiliary power supply voltage is configured in the factory according to the unit code. It is indicated on the user terminal block label.

An external **1 A** fuse must be connected on the auxiliary power supply.

CONTROL CABLES

Attention!



The control connections must be made with **shielded cables connected to the earth (or ground) at both ends** in order to ensure maximum immunity against interference.

Insulate the control cables from the power cables in the cable tray.

Fixing

The control wires must be grouped together in a shielded cable passing through the **cable clamp** under the unit (**second** cable clamp supplied for the PLU option).

Important !

To facilitate the earthing of the cable shield and to ensure maximum immunity to electromagnetic interference, the **metal** cable clamp is **fixed directly to the ground** of the unit.

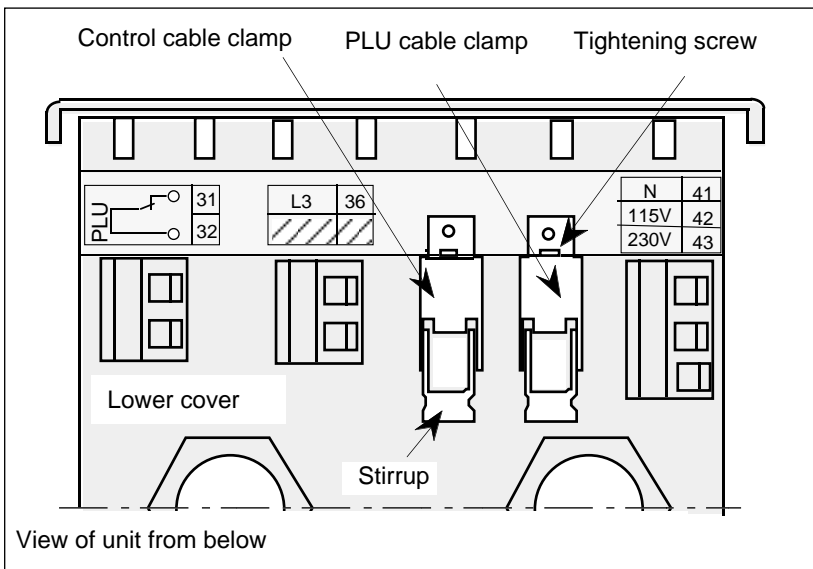


Figure 3-7 Control cable clamp layout

Shield connecting to the ground

To **insert** the control cable and **earth** its shield:

- **Strip** the shielded cable as shown in figure 3-8,a.

The length of the wires (control, PLU relay acknowledge, measurement retransmission) must ensure the connection between the metal cable clamp and the board user terminal blocks, with the door open. The cabling inside the unit must be as short as possible.

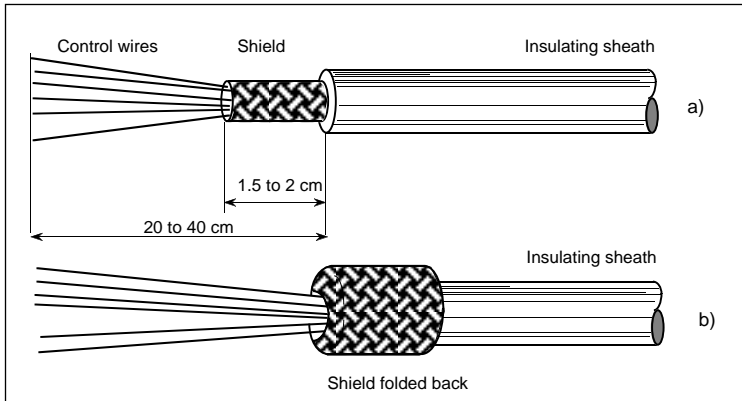


Figure 3-8 Control cable stripping

- **Fold back** the shield on the insulating sheath (figure 3-8,b)
- **Insert** the cable in the metal cable clamp so that the shield is located in the stirrup and does not enter the unit (it must not pass the lower cover).

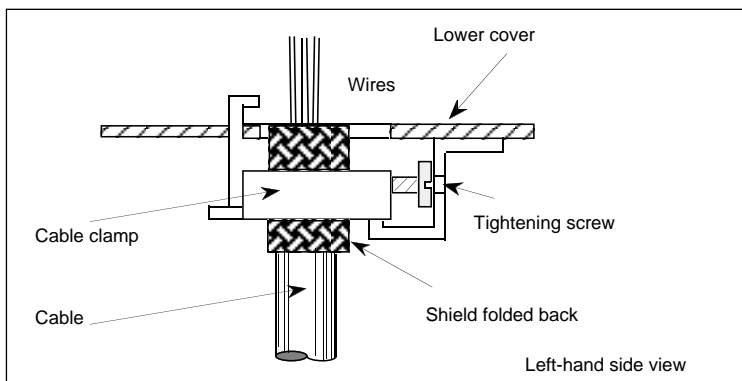


Figure 3-9 Cable tightening and shield grounding

- **Tighten** the stirrup (4 x 1 flat screwdriver; tightening torque: **0.7 N.m.**)

The possible diameters of the cables with the shield folded back are **5 to 10 mm** per cable clamp.

DRIVER TERMINAL BLOCK

The following connections are made on the driver board user terminal block:

- the analogue or logic input signals
- the manual input potentiometers.

The terminal block can be accessed by opening the front door.

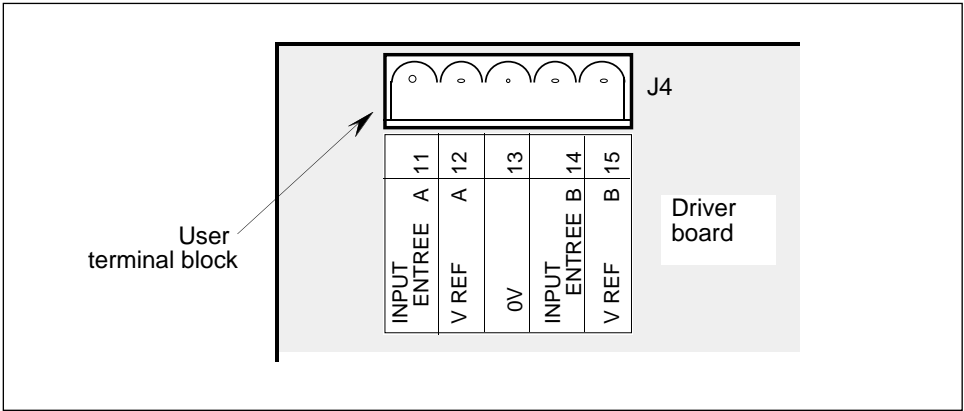


Figure 3-10 Driver terminal marking

Term.	Name on label	Destination
11	INPUT/ENTREE A	Input in three-phase configuration Input of channel A in single-phase configuration
12	V REF A	+15 V voltage output of channel A
13	0V	0 V common to the inputs of two channels
14	INPUT/ENTREE B	Input of channel B in single-phase configuration. Not used in three-phase configuration
15	V REF B	+ 15 V output of channel B

Table 3-3 Destination of the driver terminal block terminals

INPUT SIGNAL CONNECTION

The control wires are connected on the pluggable user terminal block, located on the **driver board**.

Driver terminal block terminal capacity: **0.22 mm² to 1.5 mm²**.

Driver terminal tightening torque: **0.7 N.m**.

The inputs are **insulated** from the power supply and the load circuit.

In the single-phase configuration, inputs **A and B** are independent (0 V is common).

In the three-phase configuration, only one input **A** is used for the 2 controlled phases.

The driver terminal block is accessible with **the front door open**.

To open the door, unfasten the front **screw**, release the door from its notches by raising it and pull it towards you.

Danger !



Dangerous live parts may be accessible when the door is open
(if the TC2000 unit power is on)

Solid state contactors

Two types of signal are available:

- dc logic signals (three-phase or single-phase configuration)
- ac signals (three-phase configuration only).

Signal type		ON state	OFF state	Maximum	Impedance
dc Basic version	Voltage	> 5 V	< 1 V	25 V	390 Ω
dc PLU/IPU option	Voltage	> 1.5 V	< 0.5 V	12 V	100 kΩ
	Current	> 4 mA	< 0.2 mA	40 mA	250 Ω
ac (PLU/IPU not available)	Voltage	> 85 V	< 10 V	264 V	10 kΩ (50 Hz)

Table 3-4 Solid state contactor input parameters

Each dc input is in series with 2 opto-diodes; voltage drop 4 V.

Two independent dc logic signals in the single-phase configuration are applied to terminals **11** and **13** (input **A**) and terminals **14** and **13** (input **B**).

In the three-phase static contactor configuration, terminals **11** and **13** are used.

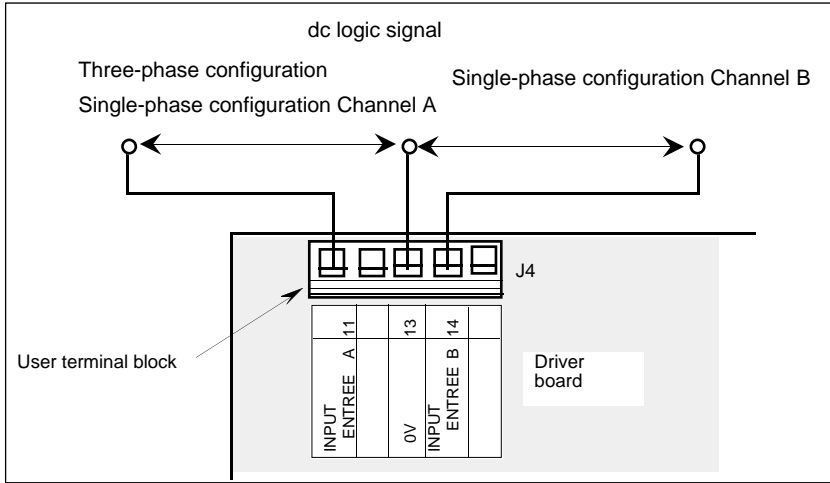


Figure 3-11 Configuration of the two solid state contactor dc inputs

An ac static contactor input (terminals **11** and **14** of the driver terminal block) is only available for the three-phase configuration without the PLU option.

The input is insulated from the power supply and from the load.

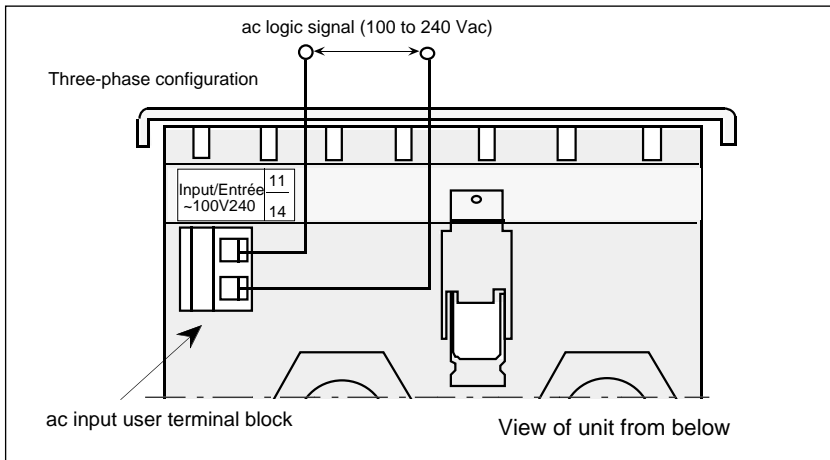


Figure 3-12 Configuration of the solid state contactor ac input

Power thyristor units

Analogue inputs

The TC2000 series power thyristor units are controlled by analogue signals.

In the single-phase configuration, two independent dc analogue signals are applied to terminals **11** and **13** (input **A**) and terminals **14** and **13** (input **B**).

In the three-phase configuration, an analogue signal is applied between terminals **11** and **13** of the power thyristor unit user terminal block.

The signal type and level can be configured using suitable jumpers.

Signal type	Signal level	Input impedance
Voltage	0 - 5 V 1 - 5 V 0 - 10 V 2 - 10 V	68 k Ω
Current	0 - 20 mA 4 - 20 mA	250 Ω

Table 3-5 Power thyristor unit analogue input parameters

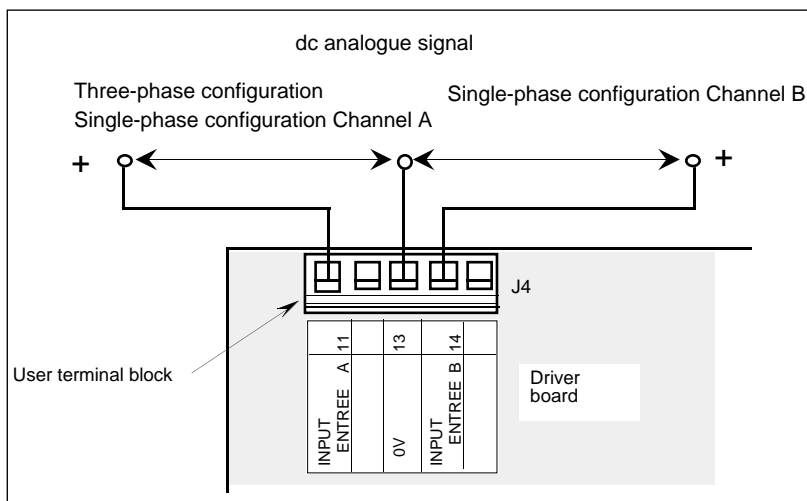


Figure 3-13 Power thyristor unit analogue input configuration

Manual inputs

The TC2000 series thyristor units (analogue operation) can be driven by **external potentiometers** when they are configured with a **0-5 V** or **0-10 V** input.

In the **three-phase** configuration, **only one** potentiometer connected to input **A** is used.

In the **single-phase** configuration, **two** potentiometers are independent.

For the connection of these potentiometers, two **+15 V** dc voltage outputs are provided on the driver terminal block (terminals **12** for channel **A** and **15** for channel **B**). The **+15 V** internal voltage is available via a **10 k Ω** resistance of the driver board.

The potentiometers (**5 k Ω** for the **0-5 V** input or **20 k Ω** for the **0-10 V** input) are connected between terminals **12** and **13** for channel **A** and between terminals **15** and **13** for channel **B**.

The **cursor**s are connected to terminal **11** (channel **A**) and to terminal **14** (channel **B**).

The auxiliary power supply must be connected.

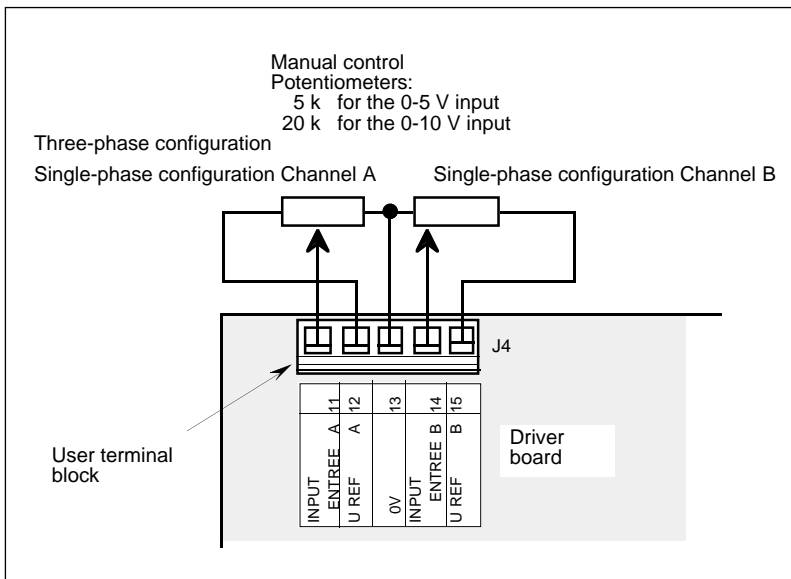


Figure 3-14 Power thyristor unit manual input configuration

PLU ALARM SIGNALLING (optional)

User terminal block

The connection of the PLU alarm relay switch, which signals the active status of the alarm, is made on the user terminal block under the unit, on the left.

The switch output terminals are marked **31** and **32** on the terminal block label.

The PLU alarm relay is **de-energised in alarm status**.
Its switch is **0.25 A** at **250 Vac** or **30 Vdc**

The type of alarm relay switch, configured in the factory (normally open N/O or normally closed N/C), is determined on the order by the PLU option code.

Code **PLU** : switch **N/O** (open in alarm status)
Code **IPU** : switch **N/C** (closed in alarm status).

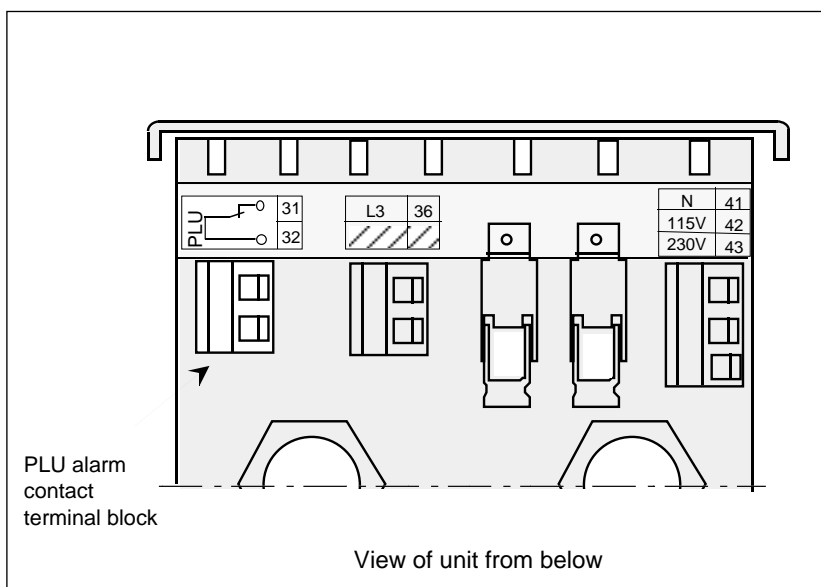


Figure 3-15 PLU relay switch user terminal block

PLU board

The PLU alarm status is acknowledged or memorised using an external switch connected on the PLU board (terminals **21** and **22**).

- Terminals **21** and **22** are short-circuited: the alarm is memorised; the opening of the shunt cancels the PLU relay alarm status if the fault disappears.
- Terminals **21** and **22** are not short-circuited: the PLU alarm is not memorised.

An external contact is connected on **one** plug-in terminal block located in the top right-hand corner of the PLU board. The external memorisation / acknowledge switch wires pass through a cable clamp, like that for control (see figures 3-7 to 3-9).

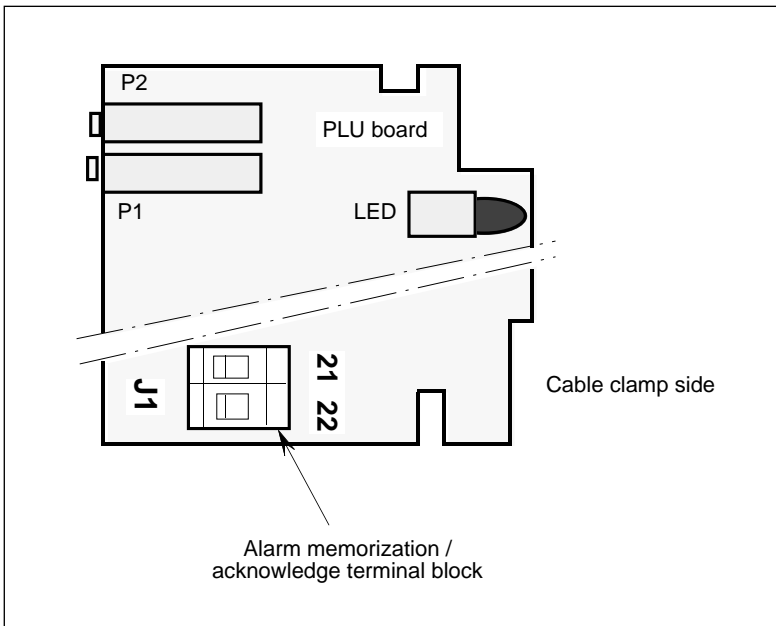


Figure 3-16 PLU alarm status memorisation / acknowledge terminal block

Chapter 4

CONFIGURATION

Contents	page
Safety during configuration	4-2
Driver board	4-2
Possible configurations	4-3
Operation type	4-4
Configuration type	4-6
Input type and level	4-7
Solid state contactors	4-7
Power thyristor units	4-8
PLU board (optional)	4-9
Supply frequency	4-10
Test	4-10
Alarm contact type	4-10

Chapitre 4 CONFIGURATION

SAFETY DURING CONFIGURATION

The thyristor unit is configured using moveable **jumper**s on the driver board.



Important

The unit is supplied fully configured in accordance with the code on the identification label.

This chapter is included in order to

- **check** that the configuration is compatible with the application
- **modify**, if necessary, certain characteristics of the unit on-site.

Danger !



For safety reasons, the reconfiguration of the unit using jumpers must be performed with the unit **switched off** and by qualified personnel only.

Before starting the reconfiguration procedure, check that the thyristor unit is insulated and that an occasional power-up is impossible.

After the reconfiguration of the unit, correct the codes on the identification label.

DRIVER BOARD

Possible configurations

The type and configuration of the driver board of **TC2000** series units determines

- the operation type
 - solid state contactor (SSC) with ON/OFF firing mode
 - power thyristor unit with Burst firing mode
- the configuration type
 - three-phase
 - single-phase
- the input signal level.

The thyristor firing mode (ON/OFF or Burst mode) is determined by the coding.

The inputs can only be configured for power thyristor units and for SSC with the PLU option.

Operation	Control signal	Configuration	PLU option	Input configuration jumpers	Thyristor firing mode
Solid state contactor (SSC)	dc logic (code LGC)	Single-phase	Not applicable	Absent	ON/OFF
		Three-phase	No option		
		Three-phase	With option	Present	
	ac logic (code ALC)	Three-phase	Not available	Absent	
Power thyristor units	dc analogue or manual (codes from 0V5 to 4mA20)	Single-phase	Not applicable	Present	Burst mode
		Three-phase	With or without option		
Reconfigured power thyristor units to SSC	dc logic or manual (order code not avail.)	Single-phase	Not applicable	Present	ON/OFF
		Three-phase	With or without option		

Table 4-1 Possible configurations of TC2000 series units

The manual control of the units requires the configuration of the inputs to **0-5 V** or **0-10 V**.

Operation type

The type of operation of the TC2000 unit (power thyristor unit and static contactor) is **configured in the factory** according to the unit order code.

- The codes **LGC** or **ACL** correspond to the operation of the unit as a **solid state contactor** with the "ON/OFF" thyristor firing mode.
- The codes **0V5** to **4mA20** correspond to the operation of the unit as a **power thyristor unit** with the "Burst mode" thyristor firing mode.

The type of operation can be reconfigured for the power thyristor units on the driver board using the following jumpers:

- **K16** and **K17** (for channel **A** in single-phase configuration and in **three-phase** configuration)
- **K26** and **K27** (for channel **B** in single-phase configuration).
In the three-phase configuration, the positions of jumpers K26 and K27 are insensitive.

Operation	Position of jumpers					
	Three-phase configuration Single-phase configuration Ch.A			Single-phase configuration Channel B		
	K16	K17	K18	K26	K27	K28
ON/OFF firing mode (logic signal)	0	0	Indifferent position	0	0	Indifferent position
Burst firing mode (analogue signal)	1	1	0 (standard)	1	1	0 (standard)

Table 4-2 Operation type configuration

Notes:

- Units configured as solid state contactors in the factory (operation with logic signals) cannot be reconfigured for operation with analogue signals (except with the PLU option).
- The operation of power thyristor units configured in the factory according to the order code, can be reconfigured on-site with a logic signal in "ON/OFF" mode according to table 4-2.
- For power thyristor units the position of jumpers **K18** and **K28** is **0** (standard). The **1** position can be used for special applications (6 s Burst mode, C23 and C24 fitted).

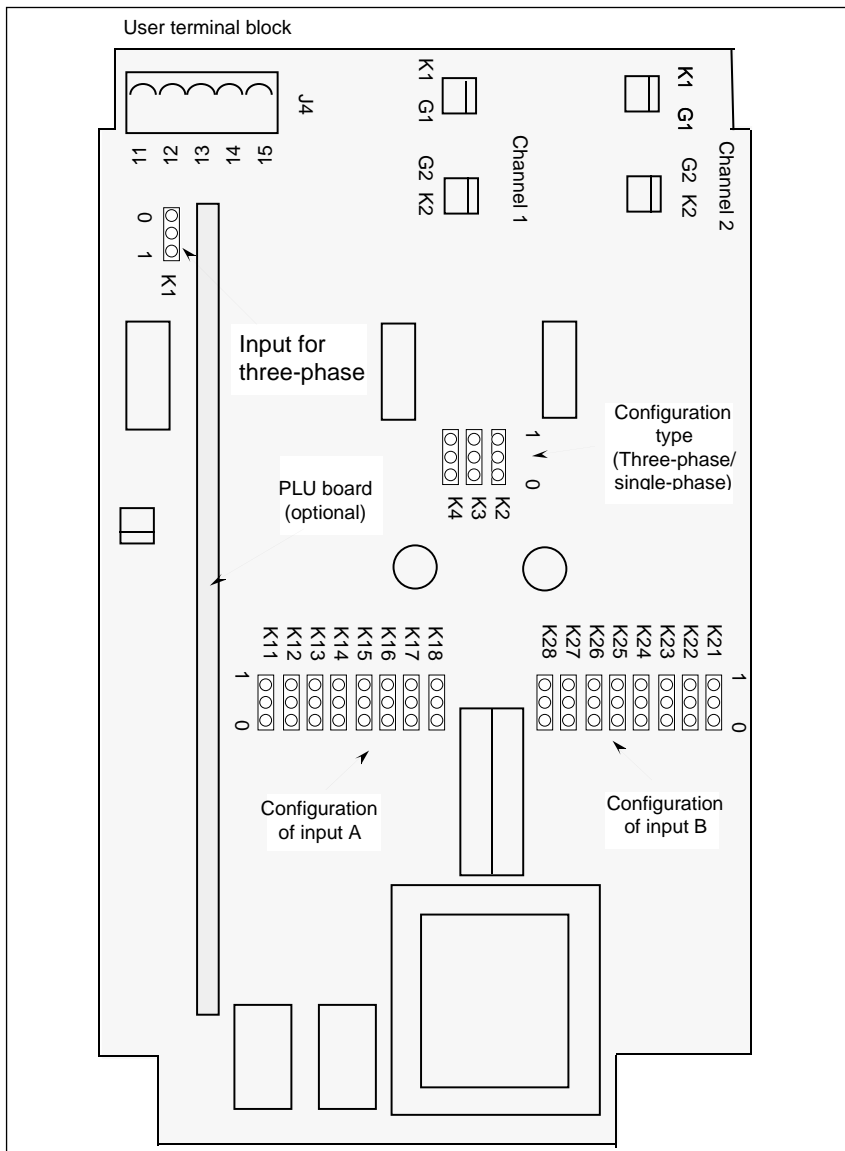


Figure 4-1 Location of the configuration jumpers on the driver board

Note: For static contactors with an ac input or a dc input without the PLU option, the driver board does not contain jumpers K11 to K28.

Configuration type

TC2000 series power thyristor units have been designed to operate in 2 types of configuration:

- **three-phase** in 2 phase control (3-wire load configuration)
- **single-phase** (the unit acts as 2 single-phase units built into the same unit with 2 different control signals); single-phase operation is impossible with the ac signal.

The configuration type is configured using jumpers **K1** to **K4** located on the driver board.

Configuration		Position of jumpers			
		K1	K2	K3	K4
Solid state contactor	Three-phase (only one control signal is used)	1	0	0	Absent
	Single-phase Two independent thyristor channels (two different control signals)	1	1	1	Absent
Power thyristor unit	Three-phase (only one control signal is used)	Absent	0	0	0
	Single-phase Two independent thyristor channels (two different control signals)	Absent	1	1	0

Table 4-3 Configuration type

- Note :**
- For **solid state contactors**, **K1 = 1** indicates that input **A** drives the unit in the three-phase configuration
 - For **power thyristor units**, **K4 = 0** indicates that input **A** drives the unit in the three-phase configuration.

Input type and level

Solid state contactors

The static contactors are driven by **logic** signals ("ON/OFF" firing).
The power is switched to zero voltage when the signal is present.

There are two possible types of input signal to control the static contactors:

- an **ac** signal (only in the three-phase configuration without the PLU / IPU option)
- a **dc** signal (three-phase configuration with or without the PLU/ IPU option or single-phase configuration).

The **ac** signal (**100 Vac** to **240 Vac**) corresponds the code **ACL**.

The input is configured in the factory with soldered bridges and specific components.
It is **impossible** to reconfigure it.

The **dc** signal corresponds to the code **LGC**. The possibility of reconfiguring the dc input depends on the type of configuration and whether the PLU / IPU option is present:

- In the three-phase configuration without the PLU/IPU option and in the single-phase configuration, it is impossible to reconfigure the logic dc inputs of the static contactor. The driver board **does not contain** configuration jumpers.
- In the three-phase configuration with the PLU / IPU option, the dc inputs can be (if necessary) reconfigured (to adapt the signal source) in terms of voltage and current. In this case, jumpers **K11** to **K15** are used for this configuration. In the standard version, the static contactor is supplied with the input configured to **0-5 V**.
The position of jumpers **K16** and **K17** must be **0** (logic control).

Control	Input rating	Position of jumpers						
		K11	K12	K13	K14	K15	K16	K17
dc logic	10 V	0	1	0	1	0	0	0
	5 V	0	0	1	1	0	0	0
	20 mA	1	0	1	1	0	0	0

Table 4-4 Configuration of static contactor dc inputs in the three-phase configuration with the PLU/IPU option

Power thyristor units

The power thyristor units are driven by **analogue** input signals.

The power in the load is switched to zero voltage with a cyclic ratio **proportional** to the input signal.

In the three-phase configuration and in the single-phase configuration with or without the PLU / IPU option, the input signals can be configured with a choice of four voltage levels and two current levels.

Jumpers **K11 to K17** are used to configure

- the three-phase input
- input A in the unit three-phase configuration.

Jumpers **K21 to K27** are used to configure input B only in the single-phase configuration.

For operation with an analogue signal or in manual mode, jumpers **K16** and **K17** for channel **A** and jumpers **K26** and **K27** for channel **B** must be in position **1**.

Control	Input level	Position of jumpers						
		K11	K12	K13	K14	K15	K16	K17
		K21	K22	K23	K24	K25	K26	K27
Analogue	0-5V	0	0	1	0	1	1	1
	1-5V	0	0	1	1	0	1	1
	0-10V	0	1	0	0	1	1	1
	2-10V	0	1	0	1	0	1	1
	0-20 mA	1	0	1	0	1	1	1
	4-20 mA	1	0	1	1	0	1	1
Manual (potentiometer)	5 kΩ	0	0	1	0	1	1	1
	20 kΩ	0	1	0	0	1	1	1

Table 4-5 Configuration of inputs for power thyristor units

PLU BOARD (OPTIONAL)

The PLU board is supplied fully configured in accordance with the ordering code. This paragraph is included in order to check that the configuration is compatible with the application or to modify, if necessary, certain characteristics of the unit on-site.

The jumpers of the partial load unbalance board (PLU board) are used to reconfigure:

- calibration or normal operation
- the supply frequency (**50 or 60 Hz**)
- the PLU detection test type.

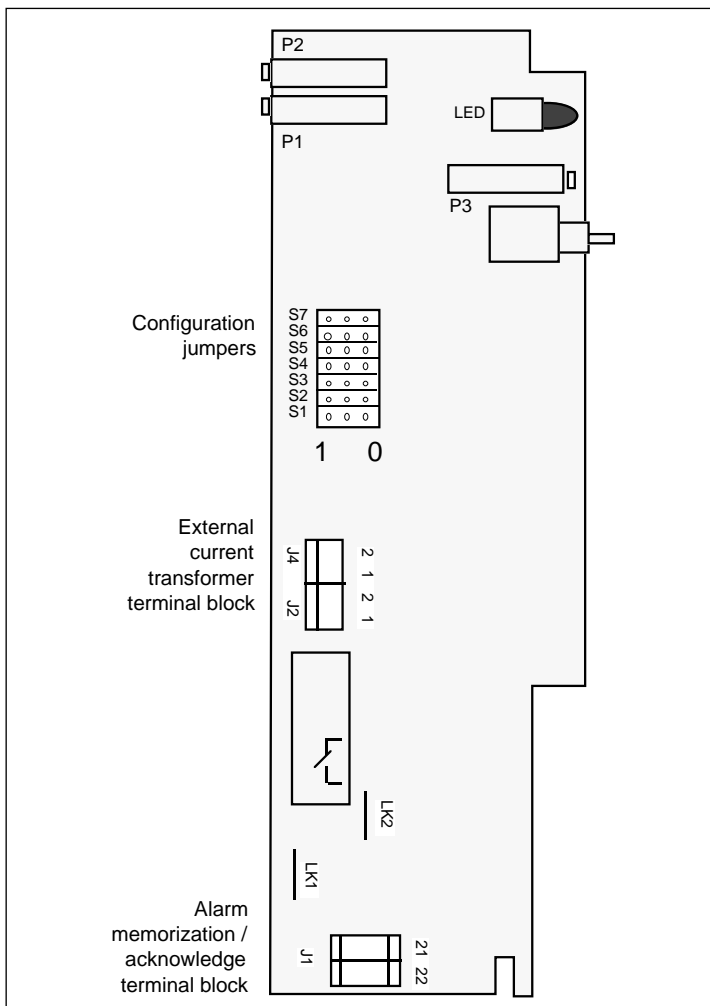


Figure 4-2 Position of configuration jumpers on the PLU board

For normal operation of the PLU circuitry jumper **S3** must be in position **0**.

The jumper **S7** must always be in position **1**.

For external measurements, two current transformers can be connected to the PLU board, in order to provide the information required for PLU detection (terminal blocks **J2** for phase **A** and **J4** for phase **B**, see figure 4-2). The jumper **S1** et **S2** must always be in position **1**.

Supply frequency

Frequency	Position of jumper
	S4
50 Hz (± 2 Hz)	0
60 Hz (± 2 Hz)	1

Table 4-6 Configuration of the frequency

Test

Operation	Position of jumper
	S5
Normal position for Test	0
Inversion of PLU for Test (PLU setting, if necessary)	1

Table 4-7 Configuration of the "Test" position

Alarm contact type

Contact type	Link soldered	
	LK1	LK2
Contact open in alarm state (PLU code)	Yes	No
Contact closed in alarm state (IPU code)	No	Yes

Table 4-8 Configuration of alarm contact type

Chapter 5

OPERATION

Contents	Page
Thyristor firing mode	5-2
General	5-2
Supply variation compensation	5-2
Logic mode	5-3
Burst firing mode	5-5
PLU detection	5-6

Chapter 5 OPERATION

THYRISTOR FIRING MODE

General



TC2000 series unit thyristors switch on and off at the **zero** supply voltage for each phase. This firing mode eliminates the steep fronts of the supply voltage applied to the load, **does not apply disturbances on the supply and, above all, prevents the generation of interference.**

The synchronisation of firing at zero voltage also means it is no longer necessary to detect the order of the phases beforehand when wiring the unit on a three-phase supply (except when the unit has the PLU/IPU option).

The thyristor firing mode of the TC2000 series units is determined by the type of operation of the unit (static contactor or power thyristor unit):

- the **solid state contactors** possess the **Logic** firing mode
- the **power thyristor units** possess the **Burst firing** mode.

For both these modes, the thyristor firing includes a whole number of alternations.

The modulation of the supply voltage applied to the load is performed:

- for the solid state contactors, by an external controller (e.g. temperature controller) with the use of a logic controller output;
- for the power thyristor units, by the internal modulator with an analogue input.

Supply variation compensation

TC2000 series **power thyristor units** with an **analogue control** are equipped with a compensation function for voltage variations within the range: **+ 10 % to - 15 %**.

This voltage is measured on the power supply.

To benefit from the supply voltage variation compensation functions, the power supply must be connected to the **same voltage** as the **power** (use of an external step-down transformer, if necessary).

Without a compensation of the supply voltage variations, a decrease (or increase) of 10% in the supply voltage would lead to a decrease (or increase) of 20% in the power sent to the load. By compensating for the supply voltage variation simultaneously, the thyristor unit does not transmit a power variation to the load, thus preventing fluctuations of the controlled value and the intervention of the controller.

"Logic" mode

The "**Logic**" mode of thyristor firing (also known as the "**ON/OFF**" mode) controls power in the load as a proportion of the firing time specified by the logic control signal.

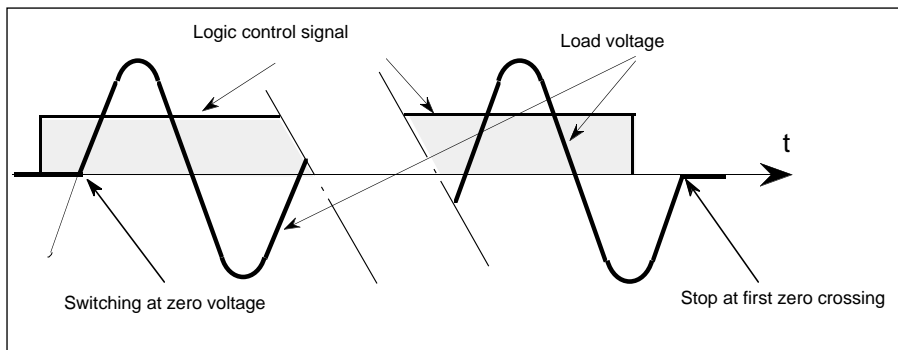


Figure 5-1 "Logic" firing mode

This firing mode is activated by a logic input signal greater than an "ON state" threshold (full thyristor firing), provided that the input signal is not less than an "OFF state" threshold.

Attention !



In logic firing mode (except specific application), use a control signal with an external modulation period less than **10 s** to reduce aging due to thermal fatigue of various elements of the installation (heating elements, thyristors, thyristor protection high-speed fuses) as much as possible and thus increase their service life.

"Burst firing" mode

In Burst firing mode, the power dissipated in the load is defined by the ratio of the thyristor firing period (T_F) and the modulation period (T_M).

The power delivered by a thyristor unit in Burst firing mode is therefore set by the firing period T_F varying within the modulation period T_M .

The load power is proportional to the firing rate τ which depends on the firing period (T_F) and the non-firing period (T_{NF}):

$$\tau = \frac{T_F}{T_F + T_{NF}}$$

or, using the modulation period ($T_M = T_F + T_{NF}$), the firing rate (or cyclic ratio) can be expressed by:

$$\tau = \frac{T_F}{T_M} \quad \text{which is inversely proportional to } T_M.$$

The load power can be expressed by:

$$P = \tau \cdot P_{MAX} ,$$

where P_{MAX} represents the load power during the thyristor firing.

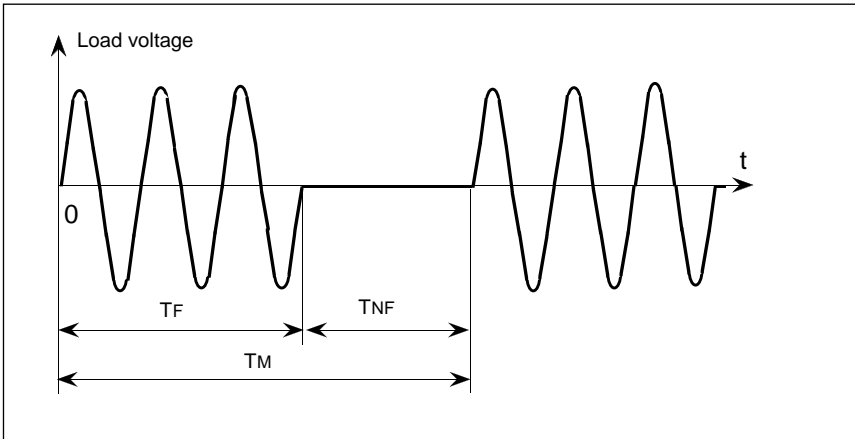


Figure 5-2 Burst firing periods

Using a variable modulation period according to the output power, the adjustment precision of the TC2000 unit is adapted to each specific setpoint zone.

At **50 %** power, the typical value of the modulation period is **0.6 s** ($T_F = T_{NF} = 0.3$ s).

- For a zone less than 50 % of the maximum setpoint, the firing period is decreased and the modulation period is increased.
- In the power zone greater than 50%, the non-firing period is reduced with the increase in the modulation period.

E.g.:

- for 50% power : $T_F = 300$ ms, $T_M = 600$ ms
- for 5 % power : $T_F = 250$ ms, $T_M = 5$ s
- for 90 % power : $T_F = 2.25$ s, $T_M = 2.5$ s

The unit output power is thus perfectly linear between **0** and **100 %** of maximum power for the analogue signal varying between **4** and **84%** of the maximum scale.

The control does not have an adjustment stage as in fixed modulation period units.

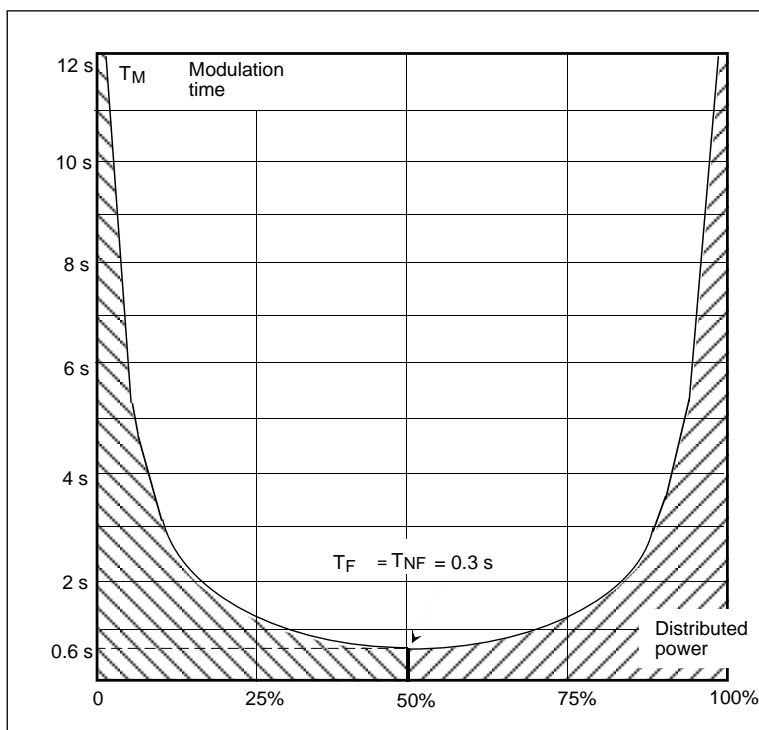


Figure 5-3 Modulation time as a function of power

PLU DETECTION

The partial load unbalance detection system (in three-phase operation only) provides an alarm for a current unbalance ΔI of

$$\Delta I = \pm 10\% \cdot I_{\text{Load}}$$

for a balanced three-phase load.

This partial load unbalance (PLU) detection is available **as an option** only for the **three-phase** configuration for:

- power thyristor units
- solid state contactors with the **dc logic** input.

The PLU option requires an auxiliary power supply irrespective of the type of unit cooling (fan-cooled or not fan-cooled) and the input type.

The PLU board is mounted perpendicularly on the driver board (see figure 4-1).

The **PLU alarm relay**, located on the PLU board, is **deactivated** in alarm status.

Depending on the code on the identification label, two types of alarm relay switch are available on the user terminal block (below the unit):

- switch N/O **open** in alarm status (code **PLU**)
- switch N/C **closed** in alarm status (code **IPU**).

The relay break-make contact cut-off capacity:

0.25 A at 250 Vac or 30 Vdc.

Chapter 6

COMMISSIONING PROCEDURE

Contents	Page
Commissioning procedure safety	6-2
Checking the characteristics	6-3
Load current	6-3
Supply voltage	6-3
Auxiliary power supply voltage	6-4
Input signals	6-4
PLU detection (optional)	6-4
PLU detection adjustment (optional)	6-5
Adjustment equipment	6-6
Initially balanced load	6-7
Initially unbalanced load	6-8

Chapter 6 COMMISSIONING PROCEDURE

Read this chapter carefully before commissioning the thyristor unit

COMMISSIONING PROCEDURE SAFETY

Important !



Eurotherm cannot be held responsible for any damage to persons or property or for any financial loss or costs resulting from the incorrect use of the product or the failure to observe the instructions contained in this manual.

It is therefore the user's responsibility to ensure that all the nominal values of the power unit are compatible with the conditions of use and installation before commissioning the unit.

Danger !



Dangerous live parts may be accessible when the front door is open.

Only personnel qualified and authorised to work in industrial low voltage electrical environments can access inside the unit, after it has been insulated (wait for at least 5 s before accessing inside the unit).

Access to internal components of the unit is prohibited to users who are not authorised to work in industrial low voltage electrical environments.

The temperature of the heatsink may exceed 100°C.
Avoid all contact, even occasional, with the heatsink if unit is operational.

The heatsink remains hot for approximately 15 min after the unit has been switched off.

CHECKING THE CHARACTERISTICS



Attention !

Before connecting the unit to an electrical supply, make sure that the **identification code** of the thyristor power unit corresponds to the coding specified in the **order** and that the characteristics of the unit are **compatible with the installation**.

Load current

The maximum current in a load phase must be less than or equal to the value of the nominal current of the TC2000 series unit for operation at a specified temperature.

In three-phase operation, if the three identical loads are configured as **closed delta**, the line current of the thyristor unit is $\sqrt{3}$ **times as high** as the current of each arm of the delta.

If the three-phase load is presented by its power (**P**), the line current of the three-phase load for all configuration types can be calculated as follows:

$$I = \frac{P}{\sqrt{3} \times V_L}$$

(in this equation V_L represents the line to line voltage).

Supply voltage

For star configurations without neutral or closed delta, the nominal value of the TC2000 series unit voltage must be greater than or equal to the **line to line** voltage of the supply used.



Danger !

Never use a thyristor unit with a supply **voltage greater** than the nominal voltage specified on the serial number label code.

Auxiliary power supply voltage

The auxiliary power supply voltage is determined on the unit order.

It powers the actual electronics (for power thyristor units and for static contactors with the PLU / IPU option) and the fans of units with permanent fan-cooling (100 A to 500 A nominal current).

The auxiliary voltage is set to 100-110-115-120 Vac or 200-220-230-240 Vac according to the type of internal transformer. The auxiliary power supply transformers are selected in the factory, according to the coding.

The configured auxiliary voltage is marked on the label of the connection user terminal block of the auxiliary voltage (below the unit) and on the identification label.

Input signals

For power thyristor units and static contactors with the PLU / IPU option, the jumper configurations on the driver board must be compatible with the levels chosen for the signals used for control (see "Configuration").

PLU detection (optional)

- Check that the unit is configured for two phase control of the three-phase load (see page 4-6).
- Check that the auxiliary power supply is correctly connected.
- Check that the loads are correctly connected (closed delta or star without neutral configuration) and that the **phase rotation order** is **direct (1, 2, 3)** as in figure 3-3, for example.

PLU DETECTION ADJUSTMENT (optional)

Partial load unbalance (**PLU**) detection is possible as an option for power thyristor units and for static contactors with the dc signal.

The PLU detection circuit is adjusted in the factory for the nominal current and voltage in the three-phase configuration.

To retain the PLU detection performances with the real load which may be different to that defined in the order, the possibility of on-site adjustment is provided for.

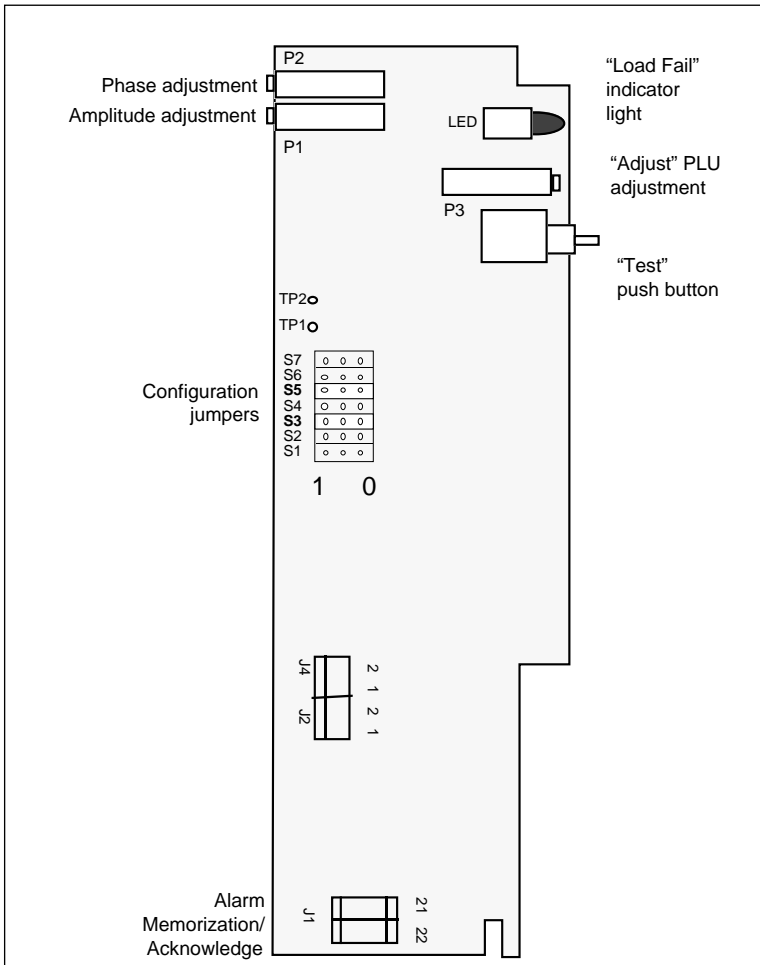


Figure 6-1 Location of adjustment equipment on the PLU board

Adjustment equipment

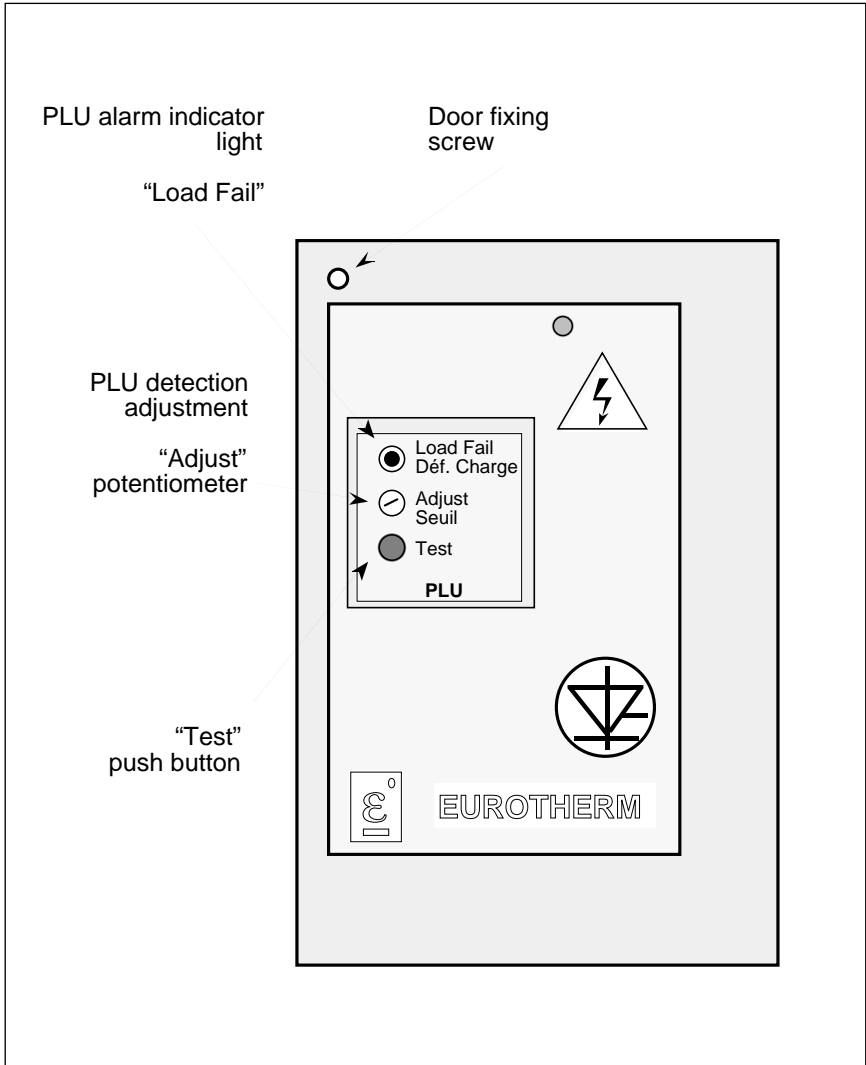


Figure 6-2 Location of adjustment equipment on the front fascia of the unit

Initially balanced load

- Set the thyristor unit to continuous firing (three-phase configuration)
- Turn the adjustment potentiometer (marked "**Adjust**" on the front fascia) to the limit anti-clockwise (minimum sensitivity).

If the "**Load Fail**" indicator light is lit, wait for a few seconds until it goes off.

- Press the "**Test**" push button and keep it in this position.
Turn the adjustment potentiometer slowly clockwise until the indicator light comes on.
- Release the "**Test**" button and check that the "**Load Fail**" indicator light goes off after a few moments. Otherwise, repeat the adjustment.
- Press the "**Test**" button again, the "**Load Fail**" indicator light should light up; the PLU alarm relay then changes status.
Release the button.
- Decrease the control signal (to approximately 50%) and check that the alarm is not triggered.

Press the button and check the triggering of the alarm (indicator light and relay).

Note : If abnormal operation is observed during the adjustment:



- **switch off** the thyristor unit and **insulate it**
- set jumper **S5** on the PLU board to position **1** (see figure 6-1)
- resume the adjustment.

The last adjustment must only be made **by personnel qualified and authorised** to work in an industrial electrical low voltage environment.

Initially unbalanced load

If the load is initially unbalanced, to obtain optimum PLU detection sensitivity, the PLU board must be recalibrated with power on.



Danger !

This adjustment must only be made **by personnel qualified and authorised** to work in an industrial low voltage electrical environment

- Set jumper **S3** on the PLU board to position **1** (see figure 6-1).
- Turn the "**Adjust**" potentiometer on the front fascia completely clockwise (see figure 6-2).
- Set the thyristor unit to full firing.
- Using the potentiometers **P1** (signal amplitude) and **P2** (signal phase) located on the PLU board, adjust in alternation to obtain the minimum of the error voltage.

This voltage is available between the test points **TP1** and **TP2** on the PLU board.

- Reset jumper **S3** to position **0**.

Follow the adjustment procedure described for the initially balanced load.

Chapter 7

MAINTENANCE

Contents	Page
Thyristor protection	7-2
Thyristor protection fuses	7-3
Fuse blown indication micro-switch	7-5
Protection fuses for auxiliary power supply connection	7-6
Servicing	7-7
Tools	7-8
Configuration recapitulatory tables	7-9
Driver board	7-9
PLU board (optional)	7-10

Chapter 7 MAINTENANCE

Danger !



The unit must be maintained by qualified personnel only

THYRISTOR PROTECTION

The thyristors of the TC2000 series power units are protected as follows:

- internal high-speed fuses against over-currents;
- RC snubber and varistors - against too fast voltage variations and transient over-voltages when the thyristors are not conductors.
- thermal switch (for units with permanent fan cooling, nominal current greater than or equal to 100 A); in the event of accidental overheating of the cooler (for 100 to 500 A units), the thermal switch opens, which causes the thyristor firing to be stopped.

THYRISTOR PROTECTION FUSES

The standard version of TC2000 series units is supplied with high-speed fuses mounted on the line busbars.

Attention



High-speed fuses are only used for the internal protection **of thyristors** against wide amplitude over-loads.

These high-speed fuses may under no circumstances be used to **protect the installation.**



The user's installation **must be protected** (non-high-speed fuses, thermal or electromagnetic circuit breaker, suitable fuse-isolator) and comply with current standards.



The use of any fuses **other** than those recommended for thyristor protection **renders the thyristor unit guarantee null and void** (see table 7-1).

Table 7-1 contains all the references of the original internal fuses (when the thyristor unit leaves the factory) and the fuse which can be used for replacements during maintenance.

Maximum line-to-line voltage: **500 V**.

Nominal current		Reference		
Th. unit (A)	Fuse (A)	EUROTHERM	FERRAZ	BUSSMANN
60	80	LA172468U080	S300051	170M3461
75	100	LA172468U100	T300052	170M3462
100	125	LA172468U125	V300053	170M3463
150	200	LA172468U200	X300055	170M3465
250	315	LA172468U315	Q300003	170M4460
300	400	LA172468U400	H300065	170M5458
400	500	LA172468U500	K300067	170M5460
500	630	LA172468U630	M300069	170M5462

Table 7-1 Recommended high-speed fuses for thyristor protection

FUSE BLOWN INDICATION MICRO-SWITCH

As an option, high-speed fuses may be equipped with a fuse blown indication micro-switch (**FUMS** option) with the part No.:

for **BUSSMANN** fuses:

EUROTHERM DC172267 or FERRAZ P96015 or BUSSMANN 170H0069

for **FERRAZ** fuses:

EUROTHERM DC172997 or FERRAZ G310 000

To ensure improved insulation between the cabling of the micro-switches and the power and the cover, TC2000 models with a nominal current of 60 to 100 A are supplied with the "flags" type lugs and the insulating sleeves.

Each external terminal of the fuse blown indication micro-switch must be cabled with a "flag" lug and an insulating sleeve in compliance with figure 7-1.

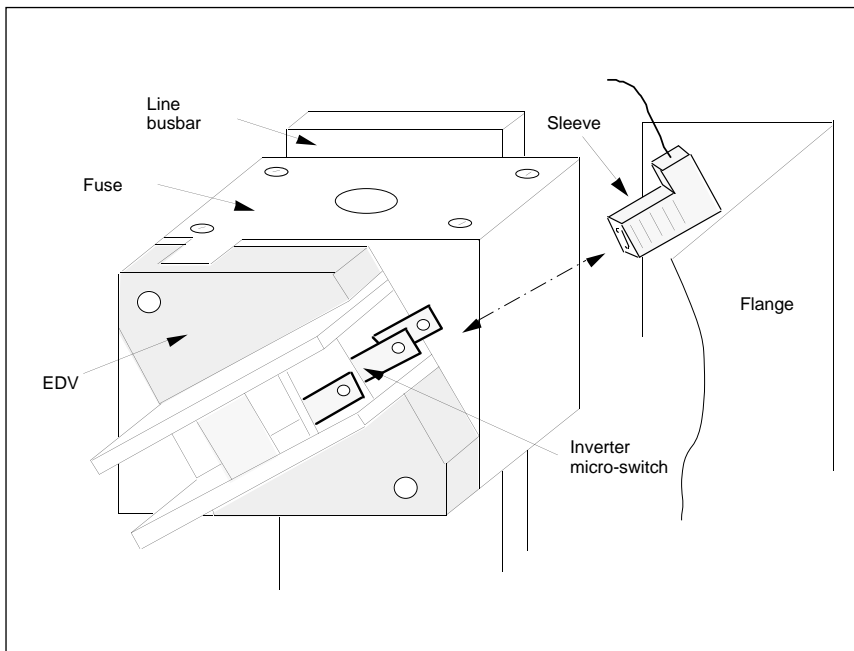


Figure 7-1 Use of "flag" lugs and insulating sleeves to observe insulating distances.

PROTECTION FUSES FOR AUXILIARY POWER SUPPLY CONNECTION

These fuses must be installed in each connection wire of the auxiliary power supply (see "Cabling") for the following units:

- power thyristor units
- static contactors with the PLU option
- all fan-cooled units (nominal current from 100 to 500 A).

Reference voltage (max)	1 A fuse 6.3 x 32 mm	Fuse-isolator support	Overall "Fuse-isolator" dimensions (mm)
500 V	CS174289U1A0	CP174293	63 x 15 x 52

Table 7-2 Recommended protection fuses for the auxiliary power supply connection

SERVICING

TC2000 thyristor units must be mounted with the heatsink positioned vertically and with no obstructions either above or below which could block the passage of the ventilation air.

Attention !



If multiple units are installed in the same cabinet, they should be arranged in such a way that the air expelled by one unit **cannot be admitted** into the unit located above it.

In order to ensure correct cooling of the unit, users are advised to **clean the heatsink and the protective grill** of the fans regularly according to the degree of environmental pollution.

Danger !



Every **six months**, check that the screws of the power cables and safety earth are **tightened correctly** (see "Cabling", page 3-3).

TOOLS

Operation	Flat screw-driver (mm)	Wrench	Electrical equipment
Fixing		Depending on M8 screw heads selected	
Opening (closing) of front door		CHc No. 4 for M5 screw	
Safety earth connection		HEX17 (M10) HEX19 (M12)	
Power connection (supply side) and fuse change		HEX13 (M8) (60 to 250 A) HEX17 (M10) (300 to 500 A)	
Load connection		HEX17 (M10) (25 to 250 A) HEX19 (M12) (250 to 500 A)	
Cable clamp tightening	0.5 x 3.5		
Control and auxiliary power supply connection	0.5 x 3.5		
Board fixing	0.8 x 5.5	For M4 nut	
Commissioning and calibration	0.4 x 2.5		Ammeter or RMS clip.

Table 7-3 Tools

CONFIGURATION RECAPITULATORY TABLES

Driver board

Unit type	Wiring	PLU	Signal	Wiring			Input rating					Log/Analog		Burst	Board type						
							A or 3Ph.					B					A /3Ph.	B			
				K1	K2/K3	K4	K11	K12	K13	K14	K15	K21	K22	K23		K24	K25	K16/K17	K26/K27	K18/K28	
Solid State Contactor (On/Off)	Three-phase	Yes	Logic	10V	NF	0	0	0	1	0	1	0	IP					0	IP	IP	Analogue
				5V	NF	0	0	0	0	1	1	0						0			
				20mA	NF	0	0	1	0	1	1	0						0			
	No	Logic	10V	1	0	NF	NF					NF					NF	NF	NF	Logic dc	
Logic		100-240Vac	NF	0	NF	NF					NF					NF	NF	NF	Logic ac		
2xSingle-phase	No	Logic	10V	1	1	NF	NF					NF					NF	NF	NF	Logic dc	
Power unit (Burst mode)	Three-phase	Yes or No	Analog	0-5V	NF	0	0	0	0	1	0	1	IP					1	IP	0	Analogue
				1-5V	NF	0	0	0	0	1	1	0						1		0	
				0-10V	NF	0	0	0	1	0	0	1						1		0	
				2-10V	NF	0	0	0	1	0	1	0						1		0	
				0-20mA	NF	0	0	1	0	1	0	1						1		0	
				4-20mA	NF	0	0	1	0	1	1	0						1		0	
	2xSingle-phase	No	Analog	0-5V	NF	1	0	0	0	1	0	1	0	0	1	0	1	1	1	0	
				1-5V	NF	1	0	0	0	1	1	0	0	0	1	1	0	1	1	0	
				0-10V	NF	1	0	0	1	0	0	1	0	1	0	1	1	1	1	0	
				2-10V	NF	1	0	0	1	0	1	0	0	1	0	1	1	1	1	0	
0-20mA	NF	1	0	1	0	1	0	1	1	0	1	0	1	1	1	1	0				
4-20mA	NF	1	0	1	0	1	1	0	1	0	1	1	0	1	1	1	0				
Reconfigured Power unit to SSC (On/Off)	Three-phase	Yes or No	Logic	10V	NF	0	0	0	1	0	1	0	IP					0	IP	IP	
				5V	NF	0	0	0	0	1	1	0						0			
				20mA	NF	0	0	1	0	1	1	0						0			
Order code not available	2xSingle-phase	No	Logic	10V	NF	1	0	0	1	0	1	0	0	1	0	1	0	0	0	IP	
				5V	NF	1	0	0	0	1	1	0	0	0	1	1	0	0	0	0	
				20mA	NF	1	0	1	0	1	1	0	1	0	1	1	0	0	0	0	

NF : Jumper not fitted
IP : Indifferent jumper position

Note : For power thyristor units the position of jumpers K18 and K28 is 0 (standard).
The 1 position can be used for special applications (6 s Burst mode, C23 and C24 fitted).

PLU board (optional)

Unit series	Jumpers function	Current information		Operation	Frequency	Test	Phase rotation		PLU alarm contact (soldered links)	
		S1	S2	S3	S4	S5	S6	S7	LK1	LK2
TC2000	Current transformer secondary connected on PLU board directly	1	1							
	Normal operation			0						
	50 Hz 60 Hz (not standard, no ordering code)				0 1					
	PLU test button unbalance action : • direct • reverse					0 1				
	Phase rotation sensitive: three-phase wiring according to documentation						1			
	Phase rotation fixed							1		
	PLU alarm contact in alarm state or unit not supplied : • open (code PLU) • closed (code IPU)								1 0	0 1

0: Factory set (selection possible but not codable)

INDEX

A

Adjustment	
adjustment safety	6-16
PLU detection	6-5 to 6-8
Alarm acknowledge	3-18
Alarm memorisation	3-18
Auxiliary power supply	1-10, 3-9, 6-4

B

Burst firing mode	5-4
-------------------	-----

C

Cables (cross-section)	3-3
Cabling	3-1
Checking the characteristics	6-3
Coding	1-10, 1-11
Commissioning	6-1
Configuration	4-1
control signal	4-7
operation type	4-4
possibilities	4-3
safety during configuration	4-2
recapitulatory tables	7-9, 7-10
Configuration jumpers	
configuration type	4-6
driver board	4-5
inputs	4-7, 4-8
location	4-5
operation	4-4
PLU board	4-9

Connection

alarm relay switch	3-17
auxiliary power supply	3-9
control cable	3-10
input	
power thyristor units	3-15, 3-16
static contactors	3-13, 3-14
manual control	3-16
power	3-3 to 3-8
safety earth	3-4, 3-7 to 3-8
single-phase	1-2, 3-7, 3-8
three-phase	1-2, 3-6
Consumption	1-9
Control	1-8
manual	3-16
Control signals	1-6
Cooling	1-9

D

Dimensions	2-3, 2-4
------------	----------

E

Electronic boards	1-4
driver	4-5
location	1-5
PLU detection	3-18, 6-5

F

Feedback	5-5
Filter	1-5
Firing mode	
burst	5-4
logic	5-3
Fixing	3-4, 3-5
Frequency	1-7
Front fascia	6-6
Fuses	
auxiliary voltage	3-9
blown indication micro-switch	7-5
power	7-3, 7-4

G

General introduction to the unit	1-2
Grounding	3-10, 3-11

I

Identifying the unit	1-1
Input impedance	1-8
Installation	2-1, 2-6
Insulation	1-8

L

Logic (firing mode)	5-3
---------------------	-----

M

Maintenance	7-1
Mechanical mounting	2-5, 2-6

O

Operating temperature	1-9
Operation	5-1
power thyristor units	1-2
static contactors	1-2
Options	1-9, 1-11
Overall view	1-5

P

Partial load unbalance	5-6, 6-4
Permanent fan cooling	2-2
PLU adjustment potentiometer	6-5 to 6-8
PLU alarm	1-9, 3-17, 6-5
adjustment	6-5 to 6-8
cabling	3-17
checking	6-4
configuration	4-9, 4-10
relay	5-6
PLU alarm relay	3-6
PLU sensitivity	5-6
Power thyristor units	1-2, 1-6
Protective covers	1-3

S

Safety	
cabling	3-2, 3-3, 3-13
commissioning	6-2, 6-3, 6-8
configuration	4-2
fuses	7-3
installation	3-2
maintenance	7-2, 7-7
PLU adjustment	6-7, 6-8
Safety earth	3-2, 3-4
Screw tightening	
cable clamp	3-11
control	3-13
power	3-3
Serial number labels	1-12
Servicing	7-7
Shield	3-10, 3-11
Supply variation compensation	5-2

T

Technical data	1-7 to 1-9
Thermal switch	1-7
Thyristor firing	5-2
Time	
firing	5-4
modulation	5-5
Tools	7-8

U

User terminal block	1-3
auxiliary power supply	3-9
driver	3-12
PLU relay switch	3-17
terminal capacity	3-3, 3-13, 3-14

W

Weight	2-4
--------	-----