Thyristor power units

TC2001
series

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

User Manual

Part No HA 174760 Issue 3 Printed in France 01/97

CE

EUROPEAN DIRECTIVES

SAFETY

The **TC2001** 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 **TC2001** products implies that the essential protection requirements of the European Low Voltage Directive are observed.

The **TC2001** Technical Construction File is approved by a Notified Body, **LCIE** (Laboratoire Central des Industries Électriques).

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 **TC2001** 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 complies with the essential protection requirements of the EMC Directive.

However, Eurotherm certifies that the **TC2001** 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 **TC2001** 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 external series filtera
- IEC 1800-3 : Without filter. Applies for the second environment.

EMC EXTERNAL SERIES FILTERS

To reduce the conducted emissions that occur when using thyristor units, Eurotherm can supply esternal series filters

Nominal current of TC2001 product	**Series filter Order Code**	
	Two-phase control of a three-phase load	**Control of two single-phase loads (2 filters)**
60 A	FILTER/TRI/63A/00	FILTER/MON/63A/00
75 A and 100 A	FILTER/TRI/100A/00	FILTER/MON/100A/00

For currents 150 A to 500 A nominal currents, please contact Eurotherm.

VALIDATION BY COMPETENT BODY

In order to guarantee the best service, Eurotherm has validated the compliance of the **TC2001** 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 Électriques).

EMC INSTALLATION GUIDE

In order to help you reduce risks related to the effects of electromagneticinterference 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 **TC2001 User Manual Part No HA 174760** intended for the TC2001 series power thyristor units manufactured beginning **December 1995**

The TC2001 User Manual (HA 174760) **replaces** the TC2001 Handbook Part N° HA 023754 for these thyristor units.

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 TC2001, 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 EUROTHERM office where technicians are at your disposal should you require advice or assistance with the commissioning of your installation.

TC2001 USER MANUAL

The safety instructions
for the installation and use of TC2001 series units are given on the following pages:

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Chapter 4 CONFIGURATION

Chapter 5 OPERATION

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Chapter 6 COMMISSIONING PROCEDURE

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Chapter 7 MAINTENANCE

Chapter 1

IDENTIFYING THE THYRISTOR UNIT

Contents page

Chapter 1 IDENTIFYING THE THYRISTOR UNIT

GENERAL INTRODUCTION TO THE TC2001 SERIES

TC2001 series thyristor units are units designed to **monitor** industrial **three-phase** or **single-phase** electric loads.

A thyristor unit comprises **2 channels**, each of which contains a pair of **thyristors** in antiparallel connection on a heatsink.

There are two possible types of operation of **TC2001** series thyristor units:

- **Three-phase** operation:

  2 thyristor channels monitor 2 phases of a three-phase load;
  the load must be connected in a star without neutral or in a closed delta (3-wire load) configuration;
  the 2 channels are controlled by a single input signal.

- **Single-phase** operation:

  2 thyristor channels monitor **two** independent single-phase loads separately;
  the 2 channels are controlled by two different input signals.

The TC2001 series is designed to monitor inductive loads (particularly primary transformer circuits) or resistive loads with low temperature coefficients.

TC2001 series thyristor units monitor current between **60 A** and **500 A**.

The nominal line voltage is between **100 V and 480 V**.

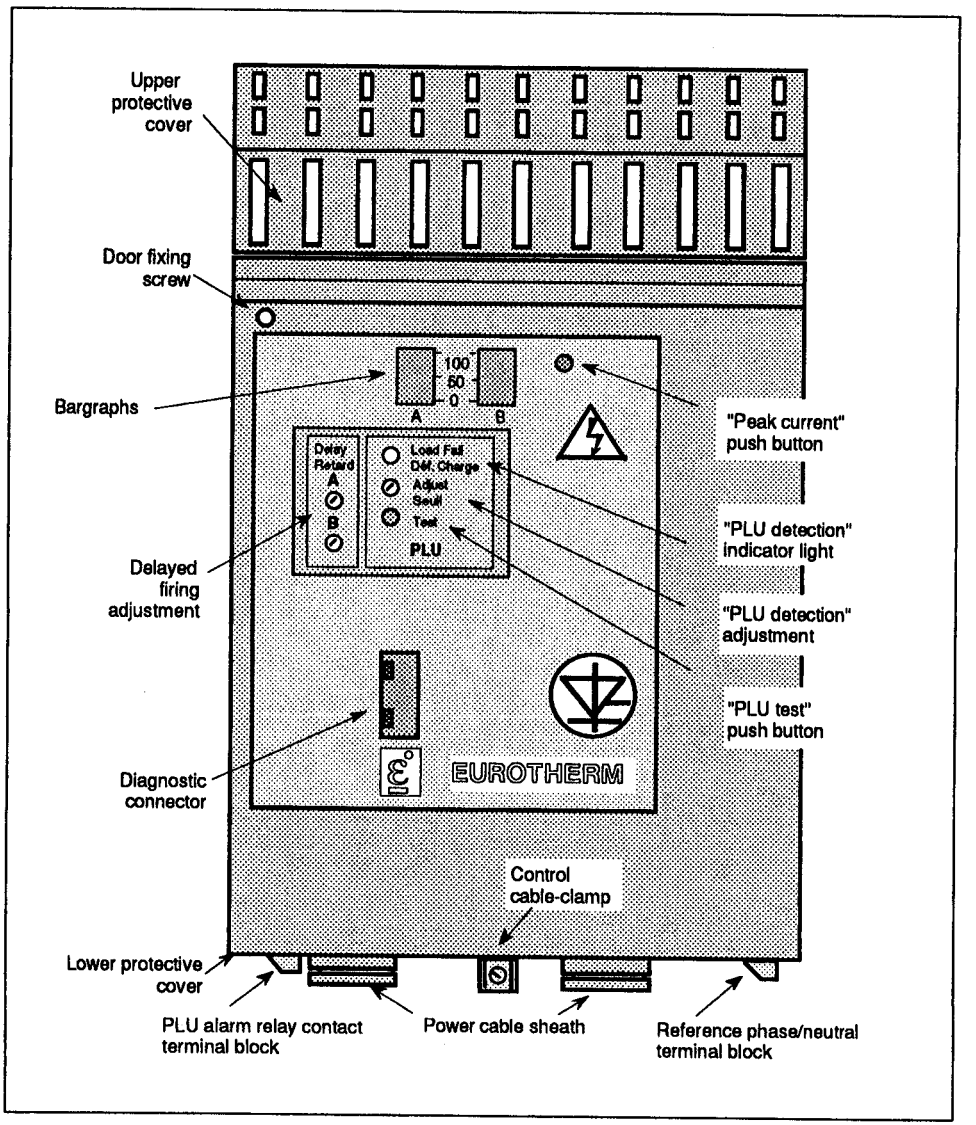


Figure 1-1 Overview of the TC2001 series thyristor unit

The standard version (**basic version**) of the **TC2001** series thyristor unit is equipped with :

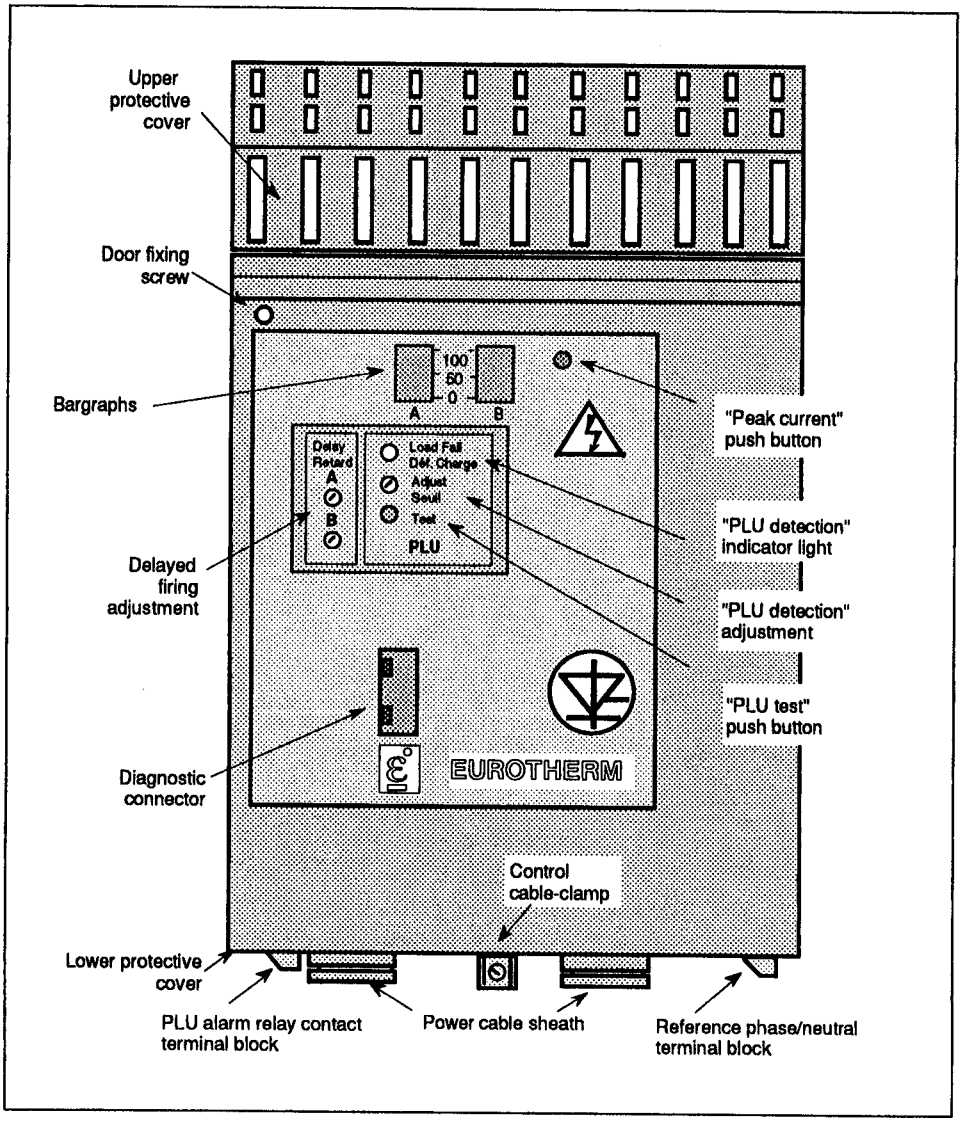
- a thyristor firing board (**"power board"**) which generates thyristor trigger and current and voltage measurement pulses;
- a **"driver board"** which generates the thyristor firing signals;
- a **"potentiometer board"** for setting the delayed thyristor firing (inductive loads);
- a **"filter board"** to protect the operation of the unit against temporary interference.

As an option, the TC2001 unit can be equipped with plug-in boards on the driver board:

- a **"control board"** which measures, regulates and retransmits the monitored parameter (power, current or voltage);
- a partial load unbalance board, **"PLU board"** (for three-phase operation only);
- a **"bargraph board"** which displays:
  - the level of the monitored parameter for the control option
  - the transient current for setting the delayed thyristor firing.

The **filters** guaranteeing **immunity** to electromagnetic interference are installed :

- at the reference phase/neutral input
- between the power supply phase ("LINE") and the safety earth connector
- between the load connection ("LOAD") and the safety earth connector.



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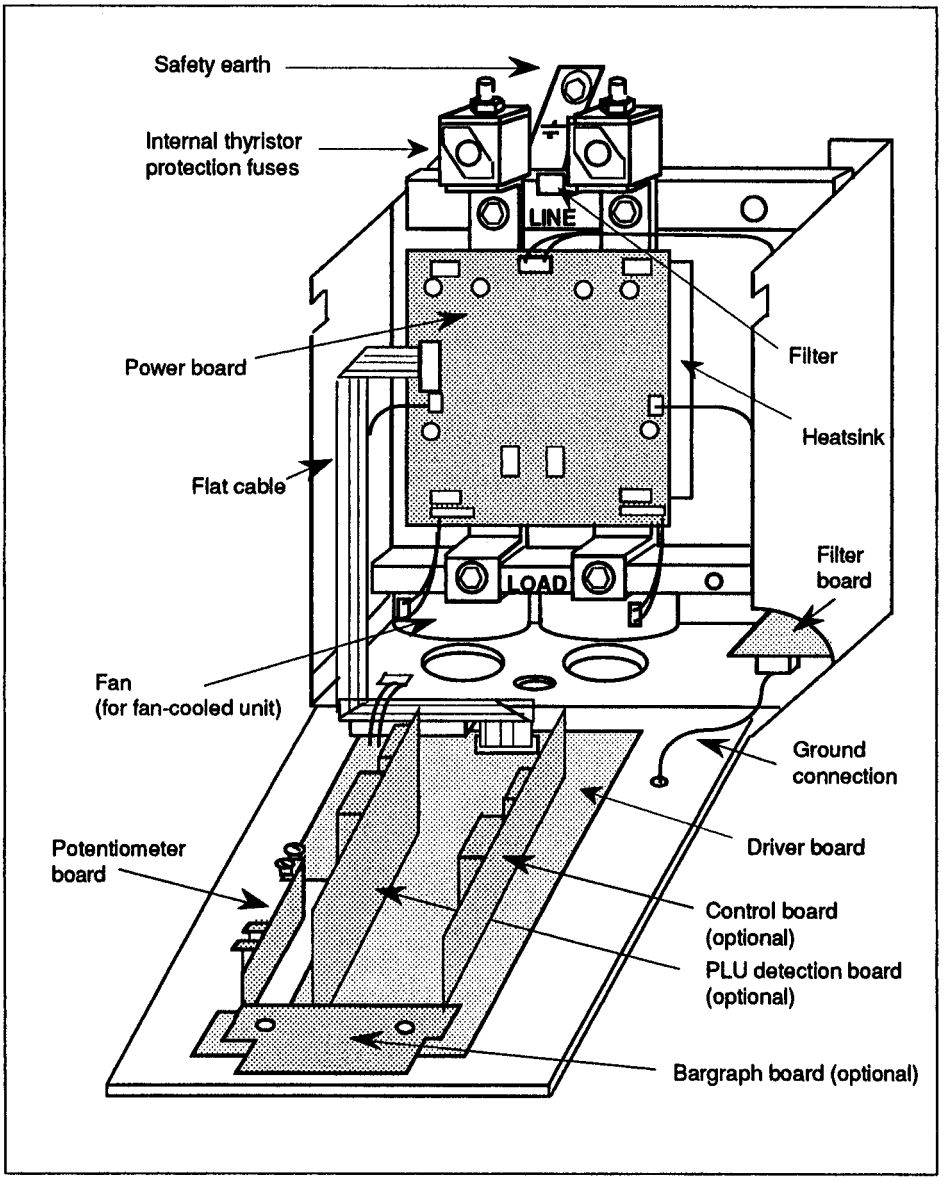

Figure 1-2 TC2001 series thyristor unit electronics boards

TC2001 series thyristor units have the following functions:

- Thyristor **firing** modes:
  - logic (ON/OFF),
  - cyclic firing ratio modulation from 0 to 100% (Burst mode).

  The soft start at power-up and the delayed firing angle at the first alternation minimize transient over-currents in the case of inductive load control (risk of fuse failure or triggering of protection circuit breaker).

- Voltage **control** with supply variation **compensation** (in basic version)

- Feedback with one of three possible **feedback** values (optional):

  - active **power**,
  - **rms current** square,
  - **load voltage** square.

- The permanent **monitoring** of the three-phase partial load unbalance (optional). The partial load unbalance detection is signalled by the alarm relay contact and by an indicator light on the front fascia.

- **Thermal protection** with a thermal switch (fan-cooled units from **100 A**).

The thyristor unit is controlled by **logic** or **analogue** signals.
The signal inputs can be configured in four voltage levels and in two current levels.

Manual control is possible using external potentiometers.

On the **standard** version, the following are located on the **front fascia:**

- two potentiometer for **setting** the first **delayed** firing on inductive loads (for channels A and B)
- a connector for **diagnostics**

and as **options:**

- two **bargraphs** indicating the level of the monitored parameter
- push button to display the **peak** current
- a potentiometer for **setting** the load unbalance detection sensitivity (in three-phase operation)
- "**Test**" push button (partial load unbalance option) to test the setting
- **indicator light** to display the load unbalance detection.

TECHNICAL DATA

The TC2001 is a thyristor-based power unit designed to 2 phases control of an industrial three-phase load or control of 2 industrial single-phase loads.

Attention !

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

Power

Nominal current (per phase)	**60 A** to **500 A**
Nominal line to line voltage	**100 A** to **480 V** (+10%,-15%) Inhibition below **80%** of the nominal voltage; response time <10 ms; automatic reset 2 s after return to nominal
Supply frequency	**50** or **60 Hz** (±2 Hz)
Power dissipation	**1.3 W** (approximately) per amp and per phase
Cooling	**Convection** cooled (**60 A** to **75 A**) **Permanent** ventilation from **100 A** onwards
Fans	**1** for **100 A** and **150 A**, **2** for **250 A** to **500 A** Power consumption: **5 W** per fan (**24 V** DC fans). Self-supplied by the power circuit.
Load	**Resistive** or **inductive** industrial loads (primary transformer coils or inducers).
Operation	• **Three-phase** Star without Neutral or Closed Delta configuration • **Single-phase** Configuration of 2 independent single-phase loads

Environment

Operating temperature	**0°C** to **+50°C** in vertical position (**+40°C** for the 500 A nominal current, to 50°C for units redesigned for 450 A)
Storage temperature	**-10°C** to **+70°C**
Protection	2 covers providing **IP20** protection on front fascia
Thyristor protection	High-speed internal **fuses**, fuse blown indication switch optional **Varistor** and **RC** snubber
External cabling	In accordance with the Standards **IEC 364**
Using atmosphere	Non-explosive, non corrosive and non conductive
Using altitude	**2000 m** maximum
Humiddity	Relative humidity: **5%** to **95%**, non-condensing
Pollution	Level **2** pollution permitted, defined in **IEC 664**
Dimensions (60 A to 150 A)	**470 mm** (H) x **133 mm** (W) x **268 mm** (D) Weight **10 kg**
(250 A)	**470** mm (H) x **248** mm (W) x **268** mm (D) Weight **16** kg
(300 A to 500 A)	**570 mm** (H) x **248 mm** (W) x **268 mm** (D) Weight **16.5** kg

Control

Power supply	**Insulated** from the power part. **Self-supply** from the power circuit Connection of a reference phase (or neutral). Consumption: **20 VA** per channel
Signal type	**Analogue** or **Logic**
Entry impedance	Voltage: **≥100 kΩ** Current: **50 Ω**
Analogue setpoint	Voltage: **0-5 V; 1-5 V; 0-10 V** or **2-10 V** Current: **0-20 mA; 4-20 mA**
Logic setpoint	ON state: voltage greater than **5.5 V** (32 V max) current greater than **10.5 mA** (40 mA max) OFF state: voltage less than **0.7 V** current less than **2 mA**
Manual control	External potentiometer **4.7** to **10 kΩ**
Thyristor firing modes	• **Logic** Response time **<25 ms** • **Burst mode** Typical modulation time (at 50% of max setpoint) - **0.6 s** (**"Fast cycle"** burst mode) - **20 s** (**"Slow cycle"** burst mode)
Thyristor firing	At **zero voltage** for resistive loads. At **zero current** on each phase for inductive loads with transient currents **suppressed** (adjusted using potentiometer on front fascia)
Power-up	**Soft** start for **150 ms** (variation of thyristor firing angle by 30° until full firing)
Validation / Inhibition	Using external switch. Response time: validation **2 s**; inhibition **<25 ms**
Diagnostics	Connector for the diagnostic unit which permits the local adjustment, monitoring and calibration of the unit by means of **20 test signals**
Feedback mode (in **basic** version)	**Control** of the square of the load voltage with **compensation** of supply variations (with analgue control signals)
Wiring	**Sheathed** cable connected to the ground at **both** ends.
Connection	Wires: **0.5 mm²** to **1.0 mm²** Tightening: **0.5 N.m**

TECHNICAL DATA

The TC2001 is a thyristor-based power unit designed to 2 phases control of an industrial three-phase load or control of 2 industrial single-phase loads.

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Protection	2 covers providing **IP20** protection on front fascia
Thyristor protection	High-speed internal **fuses**, fuse blown indication switch optional **Varistor** and **RC** snubber
External cabling	In accordance with the Standards **IEC 364**
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Feedback mode (in **basic** version)	**Control** of the square of the load voltage with **compensation** of supply variations (with analgue control signals)
Wiring	**Sheathed** cable connected to the ground at **both** ends.
Connection	Wires: **0.5 mm²** to **1.0 mm²** Tightening: **0.5 N.m**

Options

Control board

Feedback parameter	• **Active power** (three-phase load or each single-phase load) • **Rms current square** • **Square of the rms load voltage** (three-phase: mean square of two phases, single-phase: independent feedback for each channel).
Feedback quality	**Linearity:** ±1% in feedback of power and current square, ±2% in feedback of voltage square. **Stability** : ±1% with variations: - of the load impedance ±30%; - of the supply voltage +10%, -15%; - of the temperature from 0 to 50 °C
Retransmissions	**Feedback parameter** Continuous signal output (**0** to **10 V**) for each channel.
Limitation	Limitation of the **maximum** active power value. Adjustment of power limit setpoint using a potentiometer on the control board.

PLU board

Alarm	Three-phase load **unbalance.** Detection of a current unbalance between phases $\Delta I = 10\% I_{MAX}$ **Adjustment** of sensitivity on front fascia using "Adjust" potentiometer. **Storage** of the alarm status by an external switch.

Bargraph board

Display	Two displays on the front fascia indicate: • the level of the monitored parameters (between **10%** and **100%** with **10%** threshold) for each channel, 1 display for three-phase operation; • the transient current for adjusting the first thyristor firing for inductive loads.

Attention !

As a result of the constant improvement of its products, Eurotherm may modify these specifications without warning. For any further information and if in doubt, please contact your Eurotherm office.

CODING

Series / Operating mode / Nominal current / Nominal voltage / Auxiliary voltage /

Series	Code
Thyristor power unit	TC2001

Operating mode	Code
Three-phase. 2 phase control	02
Single-phase. 2 independent load control	21

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

Nominal voltage	Code
100 volts	100V
115 volts	115V
120 volts	120V
200 volts	200V
220 volts	220V
230 volts	230V
240 volts	240V
277 volts	277V
380 volts	380V
400 volts	400V
415 volts	415V
440 volts	440V
480 volts	480V

For other voltages, please contact your Eurotherm office

Note: The nominal voltage of the TC2001 thyristor unit must correspond to the voltage of the supply used to prevent malfunctioning problems in the event of a voltage less than 80% of the nominal voltage.

Auxiliary voltage	Code
Self-supply on phases	00

Input A / Input B / Thyristor firing mode / Controlled parameter / Options / 00

Input A	Code
Three-phase or single-phase operation	
0-5 V	0V5
1-5 V	1V5
0-10 V	0V10
2-10 V	2V10
0-20 mA	0mA20
4-20 mA	4mA20

Input B	Code
Three-phase operation (no input B)	00
Single-phase operation:	
0-5 V	0V5
1-5 V	1V5
0-10 V	0V10
2-10 V	2V10
0-20 mA	0mA20
4-20 mA	4mA20

Thyristor firing mode	Code
Logic ("ON/OFF")	LGC
"Fast cycle" burst mode	FC
"Slow cycle" burst mode	SC

Controlled parameter	Code
Basic version:	
Compensation of supply variations	00
Control board (option):	
Load current square	I2
Load voltage square	V2
Active power	W

Options	Code
Frequency 60 Hz	60H
Current measurement for options: "control board" (codes I2,V2 and W), "Bargraph" (code BAR) or "Unbalance detection" (code PLU) or pre-filled transformer	CTE
Bargraph (level of controlled parameter)	BAR
Unbalance detection between phases (only for three-phase system):	
- switch open in alarm status	PLU
- switch closed in alarm status	IPU
Fuse blown indication microswitch	FUMS
No internal fuses	NOFUSE

Note: For the choice of several options observed **the order of the codes**

Example of coding

Parameters of the TC2001 thyristor unit and of the installation in three-phase operation

Nominal current of load	**120 amps**
Nominal line to line voltage	**440 volts**
External input signal	**0 - 10 volts**
Firing mode	"**Fast cycle**" burst mode
Controlled parameter	**Active power**
Options:	**Unbalance** detection (switch open in alarm status)
	Fuse blown indication **microswitch** and **Bargraph**

Coding:

TC2001/ 02 / 150A / 440V / 00 / 0V10 / 00 / FC / W / CTE / BAR / PLU / FUMS / 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 thyristor unit.

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

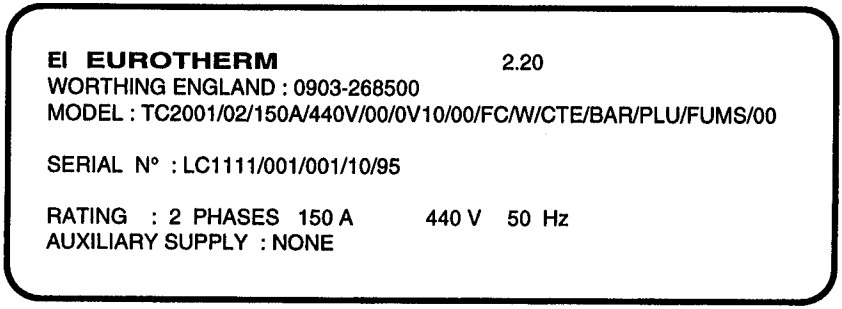

Figure 1-3 Example of identification label for a TC2001 model thyristor unit
The information corresponds to the coding example.

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

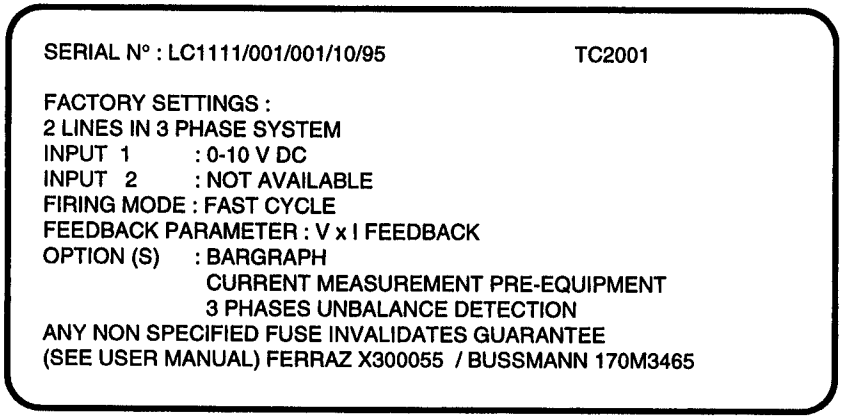

Figure 1-4 Example of configuration label for a TC2001 tyristor unit

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

Chapter 2 INSTALLATION

Read this chapter carefully before installation !

SAFETY DURING INSTALLATION

Danger !

TC2001 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 monitor in the cabinet.

Bulkhead mountings are possible with **TC2001** series units.

The 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.

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 in the components.

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

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

DIMENSIONS

The dimensions, values and weights of the TC2001 series thyristor units are given in figure 2-1 and in table 2-1.

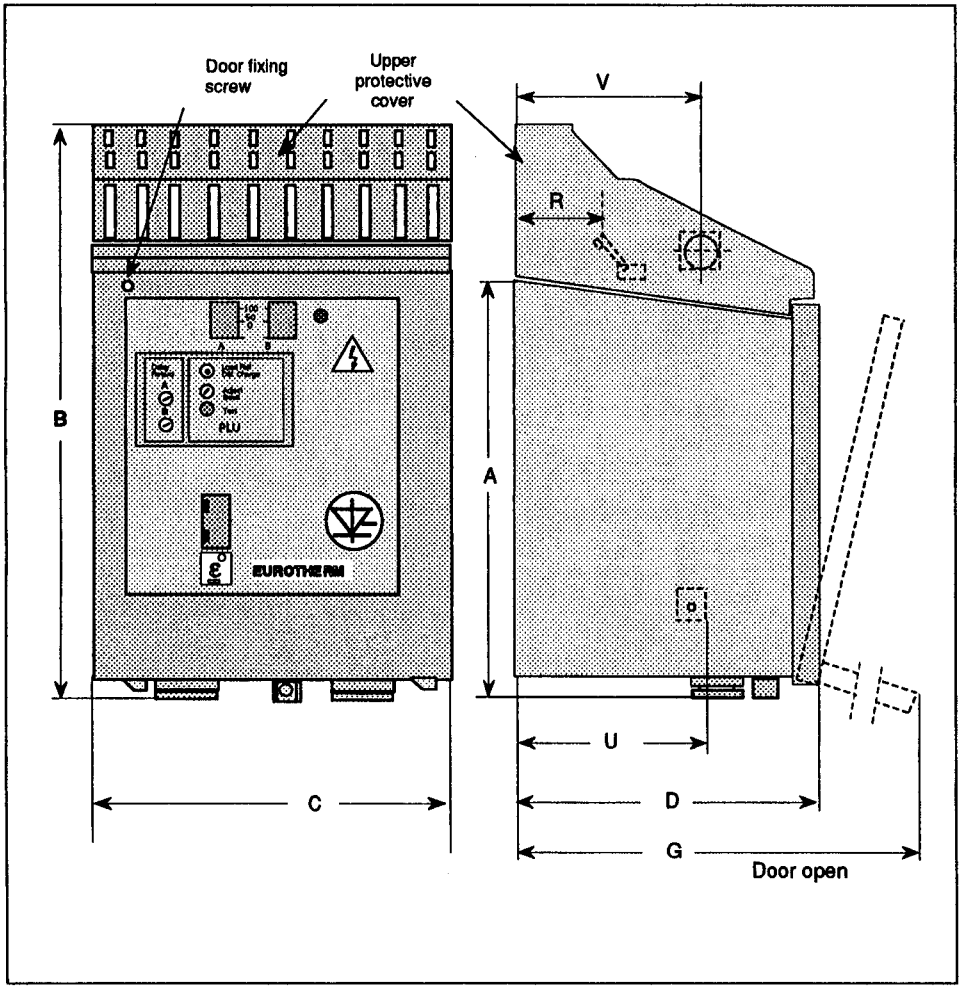

Figure 2-1 Overall dimensions with and without upper protective cover

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 fixing holes
F	328 mm	328 mm	328 mm	Height between fixing holes
G	557 mm	557 mm	557 mm	Depth with door open
M	58 mm	65 mm	110 mm	Distance between "LINE" terminals
P	44 mm	75 mm	112 mm	Distance between "LOAD" terminals
R	30 mm	50 mm	20 mm	Distance between "Earth" busbar and panel
S	50 mm	60 mm	30 mm	"Earth" busbar and upper fixing hole
T	45 mm	66 mm	96 mm	"Earth" busbar and left fixing hole
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
W	68 mm	70 mm	70 mm	Distance between att. hole hole and "LOAD" term.
X and Y	18 mm	35 mm	20 mm	"LINE", "LOAD" and left fixing hole
Z	40 mm	50 mm	30 mm	"LINE" fuse and upper fixing hole
Weight	10 kg	16 kg	16.5 kg	

Table 2-1 Dimensions, attachment values and weights of TC2001 series thyristor units

MECHANICAL MOUNTING

TC2001 thyristor units have two protective covers (upper and lower).

The thyristor 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

TC2001 series units are designed to be mounted directly on panels at the fixing points located on the rear of the unit.

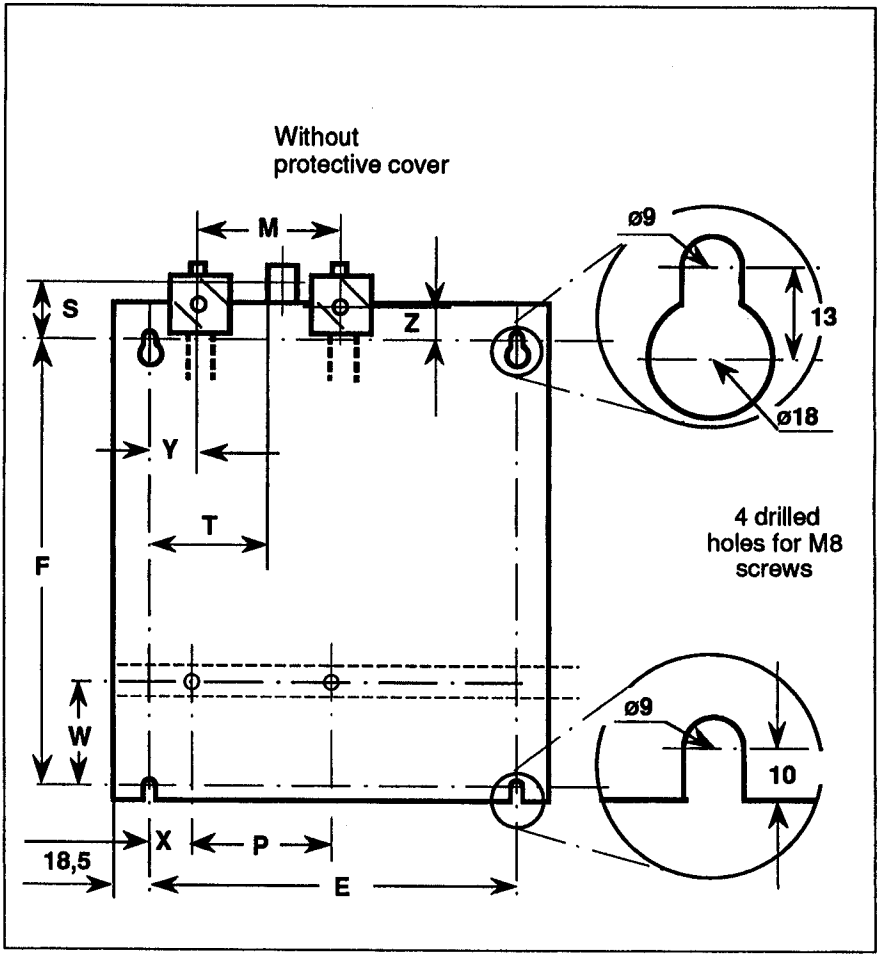

Figure 2-2 Fixing details

Chapter 3

CABLING

Contents page

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.

TC2001 series thyristor 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 TC2001 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.**

POWER CABLING DETAILS

The **supply side** power cables pass through the opening of the upper protective cover of the TC2001 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 1-2).

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 1-1 and 1-2).

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 mm² 16 to 35 mm²	120 mm² 70 mm²	185 to 2x150 mm² 95 to 185 mm²
Fuse terminals Tightening torque	M8 13.5 N.m	M8 13.5 N.m	M10 26 N.m
Load screw Tightening torque	M10 16.4 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 TC2001 thyristor units

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

POWER WIRING DIAGRAMS

Three examples of the **power** and **safety earth** wiring diagrams for three-phase and single-phase operation are given below.

Three-phase operation

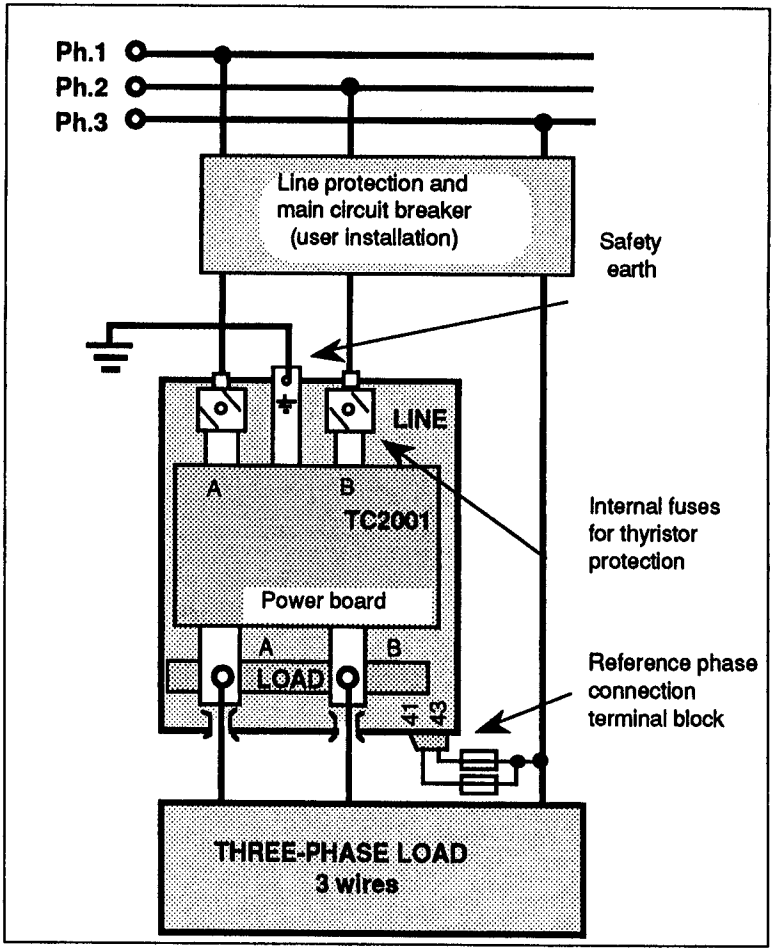

Figure 3-1 Power and safety earth connections in three-phase operation
"Star without neutral" or "Closed delta" load configuration

Reference phase connection see page 3-7.

Single-phase operation

Two independent single-phase loads can be connected between a phase and a neutral (figure 3-2) or divided between 2 or 3 phases of the supply (figure 3-3).

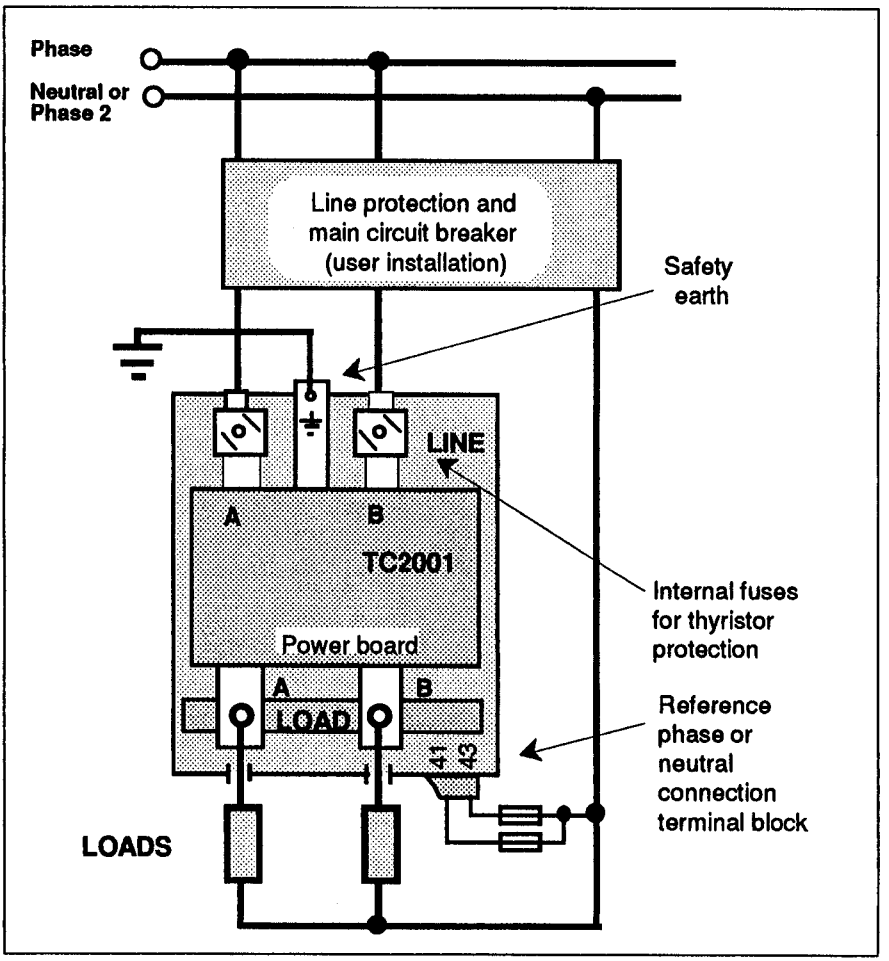

Figure 3-2 Example of power and safety earth cables
Single-phase operation
Single-phase supply

Connection of the reference neutral see page 3-8.

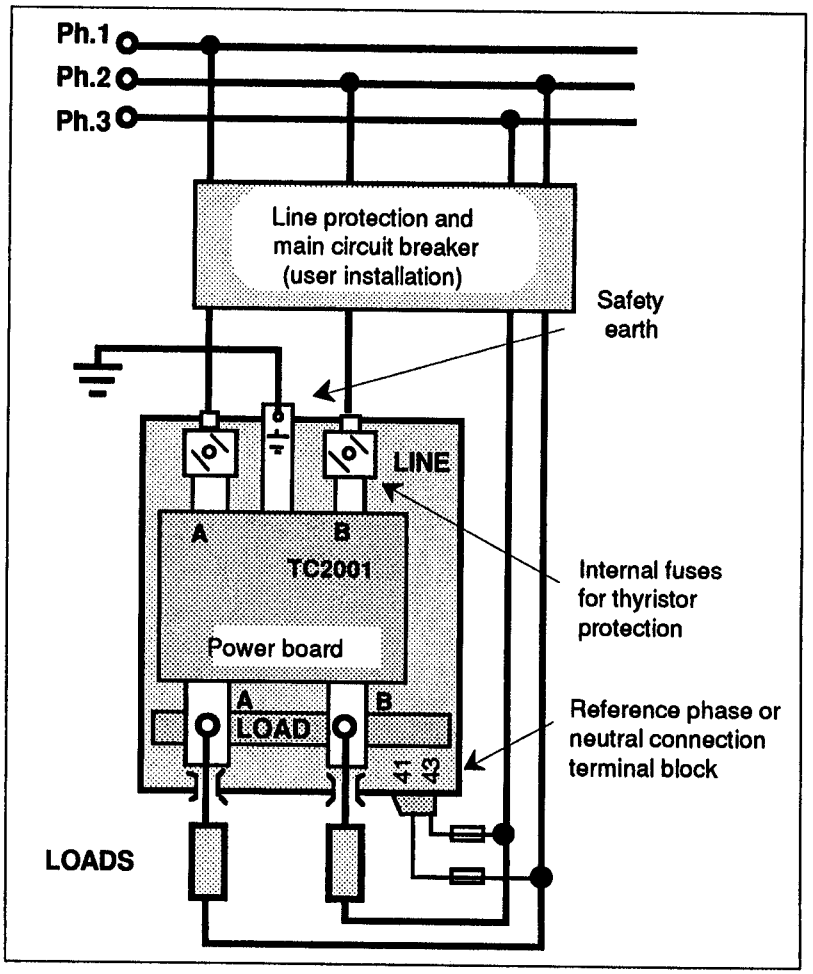

Figure 3-3 Example of power and safety earth connections
Single-phase operation
Three-phase supply.

Reference phase connection see page 3-8.

REFERENCE VOLTAGE CONNECTION

The reference voltage (supply neutral or phase) provides the main power supply and the auxiliary power supply (fans for fan-cooled units).

The connection is made on a plug-in terminal block (reference voltage connection terminal block) located below the unit on the right.
The cross-section of the wires is **1.5 mm²** max. Control terminal tightening torque: **0.5 N.m.**

The reference voltage (neutral or phase) is connected by **2 separate wires.**
Provide a **1 A** fuse in each wire to ensure the wiring protection.

Three-phase operation

For three-phase operation, the reference voltage is that of the **direct** phase.

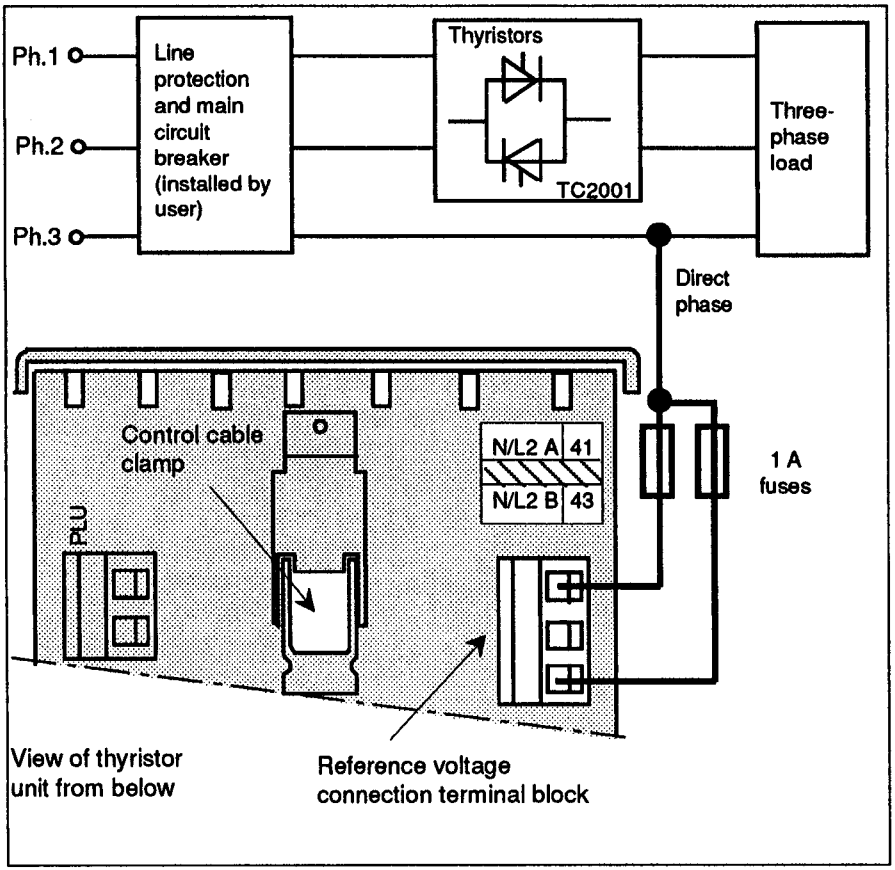

Figure 3-4 Reference voltage connection (three-phase operation)

Single-phase operation

For single-phase operation, the reference voltage for each load must correspond to the voltage used for the power.

Depending on this voltage (phase - phase or phase - neutral), it is necessary to connect terminals **41** (for channel A) and **43** (for channel B) of the reference voltage terminal block to the neutral or to the return phase of each load.

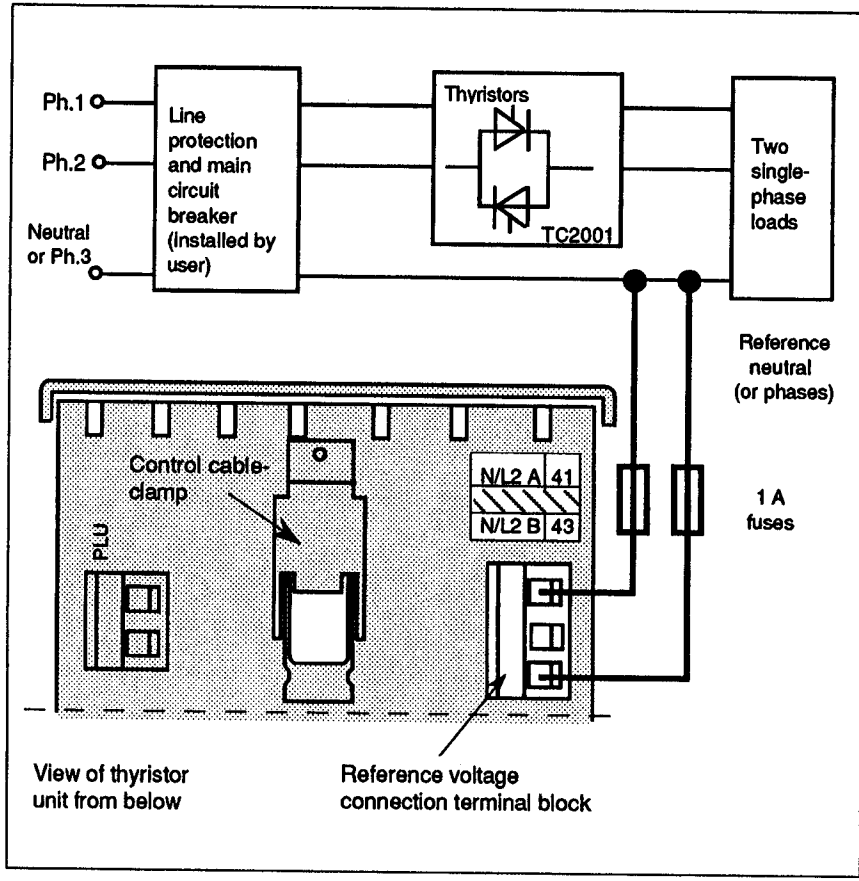

Figure 3-5 Reference voltage connection (single-phase operation)

CONTROL CONNECTION

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 trays.

The control wires are connected on pluggable user terminal blocks:

- on the **driver** board: the connection of the control setpoint and the validation
- on the **control** board (optional): the measurement output of the monitored parameter.

These terminal blocks can be accessed with **the front door open.** To open the door, unscrew the front **screw**, lift the door to release it from its notches and pull it towards you.

Danger !

Dangerous live parts may be accessible when the door is open

Control cable fixing

The control wires must be grouped together in a shielded cable passing through the **cable clamp** under the thyristor unit. To facilitate the earthing of the cable shield and to ensure maximum immunity to electromagnetic interference, the **metal** cable clamp **fixed directly to the ground** of the thyristor unit.

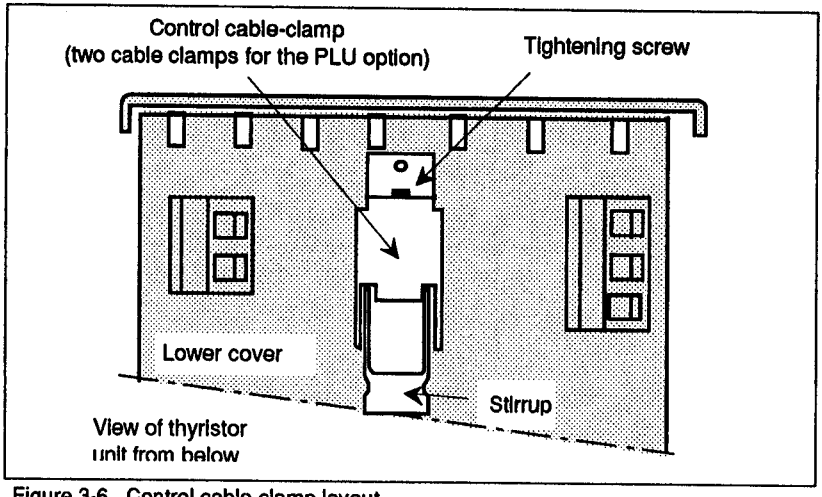

Figure 3-6 Control cable clamp layout

Shield cable connection to the ground

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

- **Strip** the shielded cable as shown in figure 3-7,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 thyristor unit must be as short as possible.

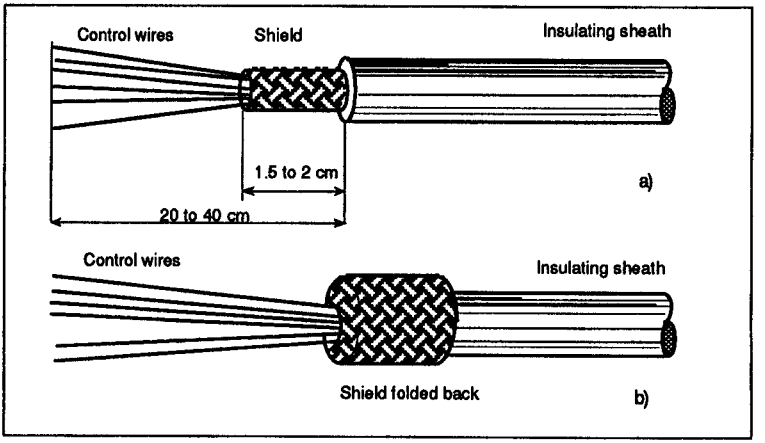

Figure 3-7 Control cable stripping

- **Fold back** the shield on the insulating sheath (figure 3-7,b)
- **Insert** the cable in the metal cable-clamp so that the shield is located in the stirrup and does not enter the thyristor unit (it must not pass the lower cover).

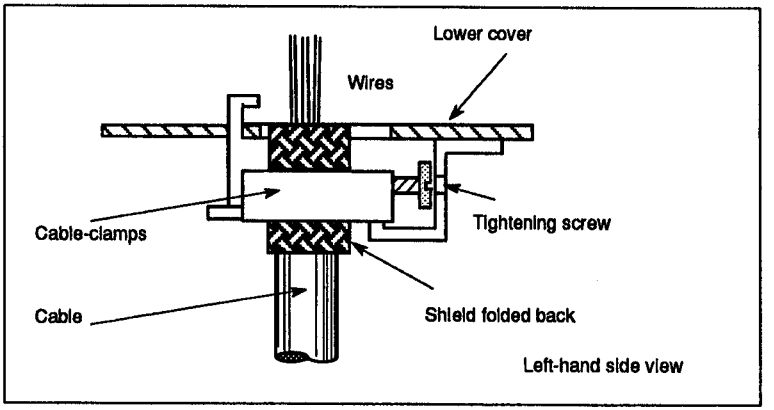

Figure 3-8 Cable tightening and shield grounding

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

The possible diameters of the cables with the shield turned over are **5 to 10 mm** per cable-clamp.

Control connection

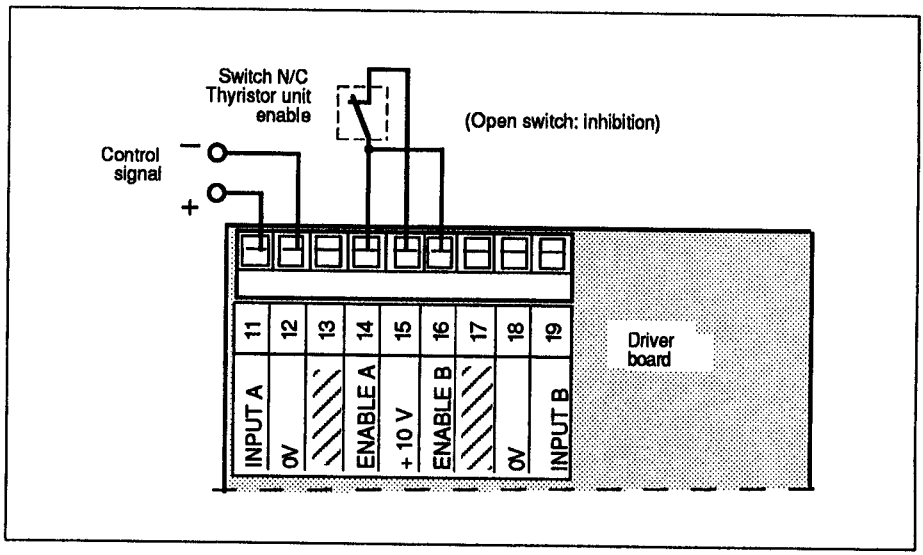

Figure 3-9 Connection of the driver board in three-phase operation.
The setpoint is sent by controllers or PLCs

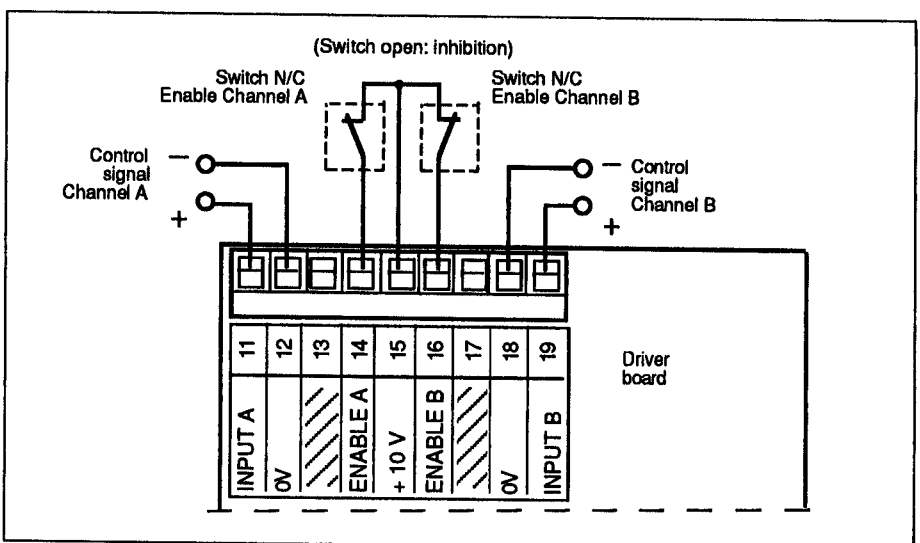

Figure 3-10 Connection of the driver board in single-phase operation.
The setpoint is sent by controllers or PLCs

Driver board

The analogue or logic control signal is connected on **one** plug-in user terminal block located in the top left-hand corner of the board.

Control terminal tightening: **0.5 N.m.**
User terminal block terminal capacity: **0.22 mm² to 1.5 mm².**

The control terminals are labelled **11** to **19** and listed in table 3-1.

Terminal	Description on board	Destination
11	INPUT A ENTREE	Input in three-phase operation or Input of Channel A in single-phase operation
12	0V	0 V of control signal
13	-	Not used
14	ENABLE A VALID.	Enable (or inhibition) of Channel A
15	+10V	+10 V internal; 40 mA max
16	ENABLE B VALID.	Enable (or inhibition) of Channel B
17	-	Not used
18	0V	0 V of control signal
19	INPUT B ENTREE	Input of Channel B

Table 3-1 Description of the control terminal block

In single-phase operation, the two inputs (**A** and **B**) are independent (**0V** is common) and are used for the connections of the control signals for each of the two phases.

In three-phase operation, only input **A** is used for the control signal.

To enable the operation of each channel, it is necessary to connect the "**Enable**" inputs (terminals **14** and **16**) to terminal **15** (internal **+ 10 V**) or to the external +10 V (referenced with relation to the common 0V). Enable time **2 s.**
This connection can be permanent or made via a switch which opens under the action of a safety device used for the immediate inhibition of the thyristor unit (during the next half-cycle).

The control wiring diagrams in three-phase and single-phase operation are given in the following pages.

Manual control

The thyristor unit can be controlled manually in **local mode**.

For operation in local mode, **4.7** to **10 kΩ** external potentiometers connected between **"0V"** (terminal **12** for channel **A** and for three-phase operation or terminal **18** for channel **B**) and **"+10 V"** (terminal **15**) must be used.
The viper of each potentiometer is connected to input A or B (terminals **11** and **19**).

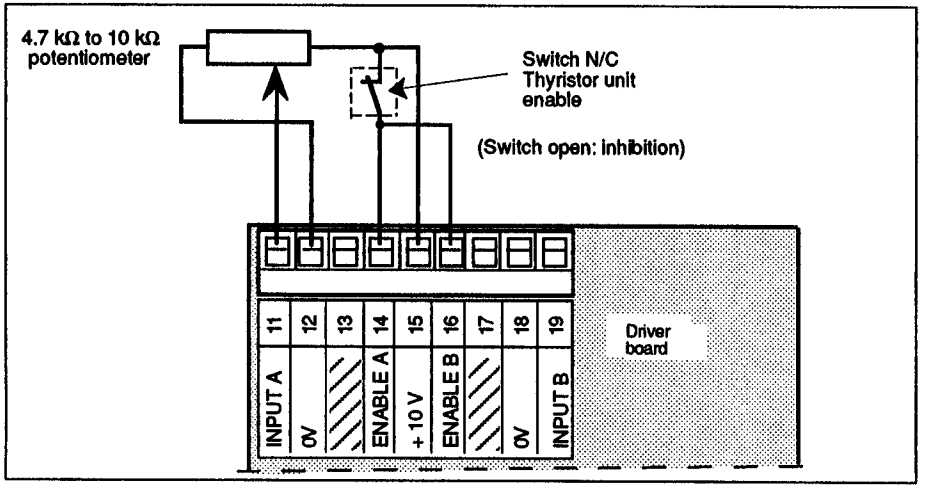

Figure 3-11 Connection of manual control in three-phase operation

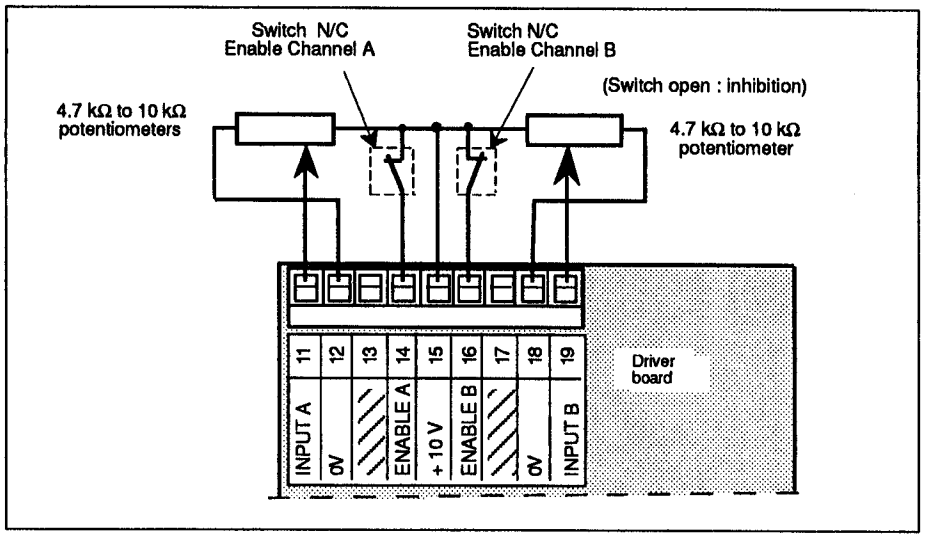

Figure 3-12 Connection of manual control in single-phase operation.

Control board (optional)

The control board is placed on the driver board (see figure 1-2) and held by a transversal strip (possibility of installation on-site, if the basic version is pre-fitted with a current transformer, code CTE). The control board has analogue measurement retransmission outputs.
Connection is made on **one** screw terminal located in the top right-hand corner of the board.

The terminals are labelled **51** to **55** and listed in table 3-2.

Terminal	Description on board	Destination
51	MES A	Retransmission of controlled parameter measurement in three-phase or single-phase operation (channel A).
52	MES B	Retransmission of controlled parameter measurement in single-phase operation (channel B). Not used in three-phase operation
53	0 V	0 V common to the two retransmission outputs
54 and 55	Not used	

Table 3-2 Description of the retransmission terminal block

The retransmission of the controlled parameter (current square, load voltage square or active power) is performed in the form of **continuous** signals (**0 - 10 V**).

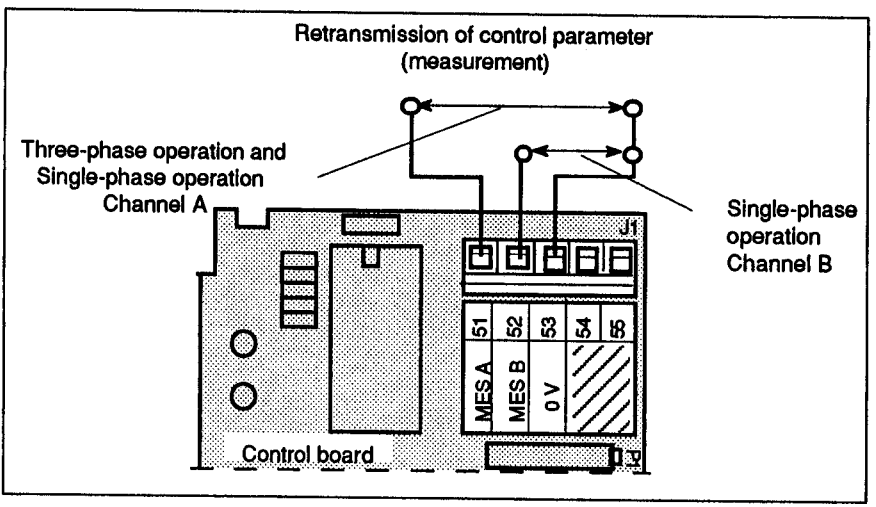

Figure 3-13 Retransmission outputs on the control board

PLU ALARM SIGNALLING (optional)

User terminal block

The connection of the PLU alarm relay switch, which signals the active state of the alarm, is made on the user terminal block under the thyristor 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 state.**

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 state)
Code **IPF**	:	switch **N/C** (closed in alarm state).

The alarm switch cutoff capacity is **0.25 A** (250 Vac or 30 Vdc).
The switch cutoff voltage must not exceed **250 Vac** in any circumstances.

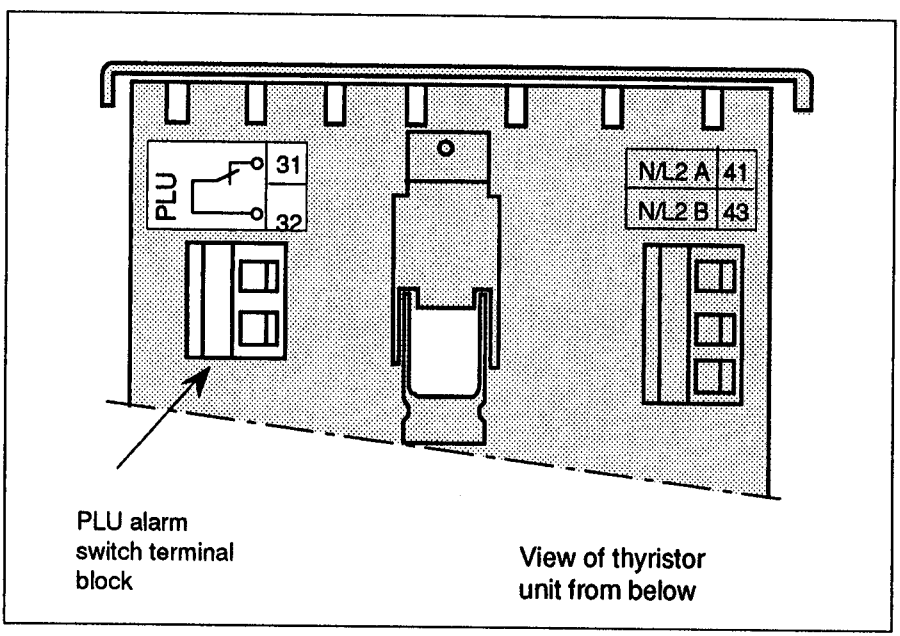

Figure 3-14 PLU relay switch user terminal block

PLU board

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

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

An external contact is connected on **one** plug-in terminal block located in the top right-hand corner of the PLU board.

The wires of the external memorization wires pass through a cable-clamp, like that for control (see figures 3-6 and 3-8).

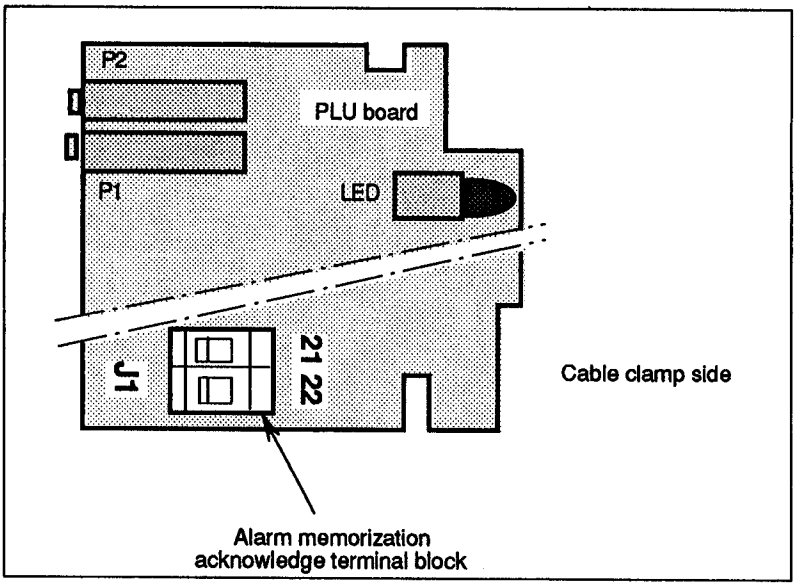

Figure 3-15 PLU alarm status memorization / acknowledge terminal block

Chapter 4 CONFIGURATION

SAFETY DURING CONFIGURATION

The thyristor unit is configured using moveable **jumpers** and soldered **links.**

Important

The thyristor 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 intended application
- **modify,** if necessary, certain characteristics of the thyristor unit on-site.

Danger !

For safety reasons, the reconfiguration of the thyristor unit using jumpers or bridges 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 to prevent any maintenance problem at a later date.

Chapter 4

CONFIGURATION

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POSSIBLE CONFIGURATIONS

The configuration of the electronic boards of the **TC2001** unit determines:

- the operation type (*three-phase* or *single-phase*),
- the control type (*logic* or *analogue*)
- the input signal (*voltage or current and level*)
- the feedback mode (*monitored parameter*)
- the supply voltage and frequency adaptation.

The thyristor firing type (*Burst mode* or *ON/OFF*) is configured in the factory by changing electronic components. The firing type is configured according to the thyristor unit code on the identification label.

Thyristor unit config.	Signal type	Thyristor firing	Feedback	Alarm	Display	Trans-mission
Basic version	Logic	ON/OFF	-	-	-	-
	Analogue	Fast or slow burst mode	Supply variation compensation	-	-	-
Control option	Analogue	Fast or slow burst mode	Active power Load voltage Load current	-	-	Controlled parameter
Control and bargraph options	Analogue	Burst mode	Active power Load voltage Load current	-	Controlled parameter	Controlled parameter
Bargraph option	As for basic version			-	Current peak	-
PLU option	As for basic version			PLU detection	-	-
Control and PLU options	As for control option			PLU detection	Current peak	Controlled parameter

Table 4-1 Possible configurations of TC2001 series thyristor units

Reminder : The order codes **I2, U2, W, BAR, PLU, IPU** require the code **CTE**
Note : With the push button pressed down, the bargraphs display the current peak.

POWER BOARD

Adaptation to the nominal supply voltage is performed on the power board.

Voltage selection

The position of jumpers **JP1** to **JP6** and the type of auxiliary power supply transformer are determined by the nominal line to line voltage specified on the order.
2 types of transformer are used (Part. No CO 174544 and CO 174613). In the factory, the line voltage **is configured** according to the code on the thyristor unit identification label.

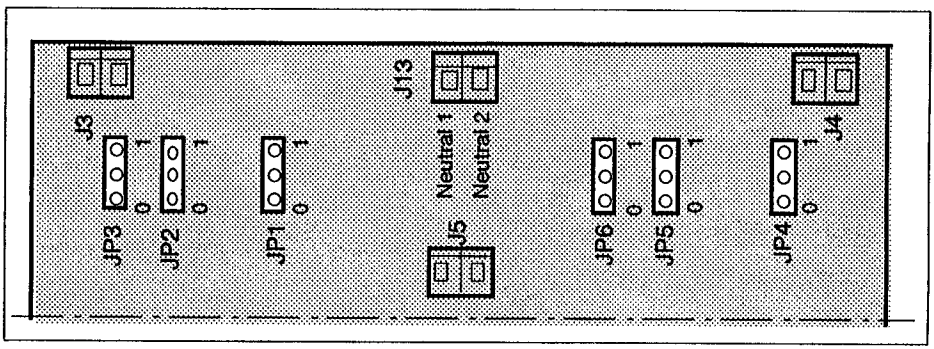

Figure 4-1 Position of jumpers on the power board

Line to line voltage (V)	Position of jumpers						Transformer Part No.
	Channel A			Channel B			
	JP1	JP2	JP3	JP4	JP5	JP6	
100	0	0	1	0	0	1	Consult Eurotherm
115	0	0	1	0	0	1	CO 174 544
127	0	0	1	0	0	1	CO 174 613
200	0	1	0	0	1	0	Consult Eurotherm
230	0	1	0	0	1	0	CO 174 544
277	0	1	0	0	1	0	CO 174 613
400	1	0	0	1	0	0	CO 174 544
480	1	0	0	1	0	0	CO 174 613

Table 4-2 Voltage configuration

The voltage given in the above table is **greater than** or **equal** to the line to line voltage

DRIVER BOARD

The driver board jumpers are used to configure the type of operation, the control mode, the input signals, the control option and the frequency of the supply used.

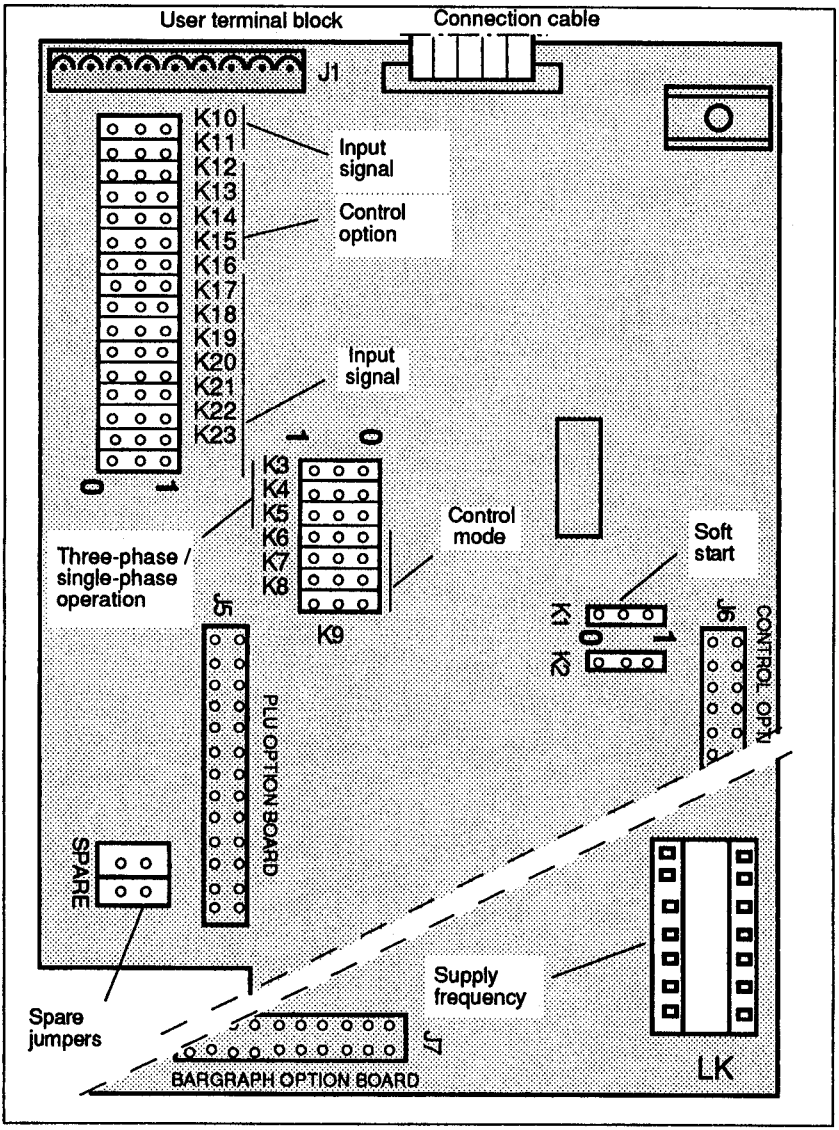

Figure 4-2 Position of configuration jumpers on the driver board

Operation type

The three jumpers **K3** to **K5** are used to configure the type of operation of the thyristor unit: three-phase or single-phase.

Operation type	Position of jumpers		
	K3	K4	K5
Three-phase (2 phase control)	0	0	0
Single-phase (Two independent loads)	1	1	1

Table 4-3 Configuration of the operation type

Control option

The **control** option performs the power, current or load voltage feedback. It requires the installation of the control board.

Control option	Position of jumpers			
	K12	K13	K14	K15
Without control option (Basic vers.)	1	1	1	1
With control option (Control board)	1	1	0	0

Table 4-4 Configuration of the control option installation

Control mode

The position of jumpers **K6** to **K9** determines the control mode (logic or analogue). In single-phase operation, channel **A** (**K6** and **K8**) and channel **B** (**K7** and **K9**) can be configured separately.

Control mode		Position of jumpers			
		K6	K7	K8	K9
Logic signal	Basic version	0	0	Jumpers **removed**	
Analogue signal	Basic version	1	1	1	1
	Control option (control board)	1	1	0	0

Table 4-5 Configuration of the control mode

Input signal

Control signal type

The control signals used to drive the TC2001 series thyristor units can be:

- analogue
  - voltage (four levels)
  - current (two levels).
- logic
  - voltage (four levels)
  - current (two levels).

Input	Analogue signal		Logic signal			
	0% power lower threshold	100% power upper threshold	OFF state guaranteed Less than	ON state guaranteed Greater than	Max	Input impedance
0 - 5 V	0.2 V	4.2 V	0.7 V	2.5 V	12 V	100 k Ω
1 - 5 V	1.16 V	4.36 V	1.0 V	2.7 V	12 V	
0 - 10 V	0.4 V	8.4 V	2.5 V	5 V	32 V	
2 - 10 V	3.3 V	8.7 V	2 V	5.5 V	32 V	
0 - 20 mA	0.8 mA	16.8 mA	2 mA	10 mA	40 mA	50 Ω
4 - 20 mA	4.6 mA	17.4 mA	4 mA	10,5 mA	40 mA	

Table 4-5 Types and scales of control signals

Input configuration in three-phase operation

Jumpers **K10, K16** and **K18** to **K20** are used in three-phase operation to configure the type and scale of the control signal (analogue and logic).

The position of jumpers **K11, K17** and **K21** to **K23** is not important in this configuration.

Type and scale of control signal		Three-phase operation				
		Position of jumpers				
		K10	**K16**	**K18**	**K19**	**K20**
Voltage	0 - 5 V	0	0	1	0	1
	1 - 5 V	0	1	1	0	1
	0 - 10 V	0	0	0	1	1
	2 - 10 V	0	1	0	1	1
Current	0 - 20 mA	1	0	1	1	0
	4 - 20 mA	1	1	1	1	0

Table 4-6 Configuration of the input in three-phase operation

Input configuration in single-phase operation

In single-phase operation, channels A and B can be configured separately.

Jumpers **K10, K16** and **K18** to **K20** are used to configure the control signal (analogue and logic) type and scale for channel A.

Jumpers **K11, K17** and **K21** to **K23** are used to configure channel B.

Type and scale of control signal		Single-phase operation				
		Position of jumpers				
	Channel A	K10	K16	K18	K19	K20
	Channel B	K11	K17	K21	K22	K23
Voltage	0 - 5 V	0	0	1	0	1
	1 - 5 V	0	1	1	0	1
	0 - 10 V	0	0	0	1	1
	2 - 10 V	0	1	0	1	1
Current	0 - 20 mA	1	0	1	1	0
	4 - 20 mA	1	1	1	1	0

Table 4-7 Configuration of the input in single-phase operation

Supply frequency

The frequency (50 or 60 Hz) is adapted by switches labelled **LK** on the driver board.

The links which short-circuits the switches are grouped together on a support ("**plug**").

If the "plug" is in position, it short-circuits the **7** mutually opposed switches.

Frequency	Position of LK "plug"
50 Hz (±2Hz)	**No** "plug" (Switches open)
60 Hz (±2Hz)	"Plug" **in position** (Switches short-circuited)

Table 4-8 Supply frequency adaptation

Note. Jumpers **K1** and **K2** are always in position **0** for all standard applications (resistive or inductive load).

If these jumpers are in position **1**, this implies a soft start ramp at the beginning of each firing cycle.

Attention !

This type of operation produces electrical and electromagnetic interference and a power unbalance in the **3** load phases.

In the factory, the thyristor units are configured for soft start at power-up only (see *Operation*).

CONTROL BOARD (OPTIONAL)

The control board jumpers are used to configure:

- calibration or normal operation
- the feedback mode (controlled parameter).

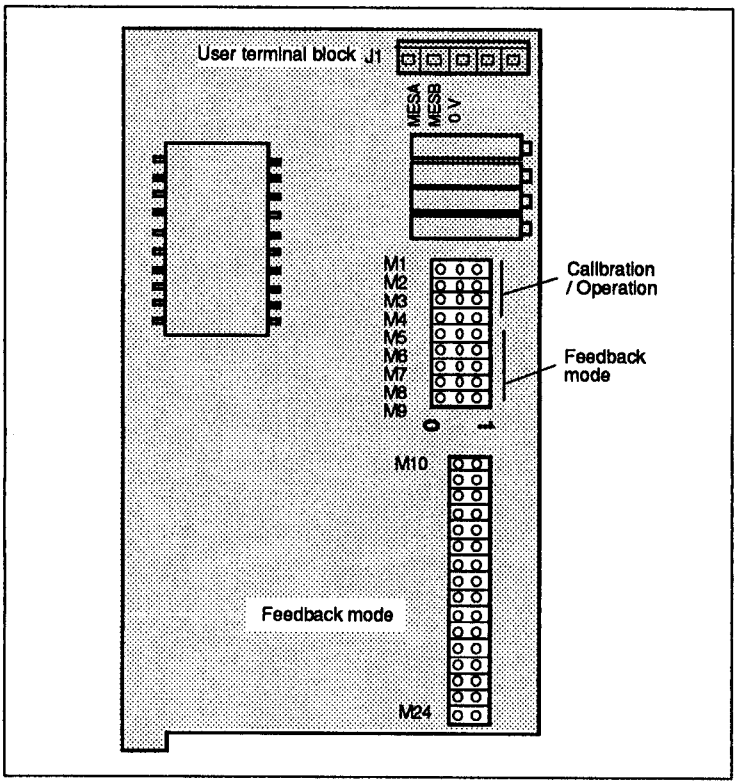

Figure 4-3 Position of configuration jumpers on the control board

Calibration / normal operation

Operation	Position of jumpers			
	M1	M3	M2	M4
Normal operation	0	0	0	0
Calibration of controlled parameter	1	1	-	-
Calibration of current	-	-	1	1

Table 4-9 Calibration or normal operation configuration

Jumpers **M1** and **M2** belong to channel **A**; **M3** and **M4** - to channel **B**.

Feedback mode

The feedback mode (power, current or voltage) is configured using:

- jumpers **M5** to **M9** and
- **6 links** short-circuiting 6 of the pins from **M10** to **M24.**

In single-phase operation, it is possible to select the different feedback modes on the two channels (A and B).

Operation	Controlled parameter	Position of jumpers				
		Channel A			Channel B	
		M5	M7	M8	M6	M9
Three-phase	Power	-	0	0	-	0
	Current square	0	-	0	0	0
	Load voltage square	1	1	0	1	0
Single-phase	Power	-	0	1	-	1
	Current square	-	-	1	-	1
	Load voltage square	-	1	1	-	1

Table 4-10 Feedback mode configuration using jumpers
("-" in the configuration tables indicates that the position is not important)

Operation	Controlled parameter	Pins short-circuited by links		
Three-phase	Power	M10 M18	M13 M20	M15 M23
	Current square	M10 M17	M14 M19	M16 M22
	Load voltage square	M11 M17	M13 M19	M16 M22
Single-phase Channel A	Power Current square Load voltage square	M10 M10 M12	M13 M12 M13	M21 M21 M21
Single-phase Channel B	Power Current square Load voltage square	M15 M15 M17	M18 M17 M18	M24 M24 M24

Table 4-11 Feedback mode configuration using links
(total number of links always remains 6)

PLU BOARD (OPTIONAL)

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

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

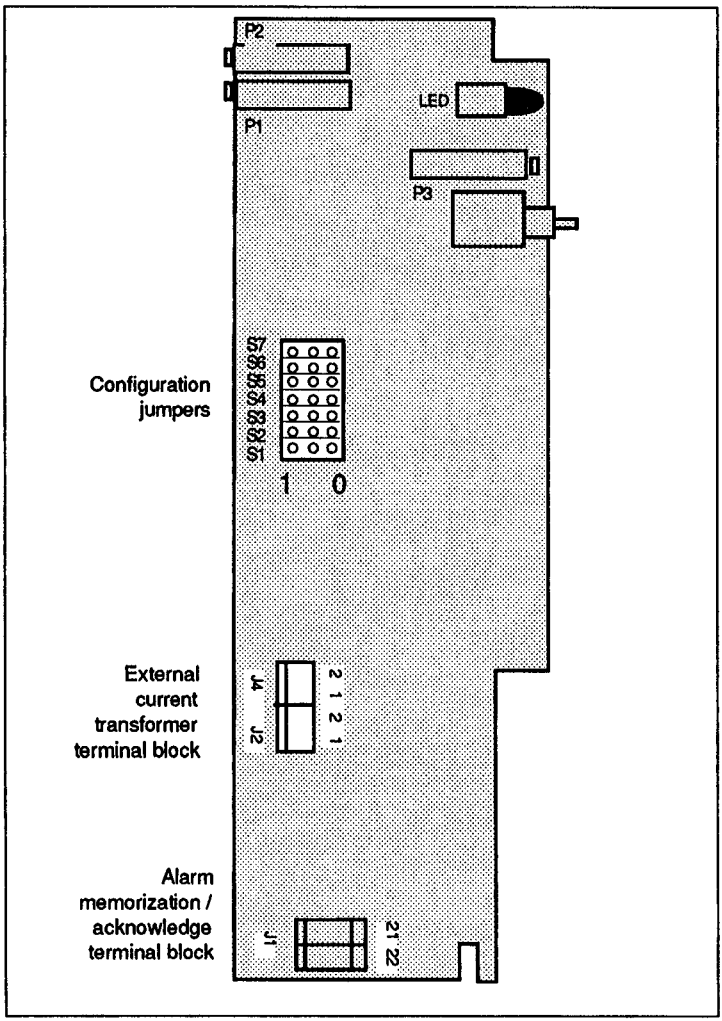

Figure 4-4 Position of configuration jumpers on the PLU board

Operation / Readjustment

Operation	Position of jumper
	S3
Normal operation	0
Compete resetting of the PLU detection circuit	1

Table 4-12 Configuration of operation / calibration

Supply frequency

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

Table 4-13 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 4-14 Configuration of the "Test" position

Current transformer

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 4-4).

Current transformer	Position of jumpers	
	S1	S2
Internal (control code CTE)	0	0
External (for external measurements	1	1

Table 4-15 Configuration of internal / external measurement

Note : Jumper **S6** is not used.
Jumper **S7** must always be in position **0**.

Chapter 5
OPERATION

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Chapter 5 OPERATION

BLOCK DIAGRAM

Figure 5-1 illustrates the way in which the main thyristor unit components interact.

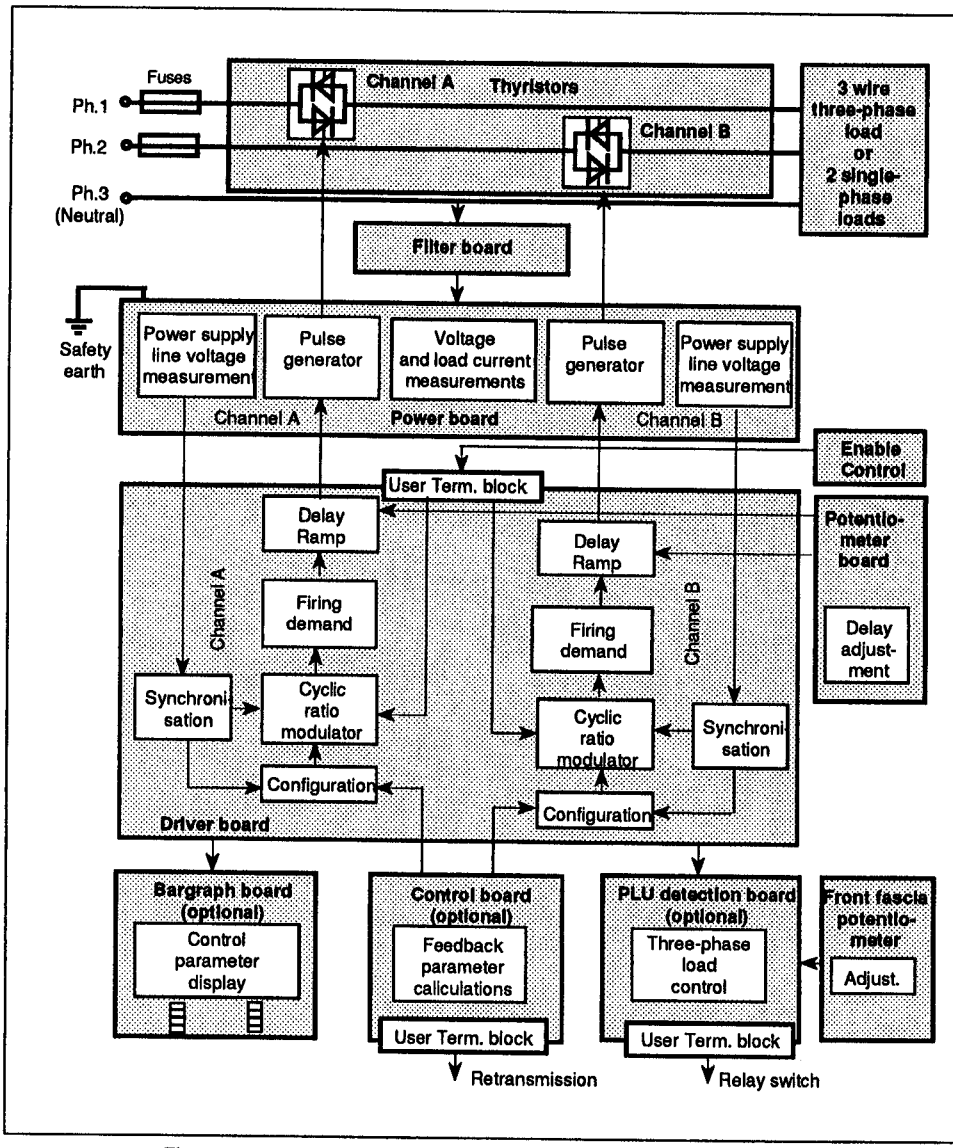

Figure 5-1 Block diagram of the TC2001 thyristor unit

Thyristors

The 2 pairs of thyristors mounted "head to foot" ensure the modulation of the supply voltage which is applied to two phases of the three-phase load (3-wire configuration) or to two independent single-phase loads.

Thyristors of up to **250 A** are mounted so as to be **insulated** from the heatsink.
Thyristors of **300** to **500 A** are not **insulated** from the thyristors.

The thyristors are protected against over-currents by **high-speed fuses** and by **RC snubbers** and **varistors** against excessively fast changes in voltage and transient over-voltages when the thyristors are not firing.

Power board

The firing demands for channels A and B of the driver board generate thyristor firing pulses which are sent to the thyristor triggers via pulse **transformers** which ensure insulation.

Two voltage transformers are used to measure the supply voltage, supply power to the electronics and the fans (for fan-cooled units) and to **monitor** the supply voltage and **synchronise** the zero voltage. In the basic version, this voltage is used for supply variation **compensation.** For options using load current measurement, **current transformers** must be installed (CTE option).

Driver board

The driver board is divided into **two** identical parts corresponding to each channel (A and B).

The control signals are applied on the **user terminal block.**
Two **firing demand** circuits, **after** the comparison of the control and feedback (or line voltage in basic version) signals, emit the power board pulse generator firing signals for each channel.

An **inhibition** line for each channel blocks the firing demand circuit in the event of a disabling of the thyristor unit (by disconnecting the terminals on the user terminal block).

Two cyclic ratio **modulators** perform the line voltage compensation (basic version) or the feedback of the monitored parameter (with the control board as an option).

For each of the channels, a ramp generation circuit ensures a **soft start** from 30 degrees thyristor firing to full firing at each power-up.

The driver board supports the option boards.

Potentiometer board

The potentiometers installed on this board are intended to adjust the delay of the first thyristor firing from **0** to **90** degrees (first alternation of firing cycle).

The delay of the first thyristor firing is used for primary transformer coils or for inducers in order to eliminate the transient over-current which is a characteristic of inductive load starts.

This adjustment is made separately for each channel.

Control board (optional)

The control board performs the following functions:

- the calculations (according to the current and voltage measurements) of the active power of the three-phase system or single-phase loads
- the calculations of the square of the rms currents of the monitored phases and the square of the rms voltages of the monitored loads
- the feedback on the calculated value (power, square of current or load voltage)
- the retransmission of the measurement on a terminal block in the form of **0** to **10 V** dc voltage.

The use of the control board requires current transformers (code **CTE**).

Bargraph board (optional)

Two **10** segment bargraph displays are used to display certain thyristor unit operating parameters with an accuracy of within **10%**; the bargraphs are switched off when idle.
The bargraphs display:

- the rms value of the monitored parameter
- the peak current of the greatest alternation if the push button on the front fascia is pressed down
- the load current of each channel without the control board.

With the control board, the value continuously indicated is:

- in single-phase operation - the feedback value selected for each channel
- in three-phase operation - the feedback value is indicated on the left display (the right display is switched off).

The use of the bargraph board requires current transformers (code **CTE**).

PLU board (optional)

In three-phase operation, this option is used to monitor the load and the thyristors.

If the difference in line current is greater than **10%** of the nominal current, the **PLU** circuit, is activated and the alarm relay changes status. The PLU alarm detects a partial or total load failure in a phase, a deterioration of one of the loads, a fuse cutoff, a short circuit or an open circuit of the thyristors, etc.

The PLU alarm is then signalled by an alarm relay switch.
This contact (**N/O** or **N/C** according to the product code - **PLU** or **IPU**) is available on the user terminal block under the thyristor unit, left-hand side, the terminals **31** and **32**.

The alarm can be memorized by an external switch connecting terminals **21** and **22** of the user terminal block on the PLU board.

The detection sensitivity is adjusted using the "**Adjust/Seuil**" potentiometer of channel **A** on the front fascia. The test button and the bargraph facilitate this procedure.

The use of the PLU board requires the installation of current transformers (code CTE).
The operation of the PLU detection board is independent of the direction of phase rotation.

Filter board

The filter board is located at the reference voltage input (terminals **41** and **43**).

The filters are so installed at the reference phase/neutral input.

It protects the operation of the thyristor unit against fast transients in common mode which can be introduced by these connections.

Diagnostic connector

A diagnostic connector located on the front fascia is used with the **EUROTHERM type 260** diagnostic unit to monitor and measure the main parameters of the feedback and operation of the thyristor unit.

THYRISTOR FIRING MODES

Thyristor firing in each power line of the TC2001 series thyristor units in "**Logic**" or "**Burst firing**" modes.

To reduce electrical interference on the power supply and electromagnetic interference by radiation, thyristor switching is performed **at zero voltage** for each phase (except in configuration for inductive loads).

"Logic" mode

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

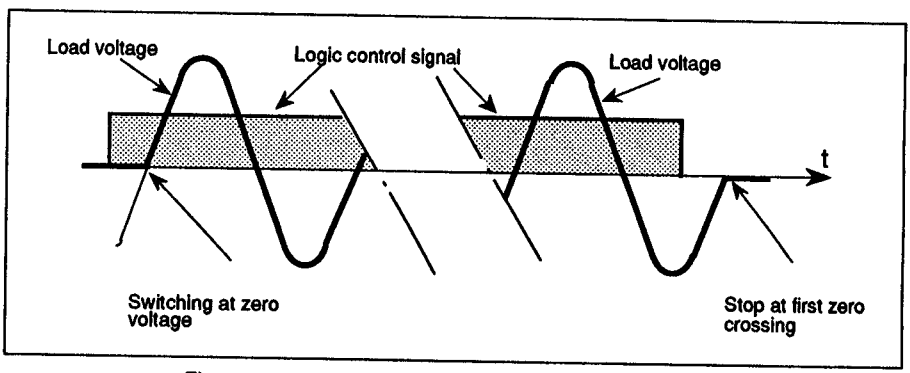

Figure 5-2 "Logic" firing mode

This firing mode is activated by a logic input signal greater than an "ON status" threshold (full thyristor firing), provided that the input signal is not less than an "OFF status" threshold (see table 4-5, page 4-7).

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

This firing mode is a **proportional cycle** which consists of supplying a series of **complete** voltage supply **cycles** to the load (see figure 5-3).
Activation and deactivation of thyristor firing is synchronised with the supply and is performed **at zero voltage** for resistive loads.

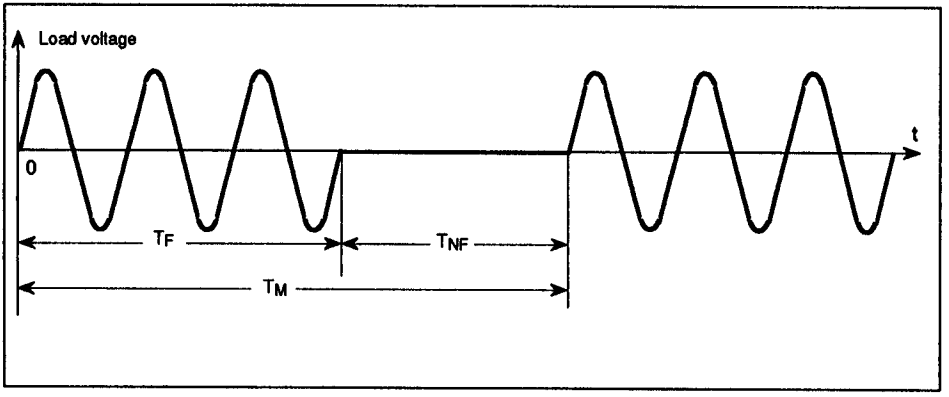

Figure 5-3 "Burst firing" mode
(T_F- firing time
T_{NF} - non firing time
T_M - modulation period)

In Burst mode operation, 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 of the load is proportional to the firing rate (or cyclic ratio) τ which is inversely proportional to T_M

$$\tau = \frac{T_F}{T_M}$$

The power of the load can be expressed by:

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

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

For the TC2001 series, there are **two** types of Burst firing mode, selected by the used at the order :

- **Fast cycle** burst firing (T_M = **0.6 s** for 50% of the full input signal scale)
- **Slow cycle** burst firing(T_M = **20 s** for 50% of the full input signal scale).

Using a variable modulation period according to the output power, the adjustment precision of the TC2001 serie adapted to each specific setpoint zone.

For a zone greater 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 "Fast cycle") :

- 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 control is thus perfectly linear between 0 and 100 % of maximum power and does not have an adjustment stage as in fixed modulation period units.

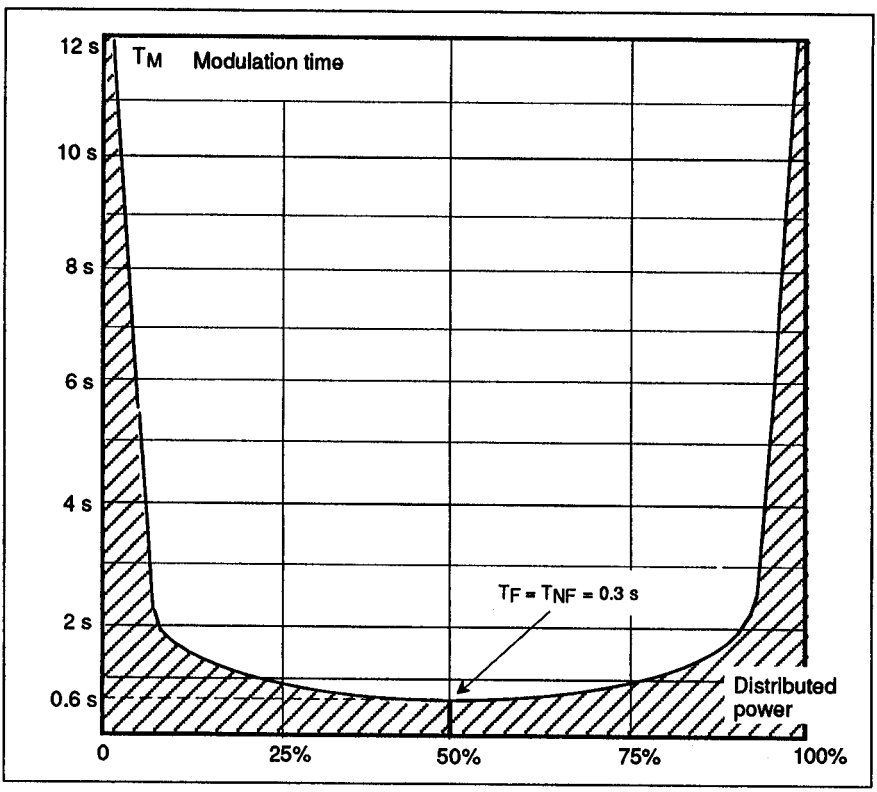

Figure 5-4 Modulation time as a function of power in Burst firing mode (Fast cycle)

FIRING START

At each power-up or after the unit has been switched off for more than **20 ms**, the unit starts up with a reduced firing angle.
For **150 ms** of the first burst, the thyristor firing angle in each channel gradually changes from the thyristor OFF status to full firing.
This **soft start** ensures an easy power-up.
The following bursts start at zero voltage for purely resistive loads.

For inductive loads, triggering at zero voltage generates transient operation which could, in some cases, cause a saturation of the magnetic circuit, the appearance of over-currents (figure 5-5,a) and a high-speed fuse blow-out (thyristor protection).

To prevent this saturation, the first thyristor firing of each phase can be **delayed** with reference to the corresponding zero voltage (figure 5-5,b). This applies for both logic signals and analogue signals. **The optimum delay angle** (ϕ) must be adjusted with the potentiometers on the front fascia (see adjustment) separately for each channel as a function of the load (max. delay **90°**).

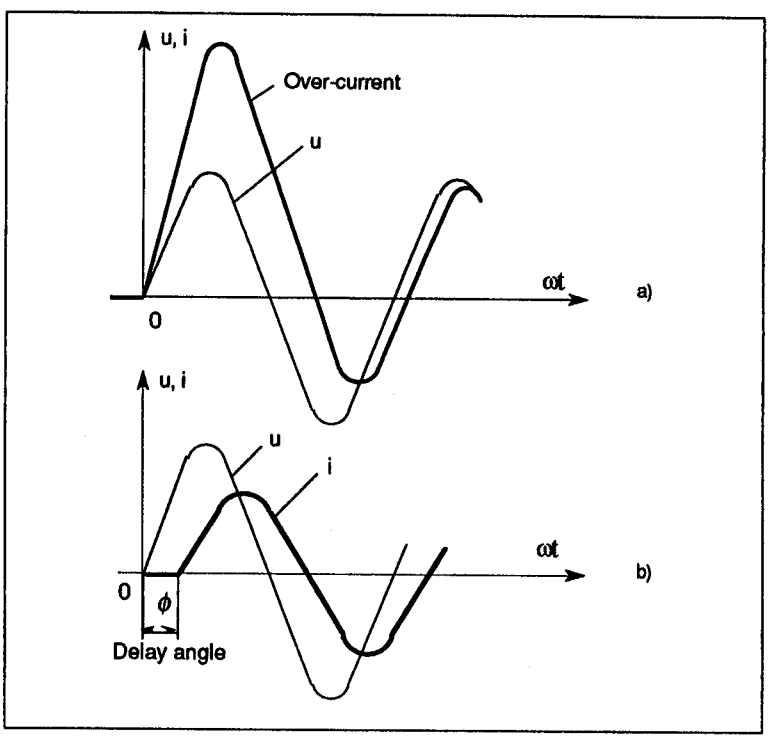

Figure 5-5 Switching of inductive load to zero voltage (a) and with a delay angle (b)

FEEDBACK OPERATION ("Burst firing" mode)

Basic version (supply variation compensation)

In the basic version (**without** control board), TC2001 series power thyristor units with **an analogue input signal**, possess supply variation compensation within the range : **+ 10 %** to **- 15 %.** This voltage is measured on the electronics power supply which is self-supplied on the power phases.

Without compensation of the supply voltage variations, a **10 %** decrease or increase in the supply voltage would cause a **20 %** decrease or increase in the power emitted to the thyristor unit load.

By compensating the variation of the supply voltage instantaenously, the thyristor unit does not transmit power variations to the load thus preventing fluctuations of the feedback value and the intervention of the controller.

Control option (control board)

With the control board, **3** types of feedback are available (jumper configuration):

- active power
- load voltage
- load current.

Operation type	Feedback	Measurement
Single-phase	Active power (separately for each channel)	Current and voltage of the monitored channel
	Current square	Current of the monitored channel
	Load voltage square	Voltage of the monitored channel
Three-phase	Active power of the three-phase load	Currents and voltages of two monitored phases
	Square of mean of two currents	Currents of two monitored phases
	Square of mean of two load voltages	Load voltages of two monitored phases in relation to the direct phase

Table 5-1 Possible feedback modes

The output power (or voltage or current square) varies in a linear fashion as a function of the input signal. Linearity deviation:

1 % in power and current feedback and **2 %** in voltage feedback.

FIRING START

At each power-up or after the unit has been switched off for more than **20 ms**, the unit starts up with a reduced firing angle.
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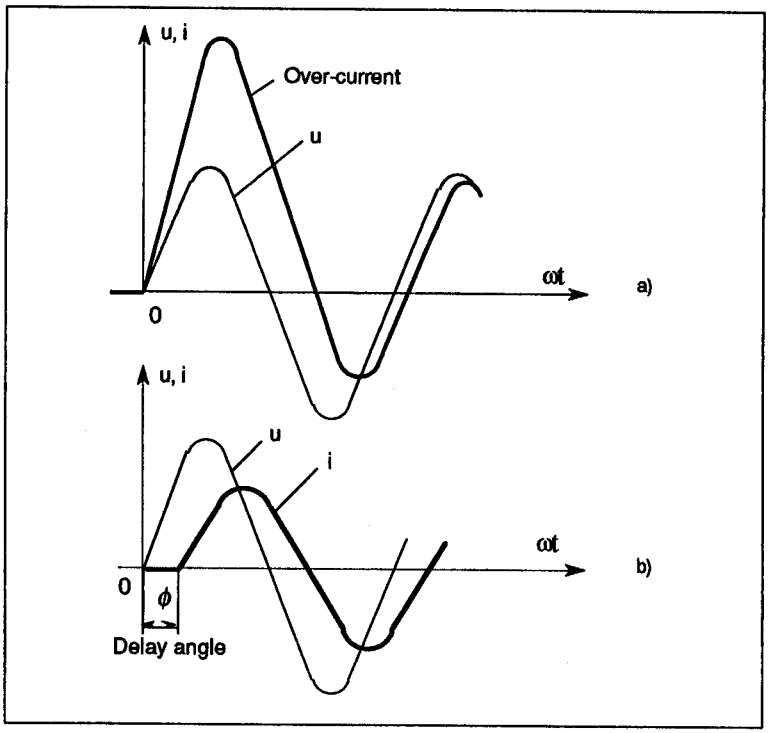

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Table 5-1 Possible feedback modes

The output power (or voltage or current square) varies in a linear fashion as a function of the input signal. Linearity deviation:

1 % in power and current feedback and **2 %** in voltage feedback.

Single-phase operation

Active power of each channel

This feedback establishes a linear relationship between the control and the active power (**P**) applied on each single-phase load.
The feedback value is calculated on the current and load voltage measurement.

Current square in each channel

The feedback parameter is the rms current square (I^2) calculated according to the instantaneous current passing through the load.

Voltage square of each load

The feedback parameter is the rms voltage square (V^2) calculated according to the instantaneous voltage measurement applied on the load.

Three-phase operation

Active power of the three-phase load

This feedback establishes a linear relationship between the control the active power (**P**) consumed by three-phase load.
The feedback value is calculated using the 2 wattmeter method, using the measurement of two currents of the controlled channels and of two composed voltages between controlled phases and the third phase.

Mean of voltage squares

The feedback parameter is the mean of the three-phase load rms current squares (I_{AVE}^2). The rms currents of the two phases (I_1 and I_2) are calculated according to the measurement of instantaneous currents passing through two controlled phases.

$$I_{AVE}^2 = \frac{I_1^2 + I_2^2}{2}$$

Mean of voltage squares

This feedback parameter is the mean of the squares of the two three-phase load rms voltages (V_{AVE}^2). The rms voltages applied to 2 phases of the load (V_1 and V_2) are calculated according to the measurement of instantaneous voltages between the two controlled phases and the direct phase.

$$V_{AVE}^2 = \frac{V_1^2 + V_2^2}{2}$$

RETRANSMISSION (control option)

The retransmission signals of the controlled parameters of two channels are available on the control board user terminal block.

In three-phase operation and for channel A in single-phase operation, terminals **51 (MES A)** and **53 (0V)** which contain information on the retransmission; for channel **B** in single-phase operation, these are terminals **52 (MES B)** and **53 (0V).**

The retransmission is presented by a dc voltage in **0 -10 V,** which becomes an image of the configured feedback value.

If the Bargraph option is installed, the retransmission voltage is supplied to the Bargraph board and corresponds to the indication displayed on the front fascia with an accuracy of within 10%.

Single-phase operation

In single-phase operation, the thyristor units use one retransmission per channel.

The voltage is calibrated at **10 V** for one of the following values:

- the nominal current square (I_N^2)
- the nominal voltage square (V_N^2)
- the nominal power of one channel of the thyristor unit ($V_N \times I_N$).

Three-phase operation

In three-phase operation, the thyristor units use one retransmission for the three-phase load. The signal is available on the retransmission terminal of channel A **(MES A).**

The voltage is calibrated at **10 V** for one of the following values (depending on the configuration) :

- the mean of nominal phase current squares (I_{NAVE}^2);
  in the case of equality of the nominal phase currents, this parameter is equal to the nominal current of a channel
- the square of the nominal voltage (V_N^2)
- the nominal power of the thyristor unit $\sqrt{3} \times (V_N \times I_N)$.

Retransmission accuracy

The absolute retransmission **accuracy** is within **2%.**

The linearity deviation is less than or equal to **1%** in active power and load current square feedback and less than or equal to **2%** in load voltage square feedback.

Chapter 6

COMMISSIONING PROCEDURE

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Chapter 6 COMMISSIONING PROCEDURE

Read this chapter carefully before commissioning the thyristor unit

COMMISSIONING PROCEDURE SAFETY

Attention !

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 !

Never use a power unit on a voltage supply greater than the nominal voltage of the unit specified on the order and in the coding.

Dangerous live parts may be accessible when the front door is open if the thyristor unit is operational. Only personnel qualified and authorised to work in industrial low voltage electrical environments can access 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 when the unit is operational.
The heatsink remains hot 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 thyristor unit.

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 load.

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).

If the real load current is significantly less than the nominal current of the unit, it is recommended to recalibrate the current (see "Current calibration", page 6-10).

Supply voltage

For star configurations without neutral or closed delta, the nominal value of the thyristor 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 unit voltage specified in the coding.

If the line voltage is less than **80%** of the nominal voltage, the thyristor unit is inhibited.

Attention !

Given the inhibition at 80% of the nominal voltage, the nominal voltage of the thyristor unit is the same (or as close as possible) as that of the nominal voltage of the supply used.

Supply voltage to the electronics

The supply voltage to the control electronics (auxiliary power supply) corresponds to the power voltage and is adapted by the position of the jumpers and by the selection of transformers on the power board.

The transformers for the power supply to the electronics (and the power supply to fans for fan-cooled units) are selected in the factory, according to the order code (see page 4-4).

Input signals

The jumper configurations on the driver board must be compatible with the levels chosen fo the signals used for control (see pages 4-8 and 4-9).

PLU detection (optional)

- Check that the unit is configured for three-phase operation (two phase control of the three-phase load, configuration 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 3-1, for example.

DIAGNOSTIC UNIT

For easier commissioning the adjustment operations and in order to diagnose the unit status, it is advisable to use the **EUROTHERM, type 260** diagnostic unit.

The **20-way switch** of the diagnostic unit is used to display the values of the unit and feedback parameters on a digital display. This displays two decimal places in order to permit the precise indication of the selected values.

The diagnostic unit possesses a flat cable which plugs into the 20-pin connector (diagnostic connector) on the front fascia of the unit.

The signals from the diagnostic connector may also be viewed using an oscilloscope.

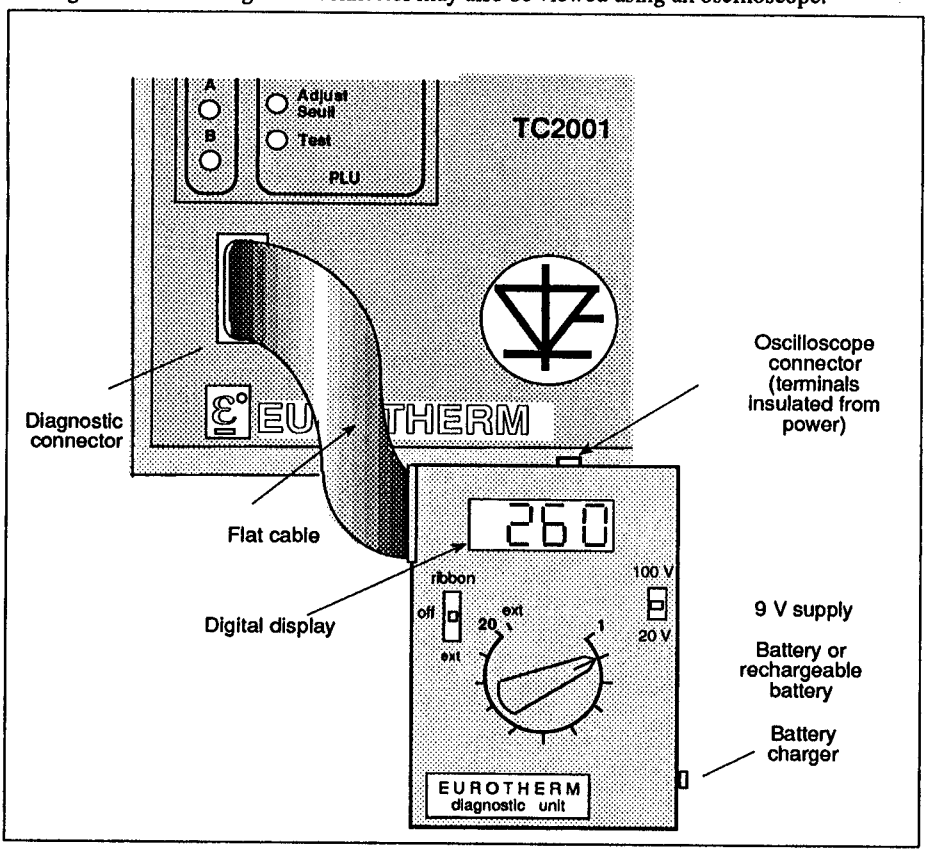

Figure 6-1 Connection of the EUROTHERM type 260 diagnostic unit and the TC2001 thyristor unit

The following table gives the description of each position of the **EUROTHERM, type 260** diagnostic unit and the typical values of the signals measured (continuous values).

Position	Description	Typical value	Comments
1	Calibrated load current. Channel A	2.5 Vdc	Control or PLU or CTE option (2.5 Vdc for nominal parameter)
2	Calibrated load current. Channel B		
3	Line voltage. Channel A	2.5 Vdc	
4	Line voltage. Channel B		
5	Retransmission of controlled parameter Channel A in single- or three-phase	0 to 10 Vdc	Control option (10 Vdc for nominal parameter)
6	Retransmission of controlled parameter Channel B in single-phase		
7	Power supply to the electronics	+15 Vdc	(14.25 to 15.75 Vdc)
8		-15 Vdc	(-14.25 to -15.75 Vdc)
9	Modulator input control signal. Channel A	0 to 1 Vdc	1 Vdc = 100% firing 0 V = 0% firing
10	Modulator input control signal. Channel B		
11	Thyristor firing logic level. Channel A	0 or 15 Vdc	0 V = thyristors OFF 15 V = thyristors ON
12	Thyristor firing logic level. Channel B		
13	Control circuit enable logic level. Channel A	0 or 15 Vdc	0 V = Enable 15 V = Inhibition
14	Control circuit enable logic level. Channel B		
15	Calibrated line current. Channel A	AC signal	Control option *
16	Calibrated line current. Channel B		
17	PLU detection	0 or -10 Vdc	0 V = outside PLU alarm -10 V = PLU alarm
18	Power supply	0 V common	
19		+24 to +40 Vdc	
20		-24 to -40 Vdc	

Table 6-1 Description of the positions of the EUROTHERM type 260 diagnostic unit

* AC value is not displayed. Available on the oscilloscope connection terminal.

PRELIMINARY ADJUSTMENTS

The preliminary adjustment is used to adapt the first thyristor firings to the type of load used.

For resistive loads with low temperature coefficients, firing at zero voltage does not generate steep voltages, thus minimising the electromagnetic interference produced.

For inductive loads, the first firing with a delay eliminates the transient over-current (see "Operation" chapter).

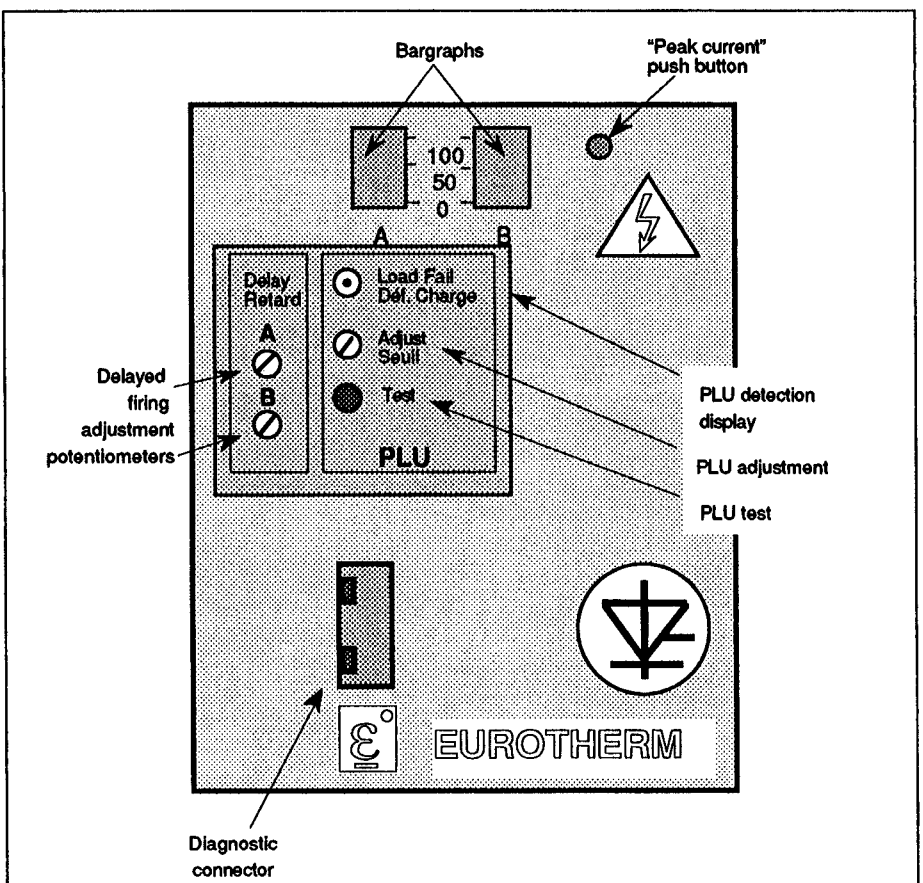

Figure 6-2 Front fascia of the TC2001 thyristor unit (PLU and Bargraph options installed)

Resistive load

- Turn the 2 thyristor delayed firing adjustment potentiometers of channels A and B completely anti-clockwise (delay angle = 0); these potentiometers are marked "**Delay**" on the front fascia of the thyristor unit.

- Power up the thyristor unit.

- In single-phase operation, place a signal corresponding to 0% of the control signal on the input of channel A and on the input of channel B.
  In three-phase operation, set the control signal on the input of channel A to **0 %**.

Using an RMS ammeter, check that the current in each of the arms of the load does not pass.

- In single-phase operation, place a signal corresponding to 100% of the control signal on the input of channel A and on the input of channel B.
  In three-phase operation, set the control signal on the input of channel A only to **100 %**.

Using an RMS ammeter, check that the current in each of the arms of the load is equal to the nominal load current.

Inductive load

When the load has an inductive component (primary transformer coil or inducer), firing at zero voltage generates transient operation which is conveyed by an over-current at each burst (see "**Operation**") and, in certain cases, the blowing of high-speed fuses (thyristor protection).

To prevent these over-currents, at the beginning of each burst of each channel, the first thyristor firing must be delayed in relation of the corresponding zero voltage.

The optimum delay angle must be adjusted according to the load used.
On the front fascia, each channel possesses a thyristor delayed firing angle adjustment potentiometer marked "**Delay**".

The delayed firing angle adjustment must be made using the front fascia bargraphs ("Bargraph" option) or using an oscilloscope displaying the load current.

Important

In the factory, the delay angle of every thyristor unit is set to **90°**

Adjustment with bargraphs

Single-phase operation

- Place a control signal corresponding to approximately **20%** of maximum output power on input A. On the inductive load, make sure the potentiometer has been turned to its limit in the clockwise direction.

- Press the "**Peak current**" push button on the front fascia in order to display the peak current of load A on the left bargraph.

- While keeping the push button pressed down, turn the potentiometer of channel A anti-clockwise in order to reduce the peak current at each beginning of a burst. (In the factory, the delay adjustment is at the clockwise limit, which corresponds to a delay of **90°**).

- Follow the same procedure for channel B using the potentiometer and the bargraph of channel B (right bargraph).

Three-phase operation

For 2 phase control in a three-phase system, the adjustments of channels A and B are **interactive.** The same adjustment must be made as for single-phase operation, but channel A must be readjusted after the adjustment of channel B.

At the beginning of the adjustment, turn the potentiometers of channels A and B once in alternation, in the anti-clockwise direction.

To fine-tune the adjustment results, simply adjust the two potentiometers in alternation in order to obtain the smallest peak currents of each of the arms of the three-phase load.

Adjustment without bargraphs (with oscilloscope)

Use an oscilloscope to display the load current.

Single-phase operation

- Place a control signal corresponding to approximately 20% of maximum output power on input A.

- Turn the potentiometer of channel A anti-clockwise, in order to reduce the over-current visible on the oscilloscope screen at the beginning of each cycle as much as possible.
- Follow the same adjustment procedure for channel B, using the potentiometer of channel B.

Three-phase operation

Follow the same adjustment procedure as with the bargraphs, but use an oscilloscope to display the peak currents in the three-phase load.

CALIBRATION OF THE THYRISTOR UNIT (control option)

The thyristor unit is calibrated so that the signal of **84 %** to **100 %** of the **maximum value of the selected scale** of the input signal **corresponds** to the **maximum current voltage values** allowed by the load used.

The calibration acts on the power retransmission signals and on the feedback signal selected for the feedback algorithm.

In the factory, the power thyristor unit is calibrated for the nominal voltage and the nominal current defined in the order.

The recalibration performed by the user for the concrete load is used to obtain the best feedback and retransmission accuracy.

Recalibration of the currents

If the real load current is considerably less than the nominal unit current (less than **70%**, for example), it is advisable, to retain the measurement accuracy, to adapt the current measurement channel to the real value (the recalibration of the currents is not essential for a voltage feedback).

The two potentiometers (labelled **P7** and **P8**) of the control board are used to calibrate the thyristor unit in terms of current.

The calibration potentiometers are accessible with the front door open.

Danger!

Dangerous live components may be accessible with the front door open.
Only personnel qualified and authorised to work in an industrial low voltage electrical environment, can perform calibration.

Calibration should be performed **during non-firing** (jumpers **M3** and **M4** on the control board are set to the **Calibration position**), meaning it is not necessary to operate the installation in its nominal conditions.

Once the non-firing calibrations have been **performed**, the calibration jumpers must be reset to the **operation** position (**0**).

Important !

Calibration **cannot be performed** at a value less than **10 %** of the nominal value.

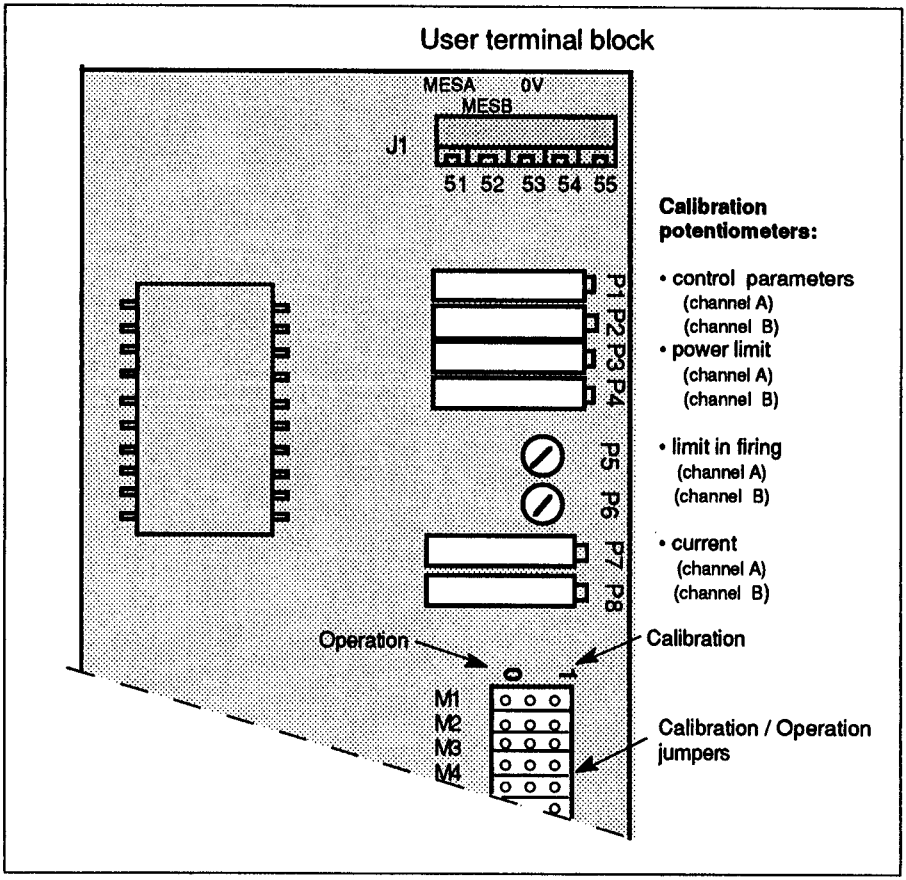

Figure 6-3 Position of the calibration potentiometers and jumpers (control board)

To **recalibrate** the current of the thyristor unit:

- Calculate the amplification ratio required to bring the real load current to the level of the nominal unit current.

$$K_I = \frac{I_{\text{Unit Nominal}}}{I_{\text{Load Nominal}}}$$

When the value is calibrated at the **nominal** value, the corresponding reading on the diagnostic unit in positions **15 and 16** is **1 V** (jumpers **M3** and **M4** in **calibration** position).

- Calculate the calibration voltage V_{CA} for each single-phase channel or for a phase of the three-phase load

$$V_{CA} = 1\,V \cdot K_I$$

- Set jumpers **M3** and **M4** of the control board to position **1** (calibration).
- Power up the thyristor unit.
- Turn potentiometer **P7** of the control board for channel **A** (potentiometer **P8** for channel **B**) completely anti-clockwise.
- Connect the EUROTHERM type 260 diagnostic unit on the front fascia connector. At the start, position **15** must be read for channel **A** (position **16** for channel **B**) **1 V** (±0.05 V).
- Adjust potentiometer **P7** of channel **A** (potentiometer **P8** for channel **B**) to display the value of the calibration voltage V_{CA} in position **15** (position **16** for channel **B**) on the diagnostic unit.
- Reset jumpers **M3** and **M4** to position **0**.

In **three-phase operation,** the 2 channels must retain an **identical** amplification even if the load is unbalanced. The adjustment of potentiometers **P7** and **P8** must be identical.

Calibration of the controlled parameter (control option)

In the case of a power or current feedback (if the real load current is slightly different from the nominal unit current) and in the case of a voltage feedback, it is possible to **recalibrate** the controlled parameter (controlled value) by using the procedure described hereunder.

Recalibration is used to obtain a **10 V** retransmission of the controlled value equal to **100 %** for the real load and the exact supply voltage.

- Check the configuration of the type of feedback selected (see "Configuration")
- Set jumpers **M1** and **M2** of the control board to position **1** (calibration position).
- Set the thyristor unit to continuous firing (input signal at **100 %**), with the load at nominal operating conditions.
- Adjust potentiometer **P1** on the control board so that the retransmission signal on channel **A** is equal to **10 V** .

For three-phase operation and for channel **A** in single-phase operation, this signal is available between terminals **51** and **53** of the user terminal block of the control board or in position **5** of the diagnostic unit.

- For the calibration of the signal of channel **B** in single-phase operation, use potentiometer **P2** of the control board.

The signal for channel **B** is available between terminals **52** and **53** of the user terminal block or in position **6** of the diagnostic unit.

- Reset jumpers **M1** and **M2** to position **0** for normal operation.

Note: Calibration is not essential if:

- retransmissions **are not used**
- the real load current is **close** to the nominal unit current

Calibration of the power limit (control option)

This calibration is used to limit the maximum value of the monitored parameter. Using the required limit factor (K_{LIM}), calculate the power limit adjustment voltage (for example):

$$K_{LIM}(\%) = \frac{P_{Max.load}}{P_{Nom.TC2001}} . 100\ \%$$

$$V_{LIM}(V) = 1\,V. \frac{K_{LIM}(\%)}{100\ \%}$$

The power limit can be adjusted with thyristor firing off or on.

Non-firing calibration

- Inhibit the thyristor unit by disconnecting the "Enable" inputs of the driver board user terminal block (terminal **14** for channel A and terminal **16** for channel B) from terminal **15** (+10 V).
- Set the control signal to 100%.

- For channel **A** in single-phase operation and for **three-phase** operation, use potentiometer **P3** of the control board to adjust position **9** of the diagnostic unit to read the limit adjustment voltage (100% power corresponds to 1 V).
  For channel **B** in single-phase operation, use potentiometer **P4** to adjust the limit and position **10** of the diagnostic unit to read the data.

- Adjust the power limit potentiometer so that the diagnostic unit displays at the corresponding positions, the V_{LIM} voltage calculated using the power limit factor.

- Enable the thyristor unit by connecting the "Enable" inputs (terminals **14** and **16** of the driver board user terminal block) to **+10 V** (terminal **15**).

Calibration during firing

Calibration with firing on offers the possibility of limiting the power using adjustment potentiometers (**P5** and **P6**) by monitoring the load power using one of the following means:

- the diagnostic unit (positions **9** and **10**)
- the front fascia bargraphs (accuracy limited to within 10% per segment)
- a wattmeter on the load.

To perform this calibration:

- Set the adjustment potentiometers to **0%** power (fully in the anti-clockwise direction) and apply the maximum control signal.
- Increase the power in the load gradually to its maximum value required by turning the potentiometer of each channel clockwise.

Note: Wait for approximately **30 s** for the measurement to stabilise.

PLU DETECTION ADJUSTMENT (optional)

THREE-PHASE OPERATION ONLY

The partial load unbalance (PLU) detection circuit is adjusted in the factory for the nominal current and voltage of the three-phase load in three-phase operation.

The sensitivity is adjusted to detect **10 %** of the difference between the rms currents of **2** controlled phases.

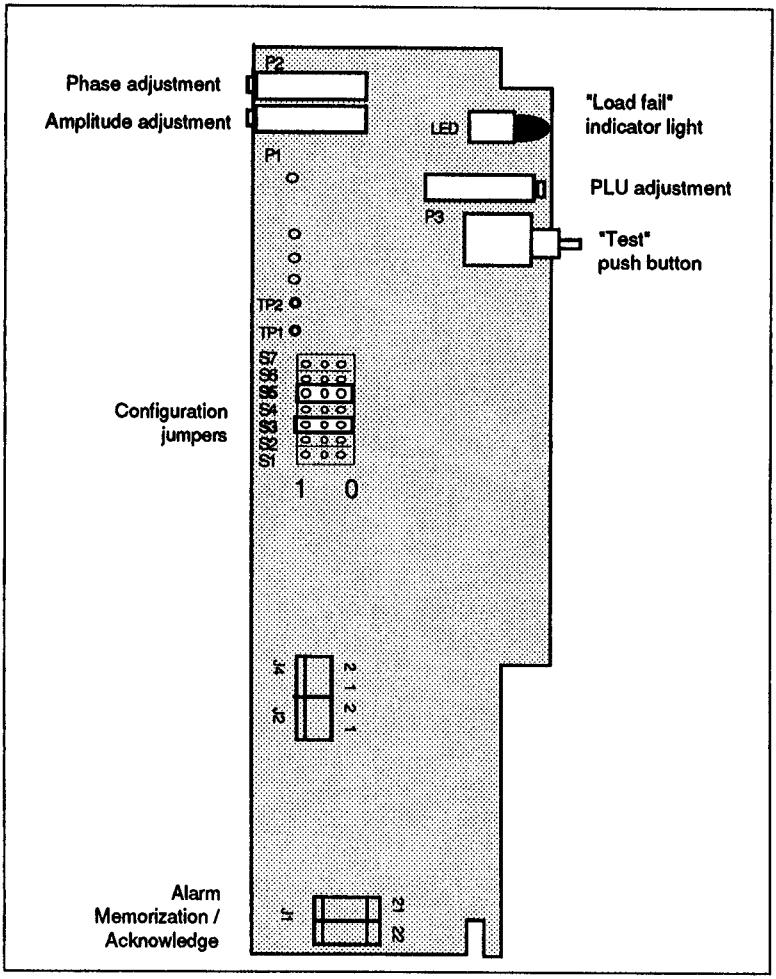

Figure 6-4 Position of adjustment equipment on the PLU board

Initially balanced load

To retain the PLU detection performance with the real load which may be different from that defined on the order or the current consumption which is lower than the normal thyristor unit current, on-site adjustment is possible.

- Set the thyristor unit to continuous firing (three-phase operation)
- Turn the adjustment potentiometer (marked "**Adjust**" on the front fascia, see figure 6-2) 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).

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 6-4)
- resume the adjustment.

Danger !

The front door must be opened for the last adjustment which must be performed **by qualified personnel only.**

Initially unbalanced load

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

Danger !

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

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- Set jumper **S3** on the PLU board to position **1** and the "**Adjust**" potentiometer on the front fascia completely clockwise.
- Set the thyristor unit to full firing
- Using the potentiometers **P1** (signal amplitude) and **P2** (signal phase) located on the PLU board (see figure 6-4), 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 or in position **17** of the Eurotherm type 260 diagnostic unit.
- Reset jumper **S3** to position **0**.
- Follow the adjustment procedure described for the initially balanced load.

CHECKS IN THE EVENT OF ABNORMAL OPERATION

Symptom	Action
1. The thyristor unit is not fired after a firing demand	1.1. Check that the "Enable" inputs on each channel (terminals 14 and 16 on the driver board) are connected to +10 V (terminal 15). 1.2. Check that the control signal arrives correctly on the driver board user terminal block: • on terminal 11 in three-phase operation and in single-phase operation for channel A ; • on terminal 12 in single-phase operation for channel B. 1.3. Check that the input signal type and level are compatible with the type and level of the configured signal. 1.4. Check the position and cabling of the thermal switches (S5 and S6) on the power board 1.5. Check the presence of the thyristor firing logic signals (15 V dc in position 11 and 12 of the diagnostic unit). 1.6. Check that the power limit is not at zero (analogue configuration and control option) and the setpoint present (in diagnostic positions 9 and 10 voltage is between 0 and 1 V). 1.7. Check that the supply voltage is greater than or equal to 80% of the nominal unit voltage.

Symptom	Action
2. The supply voltage is less than 80%.	If the voltage is greater than 80% of the nominal TC2001 unit voltage (e.g. the 440 V nominal thyristor unit used on a 380 V supply), recalibrate the thyristor unit as follows: 2.1. Power up the thyristor unit. It is preferable, whenever possible, to perform this adjustment when the thyristor unit is firing at 100% to take the supply voltage drop into account **Danger !**  Dangerous live components may be accessible during this adjustment! Only personnel authorised to work in an industrial low voltage electrical environment can perform this adjustment. Access to the internal components of the thyristor unit is prohibited to users who are not authorised to work in an industrial low voltage electrical environment. 2.2. Enable channels A and B on the power board user terminal block 2.3. Turn potentiometers P1 and P2 of the power board completely anti-clockwise (the thyristor unit is not inhibited) 2.4. Turn potentiometer P1 of the power board slowly clockwise until the thyristor unit is inhibited (positions 13 and 14 of the diagnostic unit at +15 V) 2.5. Turn potentiometer P1 of the power board approximately 45° (1/8 turn) anti-clockwise. 2.6. Repeat the same operations for potentiometer P2 of the power board 2.7. Adjust potentiometer P1 and P2 of the driver board to obtain 2.5 V in position 3 and 4 of the diagnostic unit.

Symptom	Action
3. The transient over-current during the inductive load start-up is too high.	3.1. Check that the load circuit wiring is correct. 3.2. Check the level of the thyristor firing signal (external output signal in positions 11 and 12 of the diagnostic unit is 15 V peak; for the measurement, use an oscilloscope). 3.3. The preadjustment (in the factory) of the delayed firing angle has not been readjusted. Decrease the angle slightly by turning the "Delay" potentiometer (for each channel) on the front fascia of the thyristor unit anti-clockwise. See "Preliminary adjustment of the inductive load", page 6-9.

If the fault persists after all these checks, contact your nearest Eurotherm Office, where technicians will be able to advise you and assist you during commissioning.

Chapter 7

MAINTENANCE

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Chapter 7 MAINTENANCE

Danger !

The thyristor unit must be maintained by qualified personnel only

THYRISTOR PROTECTION

The thyristors of the TC2001 series power thyristor 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 TC2001 series power thyristor 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: **480 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, TC2001 models with a nominal current of 60 to 100 A are supplied with three "flag" type lugs and two 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.

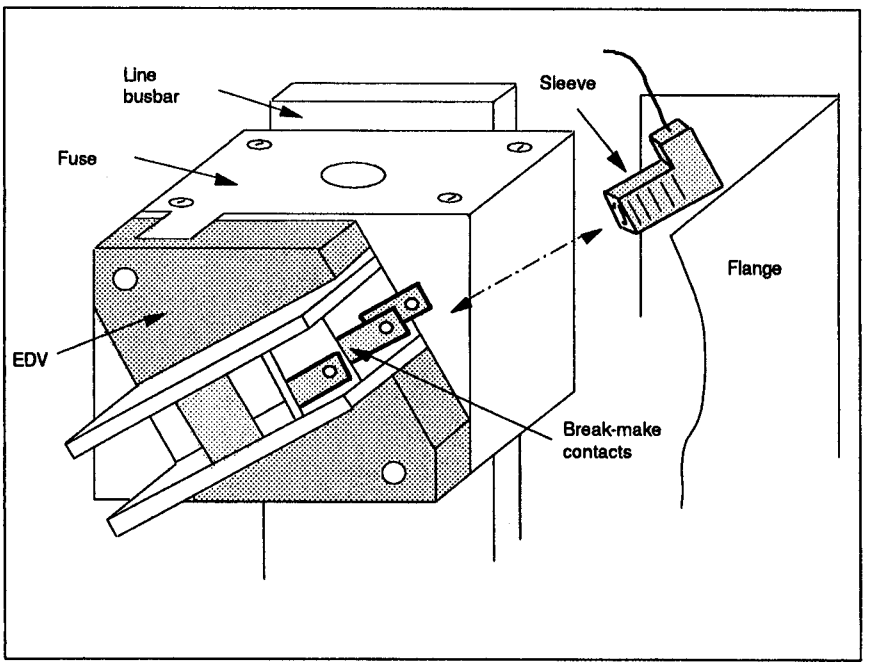

Figure 7-1 Use of "flag" lugs and insulating sleeves to observe insulating distances.

PROTECTION FUSES FOR REFERENCE PHASE VOLTAGE

These fuses must be installed in each wire of the reference phase (or neutral) configuration for TC2001 series thyristor units.

Reference voltage (max)	1 A fuse 6.3 x 32 mm	Fuse-isolator	Fuse and fuse-holder assembly dimensions (mm)
480 V	CS174289U1A0	CP174293	63 x 15 x 52

Table 7-2 Protection fuses for reference phase configuration.

SERVICING

TC2001 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 screws	
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. Eurotherm type 260 diagnostic unit (recommended) Oscilloscope *

Table 7-3 Tools

* Required for the adjustment of delayed thyristor firing in the case of the inductive load if the "bargraph" option is not installed

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