Power thyristor units

460 series

Control of single-phase resistive and inductive loads

User Manual

Part No HA 174913 ENG Issue 2 Printed in France 11/96

CE

EUROPEAN DIRECTIVES

SAFETY

The **460** products installed and used in accordance with this User Manual are designedto 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 **460** products implies that the essential protection requirements of the European Low Voltage Directive are observed.

The **460** Technical Construction File is approved by a Notified Body, **LCIE** (Laboratoire Central des Industries ƒlectriques).

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 **460** 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 **460** 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 **460** 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 filter
- ¥ IEC 1800-3 : Without external filter. Applies for the second environment.

EMC EXTERNAL SERIES FILTERS

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

Nominal current of thyristor unit	**EMC filter ordering code**	
	Single-phase wiring	**Three-phase application**
15 A and 25 A	FILTER/MON/25A/00	FILTER/TRI/63A/00
40 A and 55 A	FILTER/MON/63A/00	FILTER/TRI/63A/00
75 A and 100 A	FILTER/MON/100A/00	FILTER/TRI/100A/00
125 A and 150 A	2 x FILTER/MON/100A/00 (in parallel)	Contact Eurotherm

VALIDATION BY COMPETENT BODY

In order to guarantee the best service, Eurotherm has validated the compliance of the **460** 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 ƒlectriques).

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 **460 User Manual Part No HA 174913 ENG** intended for the 460 series power thyristor units manufactured beginning **January 1996.**

The 451-455-461 User Manual (Part No HA174485) is valid for products manufactured before this date.

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 460, 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.

460 USER MANUAL

The safety instructions for the installation and use of 460 series units are given in the pages below:

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Chapter 1

IDENTIFYING THE THYRISTOR UNITS

Contents page

Chapter 1 IDENTIFYING THE THYRISTOR UNITS

GENERAL INTRODUCTION TO THE 460 SERIES

The **460** series power thyristor units are designed for the control of industrial **single phase** loads.

The **460** series is designed to control:

- inductive loads (transformer primary circuits, in particular) or
- **high** temperature coefficient resistive loads.

A thyristor unit contains a pair of **thyristors** mounted in parallel on a heat dissipator.

The **460** series thyristors control currents between **15 A** and **150 A**.

The nominal line to line voltage varies between **120 V** and **500 V**.

The control signal, which can be reconfigured by the user, has three voltage levels:

0-5 V ; 0-10 V and 1-5 V.
and four current levels:

0-5 mA ; 0-10 mA ;
0-20 mA and 4-20 mA.

Manual control using external potentiometers is possible.

The **460** series is equipped with the following functions:

- electrical power control of inductive and resistive loads
- different thyristor firing modes
- decrease in the current requirement of high temperature coefficient loads using soft starts
- elimination of over-currents when starting inductive loads
- current limit
- partial load failure detection
- logic output to control other power units ("Slave firing" output)
- selective pulse locking circuit
- inhibition available on the user terminal block
- load current and voltage level image retransmission.

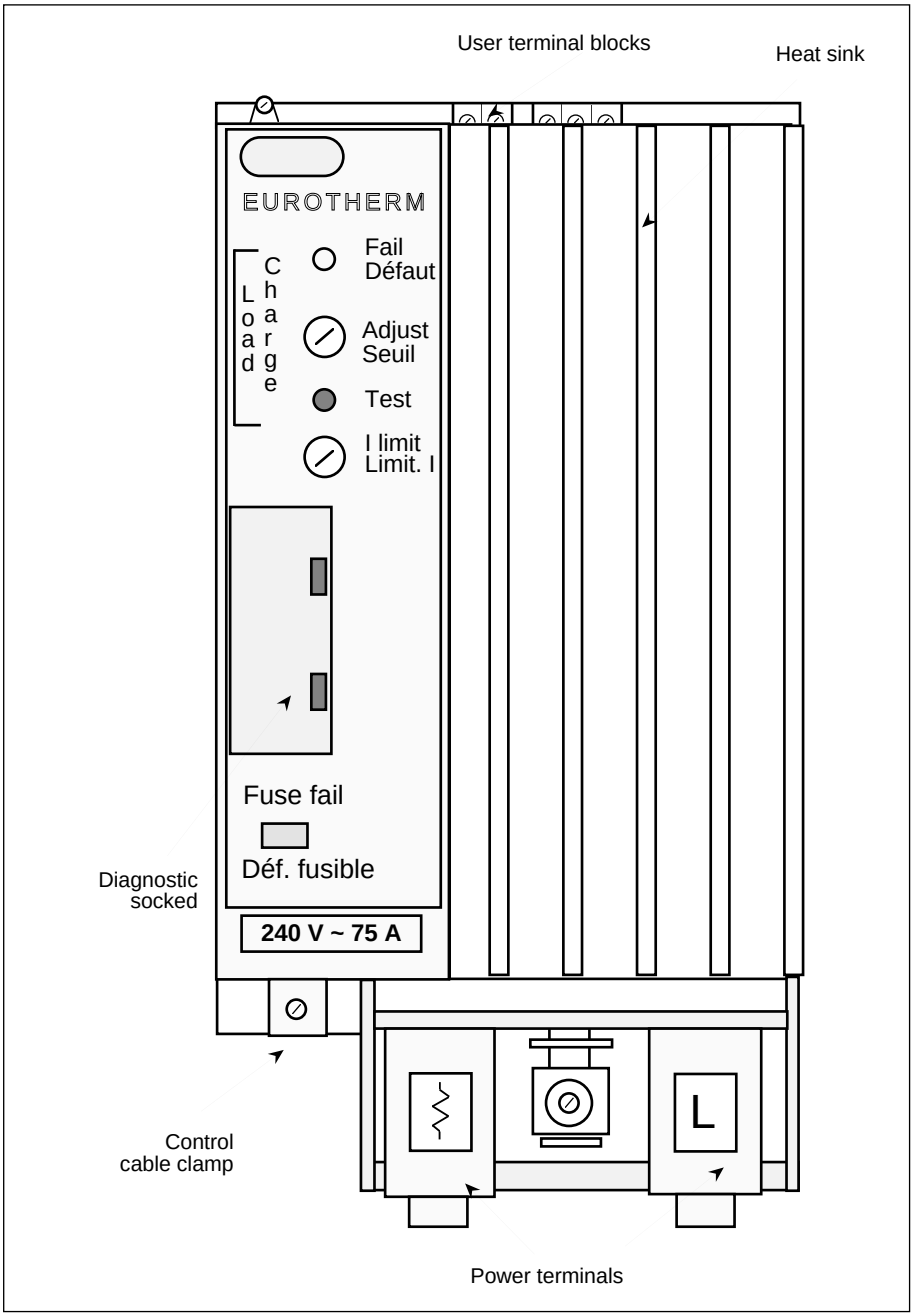

Figure 1-1 Overall view of the 460 series thyristor unit

The **460** series thyristor units are fitted with:

- a "**driver board** "which generates the thyristor firing start signals, and regulates the current and voltage measurements,

- a "**snubber board**" which protects the thyristors from fast voltage variations and generates the thyristor firing pulses

Models **462** to **464** have a **selective thyristor gate pulse locking** board to avoid unstable firing in certain applications.

The control system regulates the square of the voltage or the square of the load current as a function of an analogue input signal (automatic selection of the larger value).

460 thyristor units compensate for supply variations in a range from **+10 %** to **-15 %** of the nominal voltage.

On the **front fascia** are located:

- the partial load failure detection **adjustment** potentiometer
- the "**Test**" push button for testing the adjustment of the PLF alarm
- the **indicator** light to show partial load failure detection
- the current limit adjustment potentiometer
- the indicator light showing if the internal thyristor protection fuse has blown
- the **diagnostic** connector.

460 series thyristor units have permanent fan cooling above **100 A** nominal.

The **460** thyristor units have the following thyristor **firing** modes:

- thyristor firing angle variation **("Phase angle"),**
- cyclic firing ratio modulation from 0 to 100 % ("**Burst mode**")

"**Burst mode**" firing is characterised by different modes:

- a firing or non-firing cycle ("**Single cycle**")
- **slow** cycle (modulation time **8 s** at 50% setpoint)
- **fast** cycle (modulation time **0.8 s** at 50% setpoint)
- burst firing (fast or slow) with **soft start** in thyristor firing angle variation
- burst firing (fast or slow) with **soft start and end** in thyristor firing angle variation.

The soft start for high temperature coefficient resistive loads and the delayed firing angle at the first alternation in the case of the control of inductive loads (which may cause fuse blow-out or trigger the protective circuit breaker) **minimise** transient **over-currents**.
The soft start and end time can be adjusted between **0** and **0.25 s** using the potentiometer on the front fascia.

The **460** power thyristor units have two types of current limit:

- **linear** limit (adjustment using potentiometer on front fascia)
- **threshold** limit (adjustment using external potentiometer).

The partial load failure (**PLF**) detection circuit detects **25 %** increases in load impedance (independently from the supply voltage variation).

The PLF detection is adjusted using a potentiometer on the front fascia for the real load current used.

The PLF alarm is signalled by the alarm relay **switch** and by the "**Load Fail**" indicator light on the front fascia.

Thermal protection is provided by a thermal switch which detects if the fan has stopped or the heatsink is overheated.

The 460 thyristor unit is equipped with **active operation validation**.
An external **10 V** voltage (32 V max) or a switch connected to the user terminal block is used to **inhibit** the thyristor unit.

TECHNICAL DATA

The 460 is a power thyristor unit designed to control an industral single-phase load with a high current requirement at start-up using thyristors.

Attention !

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

Power

Nominal current	**15 A** to **150 A**
Nominal line to line voltage	**120 Vac** to **500 Vac** (+10%,-15%) Inhibition below **70%** of the nominal voltage; response time <10 ms; automatic reset 2 s after return to 85 % of the value
Supply frequency	**50** or **60 Hz** (±2 Hz)
Dissipated power	**1.3 W** (approximately) per ampere
Cooling	**Permanent fan** cooling above **100 A** nominal
Fan	Consumption **23 VA** Powered by the electronics supply voltage
Load	**Resistive** with high temperature coefficient or **inductive** (transformer primary circuit or inductor)
Residual current	In the OFF state, typically below 30 mA

Environment

Operating temperature	**0°C** to **+50°C** in vertical position
Altitude	**2000 m** maximum
Storage temperature	**-10°C** to **+70°C**
Protection	**IP00** (can be opened without tools according to **IEC 592**)
Thyristor protection	Internal high speed **fuse** fuse blown indicator light. (external fuse for 150 A model 464) **Varistor** and **RC** snubber
External cabling	To be performed according to the standards **IEC 364**
Atmosphere	Non-explosive, non-corrosive and non-conducting
Humidity	RH of **5**% to **95%** without condensation
Pollution	Degree **2** admissible, defined by **IEC 664**

Control

Power supply	Connection of the electronics power supply to the user terminal block Consumption: **7 VA** (non-fan-cooled unit) **30 VA** (fan-cooled unit)
Signal type	**Analogue**
Setpoint	Voltage: **0-5 V**; **1-5 V** or **0-10 V** Current: **0-5 mA ; 0-10 mA ; 0-20 mA** or **4-20 mA**
Input impedance	Voltage: ≥ **100 kΩ** Current: **250 Ω** or **1000 Ω**
Manual control	External potentiometer **10 kΩ**
Thyristor firing modes	The following can be reconfigured by the user: • **Phase angle** • **Single firing** (burst firing with a firing or non-firing cycle) • **Fast cycle** (typical modulation time at 50 % power : **0.8 s**) • **Slow cycle** (typical modulation time at 50 % power : **8 s**) • **Fast** cycle with adjustable **soft start** between **0** and **250 ms** (with or without soft end) • **Slow** cycle with adjustable **soft start** between **0** and **250 ms** (with or without soft end)
Delayed thyristor firing	For inductive loads the delayed firing of the first alternation of the burst mode firing (without soft operation) **eliminates** transient currents
Enable / Inhibition	Using external switch or external voltage on the control terminal block. Response time: enable **2 s**; inhibition **< 25 ms**
Diagnostics	Connector for diagnostic unit used to adjust and control the thyristor unit using **20 test signals**
Feedback type	**Squared load current** or **squared voltage** control. Supply variation **compensation**.
Configuration	**Shielded** cable connected to ground at **both** extremities.
Connection	**0.5 mm**^{2} to **2.5 mm**^{2} wires Tightening **0.7 N.m** The control terminals are insulated from the power and the load circuit.

Retransmissions

Signal outputs	Retransmission output on the control terminal block. • Instantaneous load current. The full wave rectified signal (**0** to **5 V**) proportional to the real load current image. • Instantaneous load voltage.

Current limit

Linear limit	Proportional load current limit (**0 %** to **110 %** of the nominal current). Adjustment using potentiometer on front fascia.
Threshold limit	Maximum load current limit. (**0 %** to **110 %** of the nominal current). Adjustment possible using an external potentiometer or an external voltage.

Partial load failure detection

Alarm	**20%** current decrease detection. **Adjustment** on front fascia using "**Adjust/Seuil**" potentiometer.
Test	Using front fascia "**Test**" push button.
Signalling	"**Load Fail**" indicator light on the front fascia. Alarm relay switch **open** in alarm status (in **standard** version) Switch **closed** in alarm status (option **83**)
"Slave firing" output	• Logic signal (**10 Vdc**; 10 mA max) available on the control terminal block.

Attention !

Due to the continual improvement of products, Eurotherm may be required to modify specifications without prior notice. For any further information and in the event of doubt, contact your Eurotherm Office.

CODING

Thyristor unit

Series /	Nominal current /	Nominal voltage /	Electronics supply voltage /	Input signal /	Thyristor firing mode /	Options /	00

Series	Nominal Current	Code
Without pulse locking 461	15 A	081
	25 A	082
	40 A	083
	55 A	062
With pulse locking 462	55 A	062
	75 A	113
463	100 A	114
464	125 A	117
	150 A	100

Nominal voltage	Code
115 V	10
240 V	13
277 V	32
440 V	28
480 V and 500 V	29

For other voltages, contact your EUROTHERM Office.

Electronics supply voltage	Code
Two-voltage :	
100 V and 230 V	41
115 V and 230 V	19
200 V and 230 V	42
277 V and 230 V	46
380 V and 230 V	43
440 V and 230 V	47
480 V or 500 V and 230 V	44

Input signal	Code
0-5 V	008
1-5 V	068
0-10 V	060
0-5 mA	069
0-10 mA	071
0-20 mA	072
4-20 mA	073

Thyristor firing mode	Code
Phase angle	002
Single cycle	160
Fast cycle (0.8 s)	001
Fast cycle with soft start	055
Fast cycle with soft start and soft end	SDF
Slow cycle (8 s)	050
Slow cycle with soft start	056
Slow cycle with soft start and soft end	SDS

Options	Code
Frequency 60 Hz	69
PLF alarm switch closed in alarm status	83
Unit without baseplate	76

Baseplate

Thyristor unit series / Nominal current / Baseplate code / 00

For advance installation, order the attachment baseplate without a unit.

Thyristor unit series	Nominal current	Baseplate code
461	15 A to 55 A	LA 017912
462	55 A to 75 A	LA 017959
463	100 A	LA 171068
464	125 A to 150 A	LA 171128

For deferred orders of units for pre-installed baseplates, use the thyristor unit coding option "Unit without baseplate" - code **76**.

Short or full code

The full code for the **460** series thyristor units (shown on page 1-9 in "Coding") specifies all the technical characteristics specified by the client.

To simplify the process for ordering thyristor units, the "short" code can be used, specifying the model, the nominal current and the operating voltage.

The "short" code is presented as follows.

Series / Nominal current / Nominal voltage / Electronics supply voltage / 00

If the "short" code is used, the **460** thyristor unit is supplied with the standard configuration:

- the input configured for 4-20 mA
- the thyristor firing mode: firing angle variation (Phase angle)
- frequency 50 Hz
- the thyristor firing delay potentiometer on maximum (maximum start ramp).

CODING EXAMPLE

460 series thyristor unit and installation parameters

Nominal load current	**45 amperes**
Nominal supply voltage	**440 volts line to line, 60 Hz**
Electronics supply voltage	**440 Vac**
Input signal	**0 - 10 volts**
Firing mode	"**Fast cycle**" burst mode firing with soft start.
Triggering	With selective pulse locking
Options:	• "Partial load failure detection" switch **closed** in alarm status • Unit without baseplate.

Thyristor unit coding

462 / 062 / 28 / 47 / 060 / 055 / 69 / 83 / 76 / 00

Attention !

The nominal voltage of the **460** series thyristor unit must correspond to the supply voltage used to prevent problems of **non-operation** for voltages **lower than 70%** of the nominal voltage.

SERIAL NUMBER LABELS

An **identification** label (specifying the **coding** of the thyristor unit) and a **configuration** label give all the information relating to the factory settings of the thyristor unit.

An identification label is **externally** located at the top of the right hand side panel of the unit.

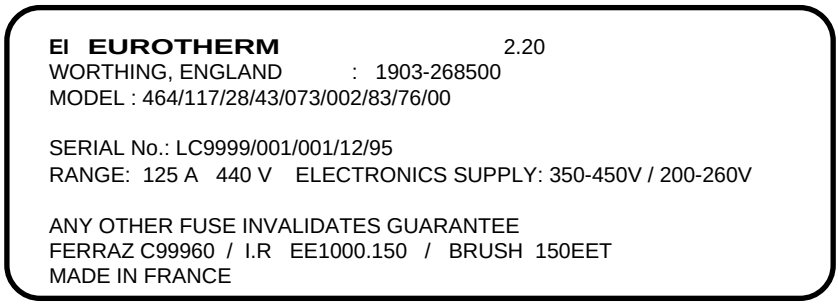

Figure 1-2 Example of an identification label for a model 464 thyristor unit
The information corresponds to a 464 thyristor unit, nominal current 125 A, nominal voltage 440 V, electronics supply in the range 350 to 450 V, 4-20 mA input, "phase angle" firing, PLF alarm switch closed in alarm status, unit delivered without baseplate.

The configuration label presents the factory settings.

The standard configuration (4-20 mA input, "Phase angle" firing mode and frequency 50 Hz) is shown.

If the configuration is different from the standard, it is shown in the appropriate field.

In this case, the position of the miniature configuration switches for the selected input signal and firing mode are shown.

The information on the configuration label is shown in French and in English.

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

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Chapter 2 INSTALLATION

SAFETY DURING INSTALLATION

Danger !

460 units must be installed by a person authorised to work in an industrial low voltage electrical environment.

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 NFC 15-100, IEC 364 or the current national standards.

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

Bulkhead mountings are possible with **460** series units.

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

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

Leave a vertical gap of at least **80 mm** between two units.

Leave a gap of at least **20 mm** between two units installed side by side.

Attention !

The units are designed to be used at an ambient temperature less than or equal to **50°C**.

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

460 series power units have **permanent** fan cooling for nominal currents above **100 A**.

DIMENSIONS

The dimensions of the 460 series thyristor units are given in figure 2-1 and table 2-1.

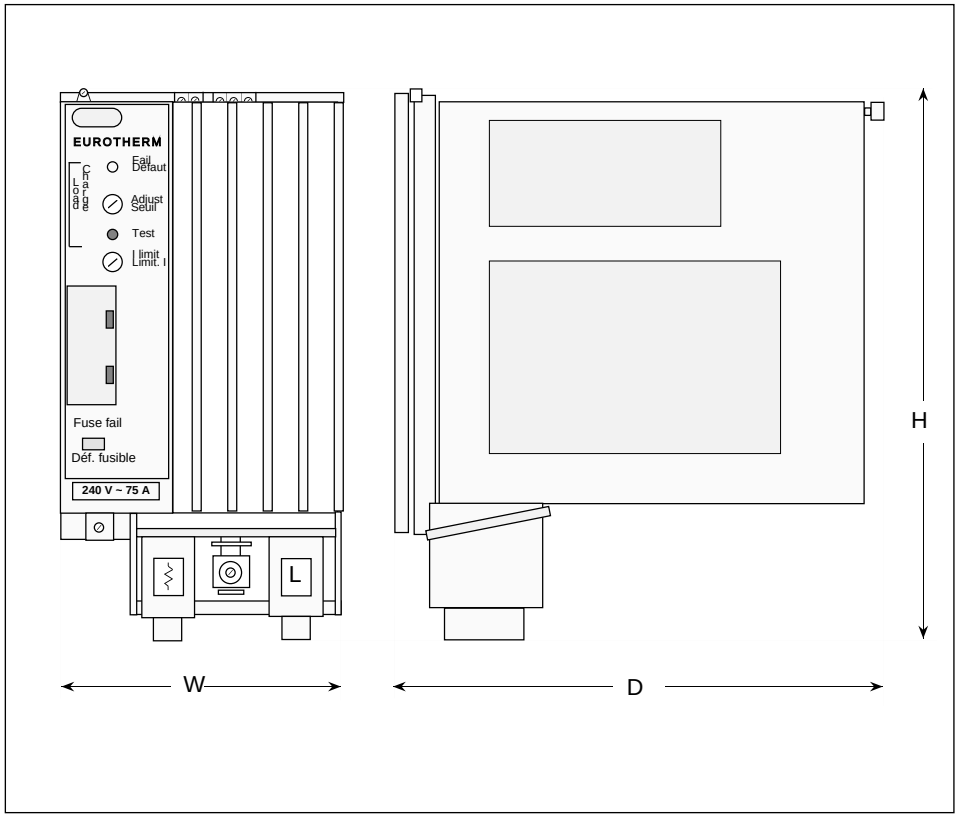

Figure 2-1 Overall dimensions

Model	Height (H) mm	Width (W) mm	Depth (D) mm	Weight kg
461	247	76	236	3
462	247	114	236	4
463	247	152	236	5
464	280	152	236	5

Table 2-1 Overall dimensions and weight

MECHANICAL MOUNTING

460 series units are slotted into a steel baseplate located at the rear of the unit.
The baseplate can be mounted:

- on a pair of asymmetric DIN rails
- on a vertical wall.

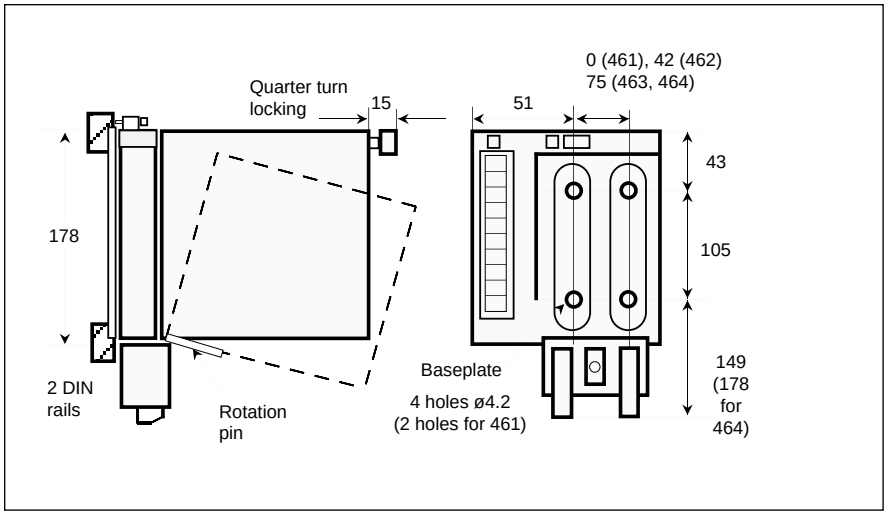

Figure 2-2 Dimensions for attachment to a vertical wall (mm)

To **mount** the unit**:**

- tilt the unit forwards to approximately 20 degrees from the horizontal
- fit the rotation pin into the slot in the baseplate
- raise the unit to the horizontal
- lock by a quarter of a turn.

To **dismount** the unit**:**

- unlock the upper attachment by a quarter of a turn
- tilt the unit forwards to approximately 20 degrees from the horizontal
- free the unit from its baseplate.

Danger !

Before dismounting the unit, ensure that it is switched off and that the heatsink is not hot.

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 upstream from the unit in order to perform the operation in complete safety.

All power and control connections are made to the terminal blocks located on the attachment baseplate and must be made without a unit present.

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 must be 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 power terminals and labelled as follows:

Attention !

To ensure that the 460 unit is grounded correctly, make sure that it is attached to the **reference ground plane** (panel or bulkhead). If this is not the case it is necessary to add a ground connection **no more than 10 cm long** between the ground connection and the reference ground plane.

Danger !

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

FIXING THE POWER CABLES

The external **cables** are connected to the terminal blocks on the baseplate, once the baseplate has been fixed, with the unit disconnected.

The power cables are attached to the power terminal blocks marked "**L**" (**Line**) and "⏦" (**Load**) located on the lower part of the unit.

The power and earth cables are connected to **tunnel** terminal blocks (15 A to 100 A) or **screw** terminals (125 A and 150 A).

Above **125 A**, it is necessary to connect the power cables using round lugs.

The capacities of the power terminals are shown in table 3-1.

The **tightening torques** must comply with the limit values shown in the same table.

Attention !

Tighten the power connections correctly.
Poor tightening can lead to incorrect operation of the thyristor unit and can have serious consequences for the installation.

Nominal current	Capacity of the power and earth terminals mm²	Tightening torque N.m
15 A to 55 A	2.5 to 16 (M4)	1.8
75 A and 100 A	2.5 to 50 (M6)	2.5
125 A and 150 A	Power: 50 or 70 (M8) Earth: 2.5 to 50 (M4)	12.5 2.5

Table 3-1 Details of power cabling for 460 units

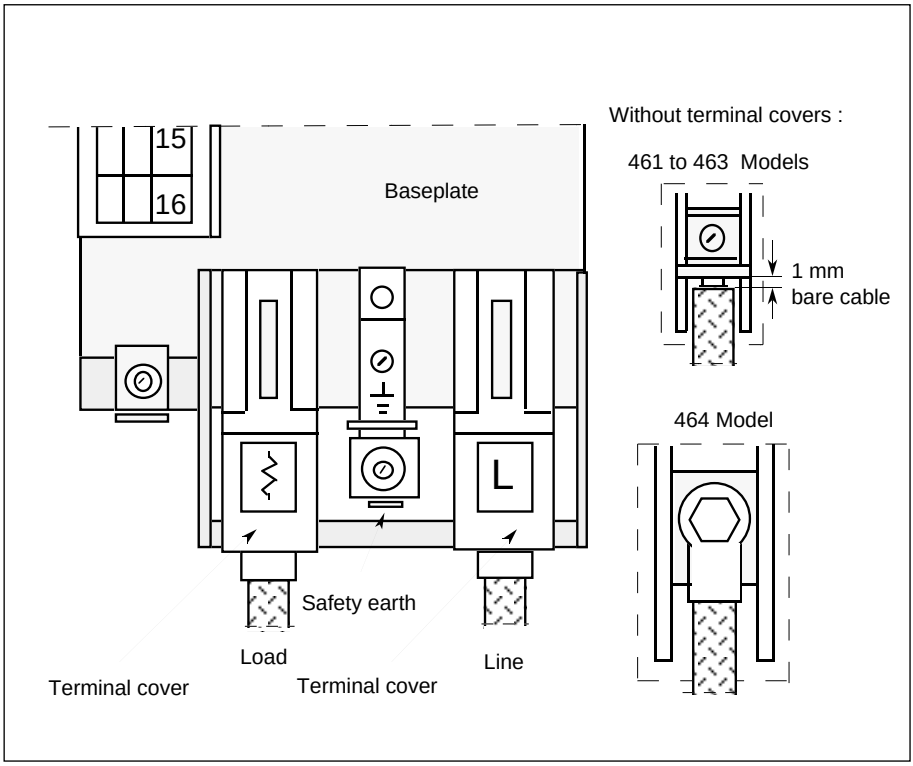

Figure 3-1 Power and safety earth cable fixing points

The cross-section of the connecting conductors used must comply with the **IEC 943** standard.

Model	**Fixing**	**Distance between terminals mm**
461	16 mm^2 tunnel terminal	25.4
462	35 mm^2 tunnel terminal	55
463	35 mm^2 tunnel terminal	82
464	M10 Screw	61.5

Table 3-2 Power cabling details for 460 units

USER TERMINAL BLOCKS

The terminal blocks used to connect the electronics power supply and the PLF alarm relay contact are located at the top left of the baseplate.

The unit must be unplugged from the baseplate in order to access the user terminal blocks.

The connections are made using screw terminals.

The maximum wire cross-section is **2.5 mm²**; terminal tightening torque: **0.7 N.m.**

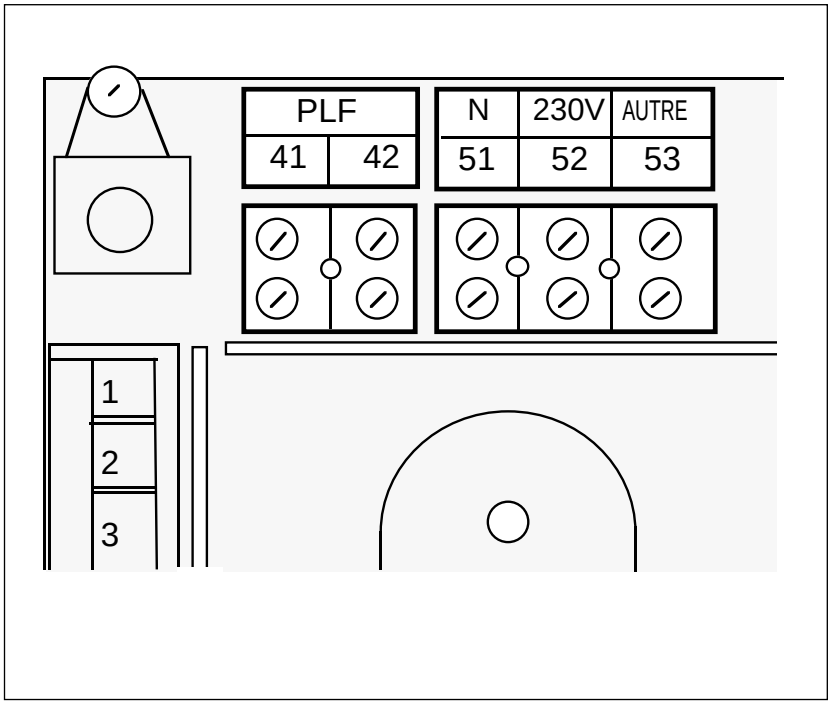

Figure 3-2 User terminal blocks

Electronics power supply

The electronics power supply powers the following:

- the electronic control
- the fan (for fan-cooled units)
- the partial load failure detection circuit.

Terminal **51** is the neutral or the reference phase.

Terminal **52** is used when the electronic control circuit is powered at **230 V** (in the voltage range 200 V to 260 V).

Terminals **51** and **53** are used for voltages **outside** the range 200-260 V (110 or 400 V, for example).

The electronics power supply voltage is specified in the unit code (see page 1-9).

Attention !

- The phases arriving on terminals **51** to **53** must be identical to those on the unit's power terminals, especially if several units are distributed amongst several phases of a three-phase network.
- The control must be powered up after the power or at the same time.
- The control must be powered down before or at the same time as the power.

The electronics power supply is protected from the electrical disturbances on the supply network in common mode.

Each connection wire from the electronics power supply **to a phase** must be protected by a **1A fuse.**

Alarm relay switch

The connection of the partial load failure detection relay switch (**PLF** alarm) which signals the active alarm status is made on the user terminal block located in the upper part of the thyristor unit, **on the left**.

The switch output terminals are marked **41** and **42** on the terminal block label.

The PLF alarm relay is **non-energised in alarm status** and when the unit is switched off.

On **standard** models, the relay switch available between terminals **41** and **42** is **open** in alarm status and in the event of a power failure.

Optionally (code **83**), the alarm relay switch is **closed** in alarm status.

The partial load failure detection relay switch is protected by a **snubber** circuit on the control board.

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

The PLF alarm relay switch output is suitable for driving an alarm unit.

The PLF alarm relay is reset either by switching off the thyristor unit or by a return to the nominal current.

CONTROL CABLES

Attention !

The control connections must be made with **shielded cables connected to earth at both ends** in order to ensure satisfactory immunity against interference.

Separate the control cables from the power cables in the cable routes.

Fixing

The control wires must be grouped together in a shielded cable passing through the **cable clamp** under the unit, to the left of the power terminal block.

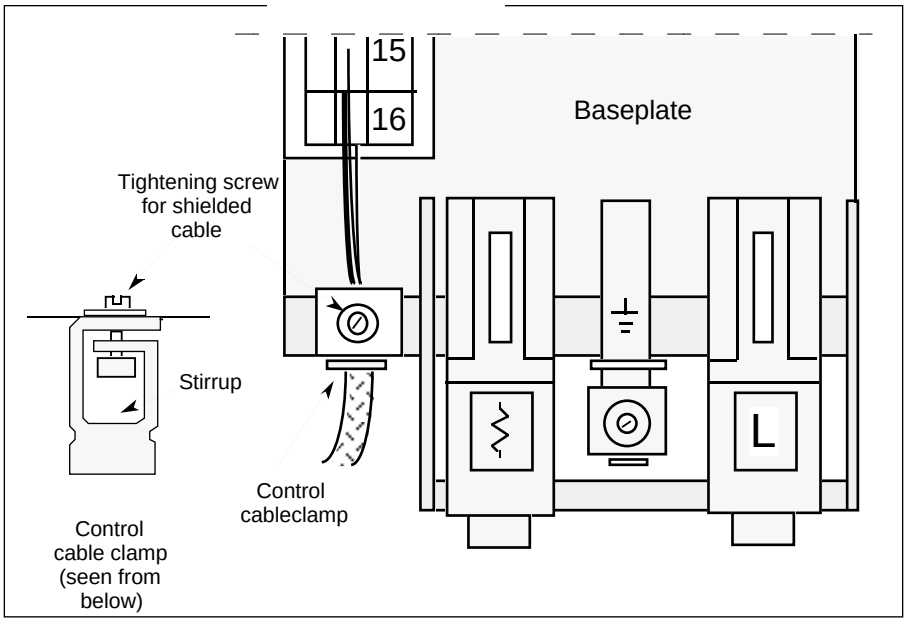

Figure 3-3 Control cable clamp location

Important !

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

Connecting the shield to the ground

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

¥ **Strip** the shielded cable as shown in figure 3-4,a.
The control wires must be long enough for the connection between the metal cable clamp and the control terminal block. The cabling inside the unit must be as short as possible.

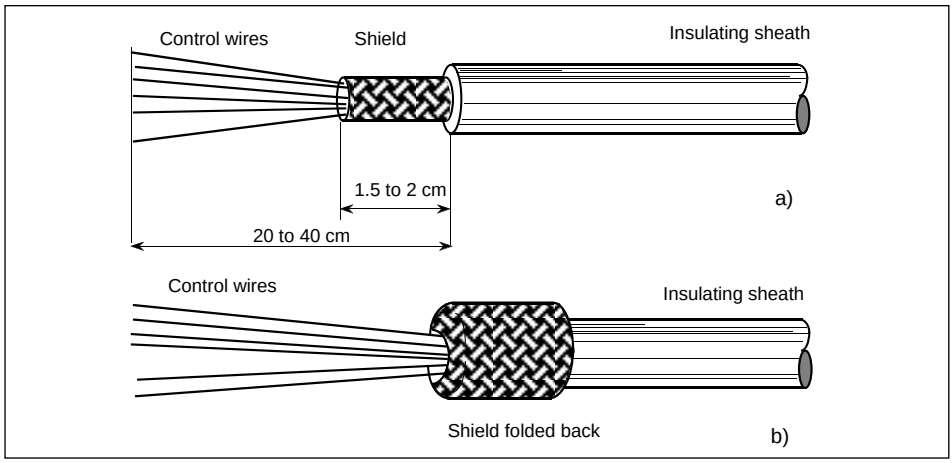

Figure 3-4 Control cable stripping

¥ **Fold back** the shield on the insulating sheath (figure 3-4,b)

¥ **Insert** the cable in the metal cable clamp so that the shield is located in the stirrup and does not pass the cable clamp.

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

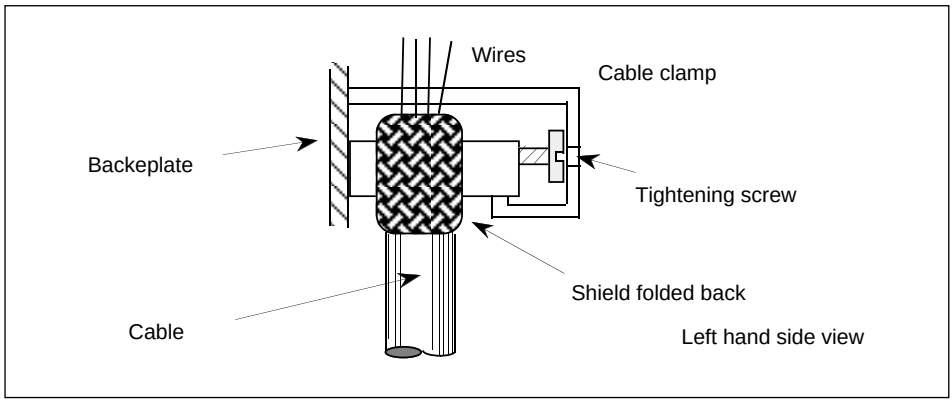

Figure 3-5 Cable tightening and shield grounding

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

CONTROL TERMINAL BLOCK

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

- the (external or manual) input signal
- the inhibition of the thyristor unit operation
- the threshold current limit
- the load current and voltage retransmission
- the logic signal output to control a solid state contactor ("Slave firing" output)

The terminal block is fixed on the baseplate and can be accessed after the 460 thyristor unit has been unplugged.

Danger !

Dangerous live parts may be accessible when the unit is unplugged.

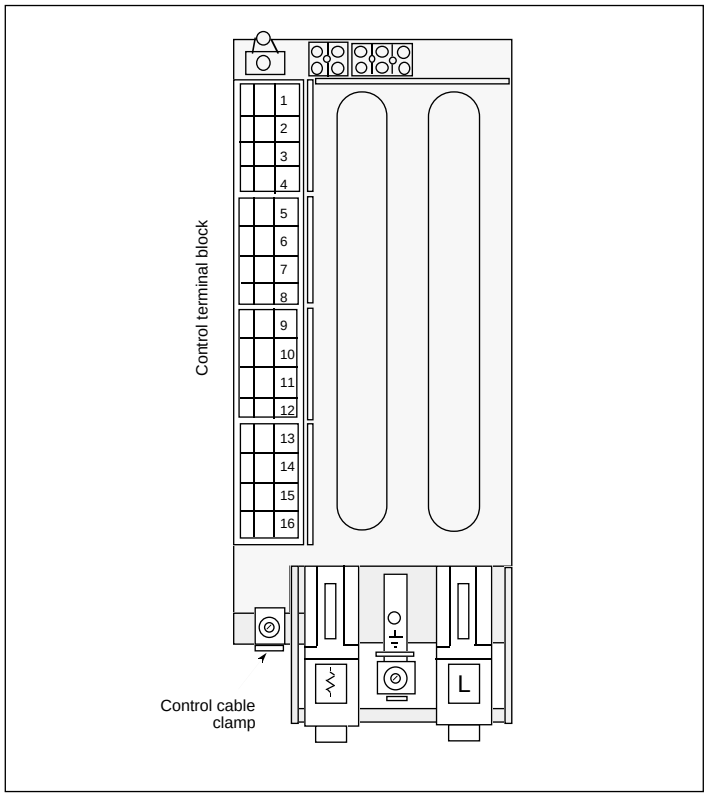

Figure 3-6 460 thyristor unit control terminal labelling

Control terminal block capacity: **0.5 mm² to 2.5 mm².**
Control terminal tightening torque: **0.7 N.m.**

Terminal number	Description
1 2	Not connected
3	Load current image output Retransmission 0-5 V Full wave rectified signal
4 5 6	Manual input External input Common 0 V
7 8 9 10 11	Not connected
12	+10 V user voltage
13	"Slave firing" output (10 Vdc ; 10 mA max)
14	Current limit input
15	Load voltage image output (electronics power supply) Retransmission 0-5 V Full wave rectified signal
16	Thyristor unit operation inhibition input

Table 3-3 Control terminal identification

INPUT SIGNALS

The control wires are connected to the screw terminal block (control terminal block) attached to the baseplate.

The terminal block is accessible with the 460 thyristor unit dismounted from the baseplate.

To dismount the thyristor unit from its baseplate:

- unlock the upper attachment by a quarter of a turn
- tilt the unit forwards to approximately 20 degrees from the horizontal
- free the unit from its baseplate.

Danger !

- Before dismounting the unit, ensure that the heatsink is not hot.
- Dangerous live parts may be accessible if the unit is dismounted when the thyristor unit is switched on.

The thyristor units can be controlled by an external analogue signal (from a controller or another signal source) or manually by an external potentiometer connected to the control terminal block.

Note: The following low level inputs / outputs:

- control signal
- load current image output
- load voltage image output
- "Slave firing" command output
- inhibition

are **isolated** by transformers from the electronics supply voltage and from the power section.

External control

The 460 thyristor unit can be configured with the choice of 3 input signal voltage levels and 4 input signal current levels (see technical data).

The external signal is applied to terminals **5** and **6** of the control terminal block ("+" on terminal **5**).

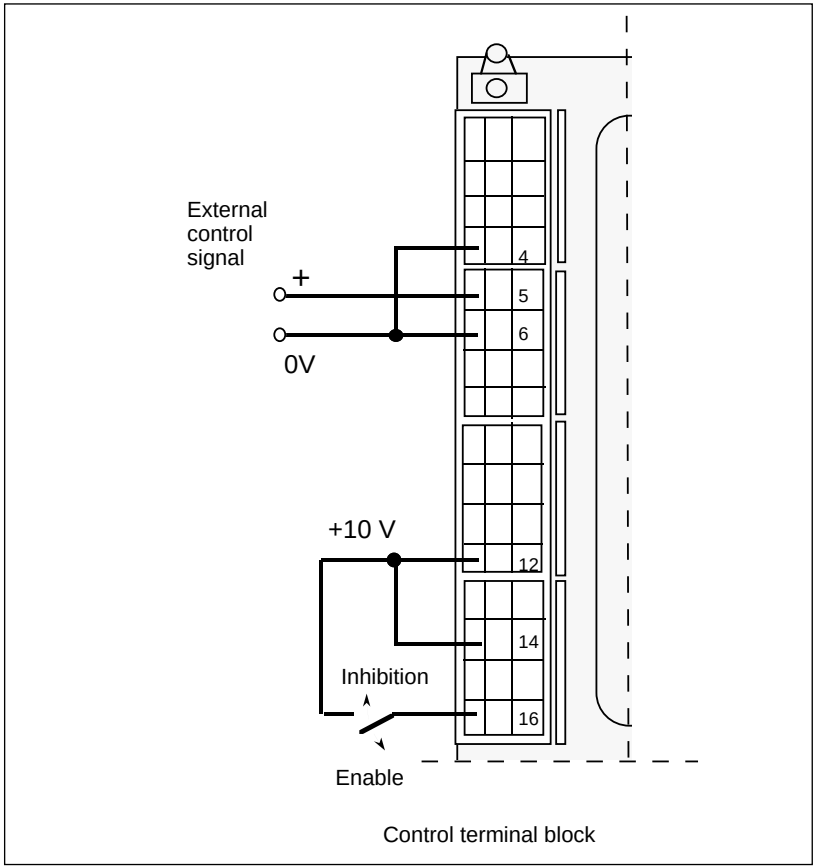

Figure 3-7 External control signal configuration

For normal operation of the **460** series thyristor unit, disconnect the "Inhibition" input (terminal **16**) from the "**+10 V** user" voltage (terminal **12**).

The "Current limit" input (terminal **14**) should be connected to the "**+10 V** user" voltage.

The "Manual input" (terminal **4**) should be connected to terminal **6** "**0 V**".

Control of multiple thyristor units

Multiple thyristor unit inputs can be configured in **parallel** or in **series.**
For these types of configuration, all the thyristor units must have the **same** type of firing and the inputs must be **configured** for the **same** signal.

Input parallel configuration

The inputs must be configured for voltage.
The input impedance for each thyristor unit is **100 kΩ**.
The current required for each thyristor unit is **0.2 mA** at full scale.

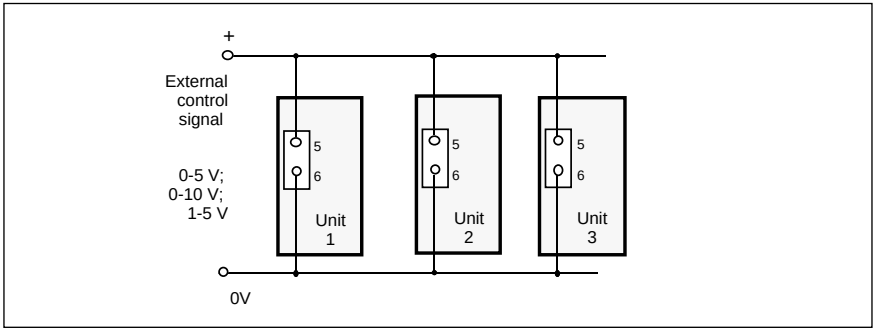

Figure 3-8 Parallel input configuration

Input serial configuration

The inputs must be configured for current.
The input impedance when configured for **0-10 mA** is **1 kΩ**.
For **0-20 mA** and **4-20 mA** inputs, the input impedance is **250 Ω** .
At full scale, a voltage of **5 V** is needed for each thyristor unit for the **0-20 mA** and **4-20 mA** inputs (**10V** for the **0-10 mA** input).

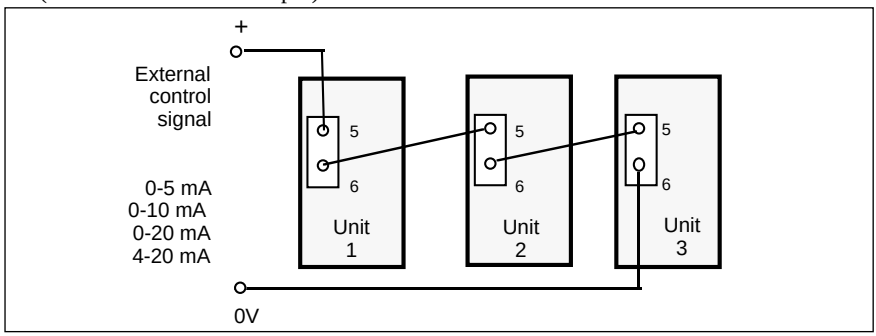

Figure 3-9 Serial input configuration

Manual control configuration

The power thyristor unit can be controlled by an external potentiometer (**manual** control).

For manual control, the external potentiometer should be connected between terminals **6** ("**0 V**") and **12** ("**+10 V**"). The wiper is connected to terminal **4** ("Manual input").

The potentiometers used are from **4.7 kΩ** to **10 kΩ**.

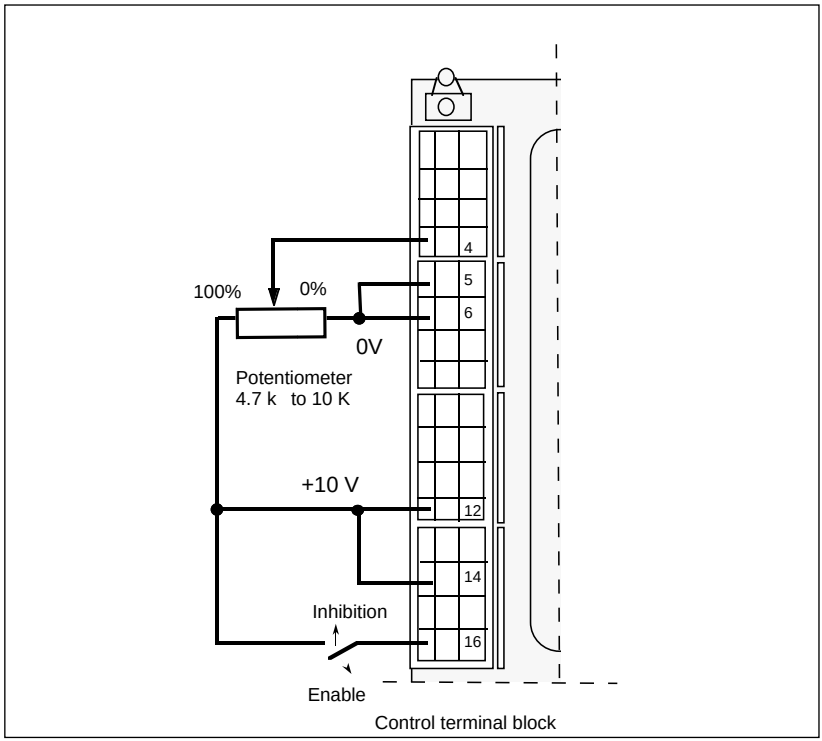

Figure 3-10 460 thyristor unit manual input

If manual control is used, terminal **5** of the external input must be connected to "**0 V**".

Attention !

If the input signal is not disconnected from terminal **5**, the **two** signals (external and manual) are added together.

The inhibition circuit should be open (terminal **16** is not connected to terminal **12**). If the current limit is not used, terminals **14** and **12** should be connected together.

Current limit configuration

The **460** series power thyristor units have **2** types of current limit (see "Operation" chapter):

- **linear** limit (internal limit) and
- **threshold** limit (external limit).

For **linear** current limit the ratio "Load current / Input signal" can be adjusted by the potentiometer marked "**I limit / Limit.I** " on the front fascia.

The threshold current limit is a function which is used to limit the load current to **a specified value**, independently from the input signal and the linear current limit.

The current limit regulates the **square** of the RMS load current (**I^2**).

The current limit can be used with an external or manual control.

Linear current limit

The linear current limit can be set by the internal voltage available on the control terminal block.

The linear current limit is maintained by connecting terminal **14** of the control terminal block to "**+10 V**" (terminal **12**).

Attention !

The terminals **14** and **12** must be connected together,
otherwise the threshold current limit is at zero
and the thyristor unit cannot operate.

For **linear** current limit the ratio "Load current / Input signal" can be adjusted by the potentiometer marked "**I limit / Limit.I** " on the front fascia.

Threshold current limit

The threshold current limit can be adjusted in **2** different ways:

- by an external voltage,
- by an external potentiometer.

External voltage adjustment

For the threshold limit, an external **0-10 V** voltage should be connected between terminals **14** ("Current limit") and **6** ("**0 V**"), terminal **14** is positive.

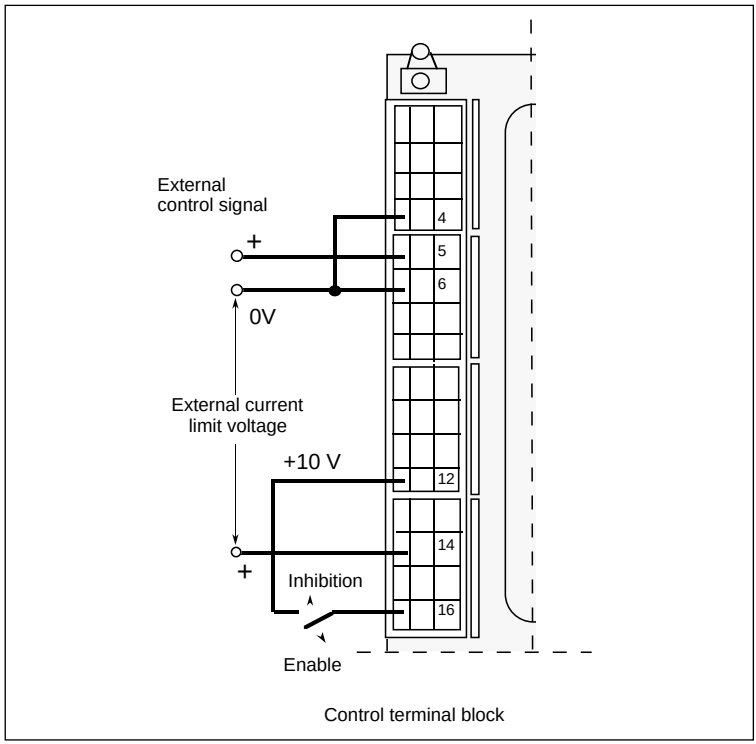

Figure 3-11 External voltage configuration for the threshold current limit

If the external current limit is not used, terminals **14** and **12** must be connected together, otherwise the threshold current limit is at zero and the thyristor unit cannot operate.

Potentiometer adjustment

For the threshold current limit, it is possible to use an external potentiometer.

This **10 kΩ** potentiometer should be connected between terminals **6** ("**0 V**") and **12** ("**+10 V**") of the control terminal block.

The wiper should be connected to terminal **14** ("Current limit").

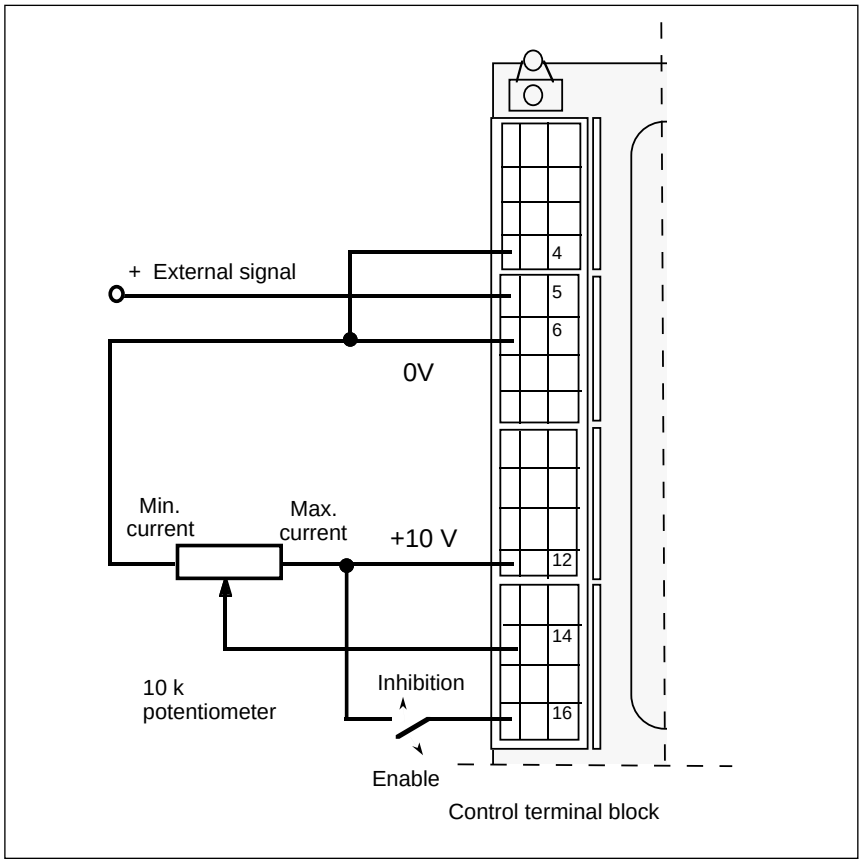

Figure 3-12 External potentiometer configuration for the threshold current limit

Retransmission signal configuration

The load current and voltage images are available on the control terminal block.

- The **voltage image** is available between terminals **15** ("Load voltage") and **6** ("**0 V**"). The voltage image is retransmitted as a full wave rectified signal produced from the **electronics power supply**.

  The value of this signal is **4.3 V** mean for the nominal voltage.

- The **current image** is retransmitted as a full wave rectified signal. This signal is available between terminals **3** and **6** ("**0V**").

The "current image" retransmission signal is proportional to the load current.
The value of the retransmitted signal is **4.8 V** mean (approximately) for the nominal current of the thyristor unit in full firing.

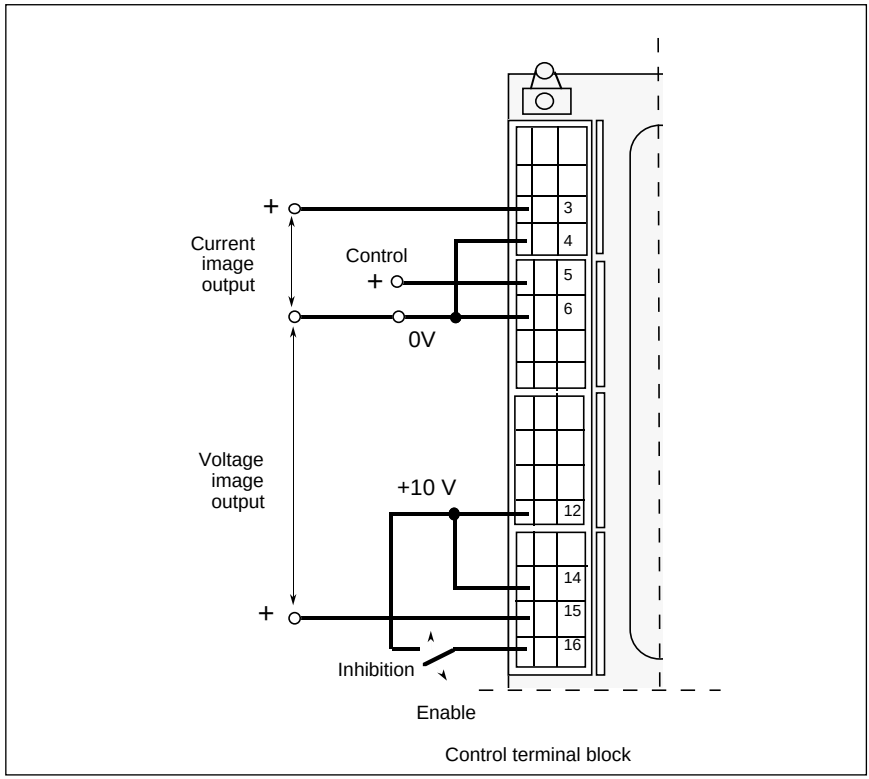

Figure 3-13 Retransmission signal configuration

Inhibition

Inhibition means that the thyristors cannot fire whatever the control signal. The inhibition input is available between terminal **16** and terminal **6** ("0 V"). The inhibition is operative when a dc voltage is applied to terminal **16**.

The inhibition signal must be between **4 V** and **32 V** relative to terminal **6** ("0 V"). The inhibition can be performed by connecting terminal **16** to terminal **12** ("+10 V") on the same control terminal block. To prevent the activation of the inhibition, terminal **16** (Inhibit input) should not be connected or alternatively apply a dc voltage of between **-2 V** and **1 V**.

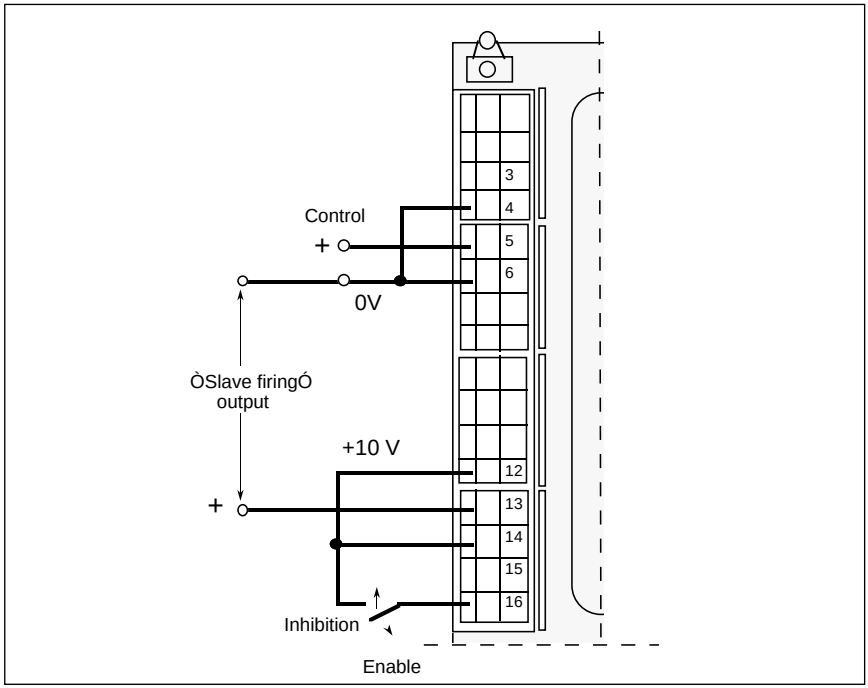

Figure 3-14 "Inhibition" and "Slave firing output" terminals on the control terminal block

"Slave firing" output

The logic signal (**10 Vdc** ; **10 mA** max.) available between terminals **13** ("Slave firing output") and **6** ("**0 V**"), is used to **drive** solid state contactors.

The capacity of this output is characterised by the number of "Slaves", as follows:

- one 450 series solid state contactor, standard input
- four 450 series solid state contactors, TTL inputs in parallel
- four 450 series solid state contactors, "Multi-control" inputs in series.

SINGLE-PHASE LOAD WIRING DIAGRAM

The load current passes through the power terminals "**L**" (Line) and « ⧘ » (Load).

The **other** load end is either connected to the **neutral** or the **2nd** phase of the supply, depending on the power configuration. The terminal "**L**" must be connected to the **line** of the supply. It is essential to comply with this configuration in order to avoid incorrect operation.

The **51** to **53** terminals must be connected depending on the supply voltage (see page 3-6).

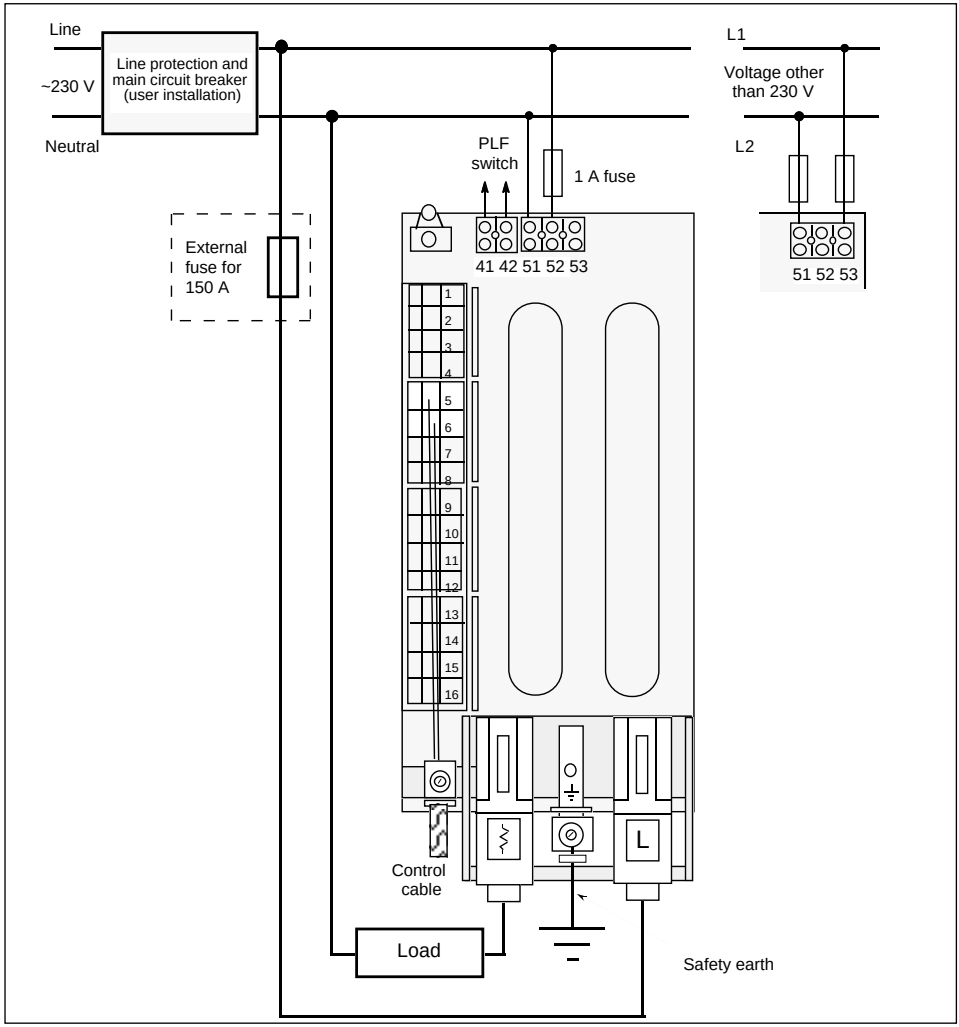

Figure 3-15 460 thyristor unit single-phase configuration, controlled by an external signal

THREE-PHASE LOAD WIRING DIAGRAMS

Although the **460** series thyristor units are single-phase units, they can be used to control three-phase units. In **three-phase operation**, the configuration of the power and the electronics power supply voltages is determined by the load type and configuration.

Three-phase configurations use **460** series thyristor units or **460** thyristors which drive the **450** series solid state contactors in "Master-Slave" operation.

Important !

- Three-phase operation of three **460** power thyristor units is only possible for a load in a **star with neutral** (4 wire configuration) or an **open delta** (6 wire configuration). It is preferable to use a three-phase Eurotherm **TC3001** series thyristor unit.
- In the case of a **3 wire** configuration (load in start without neutral or in closed delta), it is not possible to control the three phases with **460** thyristor units.
  Instead use a 460 thyristor unit ("**Master**") and two 450 solid state contactors ("**Slaves**").
- In three-phase "**Master-Slave**" operation, only "**Burst**" thyristor firing modes (Single cycle, fast or slow) without soft start or end are possible.
- It is essential to supply the control electronics with a voltage which is **in phase** with the supply voltage for the loads and the thyristors.

The choice of the three-phase configuration can be made according to the guidelines in the following table.

Load type	**Type of configuration**	**"Unit-Load" connection**	**Three-phase configuration**
Low temperature coefficient	Star with neutral Open delta	Direct	One 460 thyristor unit plus two 450 solid state contactors ("Master-Slave")
		3 single-phase transformers	Three 460 thyristor units or one TC3001 series three-phase thyristor unit
		Three-phase transformer	One TC3001 series three-phase thyristor unit
	Star without neutral Closed delta	Direct	One 460 thyristor unit plus one two-phase control. 450 solid state contactor ("Master-Slave")
	Closed delta	Three-phase transformer	One TC 3001 series three-phase thyristor unit or one TC2001 series thyristor unit in two-phase control
High temperature coefficient	Star with neutral Open delta	Direct or 3 single-phase transformers	Three 460 thyristor units (in phase angle with current limit) or one TC3001 three-phase thyristor unit
		Three-phase transformer	One TC3001 thyristor unit

Table 3-4 Possible three-phase configurations

The "**Slave**" logic output signal is provided on the control terminal block of the **460** for "**Master-Slave**" operation with solid state contactors.

The connection of the reference voltage for **450** series solid state contactors is described in the "450 User Manual" (Part N° **HA 174910 ENG**).

Attention !

For two phase control of a 3 phase application (460 'Master' and 450 'Slave') and with 450 series PLF option, auxiliary supply voltage must be the same as 3 phase line-to-line voltage

The inputs of the **450** solid state contactors should be configured for **10 V** logic signals and connected in parallel or in series.

Attention !

In the case of loads with **high temperature coefficients** connected in a star with neutral, the current in the **neutral** can be up to **1.7 times higher** than the current in the phases, as the current in the phases is limited by the current limit of each thyristor unit.

For correct operation of 460 series thyristor units, it is important to **comply** with the power and electronics power supply connections shown on figures 3-16 to 3-19.

Load in star without neutral or in closed delta (2 phase control)

For three-phase loads connected in star with neutral or in closed delta (**3 wire** configuration), the use of **2 phase control** is recommended.
One phase of the supply is direct (not controlled).

In the 2 controlled phases, a **460** thyristor unit operating as the "**Master**" (the logic control output - terminal **13**) and a "**Slave**" **450** solid state contactor should be connected.

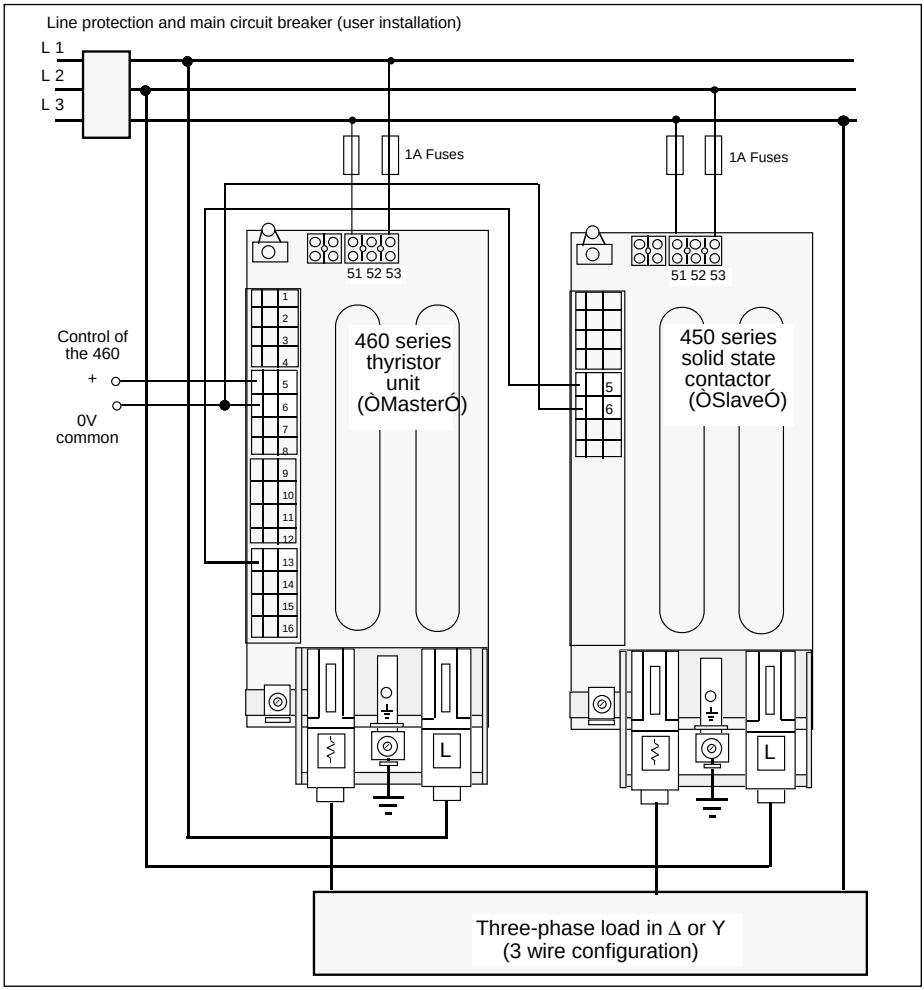

Figure 3-16 2 phase control configuration of a thyristor unit and a solid state contactor (PLF option, fan cooled); 380 V supply

EMC filter connection (2 phase control)

For **two phase control application (**three-phase loads connected in star with neutral or in closed delta) use the EMC external series three-phase filter.

The Eurotherm filter ordering codes see page III.

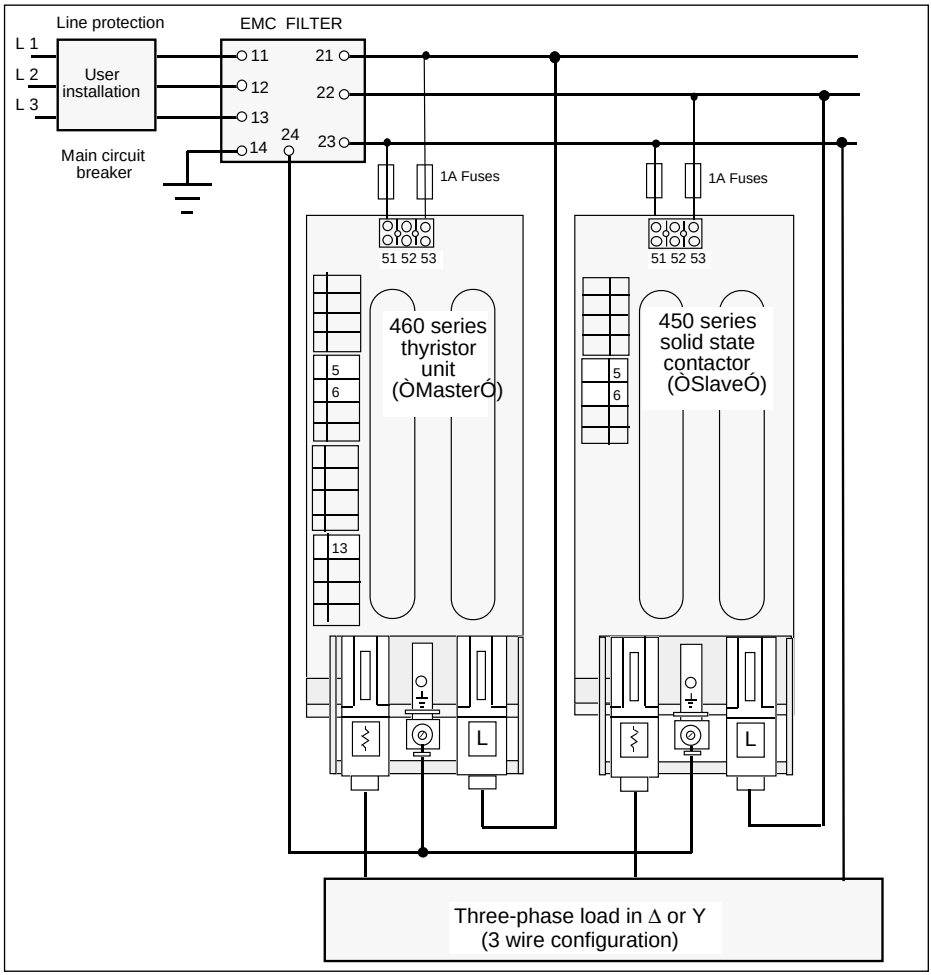

Figure 3-17 Two-phase control power configuration with the EMC series three-phase filtre (PLF option, fan cooled); 380 V supply

Load in star with neutral

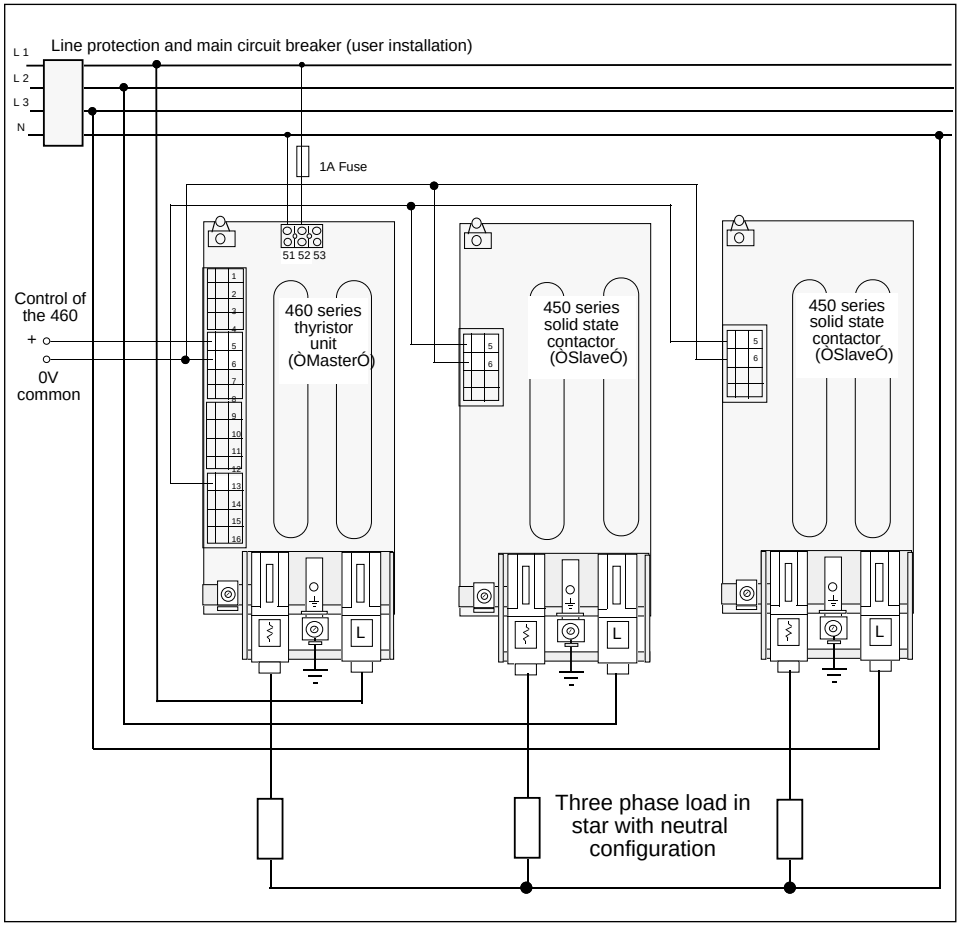

Figure 3-18 Configuration of a 460 thyristor unit ("Master") and two 450 solid state contactors ("Slaves")
Without PLF option, non-fan-cooled; voltage 230 V

Load in open delta

For the open delta load configuration (6 wire configuration) three 460 series power thyristor units can be used, in all available firing modes.
The power configuration shown in the figure below must be observed.

Danger !

The thyristor units and the electronics voltage circuits are at the line-to-line voltage.

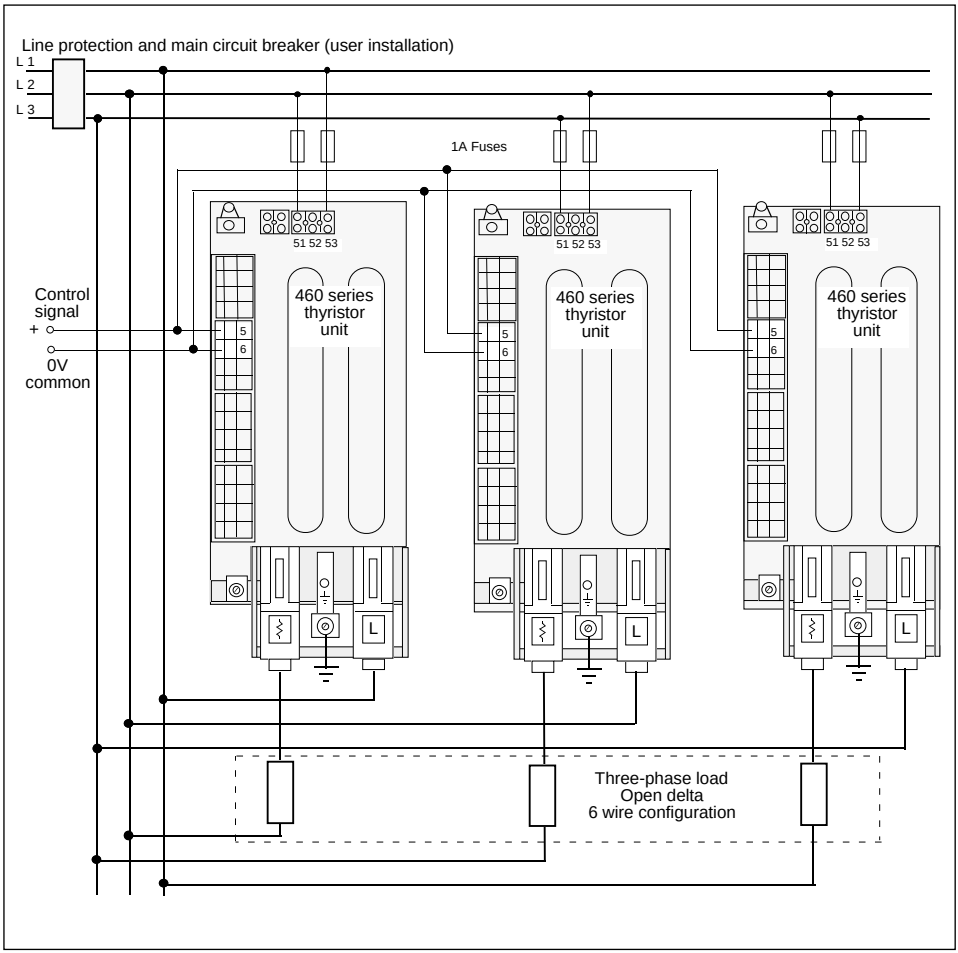

Figure 3-19 Wiring diagram for three 460 thyristor units in "Open delta" (380 V supply)

Chapter 4

CONFIGURATION

Contents page

Chapter 4 CONFIGURATION

SAFETY DURING CONFIGURATION

The thyristor unit is configured using miniature switches and mobile **jumpers** located on the driverboard.

Important !

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

This chapter is included in order to

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

Danger !

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

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

After the reconfiguration of the unit, correct the codes on the identification label to prevent any maintenance problems later.

CONFIGURATION OF THE DRIVER BOARD

The 460 series thyristor units are fitted with a strip of miniature switches and two jumpers used to select :

- the input type
- the desired thyristor firing mode
- the frequency used (50 or 60 Hz).

These miniature switches and the configuration jumpers are located on the driver board.

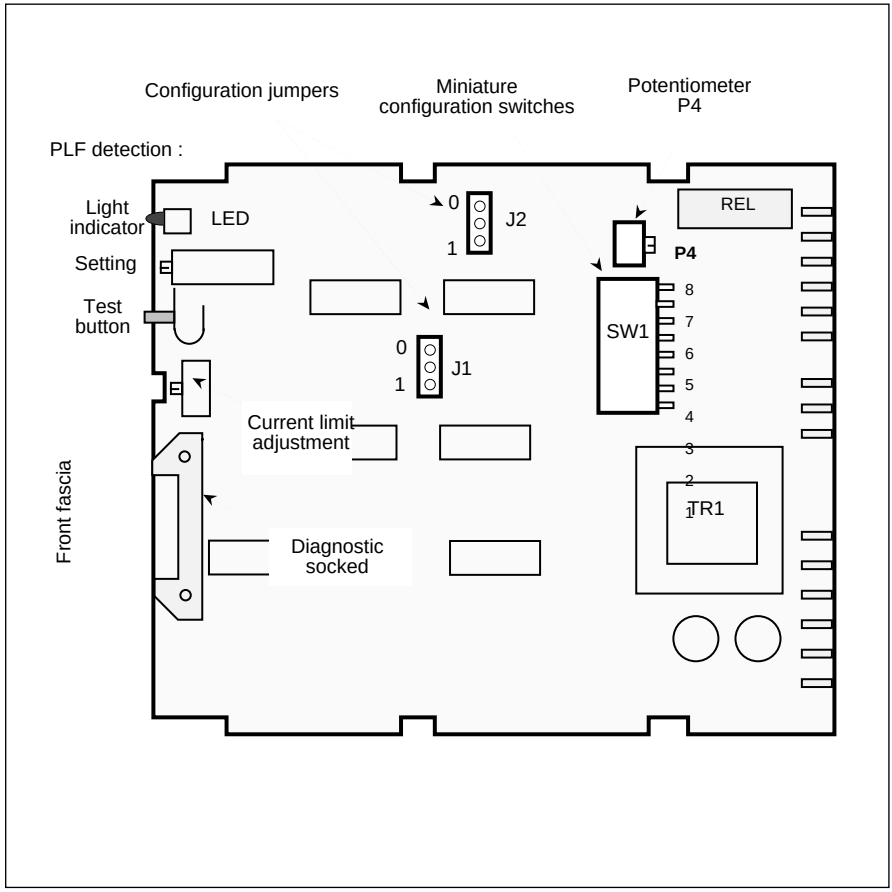

Figure 4-1 Location of the configuration elements on the driver board of the 460 thyristor unit.

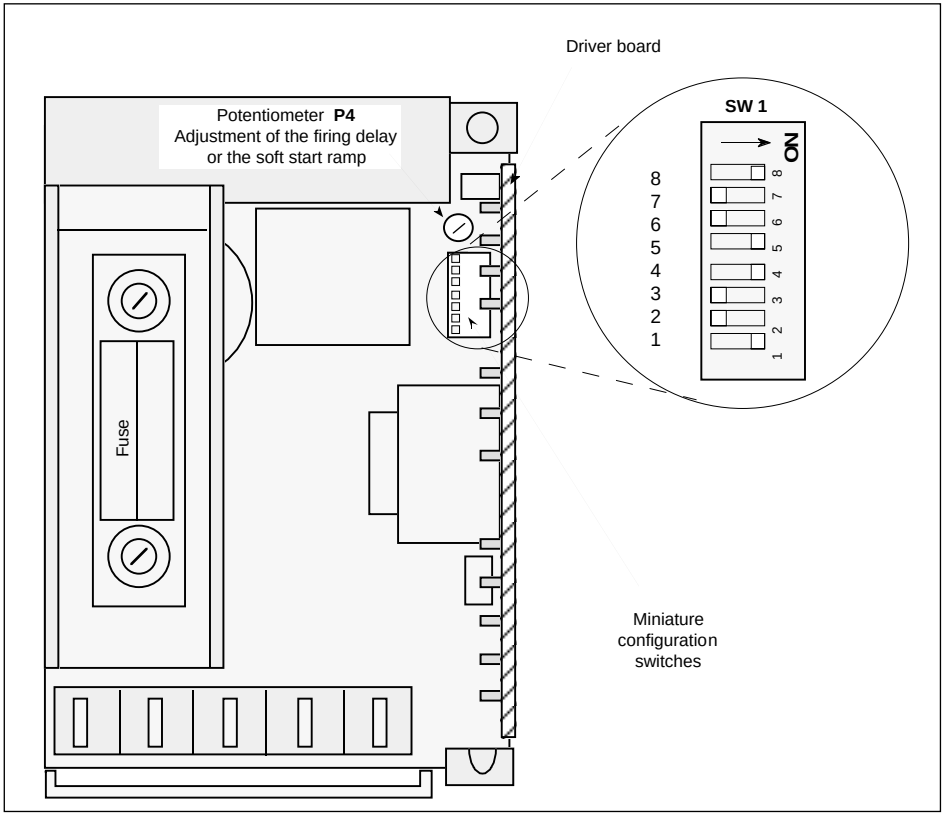

Figure 4-2 Location of the miniature switches (rear view)

The positions of the miniature switches correspond to:

1 - switch **lowered (ON position)**
0 - switch **raised**.

Unless otherwise specified in the order, the thyristor units are delivered with the following configuration:

- the input configured for 4-20 mA
- the thyristor firing mode set to firing angle variation (Phase angle)
- frequency 50 Hz
- the thyristor firing delay potentiometer set to the maximum :
  maximum start ramp (resistive load) and 90° firing delay (inductive load).

Input type

The input signal type is configured by miniature switches **1** to **4**.

In tables 4-1 to 4-4, the **1** indicates the lowered position of the switch (ON position).

Automatic input (external signal)

Automatic external input signal	Position of the miniature switches			
	1	**2**	**3**	**4**
0-5 V	0	0	0	0
0-10 V	1	0	0	0
1-5 V	0	1	0	0
0-5 mA	0	0	1	0
0-10 mA	1	0	1	0
1-5 mA	0	1	1	0
0-20 mA	0	0	1	1
4-20 mA	0	1	1	1

Table 4-1 Configuration of the automatic input

Manual input

The manual input range controlled by the external potentiometer (the wiper is connected to terminal **4**)depends on the configuration of the automatic input.

Position of the miniature switches		Manual input range
1	**2**	
0	0	0-5 V
1	0	0-10 V
0	1	1,25 V - 6,25 V

Table 4-2 Configuration of the manual input

Thyristor firing mode

The thyristor firing modes available for the 460 series power thyristor units can be configured by **miniature switches 5** to **7** and by two **jumpers J1** and **J2** located on the driver board.

Thyristor firing mode	**Position**				
	Miniature switches			**Jumpers**	
	5	**6**	**7**	**J1**	**J2**
Firing angle variation	0	0	0	0	-
Single cycle	1	0	0	0	-
Fast cycle	1	1	0	0	-
Slow cycle	1	1	0	1	-
Fast cycle with soft start	1	1	1	0	1
Slow cycle with soft start	1	1	1	1	1
Fast cycle with soft start and end	1	1	1	0	0
Slow cycle with soft start and end	1	1	1	1	0

Table 4-3 Configuration of the firing mode

"-" in table 4-3 indicates that the jumper position is irrelevant.

Frequency

The frequency used is determined by miniature switch **8**.

Frequency	**Position of miniature switch 8**
50 Hz	1
60 Hz	0

Table 4-4 Configuration of the supply frequency used

Chapter 5

OPERATION

Contents page

Chapter 5 OPERATION

THYRISTOR FIRING MODES

General

The **460** series thyristor units have the following thyristor firing modes:

- Phase angle
- Burst ("fast", "slow" or "single cycle") with or without soft start (start and end).

They can be reconfigured by the user as described in the "Configuration" chapter.

"Phase angle" mode

In "**Phase angle**" mode, the power transmitted to the load is controlled by firing the thyristors for a part of the supply voltage alternation (see figure 5-1).
The **firing angle** (Θ) varies in the same direction as the input signal with the control system. The power emitted is not a linear function of the firing angle.

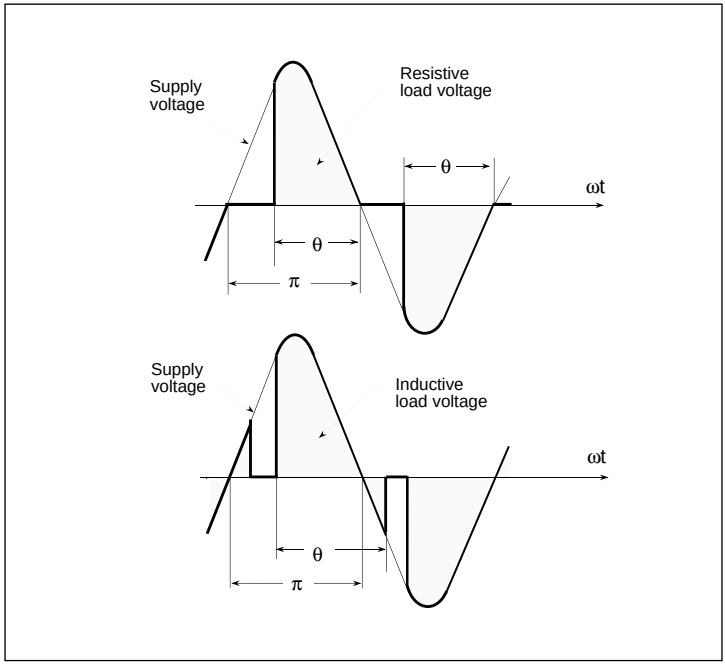

Figure 5-1 "Phase angle" firing mode

"Burst firing" mode

The "**Burst firing**" mode is a **proportional cycle** which consists of supplying a series of **complete** supply **cycles** to the load.
Thyristor firing and non-firing are synchronised with the supply and are performed **at zero voltage** for a resistive load.

This firing eliminates the steep fronts of the supply voltage applied to the load, **does not produce interference** on the supply and, in particular, prevents the generation of parasites.

In the "**Burst firing**" thyristor firing mode, the power supplied to the load depends on firing periods $\mathbf{T_F}$ and non-firing periods $\mathbf{T_{NF}}$**.** The load power is proportional to the firing rate τ and is defined by the ratio of the thyristor firing period ($\mathbf{T_F}$) and the modulation period ($\mathbf{T_M} = \mathbf{T_F} + \mathbf{T_{NF}}$).

The firing rate (or cyclic ratio) is expressed by the following ratio:

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

The load power can be expressed by:

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

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

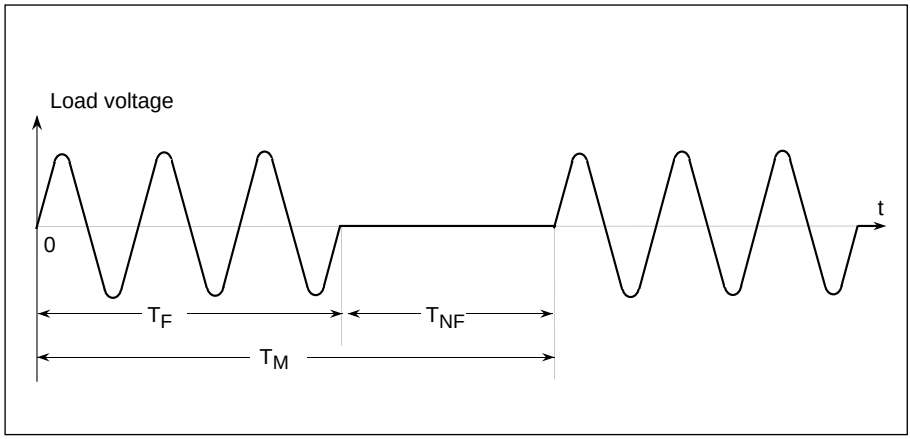

Figure 5-2 Periods of a burst firing cycle

"Single cycle" mode

The "Burst firing" mode with a **single** firing or non-firing period is called the "**Single cycle**" mode.

Modulation period

The modulation period in "Burst firing" mode is **variable** according to the output power. Due to this type of feedback, the 460 unit possesses adjustment precision adapted to each specific setpoint zone:

- At **50 %** power, the typical value of the modulation period is:
  - **0.8 s** for the "Fast" cycle
  - **8 s** for the "Slow" cycle.
- For a zone below **50 %** of the maximum setpoint, the **firing** period decreases and the modulation period increases.
- For a power zone above **50 %**, the **non-firing** period decreases as the modulation period

For example, in the "Fast" cycle:

- for 5 % power, T_F = 260 ms, T_M = 5 s
- for 90 % power , T_F = 2.2 s, T_M = 2.5 s.

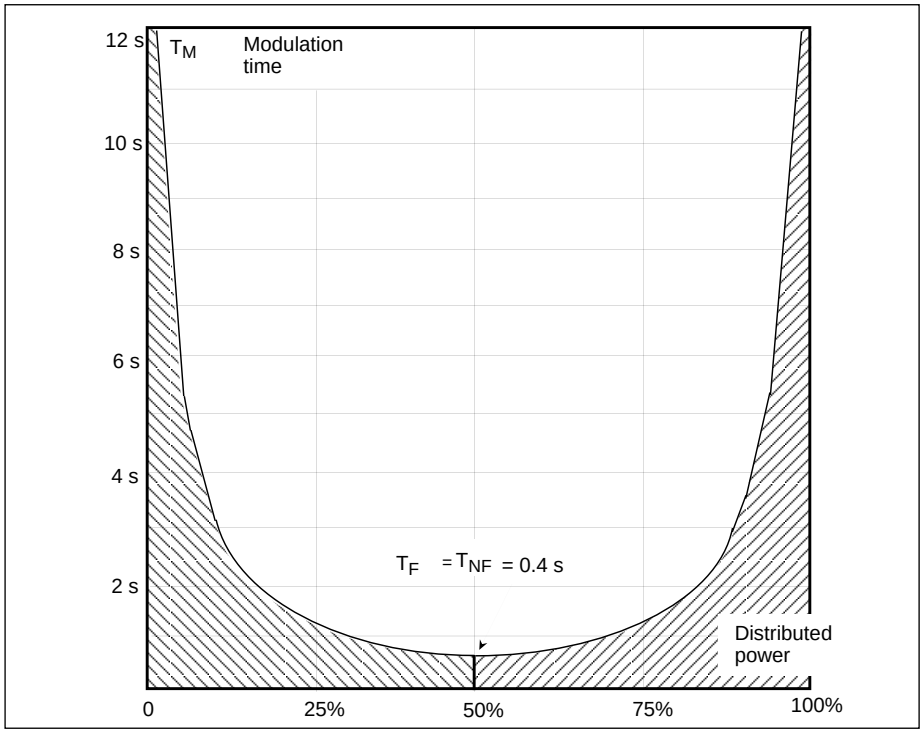

Figure 5-3 Modulation period as a function of power ("Fast" cycle)

Soft start / end

Soft operation (start or start and end) can be configured in the "Slow cycle" and "Fast cycle" Burst firing modes.

The soft start duration ($\mathbf{T_{ss}}$) is the time taken for the thyristor unit output power to change from **0%** to **100%** by varying the thyristor firing angle from **0** to **full firing**.

The soft end duration ($\mathbf{T_{se}}$) is the time take for the thyristor unit output power to **change** from **100%** to **0%** by varying the thyristor firing angle from **full firing** to **0**.

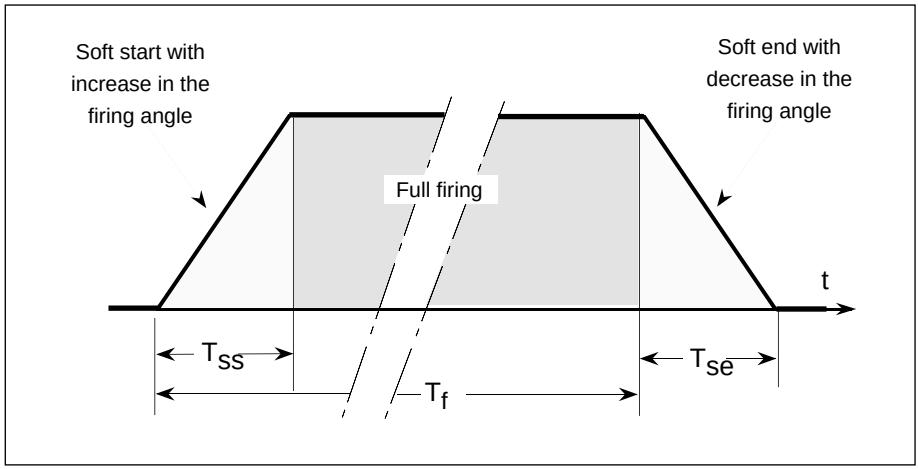

Figure 5-4 Soft start and end in burst firing mode

The duration of the soft start (and end) can be adjusted from **0** to **250** ms by the potentiometer on the driver board (See "Commissioning" chapter).

The soft end time ($\mathbf{T_{se}}$) is not included in the firing period ($\mathbf{T_F}$), but all the power sent to the load is taken into account in the feedback.

After the soft start by thyristor firing angle variation, the thyristor unit remains in **full firing** during the firing time.

Note : For soft starts of loads with very high resistance variations as a function of temperature (e.g.: Kanthal Super), use the **Special 677**, which has an increased start time.

Over-current elimination for the inductive load

The "Fast cycle" and "Slow cycle" Burst firing modes, composed of whole periods, start at zero voltage for purely resistive loads.

For inductive non saturable loads, in Single cycle and Burst mode without soft start, firing at zero voltage generates transient operation which could, in certain cases, induce the appearance of over-currents (figure 5-5,a) and a blow-out of the high speed fuse (thyristor protection).

To prevent this over-current, the first firing of the thyristors for **non-saturable** inductive loads can be **delayed** with reference to the corresponding zero voltage (figure 5-5,b). The optimum **delay angle** (ϕ) must be adjusted with the potentiometer on the driver board (see adjustment) as a function of the load (max. delay **90**°).

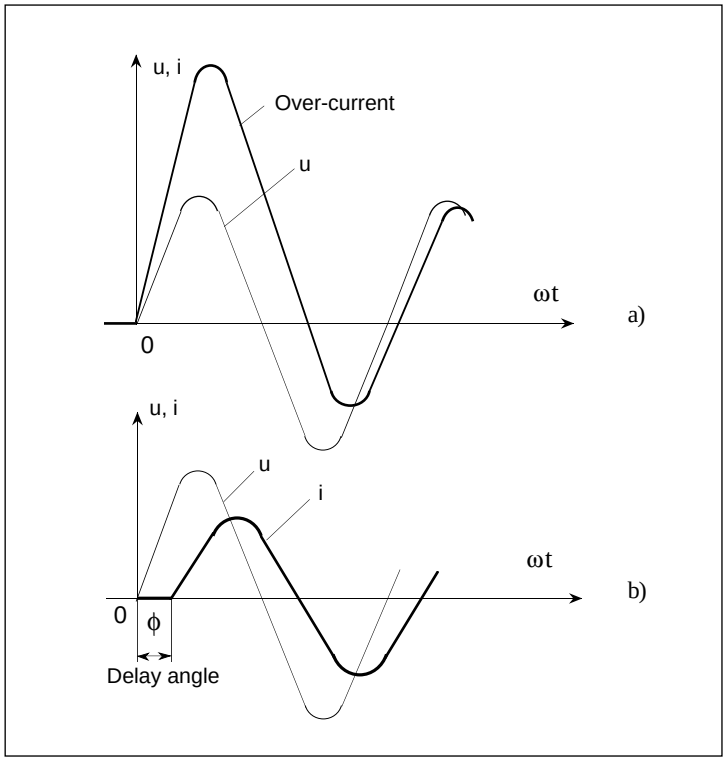

Figure 5-5 Inductive load switching at zero voltage (a) and with delay angle (b)

This firing mode is not suitable for saturable loads (transformer primaries).

CONTROL

Feedback function

The 460 series power thyristor units contain an internal feedback loop.
The thyristor unit output power is linear between **0** and **100 %** of the maximum power as the input signal varies between **4** and **84 %** of the maximum scale.

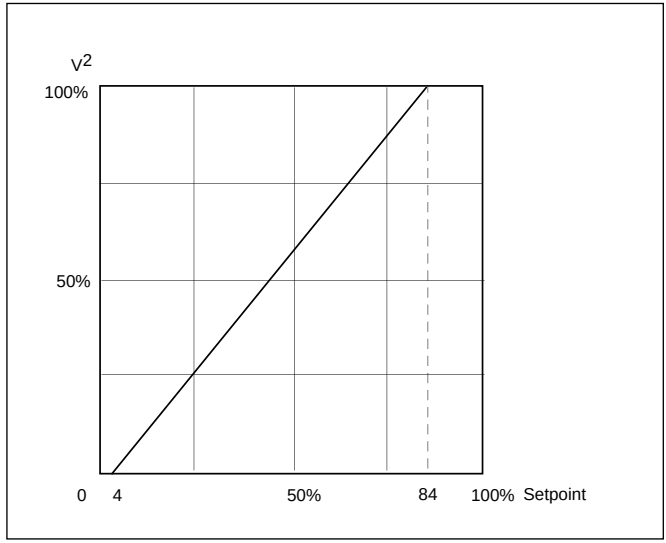

Figure 5-6 Controlled parameter as a function of the setpoint

The **squared RMS load voltage** represents the power dissipated in a purely resistive load, the value of which is constant with the temperature variation.
The accuracy of the power feedback is guaranteed to be within ± **2 %** of the maximum power.

The feedback system automatically selects the higher value of two parameters (**V²** ou **I²**).

For loads with low resistance variation as a function of temperature (iron alloys, nickel, chromium, aluminium, Inconel, etc.), the feedback in **V²** is sufficient.

Feedback with automatic transfer between the two controlled values is very important for loads with high resistance variation as a function of temperature (molybdenum, molybdenum bisilicide, tungsten, platinum, etc.).
For this type of load, the operation is as follows:

- **I²** feedback at start when cold
- automatic feedback type change to **V²** when hot,
  which allows optimum control and feedback at all temperatures.

Supply voltage variation compensation

The supply variation compensation acts in the range: **+ 10 %** to **- 15 %** of the thyristor unit nominal voltage. This voltage is self-supplied on the power and reference phases.

Without a supply voltage variation compensation, a **10 %** decrease or increase in the supply voltage would induce a **20 %** decrease or increase in the power supplied to the thyristor unit load.

For a constant resistive load, the feedback with supply variation compensation is used to maintain the output power constant in spite of the supply voltage variations.

Supply voltage variation range (%)	Setpoint (%)	Power supplied (%)	
		With compensation	Without compensation
0 to +10	100	100	100 to 121
-5 to +10	90	90	81 to 109
-10 to +10	80	80	65 to 97
-15 to +10	70	70	50 to 85

Table 5-1 Feedback with supply variation compensation

Table 5-1 shows the stabilisation of the output power on a constant resistance as a function of the supply variations.

It the voltage falls below **70%** of its nominal value, the thyristor unit is inhibited.

It will be automatically reenabled if the voltage returns to a value greater than or equal to 85 % of its nominal value.

A compensation circuit simultaneously adjusts the thyristor firing time as a function of the supply variations. This compensation prevents power fluctuations and the intervention of the feedback loop, enabling a quicker response.

Selective trigger pulse locking

The **460** thyristor unit thyristors are fired by a trigger **pulse train** of a maximum duration of**5 ms** .

In most single-phase applications, it is possible to send trigger pulses every **10 ms** so that the thyristors are polarised in direct mode (positive anode in relation to the cathode) or in inverse mode (negative anode).

Each thyristor is only fired when its voltage is positive, when it is negative, the anti-parallel thyristor is fired.

In certain applications, the trigger pulses on the polarised thyristor in inverse mode can lead to operating problems: firing instability, fuse blow-out.

It is therefore necessary to **eliminate** the trigger pulses when the thyristor is polarised in **inverse** mode.

This function is performed by the **selective trigger pulse locking** circuit available for **460** thyristor units.

This selective trigger pulse locking is essential for configurations in which multiple thyristor units are distributed between the phases of a three-phase supply and have an electrical configuration which could induce a voltage **phase shift**.

For example:

- control of heating electrodes (in transformer secondary coil) immersed in the same molten glass bath
- load in star with neutral, with the central point of the star connected to the supply neutral by a wire of a non-negligible resistance with reference to that of the load.

CURRENT LIMIT

TThe 460 thyristor units possess two types of current limit with the load current measurement (on I^2) :

- a **linear** current limit and
- a **threshold** current limit.

These two limits are **independent**.

Linear current limit

This function linear limits the squared RMS load current I^2.
In current limit, the correspondence between the load current and the input signal can be adjusted using the potentiometer labelled **"I limit / Limit.I"** on the front fascia.

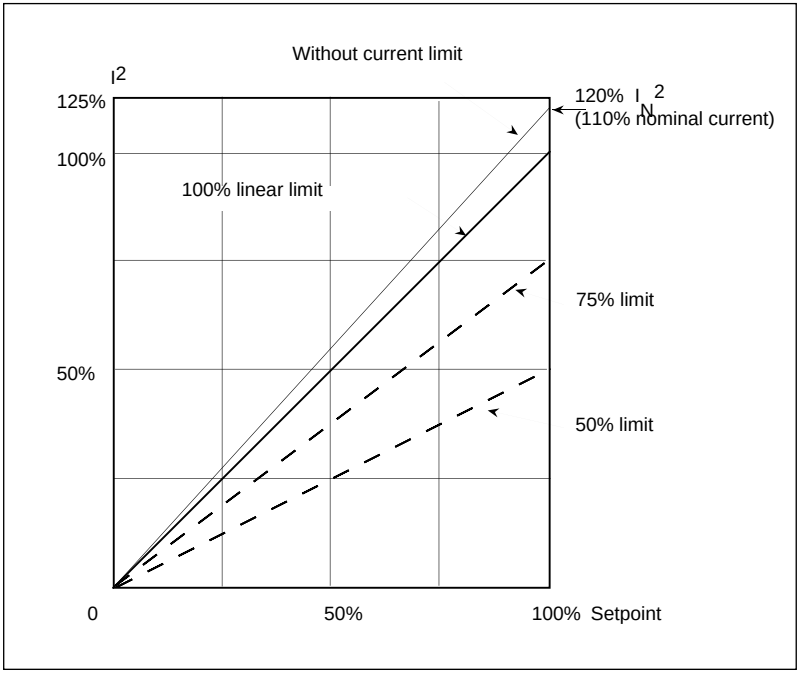

Figure 5-7 Linear current limit

The power feedback in V^2 and the current limit in I^2 provide the best control in all the feedback zones.

Threshold current limit

This type of limit is used to limit the load current to a **desired value** independently of the input signal and the linear current limit.

The "Current limit" input (terminal **14** of the control terminal block) can be controlled:

- by an external adjustment **potentiometer**
- by a **0-10 V** external dc voltage.

When the threshold limit (by potentiometer or by voltage) is not used, terminal **14** of the driver board user terminal block must be connected **directly** to the **+10 V** user voltage (terminal **12**). Otherwise, the current limit is at **zero** and the thyristor unit **cannot output**.

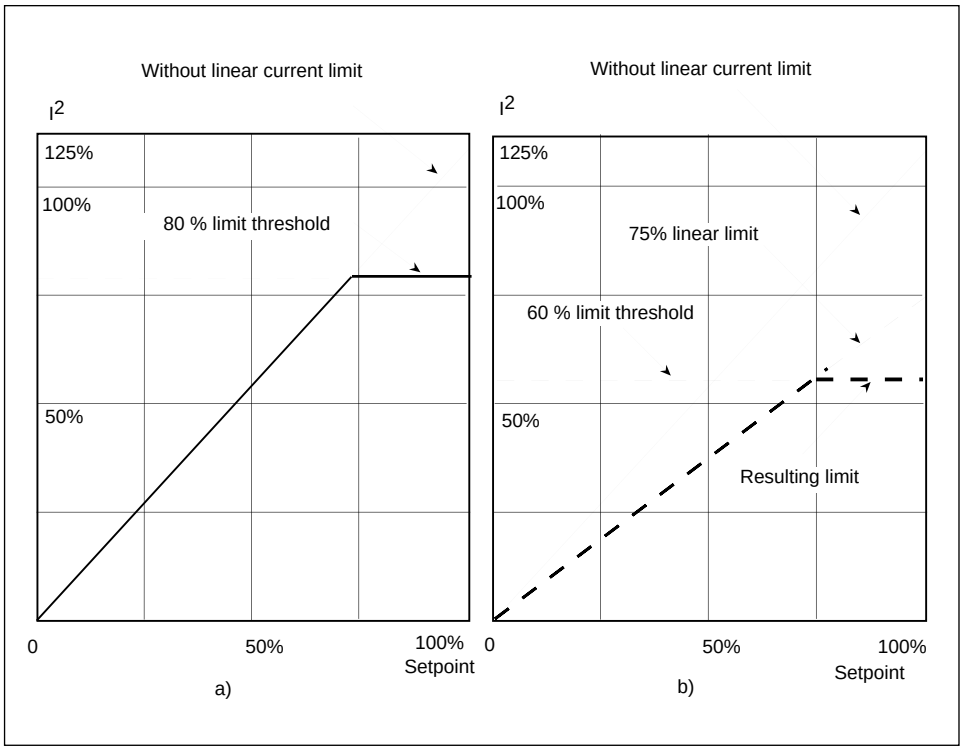

Figure 5-8 Exemple of the current limit :
- threshold current limit (a)
- simultaneous use of 2 types of limit (b)

PARTIAL LOAD FAILURE DETECTION

The "partial load failure" (**PLF**) alarm detects an increase in the load impedance due to the failure of heating elements, for example.

The sensitivity of the PLF circuit is used to detect the increase in the load impedance to **20 %**, which detects the failure of one element out of **5** identical elements mounted in parallel.

On the **460** thyristor unit, the alarm is indicated:

- by an **indicator light** mounted on the front fascia and labelled **"Load Fail"** (lit when a partial load failure is detected)
- by the alarm relay **switch** (switch output is available on terminals **41** and **42** on the user terminal block at the top left-hand corner of the thyristor unit).

The alarm relay is **non-energised** in alarm status when the thyristor unit power is on.

The alarm switch (cut-off capacity **0.25 A** at **250 Vac** or **30 Vdc**) in the standard version is **open in alarm status** or in the event of a **supply failure**.

The switch cut-off capacity must not exceed **250 V** in any circumstances.

As an option (code **83**), this switch is **closed** in alarm status.

The PLF alarm is acknowledged either by switching off the thyristor unit or by a return to the nominal current.

RETRANSMISSION

The **460** thyristor units possess retransmission of load current and voltage images in the form of a signal available on the control terminal block.

Load current image

The load current retransmission signal is available on the control terminal block, between terminals **3** ("**Current image**") and **6** ("**0V**").

The current image can be used for tests or for an external measurement (external impedance **20 kΩ** max).

The full wave rectified output signal is proportional to the instantaneous load current (**4.8V** mean for the nominal current of the thyristor unit in full firing).

Load voltage image

The load voltage retransmission signal is available between terminals **15** ("**Load voltage image**") and **6** ("**0V**") on the user terminal block on the driver board.

This is a full wave rectified signal (**4.3 V** for the load voltage in full firing), generated using the **electronics power supply** (external impedance **5 kΩ** max).

INHIBITION

The **460** thyristor units possess an **active operation inhibition** which requires a voltage to be applied to a control terminal block.

The absence of the inhibition voltage enables the operation of the thyristor unit.

The inhibition input is available between terminal **16** ("**Enable input**") and terminal **6** ("**0 V**") of the driver board.

The inhibition is active when a dc voltage of **+10 V** (**4 V** minimum, **32 V** maximum) relative to terminal **6** ("**0 V**") is applied to terminal **16** ("Inhibition") (see page 3-19).

To inhibit the thyristor unit the "**Enable input**" terminal can be connected (by a normally-closed switch) to the "**+10 V** user" voltage (terminal **12**).

If the thyristor unit is inhibited, the thyristor firing signals are suppressed whatever the input signal.

To enable the thyristor unit, terminal **16** must not be connected to a voltage specified above.

"MASTER-SLAVE" OPERATION

The logic signal (**10 Vdc**, **10 mA**) is available between terminals **13** ("**Slave Output**") and **6**(**0V**) when the **460** thyristor unit is in slow cycle, fast cycle or single cycle firing mode.

The "Slave" output is used to **control** solid state contactors.

Using this logic signal output, it is possible to configure a **460** thyristor unit ("Master") for "Master-Slave" operation, controlling one or two **450** series solid state contactors ("Slaves") for the economical control of single-phase or three-phase loads (see "Cabling" chapter).

Chapter 6

COMMISSIONING PROCEDURE

Contents Page

Chapter 6 COMMISSIONING PROCEDURE

Read this chapter carefully before commissioning the thyristor unit

COMMISSIONNING PROCEDURE SAFETY

Important !

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

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

Danger !

Never use a thyristor unit with a supply voltage greater than the nominal voltage of the thyristor unit as specified in the coding.

Dangerous live parts can be accessible when the unit is dismounted from its baseplate

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

The temperature of the heatsink can be greater than 100°C.
Avoid any contact with the heatsink, even momentarily, when the thyristor unit is operating.
The heatsink remains hot for approximately 15 min after the unit has been switched off.

The thyristor unit is delivered fully configured according to the order code.

CHECKING THE CHARACTERISTICS

Attention !

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

Load current

The maximum load current must be less than or equal to the value of the nominal current of the thyristor unit taking the load and supply variations into account.

In three-phase operation, if **3** identical loads are configured in **closed delta**, the line current of the thyristor unit (both "Master" and "Slave") is √**3 times as high** as the current of each arm of the load.

Supply voltage

The nominal value of the thyristor unit voltage must be greater than or equal to the voltage of the supply used. In three-phase operation, the nominal voltage of the thyristor unit must be greater than or equal to the **line to line** voltage.

Attention !

Given the inhibition at 70 % of the nominal voltage, it is essential that the nominal voltage of the thyristor unit is as close as possible to the nominal supply voltage.

Electronics supply voltage

The electronics supply voltage must be in phase with the power voltage. It is selected by the position of the soldered links and the choice of the transformers. This selection is made in the factory, depending on the electronics supply voltage code.

Input signals

The configuration of the miniature switches on the driver board must be compatible with the selected control signal level (see "Configuration" chapter, page 4-6).

Partial load failure detection

The voltage used for the PLF detection circuit is that used for the electronics power supply. This voltage must thus correspond to the power voltage

Attention !

The PLF alarm switch must be connected in the circuit with a voltage which never exceed 250 V (single-phase or three-phase 230 V supply).

DIAGNOSTIC UNIT

For easier commissioning and adjustment operations and for the thyristor unit state diagnostics, 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 thyristor unit and feedback parameters on its digital display.

The unit displays two decimal places in order to permit the precise indication of the selected values.

Table 6-1 gives the description of each position in the diagnostic unit and the typical values of the signals measured.

The diagnostic unit possesses a ribbon cable which is plugged into the 20-pin connector (diagnostic connector) provided on the front fascia of the thyristor unit.

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

Important !

The values measured are **dc mean values**.

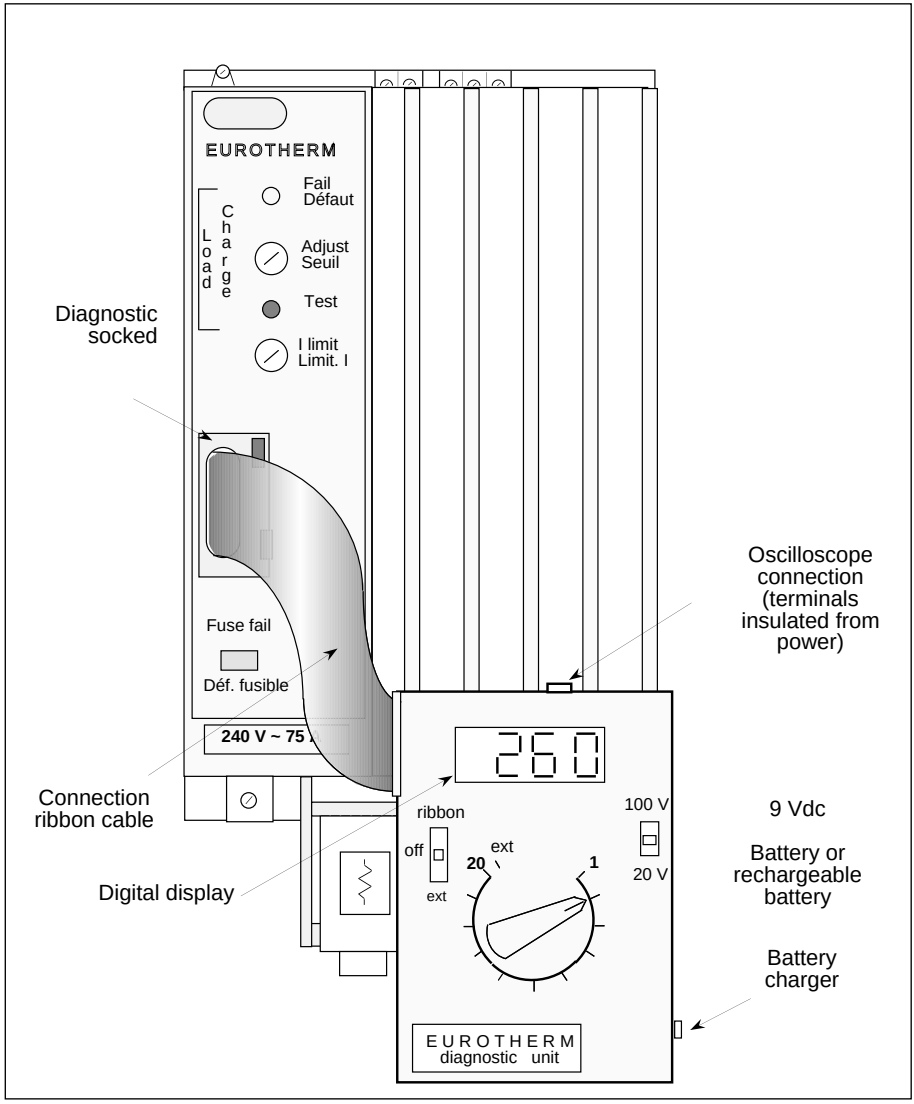

Figure 6-1 Connection of the EUROTHERM type 260 diagnostic unit to a 460 series thyristor unit

Position	Description	0 % of setpoint Θ = 0°	50 % of setpoint Θ = 90°	100 % of setpoint Θ = 180°
1	Current image (nominal load)	0 V	2.5 V	5 V
2	Manual input (if used)	0 V	2.5 V	5 V
3	PLF output (not in alarm) In alarm status	+ 13.5 V - 12.6 V		
4	External setpoint Example: 0-10 V	0 V	5 V	10 V
5	Threshold current limit 0% to 100%	approx. 0 to 10 V		
6	Current image for PLF	0 V	- 2.5 V	- 4.6 V
7	Load voltage image	0 V	2.25 V	4.1 V
8	Amplified setpoint	0 V	- 2.5 V	- 5 V
9	"Slave Firing O/P" output	not used		
10	Firing demand	0 V mean 1V peak	8.4 V	12.7 V
11	"+10V" reference	10 V ± 0.1 V		
12	Auxiliary voltage image	- 20 V		
13	Pulse output	20 V No pulses	20 V pulses	20 V pulses
14	"-15 V" supply	- 15 V± 150mV		
15	Oscillator input	0 V	1.2 V 6.4 V peak 90° pulses	1.2 V 6.4 V peak 90° pulses
16	"+ 15 V" supply	+ 15 V± 150mV		
17	"0" voltage crossing pulse	-10.5 V ±12V peak 0.6ms		
18	0 V	0 V		
19	Saw-tooth generator	3.6V 8.4V peak 10ms		
20	Enable	<- 10 V		

Table 6-1 Description of the positions of the EUROTHERM type 260 diagnostic unit **Thyristor firing angle variation (Θ).**

Position	Description	0 % of setpoint	50 % of setpoint	100 % of setpoint
1	Current image (nominal load)	0 V	Modulation 2.5 V	5 V
2	Manual input (if used)	0 V	2.5 V	5 V
3	PLF output (not in alarm) In alarm status	+ 13.5 V - 12.6 V		
4	External setpoint Example: 0-5 V	0 V	2.5 V	5 V
5	Threshold current limit 0% to 100%	approx. 0 to 10 V		
6	Current image for PLF	0 V	Modulation 0 - (-4.6 V)	- 4.6 V
7	Load voltage image	0 V	Modulation 0 - (-4.3 V)	4.3 V
8	Amplified setpoint	0 V	-2.5 V	- 5 V
9	"Slave Firing O/P" output	0 V	Modulation 0 - 13.5 V	10.2 V (0-13.5 V)
10	Power demand	0 V mean 1V peak	6.25 V 12.5 V peak	12.5 V
11	"+10V" reference	10 V ± 0.1 V		
12	Auxiliary voltage image	- 20 V		
13	Pulse output	20 V No pulses	20 V pulses	20 V pulses
14	"-15 V" supply	- 15 V± 150mV		
15	Oscillator input	0 V	6.4 V peak	1.2 V 6.4 V peak
16	"+15 V" supply	+ 15 V± 150mV		
17	"0" voltage crossing pulse	-10.5 V ±12.5V peak 0.6ms		
18	0 V	0 V		
19	Saw-tooth generator	Not used		
20	Enable	<- 10 V		

Table 6-2 Description of the positions of the EUROTHERM type 260 diagnostic unit
Fast cycle and Single cycle

PRELIMINARY ADJUSTMENTS

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

- For resistive loads **with low resistance variations**, firing at zero voltage does not generate steep voltage fronts, thus minimising the electromagnetic interference produced.

- For resistive loads **with high resistance variations**, use of the "Burst firing" modes with the soft start, reduces the current requirement when the load is cold with a low resistance.

- For **inductive** loads, the first firing with a delay eliminates the transient over-current (see "Operation" chapter).
  This delay can be adjusted between **0** and **90**° and only acts on the first alternation.

The preliminary adjustment is carried out using potentiometer **P4** located on the driverboard (see figures 4-1 and 4-2).
To access the adjustment potentiometer, the unit must be **unplugged** from its baseplate.

Danger !

Dangerous live parts are accessible when the unit is unplugged. Only a qualified person, authorised to work in a low voltage industrial electrical environment should access the inside of the unit.

The effect of the adjustment potentiometer depends on the thyristor firing mode.

Thyristor firing mode	**Action of potentiometer "P4"**
Phase angle	No action
Single cycle Slow cycle Fast cycle	Delay of the first firing of the thyristors at the start of each firing cycle
Burst firing with soft start	Soft start duration in thyristor firing angle variation
Burst firing with soft start and end	Soft start and end duration in thyristor firing angle variation

Table 6-3 Effect of the preliminary adjustment potentiometer

Resistive load with low resistance variations

For loads with low resistance variations as a function of temperature, the adjustment must guarantee thyristor firing at zero voltage.

- Ensure that potentiometer **P4** on the driverboard is turned completely anticlockwise (delay angle = **0** and ramp absent, see table 6-4).
- Switch on the thyristor unit.
- On the external input (terminal **4** of the control terminal block), apply a signal corresponding to **0%** of the control signal.

Using an ammeter, measure the RMS current and check that the load current does not pass.

- On the external input (terminal **4**) or manual input (terminal **5**), apply a signal corresponding to **100%** of the control signal.

Using an ammeter, measure the RMS current and check that the current is equal to the nominal load current.

Resistive load with high resistance variations

For loads with high temperature coefficients, use the soft start of Phase angle thyristor firing mode.

The start (or start and end) time is adjusted using potentiometer "**P4**" on the driver board, for the following thyristor firing modes:

- slow cycle with soft start (code 056)
- fast cycle with soft start (code 055)
- slow cycle with soft start and end (code SDS)
- fast cycle with soft start and end (code SDF).

The soft start (or start and end) ramp can be adjusted between **0** and **250 ms**.
The maximum ramp is obtained with potentiometer "**P4**" turned completely **clockwise**.
When the unit is shipped, the potentiometer is adjusted to its maximum position (see table 6-4).

In the case of the control of a load with very high resistance variations as a function of temperature (Kanthal Super, for example), use **the Special 677** (except for Phase angle firing).

Non-saturable inductive load

When the load has an inductive component (an inductor, for example), firing at zero voltage generates transient operation which produces an over-current ("Operation" chapter) and in some cases can cause the thyristor protection fuse to blow.

To avoid these over-currents at the start of each burst, the first firing of the thyristors must be **delayed** in relation to the corresponding zero voltage.
(Phase angle firing mode can also be used).

The **optimum** delay angle (90° max) must be adjusted with potentiometer "**P4**" depending on the **load used**. The thyristor firing delay only affects the first firing in each burst.

When shipped from the factory, potentiometer "**P4**" is adjusted as shown below.

Thyristor firing mode	**Position of potentiometer P4**
Fast cycle Slow cycle Single cycle	Completely **anti-clockwise** (Minimum delay)
Soft start Soft start and end	Completely **clockwise** (Maximum ramp)
Phase angle	No effect. Position irrelevant

Table 6-4 Factory potentiometer settings

To adjust for a non-saturable inductive load:

- Turn potentiometer "**P4**" completely clockwise (maximum delay equal to 90°).
- Set a control signal corresponding to approximately 20 % of the maximum setpoint.
- Slowly turn potentiometer "**P4**" anticlockwise in order to reduce the over-current (visible on an oscilloscope) at the beginning of each burst as much as possible.

For controlling a saturable inductive load in Burst mode (transformer primary with a resistive load having a low resistance variation on the secondary), use the **special 669** (no current limit or PLF).

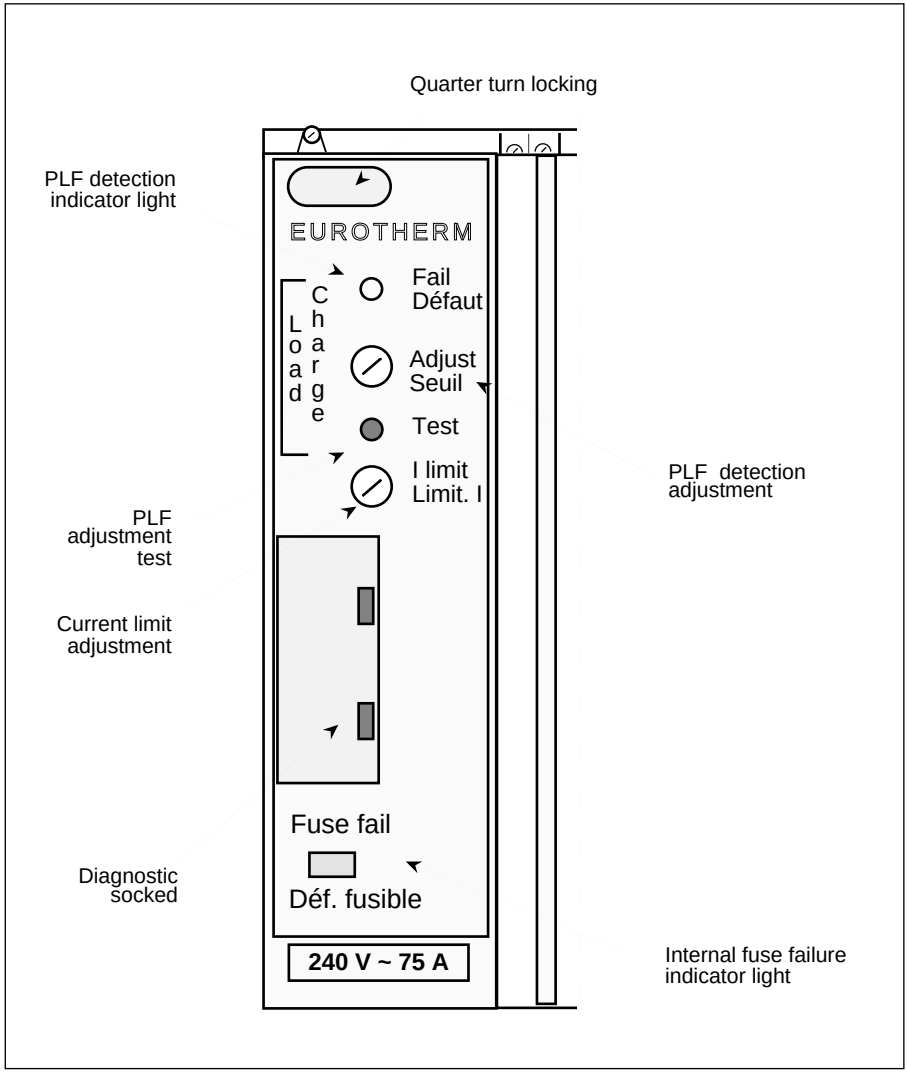

Figure 6-2 Front fascia of the 460 thyristor unit

PARTIAL LOAD FAILURE DETECTION ADJUSTMENT

The partial load failure (PLF) detection is adjusted using the potentiometer labelled "**Adjust/Seuil**" on the front fascia (see figure 6-2).

The purpose of this adjustment is to adapt the PLF detection with the maximum sensitivity to the real thyristor unit load.

To guarantee correct operation of the PLF detection circuit, the load current must not be less than **10 %** of the thyristor unit nominal current (in the case of use of a bulb as a load for a thyristor unit test in the workshop, the PLF detection indicator light "**Fail/Défaut**" is always lit).

During commissioning, the following adjustment must be made:

- First of all, make sure that the thyristor unit is connected correctly and that the thyristors are in permanent firing mode.
- Turn the PLF detection adjustment potentiometer completely **anti-clockwise** and check that the "**Fail/Défaut**" indicator light on the front fascia is off.
- Turn the **"Adjust/Seuil"** potentiometer slowly **clockwise** until the indicator light comes on.
- Turn the potentiometer slowly anti-clockwise until the "**Load Fail**" indicator light has just gone off.

The potentiometer adjusted in this way is used to obtain maximum sensitivity for the partial load failure detection really connected with the thyristor unit.

The push button on the front fascia (labelled "**Test**") which simulates a current drop of **10 %** in the load is used to check the operation of the PLF circuit without having to disconnect the load. This button must place the thyristor unit **in alarm status** if the adjustment has been performed correctly.

Reminder:

The PLF detection circuit does not use the load voltage directly, but the electronics supply voltage.

CURRENT LIMIT ADJUSTMENT

Linear limit

The linear current limit can be adjusted using the "**I limit / Limit.I**" potentiometer on the front fascia.

- Make sure that the load is connected.
  When used in conjunction with the threshold current limit (potentiometer or external signal), make sure first of all that the "Threshold limit" setpoint (terminal **14** on the control terminal block) is at the maximum value.

- Turn the "**I limit / Limit. I**" linear current limit potentiometer completely **anti-clockwise** (**minimum** current).

- Apply a **0 V** signal to terminal **14** and connect the power voltage.
  The RMS voltage at the load terminals must be zero.

- Increase the current limit input signal to 100 %.
  The load voltage must represent approximately **0%** of the supply voltage.

- Turn the current limit potentiometer gradually clockwise and check that the current rises slowly.
  Adjust the "**I limit / Limit. I**" potentiometer in order to obtain the maximum current **permitted** by the load.

Attention !

For the current limit adjustment, only use an ammeter which gives the **True RMS** value to measure the load current in order to prevent risks of errors which may reach 50 %.

For a **three-phase installation** using two or three 460 thyristor units, take care to turn each of the current limit potentiometers gradually in succession in order to maintain the balance of the currents in each phase.

Attention !

In the case of "Star with neutral" configurations, the neutral current for a load, when starting cold, can be **1.7 times greater** than the phase currents, limited by the current limit (if the operation of three units is synchronised).
Redesign the installation as a consequence.

Threshold limit

The threshold current limit is independent of the control signal, it is one of the following:

- **110 %** of the thyristor unit nominal current
  (terminal **14** of the control terminal block directly connected to terminal **12** and the "**I limit / Limit. I**" current limit potentiometer on the front fascia is **clockwise**).
- controlled by an external potentiometer connected between terminal **12** (+ 10 V) and terminal **6** (0 V); the wiper is connected to terminal **14**,
- controlled by an external dc voltage (**0-10 V**).

The "Current limit" input impedance (terminal **14**) is greater than or equal to **150k Ω**. For the threshold current limit adjustment:

- After adjusting the linear limit (using the potentiometer on the front fascia), switch on the thyristor unit, set the control to maximum.
  Reduce the "Threshold current limit" setpoint gradually until the current starts to decrease.

- Mark the current limit setpoint corresponding to position **5** of the diagnostic unit and increase it by approximately **10%** so that it is only activated as a back-up for the linear current limit.

Attention !

The threshold current limit can be **pre-adjusted** when a thyristor unit is switched on but **not firing**.

The max value of the **squared** RMS load current is **proportional** to the "Threshold current limit" setpoint observed at position **5** of the diagnostic unit.

Current limit signal (position 5 of the diagnostic unit)	**I_{RMS}^2 (%)**	**I_{RMS} (%)**
10 V	120	110
9.1 V	100	100
4.1 V	50	71

Table 6-5 Example of the threshold current limit diagnostic (for 100% setpoint)

CHECKS IN THE EVENT OF ABNORMAL OPERATION

Symptom	Action
1. The thyristor unit is not fired after a firing request.	1.1. Check that the power is present (if the power is absent but the electronics supply voltage is present, the thyristor unit indicates a PLF alarm and the indicator light on the front fascia is lit). 1.2. Check that the thyristor protection fuse has not blown. 1.3. Check the connection of the electronics supply voltage on the user terminal block (terminals 51 and 52 or 53). 1.4. Check that the "Inhibition" input (terminal **16** on the driver board) is not connected to "**+10 V**" (terminal **12**). 1.5. Check that the control signal arrives correctly on the driver board terminal block: • on terminal **4** with the external control • on terminal **5** with manual control and that the control wires are correctly inserted in the screw connection system. 1.6. Check that the polarity is correct. 1.7. Check that the input signal type and level are compatible with the type and level of the configured signal. 1.8. Check the cabling of the thermal switches on the power board. 1.9. Check the presence of the thyristor firing pulses: • **20 V** pulses for Phase angle firing • **26 V** pulses for Burst firing mode (in position **13** of the diagnostic unit). 1.10. Check that the current limit is not at zero (position **5** of the diagnostic unit). 1.11. Check that the supply voltage is greater than or equal to **70%** of the thyristor unit nominal voltage. 1.12. Check that the electronics supply voltages are present (+15V, -15V, +10V voltages present, see tables 6-1 and 6-2)

Symptom	Action
2. The transient over-current when starting up an inductive load is too high (Burst mode or Single cycle firing).	2.1.Check that the load cabling is correct. 2.2.Check the level of the oscillator input signal (signal in position 15 of the diagnostic unit is 6.4V peak; for measurement, use an oscilloscope) 2.3.The factory pre-adjustment of potentiometer P4 of the firing delay angle to 0° has not been readjusted. Increase this angle by turning potentiometer "P4" on the driver board clockwise. See "Preliminary adjustment of the inductive load", page 6-10.
3.The thyristor is in full firing with an input signal at zero	3.1.Check the configuration of the input signal and that the signal is really absent from terminals **4** and **5** of the control terminal block. 3.2.By disconnecting the 4 "gate-cathode" wires from the control circuit and insulating the connection lugs, check that the thyristors are not short-circuited. 3.3.Check that the electronics supply voltage is correct, and is in phase with the power.

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, authorised to perform work in a low voltage industrial electrical environment.

THYRISTOR PROTECTION

The thyristors of the 460 series power units are protected as follows:

- the internal high speed fuse against over-currents
- the RC snubber and the varistor against too fast voltage variations and transient over-voltages when the thyristors are not firing.
- the thermal switch for models **463** and **464**.
  In the event of accidental overheating of the cooler or if the fan stops, the thermal switch opens, which causes the thyristor firing to be stopped.

Danger !

The internal thyristor protection fuse does not **protect the installation** in any circumstances.

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

THYRISTOR PROTECTION FUSE

The 460 series power thyristor unit is supplied with the internal fuse fitted (up to 125 A). For the 150 A nominal current, the external fuse must be ordered separately.

Attention !

The high speed fuse is only used for the protection of **the thyristors** against wide amplitude over-loads.

Table 7-1 contains all the references of the original fuses (as fitted in the factory) and the fuses which are authorised for replacement during maintenance.

The thyristor unit guarantee is subject to the use of high speed fuses specified in this table.

Attention !

The use of other fuses **invalidates the thyristor unit guarantee.**

Model	Nominal current	Max. voltage	References				
				Suppliers			
			Eurotherm	Ferraz	I.R.	Brush	G.E.C
461	15 A	240 V 500 V	CH 380 163 CH 110 153	Q076650 X220958	E 1000.15	15 ET	
	25 A	240 V 500 V	CH 380 253 CH 110 253	R076651 V082450	E 1000.25	25 ET	GSG 1000.25
	40 A	500 V	CH 110 044	C220963	E 1000.40	40 ET	GSG 1000.40
	55 A	500 V	CH 110 753	S075893	E 1000.75	75 ET	--
462	55 A	500 V	CH 120 094	A099958	EE 1000.90	90 EET	--
	75 A	500 V	CH 120 114	B099959	EE 1000.110	110 EET	GSG1000.110
463	100 A	500 V	CH 120 154	C099960	EE 1000.150	150 EET	GSG1000.150
464	125 A	500 V	CH 120 154	C099960	EE 1000.150	150 EET	GSG1000.150
	150 A External fuse Fuse holder		CH 340 025 CP 171 482	H300019 V98711	Overall dimensions of "Fuse and fuse holder" assembly (mm) 220 x 50 x 110		

Table 7-1 Recommended high speed fuses for thyristor protection

REPLACEMENT OF THE HIGH SPEED INTERNAL FUSE

The 460 series power thyristor units (nominal current from 15 to 125 A) are fitted with high speed **internal** fuses.
These fuses are mounted at the rear of the pluggable module.

For the 150 A nominal current (464 model), the high speed fuse and its holder are **external** and ordered separately from the thyristor unit.

If the internal fuse **blows**, a **red indicator light** on the front fascia of the unit lights up (except for the 150 A nominal current unit).

To replace the internal fuse:

- unplug the module from its base
- loosen the two fuse attachment screws
- fit the appropriate fuse (the references are given in table 7-1).

Tightening torque **3.5 N.m**.

ELECTRONICS POWER SUPPLY PROTECTION FUSES

These fuses should be installed in the cables which connect the electronics power supply voltage (see "Cabling" chapter).

Electronics power supply voltage (max)	**1 A Fuse 6.3 x 32 mm**	**Fuse-holder isolator**	**Overall "Fuse-isolator" dimensions (mm)**
500 V	CS174289U1A0	CP174293	63 x 15 x 52

Table 7-2 Recommended fuse for protection of the electronics power supply connection

MAINTENANCE

The **460** thyristor units must be mounted with the heat sink vertical, with no obstructions above or below which could reduce or hinder the air flow.

Attention !

If several units are fitted in the same cabinet, arrange them so that the air expelled by one unit **is not taken in** by the unit placed above it.

For correct cooling of the unit, it is recommended that the **heatsink** and the fan protection **mesh** be cleaned periodically, depending on the degree of pollution of the environment.

Danger !

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

TOOLS

Operation	Flat screwdriver (mm)	Wrench	Electrical equipment
Attachment of the baseplate	Depending on M4 screw heads selected		
Safety earth connection	1 x 6 (461) 1 x 8 (462 to 464)		
Power connection (supply side) and load connection	1 x 8 (461 to 463)	HEX17 M10 (464)	
Thyristor fuse replacement	2 x 15		
Cable clamp tightening	0.5 x 3.5		
Control and electronics power supply voltage connection	0.5 x 3.5		
Commissioning and adjustment	0.4 x 2.5		RMS ammeter or clip. Eurotherm type 260 diagnostic unit recommended.

Table 7-3 Tools