



TE300

Three-phase loads controller



invensys
EUROTHERM

User Manual

Digital Power Controllers

TE300 Series

Three-phase load control

User Manual

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EUROTHERM AUTOMATION has made every effort to ensure that the specification given in this manual is as accurate and up to the minute as possible. However, in order to maintain our 'leading edge', it may be necessary to make certain changes or omissions to our specification. We cannot be held responsible for any damage to persons or property or for any financial loss or costs arising.

TE300

USER MANUAL

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EUROPEAN DIRECTIVES



CE MARKING AND SAFETY

TE300 products carry the CE mark in compliance with the essential requirements of the European Low Voltage Directive 73/23/EC of 19/2/73 (amended by the Directive 93/68/EC of 22/7/93).

For safety reasons, **TE300** products installed and used in compliance with this User Manual meet the essential requirements of the European Low Voltage Directive.

ELECTROMAGNETIC COMPATIBILITY (EMC)

For an industrial environment only, must not be used in domestic environments

Eurotherm certifies that **TE300** products, installed and used in compliance with this User Manual, meet the following EMC test standards and enable the system which incorporates them to comply with the EMC Directive, as far as the **TE300** products are concerned.

EMC test standards

Immunity	Standards	:	EN 50082-2, EN 61000-4-2, EN 61000-4-3, EN 61000-4-4, EN 61000-4-6, ENV 50204
Emission	Standards	:	EN 50081-2, EN 55011 class A, EN61800-3 (second environment)

Internal EMC filters

EMC filters are incorporated in the **TE300** to reduce conducted emission in accordance with the test standard.

EMC Guide

In order to help you reduce the effects of electromagnetic interference depending on the product installation, Eurotherm can supply you with the '**Electromagnetic Compatibility' Installation Guide** (ref: HA025464).

This guide lists the rules generally applicable for EMC.

DECLARATION OF CE CONFORMITY

Availability

A declaration of CE conformity is available on request.

Validation by Competent Body

Eurotherm has validated the compliance of **TE300** products with the European Low Voltage Directive and EMC test standards through product design and laboratory testing.

The tests carried out on **TE300** products are listed in a Technical Construction File validated by the **LCIE** (Central Laboratory for the Electrical Industries), a Recognised Competent Body.

Further information

For any further information, or if in doubt, please contact Eurotherm Controls where qualified staff are available to advise or assist you with the commissioning of your installation.

PRECAUTIONS

Safety symbols

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



DANGER

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



ATTENTION

This symbol means that failure to take note of the information may

- have serious consequences for the installation or
- lead to the incorrect operation of the power unit

These symbols must be observed for particular points.

However the whole of the manual remains applicable.

Personnel

The installation, configuration, commissioning and maintenance of the power unit should only be carried out by personnel **qualified and trained** to work with low voltage electrical equipment in an industrial environment.

Independent alarm

Given the value of the equipment controlled by **TE300** products it is the responsibility of the user, and it is highly recommended, that an independent safety device (alarm) should be installed. This alarm must be tested regularly.

Eurotherm can supply suitable equipment.

Chapter 1

IDENTIFYING THE CONTROLLERS

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Chapter 1 IDENTIFYING THE CONTROLLERS

GENERAL INTRODUCTION TO THE TE300 SERIES

The **TE300** series of controllers are thyristor units designed to **control** the electrical **power** of industrial three-phase loads.

A **TE300** series controller is made up of three channels, each comprising a pair of thyristors connected in anti-parallel.

The **TE300** series is designed to control three-phase resistive loads:

- elements with a low temperature coefficient
- short-wave infrared elements

Three-phase loads can be connected:

- in star with or without neutral
- in open or closed delta

The wiring of the controller is **indifferent** to the order of the supply phase rotation.

The nominal line-to-line voltage can be selected from **230V** to **500V**.

The nominal currents of the **TE300** series controllers are between **16A** and **63A**, per phase, defined at an ambient temperature of 45°C.

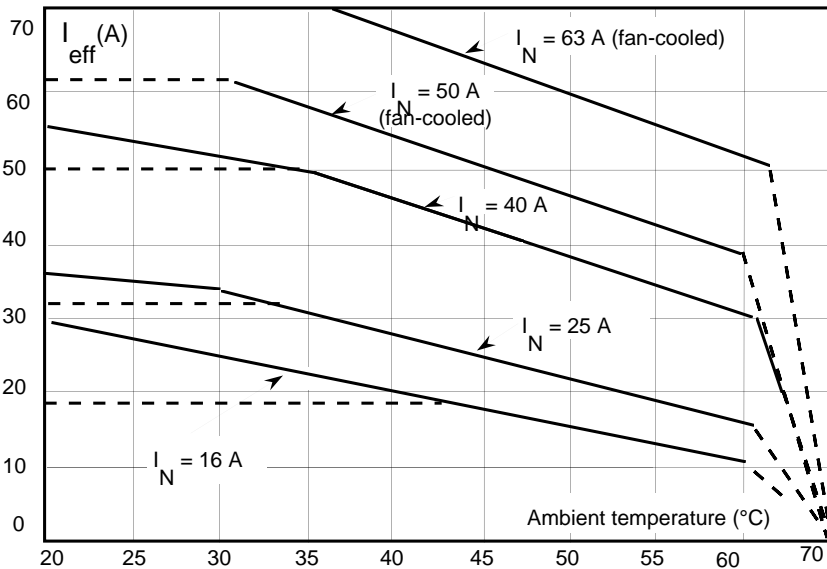


Figure 1-1 Current derating per phase as a function of ambient temperature
(dotted line: current limit for recommended fuse)



Attention!

In order to allow for variations in load resistance, the calculated current should not exceed 0.8 times the maximum rated current of the unit. The load current is calculated from the supply voltage and the load power (or resistance).

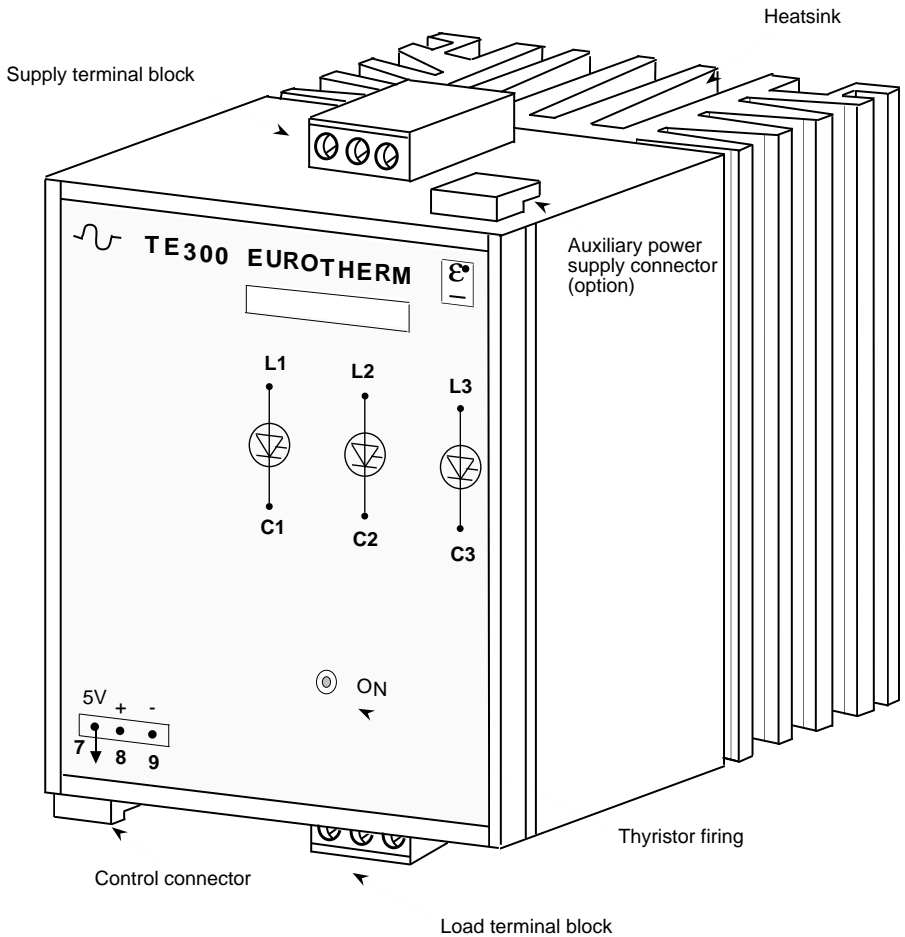


Figure 1-2 Overview of the TE300 series controller

The unit is controlled by **analogue** or **logic** signals.

The input analogue signals have two possible voltage ranges: **0 to 5V** or **0 to 10V** and a current range of: **4 to 20mA**.

The input logic signals have the following nominal values: **5V**, **10V** or **20mA**.

Local control is possible via a potentiometer or external contacts. (The input must be configured as 0 to 5V code 0V5)

The 5V,0.5mA user-voltage output on terminal 7 and 9 is intended for this purpose.

The electronics of the **TE300** controllers are self-supplied from the power voltage and do not require external connections.

The control method of the **TE300** series includes **line voltage squared (V²) compensation** for line variations in the range **+10%** to **-15%** of the nominal voltage of the controller.

TE300 series controllers have several thyristor **firing** modes:

- Logic ON-OFF
- Cycle time modulation (Burst-firing with four possible cycle times)
- Advanced Single-cycle (firing by complete cycles separated by a complete number of half-cycles of non-firing).

Thyristor firing ensures the absence of any DC component in load currents when connected in open delta or in star with neutral configurations. .

A **TE300** series controller is equipped with:

- A **‘driver board’** which generates thyristor firing pulses, implements control and provides power for the electronics. This board is also used for the signal and operating mode configurations
- A **‘filter board’** to ensure Electromagnetic Compatibility in accordance with the test standard and to protect the controller from transient interference.

The **filters** which provide immunity against electromagnetic interference are located:

- Between the power phases
- Between the phases and the safety earth connector

The user terminal block below the controller is used for the control signal connection without having to open the front door of the unit.

A green LED indicating thyristor firing (‘**ON**’) is located on the front facia.

TE300 power controllers are designed to be **bulkhead** or **DIN rail** mounted.

The **63A** rated limit must be permanently **fan-cooled**.

The fan power supply of either **115V** or **230V** should be specified when ordering the controller.

TECHNICAL SPECIFICATION

The TE300 series of controllers is intended for thyristor regulation and control of an industrial three-phase load.

Power

Nominal current (per phase)	16A, 25A, 40A, 50A or 63A (at 45°C)
Line-to-line voltage	230V to 500V (+10%, -15%)
Supply frequency	50Hz and 60Hz ($\pm 2\text{Hz}$) automatic selection
Dissipated power	1.3W (approx.) per amp, per phase. Fuses are external to TE300 and will produce 0.7W (approx) per amp per phase.
Insulation (1 min test)	2000Vac between power and earth and 3600Vac between power and control
Cooling	Natural convection for 16A, 25A, 40A ratings Permanent fan-cooling for 50A and 63A rating
Fan power supply (63 amp unit)	115V or 230V (to be specified) 13VA
Load	Resistive three-phase load with a low temperature coefficient or short-wave infrared elements
Supply phases	Wiring independent of the phase rotation order
Load configuration	Closed delta (3-wire) or open (6-wire) Star without neutral (3-wire) or with neutral (4-wire) Load configuration set by 'coffee beans'

CE Marking

Electrical safety	TE300 controllers carry the CE mark in compliance with the essential requirements of the European Low Voltage Directive 73/23/EC (amended by the Directive 93/68/EC)
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Electromagnetic compatibility

Immunity and Emissions	TE300 products comply with Electromagnetic Compatibility test standards (see page iv).
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Control

External control signal	Analogue (in Burst-firing and Single-cycle modes): voltage 0 to 5V or 0 to 10V ; current 4 to 20mA Logic (ON/OFF mode), nominal levels: voltage 5V or 10V ; current 20mA On state $\geq 50\%$ and off state $\leq 25\%$ of the nominal level
Input impedance	Voltage input: $\geq 100\text{k}\Omega$, current input: 250Ω
Configuration	'Coffee beans' on driver board
Local control	10kΩ potentiometer supplied by the user-voltage 'Dry' contact for logic operation Input configured as 0 to 5V

Thyristor firing

Firing modes	ON/OFF (Logic) Burst-firing mode Number of firing cycles at 50% of configurable power: 1, 8, 16 or 128 cycles Advanced Single-cycle (load in star with neutral or open delta) Firing by complete cycles separated by half-cycles of non-firing without DC component One cycle of firing and one cycle of non-firing at 50% power
Switching	Conduction starts and ends at zero voltage
Indication	Thyristor firing is signalled by a green LED

Control performance

Control type	The power controlled in the load (simulated by voltage squared V²) is proportional to the setpoint
Linearity	Better than ±2% of the full scale
Stability	With variations: <ul style="list-style-type: none">· Of the supply voltage +10%, -15%· Of the temperature from 0 to 40°C stability is better than ±2% of full scale

Options

Auxiliary power supply	Possibility of operation for non-standard three-phase mains by supplying the electronics separately from the power at 115V or 230V
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Environment

Operating temperature	0°C to +45°C at maximum altitude of 2000m
Storage temperature	-10°C to +70°C
Thyristor protection	High-speed external fuses (except for short-wave infrared application) Internal MOVs (varistors) and RC snubbers
Protection	IP20 on the front facia (in compliance with Standard IEC529)
External wiring	To be carried out in compliance with standard IEC 364
Operating atmosphere	Non-explosive, non-corrosive, non-conductive
Humidity	RH: 5% to 95% , non-condensing
Pollution	Pollution degree 2 permissible, defined by IEC 664

In order to maintain its 'leading edge', Eurotherm may have to make changes to its specifications without advance notice.

For any further information, or if in doubt, please contact Eurotherm Controls.

PRODUCT CODE

TE300/Current/Voltage/Cooling/Signal/Firing/Configuration/Mounting/Language/Options/00

Nominal current	Code
16 amps	16A
25 amps	25A
40 amps	40A
50 amps*	50A
63 amps*	63A
* Fan cooled	

Thyristor firing mode	Code
Logic ON/OFF	LGC
Burst-firing:	
1 cycle	FC1
8 cycles	FC8
16 cycles	C16
128 cycles	128
Advanced Single-cycle (4- or 6-wire configuration)	SCA

Mains voltage* (line-to-line)	Code
230 volts	230V
240 volts	240V
277 volts	277V
380 volts	380V
400 volts	400V
415 volts	415V
440 volts	440V
480 volts	480V
500 volts	500V

Load configuration	Code
Delta (3-wire)	3D
Star without neutral (3-wire)	3S
Star with neutral (4-wire)	4S
Open delta (6-wire)	6D

Mounting	Code
Bulkhead	BKD
DIN rail	DIN

Fan supply	Code
Without fan-cooling (16A to 40A)	000
With fan-cooling (50A & 63A):	
115V	115V
230V	230V

Manual language	Code
French	FRA
English	ENG
German	GER
Italian	ITA

Input signal	Code
0 to 5 volts	0V5
0 to 10 volts	0V10
4 to 20 milliamps	4mA20

Options	Code
Power supply separate	
from electronics	115V
(non-standard power supply)	230V

* Non-standard mains: use the coding for the voltage immediately above and choose option of power supply separated.

Bulkhead mounting TE300 controllers may be bulkhead mounted.

EXAMPLE OF PRODUCT CODE

Controller and installation parameters

Nominal load current	35 amps
Nominal supply voltage	415 volts line-to-line
Input signal	0 to 5 volts
Firing mode	Advanced Single-cycle
Load configuration	Star with neutral
DIN rail mounting	DIN
User manual	In English

Controller code:

TE300 / 40A / 415V / 000 / 0V5 / SCA / 4S / DIN / ENG / 00

SERIAL NUMBER LABELS

An **identification** label provides all the information relating to the factory settings of the controller. The identification label is located **externally** on the right side of the unit.

EI EUROTHERM	2.20
WORTHING, ENGLAND : 01903 268500	
MODEL : TE300/40A/415V/000/0V5/SCA/4S/DIN/ENG/00	
SERIAL No. : INT100/002/001/03/99	0F222935
RANGE : 40A 415V	AUX. POWER SUPPLY : SELF-SUPPLIED
INPUT : 0-5V	FAN POWER SUPPLY : NONE
FIRING : ADVANCED SINGLE-CYCLE WIRING	: STAR WITH NEUTRAL
ANY NON-SPECIFIED FUSE INVALIDATES GUARANTEE : FERRAZ B093910	

Figure 1.3 Example of identification label for a TE300 controller
The information corresponds to the product code example

Attention!



Following any re-configuration on the part of the user, there is no guarantee that the controller will correspond to the label information.

TE300 series controllers may be mounted:

MOUNTING DETAILS

Fan-cooled controllers

63A rating TE300 controllers have permanent fan-cooling

Weight of fan-cooled TE300 controller: 3.5kg

The overall dimensions of the fan-cooled TE300 controller are given in Figure 2-2.

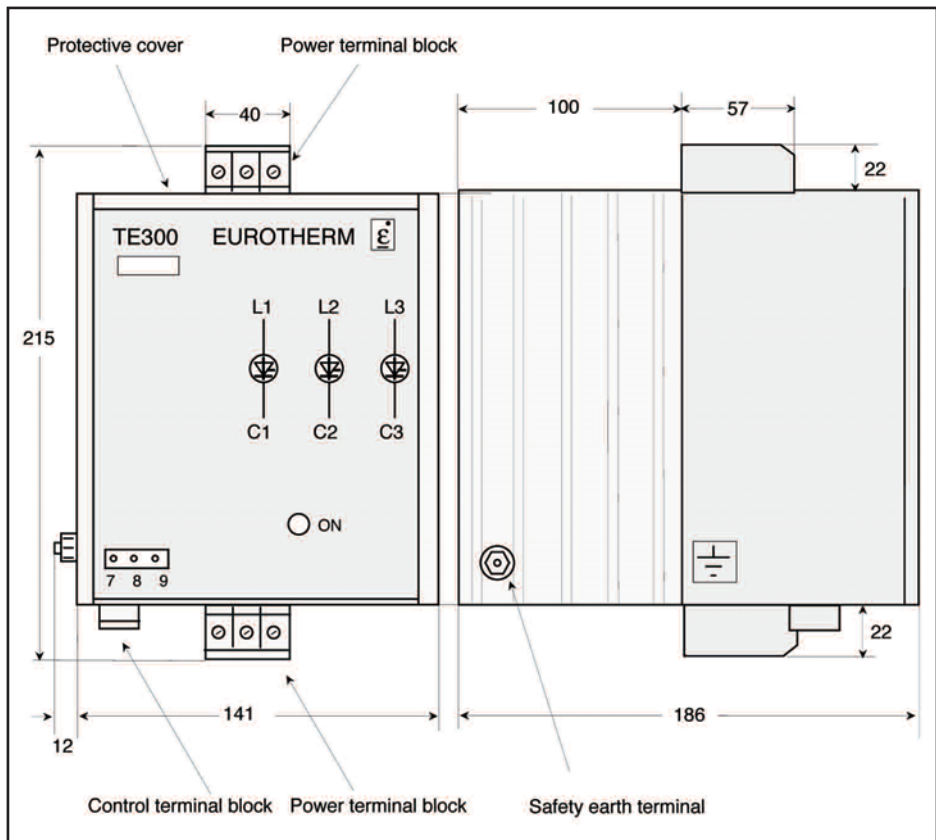


Figure 2-2 Dimensions of fan-cooled TE300 controller (63A rating)

Chapter 2

INSTALLATION

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Chapter 2 INSTALLATION

INSTALLATION - SAFETY

DANGER!

TE300 units must be installed by personnel qualified and trained to work with low voltage electrical equipment in an industrial environment.



Units must be installed in electrical cabinets correctly fan-cooled to ensure that condensation and pollution are excluded.

The cabinet must be closed and bonded to the safety earth in accordance with Standards NFC 15-100, IEC 364 or current national Standards.

For installations which are fan-cooled, it is recommended that a fan-failure detection device or a thermal safety cut-out should be fitted in the cabinet.

TE300 units may be bulkhead or DIN rail mounted.

The units must be mounted with the heatsink positioned vertically, with no obstructions above or below which could inhibit or impede airflow.

If several units are mounted in the same cabinet, they should be arranged in such a way that air expelled from one cannot be drawn into the unit located above it.



Attention!

The units are designed to be used at an ambient temperature less than or equal to 45°C.

Leave a minimum gap of 5cm between two units placed side by side.

Excessive overheating of the controller may lead to incorrect operation of the unit. This may in turn cause damage to the components.

DIMENSIONAL DETAILS

Non fan-cooled controllers

The overall dimensions of non fan-cooled **TE300** controllers (16A to 40A ratings) are given in Figure 2-1.

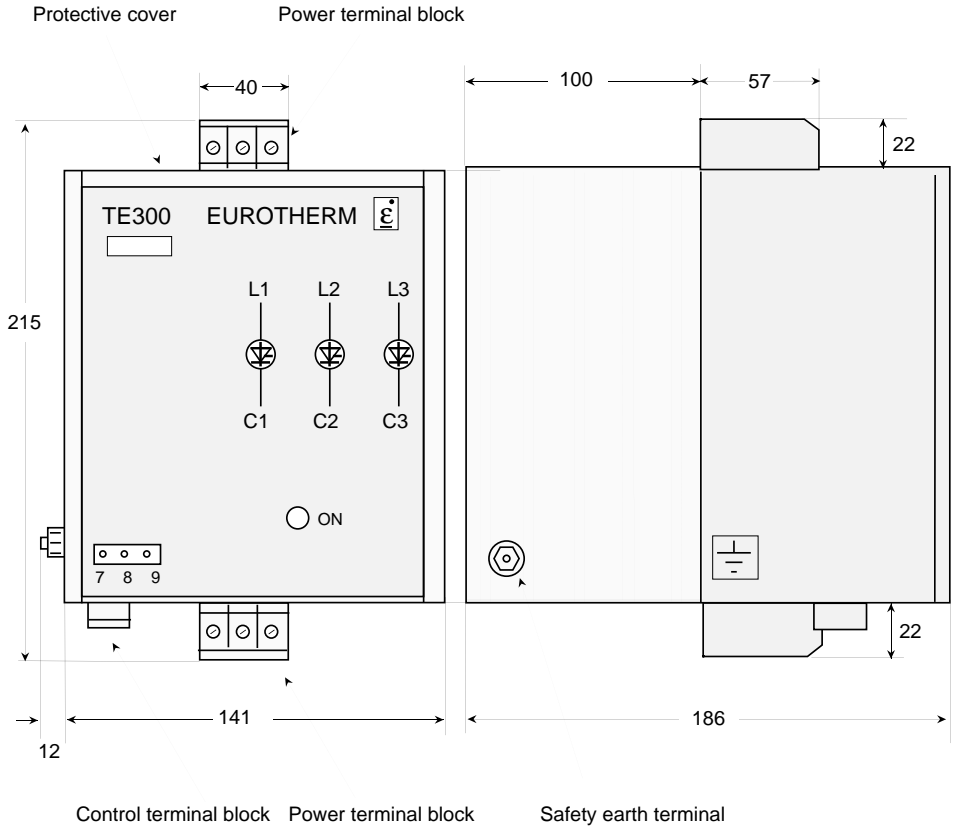


Figure 2-1 Dimensions of non fan-cooled TE300 controllers

Weight of non fan-cooled TE300 controller: **3.1kg**

Fan-cooled controllers

50A and 63A rating **TE300** controllers have permanent fan-cooling

Weight of fan-cooled TE300 controller: **3.5kg**

The overall dimensions of the fan-cooled **TE300** controller are given in Figure 2-2.

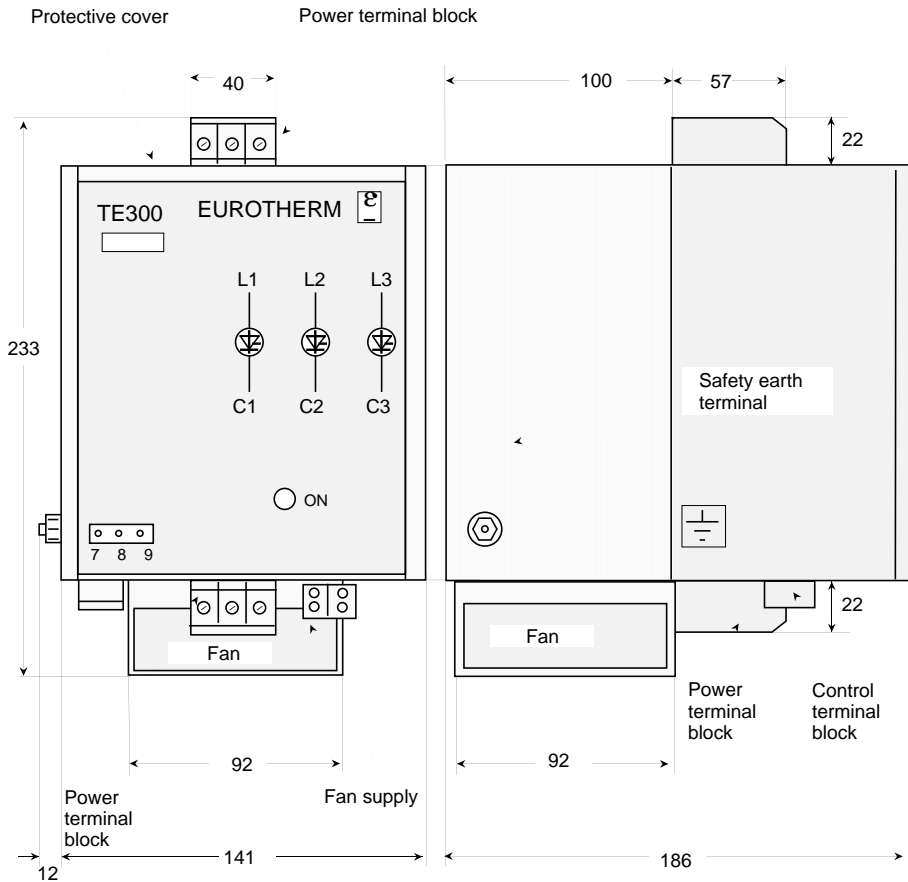


Figure 2-2 Dimensions of fan-cooled TE300 controller (50A and 63A rating)

MOUNTING DETAILS

TE300 series controllers may be mounted:

- On DIN rails (code DIN)
- On a bulkhead (code BKD)

DIN rail mounting

TE300 controllers are designed to be mounted on two DIN rails EN 50022.

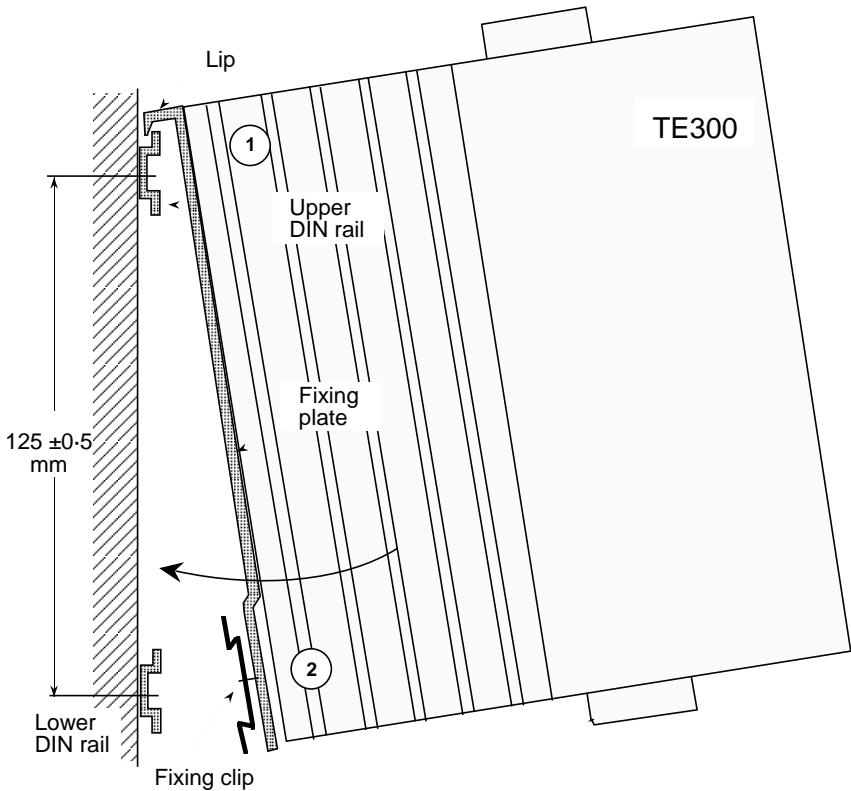


Figure 2-3 DIN rail mounting for **TE300** controller

To mount the **TE300** controller on DIN rails (see Figure 2-3).

1. Offer up the unit by first engaging the two lips on the upper part of the fixing plate (back plate of controller) on to the upper DIN rail.
2. Clip the controller (by spring clips) on to the lower DIN rail, making sure that the clip is properly engaged.

Two fixing plates are provided for this type of mounting

For this type of mounting use the following instructions:

- Drill three holes for M6 screws following the dimensions given in Figure 2-4
- Fix the upper plate on to the panel using the oblong hole at the top of the controller
- Install the lower plate with two M6 screws
- Insert the fixing lugs of the controller into the lower plate
- Slightly undo the central screw holding the upper plate in order to slide it upwards, position the controller and slide the plate back down into the slots on the heatsink. Tighten the central screw.

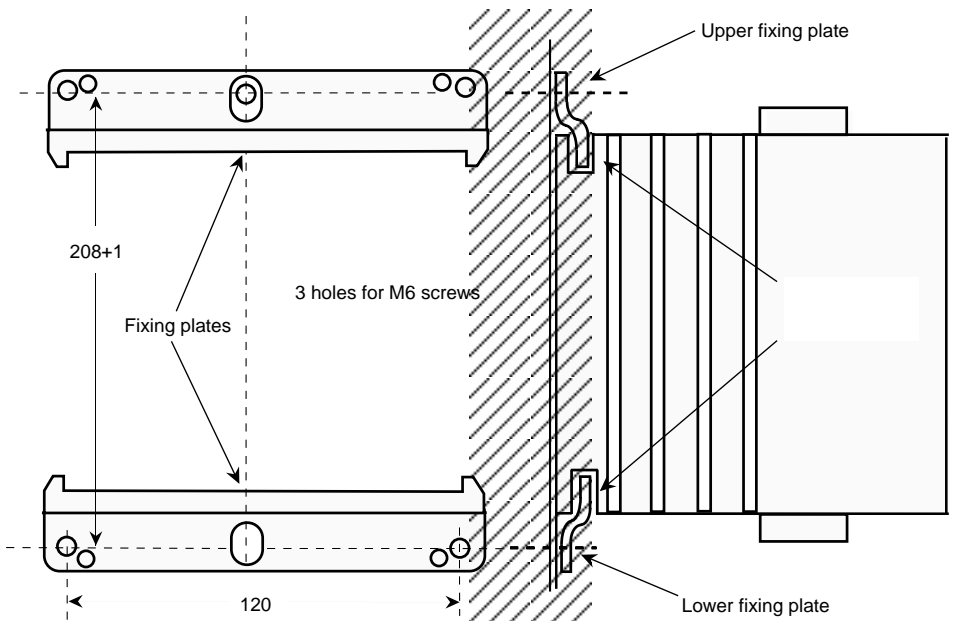


Figure 2-4 Bulkhead drilling and mounting dimensions (in mm) for the **TE300** controller

Chapter 3

WIRING

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CHAPTER 3 WIRING

WIRING - SAFETY

DANGER!

Wiring must only be carried out by personnel who are qualified to work in a low voltage industrial environment.



It is the user's responsibility to wire and protect the installation in accordance with current professional Standards.

A suitable device ensuring electrical isolation between the equipment and the supply must be installed upstream of the unit in order to permit safe operation.

TE300 series units have a protective cover.

DANGER!

Before any connection or disconnection, ensure that power and control cables or leads are isolated from voltage sources.



For safety reasons, the safety earthing cable must be connected before any other connection is made during wiring and it should be the last cable to be disconnected.

The **safety earth** is connected to the screw located on the slot at the side of the controller and is denoted by the symbol: $\frac{\perp}{\underline{\quad}}$

Attention!



To ensure correct grounding of the **TE300** unit, make sure that it is mounted on the **reference ground surface** (panel or bulkhead).

Failing this, it is necessary to add a ground connection **at most 10cms** long between the earth connection and the reference ground surface.

DANGER!



This connection, which is intended to ensure good **ground continuity**, can never be used to replace the safety earth connection.

Star without neutral and closed delta configuration

Three-phase loads connected in star without neutral or in closed delta are configured as 3-wire.

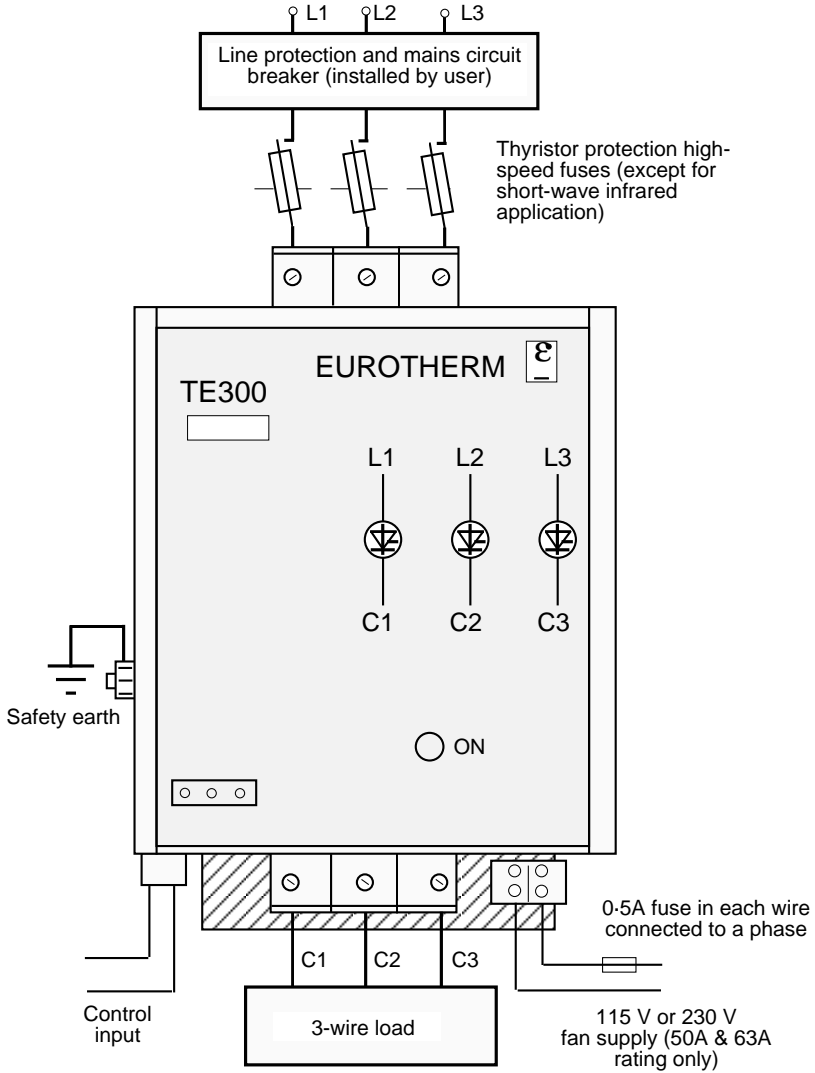


Figure 3-1 Power and safety earth wiring for a load connected in 'star without neutral' or in 'closed delta' (3-wire configuration)

Star with neutral configuration

A three-phase load connected in star with neutral is configured as 4-wire.

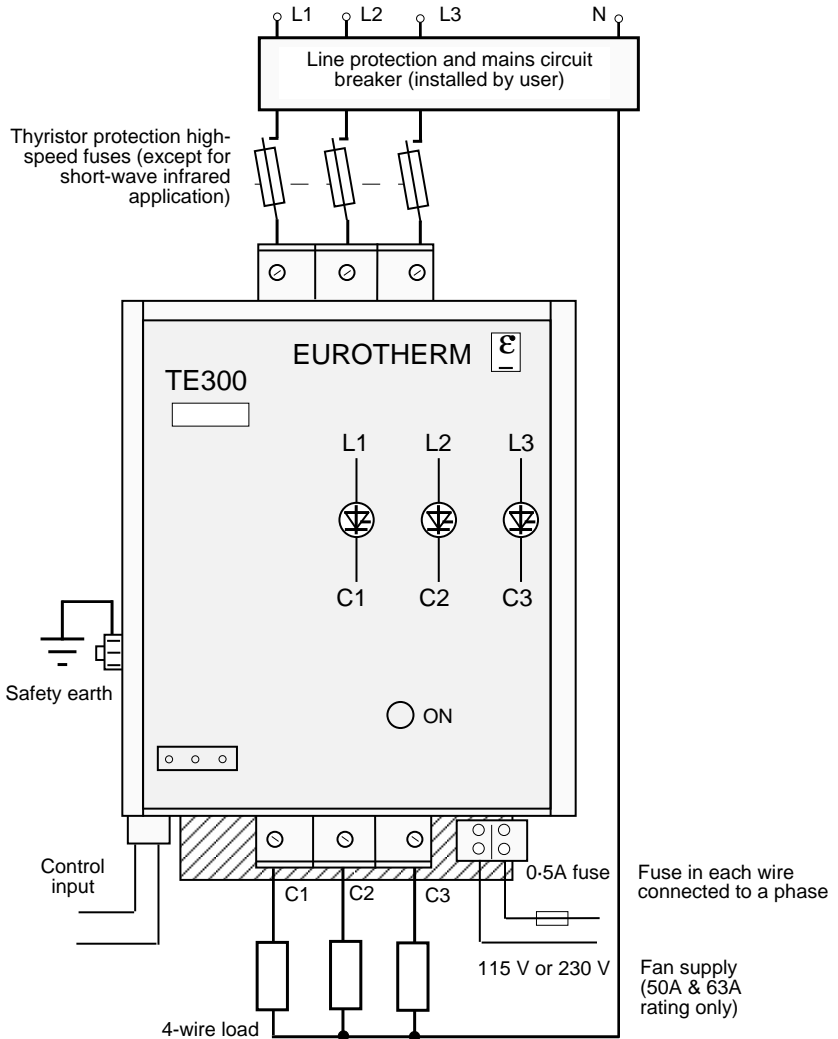


Figure 3-2 Power and safety earth wiring for a load connected in 'star with neutral' (4-wire configuration)

The cross-section of the neutral cable must match the cross-section of the phase cables.

Open delta configuration



Important!

The load wiring given below must be observed.

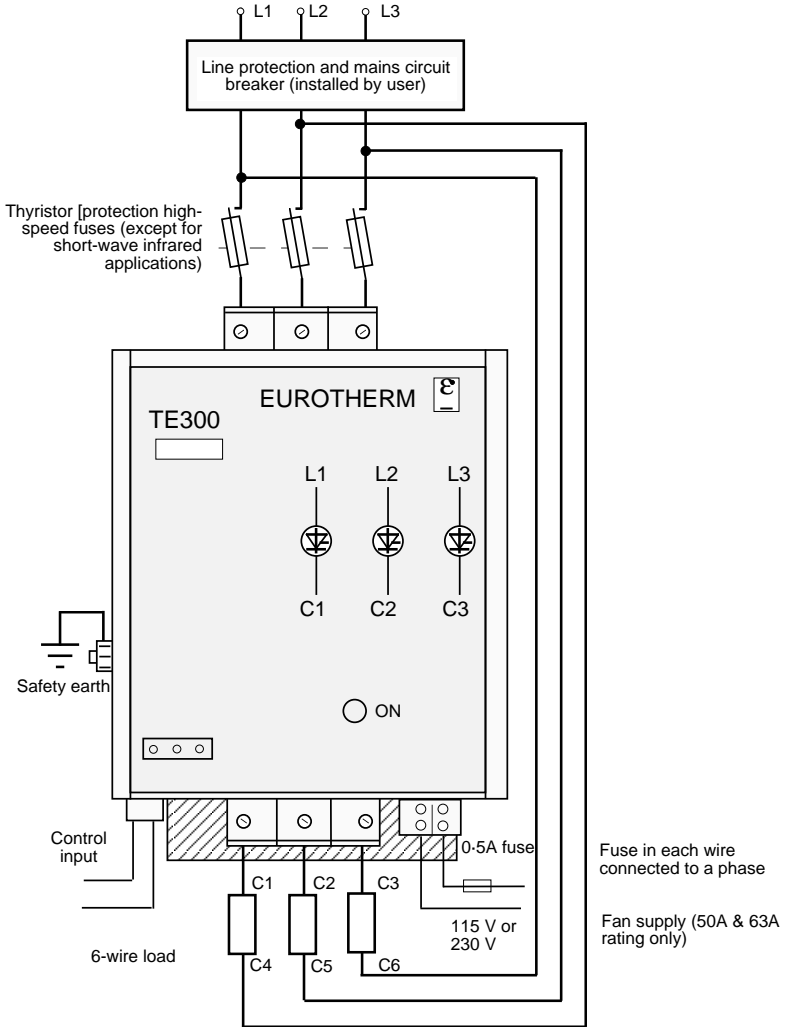


Figure 3-3 Power and safety earth wiring for a load connected in 'open delta' (6-wire configuration)

USER TERMINAL BLOCKS

General introduction

The user terminal blocks comprise:

- A control terminal block
- A fan terminal block (for the 50A and 63A rating)
- An auxiliary power supply terminal block (option).

The control terminal block is located **below** the controller on the **left** side.

The fan terminal block is located **below** the controller on the **right** side.

The auxiliary power supply terminal block is located **above** the controller on the **right** side (option).

These connectors for the wires **plug in**.

Terminal numbers (label)	Function
7	User output +5V (for wiring manual control potentiometer)
8	Control input (signal +ve)
9	Control 0V
10 & 12	Power supply separate from electronics (option)
11	Not used
115V or 230V	Fan supply (50A and 63A rating)

Table 3-2 Function of user terminals

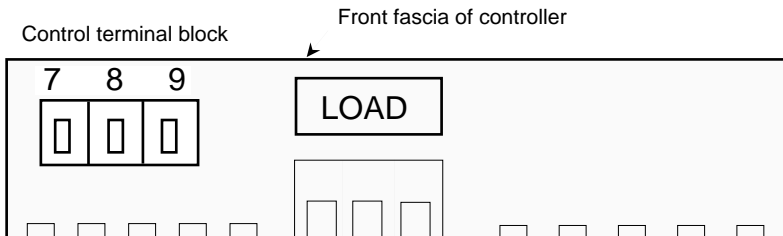


Figure 3-4 Control terminal block (view of controller from below)

External input wiring

The external control signal can be:

- Analogue for Burst-firing and Single-cycle thyristor firing modes
- Logic for ON/OFF mode of operation.

The external signal must be connected to the control terminal block between terminal **8** ('+ Input') and terminal **9** ('0V').

This input is configured by means of the 'coffee beans', solder linked pads

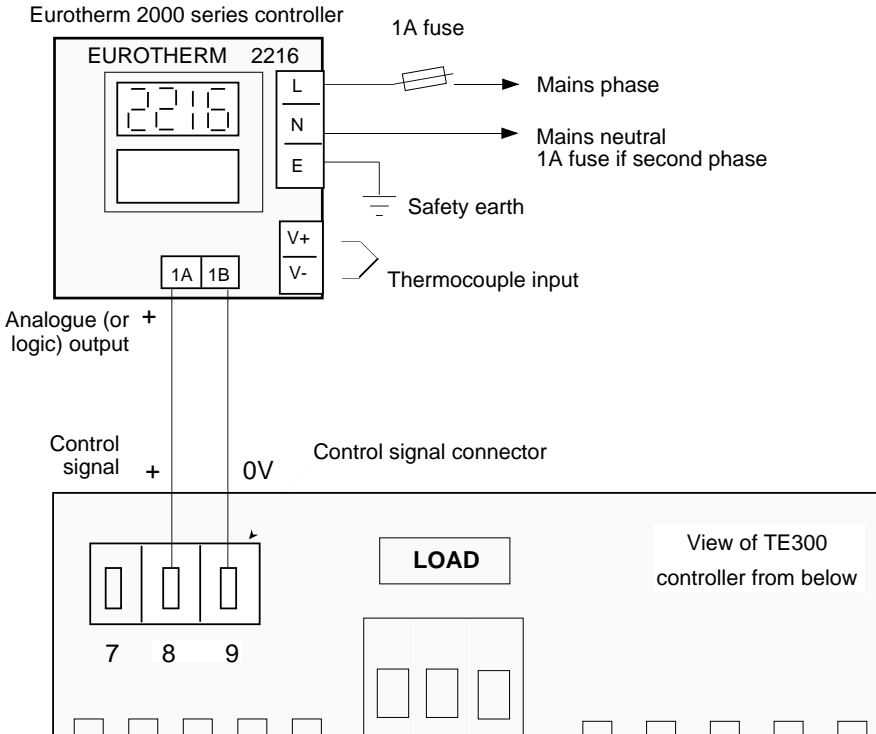


Figure 3-5 External control signal wiring

Control wiring in local mode

The controller can be driven in **local mode** by a potentiometer or by a 'dry' contact.

For operation with manual control, a **10k Ω** external potentiometer must be used, connected between terminals **9** ('0V') and **7** ('+5V', **0.5mA**).

The potentiometer wiper is connected to the control terminal block input (terminal **8**).

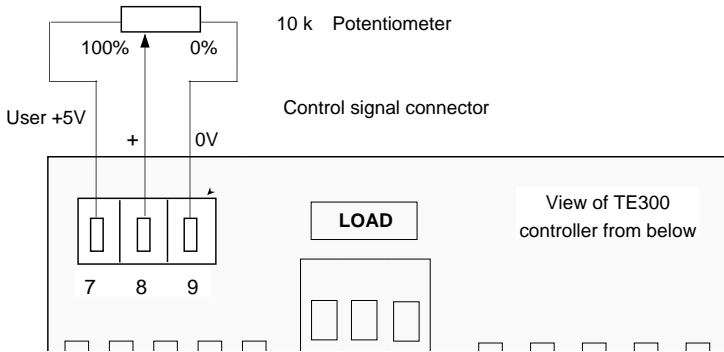


Figure 3-6 Manual control wiring using an external potentiometer

For operation in logic mode (ON/OFF) contacts can be connected between terminals **8** ('+ Input') and **7** ('+5V').

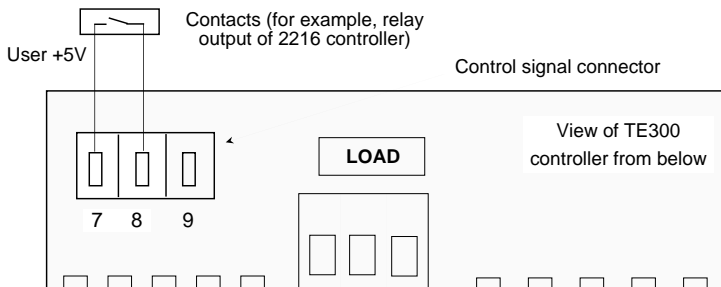


Figure 3-7 Contact wiring for logic operation

Power supply separate from electronics (option)

TE300 controllers can be used with **non-standard** mains.

If a **TE300** series controller is used with a mains supply, the voltage of which is not shown in the voltage codes, the control electronics must be fed **separately** from the power by **115V** or **230V** supply.

The separate power supply must be connected between terminals **10** and **12** (terminal 11 is not used). The auxiliary power supply must be **in phase** with the power voltage **between** phases **1** & **2** (power terminals **L1** & **L2**)

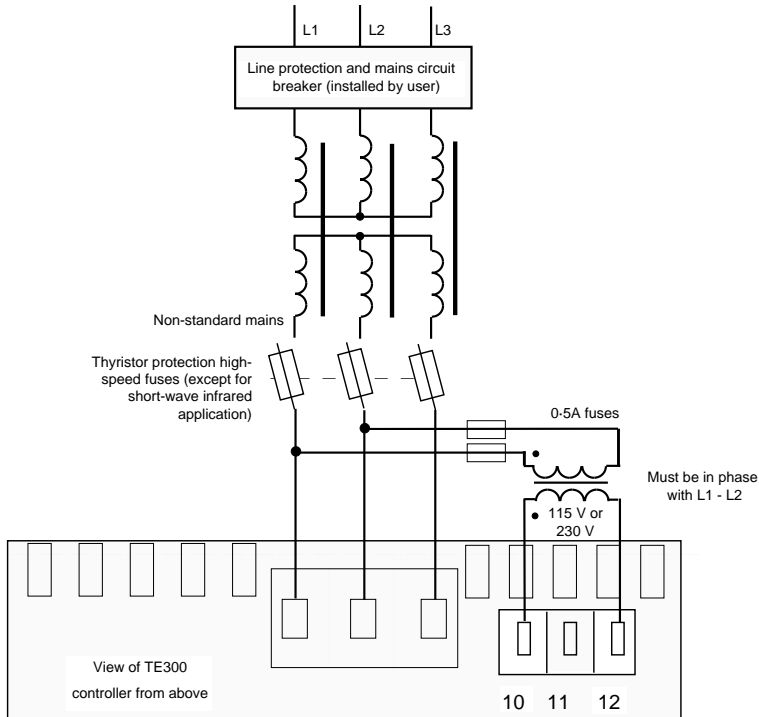


Figure 3-8 Connection of power supply separate from electronics (option)

Attention!



Each auxiliary power supply feed wire connected to a supply phase must be protected by a 0.5A fuse.

CHAPTER 3 WIRING

WIRING - SAFETY

DANGER!

Wiring must only be carried out by personnel who are qualified to work in a low voltage industrial environment.

It is the user's responsibility to wire and protect the installation in accordance with current professional Standards.

A suitable device ensuring electrical isolation between the equipment and the supply must be installed upstream of the unit in order to permit safe operation.

TE300 series units have a protective cover.

DANGER!

Before any connection or disconnection, ensure that power and control cables or leads are isolated from voltage sources.

For safety reasons, the safety earthing cable must be connected before any other connection is made during wiring and it should be the last cable to be disconnected.

The **safety earth** is connected to the screw located on the slot at the side of the controller and is denoted by the symbol:

Attention!

To ensure correct grounding of the **TE300** unit, make sure that it is mounted on the **reference ground surface** (panel or bulkhead).

Failing this, it is necessary to add a ground connection **at most 10cms** long between the earth connection and the reference ground surface.

DANGER!

This connection, which is intended to ensure good **ground continuity**, can never be used to replace the safety earth connection.

POWER WIRING

Connection

The power terminal blocks (mains and load) are **cage** terminal blocks.

The control terminal block has a plug-in screw connector.

The safety earth is connected to an **M8** screw and bolt.

The terminal capacities and tightening torques to be observed are given in Table 3-1.

Parameter	Power & load supply	Safety earth	Control
Terminal capacity (mm ²)	10 to 25	10 to 25	1.5
Tightening torque (Nm)	2	12.5	0.7

Table 3-1 TE300 controller connection details

The cross-section of the conductors to be used must comply with Standard IEC 943.

Power wiring diagrams

The **TE300** power wiring diagram depends on the load configuration.

The following three **power** and **safety earth** wiring diagrams are given below to illustrate different types of load configuration.

Chapter 4

CONFIGURATION

Contents

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Chapter 4 CONFIGURATION

CONFIGURATION - SAFETY

The controller is configured by soldered 'coffee beans', located on the driver board.



Important!

The controller is supplied **fully configured** in accordance with the product code on the identification label and is **ready for operation** after wiring.

This chapter is included with a view to:

- **Checking** that the configuration is suitable for the application
- **Modifying**, if necessary, certain characteristics of the controller on site.

DANGER!

For safety reasons, re-configuration of the controller using the 'coffee beans' must be carried out with the unit switched off and by personnel qualified and trained to work with electrical equipment in a low voltage industrial environment.



Before starting the re-configuration procedure, ensure that the controller is isolated and that any accidental power-up is not possible.

After re-configuring the controller, amend the codes on the identification label to prevent any later maintenance problems.

DRIVER BOARD CONFIGURATION

General introduction

The 'coffee beans' located on the driver board are used to configure:

- The type of load connection
- The type and level of the control signal
- The thyristor firing mode
- The 'Elimination of DC component' option.

The functions of the 'coffee beans' on the driver board are summarised in the following table.

Function	'Coffee beans'
Type of load configuration	GS7, GS6
Thyristor firing mode	GS1, GS2 GS3, GS4
Type and level of control signal	GE1, GE2, GE3

Table 4-1 Function of 'coffee beans' on driver board

'Coffee beans' GR1 to GR4 are used for factory settings and are **not intended** to be re-configured by the customer.

Important!

In the 'coffee bean' configuration tables



- X** : denotes the corresponding solder link ('coffee bean')
- : denotes absence of (open) solder link.

Location of 'coffee beans'

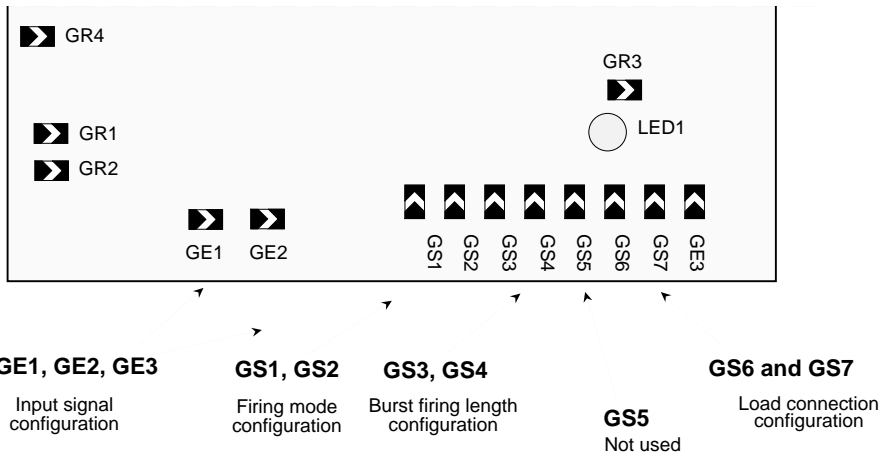


Figure 4-1 Location of configuration 'coffee beans' on the driver board (solder-side view)

The 'coffee beans' are labelled **GR**, **GE** or **GS**, depending on their function.

Configuring the type of load connection

The controller is configured for the type of load connection by means of 'coffee beans' **GS6** and **GS7** located on the driver board.

Load configuration	Code	'Coffee beans'	
		GS6	GS7
Star without neutral (3-wire)	3S	-	-
Closed delta (3-wire)	3D	-	X
Star with neutral (4-wire)	4S	X	-
Open delta (6-wire)	6D	X	X

Table 4-2 Configuration of load connection type

Control signal configuration

The three ‘coffee beans’ **GE1** to **GE3** are used to configure the controller input.

Type and range of control signal		‘Coffee beans’		
		GE1	GE2	GE3
Voltage	0 to 5V analogue & ‘5V’ logic	-	-	-
	0 to 10V analogue & ‘10V’ logic	-	X	-
Current	4 to 20mA analogue & ‘20mA’ logic	X	-	X
Local control	10k Ω potentiometer (0 to 5V)	-	-	-
	‘Dry’ controller relay contacts (0 to 5V)	-	-	-

Table 4-3 Control signal configuration using ‘coffee beans’

Thyristor firing mode configuration

The firing mode is configured by soldering ‘coffee beans’ **GS1** & **GS2**.

In Burst-firing mode the number of firing cycles is configured by ‘coffee beans’ **GS3** & **GS4** (this number is given for the cycle corresponding to 50% power).

Thyristor firing mode		‘Coffee beans’			
		GS1	GS2	GS3	GS4
Logic (All or nothing)		-	-	-	-
Burst-firing	1 cycle	X	-	-	-
	8 cycles	X	-	X	-
	16 cycles	X	-	-	X
	128 cycles	X	-	X	X
Advanced Single-cycle (4- or 6-wire load configuration)		X	X	-	-

Table 4-4 Thyristor firing mode configuration

Chapter 5

OPERATION

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Chapter 5 OPERATION

THYRISTOR FIRING MODES

General introduction

TE300 controllers have the following thyristor firing modes:

- Burst-firing with configurable cycle time
- Advanced Single-cycle (firing by cycles and non-firing by half-cycles)
- Logic (ON/OFF).

As an option, DC component elimination for 3-wire configuration is available in Burst-firing and Logic modes.

They can be **re-configured** by the user, as described in the chapter entitled 'Configuration'.

'Burst-firing' mode

Burst-firing mode is a **duty cycle** mode which consists of supplying a series of **complete** mains voltage **cycles** to the load.

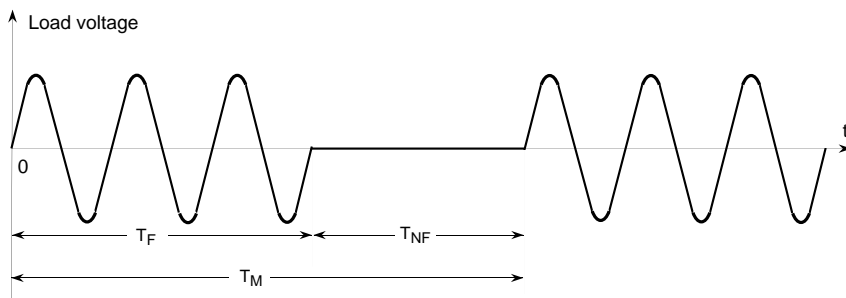


Figure 5-1 'Burst-firing' mode (T_F - firing time; T_M - modulation time)

Thyristor firing and non-firing are synchronised with the mains and, for a resistive load, are performed at **zero** voltage for each load.

This type of firing eliminates steep rates of voltage applied to the load, **minimises interference** to the supply network and, above all, avoids generating radio frequency interference (RFI).

In '**Burst-firing**' mode, the power delivered to the load depends on the firing time T_F and the non-firing time T_{NF} .

The load power is proportional to the firing ratio (τ) which is defined by the ratio of the firing time T_F to the modulation time $T_M = T_F + T_{NF}$

The firing ratio or duty cycle is expressed by the following ratio:

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

The load power can be expressed by:

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

Where P_{MAX} represents the load power for full thyristor firing.

The length of the cycle in basic Burst-firing is selected by the user from four values:

1, 8, 16 and 128

which are the number of thyristor firing cycles at 50% power.

This value is configured at the factory, when the controller is ordered.

The modulation time in ‘Burst-firing’ mode is **variable** according to the power demand.

For example, for ‘8-cycle Burst-firing’:

- At **50%** power, the typical value of the modulation time is **0.32s** (at **50Hz**):
8 firing and **8** non-firing cycles.
- For a setpoint less than **50%**, the **firing** time remains **constant** (8 cycles), the non-firing time increases and, as a consequence, the modulation time increases.
- For a setpoint greater than **50%**, the **non-firing** time remains **constant** (8 cycles), the firing time increases and, as a consequence, the modulation time increases.

The control system **adjusts** the basic Burst-firing modulation time in order to retain optimum accuracy irrespective of the power demand.

As a result of this type of modulation, **TE300** offers precision control which adapts to each particular setpoint zone.

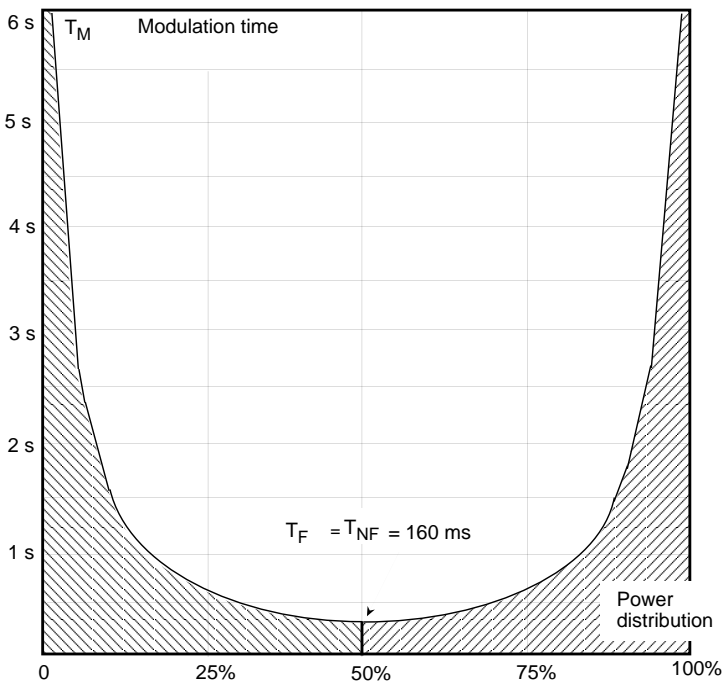


Figure 5-2 Modulation time as a function of power
(example: ‘8-cycle Burst-firing’)

'Single-cycle' mode ('1-cycle Burst-firing')

This Burst-firing mode has a **single** firing cycle or a single non-firing cycle and is called 'Single-cycle' (or 'standard Single-cycle') firing mode.

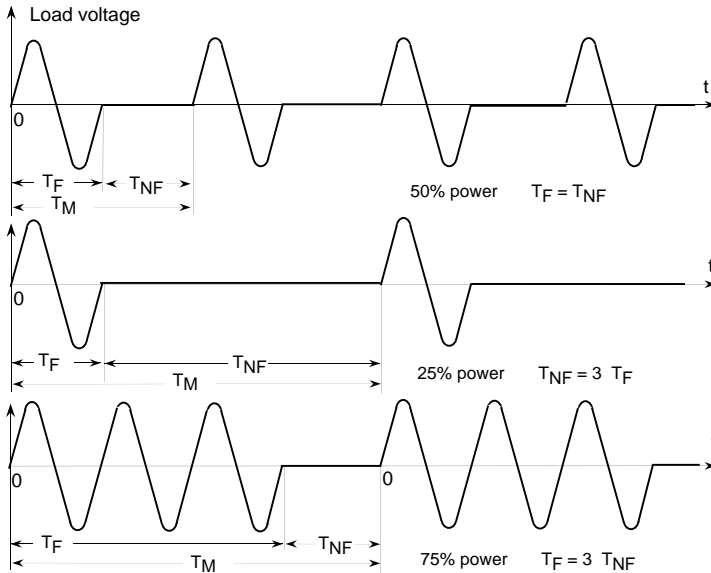


Figure 5-3 'Single-cycle' firing mode

At **50%** power, the modulation time in 'Single-cycle' mode is **40ms**:

- 1 firing cycle (**20ms at 50Hz**)
- 1 non-firing cycle (**20ms at 50Hz**)

For a setpoint **less than 50%**:

- The **firing** time remains constant (1 cycle)
- The non-firing time increases and, as a consequence,
- The modulation time increases

For a setpoint **greater than 50%**:

- The **non-firing** time remains constant (1 cycle)
- The firing time and the modulation time increase.

'Advanced Single-cycle' mode

In order to **minimise power fluctuation** during the modulation period, the 'advanced Single-cycle' thyristor firing mode uses:

- A complete number of cycles for firing
- A complete number of half-cycles for non-firing

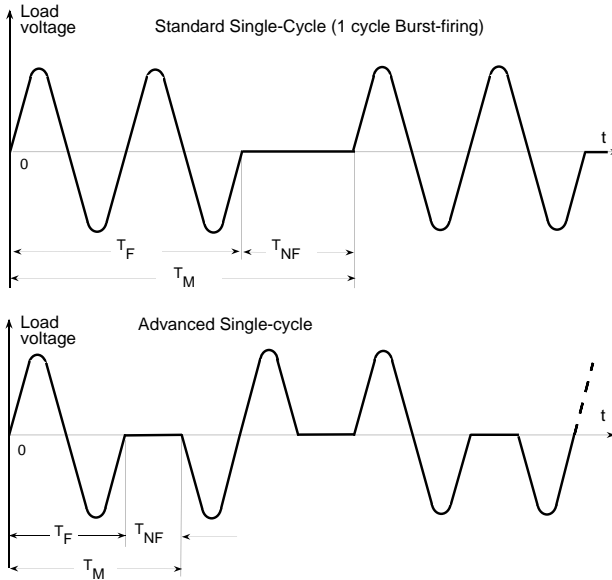


Figure 5-4 Comparison of 'Single-cycle' and 'advanced Single-cycle' firing modes
(66% power, $T_F = 2 T_{NF}$)

At 50% power, and for a setpoint less than 50%, thyristor firing takes place as in the 'standard Single-cycle' mode (see page 5-5).

For a setpoint greater than **50%** in '**advanced Single-cycle**' mode:

- The **non-firing time** is constant at **one half-cycle**
- Firing takes place over whole cycles.

The use of **half-cycles** for the non-firing time accounts for the reduced cycle time when compared to the 'standard Single-cycle' mode.

In a 'short-wave infrared' application, '**advanced Single-cycle**' firing mode reduces the brightness of the infrared elements and thus minimises annoying visual flickering.

The 'advanced Single-cycle' firing mode is available for **4-** and **6-wire** configurations.

'Logic' mode

The '**logic**' thyristor firing mode (ON/OFF) controls power in the load proportionally according to the firing time set by the **logic** control signal.

This firing mode is activated by a signal greater than **50%** of full scale. It is deactivated when the signal falls below **25%** of full scale.

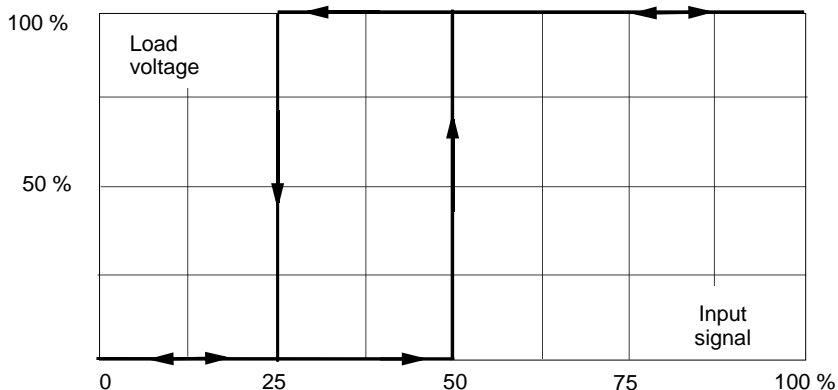


Figure 5-5 'Voltage-Logic signal' diagram

Important!

In order to reduce the emission of electrical interference and electromagnetic radiation, thyristor switching takes place at zero voltage for resistive loads, irrespective of the beginning and end of the logic control signal.

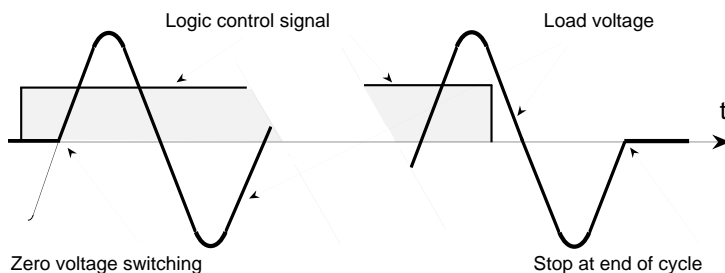


Figure 5-6 'Logic' firing mode

CONTROL OPERATION

TE300 controllers include an internal control loop.

The control algorithm of the **TE300** series takes into account the value of the r.m.s. load voltage **squared**. The square of the r.m.s. load voltage represents the power dissipated in a purely resistive load whose resistance remains constant with temperature.

The output power of the controller is linear between **0%** and **100%** of maximum power for an analogue input signal variation between **4%** and **96%** of full scale.

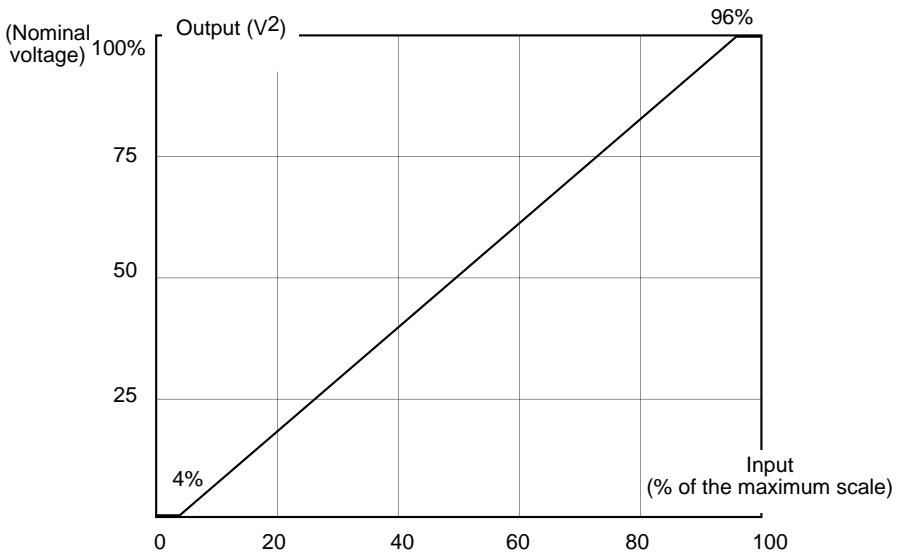


Figure 5-7 'Input/Output' response curve for an analogue signal

Control precision is guaranteed to $\pm 2\%$ of the power dissipated in the load (for constant resistance).

The output power of the controller is calibrated according to the nominal voltage specified when ordering.

Chapter 6

COMMISSIONING PROCEDURE

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Chapter 6 COMMISSIONING PROCEDURE

Read this chapter carefully before commissioning the controller

COMMISSIONING PROCEDURE - SAFETY



Important!

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

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



DANGER!

A thyristor is not an isolating device.

Touching a load terminal even with a zero load current is as dangerous as touching mains live.

Only personnel qualified and trained to work with low voltage electrical equipment in an industrial environment should have access to the interior of the unit.

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

The temperature of the heatsink may exceed 100°C.

Avoid all contact, even occasional, with the heatsink when the controller is operational. The heatsink remains hot for around 15mins after the unit has been switched off.

CHECKING THE CHARACTERISTICS

Load current

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

If three identical loads are configured in **closed delta**, the current of each phase of the controller is **√3 times greater** than the current in each **branch** of the load.

For a given power (**P**) of a three-phase load and with line-to-line voltage V_L , the current to be compared with the nominal current of the controller is:

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

For open delta, the current to be compared with the nominal current of the controller is:

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

Load configuration type

Check that the type of connection used is correctly configured by the 'coffee beans' **GS6** and **GS7** on the driver board.

Supply voltage

The nominal value of the controller voltage must be greater than or equal to the **line-to-line** voltage of the supply used.



Attention!

In order for the control algorithm to function correctly, the nominal unit voltage rating must be as close as possible to the supply voltage.

Auxiliary power supply voltage (option)

In the case of operation with non-standard three-phase mains, a separate power supply for the electronics must be provided at either **115V** or **230V**.

The auxiliary power supply voltage is set at the factory from the ordered product code.

Control signals

Configuration of the 'coffee beans' on the driver board must be compatible with the type and level of the control signals (see page 4-6).

POWERING UP THE CONTROLLER

TE300 series controllers are ready to operate correctly **immediately** after installation and wiring in accordance with this user manual.

After checking that the nominal parameters of the controller (voltages, currents, input signal and load configuration) are compatible with those of the installation, apply volts to the controller.

Check that the current in each phase of the controller is equal to **0** in the **absence** of the control signal.

Make sure that the r.m.s. current in each phase **does not exceed** the nominal controller rating when the setpoint is at **maximum**.

Chapter 7

MAINTENANCE

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Chapter 7 MAINTENANCE



DANGER!

The controller must be maintained by **personnel qualified** and **trained** to work with low voltage electrical equipment in an industrial environment.

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

FUSES

Protection of auxiliary voltage connection

Protection fuses for both the fan connection (63A nominal current unit) and separate electronics supply ('Auxiliary power supply' option) must be installed in each conductor connected to a supply phase.

Auxiliary voltage (max.)	0.5A fuse 6.3 x 32 mm	Fuse-holder isolator	'Fuse-isolator' assembly dimensions (mm)
250V	CS174290U0A5	CP174293	63 x 15 x 52

Table 7-1 Recommended fuse for auxiliary voltage connection

Thyristor protection

The thyristors in the **TE300** series controllers are protected in the following way:

- external high speed fuses against overcurrents (except for short-wave infrared applications)
- RC snubbers and MOVs (varistors) protect against over-fast voltage variations and transient overvoltages when the thyristors are not conducting.



DANGER!

High-speed fuses are used only for the protection of **thyristors** against large amplitude overloads.

Under no circumstances should these high-speed fuses be used to protect the installation.



Attention!

For the use of high-speed fuses in **short-wave infrared** applications, **please contact** Eurotherm Controls.

To protect the thyristors in the **TE300** series, 3 fuses and a **tri-polar** fuse-holder must be used. Details of these are given in the following table.

Nominal current		Eurotherm reference		Dimensions H, W, D
Controller	Fuse	Fuse	Fuse + fuse-holder assembly	
16A	20A	CH 260024	FU3038/16A/00	81 x 52.5 x 68
25A	30A	CH 260034	FU3038/25A/00	81 x 52.5 x 68
40A	50A	CH 330054	FU3451/40A/00	95 x 79 x 86
50A	63A	CS173087U063	FU3258/50A/00	140 x 108 x 90
63A	80A	CS173246U080	FU3760/63A/00	150 x 114 x 107

Table 7-2 Recommended high-speed fuses for thyristor protection

Maximum operating voltage for fuses: **500V** (line-to-line).

Attention!

For resistive loads (except short-wave infrared applications) the use of any fuses other than those recommended for thyristor protection will **invalidate the controller's guarantee.**



SERVICING

TE300 controllers must be mounted with the heatsink positioned vertically, with no obstructions above or below which could inhibit or impede airflow.



Attention!

If several units are mounted in the same cabinet, they should be arranged in such a way that air expelled from one **cannot be drawn into** the unit located above it.

In order to ensure correct cooling of the unit, users are advised, depending on the degree of environmental pollution, to regularly **clean the heatsink** and (for 63A rating units) the **protective fan guard**.



DANGER!

Cleaning should only be carried out when the controller supply is disconnected and at least 15 minutes after it has ceased operating.

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

TOOLS

Operation	Flat-blade screwdriver (mm)	Hex key
Safety earth wiring		HEX13 (M8)
Power wiring	0.5 x 4	
Load wiring	0.5 x 4	
Control, fan (50A, 63A rating) and auxiliary power supply (option) wiring	0.5 x 2.5	

Table 7-3 Tools

EUROTHERM WORLDWIDE SALES AND SERVICE

AUSTRIA

Eurotherm GmbH
Tel +43 (1) 798 7601
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Web: www.eurotherm.at

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