TE10P

ACTIVE
POWER CONTROLLER

EUROTHERM
CONTROLS

User manual

invensys
An Invensys company

Active power controller

TE10P

Control of all types of single-phase load
- optional digital communications

User Manual
(16A to 400A rated units)

CONTENTS

CE RELEVANT EUROPEAN DIRECTIVES

CE MARKING AND SAFETY

TE10P products carry the CE mark in compliance with the essential requirements of the European Low Voltage Directive 73/23/EEC of 19/2/73, amended by the Directive 93/68/EEC of 22/7/93
For safety purposes, TE10P products installed and used in compliance with this User Manual meet the essential requirements of the European Low Voltage Directive.

DECLARATION OF CE CONFORMITY

Availability

A declaration of CE conformity is available on request.

Validation by Competent Body

Eurotherm has validated the compliance of TE10P products with the European Low Voltage Directive and with EMC test standards (see following page) through product design and laboratory testing.

These tests are listed in a Technical Construction File validated by the LCIE (Central Laboratory for the Electrical Industries), a Recognised Competent Body.

ELECTROMAGNETIC COMPATIBILITY (EMC)

(For industrial environments only, must not be used in domestic environments)

Eurotherm certifies that TE10P 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 TE10P products are concerned.

Test standards

Tests		**EMC test standards**
Immunity	Generic standard Electrostatic discharge Fast transients RF electromagnetic fields	EN50082-2 EN 61000-4-2 (06/1995) EN 61000-4-4 (01/1995) ENV 50140, ENV 50141 and ENV 50204
Emission	Radiated & Conducted	EN 55011 Class A (1991)
	The choice of standard for the Conducted Emission depends on the application: · EN 50081-2 Class A (1991) - Without external filter in Burst-firing mode for resistive load ≤ 100A - With an external series filter for Phase angle mode · IEC 1800-3 (EN 61800-3 1996) - Without external filter. Applies to 2nd environment.	

Internal EMC filters

Internal EMC filters are incorporated as an option in the TE10P thyristor units to reduce conducted emission in Burst-firing mode for resistive loads ≤100A in accordance with the corresponding test standard.

To reduce conducted emissions associated with certain thyristor unit applications, Eurotherm can supply external filters.

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: HA 025464 ENG).

SCOPE OF MANUAL

This TE10P User Manual (Ref: HA 175960 ENG) is intended for use with the TE10P range of power controllers rated between 16A and 400A in two mechanical formats.

Issue 2.0 of the manual is intended for products manufactured from August 1999.

PRECAUTIONS

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.

WARNING

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 controller must only be carried out by personnel qualified and trained to work with low voltage electrical equipment in an industrial environment.

Independent alarm

Given the safety regulations concerning personnel and property, and the value of the equipment controlled by TE10P thyristor power units, we recommend the use of an independent safety device (alarm), which must be tested regularly.

Eurotherm can supply appropriate equipment.

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.

Chapter 1

IDENTIFYING THE TE10P POWER CONTROLLER

CHAPTER 1 IDENTIFYING THE CONTROLLER

GENERAL INTRODUCTION

The TE10P range of thyristor power units are electrical power controllers designed for the control of active power in all types of industrial single-phase loads (with the exception of purely capacitative loads*).

TE10P power units, in two mechanical versions, control currents between 16A and 400A.

The nominal voltage (operating voltage) ranges from 100V to 500V.

Units rated from 16A to 100A comprise of two channels; one controlled by thyristors and the other a direct link from input to output; 125A to 400A rated units comprise one channel controlled by thyristors.

The TE10P offers all the operating modes necessary to select precise control of complex loads (platinum, molybdenum disilicide, silicon carbide...) and to optimise firing modes in order to reduce flickering of short-wave infrared elements.

Configuration of the parameters for control, operation and thyristor firing mode can be implemented from the controller front panel or by means of optional digital communications.

Depending on the configuration, the TE10P may be used with analogue or logic signals or may be driven remotely by digital communications (option).

Supervisory monitoring uses the RS485 (or RS422) digital link.
Data exchange takes place using the Modbus® or Profibus-DP protocols.
The status of digital communications is indicated by LEDs.
A default mode is provided to control the unit using an external potentiometer or analogue signal.

A seven-segment four-digit display is used for local adjustment (initial commissioning) and rapid diagnosis of the state of the controller, its configuration and the state of the alarms.

Access to the scrolling menu on the display is provided by means of a push button on the front panel.

Configuration mini-switches (accessible by opening the access doors), together with four potentiometers to adjust the principal operating parameters, are located on the front panel.

A diagnostic connector is used to connect a Eurotherm 260 diagnostic unit, to test or control 20 electrical signals.

Current or voltage monitoring reduces or stops thyristor firing if limits are exceeded (depending on the configuration). Load failure detection adapts itself to standard or complex loads.

Faults on the supply, load, current or voltage are signalled by the display, by the alarm relay and via digital communications.

** Consult Eurotherm*

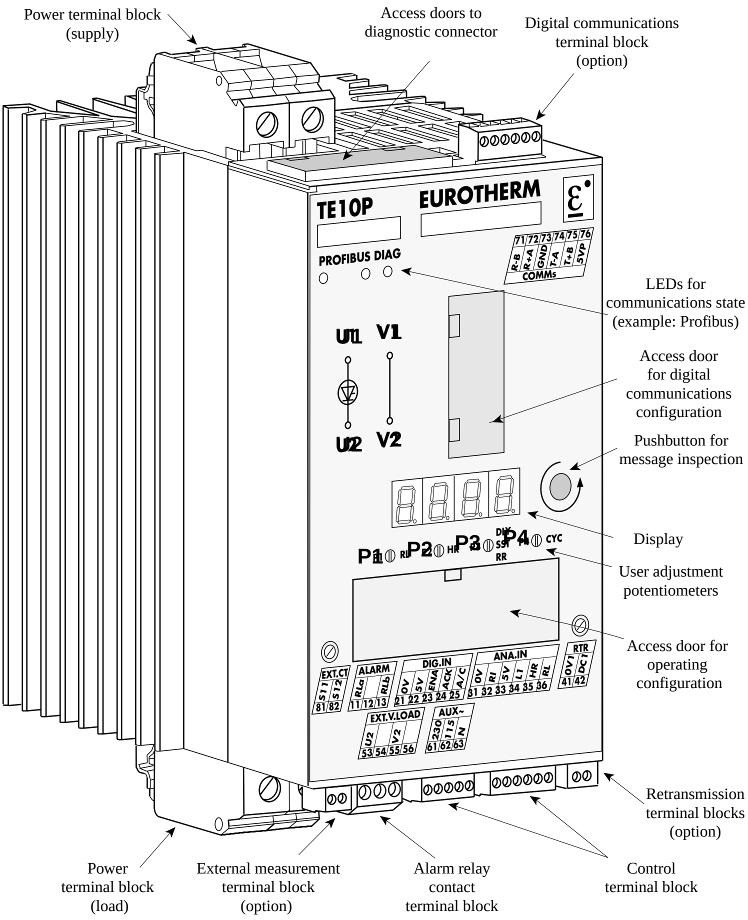


Figure 1-1 Overview of TE10P controller (16A to 100A rated units, all options)

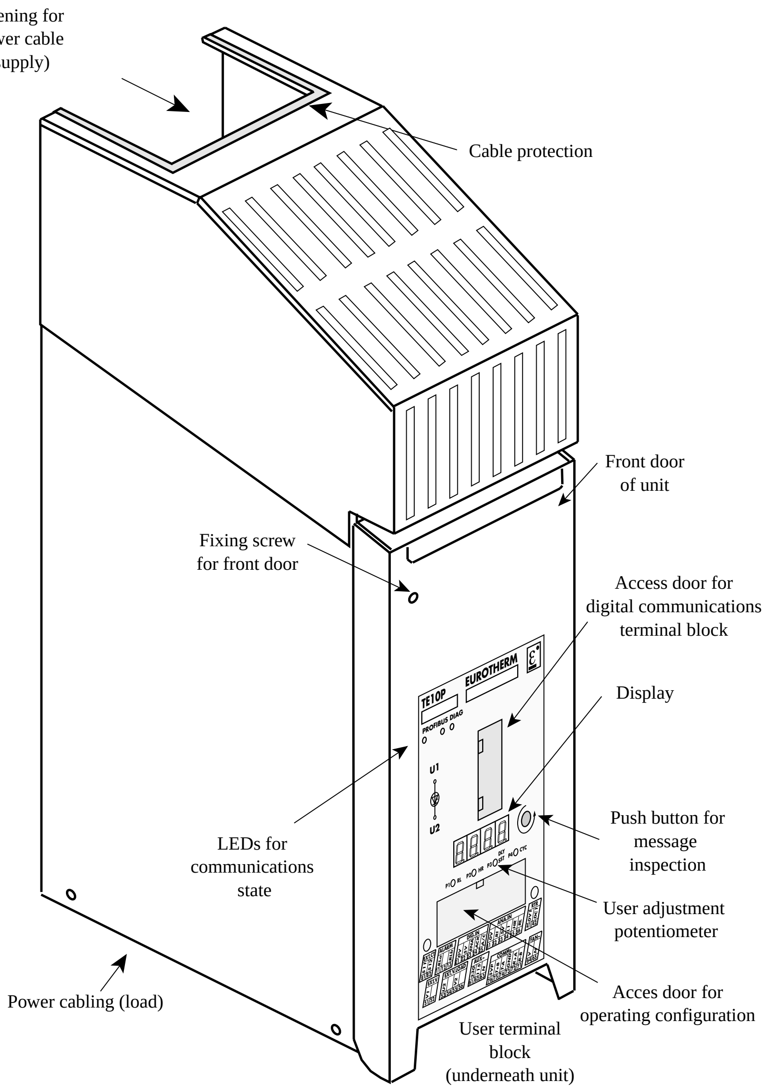


Figure 1-2 Overview of TE10P controller (125A to 400A rated units, all options)

TECHNICAL SPECIFICATION

The TE10P series of power controllers are designed to control all types of single-phase industrial loads (except for purely capacitative loads) by means of thyristors.

DANGER

Danger!

A safety device ensuring electrical isolation between the equipment and the supply must be installed in order to permit safe maintenance.

A thyristor is not an isolating device. Touching a load terminal, even with zero load current, is as dangerous as touching mains live. It is the user's responsibility to ensure, before commissioning the controller, that all the nominal ratings of the controller are compatible with the conditions of use and the installation.

WARNING

Warning!

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

CE Marking*

Electrical safety	Complies with European Low Voltage Directive 73/23 EEC TE10P products carry the CE mark in compliance with the essential requirements of this Directive.

Electromagnetic Compatibility*

Immunity	Complies with EN 50082-2, EN 61000-4-2, EN 61000-4-4, ENV 50204, ENV 50140, ENV 50141
Radiated emission	Complies with EN 550011 Standard Class A
Conducted emission	Complies with EN 50081-2 Standard : without external filter in Burst-firing mode for resistive loads and up to 100A nominal with external series filter for Phase angle mode, Complies with IEC 1800-3 Standard (EN 61800-3): without filter. Applies to second (industrial) environment.

An internal EMC filter (FILT option for units rated ≤100A) reduces radio frequency conducted interference.

** Controller installed and used in accordance with this Manual (see chapter on European Directives)*

WARNING

Warning!

In order to maintain our 'leading edge', Eurotherm may have to make certain changes to specifications without prior notice. For any further information, or if in doubt please contact your nearest Eurotherm office.

Power

Nominal current (at 45°C)	16A to 400A depending on product code
Nominal voltage	100V to 500V (+10%, -15%) depending on product code Inhibition below 80% of calibrated voltage.
Supply frequency	Between 40Hz and 70Hz, automatic selection. Inhibited outside 40Hz to 70Hz.
Dissipated power	1.3W (approx.) per amp
Cooling	Natural convection: ≤ 100A. Permanently fan cooled: ≥ 125A.
Fan (≥ 125A)	25VA consumption Supply voltage 115V or 230V depending on product code
Load	Single phase: resistive, short-wave infrared, transformer primary, inductive, or temperature dependent loads Not suitable for purely capacitive loads

Control signals

Power supply	Self-supplied from main supply, or separate power supply of 115V or 230V (+10%; -15%) Consumption: 10VA
Control type	Analogue, Logic or Digital communications
Analogue signals	Remote analogue setpoint and limiting signals 0-5V or 0-10V (input impedance ≥ 100kΩ), 0-20mA or 4-20mA (input impedance 250Ω) Local setpoint: 0-5V (input impedance ≥ 100kΩ) and / or manual control potentiometer.
Logic signals	Max values: 5V, 10V or 20mA in Logic mode only; ‘on’ state ≥ 50%; off state ≤ 25%. Enable, Reset, Default type: 5V (10kΩ input) ‘active’ state > 4V; ‘non-active’ state < 1V.
User output	5Vdc (5mA max).

Firing modes

Initial start-up	Safety ramp by means of selectable phase angle start (not availablr for Advanced Single-cycle).
Zero crossing firing	· Burst-firing 1, 8, 16, or 128 cycles · Logic (On/Off) For these two modes, the following are available: - elimination of momentary over-currents for inductive loads (delayed firing at start of each cycle) - soft-start (firing angle variation) adjustable at 2, 4, 8, 16, 32 or 64 cycles. · Advanced Single-cycle Firing by whole cycles separated by half cycles of non-firing (without DC component).
Firing angle variation	· Phase angle A linear ramp (if selected) at setpoint change. Duration of ramp is adjustable from 0 to 65s for a setpoint change from 0 to 100% using potentiometer on front panel.

Control function

Feedback parameter	· Active power (P) calculated from instantaneous measurements · RMS load voltage (V) or current (I) · Load voltage (V^2) or load current (I^2) squared · Open loop · Transfer of controlled parameters: $I^2 \leftrightarrow V^2$ or $I^2 \leftrightarrow P$
Control linearity	Better than ±1% of full scale
Stability	±1% of full scale with variations in: - load impedance ±30%; - supply voltage +10%, -15% - temperature from 0 to 50°C
Response time	In Phase angle: 250ms typically In Logic: 60ms approx. In Burst-firing depends on base time selected (T_B): 300ms (TB = 1 cycle); 1.6s (TB = 8 cycles); 3.2s (TB = 16 cycles); 26s (TB = 128 cycles).
Retransmission	· Isolated analogue output at 0 to 10V or 4 to 20mA (option): Control value (as standard), or one of parameters selected by digital communications (controlled parameter, load power, load current or voltage). Precision better than ±1% In Logic, stability guaranteed for a control signal cycle time: 0.5s < t < 20min. · Display on front panel (all operating parameters) · Digital communications (option)
Setpoint	· Analogue: adjustment using a single potentiometer or in cascade with an external analogue signal (0 to 5V, 0 to 10V, 0 to 20mA or 4 to 20mA) · Digital (option): adjustment via communications bus
I / V Limit	Current monitoring whatever the configuration (for short-wave infrared available only in Phase angle). Current limit action by reducing firing angle (except in Advanced Single-cycle) or by stopping thyristor firing. Voltage limit by reducing firing angle selectable only in Phase angle, accompanied by limit in load current to 100% non-adjustable. Limit threshold adjustable using a single front panel potentiometer or in cascade with an external analogue signal (0 to 5V, 0 to 10V, 0 to 20mA or 4 to 20mA) and in cascade with the limit digital setpoint (option) .

Digital communications (option)

Bus	Serial link RS422 or RS485 (isolated)
Protocol	PROFIBUS-DP or MODBUS®
Transmission rate	Modbus: configurable in 9.6kbaud or 19.2kbaud Profibus-DP: automatic recognition up to 1.5Mbaud.
Default mode	The default configuration is determined by mini-switches or memory (user selection).

Alarms

Supply	· Absence of supply voltage (≤ 30% of nominal voltage): firing shutdown · Under-voltage: firing shutdown below 80% of controller operating voltage · Over-voltage: alarm on voltage 10% greater than controller operating voltage · Frequency above 70Hz or below 40Hz: firing shutdown
Current	Current exceeds limit threshold by 10%, if firing shutdown action is selected.
Load	20% increase in load impedance compared with calculated value derived from voltage / current measurement (static adjustment) or continuously calculated (dynamic adjustment) Static adjustment of load failure detection using push button on front panel or via digital communications With load failure detection controlled in this way, breakage detection is ensured for at least one in six identical elements wired in parallel.
Thyristors	· Thermal monitoring: firing shutdown if thermo-contacts open for fan-cooled units (125A to 400A nominal). · Thyristor short-circuit: firing shutdown
Alarm information	Alarm type and degree of severity are permanently displayed: data available via digital communications (option), relay signalling (the alarm relay is programmable via comms).
Diagnostics	Connector for diagnostic unit permits adjustment and control of thyristor unit by means of 20 test signals

Environment

Operating temperature		0°C to +45°C at 2000m max. altitude (see current derating curves)
Storage temperature		-10°C to +70°C
Thyristor protection		Internal MOV (varistor) and RC snubber High-speed fuse: - external for 16A to 100A rated units - internal for 125A to 400A rated units
Protection		IP20 in accordance with IEC 529 on front panel, door closed for ≥ 125A rated units
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 and non-streaming
Pollution		Pollution degree 2 permissible, defined by IEC 664
Dimensions	(16A to 100A)	225mm (H) x 116mm (W) x 169mm (D)
	(125A to 400A)	470mm (H) x 133mm (W) x 260mm (D)
Weight		16A to 100A: 3.2kg 125A to 400A: 11.5kg

CURRENT DERATING

The nominal currents of TE10P controllers are defined at the ambient temperature of 45°C.

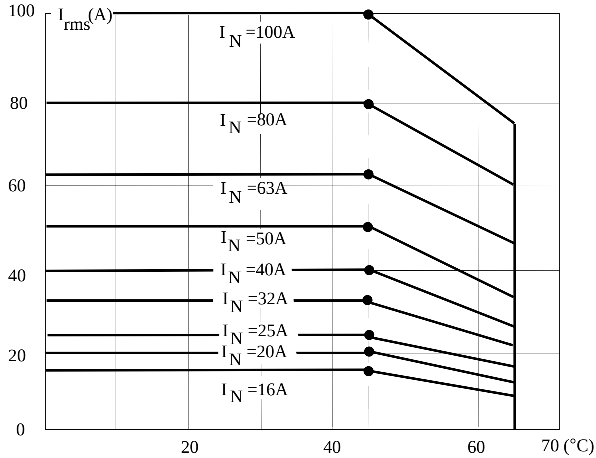


Figure 1-3 Current derating for TE10P controllers
(16A to 100A rated units)

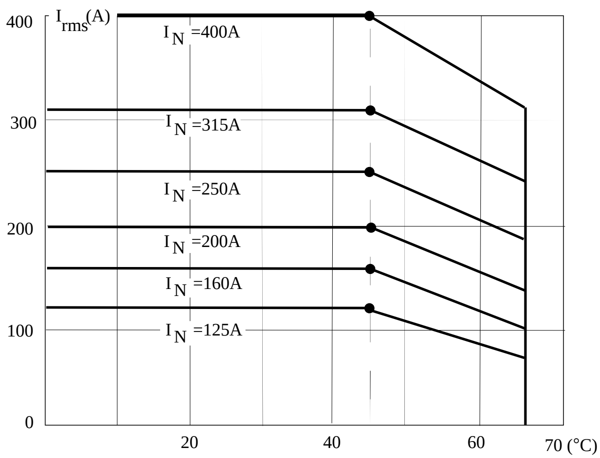


Figure 1-4 Current derating for TE10P controllers
(125A to 400A rated units)

PRODUCT CODE FOR TE10P RANGE

	Current	Voltage	Auxiliary	Fan	Analogue Setpoint	Setpoint Limit	Firing Mode	Ramp Start	Safety Ramp	Load Type
TE10P/	/	/	/	/	/	/	/	/	/	/

1. Nominal current	Code
16 amps	16A
20 amps	20A
25 amps	25A
32 amps	32A
40 amps	40A
50 amps	50A
63 amps	63A
80 amps	80A
100 amps	100A
125 amps	125A
160 amps	160A
200 amps	200A
250 amps	250A
315 amps	315A
400 amps	400A

2. Nominal voltage	Code
100 volts	100V
115 volts	115V
200 volts	200V
230 volts	230V
240 volts	240V
277 volts	277V
380 volts	380V
400 volts	400V
415 volts	415V
440 volts	440V
460 volts	460V
480 volts	480V
500 volts	500V

3. Auxiliary supply	Code
Self-supplied	AUTO
Separate external power supply:	
115 volts	115V
230 volts	230V

4. Fan supply	Code
Without fan (16A to 100A)	000
115V supply (≥ 125A)	115
230V supply (≥ 125A)	230

5. Analogue setpoint	Code
0 - 5 volts	0V5
0 - 10 volts	0V10
0 - 20 mA	0mA20
4 - 20 mA	4mA20

6. Analogue setpoint limit	Code
By potentiometer on front panel only	SPOT
By potentiometer and external signal:	
0 - 5 volts	S0V5
0 - 10 volts	S0V10
0 - 20 mA	S0mA20
4 - 20 mA	S4mA20

7. Thyristor firing mode	Code
Logic (All or nothing)	LGC
Phase angle	PA
Advanced Single-cycle	SCA
Burst-firing with Base time of:	
1 cycle	FC1
8 cycles	FC8
16 cycles	C16
128 cycles	128

8. Soft-start / Ramp	Code
Soft-start (Burst-firing and Logic) or Ramp (Phase angle)	URP
Without Soft-start / without Ramp	NRP

9. Safety ramp	Code
Initial active safety ramp (except in Advanced Single-cycle)	AR
Without initial safely ramp	NR

10. Load type	Code
Resistive load with low temperature coefficient	LTCL
Resistive load with high temperature coefficient: Molybdenum, Platinum, Tungsten, Molybdenum disilicide	HTCL
Variable load as a function of time and / or temperature: Silicon carbide	TTDL
Short-wave infrared elements	SWIR

Controlled Parameter	Limit	Limiting Signal	Mounting	Alarm Relay	Protocol	Comms Rate	Default	Options	Manual Language	
/	/	/	/	/	/	/	/	/	/	00

11. Controlled parameter — **Code**

Active power	P
RMS load current	IE
RMS load voltage	VE
RMS load current squared	I2
RMS load voltage squared	V2
Open loop	OL
Transfer of controlled parameters:	
$I^2 \leftrightarrow V^2$	I2 V2
$I^2 \leftrightarrow P$	I2P

12. Current / voltage limit* — **Code**

Firing shutdown if current limit threshold is exceeded	ICHO
Current limit by firing angle reduction	ILI
Voltage limit by firing angle reduction (available only in phase angle)	VLI

* For short-wave infrared, available only in Phase angle
* For load with code HTCL: ICHO in SCA firing mode and ILI in other firing modes

13. I or V limiting signal — **Code**

By potentiometer on front panel only	LPOT
By potentiometer and external signal:	
0 - 5V	L0V5
0 - 10V	L0V10
0 - 20mA	L0mA20
4 - 20mA	L4mA20

14. Mounting — **Code**

Bulkhead installation	BKD
DIN rail mounting (≤ 100A rated units)	DIN

15. Alarm relay — **Code**

Alarm relay contacts:	
Closed in alarm state	NC
Open in alarm state	NO

16. Communications protocol — **Code**

Without digital communications	000
Modbus®	MOP
Profibus-DP	PFP

17. Transmission rate — **Code**

Modbus® protocol:	
Read-only at 9.6kbaud	R96
Read-only at 19.2kbaud	R192
Read-write at 9.6 kbaud	W96
Read-write at 19.2kbaud	W192
Profibus protocol:	
Read-only up to 1.5Mbaud	RAUT
Read-write up to 1.5Mbaud	WAUT

18. Communications defaults — **Code**

Configuration set by mini-switches	CSW
Configuration written in non-volatile memory	CEP

19. Options — **Code**

Isolated analogue retransmission	
0 - 10V	R0V10
4 - 20mA	R4mA20
Sub-miniature communications connector (9 pin)	DB9
External load current measurement	IEXT
External load voltage measurement (select from the codes available in the nominal voltage field)	··· V
Internal EMC filter (≤ 100A) in Burst-firing mode	FILT
Fuse-blown microswitch (≥ 125A)	FUMS
Without internal fuse (≥ 125A)	NOFUSE

20. Manual language — **Code**

French	FRA
English	ENG

EXAMPLE OF PRODUCT CODE

TE10P controller and installation parameters

Nominal load current	80 amps
Nominal voltage	380 volts
Electronics supply	Self-supplied
Analogue setpoint signal	0 to 10 volts
Analogue setpoint limit	By potentiometer only on front panel
Firing mode	16 cycle burst-firing with soft-start
Safety ramp	Initial ramp
Load	Resistive with low temperature coefficient
Controlled parameter	Active power
Limit type	Current; by reducing firing angle
Limit signal	Adjustment by potentiometer only on front panel
Mounting	On DIN rails
Communications protocol	Modbus®
Transmission rate	Digital communications in read-write at 9600bauds
Communications default	Configuration by mini-switches
Options	Isolated retransmission output of 0 to 10 volts
	External load voltage measurement 100V
Manual language	English

Controller code:
TE10P / 100A / 380V / AUTO / 000 / 0V10 / SPOT / C16 / URP / AR / LTCL / P / ILI / LPOT / DIN / NO / MOP / W96 / CSW / ROV10 / 100V / ENG / 00

Warning!

WARNING

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

The operating voltage of the controller (the calibration voltage) is considered as the nominal voltage of the controller.

The nominal voltage of the TE10P controller must be as close as possible to the supply voltage used in order to eliminate problems of the controller not operating if the voltage drops below 80% of the nominal voltage.

Chapter 2

INSTALLATION

Page

CHAPTER 2 INSTALLATION

INSTALLATION - SAFETY

DANGER

Danger !

TE10P units must be installed by personnel trained to work with low voltage electrical equipment in an industrial environment.

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

The cabinet must be closed and bonded to the safety earth in accordance with Standards 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.

TE10P units may be bulkhead or DIN-rail mounted (≤100A).

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 must be arranged in such a way that air expelled from one cannot be drawn into the unit located above it.

WARNING

Warning!

The units are designed to be used at an ambient temperature not exceeding 45°C.

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

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

The TE10P range of thyristor units rated between 125A and 400A have permanent fan cooling.

DIMENSIONAL DETAILS

Overall dimensions for non-fan cooled TE10P controllers (units rated between 16A and 100A) and distances determining cabling are given in Figure 2-1.

Dimensions for 125A to 400A rated TE10P controllers are given in Figure 2-2.

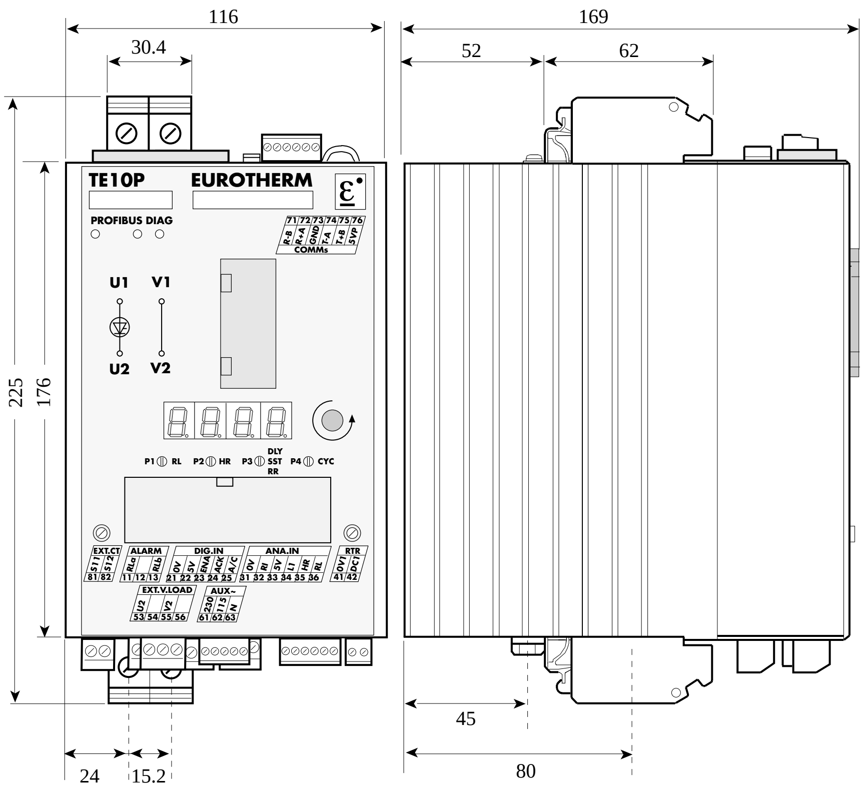


Figure 2-1 Dimensions (mm) of TE10P controller (16A to 100A rated units)

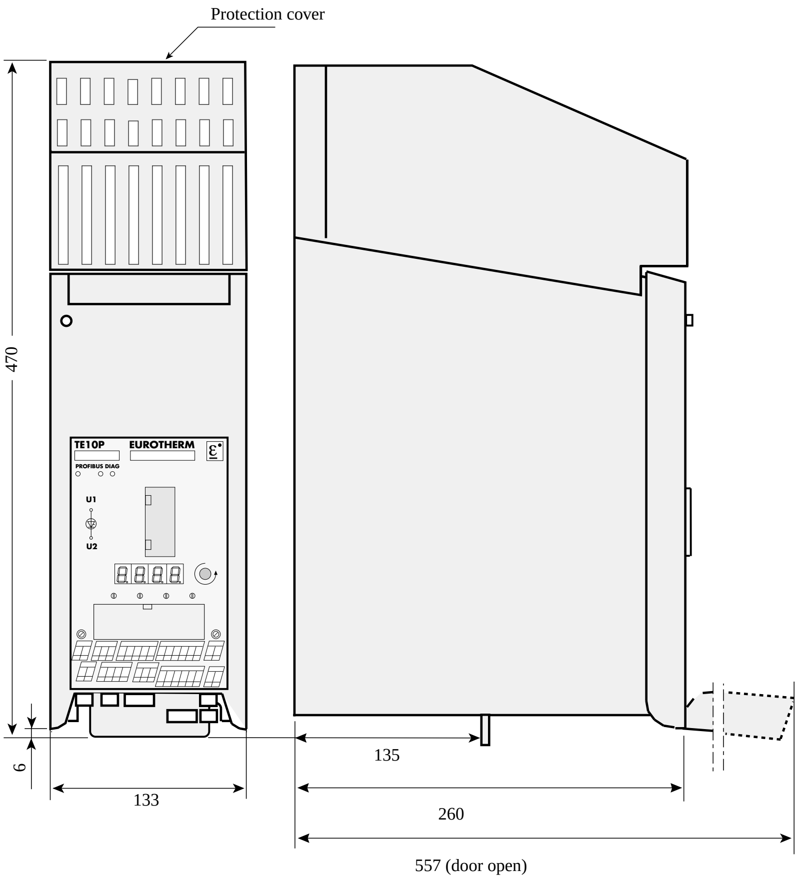


Figure 2-2 Dimensions (mm) of TE10P controller
(125A to 400A rated units)

MOUNTING

TE10P controllers may be mounted:
on two DIN rails EN 50022 (code DIN) for 16A to 100A rated units
on a bulkhead (code BKD) for all rated units.

DIN RAIL MOUNTING (units rated between 16A and 100A)

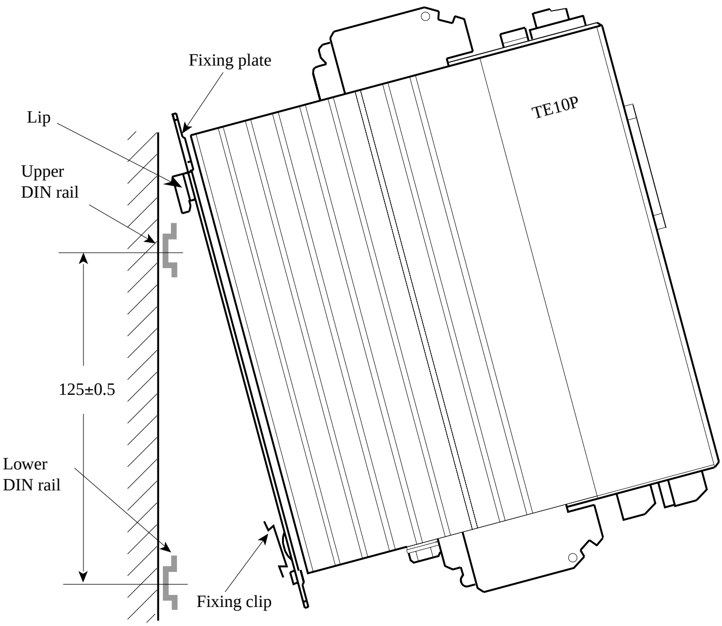


Figure 2-3 DIN rail mounting of TE10P controller (16A to 100A rated units)

To mount the TE10P controller on DIN rails, offer up the unit by first engaging the two lips on the upper part of the fixing plate (back plate of controller) onto the upper DIN rail (see Figure 2-3).
Clip the unit (using the spring fixing clip) onto the lower DIN rail, making sure that the clip is properly engaged.

BULKHEAD MOUNTING

16A to 100A rated units

Two fixing plates (upper and lower) are used for this type of mounting.

For bulkhead mounting, follow the instructions given below:

- Drill three M6 screw holes following the dimensions given in Figure 2-4
- Fix the upper plate onto the panel using the elongated hole at the top of the controller
- Install the lower plate with two M6 screws
- Insert the controller heatsink into the lower plate
- Loosen the central screw holding the upper fixing plate, in order to slide it upwards
- Slide the upper plate back down
- Tighten the central screw.

125A to 400A rated units

TE10P controllers with a rating of 125A to 400A have a protective cover.

The controllers may be mounted with their protective cover in position.

However, the protective cover must be removed to make electrical connections.

- Drill four holes in the support panel to the dimensional values given in Figure 2-5
- Insert the fixing screws halfway into the bulkhead / mounting plate holes
- Offer up the unit by first engaging the heads of the upper screws in the respective holes on the upper section
- Lower the unit making sure that it engages properly on the lower screws
- Then slide the unit down completely until it is in position
- Tighten the four screws correctly.

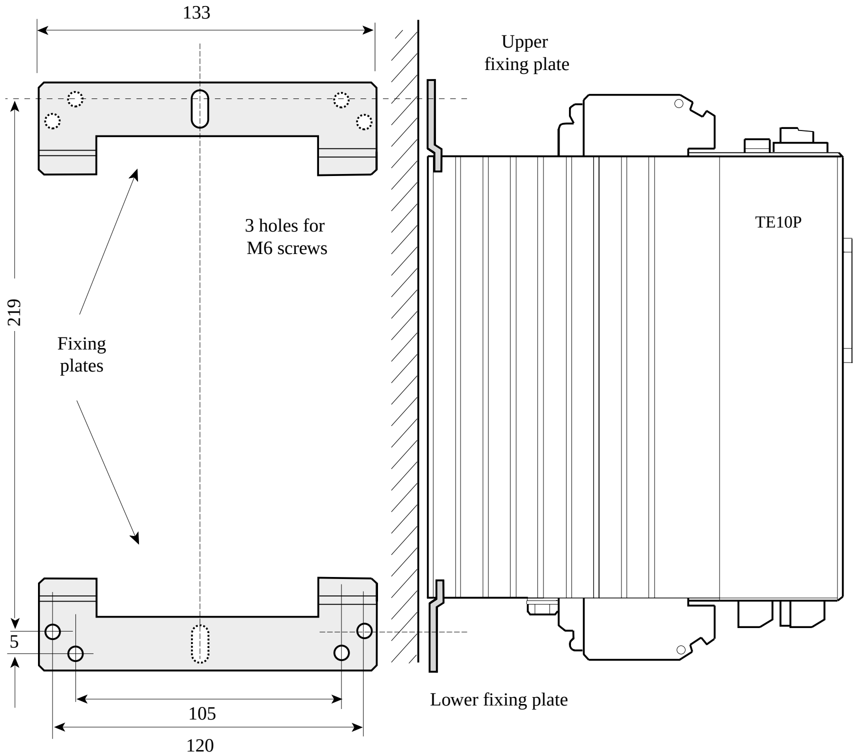


Figure 2-4 Drilling dimensions (mm) for bulkhead mounting (16A to 100A rated units)

Warning!

The upper mounting plate is pre-drilled with a central elongated hole, whilst the lower plate is pre-drilled with two of the four holes shown.

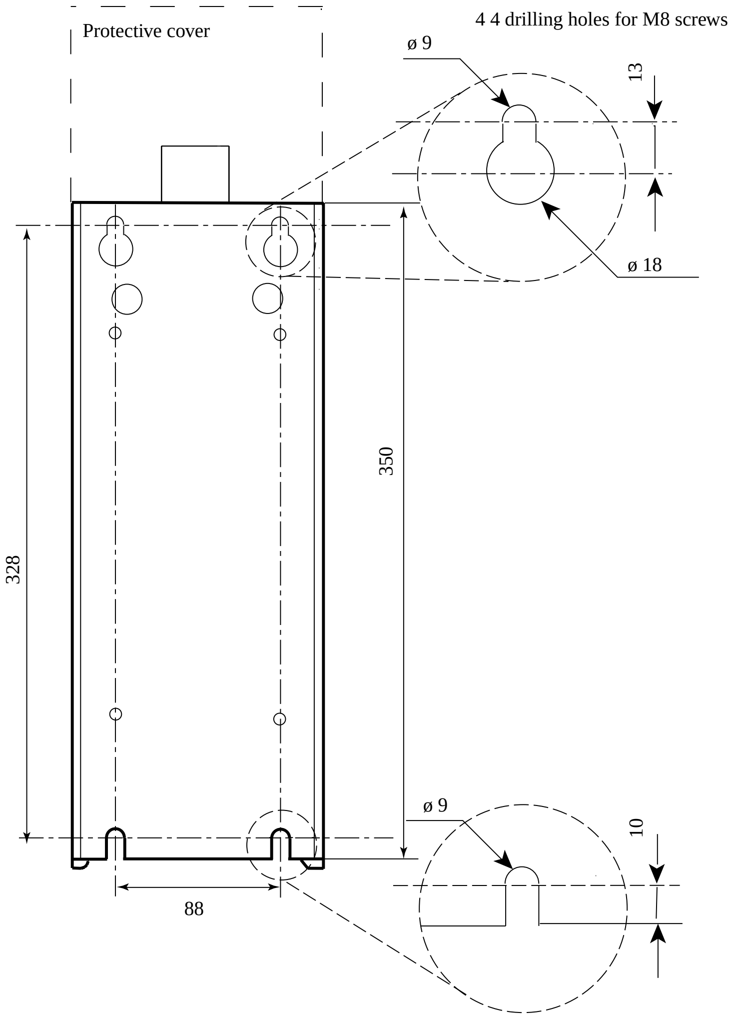


Figure 2-5 Drilling & mounting dimensions (mm) for TE10P controllers
(125A to 400A rated units)

Chapter 3

WIRING

CHAPTER 3 WIRING

WIRING - SAFETY

Danger!

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 in order to permit safe maintenance.

The cross-section of the cable conductors must comply with Standard IEC 943.

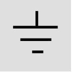
Danger!

DANGER

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

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

The safety earth is connected to the screw labelled:



For the 16A to 100A series, the safety earthing screw is located below the unit.

For the 125A to 400A series, the screw is located behind the supply voltage terminal.

Warning!

WARNING

To ensure correct grounding of the TE10P unit, make sure that it is properly 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!

DANGER

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

POWER WIRING
Power cable connections
16A to 100A rated units

The power terminal blocks (mains and load) are cage connectors (no cable lugs).
The controlled phase and the direct phase must be wired on the supply side.

Unit rating	Connection	Terminal capacity (mm^2)	Tightening torque (Nm)	Stripping length (mm)
16A to 100A	Supply & load	Flexible conductors: 2.5 to 35 Rigid conductors: 2.5 to 50	3.5 4.7	12 to 15
	Safety earth	2.5 to 25	4.4	M6 cable lug

Table 3-1 Power connection details for 16A to 100A rated units

125A to 400A rated units

For 125A to 400A rated units, only the controlled phase is wired.
The connections are accessible with the door open.
The direct phase must be connected outside the unit (see Figure 3-2).
The supply-side connection is made on the fuse stud on the upper part labelled LINE.
The cable passes through the opening in the protective cover.
In order to make connection of this cable easier, the cover of the unit should be removed.
To remove the cover:

- open the front door by undoing the screw located at the top left hand side of the door
- lift the door in order to release it from its slots and open it by pulling it towards you
- remove the cover by unscrewing the two fixing nuts (by sliding it 1cm forwards to release the two catches located at the rear), and then raising it.

The load connection is made on the screw located on the lower part of the unit, labelled LOAD.
The connection cable passes into the unit through a protected opening located below the unit. The aperture of this opening is 38mm.

Unit rating	Connection	Connection screw	Tightening torque (Nm)	Stripping length (mm)
125A to 400A	Line fuse stud	M8 (125A & 160A) M10 (200A to 400A)	12.5 25	M8 cable lug M10 cable lug
	Load & earth	M12	43.5	M12 cable lug

Table 3-2 Power connection details for 125A to 400A rated units.

Power wiring diagrams

Power wiring is made between phase and neutral or between two supply phases, depending on the nominal voltage of the controller.

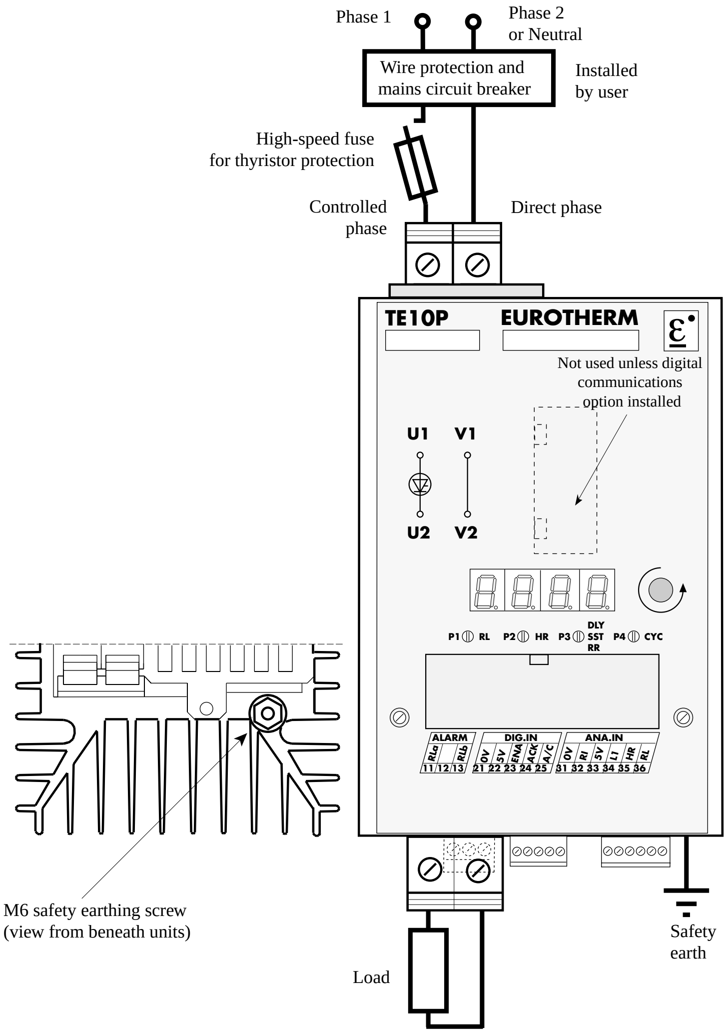


Figure 3-1 Power wiring (16A to 100A rated units); without options

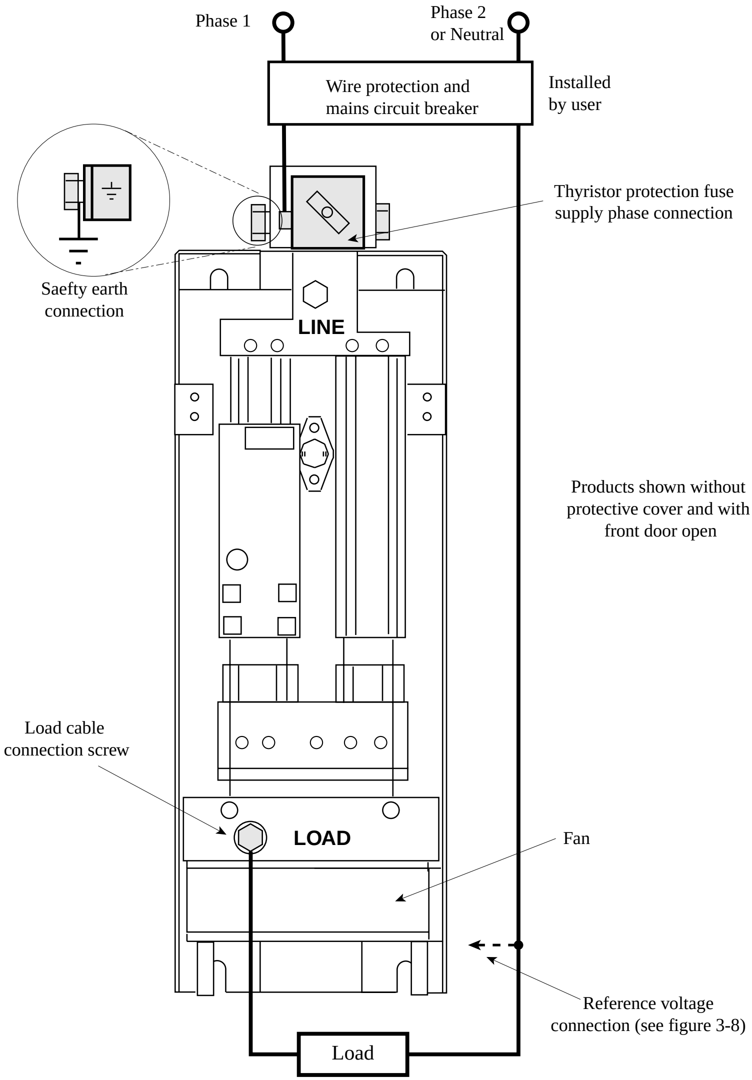


Figure 3-2 Power wiring (125A to 400A rated units)

CONTROL TERMINAL BLOCKS

Terminal function	Labelling on front panel	Comments
Analogue signal input	ANA.IN	
Logic signal input	DIG.IN	
Digital communications input	COMMs	Option
Alarm relay contact output	ALARM	
Separate electronics supply	AUX~	
Fan supply	FAN	Fan-cooled units
Reference voltage	EXT.V	125A to 400A units
External current measurement input	EXT.CT	Option
External load voltage measurement input	EXT.V.LOAD	Option

Table 3-3 Control terminal block labelling

Control terminal block wiring

The control terminal blocks are plug-in cage connectors.

Unit block type	Terminal capacity (mm2)	Tightening torque (Nm)	Stripping length (mm)
Analogue and logic signals, Analogue retransmission, Digital communications, External current measurement	1.5	0.5	6 to 7
Relay contacts, Fan supply, Separate electronics supply Reference voltage, External voltage measurement	2.5	0.7	6 to 7

Table 3-4 Details of control connections

Control terminal block layout

16A to 100A rated units

All the control terminal blocks (with the exception of Communications) are located at the bottom of the controller. The optional digital communications terminal block is located at the top of the controller.

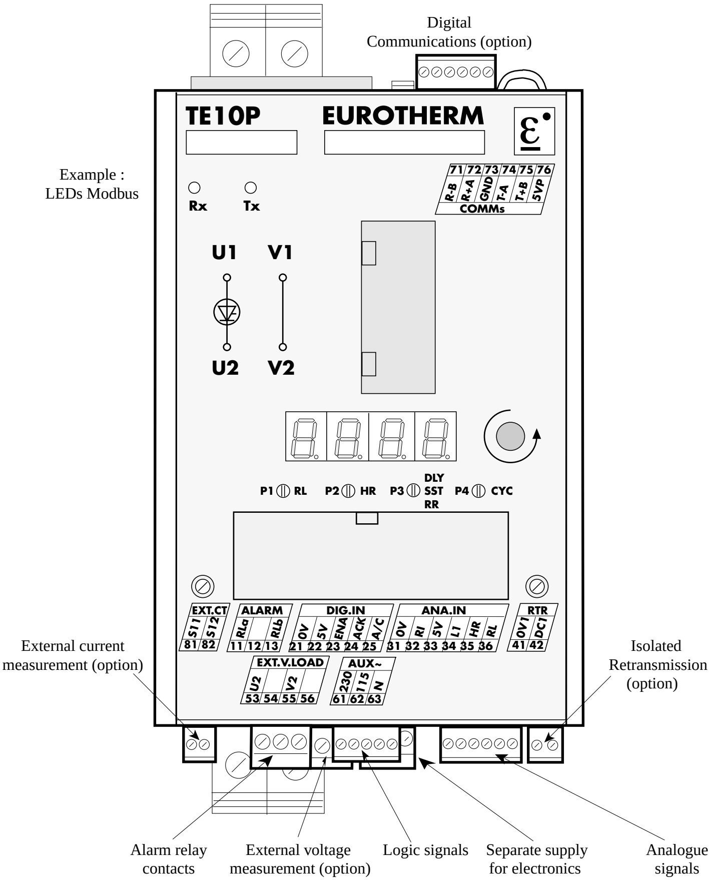


Figure 3-3 Layout of control terminal blocks
(16A to 100A rated units; front view)

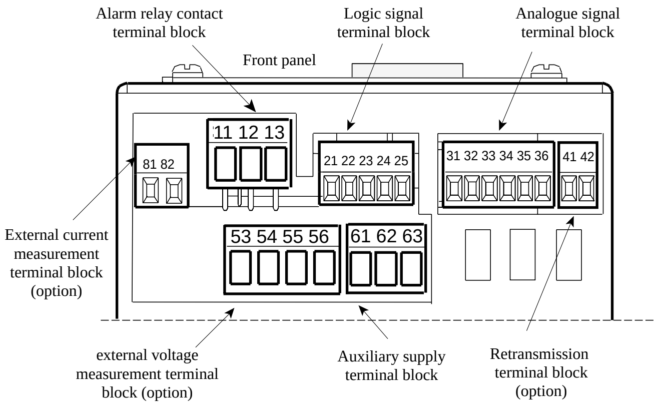


Figure 3-4 Layout of control terminal blocks
(16A to 100A rated units; view from below)

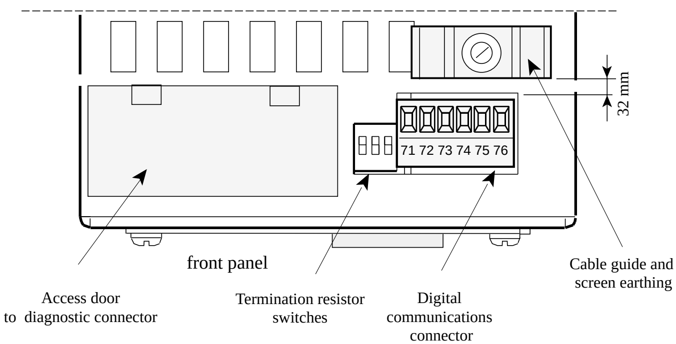


Figure 3-5 Layout of optional digital communications terminal block
(16A to 100A rated units; view from above)

125A to 400A rated units

All the control and auxiliary power supply terminal blocks are located at the bottom of the controller.

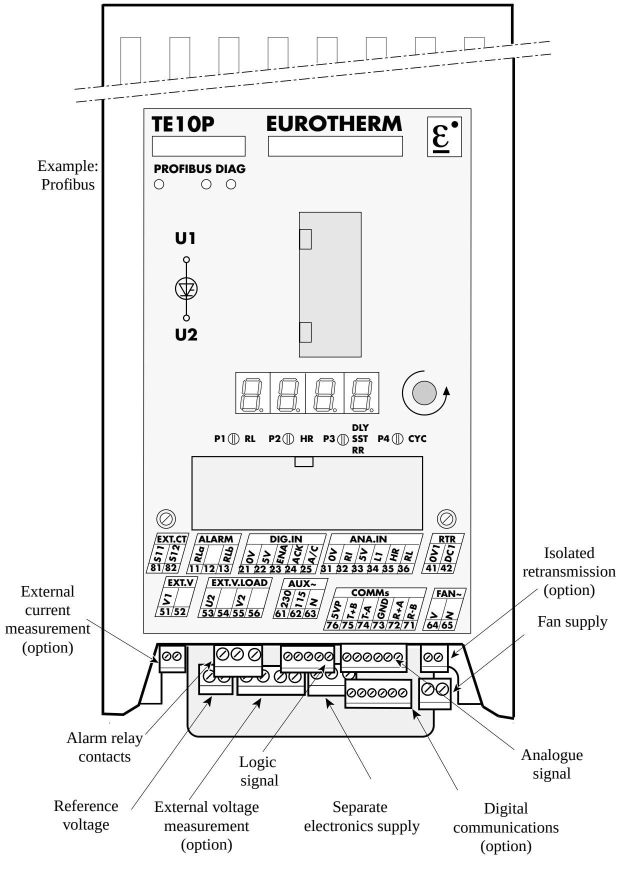


Figure 3-6 Layout of TE10P 125A/400A user terminal blocks (front view)

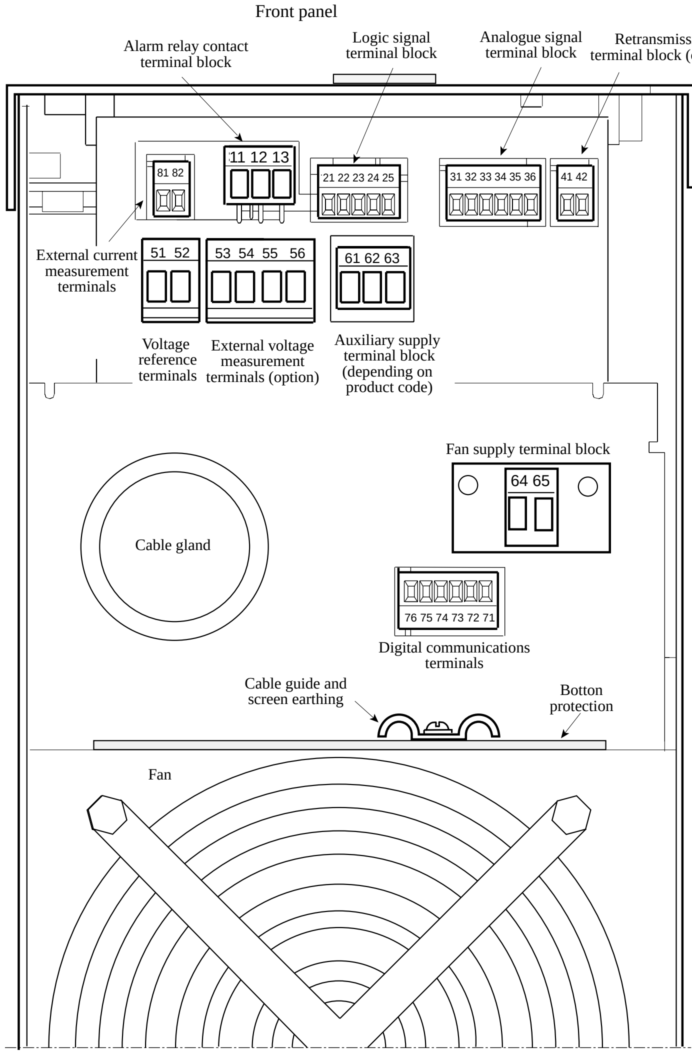


Figure 3-7 Layout of control, power supply, communications and option terminal blocks (125A to 400A rated units; view from below)

AUXILIARY POWER SUPPLY

Fan supply (125A to 400A rated units)

The fan supply terminal block (labelled FAN~) is located at the bottom of the controller. Terminals 64 (V: fan supply mains phase) and 65 (N: neutral or second phase) are connected to a 115V or 230V supply depending on the product code selected.

For fan supply protection, a 1A fuse must be installed in each wire connected to a supply phase.

Supply reference voltage (125A to 400A rated units)

Only the controlled phase is to be connected to the controller (see Figure 3-2).

The neutral or second phase, depending on the wiring installed, should be wired to terminal 51 (V1) of the Reference voltage terminal block (labelled EXT.V) to provide an external reference point against which the supply voltage is measured.

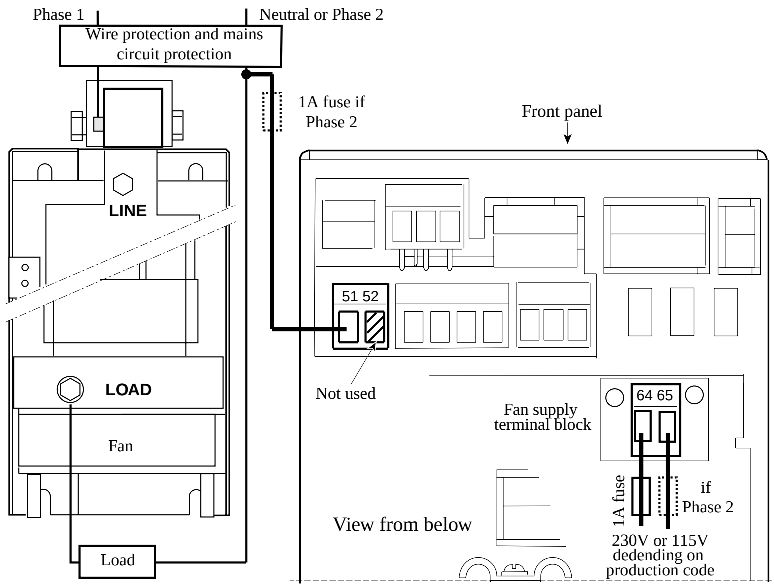


Figure 3-8 Fan and reference voltage wiring (125/400A rated units)

Separate electronics power supply

The electronics supply may be:

- self-supplied, or
- separate (115Vac or 230Vac).

When a separate power supply is selected (see product code) it is connected to the AUX~ terminal block depending on the mains voltage used.

Terminal	Labelling	Function
61	230	230Vac supply mains phase
62	115	115Vac supply mains phase
63	N	Neutral or second phase

Table 3-5 Function of separate supply terminals

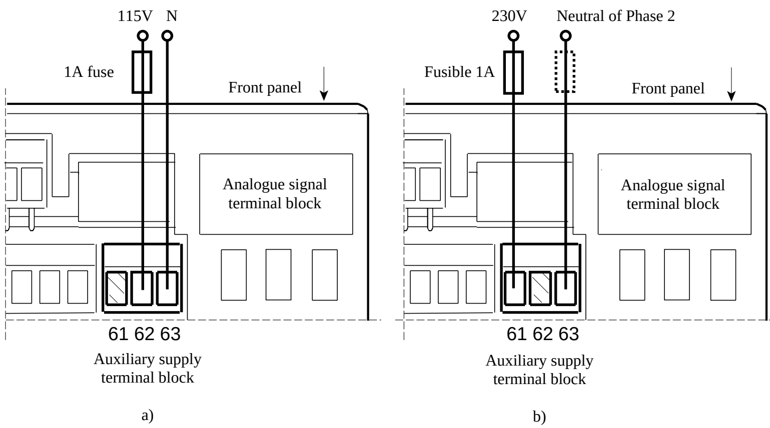


Figure 3-9 Separate electronics supply wiring:
a) 115V
b) 230V

A 1A fuse should be installed in each wire connected to a supply phase.

LOGIC SIGNAL WIRING

Logic signal terminal block

Terminal	Labelling	Function
21	0V	0V of logic signals
22	5V	User +5V supply
23	ENA	Controller operation enable
24	ACK	Latched alarms reset
25	A/C	Selection of setpoint type: Analogue or Digital and, in case of default: selection of configuration type (see Chapter 6, 'Configuration')

Table 3-6 Function of logic signal terminals

WARNING

Warning!

If the controller is used in 'Logic (ON/OFF)' firing mode with a logic signal for the setpoint, the logic signal must be connected to the Analogue input, labelled RI

(see paragraph 'Analogue signal terminal block', on page 3-16).

The RI input should be configured as 5V, 10V or 20mA

(depending on the range of logic signal used).

The Logic firing mode may be configured using the mini-switches or, as an option, via Digital Communications (see Chapter 6, 'Configuration').

Enable or inhibit

For correct controller operation, terminal 23 (ENA) on the Logic Signal terminal block must be connected to terminal 22 (User +5V) on the same terminal block.

This connection may be permanently linked or wired to external contacts, a circuit breaker or other contact-opening safety device.

Opening of these contacts causes controller inhibition in the following half-cycle.

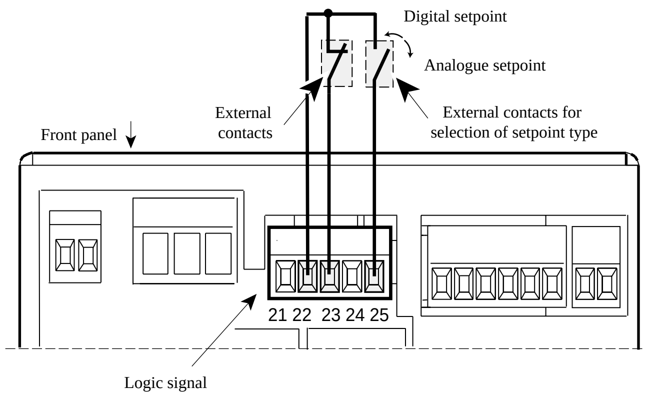


Figure 3-10 Controller enable and selection of setpoint type

Selection of Comms or Analogue setpoint

Selection between analogue or comms setpoints is made on the Logic Signal terminal block by means of the input labelled ‘A/C’, terminal 25 (see Figure 3-10).

To use the Comms setpoint, terminal 25 (A/C) on the Logic Signal terminal block must be connected to terminal 22 (5V).

To use the Analogue setpoint, terminal 25 (A/C) should be disconnected from terminal 22 (5V) or connected to 0V (terminal 21 on the same terminal block).

The state of the ‘A/C’ input also determines the configuration type (see Chapter 6, ‘Configuration’).

Alarm relay contacts

The TE10P controller is fitted with a relay which responds to certain alarms (configuration via digital communications). This alarm relay is de-energised in alarm state.

A pair of alarm relay contacts (NO or NC depending on the product code) is available between terminals 11 and 13. Emission of radio frequency interference from the relay contacts is prevented by means of an internal RC snubber.

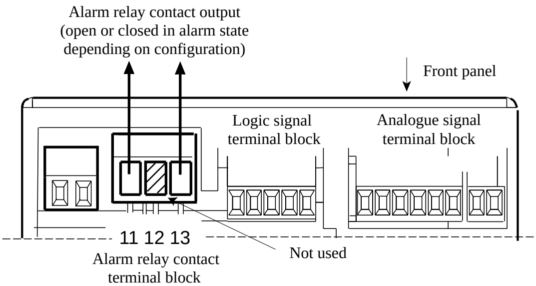


Figure 3-11 Alarm relay contact connections (view from below)

Alarm logic reset

After the causes of certain alarm states have cleared (see Chapter 8, 'Alarms'), the latched alarm must be reset in order to return to normal operation.

The controller is reset via digital communications or by means of a logic signal.

To reset the alarms using a logic signal, terminal 24 (ACQ) on the Logic Signal terminal block must be connected to internal 5V (terminal 22) or to an external 5V with a common 0V. The relay contact type (normally open NO or normally closed NC) is configured at the factory depending on the product code.

WARNING

Warning!

If the reset contacts are permanently closed, the alarm strategy is no longer followed.

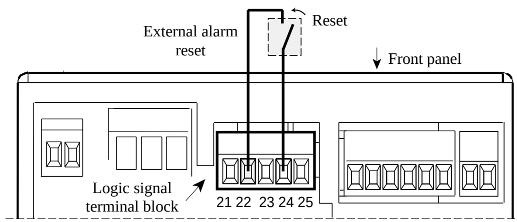


Figure 3-12 Alarm logic reset (view from below)

ANALOGUE SIGNAL WIRING

Analogue Signal terminal block (ANA.IN)

Terminal	Labelling	Function
31	0V	0V of analogue signals
32	RI	Remote analogue setpoint input (main setpoint)
33	5V	User +5V supply
34	LI	Local setpoint input (external signal or manual control)
35	HR	Setpoint limit
36	RL	Current or voltage limit

Table 3-7 Function of Analogue Signal terminals

Remote analogue setpoint

The remote analogue setpoint signal must be connected between the RI input (terminal 32) and the 0V (terminal 31) on the Analogue Signal terminal block (Figure 3-13, a).

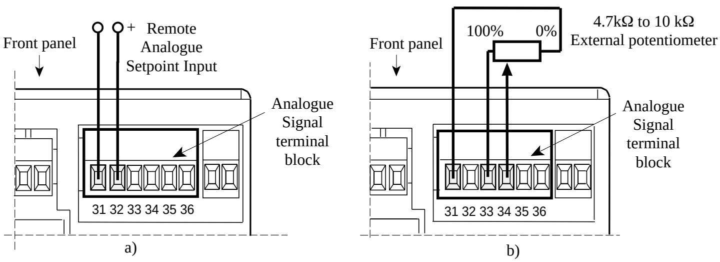


Figure 3-13 Wiring of the remote (a) and local (b) analogue setpoints (view from below).

Local analogue setpoint

The local setpoint comprises an analogue signal applied between terminals 31 (0V) and 34 (LI) or manual control:

Manual control is achieved by means of a 4.7kΩ to 10kΩ external potentiometer connected between terminals 31 (0V) and 33 (5V) or any other 5 volt source with common 0V. The potentiometer wiper is connected to the LI input, terminal 34 (Figure 3-13, b).

WARNING

Important!

The local setpoint is added to the remote setpoint.

EXTERNAL LIMIT WIRING

Analogue setpoint limit

When analogue setpoint limit using an external analogue signal is configured, this signal must be connected between terminal 31 (0V) and terminal 35 (HR) on the Analogue Signal terminal block.

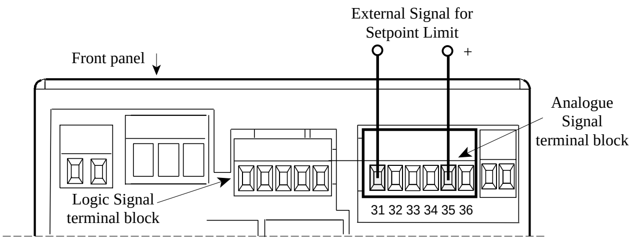


Figure 3-14 Wiring of external signal for setpoint limit (view from below)

The adjustment potentiometer on the front panel (P2) is in cascade with the external signal for setpoint limit. The level of this signal is configurable.

Load current or voltage limit

The external analogue limit signal for load current (or, depending on the configuration, load voltage) should be connected between terminal 31 (0V) and terminal 36 (RL) on the Analogue Signal terminal block.

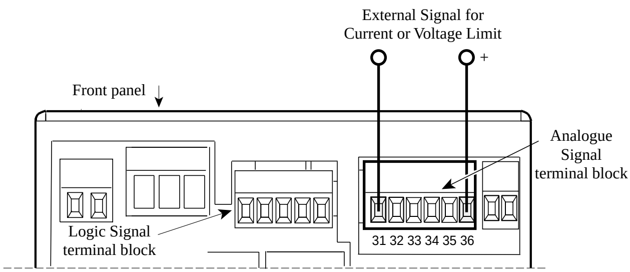


Figure 3-15 Wiring of current or voltage limit signal (view from below)

The adjustment potentiometer on the front panel (P1) is in cascade with the external limit signal. The level of this signal is configurable.

OPTION WIRING

Isolated analogue retransmission (option)

Analogue retransmission of one of the electrical variables (voltage, current or power) or of the control parameters (selection and configuration via digital communications) is available as an option between terminals 41 (0V1) and 42 (DC1) on the RTR terminal block.

Retransmitted signals are isolated from the other electronic and power circuits.

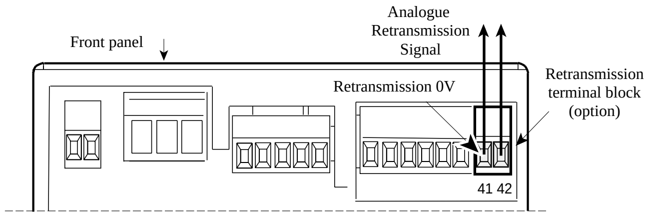


Figure 3-16 Isolated analogue retransmission wiring (option)

External current measurement (option)

As an option, a 0 to 5A external current measurement input is available between terminals 81 (S11) and 82 (S12) on the EXT.CT terminal block.

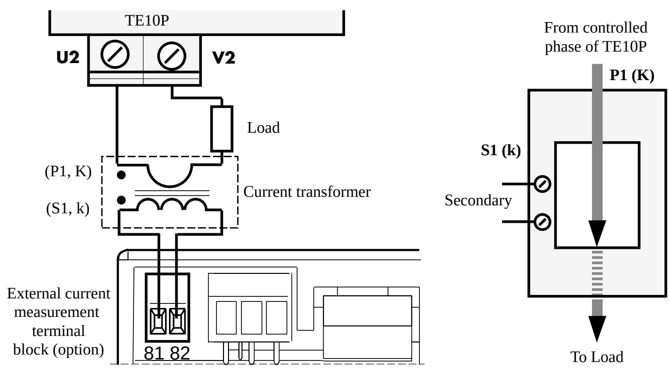


Figure 3-17 Wiring of external current measurement input (view from below)

WARNING

Important!

Observe the sense of the current transformer secondary wiring in order to obtain correct power measurement (as shown).

If it is not observed, the controller may go into constant full conduction.

External voltage measurement (option)

The load voltage external measurement inputs are located (as an option) at the bottom of the controller, on the terminal block labelled EXT.V.LOAD.

Terminal	**Labelling**	**Function**
53	U2	Load connection point to controlled phase
55	V2	Load connection point to direct phase
54, 56	-	Not used

Table 3-8 Function of external voltage measurement terminals (option)

When the ‘External load voltage measurement’ option is selected, the load voltage (corresponding to the codes provided for the nominal voltage) must be connected between terminals 53 (U2) and 55 (V2) as shown in Figure 3-18.

WARNING

Warning!

Follow the wiring sense shown in Figure 3-18 to obtain correct power measurement.

If it is not observed the controller can go into constant full conduction.

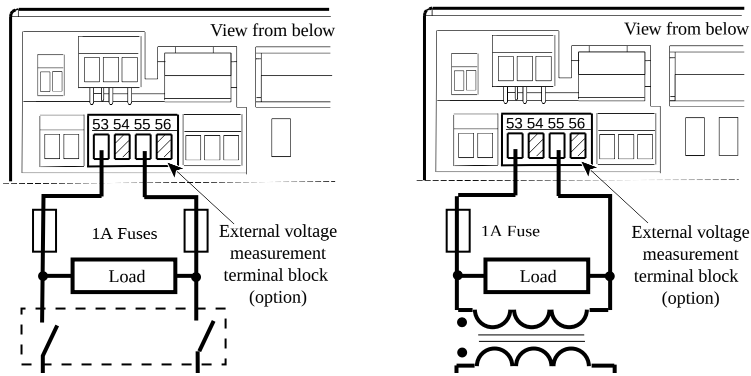


Figure 3-18 Wiring examples for external measurement of load voltage

Reminder: Terminal 51 (V1) on the EXT.V terminal block is used as the ‘Reference voltage’ input for units rated ≥125A (see Figure 3-8).

DIGITAL COMMUNICATIONS WIRING

Communications bus wiring

Warning!

WARNING

Digital communications bus connections must be made using screened, twisted pairs.
The communications bus screen should be grounded at both ends in order to ensure maximum immunity against electromagnetic interference.
Separate the communications cable from the power cables in the cable trays.

To facilitate earthing of the communications cable screen, the metal cable guide is bonded directly to the ground of the controller as standard (see Figures 3-20 and 3-21).

Each cable guide provides for a second cable to be inserted so that daisy-chained connection of multiple units can be supported (shown greyed-out in Figures 3-20 and 3-21).

For standard wiring and bonding of the communications cable, proceed as follows:

- Strip the screened cable as shown in Figure 3-19,a.
- The wires must be long enough for connection to be made to the terminals when the bare screen is grounded at the metal guide.
- Fold back the screen on to the insulating sheath (Figure 3-19,b).
- The possible diameter of the cables with the screen folded back is 5 to 10mm.
- Insert the cable into the guide so that the screen is located under the metal guide (see Figure 3-19).
- Tighten the fixing screw.

For connection to the ‘Sub-miniature connector’ option see Figure 3-22.

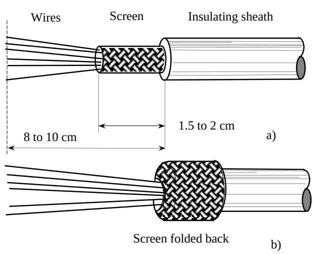


Figure 3-19 Communications cable stripping for screen grounding

The maximum length of the transmission line is 1.2km for rates (93.75kbaud.

Digital communications terminal block

The digital communications connection is made using the screw terminal block (standard) or by means of the sub-miniature connector (as an option).

The digital communication terminals are isolated from the power circuits and from other signals.

Standard terminal block

The standard digital communications terminal block (COMMS) is located:

at the top of the controller for 16A to 100A rated units (see Figures 3-4 and 3-20)

at the bottom of the controller for 125A to 400A rated units (see Figures 3-7 and 3-21).

Terminal	Labelling	Signal description		Function
		Modbus®	Profibus-DP	
71	R-B	RX-	B	Signal receive
72	R+A	RX+	A	Signal receive
73	GND	0VT	0VT	0V of digital signals
74	T-A	TX-	A	Signal transmit
75	T+B	TX+	B	Signal transmit
76	5VP	5V	+5V	+5V of digital signals

Table 3-9 Function of terminals on standard digital communications terminal block

WARNING

Warning!

The number order on the standard digital communications terminal block is:

- from left to right for 16A to 100A rated units (see Figure 3-20)
- from right to left for 125A to 400A rated units (see Figure 3-21).

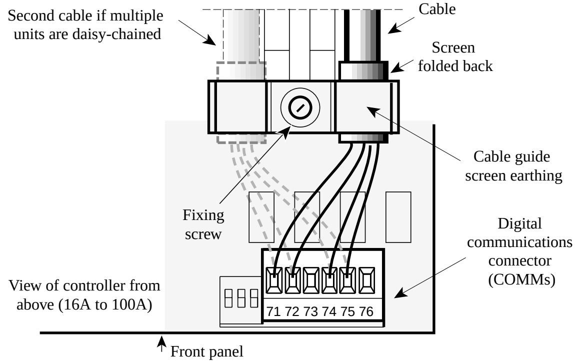


Figure 3-20 Layout of standard communications terminals for 16A to 100A rated units

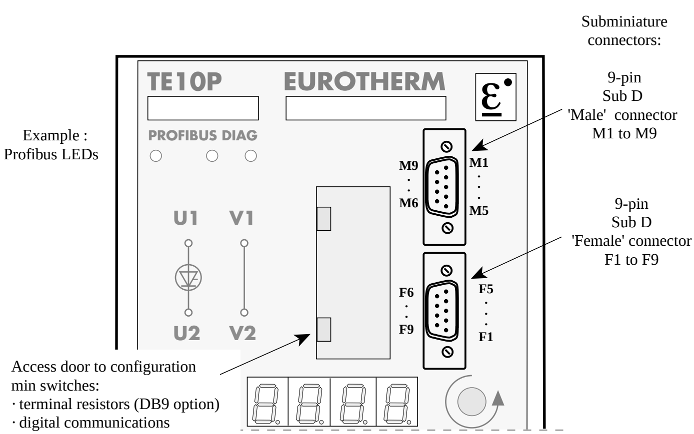


Figure 3-21 Layout of standard communications terminals for 125A to 400A rated units

Sub-miniature connector (option)

If a sub-miniature connector type Sub-D, (option DB9) is used, the connection is made from the controller front panel irrespective of the rating (see Figure 3-22).

Two 9-pin Sub-D connectors (one male and one female) are provided. One of them is used for digital communications connection to the controller, the other may be used for possible multi-drop communications with further units.

These Sub-D connectors should be fitted with metal screening covers.

Sub-D pin numbers		Signal description		Function
Male	**Female**	**Modbus®**	**Profibus-DP**	
M3	F3	RX-	B	Signal receive
M4	F4	RX+	A	Signal receive
M5	F5	0VT	0VT	0V of digital signals
M6	F6	5V	+5V	+5V of digital signals
M8	F8	TX-	A	Signal transmit
M9	F9	TX+	B	Signal transmit
M1, M2, M7	F1, F2, F7	Not used		

Table 3-10 Function of Sub-D communications connector pins (option DB9)

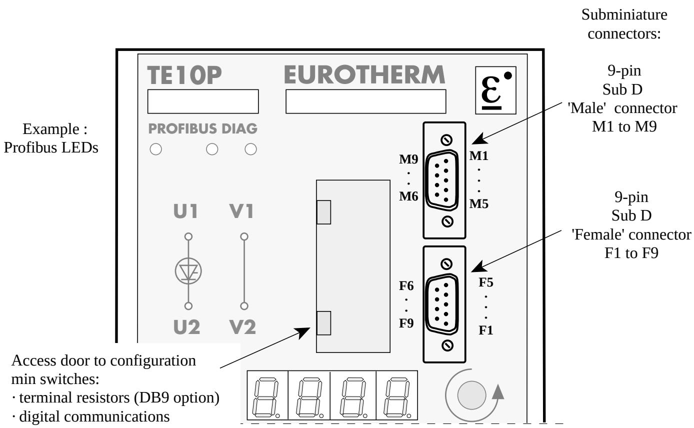


Figure 3-22 Layout of sub-miniature connectors, option DB9 (all unit ratings)

Four-wire active link (Modbus®)

The use of a four-wire active RS422 link is possible for Modbus® protocol.

The 0VT connection (terminal 73 GND) is optional.

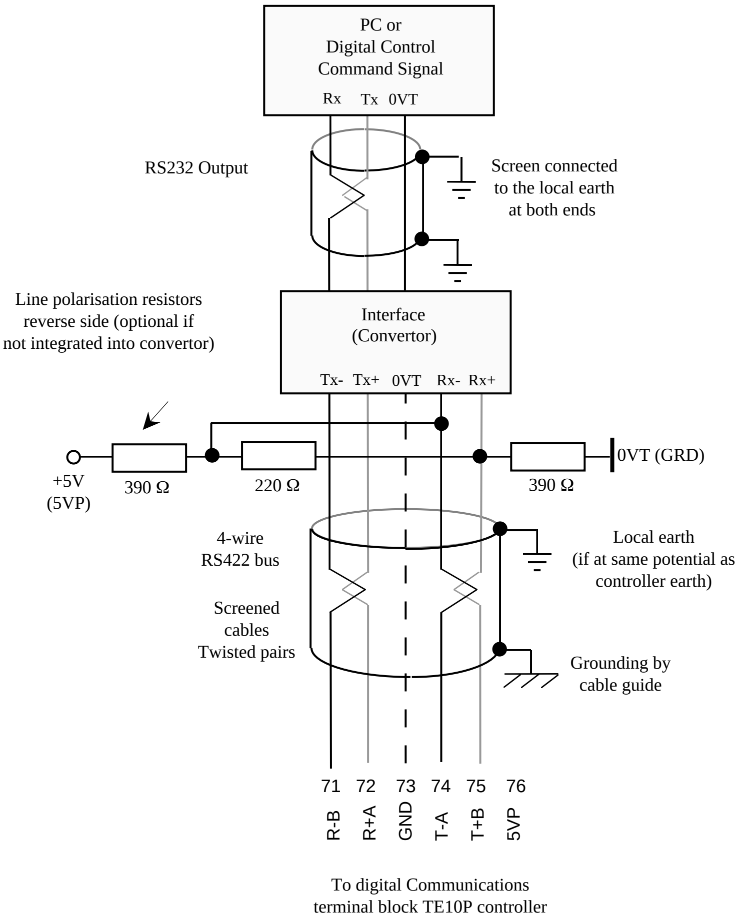


Figure 3-23 Example of digital communications wiring with an RS422 4-wire link in Modbus® protocol.

Two-wire active link (Modbus®)

Two external links should be connected for Modbus® protocol.

· a link connecting terminals 71 & 74

· a second link between terminals 72 & 75.

The 0V connection (terminal 73 GND) is optional.

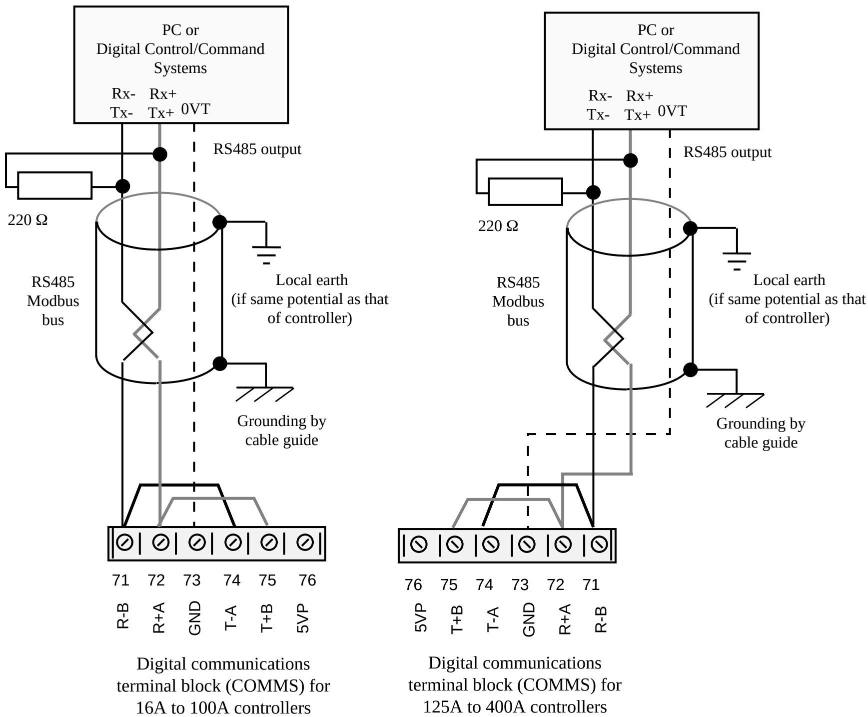


Figure 3-24 Example of digital communications wiring with an RS485 2-wire link in Modbus® protocol.

Profibus-DP protocol link

The Profibus-DP protocol uses a 2-wire active RS485 link.

Two links are installed at the factory inside the controller:

- a link connecting terminal 71 (R-B) & 75 (T+B)
- a second link between terminals 72 (R+A) & 74 (T-A).

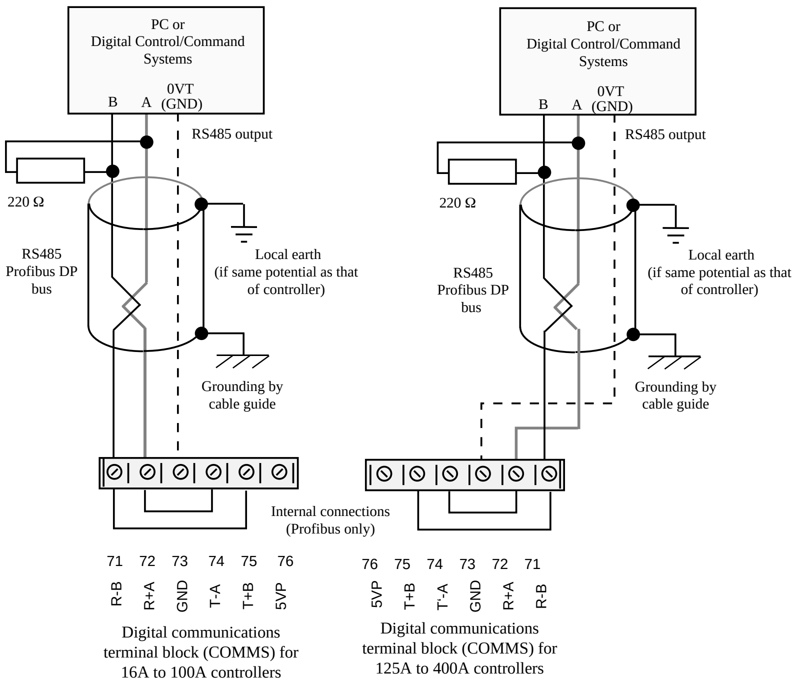


Figure 3-25 Example of digital communications wiring in Profibus-DP protocol.

Chapter 4

OPERATION

CHAPTER 1 IDENTIFYING THE CONTROLLER

THYRISTOR FIRING MODES

‘Phase angle’ mode

In ‘Phase angle’ mode the power transmitted to the load is controlled by conduction of the thyristors for a part of each half-cycle of the mains voltage.

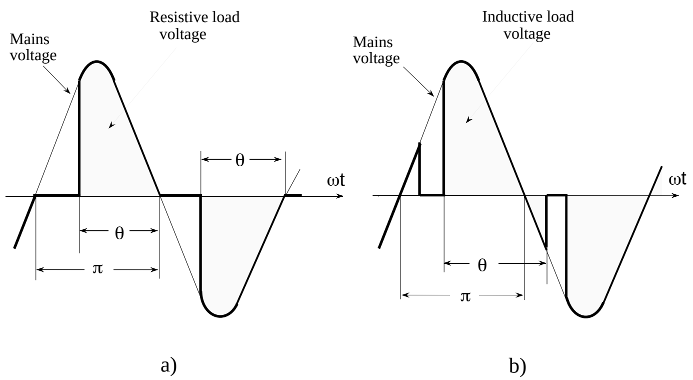


Figure 4-1 Load voltage in ‘Phase angle’ firing mode
a) resistive load; b) inductive load

The firing angle (θ) is varied in the same sense as the setpoint signal during each half cycle (π)

The power delivered is not a linear function of the firing angle.

In Phase angle mode, current or voltage limit can easily be implemented by reducing the thyristor firing angle.

Phase angle mode permits small thyristor firing angles to be used, avoiding over-currents when starting low resistance loads or transformer primaries from cold.

Gradual ramp up of the firing angle can be achieved:

- as a function of the ramp selected by the user, or
- under the control of one of the limit actions (current, voltage, setpoint).

'Logic' mode

The 'Logic'(ON/OFF) mode controls power in the load in proportion to the thyristor firing time in response to the logic control signal.

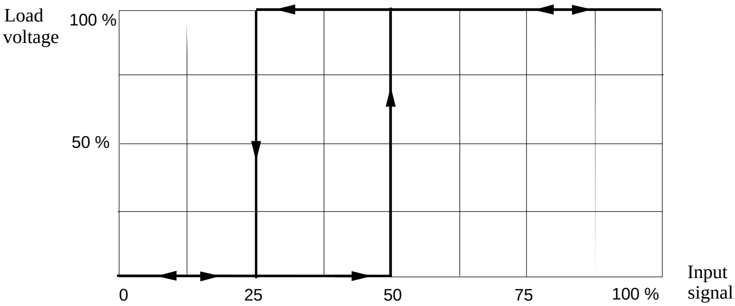


Figure 4-2 'Voltage-Logic signal' diagram

Firing is activated when the input signal is greater than 50% of full scale and as long as the input signal is not less than 25% of full scale.

To reduce emission of electrical interference and electromagnetic radiation, thyristor switching takes place:

· at zero voltage for resistive loads, or
· with a delay for inductive loads (see 'Delayed firing', page 4-10).

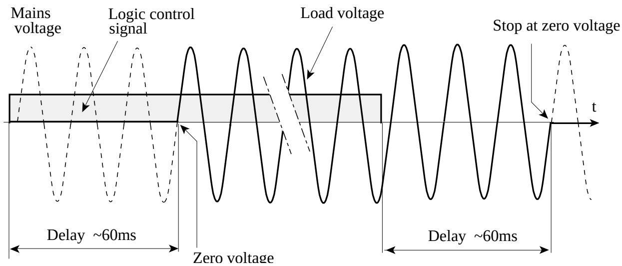


Figure 4-3 Thyristor switching in 'Logic' mode

In Logic mode, the start of thyristor switching is guaranteed at zero voltage crossing, 60ms approximately after the control signal has been asserted (response time).

Thyristor switching is terminated at the end of the cycle, approximately 60 ms after the control signal has been deactivated (response time).

To ensure that a DC component is not present, firing takes place over complete cycles.

'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 (see Figure 4-4).

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

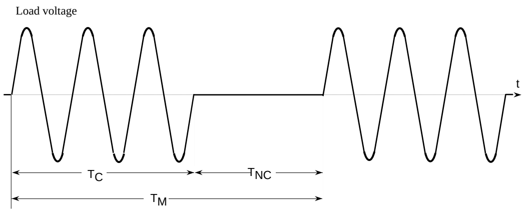


Figure 4-4 'Burst-firing' mode

Thyristor firing in 'Burst' mode is characterised by:

· conducting time (T_C) or non-conducting time (T_{NC}) and
· modulation time (T_M)

Depending on the control zone (less than or greater than 50% of nominal power) the conducting (or non-conducting) duration is fixed and the modulation time is variable, expressed by the following equation:

$T_M = T_C + T_{NC}$

The fixed conducting (or non-conducting) time is defined as the base time (TB).

Important!

The base time is equal to the number of conducting cycles at 50% of duty cycle η

Duty cycle η corresponds to the power demand; it is expressed by the following ratio:

$\eta = T_C : T_M$

Four base times may be selected for TE10P controllers:

T_B = 1, 8, 16 or 128 cycles

(see Firing mode product codes).

Important!

WARNING

For $\eta = 50\%$, conducting time is equal to non-conducting time:
TC = TNC

For $\eta < 50\%$, conducting time is fixed by the base time:TC = TB

For $\eta > 50\%$, non-conducting time is fixed by the base time:TNC = TB

The control system takes into account the working setpoint, the negative feedback and the control algorithm and adjusts the modulation period in order to maintain the highest level of accuracy, irrespective of the duty cycle value.

When the setpoint is changed, the new setpoint becomes effective after the delay time.

The total response time corresponds to the time necessary for the controlled parameter to reach 90% of the final value established as a result of the change in setpoint from 10% to 90%.

This time includes the delay time and one modulation period.

Base time (cycles)	Code	Delay time (ms)	Response time (s)
1	FC1	100	0.3
8	FC8	200	1.6
16	C16	400	3.2
128	128	2600	26.0

Table 4-1 Response time in ‘Burst-firing’

The ‘Burst-firing’ mode with a base time equal to a single firing cycle is called ‘Single-cycle’ (or ‘Standard single-cycle’).

'Advanced Single-cycle'

In order to minimise fluctuations in power during modulation time, the 'Advanced single- cycle' thyristor firing mode uses:

- a complete number of cycles for firing, and
- a complete number of half-cycles for non-firing.

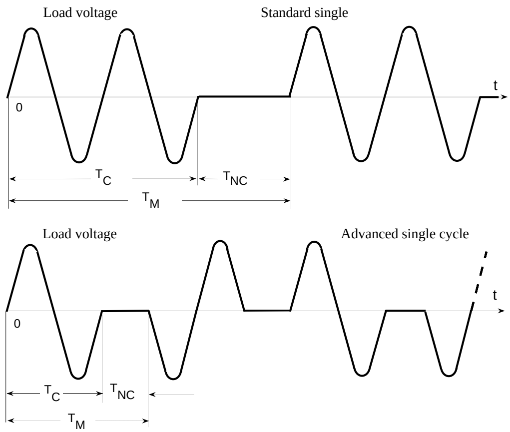


Figure 4-5 'Standard single-cycle' and 'Advanced single-cycle' firing modes (Example: η 66%, $T_C = 2T_{NC}$)

For $\eta \leq 50\%$:

thyristor firing takes place as in 'Standard single-cycle' mode, over complete cycles.

For $\eta > 50\%$:

- non-firing is constant at one half-cycle
- firing takes place over complete cycles.

The use of half-cycles for non-firing time permits a reduction in modulation time compared with the 'Standard single-cycle = 1-cycle Burst-firing' mode.

'Advanced single-cycle' firing mode reduces flickering in short-wave infrared elements and thus minimises visual nuisance.

SAFETY RAMP

A safety ramp takes place utilising firing angle variation when the unit is powered up.

Safety ramp duration (TSR) is the time taken for thyristor unit firing to change from 0% to 100%. Ramp duration is expressed as the number of supply cycles. Ramp duration depends on the load type:

- For loads with a small variation in resistance, short-wave infrared elements, and for loads which vary as a function of time and (or) temperature: T_{SR} = 8 cycles
- For loads with a large variation in resistance: T_{SR} = 32 cycles.

The safety ramp may be selected in all firing modes (except for Advanced single-cycle). Application of the safety ramp is shown in the table below.

Firing mode	Angle variation limit	Position of SW3.6	Safety ramp
Phase angle (except in Open Loop) or Burst-firing or Logic	Selected	Insensitive	Active
	Not selected	ON (code AR)	Active
	Not selected	OFF (code NR)	Inactive
Advanced single-cycle	Insensitive	Insensitive	Inactive

Table 4-2 Active state of safety ramp

The safety ramp is re-activated after an absence in power demand longer than 5s, or after the controller has been re-enabled.

For ‘Burst-firing’ and ‘Logic’ modes, thyristor firing after the ramp depends on the setpoint: the thyristors are in full conduction or off, depending on the control function.

In ‘Phase angle’ the ramp action ceases as soon as it reaches the current setpoint value.

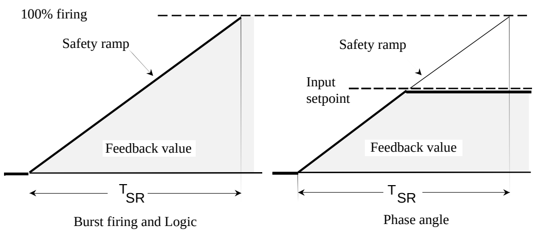


Figure 4-6 Action of safety ramp

SETPOINT CHANGE RAMP

The ramp for setpoint changes can only be activated in 'Phase angle' firing mode. It is only active when there is a demand for setpoint increase.

The ramp duration (T_R) represents:

the time taken for thyristor firing to change from 0% to 100%.

T_R time is expressed in ms.

It is incremented with each mains cycle.

Ramp duration is set by the P3 potentiometer .

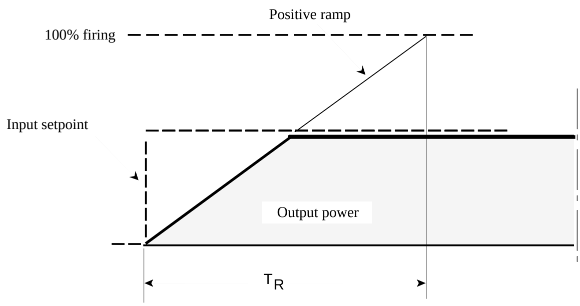


Figure 4-7 Ramp during setpoint change in 'Phase angle' firing mode

Important!

WARNING

For the same T_R adjustment the ramp slope remains constant, irrespective of the size of the analogue setpoint change.

The ramp is completed as soon as the firing angle corresponding to the current setpoint has been reached.

Warning!

WARNING

The setpoint ramp is reset to zero:

- after the controller is powered up
- if a high level alarm has occurred (the controller has ceased firing)
- after inhibition by the user.

Alarm reset or re-enable can reactivate the setpoint ramp.

SOFT START

Controller soft start is achieved by varying the thyristor firing angle. It may be configured in ‘Logic’ and ‘Burst-firing’ modes (except single-cycle burst mode).

In ‘Standard single-cycle’ and ‘Advanced single-cycle’ modes there is no soft start.

Soft start may be configured using mini-switches or by digital communications.

Soft start duration T_{SS} (expressed as the number of mains cycles) is the time taken for the firing angle to change from zero to full firing.

Important!

WARNING

In ‘Burst-firing’ mode, the number of soft start cycles is limited by the number of base time cycles configured.

In ‘Logic’ mode, soft start duration T_{SS} can be adjusted to 2, 4, 8, 16, 32 or 64 cycles.

After soft start, the controller remains in full conduction:

- during the time the input signal T_S is true in ‘Logic’ mode
- during firing time T_C in ‘Burst’ mode.

Firing ends as in firing modes without soft start.

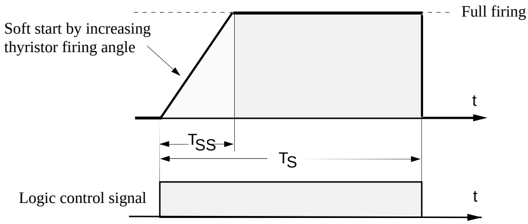


Figure 4-8 Soft start in ‘Logic’ mode

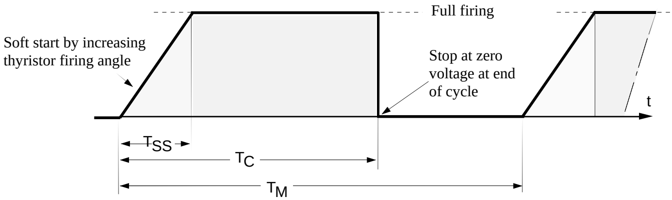


Figure 4-9 Soft start in ‘Burst’ mode

FIRING DELAY

In ‘Burst’, ‘Advanced single-cycle’ and ‘Logic’ firing modes, thyristor firing takes place at zero voltage to avoid steep rates of current change.

For an inductive load, firing at zero voltage creates transient over-currents (see Figure 4-10, a). This momentary state could, in certain cases, cause saturation of a magnetic circuit and rupture of the high-speed thyristor protection fuse.

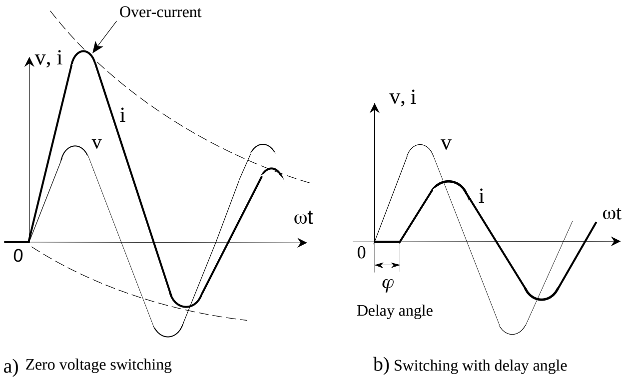


Figure 4-10 Inductive load switching at zero voltage a) and with delay angle b)

To avoid this over-current with an inductive load, the initial thyristor firing (at the beginning of conduction) should be delayed with reference to the zero crossing.

This delay in initial firing (at the beginning of conduction) may be configured with ‘Burst’ and ‘Logic’ firing modes.

The optimum delay angle should be adjusted as a function of the load power factor, using the P3 potentiometer on the front panel (see Chapter 7, ‘Commissioning’).

CONTROL OPERATION

The internal control algorithm of the TE10P takes into account the feedback parameter selected by the user by means of mini-switches or via digital communications.

Possible feedback parameters are as follows:

- active load power
- RMS current or load voltage
- RMS current squared or load voltage squared
- open loop
- automatic transfer of parameters $I^2 \leftrightarrow V^2$ and $I^2 \leftrightarrow P$.

Digital setpoint

The control value is proportional to the control signal (setpoint) transmitted via digital communications between 0% and 100% (see Figure 4-11).

Analogue setpoint

The control value is proportional to the resulting setpoint between 1% and 99%.

The resulting computed setpoint represents the remote analogue signal (applied to terminal RI) plus the local analogue signal (external 0 to 5V signal applied to terminal LI or introduced using a potentiometer).

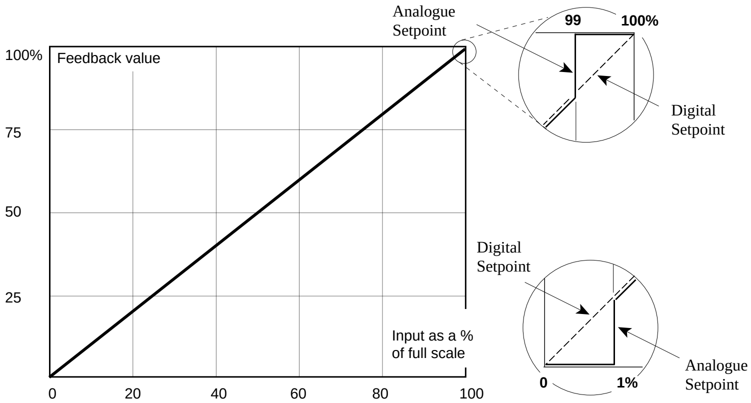


Figure 4-11 'Input/Output' transfer function

Exception: For digital and analogue setpoints, when controlling rms current or voltage the transfer function gives a 'dead band' between 0% and 10%.

Power

This parameter represents the active power calculated from instantaneous load current and voltage measurements.

RMS load current

This feedback parameter is the value of the rms current in the load.

If the controller has been calibrated to its nominal value (I_N), feedback operates in a range varying from 10% to 100% I_N.

RMS load current squared

This parameter represents the value of the rms load current squared.

RMS load voltage

This feedback parameter represents the rms load voltage.

If the controller has been calibrated to its nominal value, the feedback range is from 10% to 100% V_N.

RMS load voltage squared

This feedback parameter is the value of the rms load voltage squared.

Open loop

With open loop, the thyristor firing angle in Phase angle and the duty cycle in Burst-firing are in a fixed relationship to the setpoint used.

When powering up, the safety ramp is not active in Phase angle mode.

Feedback parameter transfer

The control system can use (depending on the configuration) automatic transfer of certain feedback parameters (depending on their values).
Two types of feedback parameter transfer are available:

- automatic selection of I^2 or P, and
- automatic selection of I^2 or V^2.

The control system selects, as its feedback value, the greater of the two selected values.
For example, in loads with a large temperature coefficient there is I^2 feedback at the start, then control is transferred to P.

External measurements (options)

The internal feedback loop can use:

- the 'External current' input signal (applied to terminal block **EXT.CT**) coming from a current transformer, or
- the direct measurement signal from the load voltage (applied to terminal block **EXT.V.LOAD**).

LIMIT OPERATION

Setpoint limit

The TE10P allows the user to limit the Working Setpoint to a chosen fixed value. **Setpoint limit works by re-scaling the transfer function and not by threshold limit.**

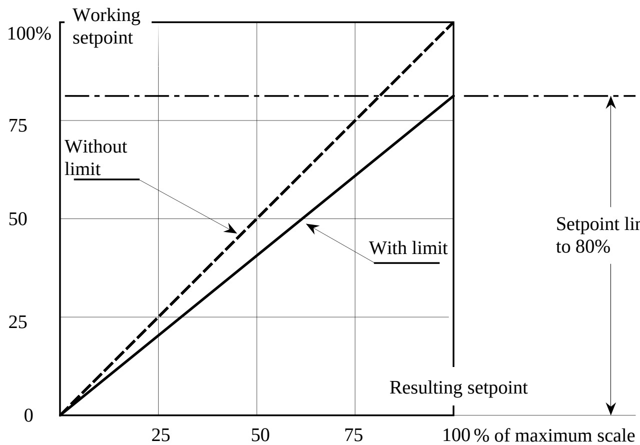


Figure 4-12 Example of setpoint limit

The setpoint limit function is active in all firing modes.

In ‘Logic’ mode the setpoint limit threshold must be 100%.

Analogue setpoint

The working setpoint is produced by multiplying the resulting setpoint (sum of the main and local analogue setpoints) with the analogue setpoint limit value.

The resulting setpoint (mnemonic: RI + LI) is limited to 100% of the configured setpoint.

The analogue setpoint limit value can be set:
- using the P2 potentiometer on the front panel, or
- using the external signal (applied to terminal HR) and using the P2 potentiometer in cascade.

Digital setpoint

The working setpoint is produced by multiplying the digital setpoint with the digital setpoint limit value.

The digital setpoint limit value (mnemonic: HS) is set by digital communications.

Current (or voltage) limit

Depending on the configuration, the firing mode and the load type, the limit circuit reacts:

· by limiting the rms current through firing angle variation

· by limiting the rms load voltage through firing angle variation accompanied by current limit at its nominal load value

· by shutting down thyristor firing in the event of over-current without limit.

WARNING

Important!

The voltage limit configuration activates, simultaneously, current limit with 100% threshold

In current or voltage limit by firing angle variation, exceeding the threshold limit causes a reduction in thyristor firing angle until the limited value is lower than the limit threshold.

In current limit by firing shutdown, if the current threshold has been exceeded by more than 10%, thyristor firing ceases and the Over-current alarm is triggered.

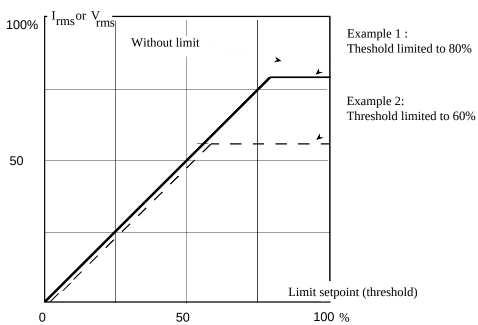


Figure 4-13 Examples of threshold current/voltage limit

In the active state of limit by angle variation, in ‘Burst-firing’ mode:

· the main feedback system takes account of the power actually dissipated in the load and calculates the new duty cycle so that the feedback value corresponds to the setpoint

· the following burst-firing cycle provides soft start over a minimum of eight cycles

The limit configuration may be changed using the configuration mini-switches or, as an option, via digital communications.

Limit action as a function of firing mode and load type

Important!

WARNING

Voltage limit is only possible in 'Phase angle' firing mode.

For short-wave infrared elements, current limit is only possible in 'Phase angle' firing mode.

In 'Advanced single-cycle' modes, current limit (except for short-wave infrared) always causes shutdown independent of the action mode configured.

For loads with a large temperature coefficient, only current limit by firing angle reduction is possible (do not use in Advanced single-cycle).

Load	Code	Firing Mode	Code	Possible limit	Code
Short-wave Infrared	SWIR	Phase Angle	PA	Reduction in firing angle if current threshold is exceeded	ILI
				Reduction in firing angle if voltage threshold is exceeded; current limited to 100%	VLI
				Shutdown if current threshold is exceeded	ICHO
		Burst firing Logic Advanced single-cycle	FC1, FC8 C16, 128 LGC SCA	No current or voltage limit, irrespective of limit configured (display:**noL**)	ILI VLI ICHO
Small temperature coeffient and variable loads	LTCL TTDL	Phase Angle	PA	Reduction in firing angle if current threshold is exceeded	ILI
				Reduction in firing angle if voltage threshold is exceeded; current limited to 100%	VLI
				Shutdown if current threshold is exceeded	ICHO
		Burst-firing	FC1, FC8 C16, 128	Reduction in firing angle if current threshold is exceeded	ILI
		Logic	LGC	Shutdown if current threshold is exceeded	ICHO
		Advanced	SCA	Shutdown if current threshold is exceeded	ILI ICHO VLI
Large temperature coefficient	HTCL	All modes except Advanced single-cycle	PA FC1-128 LGC	Reduction in firing angle if current threshold is exceeded, Irrespective of limit configured	ILI ICHO VLI
		Advanced single-cycle	SCA	Shutdown if current threshold is exceeded irrespective of limit configured	ILI ICHO VLI

Table 4-3 Possible actions for current (or voltage) limit

Limit setpoints (thresholds)

Load current (or voltage) limit acts as a safety device when the threshold set by the user has been exceeded.

The current (or voltage) limit active state threshold is set, depending on the product code:

· using the P1 potentiometer on the front panel

· using an external signal in cascade with the P1potentiometer

· via digital communications (as an option).

The first two types of threshold setting give the resulting analogue limit setpoint. Digital communications give the digital limit setpoint.

Irrespective of the type of setting selected, calculation of the limit threshold depends on the type of working setpoint (Analogue or Digital) and on the configuration default settings.

Configuration default (see also 'Configuration" Table 6-12)	**State of A/C input**	**Calculation of limit threshold LS**
From memory to memory	Insensitive	CL x RL/100
From memory to mini-switches	Connected to +5V (Digital setpoint)	CL x RL/100
	Connected to 0V (Analogue setpoint)	RL
From mini-switches to mini-switches	Insenstive	RL

Table 4-4 Calculation of current (or voltage) limit threshold

Abbreviations used in this table:

LS : resulting limit setpoint (load current or voltage limit threshold)
A/C : logic signal input for selection of setpoint type (Analogue or Digital communications
CL : current or voltage limit digital setpoint
RL : resulting analogue setpoint for current or voltage limit (external analogue signal in cascade with P1 potentiometer).

Important!

WARNING

When calculating the limit threshold, all parameters are expressed as a percentage of their maximum value.

The rms current (or voltage) value used as the limit measurement is calculated over one mains cycle during thyristor firing.

Chapter 5

DIGITAL COMMUNICATIONS (OPTION)

Page

CHAPTER 5 DIGITAL COMMUNICATIONS (OPTION)

GENERAL INTRODUCTION

TE10P series controllers are fitted with digital communications (as an option). This performs three main functions:

- configuring and / or controlling the state of the unit
- modifying the working setpoint
- monitoring all the operating parameters (setpoints, measurements, adjustments, alarms).

This digital link is available for two standards: RS422 & RS485

The communications bus is electrically isolated from all other inputs or outputs.

Two communications protocols are available as standard: Modbus® and Profibus-DP.

Selection of one of these protocols, specified when ordering, is made by:

- the addition of a specific board for Profibus-DP
- the position of the SW3.7 mini-switch and soldering of links LK3 to LK5.

Message transfer is of the 'Master/Slave' type. The TE10P unit always operates in 'Slave' mode, with the monitoring system or supervisor as 'Master'.

The parameters associated with digital communications are accessed by means of their addresses.

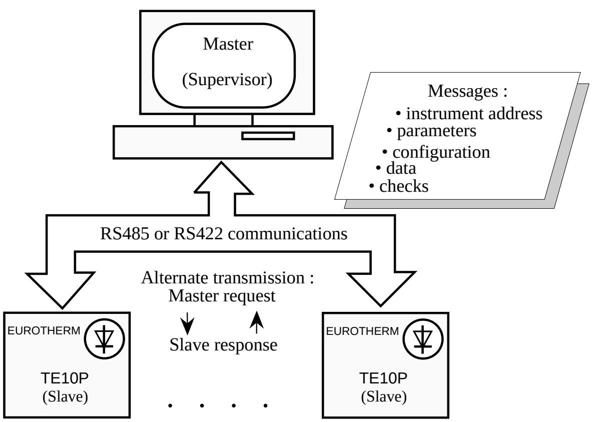


Figure 5-1 Data transfer organisation

PARAMETERS

The parameters managed by digital communications in the TE10P series are:

- instrument and alarm status words; control words
- control and adjustment parameters; electrical and communications parameters

Parameter group	Parameter Description	Mnemonic
Communications parameters	Instrument identification	II
	Manufacturer identification	MI
	Control software version	VO
	Measurement software version	VI
	Communications ‘buffer’ length	BL
	Communications error codes	EE
Control status words	Instrument status word	SW
	Writable status word	OS
	Alarm status word	XS
	Control word	CW
	Relay control word	OC
Control parameters	Feedback value	PV
	Remote analogue setpoint	RI
	Local setpoint (Manual input)	LI
	Digital setpoint	SL
	Fast setpoint	FS
	Working setpoint	SP
	Analogue setpoint limit	HR
	Digital setpoint limit	HS
	I/V analogue limit	RL
	I/V digital limit	CL
	Setpoint resulting from I/V limit	LS
	Power demand	OP
Adjustment parameters	Base time in ‘Burst-firing’ mode	CT
	Soft start duration	ST
	Ramp duration in ‘Phase angle’ mode	RR
	Thyristor firing delay	DT
Electrical parameters	Active load power	PW
	RMS load voltage	VV
	RMS line voltage	LV
	RMS load curent	CV
	Supply frequency	FR

Table 5-1 Parameters managed by digital communications in TE10P controllers

Parameter format

- The format of the operating parameters is determined by their use:
- status words are transmitted in two-byte hexadecimal format
- control words are presented in 0 to 99 format
- communications parameters have a two-byte hexadecimal format
- control parameters are presented in 0 to 1000 format (for 100%) to within 0.5%
- power, load and supply voltages have 0 to 1000 format (for 100%)
- frequency is presented in the range 40 to 70 Hz
- adjustment parameters (modulation time, soft start duration) are presented in number of cycles
- ramp duration is in hundredths of a second in Profibus and in milliseconds in Modbus protocols
- thyristor firing delay is presented in the range 0 to 90 degrees.

Parameter type

Read / write

In all protocols, message transfer between a Master and a Slave depends on parameter type: ‘Read’, or ‘Read/Write’

- ‘Read’ type (mnemonic: R/O): read-only parameter value
- ‘Read/Write’ type (mnemonic: R/W): read and modification of parameter value possible.

The following parameters are Read/Write type (mnemonic: R/W):

- Digital and Fast setpoints (mnemonics: SL & FS)
- Control word (mnemonic: CW) & Relay control word (mnemonic: OC)
- Writable status word (mnemonic: OS)
- Current (Voltage) and Setpoint limit (mnemonics: CL & HS)
- Instrument identification (mnemonic: II).

All other parameters are read-only (mnemonic: R/O).

Broadcast

In Modbus® protocol, the following parameters may be broadcast:

- digital and fast setpoints (mnemonics: SL & FS)
- control word (mnemonic: CW).

None of the other parameters may be broadcast.

Communications parameters

Instrument identification

The instrument identification parameter (mnemonic: II) indicates the identification code given for the unit. Its initial value for the TE10P controller as shipped from the factory is ‘10’ in decimal code.

The user may change the instrument identification to a different value and store it in non-volatile memory.

In Profibus-DP protocol, the ‘Type of unit’ parameter (mnemonic: TY) with a 00 address, the value of which is 20HEX, indicates it is a TE10P controller.

Manufacturer identification

The manufacturer identification parameter (mnemonic: MI) transmits the value ‘500’ in decimal code.

MI status is ‘read-only’ (mnemonic: R/O).

Software version

The software version parameters of the two microprocessors:

- control software version (mnemonic: VO)
- measurement software version (mnemonic: VI)

must be compatible.

Their values are in binary code for Modbus® and Profibus-DP protocols.

‘Buffer’ length

The ‘Buffer’ length (mnemonic: BL) is the maximum number of characters permitted in a transmission via the digital link:

for Modbus® protocol the ‘Buffer’ length is 11 characters

for Profibus-DP protocol the length of the Output and Input ‘Buffers’ is defined in the parameterisation phase, and the BL parameter does not exist.

Error codes

Digital communications error codes are specific to the protocol type. They are described in the Profibus-DP and Modbus® paragraphs respectively.

Instrument status words

Main status word

All data on the instrument configuration are contained in the instrument status word (mnemonic: SW).

The access type of the status word is ‘Read’, which allows data to be read but not directly modified.

Unit operation can be modified by using:

- the control codes (mnemonic: CW), or
- the writable status word (mnemonic: OS).

Status word data are stored in the non-volatile memory.

The instrument status word is composed of two bytes (16 bits).

Figure 5-2 gives all the necessary information on the meaning of each bit within the instrument status word.

Writable status word

The writable status word (mnemonic: OS) has write permission: it allows the controller configuration to be modified in a single communications transmission.

The access type of the writable status word is ‘Read/Write’ which allows data to be read or modified directly. After a change in configuration achieved by OS write, the controller restarts with a safety ramp (if necessary).

The composition of the writable status word OS and labelling of its bits are identical to the instrument status word SW.

To modify controller configuration, it is sufficient to write in the OS parameter the value in hexadecimal corresponding to the desired state of the SW bits.

Certain bits may not be modified by digital communications.

The following bits, 8 to 11 and 14 and 15, relate to the physical definition of the controller or of the load and must be set to zero.

Bit numbers of Instrument status word (mnemonic : SW)

15 14 13 12 11 10 9 8 7 6 5 4 3 2 1 0

Bit 15

Digital Comms active, read/write	0
Digital Comms, read only	1

Bit 14

Setpoint type :	
Analogue setpoint	0
Digital setpoint	1

Bit 13

Default type :	
Configuration from memory	0
Configuration by mini-switches	1

Bits 12, 11

Retransmission (option):		
Feedback value	0	0
Active power	0	1
RMS load voltage	1	0
RMS load current	1	1

Bit 10

Load failure detection adjustment:	
Non adjusted PLF detection	0
Adjusted PLF detection	1

Bits 9, 8

Load type Code (see product code):		
LTCL	0	0
SWIR	0	1
TTDL	1	0
HTCL	1	1

Bits 7, 6, 5

			Control parameter :
0	0	0	Transfer I^2 <-> P
0	0	1	Load voltage to load voltage squared V^2
0	1	0	Load current to load current squared I^2
0	1	1	Active power P
1	0	0	Open loop
1	0	1	RMS load voltage V_{RMS}
1	1	0	RMS load current I_{RMS}
1	1	1	Transfer I^2 <-> V^2

Bits 4, 3

		Current (voltage) limit
0	0	Current limit by angle variation
0	1	Firing shutdown if current threshold is exceeded
1	0	Voltage limit by angle variation and load current limited to 100%

Bit 2

0	No ramp
1	Ramp or Soft Start

Bits 1, 0

	Thyristor firing mode:
0 0	Logic
0 1	Burst firing
1 0	Phase angle
1 1	Advanced single cycle

Figure 5-2 Organisation of instrument status word bits (mnemonic: SW)

Alarm status word

Data on the alarm state and on the current operating mode are contained in the alarm status word (mnemonic: XS).

Each XS bit represents the state of one of the alarms:

- active state (bit = 1), or
- non-active state (bit = 0).

or it represents the state of:

- Enable / Inhibit
- Calibration / Operation
- Current or voltage limit (active or non-active)
- Setpoint change ramp in Phase angle firing mode (active or non-active).

The access type of the alarm status word is ‘Read’ (mnemonic: R/O).

The eight low-order bits (first 8 bits) of the alarm status word correspond to alarms that do not cause the unit to shut down.

The eight high-order bits (last 8 bits) of the alarm status word correspond to high level alarms which shut down controller operation.


WARNING

Important!

If the value of the alarm status word is equal to zero, this means that the controller is operating normally, without current (or voltage) limit or angle variation (ramping).

Figure 5-3 gives all the necessary information on the meaning of each bit within the alarm status word.

For further information, see Chapter 8, ‘Alarms’.

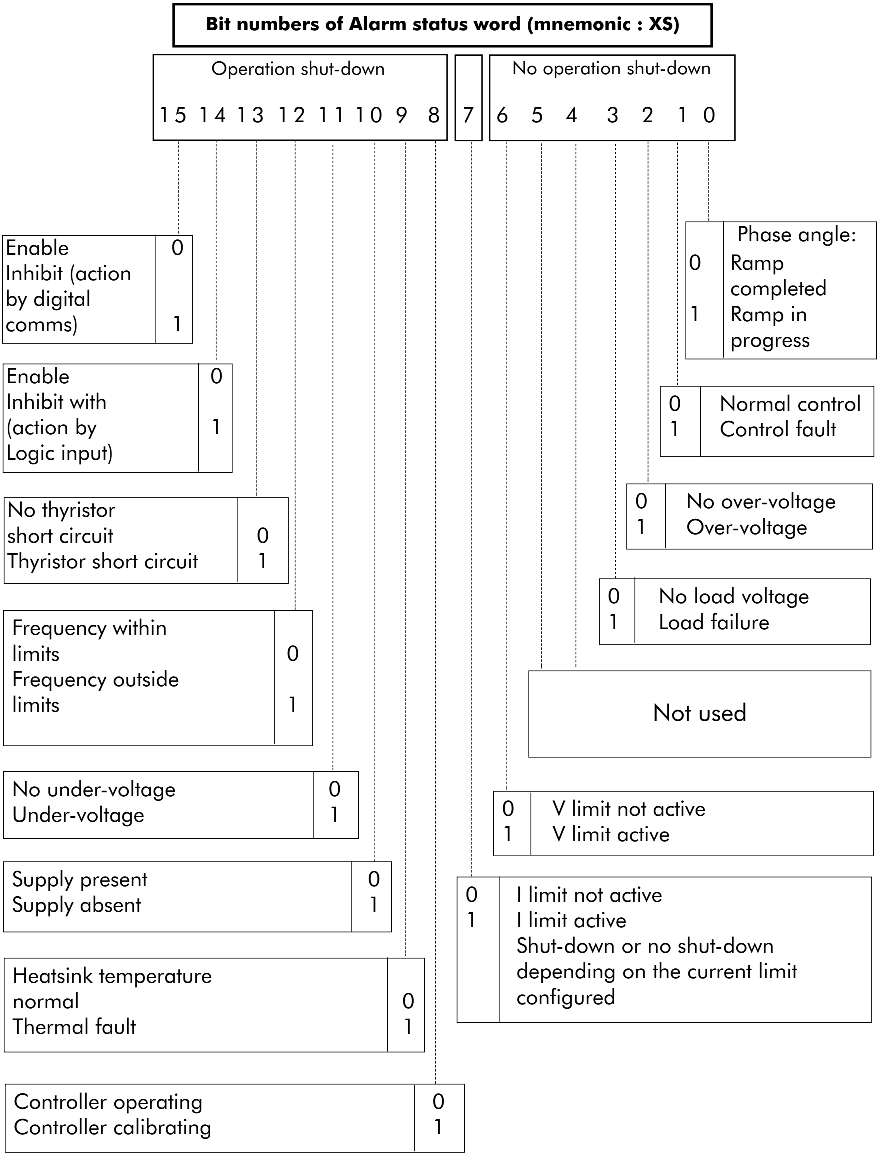


Figure 5-3 Organisation of alarm status word bits (mnemonic: XS)

Control word

The control word (mnemonic: CW) is transmitted to modify certain types of TE10P controller operation.

The access type of the control word is 'Read/Write' (R/W).

In Read mode the control word CW transmits the last code written.

After powering up, the value transmitted is 99.

All changes using the control codes can be made without interrupting controller operation.

Table 5-2 shows the functions of various control codes.

The following codes initiate a restart with safety ramp (if configured) by varying the thyristor firing angle:

02, 03

04 (for high level alarms)

08 to 11

15, 24, 25

27, 28.

The new configuration, resulting from a write of control codes, can be confirmed by reading the instrument status word SW.

Characteristics of loads with large temperature coefficient

If a load with large resistance variations is configured (load type code: HTCL), control codes 24 and 26 have no action.

For this load type the following requests for a configuration change are **not** implemented:

- controller firing ceases if current threshold is exceeded (code 24)
- voltage limit by reducing firing angle (code 26).

The controller remains in current limit through firing angle reduction even if these two codes are sent.

Reminder: For a load with a large temperature coefficient (code HTCL), the limit action is:

- by firing shutdown in Advanced single-cycle mode irrespective of the limit configured (do not use Advanced single-cycle for this type of load)
- by firing angle reduction in all other firing modes irrespective of the limit configured.

Control codes Decimal	Hex		Functions	Observations
00	00	State	Inhibit	Write in XS
01	01		Inhibit	
02	02		Enable	Write in XS
03	03		Enable	Restart
04	04		Alarm reset	Write in XS
05	05		PLF adjustment request	Write in SW
06	06	Feedback	Active power P	Write in SW
07	07		Load voltage squared V^2	
08	08	Firing mode	Phase angle	Write in SW
09	09		Burst-firing, soft start	Restart
10	0A		Advanced single-cycle	
11	0B		Burst-firing	
12	0C		Transfer FS to SL	
15	0F		Phase angle with ramp	
18	12	Control	Open loop	Write in SW
20	14		Load current squared I^2	
21	15		RMS load current	
22	16		RMS load voltage	
23	17		Transfer $I^2 \leftrightarrow V^2$	
24	18	Limit	Shutdown if I > threshold	Write in SW
25	19		I limit by angle variation	Restart
26	1A		V limit by angle variation	
27	1B	Firing mode	Logic	Write in SW
28	1C		Logic, soft start	Restart
31	1F	Control	Transfer $I^2 \leftrightarrow P$	Write in SW
32	20	Retransmission	Feedback value	Write in SW
33	21		Active power	
34	22		Load voltage	
35	23		Load current	
99	63	Value after start up: no code received		

Table 5-2 Control word codes (mnemonic: CW)

Free codes: 13, 14, 16, 17, 19, 29, 30, 36 to 98

Relay control word

The relay control word (mnemonic: OC) selects one (or more) alarm(s) which activate the TE10P controller alarm relay.

Each bit of the relay control word corresponds to a bit of the alarm status word.

Bits within OC are high-true; when set to ‘0’ they do not activate the alarm relay, conversely when set to ‘1’ they cause activation of the alarm relay.

Example 1

Bit 11 of the alarm status word XS indicates the under-voltage alarm state.

If bit 11 of the relay control word OC is 0:

the under-voltage fault does not activate the alarm relay

If bit 11 of the relay control word OC is 1:

the under-voltage fault activates the alarm relay.

The relay control word must be transmitted to a given address of the controller and may not be broadcast.

The type of the relay control word is ‘Read/Write’ (R/W).

Bits:

0,

4, 5, 6,

14, 15

have no significance for the control word OC because they do not correspond to alarms (see Figure 5-3).

After an OC write, set these bits (0, 4-6, 14 & 15) to zero.

Example 2

Bit 15 of the alarm status word XS indicates controller operation enable or inhibit via digital communications.

Bit 15 of the relay control word OC has no significance because it does not correspond to any of the alarms.

Control parameters

Feedback value

The feedback value (mnemonic: PV) represents the value of the parameter selected for the feedback system.

Control setpoints

The following setpoints can control the thyristor unit:

- The Remote Analogue Setpoint (mnemonic: RI);
  present on terminal 32 of the ANA.IN user terminal block
- The Local Analogue Setpoint: manual control or external signal (mnemonic: LI);
  present on terminal 34 of the ANA.IN user terminal block
- The Digital Setpoint (mnemonic: SL);
  transmitted via digital communications
- The Fast Transfer Setpoint (mnemonic: FS);
  transmitted via digital communications.

Resulting setpoint

The state of the logic input 'A/C' determines the source of the resulting setpoint; either the Analogue Setpoints or the Comms setpoint.

If the 'A/C' input is connected to 0V:

- the Analogue setpoints are used (bit 14 of the instrument status word SW is 0)
- the Resulting setpoint represents the sum (with a 100% maximum):
  - of the remote analogue setpoint (RI) and
  - the local analogue setpoint (LI).

Example 1
RI = 60%, LI = 30% → RI + LI = 90%

Example 2
RI = 60%, LI = 60% → RI + LI is limited to 100%.

If the 'A/C' input is connected to 5V:

- the Comms setpoint is used (bit 14 of the instrument status word SW is 1)
- the Resulting setpoint is equal to the active digital setpoint.

Fast Transfer Setpoint

The Fast transfer setpoint (FS) enables a Digital setpoint, prepared in advance, to be stored in RAM.

Replacement of the digital setpoint by the fast transfer setpoint is performed in a single transmission by sending the code OC_{HEX} in the control word.

Setpoint limit

Two setpoint limit parameters are used:

- the Analogue Limit on the analogue setpoint (mnemonic: HR);
  present on terminal 35 of the ANA.IN user terminal block
- the Digital Limit on the digital setpoint (mnemonic: HS);
  transmitted via digital communications.

Setpoint limit parameters are used to calculate the working setpoint.

Working setpoint

The Working setpoint (mnemonic: SP) is generated from the Resulting setpoint taking the setpoint limit into account:

- the Analogue Limit (mnemonic: HR), or
- the Digital Limit (mnemonic: HS).

The type of resulting setpoint (Analogue or Comms (Digital)) is determined by the state of the logic input ‘A/C’.

If the ‘A/C’ input is connected to 0V:

- the resulting setpoint is Analogue.
- The Working setpoint is calculated using the following equation:
  SP = (RI + LI) x HR / 100

If the ‘A/C’ input is connected to 5V:

- the resulting setpoint is Comms (Digital).
- The Working setpoint is calculated using the following equation:
  SP = SL x HS / 100

WARNING

Important!

In calculating the Working setpoint, all the parameters are expressed as a percentage of their maximum value.

Current or voltage limits

Two limit setpoints determine the maximum value of the current or the voltage:

- the analogue setpoint for Current or Voltage Limit (mnemonic: RL);
  present on terminal 36 of the ANA.IN user terminal block
- the digital setpoint for Current or Voltage Limit (mnemonic: CL);
  transmitted via digital communications.

The parameter for the current or voltage analogue limit sets the analogue value of the current (or voltage) threshold, which if exceeded, will invoke the limit circuit.

The threshold set by an analogue signal (terminal 36) may be adjusted using the P1 potentiometer, located on the front panel of the controller.

The parameter for the current or voltage digital limit sets the digital value of the current (or voltage) threshold, which if exceeded, will invoke the limit circuit.

The digital limit value is stored in non-volatile memory.

Setpoint resulting from limit

The Resulting Limited setpoint (mnemonic: LS) sets the maximum value of the current or voltage allowable for the load.

As a rule, it is calculated by taking the two limit setpoints (analogue and digital) into account using the following formula:

LS = CL x RL / 100

(for more details see Table 4-4)

WARNING

Important:

In this calculation, all the parameters are expressed as a percentage of their maximum value.

Power demand

The Power Demand parameter (mnemonic: OP) represents the thyristor firing demand and corresponds to the output value of the internal control loop.

Electrical parameters

Active power

The Power parameter (mnemonic: PW) represents the value of the active power at the controller output (in percent of the power obtained after any re-calibration).

This value represents the active power actually supplied to the load.

Voltage

RMS load voltage

The value of the rms load terminal voltage is given (in %) by the parameter mnemonic VV.

RMS mains voltage

The value of the rms mains voltage is given (in %) by the parameter mnemonic LV. The nominal value of LV (operating voltage) is adjusted at the factory depending on the product code.

Current

The rms thyristor current (load current) corresponds (in %) to the parameter labelled CV.

Frequency

The mains frequency measurement is stored under parameter FR. The operating range is from 40 to 70 Hz.

Adjustment parameters

Four parameters with ‘Read’ status correspond to adjustment values.

These adjustments are specific to the controller firing mode.

The adjustment parameters are:

- base time
- soft start duration
- ramp duration
- thyristor firing delay

These parameters may be adjusted using the P3 and P4 potentiometers on the front panel.

A description of this adjustment is given in Chapter 7, ‘Commissioning procedure’.

Base time (mnemonic: CT)

The ‘Base time’ parameter determines firing duration (in number of cycles) for a 50% duty cycle in Burst-firing mode.

The parameter labelled CT may be adjusted using the P4 potentiometer.

Soft start duration (mnemonic: ST)

The ‘Soft start duration’ parameter determines the time taken for the thyristor firing angle to ramp from zero to full value in Logic and Burst-firing modes (except for TB = 1 cycle).

The parameter labelled ST may be adjusted using the P3 potentiometer.

Ramp duration (mnemonic: RR)

The ‘Ramp duration’ parameter describes the ramp duration implemented by varying the firing angle for setpoint increases in Phase angle firing mode.

The parameter labelled RR may be adjusted using the P3 potentiometer.

Delayed firing (mnemonic: DT)

The ‘Delayed firing’ parameter determines, for an inductive load, the initial thyristor firing delay at the beginning of conduction in Logic and Burst-firing modes.

The parameter labelled DT may be adjusted using the P3 potentiometer as a function of the load power factor.

PROFIBUS-DP PROTOCOL

General introduction

Specifications for Profibus-DP (PROcess FIeld BUS Decentralised Periphery) communications protocol are defined in Standards EN 50170 / DIN 19245 / Part 3.

Authorisation for TE10P series controllers, with Profibus-DP option, has been granted by the PNO (Profibus Nutzer Organisation) denoted by the number:

No. Z00204

The identification number granted by the PNO is:

$1334 = 0536_{HEX}$

Important! A detailed description of Profibus-DP operation is given in the manual ‘Profibus-DP interface for the TU & TC series’, ref: HA 175215 ENG

Transmission specification

Transmission standard	RS485 2-wire, bi-directional
Transmission mode	Binary character frame. Even parity.
Character format	1 start-bit - 8 data bits - 1 parity bit - 1 stop bit
Transmission rates provided	9.6; 19.2; 93.75; 187.5; 500; 1500 kbaud (automatic recognition of rate used)

The Master initiates message transfer.

Status word reads are carried out using a diagnostic request.

Transfers between the Master and the TE10P controller can be of two types:

· Cyclic reads of pre-defined parameters (Read procedure)

· Read and/or Write of parameters at Master’s request depending on Sub-Protocol (Request and Response).

Addressing

Addresses used in Profibus-DP protocol are (in binary):

- device address of the Slave
- parameter address

Each parameter used in Profibus-DP protocol for digital communications is designated by its address (parameter address).

Device address

The device address (controller address) is set by the digital communications configuration mini-switches, accessible on the controller front panel.

This device address can not be set or altered by the communications bus.

In normal operation, the following addresses can be used:

4 to 125

(122 addresses in all).

Addresses 0 to 3 are generally reserved by the Master.

Address 126 is reserved for the delivery of the units whose address can be configured by the communications bus.

Address 127 is reserved for broadcast to comply with the Profibus Standard.

Parameter address

The parameter address is used in parameterisation, to define which variables will be transmitted when cyclic reading the input buffer.

It also applies when using the sub-protocol to access or modify the parameter value.

State diagram

The state diagram illustrating data transfer via the Read/Write process comprises four states (see Figure 5-4):

- · powering up
- · waiting for parameterisation
- · waiting for configuration
- · transfer of parameter data.

Powering up

After powering up (POWER_ON) the unit begins its initialisation.

A change of address is not allowed on this controller and an error message is transmitted if a change attempt is made.

After each power up, the unit enters a two sequence wait phase:

Parameterisation and configuration.

Parameterisation

This is the wait phase for the parameterisation message (WPRM).

In this phase, reading the configuration, (Get_Cfg) is allowed.

A diagnostic request (Slave_Diag) is permitted.

The Parameterisation frame (Set_Prm) contains the following data:

- · Parameterisation of the system (PNO identification, acceptance of synchronisation modes, 'Watchdog' time...)
- · Parameterisation of the data (the parameters designated by the Master to be accessible in cyclic read).

The maximum number of values defined in the Parameterisation phase is 16.

If the Parameterisation is changed, the parameters are redefined.

Any other type of messages will be rejected during the Parameterisation wait phase.

Configuration

This is the wait phase for the configuration message (WCFG).

Both Parameterisation (Set_Prm) and diagnostic request (Slave_Diag) are allowed.

The configuration message specifies the structure of the Input and Output Buffer.

Any other type of message will be rejected during the configuration wait phase.

The controller can only receive a change in configuration (Check_Cfg) from the Master which has set the parameters.

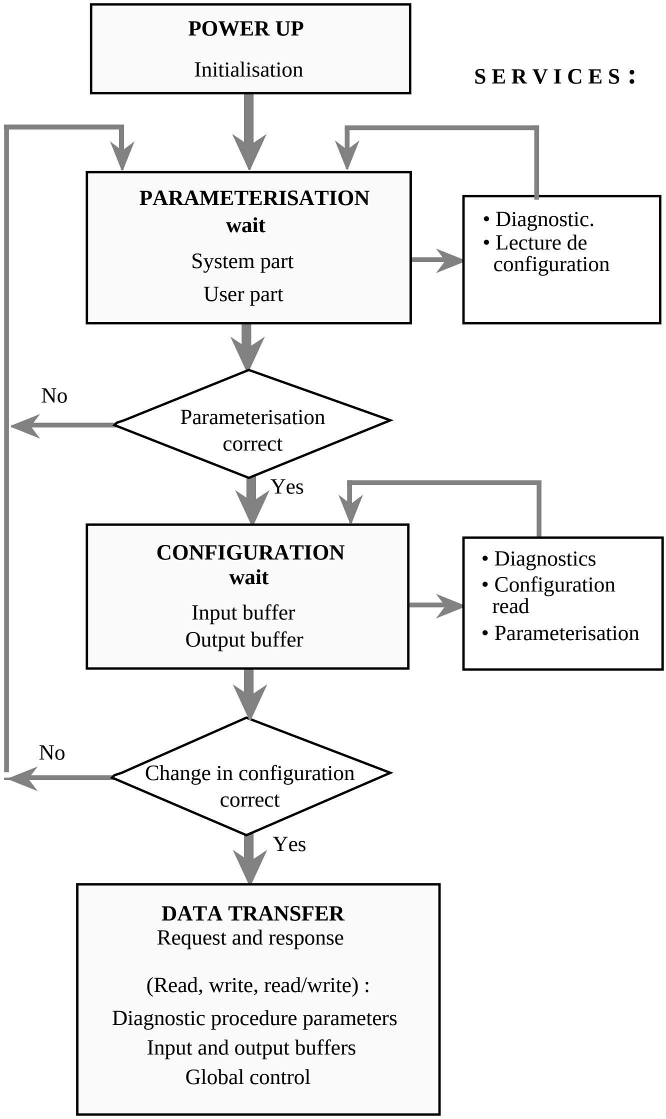


Figure 5-4 State diagram of Read/Write process

Data transfer

If Parameterisation and configuration have been accepted, in the data transfer phase (DXCHG) the TE10P controller is ready to transfer data (in Read and/or Write) with the Master which has configured and parameterised it.

In this phase, the parameter values may be transferred:

- in Read and/or
- in Write.

Cyclic Read will be performed in the order given by Parameterisation.

The data transferred during the DXCHG phase may be of the following types:

- Diagnostic (Slave_Diag)
- Parameterisation and Configuration:
  - Configuration read (Get_Cfg)
  - Configuration Change (Chk_Cfg)
  - Parameterisation (Set_Prm)
- Process data transfer:
  - Request and Response (Data_Exchange)
  - Multiple data read (Read_Input); infrequently used
  - Re-read of outputs (Read_Output); infrequently used
- Control of transmission modes (Global_Control).

The parameter values are presented in 0 to 1000 format (for 100%) by 0.5% increments.

Status read

The instrument status word (mnemonic: SW) and the alarm status word (mnemonic: XS) are only accessible in read via the Diagnostic function (Slave_Diag).

These parameters do not have parameter addresses and, because of this, can not be read by the data transfer function (DXCHG).

As defined in the Profibus-DP Standard, the diagnostic frames are divided into two parts:

- the first part concerns the interface itself
- the second part concerns the TE10P

(see Communications Manual, ref. HA 175215 ENG).

In the diagnostic frame:

- bytes 7 & 8 correspond to the instrument status word (mnemonic: SW)
- bytes 9 & 10 correspond to the alarm status word (mnemonic: XS)
- byte 6 indicates the total number of bytes specific to the application, including byte 6 itself (in this case its value is 05).

Diagnostic LEDs

In Profibus-DP protocol, the state of data transfer is shown by three light emitting diodes (LEDs) located on the controller front panel.

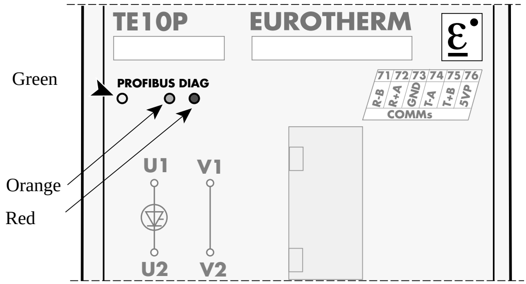


Figure 5-5 Layout of LEDs on front panel in Profibus-DP protocol

The green LED indicates that the communications processor is transmitting data on the bus (DXCHG phase).

In the Initialisation phase, the orange and red LEDs flash alternately for three seconds. After this their state has the meaning shown in the following table:

State of LEDs		Communications state
Orange	**Red**	
On	Off	Normal if green LED on Fault if green LED off
Flashing at 0.25Hz	On	External communications fault
Flashing at 1Hz	On	Internal communications fault
Don't care	Flashing	Major fault
Off	Off	Power supply absent or electronics fault

Table 5-3 State of diagnostic LEDs

For further information, please consult the ‘Profibus Interface’, Ref. HA 175215 ENG.

Communications error codes

The error code enables errors, which have arisen in the course of transmission, to be identified.

In Profibus-DP protocol the error codes are read in the Input buffer.

Important: The format and validity of the transmitted value are not checked:

if the format is incorrect or invalid, the transmitted value will not be retained.

If an error is detected in transmission, the error code parameter is as shown in the following table.

Error code			Description
Decimal	HEX	Binary	
00	00	00 0000	Parameter address error
01	01	00 0001	Attempt to write to a Read-only parameter
02	02	00 0010	Data > $7FFF_{HEX}$ (32767 decimal)
03	03	00 0011	Request to read a Write-only parameter
04	04	00 0100	Output Buffer does not contain eight bytes
05	05	00 0101	Improper command for this controller

Table 5-4 Values of Profibus-DP digital communications error codes

Operating parameters

In Profibus-DP protocol, the operating parameters are identified by their addresses.

Mnemonics are used only for user convenience in this manual so that the parameters may be more easily recognised.

The following table lists the parameters provided in TE10P controllers together with their addresses and mnemonics.

In this table, the operating parameters are listed in ascending address order.

The ‘type of equipment’ parameter (mnemonic: TY) is only accessible by the Sub-Protocol.

Status	Parameter		Address		Format
	Description	Mnemonic	Decimal	HEX	
Read	Type of equipment	TY	00	00	20_{HEX}
Read/ Write	Digital setpoint	SL	01	01	0-1000
	Fast setpoint	FS	02	02	0-1000
	Control codes	CW	03	03	$0\text{-}63_{HEX}$
	Digital setpoint limit	HS	04	04	0-1000
	Digital I/V limit	CL	05	05	0-1000
	Writable status word	OS	06	06	$0\text{-}3FFF_{HEX}$
	Relay control word	OC	07	07	$0\text{-}3FFF_{HEX}$
	Instrument identification	II	08	08	$0\text{-}7FFF_{HEX}$
Read	Main software version version	VO	09	09	HEX
	Reserved		10	0A	
	Reserved		11	0B	
	Reserved		12	0C	
	Reserved		13	0D	
	Measurement software version	V1	14	0E	HEX
	Reserved		15	0F	
	Reserved		16	10	
	Feedback value	PV	17	11	0-1000
	Working setpoint	SP	18	12	0-1000
	Power demand	OP	19	13	0-1000
	Active load power	PW	20	14	0-1210
	RMS load voltage	VV	21	15	0-1100
	RMS load current	CV	22	16	0-1100
	RMS line voltage	LV	23	17	0-1250
	Supply frequency	FR	24	18	40-70Hz
	Remote analogue setpoint	RI	25	19	0-1000
	Local setpoint (manual input)	LI	26	1A	0-1000
	Analogue setpoint limit	HR	27	1B	0-1000
	I/V analogue limit	RL	28	1C	0-1000
	Setpoint after I/V limit	LS	29	1D	0-1000
	Base time in ‘Burst-firing’	CT	30	1E	1-128 cycles
	Soft start duration	ST	31	1F	0-64 cycles
	Thyristor firing delay	DT	32	20	0 to 90°
	Ramp duration in ‘Phase angle’	RR	33	21	0 to 6502 in 1/100s of sec

Table 5-5 Operating parameter addresses in Profibus-DP protocol

MODBUS® PROTOCOL

General introduction

Modbus® protocol is of the Master-Slave type.

Message transfer between Master and Slave is initiated by the Master.

All exchanges include a Request from the Master and a Response from the Slave (except for broadcast).

TE10P digital communications support the following functions:

- read words : functions 3 and 4
- write a word : function 6
- write n words (with n=1) : function 16
- diagnostics under code 0 (in echo) : function 8.

Important: A detailed description of how Modbus® protocol operates is given in the manual 'TU Range. Digital communications', ref: HA 173535 ENG

Transmission specifications

Transmission standard	RS485 or RS422 (2-wire or 4-wire)
Transmission mode	Binary character frame
Character format	1 start bit - 8 data bits - 1 stop bit 9.6 or 19.2kbaud selected by mini-switch
Type of transmission	Asynchronous (character by character)
Type of protocol	Binary (or RTU)

Addressing

To identify the controller and the operating parameters, Modbus® protocol uses the following addresses:

· the device address (the Slave)
· the parameter addresses

The unit address is set by the mini-switches accessed on the front panel.

This device address can be neither set nor modified via the communications bus.

In normal operation, addresses 1 to 127 can be used for TE10P controller addressing.

The 00 address is reserved for broadcast mode when a Write operation is performed.

In broadcast mode each Slave performs the action requested but does not transmit a response.

Diagnostic LEDs

In Modbus® protocol the state of communications is indicated by two green light emitting diodes (LEDs) fitted on the controller front panel.

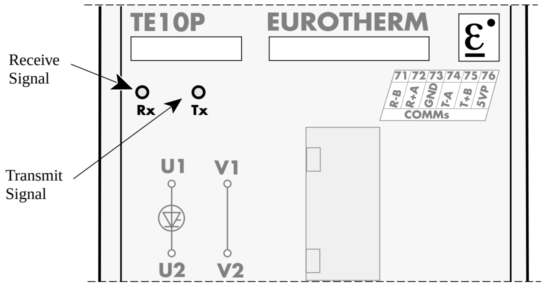


Figure 5-6 Location of LEDs on front panel in Modbus protocol

The Rx LED, connected to the 'receive' signal, enables the user to know when the Master is transmitting a request (flashing with each request).

The Tx LED, connected to the 'transmit' signal, enables the user to know if the Slave is responding (flashing with each response).

LED state		**Communications state**
Rx	**Tx**	
Flashing	Off	Master request
On	Off	Rx- and Rx+ wires are probably reversed
Flashing (2-wire) Off (4-wire)	Flashing	Slave responses
Off	Off	Power supply absent or no transmission or electronics fault, etc.

Table 5-6 State of diagnostic LEDs

Operating parameters

In Modbus® protocol parameters managed by digital communications in the TE10P series are characterised by format and type.

Format

The format of operating parameters is determined by their function:

- Communications parameters have two-byte Hexadecimal format (HEX)
- Status words have two-byte Hexadecimal format (HEX)
- the data is presented in 0 to 1000 format (for 100%) to within 0.5%

Type

In Modbus® protocol, data transfer between a Master and a Slave depends on the type of parameters: Read or Read/Write.

- **Read**

  - The Master requests the value of one or more parameters (functions 3 and 4);

  - the Slave responds with the value or values of these parameters.

- **Read/Write - two possibilities:**

  - The Master writes the value of a parameter (functions 6 or 16); the Slave responds to acknowledge if the data has been accepted (echo) or if an error has arisen (see Table 5-7, Error codes).

  - The Master requests the value of one or more parameters (functions 3 or 4), the Slave responds with the value or values of these parameters.

The Digital setpoint (mnemonic: SL), the Fast setpoint (mnemonic: FS) and the control word (mnemonic: CW) can be read and written (Read/Write type) and can be broadcast simultaneously to all controllers on the same bus.

The following parameters are Read/Write type but cannot be broadcast:

- current (voltage) and setpoint limits (mnemonics: CL and HS)
- instrument identification (mnemonic: II)
- the writable status word (mnemonic: OS)
- the alarm relay control status word (mnemonic: OC)

All other parameters may be read only (Read-only).

For the Modbus® protocol, the parameters managed by digital communications in the TE10P series are listed in the following table.

The operating parameters are classified in ascending address order in this table.

Status	Parameter	Address			Format
	Description	**Mnemonic**	**Decimal**	**HEX**	
Read/ Write/ Broad-cast	Digital setpoint	SL	01	01	0-1000
	Fast setpoint	FS	02	02	0-1000
	Control codes	CW	12	0C	0-63$_{HEX}$
Read/ Write No broadcast	Digital setpoint limit	HS	13	0D	0-1000
	Digital I/V limit	CL	14	0E	0-1000
	Writable status word	OS	22	16	0-FFFF$_{HEX}$
	Relay control word	OC	23	17	0-FFFF$_{HEX}$
	Instrument identification	II	24	18	0-FFFF$_{HEX}$
Read	Main software version	VO	25	19	HEX
	Configuration data	CI	26	1A	HEX
	'Buffer' length	BL	27	1B	HEX
	Communications error codes	EE	28	1C	HEX
	Measurement software version	V1	30	1E	HEX
	Instrument status	SW	35	23	HEX
	Alarm status	XS	36	24	HEX
	Feedback value	PV	37	25	0-1000
	Working setpoint	SP	38	26	0-1000
	Power demand	OP	39	27	0-1000
	Active load power	PW	40	28	0-1210
	RMS load voltage	VV	41	29	0-1100
	RMS load current	CV	42	2A	0-1100
	RMS line voltage	LV	43	2B	0-1250
	Supply frequency	FR	44	2C	40-70Hz
	Remote analogue setpoint	RI	61	3D	0-1000
	Local setpoint (manual input)	LI	62	3E	0-1000
	Analogue setpoint limit	HR	63	3F	0-1000
	I/V analogue limit	RL	64	40	0-1000
	Setpoint after I/V limit	LS	65	41	0-1000
	Base time in 'Burst-firing'	CT	66	42	1-128 cycles
	Soft start duration	ST	67	43	0-64 cycles
	Thyristor firing delay	DT	68	44	0 to 90°
	Ramp duration in 'Phase angle'	RR	69	45	0 to 65025ms
	Manufacturer identification (CNOMO)	MI	121	79	HEX

Table 5-6 Operating parameter addresses in Modbus® protocol

Communications error codes

The error code enables errors that have arisen in the course of transmission to be identified.

In Modbus® protocol, the communications error code parameter has the mnemonic EE. It must be read immediately after transmission.

After each valid transmission, the digital communications error code is 00. If an error is detected in transmission, the error code parameter is coded as shown in the following table.

Error code			Description
Decimal	**HEX**	**Binary**	
00	00	00 0000	No error
01	01	00 0001	Parameter address outside limits
02	02	00 0010	Transmission frame error CRC 16 error
03	03	00 0011	Not used
04	04	00 0100	Not used
05	05	00 0101	Attempt to write to a Read-only parameter
07	07	00 0111	Data invalid
08	08	00 1000	Data outside limits
09	09	00 1001	Control code invalid
10	0A	00 1010	Unauthorised broadcast
11	0B	00 1011	Not used
12	0C	00 1100	Function invalid
35	23	10 0011	Write mode de-selected: Write operation not possible
47	2F	10 1111	EEPROM write not possible

Table 5-7 Values of digital communications error codes in Modbus® protocol.

Chapter 6

CONFIGURATION

CHAPTER 6 CONFIGURATION

CONFIGURATION -SAFETY

The controller is configured at the factory by:

- mini-switches
- soldered links, and
- digital communications (option).

The controller is reconfigured on site (user configuration) using:

- mini-switches which can be accessed via the controller front panel
- digital communications (option).

Important!

WARNING

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

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.

Warning!

WARNING

To reconfigure the controller, open the access doors to the user configuration mini-switches.

For 125 to 400A rated units, the termination resistors are configured on the board (with the front door open).

Danger!

DANGER

For safety reasons, reconfiguration of the controller using mini-switches must be carried out with the unit switched off and by personnel trained and qualified to work with low voltage electrical equipment in an industrial environment.

Before starting the reconfiguration procedure, check that the controller is isolated and that any accidental power-up is not possible.

After reconfiguring the controller, amend the codes on the identification label to prevent any subsequent maintenance problems.

CONFIGURATION MINI-SWITCHES

The user configuration mini-switches, located on the driver board, are accessed from the outside via two access doors on the front panel.

For 125A to 400A units, the front panel needs only to be opened when configuring the termination resistors on the digital communications bus.

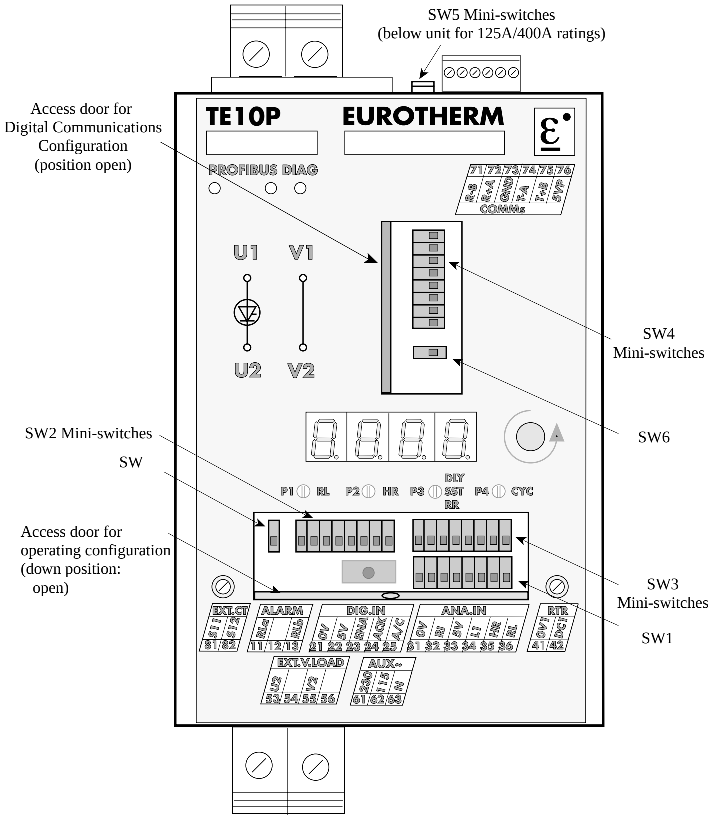


Figure 6-1 Layout of user configuration mini-switches

OPERATION

TE10P controller operation is determined by the position of the mini-switches on the driver board. This configuration (thyristor firing mode, feedback limits and parameters) is performed by the SW2 mini-switches.

Important! The microprocessor reads the configuration when the controller is switched on.

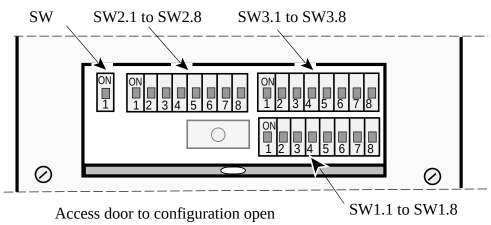


Figure 6-2 Mini-switches for configuring operation (front view)

WARNING

Important!

- To use without digital communications, the SW3.8 mini-switch must be in the OFF position.
- For configuration with digital communications, see page 6-15.

Thyristor firing mode

The type of thyristor firing mode and the operation of the setpoint change ramp (or soft start) are determined by the position of mini-switches SW2.1 to SW2.3. The configuration may be changed by digital communications.

Thyristor firing	**Position of mini-switches**		
	SW2.1	**SW2.2**	**SW2.3**
Logic (on/off)	OFF	OFF	-
Phase angle	OFF	ON	-
Burst-firing	ON	OFF	-
Advanced single-cycle	ON	ON	-
With positive ramp in Phase angle	-	-	ON
Soft start in Burst-firing or Logic	-	-	ON
No ramp and no soft start	-	-	OFF

Table 6-1 Configuration of thyristor firing mode

Feedback

The feedback value is selected using the position of mini-switches SW2.6 to SW2.8 and may be changed by digital communications.

Thyristor firing	Position of mini-switches		
	SW2.6	SW2.7	SW2.8
Active load power (P)	ON	ON	OFF
RMS load current (I_{RMS})	OFF	ON	ON
RMS load voltage (V_{RMS})	ON	OFF	ON
RMS current squared (I^2)	OFF	ON	OFF
Load voltage squared (V^2)	ON	OFF	OFF
Feedback transfer of I^2 to V^2 (depending on the measurement)	ON	ON	ON
Feedback transfer of I^2 to P (depending on the measurement)	OFF	OFF	OFF
Open loop	OFF	OFF	ON

Table 6-2 Configuration of feedback value

Analogue setpoint

Three mini-switches, SW1.1, SW1.2 and SW3.3, are used to configure the type of analogue setpoint (voltage or current) and the signal scale from the levels provided. The configuration can not be changed by digital communications.

Type and level of analogue setpoint	Position of mini-switches		
	SW1.1	SW1.2	SW3.3
0 to 5V	OFF	OFF	OFF
0 to 10V	OFF	ON	OFF
0 to 20mA	ON	OFF	OFF
4 to 20mA	ON	OFF	ON

Table 6-3 Configuration of analogue setpoint

Reminder:

Analogue setpoint is active when the 'A/C' terminal on the Logic Signal terminal block is at 0V, or disconnected from the 5V.

Current or voltage limit

Configuration of:

- the current (or voltage) limit
- the current limit action mode (firing angle variation or firing shutdown)
- the limit threshold adjustment (using the potentiometer or an external signal and the potentiometer)

is carried out using mini-switches SW2.4 and SW2.5, SW1.6 to SW1.8 and SW3.5.

The current limit action mode may be changed by digital communications.

Limit operation	**Position of mini-switches**	
	SW2.4	**SW2.5**
Current limit by thyristor firing angle variation	OFF	OFF
Voltage limit by thyristor firing angle variation*	OFF	ON
Controller firing shutdown if current threshold exceeded	ON	OFF

Table 6-4 Configuration of current or voltage limit operation

*Available only in Phase angle firing mode.
Accompanied by load current limited to 100% of its nominal value.

WARNING

Important!

For a large temperature coefficient load (code HTCL) only one configuration type is recommended: current limit by firing angle variation.

For short-wave infrared elements (code SWIR) in Phase angle mode, limit by firing shutdown is not recommended.

Analogue I (or V) limit input	**Position of mini-switches**			
	SW1.6	**SW1.7**	**SW1.8**	**SW3.5**
Threshold adjustment using PI potentiometer only	OFF	OFF	ON	OFF
Threshold adjustment using external signal:				
0 to 5V	OFF	OFF	OFF	OFF
0 to 10V	OFF	ON	OFF	OFF
0 to 20mA	ON	OFF	OFF	OFF
4 to 20mA	ON	OFF	OFF	ON
In cascade with P1 potentiometer				

Table 6-5 Configuration of analogue adjustment of current or voltage limit

Reminder: Detailed operation of limit is described in Chapter 4, ‘Operation’.

Analogue setpoint limit

When using the analogue setpoint limit, configure via mini-switches SW1.3 to SW1.5 and SW3.4 to set limit threshold adjustment mode.

Setpoint limit adjustment mode	Position of mini-switches			
	SW1.3	SW1.4	SW1.5	SW3.4
Threshold adjustment using P2 potentiometer only	OFF	OFF	ON	OFF
Adjustment using external signal:				
0 to 5V	OFF	OFF	OFF	OFF
0 to 10V	OFF	ON	OFF	OFF
0 to 20mA	ON	OFF	OFF	OFF
4 to 20mA	ON	OFF	OFF	ON
In cascade with P2 potentiometer				

Table 6-6 Configuration of adjustment mode for analogue setpoint limit

Calibration or operation

The SW mini-switch is used to configure:

· Normal controller operation (SW is in the OFF position), or

· Controller calibration (SW is in the ON position).

The calibration configuration can not be changed via digital communications.

Safety ramp

When powering up the controller, the safety ramp is applied in one of the following configuration modes if:

· the SW3.6 mini-switch is in the ON position
(irrespective of the current limit mode of action)

· current or voltage limit using firing angle variation is configured

WARNING

Warning!

There is no safety ramp in Advanced single-cycle mode

Ramp configuration using the SW3.6 mini-switch can not be changed by digital communications.

Load type

Four types of load may be configured using mini-switches SW3.1 and SW3.2.

The choice of load type determines the operation of certain controller functions:

· limit type

· safety ramp duration

· type of adjustment of load failure detection: static or dynamic.

For safety reasons, the load type is configured using mini-switches only, and can not be modified via digital communications.

Codes for load types use English abbreviations:

· LTCL : Low (small) Temperature Coefficient Load

· HTCL : High (large) Temperature Coefficient Load

· TTDL : Time and/or Temperature Dependent Load

· SWIR : Short Wave Infra Red elements.

Load type	**Code for load type**	**Position of mini-switches**		**Load fail detection type**	**Safety ramp duration (if active)**
		SW3.1	**SW3.2**		
Small temperature coefficient load	LTCL	OFF	OFF	Static	8 cycles
Large temperature coefficient load: Molybdenum, Platinum, Tungsten, Molybdenum di-silicide*	HTCL	ON	ON	Static	32 cycles
Variable load as a function of time and/or temperature: Graphite, Silicon carbide	TTDL	OFF	ON	Dynamic	8 cycles
Short-wave infrared elements	SWIR	ON	OFF	Static	8 cycles

Table 6-7 Configuration of load type

*) **Important**: This type of configuration invokes limit circuit operation, imposing current limit action through firing angle variation.

Alarm relay contact type

The alarm relay is de-energised:

- in an active alarm state selected via digital communications, and
- when the electronics supply is off.

Soldered links LK2 & LK3 on the driver board are used to select the type of contacts, depending on the application required:

open in alarm state (contacts normally open: code NO), or

closed in alarm state (contacts normally closed: code NC).

The layout for links LK2 and LK3 is shown in Figure 6-3.

Contact type	**Configuration links**	
	LK2	**LK3**
Open in alarm state and with power off (code NO)	Soldered	Cut
Closed in alarm state and with power off (code NC)	Cut	Soldered

Table 6-8 Configuration of alarm relay contact type

As shipped from the factory, the alarm relay contacts are configured according to the product code ordered.

The alarm relay contacts selected are provided on the ALARM user terminal block below the controller.

These contacts (NO or NF) are protected against interference emission by an RC snubber.

OPERATING VOLTAGE

For synchronisation of the electronics and for measurement, the load and line voltage, configured in the factory according to the product code, must be compatible with the operating conditions.

Internal electronics supply

WARNING

Warning!

Operation at a different voltage to that specified in the order is only possible if it is in the same voltage group (see Table 6-9)

In this case the voltage measurement must be recalibrated and the links (also known as ‘coffee beans’: GR) must be soldered or unsoldered on the driver board (for layout see Figure 6-3):

· GR1 to GR8 (line voltage selection) and

· GR9 to GR16 (load voltage selection).

If the operating voltage belongs to a different group to that configured, please contact Eurotherm.

Voltage group	Operating voltage (V)	State of configuration soldered links							
		GR1 GR9	GR2 GR10	GR3 GR11	GR4 GR12	GR5 GR13	GR6 GR14	GR7 GR15	GR8 GR16
1	100					X	X	X	X
	115						X	X	X
2	200				X			X	X
	230							X	X
	240						X		X
3	277			X					X
4	380		X						X
	400								X
	415						X	X	
	440							X	
5	460	X					X		
	480						X		
	500	No links to solder							

Table 6-9 Configuration of operating voltage using soldered links

X : signifies soldered link

Separate electronics supply

· Load and line voltage - Reconfiguration possible according to Table 6-9: membership of group must be respected!

· Electronics voltage - **Modification of separate supply only possible at factory; please contact Eurotherm.**

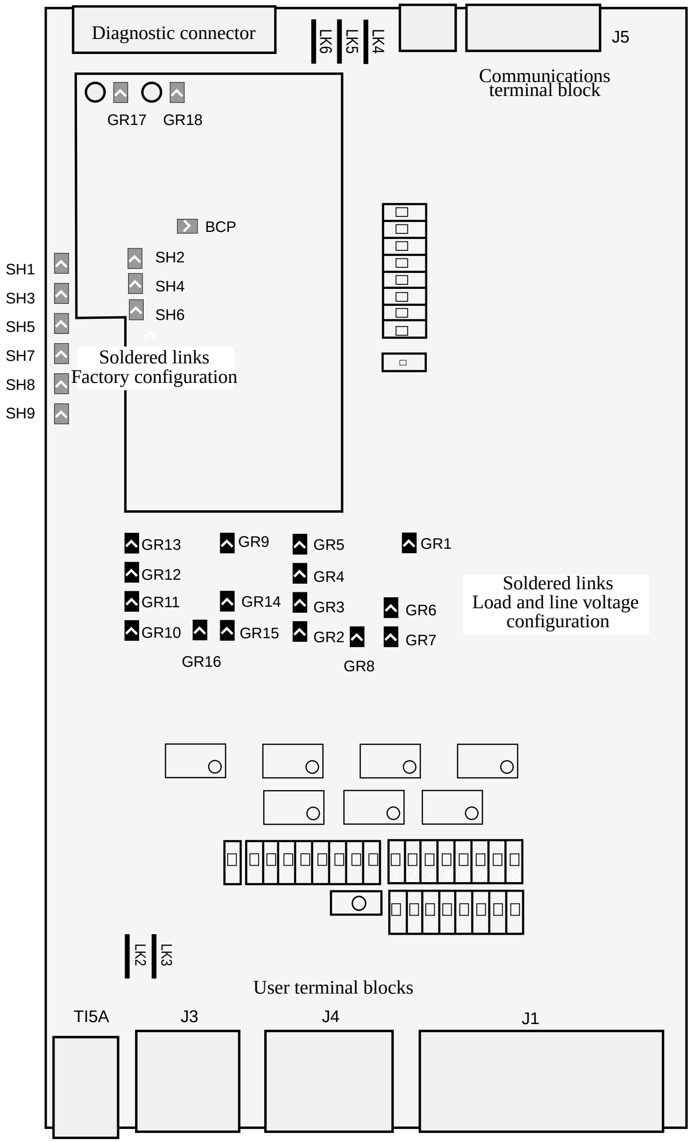


Figure 6-3 Location of soldered configuration links on driver board

DIGITAL COMMUNICATIONS (OPTION)

Configurations provided

Digital communications configuration consists of selecting:

· the operating mode (parameter type and configuration type)

· the controller address on the communications bus

· the transmission rate

· the type of communications protocol

· the default type.

Configuration is performed using mini-switches SW4 & SW6 (reached through the front panel by the configuration access door).

Configuration of the address, the protocol and the transmission rate can be checked on the display (see Chapter 7, 'Commissioning').

Note: The BCP soldered link (Figure 6-3) must never be soldered; it is reserved for future applications.

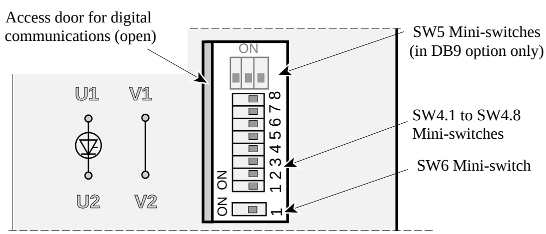


Figure 6-4 Location of mini-switches for communications configuration

Communications protocol

The type of communications protocol programmed into the unit microprocessor is determined when ordering. It is configured by the position of the SW3.7 mini-switch and by the presence of links LK4 to LK6 on the driver board (for layout see Figure 6-3).

Communications protocol	Position of SW3.7 mini-switch	LK4 to LK6 links
Modbus®	OFF	Present
Profibus-DP	ON	Absent

Table 6-10 Configuration of communications protocol

Operating mode

Mini-switch SW3.8 determines:

· the origin of the operating configuration (memory or mini-switches), and

· the type of various parameters (Read or Read/Write)

'Read' type (mnemonic: R/O) signifies:

read-only parameter values.

In Modbus® protocol, any attempt to modify the parameter values by digital communications causes the error code EE = 35 to appear.

'Read/Write' type (mnemonic: R/W) signifies:

read and modify parameter values by digital communications.

With SW3.8 in the ON position:

· all parameters are 'Read' type

· the operating configuration is defined by the mini-switches.

With SW3.8 in the OFF position:

· the following parameters:

SL, FS, CW, HS, CL, OS, OC & II

are 'Read/Write' type,

the other parameters are 'Read-only' type

· depending on the state of the 'A/C' input and the SW6 mini-switch, operating configuration is written in non-volatile memory or it is defined by mini-switches (see Table 6-12, page 6-15).

By default if the non-volatile memory is blank, the operating configuration used is that defined by the mini-switches.

The microprocessor loads the configuration as soon as the controller is switched on.

Transmission rate

Transmission rate	Position of SW4.8 mini-switch
Modbus® protocol:	
9.6kbaud	OFF
19.2kbaud	ON
Profibus-DP protocol:	
Automatic recognition up to 1.5Mbaud	OFF

Table 6-11 Configuration of transmission rate

Controller address

The user assigns one user address numbered 0 to 127 to each unit (addresses which are reserved for specific functions are described in Chapter 5, ‘Digital communications’).

Important!

As shipped from the factory, the configured address for the unit is 32.

This address may be reconfigured by the user.

Reconfiguration is performed using mini-switches SW4.1 to SW4.7, which can be reached through the access door for communications configuration (controller front panel).

The position of the mini-switches is related to the address, expressed in 7-bit binary.

When a bit value is 1, this signifies that the position of the corresponding mini-switch is set to ON.

Bit 0 corresponds to mini-switch SW4.1

Bit 6 corresponds to mini-switch SW4.7.

Example: The controller address is 92 in decimal (5C in hexadecimal).

Address 92 in 7-bit binary is:

1 0 1 1 1 0 0

Bit 6 (first digit) ... Bit 0 (last digit)

it is expressed by the positions of the corresponding mini-switches:

ON OFF ON ON ON OFF OFF

For this example, configuration of the SW4.1 to SW4.7 mini-switches is shown in the figure below.

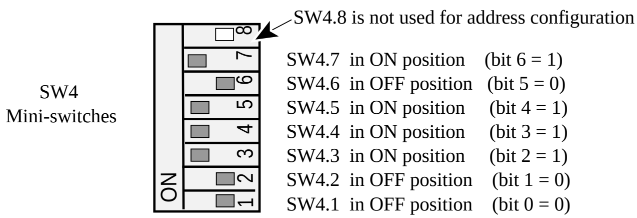


Figure 6-5 Example showing configuration of address 92

Setpoint type

Selection of the Analogue setpoint or the Digital setpoint is made using the input labelled ‘A/C’, terminal 25 on the Logic Signal terminal block.

If the ‘A/C’ input is connected to +5V: the active setpoint is Digital.

If the ‘A/C’ input is connected to 0V: the active setpoint is Analogue.

Default type

The operating default denotes the change when powered up of the setpoint type and/or the configuration type to those already established.

This change depends on the position of mini-switches SW3.8 and SW6 and the state of ‘A/C’.

Changes can occur either from the Digital setpoint to the established Analogue setpoint, or vice versa.

The following table shows the configuration modes and the possible operating default positions.

Paramerter type	Default configuration	Position of mini-switches		A/C input connected to	Setpoint active	Config. active
		WS3.8	SW6			
R/O	Mini-switches/ /Mini-switches	ON	ON	+5V	Digital	Mini-switches
				0V	Analogue	
R/W	Memory/ /Memory	OFF	OFF	+5V	Digital	Stored in memory
				0V	Analogue	
R/W	Memory/ /Mini-switches*	OFF	ON	+5V	Digital	Stored in memory
				0V	Analogue	Mini-switches

Table 6-12 Configuration mode

*) For this default configuration:

- If the controller is inhibited via digital communications at the time the Digital setpoint (configuration from memory) is changing to the Analogue setpoint (configuration by mini-switches), the controller is re-enabled and the alarms are reset.
- Current (voltage) limit only depends on the analogue limit input in cascade with the P1 potentiometer on the front panel.

Termination and polarisation resistors

In order to protect against possible line reflections, the bus must be fitted with termination resistors.

The communications bus must be terminated with an appropriate resistor at each end (on the receive conductors: Rx).

The resistor value depends on the characteristic impedance of the line (R = 120 to 220Ω).

Polarisation resistors are used to set the output condition of the receivers when at rest (no communications).

For termination and polarisation of the TE10P communications bus, three mini-switches SW5.1, SW5.2 and SW5.3 are provided to allow three internal resistors to be connected at the end of the bus.

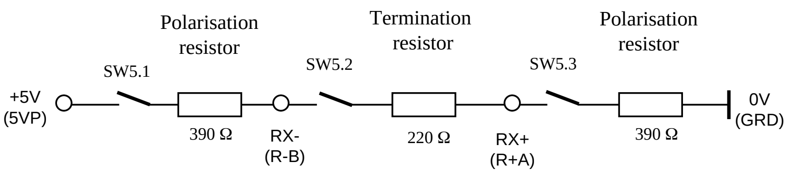


Figure 6-6 Internal connection diagram for termination and polarisation resistors

As shipped from the factory, mini-switches SW5.1 to SW5.3 are in the OFF setting.

WARNING

Warning!

- If a single TE10P controller is connected to the communications bus, set the SW5.1 to SW5.3 mini-switches to ON.
- If using multiple units on the same bus, mini-switches SW5.1, SW5.2 and SW5.3 must be:

  - in the ON setting for the last unit

  - in the OFF setting for the other units.

If the last unit is disconnected, reposition mini-switches SW5.1 to SW5.3.

For 16A to 100A rated units, the SW5 mini-switches are located on the top of the controller to the left of the COMMS (Digital communications) terminal block.

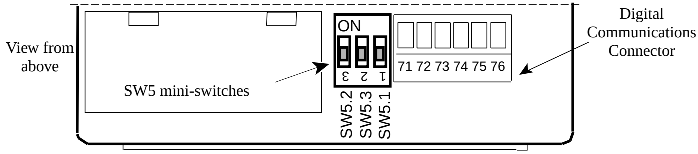


Figure 6-7 Location of resistor configuration mini-switches (16A to 100A)

For 125A to 400A rated units, the SW5 mini-switches are located on the upper part of the driver board, accessible with the front door of the unit open.

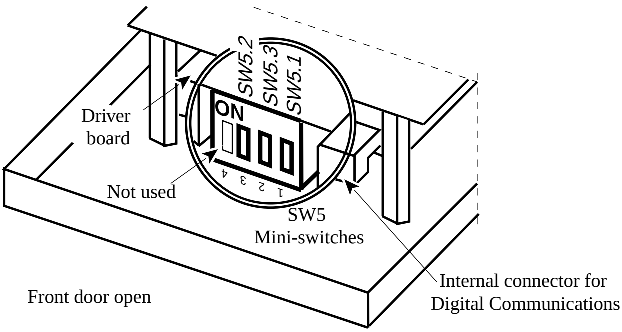


Figure 6-8 Location of resistor configuration mini-switches (125A to 400A)

If using the sub-miniature connector (DB9 option), the SW5 mini-switches may be reached through the access door irrespective of the unit rating.

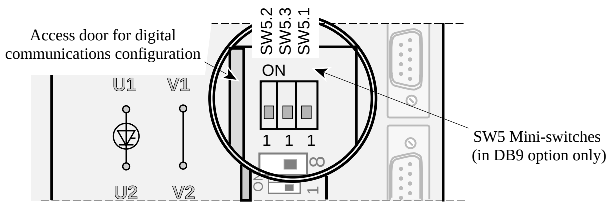


Figure 6-9 Location of resistor configuration mini-switches (DB9 option)

SUMMARY TABLE

The functions of all of the configuration elements (user mini-switches and soldered links on the driver board) are summarised in the following table:

Configuration element	Function	Refer to:
SW	Operation / calibration	Page 6-7
SW1.1, SW1.2, SW3.3	Analogue setpoint signal	Table 6-3
SW1.3 to SW1.5, SW3.4	Setpoint limit adjustment type	Table 6-6
SW1.6 to SW1.8, SW3.5	Current or voltage limit adjustment type	Table 6-5
SW2.1 to SW2.3	Thyristor firing mode	Table 6-1
SW2.4 and SW2.5	Limit action type	Table 6-4
SW2.6 to SW2.8	Feedback value	Table 6-2
SW3.1 and SW3.2	Load type	Table 6-7
SW3.6	Safety ramp	Page 6-7
SW3.7, LK4 to LK6	Communications protocol	Table 6-10
SW3.8	Parameter type (Read/Write or Read) and communications operating mode	Page 6-13
GR9 to GR16	Load operating voltage	Table 6-9
SW4.8	Transmission rate	Table 6-11
SW4.1 to SW4.7	Controller address on digital communications bus	Page 6-14
SW5	Digital communications termination and polarisation resistors	Page 6-16
SW6	Configuration origin, default type	Table 6-12
LK2 and LK3	Relay contact type	Table 6-8
GR1 to GR8	Supply operating voltage	Table 6-9

Table 6-13 Function of configuration elements

Chapter 7

COMMISSIONING PROCEDURE

Page

CHAPTER 7 COMMISSIONING PROCEDURE

COMMISSIONING PROCEDURE -SAFETY

Read this chapter carefully before commissioning the controller

WARNING

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

Danger!

The heatsink of units rated 125A to 400A is live when the controller is switched on.

For 125A to 400A rated units, live parts may be exposed when the door is open.

DANGER

Danger!

Only personnel trained and qualified 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.

DANGER

Danger!

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.

FLOWCHART OF COMMISSIONING PROCEDURE

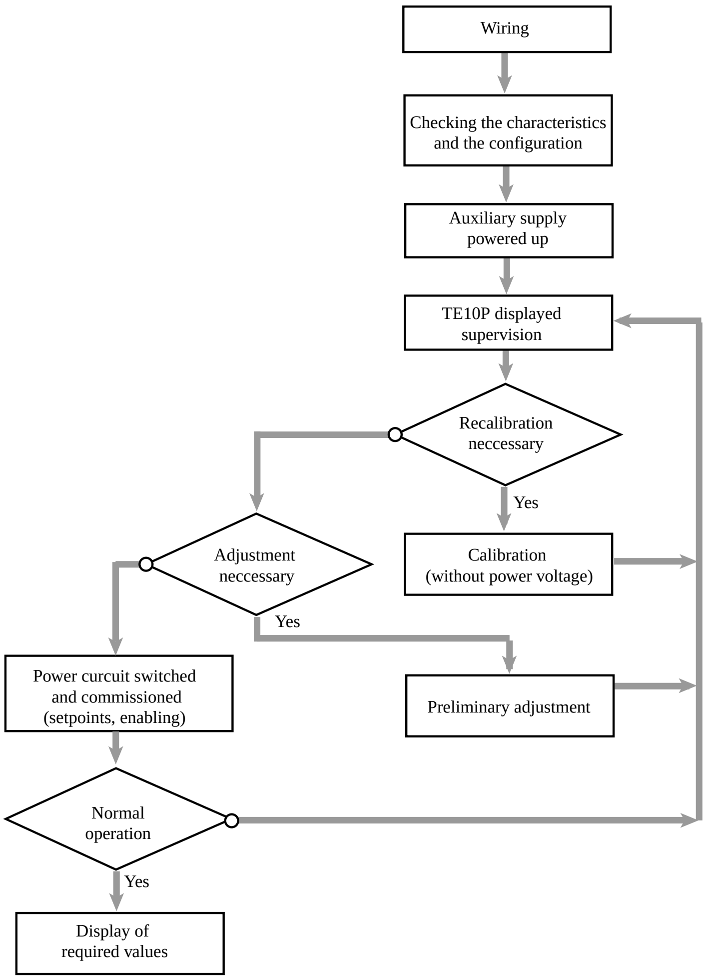


Figure 7-1 Flowchart of commissioning procedure

CHECKING THE CHARACTERISTICS

WARNING

Warning!

Before powering up the controller, make sure that the identification code on the controller complies with the product code specified when ordering and that the controller characteristics 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 unit, taking into account load and power supply variations.

Supply voltage

The nominal value of the TE10P controller voltage must be greater than or equal to the line-to-line voltage or line-to-neutral of the supply used (depending on the wiring diagram).

WARNING

Warning!

Never use a controller with a supply voltage greater than the value specified. This could damage the protective components and possibly the thyristors themselves.

With the 'Separate auxiliary power supply' option, never use a controller on a separate supply with a voltage greater than the value specified.

A controller may be used with a supply voltage less than the voltage specified for the controller, by reconfiguring it.

If the line voltage is less than 80% of the nominal voltage, the controller is inhibited (thyristor control removed) after 5 seconds of integration.

WARNING

Warning!

Given that inhibition occurs at 80% of nominal voltage, it is essential that the operating (calibration) voltage should be as close as possible to the nominal supply voltage used.

Fan supply voltage

TE10P controllers rated from 125A are fan-cooled.

The fans are single voltage and can be supplied by:

- 115Vac or
- 230Vac.

Selection of this voltage is made at the factory, depending on the product code.

The supply voltage used for the fan must be compatible with one of the above fan voltages.

Separate electronics supply voltage

Depending on the product code, the electronics are internally supplied or can be supplied separately from the power by:

- 115Vac or
- 230Vac.

The electronics supply voltage, shown on the controller identification label, should be compatible with the mains voltage.

Digital communications (option)

The protocol and the digital communications parameters must correspond to the product codes (see Chapter 5, ‘Digital communications’).

The controller address, which should be unique to the System used, must be correctly defined.

Active configuration and type of communications parameters

Check the position of mini-switch SW3.8 which determines:

- active configuration, defined by mini-switches and ‘Read’ type of parameters, or
- active configuration in non-volatile memory and ‘Read/Write’ type of digital communications parameters.

Analogue inputs

Configuration of the mini-switches must be compatible with the levels selected for the analogue signals used for:

- remote analogue setpoint
- analogue setpoint limit
- current or voltage limit signal.

Load type

To ensure correct controller operation, check that the load type used is properly configured using the mini-switches.

CHECKING THE WIRING

Qualifications, safety earth, supply voltage isolation

Danger!

DANGER

Wiring checks must be carried out by personnel 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.
Check that a suitable device ensuring electrical isolation between the equipment and the supply is installed upstream in order to permit safe maintenance.

Danger!

DANGER

Before checking the wiring, make sure that power and control cables or leads are isolated from voltage sources.
Make sure that the safety earth is connected to the earthing screw on the controller.

Reminder: For units rated from 16A to 100A, the safety earthing screw is located below the unit.
For units rated from 125A to 400A, the screw is located behind the supply phase terminal.

Power and analogue signal wiring

Check:

- that the power cabling follows the wiring diagram (Figure 3-1 for 16A to 100A rated units or Figure 3-2 for 125A to 400A units)
- the fan supply wiring (for fan-cooled units from 125A to 400A)
- the supply reference voltage wiring (for 125A to 400A rated units)
- the analogue signal wiring (setpoints, limits and retransmission option)
- the digital communications bus wiring (option).

Logic signal and configuration connections

Make sure that:

- the enable input (terminal 23 on the Logic Signal terminal block: 'ENA') is properly connected directly, or by means of closed contacts, to '5V' (terminal 22 on the same terminal block) or to an external +5V, referenced to the '0V' (terminal 21)
- the setpoint type select input 'A/C' is connected according to the setpoint used (analogue or digital communications, see Figure 3-10)
- the alarm logic reset input 'ACK' (terminal 24) is disconnected from the 5V terminal to display any alarms after the installation has been commissioned
- the SW mini-switch is in the correct operating position (OFF).

Check the configuration of the current (or voltage) limit (or limit absence) and the analogue limit signal.

DISPLAY MESSAGES

Display

A four-digit, seven segment green display enables the operating parameters, the configuration and the alarm messages to be shown on the front panel.

The display message sequence may be scrolled by using the display push button (BPA), fitted on the front panel.

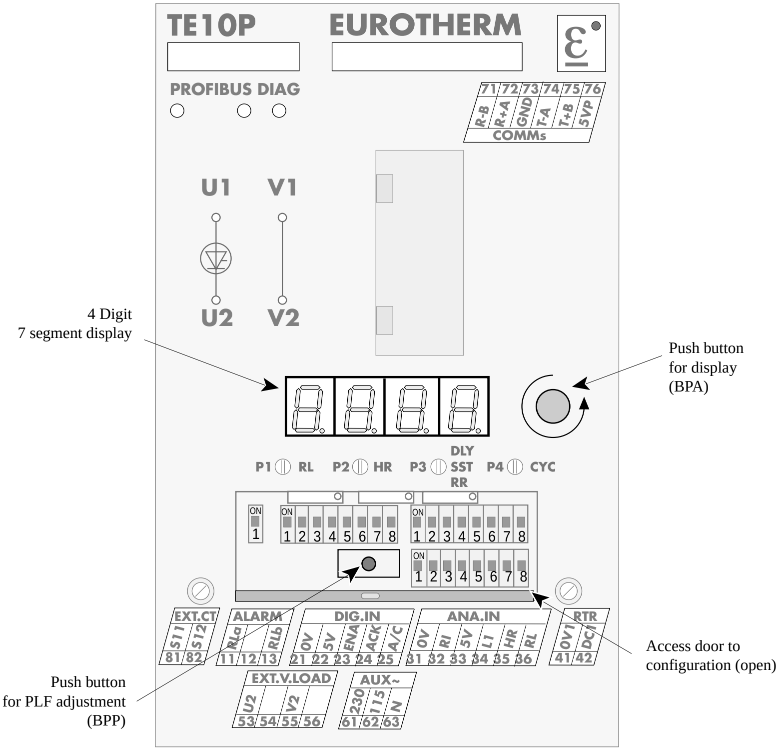


Figure 7-2 Location of display and push buttons on the front panel

General organisation of display messages

Normally, after the controller commissioning procedure and while it is operating, display messages correspond to parameter values.

Two types of action are provided using the BPA button to view the display sequence:

- a short push on BPA (less than 0.5s) shows the parameter name of the value being displayed
  (after a one second delay, the display returns to the value of the parameter)
- a long push on BPA (more than 1s) moves the display on to the next parameter name in the display sequence.

The display parameters are scrolled in one direction, making a loop between the first and last parameters.

The complete parameter viewing sequence is shown in Figures 7-4 to 7-10. Each Figure is devoted to one part of the whole sequence, i.e. a group (or groups) of parameters.

The previous and following parameters are also shown to enable the user to follow the viewing sequence.

Priority messages providing information on alarms and load failure detection adjustment state can interrupt the set viewing order of the parameters and their values (see general message flowchart in Figure 7-3).

- One push of the PLF button (BPP) interrupts the normal message sequence to display data on the state of adjustment (adjustment or non-adjustment) of load failure detection (for details see Figure 7-7).
- If there is an alarm, the priority message with the code for the alarm detected appears on the display.

If there are several simultaneous alarms, a single message will be displayed depending on the alarm handling hierarchy (for details see Figure 7-6).

One push of BPA enables the user to return to the parameter message being viewed.

If BPA is not pushed within 50s, an alarm code message is displayed.

WARNING

Warning!

Alarm messages are not displayed in calibration mode.

The calibration position is indicated by one of the controller operating state messages (see Figure 7-8).

Key to display push button (BPA) operation :

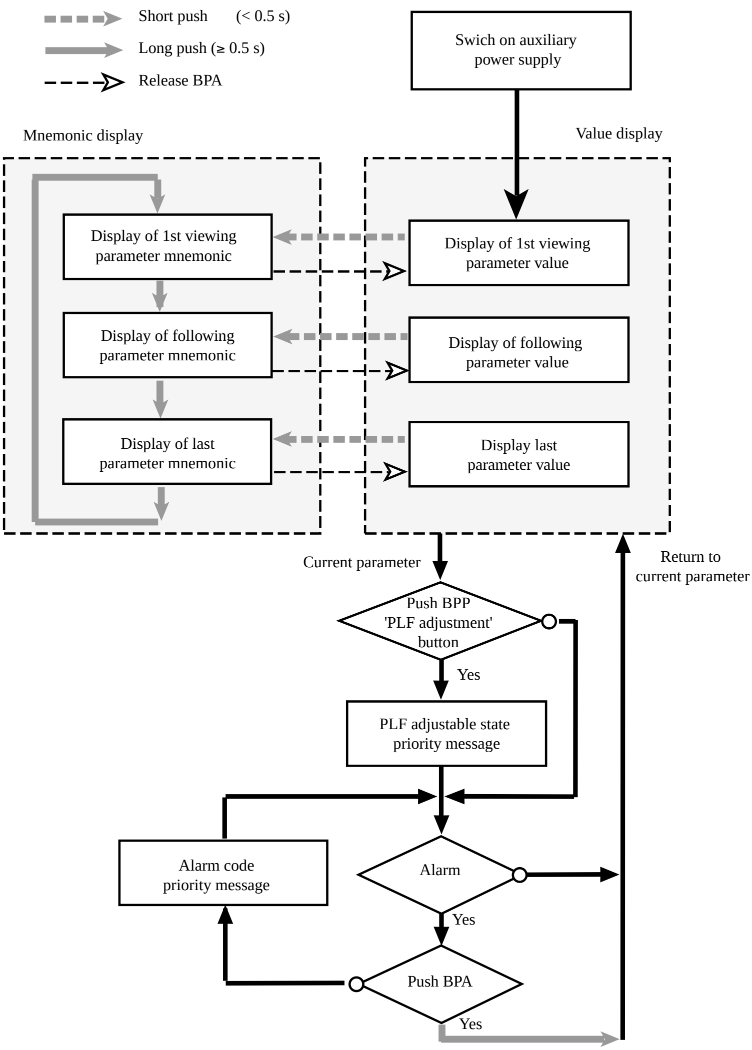


Figure 7-3 General flowchart of display messages

Display messages

Display messages give the user all the necessary data on the state of:

- the controller
- the thyristor firing mode configuration
- the ramp or soft start configuration
- all the operating parameter values
- the mains parameter values
- the input signal setpoints
- the current (or voltage) limit
- the high level and low level alarms
- the PLF adjustment
- inhibition or enable of the controller
- various adjustments and calibration
- the logic inputs
- the digital communications parameters (option).

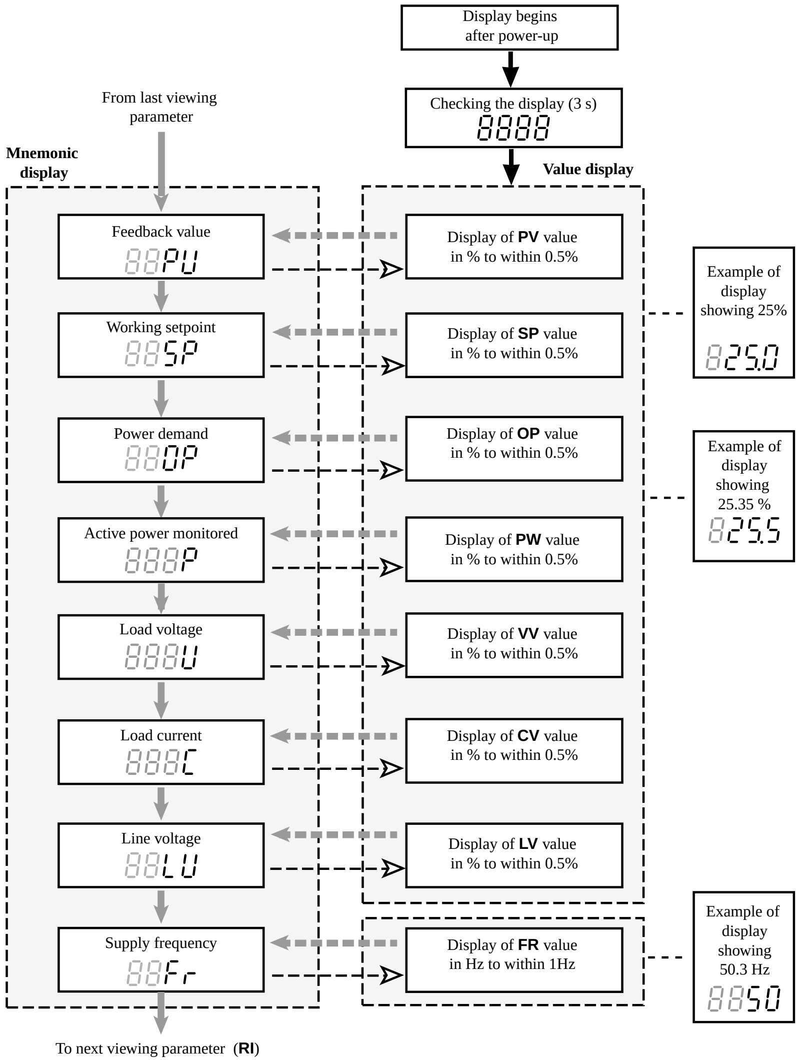


Figure 7-4 Display message sequence (electrical parameters)

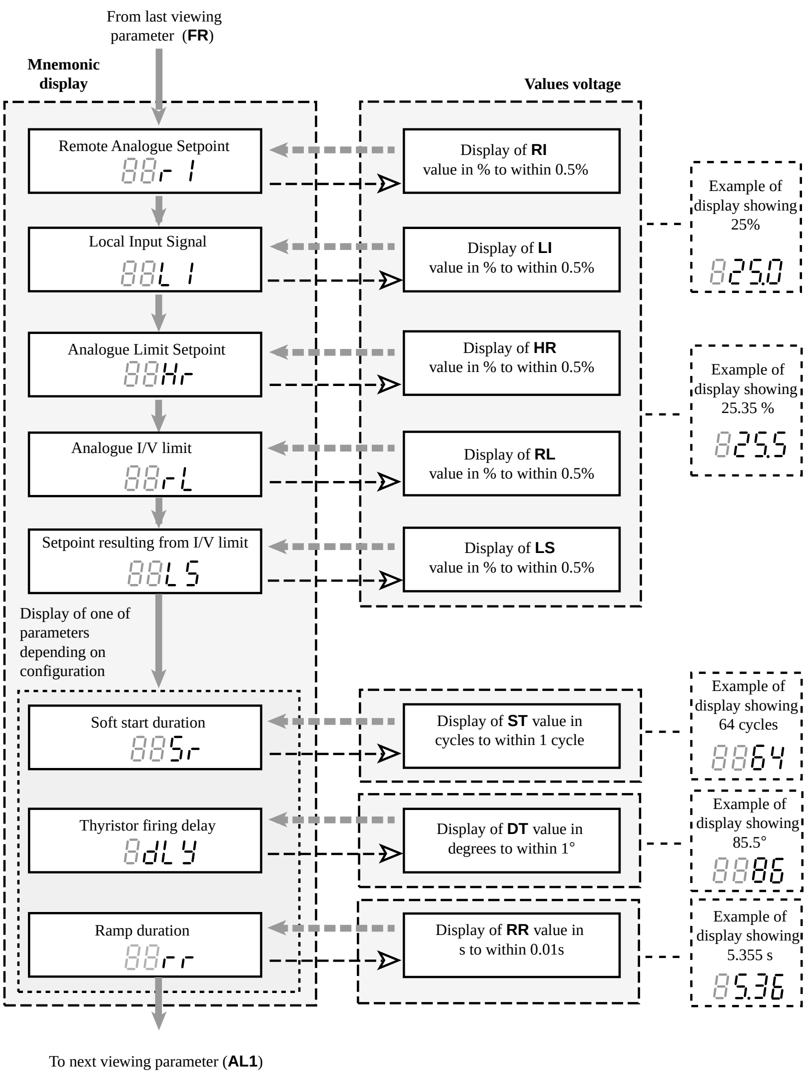


Figure 7-5 Display message sequence (setpoints, limit, adjustment)

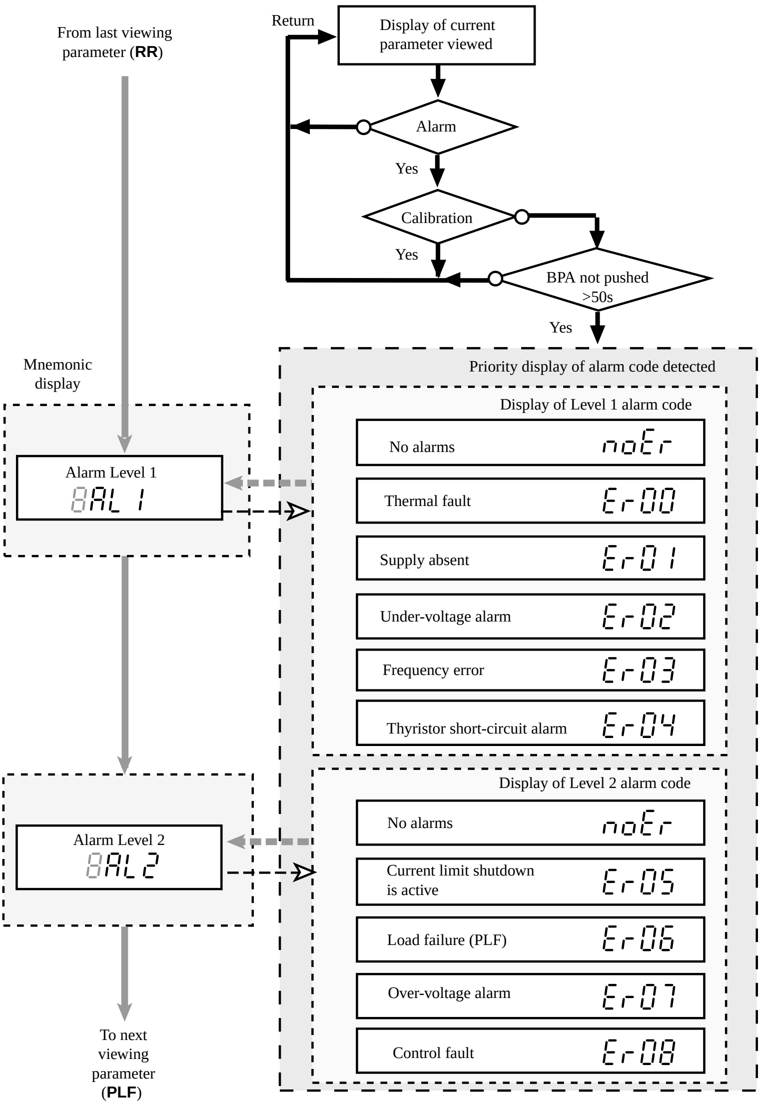


Figure 7-6 Alarm message sequence

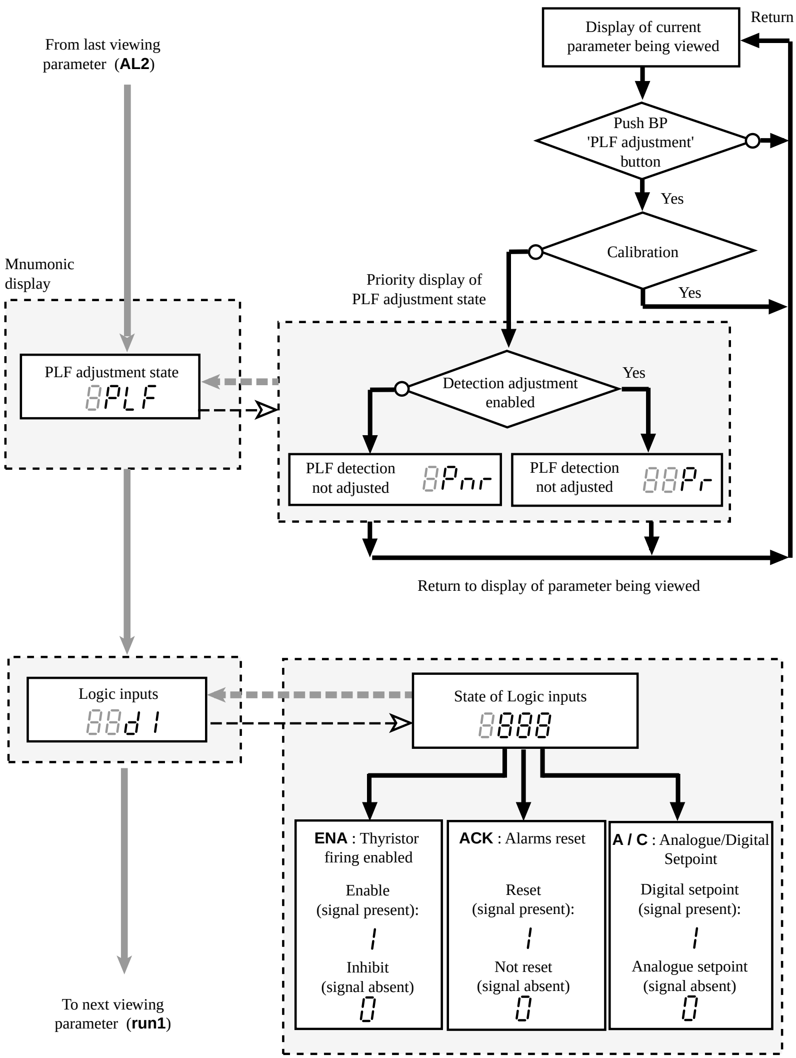


Figure 7-7 Controller state display message sequence

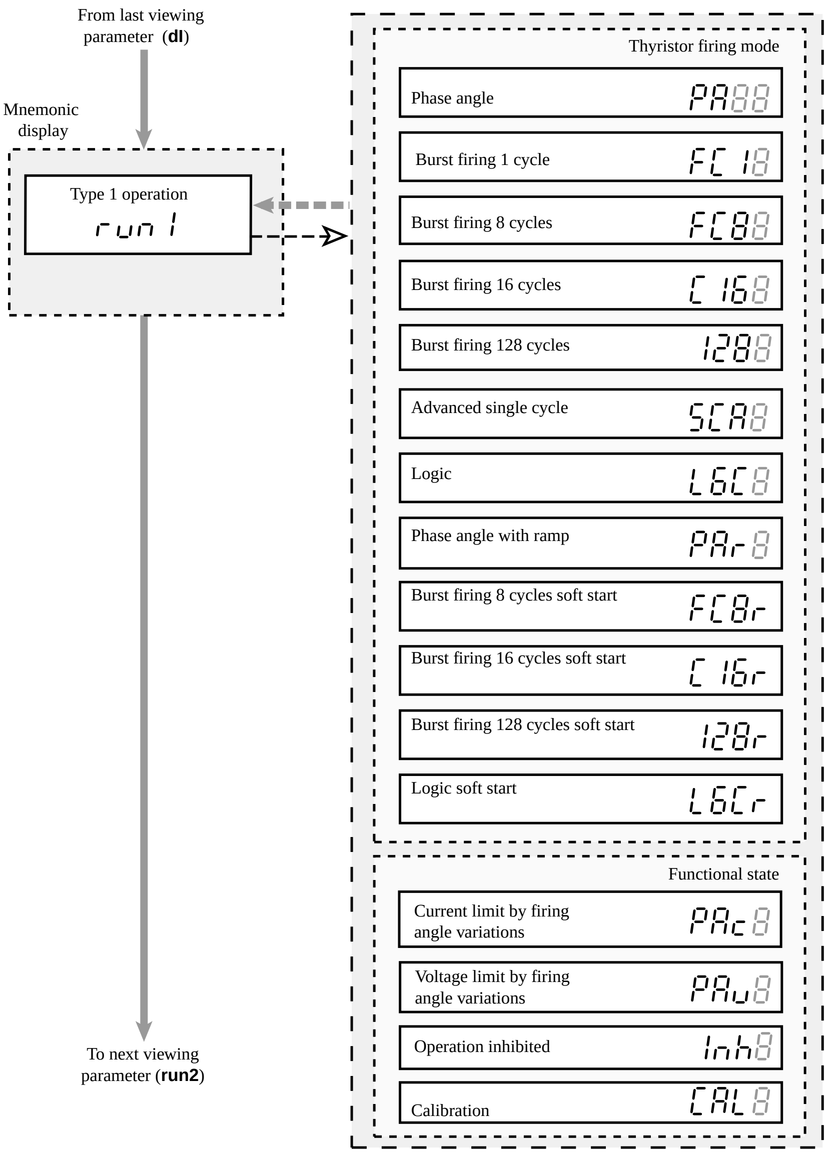


Figure 7-8 First sequence of operating messages

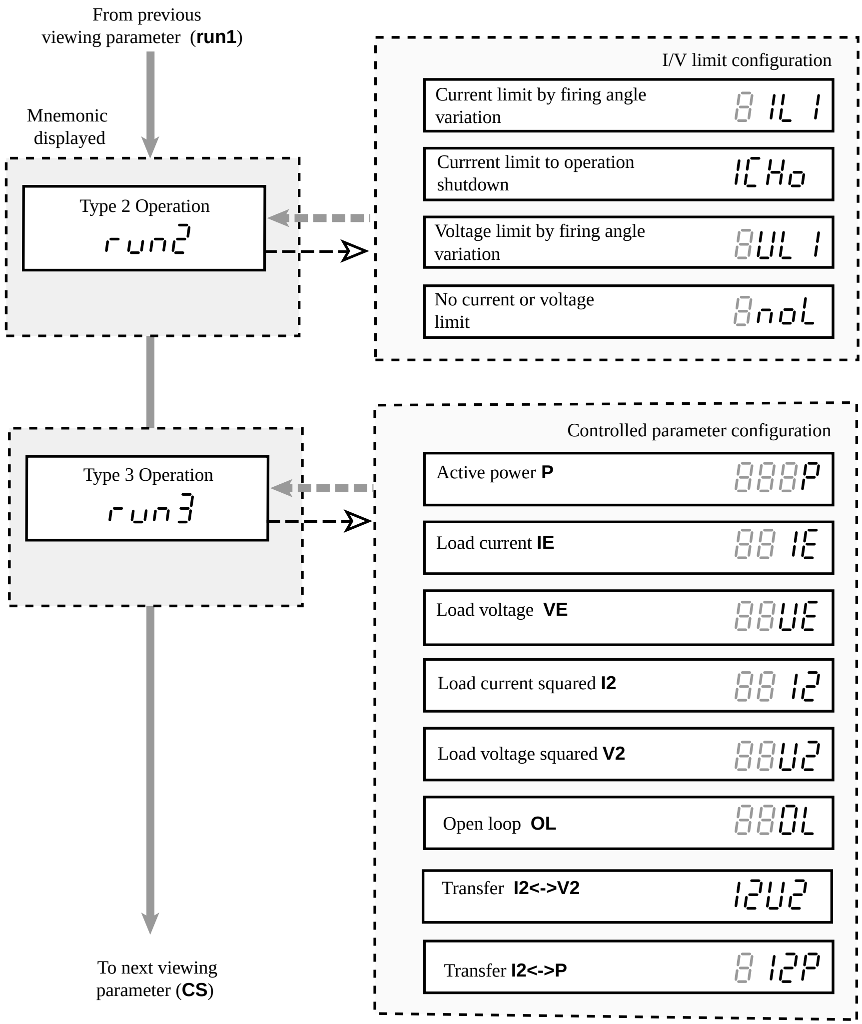


Figure 7-9 Second and third sequences of operating messages

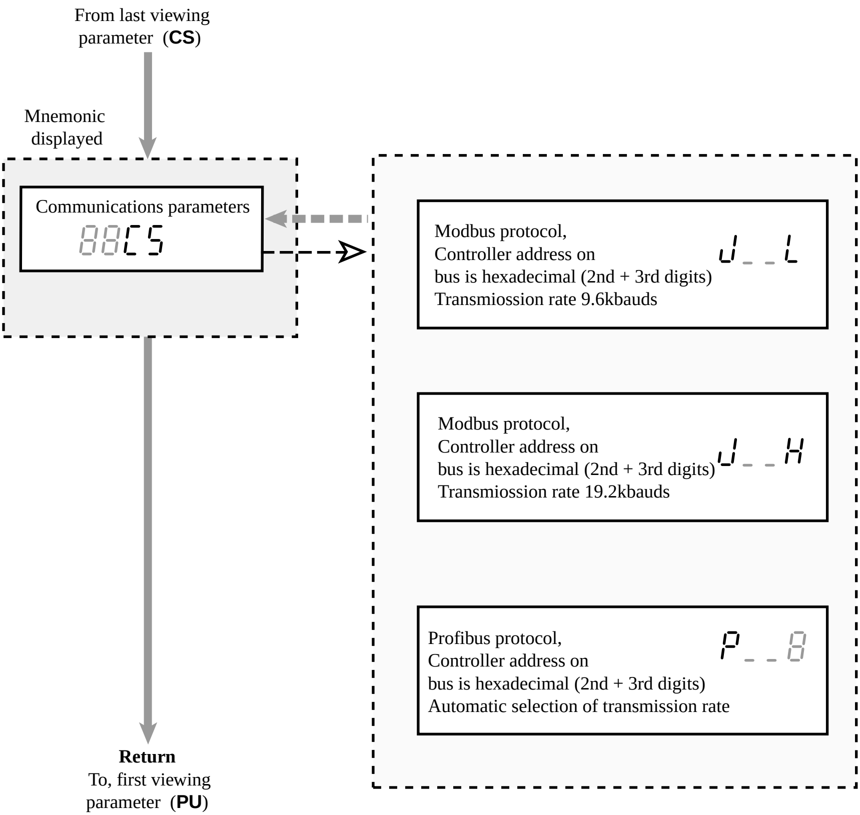


Figure 7-10 Communications parameter message sequence

CONTROLLER RE-CALIBRATION

Conditions for re-calibration

The controller is re-calibrated so that the maximum value of the configured input signal scale corresponds to the nominal values of the specific load current and voltage.
Three potentiometers (labelled P5 to P7) are used to re-calibrate the controller.
The calibration potentiometers can be reached through the configuration access door.
Each potentiometer can be adjusted by 25 turns.

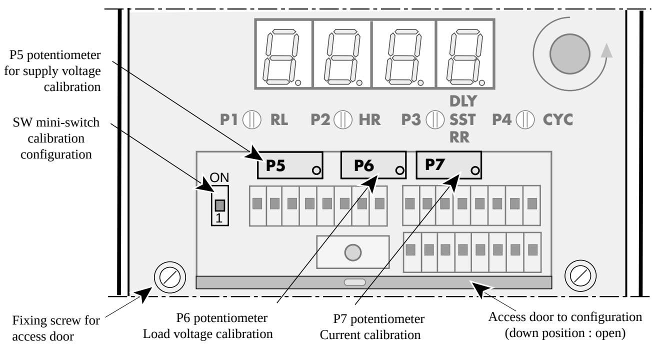


Figure 7-11 Location of calibration potentiometers

The calibration procedure is performed at the factory according to the product code.

It is the user's responsibility to re-calibrate the unit if the actual current, load and line voltage values are substantially different to the nominal values of the controller (IN and VN).

Warning!

Re-calibration is only possible under the following conditions:
· the nominal load current I_{NC} is:

$75\%\ I_N \le I_{NC} \le 100\%\ I_N$

· the nominal load voltage V_{NC} (or supply V) is:

$75\%\ V_N \le V_{NC}$ (or V) $\le 110\%\ V_N$ (separate power supply) or

$85\%\ V_N \le V_{NC}$ (or V) $\le 110\%\ V_N$ (self-supplied)

If this does not apply, please contact your nearest Eurotherm office.

The re-calibration procedure and accurate readings of the calibrated values must be performed using:

- the TE10P controller display, or
- a Eurotherm type 260 diagnostic unit (for maintenance purposes).

Two calibration modes

There are two possible re-calibration modes, depending on the position of the SW mini-switch (reached through the access door):

- non-firing re-calibration
- full firing calibration (sinusoidal current operation).

Re-calibration of the controller load voltage and current, if performed during non-firing, does not require the installation to be operating under nominal conditions and can be performed without the power circuit voltage being present.

WARNING

Warning!

Once non-firing calibrations have been performed, the SW calibration mini-switch must be re-set to the operating position (OFF).

Full firing calibration (sinusoidal current operation) is performed if it is necessary to fine-tune or re-adjust calibration during controller operation.

In this case, the SW mini-switch must be left in the operating position (OFF).

As shipped from the factory, the calibration signals are adjusted for the nominal voltage and current specified when ordering the controller.

This is why the re-calibration procedure is optional; it is only to be performed when the nominal load voltage and current may have changed.

WARNING

Important!

If the value is calibrated to the nominal value of the controller, the corresponding reading

- on the controller display is 100%
- on the diagnostic unit is equal to the typical value in volts (see Table 9-1).

Re-calibration using the TE10P controller display, described in this chapter, may be used when the installation is commissioned.

Re-calibration using the Eurotherm type 260 diagnostic unit is described in Chapter 9, ‘Maintenance’.

When re-calibration has been performed, it acts equally on the isolated re-transmission signals (option) and on the negative feedback signal (controlled parameter) selected for the control algorithm.

Load current re-calibration

Re-calibration during non-firing

Set the SW mini-switch to the calibration position (ON).

Using the display button (BPA) on the controller front panel, scroll down the message sequence until the run 1 message appears (operating type).

Release BPA; the CAL (calibration) message now appears on the controller display.

Calculate the value of the current re-calibration CALI using the following equation:

$$CAL_I = \frac{I_{LN}}{I_{UN}} \text{ x } 100\%$$

where I_{UN} → nominal thyristor unit current (see product code or identification label)

I_{LN} → nominal current of load used.

Using BPA, display the message C (current)

Turning the current calibration potentiometer (P7), display the calculated value of the CALI(%)

Reset the SW mini-switch to the operating position (OFF).

Example

Nominal current of unit I_{UN} = 80A
Nominal load current I_{LN} = 70A

The current re-calibration equation is: $CAL_I = \frac{70}{80} \text{ x } 100\% = 87.5\%$

Turn the P7 potentiometer to display the value 087.5 on the controller display in the calibration position (the SW mini-switch is in the ON position).

To verify the re-calibration performed, check that when fully firing (SW in OFF position and C message displayed), the value of the current displayed is 100.0 (100% of nominal current).

Re-calibration during firing

To fine-tune or re-adjust calibration during controller operation:

- set the SW mini-switch to the OFF position
- using BPA (long pushes) scroll down the message sequence until the message C appears
- release BPA
- in sinusoidal current operation, the current value displayed must be 100.0 (100% of nominal current).

If not, current re-calibration during full firing can be performed using the P7 potentiometer, to obtain a 100.0 display.

Load voltage re-calibration

Re-calibration during non-firing

Set the SW mini-switch to the calibration position (ON).

Using the display button (BPA) on the controller front panel, scroll down the message sequence until the run 1 message appears (operating type).

Release BPA; the CAL (calibration) message now appears on the controller display.

Calculate the value of the load voltage re-calibration CAL_V using the following equation:

$$CAL_V = \frac{V_L}{V_{UN}} \times 100\%$$

where V_{UN} → nominal unit voltage (see product code or identification label)
V_{LN} → nominal voltage of load used.

Using BPA, display the message V (volts)

Turning the load voltage calibration potentiometer (P6), display the calculated value of the CALV (%).

Reset the SW mini-switch to the operating position (OFF).

Example

Nominal voltage of unit V_{UN} = 230V

Nominal load voltage V_{LN} = 220V

The voltage re-calibration equation is: $CAL_V = \frac{220}{230} \times 100\% = 95.65\%$

Turn the P6 potentiometer to display the value 95.5 on the controller display in the calibration position (the SW mini-switch is in the ON position).

To verify the re-calibration performed, check that when fully firing (SW in OFF position and V message displayed), the value of the load voltage displayed is 100.0 (100% of nominal voltage).

Re-calibration during firing

To fine-tune or re-adjust the load voltage calibration during operation:

- set the SW mini-switch to the OFF position
- using BPA (long pushes) scroll down the message sequence until the message V appears
- release BPA
- in full-firing (sinusoidal load voltage operation), the value displayed must be 100.0 (100% of nominal voltage).

If not, voltage re-calibration during full firing can be performed using the P6 potentiometer, to obtain a 100.0 display.

Line voltage re-calibration

To re-calibrate the line voltage, the power voltage must be present.

Turning potentiometer P5, display the value:

100.0

which signifies 100% of the controller nominal voltage.

This adjustment can be made:

- during calibration (SW in ON position), or
- during operation (SW in OFF position).

In calibration, the message CAL appears in the run1 parameter.

The message LU (line voltage, mnemonic: LV) should be found in the electrical parameters in the display sequence.

Reset the SW mini-switch to the operating position (OFF) if it was previously in the calibration position (ON).

PRELIMINARY ADJUSTMENTS

During preliminary adjustments, before the thyristor unit power is switched on, the following four potentiometers:

- potentiometer P1 ‘Current (or voltage) limit’
- potentiometer P2 ‘Analogue setpoint limit’
- potentiometer P3 ‘Ramp, soft start and firing delay duration’
- potentiometer P4 ‘Base time’ (Burst-firing cycle time)

must be set in the initial position, depending on the client configuration (see product code) and the operating mode.

The potentiometers have an adjustment range of 25 turns.

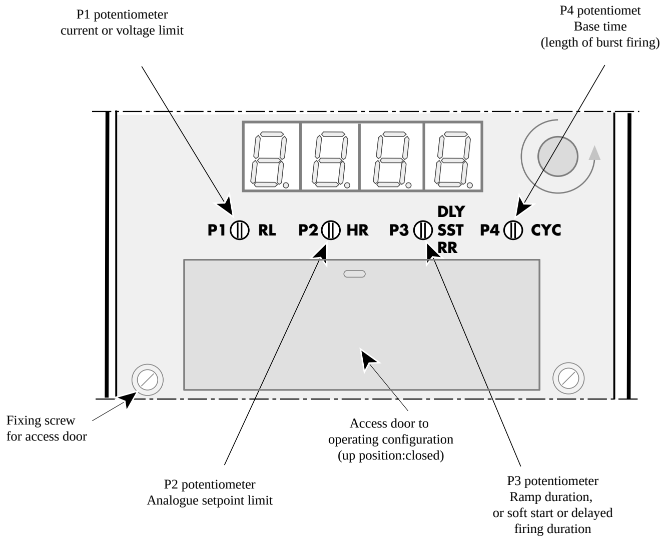


Figure 7-12 Layout of adjustment potentiometers

Potentiometer P1

Potentiometer P1, labelled RL on the front panel, is used to adjust (alone or in cascade with the analogue signal) the analogue current or voltage limit threshold.

Select the limit action threshold value (setpoint resulting from current or voltage limit, mnemonic: LS).

If necessary, read the paragraph ‘Current or voltage limit’ in Chapter 4, ‘Operation’.

Check the value of the analogue limit signal at the analogue input RL; to do this, using the display button BPA scroll down the display sequence until the message rL appears (see Figure 7-5).

Release BPA; the value of RL will be displayed in % to within 0.5%.

Press BPA to display the next message (LS).

Release BPA to display the value of LS in % to within 0.5%.

Turn the P1 potentiometer to adjust the resulting current (voltage) limit threshold.

To increase the limit threshold, potentiometer P1 must be turned clockwise.

If the digital communications option has been selected, adjustment of the digital current or voltage limit parameter (mnemonic: CL) must be taken into account (see Chapter 5, ‘Digital communications’).

Example

Nominal current of unit	$I_{UN} = 80A$
Limit threshold of load current permitted	$I_{L.MAX} = 60A$
Value of setpoint resulting from limit	$LS = \frac{60}{80} \times 100 = 75\%$

Turn the P1 potentiometer to display the value
075.0 (BPA is released)

when the message mnemonic is
LS (BPA is pressed).

Potentiometer P2

Potentiometer P2, labelled HR on the front panel, is used to adjust linearly (alone or in cascade with the analogue signal) the analogue setpoint limit.

Select the setpoint limit value (mnemonic: HR).

If necessary, read the paragraph ‘Setpoint limit’ in Chapter 4, ‘Operation’.

Check the value of the analogue setpoint limit signal at the HR input; to do this, using the display button BPA scroll down the display sequence until the message Hr appears (see Figure 7-5).

Release BPA; the value of HR will be displayed in % to within 0.5%.

If necessary turn the P2 potentiometer to adjust the analogue setpoint limit value to the desired ratio.

To decrease the ratio between the analogue setpoint and the working setpoint, potentiometer P2 must be turned anti-clockwise.

If the digital communications option has been selected, the digital setpoint limit parameter (mnemonic: HS) must be adjusted via digital communications (see Chapter 5 ‘Digital communications’).

Example

The analogue setpoint limit (HR) is selected to be 80%.

For this limit, adjust potentiometer P2 until the value of HR is displayed as 080.0.

For the resulting analogue setpoint (RI + LI) to equal (for example) 60%, the working setpoint (mnemonic: SP) will be adjusted, taking the limit into account, to:

$$SP = \frac{(RI + LI) \times HR}{100} = \frac{60 \times 80}{100} = 48\%$$

Potentiometer P3

Potentiometer P3, labelled DLY / SST / RR on the front panel, is used to adjust:

- ramp duration
- soft start
- initial firing delay,

depending on the firing mode configured.

Firing mode			Functions of P3 potentiometer		
Name of mode	**Code**	**Display**	**Parameter adjusted**	**Mnemonic**	**Display**
Phase angle with ramp	PA/URP	PAr	Ramp duration	RR	rr
Logic and Soft start	LGC/URP	LGCr	Duration of soft start	ST	Sr
Burst-firing and soft start	FC8/URP C16/URP 128/URP	FC8r C16r 128r			
Burst-firing	FC8 C16 128	FC8 C16 128	Delayed first firing	DT	dLY
Logic	LGC	LGC			
Single-cycle	FC1	FC1			
Advanced single-cycle	SCA	SCA	No action		

Table 7-1 Functions of P3 potentiometer

Ramp duration can be adjusted:
from 0s (P3 is turned fully anti-clockwise)
to 65.025s (P3 is turned fully clockwise).

Display of the value RR is in seconds to within 0.255s

Soft start duration can be adjusted to one of the values provided:
0 (P3 is turned fully anti-clockwise)
8, 16, 32,
64 (P3 is turned fully clockwise).

Display of the value ST is in cycles.

Delay in first firing can be adjusted:
from 0 (P3 is turned fully anti-clockwise)
to 90((P3 is turned fully clockwise)

Display of the value DT is in degrees.

To display the value of one of the adjustment parameters, scroll down the display sequence using BPA until the message rr, Sr or dLY appears (depending on the firing mode configured).

Release BPA; the corresponding value will be displayed.

Potentiometer P4

The P4 potentiometer is used to adjust Base Time (T_B) in ‘Burst-firing’ and ‘Burst-firing with soft start’ firing modes.

Reminder:

Base time equals the number of firing cycles at 50% duty cycle ((see Chapter 4, ‘Operation’).

Potentiometer P4 is labelled CYC on the front panel.

Check that the ‘Burst-firing’ or ‘Burst-firing with soft start’ firing mode and the desired base time are configured.

To do this using BPA, scroll down the display sequence until the message run1 appears.

Release BPA; one of the following messages should be displayed:

FC1	FC8	C16	128
FC8r	C16r	128r	

which corresponds to the product code (not re-configured).

Base time duration can be adjusted:

from one cycle (P4 is turned fully anti-clockwise)

to 128 cycles (P4 is turned fully clockwise).

within the limit of the four values provided:

1, 8, 16 or 128 cycles.

To increase base time (within the base times provided), turn potentiometer P4 clockwise.

To decrease base time, turn potentiometer P4 anti-clockwise.

WARNING

Important!

For firing with soft start, adjusting the base time to one cycle using potentiometer P4 causes soft start to disappear (which is not possible in Single-cycle, code FC1).

Thus, adjustment using P4 takes priority over the mode configured.

POWERING UP

Auxiliary power supply

The separate supply for the electronics (if selected) and the fan supply (fan-cooled units) should be switched on before, or at the same time as, the power circuit.

WARNING

Warning!

If the separate control supply is applied before the power voltage, the 'Supply absent' alarm is displayed.

If the control electronics is self-supplied from the power circuit, it does not require a separate power-up.

Firing mode

The thyristor firing mode at first power-up depends on the configuration

Start using configuration by mini-switches

- use without digital communications or with communications in Read mode (SW3.8 is in the ON position)
- use with digital communications in Read / Write (SW3.8 in the OFF position), the default type selected is 'By mini-switches' (SW6 is in the ON position) and
- the setpoint selected is analogue (A/C input is connected to 0V).

Start using configuration programmed in non-volatile memory

- use with digital communications in Read / Write (SW3.8 is in the OFF position), the default type selected is 'In memory' (SW6 is in the OFF position)
- use with digital communications in Read / Write (SW3.8 is in the OFF position), the default type selected is 'By mini-switches' (SW6 is in the ON position) and the setpoint selected is digital (A/C input is connected to +5V).

For the configuration programmed into the memory, the firing mode can be modified by digital communications; the mini-switch configuration is ignored.

Safety ramp

The controller starts up with a safety ramp (except in Advanced single-cycle) provided that:

- it is configured (SW3.6 is in the ON position), or
- limit by firing angle variation is configured.

This safety ramp is applied when starting:

- at controller power-up
- after an absence in power demand longer than 5s
- after inhibition due to:
  - break in the relevant logic signal
  - a command via digital communications, or
  - a high level alarm.

After a voltage break, the controller retains the firing mode that was active in its memory before the break.

ANALOGUE SETPOINT

Switch on the controller.

Check that the load current is equal is to 0 in the absence of a control signal.

If necessary, adjust:

- supply voltage calibration (P5 potentiometer)
- load current or voltage limit (P1 potentiometer)
- setpoint limit (P2 potentiometer).

Apply a control signal to the input:

- terminal 32, labelled RI, if remote setpoint, or
- terminal 34, labelled LI, if local setpoint (manual input).

The control signal can be read in % on the controller front panel display (if necessary, see paragraph 'Display', page 7-7).

Check (using the display, or by means of an rms current ammeter) that the load current goes up when the following are increased:

- the input signal, or
- the P2 adjustment potentiometer for analogue setpoint limit (to increase, turn clockwise).

The resulting control signal (input signal together with setpoint limit) may be read on the display by scrolling down until the message SP (which corresponds to the parameter 'Working setpoint') is visible.

Data on the rms load current (in % of the current calibrated) is provided on the display (by scrolling down the menu until the message C appears).

Make sure that the current does not exceed the nominal controller current when the setpoint is 100% and that the limit potentiometers P1 & P2 are turned fully clockwise.

WARNING

Important!

If the current does not correspond to the analogue setpoint when P1 & P2 potentiometer signals are 100%, re-adjust the current calibration (see 'Re-calibration' paragraph).

Data on the load current is also provided on the diagnostic unit (see Chapter 9, 'Maintenance).

Digital setpoint (option)

Switch the controller on (refer to Chapter 5, 'Digital communications' beforehand).

Make sure, by reading the status word, the controller configuration corresponds to the product code.

Transmit the digital setpoint SL = 0% via digital communications to the controller address and check that the load current is equal to 0.

Read the supply voltage and, if necessary, adjust the supply voltage calibration using potentiometer P5 to obtain LV = 100%.

Transmit via digital communications, the selected values of:

- the digital current/voltage limit (mnemonic;CL), and
- the digital setpoint limit(mnemonic:HS)

Check that the current and the parameter CV are responding in relation to parameters SL and HS.

Measure the current (C on display or rms current ammeter).

Make sure that the rms current does not exceed the nominal controller current when the parameters:

SL, LS and HS are 100%

and when the limit potentiometer P1 is turned fully clockwise.

If the current does not correspond to the digital setpoint SL, when the parameter LS and potentiometer P1 settings are 100%, readjust the current calibration.

Delayed firing adjustment for inductive load

To eliminate transient over-currents in operation during power-up of inductive loads, the initial firing in 'Burst-firing' and 'Logic' modes must be delayed with reference to the corresponding zero voltage (see Chapter 4, 'Operation').

The optimum delay angle for initial thyristor firing depends on the load used and can be adjusted using potentiometer P3.

For the preliminary start adjustment with an inductive load, the recommended delay angle is 90° (potentiometer P3 turned fully clockwise).

To fine-tune the delay angle during commissioning, follow the procedure below:

- connect an oscilloscope to display the transient current
- after power-up, slowly turn potentiometer P3 anti-clockwise until the transient current at firing, displayed on the oscilloscope, has a minimum amplitude.

Data on the delayed firing angle is provided in the message dLY on the display and can be read via digital communications in parameter DT.

Chapter 8

ALARMS

Page

CHAPTER 8 ALARMS

SAFETY DEVICES

The alarms used for the TE10P controller protect the thyristors and the load against abnormal operation and give the user data on the type of faults that have occurred.

DANGER

Danger!

Alarms cannot be used as a replacement for personnel protection systems.

It is the user's responsibility, and it is highly recommended, given the value of the equipment controlled by the TE10P, that independent safety devices, which should be tested regularly must be installed.

Eurotherm can supply various types of safety systems for this purpose.

ALARM STRATEGY

Alarms are prioritised. The treatment of alarms follows a pre-established order, which is shown on the flowchart in Figure 8-1.

The highest level alarm is 'Supply absent', which takes priority over all other alarms.

If the following alarms:

- Thermal fault
- Voltage faults (under and over-voltage)
- Thyristor short-circuit
- Load failure

are detected, they do not interrupt the processing of other alarms.

The other alarms do interrupt the processing of lower level alarms defined in the flowchart, Figure 8-1.

Active alarms (or absence of alarms) are shown on the display in the order given in Figure 7-6 (sequence of alarm messages) and in the summary table of alarm displays (Table 8-1).

If several alarms have arisen simultaneously, a single message appears in the display order.

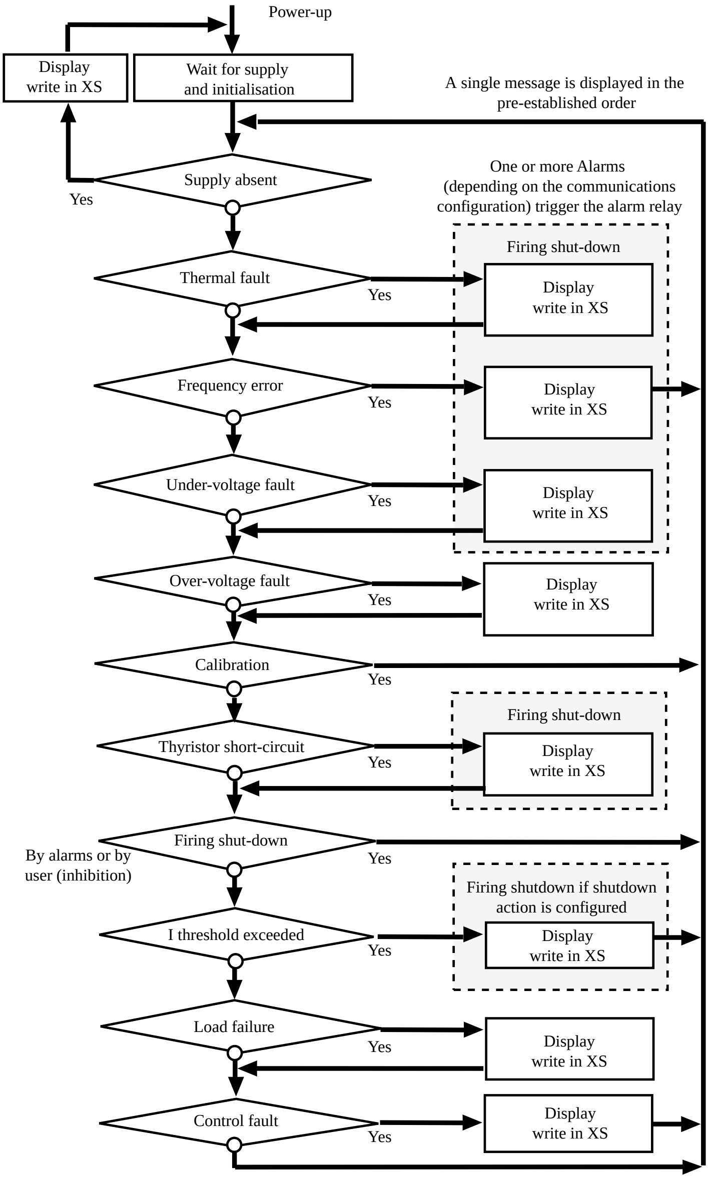


Figure 8-1 General flowchart of Alarm management

ALARM LEVELS

Depending on their actions, two types of alarm are provided:

- high level alarms, which if detected, cause the controller to stop firing
- low level alarms, which if detected, do not stop controller firing;
- the user can choose whether these alarms are active or not.

High level alarms detect the following faults:

- absence of power voltage
- thermal fault (fan-cooled units)
- supply frequency outside operating limits
- under-voltage
- thyristor short-circuit
- current threshold exceeded
  (if firing shutdown action has been configured).

Low level alarms monitor:

- over-voltage
- load failure (partial or total)
- control fault.

ALARM TRANSMISSION

TE10P controller alarms are managed entirely by the microprocessor on the driver board, which re-transmits its data (alarms active or not) using:

- the display on the controller front panel
- the alarm relay
- digital communications (if option present).

Display

Displaying active alarm messages takes priority over other messages. If an alarm is detected and calibration mode is not selected, the alarm code is displayed.

If several alarms have arisen simultaneously, a single message appears in the pre-established order of display (see table below, or the alarm message sequence in Figure 7-6).

Alarm codes are grouped into two message viewing parameters:

- AL1 : Level 1 alarms (high level)
- AL2 : Level 2 alarms (low level).

Irrespective of the alarm level and the controller configuration, it is possible to see the alarm state by displaying parameter AL1 or AL2 via manual selection.

As soon as code AL1 or AL2 has appeared, release the push button; the first of the alarm codes detected is displayed (see also alarm message sequence in Figure 7-6).

Summary: Two types of input are provided to display the state of alarms:|

- priority message of active alarms, and
- manual inspection of parameters AL1 and AL2.

Parameter to be viewed	**Level**	**Type of alarm**	**Display code**	**Order of appearance on display**	
AL1	-	No alarm	noEr	-	1
	High	Thermal fault	Er00	1	2
		Absence of power voltage	Er01	2	3
		Under-voltage	Er02	3	4
		Frequency error	Er03	4	5
		Thyristor short-circuit	Er04	5	6
AL2	High	I limit if shutdown action is configured	Er05	6	2
	-	No alarm	noEr	-	1
	Low	Load failure	Er06	7	3
		Over-voltage	Er07	8	4
		Control fault	Er08	9	5

Table 8-1 Alarm messages

Alarm relay

The alarm relay is de-activated in alarm state or when the controller is switched off.

The contacts (open in alarm or closed in alarm, depending on the product code) are provided between terminals 11 & 13 of ‘ALARM’ terminal block (labelled: ‘RLa’ & ‘RLb’).
These contacts can be used to indicate the alarm state.
The breaking capacity of the contacts is 0.25A (250Vac or 30Vdc maximum).

In the standard version, without digital communications, the Alarm Relay is activated by all the active alarms.

When using digital communications (option), by default the alarm relay is activated by all the active alarms.

Nevertheless, the relay action can be programmed via digital communications to react only to those alarms (or alarm) selected.

Programming the Alarm Relay is performed by a Write operation to the Alarm Relay control word (mnemonic: OC).
The function of the OC bits corresponds to that of the alarm status word XS (see Figure 5-3, page 5-8).

Bits set to 1 program the relay to be active through the corresponding alarm.
Bits set to 0 do not activate the relay despite the active state of the corresponding alarm.

The XS bits that do not correspond to alarms have no significance for OC.

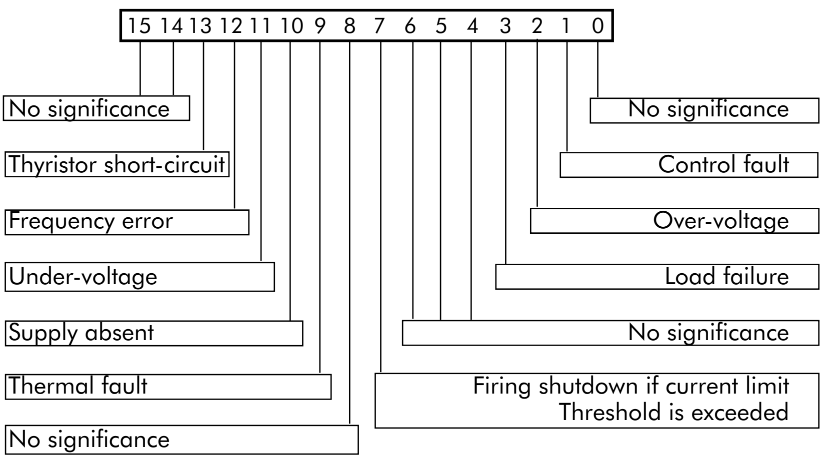


Figure 8-2 Function of Alarm Relay control word bits (mnemonic: OC)

Digital communications (option)

If digital communications are used, data on the state of all the alarms is provided in the Alarm status word (mnemonic: XS).

The location of the Alarm status word bits is shown in Figure 5-3.

An active alarm state is indicated in the alarm status word by the value 1 of the corresponding bit. Unlike the display, the Alarm status word contains, simultaneously, data on the state of all active alarms.

Three of the eight Alarm status word low order bits (bits 1 to 3) correspond to alarms which do not cause firing shutdown (Low level alarms).

Bit 7 corresponds to current limit, which reacts differently depending on the configuration.

Only current limit with firing shutdown action configured is considered as an alarm (High level alarm) and affects bit 7.

Limit by firing angle variation is a form of control and is not considered as an alarm.

Five of the eight Alarm status word high order bits correspond to High level alarms which shut down controller firing.

The following table gives a summary of the links between the alarms and the Alarm status word bit numbers (see also Chapter 5, ‘Digital communications’).

Alarm status word bit number XS	**Type of alarm**	**Alarm level**
1 2 3	Control fault Over-voltage Load failure	Low (does not cause firing shutdown)
7	Current limit active	No alarm (if action by angle variation)
		High (if action by firing shutdown)
9 10 11 12 13	Thermal fault Supply absent Under-voltage Frequency error Thyristor short-circuit	High (stops firing)

Table 8-2 Alarm status word bits (mnemonic: XS)

Reminder: The ‘Alarm Status Word’ parameter also contains data on:

- the state of voltage limit by angle reduction (bit 6)
- the controller operation enable or inhibit (bits 14 & 15) by means of the logic input ENA or digital communications.
- the calibration or normal controller operation (bit 8)
- the state of the ramp in ‘Phase angle’ firing mode (bit 0).

ALARM LATCHING AND RESETTING

The following alarms enable the controller to return to normal operation automatically and to restart (in the case of High level alarms) after the alarm has cleared:

- Supply absent
- Thermal fault
- Frequency error
- Under-voltage
- Over-voltage.

The following alarms are latched and need to be reset:

- Thyristor short-circuit
- Current threshold exceeded
- Load failure with dynamic adjustment

Latched alarms can be reset:

- using the logic signal
  (connect terminal 24 ‘ACK’ to terminal 22 ‘5V’ on the ‘DIG.IN’ Logic Signal terminal block)
- via digital communications (transmit code 04 of the control word CW)
- by switching off the controller (or the auxiliary power supply).

The following alarms:

- Load failure with static adjustment
- Control fault

are not latched but it is possible to force them to reset (as described above).

WARNING

Warning!

If the reset contacts are permanently closed between terminal 24 ‘ACK’ and terminal 22 ‘5V’, the alarm strategy is defeated.

HIGH LEVEL ALARMS

Supply absent

The 'Supply absent' alarm takes priority over all other alarms.

Before the power voltage is present, the other alarms are not processed. The controller is in the Wait for supply mode, which is indicated by:

- the message Er01 displayed on the front panel
- the state of bit 10 of the Alarm status word (which is equal to 1) in digital communications option
- deactivation of the alarm relay (standard version)

Absence of the supply prevents the thyristors conducting current. As soon as the power voltage is present, data on voltage and frequency values will be initialised and the alarm system moves on to other processing.

The 'Supply absent' alarm is not latched and does not require resetting.

Thermal fault

Thermal monitoring of fan-cooled controllers is provided by a thermal switch.

For controllers rated 125A to 400A, the thermal switch is opened if the heatsink temperature is higher than 115°C and closes again if the heatsink temperature drops below 100°C.

Opening the thermal switch causes:

- thyristor firing shutdown
- display of priority message Er00 on the front panel
- bit 9 of the Alarm status word to be set to 1 in the digital communications option
- deactivation of the alarm relay (standard version).

This alarm is not latched and disappears as soon as the thermal switch returns to its normal position. Thermal fault detection does not interrupt the processing sequence of other alarms defined in the controller alarm strategy (see Figure 8-1).

Under-voltage alarm

If the voltage drops by more than 20% relative to the calibrated value, the 'Under-voltage fault' alarm is detected which:

- shuts down thyristor firing
- displays the message Er02 on the front panel
  (if the 'Thermal' and 'Frequency' alarms are not displayed)
- sets bit 11 of the Alarm Status word to 1 in the digital communications option
- deactivates the alarm relay (standard version).

This alarm is not latched and as soon as the nominal voltage returns to more than 85%, the controller restarts automatically (with bit 11 of the XS reset to 0).

Detection of 'Under-voltage' does not interrupt the processing sequence of other alarms defined in the controller alarm strategy (see Figure 8-1).

Frequency error

If the supply frequency is outside normal operating limits (40 to 70Hz) the ‘Frequency error’’ alarm is detected which:

- shuts down thyristor firing
- displays the message Er03 on the front panel
  (if higher level alarms within the hierarchy are not displayed)
- sets bit 12 of the Alarm Status word to 1 in the digital communications option
- deactivates the alarm relay (standard version).

This alarm is not latched and disappears as soon as the supply frequency returns to within normal operating limits.

Detection of a frequency error does not interrupt the processing sequence of other alarms defined in the controller alarm strategy (see Figure 8-1).

Thyristor short-circuit

Thyristor short-circuit detection is active if:

- the measured current is greater than 25% of the load current calibrated, and the thyristor firing demand is zero.

If a thyristor short-circuit is detected, the corresponding alarm:

- cancels the thyristor firing order
  (request for firing shutdown, not possible given the short-circuit)
- displays the message Er04 on the front panel
  (if higher level alarms within the hierarchy are not displayed, see Figure 8-1)
- sets bit 13 of the Alarm Status word to 1 in the digital communications option
- deactivates the alarm relay (standard version).

This alarm is latched. To deactivate this alarm and restart the controller, the alarm must be reset (using a logic signal or via digital communications), or the power switched off.

Detection of thyristor short-circuit does not interrupt the processing sequence of other alarms (defined in the controller alarm strategy, see Figure 8-1).

Current (voltage) limit threshold exceeded

If the current threshold is exceeded, two types of action are possible:

- firing shutdown (considered as an alarm)
- decrease in firing angle (considered as the limiting method).

Data on the type of action when the threshold is exceeded are provided:

- on the front panel display, and
- by the state of bits 3 & 4 of the instrument status word (mnemonic: SW), in the digital communications option

If the current limit action by shutdown is selected, the value of the operating message run2 is: ICHo.

If current (voltage) limit action by firing angle variation is selected, the value of the run2 message is: ILI (current limit/control) or ULI (voltage limit/control).

The threshold of the active limit state is set:

- using the P1 potentiometer on the front panel, or
- using an analogue limit setpoint (in cascade with P1), or
- via digital communications (option).

Firing shutdown if current threshold exceeded

If current limit action by firing shutdown is selected, it triggers a high level alarm.

When the rms load current value exceeds the pre-set threshold by 10%, this alarm:

- shuts down thyristor firing after 5 cycles of firing in over-current within 5s
- displays the message Er05 on the front panel (if higher level alarms within the hierarchy are not displayed, see Figure 8-1)
- sets bit 7 of the Alarm Status word to 1 in the digital communications option
- deactivates the alarm relay (standard version).

After firing shutdown, the controller may only be re-started if the alarm has been re-set (using a logic signal or via digital communications) or after the power has been switched off.

Firing angle variation if current (voltage) exceeded

If current (voltage) limit action by firing angle variation is selected, it operates as a control function: it is not an alarm.

When the rms load current (or voltage) value exceeds the pre-set threshold:

- thyristor firing decreases (in order to maintain the maximum current or voltage value less than or equal to the limit threshold)
- bit 6 of the Alarm Status word is set to 1 (in the digital communications option) if the voltage threshold is exceeded.
- bit 7 of the Alarm Status word is set to 1 (in the digital communications option) if the current threshold is exceeded.

LOW LEVEL ALARMS

Detection of low level alarms:

- displays the corresponding message on the front panel (if higher level alarms within the hierarchy are not displayed, see Figure 8-1)
- deactivates the alarm relay (standard version).
- sets the corresponding bit of the Alarm status word to 1 in the digital communications option.

Low level alarms do not shut down controller firing.

If the unit returns to non-alarm state, the alarm message disappears. The alarm relay is reset to non-alarm state (if it was deactivated in the standard version or by choice) and the corresponding bit of the alarm status word is reset to 0.

Over-voltage fault

If the supply voltage becomes more than 12% greater than the nominal controller voltage (calibration voltage), the 'Over-voltage' alarm is triggered, which,

- displays the message Er07 on the front panel
- (if higher level alarms within the hierarchy are not displayed, see Figure 8-1)
- sets bit 2 of the Alarm Status word to 1 in the digital communications option
- deactivates the alarm relay (by default, in the standard version).

If over-voltage occurs, controller firing is not shut down; control action keeps the feedback parameter value constant for a given operating point.

If the unit returns to a voltage less than or equal to 110% of the nominal controller voltage, the Er07 message disappears. The alarm relay is reset to non-alarm state (if it was deactivated) and bit 2 of the alarm status word XS is reset to 0.

Control fault

The 'Control fault' alarm is considered active if:

- the initial thyristor firing demand, mnemonic: OP, is 100% (which corresponds to full firing) and if
- the gap between the working setpoint (SP) and the feedback value (PV) is greater than 10%.

If these conditions are detected:

- the message Er08 is displayed on the front panel (if higher level alarms within the hierarchy are not displayed, see Figure 8-1)
- bit 1 of the Alarm Status word is set to 1 in the digital communications option
- the alarm relay is deactivated (in the standard version).

If a 'Control fault' alarm occurs, controller firing is not shut down.
A return to normal conditions causes the Er08 message to disappear, resets the alarm relay in non-alarm state (if it was deactivated) and resets bit 1 of the alarm status word XS to 0.

Load failure

The ‘Load Failure’ alarm detects an abnormal increase in load impedance, which may have as its cause partial or total failure of parallel-wired load elements.

The mnemonic for this alarm is: PLF (Partial Load Failure).

The PLF detection circuit continuously measures the rms voltage at the load terminals and the rms load current. The impedance, estimated from the values measured in this way is compared with the value of the Reference Impedance, calculated from the voltage and current defined during the adjustment sequence.

This comparison makes it possible to detect an increase in load impedance.

The PLF detection circuit is matched to the load. Selection of the load type is performed according to the product code using mini-switches SW3.1 and SW3.2 (see Table 6-7).

The TE10P controller has two types of PLF detection depending on the load type:

- Static detection (Static adjustment) used for resistive loads and short-wave infrared elements, load codes: LTCL, HTCL and SWIR
- Dynamic detection (Dynamic adjustment) used for loads that are variable as a function of time and/or temperature, load code: TTDL.

Data on the type of load configured (and, as a result, the type of PLF detection) is provided in the digital communications option by the state of bits 8 & 9 of the instrument status word.

WARNING

Warning!

Detection of ‘Load Failure’ is only possible if the load voltage is greater than 30% of the nominal voltage. In addition, for dynamic detection, current (or voltage) limit must not be active.

If load failure is detected:

- the priority message Er06 is displayed on the front panel
  (if higher level alarms within the hierarchy are not displayed, see Figure 8-1)
- bit 3 of the Alarm Status word is set to 1 in the digital communications option
- the alarm relay is deactivated (in the standard version).

Load failure detection sensitivity

The sensitivity of load failure detection may be defined as the maximum number of load elements configured in parallel for which the failure of one can still be detected by the PLF circuit.

The ‘Load Failure’ alarm detects the failure of one in six elements mounted in parallel.

This sensitivity is equivalent to an increase in load impedance of 20% compared to the Reference Impedance.

Static adjustment of load failure detection (resistive load or short-wave infrared elements)

Static adjustment consists of an automatic calculation and storage of the Reference Impedance as a result of an adjustment order made by the user.

Warning!

WARNING

PLF adjustment is only possible if the following conditions are met:

the nominal controller current is greater than 30% of the nominal load current

the load voltage is greater than 30% of the nominal load voltage.

It is highly recommended that the controller calibration should be checked and re-calibrated, if necessary.

Before static adjustment of load failure detection, it is advisable that the controller should be in a nominal operation mode so that PLF detection sensitivity will be most discriminating.

For static adjustment of PLF detection:

- push the PLF static adjustment button (BPP) located behind the access door, or transmit the code 05 in the Control word to the controller address in the digital communications option.
- check that the message Pr (PLF adjusted) is displayed or, in the digital communications option, that bit 10 of the instrument status word is set to 1.

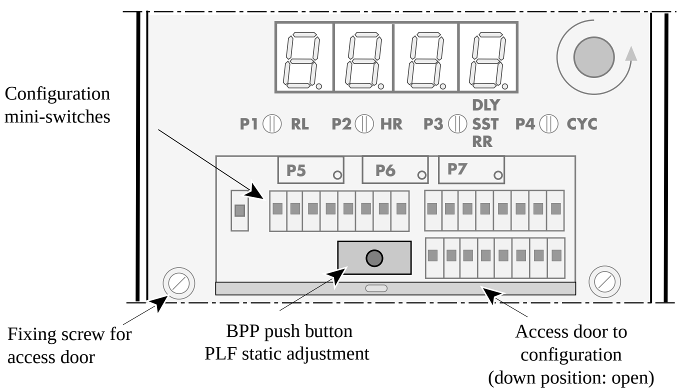


Figure 8-3 Location of PLF static adjustment button (BPP)

Warning!

WARNING

Static detection of partial load failure cannot function unless the PLF detection adjustment has been made or if the adjustment was made outside conditions indicated for adjustment.

Detection of total load failure remains possible even if PLF detection is not adjusted.

Messages relating to the state of detection adjustment (Pr & Pnr) have priority after pushing BPP (provided that the controller is not in calibration mode).

The state of load failure detection adjustment can also be displayed by the message provided in the PLF viewing parameter, the value of which is Pr or Pnr (see Figure 7-7).

If the message is Pnr (PLF not adjusted) the detection circuit has not been able to set up a PLF value due to unsatisfactory adjustment conditions.

If this happens, check that the load current and voltage values are greater than 30% of the nominal value, and restart adjustment.

The value of the load failure detection static adjustment (Reference Impedance) is stored in non-volatile memory.

If the non-volatile memory is not initialised, no impedance value will have been stored. In the event of non-initialisation or corruption of the non-volatile memory, irrespective of the cause, partial load failure detection will not be adjusted.

In this case, the priority display and the PLF viewing parameter display is: Pnr.

Warning!

WARNING

If the controller calibration is modified, PLF detection adjustment must be made again.

The ‘Load Failure with Static Adjustment’ alarm is not latched.

This alarm disappears if:

- the fault clears, or
- another PLF static adjustment is initiated.

If the fault persists, the alarm returns.

Nevertheless, a reset of the PLF alarm with static adjustment can be forced before the fault has cleared:

- by transmitting a logic signal on the ACK input, or
- by transmitting the code 04 to the control word (in the digital communications option).

Dynamic adjustment of load failure detection (load variable as a function of time and/or temperature)

For various loads whose value changes:

- with time (example: variation through ageing), and/or
- as a result of temperature (example: Graphite, Silicon carbide)

load monitoring with static adjustment cannot be used.

An increase in impedance can arise from the normal behaviour of the load and not from a fault.

As a result, load monitoring must use dynamic adjustment.

Configuration of the load type (see Table 6-7) using mini-switches SW3.1 and SW3.2 determines the application of dynamic adjustment.

WARNING

Warning!

Dynamic adjustment is possible if load current and voltage are greater than 30% of the nominal and if current (or voltage) limit is not active.

To perform dynamic adjustment, the load failure detection circuit re-calculates the impedance from time to time. This impedance is known as the Reference Impedance (Z_R).

The value of Z_R is compared to the load impedance value Z, calculated periodically from rms voltage and current measurements.

From time to time, the dynamic load failure detection circuit calculates the load impedance variation ΔZ compared to the previous cycle's impedance:

$$\Delta Z = [Z_R - Z]$$

If the impedance variation ΔZ is greater than a pre-defined value, the Reference Impedance remains unchanged and the increase in impedance is considered to be a fault.

In this way load failure is detected.

The state of PLF dynamic detection adjustment can be displayed using the message provided, i.e.:

Pr : Load failure detection adjusted (automatic dynamic adjustment)
Pnr : Load failure detection not adjusted (conditions for adjustment not met).

The load failure with dynamic adjustment alarm is latched.

It is reset:

- using a logic signal on the ACK input, or
- by transmitting the code 04 (in the digital communications option) of the Control word.

The alarm can not be reset when power is not available (Er01 display).

SUMMARY OF ALARM CHARACTERISTICS

The following table (Table 8-3) summarises:

- main characteristics of all TE10P controller alarms
- conditions for alarm and non-alarm state
- display messages
- alarm actions (firing shutdown or not)
- necessity for alarm reset
- bit numbers of alarm status word (digital communications option) equal to 1 in event of corresponding alarm
- bit numbers of alarm relay control word (digital communications option) for programming alarm relay.

In this table, the following abbreviations are used:

V_{LINE} - line-to-line voltage

V_N - nominal line voltage (after re-calibration)

V_L - rms load voltage

V_{LN} - nominal load voltage (after re-calibration)

V_{LIM} - voltage limit (voltage limit threshold depending on resulting setpoint)

I_L - rms load current

I_{LN} - nominal load current (after calibration)

I_{LIM} - current limit (current limit threshold depending on resulting setpoint)

f - supply frequency

Z - load impedance

Z_R - reference impedance
- static detection: impedance calculated at time of PLF adjustment
- dynamic detection: impedance calculated over previous cycle.

OP - power demand, internal to controller (mnemonic)

PV - feedback value (mnemonic)

SP - working setpoint (mnemonic).

Alarm	Conditions In alarm	` No alarm	Firing shut-down	Display code	Bit no. XS/OC	Latch-ing
Thermal fault	115°C	100°C	Yes	Er00	9	No
Supply absent	$V_{LINE} < 30\% V_N$	$V_{LINE} > 40\% V_N$	Yes	Er01	10	No
Under-voltage	VLINE < 80% VN	VLINE ≥ 85% V_N	Yes	Er02	11	No
Frequency error	40Hz> f >70Hz	40Hz≤ f ≤ 70Hz	Yes	Er03	12	No
Thyristor short-circuit	$I_L > 25\% I_{LN}$ *	Reset	Requested	Er04	13	Yes
Current limit**	IL > 1.1 ILIM	Reset	Yes	Er05 (ICHo)	7	Yes
Load failure***	$\Delta Z > 20\% Z_R$	Static: $\Delta Z < 16\% Z_R$ or new adjustment	No	Er06	3	Static: No
		Dynamic: Reset	No	Er06	3	Dyn'c: Yes
Over-voltage	$V_{LINE} < 1.12 V_N$	$V_{LINE} \leq 1.1 V_N$	No	Er07	2	No
Control fault	(SP-PV)> 10% & OP = 100%	(SP-PV)< 9.5%	No	Er08	1	No

Table 8-3 Summary of all alarm characteristics

* when thyristor firing demand is zero

** if thyristor firing action is configured (current or voltage limit by firing angle variation is not considered as an alarm)

*** provided that load voltage / current > 30% of nominal value.

Chapter 9

MAINTENANCE

Page

CHAPTER 9 MAINTENANCE

MAINTENANCE SAFETY

DANGER

Danger!

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

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

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.

The temperature of the heatsink may exceed 100°C.

SERVICING

TE10P controllers must be mounted with the heatsink positioned vertically, with no obstructions above or below which could inhibit or impede airflow.

WARNING

Warning!

If several units are mounted in the same cabinet, they must 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, it is advisable to clean the heatsink and (for fan-cooled units) the protective fan guard regularly, depending on the degree of environmental pollution.

DANGER

Danger!

Cleaning must be carried out when the controller is switched off and at least 15mins after it has stopped operating.

Every six months check that the screws of the power and safety earth cables are correctly tightened (see Chapter 3, ‘Wiring’).

DIAGNOSTICS

Diagnostic unit

To make maintenance easier and to diagnose the state of the controller, it is advisable to use the Eurotherm type 260 diagnostic unit.

The diagnostic unit is fitted with a flat ribbon cable which plugs into the 20-pin connector. This diagnostic connector is located:

- on the top part of the controller for units rated 16A to 100A; the connection is accessible without opening the access door;
- on the driver board accessible with the front door open for 125A to 400A units.

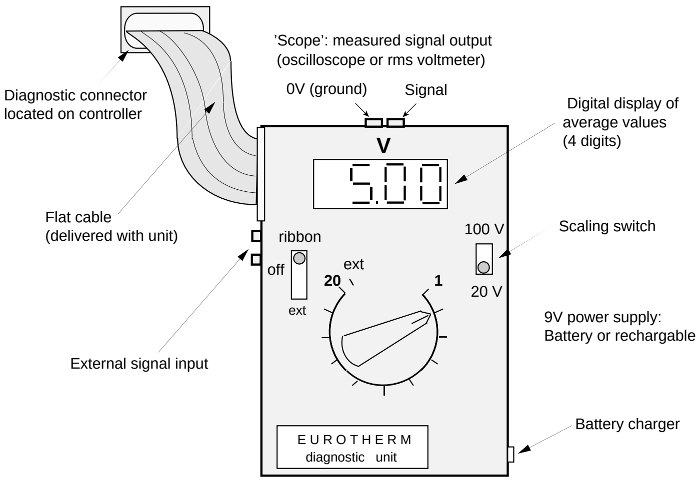


Figure 9-1 The EUROTHERM type 260 diagnostic unit

Provided with a 20-way switch, the diagnostic unit is used to measure the values of certain control parameters. In the '20V' position of the scaling switch, the digital display shows two decimal places to give a precise reading of the selected values.

The diagnostic unit display corresponds to the average values of the rectified signals.

Because of the 'Scope' output, the signals may also be viewed using an oscilloscope, or measured with an rms reading voltmeter for the AC component (voltmeter in AC position).

The following table gives a description of each position of the EUROTHERM type 260 diagnostic unit, together with typical values of the signals measured.

Position	Function	Mnemo-nic	Diagnostic unit display	'Scope' output	Adjust-ment
1	Power supply -	+7.5V			
2	Power supply -	+5.6V			
3	Power supply -	-6.2V	-	-	
4	Reference voltage	-	+5V		
5	Remote analogue setpoint	RI	0 to 5V		
6	Local setpoint LI	0 to 5V			
7	Current or voltage limit	RL	0 to 5V	-	P1
8	Analogue setpoint limit	HR	0 to 5V	-	P2
9	Modulation time in Burst-firing	CT	0 to 5V	-	P4
10	Ramp, delayed firing,	RR, DT			
	Soft start	ST	0 to 5V	-	P3
11	SW = OFF Current measurement	CV	2.5V	0 to 1.767V	P7
	SW = ON Current calibration	-	5 to 3.75V	-	P7
	Nominal calibration	-	3.75V		
12	SW = OFF Current measurement				
	(multiplied by 4)	CV	2.5V	0 to 0.441V	-
13	SW = OFF Load volt measurement	VV	2.5V	0 to 1.414V	P6
	SW = ON Load volt calibration	-	5 to 3.4V	-	P6
	Nominal calibration	-	3.75V		
14	SW = ON or Supply volt measur'mnt	LV	5 to 3V	-	P5
	SW = OFF Nominal supply voltage	-	4V		
15	Synchronisation (zero crossing)	-	2.5V		
16	Thyristor 1 Firing	-	2.8V		
	gate Shutdown	-	5.6V		
17	Thyristor 2 Firing	-	2.8V	-	-
	gate Shutdown	-	5.6V		
18	Supply (0V common)	-	0V		
19	Controller Enable	-	0V		
	state Inhibit	-	5.6V		
20	Power Present	-	5.6V		
	voltage Absent (V < 30% VN)	-	0V		

Table 9-1 Typical values displayed by diagnostic unit (mean rectified values)

*) Rms value of AC component (rms reading voltmeter in AC position)

Controller state diagnostics

Inhibit / Enable

Controller state: inhibition or enabling of thyristor firing is shown at position 19 of the diagnostic unit.

If the value displayed is 5.6V at position 19, the controller is inhibited by the user (enable signal absent on the Logic Signal terminal block).

When the controller is enabled, the value 0V is displayed at position 19.

Power supply

The diagnostic unit display is 5.6V at position 20 if the power voltage is present (voltage measured greater than 40% of the controller V_N).

When the voltage is less than 30% of VN, the supply is considered to be absent with 0V displayed at position 20.

Electronics supply

Positions 1, 2, 3, 4 and 18 of the diagnostic unit are used for precise measurements of the electronics supply voltage and the reference voltage.

Typical display values are shown in Table 9-1.

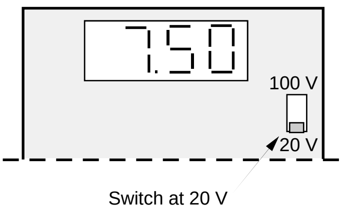


Figure 9-2 Measurement example (position 1)

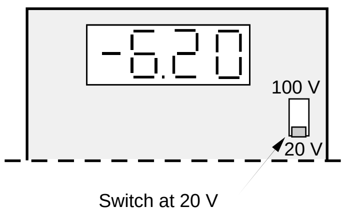


Figure 9-3 Measurement example (position 3)

Synchronisation

If the synchronisation circuit is operating normally, the mean voltage displayed by the diagnostic unit at position 15 is 2.8V.

An oscilloscope, connected to the ‘Scope’ output on the diagnostic unit, displays a 5.6 volt pulse at each positive mains half-cycle (normal synchronisation) at position 15.

Analogue signal diagnostics

The values of the remote analogue setpoint in progress (mnemonic: RI) and the local setpoint ñ the external signal or manual input (mnemonic: LI) ñ are measured at positions 5 & 6 respectively.

The 5V value displayed corresponds to 100% of the scale used by the control signal, irrespective of the input configuration.

Thyristor firing diagnostics

Diagnostics for thyristor firing pulses are provided at positions:

- 16 for thyristors in the ‘Line → load’ direction
- 17 for thyristors in the ‘Load → line’ direction.

The mean voltage value displayed by the diagnostic unit at the positions given above is 2.8V:

- ‘Burst-firing’ or ‘Logic’ : in full firing, and
- ‘Phase angle’ modes : irrespective of the firing angle.

The signal applied to the thyristor gates may be displayed on an oscilloscope connected to the ‘Scope’ output. This signal gives 5.6V pulses.

When firing has ceased, the value displayed is 5.6V at positions 16 & 17.

Adjustment diagnostics

Current or voltage limit

Diagnostics for the analogue current or voltage limit threshold (mnemonic: RL) are provided at position 7 of the diagnostic unit.

This value represents the result of the adjustment made using the P1 potentiometer (alone or in cascade with an analogue signal) and corresponds to the setpoint resulting from the limit, provided that:

- the digital limit value (mnemonic: CL) is 100%
- the default configuration is set on the mini-switches (code CSW) with a choice of analogue setpoint (the ‘A/C’ input is connected to 0V).

The 5V value, displayed at position 7, corresponds to an analogue limit threshold adjusted to 100%.

Example 1: The value measured at position 7 of the diagnostic unit is 4.0V.
The digital limit setpoint CL is 90%.
The ‘A/C’ input is connected to 5V (digital setpoint selected).
The setpoint resulting from the limit (mnemonic: LS), which corresponds to the limit threshold value, is thus adjusted to:

$$LS = RL \times CL/100\% = \left(\frac{4V}{5V} \times 100\%\right) \times 90\%/100\% = 72\%$$

Example 2: Same conditions as in example 1, but the ‘A/C’ input is connected to 0V and the default configuration is selected using mini-switches (code CSW).

The resulting limit setpoint is adjusted to:

$$LS = RL = \frac{4V}{5V} \times 100\% = 80\%$$

Setpoint limit

Data on the value of the analogue setpoint limit, (mnemonic: HR), is provided at position 8 of the diagnostic unit.

This value determines the working setpoint, taking into account the sum of:
the analogue setpoints, and
the limit performed using the P2 pot.

The 5V value displayed at position 8 corresponds to a setpoint limit threshold adjusted to 100%.

Example: The value measured at position 8 of the diagnostic unit is 2.5V.
The resulting setpoint, derived from the remote and local analogue setpoints (mnemonics: RI & LI), is 80%.

The working setpoint (mnemonic: SP) is therefore adjusted to:

$$SP = HR \times (RI + LI)/100\% = \left(\frac{2.5V}{5.0V} \times 100\%\right) \times 80\%/100\% = 40\%$$

Base time

Measurement of Base Time in 'Burst-firing' mode is provided at position 9. The value displayed (in V) corresponds to the number of base time cycles, as shown in the diagram below.

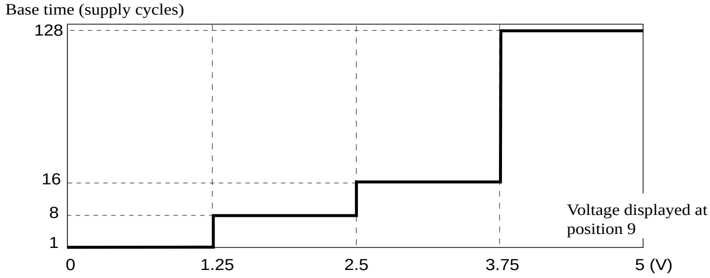


Figure 9-4 Diagnostic diagram for Base Time in Burst-firing mode

Four base times are provided depending on the product code (1, 8, 16 & 128 cycles).

Adjustment of cycle time is carried out using the P4 potentiometer, labelled CYC on the front panel.

Soft start duration

If Burst-firing or Logic modes are configured with soft start, diagnostics for soft start duration are available at position 10.

The display (in V) corresponds to the number of start cycles as shown in Figure 9-5.

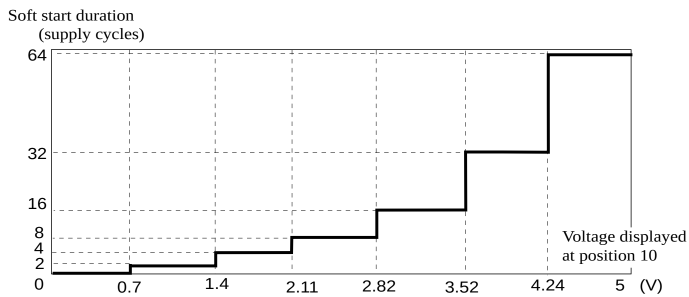


Figure 9-5 Diagnostic diagram for soft start duration

Soft start duration is limited by the base time configured.

Choice of one of the values provided is made using potentiometer P3 on the front panel.

Ramp duration

Diagnostics for ramp duration at change of setpoint are provided at position 10 when 'Phase angle' firing mode is configured.

The 5V value, displayed at position 10, corresponds to a ramp duration of 65,025ms.

Example: In Phase angle mode, if the value displayed at position 10 of the diagnostic unit is 0.25V, ramp duration (mnemonic: RR) is:

$$RR = 65{,}025\text{ms} \times \frac{0.25\text{V}}{5.00\text{V}} = 3315\text{ms}$$

Taking into account the 20ms granularity, the ramp duration at setpoint change is thus adjusted to 3s 320ms.

Adjustment of ramp duration at setpoint change is carried out using the P3 potentiometer, located on the controller front panel.

Delay duration

Diagnostics for delayed thyristor firing duration (for inductive loads) are provided at position 10 for 'Burst-firing' and 'Logic' firing modes.

The 5V value, displayed at position 10 of the diagnostic unit for these modes, corresponds to the initial firing delay of 90°.

Example: In Burst firing mode, the value displayed at position 10 is 4.00V. The initial firing delay duration (mnemonic: DT) is thus adjusted to:

$$DT = 90° \times \frac{4.00\text{V}}{5.00\text{V}} = 72°$$

The firing adjustment is performed using the P3 potentiometer located on the controller front panel.

Current diagnostics

Normal operation of the current measurement circuit is diagnosed:

by a display of 2.50 at positions 11 & 12 of the diagnostic unit

(controller calibrated to nominal values and SW mini-switch in OFF position).

When the controller is operating (SW in OFF position), the rms load current value can be obtained at positions 11 & 12 using the ‘Scope’ output of the diagnostic unit by measuring the rms value of the AC component

(set the rms reading voltmeter to AC).

WARNING

Important!

The ‘Scope’ output on the diagnostic unit at positions 11 & 12 comprises an alternating signal (current measurement) superimposed on a 2.5Vdc component.

At position 11, the nominal load current (nominal calibration) corresponds to an rms voltage of 1.767Vrms (AC component of ‘Scope’ output).

At position 12, the current measurement is shown in a 400% scale.

Nominal load current corresponds to the voltage:

$$1.767V_{RMS} \times \frac{100\%}{400\%} = 0.441V_{RMS}$$

measured at position12 of the diagnostic unit (AC component of ‘Scope’ output).

Example 1: Nominal load current (calibrated current) 25A

Rms value of AC component

measured at position 11 of the ‘Scope’ output is 1.5Vrms

The rms load current equals:

$$I_L = 25A \times \frac{1.50V}{1.767V} = 21.22A$$

Example 2: Nominal load current (calibrated current) 25A

Rms value of AC component

measured at position 12 of the ‘Scope’ output is 0.3Vrms

The rms load current equals:

$$I_L = 25A \times \frac{0.30V}{0.441V} = 17A$$

The signal provided on the 'Scope' output at positions 11 & 12 can be used for maintenance to display the load current on an oscilloscope.

It is important to consider that the current measurement provided on the diagnostic unit at position 11 can be saturated if operating with a small load impedance. In that event, the current would be greater than the nominal controller current (see Figure 9-6).

Saturation prevents correct current display at position 11.

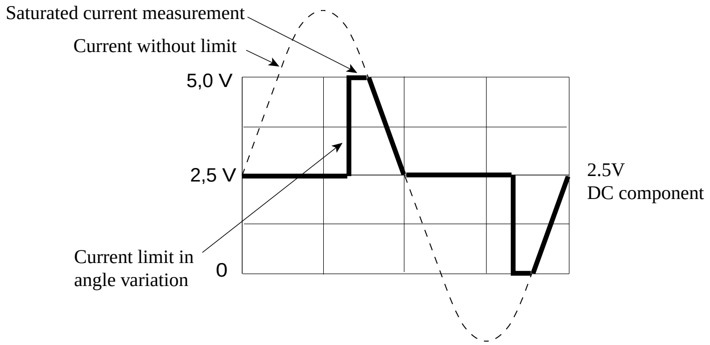


Figure 9-6 Current measurement displayed at position 11 (current limit active)

To observe or measure current under these conditions, it is recommended that position 12 (400% scale) should be used.

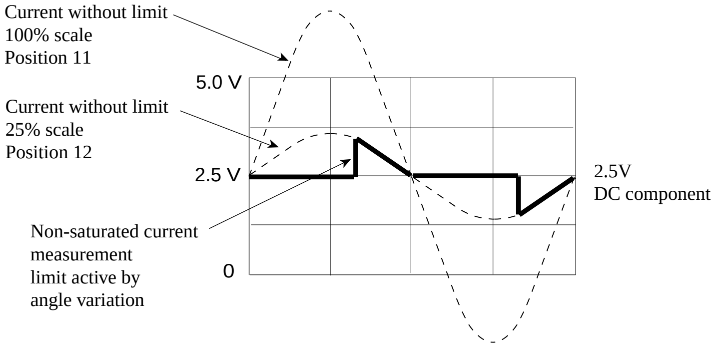


Figure 9-7 Current measurement displayed at position 12 (current limit active)

Voltage diagnostics

Load voltage

Normal operation of the load voltage measurement circuit is diagnosed: by a display of 2.50 at position 13 of the diagnostic unit

(controller calibrated to nominal values and SW mini-switch in OFF position.

When the controller is operating (SW in OFF position), the rms load voltage value can be obtained at position 13 using the 'Scope' output of the diagnostic unit by measuring the rms value of the AC component

(set the rms reading voltmeter to AC).

WARNING

Important!

The 'Scope' output on the diagnostic unit at position 13 comprises an alternating signal (load voltage measurement) superimposed on a 2.5Vdc component.

At position 13, the nominal load voltage (nominal calibration) corresponds to an rms voltage of $1.414V_{rms}$ (AC component of 'Scope' output).

Example: Nominal load voltage (calibrated value) 220V
Rms value of AC component
measured at position 13 of the 'Scope' output is 1.2Vrms
The rms load voltage equals:

$$V_L = 220V \times \frac{1.20V}{1.414V} = 186.7V$$

Supply voltage

The line voltage measurement is provided at position 14 of the diagnostic unit, regardless of the SW mini-switch position (SW = OFF as well as SW = ON)

Measurement of rms nominal line voltage corresponds to the value 4.00V, displayed on the diagnostic unit at position 14.

Example: Nominal controller voltage (given in product code): 230V.
Value displayed at position 14 of the diagnostic unit: 4.1V.
The rms supply voltage equals:

$$V_{LINE} = 230V \times \frac{4.1V}{4.0V} = 235.75V$$

CONTROLLER CALIBRATION

Controller calibration diagnostics

As shipped from the factory, the TE10P controller is calibrated so that the maximum value of the input signal scale corresponds to the nominal current and voltage values (see product code).

For calibration diagnostics, set the SW mini-switch to the ON position.

The diagnostic unit display is 3.75V:
at position 11 if the load current is calibrated to the nominal value
at position 13 if the load voltage is calibrated to the nominal value.

WARNING

Compare!

The value displayed at positions 11 & 13 is:
· 3.75 in calibration mode (SW in ON position)
· 2.50 in operating mode (SW in OFF position)

Controller re-calibration

If the load current (or voltage) actually used is different to that of the controller nominal value(s), the user can re-calibrate via the Eurotherm type 260 diagnostic unit.

Reminder: Re-calibration is not possible if:

- the difference between the controller nominal voltage and the operating voltage exceeds the following limits:
  +10% to (-15%) when the electronics is self-supplied
  +10% to (-25%) when the electronics is supplied separately
- the difference between the nominal current of the controller and of the load used exceeds the limit:
  +0 to (-25%).

When re-calibration has been performed, it acts equally on the isolated retransmission signals (option) and on the negative feedback signal.

To perform controller re-calibration:

- plug in the diagnostic unit to the diagnostic connector on the controller
- set the diagnostic unit selector to position 11 to calibrate the current, or
- to position 13 to calibrate the voltage.

Two types of re-calibration are described on the following pages:

- non-firing (calibration position: SW = ON)
- full-firing (operating position: SW = OFF).

Re-calibration during non-firing (calibration position)

Set the SW mini-switch to the calibration position (ON).

To re-calibrate the current, calculate the value KI (in V) using the following equation:

$$K_I = \frac{I_{UN}}{I_{LN}} \times 3.75V$$

To re-calibrate the voltage, calculate the value KV (in V) using the following equation:

$$K_I = \frac{V_{UN}}{V_{LN}} \times 3.75V$$

where: I_{UN} (V_{UN}) → nominal thyristor unit current (nominal voltage) shown in the product code or on the identification label

I_{LN} (V_{LN}) → nominal current (nominal voltage) of load used.

Turning the calibration potentiometer (P7 for load current, or P6 for load voltage), display the calculated value of KI (or of KV) on the diagnostic unit display at position 11 or 13 respectively.

After the adjustment, reset the SW mini-switch to the operating position (OFF).

Example 1: Nominal current of unit I_{UN} = 80A
Nominal load current I_{LN} = 70A
The current re-calibration equation is:

$$K_I = \frac{80}{70} \times 3.75V = 4.2857V$$

Turn the P7 potentiometer to obtain the value 4.28 (two decimal places) on the diagnostic unit display at position 11.

Example 2: Nominal voltage of unit V_{UN} = 230V
Nominal load voltage V_{LN} = 220V
The voltage re-calibration equation is:

$$K_V = \frac{230V}{220V} \times 3.75V = 3.92V$$

Turn the P6 potentiometer to obtain the value 3.92 (two decimal places) on the diagnostic unit display at position 13.

Re-calibration during firing (operating position)

To fine-tune or re-adjust calibration during controller operation, it is possible to carry out the adjustment using the SW mini-switch in the OFF position.

WARNING

Warning!

This adjustment must be made using an rms reading voltmeter (in the AC position) connected to the ‘Scope’ output on the diagnostic unit.

The value displayed on the diagnostic unit has no numerical significance.

Reminder: During firing, the ‘Scope’ output on the diagnostic unit comprises an alternating signal (voltage measurement) and a 2.5Vdc component.

Current re-calibration

Calibration of the load current is nominal if, during full firing, the rms value of the AC component measured at position 11 of the ‘Scope’ output is 1.767V_{rms}.

If the value measured is different, turn the current calibration potentiometer P7 to obtain the value 1.767V_{rms}.

Voltage re-calibration

Calibration of the load voltage is nominal if, during full firing, the rms value of the AC component measured at position 13 of the ‘Scope’ output is 1.414V_{rms}.

If the value measured is different, turn the load voltage calibration potentiometer P6 to obtain the value 1.414V_{rms}.

FUSES

Thyristor protection fuses

Thyristors in the TE10P series of power controllers are protected in the following way:
a high speed fuse against over-currents for all types of load except short-wave infrared elements

MOV (varistor) and RC snubbers which protect against over-fast voltage variations and transient over-voltages when the thyristors are not conducting.

WARNING

Warning!

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

DANGER

Danger!

High-speed fuses are used only for internal thyristor protection against large amplitude overloads.

Under no circumstances should these high-speed fuses be used to protect the installation. The installation must be protected upstream (non high-speed fuses, thermal or electromagnetic circuit breaker, suitable fuse-isolator) and must comply with current standards.

For 16A to 100A rated units, the thyristor protection fuses are outside the controller and should be ordered separately (one fuse and one fuseholder per unit).

For 125A to 400A rated units, the thyristor protection fuse is internal (one fuse per unit); the standard version of the controller is delivered with a high-speed fuse mounted on the line busbar.

In the NOFUSE option (for short-wave infrared elements, for example) the internal fuse is not mounted as shipped from the factory.

The following tables summarise the part numbers for the original fuses and the recommended replacement fuses, which can be used during maintenance.

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

Unit rating	Fuseholder part number	'External fuse and fuseholder' assembly	
		Reference	Dimensions (mm) H x W x D
16A	CP018525	FU1038/16A/00	81 x 17.5 x 68
20A	CP018525	FU1038/20A/00	81 x 17.5 x 68
25A	CP018525	FU1038/25A/00	81 x 17.5 x 68
32A	CP171480	FU1451/32A/00	95 x 30 x 86
40A	CP171480	FU1451/40A/00	95 x 30 x 86
50A	CP173083	FU2258/50A/00	140 x 35 x 90
63A	CP173083	FU2258/63A/00	140 x 35 x 90
80A	CP173083	FU2258/75A/00	140 x 35 x 90
100A	CP173245	FU2760/100A/00	150 x 38 x 107

Table 9-2 'External fuse and fuseholder' assembly for 16A to 100A rated units

Nominal current		Part numbers for thyristor protection fuses			
Controller	Fuse	Position	Eurotherm	Ferraz	Bussman
16A	20A	External	CH260024	K330013	-
20A	32A	"	CH260034	M330015	-
25A	50A	"	CH260034	M330015	-
32A	40A	"	CH330044	A093909	
40A	80A	"	CH330054	B053910	-
50A	63A	"	CS173087U063	T094823	-
63A	80A	"	CS173087U080	Y094827	-
100A	125A	"	CS173246U125	P209865J	-
125A	200A	Internal*	LA172468U200	X300055	170M3465
160A	200A	"	LA172468U200	X300055	170M3465
200A	400A	"	LA172468U400	H300065	170M5458
250A	400A	"	LA172468U400	H300065	170M5458
315A	400A	"	LA172468U400	H300065	170M5458
400A	500A	"	LA172468U500	K300067	170M5460

Table 9-3 Recommended high-speed fuses for thyristor protection

*) except for NOFUSE option

WARNING

Attention!

For all loads (except short-wave infrared elements) the use of any fuse other than that recommended for thyristor protection invalidates the controller's guarantee.

Fuse-blown indication microswitch

As an option, the external thyristor protection fuse for units rated between 125A and 400A can be fitted with a fuse-blown indication microswitch (FUMS option) with the part number:

- for Bussmann fuses:
  - Eurotherm DC172267, or
  - Ferraz P96015, or
  - Bussmann 170H0069
- for Ferraz fuses:
  - Eurotherm DC172997, or
  - Ferraz X310014C.

Important: it is the user's responsibility to connect the microswitch (normally open - NO or normally closed - NF) to their alarm or protection system.

To ensure better isolation between the wiring of the microswitch terminals, the power and the cover, TE10P power controllers rated between 125A and 400A are supplied with 'flag' type cable lugs with insulating sleeves.

Each external terminal on the fuse-blown indication microswitch must be wired with a 'flag' lug fitted with an insulating sleeve (to comply with electrical clearance distances) as shown in Figure 9-8.

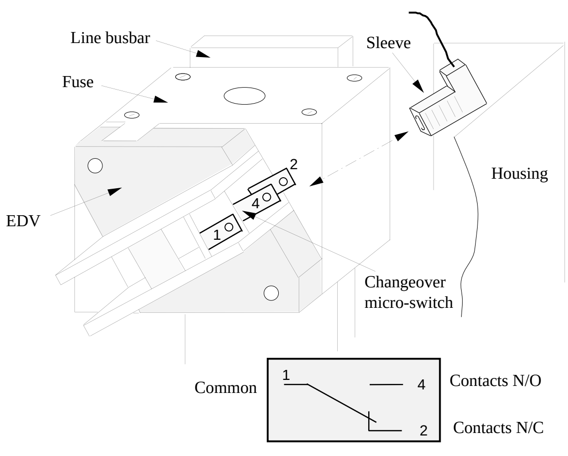


Figure 9-8 Use of 'flag' lugs and insulating sleeves.

Protection fuse for auxiliary voltage connection

A protection fuse for connections to:

- the fan (for 125A to 400A rated units)
- the separate electronics supply (if selected)
- the reference voltage for 125A to 400A units
- the load voltage external measurement (option)

must be installed in each connection wire leading to a supply phase (see Chapter 3 ‘Wiring’).

Auxiliary voltage (max)	**1A fuse 6.3 x 32 mm**		**Fuseholder isolator**	
	Part number		**Part number**	**Dimension (mm)**
	Eurotherm	**Ferraz**	**Eurotherm**	
500 V	CS174291U1A0	M93295	CP174293	63 x 15 x 52

Table 9-4 Recommended protection fuse for auxiliary voltage connection

TOOLS

Task	Unit rating	
	16A to 100A	125A to 400A
Mounting	Depending on screws selected by user	Depending on screws selected by user
Power connection	0.8 x 5.5 screwdriver	HEX key 13 (125A to 160A) HEX key 17 (200A to 400A)
Load connection	0.8 x 5.5 screwdriver	HEX key 19
Safety earth connection	HEX key 10	HEX key 19
Power fuse changing	-	HEX key 13 (125A to 160A) HEX key 17 (200A to 400A)
Fan connection	-	0.5 x 3.5 screwdriver
Control connection	0.4 x 2.5 screwdriver	0.4 x 2.5 screwdriver
Alarm contacts, separate power supply, ext. voltage measurement connections	0.5 x 3.5 screwdriver	0.5 x 3.5 screwdriver
Cable guide tightening (screen earthing)	Torx 10 screwdriver	Torx 10 screwdriver
Opening (closing) of front door	-	4mm HEX socket
Opening (closing) of configuration access door	0.5 x 3.5 screwdriver	0.5 x 3.5 screwdriver
Securing configuration access door	1 x 6.5 screwdriver	1 x 6.5 screwdriver
Commissioning and calibration	0.5 x 3.5 screwdriver	0.5 x 3.5 screwdriver
Fan replacement	-	HEX key 7
Maintenance	rms voltmeter and ammeter Clip-on current probe Oscilloscope (recommended) Eurotherm type 260 diagnostic unit.	

Table 9-5 Tools used for installation, wiring, adjustment and maintenance.

Chapter 10

TYPICAL APPLICATIONS

Page

CHAPTER 10
RECOMMENDED CONFIGURATIONS

GENERAL NOTES

The TE10P has been developed to control industrial installations using practically any type of load.

In order to ensure perfect operation of the controlled installation and to take best advantage of the TE10P controller's performance, its configuration should be properly matched to the user's application.

This chapter has been written to summarise the configurations recommended for various typical applications. As described in Chapter 6 of this manual, configuration is achieved by using the mini-switches and/or, as an option, by digital communications.

As a function of the type of heating elements (the four load types described in the product coding) and of the type of control (direct or using a transformer) recommendations are given for the configuration of the following parameters:

- firing mode
- parameter controlled
- type of current/voltage limit
- type of setpoint limit (if necessary).

WARNING

Warning!

Eurotherm cannot be held responsible for the configurations recommended: each user must ensure that they:

- comply with the recommendations and specifications given by heating element suppliers
- are compatible with the mains supply and environment
- comply with current EC Directives and Standards.

FIRING MODE APPLICATIONS

The user can choose one of four thyristor firing modes depending on the application and the firing requirements:
‘Logic’ (LGC code)
‘Phase angle’ (PA code)
‘Burst-firing’ (FC1, FC4, FC8 and C16 codes)
‘Advanced Single-cycle’ (SCA code).

Logic
Advantages

· Reduced electromagnetic interference; absence of reactive power consumption (owing to zero voltage switching)

Disadvantages

· Generation of thermal constraints and/or electrodynamics on certain types of load (quality of control depends on performance of temperature controller)

· Temperature fluctuations in elements with a small thermal inertia

Phase angle
Advantages

· Optimum control accuracy

· Control of the majority of loads:

  · control of loads with small thermal inertia (assisted by a reduced response time)

  · control of loads which require a progressive application of volts when starting from cold

  · control of loads with a large resistance variation as a function of temperature (thanks to variation by firing angle).

Disadvantages

· Generation of odd harmonic currents which could lead to supply interference

· Consumption of reactive power even in purely resistive loads (due to power factor degradation)

· Generation of electromagnetic interference.

Burst-firing
Advantages

Reduced electromagnetic interference (owing to zero voltage switching)

Absence of reactive power consumption

Absence of harmonic generation.

Disadvantages

Possible variations in the mains supply as result of modulation (flicker effect) if the power controlled is significant compared with the mains installed rating

Thermal constraints and/or electrodynamics on certain types of load

Use of specific instruments to measure voltage, current and power.

WARNING

Important!

For ‘Burst-firing’ mode, firing by complete cycles will only take place if the current limit becomes inactive (depending on the state of the load)

If this is not the case, firing will take place by burst mode with cut-off half cycles (in Phase angle)

Advanced single-cycle
Advantages

- Extremely rapid response time
- Optimum control of small thermal inertia heating elements
- Reduction in flickering of short-wave infrared elements
- Reduction in electromagnetic interference
- No generation of harmonics
- Absence of reactive power consumption (owing to zero voltage switching).

Disadvantage

- Use of specific instruments to measure voltage, current and power.

DIRECT CONTROL OR CONTROL BY TRANSFORMER

As a result of the nominal voltages and currents of the controller and of those of the load used, heating elements may be controlled:

- directly (the load will be connected to the controller power terminals)
- by means of a transformer.

Direct load control

The firing mode is defined:

- by the load type

and will be described below for each application

Control by means of a transformer

The TE10P controls the transformer primary, the secondary of which supplies the load.

This control is defined:

- by the characteristics of the transformer and
- by the load connected to the secondary

The firing mode selected can be:

- 'Phase angle' (maximum transformer induction 1.4Tesla) or
- 'Burst-firing'.

The use of a transformer requires a particular control technique provided by the TE10P thyristor unit:

- magnetisation ramp in 'Phase angle'
- delay in initial thyristor firing in 'Burst' mode or in 'Logic'.

PRINCIPAL RECOMMENDED CONFIGURATIONS

General recommendations

WARNING

- With the controlled parameters P or V2, use the setpoint limit (analogue and/or, as an option, digital).
- For correct transformer or induction coil magnetisation, and for all start-ups with current limit:

  activate the safety ramp except for loads with small temperature coefficients in direct control.

To best suit the particular features of various applications of the TE10P controller, all the loads used are grouped into four categories:

- resistive loads
  - with a small temperature coefficient and
  - 50/60 Hz inductors

  coded LTCL

- resistive loads
  - with a large temperature coefficient and
  - direct glass heating

  coded HTCL

- variable loads as a function of
  - time and/or
  - temperature

  coded TTDL

- short-wave infrared elements

  coded SWIR.

The following are summarised in this paragraph:

- a description of the most representative heating elements for each group of loads
- the recommended configurations

Loads with a small resistance variation (LTCL code)

Resistive loads with a small temperature coefficient

The resistance of these elements only varies by 3% to 15% as a function of their temperature. They are principally:

- metal resistance elements
- nickel, chrome, iron and aluminium-based alloys
- medium or long-wave infrared elements.

50/60 Hz inductors

WARNING

Warning!

When using power factor ‘cosφ‘ correction capacitors, check that the capacitor cabling is upstream of the TE10P and not directly on the load.

LTCL code

Type of element	Type of control	Firing code	Controlled parameter	Limit code	Recommendations
Resesitive	Direct	FC1, FC8 & C16	P	ILI or ICHO	-
	With trans-former	FC8 & C16	P	ILI	· Activate the safety ramp · Adjust initial thyristor firing for trasformer primary
Inductor	Direct or with trans-former	C16	P	ILI	· Activate the safety ramp · Set a margin in TE10P calibration to prevent tripping on momentary over-current at each · Adjust the initial thyristor firing delay · Use the setpoint limit
		PA	P	ILI	· Activate the safety ramp · Use the setpoint limit

Table 10-1 Recommended configurations for resistive loads of small variation

Important! In ‘Burst-firing’, ensure that the RMS current (over 20ms) is less than the value of the current limit (allow a minimum 20% margin)

Loads with a large resistance variation (HTCL code)

The control operation uses automatic transfer from the I^2 ‘current squared’ feedback value to the P ‘active power’ feedback value (code I <-> P) to ensure optimum control of elements of large temperature coefficient, irrespective of temperature.

Resistive loads with a large positive temperature coefficient

The resistance of these elements increases considerably (up to a ratio of 15) between cold and hot states.

Heating elements which have a large positive temperature coefficient are: platinum, molybdenum and molybdenum di-silicide, tungsten, rhodium and tantalum.

HTCL code

Type of control	**Firing code**	**Controlled parameter**	**Limit code**	**Recommendations**
Direct	FC8 or C16	I2P	ILI	· Activate the safety ramp · Use the setpoint limit
Direct or with trans-former	PA	I2P		· Activate the safety ramp · When hot, change by digital communiucations to FC8 or C16 (if load is compatible) · Use the setpoint limit
With trans-former	C16	I2P	ILI	· Activate the safety ramp · Adjust the initial thyristor firing delay for transformer primary · Use the setpoint limit

Table 10-2 Recommended configurations for resistive loads with a large positive variation

Important!

WARNING

For these types of load, FC8 and C16 firing modes are used to:

- limit the current when cold by reducing the firing angle under control of the current limit
- take advantage of a good power factor when hot (‘Burst-firing’ mode) when the heating elements come out of current limit.

It is up to the user to check that the process and the heating elements are suitable for FC8 and C16 firing modes.

Resistive loads with a large negative temperature coefficient

Typical application : Direct glass heating

Other types of possible elements:

- Zirconium oxide
- Lanthanum chromite

The resistance of these elements decreases in a significant manner when the temperature increases.

Direct heating of glass by ‘dipping’ electrodes is used for additional electrical backup (boosting) or for ‘feeder’ heating.

I^2, ‘current squared’, feedback gives automatic control action on the power injected into the glass, taking account of variations in temperature.

Direct glass heating (HTCL code)

Type of control	Firing code	Controlled parameter	Limit code	Recommendations
Direct or with trans-former	PA	I2 or P	ILI	· Activate the safety ramp

Table 10-3 Recommended configuration for direct glass heating installation

Variable loads (TTDL codes)

WARNING

Important!

Check that when the resistance is lowest, the maximum RMS current (over 20ms) is less than the current limit threshold (at maximum, equal to the calibration current).

Resistive loads with a non-monotonic function of temperature

Typical element : Graphite

The resistance value of heating elements of this type of load decreases then increases with rising temperature.

Graphite (TTDL code)

Type of control	Firing code	Controlled parameter	Limit code	Recommendations
Direct	PA or C16	P	ILI	· Activate the safety ramp · Use the setpoint limit
With trans-former	C16	P	ILI	· Activate the safety ramp delay for transformer primary · Use the setpoint limit

Table 10-4 Recommended configurations for graphite elements

Resistive loads with a non-monotonic function of temperature and time

Typical element : Silicon carbide*

The resistance value of heating elements of this type of load decreases then increases with rising temperature.

In addition, the resistance value of this type of load increases as a function of the operating time (ageing).

* There are various forms of silicon carbide, refer to the manufacturers.

WARNING

Important!

Check that the power dissipated by the heating elements does not exceed the limit values specified by the supplier.

Silicon Carbide (TTDL code)

Type of control	Firing code	Controlled parameter	Limit code	Recommendations
Direct	FC1 or FC8	P	ILI	· Activate the safety ramp · Use the setpoint limit so as not to exceed the maximum power of the heating elements while firing
Direct or with transformer	PA	P	VLI	· Activate the safety ramp · Use the voltage limit when the supply voltage is greater than the voltage allowed when starting from cold
With transformer	FC8	P	ILI	· Activate the safety ramp · Adjust the initial thyristor firing delay for transformer primary · Use the setpoint limit

Table 10-5 Recommended configurations for silicon carbide

Heating by short-wave infrared radiation (SWIR codes)

WARNING

Important!

Short-wave infrared elements are characterised by very high currents when cold.

Shortwave Infrared (SWIR code)

Type of control	Firing code	Controlled parameter	Limit code	Recommendations
Direct	SCA or FC1	V2	-	· The load current should not exceed 70% of the TE10P calibration current; re-linearise the input by setpoint limit · No voltage or current limits, irrespective of the limit configured. Use the setpoint limit when the supply voltage is greater than the voltage permitted. · For units rated ≤ 100A do not use an external high-speed fuse · For units rated ≥ 125A select the NOFUSE (without internal fuse) option.
Direct or with trans-former	PA	P	ILI or VLI	· Activate the safety ramp · Use the setpoint limit · Use the voltage limit when the supply voltage is greater than the voltage permitted by the short-wave infrared elements.

Table 10-6 Recommended configurations for short-wave infrared elements

INDEX

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