invensys
Eurotherm

EFit
User Guide

Power Controller

HA031980ENG issue 1
February 2014

Restriction of Hazardous Substances (RoHS)

Product group EFit

Table listing restricted substances

Chinese

限制使用材料一览表						
产品	有毒有害物质或元素					
EFit	铅	汞	镉	六价铬	多溴联苯	多溴二苯醚
功率模块 16安培	X	X	O	O	O	O
功率模块 25安培	X	X	O	O	O	O
功率模块 40安培	X	X	O	O	O	O
功率模块 50安培	X	X	O	O	O	O
O	表示该有毒有害物质在该部件所有均质材料中的含量均在SJ/T11363-2006 标准规定的限量要求以下。					
X	表示该有毒有害物质至少在该部件的某一均质材料中的含量超出SJ/T11363-2006 标准规定的限量要求。					

English

Restricted Materials Table						
Product	Toxic and hazardous substances and elements					
EFit	Pb	Hg	Cd	Cr(VI)	PBB	PBDE
Power Module 16A	X	X	O	O	O	O
Power Module 25A	X	X	O	O	O	O
Power Module 40A	X	X	O	O	O	O
Power Module 50A	X	X	O	O	O	O
O	Indicates that this toxic or hazardous substance contained in all of the homogeneous materials for this part is below the limit requirement in SJ/T11363-2006.					
X	Indicates that this toxic or hazardous substance contained in at least one of the homogeneous materials used for this part is above the limit requirement in SJ/T11363-2006.					

Approval

Name:	Position:	Signature:	Date:
Kevin Shaw	R&D Director	KShaw	27th February 2014

Thyristor power controllers

EFit Series

For the control of heating elements up to 25 Kw

User Manual

Before installation, please read this manual thoroughly.
Eurotherm cannot be held responsible for any damage to persons or property, or for any financial loss or costs arising from incorrect use of the product or failure to observe the instructions given in this manual.
In order to maintain its 'leading edge' Eurotherm may have to make changes to its specifications without advance notice.
For any further information, or if in doubt, please contact Invensys Eurotherm, where qualified staff are available to advise or assist you with the commissioning of your installation.

Guarantee
Two years parts and labour garantee

Contents List

1. SAFETY NOTES

1.1 WARNING

BRANCH-CIRCUIT PROTECTION
AND SAFETY OVERLOAD PROTECTION

This product does not contain any branch-circuit protection or internal safety overload protection. It is the responsibility of the user to add branch-circuit protection upstream of the unit. It is also the responsibility of the user to provide external or remote safety overload protection to the end installation.
Such branch-circuit and safety overload protection must comply with applicable local regulations.
UL: The above mentioned branch-circuit protection is necessary for compliance with National Electric Code (NEC) requirements.
If opening of the branch circuit protective or the supplemental fuses (high speed fuse) EFit shall be examined and replaced if damaged.

It is strongly recommended that the installing authority includes independent, system-safety mechanisms to protect both personnel and equipment against injury or damage, and that such safety mechanisms be regularly inspected and maintained. Consult the EFit supplier for advice.
The instrument shall have one of the following as a disconnecting device, fitted within easy reach of the operator, and labelled as the disconnecting device.
a. A branch-circuit protection (circuit breaker or fuse which complies with the requirements of IEC60947-1).
b. A separable coupler which can be disconnected without the use of a tool.

1. Any interruption of the protective conductor outside the equipment, or disconnection of the protective earth terminal is likely to make the device dangerous under some fault conditions. Intentional interruption is prohibited.
2. Before carrying out any wiring to the unit it must be ensured that all relevant power and control cables, leads or harnesses are isolated from voltage sources. Wire conductor cross sections must comply with table 9 of IEC60947-1 (or NEC, Article 310 Table 310-16).
3. This equipment is not suitable for isolation applications, within the meaning of IEC60947-1.
4. The heatsink becomes hot whilst the unit is running, and it can take up to 15 minutes to cool after the unit is shut down. The heatsink temperature may rise above 50 degrees Celsius. If operators are likely to come into contact with such heatsinks, adequate warnings and barriers must be put in place in order to prevent injury.

Before any other connection is made, the protective earth terminal shall be connected to a protective conductor by a listed ring crimp. Whenever it is likely that protection has been impaired, the unit shall be made inoperative, and secured against accidental operation. The manufacturer's nearest service centre should be contacted for advice.
Any adjustment, maintenance and repair of the opened apparatus under voltage, is forbidden for safety reasons.
Units are designed to be installed in a cabinet connected to the protective earth according to IEC60364-1 and IEC60364-5-54 or applicable national standards. The cabinet must be closed under normal operating conditions. Adequate air conditioning/ filtering/ cooling equipment must be fitted to the cabinet in order to prevent the ingress of conductive pollution, the formation of condensation etc.

5. Units are designed to be mounted vertically. There must be no obstructions (above or below) which could reduce or hamper airflow. If more than one set of units is located in the same cabinet, they must be mounted in such a way that air from one unit is not drawn into another.
6. Signal and power voltage wiring must be kept separate from one another. Where this is impractical, shielded cables should be used for the signal wiring.
7. If the equipment is used in a manner not specified by the manufacturer, the protection provided by the equipment might be impaired.
8. This product has been designed for environment A (Industrial). Use of this product in environment B (domestic, commercial and light industrial) may cause unwanted electromagnetic disturbances in which cases the user may be required to take adequate mitigation measures.

1.2 SELV

Safety Extra Low Voltage. This is defined (in IEC60947-1) as an electrical circuit in which the voltage cannot exceed 'ELV' under normal conditions or under single fault conditions, including earth faults in other circuits. The definition of ELV is complex as it depends on environment, signal frequency etc. See IEC 61140 for further details. The input connector (pin 5 to 7) is compliant to the SELV requirements.

1.3 SYMBOLS USED IN THE INSTRUMENT LABELING

One or more of the symbols below may appear as a part of the instrument labeling.

	Protective conductor terminal		Risk of electric shock
	AC supply only		Precautions against static electrical discharge must be taken when handling this unit
	Underwriters Laboratories listed mark for Canada and the US		Refer to the manual for instructions
	Do not touch Heatsink Hot Surface		Declaration of conformity to European standard

2. Technical specifications

General					
Directive	EMC directive 2004/108/EC Low Voltage Directive 2006/95/EC				
Safety specification	EN 60947-4-3:2000 (2000-01-12) + EN 60947-4-3:2000/A1:2006 (2006-12-08) + EN 60947-4-3:2000/A2:2011 (2011-09-02)				
EMC emissions specification	EN 60947-4-3:2000 (2000-01-12) + EN 60947-4-3:2000/A1:2006 (2006-12-08) + EN 60947-4-3:2000/A2:2011 (2011-09-02) Class A product				
EMC immunity specification	EN 60947-4-3:2000 (2000-01-12) EN 60947-4-3:2000/A1:2006 (2006-12-08) EN 60947-4-3:2000/A2:2011 (2011-09-02)				
Vibration tests	EN60947-1 annex Q category E				
Shock tests	EN60947-1 annex Q category E				
Approvals					
cUL	UL60947-4-1A and UL60947-1				
CE	EN60947-4-3 and EN 60947-1 A certificate of conformity can be provided on simple request				
CCC (China Compulsory Certificate)	Product not listed in catalogue of Products Subject to Compulsory Certification				
Protection	IP20 According to EN60529 - CE, Open type - UL				
Installation Category					
	Rated impulse withstand voltage (U imp)		Rated insulated voltage (Ui)	Installation Category	
	CE	UL		CE	UL
Control	0,5kV	0,8kV	50V	II	III
Auxilary Supply	2,5kV	4kV	230V	II	III
Power terminals	4kV	6kV	500V	II	III

Condition of use	
Atmosphere	Non-corrosive, non-explosive, non-conductive
Usage temperature	0 to 45°C without derating
Storage temperature	–25°C to 70°C (maximum)
Altitude	1000m maximum at 45 °C 2000 m maximum at 40°C
Degree of pollution	Degree 2
Humidity limits	5% to 95% RH (non-condensing)
Mechanical Details	
Dimensions Model 16 amps Model 25 amps Model 40 amps Model 50 amps	 115 mm (Height) x 52.5 mm (Width) x 92.5 mm (Depth) 115 mm (Height) x 70 mm (Width) x 92.5 mm (Depth) 115 mm (Height) x 105 mm (Width) x 92.5 mm (Depth) 115 mm (Height) x 122.5 mm (Width) x 92.5 mm (Depth)
Mounting	DIN rail
Power	
Nominal current	16 to 50 A
Nominal voltage	100V to 500V (+10%/–15%). Refer to 'Codification' for more details
Frequency	47Hz to 63Hz
Rated short-circuit conditional current	100KA (coordination type 1) (see 3.2)
Type of loads AC51 AC-56a	 Pure resistive Transformer Primary (Phase Angle product only with current limit)

Control	
Supply of electronics	Self powered product: 100Vac to 500Vac Auxiliary supply: 115Vac or 230Vac. Auxiliary supply must be in phase with the line. The control circuit shall be protected by a ATM2 fuse rated 600Vac/dc, 2A, 100kA
Control setpoint	Either analogue (analogue input or potentiometer) or logic
• Analogue input signal	DC voltage : 0-5V, 0-10V, Input impedance 100k ohms DC current : 4-20mA Burden resistor 250 ohms
• Potentiometer	A '5V user' voltage is available between terminals 5 and 7 to be used with an external potentiometer of 10Kohm. One potentiometer per unit should be used
• Logic	Contact for On/Off logic operation
Control Performance	
Linearity	Better than ±2% of the full range
Stability	Better than ± 2% of the full range with constant resistance Automatic compensation for supply fluctuation (variation: between -10% and +10% of the nominal voltage).
Firing modes	**Burst** - Burst variable (16 periods) - Single cycle - Advanced single cycle **Phase angle** - With or Without current limit

3. Codification

Ordering Code

Model /Current/Voltage/Input /Firing /Manual language/Supply Current limit /Fuse/00

Model	
EFit	EFIT
Nominal Current	
16 amps	16A
25 amps	25A
40 amps	40A
50 amps	50A
Nominal Voltage	
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
480 volts	480V
500 volts	500V
Input	
0-5Vdc	0V5
4-20mA	4mA20
0-10V	0V10

(1) See 3.2

Firing mode	
Burst Variable	FC
Single cycle	FC1
Advanced single cycle	SCA
Phase angle	PA
Language	
English	ENG
French	FRA
German	GER
Supply	
Self-powered	SELF
Aux power supply 115 volts	115V
Aux power supply 230 volts	230V
Current limit	
Without current limit	XX
With current limit (only with PA)	CL
Fuse	
Without fuse (1)	NOFUSE
With fuse without microswitch	FUSE
With fuse with microswitch	MSFUSE

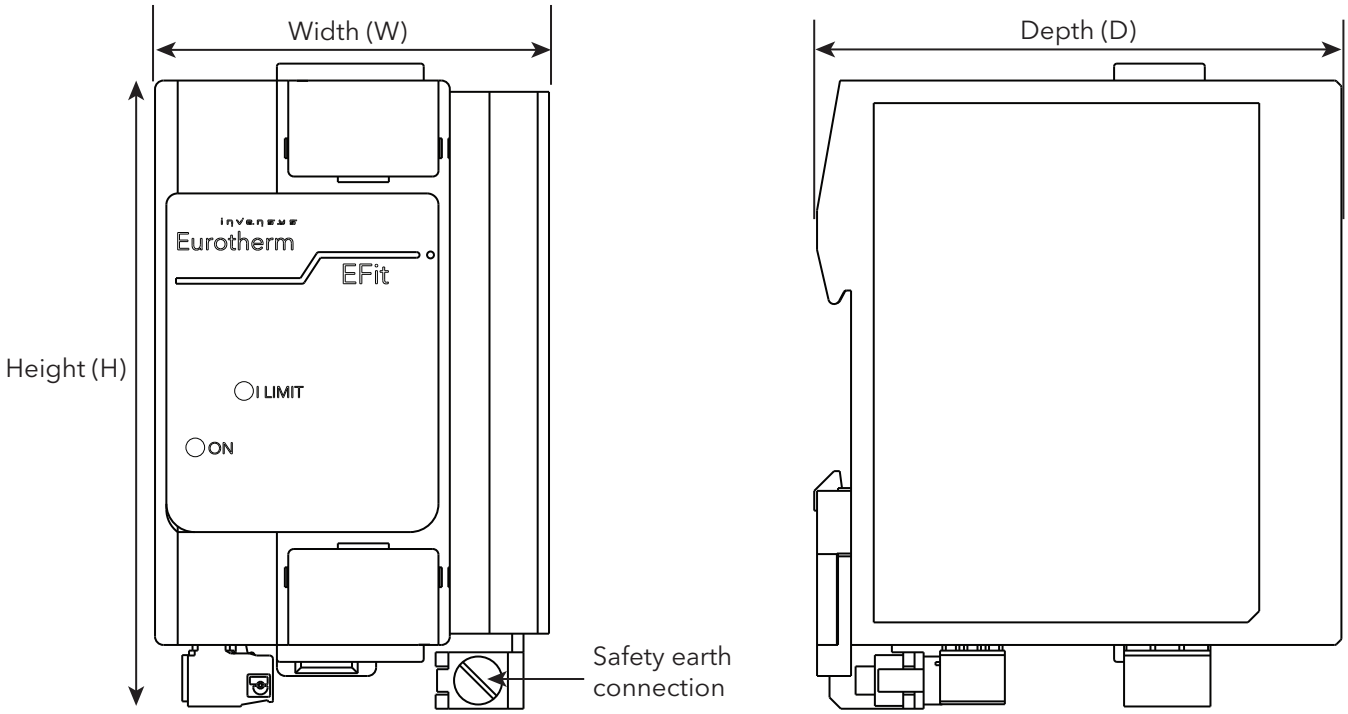
3.2 Fuses

According to the CE and UL certifications, high speed fuses are necessary for the protection of the EFit power controller against short circuit.
The power circuit shall be protected by a supplemental fuse as described in the table below. These should be used in conjunction with suitable fuse holders and contact kits (if required) as shown in this table.
With suplemental fuse (high speed fuse), EFit is suitable for use on a circuit capable of delivering not more than 100kA rms symmetrical amperes, 500 Volts Maximum. (coordination Type 1)

Warning : if opening of the branch circuit protective or the supplemental fuse (high speed fuse) EFit shall be examined and replaced if damaged.

		Fuse body size (mm)	Fuse holder part no.	Fuse part no.	Contact kit part no.
16A	w/o MS	10x38	CP018525	CS031505U002	
	with MS	14x51	CP171480	CS031506U002	CP177220
25A	w/o MS	10x38	CP018525	CS031505U002	
	with MS	14x51	CP171480	CS031506U002	CP177220
40A	w/o MS	14x51	CP171480	CS031509U002	
	with MS	14x51	CP171480	CS031510U002	CP177220
50A	w/o MS	22x58	CP173083	CS031511U002	
	with MS	22x58	CP173083	CS031512U002	CP177221

4. Mechanical installation
4.1 Dimensional details

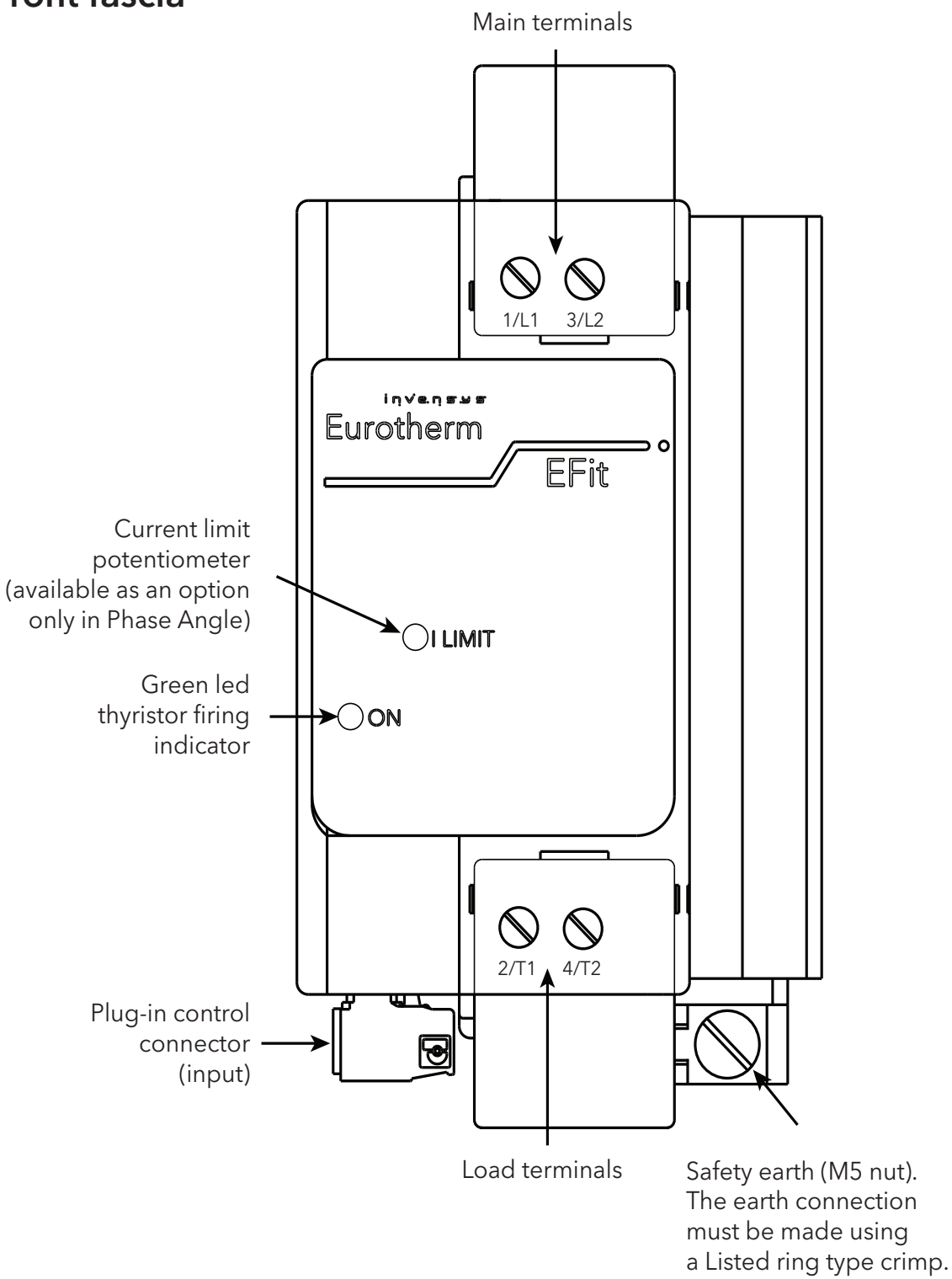


Model	Height (mm)	Width (mm)	Depht (mm)
16A	115	52,5	92,5
25A	115	70	92,5
40A	115	105	92,5
50A	115	122,5	92,5

Minimum spacing (width) between two EFit units:
- 10mm up to 45°C (ambient temperature)

Safety earth: For EMC compliance ensure that the DIN rail is electrically bonded to the reference ground (panel or bulkhead)

4.2 Front fascia



FRONT FASCIA

5. Electrical Installation

5.1 Terminals and connectors

Tables below, give details of wire sizes and tightening torques for both power supply and signal wiring connection. Where a range of wire sizes is given it is up to the user to select the correct cross sectional area required for the application. The safety earth cable should be, as a minimum, of the same cross sectional area as the cables used for the load (i.e. the cables terminated at the 1/L1, 3/L2, 2/T1 and 4/T2 terminals. “The earth connection must be made using a listed ring type crimp.“

POWER TERMINALS

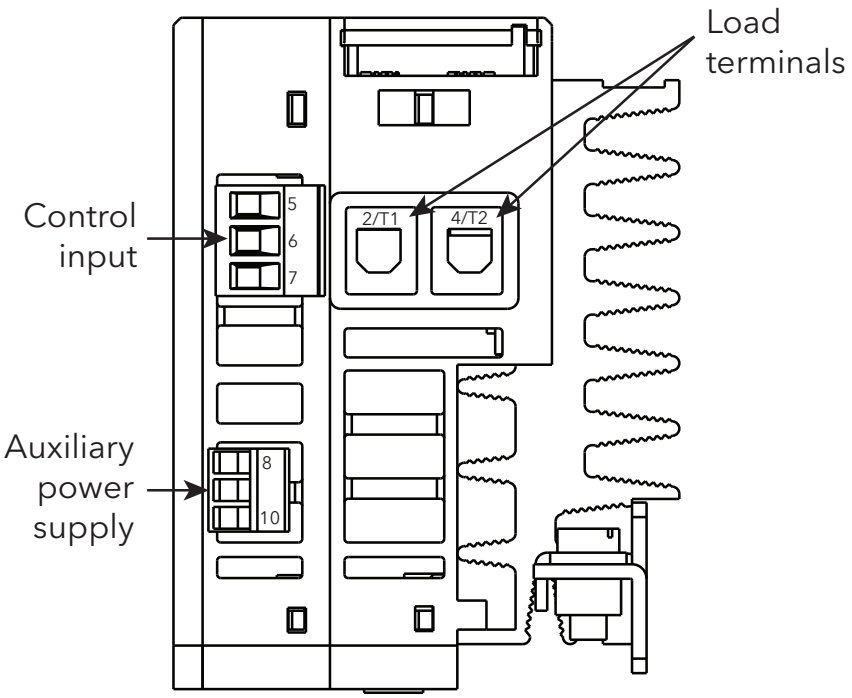
Terminal	Function	Terminal type	Cable	Stripping	Tightening torque	Screw driver details
1/L1	Mains - Controlled phase	Cage	1.5mm^2 to 16mm^2 (14 to 6 AWG) rated 90°C	16mm	2.3N.m (20.4 Lb.In)	1x5,5mm
3/L2	Mains - Direct phase/Neutral					
2/T1	Load - Controlled phase					
4/T2	Load - Direct phase/Neutral					
⏚	Safety earth	M5 screw	Same section as power minimum rated 90°C	The earth connection must be made using a listed ring type crimp		

CONTROL BOARD CONNECTORS

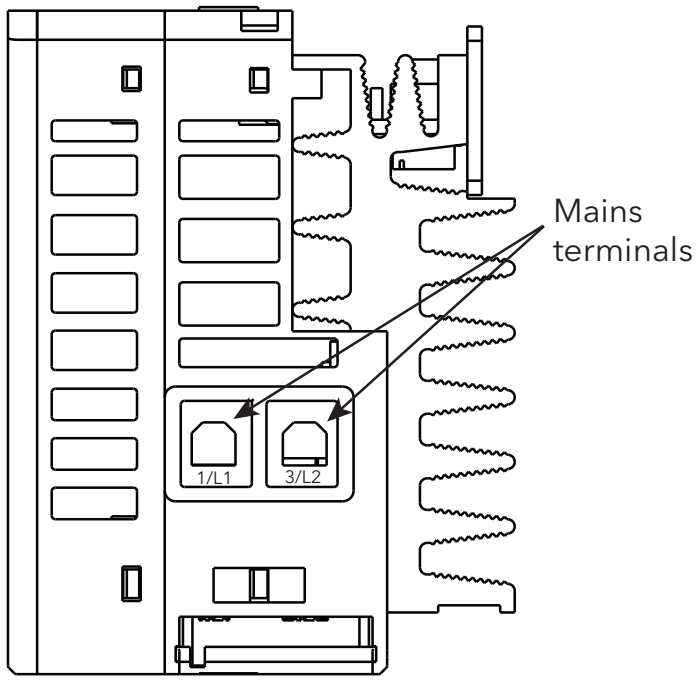
Terminal	Function	Connector type	Cable	Stripping	Tightening torque	Screw driver details
5	0V of control signal	Plug-in	0.5 to 2.5mm^2 (24 to 12 AWG) rated 75°C	7mm	0.6N.m (5.31 Lb.In)	0,6 x3,5mm
6	‘+’ of control signal					
7	User 5V					
8 & 10	Auxiliary power supply (option)	Plug-in	0.5 to 1.5mm^2 (24 to 14 AWG) rated 75°C	7mm	0.25N.m (2.25 Lb.In)	0,4 x2,5mm
9	Not used					

5.2 Connectors

5.2.1 View on lower face

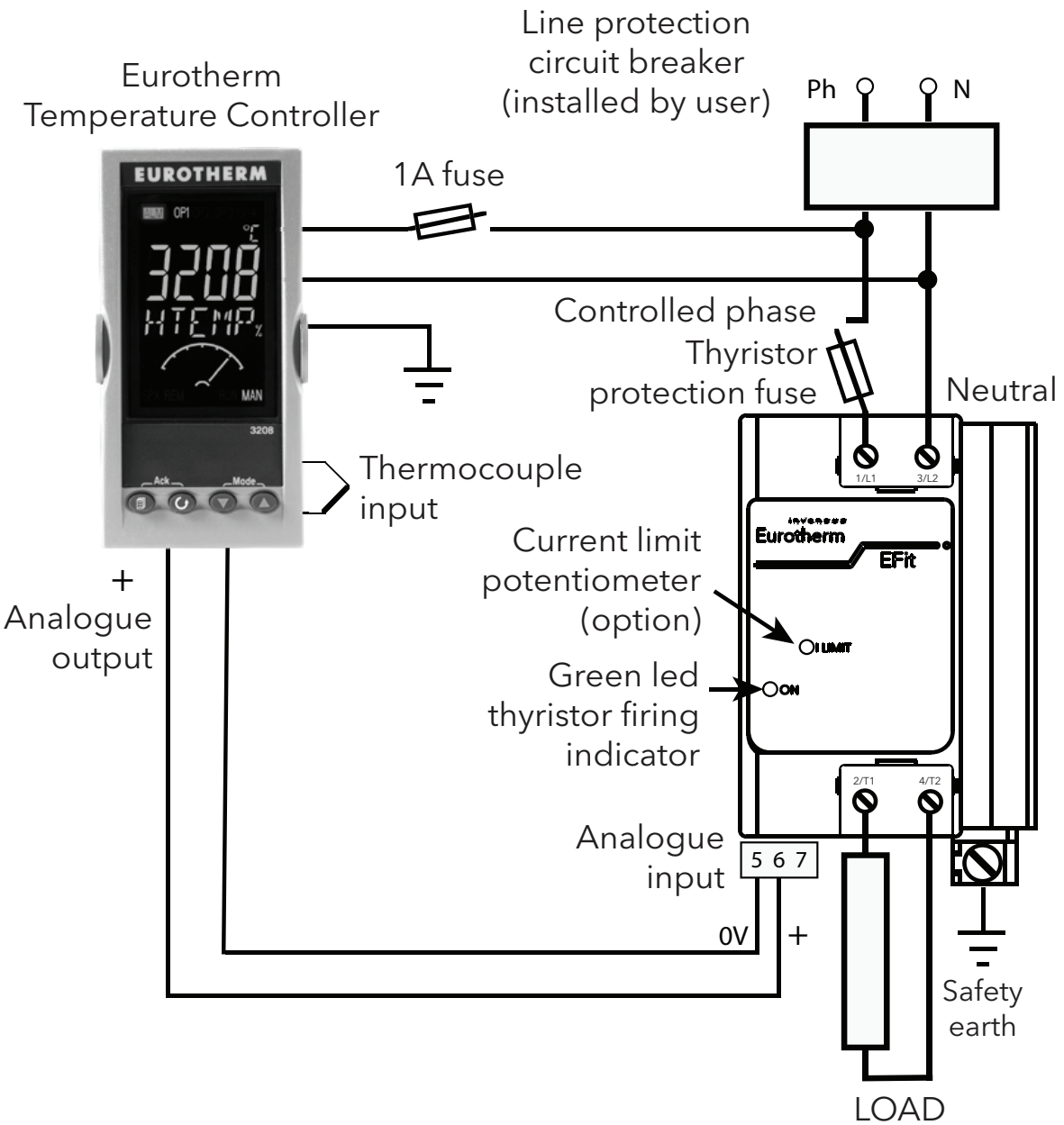


5.2.2 View on upper face



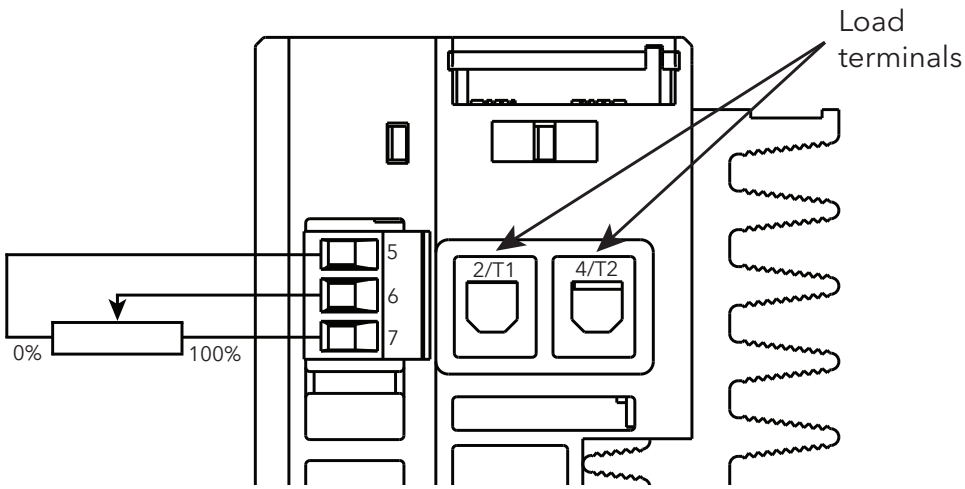
6. Control wiring
6.1 Input signal wiring
6.1.1 Remote Control

Example with an EFit driven by an analogue signal coming from the temperature controller



6.1.2 Local control by potentiometer

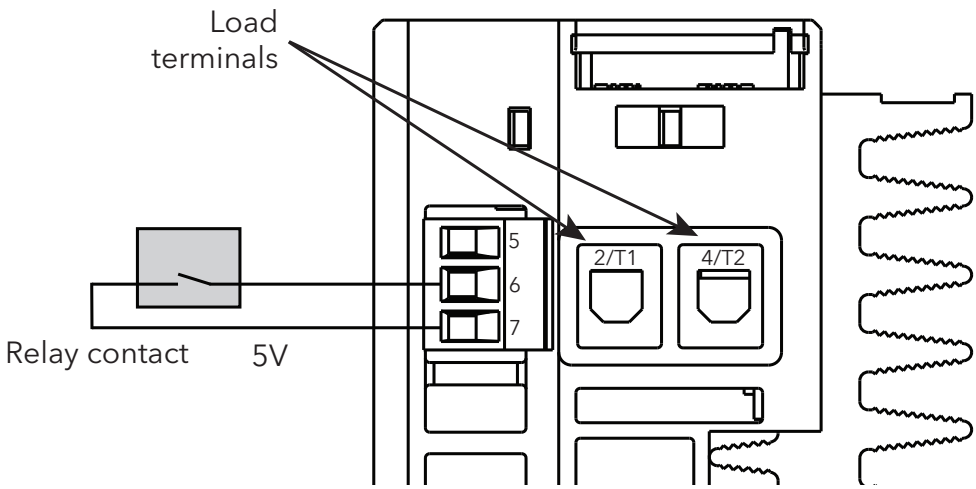
The input must be configured as 0 to 5V (code 0V5)



Wiring of the External potentiometer
(view on lower face)

6.1.3 Local control by contacts

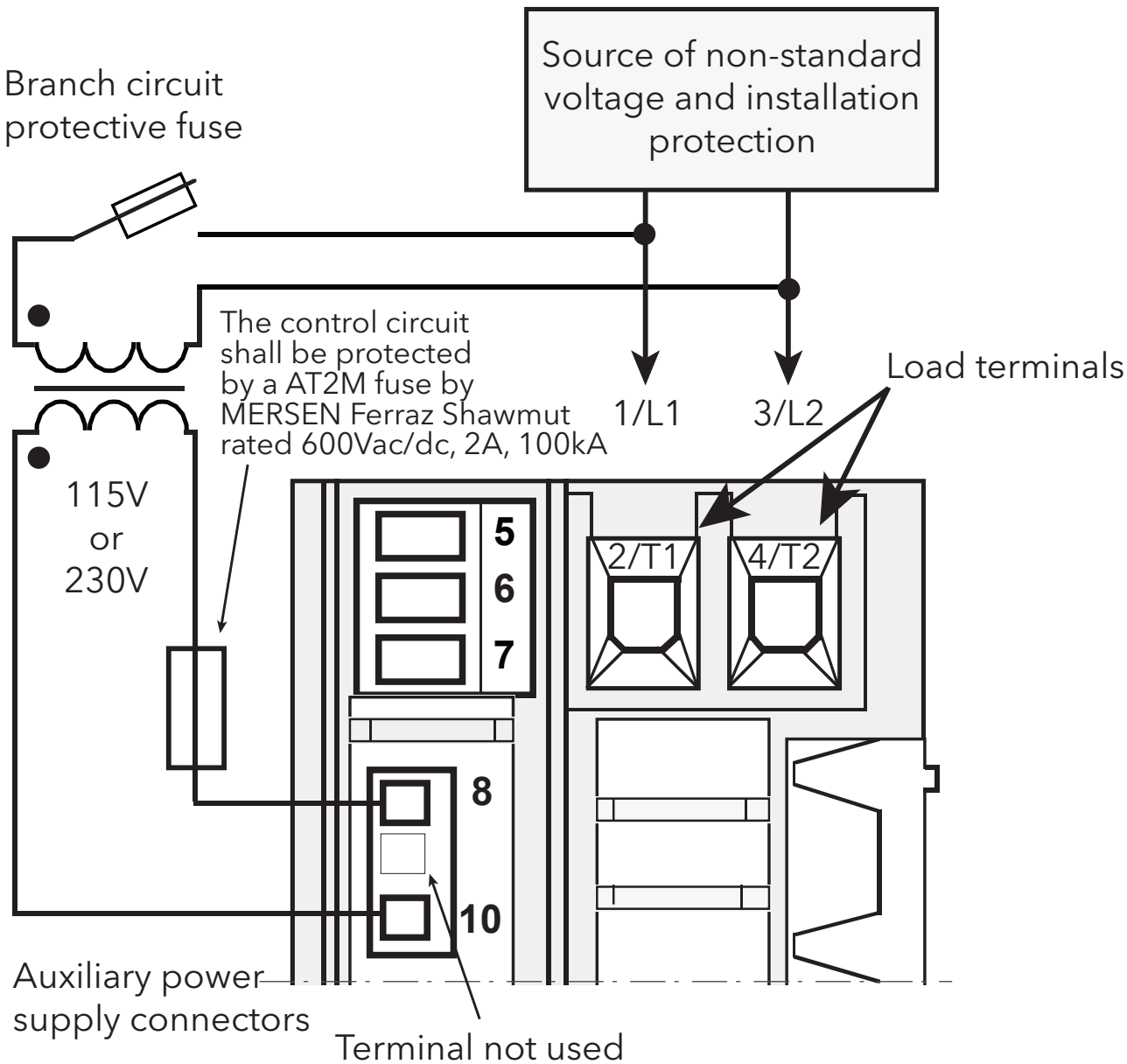
The input must be configured as 0 to 5V (code 0V5).



Wiring of the Relay Contact input
(view on lower face)

6.2 Auxiliary power supply (option)

In the case of non-standard mains, the auxiliary power supply must be in phase with the power supply voltage.



View on the lower face

7. Current limit option (only available with phase angle firing mode)

7.1 Operation

The EFit controller features an adjustable rms load current limit. This function enables the user to limit the load current to a desired value independent of variation in load resistance.
The current limit threshold can be set from 30% to 100% of the nominal current of the controller using the potentiometer labelled 'I LIMIT' on the front facia.

7.2 Adjustment

Warning: This operation must be performed by suitable qualified and trained person.
Current limit adjustment is achievable if the rms load current is greater than or equal to 30% of the nominal current of the power controller. For this adjustment, use a flat bladed screw driver 2,5x0,4mm and a true rms ampmeter in order to minimise errors, which could otherwise amount to as much as 50% of the value of the current.
For current limit adjustment, proceed as follows:

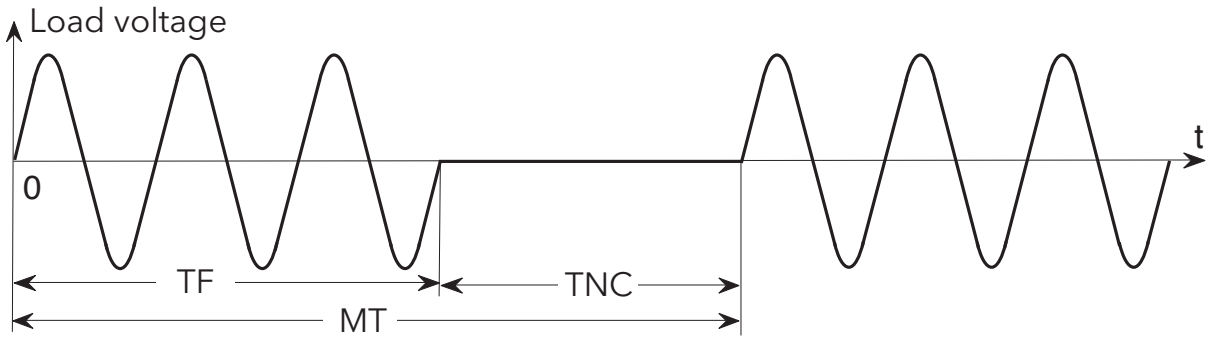
- Check that the load circuit is connected but not supplied
- Turn the potentiometer (labelled 'I LIMIT' on the front fascia) fully anti-clockwise (minimum position)
- Apply a 0% setpoint to the controller input
- If you have the 'Auxiliary power supply' option, switch on the auxiliary power supply
- Switch on the power circuit.
- Set the input signal at 100%.
- Turn slowly the current limit potentiometer clockwise and check that the current increases
- Adjust the potentiometer in order to reach the current limit value in the load.

8. THYRISTORS FIRING MODES

Four firing modes are proposed: Variable burst (or Fast cycle), Single-cycle, advanced Single-cycle and Phase Angle. For the burst modes (FC, FC1 and SCA codes), Thyristor firing and quenching occurs at **zero voltage** which reduce the interferences on the supply network.

8.1 Variable burst (or Fast cycle)

Variable burst (or Fast cycle) mode consists in supplying series of **whole mains cycles** to the load.

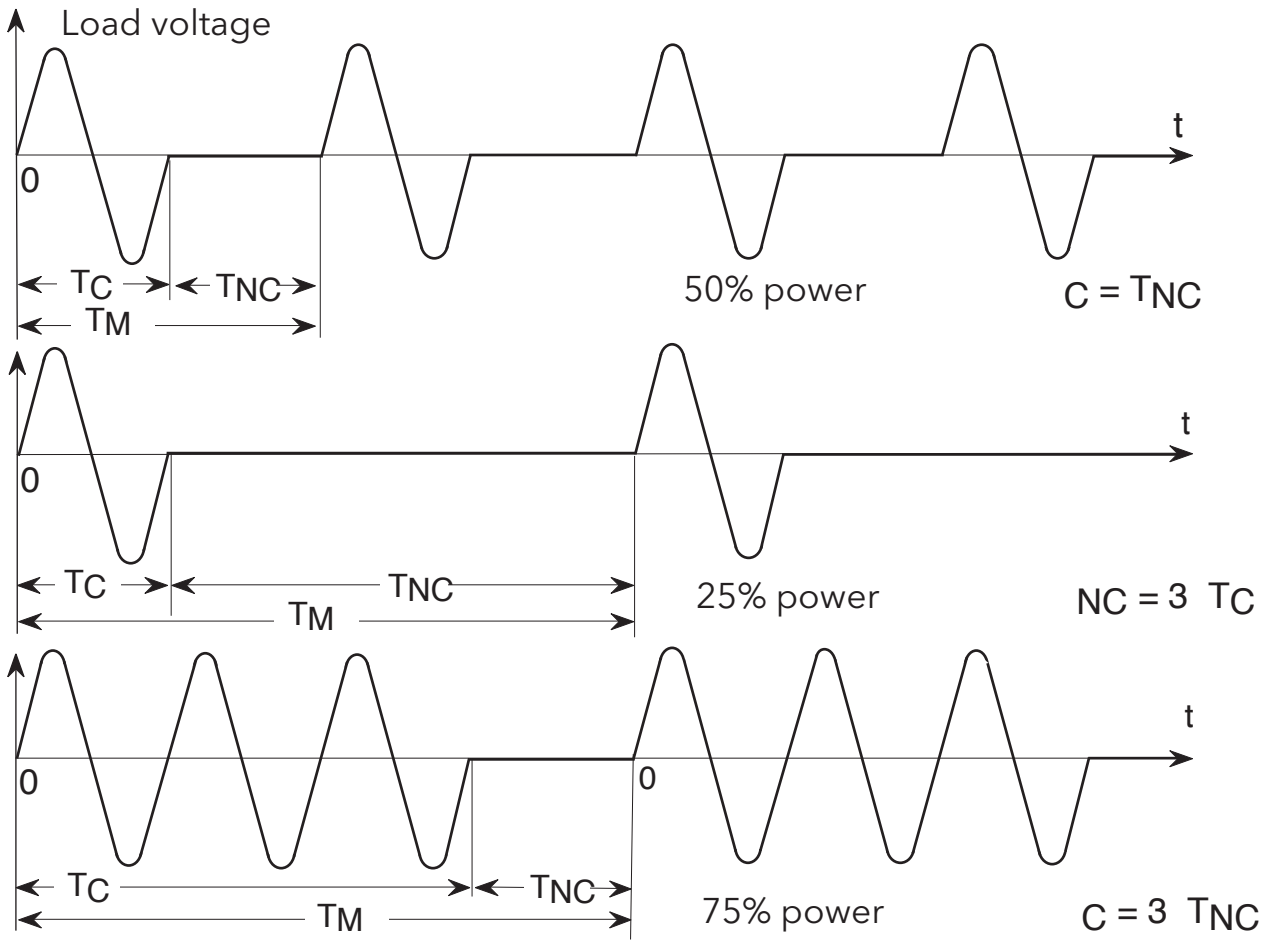


The load power is proportional to the ratio of the firing time (TF) to the modulation time (TM). The OFF time (TNF) is also a series of whole mains cycles. TM= TF+ TNF
The period of modulation is **variable** according to the output power demand.

- At 50% of nominal power the thyristors are on for 16 periods and are off for 16 periods
- For a setpoint less than 50%, the **non-firing** period **increases**, and the firing period is fixed (16 periods)
- For a setpoint greater than 50%, the **firing** period **increases**, and it is the non-firing period which is fixed (16 periods)

8.2 Single-cycle

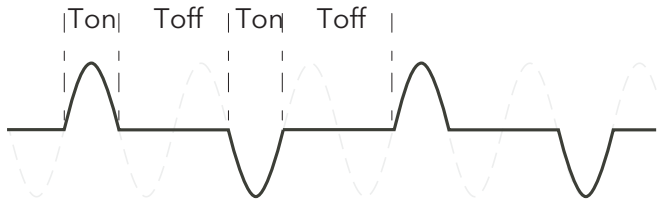
The mode of firing with only one firing or non-firing mains cycle is called **Single-cycle**.



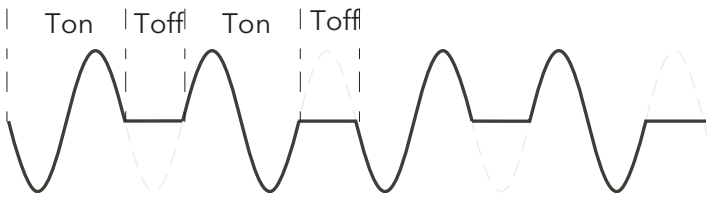
- At 50% of nominal power the thyristors are on for 20ms and are off for 20ms (at 50Hz)
- For a setpoint less than 50% the non-firing period increases and the **firing** period is **fixed** at 20ms
- For a setpoint greater than 50% the firing period increases and it is the **non-firing** period which is **fixed** at 20ms

8.3 Advanced Single-cycle

In order to minimise power fluctuation during the modulation period, the advanced Single-cycle mode uses half-cycles for non-firing duration.



For 33% duty cycle
Ton = 1 half cycle; Toff = 2 half cycles



For 66% duty cycle
Ton = 2 half cycles; Toff = 1 half cycle

Examples of firing in Single-cycle (a) and in advanced Single-cycle (b) modes at 66.6% of nominal power.

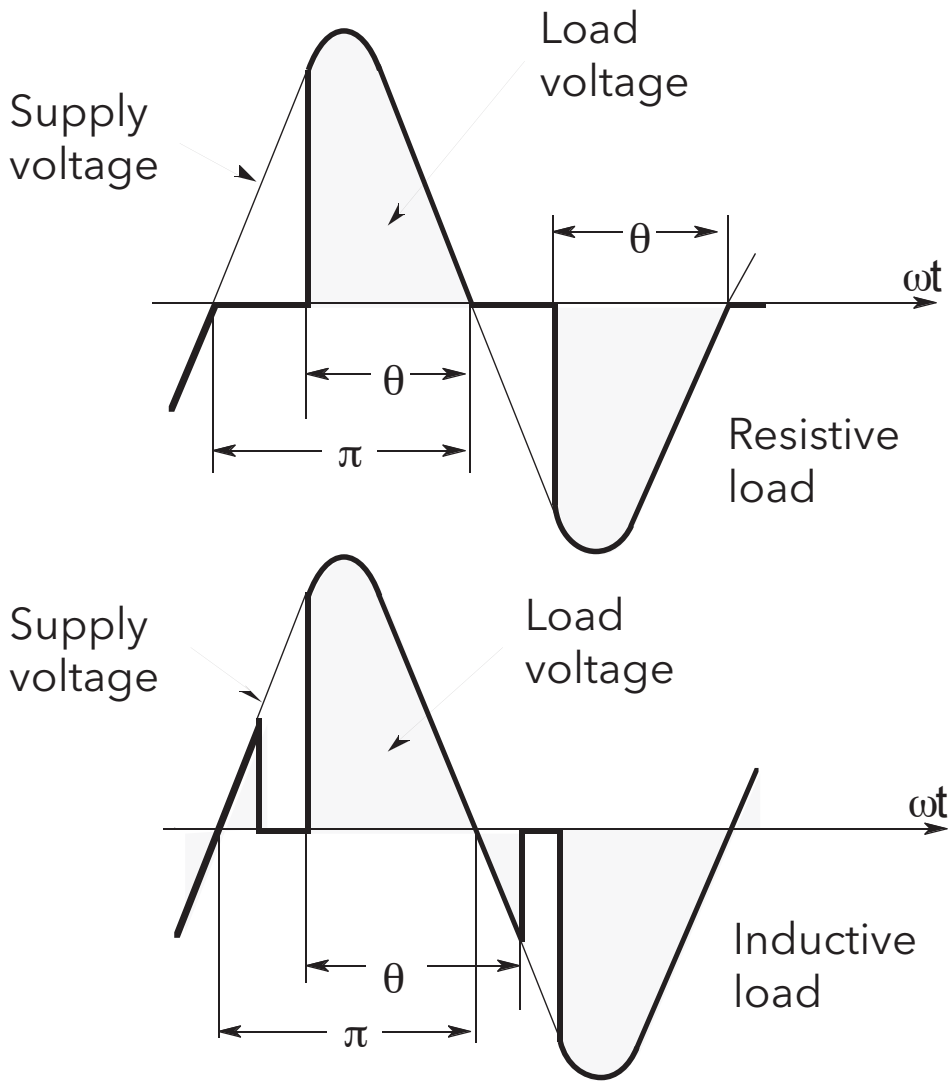
• For a setpoint less than 50%, firing is effected on mains halfcycles. The firing time is fixed at one cycle (20ms at 50Hz)

• For a setpoint greater than 50%, **non-firing** is reduced to **one halfcycle**. Firing is effected over whole cycles.

The use of half-cycles for non-firing allows the reduction in flicker and brightness of infrared elements compared with Single-cycle.

8.4 Phase angle

In ‘phase angle’ thyristor firing mode the power transmitted to the load is controlled by firing the thyristors over part of the supply voltage half cycles.



Load voltage in ‘phase angle’ firing mode (θ: thyristor firing angle)

9. Power control
9.1 Description

EFit controls on the square of the rms load voltage. Control precision is guaranteed at ±2% of the maximum voltage.
The power controlled varies linearly from 0% to 100% of maximum power for an input signal variation from 4% to 96% of full scale. Linearity is better than ±2% of full scale.

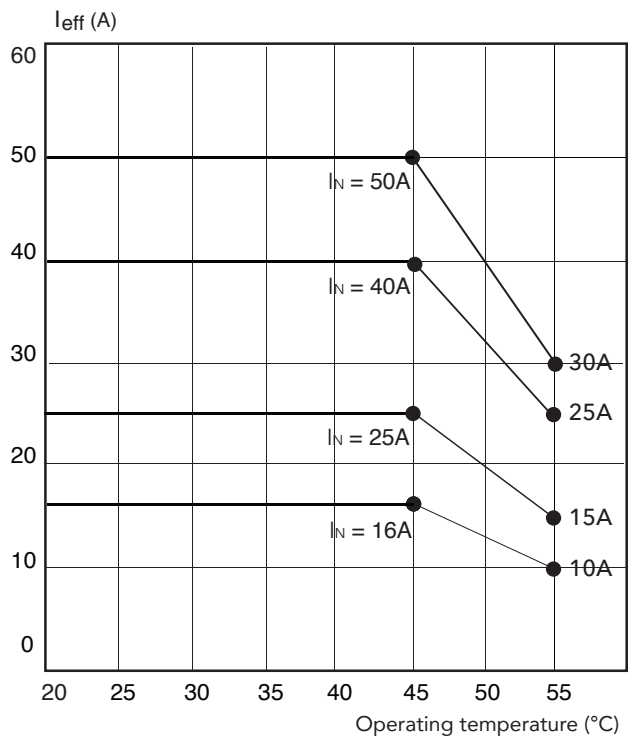
9.2 Compensation of power supply fluctuations

Automatic compensation of supply variation is effective for fluctuations between +10 and -10% of the nominal voltage of the controller.

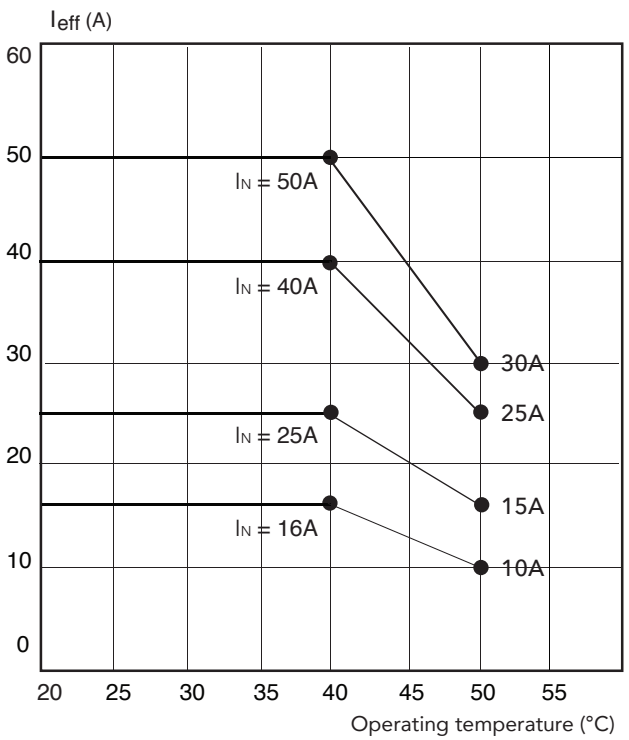
Control with this compensation device enable constant output power to be maintained on a constant load, despite variations in supply voltage.

Without compensation for supply variations, a reduction, for example, of 10% in supply voltage would result in a reduction of 20% in load power. Thanks to this compensation device the variation will be less than ±2%.

10. Current derating



Current derating curves as a function of ambient temperature (I_N = nominal current at 45°C) for an altitude up to 1000m.



Current derating curves as a function of ambient temperature (I_N = nominal current at 40°C) for an altitude up to 2000m.

Eurotherm: International sales and service

ASEAN (Indonesia, Malaysia, Philippines, Singapore, Thailand, Vietnam)
Invensys Process Systems (S) Pte Ltd
T (+65) 6829 8888
F (+65) 6829 8401
E info.eurotherm.asean@invensys.com

AUSTRALIA Melbourne
Invensys Process Systems Australia Pty. Ltd.
T (+61 0) 8562 9800
F (+61 0) 8562 9801
E info.eurotherm.au@invensys.com

AUSTRIA Vienna
Eurotherm GmbH
T (+43 1) 7987601
F (+43 1) 7987605
E info.eurotherm.at@invensys.com

BELGIUM & LUXEMBOURG Moha
Eurotherm S.A./N.V.
T (+32) 85 274080
F (+32) 85 274081
E info.eurotherm.be@invensys.com

BRAZIL Campinas-SP
Eurotherm Ltda.
T (+5519) 3112 5333
F (+5519) 3112 5345
E info.eurotherm.br@invensys.com

CHINA
Eurotherm China
T (+86 21) 61451188
F (+86 21) 61452602
E info.eurotherm.cn@invensys.com
Beijing Office
T (+86 10) 5909 5700
F (+86 10) 5909 5709/10
E info.eurotherm.cn@invensys.com

FRANCE Lyon
Eurotherm Automation SA
T (+33 478) 664500
F (+33 478) 352490
E info.eurotherm.fr@invensys.com

GERMANY Limburg
Invensys Systems GmbH
>EUROTHERM<
T (+49 6431) 2980
F (+49 6431) 298119
E info.eurotherm.de@invensys.com

INDIA Mumbai
Invensys India Pvt. Ltd.
T (+91 22) 67579800
F (+91 22) 67579999
E info.eurotherm.in@invensys.com

IRELAND Dublin
Eurotherm Ireland Limited
T (+353 1) 4691800
F (+353 1) 4691300
E info.eurotherm.ie@invensys.com

ITALY Como
Eurotherm S.r.l
T (+39 031) 975111
F (+39 031) 977512
E info.eurotherm.it@invensys.com

JAPAN Tokyo
Invensys Process Systems Japan, Inc.
T (+81 3) 6450 1092
F (+81 3) 5408-9220
E info.eurotherm.jp@invensys.com

KOREA Seoul
Invensys Operations Management Korea
T (+82 2) 2090 0900
F (+82 2) 2090 0800
E info.eurotherm.kr@invensys.com

NETHERLANDS Alphen a/d Rijn
Eurotherm B.V.
T (+31 172) 411752
F (+31 172) 417260
E info.eurotherm.nl@invensys.com

MIDDLE EAST AND NORTH AFRICA
UAE Dubai
Invensys Middle East FZE
T (+971 4) 8074700
F (+971 4) 8074777
E marketing.mena@invensys.com

POLAND Katowice
Invensys Eurotherm Sp z o.o.
T (+48 32) 7839500
F (+48 32) 7843608/7843609
E info.eurotherm.pl@invensys.com
Warsaw
Invensys Systems Sp z o.o.
T (+48 22) 8556010
F (+48 22) 8556011
E biuro@invensys-systems.pl

SPAIN Madrid
Eurotherm España SA
T (+34 91) 6616001
F (+34 91) 6619093
E info.eurotherm.es@invensys.com

SWEDEN Malmo
Eurotherm AB
T (+46 40) 384500
F (+46 40) 384545
E info.eurotherm.se@invensys.com

SWITZERLAND Wollerau
Eurotherm Produkte (Schweiz) AG
T (+41 44) 7871040
F (+41 44) 7871044
E info.eurotherm.ch@invensys.com

TAIWAN Kaohsiung
Invensys Taiwan
T (+ 886 7) 811-2269
F (+ 886 7) 811-9249
E apmarketing.iom@invensys.com
Taipei City Office
T (+ 886 2) 8797 1001
F (+ 886 2) 2799 7071
E apmarketing.iom@invensys.com

UNITED KINGDOM Worthing
Eurotherm Limited
T (+44 1903) 268500
F (+44 1903) 265982
E info.eurotherm.uk@invensys.com

U.S.A. Ashburn VA
Invensys Eurotherm
T (+1 703) 724 7300
F (+1 703) 724 7301
E info.eurotherm.us@invensys.com

ED70
Contact details correct at time of print

HA031980ENG issue 1

invensys
Eurotherm