Q7000

QUALITE
MODULARITE
ADAPTABILITE
PRECISION
SIMPLICITE
MULTIZONE

Multichannel
Thyristor Power Unit

invensys

EUROTHERM

User
Manual

ENG

CONTENTS

This manual (Issue 3.0) describes the basic Version and Options of the Q7000 Thyristor Power Unit.

EUROPEAN DIRECTIVES AND APPLICABLE STANDARDS

COMPLANCE WITH PRODUCT STANDARD

Q7000 products comply with the terms of product standard **EN 60947-4-3**
'Contactors and motor-starters - AC semiconductor controllers and contactors for non-motor loads'.
The number of this standard is indicated on the front panel label.

CE LABELLING

Q7000 products, installed and used in accordance with their user manual, bear CE labelling to indicate compliance with
the essential requirements of:
• the **European Low Voltage Directive** 73/23 EEC dated 19 February 1973 amended by 93/68 EEC dated 22 July 1993
• the **Electromagnetic Compatibility Directive** 89/336/EEC dated 3 May 1969 amended by 92/31/EEC dated 28 April 1992 and
  93/68/EEC dated 22 July 1993.

SAFETY

The units have IP20 protection rating as defined by standard IEC 60529.
External wiring must comply with standards IEC 60364-4-43 and IEC 60943.
Copper cables and conductors rated to a temperature of 75°C (167°F) must be used.

ELECTROMAGNETIC COMPATIBILITY (EMC) TEST STANDARDS

Q7000 products installed and used in accordance with the user manual, are designed for an industrial environment and
must not be used in the home.

IMMUNITY

The EMC immunity test standards required by product standard EN 60947-4-3 are given in table 1.

Test Type	Minimum Level	EMC test standards
Electrostatic discharge	4 kV on contact ; 8 kV in air	EN 61000-4-2
Radiated, radio frequency electromagnetic field	10 V/m 80 MHz $\leq$ f $\leq$ 1 GHz ; 80% modulation 1 kHz sinusoidal	EN 61000-4-3
Electrical fast transient / burst	2 kV / 5 kHz	EN 61000-4-4
Electical surge	4 kV line to earth; 2 kV line to line.	EN 61000-4-5
Conducted disturbances	140 dBmV; 150 kHz $\leq$ f $\leq$ 80 MHz	EN 61000-4-6
Voltage dips, short interruptions and voltage variation	5 s interruptions	EN 61000-4-11

Table 1 - EMC immunity standards compliance

EMISSIONS

The EMC emissions test standards required by product standard EN 60947-4-3 are given in table 2.

Emission Type	Firing Mode	EMC test standards
Radiated, radio frequency	All firing modes	CISPR 11 Class A
Conducted, radio frequency	'Burst mode' and 'Single-cycle'	CISPR 11 Class A Groupe 2

Table 2 - EMC emissions standards compliance

EMC GUIDE

To help you deal with installation-dependent electromagnetic interference effects, Eurotherm provides an 'Electromagnetic
compatibility' installation guide (ref. HA025464) which sets out best current practice regarding EMC.
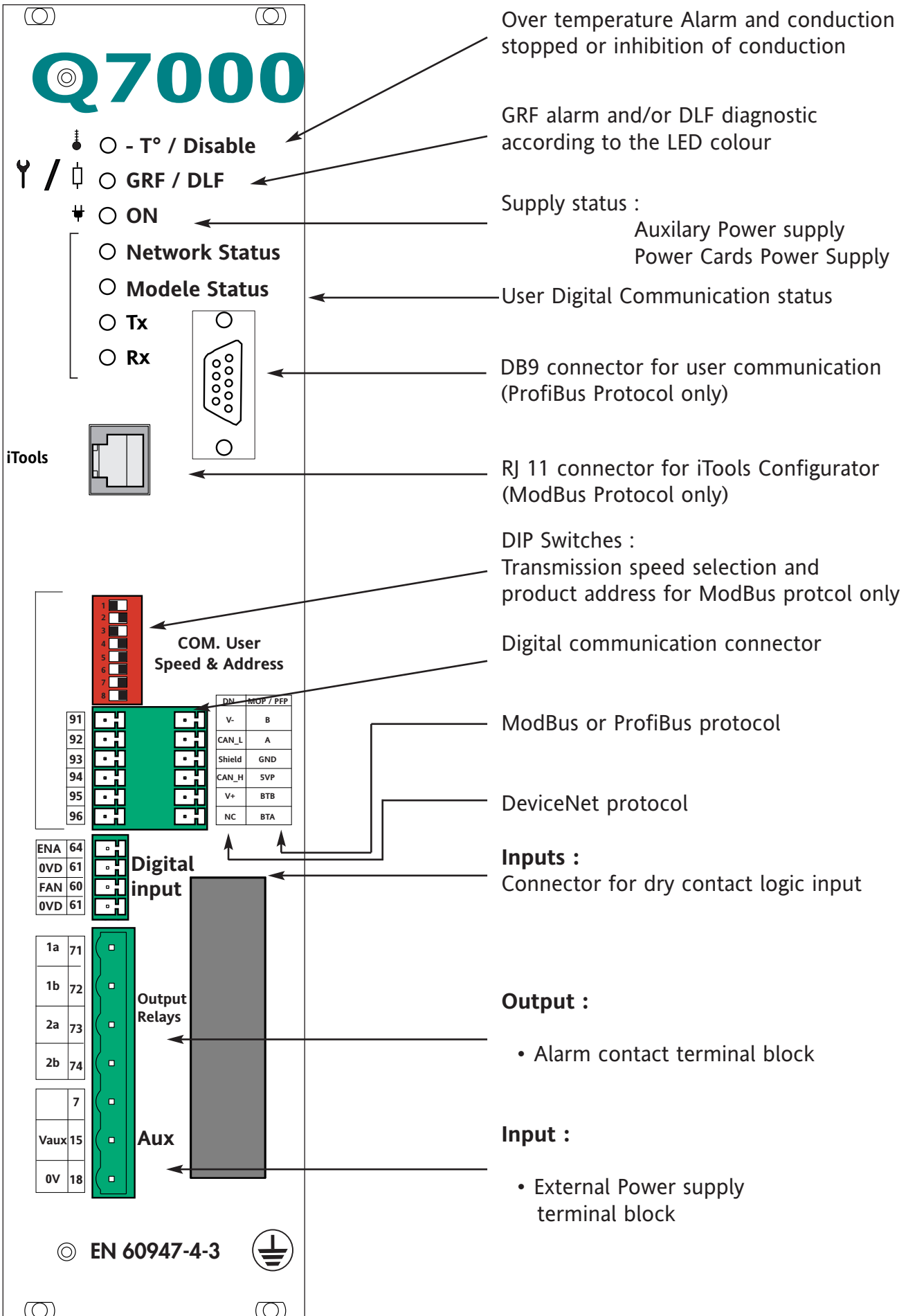
DECLARATION OF CONFORMITY

A CE declaration of conformity is available on request.
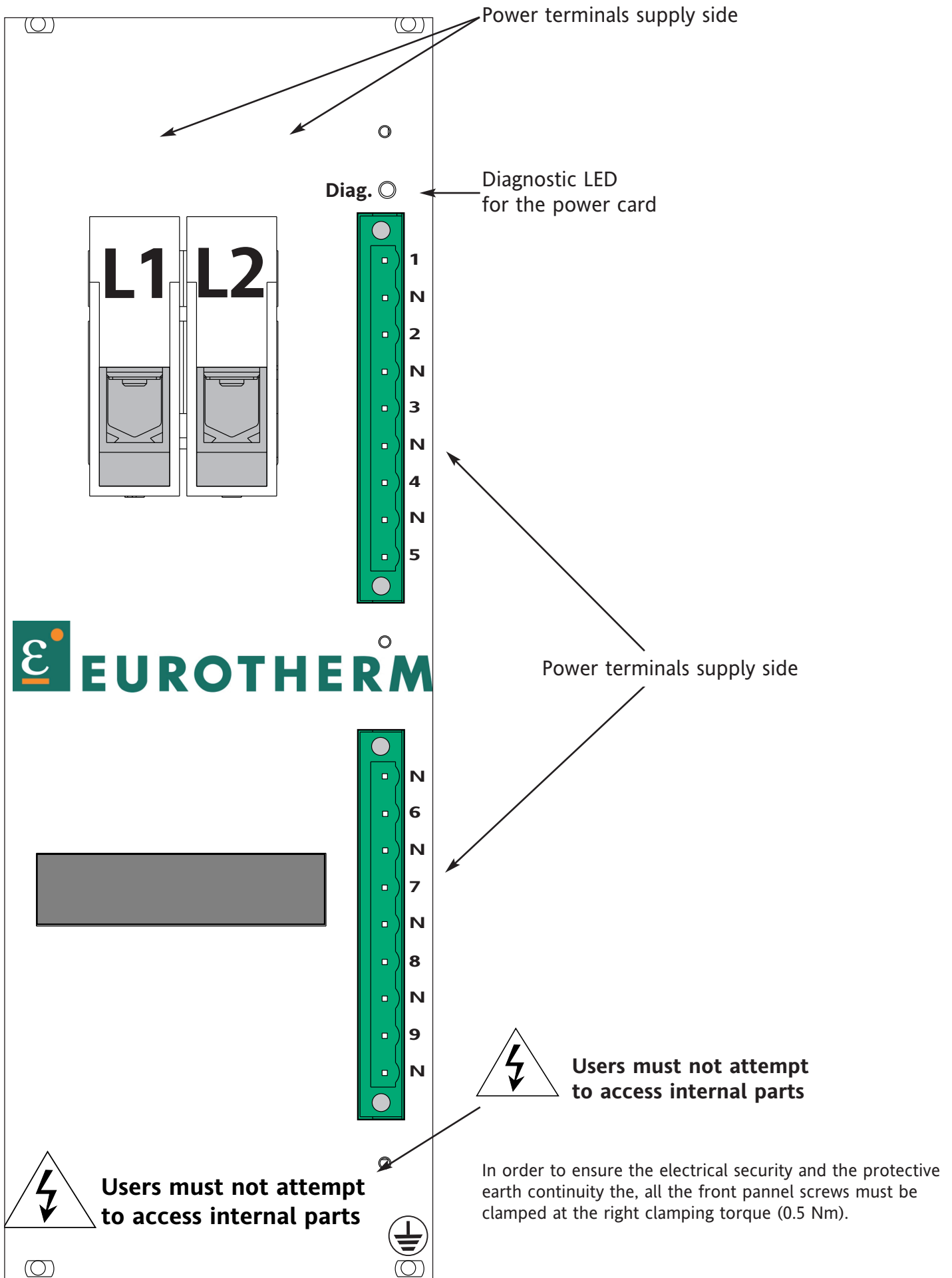
CHAPTER 1

1. Q7000 IDENTIFICATION

1.1. DRIVER CARD DESCRIPTION

Over temperature Alarm and conduction stopped or inhibition of conduction

GRF alarm and/or DLF diagnostic according to the LED colour

Supply status :
Auxilary Power supply
Power Cards Power Supply

User Digital Communication status

DB9 connector for user communication (ProfiBus Protocol only)

RJ 11 connector for iTools Configurator (ModBus Protocol only)

DIP Switches :
Transmission speed selection and product address for ModBus protcol only

Digital communication connector

ModBus or ProfiBus protocol

DeviceNet protocol

Inputs :
Connector for dry contact logic input

Output :

• Alarm contact terminal block

Input :

• External Power supply
terminal block

Q7000

- T° / Disable

GRF / DLF

ON

Network Status

Modele Status

Tx

Rx

iTools

COM. User
Speed & Address

	DN	MOP / PFP
91	V-	B
92	CAN_L	A
93	Shield	GND
94	CAN_H	5VP
95	V+	BTB
96	NC	BTA

ENA	64	
0VD	61	**Digital**
FAN	60	**input**
0VD	61	

1a	71	
1b	72	**Output**
2a	73	**Relays**
2b	74	
	7	
Vaux	15	**Aux**
0V	18	

◎ **EN 60947-4-3**

1.2. POWER CARD DESCRIPTION

Power terminals supply side

Diagnostic LED
for the power card

Diag.

L1 L2

1
N
2
N
3
N
4
N
5

EUROTHERM

Power terminals supply side

N
6
N
7
N
8
N
9
N

⚡ **Users must not attempt
to access internal parts**

⚡ **Users must not attempt
to access internal parts**

In order to ensure the electrical security and the protective
earth continuity the, all the front pannel screws must be
clamped at the right clamping torque (0.5 Nm).

1.3. TECHNICAL SPECIFICATIONS

1.3.1. PRODUCT STANDARDS AND CE LABELLING

Q7000 products comply with the terms of product standard **EN 60947-4-3**
'Contactors and motor-starters - AC semiconductor controllers and contactors for non-motor loads'.
The number of this standard is indicated on the front panel label.

Q7000 products, installed and used in accordance with their user manual, bear CE labelling to indicate compliance with the essential requirements of:
• the **European Low Voltage Directive** 73/23 EEC dated 19 February 1973 amended by 93/68 EEC dated 22 July 1993
• the **Electromagnetic Compatibility Directive** 89/336/EEC dated 3 May 1969 amended by 92/31/EEC dated 28 April 1992 and 93/68/EEC dated 22 July 1993.

IP 20 protection without any added protections, according to EN 60529, defined by IEC 664

A fuse on each line is installed inside the rack.

1.3.2. ENVIRONMENT

Use	0 to 45 °C of ambient temperature with a nominal current of 11 A with a derating to 5.5 A for 0 to 60 °C af ambient temperature
	The minimum working temperature is 0 °C at a maximum altitude of 2000 m Max.
Storage	from -10°C to 70°
Pollution	Degree 2 acceptable (definied by IEC 60664).
Atmosphere	Non explosive, non-corrosive, non-conductive.
Humidity	RH 5% to 95%, non-condensing, non-streaming.

1.3.3. POWER

Nominal Current	11 A at 45 °C
Nominal Voltage	230 V or 115 V (+10 % ; -15 %) standards.
	For other voltages (24V, 48V and 63.5V) please contact Eurotherm.
Frequency	Use from 47 to 63 Hz (automatic matching)
Dissipated Power	$\approx 1{,}3$ W per amp and per phase.
Cooling	Ventilation rack. 115 V or 230 V ; consumption 10 VA.
	Water cooling in addition to air cooling is necessary for working temperature of use higher than the ones indicated.
Load type	Single-phased load, they can be distibuted among one, two or three phase according to the custommer choice
Category of Use	AC-51. Non-indictive or low inductance loads, furnace resistances
	Resistive load with low temperature coefficient

1.3.4. CONTROL

Power supply	External power supply (115 V or 230 V ; +10 %, -15 %), consumption 10 VA.
Control type	Digital

1.3.5. TRIAC PROTECTION

• Triacs protection by RC snubbers (each)
• General protection of the product by Varistors

1.3.6. CONTROL

Control type V^2, compensation of supply voltage variations
                  I^2, V x I, Open Loop, Vrms ou Irms.
Linearity   ±1 % (Balanced load and supply)
Stability   ±1 % (supply variation from +10 % to -15 %)
Accuracy   ±1 % (Balanced load and supply)

1.3.7. FIRING MODES

Digital Communication configuration.
Zero crossing firing - **Burst mode**, from 2 to 255 cycles
                          - **Single-Cycle** (1 base cycle),
                         - **Advanced Single-Cycle,** conduction / no conduction by half cycles.

1.4. ALARMS

Note : Powerering on acts the same way as alarm acknoledgement

1.4.1. Thyristor Short-Circuit and Total Load Failure (GRF)

• Alarm signalling Thyristor Short-Circuit or Total Load Failure

• Alarm relay contact signalling (if defined by user for this alarm) :
  Alarm Relay 1 and/or Alarm Relay 2 (NO or NC see code).
  These two relays are entirely configurable by the user.

• GRF/DLF red LED on front panel shows if on of the power slot has failed and
  via SWC and GSW1 status words.

1.4.2. Diagnostic and Partial Load Failure (DLF)

• Adjustable up to I>30% and V>40% of the nominal current and voltage of the unit.

• Failure detection of one element out of two (Consatnt resistance loads)

• Alarm relay contact signalling (if defined by user for this alarm) :
  Alarm Relay 1 and/or Alarm Relay 2 (NO or NC see code).
  These two relays are entirely configurable by the user

• GRF/DLF flashing orange LED on front panel, showing if one of the power slot has failed,
  Alarm Relay 1 and/or Alarm Relay 2 (NO or NC see code) if set during configuration and
  via SWC and GSW1 status words.

Important :
Even if the PLF detection is OFF, the TLF detection stays active. The PLF setting request is made with the
Command word 7 with all the currents > 30% of I_N, for the load to be monitored. Disabelling the PLF alram is
done by setting the setpiont th 0%.

1.4.3. Overtemperature
• Conductions stopped if the temperature exceeds the temperature level. Indicated by the
  T° red LED and alarm relay if selected.

1.4.4. Alarm Relays

Two alarm relay contacts are available and reconfigurable by the user.
Relay contact (0,25 A/230 Vac, 32 Vdc) is closed or open in alarm according to the code.

1.5. MECHANICAL ASPECT

Constitution   The Q7000 is a 19'' standard rack
Driver and Power parts can be bought separately (Kit version)

Dimensions	Height	Width	Depth
Rack	6U (265,9 mm)	19'' (482,6mm)	295 mm
Driver	233,25 mm	12 F (60,96 mm)	220 mm
Power	233,25 mm	18 F (91,44 mm)	220 mm
Cabinet	≤ 2 m	400 mm	600 mm

Mounting   Into a cabinet, from 1 to 3 racks.

Warning ! Only 3 racks can be mounted into a cabinet with the right cooling process

Cooling

With a current of 11 A per channel, without exceeding 40 °C of ambiant temperature, cooling is assured with a ventilation unit.If the temprature exceeds 40 °C, water-cooling is necessary in addition to air-cooling, in order to maitain 40 °C inside the cabinet.The units have a thermal switch in order to avoid over-heating damage if the ventilation units fails.

Use example for 3 racks into a cabinet (1400*600*400 mm)

• Max ambient temperature of 45 °C,11 A of nominal current
   Minimum output flow the fan-cooling system must deliver : 3 x 900 m3/h
• Max ambient temperature of 60 °C,11 A of nominal current
  (Water cooling system in addition to the fan-cooling system)
   Minimum output flow the water-cooling system must deliver : 100 l/h,
under 10 bars pressure (T water < 20 °C)

Fan
Q7000
Fan
Q7000
Fan
Q7000
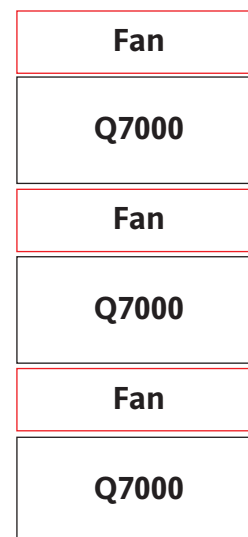
1.6. USER DIGITAL COMMUNICATION

Protocol	ModBus RTU, ProfiBus, DeviceNet
Transmission Standard	RS485, 2 wires (A and B)

ModBus Protocol

Transmission speed	9600 to 19200 bauds (dipswith 1),
Address	Dip Switches from 2 to 8 selection

Communication complies with the specification given in 'GOULD MODICON Protocol Reference Guide PI-MBUS-300 rev J'.

ProofiBus Protocol
The Profibus (Process Field Bus Decentralized Periphery) communication protocol specifications are defined by the EN 50170 / DIN 19245 / Part3 directives.

DeviceNet Protocol*
* available later

1.7. DIGITAL COMMUNICATION CONFIGURATOR (iTools)

Protocol	ModBus®
Standard de transmission	RS232, 3 wires (Rx, Tx and GND), RJ11 connector, with Eurotherm link reference : 2500A/CABLE/CONFIG/RJ11/9PINDF/3Mo
Transmission speed	19200 bauds
Address :	1 by default

Coding : Q7000 1 / 2 / 3 / 4 / 5 / 6 / 7 / 8 / 9 / 10

1. Number of Channels	Code
9 Channels	9
18 Channels	18
27 Channels	27
36 Channels	36

2. Nominal Load Voltage - Slot 1	Code
115 Volts	115V
230 Volts	230V

3. Nominal Load Voltage - Slot 2	Code
No slot 2	XXXX
115 Volts	115V
230 Volts	230V

4. Nominal Load Voltage - Slot 3	Code
No slot 3	XXXX
115 Volts	115V
230 Volts	230V

5. Nominal Load Voltage - Slot 4	Code
No slot 4	XXXX
115 Volts	115V
230 Volts	230V

6. Fan	Code
With fan	FAN
Without Fan	NOFAN

7.Electronic and fan Supply	Code
External 24 V Supply	24V*
External 115 V Supply	115V
External 230 V Supply	230V

8. Digital Communication	Code
Modbus® Protocol	MOP
Profibus-DP Protocol	PFP
DeviceNet Protocol	DNP*

9. Relay Configuration - R1 and R2		Code
Relay 1	Relay 2	
Normally Closed	Normally Closed	NC-NC
Normally Closed	Normally Open	NC-NO
Normally Open	Normally Closed	NO-NC
Normally Open	Normally Open	NO-NO
The standard, out of factory configuration, being NC-NC		

10. Certification	Code
With Certificate	CERT
None	XXXX

* Available later

CHAPTER 2

2. INSTALLATION

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2. INSTALLATION

2.1. SAFETY DURING INSTALLATION (MOUNTING AND WIRING)

Danger !

• Q7000 must be installed and wired by qualified staff authorised to work on low voltage industrial electrical facilities.

• Load connectors must stay plugged-in, even if they are not used.

• Units must be installed in a fan-cooled cabinet, to ensure that condensation and pollution are excluded. We recommend fitting fan-cooled cabinets with a fan failure detection device or a thermal safety cut-out. The cabinet must be closed and connected to the protective earth according to IEC 364 or applicable national standards.

• Units must be mounted with no obstructions above or below the unit which could reduce or hamper air flow. If several units are fitted in the same cabinet, arrange them such that air from one unit is not drawn in by the unit above. Leave a gap of at least 10 mm between two adjacent units.

Warning !

• Nominal currents correspond to use at ambient temperatures.
  Overheating may cause incorrect operation and may even lead to components being damaged.

Danger !

• It is the user's responsibility to wire and protect the facility according to best practice and applicable standards. A suitable device, ensuring that the unit can be electrically isolated from the supply, must be installed upline to enable work to be performed safely. Conductor cross-sections should comply with IEC 943. Use only copper cables and wires designed for use at up to 75°C.

• Before connecting or disconnecting the unit check that power and control cables and leads are isolated from voltage sources. The protective earth must be connected before any other connections are made and should be the last cable to be disconnected.
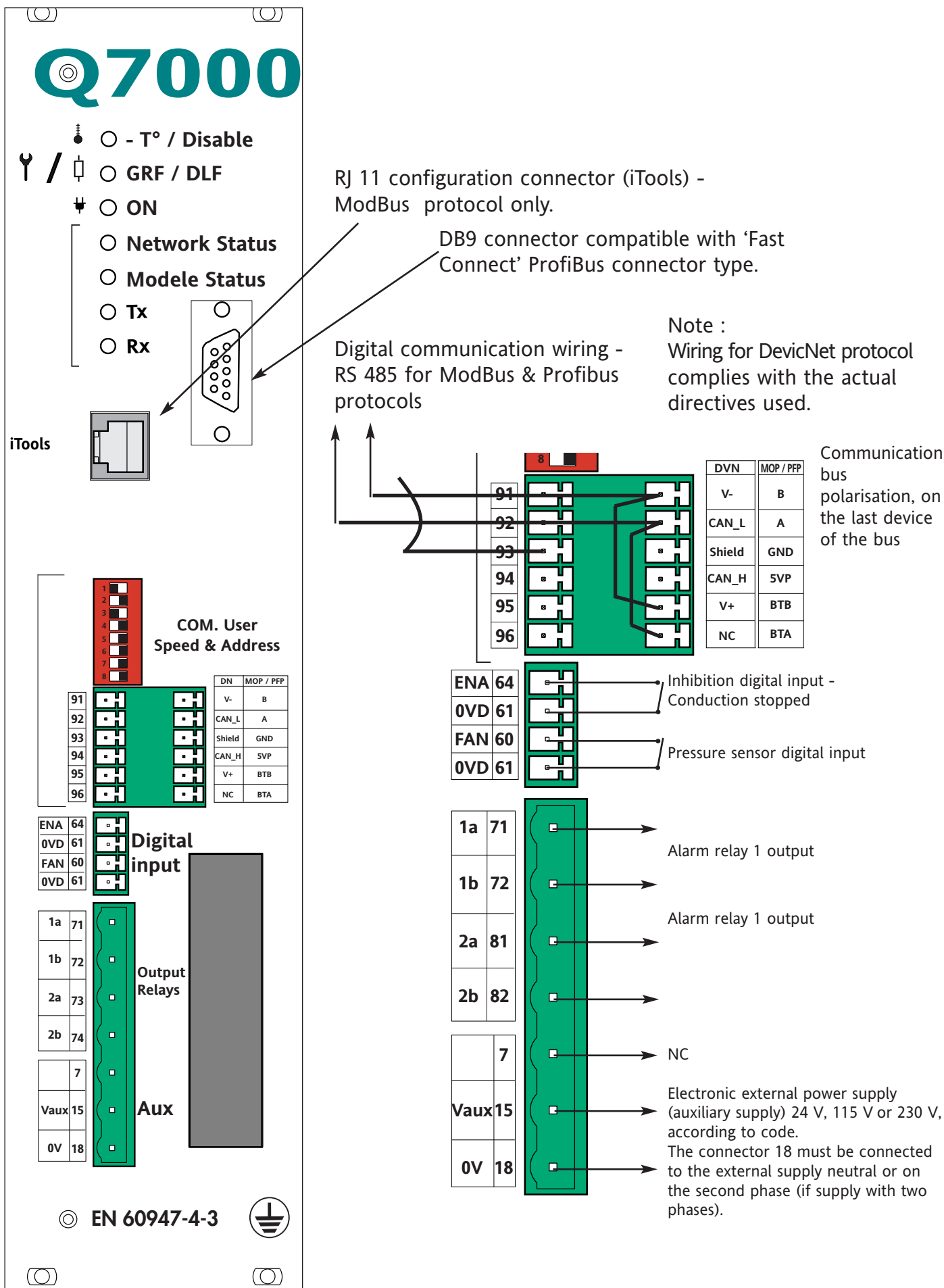 The protective earth connection terminal is marked with the symbol.

In order to ensure the electrical security and the protective earth continuity, all the front panel screws must be clamped at the right clamping torque (0.5 Nm).
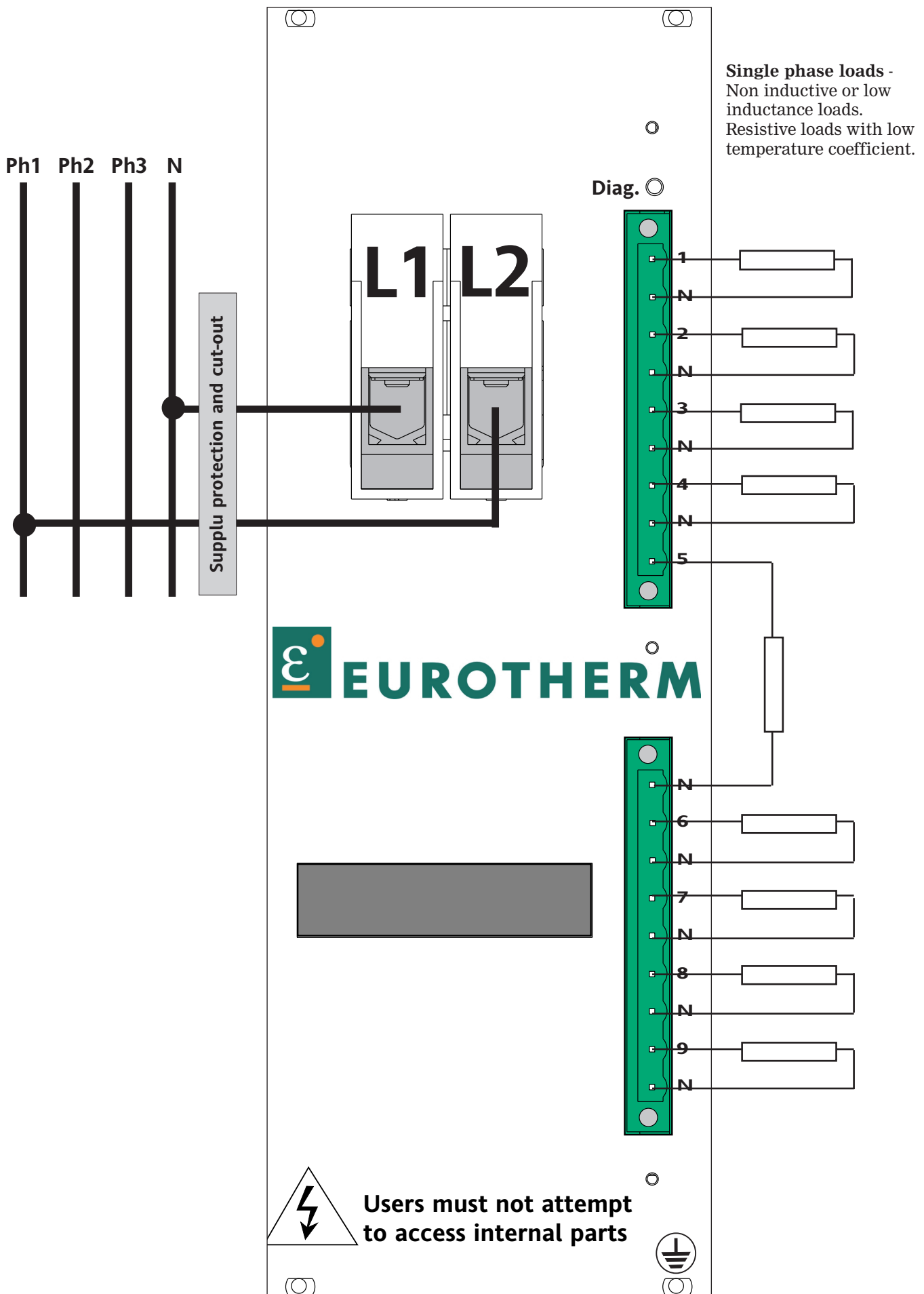
Warning !

• To ensure that Q7000 comply with Electromagnetic Compatibility requirements, ensure that the panel to which they are attached is correctly grounded. The ground connection, designed to ensure **ground continuity**, is not in any way a substitute for the protective earth connection. To ensure the protective earth continuity and the electrical safety of the installation, all the front panel screws must be clamped correctly, at the clamping torque indicated.

2.2. WIRING DRIVER CONNECTION DIAGRAM

Q7000

○ - T° / Disable

○ GRF / DLF

○ ON

○ Network Status

○ Modele Status

○ Tx

○ Rx

iTools

RJ 11 configuration connector (iTools) - ModBus protocol only.

DB9 connector compatible with 'Fast Connect' ProfiBus connector type.

Digital communication wiring - RS 485 for ModBus & Profibus protocols

Note :
Wiring for DevicNet protocol complies with the actual directives used.

COM. User Speed & Address

	DN	MOP / PFP
91	V-	B
92	CAN_L	A
93	Shield	GND
94	CAN_H	5VP
95	V+	BTB
96	NC	BTA

ENA	64		**Digital**
0VD	61		**input**
FAN	60		
0VD	61		

1a	71		
1b	72		**Output Relays**
2a	73		
2b	74		
	7		
Vaux	15		**Aux**
0V	18		

◎ **EN 60947-4-3** ⏚

	DVN	MOP / PFP
91	V-	B
92	CAN_L	A
93	Shield	GND
94	CAN_H	5VP
95	V+	BTB
96	NC	BTA

Communication bus polarisation, on the last device of the bus

ENA	64	Inhibition digital input - Conduction stopped
0VD	61	
FAN	60	Pressure sensor digital input
0VD	61	

1a	71	→ Alarm relay 1 output
1b	72	→
2a	81	→ Alarm relay 1 output
2b	82	→
	7	→ NC
Vaux	15	→ Electronic external power supply (auxiliary supply) 24 V, 115 V or 230 V, according to code.
0V	18	→ The connector 18 must be connected to the external supply neutral or on the second phase (if supply with two phases).

2.3. Wiring power connection diagram

Power / Load connection

Ph1 Ph2 Ph3 N

Supplu protection and cut-out

L1 L2

Diag.

Single phase loads - Non inductive or low inductance loads. Resistive loads with low temperature coefficient.

2-4

1
N
2
N
3
N
4
N
5

N
6
N
7
N
8
N
9
N

EUROTHERM

Users must not attempt to access internal parts

CHAPTER 3

3. FIRING MODES

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3. FIRING MODES

Q7000 power thyristor units can be controlled with one of the following thyristor firing types:
   • a series of supply voltage cycles with zero crossing firing.

3.1. BURST MODE - CT ≥ 2

'**Burst mode**' firing is a **proportional cycle** which delivers a series of **whole supply cycles** to the load.

Thyristor firing and cut-off is synchronised with the supply and occurs at **zero** crossing.

Thyristor firing in 'Burst mode' can be described by the :
firing time (T_F) ,
non-firing time (T_{NF}) and
the modulation time (T_M)
where $T_M = T_F + T_{NF}$
The power delivered to the load is defined by the **duty ratio** $\eta = T_F / T_M$
Firing in 'Burst mode' is defined by the **Base Cycle Time (T_B)**.
The Base Cycle Time is equal to the **number of cycles** firing at **50%** of the duty ratio (or 50% of the power supplied to the load):
$$T_B = T_F = T_{NF}.$$

The Base Cycle time is equal to **16 cycles** for code **C16** and **64 cycles** for code **C64.**

The control system **adjusts** the modulation time to retain the same precision for all duty ratios η (power requested).

Thyristor firing for one of the phases, in 'Burst mode'
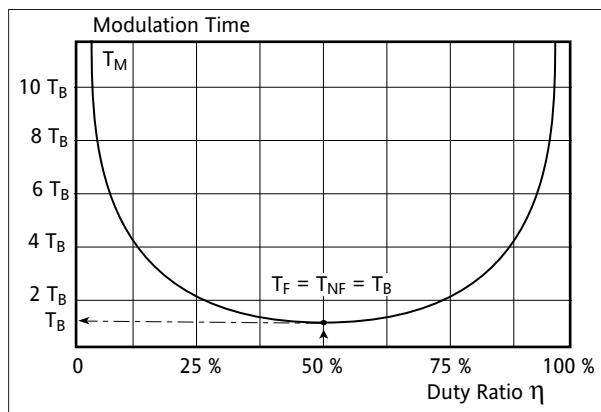
'Burst mode' modulation time depending on setpoint

3.2. SINGLE-CYCLE (code FC1) - CT = 1

'**Burst mode**' firing with a single firing or non-firing cycle is known as '**Single-cycle**'.

For example, with a setpoint of 50% (corresponding to a duty ratio $\eta = $ **50%**) the modulation comprises 1 firing cycle and 1 non-firing cycle.

For duty ratios $\eta <$ **50%** the **firing** time remains **unchanged** (1 cycle) and the non-firing time increases.

For duty ratios $\eta >$ **50%** the **non-firing** time remains **unchanged** (1 cycle) and the firing time increases.
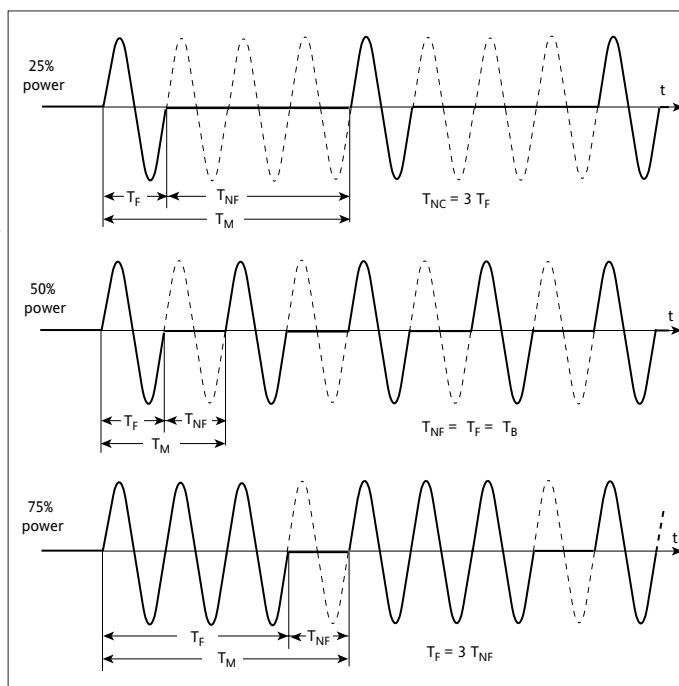
Typical firing in 'Single-cycle' mode for various duty ratios

3.3. INTELLIGENT HALF-CYCLE (code IHC) - CT = 0

In order to **reduce power fluctuations** during firing time, '**Intelligent Half-Cycle**' thyristor firing mode uses:
- a whole number of **half-cycles** for firing, and
- a whole number of **half-cycles** for non-firing.

For duty ratios η< **50%**:
- the thyristor firing time is **set to one half-cycles**
- non-firing occurs for half-cycles.

For duty ratios η > **50%**:
- the non-firing time is **set to half a cycle**,

- firing occurs for half-cycles.

By using **half-cycles** for non-firing time,
the modulation time is reduced compared with
standard 'Single-cycle' mode, which is equivalent to
burst mode with one cycle.
'Intelligent half-cycle ' mode (Code IHC) **reduces
flicker** on short wave infrared elements and is thus
less annoying on the eyes.

Standard Single-cycle (T_F ou T_{NF} = 1 cycle)

66,6 % Power
($T_C = 2 T_{NC}$)

T_F T_{NF}

T_M

T_M

Intelligent Half-Cycle
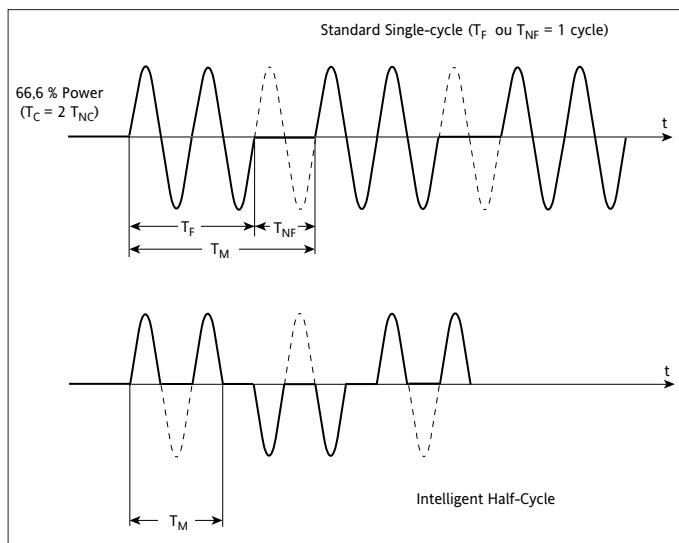
Comparison of firing in 'Single-cycle' and 'Intelligent half-cycle modes

3.4. CONTROL AND LIMITS

CONTROL PARAMETERS

Q7000 power thyristor units use one of the following control parameters :
- rms load voltage squared V^2
- rms load current squared I^2
- power delivered to the load $P = V \cdot I$

For a constant resistive load, all control parameter percentages represent the active power delivered to
the load by the thyristor power unit.

The control parameters are defined in the coding.

Control Parameter	Use
V^2	Squared voltage control
I^2	Squared current control
Vrms	RMS volage control
Irms	RMS current control
V·I	Power control, with power limit
OL	Open Loop Input demand without any control

V^2 control assures input voltage variation compensation of the power supply.
Current and voltage values used by the control system are **measured values**.
Power control (**P = Vrms . Irms**) also uses **measured values**.

Out of the factorythe default settings are :
control option is UxI, load volatage of 230 V and load current of 11 A.
All these parameters are configurable.

CHAPTER 4

4. ALARMS

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4. ALARMS

4.1. SAFETY MECHANISMS

Q7000 units have alarms to protect the thyristors and the loads against certain types of abnormal operation and provide the user with information about the type of fault.

Danger!
· Alarms are not under any circumstances a replacement for personnel protection.
· The user is responsible for installing independent safety mechanisms which must be inspected regularly. Given the value of the equipment controlled by the Q7000, this is strongly recommended.

4.2. GENERAL

All alarm setpoints need commissioning by user. Only one alarm is indicated on the front panel LEDs.

4.2.1. Hirarchy

> Thermal failure
> Rack inhibition
> Power supply loss on main slot
> Thyristor Short-Circuit
> TLF alarm (Total Load Failure)
> SIOP failure
> (SIOP : communication link between the driver card and the power cards)

No PLF settings will be taken into account if GRF or DLF alarm are set off.

4.2.2. Temperature

Over temperature alarm can by set with an automation device.
Users can read the ambient temperature of each of the 4 power card using digital communication.
If the one of the power card heatsink temperature exceeds 90 °C ($\pm$ 5%), then a logical temperature sensor stops the card's conduction.

4.2.3. Alarm Relay

The only way to cancel a thermal failure indication is to let the unit cool down.

Two digital inputs are available on the Q7000 front panel one to plug in a pressure sensure (FAN input), useful for the ventilation rack maintenance and a conduction authorisation input (Enable input)

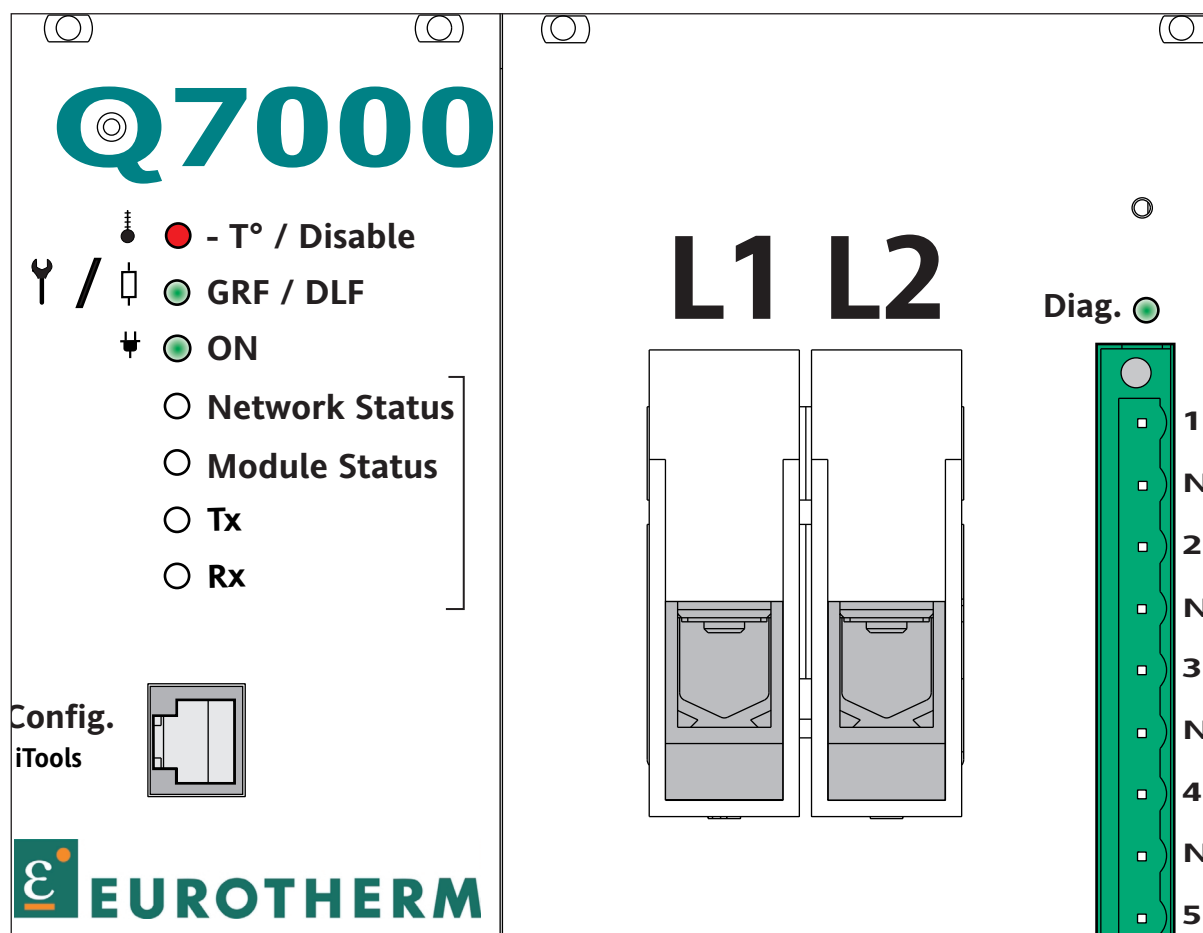Two configurable alarm relay contacts are available.
These two relays can be set off and set for any alarm, via the communication devices.

by default :   Relay 1 operates on all the alarms
               (Total Load Failure, Thyrisor Short-Circuit, DLF, Over temperature, Enable i/p and FAN i/p)
               Relay 2 operates on the FAN input
               (FAN i/p)

4.2.4. Status Word

Alarm status are available using the digital communication with the 'General Status Word' ant the 'Channel Status words'. See Digital communication chapter.

4.3. SIGNALLING ALARMS LEDs

Q7000

- – T° / Disable
- GRF / DLF
- ON
- Network Status
- Module Status
- Tx
- Rx

Config.
iTools

EUROTHERM

L1 L2

Diag.

1
N
2
N
3
N
4
N
5

LED name on front panel	Function	Coulor and LED status
Driver board **T° / Disable**	No faults	OFF
	Rack conduction inhibited	Flashing Red (0.5 s ON / O.5 s OFF)
	Temperature Default and conduction stopped	Red
	Abnormal temperature rise	Flashing Red (0.5 s ON / 3 s OFF)
GRF / DLF	No fault	Green
	Thyristor Short-Circuit fault	Red
	TLF fault	Flashing Red
	DLF Alarm	Flashing Orange
ON	No faults	OFF
	Supply present and no failure	Green
	Supply fault on one slot	Flashing Red
	Supply fault on slot 1	Red
	Communication fault on one slot	Orange
Power board **Diag.**	No fault	Green
	Temperature fault	Red

CHAPITRE 5

5. DIGITAL COMMUNICATION

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* Available Later

5. USER DIGITAL COMMUNICATION

5.1. GENERAL

The Q7000 has to communication ports : 'Config.iTools' and 'COM.User'

'Config.iTools' - Configuration and diagnostic port

Q7000 configuration and use are possible using iTools, with a specific link on Q7000 front panel, RJ 11 conector.
iTools software can be downloaded from :

http://www.eurotherm.co.uk/eng/eurothermproducts/software_tools/iTools.htm

Protocol :   ModBus RTU
Transmission Standards :   RS 232
Transmission Speed :   19200 Bauds

'COM.User' - User port

Q7000 Configuration and and use are possible using the COM.User connector.

Protocols :   ModBus RTU, ProfiBus or DeviceNet*
Transmission Standards :   RS 485
Transmission Speed :   9600 or 19200 Bauds (Dip switch selection) ModBus protocol
                                     from 9,6 to 1500 Kbauds (AUTO selection) ProfiBus protocol
Asynchronous Transmission

Parameter Status

The parameter status can be : Read only, Read and Write or Memorised Read/Write (non volatile Write)

   • Read only parameters are labelled '**R**'
   • Read and Write parameters are labelled '**R/W**'
   • Memorised Read and Write parameters are labelled '**R/W/M**'

Exchange type

Message are exchanged in 'Master/Slave' mode.
The Q7000 digital communication always operates as a slave, with a supervision system or PLC as Master.
Each exchange includes a Master request and a Slave answer.

Important !

If using the 'COM.User' digital communication port, it is possible to use the 'Config.iTools' port for the loads diagnosis, for example. However, it is recommended to the 'Config.iToold' port in reading mode only, inorder to avoid any communication conflict between the two ports.

5.2. ModBus protocol

Word reading, function 3 and 4, Word writing, function 6, n words writing (1<n<255), function 16
8 bits fast reading, function 7, Code 0 diagnosis (echo), fucntion 8
Communication complies with the specifications given in
'GOULD MODICON ProtocolReference Guide PI-MBUS-300 rev J'.
The communication bus is at the same voltage as the user digital communication function supply (COM. User)
Character Format :   1 bit of start - 8 bits of data - 1 bit of stop

5.3. PROFIBUS-DP Protocol

Communication complies with the specifications given in the directive EN 50170 / DIN 19245 / Part 3.
The transmission bus, is in binary characters, with an even parity.
Character Format : 1 start bit - 8 bits of data - 1 parity bit - 1 stop bit.

Buffers definition for ProfiBus

Output Buffer : 80 Octets

CW
Read1 Address
Read2 Address
Write Address
Var1
to
Var36

Command Word - see page 5-6
Adress block (see page 5-6) of the first selected variable block to read
Adress block (see page 5-6) of the second selected variable block to read
Adress block (see page 5-6) of the selected variable block to write

Variables to be sent to the selected block, selected in 'Write Address'

Input Buffer : 156 Octets

GSW1
GSW2
TempSlot 1
to
Templot 4
Var1
to
Var 36
Var1
to
Var 36

General Statu Word GSW1 reading - see page 5-7
General Statu Word GSW2 reading- see page 5-7

Temperatur reading of the 4 power slots

Reading of the first selectec variable block, selected during the preceeding transaction

Reading of the second selectec variable block, selected during the preceeding transaction

User Diag Buffer : 83 Octets

System Diag
Nd User Diag
GSW1
GSW2
SWC1
to
SWC36

Bytes 0 to 5 : ProfiBus directive definition
Byte 6 : ProfiBus directive definition
Bytes 7 to 8 : General Statu Word GSW1 - see page 5-7
Bytes 9 to 10 : General Statu Word GSW2 - see page 5-7

Bytes 11 to 82 : Status Word for each channel of the Q7000

User Prm Buffer : 18 Octets

System Prm
Reserved
MaskR1
MaskR2
CTO
STO

Bytes 0 to 6 : ProfiBus directive definition

Bytes 7 to 9 : Reserved, must be set to zero

Bytes 10 to 11 : Mask for R1 relay. User configuration
Bytes 12 to 13 : Mask for R2 relay. User configuration

Bytes 14 to 15 : User configuration. Time in seconds, from which all the Q7000
setpoints take for setpoint value the safe setpoint value
STO (Time Out Setpoint) see page 5-7.

Bytes 16 to 17 : User configuration. Safe setpoint value. In percent. All the Q7000
setpoints take this value when the communication default occurs
during more than the value of the CTO (Communication Time Out)
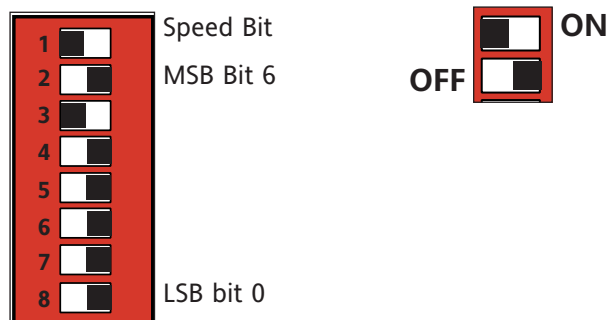
5.2. User Digital Communication

5.2.1. Transmission speed

- **Modbus - Switch 1**
  «**OFF**» corresponds to a speed of **9,6** kbauds
  «**ON**» corresponds to a speed of **19,2** kbauds.
- **ProfiBus**
  AUTO speed for Profibus (from 9,6 kbauds to 1500 kbauds)
- **Devicenet - Switches 1 & 2**

Speed Bit
MSB Bit 6

LSB bit 0

ON
OFF

5.2.2. Unit address on the communication bus (ModBus and ProfiBus protocols)

It is set using microswitches 2 (Bit 6, MSB) to 8 (Bit 0, LSB).
1< Unit Address < 127 (ModBus) 4<Unit Address<125 (ProfiBus)

Example :

32 binary address on **7 bits**	0	1	0	0	0	0	0
Dip switch position	Off	On	Off	Off	Off	Off	Off
Dip switch number	2	3	4	5	6	7	8

5.2.3. Addressing

In order to distinguish the power unit and the different parameters, the Modbus and ProfiBus protocols use : • The 7000 series unit **Physical** address on the communication bus.
• The **parameter** addresses which determine the parameter required.
The physical address is configured by dip switches on the front panel of the unit, and cannot be changed using digital communication.
The address 00 is reserved for broadcasting, the slave will do what is requsted but will not answer
Parameter broadcasitn is allowed for all the **Read & Write** parameters
The factory default settings are for an address of 32 and the transmission speed corresponding to the product code.

5.2.4. Error Code

If the interface detects an error in the frame received, it returns an error code :

Error Code (decimal)	Corresponding error type
1	Prohibited function
2	Prohibited parameter address (unauthirised code sent)
3	Internal link failure (if present)
4	Prohibited data value
9	No data in request
10	Too much data in request

Meaning of communication error codes

5.2.5. Communication Bus

By convention, the potential on B terminal is higher than the one on the A terminal when the RS485 line is at its active status. To guarantee reliable operation of the digital communication link, the bus must be connected using shielded twisted pairs. The shield of the communication cable must be connected to ground using the shortest possible connection at both ends.
We recommend connecting the shielding to the cabinet mounting rails as close as possible to the interface.
The communication bus must have termination resistors fitted at each end :
• One line impedance matching resistor
• Two RS485 bus polarisation resistors
The intertface as standard with the following internal resistors :
• **100 k**Ω polarisation resistors,
• **100 k**Ω resistor betweeen the 'A' and 'B' terminals
To ensure correct operation, EUROTHERM recommends installing a matching resistor of typical value 220 Ω, on the last unit on the communication bus.
If the last unit on the bus is one of the 7000 series with digital communication, this resistor must be connected between terminals 'A' and 'B'.
When usine a 'Fast Connect' connector, connected to the DB9, the switches of this connector must be set correctly to polarise the line.

5.3. DIGITAL COMMUNICATION LEDs

5.3.1. MODBUS Protocol

Led	Function	Coulour & status
Tx	Communication - Sending	Yellow Sending Off Receiving
Rx	Communication - Receiving Sending Data	Yellow while receiving Yellow while sending
Network Status	Data Exchange Time-Out or Communication not established Wrong Address (address = 0)	Green Off Flashing Red
Module Status	Reserved for ProfiBus & DeviceNet Protocols	Off

5.3.2. PROFIBUS Protocol

Led	Function	Coulour & status
Tx	Communication - Sending	Yellow Sending Off Receiving
Rx	Communication - Receiving Sending Data	Yellow while receiving Yellow while sending
Network Status	Data Exchange Waiting for Parameterisation Waiting for Setting Wrong Address (> 125 or = 0)	Green Orange Flashing Green Flashing Red
Module Status	SPC3 Failure SPC3 OK	Red Green

5.3.3. DeviceNet Protocol * (Available Later)

Led	Function	Coulour & status
Tx & Rx	Not Used	Off
Network Status	Initial Test Time Out Link Failure On Line / Not Connected On Line / Connected	Flashing Red and Green Flashing Red Red Flashing Green Green
Module Status	Initial Test Recoverable Fault Unrecoverable Failure Waiting for Configuration OK	Flashing Red and Green Flashing Red Red Flashing Green Green

Note :

If the Rx LED stays ON, it can be because the communication signals polarities have been inverted (A and B swapped).

5.4. Software Settings

The parameter settings are available using either the User communication or the Configurator communication.

Parameter list and digital communication strategy is defined as follow :
The following parameters are at fixed addresses, which enables ModBus Master (iTools, PFP/MOP bridges) to have the information of the slave.

Abreviation	Parameter	Address		Status	Format
		DEC.	HEX.		
MI	Manufacturer Identifier	65280	FF00	R	32 bytes
CW	Command Word	65488	FFD0	R/W	2 bytes
GSW1	General Status Word 1	65504	FFE0	R	2 bytes
GSW2	General Status Word 2	65505	FFE1	R	2 bytes
SN	Serial Number	65520	FFF0	R	4 bytes
VD	Version D	65522	FFF2	R	2 bytes.
VP	Version P	65526	FFF6	R	2 bytes
DI	Device Identifier	65528	FFF8	R	2 bytes
MF	Modbus Function	65529	FFF9	R	2 bytes
CTO	Comm Time Out	65531	FFFB	R/W	2 bytes
STO	Time Out Setpoint	65532	FFFC	R/W	1000

DESCRIPTION OF PARAMETERS

Manufacturer Identifier (MI) :
This parameter returns 'EUROTHERM Automation' as an ASCII character string
(32 consecutive bytes read, starting at address 65280)

Command Word (CW) :
This parameter is used to modify the operation of the digital communication

Codes and associated functions are given in the following table :

Code Sent	Function
0	Firing Inhibition
1	Firing Enabled
2	N/A
3	N/A
4	N/A
5	Transfer fast setpoint to active setpoint
6	Alarm Acknowledge
7	PLF rating and validation setting requirement
8 to 15	Not used
16	Open Loop : OL
17	V^2 Control
18	I^2 Control
19	V x I Control
20	Vrms control
21	Irms Control
22 to 31	Reserved
100	ModBus communication requirement (only via configurator)
101	ProfiBus communication requirement (only via configurator)
102	DeviceNet communication requirement (only via configurator)

Note : If the same value is sent twice, the second time, the value is not taken into account by the device. To sned twice the same value, an unused value must be sent between the two identic values.

General Status Word (**GSW 1** and **GSW 2**) :
These parameters indicate the status of the main alarms and the status of monitoring during the time between communication frames.
The byte containing 0 to 7 may be read by Modbus function 7 (Quick Read)

GSW 1

Bit Number	State	Description
0	1	GRF Alarm Active : TLF
1	1	GRF Alarm Active : CCTH
2	1	Rack PLF failure
3	1	Supply failure on one of the power slots of the rack
4	1	Power inhibition
5	1	Over temperature Alarm Active
6	1	Fan pressure failure
7	1	Parameter Write. Reserved for configurator
8	1	Communication failure on at least one slot
9	1	Communication failure on slot 1
10	1	Communication failure on slot 2
11	1	Communication failure on slot 3
12	1	Communication failure on slot 4
13	1	Abnormal temperature rising
14 to 15		Not used

GSW 2
Bit 0 to bit 3 :

Bit 3	Bit 2	Bit 1	Bit 0	Control
0	0	0	0	OL
0	0	0	1	V2
0	0	1	0	I2
0	0	1	1	V x I
0	1	0	0	V
0	1	0	1	I

Bit Number	State	Description
4	1	Time out exceeded.Bit is put low when GSW is read
5	1	Power supply failure on slot 1
6	1	Power supply failure on slot 2
7	1	Power supply failure on slot 3
8	1	Power supply failure on slot 4
9	1	Load Power firing inhibited by communication
10	1	Load Power Firing inhibited by user : 'Enable input'
11	1	Slot 1 present
12	1	Slot 2 present
13	1	Slot 3 present
14	1	Slot 4 present
15	1	FAN- Digital Input active

Serial Number (SN) :
Each power units has a unique serial number at the address 65520 (coded in 4 bytes).

Control board version number (VD) & Power board version number (VP)

Device Identifier (DI) :
Enables the configurator to automaticaly determine the device with which its communicating.
The value sent is : 200 (HEX.) for the Q7000.
It is a factory-configured value, stored into permanent memeory

Modbus functions supported (MF) :
Returns the value 186 (decimal) at the address 65529 which means that the option supports the functions 3,6,7,8 and 16.Setpoint transfer and R/W Data settings are available.

Communication Time-Out (CTO) :
Sets the time (in seconds) for which the interface listens between two validated communication frames sent to the power unit. If the parameter is set to 0 monitoring is disabled. The time-out is disabled by default (CTO = 0).The authorised values are between 1 and 65535 s and are stored in permanent memory.
If the time-out is exceeded, the interface behaves as follows :
Network Led off. The value in the 'Setpoint after time-out' parameter is transfered to the active setpoint if its value is higher. Bit 8 of the General Status Word is set to 1 and will be set to 0 when next read.

Setpoint after time-out (STO) :
Used to set the setpoint used if the time-out is exceeded. STO ≤ SL (Setpoint Local)
Authorised values are between 0 and 1000, stored in permanent memeory.

5.5. Address Table of the 36 parameter blocks

Each blok has the same set of parameter, defined for the 36 channels

Abreviation	Block	Parameter	Address	Format	Statut
	0	Reserved			
SL	1	Setpoint Local	0x0040	1000	R/W
FS	2	Fast Setpoint Transfer	0x0080	1000	R/W
HS	3	High Setpoint Limit	0x00C0	1000	R/W/M
OPL	4	Output Power Limit	0x0100	1000	R/W/M
CT	5	Cycle time	0x0140	255	R/W/M
SWC	6	Status Word Channel	0x0180	Binary	R
OP	7	Output Power	0x01C0	1000	R
PV	8	Process Value	0x0200	1000	R
SP	9	Working Setpoint	0x0240	1000	R
PW	10	Power	0x0280	1000	R
VV	11	Voltage Value	0x02C0	1000	R
CV	12	Current Value	0x0300	1000	R
Z	13	Impedance	0x0340	1000	R
VCO	14	Voltage Constant	0x0600	1000	R/W/M
CCO	15	Current Constant	0x0640	1000	R/W/M
TempSlot	16	Temperature of Slot	0x7000	°C	R
MaskR	17	Mask Relay	0x0740	Binary	R/W/M

DESCRIPTION OF PARAMETERS

Digital Setpoint (SL) :
Corresponds to the input. Authorised value between 0 and 1000 (R/W).

Fast setpoint (FS) :
Used to store a setpoint prepared in advance in live memory.
The data transfer to the active data is done sending 05 code into the status word
Authorised value between 0 and 1000.

High setpoint Limit (HS) :
Sets the maximum allowable value of the resulting digital input request.
Authorised value between 0 and 1000, stored in permanent memory.

Output Power High Limit (OPL)
Sets input gain for the output power request.
Authorised value between 0 and 1000, stored in permanent memory.

Base Time in 'Burst Mode (CT)
Used to set the firing period, defined at 50% of the duty ratio.
Authorised value between 0 and 255, stored in permanent memory.
        Value '0' : advanced single-cycle firing mode * (* Available Later)
        Value '1' : Single cycle firing mode

Channel Status Word (SWC) :
Bit to bit slot status definition. read only parameter
Bit definition :

Bit Number	State	Definition
0	1	Channel TLF failure
1	1	Channel CCTH failure
2	1	Channel PLF failure
3	1	Automatic Load cut-off because of overtemperature failure
4	1	Abnormal temperature rise
5 to 7		N/A
8	1	Channel rating done
9	1	PLF setting for 1 out of 2 sensitivity
10 to 15		Not used

Output Power (OP) :
Corresponds to the duty ratio value sent to the power unit. It has the same value as the Open Loop value.
Read value between 0 and 1000.

Process Value (PV) :
Set parameter for the control system.Read only parameter value from 0 to 1000.

Working Setpoint (SP) :
Corresponds to result of the product between the Setpoint Local and the High Setpoint Limit.
The working setpoint is equal to :
$$SP = (SL * HS)/1000$$
Read only value from 0 to 1000.

Power (PW) :
Corresponds to the output power of the power thyristor unit after possible recalibration.
Read only value between 0 and 1000.

Voltage Value (VV) :
rms load voltage read on one modulation cycle. Possible value from 0 to 1000.
Read only value. 1000 = nominal value - Vrms = (VCO*VV)/1000

Current Value (CV) :
rms load current read on one modulation cycle. Possible value from 0 to 1000. 1000 = nominal value
Irms = (CCO*CV)/1000

Impedance (Z) :
Used to determine the heating-load using the rms current value. 1000 = nominal value

Voltage Constant and Current Constant (VCO and CCO) :
independant for each of the 36 channels. Read/Wrtie parameter, memorised into ,permanent memeory
The real value is 10 Times the effective Voltage or Current

Temperature of Slot (TempSlot) :
Available for each of the 4 power slots of the rack. Read only parameter, the read value are directly read in °C.

Mask Relay (MaskR) :
Using a 16 bit word equivalent to the GSW1 status word. MaskR1 for relay R1 and MaskR2 for relay R2.
Bit set to 1 for the alarm operating the relay. Read / Write paramater, memorised in permanent memory.

Example:
        0000 0000 0000 0000   no alarms activating the relays
        0000 0000 0000 0011   TLF and CCTH operating the relay if the failure occurs.

By default the 2 Masks have the following values :
        MaskR1 : 0xFFFF (Every single Alarm sets off Relay R1)
        MaskR2 : 0x0020   (Ventilation default, Fan sets off the Relay R2)

CHAPTER 6

6. COMMISSIONING AND MAINTENANCE

Contents   Page

6. COMMISSIONING AND MAINTENANCE

Please read carefully before commissioning the unit

6.1. SAFETY DURING COMMISSIONING AND MAINTENANCE

Warning!
- Eurotherm shall not be held responsible for any damage, injury, losses or expenses incurred by inappropriate use of the product or failure to comply with this manual.
- Accordingly the user is responsible for checking, before commissioning the unit, that all the nominal characteristics correspond to the conditions under which it is to be installed and used.

Danger!
- The product must be commissioned and maintained by qualified personnel, authorised to work in an industrial low voltage environment. Users must not attempt to access internal parts. The heatsink temperature may exceed 100°C. The heatsink remains hot for approx. 15 minutes after the unit is shut down. Avoid touching the heatsink even briefly while the unit is operating.

6.1.1. COMMISSIONING - CHECKING THE CHARACTERISTICS

Before powering up the unit, check that the **identification code** corresponds to the code specified on the order and that the characteristics are **compatible** with the facility.

Load current
The maximum load current must be less than or equal to the nominal current value of the solid state contactor, taking account of supply and load variations.

Supply voltage
The nominal voltage value must be greater than or equal to the line-to-line or line-to-neutral supply voltage (depending on the connection scheme).

Never use the unit on a supply with a voltage greater than the nominal value +10% as this could damage the protection components or even the thryistors.

Load type (DLF option)
For correct operation of the partial load failure detection system, ensures that load type used corresponds to the product code (**LTCL** or **SWIR**)

6.1.2. COMMISSIONING - CHECKING THE WIRING

Cut-off and isolation systems

It is the user's responsibility to wire and protect the facility according to best practice and applicable standards

Danger !
A suitable device ensuring that the unit can be electrically isolated from the supply must be installed upline to enable   work to be performed safely.

Protective earth, power and control connections

Before checking the wiring, ensure that the power and control wires are **isolated** from power sources.
Check that the **protective earth** cable is connected to the earth terminal on the unit.
Check that the **wiring** corresponds to the connection diagram
Check the **fan** power supply (voltage, connections and fuse).

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Fax (+61 2) 9634 8555
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AUSTRIA
Eurotherm GmbH
Tel Vienna (+43 1) 798 7601
Fax (+43 1) 798 7605
Web : www.eurotherm.at

BELGIUM
Eurotherm S.A/N.V.
Tel Moha (+32 0) 85 274080
Fax (+32 0) 85 274081
WEB: www.eurotherm.co.uk

DENMARK
Eurotherm A/S
Tel Frederiksberg (+45 38) 871 622
Fax (+45 38) 872 124

FRANCE
Eurotherm Automation SAS
Tel Lyon (+33) 4 78 66 45 00
Fax (+33) 4 78 35 24 90
WEB: ww.eurotherm.tm.fr

GERMANY
Eurotherm Regler GmbH
Tel Limbourg (+49 6431) 2980
Fax (+49 6431) 298119
WEB: www.eurotherm-deutschland.de

HONG KONG
Eurotherm Limited
Tel Hong Kong (+852) 2873 3826
Fax (+852) 2870 0148

INDIA
Eurotherm India Limited
Tel Madras (+9144) 2496 1129
Fax (+9144) 2496 1831

IRELAND
Eurotherm Ireland Limited
Tel Naas (+353 45) 879937
Fax (+353 45) 875123

ITALY
Eurotherm SpA
Tel Guanzate (+39 31) 975111
Fax (+39 31) 977512
WEB: www.eurotherm.it

JAPAN
PTI Japan Limited
Eurotherm Japan Group
Sales Offic
7F, Yukakuchu Building,
10-1, Yurakuchu 1-Chome
Chiyoda-Ku
Tokyo 1000-0006
Tel (+81 3) 3213 2111
Fax (+81 3) 2213 1900
Web : www.nemic.co.jp

KOREA
Eurotherm Korea Limited
Tel (+82) 31 286 8507
Fax (+82) 31 287 8508

NETHERLANDS
Eurotherm B.V.
Tel Alphen aan den Rijn (+31 172) 411 752
Fax (+31 172) 417 260
WEB:www.eurotherm.nl

NORWAY
Eurotherm A/S
Tel Lysacer (+47) 67 - 59 21 70
Fax (+47) 67 - 11 83 01

SPAIN
Eurotherm España SA
Tel Madrid (+34 91) 6616001
Fax (+34 91) 6619093
WEB: www.eurotherm.es

SWEDEN
Eurotherm AB
Tel Malmo (+46 40) 384500
Fax (+46 40) 384545
WEB: www.eurotherm.se

SWITZERLAND
Eurotherm Produkte AG
Tel Freienbach(+41 055) 4154400
Fax (+41 055) 4154415
Web : www.eurotherm.ch

UNITED KINGDOM
Eurotherm Limited.
Tel. Worthing (+44 1903) 695888
Fax(+44 1903) 695666
WEB:www.eurotherm.co.uk

U.S.A.
Eurotherm Controls Inc.
Tel Leesburg, (+1703) 443-0000
Fax (+1703) 669-1300
WEB: www.eurotherm.com

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