

# CD3000 *M*-2PH THYRISTOR UNIT

000005

from 125A to 700A

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CD Automation UK Ltd

Product Support:

Tel: +44 1323 811100 Email: [info@cdautomation.co.uk](mailto:info@cdautomation.co.uk)



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# 1 Important warnings for safety

This chapter contains important information for the safety. The not observance of these instructions may result in serious personal injury or death and can cause serious damages to the Thyristor unit and to the components system included.

The installation should be performed by qualified persons.



The Thyristor unit are integral part of industrial equipments. When it is supply, the Thyristor unit is subject to dangerous tensions.

- Don't remove the protection Cover.
- Don't use these unit in aerospace applications and/ or nuclear.



The nominal current corresponds to use at temperature not superior to 45°C.

- The Thyristor unit must be mounted in vertical position and without obstruction above and below to allow a good flow ventilation.
- The hot air of one thyristor unit must not invest the unit positioned above.
- For side by side placed leave a space of 15mm between the unit.



A suitable device must ensure that the unit can be electrically isolated from the supply, this allows the qualified people to work in safety.



## **Protection (Protection, Protezione)**

The unit have IP20 protection rating as defined by the specific international. Is necessary consider the place of installation.



## **Earth (Terre, Messa a terra)**

For safety, the Thyristor unit with isolated heat-sink must be connected to earth. Earth impedance should be correspondent to local earth regulation. Periodically the earth efficiency should be inspected.



## **Electronic supply (Alimentation électronique, Alimentazione elettronica)**

The electronic circuit of the Thyristor unit must be supplied by dedicated voltage for all electronic circuits and not in parallel with coil contactors, solenoids and other.

It's recommended to use a shielded transformer.



## **Electric Shock Hazard (Risque de choque électrique, Rischi di scosse elettriche)**

When the Thyristor unit is energized, after the power supply is shut off, wait least a minute for allow the discharge of the internal capacitors where there is a dangerous tension. Before working, make sure that:

- Only authorized personnel must perform maintenance, inspection, and replacement operations.
- The authorized personnel must read this manual before to have access to the unit.
- Unqualified People don't perform jobs on the same unit or in the immediate vicinities.

**Important warnings (Attention, Avvertenze importanti)**

During the operations with units under tension, local regulations regarding electrical installation should be rigidly observed:

- Respect the internal safety rules.
- Don't bend components to maintain insulation distances.
- Protect the units from high temperature humidity and vibrations.
- Don't touch components to prevent electrostatic discharges on them.
- Verify that the size is in line with real needs.
- To measure voltage current etc. on unit, remove rings and other jewels from fingers and hands.
- Authorized personnel that work on thyristor unit under power supply voltage must be on insulated board

This listing does not represent a complete enumeration of all necessary safety cautions.

**Electromagnetic compatibility****(Compatibilità elettromagnétique, Compatibilità elettromagnetica)**

Our thyristor units have an excellent immunity to electromagnetic interferences if all suggestions contained in this manual are respected. In respect to a good Engineering practice, all inductive loads like solenoids contactor coils should have a filter in parallel.

**Emissions (Emission, Emissioni)**

All solid-state power controllers emit a certain amount of radio-frequency energy because of the fast switching of the power devices.

The CD Automation's Thyristor unit are in accord with the EMC norms, CE mark.

In most installations, near by electronic systems will experience no difficulty with interference. If very sensitive electronic measuring equipment or low-frequency radio receivers are to be used near the unit, some special precautions may be required. These may include the installation of a line supply filter and the use of screened (shielded) output cable to the load.

**Note**

**Warning:** This icon is present in all the operational procedures where the Improper operation may result in serious personal injury or death



**Caution:** This icon is present in all the operational procedures where the Improper operation can cause damage for the Thyristor unit.

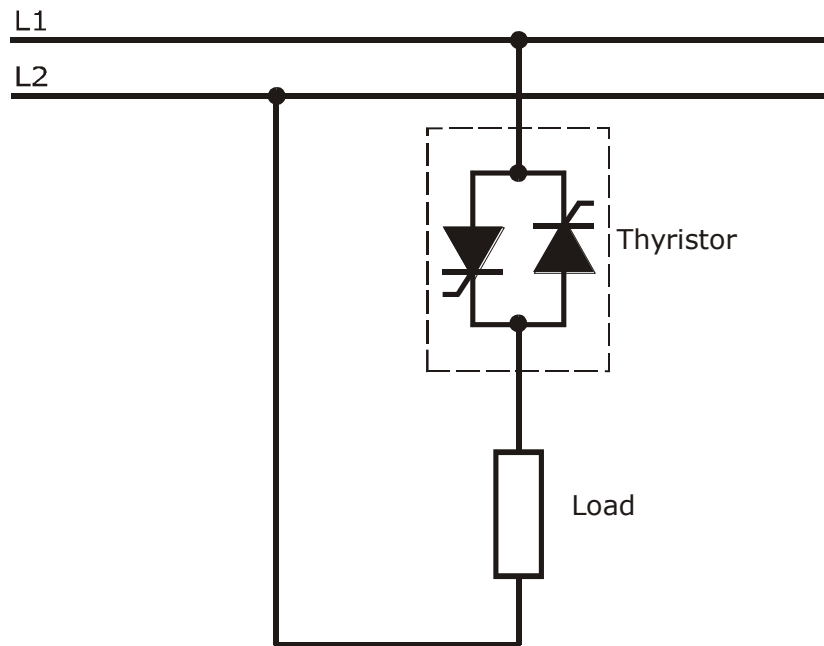
CD Automation reserves the right to modify the own products and this manual without any advise.



## 2 Introduction

A thyristor unit is semiconductor device which acts as a switch formed by two thyristors in antiparallel. To switch on the alternating current the input signal will be on and the thyristor will switch off at first Zero Crossing voltage with no input signal.

The benefits of thyristor units compared with electromechanical contactors are numerous: no moving parts, no maintenance and capacity to switch very fast. Thyristors are the only solution to control transformers and special loads that change resistance with temperature and with age.



### 2.1 Advantages compared with analog thyristor unit

Communication RS485 is a standard feature of CD3000M this allows the use of many information like: current, power, load state and all the parameters for diagnostic and configuration. Ulterior advantages of the digital system vs the analogical is the flexibility and the possibility of implement special characteristics without change the hardware. Several strategies can be implemented and selected through the configuration parameters.

With CD-KP, you can have access to the configuration parameters without expose at the dangerous voltage inside the cabinet and without stop the plant.

CD THYRISTOR UNIT  
INSIDE CABINET

CD-KP  
ON FRONT DOOR

PC FOR CONFIGURATION



## 2.2 CD-KP

The CD-KP is designed to be connected with all CD Automation's Thyristor units via RS485 communication. On front unit is possible to read the principal operational parameters of the unit like: power, tension, current, reference, alarms, etc.

One of these variables can be selected and retransmitted via an isolated output (4÷20mA or 0÷10V). All the menus (except the operator menu) can be protected by password to avoid accidental change of configuration parameters by unauthorised personnel.

On front unit is also available a plug-in connector RS485 for connect a PC with the Thyristor units without open the cabinet and without stop the production process.

### Technical Specification:

- Use in Local/Remote
- Set Point Ramp UP - Down
- Scroll selection of:
  - Set point
  - Power output
  - Current
  - Voltage
- Display indication for:
  - Heater Break alarm
  - SCR short circuit
- Password for configuration parameters
- Plug-in connector on front to use software configurator
- Retransmission (4÷20mA or 0÷10Vdc) of one of these parameters: Power PV, Current, Voltage.
- Dimension 48x96x92mm (LxPxP)
- Comply with EMC, CE marked



## 2.3 CD-EASY

CD-EASY is a Memory of support used for maintenance people that is not confident in personal computer.

With the CD-EASY is possible memorize the configuration of one Thyristor Unit and paste it into another in few seconds.

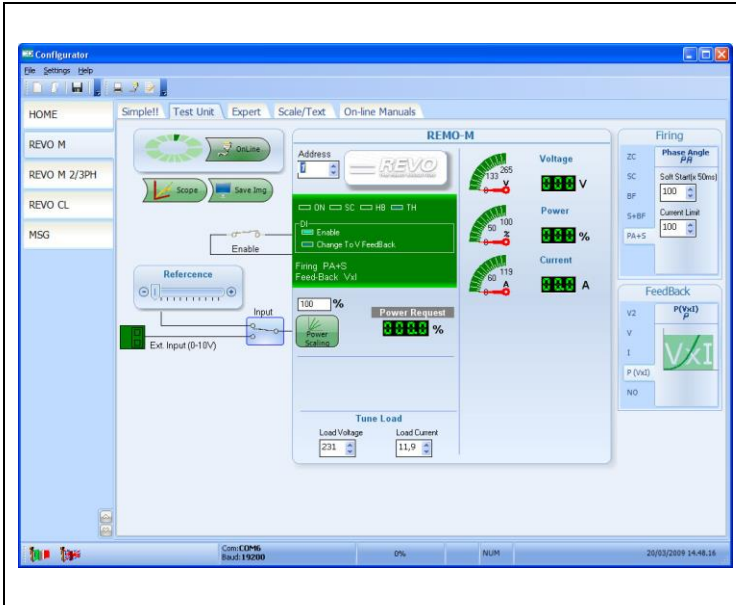
CD-EASY could be loaded with the personal configuration of the unit and stored together with the system drawings in a convenient place, enabling unit reconfiguration within seconds if require.

CD THYRISTOR UNIT 1

CD THYRISTOR UNIT 2



## 2.4 Software Configurator



The software configuration is free and is possible download it from our site:  
[www.cdautomation.com](http://www.cdautomation.com)

If the Order Code is in line with requirement, then CD3000M has been already configured in Factory and it's ready to use. You need the software only to modify the ordered configuration. Anyway we suggest to check the unit on the machine with the "Test unit" section.

For install the software, launch the program and follow the instructions on the screen.



To connect the unit at the PC, it's necessary use the USB\TTL converter connected between the unit and the USB port of the PC.

USB\TTL converter need a driver to work properly, you can find it from our site. Is available a full programmer kit composed by

- USB\TTL converter,
- Two cable
- Thyristor configurator software
- USB driver



With the CD-RS serial converter is possible configure the Thyristor unit also through the RS485 (see par. 12.7). For this solution, the programming cable is not necessary.

Run the software configurator and set the serial port of the PC with con baudrate =9600 and the address of Thyristor unit (default=1).

## 3 Quick Start



**Caution:** this procedure must be performed only by qualified persons.

If the Order Code of the Thyristor unit is in line with what you really need, then CD3000M has been already configured in Factory and you just need to do the following steps:

1. Verify the CD3000M Sizing. Making sure that:
  - The load current is equal or less than the MAX current of CD3000M.
  - The load voltage is equal or less than the MAX voltage of CD3000M.
 (see par. 4)
2. Verify the Order Code  
(see par. 5.2)
3. Verify the Installation  
(see par. 0)
4. Verify the Diagram of control connection:
  - All auxiliary connections must be done in line with wirings on this manual.
  - Verify that there isn't a short circuit on the load.
  - Verify that the Reset Contact on terminal 7 and 8 are closed.
  - With External Enable option give Enable to the unit.
 (see par. 9.5)
5. Supply the Electronic boards  
(see Order Code)
6. Supply the Fan at 230VAC  $\pm 15\%$  50/60Hz (110VAC  $\pm 15\%$  50/60Hz Optional)  
(see par. **Errore. L'origine riferimento non è stata trovata.**)
7. Supply the Power unit  
(see par. 9.3)
8. If you have HB option make the Calibration procedure (see par. 10.3)

**The CD3000M Thyristor unit is ready to start.**

## 4 CD3000M Sizing

### 4.1.1 Star wiring with resistive load

$$I = \frac{P}{1,73V}$$

V = Nominal voltage phase to phase

I = Nominal current of the load

P = Nominal power of the load

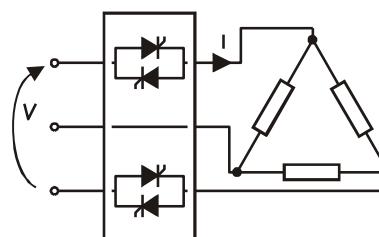
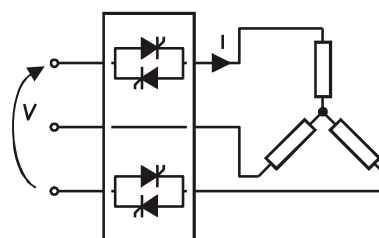
### 4.1.2 Delta wiring with resistive load

$$I = \frac{P}{1,73V}$$

V = Nominal voltage phase to phase

I = Nominal current of the load

P = Nominal power of the load



## 5 Identification and Order Code

### 5.1 Identification of the unit



**Caution:** Before to install, make sure that the Thyristor unit have not damages. If the product has a fault, please contact the dealer from which you purchased the product.

The identification's label give all the information regarding the factory settings of the Thyristor unit, this label is on the unit, like represented in figure.

Verify that the product is the same thing as ordered (see par. 5.2).



## 5.2 Order Code

Model	1	2	3	4	5	6	7
CD3000M-2PH							

<b>1</b>	<b>Max Current of CD3000M</b>											
	125A		200A		400A		500A		700A			
	150A		275A		450A		600A					
The Max Current must be equal or more than Load Current												

<b>2</b>	<b>Load Current</b>
Specify this value to configure the unit in CD Automation	

3	Max Voltage of CD3000M	
	480V	
	600V	
The Max Voltage must be equal or more than Load Voltage		

<b>4</b>	<b>Auxiliary Voltage (Voltage supply for the Electronic boards)</b>											
	90:130	From 90 to 130Vac; 10VA										
	170:265	From 170 to 265Vac; 10VA										
	230:345	From 230 to 345Vac; 10VA										
	300:530	From 300 to 530Vac; 10VA										
	510:690	From 510 to 690Vac; 10VA										

<b>5</b>	<b>Input</b>											
	SSR	4÷30Vdc										
	0÷10V	0÷10Vdc										
	4÷20mA	4÷20mA										
	POT	Potentiometer 10KΩ										

6	Firing Type	
	ZC	Zero Crossing
	BF___n	Burst Firing
	n Specify the number of firing cycles at 50% of the input signal (from 1 to 255)	

<b>7</b>	<b>Option</b>											
	IF	Internal fuses (standard)										
	NF	No fuses										
	HB	Heater Break Alarm										
	CD-KP	External Keypad										
	110Fan	Fan voltage supply 110VAC ± 15% (std 230VAC ± 15%) 50/60Hz										
	UL	UL Certification										

## 6 Technical Specifications



### 6.1 Power output features

Current	Voltage range	Repetitive peak reverse voltage		Latching current	Max peak one cycle	Leakage current	FUSE I2T value Suggested A2s (at500V)	Frequency range	Power loss Thyristor + Fuse	Isolation Voltage
(A)	(V)	(480V)	(600V)	(mAeff)	(10msec.) (A)	(mAeff)	tp=10msec	(Hz)	I=Inom (W)	Vac
125A	24÷600	1200	1600	450	2000	15	7980	47÷70	395	2500
150A	24÷600	1200	1600	300	5250	15	30800	47÷70	400	2500
200A	24÷600	1200	1600	300	5250	15	53900	47÷70	613	2500
275A	24÷600	1200	1600	300	4800	15	53900	47÷70	828	2500
400A	24÷600	1200	1600	200	7800	15	150500	47÷70	1182	2500
450A	24÷600	1200	1600	200	7800	15	215600	47÷70	1378	2500
500A	24÷600	1200	1600	200	8000	15	215600	47÷70	1409	2500
600A	24÷600	1200	1600	1000	17800	15	294000	47÷70	1837	2500
700A	24÷600	1200	1600	1000	17800	15	294000	47÷70	2143	2500

### 6.2 Fan Specification

The CD3000M thyristor unit is equipped with a cooling fans. The supply voltage is standard 230VAC  $\pm 15\%$  50/60Hz or optional 110VAC  $\pm 15\%$  50/60Hz.

The fan's power consumption is below listed:

Size	 Number of fans	 Number of fans
125A, 150A, 200A	One Fan - 16W	One Fan - 16W
400A, 500A, 600A	Two Fans - 30W	Four Fan - 60W
275A, 450A, 700A	Four Fan - 60W	Four Fan - 60W

## 7 Installation



**Caution:** Don't install near the hot elements or near the units that could give electromagnetic interferences.

The CD3000M Thyristor unit must be always mounted in vertical position to improve air cooling on heat-sink. Maintain the minimum distances in vertical and in horizontal as represented.

When more unit has mounted inside the cabinet maintain the air circulation like represented in figure. Sometimes is necessary installing a fan to have better air circulation.

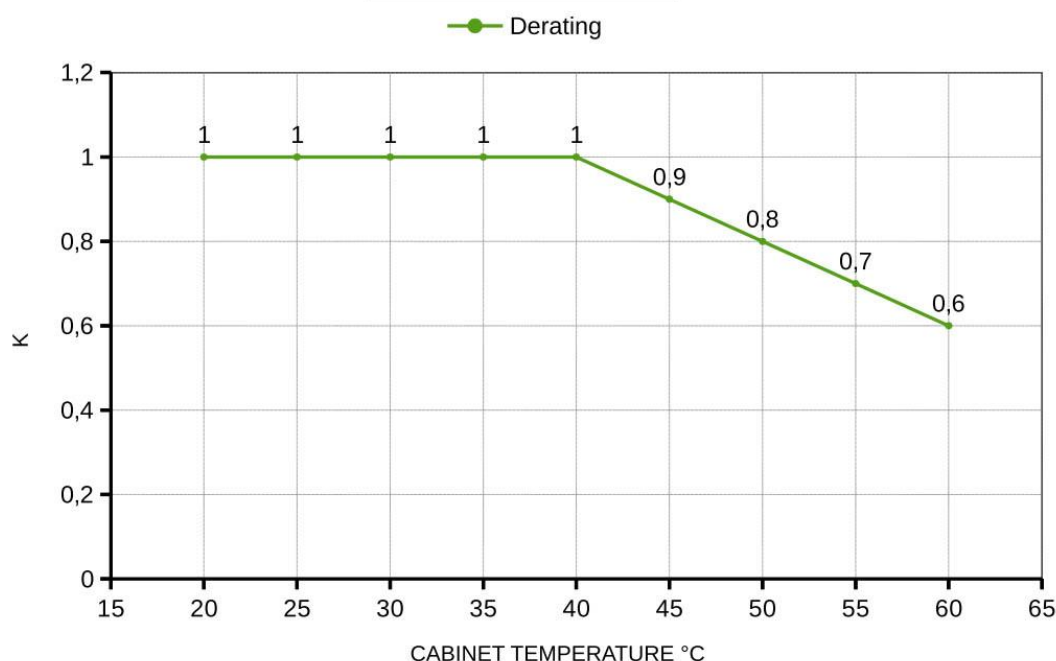
### 7.1 Environmental installation conditions

Ambient temperature	0-40°C at nominal current. Over 40°C use the derating curve
Storage temperature	-25°C to 70°C
Installation place	Don't install at direct sun light, where there are conductive dust, corrosive gas, vibration or water and also in salty environmental.
Altitude	Up to 1000 meter over sea level. For higher altitude reduce the nominal current of 2% for each 100m over 1000m
Humidity	From 5 to 95% without condense and ice

### 7.2 Derating Curve and Thermal conditions

The nominal current of the units in specification are referred to continuous service at 40 ambient temperature. For higher temperature multiply the nominal current times derating coefficient K below Represented:

$$I_{\max} = I_{\text{nominal}} \times K$$



## 7.3 Calculating flow capacity of the fan

All the thyristor units when are in conduction produces power loss that is dissipated inside cubicle in terms of heating. Due to this fact the internal temperature of cubicle is higher than ambient temperature. To be cooled the thyristor need of fresh air cooling and to do it is normally used a fan mounted on the front door or on the roof of the cabinet.

Procedure to size **Fan air mass flow (V)** : see power loss for each thyristor and fuse mounted indicated in the manual related to the current (Output feature and Internal fuse Chapter)

$V = f * \frac{Q_v}{t_c - t_a}$	<p><b>Qv</b>= total power losses (w) (thyristor + fuse power loss) <b>ta</b>= ambient temperature (°C) <b>tc</b>= cabinet temperature (°C) <b>V</b>= fan air mass flow (m3/h) <b>f</b>= altitude coefficient (see table on right)</p>	<p><b>Altitude</b> 0:100 meters <b>f= 3.1</b> m3k/Wh 100:250 meters <b>f=3.2</b> m3k/Wh 250:500 meters <b>f=3.3</b> m3k/Wh 500:750 meters <b>f= 3.4</b> m3k/Wh</p>
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The formulas used are for information only and is not a substitute for a proper thermal rating done by a qualified person.

## 8 Installation

Prima dell'installazione, assicurarsi che l'unità non abbia subito danni durante il trasporto. In caso di danneggiamento, notificarlo immediatamente al corriere.

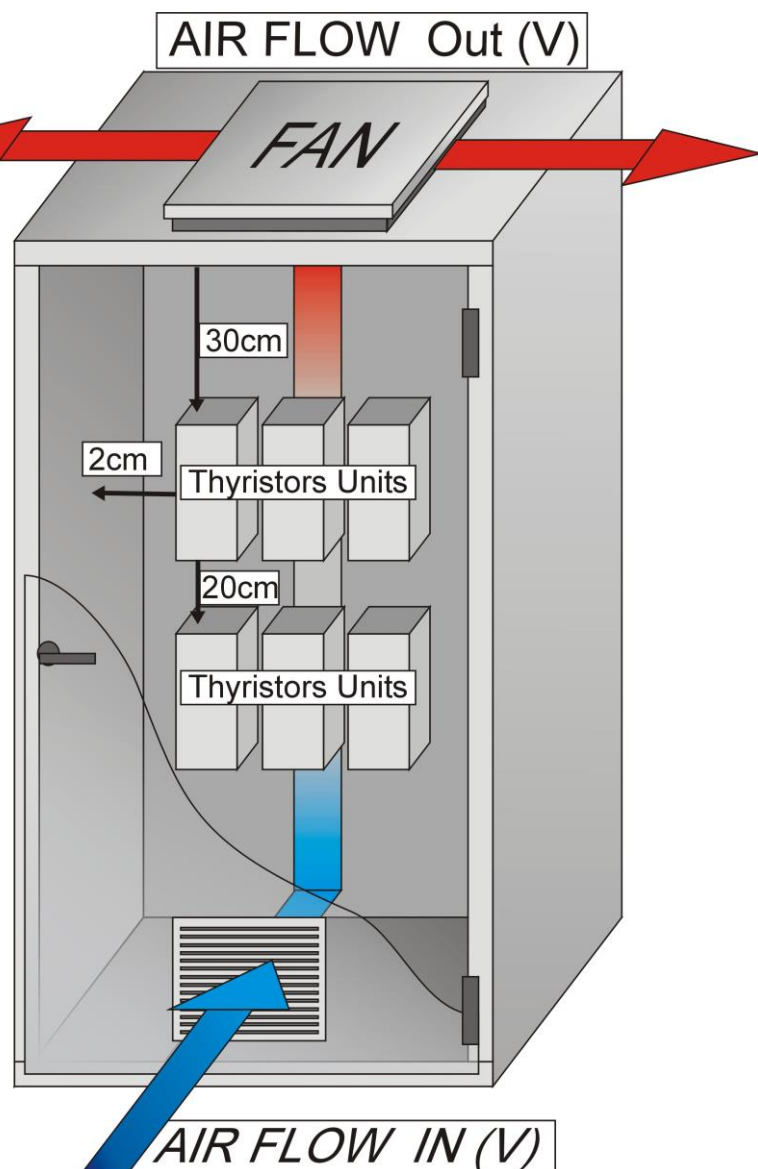
Verificare che il prodotto corrisponda effettivamente a quello ordinato.

Le unità devono essere sempre montate in posizione verticale al fine di facilitare il raffreddamento del dissipatore.

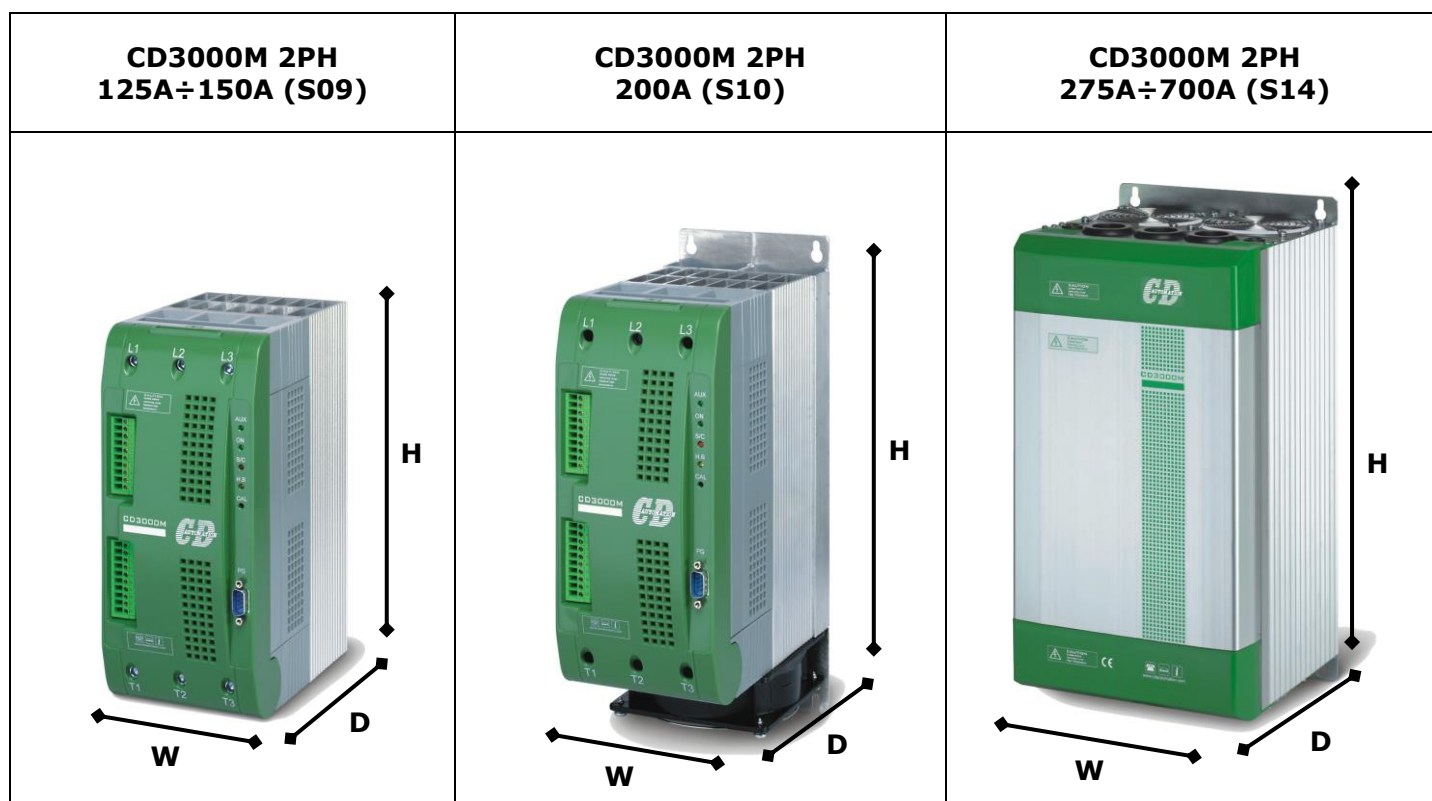
Mantenere le distanze minime in orizzontale e in verticale come rappresentato, queste aree devono essere libere da ostacoli (cavi, barre di rame, canaline plastiche).

Quando più unità sono montate all'interno di un armadio elettrico mantenere una circolazione dell'aria come rappresentato in figura.

Se necessario prevedere una ventola per avere una migliore circolazione di aria come calcolato precedentemente.

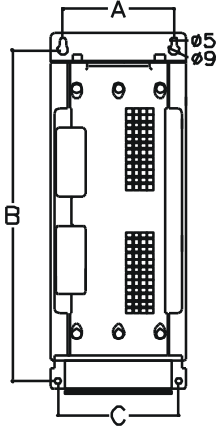
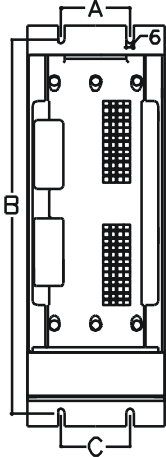
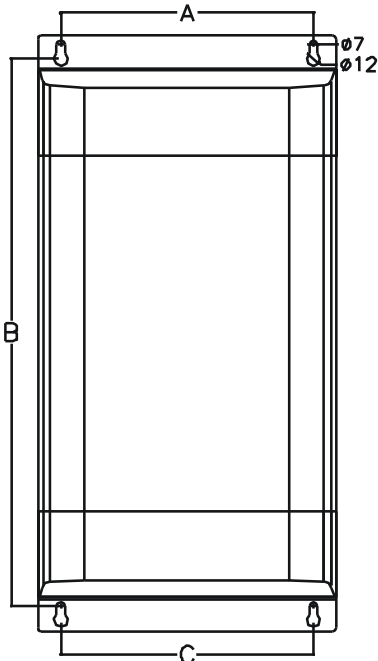


## 8.1 Dimensions and Weight



Size	W(mm)	H(mm)	D(mm)	Weight (kg)
125A (S09)	116	316	187	5
150A (S09)	116	316	187	5
200A (S10)	120	350	220	5,5
275A (S14)	262	520	270	22,5
400A (S14)	262	520	270	22,5
450A (S14)	262	520	270	22,5
500A (S14)	262	520	270	22,5
600A (S14)	262	520	270	22,5
700A (S14)	262	520	270	22,5

## 8.2 Fixing holes

CD3000M 2PH 125A÷150A (S09)	CD3000M 2PH 200A (S10)	CD3000M 2PH 275A÷700A (S14)
		

Size	A(mm)	B(mm)	C(mm)
125A (S09)	96	290	104
150A (S09)	96	290	104
200A (S10)	60	326	60
275A (S14)	222	490	222
400A (S14)	222	490	222
450A (S14)	222	490	222
500A (S14)	222	490	222
600A (S14)	222	490	222
700A (S14)	222	490	222

## 9 Wiring instructions



**Caution:** *this procedure must be performed only by qualified persons.*

The Thyristor unit could be susceptible to interferences lost by near equipments or by the power supply, for this reason in accord to the fundamental practices rules is opportune take some precautions:

- The electronic circuit of the Thyristor unit must be supplied from a dedicated voltage and not with inductive or capacitive loads. We recommend the use of a screened transformer.
- The coil contactor, the relays and other inductive loads must be equipped with opportune RC filter.
- Use shielded bipolar cables for all the input and output signals.
- The signal cables must not be near and parallel to the power cables.
- Local regulations regarding electrical installation should be rigidly observed.

For safety connect the heat-sink to the earth with his terminal.

### 9.1 Removing the cover

Instructions for open the thyristor unit size S09 & S10



Instructions for open the thyristor unit size S14



## 9.2 Wiring details

Use copper cables and wires rated for use at 75°C only.

### 9.2.1 Power cable torque (suggested)

Current	Connector Type	Torque Lb-in (N-m)	Wire Range AWG / kcmil	Wire Terminal
125A, 150A, 200A,	Terminal Block M8	265 (30.0)	1 3/0	Copper wire Compact (Solid) Stranded
275A	Bus Bar with M8 screw	141.6 (16.0)	2x1/0 300	UL Listed (ZMVV) Copper Tube Crimp. Lug
400A	Bus Bar with M10 screw	505 (57.0)	2x3/0 600	UL Listed (ZMVV) Copper Tube Crimp. Lug
450A	Bus Bar with M10 screw	505 (57.0)	Bus bar 30x6mm	
500A	Bus Bar with M10 screw	505 (57.0)	Bus bar 60x4mm	
600A	Bus Bar with M10 screw	505 (57.0)	Bus bar 60x5mm	
700A	Bus Bar with M10 screw	505 (57.0)	Bus bar 60x6mm	

**9.2.2 Power cable dimensions (suggested)**

Current	Supply			Load		
	Cable		Screw	Cable		Screw
	mm <sup>2</sup>	AWG		mm <sup>2</sup>	AWG	
125A (S09)	50	1	M8	50	1	M8
150A (S09)	70	1/0	M8	70	1/0	M8
200A (S10)	95	3/0	M8	95	3/0	M8
275A (S14)	2 x 70	2 x 1/0	M8	2 x 70	2 x 1/0	M8
400A (S14)	2 x 95	2 x 3/0	M10	2 x 95	2 x 3/0	M10
450A (S14)	Bus Bar		30 x 6 mm	Bus Bar		30 x 6 mm
500A (S14)	Bus Bar		60 x 4 mm	Bus Bar		60 x 4 mm
600A (S14)	Bus Bar		60 x 5 mm	Bus Bar		60 x 5 mm
700A (S14)	Bus Bar		60 x 6 mm	Bus Bar		60 x 6 mm

**9.2.3 Cable dimensions (suggested) of Earth and of the Command Terminals**

Current	Earth			Command Terminals		
	Cable		Screw	Cable		
	mm <sup>2</sup>	AWG		mm <sup>2</sup>	AWG	
125A (S09)	16	6	M6	0,50	18	
150A (S09)	16	6	M6	0,50	18	
200A (S10)	25	4	M6	0,50	18	
275A (S14)	50	1	M8	0,50	18	
400A (S14)	50	1	M8	0,50	18	
450A (S14)	70	1/0	M8	0,50	18	
500A (S14)	70	1/0	M8	0,50	18	
600A (S14)	70	1/0	M8	0,50	18	
700A (S14)	70	1/0	M8	0,50	18	

## 9.3 Power Terminals



**Warning:** Before connecting or disconnecting the unit check that power and control cables are isolated from voltage sources.

Terminal	Description
L1	Line Input Phase 1
L2	Line Input Phase 2
L3	Line Input Phase 3
T1	Load Output Phase 1
T2	Load Output Phase 2 - Not controlled by the thyristor
T3	Load Output Phase 3

CD3000M 2PH 125A÷150A (S09)	CD3000M 2PH 200A (S10)	CD3000M 2PH 275A÷700A (S14)

## 9.4 Command Terminals



**Warning:** Before connecting or disconnecting the unit check that power and control cables are isolated from voltage sources.

Terminal	Description
1	Voltage Supply for Electronic Boards (Auxiliary see par. 12.2)
2	Not Used
3	Voltage Supply for Electronic Boards (Auxiliary see par. 12.2)
4	Earth
5	Fan supply voltage (see par. <b>Errore. L'origine riferimento non è stata trovata.</b> )
6	Fan supply voltage (see par. <b>Errore. L'origine riferimento non è stata trovata.</b> )
7	RESET
8	RESET
9	(+)Input command signal SSR, 0÷10V,4÷20mA,POT
10	(-)Input command signal SSR, 0÷10V,4÷20mA,POT

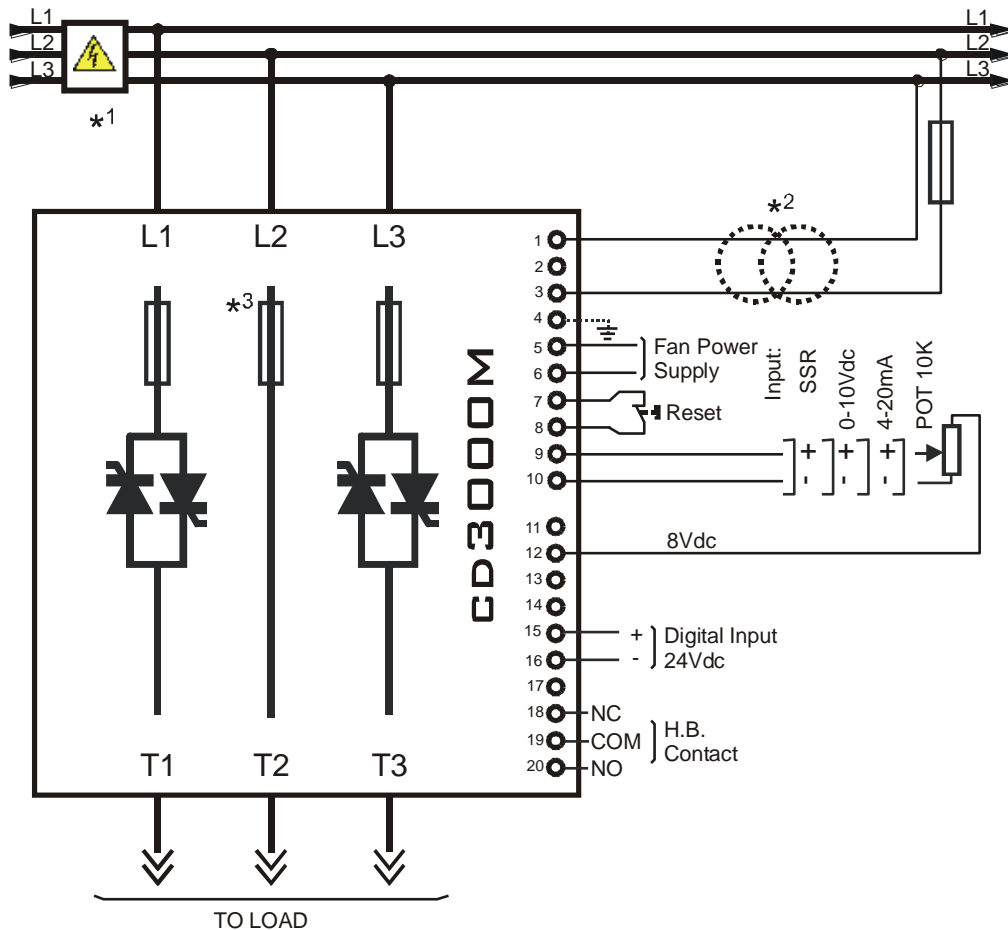
Terminal	Description
11	0V GND
12	Output +8Vdc stabilized 1 mA MAX
13	(+)Output command for Slave unit
14	(-)Output command for Slave unit
15	(+)External Calibration 24 Vdc max
16	(-) External Calibration 24 Vdc max
17	Not Used
18	HB relay contact NC (Max 500mA , 125Vac) Optional (see par. 12.5)
19	Common HB relay contact (Max 500mA , 125Vac) Optional
20	HB relay contact NO (Max 500mA , 125Vac) Optional (see par. 12.5)



## 9.5 Diagram of control connection



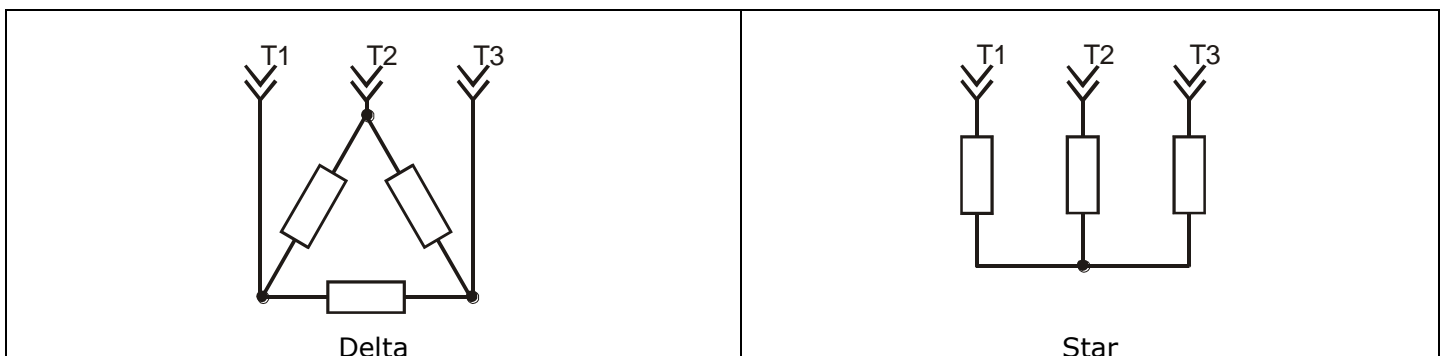
**Caution:** this procedure must be performed only by qualified persons.



### NOTE:

- \*1 The user installation must be protecting by electromagnetic circuit breaker or by fuse isolator.
- \*2 The auxiliary voltage supply of the CD3000M unit must be synchronized with load voltage power supply. If the Auxiliary Voltage (written on the identification label) is different from Supply Voltage (to the load), use an external transformer as designated.
- \*3 only for size S14
- To work, the Reset Contact on terminal 7 and 8 must be closed.

### Load Type



## 10 Led status and Alarms

### 10.1 LED Status Table

In front of the thyristor unit there are LED that indicates the state of the Electronic cards:

LED For All size	STATUS	DESCRIPTION
Aux	○	The power supply is not connected or fault on the electronic board
	●	The power supply is not connected and the Electronic board is OK
ON	○	OFF Condition (Load IS NOT Powered)
	●	ON Condition (Load IS Powered)
SC	○	SCR OK
	●	SCR short circuit
	⦿	No External Enable (see par. 12.4)
HB	○	Load OK
	●	Load Fault
	○	= OFF
	●	= ON
	⦿	= Flashing

### 10.2 Not Critical Alarm

The Not Critical Alarm, doesn't stop the thyristor unit.

When one of these Not Critical Alarm is active, the HB relay change status (see par. 12.5)

#### 10.2.1 SCR Short Circuit (only with the HB option)

This alarm is active when the thyristor unit read the output current in absence of the input signal. This is possible if there are a short circuit on the thyristor or if there are a wrong wiring of the load.

When the problem is solved is necessary use the digital input: "Reset"  
(Terminals 7-8)

### 10.2.2 Heater Break alarm HB (only with the HB option)

This alarm is active when the load current decrease under the threshold set on the parameter P124H (see par. 14).

The Heater Break alarm could be active also if there are a wrong wiring of the load.

When the problem is solved is necessary use the digital input: "Reset"

(Terminals 7-8).

H.B. circuit read load current via a current transformer internal to the unit.

Minimum current is 10% of the current transformer size's.

The current transformer size's depending to the thyristor unit size.



**Caution:** *In the first start, and each time that the load is replaced, it's necessary make the Calibration procedure.*

## 10.3 Calibration Procedure

The Calibration procedure is an automatic procedure that save in memory the value of load current.

This procedure is necessary if you use the Heater Break Alarm.

To make the Calibration procedure follow these steps:

- Give the power supply.
- Press the "CAL" button on front unit, or use the configurable digital input (see par. 12.4).
- All LEDS are on, this means that calibration procedure is active.
- The CD3000M gives the maximum voltage output.
- After a minute the values of voltage and current are stored in memory.
- the CD3000M comes back to the initial situation.

The Calibration procedure is done.

## 11 Firing type

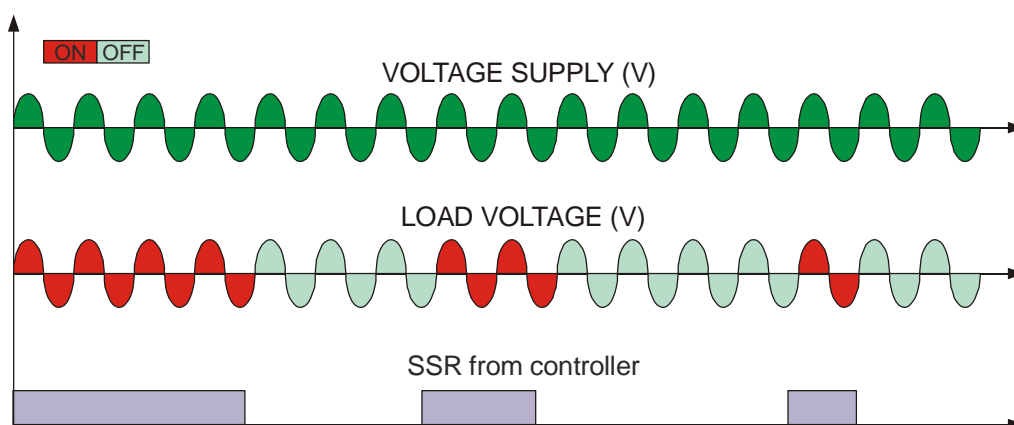
Choose an correct firing type allows to optimize the thyristor unit for the installed load. The firing type has already configured in line with customer requirements that are defined in the Order Code. The Order Code is written on the identification label. However, if you wish to change the firing type you can use the software configurator or the parameter on serial link (see par. 14).



**Caution:** this procedure must be performed only by qualified persons.

### 11.1 Zero Crossing (ZC)

ZC firing mode is used with Logic Output from temperature controllers and the Thyristor operates like a contactor. The Cycle time is performed by temperature controller. ZC minimizes interferences because the Thyristor unit switches ON-OFF at zero voltage.

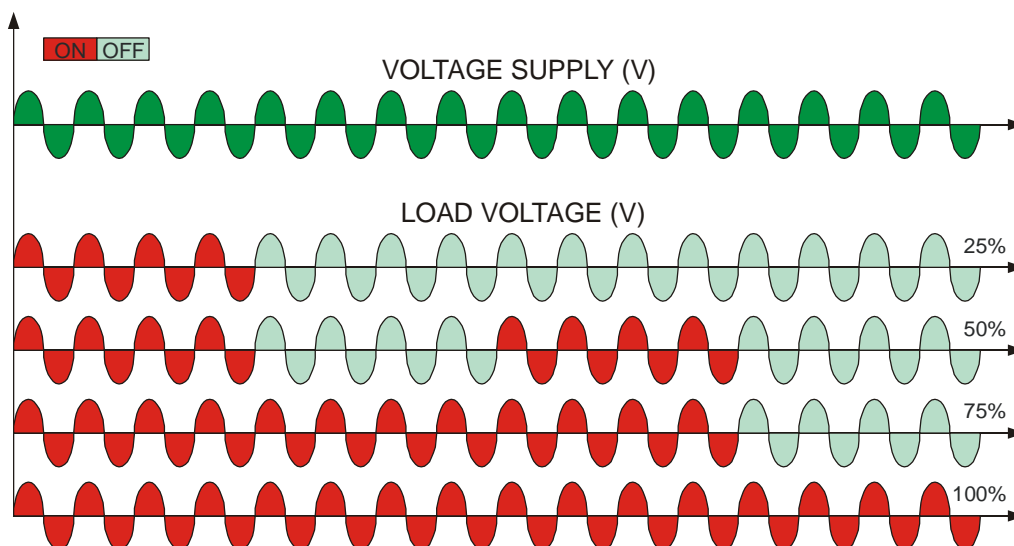


### 11.2 Burst Firing (BF)

The Burst Firing is a burst of consecutive cycles, the consecutive cycles ON are selectable between 2 and 255, with input signal equal at 50%.

Burst Firing is a method zero crossing that it reduces the electromagnetic interferences because the thyristor switches at zero voltage crossing.

The example show the Burst Firing with Burst cycles: P126L=4



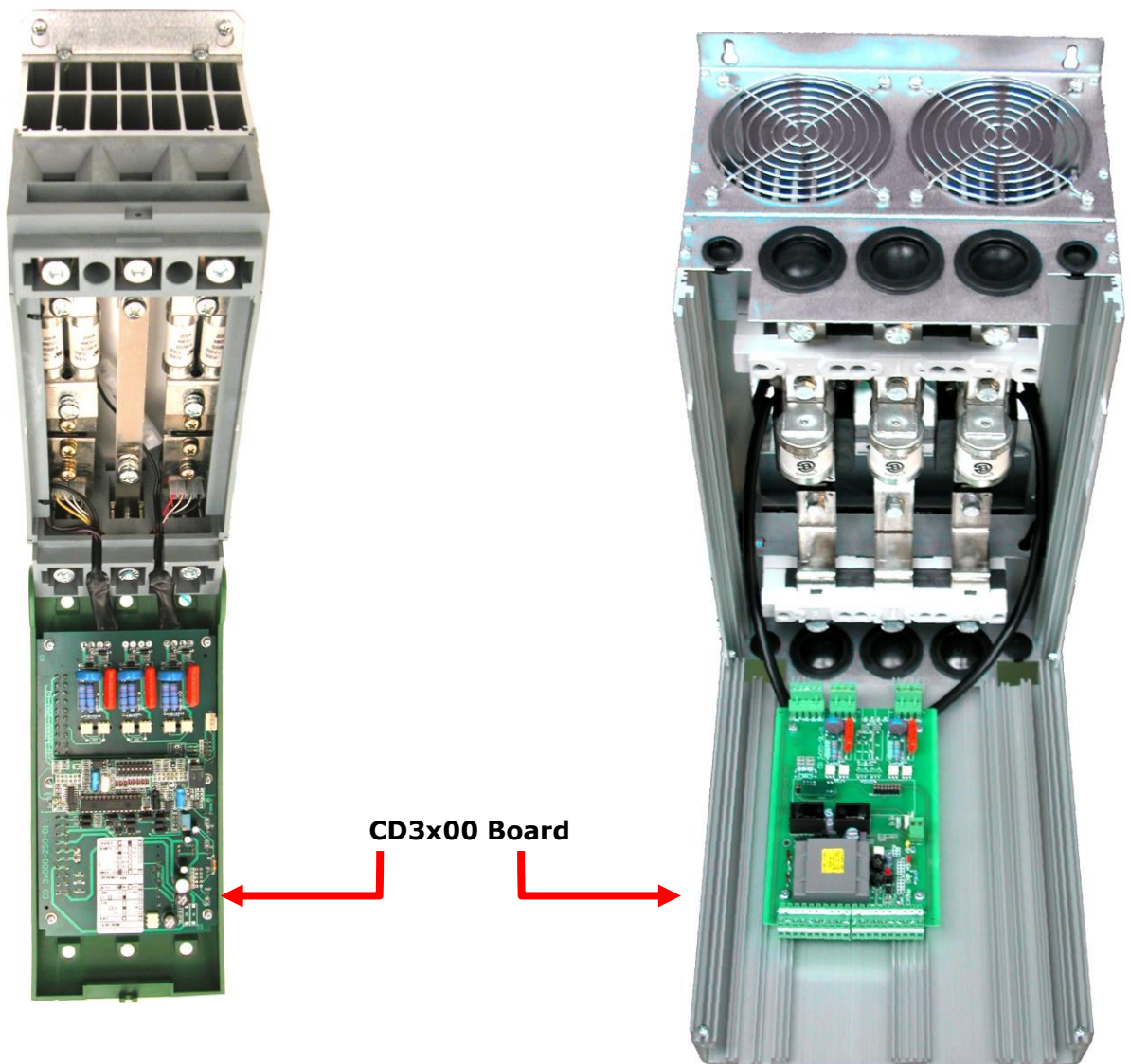
## 12 Connection description

### 12.1 Access to the Electronic boards

To have access to the electronic boards the user must removing the unit's cover (see par.9.1)



**Warning:** Before operate, be sure that power and control cables are isolated from voltage sources



# 12.2 Supply the Electronic Board

The CD3000M thyristor unit, to work, requires a voltage supply for the electronic boards. The Max consumption is 10VA.

The voltage supply for the electronic boards is configured in line with customer requirements that are defined in the Order Code. The Order Code is written on the identification label.



**Warning:** Before connecting or disconnecting the unit check that power and control cables are isolated from voltage sources.

Terminal	Description
1	Voltage Supply for Electronic Boards (Auxiliary Voltage)
2	Not Used
3	Voltage Supply for Electronic Boards (Auxiliary Voltage)
4	Earth

To change auxiliary supply voltage sold the correct link-jumper on CD3x00 board  
 The type of mounted transformer depends of the chosen Voltage in the order code.  
 (See par. 5.2)

Size S09 and S10		Size S14	
<b>Link-Jumper J9+J11</b> 		<b>Link-Jumper J9+J11</b> 	
<b>Link-Jumper J10</b> 		<b>Link-Jumper J10</b> 	

Transformer Type	Link-Jumper J9+J11	Link-Jumper J10
TR-605 120V	90:130V	-
TR-605 230V	170:265V	300:530V
TR-605 300V	230:345V	510:690V

If the Auxiliary Voltage (written on the identification label) is different from Supply Voltage (to the load), use an external transformer with primary equal to load voltage and secondary equal to the Auxiliary Voltage

## 12.3 Analog Inputs

CD3000M thyristor unit have an analogue input to drive the output power.

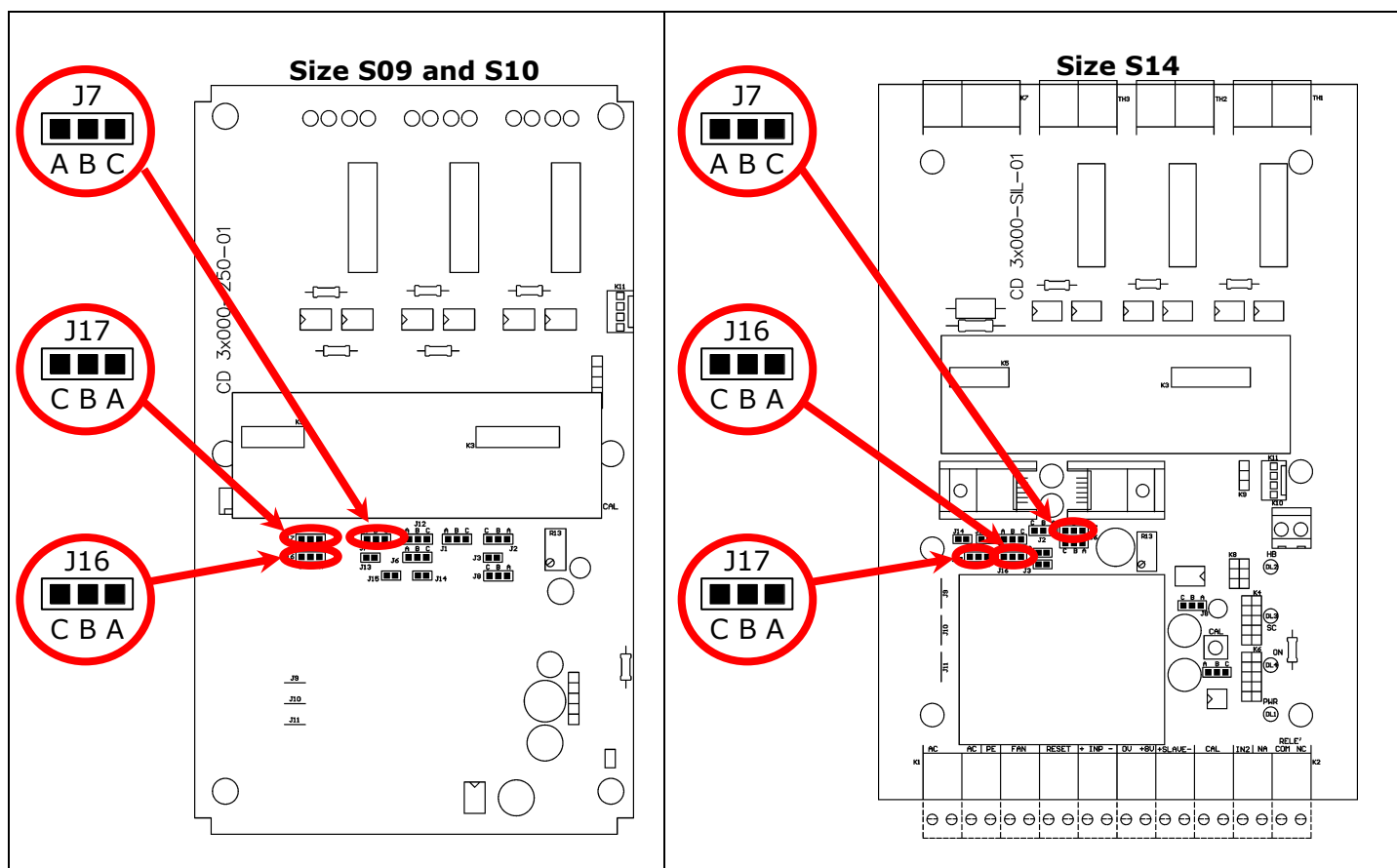
### 12.3.1 Input command signal configuration (Terminals 9 and 10 see par. 9.4)

The Input command signal is already configured in line with customer requirements that are defined in the complete product code. The product code is written on the identification label.

However, if you wish to change the input type (i.e. from 0÷10V to 4÷20mA) proceed as follows:



**Warning:** this procedure can be done just by specialized personnel.



To configure the input type, set the jumper as below represented:

Type	Input features		J7	J16	J17
SSR	Current drain	5mA	C-B	C-B	C-B
	ON	$\geq 4\text{Vdc}$ Max 30Vdc			
	OFF	$< 1\text{Vdc}$			
0÷10V	Impedance	10K $\Omega$	C-B	B-A	B-A
POT	Impedance	10K $\Omega$ min	C-B	B-A	B-A
4÷20mA	Impedance	100 $\Omega$	B-A	B-A	B-A

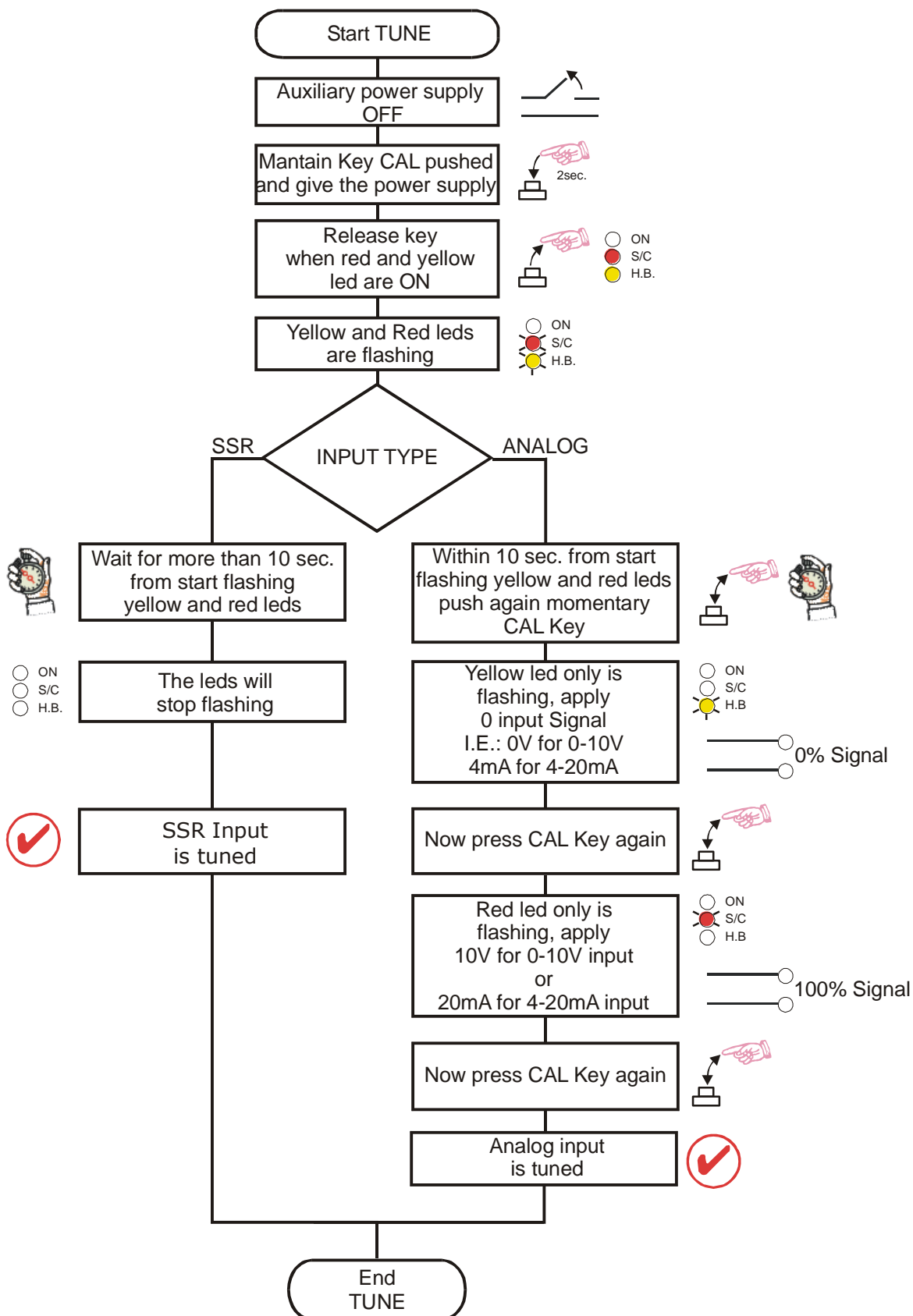
**When operator finishes to configure the hardware setting he must do the input calibration procedure**

### 12.3.2 Input calibration procedure



**Warning:** this procedure can be done just by specialized personnel

**This procedure is needed only if you change the input type**



## 12.4 Digital Input

CD3000M thyristor unit has two digital inputs.

### 12.4.1 Configurable Input (Terminals 15 and 16 see par. 9.4)

This digital input is configurable and can be:

- External Calibration (Standard):  
The Calibration input activates the Calibration procedure that is necessary if you use the Heater break alarm (see par. 10.3). Supply with 24Vdc terminals 15-16 to start the Heater Break procedure.
  - External Enable:  
Without Enable the out is always to zero and red led (SC) flashing, otherwise the out will follow the input signal.
- to configure the input type, set the jumper as below represented:



**Warning:** this procedure can be done just by specialized personnel

J12  
A B C

J6  
A B C

J15

J14

Size S09 and S10

J6  
C B A

J15

J14

J12  
A B C

Size S14

Type	J12	J6	J14	J15
External Calibration	C-B	C-B	Open	Close
External Enable	B-A	Open	Open	Close

**If you use the input like External Enable, is not possible use the input for the "Heater Break procedure".**

31

**12.4.2 Reset (Terminals 7 and 8 see par. 9.4)**

The Reset Alarm is used for restore the unit after an alarm occurs (see par. 10.2).  
Open link to terminals 7-8 to stop the CD3000M thyristor unit and reset the alarm.

**12.5 Digital Output**

CD3000M thyristor unit with HB option has 1 digital output with relay contact (Max 500mA, 125Vac) that gives indications of the alarms state, the contacts can be (NO and NC).

**12.5.1 HB alarm contact (Only with HB Option - see par. 10.2)**

The contact at terminals 19-20 is normally open (NO):

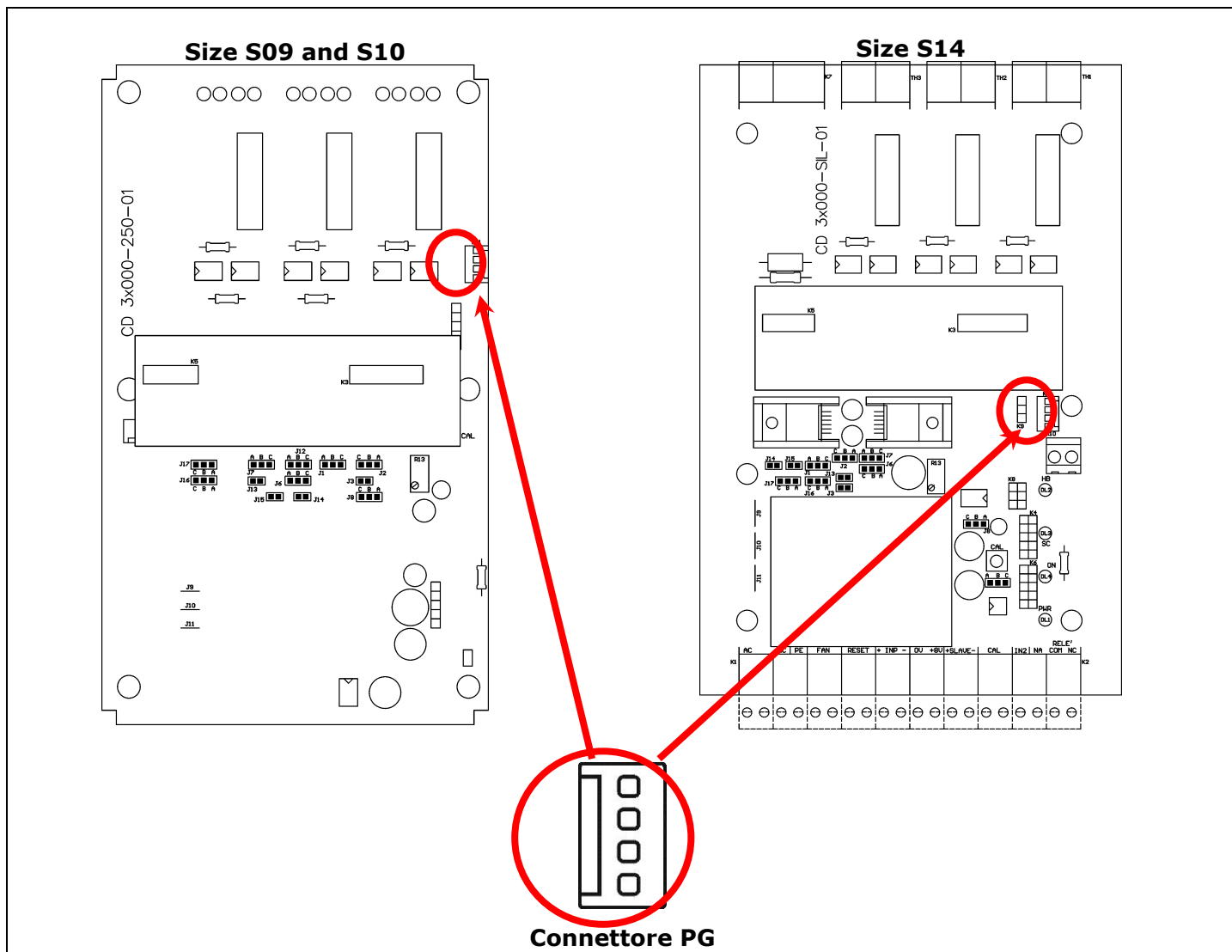
- In normal conditions (without alarm) and with auxiliary power supply, the contact to the terminals has opened (relay coil energized).
- In alarm condition or without auxiliary power supply the contact to the terminals is closed (relay coil not energized).

Also you can use the NC (closed without alarm) contact at terminals 18-19.

## 12.6 PG Connector

The PG Connector is used to configure the thyristor unit with the configuration software and with the programming cable.

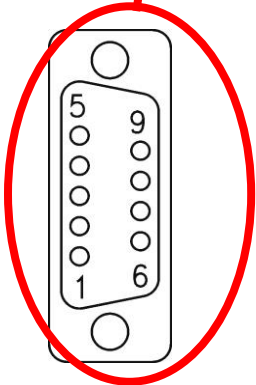
The programming cable is not included.



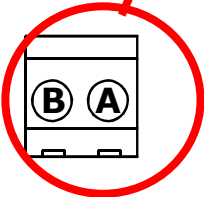
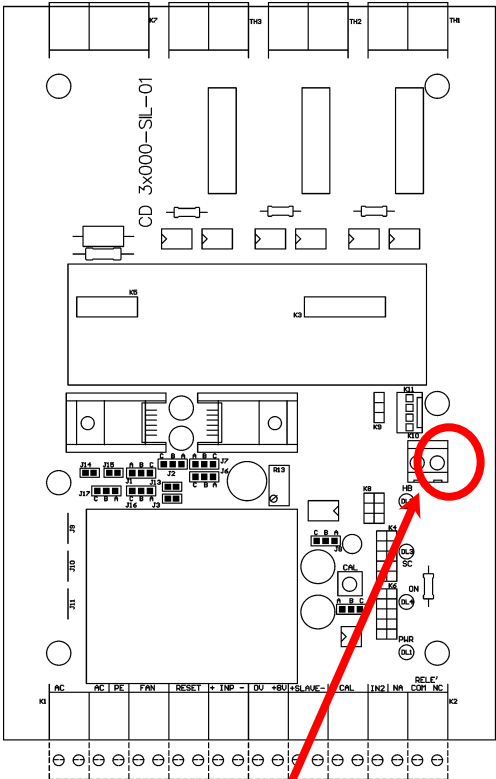
12.7 RS485 Serial Port

CD3000M have a serial communication port RS485.  
On this port may be done a network up to 255 unit.

Size S09 and S10



Size S14



Pin	Description
1	PMS5 (+5V)
2	GND 0V
3	GND 0V
4	Riserved (Rxd0)
5	GND 0V
6	RS485 A
7	RS485 B
8	nc
9	Riserved (Txd0)

Terminal	Description
B	RS485 B
A	RS485 A

## 12.8 Address configuration

The thyristor unit is assigned a unique device address by the user in the range 1 (default) to 255. This address is used to recognise the messages queries to her assigned.

The thyristor unit does not respond at the messages queries that don't have the same assigned address. The thyristor unit will also accept global messages (Broadcast) sends at the address 0. No responses are returned for globally addressed queries.

To configure communication address remove cover and set the dip-switch as below specified:



Convert the Address Number in Binary for Example: 150 Dec = 10010110 Bin

The dip switch number corresponds to the bit number:

Address Number	Dip Switch Number							
	8	7	6	5	4	3	2	1
150 Dec -> 10010110 Bin	1 (On)	0 (Off)	0 (Off)	1 (On)	0 (Off)	1 (On)	1 (On)	0 (Off)

For convert the Number in Binary you can use this method:

Dip Switch Number have this value:

	Dip Switch Number							
	8	7	6	5	4	3	2	1
Value	128	64	32	16	8	4	2	1

The Address Number Ex. 150 = 128(Dip 8) + 16(Dip 5) + 4(Dip 3) + 2(Dip 2)

## 13 MODBUS communication

The serial communication port of the thyristor unit is two-wire RS485 type.

This port use an half-duplex system.

When a Unit must transmit active the transmission line, and when there are not units in transmission the outputs are fixed to high impedance.

The serial communication port allows to communicate between the thyristor units and a MASTER device (ex. an computer or a terminal). The cable must be rated for use to data transfer.

### 13.1 MODBUS RTU Protocol

The communication is based on the standard industrial MODBUS RTU with the following restrictions:



- The Baud rate is 9600 Baud.
- The Preset Multiple Registers (Funct. 16) is limited to the writing of a single parameter for message.

The following MODBUS functions are supported:

Function	Description
03	Read Holding Registers
16	Preset Multiple Registers



The unit support the Broadcast messages:

It's possible send a Broadcast messages using the address 0, all the units respond at the message without sending back any reply.

### 13.2 Message Format

The transmission format is a 1 bit start, 8 data bit, and 1 bit stop with no parity verification.

Each message terminate after a said time of "time out", equal at 3.5 time of a character transmission, where there are not transitions on the transmission line.

The first Byte of each message is always the address of the unit that is a value from 1 to 255 or 0 for the broadcast messages, the second is always the function number, and the rest of the message depends of the function demand.



When a Slave receive an message, the unit send an answer with the same structure but with the information demanded.

Each message is followed by CRC (Cyclic Redundancy Check) with two byte. The CRC identify the incongruity situations of the message, in this case the receiver ignore the message.

The CRC is calculated in accordance with a formula that imply a recursive division of the data by a polynomial.

The polynomial divisor is:

$$2^{16} + 2^{15} + 2^2 + 1 (\text{Hex } 18005)$$

but is modified in two ways:

- Since the bits order are reversed, then the binary pattern is also reversed, and the most significant bit (MSB) is the right-most bit.
- Since interest only the remainder, the right-most bit could be discarded.

Therefore, the polynomial divisor has value: Hex A001

#### Normal bit order:

Most significant bit																Least significant bit
Most significant Byte								Least significant Byte								

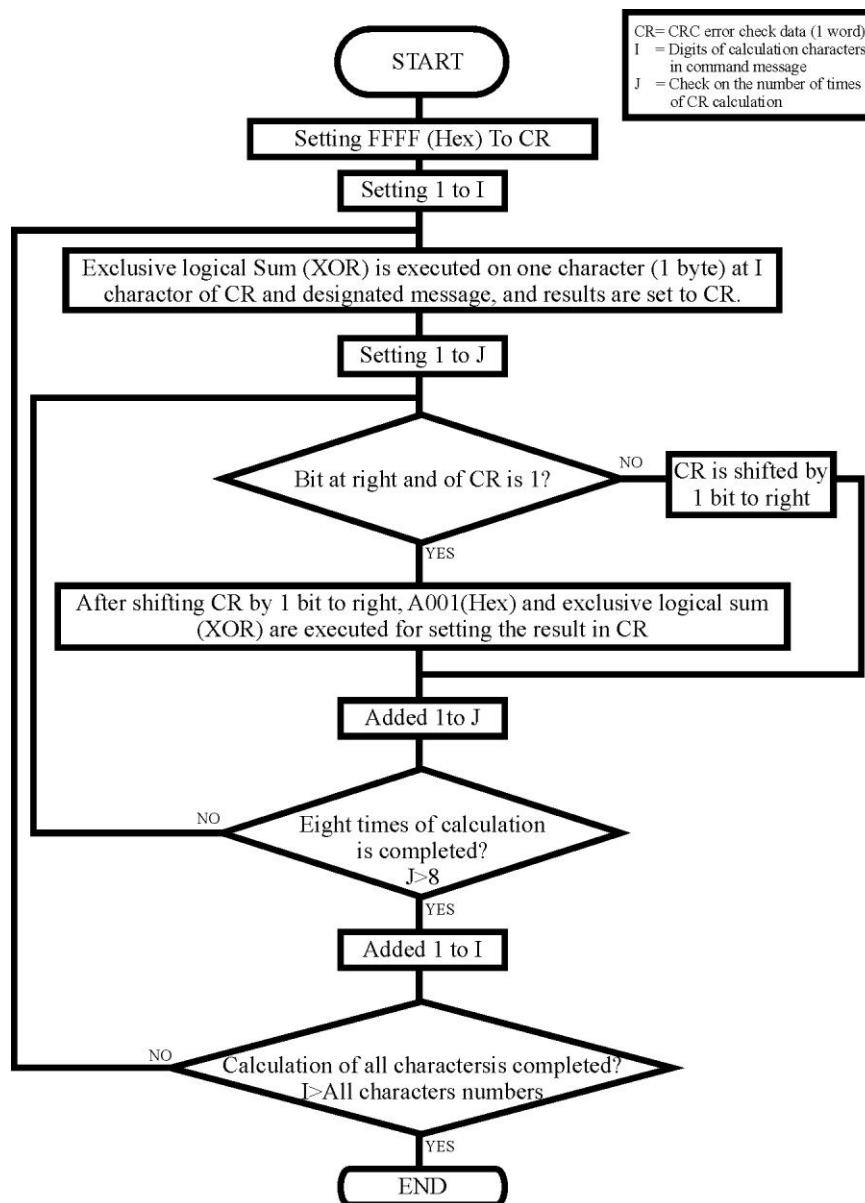
#### Reversed bit order:

Least significant bit																Most significant bit
Least significant Byte								Most significant Byte								

N.B.: With the reversed bit order, also the CRC16 returns the with the reversed bit order



The following flow-diagram show how to organize the CRC 16 bit.



### C Language CRC 16 Example

```

static short CRC16 (unsigned char *p_first,unsigned char *p_last)
{
    unsigned int crc=0xffff;
    short j;
    for (;p_first<=p_last;p_first++)
    {
        crc ^= *p_first;
        for(j=8;j>0;j--)
        {
            if(crc & 0x0001)
            {
                crc = crc >> 1;
                crc ^= 0xA001;
            }
            else
            {
                crc = crc >> 1;
            }
        }
    }
    return (crc);
}
  
```

### 13.3 Read Holding Registers

This function reads the instantaneous value of a specified number of parameters from an address. The message is composed by 8 Byte: one Byte is for the address, one for the function (03 Hex), two Byte for the first parameter to read, two Byte for the total number of parameters to read and finally two Byte for the CRC:

Address Unit	Function	Address of the First Parameter		N° of the Parameter		CRC 16	
	3 3Hex	HI	LO	HI	LO	LO	HI

The answer is an echo of the first two Byte (address and function), one byte with the number of following byte to exclusion of the CRC, the demanded values and finally two Byte for the CRC:

Address Unit	Function	N° of Byte	First Parameter Value			Last parameter value		CRC 16	
	3 3Hex		HI	LO	...	HI	LO	LO	HI

### 13.4 Preset Multiple Registers

This function could write only a parameter for each message.

The message is composed by 11 Byte: one Byte for the address, one for the function (10 Hex), two Byte for first parameter to write, two Bytes for the N° of parameters, fixed to 1 (0001 Hex), one Byte with the number of following Bytes, fixed to 2 (02 Hex), two Byte for the CRC:

Address Unit	Function	Address of the First Parameter		N° of the Parameter		N° of Byte	Value to write		CRC 16	
	16 10Hex	HI	LO	0	1	2	HI	LO	LO	HI

The answer is an echo of the first two Byte (address and function), two Byte for first written parameter, two Byte with the N° of parameters, fixed to 1 (0001 Hex), two Byte for the CRC:

Address Unit	Function	Address of the First Parameter		N° of the Parameter		CRC 16	
	16 10Hex	HI	LO	0	1	LO	HI

## 13.5 Error and exception responses

If a message contains an altered character, if fails the CRC, or if the received message contains a syntax error (for example the number of the byte or of the words is not correct), then the unit will ignore the message.

If the received message is correct but contains a not valid value, the unit will send an answer of exception (5 byte):

Address Unit	Function	Error Code	CRC 16	
			LO	HI

The byte with the function number, represent the function number of the message that has caused the error with the first Bit set to 1 (ex. the function 3 becomes 0x83) The error code could be one of the followings:

Error Code	Name	Cause
1	ILLEGAL FUNCTION	Function not supported.
2	ILLEGAL DATA ADDRESS	Address out of range.
3	ILLEGAL DATA VALUE	Attempt to write invalid or action not carried out.



NOTE: If you write a parameter's value equal at his actual value this is a valid transaction and don't cause an error.

# 14 Configuration Parameters

The Configuration Parameters are accessible from the software configurator or through the serial communication port RS485.

## P001 (H01)

### Load Current

R

Function:

This parameter shows the Current rms value.

Min/Max:

0 ÷ 255 (0 ÷ FF Hex)

Value:

Value depends of current transformer and from his size's

Example:

With current transformer (CT) 150/0.05A, the max value corresponds to the max value of the CT:  
Read value=255 (FF Hex) -> Load Current= 150A

## P002 (H02)

### Set-point HB

R/W

Function:

This parameter is the Set-point of current below which HB alarm occurs.

Min/Max:

0 ÷ 255 (0 ÷ FF Hex)

Value:

This value is the load current(P001) minus % value of parameter P124H.

## P003 (H03)

### Status Table

R

Function:

It's a tab in bit that represent the "Status" of thyristor unit

Value:

Bit 0 = 1 -> Short circuit on SCR  
Bit 1 = 1 -> Load Failure (HB Alarm)  
Bit 2 = 1 -> Output signal ON  
Bit 3 = 1 -> HB Calibration in progress

## P004 (H04)

### Command Table

R/W

Function:

It's a tab in bit for remote commands via RS485

Value:

Bit 0 = 1 -> Activate HB Calibration procedure  
Bit 1 = 1 -> Input Command from RS485 (see P005)  
Bit 2 = 1 -> Disable Output signal (Only with Input from RS485)  
Bit 3 = 1 -> Reset HB Alarm

Note:

When unit is switch off all command parameter are set to 0

## P005 (H05)

### Input command signal

R

Function:

This parameter reads the Input command signal (see par. 9.4)  
When the P004 Bit1 =1 This parameter could be written and become the Input Command from RS485

Min/Max:

0 ÷ 255 (0 ÷ FF Hex)

Example:

Input 4mA -> P005 = 0 (0%)  
Input 12mA -> P005 = 128 (50%)  
Input 20mA -> P005 = 255 (100%)

## P006 (H06)

### Power adjust

R/W

Function:

Its' a scaling factor of the Input command signal

Min/Max:

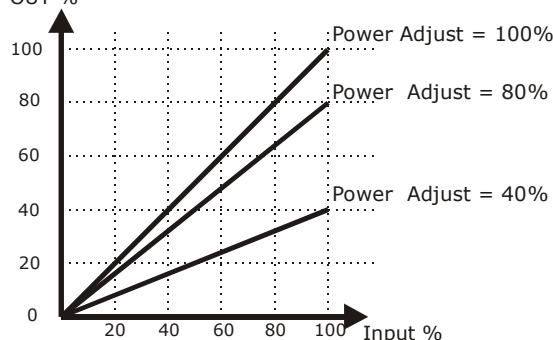
0 ÷ 255 (0 ÷ FF Hex)

Value:

from 0 = 0% of Output,  
To 255 = 100% of Output.

Note:

This parameter limit the Output Power



<b>P121 (H79)</b>	<b>CD Unit ID</b>	<b>R</b>
Function:	This parameter Identify the CD type Family	
Value:	CD01 Hex = CD1000-CD3000M Family	
<b>P122 (H7A)</b>	<b>CD Ver</b>	<b>R</b>
Function:	This parameter is for internal use	
<b>P123 (H7B)</b>	<b>Password</b>	<b>R/W</b>
Function:	This parameter give the access to configuration	
Min/Max:	0 ÷ FFFF Hex	
Value:	9357 Hex = Writing parameters activated any value = Writing parameters disabled	
Note:	When the CD3000M comes out and then re-lighted, for change the parameters you must re-insert the password.	
<b>P124L (H7C)</b>	<b>Byte Lo = Delay trigger (Only for 1PH version)</b>	<b>R/W</b>
Function:	This parameter is the delay of firing in first half period with respect zero voltage crossing	
Min/Max:	0 ÷ 50 (0 ÷ 32 Hex)	
Value:	Each step is 0,1msec	
Default:	30	
<b>P124H (H7C)</b>	<b>Byte Hi = HB sensibility</b>	<b>R/W</b>
Function:	This parameter is the maximum reduction of Load Current to establish the HB Alarm	
Min/Max:	0 ÷ 100 (0 ÷ 64 Hex)	
Value:	0 = 0% of Nominal Current 255 = 100% of Nominal Current	
Default:	51	
Note:	When you change this parameter, HB Calibration procedure is necessary.	
<b>P125L (H7D)</b>	<b>Byte Lo = Firing type</b>	<b>R/W</b>
Function:	This parameter set the Firing Type	
Value:	01 Hex = Zero Crossing 02 Hex = Single Cycle (Only for 1PH version) 03 Hex = Burst Firing 13 Hex = Burst Firing+ Soft Start (Only for 1PH version) 23 Hex = Burst Firing+ Delay trigger (Only for 1PH version) 24 Hex = Phase Angle (Only for 1PH version)	
Default:	3 (if not specified in the Order Code)	
<b>P125H (H7D)</b>	<b>Byte Hi = Soft start time (Only for 1PH version)</b>	<b>R/W</b>
Function:	The Unit starts in phase angle mode with a ramp starting from zero up to full voltage in a presetted and Adjustable time. The time is setted by this parameter	
Min/Max:	0 ÷ 255 (0 ÷ FF Hex)	
Value:	Each step is 5msec	
Default:	4	
Note:	Value of this parameter must be less than cycle time. For burst firing this parameter must be less than: 50Hz -> 20msec x Number of cycles (P126L). 60Hz -> 16,6msec x Number of cycles (P126L).	
<b>P126L (H7E)</b>	<b>Byte Lo = Number of cycles (Burst)</b>	<b>R/W</b>
Function:	This parameter defines the number of voltage cycles in ON condition at 50% of power demand	
Min/Max:	1 ÷ 255 (0 ÷ FF Hex)	
Value:	Each step is 1 cycle	
Default:	8 (if not specified in the Order Code)	

**P126H (H7E)**

Function:  
Min/Max:  
Value:  
Default:  
Note:

**Byte Hi = HB Delay time**

This parameter set a delay to have HB alarm active  
0 ÷ 255 (0 ÷ FF Hex)  
Each step is 50msec  
3  
If Soft start option is enabled HB Delay time must be greater than Soft start time:  $P126H \times 50\text{msec} > P125H \times 10\text{msec}$   
When Zero Crossing firing is used must be less than Cycle time:  
 $P126H \times 50\text{msec} < P127H \times 50\text{msec}$

**R/W**

**P127L (H7F)**

Function:  
Min/Max:  
Value:  
Default:

**Byte Lo = Max power for SSR Input**

When SSR input is used it represent the value of the power (%) when is in ON status  
0 ÷ 255 (0 ÷ FF Hex)  
from 0 = 0% of Output,  
to 255 = 100% of Output  
255

**R/W**

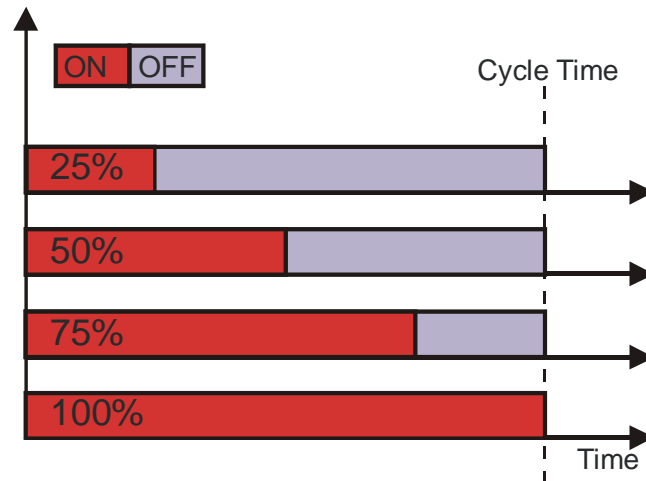
**P127H (H7F)**

Function:  
Min/Max:  
Value:  
Default:  
Example:

**Byte Hi = Cycle time**

The Cycle Time is the time which the Thyristor modulates to obtain the power demand  
0 ÷ 255 (0 ÷ FF Hex)  
Each step is 50msec  
60 (3C Hex) = Zero Crossing  
240 (F0 Hex) = Burst Firing  
With a Cycle time at 4 sec:  
25%-> 1sec On+3sec off  
50%-> 2sec On+2sec off  
75%-> 3sec On+1sec off

**R/W**



**P128L (H80)**

Function:  
Min/Max:  
Value:  
Note:

**Byte Lo = Number of half period (DT firing)**

This parameter defines the number of half period in delay of firing.  
1 ÷ 255 (0 ÷ FF Hex)  
Each step is 1 half period  
Must be setted at 1

**R/W**

## 15 Internal Fuse

The CD3000M thyristor unit have internal fuse extrarapid at low  $I^2t$  for the thyristor protection of against the short-circuits.

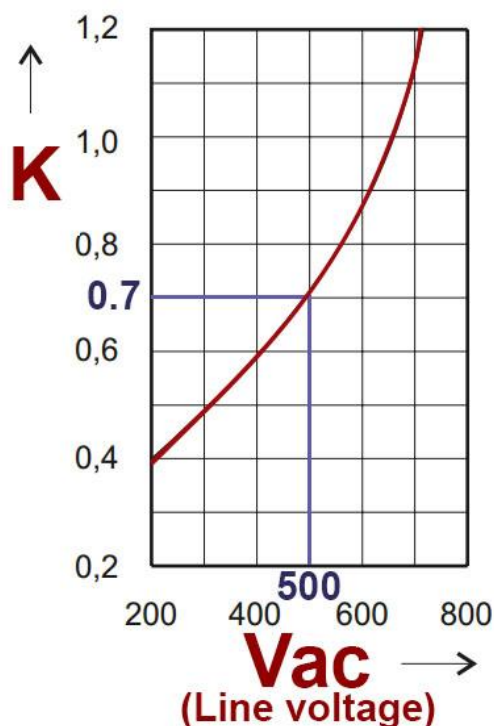
The fuse must have  $I^2t$  lower than the thyristor one ( $I^2t_{max}$ )



**Caution:** USE ONLY EXTRARAPID FUSE WITH APPROPRIATE  $I^2t$

### 15.1 Fuse Code

Size	200 kARMS Symmetrical A.I.C.					Qty
	Fuse CODE	Current (A RMS)	FUSE I <sup>2</sup> T value Suggested A2s (at500V)*	FUSE I <sup>2</sup> T value Suggested A2s (at660V)	Vac	
125A (S09)	FU200FEE	200	7980	11400	660	2
150A (S09)	FU200FEE	200	7980	11400	660	2
200A (S10)	FUURE315	315	53900	77000	660	2
275A (S14)	FUURE315	315	53900	77000	660	3
400A (S14)	FU550FMM	550	150500	215000	660	3
450A (S14)	2xFU315FM or 1xFU630FMM	630	215600	308000	660	3
500A (S14)	2xFU315FM or 1xFU630FMM	630	215600	308000	660	3
600A (S14)	2xFU450FMM	900	294000	420000	660	2
700A (S14)	2xFU450FMM	900	294000	420000	660	2



\*  $I^2t$  è moltiplicato per il fattore K in funzione della Vac, a 500V K è uguale a 0,7 (es:  $420000 \times 0,7 = 294000$ ). A 660Vsc K è uguale ad 1.



**Caution:** The Fuses must have  $I^2t$  20% less than thyristor's  $I^2t$



**Caution:** High speed fuses are used only for the thyristor protection and can not be used to protect the installation.



**Caution:** The warranty of thyristor is null if no proper fuses are used. See tab.



**Warning:** The user installation must be protected by electromagnetic circuit breaker or by fuse isolator.



## 16 Maintenance

### 16.1 Trouble Shooting

Small problems sometimes can be solved locally with the help of the below tab of trouble shooting. If you don't succeed, contact us or your nearest distributor.

Symptom	Indication on front unit	Possible reasons of the symptom	Actions
Thyristor unit doesn't go in conduction with input signal	Green LED (Aux) always light off	<ul style="list-style-type: none"> <li>No voltage auxiliary power</li> </ul>	<ul style="list-style-type: none"> <li>Give auxiliary voltage supply (see wiring diagram)</li> </ul>
	Green LED (Aux) light on Green LED (ON) light off	<ul style="list-style-type: none"> <li>No input signal</li> <li>Reversed polarities of input signal</li> <li>Reset contact is open</li> </ul>	<ul style="list-style-type: none"> <li>Provide to give input signal</li> <li>Reverse the input signal polarity</li> <li>Make link on reset terminals (see wiring diagram)</li> </ul>
	Green LED (Aux) light on Green LED (ON) light on	<ul style="list-style-type: none"> <li>Fuse failure</li> <li>Load failure</li> <li>Load connection interruption</li> <li>Thyristor faulty and always in open circuit</li> </ul> With HB option the yellow led (HB) is light on	<ul style="list-style-type: none"> <li>Substitute the fuse</li> <li>Check the load</li> <li>Check the wiring</li> <li>Substitute the faulty thyristor</li> </ul>
Load current flows also with no input signal	Green LED (ON) always light off.	<ul style="list-style-type: none"> <li>Wrong wiring</li> <li>Short circuit on thyristor</li> </ul> If there is HB option the red LED (SC) is light on	<ul style="list-style-type: none"> <li>Check the load wiring</li> <li>Substitute the thyristor</li> </ul>
Current flows at nominal value but Yellow LED (HB) is light on	Yellow LED (HB) light on	<ul style="list-style-type: none"> <li>HB circuit not tuned</li> <li>Current transformers not properly wired</li> </ul>	<ul style="list-style-type: none"> <li>Make HB calibration procedure</li> <li>Control current transformers wiring</li> </ul>
Current flows at nominal value but Red LED (SC) is light on	Red LED (SC) light on	<ul style="list-style-type: none"> <li>HB circuit not tuned</li> </ul>	<ul style="list-style-type: none"> <li>Make HB calibration procedure</li> </ul>
Thyristor unit doesn't work properly		<ul style="list-style-type: none"> <li>Wrong input signal selection.</li> <li>Wrong input signal calibration (out of range).</li> <li>Auxiliary voltage supply out of limits</li> </ul>	<ul style="list-style-type: none"> <li>Control input signal setting.</li> <li>Repeat input calibration procedure.</li> <li>Verify the auxiliary voltage supply</li> </ul>

## 16.2 Fans

The thyristor unit with forced ventilation uses fans that rotate permanently when the unit is supplied. In case of fan failure, the heat-sink can reach high temperature. In this case to give protection to thyristor there is a thermal switch properly setted. The function of this switch is to open the input signal until the heat-sink temperature falls below the setted value. This means that also with input signal in ON condition the unit is switched OFF and the system can not work at full power. For this reason is important to control periodically the fans status checking that are rotating.

## 16.3 Maintenance

For maintain a correct cooling, the consumer must clean the heat-sink and the protective grate of the fans. The frequency of these operations depends on the atmospheric local pollution. Check also that the screw of the power terminals and earth terminals are shut correctly (see Diagram of control connection).

## 16.4 Repairing procedure

- Phone to CD Automation.
- Explain to Service Engineer the problem because sometimes it can be solved with a phone call. If this is not possible, ship the unit to CD Automation or to your distributor.
- Write a fault description and give the name of your personnel to which refers.
- Use a rugged packaging to ship the unit.

## 16.5 Warranty condition

CD Automation gives a 12 months warranty to its products. The warranty is limited to repairing and parts substitution in our factory and does exclude products not properly used and fuses. Warranty does not include products with serial numbers deleted. The faulty product should be shipped to CD Automation at customer's cost and our Service will evaluate if product is under warranty terms. Substituted parts remain of CD Automation property.

