Tde Macno

User's manual
NOT RIGENERATIVE AC/DC

Cod. MP00501E00 V_1.0

1. INTRODUCTION

This manual contains the necessary instructions for installing and using the non-regenerative AC/DC converter (**AC/DC converter**).

1.1. READING HINTS

THE GENERIC HAZARD SING AND THE FRAMED TEXT IN CAPITAL LETTERS FOCUSES THE ATTENTION OF THE USER ON THE WARNINGS CONTAINED IN THIS MANUAL.

Bold : It highlights some meaningful sentences in the text.

1.2. SYMBOLS USED IN THE CONVERTER MARKING

The AC/DC converter bears - outside and inside (in the accessible parts for wiring) - **labels** that indicate the presence of danger for people. Here below, there is a legend with the meaning of the symbols used:

SYMBOL	DESCRIPTION
	Caution, risk of electric shock. Accumulation of energy, wait for the time indicated next to the symbol.
	Protective conductor fastening terminal
	Refer to the installation manual

TAB. 1 – Symbols used

1.3. WARRANTY

a) Within the limits set forth in this warranty, the undersigned manufacturer undertakes to repair any and all manufacturing defects that may become patent during the warranty period.

b) The warranty becomes void if the purchaser does not properly follow all the instructions described in these "Installation Instructions".

c) In order to take advantage of the right of warranty, the purchaser, upon occurrence of the fault, shall timely notify it to the manufacturer and allow the same, if necessary, to carry out the related inspections and repairs.

d) The purchaser shall bear the transport charges for sending the defective part covered by warranty to the manufacturer and then back to the purchaser, in order to allow the repair or replacement of the same. The warranty obligation, as provided in this clause, shall be deemed fulfilled with the delivery to the purchaser of the part properly repaired or replaced.

e) During the warranty period referred to in clause 1), labor costs for the repair will be borne by the manufacturer. If repairs or replacements have to be made at the customer's premises, the costs of travel and lodge of the personnel shall be borne by the purchaser.

f) The guarantee does not include breaks caused by wrong operation, incompetence, accident or otherwise attributable to the user, both due to himself and to third parties, or when the user has made modifications or repairs without the written consent of the manufacturer, regardless of the connection between such changes or repairs and the detected defects.

g) It is expressly agreed that the manufacturer will be relieved from any responsibility for any damages caused to the purchaser by a loss of or decreased production, resulting from manufacturing faults or defects.

1.4. CE MARKING / RATING PLATE

The CE marking certifies the conformity of the equipment with the essential safety and health requirements set forth by the European Directives mentioned on the Declaration of CE Conformity. It consists of a silver polyester adhesive label with black print, having the following dimensions: L= 102 mm - H= 50 mm (FIG. 1).
It is applied externally on the front panel. The rating plate bears the logo, CE marking, type, serial number, software, warnings, and all other rating data as shown in the facsimile below:

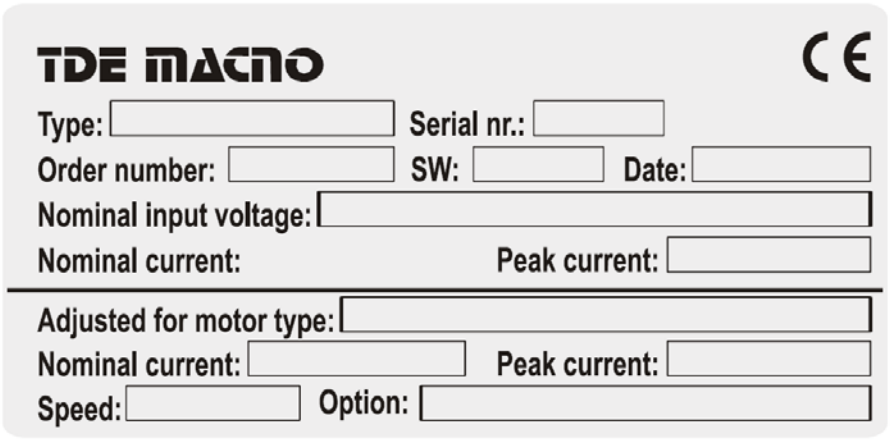


FIG. 1 – Adhesive plate

2. INTENDED USE

The AC/DC converter has been designed and manufactured for the following intended use:

Field of use	Power conversion (AC/DC) for plants connected to three-phase mains.
Place of use	In a close, covered, and dry environment showing the temperature and humidity values indicated in the section "Limits of use" and complying with the law provisions in force in the country of use concerning occupational safety and health. The AC/DC converter has to be secured to a wall able to assure its stability with reference to its overall dimensions and weight, and complying with the minimum positioning measures.
Entrusted operator (suitable person)	This technical manual is intended exclusively for the authorized operators entrusted with the use and maintenance of the equipment according to the specific technical and professional skills required by the type of works. **THE AUTHORIZED OPERATORS SHALL PERFORM ON THE EQUIPMENT EXCLUSIVELY THE INTERVENTIONS INCLUDED IN THEIR SPECIFIC AREA OF COMPETENCE. BEFORE PERFORMING ANY INTERVENTION ON THE EQUIPMENT, THE AUTHORIZED PEOPLE SHALL MAKE SURE TO BE IN SUCH A MENTAL AND PHYSICAL CONDITION AS TO ASSURE THE OBSERVANCE OF SAFETY CONDITIONS AT ANY TIME.** The entrusted operator is a qualified technician (a suitable person meeting the technical and professional requirements required by current standards), authorized to install and use the equipment operating even in the presence of voltage and with disabled protections (with the consent of the Safety Manager) in strict compliance with the instructions contained in this manual or any other document, which is provided exclusively by the manufacturer.

2.1. STATE OF "SWITCHED OFF" DEVICE

Before performing any type of maintenance and/or adjustment on the equipment, it is compulsory to disconnect the power source (both mains and DC BUS side). The mains power supply can be considered disconnected when at least one of the following conditions is met:
• the main switches on the AC side have been disconnected;
• the mains side protection fuses have been removed;
• not any power supply is provided.
The DC power supply can be considered disconnected when at least one of the following conditions is met:
• the DC side output cables are disconnected;
• the fuses protecting all elements related to the DC BUS have been removed
The AC/DC converter is considered "OFF", if power supply is disconnected on both the mains and DC BUS power supply side.
Moreover, it is necessary to wait at least minimum 8 minutes to be sure that all the live parts are discharged as stated on the adhesive labels applied to the AC/DC converter (FIG. 2).

FIG. 2 – Adhesive labels

3. TECHNICAL DATA

AC/DC CONVERTER SIZE		60	200	60	200
MAINS INPUT					
Input voltage	[Vac]	3x230Vac ±10%		3x380Vac -15% ÷ 460Vac +10%	
Input frequency	[Hz]	45 ÷ 65			
Input current at rated power	[Aac]	50	170	50	170
DC BUS OUTPUT					
Rated output current	[Adc]	60	200	60	200
Transient overload (45s)	[Adc]	90	200	90	200
BRAKING CIRCUIT					
Brake triggering voltage	[Vdc]	385		730	
Brake release voltage	[Vdc]	370		710	
Peak current	[Adc]	80	190	90	190
Braking thermal current	[Adc]	55	190	55	190

TAB. 2 – Technical data

AC/DC CONVERTER SIZE		400	750		
MAINS INPUT					
Input voltage	[Vac]	3x380Vac -15% ÷ 460Vac +10%			
Input frequency	[Hz]	45 ÷ 65			
Input current at rated power	[Aac]	340	640		
DC BUS OUTPUT					
Rated output current	[Adc]	400	750		
Transient overload (45s)	[Adc]	400	750		
BRAKING CIRCUIT					
Brake triggering voltage	[Vdc]	730	Braking circuit not forecast		
Brake release voltage	[Vdc]	710	-		
Peak current	[Adc]	320	-		
Braking thermal current	[Adc]	250	-		

TAB. 3 – Technical data

4. STORAGE - HANDLING

4.1. STORAGE ENVIRONMENTAL CONDITIONS

If the AC/DC converter has to remain stored for a long time, it is necessary to store it in a safe environment with an adequate temperature and humidity degree, and protected against dust.

temperature	-20÷60	°C
humidity	5÷95	%
condensation	NO	

TAB. 4 - Storage

THE AC/DC CONVERTER SIZES UP TO 400A CONTAIN INSIDE THEM ELECTROLYTIC CAPACITORS ON THE DC BUS. EVERY 6 MONTHS – 1 YEAR, IT IS NECESSARY TO REGENERATE THESE CAPACITORS. FIRST IMPLEMENT THE RECOVERY PROCEDURE AFTER STORAGE WITH SWITCHED OFF AC/DC CONVERTER. THEREAFTER, FEED THE AC/DC CONVERTER THROUGH L1, L2 AND L3 USING THE WIRING DIAGRAM OF THE POWER EQUIPMENT.

4.2. RECOVERY PROCEDURE AFTER THE STORAGE

The converter cannot be used immediately after a storage period. To prevent faults, it is necessary to adopt the following recovery procedure.

PHASE 1:

AC/DC converter not powered		
temperature	15÷35	°C
humidity	5÷75	%
condensation	NO	
Atmospheric pressure	86÷106	kPa
Recovery time (1)	1	h

TAB. 5 – Recovery after storage

(1) After this recovery time, there should be no trace of condensation inside or outside the converter (well ventilated environment).

PHASE 2:

If the time that has elapsed since the last regeneration of the electrolytic capacitors of the power bus ranges between 6 months and one year, it is necessary to perform the regeneration once again:

a) connect the AC/DC converter to the line (using the appropriate mains resistor);
b) do not connect anything on the terminals +, - and F;
c) power supply the AC/DC converter with the mains voltage;
d) give the pre-charge enabling command;
e) leave the AC/DC converter in this status for at least 2 hours

Once the regeneration process has ended, the converter can work normally.

THE REGENERATION PROCEDURE OF THE POWER BUS ELECTROLYTIC CAPACITORS GIVEN ABOVE IS NO MORE VALID IF:

- **THE TIME ELAPSED SINCE THE LAST REGENERATION IS GREATER THAN 1 YEAR**
- **THE TIME ELAPSED SINCE THE PURCHASE IS GREATER THAN 1 YEAR AND THE REGENERATION PROCEDURE HAS NEVER BEEN DONE**

IN THESE CASES, IT IS NECESSARY TO ASK TDE MACNO ABOUT THE OPERATING PROCEDURE TO BE ADOPTED.

4.3. HANDLING

Not any lifting brackets have been forecast for the AC/DC converter. Given its limited size and weight, the converter can be transported directly by the entrusted personnel.
Protect the equipment against bumps during handling.

5. LIMITS OF USE

The AC/DC converter shows environmental limitations to the use as set out below.

5.1. CLIMATIC CONDITIONS

3K3 class according to EN 60721-3-3

Environmental parameter	Limits	Measurement unit
operating temperature	-20÷45 (1)	°C
humidity	5÷95	%
atmospheric pressure	70÷106 (2)	kPa
maximum movement of the surrounding air	1	m/s
maximum temperature gradient	0.5	°C/min
maximum thermal radiation	700	W/m^2
condensation	NO	
rainfall with wind	NO (3)	
water of different origin from rain	NO	
icing	NO	

TAB. 6 – Climatic conditions

(1) As a matter of fact, the limits of the climatic class 3K3 involve a 5÷45 °C working temperature; however, the AC/DC converter can work within a wider temperature range without any kind of downgrading.

(2) The air pressure limits correspond to an operating field of 0÷3000m a.s.l. As a matter of fact, over 1000 m above sea level, it is necessary to derate the rated current of the converter by 1% every 100 m.

(3) The converter must be installed inside an electrical panel and, therefore, not outdoor.

5.2. RESISTANCE TO CHEMICALLY ACTIVE SUBSTANCES

3C1R class according to EN 60721-3-3

Environmental parameter	Maximum value	Measurement unit
sea salts	NO	-
sulfur dioxide	0.01	mg/m^3
	0.0037	cm^3/m^3
hydrogen sulfide	0.0015	mg/m^3
	0.001	cm^3/m^3
chlorine	0.001	mg/m^3
	0.00034	cm^3/m^3
hydrochloric acid	0.001	mg/m^3
	0.00066	cm^3/m^3

Environmental parameter	Maximum value	Measurement unit
hydrofluoric acid	0.001	mg/m^3
	0.0012	cm^3/m^3
ammonia	0.03	mg/m^3
	0.042	cm^3/m^3
ozone	0.004	mg/m^3
	0.002	cm^3/m^3
nitrogen oxide	0.01	mg/m^3
	0.005	cm^3/m^3

TAB. 7 – Resistance to chemically active substances

5.3. RESISTANCE TO VIBRATIONS

As regards vibrations, the limits of use are the following:

10Hz ≤ frequency ≤ 57Hz	0.075	mm (amplitude)
57Hz ≤ frequency ≤ 150Hz	1	G

TAB. 8 – Vibrations

In the case of vibrations above the indicated limits, it is necessary to adopt suitable damping solutions.

5.4. PROTECTION AND POLLUTION DEGREE

Protection degree	IP20 only for AC/DC 60 IP00 for other sizes
Pollution degree	2 (1)

TAB. 9 – Protections

(1) Non-conductive pollution and, occasionally and temporarily, conductive pollution generated by condensation.

6. INSTALLATION INSTRUCTIONS

6.1. MECHANICAL INSTALLATION

The AC/DC converter has to be installed under the environmental conditions specified in the section "Limits of use" and in compliance with the following instructions:

a) Position the converter observing the minimum positioning measures.
b) Connect the AC/DC converter to the wall using screws, according to the dimensions shown.
c) Prevent metallic residues resulting from drilling or works performed on connection electrical cables from falling into the converter.
d) In no case, the converter has to be mounted close to easily flammable materials.

IT IS COMPULSORY TO HAVE AUTHORIZED OPERATORS PERFORM THE INSTALLATION OF THE AC/DC CONVERTER

IT IS COMPULSORY TO INSTALL THE AC/DC CONVERTER BEING SURE THAT THE ELECTRICAL PANEL TO WHICH IT IS GOING TO BE CONNECTED DOES NOT SHOW ANY POWER SUPPLY.

ANY OPERATION WITHIN THE CONVERTER MUST BE DONE WITHOUT VOLTAGE PRESENCE AND, IN ANY CASE, WAIT FOR AT LEAST 8 MIN. BEFORE ACCESSING THE SAME (FIG. 2).

IT IS COMPULSORY TO INSTALL THE CONVERTER ONLY IN VERTICAL POSITION BECAUSE ONLY IN THIS WAY HEAT CONVECTION IS NOT HINDERED, WHICH WOULD CAUSE DAMAGES. IF IT IS NECESSARY TO INSTALL THE CONVERTER IN NON VERTICAL POSITION CONTACT THE TECHNICIAN OF TDE MACNO TO EVALUATE THE SITUATION CASE BY CASE.

IT IS COMPULSORY TO ASSURE A GOOD ACCESS TO ALL THE CONTROL ELEMENTS.

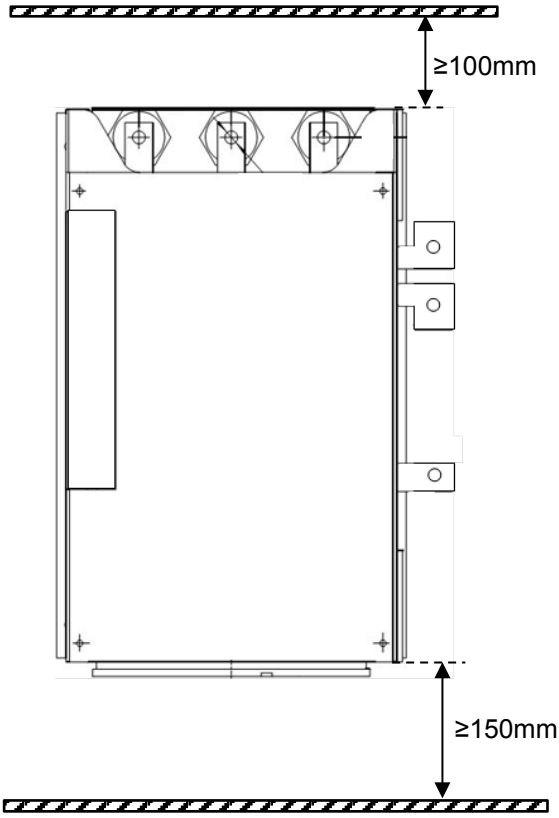
THE CONVERTER INSTALLATION SHALL NOT HINDER ACCESS TO DISCONNECTING AND CUTTING-OFF TOOLS.

IF THE CONVERTER IS USED IN A DIFFERENT WAY THAN THE ONE SPECIFIED BY THE MANUFACTURER, THE PROTECTIONS PROVIDED BY THE CONVERTER ARE NOT GUARANTEED.

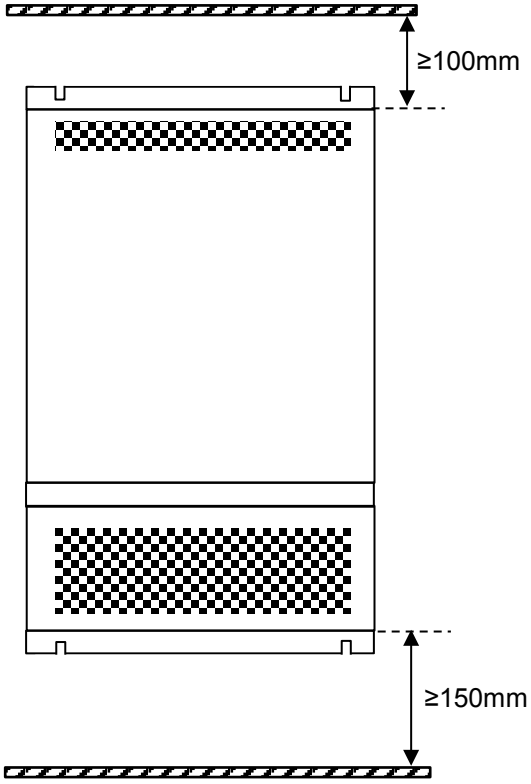
AC/DC CONVERTER SIZE	Wall mounting points	Fastening screws
60	2	M5
200	4	M6
400	4	M6
750	4	M6

TAB. 10 – Fastening screws

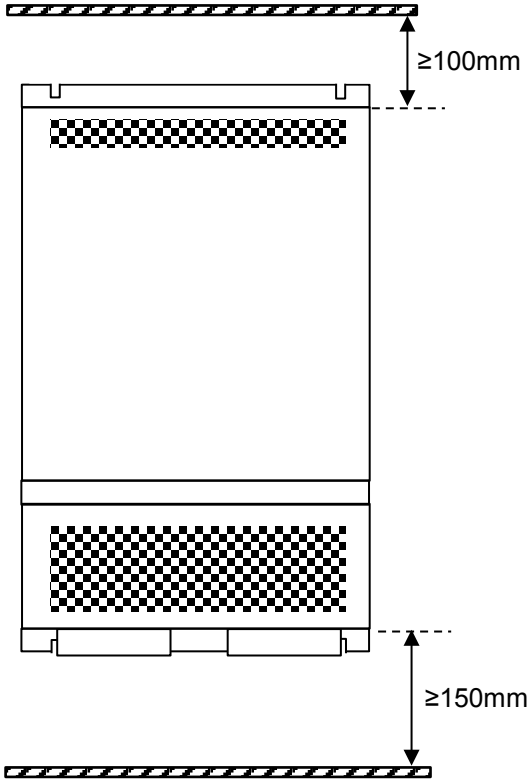
AC/DC 60



AC/DC 200



AC/DC 400



AC/DC 750

FIG. 3 – Minimum distances for installation

6.2. DIMENSIONS

The overall dimensions of the AC/DC converter sizes are given here below

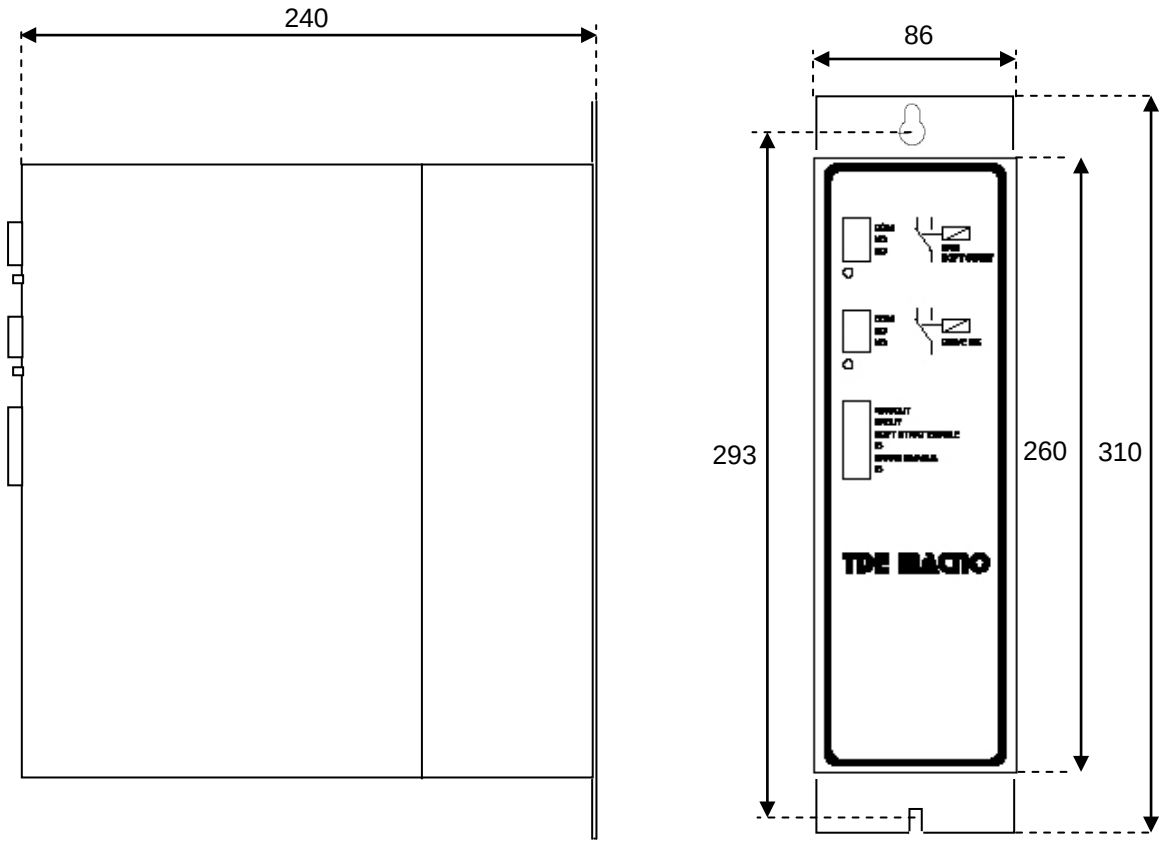


FIG. 4 – Dimensions - AC/DC 60

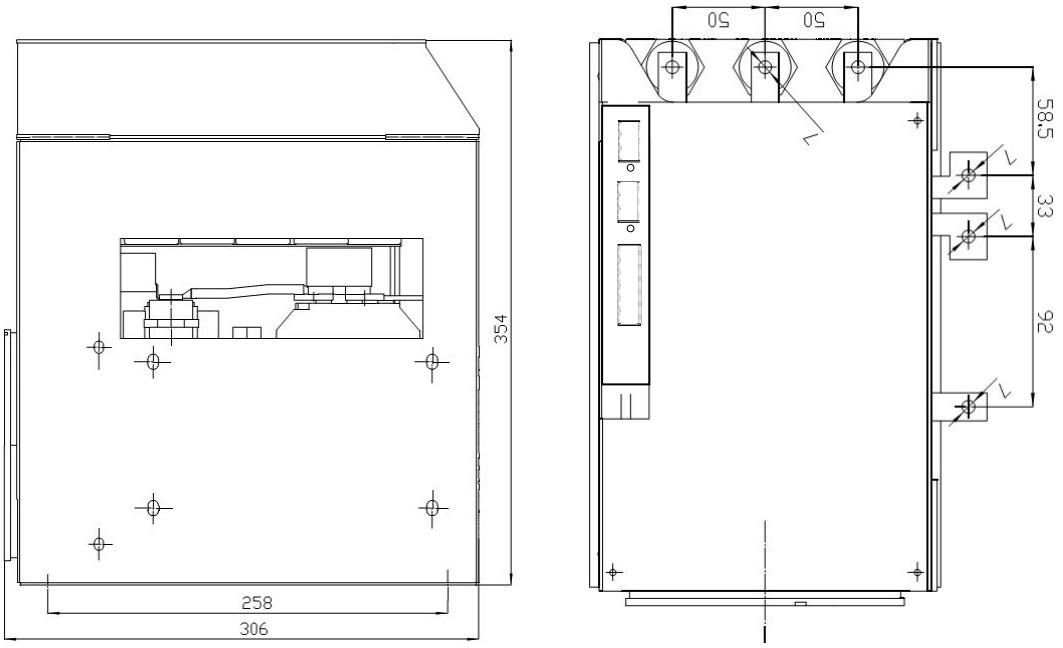


FIG. 5 – Dimensions - AC/DC 200

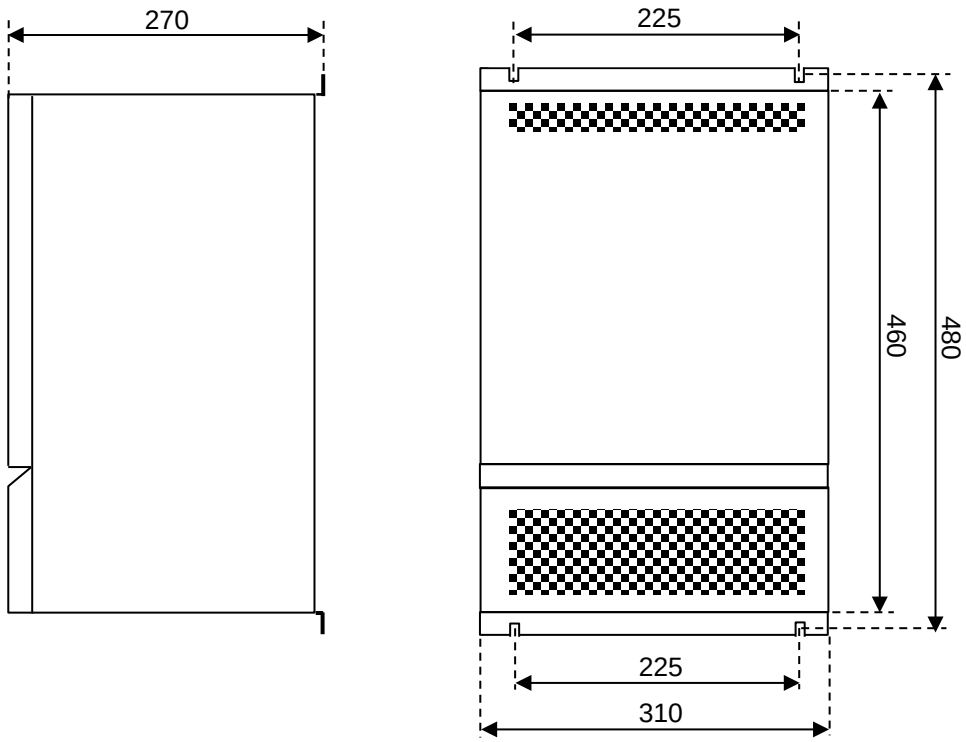


FIG. 6 – Dimensions - AC/DC 400

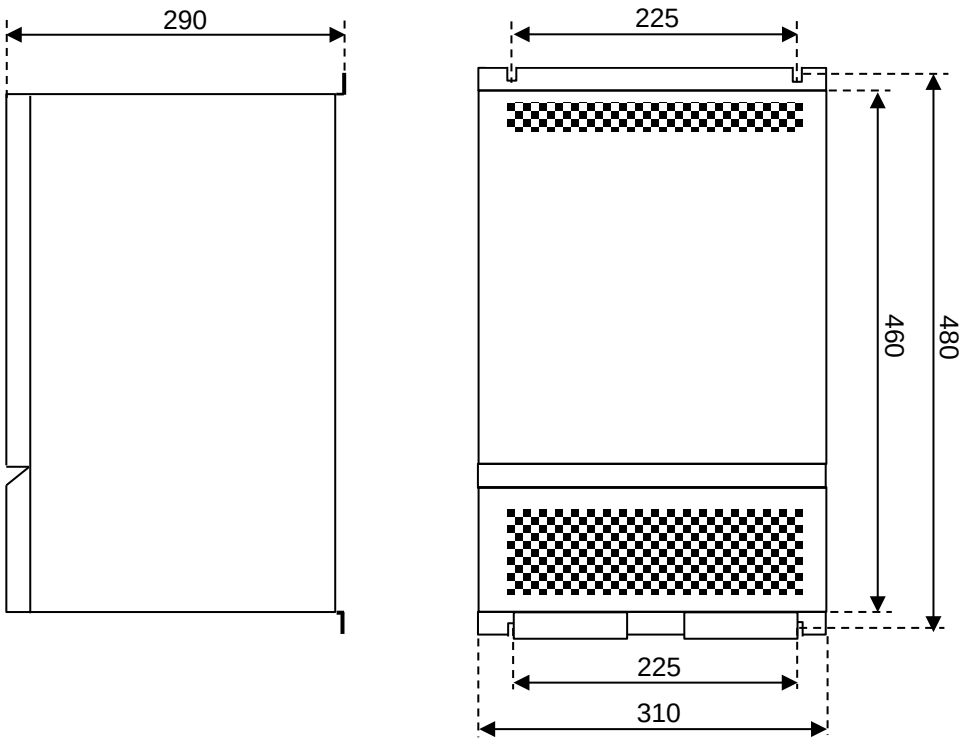


FIG. 7 – Dimensions - AC/DC 750

6.3. CLOSED ENVIRONMENT: DISSIPATED POWER

The following table shows the power dissipated by the AC/DC converter operating at rated current, including the regulation and ventilation losses.
In case of installation in a closed environment, e.g. in a cabinet, it is necessary to make sure that the inner temperature does not exceed the ambient temperature permissible for the AC/DC converter.
The environment has to be ventilated with a sufficient air quantity as to remove the heat generated by the same and by the other components.

AC/DC CONVERTER SIZE [SIZE]	DISSIPATED POWER [W]
60	140
200	570
400	890
750	2070

TAB. 11 – Dissipated power

7. POWER EQUIPMENT

7.1. DESCRIPTION OF THE POWER CIRCUIT

The power diagram of the AC/DC converter is shown in FIG. 8. The power equipment consists of several parts:
a) semi-controlled bridge that will be properly controlled by the ignition card so as to gradually charge the power bus
b) filter capacitors on the power bus (only for the sizes 60A, 200A and 400A).
c) Braking IGBT for dissipating the energy returned by the converters to the power bus (only for the sizes 60A, 200A and 400A).

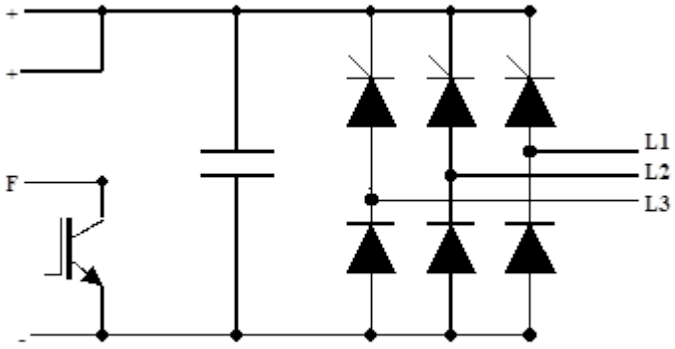


FIG. 8 – Basic diagram of the power equipment

7.2. DESCRIPTION OF POWER CONNECTIONS

TAB. 12 and TAB. 13 show the terminals or power bars and their corresponding meaning. TAB. 12 refers to terminals or input (AC power supply side) or output (DC side) bars; while TAB.13 refers to terminals or bars of the braking circuit (valid only for AC/DC 60, 200, and 400).

TERMINAL	DESCRIPTION
L1, L2, L3	Power supply input
+	Positive of the shared power bus
-	Negative of the shared power bus

TAB. 12 – Input and output connections

TERMINAL	DESCRIPTION
+	Terminal only present in the AC/DC 60 version: Positive of the shared power bus to be used **exclusively** for connecting the braking resistor
F	Braking IGBT collector to be used for connecting the braking resistor (only for the sizes 60A, 200A, and 400A)

TAB. 13 – Braking resistor connections

Here below, for each size, the position of the power connections is given.

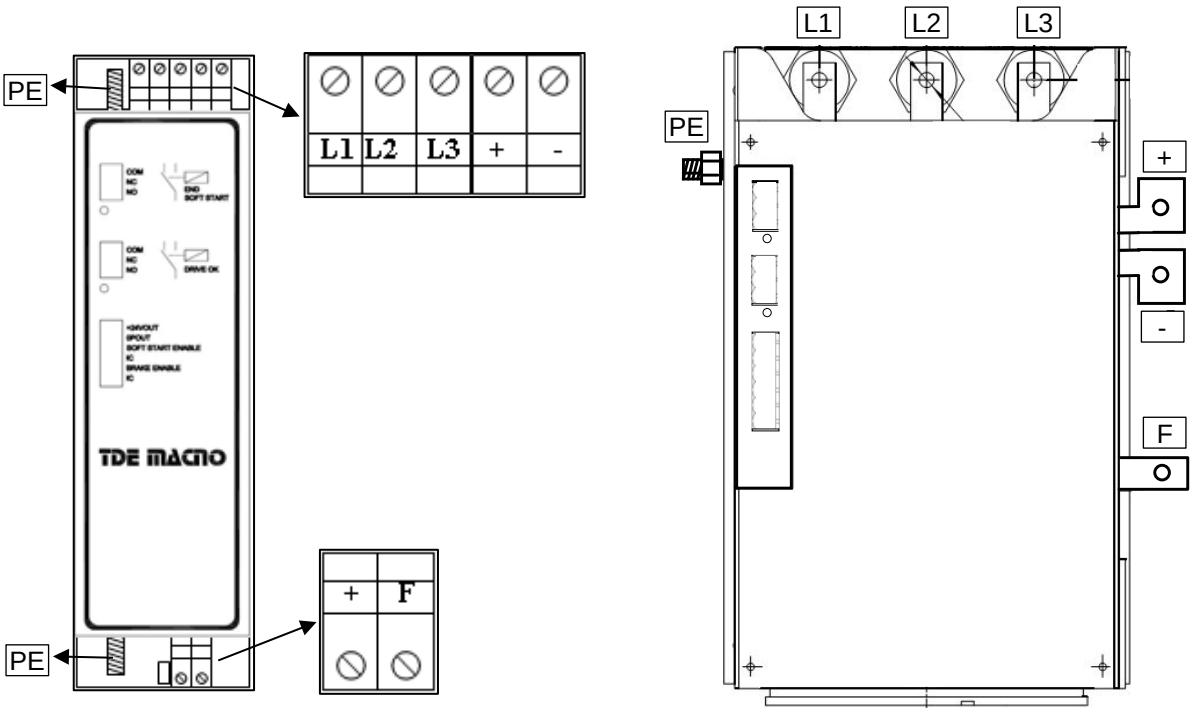


FIG. 9 – Arrangement of the power connections for AC/DC 60 (left) and 200 (right)

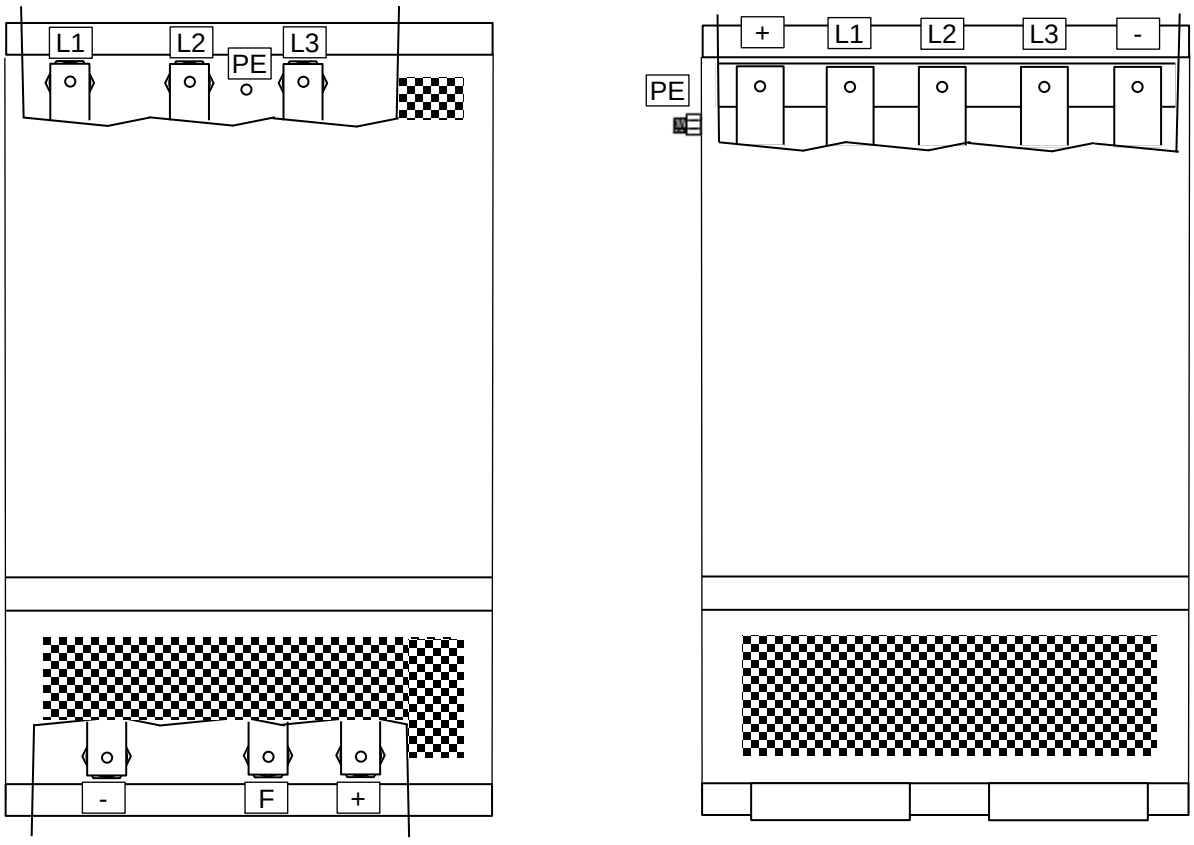
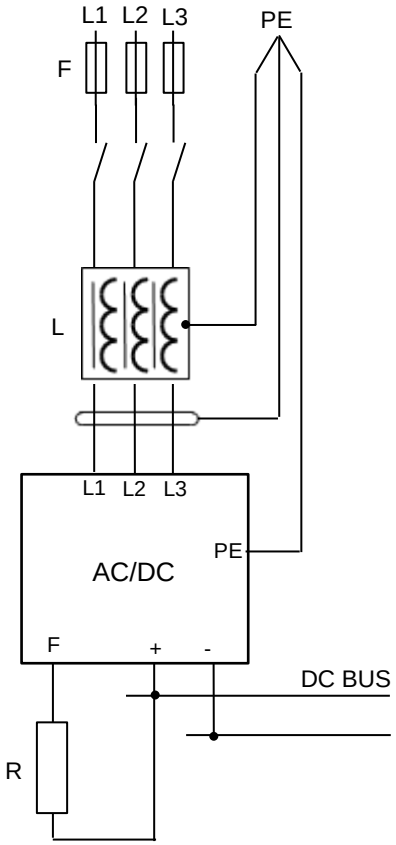


FIG. 10 – Arrangement of the power connections for AC/DC 400 (left) and 750 (right)

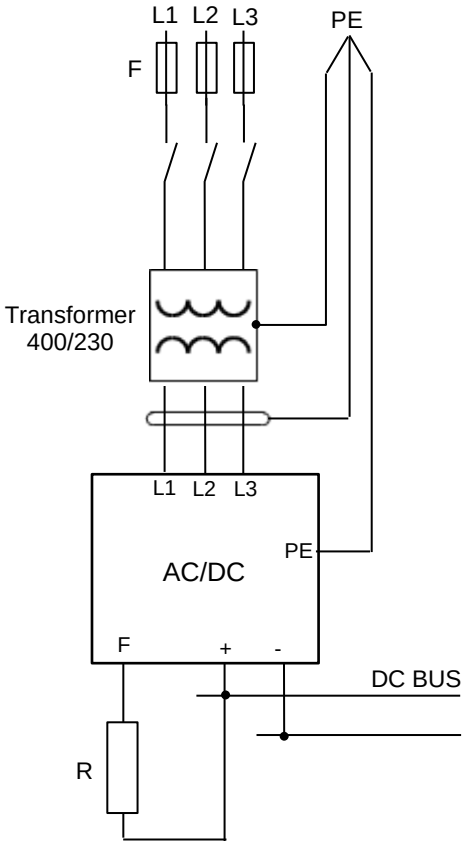
7.3. CONNECTION OF THE POWER EQUIPMENT

FIG. 11 shows the power connection recommended for the AC/DC converter. In the standard configuration of the product, a line voltage equal to 400Vac is forecast. Only for the sizes AC/DC 60 and AC/DC 200, and specifying this when ordering, it is possible to configure the AC/DC converter for an input voltage of 230Vac. In this case, the connections are shown in FIG. 12.



Power connections for 400Vac mains voltage (standard configuration)

FIG. 11



Power connections for 230Vac mains voltage (option only available for AC/DC 60 and AC/DC 200)

FIG. 12

7.4. CONNECTION OF THE POWER SUPPLY FOR COOLING FANS

All current sizes of the AC/DC converters include cooling fans for the radiator. Only the version AC/DC 60 is able to internally generate the voltage to be supplied to the cooling fans. For the other current sizes, it is necessary to provide a 230Vac 50/60Hz supply voltage. TAB. 14 shows the characteristics of the power supply of the fans.

AC/DC converter size	Fans power supply	Voltage [V]	Required power [W]
60	Internal	24Vdc	-
200	External	230Vac 50/60Hz	45
400	External	230Vac 50/60Hz	24
750	External	230Vac 50/60Hz	80

TAB. 14 – Fans power supply

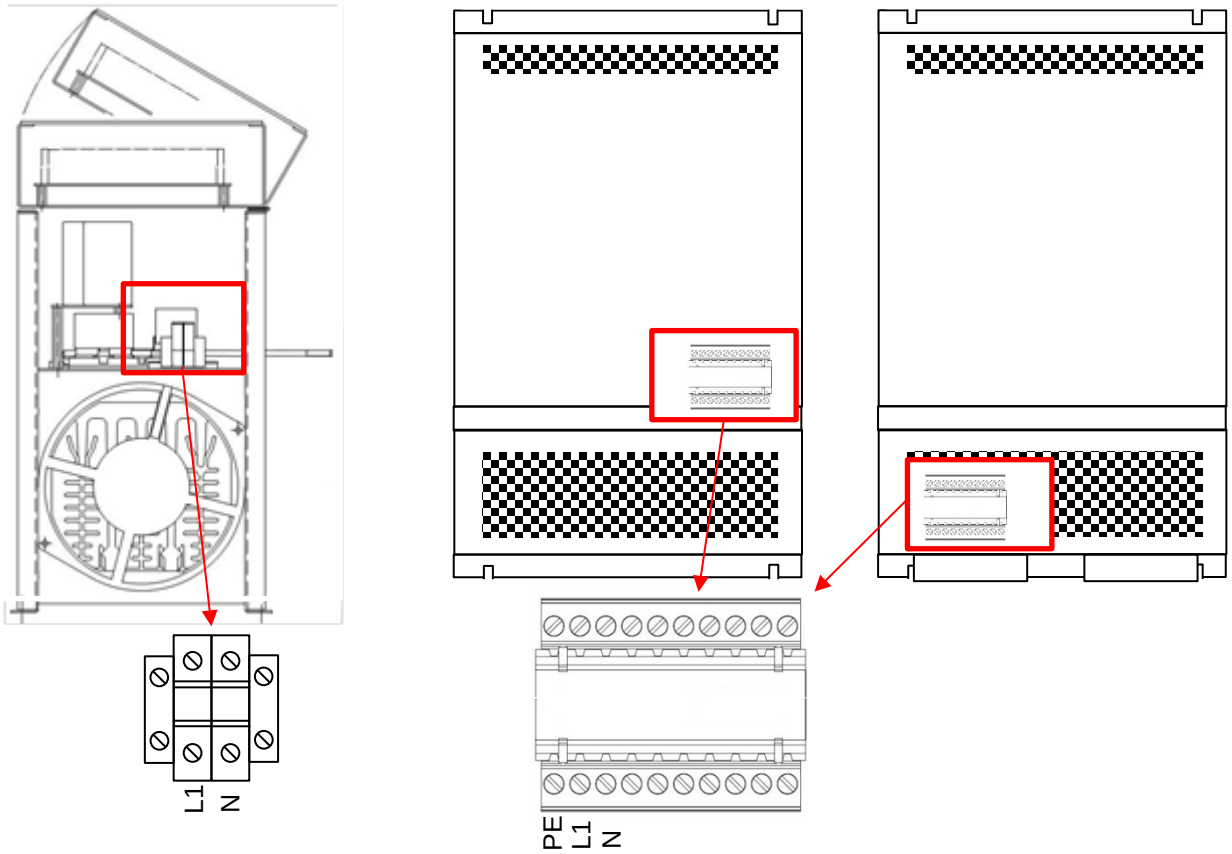


FIG. 13 - Arrangement of fans connectors for AC/DC 200 (left), 400 and 750 (center and right)

7.5. POWER COMPONENTS (STANDARD CONFIGURATION)

The following tables outline all the power components recommended to assure the correct operation of the AC/DC converters powered with 400-460Vac at rated load conditions. The tables refer to FIG. 11.

Protection fuses (F)				
AC/DC converter size	Rated current	Minimum rated voltage	Fuse type	I^2T Maximum
	[A]	[V]		[A^2s]
60	63	480	Ultra rapid	<7800
200	200-250	480	Ultra rapid	<18000
400	400-450	480	Ultra rapid	<320000
750	630-700-800	480	Ultra rapid	<320000

TAB. 15 – Protection fuses

NOTE: The fuses were calculated for a minimum short-circuit current equal to 10 times the rated current. The maximum short-circuit current must not exceed 20 times the rated current.

Section of the line input cables/connection bars (L1, L2, L3, PE) (1) (2)						
	L1, L2, L3				PE	
Size AC/DC	Bar width (min-max)	Minimum section	Screw pitch	Tightening torque	Protective conductor section	Cable lugs tightening torque
	[mm]	[mm^2]		[Nm]	[mm^2]	[Nm]
60	-	10 (PVC cable)	-	1.5-1.8	10	9
200	12-15	45	M6	9	50 (PVC cable)	9
400	25-30	150	M8	20	70 (PVC cable)	20
750	30-35	300	M8	20	150 (PVC cable) / 30mmx5mm (copper bar)	20

TAB. 16 - Line input connection

Section of the output connection bars (+, -, F) (2)						
	+, - DC BUS				+, F Braking resistor	
Size AC/DC	Bar width (min-max)	Minimum section	Screw pitch	Tightening torque	Conductor section (3)	Tightening torque
	[mm]	[mm^2]		[Nm]	[mm^2]	[Nm]
60	-	10 (PVC cable)	-	1.5-1.8	6-10 (PVC cable)	1.5-1.8
200	15-20	60	M6	9	50-95 (PVC cable)	9
400	30	150	M8	20	70-120 (PVC cable)	20
750	30-35	350	M8	20	-	-

TAB. 17 – Output connection

	Line input resistor (5)				Braking resistor			
Size AC/DC	Minimum inductance	Thermal current	Effective saturation current	Saturation current (Peak)	Minimum value	Peak power (6)	Resistor minimum voltage	Average power (4)
	[mH]	[Aac]	[Aac]	[A]	[Ω]	[kW]	[Vdc]	[kW]
60	0.5	50	98	139	8	72.2	1000	-
200	0.15	170	326	462	4	144.4	1000	-
400	0.074	326	653	924	2.5	231.0	1000	-
750	0.04	612	1225	1732	-	-	-	-

TAB. 18 – Line resistor and braking resistor

(1) The indications on the sections of the connection cables refer to PVC cables at 70 °C. The sections of the cables were calculated according to the standard 60204-1 with installation method B1 and ambient temperature of 40 ° C.
(2) The indications about the dimensions of the bars refer to bare copper conductors at an ambient temperature of 40 °C and with a maximum temperature difference of 35 °C.
(3) The cable section depends on the effective current of the braking circuit.
(4) The value of the average power of the braking resistor depends on the type of application.
(5) The resistors are calculated to obtain a voltage drop of 3.3% of the rated voltage (400Vac) at the rated current. The input line resistors must have all the following common features:
Rated voltage = Installation mains voltage
Rated frequency = Installation mains frequency
Ambient temperature = 40°C
Overtemperature class = F
Class of materials = H
Insulation voltage = 1.1kV
Test voltage (for 30s) = 3kV
(6) The peak power is calculated for the minimum value of the braking resistor and for a voltage of 760Vdc.

7.6. POWER COMPONENTS FOR 230VAC LINE INPUT (ONLY FOR AC/DC 60 AND AC/DC 200)

Here below there are all the power components recommended to assure the correct operation of the AC/DC converters powered with 400Vac at rated load conditions. The tables refer to FIG.12

Protection fuses (F)				
AC/DC converter size	Rated current	Minimum rated voltage	Fuse type	I^2T Maximum
	[A]	[V]		[A^2s]
60	32	480	Ultra rapid	<7800
200	125-160	480	Ultra rapid	<18000

TAB. 19 – Protection fuses

REMARK: The fuses were calculated for a minimum short-circuit current equal to 10 times the rated current. The maximum short-circuit current must not exceed 20 times the rated current.

Section of the line input connection cables (L1, L2, L3, PE) (1) (2)						
	Mains side	**AC/DC converter side**			**PE**	
AC/DC converter size	Section	Section	Screw pitch	Tightening torque	Protective conductor section	Cable lugs tightening torque
	[mm^2]	[mm^2]		[Nm]	[mm^2]	[Nm]
60	6	10	-	1.5-1.8	6	9
200	50	95 (PVC cable) / 15mm x 3mm (copper bar)	M6	9	35	9

TAB. 20 – Connections on the mains and AC/DC converter input side

Section of the output connection conductors (+, -, F) (2)						
	+, - DC BUS				**+, F Braking resistor**	
AC/DC converter size	Bar width (min-max)	Minimum section	Screw pitch	Tightening torque	Conductor section (3)	Tightening torque
	[mm]	[mm^2]		[Nm]	[mm^2]	[Nm]
60	-	10 (PVC cable)	-	1.5-1.8	6-10 (PVC cable)	1.5-1.8
200	15-20	60	M6	9	50-95 (PVC cable)	9

TAB. 21 – Output connections

	Line input transformer / autotransformer (5)				**Braking resistor**			
AC/DC converter size	Primary voltage	Secondary voltage	Frequency	Rated power (7)	Minimum value	Peak power (6)	Resistor minimum voltage	Average power (4)
	[Vac]	[Vac]	[Hz]	[kVA]	[Ω]	[kW]	[Vdc]	[kW]
60	Mains voltage	230	Mains frequency	24	5	320	500	-
200				82	2	800	500	-

TAB. 22 – Transformer and braking resistor

(1) The indications on the sections of the connection cables refer to PVC cables at 70 °C. The sections of the cables were calculated according to the standard 60204-1 with installation method B1 and ambient temperature of 40 ° C.
(2) The indications about the dimensions of the bars refer to bare copper conductors at an ambient temperature of 40 °C and with a maximum temperature difference of 35 °C.
(3) The cable section depends on the effective current of the braking circuit.
(4) The value of the average power of the braking resistor depends on the type of application.
The input line transformers / autotransformers must have all the following common features:
Ambient temperature = 40°C
Overtemperature class = F
Class of materials = H
Insulation voltage = 1.1kV
Test voltage (for 30s) = 3kV
(6) The peak power is calculated for the minimum value of the braking resistor and for a voltage of 400Vdc.
(7) The indicated apparent power refers to the rated load conditions. The correct value of the transformer (or autotransformer) power depends on the average power required in the specific application.

8. CONTROL EQUIPMENT

8.1. DESCRIPTION OF THE TERMINAL BOARDS

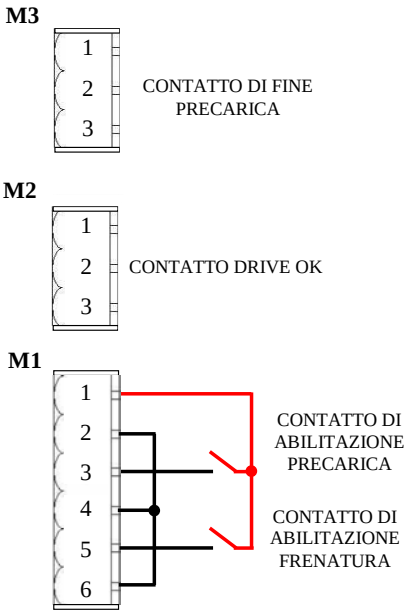
TAB. 23 shows the three control terminal boards

CONTROLS TERMINAL BOARDS		
TERMINAL	**DESCRIPTION**	
M1-1	+24VOUT	Auxiliary output voltage, 21.6÷26.5V, referred to 0POUT. Maximum output current 300mA.
M1-2	0POUT	Shared connection of the auxiliary voltage +24VOUT.
M1-3	SOFT START ENABLE	Logic input for enabling the pre-charge circuit. The input is optically isolated from the internal regulation and is referred to IC (M1-4 or M1-6). Input voltage range 21.6÷26.5V, absorbed current 10mA.
M1-4	IC	Shared connection of the logic inputs SOFT START ENABLE (M1-3) and BRAKE ENABLE (M1-5).
M1-5	BRAKE ENABLE	Logic input for enabling the braking circuit. The input is optically isolated from the internal regulation and is referred to IC (M1-4 or M1-6). Input voltage 21.6÷26.5V, absorbed current 10mA.
M1-6	IC	Shared connection of the logic inputs SOFT START ENABLE (M1-3) and BRAKE ENABLE (M1-5).
M2-1	COM DRIVE OK	Output of powered AC/DC converter. The output consists of a clean contact.
M2-2	NC DRIVE OK	In the terminal board the following connections are available: the shared contact (COM DRIVE OK), the normally open contact (NO DRIVE OK) and the normally closed (NC DRIVE OK).
M2-3	NO DRIVE OK	Features of the relay: 250VAC 8A.
M3-1	COM END SOFT START	AC/DC converter pre-charge end output. The output consists of a clean contact.
M3-2	NC END SOFT START	In the terminal board the following connections are available: the shared contact (COM END SOFT START), the normally open contact (NO END SOFT START) and the normally closed (NC END SOFT START).
M3-3	NO END SOFT START	Features of the relay: 250VAC 8A.

TAB. 23 – Control terminal boards

Example of connection of the control equipment

FIG. 14 shows one of the possible connections of the signal equipment



REMARK: The pre-charge end contact can be used by the control as a consent for enabling the converters connected to the power bus.

PRE-CHARGE END CONTACT

DRIVE OK CONTACT

PRE-CHARGE ENABLING CONTACT

BRAKING ENABLING CONTACT

FIG. 14 – Example of connection

9. DESCRIPTION OF THE IMPLEMENTED FUNCTIONS

9.1. PRE-CHARGE MANAGEMENT CIRCUIT

Once the mains voltage is supplied, the AC/DC converter turns on and, if there is no radiator thermal alarm, the logic output DRIVE OK activates on the terminal board.
Now, if the logic input SOFT START ENABLE is available, the AC/DC converter begins to control the SCR of the semi-controlled bridge in order to load gradually the capacitors to power buses.
The ramp with which the bus capacitors are loaded, is selectable through the welding points K4, K5 and K6, present in the control card CS957.2.
In the default configuration, K4, K5 and K6 are open. The charge ramp is approximately 9.0s.
TAB. 24 shows, based on the status of the welding points K4, K5 and K6, the times of the pre-charge ramp. These times are subject to the tolerances set for the components used in the circuit. In particular, to the tolerance of the tantalum capacitors (±20%).

K6	K4	K5	Ramp time [s]
1	1	1	19
0	1	1	29
1	0	1	38
0	0	1	52
1	1	0	57
0	1	0	71
1	0	0	76
0	**0**	**0**	**90**

TAB. 24 – Pre-charge times

The times indicated on the left refer to the pre-charge time when the command SOFT START ENABLE is supplied with the completely discharged bus.
The ramp will be shorter as the bus voltage is higher, when the SOFT START ENABLE command is given.
This function was implemented to return quickly to the standard conditions in presence of voltage dips of short duration.

Once the pre-charge ramp has ended, the AC/DC converter enables the END SOFT START logic output. The pre-charge end contact (END SOFT START) can be used by the control as a consent for enabling the converters connected to the power bus.
The position of the welding points is shown in FIG. 15.

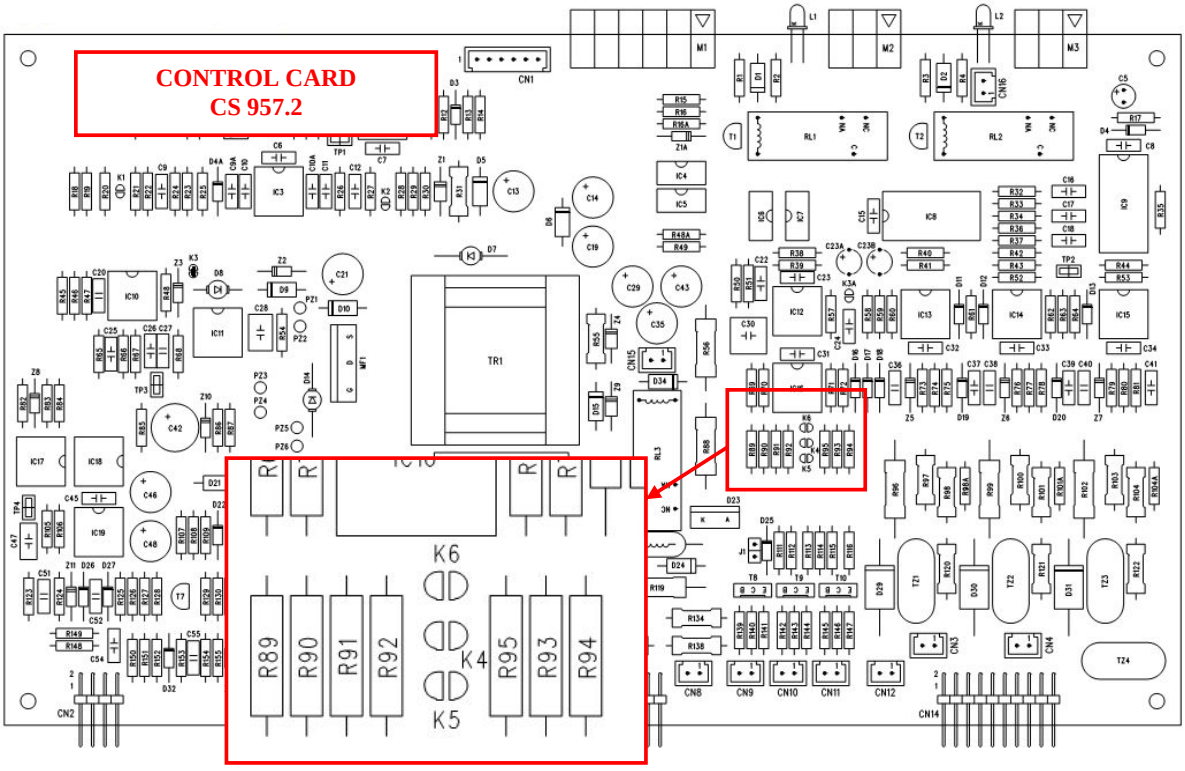


FIG. 15 – Control card and position of the welding points

9.2. MAINS FAILURE ALARM MANAGEMENT CIRCUIT

The AC/DC converter contains a circuit that checks the presence of input voltage. In detail, it checks that all three phases are present and that the voltage of the input grid is greater than 175Vac (for AC/DC converters designed for 230Vac grids) and 290Vac (for AC/DC converters designed for 400-460Vac grids). The power failure alarm is series-connected to the logical input SOFT START ENABLE; therefore, when the protection is active, the command of the thyristors of the semi-controlled bridge is disabled.
Inside the board, there is no indication of the protection tripping. Instead, on the terminal board, the only way to detect the alarm is to verify that the logic output END SOFT START changes its status although the input SOFT START ENABLE is active.
REMARK: The power failure alarm has no memory; therefore, once the mains returns within acceptable values, the pre-charge circuit starts again to work regularly.

9.3. BRAKING CIRCUIT TRIGGERING MANAGEMENT CIRCUIT

9.3.1. Control of the power bus voltage

Inside the AC/DC converters (except for AC/DC 750) there is a circuit that controls a braking IGBT if there is a recovery of energy by the converters connected to the power bus. The tripping threshold of braking circuit is 385Vdc (for AC/DC converters designed for 230Vac grids) and 730Vdc (AC/DC converters designed for 400-460Vac grids). The release voltage is set to 370Vdc or 710Vdc depending on whether the AC/DC converter is designed for 230Vac or 400-460Vac grids.

9.3.2. Discharging the bus in case of an emergency

It may happen that, for safety reasons, the power bus has to be fully discharged in case of an emergency. This can be done using the same braking circuit adopted to limit the voltage of the power bus in case of recovery of energy by the connected converters.
To meet this need, a logic input (BRAKE ENABLE) was included working in parallel to the regular braking triggering command and managed by the same board.
The sequence to be used in case of an emergency is as follows:

a) Disable the logic input SOFT START ENABLE
b) Wait for at least 10ms so that all SCRs of the semi-controlled bridge turn off
c) Enable the logic input BRAKE ENABLE

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