ALTER ELETTRONICA S.R.L.
CASALE MONFERRATO (ITALY)

# THYRISTORS

# THREE-PHASE CONVERTER

# FOR D.C. MOTOR

# MODEL

# TTB-M00
# TTU-M00

Instruction book **91/094** – Revision **00** – Edition **02** – Date **25/05/2007**

**INDEX**

# 1 SAFETY AND STANDARDS

## 1.1 Recall to the safety standards

The converters model TTB and TTU they are designed and built according to the standards recalled on the point 1.3 of this chapter and they satisfy the demanded requirements for the marking CE. About the safety it put in evidence: **a)** that it has relatively defined to a situation that could bring to damages to the people or to the equipment or to the operated system and not to the operation of the driver (you also see paragraph 9.2 of the standards recalled on [7] of the point 1.3); **b)** that for the safety it is necessary that the integrator of the driver (PDS: please to see point 2.2.2), the technician and the end user not only follow the prescriptions contained on this instruction book but also observe the standards safety specifications of the operated machine, particularly how much prescribed on the standards EN 60204-1, recalled on [9] of the point 1.3.
Please to see here following the meaning of some used symbols.

WARNING! This symbol recalls the attention to a situation of danger that could also bring to **serious damages** to the people (**also potentially lethal**) or to irreparable breakdowns to the equipment or to the operated system. This is the level of more important alarm. It's **absolutely** necessary to follow the instructions underlined with the symbols under brought.


WARNING!

**Dangerous voltage:** it signals the situations of danger owed from electric voltages.


WARNING!

**Generic danger:** it signals the situations of danger owed to different causes from the electric voltage.

## 1.2 Safety general standards

### *1.2.1 Preliminary advice*

Some instructions are brought about the general character safety, informing that other instructions, specific for the converters model TTB and TTU, they are brought on the Chapter 2.

### *1.2.2 Operations of installation, startup and maintenance*


WARNING!

Only qualified personnel have to operate during the installation, the possible breakdowns search and, generally, for whatever type of intervention in the drive.

This personnel has to own the special documentation furnished by ALTER, particularly this instruction book.
For any reason the unqualified operator has to operate on the terminal block of the converter. Besides it is necessary that the converter be preventively disconnected from mains, as specified on the point 2.3.4.5.

### *1.2.3 Power-supply sectioning device*


WARNING!

Since the converter has built for being embedded on an electrical cabinet, containing eventually also other equipments, the **sectioning device for the command manual feeding**, required by EN 60204-1 §s 5.3.1, can be that common to the whole electrical cabinet and it owes - in every case - must be inserts **at the builder of the machine**.

### *1.2.4 Stop Function*


WARNING!

**The stop functions**, as prescribed on EN 60204-1 §s 9.2.2, particularly **the 0 category stop, must be realized by the builder of the machine**, in how much inherent to the logic of machine, that obviously differs according to the type of machine and following the instructions contained in this instruction book.

### *1.2.5 Emergency Stop*

WARNING!

Also **the emergency stop**, according to EN 60204-1 §s 9.2.5.4, must be made according to the specific characteristics of the operating machine and therefore **the builder of the machine must realize it**.

### *1.2.6 Unintentional starting and uncontrolled running*

WARNING!

The motor connected to a drive type TTB and TTU can be started and stopped utilizing the commands performed by the operator (please to see point 3.4). **If it is necessary to manually act on a mover controlled by the motor**, to satisfy the safety conditions for the operator, it is necessary not only to stop the motor by the command of the converter, but also to **insulate the converter from the feeder line**. In fact the motor can to run without any command but only by cause of fault of the electronic components or other accidental causes (breakdown on mains or on the cables e/o connections, etc.). For the same causes, during the normal operation the converter would be able not to run as described in this instruction book and could be happen that the motor is fed by electric quantity not checked and therefore also the speed and the direction of rotation of the motor are uncontrolled. **The user owes therefore to predispose additional protection e/o safety systems** suitable to prevent damages to people or things.

## 1.3 Reference documents and standards

Here following are recalled the principals standards, to which we make reference on this instruction book. On the text the calls are brought among square parenthesis.


[1] Community directive 89/336/CEE dated May 3rd 1989 regarding the Electromagnetic Compatibility and following changes 92/31/CEE and 93/68 / CEE.

[2] Legislative Decree dated December 4th 1992, n° 476 "Putting into effect of the directive 89/336/CEE of the Board dated May 3rd 1989, in subject of approaching of the legislations of members States regarding the electromagnetic compatibility, modified by the directive 92/31/CEE of the Board dated April 28th 1992."

[3] Legislative Decree dated November 12th 1996, n° 615 "Putting into effect of the directive 89/336/CEE of the Board dated May 3rd 1989, in subject of approaching of the legislations of members States regarding the electromagnetic compatibility, modified and integrated by the directive 92/31/CEE of the Board dated July 22nd 1993 and by the directive 93/97/CEE of the Board dated October 29th 1993". (Abrogative, paragraph excepted 2 of the article 14, of the legislative decree of which to the [2]).

[4] Directive 73/23/CEE dated February 19th1973, concerning the approaching of the legislations of members States regarding the electric material destined to be used within some limits of voltage, integrated by the Directive 93/68/CEE dated June 29th 1993.

[5] Law October 18th 1977, n° 791 "Putting into effect of the directive of the Board of the European Communities (n.73/23/CEE) regarding the safety guarantees that it has to possess the electric material destined to be used within some limits of voltage."

[6] Legislative Decree dated November 25th 1996, n° 626 "Putting into effect of the directive 93/68/CEE in subject of CE marking of the electric material destined to be used within some limits of voltage."

[7] Standards CEI EN 61800-1, 2000-05, classification CEI 22-19, "Electric Drives for speed varying Part 1: General prescriptions and rated specifications of low voltage drives for D.C. motor."

[8] Standards CEI EN 61800-3, 1996-09: "Electric drives for speed varying Part 3: Product Standards regarding the electromagnetic compatibility and to the specific test methods", classification CEI 22-10, emission 2861.

[9] Standards CEI EN 60204-1, 1998-04, classification CEI 44-5, "Safety of the machinery. Electric equipment of the machines. Part 1: General rules."

[10] Standards CEI EN 60146-1-1 "Semiconductors Converters - General prescriptions and mains commutation converters. Part 1-1: Specifications for the fundamental prescriptions."

[11] Standards CEI EN 60146-1-3 "Semiconductors Converters - General prescriptions and mains commutation converters. Part 1-3: Transformers and Reactors."

[12] Standards CEI 301-1, 1997-10, Classification CEI 301-1, Electric Drives - Dictionary (bilingual).

## 1.4 Conformity to the CEE directives and CE marking

### *1.4.1 Advice*

The converters model TTB and TTU are CDM (please to see the point 2.2.2) and therefore they are utilized together with a D.C. motor to constitute a drive (PDS). The PDS is, in turn, integrated in the electric equipment. The phenomenon EMCs are particularly sensitive to the conditions of the plant, what length of the connections, shielding and connections to the PE and to the earth.
The conformity of the converters model TTB and TTU, listed on the Chart 1 and on the Chart 2 of the Chapter 3 and the relative CE marking, placed on the converters, for how much it concern to the **EMCs directive**, of which to the documents [1], [2], and [3] mentioned on the paragraph 1.3, ago reference to the standards [8], with the following precise statements:

**1.4.1.1**

The drives type TTB and TTU, since are CDM, they are commercialized in condition of **narrow distribution** (please to see the point 2.2.4); this implies that the builder of the drive, and/or the electrical cabinet and/or the installer and/or the builder of the machine and/or the final user they are competent people about EMC.

**1.4.1.2**

The drives type TTB and TTU can be applied both in "**first environment**" that in "**second environment**" (please to see the points 2.2.5 and 2.2.6). In the case of application in first environment it is necessary to install a filter to the three-phase supply of the converter, as specified on Chart 1 on page 19 of the chapter 3.

**1.4.1.3**

The drives type TTB and TTU, since they are components of a PDS, they are sold to be included as a part of an apparatus or system or installed system; therefore the operational conditions of the CDM inside the PDS, and therefore of an apparatus, system or installed system, **they have to follow, in subject of EMC, how much prescribed and/or recommended on this instruction book, particularly on the Chapter 2.**

**1.4.1.4**

For how much required by the directives "Low Voltage", according to the documents [4], [5] and [6], the drives type TTB and TTU, make reference to the standards [7], [10] and [11], however applicable.

### *1.4.2 Declaration of conformity and CE marking*

*The ALTER Elettronica S.r.l. it declares that, under the conditions specified on this document, particularly at the paragraph 1.4.1,* ***the converters (CDM) model TTB and TTU, specified on the Chart 1 and on the Chart 2 of the Chapter 3****, result in conformity, to the community directives EMC [1], understood the last changes with the relative Italian legislation [2] and [3] , with the Low Voltage directives community [4] understood the last changes with the relative Italian legislation [5] and [6].*
*The applicable standards references are brought on the paragraph 1.3.*
***Therefore the CE marking, placed on the converters (CDM) model TTB and TTU, attest the conformity both to the EMC directive and to the Low Voltage directive.***

### *1.4.3 Application of other CEE directives*

The converters are not subject to other CEE directives, over those suitable to the paragraph 1.3. They exist nevertheless, for application motives, calls on other directives; particularly to comply to how much in demand on the article 4 of the **Machines Directive 89/392 CEE and following changes 91/368/CEE, 93/44 CEE, 93/68 CEE, Italian legislation of Putting into effect D.P.R. n° 459 dated July 24th 1996.**
Bring here him following the declaration of the manufacturer (known also as "Declaration of Incorporation").

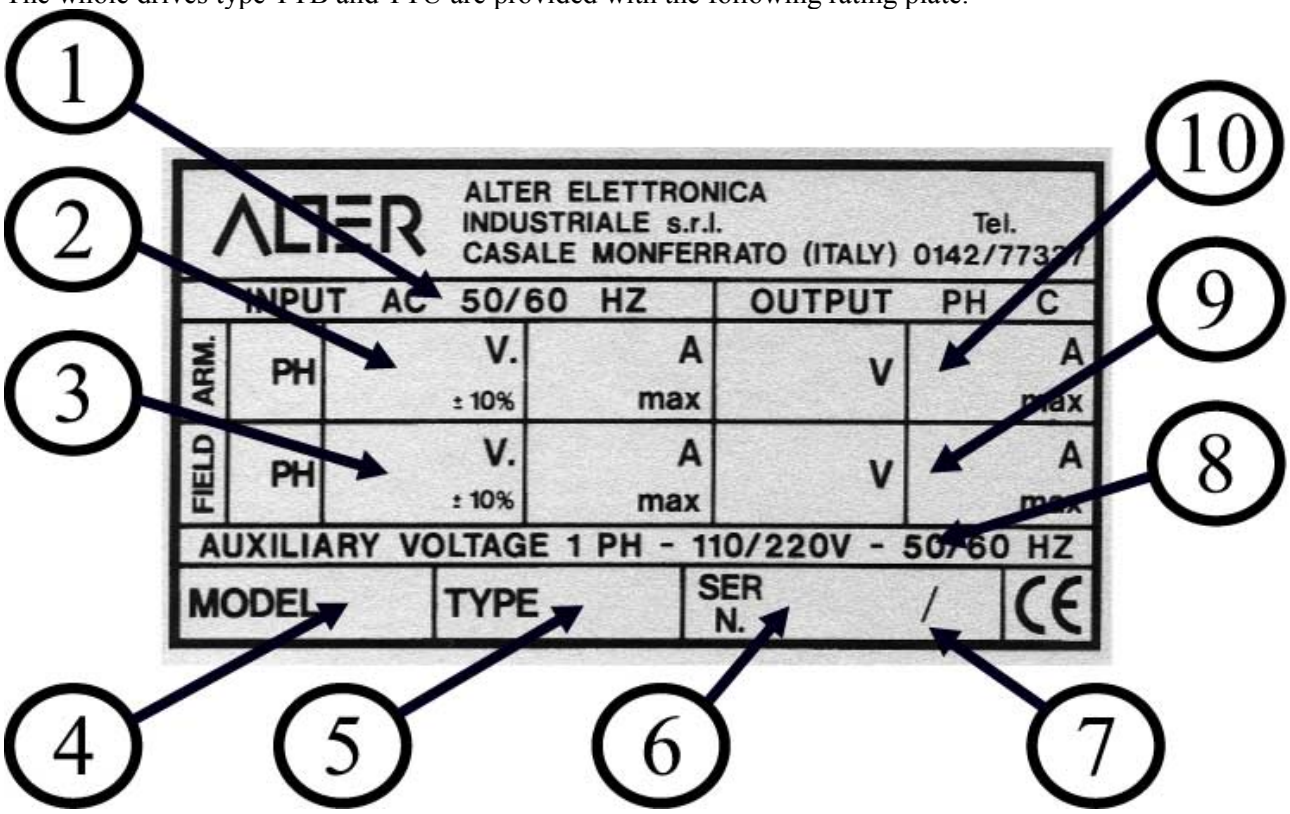
### *1.4.4 Declaration of the manufacturer*

The ALTER Elettronica S.r.l., to the goals than in demand on the Machines Directive (DM) 89/392 and following changes, with the relative Italian legislation D.P.R. 459 of 1996-07-24, declare that the drives type TTB and TTU must be installed according to the instructions contained on this instruction book and must not to run as long as the machines in which will be incorporated has not been declared conforming to the DM directive here mentioned.

## 1.5 Rating Plate and information for the technical support

### *1.5.1 Rating plate of the converter*

The whole drives type TTB and TTU are provided with the following rating plate.




1. Mains frequency.
2. Rated voltage of three-phase supply.
3. Rated voltage of single-phase supply.
4. Model converter (TTB or TTU).
5. Type of the Converter (02/xxx).
6. Serial Number
7. Data of registration (month/year).
8. Rated single-phase service supply.
9. Maximum field supply.
10. Maximum armature supply.

### *1.5.2 Informative notes*

This instruction book contains the electronic schemes of some circuits and the topographical one some component layouts, to understand better the operation of the converter and, if necessary, to modify the values of the components to be able to suit to the application. On the schemes they are suitable the components values placed at factory. The changes can to be performed only by qualified personnel that has familiarity about the electronic components, with specific knowledge of analog electronics, with the use of the operational amplifiers and, if necessary, also of debugging of the P.I.D. nets and stabilization of the closed loops.
We recommend to annotate: the model of the converter, the serial number, the components' values that have been modified, the values read on the T.P. and the presetting.
These data are useful to buy some spare parts and to set a new converter in case of replacement.

**For commercial information, technical and application advice are available the followings address:**

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On the site **Internet http://www.alterelettronica.it** are available all the information about the products and the update editions of the instruction manuals.
The specifications of product and the content of this instruction book can be changed without notice, we recommends therefore to check on the special sections of the internet site the possible variations of specifications and the updating of this instruction book.
**The ALTER Elettronica S.r.l. it declines every responsibility for inaccuracies or mistakes brought on this instruction book.**

# 2 GUIDE FOR THE INSTALLATION

## 2.1 Purpose and destination

**2.1.1**
This guide is also furnished in observance to how much prescribed on the paragraph 4.3 of the standards about the EMC (Electromagnetic Compatibility) of the electric drives to vary the speed [8].

**2.1.2**
Purpose of this guide is that to furnish to the technician, to the builder of the machine and to the final user of the drives type TTB and TTU information as required by the CEE Directives in vigor **in subject of Electromagnetic and Safety Compatibility for the so-called Low Voltage materials**. Particularly prescriptions and indications are recalled regarding the EMC to the various operators that utilize the drives type TTB and TTU to realize installations including speed varying drives by d.c. motor. With reference to this, we recall the attention on the fact that is necessary, for the performer of the drive, to **coordinate the content of this guide with the EMC guide of the builder of the d.c. motor**, that is joined to TTB and TTU drive type.

## 2.2 Recall of some definitions

**2.2.1**
The specific terms, regarding the electric drives, utilized on this instruction book, they have been defined on the standards [8] and on the dictionary [12] and it is referred to such documents. For some terms, that have a remarkable value from the technical-contractual point of view, the definitions are brought.

***2.2.2***
ELECTRIC DRIVE (**PDS**): an electric drive is systems that convert electric energy into mechanics, by power electronic equipments, according to a command function (and according to an established program).
A drive consist of:

- A POWER SUPPLY, CONVERSION AND CONTROL MODULE, (**CDM**) that it includes the whole drive with the exception of the motor and the sensors placed on the motor; particularly it includes a CONVERSION AND CONTROL MODULE (**BDM**) and its possible extensions as the supply module or some auxiliary ones (for example: fan). The BDM includes the functions of conversion, control and self-protection. In the practice the CDM has often called, shortly, **CONVERTER**.
- A MOTOR UNIT.

**2.2.3**
NOT NARROW DISTRIBUTION: marketing modality in which the supply of the equipments doesn't depend from the competence of the client or of the user about EMC for the utilization of drives. This involves restrictive limits of emission according to the essential requirements of EMC protection.

**2.2.4**
NARROW DISTRIBUTION: marketing modality in which the builder limits the supply of the equipments to suppliers, clients or users that, separately or jointly have technical competence of the requisite regarding the EMC for the application of drives. For economic motives, the interested parts should guarantee the essential requisite of EMC protection, for the specific installation, choosing suitable categories of emission, through measurement "on site" at the real conditions to the contour and through exchange of exchange of technical specifications.

**2.2.5**
FIRST ENVIRONMENT: environment that include the home purposes. It directly includes also the connected industrial uses, without input transformers, to low voltage mains that feed buildings assigned to home purposes.

**2.2.6**
SECOND ENVIRONMENT: environment that includes all the different industrial purposes, not those connected to low voltage mains that feed buildings assigned to home purposes.

## 2.3 Indications for the installation

### *2.3.1 General indications*

**2.3.1.1**

We essentially report on these paragraphs the particular dispositions of installation concerning the electromagnetic compatibility, both as phenomenon of emission that can disturb other equipments, and both as immunity from the electric noise. The measures to be adopted, that they are recommended on this instruction book, are useful very often in all cases.

**2.3.1.2**

Very particular cases accepted, the **converters TTB and TTU** are placed inside a metallic cabinet (so-called electrical cabinet), that contains also electric equipments of various type (other electronic power converters, contactors, transformers, inductors, etc.)

**The motor** or, better, the motor unit (because they can also exist other accessories what a tachogenerator, an electric fan, a brake, etc.) it is located on the machine, to a certain distance from the electrical cabinet.

They exist therefore, in reality, two separate types of plant: what refers to the wiring of the electrical cabinet and the real definitive plant that the technician realizes at the final client.

### *2.3.2 Installation of the converter inside the electrical cabinet*

**2.3.2.1**

The drives type TTB and TTU, have **IP20** degree of protection (please to see the point 3.3.1). To comply with how much prescribed on the § 4.4.6 "Contaminating" of the EN 60204-1 (1998) standards it is necessary, that they be situated, by the builder of the machine, in a suitable case, according to the required protection degree. Of rule they will have placed therefore inside a cabinet; **to satisfy EMC standards the cabinet has to be metallic made by iron plate having thickness at least 1 mm**.

It is important that inside the electric cabinet all the panels are connected among them by mechanical connections that introduce low electric impedance at high frequencies. This can be made, for example, adding fastening screws, using galvanized surface panels or cadmium plated rather than painted or removing the paint under the connection points, using special metallic EMC gaskets.

**2.3.2.2**

The **components' layout** inside the electrical cabinet, both in terms of positioning and in terms of distances, must be performs with the criterion to minimize the mutual influences regarding the electromagnetic noises of the equipments. Generally the transformers, the inductors, the contactors, because of their coils, they can produce high electric field at close distance.

**2.3.2.3**

**The wiring of the power circuits** must be physically separated from the wiring of the control circuits (signal circuits); the power circuits must carefully be shielded from the signal circuits; this is made utilizing some metallic raceways inside the electrical cabinet, metallic sheath or shielded cables, also for power connection.

**2.3.2.4**

Particular attention must be put on the **wiring of the signal circuits**, for motives about electromagnetic immunity. Is necessary therefore that the **connections of the signal circuits** of the converter, both input and output, **are made using twisted pair cables and carefully shielded.** The shield must be connected to ground on the converter side, as illustrated on the page 45 of this instruction book and, where it is necessary, also to the ground connection of the interested peripheral.

**2.3.2.5**

All the equipments, for which **additional devices** are prescribed to conform them to the EMC standards, must be provided of such devices, placed according to the prescriptions of the manufacturer; particularly the good rules recalls to place the **spikes limiting devices** in parallel to the a.c. coils of the contactors, the **diodes** in parallel to the d.c. coils of relay or contactors, the **filters** against the conducted H.F. electrical noises placed on the three-phases power input of some converters, when is prescribed.

**2.3.2.6**

**The shielding of the cables** have to finish the nearest possible to the terminal block; if the connection of the shield is prescribed to ground or, in some cases, to the earth, it must possibly be made by some special cable-head that let a 360° contact between the shield and the ground, in absence of this, by connections as short as possible and having

a suitable cross section area.

**2.3.2.7**

WARNING!

**To disconnect the converter from the circuit under electric test,** before making resistance or isolation tests and/or applied voltage test.
The not compliance of this prescription can seriously damage the converter.

### *2.3.3 Complete electric plant*

**2.3.3.1**

As we have previously said, we report there to the plant in the final installation of the machine. For some types of machines the electrical cabinet is physically connected to the machine and therefore, in practice, the electric plant "on site" is reduced to the connection of the machine to mains.
Usually, nevertheless, the electrical cabinet is found to a certain distance from the machine, on which is placed the motor unit; a pulpit sometimes exists for also remote command, to which some conductors could be connected.
In this case, since the problem list of the emissions is very tied up to factors of plant, the recommendations that follow they are dictated by good technique standards and by experiences on the field and they must essentially have concerned as reference lines and not as certain solutions.

**2.3.3.2**

**The three-phase transformer MV/LV** of the feeder line to which some converters of electric drives are connected must have an apparent power suitable to the loads, keeping in mind the power factor and the distortion factor. For the converters TTB and TTU please to see **Chart 1** on page 19.

**2.3.3.3**

**The copper cross section area of the feeder line** connected to the terminal block of the converter (see the schemes "external Connections for converters" Figure 10 and Figure 11) must be suitable to the rated current of every converter. The design must be made in such way to avoid voltage drops that can bring the supply voltage values out of the contractual tolerance.
Moreover it is necessary to carefully study the runs to minimize the cables length.

**2.3.3.4**

All the metallic raceways, the metallic sheaths and, all the shielding, if not otherwise specified, must generally to be connected to the PE both on the electrical cabinet both on the motor; these connections must to be very short and have a wide cross section area.

### *2.3.4 Specific indications for the drives type TTB and TTU*

**2.3.4.1**

The drives type TTB and TTU don't require, generally, particular modality for placing and installation over the normal professionalism and knowledge of the rules of the art of the electric and electronic planting sector.
In every case, it is necessary to follow how much prescribed or recommended on this instruction book.
Following some specific indications are brought for the installation of the converters TTB and TTU, as it regards the EMC and Low Voltage directive.

**2.3.4.2**

The connection schemes of the converters with built-in armature bridge (please to see Figure 10) and those with external armature bridge (please to see Figure 11) **they have to be integrated by the connection scheme brought on Figure 12**. Such scheme contains some important practical instructions about wiring to respect the EMC standards, and about the shields connections to the drives type TTB and TTU.
When the drives type TTB and TTU are utilized in **first environment**, with reference to how much brought on the point 1.4.1.2 it is necessary to install a **filter** on the three-phase supply of the converter; also the connections of such filters are suitable on the figure above pointed.
On the Chart 1 on page 19 of the Chapter 3 are brought the types of the three-phase filters to utilize when is used the scheme at Figure 12.
Making the connections brought on the pointed scheme must be observed the following rules.

**WARNING!** It is necessary to keep in mind that the run of the cables, their length, their shielding and the shield connection to the right ground point of the converter are **essential to the EMC compliance**.

- The **location of the filter** is very important: it must be placed, inside the electrical cabinet, the nearest possible to the component connected to her output. On the Figure 12 such component is named **Z inductor**.
- **The length of the connections** between the filter output and the input of the component connected to its output **should not overcome 0,3 m** and must be made by conductors, having a suitable cross section area, shielded as far as possible. It is evident that, in certain cases, is not be possible to shield components as fuses and contactors; for this reason it is necessary that the runs of the connections are the shortest possible.
- **WARNING! The input and the output of the filter cannot be exchanged!**
- Many ground connections are available on the converter to make easier the wiring;
- Different ground points of the converter are marked by the symbol "⏚". (Please to see the schemes to Figure 13 the pointed out connections "E1" and "E2").


WARNING!

**E1** (Figure 13), made by 2 M5 screws. It is the main ground and must to be connected to the PE and therefore to the earth of the plant, by a conductor having a cross section area not less then that of the three-phase supply conductors. **This connection is essential to the protection compliance** and not only to the EMC compliance.
**E2** it is the connecting point of the shields of the signal cables, that they are brought on Figure 8.

- The ground terminal of the metallic frame of the filter, must to be connected as suitable on Figure 12.

**2.3.4.3**
You have seen, on the point 2.3.3.2 that the three-phase MV/LV transformer must have a suitable apparent power (kVA).
In this session it is important to note however that in addition to the transformer, also the filter must have a power suitable to that of the converter (or of the converters); it is also necessary that the voltage drop of the transformer, to full load, it must be less them 3%.

**2.3.4.4**
To comply with how much prescribed on the Low Voltage directive and on the standards that can make reference to it, we recall, as follow, some connected general safety dispositions with specific references to the drives type TTB and TTU.

**2.3.4.5**


WARNING!

For any reason, safe during the operations of which to the point 2.3.4.6, are had to enter inside the converter when it is fed. To enter **must surely be disconnected: the three-phase supply (terminals L1, L2, L3), the single-phase supply (terminals FL1, FL2)**, **the service supply (terminals 230V, 230V)** and every other supply having a voltage value more them 50Va.c. and 75Vd.c., eventually existing on the connectors. Inside the converter, when it is fed, **there are some voltages potentially dangerous for the safety of the operator!**

**2.3.4.6**
Only during the startup operations, that must be carry out by **qualified personal**, it is allowed to provisionally remove the protection panel to have only access to the Tests Point and to the Trimmers placed on the frontal plate. **After the startup to reassemble the panel.**

**2.3.4.7**


WARNING!

To observance the instructions contained on this instruction book, **from the point of view of the safety, it is important to follow the prescriptions regarding the value and the type of protections (fuses) prescribed** (please to see Chart 2 on page 19).

**2.3.4.8**

In relationship to the current of every type of the converters TTB and TTU, current range from 15A up to 500A, it is **necessary that the cross section area of the conductors** for the connection to the feeder line and to the motor **must guarantee a current density according to the general prescriptions of the plant**.

**2.3.4.9**

WARNING!

All the connections to the common ground of the electrical cabinet has to be short and have a suitable cross section area; the PE of the electrical cabinet must to be connected to a **good heart**. Also the ground of the motor must be connected to a good heart, as suggested on Figure 12.

# 1 CHARACTERISTICS OF THE DRIVES TYPE TTB AND TTU

## 3.1 Generality

These converters are designed to feed and to control the running of d.c. motors both with field coils both with permanent magnets field.
The model TTB have a 12 thyristors bridge to feed the armature and run on the 4 quadrants.
The model TTU have a 6 thyristors bridge to feed the armature and run on the 2 quadrants.
The thyristors bridge is built inside the frame for armature current up to 500A.
For greater current an external bridge is utilized instead.
The energy recovery is made to mains and therefore it is possible to have the motor running as a brake for as long as required.
The field current of the motor is fed by a half-controlled single-phase thyristors bridge that allow to get how much it follows:

- To maintain constant and independent from the temperature of the motor the ratio between torque and armature current of the motor.
- To reduce the field current to prevent that the armature voltage exceeds the rated value of the motor.
- The constant power operation (only with fit motor for this mode of operation and equipped by Tachogenerator).

The enables of the armature bridge and of the field bridge are independent.
All the regulation circuits and control are analog and completely isolated from mains.
The inputs and the digital outputs are type static and optoinsulated.
They are available numerous analog inputs for the speed references with possibility to perform sums, differences and partitions of the signals.
By a digital input it is possible to have a ramp of acceleration and deceleration on the speed reference.
The acceleration and deceleration times are adjustable and selectable between two ranges.
In the model TTB it is possible to prevent the rotation of the motor in one direction maintaining the regular running as motor and as brake in the other direction.
The limit of the armature current is internally set in constant mode or in dependent way from the motor speed and is also adjustable from the outside by an analog reference.
The I/O Connectors, Test Points, LEDs, Trimmers are placed on a completely accessible frontal card, this placing facilitate the connections, the measures, the regulations, the adjustments and the operation diagnosis.
These converters are designed to feed and to control the running of the d.c. motors utilized in the machines-tool, graphics, tape motion control, etc. and in all those applications where it is requires a great flexibility of operation.
On the Chart 1 and Chart 2 are available the rated values of some greatness for every size of the converters.

## 3.2 Modes and limits of operation of the converters

### *3.2.1 Speed Control by Analog Tachogenerator*

The tachogenerator (T.G.) must be placed on the motor shaft utilizing a coupling without elasticity and backlashes.
If possible it is better to utilize a T.G. through-shaft type placed on the projection of the motor shaft.
A converter running in this mode regulates the armature voltage to get that the speed of the motor shaft follows the speed reference.
This happens if the necessary current is less them the set limit current and if the armature voltages don’t exceed the maximum voltage allowed by the a.c. feeder line of the thyristors bridge.
If a torque or a braking torque it is applied to the motor shaft, the converter make to circulate in the armature a current value able to provide an opposite torque to that applied to maintaining the motor speed.
If the armature current reaches the set limit, the converter loses the speed control.
If the armature voltage exceeds the maximum value allowed by the a.c. feeder line, the converter cannot to make to circulate the current in the armature and the motor doesn't deliver torque anymore.
If the field is reduced they are reduced both the armature voltage, at constant speed, both the delivered torque, at constant armature current.
Controlling the field current is therefore possible to get two operating modes of the motor:

- Maximum constant Torque
- Maximum constant Power

The maximum constant torque operation is had when the field is to the maximum value and the armature voltage it is proportional to the speed.

The maximum constant power operation is had when the armature voltage reaches the maximum value and the field it is reduced in inversely proportional way to the speed.
A converter running in this mode provides the maximum regulation precision of the motor speed and the maximum quickness of response.
It allows also the motor operation at maximum constant torque / power and the best use of the auxiliary functions joined to the speed:

- Motor Standstill
- Steady speed
- Speed over threshold
- Speed monitor
- Limit of the armature current dependent from the motor speed.
- IN THIS OPERATING MODE TO NEVER CONNECT THE SERIES STABILIZING WINDING IN THE TERMINAL BLOCK OF THE MOTOR.

The connection of these winding it is joined to the rotation direction of the motor (as indicated by the manufacturer of the motor) and their use can to generate instability in the speed loop of the converter.

### *3.2.2 Speed Control by Armature Voltage*

The armature voltage is used when it is not placed or it is not possible to place some T.G. on the motor shaft.
The converter, in this case, it is a power supply able to provide an adjustable voltage from 0 to the maximum one allowed by the a.c. feeder line of the thyristors bridge.
The maximum current is limited to the set value.
The maximum motor speed is limited therefore by the maximum voltage allowed by the a.c. feeder line.
If a torque or a braking torque it is applied to the motor shaft, the converter makes to circulate in the armature a current value able to provide an opposite torque to that applied to maintaining constant the armature voltage.
If the armature current reaches the set limit, the converter loses the control of the armature voltage that become dependent from the motor speed.
If the field of the motor is constant, the motor speed is proportional to the armature voltage to condition that the resistance of the armature windings is zero, as it results from the following formula:

$$Varm = (K \bullet \phi \bullet \omega) \pm (Rarm \bullet Iarm)$$

*Varm = Armature voltage of the motor*
*K = Dependent constant from the constructive characteristics of the motor*
$\phi$ *= Intensity of the magnetic field in the motor*
$\omega$ *= Speed of rotation of the motor shaft*
*Rarm = Resistance of the armature windings of the motor*
*Iarm = Current in the motor armature*

This condition can never be reached, even if the resistance of the windings will be reduced remarkably to the increase of the rated power of the motor.
To control the armature voltage to indirectly control the motor speed is advised against therefore in the most greater part of the cases, since of the insufficient obtainable speed precision specially to the low speeds and utilizing such small power motor.

***In this mode it is not possible the motor operation in maximum constant power mode.***

The set for this mode of operation is made by SWITCH.
The converter, not having the speed signal of the motor supplied by the T.G., it uses the armature voltage for all the auxiliary functions joined to the speed. In the use of these auxiliary functions it is to keep in mind that to identify the motor speed with his armature voltage especially causes remarkable inaccuracies to the low values.
Measuring the armature voltage and using the data of motor rating plate, it is possible to calculate, in approximate way, the speed of the motor shaft by the following formula:

$$\omega = \frac{MaxMotorSpeed}{MaxArmatureVoltage} \bullet ArmatureVoltage$$

### *3.2.3 Torque Control by the Armature Current*

The torque and the armature current in a motor, are joined by the following formula:

$$C = K \bullet \phi \bullet I_{ARM}$$

*C = Available torque on the motor shaft*
*K =* Dependent *constant from the constructive characteristics of the motor*
$\phi$ *= Intensity of the magnetic field in the motor*
$I_{ARM}$ *= Current in the motor armature*

A converter running in this mode imposes that the current in the motor armature follows the reference.
This happen to condition that the current doesn't exceed the set limit and the armature voltage don't exceed the maximum voltage allowed by the a.c. feeder line of the thyristors bridge.
If the torque of the load is not equal to that provided by the motor, the motor speed it reaches the maximum value allowed by the a.c. feeder line.
It is not therefore possible to determine the operation speed of a single group converter + motor. The control of the motor torque can be used only in a system in which the operation speed is imposed by another motor.
The most important characteristic of this type of control is the quickness of answer of the motor obtained by exclusion from the operation of the speed control loop / armature voltage loop of the converter.
The current reference, supplied by the speed loop, is replaced by the external reference and it is forwarded to the armature current loop control.
The digital command **CME** (Current Mode Enable) it enables this mode of operation and it excludes the speed loop of the converter. Without such command the converter controls the motor speed.
The same converter can run then in the two operating modes.

***For the operation it needs nevertheless to also predispose the converter for the speed control by T.G. or by ARMATURE VOLTAGE.***

The operation on maximum constant power mode it is possible only if the speed control is made by T.G.; by armature voltage it is not possible.
In this mode of operation are available only the followings auxiliary functions:

- Motor standstill
- Speed over threshold
- Speed monitor
- Limit of the armature current dependent from the motor speed

In the use of these auxiliary functions you must make reference to that written for the 3.2.1 Speed Control by Analog Tachogenerator or ARMATURE VOLTAGE.
The armature current reference must be applies to the analog input **CRI** (Current Reference Input).
Without the digital command **CME** this reference, even if it exist, it doesn't produce regulation effects on the armature current. If the command **CME** it exist, the speed reference existing on the input don't produce regulation effects of the speed or of the armature voltage.

### *3.2.4 Master - Slave Interlocking*

If two or more electric motors are mechanically connected to the same transmission shaft it is possible to divide on the different motors the total torque transmitted to the shaft.
To get this so many converters are needed how many the motors are.
The system is composed by a Master converter, that control the speed of the system and it determines the necessary total current, and by one or more SLAVES converters, that receives the current reference from the Master and they supplies each a part of the total current.
The current supplied by the Master added to the currents supplied by the SLAVES it is the current necessary to run.
The Master converter must to run as speed control mode by T.G. or by Armature Voltage.
The Slaves converters must run as Torque Control by the Armature Current.

***The mode and the operation limits of the SLAVES are the same of the Torque Control by the Armature Current.***

The digital command **CME** (Current Mode Enable) it enables this operating mode and it disables the motor speed control.
Without the digital command **CME** the converter controls the motor speed.
The same converter can run then in the two modes MASTER and SLAVE.
The analog input **CRI** (Current Reference Input) of the SLAVES it must to be connected to the armature current reference that is supplied by the analog output **CRO** (Current Reference Output) of the Master.

Examples of use of this mode of operation:

1) If we have a driving shaft that can be sectioned, that allow to divide in groups the elements of a machine, and every group is equipped by a motor, the different groups it can run in independent mode (all Master) or

coupled (one Master and one or more SLAVES).

2) In some lathe having two spindles it is possible to divide between two motors (equal) the necessary working torque using the first converter as a Master and the second as SLAVE. In this case, the piece to be turned, mechanically colleague the two motors. The operation of the two motors can be in constant torque and in constant power mode if both the converters have the speed control by T.G.

## 3.3 Technical data

### *3.3.1 General technical characteristics*

- Vertical placing on the panel board (please to see figure 13)
- Fixing by 4 screws using the holes predisposed on the base.
- Degree of protection: IP20.
- Operation:
  - 4 quadrants for the model TTB
  - 2 quadrants for the model TTU
- Power connections by terminal block or bars.
- Signal connections by screwed connectors.
- Field and Armature current ranges (please to see on pages 17 and 18)
- Maximum power dissipation = 3 x Rated Armature Current.
- Thermal time constant = 5 min.
- Storage temperature: from -10 to +60°C.
- Operating temperature: from 0 to +40°C.
- Non-inflammable atmosphere, not corrosive and without condense.
- Maximum altitude: 1000 m o.s.l.
- Ventilation:
  - Natural air for rated armature current up to 60A.
  - Forced air by built-in fan for rated current higher than 60A.
  - WARNING! The temperature of the metallic parts of the converter can reach 65°C.
- Setting by SWITCHES
- Diagnostic:
  - Red LED for the alarms
  - Green LED for the logical states
  - TEST POINT for the analog signals
- Protection by varistors against spikes on the feeder line.
- Inside protections:
  - Service Supply fault
  - Three-phase mains fault
  - Field fault
  - Fault or T.G. sign inversion
  - Short circuit on the digital outputs
  - Armature over voltage
  - Armature over current
  - Converter overload
  - Heat-sink over temperature
- Optoinsulated digital inputs (24Vd.c. - 10mA max):
  - JOG running
  - Sign inversion of the speed reference
  - Torque Control
  - Enable of the analog group inputs 1
  - Enable of the analog group inputs 2
  - Enable of the speed reference ramp
  - Enable of the armature bridge
  - Enable of the field bridge

  - Reset of the memorized alarms
- Optoinsulated digital outputs (24Vd.c. - 100mA max):
  - Converter OK
  - Motor Standstill
  - Speed Threshold
  - Converter Overload
  - Steady speed
  - Maximum Motor load
- Analog inputs:
  - T.G. Signal
  - N° 6 speed references, divided in 2 groups, with possibility to perform operations of sum and difference on the signals.
  - External limitation of the armature current.
  - Armature current reference (only with Torque Control by the Armature Current).
- Analog outputs:
  - +10V ±5% - 5mA max
  - -10V ±5% - 5mA max
  - +24V ±20% - 300mA max
  - Speed monitor
  - Armature current monitor
  - T.G. Signal
  - Armature Current reference (only with Torque Control by the Armature Current)

### *3.3.2 Supply*

**NOTES:**

The supply frequency can be 50Hz or 60Hz. The selection is made by the jumper **FRQ** (please to see on page 30 paragraph 4.3.3 point ). Please make reference to the connection schemes of the converters:

- With built-in armature bridge (Figure 10 on page 43).
- With external armature bridge (Figure 11 on page 44)

The differential circuit breaker utilized to protect the converters must have a B type-working characteristic (According to the 2nd amendment of the IEC 755 standards).

**SERVICES**

Supply: single-phase 230Va.c. ±10% - 500mA max. (Terminals: 230V)
Cross section area of the connection cables: 1,5 $mm^2$
Supply Protection by N°2 fuses having rated current 1A

**FIELD**

The single-phase supply voltage of the converter VFL (terminals FL1-FL2) it is calculated by the following formula:

$$V_{FL} = 1,2 \times \text{Maximum voltage of the motor field}$$

Tolerance on the supply voltage: from 0 to +20%

*Note: Supply Voltage Range: from 60Va.c. to 440Va.c.*

The maximum input current of the converter $I_{FL}$ (terminals FL1-FL2) it is calculated by the following formula:

$$I_{FL} = 1,2 \times \text{maximum field current of the motor}$$

To use a transformer or an autotransformer to fit the supply voltage to mains.
The minimum rating power $P_{FL}$ of the transformer / autotransformer is calculated by the following formula:

$$P_{FL} = 1,2 \times V_{FL} \times I_{FL}$$

Rated Current of the protection fuses > 1,5 x $I_{FL}$.
Max. rated current of the fuses: 32A ($I^2t$ to 25°C and 10msec <1.100$A^2$sec)
The motor field must to be connected as it follows:

To the terminals F0-F1 if the maximum field current is from 0,8A to 4A.
To the terminals F0-F2 if the maximum field current is from 4A to 20A.
Maximum cross section area of the connection cables:
Terminals FL1 - FL2 - F0 - F2: 6 $mm^2$
Terminal F1: 2,5 $mm^2$
On request they are available converters having different Voltages and Field Currents.
In this case the data are available on the rating plate of the converter.

**ARMATURE**

The converter must be connected to a three-phase mains having grounded neutral and rating voltage: 400/230Va.c. ±10% 50/60Hz. (the selection of the voltage and of the frequency are described on page 30 paragraph 4.3.3). To insert between the three-phase mains and the converter a three-phase inductor having an inductance of at least 100µ H, that must to be designed for the current supplied to the converter and having a saturation current at least the double one of the designing current.
To use some transformer having connections Δ/Y with center tap connected to ground or some autotransformer (Y/Y) to fit mains.
To protect the converter bridge by N°3 ultra-fast fuses as suitable on the Chart 2.

**Maximum Armature Voltages**

| **TTB** | **TTU** |
|---|---|
| 400Vd.c. with 400Va.c. supply | 440Vd.c. with 400Va.c. supply |
| 230Vd.c. with 230Va.c. supply | 250Vd.c. with 230Va.c. supply |

The rating of the converters are brought on Chart 1 and Chart 2 on page 19.

| CONVERTER | | | | | FILTER | INDUCTANCE |
|---|---|---|---|---|---|---|
| TYPE | | OUTPUT CURRENT Rated/Peak | SIZE | ABSORBED APPARENT POWER Rated/Peak | | |
| TTB | TTU | (1) [A] | (2) | (3) [KVA] | (4) TYPE | TYPE |
| 02/211 | 02/231 | 15 / 20 | 1 | 8,5 / 11,4 | 23/001 | 17/001 |
| 02/212 | 02/232 | 30 / 40 | 1 | 17 / 22,7 | 23/002 | 17/001 |
| 02/213 | 02/233 | 60 / 80 | 1 | 34 / 45,4 | 23/003 | 17/003 |
| 02/214 | 02/234 | 90 / 120 | 1 | 51,1 / 68,1 | 23/004 | 17/004 |
| 02/215 | 02/235 | 120 / 160 | 1 | 68,1 / 90,9 | 23/005 | 17/005 |
| 02/216 | 02/236 | 180 / 240 | 2 | 102,2 / 136,3 | 23/007 | 17/007 |
| 02/217 | 02/237 | 240 / 320 | 2 | 136,3 / 181,8 | 23/008 | 17/008 |
| 02/218 | 02/238 | 300 / 400 | 3 | 170,4 / 227,2 | 23/010 | 17/009 |
| 02/219 | 02/239 | 400 / 530 | 3 | 227,2 / 301 | 23/010 | 17/010 |
| 02/220 | 02/240 | 500 / 660 | 3 | 284 / 375 | 23/010 | ---- |
| -- | -- | >500 | 1 | (5) Driving Unity of external bridge | | |

**Chart 1**

NOTE:
The Rated / Peak apparent power is absorbed from mains, when the converter deliver the Rated / Peak current.

| CONVERTER | | | THREE-PHASE SUPPLY FUSES | | CONNECTION | |
|---|---|---|---|---|---|---|
| TYPE | | OUTPUT CURRENT Rated/Peak | RATED CURRENT | Max. $I^2t$ at 10ms | SUPPLY L1-L2-L3 | MOTOR A-B |
| TTB | TTU | (1) [A] | [A] | [$A^2s$] | (6) [$mm^2$] | [$mm^2$] |
| 02/211 | 02/231 | 15/20 | 32 | 1.100 | 4 | 4 |
| 02/212 | 02/232 | 30/40 | 50 | 1.100 | 10 | 10 |
| 02/213 | 02/233 | 60/80 | 100 | 3.500 | 16 | 16 |
| 02/214 | 02/234 | 90/120 | 160 | 15.000 | 35 | 35 |
| 02/215 | 02/235 | 120/160 | 200 | 18.000 | 70 | 70 |
| 02/216 | 02/236 | 180/240 | 250 | 18.000 | BAR | BAR |
| 02/217 | 02/237 | 240/320 | 400 | 125.000 | BAR | BAR |
| 02/218 | 02/238 | 300/400 | 500 | 125.000 | BAR | BAR |
| 02/219 | 02/239 | 400/530 | 630 | 320.000 | BAR | BAR |
| 02/220 | 02/240 | 500/660 | 700 | 320.000 | BAR | BAR |
| -- | -- | >500 | (5) Driving Unity of external bridge | | | |

**Chart 2**

**NOTE**

(1) Inside temperature of the electrical cabinet, inside which the converter is placed, from 0 to 40°C.
4% of current derating for every °C over 40°C.

(2) Outline dimensions and weights on the Figure 13.

(3) Power calculated with 400Va.c. three-phase mains.

(4) The filter is necessary when the drives type TTB and TTU are utilized in first environment, to satisfy the requisite regarding the EMC compatibility (please to see the point 2.3.4.2).

(5) The Driving unity of external bridge (please to see the Figure 11) it is available to drive:
- An already existing bridge;
- A bridge for current >500A.

Inside the frame they are placed: the bridge for the field supplying and the relative terminals block, the terminal block for the connections to the external bridge.
The three-phase supply fuses size and the cross sections area of the cables is dependent from the current.

(6) Input a.c. current = 0,82 x Armature Current

## 3.4 Commands, signaling, inputs and outputs (I/O)

### *3.4.1 Switch (SW1)*

To easy locate the dipswitch on the frontal card, please to see on page 38

SW1.1 Ramp time range selector. (please to see on page 34)
SW1.2 Rotation directions of the motor shaft for the model TTB. (please to see scheme on page36)
SW1.3 Speed threshold ranges. (please to see on page 35)
SW1.4 T.G. voltage selector. (please to see on page 31)
SW1.5 T.G. voltage selector. (please to see on page 31)
SW1.6 Enable of the speed control by armature voltage (please to see on page 32)
SW1.7 Enable of the limit of the armature current dependent from the motor speed (please to see on page 34)
SW1.8 Enable of the external setting of the armature current limit. (please to see on page 30)

### *3.4.2 Signaling LED (green)*

To easy locate the following LEDs on the frontal card, please to see on page 38

**ABE** ARMATURE BRIDGE ENABLE
Command to enable the bridge that supplies the motor armature.
The armature is fed only if the led DOK is lighted

**ALR** ALARM RESET
Reset Command for alls the memorized alarms.

**CME** CURRENT MODE ENABLE
Command to enable the following operation mode: Torque Control by the armature current (please to see on page 33)

**DOK** DRIVE OK
Converter regularly running (any failure)

**FBE** FIELD BRIDGE ENABLE
Command to enable the bridge that supplies the motor field. The field is fed if the led FLF is not lighted.

**JOG** JOG
Command to enable JOG speed reference. (please to see scheme on page 36).

**RSR** REVERSE SPEED REFERENCE
Command to reverse the speed reference sign. (please to see scheme on page 36)

**SOT** SPEED OVER THRESHOLD
Speed over the set threshold (please to see on page 35)

**SR1** SPEED REFERENCE 1
Command to enable the analog references 1 group (please to see scheme on page 36).

**SR2** SPEED REFERENCE 2
Command to enable the analog references 2 group (please to see scheme on page 36).

**SRE** SPEED RAMP ENABLE
Command to enable speed ramp. (please to see on page 34)

**STS** STEADY SPEED
Steady speed of the motor. (please to see on page 35)

**SUP** SERVICE SUPPLY OK
Presence of the stabilized supplies inside the converter.
If this led is not lighted please check the service supply 230Va.c.

**ZES** ZERO SPEED
Motor Standstill.

### *3.4.3 Alarm LED (red)*

To easy locate the following LEDs on the frontal card, please to see on page 38

**3PF** THREE-PHASE FAILED (**)
Absence of one or more phases of the three-phase supply

**AOC** ARMATURE OVERCURRENT memorized (*)
Overcurrent in the motor armature.
Please check the isolation of the armature connections and the armature windings of the motor.

**AOV** ARMATURE OVERVOLTAGE
Armature voltage more than the maximum value allowed by the three-phase supply.
Please check the armature voltage to the maximum motor speed.
In the model TTB the operation of the motor as brake is blocked.

**BOT** BRIDGE OVERTEMPERATURE memorized (*)
Overtemperature of the thyristors bridge

**DOL** DRIVE OVERLOAD (*)
Converter in overload condition. The armature current overcomes the rated value and lasts for a long time. Greater it is the overload smaller it is the allowed time. A 33% constant overload can, for instance, to last 60 sec. If the overload doesn't quit within 5 sec after the signaling, the alarm is memorized. The alarm reset (if memorized) it happens by the command ALR. A proportional signal to the entity of the overload is available on the T.P. OLL (+10V on the T.P. they correspond to the maximum overload).

**FLF** FIELD FAILED (**)
Absence of the field current in the motor.
If the led FBE is lighted please check: the single-phase field supply, the connections and the field windings of the motor.

**OUF** OUTPUT FAULT memorized (*)
Overload or short circuit on one or more digital outputs.
In this alarm condition all the digital outputs are OFF and the armature bridge is disabled.

**PML** PEAK MOTOR LOAD
Armature current equal or more than 90% of the set limit on the Test Point ACL by the trimmer ACL.
If the armature current reaches the 100% of the set limit the motor it loses speed up to stop.

**TGF** TACHOGENERATOR FAILED memorized (*)
Absence or reverse polarity of the T.G. signal.
Please check:

- Polarity, Continuity and Isolation of the connections and the windings of the T.G. and of the Motor.
- Brushes of the T.G. and of the Motor.
- Coupling between Motor and T.G.

***NOTES:***
*(*) With this alarm the armature bridge is disabled, the led DOK is out and the digital output DOK is OFF.*
*(* *) With this alarm the armature bridge is disabled, the led DOK is out and the digital output DOK is OFF only if the enabling commands of the corresponding bridge are existing (ABE and/or FBE).*
*The reset of the memorized alarms happens by the digital command ALR.*

### *3.4.4 Test point of measure (T.P.)*

To easy locate the following TEST POINTS on the frontal card, please to see on page 38.

**A0V** Supplies Common (0V) (connected to the metallic frame)
**+5V** Stabilized inside supply +5V ±0,5V
**+15V** Stabilized inside supply +15V ±0,5V
**-15V** Stabilized inside supply -15V ±0,5V
**ACL** ARMATURE CURRENT LIMIT (6,7V max)
Value set of the of the armature current limit.
+5V correspond to the rated current of the converter.
**ACM** ARMATURE CURRENT MONITOR (10V max)
Proportional signal to the current in the motor armature.
(Same signal on the analog output ACM - please to see on page 25)
**ACR** ARMATURE CURRENT REFERENCE (6,7V max)
Armature current reference for the control of the torque by the armature current
(please to see page 33).
5V correspond to the rated current of the converter.
**ARC** ARMATURE CURRENT (1,33V max)
Proportional signal to the current in the motor armature.
1V correspond to the rated current of the converter.
**ARV** ARMATURE VOLTAGE (5V max)
Signal corresponding to 1/100 of the armature voltage.
**CP1** CURRENT PROFILE 1 (please to see on page 34)
**CP2** CURRENT PROFILE 2 (please to see on page 34)
**FLC** FIELD CURRENT (+10V max)
Proportional signal to the current in the motor field.
+10V correspond to the maximum current of the utilized output.
**JOG** JOG SPEED REFERENCE (*) (+1,5V max.)
Jog speed Reference (please to see the scheme on page 36)
**OLL** OVERLOAD LEVEL (+10V max)
Proportional signal to the converter overload. (please to see led DOL on page 21)
**SEL** SPEED ERROR LIMIT (*) (+10V max)
Maximum speed error set for the STEADY SPEED signaling (please to see on page 35)
**SP1** SPEED 1 (*) (10V max)
Speed references inputs group 1 (please to see the scheme on page 36)
**SP2** SPEED 2 (*) (10V max)
Speed references inputs group 2 (please to see the scheme on page 36)
**SPM** SPEED MONITOR (*) (10V max)
Proportional signal to the motor speed.
(Same signal on the analog output SPM. please to the see on page 25)
**SPR** SPEED REFERENCE (*) (10V max)
Value of the speed reference (please to see the scheme on page 36)
**SPT** SPEED THRESHOLD (*) (+10V max)
Value set for the speed threshold. (please to see on page 35)
**SR1** SPEED REFERENCE 1 (*) (10V max)
Total speed reference of inputs group 1 (please to see the scheme on page 36)
**SR2** SPEED REFERENCE 2 (*) (10V max)
Total speed reference of inputs group 2 (please to see the scheme on page 36)
**RAV** RATED ARMATURE VOLTAGE (+10V max)
Value set for the maximum voltage armature (please to see on page32 point )

(*) Please replace Speed with Armature Voltage if the control is by Armature Voltage

### *3.4.5 Regulation Trimmers*

To easy locate the following TRIMMERS on the frontal card, see on page 38.

**ACL** ARMATURE CURRENT LIMIT
Limit of the armature current (please to see on page 30)

**ACM** ARMATURE CURRENT MONITOR
Proportional signal to the current in the motor armature.
(please to see the analog output ACM on page 25)

**CDE** CURRENT DERATING
Limit of the armature current dependent from the motor speed (please to see on page 34)

**CP1** CURRENT PROFILE 1
Limit of the armature current dependent from the motor speed (please to see on page 34)

**CP2** CURRENT PROFILE 2
Limit of the armature current dependent from the motor speed (please to see on page 34)

**JOG** JOG SPEED REFERENCE (*)
JOG speed Reference (please to see the scheme on page 36)

**OF1** OFFSET 1
Offset adjust of the input reference group 1 (please to see the scheme on page 36)

**OF2** OFFSET 2
Offset adjust of the input reference group 2 (please to see the scheme on page 36)

**RAV** RATED ARMATURE VOLTAGE
Maximum Armature Voltage (please to see on page32 point )

**RFC** RATED FIELD CURRENT
Field Rated Current (please to see on page 31 point )

**SEL** SPEED ERROR LIMIT (*)
Maximum speed error for the output STEADY SPEED (please to see on page 35)

**SLG** SPEED LOOP GAIN (*)
Quickness of answer of the converter (please to see on page 32 point )

**SOF** SPEED OFFSET (*)
Offset adjust of the speed (please to see on page 32 point )

**SP1** SPEED REFERENCE 1 (*)
Speed Reference of inputs group 1 (please to see the scheme on page 36)

**SP2** SPEED REFERENCE 2 (*)
Speed Reference of inputs group 2 (please to see the scheme on page 36)

**SPM** SPEED MONITOR (*)
Proportional signal to the motor speed (please to see the analog output SPM on page 25)

**SPT** SPEED THRESHOLD (*)
Value of the speed threshold (please to see on page 35)

**SRT** SPEED RAMP TIME (*)
Rise and Fall time of the speed ramp (please to see on page 34)

(*) Please replace Speed with Armature Voltage if the control is by Armature Voltage

### *3.4.6 Analog inputs*

*NOTES:*

- *Please always to use only some good quality shielded cables and to connect to ground the two ends of the shield.*
- *On the frame of the converter, near to the connectors, are available the connecting points of the shields (please to see on page 46).*

For the connections to make reference to the scheme on page 40.

**A0V** ANALOG 0V (terminal 4-6-10-35-40-43)
Analog 0V.
The analog 0V is connected to the frame of the converter.

**CLI** CURRENT LIMIT INPUT (terminal 31)
External reference of the limit of the armature current.
(10V max – Input Resistance 100KΩ) (please to see on page 30)

**CRI** CURRENT REFERENCE INPUT (terminal 38)
Current Reference for the torque control by the armature current.
(10V max – Input Resistance 100KΩ) (please to see on page 33)

**SI1** SPEED INPUT 1 (terminal 5) (*)
Speed Reference 1 (10V max - Input Resistance 100KΩ) (please to see the scheme on page 36)

**SI2** SPEED INPUT 2 (terminal 7) (*)
Speed Reference 2 (10V max - Input Resistance 100KΩ) (please to see the scheme on page 36)

**SI3** SPEED INPUT 3 (terminal 8) (*)
Speed Reference 3 (10V max - Input Resistance 200KΩ) (please to see the scheme on page 36)

**SI4** SPEED INPUT 4 (terminal 9) (*)
Speed Reference 4 (10V max - Input Resistance 100KΩ) (please to see the scheme on page 36)

**SI5** SPEED INPUT 5 (terminal 11) (*)
Speed Reference 5 (10V max - Input Resistance 200KΩ) (please to see the scheme on page 36)

**SI6** SPEED INPUT 6 (terminal 12) (*)
Speed Reference 6 (10V max - Input Resistance 100KΩ) (please to see the scheme on page 36)

**TGI** TACHOGENERATOR INPUT (terminal 1)
T.G. signal (please to see on page 31)
(400V max - Input Resistance 800KΩ)
(10V max - Input Resistance 200KΩ)

(*) Please replace Speed with Armature Voltage if the control is by Armature Voltage.

### *3.4.7 Analog outputs*

*NOTES:*

- *Please always to use only some good quality shielded cables and to connect to ground the two ends of the shield.*
- *On the frame of the converter, near to the connectors, are available the connecting points of the shields (please to see on page 46).*

For the connections to make reference to the scheme on page 40.

**+10** +10V ±5% - 5mA max (terminal 39)
**-10** -10V ±5% - 5mA max (terminal 41)
**+24** +24V ±20% - 300mA max (terminal 42)
**A0V** ANALOG 0V (terminals 4-6-10-35-40-43)
0V analog.
The analog 0V is connected to the frame of the converter.
**ACM** ARMATURE CURRENT MONITOR (terminal 36)
(+10V max - 5mA max - Output Resistance 100 Ω).
Proportional signal to the armature current of the motor. The amplitude regulation happens by the trimmer ACM. +5V they correspond to the armature rated current of the converter if the trimmer ACM is at counterclockwise limit stop position. Note: to have the bipolar output move R122 in R121 position.
**CRO** CURRENT REFERENCE OUTPUT (terminal 32)
(6,7V max - 5mA max - Output Resistance 100 Ω).
Current Reference for SLAVES converters.
5V correspond to the armature rated current of the converter.
**SPM** SPEED MONITOR (terminal 33) (*)
(+10V max - 5mA max. Output Resistance 100 Ω).
Proportional signal to the motor speed.
The amplitude regulation happens by the trimmer SPM.
NOTE:
To have the bipolar output move R126 in R125 position.
**TGO** TACHOGENERATOR OUTPUT (terminal 2)
This output is connected to the input TGI (terminal 1) (400Vd.c.max)

(*) Please replace Speed with Armature Voltage if the control is by Armature Voltage

### *3.4.8 Common digital I/O*

D0V DIGITAL 0V (terminal 22)
Digital 0V. To connect this terminal to the 0V supply of the digital inputs / outputs.

D24 DIGITAL 24V (terminal 24)
24V supply of the digital outputs.
To connect this terminal to the +24V supply of the digital inputs / outputs.

### *3.4.9 Digital inputs*

*NOTES:*

- *Supply Voltage from 18Vd.c. to 30Vd.c. (rated 24Vd.c.)*
- *Input Current 10mA*
- *The Lighted led indicates the presence of the corresponding command.*
- *To reduce the electric noises it is advised to use only some good quality shielded cables and to connect to the ground the two ends of the shield.*
- *On the frame of the converter, near to the connectors, are available the connecting points of the shields (please to see on page 46).*

For the connections to make reference to the scheme on page 41.

**ABE** ARMATURE BRIDGE ENABLE (terminal 19)
Command to enable the bridge to supply the motor armature.
The armature is fed only if the led DOK is lighted.

**ALR** ALARM RESET (terminal 20)
Reset Command for alls the memorized alarms (minimum time required of the command: 1 msec)
**The Reset of the alarms happen only if the digital input ABE is OFF**

**CME** CURRENT MODE ENABLE (terminal 15)
Enabling of the Control of the torque by the armature current (please to see on page 33).

**FBE** FIELD BRIDGE ENABLE (terminal 21)
Command to enable the bridge to supply the motor field. The field is fed if the led FLF is not lighted. Let's not give this command if the d.c. motor is a permanent magnets type

**JOG** JOG (terminal 13) (*)
Command to enable JOG speed reference (please to see the scheme on page 36)

**RSR** REVERSE SPEED REFERENCE (terminal 14) (*)
Command to reverse the speed reference sign (please to see the scheme on page 36)

**SR1** SPEED REFERENCE 1 (terminal 16) (*)
Command to enable the analog references group 1 (please to see the scheme on page 36)

**SR2** SPEED REFERENCE 2 (terminal 17) (*)
Command to enable the analog references group 2 (please to see the scheme on page 36)

**SRE** SPEED RAMP ENABLE (terminal 18) (*)
Command to enable the speed ramp (please to see on page 34)

(*) Please replace Speed with Armature Voltage if the control is by Armature Voltage.

### *3.4.10 Digital outputs*

*NOTES:*

- *Supply Voltage from 18Vd.c. to 30Vd.c. (rated 24Vd.c.)*
- *Output states:*
  - *OFF = Floating*
  - *ON = Connected to +24V supply (D24) (signaled by the lighting of the corresponding led)*
- *Maximum current of each output = 100 mA*
- *Inside voltage drop at the maximum output current = 2V*
- *Without service supply all the outputs are OFF.*
- *The state of the outputs is valid 200 msec after the services are supplied.*
- *In case of overload or short circuit on one or more outputs all the outputs are permanently forced in the OFF state.*
- *The anomaly is signaled by the alarm led OUF and the armature bridge is disabled.*
- *The alarm reset happens by the digital command ALR.*

For the connections to make reference to the scheme on page 41

**DOK** DRIVE OK (terminal 30)
Converter regularly running (no failures) (please to see the notes on page 20)

**DOL** DRIVE OVERLOAD (terminal 25)
Converter in overload condition (please to see on page 21)

**PML** PEAK MOTOR LOAD (terminal 27)
Armature Current equal or more than 90% of the set limit (please to see on page 21)

**SOT** SPEED OVER THRESHOLD (*) (terminal 29)
Speed more than the set threshold (please to see on page 35)

**STS** STEADY SPEED (*) (terminal 26)
Steady speed of the motor (please to see on page 35)

**ZES** ZERO SPEED (*) (terminal 28)
Motor Standstill.

(*) Please replace Speed with Armature Voltage if the control is by Armature Voltage.

# 4 RUNNING SEQUENCES OF THE CONVERTER AND STARTUP

## 4.1 Starting Sequence

Supply the services (230Va.c. single-phase).

1. To apply the single-phase voltage to supply the motor field.
2. To enable the bridge that supplies the motor field (**FBE** command).
3. To apply the three-phase voltage to supply the motor armature.
4. To enable the bridge that supplies the motor armature (**ABE** command).
5. To command the drive in the desired operation mode.

## 4.2 Shutdown Sequence

6. To stop the motor.
7. To disable the bridge that supplies the motor armature (**ABE** command).
8. To remove the three-phase voltage to supply the motor armature.
9. To disable the bridge that supplies the motor field (**FBE** command).
10. To remove the single-phase voltage to supply the motor field

    Turn off the services supply.

**NOTES:**

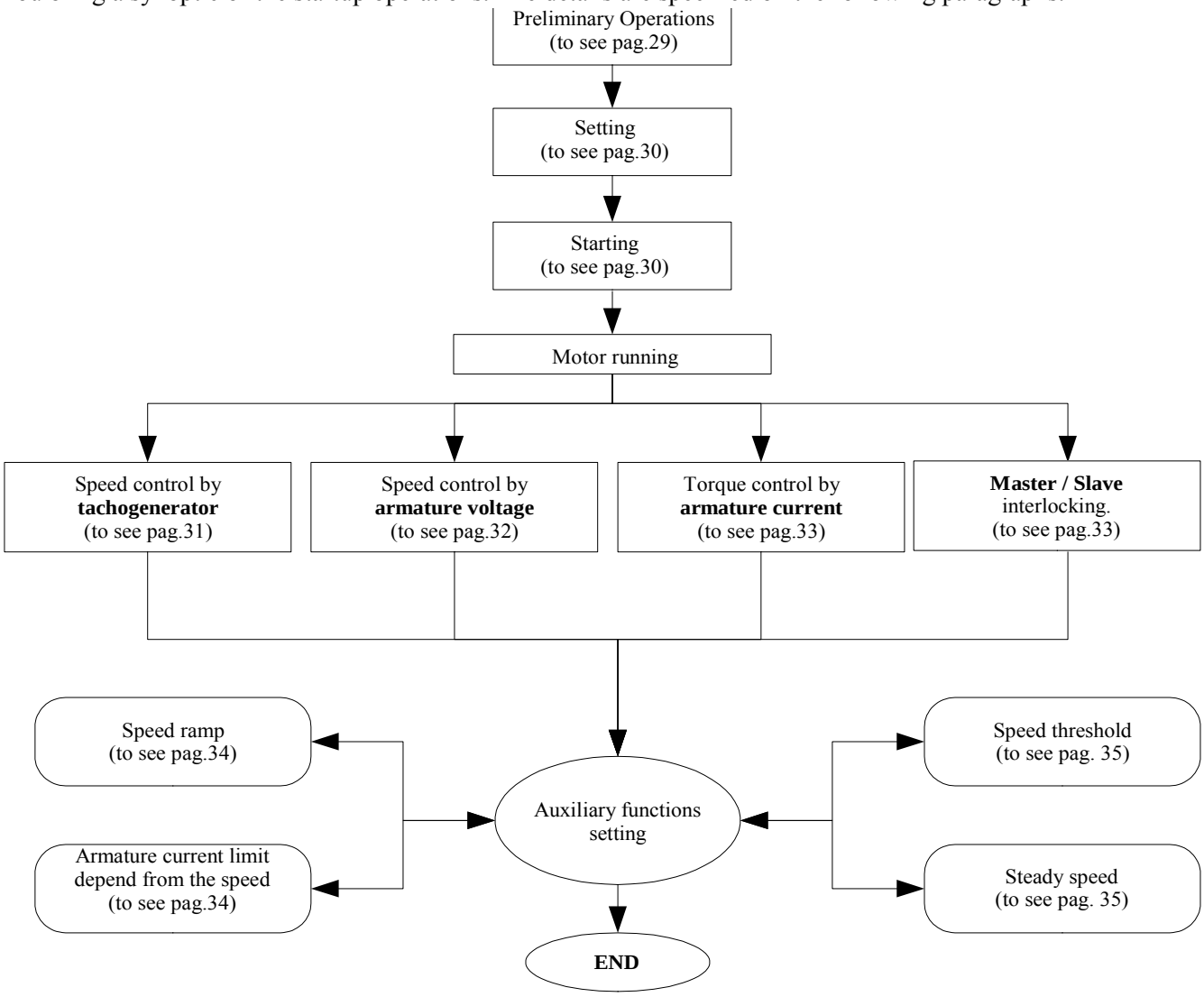
- To eliminate the points 1 - 2 - 9 - 10 if the d.c. motor is a permanent magnets type.
- The commands of which points 1 - 2 can be simultaneous.
- The commands of which points 7 - 8 - 9 - 10 can be simultaneous.
- To apply the three-phase voltage to supply the motor armature (point 3) only if the digital output **DOK** is found in the ON state.
- If the commands of which points 3 and 4 are simultaneous, the enabling of the armature supply bridge it happens 100 msec after the three-phase voltage is applying.
- After the enabling of the bridge to supply the motor field, (with the single-phase voltage to supply the motor field applied) to wait at least 1 sec before to enable the armature bridge (point 4) to let the field current to reach the steady value.
- When the motor is not running, can be useful to stop the fan of the motor and to also disable the bridge to supply the motor field not to overheat the motor in absence of ventilation. To also remove the three-phase voltage supply and the enabling of the armature bridge.
- To immediately remove the three-phase voltage supplies to the armature bridge if the digital output DOK go in the OFF state.

To always observe the starting and the shutdown sequences.

## 4.3 Startup

### *4.3.1 Synoptic picture of the operations*

You bring a synoptic of the startup operations. The details are specified on the following paragraphs.




### *4.3.2 Preliminary operations*

To check that:

- The converter underwent no damages while the transport or the placement.
- The supply voltage correspond to that indicated on the converter rating plate and suitable to the motor.
- The connections correspond to that indicated on this instruction book.
- The shields of all the shielded cables are connected to ground.
- Spikes suppressors (RC snubber for a.c. supply and diodes for d.c. supply) must be placed in parallel to the coils of: contactor, relay, electro valves, clutches, brakes, etc. and on the terminals of the single-phase and three-phase induction motors.
- Enough room exists for the circulation of the cooling air.

To remove the anterior panel of protection, unscrewing the screws, to be able to access the components placed on the frontal plate.

After the startup, to reassemble the anterior panel of protection.

### *4.3.3 Setting*

**1 ARMATURE BRIDGE SUPPLY VOLTAGE.**

At factory, the converter is set to **400Va.c.** operation voltage

For **230Va.c.** operation voltage to cut the jumper **3PV**.

**2 SUPPLY FREQUENCY (50/60HZ)**

At factory the converter is set to **50Hz**.

For **60Hz** operation frequency to cut the jumper **FRQ**.

### *4.3.4 Starting*

- **NOTES:**
- The regulations are described in the sequence in which they must be made.
- The **clockwise** rotation of the trimmer's regulation screw corresponds to an **Increase** of the corresponding greatness.
- To connect to the T.P. **A0V** or to the metallic frame of the converter the negative prod of the voltmeter and the ground of the probe of the oscilloscope.
- **Make use of insulated screwdriver to regulate the trimmers**.
- **The trimmer's regulation screw sealed by enamel must not be turned**.
- The motor speed is calculable by the following formula**:**

$$Motor\ Speed = \frac{V_{T.G.}(read\ on\ terminal\ 2)}{K_{T.G.}(read\ on\ T.G.)}$$

**1** To supply only the services and to verify that: the fan (if built-in) is running, the lighting of the following led:

**DOK STS SUP ZES**

**NOTE: Any red LED must be lighted.**

**2 SETTING OF THE ARMATURE CURRENT LIMIT**

- **Limit Setting INSIDE** to the converter:

  To switch **SW1.8 = ON**.

  To calculate the voltage corresponding to the limit of current desired by the following formula:

$$V_{T.P.ACL} = 5 \bullet \frac{Armature\ Motor\ Rat.Current}{Converter\ Rat.Current}\ [V]$$

  1. To set by the trimmer ACL on the T.P. ACL the calculated voltage.

- **Limit Setting EXTERNAL** to the converter:
  1. To switch **SW1.8 = OFF**.
  2. To apply the maximum signal (+10V) on the input **CLI** (terminal 31); if the external signal is less than +10V it is necessary to amplify this signal placing such resistor in R75 position (please to see the scheme on page 37 Figure 5). The value of such resistor is calculated by the following formula:

$$R75 = \left( \frac{10}{V_{CLI}\ \max} - 1 \right) \bullet 100.000\ \ [\Omega]$$

  | *$V_{CLI}$ max = Maximum value of the signal on the input **CLI**.*

  3. To place in R75 position a resistor having equal or approximate value for excess in comparison to the calculated one.
  4. To calculate the voltage corresponding to the limit of current desired by the following formula:

$$V_{T.P.ACL} = 5 \bullet \frac{Armature\ Motor\ Rat.Current}{Converter\ Rat.Current}\ [V]$$

  5. To set by the trimmer ACL on the T.P. ACL the calculated voltage.

**MAXIMUM SETTING VALUE ON THE T.P. ACL = 6,7V**

## 3 SETTING OF THE MAXIMUM FIELD CURRENT

***NOTE:*** *Don't make this setting if the motor is a permanent magnets type. To use the converter output suitable to the rated field current of the motor (please to see on page 17).*

To calculate the voltage corresponding to the rated field current by the following formula:

$$V_{T.P.FLC} = 10 \bullet \frac{Field\ Motor\ Rat.Current}{Converter\ Field\ Rat.Current\ Output\ (4A\ or\ 20A)}\ [V]$$

To apply the single-phase voltage, that supply the field bridge, and to enable the field control (digital Input **FBE**).
To adjust by the trimmer **RFC** the voltage on the T.P. **FLC** to get the calculated value.
**NOTE**: The supply voltage of the field is not significant, to verify only that it is not more than the rated value indicated on the rating plate of the motor.

### *4.3.5 Motor Running*

#### *4.3.5.1 SPEED CONTROL BY TACHOGENERATOR*

**Before beginning to carefully read the paragraph 3.2** (page 13).

1) To set **SW1.2** and **SW1.6** in **OFF** position and **SW1.8** in **ON** position.
2) To fit the converter to the T.G. coupled to the motor, to the running speed and to the speed reference, it is necessary to calculate the *X* parameter by the following formula:

$$X = \frac{K_{T.G.} \bullet \omega_{\max} \bullet 10}{V_{R\max}}\ [V]$$

*$K_{TG}$ = Speed Constant (noticed on the rating plate of the T.G.) [V / RPM]*
*$\omega_{max}$ = Maximum running speed of the motor [RPM]*
*$V_{Rmax}$ = Maximum speed reference (maximum voltage on the T.P. **SPR**) [V]. (It must be more than 7V and less than 10V)*

To amplify the speed reference it is necessary to increase the value of R29 / R33 (please to see the scheme on page 36).
To set the dipswitch SW1 as showed on the following chart:

| X | SW1.4 | SW1.5 | R14 |
|---|---|---|---|
| 5÷10 | OFF | OFF | 10KΩ |
| 10÷20 | OFF | OFF | 330KΩ |
| 20÷50 | OFF | OFF | ---- |
| 50÷130 | ON | OFF | ---- |
| 130÷290 | OFF | ON | ---- |
| 290÷370 | ON | ON | ---- |
| >370 | ON | ON | ---- |

If X > 370 is necessary to insert one or more resistors in series to the hot pole of the T.G. (terminal 1).
The total resistance value of these resistors is calculated by the following formula:

$$R_{TOT} = \frac{X - 370}{370} \bullet 800.000\ [\Omega]$$

Characteristics of every resistor: R ≤ 100KΩ e P ≥ 1/4W.

3) To apply the three-phase supply (armature bridge) and single-phase supply (field bridge).
4) To enable the field control (digital Input **FBE**) and the armature control (digital Input **ABE**) and to verify that any red led is lighted. To command the digital inputs **SR1** and/or **SR2.** To check that the trimmers SP1-SP2 are not at the counterclockwise limit stop position (please to see the scheme on page 36).
5) To apply to the converter a small speed reference on the inputs **SI1÷6** and to verify that the motor shaft run in the right direction of rotation.

*NOTES:*
*If the direction of rotation is wrong it is necessary to reverse the connections of the armature or of the field of the motor and of the T.G. after to have removed the commands ABE, FBE and all the supplies.*
*In case of converter fault (the led TGF is lighted) to remove the commands ABE, FBE, all the supplies and check all that indicated on page 21 (about this alarm).*
*To apply therefore the supplies and to repeat the MOTOR RUNNING.*

**1 SPEED REFERENCE OFFSET ADJUST**
To set to zero the voltage offset on the T.P. **SR1/SR2** by the trimmer **OF1/OF2**.

**2 SPEED OFFSET ADJUST**
Stop the motor shaft, with zero speed reference, by the trimmer **SOF**. (Digital inputs **SR1-SR2-JOG** = OFF).

**3 SETTING OF THE MAXIMUM ARMATURE VOLTAGE**
To set on the T.P. RAV by the trimmer RAV the voltage calculated by the following formula:

$$V_{T.P.RAV} = \frac{8 \bullet V_{MOTOR\ RAT.ARM}}{V_{THREE-PHASE\ POWER\ NET}}$$

$V_{T.P. RAV}$ = Voltage on the Test Point "RAV."
$V_{MOTOR\ RAT.\ ARM}$ = Rated armature voltage.
$V_{THREE\text{-}PHASE\ POWER\ MAINS}$ = three-phase mains voltage

Respecting the limits brought on the following chart:

| MAINS | Jumper "3PV" | Armature maximum rated voltage | |
|---|---|---|---|
| | | Constant torque | Constant Torque / Power |
| **400Va.c.** | ON | 400Vd.c. | 380Vd.c. |
| **230Va.c.** | OFF | 230Vd.c. | 220Vd.c. |

**4 SPEED SETTING**
To set the motor speed corresponding to the various speed references by the trimmers **SP1 - SP2 - JOG** and to verify the total value of the speed reference on the TP **SPR**. (10V max).

**5 CONVERTER RESPONSE ADJUST**
Adjust by the trimmer **SLG** the converter response to have a quick response, without oscillations, of the motor to speed reference steps. If it is necessary to modify the response of the converter it is available on the Figure 3 the scheme of the compensation network of the speed loop.

**6 If the auxiliary functions are used, to make the corresponding setting described on the pages 34 and 35.**

### *4.3.5.2 SPEED CONTROL BY THE ARMATURE VOLTAGE*

**Before beginning to carefully read the paragraph 3.2** (page 13).

1) The armature voltage is taken inside the converter and external connection doesn't be needed.
2) To set the switches **SW1.2 - SW1.7** in **OFF** position
3) To set the switch **SW1.6** in **ON** position.
4) To apply the three-phase supply (armature bridge) and single-phase supply (field bridge).
5) To enable the field control (digital Input **FBE**) and the armature control (digital Input **ABE**) and to verify that any red led is lighted. To command the digital inputs **SR1** and/or **SR2**. To check that the trimmers SP1-SP2 are not at counterclockwise limit stop position (please to see the scheme on page 36).
6) To apply to the converter a small speed reference on the inputs **SI1÷6** and to verify that the motor shaft run in the right direction of rotation.

*NOTES:*
*If the direction of rotation is wrong it is necessary to reverse the connections of the armature or of the field of the motor after having removed the commands ABE, FBE and all the supplies.*
*To apply therefore the supplies and to repeat the MOTOR RUNNING.*

**1 To make the offset adjust as indicated to the page 32 point and .**

**2 MAXIMUM ARMATURE VOLTAGE CHECK**
To carry the trimmer **RAV** to the counterclockwise limit stop position and to check that the voltage on the T.P. **RAV** is +15V.
To apply such increasing speed reference up to reach the maximum operation speed of the motor and to check (on the T.P. **ARV)** that the armature voltage doesn't exceed the rating voltage indicated on the rating plate of the motor and that allowed by the three-phase supply of the converter. (The voltage on the T.P. **ARV** is 1/100 of the armature voltage of the motor).

**3 To execute the suitable setting described on page 32 point and .**

**4 If the auxiliary functions are used, to make the corresponding setting described on pages 34 and 35.**

### *4.3.5.3 TORQUE CONTROL BY THE ARMATURE CURRENT*

**Before beginning to carefully read the paragraph 3.2** (page13).

**Setting of the armature current reference:**

**This setting must be made only if the converter is running in this mode of operation or as SLAVE.**

With reference to the scheme indicated on the Figure 4, to calculate the voltage on the T.P ACR by the following formula:

$$V_{T.P.ACL} = 5 \bullet \frac{Motor\ Armature\ Rat.Current}{Converter\ Rat.Current}\ [V]$$

Maximum Voltage On the T.P. ACR = 6,7V

To calculate the resistor value R by the following formula:

$$R = \frac{V_{T.P.ACR}}{V_{REF\ \max.}} \bullet 100.000\ [\Omega]$$

*$V_{REF\ max}$ = Maximum value of the current reference on the input **CRI.***

To place in R99, R100, R101 positions some resistors of such value that there sum coincide with the calculated R-value.

*The converter also control the motor speed in one of the two modes: by T.G. or by ARMATURE VOLTAGE, then it is necessary also to make the motor running for the corresponding operation mode (please to see on page 31 or on page 32).*

To apply the digital command **CME** that enables this operation mode.

To apply a current reference on the input **CRI** (terminal 34) (less than 1V on the T.P. **ACR**) and to verify that the torque direction on the motor shaft be right.

***NOTES:***

*If the sign of the torque is wrong it is necessary to reverse the sign of the current reference on the input ACR or to reverse the connections of the armature or of the field of the motor after having removed the commands ABE, FBE and all the supplies.*

*To apply therefore the supplies and then to repeat the MOTOR RUNNING.*

### *4.3.5.4 MASTER - SLAVE INTERLOCKING*

Before beginning to carefully read the paragraph 3.2 (page 13).

- To execute the startup of the MASTER converter.
- To execute the startup of the SLAVE converter in the operation mode "Torque Control by the Armature Current" (please to see on page33).

***NOTES:***

*You must connect the current reference output of the MASTER converter (CRO output terminal 32) to the current reference input of the SLAVE converter (CRI input terminal 34).*

### *4.3.6 Setting of the auxiliary functions*

The following setting must only be executed if the corresponding functions are used:

#### *4.3.6.1 SPEED RAMP TIME*

**NOTE: The rise and the fall times of the speed ramp are equal**.
To enable the **RAMP** function by the digital input **SRE**.
To select the range of rise / fall time of the ramp by **SW1-1**.
If **SW1.1 = OFF** the time is adjustable from 0,5 to 5 sec.
If **SW1.1 = ON** the time is adjustable from 5 to 50 sec. To have time greater than 50 sec. it is necessary to place a capacitor in **C20** position (please to see the scheme on page 36). The capacity is calculated by the following formula:

$$C_{20} = \frac{T - 50}{50} \quad [\mu F]$$

*T = Maximum approximate rise / fall time [sec.].*
These times are gotten with 10V speed reference amplitude. If the amplitude is less than 10V the times are proportionally shortest.
Adjust, by the trimmer **SRT,** the rise / fall time corresponding to the maximum speed reference on the inputs **SI1÷6** and check the time, by the oscilloscope, on the T.P. **SPR**.

#### *4.3.6.2 ARMATURE CURRENT LIMIT DEPENDENT FROM THE SPEED*

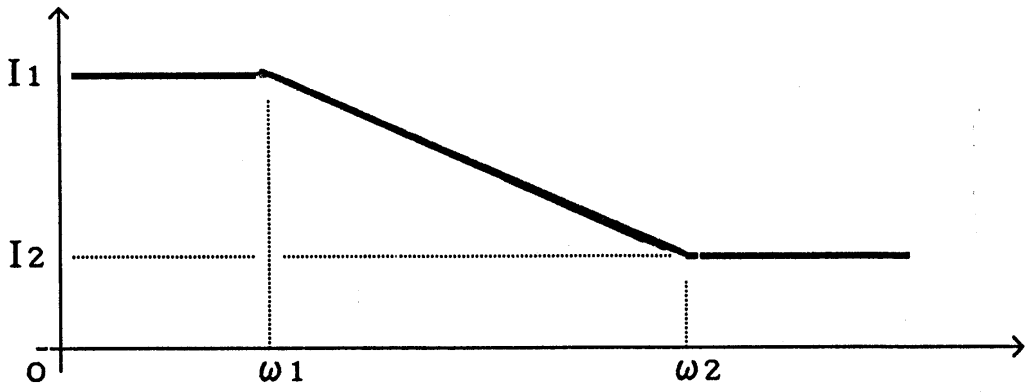



**Figure 1**
**DIAGRAM OF THE ARMATURE CURRENT LIMIT DEPENDENT FROM THE SPEED**

***NOTES:*** *This setting must be made if required by the builder of the motor (please to see data on the rating plate of the motor) or by the application.*
Before making this setting you have to verify the set limit of the armature current $I_1$ (please to see on page 30).
If **SW1.7 = OFF** the setting is disabled (limit of the current is constant = $I_1$).
If **SW1.7 = ON** the setting is enabled.
**Setting:**
- To carry the trimmers **CP1** and **CP2** to clockwise limit stop position and the trimmer **CDE** to counterclockwise limit stop position.
- To carry the motor to the speed $\omega_1$.
- To adjust, by the trimmer **CP1,** the voltage on the TP **CP1** to be equal to that measured on the T.P. **SPR** (eliminating the sign).
- To slowly carry the motor to the speed $\omega_2$ and to adjust, by the trimmer **CP2,** the voltage on the TP **CP2** to be equal to that measured on the T.P. **SPR**.
- To adjust, by the trimmer **CDE,** the voltage on the TP **ACL** to have a value corresponding to the current $I_2$ calculated by the following formula:

$$V_{T.P.ACL} = 5 \bullet \frac{I_2}{Converter\ \ Nom.\ Current}$$

$I_2$ = Armature current indicated on the rating plate of the motor, corresponding to the speed $\omega_2$ (the $\omega_2$ can be that suitable on the plate of the motor or that of maximum use if it is inferior).

#### *4.3.6.3 SPEED THRESHOLD*

(Digital output "**SOT**") (Terminal 29)

Range selection of the speed threshold:

| **SW1.3** | **RANGE OF THE THRESHOLD** (Referred to the maximum speed of the motor) |
|---|---|
| OFF | 0 ÷100 % |
| ON | 0 ÷10 % |

To carry the motor to the speed corresponding to the threshold and to adjust the trimmer **SPT** to get the commutation of the output signal (displayed by the led **SOT**).

A proportional voltage to the threshold is measurable on the T.P. **SPT** (regulation range from 0 to 10V).

#### *4.3.6.4 MAXIMUM ALLOWABLE SPEED ERROR FOR THE STEADY SPEED SIGNALING*

(Digital output "**STS**") (Terminal 26).

This setting must be execute only to make use of the digital output STS.

To set by the trimmer **SEL** on the T.P. **SEL** the voltage calculated by the following formula:

$$V_{T.P.SEL} = \frac{\Delta\omega}{\omega_{MAX}} \bullet V_{R\max.} \qquad [V]$$

*$\Delta\omega$ = Maximum speed error (constant at all the speeds) [RPM].*
*$\omega_{MAX}$ = Maximum motor speed (corresponding to the Maximum speed reference) [RPM].*
*$V_{Rmax}$ = Maximum speed reference (voltage on the T.P **SPR**) [V].*

---

### *4.3.7 Setting after substitution of the converter*

In the case of substitution of a converter, **it is necessary to set the new converter**, following the same procedures and to set the same values of the replaced converter.

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# ATTACHMENTS

## VARIOUS SCHEMES OF CIRCUIT

### *SPEED REFERENCES INPUTS*

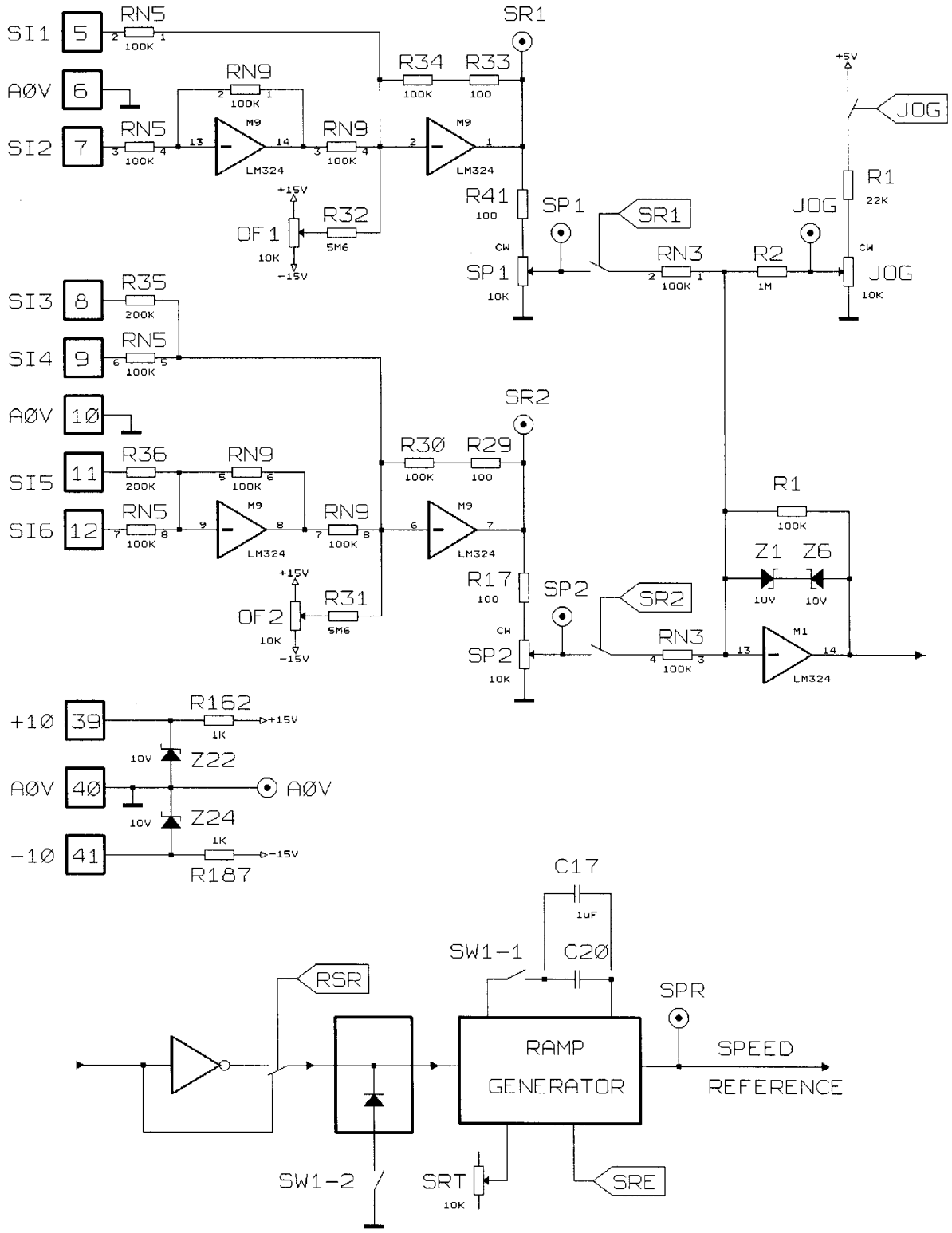



**Figure 2**

***SPEED LOOP***

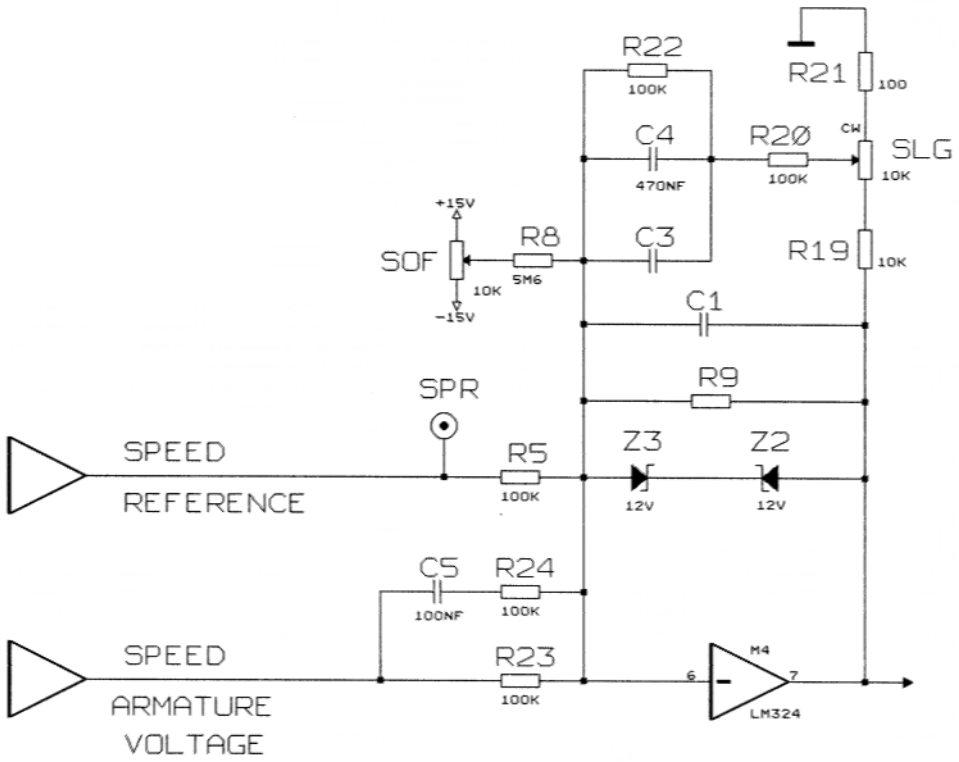



**Figure 3**

***CURRENT REFERENCE INPUT***

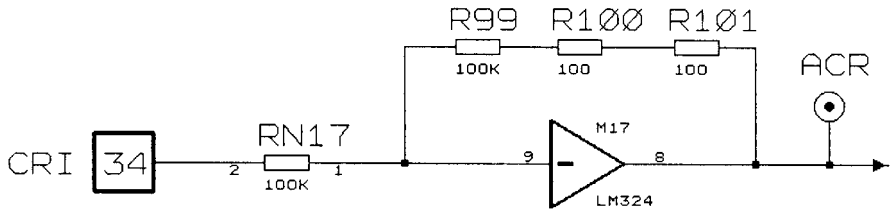



**Figure 4**

***EXTERNAL CURRENT LIMIT INPUT***

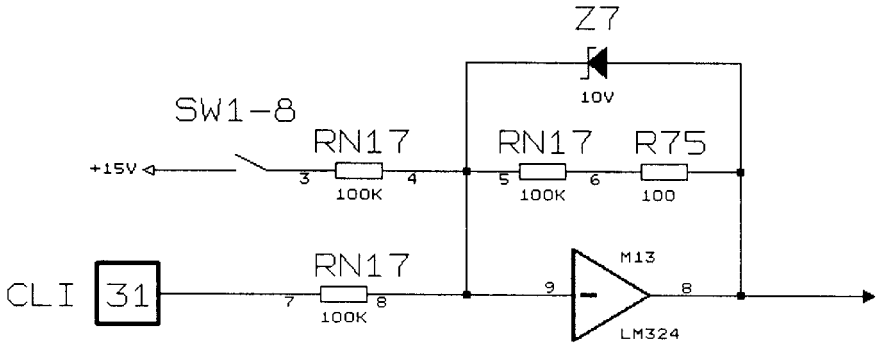



**Figure 5**

## COMPONENT LAYOUT

### *SETTING AND DIAGNOSTIC COMPONENT LAYOUT*

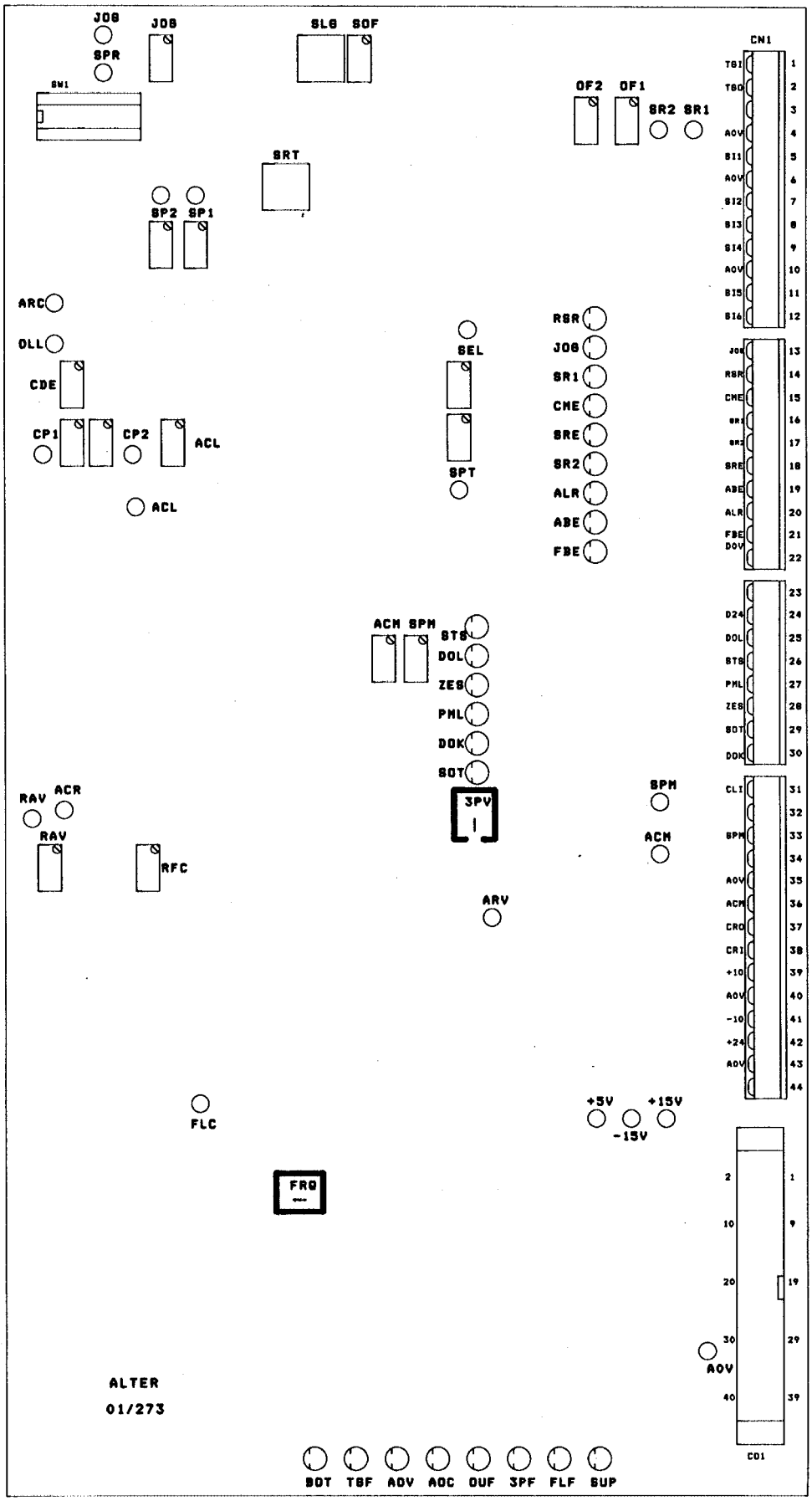



**Figure 6**

***GENERAL LAYOUT***

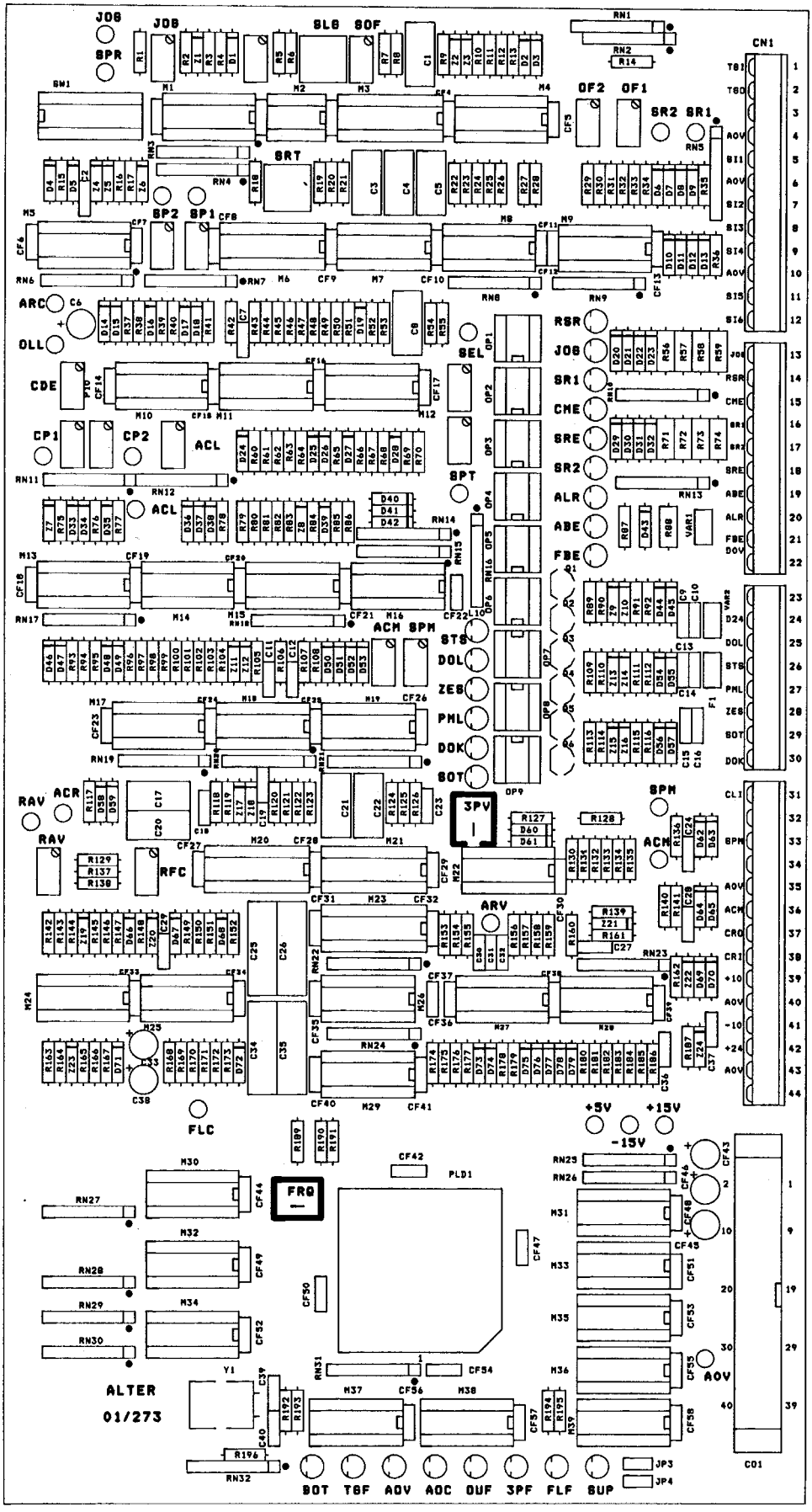



**Figure 7**

## EXTERNAL LINKS

### *ANALOG I/O*

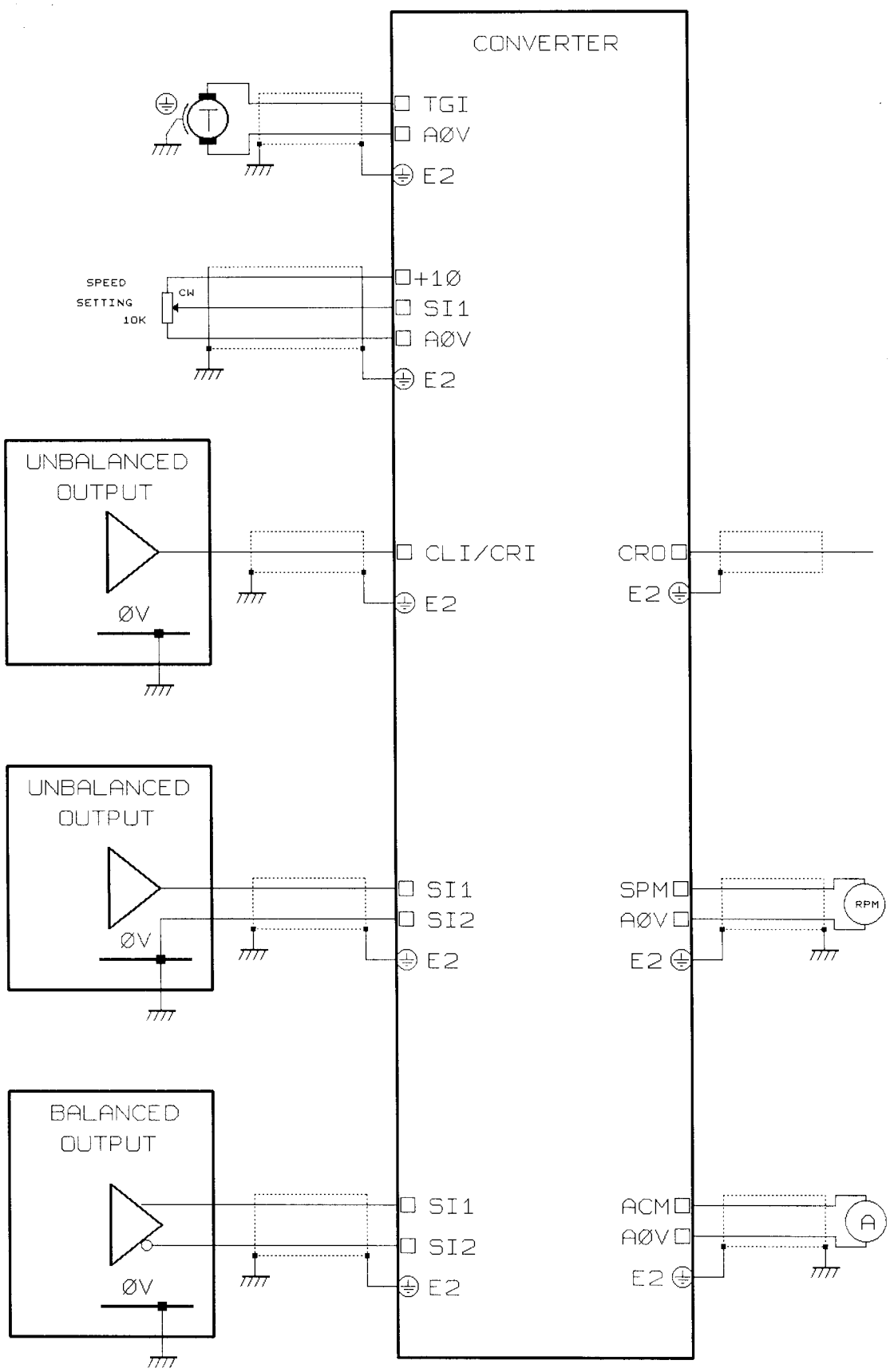
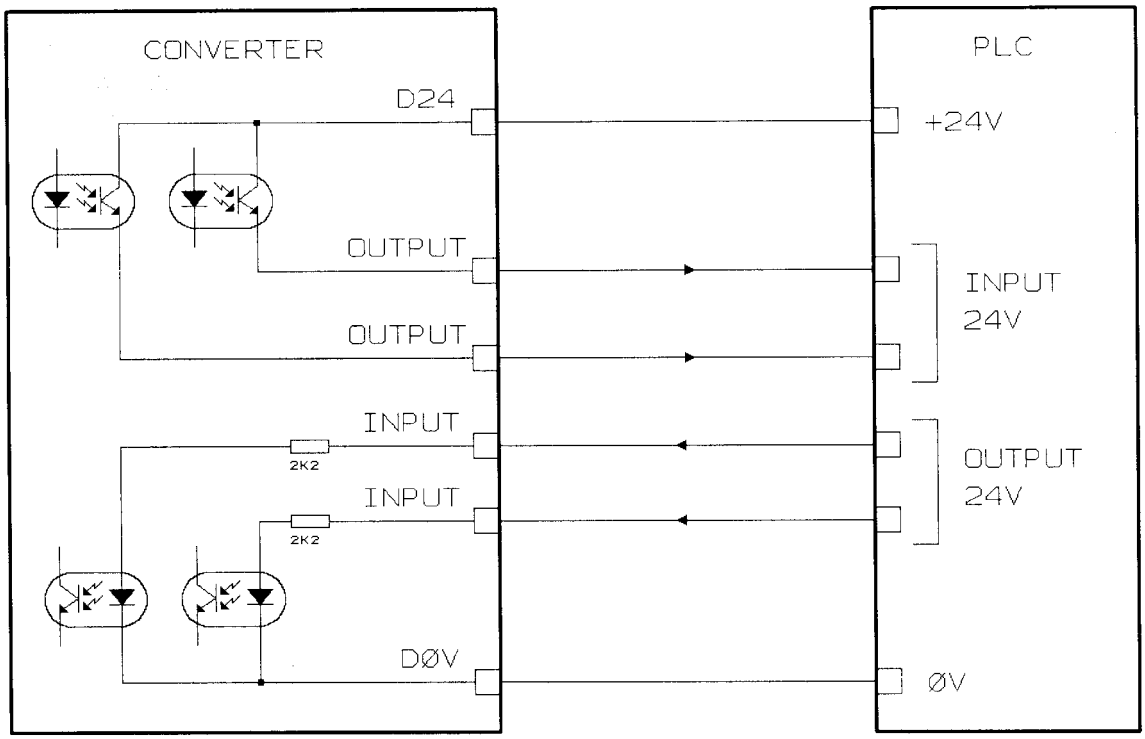



**Figure 8**

***DIGITAL I/O***



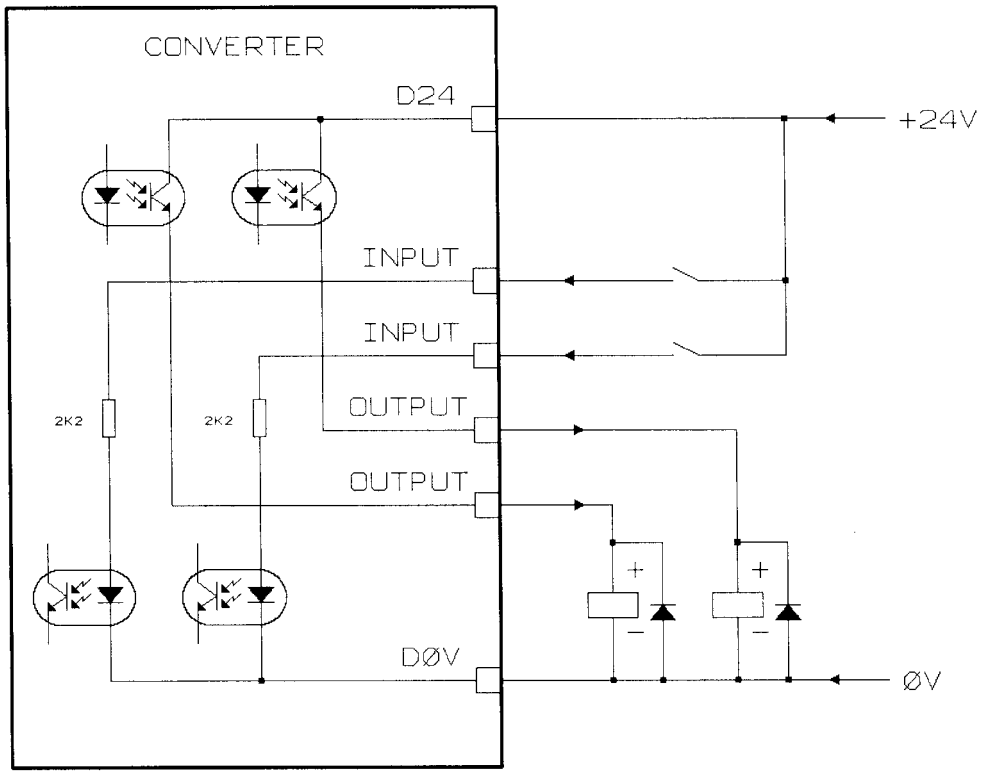




**Figure 9**

If the necessary total current overcomes 300mA, it is not possible to use the 24V output of the converter; it needs therefore to have a 24V stand-alone power supply.

## I/O CONNECTOR SIGNAL

| | | |
|---|---|---|
| 1 | TGI | TACHOGENERATOR INPUT |
| 2 | TGO | TACHOGENERATOR OUTPUT |
| 3 | | |
| 4 | A0V | 0V ANALOG |
| 5 | SI1 | SPEED REFERENCE INPUT 1 |
| 6 | A0V | 0V ANALOG |
| 7 | SI2 | SPEED REFERENCE INPUT 2 |
| 8 | SI3 | SPEED REFERENCE INPUT 3 |
| 9 | SI4 | SPEED REFERENCE INPUT 4 |
| 10 | A0V | 0V ANALOG |
| 11 | SI5 | SPEED REFERENCE INPUT 5 |
| 12 | SI6 | SPEED REFERENCE INPUT 6 |
| 13 | JOG | JOG SPEED REFERENCE ENABLE |
| 14 | RSR | REVERSE SPEED REFERENCE ENABLE |
| 15 | CME | CURRENT MODE ENABLE |
| 16 | SR1 | SPEED REFERENCE GROUP 1 ENABLE |
| 17 | SR2 | SPEED REFERENCE GROUP 2 ENABLE |
| 18 | SRE | SPEED RAMP ENABLE |
| 19 | ABE | ARMATURE BRIDGE ENABLE |
| 20 | ALR | ALARM RESET COMMAND |
| 21 | FBE | FIELD BRIDGE ENABLE |
| 22 | D0V | 0V DIGITAL |
| 23 | | |
| 24 | D24 | +24V DIGITAL |
| 25 | DOL | DRIVE OVERLOAD OUTPUT |
| 26 | STS | STEADY SPEED OUTPUT |
| 27 | PML | PEAK MOTOR LOAD OUTPUT |
| 28 | ZES | ZERO SPEED OUTPUT |
| 29 | SOT | SPEED OVER THRESHOLD OUTPUT |
| 30 | DOK | DRIVE OK OUTPUT |
| 31 | CLI | ARMATURE CURRENT LIMIT REFERENCE INPUT |
| 32 | | |
| 33 | SPM | SPEED MONITOR OUTPUT |
| 34 | | |
| 35 | A0V | 0V ANALOG |
| 36 | ACM | ARMATURE CURRENT MONITOR OUTPUT |
| 37 | CRO | CURRENT REFERENCE OUTPUT (FOR SLAVES) |
| 38 | CRI | CURRENT REFERENCE INPUT (FROM MASTER) |
| 39 | +10 | OUTPUT +10V |
| 40 | A0V | 0V ANALOG |
| 41 | -10 | OUTPUT -10V |
| 42 | +24 | OUTPUT +24V |
| 43 | A0V | 0V ANALOG |
| 44 | | |

## CONVERTERS EXTERNAL CONNECTIONS

### *CONVERTERS WITH BUILT-IN ARMATURE BRIDGE*

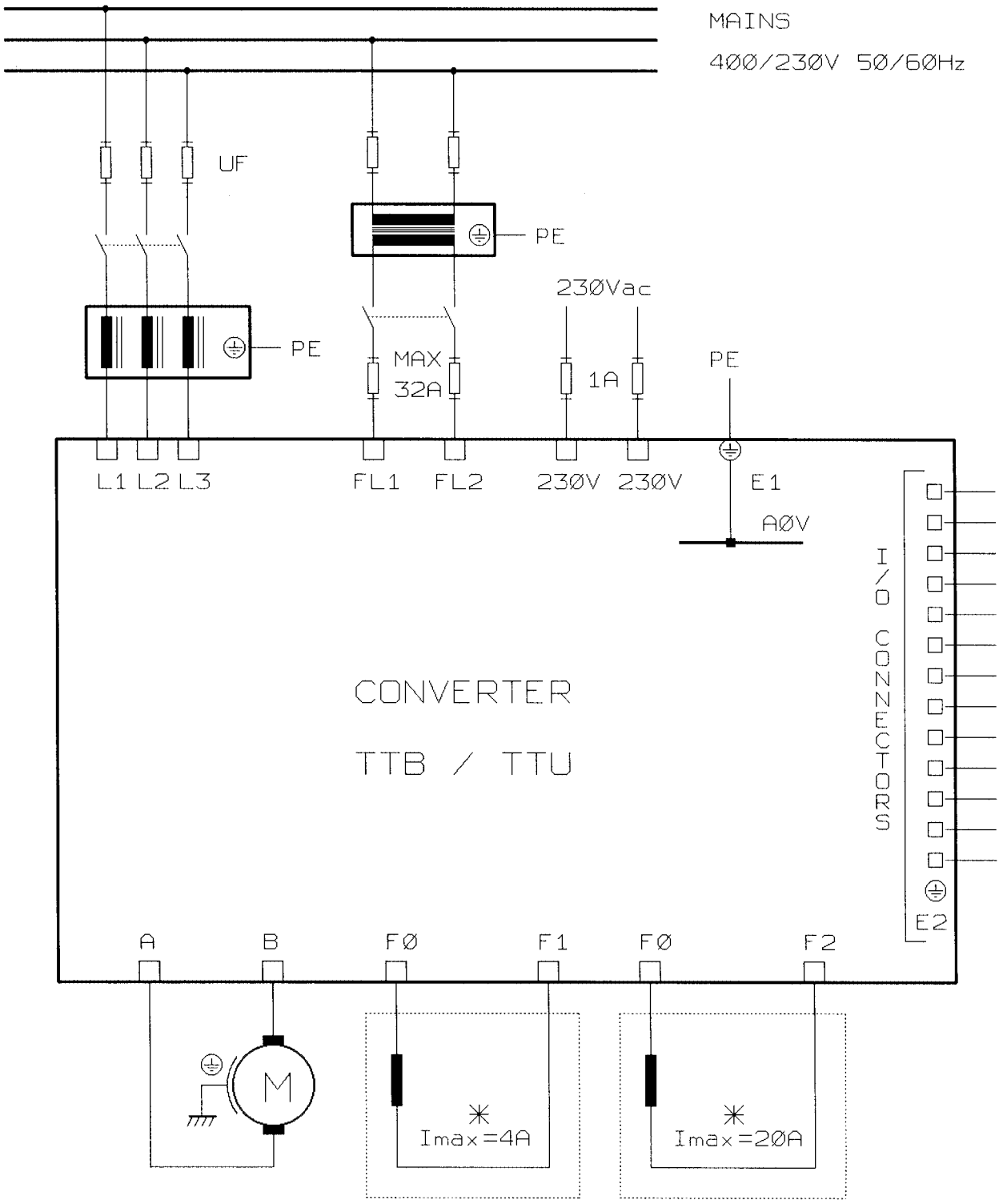



**Figure 10**

***** For further information about the motor field connections please to see on page 17 paragraph “FIELD”

***CONVERTERS WITH EXTERNAL ARMATURE BRIDGE***

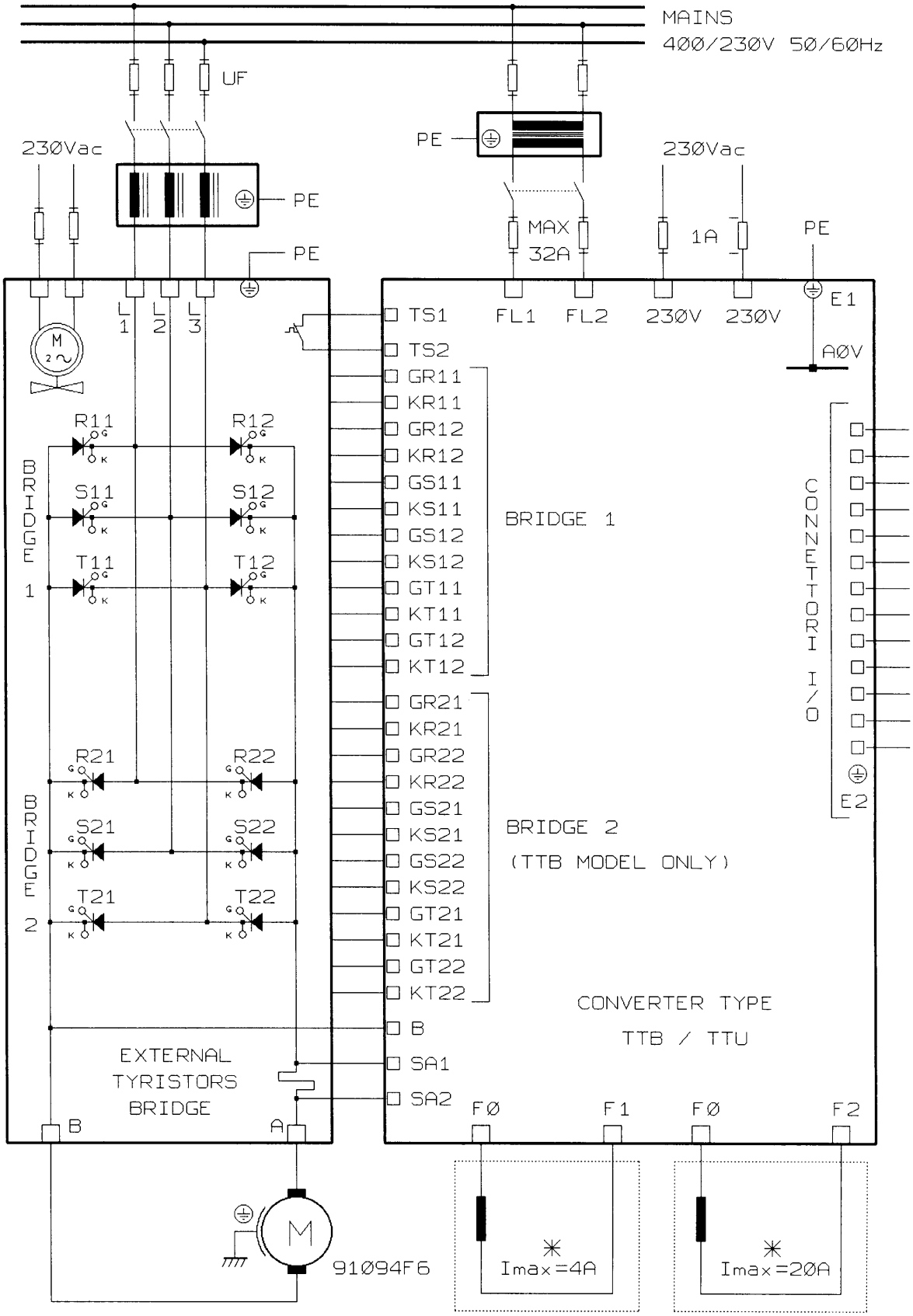



**Figure 11**

***** For further information about the motor field connections please to see on page 17 paragraph “FIELD”.

***CONNECTIONS IN CONFORMITY TO THE EMC AND LV DIRECTIVES***

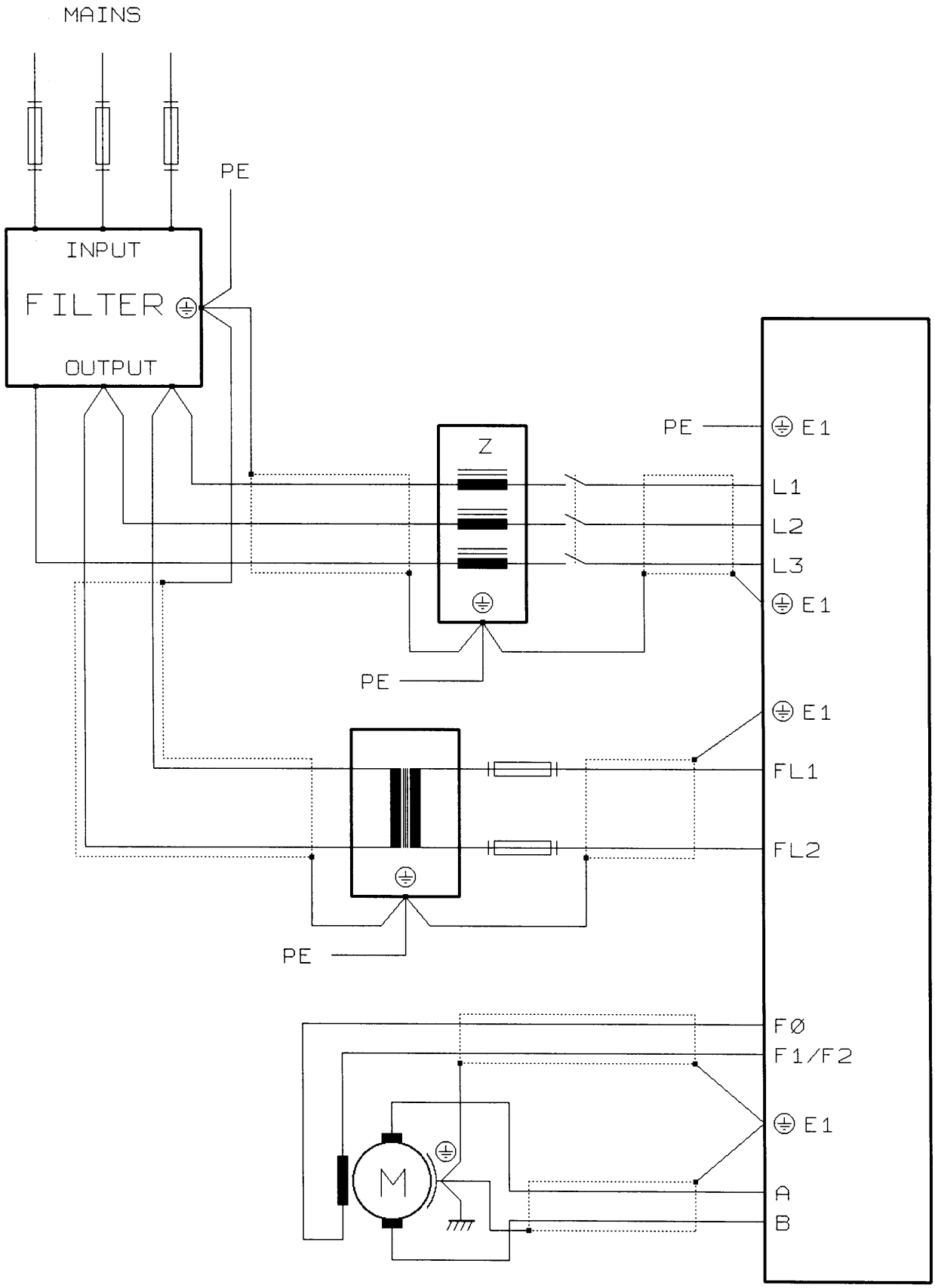



**Figure 12**

## MECHANICAL FEATURES

### *DIMENSIONS, MASSES AND PLACING POSITION*

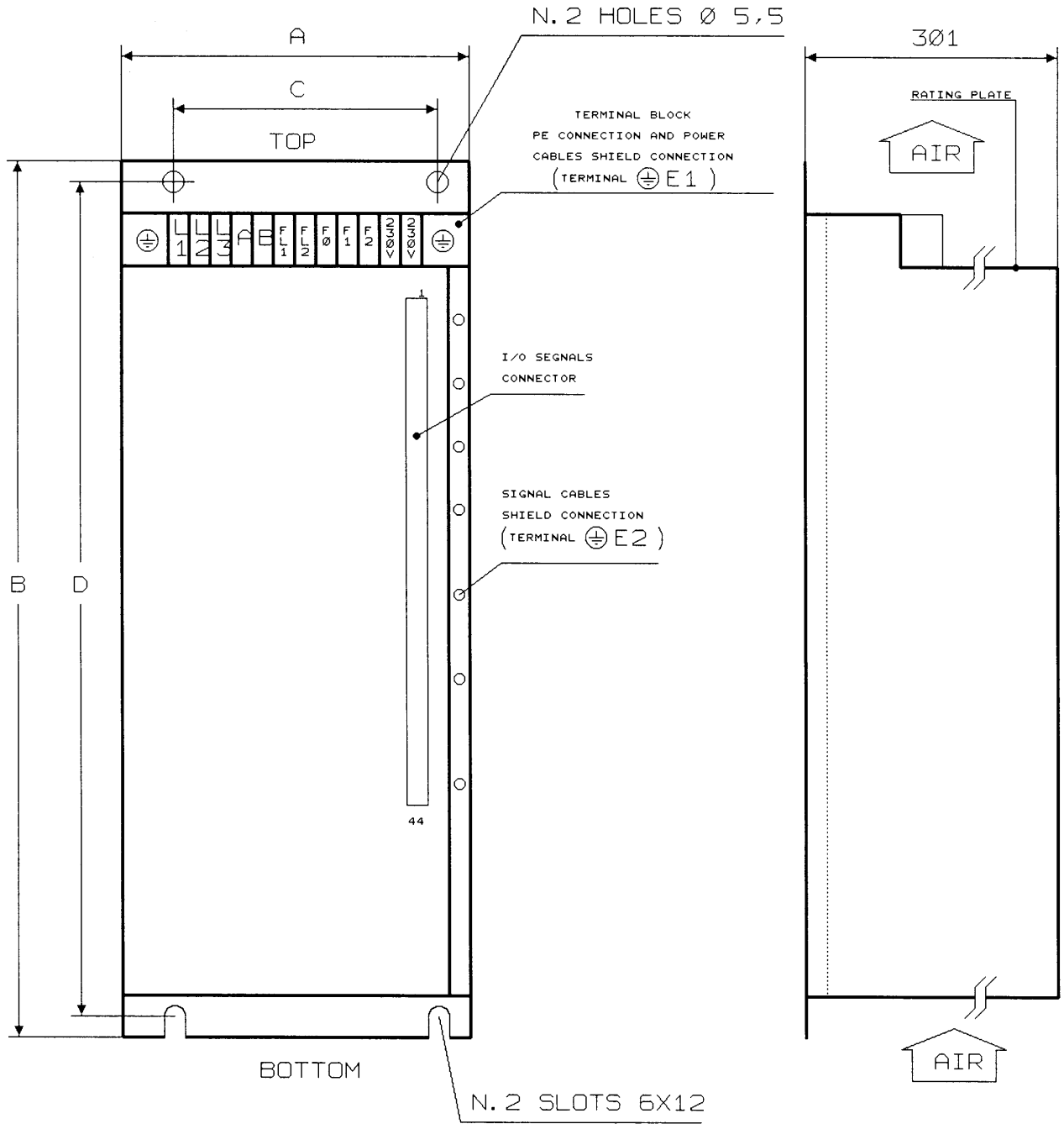



**Figure 13**

**DIMENSION ON mm**

| SIZE | A | B | C | D | MASS |
|---|---|---|---|---|---|
| 1 | 194 | 390 | 157 | 372 | Kg 13,5 |
| 2 | 288 | 430 | 228 | 412 | Kg 20 |
| 3 | 288 | 587 | 228 | 412 | -- |

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