TDE MACNO
s.p.a. tecnologie digitali elettroniche

DC DRIVES
MAXI MASTER SERIES

User manual

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SOMMARIO

1 GENERAL INFORMATION

" MAXI MASTER " is an IGBT converter designed for speed or torque control of permanent magnet D.C. motors.
For proper operation, all it needs is one three-phase power supply, since the operating voltages are obtained via an internal power supply.
This converter includes the power rectifier bridge and filtering capacity, as well as the braking energy dissipation circuit, whilst the relevant power resistor is located outside the unit.
All signals and power connections can be accessed from the front panel, through appropriate connectors. The personalization module is also accessible from the front. This module can be pulled out to make the setting operations easier, or just to allow you to transfer a given value setting to another converter, by simply changing the personalization module.
To be installed, MAXI MASTER requires a voltage and power transformer suited to each specific application (the drive can also be powered directly from a direct voltage).
Additional options are the possibility of speed feedback from either a tachogenerator (“tachometer dynamo”) or armature voltage, as well as to install a tachometer breakage protection and an acceleration-deceleration ramps control. All of these options can be selected through dip-switches located on the personalization module.

2 MAIN FEATURES

IGBT converter with 4 quadrants	
Tachogenerator input at max. speed	from 4 to 100 V
Reference analogue input	+/- 10 V
Reference input impedance	> 10 KOhm
Current loop response time	< 200 μs
PWM frequency	10 KHz
Error amplifier static gain	> 200000
Current form factor	< 1.005 (Lmot > 3 mH)
High performance	> 95 %
Required current monitor output	
Thermal drift	< 0.006 mV/ °C
Operating temperature	-10 / 50 °C

POWER SUPPLY	
- From three-phase transformer	150 V no-load nominal voltage
- From D.C. supply	120 - 250 Vdc

Maximum voltage to motor	212 V with 150 V 3-phase supply
Maximum current	50 A (or lower) for 2 s
Rated current	25 A (or lower)
Current tolerance	+/- 10 %
External braking resistance	8 Ohm 500 W

2.1 ADJUSTMENTS

- Speed scale max. value
- Maximum current
- Rated current
- Dynamic gain
- Offset
- Ramp slope

2.2 PROTECTIONS

- Protection I2T
- Thermal protection (t > 85 °C on dissipation unit)
- Short circuit protection, power module over temperature, over current
- Under voltage protection (120 V on DC bus)
- Over voltage protection (275 V on DC bus)

2.3 SIGNALS

- Green led – power indicator
- Yellow led – indicates brake activation
- Yellow led – indicates activation of protection I2T
- Red led – indicates activation of tachometer breakage protection
- Red led – activation of thermal protection (drive), over and under voltage
- Red led (next to signal terminal) – signals activation of power module protection
- DRIVE output OK

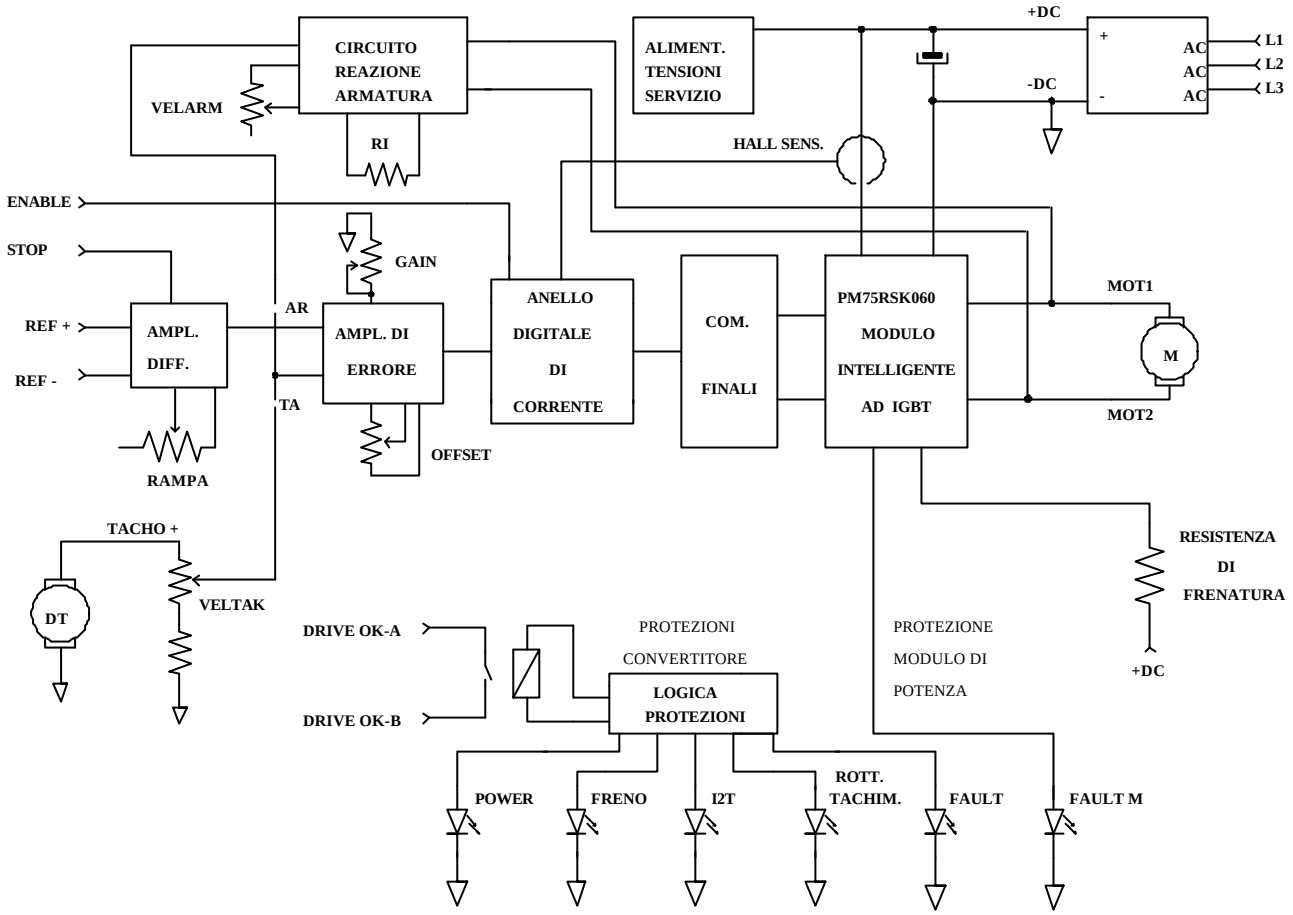
- I2T activation signal output
- Motor current monitor output

2.4 OPTIONS SELECTABLE THROUGH DIP-SWITCHES

- Speed feedback via tachogenerator
- Speed feedback via armature voltage
- Insertion of acceleration/deceleration ramps
- Insertion of tachometer breakage protection

2.5 BLOCK DIAGRAM DESCRIPTION

The speed analogue reference input is applied to terminals VA and VAL and, after passing through the circuit that generates acceleration and deceleration ramps (if present), it is applied to the error amplifier. In this block the input reference is compared to the speed feedback signal fed either by the tachogenerator (via the RDT) or by the armature voltage normalization circuit (via RARM).
The error signal enters the PI speed regulator (the digital current loop makes derivative action unnecessary), whose output signal is fed to the current loop.
The PI filter output is present on the connector at pin TP and varies between +10 V and - 10 V, which corresponds to the converter rated current.
The digital current regulation loop controls the power part, so as to generate a torque that allows to reach and maintain the required speed and, thus, to eliminate the speed static error.
The personalization module incorporates four trimmers designed to adjust maximum speed values, reference signal offset values, PI regulator static gain, as well as acceleration and deceleration ramps.
Protection I2T is activated when the amount of current drawn is higher than the rated current. Activation time varies between 2 and 200 s, depending on the amount of current drawn. The operating level of protection I2T can be adjusted through RINOM. Activation of this protection will cause the relevant led to turn on immediately, while the current will be limited to within the value set by RINOM and a signal will be sent outside through output I2T forced to high logic level (in the presence of external pull-up).
Under / over voltage and radiator over temperature protections are not retained and consequently they will reset automatically the converter as soon as the problem condition is corrected.
By contrast, short-circuit and tachometer breakage protections are retained and will prevent operation.
This unit also features an ENABLE input, designed to enable the IGBTs, as well as a speed enable input or ” ENREF”, which forces the converter to null speed (apart from any offsets that cannot be eliminated).



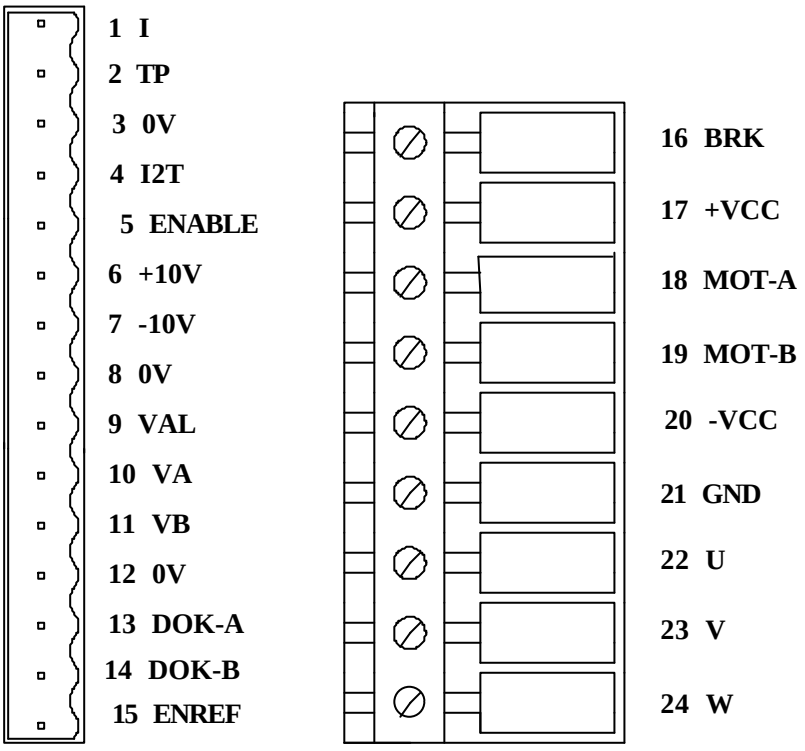
MAXI MASTER Block Diagram

2.6 SIGNAL CONNECTOR DESCRIPTION

1	**I**	It is a motor current monitor with rated Imax equal to +/- 8
2	**TP**	This is the monitor of the current required out of the digital current loop. The maximum rated current of the converter corresponds to a voltage range of +/- 10 V. This pin can also be used to limit maximum current (by connecting a suitable resistor between the pin and the grounding) or as torque control input, if a signal is available from outside proportional to the desired motor torque.
3	**0 V**	(Common) This pin is connected to -VCC via a 100 Ohm resistor and via diodes, which limit the voltage difference between the two points to a value of 1.5 V. It is connected to connector pins 8 and 12, as well as to signal 0 V.
4	**I2T**	This logic output monitors the status of protection I2T. Typically, the logic level of this output is 0 with a max drive capacity of 100 mA DC. When the protection is activated, this output takes on a high logic level (high impedance) The maximum allowed voltage at high logic level is 48 V. Activation of the protection causes the yellow led I2T to turn on simultaneously.
5	**ENABLE**	(Enable) Release input of power IGBTs. Active at high logic level (10 - 30 V).
6	**+10 V**	Voltage reference +10 V (max 10 mA)
7	**-10 V**	Voltage reference -10 V (max 10 mA)
8	**0 V**	
9	**VAL**	Inverting input of the speed reference ("cold" side of reference)
10	**VA**	Non-inverting input of the speed reference ("hot" side of reference)
11	**VB**	Tachogenerator feedback input (tachogenerator signal "hot" side)
12	**0 V**	
13	**DOK-A**	
14	**DOK-B**	Together with pin 13, this is a clean closed contact when the converter is energized. In the event of an alarm, this contact opens. It will not open in two circumstances: upon activation of protection I2T or of power module protection. Contact: 30 V dc/ac 1A max.
15	**ENREF**	Speed reference release input. If 0 V is applied or if it is left free, the external speed reference is enabled. By applying a voltage between 7 and 30 V (as referred to 0 V), you will enable motor stop.

2.7 POWER CONNECTOR DESCRIPTION

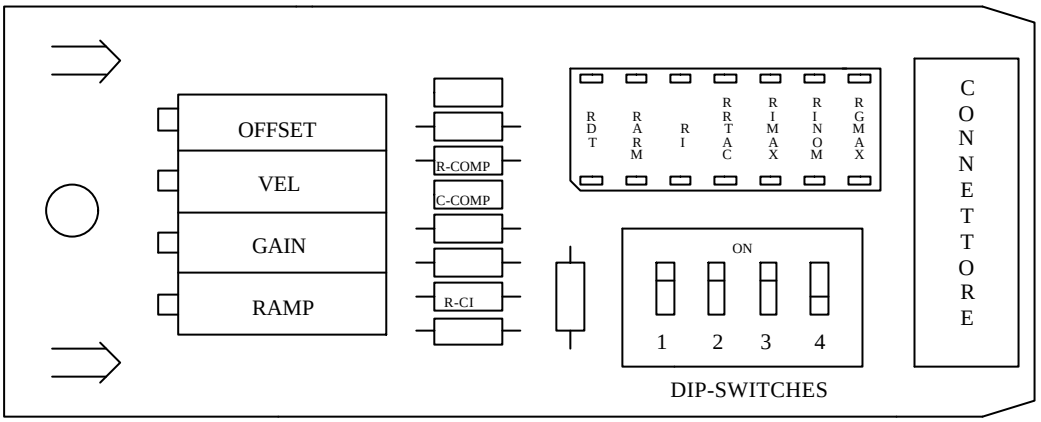
16	**EXT. BRK.**	Braking IGBT collector. The braking resistance must be connected between this terminal and terminal 17 (+VCC)
17	**+VCC**	Power positive (+ bus DC)
18	**MOT-A**	Motor outlet positive terminal
19	**MOT-B**	Motor outlet negative terminal
20	**-VCC**	Power negative (- bus DC)
21	**GND**	Connected to converter frame
22	**U**	
23	**V**	
24	**W**	Terminals U V W are the three A.C. power inputs of the converter. They must be connected either to the secondary of a 3-phase voltage and power transformer, or to a delta-connected secondary.



CONNETTORE DEI SEGNALI **CONNETTORE DI POTENZA**

3 SETTING UP

The figure below shows the personalization module LAYOUT, with all the adjustments and settings needed to start up the unit. The personalization module can be removed from the front side, after removing the signal connector, so as to be able to transfer the settings from one converter to another effortlessly. The 4 trimmers can be reached from the front panel without pulling out the module, so that the settings can be done even while the converter is running.
Before removing the personalization module, switch the converter off and wait at least 20 s, or a specific protection will be activated and retained, disabling operation. To restore normal operation, insert the module while the converter is switched off and then energize again.



MAXI MASTER Personalization Module

3.1 REGULATION TRIMMER

OFFSET Zero speed regulation. By acting on this potentiometer, you can eliminate any offset present at the input reference.

VEL Maximum speed (velocity) regulation. By acting on this trimmer, you will adjust the maximum speed set through resistor RDT (RARM in case of armature voltage feedback) within a variation range of +20 / -50 %.

GAIN Converter's dynamic gain regulation. It is used to increase gain (clockwise) or to decrease it (counterclockwise).

RAMP Adjusts the slope of acceleration / deceleration ramps. Through the trimmer screw, ramp slope can be increased (turning the screw clockwise) or decreased (turning the screw counterclockwise). This trimmer allows to reach maximum speed (corresponding to 10 V of the reference) in a variable time between 0.2 s and 2 s approx.

3.2 PERSONALIZED SETTINGS

The personalization module incorporates a base suitable for mounting fixed resistors for the calibration of specific working parameters. These resistors are (from left to right):

RDT Tachogenerator normalization resistor
RARM Speed adaptation resistor with armature voltage feedback
RI RxI compensation resistor in case of armature voltage feedback
RRTAC Tachogenerator adaptation resistor for detection of failed or missing tachogenerator
RIMAX Maximum current setting resistor
RINOM Nominal current setting resistor
RGMAX Resistor designed to reduce the error amplifier static gain

The personalization module features also some “notable” components:

R-COMP Resistor defining PI filter base dynamic gain
C-COMP Capacitor defining the regularity of base motion
RC-I Resistor connecting the output of PI regulator to terminal TPCR located on the signal connector. This resistor should be removed in case you wish to drive the motor via a torque control.

3.3 DIP-SWITCHES

The personalization module features four dip-switches designed to enable or disable specific functions.

1 Enables acceleration / deceleration ramps
ON = disables ramps
OFF = enables ramps
2 Enables tachometer breakage protection
ON = disables protection
OFF = enables protection
3 Enables tachogenerator feedback
ON = enables feedback
OFF = disables feedback
4 Enables armature voltage feedback
ON = enables feedback
OFF = disables feedback

CAUTION: dip-switches 3 and 4 can be set to ON only one at a time, or speed regulation will not work properly.
When the converter is controlled by an external speed reference signal, at least one of dip-switches 3 and 4 must be ON, in order to prevent uncontrolled over speed (racing) of the motor.

3.4 CONTROL SIGNALS

ENABLE (enable)
A voltage level (included between 10 and 30 V) applied at input 5 of the signal connector (enable) will enable operation of the converter power components and, consequently, torque generation. If this input is connected to 0V or if it is left free, the motor will be free to rotate as a result of an external torque. The +10V auxiliary voltage present on the connector should not be used to enable the converter, except for very short distances (< 50 cm). This in order to prevent any electrical interference from entering the converter.
ENREF (enable reference)
Connecting this input to 0 V or leaving it free will enable speed control from outside. If this input is connected to a voltage between 10 and 30 V, the external speed reference will be forced to zero, causing a motor STOP. This stop will occur independently of the ramp circuit (even if this function is set). In the event that a stop without offset were needed, you can mount resistor RGMAX, which will decrease the error amplifier static gain. However, this is not necessary in normal conditions.
Regarding the use of +10 V auxiliary voltage, pls. refer to what has been said above concerning the ENABLE input.

3.5 INDICATIONS

6 leds and two status logic outputs provide converter status and diagnostic information.

Green led PWR (power) Indicates that the drive is energized and that the internal voltage supply is working properly.

Yellow led BRK (brake) Indicates activation of the braking energy dissipation circuit. This led will illuminate to identify a transient braking condition. It might turn on also in the event that the input voltage were too high, even if the drive were disabled. In this case, make sure that the supply voltage is correct, in order to prevent too high power dissipation at the braking resistor.

Yellow led I2T It turns on to signal activation of current limiting to within nominal value, if the current output has been higher than the rated current for too long (more than 2 s for I = Imax). At the same time, output I2T (pin 4 signal connector) will be forced to take on a high logic level (high impedance). This alarm will also illuminate to signal activation of the power module protection, which will cut off PWM to the motor, which will thus come to a halt. The lack of regulation will result in saturation of the speed PI and, in turn, activation of the protection.

Red led RTC (tachometer breakage) Activation of the tachometer breakage protection will turn on red led RTC, will disable the converter and will cause contact DOK available at pins 13-14 of the signal connector to open. This protection is retained. To restore operation, besides removing the problem condition, you must switch the converter off, wait 30 s and then switch it on again. The tachometer dynamo breakage protection will be activated under any of the following conditions:
- RTC computing mistake
- tachogenerator disconnected
- tachogenerator connected with wrong polarity
- short circuit of tachogenerator wiring
- tachogenerator failure

Red led FLT (fault) Led FLT is a cumulative signal indicating that a protection has been activated. When it turns on, contact DOK (signal connector pins 13-14) will open simultaneously.
This led will turn on due to any of these causes:
- under voltage (+VCC< 120 V)
- over voltage (+VCC > 275 V)
- radiator over temperature (t > 85 °C)

These causes will not cause the alarm to be retained, consequently, once the cause has been removed, the drive will resume normal operation.
- removal of the personalization module wile the drive is energized

This fault condition shall be retained. To resume work, switch the drive off, wait 30 s and then switch it on again, after removing the alarm condition.

Red led FLTM (power module fault) This led is located on the power board, next to the signal connector, and can be seen from the front door, just like the other leds. It illuminates to identify a power circuit fault, due to:
- under voltage of power module input currents
- module over temperature
- over current
- short circuit

When activated, this protection will cut off the IGBTs and, as a result, the torque to the motor. However, the regulation board shall remain operative and, without regulation, the speed PI shall saturate causing the activation of protection I2T. However, a power module fault will not cause DOK to open. To restore the system, the drive must be switched off and then on again after 30 s, after the problem condition has been removed.

Contact DOK (drive-ok) This contact is available at terminals 13-14 of the signal connector and is normally closed when the drive is energized and working. This contact will open in any one of the following conditions :
- drive de-energized
- tachogenerator breakage
- under voltage
- over voltage
- over temperature
- removal of the personalization module

DOK will open upon activation of any alarm, save for I2T and FLTM.

Outlet I2T The logic output I2T available at pin 4 of the signal connector, will take on a high logic state (high impedance) when the relevant protection is activated. A high impedance status will also be present when power is not being supplied to the converter.

4 INSTALLATION

MAXI MASTER behaves just like an amplifier, generating high currents and voltages from a low level signal. The technique used to generate output currents (PWM) will inevitably generate interferences, whether irradiated or brought in through the power connection leads. Therefore, care must be taken to execute a correct wiring following the indications herein, in order to avoid unsatisfactory operation or high irradiation of electrical interferences towards other equipment.
A) The power and signal cables shall pass through separated cableways.
B) Motor connection cables must be twisted.
C) Use a two-pole shielded cable to connect the tachogenerator and speed reference, using the least possible number of junctions via terminal boards or connectors. The shield should not present interruptions and must be connected to signal 0 V (pin 8 of connector signal) at one side only.
D) Use cables of adequate section for the power connections (4 mm^2 recommended) and signal connections (0.5 mm^2), fitted with suitable terminal ends.
E) If an additional inductor is added in series to the motor, the converter-inductor connecting cables should be as short as possible, since the highest amount of interferences is irradiated along these cables.

4.1 MECHANICAL INSTALLATION

MAXI MASTER must always be mounted in vertical position to ensure proper elimination of the heat generated by the converter itself. Inside the electric cabinet, the braking resistor, too, should be mounted in such a way as to allow elimination of the energy generated during motor braking. Allow sufficient space for free air circulation at the top and bottom of converters (min. 60 mm). The cabinet shall feature an appropriate system designed to exchange heat with the surrounding environment, in order to prevent an overheating condition inside the cabinet. To this purpose, it should be reminded that the amount of power dissipated in the form of heat by converters, power transformers, inductors (if any) and by the braking resistor is in the range of 10 / 15 % of the power generated by the motor shaft.
If you use motors with an inductance of less than 3 mH, an additional inductor must be mounted in series to the motor.

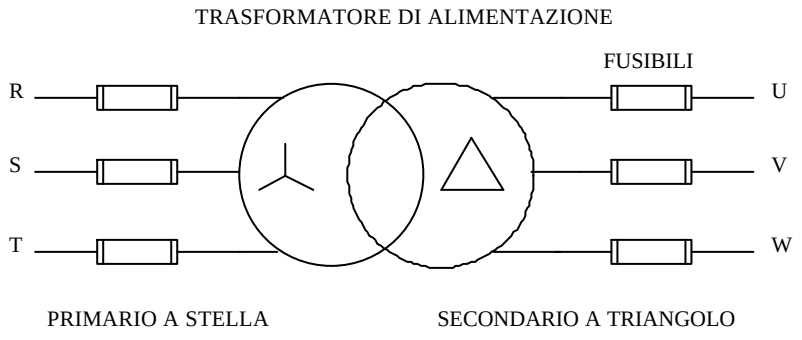
5 POWER SUPPLY

MAXI MASTER is designed for connection to an A.C. or D.C. power supply. If ac power is supplied, it must be fitted with a 3-phase transformer using a delta-connected secondary (or secondaries) of suitable power, so as to ensure galvanic insulation of the supply mains.
The primary can be either star- or delta-connected. However, we recommend that a star-connection be used, in order to fit more easily the mains voltage adapter plugs.

Transformer power
If only one converter is used, power can be calculated as follows:
P = 0.16 * vm *cn
where
P is the power of the transformer (in VA)
vm is the maximum working speed of the motor (in rev / min)
cn is the nominal torque of the motor
If several converters powered by the same transformer are used, the power of each single secondary can be calculated through the following empirical formula:
Ps = (0.27 * vm *cn) *K
where K is a constant whose value is
- K = 0.5 with two converters
- K = 0.45 with three converters
- K = 0.4 with four converters or more

The power of the transformer is determined by adding up the powers of each individual secondary
Pt = Ps1 + Ps2 + Ps3 + ...
where
Ps1 = secondary 1 power
Ps2 = secondary 2 power
Ps3 = secondary 3 power

Transformer output voltage
No-load effective voltage: 150 V nominal / 85 V minimum.
Three protection fuses (one per phase), typical value 30 A, shall be added in series to the three phases of the transformer secondary.
If the transformer is to supply power to several converters, each secondary shall be fitted with independent fuses.



6 CONNECTIONS

Grounding connection

In order to ensure proper operation and to avoid any anomalies, a ground plate shall be located as close as possible to the converters to which -VCC, GND, 0 V on the converter connectors are connected. If more than one are used, use a copper bar, with a width of 20 mm and a section of 10 mm2 or larger, running along the converters placed side by side, so that the connections from the drives to the bar are as short and direct as possible.

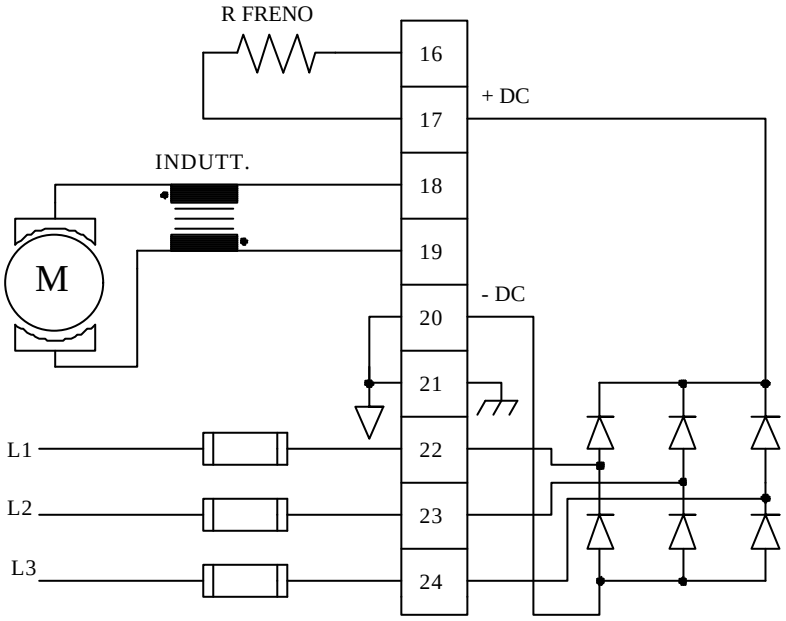
Motor connections

A filter inductor shall be connected at the drive output whenever the motor inductance is less than 3 mH.

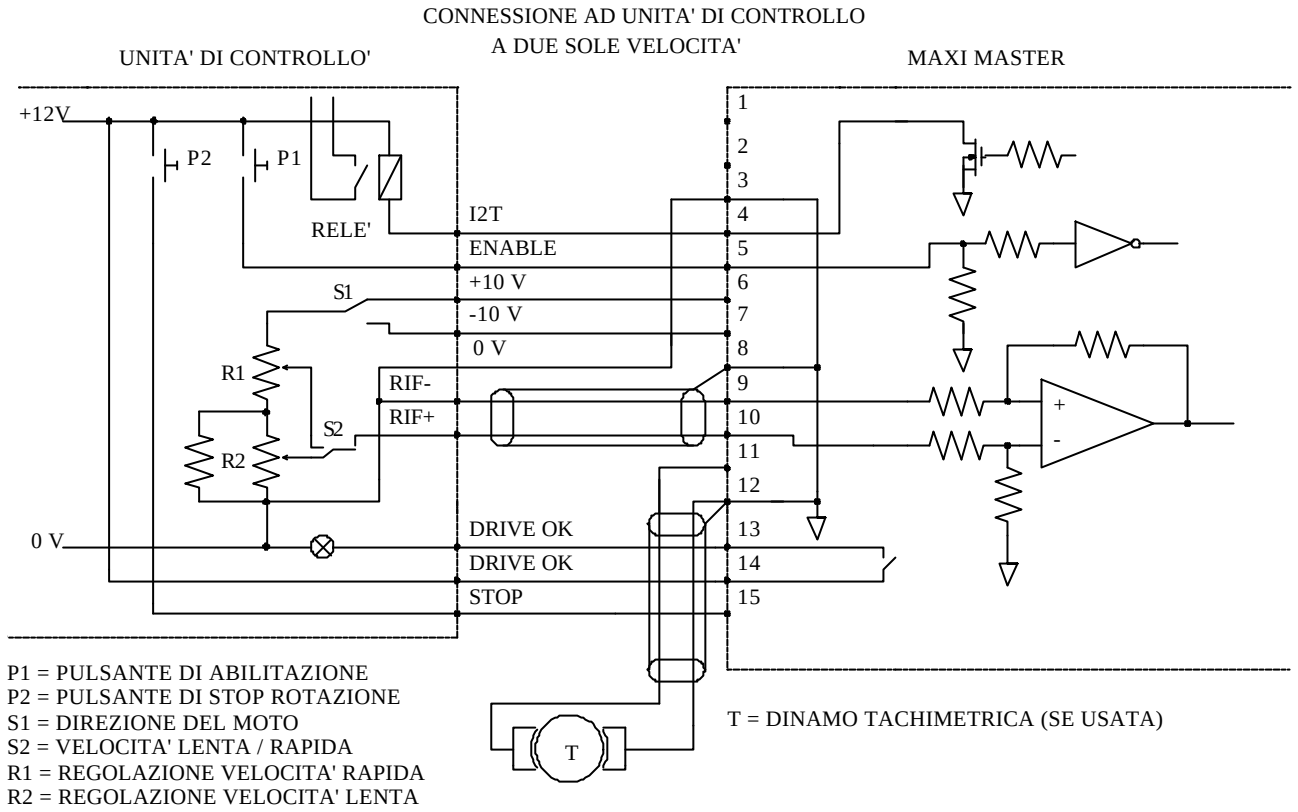
An inductor must be used also in the following cases:

- When the motor, despite an inductance higher than 3 mH, reaches high operating temperatures due to losses through the iron.
- When a filtering action is needed for protection against interferences brought in or irradiated by motor cables.
- When the motor is connected though a shielded cable more than 2 m in length.
- If short circuits develop at the motor terminals during emergency conditions.

In any of the above cases, care should be taken to keep the cables connecting the inductor to the converter as short as possible.



Connessioni alla morsettiera di potenza



Connessioni alla morsettiera di segnale

7 SETTING UP AND CALIBRATIONS

Preliminary Checks
1) Check the wiring, particularly motor connections, power and grounding connections.
2) Be sure that terminals are secured tightly.
3) Check the polarity of motor and tachogenerator. A wrong polarity of either of them would result in uncontrolled motor speed, which would endanger operators' safety.

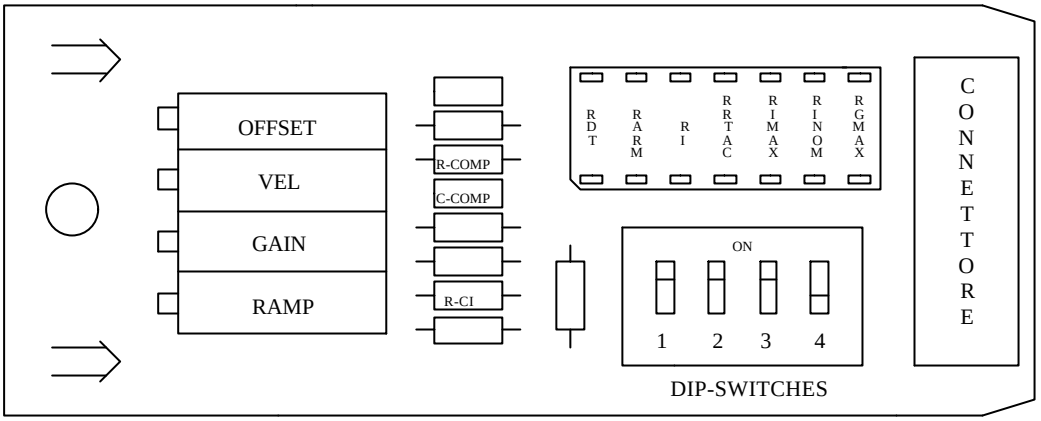
Caution: failure to mount resistor RDT will result in a hazardous motor "racing" condition, with similar effects to those caused by a wrong polarity of the motor or tachogenerator.

We remind you that a positive speed reference at pin 10 (VA) corresponds to a positive voltage at terminal 18 (MOT-A), which will be connected to terminal " + " of the motor to obtain positive rotation (i.e., rotation in clockwise direction if you look at the motor from the shaft side). If, given the same reference, you wish to reverse the direction of rotation, you will have to invert both the motor and the tachogenerator connection polarity.

STARTING

a) Remove all the fuses connected to the input power transformer secondaries.
b) Supply voltage and check the level of the various secondaries (150 V nominal / 85 V minimum) Switch power off.
c) Remove all signal connectors (pins 1 through 15)
d) Fit the power fuses on the first drive.
e) Supply voltage, make sure that green led PWR of the converter turns on and that the latter does not generate a torque (motor shaft must rotate freely).
No other led should be on in this condition. Now wait a few seconds and then switch off and wait for the PWR green led to go out.
f) Remove the three fuses and move them to another converter; repeat step " e" above.
g) Repeat these operations for each converter installed.
h) Make sure that the reference voltage delivered by the converters control unit is null and that it will not enable operation (pin 5 ENABLE set to 0 V).
While the converters are disconnected, connect the signal connector of the first device. Now supply power and check that the behavior is the same as in step " e" above, that is, that only green led PWR illuminates and that the motor does not generate torque.
Enable the converter, making sure that you will be able to disable or disconnect it quickly if the motor started running out of control as a result of wrong connections. Motor should either remain still or move very slowly, driven by unavoidable offsets. Command a motor STOP (pin 15 - signal terminal board) and check that a suitable torque in both directions of rotation can be generated on the shaft.
i) Using the manual controls, supply a reference either than zero and check that the direction of rotation is correct. If necessary, invert the polarities of the motor cables and tachogenerator.
l) Repeat steps " h " and " i " for each converter, so as to check them all.
m) Now you can run a real working test, by keeping the machine in operation under normal conditions for at least ten minutes and then checking that no protection is activated on the converters, including protection I2T.
If you should detect an anomalous behavior at any point, consult the troubleshooting section.

8 PERSONALIZED SETTINGS



Personalization module

Maximum Speed Calibration
These converters are supplied with a 187 Kohm resistor "RDT" mounted to the personalization module. The relation for determining the RDT best suited to a given application is:

RDT = (6860 * vm * Ke) - 27400
Where:
RDT = tachogenerator normalization resistance
vm = maximum speed in thousands of revolutions per minute (e.g. 3000 rev / min => vm = 3)
Ke = tachogenerator voltage constant expressed in V per 1000 rev / min (or generator output voltage at 1000 rev / min).
The value thereby calculated is expressed in Ohms and you can select the value closest to the result obtained through this formula, rounded by 5%. For fine speed adjustment you can use "VEL" regulation trimmer.
If the value obtained is 0, you will have to mount a jumper in the place of resistor RDT; if the result is negative, it will just be impossible to reach the desired speed with a 10 V reference signal.

Example:
Maximum desired speed 3000 rev / min => vm = 3
Tachogenerator 6 V / 1000 rev / min => Ke = 6
RDT = (6860 * 3 * 6) - 27400 = 96080 Ohm => RDT = 100 KOhm
100 KOhm has been selected, it being the standard value rounded up to 5 % closest to 96080 Ohms.

If the control in use delivers a maximum reference voltage of less than 10 V, this formula needs be modified as follows:

RDT = ((68600 * vm *Ke) / Vrm) - 27400

where Vrm is the maximum voltage supplied by the control (in V).
Example:
Vrm = 5 V
vm = 3 (3000 rev / min)
Ke = 6 (6 V / 1000 rev / min)
RDT = ((68600 * 3 * 6) / 5) - 27400 = 219560 => RDT = 220 KOhm

For fine speed adjustment, you should deliver to the converter a reference voltage (Vref) preferably higher than 2 V, measure it accurately with a digital tester in-between pins 9 and 10 (VAL-VA) and act on the trimmer until the tachogenerator (pin 11 – 12) delivers a voltage equal to the voltage determined through this formula:

Vdt = (Vref * Ke * vm) / Vrm

where:
Vref = voltage measured between pins 9 and 10
Ke = tachogenerator voltage constant in Volts * 1000 rpm
vm = maximum desired speed in thousands of rpm
Vrm = maximum reference voltage supplied by the control.
For instance:
Vref = 4 V
Ke = 6 V *1000 rpm (6 mV * rpm)
vm = 3 (3000 rpm)
Vrm = 10 V
Vdt = (4 * 6 * 3) / 10 = 7.2 V
You will have to act on “VEL” trimmer until you obtain a 7.2 V reading between signal connector pins 11 and 12.
Alternatively, you may use a speed indicator and calibrate the “VEL” trimmer so as to obtain a speed equal to:
Vel = (Vref *vm *1000) / Vrm where Vel is expressed in rev / min
Using the data in the previous example:
Vel = (4 * 3 *1000) / 10 = 1200 rpm

Zero Speed Calibration
In order to calibrate the zero speed correctly, you should:
- Make sure that the offset of the control is calibrated accurately.
- Make sure that pins 9 and 10 are properly connected to the control.
- Disconnect pin 15 ENREF or ensure it is set to low logic level.
- Enable the drive and regulate the OFS trimmer, until the motor shaft comes to a halt. If visual inspection is not viable, you can measure the tachogenerator voltage between pin 9 and 10 and regulate until it is as close as possible to zero.

Prior to performing the steps described above, always disable the control position loop, or the motor would be at a standstill in any case. If the position loop cannot be disabled, you can perform the above steps taking care to adjust the offset trimmer so as to obtain a voltage reading between pin 9 and 10 of the connector signal as close as possible to zero.

Peak Current Calibration
If resistor RIMAX is not mounted, the converter will deliver a peak current equal to the nominal Itg value, that is 50 A. In case of need, the peak current will be limited automatically to the nominal value through activation of protection I2T.
If you wish to obtain a peak value of less than the nominal value, you should mount a RIMAX resistor to the personalization module, with a value equal to:

RIMAX = (10000 * Imax) / (Itg - Imax)

Itg = maximum nominal current
Imax = desired peak current

Obviously, the converter can deliver current below the nominal value, in which case: Imax <Itg.
By modifying the Imax value, the Imax / Inom (nominal current) ratio will be modified consequently, and so will be the activation of protection I2T – namely, if Imax is decreased while Inom remains unchanged, the protection activation time will be increased.
Example:
Itg = 50 A
Imax = 40 A (desired value)
RIMAX = (10000 * 20) / (50 - 40) = 20 KOhm
The closest value in the range of 1 % or 5 % must be selected, always remembering that by selecting a smaller value the current output will be lower, whilst a greater value will result in higher peak current. Reduced peak current is needed only in the event that the motor, to which the drive is coupled, withstands a maximum instantaneous current value of less than the nameplate value.

Nominal Current Calibration
If the motor in use is capable to withstand a continuous current value below the max. nominal current value of the drive (Intg = 25 A), then you will have to mount resistor RINOM to the personalization module: RINOM shall be determined through this formula:

RINOM = (14660 * Inom) / (Intg - Inom)

Inom = continuous value desired
Example:
Inom = 20 A
RINOM = (14660 * 20) / (25 - 20) = 58640 Ohm
As usual, the closest standard value will be chosen, considering that a higher value will result in higher continuous current output, while a lower resistance value will result in less current.

Tachometer Breakage Protection Calibration
Setting dip-switch n. 2 on the personalization module to OFF enables the tachometer breakage protection. When this protection is disabled, you can avoid mounting resistor RRTAC. On the contrary, if the tachometer breakage protection is enabled, you will have to mount resistor RRTAC, determining it through this formula:

RRTAC = (385500 * Ke / Km) - 21500

where:
Ke = tachogenerator voltage constant in Volts * 1000 rpm
Km = motor voltage constant in Volts * 1000 rpm
Typically, Km corresponds to the motor nameplate datum (counter electromotive force at 1000 rev / min)
Example:
Ke = 6 (6 V at 1000 rpm)
Km = 30 (30 V FCEM at 1000 rev / min or 90 V at 3000 rpm)
RRTAC = (385500 * 6 / 30) - 21500 = 55600 Ohm => 56 KOhm
The value chosen for resistor RRTAC should be the standard value closest to the value calculated as above, + / - 5 % variation as a maximum.

Calibration in Case of Control with Armature Voltage Speed Feedback
If you do not wish to use a tachogenerator for rotational speed control, MAXI MASTER offers the possibility of speed feedback directly from the motor armature voltage.

Armature voltage feedback will result in not-so-close speed regulation and, particularly at slow rotational speed, regulation will not be very satisfactory.
Therefore, this type of feedback should only be used for applications that are not affected by rough regulation. In order to enable armature feedback, set dip-switch 3 to OFF and dip-switch 4 to ON. Furthermore, resistor RARM must be mounted to the personalization module and its value shall be determined through this formula:

RARM = 382 * Km * vm

where:
Km = motor voltage constant in volts * 1000 rpm
vm = maximum desired speed in thousand rpm
Example:
Km = 30 (30 V *1000 rpm or 90 V at 3000 rpm)
vm = 3 (3000 rpm)
RARM = 382 * 30 *3 = 34380 Ohm => RARM = 33 KOhm
Select the next closest standard value and remember that through the speed regulator trimmer "VEL" you will be able to regulate speed by +20 / -50 %.
For improved speed regulation, it is possible to mount resistor PI on the personalization module. This resistor shall compensate the constant part of the motor inner resistance. Its value depends on the motor features, on the materials used as well as on wear. You can obtain an indicative value through this formula:

RI = 150000 / Rmot where Rmot is the armature resistance of the motor in use

Example:
Rmot = 1.5 Ohm
RI = 150000 / 1.5 = 10000 Ohm
This value is merely indicative and should be used as a reference for running trial tests; remember that a low value results in better regulation but may develop instability (excessive current draw), whilst a higher value will result in poorer regulation and improved stability.
If resistor RI is not mounted, the unit will still be operational; this resistor need only be used to improve speed regulation.

Static Gain Calibration
Under normal operating conditions, it is preferable to have a static gain of the speed loop error amplifier as high as possible. In that case, you need not use resistor RGMAX.
For applications requiring low static gain or a motor STOP function without offset, you can mount resistor RGMAX on the personalization module.
However, you should remember that a decrease of the error amplifier gain will result in less accurate speed regulation. Once the required error amplifier static gain has been determined, you can determine the approximate value of RGMAX as follows:

RGMAX = Gs * 77000

Gs = value of the required static gain
Example: given a static gain Gs = 50
RGMAX = 50 * 77000 = 3850000 => RGMAX = 3.9 MOhm

8.1 DYNAMIC CALIBRATIONS

Usually, in order to optimize the dynamic performance of MAXI MASTER you only need to act on the GAIN trimmer. Remember that if you turn the screw clockwise the system response will be quicker and more precise, but a condition of instability might develop. On the contrary, turning the screw counterclockwise will result in a longer response time and a more stable condition.
By acting on the trimmer, you will be able to find the condition that allows fast positioning while avoiding overshooting. After this condition is reached, you can measure the resistance of the two sections of the trimmer, with respect to the cursor, and then calibrate the next converters.

8.2 TORQUE CONTROL

The converter can also be used as current amplifier, for motor torque control. The reference signal must be supplied to pin 2 of the connector signal (TP). Its allowable excursion is +/- 10 V, which corresponds to a current output equal to the max. nominal current value Itg, or to the peak value. The reference voltage sign determines the output current direction and, consequently, the direction of the torque available at the motor shaft.
Protection I2T will remain active and therefore after a given time it shall limit the current to within the nominal value set through resistor RINOM, if mounted. The tacho breakage protection can be disabled.
The 2.2 KOhm R-CI resistor must be removed from the personalization module. Terminals 9 / 10 / 11 should remain disconnected or should be connected only to 0 V (pin 12).
A typical application is the situation where two motors contribute to delivering torque to the same transmission organ. In this case you can use a converter in standard arrangement, which will drive through its pin TP the corresponding pin TP of the second drive, which in turn will act as a slave generating the same torque as the first drive.