PRIMA ELECTRONICS S.p.A.

SERVOAMPLIFIERS FOR BRUSHLESS MOTORS

BHL-T SERIES

- USER MANUAL -

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DOCUMENT INFORMATION

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1	7 January 1994	first edition
2	22 March 1996	Added chapter EMC Prescriptions
3	22 December 1997	Added size 30/60
4	02 February 1999	New SMD PCB base; added size 2/5

BHL BRUSHLESS CONVERTER – T SERIES

DESCRIPTION

This servoamplifier is a PWM controlled converter with three-phase power stage configuration, suitable for driving brushless motors with tachometer transducer.

The converter is built using IGBT transistors for the power stage, has an integrated switching power supply, integrated controller and protection circuits. The power ground and the signal ground are galvanically insulated.

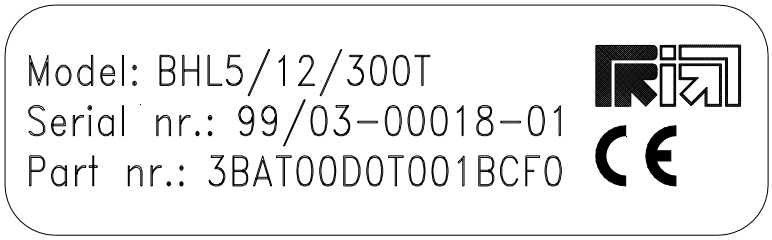
The reference input is set through a ±10V analog input, all the other input signals are +24V optically coupled signals. A potential free contact is available for FAULT signal (drive OK).

The power supply and the control for an electromagnetic brake is incorporated in the drive.

PRODUCT IDENTIFICATION

An identification label is applied on the side of the unit, with the relevant identification data.

When contacting the customer service, please report the Model, Serial number and Part number, which are indicated on the label.



MODEL SPECIFICATION

Different models (7 sizes) are available: specification depending on size are shown in the table below

Ratings	Dim	2/5	5/12	8/20	12/30	20/50	27/55	30/60
Peak current	A	5	12	20	30	50	55	60
Rated current	A	2	5	8	12	20	27	30
Power loss at rated current (with electromechanical brake)	W	70	70	79	122	152	195	240
Quiscent power loss (disabled)	W	22	22	22	22	22	22	22
Quiscent power loss (with electromechanica brake)	W	40	40	40	40	40	40	40
Efficiency at rated current	%	90	90	96	96	97	97	97
PWM switching frequency	kHz	18	18	18	18	12	6	6

Mechanical specification	Dim	5/12	5/12	8/20	12/30	20/50	27/55	30/60
Weight	kg	3,2	3,2	3,2	3,2	3,6	3,6	3,6
Dimensions	mm	268x55x230	268x55x230	268x55x230	268x55x230	268x65x230	268x65x230	268x65x230

WARNING

The drive operates with high voltage, only qualified personnal should be allowed to operate on the drive. ATTENTION, DANGEROUS VOLTAGES MAY REMAIN ON DRIVE TERMINALS AND INSIDE THE DRIVE ENCLOSURE UP TO 5 MINUTES AFTER THE POWER HAS BEEN SWITCHED OFF.

TECHNICAL CHARACTERISTICS

Main supply

- Three phase input 230 Vac +10% ÷ -20%
- DC bus nominal voltage 320Vdc
- Internal switching power supply for the control circuitry
- Maximum output voltage to the motor: ≡95% of the DC bus (320Vdc)
- Galvanic insulation between the control circuitry and the power stage

Auxiliary supply

- Auxiliary supply 110Vac, 30VA (optional)

The auxiliary supply is needed when the status of the LED indicators should be maintained active also after removing the main power supply (230Vac three phase)

When using the auxiliary supply, the input voltage on the main supply can be reduced up to 35 Vac three phase minimum, by eliminating the undervoltage protection via a dedicated jumper on the base board. (see Jumpers), for usage with low voltage motors.

Output current

Depends on the model:

- Continuous current : 2 / 5 / 8 / 12 / 20 / 27 / 30 A rms
- Maximum current : 5 / 12 / 20 / 30 / 50 / 55 / 60 A peak

The peak current can be sourced for no more than 10 seconds, with the motor rotating, or no more than 0.7 seconds at stall. After this time the Ixt protection trips, and the output currrent is automatically limited to the continuos rated current.

Clamping circuit

- clamp (ballast) circuit short circuit protected.
- DC voltage threshold set at 380Vdc

The braking resistor should be located externally and connnected to the relevant screw teminals on the front panel.

Install the appropriate resistor according to the drive model, as shown:

MODEL	CLAMPING RESISTOR.	PEAK POWER (1 second)	AVERAGE POWER
2/5	33Ω	4,6 kW	100 W
5/12	33Ω	4,6 kW	100 W
8/20	15Ω	10,6 kW	240 W
12/30	15Ω	10,6 kW	240 W
20/50	10Ω	16 kW	420 W
27/55	10Ω	16 kW	420 W
30/60	10Ω	16 kW	420 W

Electromagnetic brake

- the brake can be connected on front panel terminals
- internal power supply for the brake 24Vdc, 0.8A max.
- brake release/lock is automatically operated by the drive
- connections for an optional emergency switch (potential free contact) in series with the brake are available

Dynamic braking

The drive is capable of braking the motor shorting its windings, and controlling the motor current at a presettable level.

This feature is automatic in case of a fault or drive disable.

This feature can be disabled by connecting to +24V the input 24VSBLO (pin 11 of connector JP2). If an electromagnetic brake is connected to the drive, the brake is also energized (released).

Tachometer and hall sensors

- connection to a Brushless three phase tachometer or brushed type tachometer (selectable with a jumper)

  4 range (x1, x0.5, x0.33, x0.25), max input voltage 12.5 V / 25 V / 37.5 V / 50 V
- interface for Hall effect sensors for motor commutation, (15V open collector signals)
- Hall sensor power supply 15Vdc 50 mA, short circuit protected

Input / Output signals

- digital input for power enable(ENABLE) 15÷24V 20mA
- FAULT output (potential free contact) 24V 1A Max
- power supply output ±15V 50mA
- analog reference input ±10V (differential) 1kΩ impedance
- analog input (0÷10V, unipolar, 1kΩ impedance) for setting the limit of the output current from 0% (0V) to 100% (10V) of the rated current of the drive. Option.

Protections

- under/overvoltage on DC bus
- short circuit between motor terminals and/or ground
- overcurrent
- Tachometer connection fault (wire broken)
- drive overtemperature
- motor overtemperature

In case of intervention of any of the above protection, the FAULT contact is opened. The protections are cleared by cycling the ENABLE input off and on again.

- Ixt protection circuit

The peak current can be sourced for no more than 10 second rotating and 0.7s at stall. After this time the Ixt protection trips, and the output currrent is automatically limited to the rated current. The protection do not cause the opening of the FAULT contact.

Ixt protection is automatically reset after 10 seconds, provided that the rated continuous currrent is set at least 10% less than the Ixt threshold. The led indicator stays latched on until the power is removed to the unit, to indicate the occurrence of the problem.

Operating temperature

- Storage temperature: -10°C ÷ 70°C
- Operating temperature: 10°C ÷ 40°C.

  For sizes 20/50, 27/55 and 30/60, forced ventilation is necessary for operation in the full temperature range at the rated current. (see Cooling requirements)

Others

- Current loop bandwidth: 3 kHz
- Speed loop bandwidth: 200 Hz (typical)
- Linearity better than: 0.6%

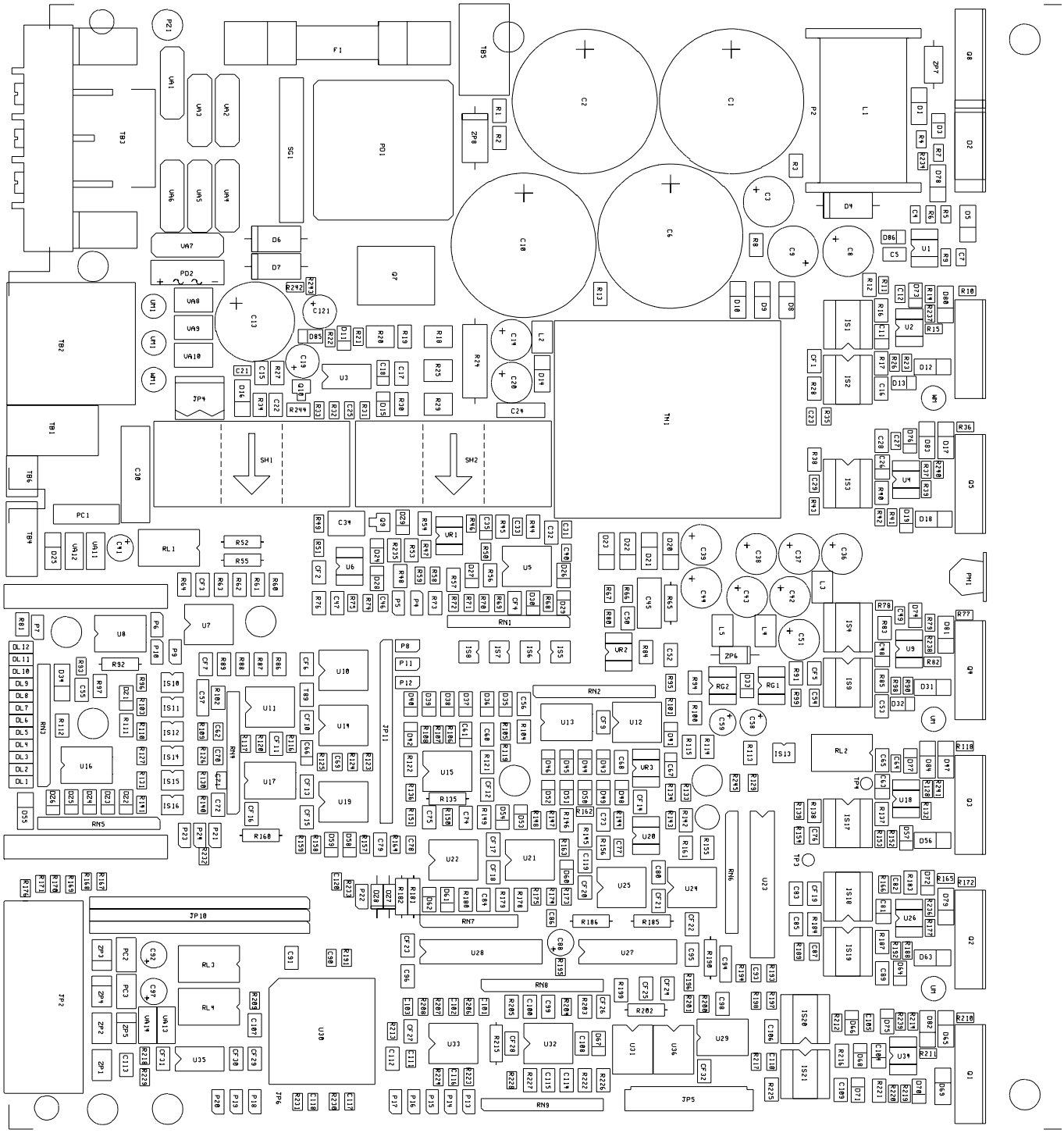


Fig. 1.: Printed circuit board layout (New SMD base board)

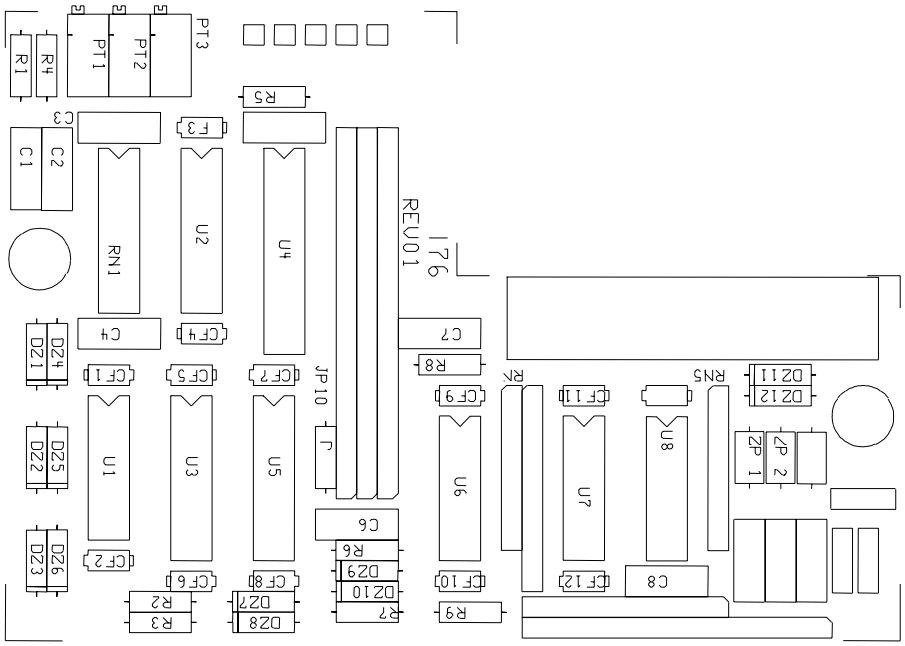


Fig. 2.: Printed circuit board layout (interface board)

CONNECTIONS

The present chapter illustrates the external connections of the BHL servoamplifier, both towards the brushless motor and toward the numerical control.

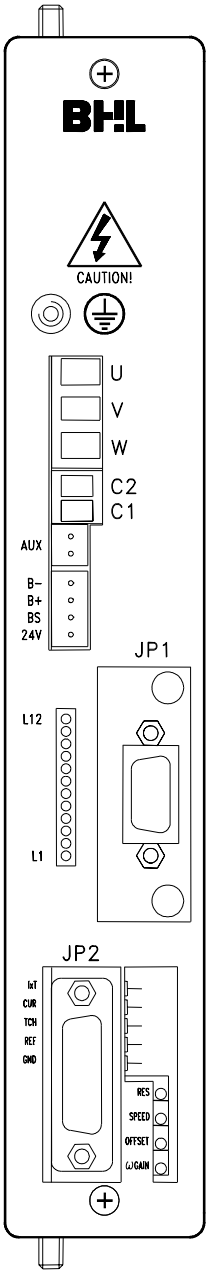


Fig. 3.: Front Panel

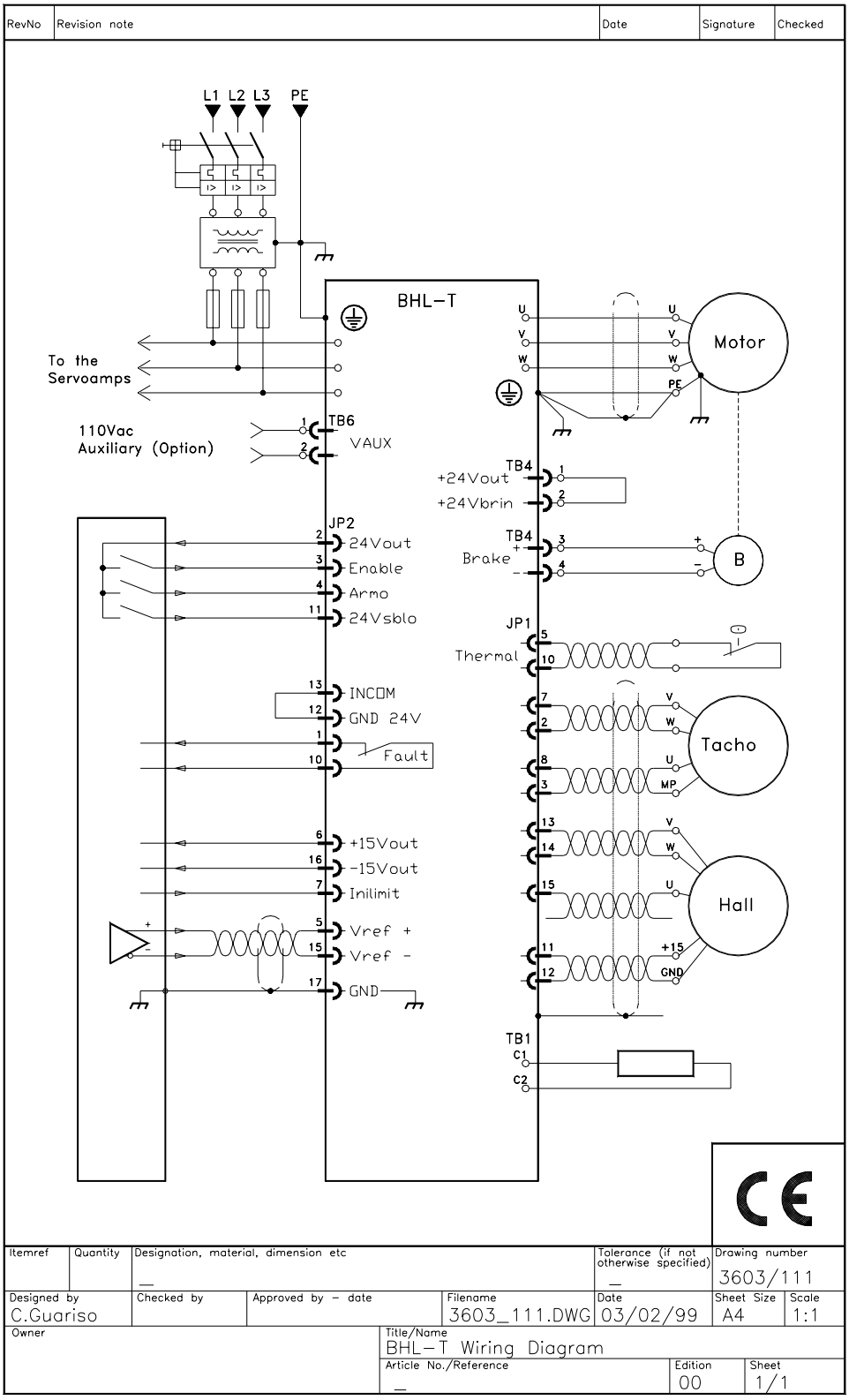
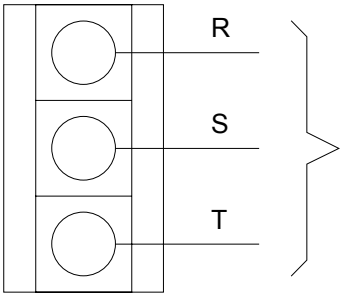


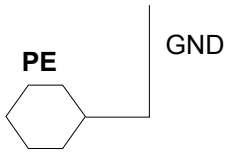
Fig. 4.: Wiring diagram

MAIN SUPPLY CONNECTIONS

TB3



line connection - three-phase



screw connection

ring or fork terminal

3.5 mm internal diameter

8.0 mm external diameter

(frame)

When the line transformer or the autotransformer has a rated power higher than 6kVA, we recommend to limit the inrush current as depicted:

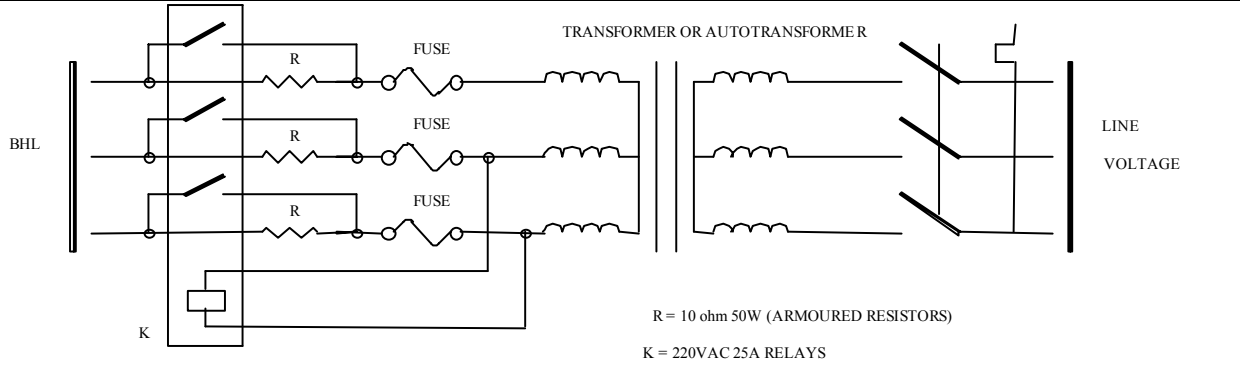
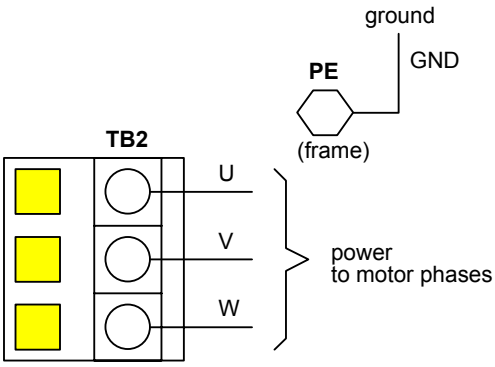


Fig. 5.: Wiring for a line transformer or autotransformer with rated power > 6kVA

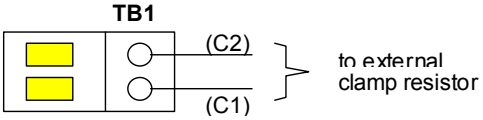
MOTOR CONNECTIONS



screw connection, max. 4mm^2 terminals

Note: an optional noise suppressor ferrite clamp has been foreseen for motor cable

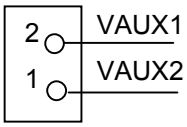
CLAMP RESISTOR CONNECTIONS



screw connection, max. 1.5mm^2 terminals

BRAKE AND AUX. CONNECTIONS

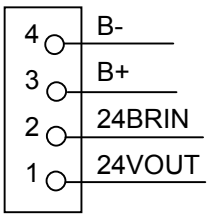
TB6



VAUX1 auxiliary power supply input 110Vac

VAUX2 auxiliary power supply input 110Vac

TB4



B- brake -

B+ brake +

24BRIN brake supply input (24Vdc, 2A)

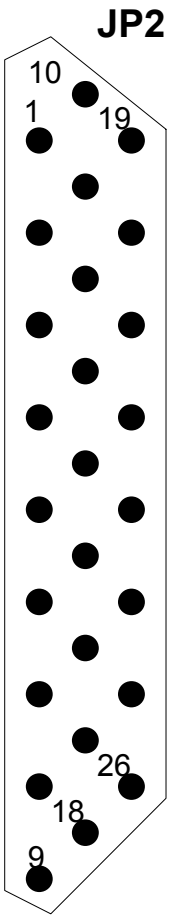
24VOUT internal brake supply input (24Vdc, 0.8Amax)

screw connection, max. 1mm^2 terminals

Note: The drive automatically cuts off power and releases the electromechanic brake when connection between pins 1 and 2 is open
Connect a potential free contact emergency switch between pins 1 and 2, or jumper them.

Brake supply input: connect between TB4-2 (24Vdc, 2A) and TB4-4 (GND 24Vdc, 2A).

CONNECTIONS TO THE CONTROL UNIT



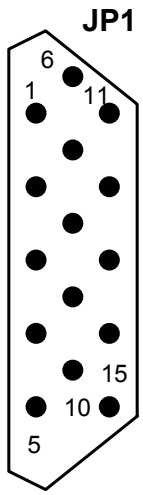
High density 26 pin
male sub-D connector

JP2 - SIGNALS TOWARDS THE CONTROL UNIT		
pin	**refernce**	**description**
1	FAULT2	error signal input (relay contact)
2	+24VOUT	auxiliary voltage output (24Vdc 0.8A max.)
3	ENABLE	power enable input
4	ARMO	**Reference enable input**
5	VREF+	velocity (or current) reference input (+)
6	+15VOUT	auxiliary voltage output (50mA max.)
7	INILIMIT*	current limit analog input (0÷10V) (option)
8		**DO NOT CONNECT**
9		**DO NOT CONNECT**
10	FAULT1	error output (relay contact)
11	24VSBLO	manual brake unlock
12	GND24V	auxiliary voltage ground (24Vdc)
13	INCOM	ENABLE signal common
14	SHIELD	cable shield
15	VREF-	velocity (or current) reference input (-)
16	-15VOUT	auxiliary voltage output (50mA max.)
17	GND	analog ground
18		**DO NOT CONNECT**
19		**DO NOT CONNECT**
20		**DO NOT CONNECT**
21		**DO NOT CONNECT**
22		**DO NOT CONNECT**
23		**DO NOT CONNECT**
24		**DO NOT CONNECT**
25	GND	analog ground
26		**DO NOT CONNECT**

Note: signals marked with "*" are optional and supplied on request

Note: connecting 24VSBLO to +24OUT, the elecromagnetic brake is unlocked and motor's dynamic braking is disabled.

CONNECTIONS TO TACHOMETER



Male 15 pin Sub-D connector
High density

JP1 - MOTOR SIGNALS		
pin	**reference**	**description**
1	GND	ground (shield)
2	TACHO W	a.c. tachometer W (S)
3	TACHO MP	a.c. tachometer star center
4	-TACHODC	d.c. tachometer (-)
5	THERMAL1	motor thermal protection (1) *
6		(free)
7	TACHO V	a.c. tachometer V (R)
8	TACHO U	a.c. tachometer U (T)
9	+TACHODC	d.c. tachometer (+)
10	THERMAL2	motor thermal protection (2) *
11	+15VOUT	HALL supply (50mA max.)
12	GND	HALL sensors ground
13	HALL V	HALL sensor V (R)
14	HALL W	HALL sensor W (S)
15	HALL U	HALL sensor U (T)

* Connect the thermostatic potential free contact (n.c.), or PTC resistor between these pins

TABLE OF CONDUCTORS SECTION V.S CONVERTER SIZE

Connector	Function	2/5, 5/12	8/20, 12/30	20/50, 27/55, 30/60
TB1	clamp resistor cable	1,5 mm^2		
TB2	motor cable	1,5 mm^2	2,5 mm^2	4 mm^2
TB3	power supply cable	1,5 mm^2	2,5 mm^2	4 mm^2
TB4, TB6	brake cable, brake supply and services	0,5 ÷ 1 mm^2		
JP1	motor signal cable	0,14 ÷ 0,22 mm^2		
JP2	control unit signal cable	0,14 mm^2		

LEDS DESCRIPTION

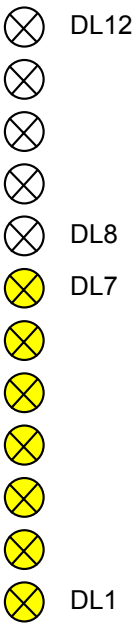
On the front of the drive two sets (green and red ones) of LEDs are mouted to display the status

The green LEDs are normally on and their meaning is :

- DL12 : 24Vdc supply to the brake
- DL11 : 230V tri-phase power on
- DL10 : auxiliary voltage on
- DL9 : power enable digital input (ENABLE) on
- DL8 : reference enable digital input (ARMO) on

The red LEDs are normally off and they display a faults when lit :

- DL7 : overvoltage or wrong clamp resistor value
- DL6 : overcurrent
- DL5 : HALL sensors/tachometer phases error
- DL4 : Ixt fault
  Note: Ixt fault automatically goes off after 10 s.; anyway the LED stays permanently on, to point out a protection intervention has occurred.
- DL3 : thermal protection of the drive
- DL2 : thermal protection of the motor
- DL1 : undervoltage on the 230V tri-phases power supply.

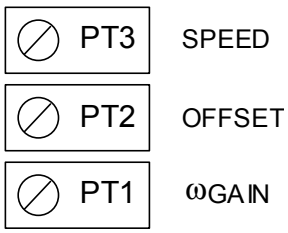


Front view of LEDs

TRIMMERS DESCRIPTION

On the front of the drive three trimmers are accessible for the following tunings :

- PT1 : velocity loop gain adjust
- PT2 : velocity offset adjust (± 30mV)
- PT3 : motor speed adjust (± 25%)



For the correct adjust of trimmers, please refer to chapter "Customizations"

TEST POINTS DESCRIPTION

On the front of the drive test points are accessible :

TP2 ◯ IxT (average motor current)

TP4 ◯ CURR (istantaneous motor current)

TP6 ◯ TACHO (speed)

TP7 ◯ REF (reference voltage Vref)

TP8 ◯ GND (analog ground)

The voltage on TACHO test point depends on the tacho circuit sensitivity set on the personalization card (jumpers P4, P5); the value read is the tacho voltage multiplied by the K_{gain} factor (see table on pag.21)

The voltage on the test point CURR depends on the drive's model, according to the following table:

Model	CURR signal
Mod. 2/5	0.738V/1A
Mod. 5/12	0.3V/1A
Mod. 8/20	0.2V/1A
Mod. 12/30	0.1V/1A
Mod. 20/50	0.082V/1A
Mod. 27/55	0.082V/1A
Mod. 30/60	0.082V/1A

JUMPERS

The following jumpers on the base board are factory settings, and do not need normally to be changed by the user. These jumpers are not accessible and require opening the enclosure.

The following jumpers are on the base board:

- P0, P1 : used for testing purposes (normally open)
- P5 : undervoltage disable
- P7 : connects GND24V to GND (GND24V is normally floating)
- P10 : if the electromechanical brake is not used, connection to the TB4 front connector can be avoided by closing this jumper

CUSTOMIZATIONS

In order to fit the characteristics of the actual brushless motor used, a set of parameters are customizable, changing the default values of the components mounted on the plug in card. Customizable parameters are the following ones :

- tachometer gain
- Vref frequency bandwidth
- speed loop compensation
- current loop compensation
- continuous current value
- maximum (peak) current value
- Ixt protection triggering level
- dynamic braking current
- ramp function.

Note : the various personalization parameters can be calculated by using the formulas reported in the following chapters;

CUSTOMIZATION BOARD

A customization board is plugged on the front panel, allowing the setting of all the customization parameters. The setting is obtained mounting the appropriate passive components (resistors and capacitors). The values of customization components have to be computed using the formulas described further in this chapter.

Components

R1 = positive ramp duration
R2 = current loop gain (not mounted)
R3 = tachometer gain
R4 = negative ramp duration
R5 = serial resistor (fixed value 10kΩ)
R6 = brake dynamic current value
R7 = I x t gain
R8 = continous motor current value
R9 = maximum motor current value
R10 = velocity loop gain
C1 = ramp duration timing range
C2 = current loop gain (not mounted)
C3 = Vref bandwidth
C4 = fixed velocity loop gain
C5 = velocity loop gain through PT1 (gain adj.)
D1, D2 = serial diodes (type: BAT43)

Note : customization jumpers are on the card soldering side.

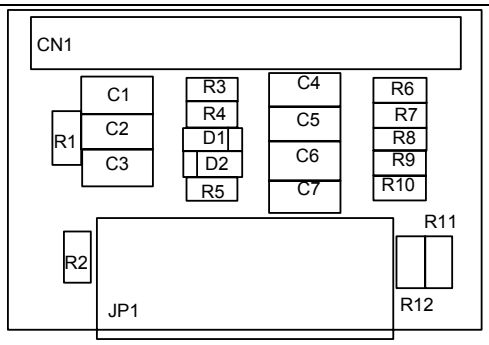


Fig. 6.:Customization board layout

CUSTOMIZATION JUMPER SUMMARY

Some jumpers are present on the personalization card for the following functions:

- P1 : tacho error disable when in current mode functioning (open for enable)
- P2 : motor thermal protection disable (open for enable)
- P3 : phase selection (closed = 120°, open = 60°)
- P4, P5 : tacho input circuit sensitivity (setting according to table – see “Tachometer gain” further chapter)
- P6, P7 : selection of ramp function (P6) or Vref function (P7) (mutually exclusive)
- P8, P9 : selection of current mode functioning (P8) or speed mode functioning (P9) (mutually exclusive)
- P10, P11 : selection of 3-phase tachometer feedback (P11) or DC tachometer (P10) (mutually exclusive)
- P12, P13 : selection of Vref negative (P13) or Vref (P12) (mutually exclusive)

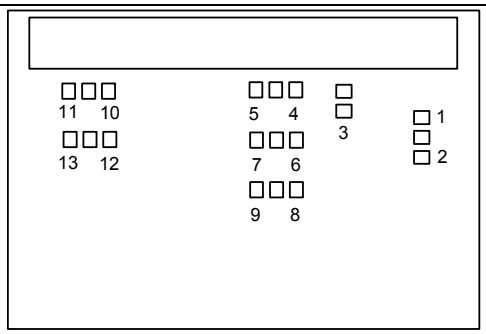


Fig. 7.: Jumper layout on customization board

TACHOMETER GAIN

The personalization of this parameter is determined by resistor R3, mounted on the personalization card, which value is calculated as follows:.

$$R3 = \frac{20x10^4}{Kgain \cdot Ktacho \cdot Rpm}[ohm]$$

where:

K_{gain} = sensitivity coefficient of the a.c. tacho circuit

K_{tacho} = a.c. tacho voltage/Rpm coefficient [V/rpm]

Rpm = maximum motor speed [rpm]

$$K\text{sense} = \frac{12.5}{Ktacho \cdot Rpm}$$

According to the Ksense value calculated, jumpers P4, P5 must be set as follows:

Kgain	Ksense	P4	P5	Vtacho max
1	>1	Open	Open	12.5V
0.5	1 ÷ 0.5	Open	Closed	25V
0.33	0.5 ÷ 0.33	Closed	Open	37.5V
0.25	0.33 ÷ 0.25	closed	Closed	50V

Note : the maximum a.c. tacho voltage allowed is 50V, equivalent to Ksense equal to or higher than 0.25.

Example: calculation of R3 for a max speed of 3000 Rpm and with Ktacho = 13mV/Rpm:

$$K\text{sense} = \frac{12.5}{13 \cdot 10^{-3} \cdot 3000} = 0.32$$

$$R3 = \frac{20 \cdot 10^4}{0.25 \cdot 13 \cdot 10^{-3} \cdot 3000} = 20512$$ (commercial value = 22 Kohm)

Vref FREQUENCY BANDWIDTH

The personalization of this parameter is determined by capacitor C3, mounted on the personalization card, which value depends on the maximum frequence of the Vref. The nominal value of C3 is 33nF.

The capacitor value is calculated as follows:

$$C3 = \frac{1}{2\pi \cdot f \cdot 10^4}[F]$$

where:

f = maximum frequency of Vref [Hz]

VELOCITY LOOP COMPENSATION

The personalization of this parameter is determined by resistor R10 and by capacitors C4 or C5. Capacitor C4 determines a fixed gain of the loop compensation, while C5 determines a variable gain, adjustable through PT1 (ωgain). This latter should be used when the load inertia and motor parameters are unknown, in order to obtain a response of the tachometer as shown further in the tachometer response diagram.

Case 1:

Knowing the parameters relative to motor inertia and load inertia, mount C4: trimmer ωgain is disabled and R10 is calculated as follow:

$$R10 = \frac{1}{\frac{K_T * I_{\max}}{\omega_c * 1 \cdot 10^4 * J_{tot} * \omega_{\max}} - \frac{1}{10 \cdot 10^6}}[\Omega]$$

where:

- ω_c = speed loop crossover frequency (typically 200 ÷ 300 rad/s) [rad/s]
- J_{tot} = sum of motor inertia and load inertia seen from the motor shaft (inerzia of gearing should be included) [Kgm^2]
- ω_{max} = max motor speed in the application [rad/s]
- K_T = torque constant of the motor [Nm/A]
- I_{max} = maximum current set for the application [A]

$$C4 = \frac{1}{R10 * \omega_z}[F]$$

where:

- ω_z = speed loop bandwidth (typically $50 \div 80$ rad/s)

Case 2:

If the load inertia is not known, mount C5 (do not mount C4): trimmer ωgain is enabled and R10 is calculated as follows:

$$R10 = \frac{1}{\frac{K_T * I_{\max}}{\omega_c * 1 \cdot 10^4 * J_{mot} * \omega_{\max}} - \frac{1}{10 \cdot 10^6}} [\Omega]$$

where :

- ω_c = speed loop crossover frequency (typically 200 ÷ 300 rad/s) [rad/s]
- J_{mot} = motor inertia [Kgm^2]
- ω_{max} = max motor speed in the application [rad/s]
- K_T = torque constant of the motor [Nm/A]
- I_{max} = maximum current set for the application [A]

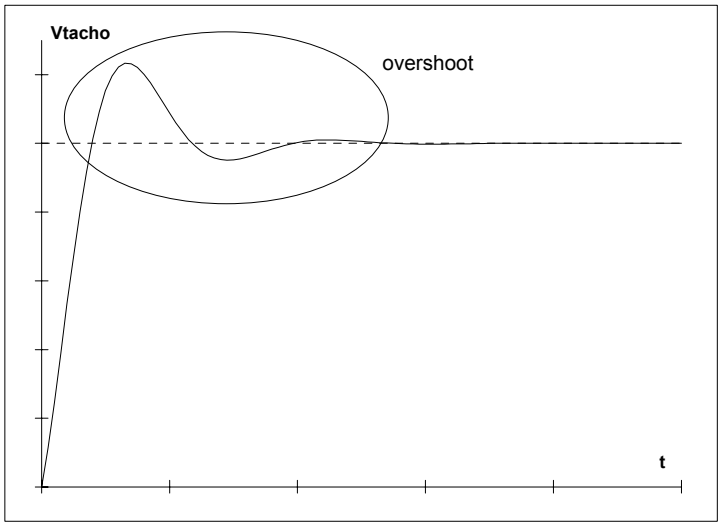
$$C5 = \frac{1}{R10 * \omega_z} [F]$$

where :

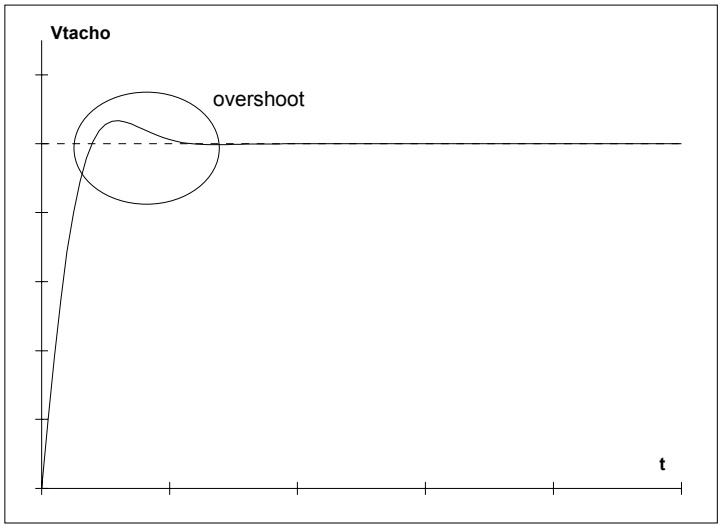
- ω_z = speed loop bandwidth (typically $50 \div 80$ rad/s)

After setting R10 and C5 as described above, use ωgain trimmer to optimize the velocity loop and adjust it till obtaining the best response (see next diagrams).

Verify that the response of the speed loop to a square wave doesn't produce too much overshoot and oscillations:



ωgain low

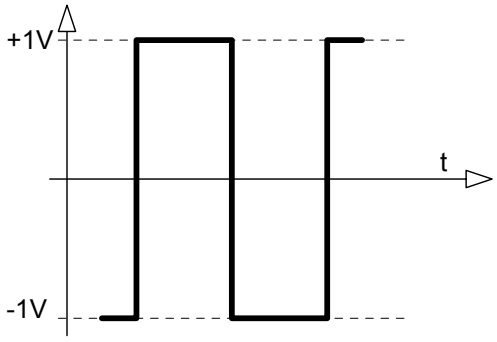


ωgain correct

In the first figure, excessive overshoot and oscillation in the response is observed; the second figure shows a good response.

Proceed as following to regulate the gain:

- rotate ωgain trimmer fully clockwise.
- apply an input square wave to Vref (±1V amplitude, frequency 0.5 ÷1 Hz, as shown:



- rotate ωgain trimmer counterclockwise until a correct response is obtained.

CURRENT LOOP COMPENSATION

This parameter is set by fixed components R233 and C120 on the base board, and normally does not need to be adjusted. If for special cases it should be ajusted, it can be done opening the jumper P22 on the base board and installing desired values for R2 and C2 on the customization board.

Note : to calculate the precise component values of R2 and C2 for a different personalization, contact the supplier for parameter calculation.

MAXIMUM CURRENT VALUE

The personalization of this parameter is determined by resistor R9 of the personalization card, which values is calculated as follows:

$$R9 = \frac{K_m * 1 \cdot 10^4}{8.9 - K_m} [\Omega]$$

Note: for size 30/60 use constant 1.5×10^3 instead of 1×10^4

with $$K_m = \frac{8.9 * I_{max1}}{I_{max2}}$$

where:

- Imax1 is the maximum desired current [A]
- Imax2 is the maximum current of the converter being used [A]

Example: calculation of R9 (with size 12/30) for a maximum setpoint of 24A:

$$K_m = \frac{8.9 * 24}{30} = 7.12 \qquad R9 = \frac{7.12 * 1 \cdot 10^4}{8.9 - 7.12} = 40{,}000\Omega$$ (commercial value 39kΩ)

Note: to set a maximum current equal to the maximum current of the drive, do not mount R9.

CONTINUOUS CURRENT SETPOINT

The personalization of this parameter is determined by resistor R8, mounted on the personalization card, which value depends on the maximum current delivered by the converter and/or on the rated current of the motor being used.

The value of R8 can be calculated as follows:

$$R8 = \frac{1}{\frac{1}{X} - \frac{1}{R9}} [\Omega]$$

With $$X = \frac{K_c * 1 \cdot 10^4}{8.9 - K_c} \qquad K_c = \frac{8.9 * I_{cont}}{I_{max}}$$

Note: for size 30/60 use constant 1.5×10^3 instead of 1×10^4

where:

- R9 is the resistor which sets the maximum current [Ω]
- I_{cont} is the desired continuous current [A]
- I_{max} is the maximum current for the size of the drive [A].

Example: calculation of R8 (size 12/30) for a continuous current of 8A, with R9=39kΩ :

$$K_c = \frac{8.9 * 8}{30} = 2.37 \qquad X = \frac{2.37 * 1 \cdot 10^4}{8.9 - 2.37} = 3629$$

$$R8 = \frac{1}{\frac{1}{3636} - \frac{1}{39000}} = 4001\Omega$$ (commercial value 3.9kΩ)

IXT PROTECTION THRESHOLD

The personalization of this parameter is determined by resistor R7 mounted on the personalization card, and it can be calculated as follows:

$$R7 = \frac{R_t * 1 \cdot 10^3}{(\frac{4.6}{I_{rms} * 1.2 * K_i} - 1) * 1 \cdot 10^3 - R_t} - 47[\Omega]$$

where:

- Ki, depending on the drive size is:

size 2/5	Ki = 0.738
size 5/12	Ki = 0.3
size 8/20	Ki = 0.2
size 12/30	Ki= 0 .1
size 20/50	Ki = 0.082
size 27/55	Ki = 0.082
size 30/60	Ki = 0.082

- R_t, depending on the drive size is:

size 2/5	1500Ω
size 5/12	1500Ω
size 8/20	1270Ω
size 12/30	2200Ω
size 20/50	1500Ω
size 27/55	1000Ω
size 30/60	1000Ω

- I_{rms} is the rms value of the continuous current of the motor.

The maximum Ixt value corresponds to the rated continous current of the converter model being used.

Note : to obtain the maximum value of Ixt value, do not mount R7

Example: calculation of R7 for a converter size 12/30 applied to a motor with a stall current of 7.5A

$$R7 = \frac{2200 * 1 \cdot 10^3}{(\frac{4.6}{7.5 * 1.2 * 0.1} - 1) * 1 \cdot 10^3 - 2200} - 47 = 1104\Omega$$ (commercial value = 1.2Kohm)

BRAKING CURRENT VALUE

When an error occurs or power is disabled, in order to stop the motor its phases are short circuited, and the current flowing is regulated to a custom value I_{brk}. Depending on drive size, I_{brk} can range within the limits shown in the following table :

SIZE	Ibrk (min.)	Ibrk (max.)
2/5	0.33A	2A
5/12	0.8A	5A
8/20	1.2A	8A
12/30	2.5A	12A
20/50	3.0A	20A
27/55	3.0A	27A
30/60	3.0A	30A

This parameter depends on the resistor R6 as follows :

$$R6 = \frac{1}{\frac{1}{R_p} - 2.13 \cdot 10^{-3}} [\Omega]$$

with $R_p = \frac{V_X * 1 \cdot 10^3}{2.5 - V_X} [\Omega]$ $V_X = [K_i * I_{brk} - 0.25] * K_{br} [V]$

where :

- I_{brk} is the desired braking current value
- Ki and Kbr depend on the drive size :

SIZE	ki	Kbr
2/5	0.738	0.617
5/12	0.3	0.617
8/20	0.2	0.549
12/30	0.1	0.752
20/50	0.082	0.523
27/55	0.082	0.370
30/60	0.082	0.370

Example : computation of R6 for a 12/30 size, to obtain a 10A braking current :

$$V_X = [0.1 * 10 - 0.25] * 0.752 = 0.564V \qquad R_p = \frac{0.564 * 1 \cdot 10^3}{2.5 - 0.564} = 291\Omega$$

$$R6 = \frac{1}{\frac{1}{291} - 2.13 \cdot 10^{-3}} = 767\Omega$$ (commercial value 820Ω)

Note : in order to have the maximum I_{brk} value, do not mount R6.

RAMP DURATION

Ramp rise and fall times depend on R4 and R3 respectively, mounted on the personalization card. They are calculated as follows:

$$R1 = \frac{T_{RAMP+} \cdot 10.6 \cdot 10^3}{C1 \cdot V_{ref}} [\Omega]$$

$$R4 = \frac{T_{RAMP-} \cdot 10.6 \cdot 10^3}{C1 \cdot V_{ref}} [\Omega]$$

where:

- T_{RAMP+} is ramp's rise time [msec]
- T_{RAMP-} is ramp's fall time [msec]
- C1 is the customization capacitor [µF]
  standard value1 µF (50V, 10%).
  Use only capacitors with good thermal stability and 10% tolerance
- Vref is the maximum reference input (10V typically)

Note : ramp's customization requires the ramp option card to be present; it is supplied only on request, if the ramp option is not present, R1, R4 and C1 are not mounted.

COOLING REQUIREMENTS

NATURAL CONVECTION

The unit dissipates power through its standard lateral heatsink. The thermal shutdown intervention is set at 85°C. The following table shows the maximum continous current for each model with an environment temperature of 40°C. The table apply on vertical mounted units, with 20 mm free space on both lateral sides and 200 mm free space on top and bottom sides for a better air circulation.

SIZE	MAX CONTINUOUS CURRENT
2.5	2A rms
5.12	5A rms
8.20	8A rms
12.30	12A rms
20.50	15A rms (1)
27.55	18A rms (1)
30.60	18A rms (1)

Note - (1) for these models, forced ventilation is required to have 20A, 27A and 30A continuous current respectively.

FORCED VENTILATION

The unit has an internal temperature limit switch, set at 85°C. In the following table is shown the temperature rise **ΔT** of the heatsink at an ambient temperature of 40°C, using a fan model PAPST multifan 4314 (119x119 mm):

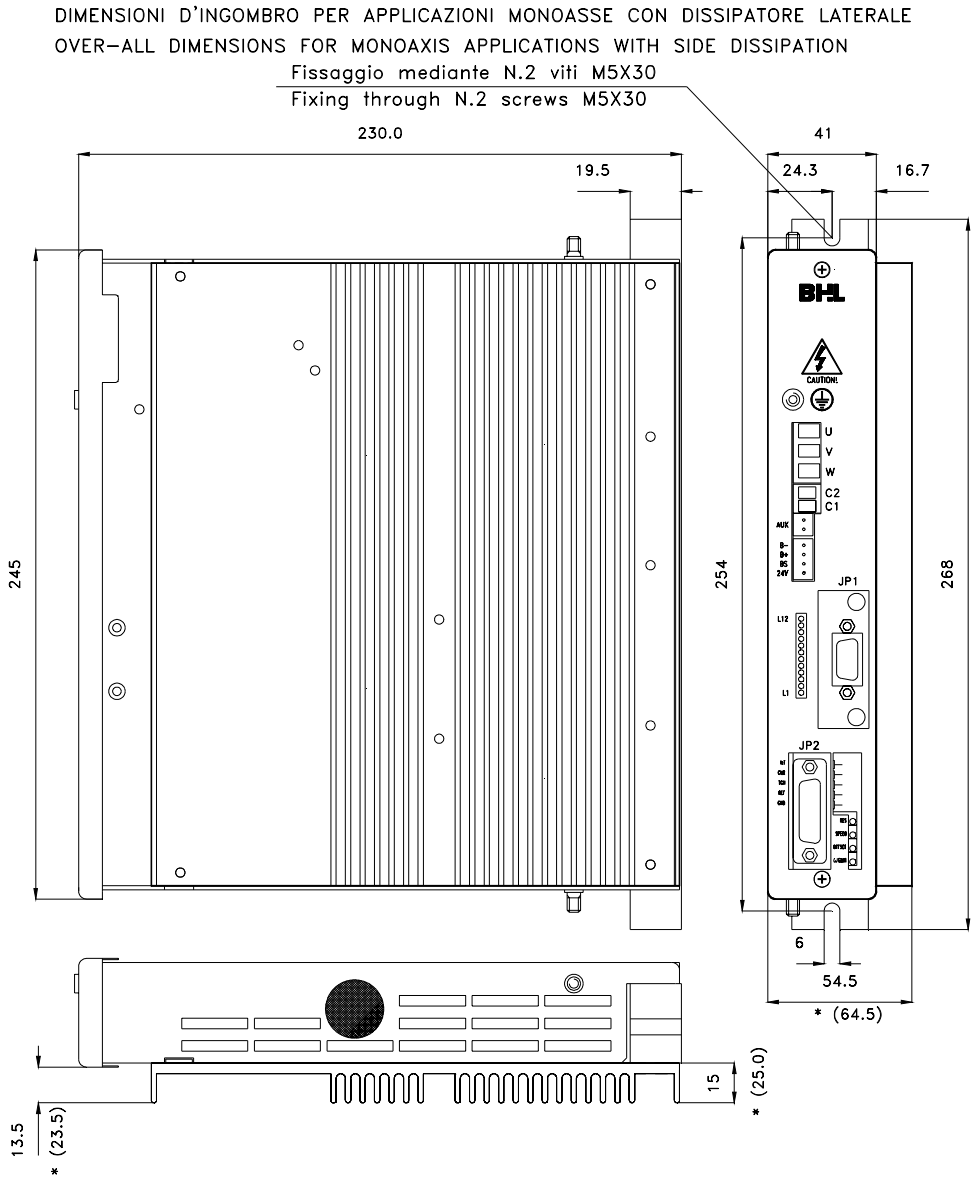
SIZE	CURRENT	Δ OF TEMPERATURE
2.5	2A rms	6°C
5.12	5A rms	6°C
8.20	8A rms	9°C
12.30	12A rms	13°C
20.50	20A rms	17°C
27.55	27A rms	20°C
30.60	30A rms	22°C

The above table applies with an ambient temperature of 40°C, and unit mounted vertically with 20 mm free space on both sides and 200 mm above and below to ensure air circulation. The fan should be installed below the unit, with 100mm maximum spacing from the drive. The required airflow is 100 CFM.

When using a 24Vdc fan, as the above mentioned PAPST fan, its power supply can be obtained from the drive, using the brake 24V supply (TB4 connector, pin B+, B-). It should be checked that if the brake is used, the total current consumption on this power supply (brake+fan) is less than 0.8 A.

DIMENSIONS AND FIXING

LATERAL HEATSINK APPLICATION



*Nota: le dimensioni tra parentesi sono valide per le sole taglie 20/50, 27/55, 30/60.
*Note: the dimensions between parenthesis are valid for the sizes 20/50, 27/55, 30/60 only.

Note : to guarantee an adequate air flow, it is needed to leave a 40 mm clearance between the units in the multi-axis application.

EMC PRESCRIPTION

FOREWORD

The converter is a product designed to be incorporated in a more complex equipment .

Therefore elettromagnetic compatibility depends by factors that are not totally under control of the manufacturer but depends on the installation, wiring and grounding of the equipment.

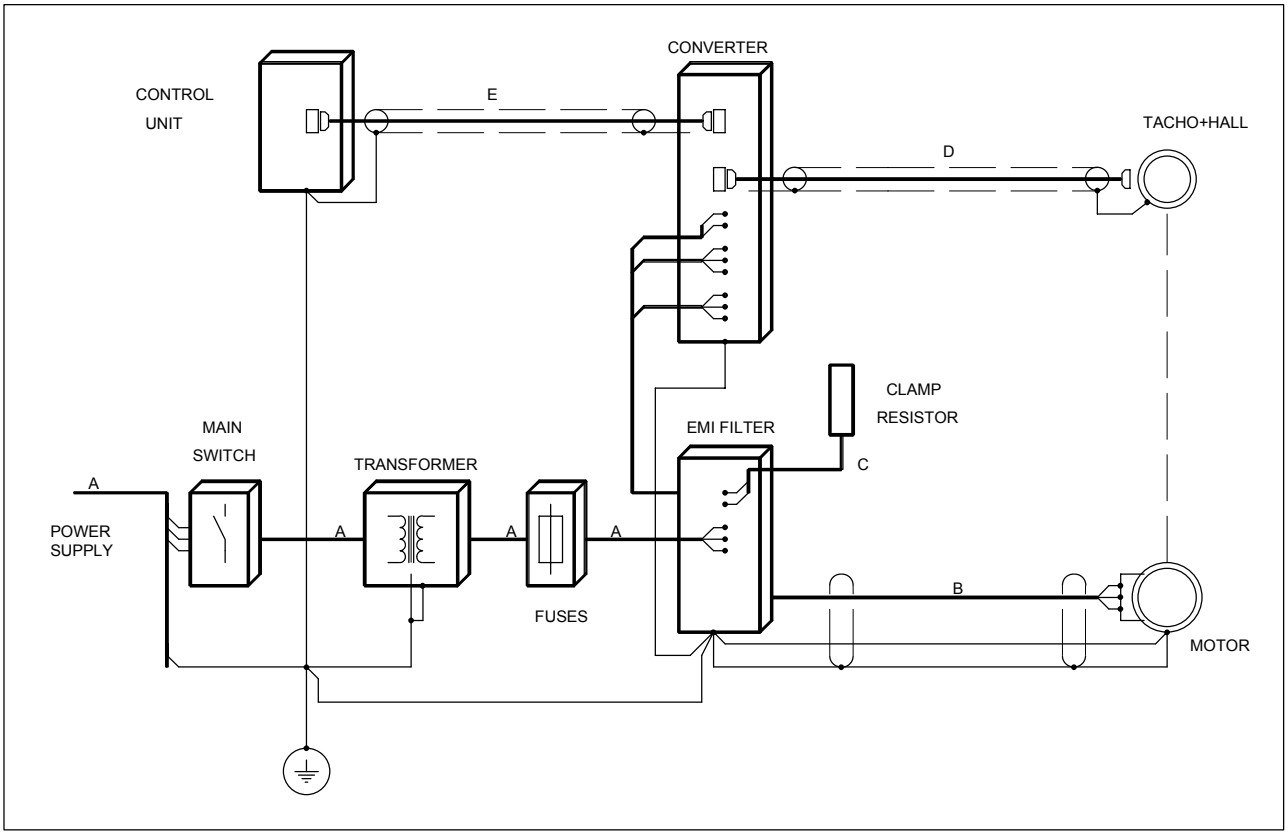
In this manual are given instructions for installation in order to obtain comformity with actual standards for elettromagnetic compatibility. This information have been collected after a comprehensive test campaign and their purpose is to make the job of the end user as easy as possible.

REFERENCE STANDARDS

Generic Standard EN 50081-2 e EN 50082-2 (industrial environment)

- EN61000-4-2 Electrostatic discharge
- EN61000-4-4 Electrical fast transient burst
- EN61000-4-5 Surge immunity (FULL-LIGHTNING)
- EN61000-4-8 Power frequency magnetic field
- ENV50140 High frequency elettromagnetic fields
- ENV50204 Elettromagnetic field at 900 MHz with ON/OFF modulation
- ENV50141 Radiofrequency
- EN55011 Radiated and conducted emission
- EN61800-3 Semiconductor power converters for adjustable speed electric drive system

INSTALLATION WITH SPECIAL FILTER FOR CONVERTER

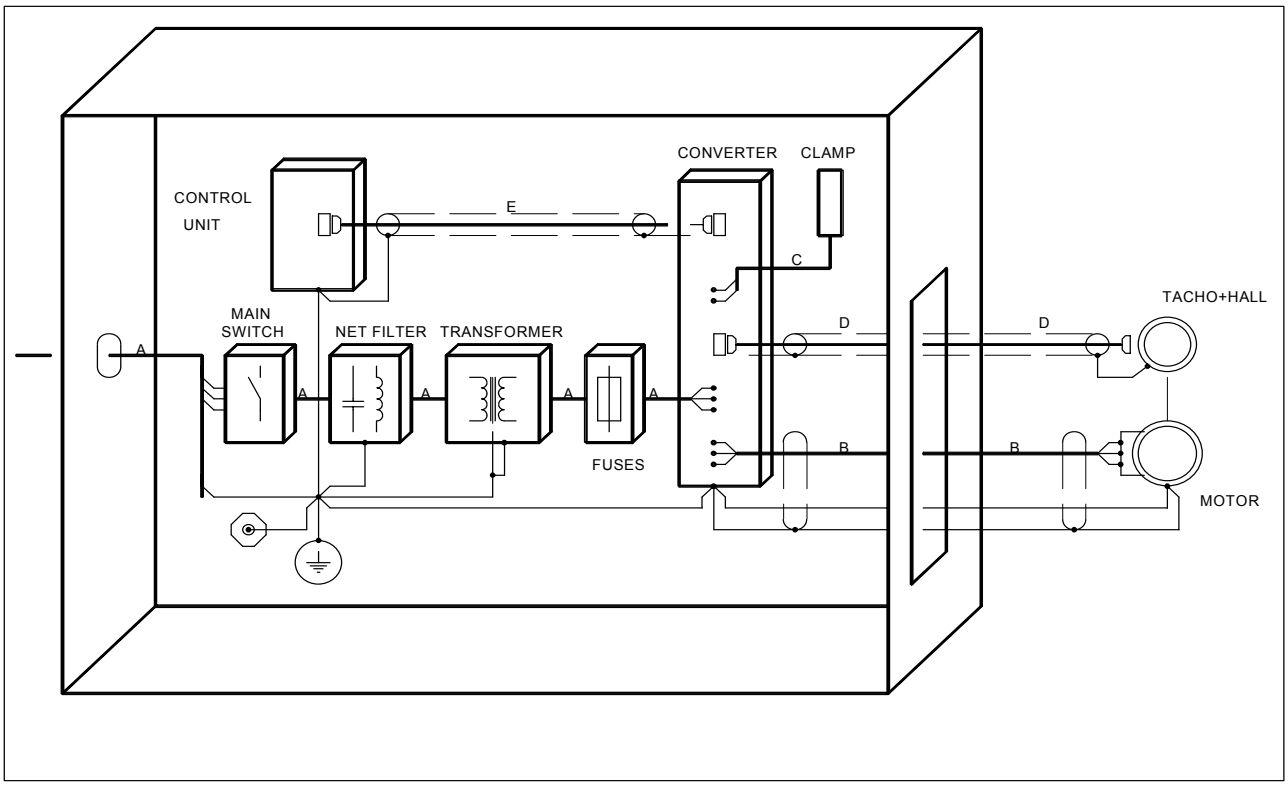


- Supply cable(A): no prescription
- Motor cable(B): to prevent emission of the motor cable is recommended to use shielded cable. The shielding must be connected to the ground of the converter and to the ground terminal of the motor.
  In this configuration due to the characteristics of the special filter for converter, it is allowed to use unshielded cable. The cable length must be less or equal 25m.
- Transformer: must be shielded between primary and secondary windings and its rated power must be adeguate for equipment requirements.
- Clamp resistor (C): connected through twisted cable with length less or equal 2m.
- Motor signal cable (D): shielded cable with length less or equal 25m.
- Control connections (E): shielded cable with length less or equal 3m.
- EMI filter: special filter for converter code 2SMPM3338/OC (cable is included).

Conformity

In this configuration the converter is compliant with the regulations referenced above .

INSTALLATION WITHOUT SPECIAL FILTER FOR CONVERTER



- Supply cable(A): no prescription
- Motor cable(B): to prevent emission of the motor cable is recommended to use of shielded cable. The shield must be connect to the converter ground terminal and to the ground terminal of the motor. The cable length must be less or equal 25m.
- Transformer: must be shielded between primary and secondary windings and its rated power must be adeguate for equipment requirements.
- Clamp resistor (C): connected through twisted cable with length less or equal 2m.
- Motor signal cable (D): shielded cable with length less or equal 25m.
- Control connections (E): shielded cable with lenght less or equal 3m.
- Network filter: Siemens B84143-B XXR with following characteristics:

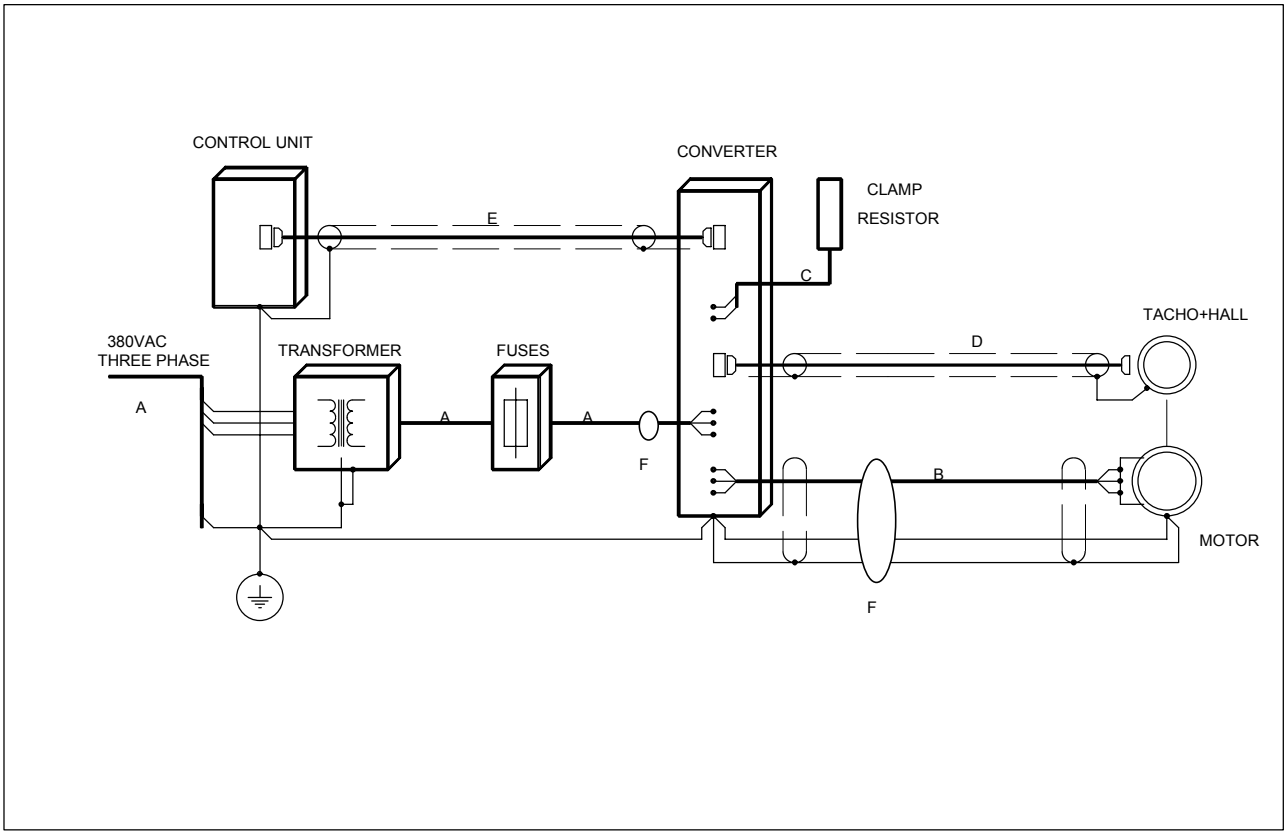
  Nominal voltage: 440/250 Vac, 50/60Hz
  Phase number: 3
  Temperature range: -25...+40 °C
  Nominal current: range XX = 8-12-16-25-36A for different models

- Cabinet: All equipments should be installed in metal cabinet closed over all sides.

Conformity

In this configuration the converter is compliant with the regulations referenced above .

INSTALLATION WITHOUT FILTERS



- Supply cable(A): no prescription. Install a suppression ferrite KITAGAWA SFC10 (F)
- Motor cable(B): to prevent emission of the motor cable is recomended to use of shielded cable. The shield must be connect to the converter ground terminal and to the ground terminal of the motor. The cable length must be less or equal 25m. Install a suppression ferrite KITAGAWA SFC10 (F)
- Transformer: must be shielded between primary and secondary windings and its rated power must be adeguate for equipment requirements.
- Clamp resistor (C): connected through twisted cable with length less or equal 2m.
- Motor signal cable (D): shielded cable with length less or equal 25m.
- Control connections (E): shielded cable with lenght less or equal 3m.

Conformity

In this configuration the converter is compliant with all the regulation referenced above regarding immunity (EN50082-2).

In this configuration the converter is not compliant to the emission regulation EN55011 (Emission, Generic standard).

In this configuration the converter is compliant to the product specific regulation EN61800-3 for the class "Restricted distribution"and "Second environment".

Note:

Restricted distribution: the mode of sales distribution in which the manufacturer restricts the supply of equipment to supplier, customer or users who separatedly or jointly have technical competence in the EMC requiremets of the application drives.

Second environment: the environment which includes all establishment other than those directly connected to a low voltage power supply network which supplies building used for domestic purposes.

It is available on request the documentation of the radiated and conducted emission measurements to perform adequate action.

If this equipment must work in the first environment please contact the manufacturer.

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