



SERVICE MANUAL

ENGLISH

AXOR INDUSTRIES[®] MOTORS & DRIVES



Mack Drive+Power

Sistema Brushless Multiasse

Ver.1 rev.10/19

VERSION/RELEASE	DESCRIPTION
ver.1 rev. 02/'13	First preliminary edition.
ver.1 rev. 05/'13	Connection of AGND to ground corrected.
ver.1 rev. 06/'13	Note on power supply.
ver.1 rev. 07/'13	Main supply value update.
ver.1 rev. 09/'13	Chapter 3 updated. Chapter 4 inserted. Corrections.
ver.1 rev. 03/'14	Analog inputs inserted. Corrections.
ver.1 rev. 07/'16	Chapter 2, 3, 4 updated. EtherCat, Commutation encoder inserted. Corrections.
ver.1 rev. 10/'19	All Chapter updated.

All rights reserved.

Reproduction in whole or in part is prohibited without prior written consent of the copyright owner.

All specifications are subject to change without prior notification.

This manual has been carefully checked, however Axor does not assume liability for errors or inaccuracies.

The Mack® is a registered trademark.



THIS MANUAL CONTAINS A DESCRIPTION OF THE MACK® SYSTEM AND A GUIDELINES FOR THE INSTALLATION.

**USING THE DEVICES INCORRECTLY CAN INJURE PEOPLE OR MANAGE THINGS.
FULLY RESPECT THE TECHNICAL DATA
AND INDICATIONS ON CONNECTION CONDITIONS.**

Summary

1) Description

1.1 General view	8
1.2 Description.....	9
1.3 Technical Data	11
1.4 Mechanical Dimension	14
1.5 Mack Power Connectors	15
1.6 Mack Drive Connectors	16
1.7 Product plate and Ordering Code.....	17

2) Installation

2.1 General Advices	16
2.2 Positioning	19
2.3 Environmental conditions	20
2.4 Cables	21
2.5 Connection to ground and earth.....	22
2.6 Note about cable shielding	24
2.7 Base installation procedure.....	25
2.8 Example of base connection	26
2.9 Supply connections	27
2.10 DC bus connections	29
2.11 Back UP connections.....	30
2.12 Motor power connection	31
2.13 Feedback signals connections.....	32
2.14 Regen resistance connections.....	34
2.15 Relè OK connection.....	35
2.16 Emulated encoder outputs connection	36
2.17 CanBus Connection.....	37
2.18 EtherCAT Connection	38
2.20 Analog inputs connections	40
2.21 Digital inputs connection	41
2.22 digital outputs connections	42
2.23 Clock/Dir inputs connections.....	43
2.24 Gearing connections	46
2.25 Power up.....	47
2.26 Motor Test	48
2.27 MackPower Display.....	50
2.28 MackDrive Led	51

3) SpeederOne Interface

3.1 SpeederOne Interface.....	54
3.2 Mack Power main menu	56
3.3 Mack Drive main menu	60
3.4 Mack Drive Operative Modes.....	64
3.5 Mack Drive Status	65
3.6 Speed window Mack Drive	66
3.7 Current window Mack Drive	67
3.8 Encoder Out window Mack Drive	68
3.9 Motor window Mack Drive.....	69
3.10 Analog I/O window Mack Drive.....	70

Summary

3.11 Digital I/O window Mack Drive	71
3.12 Position window Mack Drive	74
3.13 Homing window Mack Drive	76
3.14 Standard configuration files Mack Drive	78
3.15 Oscilloscope Mack Drive	80
3.16 Mack Power Alarms	87
3.17 Mack Drive Alarms.....	88

4) Operative Modes

4.1 Operative Modes	88
4.2 Digital Speed.....	89
4.3 Analog Speed	90
4.4 Digital Torque	93
4.5 Digital Toque Limitation	94
4.6 Analog Torque	95
4.7 Analog Toque Limitation	96
4.8 Gearing (Electrical Axis)	97
4.9 Pulse/Dir Command.....	100
4.10 CW/CCW Command.....	103
4.11 CanBus - Settings	106
4.12 Can Bus - Command Sequences	107
4.13 EtherCAT - Settings	116
4.14 Square Wave	117
4.15 Homing - Procedures	118
4.16 Homing - Settings	122
4.17 Homing - Example.....	126

Conformity	129
-------------------------	------------

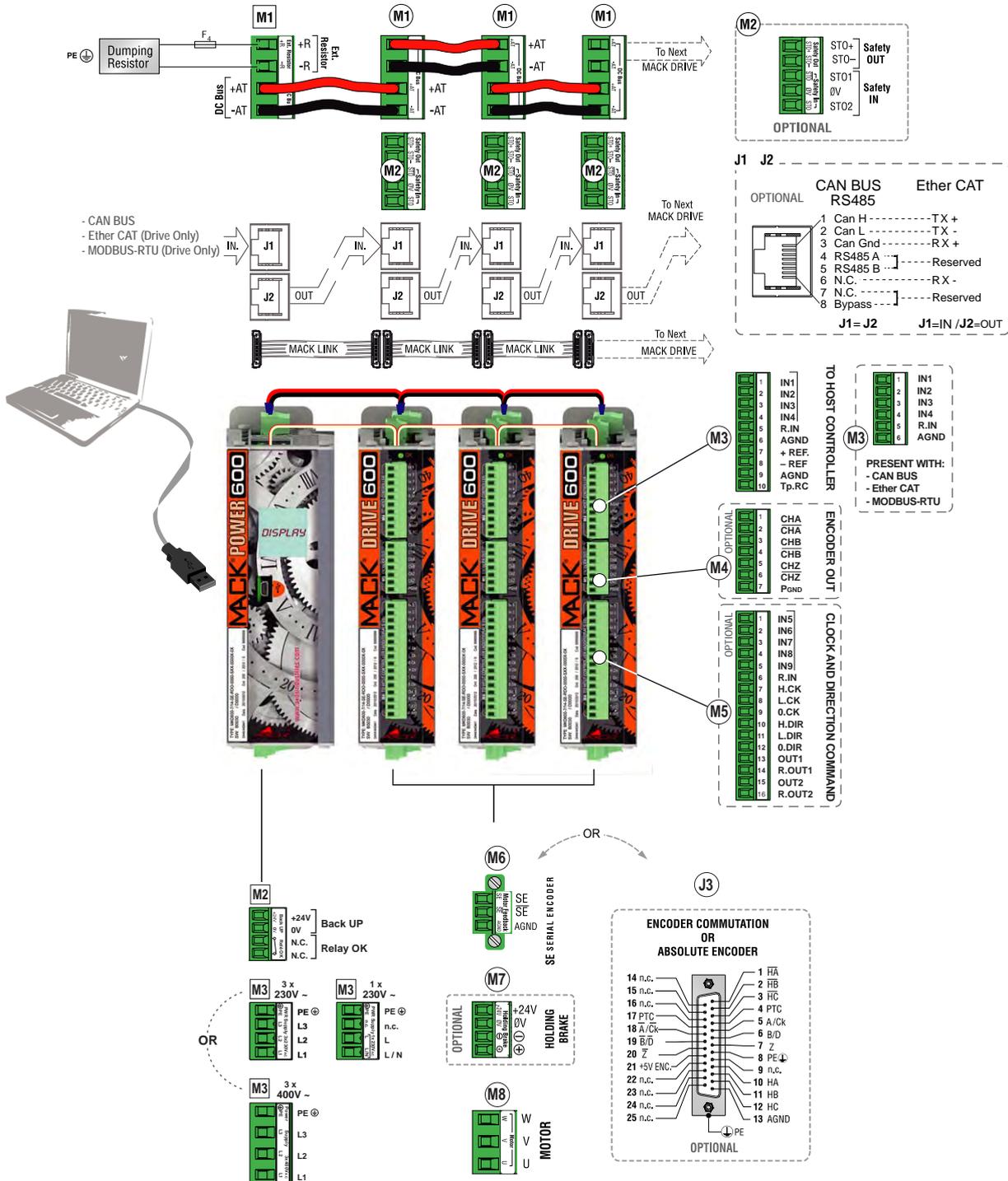
Chapter 1

Description

1.1 General view	8
1.2 Description.....	9
1.3 Technical Data	11
1.4 Mechanical Dimension	14
1.5 Mack Power Connectors	15
1.6 Mack Drive Connectors	16
1.7 Product plate and Ordering Code.....	17

1.1 General view

MACK DRIVE+POWER is a compact multi-axis system of servodrives (one or more **MACK DRIVES**, powered by a single supply unit, **MACK POWER**), capable of piloting rotary AC brushless motor up to **11Nm** with a 3-phase supply of **230÷400 Vac** (230 1-phase available with reduced performance).



1.2 Description

OPERATIVE MODES	
ANALOG SPEED	Speed piloting utilising an analogue reference.
DIGITAL SPEED	Speed piloting utilising a digital reference.
ANALOG TORQUE	Torque piloting utilising an analogue reference.
DIGITAL TORQUE	Torque piloting utilising a digital reference.
GEARING (ELECTRICAL AXIS)	It will be possible to pilot the drives with the quadrature signals of an emulated encoder from a Master drive or with the quadrature signals of an incremental encoder from a Master motor.
PULSE/DIR MODE	It will be possible to connect the drives to a motor controller , piloting it with the H.CK/L.CK/O.CK and H.DIR/L.DIR/O.DIR signals.
CANOPEN	It can be configured and controlled using CanBus . It supports the following Can Open protocols: <ul style="list-style-type: none"> • Part of the DS301-V4.02 • Part of the DSP402-V2.0
CW/CCW	It is possible to connect the drive to a motor piloting it with the CLOCK and DIR signals: if pulses arrive at the CLOCK input, the motor rotates clockwise (CW); while if pulses arrive at the DIR input, the motor rotates counter clockwise (CCW).
ETHERCAT	The drive can be configured and controlled using EtherCAT .
SQUARE WAVE	The motor is piloted with a "square wave" signal. This is useful for adjustments of the speed loop.
RS485 MODBUS-RTU	It allows to communicate and control the drive by using the RS485 interface.
FEEDBACK	
SERIAL ENCODER	Serial angular encoder.
ABSOLUTE ENCODER	Absolute multi-turn encoder.
COMMUTATION ENCODER	Commutation encoder + hall.
ANALOG INPUT	
1 ANALOG COMMON MODE INPUT (Tp.RC)	It is used for controlling the current from the drive.
1 ANALOG DIFFERENTIAL or COMMON MODE INPUT (+/-REF)	It can be used for piloting the drive with an analogue speed reference from an external controller.

1.2 Description

1

DIGITAL INPUTS/OUTPUTS	
9 DIGITAL INPUTS (IN1÷IN9)	They will be programmable for: the limit switch, the homing procedures, the emergency stop, and other drive functions. The inputs IN1 e IN5 pre-setted with the function ENABLE and they aren't programmable.
2 programmable DIGITAL OUTPUTS (OUT1/OUT2)	They will be used to send messages from pre-programmed drive functions.
EMULATED ENCODER OUTPUTS	There are 6 pins dedicated to an emulated encoder with different programmed ratios (1:1, 1:2, 1:4, 1:8, 1:16, 1:32, 1:64, 1:128).

STANDARD AND ADDITIONAL FEATURES	
HOLDING BRAKE	The MACK DRIVE will have a circuitry that allows the control of the electromechanical brake integrated in the motor, which can be used with <i>motor not running, for blocking the motor's axis</i> . It will be externally managed by the user or automatically by the drive.
EMI FILTER	The MACK POWER is equipped with an integrated EMI anti-disturbance filter at the 3-phase power supply input and with another EMI anti-disturbance filter at the auxiliary +24Vdc power supply input.
SPEEDER ONE SOFTWARE INTERFACE	The Axor <i>Speeder One</i> interface allows user to set and manage all Mack's parameters, just using an USB single access cable.

SAFETY	
SAFETY	The system is protected from the short circuitry, the Max/Min Voltage, the drive I ² t , the Motor I ² t , etc. When there is an alarm the "Relè OK" contact opens and the motor is stopped, without compromising the system's functioning.
SAFE TORQUE OFF FUNCTION	It is a safety function which avoids the accidental startup of the motor in the absence of +24Vdc on indicated pins (See enclosure "STO Manual" to find more information provided on request).

1.3 Technical Data

Technical Data - MACK POWER			
MODEL	<i>MKP 300 M *</i>	<i>MKP 300 T</i>	<i>MKP 600 T</i>
SIZE (Rated Output Power)	3000Wrms	4500Wrms	4500Wrms
Power Supply (grounded system only)	1 x 230Vac ($\pm 10\%$) 8A / 50/60Hz	3 x 230Vac ($\pm 10\%$) 12A / 50/60Hz	3 x 400Vac ($\pm 10\%$) 7A / 50/60Hz
Power Output (at full load)	310 ÷ 385 Vdc 10A 20APK x 5"	310 ÷ 385 Vdc 15A 30APK x 5"	530 ÷ 650 Vdc 8.5A 7APK x 5"
Thermal Dissipation at rated current	35W	35W	25W
BackUp In (from insulating transformer)	+24Vdc ($\pm 10\%$) - 2.5A max (0.25A for each drive supplied by the MACK POWER)		
F1 Power In Line Fuse	12A / 250V (T-type=time-lag)	16A / 250V (T-type=time-lag)	8A / 500V (T-type=time-lag)
F2 BackUP Fuse	4A / 250V (T-type=time-lag)		
F4 Dumping resistor Fuse	5A / 600V (T-type=time-lag)		
Case	B		

* The single phase version is with restricted performance.

Braking Resistance - MACK POWER		
	<i>MACK POWER 300 T</i>	<i>MACK POWER 600 T</i>
External Resistance	-	100W - 39 ohm (standard)
	160W - 22 ohm (standard)	160W - 33 ohm (optional)
	500W - 22 ohm (optional)	500W - 33 ohm (optional)
	-	1000W - 66//66 ohm (optional)
Set point values	273Vac	460Vac
	385 V _{DC} BUS	650 V _{DC} BUS

1.3 Technical Data

1

Technical Data - <i>MACK DRIVE</i>									
MODEL	<i>MKD 300</i>				<i>MKD 600</i>				
SIZE	2/4	4/8	6/12	8/16	1.5/3	2.5/5	3.5/7	5/10	7/14
Rated Current (Arms)	2	4	6	8	1.5	2.5	3.5	5	7
Peak Current x 5" (Arms)	4	8	12	16	3	5	7	10	14
Thermal Dissipation at rated current (W)	30	45	60	80	30	45	60	80	110
Case	A	A	A-V Ⓢ	A-V Ⓢ	A	A	A-V Ⓢ	A-V Ⓢ	A-V Ⓢ
Control Brake Supply	+24Vdc (±5%) - 1A (from insulating transformer)								
F3 Brake Resistor Fuse	2A fuse (T-type=time-lag)								
BackUp Logic Supply	+24Vdc (±10%) - 0.25A (from MACK POWER)								
Power Supply	310 ÷ 385 Vdc (coupling with MACK POWER 300)				530 ÷ 650 Vdc (coupling with MACK POWER 600)				

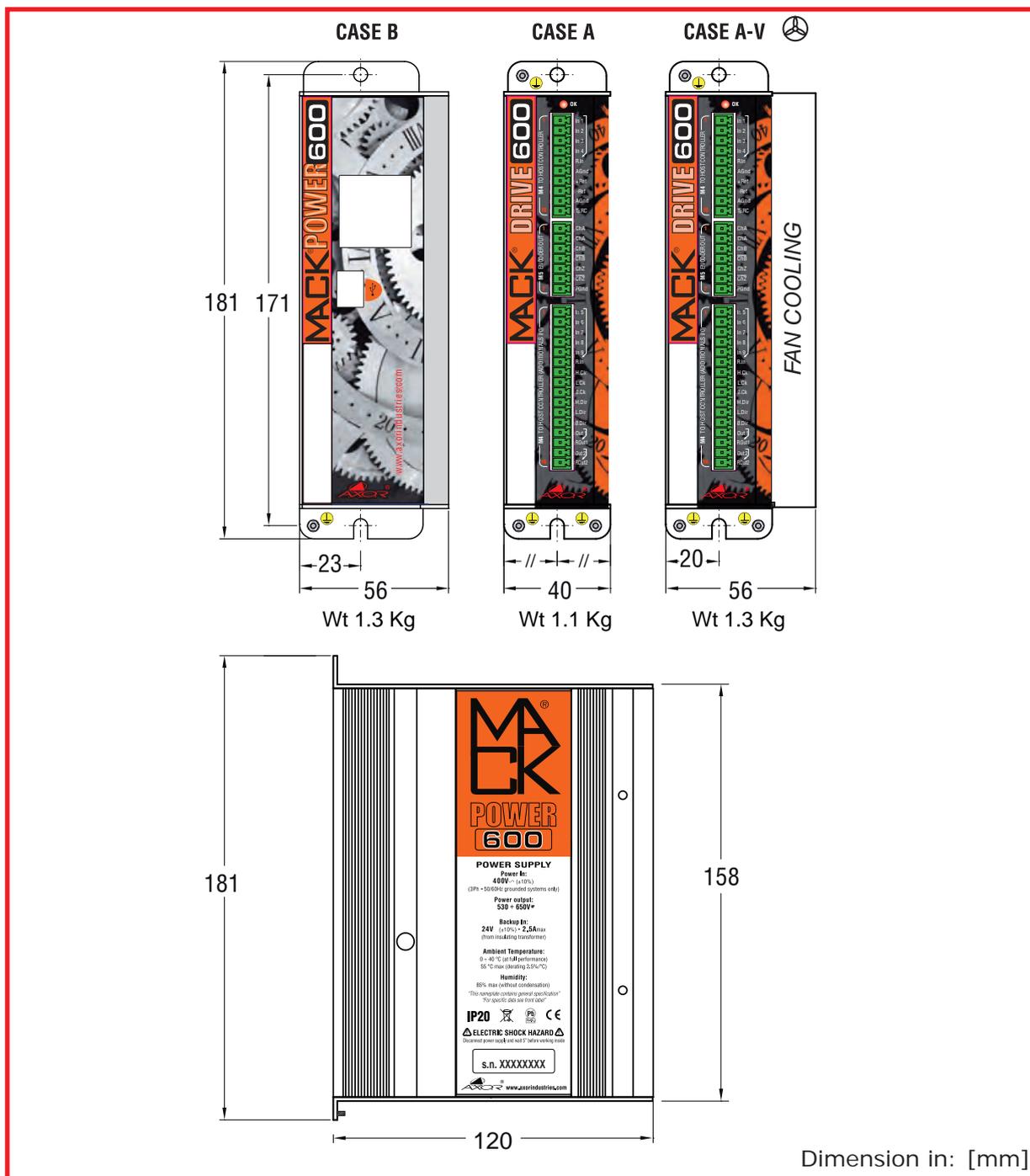
Control signals - <i>MACK DRIVE</i>	
Optoisolated digital inputs	+24Vdc - 7mA (PLC compatible)
Optoisolated digital outputs	+24Vdc - 50mA (PLC compatible)
Analog common mode input (Tp.RC)	±10V max, 25kOhm input resistance
Analog differential or common input (+/-REF)	10V max, 50kOhm input resistance, 13bit
CLOCK/DIR digital inputs	+5V, optoisolated, max. frequency 500kHz
Emulated encoder outputs	$V_{OH}=2.5V \text{ min} - I_{OH}=-20mA$ $V_{OL}=0.5V \text{ max} - I_{OL}=20mA$
Delay between motor encoder and encoder emulated	100ns

1.3 Technical Data

Ambient Condition <i>MACK DRIVE - POWER</i>		
During operation	Temperature	From +5°C to +40°C (without condensation) [Class 3K3 according to EN 60721-3-3]. From +40°C to +55°C derating 2.5%/°C in reference to nominal and peak current.
	Humidity	From 5% to 85% (without condensation) [Class 3K3 according to EN 60721-3-3].
	Vibration	Class 3M1 according to EN 60721-3-3.
During transport	Temperature	From -25°C to +70°C [Class 2K3 according to EN 60721-3-2].
	Humidity	Relative humidity max 95% (without condensation) [Class 2K3 according to EN 60721-3-2].
	Vibration	Class 2M1 according to EN 60721-3-2.
During storage	Temperature	From -5°C to +45°C [Class 1K3 according to EN 60721-3-1].
	Humidity	Relative humidity from 5% to 95% (without condensation). [Class 1K3 according to EN 60721-3-1]
	Vibration	Class 1M1 according to EN 60721-3-1.

1.4 Mechanical Dimension

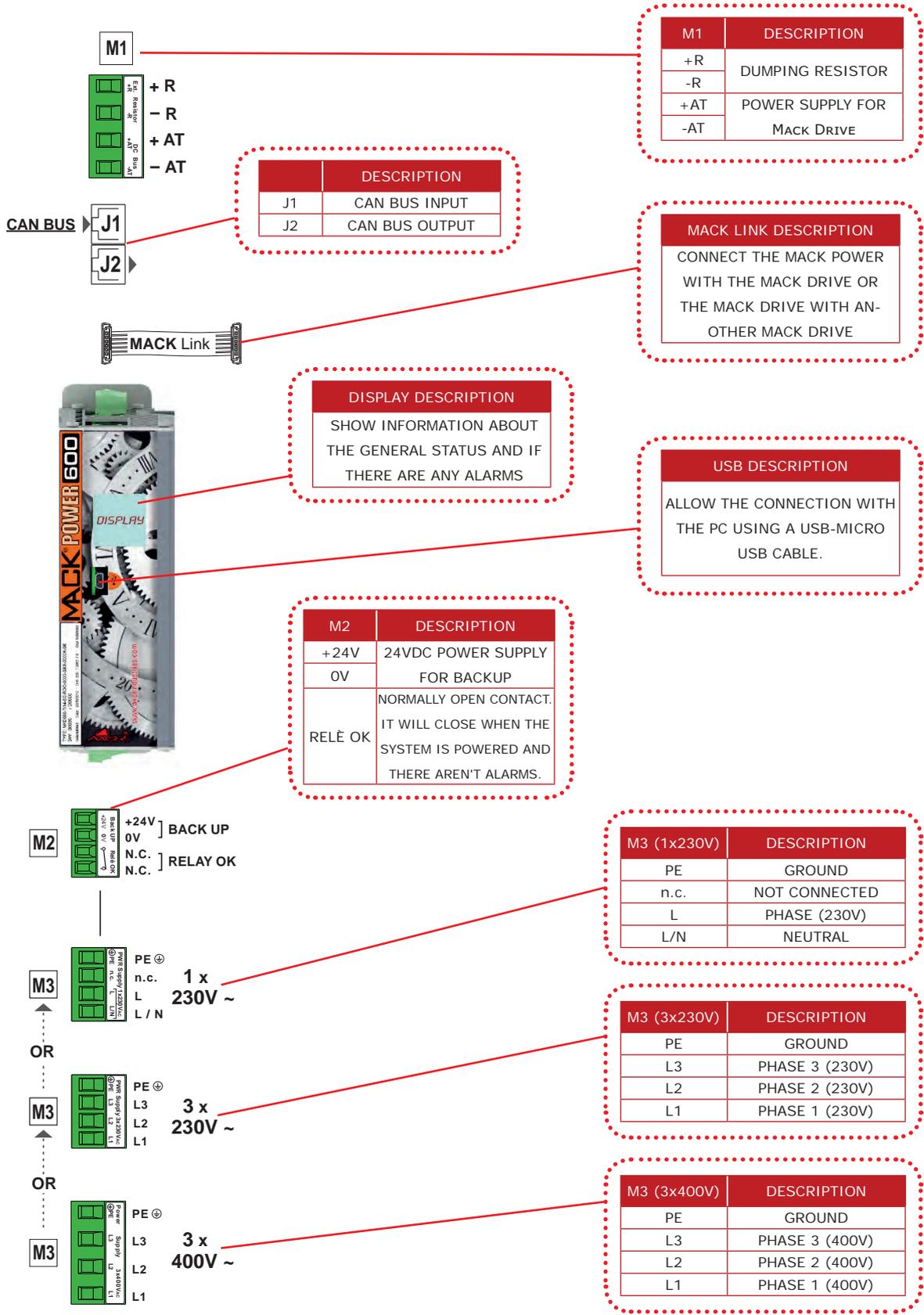
1



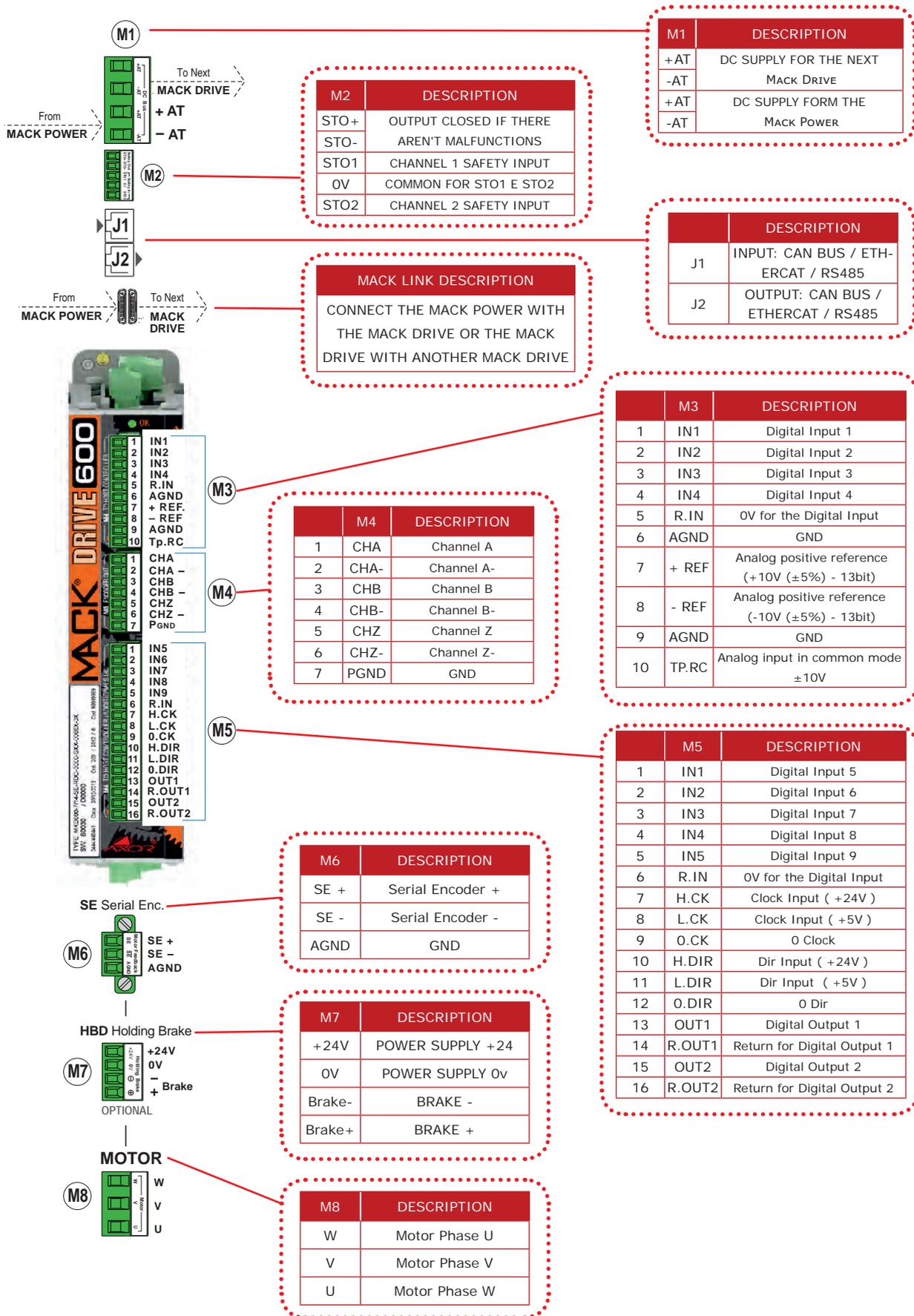
Mechanical specifications

Drive assembly		Panel mount		
External dimensions	mm	MACK POWER CASE B	MACK DRIVE CASE A	MACK DRIVE CASE A-V ⚡
		181 x 120 x 56	181 x 120 x 40	181 x 120 x 56
Weight	Kg	1.3	1.1	1.3

1.5 MACK Power Connectors

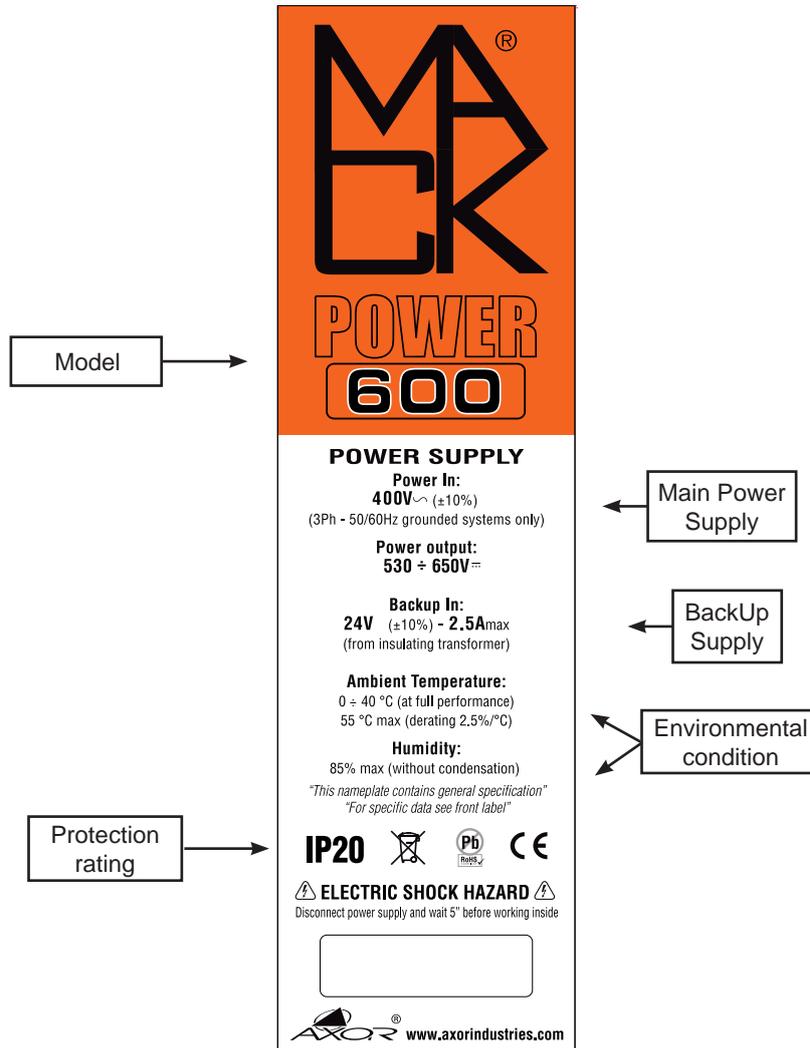


1.6 MACK DRIVE Connectors

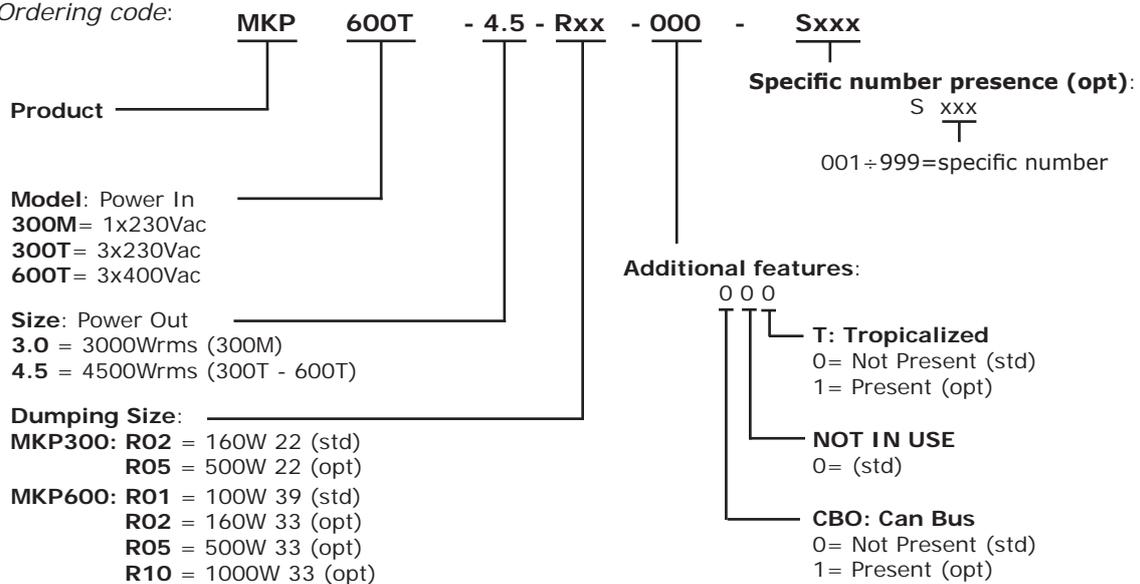


1.7 Product plate and Ordering Code

On the side of each **MACK POWER** there is a *product plate* like the follow:



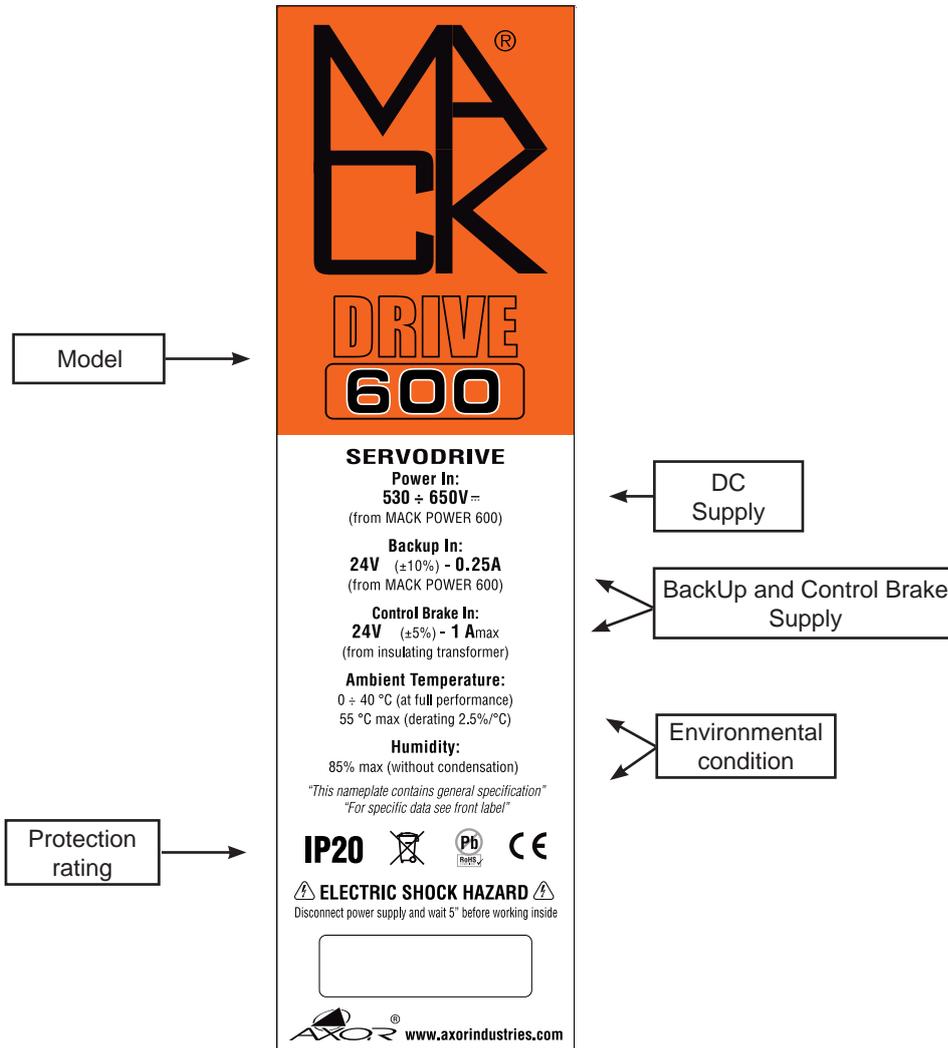
Ordering code:



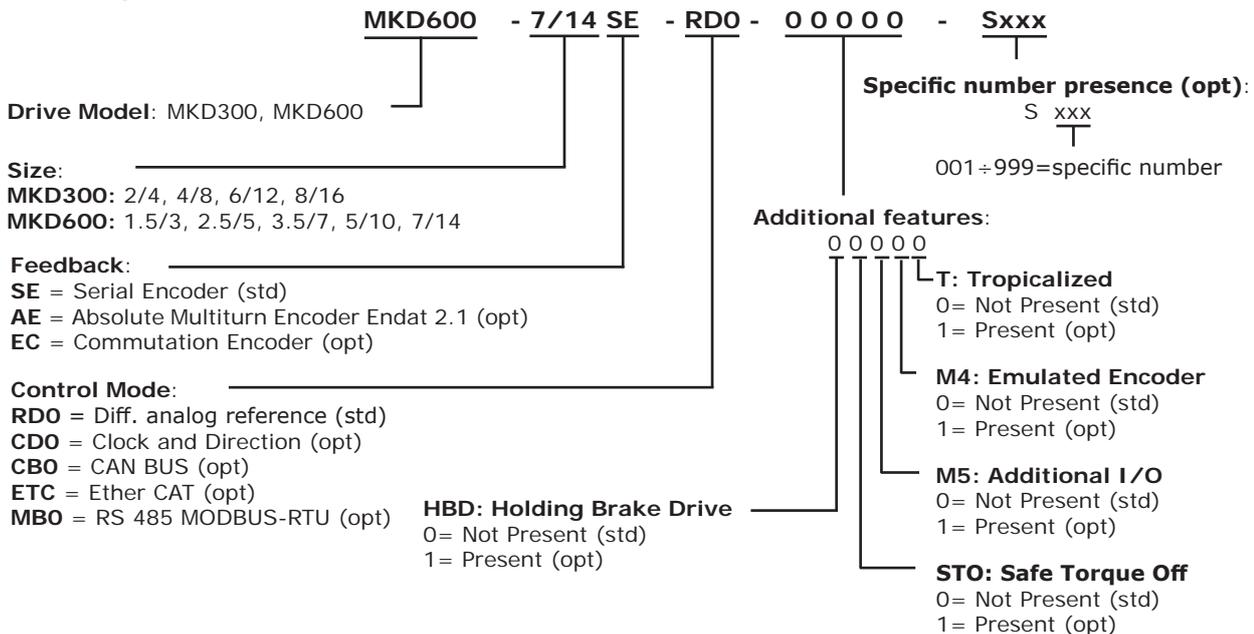
1.7 Product plate and Ordering Code

1

On the side of each **MACK DRIVE** there is a *product plate* like the follow:



Ordering code:



Capitolo 2

Installation

2.1 General Advices	16
2.2 Positioning	19
2.3 Environmental conditions	20
2.4 Cables	21
2.5 Connection to ground and earth	22
2.6 Note about cable shielding	24
2.7 Base installation procedure	25
2.8 Example of base connection	26
2.9 Supply connections	27
2.10 DC bus connections	29
2.11 Back UP connections	30
2.12 Motor power connection	31
2.13 Feedback signals connections	32
2.14 Regen resistance connections	34
2.15 Relè OK connection	35
2.16 Emulated encoder outputs connection	36
2.17 CanBus Connection	37
2.18 EtherCAT Connection	38
2.19 RS485 Connection	39
2.20 Analog inputs connections	40
2.21 Digital inputs connection	41
2.22 digital outputs connections	42
2.23 Clock/Dir inputs connections	43
2.24 Gearing connections	46
2.25 Power up	47
2.26 Motor Test	48
2.27 MackPower Display	50
2.28 MackDrive Led	51

2.1 General Advices

Transport

During the transport of the device respect the following indications:

- The transport must be made by qualified personnel.
- The temperature range must be between -25°C and +70°C [class 2K3 according to EN 60721-3-2].
- The Max humidity must be 95% (without condensation) [class 2K3 according to EN 60721-3-2].
- The system contains elements which are sensitive to electrostatic discharges. These elements can be damaged by careless manipulation.

Discharge static electricity from your body before touching the converter.

Avoid contact with material that insulates well (synthetic fibres, films of plastic material and so forth).

- We suggest to check the device condition at its arrival to survey eventual damages.
- Avoid shocks (the **Mack**® has class 2M1 is according to EN 60721-3-2).

Storage

The unused devices must be storage in an environment having the following characteristics:

- Temperature from -5°C to +45°C [class 1K3 according to EN 60721-3-1];
- Max relative humidity: 95% (without condensation) [class 1K3 according to EN 60721-3-1];
- Max time with the drive powered off (without supply connections): **1 YEAR**.

After this time, before enable the system, it is necessary activate the MACK POWER's capacitors following this procedure: remove all electrical connections, then supply the input terminals of the **MACK POWER** supply with the main voltage (three phase or single phase) for 30 minutes.

In details:

- For the **MACK POWER** 600 T having a power supply equal to 400VAC: power it by using a single phase (or three phase) supply equal to 230VAC;
- For the **MACK POWER** 300 T having a power supply equal to 230VAC: power it by using a single phase (or three phase) supply equal to 110÷130VAC.

In order to avoid this procedure, we suggest to power on the **MACK POWER** with its rated voltage for 30 minutes, before the Max time is reached.

- Avoid shocks (the **Mack**® has class 1M1 is according to EN 60721-3-1).

Maintenance



We recommend an *accurate maintenance plane*, according to using norms (for example CEI EN 60439-1).

In particular, we recommend the following:

- *If the casing is dirty*, clean it with isopropanol or similar;
- *If the drive is dirty*: the cleaning is reserved to the producer;
- ***Monthly clean drives from external dirt and dust deposits; pay particular attention on fans and grids cleaning.***

If the fans and grid are dirty, clean them by using a dry brush or an adequate air compressed jet.

ADOPT ALL NECESSARY MEASURE TO AVOID DUST DEPOSITS INSIDE THE DRIVE AND ON FANS.

- ***Monthly control the correct functioning of the drives fans (if present); in case of malfunctions contact Axor.***
- ***Monthly control the functioning of the extracted air filter and cooling air filter of the electrical cabinet, in particular control the functioning and cleaning of fans and filters.***

Disposal

The disposal should be carried out by a certified company.

2.1 General Advices

Security standard

- This manual is exclusively addressed to technical personnel with the following requirements:
 - ✓ Technician with knowledge on movimentation of elements sensitive to electrostatic discharges (for the transport).
 - ✓ Technician with appropriate technical training and with vast knowledge on electrotechnics/drive technical field (for the installation and operation of servodrives).

Using the drive incorrectly can injure people or damage things. Fully respect the technical data and indications on connection conditions.

- As well as the points described in this manual, current regulations regarding safety and accident prevention must be followed in order to prevent accidents and residual risks.

- The user must analyse possible machine risks and take the necessary measures to avoid injuries to people and damage to things because of unpredictable movements.

- The converters contains elements which are sensitive to electrostatic discharges. These elements can be damaged by careless manipulation.

Discharge static electricity from your body before touching the converter.

Avoid contact with material that insulates well (synthetic fibres, films of plastic material and so forth).

- During operation, the drive surface can become hot. Protect the user from accidental contact and keep the indicated distances from all objects.

- **Never loosen electrical connections while the drives are being powered. The appropriate terminals of the drive must always be connected to earth as instructed in this manual. After having disconnected the drives from the supply current, always wait at least 5 minutes before touching the powered components (e.g. contacts) or loosening connections.**



- Switch off the drive and wait at least 5 minutes before opening it. Remove the fuses or switch off the main switch before removing the drive. When opening, place the drive on a surface that does not belong to the electrical panel.

The residual charges in the capacitors can remain at a dangerous level for up to 5 minutes after disconnection from the mains. Measure the voltage at the intermediate circuit (+AT/-AT) and wait until it is below 15V.

- The command and power connections can still hold current even when the motor has stopped.

- The **Mack**[®] is equipped with electronic protections that deactivate it in case of irregularities. The motor, as a result, is not controlled and can stop or go into neutral (for a time determined by the type of system).

- During installation, avoid letting any residue with metallic components fall inside the drive.

2.1 General Advices

- Protect the **Mack**[®] from excessive mechanical vibrations in the electrical box.
- Check that the main supply and the nominal current are coherent with the rating of the drive. Be sure that the voltage between the connectors L1-L2-L3 is not greater than 10% of the nominal values. An excessively high voltage causes the breakdown of the load circuitry and of the drive.
- The **Mack**[®] is equipped with an integrated **EMI anti-disturbance filter** at the 3-phase power supply input and with another EMI anti-disturbance filter at the auxiliary +24V power supply input. Being implicit to filter operation the deviation towards earth or mass of the undesired frequencies, ensure that these devices can produce leakage currents towards earth, which are measurable in milliAmperes. **Please remember that "leakage currents" must be considered when settings differential devices in order to avoid useless interventions.** For safety reasons connect the prepared terminal to earth before powering the drive. Incorrect connections make filter operation unreliable.



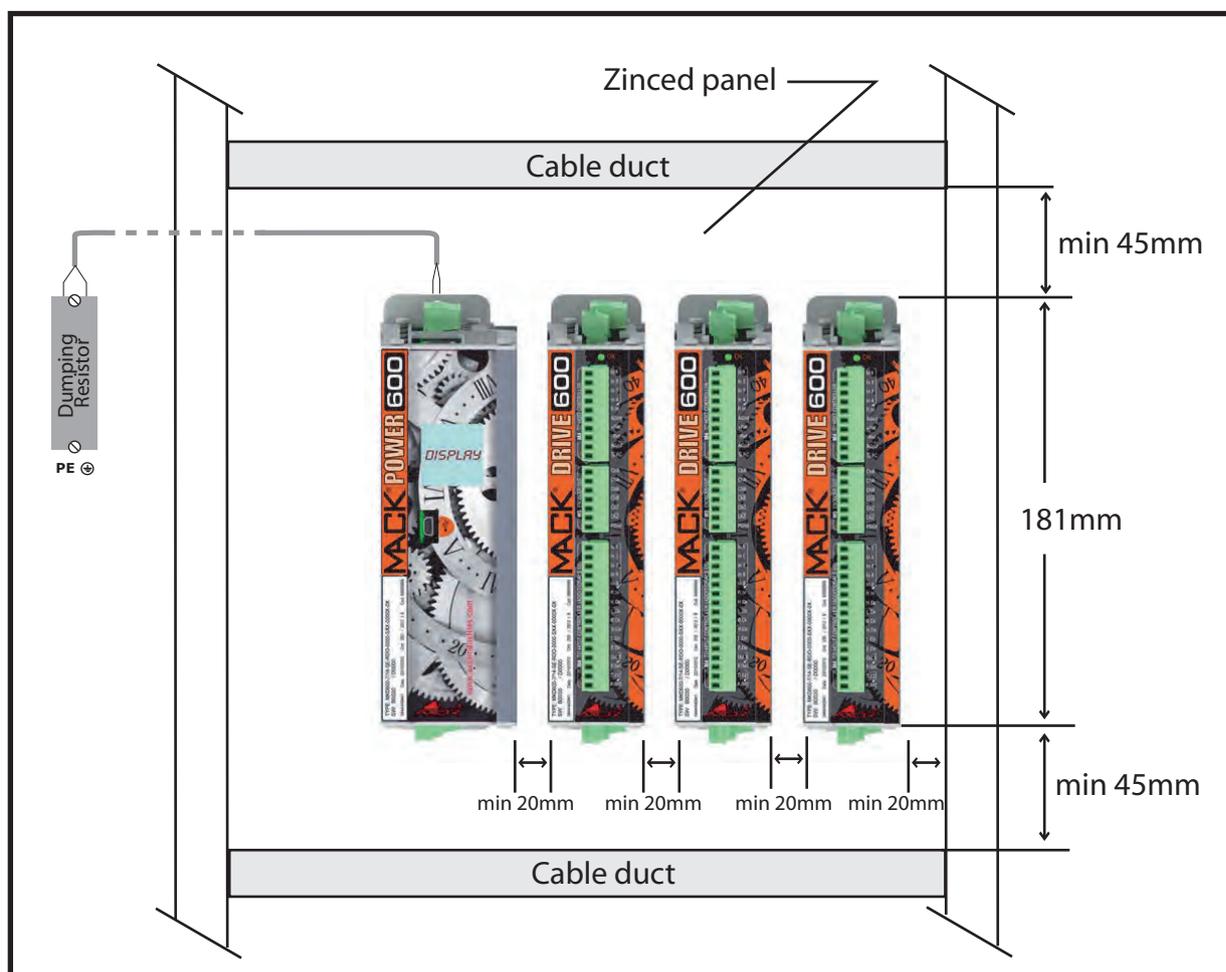
- The **Mack**[®] has the leakage current higher then 3.5mA, caused by the EMC filter and motor cable length. As a consequence, in accordance with norms CEI EN 61800-5-1 and CEI EN 60204-1, each drive requires a fixed connection, and it is necessary to use a protective conductor of at least 10mm² (copper), or an additional terminal for protective conductor, of the same cross-section area as the original protective conductor, has to be used. For the previous connections use the PE pin and the ground predisposed screw.

- **WARNING:**

The **Mack**[®] system meets limits of category C3 (second environment ⇒ industrial environment). In a domestic environment this product may cause radio interference in which case supplementary mitigation measures may be required.

2.2 Positioning

The **Mack**® is made to be fixed vertically to the **bottom of a closed electrical box** in order to guarantee reliable cooling, respecting the following distances:



Notes:

- ✓ Arrange the power components (converters, main's filters, resistors, terminals, ...) in bins of the electrical panel different from those reserved to the command or control systems (PLC, PC, CNC, regulators, ...). This improves the level of immunity to interference of the system.
- ✓ **Fix the drives on a conductive zinc-coated panel.**
- ✓ We recommend putting the drives **at least 20mm each other**.
- ✓ **Possibly connect the resistance externally to the zinc-coated panel utilising two screws.**
If the above solution is not practicable, connect the resistance inside the zinc-coated panel, but as far as possible above the drives and isolated from the zinc-coated panel.
In both cases, if the cable length is greater than 20/30cm, it must be twisted and shielded. The shield must be connected to ground on both ends, utilising U-clamps.

2.3 Environmental conditions

During the storage and the installation respect the followings *environmental conditions*:

Environmental conditions		
Ambient condition during operation	Temperature	From +5°C to +40°C (without condensation). From +40°C to +55°C the drive must be derated 2.5%/°C in reference to nominal and peak current. Class 3K3 according to EN 60721-3-3.
	Humidity	From 5% to 85% (without condensation). Class 3K3 according to EN 60721-3-3.
	Vibration	Class 3M1 according to EN 60721-3-3.
Ambient condition during transport	Temperature	From -25°C to +70°C . Class 2K3 according to EN 60721-3-2.
	Humidity	Relative humidity Max 95% (without condensation). Class 2K3 according to EN 60721-3-2.
	Vibration	Class 2M1 according to EN 60721-3-2.
Ambient condition during storage	Temperature	From -5°C to +45°C . Class 1K3 according to EN 60721-3-1.
	Humidity	Relative humidity from 5% to 95% (without condensation). Class 1K3 according to EN 60721-3-1.
	Vibration	Class 1M1 according to EN 60721-3-1.
Altitude	Up to 1000m without restriction. From 1000 to 2500m of altitude the converter must be derated in the output current of 1.5% every 100m .	
Enclosure protection	IP20	
Pollution level	LEVEL 2 (according to norm EN60664-1) The drives are designed to be utilized in an electrical box protected against the infiltration of polluting agents such as water, oil, conductive dust and others. <u>Do not permit the dust accumulation inside the drive, on grids and fans [see Notes].</u>	

Notes:

- The electrical box must have suitably **filtered air vents**.

Leave the necessary space both above and below the drives.

 **You must pay particular attention to the sizing of the (eventual) cooling system, remembering that the electrical box size and power internal dissipation of the drive(s) and braking resistors (if positioned inside of the electrical box).**

Monthly control the functioning of the extracted air filter and cooling air filter of the electrical cabinet, in particular control the functioning and cleaning of fans and filters.

- Monthly** check the internal cleaning of the electrical panel and define an **accurate cleaning plane**, according to using norms (for example CEI EN 60439-1).
- Monthly** check drive case and fans for excess dust or dirt, that could interfere with the correct dissipation of the drive.

2.4 Cables

The following table illustrates the recommended technical characteristics of all cables:

Cables (as norm EN60204)		
Type	Section	Notes
MACK POWER main supply	2.5mm ²	Always insert a fuse (see cap. 1.3 Technical Data on page 11) or a power protective switch on every phase of the products power supply.
DC BUS	2.5mm ²	The cable must be as short as possible.
Back UP supply	1.5mm ²	Connect the 0V of the auxiliary supply to the ground bar.
motor's brake	1mm ²	It must shielded.
motor's power	1.5/2.5mm ²	It must be shielded. It must have a capacity of ≤150pF/m. In the configuration without filter, the cable can reach a maximum length of 20/25m. If the length exceeds 20/25m, insert an Axor 3x1.2mH filter.
control signals and I/O signals from PLC/CNC	0.5mm ²	<i>see cap. 2.6 Note about cable shielding on page 24</i>
hybrid cable (power + serial encoder)	4x1.5mm ² / 2x1mm ² / 2x0.2mm ²	Shielded (drive side connect the shield to ground, utilising U-clamps to the zinced panel of the electrical box). The cable length must be 20m Max. Provided by Axor..
external resistor	1.5mm ²	If the cable length is longer than 20/30cm, it must be twisted and shielded. The shield must be connected to ground on both ends, utilising U-clamps to the zinced panel of the electrical box.
mack link	-	Provided by Axor.
SpeederOne interface	-	Mini USB B 5P to USB A type male. The cable length must be 3m Max.
CanBus communication	0.25mm ² / 0.34mm ²	Cable capacitance: Max 60 nF/km. Impedance characteristics : 100...120Ω. Lead resistance (loop): 159,8 Ω/km The length depends upon the transmission speed: • 1000kbit/s ⇒20m Max; • 500kbit/s ⇒70m Max; • 250kbit/s ⇒115m Max. On request Axor provides the RJ45 cable (for connecting drives together) and the terminal resistor.
EtherCAT communication	26-27AWG	CAT. 5E (Min) - 6A (suggested) / SFTP

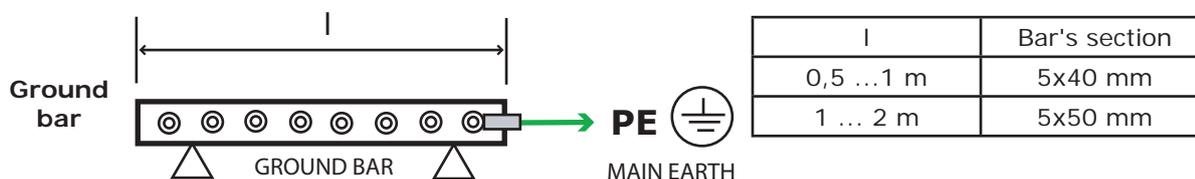
Note:

- Use only copper conductors for cabling.
- Avoid crossing, overlapping and twisting cables together. If it is absolutely necessary to cross them, do so at 90°.

2.5 Connection to ground and earth

Make sure that the **MACK POWER**, **MACK DRIVE** and the motors are connected to earth in accordance with the current norms.

This connection must be done by using a copper bar, mounted on insulating supports:



then follow these indications:

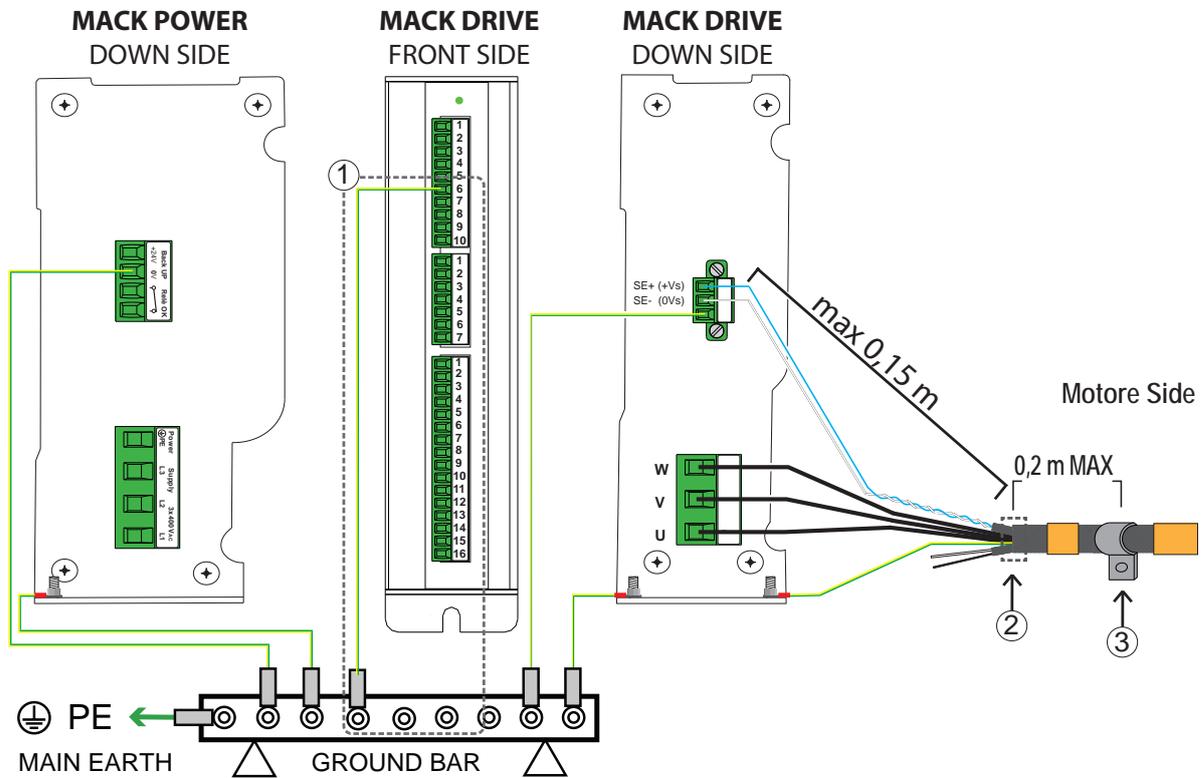
1. **All yellow/green cables** used for ground connections must have **a section greater or equal** then the power one (according to norm CEI 64-8).
2. Connect to the ground bar:
 - ✓ The **earth power terminal of the MACK POWER (PE pin of the main supply connector)**;
 - ✓ The **CHASSIS** of the **MACK POWER** (using the predisposed screw);
 - ✓ The **CHASSIS** of all **MACK DRIVES** (using the predisposed screws);
 - ✓ The **AGND** (pin AGND of **SE Serial Encoder** connector, or **pin 1** of **AE Absolute Encoder** connector) for each Mack Drive;
 - ✓ The **OV of the auxiliary supply**;
 - ✓ The **internal zero voltage of the CNC**;
 - ✓ The **earth terminals of the PLC/CNC frames**;
3. Connect the **ground bar** to the **main earth (following prescriptions of CEI 64-8 norm)**.
4. Connect the shield of the control signal to ground by using an U-clamp (see "2.6 Note about cable shielding").
5. Connect the PE terminal of the motor power cable to the **MACK DRIVE's** chassis by using the predisposed screw.

The table below illustrates the symbols used in the following pages:

Symbol	Description
	It suggests a conductive connection as much as possible to the chassis, or the heat-sink, or the mounting panel of the electrical box.
	It refers to the connection to the ground bar.
	It refers to the connection of the shield to the connector's metal ring.

2.5 Connection to ground and earth

The scheme below show the connection of ground and earth:



NOTE:

- ① Connected when the feedback is Commutation Encoder or absolute encoder.
- ② Internal and external shield wrapped together.
- ③ Uclamp (connect it to the cabinet's metal back plane PE ⊕).

2.6 Note about cable shielding

Control signal cables

The conductor of the analogical signal must be twisted and shielded, and the shield must be connected to ground ⇒ remove the outside sheath and affix the shield to the zinc panel by using a U-clamp.

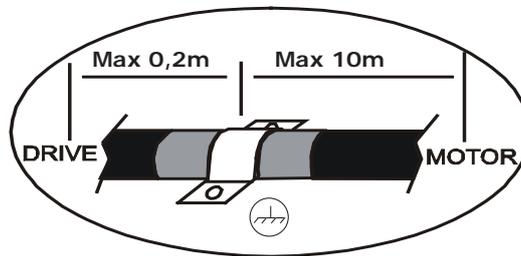
To reduce the capacitive and inductive coupling, these cables must be run keeping a distance of more than 30cm from the power cables (10 cm if they are shielded).

If it is absolutely necessary to cross the control cables with the power's, do so at 90°, in order to reduce the effect of the magnetic fields.

Motor cable

The shield of the motor cable (hybrid cable) has to be connected as follows:

- *drive side* ⇒ remove the outside sheath and fix shield to the zinc panel, by using a U-clamp:



2.7 Base installation procedure



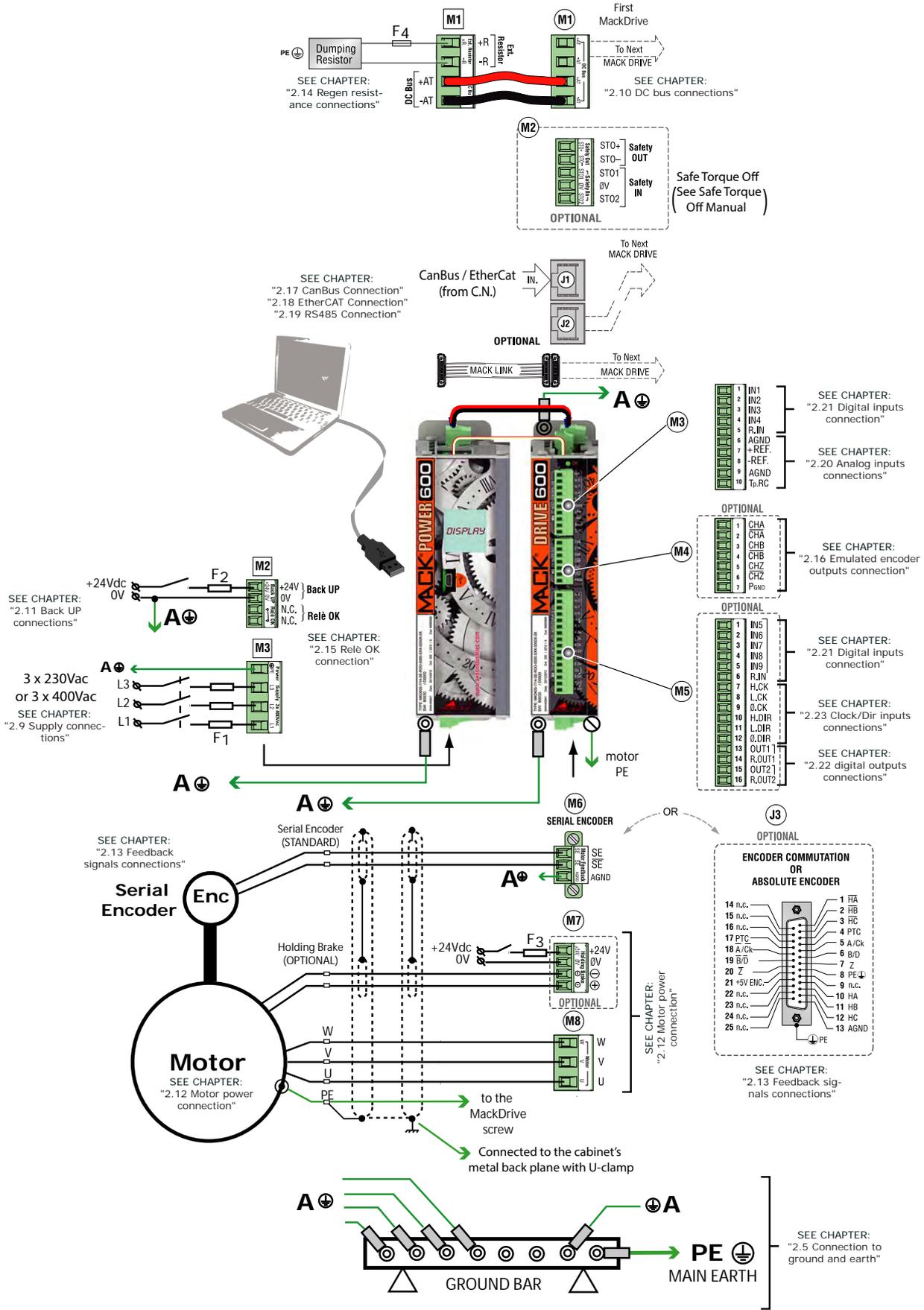
This procedure must be done only by qualified personnel which are familiar with drives.

- a) **Power off** all the supplies of the electrical box.
- b) Verify:
 - ✓ The **drive-motor coupling** \Rightarrow the stall current (I_o) of the motor should be equal to/or greater than the nominal output current of the drive;
 - ✓ The **positioning** of the drive into the electrical box;
 - ✓ The **pollution level** and the **ventilation**;
 - ✓ The **connection to earth** of the electrical box where the drive is installed (*see cap. 2.5 Connection to ground and earth on page 22*).
- c) Execute the wiring following this order, avoiding that wiring's pieces, cables, wires, screws, conductive objects, etc. do not enter into the drive through its slits:
 - 1- First connect **the ground bar to earth**.
 - 2- Connect the **cables for the motor's power** (U, V, W) and the Axor **3x1.2mH filter**, if the cable length is greater than 10m.
 - 3- Connect the **earth of the motor's power** (PE) to the **MACK DRIVE's** chassis by using the predisposed screw and, if necessary, connect the cables of the **electromechanical brake** and the cables for the **brake supply** (0/+24Vdc). [If there is the brake insert the F_3 fuse]
 - 4- Connect the **external shield** of the motor's cable: it must be shielded utilising an U-clamp to the zinc panel of the electrical box (*see cap. 2.6 Note about cable shielding on page 24*).
 - 5- Connect the **external braking resistor** between pins +R and -R of the **MACK POWER M1** connector. The cable must be twisted and shielded, besides the shield must be connected to ground on both ends utilising U-clamps to the zinc panel of the electrical box. Insert the F_4 fuse.
 - 6- Connect the motor's feedback cable.
 - 7- Connect the **earth cable** (PE) and the **main power supply cable** (L1-L2-L3) in the **MACK POWER**. **Always insert a fuse** (*see cap. 1.3 Technical Data on page 11*) or a power protective switch on every phase of the products power supply..
 - 8- Connect the **Back UP supply cable** (+24V) in the **MACK POWER**. Use an external power supply, that must be stabilized and galvanically isolated from the main supply. Insert the F_2 fuse.
 - 9- Connect the **DC Bus Supply** from the **MACK POWER** and the first **MACK DRIVE**, and from each **MACK DRIVE** to the next, between pins +AT and -AT using a cable as short as possible.
 - 10- Connect the **Mack Link** from the **MACK POWER** and the first **MACK DRIVE**, and from each **MACK DRIVE** to the next.
 - 11- Connect the PC to the **MACK POWER** utilising an **USB** cable. The cable length must be 3m Max.
 - 12- Supply the **MACK POWER** with the **Back UP supply** and then the **main supply** following the procedure at *cap. 2.25 Power up on page 47*.
 - 13- Open the *Speeder One* interface.
 - 14- Execute the tests on the drive and the motor.

In the following page there is an *example of a basic connection*.

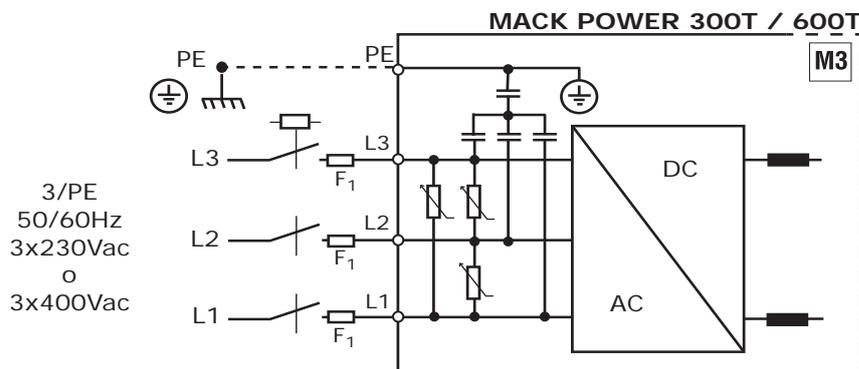
2.8 Example of base connection

2



2.9 Supply connections

3-PHASE POWER SUPPLY (MKP 300T / 600T)



Note:

- **MACK POWER 300T / 600T** need to be supplied from a 3-phase grounded industrial supply network, TN-system or TT-system (overvoltage category III according to EN61800-5-1).

- **Always insert a fuse (see cap. 1.3 Technical Data on page 11) or a power protective switch on every phase of the products power supply.**

- If the utilized power supply system has not ground protection, or there is an asymmetrical grounding system, it is necessary to use an **isolation transformer** with secondary star connection and star center to protective earth.

The **nominal power of the transformer** is calculated by adding the various wattage of each motor:

$$P_t = P_n + P_n + P_n + \dots$$

P_t = nominal power of the transformer (VA)

P_n = nominal power of each motor (VA), which can be calculated in this way:

$$P_n = n \times C_n / 9,55$$

P_n = nominal motor power (W)

n = motor speed (rpm)

C_n = motor nominal torque (Nm)

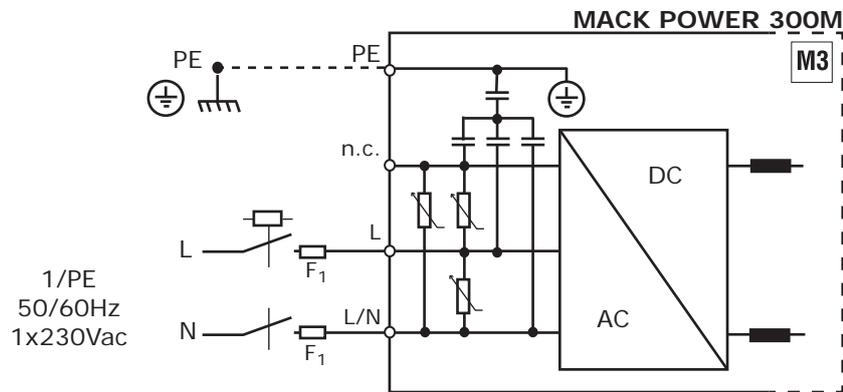
However, if there are axes having alternate functioning, the power of the transformer can be reduced.

- **This product can cause a DC current in the protective conductor. Where a residual current device (RCD) is used for protection in case of direct or indirect contact, only an RCD of Type B is allowed on the supply side of this product. Otherwise, another protective measure shall be applied, such as separation from the environment by double or reinforced insulation, or isolation from the supply system by a transformer [according to CEI EN 61800-5-1].**



2.9 Supply connections

1-PHASE POWER SUPPLY (MKP 300M)

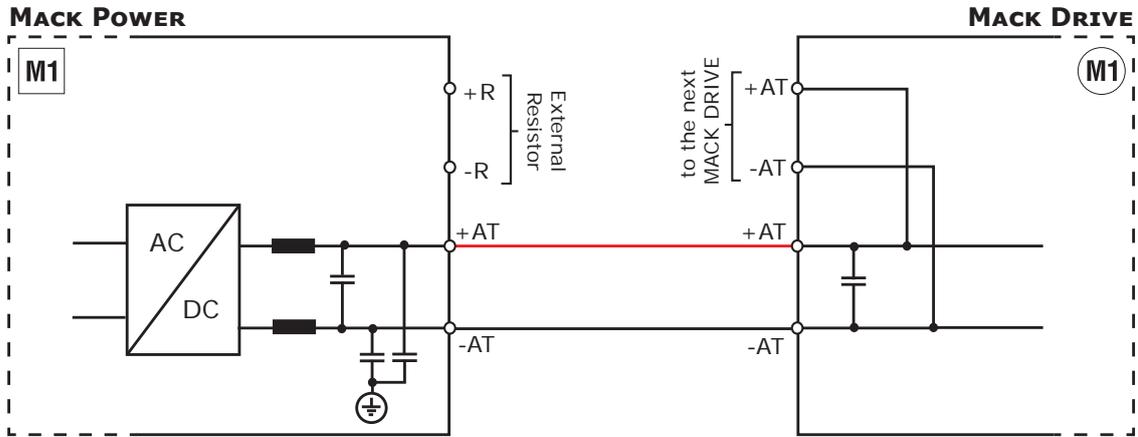


Note:

- **MACK POWER 300M** need to be supplied from a 1-phase grounded industrial supply network.
- The single phase model doesn't permit to reach the Max performance with all the MKD 300 sizes.

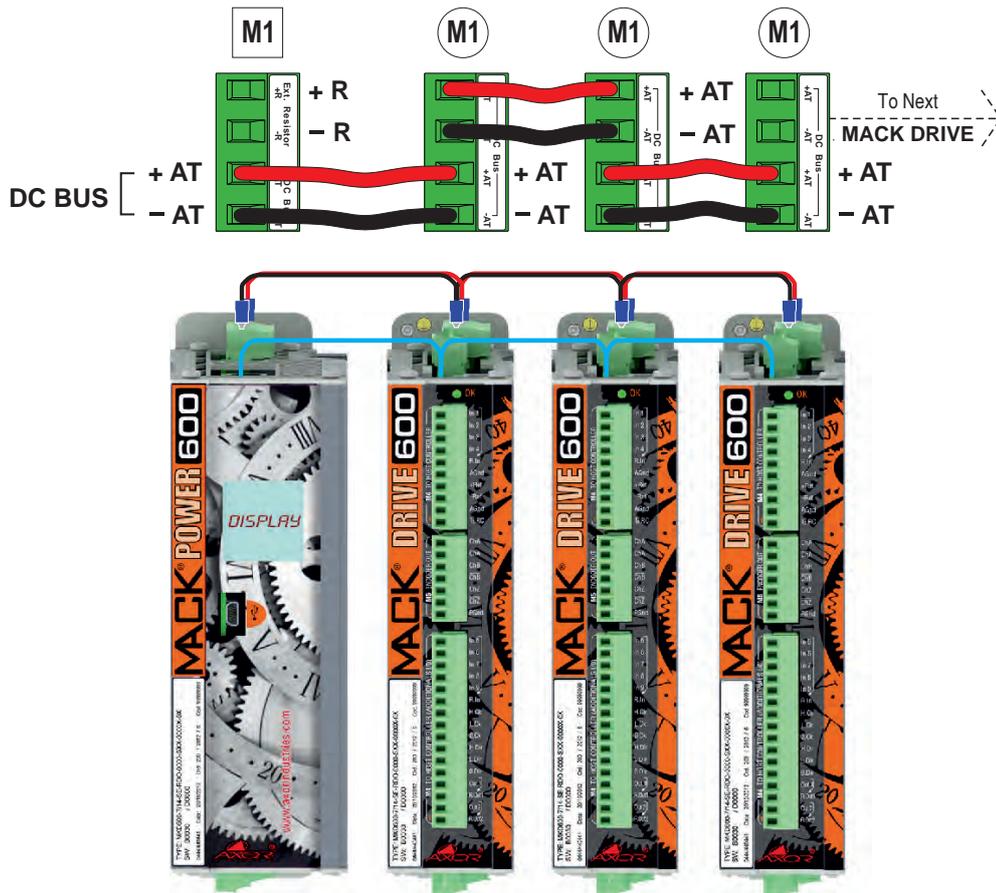
2.10 DC bus connections

DC BUS



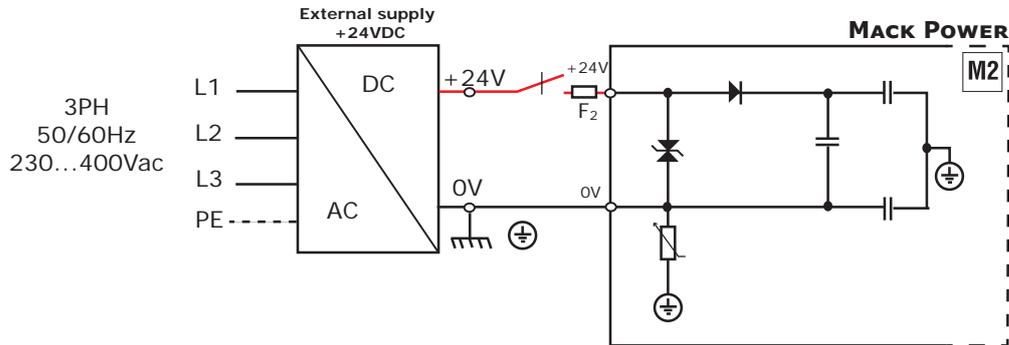
Note:

- The DC bus cables must be as short as possible.



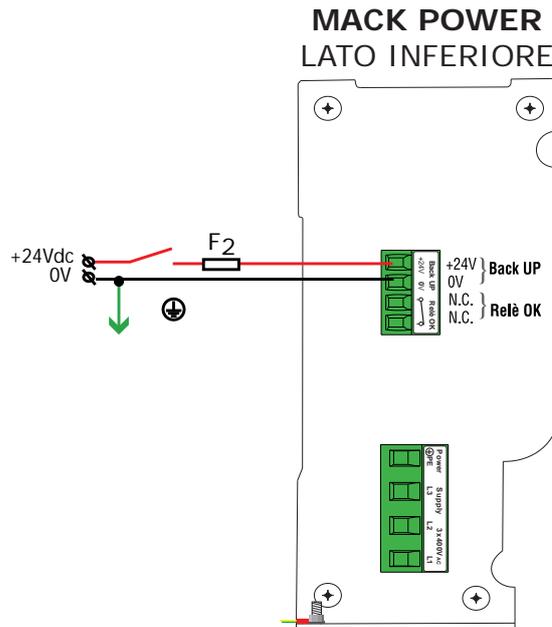
2.11 Back UP connections

Back UP SUPPLY +24Vdc



Note:

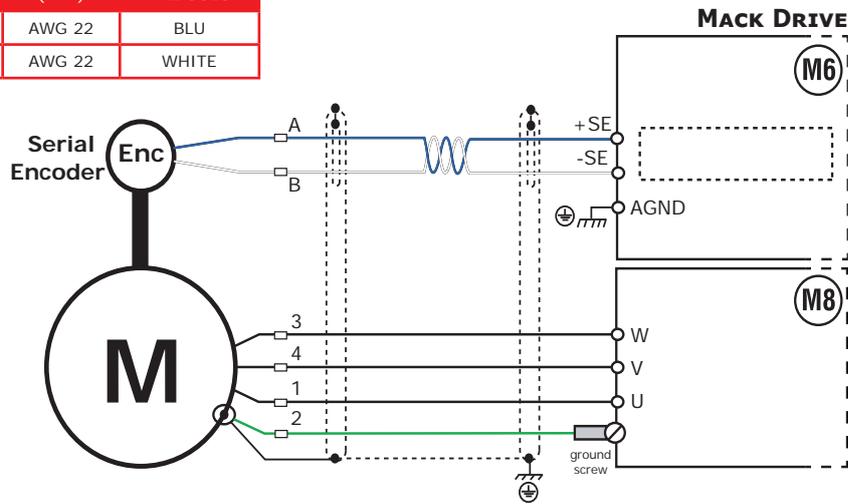
- Accepted voltage: **+24VDC** ($\pm 10\%$);
- Max current required for the external supply: **2.5A** (0.25A for each **MACK DRIVE** supplied by the **MACK POWER**);
- We suggest to insert the **F₂** (4AT/250V T-type) fuse;
- Remember to connect to the ground bar the 0V pin of the M2 connector of the **MACK POWER**.
- The MACK system works fine without the Back Up in case the following function isn't used: Emulated Encoder, EtherCAT and historical of alarms.



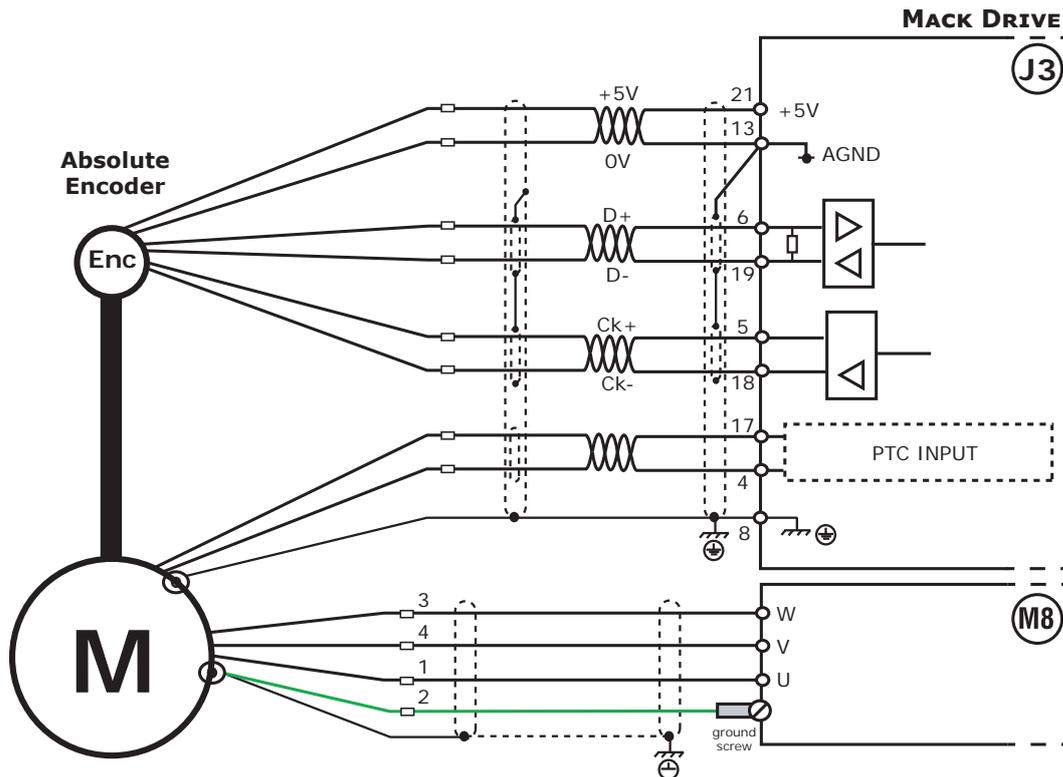
2.13 Feedback signals connections

SERIAL ENCODER FEEDBACK connection

FUNCTION	(MM ²)	WIRE COLOR
SE + (SER.ENC)	AWG 22	BLU
SE - (SER.ENC)	AWG 22	WHITE

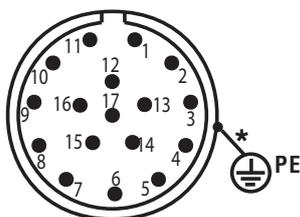
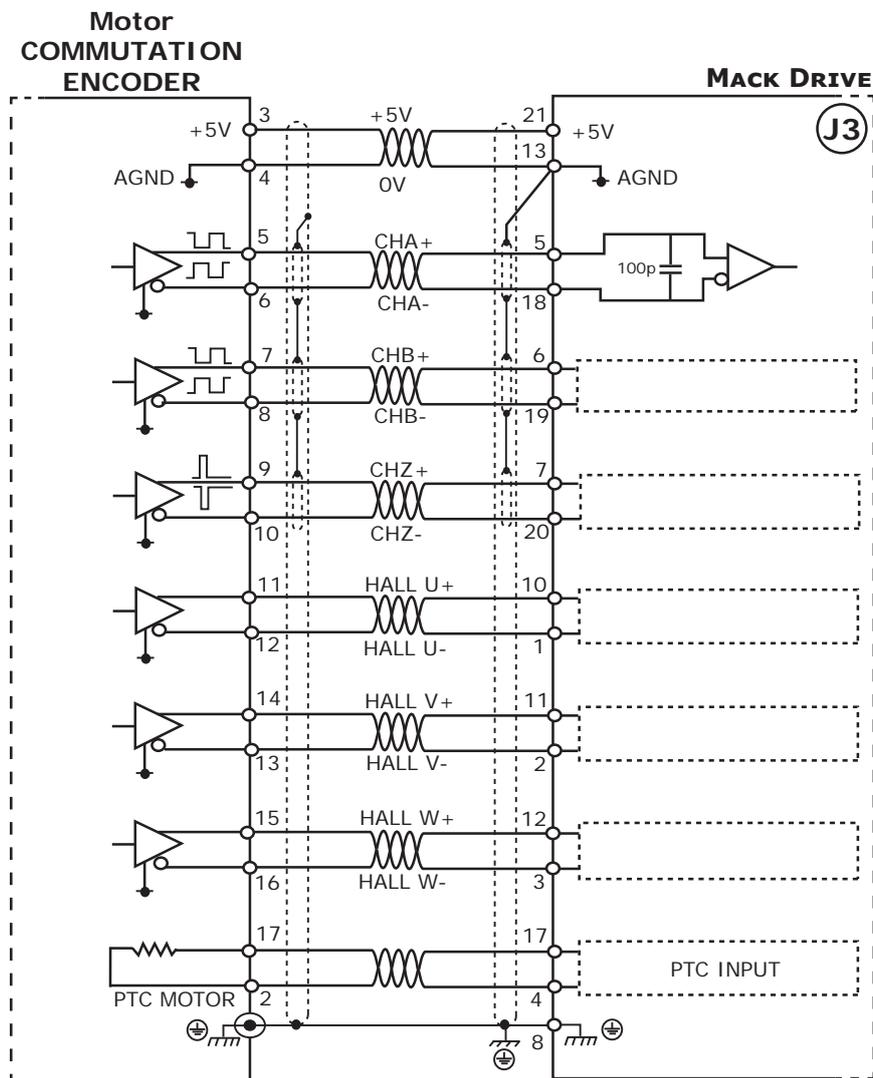


ABSOLUTE ENCODER FEEDBACK connection

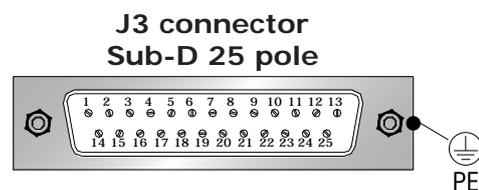


2.13 Feedback signals connections

COMMUTATION ENCODER FEEDBACK connection



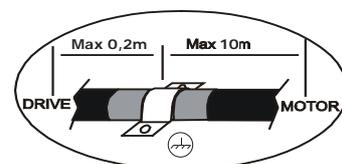
17 pole connector
(Encoder)



J3 connector
Sub-D 25 pole

If the motor has not the thermal protection (PTC MOTOR) you should bridge pins 4 and 17 on the "J3, Sub-D 25 pole" connector of the drive.

Note: The **ground connection** of the external shield must be made on the zinc-coated panel (using a U-clamp) near the drive (Max. 20cm). Motor side: the shield is connected to connector's metal ring.



2.14 Regen resistance connections

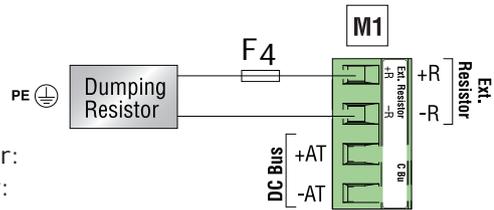
EXTERNAL REGEN RESISTANCE connection

For the **MACK POWER 300** it is possible to use:

- One external resistance: **22 ohm - 160W** (standard);
- One external resistance: **22 ohm - 500W** (optional);

While for the **MACK POWER 600** it is possible to use:

- One external resistance: **39 ohm - 100W** (standard); or:
- One external resistance: **33 ohm - 160W** (optional); or:
- One external resistance: **33 ohm - 500W** (optional); or:
- Two external resistances: **66 // 66 ohm (1000W)** (optional).

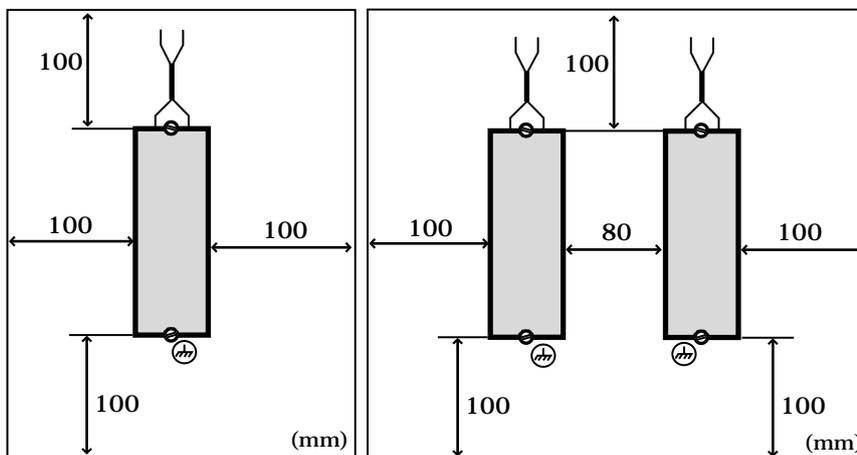


Notes:



• The resistance must be connected to the zinc panel utilising two screws, possibly out of the panel or, if it is not possible, inside the panel but as far as possible above the **MACK POWER**.

- If the resistance cable length is greater than 20/30cm, it must be twisted and shielded. The shield must be connected to ground on both ends, utilising U-clamps to the zinc panel of the electrical box.
- Insert the fuse **F₄** (**5A T / 600V** T-type).
- The temperature of the zinc panel of the electrical box can be higher than 200°C.
- Do not mount the resistor on surfaces which can be damaged by heat.
- If the resistors are mounted externally, protect them.
- Respect the distances and shieldings illustrated in figure below.



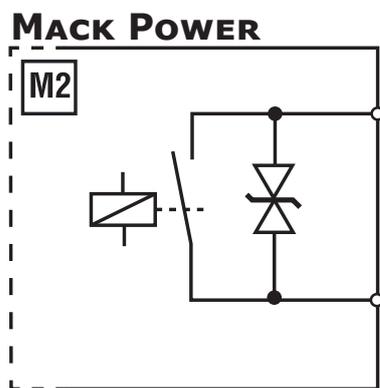
Note: In accordance with the used resistance, we recommend to correctly set the *Regen Resistance* parameter in the main window of **MACK POWER** in the *Speeder One* interface.

2.15 Relè OK connection

RELE' OK

It is normally open when the system is not supplied; it is normally closed when the system is supplied and the connected **MACK DRIVES** and **MACK POWER** has not active alarms

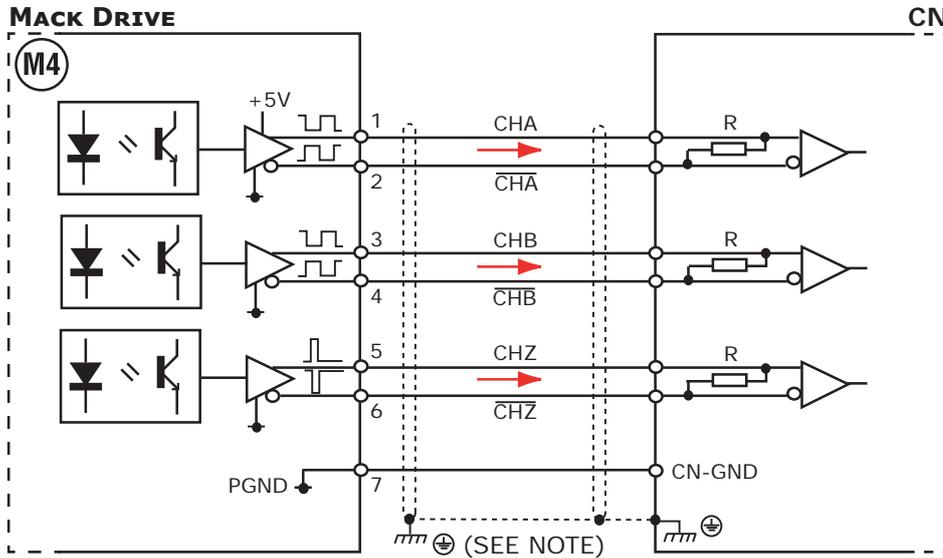
The rated load for the contact is: 0,3A - 125VAc / 1A - 24Vdc .



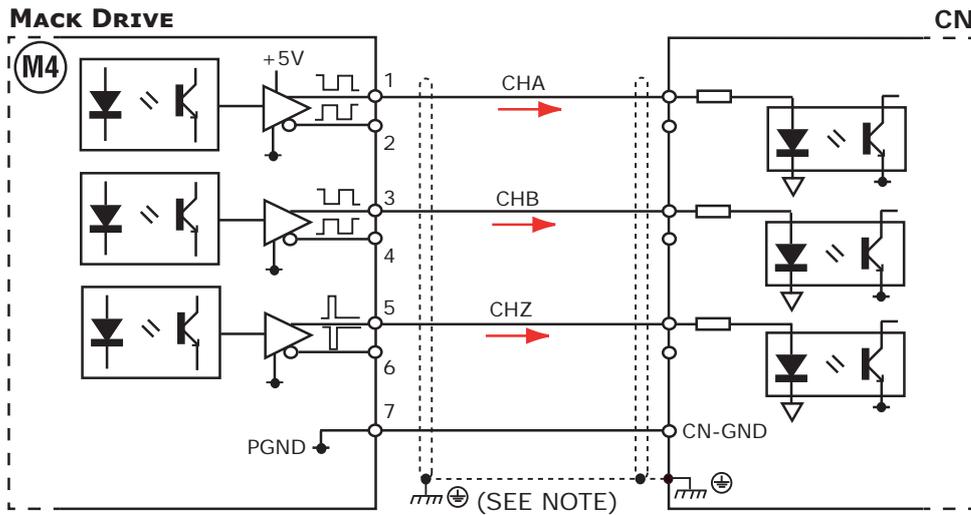
2.16 Emulated encoder outputs connection

EMULATED ENCODER OUTPUTS connection

LINE RECEIVER CN inputs



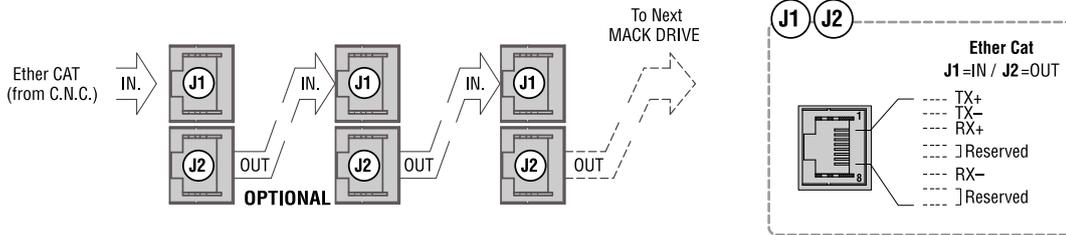
COMMON MODE CN inputs



Note: We suggest connecting the shield on both sides.

2.18 EtherCAT Connection

EtherCAT connections



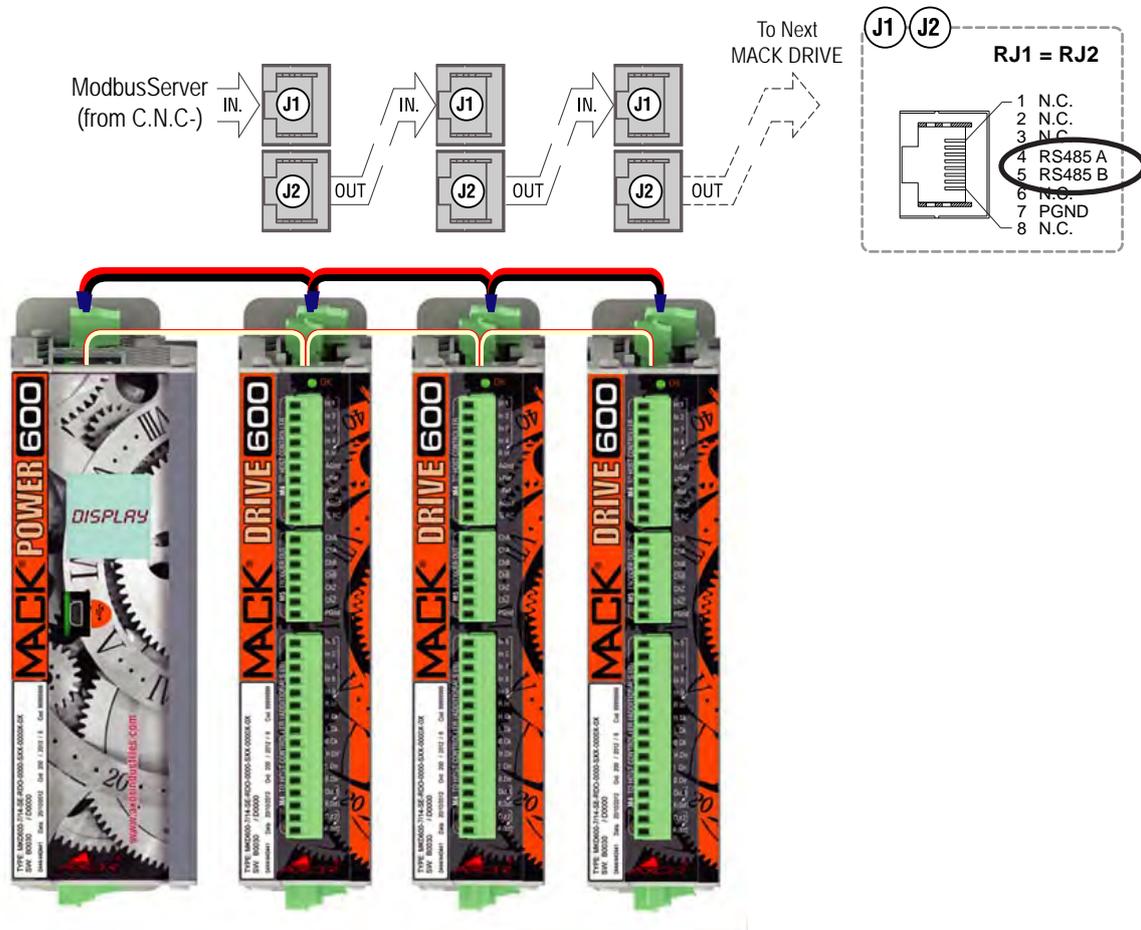
Notes:

- Respect the input and output of the RJ45 connectors:
 J1 = Input;
 J2 = Output;
- For the settings *see cap. 4.13 EtherCAT - Settings on page 116.*

2.19 RS485 Connection

RS485 Connection

In order to connect the ModBus RS485 interface, use pins 4 (for RS485 A) and pins 5 (for RS485 B), of RJ1 and RJ2 connector:

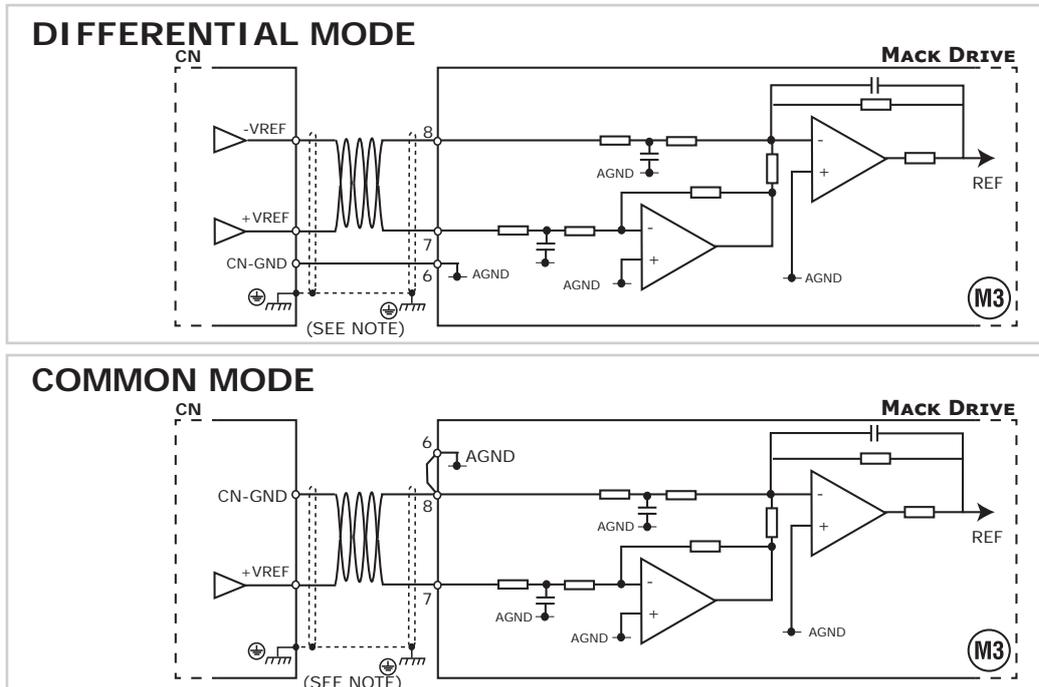


Notes:

- Is recommended to connect a **RESISTOR (120 Ohm, 1/4W)** between pins **4** and **5** on each end of the line of the same value of the twisted cable used as the line in order to avoid signal reflections.
- Respect the input and output of the RJ45 connectors:
J1 = Input;
J2 = Output;
- See "**Manual Modbus MackDrive**" for a more detailed description about the ModBus RS485 protocol implemented on the drive.

2.20 Analog inputs connections

ANALOG DIFFERENTIAL OR COMMON MODE INPUTS (+/-REF)

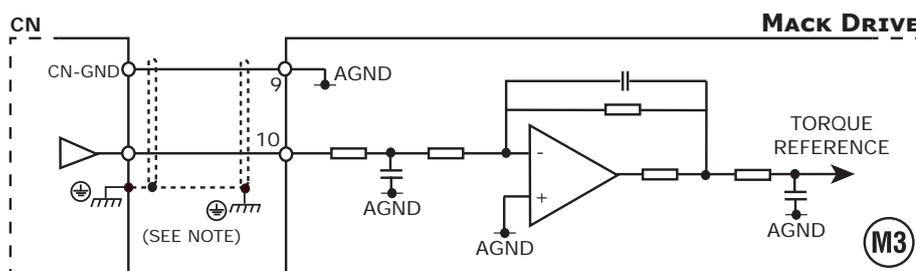


The **technical characteristics** of these inputs are as follows:

- Voltage: 10V Max Diff.
- Input impedance: 50k ohm.

To change the sense of rotation, apply the positive voltage reference to **M3-8**, or change the **Rotary Direction** parameter in the **Speed** window (from **Positive** to **Negative**).

ANALOG COMMON MODE INPUT (*Tp.RC*) used as torque analog reference



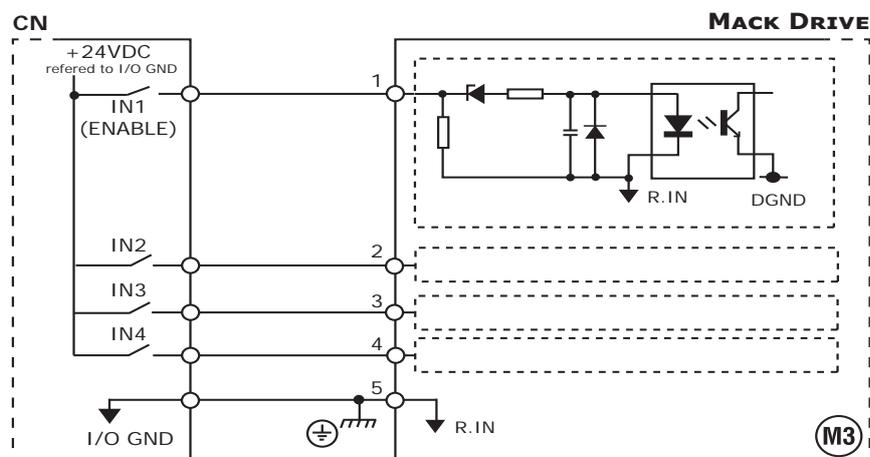
The **technical characteristics** of *Tp.RC* input are as follows:

- Voltage: $\pm 10V$ Max.
- Input impedance: 25k ohm.

Note: We suggest connecting the shield on both sides.

2.21 Digital inputs connection

DIGITAL INPUTS connection



Note:

- The enable signal should be **+24VDC-7mA** (PLC compatible). The inputs are *enabled* with a voltage between **+14V Min** and **+30V Max**; they are *disabled* with a voltage less than **+5VDC max**.

- The **M3-1 (ENABLE)** AND **M5-1** terminal is used only as the drive's enable. If ENABLE is HIGH the drive is enabled (without active alarms and if start up sequence is respected); if ENABLE is LOW, the motor is without torque.

ATTENTION: THE DRIVE'S ENABLE/DISABLE, BY USING THE ENABLE INPUT, IS NOT CONSIDERED A SECURITY FUNCTION.

- The **M3-2/3/4** (standard) and **M5-2/3/4/5** (optional) *programmable* inputs can be used to activate pre-programmed functions of the drive (for example: limit switch , electromechanical brake, homing and positioning procedures, emergency stop, etc.).

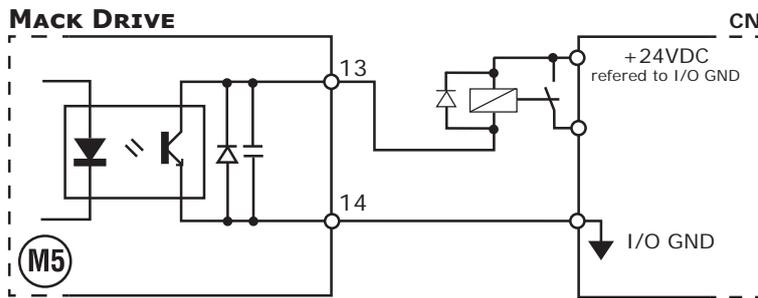
For a detailed description of the pre-programmed functions *see cap. 3.11 Digital I/O window Mack Drive on page 71.*

- Connect **M3-5 (R.IN)** and **M5-6 (R.IN)** pin to the ground bar of the system.

2.22 digital outputs connections

DIGITAL OUTPUT Connection (example)

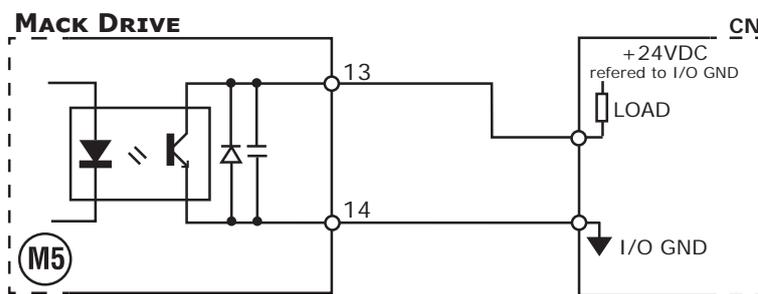
Esempio 1:



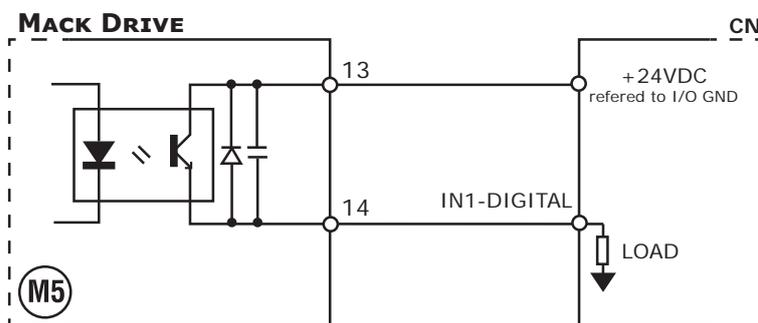
Max. load for each output:
50[mA].

Always use a relay with a diode
in parallel.

Esempio 2:



Esempio 3:

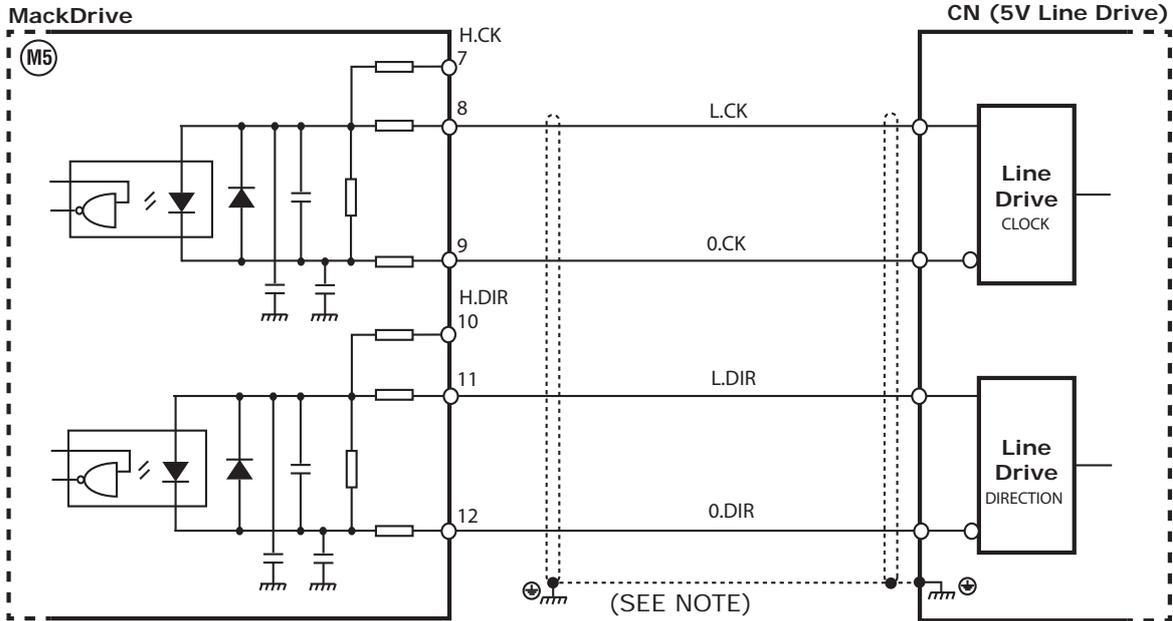


This digital output can be used to send messages from the pre-programmed function of the drive.
For a detailed description of the pre-programmed functions *see cap. 3.11 Digital I/O window Mack Drive on page 71.*

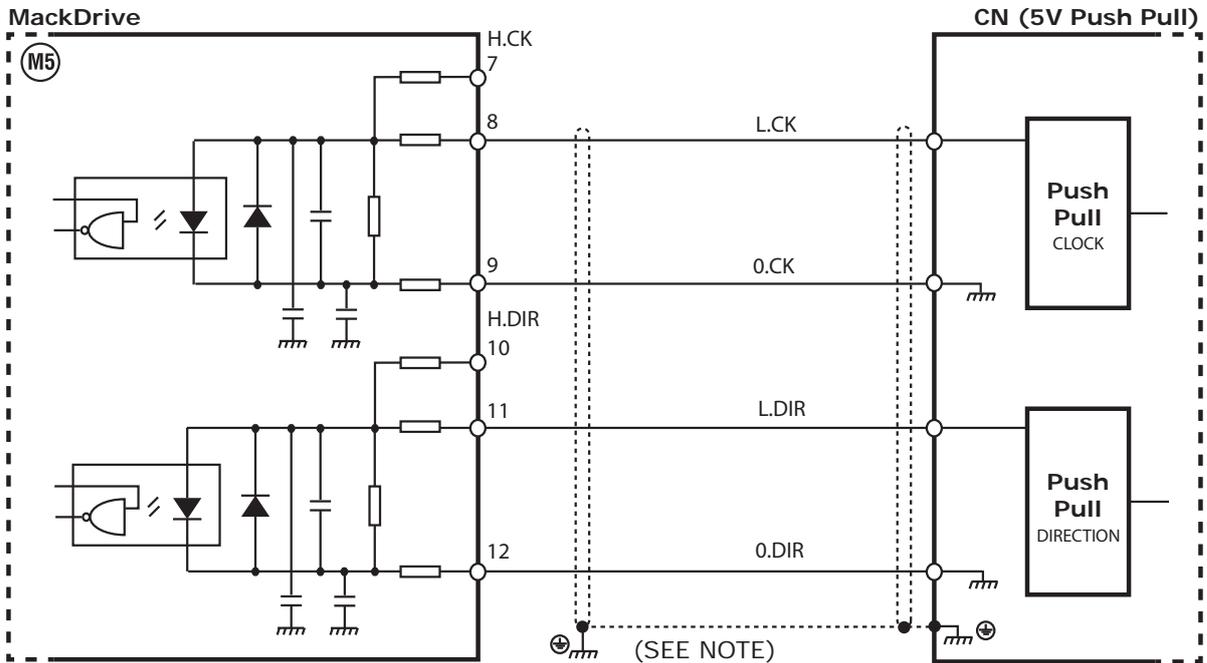
2.23 Clock/Dir inputs connections

CLOCK/DIRECTION MODE connections

5V Line Drive control



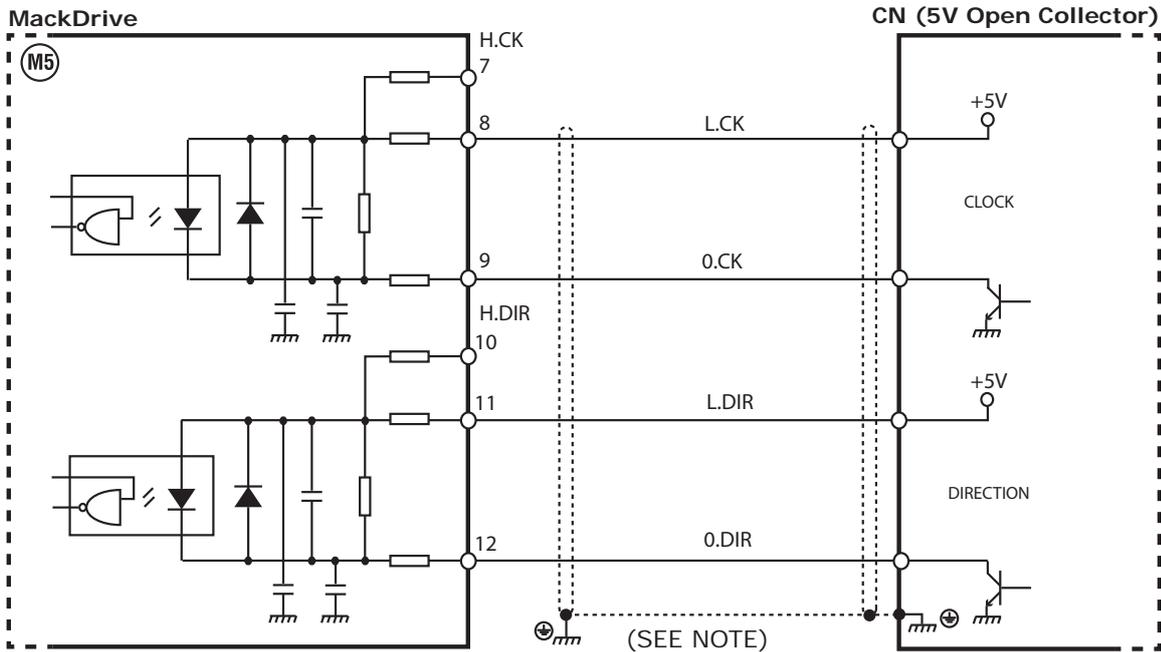
5V Line Drive control



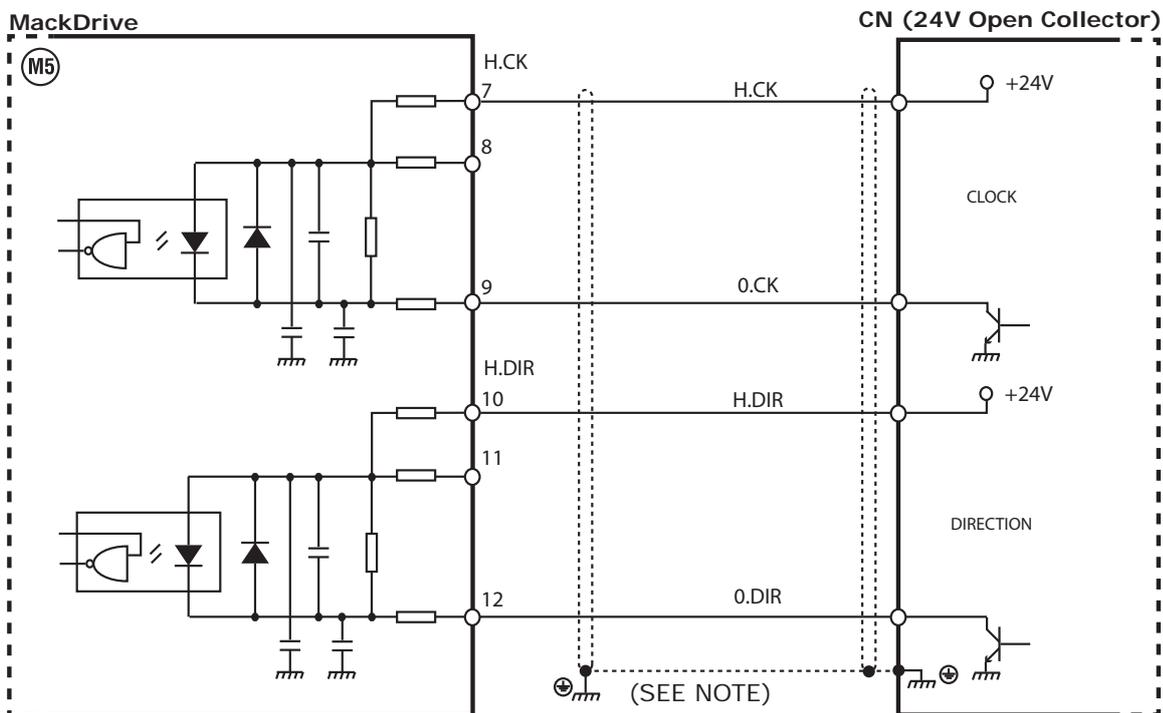
Note: We suggest connecting the shield on both sides.

2.23 Clock/Dir inputs connections

5V Open Collector control



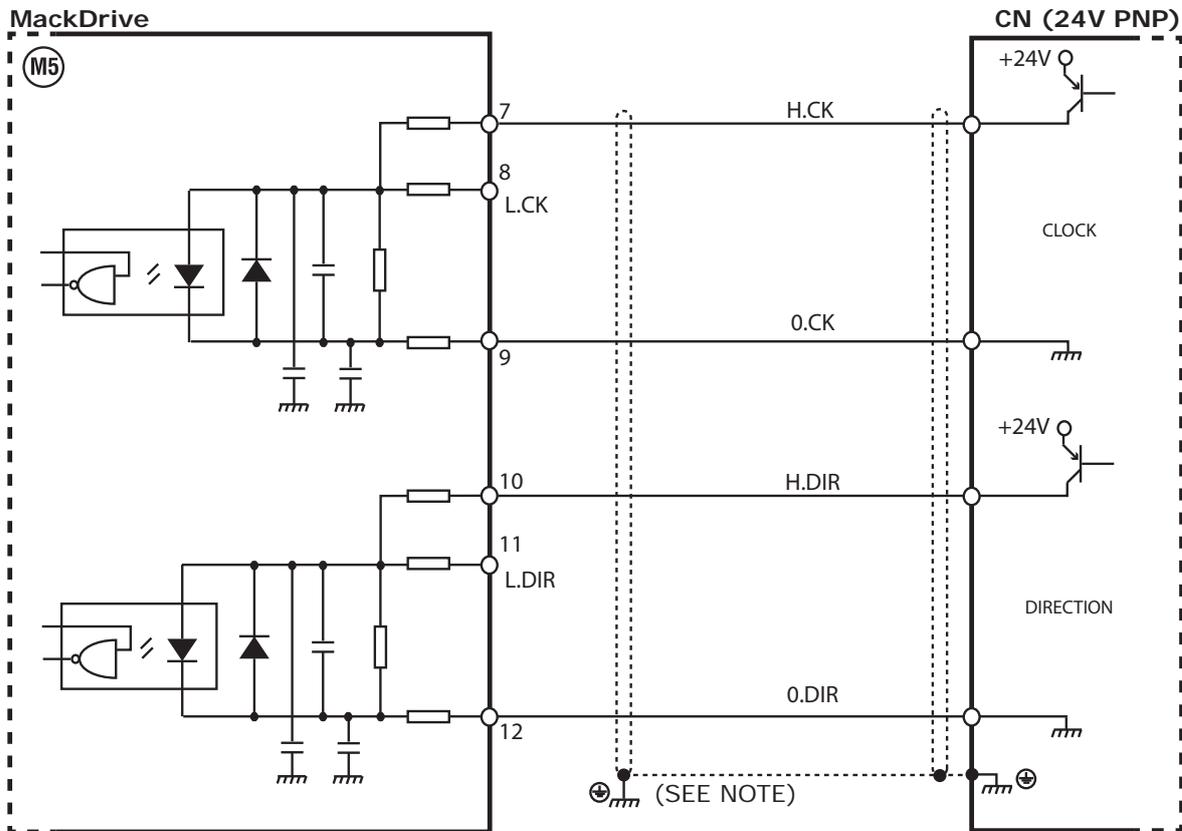
24V Open Collector control



Note: We suggest connecting the shield on both sides.

2.23 Clock/Dir connections

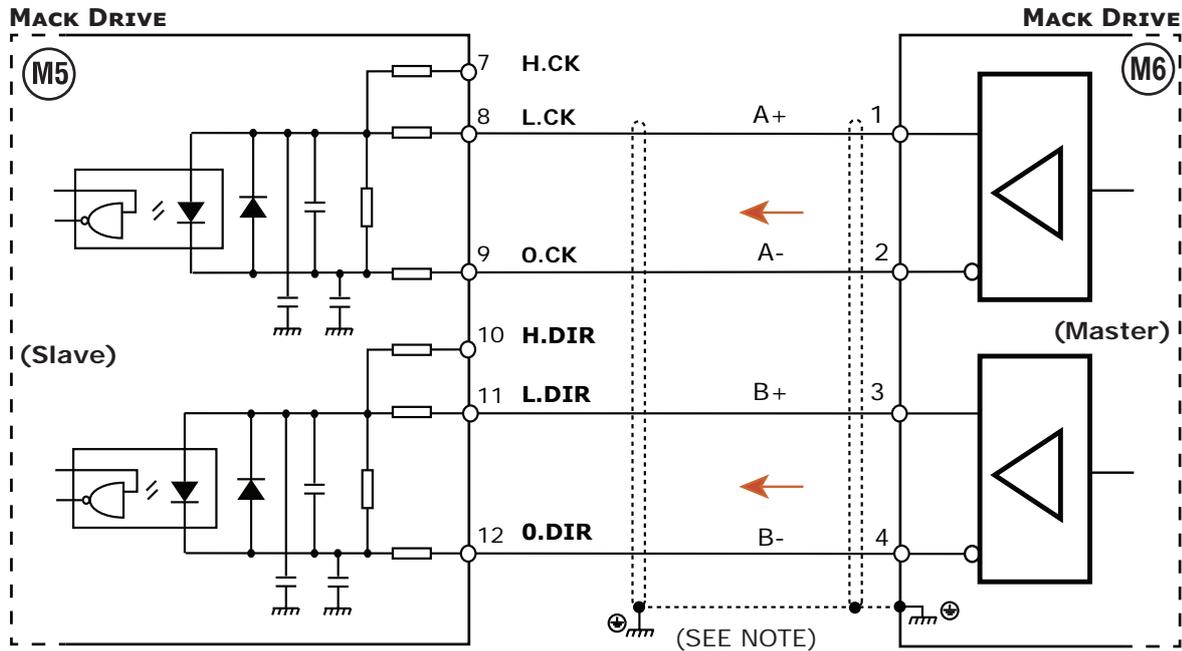
24V PNP control



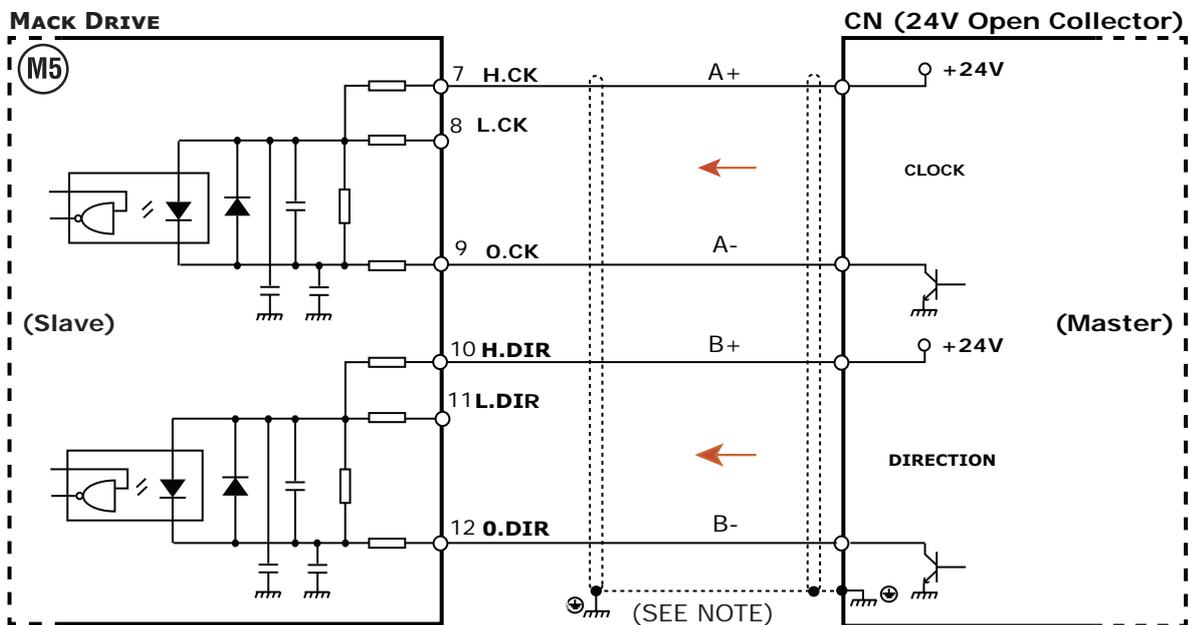
Note: We suggest connecting the shield on both sides.

2.24 Gearing connections

GEARING MODE connection (5V signal)



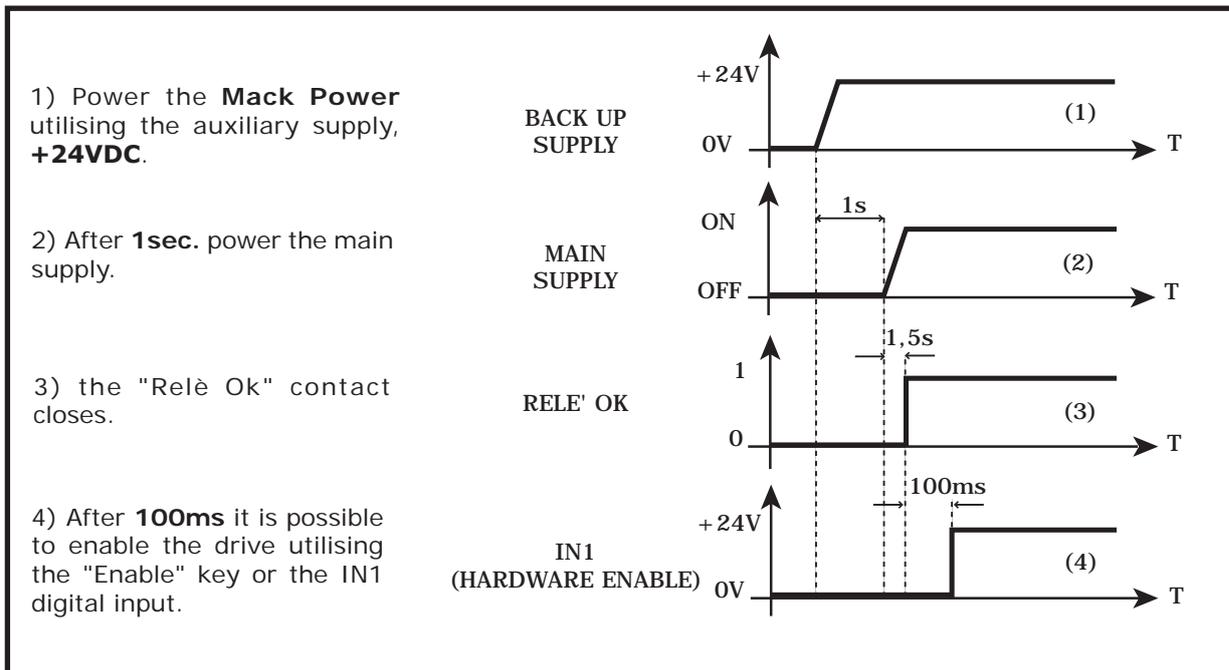
GEARING MODE connection (24V signal)



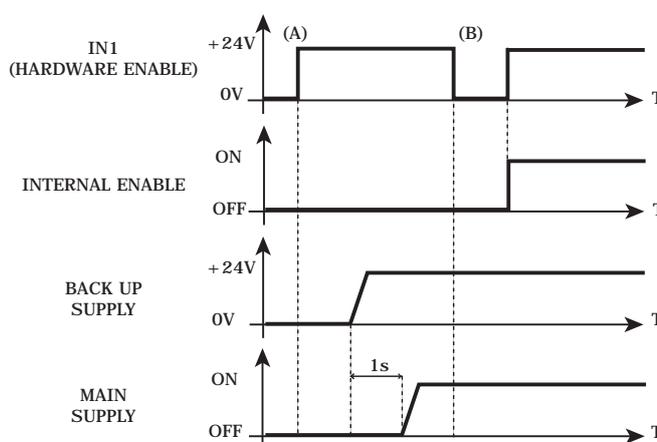
Note: We suggest connecting the shield on both sides.

2.25 Power up

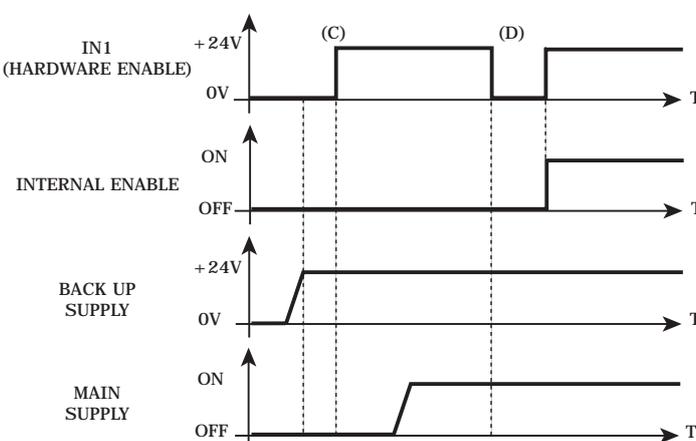
The power up of the system must be done following this diagram, in order to save the drive and the electrical box:



Attention: If the IN1 (ENABLE) digital input is enabled by the CN before powering the drive (A), after powering the drive utilising the auxiliary supply and the main supply, it is necessary to disable and enable the IN1 input (B), in order to enable the INTERNAL ENABLE. If the IN5 is not disabled, then re-enabled, the INTERNAL ENABLE remains disabled and the user cannot execute any movement.



Attention: If the digital input IN1 (ENABLE) is enabled by the CN after powering the drive utilising the auxiliary supply, but before powering the drive utilising the main supply (C), it is necessary to disable and then re-enable IN1 input (D), in order to enable the INTERNAL ENABLE also. If the IN5 is not disabled then re-enabled, the INTERNAL ENABLE remains disabled and the user cannot execute any movement.



2.26 Motor Test



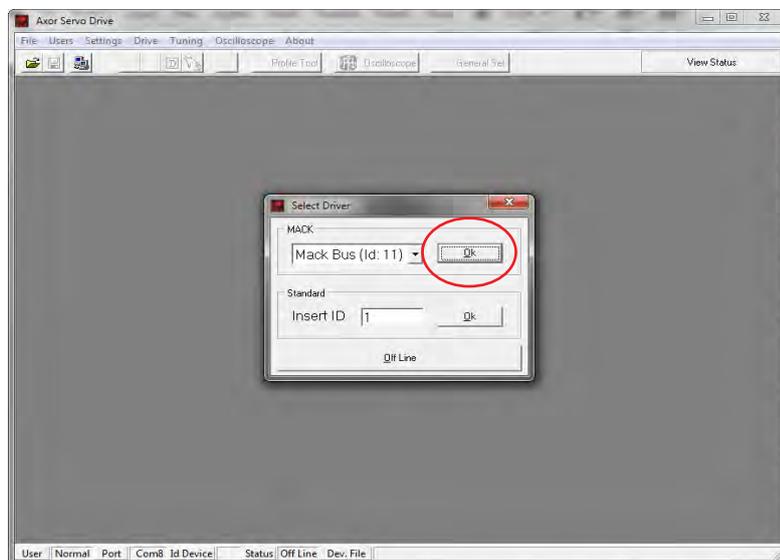
This procedure is a guide line for the first power up of the drive-motor system. **It must only be executed by technically qualified personnel. If you need more information contact Axor.**

1) Follow the *base installation procedure* (see cap. 2.7 *Base installation procedure on page 25*) . **ATTENTION: do not apply load to the motor.**

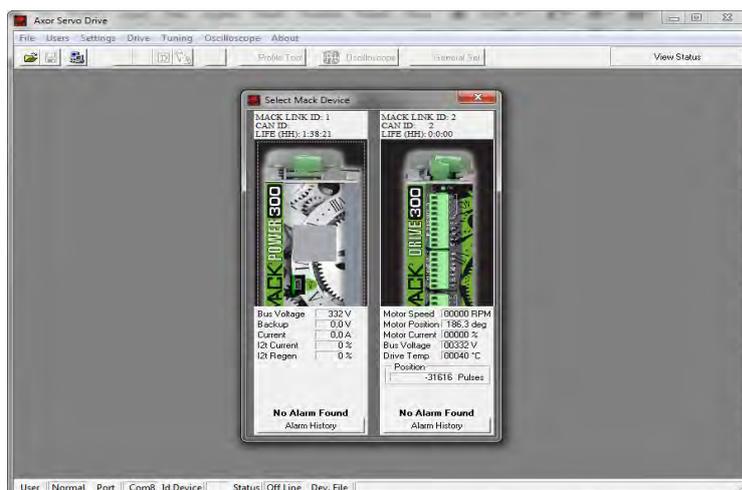
2) Install *Axor Speeder One* interface from CD (*available on the website www.axorindustries.com*).

3) Power up the system: apply the auxiliary supply and then the main supply (follow the procedure previously described).

4) Open the *Speeder One* interface clicking on "Axormb.exe" executable file on directory: "C:\Program\Axor". The main window "**Axor Servo Drive**" and the "**Select Driver**" windows open simultaneously.



Clicking **OK** (refer to MACK) on the "**Select Driver**" window, the "**Select Mack Device**" window opens; in this window you can find the **MACK POWER** and all the **MACK DRIVES** connected to it.



If you want to set the **MACK POWER** parameters click on the **MACK POWER** picture; while if you want to set the **MACK DRIVE** parameters click on the **MACK DRIVE** pictures.

2.26 Motor Test

5) If the system is "**Not configured**", it is necessary to open a pre-set configuration file, following this procedure:

- In the main window select the "**File**" menu and then "**Open**";
- For the **MACK POWER**: in the directory C:\Program\Axor\Data\Devices\MackPower select a file reference to the having **MACK POWER**, then click on "**Open**" and save load parameters by using "**Save Data To EEPROM**" icon;
- For the **MACK DRIVE**: in the directory: C:\Program\Axor\Data\Devices\MackDrive select a file reference to the coupling drive-motor, then click on "**Open**" and save load parameters by using "**Save Data To EEPROM**" icon.

If the **MACK DRIVE** is *configured for a specified motor*, it is sufficient to check these parameters:

- Main voltage (*Main Voltage* menu in the main window of the interface)
- Number of motor poles (*Motor* window)
- Feedback type (*Motor* window)
- Irms current (*Current* window)
- Ipeak current (*Current* window)
- Speed Limit (*Speed* window)

2.27 MackPower Display

At the system power up, on the **MACK POWER** display appears as following:

1) Axor's logo for few seconds;

2) the **MACK POWER**'s status with the following informations:

Bus	...	V	(<i>bus voltage</i>)
Current	...	A	(<i>provided current</i>)
Backup	...	V	(<i>backup voltage</i>)
I2t OUT	...	%	(<i>thermal image</i>)
I2t reg	...	%	(<i>thermal image of the regen resistance</i>)

3) a window displaying the alarms currently on and/or the history of **MACK POWER**'s alarms;

4) a window displaying the alarms currently on and/or the history of **MACK DRIVE**'s alarms.

A dot near the name of the alarm indicate that the alarm is currently on, while a checkmark ✓ signifies that the alarm has been resolved.

The 2) 3) 4) points just described, will be continuously visualized in sequence.

2.28 MackDrive Led

In the **MACK DRIVE** there is a **LED** (red or green, fixed or blinking) that visualises the systems' status:

COLOR	STATE	CAUSE
No colour	-	The MACK DRIVE is turn off.
 (Green)	Blinking	There is only the +24Vdc auxiliary supply.
 (Green)	Fixed	The MACK DRIVE is ready.
		The rotor is not running or it is running and there are not active alarms.
 (Red)	Fixed	There is an alarm.
 (Red)	Blinking	There is I ² t alarm (alarm 6).

Chapter 3

SpeederOne Interface

3.1 SpeederOne Interface.....	54
3.2 Mack Power main menu	56
3.3 Mack Drive main menu	60
3.4 Mack Drive Operative Modes.....	64
3.5 Mack Drive Status	65
3.6 Speed window Mack Drive	66
3.7 Current window Mack Drive	67
3.8 Encoder Out window Mack Drive	68
3.9 Motor window Mack Drive.....	69
3.10 Analog I/O window Mack Drive.....	70
3.11 Digital I/O window Mack Drive	71
3.12 Position window Mack Drive	74
3.13 Homing window Mack Drive	76
3.14 Standard configuration files Mack Drive	78
3.15 Oscilloscope Mack Drive	80
3.16 Mack Power Alarms	87
3.17 Mack Drive Alarms.....	88

3.1 SpeederOne Interface

The Axor software **Speeder One** interface allows you to setup, modify and save all parameters, by connecting a PC to the system.



PC minimum preconditions:

Operative system: *Windows 98, Windows 2000, Windows XP and following;*
Graphic sheet: Windows compatible, coloured;
Drive: Hard disk having at least 20 MB free;
Interface: free USB port.

Installation procedure:

1. **Download "SpeederOne" from the website www.axorindustries.com;**
2. **Install the downloaded file;**
3. **Run SpeederOne;**

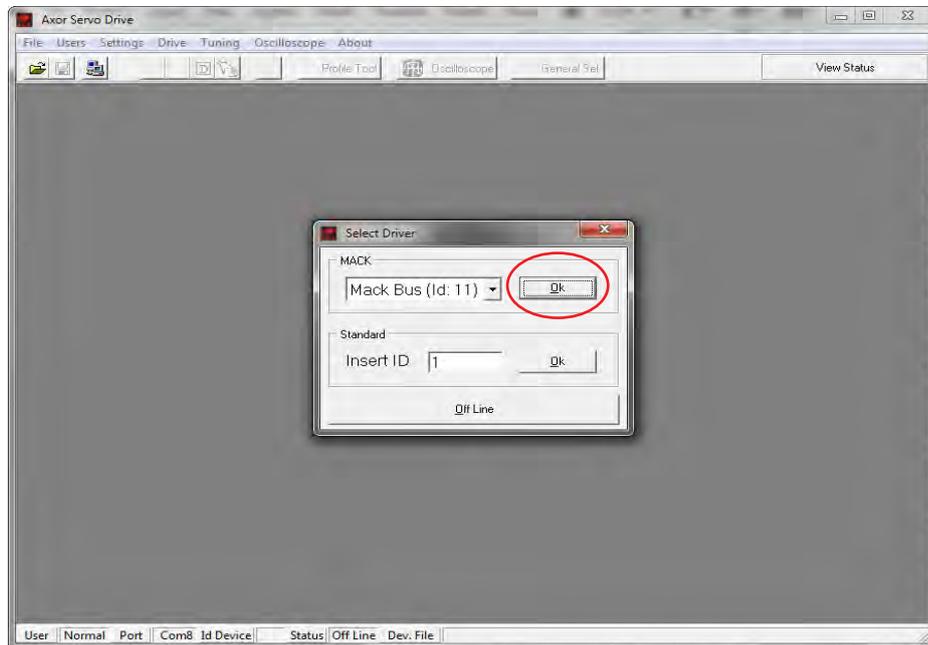


Attention: The parameter variation, via interface, should be done only by technical qualified personnel.

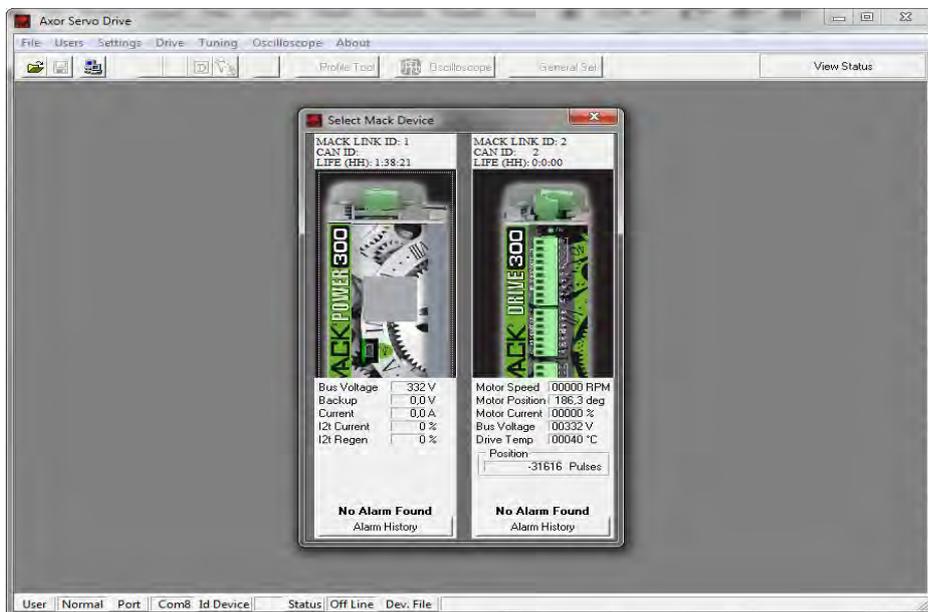
3.1 SpeederOne Interface

The program is started by clicking on "Axormb.exe".

The main window "Axor Servo Drive" and the "Select Driver" window open simultaneously.



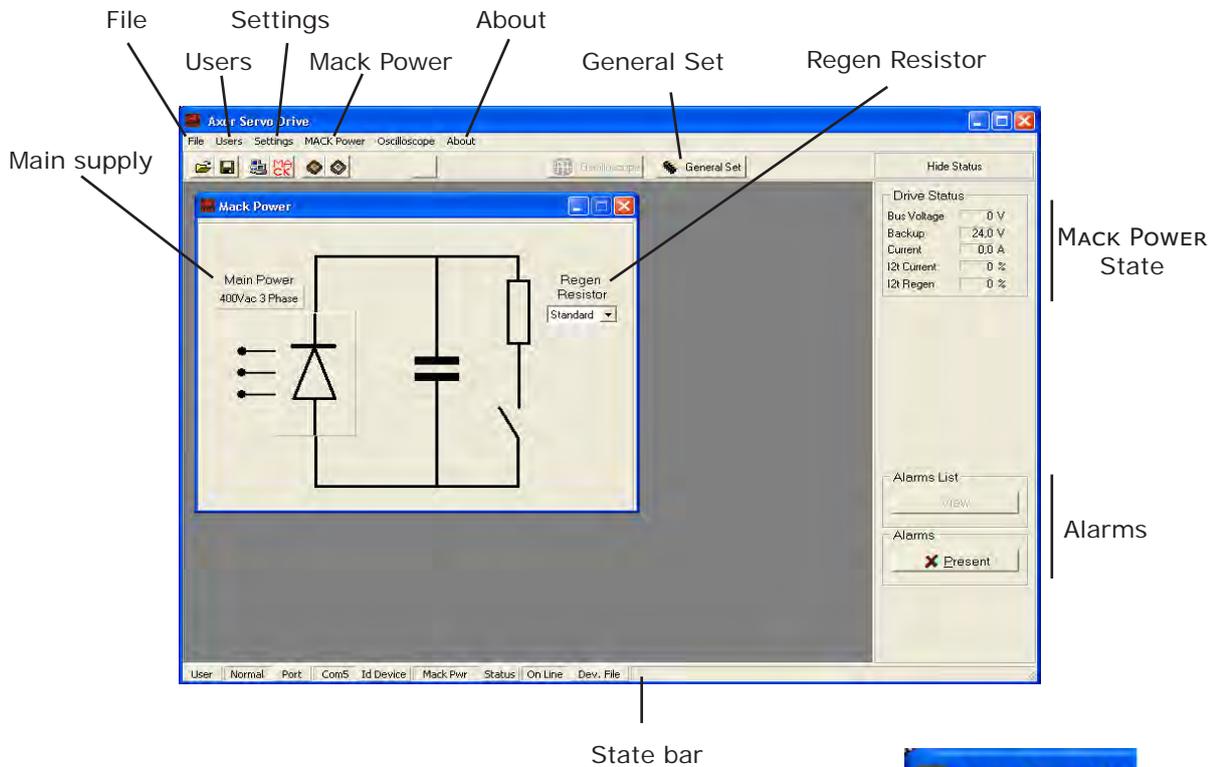
Clicking **OK** (refer to MACK) on the "Select Driver" window, the "Select Mack Device" window opens; in this window you can find the **MACK POWER** and all the **Mack Drives** connected to it.



If you want to set the **MACK POWER** parameters click on the **MACK POWER** picture; while if you want to set the **Mack Drive** parameters click on the **Mack Drive** pictures.

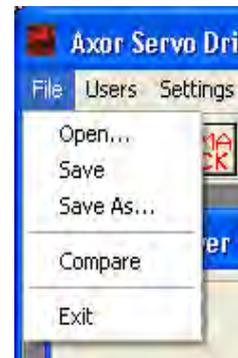
3.2 MACK POWER main menu

Clicking on the **MACK POWER** picture the following window appears:



File

By clicking on "File" it is possible to *open*, *save* or *save as* a file ".mkp", or to *compare* two configurations or to *exit* the program.



Users

Axor reserved information.

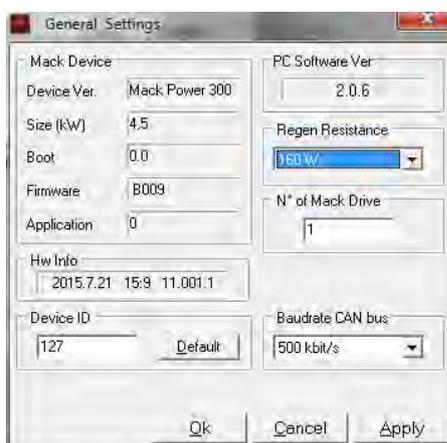
3.2 MACK POWER main menu

Settings

By clicking on "Settings" the "General Settings" is displayed.

General Settings

By clicking on "General Settings", it is possible to visualize some of the drive's properties, and to impose some generic functions:



Mack Device

It visualizes the main properties of the **MACK POWER**, such as:

- **Device Ver.** Type of digital connected: **MACK POWER 300** or **Mack Power 600**;
- **Size (kW)** Power Output in kW;
- **Boot** Boot Software version;
- **Firmware** Firmw are version;
- **Application** Reserved for future use.

PC Software Ver.

It visualizes the software version of *SpeederOne*.

Regen Resistance

It visualizes the type of regen resistance.

N° of Mack Drive

It visualizes the number of **MACK DRIVES** supplied by the **MACK POWER**.

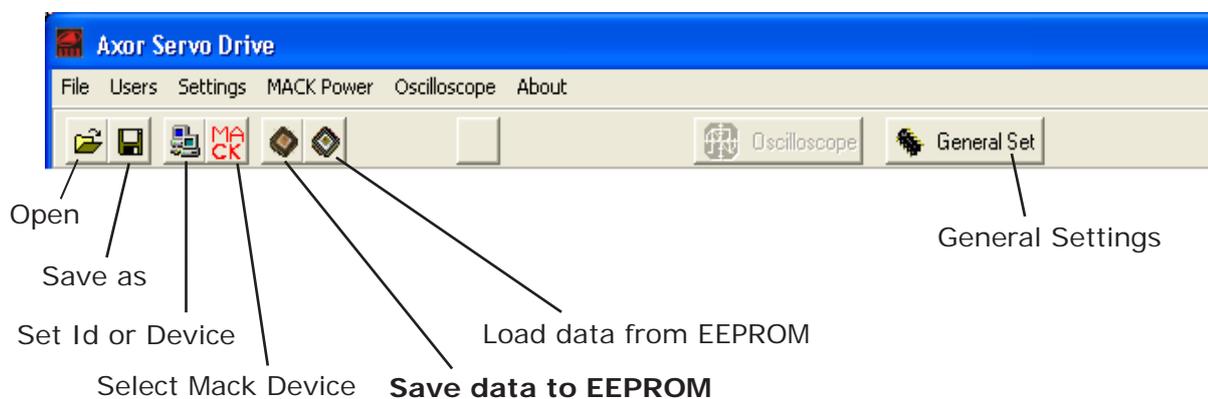
Can Bus Settings

It visualizes the main canbus settings:

- **CanBus ID**
- **Baud rate CAN:** this option allows you to set the "baudrate" of the drive during the Can Bus communications. The selectable values are those specified by the CAN DS301 ver. 4.0.2 instructions, therefore: 50, 100, 125, 250, 500, 800, 1000 Kbps.

3.2 MACK POWER main menu

The program functions may be chosen both from the main menu, as well as from the icons shown below:



Open

It opens a file "*filename.mkp*".

Save as

It saves with name a file with the configuration visualized on the interface at the moment of the memorisation.

Set Id Device

It opens the "**Select Driver**" window, which allows you to select the drive with which you wish to communicate.

Select Mack Device

It opens the "**Select Mack Device**" window, which allows you to select the device (**MACK POWER** or **MACK DRIVES**) of which you wish to set parameters.

Save data to EEPROM

It saves the configuration created on EEPROM of the drive and therefore it makes it operative. The program asks for confirmation. Successively, power off and power on the system.

Note: Every time you desire to make modifications and render them operative at the restart of the drive, the information must be saved on the EEPROM by clicking this icon.

Load data from EEPROM

It loads all the values which are present on EEPROM to the drive.
The program asks for confirmation.

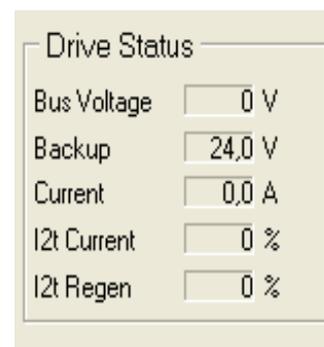
General Settings

It opens the "**General Setting**" window.

3.2 MACK POWER main menu

Drive Status (Status bar on the right of the main window)

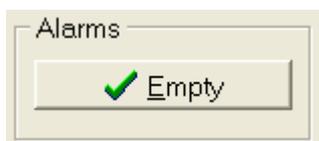
- ✓ **Bus Voltage:** displays the bus voltage;
- ✓ **Backup:** displays the backup voltage;
- ✓ **Current:** displays the current provided by the **MACK POWER**;
- ✓ **I2t Current:** displays the thermal image of the **MACK POWER**;
- ✓ **I2t Regen:** displays the thermal image of the regen resistance.



3

Alarms

Selecting **Alarm** window allows you to visualize the history of the **MACK POWER**'s alarms and the status of them.



There are not active alarms



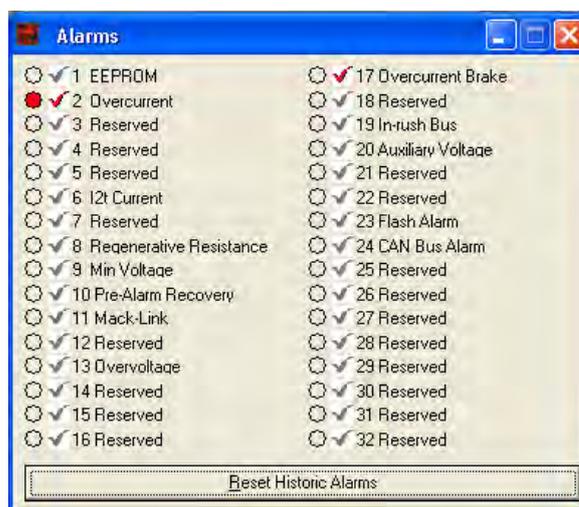
There are active alarms

Clicking on **Empty/Present** button "Alarms" window opens:

A red dot ● and the red symbol ✓ near the alarm name indicate that the alarm is currently on, while a red checkmark signifies that the alarm has been resolved.

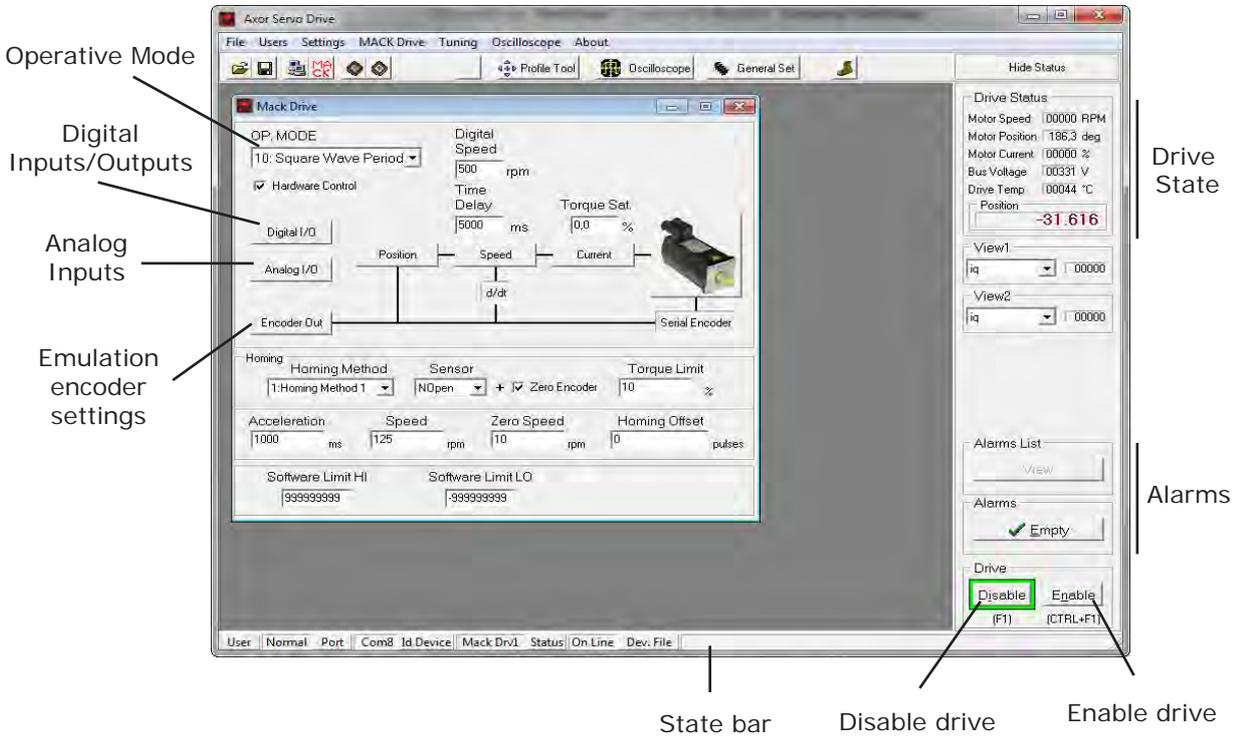
It is possible to reset the *history* of alarms by disabling and enabling the **MACK POWER** or clicking on "**Reset Historic Alarms**".

You can find more information about alarms at the end of this chapter.



3.3 MACK DRIVE main menu

Clicking on one of the **MACK DRIVE** pictures the following window appears:



File

By clicking on "File" it is possible to *open*, *save* or *save as* a file "*.mkd", or to *compare* two configurations or to *exit* the program.



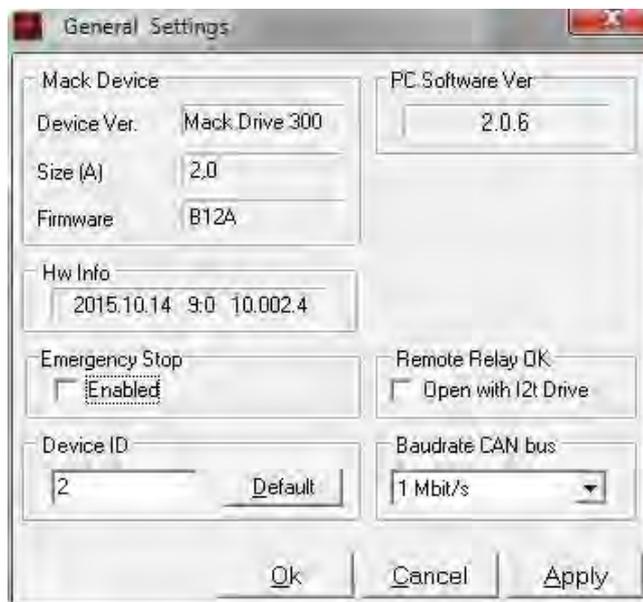
3.3 MACK DRIVE main menu

Settings

By clicking on "Settings" the "General Settings" is displayed.

General Settings

By clicking on "General Settings", it is possible to visualize some of the drive's properties, and to impose some generic functions:



Mack Device

It visualizes the main properties of the drive, such as:

- **Device Ver.** Type of digital connected servodrive: **MACK DRIVE** 300 or 600;
- **Size (A)** Nominal size in Amperage;
- **Boot** Boot Software version;
- **Firmware** Firmware version;
- **Application** Reserved for future use.

PC Software Ver.

It visualizes the software version of *SpeederOne*.

Emergency Stop

It enables or disables the **Emergency Stop** function, which allows you to stop the motor, by using a settable emergency ramp, in presence of a disable or an alarm.

Remote Relay OK

It enables or disables the **Open with I2t Drive** function, which enables or not the opening of the **MACK POWER** "Relè OK" contact during the alarm 6: "I2t Drive".

Can Bus Settings

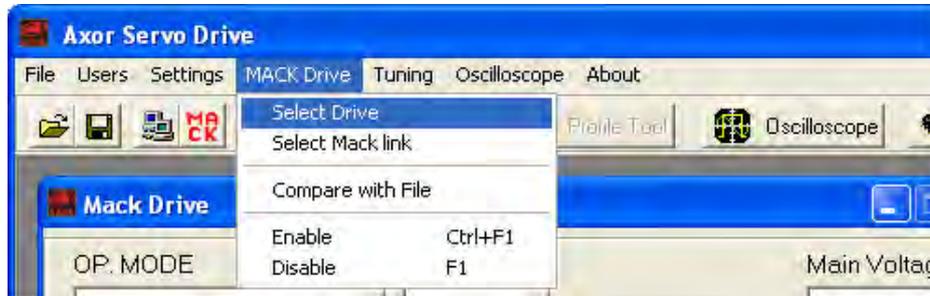
It visualizes the main CANbus settings:

- **CanBus ID**
- **Baud rate CAN:** this option allows you to set the "baudrate" of the drive during the Can Bus communications. The selectable values are those specified by the CAN DS301 ver. 4.0.2 instructions, therefore: 50, 100, 125, 250, 500, 800, 1000 Kbps.

3.3 MACK DRIVE main menu

MACK DRIVE

"MACK Drive" opens the "Select Driver" window, the "Select Mack link" window, the "Compare with File" window which allows you to compare two configuration files, while "Enable" and "Disable" manage the state of the drive.



Tuning

This menu is utilized for the phasing of the motor ("Motor Phasing"), the speed offset settings ("Speed Offset") or the torque offset settings ("Torque Offset").



Motor Phasing

When you select this option the program asks if it should execute motor phasing, if confirmed the motor automatically enables and executes. The phase angle is visualized in the "Motor" window.

Speed Offset

This option is to be paired with the operation mode "0:Analog Speed" and it calculates the voltage on the analog +/-VREF inputs taken as zero speed reference (0 rpm). The value of the calculated offset can be read in the "Analog I/O" window and it is expressed in mV.

Torque Offset

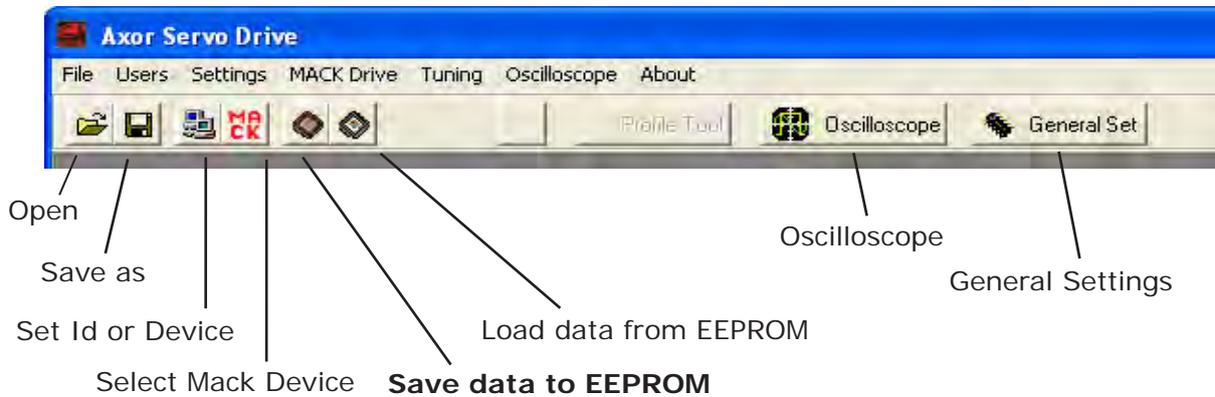
This option calculates the voltage on the analog Tp.RC input taken as zero torque reference. The value of the calculated offset can be read in the "Analog I/O" window and it is expressed in mV.

About

This option shows the program version and additional information, for example: "Axor Servo Drive Software 2.0.0".

3.3 MACK DRIVE main menu

The program functions may be chosen both from the main menu, as well as from the icons shown below:



Open

It opens a file "filename.mkd".

Save as

It saves with name a file with the configuration visualized on the interface at the moment of the memorisation.

Set ID Device

It opens the "Select Driver" window, which allows you to select the drive with which you wish to communicate.

Select Mack Device

It opens the "Select Mack Device" window, which allows you to select the device (**MACK POWER** or **MACK DRIVES**) of which you wish to set parameters.

Save data to EEPROM

It saves the configuration created on EEPROM of the drive and therefore it makes it definitive. The program asks for confirmation. Successively, power off and power on the system.

Note: Every time you desire to make modifications and render them operative at the restart of the drive, the information must be saved on the EEPROM by clicking this icon.

Load data from EEPROM

It loads all the values which are present on EEPROM to the drive.
The program asks for confirmation.

Oscilloscope

It opens the "Oscilloscope" window.

General Settings

It opens the "General Setting" window.

3.4 MACK DRIVE Operative Modes

The "OP. MODE" menu allows you to select the operation mode of the drive. With every selection all associated information are automatically pre-disposed.

The drive offer the following operation modes:

0: Analog Speed

The motor is controlled in velocity mode through an analog differential or common mode input from an external controller, by using +/-REF or Tp.RC inputs.

1: Digital Speed

The motor is controlled in velocity mode through a digital reference.

2: Analog Torque

The motor is controlled in torque mode through an analog reference.

3: Digital Torque

The motor is controlled in torque mode through a digital reference.

4: Position Mode

Not enabled.

5: Gearing

The position of the motor is controlled through the quadrature signals from an incremental encoder of a Master motor, or through the emulated encoder signals from a Master drive.

6: Pulse/Dir Mode

The position of the motor is controlled through the digital piloting inputs: H.CK/L.CK/O.CK and H.DIR/L.DIR/O.DIR.

7: Can Open

This mode allows you to configure and control the drive using CanBus.

8: CW/CCW

It is possible to connect the drive to a motor piloting it with the CLOCK and DIR signals: if pulses arrive at the CLOCK input, the motor rotates clockwise (CW); while if pulses arrive at the DIR input, the motor rotates counter clockwise (CCW).

9: EtherCAT

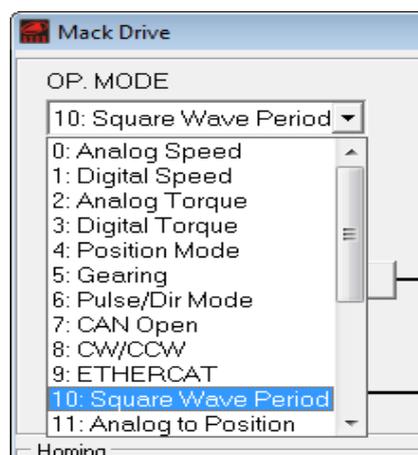
This mode allows you to configure and control the drive using EtherCat.

10: Square Wave

The motor is piloted with a "square wave" signal. This is useful for adjustments of the speed loop.

11÷20: Op Mode 11÷20

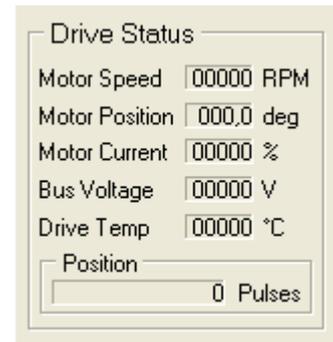
Modalità operative per usi futuri.



3.5 MACK DRIVE Status

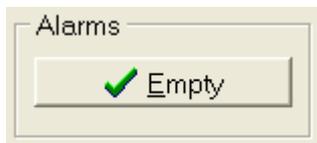
Drive Status (Status bar on the right of the main window)

- ✓ **Motor Speed** displays the velocity of the motor in RPM.
- ✓ **Motor Position** displays the rotor position in mechanical degrees.
- ✓ **Motor Current** displays the motor current (in percentages) with respect to twice the rated current of the drive. 50%= rated current, 100%= 2*rated current.
- ✓ **Bus Voltage** displays the bus voltage.
- ✓ **Drive Temp** displays the temperature of the **MACK DRIVE** board in degrees.
- ✓ **Position** displays the rotor position in pulses.



Alarms

Selecting **Alarms** window allows you to visualize the history of the **MACK DRIVE**'s alarms and the status of them.



There are not active alarms



There are active alarms

Clicking on **Empty/Present** button "Alarms" window opens:

A red dot ● and the red symbol ✓ near the alarm name indicate that the alarm is currently on, while a red checkmark signifies that the alarm has been resolved.

It is possible to reset the *history* of alarms by disabling and enabling the drive or clicking on "**Reset Historic Alarms**".

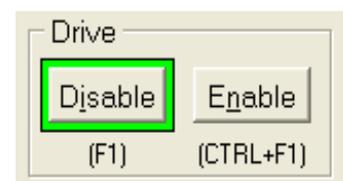
You can found more information about alarms at the end of this chapter.



Enable, Disable

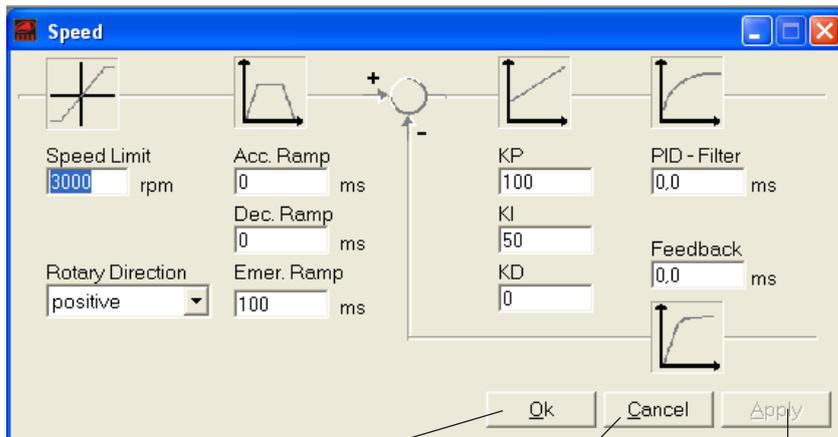
By clicking on this button you can enable or disable the drive's torque.

ATTENTION: DRIVE'S ENABLE/DISABLE IS NOT CONSIDERED A SAFETY FUNCTION.



3.6 Speed window MACK DRIVE

This window allows modification of the dynamic constants of the drive's **speed loop**.



OK confirms the set value and closes the window.

Cancel closes the window without change any parameter.

Apply confirms the set value (which change from red to black), but it does not close the window.

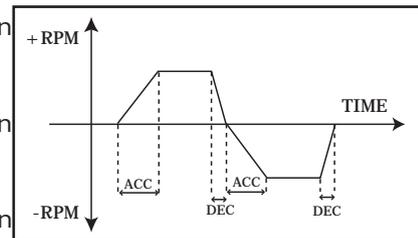
Speed limit: Generally in this box there is the rated speed of the motor coupled with the drive, but it is possible to insert greater value up to 8000rpm max.

Rotary Direction: It allows you to set the rotor's sense of rotation: Positive (CW) or Negative (CCW).

Acc. Ramp*: It is possible to insert the value of the acceleration ramp "in ms". The range is between zero and 5000 ms (0-5sec).

Dec. Ramp*: It is possible to insert the value of the deceleration ramp "in ms". The range is between zero and 5000 ms (0-5sec).

Emer. Ramp*: It is possible to insert the value of the deceleration ramp "in ms" during the emergency stop.



PID-Filter: It is a filter on the output of the speed regulator.

Feedback: It is a filter on the feedback speed.

Note: Setting the PID-Filter and Feedback parameters make the system less noisy, therefore non appropriate tuning may cause a less dynamic or instable system.

KP: It is the proportional gain of the speed loop.

This setting optimises the dynamic behaviour of the motor. The range is between zero and 4000.

KI: It is the integral gain of the speed loop.

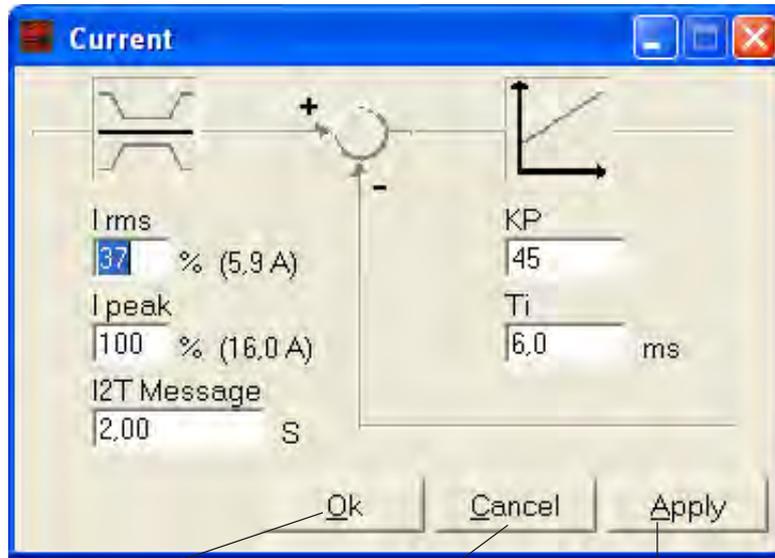
This setting optimises the dynamic behaviour of the motor. The range is between zero and 4000.

KD: (not used)

***The ramp time indicates the time used to reach the Max speed (Speed Limit) form the 0 rpm in acceleration and reach the 0 rpm form the Max speed (Speed Limit) in deceleration.**

3.7 Current window MACK DRIVE

This window allows you to modify the dynamic constants of the drive's **current loop**.



OK confirms the set value and closes the window.

Cancel closes the window without change any parameter.

Apply confirms the set value (which change from red to black), but it does not close the window.

I rms

In this box it is possible to insert the percentage value of the rated current furnished by the drive. The numerical range is between 1 and 50 and it is referred to the peak current value.

Example: suppose we have a drive size 8/16, if we insert into this box the value 15%, we'll have a setting of rated current equal to 2,4A (in fact $16 \times 15 / 100 = 2,4$), so the drive will provide a rated current equal to 2,4A to the motor.

I peak

In this section it is possible to insert the percentage value of the peak current furnished by the drive. The numerical range is between 1 and 100

Example: suppose we have a drive size 8/16, if we insert into this box the value 75%, we'll have a setting of peak current equal to 12A (in fact $16 \times 75 / 100 = 12$), so the drive will provide a peak current equal to 12A to the motor.

The value of nominal and peak current is RMS.

I2T Message

Time of the peak current.

Typically with an adjustment of $I_{peak} = 100\%$, the time will be 5 seconds.

Is recommended to NOT change this parameter.

KP

It is the proportional gain of the current loop. This adjustment allows for optimizing the dynamic behaviour of the motor's current loop. The numerical range of this parameter varies from 0 up to 999.

TI

It is the integral time in "ms" of the current loop.

The numerical range of this parameter varies from 0 up to 999ms.

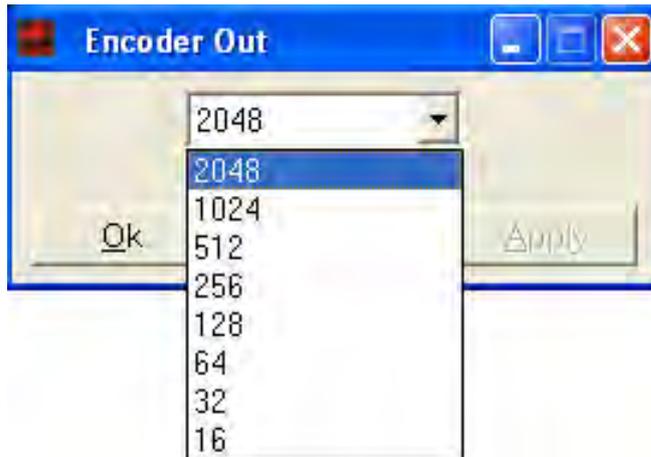
3.8 Encoder Out window MACK DRIVE

With this parameter you can set the number of pulses per turn on encoder emulation outputs available to the numerical controller or PLC.

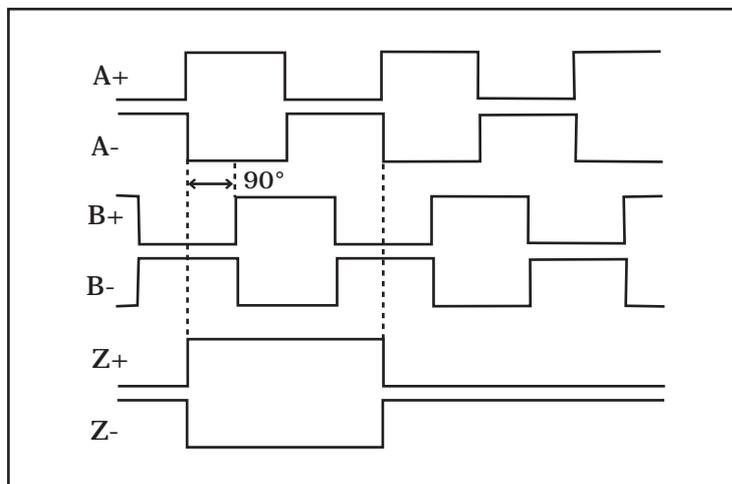
Using an encoder with **N** pulse/rev, it is possible to set **N**, **N/2**, **N/4**, **N/8**, **N/16**, **N/32**, **N/64**, **N/128** pulse/rev.

After the changes, save to the Eeprom and restart the drive.

Example: Utilizing a motor transducer with 2048 PPR, the settable values are: 2048, 1024, 512, 256, 128, 64, 32 and 16.

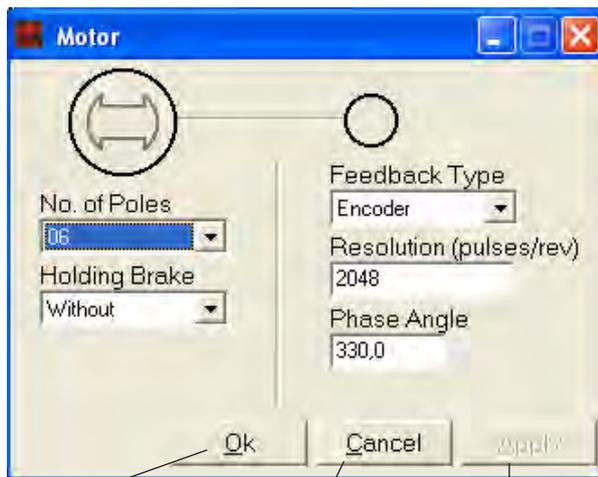


The figure below illustrates the typical encoder emulation output pulses when the motor turns *clockwise*: the emulation output pulses are emitted under the form of two signals, **A** and **B**, which are electrically staggered by 90° and a zero signal, **Z**.



3.9 Motor window MACK DRIVE

Clicking this icon it is possible to modify items relating to the **motor's** characteristics.



OK confirms the set value and closes the window.

Cancel closes the window without change any parameter.

Apply confirms the set value (which change from red to black), but it does not close the window.

No. of Poles

Number of motor poles. It is possible to set 2, 4, 6, 8, 10, and 12 poles. The value pre-set as a default is 6 poles.

Feedback Type

It permits to select the type of motor feedback: Serial Encoder (MackCoder), Absolute Multiturn Encoder (Absolute Encoder) or Commutation Encoder.

Resolution (pulses/rev)

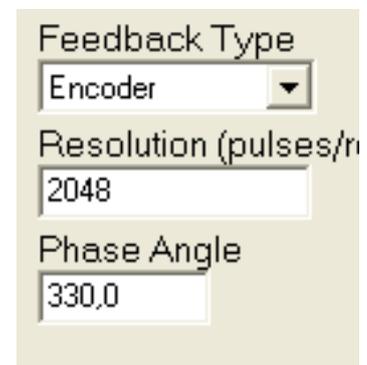
Insert in this section the value of Encoder pulses/rev.

Phase angle

In this section the phasing angle of the motor, previously calculated with the "Tuning ⇒ "Motor Phasing" procedures, is visualized.

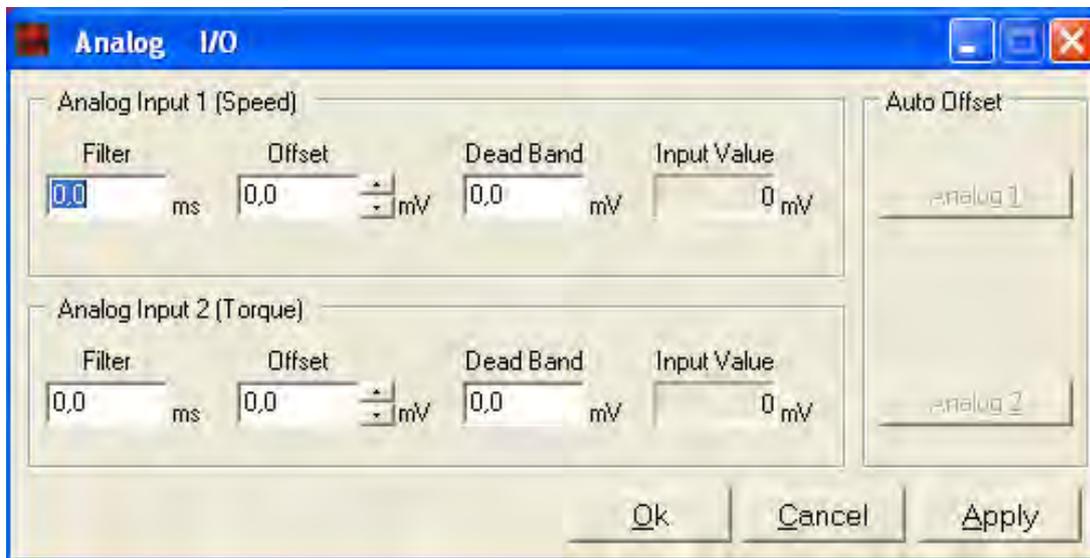
Holding Brake

When the "Without" option is selected the electromechanical brake integrated on the motor is not manage, while when the "With" option is selected the electromechanical brake can be manage *externally* by the user or *internally* by the **MACK DRIVE**.



3.10 Analog I/O window MACK DRIVE

This window allows you to control and condition the analogic signal of the differential or common mode reference from the external controller or the analogic signal of the torque reference (Tp.RC input).



Filter

Filter in "ms" on the analog input signal.

Offset (Speed)

Voltage in "mV" on the +/-REF analog inputs taken as zero speed reference (0 rpm). This value is calculated using the "Tuning ⇒ Speed Offset" procedure or by clicking on the "Speed" button of the "Analog I/O" window, otherwise it is possible to increase or decrease this value using the up/down arrows near the "Offset" window.

Offset (Torque)

Voltage in "mV" on the Tp.RC analog input taken as zero torque reference. This value is calculated using the "Tuning ⇒ Torque Offset" procedure or by clicking on the "Torque" button of the "Analog I/O" window, otherwise it is possible to increase or decrease this value using the up/down arrows near the "Offset" window.

Dead Band (Speed)

If the voltage on the +/-REF analog inputs is within the range [-Dead Band, +Dead Band], the analog speed reference is zero (0 rpm).

Dead Band (Torque)

If the voltage on the Tp.RC analog input is within the range [-Dead Band, +Dead Band], the analog torque reference is zero.

Input Value

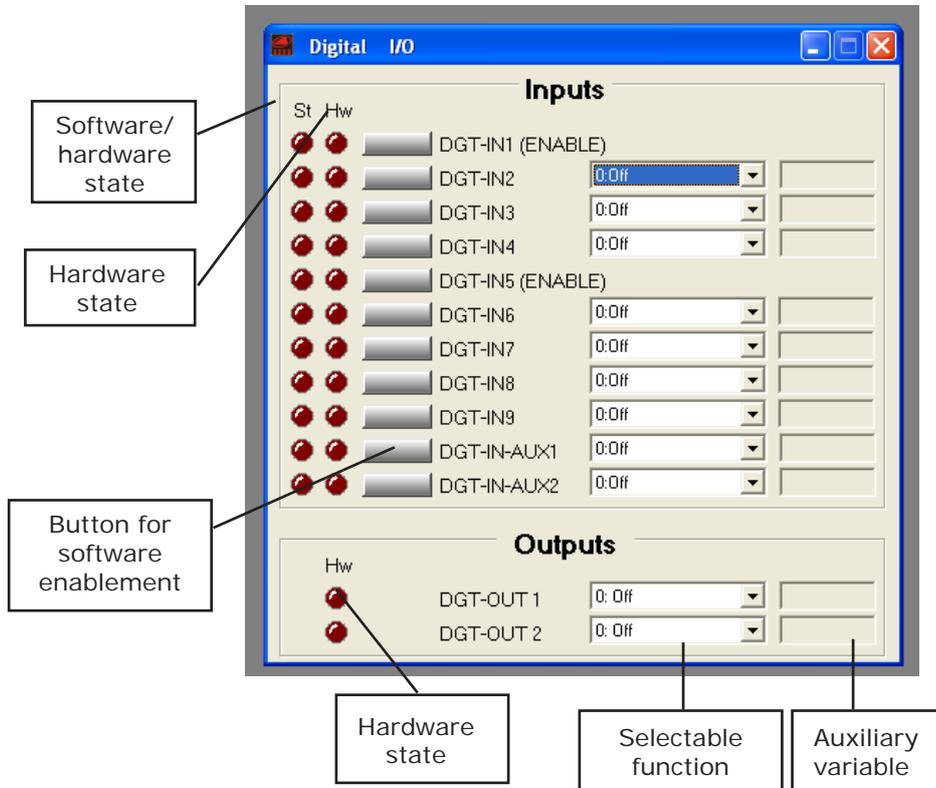
It visualises in "mV" the voltage measured on the analog inputs. This value depends by the Offset, the Filter and the Dead Band settings.

Auto Offset

This button *automatically* execute the settings of the offset of the torque offset settings ("Analog2").

3.11 Digital I/O window MACK DRIVE

This window allows you to modify **via software** the status of the programmable digital inputs and to control the hardware status of the digital inputs and outputs.



The **"St"** led visualises the **status (software or hardware)** of the digital inputs. Clicking on the button near the name of the digital input, the **"St"** led becomes red and a high logic signal is present on the input.

The **"Hw"** led visualises the **hardware status** of the digital input, if it is red a voltage is present on the input.

If the Hw led is red, the St led is red too.

The **"Hw"** led, about digital outputs, visualises the **hardware status** of the digital outputs, if it is red the output is closed.

Near the name of each digital input/output there are two fields:

- ✓ There is a menu that allows you to select a **function**;
- ✓ There is a field where you can insert the **auxiliary variable** if necessary. s

3.11 Digital I/O window **MACK DRIVE**

The **DGT-IN2...DGT-IN9** and **DGT-IN-AUX1...DGT-IN-AUX2** inputs can be set to enable the following functions:

FUNCTION	DESCRIPTION
0: Off	With this settings there is not a particular function assigned to the input.
1: Ref-On	It enables the motor rotation.
2: PStop	Positive limit switch. A low logical signal on this input disables the "CW" rotation of the motor.
3: NStop	Negative limit switch. A low logical signal on this input disables the "CCW" rotation of the motor.
4: Brake	It enables the external manage braking by the user.
5: P+N Stop	Positive and negative limit switch. A low logical signal on this input disables the CW or CCW rotation of the motor.
6: Homing Sensor	Homing sensor.
12: Emergency	Lowering the logic input along with this function, stops the motor rotation utilising the Emer. Ramp set in the Speed window (The drive remain enabled at 0 RPM).
13: Start Homing	It is used to start/stop the homing procedure.
14: Reset Fault	It allows the reset the "resettable" alarms.
15: Speed Inv.	Inversion of the motor rotation.
31: Fan On	Manual start of the cooling fan.

Very Important Notes:

- **The function just illustrated are selectable on all the digital inputs, otherwise the functions: Ref-On, PStop, NStop, Brake, P+N Stop, Homing Sensor, Emergency, Start Homing, Reset Alarm can be set on one input at a time.**

- Before changing the function on a programmable input make sure that the function is disabled.

For example:

The "Start Homing" function is not active with a **low** signal on the dedicated input. The "Pstop" function is not active with a **high** signal on the dedicated input.

- Remember to save to the EEPROM all settings made on the programmable digital input in order to make them permanent.

3.11 Digital I/O window MACK DRIVE

In the following table there are the setting functions for the two digital outputs:

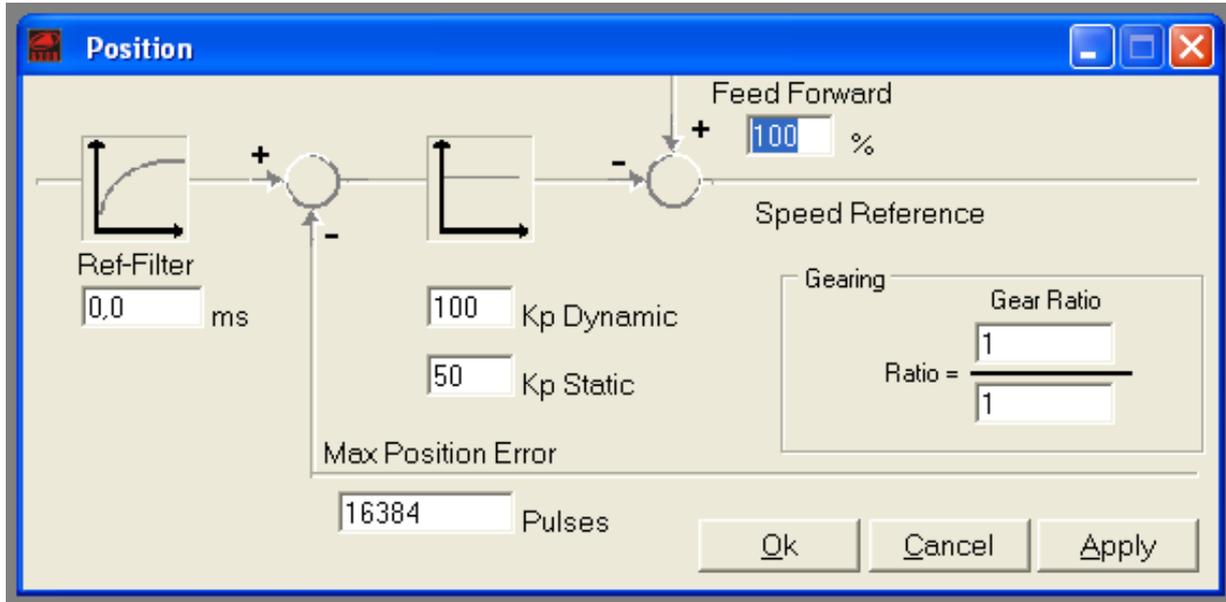
FUNCTION	DESCRIPTION
0: Off	Selecting this function the output will always be open.
1: Speed >x	If the absolute value of the actual speed is greater than the value inserted in the auxiliary variable, the output will be closed. On the contrary, if the absolute value of the actual speed is less than the value inserted in the auxiliary variable the output will be opened.
2: Speed <x	If the absolute value of the actual speed is less than the value inserted in the auxiliary variable, the output will be closed. On the contrary, if the absolute value of the actual speed is greater than the value inserted in the auxiliary variable the output will be opened.
3: Homing OK	The output will be closed after a complete and successful homing procedure. At the start of every new homing procedure the output will be opened.
4: I2t	The output will be closed if the I ² t condition is reached. When this condition comes down the output will be opened.
5: Irms% >x	If the absolute value of the actual current is greater than the value inserted in the auxiliary variable, the output will be closed. On the contrary, if the absolute value of the actual current is less than the value inserted in the auxiliary variable the output will be opened.
6: Irms% <x	If the absolute value of the actual current is less than the value inserted in the auxiliary variable, the output will be closed. On the contrary, if the absolute value of the actual current is greater than the value inserted in the auxiliary variable the output will be opened.
8: Error	With this function the output is closed if one or more alarms are present. When all alarm are cleared the output will be opened.
9: Ready	When the control circuitry is powered up (with a minimum delay), the output will be closed.
20: Torque Limit	The output will be closed if the drive have reached the torque limitation.
31: Fan On	The output will be closed if the cooling fan is active.

3.12 Position window MACK DRIVE

This window allows you to set the static and dynamic parameters about: "5:Gearing", "6:Pulse/Dir Mode". With every selection all associated parameters are pre-disposed automatically.

"5:Gearing"

If the "5:Gearing" operative mode is set, the "Position" window is the following:



The **Feedforward**, **Kp Dynamic**, **Kp Static** and **Max.Position Error** parameters have the same functions illustrated in the preceding page, but may have to be re-set, while adding the new parameters for gearing:

Pulses per turn

Insert into this field the number of pulses per turn of the encoder of the Master motor or the number of pulses per turn of the emulated encoder from the Master drive.

Gear Ratio

Insert into the numerator and denominator, the ratio that allows you to obtain the desired Slave speed in regards to the Master.

Note: the values which you can insert are between the $\frac{1}{64} < |\text{Ratio}| < 64$ range.

Ref-Filter

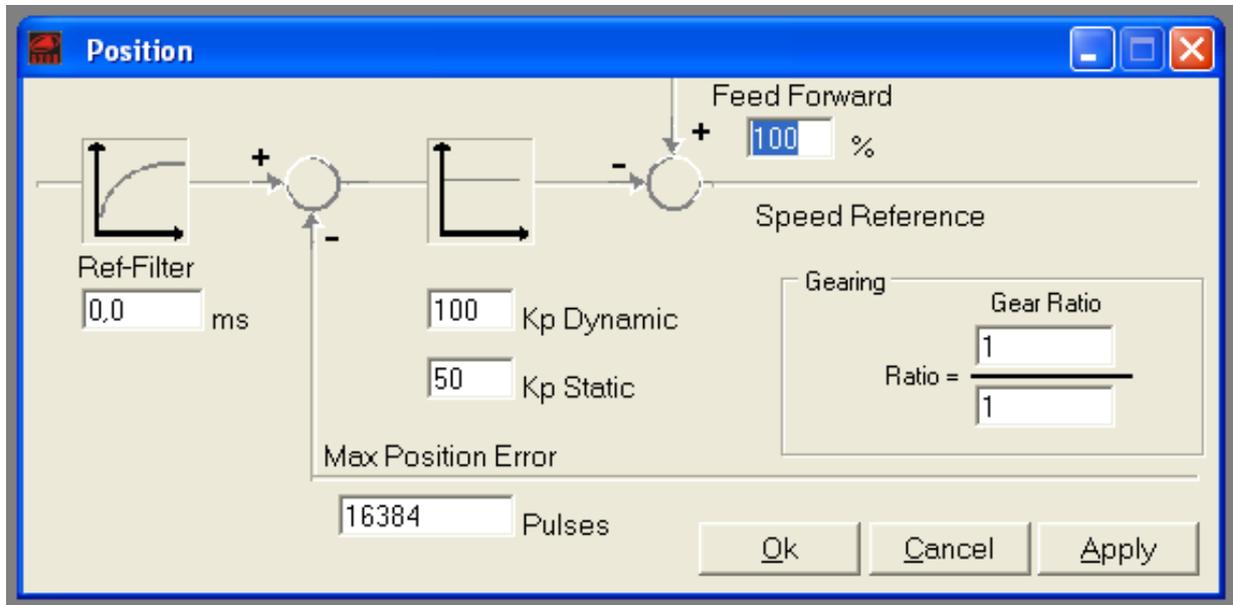
It is a filter on the position reference. It can be used, at low speed, to limit axis' vibration or to make the system less noisy.

You can find more information about gearing on Chapter 4.8 Gearing (Electrical Axis).

3.12 Position window MACK DRIVE

"6:Pulse/Dir Mode"

If the "6:Pulse/Dir Mode" operative mode is set, the "Position" window is the following:

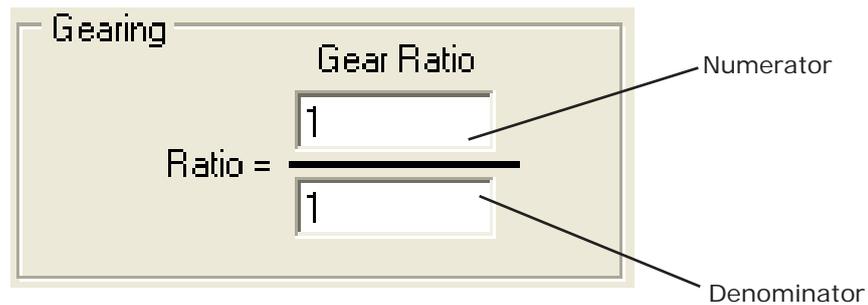


3

The **Feedforward**, **Kp Dynamic**, **Kp Static**, **Max Position Error** and **Ref-Filter** parameters have the same functions illustrated in the preceding page, but for the other parameter are significantly different:

Gear Ratio

Transmission ratio between revolutions(numerator) and pulses(denominator).



It is suggested to use values around 1, especially in systems that requires high precision.

You can find more information about Pulse/Direction mode on Chapter 4.9 Pulse/Dir Command.

3.13 Homing window MACK DRIVE

In the main window of the interface there is an area where you can set the parameters of the **Homing procedure**:

Homing			
Homing Method	Sensor	<input type="checkbox"/> Zero Encoder	Max Search Angle
No Homing			deg
Acceleration	Speed	Zero Speed	Homing Offset
ms	rpm	rpm	pulses

The homing procedure uses the **signal of the homing sensor** and, eventually, the **zero signal of the encoder**.

Before start a positioning it is necessary execute a successful homing procedure.

Homing Method

It defines the method of homing. The supported options are:

- **No homing**: disables the homing procedure.
If this method is set it will not be possible to make the positioning procedure.
- **Homing method 1 (direct)**: the drive makes the motor turn in a **counter-clockwise** direction to search for the homing sensor.
- **Homing method 2 (reverse)**: the drive makes the motor turn in a **clockwise** direction to search for the homing sensor.
- **Immediate**: the current position becomes the home position without moving the motor to search the homing sensor.

Sensor

It selects the type of sensor used for the homing procedure. The available options are **NOpen (normally open)** or **NClosed (normally closed)**.

Zero Encoder

Marking the **"Zero Encoder"** box the home position is set on the **first zero pulse** of the motor feedback after the interception of the homing sensor. This allows you to execute the homing procedure with better precision.

Max Search Angle

It is the maximum mechanical angle (0-359 degrees) that can be made during the search for the zero encoder signal after the correct interception of the homing sensor. Above this angle the motor stops, no homing position is saved and alarm 26 (the "Homing Error" alarm) is displayed (this alarm is cleared after the disabling of the digital input set with the "Reset Fault" function).

This parameter (when used correctly) allows the homing process to be repeated with excellent results and avoid errors due to sensor signal elasticity or mechanical tolerance.

Speed

This parameter sets the speed reference used during the homing process and it is given in "rpm". The admitted values are in ranges between 10 and 1000 rpm.

3.13 Homing window MACK DRIVE

Acceleration

This is the acceleration and deceleration time for the homing procedure. It is defined in milliseconds and allows values in ranges between 10 and 5000 ms. This time references the maximum motor speed set by using the "Speed Limit" parameter in the "Speed" window, so the **actual acceleration** time can be found utilizing the following formula:

$$T_{\text{acc_homing}} [\text{ms}] = \frac{\text{Speed_homing} [\text{rpm}] * T_{\text{acc_sett}} [\text{ms}]}{\text{Speed_motor} [\text{rpm}]}$$

Where: **T_acc_homing** = real acceleration time during the homing search process;
Speed_homing = speed set for the homing process ("Speed" parameter);
Speed_motor = motor speed limit set on the interface ("Speed Limit" parameter);
T_acc_set = value inserted in the "Acceleration" parameter.

For example if you have a motor with the following parameters:

- "Speed Limit" (on the "Speed" window) = 3000 rpm;
- "Acceleration" (on the "Homing" window) = 500 ms;
- "Speed" (on the "Homing" window) = 1000 rpm.

The acceleration time set in the homing window is the time that the motor should employ to accelerate from 0 rpm to the maximum speed (in this case 3000rpm).

The real acceleration time from 0 rpm to 1000 rpm is 167ms, in fact:

$$T_{\text{acc_homing}} [\text{ms}] = \frac{100 \text{ rpm} * 500 \text{ ms}}{3000 \text{ rpm}} = 167 \text{ ms}$$

Zero Speed

This defines the motor's speed during the realignment with the homing sensor and/or during the search for the encoder's zero pulse from the motor feedback after the home sensor is reached.

It is defined in "rpm" and allows values in ranges between 1 and 50 rpm. We suggested utilizing low values for this parameter in order to obtain good precision.

Homing Offset

This defines the difference between the zero position for the application and the machine's home position (which is found during homing process). It is measured in pulses and the allowed values are in ranges: +/- (2³²-1). This value is assigned to the home position found at the end of a successful homing process. The Homing Offset value is obtained by the execution of the following calculation:

$$\text{Homing Offset} = n^{\circ} \text{ turns (also not integer)} * 65536$$

Example: suppose we have an application where the distance between the home position and the zero position of the axis is equal to the distance that the axis can go with a rotation of 4 turns plus an addition 90° mechanical turn.

The first thing to do is to find the number of turns to insert into the formula. In this example: n° turns = 4 + 90°/360° = 4.25 to refer to the fraction of turn above 360°. Now it is possible to calculate utilizing the following operation: 4.25 * 65536 = **278528**. This bold number is the value that must be inserted in the "Homing Offset" window.

After the setting of the desired homing parameters save the changes using the "Save To EEPROM" function on the software interface, doing this the drive's setup will become permanent.

You can find more information about homing on Chapter 4.15 Homing - Procedures.

3.14 Standard configuration files MACK DRIVE

Using the *Speeder One* software you can select some *standard configuration files* to allow the drive to be setup for brushless series servomotors.

To select a "standard" configuration file with the software:

1) Open the *Speeder One* interface.

2) In the main window select the "Open" icon (otherwise select "File" and then "Open").



3) Select a file in the directory: C:\Program\Axor\Data\Devices\MackDrive, and then press "Open".

4) Save the values loaded using the "Save Data To EEPROM" button.

5) Disable and enable the drive.

6)

ABBINAMENTO DRIVE-MOTORE/MOTOR-DRIVE COUPLING

In fase di assemblaggio della macchina si raccomanda di eseguire il corretto abbinamento drive-motore. A tal proposito confrontare l'etichetta presente nel drive (vedi FIG.1) con il certificato di collaudo abbinato allo stesso drive. Nel certificato di collaudo sono presenti il codice e la descrizione del file di taratura caricato nel drive, nonché il motore da abbinare al drive (vedi FIG.2). / *During the machine assembly phase remember to correctly execute the proper drive/motor coupling. With this in mind, compare the drive label (see FIG.1) with the test certificate supplied with the drive. You will find on the test certificate the code and description of the adjustment file, along with the proper motor coupling for the drive (see FIG.2).*

FIG.1 (Etichetta presente nel drive / Drive label)

Certificato di collaudo / Test certificate

M000090 Rev.1.1

Descrizione del file di taratura caricato nel drive / Description of the adjustment file for which drive has been setup

Codice del file di taratura caricato nel drive / Code of the adjustment file for which drive has been setup

Motore da abbinare al drive / Motor to couple with drive

AXOR MACK® DRIVE
 Cliente / Client: _____ N. Ordine / Order N.: _____
 Totale pezzi / Tot. pieces: 1 di / of: 1 Data / Date: _____
 Codice prod. / Order code: 93910291 Matricola / ID No.: _____
 HW: MKD600-5/10SE-RD0-01100 SW: C109 / X000 / D360

N. Lotto modulo / N. Block modular board: 3119 N. Lotto etichetta / N. Block etichetta: _____
 N. Lotto com-reg / N. Block com-reg: 1119

File di taratura / Adjustment file: MKD600_5_10_MKM120_M_V38_0_MKES1
Tarature / Settings:
 Versione firmware / Firmware version: _____ I rms / Rated I : 4,3 Arms
 firmware_MKD_C_105.mot I peak / Peak I : 10 Arms
 Versione CPLD / CPLD version: _____ Speed limit: 3000 Rpm
 cpld_MKD_1_3_ems.jed Note: _____
 Versione Boot / Boot version: _____
 boot_MKD_0_0_046
 Versione software / Software version: _____
 Etichetta prodotto / Product label: _____

Caratteristiche motore / Motor features:
 Tipo motore / Motor type: MKM120_M_V38_0_MKES1
 Encoder: 2048 Imp/rev I o : 4,3 Arms U n : 285 V rms
 P. Motor : 8 W I pk : 19 Arms M o : 7,5 Nm
 P. Resolver : _____ N n : 3000 Rpm M s : 30 Nm
 Phasing angle : 330 deg L : 12 mH K e : 95 V/1000 rpm
 Brake : no R : 4,1 ohm K t : 1,57 Nm/A

N. ID strumento / Instrument ID: _____ N. ID attrezzature di prod. / N. ID prod equipment: _____
 Misure relative alla qualità del prodotto / Product quality tests: _____
 Misure relative ai dati feedback per la progettazione / Project feedback data tests: _____

COLLAUDO / TEST

Questo documento certifica che l'apparecchiatura soddisfa i requisiti specifici nel contratto di acquisto, in quanto tutte le prove previste nelle procedure di collaudo sono state superate con esito positivo.
 This document certifies that the device meets the requirements that are displayed on the purchase contract, because all of the programmed tests on the test procedures were positive.

Operatore C.Q. / Quality test op: _____
 Firma / Signature: _____

AXOR sas - Viale Stazione 5, Montebello Vic.no (VI) Italia - Tel. +39 0444440441 - Fax +39 0444440418 - info@axorindustries.com

FIG.2 (Certificato di collaudo / Test Certificate)

Nota/Note: Si raccomanda al cliente di archiviare il certificato di collaudo del drive e del motore / *It is recommended that the client retains the test certificate of both drive and motor.*

78

AXOR Industries

Service Manual

MACK®

ver.1 rev.10/'19

3.14 Standard configuration files MACK DRIVE

The files are made in this conditions:

- Drive standard.
- Motor with no load (free to run).
- Encoder feedback 2048 pulse/rev.
- Motor with or without electromechanical brake.

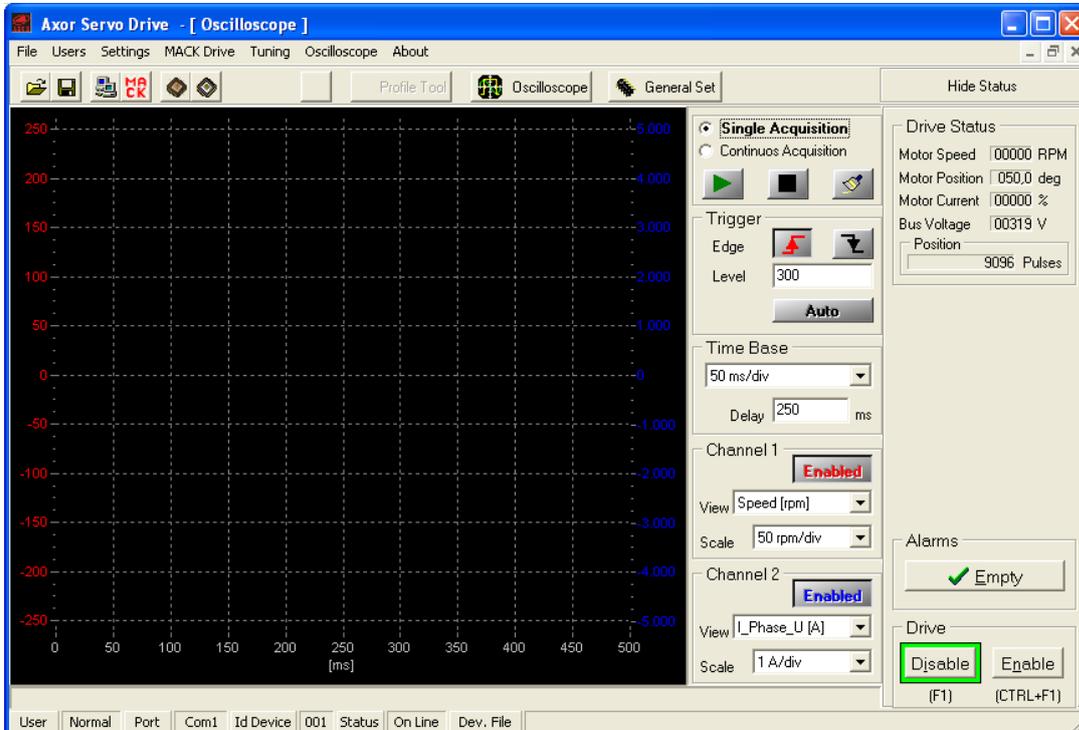
Notes:

- **The loading of a file and the parameter variation should be done only by qualified technical personnel.**
- The standard configuration files are not protected against accidental changing, so after loading a new file it is necessary to control all the parameter, in particular:
 - Main voltage
 - Number of motor pole (*Motor window*)
 - Feedback (*Motor window*)
 - Irms (*Current window*)
 - Ipeak (*Current window*)
 - Rated speed (*Speed window*)

3.15 Oscilloscope MACK DRIVE

Clicking on "Oscilloscope" it is possible to open the digital oscilloscope implemented into the *Speeder One* interface.

The oscilloscope functions as a normal two channel digital oscilloscope and it allows visualizing: *motor speed, phase current, position error, etc.*



Oscilloscope window

3.15 Oscilloscope MACK DRIVE

DATA ACQUISITION:



Data acquisition settings

Single Acquisition

Selecting the *Single Acquisition* option, the oscilloscope's behaviour is dependant upon enablement/disablement of a trigger event:

CASE 1: If the trigger event is enabled on rising edge or falling one of signal in Channel 1, the oscilloscope waits for the first trigger event. At trigger arrival the trace is visualized and data acquisition is stopped. To capture a new trigger event it is necessary to start a new acquisition by clicking on the icon ►.

CASE 2: If trigger event is disabled, the oscilloscope acquires new data, it visualizes it, then it stops. To upgrade the trace it is necessary to start a new acquisition by clicking on the icon ►.

Continuous Acquisition

Selecting the *Continuous Acquisition* option, the oscilloscope's behaviour depends upon enablement/disablement of trigger event:

CASE 1: If trigger event is enabled on the rising or falling edge of a signal in Channel 1, oscilloscope waits until the first trigger event. At trigger's arrival the trace is visualized and it is updated at each trigger event.

CASE 2: If trigger is disabled, oscilloscope continually acquires new data and updates traces.

START/STOP/RESET DATA ACQUISITION:



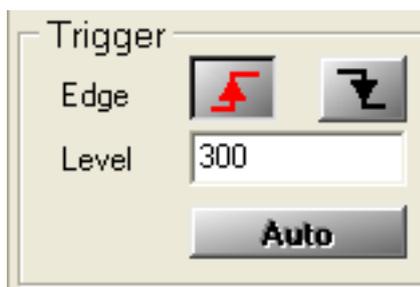
It starts data acquisition in both modes *Single* or *Continuous Acquisition*.

It stops data acquisition in Continuous Acquisition mode, or in Single Acquisition mode if there is not a trigger event.

It resets the window eliminating the visualized traces.

3.15 Oscilloscope MACK DRIVE

TRIGGER EVENT:



Trigger event setting

Enabling trigger event it is possible to acquire and visualize the traces only at the occurrence of a definite signal in Channel 1; that signal is characterized by a rising edge or a falling one and by a level (or amplitude). To enable a trigger event it is necessary:

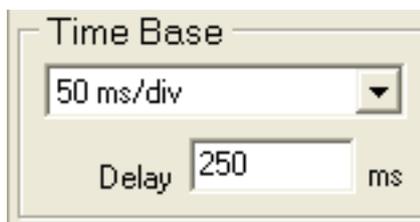
- 1st to set the rising or falling edge (**Edge** icons);
- 2d to set the desired level (**Level** parameter).

Clicking the **Auto** button it is possible to disable the trigger event \Rightarrow the oscilloscope will continue to acquire new data and update the traces.

You should use the **Auto** trigger function:

- During first acquisition, in order to know the scale of input signals;
- In presence of low repetitive signal rates;
- In presence of DC signals.

TIME BASE:



Time base setting

Time Base

This allows you to change the scale of the horizontal axis, the time base. The min. resolution is 1ms/div, while the Max is 1s/div.

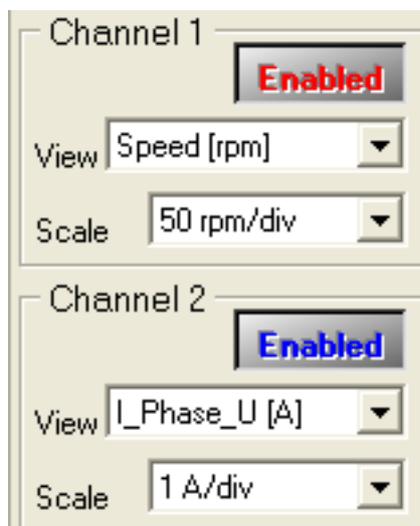
Delay

If the trigger event is enabled the value set in **Delay** fixes the point, in the horizontal axis, where the trigger event will be visualized; on the contrary, if the trigger event is disabled the value set in Delay is ignored.

The default value set for the Delay parameter is in the middle window.

3.15 Oscilloscope MACK DRIVE

SIGNAL SETTING:



Input signal setting

Channel 1 (View) and Channel 2 (View)

This allows you to select the signal to visualize. The different options are as follows:

- The motor speed: **Speed [rpm]**
- The phase U current: **I_Phase_U [A]**
- The position error: **Posit_Err [Pulses]** (not yet enabled)
- The quadrature current: **Iq[A]**

The Channel 1 is enabled if the reference button **Enabled** is red, while Channel 2 is enabled if the reference button **Enabled** is blue.

To disable a channel click on the Enabled button \Rightarrow **Disabled** appears.

Channel 1 (Scale) and Channel 2 (Scale)

The unit of vertical scale is automatically set by choosing an input signal:

- **rpm/div** for speed
- **mA/div** or **A/div** for current
- **Pulses/div** for position error

However, it is possible to change the scale selecting from values in the **Scale** menu.

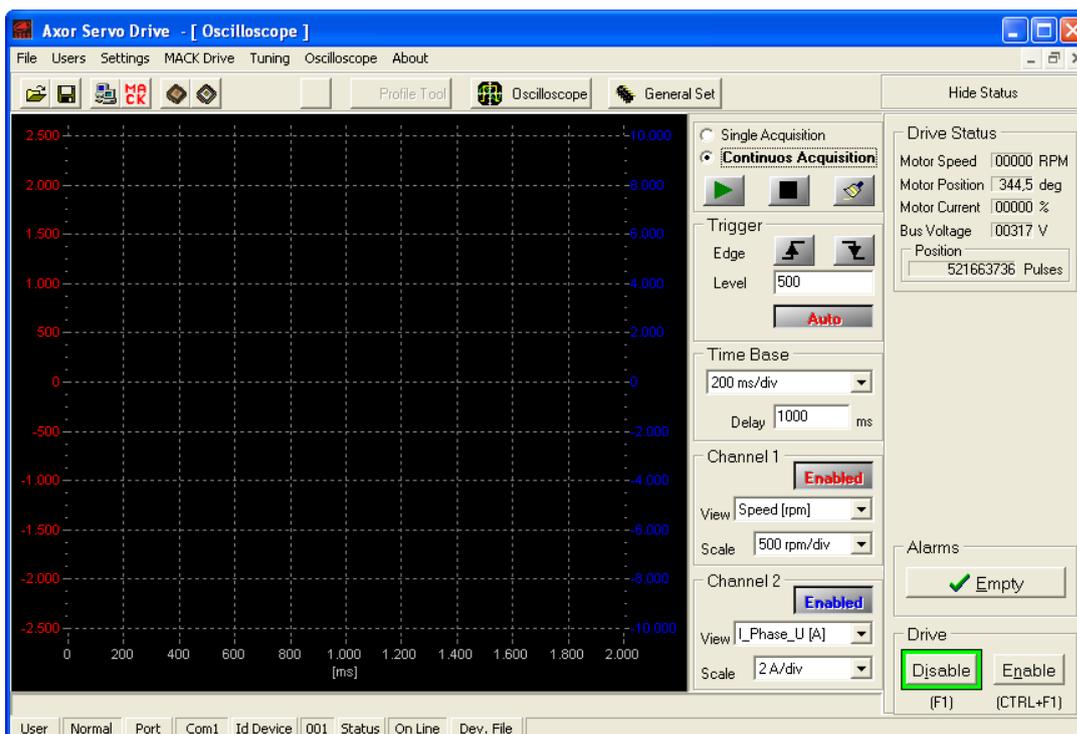
For Channel 1 the scale will be visualized in red on the left, while for Channel 2 the scale will be visualized in blue on the right.

3.15 Oscilloscope MACK DRIVE

EXAMPLE: Suppose we want to visualize by digital oscilloscope *motor speed* and *phase current*.

The procedure is described below:

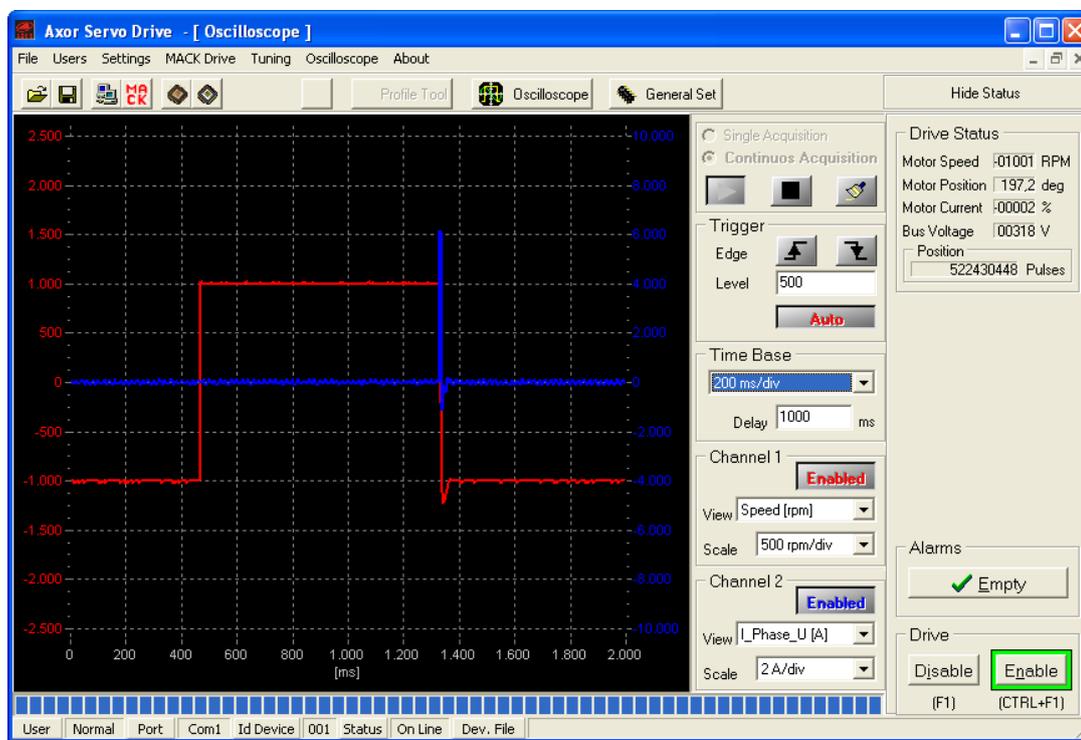
- 1- Follow the *base installation procedure* illustrated in the previous chapter.
- 2- Open the *Speeder One* interface and connect to the drive.
- 3- Select, for example, the operative mode "**Square Wave**", then set a *speed reference* equal to 1000rpm and a *square wave period* equal to 2000ms.
- 4- Open the **Oscilloscope** window by clicking on oscilloscope icon.
- 5- In the Oscilloscope window set the *initial parameters* (see Fig.6):
 - a) Select **Continuous Acquisition**.
 - b) Trigger \Rightarrow click on **Auto** button.
 - c) Time base \Rightarrow set to 200ms/div.
 - d) Channel 1: View \Rightarrow select Speed[rpm].
Scale \Rightarrow select 500rpm/div.
 - e) Channel 2: View \Rightarrow select I_Phase U[A].
Scale \Rightarrow select 2A/div.



3.15 Oscilloscope MACK DRIVE

6- Enable the drive by clicking the **Enable** icon.

7- Start data acquisition by clicking the icon ►. Wait a few seconds in order to acquire traces:



Traces visualized using initial parameters

8- Parameters corrections:

a) If necessary, *adjust the vertical scale* of speed and current:

- If the trace overflows the window ⇒ increase the scale.
- If the trace is too pressed ⇒ decrease the scale.

In the above visualized trace, it is not necessary to change the speed scale nor the current scale.

b) Set the *Trigger* on the rising edge (or falling edge) of the signal in Channel 1, choosing a trigger level based upon the signal to be visualized. Setting a level that is too high will result in no data acquisition.

Having the above visualized traces, it is convenient to set the trigger on the rising edge and with a level equal to 500 (in the range between -1000 and +1000); in fact setting a level too high (>1000 or <-1000) should result in no valid trigger event.

c) If necessary, *adjust the horizontal scale, Time Base* parameter:

- To visualize more periods of input signals ⇒ increase Time Base parameter.
- To visualize less periods of input signals ⇒ decrease Time Base parameter.

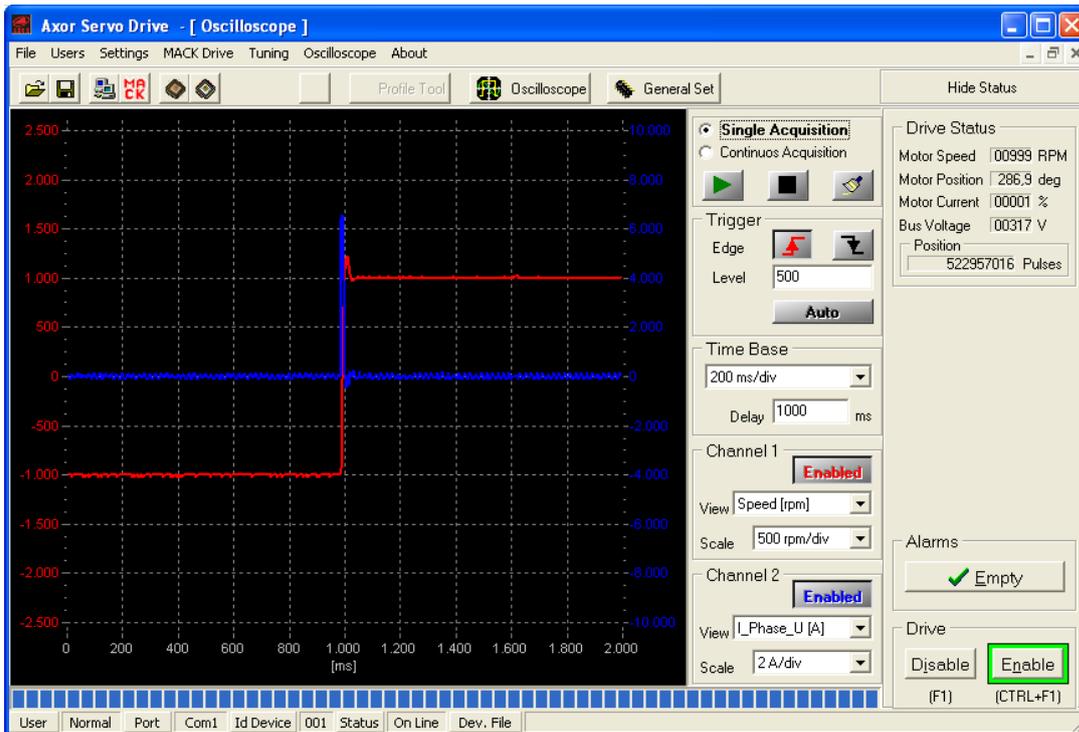
In the above visualized trace, it is not necessary to change the time base.

3.15 Oscilloscope MACK DRIVE

d) To avoid the continuous trace refresh and to visualize the signal on the first valid trigger event:

1. Click on icon ■.
2. Select **Single Acquisition**.
3. Click on icon ►.
4. At each new desired acquisition click on icon ►.

Doing the adjustments described above, we acquired the traces illustrated in the following:



Traces visualized after parameter adjustment

3.16 MACK POWER Alarms

The table below illustrates all the **MACK POWER** message errors:

ALARM		SOLUTION
1	EEPROM Error while memorising parameters to the device's EEPROM.	Re-try to memorise the parameters to the device's EEPROM.
2	Overcurrent Short circuit between +AT/-AT or towards earth.	Disconnect the power, verify the wiring, then power up again.
8	Regenerative Resistance The value I ² t energy recovery has reached the maximum allowed.	Disable the system: <ul style="list-style-type: none"> • Check the resistor setting in the SpeederOne; • Check the AC power supply input; • Check that the working cycles are not excessive; • Verify if the motor, going at half speed, shows the same problem. Reset the alarm, then enable the system.
9	Min Voltage Minimum converter voltage.	Disable the drive, wait until the DC power supply voltage reaches the correct threshold, check the AC power supply input, then enable the drive.
10	Pre-Alarm Recovery 80% of the I ² t energy recovery value has been reached.	Check the AC power supply input and the working cycles. This is a visual alarm, it anticipates the intervention of the "Maximum recovery" alarm.
11	Mack-Link Malfunctions in the device's communication.	Control the system connections and configurations.
13	Overvoltage Maximum converter voltage.	Disable the system, wait until the DC power supply voltage reaches the correct threshold, check the AC power supply input, then enable the drive.
17	Overcurrent Brake circuit Possible short-circuit in the regen resistance circuit. This causes the opening of the Relè OK contact and the disabling of the functioning.	Power off the drive, control the short-circuit, then power on the drive.
19	In-rush Bus Indication of the drive's in-rush phase or the lack of the main supply.	It is only a message.
20	Auxiliary Voltage The auxiliary +24Vdc voltage is missing.	Disable the system, control the Auxiliary Voltage, and then re-enable.
23	Flash Errors in reading/writing parameters on the Flash memory, or Flash memory is empty.	Disable the system, save new values, then re-enable. If the problem persists contact Axor.
24	Can Bus Error during communication on Can Bus.	Disable the system, check the cabling and re-enable. If the problem persists contact Axor.

3.17 MACK DRIVE Alarms

The table below illustrates all the **MACK DRIVE** message errors:

	ALARM	SOLUTION	RESET
1	EEPROM Error while memorising parameter to the drive's EEPROM.	Disable the drive, try to memorise the parameter, then re-enable.	NO
2	Overcurrent Short circuit between U, V, W towards earth.	Disconnect the power, verify the motor U/V/W wiring, then power up again.	NO
3	Drive Temperature Heat sink temperature too high, >70°C.	Disable the drive, verify: <ul style="list-style-type: none"> • The forced ventilation functioning (if present), • The ambient drive temperature, wait until the radiator has cooled off, reset the alarm then enable the drive. 	YES
4	Hall This alarm comes on if one or more of the hall cell's wires are disconnected.	Disable the drive, verify the cell's wire connection, reset the alarm, then enable the drive.	YES
5	Encoder This alarm comes on if one or more of the encoder channels are interrupted.	Disable the drive, control the connections, reset the alarm, then enable the drive.	YES
6	I²t Drive The internal I ² t function (refer to the rated current) has reached the maximum permitted. The cause could be one of the following: <ul style="list-style-type: none"> • The working cycle could be too heavy; • A possible mechanical block; • Motor phase inversion; • The electronic brake is not unblocked; • The amplifier's dynamic constants: "KP", "KI" and "KD", could create useless current oscillation. 	This does not cause the disabling of the drive's functioning.	AUTO
7	Motor Temperature Heat sink temperature too high.	Disable the drive: <ul style="list-style-type: none"> • Control the heat sink temperature; • Decrease the dynamic constant if the motor is vibrating. This situation causes current oscillation and consequently the overheating of the motor. Wait until the motor has cooled off, reset the alarm, then enable the drive.	YES
8	MKP Regenerative Resistance Duplicate the alarm 8 of the MACK POWER on the Mack Drive .	See the solution on MACK POWER alarm table.	NO
9	Min Voltage Minimum converter voltage.	Disable the drive, wait until the DC power supply voltage reaches the correct threshold, check the AC power supply input, then enable the drive.	AUTO

3.17 MACK DRIVE Alarms

11	Mack-Link Malfunctions in the drives' communication.	Control the system connections and configuration.	NO
13	Overvoltage Maximum converter voltage.	Disable the drive, wait until the DC power supply voltage reaches the correct threshold, check the AC power supply input, then enable the drive.	AUTO
14	Following Error The error between the position reference and the position feedback exceeds the "Max Position Error" parameter, because the "Max Position Error" parameter is too small, or the dynamic gains of the velocity-positioning loop are wrong.	Disable the drive, check the Max Position Error parameter, check the dynamic gains, reset the alarm, then enable the drive.	YES
15	Limit Switch The two fixed limit switches have both been disabled or interrupted.	Disable the drive, check the limit limit switches and external connections, then enable the drive.	AUTO
18	Mechanical Brake Overcurrent at the internal brake command or wrong connections.	Disconnect the power: <ul style="list-style-type: none"> • Control the external connections; • Control the current absorption of the motor brake; • Verify the settings of the "Holding Brake" parameter on the "Motor" window; then power up again.	YES
20	Auxiliary Voltage The auxiliary +24Vdc voltage is missing.	Disable the drive, check the voltage level is >21.6Vdc and then re-enable.	AUTO
22	STO Malfunction in the Safe Torque Off safety function or wrong sequence.	Verify the presence of the STO signals (STO+ and STO-) applied on M2 connector. Verify the correct sequence of application of the STO signals and the Enable signal. If the alarm persists contact Axor.	YES
24	Can Bus Alarm Error during communication on CANBus.	Disable the drive, check the cabling and re-enable. If the problem persists contact Axor.	YES
26	Homing Error Position error too high during the homing procedure. The motor stops, but it is not disabled.	Check the homing setup, then reset the alarm using the "Start Homing" function.	YES

Chapter 4

Operative Modes

4.1 Operative Modes	88
4.2 Digital Speed.....	89
4.3 Analog Speed	90
4.4 Digital Torque	93
4.5 Digital Toque Limitation	94
4.6 Analog Torque	95
4.7 Analog Toque Limitation	96
4.8 Gearing (Electrical Axis).....	97
4.9 Pulse/Dir Command.....	100
4.10 CW/CCW Command.....	103
4.11 CanBus - Settings	106
4.12 Can Bus - Command Sequences	107
4.13 EtherCAT - Settings	116
4.14 Square Wave	117
4.15 Homing - Procedures	118
4.16 Homing - Settings	122
4.17 Homing - Example.....	126

4.1 Operative Modes

The **MACK DRIVE** supports the followings operative modes:

OPERATIVE MODES	
ANALOG SPEED	Speed piloting utilising an analogue reference.
DIGITAL SPEED	Speed piloting utilising a digital reference.
ANALOG TORQUE	Torque piloting utilising an analogue reference.
DIGITAL TORQUE	Torque piloting utilising a digital reference.
GEARING (ELECTRICAL AXIS)	It will be possible to pilot the drives with the quadrature signals of an emulated encoder from a Master drive or with the quadrature signals of an incremental encoder from a Master motor.
PULSE/DIR MODE	It will be possible to connect the drives to a motor controller , piloting it with the H.CK/L.CK/O.CK and H.DIR/L.DIR/O.DIR signals.
CANOPEN	It can be configured and controlled using CanBus . It supports the following Can Open protocols: <ul style="list-style-type: none"> • Part of the DS301-V4.02 • Part of the DSP402-V2.0
CW/CCW	It is possible to connect the drive to a motor piloting it with the CLOCK and DIR signals: if pulses arrive at the CLOCK input, the motor rotates clockwise (CW); while if pulses arrive at the DIR input, the motor rotates counter clockwise (CCW).
ETHERCAT	The drive can be configured and controlled using EtherCAT .
SQUARE WAVE	The motor is piloted with a "square wave" signal. This is useful for adjustments of the speed loop.

4.2 Digital Speed

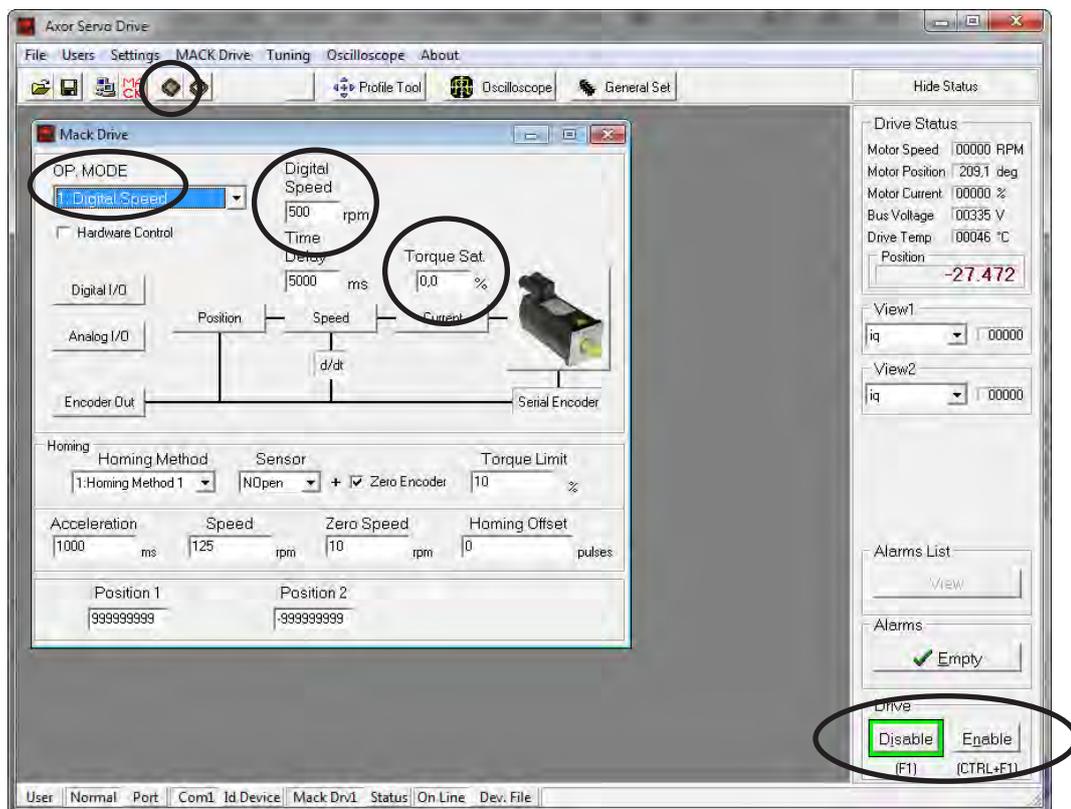
The **MACK DRIVE** can control a motor by using a *speed digital reference*.

The procedure is the following:

1- Perform the *basic installation procedure* and *the motor tests* previously illustrated (*see cap. 2.26 Motor Test on page 48*);

2- Enable digital speed control via *Speeder One interface*:

1. Set the operative mode **1:Digital Speed**;
2. Insert the desired speed reference [in rpm];
3. Save settings by clicking on icon "**Save data to Eeprom**";
4. Enable/disable the drive by using the **Enable/Disable** buttons.
5. Is possible to limit the Max torque using the option Torque Sat. (The % is referred to the I_{max} of the drive, to disable this option set it to 0).



3- If the turning is irregular or noisy, it should be necessary to *adjust the gains of the speed loop* by using an adequate procedure.

4.3 Analog Speed

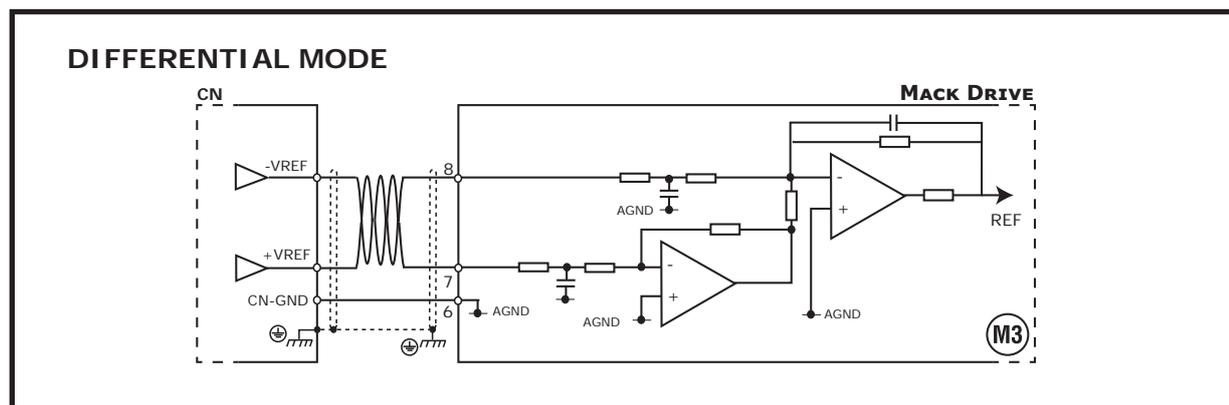
The **MACK DRIVE** can control a motor by using a **differential or common mode analog speed reference from the CN or PLC**.

The procedure is the following:

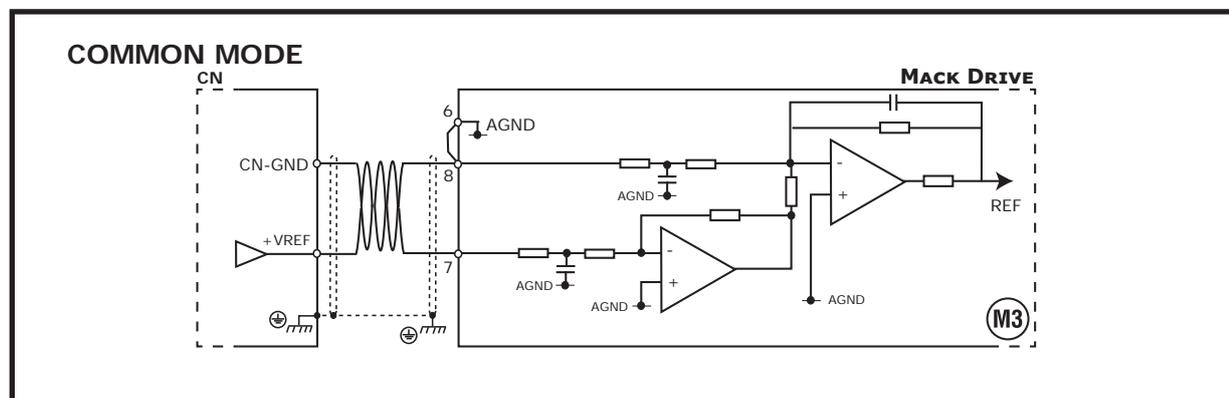
1- Perform the *basic installation procedure* and the *motor tests* previously illustrated (see *cap. 2.26 Motor Test on page 48*);

2- Use the pins **+REF**, **-REF** and **AGND** to *apply the desired speed reference* ⇒ the axis card used in the Numerical Control or PLC can have two different types of analog reference outputs:

- **Differential analog output**, in this case connect the positive speed reference to **+REF** and the negative speed reference to **-REF**.



- **Common mode reference analog output**, in this case connect the control's analogue output either to the **+REF** terminal or to the **-REF** terminal, depending upon the required rotational direction. Then connect the **AGND** to the reference input terminal that is NOT used.



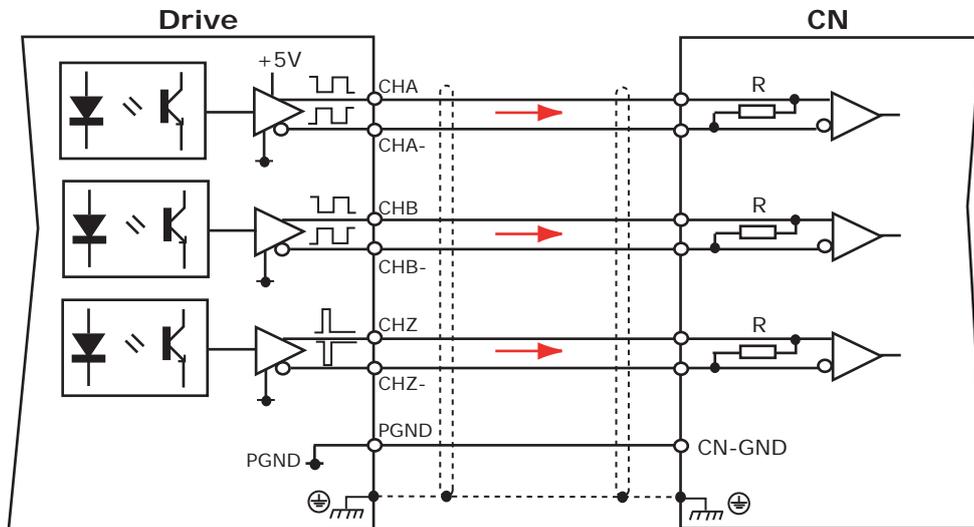
Notes:

- ✓ To change the sense of rotation apply the positive voltage reference to **-REF**, or change the **Rotary Direction** parameter in the **Speed** window (from **Positive** to **Negative**).
- ✓ We suggest to connect the shield on both sides.

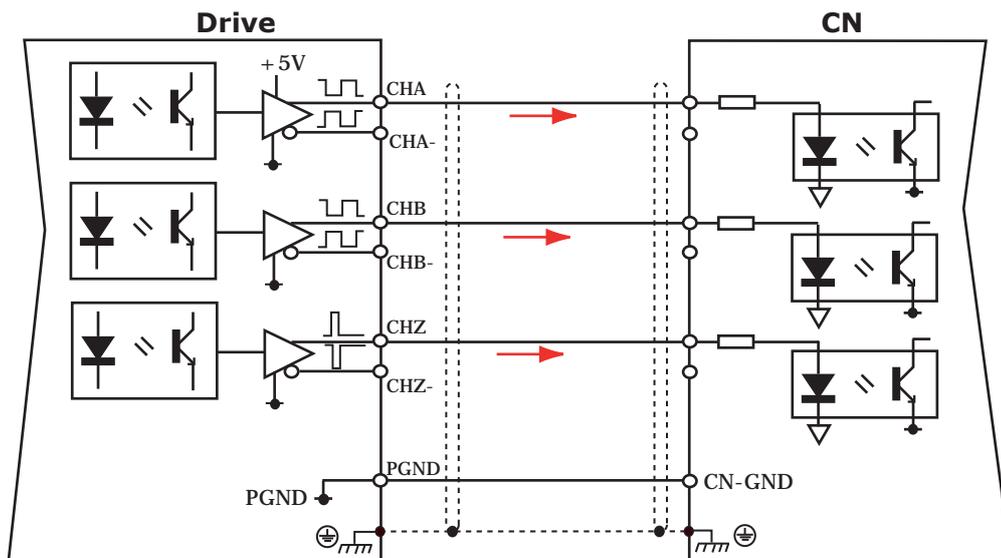
4.3 Analog Speed

3- Connect the emulated encoder outputs of the drive to the CN:

- If the CN has **LINE RECEIVER** inputs, follow these connections:



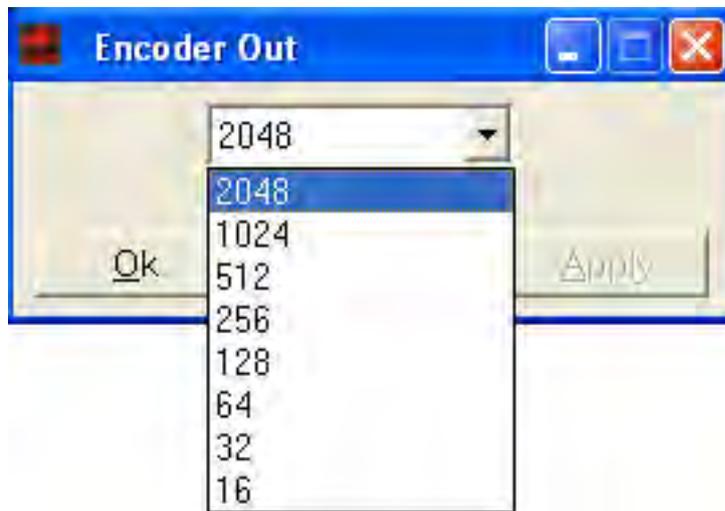
- If the CN has **COMMON MODE** inputs, follow these connections:



Note: We suggest connecting the shield on both sides.

4.3 Analog Speed

4- Set the desired pulses per turn on emulated encoder outputs by **Speeder One interface**: open the "**Encoder Out**" window and select the desired pulses per turn:



5- Execute the *settings of the offset of the velocity analog input reference* via **Speeder One interface**: open the "**Analog I/O**" window and click on the **Analog 1** icon.

6- Enable analog speed control via **Speeder One interface**:

1. Set the operative mode **0:Analog Speed** and keep the **Torque Sat.** box to **OFF**;
2. Save settings by clicking on icon "**Save data to Eeprom**";
3. Enable/disable the drive by using the **Enable/Disable** buttons.
4. Is possible to limit the Max torque using the option Torque Sat. (The % is referred to the I_{max} of the drive, to disable this option set it to 0).

7- If the rotation is irregular or noisy, it should be necessary to *adjust the gains of the speed loop* by using an adequate procedure.

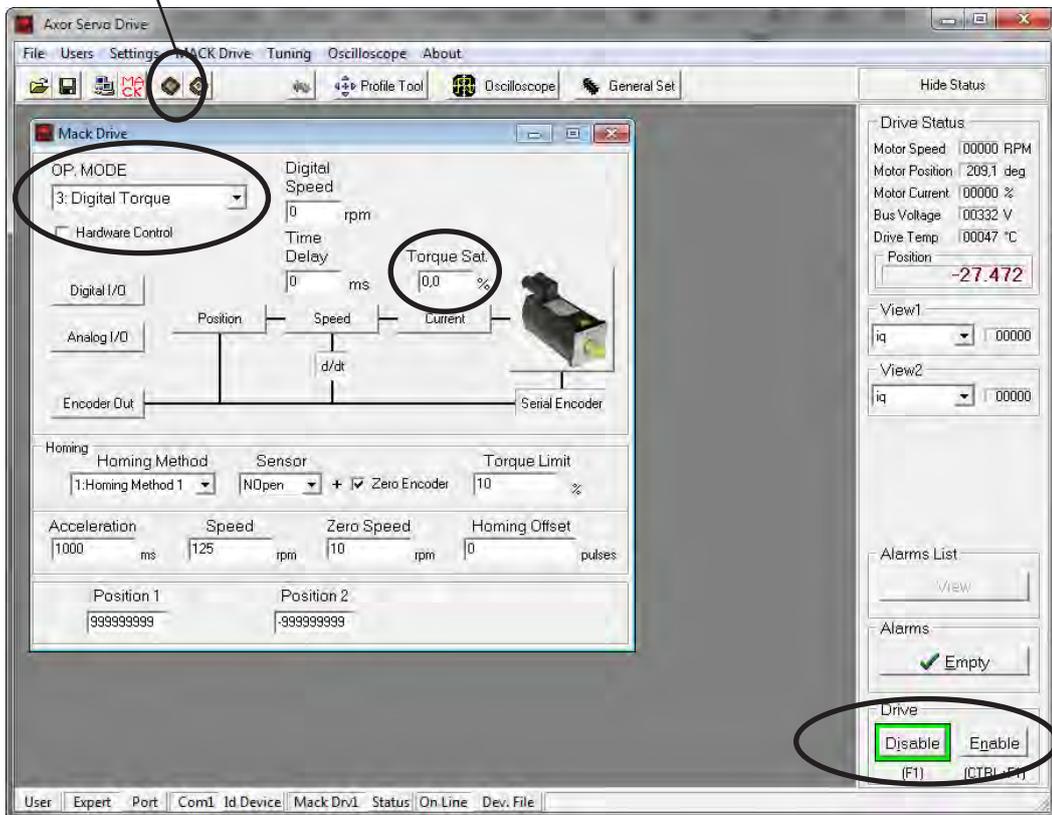
4.4 Digital Torque

The **MACK DRIVE** can control a motor by using a **digital torque reference**.

The procedure is the following:

- 1- Perform the *basic installation procedure* and the *motor tests* previously illustrated (*see cap. 2.26 Motor Test on page 48*);
- 2- Enable the control via **Speeder One interface**:
 1. Set the operative mode **3:Digital Torque**;
 2. Insert the desired torque reference (*) in the Torque Sat. then click ↵;
 3. Save all settings by clicking on icon "**Save data to Eeprom**";
 4. Enable/disable the drive by using the **Enable/Disable** buttons.

Save Data to Eeprom



(*) Insert the calculate torque reference using this formula:

$$\frac{I_{\text{desired}} \times 100}{I_{\text{peak}}}$$

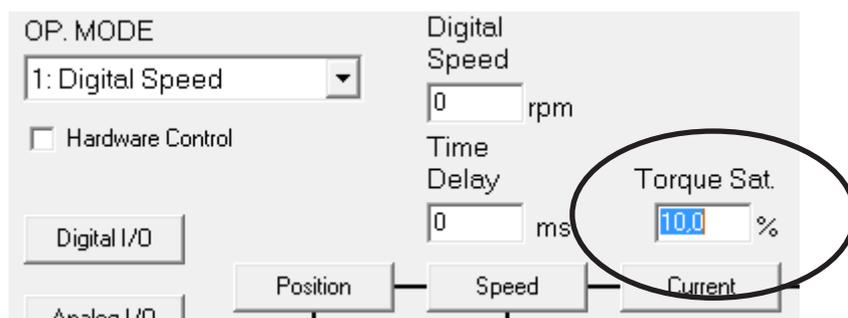
Example: Suppose we want to set a digital torque reference equal to 5A, having a drive size of 10/20 (10A=rated current, 20A=peak current) ⇒ at Torque Sat. insert the value 25, in fact $(5 \times 100) / 20 = 25$.

P.S. The value 0,0% disable the torque limitation.

4.5 Digital Torque Limitation

The **Mack Drive** can limit the Max torque with the digital value "Torque Sat.", this option is available with the following operative mode:

- 0: Analog Speed
- 1: Digital Speed
- 5: Gearing
- 6: Pulse/Dir Mode
- 8: CW/CWW
- 10: Square wave period



To limit the Max torque use the following procedure:

- 1 - Select the supported operative mode;
- 2 - Insert the desired torque in "Tarque Sat." using the formula(*)
- 3 - Save settings by clicking on icon "**Save data to Eeprom**";
- 4 - To calculate the motor torque output form the current limitation use the following formula:

$$M(\text{Nm}) = I_{\text{DESIRED}} * K_T (\text{Nm} / \text{ARMS OF MOTOR})$$

(*) Insert the calculate torque reference using this formula:

$$\frac{I_{\text{desired}} \times 100}{I_{\text{peak}}}$$

Example: Suppose we want to set a digital torque reference equal to 5A, having a drive size of 10/20 (10A=rated current, 20A=peak current) ⇒ at Torque Sat. insert the value 25, in fact $(5 \times 100) / 20 = 25$.

P.S. The value 0,0% disable the torque limitation.

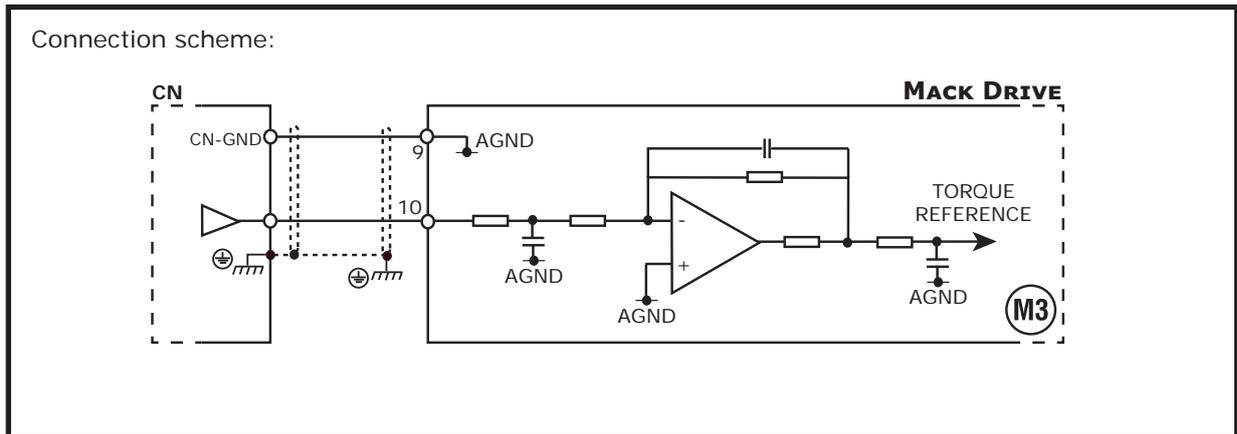
4.6 Analog Torque

The **Mack Drive** can control a motor by using an **analog torque reference**.

The procedure is the following:

1- perform the *basic installation procedure* and the *motor tests* previously illustrated (*see cap. 2.26 Motor Test on page 48*);

2- use pins **TPRC** and **AGND** to apply the desired torque reference (using a common mode signal equal to **+/-10V**):



The formula for determining the voltage value to be applied in TPRC in order to obtain the necessary current is as follows:

$$V_{TPRC} = 10 * \frac{(+/-) I_{desired}}{I_{peak}}$$

3- enable the control via **Speeder One interface**:

a- Set operative mode "**2:Analog Torque**":



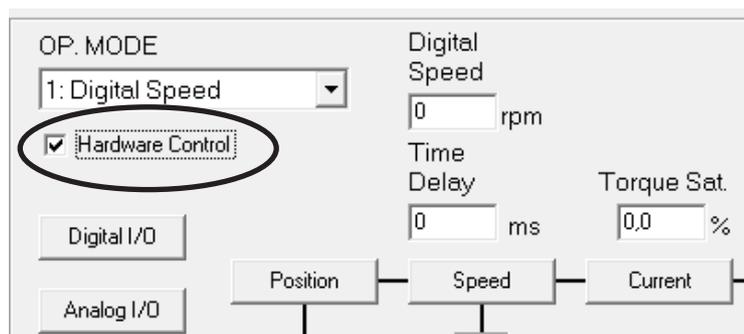
b- save settings by clicking on icon "**Save data to Eeprom**";

c- enable/disable the drive by using the **Enable/Disable** buttons.

4.7 Analog Torque Limitation

The **Mack Drive** can limit the Max torque with the analog input "TP.RC" enabling the function "Hardware Control", this option is available with the following operative mode:

- 0: Analog Speed
- 1: Digital Speed
- 5: Gearing
- 6: Pulse/Dir Mode
- 8: CW/CWW
- 10: Square wave period



To limit the Max torque use the following procedure:

- 1- perform the *basic installation procedure* and the *motor tests* previously illustrated (*see cap. 2.26 Motor Test on page 48*);
- 2- use pins **TPRC** and **AGND** to apply the desired torque reference (using a common mode signal equal to **+/-10V**);
- 3- Select the supported operative mode;
- 4- Set the offset of the analog input TP.RC with the **Speeder One Interface**: open the window "**Analog I/O**", apply **0V** on the input "TP.RC" and press on the button **Analog 2**.
- 5 - Save settings by clicking on icon "**Save data to Eeprom**";
- 6 - The formula for determining the voltage value to be applied in TPRC in order to obtain the necessary current is as follows:

$$V_{TPRC} = 10 * \frac{(+/-) I_{desired}}{I_{peak}}$$

To calculate the motor torque output from the current limitation use the following formula:

$$M(Nm) = I_{DESIRED} * K_T (Nm / ARMS OF MOTOR)$$

4.8 Gearing (Electrical Axis)

The operative mode **Gearing** allows you to connect together two drives: the first drive will be set as **Master**, the second as **Slave**. The Slave will be controlled by the **emulation encoder outputs** from the Master drive.

The procedure is the following:

- 1- Perform the *basic installation procedure* and the motor tests previously illustrated (*see cap. 2.26 Motor Test on page 48*).
- 2- Execute hardware connections between the Master and the Slave drive as illustrated on chapter 2 (*see cap. 2.24 Gearing connections on page 46*)
- 3- Set the Master and the Slave drives by using the *Speeder One* interface:

Setting Master drive

- a- Select one of the possible operating modes (You may select any of the available operating modes, with the exception of "5: Gearing").
- b- Select the number of pulses in the "**Encoder Out**" window, which must be sent to the Slave drive.

Setting Slave drive

- a- Select the "**5:Gearing**" operating mode.
- b- Select the ratio between the pulses from the Master drive and the desired pulses/rev on the Slave drive, setting the "**Pulses per Turn**" and "**Gear Ratio**" parameters in the "**Position**" window:

Pulses per turn

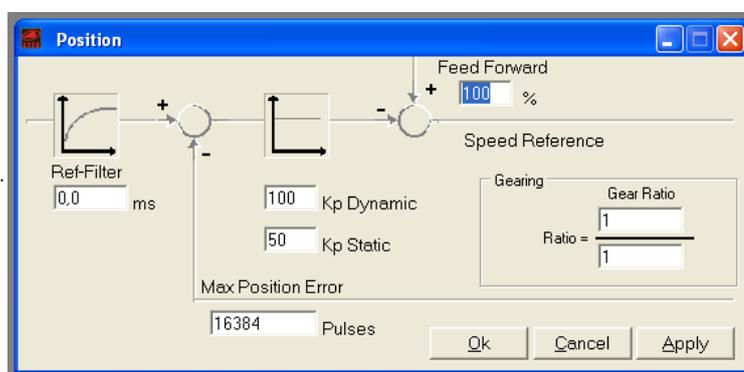
Insert into this field the number of pulses per turn of the emulated encoder from the Master drive.

Gear Ratio

Insert into the numerator and denominator, the ratio that allows you to obtain the desired Slave speed in regards to the Master.

Example: Inserting the value **-1** at numerator and **2** at denominator in the "**Gear Ratio**", SLAVE motor will rotate at half that of the MASTER's speed.

- 4- In **Position** window set:
 - ✓ **FeedForward**: set to 100;
 - ✓ **Kp Dynamic** e **Kp Static**;
 - ✓ **Ref-Filter**;
 - ✓ **Max Position Error**: set to 4096.



- 5- Save all settings by clicking on icon "**Save data to Eeprom**".

4.8 Gearing (Electrical Axis)

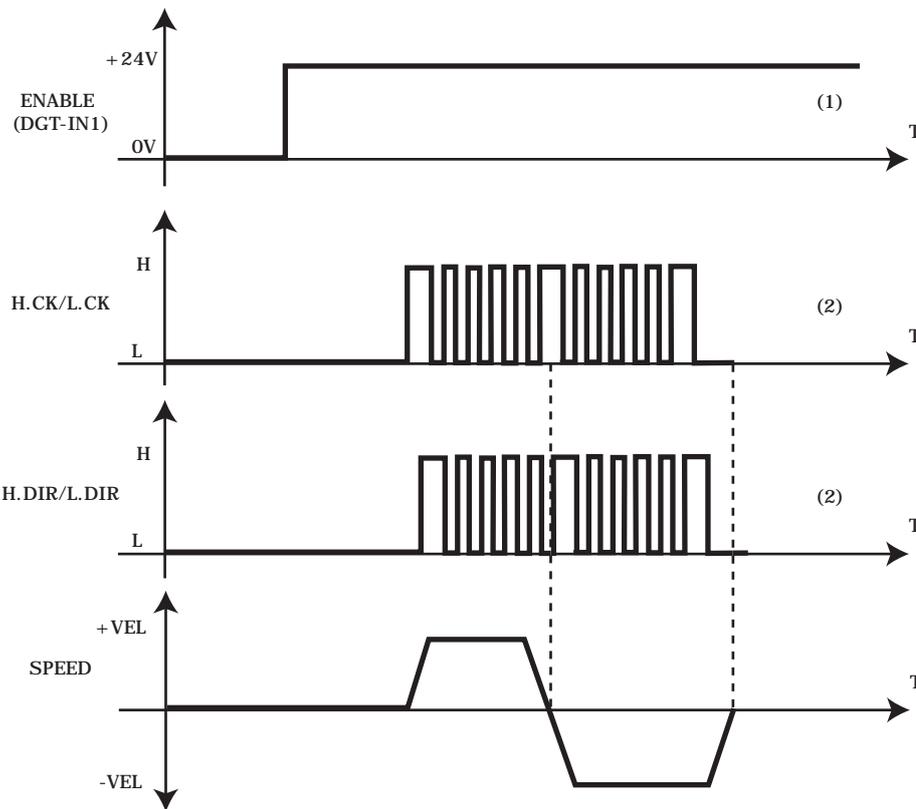
6- For enabling the Electrical Axis follow this procedure:

a- Enable the Master giving +24V to the **DGT-IN1** (ENABLE) input. The motor will start move following the operating mode set for the Master.

b- Enable the Slave giving +24V to the ENABLE input. The motor will remain blocked in torque with the position loop inserted and waiting to move. See (1)

c- When the pulses's arrive at the inputs the motor will move. See (2)

Electrical Axis sequence:



Note: If required by the application, at anytime it is possible to execute a *homing procedure* (see cap. 4.15 Homing - Procedures on page 118).

4.8 Gearing (Electrical Axis)

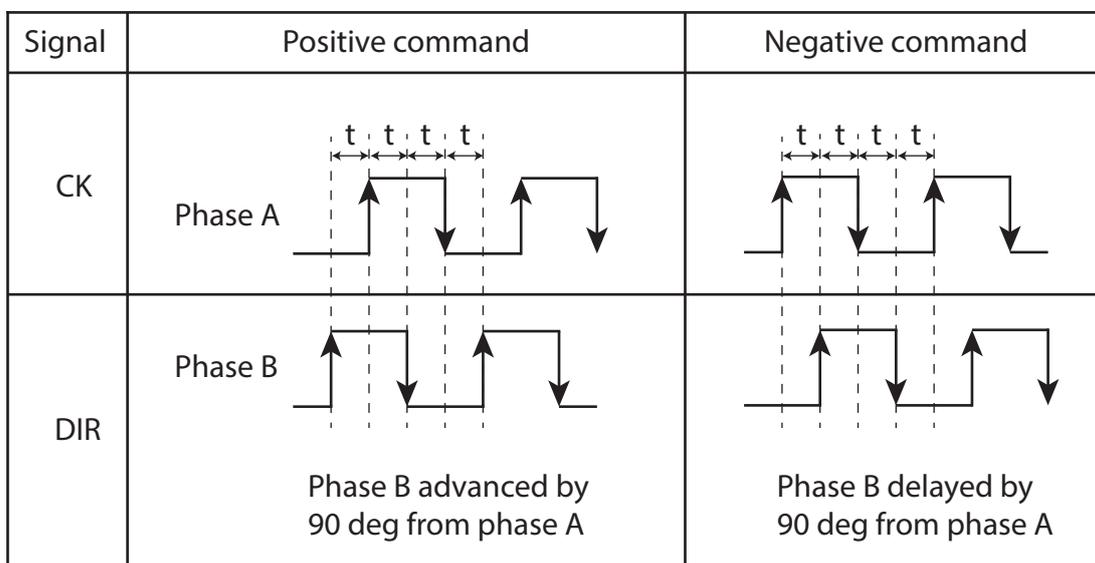
It is possible to control the Slave by using the **increasing channels of an external encoder** or the **emulated encoder signals from a CN**, in this case:

- 1- Use the **H.CK/L.CK/O.CK** and **H.DIR/L.DIR/O.DIR** pins to connect encoder signals (+/-CHA and +/-CHB).
- 2- Set the operative mode "**5:Gearing**" in the OP. MODE menu.
- 3- Insert into the **Pulse per Turn** field the number of pulses per turn of the external encoder.
- 4- Insert into the numerator and denominator of the **Gear Ratio**, the ratio that allows you to obtain the desired Slave speed in regards to the encoder.
- 5- Enable the drive giving +24V to the **DGT-IN1 (ENABLE)** input. The motor will remain blocked in torque with the position loop inserted and waiting to move.
- 6- When the pulses's arrive at the inputs the motor will move.

ATTENTION: If the rotation is irregular or noisy, it should be necessary to *adjust the gains of the speed loop or of the position loop* by using an adequate procedure.

Timing on inputs:

The following table show the timing to respect on the input **H.CK**, **L.CK**, **H.DIR**, **L.DIR**.



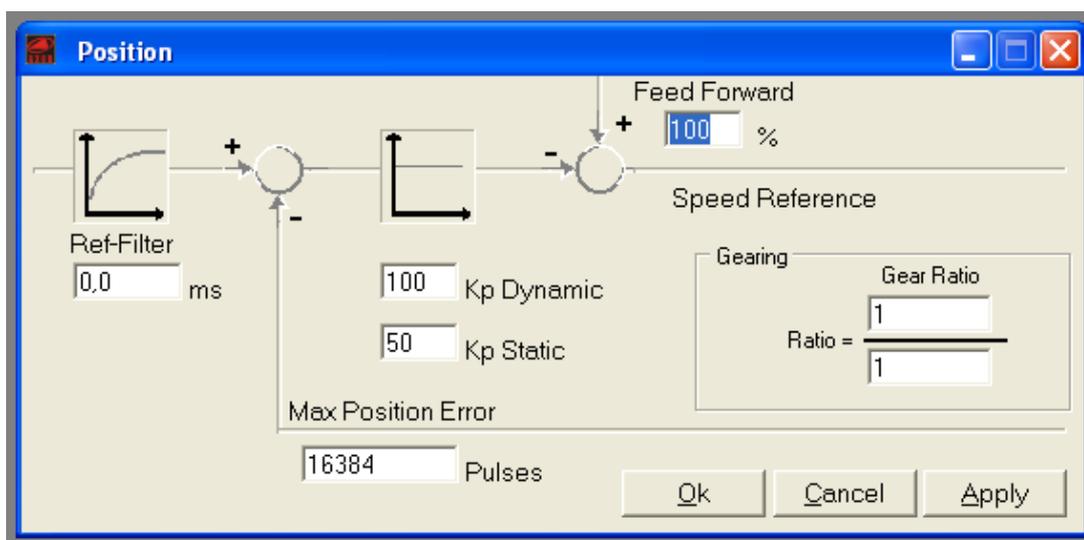
CK / DIR signal	Max. allowable input frequency	Minimum required time width [μ s]
		t
Line driver	500 KHz	2
Open collector	200 KHz	5

4.9 Pulse/Dir Command

The **Pulse/Dir Mode** allows you to connect the drive to a **stepper-motor controller**.

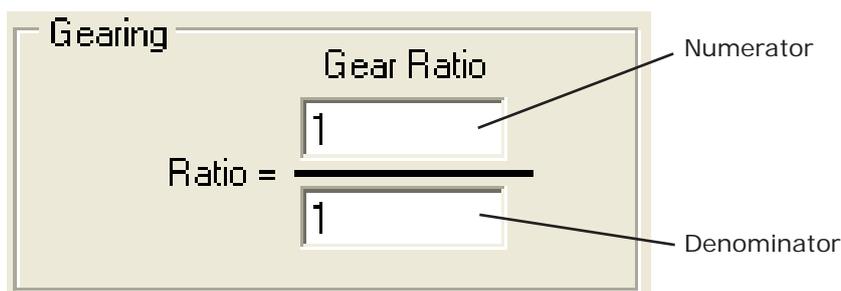
The procedure is the following:

- 1- Perform the *basic installation procedure* and the *motor tests* previously illustrated (see *cap. 2.26 Motor Test on page 48*).
- 2- Execute hardware connections between drive and CN as illustrated in the chapter 2 (see *cap. 2.23 Clock/Dir inputs connections on page 43*).
- 3- Set the drive by using the *Speeder One* interface:
 - set the operative mode "**6:Pulse/Dir Mode**" in the OP. MODE window;
 - open the "**Position**" window and set **Gear Ratio** parameters:



Gear Ratio

Transmission ratio between revolutions(numerator) and pulses(denominator).



Example: For 2500 pulses/revolution set as in figure(1/2500).

- 4- Save all settings by clicking on icon "**Save data to Eeprom**".

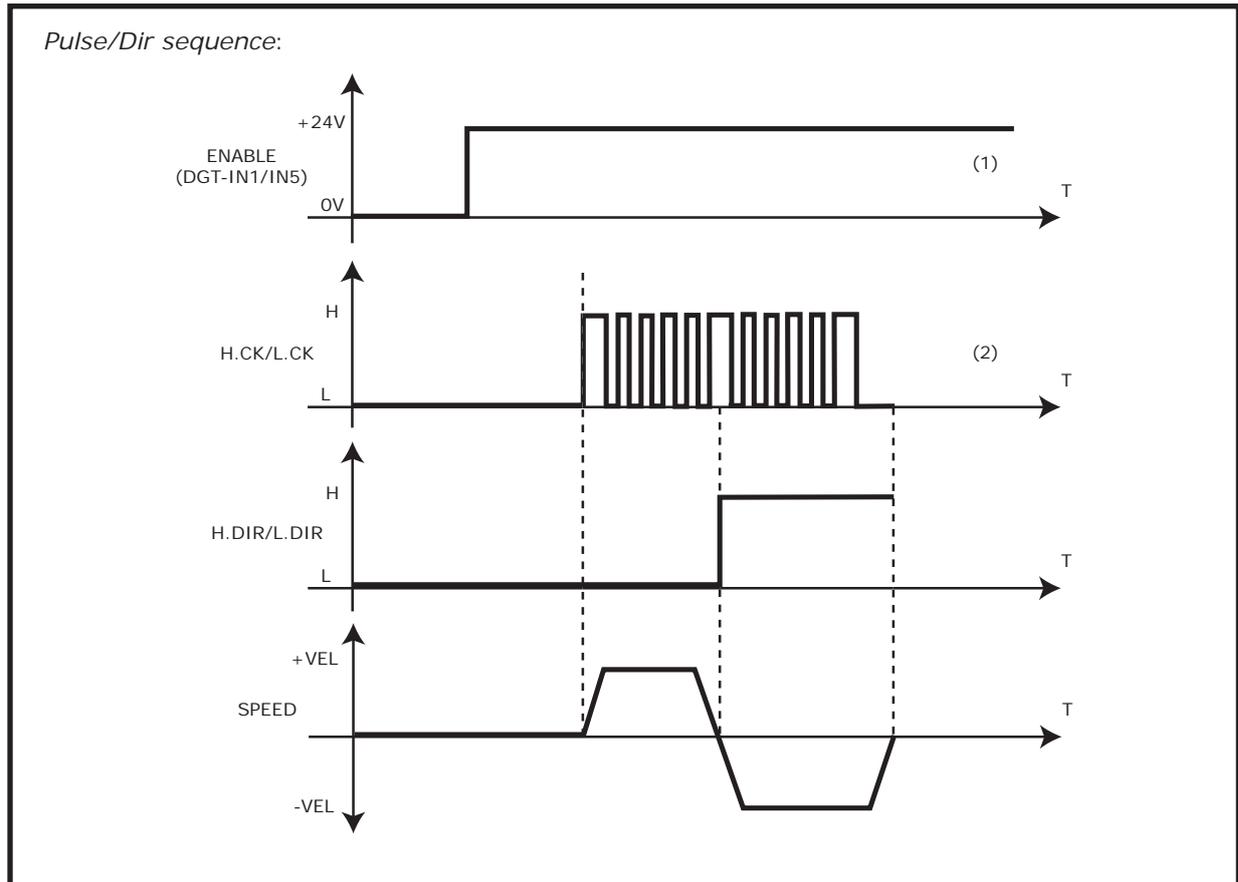
4.9 Pulse/Dir Command

5- For enabling the Pulse/Dir Mode follow this procedure:

a- Enable the drive giving +24V to the ENABLE input (DGT-IN1). The motor will remain locked in torque with the position loop inserted and waiting to move. See (1)

b- When the pulses arrive at the input the motor will move. See (3)

The **H.DIR/L.DIR** logic signal determines the motor's direction: with the signal **H.DIR/L.DIR = L** the motor turns clockwise (**CW**); with the signal **H.DIR/L.DIR = H**, the motor turns counter-clockwise (**CCW**).



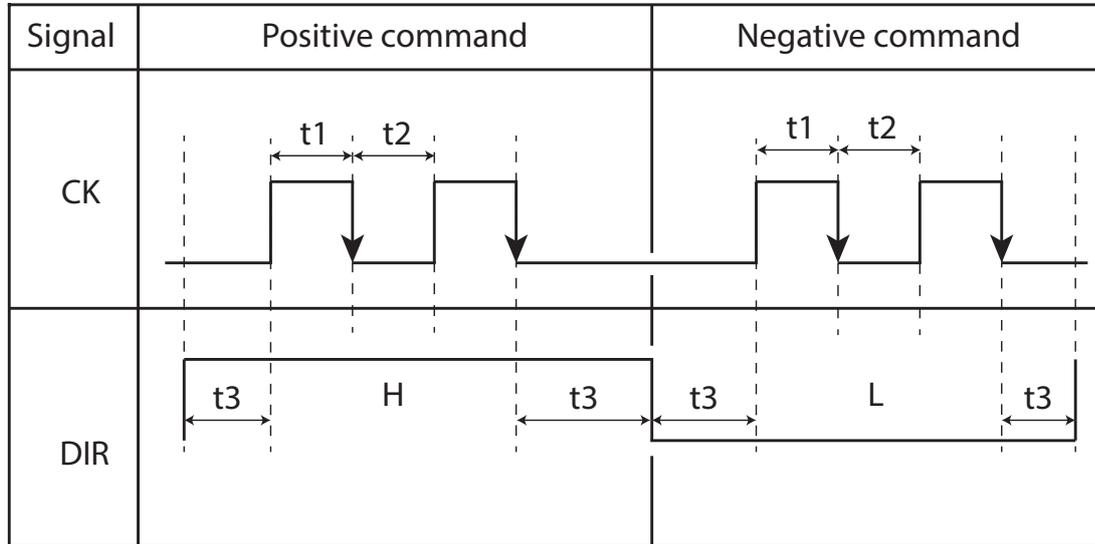
Note: If required by the application, at anytime it is possible to execute a **homing procedure** (see cap. 4.15 Homing - Procedures on page 118).

ATTENTION: If the rotation is irregular or noisy, it should be necessary to **adjust the gains of the speed loop or of the position loop** by using an adequate procedure.

4.9 Pulse/Dir Command

Timing on inputs:

The following table show the timing to respect on the input **H.CK**, **L.CK**, **H.DIR**, **L.DIR**.



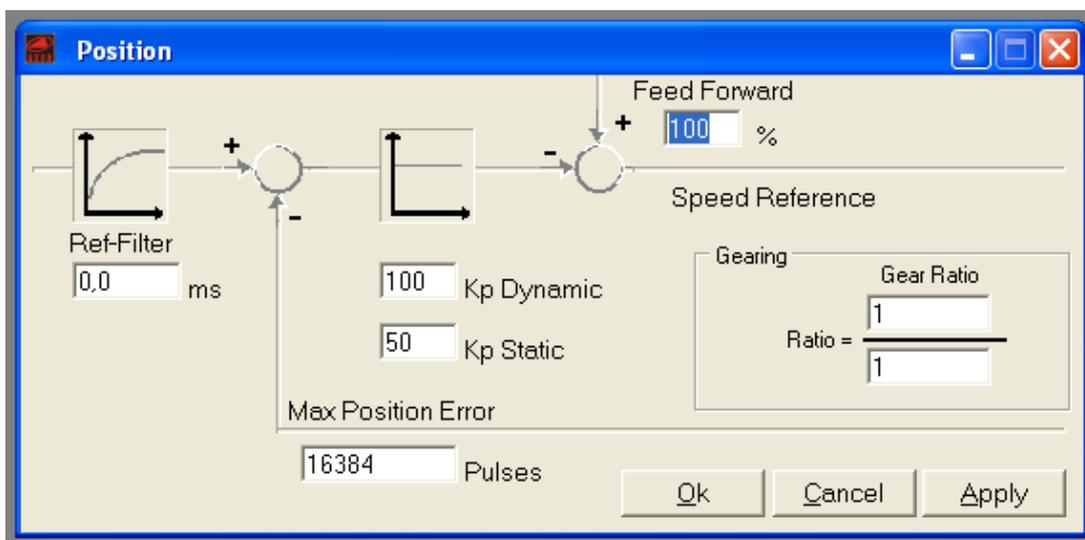
CK / DIR signal	Max. allowable input frequency	Minimum required time width [μ s]		
		t1	t2	t3
Line driver	500 KHz	1	1	1
Open collector	200 KHz	2.5	2.5	2.5

4.10 CW/CCW Command

The motor is piloted with a pulse signal applied on the input **H.DIR/L.DIR/O.DIR** or **H.CK/L.CK/O.CK** to get respectively the rotation of motor in clockwise direction or counter-clockwise.

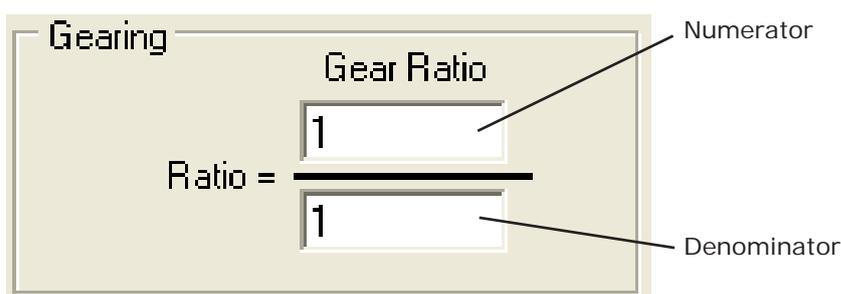
The procedure is the following:

- 1- Perform the *basic installation procedure* and the *motor tests* previously illustrated (*see cap. 2.26 Motor Test on page 48*).
- 2- Execute hardware connections between drive and CN as illustrated in the chapter 2 (*see cap. 2.23 Clock/Dir inputs connections on page 43*).
- 3- Set the drive by using the *Speeder One* interface:
 - set the operative mode "**8: CW/CCW**" in the OP. MODE window;
 - open the "**Position**" window and set **Gear Ratio** parameters:



Gear Ratio

Transmission ratio between revolutions(numerator) and pulses(denominator).



Example: For 2500 pulses/revolution set as in figure(1/2500).

- 4- Save all settings by clicking on icon "**Save data to Eeprom**".

4.10 CW/CCW Command

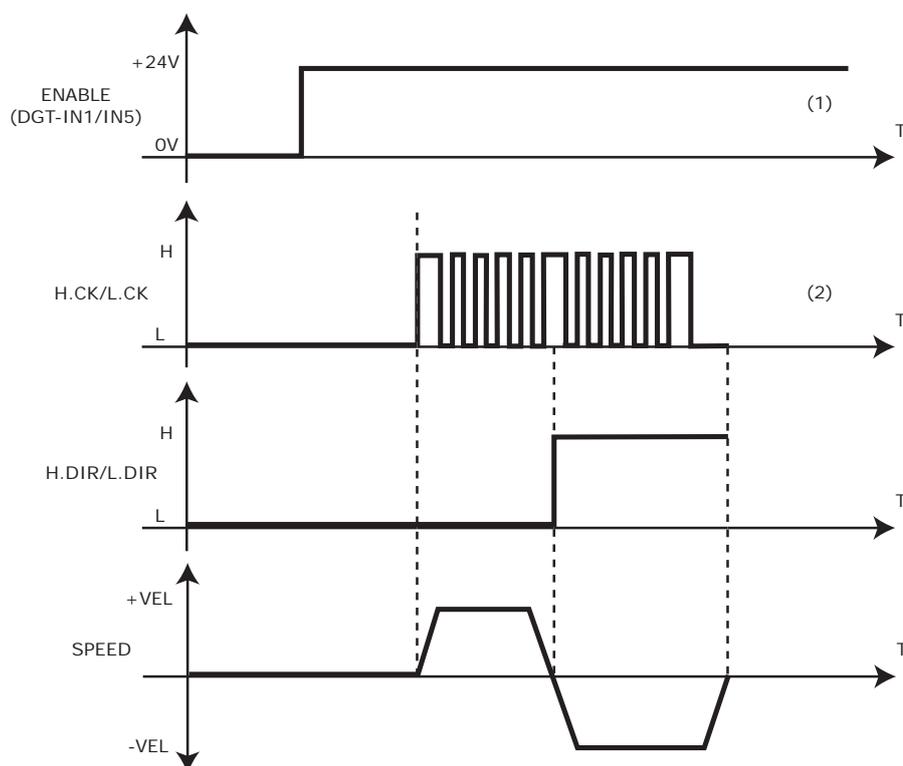
5- For enabling the Pulse/Dir Mode follow this procedure:

a- Enable the drive giving +24V to the ENABLE input (DGT-IN1). The motor will remain locked in torque with the position loop inserted and waiting to move. See (1)

b- When the pulses arrive at the input the motor will move. See (3)

The **H.DIR/L.DIR** logic signal determines the motor's direction: with the signal **H.DIR/L.DIR = L** the motor turns clockwise (**CW**); with the signal **H.DIR/L.DIR = H**, the motor turns counter-clockwise (**CCW**).

Pulse/Dir sequence:



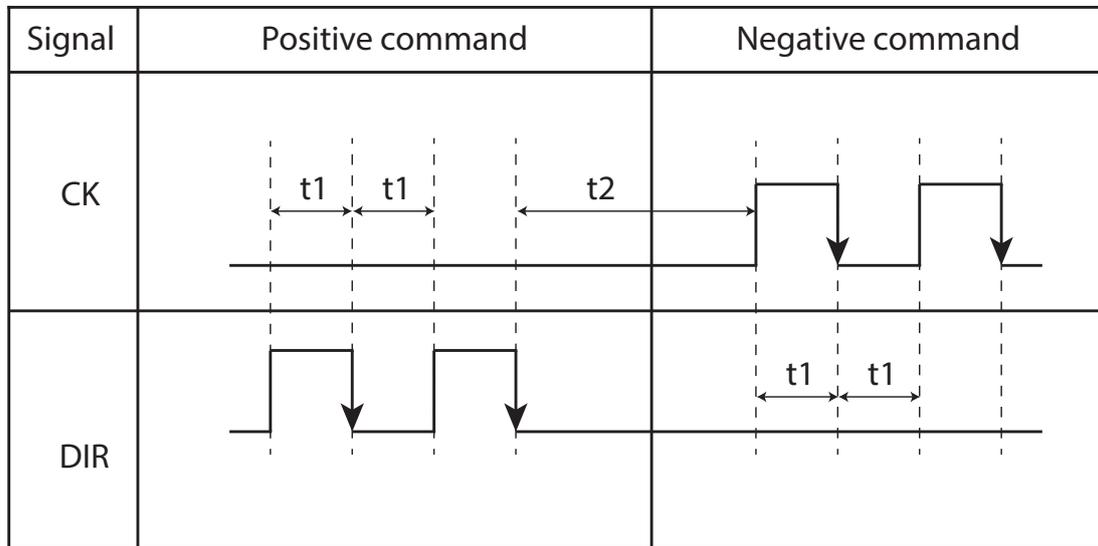
Note: If required by the application, at anytime it is possible to execute a **homing procedure** (see *cap. 4.15 Homing - Procedures on page 118*).

ATTENTION: If the rotation is irregular or noisy, it should be necessary to **adjust the gains of the speed loop or of the position loop** by using an adequate procedure.

4.10 CW/CCW Command

Timing on inputs:

The following table show the timing to respect on the input **H.CK**, **L.CK**, **H.DIR**, **L.DIR**.



CK / DIR signal	Max. allowable input frequency	Minimum required time width [μ s]	
		t1	t2
Line driver	500 KHz	1	1
Open collector	200 KHz	2.5	2.5

4.11 CanBus - Settings

The **Mack**® system can be controlled in **CanBus**.

The procedure is the following:

- 1- For each drive perform the *basic installation procedure* and the *motor tests previously illustrated (see cap. 2.26 Motor Test on page 48)*;
- 2- In the "**General Settings**" window of each drive set the **baud rate** parameter to define the communication speed and so the performance of the system.
All drives connected to the same network must have the same baud rate.
- 3- For each drive set the operative mode "**7: Can Open**".
- 4- For each drive set a different Id.
- 5- Connect the first drive to the CAN MASTER by using a CanBus cable.
- 6- Connect each drive to the preceding and the following by using a CanBus cable.
- 7- Connect a **RESISTOR** (120 ohm, 1/4W) between pins **CAN H** and **CAN L** of the last drive of the network.

Note:

The interface is isolated by opto-isolators and a dc-dc power converter is present, which powers all of the circuitry of this interface. It is therefore not necessary to connect any external power supply to the drive.

4.12 Can Bus - Command Sequences

The integrated software is based upon the **CAN open DS301** communication protocol and on profile **DSP402**.

Objects used in all operative modes

The following objects can be used independently to the selected operative mode (*Position Mode, Velocity Mode, Homing Mode or Interpolated Mode*) and they allow to check and command the axis:

Index	Name	Access	Description
6040.0 _H	Controlword	R/W	It enables the axis and, in some modes, it gives the start motion command.
6041.0 _H	Statusword	RO	It reads the axis status.
6060.0 _H	Mode of operation	R/W	It sets one of the CanOPEN (DSP402) operative modes: <ul style="list-style-type: none"> • <i>profile velocity mode</i>: 3 • <i>profile position mode</i>: 1 • <i>homing mode</i>: 6 • <i>interpolated mode</i>: 7
6061.0 _H	Mode of op. display	RO	It reads the active operative mode.
6064.0 _H	Position actual value	RO	It provides the actual axis position, in Um.
606C.0 _H	Velocity actual value	RO	It provides the actual axis velocity, in Um/s.
6092.1 _H	Feed	R/W	It converts the Can unit of measurement into increments by using the following formula: $Position_{Um} = Position_{inc} * Feed / (65536 * Motor\ shaft)$
6092.2 _H	Motor shaft	R/W	

4.12 Can Bus - Command Sequences

Object 6040_H: Controlword

This object has 16 bits, each of these has a particular meaning; some bits have a different function in accordance to the selected operative mode.

In the following table there are the bits descriptions for all drive operative modes.

Profile Position Mode (OP number: 1)							
BIT 15 MANUFACT SPECIFIC	BIT 14 MANUFACT SPECIFIC	BIT 13 MANUFACT SPECIFIC	BIT 12 MANUFACT SPECIFIC	BIT 11 MANUFACT SPECIFIC	BIT 10 RESERVED	BIT 9 RESERVED	BIT 8 HALT
BIT 7 FAULT RESET	BIT 6 ABSOLUTE RELATIVE	BIT 5 CHANGE SET IMMEDIATELY	BIT 4 NEW SET POINT	BIT 3 ENABLE OPERATION	BIT 2 QUICK STOP	BIT 1 ENABLE VOLTAGE	BIT 0 SWITCH ON

Profile Velocity Mode (OP number: 3)							
BIT 15 MANUFACT SPECIFIC	BIT 14 MANUFACT SPECIFIC	BIT 13 MANUFACT SPECIFIC	BIT 12 MANUFACT SPECIFIC	BIT 11 MANUFACT SPECIFIC	BIT 10 RESERVED	BIT 9 RESERVED	BIT 8 HALT
BIT 7 FAULT RESET	BIT 6 RESERVED	BIT 5 RESERVED	BIT 4 RESERVED	BIT 3 ENABLE OPERATION	BIT 2 QUICK STOP	BIT 1 ENABLE VOLTAGE	BIT 0 SWITCH ON

Homing Mode (OP number: 6)							
BIT 15 MANUFACT SPECIFIC	BIT 14 MANUFACT SPECIFIC	BIT 13 MANUFACT SPECIFIC	BIT 12 MANUFACT SPECIFIC	BIT 11 MANUFACT SPECIFIC	BIT 10 RESERVED	BIT 9 RESERVED	BIT 8 HALT
BIT 7 FAULT RESET	BIT 6 RESERVED	BIT 5 RESERVED	BIT 4 START OPERATION	BIT 3 ENABLE OPERATION	BIT 2 QUICK STOP	BIT 1 ENABLE VOLTAGE	BIT 0 SWITCH ON

Interpolated Mode (OP number: 7)							
BIT 15 MANUFACT SPECIFIC	BIT 14 MANUFACT SPECIFIC	BIT 13 MANUFACT SPECIFIC	BIT 12 MANUFACT SPECIFIC	BIT 11 MANUFACT SPECIFIC	BIT 10 RESERVED	BIT 9 RESERVED	BIT 8 HALT
BIT 7 FAULT RESET	BIT 6 RESERVED	BIT 5 RESERVED	BIT 4 ENABLE IP MODE	BIT 3 ENABLE OPERATION	BIT 2 QUICK STOP	BIT 1 ENABLE VOLTAGE	BIT 0 SWITCH ON

4.12 Can Bus - Command Sequences

Object 6041_H: Statusword

This object has 16 bits, each of these has a particular meaning; some bits have a different function in accordance to the selected operative mode.

In the following table there are the bits descriptions for all drive operative modes.

Profile Position Mode (OP number: 1)							
BIT 15 MANUFACT SPECIFIC	BIT 14 MANUFACT SPECIFIC	BIT 13 FOLLOWING ERROR	BIT 12 SET PINT ACK	BIT 11 INTERNAL LIM ACTIVE	BIT 10 TARGET REACHED	BIT 9 REMOTE	BIT 8 MANUFACT SPECIFIC
BIT 7 WARNING	BIT 6 SWITCH ON DISABLED	BIT 5 QUICK STOP	BIT 4 VOLTAGE ENABLED	BIT 3 FAULT	BIT 2 OPERATION ENABLED	BIT 1 SWITCH ON	BIT 0 READY TO SWITCH ON

Profile Velocity Mode (OP number: 3)							
BIT 15 MANUFACT SPECIFIC	BIT 14 MANUFACT SPECIFIC	BIT 13 MAX SLIP ERROR	BIT 12 SPEED	BIT 11 INTERNAL LIM ACTIVE	BIT 10 TARGET REACHED	BIT 9 REMOTE	BIT 8 MANUFACT SPECIFIC
BIT 7 WARNING	BIT 6 SWITCH ON DISABLED	BIT 5 QUICK STOP	BIT 4 VOLTAGE ENABLED	BIT 3 FAULT	BIT 2 OPERATION ENABLED	BIT 1 SWITCH ON	BIT 0 READY TO SWITCH ON

Homing Mode (OP number: 6)							
BIT 15 MANUFACT SPECIFIC	BIT 14 MANUFACT SPECIFIC	BIT 13 HOMING ERROR	BIT 12 HOMING ATTAINED	BIT 11 INTERNAL LIM ACTIVE	BIT 10 TARGET REACHED	BIT 9 REMOTE	BIT 8 MANUFACT SPECIFIC
BIT 7 WARNING	BIT 6 SWITCH ON DISABLED	BIT 5 QUICK STOP	BIT 4 VOLTAGE ENABLED	BIT 3 FAULT	BIT 2 OPERATION ENABLED	BIT 1 SWITCH ON	BIT 0 READY TO SWITCH ON

Interpolated Mode (OP number: 7)							
BIT 15 MANUFACT SPECIFIC	BIT 14 MANUFACT SPECIFIC	BIT 13 RESERVED	BIT 12 IP MODE ACTIVE	BIT 11 INTERNAL LIM ACTIVE	BIT 10 TARGET REACHED	BIT 9 REMOTE	BIT 8 MANUFACT SPECIFIC
BIT 7 WARNING	BIT 6 SWITCH ON DISABLED	BIT 5 QUICK STOP	BIT 4 VOLTAGE ENABLED	BIT 3 FAULT	BIT 2 OPERATION ENABLED	BIT 1 SWITCH ON	BIT 0 READY TO SWITCH ON

4.12 Can Bus - Command Sequences

Profile Velocity (mode of operation=3)

In this operative mode the axis is control by using a *speed reference*, that can be changed at any moment. SDO and PDO messages can be used indifferently.

In the following table there are the specific objects which can be used in this operative mode:

Usable objects:

Index	Name	Access	Description
607E.0 _H	Polarity	R/W	It inverts the movement direction setting to 1 the bit 6 of the object.
60FF0 _H	Target velocity(*)	R/W	It sets a value for the <i>speed</i> reference.
6083.0 _H	Profile acceleration(**)	R/W	It sets the <i>acceleration</i> used to reach the set speed reference, in Um/s ² .
6084.0 _H	Profile deceleration(**)	R/W	It sets the <i>deceleration</i> used by the axis during normal functioning, Um/s ² .
6085.0 _H	Quick stop deceleration(**)	R/W	It sets the <i>deceleration</i> used by the axis in case of malfunctions, Um/s ² .

(*) The object 0x60FF:Target velocity depend on the object 0x6092:Feed constant(see CiA402 Part2).

By default the object 0x6092 is setted with: - 0x06092.01 : Feed = 65536
- 0x06092.02 : Shaft revolutions = 1

To calculate the value to fill in the object Target velocity use the following formula:

$$V_{um/s} = V_{giri/min} / 60 * Feed / ShaftRevolution$$

(**) The acceleration values are then converted in ms to calculate the time for the ramp, by using the following formula:

$$t_{ms} = V_{um/s} / a_{Um/s^2} * 1000 * 2^{15} / V_{norm}$$

where:

V_{norm} is a value parametrized value of the reference speed with respect to the maximum speed in format [1.15]. This means a value of $V_{norm} = 2^{15}$ means Max speed for the motor.

Um means unit of measure.

Command sequence

In the following table there is the axis enable and movement sequence in the *profile velocity mode*. **CW** means *controlword* and **SW** means *statusword* and we suppose that the Can node is into the operational state (NMT state= 5).

Command	Issue
---	Start state, machine start up: node into <i>operational</i> mode, axis without torque: CW=0000 _H and SW=0250 _H .
obj(6060 _H) = 3	I set the <i>Profile velocity</i> Can operative mode.
CW=0006 _H	First step of the enable sequence: SW=0231 _H .
CW=0007 _H	Second step of the enable sequence: SW=0233 _H .
CW=000F _H	Third step of the enable sequence: SW=0237 _H . At this point the motor is steady with torque.
obj(6083 _H) = <i>acc</i>	I set the acceleration value.
obj(6084 _H) = <i>dec</i>	I set the deceleration value.
obj(60FF _H) = <i>value</i>	The axis moves with an acceleration equal to <i>acc</i> and reach the <i>value</i> speed.
obj(60FF _H) = 0	The axis stops with a deceleration equal to <i>dec</i> and it remains steady with torque.

4.12 Can Bus - Command Sequences

Profile Position (mode of operation=1)

In this mode the axis has to reach an absolute position; the speed profile, the acceleration and the deceleration have to be set. The axis movement starts after the start command expedition; at this point the axis makes the positioning and when the positioning is finished it informs the control that the set position is reached or it dispatches a following error if the positioning has not been completed. During the positioning the control cannot modify the parameters of the previously set profile; it can only stop the movement by using the *Halt* command.

Usable objects:

Index	Name	Access	Description
6067.0 _H	Position window	R/W	It sets the <i>space range</i> for the set quote, in Um.
6068.0 _H	Pos. window time	R/W	It sets the <i>time</i> , in ms, after which the attainment of the quote is indicated .
607A.0 _H	Target position	R/W	It sets the <i>absolute position</i> that has to be reached.
607D.1 _H	Min position limit	R/W	It sets the <i>min value</i> that the set quote can reach.
607D.2 _H	Max position limit	R/W	It sets the <i>max value</i> that the set quote can reach.
607E.0 _H	Polarity	R/W	It inverts the movement direction by setting to 1 the bit 7 of the object.
607F.0 _H	Max profile velocity	R/W	It sets the max value for the profile speed.
6081.0 _H	Profile velocity	R/W	It sets the profile <i>speed</i> used to reach the set quote.
6083.0 _H	Profile acceleration(*)	R/W	It sets the <i>acceleration</i> used to reach the set reference speed.
6084.0 _H	Profile deceleration(*)	R/W	It sets the <i>deceleration</i> used by the axis to stop in normal conditions.
6085.0 _H	Quick stop deceleration(*)	R/W	It sets the <i>deceleration</i> used by the axis during malfunctions.

(*) The acceleration values are converted in ms in order to calculate the ramp time by using the following formula:

$$t_{ms} = V_{um/s} / a_{Um/s^2} * 1000 * 2^{15} / V_{norm}$$

where:

V_{norm} is a parameter value of the speed reference regarding the maximum speed.

4.12 Can Bus - Command Sequences

Command sequence

In the following table there is the axis enable and movement sequence in the *profile position mode*.

CW means *controlword* and **SW** means *statusword* and we suppose that the Can node is into the operational state (NMT state= 5).

Command	Issue
---	Start state, machine start up: node into <i>operational mode</i> , exit without torque: CW=0000 _H and SW=0250 _H .
obj(6060 _H) = 1	I set the <i>Profile position</i> Can operative mode.
CW=0006 _H	First step of the enable sequence: SW=0231 _H .
CW=0007 _H	Second step of the enable sequence: SW=0233 _H .
CW=000F _H	Third step of the enable sequence: SW=0237 _H . At this point the motor is steady with torque.
obj(607A _H) = <i>pos_rif</i>	I set the <i>absolute quote</i> that has to be reached.
obj(6083 _H) = <i>acc</i>	I set the <i>acceleration</i> value.
obj(6084 _H) = <i>dec</i>	I set the <i>deceleration</i> value.
obj(6081 _H) = <i>vel_profile</i>	I set the profile <i>velocity</i> .
CW=001F _H	Start command: the axis starts to move toward the set quote.
---	SW = 1237 _H ...positioning...
---	SW = 0637 _H ...positioning ended: the quote is reached.

4.12 Can Bus - Command Sequences

Homing mode (mode of operation = 6)

This mode allows for zeroing the axis; the homing mode is one of the following:

Mode	Description
3	Clockwise + NA sensor + zero encoder
4	Counter clockwise + NC sensor + zero encoder
5	Counter clockwise + NA sensor + zero encoder
6	Clockwise + NC sensor + zero encoder
7	Clockwise + NA sensor
8	Counter clockwise + NC sensor
9	Counter clockwise + NA sensor
10	Clockwise + NC sensor
33	Clockwise + zero encoder
34	Counter clockwise + zero encoder
35	Immediate homing

Usable objects:

Index	Name	Access	Description
607C.0 _H	Home offset(*)	R/W	It sets the <i>preset quote</i> desired after homing.
6098.0 _H	Home method	R/W	It sets the desired <i>homing mode</i> . See the previous table.
6099.1 _H	Speed during search for switch	R/W	It sets the <i>speed</i> used during the homing for switch search.
6099.2 _H	Speed during search for zero	R/W	It sets the <i>speed</i> used during the homing for zero search.
609A.0 _H	Profile deceleration(**)	R/W	It sets the <i>acceleration</i> and <i>deceleration</i> used to reach the set homing speed.

(*) This value does not modify the homing procedure, it just sets the start up quote (preset) visualized after homing; the real position does not change.

(**) The acceleration values are converted in ms in order to calculate the ramp time by using the following formula:

$$t_{ms} = V_{um/s} / a_{Um/s^2} * 1000 * 2^{15} / V_{norm}$$

where:

V_{norm} is a parameter value of the speed reference regarding the maximum speed.

4.12 Can Bus - Command Sequences

Command sequence

In the following table there is the axis enable and movement sequence in the *homing mode*.

CW means *controlword* and **SW** means *statusword* and we suppose that the Can node is into the operational state (NMT state= 5).

Command	Issue
---	Start state, machine start up: node into <i>operational mode</i> , exit without torque: CW=0000 _H and SW=0250 _H
obj(6060 _H) = 6	I set the <i>Homing mode</i> Can operative mode.
CW=0006 _H	First step of the enable sequence: SW=0231 _H .
CW=0007 _H	Second step of the enable sequence: SW=0233 _H .
CW=000F _H	Third step of the enable sequence: SW=0237 _H . At this point the motor is steady with torque.
obj(609A _H) = acc	I set the <i>acceleration</i> value.
obj(6099.1 _H) = vel1	It sets the <i>speed</i> used during the homing for switch search.
obj(6099.2 _H) = vel2	It sets the <i>speed</i> used during the homing for zero search.
obj(6098 _H) = home	I set the <i>homing mode</i> (see the previous table)
CW=001F _H	Start up command: the axis starts moving for zero search.
---	SW = 0237H ...homing...
---	SW = 1237H ...homing ended correctly SW = 2237H ...error during homing procedure

See enclosure "CanOpen Reference Manual" to find more information.

4.12 Can Bus - Command Sequences

Interpolated mode (mode of operation = 7)

In this mode, the master sends to the drive, at a predetermined interval of time, a quota delta that the axis must reach. The drive divides this interval into four subintervals and calculates the share of feed to meet the reference setted form the can master (delta quota). To start the movement, the master has to send a start command via the controlword.

Usable objects:

Indice	Nome	Accesso	Descrizione
60C0.0 _H	Interpolation submode select	R/W	Set the type of interpolation: the only value accepted is 0, linear interpolation.
60C1.1 _H	Interpolation Data	R/W	Quota sent form the can master
60C2.1 _H	Ip Time Unit	R/W	Set the value n of the period using the following formula $n * 10^{Ip_Time_Index}$ second.
60C2.2 _H	Ip Time Index	R/W	The only accepted value is -3, milliseconds.
60C3.1 _H	Synchronize on Group	R/W	The only accepted value is 0, generic sync.
60C3.2 _H	Ip_Sync every n Event	R/W	Set the number of sync that must arrive before receiving the quota.

Command sequence

In the following table is showed the sequence of enable and movement of the axis in interpolation mode. For convenience is indicated with CW the controlword e SW the statusword and is assumed that the node Can is in the operational state (state NMT = 5).

Comando	Esito
---	Initial state, machine powerup: nodoe in operational mode, axis is not in torque: CW=0000 _H e SW=0250 _H .
obj(6060 _H) = 7	Set the operative mode of Can in <i>Interpolated Mode</i> .
obj(60C2.1 _H) = p	Set the period of interpolazione.
CW=0006 _H	First step of the enable sequence: SW=0231 _H .
CW=0007 _H	Second step of the enable sequence: SW=0233 _H .
CW=000F _H	Third step of the enable sequence: SW=0237 _H . Now the motor in stoppend in troque.
CW=001F _H	Start command: the axis start to move.
obj(60C1.1 _H) = Q _i	The can master sent the quote of position every interval of p time.

NOTE: FOR MORE DETAIL ABOUT CANOPEN PROTOCOL IMPLEMENTED BY AXOR SEE "CANOPEN/ETHERCAT REFERENCE MANUAL" PROVIDED BY AXOR ON REQUEST.

4.13 EtherCAT - Settings

The **MACK DRIVE** can be setted and controlled in **EtherCAT** mode.

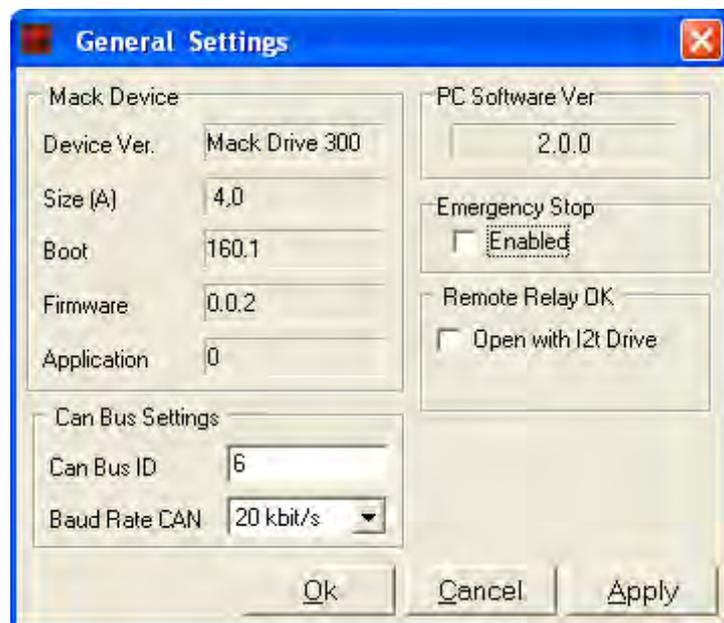
EtherCAT - Setting of operative mode

Set the "OP.MODE" with "9:ETHERCAT" mode with the SpeederOne interface.



EtherCAT - Setting node ID

EtherCAT protocol supports up to 65536 nodes in a communication network. Each Axor drive has its own ID, which may only exist once in the system. It can be set via Axor SpeederOne interface --> "General Settings" window:



The value 0 or values > 32767 are not allowed and cannot be set.

After changing of the node ID, save on eeprom, then power off and on the drive.

A value equal to 32767 means that the master EtherCAT allocates automatically the node ID.

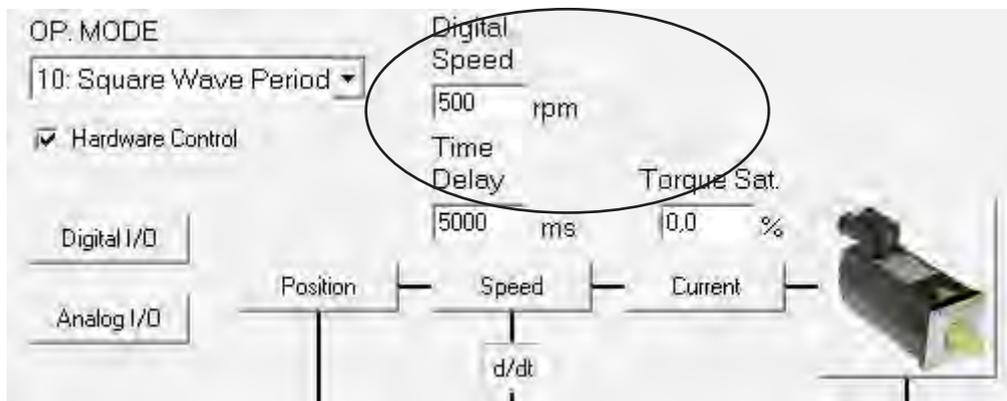
NOTE: FOR MORE DETAIL ABOUT ETHERCAT PROTOCOL IMPLEMENTED BY AXOR SEE "CANOPEN/ETHERCAT REFERENCE MANUAL" PROVIDED BY AXOR ON REQUEST.

4.14 Square Wave

If **MACK DRIVE** can pilot the motor with a square wave signal.

For pilot the motor with a square wave signal the procedure is the following:

- 1- Perform the *basic installation procedure* and the *motor tests* previously illustrated (*see cap. 2.26 Test sul motore on page 48*).
- 2- Perform the following settings in **interface Speeder One**:
 - a - select the operative mode **10:Square Wave Period**;
 - b - insert the desired speed in "Digital Speed" and press enter ↵;
 - c - insert the desired reversal motor period in "Square Wave" in milliseconds and press enter ↵;
 - d - is possible to set the ramp of acceleration and deceleration with the parameters "Acc. Ramp" and "Dec. Ramp" in the "Speed" window;
 - e - save all settings by clicking on icon **Save Data to Eeprom**;
 - f - enable/disable the drive by using the **Enable/Disable** buttons.
 - g - Is possible to limit the Max torque using the option Torque Sat. (The % is referred to the I_{max} of the drive, to disable this option set it to 0).



4.15 Homing - Procedures

A homing procedure uses the signal of the **homing sensor** and, eventually, the **zero signal** of the encoder.

The Mack® supports the following **HOMING PROCEDURES**:

a- Direct homing procedure with normally opened home sensor

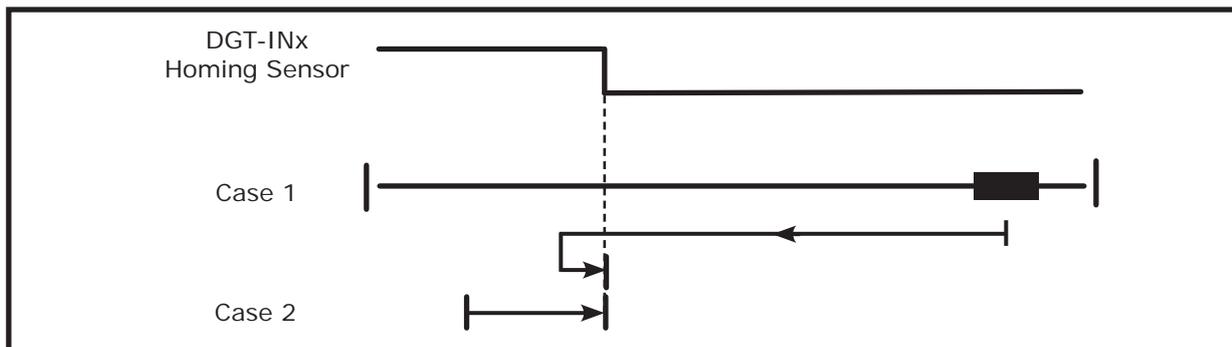
Example:

Homing		Sensor		Max Search Angle	
Homing Method		Sensor			
1:Homing Method 1		NOopen		+ <input type="checkbox"/> Zero Encoder	
				deg	
Acceleration		Speed		Zero Speed	
1000 ms		100 rpm		10 rpm	
				Homing Offset	
				0 pulses	

Case 1: If the homing sensor is low at the start homing the drive pilots the motor in counter-clockwise direction searching for the home sensor. When the sensor output becomes high, the motor decelerates and inverts its motion.

Case2: If the homing sensor output is already high at the homing start the motor simply turns clockwise with a speed like the "Zero speed" parameter.

The home position will be set when the falling edge of the home sensor is received.

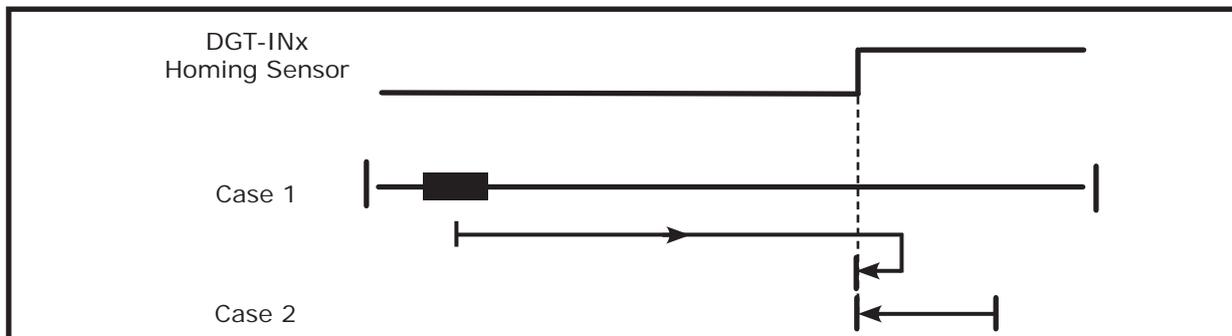


b- Reverse homing procedure with normally opened home sensor

Case 1: If the homing sensor is low at the start homing the drive pilots the motor in clockwise direction searching for the home sensor. When the sensor output becomes high, the motor decelerates and inverts its motion.

Case2: If the homing sensor output is already high at the homing start the motor simply turns counter-clockwise with a speed like the "Zero speed" parameter.

The home position will be set when the falling edge of home sensor is received.



4.15 Homing - Procedures

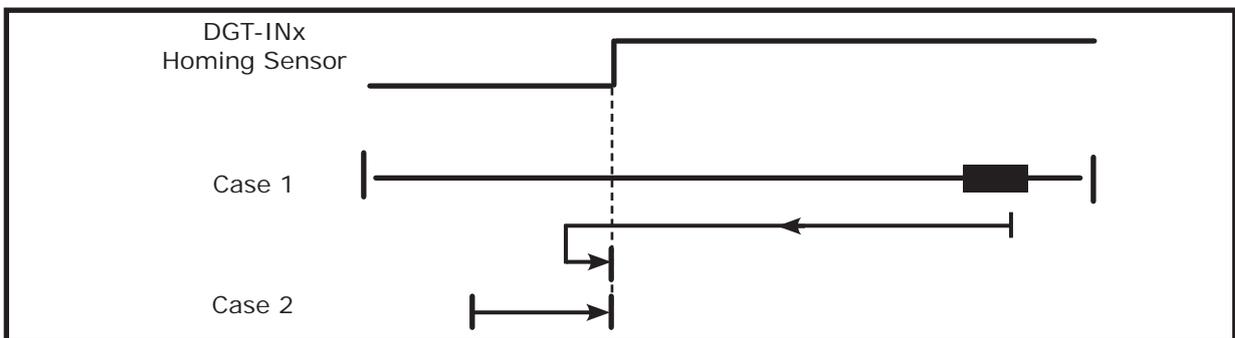
c- Direct homing procedure with normally closed home sensor

Example:

Homing			
Homing Method	Sensor	Max Search Angle	
1:Homing Method 1	NClosed	+ <input type="checkbox"/> Zero Encoder	deg
Acceleration	Speed	Zero Speed	Homing Offset
1000 ms	100 rpm	10 rpm	0 pulses

Case1: If the homing sensor is high at the start homing the drive pilots the motor in counter-clockwise direction searching for the home sensor. When the sensor output becomes low, the motor decelerates and inverts its motion.

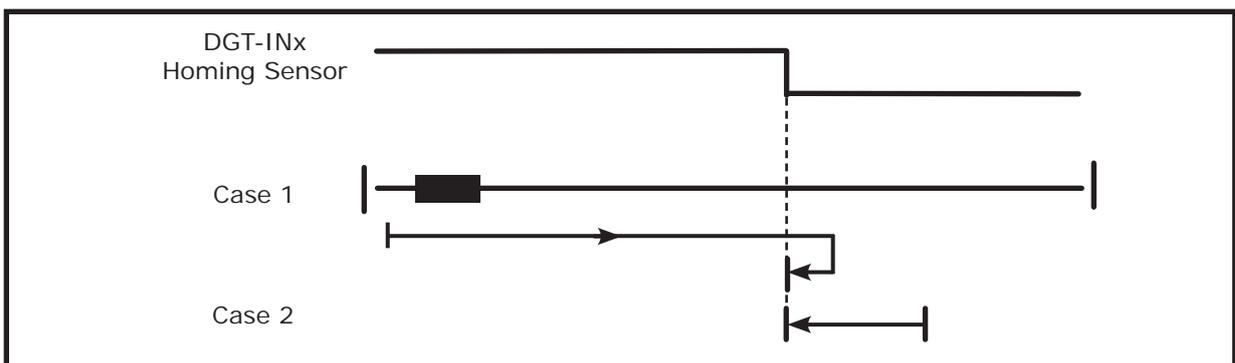
Case2: If the homing sensor output is already low at the homing start the motor simply turns clockwise with a speed like the "Zero speed" parameter. The home position will be set when the rising edge of home sensor is received.



d- Reverse homing procedure with normally closed home sensor

Case1: If the homing sensor is high at the start homing the drive pilots the motor in clockwise direction searching for the home sensor. When the sensor output becomes low, the motor decelerates and inverts its motion.

Case2: If the homing sensor output was already low at the homing start the motor axis simply turns counter-clockwise with a speed like the "Zero speed" parameter. The home position will be set when the rising edge of home sensor is received.



4.15 Homing - Procedures

e- Direct homing procedure with normally opened home sensor and zero index pulses

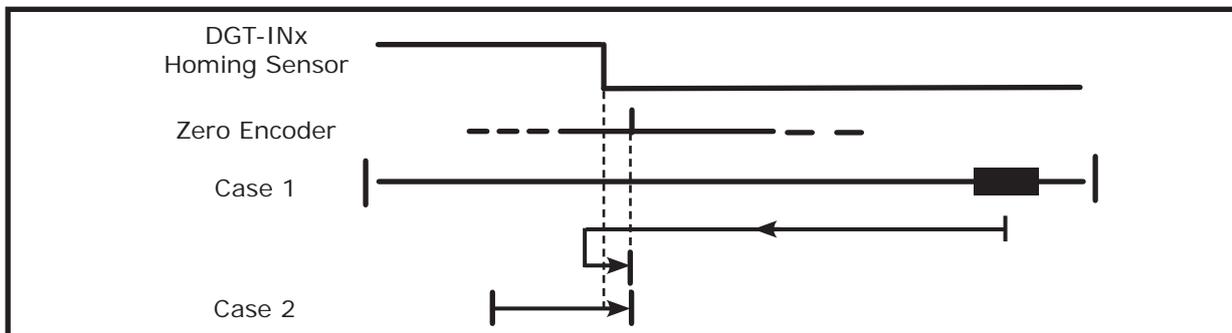
Example:

Homing Method		Sensor		Max Search Angle	
:Homing Method 1		NOpen		+ <input checked="" type="checkbox"/> Zero Encoder 300 deg	
Acceleration		Speed		Zero Speed	
1000 ms		100 rpm		10 rpm	
		Homing Offset			
		0 pulses			

Case1: If the homing sensor is low at the start homing the drive pilots the motor axis in counter-clockwise direction searching for the home sensor. When the sensor output becomes high, the motor decelerates and inverts its motion.

Case2: If the homing sensor output is already high at the homing start the motor simply turns clockwise with a speed like the "Zero speed" parameter.

The home position will be set on the first zero pulse after the falling edge of the home sensor.

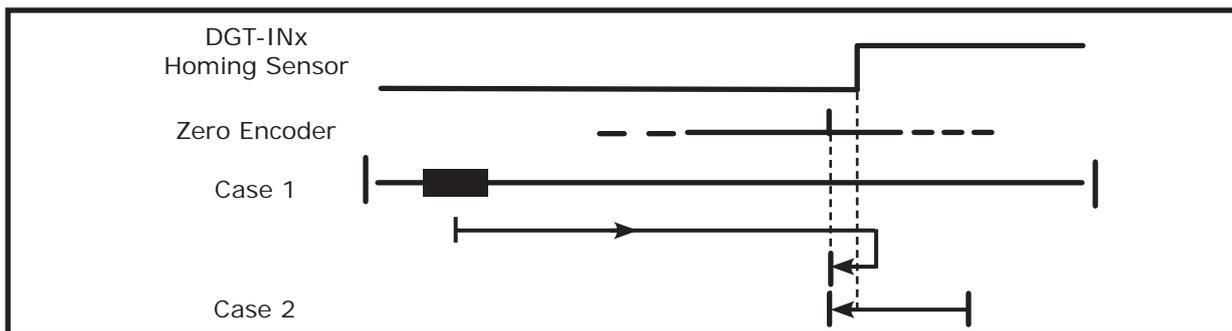


f- Reverse homing procedure with normally opened sensor and zero index pulses

Case1: If the homing sensor is low at the start homing the drive pilots the motor in clockwise direction searching for the home sensor. When the sensor output becomes high, the motor decelerates and inverts its motion.

Case2: If the homing sensor output is already high at the homing start the motor simply turns counter-clockwise with a speed like the "Zero speed" parameter.

The home position will be set on the first zero pulse after that the falling edge of the home sensor.



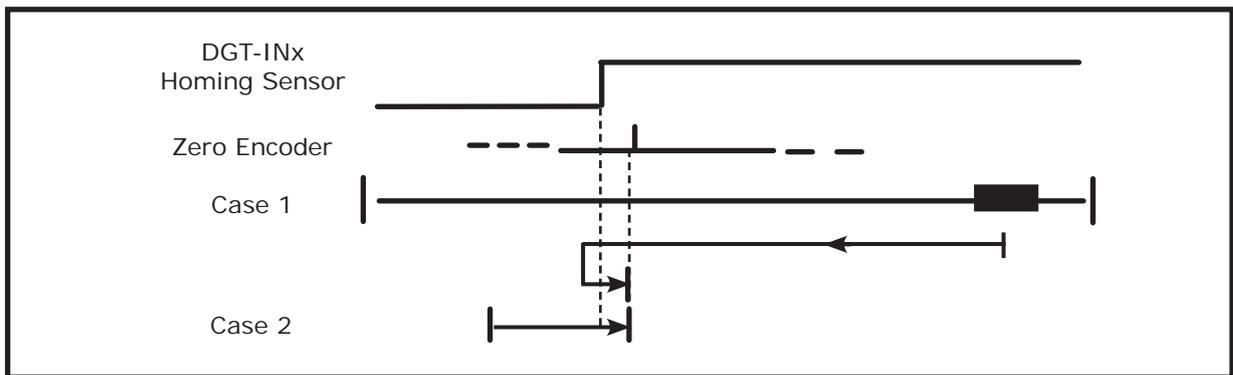
4.15 Homing - Procedures

g- Direct homing procedure with normally closed home sensor and zero index pulses

Case1: If the homing sensor is high at the start homing the drive pilots the motor in counter-clockwise direction searching for the home sensor. When the sensor output becomes low, the motor decelerates and inverts its motion.

Case2: If the homing sensor output is already low at the homing start the motor simply turns clockwise with a speed like the "Zero speed" parameter.

The home position will be set on the first zero pulse after that the rising edge of home sensor is received.

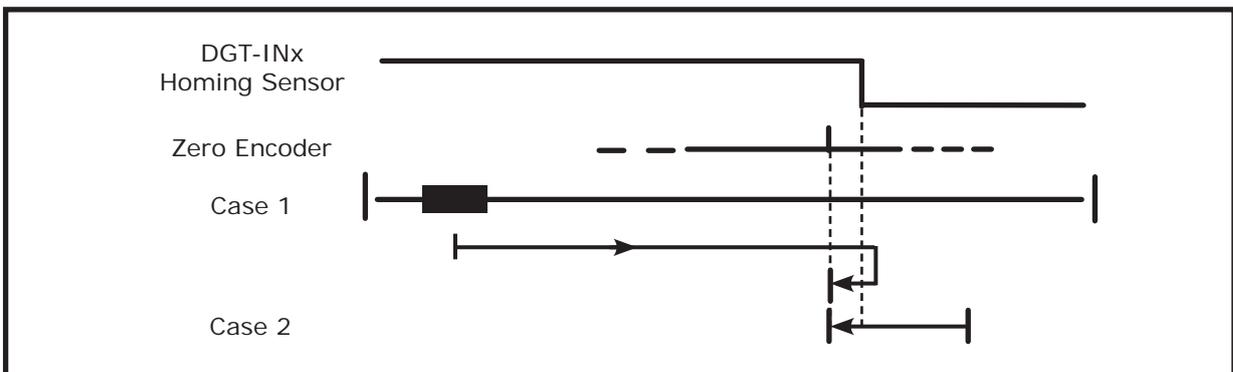


h- Reverse homing procedure with normally closed home sensor and zero index pulses

Case1: If the homing sensor is high at the start homing the drive pilots the motor in clockwise direction searching for the home sensor. When the sensor output becomes low, the motor decelerates and inverts its motion.

Case2: If the homing sensor output is already low at the homing start the motor simply turns counter-clockwise with a speed like the "Zero speed" parameter.

The home position will be set on the first zero pulse after that the rising edge of home sensor is received.



i- Homing immediate

Enabling the digital input (active high) with this homing method the motor doesn't move and the current position is set as the home position.

4.16 Homing - Settings

To execute a homing procedure you have to:

- 1- set the desired operative mode;
- 2- set correctly parameters in the "Position" window;
- 3- set correctly **homing parameters** in the main window of *Speeder One* interface;
- 4- set a digital input with function "Homing Sensor", another input with function "Start Homing" and an output with function "Homing OK";
- 5- connect homing sensor to digital input pin set with "Homing Sensor" function (refer to point 4 settings).

Let us see settings in detail:

1- Operative mode settings:

Set the desired operative mode.

2- Settings on "Position" window:

Feed Forward

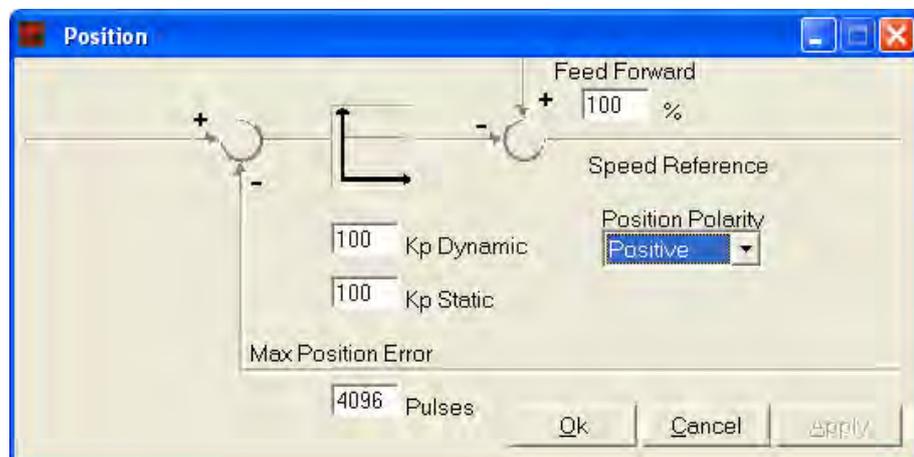
This improves the system's dynamics.
Suggested value: 100%.

Kp Dynamic

This is the position loop gain.
Suggested values:
1 ÷ 999.

Kp Static

Set as Kp Dynamic.



Position Polarity

Positive or Negative. This parameter enables a **complete inversion of axis control**, in fact selecting the "Negative" choice you have effects on homing and positioning procedures like as follow:

- 1) the rotation wise of supported homing procedures is inverted referred to the procedures in the chapter relative to homing procedures;
- 2) the "Homing Offset" value set is multiplied by -1;
- 3) all target positions ("Final Position") are multiplied by -1.

Max Position Error

This is the position error after which the drive goes into alarm 14 ("Following Error").
To calculate the value to insert in this field, use the following formula:

$$\text{Max_Position_Error} = \frac{K^\circ}{360^\circ} * 65536$$

where K° is the value in mechanical degrees of the maximum accepted error.
The maximum selectable position error is 180° (32767 pulses).

Example: If the maximum mechanical accepted error is 45° (1/8 mechanical turn), then the value to insert in the Max Position Error box is 8192, in fact $45^\circ \times 65536 / 360^\circ = 8192$.

We suggest to insert the value 8192.

4.16 Homing - Settings

3- Homing parameters settings:

Homing			
Homing Method	Sensor	<input type="checkbox"/> Zero Encoder	Max Search Angle
<input type="text" value="No Homing"/>	<input type="text"/>		<input type="text"/> deg
Acceleration	Speed	Zero Speed	Homing Offset
<input type="text"/> ms	<input type="text"/> rpm	<input type="text"/> rpm	<input type="text"/> pulses

Homing Method

It defines the method of homing. The supported options are:

- **No homing**: disables the homing procedure. If this method is set it will not be possible to make the positioning procedure.
- **Homing method 1 (direct)**: the drive makes the motor turn in a **counter-clockwise** direction to search for the homing sensor.
- **Homing method 2 (reverse)**: the drive makes the motor turn in a **clockwise** direction to search for the homing sensor.
- **Immediate**: the current position becomes the home position without moving the motor to search the homing sensor.

Sensor

It selects the type of sensor used for the homing procedure. The available options are **NOpen (normally open)** or **NClosed (normally closed)**.

Zero Encoder

Marking the "**Zero Encoder**" box the home position is set on the **first zero pulse** of the motor feedback after the interception of the homing sensor. This allows you to execute the homing procedure with better precision.

Max Search Angle

It is the maximum mechanical angle (0-359 degrees) that can be made during the search for the zero encoder signal after the correct interception of the homing sensor. Above this angle the motor stops, no homing position is saved and alarm 26 (the "Homing Error" alarm) is displayed (this alarm is cleared after the disabling of the digital input set with the "Reset Fault" function).

This parameter (when used correctly) allows the homing process to be repeated with excellent results and avoid errors due to sensor signal elasticity or mechanical tolerance.

Speed

This parameter sets the speed reference used during the homing process and it is given in "rpm". The admitted values are in ranges between 10 and 1000 rpm.

4.16 Homing - Settings

Acceleration

This is the acceleration and deceleration time for the homing procedure. It is defined in milliseconds and allows values in ranges between 10 and 5000 ms. This time references the maximum motor speed set by using the "Speed Limit" parameter in the "Speed" window, so the **actual acceleration** time can be found utilizing the following formula:

$$T_{\text{acc_homing}} [\text{ms}] = \frac{\text{Speed_homing} [\text{rpm}] * T_{\text{acc_sett}}[\text{ms}]}{\text{Speed_motor}[\text{rpm}]}$$

Where: **T_acc_homing** = real acceleration time during the homing search process;
Speed_homing = speed set for the homing process ("Speed" parameter);
Speed_motor = motor speed limit set on the interface ("Speed Limit" parameter);
T_acc_set = value inserted in the "Acceleration" parameter.

For example if you have a motor with the following parameters:

- "Speed Limit" (on the "Speed" window) = 3000 rpm;
- "Acceleration" (on the "Homing" window) = 500 ms;
- "Speed" (on the "Homing" window) = 1000 rpm.

The acceleration time set in the homing window is the time that the motor should employ to accelerate from 0 rpm to the maximum speed (in this case 3000rpm).

The real acceleration time from 0 rpm to 1000 rpm is 167ms, in fact:

$$T_{\text{acc_homing}} [\text{ms}] = \frac{1000 \text{ rpm} * 500 \text{ ms}}{3000 \text{ rpm}} = 167 \text{ ms}$$

Zero Speed

This defines the motor's speed during the realignment with the homing sensor and/or during the search for the encoder's zero pulse from the motor feedback after the home sensor is reached.

It is defined in "rpm" and allows values in ranges between 1 and 50 rpm. We suggested utilizing low values for this parameter in order to obtain good precision.

Homing Offset

This defines the difference between the zero position for the application and the machine's home position (which is found during homing process). It is measured in pulses and the allowed values are in ranges: +/- (2³²-1). This value is assigned to the home position found at the end of a successful homing process. The Homing Offset value is obtained by the execution of the following calculation:

$$\text{Homing Offset} = n^{\circ} \text{ turns (also not integer)} * 65536$$

Example: suppose we have an application where the distance between the home position and the zero position of the axis is equal to the distance that the axis can go with a rotation of 4 turns plus an addition 90° mechanical turn.

The first thing to do is to find the number of turns to insert into the formula. In this example: n° turns = 4 + 90°/360° = 4.25 to refer to the fraction of turn above 360°. Now it is possible to calculate utilizing the following operation: 4.25 * 65536 = **278528**. This bold number is the value that must be inserted in the "Homing Offset" window.

After the setting of the desired homing parameters save the changes using the "Save To EE-PROM" function on the software interface, doing this the drive's setup will become permanent.

4.16 Homing - Settings

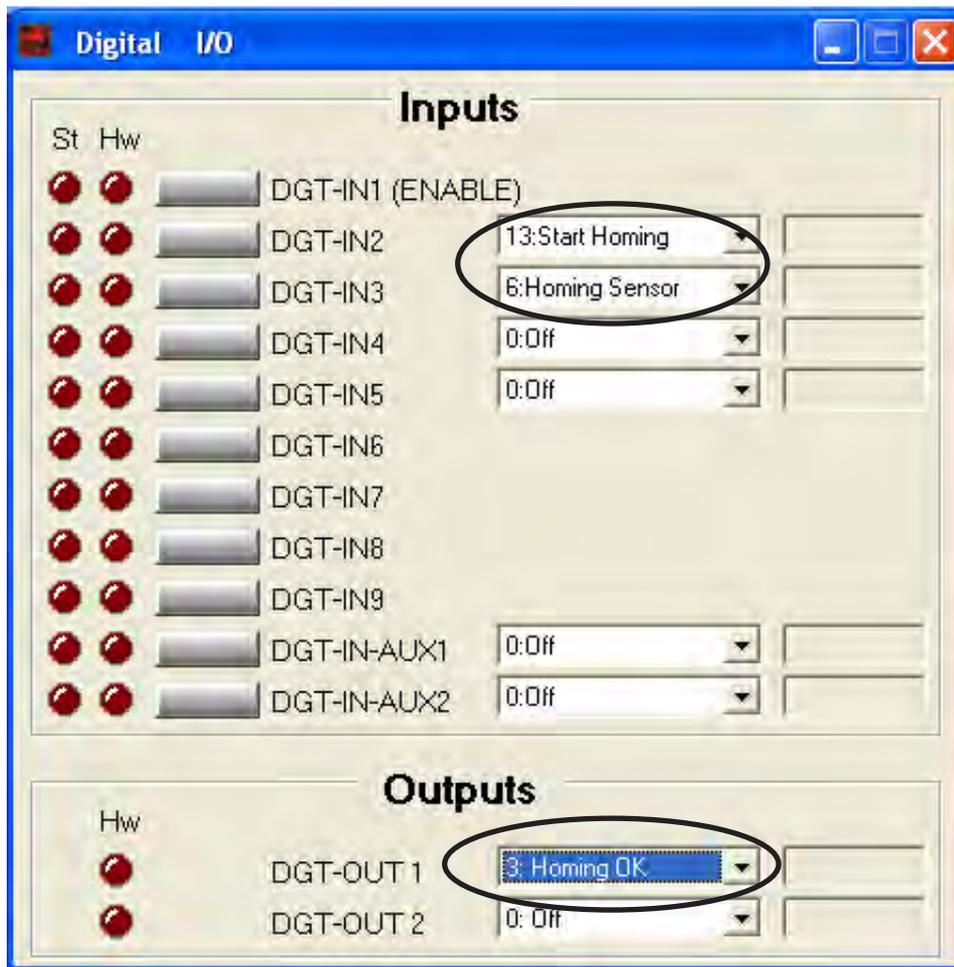
4- Digital inputs/output settings:

To *enable/disable/control* a homing procedure "Digital I/O" window is used.

A homing procedure needs following settings:

- A digital programmable input with function **Start Homing**;
- A digital programmable input with function **Homing Sensor**;
- An output with function **Homing OK**.

For example:



5- Homing sensor connection:

Connect homing sensor to digital input pin set with "**Homing Sensor**" function (see service manual of the drive).

4.17 Homing - Example

Example: Homing sequence

Suppose to do the homing procedure: "b- **Reverse homing procedure with normally opened home sensor**". The procedure is the following:

- 1- Select the operative mode "**5:Gearing**".
- 2- In the main window of the interface set the desired homing method and its parameters. For example:

Homing			
Homing Method	Sensor	Max Search Angle	
2:Homing Method 2	NOpen + <input type="checkbox"/> Zero Encoder	<input type="text"/> deg	
Acceleration	Speed	Zero Speed	Homing Offset
<input type="text"/> 1000 ms	<input type="text"/> 100 rpm	<input type="text"/> 10 rpm	<input type="text"/> 0 pulses

Save all by using the "**Save to EEPROM**" icon.

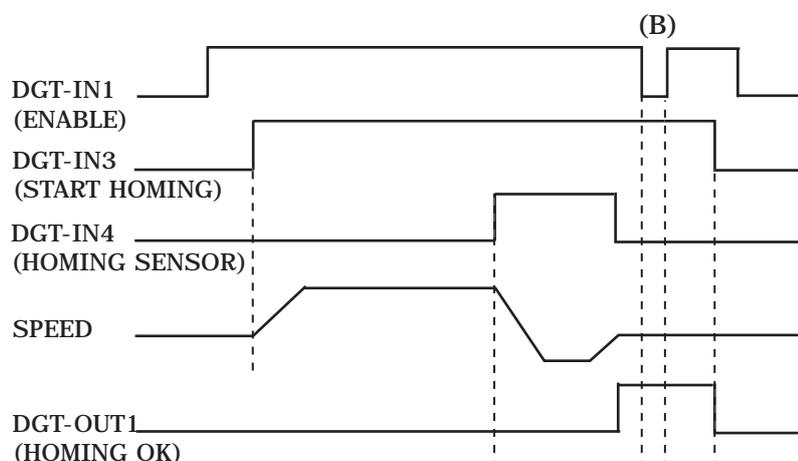
- 3- Open the "**Digital I/O**" window and set:
 - a digital programmable input with the **Start Homing** function (for example: **DGT-IN3**);
 - a digital programmable input with the **Homing Sensor** function (for example: **DGT-IN2**);
 - a digital output with the **Homing OK** function (for example: **DGT-OUT1**);

Save all using the "**Save to EEPROM**" icon.

- 4- Execute homing procedure:

- a- Enable the **DGT-IN1 (Enable)** digital input ⇒ the motor will be on torque.
- b- Enable the **DGT-IN3 (Start Homing)** digital input ⇒ the motor moves to search the home position using the homing parameters saved on the interface. Every time this input is disabled the homing position is resetted.
- c- When the home sensor output, connected to the **DGT-IN2 (Homing Sensor)** digital input, is sensed active (in this example we considered a normally opened sensor), the motor decelerates and inverts its motion.
- d- The home position is set when the falling edge of home sensor is received. When this happens the drive enables the **DGT-OUT1 (Homing OK)** digital output. This value is kept high as soon as the **DGT-IN3 (Start Homing)** digital input is kept high, independently of the **DGT-IN1** digital input (see (B) in the figure).

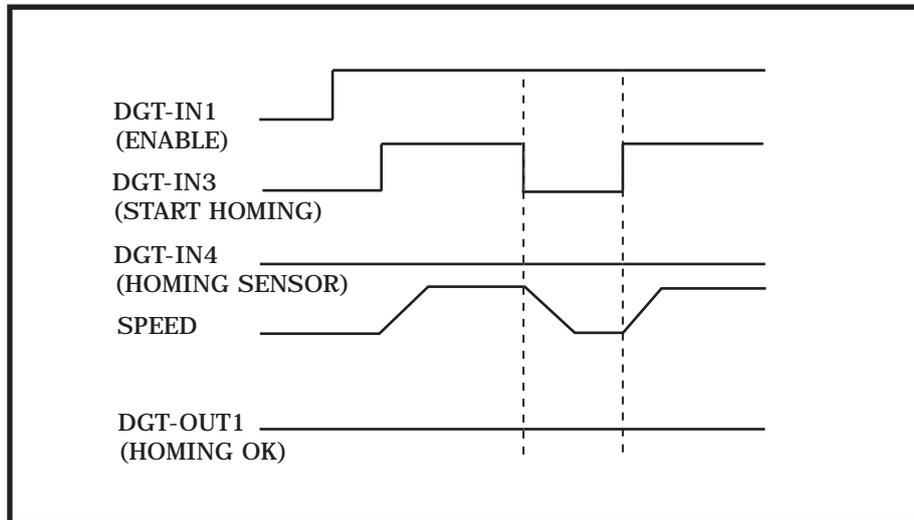
Example: homing procedure



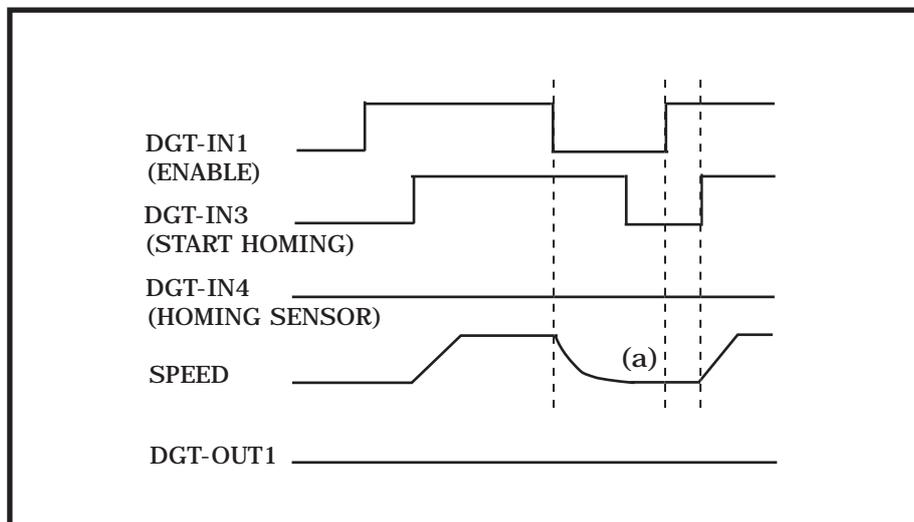
4.17 Homing - Example

Warnings:

1) Disabling the **DIG-IN3 (Start Homing)** digital input, before that the home position reached indication is generated, makes the homing process to abort. No home position is saved and the motor decelerates using the “**Acceleration**” parameter.



2) Disabling the **DGT-IN1 (ENABLE)** digital input, before the ending of the homing procedure, causes the interruption of homing process. In this case no homing position is saved and the motor is left free (deceleration is depending of inertia and friction). A new homing process can be start disabling the **DGT-IN3** input and then enabling the **DGT-IN1** and **DGT-IN3** digital inputs ((a) in figure).



Conformity

European directives and norms

The servodrives are "*components*" that are intended to be incorporated into electrical plant and machines for industrial use.

When the servodrive is used into machines or plant, the electrical plant/machine must respect the following directives: **EC Machinery Directive (2006/42/EC)**, **EC Directive on EMC (2004/108/EC)**, **Low Voltage Directive (2006/95/EEC)**.

The machine/plant manufacturer must examine whether with its machine/plant still further or other standards or EEC guidelines are to be used.

EC Conformity

The **EC** mark that is applied to the drives references to the **Low Voltage Directive (2006/95/EC)** and **EC Directive on EMC (2004/108/EC)**.

The standard EN 61800-5-1 is applied to ensure conformance with the Low Voltage Directive.

The standard EN 61800-3 is applied to ensure conformance with the EMC Directive.

In reference to noise immunity and noise emission the converters fulfil the requirement to the category 3 - *second environment* (industrial environment).

If the installation of the drive is carried out differently than described in this manual, the user must carry out new measures to satisfy the requisites of law.

In a domestic environment this product may cause radio interference in which case supplementary mitigation measures may be required.



AXOR IND. s.a.s.

viale Stazione, 5 - 36054 Montebello Vic.no
Vicenza - Italy

phone (+39) 0444 440441

www.axorindustries.com - info@axorindustries.com

