High Digital Technology

NTT 240/460

Compact digital drive for AC and DC, rotary, linear and tubular, brushless, asynchronous, and DC permanent magnets motors at 230Vac and 400Vac with resolver or incremental/absolute encoder. Operation mode via Ethercat CoE, Profinet RT, Profibus DPv0, Canopen®, ModbusRTU and I/O.

INSTALLATION AND USER GUIDE

Manual or NTT 240/460 drive changes				
Manual	*Changes Description* *Manual, Drive and Caliper*	*Vers. FW Drive*	*Vers. SW Caliper*	*HW Vers. Drive*
10/01/2019 Rev: 4.0	• First release for Caliper software suitable for NTT 240/460 drives.	• 4.00	• 4.04 • 4.05	0 - 0
	• V/Hz control for asynchronous motors.	• 4.01	• 4.07 • 4.08	
	• Ethernet connector now available (not managed at the moment). • J7 connector at pin 16: +24V supply for frequency output now available on request.	• 4.02	• 4.08 • 4.09 • 4.10 • 4.11	0-1
	• External encoder loop management now added.	• 4.05	• 4.12 • 4.13	
	• Position software limit now added for Canopen operation mode.	• 4.06		
	• Pressure control topology now added. • Automatic convertion for IVT file from previous DGM series now added.	• 4.07	• 4.15	
	• Current offset for motor brake management now added.	• 4.08		
	• Current limit management available with or without decimal. • Display H6 menu moved in S9.	• 4.09 • 4.10 • 4.11	• 4.16	

It's recommended to always verify drive firmware version in order to connect it to the related and correct Caliper version.

Thanks for choosing this H.D.T. product.

www.hdtlovato.com

Read carefully this manual before using this product.

For continuous improvement, H.D.T. reserves the right to change features and specifications to manual and product without notice for the customer.

Any parts of this manual can not be reproduced in any way or transmitted without a write permission from the manufacturer.

Details of images, contained here in, may be different from real product.

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Rev. N°	4.0
Date	10/01/2019

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Summary

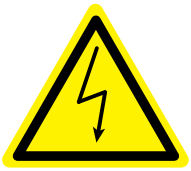
Ch. 1 Safety Informations

Read carefully this manual before using NTT 240/460 drive.

Take care of this handbook and keep it at hand for later reference.

Please make sure that this handbook is delivered to the final customer and user.

Safety symbols used in this guide are described below:

	**DANGER:** This symbol means the possibility of serious body hazards due to electrical, thermal or mechanical shock.
	**ATTENTION/WARNING:** This symbol means the possibility of damaging drive or other equipment.
	**NOTES:** This symbol suggests auxiliary informations to ensure a correct operation for drive or other equipment.

1.01 Danger 

- Never supply the drive without the cover and never remove the cover while supply is on.
- Do not manipulate the drive with wet hands. Failure to observe this could lead to electrical shocks.
- Keep a safety distance from the motor and the machine when the power is on and never touch the rotary parts of the motor when it is in function.
- When reset the alarms make sure that the signal of running is enabled in order to avoid unexpected start of the motor. Fix up a separate emergency stop device. It exists the risk of injury.
- Do not touch the terminals of the drive, the motor or the external braking resistance, while the power is on. Failure to observe this could lead to electrical or thermal shocks.
- Before starting wiring, ensure that all supplies are off and motor is stopped.
- Always turn the device's input off before starting any maintenance. Failure to observe this could lead to fires or electrical shocks.
- Disconnect all supplies before performing drive maintenance.
- Always wait at least 8 minutes after turning off the input power before starting inspections. Make sure that LEDs have been erased.Failure to observe this could lead to electrical shock.
- The maintenance, the inspection and part replacement must be done by a designated person. Remove all the metal accessories like watches, bracelets etc before beginning the job. Failure to observe this could lead to electrical shocks and injuries.
- Always turn the power off before inspecting the motor or machine. A potential is applied on the motor terminal even when the motor is stopped. Failure to observe this could lead to electrical shock.
- Ensure that supply voltage range mathes with drive features.

1.02 Attention

- Earth cable must be wired according to safety standards of the Country where drive is installed.
- Installation must be done by a designated person.
- Always fix the drive before executing the wiring.
- Install a protection circuit (fuses or magnetic contactor) on drive supply.
- Do not connect an esternal supply on terminals U, V, W.
- Ensure that the drive voltage correspond to the voltage of the supply.
- Fix terminal screws with a correct fixing torque.
- Connect correctly the output side (U,V,W). Failure to do so could cause the motor to rotate in reverse and the machine to be damage.
- If drive power supply is not connected, not connect motor cable if motor is rotating. It exists the danger to damage the machine.
- Not obstruct the entry and the escape of the air and not introduce stranger object. Fire danger exists.
- Ensure the functionality of the motor as single unit before connecting it mechanically to the machine and verify that the max speed of the motor are accepted from the machine. It exists the danger to hurt and to damage the machine.
- Never modify the drive.
- Clean the drive with a vacuum cleaner. Do not use organic solvents. Failure to observe this could lead to burns or damage.
- For your safety, it is very important that any software update or service have to be done by our company.
- When you have to throw away the drive, please dispose of this product as industrial waste, so respect standards enforced by Country laws.

1.03 Notes

- Qualified electrical staff must execute installation and maintenance.
- Earth cable must be wired according to safety standards of the Country where drive is installed.
- The machine operator must receive an adapt preparation.
- The drive may be source of radio-frequency noise if unprovided of the adequate mains filter.
- Observe the drive specifiations and the warnings contained in this manual.
- Always provide an adequate ventilation and keep clean the drive.
- Avoid water or other liquid penetration inside the drive.
- Connect adequate cable to the imput/output terminals.
- Product in C2 cat. may be source of radio-frequency noise if used in public mains feeding voltage to habitation.
- Product in C3 cat. is not suitable in public mains feeding voltage to habitation. The drive may be source of radio-frequency noise.

1.04 Directives, marks and industrial standards

Standard/Mark	Description
CEI EN 60204-1	Low voltage safety directive, 2006/95/CE.
CEI EN 61800-3	Product rule reffered to EMC 2004/108/CE directive.
CEI EN 60529	IP protection level.
CE	CE marking.

Ch. 2 Introduction

2.01 Description

NTT 240/460 digital servodrives replace the well known previous DGM series. The evolution version incorporates a last generation microcontroller that provides a doubled calculation performance, a quadruplicated analog to digital converter accuracy, resulting in an evolution for motor control and software application.

According to drive selected configuration, functionality control takes place via the most advanced fieldbus comunication protocols, including ETHERCAT CoE, PROFINET RT, PROFIBUS, Canopen® and Modbus RTU, as well as the Input/Output operating mode (always available in each drive configuration).

It allows control for AC and DC Brushless motors, type rotary, linear and tubular, asynchronous motors and permanent magnets continuous current motors equipped with HALL sensors, incremental encoder with or without HALL sensors, absolute encoder on SSI serial protocol and resolver (optional), for position and speed feedback. An AC power supply, 230Vac singlephase or triphase and 400Vac triphase, or DC power supply from 250V to 360V for NTT 240 and from 400V to 700V for NTT 460, is requested for power stage and a second DC logic supply is requested for turning on the drive.

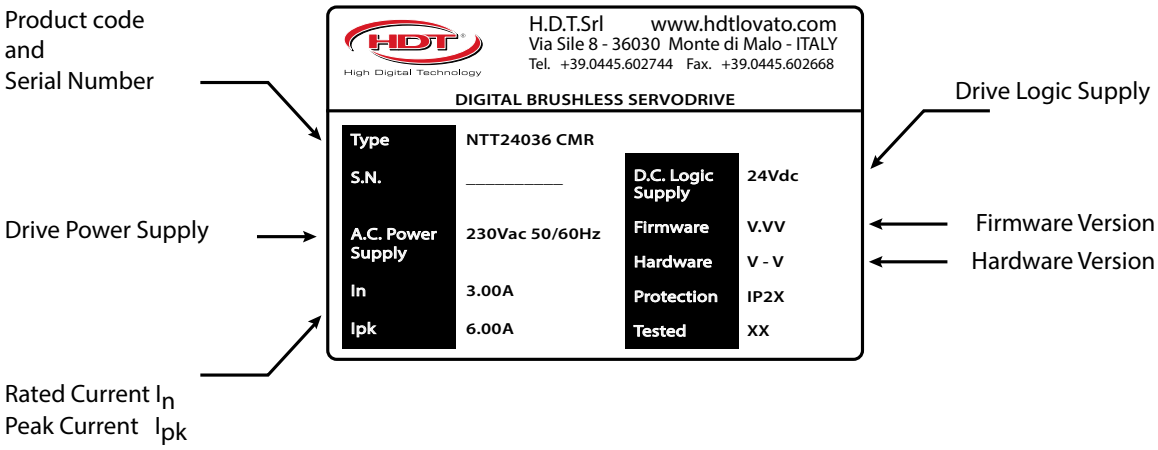
NTT 240/460 can be set up with property software, Caliper, (compatible with Microsoft Windows® operative systems), that allows to enter all calibration settings, parameters saving and alarm management and, thanks to USB 2.0 comunication, to perform debug with realtime scope up to 100µs on 4 simultaneous channels.

Head-on display allows to check drive state and to verify alarms/warnings, leading to a fast failure diagnostic.

2.02 Delivery ispection

For delivery ispection and storage:

1. Remove drive from the packaging and check details on the label that confirm the drive correspond to the one ordered. The label in on the heatsink side.
2. Make sure that the product has not been damaged.
3. If the drive is not to be used for a while after purchasing, it has to be stored, possibly with its shipment covering, in a place with no humidity, absence of vibrations and far from water sprays.
4. Always inspect the inverter before using after a long period storage.



It's recommended to always verify drive firmware version in order to connect it to the related and correct Caliper version.

2.03 Drive sizes and option configuration

The power available is covered by following models:

MODEL		Output Current		Dimension	Power Voltage
		Rated	Maximum	Mechanical Size	V_{AC} / V_{DC} nominali
Name	***Size***	A_{rms}			
NTT 240	**1.5/3**	1.5	3	T0	230V_{AC} / 300V_{DC}
	3/6	3	6		
	6/12	6	12	T1	
	10/20	10	20	T2	
NTT 460	**1.5/3**	1.5	3	T0	400V_{AC} / 540V_{DC}
	3/6	3	6	T1	
	6/12	6	12	T2	
	10/20	10	20	T3	
	20/40	20	40		
	35/70	35	70	T4	
	45/90	45	90		
	45/150	45	150		
	75/150	75	150	T5	
	100/200*	100	200	*	
	150/300*	150	300	*	
	200/400*	200	400	*	

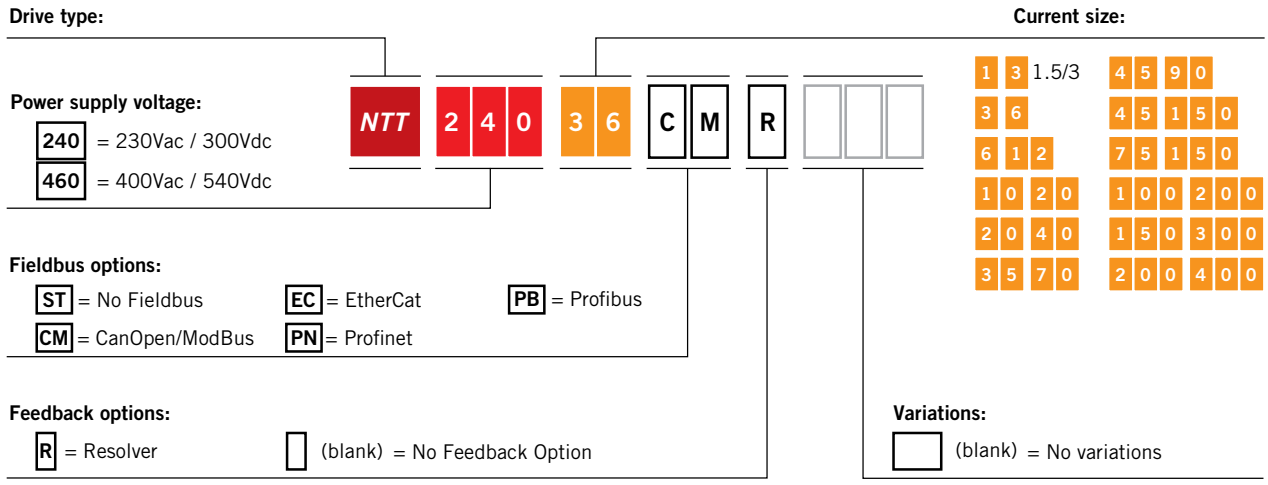
Available configurations differ for fieldbus option and for secondary feedback desired and are shown below:

Label	***CONFIGURATION description***
ST	**"STANDARD" (no installed option)** I/O operation mode: analog, frequency and I/O commands. Feedback1 from incremental encoder with/without HALL and SSI absolute encoder.
ST R	**"STANDARD" + "R" Feedback option installed** I/O operation mode: analog, frequency and I/O commands. Feedback1 from incremental encoder with/without HALL and SSI absolute encoder. Feedback2 from resolver.
CM	**"CM" Fieldbus option installed** Canopen CiA402 or Modbus RTU operation mode. I/O operation mode: analog, frequency and I/O commands. Feedback1 from incremental encoder with/without HALL and SSI absolute encoder.
CM R	**"CM" Fieldbus option + "R" Feedback option installed** Canopen CiA402 or Modbus RTU operation mode. I/O operation mode: analog, frequency and I/O commands. Feedback1 from incremental encoder with/without HALL and SSI absolute encoder. Feedback2 from resolver.

*This model is under development. For information please contact our technical department.

Label	CONFIGURATION description
EC	**"EC" Fieldbus option installed** Ethercat CoE operation mode. I/O operation mode: analog, frequency and I/O commands. Feedback1 from incremental encoder with/without HALL and SSI absolute encoder.
EC R	**"EC" Fieldbus option + "R" Feedback option installed** Ethercat CoE operation mode. I/O operation mode: analog, frequency and I/O commands. Feedback1 from incremental encoder with/without HALL and SSI absolute encoder. Feedback2 from resolver.
PN	**"PN" Fieldbus option installed** Profinet RT operation mode. I/O operation mode: analog, frequency and I/O commands. Feedback1 from incremental encoder with/without HALL and SSI absolute encoder.
PN R	**"PN" Fieldbus option + "R" Feedback option installed** Profinet RT operation mode. I/O operation mode: analog, frequency and I/O commands. Feedback1 from incremental encoder with/without HALL and SSI absolute encoder. Feedback2 from resolver.
PB	**"PB" Fieldbus option installed** PROFIBUS DPv0 operation mode. I/O operation mode: analog, frequency and I/O commands. Feedback1 from incremental encoder with/without HALL and SSI absolute encoder.
PB R	**"PB" Fieldbus option + "R" Feedback option installed** PROFIBUS DPv0 operation mode. I/O operation mode: analog, frequency and I/O commands. Feedback1 from incremental encoder with/without HALL and SSI absolute encoder. Feedback2 from resolver.

Order code composition:



EXAMPLE:	NTT 240 36 CM R	NTT 230Vac - 3/6A - With CanOpen/Modbus option and Feedback R option

2.04 NTT 240 drive features

		NTT 240						
Sizes		***1.5/3***		***3/6***		***6/12***		***10/20***
Rated power supply	V_{AC}	1Ph	3Ph	1Ph	3Ph	1Ph	3Ph	3Ph
		$230V_{AC}$ +/- 15% 50/60Hz						
	V_{DC}	$200V_{DC} \div 360V_{DC}$						
Rated current	A_{RMS}	1.5		3		6		10
Peak current (I_{PEAK})	A_{RMS}	3		6		12		20
Rated output power	kW	0.5		1		1.5		3
Switching frequency	kHz	10kHz						
Forced ventilation	-	-						√
Rated logic supply	V_{DC}	$+24V_{DC}$ ± 10%						
	VA_{MAX}	15VA						18VA
Dimensions	-	T0				T1		T2
Internal braking resistor	-	-				39Ω 100W		
External braking resistor	*	√						
Internal EMC filter	**	√ (in appliance with 61800-3 cat. C2 - C3)						
Safety function	-	STO SIL3 - Safe Torque Off for cat. 0 stop; realized with IEC EN 61800-5-2 law conformal and IEC61508 safety level conformal law.						
Weight	~ Kg	1.8				2.4		2.7
H.D.T. motors suitable with NTT 240 drive	-	MS04M MS06M B05S B05M B05L B07S		MS04M MS06M MS08L B07S B07M B07L		MS08G B07L B07G B10S B10N B14K		B10N B10M B10L B10G B14K B14S

For information about additional optional, see *"Ch. 9 Accessories" pag. 126*.

For information about H.D.T. AC brushless motors, refer to related manuals downloaded from internet corporate site:

www.hdtlovato.com

*Other major power resistors are available for heavy braking cycles: please, see additional optional or contact our technical department.

**Depending on drive size, H.D.T. provides external EMC filters.

2.05 NTT 460 drive features

		NTT 460				
Sizes		***1.5/3***	***3/6***	***6/12***	***10/20***	***20/40***
Rated power supply	V_{AC}	3Ph				
		$400V_{AC}$ +/- 15% 50/60Hz				
	V_{DC}	$400V_{DC} \div 700V_{DC}$				
Rated current	A_{RMS}	1.5	3	6	10	20
Peak current (I_{PEAK})	A_{RMS}	3	6	12	20	40
Rated output power	kW	0.9	1.8	3	5	10
Switching frequency	kHz	10kHz				
Forced ventilation	-	-		√		
Rated logic supply	V_{DC}	$+24V_{DC}$ ± 10%				
	VA_{MAX}	15VA		18VA		
Dimensions	-	T0	T1	T2	T3	
Internal braking resistor	-	-	100Ω 100W		82Ω 300W	-
External braking resistor	*	√				
Internal EMC filter	**	√ (in appliance with 61800-3 cat. C3)			-	
Safety function	-	STO SIL3 - Safe Torque Off for cat. 0 stop; realized with IEC EN 61800-5-2 law conformal and IEC61508 safety level conformal law.				
Weight	~ Kg	1.8	2.4	2.7	5.7	
H.D.T. motors suitable with NTT 460	-	B05S B05M B05L B07S B07M	B07M B07L B07G B10S B10N	B10N B10M B10L B10G B14K B14S	B10L B10G B14S B14N B14M B20S	B14M B20S B20M B20L

For information about additional optional, see *"Ch. 9 Accessories" pag. 126*.

For information about H.D.T. AC brushless motors, refer to related manuals downloaded from internet corporate site:

www.hdtlovato.com

*Other major power resistors are available for heavy braking cycles: for information please contact our technical department.

**Depending on drive size, H.D.T. provides external EMC filters.

		NTT 460						
Sizes		***35/70***	***45/90***	***45/150***	***75/150***	****** 100/200***	****** 150/300***	****** 200/400***
Rated power supply	V_{AC}	3Ph						
		$400V_{AC}$ +/- 15% 50/60Hz						
	V_{DC}	$400V_{DC} \div 700V_{DC}$						
Rated current	A_{RMS}	35	45	45	75	***	***	***
Peak current (I_{PEAK})	A_{RMS}	70	90	150	150	***	***	***
Rated output power	kW	17	22		40	***	***	***
Switching frequency	kHz	5kHz				***	***	***
Forced ventilation	-	√						
Rated logic supply	V_{DC}	$+24V_{DC}$ ± 10%						
	VA_{MAX}	20VA			22VA	***	***	***
Dimensions	-	T4			T5	***	***	***
Internal braking resistor	-	-						
External braking resistor	*	√						
Internal EMC filter	**	-						
Safety function	-	STO SIL3 - Safe Torque Off for cat. 0 stop; realized with IEC EN 61800-5-2 law conformal and IEC61508 safety level conformal law.						
Weight	~ Kg	12			20	***	***	***
H.D.T. motors suitable with NTT 460	-	B20S B20M B20L B20G B26S B26M	B20M B20L B20G B26S B26M		B20M B20L B20G B26S B26M B26L B26G	***	***	***

For information about additional optional, see *"Ch. 9 Accessories" pag. 126*.

For information about H.D.T. AC brushless motors, refer to related manuals downloaded from internet corporate site:

www.hdtlovato.com

*Other major power resistors are available for heavy braking cycles: for information please contact our technical department.

**Depending on drive size, H.D.T. provides external EMC filters.

***Not available at the moment.

2.06 Technical data

NTT 240/460 TECHNICAL FEATURES	
Control	Fully digital ring regulation control: • Synchronous AC brushless rotary and linear motor: FOC control, SVM modulation, with feedback or sensorless. • Asynchronous inductive rotary motor: V/Hz and FOC control, SVM modulation, with feedback or sensorless. • Synchronous AC brushless rotary and linear motor: Trapezoidal modulation only with HALL sensors. • Permanent magnets continuous current rotary motor with feedback. Speed, torque, position and pressure reference: • via analog input or frequency input (pulse train). • single parameter or parameter table selectable via digital input o fieldbus. • with torque limit management. • with factors management useful to make easier convertions. • with change target on the fly. • with trapezoidal ramps or S ramps distinct for rotation direction. Position feedback: • motor sensor (incremental or absolute encoder or resolver). • external incremental encoder. Available filters: • Observer on motor feedback. • Notch filter on current reference. • Iq filter on quadrature current to motor. • PB filter in analog and digital input. Motor autophasing procedure available for all feedback. Digital I/O fully programmable. Cogging motor compensation available for brushless motors. DC braking procedure available for asynchronous inductive motors. Motor mechanical brake management. Drive setting via Caliper software or via display and keypad (limited parameter set).
Protections and diagnostics	Short-circuit of motore and between phase and earth. AC power supply overvoltage and undervoltage. Overpressure and underpressure. Phase lack and voltage lack for power supply. Digital I/O +24V voltage lack. Overcurrent limitation. Drive heatsink overtemperature (Fan dynamic management). Motor thermal image and motor PTC. Braking resistor thermal image. Resolver and Hall sensors/encoder damage. Safety stop input STO, Safe Torque Off. Drive status and alarms/warning occured shown via 5-digit display. Fieldbus status shown via LEDs and 5-digit display.
Operating and storage condition	Operating temperature: 0°C / +40°C. Storage and transport : -20°C / +70°C. Altitude: up to 1000m. For upper altitude, degrade drive by 1% each additional 100meters. Protection level: IP20.

NTT 240/460 TECHNICAL FEATURES	
Operating modes	**INPUT / OUTPUT** (always available for all drive configuration) 1. Speed/Torque Control or Speed with Torque limit. 2. Electronic Gearbox (CHA-B, CW-CCW, Pulse-Direction). 3. Position: single, analog 12 bit, up to 64 target table via cyclic/acyclic target, via digital input selection, via input start selection. 4. Electronic Cam (CHA-B, Pulse-Direction, 576 points per cam, up to 8 cams). 5. Pressure control.
	CANOPEN® and **MODBUS RTU** (available only for CM or CMR options) » **Canopen® CiA301 e CiA402** up to 1Mbps and Sync up to 1ms 1. Electronic Gear 2. Position Mode 3. Velocity Mode 4. Profile Velocity Mode 5. Profile Torque Mode 6. Homing Mode 7. Interpolated Position Mode 8. Cyclic Sync Position Mode 9. Cyclic Sync Velocity Mode 10. Cyclic Sync Torque Mode 11. Touch Probe 12. Pressure control » **Modbus RTU** up to 57.6Kbps 1. Speed/Torque Control and Speed with Torque limit control. 2. Electronic Gearbox (CHA-B, CW-CCW, Pulse-Direction). 3. Position: single, analog 12 bit, up to 64 target table via cyclic/acyclic target, via digital input selection, via input start selection. 4. Electronic Cam (576 points per cam, up to 8 cams). 5. Pressure control.
	ETHERCAT CoE (available only for EC or ECR options) » **Canopen® CiA301 and CiA402 over Ethercat** Free Run, Sync Manager, DC up to 500µs: 1. Electronic Gear 2. Position Mode 3. Velocity Mode 4. Profile Velocity Mode 5. Profile Torque Mode 6. Homing Mode 7. Interpolated Position Mode 8. Cyclic Sync Position Mode 9. Cyclic Sync Velocity Mode 10. Cyclic Sync Torque Mode 11. Touch Probe 12. Pressure control
	PROFINET RT Realtime CC-A and CC-B (available only for PN or PNR options) » **PROFIDRIVE** 1. Speed control (AC1) 2. Position in Program Mode (AC3) 3. Position (manual AC3) 4. Pressure control
	PROFIBUS DPv0 (available only for PB or PBR options) » **PROFIDRIVE** 1. Speed control 2. Position (single) 3. Torque control 4. Pressure control

NTT 240/460 ELECTRICAL FEATURES	
Output current	**I_{PEAK} up to 2 seconds**
Output frequency	**Up to 1000Hz**
Digital output	**N° 6 PNP optoinsulated: OUT0 to OUT5 programmable** • V_{DC} < 30V and $I_{MAX\ LOAD}$ < 30mA for each output. **N° 1 clean contact relay: OUT6 programmable** • $V_{MAX\ ISOL}$ < 100V / $I_{MAX\ LOAD}$ < 1Amp / TC < 10ms (bounce time included).
Analog output	**N°2 single ended range ±10V DAC-10bit: AN1-AN2 programmable** • Impedence = 100Ω.
Stabilized supply output	**N°1 +10V, max 15mA** (stabilized). **N°1 –10V, max 15mA** (stabilized). **N°1 +24V, max 100mA** (provided by logic supply +24V - 2V internal voltage drop). **N°1 +5V, max 100mA** (stabilized).
Digital input	**N° 8 PNP optoinsulated 10-30V: IN0 to IN7 programmable** • Impedence ≥ 3.5kΩ. • IN6-IN7 are also Input Capture type. **N° 3 PNP not insulated 10-30V: IN8 to IN10 programmable** • Impedence = 300kΩ. • derived from analog input converted to digital input.
Analog input reference	**N°1 main differential input range ±10V ADC 16bit: IN8** • Impedence = 400kΩ. • available only if not used as digital input. **N°2 auxiliary differential input range ±10V ADC 12bit: IN9-IN10** • Impedence = 400kΩ. • available only if not used as digital input.
Frequency input reference	**N°1 main optoinsulated input** (2 x differential or single ended channels) • Line Driver 5V: impedence = 200Ω / up to 500kHz for each channel. • NPN/PNP 24V: internal 1.8kΩ pull-up resistor / up to 200kHz for each channel.
Main Feedback 1	**Incremental Encoder with/without HALL sensors:** • *Supply*: V_{DC} = 5-9V adjustable with encoder sensing / $I_{MAX\ LOAD}$ < 200mA. • *HALL sensors*: single ended 0/+5V (120° sequence management). • *Incremental Encoder* (2 x differential or single ended channels) 1. Line Driver 5V: impedence 1kΩ / up to 2.5MHz for each channel. 2. Push-Pull 5V: impedence 1kΩ / up to 400kHz for each channel. 3. Open Collector 5V: up to 200kHz for each channel (with internal pull up resistor with value equal to1kΩ). **SSI Absolute Encoder:** • *Supply*: V_{DC} = 5-9V adjustable with encoder sensing / $I_{MAX\ LOAD}$< 300mA. • *DATA* Line Driver 5V: impedence = 220Ω. • *CLOCK* Line Driver 5V: $I_{MAX\ LOAD}$ = 20mA. • *SSI binary code single and multiturn*: up to 16bit in single-turn and 15bit in multi-turn, including MSB used for sign management.
Optional Feedback 2	**Resolver:** (available only with "R" option) • *Supply*: V_{AC} = 6.5V_{RMS} from 2 to 10 kHz / $I_{MAX\ LOAD}$ < 100mA_{RMS}. • *Transformation Ratio*: from 0.28 to 0.5. • *Resolution*: up to 16bit at 5000RPM. • Up to 8 pole pairs.

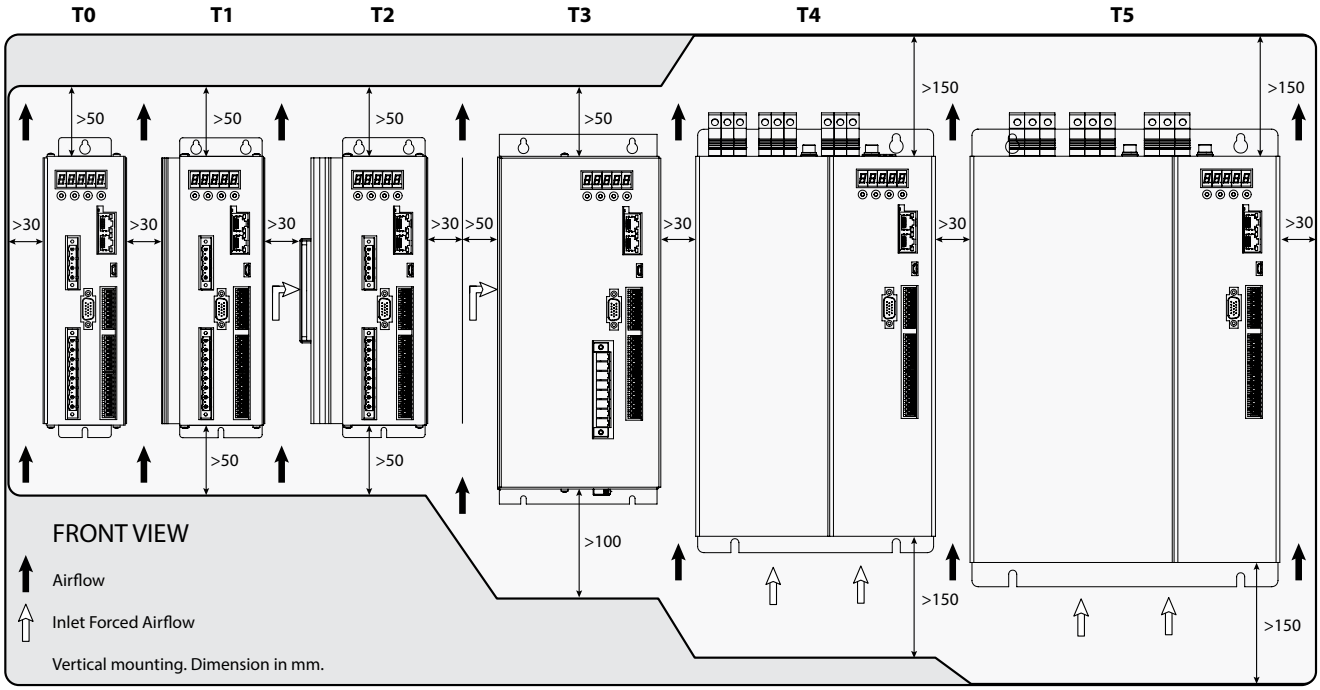
NTT 240/460 ELECTRICAL FEATURES	
Encoder output	**Output selectable between:** • Feedback 1 encoder with/without zero index repetition. • Frequency input reference repetition. • Feedback 2 emulation encoder output. **Encoder Signals:** • ABZ Line Driver 5V: internal supply / $I_{MAX\ LOAD}$ < 20mA for each channel. • ABZ Line Driver 12-24V: external supply up to 30V / $I_{MAX\ LOAD}$ < 20mA (only upon request: contact our technical department). • GND and SHIELD connection.
Motor PTC	**N°2 PTC sensor: one for main feedback and other one for "R" feedback** • PTC rated value ≤ 550Ω (low temperature). • Overtemperature PTC value ≥ 1400Ω.
USB 2.0	**USB 2.0 port for drive setting via Caliper software** • USB micro-AB port.
Ethernet	**Standard Ethernet port (not managed at present)** • RJ45 shielded with leds.
MODBUS (RS485)	**MODBUS (RS485) port for comunication (not managed at present)** • IN/OUT connection via screw terminal.

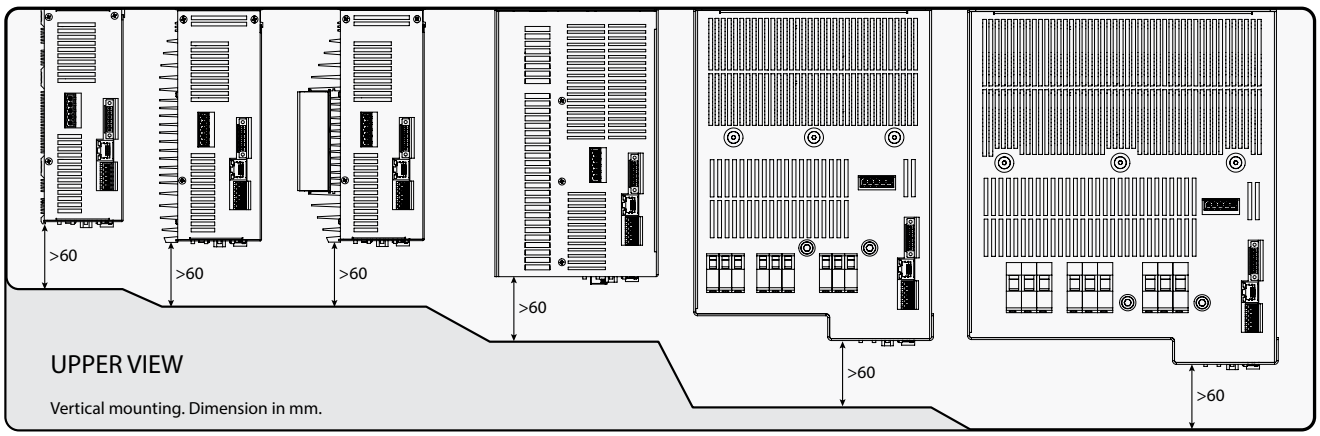
Ch. 3 Installation

3.01 Mechanical installation

Please follow the following instruction during the installation:

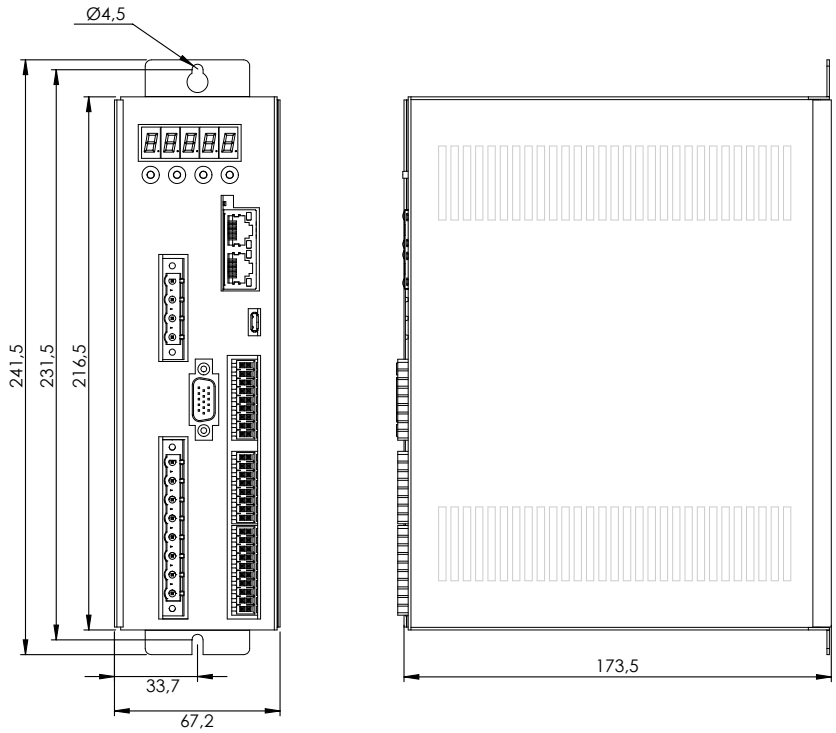
1. Install the drive in a vertical and perpendicular position regarding the floor.
2. Insure yourself that the environment temperature is comprised between 0 and 40° Celsius.
3. Avoid the following conditions:
   - Direct exposure to the solar light
   - Assemble in places with presence of powders, soil, particles of iron.
   - Assemble in places with corrosive gas, explosive gas or high grade of humidity.
   - Assemble in proximity of machines that generate vibrations.
   - Assemble in proximity or on inflammable matter (as wood) or not resistant to the heat.
4. Insure yourself that the driver will be assembled in a position that guarantee a correct ventilation, as shown in picture below.



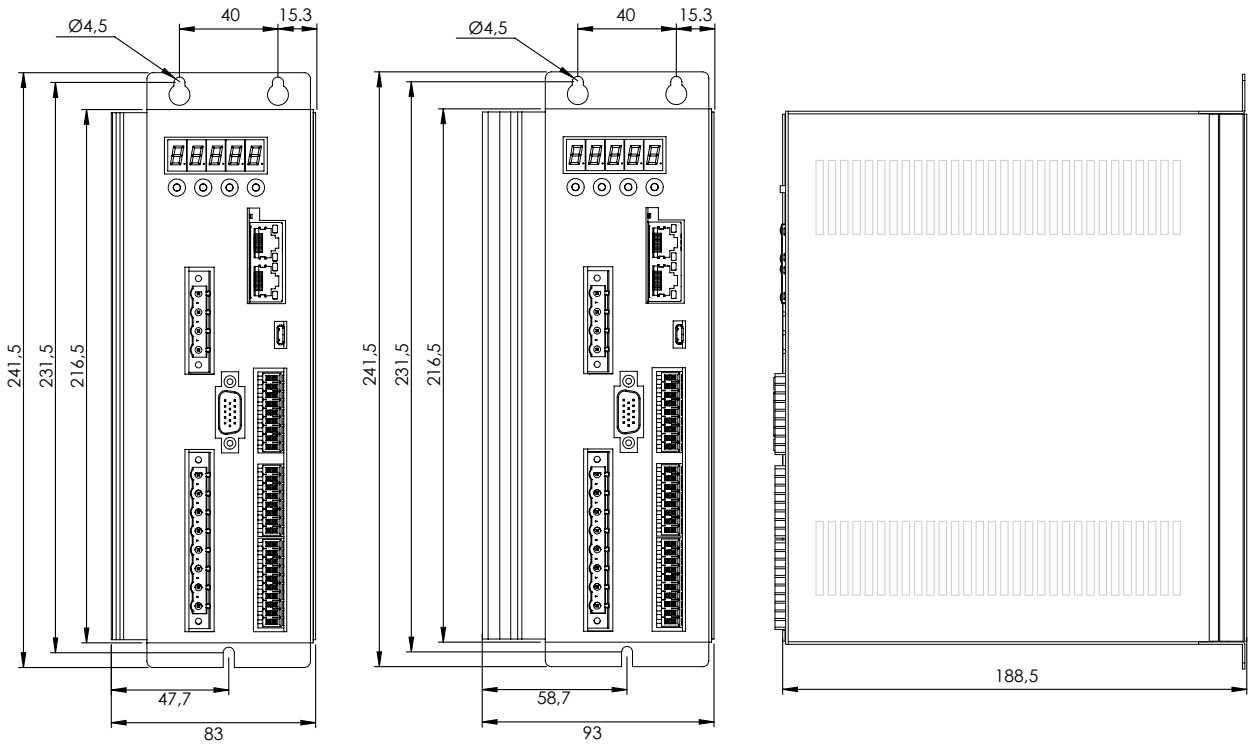


3.02 Dimensions and side view

T0 | T0 side view

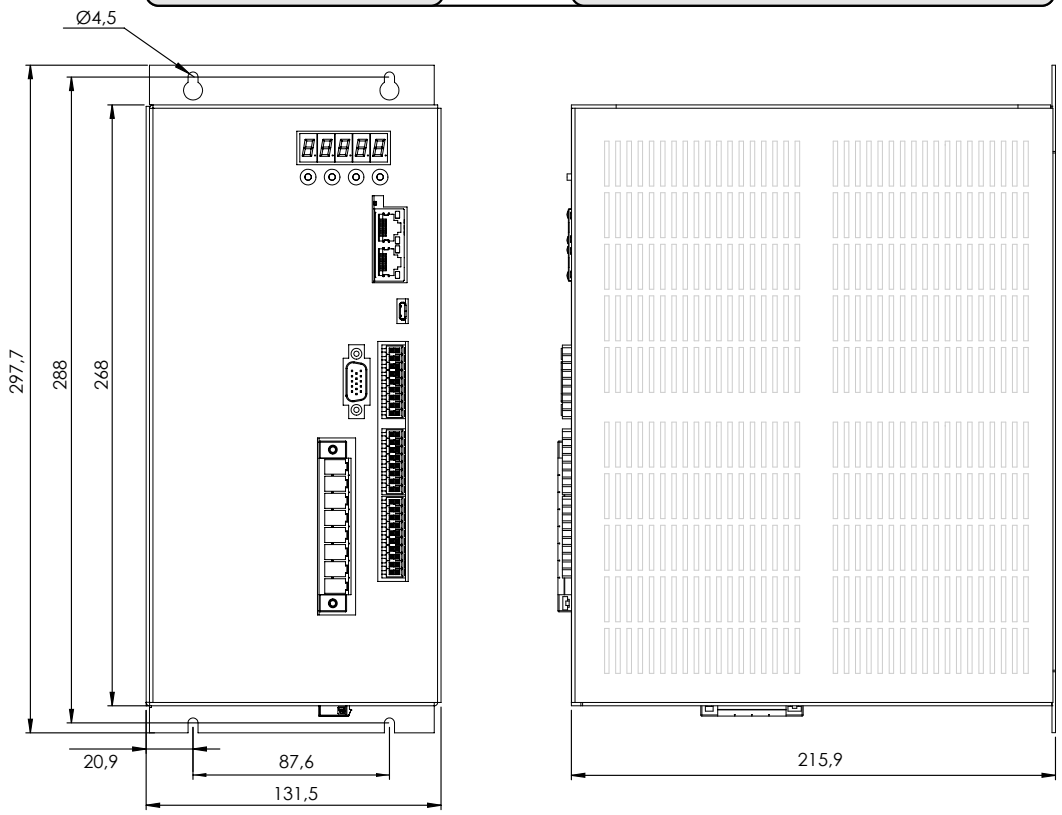


T1 | T2 | T1-2 side view

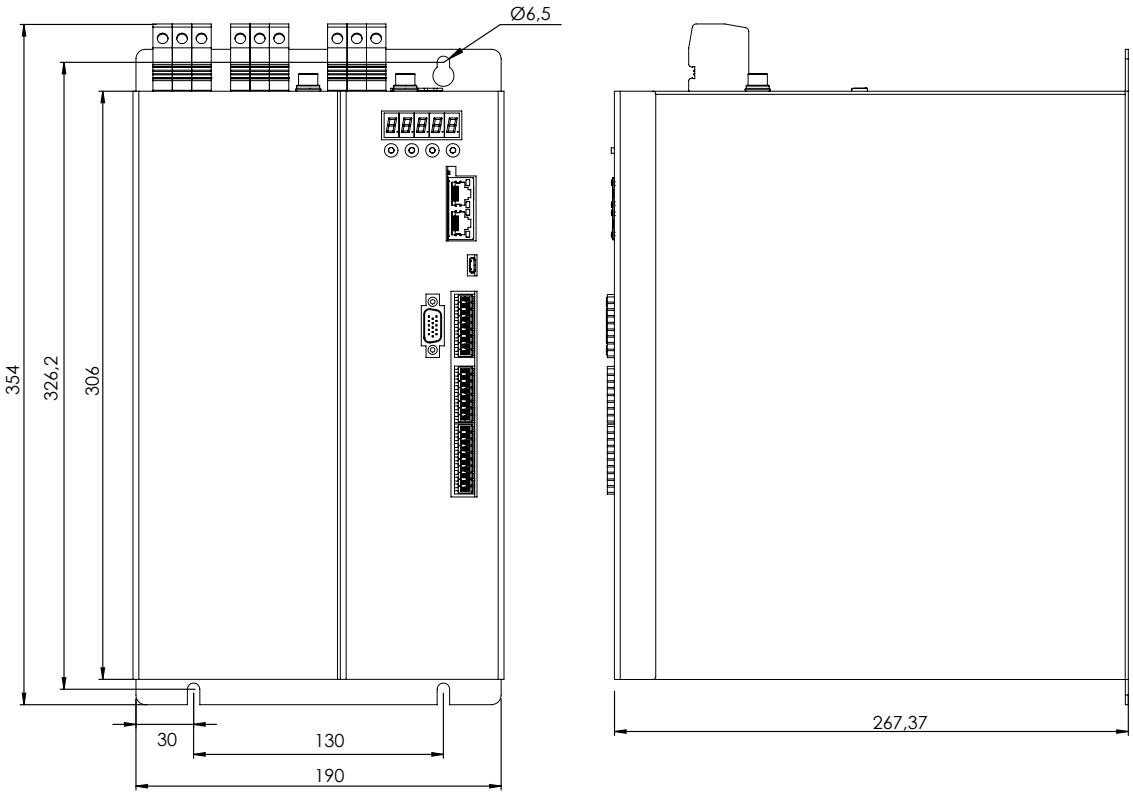


Dimensions in mm.

T3 | T3 side view

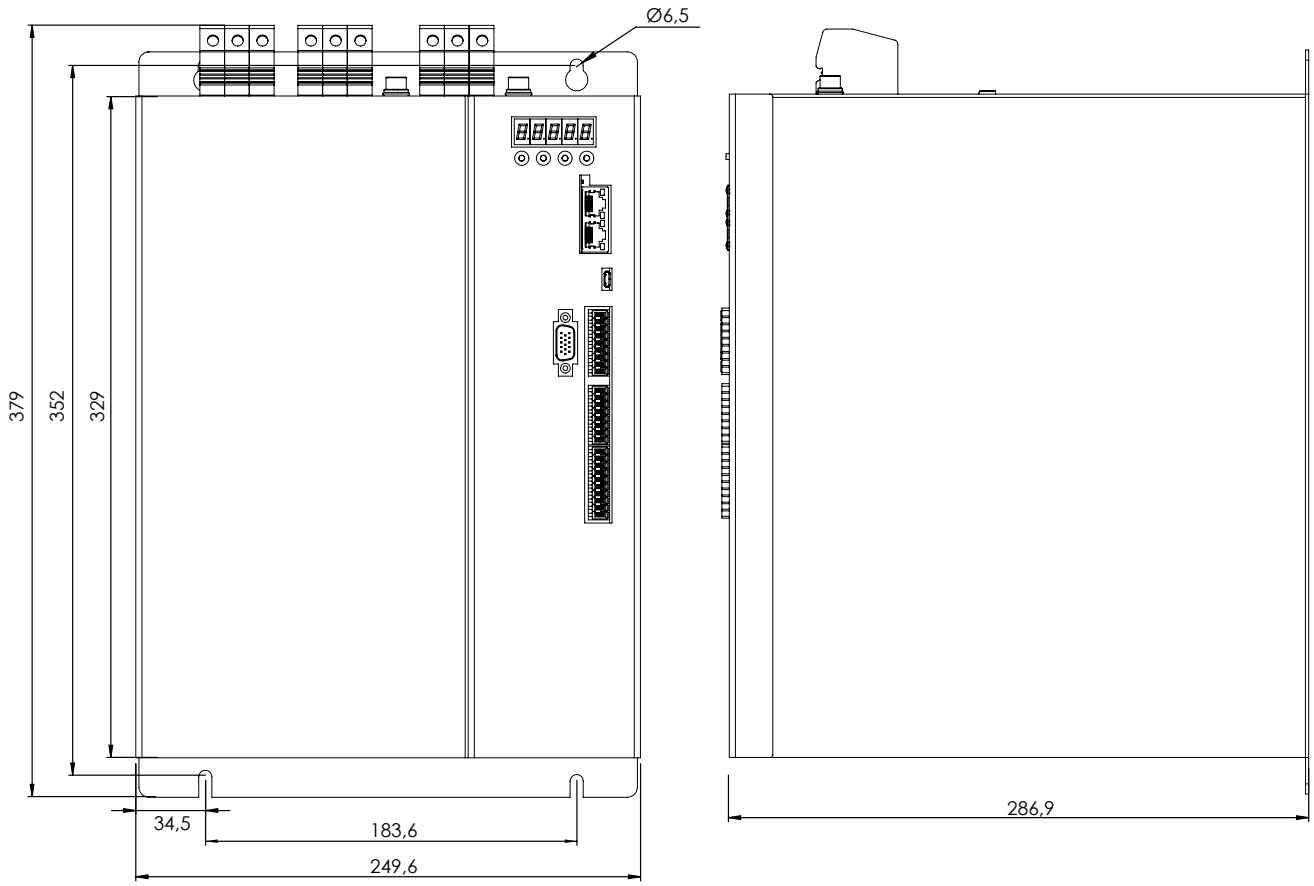


T4 | T4 side view



Dimensions in mm.

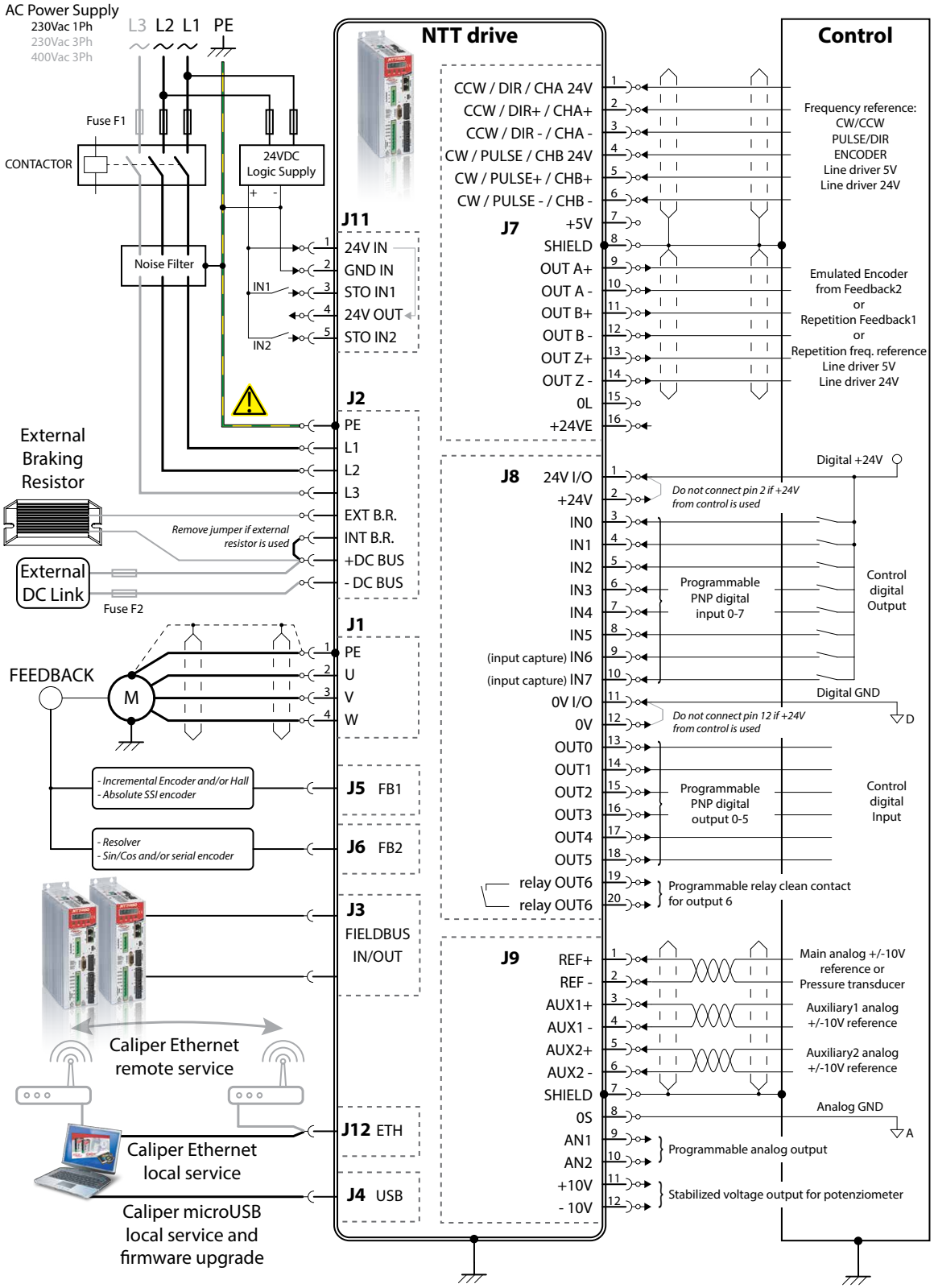
T5 | T5 side view



Dimensions in mm.

Ch. 4 Supply and quick start

4.01 Standard wiring for quick start



For detailed information about connection between 'external control-drive-motor', please see:

- *"Ch. 5 Wiring and connections" pag. 26*
- *"6.15 Control topologies" pag. 98*

4.02 Fuses

F1 must be ultra fast fuse.

In order to choice a correct value for F1 with single phase and tri-phase line, please use formulas below, where P_T is maximum output active power provided by drive and VAC_{IN} is minimum AC input line voltage at L1-2-3 pins:

$$F_{1\,1Ph} = \frac{2 \cdot P_T}{VAC_{IN}} \; [A] \qquad F_{1\,3Ph} = \frac{2 \cdot P_T}{VAC_{IN} \cdot \sqrt{3}} \; [A]$$

In order to choice a correct value for F2 with DC line, please use formulas below, where P_T is maximum output active power provided by drive and VAC_{IN} is minimum DC input voltage at +/-DC pins:

$$F_2 = \frac{2 \cdot P_T}{VDC_{IN}} \; [A]$$

4.03 External braking resistor

If external braking resistor is used, please disconnet any internal resistor; please see *"5.03 J2 connector: drive power supply and braking resistor" pag. 30*.

External braking resistor must be placed at 50mm far from drive at least and on a NOT inflammable matter also resistant to the heat.

Do not touch the insulated metal case of resistor, that could reach high temperature. Failure to observe this could lead to thermal shocks.

For information, please see *"Ch. 9 Accessories" pag. 126*. or contact our technical department.

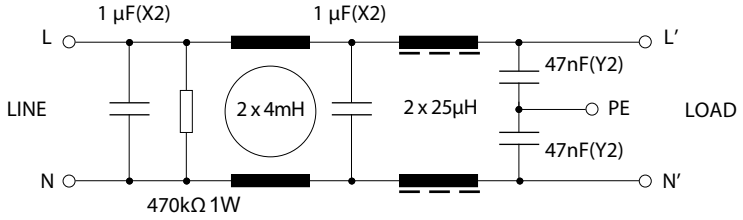
4.04 EMC Filter

Cat. C2 product may be source of radio-frequency noise if used in public mains feeding voltage to habitation. Only NTT 240 single phase with internal EMC filter is suitable to C2 cat. - A class.

Cat. C3 product is not suitable in public mains feeding voltage to habitation. The drive may be source of radio-frequency noise. NTT 240/460 triphase with internal/external EMC filter is suitable to C3 cat.

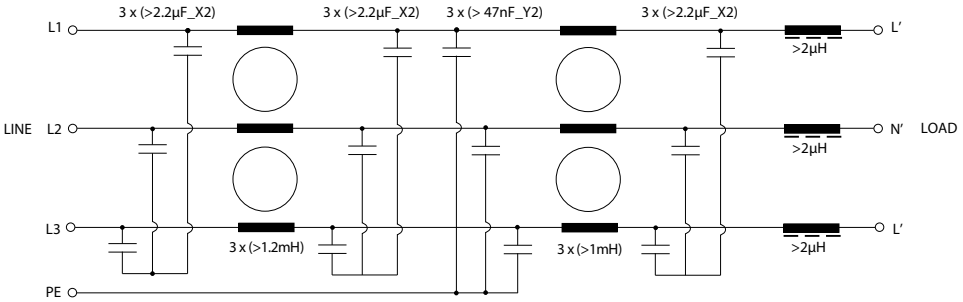
To ensure IEC61800-3 law compliance, about line conducted emissions, in C2 cat. - A class, type 2 environment (industrial), please respect the instructions below:

- EMC input filter must be placed less than 300mm far from drive.
- motor cable must be less than 5m lenght and stricly shielded: shield must be connect to both Power Earth cable ends; shield must also be connect to drive Power Earth of motor connector (pin PE of J1).
- part of input power supply cable, that from EMC filter goes to drive input power supply connector (J1), must be shielded; shield must also be connect to drive Power Earth of input power supply connector (pin PE of J1).
- it's recommended to use n°1 common mode toroid, with high permeability, to be inserted in power motor cable; to ensure a proper use, enter only and exclusively U-V-W motor cables through toroid hole.
- keep line cable at least 15cm far from load filter cable.
- for longer motor cable, external EMC filter has principle diagramm shown below, in singlephase topology:



To ensure IEC61800-3 law compliance, about line conducted emissions, in C3 category, type 2 ambient (industry), please respect the instructions below:

- EMC input filter must be placed less than 300mm far from drive.
- motor cable must be less than 5m lenght fot NTT 460 and less than 10m for NTT 240; it must be stricly shielded: shield must be connect to both Power Earth cable ends; shield must also be connect to drive Power Earth of motor connector (pin PE of J1).
- part of input power supply cable, that from EMC filter goes to drive input power supply connector (J2), must be shielded; shield must also be connect to drive Power Earth of input power supply connector (pin PE of J2).
- it's recommended to use n°1 common mode toroid, with high permeability, to be inserted in power motor cable; to ensure a proper use, enter only and exclusively U-V-W motor cables through toroid hole.
- keep line cable at least 15cm far from load filter cable.
- for longer motor cable, external EMC filter has principle diagramm shown below, in triphase topology:



NOTES:

- External H.D.T. EMC filter, depending on drive size, could supply more NTT 240/460 parallel drive. EMC input filter must be placed less than 300mm far from any drive and grounded to one point only.
- The actual EMC level may be different depending on the actual system configuration, wiring, and other conditions.
- For information about additional optional, see *"Ch. 9 Accessories" pag. 126*.

4.05 External DC link power supply

Connect DC link only if DC ar AC supply is the same.

If only DC link power supply is used, it's mandatory to perform an external DC precharge procedure for all connected drives, limiting peak precharge current to 10Amps.

If AC power supply with DC linked is used, it's mandatory to connect AC power supply to all connected drives (external precharge is not necessary).

If external braking resistor is used, connect it to only one drive.

4.06 DC bus reforming

After long storage periods (more than 1 year), it's strongly recommended to perform the reforming procedure, providing voltage supply at step by step value up to rated value; using a variable transformer, provide first 30-50Vac for 30minutes, then increase value adding 30-50Vac avery 30minutes up to rated voltage.

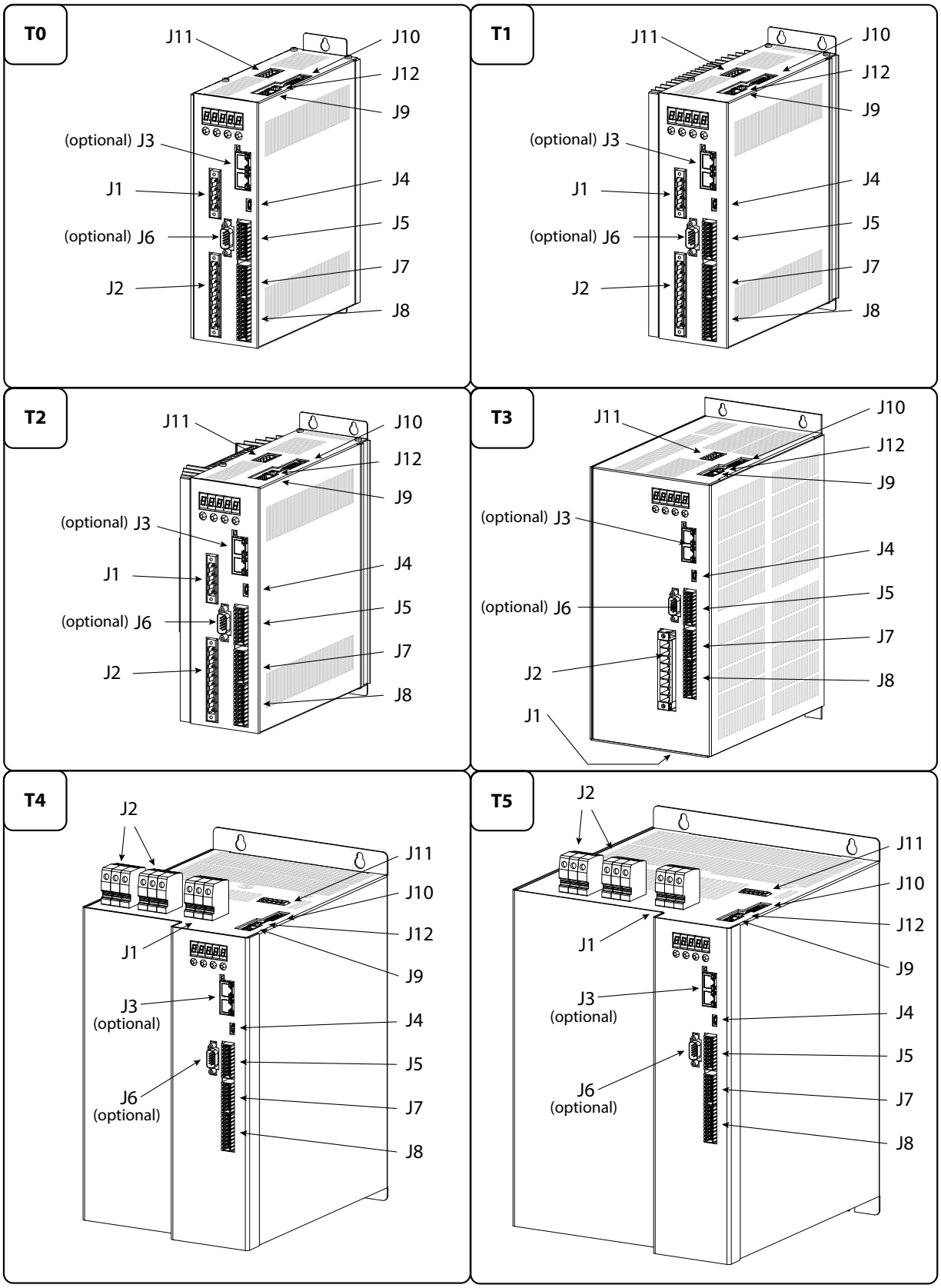
Hold the rated voltage for 1 hour at least, before starting the application.

It's also recommended to perform this procedure 1 time per year also if drive will not be used, in order to prevent rapid performance decreasing during next operation.

Ch. 5 Wiring and connections

5.01 General description

Position and name of connectors related to mechanical size are shown below:



The table below describes connector function and shown their naming on front and upper graphic label related to mechanical size:

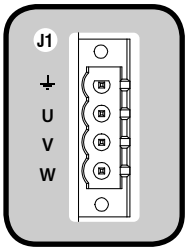
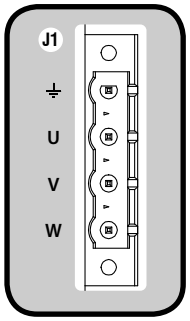
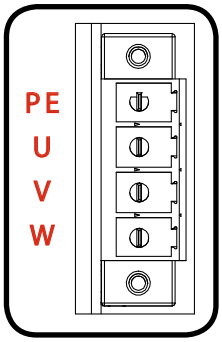
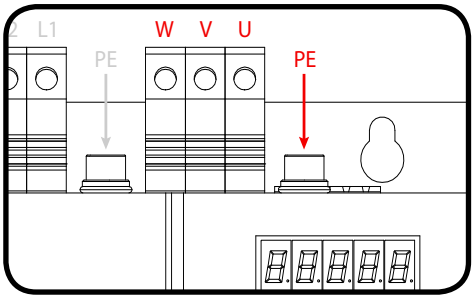
Connector	Description	Drive	Graphic Labels
J1	Motor supply output connector U, V, W, PE	NTT 240 T0-1-2 NTT 460 T0-1-2-3	**J1**
		NTT 460 T4-5	terminal marking **U V W**
J2	Input power supply for single phase, triphase line or DC link and internal/external braking resistor	NTT 240 T0-1-2 NTT 460 T0-1-2-3	**J2**
		NTT 460 T4-5	terminal marking **+DC -DC RF L1 L2 L3**
J3	Fieldbus comunicazion connector (optional)	NTT 240/460 all size	**J3**
J4	USB Micro AB port for drive setting via Caliper on PC		**J4**
J5	Feedback 1 from motor: encoder, HALL sensors		**J5**
J6	Feedback 2 from motor: resolver and encoder (optional - feedback R)		**J6**
J7	I/O connector: frequency input and encoder output buffered or emulated.		**J7**
J8	I/O connector: digital input and output and relay clean contact.		**J8**
J9	I/O connector: analog input and output		**J9**
J10	RS485 Modbus comunication connector		**J10**
J11	$+24V_{DC}$ logic supply and safety stop connector S.T.O., (Safe Torque Off, SIL3)		**J11**
J12	Ethernet comunication connector (available only for HW 0-1 or later drives)		**J12**

For information about drive mechanical size, see *"2.03 Drive sizes and option configuration" pag. 10*.

5.02 J1 connector: motor power connection

Do not connect an external supply on terminals U, V, W.
Do not connect cable when drive power supply is off and motor is rotating.
Connect correctly U,V,W wiring both H.D.T. drive and motor:

Connector TYPE	**Screw connector for mechanical size T0-1-2-3, male connection** **Terminal block for mechanical size T4-5**
Utility	U,V,W motor power connection
N° pins	Mechanical size T0-1-2-3: **4 pins (3 motor phases + PE)** Mechanical T4-5: **3 terminal block (motor phases) + screw for Power Earth (PE) eyelet**

NTT240 T0-1-2 *front output*	**NTT460 T0-1-2** *front output*	**NTT460 T3** *lower output*	**NTT460 T4-5** *upper output*
			

PIN	J1 connector description	
U	Motor connection, U phase or +M pole for continuous current motor.	
V	Motor connection, V phase.	
W	Motor connection, W phase or -M pole for continuous current motor.	
PE	Power Earth connection , PE	

The table below shows the power connection with H.D.T. motors:

- B05 - B07 - B10 - B14 - B20 - BK20 - B26
- BSP - BSD
- MS04 - MS06 - MS08

J1 DRIVE	ID/COLOUR EXTENTION CABLE	MOTOR				
		B05-B07	B10-B14	B20-BK20-B26	BSP-BSD	MS04-MS06-MS08
U	U -1 / BLACK	1	A	A / U	1	1
V	V - 2 / BLACK o GREY	3	B	B / V	3	2
W	W - 3 / BLACK o BROWN	5	C	C / W	4	3
PE + SHIELD	YELLOW-GREEN + shield (PE and SHIELD connected both side drive and motor)	6	D	PE	2	4

Minimum cable section for motor cable is shown below related to drive power sizes:

Drive Power Size	Minimum Section mm2 (AWG)	Maximum Section mm2 (AWG)
NTT 240 1,5/3	4 x 1 mm² (AWG17) Shielded	2.5 mm² (AWG13)
NTT 240 3/6	4 x 1 mm² (AWG17) Shielded	
NTT 240 6/12	4 x 1.5 mm² (AWG15) Shielded	
NTT 240 10/20	4 x 2.5 mm² (AWG13) Shielded	
NTT 460 1,5/3	4 x 1 mm² (AWG17) Shielded	2.5 mm² (AWG13)
NTT 460 3/6	4 x 1 mm² (AWG17) Shielded	
NTT 460 6/12	4 x 1.5 mm² (AWG15) Shielded	
NTT 460 10/20	4 x 2.5 mm² (AWG13) Shielded	6 mm² (AWG9)
NTT 460 20/40	4 x 4 mm² (AWG11) Shielded	
NTT 460 35/70	4 x 6 mm² (AWG9) Shielded + M6x16 exagonal screw	16 mm² (AWG5)
NTT 460 45/90 (45/150)	4 x 10 mm² (AWG7) Shielded + M6x16 exagonal screw	
NTT 460 75/150	4 x 25 mm² (AWG3) Shielded + M6x16 exagonal screw	25 mm² (AWG3)

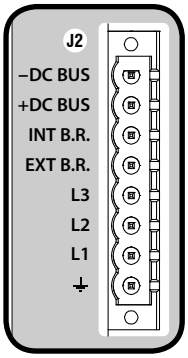
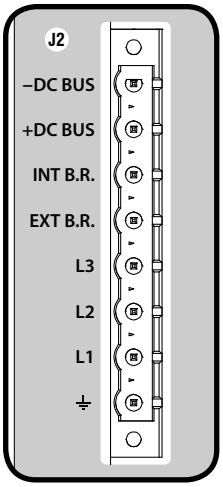
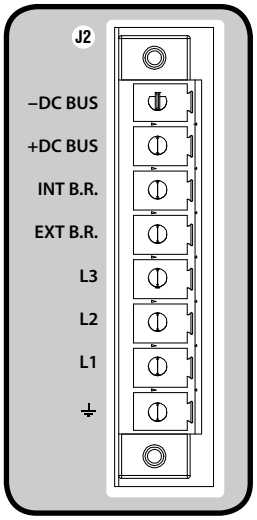
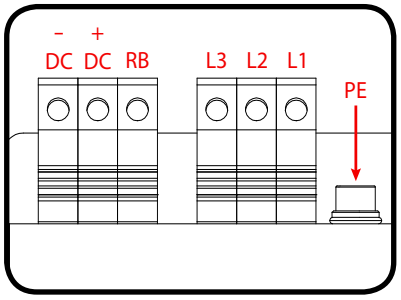
NOTES:

- It's mandatory to use shielded cables and to connect shield to PE terminal both drive and motor side.
- To ensure a correct electric wiring, and for electric safety, use an adequate cap.
- For cable lenght longer than 50meters, it could be necessary to use a triphase motor choke to grant drive correct operation.
- It's recommended to perform motor autophasing procedure to ensure that connection is correct (it's mandatory if third party motor is used). Please see *"6.07 Motor autophasing" pag. 82*.
- For information about H.D.T. AC brushless motors wiring (serie B05-B26, BSD10-BSD14 e MS04-MS08), refer to technical manuals downloaded from internet corporate site:

www.hdtlovato.com

5.03 J2 connector: drive power supply and braking resistor

Connector TYPE	**Screw connector for mechanical size T0-1-2-3, male connection** **Terminal block for mechanical size T4-5**
Utility	AC power supply, DC link and internal or external braking resistor connection.
N° pins	Mechanical size T0-1-2-3: **8 pins** Mechanical T4-5: **6 terminal block + screw for Power Earth (PE) eyelet**

NTT240 T0-1-2 *front output*	**NTT460 T0-1-2** *front output*	**NTT460 T3** *front output*	**NTT460 T4-5** *upper output*
			

PIN	J2 connector description	
– DC BUS	DC link connection. Monitored Voltage: for information, see *"8.03 Diagnostics" pag. 121*.	
+ DC BUS		
INT B.R.	Internal braking resistor connection. In order to use internal resistor, connect 'INT B.R.' with '+DC BUS' pin. Monitored Resistor: for information, see *"8.03 Diagnostics" pag. 121*.	
EXT B.R.	Internal braking resistor connection. In order to use internal resistor, disconnect 'INT B.R.' with '+DC BUS' pin, if present, and connect resistor between 'EXT B.R.' and '+DC BUS' pin. Monitored Resistor: for information, see *"8.03 Diagnostics" pag. 121*.	
L3	Drive AC power supply. For NTT 240 single phase power supply, it's possible to connect phases into any 2 input of 3 available equally. Monitored Voltage: for information, see *"8.03 Diagnostics" pag. 121*.	
L2		
L1		
PE	Drive power connection, Power Earth (PE).	

Minimum cable section for drive power supply cable is shown below related to drive power sizes:

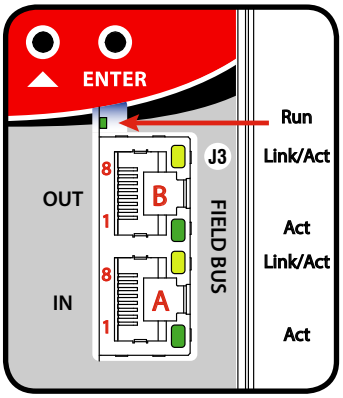
Drive power size	Minimun section 1Ph - mm² (AWG)	Minimum Section 3Ph - mm² (AWG)	Maximum Section mm² (AWG)
NTT 240 1,5/3	1 mm² (AWG17)	1 mm² (AWG17)	2.5 mm² (AWG13)
NTT 240 3/6	1 mm² (AWG17)	1 mm² (AWG17)	
NTT 240 6/12	2.5 mm² (AWG13)	1.5 mm² (AWG15)	
NTT 240 10/20	-	2.5 mm² (AWG13)	
NTT 460 1,5/3	-	1 mm² (AWG17)	2.5 mm² (AWG13)
NTT 460 3/6	-	1 mm² (AWG17)	
NTT 460 6/12	-	1.5 mm² (AWG15)	
NTT 460 10/20	-	2.5 mm² (AWG13)	6 mm² (AWG9)
NTT 460 20/40	-	4 mm² (AWG11)	
NTT 460 35/70	-	6 mm² (AWG9) + M6x16 exagonal screw	16 mm² (AWG5)
NTT 460 45/90 (45/150)	-	10 mm² (AWG7) + M6x16 exagonal screw	
NTT 460 75/150	-	25 mm² (AWG3) + M6x16 exagonal screw	25 mm² (AWG3)

NOTES:

- NTT 240/460 drives, that include internal resistor, are already equipped with bridge connection between INT. B.R. and +DC BUS pins.
- If AC power supply with external EMC filter is used, it's recommended to use shielded cables.
- If DC power supply or DC link is used, it's mandatory to use shielded cables and to connect shield to PE drive terminal.
- To ensure a correct electric wiring, and for electric safety, use an adequate cap.

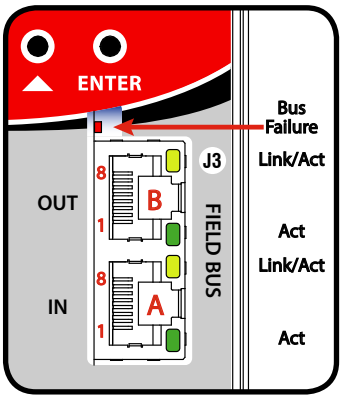
5.04 J3 connector: EC and PN option configuration

» EC configuration: Ethercat

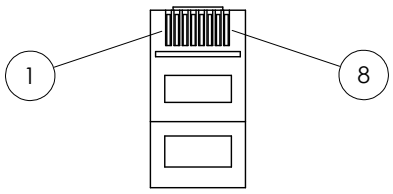


Connector TYPE	**Double RJ45: IN (A) and OUT (B) port with Link/Act and fieldbus status led.**
Utility	Fieldbus comunication protocol: • **Ethercat CoE**, (Canopen® CiA 402 over Ethercat) with EC option.
N° pins and LEDs	**8 x 2** (Ethernet standard according to EN50173-1:2011). **4 x LED** link/activity and **1 x green LED** for fieldbus status.

» PN configuration: Profinet



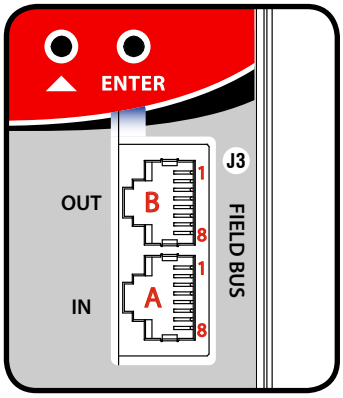
Connector TYPE	**Double RJ45: IN (A) and OUT (B) port with Link/Act and fieldbus status led.**
Utility	Fieldbus comunication protocol: • **Profinet RT**, (Profidrive CA e CB) with PN option.
N° pins and LEDs	**8 x 2** (Ethernet standard according to EN50173-1:2011). **4 x LED** link/activity and **1 x red LED** for fieldbus status.

PIN	J3 connector description - EC and PN Option		Cable
A1-B1	TD +	Transmit Data +	
A2-B2	TD –	Transmit Data –	
A3-B3	RD +	Receive Data +	
A4-B4	-		
A5-B5	-		
A6-B6	RD –	Receive Data –	
A7-B7	-		
A8-B8	-		

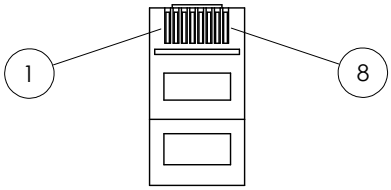
NOTES:

- Monitored Fieldbus: for information, see *"8.03 Diagnostics" pag. 121*.
- Keep comunication cables far from power and feedback cables.
- It may be necessary to use a switch repeter for bus lenght grater than 1000m.
- Use shielded patch cable (pin-to-pin) FTP 568 (B) Cat. 5 or better.
- As to connect multiple drives, RJ45 needs a cascade connection, so the wiring between the drives themselves must be pin-to-pin.
- For information about cable, see *"Ch. 9 Accessories" pag. 126*.

5.05 J3 connector: CM option configuration



Connector TYPE	**Double RJ45: IN (A) and OUT (B) parallel connected ports**
Utility	Fieldbus comunication protocols: • Canopen® CiA301e CiA402 • Modbus RTU
N° pins	**8 x 2: A1-A8 and B1-B8** (CIA303 standard + Modbus RTU standard)

PIN	J3 connector description - CM Option		Cable
A1-B1	CAN H	High Canopen® data	
A2-B2	CAN L	Low Canopen® data	
A3-B3	GND	Common Ground for Canopen®	
A4-B4	MODBUS +	+ data for RS485 Modbus RTU	
A5-B5	MODBUS –	– data for RS485 Modbus RTU	
A6-B6	-		
A7-B7	Shortcircuit	For possible external signal or supply	
A8-B8	GND	Common Ground for Modbus RTU	

In order to ensure a correct operation for Canopen® Fieldbus comunication, please follow instruction below:

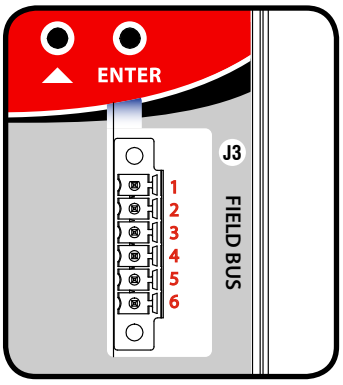
- connect external 120Ω termination resistor
- the table below shows Bus total lenght related to Baudrate:

Baudrate	Bus total lenght
1 Mbit/s	< 20m
500 kbit/s	< 100m
250 kbit/s	< 250m
125 kbit/s	< 500m
50 kbit/s	< 1000m
20 kbit/s	< 2500m
10 kbit/s	< 5000m

NOTES:

- Monitored Fieldbus: for information, see *"8.03 Diagnostics" pag. 121*.
- Keep comunication cables far from supply and feedback cables.
- It may be necessary to use a repeter or signal amplifier for bus lenght grater than 1000m.
- Use shielded patch cable (pin-to-pin) FTP 568 (B) Cat. 5 or better.
- As to connect multiple drives, RJ45 needs a cascade connection, so the wiring between the drives themselves must be pin-to-pin.
- Node id address is settable via keybord; please see *"6.06 Display and keyboard" pag. 76*.
- For information about cable, see *"Ch. 9 Accessories" pag. 126*.

5.06 J3 connector: PB option configuration



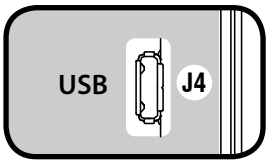
Connector TYPE	**Pitch 3.5mm, male connection** **Max cable section: 1mm²**
Utility	PROFIBUS Comunication with IN/OUT connection
N° pins	**6**

PIN	J3 connector description - PB Option	
1	PROFI+	+ data for PROFIBUS comunication
2	PROFI–	– data for PROFIBUS comunication
3	GND	Common Ground for PROFIBUS comunication
4	PROFI+	+ data for PROFIBUS comunication
5	PROFI–	– data for PROFIBUS comunication
6	SHIELD	Cable shield. This pin is connected to drive Power Earth (PE)

NOTES:

- Monitored Fieldbus: for information, see *"8.03 Diagnostics" pag. 121*.
- Keep comunication cables far from supply and feedback cables.
- It may be necessary to use a repeter or signal amplifier for bus lenght grater than 1000m.
- Node id address is settable via keybord; please see *"6.06 Display and keyboard" pag. 76*.

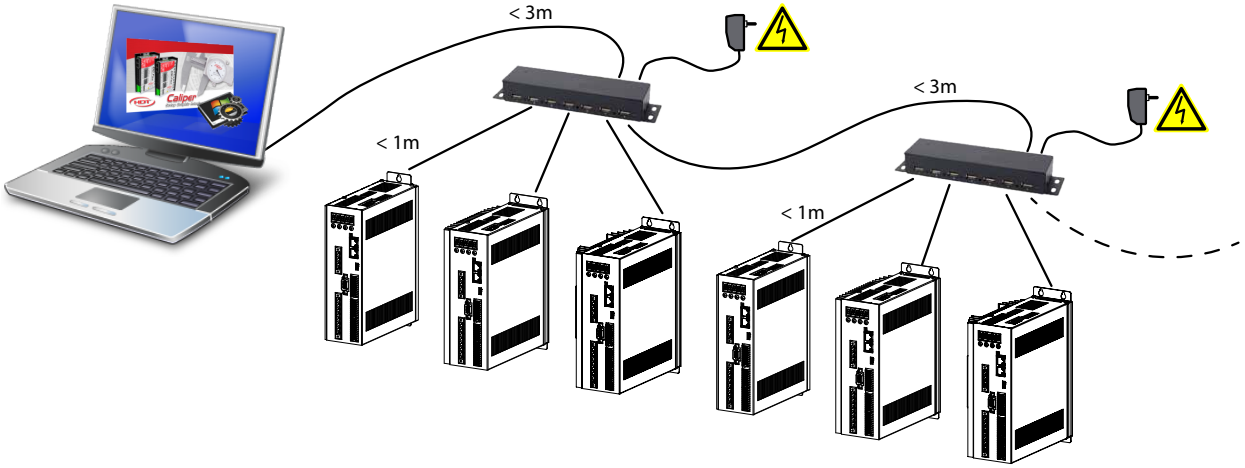
5.07 J4 connector: drive settings



Connector TYPE	**Micro USB AB type**
Utility	USB 2.0 comunication protocol at 12Mbps. Setting operating modes, diagnostic and calibration via Caliper. Firmware upgrade.
N° pins	**Standard USB A type to micro-B type, shielded cable.**

5.07.1 Using USB 2.0 HUB

I's allowed to use USB 2.0 HUBs in cascaded connection to visualize more axises with same PC. Tipical connection available between PC and NTT 240/460 drive, using USB HUBs, is shown below:

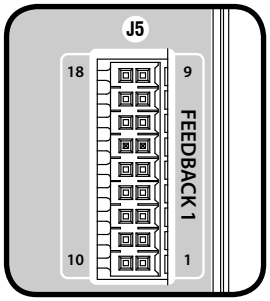


NOTES:

- Not insulated connection: USB comunication ground and 0L drive ground are equipotential. Maximum permitted voltage against Power Earth (PE) is 50V.
- It's strongly recommended to use USB shielded cables, whose lenght is less than 3m for single drive or less than 1m for each drive connected to an USB HUB.
- Keep USB comunication cables far from power and feedback cables.
- It's recommended to use shielded HUB with active supply if long distances are required.
- Maximum number of installable USB devices is 128, but real displayable number is related to PC hardware and used operating system.
- It's possible to connect all other H.D.T. drive families, that support USB, to the same HUB.
- For information about cable, see *"Ch. 9 Accessories" pag. 126*.

5.08 J5 connector: Feedback 1

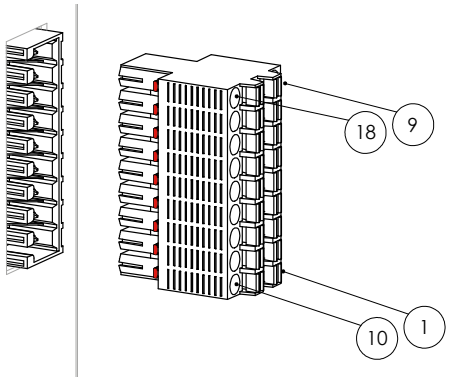
To avoid motor feedback damage, befors connecting cables, please ensure that connection is correct and that drive is set correctly.

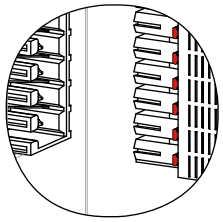


Connector TYPE	**Double row, pitch 3.5mm, male connection** **Max cable section: 1mm²**
Utility	Motor main Feedback. Incremental or absolute encoder and HALL sensors.
N° pins	**18**

PIN	J5 connector description	
1	A +	Differential line driver (5V) input for incremental channel A.
2	A –	
	A	Single (5V) Open Collector and Push Pull input for incremental channel A.
3	B +	Differential line driver (5V) input for incremental channel B.
4	B –	
	B	Single (5V) Open Collector and Push Pull input for incremental channel B.
5	Z + / CK+	Differential line driver (5V) input for channel Z of incremental encoder.
6	Z – / CK –	Differential line driver (5V) output for CLOCK data for SSI absolute encoder.
	Z	Single (5V) Open Collector and Push Pull input for incremental channel Z.
7	PTC	Digital input for motor PTC. If motor is devoid of PTC, ensure to short pin 7 and 8.
8	PTC	
9	+V_SENSE1	Supply voltage sensing input pin from encoder.
10	+V	Regulated encoder supply 5-9V for feedback 1. • for 5V encoder supply: if available, connect supply sensing pins (9 and 18 pin), otherwise, leave them open circuit. • for encoder supply higher than 5V: perform short circuit between supply sensing pins (9 and 18 pin) to obtain 9V encoder supply.
11	0L	Common Ground 0L for encoder supply and signals.
12	D –	Differential line driver (5V) input for DATA for SSI absolute encoder.
13	(HA) / D +	
	HA / (D +)	HALL sensor A signal input
14	HB	HALL sensor B signal input
15	HC	HALL sensor C signal input
16	SHIELD	Encoder and signal cable shield. This pin is connected to drive Power Earth (PE)
17	SHIELD	
18	0L_SENSE1	Supply common groung sensing input pin from encoder.

Wiring connections and pins numbering for J5 connector is shown below, according to previous table:

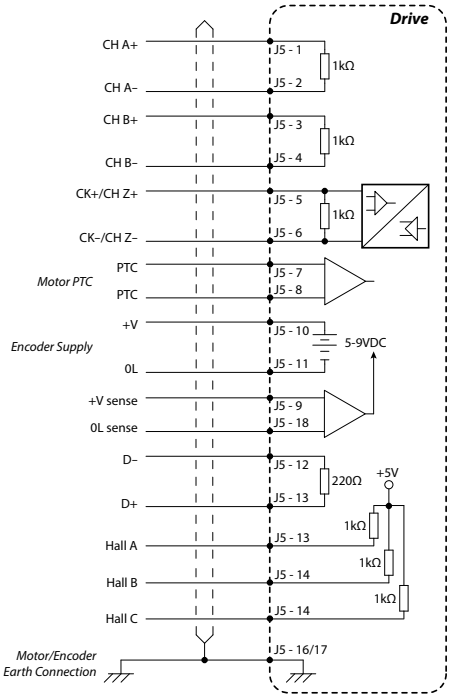




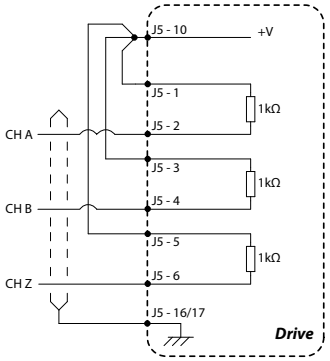
Porre attenzione al gancio di inserzione del connettore prima di cablare la matassa: assicurarsi che sia orientato correttamente.

Tipical encoder wiring connections for J5 connector and incremental encoder variation wiring is shown below:

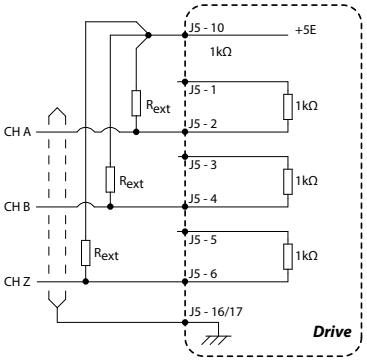
Line Driver incremental Encoder connection



Open Collector incremental Encoder connection with internal Pull-up resistor



Open Collector incremental Encoder connection with external Pull-up resistor



External resistor must be dimensioned according to main feedback encoder used.

NOTES:

- Monitored Feedback: for information, see *"8.03 Diagnostics" pag. 121*.
- Maximum permitted voltage for 0L against Power Earth (PE) is 50V.
- Use shielded cable. Keep I/O cables far from supply and feedback cables.
- To ensure a correct electric wiring, and for electric safety, strip the wire up to 6-8mm, or use an adequate cap.
- In order to use cable lenght between 50m and 100m, ti's recommended to use incremental encoders that allow not to exceed 250kHz, during application rated speed.
- For absolute encoders, whose sum of single-turn and multi-turn bit is higher than 15, it's recommended to use cable lenght lower than 50meters.
- It's recommended to perform motor autophasing procedure to ensure that connection is correct (it's mandatory if third party motor is used). Please see *"6.07 Motor autophasing" pag. 82*.

5.08.1 Wiring a H.D.T. motor with encoder feedback

Tables below show connection with H.D.T. Bxx, BSDxx and MSxx motor series with:

1. **absolute SSI encoder for Bxx e BSDxx motors:**
   - **cod. 480***: ST 12bit + incremental channels (only Bxx series)
   - **cod. 500***: MT 12bit and ST 17bit

J5 DRIVE CONNECTOR	FUNCTION		EXTENTION CABLE COLOUR		MOTORE CONNECTOR
	cod. 480	cod. 500			
1	A+	-	GREEN		5
2	A -	-	BROWN		6
3	B+	-	YELLOW		7
4	B -	-	ORANGE	PINK	8
5	CK+		PURPLE		14
6	CK -		WHITE/GREEN		13
7	PTC		WHITE/YELLOW		17
8	PTC		YELLOW/BROWN		2
9	-	+V_SENSE1	BROWN/GREEN		16
10	+V		RED		3
11	0L		BLACK		4
12	D -		RED/BLUE		12
13	D+		GREY		11
14	-		-		-
15	-		-		-
16	PE / Shield		drain or braid		1
17	PE / Shield				
18	-	0L_SENSE1	GREY/PINK		15

2. **incremental encoder for Bxx motors:**
   - **cod. 2* o 280***: 1024ppr with HALL sensors

J5 DRIVE CONNECTOR	FUNCTION	EXTENTION CABLE COLOUR		MOTORE CONNECTOR
1	A+	GREEN		5
2	A -	BROWN		6
3	B+	YELLOW		7
4	B -	ORANGE	PINK	8
5	Z+	BLUE		9
6	Z -	WHITE		10
7	PTC	WHITE/YELLOW		17
8	PTC	YELLOW/BROWN		2
9	-			-
10	+V	RED		3
11	0L	BLACK		4
12	-	-		-
13	HA+	GREY		11
14	HB+	PURPLE		14
15	HC+	GREY/PINK		15
16	PE / Shield	drain or braid		1
17	PE / Shield			
18	-			-

3. **incremental encoder for MS motor:**
   - **cod. 200***: 2500ppr with HALL sensors, output with flying MATE'N'LOK capsule (AMP 172171-1) and plug (AMP 172163-1).

J5 DRIVE CONNECTOR	FUNCTION	EXTENTION CABLE		MOTOR	
		COLOUR		AMP 172163-1 N. PIN	AMP 172171-1 ENCODER OUTPUT CABLE COLOUR
1	A+	GREEN		9	BLUE/BLACK
2	A -	BROWN		10	BLUE
3	B+	YELLOW		11	GREEN
4	B -	ORANGE	PINK	12	GREEN/BLACK
5	Z+	BLUE		13	YELLOW
6	Z -	WHITE		14	YELLOW/BLACK
7	PTC	I motori della serie MS non prevedono il PTC. Cortocircuitare il pin 7 e 8 sul connettore J5.			
8	PTC				
9	+V_SENSE1	-		-	-
10	+V	RED		1	RED
11	0L	BLACK		2	BLACK
12	-	-		-	-
13	HA+	GREY		7	WHITE
14	HB+	PURPLE		5	GREY
15	HC+	GREY/PINK		3	BROWN
16	PE / Shield	drain or braid		15	SHIELD
17	PE / Shield				
18	0V_SENSE1	-		-	-

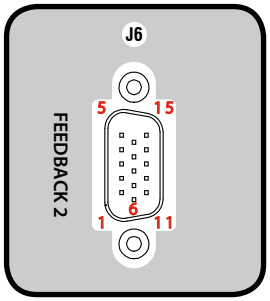
NOTE:
- incremental channels LD 5V, also using the absolute encoder cod. 480, can be sent to on PLC or CN via J8 connector in order to close the position loop.
- All pins of motor side and colours cable not mentioned are unused.

* For information about H.D.T. AC brushless motors wiring (serie B05-B26, BSD10-BSD14 e MS04-MS08), refer to technical manuals downloaded from internet corporate site:

www.hdtlovato.com

5.09 J6 connector: Feedback 2

To avoid motor feedback damage, befors connecting cables, please ensure that connection is correct and that drive is set correctly.



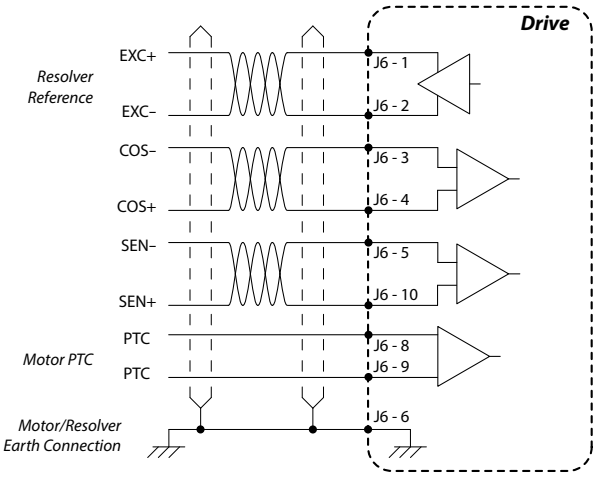
Connector TYPE	**High density D-Sub, male connection** **Max cable section: 0.5mm²**
Utility	Feedback 2 from motor: resolver. Only available with FEEDBACK R option.
N° pins	**15**

PIN	J6 connector description	
1	EXC +	Differential line driver supply for Resolver excitation/primary winding.
2	EXC –	
3	COS –	COS – input from Resolver feedback.
4	COS +	COS + input from Resolver feedback.
5	SEN –	SEN – input from Resolver feedback.
6	SHIELD	Encoder and signal cable shield. This pin is connected to drive Power Earth (PE).
7	-	***Do not use this connection.***
8	PTC –	Digital input for motor PTC. If motor is devoid of PTC, ensure to short pin 8 and 9.
9	PTC +	
10	SEN +	SEN + input from Resolver feedback.
11	-	***Do not use this connection.***
12	-	
13	-	
14	-	
15	-	

NOTES:

- Monitored Feedback: for information, see *"8.03 Diagnostics" pag. 121*.
- Maximum permitted voltage for 0L against Power Earth (PE) is 50V.
- Use shielded and twisted cable. Keep I/O cables far from supply and feedback cables.
- It's recommended to perform motor autophasing procedure to ensure that connection is correct (it's mandatory if third party motor is used). Please see *"6.07 Motor autophasing" pag. 82*.

Resolver wiring connections for J6 connector:



5.09.1 Wiring a H.D.T. motor with resolver feedback

Table below shows connection with H.D.T. B05-B07-B10-B14-B20-BK20-B26 and BSP-BSD motor series with resolver **cod. 1***:

J6 DRIVE CONNECTOR	FUNCTION	EXTENTION CABLE COLOUR	RESOLVER CONNECTOR		
			B05-B07, BSP-BSD	B10-B14-B20-B26	BK20
1	EXC +	BIANCO	6	F	10
2	EXC –	MARRONE	4	D	7
3	COS –	GIALLO	2	B	5
4	COS +	VERDE	1	A	6
5	SEN –	ROSSO	3	C	4
6	SHIELD	drenaggio o calza	-	-	-
7	-	-	-	-	-
8	PTC –	GRIGIO	7	H	9
9	PTC +	ROSA	8	G	8
10	SEN +	BLU	5	E	14
11	-	-	-	-	-
12	-	-	-	-	-
13	-	-	-	-	-
14	-	-	-	-	-
15	-	-	-	-	-

NOTES:

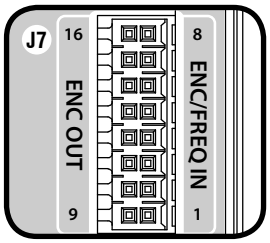
- All pins of motor side and colours cable not mentioned are unused.

* For information about H.D.T. AC brushless motors wiring (B05-B07-B10-B14-B20-BK20-B26 and BSP-BSD series), refer to technical manuals downloaded from internet corporate site:

www.hdtlovato.com

5.10 J7-8-9 connectors: Frequency, digital and analog I/O

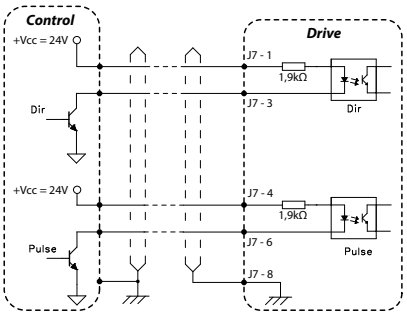
5.10.1 J7 connector: frequency I/O



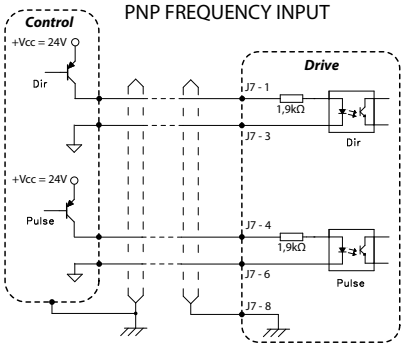
Connector TYPE	**Double row, pitch 3.5mm, male connection** **Maximum cable section: 1mm²**
Utility	Frequency main reference input. Emulated or buffered encoder output.
N° pins	**16**

PIN	J7 connector description		
1	CCW/DIR/CHA 24V	Frequency main reference input	Optoinsulated digital input for DIRECTION / CH A / CCW data. Line Driver 5V (pin 2-3) or NPN/PNP input (pin 1-3); see image below.
2	CCW/DIR/CHA +		
3	CCW/DIR/CHA –		
4	CW/PULSE/CHB 24V		Optoinsulated digital input for PULSE / CH B / CW data. Line Driver 5V (pin 5-6) or NPN/PNP input (pin 4-6); see image below.
5	CW/PULSE/CHB +		
6	CW/PULSE/CHB –		
7	+5V	Stabilized internal supply +5V (<100mA) for any external encoder.	
8	SHIELD	Encoder and signal cable shield. This pin is connected to drive Power Earth (PE).	
9	OUT A +	Frequency encoder output	Differential line driver (5V) output for buffered encoder or emulated encoder channel A (+24V available on request).
10	OUT A –		
11	OUT B +		Differential line driver (5V) output for buffered encoder or emulated encoder channel B (+24V available on request).
12	OUT B –		
13	OUT Z +		Differential line driver (5V) output for buffered encoder or emulated encoder channel Z (+24V available on request).
14	OUT Z –		
15	0L	Ground 0L for I/O frequency signals and for supply +5V (pin 7) or +24VE (pin 16).	
16	+24VE	***Do not use this connection with hardware "0-0" drives. Available on request.*** +24V input supply for frequency encoder output stage.	

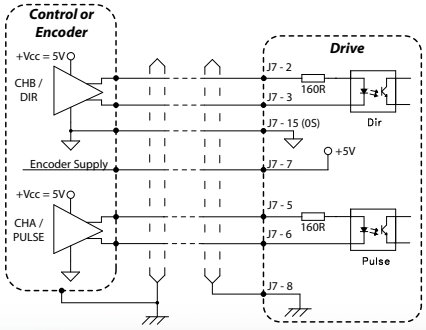
NPN FREQUENCY INPUT



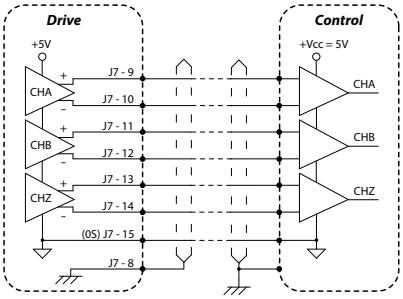
PNP FREQUENCY INPUT



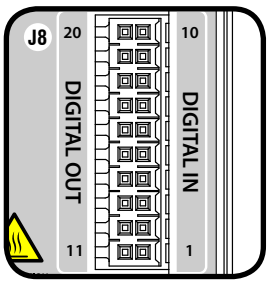
LINE DRIVER FREQUENCY INPUT



LINE DRIVER ENCODER OUTPUT



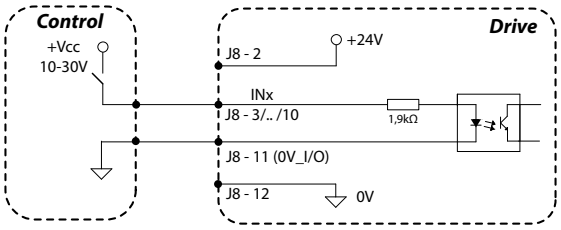
5.10.2 J8 connector: digital I/O



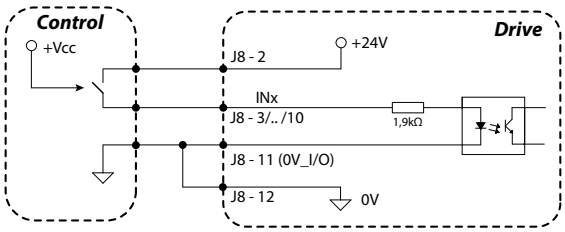
Connector TYPE	**Double row, pitch 3.5mm, male connection** **Maximum cable section: 1mm²**
Utility	Programmable 10-30V digital I/O. Programmable clean contact relay output.
N° pins	**20**

PIN	J8 connector description	
1	+24V I/O	Digital OUTx supply +24V voltage input. Monitored supply: for information, see *"8.03 Diagnostics" pag. 121*.
2	+24V	+24V internal supply available for feeding voltage to digital OUTx (pin 1).
3	IN0	Optoinsulated PNP input also programmable related to chosen operating mode. For information, see *"6.08.1 Digital I/O functions" pag. 85*.
4	IN1	
5	IN2	
6	IN3	
7	IN4	
8	IN5	
9	IN6	
10	IN7	
11	0V I/O	Isolated Common Ground 0V_I/O for I/O signals.
12	0V	Common Ground 0V for +24V
13	OUT0	Optoinsulated PNP output also programmable. For information, see *"6.08.1 Digital I/O functions" pag. 85*.
14	OUT1	
15	OUT2	
16	OUT3	
17	OUT4	
18	OUT5	
19	OUT6 relay	Programmable clean contact relay output. For information, see *"6.08.1 Digital I/O functions" pag. 85*.
20		

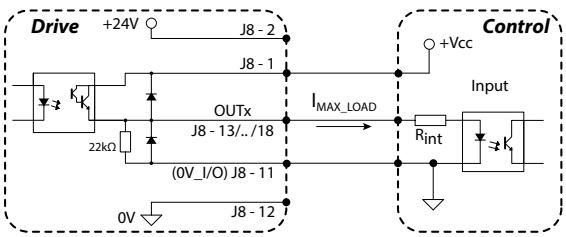
EXTERNAL SOURCE PNP INPUT



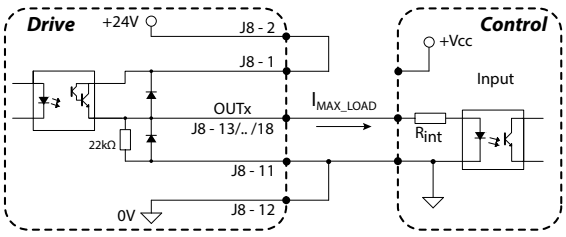
INTERNAL SOURCE PNP INPUT



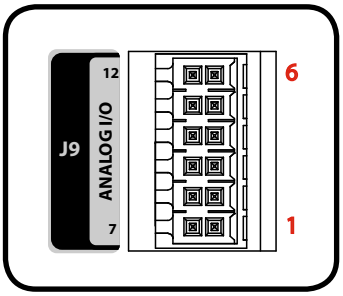
EXTERNAL SOURCE PNP OUTPUT



INTERNAL SOURCE PNP OUTPUT



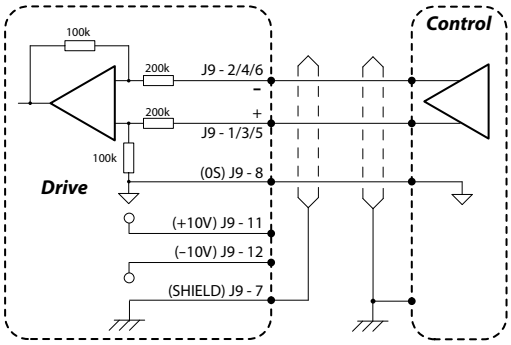
5.10.3 J9 connector: analog I/O



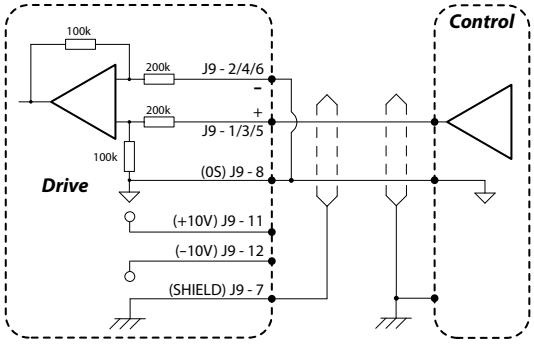
Connector TYPE	**Double row, pitch 3.5mm, male connection** **Maximum cable section: 1mm²**
Utility	Analog I/O
N° pins	**12**

PIN	J9 connector description		
1	REF +	IN8	Analog differential IN8 ±10V input ADC 16bit for main reference. Also available as IN8 digital input (single ended PNP). For information, see *"6.09 Drive references" pag. 87*.
2	REF –		
3	AUX1 +	IN9	Analog differential ±10V input ADC 12bit for auxiliary IN9-IN10 references. Also available as IN9-IN10 digital input (single ended PNP). For information, see *"6.09.2 Auxiliary references" pag. 88*.
4	AUX1 –		
5	AUX2 +	IN10	
6	AUX2 –		
7	SHIELD		Signal cable shield. This pin is connected to drive Power Earth (PE).
8	0S		Common Ground 0L for analog I/O and stabilized +/-10V supply.
9	AN0		Analog single ended ±10V programmable output DAC 10bit.
10	AN1		
11	+10V		Stabilized internal supply output +/-10V (< 15mA), usefull for feeding voltage to analog input via external potentiometer.
12	–10V		

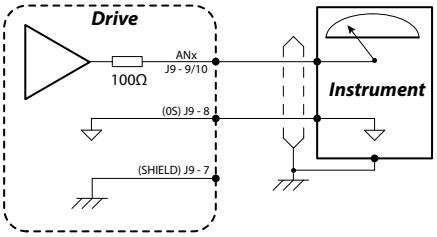
ANALOG DIFFERENTIAL INPUT



ANALOG SINGLE ENDED INPUT

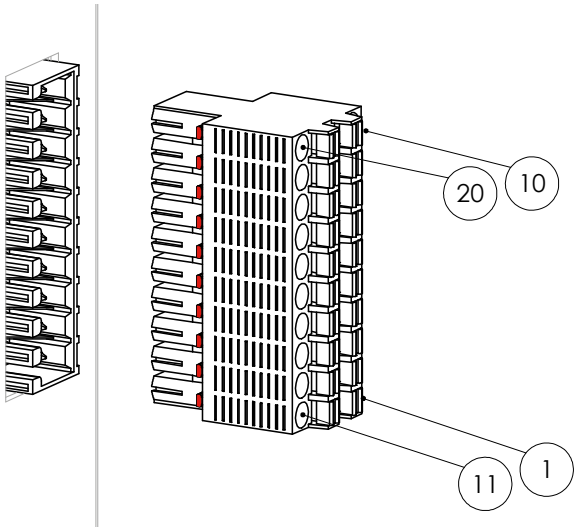


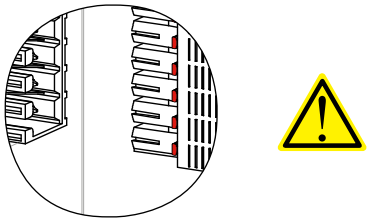
ANALOG OUTPUT



5.10.4 Cable per J7-8-9

Wiring connections and pins numbering for J4 connector is shown below, according to previous table related to J8 connector (J7 and J9 connector cable are similar, but with different pin number):



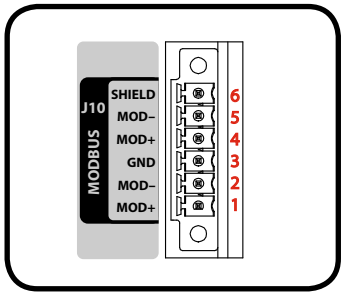


Please ensure that insertion hook of connector is facing correctly.

NOTES:

- 0L and 0S common ground are equipotential and maximum permitted voltage against Power Earth (PE) is 50V.
- Maximum permitted voltage for 0V, 0V_I/O against Power Earth (PE) is 100V.
- Do not use +24V (pin 2 of J8) to directly engage motor brake.
- Single ended PNP connection for analog references is to connect negative pins (pin 2-4-6 of J9)) to 0S ground (pin 8 of J9) and to connect signal to positive pins (pin1-3-5 of J9); this connection type is usefull if the external controller device has not differential analog output, but ±10V single ended only, and if this analog input is used as digital input.
- Keep I/O cables far from supply and feedback cables.
- To ensure a correct electric wiring, and for electric safety, strip the wire up to 6-8mm, or use an appropriate cap.
- For frequency main reference input and analog input, it's mandatory to use shielded cable.

5.11 J10 connector: RS485



Connector TYPE	**Pitch 3.5mm, male connection** **Maximum cable section: 1mm²**
Utility	RS485 serial comunication with IN/OUT. connection. (Not managed at the moment).
N° pins	**6**

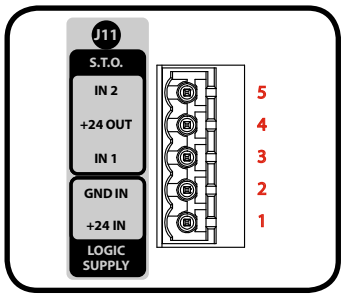
PIN	J10 connector description	
1	D+	+ data for RS485 comunication
2	D–	– data for RS485 comunication
3	0L	Common Ground for RS485 comunication
4	D+	+ data for RS485 comunication
5	D–	– data for RS485 comunication
6	SHIELD	Cable shield. This pin is connected to drive Power Earth (PE)

NOTES:

- Not insulated: maximum permitted voltage for 0L against Power Earth (PE) is 50V.

5.12 J11 connector: logic supply and S.T.O. safety function

The cable for J1 is composed of logic supply voltage and STO safety circuit contacts (Safe Torque Off). For further information about safety circuit, please see *"Ch. 7 S.T.O. safety circuit" pag. 116*.



Connector TYPE	**Pitch 5mm, male connection** **Maximum cable section: 2.5mm²**
Utility	$+24V_{DC}$ logic supply connection and safety function STO (Safe Torque Off).
N° pins	**5**

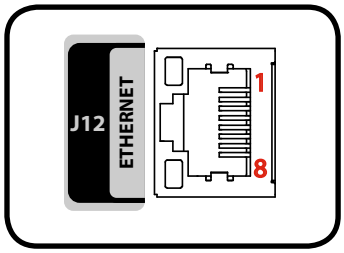
PIN	J11 connector description	
1	+24V IN	Drive logic supply voltage. This voltage line is necessary to use NTT 240/460 drive.
2	GND IN (0V)	
3	IN1	Redundant n°1 input channel for STO safety function. Monitored input: for information, see *"8.03 Diagnostics" pag. 121*.
4	+24V OUT	Alimentazione del circuito di sicurezza STO, fornita dal drive.
5	IN2	Redundant n°1 input channel for STO safety function. Monitored input: for information, see *"8.03 Diagnostics" pag. 121*.

NOTES:

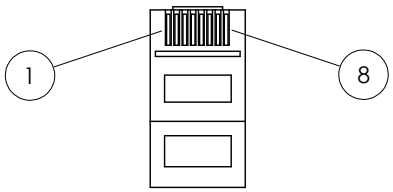
- Maximum permitted voltage for 0V against Power Earth (PE) is 100V.
- NTT 240/460 drives are equipped with bridge connection between pin 3-4-5, on connector. To use correctly the STO function, please disconnect bridge connection.

5.13 J12 connector: Ethernet

Connection available only for hardware 0-1 o later versions.



Connector TYPE	**RJ45 with Link and Activity LEDs**
Utility	Comunication protocol: • **IEEE 802.3™ Compliant Ethernet 10/100 Base-T** (Not managed at the moment).
N° pins	**8** (standard Ethernet secondo EN50173-1:2011).

PIN	J12 connector description: Ethernet		Cable
1	TD +	Transmit Data +	
2	TD –	Transmit Data –	
3	RD +	Receive Data +	
4	-		
5	-		
6	RD –	Receive Data –	
7	-		
8	-		

NOTES:

- Keep comunication cables far from power and feedback cables.
- It may be necessary to use a switch repeter for bus lenght grater than 1000m.
- Use shielded patch cable (pin-to-pin) FTP 568 (B) Cat. 5 or better.

Ch. 6 Operation mode

Operation mode supported by drive are listed below:

1. Input / Output (I/O): analog and digital input and output.
2. Modbus RTU (for CM configuration only).
3. Canopen® CiA301 and CiA402 protocol (for CM configuration only).
4. Ethercat CoE CiA402 protocol (for EC configuration only).
5. Profinet RT Profidrive protocol (for PN configuration only).
6. Profibus Profidrive DPv0 (for PB configuration only).

Control topologies supported by drive, with rotary and linear or tubular motor type, are listed below:

1. *Torque* control via analog/inside input reference or via fieldbus parameter.
2. *Speed and Speed with Torque limit* control via analog/inside/frequency/Table-selection input reference or via fieldbus parameter.
3. *Sensorless speed* control.
4. *Position* control related to desired operation mode:
   - *Single Target positioner* via analog reference or via single parameter.
   - *Table Target Positioner up to 64 target:* cyclic/acyclic target or via digital input selection or via input-start selection.
   - *Electronic Gearbox* via frequency reference (CHA/CHB, pulse/direction and CW/CCW).
   - *Electronic Cam* via frequency reference (CHA/CHB, pulse/direction).
5. *Pressure* control via analog input references or via fieldbus parameter.

Main drive status, during operation, are shown below and are visible on display device (please see also *"Ch. 8 Drive status and diagnostics" pag. 120*):

- *SWITCH-OFF state*: drive will not provide torque to motor and shows Drive OK or FAULT condition.
- *SWITCH-ON state*: drive will provide torque to motor in order to keep it stopped.
- *OPERATION ENABLED state*: drive will follow speed, torque or position reference, depending on choosen control topology.
- *Drive OK or FAULT condition*: drive will show Drive OK condition, only when there are no active alarms. If an alarm occurs, drive will show a *FAULT condition*.

Drive has a firmware that communicates with proprietary **Caliper 4.0** software: the using of this software leads to:

- select the desired drive operation mode.
- select the motor between rotary and linear or tubular type, with related feedback.
- configure all motor and drive parameters.
- save, modify or reload previous configured motor and drive parameters.
- configure, reload, modify and save all parameters for drive integrated software applications.
- monitor drive and motor during operation.
- perform debug of the entire machine quickly viewing all parameter addresses related to Fieldbus operation mode and emulating functionality and commands.
- perform HALL sensors autophasing.
- configure analog and digital I/O.
- configure drive to react in alarm, emergency and safe stop conditions.
- configure languages.
- use Scope function.

6.01 Introducing Caliper

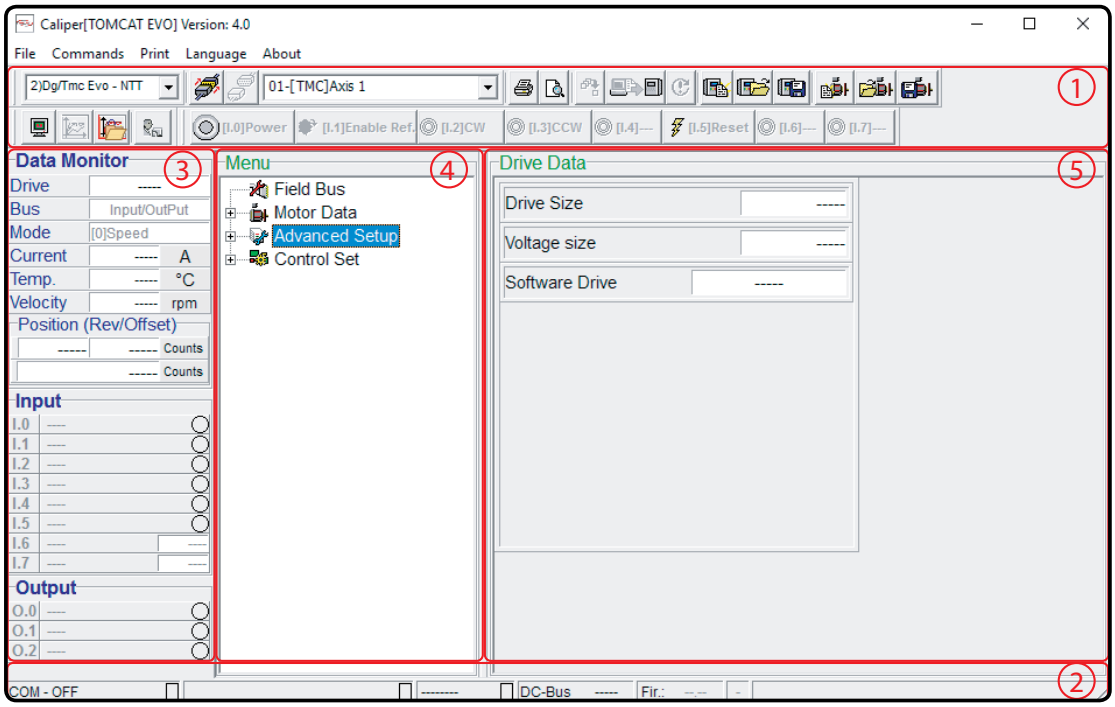
Caliper software requires a PC Windows98® or later and installation software pack can be downloaded from enterprise web site, after registration and login:

www.hdtlovato.com

During Caliper installation procedure, when Windows® gives message related to reliable installation USB driver origin, please accept all in order to go on with installation procedure; if not do so, Windows® will not reach H.D.T. drive and a new installation procedure is mandatory.

Caliper main window consists of:

1. a **Toolbar,** located at the top, that, via drop-down menu, allows to set the correct Caliper type related to drive connected; if a USB HUB 2.0 is used, it allows to connect with the desired drive. It allows to send to drive command signals, as SWITCH-ON, OPERATION ENABLED, RESET, emulating fieldbus protocol and I/O functions, and also to configure drive parameters in offline mode, perform HALL sensors autophasing and use Scope function.
2. a **State bar,** located at the lower, shows drive state and any active alarms, DC bus power supply voltage and firmware release for the connected drive.
3. a **Data Monitor**, located at the left column, gives information about connected drive size, actual drive operation mode (Fieldbus or I/O), actual control topology (Mode), motor speed and position parameters and drive current and temperature. Also actual digital I/O function and state (with a graphic view for state) is displayed.
4. a **Menu**, into a tree view, located at the right of *Data Monitor*, allows to set all drive parameters: operation mode selection (*Field Bus* menu item), motor and feedback Data parameters (*Motor Data* menu item), advanced setup parameters (*Advanced Setup* menu item) and control topology selection (menu item depends on desired operation mode in *Field Bus* menu item).
5. a **Drive Data** allows to configure Menu parameters directly, set desired Application related to Factors submenu and to visualize all parameter addresses related to Fieldbus operation mode.

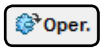
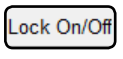
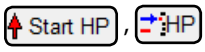
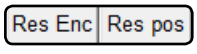
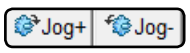


Caliper 4.0 present version and later, extend compatibility with 3.xx previous version in order to use a unique software to configure all H.D.T. drive families that support it, selecting the correct Caliper version via drop-down menu into Toolbar. Present maual will describe Caliper 4.0 and later releases.

NOTES:

- Pointing mouse on icons, a brief description will appeare, showing the function.
- To confirm any modified parameters (and to automatically send to drive), press ENTER key, or you can enable Autosave function in Commands menu to send any modified parameters to drive (a label 'A' = Automatic appears in state bar).
- There is an 'Hidden Menu' (reachable only entering a password in Commands menu) that allows to set other critical parameters not interesting for user (voltage, I2T drive and temperature thresholds). For other informations, please contact our technical support office.

Main software icons, in the toolbar, are described below:

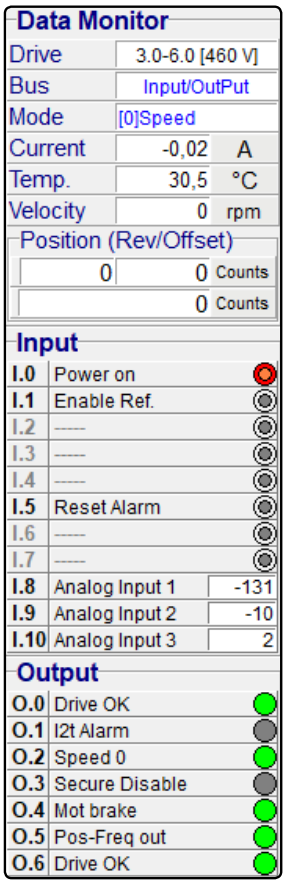
Icon	Description
	*Drive and PC connection*: choose correct Caliper Version and desired drive, then press to connect the drive. State bar, in the lower, shows if connection is OK or not.
	*Drive and PC disconnection*: USB comunication is disabled and drive continues to operate according to latest modifided parameters before disconnection.
	*Loading just set configuration into drive memory*. It's recommended always to perform backup files for drive and motor parameters.  *Load default parameters*: factory settings will reload into drive memory 
 *Ch. 6.07*	*Motor autophasing*: a window is opened to perform motor autophasing, that lets to verify poles and HALL sensors allignment. Please ensure to set correct encoder pulse number before proceding. Rotor must be free to rotate. 
	*Local control via Caliper:* this key lets to enable, into Caliper software, all **emulated signals and parameters** related to each mode operation. If Local control is pressed, **all real fieldbus and I/O signals** are NOT considered. Howerver, some input signals, as limit switch, are considered for machine debug operation. Enter password, called "1035", into Commands Menu to enable *Local control via Caliper*.
	 'SWITCH-ON'  'OPERATION ENABLED'  'CW' (clock wise)  'CCW' (counter clock wise)  'IN 4' Input  'RESET'  'HALT'  'Ramp reference enable'
	 'Ramp unlock'  'Ramp enable'  'Start Home Position'  'Absolut/Relative' reference  'Start Quota'  'Change' (change set)  'Reset Encoder' e 'Reset Position'  'Axis enable'  'JOG back and forth'
 *Ch. 6.14*	*Scope:* a window is opened to show Scope that allows some drive variables monitoring.  *Open a Scope file* saved into a PC directory.
	*System state:* a window is opened to show any active or occured alarms with ID code e type information about alarms and warnings.

Icon	Description
	*Drive setting:* a window is opened to show all drive setting parameters and lets to create a calibration setup without RS232 active connection yet.  *Save all drive calibration setup* for motor + drive into a PC directory. This procedure will save all drive and motor data into default folders created from Caliper software at first program launch. Saving folder directory can be changed.  *Open a drive calibration setup* saved into a PC directory.
	*Motor setting:* a window is opened to show all motor setting parameters and lets to create a calibration setup without RS232 active connection yet.  *Save all motor calibration setup* and PID current regulator into a PC directory.  *Open a drive calibration setup* saved into a PC directory.

6.02 Caliper Data Monitor

Data Monitor shows drive main parameters listed below:

1. Drive size, operation mode and set control topology
2. Current provided to motor (A) and Drive heat sink temperature (°C)
3. Speed (with fixed unit):
   - *RPM*: rotary motor.
   - *mm/s*: linear or tubular motor.
4. Position (with fixed unit):
   - *N. of revolution / counts per turn* (16bit) *and total counts* (32bit with 1bit for sign management): rotary motor.
   - *mm*: linear or tubular motor.
5. Digital I/O state
   - Digital input are programmable and enabled depending on choosen operation mode and choosen control topology.
   - Analog input (12bit) with sign management whose values are displayed and realtime updated.
   - Digital output are programmable and always enabled.
   - Graphic LED for digital input activation.



NOTES:

- Graphics allows to see I/O function selected and if they are enabled; for digital input, the external LED ring is activated if hardware input is on High level and internal circle is activated when input function is enabled.
- Visualized speed and position parameters units can not be changed and depend on motor type (rotary and linear or tubular). Drive position, speed and acceleration reference units can be changed, instead. For further information, please see *"6.05 Factors" pag. 73*.
- For further information about digital I/O, please see *"6.08 Digital I/O" pag. 83*.

6.03 Caliper Menu

In order to modify drive parameters, please ensure to:

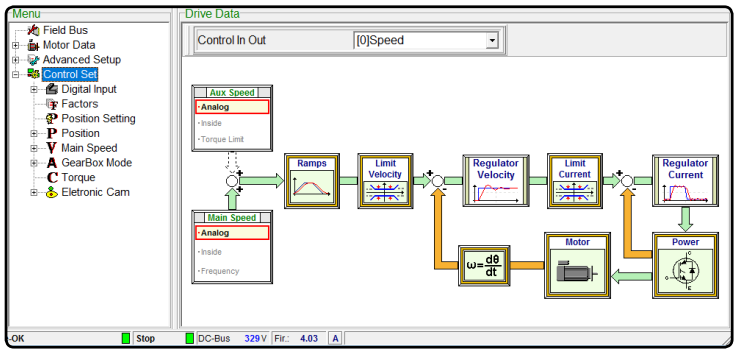
- enable USB connection with desired drive: if connection is missing, parameters can be set clicking *Drive setting* key; then save configuration into PC directory in order to load it into drive memory during active USB connection.
- enable *Local control via Caliper* icon key (after entering "1035" password) and ensure to set drive state in SWITCH-OFF (disable related icon key).

Whenever a *Menu* item is selected, all relevant parameters appear into *Drive Data* window: to confirm any modified parameters (and to automatically send to drive), press ENTER key, or you can enable Autosave function in Commands menu to send any modified parameters to drive; last modified parameters highlighted in blue track.

Menu items are listed below:

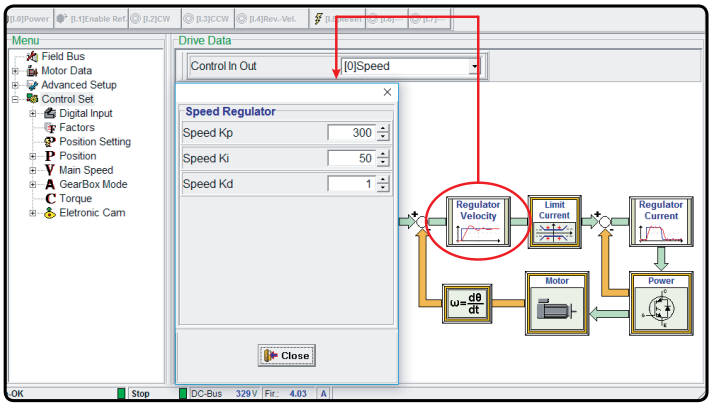
1. **FIELD BUS**: operation mode selection.
2. **MOTOR DATA**: motor and feedback parameters settings.
3. **ADVANCED SETUP**: regulator, filter, limiters settings and alarms managing.
4. The fourth Menu item depends on the desired operation mode and can be set in:
   - **Control Set**: I/O operatio.
   - **Modbus**: Modbus RTU operation.
   - **CanOpen CiA301** e **CanOpen CiA402**: Canopen® operation.
   - **Ethercat:** Canopen® CiA301 and CiA402 over Ethercat operation.
   - **Profinet** and **Profidrive:** Profinet RT Profidrive operation.
   - **Profidrive:** Profibus Profidrive DPv0 operation.

For example, *Control Set* item into Menu, with its contents in *Drive Data* and during I/O operation, is shown below:



NOTES:

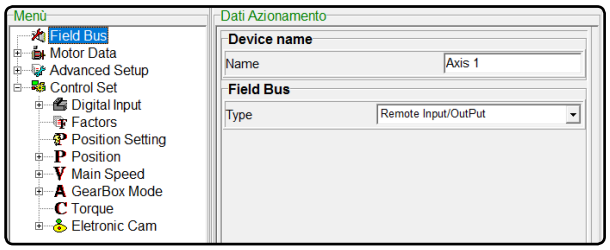
- *Control Set* item allows an overview of choosen control type into a block diagram (see previous image). Each time a block is enabled (ramps, filter and limiters), these blocks appear inside block diagram in appropriate location.
- Into *Drive Data* window, a single block diagram can be selected and can be opened into a new window where main block parameters can be set, without looking for it into *Advanced Setup* (see image below):



6.03.1 Menu: 'FIELD BUS' item

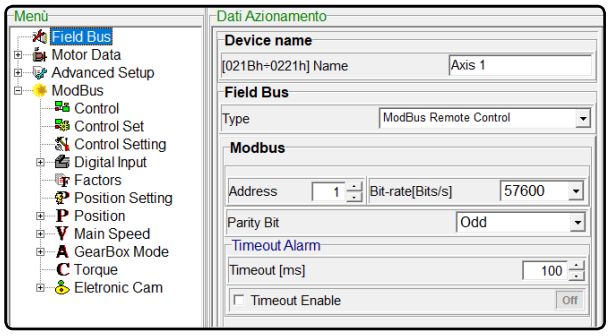
'Field Bus' item allows to:

- set drive name, usefull for identification between a multiple axis connection via USB HUB.
- select the desired operation mode.



Operation mode: I/O (Input/Output)

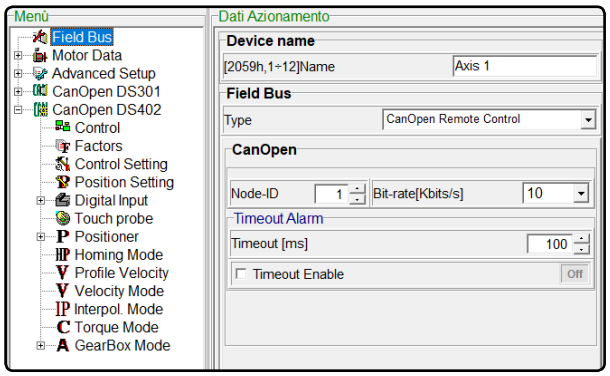
During this operation mode, *Control Set* item is enable into Menu and lets to configure analog/digital input and desired control topology.



Operation mode: Modbus RTU

This screen allows to set fieldbus Address (up to 247) and comunication Baudrate (up to 57.6KBit).

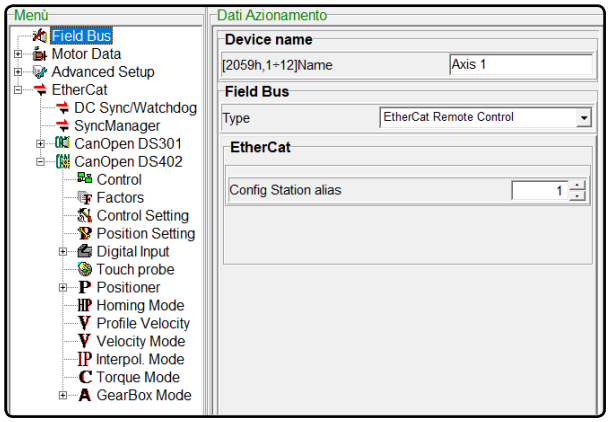
A Time-out comunication alarm can be configure to report failure comunication after a time of inactivity.



Operation mode: Canopen® CiA301 and CiA402

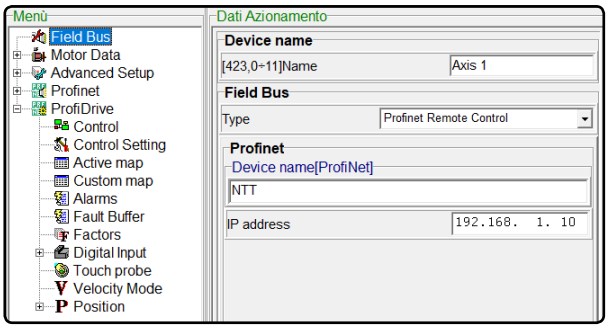
This screen allows to set fieldbus Node (up to 127) and comunication Baudrate (up to 1Mbit).

A Time-out comunication alarm can be configure to report failure comunication after a time of inactivity.



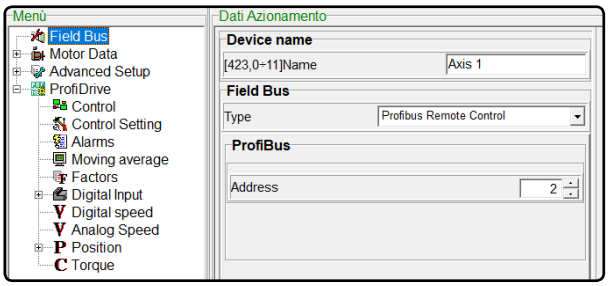
Operation mode: Ethercat CoE CiA301 and CiA402

This screen allows to set "Station Alias" addressing type (up to 65536)



Modalità di funzionamento: Profinet RT Profidrive

This screen allows to set Device Name and IP Address for Profinet comunication.



Modalità di funzionamento: Profibus DPv0

This screen allows to set Node ID for Profibus Profidrive DPv0 comunication.

Operation mode is settable only if drive is in SWITCH-OFF state:

- during Fieldbus operation, to ensure witch drive and motor parameters are settable, related to drive state, please see related fieldbus user guide, downloadable from enterprise web site:

  www.hdtlovato.com

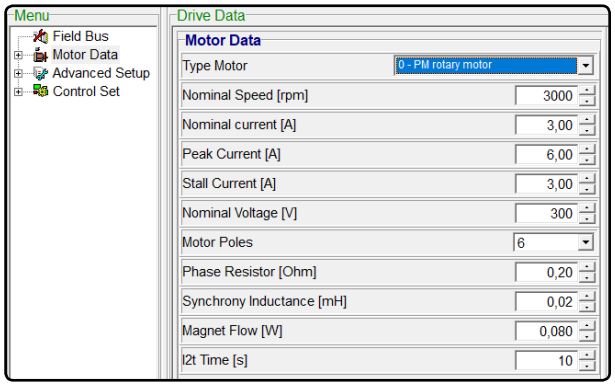
- during I/O operation, parameters can be modified only via software Caliper; if parameter is not changeable, it will appear grey coloured and it will be not selectable.

6.03.2 Menu: 'MOTOR DATA' item and 'FEEDBACK' sub-menu

'Motor Data' item allows to enter parameters and permanent magnets motor type connected to drive:

1. ***"PM rotary motor"***: brushless permanent magnet rotative motor.
2. ***"PM linear motor"***: brushless permanent magnet linear motor.
3. ***"Rotary, brushed DC motor"***: brushed permanent magnet DC motor.
4. ***"Induction V/Hz"***: asynchronous motor (induction) with V/Hz control.

6.03.2.a *Brushless permanent magnet rotative motor*

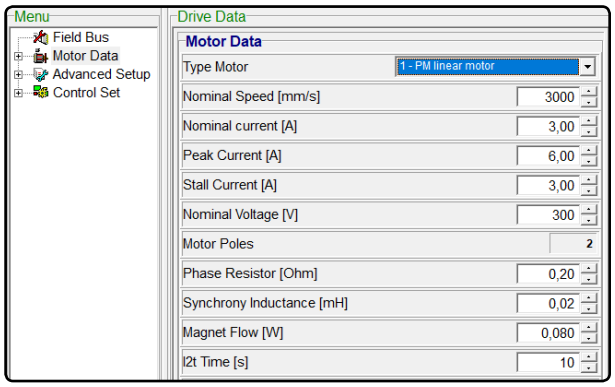


It's necessary to set correctly:

- *Nominal Speed*
- *Nominal Current*
- *Peak Current*
- *Motor Poles*: (up to 50poles).
- *I2T Time*: motor I2T, default set to 10s.

All feedback supported are suitable for this motor type.
Other choke parameters usefull for sensorless control.

6.03.2.b *Brushless permanent magnet linear motor*

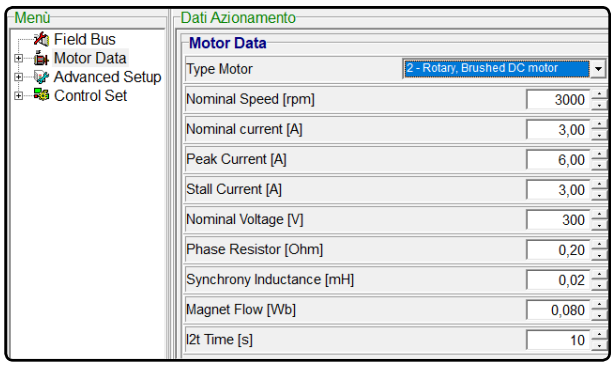


It's necessary to set correctly:

- *Nominal Speed*
- *Nominal Current*
- *Peak Current*
- *Pole Pitch* in mm.
- *I2T Time*: motor I2T, default set to 10s.

All feedback supported are suitable for this motor type.
Other choke parameters usefull for sensorless control.

6.03.2.c *Brushed permanent magnet DC motor*

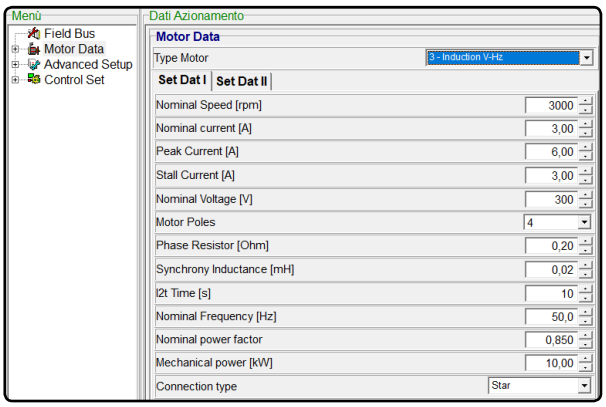


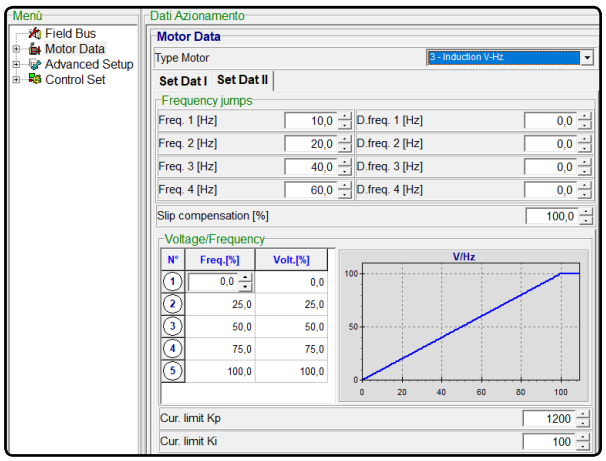
It's necessary to set correctly:

- *Nominal Speed*
- *Nominal Current*
- *Peak Current*
- *I2T Time*: motor I2T, default set to 10s.

All feedback supported are suitable for this motor type with exception for sensorless control.

6.03.2.d *Asynchronous motor with V/Hz control*





V/Hz control does not need any kind of feedback.

First parameter set allows to enter motor data parameters usefull for a correct functionality; second parameter set allows to ender parameters for frequency jumps (if necessary) and V/Hz function curve.

NOTES:

- *Nominal Speed* parameter units depends on choosen motor type (rotary and linear or tubular). For further informations, please see *"6.05 Factors" pag. 73*.
- I2T motor protection is settable and identifies a motor overload time limit: default set to 10s (setable from 1s a 3000s). If stress is too high, drive will provide an appropriate alarm/warning (FA 16) and will limit motor current equal to 'Nominal Current' parameter. The choice of this parameter is normally related to motor physical size.

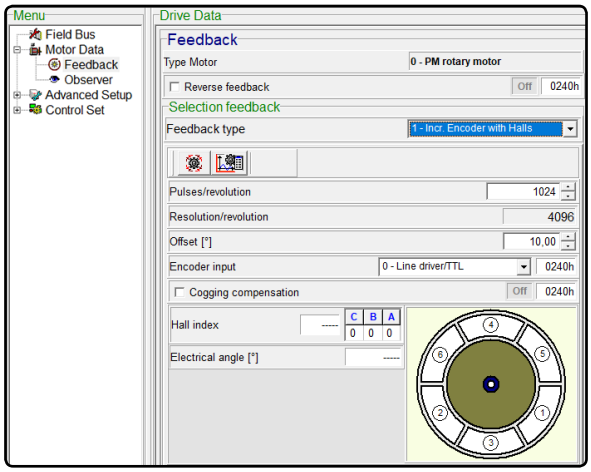
'Feedback' sub-menu item allows to choose correct feedback and to enable motor cogging compensation:

1. ***"Incr. Encoder without HALL"***
2. ***"Incr. Encoder with HALL"***
3. ***"HALL only"***
4. ***"Encoder SSI"*** (absolute encoder)
5. ***"Sensorless"***
6. ***"Resolver"*** (with FEEDBACK R option only)

Ensure to select correct feedback type before connecting to motor.

All H.D.T. drives, in standard condition, that is no feedback reversing and default factors values (please see *"6.05 Factors" pag. 73*), consider that increasing feedback counter is related to a clockwise rotation of the motor, viewed by front shaft side.

6.03.2.e *Incremental encoder with/without HALL sensors*



It's necessary to set correctly:

- *Pulse/Revolution*: encoder pulse number per round.
- *Offset*: offset encoder (only for HALL management)
- *Encoder input*: set input type between Line Driver and Open Collector/Push-Pull topology.

Other parameters are:

- *Reverse Feedback*: encoder counter is reversed related to motor rotation.
- *Cogging compensation*: motor cogging mapping.

If incremental encoder without HALL sensors is used, after SWITCH-ON command, drive will perform a rotation angle, more or less evidence, related to real shaft position. I's possible to perform this procedure at first start, at every start or at every reset command, as set into drop-down menu.

If incremental encoder with HALL sensors is used, it's mandatory to correctly set offset-encoder parameter, set to 0° for all H.D.T. motors; otherwise perform the autophasing procedure if third part motor is used (*"6.07 Motor autophasing" pag. 82*).

Motor cogging map is available only if encoder provides zero index.

Connection is located into J5 connector (please see *"5.08 J5 connector: Feedback 1" pag. 36*):

1. supply +V power to the feedback of used motor: +V (pin 10) and 0L (pin 11) and sensing pin if available (pin 9-18), otherwise leave them not connected for feedback at +5V or short-circuit them for feedback up to +9V.
2. connect the incremental signals: A+ (pin 1), A- (pin 2), B+ (pin 3), B- (pin 4).
3. if available, connect three HALL signals: HA (pin 13), HB (pin 14) e HC (pin 15).
4. if available, connect encoder zero index: Z+ (pin 5) and Z- (pin 6).
5. if available, connect motor temperature sensor PTC (pin 7-8).

6.03.2.f *HALL sensors only*

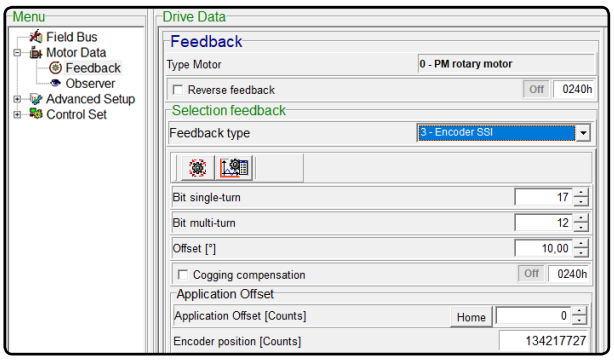
For a trapezoidal control (DC brushless motors), only HALL sensors feedback is used. It's necessary to enter offset parameter. Autophasing procedure is not available.

Motor cogging map is not available.

Connection is located into J5 connector (please see *"5.08 J5 connector: Feedback 1" pag. 36*):

1. supply +V power to the feedback of used motor: +V (pin 10) and 0L (pin 11) and sensing pin if available (pin 9-18), otherwise leave them not connected for feedback at +5V or short-circuit them for feedback up to +9V.
2. if available, connect three HALL signals: HA (pin 13), HB (pin 14) e HC (pin 15).
3. if available, connect motor temperature sensor PTC (pin 7-8).

6.03.2.g *SSI absolute encoder*



It's necessary to set correctly:

- *Bit single-Turn*
- *Bit multi-Turn* (if present).
- *Offset*: offset encoder.

Other parameters are:

- *Reverse Feedback*: encoder counter is reversed related to motor rotation.
- *Cogging compensation*: motor cogging mapping.

If SSI absolute encoder is used, it's mandatory to correctly set offset-encoder parameter, set to 0° for all H.D.T. motors; otherwise, perform the autophasing procedure if third part motor is used (*"6.07 Motor autophasing" pag. 82*).

For single-turn absolute encoders, set *Bit multi-Turn* to 0.

It's possible to set the "application offset" parameter related to encoder absolute 0 position: keep motor on desired position and press 'Home' key into sub-menu *Feedback* inside *Drive Data*, to store the offset (this parameter is mapped in every operation mode supported).

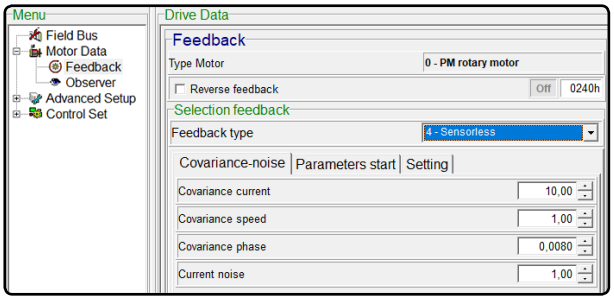
Besides, it's possible to connect encoders having single-turn and multi-turn resolutions higher than 16bit and 15bit respectively; if single-turn and multi-turn bit sum is higher than 31bit, drive provides an error. If single-turn bit are higher than 16bit, drive performs an automatic truncation of excess bits; by the way drive operates correctly, affecting offered resolution, limiting it to 16bit. Istantaneous real value for encoder absolute position is always visible.

Motor cogging map is available.

Connection is located into J5 connector (please see *"5.08 J5 connector: Feedback 1" pag. 36*):

1. supply +V power to the feedback of used motor: +V (pin 10) and 0L (pin 11) and sensing pin if available (pin 9-18), otherwise leave them not connected for feedback at +5V or short-circuit them for feedback up to +9V.
2. connect signals: CK+ (pin 5), CK - (pin 6), D - (pin 12) e D+ (pin 13).
3. if available, it's possible to connect the incremental signals: A+ (pin 1), A- (pin 2), B+ (pin 3), B- (pin 4).
4. if available, connect motor temperature sensor PTC (pin 7-8).

6.03.2.h *Sensorless*



It's necessary to perform a correct sensorless tuning to obtain desired performances for applications.

Other parameters are:

- *Reverse Feedback*: encoder counter is reversed related to motor rotation.

If brushless encoder is used, drive performs a start procedure with V/hz sensorless control to engage rotor position; then predictive FOC control is used.

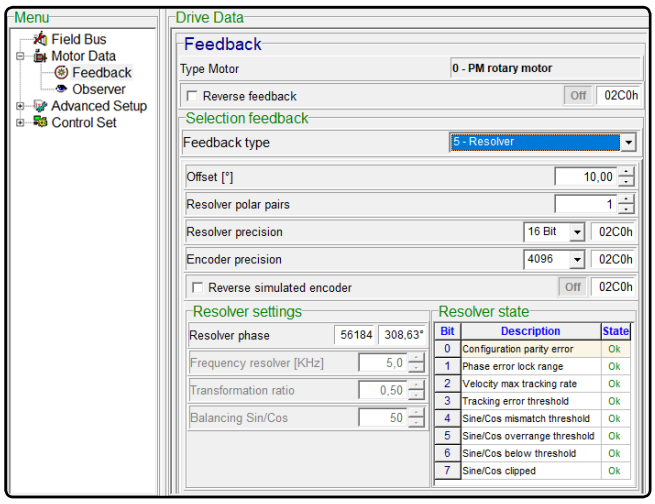
If asynchronous motor is used start procedureis not managed.

All sub-window include sensorless parameters usefull for motor regulation and application desired performances:

- current, speed and phase covariance.
- current noise.
- start procedure set.
- zero crossing speed and rotor lock current parameters.

For further information about sensorless loop tuning, please see *"6.17 Sensorless loop tuning" pag. 111.*

6.03.2.i *Resolver*



E' necessario inserire correttamente:

- *Resolver pole pairs*
- *Offset*

Other parameters are:

- *Reverse Feedback*: feedback counter is reversed related to motor rotation.
- *Resolver precision*: motor feedback ADC conversion precision.
- *Encoder precision*: emulated encoder output precision.
- *Reverse simulater encoder*: emulated encoder counter direction is reversed related to motor feedback counter.
- *Cogging compensation*: motor cogging mapping.

If resolver is used, it's mandatory to correctly set resolver pole pairs. Then it's mandatory to set correctly feedback offset, set to 0° for all H.D.T. motors; otherwise, if third-party motor is used instead, please perform the autophasing procedure *"6.07 Motor autophasing" pag. 82*.

Feedback resolution parameter allows to tune resolver precision between 10 and 16bit. Default value is set to 14bit and it allows to cover most applications with excellent behaviour; for application speed up to 5000RPM, it's possible to set 16bit resolution to increase positioning performance, but accepting a speed loop bandwidth decreasing (at least 4 times lower than 14bit).

Encoder resolution parameter sets number of pulse per mechanical round (PPR), performed by emulated encoder output with zero index. It's possible to set only values equal to Feedback resolution or lower.

Besides, monitoring for resolver funcionality is visible.

Some visualized parameters are reserved.

Motor cogging map is available.

Connection is located into J5 connector (please see *"5.08 J5 connector: Feedback 1" pag. 36*):

1. supply excitation to resolver primary winding: EXC+ (pin 1) and EXC- (pin 2).
2. connect the sin/cos signals: COS- (pin 3), COS+ (pin 4), SEN- (pin 5), SEN+ (pin 10).
3. if available, connect motor temperature sensor PTC (pin 8-9).

NOTES:

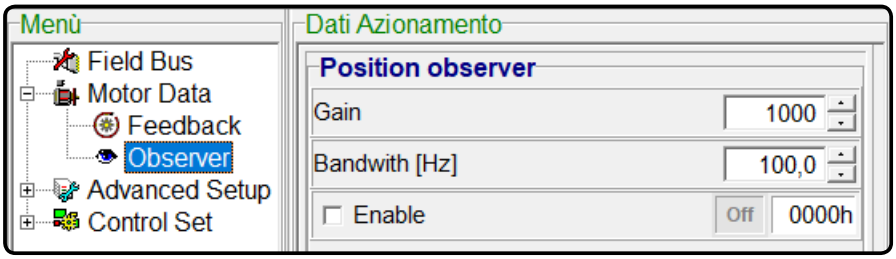
- If motor has not temperature PTC sensor, please short-circuit connector pins to bypass alarm provided by drive.
- If Hall sensors are managed, real shaft electric position related to HALL position sectors is displayed.
- Hall sensor only does not provide good performance at low speeds. It has a good function starting from 10% of maximum speed, therefore, in the case of a 3000RPM motor, good performance are obtained at more than 300RPM.
- It's possible to provide incremental channels to external controller via J7 connector in order to close position loop externally.
- For further information about motor cogging compensation, please see *"6.13 Motor cogging torque compensation" pag. 93*.

'Observer' sub-menu item allows to enable and set gain and bandwidth for observer system applied to position feedback from motor: with this tool, it's possible to increase round resolution up to 16bit. Observer system is available for all supported feedback (with exception for sensorless control).

It's useful to reduce motor noise keeping unchanged application bandwidth.

It's disabled for default condition, but it's recommended when:

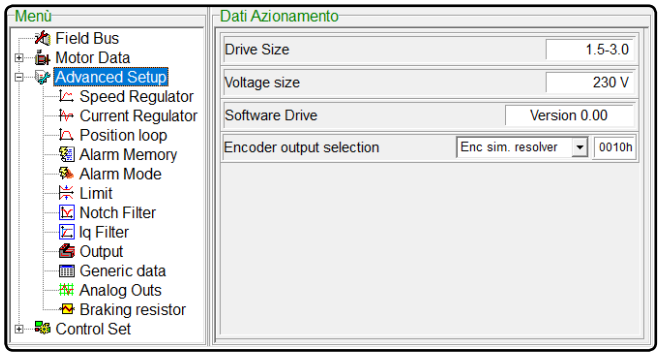
- encoder feedbacks, that provide resolution lower than 1000ppr or lower than 12bit, is used.
- HALL sensor feedbacks is used.



Observer function could lead to system instability, so please follow tuning instruction at *"6.16 Closed loop regulation tuning" pag. 107*.

6.03.3 Menu: 'ADVANCED SETUP' item

'Advanced Setup' item allows to set regulators, filters, limiters, alarms managements, brake managements and digital outputs and it is independent of the operation mode selection.



This item shows firmware release and drive label data.

It's possible to set the desired encoder output from drop-down menu choosing between incremental encoder, frequency input or simulated encoder output.

This item allows to set:

- ***control loop gains.***
- ***alarms with relevant reset manegment.***
- ***filters and limiters.***
- ***digital outputs function.***

To set each of items in the sub-menu, just select it and modifing window will appear in *Drive Data*.

Advanced Setup sub-menu items are listed below:

1. *Speed Regulator:* PID speed regulator (set from 1 to 3000). Increasing value, coefficients K_p, K_i increase their effect.
2. *Current Regulator:* PID current regulator (set from 1 to 2000). Increasing value, coefficients K_p, K_i increase their effect.
3. *Position loop:* position regulator. Increasing value, coefficients K_p increases its effect. Parameter for choosing feedback to close position loop (motor feedback or external encoder). Parameters for axis ratio between motor and encoder and encoder pulse number.
4. *Alarm Memory:* occured alarm history up to 16 maximum stored locations, with description; alarm list can be erased.
5. *Alarm Mode:* some alarm managment including Overvoltage, Undervoltage, Voltage/phase lack and drive I2T; they can be set as shown below:
   - *Autoreset* or *Stored* for voltage faults.
   - *Rated current limit* or *Cyclic auto reset* for drive I2T warning; also it's possible to define the I2T alarm after parameter time elapsed.
6. *Limit:* limiter for upper speed and current in percentage of motor rated current.
7. *Notch Filter:* notch filter enable and engage at desired frequency and attenuation.
8. *Iq Filter:* 1^{ST} order time constant filter for quadrature current reference (set from 0.01ms to 30ms). Please be carefull using this filter that could lead to instability conditions.
9. *Output:* digital output managment. For any information about output functions, please see *"6.08.1 Digital I/O functions" pag. 85.*
10. *Generic data:* flash memory (non volatile) location addresses available for customer and reachable only via fieldbus comunication.
11. *Analog Out:* analog output management; they can monitor measured speed/current or speed/current reference.
12. *Braking Resistor:* parameters related to internal/external braking resistor.

NOTES:

- Drive position, speed and acceleration reference units depends on motor type (rotary and linear or tubular). For further information, please see *"6.05 Factors" pag. 73*.

6.03.4 Menu: 'Control Set' 'Modbus' 'CanOpen' 'Ethercat' 'Profinet' items

As already described above, the 4th Menu item depends of operation mode selection. Drive parameters for the type of selected control are settable, including:

1. Desired control topology via drop-down menu inside Drive Data window.
2. FACTORS setting: drive position, speed and acceleration reference units depends on motor type (rotary and linear or tubular). For further information, please see *"6.05 Factors" pag. 73*.
3. analog and digital I/O setting: digital output are manageble also via fieldbus parameter.
4. all parameters related to desired control topology.

NOTES:

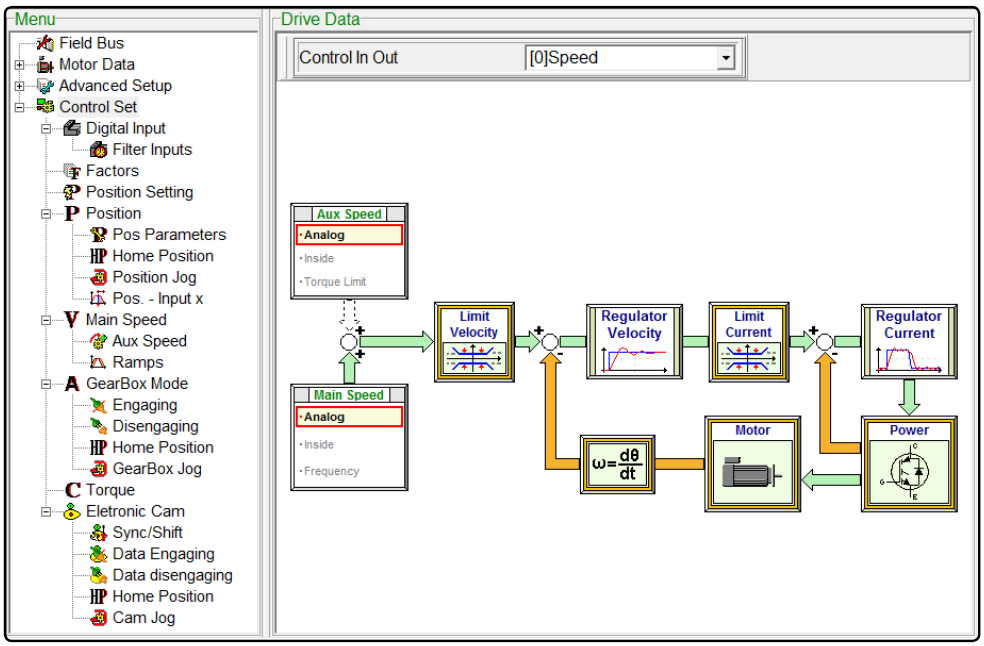
- To set all parameters via Caliper, *'Local Controll via Caliper'* key must be enabled. Comunication with Master controller is cut off.
- For further information about fieldbus protocols, please see related fieldbus user guide, downloadable from enterprise web site:

www.hdtlovato.com

6.03.4.a Input/Output operation mode: 'Control Set' items

- *speed control (and speed with torque limit).*
- *torque control.*
- *electronic gearbox control (CHA/B, CW/CCW, Pulse/Direction).*
- *position control (single target positioner, analog positioner, cyclic table selection positioner or via digital input up to 64 target).*
- *electronic cam control.*
- *Pressure control.*

For example, speed control with analog +/-10V input is shown below:



Control Set sub-menu items are listed below:

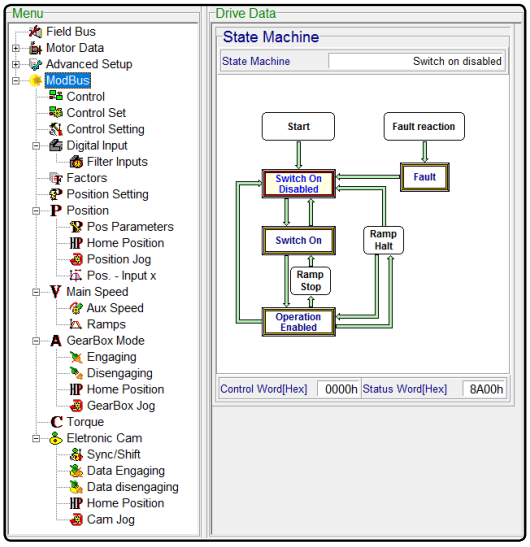
1. *Control setting*: Stop mode management during Fault Reaction and HALT conditions. For further information, please see *"6.04 Emergency stop functions" pag. 71*. Stop mode available are shown below (selectable from dropdown menu):
   - Disable power: motor inertia stop.
   - Ramp controlled stop and then disable power.
   - Ramp controlled stop keeping motor in standstill condition at power on.
   - Limit torque stop, setting desired torque limit.

2. *Digital Input:* drive digital input setting in I/O operation mode. For any other information about digital input functions, please see *"6.08.1 Digital I/O functions" pag. 85.*
   - *Filter Input*: input 1ST order filter parameters, in ms unit.
3. *Factors:* multiplier factors associated with input reference in order to modify scale resolution. Please see *"6.05 Factors" pag. 73*.
4. *Position Setting:* maximum admitted position error and maximum admitted recovery time setting; beyond these values drive provides an error/alarm condition.
5. *Position*: setting for all parameters related to desired position control between single target positioner, analog positioner, cyclic/acyclic table selection or via digital input or via input start up to 64 target. For further information, please see *"6.09 Drive references" pag. 87* and *"6.15.5 Position control: positioner mode" pag. 104*.
   - *Pos Parameter:* profile setting and position procedure setting, software positive and negative limits and Homing offset.
   - *Position Jog:* JOG setting.
   - *Home Position:* HOMING procedures and parameters. For further information, please see Modbus user guide.
   - *Pos. - Input X:* index stop, at relative position, when event happens on INPUT X of drive I/O connector.
6. *Main Speed:* speed control and main speed reference setting between analog, inside, frequency or Tab-selection. For further information please see *"6.09 Drive references" pag. 87* and *"6.15.2 Sensored speed control" pag. 101* or *"6.15.3 Sensorless speed control" pag. 102*.
   - *Aux Speed*: auxiliary speed reference setting between analog, inside or torque limit.
   - *Ramps*: acceleration and deceleration ramp managment; linear ramp or S ramp (JERK parameter).
7. *GearBox:* gearbox axis rate management and engage and disengage settings; input type can be selected between *CHA/B*, *CW/CCW, Pulse/Direction* input reference. For further information please see *"6.09 Drive references" pag. 87* and *"6.15.4 Position control: electronic gearbox mode" pag. 103*.
   - *Engaging:* engaging phase parameter set
   - *Disengaging:* disengaging phase parameter set
   - *Home position:* HOMING procedures and parameters. For further information, please see Modbus user guide.
   - *Gearbox JOG:* JOG setting.
8. *Torque:* torque control setting and input reference setting between analog and inside. For further information please see *"6.09 Drive references" pag. 87* and *"6.15.1 Torque control" pag. 100*.
9. *Electronic Cam:* Cam table and all parameter setting. For further information, please see *"6.09 Drive references" pag. 87* and *"6.15.6 Position control: electronic cam mode" pag. 105*.
   - *Sync/Shift:* isync parameter set and master/slave position shift setting.
   - *Data Engaging:* engaging phase parameter set
   - *Data Disengaging:* disengaging phase parameter set
   - *Home position:* HOMING procedures and parameters. For further information, please see Modbus user guide.
   - *Cam JOG:* JOG setting.
10. *Press:* pressure reference accuracy setting and fullscale setting for speed and pressure reference and for pressure transducer. For further information please see *"6.09 Drive references" pag. 87* and *"6.15.7 Pressure control" pag. 106*.
    - *Setting:* safety pressure threshold setting, beyond which the drive introduces set speed limit. Speed variation is managed with ramp.
    - *Limit:* current and negative speed limit setting.
    - *Alarm mode:* overpressure and underpressure threshold setting and enabling.
    - *Pressure Reg.:* pressure ring regulators setting.
    - *Ramps:* pressure and speed ramps setting and enabling.
    - *Output:* analog output fullscale setting and output setting for pressure reached condition related to pressure and time window parameter.

6.03.4.b Modbus RTU operation mode: 'Modbus' items

Control type and state machine in picture:

- *speed control (and speed with torque limit).*
- *torque control.*
- *electronic gearbox control (CHA/B, CW/CCW, Pulse/Direction).*
- *position control (single target positioner, analog positioner, cyclic table selection positioner or via digital input up to 64 target).*
- *electronic cam control.*
- *pressure control.*



During fieldbus operation mode, Caliper software shows all Modbus RTU parameter addresses, nearby the parameter.

Same Modbus RTU protocol implemented inside NTT 240/460 drive is è compatible with all other H.D.T. drive families that support it.

Modbus sub-menu items are listed below:

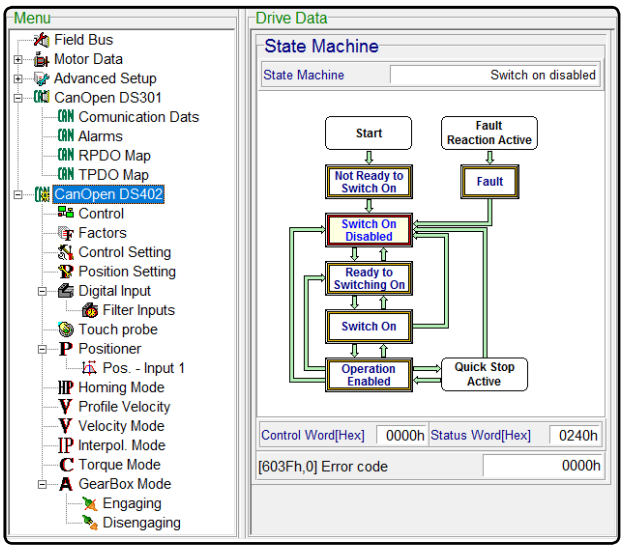
1. *Control:* Modbus RTU Control Word and Status Word informations.
2. *Control Set:* control type selection.
3. *Control setting*: Stop mode management during Fault Reaction, HALT conditions, comunication timeout and speed reached with window parameters. For further information, please see *"6.04 Emergency stop functions" pag. 71*.Stop mode available are shown below (selectable from dropdown menu):
   - Disable power: motor inertia stop.
   - Ramp controlled stop and then disable power.
   - Ramp controlled stop keeping motor in standstill condition at power on.
   - Limit torque stop, setting desired torque limit.
4. *Digital Input:* drive digital input setting in Modbus RTU operation mode. For any other information about digital input functions, please see *"6.08.1 Digital I/O functions" pag. 85.*
   - *Filter Input*: input 1ST order filter parameters, in ms unit.
5. *Factors:* multiplier factors associated with input reference in order to modify scale resolution. Please see *"6.05 Factors" pag. 73*.
6. *Position Setting:* maximum admitted position error and maximum admitted recovery time setting; beyond these values drive provides an error/alarm condition.
7. *Position*: setting for all parameters related to desired position control between single target positioner, analog positioner, cyclic/acyclic table selection or via digital input or via input start up to 64 target. For further information, please see *"6.09 Drive references" pag. 87* and *"6.15.5 Position control: positioner mode" pag. 104*.
   - *Pos Parameter:* profile setting and position procedure setting, software positive and negative limits and Homing offset.
   - *Position Jog:* JOG setting.
   - *Home Position:* HOMING procedures and parameters.
   - *Pos. - Input X:* index stop, at relative position, when event happens on INPUT X of drive I/O connector.
8. *Main Speed:* speed control and main speed reference setting between analog, inside, frequency or Tab-selection. For further information please see *"6.09 Drive references" pag. 87*, and *"6.15.2 Sensored speed control" pag. 101* or *"6.15.3 Sensorless speed control" pag. 102*.
   - *Aux Speed*: auxiliary speed reference setting between analog, inside or torque limit.
   - *Ramps*: acceleration and deceleration ramp managment; linear ramp or S ramp (JERK parameter).

9. *GearBox:* gearbox axis rate management and engage and disengage settings; input type can be selected between *CHA/B*, *CW/CCW, Pulse/Direction* input reference. For turther information please see *"6.09 Drive references" pag. 87* and *"6.15.4 Position control: electronic gearbox mode" pag. 103*.
    - *Engaging:* engaging phase parameter set.
    - *Disengaging:* disengaging phase parameter set.
    - *Home position:* HOMING procedures and parameters.
    - *Gearbox JOG:* JOG setting.
10. *Torque:* torque control setting and input reference setting between analog and inside. For further information please see *"6.09 Drive references" pag. 87* and *"6.15.1 Torque control" pag. 100*.
11. *Electronic Cam:* Cam table and all parameter setting. For further information, please see *"6.09 Drive references" pag. 87* and *"6.15.6 Position control: electronic cam mode" pag. 105*.
    - *Sync/Shift:* isync parameter set and master/slave position shift setting.
    - *Data Engaging:* engaging phase parameter set
    - *Data Disengaging:* disengaging phase parameter set
    - *Home position:* HOMING procedures and parameters. For further information, please see Modbus user guide.
    - *Cam JOG:* JOG setting.
12. *Press:* pressure reference accuracy setting and fullscale setting for speed and pressure reference and for pressure transducer. For further information please see *"6.09 Drive references" pag. 87* and *"6.15.7 Pressure control" pag. 106*.
    - *Setting:* safety pressure threshold setting, beyond which the drive introduces set speed limit. Speed variation is managed with ramp.
    - *Limit:* current and negative speed limit setting.
    - *Alarm mode:* overpressure and underpressure threshold setting and enabling.
    - *Pressure Reg.:* pressure ring regulators setting.
    - *Ramps:* pressure and speed ramps setting and enabling.
    - *Output:* analog output fullscale setting and output setting for pressure reached condition related to pressure and time window parameter.

6.03.4.c Canopen® operation mode: Canopen CiA301 and Canopen CiA402 item

Control type and state machine in picture:

- *Position Mode*
- *Velocity Mode*
- *Profile Velocity Mode*
- *Profile Torque Mode*
- *Homing Mode*
- *Interpolated Position Mode*
- *Cyclic Sync Position Mode*
- *Cyclic Sync Velocity Mode*
- *Cyclic Sync Torque Mode*
- *Touch Probe*
- *Electronic Gear*
- *Pressure control*



During fieldbus operation mode, Caliper software shows all Canopen parameter addresses, nearby the parameter. Same Canopen protocol implemented inside NTT 240/460 drive is è compatible with all other H.D.T. drive families that support it.

Canopen CiA301 sub-menu items are listed below:

1. *Comunication Data:* guard time setting and parameters saving in EEPROM (according to Canopen® standards).
2. *Alarms:* alarms setting and erasing.
3. *RPDO MAP:* RPDO map visualization.
4. *TPDO MAP:* TPDO map visualization.

Canopen CiA402 sub-menu items are listed below:

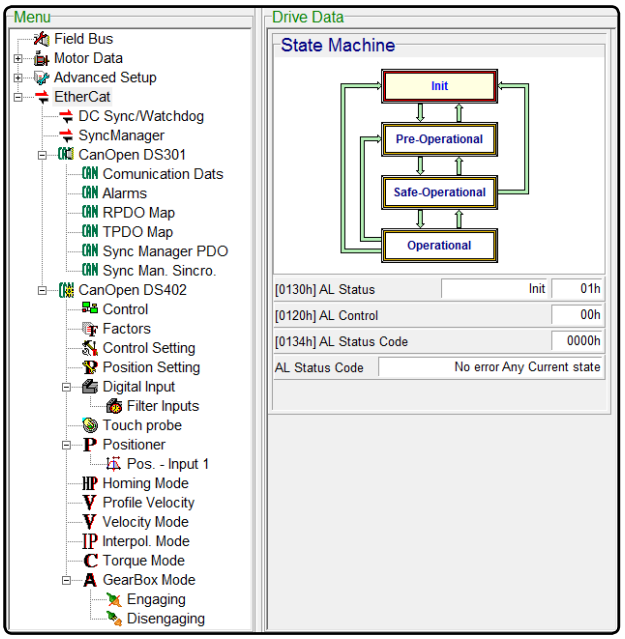
1. *Control:* Canopen® Control Word and Status Word informations.
2. *Factors:* multiplier factors associated with input reference in order to modify scale resolution. Please see *"6.05 Factors" pag. 73*.
3. *Control setting*: Stop mode management during Fault Reaction, HALT conditions and comunication timeout. For further information, please see *"6.04 Emergency stop functions" pag. 71*. Stop mode available are shown below (selectable from dropdown menu):
   - Disable power: motor inertia stop.
   - Ramp controlled stop and then disable power.
   - Ramp controlled stop keeping motor in standstill condition at power on.
   - Limit torque stop, setting desired torque limit.
4. *Position Setting:* maximum admitted position error and maximum admitted recovery time setting; beyond these values drive provides an error/alarm condition.
5. *Digital Input:* drive digital input setting in Modbus RTU operation mode. For any other information about digital input functions, please see *"6.08.1 Digital I/O functions" pag. 85.*
   - *Filter Input*: input 1ST order filter parameters, in ms unit.
6. *Touch Probe:* parameters for Touch Probe input setting. It's possible to see Touch Probe status word inside Drive Data window.
7. *Positioner:* ramp topology and speed/position targets setting; position with its error visualization during operation.
   - *Pos. - Input X:* index stop, at relative position, when event happens on INPUT X of drive I/O connector.
8. *Homing Mode:* HOMING mode setting; zero search speed and switch search speed with acceleration parameter.
9. *Profile Velocity:* point to point speed targets setting; ramps and speed error window with timeout; speed visualization during operation.

10. *Velocity Mode:* speed reference and ramp setting; speed visualization during operation.
11. *Interpol. Mode:* interpolator mode parameter visualization.
12. *Torque Mode:* profile torque and torque reference setting; torque value visualization during operation.
13. *GearBox:* gearbox axis rate management and engage and disengage settings; input type can be selected between *CHA/B, CW/CCW, Pulse/Direction* input reference. For further information please see *"6.09 Drive references" pag. 87*.
    - *Engaging:* engaging phase parameter set.
    - *Disengaging:* disengaging phase parameter set.
14. *Press:* pressure reference accuracy setting and fullscale setting for speed and pressure reference and for pressure transducer. For further information please see *"6.09 Drive references" pag. 87* and *"6.15.7 Pressure control" pag. 106*.
    - *Setting:* safety pressure threshold setting, beyond which the drive introduces set speed limit. Speed variation is managed with ramp.
    - *Limit:* current and negative speed limit setting.
    - *Alarm mode:* overpressure and underpressure threshold setting and enabling.
    - *Pressure Reg.:* pressure ring regulators setting.
    - *Ramps:* pressure and speed ramps setting and enabling.
    - *Output:* analog output fullscale setting and output setting for pressure reached condition related to pressure and time window parameter.

6.03.4.d Ethercat operation mode: Ethercat item

Control type and state machine in picture:

- *Position Mode*
- *Velocity Mode*
- *Profile Velocity Mode*
- *Profile Torque Mode*
- *Homing Mode*
- *Interpolated Position Mode*
- *Cyclic Sync Position Mode*
- *Cyclic Sync Velocity Mode*
- *Cyclic Sync Torque Mode*
- *Touch Probe*
- *Electronic Gear*
- *Pressure control*



During fieldbus operation mode, Caliper software shows all Canopen (index and subindex) parameter addresses, nearby the parameter.

Same Ethercat CoE protocol implemented inside NTT 240/460 drive is è compatible with all other H.D.T. drive families that support it.

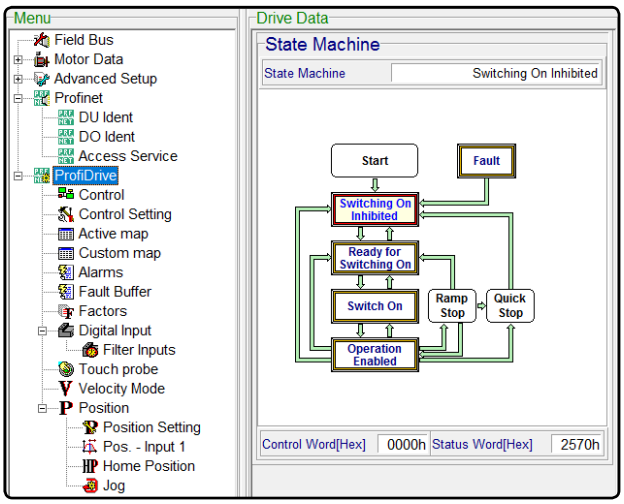
Ethercat sub-menu items are listed below:

1. *DC Sync/Watchdog:* syncronization type set view.
2. Watch dog: process watchdog viewer.
3. *SyncManager:* alarm setting and erasing.
4. *CanOpen CiA301 and CanOpen CiA402: see "6.03.4.c Canopen® operation mode: Canopen CiA301 and Canopen CiA402 item" pag. 66*. Following item added to submenu:
    - *Sync Manager PDO:* PDO map for sync manager operation.
    - *Sync Man Synchro:* all parameter related to syncronization.

6.03.4.e Profinet RT operation mode: Profinet e ProfiDrive items

Control type and state machine in picture:

- *Speed control (AC1)*
- *Position control (AC3, program mode and manual positioner)*
- *Pressure control*



During fieldbus operation mode, Caliper software shows all Profinet (PNU index and sub-index) parameter addresses, nearby the parameter.

Same Profinet RT Profidrive protocol implemented inside NTT 240/460 drive is è compatible with all other H.D.T. drive families that support it.

Profinet sub-menu items are listed below:

1. *DU Ident:* protocol PNU parameter useful to identify Drive Unit.
2. *DO Ident:* protocol PNU parameter useful to identify Data Object.
3. *Access Service:* identification for *Base mode parameter Access* of Profinet protocol.

Profidrive sub-menu items are listed below:

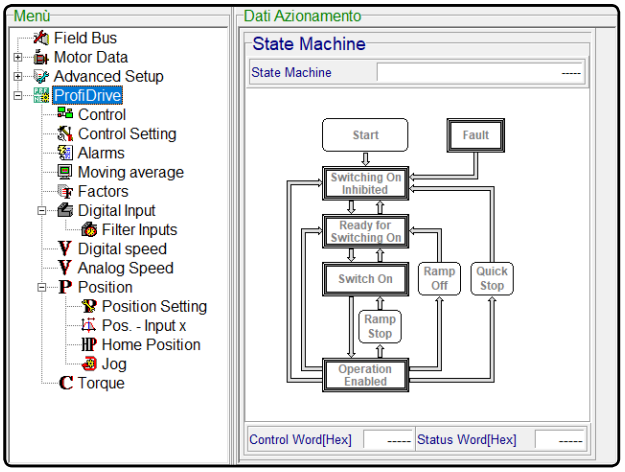
1. *Control:* Profinet Profidrive Control Word and Status Word informations.
2. *Control setting*: Stop mode management during Fault Reaction, HALT conditions and comunication timeout. For further information, please see *"6.04 Emergency stop functions" pag. 71*. Stop mode available are shown below (selectable from dropdown menu):
   - Disable power: motor inertia stop.
   - Ramp controlled stop and then disable power.
   - Limit torque stop, setting desired torque limit.
3. *Active map:* active cyclic telegram structure and its number is displayed.
4. *Custom map:* set-point, misures and other available parameters setting.
5. *Allarms*: buffer memory for drive alarm event.
6. *Fault buffer*: Profidrive buffer memory for drive alarm event.
7. *Factors:* multiplier factors associated with input reference in order to modify scale resolution. Please see *"6.05 Factors" pag. 73*.
8. *Digital Input:* drive digital input setting in Profinet operation mode. For any other information about digital input functions, please see *"6.08.1 Digital I/O functions" pag. 85.*
   - *Filter Input*: input 1ST order filter parameters, in ms unit.
9. *Touch Probe:* parameters for Touch Probe input setting. It's possible to see Touch Probe status word inside Drive Data window.
10. *Velocity Mode:* speed reference and ramp setting; speed visualization during operation.

11. *Position*: setting for all parameters related to desired position control between manual positioner (single target) or program mode via 64 target parameters.
    - *Pos Parameter:* profile setting and position procedure setting, software positive and negative limits and Homing offset.
    - *Position Jog:* JOG setting.
    - *Home Position:* HOMING procedures and parameters.
    - *Pos. - Input X:* index stop, at relative position, when event happens on INPUT X of drive I/O connector.
12. *Press:* pressure reference accuracy setting and fullscale setting for speed and pressure reference and for pressure transducer. For further information please see *"6.09 Drive references" pag. 87* and *"6.15.7 Pressure control" pag. 106*.
    - *Setting:* safety pressure threshold setting, beyond which the drive introduces set speed limit. Speed variation is managed with ramp.
    - *Limit:* current and negative speed limit setting.
    - *Alarm mode:* overpressure and underpressure threshold setting and enabling.
    - *Pressure Reg.:* pressure ring regulators setting.
    - *Ramps:* pressure and speed ramps setting and enabling.
    - *Output:* analog output fullscale setting and output setting for pressure reached condition related to pressure and time window parameter.

6.03.4.f Profibus operation mode: ProfiDrive item

Control type and state machine in picture:

- *Speed control (PNU)*
- *Position control (Single target)*
- *Speed control (Analog reference)*
- *Torque control (PNU)*
- *Torque control (Analog reference)*
- *Pressure control*



During fieldbus operation mode, Caliper software shows all Profibus (PNU) parameter addresses, nearby the parameter.

Same Profibus Profidrive protocol implemented inside NTT 240/460 drive is è compatible with all other H.D.T. drive families that support it.

Profidrive sub-menu items are listed below:

1. *Control:* Profinet Profidrive Control Word and Status Word informations.
2. *Control setting*: Stop mode management during Fault Reaction, HALT conditions and comunication timeout. For further information, please see *"6.04 Emergency stop functions" pag. 71*. Stop mode available are shown below (selectable from dropdown menu):
    - Disable power: motor inertia stop.
    - Ramp controlled stop and then disable power.
3. *Allarms*: buffer memory for drive alarm event.
4. *Moving average:* moving average operation on parameters inside "*Drive data*" window
5. *Factors:* multiplier factors associated with input reference in order to modify scale resolution.Please see *"6.05 Factors" pag. 73*.

6. *Digital Input:* drive digital input setting in Profibus operation mode. For any other information about digital input functions, please see *"6.08.1 Digital I/O functions" pag. 85.*
   - *Filter Input*: input 1ST order filter parameters, in ms unit.
7. *Digital speed:* speed reference (PNU) and ramp setting; speed visualization during operation.
8. *Analog speed:* analog speed reference and ramp setting; speed visualization during operation. For further information, please see *"6.09 Drive references" pag. 87*.
9. *Position*: setting for all parameters related to single target position control:
   - *Pos Parameter:* profile setting and position procedure setting, software positive and negative limits and Homing offset.
   - *Position Jog:* JOG setting.
   - *Home Position:* HOMING procedures and parameters.
   - *Pos. - Input X:* index stop, at relative position, when event happens on INPUT X of drive I/O connector.
10. *Torque:* torque reference (PNU or analog input) in percentage related to "*Nominal Current*" motor parameter; speed visualization during operation. For further information, please see *"6.09 Drive references" pag. 87*.
11. *Press:* pressure reference accuracy setting and fullscale setting for speed and pressure reference and for pressure transducer. For further information please see *"6.09 Drive references" pag. 87* and *"6.15.7 Pressure control" pag. 106*.
    - *Setting:* safety pressure threshold setting, beyond which the drive introduces set speed limit. Speed variation is managed with ramp.
    - *Limit:* current and negative speed limit setting.
    - *Alarm mode:* overpressure and underpressure threshold setting and enabling.
    - *Pressure Reg.:* pressure ring regulators setting.
    - *Ramps:* pressure and speed ramps setting and enabling.
    - *Output:* analog output fullscale setting and output setting for pressure reached condition related to pressure and time window parameter.

6.04 Emergency stop functions

In order to perform correctly the emergency stop functions, it's mandatory that +24V for logic supply is available untill the procedure is completed.

For managing the emergency stop, drive provides some features that can change the operating status. Function are shown below:

1. FAULT REACTION function
2. HALT function
3. SAFE TORQUE OFF safety function

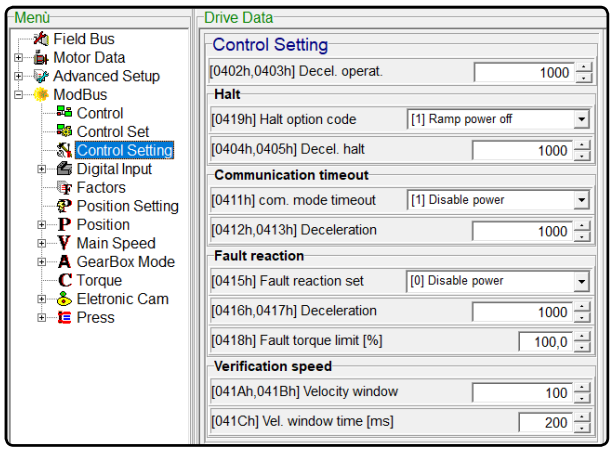
Drive operating status are shown below:

- *SWITCH-OFF status*: drive does not provide current to motor and Drive OK or Fault condition is shown. This status is reachable during operation when emergency stop procedure is active.
- *SWITCH-ON status*: drive provides current to motor in standstill only if Drive OK or warning condition is active. This status is reachable during operation when emergency stop procedure is active.
- *OPERATION ENABLED status*: drive follows speed, torque or position reference, related to desired control topology only if Drive OK or warning condition is active.

Drive operating conditions are shown below:

- *DRIVE OK or FAULT conditions*: drive provides high active output for DRIVE OK condition when no alarms occured. If an alarm occurs, drive goes into FAULT condition and output is low.
- *WARNING condition*: some alarms allow the drive to enter the WARNING condition where motor control is available but only with limit performance or simply showing that an unusual situation is occured. To further information about alarms that cause warning condition, please see *"Ch. 8 Drive status and diagnostics" pag. 120*.

Emergency stop function during Modbus operation mode is shown below:



6.04.1 FAULT REACTION function

With the FAULT REACTION function is possible to set drive management when an alarm occures.

To further information about alarms that allow fault reaction function, please see *"Ch. 8 Drive status and diagnostics" pag. 120*.

Settings for this function are shown below:

- Inertia stop: drive goes immediatly into *SWITCH-OFF* status disabling power to motor.
- Ramp controlled stop, setting related ramp parameter, then drive goes into *SWITCH-OFF* status disabling power to motor.
- Limit torque stop, setting related torque limit parameter then drive goes into *SWITCH-OFF* status disabling power to motor.

6.04.2 HALT function

HALT function is achieveable via digital input or via fieldbus operation mode and it's available only when *DRIVE OK* (o *WARNING*) condition is active.

Settings for this function are shown below:

- Inertia stop: drive goes immediatly into *SWITCH-OFF* status disabling power to motor.
- Ramp controlled stop, setting related ramp parameter, then drive goes into *SWITCH-OFF* status disabling power to motor.
- Ramp controlled stop, setting related ramp parameter, then drive goes into *SWITCH-ON* status providing current to motor in standstill.
- Limit torque stop, setting related torque limit parameter then drive goes into *SWITCH-OFF* status disabling power to motor.

During fieldbus operation mode, in addition to HALT, other emergency stop functions are available managing them via fieldbus that allow to set drive behaviour during particular operating conditions.

These function are shown below:

- QUICK STOP, set via fieldbus control word, with slow and quick ramp, and managing the SWITCH-ON o SWITCH OFF status.
- COMUNICATION TIMOUT for managing the emergency stop when fieldbus comunication timeout occures.

Some settings are not available depending on operation mode.

For further information about fieldbus emergency stop, please see related manuals available at enterprise website:

www.hdtlovato.com

6.04.3 Safe Torque Off safety stop function

Safe Torque Off hardware safety function is realized with IEC EN 61800-5-2 law reference conformal, 0 stop category, and with IEC61508 law reference for SIL3.

The Safe Torque-Off (STO) feature of NTT 240/460 drive is made of a redundant electrical circuit designed to bring a drive to a state of safe torque absence. It is a feature used to prevent unexpected motor rotation in case of emergency without the necessity to interrupt power supply. When STO function is active, the servodrive and the motor are in a state of functional safety, which means that is impossible to cause an active rotation of motor shaft or, if it is alredy rotating, it stops by inertia.

The safety stop category 0 is achieved with the immediate disconnection of electronic components (IGBT) capable of system energization, that cause an uncontrolled stop of the axis, by inertia.

For further information about this function, please see *"Ch. 7 S.T.O. safety circuit" pag. 116*.

6.05 Factors

To ensure a correct operation for entire application, FACTORS calculation procedure must be performed. This calculation is automatic and must be started via Caliper software whenever position, speed and acceleration parameter units, that drive will receive as reference, will be changed.

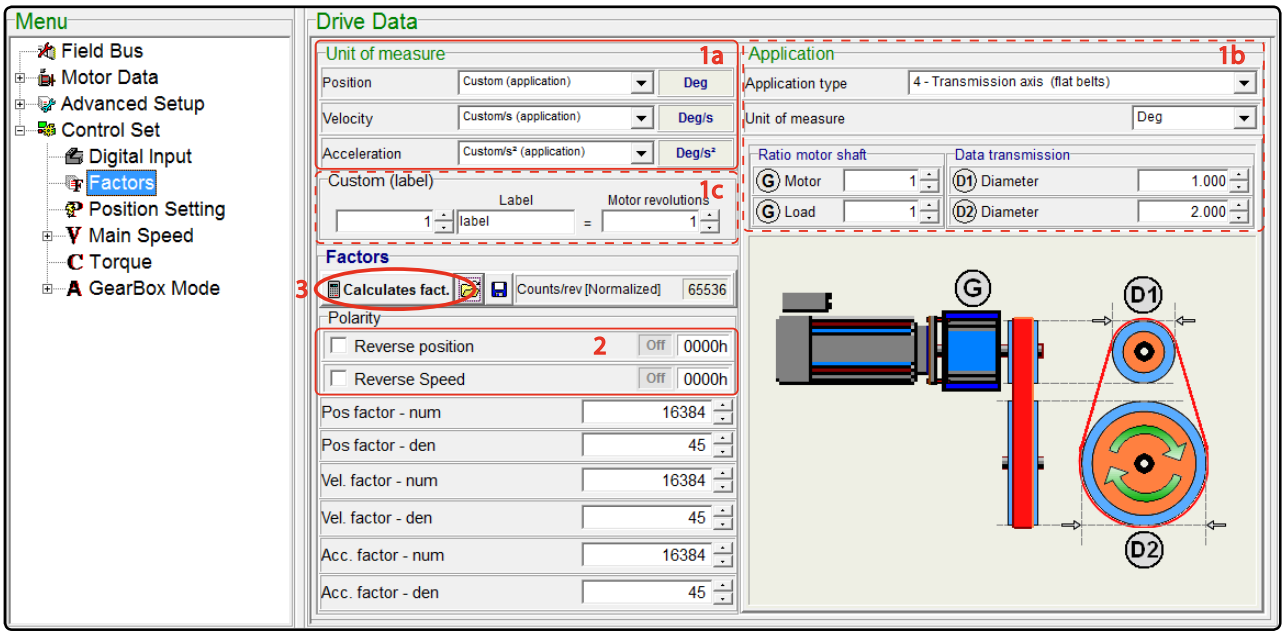
Factors:

- let thew drive to know input reference topology (position, speed and acceleration units), that it will receive depending on operation mode.
- depend on chosen units and a correct value must be set at any changing in order to use drive correctly.

6.05.1 Factor calculation procedure

Factors set via Caliper software is shown below (the picture shows rotary motor, for example):

1. choose between base units or custom application units or custom label units defined by user:
   - *1a - Base units:* reffered to motor shaft, driven by drive, can be selected by a drop-down menu related to position, speed and acceleration parameters.
   - *1b - Custom Application:* only when units depends on application (*Custom Application*), it's necessary to set it in the *Application* submenu of *Drive Data* window; please see *"6.05.2 Custom Application" pag. 74*.
   - *1c - Custom Label:* only when units depends on a desired label (*Custom Label*), it's necessary to set it in the *Application* submenu of *Drive Data* window; please see *"6.05.3 Custom Label" pag. 75*.
2. choose polarity for position and speed reference.
3. automatic calculate for factors.



NOTES:

- It's recommended to use the Custom Label only after be ensured that the desired units are not implemented as main units, in order to avoid any errors in factors.
- It's recommended to use the Custom Application, if position, speed and acceleration references, provided to drive, are reffered to load and not to motor shaft (so downstream any reducers or rack).
- Graphics allow to see the chosen Custom Application.
- Calculated factors can be save/load from the used PC directory.

Main units supported by drive are listed below:

	Angular units	***Linear units***	***Standard units***
Position	radians, deg	cm, mm, µm, nm, inches, mils	counts
Speed	radians/s, deg/s	cm/s, mm/s, µm/s, nm/s, inches/s, mils/s	counts/s, RPM, RPS
Acceleration	radians/s^2, deg/s^2	cm/s^2, mm/s^2, µm/s^2, nm/s^2, inches/s^2, mils/s^2	counts/s^2, RPM/s, RPS/s

NOTES:

- There are other units, in the same drop-down menu, that allow to set tenths, cents and thousandth of main units.

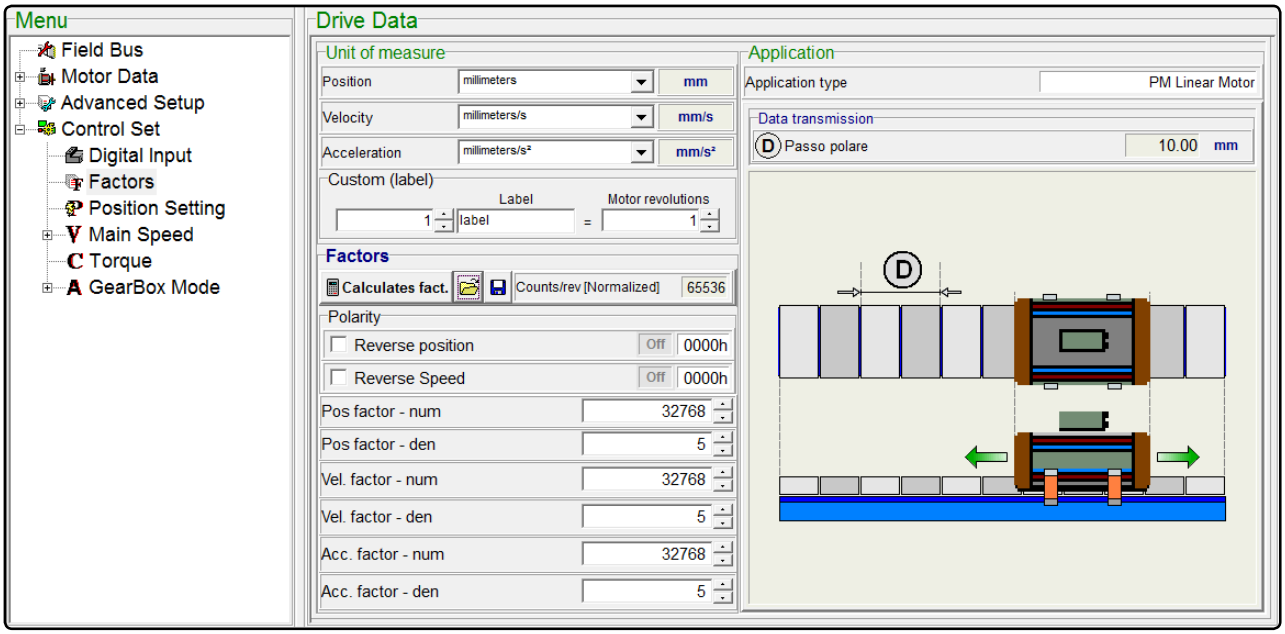
6.05.2 Custom Application

» In case of rotary motor, supported Custom Application can be selected by a drop-down menu and they are listed below:

1. *Disk axis (angular measurement)*: application with angular units reffered directy to a load represented by a rotary disk downstream any reducer. Set parameters are:
   - units
   - reducer ratio
2. *Disk axis (angular measurement)*: application with linear units reffered directy to a load represented by a rotary disk downstream any reducer. Set parameters are:
   - units
   - reducer ratio
   - disk diameter
3. *Axis conveyor belt (flat belt)*: application with linear units reffered directy to a load represented by an axis conveyor belt downstream any reducer. Set parameters are:
   - units
   - reducer ratio
   - dragged disk diameter
4. *Axis conveyor belt (toothed belt)*: application with linear units reffered directy to a load represented by an axis conveyor belt downstream any reducer. Set parameters are:
   - units
   - reducer ratio
   - tooth number e tooth pitch
5. *Transmission axis (flat belt)*: application with linear units reffered directy to a load represented by a transmission axis downstream any reducer. Set parameters are:
   - units
   - reducer ratio
   - disks diameters
6. *Transmission axis (toothed belt)*: application with linear units reffered directy to a load represented by a transmission axis downstream any reducer. Set parameters are:
   - units
   - reducer ratio
   - toohtd disks number
7. *Axis with worm*: application with linear units reffered directy to a load represented by an axis with worm downstream any reducer. Set parameters are:
   - units
   - reducer ratio
   - screw pitch

8. *Axis with hollow shaft motor*: application with linear units reffered directy to a load represented by an axis with an hollow shaft motor. Set parameters are:
   - units
   - screw pitch

» In case of linear or tubular motor, the Custom Application is unique, and the calculation for Factors is equal to that described for rotary motor:



NOTES:

- Some units, as *nm*, are not implemented in linear motor application; by the way, it can be created with Custom Label.
- Graphics allow to see the chosen Custom Application.
- Calculated factors can be save/load from the used PC directory.

6.05.3 Custom Label

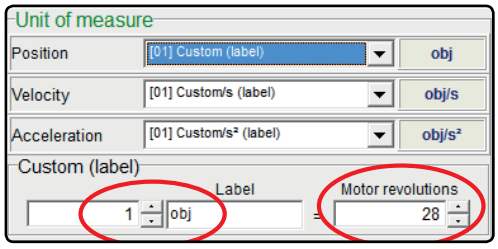
Custom Label allows user to set custom units related to a specified application.

To define units, it's allow to set:

- a ratio between number of desired revolutions to perform in order to reach target of specified application (in case of rotary motor).
- a ratio between number of desired pole pitch to perform in order to reach target of specified application (in case of linear or tubular motor).

This means that target quota, that user provides to drive, is equal to that set as number of revolution or number of pole pitch.

An example of Custom Label setting is shown in the picture below:



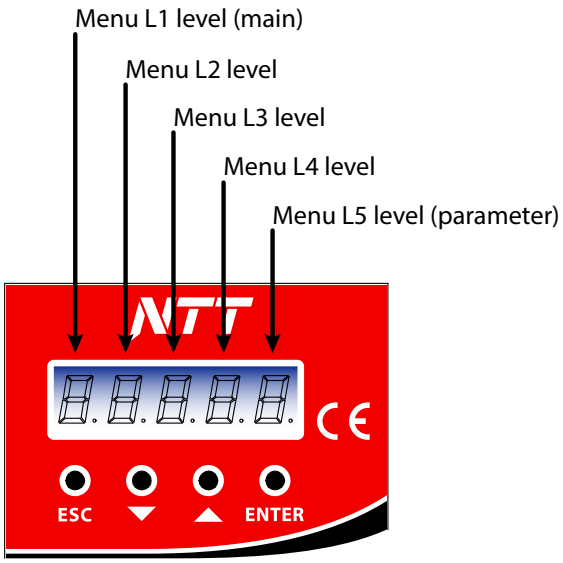
Setting, as target ('obj'), value '1' and, as number of revolutions, value '28', drive will perform 28 revolutions when user provides it , as target position, value '1'.

NOTES:

- Custom Label settable parameters are 16bit (resolution at 65535).

6.06 Display and keyboard

Drive has 5-digit (7-segment) display, useful for rapid view of drive status and parameters, and a keybord for navigate the parameter set and for modify then in realtime during operation or during tuning procedure if PC is missing.



Parameter set is organized into levels and sub-levels, displayed during navigation.

The keyboard is formed by 4 buttons:

- ESC: it leads to navigate escaping levels or sub-levels and to escape from parameter without saving.
- DIRECTIONAL INDICATORS (UP and DOWN): they lead to navigate into levels or sub-levels and to modify parameters.
- ENTER: it leads to navigate entering levels or sub-levels and to select and save parameters.

After turn-on, drive shows installed firmware version for a few seconds; then it displays **main display visualizatrion menu** for primary drive parameters.

d.0000	Drive status (STOP, ENA, RUN, F xx and FA xx)	d.0007	Absolute feedback position freezing when going out from Home sensor
d.0001	Motor speed in RPM	d.0008	Drive current size
d.0002	Motor current in Ampere	d.0009	Drive voltage size
d.0003	DC link voltage in Volt	d.000A	*Reserved*
d.0004	Drive Heatsink temperature in °C	d.000b	Pressure reference
d.0005	Position-rounds of the motor	d.000C	Measured pressure
d.0006	Position-offset-round of the motor		

The amount of parameters that can be viewed and modified is limited to available number of 5-digit. For further information about these parameters, please see "6.06.1 Keybord access parameters" pag. 77. For a complete drive setting, please use Caliper 4 software (or newer).

To enter drive **main setting menu**, press ESC + ENTER at the same time; main menu in navigation are shown:

	***Menu M:*** motor parameter setting
	***Menu T:*** control topology setting
	***Menu U:*** speed control parameter setting
	***Menu C:*** torque control parameter setting

	***Menu P:*** position control parameter setting
	***Menu F:*** pressure control parameter setting
	***Menu S:*** drive advanced setup parameters
	***Menu H:*** drive reserved setup parameters (only for authorized personnel)

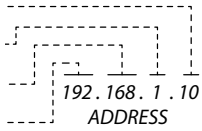
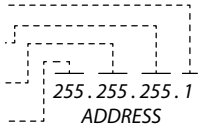
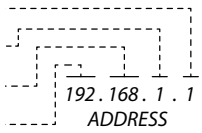
6.06.1 Keybord access parameters

Table below shows parameter access via keyboard (press ESC + ENTER at the same time).

L1	Description	L2	Description	L3	Description	PAR.	Description	Value	Type
d	BASIC DISPLAY PARAMETERS					d.0000	Drive status	'EnA' = Switch-ON 'Run' = Operation Enable 'StoP' = Switch-OFF 'F XX' or 'FA XX' = Fault XX	R
						d.0001	Motor speed	-9999 ÷ 9999 RPM	R
						d.0002	Provided current	-99.99 ÷ 99.99A o -999.9 ÷ 999.9 A	R
						d.0003	DCbus voltage	0 ÷ 1000V	R
						d.0004	Drive temperature	0 ÷ 200.00 °C	R
						d.0005	Position-rounds	-32767 ÷ 32767 cnts	R
						d.0006	Position-offset	0 ÷ 65535 cnts	R
						d.0007	H.P. freezing	0 ÷ 65535 cnts	R
						d.0008	Drive current size	Drive current size	R
						d.0009	Drive voltage size	240 / 460	R
						d.000A	Reserved	-	
						d.000b	Pressure reference	0 ÷ 1000.0Bar	R
						d.000C	Measured pressure	0 ÷ 1000.0Bar	R
m	MOTOR DATA	m1	MOTOR MAIN PARAMETERS			m.1000	Motor type	'0 S-r' = Synchronous rotative '1 S-L' = Synchronous linear '2 dC' = Permanent mag. DC '3 U-F' = Induction V/Hz '4 IM' = Induction FOC	S
						m.1001	Rated speed	0 ÷ 20000 RPM	S
						m.1002	Rated current	0 ÷ 600.00 A	S
						m.1003	Peak current	0 ÷ 600.00 A	S
						m.1004	Stall current	0 ÷ 600.00 A	S
						m.1005	Rated voltage	10 ÷ 460 V	S
						m.1006	Poli motore	2 ÷ 50 poli	S
						m.1007	Poli resolver	2 ÷ 16 poli	S
		m2	MOTOR ADVANCED PARAMETERS			m.2000	Phase resistance	0.01 ÷ 650 Ω	S
						m.2001	Sync. inductance	0.01 ÷ 650 mH	S
						m.2002	I2T Time	1 ÷ 3000 s	S
						m.2003	Motor autophasing command	'C off' = OFF command 'C on' = ON command	S
						m.2004	Feedback offset	0 ÷ 360.00 °	S

L1	Description	L2	Description	L3	Description	PAR.	Description	Value	Type
t	CONTROL TOPOLOGIES					- t -	Control topologies	'U' = Speed 'C' = Torque 'A' = Electr. Gearbox 'P' = Position 'E' = Electr. Cam 'F' = Servo press	S
U	SPEED CONTROL	U1	MAIN REFERENCE	U10	CHOICE	U.1000	Choose reference type	'0-AnL' = Analog '1-Int' = Inside '2-FrE' = Frequency '3-tAb' = Selection Table	S
				U11	ANALOG REF.	U.1100	Fullscale	0 ÷ 60000 RPM	W
						U.1101	Offset	-999.9 ÷ 999.9 RPM	W
				U12	INTERNAL REF.	U.1200	Target speed	-9999 ÷ 9999 RPM	W
				U15	FREQUENCY REF.	U.1500	Pulse per round	128 ÷ 16384	S
						U.1501	Input type	'0 A-b' = encoder ChA/ChB '1 F-d' = Frequency/Direction '2 ImP' = CW/CCW Pulse	S
		U2	AUXILIARY REFERENCE	U20	CHOICE	U.2000	Choose reference type	'0-AnL' = Analog '1-Int' = Interno '2-LIm' = Limite di Coppia	S
				U21	ANALOG REF.	U.2100	Fullscale	0 ÷ 60000 RPM	W
						U.2101	Offset	-999.9 ÷ 999.9 RPM	W
				U22	INTERNAL REF.	U.2200	Target speed	-9999 ÷ 9999 RPM	W
				U23	TORQUE LIMIT	U.2300	Fullscale	0.0 ÷ 250.0%	W
						U.2301	Offset	-100.0 ÷ 100.0%	W
				U24	ENABLE	U.2400	Enable reference	On/Off	W
		U3	RAMPS	U30	ENABLE	U.3005	Enable S-ramps	On/Off	W
						U.3006	Enable linear ramps	On/Off	W
C	TORQUE CONTROL	C0	CHOICE			C.0000	Choose reference type	'0-AnL' = Analog '1-Int' = Inside	S
		C1	ANALOG REFERENCE			C.1000	Fullscale	0.0 ÷ 250.0%	W
						C.1001	Offset	-100.0 ÷ 100.0%	W
		C2	INTERNAL REFERENCE			C.2000	Target torque	-250.0 ÷ 250.0%	W
P	POSITION CONTROL - POSITIONER	P0	CHOICE			P.1000	Choose reference type	'0-SnG' = Single target '1-AnL' = Analog '2-tAb' = Selection Table '3-CLC' = Cyclic Table '4-t/S' = Input start table	S
F	PRESSURE CONTROL	F1	FULLSCALE PARAMETERS FOR PRESSURE REFERENCE AND TRANSDUCER			F.1000	Speed reference	1 ÷ 9999 RPM	W
						F.1001	Speed ref. offset	-999.9 ÷ 999.9 RPM	W
						F.1002	Pressure reference	1 ÷ 1000.0 bar	W
						F.1003	Pressure ref. offset	-100.0 ÷ 100.0 bar	W
						F.1004	Transducer	1 ÷ 1000.0 bar	W
						F.1005	Transducer offset	-100.0 ÷ 100.0 bar	W
						F.1006	Pressure reference accuracy	'dEC 0' without decimal 'dEC 1' with 1 decimal	S
		F2	THRESHOLD SETTING FOR POWER LIMITING			F.2000	Pressure threshold	0 ÷ 1000 bar	W
						F.2001	Hysteresis for F.2000	1 ÷ 50 bar	W
						F.2002	Speed threshold	0 ÷ 9999 RPM	W
						F.2003	Speed ramps	1 ÷ 60000 RPM/s	W
		F3	LIMITS			F.3000	Current limit	0.0 ÷ 1000.0 %	W
						F.3001	Negative speed	-9999 ÷ 0 RPM	W
						F.3002	It acts on S.5002 parameter		

L1	Description	L2	Description	L3	Description	PAR.	Description	Value	Type
F	PRESSURE CONTROL (continue)	F4	ANALOG OUTPUT MANAGEMENT			F.4000	Pressure output	0 ÷ 1000 bar	W
						F.4001	Speed output	1 ÷ 9999 RPM	W
			DIGITAL OUTPUT MANAGEMENT			F.4002	Pressure error	1 ÷ 1000 bar	W
						F.4003	Threshold time	1 ÷ 60000 ms	W
		F5	ALARM MODE THRESHOLD MANAGEMENT			F.5000	Overpressure	1 ÷ 1000 bar	W
						F.5001	Time for F.5000	1 ÷ 60000 ms	W
						F.5002	Enable F.5000	ON/OFF	S
						F.5003	Under pressure	1 ÷ 1000 bar	W
						F.5004	Time for F.5003	1 ÷ 60000 s	W
						F.5005	Enable F.5003	ON/OFF	S
		F6	PRESSURE PID REGULATORS AND EXPONENTIAL MULTIPLYER COEFFICIENTS			F.6000	KP Pressure	1 ÷ 32767	W
						F.6001	Exponential for KP	-16 ÷ 16	W
						F.6002	KI Pressure	1 ÷ 32767	W
						F.6003	Exponential for KI	-16 ÷ 16	W
						F.6004	KD Pressure	1 ÷ 32767	W
						F.6005	Exponential for KD	-16 ÷ 16	W
		F7	PRESSURE RAMPS ON REFERENCE			F.7000	Acceleration	1 ÷ 60000 bar/s	W
						F.7001	Deceleration	1 ÷ 60000 bar/s	W
						F.7002	Jerk	0 ÷ 10000 ms	W
						F.7003	Ramp enable	ON/OFF	S
			SPEED RAMPS ON REFERENCE			F.7004	Acceleration	1 ÷ 60000 RPM/s	W
						F.7005	Deceleration	1 ÷ 60000 RPM/s	W
						F.7006	Ramp enable	ON/OFF	S
S	ADVANCED SETUP	S1	PID REGULATORS	S10	PID SPEED	S.1000	KP speed	1 ÷ 65535	W
						S.1001	KI speed	0 ÷ 65535	W
						S.1002	KD speed	0 ÷ 65535	W
				S11	PID CORRENTE	S.1100	KP current	1 ÷ 65535	W
						S.1101	KI current	0 ÷ 65535	W
						S.1102	KD current	0 ÷ 65535	W
				S12	PID ASINCRONO DI FLUSSO	S.1200	KP flux	0 ÷ 65535	W
						S.1201	KI flux	0 ÷ 65535	W
				S13	PID ASINCRONO DEFLUSSAGGIO	S.1300	KP flux weakening	0 ÷ 65535	W
						S.1301	KI flux weakening	0 ÷ 65535	W
				S14	PID POSIZIONE	S.1400	KP posizione	0 ÷ 4000	W
				S15	ERRORE DI POSIZIONE	S.1500	Error threshold	0 ÷ 65535 cnts	W
						S.1501	Threshold time	10 ÷ 10000 ms	W
		S3	ENCODER RESOLUTION and ALARMS			S.3000	Encoder output res.	256-1024-4096-16384 ppr	S
						S.3002	Reset alarms command	ON/OFF	W
						S.3003	Alarm list	Last 16 appeared alarms	R
						S.3004	Firmware version	'SFX.XX' firmware version	R
						S.3005	Feedback Reverse	ON/OFF	S
						S.3006	Encoder output type	'0 rIF' frequency reference '1 SIM' emulated enc. out '2 EnC' motor encoder	S
						S.3007	Enc. out. reverse	ON/OFF	S
		S4	ALARM MODE			S.4002	STO alarm mode	'oFF' stored 'on' autoreset	W
						S.4008	Check 24V for I/O	ON/OFF	W

L1	Description	L2	Description	L3	Description	PAR.	Description	Value	Type
S	ADVANCED SETUP (continue)	S5	LIMITS			S.5000	Maximum speed	0 ÷ 20000 RPM	W
						S.5001	Maximum current	0.0 ÷ 1000.0 %	W
						S.5002	Limit current accuracy	'dEC 0' without decimal 'dEC 1' with 1 decimal	S
		S7	FIELDBUS	S70	CHOICE	S.7000	Fieldbus choice	'0 Io' Input/Output '1 mod' Modbus '2 CAn' Canopen '3 EtH' Ethercat '4 Pnt' Profinet '5 PrF' Profibus	S
				S71	MODBUS	S.7100	MODBUS address	1 ÷ 247	S
						S.7101	MODBUS parity check	'0 nuL' null '1 EUE' pari '2 odd' dispari	S
						S.7102	MODBUS baudrate	'9600' - '14400' - '19200' '38400' - '57600' - '115200'	S
						S.7103	Timeout	10 ÷ 4000 ms	S
						S.7104	Timout enable	ON/OFF	S
				S72	CANOPEN	S.7200	CANOPEN address	1 ÷ 127	S
						S.7201	CANOPEN baudrate	'10' - '20' - '50' - '100' - '125' '250' - '500' - '800' - '1000'	S
						S.7202	Timeout	10 ÷ 4000 ms	S
						S.7203	Timout enable	ON/OFF	S
				S73	PROFIBUS	S.7300	PROFIBUS address	1 ÷ 125	S
				S74	ETHERCAT	S.7400	ETHERCAT alias	1 ÷ 65535	S
				S75	PROFINET	S.7500		Profinet IP address fields	W
						S.7501			
						S.7502			
						S.7503			
						S.7510		Profinet Subnet Mask address fields	W
						S.7511			
						S.7512			
						S.7513			
						S.7520		Profinet Gateway address fields	W
						S.7521			
						S.7522			
						S.7523			
		S8	MOTOR BAKE			S.8000	Enable time	10 ÷ 2000 ms	W
						S.8001	Disable time	10 ÷ 2000 ms	W
						S.8002	Deceleration ramp	0 ÷ 60000 RPM/s	W
						S.8003	Brake enable speed	1 ÷ 500 RPM	W
		H6	BRAKING RESISTOR			H.6000	Ohmic value	10 ÷ 10000 Ω	S
						H.6001	Power rating	30 ÷10000 W	S
						H.6002	Overload time	1 ÷ 255 s	S

L1	Description	L2	Description	L3	Description	PAR.	Description	Value	Type
H	RESERVED SETUP	H0	RESERVED PARAMETER ACCES			H.0000	Password entering	-	W
		H1	-			H.1002	I2T drive time	0.1 ÷ 25.0 s	W
						H.1003	Voltage lack control enable	ON/OFF	S
						H.1004	Switching frequency	2.0 ÷20.0 kHz	W
						H.1005	Heat temp. threshold	1.0 ÷ 200.0 °C	W
						H.1006	Fan enable threshold	0.0 ÷ 200.0 °C	W
						H.1007	Stop fan hysteresis	1.0 ÷ 200.0 °C	W
		H3	-			H.3000	DC braking threshold	15 ÷ 960 V	W
						H.3001	Hysteresis for H.3000	1 ÷ 125 V	W
						H.3002	DC max threshold	15 ÷ 960 V	W
						H.3003	Hysteresis for H.3002	1 ÷ 125 V	W
						H.3004	DC min threshold	5 ÷ 560 V	W
						H.3005	Hysteresis for H.3004	1 ÷ 125 V	W
		H4	I2T LIMIT FREQUENCY			H.4000	I2T limit threshold	0.00 ÷10.00 Hz	W
		H5	ALARMS ERASING			H.5000	Erase alarms	ON/OFF	W

Variable "Type" show:

1. R = read only
2. W = always write (STOP, ENA, RUN o FAULT)
3. S = write only in STOP (or FAULT) drive status

6.07 Motor autophasing

Autophasing function allows drive to identify connected motor poles number and incremental encoder offset (all data are visible in 'Motor Data' item); ensure to perform autophasing procedure if a third parts motor is used, in order to grant a correct drive functionality.

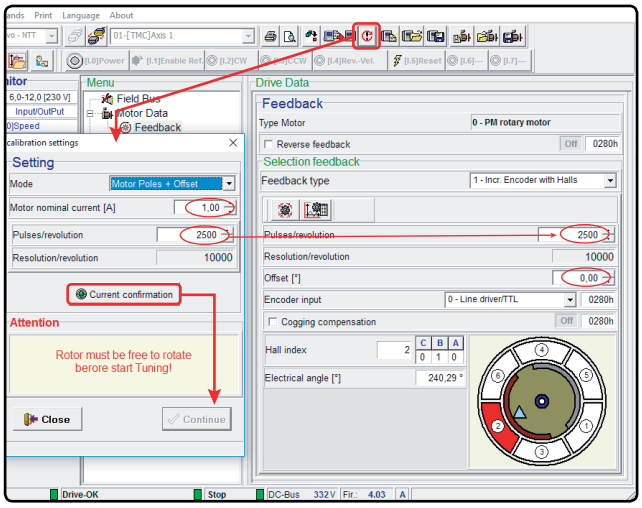
If drive manages motor brake, its disengage is performed during autophasing function. In case of vertical axis load, please use an oppropriate external mechanic brake esterno and separate rotor from load. In the end of autophasing operation, motor brake will engage.

Rotor MUST be free to rotate during autophasing function.

Please set correct used motor encoder pulse number and motor rated current before performing autophasing.

Drive can perform autophasing also without HALL sensors in order to identify only connected motor poles number.

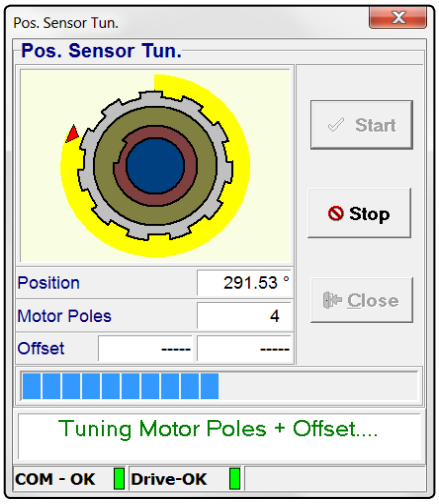
In the launching window, dove a motor current confirmation message appears and lets to enter correct data; also a free rotor message appears, as shown in the image below:



NOTES:

- Modifing current data and encoder pulse number before performing autophasing, it lets to auto update related into *Motor Data* item, as shown in previous image.
- H.D.T. motors are normally phased at drive default value, so, during first start up, it is not necessary to perform autophasing.

Caliper software shows some information during autophasing operation, as shown in the image below:



During this operation, motor performs one complete turn at low speed, identifing total motor poles number; the graphic window shows istantaneous information about rotor position within turn.

Press Start to perform autophasing.

Autophasing can be stopped in any tyme pressing Stop key. An autophasing operation must have been complete at least, in order to ensure a drive correct operation with connected motor.

If during autophasing motor runs in counterclockwise, (shaft side view), please invert two motor phases of cable connection.

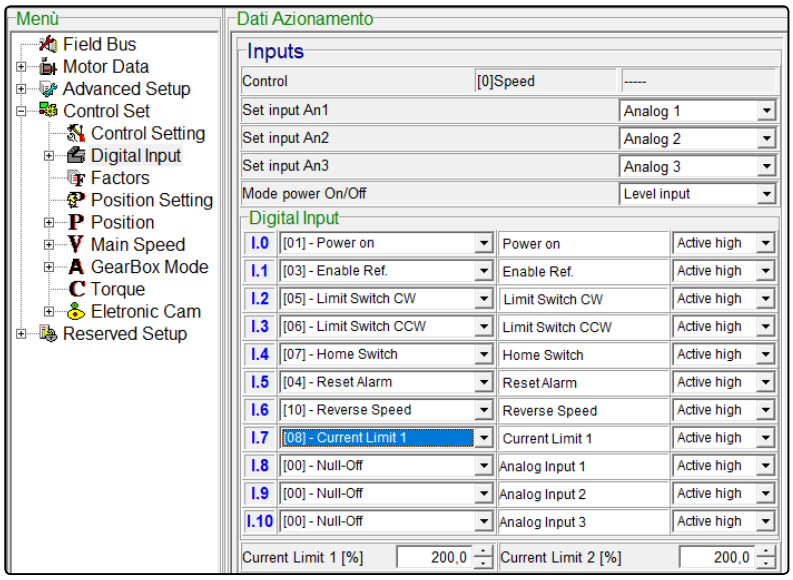
In the end, Caliper software will update motor poles number into 'Motor Data' item and will automatically send data to drive.

6.08 Digital I/O

Digital input (also analog input used as digital input) and output ports are totally configurable with all theri input function, so they are not linked to hardware input position, exception for 2 input capture functions, as Touch Probe.

To learn more about digital I/O functions according to choosen operation mode, please see *"6.08.1 Digital I/O functions" pag. 85*, and for information about I/O topology, please see *"5.10 J7-8-9 connectors: Frequency, digital and analog I/O" pag. 42*.

Please remember that 'Digital Input' sub item is nested in Menu item releated to desired operation mode; for example, a kind of useful configuration for digital input functions, with related settings, during speed control in I/O operation mode is shown below:



Setting into window is shown below:

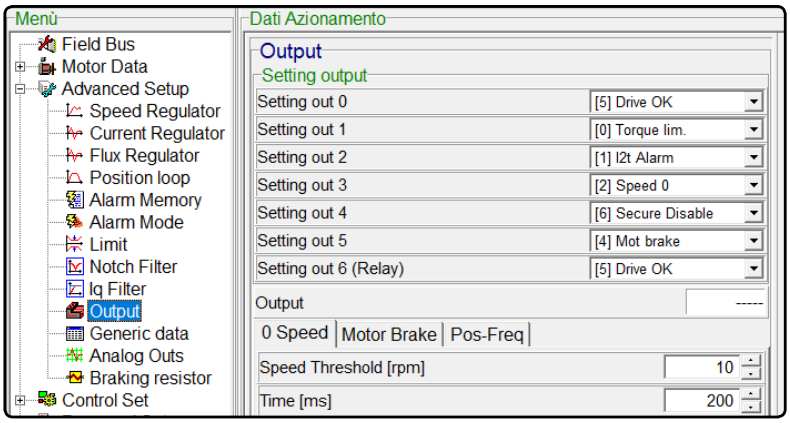
- setting input 6 and 7 as analog or digital input.
- setting Power ON/OFF activation type between Level or Edge of selected input signal.
- setting input function from dropdown menu and desired logic state.

Digital input functions are listed below:

1. ***Power ON*** o ***Switch ON***: motor locked in torque standstill condition command.
2. ***Power ON/Reset***: reset alarms and torque standstill condition joint command.
3. ***Power/Operat.***: torque standstill condition and reference enabled joint command.
4. ***Power/Operat./ Reset***: reset + torque standstill + reference enabled joint command.
5. ***Enable Reference*** o ***Enable Operation***: reference enabled command.
6. ***Start Reference***: Start position command.
7. ***Halt***: Halt command.
8. ***Position Abs./Rel.***: target conversion between absolute and relative and viceversa.
9. ***Reset Alarms*** o ***Fault Reset***: drive alarms reset command.
10. ***Limit Switch CW*** and ***Limit Switch CCW***: input for clockwise (CW) and counterclockwise limit switch (CCW).
11. ***Home Switch***: input for Home switch.
12. ***Current limit 1*** and ***Current limit 2***: input for 1ST and 2ND torque limit at specified percentage value.
13. ***Reverse Speed***: reverse speed command.
14. ***Home Position***: start Home Position procedure command.
15. ***JOG+*** and ***JOG-***: speed JOG command.
16. ***Selection-Start***: target table selection input and start per input-start position control.
17. ***Reference Select(0-5)***: target table selection input via Modbus operation mode.
18. ***Reset Index***: cyclic positioner index reset.
19. ***Position on Input X***: index stop, at relative position, when event happens on defined Input.
20. ***Measure position on In X***: start/stop position measurement on defined input.
21. ***Selection Cam***: electronic cam table selection input.
22. ***Input Sync Cam***: electronic cam sync input.
23. ***Input Sync Slave***: electronic cam slave module sync input.

24. ***Position Phase Shift***: input for performing axis posizion phase shift.
25. ***Velocity Shift +*** and ***Velocity Shift -***: input for performing axis speed phase shift.
26. ***Touch Probe 1*** and ***Touch Probe 2***: Touch Probe 1 and 2 function input.

Output can be set into *Advanced Setup* as shown below:



Output is enabled for each operation mode supported by drive.

Drive Data window lets choosing output port function and shows some function parameter.

In order to enable function, please select it in the drop-down menu into *Drive Data* item.

Digital output functions are available in every supported operation mode.

Output functions are listed below:

1. ***Torque limit***: if drive provides rated torque or reaches torque limit set as reference, output will switched to an high state value.
2. ***I2T Alarm***: if drive identifies a drive or motor I2T alarm condition, output will switched to an high state value.
3. ***Speed 0***: if drive identifies a Zero Speed condition, output will switched to an high state value. Speed value and timeout, beyond that it's necessary to send alarm, can be set in *Drive Data* item.
4. ***Target reached***: output will switched to an high state value if drive identifies one of the following reached target condition: target position reached, home position executed, cam completed and pressure reached.
5. ***Mot. Brake***: motor brake management and current offset parameter for vertical axis. To learn more about this function, please see *"6.11 Motor brake" pag. 90*.
6. ***Drive OK***: high active logic signal for *Drive OK* status; output is disabled if any alarms occur.
7. ***Secure Power disable***: this function provides an high active output if both SPD contacts are correctly opened; please see *"Ch. 7 S.T.O. safety circuit" pag. 116.*
8. ***Pos-Freq. Out***: this output provides a squared wave whose frequency is equal to a divider, settable with a power of two, of motor position in turn (counts). Maximum allowable frequency for output is 2.5kHz so for using correctly thi function, please follow the formula shown below:

$$DIV_{MIN} = \frac{N_{RPM.V} \cdot FB_{RESOLUTION}}{3 \cdot 10^5} \qquad ENC_{OUT} = \frac{FB_{RESOLUTION}}{2 \cdot DIV}$$

where $N_{RPM.V}$ (RPM) is the maximum speed reachable by the motor in the application, $FB_{RESOLUTION}$ is the feedback resolution (it equals to encoder pulse number multiplied by 4, if incremental encoder is used, whereas it equals to resolution due to number of bit if absolute encoder is used), and DIV_{MIN} is the minimum allowable divider; so from Caliper drop-down menu, please choose an "Encoder count Divider", DIV, higher than DIV_{MIN} found value, to result in ENC_{OUT}, that is the output resolution in CPR (counts per round).

9. ***Pos Output***: available only for input-start position mode, it provides an output pulse, with time setting, when position is reached.
10. ***Homing attained***: when any homing procedure is performed, output will switched to an high state value and it will remain untill next Homing procedure call (or drive turn off).

NOTES:

- Digital output are also configurable to be controlled via fieldbus parameter in order to let controller to perform custom function.

6.08.1 Digital I/O functions

Available functions, during I/O operation mode and related control type, are shown in table below:

	I/O Operation mode					
	Speed	***Torque***	***Elect. Axis***	***Position***	***Elect. Cam***	***Press***
IN 0	Power ON Power ON/Reset Enable Reference Reset Alarms Current Limit 1 Current Limit 2 Halt Reverse Speed Limit Switch CW Limit Switch CCW Home Switch	Power ON Power ON/Reset Enable Reference Reset Alarms Current Limit 1 Current Limit 2 Halt	Power ON Power ON/Reset Enable Reference Reset Alarms Current Limit 1 Current Limit 2 Halt Home position Limit Switch CW Limit Switch CCW Home Switch JOG+ JOG– Pos. Phase Shift Velocity Shift + Velocity Shift –	Power ON Power ON/Reset Enable Reference Reset Alarms Current Limit 1 Current Limit 2 Halt Home position Limit Switch CW Limit Switch CCW Home Switch JOG+ JOG– Selection-Start Position on Input X	Power ON Power ON/Reset Enable Reference Reset Alarms Current Limit 1 Current Limit 2 Halt Home position Limit Switch CW Limit Switch CCW Home Switch JOG+ JOG– Selection Cam Velocity Shift + Velocity Shift – Input Sync Cam Input Sync Slave	Power ON Power ON/Reset Enable Reference Reset Alarms Current Limit 1 Current Limit 2 Halt Limit Switch CW Limit Switch CCW
IN 1						
IN 2						
IN 3						
IN 4						
IN 5						
IN 6						
IN 7						
IN 8*						
IN 9*						
IN 10*						
DIR	CHA - CCW - DIR	–	CHA - CCW - DIR	–	CHA - DIR	–
PULSE	CHB - CW - PULSE	–	CHB - CW - PULSE	–	CHB - PULSE	–

Available functions, during Modbus RTU operation mode and related control type, are shown in table below:

	MODBUS RTU Operation mode					
	Speed	***Torque***	***Elect. Axis***	***Position***	***Elect. Cam***	***Press***
IN 0	Switch ON Power/Operation Pow./Op./Reset Enable Operation Fault Reset Halt Meas. pos. Input X Limit Switch CW Limit Switch CCW Home Switch	Switch ON Power/Operation Pow./Op./Reset Enable Operation Fault Reset Halt Start reference Meas. pos. Input X	Switch ON Power/Operation Pow./Op./Reset Enable Operation Fault Reset Halt Meas. pos. Input X Limit Switch CW Limit Switch CCW Home Switch Start reference Home Position JOG+ JOG– Pos. Phase Shift Velocity Shift + Velocity Shift –	Switch ON Power/Operation Pow./Op./Reset Enable Operation Fault Reset Halt Meas. pos. Input X Limit Switch CW Limit Switch CCW Home Switch Start reference Home Position JOG+ JOG– Selection-Start Reference select (0-5) Position Abs./Rel Position on Input X	Switch ON Power/Operation Pow./Op./Reset Enable Operation Fault Reset Halt Meas. pos. Input X Limit Switch CW Limit Switch CCW Home Switch Start reference Home Position JOG+ JOG– Selection Cam (0-2) Velocity Shift + Velocity Shift – Input Sync Cam Input Sync Slave	Switch ON Power/Operation Pow./Op./Reset Enable Operation Fault Reset Halt Start reference Meas. pos. Input X Limit Switch CW Limit Switch CCW
IN 1						
IN 2						
IN 3						
IN 4						
IN 5						
IN 6						
IN 7						
IN 8*						
IN 9*						
IN 10*						
DIR	CHA - CCW - DIR	–	CHA - CCW - DIR	–	CHA - DIR	–
PULSE	CHB - CW - PULSE	–	CHB - CW - PULSE	–	CHB - PULSE	–

Available functions, during Canopen, Ethercat CoE, Profinet and Profibus operation mode are shown in table below:

	Operation Mode			
	Canopen CiA402	***Ethercat CoE CiA402***	***Profinet Profidrive***	***Profibus DPv0***
IN 0	Position on Input X - Measuring Position			-
IN 1	Position on Input X - Measuring Position			Limit Switch CW
IN 2	Limit Switch CW			Limit Switch CCW
IN 3	Limit Switch CCW			-
IN 4	Home Switch			-
IN 5	Position on Input X - Measuring Position			-
IN 6	Position on Input X - Measuring Position - Touch Probe 1 - Touch Probe 2			Home Switch
IN 7	Position on Input X - Measuring Position - Touch Probe 1 - Touch Probe 2			Position on Input X
DIR	CHA - CCW - DIR *(only for Electronic Gearbox)*		-	-
PULSE	CHB - CW - PULSE *(only for Electronic Gearbox)*		-	-

NOTES:

- Drive considers that an I/O port is activated when high level logic state is detected. For any information about logic state levels, please see *"2.06 Technical data" pag. 15*. For further information about wiring, please see *"5.10 J7-8-9 connectors: Frequency, digital and analog I/O" pag. 42*
- * Input 8,9 and 10 are same hardware analog input; to use them as digital input, they must be enabled: single ended PNP connection for analog references is to connect negative pins (pin 2-4-6 of J9)) to 0S ground (pin 8 of J9) and to connect signal to positive pins (pin1-3-5 of J9).
- Function related to Position table selection (Selection Position from 0 to 5) and Cam table selection (Selection Cam from 0 to 2) have to be set manually during Modbus RTU operation mode.
- Please, see fieldbus user guides for any other detailes related to how to manage digital I/O (logic states or activation sequences).

6.09 Drive references

Drive acquires references, related to operation mode and control topology, from type shown below:

1. Main reference
2. Auxiliary AUX1 reference
3. Auxiliary AUX2 reference

Having the analog references a voltage range between -10V e +10V, zero condition is obtained when input voltage to drive pin port (pin 1-2, 3-4, 5-6 of J9 connector) equals to 0V. For further information about connections and about analog input topology, please see "5.10 J7-8-9 connectors: Frequency, digital and analog I/O" pag. 42.

6.09.1 Main reference

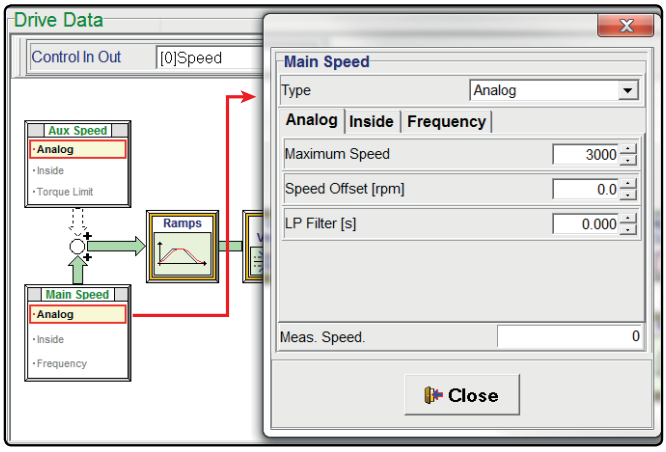
Main reference provides following features:

- *speed control* as IN8 analog speed reference (I/O and Modbus op. mode): pin 1-2 of J9 connector.
- *speed control* as frequency speed reference (I/O and Modbus op. mode): pin 1 to 6 of J7 connector.
- *speed control* as target speed table selection reference (I/O and Modbus op. mode).
- *torque control* as IN8 analog torque reference (I/O, Modbus and Profibus op. mode): pin 1-2 of J9 connector.
- *position control* as frequency position reference ('elect. gearbox' for I/O, Modbus, Canopen and Ethercat op. mode and 'electronic cam' for I/O and Modbus op. mode): pin 1 to 6 of J7 connector.
- *position control* as IN8 analog speed reference (I/O and Modbus op. mode): pin 1-2 of J9 connector., if 'single target positioner' or 'analog positioner' is used.
- *pressure control* as analog IN8 pressure transducer reading feedback: pin 1-2 of J9 connector.

Topologies are shown below:

1. **Analog IN8**: reference is feeded from external signal, whose voltage range lies between ±10V. Drive input is a differential port (pin 1-2 of J9 connector).
   - *In speed control*, this signal feeds main speed reference related to settable parameters.
   - *In torque control*, this signal feeds percentage torque reference according to rated motor current data ('Nominal Current' in Motor Data item).
   - *In position control*, if 'single target positioner' or 'analog positioner' is used, this signal feeds main speed reference related to settable parameters into position sub-menu.
   - *In pressure control*, this signal feeds pressure transducer reading related to settable parameters into press sub-menu.
2. **Inside**: speed or torque reference is generated internally by drive and it's constant. By the way, it can be modified via Caliper software during operation or via fieldbus parameter.
3. **Frequency**: speed or position reference is feeded from 2 frequency signals (pin 1 to 6 of J7 connector) with these features:
   - PULSE - DIRECTION mode: a signal frequency provides to drive the position/speed refererce, whereas the second one provides to drive the direction signal depending on high logic signal (forward motion) or low logic signal (backwards motion).
   - EXTERNAL ENCODER CHA - CHB: external real or simulated encoder input. *It's recommended not to connect more than 2 drives on external encoder incremental channels in order to not overload it; in this case, please use a signal amplifier device every 2 drives connected.*
   - CW - CCW: a signal frequency provides to drive the position/speed refererce, whereas the second one provides to drive the 'Start' command (low logic signal). Depending on which of the two inputs receives the frequency signal, the drive controls motor in forward motion (CW) or in backwards motion (CCW).
4. **Tab-Speed**: reference is located into 64 target table with index selection via digital input or fieldbus parameters.

Analog input setting, related to a speed control, is shown in picture below:



Parameters to set are:

- maximum absolute value for reachable speed (back and forth operation) when analog input voltage value matches with ±10V scale value (example: ±3000RPM).
- speed offset useful to compensate any external signal offset.
- a low pass digital filter on external signal.

Information about istantaneous measured speed appears.

6.09.2 Auxiliary references

Auxiliary reference AUX1/IN9 provides following features:

- *speed control* as auxiliary speed reference.
- *speed control* as torque limit reference.
- *position control* as analog position reference, if 'analog positioner' is used.
- *pressure control* as analog/inside pressure reference.

Topologies are shown below:

1. **Analog IN9**: reference is feeded from external signal, whose voltage range lies between ±10V. Drive input is a differential port (pin 3-4 of J9 connector).
   - *In auxiliary speed control*, this signal is added to main speed reference and parameters to set are maximum reachable speed (in absolute value) when analog input voltage value matches with ±10V scale value (example: ±3000RPM).
   - *In position control*, setting minimum target position (equivalent -10V) and maximun target position (equivalent +10V) parameters, drive performs positioning between this two values following the 12 bit analog auxiliary reference range (±10V).
   - *In pressure control*, this signal feeds pressure reference related to settable parameters into press sub-menu.
2. **Inside**: auxiliary reference is generated internally by drive and it's constant. By the way, it can be modified via Caliper software during operation or via fieldbus parameter.
3. **Torque limit**: reference is used in speed control as torque limit value. Reference is feeded from external signal, whose voltage range lies between ±10V (pin 3-4 of J9 connector). Parameters to set are:
   - absolute torque value to load when analog input voltage value matches with +10V scale value (example: 100%).
   - torque offset useful to compensate any external signal offset.

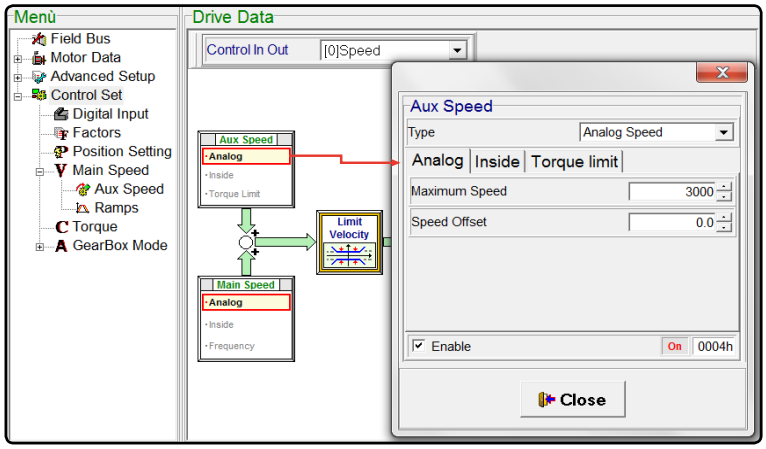
Auxiliary reference AUX2/IN10 (pin 5-6 of J9 connector) is available with all operatin modes and and provides following features:

- *pressure control* as analog/inside speed reference.

Topologies are shown below:

1. **Analog IN10**: pressure transducer feedback is feeded from external signal, whose voltage range lies between ±10V. Drive input is a differential port (pin 5-6 of J9 connector).
   - *In pressure control*, this signal feeds speed reference related to settable parameters into press sub-menu.
2. **Inside**: auxiliary reference is generated internally by drive and it's constant. By the way, it can be modified via Caliper software during operation or via fieldbus parameter.

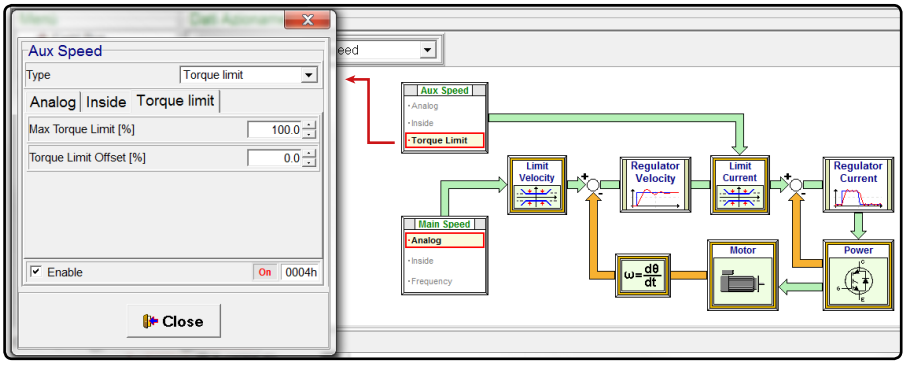
Analog input setting, related to auxiliary speed control, is shown in picture below:



Parameters to set are:

- maximum added value for reachable speed (back and forth operation) when analog input voltage value matches with ±10V scale value (example: ±3000RPM).
- speed offset useful to compensate any external signal offset.

Limit torque function, related to auxiliary speed control, is shown in picture below:



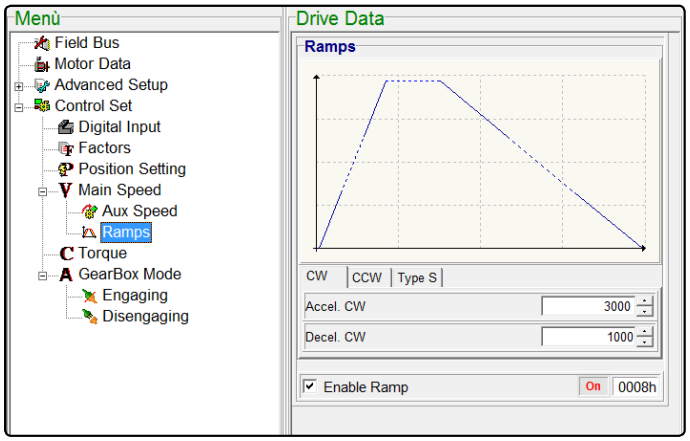
NOTES:

- please pay attention to any activated digital input set for torque limit function.

6.10 Speed ramps

Acceleration and deceleration ramps management is enabled only with speed control in any operation mode. Drive performs ramps at any reference change.

Acceleration and deceleration ramps enabling and setting are shown below:



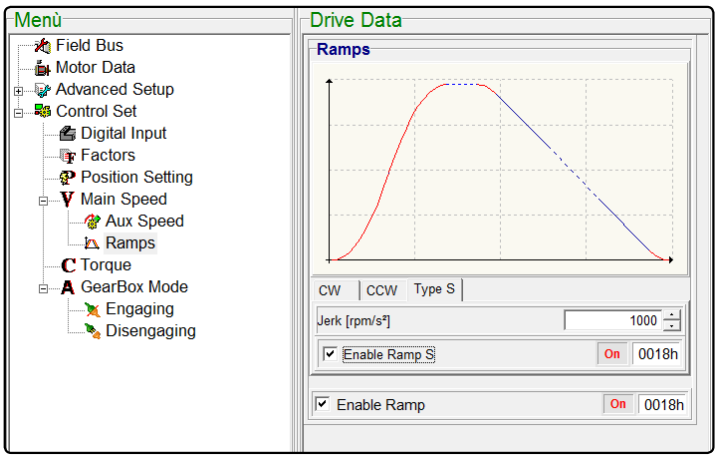
After ramps enabling, acceleration and deceleration values must be set, as RPM/s, both clockwise (CW) that counterclockwise (CCW): so, knowing $T_{RAMP\text{-}V}$ time to reach $N_{RPM\text{-}V}$ operating speed, acceleration and deceleration parameters (*RAMP-V*) are provided by following formula:

$$RAMP\text{-}V = \frac{N_{RPM\text{-}V}}{T_{RAMP\text{-}V}} \quad [\frac{RPM}{s}]$$

Another ramp type supported by drive is the S ramp (Type S) that, besides just described parameters, uses a further parameter called JERK (RPM/s²); this last parameter, also called smooth factor, introduces another ramp coefficient related to acceleration and deceleration profile, and lets drive to smooth speed profile around reference change; knowing T_{RAMP-A} time to reach *RAMP*-V parameter, acceleration and deceleration ramps (*JERK or smooth factor*) are provided by following formula:

$$JERK = \frac{RAMP.V}{T_{RAMP.A}} \quad [\frac{RPM}{s^2}]$$

Smooth factor effect on speed profile is shown below:



6.11 Motor brake

Motor brake function provides that drive, at any SWITCH-OFF command (load torque disabled), performs a ramp to stop load, before brake enabling and before leaving SWITCH-ON state.

If application requires motor brake function, ***do NOT use a control feedback from incremental channel only (without HALL sensors)*** *because, in this condition, drive needs to perform, at every SWITCH-ON command, a rotation angle, in order to align poles, more or less pronounced, depending on the rotor position in that moment.*

It's recommended NOT to connect OUT-x output directly to motor brake command contact. Please use a mechanical contact (as a relay) or any other proper mechanical/electric contact as long as OUT-x current consumption is lower than limit imposed by drive electrical features.

'Time brake enable' and 'time brake disable' must be appropriate to estimated time for brake handling.

Into *Advanced Setup* item, into *Output* sub-item, output OUT-x can be set for motor brake management (please see *"6.08 Digital I/O" pag. 83* to learn about output setting), with features shown below:

1. convention used for output provides to 'disable' brake (disengage) at high logic signal and 'enable' brake (engage) at low logic signal.
2. 'time brake enable' and 'time brake disable' setting from 10 to 2000 ms.
3. 'speed brake enable' setting: it is the speed target to enable brake.
4. deceleration ramp setting, to reach speed target, at any SWITCH-OFF command (only with operating speed grater than speed target).

During engaging brake, drive provides to stop load keeping block torque, after reaching speed target, and, at this time, it provides output signal; drive holds torque until 'time brake enable' set is expired.

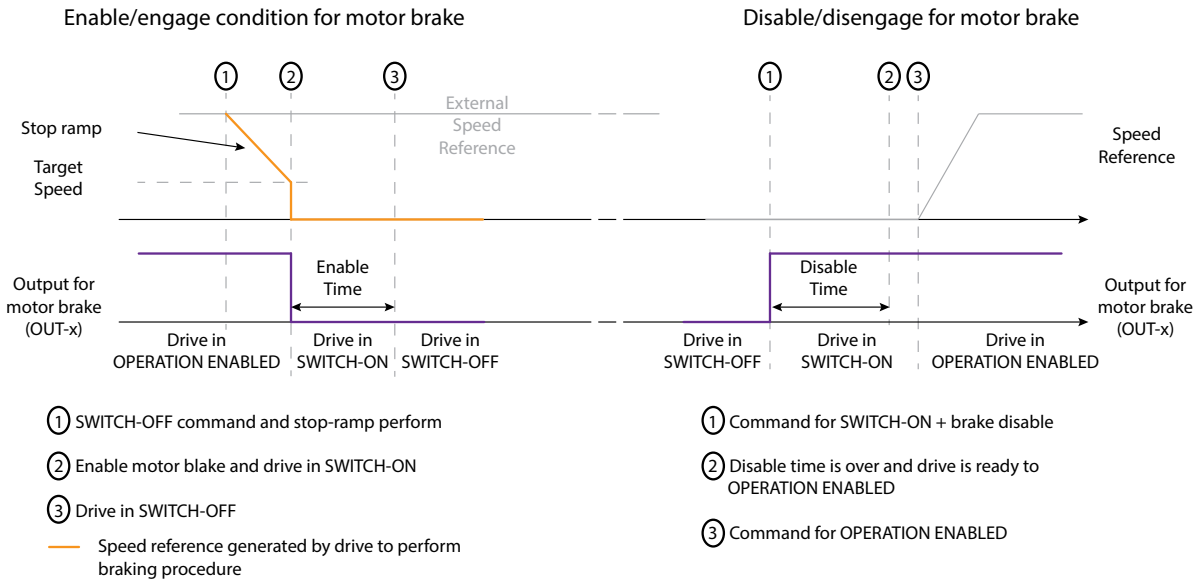
During disengaging brake, drive provides to keep motor rated torque/current. When brake contact is really disengage, drive provides load proper torque/current in order to hold it until 'time brake disable' set is expired.

During disengaging brake, any axis movements may occur, because of mechanical brake disable time and drive PID regulator smartness. For this reason, "Current Offset" parameter is available for pre-applying torque to motor during the brake disable time, in order to avoid axis movements when PID regulators start to operate.

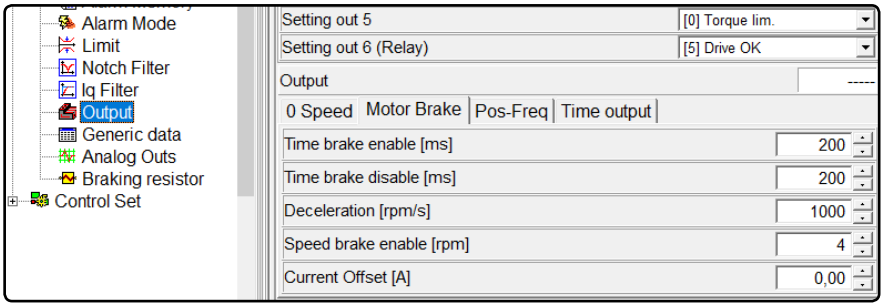
To use correctly the pre-torque function, follow the instruction below:

- set "Current Offset" parameter to 0.
- disengage brake and read the current value provided by the drive to keep load.
- write the current value (with sign value) into "Current Offset" parameter.

The timing-chart for motor brake function is described in the image below:



Output brake function setting and parameter described above are shown in the image below:



NOTES:

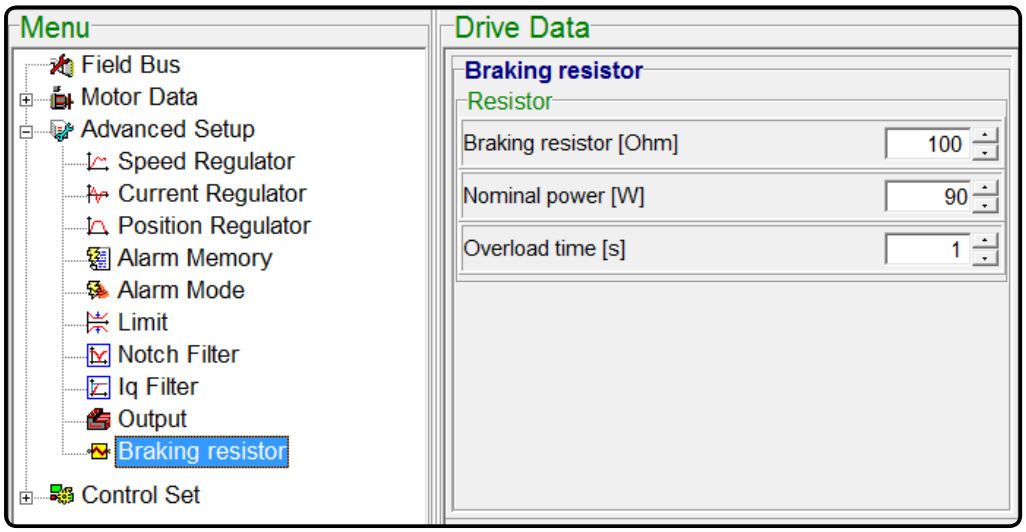
- Drive performs stop following speed reference, not measured speed, in order to engage motor brake also during power stage failure conditions.
- Motor brake function is not available during torque control.
- To ensure that pre-torque function works properly, it's necessary that vertical axis load should be quite constant during all machine working cycle.

6.12 Braking resistor

Into *Advanced Setup* item, into *Braking Resistor* sub-item, drive braking resistor parameters can be set. If braking resistor is provided by H.D.T., all parameters are will be default setting in NTT 240/460 drive.

Parameters are shown below:

- Braking resistor value (from 10Ω to 10000Ω)
- Nominal/rated power (from 30W to 3000W)
- Overload time (from 1s to 255s): time until it's possible to provide to braking resistor a power 10 times grater than rated one.



NOTES:

- To ensure operation during braking conditions, please enter correct parameters related to suitable resistor; please, pay attention to enter correct value to the Overload Time.
- Drive will provide alarm if theoretical calculation for thermal behaviour has detected an overheating of resistor due to an heavy braking cycle not supported by resistor features. For further information, please see *"Ch. 8 Drive status and diagnostics" pag. 120*.
- Other major power resistors are available for heavy braking cycles: for information please contact our technical department.

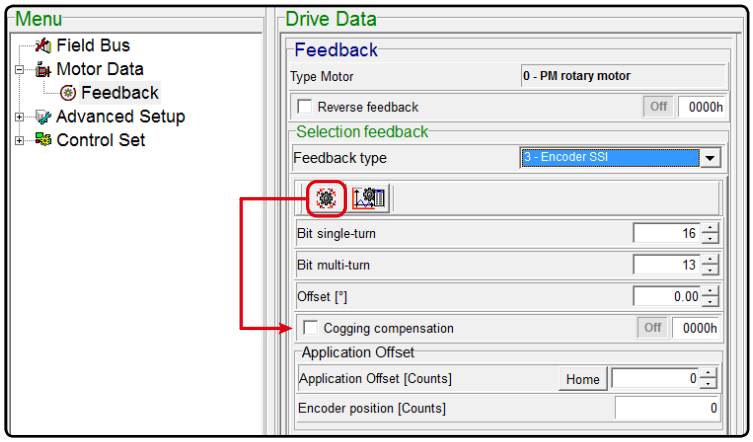
6.13 Motor cogging torque compensation

Motor cogging compensation function lets to get a better accuracy during a torque control reference following.

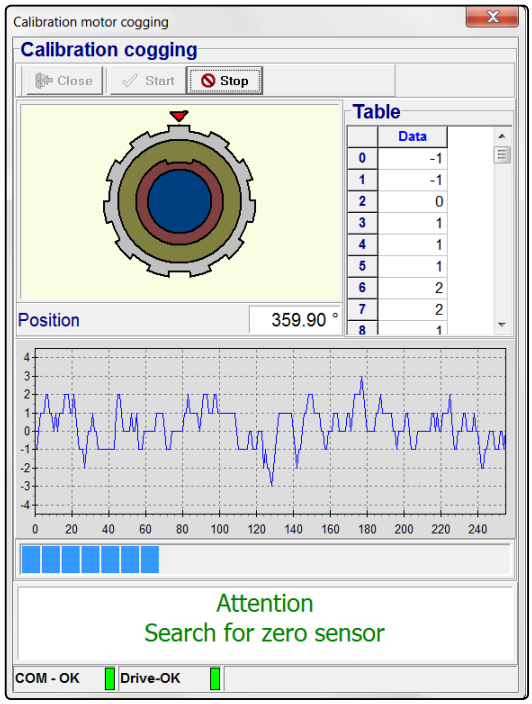
Motor cogging mapping is valid:

- only for rotative motors.
- only for absolute encoder feedback or at least for incremental encoder with zero index (mandatory).
- only for the motor on witch the procedure was performed; in case of motor replacement or encoder rephasing, a new procedure launch is required.

Mapping procedure must be performed only via Caliper software, then the enabling and disabling function can be reached also via fieladbus operation; before starting procedure, rotor must be free to rotate, so ensure to disconnect the load.



Mapping procedure is shown below:



NOTES:

- Advise against using motor cogging compensation during a speed or position control.
- If motor cogging compensation is uded with incremental encoder feedback without ZERO index, procedure will be aborted.

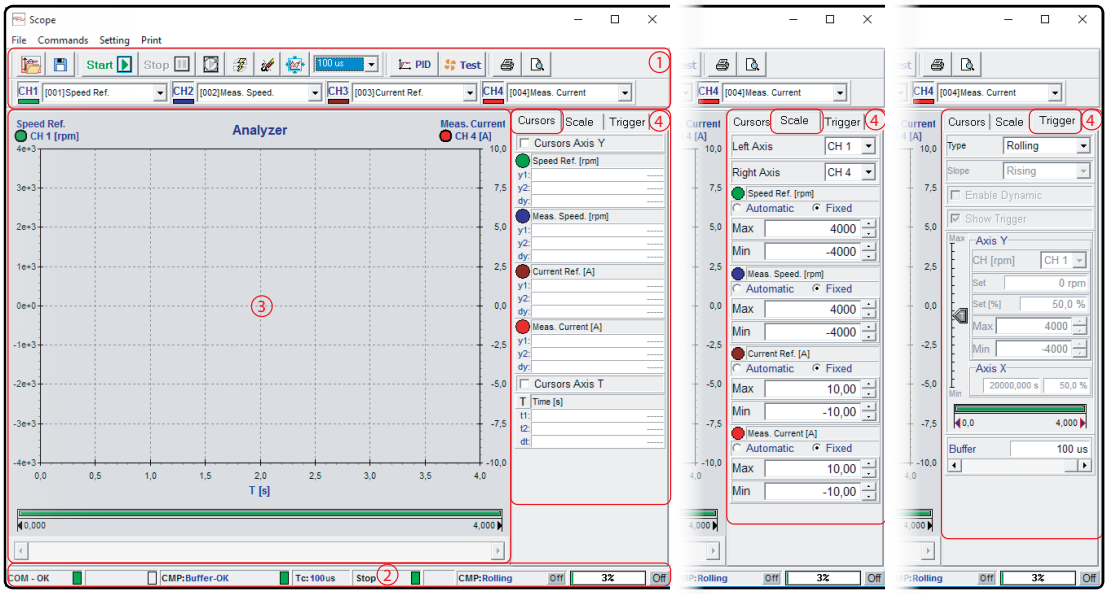
6.14 Scope function

Available on Caliper software, Scope function allows to control drive several variables time trend. It can display up to 4 channel at a time and with a sampling rate up to 100µs.

Scope main screen consists of:

1. a **toolbar** located at the top allows to:
   - open and save in a used PC folder and stamp all display traces.
   - provide Start and Stop acquiring, Refresh data and Erase data commands.
   - configure channels to display and sampling time.
   - configure PID regulator looking at traces during operation mode.
2. a **state bar** located at the lower allows to monitor drive state and to provide information about set trigger type and about PC RAM buffer usage, to receive and trasmit via USB2.0 port.
3. a **display** allows to visualize acquired enable channel data, creating a amplitude-time graph on an adjustable time base, depending on sampling time. It allows graphic zoom by selecting the interested area with the PC mouse.
4. a **setting window** located at the right of display, divided into 3 different item, allows to:
   - enable misure cursor for timebase axis (X axis) and for amplitude axis (Y axis) and to check the realtime value.
   - define visualized variables amplitude resolution (automatic or manual setting).
   - set desired trigger topology between 'Rolling', 'Automatic' and 'One Shot'.

Scope main window is shown below, divided into three separated views for the *setting window*:



NOTES:

- Timebase resolution is adjustable up to a total display time equal to 60000 seconds, depending to choosen sampling time. Buffer is FIFO type, so for this reason first data stored will be lost if monitoring continues besides full time elapsed.
- Channels are enabled pushing '***CHx***' key related to desired channel.
- If comunication buffer, visible on state bar, exceed maximun size (100%), the transmission crashes.
- To mark traced, a color palette is available, pushing the coloured round visible near Channel identification in toolbar.

Main scope icons, in the toolbar, are described below:

Icon	Description
	*Open a saved Scope session*: it opens a previous saved session.  *Save current Scope session in a PC folder.*
	*Start acquiring command*: it starts data acquiring with selected sampling time.  *Stop acquiring command.*
	*Force Scope Trigger*: this icon forces a start acquiring command at pressing. This key is enabled only after *Start acquiring command pressed*. Function is useful when trigger is set in 'Automatic' or 'One shot' mode and allow to crossover trigger setup into *setting window*.  *Restart Trigger:* only in 'One Shot' mode, it allows to restart waiting trigger; This key is enabled only after total acquiring time is elapsed.
	*Erase graph:* it erases actual acquired data or, during monitoring, it restarts acquiring. Stored data will be lost.  *Refresh graph:* restart data acquiring. 
	*Scope channel setting:* it opens a new window to set 4 channels to monitor, choosed from a preset list. It aalows to set channels desired sampling time too.
	*PID setting:* it opens a new window to set PID regulator cefficients in realtime and to enable 'Wave Generator' function.
	*TEST:* it opens a new window to set position target values (from 2 and up to 5 values) used to tune loop gain regulator parameters, in order to test all real automation system performances.

6.14.1 Scope: 'CHANNEL SETTING'

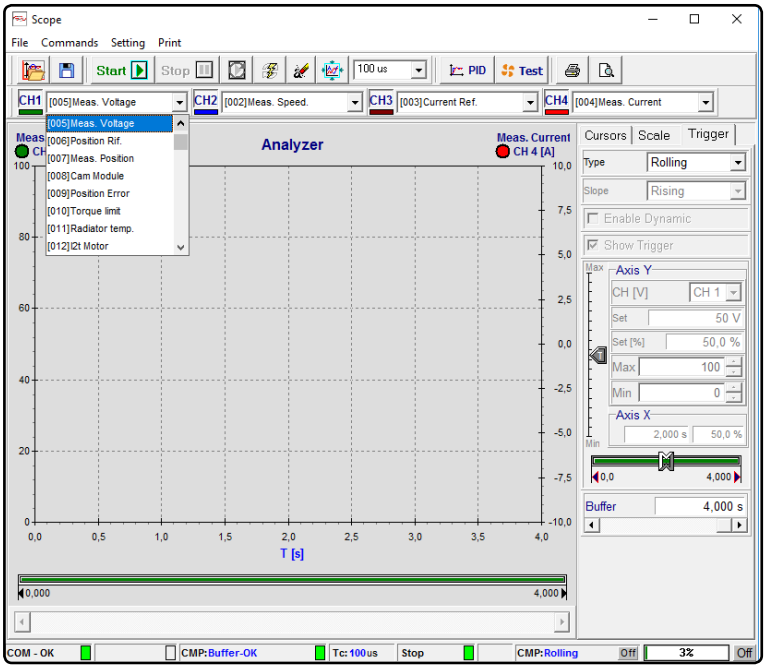
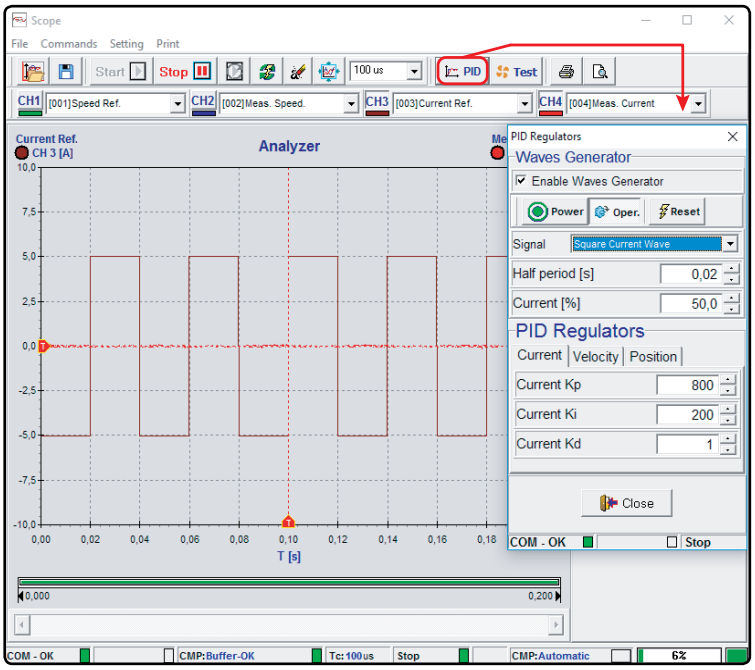


Image nearby shows how to set sampling time and Scope channels, among which the main are:

- *Speed reference and measured speed* (RPM).
- *Current referenceand measured current* (A).
- *Position reference, measured position and position error.*
- *DCbus measured voltage* (V).
- *Torque limit* (%).
- *Heatsink measured temperature* (°C).
- *Drive and motor I2T* (°C).
- *Digital I/O logic status.*
- *Bit-word status for Modbus RTU and Canopen® protocols.*

6.14.2 Scope: 'PID SETTING' and 'WAVE GENERATOR'



Scope allows to use a Wave Generator to create simulated input current/speed references simulati that drive has to follow.

Generated waveforms are settable as shown below:

- square wave
- triangular wave
- sinusoidal wave

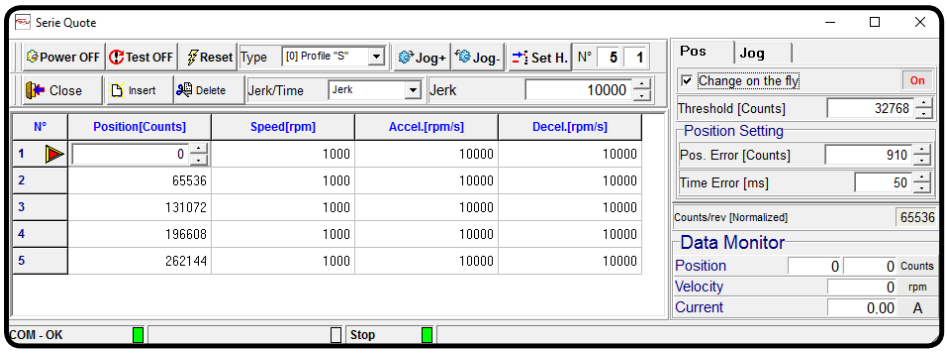
SWITCH-ON, OPERATION ENABLED and RESET commands could be launched directly in this window.

Speed/current reference is created setting desired operating speed/current and waveform period.

If the connected load permits it, speed/current and position regulators could be set in realtime in order to perform tuning for all automation system parameters. For further informations about gain loop tuning, please see *"6.16 Closed loop regulation tuning" pag. 107*.

6.14.3 Scope: 'TEST'

This function allows to set target postion values that drive has to cyclically reach: so this function performs a cyclic positioner simulator. It allows to set operation speed to reach during positioning and to set CW/CCW acceleration and deceleration ramps .



It allows to set:

- up to 5 target position values.
- following position profile, that can be set as standard ramps with related acceleration and deceleration parameters, and as S ramps with JERK.
- change target on the fly.
- position target values, that can be set as number of turns (revolution parameter) or as angular/linear target to perform respect to an initial offset position and to an operating speed.
- JOG function, with related parameters.
- *Power ON, Test OFF, RESET, JOG* and *Start Quota* commands, that could be launched directly in this window.

If the connected load permits it, speed/current and position regulators could be set in realtime in order to perform tuning for all automation system parameters. For further informations about gain loop tuning, please see *"6.16 Closed loop regulation tuning" pag. 107*.

6.14.4 Scope: 'TRIGGER'

Trigger modes are listed below:

- **Rolling**: in this mode, Scope acquires continuously all enable channel data; trigger menu shown below is disabled.
- **Automatic**: in this mode, Scope acquires data every occured trigger condition; trigger menu is enabled in order to allow setting channel selection, trigger amplitude and position time fopr triggering.
- **One Shot**: in this mode, Scope acquires data once, only when desired condition trigger is occured; trigger menu is enabled in order to allow setting channel selection, trigger amplitude and position time fopr triggering.

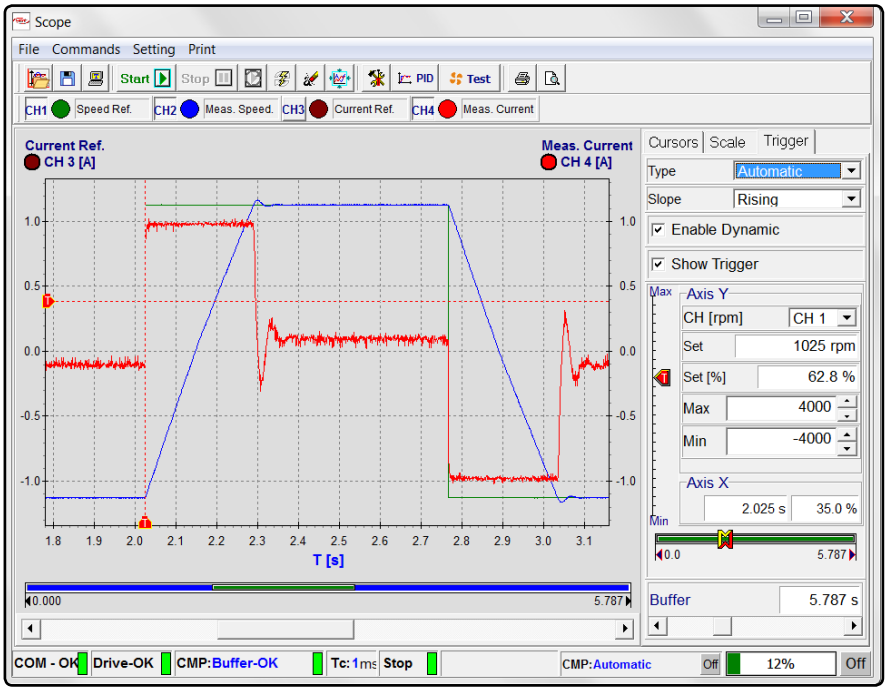
Optional dinamic trigger (Enable Dinamic) allows to visualize data in realtime during acquiring.

Buffer bar, shown at the low of trigger menu, allows to set total or partial data related to time axis up to maximum admitted acquiring time. Decreasing visualization time, only a part of acquired data is shown in Scope, while the resolution is unchanged.

It's recommended to set buffer bar correctly in order to view periodic signals in realtime.

An example of trigger setting and related acquiring condition is shown below; acquiring condition is enabled on channels described below:

1. CH1 - Speed reference: this is the read reference provided to drive into the main speed reference input; trigger will acquire this channel when signal rises beyond threshold set into *trigger set-up window*.
2. CH2 - Measured speed: this signal is the motor speed reading.
3. CH4 - Measured current: this signal is the supplied current reading.



6.15 Control topologies

Torque control: it allows to control the motor torque managed by an analog input reference or a fieldbus command. The provided torque reference is proportional to the rated torque of the motor.

According to the type of reference you work with, in Caliper software it is possible to set different parameters, for example full-scale of analog input, optimal PID controlers for the application and the desired digital I/O.

For further information, please see *"6.15.1 Torque control" pag. 100*.

Speed control: it allows to control the motor speed managed by an analog input, a frequency input or a fieldbus command.

In I/O or Modbus operating mode, it is possible to use an additional analog auxiliary speed reference or a torque limit reference. Therefore, it is possible to work in speed control mode, limiting the maximum torque output by imposing a limit threshold.

Also a sensorles speed control is possible for motor with no feedback on board.

For further information, please see *"6.15.2 Sensored speed control" pag. 101* and *"6.15.3 Sensorless speed control" pag. 102*.

Position control - electronic gearbox: it allows to set a transmission ratio between one or more motors, where a slave axis, or "follower", follows a master axis according to a preset ratio. This ratio is set in the slave drive and can be freely changed.

The movement of the master is measured with an encoder, which signal is sent to the input of the follower drive, that follows according the set ratio. The electronic gearbox replicates the mechanical transmission principle, in the same way that happens in a mechanical reducer/gearbox or in a recirculating ball screw or in a rack or a pulley and belt system.

The transmission with mechanical reduction allows to change speed, to increase torque and helps to match inertia between motor and load. The electronic gearbox function, compared to mechanical reduction/gearbox, only regulates the speed but with the advantage of allowing to freely change and to eliminate backlash and deterioration typical of mechanical systems. It is possible to connect different slave axes to a single master axis, with different electrial gear ratio.

When managing the electrical axis, it is important to calibrate the parameters of slave axis, especially response times, in order to not let the slave to be in late than master dynamics.

For further information, please see *"6.15.4 Position control: electronic gearbox mode" pag. 103*.

Position control - electronic cam: it is a feature that replicate the concept of mechanical cam. The mechanical cam is an element with irregular shape (tipically ovoid) fixed to a rotating shaft of an axis and wihich moves another mechanical parts that follows and reproduces the profile.

In the electronic cam, the mechanical regulation is replaced with electronics. A cam profile is defined via a X/Y table up to 576 interpolation points. Where the cam profile is fixed to master axis, in the electronic cam the profile is stored in the drive. The "slave" axis receives the space reference of the "master" axis and replicates the profile described in the table of X/Y points, generating the resulting motion. The signal of the master axis can come from an external encoder or from the signal of a simulated encoder of another servo axis.

Up to 8 profiles are storable inside drive and they can be set via digital I/O; also it's possible to freely change cam profiles via Modbus RTU fieldbus.

The benefit of the electronic cam compared to the mechanical one is evident in the flexibility to manage more than one profile, to be able to modify the profile very easily in any moment and not least the reduction of mechanical backlash and the corresponding adjustments that follow.

For further information, please see *"6.15.6 Position control: electronic cam mode" pag. 105*.

Position control - integrated positioner: the positioner application generates a speed profile to reproduce a motion trajectory with controlled acceleration and jerk, allowing accurate positioning. The profile calculation is performed in real time allowing to modify on-the-fly the position target. This allows to manage in a fast way different motion profiles.

The positioner provides also a functionality called "index stop" that allows to perform a controlled position stop when a sensor signal is detected by a digital input of the drive during the execution of the trajectory.

For further information, please see *"6.15.5 Position control: positioner mode" pag. 104*.

Positioner application is divided into 4 selectable modes:

- *Single target positioner:* this mode can be activated both with digital/analog input and with all fieldbuses. The drive configured in this way allows to generate a trajectory profile only for a target defined as position target, with speed, acceleration, decelaration and jerk. The positions can be absolute or relative. Using the fieldbuses, all parameters can only be set on the fly by telegram; only the Modbus RTU allows to work with maximum flexibility using both modbus commands and digital/analog input commands. In case a fieldbus is not available, position and speed can be set in analog mode via the related input, while the other parameters can be set via Caliper software.
- *Target table positioner:* this mode can be activated both with digital/analog inputs and with Modbus RTU and ProfiNet RT. The positioner allows to manage a maximum of 64 targets. As with the single target, for each target it is possible to set position, speed, acceleration and jerk. The positions can be absolute or relative. The targets are wrote in a table on the drive via Caliper or via fieldbus. The targets can be executed individually or linked in different ways allowing to generate more complex profiles. It is possible to cycle automatically the series of linked targets and to interpose a waiting time between one target and the other.
- *Cyclic positioner:* this mode is similar to the target table positioner, with the difference that the targets are rigidly executed one after the other. The targets can be activated manually via I/O or via Modbus RTU. The option to make the sequence of set dimensions cyclical is provided.
- *"Input-start" positioner*: this mode allows to synchronize the starting of an axis with the position reached condition of another axis, without the necessity to use a PLC. It is different from the previous one because the input that selects the target or the group of linked targets also becomes the start command of the target itself. The "reached position" signal can be activated on each of the digital output of the drive. Therefore, connecting one of the output of reached target of a drive to the "input-start" digital input of another drive, it allows the synchronized starting of the latter. This mode only works with digital/analog inputs and with Modbus RTU fieldbus.

Pressure control - servo press application: designed expressly for applications that use servo-pumps like in presses and plastic injection machine, which are applications that combine an idraulic system with an electrical regulation via servodrive and brushless motor.

By activating this mode on NTT 240/460 servodrives, three inputs are enabled: the first input for the speed reference signal is used to regolate the speed of a motor connected to a pump, and so the respective flow; the second input is enabled to receive the pressure reference signal, and the third input is enabled for the pressure transducer signal (pressure feedback). The two pressure signals are compared and the servodrive operates the control of speed to maintain the real pressure equal to the reference.

The pairing of NTT 240/460 with a brushless servomotor. thanks to this application, allows to replace a traditional system with pump and asynchronous motor, obtaining an incredible benefit in the system efficiency and minimal response times that allow a very accurate control and repetibility with considerable improvement in the accuracy of moulding process.

Energy consumption is drastically reduced, oil temperature is reduced (reducing also radiators system), idraulic system is simplified thanks to the elimination of proportional valve and the pressure and flow control is improved, that are reflected on the product quality.

The drastic energy saving is due to the fact that NTT 240/460 allows to stop the motor maintaining the system pressure with a near-zero power consumption, while in the traditional systems with asynchronous motor , the motor heve to rotate at fixed speed around 1500rpm to maintain the system pressure even if the application is not working.

Furthermore, among the motors, the brushless is the one with higher efficiency, with values around 95%. Not least, the system is much more silent and with lower size.

For further information, please see *"6.15.7 Pressure control" pag. 106*.

6.15.1 Torque control

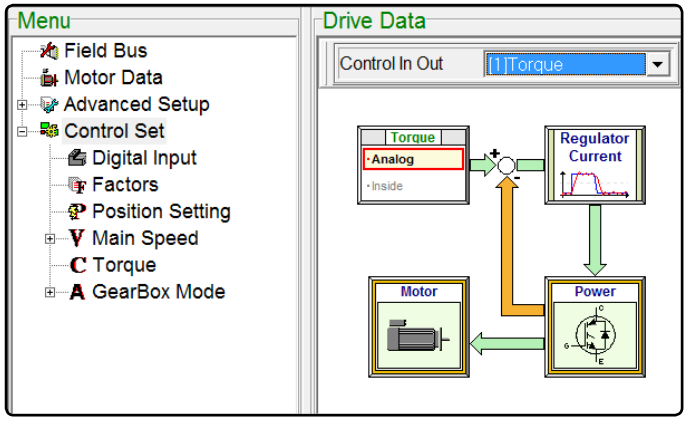
Operation conditions:

- control is available with any supported motor type and with any supported feedback, except for sensorless (also only Hall sensor feedback is not recommended).
- main torque reference can be analog or inside reference and fieldbus reference available for I/O, Modbus, Canopen, Ethercat and Pro operation mode.
- about regulation, only current regulator is available.
- brake motor management not available.
- ramps not available.

During torque control mode, the percentage of set torque is reffered to motor parameter called '*Nominal Current*'.

The following image shows an example of setting of a torque control working with I/O mode, then you can set:

- the type of reference: analog/inside mode in case of I/O and Modbus mode, or fieldbus prameters (in the case shown in picture the reference of torque is analog).
- the setting of full scale for the analog inputs.
- optimal PID regulators for application.
- desired digital I/O.



In order to obtain a correct operation, please ensure to perform Factors calculation procedure: please see *"6.05 Factors" pag. 73*.

See *"Ch. 5 Wiring and connections" pag. 26* for more details about connectors:

» **J5-6 connector**: for feedback connection, see:

1. *"6.03.2.e Incremental encoder with/without HALL sensors" pag. 57*
2. *"6.03.2.g SSI absolute encoder" pag. 58*
3. *"6.03.2.i Resolver" pag. 59*

» **J3 and J7-8-9 connector**:

1. provide the main torque reference in the differential input (pins 1-2 of J9). For details about input reference, please see *"6.09 Drive references" pag. 87*.
2. for fieldbus operation modes, connect J3 connector and see related fieldbus manuals for information about all control topology parameters.
3. connect the appropriate input and output signals (please see *"6.08 Digital I/O" pag. 83*).

6.15.2 Sensored speed control

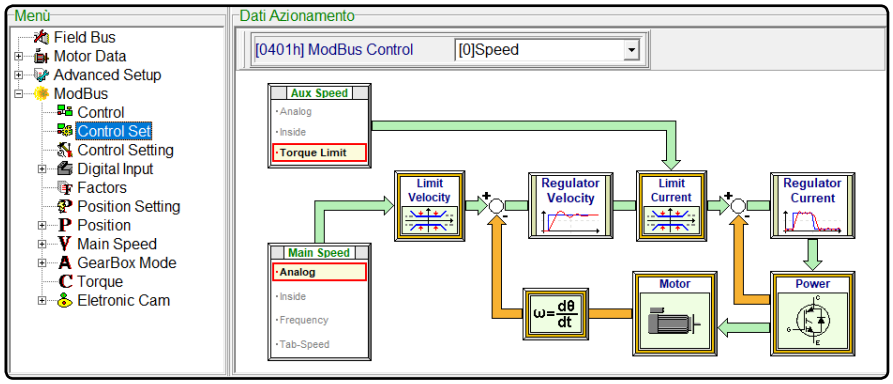
Operation conditions:

- control is available with any supported motor type and with any supported feedback (also Hall sensor feedback is recommended for low performance application only).
- main speed reference can be analog, inside or frequency reference and fieldbus reference available for any operation mode.
- auxiliary speed reference or torque limit reference are available for I/O and Modbus RTU operation mode only.
- about regulation, speed/current regulators are available.
- brake motor management is available.
- trapezoidal ramps and "S"-ramps are available.

During speed control with torque limit, the percentage of set torque is reffered to motor parameter called '*Nominal Current*'.

The following image shows an example of setting of a speed control, with torque limit, working in Modbus RTU mode, then you can set:

- the reference type: analog/inside/frequency/tab. selection for I/O and Modbus mode or or fieldbus prameters (in the case shown in picture, speed and torque reference are analog).
- full scale for analog analog inputs.
- optimal PID regulators for application.
- desired digital I/O.



In order to obtain a correct operation, please ensure to perform Factors calculation procedure: please see *"6.05 Factors" pag. 73*.

See *"Ch. 5 Wiring and connections" pag. 26* for more details about connectors:

» **J5-6 connector**: for feedback connection, see:

1. *"6.03.2.e Incremental encoder with/without HALL sensors" pag. 57*
2. *"6.03.2.f HALL sensors only" pag. 57*
3. *"6.03.2.g SSI absolute encoder" pag. 58*
4. *"6.03.2.i Resolver" pag. 59*

» **J3 and J7-8-9 connector**:

1. provide the main speed reference in the differential input (pins 1-2 of J9) or the frequency reference (pins 1 to 6 of J7) or fill the target speed table-selection. For details about input reference, please see *"6.09 Drive references" pag. 87*.
2. provide the auxiliary reference for torque limit control or for second speed reference (pin 3-4 of J9). For details about input reference, please see *"6.09.2 Auxiliary references" pag. 88*.
3. for fieldbus operation modes, connect J3 connector and see related fieldbus manuals for information about all control topology parameters.
4. connect the appropriate input and output signals (please see *"6.08 Digital I/O" pag. 83*).

6.15.3 Sensorless speed control

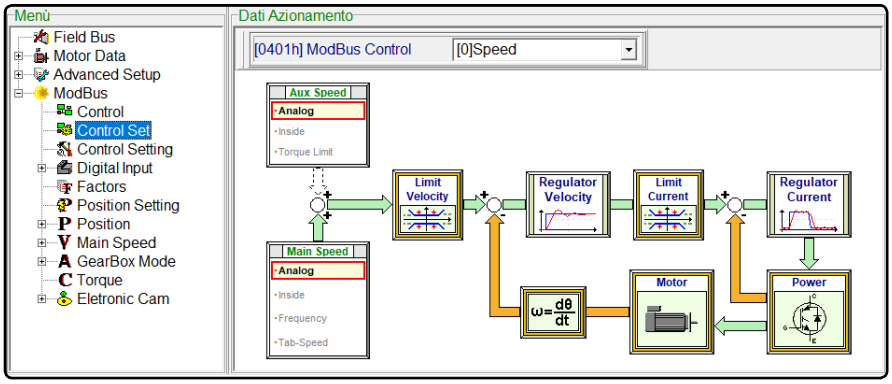
This control topology is designed only for applications that require medium-low performance where speed and position accuracy are not strictly necessary.

Operation conditions:

- control is available with rotary brushless or asynchronous motor type only.
- main speed reference can be analog, inside or frequency reference and fieldbus reference available for any operation mode.
- auxiliary speed reference for I/O and Modbus RTU operation mode only.
- about regulation, standard speed/current regulators are available and also sensorless regulators for brushless and asynchronous motors.
- brake motor management is not available.
- trapezoidal ramps are available.

The following image shows an example of setting of a speed control working in Modbus RTU mode, then you can set:

- the reference type, analog mode in case of Input / Output mode and Modbus RTU mode or internal mode in case of fieldbus (in the case shown in picture, speed and torque reference are analog).
- full scale for analog analog inputs.
- optimal standard and sensorless PID regulators for application.
- desired digital I/O.



In order to obtain a correct operation, please ensure to perform Factors calculation procedure: please see *"6.05 Factors" pag. 73*.

See *"Ch. 5 Wiring and connections" pag. 26* for more details about connectors:

» **J5-6 connector**: for feedback connection, see:

1. *"6.03.2.h Sensorless" pag. 58*

» **J3 and J7-8-9 connector**:

1. provide the main speed reference in the differential input (pins 1-2 of J9) or the frequency reference (pins 1 to 6 of J7) or fill the target speed table-selection. For details about input reference, please see *"6.09 Drive references" pag. 87*.
2. provide the auxiliary reference for second speed reference (pin 3-4 of J9). For details about input reference, please see *"6.09.2 Auxiliary references" pag. 88*.
3. for fieldbus operation modes, connect J3 connector and see related fieldbus manuals for information about all control topology parameters.
4. connect the appropriate input and output signals (please see *"6.08 Digital I/O" pag. 83*).

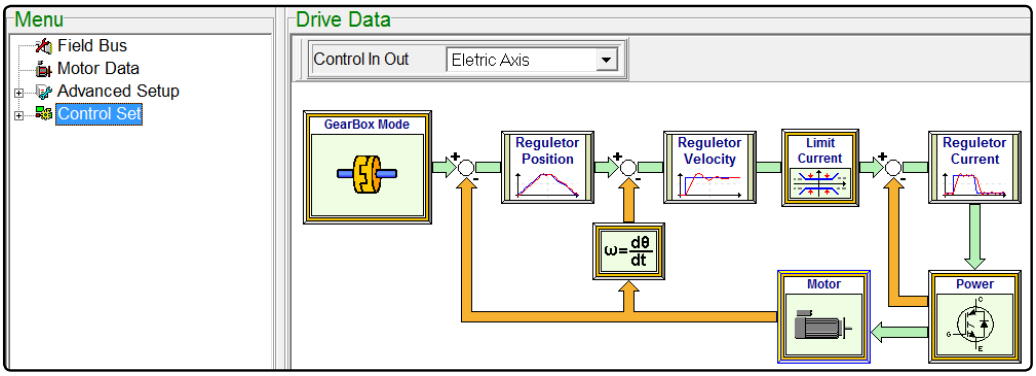
6.15.4 Position control: electronic gearbox mode

Operation conditions:

- control is available with any supported motor type and with any supported feedback, except for sensorless (Hall sensor feedback is not recommended).
- main position reference can be only frequency reference: CHA-CHB, Pulse-Direction and CW-CCW.
- control is available for I/O, Modbus RTU, Canopen and Ethercat operation mode.
- about regulation, position/speed/current regulators are available.
- brake motor management is available.
- trapezoidal ramps are available.

The following image shows an example of I/O setting, then you can set:

- axis ratio: numerator (NUM) and denominator (DEN).
- master device pulse number ($PULSE_{master}$): it provides to slave the information about master device pulse number.
- engage, disengage and phase shift for slave axis parameters and also Homing and JOG parameters.
- optimal PID regulators for application.
- desired digital I/O.



Therefore, number per turn performed by slave device, depending on frequency signal received, is shown below:

$$N^{\circ}turn_{slave} = \frac{PULSE_{input}}{PULSE_{master}} \cdot \frac{NUM}{DEN}$$

Ratio between pulse number, read by slave drive ($PULSE_{input}$), and set master pulse number ($PULSE_{master}$) provides information about axis position of master device, whereas ratio between NUM and DEN provides information about percentage axis position in turn of slave device related to master position in turn.

In order to obtain a correct operation, please ensure to perform Factors calculation procedure: please see *"6.05 Factors" pag. 73*.

See *"Ch. 5 Wiring and connections" pag. 26* for more details about connectors:

» **J5-6 connector**: for feedback connection, see:

1. *"6.03.2.e Incremental encoder with/without HALL sensors" pag. 57*
2. *"6.03.2.g SSI absolute encoder" pag. 58*
3. *"6.03.2.i Resolver" pag. 59*

» **J3 and J7-8-9 connector**:

1. provide the main position reference (pins 1 to 6 of J7). For details about input reference, please see *"6.09 Drive references" pag. 87*.
2. for fieldbus operation modes, connect J3 connector and see related fieldbus manuals for information about all control topology parameters.
3. connect the appropriate input and output signals (please see *"6.08 Digital I/O" pag. 83*).

6.15.5 Position control: positioner mode

"Positioner" mode is settable as following:

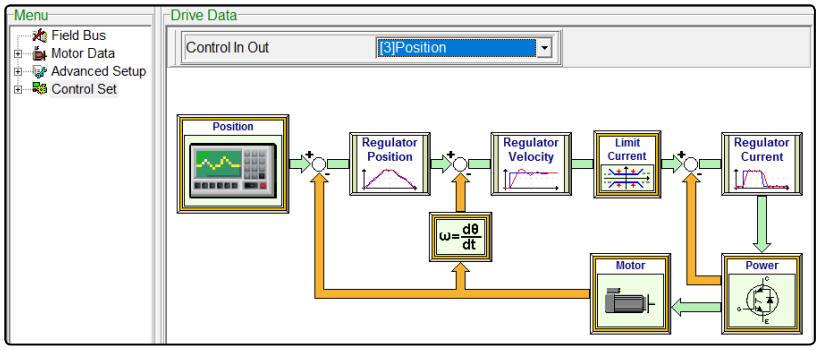
1. *Single target positioning:* available for any operation mode. Parameter target position with internal or main analog speed reference (for I/O and Modbus) or fieldbus parameters.
2. *Analog main reference positioning (12bit)*: available for I/O and Modbus operation mode. Setting minimum target position and maximun target position parameters, drive performs positioning between this two values following the 12 bit AUX1 analog reference range, with analog or internal speed reference.
3. *Up to 64 target table selection positioning via digital input or via Profinet parameter*: available for I/O, Modbus, Profibus and Profinet operation mode. At every start command, drive performs positioning at target identified via binary digital input combination (I/O and Modbus) or via fieldbus addresses.
4. *Up to 64 target cyclic/acyclic table positioning*: available for I/O and Modbus. At every start command, drive performs cyclic or acyclic positioning between target set inside table.
5. *Up to 64 target table positioning via input start*: available for I/O and Modbus. At every edge transition (Low to High) of the enabled input, it performs related target set in the table.

Operation conditions:

- control is available with any supported motor type and with any supported feedback, except for sensorless (also Hall sensor feedback is not recommended).
- about regulation, position/speed/current regulators are available.
- brake motor management is available.
- trapezoidal ramps and "S"-ramps are available.

The following image shows an example of I/O setting, then you can set:

- desired position application type and position profile type between trapezoidal or ramps with/without JERK.
- recovery position and End position pocedures and limit switch, homing and JOG parameters.
- optimal PID regulators for application.
- desired digital I/O configuration.



In order to obtain a correct operation, please ensure to perform Factors calculation procedure: please see *"6.05 Factors" pag. 73*.

See *"Ch. 5 Wiring and connections" pag. 26* for more details about connectors:

» **J5-6 connector**: for feedback connection, see:

1. *"6.03.2.e Incremental encoder with/without HALL sensors" pag. 57*
2. *"6.03.2.g SSI absolute encoder" pag. 58*
3. *"6.03.2.i Resolver" pag. 59*

» **J3 and J7-8-9 connector**:

1. for positioning with analog speed reference, provide main speed reference in the differential input (pins 1-2 of J9). For details about input reference, please see *"6.09 Drive references" pag. 87*.
2. for analog positioning, provide position analog reference +/-10V (pin 3-4 of J9). For details about input reference, please see *"6.09.2 Auxiliary references" pag. 88*.
3. for fieldbus operation modes, connect J3 connector and see related fieldbus manuals for information about all control topology parameters.
4. connect the appropriate input and output signals (please see *"6.08 Digital I/O" pag. 83*).

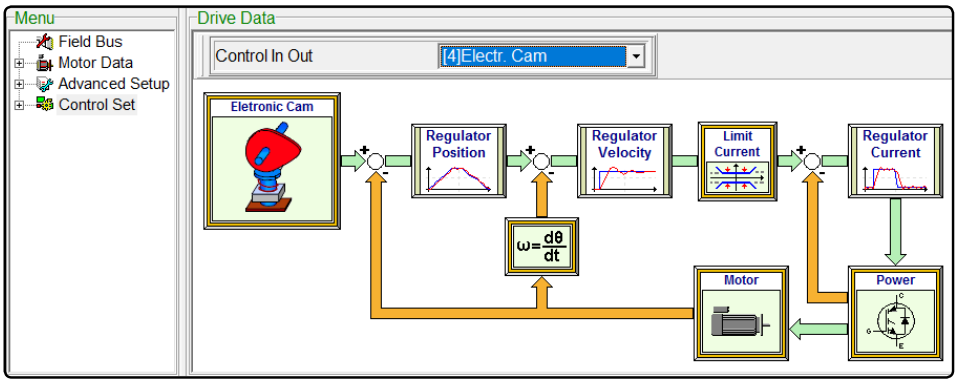
6.15.6 Position control: electronic cam mode

Operation conditions:

- control is available with any supported motor type and with any supported feedback, except for sensorless (also Hall sensor feedback is not recommended).
- main position reference can be only frequency reference: CHA-CHB and Pulse-Direction
- control is available for I/O and Modbus operation mode.
- about regulation, position/speed/current regulators are available.
- brake motor management is available.
- trapezoidal ramps are available.

The following image shows an example of I/O setting, then you can set:

- up to 8 cam tables and up to 576 points per cam with linear or cubic interpolation.
- axis rate (Numerator e Denominator) and Master and Slave Module pulses for every cam.
- engage, disengage and phase shift position parameters for slave axis, Homing and JOG parameters.
- desired I/O configuration and optimal PID regulators for application.



This operating mode allows a control in space of axis related to a space reference acquired from encoder, conditioned by the values of "Encoder Numerator" and "Encoder Denominator". This function can be used in application that require to follow special curves such as Packaging machines, Flying saw, Flying shear, Cut to Lenght and more.

The "Master module" indicates master encoder pulse number used to calculate shape of cam profile. The result of the division of "Master module" and "Number of table points" gives the space range between two consecutive points of the table. The profile of the cam between two points is calculated using a cubic interpolation.

The "Slave module" represent the excursion of the cam measured in terms of resolver pulses (the numbers of resolver pulses in a single revolution of the motor shaft is 65535), Every point of the cam table (that can range from 0 to 65535) is multiply for the "Slave module" and divided for 65536, in this way every point of the cam table can take an effective value ranging from 0 and "Slave module ".

$$\Delta space_{\cdot cam.point} = \frac{MODULE_{MASTER}}{N°_{table.point} - 1} \qquad Value_{\cdot cam.point} = \frac{MODULE_{SLAVE} \cdot Value_{\cdot table.point}}{65536}$$

In order to obtain a correct operation, please ensure to perform Factors calculation procedure: please see *"6.05 Factors" pag. 73*.

See *"Ch. 5 Wiring and connections" pag. 26* for more details about connectors:

» **J5-6 connector**: for feedback connection, see:

1. *"6.03.2.e Incremental encoder with/without HALL sensors" pag. 57*
2. *"6.03.2.g SSI absolute encoder" pag. 58*
3. *"6.03.2.i Resolver" pag. 59*

» **J3 and J7-8-9 connector**:

1. provide the main position reference (pins 1 to 6 of J7). For details about input reference, please see *"6.09 Drive references" pag. 87*.
2. for fieldbus operation modes, connect J3 connector and see related fieldbus manuals for information about all control topology parameters.
3. connect the appropriate input and output signals (please see *"6.08 Digital I/O" pag. 83*).

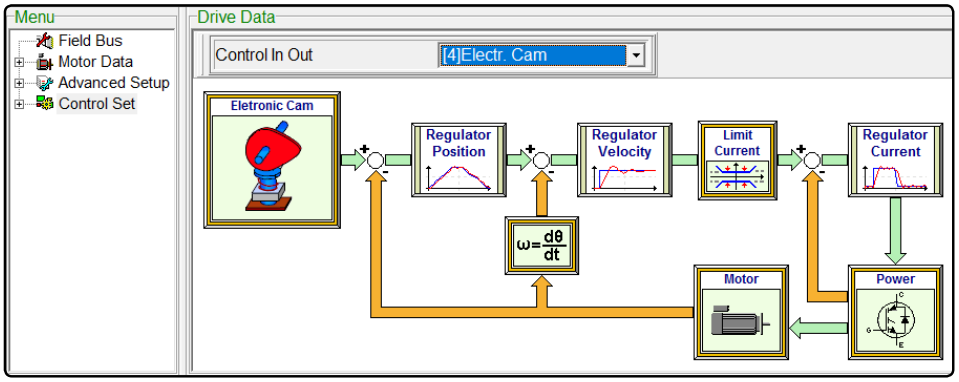
6.15.7 Pressure control

Operation conditions:

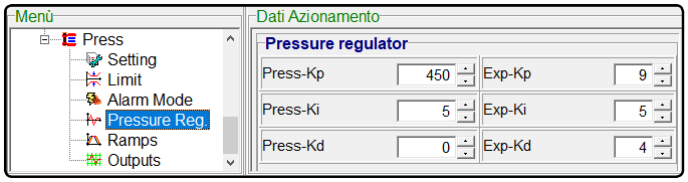
- control is available with any supported motor type and with any supported feedback, except for sensorless (also Hall sensor feedback is not recommended).
- control is available for all operation mode.
- pressure transducer feedback is only available via analog input for all operation mode.
- pressure and speed references via analog input or via fieldbus operation.
- about regulation, pressure/speed/current regulators are available.
- brake motor management is available.
- trapezoidal ramps and "S" ramps are available for speed and pressure.

The following image shows an example of I/O setting, then you can set:

- type and fullscale for pressure reference or feedback, and speed/pressure ramps.
- speed, current and pressure limit, and overpressure and underpressure alarm threshold.
- desired I/O configuration and optimal current/speed PID regulators for application.



- Pressure PID regulator management shown a further exponential (2^) multiplier parameter useful during the tuning of the pressure loop regulation to appreciate visible variations. Default parameter set is a good compromise for the most servo press applications.



In order to obtain a correct operation, please ensure to perform Factors calculation procedure: please see *"6.05 Factors" pag. 73*.

See *"Ch. 5 Wiring and connections" pag. 26* for more details about connectors:

» **J5-6 connector**: for feedback connection, see:

1. *"6.03.2.e Incremental encoder with/without HALL sensors" pag. 57*
2. *"6.03.2.g SSI absolute encoder" pag. 58*
3. *"6.03.2.i Resolver" pag. 59*

» **J3 and J7-8-9 connector**:

1. for I/O operation mode, please see *"6.09 Drive references" pag. 87*:
   - provide pressure transducer feedback in the differential input +/-10V (pins 1-2 of J9).
   - provide pressure reference in the AUX1 differential input +/-10V (pins 3-4 of J9).
   - provide speed reference in the AUX2 differential input +/-10V (pins 5-6 of J9).
2. for fieldbus operation modes:
   - provide pressure transducer feedback in the differential input +/-10V (pins 1-2 of J9).
   - connect J3 connector and see related fieldbus manuals for information about all control topology parameters.
3. connect the appropriate input and output signals (please see *"6.08 Digital I/O" pag. 83*).

6.16 Closed loop regulation tuning

The tuning procedure is essential to obtain stability and performance of the entire controlled system; the drive, that performs the control, has PID controller both for the current loop that for the speed loop.

To perform tuning, please use Caliper software and observe some variables with Scope during operation (see *"6.14 Scope function" pag. 94*).

The following tuning procedure provides good results in most types of controlled systems, if following conditions are met:

- drive must be able to provide motor rated current.
- load inertia is 6 times grater than motor, maximum.

6.16.1 Current loop tuning

If drive controls an H.D.T. motor, the optimum PID current regulator setting is stored in a motor configuration file, in the directory to save data in PC used*.

To perform PID current tuning, *it is not essential that the load remains connected to the motor*.

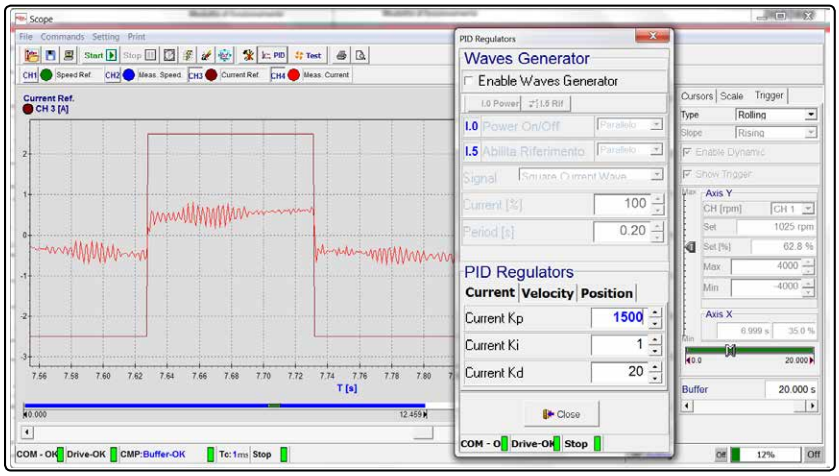
If third parts motor is used, it's recommended to perform motor autophasing *both before and after the PID current tuning* (see *"6.07 Motor autophasing" pag. 82*). Please use an appropriate mechanical brake, in the case of vertical axis load (safety condition required during current loop tuning, due to automatic 90° motor phase autoshifting in order to avoid providing torque.

To perform tuning, please do the following:

1. **generate a square wave current reference**: use 'Wave Generator' function into Caliper software to create desired reference (see *"6.14 Scope function" pag. 94*). Provide to drive a reference with rated motor current amplitude and period set between 0.05seconds and 0.1seconds.

In this operation, drive provides the rated motor current, so the motor could reach high case temperature.

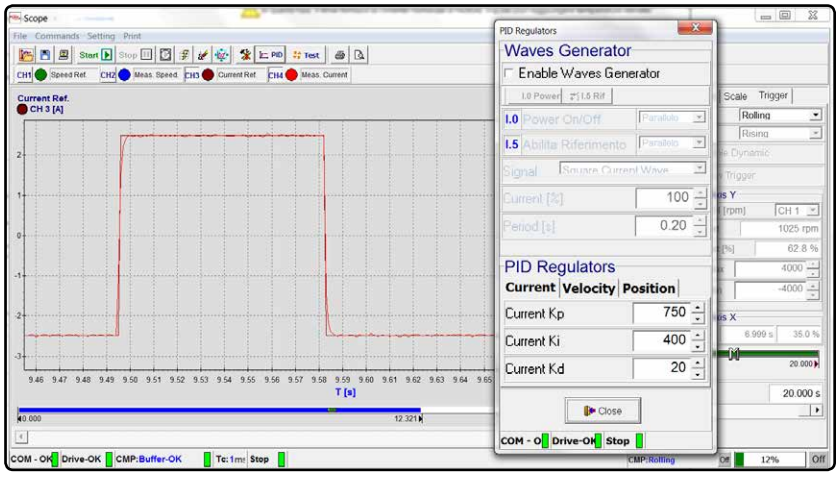
2. **PID current setting**: parameters to set are K_p e il K_I.
   - ***set K_I = 1***: integral action erased.
   - ***increase gradually K_p until current resonance appears:*** in this condition, an evident current resonance appears in Scope visualization (besides, this condition leads to a motor unusual noise).



   - ***halve K_p value***: halving K_p, system avoids oscillation in transient conditions.
   - ***increase gradually K_I***: increase until misured current variable accurately follows the desired current reference. In any case, K_I parameter should not be greater than ***60% of K_p*** previously set.

*To get PID current configuration data related to H.D.T. motor, please contact our technical department.

An optimal current loop tuning is shown in picture below:



At the end of PID current tuning, if a third parts motor is used, please perform a 'Motor Autophasing' (see *"6.07 Motor autophasing" pag. 82*).

NOTES:

- K_p and K_i optimum values could vary greatly depending on application.
- In high inertia systems, resonance may not occur at any K_p values lower than maximum set value (2000). In these cases, set K_p equal to 1000 and increase K_i until misured current variable accurately follows the desired current reference: repeat entire operation erasing K_i and increasing K_p at step of 200.
- In any case, it's recommended to set $K_p \leq 1800$.

6.16.2 Speed loop tuning

Speed loop tuning must be performed with load connected because time constants depend on dinamic system to control.

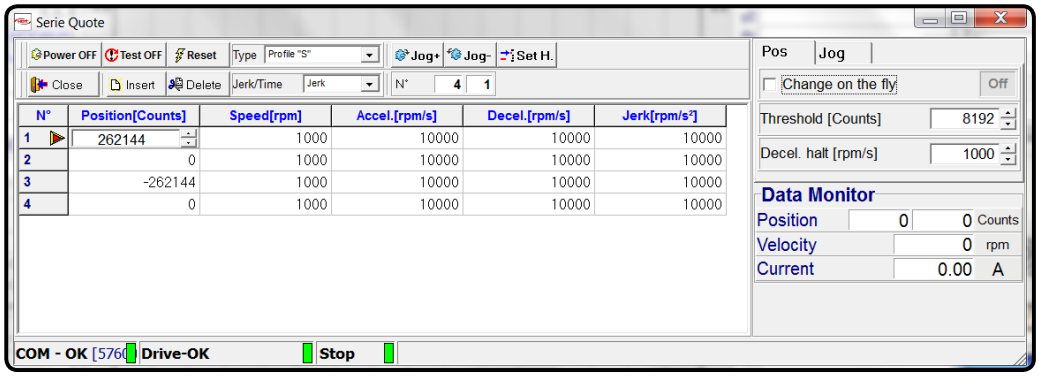
Speed loop tuning must be performed after current loop tuning and execution step are similar.

It's recommended to perform motor autophasing *before speed loop tuning* (see *"6.07 Motor autophasing" pag. 82*).

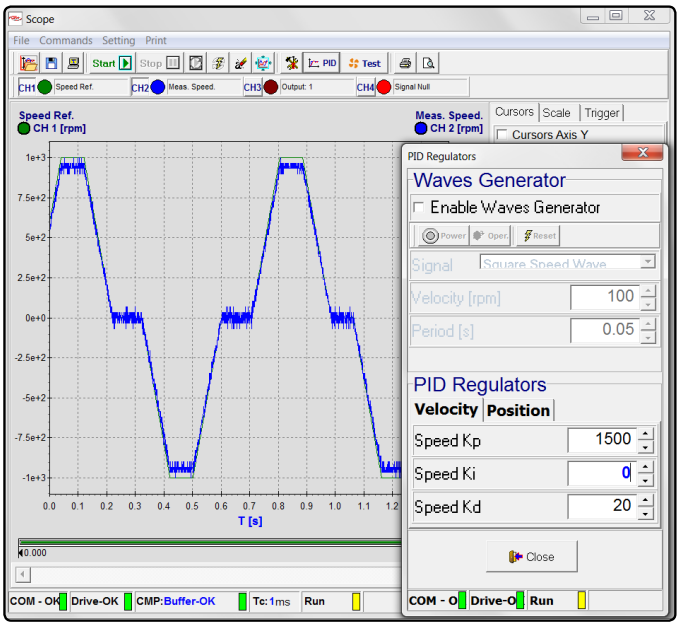
To perform tuning, please do the following:

1. **generate appropriate cyclic target position**: use 'TEST' function into Caliper software to create desired reference (see *"6.14 Scope function" pag. 94*). Set target position with appropriate acceleration and deceleration parameters according to system dinamic, as shown in the image below:

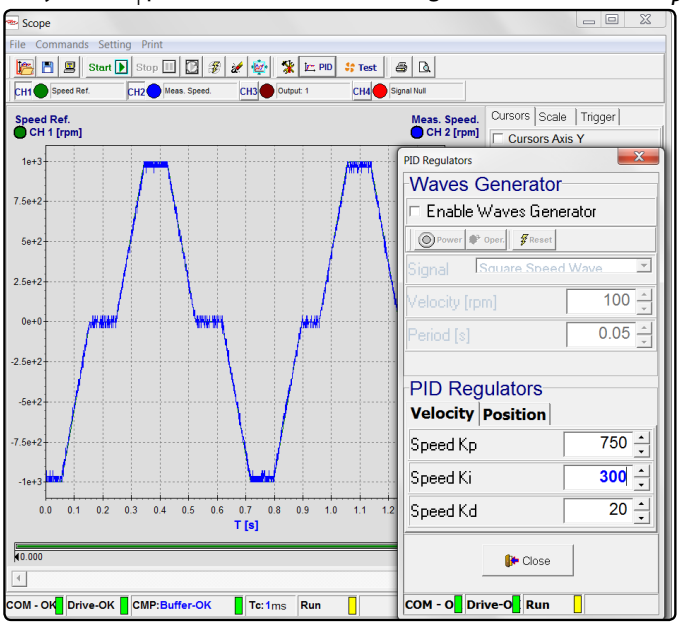
   In these conditions, drive follows a speed and cyclic position reference with ramp parameters: please, pay attention to load during operation.



2. **PID speed setting**: parameters to set are K_p e il K_i.
   - ***set K_i = 0***: integral action erased.
   - ***increase gradually K_p until until speed resonance appears***: in this condition an evident speed error and resonance appear in Scope visualization (besides, this condition leads to a motor unusual noise).

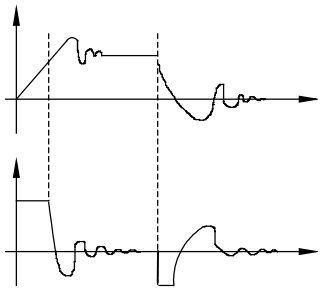


   - ***halve K_p* value**: halving K_p, system avoids oscillation in transient conditions..
   - ***increase gradually K_i***: increase until misured speed variable accurately follows the desired speed reference. In any case, K_i parameter should not be greater than ***40% of K_p*** previously set.



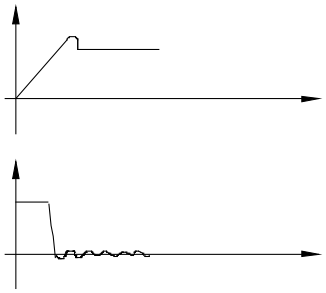
When observing the behavior of the load corresponding to the reference changes, please keep a waveform responce as possible without overshoot (low gain set), but also with enough performance (high gain set). Therefore tuning is always the result of compromises between stability and performance.

Images below show tipical step of fisical closed loop system (current loop in the image at the low of graph and speed in the image above of graph).



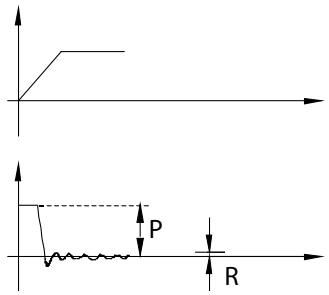
- *Step responce with low proporzional gain:* internal current reference, provided by speed regulator, is too slow andlead to overshoots around the constant condition reference, before get stability.

  Note that, in correspondence with current reference variation (origin of the axes), current loop responds correctly without overshoots; then the problem is caused by speed control gain.



- *Step responce with acceptable proporzional gain*: current reference is fast enough and speed step responce shows anly one overshoot.

  In these cases, a too high integral gain, could leads to get more speed overshoots.



- *Step responce with optimum gain*:

  This condition leads to get performance and stability of system.

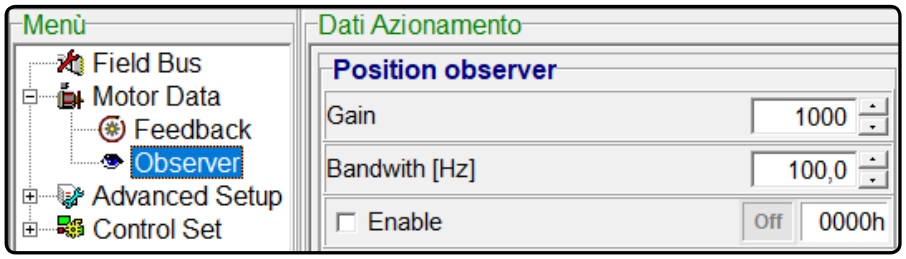
  It's recommended that noise amplitude *R* is lower than 15% of peak drive current value.

6.16.3 Position observer tuning

Observer function allows to filter motor position information in order to reduce application noise due to speed loop ruggedness, while maintaining sufficiently static and dinamic performances. This function is very usefull when motor provide a low resolution feedback (lower than 1000ppr) or with Hall sensor only applications.

Observer function is available with all supported feedback type (sensorless not supported).

Position observer tuning must be performed with load connected to motor and only after speed loop tuning is correctly done.



Usefull parameters are a Gain and a Bandwidth; the major filtering effect is due to bandwidth parameter, while observer responce is due to gain parameter, whose default value is correctly set for a lot of application.

For a correct and safety tuning, it's recommended to start with high bandwidth value, for example 300Hz where observer filtering is very low, then decrease this parameter gradually untill the application noise reduction desired is obtained.

⚠ Decreasing parameters excessively could lead to instability condition and to loss of motor controll, with consequently risk of damage equipment.

6.17 Sensorless loop tuning

The tuning procedure is necessary in order to obtain entire system ***stability***; drive uses the internal current and speed loop regulator and the sensorless loop regulator together.

To perform the procedure, Caliper software is necessary to observe some variables in Scope function during the drive operation (please see *"6.14 Scope function" pag. 94*).

The following tuning procedure provides good results in most types of controlled systems, if following conditions are met:

- drive must be able to provide motor rated current.
- load inertia is 6 times grater than motor, maximum.
- speed ramps must be enabled and lower than 5000RPM/s.

6.17.1 Setting speed/current loop and motor parameters

» Regarding motor data, it's necessary to enter these parameters into *Motor Data* menu:

- *Motor PHASE resistor value* in Ω. ATTENTION: If motor datasheet provides PHASE to PHASE resistor, please enter that halved parameter.
- *Motor PHASE Inductance* (*Synchrony*) in mH. ATTENTION: If motor datasheet provides PHASE to PHASE inductance, please enter that halved parameter.
- *Magnetic flux* (*Magnet Flow*) in Wb using the following formula:

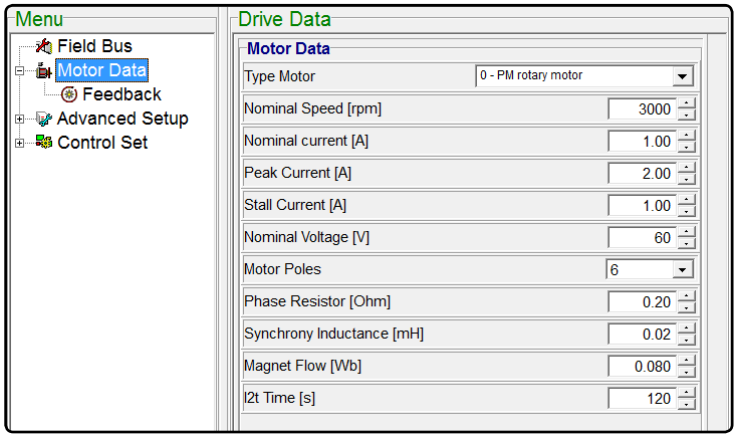
$$MAG = \frac{Ke}{p} \cdot \frac{\sqrt{2}}{\sqrt{3}} \cdot 20 \quad [Wb]$$

In the previous formula, 'Ke' is motor e.m.f. parameter in Vs (Volt x second), 'P' is motor poles number.

Just in case 'Ke' would not be directly provided into datasheet, please use formula below to get the correct parameter by motor e.m.f. (FEM_{RPM}) given at a specified speed (RPM):

$$Ke = \frac{FEM_{RPM}}{RPM} \cdot \frac{60}{2\pi} \quad [V \cdot s]$$

Motor data must be set as shown in the picture below:

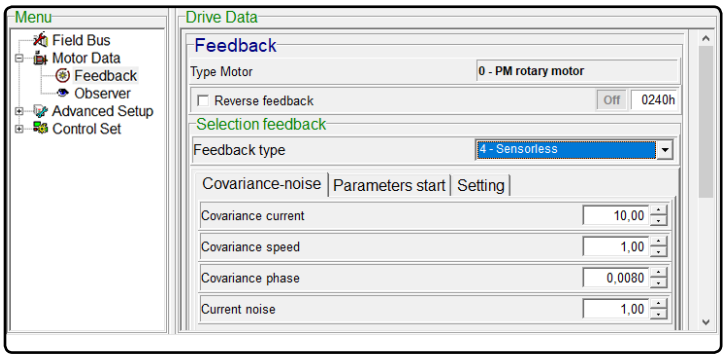


» Regarding speed and current loop regulators, as main parameters are related to sensorless predictive control, speed and current PID must be set as low as possible in order to avoid to let the system to instability conditions; it's recommended to set PID parameters (nel sottomenu *Advanced Setup*) as shown in the table below:

PID	*Speed*	*Current*
Kp	50	120
Ki	10	70
Kd	1	1

6.17.2 Setting sensorless parameters

The main window for sensorless setting parameters is shown in the image below, reporting default data:



Covariance-noise window shows sensorless regulation parameters sensorless:

- *Covariance current*: sensorless regulation parameter; range between 0.01 and 650.00;
- *Covariance speed*: sensorless regulation parameter; range between 0.01 and 650.00;
- *Covariance phase*: sensorless regulation parameter; range between 0.0001 and 6.5000;
- *Current noise*: sensorless regulation parameter; range between 0.01 and 650.00;

Parameters start window allows to set:

- *Starting current:* current provided by drive to motor in order to guide the shaft to initial position; this parameter is percentage related to Nominal current parameter.
- *Current ramp*: ramp, in seconds, to reach starting current.
- *Initial speed*: speed parameter, in RPM, beyond which drive changes control algorithm, from V/F to sensorless.
- *Speed Hysteresis*: it's reffered to initial speed; this parameter is shown in RPM.
- *Speed ramp*: ramp, in RPM/s, to reach initial speed from zero speed.
- *Initial delay*: time parameter beyond which drive starts to follow speed reference; the delay is necessary to let the motor shaft to reach the corrrect start position.

Setting windows allow to set:

- *Zero crossing mode parameter*: it's available as *Continuous* or *Stop-Start*. Continuous mode allows to cross zero speed without the stop procedure, when a speed reference inversion occurs. Otherwise, Stop/Start mode let the drive to change into V/F control and perform the starting procedure in accordance with parameters shown into *Parameters start* window.
- *Stationing current*: when SWITCH-ON command is provided to drive, this parameter shows the 0 speed current that drive must provide to motor; this parameter is percentage related to Nominal current parameter.
- *Fault measured speed*: speed parameter, in RPM, beyond which drive provides alarm.

6.17.3 Sensorless loop tuning

ATTENTION:

- default data do not guarantee a correct sensorless tuning for any motors and must be used only for initial conditions of the tuning procedure.
- during procedure, drive could lose motor control engage and lead to an overrun rotation or to an unexpected shutdown. Please take safety relatated actions.

For sensorless tuning procedure, it's necessary to observe the following variables into Scope function of Caliper software:

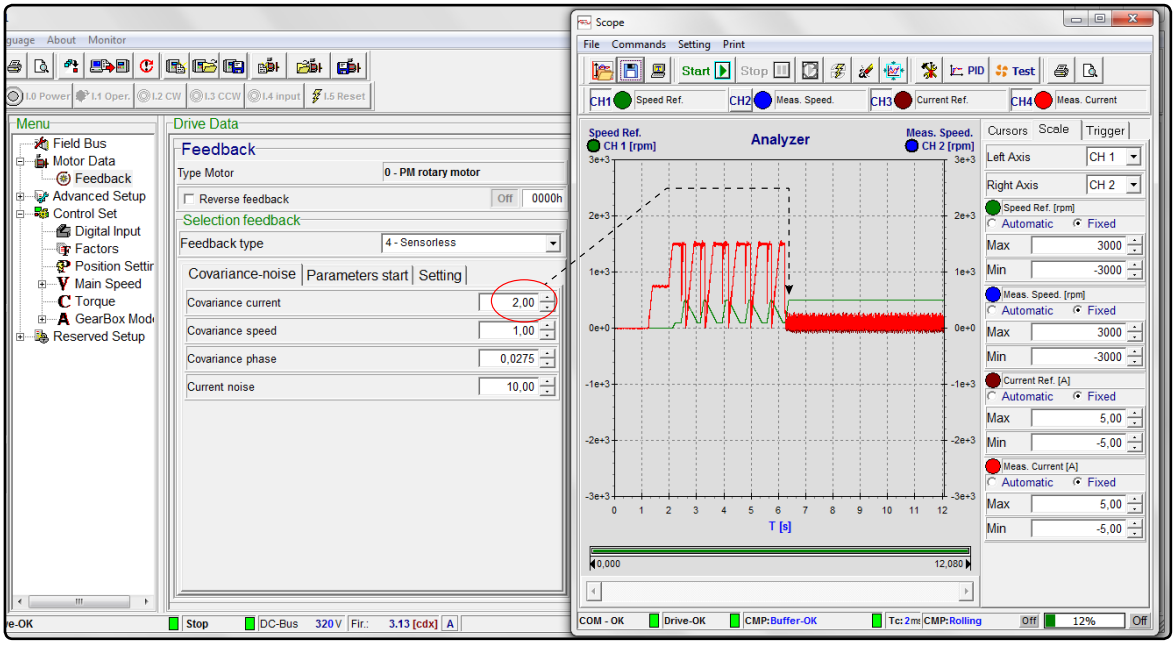
- current reference
- measured current.
- speed reference.
- measured speed.

» *INITIAL PHASE: disconnect load and verify the correct motor phase connection.*

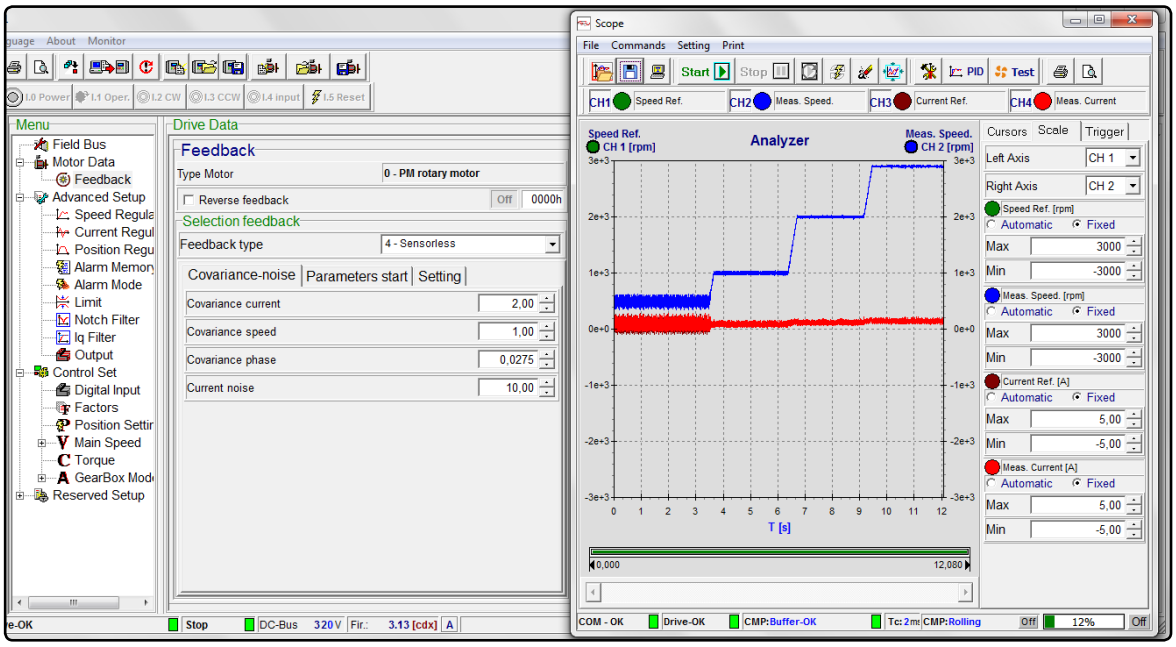
1. set an internal speed reference whose value must be positive and lower than default initial speed; so, for example, 50RPM.
2. enable the OPERATION ENABLE command neighter with digital input or with Caliper software.
3. ensure that motor rotate in clockwise viewing it from shaft; otherwise turn off the drive and invert two phases of motor, then re-execute 1-2-3 instruction points.

» *MIDDLE PHASE: tuning with no load.*

4. set an internal speed reference whose value must be a bit higher than default initial speed; so, for example, 500RPM. In this condition, motor could rotate in a discontinuous way or even NOT rotate.
5. enable the OPERATION ENABLE command and ensure that speed reference is actually brought to the desired value set into instruction point 4. Otherwise increase or decrease *Covariance current* parameter; it's recommended to increase or decrease with steps of 2-5 units. The initial sensorless setting example is shown below. In most cases:
   - for motor with a PHASE resistor lower than 0.8Ω and a PHASE inductance lower than 0.8mH, parameter should be increased. *When target is reached, please do not exceed beyond with the parameter setting.*
   - for motor with a PHASE resistor higher than 0.8Ω and a PHASE inductance higher than 0.8mH, parameter should be decreased. *When target is reached, please do not exceed beyond with the parameter setting.*

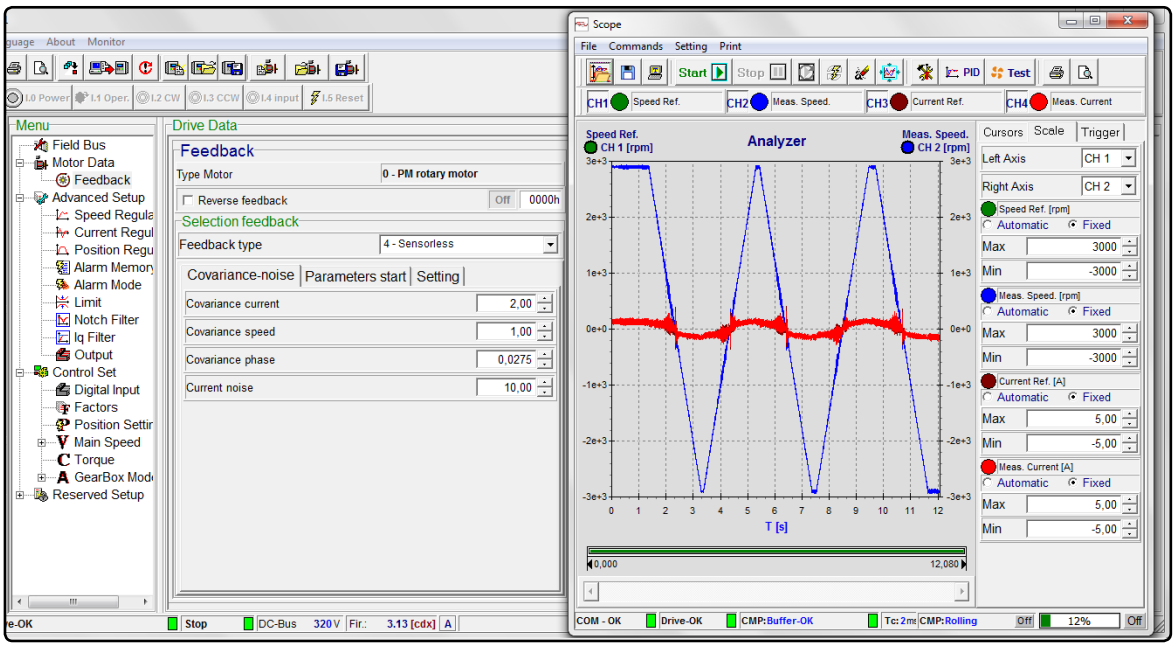


6. if, with procedure described into instruction point 5, it's not easy to stabilize correctly the speed reference to the desired value set into instruction point 4, then reset the *Covariance current* parameter at default value (6) and increase *Covariance phase* parameter; it's recommended to increase with steps of 0.01 units, untill the speed reference is correctly stabilized to the desired value set into instruction point 4. *When target is reached, please do not exceed beyond with the parameter setting.*
7. increase speed reference: for example 700-1000RPM.
8. to further reduce the measured speed noise and current reference noise, increase or decrease *Covariance current* parameter; it's recommended to increase or decrease with steps of 2-5 units. In most cases:
   - for motor with a PHASE resistor lower than 0.8Ω and a PHASE inductance lower than 0.8mH, parameter should be increased. *When target is reached, please do not exceed beyond with the parameter setting.*
   - for motor with a PHASE resistor higher than 0.8Ω and a PHASE inductance higher than 0.8mH, parameter should be decreased. *When target is reached, please do not exceed beyond with the parameter setting.*
9. if necessary, to reduce the measured current noise and consequently the measured speed noise, increase or decrease *Current noise* parameter; it's recommended to increase or decrease with steps of 2-5 units. In most cases:
   - for motor with a PHASE resistor lower than 0.8Ω and a PHASE inductance lower than 0.8mH, parameter should be increased. *When target is reached, please do not exceed beyond with the parameter setting.*
   - for motor with a PHASE resistor higher than 0.8Ω and a PHASE inductance higher than 0.8mH, parameter should be decreased. *When target is reached, please do not exceed beyond with the parameter setting.*
10. if necessary, it's possible to act further on *Covariance phase* parameter to reduce the no load current of the drive; however, in this way the measured speed noise increases. This solution could be usefull with low power/current motors.
11. now perform again all instruction points 8-9-10, increasing the speed reference with steps of 200-500RPM untill the desired application speed is reached. Note that the tuning performed at 500RPM could NOT be excellent for 2000RPM and vice versa. It's recommended to iterate the procedure with steps untill the desired speed is reached and then perform an excellent sensorless tuning. The picture below shows that setting is not excellent at 500RPM, but it's excellent for speed higher than 1000RPM.



12. to further reduce the measured current noise and measured speed noise at 500RPM (see previous image), it's possible to decrease *Covariance current* parameter again: but this solution does NOT guarantee that tuning will be excellent at 2000RPM. For this reason, the tuning procedure requires an iteration with increasing steps for speed reference, in order to avoid abnormal behaviours that may occur if the speed reference changes from 500RPM to 3000RPM without an excellent tuning in the range.

13. *Covariance speed* parameter takes effect only for output frequency above 500Hz. In applications where these frequencies or above are necessary, usually speed noise or speed resonance may occurs; it's recommended to decrease *Covariance speed* parameter with step of 0.1 or 0.2 units untill the measured the speed is correctly stabilized to the desired value.
14. to increase performances during speed reference invertion, set zero crossing parameter to continuous value and perform an reference invertion. The speed sensorless control performs a commutation that may cause an abnormal rotation, during a zero crossing reference. Just in case the zero crossing may lead to drive alarms, with consequently loss of motor control, try to further decrease speed and current PID regulators (especially the integral action Ki) or set zero crossing parameter to stop/start value.



» *END PHASE: load connected*

15. it's possible to act further to all parameter described to get the excellent sensorles control tuning with load connected agire ulteriormente sui parametri precedentemente descritti per ottenere un tuning ottimale in condizione di carico. In most cases, the excellent parameters with load are not much different to parameters get with no load, if the following conditions are met:
    - drive must be able to provide motor rated current.
    - load inertia is 6 times grater than motor, maximum.
    - speed ramps must be enabled and lower than 5000RPM/s.

NOTES:

- factors are enabled: in order to ensure the correct function, it's recommended to perform an automatic calculation; si veda *"6.05 Factors" pag. 73*.
- the use of sensorless control with ramps higher than 5000RPM are allowed, but, during fast transient reference changes, instability may occure; this instability condition may not occure with slower dynamics.
- into the scope function, it's recommended to set fixed scale for all variables and, in order to observe the correct overlap of traces, it's further recommended that scale for reference and related measured variables are the same.
- it's recommended to keep visible on PC monitor both the main Caliper window and the Scope window appropriately scaled; in this way, it's easy to set sensorless parameters on Caliper main window observing effects on scope window.

Ch. 7 S.T.O. safety circuit

S.T.O. safety circuit (Safe Torque Off) is realized with IEC EN 61800-5-2 law reference conformal, 0 stop category, and with IEC61508 law reference for SIL3.

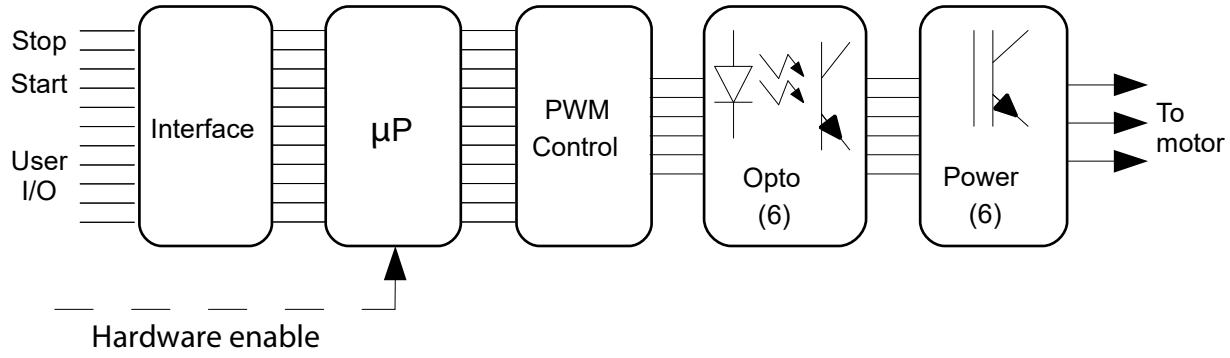
The a.c. induction motor requires a rotating magnetic field to produce torque. This requires a threephase source of alternating current at the connections. The drive has a single internal d.c. power supply available which is converted to a.c. by a continuous active switching action of the six power semiconductor devices.

The Safe Torque-Off (STO) feature of NTT 240/460 drive is made of a redundant electrical circuit designed to bring a drive to a state of safe torque absence. It is a feature used to prevent unexpected motor rotation in case of emergency without the necessity to interrupt power supply. When STO function is active, the servodrive and the motor are in a state of functional safety, which means that is impossible to cause an active rotation of motor shaft or, if it is alredy rotating, it stops by inertia.

The safety stop category 0 is achieved with the immediate disconnection of electronic components (IGBT) capable of system energization, that cause an uncontrolled stop of the axis, by inertia.

It is usual, in the applications where there isn't a drive equipped with STO, to secure the system interrupting the power supply using a contactor of adequate capacity. Using a STO it is possible to eliminate the contactor allowing economical advantage, space saving in the cabinet and achieving an higher level of integrity.

Principle diagram for drive without STO safety circuit is shown below:

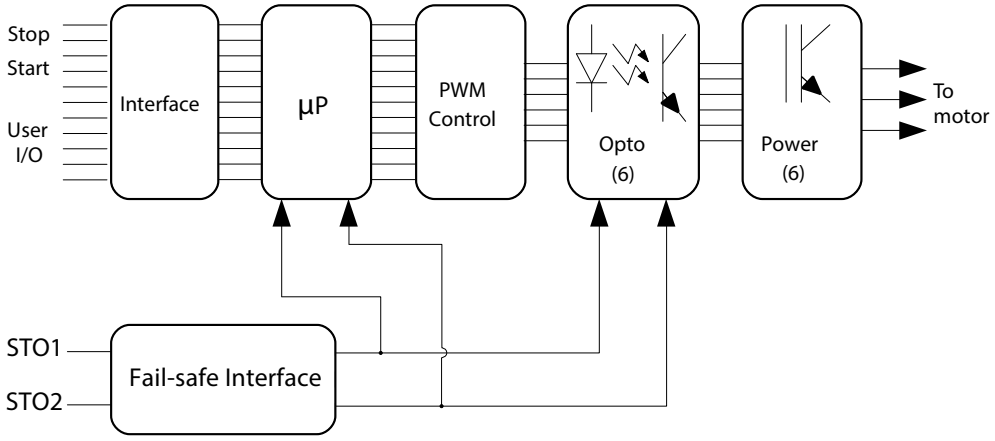


The commutation signals are transmitted from the complex control circuit of the PWM to the IGBTs by optocouplers that use light-emitting diodes (LED) for the transmission of simple on/off commands through the electrical isolation barrier. In the Secure Power Disable system shown in Figure_2, the LED power is provided by a safety circuit from the two enable inputs (STO IN 1, STO IN 2). The switching sequence can reach the IGBTs only if the two enable inputs are present, or if therehas been a highly improbable combination of undetected errors, which allowed both the two enable inputs to receive power supply. If the STO signal is inactive, the drive is certainly disabled through the loss of power of the LEDs and by the microprocessor.

NOTES:

- Failure of an individual IGBT or their drive circuits either into the on or in the off state cannot generate torque, but when a permanent magnet motor such as a servo motor is used, a single torque transient could be produced by a multiple IGBT failure. The motor can rotate at the maximun of 360°/p, where p is the number of poles.

Principle diagram for drive with STO safety circuit is shown below:



1. ***Safety function Safe Torque Off (STO)***

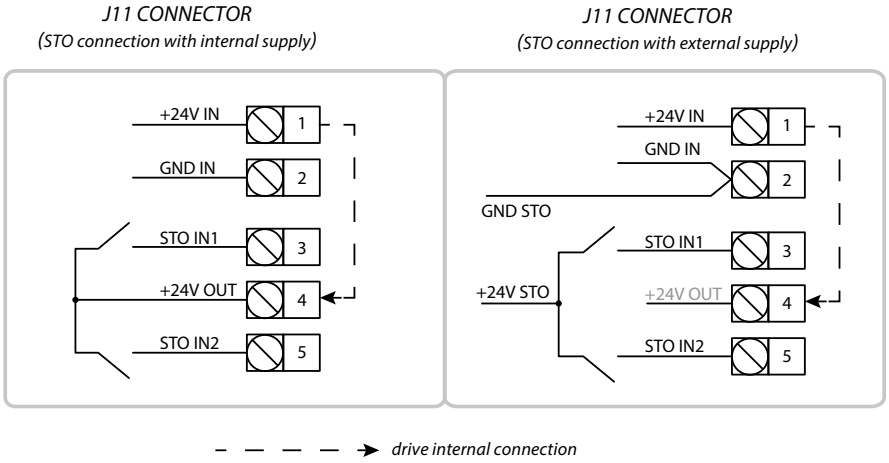
When the two drive enable inputs STO IN 1, STO IN 2 are not connected, the drive is in a high integrity disabled state. It will not produce torque in the motor even if internal faults are present. The drive remains active: its internal circuits are working, parameters can be modify, signal inputs and outputs are active and it keeps communicating. Instead, when the twoenable inputs are connected to a digital level of +24V nominal, the drive operates normally.

2. ***How to use Safe Torque Off (STO)***

ATTENTION!!!

Normally, drive is provided with J11 connector with bridge cables between 3-4-5 pins; in this condition, user shall not consider the drive to be in Safe State. In order to use correctly the Safety Function STO, please take off all bridge cables and wire external contacts.

Secure Power Disable is used in exactly the same way as a conventional enable input, so all existing applications remain the same. In addition it disables the drive with a very high integrity, so that it can be used in safety-related applications.



It can also be used in other applications where a highly reliable disable function is required. For example, it is common for a start/stop function to use a simple reliable contactor latch circuit in order to avoid expensive, non-safety-related damage from inadvertent start-up. Secure Power Disable can eliminate the use of a contactor.

3. ***STO does not provide motor braking***

If a running drive is disabled, it immediately ends to produce torque, either motoring or braking. The motor continue to run by its inertia untill it stops.

4. ***STO does not provide electrical isolation of the drive output.***

If access is needed to the electrical connections of the motor circuit, an approved isolation device must isolate the drive power input. The required discharge time that must spent before access is permitted is usually about 10 minutes.

5. ***STO cannot detect if the two enable inputs have been energised both inadvertently.***

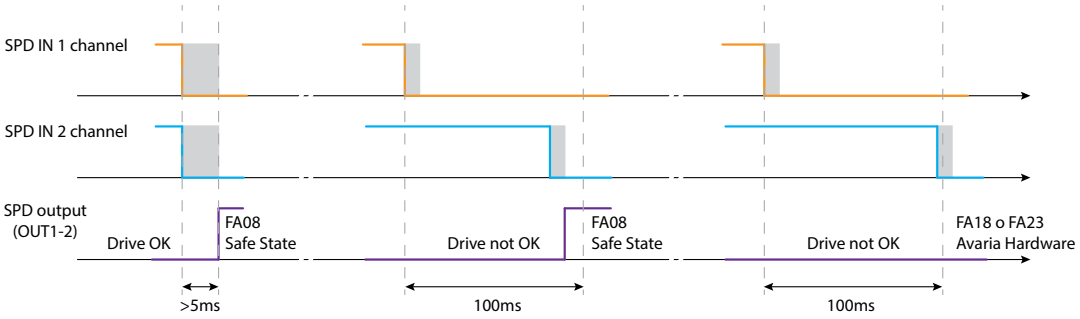
If both the two input channel STO IN 1, STO IN 2 have been inadvertently connected to a positive digital signal within the specified range, the drive will be enabled.The probability of this happening is very low. However, to ensure the maximun integrity, during installation the wiring must be protected from accidental contact with digital signals or supplies.

6. ***Special Requirement***

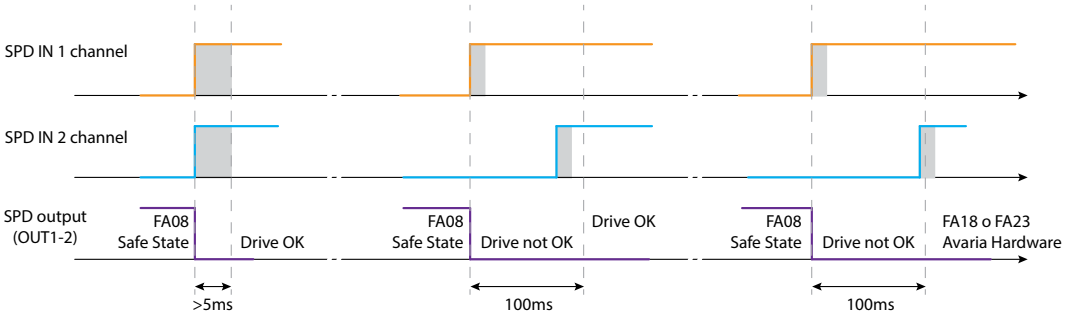
The output of SDP should be monitored at every intervention of the safety circuit by user. If the STO output is not active, with both the two STO inputs de-energized, it means that at least one of the two safety circuits is faulty and therefore the drive must be send to repaired. STO output is managed by microcontroller and for this reason, it's not considered as a secure output.

STO output follows graphs below:

De-energize condition for SPD IN 1 e SPD IN 2 channels



Energize condition for SPD IN 1 e SPD IN 2 channels



A special requirement is needed for the use of protected wiring to the two enable (STO IN 1, STO IN 2) inputs, in order to exclude the possibility of a short-circuit to a positive supply (see box below). Is reccomanded, under UNI EN ISO 13849-2 law, the use of protected wiring.

PROTECTED WIRING

Protected wiring is arranged so that no short circuit is credible to any source of voltage which might cause a failure in the unsafe direction. A practical implementation is either:
Fully segregated in dedicated trunking etc. or
Screened, with the screen connected to ground, in a positive-logic grounded control circuit.

7. ***Caratteristiche dei contatti esterni***

With mechanical contacts, it's mandatory that activation or deactivation latency time will be less than **100ms** (including any rebounds for mechanical contacts within **20ms**). It's recommended to use contact that allows activation and deactivation delay to be less than **50ms**, or please use contacts that are granted by external STO Safety Function approved modules.

8. ***Operations relating to the functions of the STO***

STO INPUT STATUS	DRIVE STATUS	MOTOR BEHAVIOUR	DISPLAY SIGNALING	STO OUTPUT (OUTx)
DE-ENERGIZED	OPERATION ENABLED	Stop by inertia	FA08	1
	SWITCH-ON	Free	FA08	1
	SWITCH-OFF	Free	FA08	1
ENERGIZED	OPERATION ENABLED	Turns	RUN	0
	SWITCH-ON	Still in torque	ENA	0
	SWITCH-OFF	Free	STOP	0

9. ***Fault management on the STO circuit***

STO circuit faults are detected when the STO input is de-energized.

STO CHANNEL	DRIVE STATUS	MOTOR BEHAVIOUR	HOW TO INTERVENT	DISPLAY SIGNALING	STO OUTPUT (OUTx)
STO IN1	OPERATION ENABLED	Stop by inertia	Repair needed	FA18	0
	SWITCH-ON	Free	Repair needed	FA18	0
	SWITCH-OFF	Free	Repair needed	FA18	0
STO IN2	OPERATION ENABLED	Stop by inertia	Repair needed	FA23	0
	SWITCH-ON	Free	Repair needed	FA23	0
	SWITCH-OFF	Free	Repair needed	FA23	0

For further information about drive status and error descriptions, please see *"Ch. 8 Drive status and diagnostics" pag. 120*.

ATTENTION!!!

TURN ON THE MACHINE WITH THE STO1 AND STO2 INPUT SIGNALS DE-ENERGIZED
TO VERIFY THAT THE SAFETY CIRCUIT IS WIRING IN THE CORRECT WAY
AND THAT IT IS INTACT WHITIN THE DRIVE:
FA08 ALARM MUST OCCURE AND THE STO OUTPUT MUST BE ACTIVE .

Ch. 8 Drive status and diagnostics

8.01 Drive status

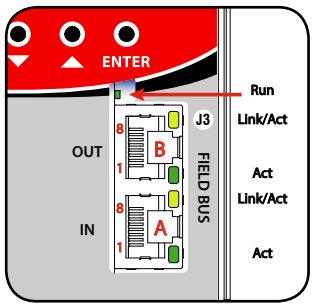
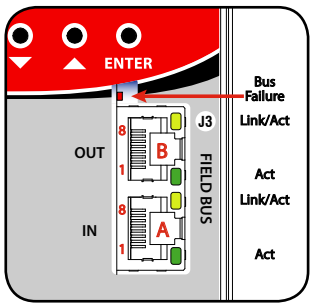
Main drive status, during operation, are visible on d.0000 display parameter, and description is shown below:

STATUS	CONDITION	DISPLAY d.0000	DESCRIPTION
SWITCH OFF	Drive OK	"STOP"	Drive does not provide torque to motor and shows Drive OK condition.
	FAULT - Warning	"F xx" o "FA xx"	Drive does not provide torque to motor and shows Fault condition or Warning condition.
SWITCH ON	Drive OK	"ENA"	Drive keeps motor in standstill torque and shows Drive OK condition.
	Warning	"F xx"	Drive keeps motor in standstill torque and shows Warning condition.
OPERATION ENABLED	Drive OK	"RUN"	Drive provides torque to motor following references and shows Drive OK condition.
	Warning	"F xx"	Drive provides torque to motor following references and shows Warning condition.

8.02 Fieldbus status signaling

During Ethercat CoE and Profinet operation modes, other LEDs provide following bus status:

- LINK and ACTIVITY (Green and Yellow LEDs on each port of J3 connector) show status for ethernet comunication.
- state machine identification during Ethercat operation mode with green LED or Bus Failure identification during Profinet operation mode with red LED.

ETHERCAT	PROFINET
	

"RUN" (green)	*LED status*	"BUS FAILURE" (red)
Inizialisation	*Off*	*Active comunication link*
Pre-Operational	*flashing*	*Status OK / NO Comunication*
Safe-Operational	*single flash*	-
Operational	*On*	*No link available*

8.03 Diagnostics

Alarms (display view as "FA xx") and warnings (display view as "F xx") can be reset by related command, depending on set operation mode (RESET digital input or RESET key in Caliper software or RESET command in fieldbus operation). If logic supply is turned off, alarms/warnings will be reset.

To learn error-code details, use Caliper software and see 'Advanced Setup - Alarm Memory' section.

When an alarm occures, drive immediatly can stop providing current to motor or can perform the FAult Reaction precedure; instead, in some warning situations, drive can hold motor control (this feature can be set via Caliper software).

Alarms /warnings codes, descriptions and solutions are shown below:

ERROR	ID	DESCRIPTION	SOLUTION	RESET	FAULT REACT.
EEPROM CORRUPTED DATA	FA01	An error occured while attempting to read EEPROM memory data. Drive stops providing current and 'Drive OK' condition is disabled.	This alarm code may result in EEPROM memory data loss. It requires a default data upload and then a new customer data upload, with riserved data too.	NO	NO
CURRENT SENSORS	FA02	An error occured while attempting to read signals from inverter current sensors. Drive stops providing current and 'Drive OK' condition is disabled.	At least, one of inverter current sensors has failed. A repair from technical and designating person is required.	NO	NO
OVER CURRENT	FA03	Drive has detected an overcurrent condition in inverter current reading signals. Drive stops providing current and 'Drive OK' condition is disabled.	Please remove U,V,W cable from drive wirings and try OPERATION ENABLED status in this condition. If alarms still occures, a repair from technical and designating person is required. If alarm does not occure please ensure: • any short-circuits between motor phases or phase to Power Earth may occur. • that current loop gain coefficients are correctly set.	YES	NO
OVER VOLTAGE	FA04	Drive has detected an overvoltage condition in DC bus voltage reading signals. Drive stops providing current and 'Drive OK' condition is disabled.	Please ensure that power supply voltage is within expected range. If alarm occures during braking operations, try to connect an appropriate external braking resistor.	YES	NO
VOLTAGE FAULT	FA05	Drive has detected supply voltage fault or 2 phase lack for triphase supply, at least. Drive stops providing current and 'Drive OK' condition is disabled.	Disable alarm if drive is supplied by DC voltage. It's possible to set: • AUTO RESET when 2 phases are present at least (only with FA06 disabled). • RESET signal request.	YES	YES
PHASE FAULT	FA06	Drive has detected voltage fault for 1 phase of triphase supply. Drive stops providing current and 'Drive OK' condition is disabled.	Please, verify if power cables are OK or if input power supply fuses are OK.	YES	YES

ERROR	ID	DESCRIPTION	SOLUTION	RESET	FAULT REACT.
FEEDBACK FAULT	FA07	Feedback wiring cable is wrong or damaged. Drive stops providing current and 'Drive OK' condition is disabled.	Please verify encoder wiring cable (*"5.08 J5 connector: Feedback 1" pag. 36* or *"5.09 J6 connector: Feedback 2" pag. 40*) or check encoder and cable integrity. If wiring is OK, encoder may be damaged. Replace motor encoder.	YES	NO
S.T.O.	FA08	STO safey circuit action (safe torque off): external contact, feeding voltage to STO safety circuit, is opened. Drive stops providing current and 'Drive OK' condition is disabled.	Close external contact and reset all alarms. If STO safety circuit has failed, drive will provide alarm FA18 or FA23 after closing external contact. In this case, a repair from technical and designating person is required.	YES	NO
MOTOR PTC	FA09	Thermal sensor has detected a motor overtemperature. Drive stops providing current and 'Drive OK' condition is disabled.	Ensure that motor work cycle is not much heavy for used motor. Ensure that PTC cables are correctly connected to drive and, if PTC is not present, please short pin 7-8 of J5 connector.	YES	NO
BRAKING RESISTOR	FA10	During braking condition, theoretical calculation for thermal behaviour has detected an overheating of resistor. Drive stops providing current and 'Drive OK' condition is disabled.	Number of cycle during braking condition is too much heavy for used resistor. Ensure that braking work cycle is not much heavy for used resistor or use an higher power resistor, setting correct parameters into Caliper software; vedi *"6.12 Braking resistor" pag. 92*.	YES	NO
+24V I/O FAULT	FA11	I/O Voltage fault (+24V I/O, pin 1-11 di J8). Drive stops providing current and 'Drive OK' condition is disabled.	Provide $24V_{DC}$ at pin 1 (+24V I/O) and 11 (0V I/O) of J8 connector. Voltage is available at pin 2-12 di J8 connector. It's possible to disable alarm.	YES	NO
UNDER VOLTAGE	FA12	Drive has detected an undervoltage condition in DC bus voltage reading signals. Drive stops providing current and 'Drive OK' condition is disabled.	Solutions: • automatic restart, when DC voltage value will be within expected range. • restart with RESET signal.	YES	YES
POSITION FOLLOWING ERROR	FA13	In gearbox control or position control, difference between reference and feedback signals is out of chosen tollerance. Drive stops providing current and 'Drive OK' condition is disabled.	Recommended solutions: • increase following error threshold. • edit PID speed parameters. • decrease dynamics.	YES	YES
HOME POSITION	FA14	Drive has detected the Home Position lack. Drive stops providing current and 'Drive OK' condition is disabled.	Please perform an Home Position command, after drive operation mode was selected. See *"6.03 Caliper Menu" pag. 52*.	YES	NO

ERROR	ID	DESCRIPTION	SOLUTION	RESET	FAULT REACT.
I2T DRIVE WARNING	F15	Theoretical drive temperature, due to provided current to load, exceeded maximum threshold. Drive continuous to operate normally, but maximum provided current is equal to drive rated current.	During initial start-up, please ensure a correct motor and drive wiring. Ensure that working cycle to be performed is not too much hard for selected drive. Ensure that control loop parameters (speed) are not heavy. If application allows, increase ramp times.	YES	NO
I2T MOTOR WARNING	F16	Theoretical motor temperature, due to provided current from drive, exceeded maximum 100°C ΔT threshold. Drive continuous to operate normally, but maximum provided current is equal to motor rated current.	Ensure that working cycle to be performed is not too much heavy for used motor. Ensure that control loop parameters (speed) are not heavy. If application allows, increase ramp times. Ensure that 'I2T Time' value, set in Motor Data section via Caliper, is correct for used motor.	YES	NO
OVER SPEED WARNING	F17	Maximum velocity value, set in Advanced Setup - Limiter section via Caliper, exceeded threshold. Drive continuous to operate normally, showing warning condition.	Please ensure that 'Speed Limit' parameter is at least 10% upper than maximum reachable speed. Ensure that speed loop parameters do not generate high speed overshoot.	YES	NO
CH1 STO	FA18	Redundant n°1 channel of safety circuit is broken.	If external environment cable is correctly set, a repair from technical and designating person is required.	NO	NO
TARGET OUTSIDE WARNING	F19	During position control, drive has detected that position reached is different to target position. Drive continuous to operate normally, showing warning condition.	Drive received an external signal and has been stopped during positioning; for this reason it was not able to reach target position. Verify if commands sent to drive are OK	YES	NO
FIELDBUS	FA20	Canopen® Node Guarding error occures or Time out error Modbus occures. Drive stops providing current and 'Drive OK' condition is disabled. Depending on settings, drive stops providing current or decelerates in ramp.	Restore fieldbus comunication. See *"5.05 J3 connector: CM option configuration" pag. 33*.	YES	YES
BROKEN EEPROM	FA21	EEPROM memory does not respond. Drive stops.	A repair from technical and designating person is required.	NO	NO

ERROR	ID	DESCRIPTION	SOLUTION	RESET	FAULT REACT.
MOTOR PHASES	F22	During motor autophasing, drive has detected a wrong wiring connection. If SWITCH-ON command is able, motor could run without control.	Depending on used motor, recommended solutions are: • H.D.T. motor: ensure the correct wiring between drive and motor, then execute motor autophasing. See *"5.02 J1 connector: motor power connection" pag. 28* e *"6.07 Motor autophasing" pag. 82*. • Third party motor: invert 2 motor phases, then execute motor autophasing.	YES	NO
CH2 STO	FA23	Redundant n°2 channel of safety circuit is broken.	If external environment cable is correctly set, a repair from technical and designating person is required.	NO	NO
OVER TEMP.	FA24	Heatsink temperature exceeded maximum threshold. Drive stops providing current and 'Drive OK' condition is disabled.	Recommended solutions: • wait some minutes before restarting drive. • ensure ambient temperature to be lower than 40°C.	YES	NO
HALL ENSORS SEQUENCE ERROR	FA25	Drive detected a wrong HALL sequence. Drive stops providing current and 'Drive OK' condition is disabled.	Recommended solutions: • connect correctly HALL sensors.	YES	NO
SPEED ERROR	FA26	In Canopen mode, in profile velocity mode, drive detected a speed error depending on velocity window and velocity window time parameters. Drive stops providing current and 'Drive OK' condition is disabled.	Recommended solutions: • increase velocity window and velocity window time parameters. • if application allows, decrease acceleration and deceleration ramp parameters. • ensure that there are not any barriers or obstacles during movement.	YES	NO
I2T DRIVE ALARM	FA27	Theoretical drive temperature, due to provided current to motor, exceeded maximum threshold and drive continued to provide current beyond set time. Drive stops providing current and 'Drive OK' condition is disabled.	During initial start-up, please ensure a correct motor and drive wiring. Ensure that there are no obstacles along the axis stroke.	YES	NO
I2T MOTOR ALARM	FA28	Theoretical motor temperature, due to provided current from drive, exceeded maximum 100°C ΔT threshold and drive continued to provide current beyond set time. Drive stops providing current and 'Drive OK' condition is disabled.	Ensure that working cycle to be performed is not too much heavy for used motor.	YES	NO
DC BUS SYMMETRY	FA29	Drive has detected that DC bus symmetry is out of range. Drive stops providing current and 'Drive OK' condition is disabled.	Disconnect power supply by the drive immediatly. A repair from technical and designating person is required.	YES	NO

ERROR	ID	DESCRIPTION	SOLUTION	RESET	FAULT REACT.
OVER PRESSURE	FA30	Drive detected hydraulic over pressure condition from pressure transducer. Drive stops providing current and 'Drive OK' condition is disabled.	Ensure that transducer cable is whole and correct. Ensure also that transducer works properly. Check pressure parameter set into drive are correct. Ensure, via Caliper, that analog input reads correctly, otherwise a repair from technical and designating person is required.	YES	NO
UNDER PRESSURE	FA31	Drive detected hydraulic under pressure condition from pressure transducer. Drive stops providing current and 'Drive OK' condition is disabled.	Ensure that transducer cable is whole and correct. Ensure also that transducer works properly. Check pressure parameter set into drive are correct. Ensure, via Caliper, that analog input reads correctly, otherwise a repair from technical and designating person is required.	YES	NO

Ch. 9 Accessories

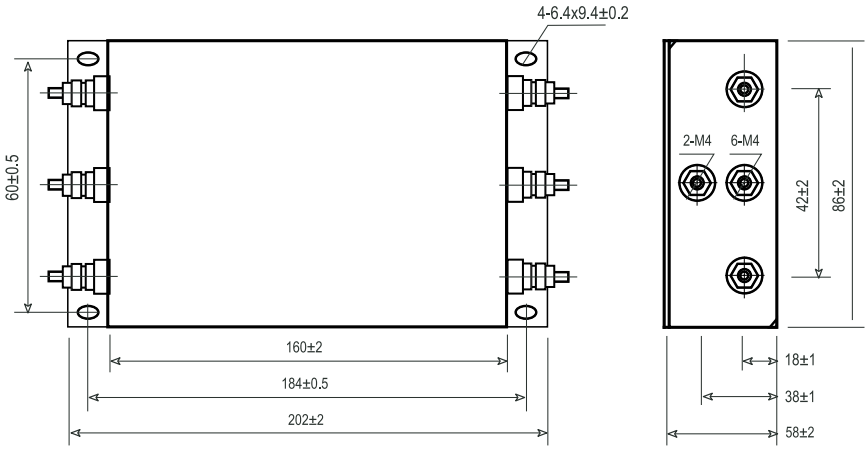
Caliper 4 setup cable	CODE:	CNTPRG53
	**Description**	
	USB cable for drive setting and tuning via Caliper 4 software. Shielded, shield connected to both side of connector plugs. For any informations about connections, please see *"5.07 J4 connector: drive settings" pag. 35*.	
	Type:	USB A to micro B shielded for USB 2.0
	Poles:	5pin standard
	Total lenght:	3m

Termination resistors for Canopen and Modbus	CODE:	CNTETH00
	**Description**	
	Termination resistors connection for Canopen and Modbus network.	
	Type:	RJ45
	Termination value:	120Ω between CAN H to CAN L 120Ω between MODBUS + to MODBUS -
	Total lenght:	40mm

Multiple drives fieldbus wiring patch cable:	CODE:	CNTETH01
	**Description**	
	Multiple NTT 240/460 drives wiring cable for cascade connection in fieldbus operation. Shielded FTP Cat. 5E EIA/TIA568B.	
	Type:	RJ45 / RJ45 Shielded FTP
	Poles:	8 pin-to-pin EIA/TIA568B
	Total lenght:	250mm

EMC filters for NTT 460

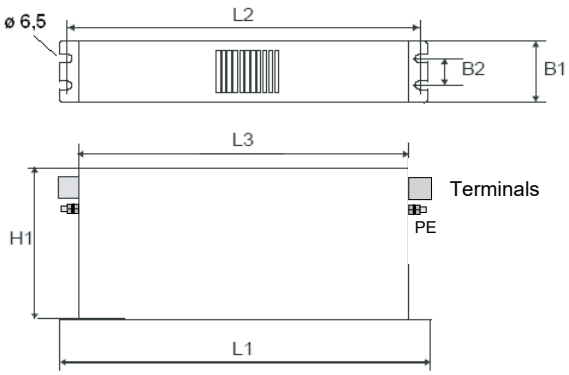
Description

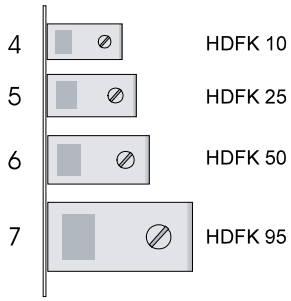


		Type: 2 x (3xCM) + 3 x (1xDM)	Note: dimension in mm. Bolt connection.
		Rated current	
CODE	**TDC10**	10A@40°C	
	TDC20	20A@40°C	

EMC filters for NTT 460

Description

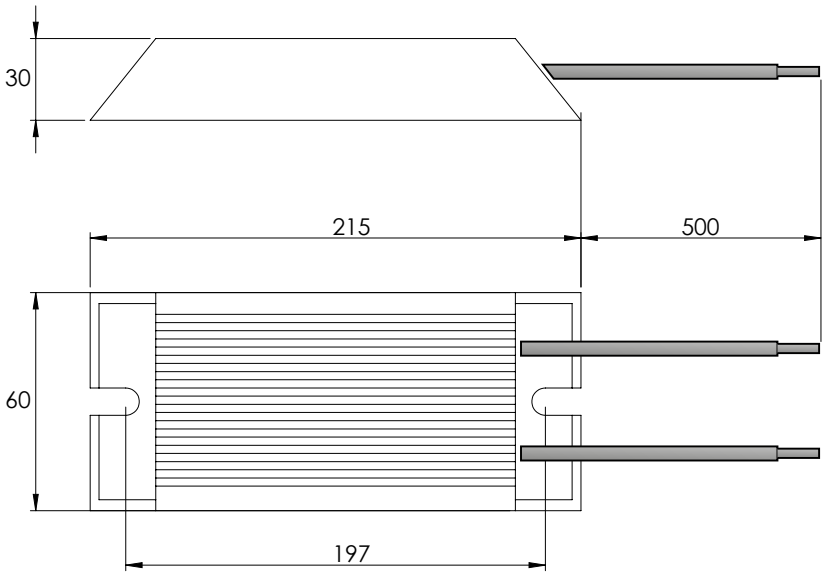




		Type: 3 x (3xCM)	Note: dimension in mm and terminal connection							
		Rated current	*L1*	*L2*	*L3*	*L4*	*B1*	*B2*	*H1*	*Connection*
CODE	**CNW207/35**	35A@40°C	335	320	305	400	60	35	150	4
	CNW207/50	50A@40°C				500				5
	CNW207/65	65A@40°C								
	CNW207/80	80A@40°C	380	364	350	-	178	130	220	6
	CNW207/100	100A@40°C								7
	CNW207/150	150A@40°C								8
	CNW207/200	200A@40°C								

Braking external resistor for NTT 460 20/40 e 35/70	CODE:	RF39R1300W

Description



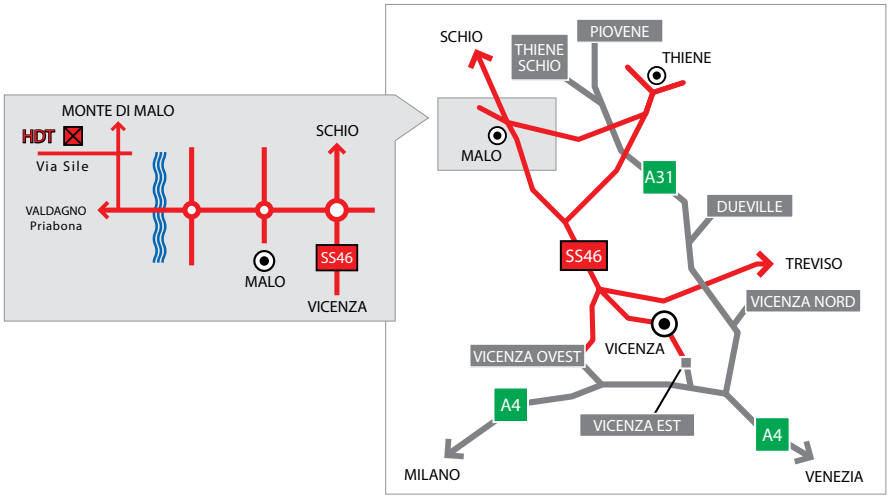
Value	39Ω
Rated/peak power	300W / 1300W

Note: dimension in mm.

For 35/70 size, it's recommended to use two same resistor parallel connected.

Please contact H.D.T. technical/sales department for further resistance and power values.

High Digital Technology



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