

DS2020

MAINTENANCE AND USER MANUAL

SINGLE AXIS DIGITAL SERVO DRIVE



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1 OVERVIEW

1.1. Manual contents

This manual provides information to the user to ensure proper installation and optimal functioning of the digital servo drives, DS2020 series.




All information contained herein, including methods, techniques and concepts are the exclusive property of Moog Components Group Casella and may be neither copied nor used without specific authorization.

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The following materials are also available:

- QUICK GUIDE - INSTRUCTIONS AND GUIDELINES FOR FIRST START
- MAINTENANCE AND USER MANUAL (this document)
- FIELDBUS MANUAL
- SOFTWARE Dx2020 GUI

1.2. Utilized symbols

	<i>Danger that can result in death or serious injury</i>
	<i>Danger that can result in minor injury and / or property damage</i>
	<i>Notification of an important information</i>

1.3. Package contents

The complete supply of DS2020 drives includes:

- One DS2020 drive module
- Anchoring support for the screens

Note: a possible connector kits must be ordered individually and is supplied separately.

1.4. Required qualifications of the users

This manual is intended for qualified personnel, that is having the following skills, depending on the tasks performed:

Transport: The staff must have notions of handling components sensitive to electrostatic charges

Unpacking: The staff must have knowledge of handling of components sensitive to shock and electrostatic discharge

Installation: The staff must have notions of installation of electrical equipment

Startup: The staff must have extensive technical knowledge of electrical drives and their technology.



Info

The qualified personnel must know and observe the following standards: IEC 60364, IEC 60664, and all relevant national accident prevention regulations.



ATTENTION

When the drive is in operation there is a risk of death, serious injury or serious damage to property. Therefore, the installer is required to ensure that the safety instructions detailed in this manual are read, understood and observed by all personnel responsible for the operation of the drive.

1.5. Applicable laws

The DS2020 drives meet the Low Voltage Directive (2006/95 / EC) and EMC Directive (2004/108 / EC). The safety function "Safe Torque Off" (STO) integrated in the drive complies with the Machinery Directive (2006/42 / EC).

To comply with the European Directives, the drive meets the requirements of the relevant harmonized installation standards EN 50178 (LVD), EN61800-3 (EMC) and EN 61800-5-2 (Safety of machinery).

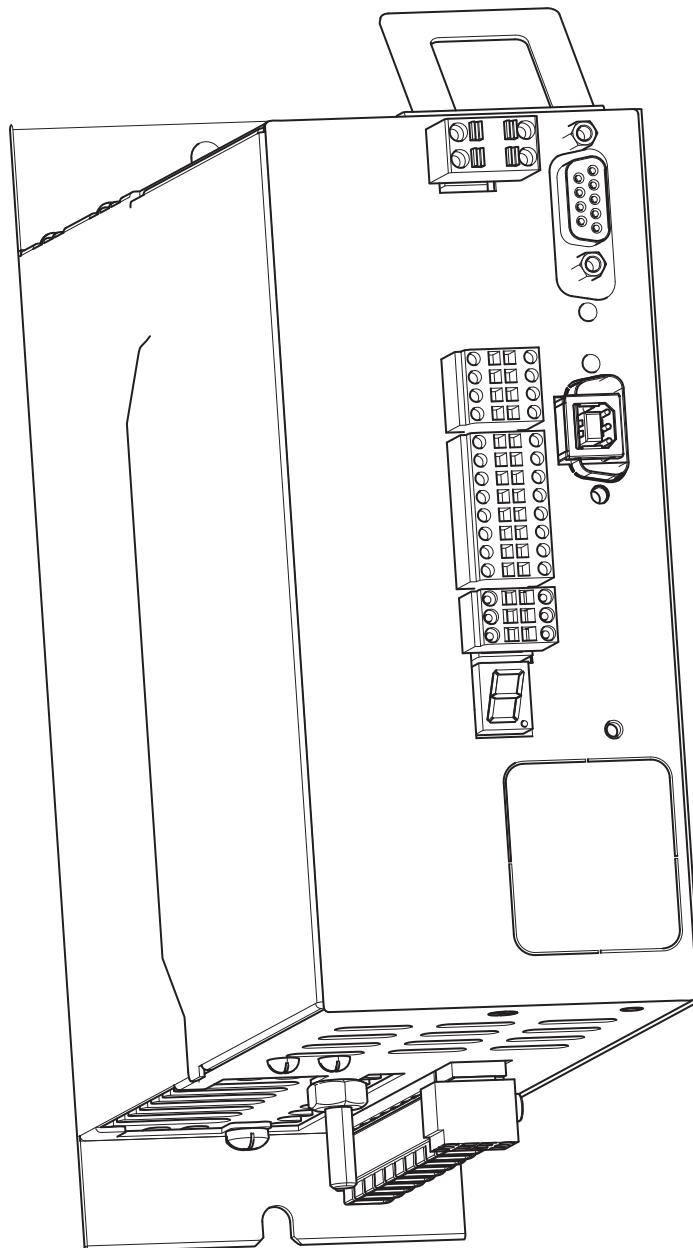
The DS2020 drives are CE certified.

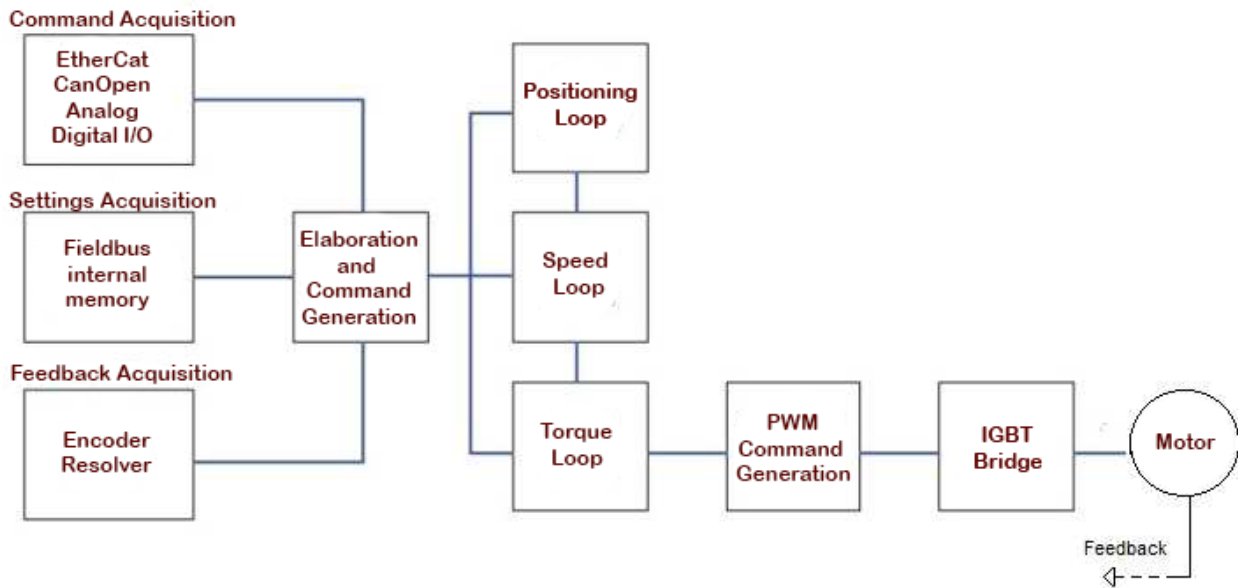
2. SYSTEM OVERVIEW

2.1. Product structure

2.1.1. Product description

The DS2020 drive represents Moog Casella's new generation of digital servo drives for the control of brushless synchronous or asynchronous motors. It is constituted by a single stand alone module powered directly by an AC network and by an auxiliary voltage of 24 Vdc. The digital control system of the motors and the diagnosis functions of the DS2020 series, are realized using a microprocessor.





Control functions	Implementation of the Torque, Speed and Position loops
Command protocols	EtherCAT, CANopen and “Analog”
Configuration/Commissioning	Via GUI : Dx2020GUI, allows to configure, calibrate and control the drive.
Diagnostic	Via GUI
Positioning transducers	<ul style="list-style-type: none"> • Resolver standard • Encoder Incremental TTL • Encoder Stegmann Sinusoidal Absolute Single/Multi-Turn with HYPERFACE communication • Encoder Hedenhain Sinusoidal Absolute Single/Multi-Turn with ENDAT communication <p>Sensorless mode</p>
User Interface	Dx2020GUI
Data logging	From GUI
AC/DC conversion	Three-phase input bridge with soft start
Power range	From 120 Vac to 480 Vac +/- 10 %
PWM frequency	8 kHz (from 2 to 16 kHz configurable by Software)
Encoder simulation	Simulated encoder output with programmable number of pulses
Auxiliary power supply voltage	+ 24 Vac +/- 10 %
Rated current	From 2 to 48 Arms
Peak current	From 4 to 96 Arms
Analog inputs	2 inputs +/- 10 volt differential
Analog outputs	2 output +/- 10 volt single ended
Digital inputs	2 digital inputs opto isolated
Digital outputs	1 Digital output opto isolated
Communication interface for set-up	<ul style="list-style-type: none"> • RS422 ↔ PC • USB ↔ PC • EtherNET or CANopen ↔ PC (option)
Motor brake control	Integrated
Braking resistor	Integrated (External optional)
Electromagnetic compatibility	EMC filters
Cooling	Forced air, with integrated fans in each module

2.1.2. Storage and working conditions

Operating environment temperature	from 0 °C to 40 °C up to 55 °C with current derating
Storage temperature	from -25 °C to 55 °C
Transport temperature	from -25 °C to 70 °C
Motor overheating protection	PTC or NTC
Relative humidity	5...95 % without condensation
Mounting altitude	Up to 1000 m, up to 2000 m with output current derating
Certification	CE
Protection	IP20
Pollution rating	2 or less (normally allowed only non-conductive pollution. However, occasionally we can expect a temporary conductivity caused by the condensation only when the drive is idle or powered)
Resistenza meccanica conforme a EN 60721-3-3	Vibration: 3 mm for frequencies between 2 and 9 Hz Vibration: 1 g for frequencies between 9 and 200 Hz Shock: 98 m/s ² (10 g) for 11 ms
Machine safety	STO (Safe Torque Off) SIL3 PLe

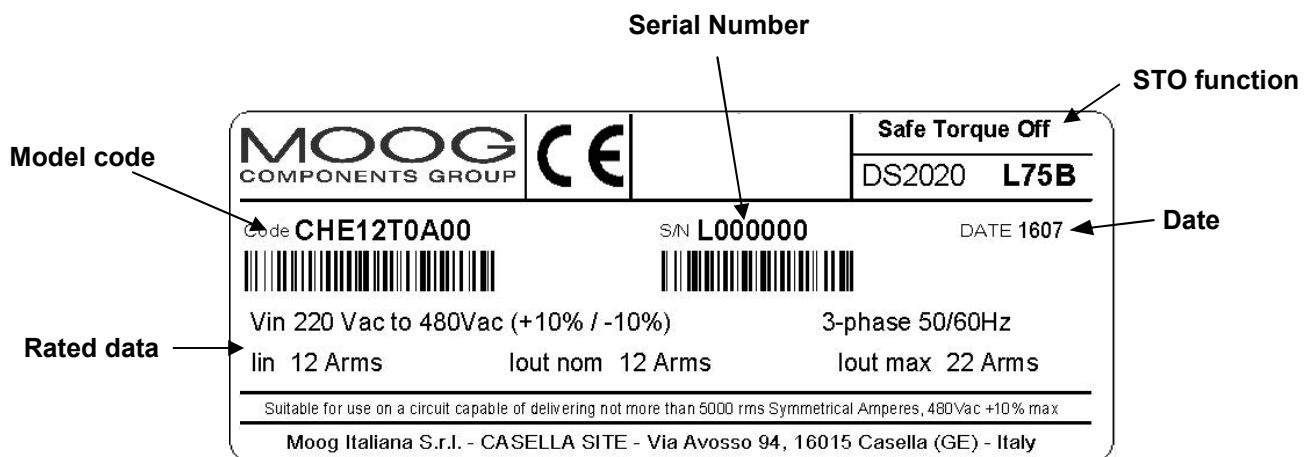
2.1.3. Standard models of modules

	L50A	L50A	L75A	L75A	L75B	L85A	L85A	L125A	L125A
Dimensions [mm]	50	50	75	75	75	85	85	125	125
Rated current [Arms]	2	4	6	8	12	16	24	32	48
Peak current [Arms]	4	8	12	16	22	32	48	64	96

The module code is found on a plate on the side of the module.

To request any kind of information about a specific module it is essential to communicate to Moog Components Group Casella all the data indicated on the plate, which identifies each individual module.

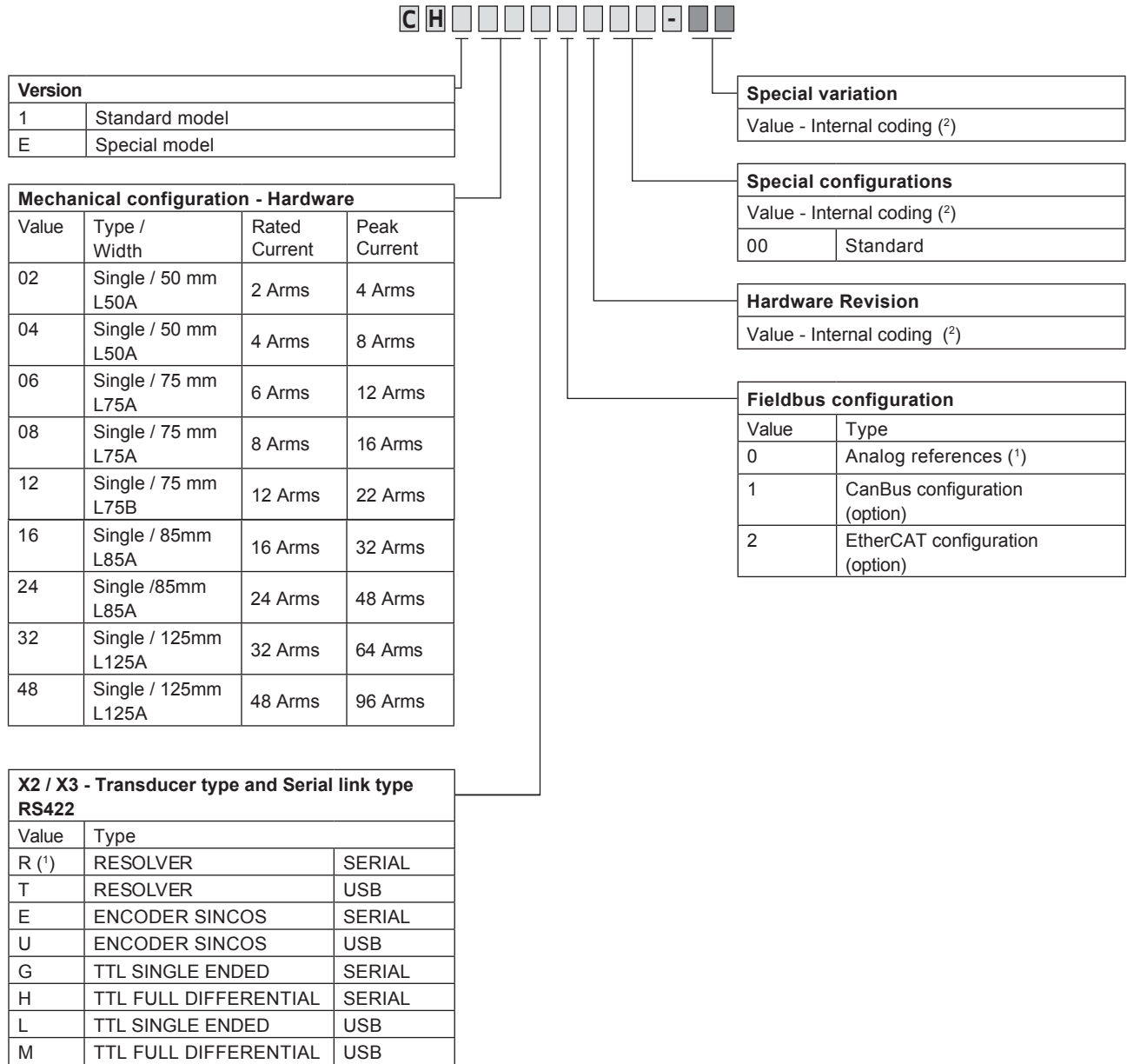
The year and week of construction are identified by the field 'Date' The first two digits of the number are for the year the second two indicate the week (example DATE 1607: 2016, week 7).



Example of a drive plate

2.1.4 Module codification

To identify the different models it is necessary to refer to the following codification



To order a connector kit

Connector kit code	Transducer type and Serial link type	
BC8901-R	RESOLVER	SERIAL
	RESOLVER	USB
BC8902-R	ENCODER SINCOS	SERIAL
	ENCODER SINCOS	USB
	TTL SINGLE ENDED	SERIAL
	TTL FULL DIFFERENTIAL	SERIAL
	TTL SINGLE ENDED	USB
	TTL FULL DIFFERENTIAL	USB

The first two characters are "CH" and are used to identify the DS2020 family

(1) Standard version

(2) Values attributed by Moog

2.2. Features and components details

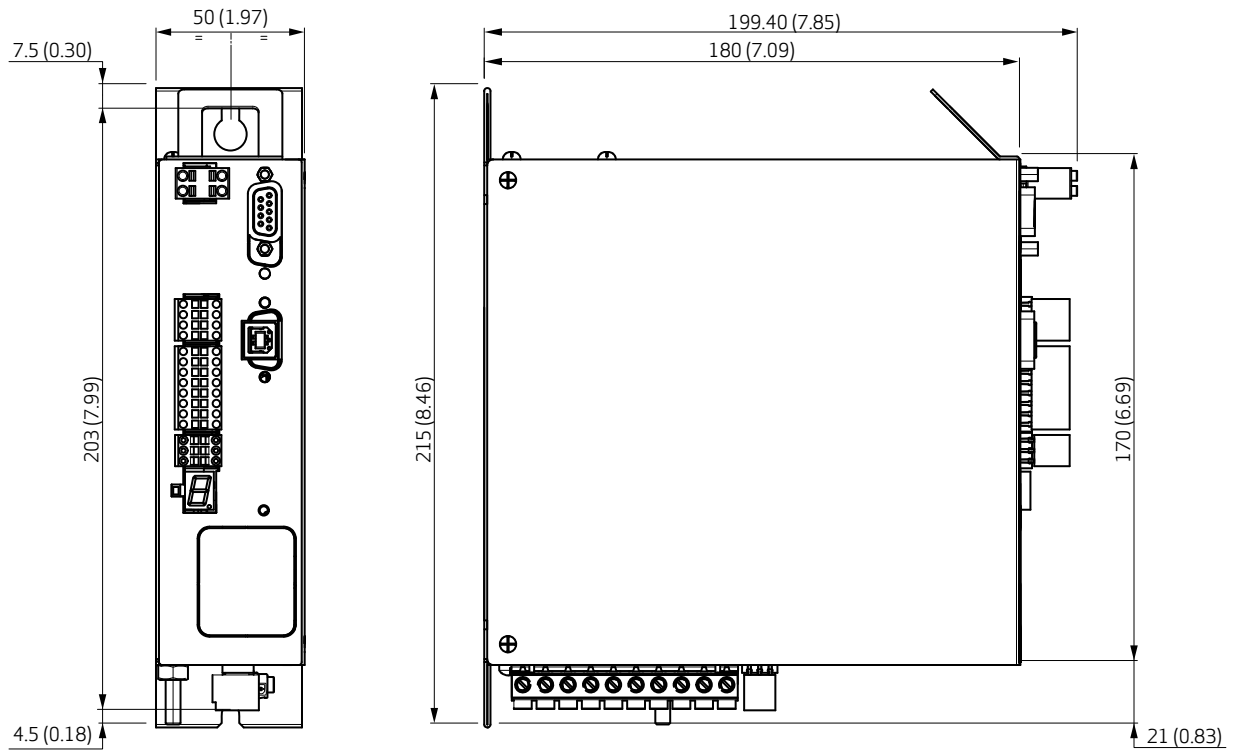
2.2.1. Electrical data

Electrical data	L50A	L75A – L75B	L85A	L125A
Network power supply voltage	From 120 Vac to 480 Vac +/- 10 %			
Auxiliary voltage	24 Vdc +/-10%			
Rated current Arms	from 2 to 4	from 6 to 12	from 16 to 24	from 32 to 48
Peak current Arms	from 4 to 8	from 12 to 22	from 32 to 48	from 64 to 96
Protections	Protection with thermal reading of the heat sink temperature and estimation of the temperature of the power module junction. Insufficient voltage (Under Voltage) or excessive voltage (over voltage) detection			
Cooling	Forced air, with built-in fans			

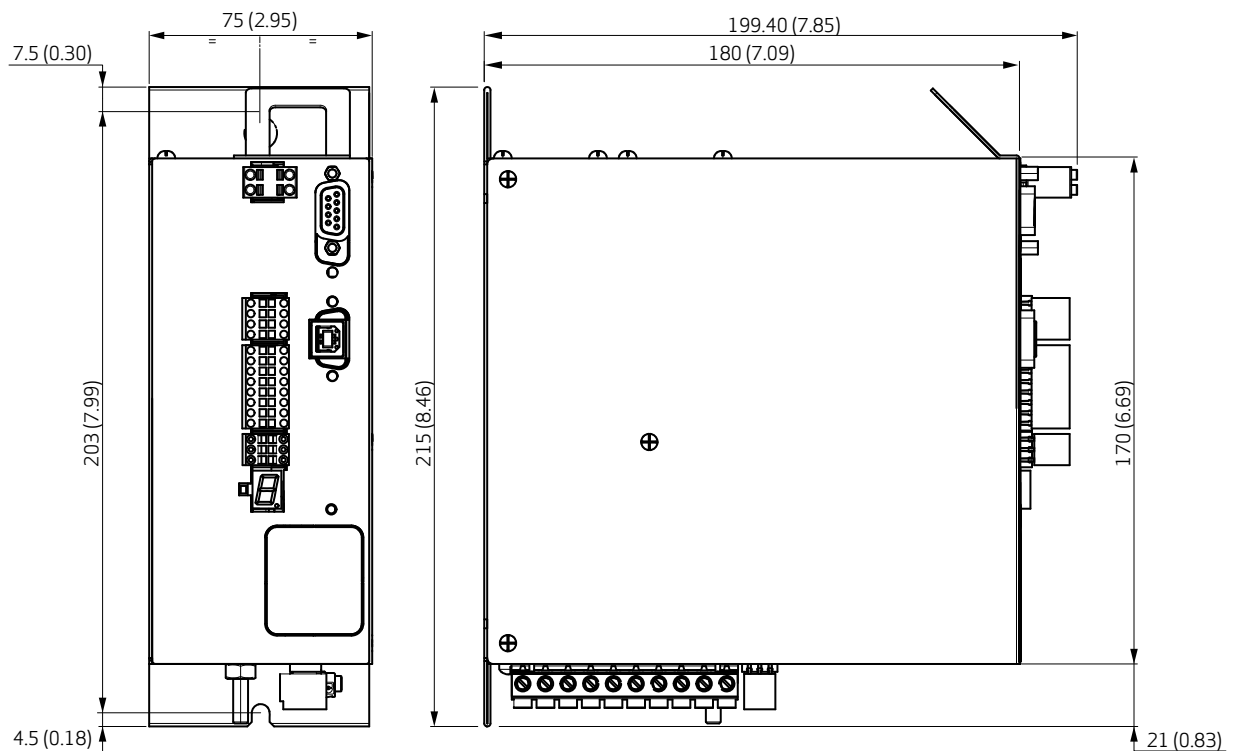
2.2.2 Mechanical data

Mechanical data	L50	L75	L85	L125
Weight [Kg]	1,493	2,344	5,633	8,000
Height [mm]	215		H í	
Width [mm]	50	75	85	125
Depth [mm]	199.4		243,2	

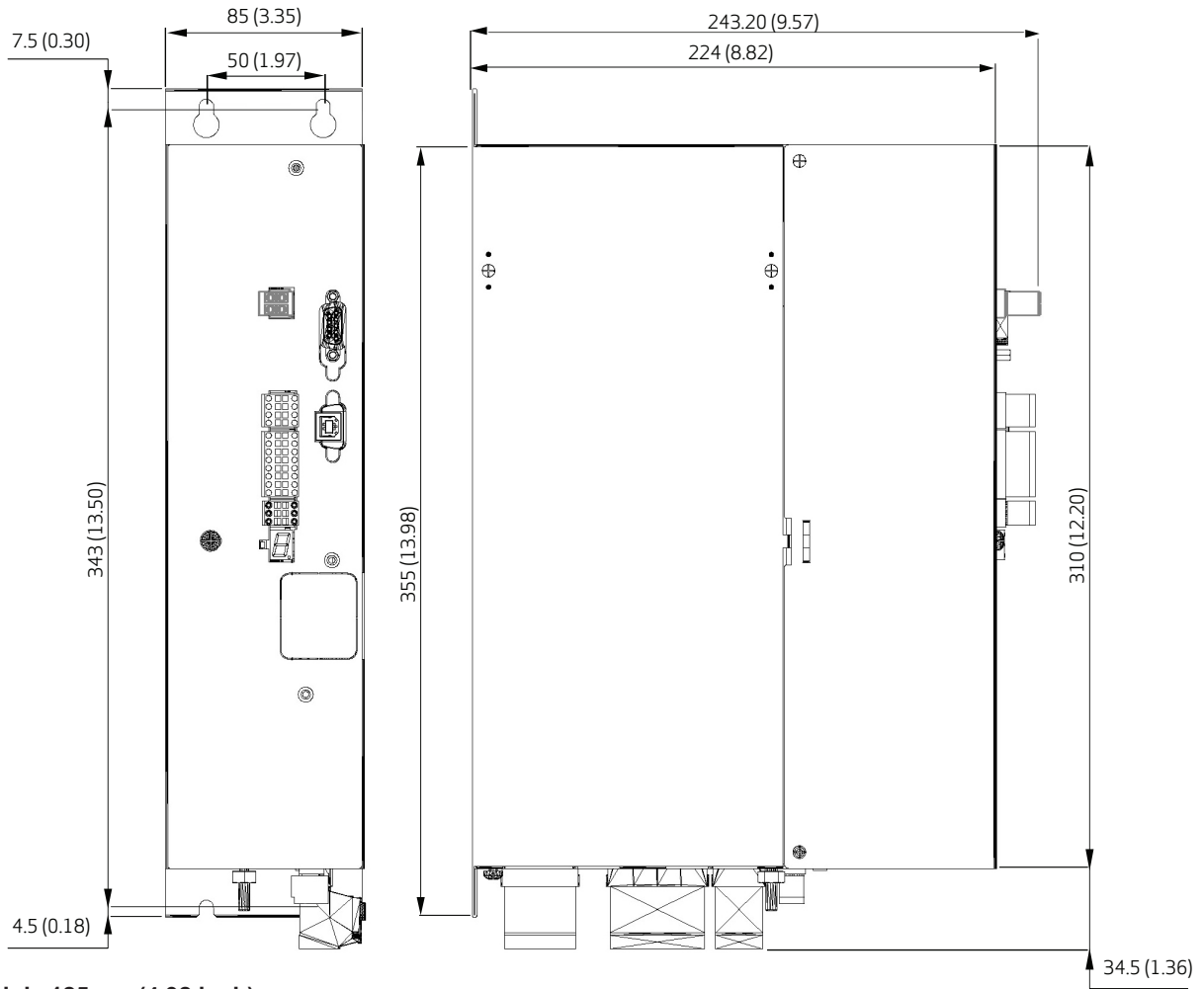
Module 50 mm (1,97 inch)



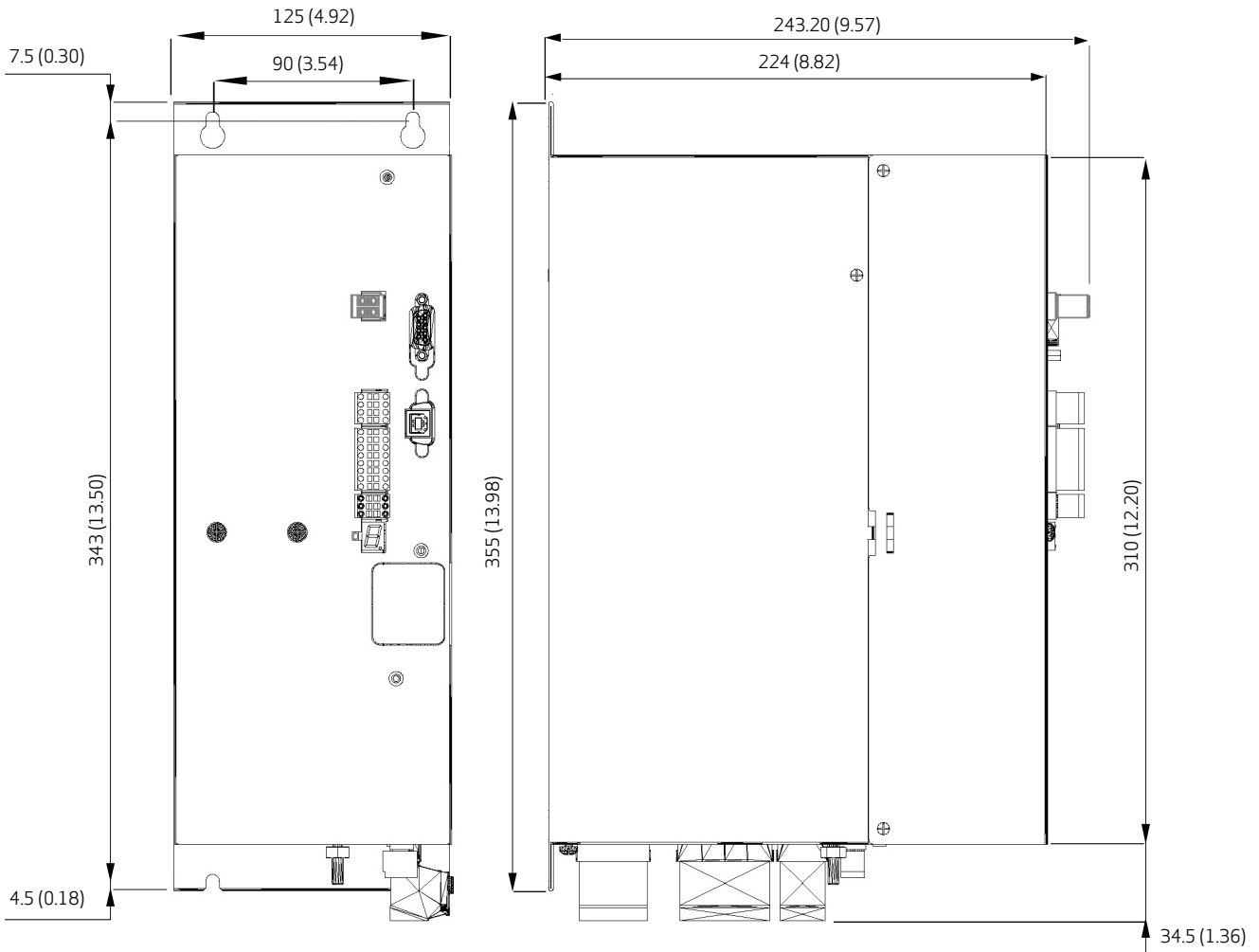
Module 75 mm (2,95 inch)



Module 85mm (3.35 inch)



Module 125mm (4.92 inch)

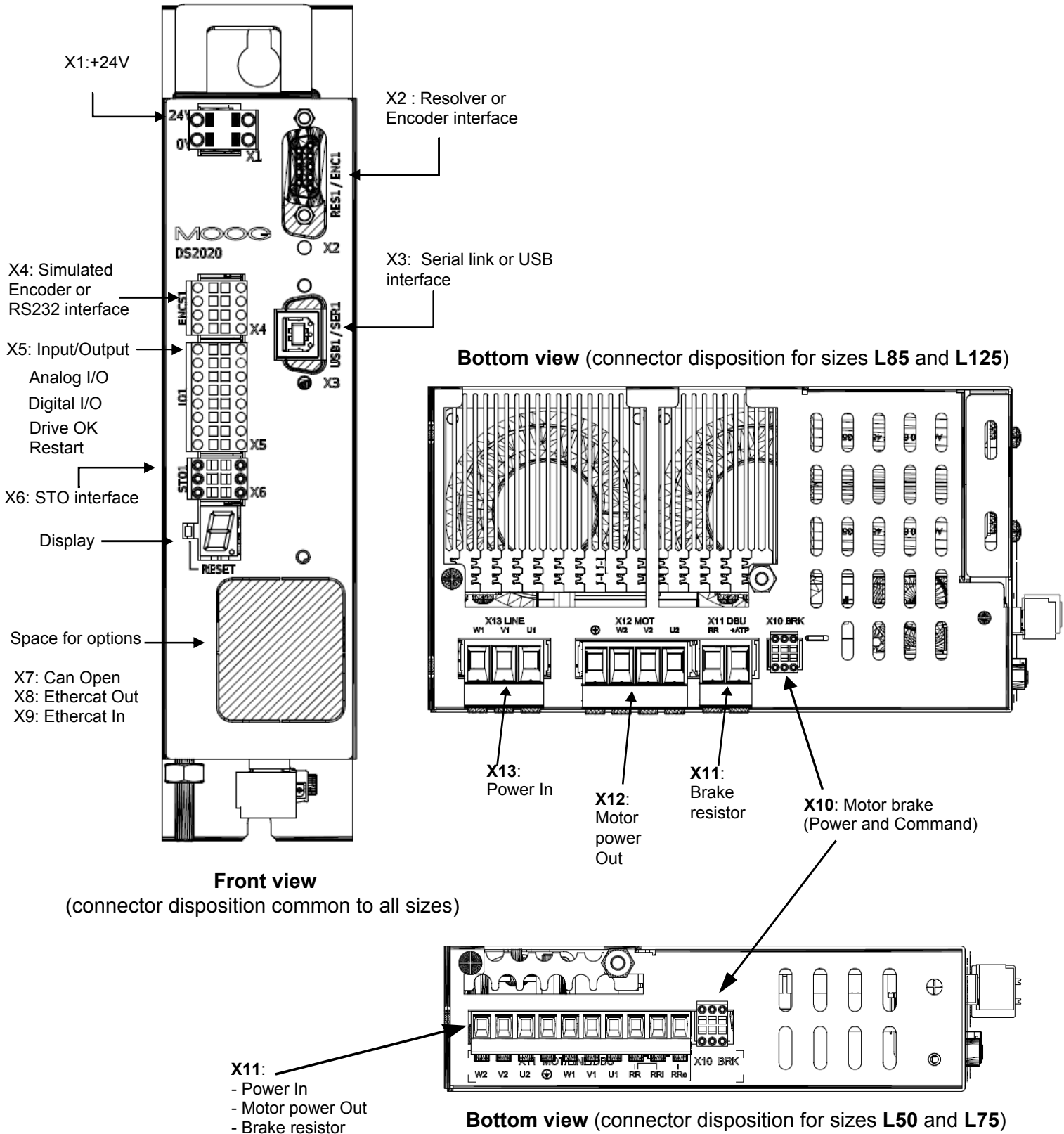


2.2.3. Transducers

The DS2020 can manage the following transducers:

- Resolver standard
- Encoder Incremental TTL
- Encoder Stegmann Sinusoidal Absolute Single/Multi-Turn with HYPERFACE communication
- Encoder Hedenhain Sinusoidal Absolute Single/Multi-Turn with ENDAT communication
- **Sensorless Mode**

2.2.4 Connectors



Below is the list of connectors

	Connector	Function
All sizes	X1	+ 24 Volt Auxiliary power supply
	X2	Resolver or Encoder motor feedback
	X3	Interface USB or RS422
	X4	Programmable digital connector
	X5	Analog digital I/O
	X6	Interface STO
	X7	Can Open Fieldbus (Optional)
	X8	Ethercat Out Fieldbus (Optional)
	X9	Ethercat In Fieldbus (Optional)
	X10	Motor brake connector (Power and Command)
L50/L75 only	X11	Power In, Motor power Out, Brake resistor

L85/L125 only	X11	Brake resistor
	X12	Motor power Out
	X13	Power In



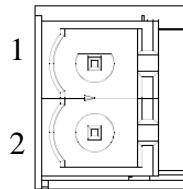
Info: It is possible to have the connector X7 (Connection via CANopen) or, depending on the configuration of the drive code, the X8-X9 connectors (connection via EtherCAT)

2.2.4.1 Connector layout

The connector pin tables are shown below

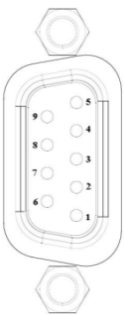
X1 - Auxiliary power supply

Pin	Function
1	+ 24 Volt
2	0 Volt

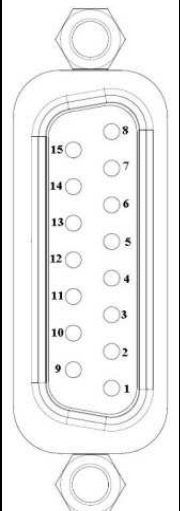


X2 - Motor Feedback

X2 – Resolver	
Pin	Function
1	COS-
2	COS+
3	GND
4	SIN-
5	SIN+
6	TERM A
7	8 kHz-
8	TERM B
9	8 kHz+



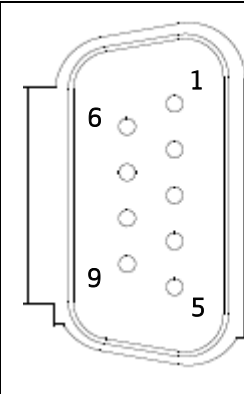
X2 - Encoder TTL		X2 - Encoder Stegmann	X2 - Encoder ENDAT Heidenhain
Pin	Function	Function	Function
1	+ 5V (max 100 mA)	REFSIN	B-
2	GND	GND	0 V
3	W-	REFCOS	A-
4	W+	US	UP
5	V+	DATA+	DATA+
6	V-	N.C.	N.C.
7	A+	PTC	PTC
8	A-	N.C.	CLOCK+
9	C+	+SIN	B+
10	C-	N.C.	0 V SENSE
11	U+	+COS	A+
12	U-	N.C.	UP SENSE
13	B-	DATA-	DATA-
14	B+	PTC	PTC
15	PTC	N.C.	CLOCK-



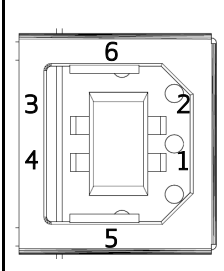
X3 - Serial (RS422) or USB Interface

The X3 connector can be either a 9-pin RS422 or a USB type B

Pin	Definition	Function
1	RX+	Data+ reception
2	N.C.	Non connected
3	TX+	Data+Transmission
4	N.C	Non connected
5	N.C	Non connected
6	RX-	Data- reception
7	0V	0V Reference
8	TX-	Data-Transmission
9	N.C	Non connected



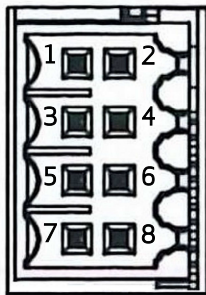
9 poles RS422 communication interface



Pin	Definition	Function
1	USB_+5V	Power
2	USBDM	USB- data channel
3	USBDP	USB+ data channel
4	0V	0V Reference
5	Shield	Shield
6	Shield	Shield

USB_B communication interface

X4 Digital I/O Programmable



Pin	Definition	Function
1	+24V_EXT	Output voltage 24Vdc 200 mA
2	A+	Channel A
3	A-	Channel A inverted
4	B+	Channel B
5	B-	Channel B inverted
6	C+	Channel C
7	C-	Channel C inverted
8	0V	0V reference



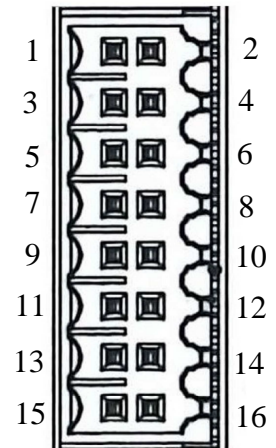
Info: The 24 Volt power supply provided on the connector, can be used to feed external devices



Info: We recommend the use of a shielded twisted cable for connection between devices and Drive.

X5 Analog digital I/O connector

PIN	DEFINITION	FUNCTION
1	IN AN 1 +	Positive Analog Input 1, 12 bit resolution, sampling 3.9 us (256 kHz)
2	IN AN 1 -	Analog negative input 1, 12 bit resolution, sampling 3.9 us (256 kHz)
3	IN AN 2 +	Positive Analog Input 2, 12 bit resolution, sampling 3.9 us (256 kHz)
4	IN AN 2 -	Analog negative input 2, 12 bit resolution, sampling 3.9 us (256 kHz)
5	OUT AN 1	Analog output 1, 12 bit resolution
6	OUT AN 2	Analog output 2, 12 bit resolution
7	+24VOLT	24 volts input for the power supply of the digital output
8	0 VOLT	Common ground for digital I / O
9	OUT DIG 1	Digital output 1, optoisolated
10	NC	NC
11	DRIVE_OK	Drive ok contact
12	DRIVE_OK	Drive ok contact
13	IN DIG 1	Digital input 1, fast, optoisolated
14	IN DIG 2	Digital input 2 fast, optoisolated
15	RESTART	Reset of the module
16	0 VOLT	Common ground for analog I / O



Info: The two grounds on pins 8 and 16 are separated to increase the rejection to electrical noise induced by wirings.

Programming X5 connector analog digital I/O:

Analog Input 1 and 2 options

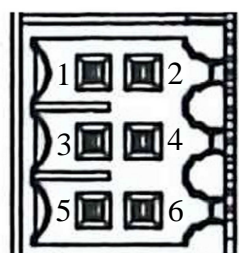
- Torque reference
- Speed reference
- Position reference
- Current limitation (maximum output torque)

Analog Out 1 and 2 options

- Measured voltage DC BUS
- Current measured I_q
- Current reference I_q
- Measured phase current U
- Measured phase current V
- Motor speed measured
- Internal test variable

X6 STO interface

Pin	Definition	Function
1	+24 V S1	STO power input
2	0 V S1	0 Volt
3	+24 V S2	STO power input
4	0 V S2	0 Volt
5	FEEDBACK	Contact S1
6	FEEDBACK	Contact S2

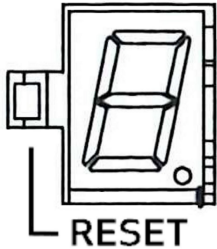


Reset button

When pressed causes the initialization of the drive control section; a long press (> 3 seconds) causes access to the boot routine of the drive and the ability to download a different version of the control SW, through the GUI.

LED 7-segment display

Indicates the axis state after the insertion of the auxiliary 24 V.
The meaning of the different messages is reported in the following table:



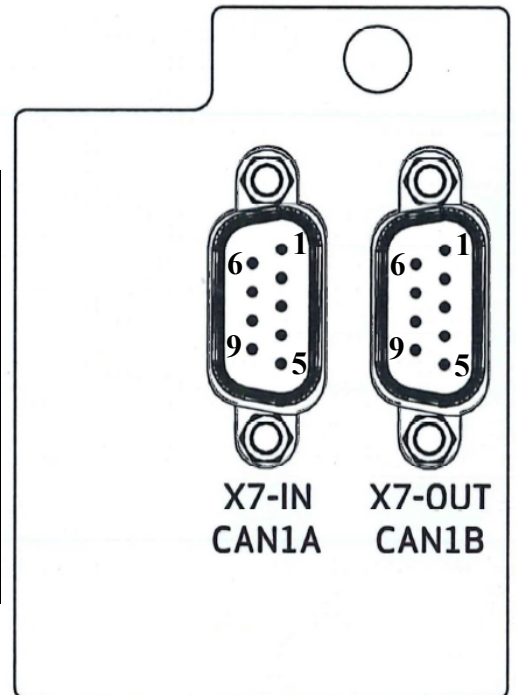
Message on display	Status	Note
I	Intialization	The drive has completed the initialization phase
S	Ready	The drive is ready to be enabled
E	Enabled	The drive is controlling the motor
F	Fault	The drive is in alarm
8 blinking	Boot	The drive is being programmed via serial line RS422 or via USB
b fixed light	Boot	The drive is being programmed via EtherCAT



If the operation mode choice is Analog, in the event of fault, the letter F would follow a 2-digit code that identifies the alarm present. The correspondence can be found in paragraph 6.4.

X7 CAN option

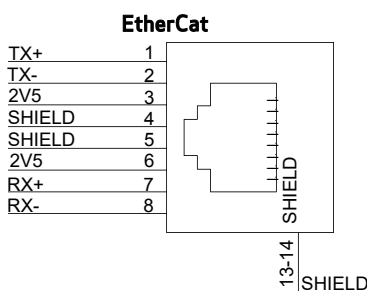
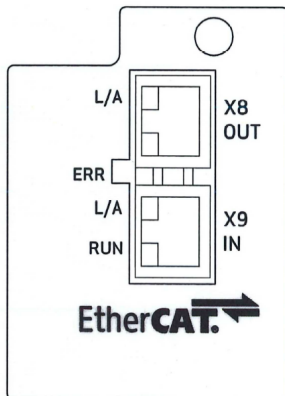
N° pin	Name	Function
1	Reserved	not associated to a function
2	CAN L	Negative terminal CAN line
3	CAN_GND	Logic 0 CAN line
4	Reserved	not associated to a function
5	CAN_shield (optional)	Shield (optional))
6	GND (optional)	Logic 0 CAN line (optional)
7	CAN_H	Positive terminal CAN line
8	Reserved	not associated to a function
9	CAN_V+	Power supply line CAN (supplied by power adapter)



The PC connection via CAN Drive is currently performed using a USB adapter CAN IXXAT Automation (www.ixxat.com) VCI V3 model; other models or devices can be added to the GUI on request.

X8 – X9 EtherCat Option

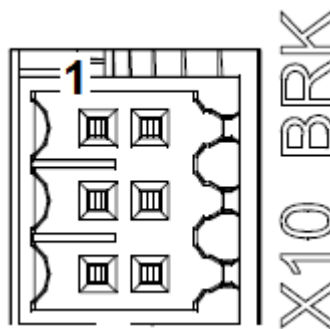
The cable used is an Ethercat standard one, the connector is a RJ45.



LED	Nome	Descrizione
X9 - RUN	EtherCAT RUN Indicator	OFF - The drive is in the state INIT
		BLINKING - The drive is in the state PRE-OPERATIONAL
		SINGLE FLASH - The drive is in the state SAFE-OPERATIONAL
		ON - The drive is in the state OPERATIONAL
		FLICKERING - The drive is in the state BOOTSTRAP
X9 - L/A	EtherCAT Link/Activity	OFF - The input Ethernet port is closed
		ON - The input Ethernet port is open
		FLICKERING - The input Ethernet port is open and there is network activity
X8 - L/A	EtherCAT Link/Activity	OFF - The output Ethernet port is closed
		ON - The output Ethernet port is open
		FLICKERING - The output Ethernet port is open and there is network activity

X10 - Integrated brake motor

Pin	Function
1	0 Volt
2	+ 24 Volt
3	0 Volt
4	Brake output
5	Therm. Prot.
6	Therm. Prot.



The brake control circuit must be powered from the outside, through X10.



The connection to the motor brake by itself alone does not guarantee the personnel's safety. In particular, the vertical loads require an additional mechanical brake to operate in a certifiably safe manner.

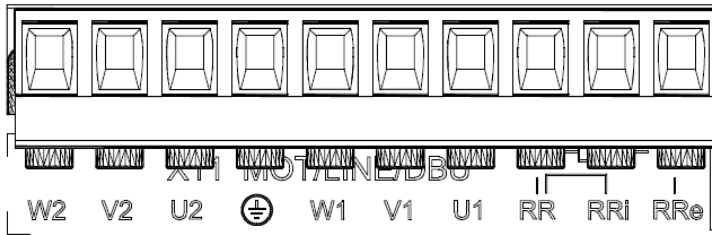


The brake cannot monitor autonomously if the voltage level is sufficient to its own operation. Consequently, it is necessary to measure the voltage on the input of the brake and always verify the functionality during release and braking, in particular in the case of connections with long cables or cables with reduced section, that are subject to significant voltage drops.

The brake can be enabled in four different ways:

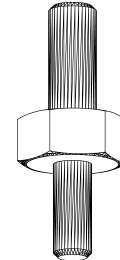
1. According to logic defined by the user condition (disable / enable the axis)
2. With a command via fieldbus
3. With a suitably programmed digital input
4. Through special command via the GUI software

X11, X12, X13 - Power connections

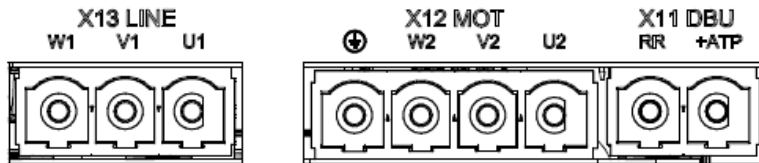


X11 connection - sizes L50 and L75

Definition	Function
U2, V2, W2, ⊕	Motor connection
GND	Connection to power ground through M5 stud
U1, V1, W1	Connection to the three-phase network
RRe, RR	Connection to external brake resistor
RRI, RR	Bridge to use the internal braking resistor



Ground stud M5



X11-X12-X13 connections - sizes L85 and L125

The cable must be shielded. The screen connection towards ground can be closed with a conductive strap, with whom connect the cable to the metal bracket fixed under the drive.

2.2.5 Filters

To ensure proper compatibility with the EMC standards insert between the network and drive an EMC filter code AT6009 and AT6010 or a model with equivalent features.

Code	AT6009 / AT6010
Rated current	3 x (400/480 V), 50/60 Hz, to 50 °C
Overcharge	4x on startup 1.5x for 60 s, repeatable every 60 min.
Environmental temperature	From -25 °C to +100 °C, with current reduction from 60 °C (1,3 % / °C)
Mounting altitude	1000 m, with current reduction from 4000 m (6 % / 1000 m)
Relative air humidity	15 ... 85 %, condensation non allowed
Storage temperature	From -25 °C to +70 °C
Protection	IP20
Acceptance test	Compliant CE
Non industrial environment EN61800-3 complies with radio shielding	Allowable length of the cable between the drive and motor up to 50 m
Non industrial environment EN61800-3 complies with radio shielding	Allowable length of the cable between the drive and motor up to 100 m

Code	Module	Type	Rated current [A]	Total current loss [W]	Current contact [mA]	Weight [kg]	Connecting cables [mm ²]
AT6009	L50	A	7	9	16,5	1	up to 4 mm ² flex. Bolt PE M5
AT6010	L75/L85	A	16	20	18,3	1,4	up to 4 mm ² flex. Bolt PE M5
AT6011	L85	A	30	21	24,2	1,7	up to 10 mm ² flex. Bolt PE M5
AT6012	L85/L125	A	42	30	25,8	2,5	up to 10 mm ² flex. Bolt PE M6
AT6013	L125	A	55	30	25,8	2,9	up to 25 mm ² flex. Bolt PE M6

2.2.6. Braking resistor

When the motor accelerates, the energy is dissipated as heat in the braking resistor. The table shows the values of the brake resistors, broken down by size

Size	Power [Watt]	Ohm	Position
L50A	100	75	Internal
L75A – L75B	100	51	Internal
L85A	200	51	External
L85B	240	22	External
L125A	370	22	External
L125B	370	12	External



Info: The supplied brake resistor ensures an adequate dissipation for a typical light work cycle in terms of power dissipated in which the braking current is lower than the nominal value. In cases where it is foreseen an heavy braking cycle, contact the Applications Service.



Notice

The braking resistor must always be connected as it also performs the soft-start function. Failing that the system does not start, and in addition it would not be possible a controlled stop of the rotating motors.

2.2.7 Line Inductors

To date, for normal operation, it is not foreseen the use of inductors inserted between the phase network and the drive input.

2.3 Cables

Module Feature	2A	4A	6A	8A	12A	16A	24A	32A	48A
Section of the motor cable (X11 connector)	2.1 mm ² AWG14					3.3 mm ² AWG12	5.3 mm ² AWG10	8.4 mm ² AWG8	13 mm ² AWG6
Section of the brake cable (X10 connector)	1 mm ² AWG16								
Max motor cable length	100 m								
Maximum cable capacitance	< 150 pF/m								
Section of I/O cable (X5 connector)	0,22-1 mm ² AWG16								
Section of network cable (X11 connector)	2.1 mm ² AWG14					3.3 mm ² AWG12	5.3 mm ² AWG10	8.4 mm ² AWG8	13 mm ² AWG6
Section of brake resistor cable (X11 connector)	2.1 mm ² AWG14					3.3 mm ² AWG12	5.3 mm ² AWG10	8.4 mm ² AWG8	13 mm ² AWG6
Section of 24Vdc cable (X1 connector)	0.8 mm ² AWG18								
Section of ground cable (X11 connector)	2.1 mm ² AWG14					3.3 mm ² AWG12	5.3 mm ² AWG10	8.4 mm ² AWG8	13 mm ² AWG6

See annex 8.1 for the Metric / AWG conversion table.



Info: The power and control cables (except those that go from the network to the filter) must be shielded and possibly kept separated from each other at a distance greater than 200 mm.



Info: Shielded power cables can be interrupted and grounded by a copper bar using a clamp that ensures an efficient electrical contact section with larger cross-section of the ground wire.

It is foreseen to use of class F or higher motors suitable to be supplied with modulated high frequency PWM waveforms. Particular attention should be given to the use of appropriate cables.

The cable and the motor winding may result with the drive output stage to an oscillating circuit that increases the maximum voltage of the system; the parameters that contribute to determining this maximum voltage are the capacity and the length of the cables, the motor inductance, the frequency and the rising edges of the PWM modulation, and then it is recommended an analysis of the above parameters in order to prevent too high voltages for applications with specific issues.

Our Applications Service is available for the necessary support.

2.4. Safety and usage guidelines

2.4.1. General description of safety features

The intervention on the in operation is permitted only to qualified personnel.

The power from the drive to the motor can be removed in "a safe manner". In this way, when the safe power stage is disabled, the motor is not able to produce torque.

During the operation of the drives, depending on the degree of mechanical protection in the control cabinet installation, may present uncovered live parts.

The equipment during normal operation should not be accessible and all covers and cabinet doors should be kept closed.

The power and control connections may be live, even with the motor stopped.

During the operation Drives may also reach a temperature of 80 °C.

Voltage arcs may occur that can potentially hurt persons or damage contacts so avoid to loosen or disconnect the electrical connections when the drives are powered up and wait at least eight minutes after disconnecting the power supply, before touching live parts or loosen connections.

Capacitors can have dangerous voltages present up to eight minutes after the removal of the mains voltage and in any case for safety it is necessary to measure the voltage of the direct current circuit (BUS) and wait until the voltage drops below 40V.

2.4.2. STO Safety feature

2.4.2.1. Description

The DS2020 drives include as standard the STO function (Safe Torque Off) that shall ensure personnel protection against accidental restart of the drive.

The DS2020 standard version contains the STO function to be used as interlock against accidental motor starts.

The STO function can be used to turn off the power to prevent accidental starting.

The function disables the power control voltage of the semiconductors of the converter output stage, preventing the drive from generating the voltage required to rotate the motor.

Using this feature, you can perform short-term operations and / or maintenance work on non- electrical parts of the machine without switching off the power supply. This function must be enabled from a safe external control (mechanical or semiconductor) or by a specific external security board.

2.4.2.2. Directives on safety



Attention

Suspended loads must in any case be mechanically locked securely. The STO function, if activated does not ensure suspended loads.



Attention

Removing the 24Vdc from the two inputs of the STO connector the motor is out of control.



Attention

The STO function does not guarantee an electrical separation from the power output so if you need an intervention on the motor cable, you have to disconnect the drive from the power supply always waiting the discharging time of the intermediate circuit.



Notice

When using the STO function it is necessary to follow the sequence of operations below:

1. Stop the movement in a regulated manner, placing the nominal speed value to zero
2. Upon reaching the zero speed, and in the case of suspended loads, mechanically lock the load
3. Disable the drive and at this point turn on the STO function

Input voltage	24V +/- 10 %
Max input current	50mA +/- 10 %
Voltage Feedback	30V max
Current Feedback	200mA max

2.4.3. Usage guidelines of the Drive

It is absolutely necessary that the technical data of the modules and directions on how to connect them (nameplate and documentation) are available and observed.

Only qualified technical personnel, who is familiar with the transport, installation, assembly, commissioning can be in charge of such activities.

The qualified personnel must know and observe the following standards:

- IEC 60364 e IEC 60664
- Accident prevention national regulations

The drives contain electrostatically sensitive components, which can be damaged by improper handling that it touches a conductive object that is grounded. It is advisable also to discharge any electrostatic charge before handling the drive and place it on a conductive surface.

Proper use

The drives are safe devices that are placed in electrical systems or machines and can only be operated as integrated parts of these plants or machines. The manufacturer of the machine must generate a risk assessment for the machine and take appropriate measures to avoid unexpected movements that could cause injury or damage to persons or objects. If the drives are used in residential, commercial or light industrial environments, additional filters have to be implemented by the user as a result of comprehensive measures on the system .

Electrical connections

The drives must operate only inside a closed control cabinet. Taking into account the external environmental conditions, ventilation or cooling may be necessary. Use only copper conductors for wiring.

The conductor cross sections must comply with the norm IEC 60204.

Motors

The DS2020 drives have been designed to control brushless asynchronous and synchronous motors with torque control, speed and / or position. The rated voltage of the motors must be at least the same level of the DC-link voltage / $\sqrt{2}$ produced by the drive.

Power supply

The drives of the DS2020 series (overvoltage category III according to EN 61800-5-1) can be powered by three-phase industrial supply networks grounded (TN system, TT with grounded neutral and symmetrical rated current of not more than 10KA 120V to 480V \pm 10%).

Overvoltage between phases and the drive housing must not be greater than 1000V peak.

According to EN61800-3 transient voltage spikes (<50ms) between the phases must not exceed 1000V.

transient voltage surge (<50 μ s) between a phase and the housing must not exceed 2000V.

Prohibited Use

Uses other than those described above (Intended use) are not covered and can lead to damage to people, equipment or objects in general.

The use of the drive is normally prohibited in the following environments:

- hazardous areas
- areas subject to corrosive and / or electrically conductive acids, alkaline solutions, vapors, oils
- directly on electrical networks not connected to the ground or on asymmetrically grounded power supplies with a higher voltage 240V
- on ships or offshore installations

The installation and start-up of the drive are prohibited in cases where the machine on which it is installed:

- It does not comply with the requirements of the EC Machinery Directive
- It does not comply with the Directives on EMC or Low Voltage Directives
- It does not conform to national directives

The control of the brake by the drive DS2020 alone is not considered sufficient in those applications in which the safety of personnel must be ensured via the brake.

Storage

The storage of DS2020 for a consecutive period of up to one year does not require special limitations and actions; in the case where the storage period is longer than 1 year, prior to proceeding to installation and commissioning of the drive please contact Moog's Application Service in order to perform the following regeneration procedure of the electrolytic capacitors:

- Gradually apply a DC voltage of value 300VDCp with limited current by connecting the positive pole of the supply to the "X11-RRext" connector and the negative pole to the connector "X11-V1"
- Maintain the voltage value for about 20 minutes
- Disconnect the power source and wait for the discharge time

Maintenance / cleaning

The DS2020 drives are maintenance-free; the opening of the modules will void your warranty.

Cleaning

Do not immerse or spray the module

If the surface is dirty: clean with a dry cloth

In case of dirty ventilation grids: clean with a dry brush

Decommissioning

To disable a DS2020 (replacement, dismantling) follow the procedure below:

- Disconnect the supply voltage of the electrical panel and wait
- Check that the temperatures of the heat sink and of the mechanical parts are not too high
- Loosen all connections and disconnect all connectors
- Disassemble the module from the electrical panel

Repair

The servo drive can be repaired only by the manufacturer; the opening of the modules will void your warranty.

Perform the procedure for placing out of service and re-send it to the address of the manufacturer (with the original packing material if available).

Disposal

In accordance to Directive 2012/19 / EC electronic devices are "special waste" and should receive treatment and professional disposal; after notification the old modules and related accessories can be returned at the sender's expense to us for the correct disposal.

3. CERTIFICATIONS

3.1. CE

According to the European Community Directives drives must conform to:

- EMC 2004/108/CE directive
- Low Voltage Directive 2006/95/CE

The DS2020 has been tested in a laboratory for the verification of the parameters of compliance of the above Directives.

Regarding electromagnetic compatibility the DS2020 refers to C3 industrial environments.



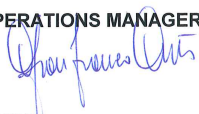
Notice

In a domestic environment, the DS2020 can emit radio frequency interferences.



Info

The machine manufacturer MUST NOT use the drives if there is no documentation that ensure the fulfillment of the requirements of Directive 2006/42 / EC.

MOOG ITALIANA S.r.l. Sede di Casella Via Avosso, 94 16015 Casella (GE) - ITALIA Telefono (39) 010.96711 Telefax (39) 010.9671280 www.moog.it		MOOG
CENELEC		Memorandum N°3
DICHIARAZIONE CE DI CONFORMITA' / EC DECLARATION OF CONFORMITY		
Il sottoscritto, rappresentante il seguente costruttore / <i>The undersigned, representing the following manufacturer</i>		
MOOG ITALIANA S.r.l., Sede di Casella / Casella Site		
Via Avosso 94, Casella (Genova), Italy		
dichiara qui di seguito che i prodotti / <i>herewith declares that the products</i>		
Marchio / Brand : MOOG		
Azionamenti Serie / <i>Drives Series</i> : DS2020		
risultano in conformità' a quanto previsto dalle seguenti direttive comunitarie / <i>are in conformity with the provisions of the following EC directives</i> (comprese tutte le modifiche applicabili / <i>including all applicable amendments</i>)		
rif. / ref nr	titolo / title	
2014/30/EC	Direttiva Compatibilità Elettromagnetica/ EMC Directive	
2014/35/EC	Direttiva Bassa Tensione/ Low Voltage Directive	
e che sono state applicate le norme armonizzate, o parti di esse, indicate di seguito / <i>and that the following harmonized standards, or parts thereof, have been applied</i>		
nr	issue	titolo / title
EN 50178	1997	Electronic equipment for use in power installations
EN 61800-3	2004	Adjustable speed electrical power drive systems. Part 3: EMC product standard including specific test methods
EN 61800-3: 2004 A1	2012	Adjustable speed electrical power drive systems. Amendment 1
Altri riferimenti o informazioni richiesti dalle direttive comunitarie applicabili / <i>Other references or information required by the applicable EC directives</i> : La conformità dei prodotti è subordinata al rispetto delle procedure contenute nei rispettivi "Manuale di installazione". L'utilizzatore ha la responsabilità primaria nel seguire le raccomandazioni del costruttore riguardo alle problematiche EMC. / <i>The conformity of products is subjected to observation of the procedures included in the proper "Installation Manual". The user has the primary EMC responsibility in following the recommendations of the manufacturer.</i>		
Ultime due cifre dell'anno in cui e' stata affissa la marcatura CE / <i>Last two digits of the year in which the CE marking was affixed</i> : 14		
Casella, 20 Aprile , 2016		
Gianfranco Costa		
OPERATIONS MANAGER 		
CENELEC		Memorandum N°3

EC declaration of conformity

3.2. Safe Torque Off (Re-start lock)

The DS2020 integrates the Safe Torque Off (STO) function according to standards EN 61800-5-2; EN / ISO 13849-1. SILCL 3 PL "e" (as per certificate). The function also corresponds to an uncontrolled stop in accordance with stop category 0 of IEC / EN 60204-1 standard.

The validation of the function is based on:

- a guarantee that a single fault does not lead to loss of the safety function
- some, but not all possible faults, may be identified
- the addition of more failures undetected can lead to loss of the safety function

In case of occurrence of two simultaneous faults in the power section residual risk is for the motor to rotate by an angle dependent on the number of its pole pairs, so for example a 6-pole motor can give rise to a maximum rotation of 60°.



Attention

The manufacturer of the machine and / or final apparatus must maintain and make available a risk analysis of the machine in accordance with the ISO12100 and ISO14121 standards and implement all necessary measures to avoid that unforeseen movements can cause damage to persons or objects. In particular the manufacturer of the machine and / or final apparatus has to comply with the relevant product standards. Where it has been chosen to perform safety functions by means of electrical / electronic devices (SCRF), must be specified for these functions, the safety integrity levels (SIL) and the functional requirements. According to TECHNICAL STANDARD IEC EN 62061, this specification must include all information likely to influence the design of the electrical / electronic device, including, where applicable:

- The machine operating conditions
- Prioritization of functions that can be active simultaneously and cause conflicting actions
- The frequency of operation of each SCRF
- Requested response time of each SCRF
- Description of each SCRF
- SCRF interface with other functions of the machine
- Description of the reactions related to machine reboot failures and constraints when the reaction to the fault results in the interruption of the reboot
- The operating environment description
- Tests and associated equipment
- (Eg, access doors)
- Frequency of cycles of operation and utilization factor within the working cycles

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MOOG L MAS2-E-161

DICHIARAZIONE CE DI CONFORMITA'
(LINGUA ORIGINALE)
ai sensi dell'Allegato II A della Direttiva 2006/42/CE

Noi,

MOOG ITALIANA S.r.l., Casella Site
Via Avosso 94, Casella (Genova), Italy

dichiaro sotto la nostra esclusiva responsabilità che il blocco logico per la funzione di sicurezza "Coppia Disinserita in Sicurezza" ("Safe Torque Off") integrato nei nostri azionamenti serie DS2020

è conforme alle disposizioni della Direttiva Macchine 2006/42/CE

ed è conforme al modello sottoposto ad esame CE del tipo, che ha ottenuto la certificazione CE n. 14CMAC0030 del 13/11/2014 rilasciata dal seguente organismo notificato:

I.C.E.P.I. S.p.A. (Istituto Certificazione Europea Prodotti Industriali)
Via G. Pastore, 4 - 21046 Mainate (VA) - Telefono (39) 0332.421111 Fax (39) 0332.429233
Numero di identificazione 0066

e che il Fascicolo Tecnico è stato costituito da:

MOOG ITALIANA S.r.l., Casella Site
Via Avosso 94, Casella (Genova), Italy

Inoltre sono state applicate le seguenti:

norme armonizzate

CEI EN 61800-5-2:2008, UNI EN ISO 13849-1:2008

Casella, 09 Aprile 2015

Gianfranco Costa

OPERATIONS MANAGER

Sede Legale: MOOG ITALIANA S.r.l. - Società a Socio Unico soggetta a direzione e coordinamento da parte di MOOG GmbH & Co.KG
Via G. Pastore, 4 - 21046 Mainate (VA) - Telefono (39) 0332.421111 Fax (39) 0332.429233
R.E.A. Varese 138918 - Cod. Fisc. , Partita IVA, Nr. Reg. Imp.Varese: IT00531090124 - Cap. Soc. Euro 520.000 i.v.



Istituto Certificazione Europea Prodotti Industriali S.p.A.
organismo notificato n. 0066

ATTESTATO D'ESAME CE DI TIPO
EC-TYPE EXAMINATION CERTIFICATE
2006/42/CE - ALLEGATO IX
2006/42/EC - ANNEX IX

14CMAC0030

<input checked="" type="checkbox"/> Nome e indirizzo del costruttore <input type="checkbox"/> Name and address of the manufacturer	MOOG ITALIANA S.r.l. Via Avosso, 94 16015 CASELLA (GE)
<input type="checkbox"/> Nome e indirizzo mandatario <input type="checkbox"/> Name and address of the authorised representative	
<input checked="" type="checkbox"/> Genere prodotto / Funzione di sicurezza <input type="checkbox"/> Product designation / Safety function	Funzione di coppia disinserita in sicurezza (STO) per convertitore di frequenza Safe torque off (STO) function for frequency converter
<input checked="" type="checkbox"/> Serie / Tipo <input type="checkbox"/> Series / Type	DS2020
<input checked="" type="checkbox"/> Numero e data del rapporto di verifica <input type="checkbox"/> Date and number of test report	Vedere ALLEGATO N.1 See ANNEX Nr.1
<input checked="" type="checkbox"/> Direttiva / Categoria della macchina <input type="checkbox"/> EC Directive / Category of machinery	2006/42/CE - All. IV n. 21
<input checked="" type="checkbox"/> Risultato dell'esame <input type="checkbox"/> Examination result	Il modello esaminato nel contesto delle specifiche e dei limiti riportati nel rapporto di verifica riportato in allegato risulta conforme ai Requisiti Essenziali di Sicurezza e Salute ad esso applicabili contenuti nella Direttiva Macchine 2006/42/CE, Allegato I. The model examined under the specifications and limits stated in the annex test report complies with the related Essential and Safety Requirements listed in the Machinery Directive 2006/42/EC Annex I.
<input checked="" type="checkbox"/> Note <input type="checkbox"/> Remarks	Vedere ALLEGATO N.1 See ANNEX Nr.1
<input checked="" type="checkbox"/> Condizioni di validità <input type="checkbox"/> Validity conditions	Le condizioni di validità della certificazione ICEPI sono indicate ai punti 4 e 5 del contratto per l'attività di certificazione intervenuto tra il Contraente ed ICEPI. Il presente certificato emesso nella revisione corrente annulla e sostituisce la precedente revisione, se esistente. Il presente certificato è valido solo se accompagnato dall'allegato 1, unitamente al quale deve essere riprodotto senza modifica alcuna per essere ritenuto valido. ICEPI certification validity terms are stated in clauses 4 and 5 of the certification activity contract between Contractor and ICEPI. This certificate is issued in the current revision cancels and replaces the previous revision, if it is present. This certificate is valid only if accompanied by the Annex 1 and it shall be reproduced with the Annex 1 without any change to be considered valid.

Data emissione
Issue date
13.11.2014

Revisione 00
Revision 00
13.11.2014

Data di scadenza
Expiry date
12.11.2019

Il Direttore Generale
The General Manager
Dott. Ing. Andrea Guido Esposito

4. ELECTRICAL AND MECHANICAL INSTALLATION

4.1. Tools and equipment

Tools:

Si consiglia di avere a disposizione i seguenti utensili per l'installazione dei vari moduli:

- Screwdriver M2 (connector insertion)
- Screwdriver M3 (mounting screws and connectors on the front)
- Screwdriver M4 (mounting power connectors)
- Screwdriver M4
- Box wrench $\varnothing 10$
- Box wrench $\varnothing 8$

Equipment:

There is no need of any specific electronic tool; it is suggested, however, to have a digital multimeter, useful for verification of voltages, continuity and to make comparisons and reliefs.

4.2. Mechanical installation

4.2.1. Assembly of various components



Info The modules have been designed and built for vertical assembly providing a free space of at least 100 mm above and below to ensure sufficient air circulation.

Module installation

Standard vertical mounting.

Mounting material: 2/4 socket head screws M5.

For horizontal mounting applications contact the Applications Service verification.

Filter installation

For the installation of the filters follow the same requirements as defined for the installation of the drives.

Braking resistors positioning

The drives DS2020 L50 and L75 sizes are equipped with internal braking resistors while the L85 and L125 sizes have external resistors (available for all sizes, if the application requires it) placed at the top of the electrical panel to facilitate the dissipation of the generated heat .

Installation with provided brackets for the internal resistance and on heat sink for the external resistance (armored).

4.3. Electrical installation and thermal rating

4.3.1. Safety and general instructions



Attention

While the Drive is running there is danger of death, serious injury or serious material damage.

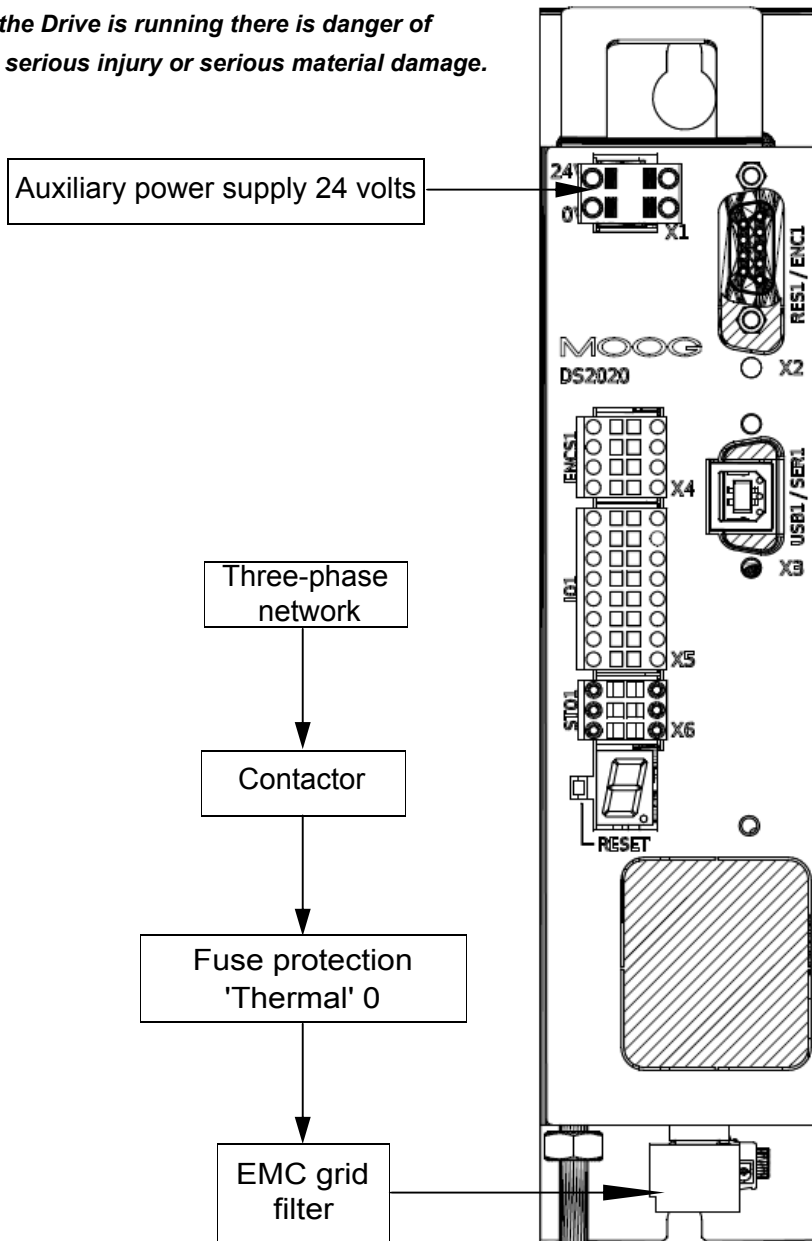


Illustration: Structure of the electrical panel with the components of a servo system

Particular attention should be given to grounding, shielding and the use of the filter, in order to reduce or suppress particularly steep voltage fronts (derived by PWM modulation) capable of generating significant unwanted currents through capacitive couplings and grounded systems. These voltage fronts can also generate high-frequency radiation mainly through the motor cable.

The installed on the network filters reduce conducted disturbances: see section 2.2.5. "Filters" for the recommended models.

With regard to the grounding in the panels normally there are two types of problems:

- Ground EMC (high frequency) constituted by a portion of the metal wall, unpainted, on which the drives and the filters must be positioned to create an adequate electrical contact for the mitigation of high frequency noise.
- Ground safety (PE = protective earth) according to standard EN60204-1, to be performed with minimum wire section of 10 mm².

Regarding the shielding, all the power and control cables must be shielded except those from the mains to the network filter, whose shield is connected to the layout of the electrical panel and may not be required.

Generally, the screen must be connected at each end. In some cases, however, the control cable screen can only be connected at one end to clear the noise that might be going to interfere with the control signal.

Requirements for laying the connecting cables:

- Avoid crossing power cables with signal cables
- The shielding cover must be greater than 70%
- Avoid laying the power and signal cables side by side with each other, especially near the line filter whilst maintaining physical separation
- Avoid the formation of "loops" in the cables, keep the wiring as short as possible and close the common potential correctly
- Keep the power cables of the input power separate from those of the motor
- If the motor is equipped with a brake, keep the cables of the 24 V of the brake separated from the signal (feedback) unless they are not already incorporated in the motor power cable.

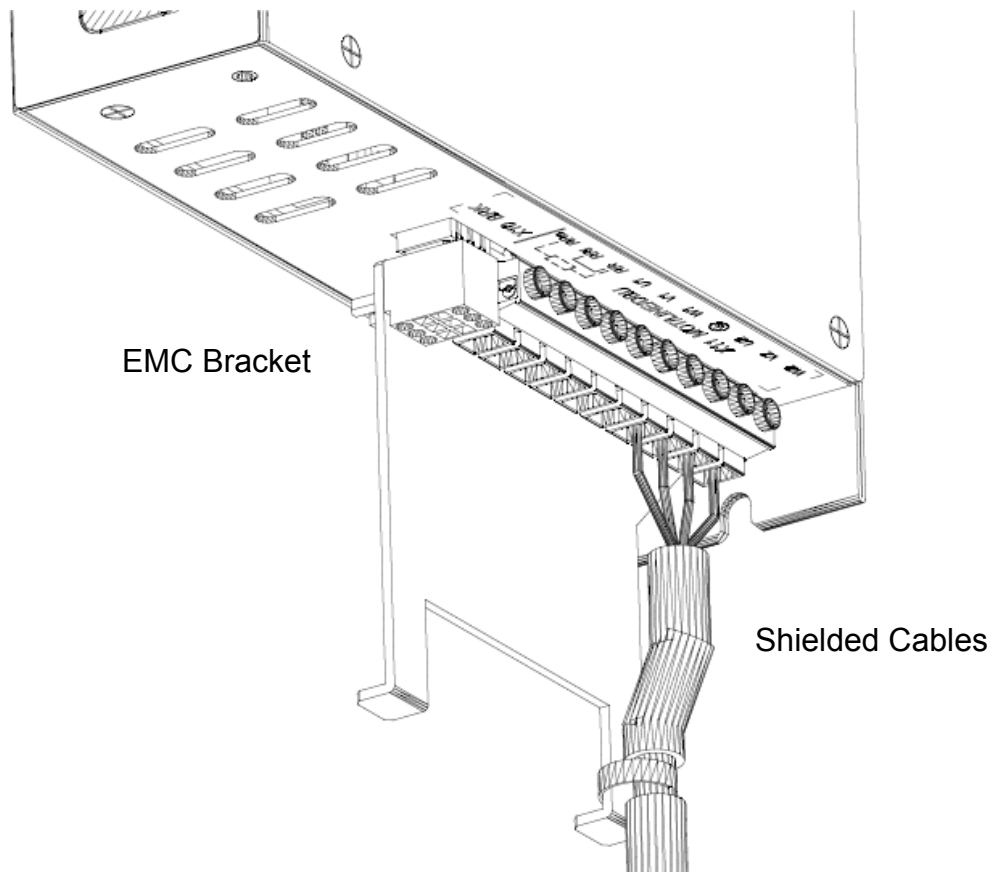


Illustration - Connection Cables EMC-bracket

4.3.2. Thermal rating of the electrical panel

For a thermal rating of the electrical panel refer to the following table indicating, in the first column, the value of the maximum power that can be dissipated from the radiator, in the second column, the value of the power dissipated by the module under nominal operating conditions. The value of maximum power which can be dissipated from the radiator is useful to estimate the power dissipated on the internal braking resistors.

If in the application the power dissipation values in the loop are higher than the values indicated contact Customer Support.

4.3.2.1 Drive axis module dissipation

Type	Rated size	Power dissipated from the module to the rated current [W]
L50	2	21
	4	42
L75	6	63
	8	82
	12	122
L85	16	195
	24	293
L125	32	400
	48	567

4.3.2.2. Thermal dissipation of the accessories

Device	Dissipated power (W)
Network filter	From 9 to 30
External braking resistor	From 100 to 370



Info: We recommend, if possible, mounting the braking resistors outside the control cabinet, suitably protected against accidental contact, to avoid having to remove the heat generated by them from the electrical panel.

4.3.3. Auxiliary power characteristics

The auxiliary power supply must be 24 V with a tolerance of +/- 10%, and "Ripple" of less than 200 mV

The current consumption will depend on which and how many modules make up the system.

The maximum required current will be the sum of currents required by each component.

Module	Current consumption (A)
Size L50	1,0
Size L75	1,0
Size L85	1,5
Size L125	1,5
Motor brake	2,0



Notice

In the absence of power dedicated to the motor brake it is necessary for the general auxiliary power supply system to be correctly dimensioned and that the tolerances comply with those required by the brake.

4.3.4. Grid connection



Attention

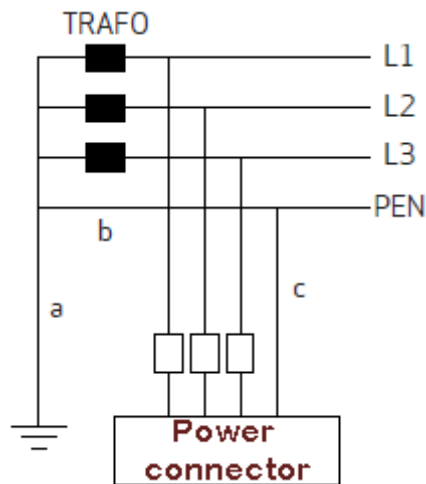
It is necessary to ground the drive properly to avoid risk of injury or death. In the case of networks ungrounded or asymmetrically grounded you need to insert an isolation transformer

4.3.4.1. Types of electrical networks

TN-C grid

The type of network shown in the figure is common to many industrial plants and has the following characteristics:

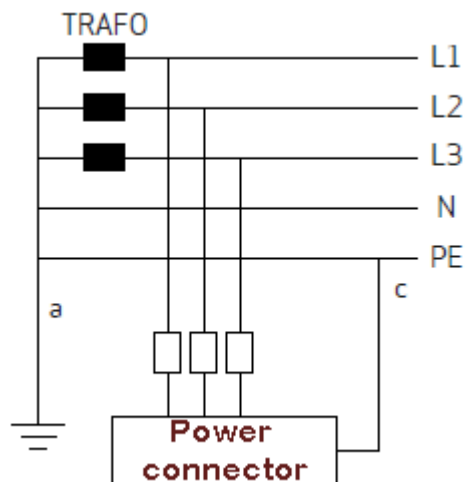
- Direct connection network (ground point)
- The neutral and grounding of the whole system are wired in a single connector, the PEN
- Connection to the ground of all parts exposed to contact and all shields



TN-S grid

The type of network shown in the figure is the most widespread in Europe and has the following characteristics:

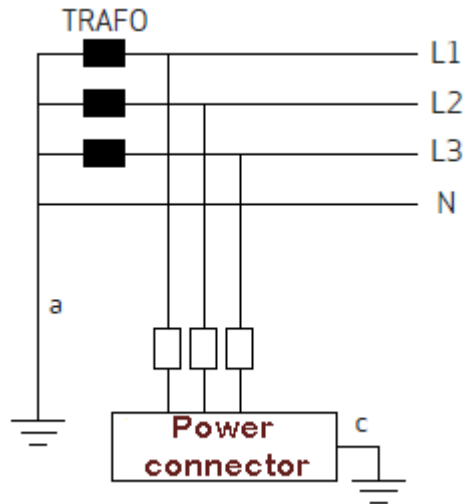
- Direct connection network (ground point)
- NA
- Connection to the ground of all parts exposed to contact and all shields



TT grid

The electrical network shown in the figure is not widespread and presents problems for the EMC requirements, which can only be met fully with precautions and measurements in the field. The following are the main features:

- Direct connection network (ground point)
- NA
- Connection to the ground of all parts exposed to contact and all shields



4.3.4.2. Protection components

Fuses

It is recommended that protection against short branch circuit in the final application via external fuses type semiconductor, 660 Vac, 200 kA M.A.H. or other with the same characteristics.

The dimensioning of the mains fuses can be done on the size immediately superior to the single module current.

Needing to use a single protection with insertion of the three fuses on the input line to a system consisting of several modules, the choice of the size will be the one immediately higher than the sum of the currents of the individual modules.

Example: in a system consisting of 3 modules (one module L50 4A, one L75 6A and one L75 12A) it is needed a fuse sized immediately above $4 + 6 + 12A = 22A$ that is a fuse 25A, in case simultaneity in the use of axes.

Safety switches for fault currents.

According to the EN60204-1 standard for electrical equipment of machinery, can be used a safety switch for fault currents provided it is ensured the respect of the applicable provisions. To protect against direct accidental contact it needs to be installed on each power supply system / modules-axis a safety switch against fault currents (leakage) with 30 mA sensitivity

4.3.4.3. Ground connection

In the electrical panels there are normally two types of grounds:

- Ground EMC (high frequency) constituted by a portion of the metal wall, unpainted, on which the drives and the filters must be positioned to create an adequate electrical contact for the mitigation of high frequency noise.
- Ground safety (PE = protective earth) according to standard EN60204-1, to be performed with minimum wire section of 10 mm².

The length of the individual cables that connect to the ground should be minimal so it is advisable to place a grounding bar as close as possible to the drives.

4.3.5. Drive wiring

Proceed as follows:

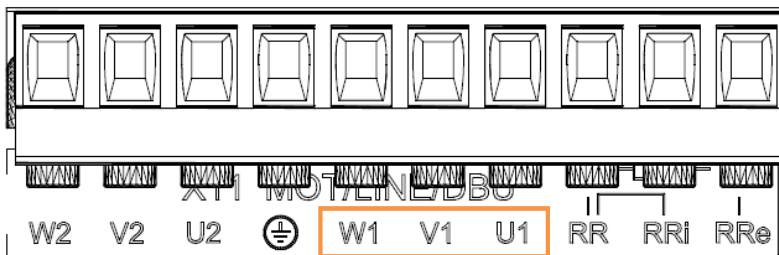
1. Ground the drive mounting plate, the casing of the motor and the control unit ground
2. Lay separately the power and the control signal cables
3. Connect the auxiliary power on X1
4. Connect the feedback device on X2
5. Connect the communication interface on X3, if USB or RS422; on X4 if RS232, CANopen on X7 if, on X8, X9 if Ethercat
6. Connect the "power" phase and the motor on X11
7. Prepare the connections for the STO on X6
8. Connect the motor brake on X10
9. Connect the braking resistor on X11
10. Final check: Check the consistency of the wiring based on the wiring diagram of the electrical panel

4.3.5.1. Grounding

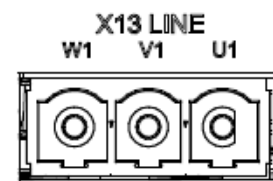
Connect the module housing to the cabinet structure ensuring that the contact surface is adequate and that the connection is at low resistance and inductance. Avoid mounting the module frame on painted and insulated surfaces.

4.3.5.2. Collegamento cavo di alimentazione

See 2.3 for selection.

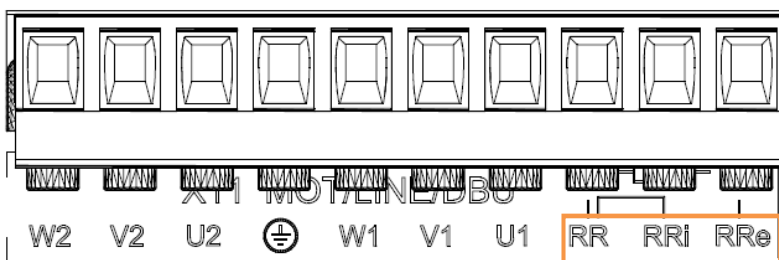


Connector X11 – [W1-V1-U1] sizes L50 and L75

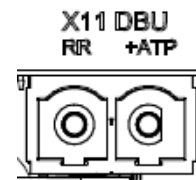


Connector X13 – [W1-V1-U1]
sizes L85 and L125

4.3.5.3. Braking resistor connection



Connector X11 – [RRe – RRi - RR] size L50 and L75



Connector X11 – [RRe-RRi-RR]
sizes L85 and L125

- If the resistance is inside, insert a bridge between RRi, RR (only L50 / L75)
- If the resistor is external, connect it between RRe and RR (only L50 / L75)
- If the resistor is external, connect it between RR and + ATP (only L85 / L125)

The cable must be shielded. The connection of the screen to ground can be closed with a conductive strap, with whom to connect the cable to the metal bracket fixed under the drive.

See paragraph 2.2.6. "Braking resistor" for the selection of the resistance

4.3.5.4. Auxiliary power connection

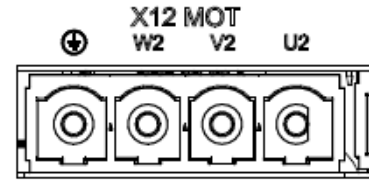
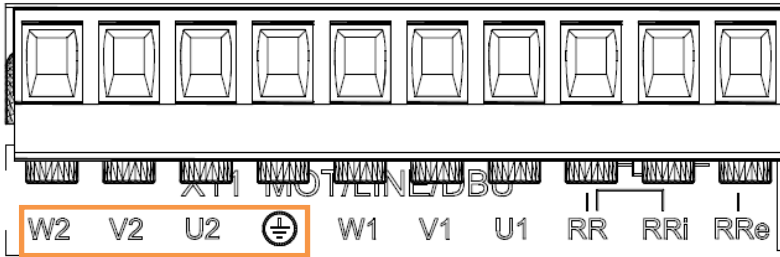
An auxiliary voltage of 24VDC, must be provided externally to the terminals +24 V and 0 V on the front, connector X1.

4.3.5.5. Signal connection

For connection of the control signals, transducer interface, linear communication, see paragraph 2.2.4.

4.3.5.6. Motor cable connection

See paragraph 2.3.



Connector X11 – [W2-V2-U2- ⊖] sizes L50 and L75

Connector X12– [W2-V2-U2- ⊖] sizes L85 and L125

Info

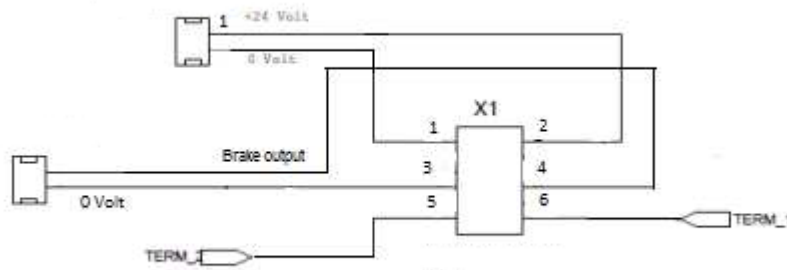
For motor power cables with capacity greater than 150 pF / m the leakage currents could cause false alarms which can be overcome with an inductor in series to the power cable, to be placed as close as possible to the drive. For cables longer than 50 meters and for the eventual sizing of the inductor, contact the Applications Service.

4.3.5.7. Brake cable connection



Notice

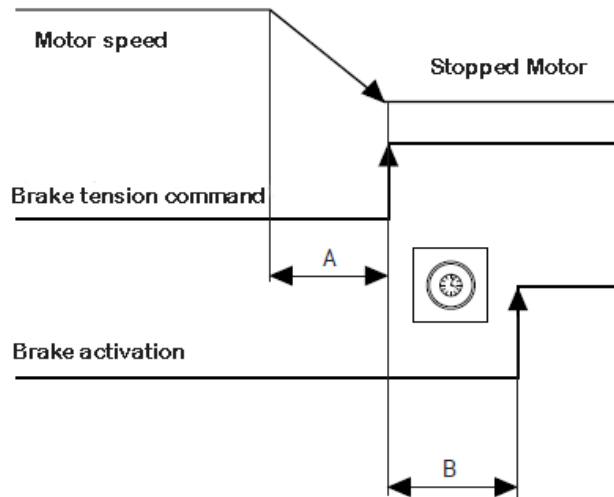
During the definition of the brake connections, take into account the possible voltage drop for connections over 10 m made with not adequate cable section.



- The power must be supplied externally (pin 2 on the 24 Volt connection while on pin 1 the return to 0 volts).
- The protection against overload is realized with a fuse of 2 A maximum, delayed, to protect both the internal devices and the power supply, to be installed externally on the 24 Volt line if not protected in any other way.

- The internal devices are protected from short circuit between the terminals (between 3 and 4) and to ground.
- The drive detects the correct execution of the command, the possible short-circuit condition is indicated as the absence of output on terminal 4.
- On the same connector, there is the input for a thermal sensor of the motor protection, having the same characteristics as the one on the connectors of the X2 feedback position.

In the figure below functional and timing relationships between enabling signal, activation and speed command. The timing of the brake of the motor varies depending on the specific data of the motor itself. The external control of the brake activation must get to the drive when the motor speed is close to or equal to 0. The delay introduced by the drive between reception of the command and its transmission to the brake is less than 125 us. The brake activation delay depends on the type of brake and is specified by the manufacturer of the motor.



Brake activation timing diagram

A: deceleration time of the machine (variable)

B: Brake activation (300ms)



Attention

The same considerations relating to the motor cable also applies, so it is recommended to pay special attention to the execution of shielding even if the conductors are not already incorporated in the motor cable.



Attention

The connection to the motor brake by itself alone does not guarantee the personnel's safety. In particular, the vertical loads require an additional mechanical brake to operate in a certifiably safe manner.



Notice

The brake cannot monitor autonomously if the voltage level is sufficient to its own operation. Consequently, it is necessary to measure the voltage on the input of the brake and always verify the functionality during release and braking, in particular in the case of connections with long cables or cables with reduced section, that are subject to significant voltage drops.

4.3.5.8. I/O signal connection

For the connector pin assignment see paragraph 2.2.4.



Notice

The analog inputs and outputs are referenced to ground 0 V ext. present on pin 16 of X5; the 0 Volt. present on pin 8 of X5 is used for the power supply of the digital inputs and outputs.

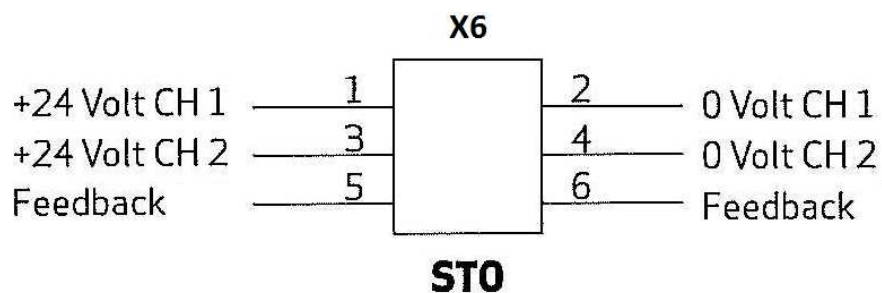
Explanatory notes for the analog inputs

- For analog rated values there are two programmable differential inputs; as reference to the potential connect pin 16 to the corresponding control module ground pin; the default settings are the nominal speed value for pins 1 and 2 and the torque limit for pins 3 and 4 when the drive is used as "analog."
- Maximum differential voltage: $\pm 10V$
- Ground reference pin 16
- Input resistance: 22 kOhm
- Scanning rate: 32.5 usec
- Resolution: 12 bit

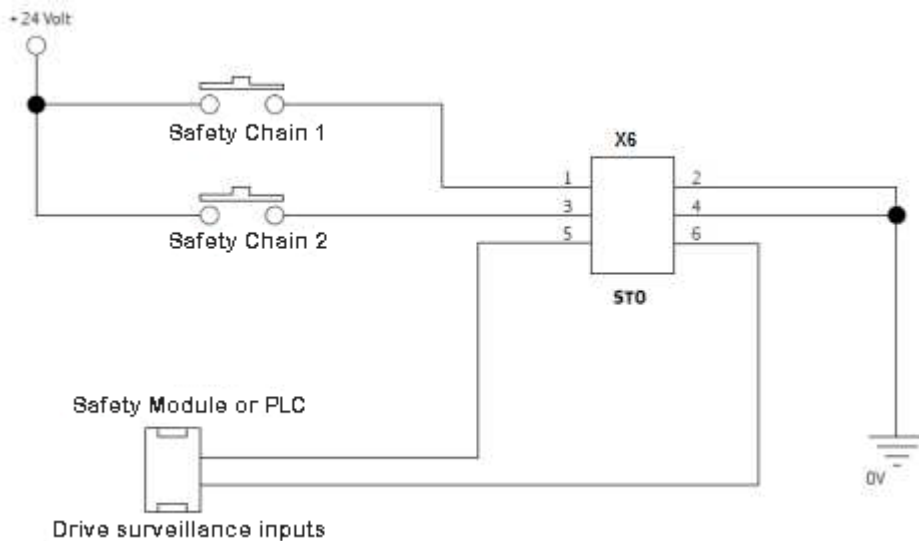
Explanatory notes for the digital inputs:

- There are programmable digital inputs, DIG IN 1 and 2, also suitable for "latch functions" or quick feedback ("Capture" type) of positions or specific events.
- The possible functions related to the X4 connector pins can be set by the Dx2020GUI program and are:
 1. Serial RS232 with inputs and / or outputs
 2. simulated encoder
 3. Digital I / O line drivers programmable as inputs or outputs

4.3.5.9. Connection STO signals - connector X6



Detail of the feedback contact circuit



By inserting in series to the circuit of the "safeties" STO the two commands, the axis enablement is controlled only when the PLC controls both the S1 and S2 signals and simultaneously all the safeties of the machine are "closed." The opening of a "safe" contact causes the axis to drop uncontrollably; in situations where this behavior is not compatible with the machine movements (for example with interpolated axes or ones that interfere mechanically) it is recommended to use appropriate delayed safety contacts to release the axis only after full stopping of the movement in a position suitable not to cause any damage to the machine.

The dual channel consists of two separate independent circuits; each control line is independent but acts on devices connected in series with each other; only when both commands are given properly one can proceed with the motor movements.

The absorption on the two inputs S1 and S2 is less than 50mA at 24 volts.

As feedback of the 2 commands given, the drive closes an electrical contact to the controller to verify the accuracy and consistency of the supplied commands and then control the movements with a proper sequence.

The delay between the application of the command (S1 or S2) and the feedback, executed command signaling, is less than 50 ms; the delay between the removal of the command and its feedback signal is less than 20 ms.

In any case wait at least 50 ms before moving the axes after applying the controls and 20 ms before detecting that the drive is in "safe condition".

The STO function is certified according to SIL 3 (EN62061) and PL e (ISO 13849-1) and allows a simplification of the machine's safeties wiring.

Attention:

Se i cavi di collegamento della funzione STO si trovano all'esterno del luogo d'installazione devono essere protetti dall'esterno (ad esempio tramite canalina) e posati in modo "fisso".

4.3.5.10. Transducers connection

The DS2020 is able to handle the most common of the motor position transducers shown in the following table

Resolver standard	X2 Connector
Encoder incremental TTL	X2 Connector
Encoder Stegmann Sinusoidal Absolute Single / Multiturn with hyperface communication	X2 Connector
Encoder Hedenhain Sinusoidal Absolute Single / Multiturn with ENDAT communication	X2 Connector

The connector X2 is for all, but can be of different types depending on the transducer, for the pin description see paragraph 2.2.4.1



Notice

The cable for the incremental encoder must be at least 6 and possibly individually shielded twisted pairs for incremental signals A, B, C and Hall signals U, V, W.



Info: For long connection cables over 50 m please contact the Applications Service

4.3.5.11 Connecting the Fieldbus - X8, X9, X10 connectors



Info: Depending on the type of fieldbus you must install a different firmware. If the connection is via Ethercat the file will have the suffix **_ecat** if it is via CanBus the file will have the suffix **_can**

- EtherCAT

The X8 (X9) connector is used for the Ethernet interface. The installed software handles the communication with the network EtherCAT.

For details on the connector see paragraph 2.2.4

- CANBus

The X7 connector is used for the CAN interface.

For details on the connector see paragraph 2.2.4.1

For the connection it must be used a cable terminated at the ends with two 120 ohm resistors. The cable length usable in order to ensure a secure communication decreases with increasing transmission speed. Indicatively, reference can be made to the following table: FOR CABLE LENGTHS GREATER THAN 100 METERS contact the Customer Support for the verification of the relation length / speed.

Transmission speed (kBaud)	Max cable length (m)
1000	10
500	60
250	100

5. COMMISSIONING VIA GUI

The commissioning of the system is performed via the operator Dx2020 GUI.

For a detailed description of the menus and procedures please refer to the Help on line on the GUI itself.

5.1. Safety



Attention

The drive can generate potentially lethal voltages up to 900 V.

So verify that all live parts are protected from contact with the human body.



Attention

Only qualified personnel, specialized in electrotechnics and electric drives can operate the drive.



Notice

Changing parameters without prior verification, may result in unexpected and incorrect machine movements



Notice

Only qualified personnel is authorized to set the parameters of a running drive.



Notice

We recommend, before operating the drive, to carefully check that the settings of all parameters are correct.



Attention

When the drives are energized, avoid loosening the electrical connections. After removing the power supply the capacitors can still have dangerous voltages present up to eight minutes after switching off and for safety reasons it is appropriate to measure the voltage in the intermediate circuit and wait until it has fallen below 40 V.



Attention

During operation, the heat sink and the rear panel can reach very high temperatures, up to 80 °C, thus representing a danger to the operator's safety. Before working make sure the temperature is decreased below 40 °C.



Attention

Before installation, the machine manufacturer must undertake a thorough analysis of the risks and take appropriate precautions, so that any unexpected movements of the machine can not harm persons or things.

5.2. Dx2020 GUI

5.2.1 Overview

A graphic interface software called Dx2020 GUI is associated with each drive. It allows to set and change the parameters and configure the drives.

The main features are:

- System Configuration with access to the basic parameters of the system (sensors, digital and analog I / O, motor parameters, etc.)
- Calibration of the loop speed and position to customize and optimize the drive response
- Drive direct control (Jog mode, speed profile with internal generator)
- Commissioning
- Diagnostics
- Monitoring of the variables internal to the drive and I / O signals
- Data logging
- Display signals on a digital 4 track oscilloscope
- Update Firmware
- Drive parameters management (save, restore, etc.)



Info it is recommended to have at least the access rights 'Power User'. This is necessary because of a limitation related to the write accesses of the file from the Windows operating system.

5.2.2 Minimum PC requirements

- Pentium® 1 GHz processor or superior
- 512 MB RAM
- 150 MB free HD space
- x86 and x64 supported
- Internet connection for software download and update
- Serial port onboard, PCI adapter or USB-serial converter, Ethernet port, CAN interface (IXXAT)

The GUI uses .NET Framework 4.0 libraries, needing the following:

- x86: 600 MB free HD space
- x64: 1,5 GB free HD space

Supported OS

- Windows XP Home Edition (Service Pack 3)
- Windows XP Professional (Service Pack 3)
- Windows XP Professional x64 Edition (Service Pack 3)
- Windows Vista
- Windows 7
- Windows 8
- Windows 8.1



Info:

There are some versions of Windows XP NOT supported by the .NET Framework 4.0. Windows 8 and Windows 8.1, already have pre-installed the .NET Framework 4.5 libraries that are an update of the 4.0 ones. So users who have these versions of Windows can use the installer without the .NET Framework 4.0. In case of installation problems, contact the Applications Service.



Info:

You must have administrative rights for both the installation and to run the program.



Info:

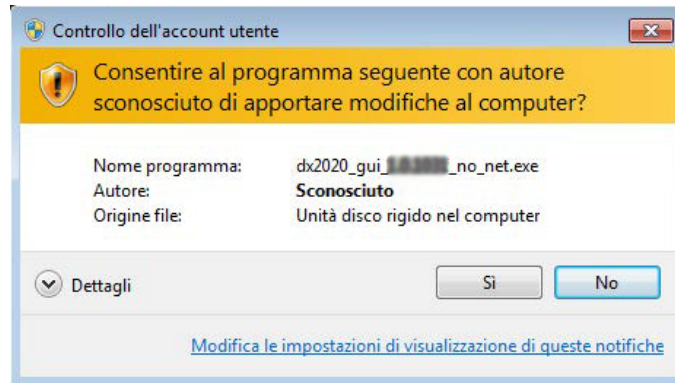
If the SW configuration of the system does not meet the requirements, you can upgrade using the Microsoft Update site through the utility included in the operating system

5.2.3 Dx2020GUI installation

After downloading the installer, start by double clicking on it. Windows Vista and Windows 7 compared to Windows XP have a system of control on the opening of more advanced applications, called UAC (User Account Control). This system every time you start any program that needs more administrative rights asks if you want to proceed

The installation software may be obtained from Moog-Casella.

Windows 7



Click **Yes** or **Allow** to proceed with the installation.

If the software is installed for the first time on the PC, the desired language will be asked.

By default, if available, the program will select the operating system language as their first choice automatically.

This setting applies to both the Installer and for the application dx2020 GUI.

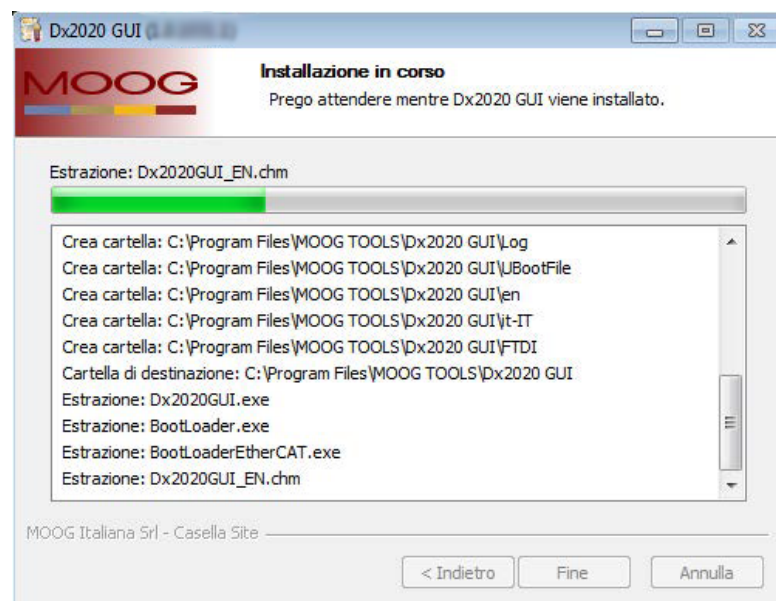
Available languages are English and Italian.

However you can also change the language via GUI (Graphics User Interface) at a later time.

After you upgrade the program will proceed with the installation of the .Net FrameWork 4 if it is not detected.

installing this latest package requires 5 to 10 minutes depending on the PC.

The installer requires the installation of additional components, some are installed automatically others require user consent. During installation, you can view the steps performed by the installer, and any installation errors, in a LOG window.



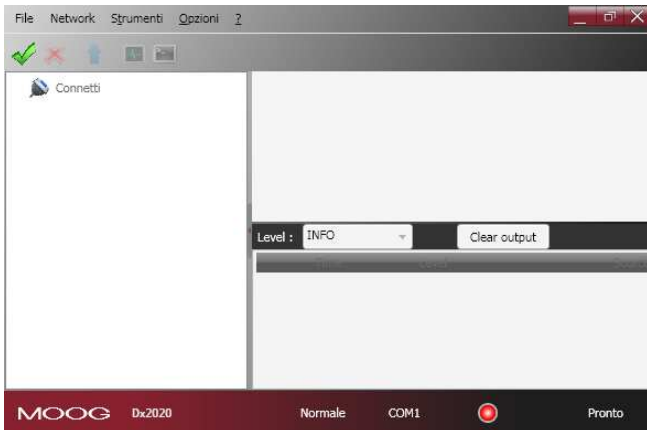
After installation, click on **Finish**.

If an error occurs during installation report the error message to the Customer Service.

Once the program is installed, the Dx2020GUI icon will be displayed on the desktop.

5.2.4 GUI-Drive connection

Run the executable Dx2020GUI with the drive powered.

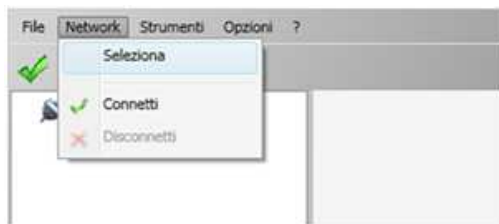


The GUI can connect to the drive via:


- Serial RS422/RS232 or USB (connector X3)
- EtherCAT (X9-IN)
- CanBus (connector X7-IN)

Note: The GUI automatically detects whether it is used on RS422 or RS232. For details on connectors see paragraph 2.2.4

The EtherCAT and CanBus interfaces are optional. From the **Network** menu, click **Select** to choose the type of communication protocol.



For more details, see the Help Online (for how to access the Help Online, see paragraph 5.2.7)

Select the Connect command from the toolbar or through the drop-down menu **Network** . The LED in the Statusbar turns green if the connection was successful, otherwise it becomes red. Depending on the type of connection:

- **RS422/RS232 or USB:** The GUI connects and loads the parameters automatically

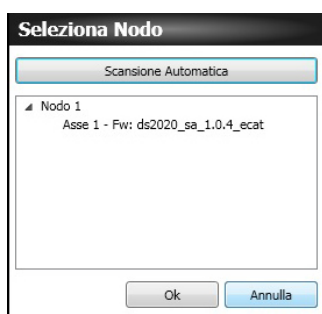


RS422/RS232



USB

- **EtherCAT:** Press "Auto Scan" to detect available nodes. Then press "OK". The GUI connects and uploads the parameters of all nodes.



- **CANBus:** from the connection selection window choose Port and Baud Rate. Then press "OK".



In the "Select node" window confirm the values "Node" and "ID". Then press "OK"

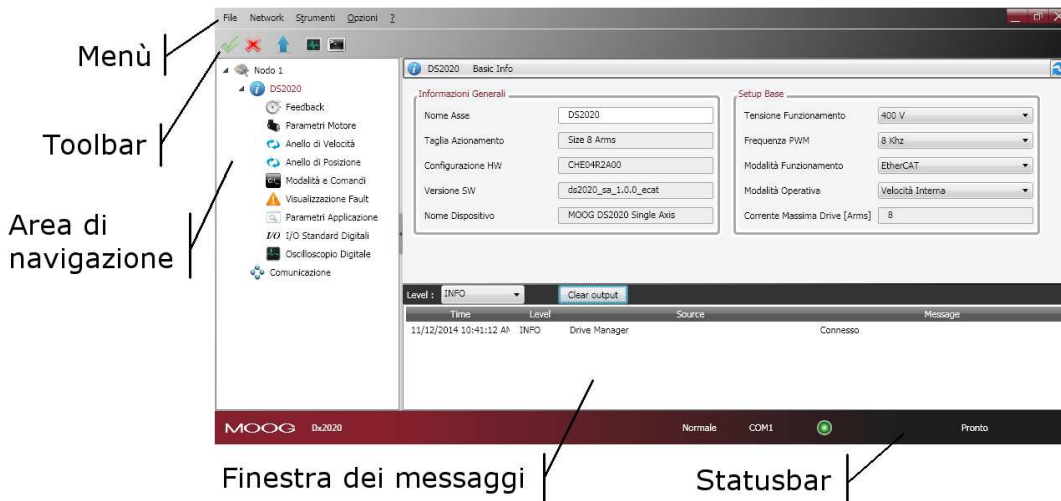


Info

In case of failure during connection, refer to the chapter "Troubleshooting" and follow the suggested actions.

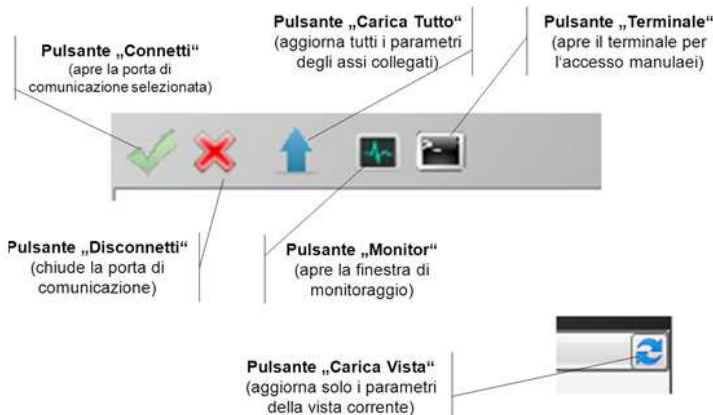
5.2.5 Layout

Performing the connection, the following screen will appear:



- **Menu:** Contains the following File menus Network, Tools, Options,? For more information, refer to the Help Online.

Toolbar:



• **Navigation area:**

This area allows thanks to a neat and intuitive structure to access all the information organized into views. The axis has a submenu that contains the parameters by function (transducer, motor, speed loop, etc.) Clicking submenus in the main area displays the associated graphic window.

- The last menu item is related to the EtherCAT or CAN communication parameters (one per module)



• **Main area:**

This area displays the information and the parameters associated with the selected view in the navigation area. This window allows to view and set the DS2020 drive parameters. For more information refer to the Help Online.

• **Notification window:**



This area is dedicated to display messages that may have different meanings. You can set a filter to display messages based on the type (ERROR, WARNING, INFO, DEBUG).

ERROR	Error messages sent by the device or related to the connection (e.g. transmission errors)
WARN	Messages at this level are usually caused by the impossibility to access parameters (eg "object not found") and require your attention
INFO	Messages relating to the data exchange between the device and the application that show the progress of the operations
DEBUG	Program Control information

• **Statusbar:**

The Status Bar displays information about the state of the application. It indicates which protocol you are using, if you are connected and progress of operations involving all views



5.2.6 Firmware update (BootLoader)

The firmware update can take place via a serial RS422, USB or via EtherCAT. The download file extension is ***.zhm**.

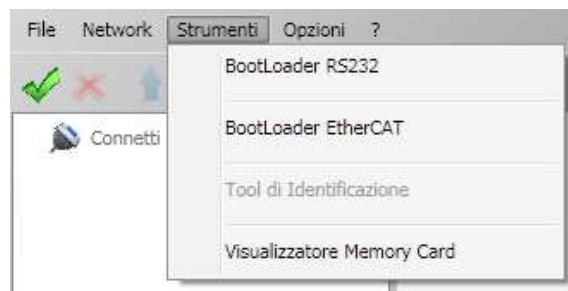
The firmware update occurs through dedicated applications (BootLoader EtherCat and BootLoader RS232) which simultaneously install with the Dx2020 GUI. The firmware download procedure is only possible if the GUI is disconnected from the drive

- Access to the procedure from the Tools menu
- Follow the instructions present in the user interface Help

To access the tools dedicated from PC:

- Windows XP: Start ► Programs ► MOOG TOOLS ► Dx2020 GUI ► ...
- Windows Vista / 7: Start ► All programs ► MOOG TOOLS ► Dx2020 GUI ► ...

Or from the **Tools** menu

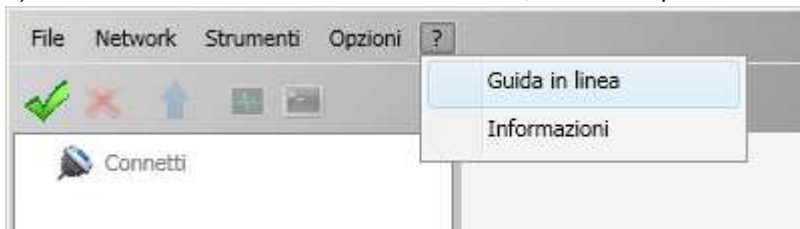


For more information refer to the Help Online.

5.2.7 How to access the Help Online

It can be accessed in two ways:

1) Use Interface Dx2020 GUI: from the Menu bar, select? 'Help'



- 2) • Windows XP: Start ► Programs ► MOOG TOOLS ► Dx2020 GUI ► ...
 Windows Vista / 7: Start ► All programs ► MOOG TOOLS ► Dx2020 GUI ► ...

5.3. System configuration

The steps to follow are:

1. Identification of the axis module
2. Configuration of the motor parameters
3. Configuration of the transducers
4. I / O Configuration
5. Configurations of control loops (torque, speed, position)
6. Configuration of Fault
7. Application Parameters
8. Definition of Procedures and Controls
9. Power Supply
10. STO activation
11. Enabling

5.3.1 Identifying the axis module

Follow the instructions in the Help Online related to the specific modes of communication and identification. For multiple axis modules connected simultaneously you need to establish a correspondence between the nodes listed in the "Navigation Area" of the GUI and the physically installed modules in the application.

5.3.2 Motor parameter configuration

The DS2020 can be used to control:

- Synchronous motors with permanent magnets (brushless)
- asynchronous motors with IFOC control (impressed current)
- asynchronous motors with V/F control

There is a motor database, accessible by clicking on View Motors Database. The Database is editable and you can add additional motor models. The file DBMotors.xml is present in the Version installation folder of the GUI.



Info: If the phasing angle is not known in advance, after entering all other motor parameters, perform the procedure in the Autophasing paragraph 5.3.2.1

For all three types of motor Thermal protection can be activated via software. You will need to enter the thermal model parameters.



Attention If the boot drive happens while the motor is hot, the thermal image provided by SW provides a false estimate. This protection supports but doesn't completely replaces the thermal switch in the motor.



Info In the case of permanent magnet synchronous motor, you can activate the Field weakening.

Field Weakening Algorithm

is available a "torque increase function" at high speed allowing to increase the torque available above the nominal speed. This obviously takes place at the expense of a greater output current and consequent lower yield of the system.

To enable this feature click on the "Enable weakening" field. Enabling the "weakening" you can automatically take advantage of this feature without having to set any parameter. It will prompt you to select the type of algorithm to use chosen depending on the type of application required; contact the Applications Service for an appropriate evaluation.

If control of an asynchronous motor with IFOC algorithm, the correct Id current and Sg scrolling values may be required to Applications Service, providing the electrical motor parameters to control.

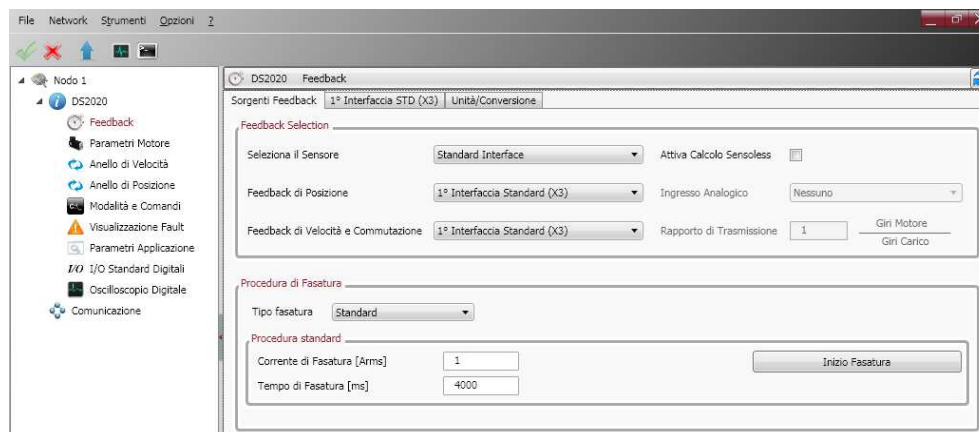
From the view "MotorParameters" it is possible to configure the brake, through the Brake Motor view. For more information on configuration, refer to Help Online, selecting dx2020 Gui-Views-Configuration Parameters Motor

From the Navigation Area select "Feedback": Choose the Tab "Feedback Sources".

Set the timing with a current value initially at or below the rated motor current in order not to warm up the engine in case of repetition of the procedure. Later this value can be increased if applied to the motor load. (Field current timing).

Set Time of Phasing according to the requirements (set to the maximum value of 4 seconds).

Press the button "Start Phasing": it shows the progress indicator (green if everything OK, red if there are alarms). By selecting the tab "1st STD interface", or "2nd STD interface" or "Interface Option" you can acquire the phasing value before and after the operation, in order to follow their implementation (angle Theta)



5.3.3. Transducers Configuration

The DS2020 can handle various types of feedback transducers to close the control loops.

Resolver standard
Encoder Incremental TTL
Encoder Stegmann Sinusoidal Absolute Single / Multiturn with HYPERFACE communication
Encoder Hedenhain Sinusoidal Absolute Single / Multiturn with ENDAT communication

To configure it, follow the instructions in the Help Online, select **dx2020 Gui** ➔ **Configuration views** ➔ **Feedback**

Using a 2nd position transducer it is possible to enter the transmission ratio between motor and load (Transmission Ratio field).

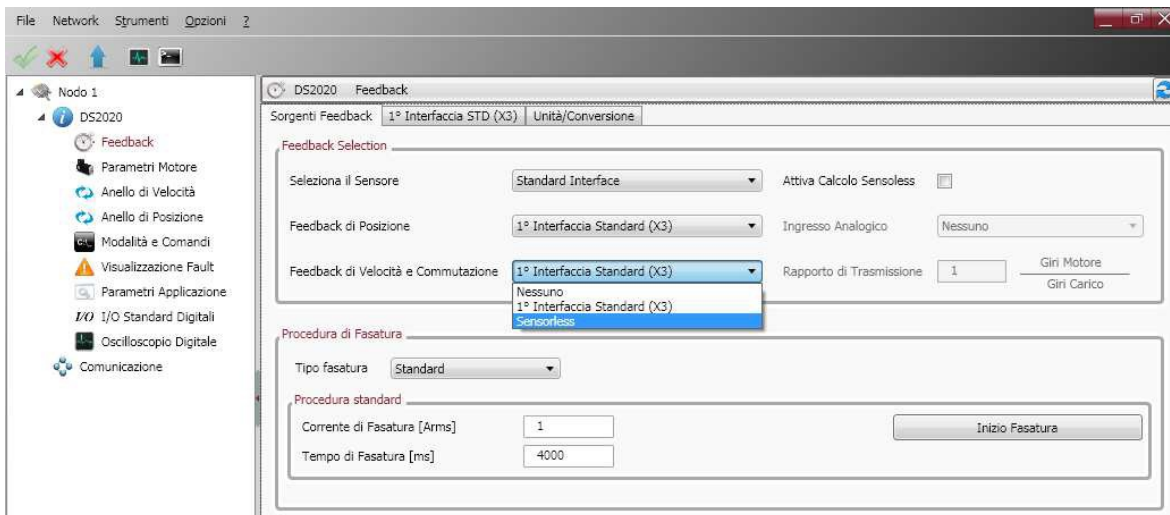


Info It is necessary for some encoders to enter the angle of timing, if this is not known perform the procedure Autophasing (par 5.3.2.1)

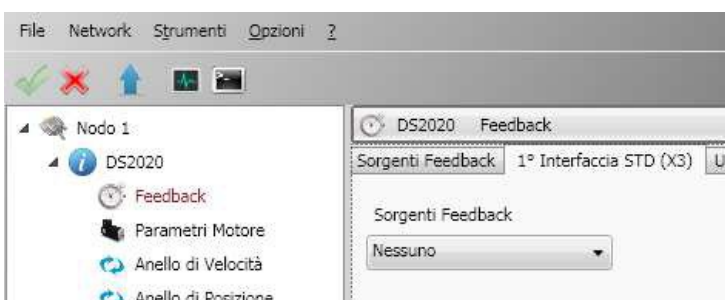
5.3.3.1 Sensorless

The DS2020 provides the sensorless mode, ie without a speed transducer.

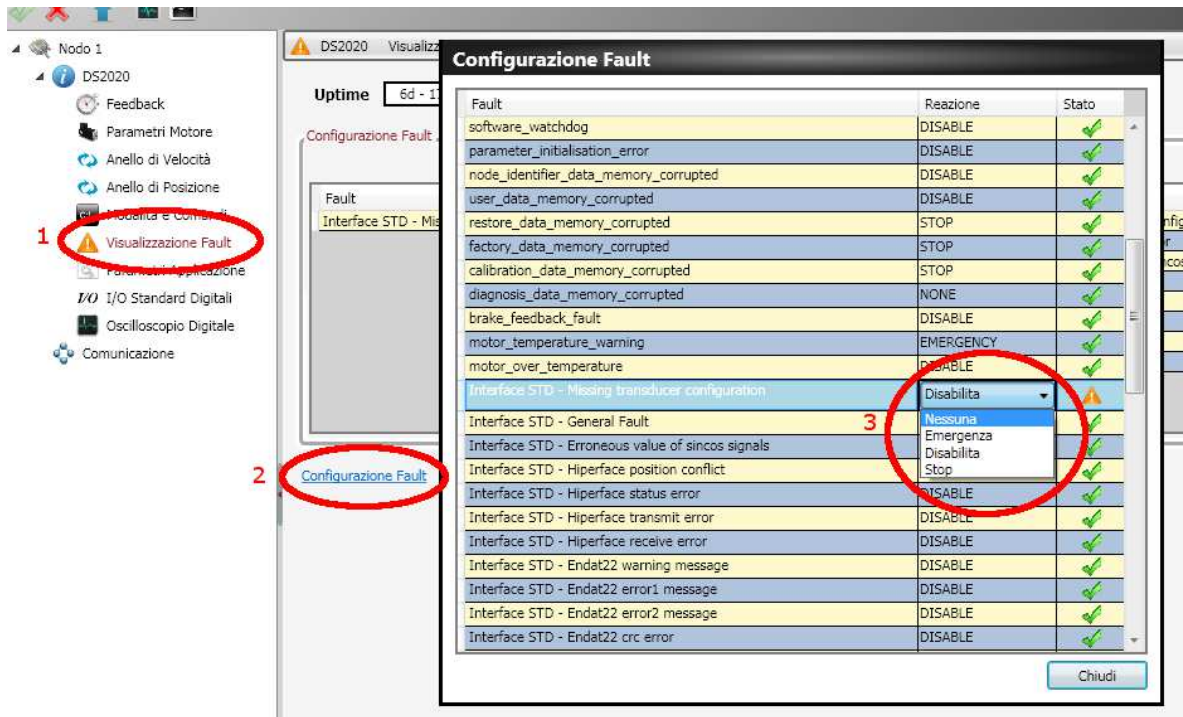
To enable it select Feedback from the Navigation Area. In Tab Sources feedback set the fields as indicated in the figure



In Tab 1 Interface STD (X3), set the fields as indicated in the figure



Finally set the fault Interface X3 - Missing Transducer Configuration to "No" as in the image below.



5.3.4 I/O Configuration

Through the interface you can set the various configurations available for X4 and X5 connectors.

Programming analog and digital I / O connector X4:

Channels	Configuration							
	0	1	2	3	4	5	6	7
1	+24 Volt output							
2	INP A +	OUT A +	A +	SYNC 0 +	INP A +	OUT A +	INP A +	OUT A +
3	INP A -	OUT A -	A -	SYNC 0 -	INP A -	OUT A -	INP A -	OUT A -
4	INP B +	INP B +	B +	SYNC 1 +	INP B +	OUT B +	OUT B +	INP B +
5	INP B -	INP B -	B -	SYNC 1 -	INP B -	OUT B -	OUT B -	INP B -
6	TX	TX	C +	SM 2 +	INP C +	OUT C +	OUT C +	INP C +
7	RX	RX	C -	SM 2 -	INP C -	OUT C -	OUT C -	INP C -
8	0 Volt_							

Information: The maximum extractable current from PIN 1 (Output +24 Volt) is 200 mA.

DETAILS OF VARIOUS POSSIBLE CONFIGURATIONS:

Configuration description 0

In this mode the three channels are configured as 2 digital inputs plus the serial line RS232.

Configuration description 1

In this mode the three channels are configured as 1 digital output, 1 digital input plus the serial line RS232.

Configuration description 2

In this mode are generated the signals on the connector of an incremental encoder starting from internal information of the drive (instantaneous position of the motor) and with which it is possible to close the position of the machine control, via an external PLC, leaving to the drive the speed control with an analog reference. The number of encoder pulses is configurable in multiples of 2, starting with 128 pulses / rev., up to 8192 pulses / rev.

The amplitude of the marker on the output C is configurable as $\frac{1}{4}$, $\frac{1}{2}$ and 1 impulse.

La configurazione di base è di 4096 Impulsi per giro meccanico del motore con marker $\frac{1}{4}$.

Configuration description 3

The third mode allows you to monitor the synchronization signals of the EtherCAT network used for synchronization of the various modules, working with distributed clock.

The SYNC 0 signal has a period of 62.5 us (16 kHz) and corresponds to the basic servo time.

The SYNC 1 signal has a period equal to the period set for the EtherCAT communication network and is used to synchronize the devices on the reception of the data packet.

The SM2 signal indicates the actual time of receipt of the data packet by the device.

Configuration description 4-5-6-7

All digital inputs (TTL Line Driver, differential), can be configured as follows:

- Drive Enable
- Reference Enable
- Quick Stop
- Reset Alarm
- Limit switch (CCW e CW)
- Reset fault
- No reference signal
- Emergency Stop activated
- CW
- CCW
- Axis stopped

All digital ioutputs can be configured as follows:

- Copyof Limit switch (if programmed on the digital inputs available on J6).
- Warning motor temperature
- Warning for motor I²T
- Warning drive temperature



Attention: The X4 connector is not optoisolated

Programming analog and digital I / O connector X5:

Analog Input 1 and 2

- Torque reference
- Speed reference
- Position reference
- Current limitation (maximum output torque)

Analog Output 1 and 2

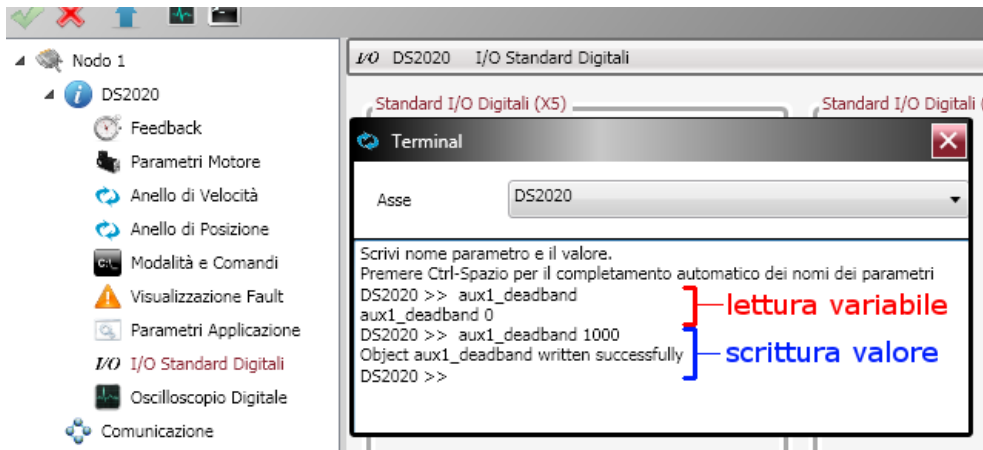
- Measured voltage DC BUS
- Current measured Iq
- Current reference Iq
- Measured phase current U
- Measured phase current V
- Mmeasured motor speed
- Internal test variable

Digital Output 1

- Halt function active
- Stop function active
- Positive rotation speed (clockwise)
- Negative rotation speed (counterclockwise)
- Rotation Zero speed

Digital Input

- Signal command
- Points deactivation
- Reset fault command
- Drive enable command
- Reference enable command
- Quick stop command
- DX limit switch
- SX limit switch



Info Each analog input can be configured with a different parameter.

**Info:**

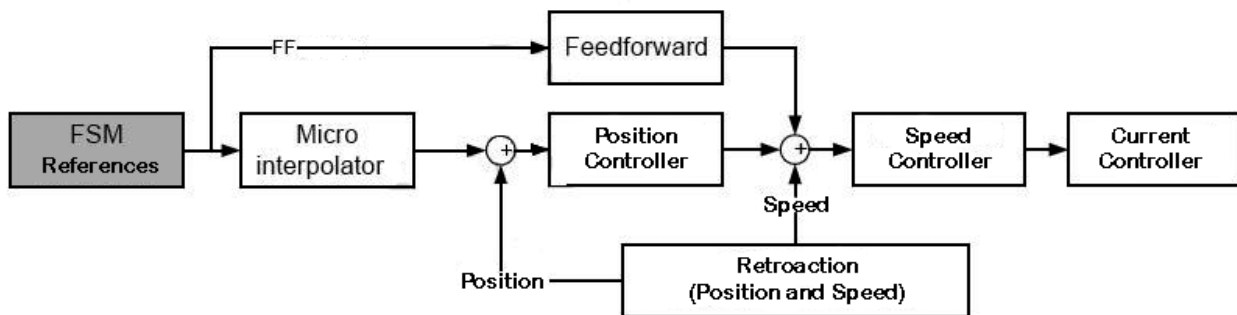
The digital outputs are active if + 24V power is supplied on the X5 connector on the pin 7 and ground on pin 8.

5.3.5 Control loops configuration

5.3.5.1. Control mode configuration

The DS2020 operates up to three control loops according to the drive operation mode: torque, speed, position, each one inside the other, with the torque as the inner loop, the speed as intermediate and the position as the outermost in a manner that the output of each loop will become the reference for the next one.

The following figure illustrates the general block diagram of the control structure



Depending on the structure chosen, the reference for torque, speed or position must be provided.



Info The calibration activities of the control loops must be performed by qualified personnel

5.3.5.2. Torque loop parameter configuration

The torque loop (current given the direct proportionality) is the innermost. Parameters are assigned automatically starting with the motor setup data with the menu Parameters Motor.

L'utente può configurare la banda passante dell'anello chiuso di coppia tramite finestra Terminale, andando a settare la variabile 'bandPass' i valori possibili sono 3000 (default), 2000,1000, 600,400 in Hz.

**Info**

Changing the bandwidth from the default value may result in degraded motor performance.

5.3.5.3. Speed loop parameter configuration

The speed control must ensure that the motor speed follows as faithfully as possible to the speed reference, both in static conditions and in dynamic conditions. The quality of response of the system depends on the loop parameterization.

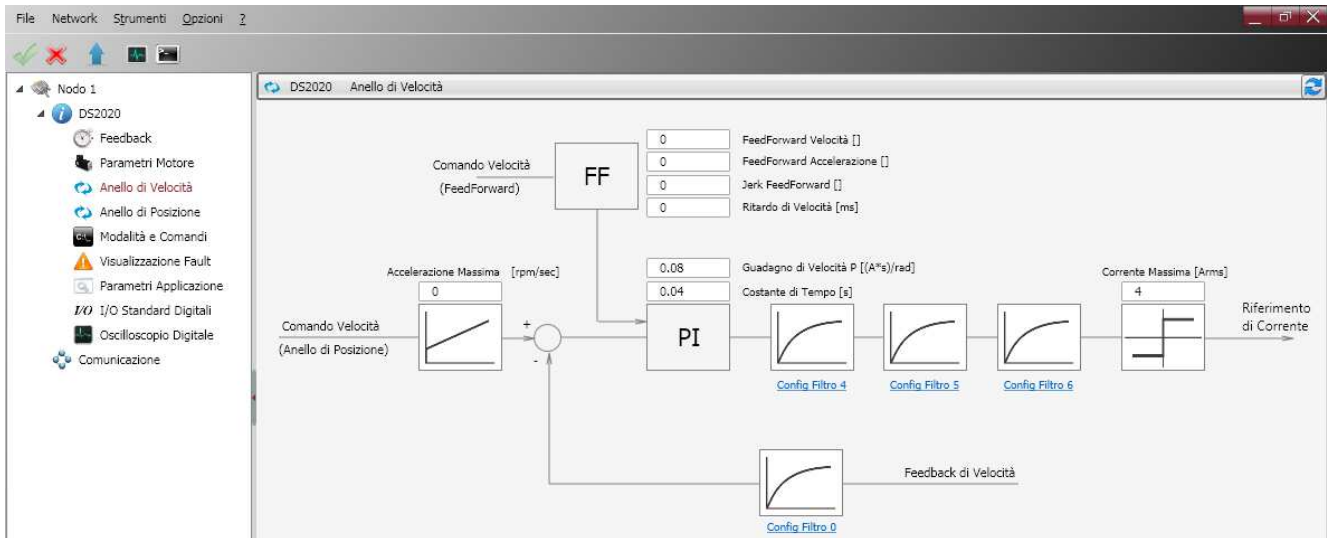
The base rate is a PI (proportional-integral) type control with the addition of a feedforward control (ff_calc) and a Saturation Variable (SAT_VARIABLE).

The proportional term provides an action as strong as the error is large while the integral term (speed error) corrects small errors that are maintained over time, due to constant noise and allows you to reach the required target.

The block of Feedforward serves to minimize the velocity error in the cases of disorders known in advance, contributing directly to the reference for speed processed by the PI controller, with the linear combination of the speed references, acceleration, jerk, delayed speed of n samples, calculated at the microinterpolator valley and minimizes errors during transients.

The variable saturation block serves to prevent the formation of a stationary axis instability of position (zero speed reference acting in practice as a filter "low pass" with very limited bandwidth).

To set the parameters, from the Navigation Area select "Speed loop": it will open the window that shows the block diagram of the loop .



It recognizes the standard corrector network (IP) characterized by two parameters. There is then a sequence of filters and a filter on the feedback chain, this allows the implementation of more 'complex control structures as well as filtering of known disturbances (filtro Notch).

5.3.5.3.1 Filter configuration

The four filters all have the same basic structure or IIR 2nd order. it is possible to configure them as needed (to access the Configuration menu of each filter click on the link placed under each block) You can choose between the following types:

- **Lag:** The filter consists of a real pole and a real zero. Put the pole and zero frequency that must be positive or null.
- **Bq:** It is a standard biquadratic filter, with a pair of complex conjugate zeros and a pair of complex conjugate poles. The parameters to be specified are:
Zero frequency:
Zero dampening
Pole frequency
Pole dampening
Frequencies must be positive or null. The damping must be between -1 and 1.
- **Pole:** The filter has a single real pole. The parameter to be specified is the frequency of the pole, which will be positive or null.
- **DbPole:** The filter has two complex conjugate poles. The parameters to be specified are:
Pole frequency
Pole dampening
Frequencies must be positive or null. The damping must be between -1 and 1.
- **Dircoef:** insert the coefficients of the numerator and denominator of the filter (rarely used)



Info Maintain the filter disabled until all the other parameters of the filter are inserted

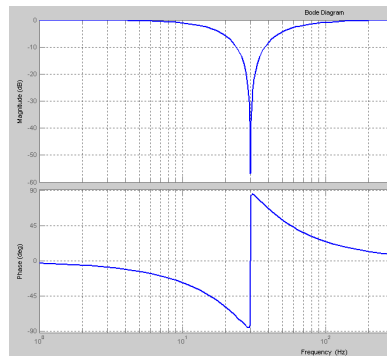
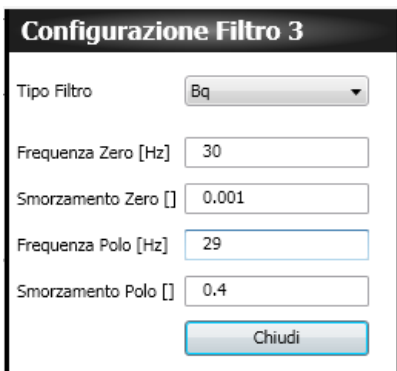


Info You must enter the parameters following an established order

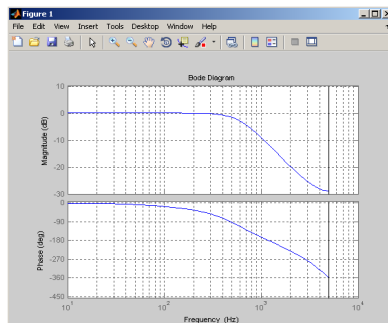
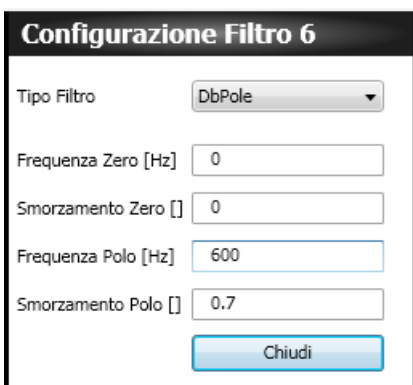
- 1° Damping
- 2° Frequency
- 3° Filter type

Examples of filters

Example of a Notch filter configuration: insert a Notch filter centered at 30 Hz



Example of configuration of a low pass filter of 2nd order



5.3.5.4. Configuration of the position loop parameters

The position control must ensure that the motor position follows as faithfully as possible the position reference. The quality of the response of the system depends on the loop parameterization.

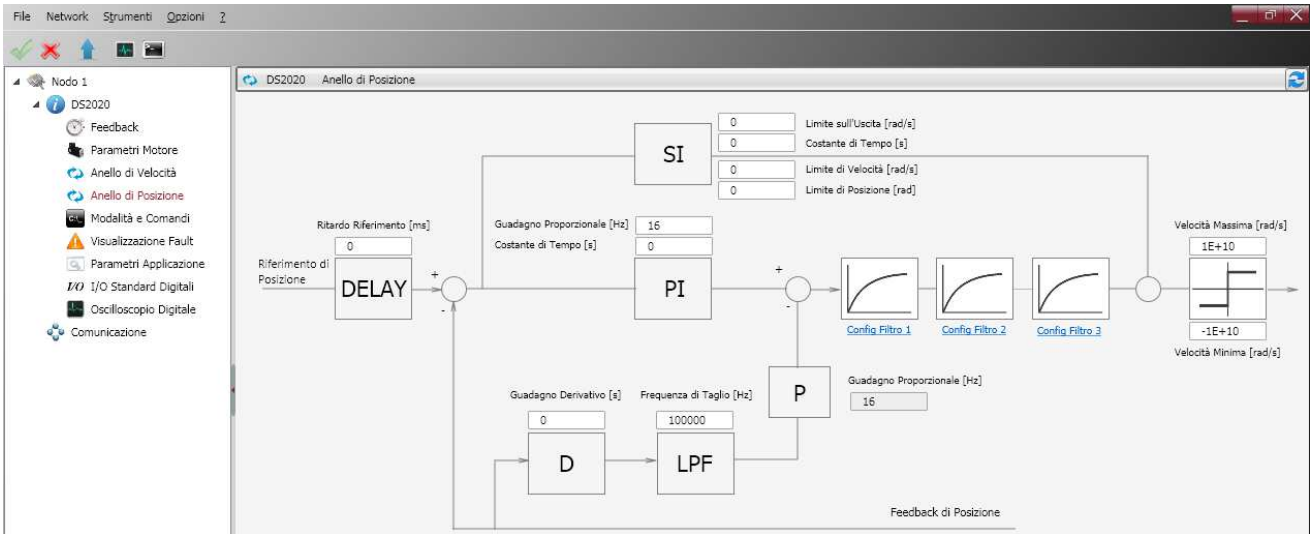
The position control is PID (proportional-integral-derivative).

The proportional term provides an action as strong as the error is large.

The derivative term notes if the error is increasing or decreasing the dampening behavior of the system.

The integration term cancels the steady-state error.

About the setting of the parameters, from the Navigation Area select "Position loop": it will open the window showing the loop diagram in question.



It recognizes the standard corrector network (PID) characterized by four parameters. There is then a sequence of filters that allows the implementation of more complex control structures. For parameterization of the filters see paragraph 5.3.5.3.1.

5.3.6 Fault configuration

From the navigation area select "Display Fault"

The fault management display will appear. On the left side of the window there is a list of active alarms (Active Fault List), on the right there is another with the last 8 alarms (Fault History).

Lista Fault Attivi		Storia dei fault		
Fault		Numero	Fault	Tempo
Interface STD - General Fault		1/8	Interface STD - Hiperface receive error	6d - 21h - 35m
Interface STD - Erroneous value of sincos signals		2/8	Interface STD - Erroneous value of sincos signals	6d - 21h - 35m
Interface STD - Hiperface receive error		3/8	Interface STD - General Fault	6d - 21h - 35m
		4/8	Interface STD - Missing transducer configuration	6d - 16h - 56m
		5/8	Interface STD - Hiperface receive error	6d - 16h - 35m
		6/8	Interface STD - Erroneous value of sincos signals	6d - 16h - 35m
		7/8	Interface STD - General Fault	6d - 16h - 35m
		8/8	motor_over_temperature	6d - 16h - 35m

The drive response to each alarm can be configured individually by selecting the link Fault Configuration This will open the window with a list of the faults: For each fault will be possible to choose the reaction from a dropdown menu.

Fault	Reazione	Stato
Interface STD - General Fault	DISABLE	⚠
Interface STD - Erroneous value of sincos signals	Disabilita	⚠
Interface STD - Hiperface position conflict	Nessuna	✅
Interface STD - Hiperface status error	Emergenza	✅
Interface STD - Hiperface transmit error	Stop	✅
Interface STD - Hiperface receive error	DISABLE	⚠
Interface STD - Endat22 warnino message	DISABLE	✅

The options are four:

Reaction	Effect
None	The alarm is ignored CAUTION Only during commissioning or "Troubleshooting". Setting to avoid with machine in normal working conditions.
Emergency	The drive sends an emergency message but does not stop nor disable
Disable	Disables the drive and executes the stop procedure configured by Application / Fault Response parameters
Stop	Immediate disabling; The drive releases the motor control, if the axis was in motion it continues to move by inertia.

For each alarm it must be programmed the most appropriate response depending on the characteristics of the machine.

For some alarms the Dx2020GUI software prevents the selection of some reactions to ensure the integrity of the drive (for example, you can not make emergency braking due to "Overvoltage").

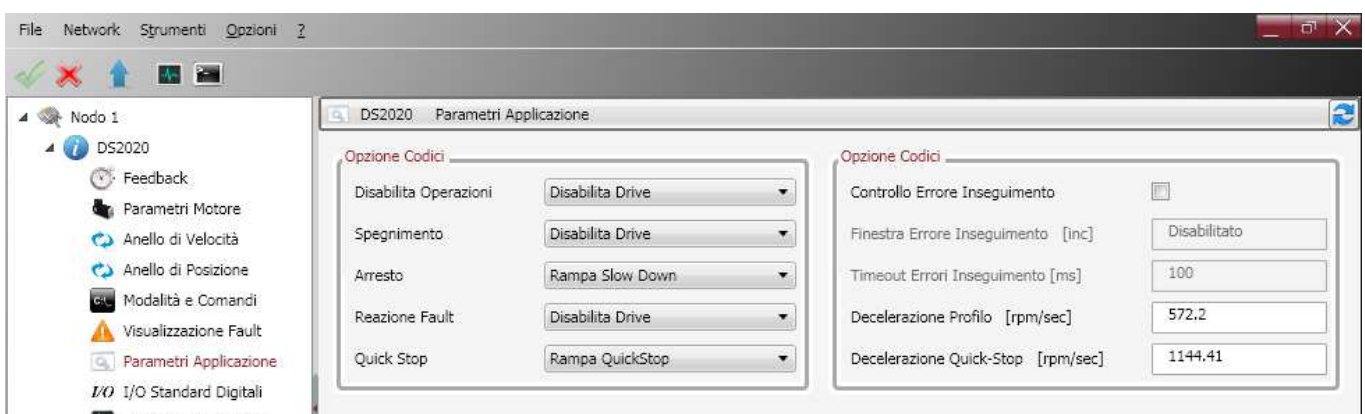
The following Fault listed are not configurable and the reaction is always 'STOP':

- short_circuit_phase_U_low
- short_circuit_phase_U_hi
- short_circuit_phase_V_low
- short_circuit_phase_V_hi
- short_circuit_phase_W_low
- short_circuit_phase_W_hi
- restore_data_memory_corrupted
- factory_data_memory_corrupted
- calibration_data_memory_corrupted

Contact the Moog Casella Support center for advice or controls

5.3.7 Application parameters

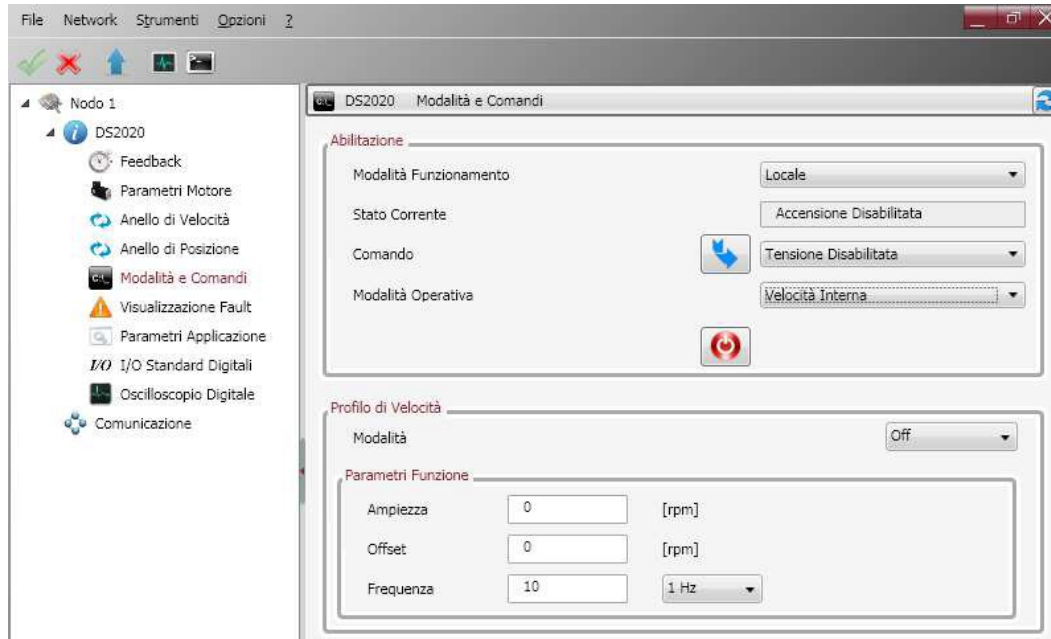
From this menu you can configure the reaction of the drive in case of particular events.



Details about the events and the type of reaction are described in the Help Online.

5.3.8. Commands and modes configuration

This menu allows to determine the origin of the controls and the role played by the drive.



Operating mode



Check that the firmware installed supports the fieldbus selected (in the case of EtherCAT fieldbus firmware will have _ecat suffix, in case of fieldbus Can the firmware will have _can suffix).

Sets the source of the drive commands. You can choose from the following values:

- **EtherCAT**

the drive receives the commands / setpoints remotely, via the EtherCAT fieldbus (if supported by the drive)

- **CANOpen**

the drive receives the commands / setpoints remotely, through CanBus (if supported by the drive)

- **Local**

the drive receives the commands / setpoints from Dx2020 GUI

- **Analog**

the drive receives the commands / set-point through digital and analog inputs configured (for more information see Help Online **Dx2020 Gui** ➔ **Configuration view** ➔ **I/O Standard Digitali**)

Current status

The current status of the state machine (FSA) defined with the DS402 standard that governs the drive (see below state machine).

Command

Selects the command that will be tried by the of the drive state machine. The command will fact launch when the Enter key is pressed, this button is enabled only if the operating mode is set to Local

Operating mode

Sets the operating mode, or the function performed by the drive. You can choose from the following values:

- **Analog speed**

the drive operates a speed control following a reference coming from an analog input. You can set a variable torque limit also coming from the analog input. (Typical operating mode: Analog)

- **Analog torque**

the drive operates a torque control following a reference coming from an analog input. You can set a variable torque limit also coming from the analog input. (Typical operating mode: Analog)

- **Internal speed**

the drive operates a speed control following a reference generated internally by the drive itself (see function generator) (Typical operating mode: Local)

- **Internal torque**

the drive operates a torque control following a reference generated internally by the drive itself (see function generator) (Typical operating mode: Local)

- Sync Cyclic position

the drive operates a position control following a reference cyclically generated by a device / remote control. This is the mode Cyclic Synchronous Position Mode defined in the DS402 standard. (Typical operating mode: EtherCAT / CANopen)

- Cyclic Sync Speed

the drive operates a speed control following a reference cyclically generated by a device / remote control. This is the mode Cyclic Synchronous Speed Mode defined in the DS402 standard. (Typical operating mode: EtherCAT / CANopen)

- Coppia Sync Ciclica

the drive operates a torque control following a reference cyclically generated by a device / remote control. This is the mode Cyclic Synchronous Torque Mode defined in the DS402 standard. (Typical operating mode: EtherCAT / CANopen)

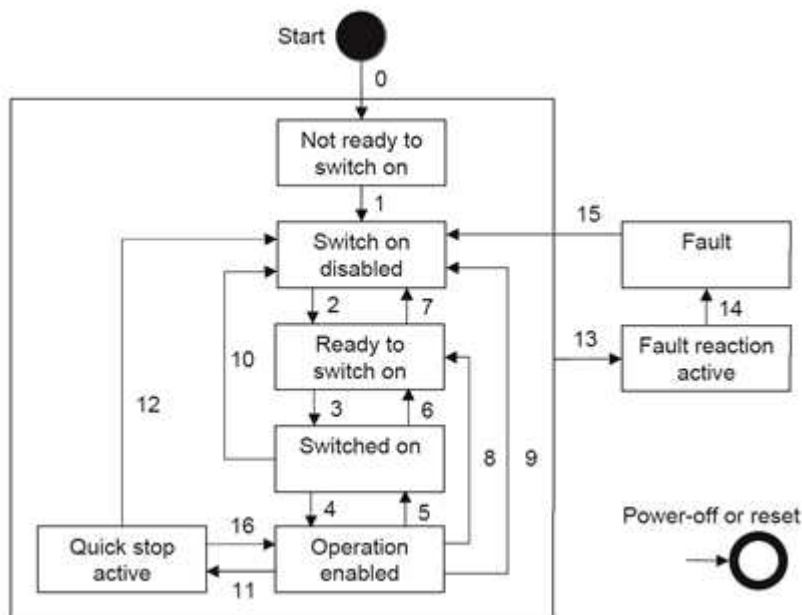


More Application-specific modes are available and are not described in this document

When the drive commands come from inside (eg: Operating mode = Local, Operational Mode = Internal speed) is possible to characterize different reference profiles (Square, Triangulate, Sawtooth, Keystone, Sin, Profile, Jog).

DS2020 state machine

For details on the FSA refer to the Help Online, dx2020 Gui ➡ Configuration View ➡ Modes and Commands



Function	Stati FSA							
	Not ready to start	Start disabled	Ready to start	On	Operation enabled	Quick stop active	Fault reaction active	Fault
If blocked brake locked	Yes	Yes	Yes	Yes	Yes/No	Yes/No	Yes/No	Yes
Low level of applied power	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes
High level of applied power	Yes/No	Yes/No	Yes/No	Yes	Yes	Yes	Yes	Yes/No
Drive enabled function	No	No	No	No	Yes	Yes	Yes	No
Configuration allowed	Yes	Yes	Yes	Yes	Yes/No	Yes/No	Yes/No	Yes

Transition	Event(s)	Action(s)
0	Automatic transition after switching on or resetting the application	Automatic verification of drive and / or automatic initialization is performed
1	Automatic transition	Communication is activated.
2	Shutdown command sent from drive or from the GUI	-
3	Ignition control command received from the drive or from the GUI	If possible, the high-level output is enabled.
4	Enable operation command received from the drive control or from the GUI	The operating mode is enabled and all the set-point extensions will be cleared.
5	Disable operation command received from the drive control or from the GUI	The operating mode is disabled.
6	Shutdown command received from the drive or from the GUI	If possible, the high-level power is disabled.
7	Quick stop or voltage disable command received from drive or from the GUI	-
8	Shutdown command received from drive or from the GUI	If possible the operating mode is disabled while the high-level power is disabled.
9	Voltage deactivation command received from drive or from the GUI	If possible the operating mode is disabled while the high-level output is disabled.
10	Voltage deactivation command or quick stop command received from drive or from the GUI	If possible, the high-level power is disabled.
11	Quick stop command received from drive or from the GUI	The the Quick Stop function is started.
12	If the quick stop function is complete and the quick stop option code is 1, 2, 3 or 4, or the voltage deactivation command received by the drive the auto transition is active (it depends on the Quick Stop option code)	If possible, the drive is disabled while the high-level power is disabled.
13	Fault Signal (see also IEC 61800-7-301)	The configured fault reaction function is executed.
14	Automatic transition	If possible, the drive is disabled while the high-level power is disabled.
15	Fault reset command received from drive or from the GUI	If the error does not exist and the restoration of the fault condition is performed the fault condition is cleared by clearing the bit control word
16	If the code of the Quick Stop option is 5, 6, 7, or 8 the drive control Enables Operation is received	The drive is disabled

NOTE: It is not recommended to support the transition 16.

5.4. Power supply

Supply three-phase power to the system, use the monitor function on the GUI to verify the correct value of the DC bus voltage (560 V) (see paragraph "5.2.5. Layout").

5.5. STO activation

In order to enable the axis you must enable the STO circuit. The 24 V power of the STO circuit must be integrated within the chain of emergencies.

See chapter 7.



Attention

After interventions on the connections, the replacement of parts and in any case at the first system start-up is always advisable to check the STO function.



Attention

Do not access to the protected area and in any case do not touch any live part of the drive. The opening of a protective door provokes the intervention of the emergency chain (interruption of motor power) and the intervention of the STO. If the STO signal is not removed following the correct sequence, the display will show "F" (Fault).

5.5.1. Autophasing procedure

The phasing is driven by the software Dx2020GUI.

To set the motor parameters select "Modes and Commands" in the Navigation Area

Check that the power supply and STO are present then from the "Command" field, press in sequence:

- "Shutdown"
- "Startup", leaving the drive in this state.

The drive signals the activation with an "S" on the display.



5.6. Axis enablement

The drive implements profile DS402 (CIA standard). The enabling of the drive depends on the application of a command that can be received from remote (fieldbus (EtherCAT or Can)), by HW (Analog mode) or GUI (Local operation).

- Fieldbus (EtherCAT o Can) : enabling is done by the master (PLC) via the Control-Word
- Analog : The Enabling occurs through hardware by configuring the I / O
- Local : The Enabling occurs by means of GUI **(Modes and Commands ➔Command)**

Below the sequence of commands to enable:

- 1) Fault reset (if Fault present)
- 2) Shutdown
- 3) Startup
- 4) Enable operation

Refer to Help Online for more details.

To turn off repeat the procedure in reverse, or select the "Quick Stop" procedure.

5.7. Oscilloscope function and log File (".UCX")

It is possible record and display numerous drive internal variables from the navigation selecting "Digital Oscilloscope"

5.7.1 Log configuration

Select the tab "Channels" for each channel in the drop down menu to choose the variable to display. The number of accessible variables depends on the mode of access ("Advanced" or "Normal").

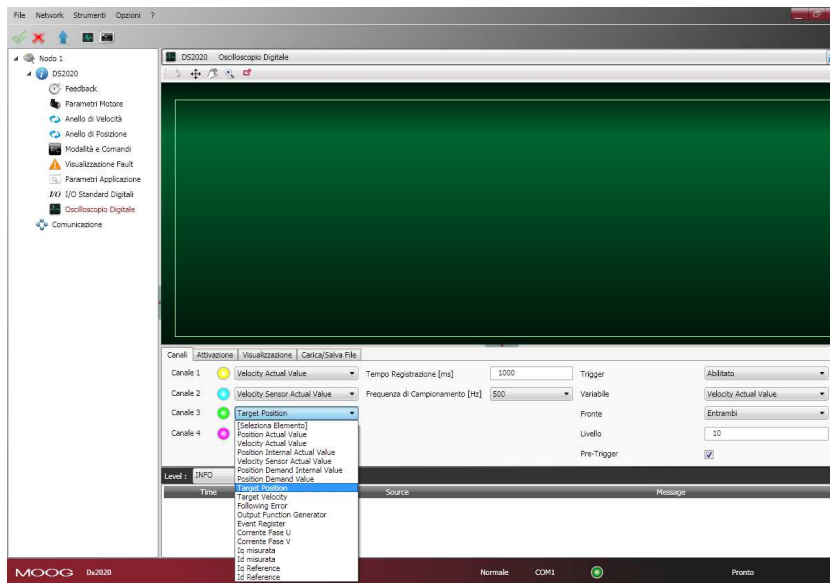
To change the access mode, from the toolbar, select Options ➡ Modes and proceed with the choice.

You can display up to four tracks.

Set the recording time in msec ("Record Time") and "Sampling Frequency" in Hz.

Triggering is possible to display (and record) on an event, choosing "Enabled" in the "Trigger" field (choosing "Continuous" you will have the repeated display of the same event automatically).

To configure the trigger: choose the trigger variable from those that appear in the dropdown menu of the "Variable" field; below choose the opposite ("Ascent" / "descent" of the "Front") and the level of the trigger activation (numerical value, "level" field). The setting of the "Pre Trigger" lets you view 512 bytes before the signal is subject to triggering.



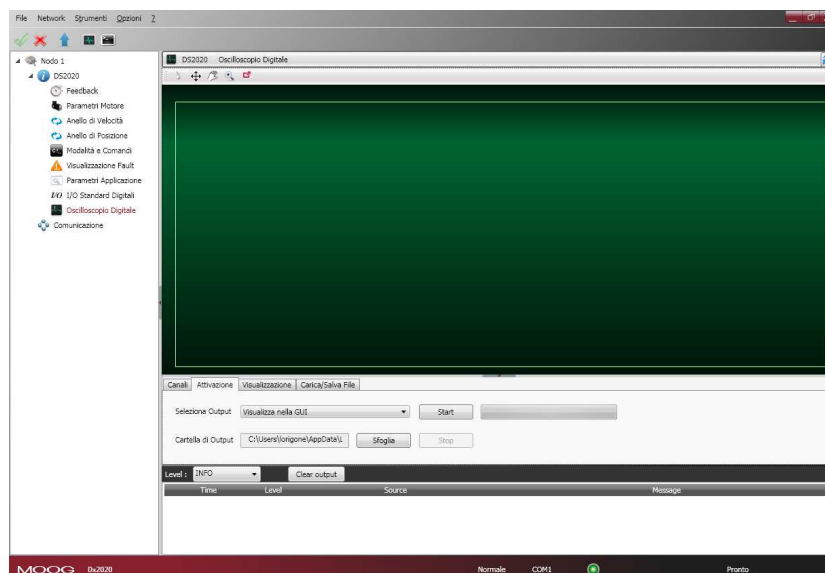
5.7.2 Start logging

Select the tab "Activation".

From the "Select Output" choose from the drop down menu among the following options

- Displays on the GUI: the data are only displayed and not recorded
- Save Locally: the data are displayed and saved on the PC in the directory indicated in the "Output Folder"
- Save to memory card: the data are displayed and saved internal memory

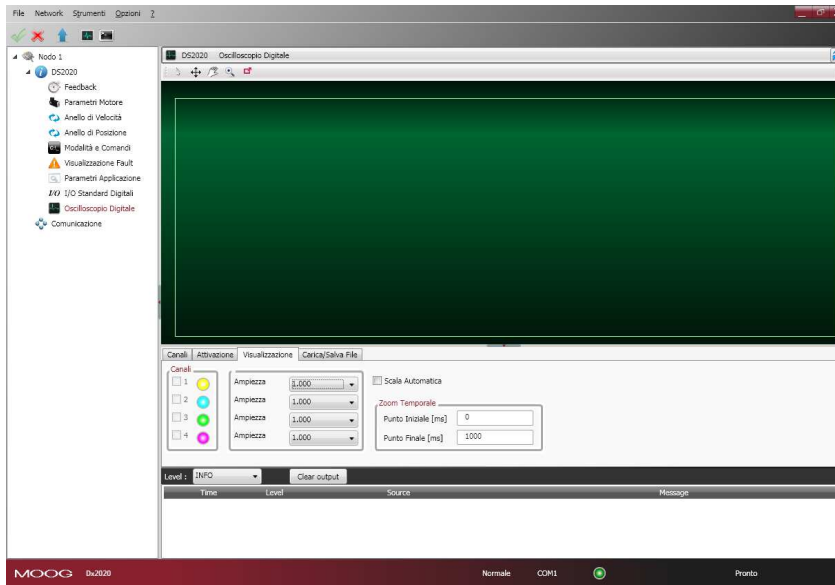
Start recording by pressing the "Start" button and stop it with the button "Stop"







5.7.3 View logs

Select the tab "View"

After the acquisition, the data appears on the display.

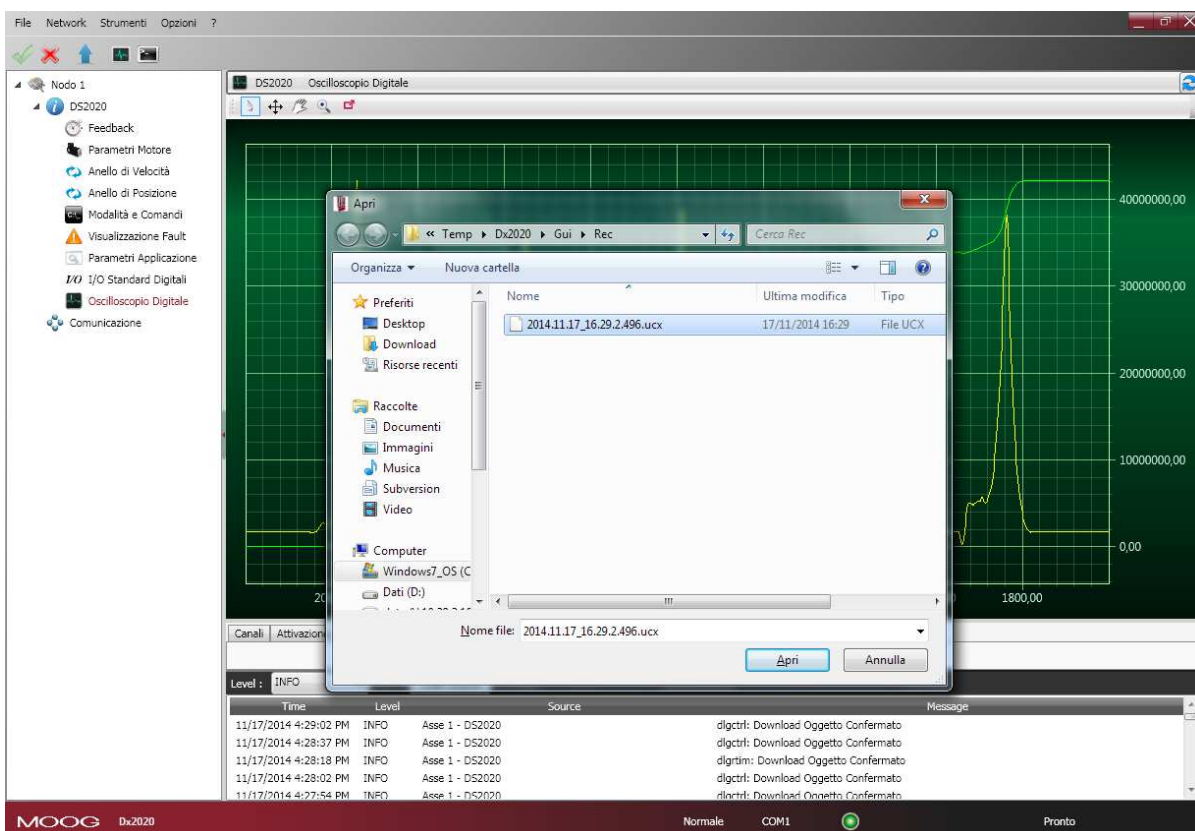


In the top left there are the functions of Cursor Activation (Cursor ) , Displacement of the Graph (Pan ) , Magnification of the details (Zoom ) and printing of the image (Screenshot ) ; mouse cursor shall show the legend of the 4 buttons when hovering above them.

By ticking Auto Range each signal is shown in the window, otherwise the data appears with the scale with which they are acquired unless you modify them by changing their scale with the command Amplitude.

5.7.4 UCX file management

Saving data in Local, a file is created with the name date and time of capture. The extension of these files is "*.UCX". To view archived recordings go to the Tab "Load / Save File", accessing the file system using the "Open UCX" button.

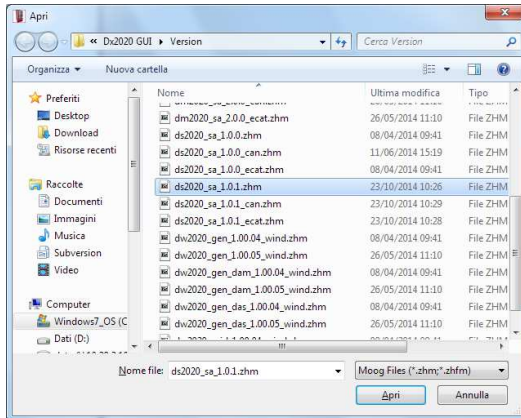


5.8 Using the GUI in OFF LINE mode

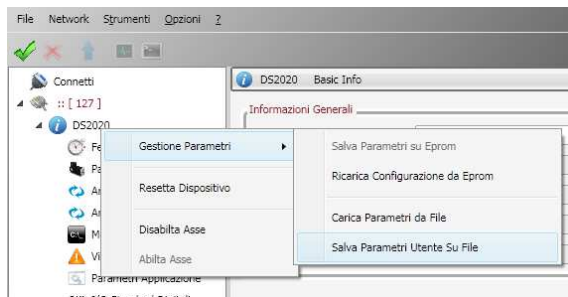
The GUIDE can also be used in offline mode in the absence of the drive to prepare the drives configuration file, to edit them or to verify their contents.

To enter Offline mode select File ➔ Offline

Select File ➔ Open to select the SW release you need to use



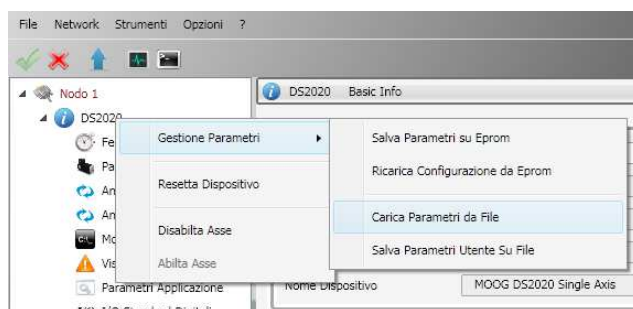
To check a parameter file, from the main menu select the axis with the right mouse button, load the parameters as if there was a real drive connected, modify them if needed and save the new configuration to the new parameter file.



5.9 Contextual help menu for parameter management

A click with the right mouse button on the axis name opens the menu. The following operations are possible:

- **Parameter management:**
 - Saving the current configuration on the internal memory of the drive
 - Restore configuration previously saved in the internal memory
 - Loading a saved configuration file (parameter download file)
 - Saving the current configuration file (parameter file upload)
- **Reset Device:** Reset device selected
- **Disable Axis:** Disable axis selected
- **Enable Axis:** Enable axis selected



6. TROUBLESHOOTING

6.1. Introduction

The following list describes the main malfunctions and provides a series of recommendations on how to fix them.

If the problem persists, contact Moog Casella.

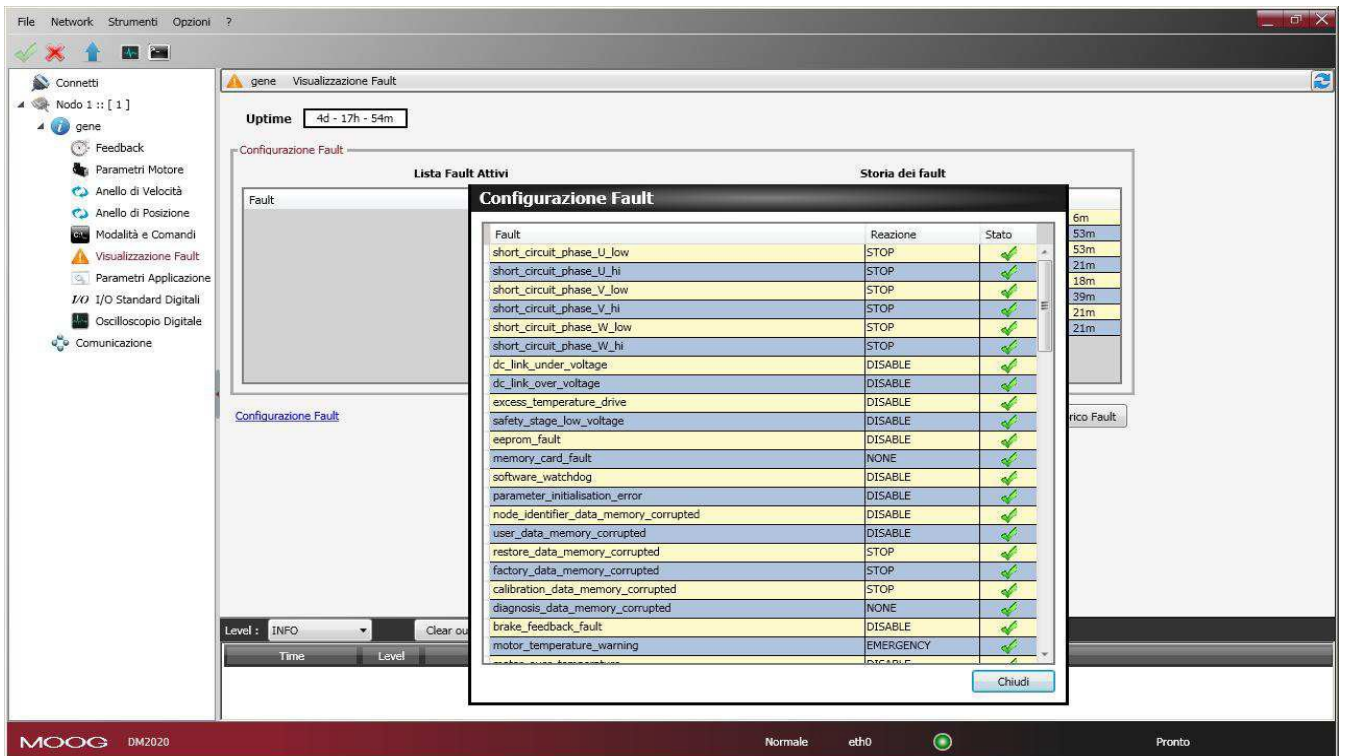
6.2. Power section anomalies

Cause	Action
The drive temperature is high	<ul style="list-style-type: none"> - Check the continuous current supplied to the axes - Check the efficiency of the fans
Failure recovery	Check the braking resistor
Overvoltage	

If the resistance is not open, in short circuit or does not disperse to ground, try removing it and slowly move the axis to see if the problem still exists; if it persists, replace the drive.

6.3. Drive anomalies

The module-axis alarms are shown on the axis display by the letter F; for the detailed analysis is necessary to connect with the Dx2020GUI software, select the item Fault Display and then proceed the analysis of the anomalies.



6.3.1. Alarms on the power section

- **Short_Circuit_Phase_x_Low**
- **Short_Circuit_Phase_x_Hi**

Identifies the IGBT affected by the phase x: (U, V or W)

This type of alarm occurs when the drive detects an excessive current or a short circuit on one of the six IGBT output stage.



With this type of alarm, the reaction is always disabling, as the appropriate control of the motor is no longer possible.

The probable causes of this type of alarm are listed in the table below:

Cause	Suggested action
Cortocircuito nel motore	Check the motor insulation with a multimeter or other suitable tool. Alternatively: <ul style="list-style-type: none"> • unplug the power cable from the motor; • re-enable the axis; • If the problem persists, replace the motor.
Cortocircuito tra i cavi del motore	Disconnect the cable from the motor and from the drive and check the cable insulation with a multimeter or other suitable tool. Alternatively: <ul style="list-style-type: none"> • unplug the power cable from the drive side; • enable the axis again.
Wrong setting of the current loop	Check motor parameters stored in the drive configuration.
Internal components of the drive damaged	If after the previous tests, the problem persists, replace the drive.

6.3.2. Allarme per Tensione VBUS fuori tolleranza

Fault		Cause	Action
DC_Link_Under Voltage	Voltage lower than the minimum threshold set	Fault of the sensing circuit	Misurare la tensione su bus dc e confrontare con quella misurata dall'azionamento
DC_Link_Over Voltage	Voltage higher than the maximum threshold set	Brake resistor not connected to the power supply or faulty	Measure the ohmic value of the resistor and replace it if necessary



Attention

In the case of controlled braking, the available kinetic energy is regenerated on the DC BUS and is partly stored in the capacitors; the excess, if not dissipated by the braking resistor (RR power supply) can cause a DC_Link_Over Voltage that can damage to the drives.

6.3.3. Drive or motor overtemperature

- `excess_temperature_drive`
- `motor_temperature_warning`
- `motor_over_temperature`

In case of excessive drive or engine temperature warning, an analysis of the cause of the problem must be performed according to the following table

Cause	Action
The drive temperature is high (above 50 ° C on the chassis)	Check the efficiency of the cooling fans; if they do not work, replace the module Check the continuous current supplied by the axes; if greater than the expected value, check the operation state of the machine
The temperature of the motor is high (higher than 85 ° C on the structure of the motor)	Check that there are no changes in the work cycle of the machine or if the control parameters are no longer suitable for the application. Make sure the phasing has not changed
The drive temperature is low (below 50 ° C)	A failure of the internal circuit of temperature reading is possible
The engine temperature is low (below 60 ° C on the structure of the motor)	There could be a fault in the temperature sensor inside, or an error in the thermal protection settings (software).

6.3.4. Removal of STO signal

- **Safety_stage_low_voltage**: STO protection intervention

In case of STO circuit removal of power it releases the axis disabling the output power. In case of discrepancy between the command and the feedback signal, the STO circuit inside the drive may be damaged; verify that the absorption at 24 Vdc at both inputs is approximately 50 mA per input. If the absorption is different from this value (null or greater than 200 mA), replace the module.

6.3.5. Errors on memory devices

- **eeeprom_fault**

The drive's internal memory is damaged or inaccessible. Replace the drive module.

6.3.6. Data Corrupted Fault

- **parameter_initialisation_error**
- **node_identifier_data_memory_corrupted**
- **user_data_memory_corrupted**
- **restore_data_memory_corrupted**
- **factory_data_memory_corrupted**
- **calibration_data_memory_corrupted**
- **diagnosis_data_memory_corrupted**

If there is invalid information in the memory, the drive signals an alarm, to solve the problem, try, through the GUI, to verify the correct configuration of the drive and save the parameters in advanced mode. Subsequently reset the drive and restart the GUI. If the problem persists, replace the drive

6.3.7. Brake Chopper Fault

- **brake_feedback_fault**

This alarm indicates a fault in the motor braking circuit.

The drive controls the voltage output to be consistent with the command; the alarm can be caused by a discrepancy between command and voltage output.

The internal circuit is protected against short circuits and the protection is triggered if the output current exceeds 2 A towards the motor brake; if this happens the causes can be:

Cause	Action
Short circuit on the connection cable to the brake	<p>Check for short circuits in the brake cable or between the brake cable and ground through a multimeter or an appropriate tool or:</p> <ul style="list-style-type: none"> • Disconnect the brake cable on the drive side and try again to enable; • If the problem does not reoccur replace the brake cable.
Brake short circuit	<p>Check for short circuits in the brake cable or between the brake and ground through a multimeter or an appropriate tool or:</p> <ul style="list-style-type: none"> • Disconnect the brake cable on the motor side and try again to enable; • If the problem does not reoccur replace the motor.
Failure detection circuit	<ul style="list-style-type: none"> • Send the drive for analysis and possible repair.

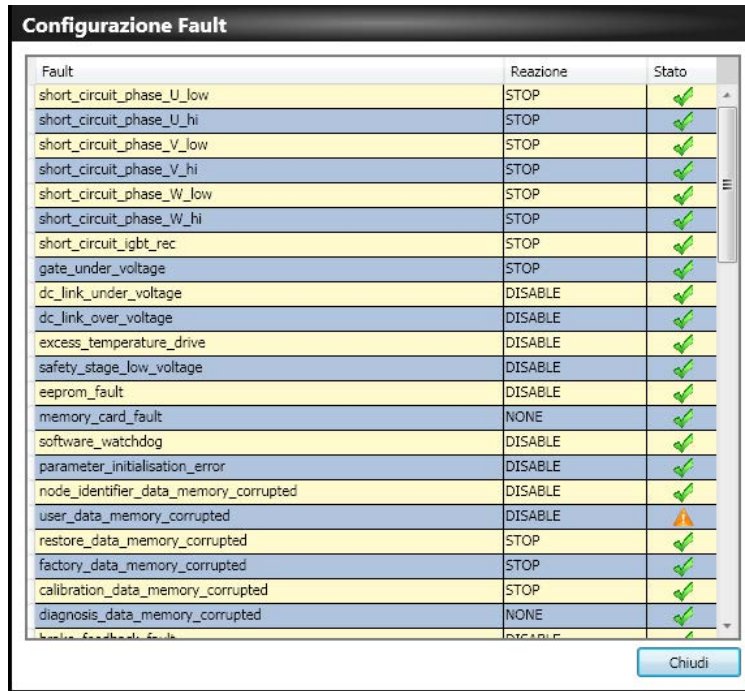
6.3.8. Errors on feedback devices

For a correct operation all the feedback signals must arrive to the drive in an appropriate manner; if this does not happen the causes are indicated by the alarm that identifies in detail what functionality of the transducer is wrong or missing.

First check that the cable is wired correctly, that is not interrupted and that the settings are correct. This analysis must be repeated for all the situations described below.

In the window **Configurazione Fault** the feedback errors are:

- Interface X3-XXX,**
- Interface X2-XXX,**
- Interface X1-XXX**



Fault	Cause	Action
Missing Transducer Configuration	Interface transducer enabled but not configured	Configure it.
Resolver Signals Fault	Error resolver signal level (amplitude)	Perform compensation of the cable
Erroneous value of sincos signals	Each of these alarms details a problem with the transducer, having excluded the lack of feedback or the wrong configuration, replace the motor.	
hyperface position conflict		
hyperface status error		
hyperface transmit error		
hyperface receive error		
Endat22 warning message		
Endat22 error1 message		
Endat22 error2 message		
Endat22 crc error		
Endat22 position not ready		
Endat22 not ready for strobe		

6.3.9. Synchronization , Interrupt Time e Task Time Error

Fault	Cause	Action
Synchronization error	Internal interrupt irregular frequency	Reprogram the drive (firmware and parameters) if the alarm persists replace the drive
Interrupt_time_exceeded	Internal interrupt signal not detected	
Task_time_exceeded	The execution of the task has exceeded the maximum duration	

6.3.10. EtherCAT Fault

Fault	Cause	Action
EtherCAT_communication_fault	communication error	Check wiring configuration of the drive communication and / or master Ethercat
EtherCAT_link_fault	link eth not present	
EtherCAT_rpdo_data	pdo data received incorrect	
EtherCAT_rpdo_time_out	pdo data not received or received after the time out	
EtherCAT_tpdo_data	data received not transmitted	
EtherCAT_tpdo_time_out	data not transmitted or transmitted after the time out	
Internal_transmit_pdo_time_out	communication error PDO internal data (double axle)	
Internal_receive_pdo_time_out	time out internal PDO communication (dual axis)	

6.3.11. Alarms related to the control loops

Fault	Cause	Action
Velocity Control Monitoring	It has been exceeded the maximum speed permitted by the application (set with a parameter)	check the control signals and their consistency with the set data and the functioning of the drive
Following Error	It has been exceeded the maximum following error allowed by the application (set with a parameter)	check the control signals and their consistency with the set data and the functioning of the drive and of the driven machine

6.3.12 CAN Bus alarms

Fault	Cause	Action
CAN_communication_fault	pdo data not received or received after the time out	Check wiring configuration of the drive communication and / or the master Can
CAN_rpdo0_time_out	pdo data not received or received after the time out	
CAN_rpdo1_time_out		
CAN_rpdo2_time_out		
CAN_rpdo3_time_out		
CAN_rpdo0_data	pdo data received incorrect	
CAN_rpdo1_data		
CAN_rpdo2_data		
CAN_rpdo3_data		
CAN_tpdo0_time_out	pdo data not received or received after the time out	
CAN_tpdo1_time_out		
CAN_tpdo2_time_out		
CAN_tpdo3_time_out		
CAN_tpdo0_data	data not transmitted	
CAN_tpdo1_data		
CAN_tpdo2_data		
CAN_tpdo3_data		
CAN_sync_consumer_time_out	Sync not received or received after the time out	
CAN_life_guard_error	Error on the life guarding protocol	Check the configuration

6.4 Alarm display in Analog operating mode

If the drive is in operation mode "Analog" (Mode and Commands / Mode Operation: Analog), the display on the front side indicates the presence of an alarm and an additional error index, consisting of 2 numerical digits. In this way, the operator can identify the cause of the error present without a PC. For example in the case of eeprom_fault (index 11) will display the sequence F-1-1.

NOTE If the drive is used in fieldbus mode (Ethercat / Can) the display will show a fixed F, the error code will be transmitted via an EMERGENCY message (according to the CANopen standard) composed ErrorCode and ErrorRegister

Indice Fault	Error Code	Error Register	Fault	Description
1	0x2344	0x04	short_circuit_phase_U_low	Igbt fault phase U low arm
2	0x2345	0x04	short_circuit_phase_U_hi	Igbt fault phase U high arm
3	0x2346	0x04	short_circuit_phase_V_low	Igbt fault phase V low arm
4	0x2347	0x04	short_circuit_phase_V_hi	Igbt fault phase V high arm
5	0x2348	0x04	short_circuit_phase_W_low	Igbt fault phase W low arm
6	0x2349	0x04	short_circuit_phase_W_hi	Igbt fault phase W high arm
7	0x2351	0x04	short_circuit_igbt_rec	X
8	0x2350	0x04	gate_under_voltage	
9	0x3220	0x04	dc_link_under_voltage	Bus under voltage
10	0x3210	0x04	dc_link_over_voltage	Bus over voltage
11	0x4310	0x08	excess_temperature_drive	Excessive temperature of the drive (IGBT module fuse)
12	0x5114	0x04	safety_stage_low_voltage	Power STO circuit detected (this fault is detected only in "Enable operation")
13	0x5530	0x01	eeprom_fault	Reading error eeprom power block or invalid content
14	0x5540	0x01	sd_memory_fault	External Memory Card Not Detected.
15	0x6010	0x01	software_watchdog	Software alarm
16	0x6320	0x01	parameter_initialisation_error	Initialization error
17	0x6311	0x01	node_identifier_data_memory_corrupted	Memory of the user parameters corrupted / not configured
18	0x6312	0x01	user_data_memory_corrupted	Memory of the user parameters corrupted / not configured
19	0x6313	0x01	restore_data_memory_corrupted	Not used
20	0x6314	0x01	factory_data_memory_corrupted	Memory of the factory parameters corrupted / not configured

21	0x6315	0x01	calibration_data_memory_corrupted	Not used
22	0x6316	0x01	diagnosis_data_memory_corrupted	Not used
23	0x7110	0x01	brake_feedback_fault	Brake status signal inconsistent
24	0x7124	0x08	motor_temperature_warning	Warning motor temperature
25	0x7125	0x08	motor_over_temperature	Fault motor temperature
26	0x73A2	0x01	Interface STD - Erroneous value of <u>sinco</u> s signals	Amplitude sinusoidal signals incoherent (Optional interface X1)
27	0x73A3	0x01	Interface STD - <u>hyperface</u> position conflict	digital position (hyperface protocol) inconsistent with the calculated position (Optional interface X1)
28	0x73A4	0x01	Interface STD - <u>Hyperface</u> status error	Error encoder status (hyperface protocol-Optional interface X1)
29	0x73A5	0x01	Interface STD - <u>hyperface</u> transmit error	Transmission error encoder (hyperface protocol-Optional interface X1)
30	0x73A6	0x01	Interface STD - <u>hyperface</u> receive error	Reception error encoder (hyperface protocol- optional interface X1)
31	0x73A7	0x01	Interface STD - Endat22 warning message	Warning from encoder endat 22 (Optional interface X1)
32	0x73A8	0x01	Interface STD - Endat22 error1 message	Error type 1 encoder EnDat 22 (optional interface X1)
33	0x73A9	0x01	Interface STD - Endat22 error2 message	Error type 2 encoder EnDat 22 (optional interface X1)
34	0x73AA	0x01	Interface STD - Endat22 <u>crc</u> error	Error CRC encoder EnDat 22 (optional interface X1)
35	0x73AB	0x01	Interface STD - Endat22 position not ready	Error position not ready encoder EnDat 22 (optional X1 interface)
36	0x73AC	0x01	Interface STD - Endat22 not ready for strobe	Error strobe not ready encoder EnDat 22 (optional X1 interface)
37	0x73AD	0x01	Interface STD - Resolver synchronization fault	Resolver signal synchronization error (phase)
38	0x73AE	0x01	Interface STD - Resolver signals fault	Resolver level signal error (amplitude)

39	0x8700	0x01	synchronization_error	Internal interrupt frequency irregular
40	0x6102	0x01	interrupt_missing (era Interrupt_time_exceeded)	Internal interrupt frequency not registered
41	0x6103	0x01	Task_time_exceeded	Task exceeded the maximum time
42	0x8400	0x01	velocity_control_monitoring	Error exceeding maximum speed
43	0x8611	0x01	following_error	position tracking error
44	0x8612	0x01	position_reference_limit	Not used
45	0x8101	0x10	EtherCAT_link_fault	Link EtherCAT not detected
46	0x8100	0x10	EtherCAT_communication_fault	Generic Fault EtherCAT communication
47	0x8231	0x10	EtherCAT_rpdo_time_out	Time out PDO reception
48	0x8241	0x10	EtherCAT_rpdo_data	PDO data reception error
49	0x8235	0x10	EtherCAT_tpdo_time_out	Time out PDO transmission
50	0x8245	0x10	EtherCAT_tpdo_data	PDO data transmission error
51	0x8181	0x10	Internal_comunication_fault	Generic Fault internal communication (double-axis module)
52	0x8182	0x10	Internal_comunication_heartbeat_error	Fault internal communication - the axis 1 (2) does not detect the presence of axis 2 (1) (dual-axis module)
53	0x8183	0x10	internal_receive_pdo_time_out	Fault internal communication - PDO reception timeout (double-axis module)
54	0x8184	0x10	internal_transmit_pdo_time_out	Fault internal communication - timeout PDO transmission (Double-axis module)
55	0x3100	0x10	Phases_not_ok	Not used
56	0x3200	0x04	Over Current	overcurrent fault
57	0x8100	0x04	CAN_communication_fault	Generic CAN communication fault
58	0x8231	0x10	CAN_rpdo0_time_out	Time out PDO0 reception
59	0x8232	0x10	CAN_rpdo1_time_out	Time out PDO1 reception
60	0x8233	0x10	CAN_rpdo2_time_out	Time out PDO2 reception
61	0x8234	0x10	CAN_rpdo3_time_out	Time out PDO3 reception
62	0x8241	0x10	CAN_rpdo0_data	PDO0 data reception error
63	0x8242	0x10	CAN_rpdo1_data	PDO1 data reception error
64	0x8243	0x10	CAN_rpdo2_data	PDO2 data reception error

65	0x8244	0x10	CAN_rpdo3_data	PDO3 data reception error
66	0x8235	0x10	CAN_tpdo0_time_out	Time out PDO0 di trasmissione
67	0x8236	0x10	CAN_tpdo1_time_out	Time out PDO1 transmission
68	0x8237	0x10	CAN_tpdo2_time_out	Time out PDO2 transmission
69	0x8238	0x10	CAN_tpdo3_time_out	Time out PDO3 transmission
70	0x8245	0x10	CAN_tpdo0_data	Error PDO0 data transmission
71	0x8246	0x10	CAN_tpdo1_data	Error PDO1 data transmission
72	0x8247	0x10	CAN_tpdo2_data	Error PDO2 data transmission
73	0x8248	0x10	CAN_tpdo3_data	Error PDO3 data transmission
74	0x8130	0x10	CAN_life_guard_error	Errore life guardian protocol
75	0x823A	0x10	CAN_sync_consumer_time_out	Time out sync

6.5 Faults during the GUI – drive connection

In the case in which the communication between the PC and drive fails, an error message will appear.



If the connection is made the serial line:

- ensure that you select the correct COM port and the baud rate is set to 115200.

If the connection is made via CAN:

- make sure that the CAN line is properly terminated;
- make sure it is used the IXXATe converter and that the appropriate drivers are properly installed on the PC;
- make sure that the baud rate and the node are configured as they are set on the drive.



The default baud rate is 500 Kbps. The default node 127.

To check the values set on the drive, proceed as follows:

- connect to the driver by using another network.
- from the terminal read the value of the baud rate (canbdr parameter);
- from the terminal read the ID of the node (modide parameter).

If the connection is made via EtherCAT:

- verify that the correct network adapter is selected;
- verify that the cable you use is appropriate.



The EtherCAT CAT5 cable must be STRAIGHT, NOT CROSS.

7. SAFE TORQUE OFF SAFETY FUNCTION

(SAFELY DISABLED TORQUE)

7.1. Application

The safety function Safe Torque Off (STO) of the DS2020 has been designed with an integrated redundant circuit in the control board.

The use of the STO function outside of the instructions contained in this Manual is considered misuse.

7.2. Installation risk assessment

The security functional requirements of a drive depend on the application, and should be considered during the evaluation of the overall risk of the installation. If the drive manufacturer is also liable for the operated equipment, the designer of the installation is responsible for the risk assessment, and the specification of requirements for levels of functional integrity and safety integrity levels (SIL) of the drive according to CEI EN 62061: 2005 and / or performance levels (PL) according to EN ISO 13849-1: 2008.

The following table, identical to Tab.4 of the UNI EN ISO 13849-1: 2008, shows the relationship between PL and SIL.

PL	SIL (IEC 61508-1) operational mode high / continuous
a	No match
b	1
c	1
d	2
e	3

Relationship between performance levels (PL) and safety integrity levels (SIL)



Info

Since SIL 4 level refers to catastrophic events, it does not cover the risks relating to machinery.

The risk assessment presented by the machine must be carried out in accordance with Directive 2006/42 / EC, referring to UNI EN ISO 12100: 2010 and must contain the safety circuit configuration relating to the entire machine by taking into account all components of the integrated security system, including the drive.

7.3. Safe Torque Off Function

The Safe Torque Off safety function of the DS2020 has been validated according to the level of safety integrity SIL 3 as defined in the product standard CEI EN 61800-5-2: 2008 showing that:

- The probability of dangerous failure per hour (PFHd) is 9×10^{-10} hours⁻¹ (see 7.3.1 / 2).

The validation of the function and the relative STO circuit involve the use of two distinct types of monitoring: the first consists of a normally closed electric contact (hereinafter referred to as "Hardware Feedback"), the second identified by a digital signal of binary type (hereinafter referred to as "Software Feedback") defined by the standard IEC61800-7-201, CIA 402, Object 60FD (digital inputs), bit 3.

Also compliance with UNI EN ISO 13849-1: 2008 has been verified using the PFHd calculated by reference to CEI EN 61800-5-2: 2008. According to this standard, STO complies with performance level (PL) "e" (See 7.3.1).

The STO function is located in a subsystem as defined by the Standard IEC 62061: 2005, with a SIL limit requested SILCL3.

The STO safety function of the DS2020 can also be used to ensuring the safe stop of the injection molding machines, for the interlocked guards in the area of the mold and in other less hazardous areas in compliance with the standard UNI EN 201:2010.

7.3.1. Characteristic values according to UNI EN ISO 13849-1

- "Hardware Feedback" standard values according to UNI EN ISO 13849-1

	Value	Observations
Level of performance	PL e	
Category	4	The external subsystems must be capable of carrying out the diagnostic function in correspondence with, or before, the next request of the safety function, for example immediately at power up or at the end of an operating cycle of a machine
MTTFd	> 100 years	According to the UNI EN ISO 13849-1 it can be taken into account a maximum value of 100 years
Diagnostic coverage	DC=99%	The external subsystems that perform the diagnostic function must use techniques capable of providing a DC \geq 99%
Service life	20 years	Change the drive
Repair Time	8 hours	
Diagnostic test interval	8 hours max	See also the observation relative to the category

- "Software Feedback" standard values according to UNI EN ISO 13849-1

	Value	Observations
Level of performance	PL e	
Category	4	The external subsystems must be capable of carrying out the diagnostic function in correspondence with, or before, the next request of the safety function, for example immediately at power up or at the end of an operating cycle of a machine
MTTFd	> 100 years	According to the UNI EN ISO 13849-1 it can be taken into account a maximum value of 100 years
Diagnostic coverage	DC=99%	The external subsystems that perform the diagnostic function must use techniques capable of providing a DC \geq 99%

Service life	20 years	Change the drive
Repair Time	8 hours	
Diagnostic test interval	8 hours max	See also the observation relative to the category

7.3.2 Characteristic values according to CEI EN 62061

- “Hardware Feedback” standard values according to CEI EN 62061

	Value	Observations
Levels of integrity of security	SIL 3	
PFHd	9×10^{-10} hours ⁻¹	
Verification test interval	20 years	

- “Software Feedback” standard values according to CEI EN 62061

	Value	Observations
Levels of integrity of security	SIL 3	
PFHd	9×10^{-10} hours ⁻¹	
Verification test interval	20 years	

7.4. Safety requirements

- Full stop. The Safe Torque Off safety function prevents unintended restart of a motor in an arrest status. This circuit can be used in the machine "Safe arrest" function. When the motor is in the process of rotating, the activation of the Safe Torque Off function generates an uncontrolled stop (Category 0 according to EN 60204- 1: 2006). When prompted for a controlled stop category 1 according to EN 60204-1: 2006, must be satisfied the condition of motor stop within predefined limits of deceleration or after a delay function of the application. The final machine must be able to stop the motor.



Attention

During the risk assessment, the designer must evaluate the stopping time of the machine. The safety function Safe Torque Off time of intervention must be greater than the deceleration ramp braking time set by the drive with maximum speed and maximum load on the axle. The assessment should include the possibility of a fault. The machine may have a dangerous overload in the event of failure of the motor and additional protective measures may be required to achieve a more secure state.

Answer time. The maximum response time for the activation and the deactivation of the safety function STO is 10 ms.

- Environmental conditions. (The following conditions have been validated for safety. The other conditions can be found in Chapter 2 of this Manual)
 - Ambient temperature: 0 to + 40 ° C
 - EMC immunity: according to EN 61800-3: 2004, second environment (industrial), category C3 (not suitable for use in the first environment that includes domestic environments)
 - Vibration resistance: from 2 to 9 Hz, with a 3 mm amplitude (peak); 9 to 200 Hz, acceleration of 1 g, according to EN 60721-3-3: 1995, Class 3 M4
 - Shock resistance: 10 g, half-sine, 11 ms, according to EN 60721-3-3: 1995, Class 3 M4
 - Body: The electronic device has to be installed in an enclosure with a minimum degree of protection IP54.
 - Pollution degree 2: The device must be installed in an environment with pollution degree 2, where normally there is only non-conductive pollution. Occasionally, however, there may be a temporary conductivity caused by condensation, when the electronic device is not in operation.

**Attention**

When the Safe Torque Off circuit is activated, the motor can no longer produce torque. When external forces are acting on the axis (eg. On the vertical force of gravity), they must be provided suitable protections such as a mechanical automatic lock or a weight equalization system.

**Attention**

The Safe Torque Off function does not provide electrical isolation. There is no protection against electric shock. The machine or the system must always be electrically isolated from the power line through the main disconnection device, locked in the open position, before performing any work on the machine or system, such as maintenance, service or cleaning (do refer to EN 60204-1: 2006, par. 5.3). The staff must be aware that the bus bars can carry dangerous voltages even after power off (capacitive voltage) and that the discharge time is about 6 minutes.

7.5. Safe Torque Off Circuit

The Safe Torque Off function has been made by means of redundant blocking devices which act independently on the power modules. This allows not to disable the power supply of the drive and avoid the normal restart process.

**Attention**

The restart of the STO function is automatic when the safety inputs are active. It is the responsibility of the machine manufacturer to check and install, if necessary, a manual reset function to prevent the automatic restart of the motor.

The DS2020 drive controls the movements of a three-phase AC motor by the generation of a rotating magnetic field. To this end, the microprocessor generates a complex pattern of pulses (PWM), which are amplified and used to pilot the power semiconductors. The Safe Torque Off function of the DS2020 operates through hardware with two channels that interrupt the direct impulses to IGBT.

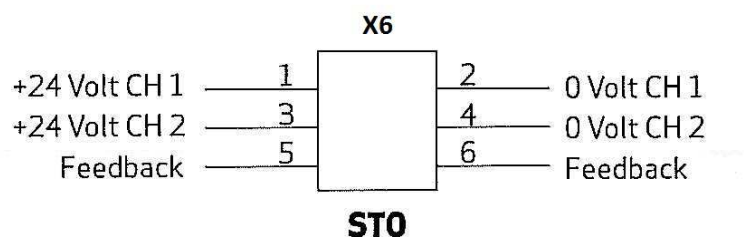
They are provided two modes of monitoring for detecting dangerous faults: the monitoring system "Hardware Feedback" indicates the status of the circuit; the same information is available through the "Software Feedback" a system consisting of a binary digital signal defined by the IEC 61800-7-201, 402 CIA Object 60FD, (digital inputs) bit 3.

7.6. Safe Torque Off connections

Management channels, including the "Hardware feedback", of Safe Torque Off circuit are controlled using the X6 Connector called also JRC1.

Both of the monitoring channel modes are always available; is the user's prerogative to choose which type of monitoring to use; the type "Hardware feedback" or the type "Software feedback" or both features at the same time.

Connector X6 – Jric1



Movable connector pinout: 6 contacts, model B2 3.50 / 06/180 SN BK BX Weidmuller

Pin	Name	Function
1	+ "Channel 1"	+ 24Vdc input of Channel 1. This input must be high (+ 24V) to power the motor. When the input goes low (0V), the motor is not powered.
2	- "Channel 1"	0V of Channel 1
3	+ "Channel 2"	+ 24Vdc input of Channel 2. This input must be high (+ 24V) to power the motor. When the input goes low (0V), the motor is not powered.
4	- "Channel 2"	0V of Channel 2
5	Monitoring Channel	The electrical contact "hardware feedback" is composed of a relay "Photo-Mos" fuse protected. When both control channels "Channel 1" and "Channel 2" are low (0V), the STO circuit is in a safe state (safety function enabled), the monitoring signal is active and provides closed contact. In all other cases, the tracking signal is always off, and provides open contact. The Monitoring Channel of the complete system must include this signal in order to properly run the plausibility check
6	Hardware Feedback	



Attention

To be validated according to the categories 1 to 4 according to basic safety principles of the UNI EN ISO 13849-2: 2008, tab. D.2, the external cables entering the JRC1 connector must have the screens connected to the grounding circuit



Attention

To avoid common failure causes the cable of the "Channel 1" (in correspondence of the pins 1, 2 and 6 of JRC1) must be separated from the cable of the "Channel 2" (in correspondence of the pins 3, 4 and 5 of JRC1) during the installation.



Attention

To prevent a short circuit between the input and the verification signal, the multi row wires of the two channels should end with cable lugs or other appropriate devices



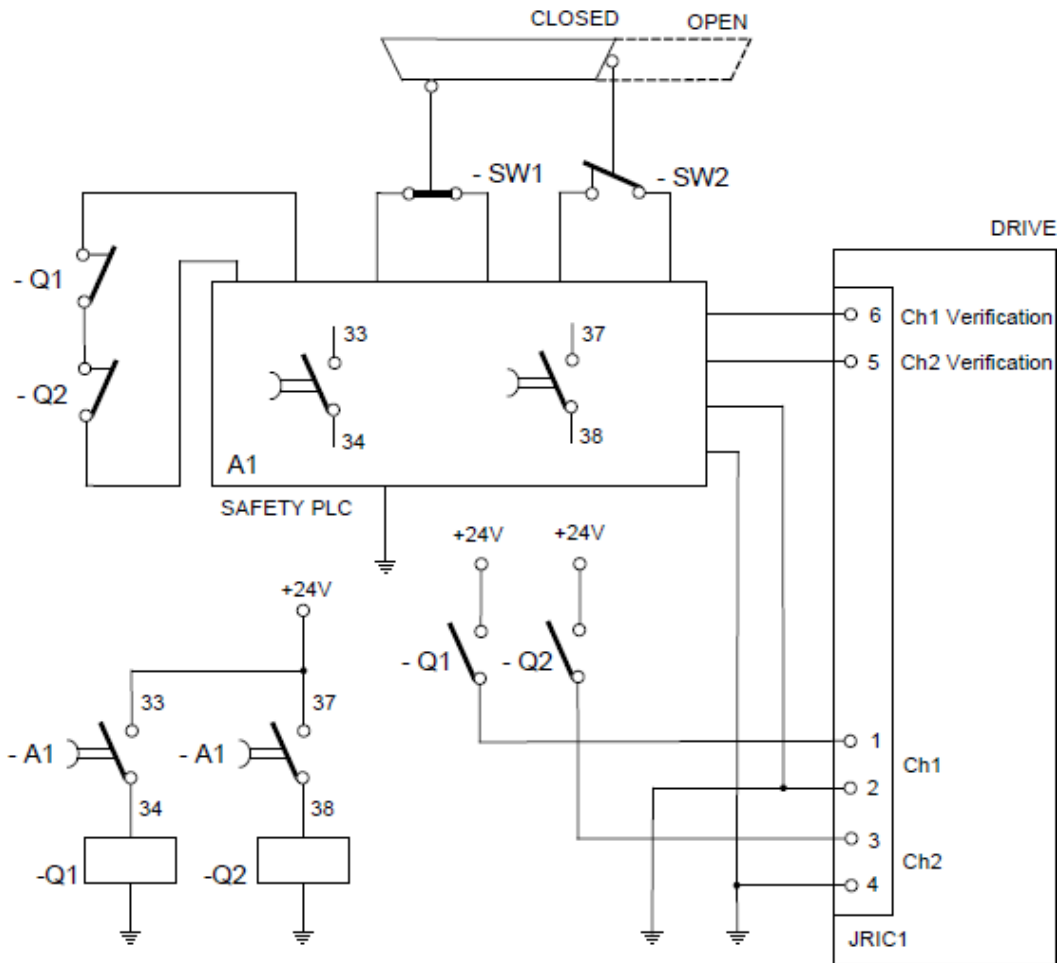
Attention

The verification of the two channels of the signal wiring must be protected from short circuits towards the voltage sources and should never be applied external power to the verification signal even in case of failure.

Electrical input / output specifications

Input Channel	$I_{nom} = 30\text{mA} (\pm 10\%)$ $V_{nom} = 24\text{Vcc} (\pm 10\%)$ $V_{max} = 30\text{Vcc}$
Otput – Verification Channel	$I_{max} = 200\text{mA}$ $V_{max} = 30\text{Vdc}$

7.7. Example of an application



Example of Safe Torque Off after a controlled stop

Description

Two redundant channels are used. The switches SW1 and SW2 are connected to an A1 safety PLC that controls two contactors Q1 and Q2 with associated contacts. The NO contacts of Q1 and Q2 control the two input channels of the DS2020 security for the shutdown of the the motor power connections. The NC contacts of Q1 and Q2 are used in series to control the A1 safety PLC in the event of welding of a NO contact. The two output safety channels of the DS2020 are connected to an A1 safety PLC to allow the diagnostic coverage of the DS2020 subsystem.



Info

In the example, the controlled stop can be achieved using the delayed outputs of A1. The controlled stop is not an integrated security function in the drive therefore its circuit is not shown in the figure.

According to UNI EN ISO 13849-1:2008 the subsystem to the input and output devices can reach PL = e because:

- the channels are redundant
- the switches SW1 and SW2 have high MTTFd and DC
- SW2 a command with positive opening
- Q1 and Q2 have high MTTFd and DC
- CCF value is > 65

Subsystems:

- PLC A1 has PL = e
- DS2020 drive (STO circuit) has PL = e

The security system can reach PL = e and the Category is 4.

According to CEI EN 62061: 2005, the subsystem to the input and output devices can achieve SIL 3 because:

- All safety-related devices have PFHd <10⁻⁷

Subsystems:

- Safety PLC A1 has SIL 3
- DS2020 drive (STO circuit) has SIL 3

The safety system can reach SIL 3.

Example requirements

- Before activating the STO function it is necessary to stop the motor while maintaining the power supply during the stop (controlled stop).
- Delay of outputs A1 which operate the contactors Q1 and Q2 should be > T (general shutdown capability).
- The safety PLC A1 has to fulfill the requirements for PL e according to EN ISO 13849-1.
- The safety contactors Q1 and Q2 should be linked to contacts according to IEC 60947-5-2, Annex L ("mirror contacts").
- When it is possible that a person is with the whole body in the danger zone, beyond the protective cover, a detection system must be installed, or the restart must be available only after a separate restart following the end of the safety guards confirming that no member of staff is in the danger zone in accordance with the risk assessment.
- The short circuit between conductors connected to 33-34 A1 and between conductors connected to 37-38 A1 and among those connected to pins 1 and 2 of the drive must be avoided.
- It must be created a physical separation between signal paths.
- The multi-wired cables connected to the multi-pole connectors should end with cable lugs or other appropriate devices.
- The verification of the two channels of the signal wiring must be protected from short circuit towards voltage sources and should never be exposed to voltage external to the verification signal even in case of failure.
- The safety system must be validated according to EN ISO 13949-2: 2008

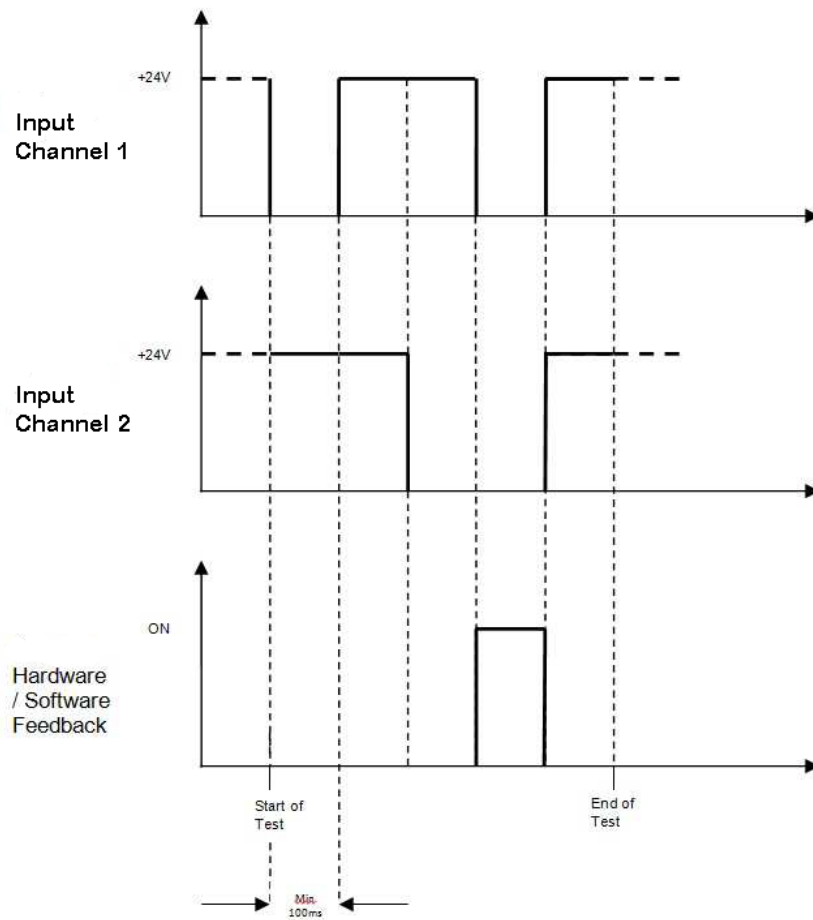
7.8. Installation and maintenance procedure Safe Torque Off

The following method of installation and maintenance should always be performed as indicated by qualified personnel who adopt safety procedures required by current regulations:

- on the first start
- at restart in the event that a fault has been detected and removed
- in any case at least every 8 hours

Run the sequence of on / off commutation shown in the figure below by providing + 24VDC and 0V on the two input channels connected to the X6-JRIC1 connector and perform a plausibility check with monitoring signals:

- **Hardware feedback** : on the connector JRIC1 contacts 5:06 check closed (ON) or open (OFF) electrical contact
- **Software feedback** : check the "INTERLOCK STATUS" parameter value object 60FD (digital inputs) bit3 defined by the standard IEC61800-7-201, CIA 402



Mandatory sequence circuit test STO



Attention

if one of the above conditions is not met, the STO function can not be used. After the fault has been removed, the procedure must be repeated.

Stop Category 1

- Disable the protection devices, eg. open safety guards while the motor is running, and check that the motor goes in an arrest status.
- If the arrest is a category 1 according to EN 60204-1: 2006, check that the motor is braked in a controlled manner and that the Safe Torque Off function is active after the arrest. This should not cause dangerous situations.

7.9. Assembly and Serial tests

The Safe Torque Off circuit (STO) is assembled and tested at Moog Casella.

7.10. Identification of the STO function on the plate

The Safe Torque Off circuit is identified by the words "Safe Torque Off" on the plate.

8 Annexes

8.1 Glossary

A	
Acceleration	The rate of increase of velocity with respect to time
Alarms	Irregular operating situations highlighted by LED or DISPLAY, with subsequent analysis via GUI.
Asynchronous Motor	Motor in which the rotor and the magnetic field turn at different speeds.
B	
Base control board	Section of the main control circuit with interface to other internal or external functions and slots for optional modules.
Brushless Motor	Motor in which the rotor and the magnetic field rotate at the same speed. The rotor is normally constituted by magnets according to one or more polar couples. The stator is constituted by a three-phase winding housed in the slots of a magnetic lamination pack.
C	
CANopen	CANopen is a communication protocol used in automation systems. The communication profiles and the basic specifications of the CANopen devices are provided by the CAN in Automation (CiA) draft standard 301. The motion control is instead specified in CiA402.
Capacity towards ground	The drives and the power supply have a capacitance to ground (the metal case), composed mainly by the capacitors on the DC bus circuit in order to have a low impedance connection for high frequency currents of dispersion.
DC bus	Circuit constituted from the rectified and flattened network voltage.
Braking Circuit	Circuit that turns into heat the excess energy regenerated by the motor during the deceleration phase.
Short Circuit	Connection into electrical conduction between two phases or conductors with different polarity of an alternating or continuous voltage.
Clock	Timing signal.
Control loops	Set of hardware and firmware circuits that determine the control of the quantities relating to torque, speed, position on the basis of the values measured by the relative sensors. They can be closed or open. The closed control loops are based on sensors for the feedback signals: resolvers and encoders for position and speed loop, Hall effect current sensors for the current loop. A typical open control loop is related to the control voltage / frequency (V / f) of an asynchronous motor without speed transducer.
Convection	Free movement of air (not forced) for cooling.
D	
DC bus - Intermediate circuit	It is the power supply for the individual axis modules formed from the rectified grid voltage and filtered by powerful capacitors..
Disable	Removes the ENABLE signal.
Deceleration	The rate of decrease of velocity with respect to time
Display	Part of the front panel used for the visual signaling of information.
Directive (Machine)	The Machinery Directive is a set of rules defined by the European Union, which serve to provide the necessary requirements for health and safety relating to the design and construction of machinery present on the European market. It applies to fixed, mobile, transportable and hoisting / moving machinery.

Directive (Low Voltage)	The Low Voltage Directive concerns machinery in which electric low voltage circuits are present. The manufacturer must compile a technical dossier, make a declaration of conformity and affix the CE marking.
Dispersion towards ground	Current (usually of reduced intensity) flowing from a wire to the ground.
Dynamic braking	The energy accumulated by the motor during the acceleration is converted into heat through the braking resistor.
Directive (EMC)	<p>The EMC Directive requires that all electrical and electronic devices placed on the market from 1 January 1996 must satisfy the essential requirements of electromagnetic compatibility.</p> <p>The essential electromagnetic compatibility requirements are met by applying the harmonized technical standards published in the EU Official Journal.</p> <p>The harmonized standards can be essentially divided into:</p> <ul style="list-style-type: none"> • Product standards • Generic standards • Basic standards
E	
Electric Drive	<p>Electric power converter for controlling torque speed and position of a motor. It consists of four main parts:</p> <ul style="list-style-type: none"> • Rectifier of AC mains voltage • DC link voltage rectified and leveled • Inverter of the rectified voltage in voltage with frequency and voltage variables • Control circuit that transmits signals for the switching of the power semiconductors of the inverter
Electric noise	Set of unwanted signals or current that overlap the useful signal typically transmitted on a communication channel between electronic devices.
EMC	Radio frequency emitted during the electronic power equipment operation, likely to generate or induce disturbances in other electronic equipment.
Emissions	Electromagnetic interference caused by electronic equipment operating at frequencies likely to generate or induce disturbances.
Enable	Signal that enables the drive.
Encoder	Motor component that detects the value of the position of the shaft and transmits it to the drive to operate the control.
Encoder incremental	Motor component that detects the incremental changes in the position of the shaft and transmits them to drive to operate the control with information the current position.
Encoder simulated	TTL encoder signals (A, B and C) differential line drivers generated by the drive, starting from internal information, to emulate an encoder.
Encoder sinusoidal	Motor component that detects the incremental changes in the position of the shaft and transmits the drive to operate the control with information the current position The information is acquired through the reading of two sinusoidal signals sampled from the drive.
EnDat 22	Serial protocol for communication with Heidenhain encoder. Allows the reading of the position of absolute encoders, as well as updating and saving data stored in the encoder. It is compatible with the previous version 21 offering advantages such as the transfer of other data together with that of position without a separate request.
EtherCAT	communication protocol implemented on the Ethernet the network for the synchronous transmission of information
Ethernet	High speed data communication network.
F	
Filter (Network)	Device that reduces noise generated by the power supply cables.
FMEA	Failure Mode and Effects Analysis.

FieldBus	Structure that allows communication between different devices; are connection lines on which the digital information is transferred from one or more sources to one or more destinations. Their aim is therefore to reduce the number of interconnections required. The bus techniques are of great importance in microprocessor systems but it is necessary to regulate this flow of data in order to allow for a single communication at a time by disabling other possible data sources at that moment.
Fuses	Overcurrent protection devices
G	
Grade of protection (Protection grade)	Security level of the system components.
Ground	Connection of the conductor or the frame to the ground connector.
GUI	Graphical User Interface.
H	
Hyperface	Fully digital, synchronous two-way, multi-channel protocol to transfer position information and speed that requires minimal wiring between drive and feedback from the motor (2-wire).
I	
IGBT	semiconductor devices for the control of PWM switching..
Interface Fieldbus	EtherCAT or CANopen
IFOC (control)	Indirect Field Oriented Control
M	
Machine	Set of mechanical devices, connected to each other of which at least one is in motion.
Multiaxis system	Machine with several axes with independent transmission.
R	
Rectifier	Circuit that converts an AC voltage into a DC voltage.
Regolator P	Regulating circuit functioning in a purely proportional manner.
Regolator PI	Control circuit running in a proportional and integral way.
Regolator PID	Proportional adjustment circuit functioning, integral and derivative way
Reset	Restart the microprocessor.
Braking resistor	When the motor decelerates, a braking resistor converts the kinetic energy of the motor into heat. The braking resistor is automatically connected to the DC bus voltage when the bus voltage exceeds its threshold and intervenes in the braking circuit.
RS232	Very common standard hardware for the transmission of signals with the same voltage level. Suitable for low transmission rates and limited distances.
S	
Serial Communication	Transmission based on sending each signal at different times.
Shield	Devices designed to reduce electromagnetic emissions.
Servodrive	Drive that operates the regulation of torque, speed and position of a servomotor.
Safety	All necessary measures to avoid damage to property or to persons.
Soft-start	Circuit for limiting the power from the network to the system during the power up
Stiffness	Capacity of a mechanical system to withstand the stresses or disorders that are applied from outside.
STO	Safe Torque Off: protection against unexpected restart. The STO function safely interrupts the power supply to the motor.

8.2. Metric/AWG conversion table

AWG	Diameter		Cross-section		Ohmic resistance at 20 °C	Weight
	mils	mm	Circ. mils	mm ²		
44	2.0	0.50	4.00	0.0020	8498	0.0180
43	2.2	0.055	4.84	0.0025	7021	0.0218
42	2.5	0.063	6.25	0.0032	5446	0.0281
41	2.8	0.071	7.84	0.0039	4330	0.0352
40	3.1	0.079	9.61	0.0049	3540	0.0433
39	3.5	0.089	12.3	0.0062	2780	0.0552
38	4.0	0.102	16.0	0.0081	2130	0.0720
37	4.5	0.114	20.3	0.0103	1680	0.0912
36	5.0	0.127	25.0	0.0127	1360	0.1126
35	5.6	0.142	31.4	0.0159	1080	0.1412
34	6.3	0.160	39.7	0.0201	857	0.1785
33	7.1	0.180	50.4	0.0255	675	0.2276
32	8.0	0.203	64.0	0.0324	532	0.2886
31	8.9	0.226	79.2	0.0401	430	0.3571
30	10.0	0.254	100	0.0507	340	0.4508
29	11.3	0.287	128	0.0649	266	0.5758
28	12.6	0.320	159	0.0806	214	0.7157
27	14.2	0.361	202	0.102	169	0.9076
26	15.9	0.404	253	0.128	135	1.1383
25	17.9	0.455	320	0.162	106	1.4433
24	20.1	0.511	404	0.205	84.2	1.8153
23	22.6	0.574	511	0.259	66.6	2.3064
22	25.3	0.643	640	0.324	53.2	2.8867
21	28.5	0.724	812	0.411	41.9	3.6604
20	32.0	0.813	1020	0.519	33.2	4.6128
19	35.9	0.912	1290	0.653	26.4	5.8032
18	40.3	1.02	1620	0.823	21.0	7.3209
17	45.3	1.15	2050	1.04	16.6	9.2404
16	50.8	1.29	2580	1.31	13.2	11.6212
15	57.1	1.45	3260	1.65	10.4	14.6885
14	64.1	1.63	4110	2.08	8.28	18.4512
13	72.0	1.83	5180	2.63	6.56	23.3616
12	80.8	2.05	6530	3.31	5.21	29.4624
11	90.7	2.30	8230	4.17	4.14	37.0512
10	101.9	2.588	10380	5.26	3.277	46.7232
9	114.4	2.906	13090	6.63	2.600	58.9248
8	125.5	3.264	16510	8.37	2.061	74.4000
7	114.3	3.655	20820	10.55	1.634	93.744
6	162.0	4.115	26240	13.30	1.296	118.1472
5	181.9	4.620	33090	16.77	1.028	148.8
4	204.3	5.189	41740	21.15	0.8152	187.488
3	229.4	5.287	52260	26.67	0.6466	235.592
2	257.6	6.543	66360	33.62	0.5128	299.088
1	289.3	7.348	83690	42.41	0.4065	376.464
1/0	324.9	8.252	105600	53.49	0.3223	474.672
2/0	364.8	9.266	133100	67.43	0.2557	599.664
3/0	409.6	10.40	167800	85.01	0.2028	755.904
4/0	460.0	11.68	211600	107.22	0.1608	953.808