

DR2020

USE AND MAINTENANCE MANUAL

DECENTRALIZED DIGITAL SERVO DRIVE

MOOG

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1. OVERVIEW

1.1. Contents

This manual provides information on the correct installation and optimal operation of the DR2020 series of digital multi-axis servo drives.

All information in this manual, including methods, technologies and concepts is the exclusive property of Moog-Casella, and may not be copied or reused without specific authorisation.

Moog-Casella reserves the right to make changes to the product and relative documentation, at any time, without notice.

The following documents are available on the Website:

- QUICK GUIDE - INSTRUCTIONS AND GUIDELINES FOR INITIAL START-UP
- USER AND INSTALLATION MANUAL (this document)
- FIELDBUS MANUAL
- CONFIGURATION SOFTWARE Dx2020 GUI






WARNING

When the drive is operating, there is a risk of death, serious injury or serious material damage. The installer shall therefore make sure that the safety instructions in this manual are read, understood and observed by all personnel responsible for operating the drive.

AVERTISSEMENT

Lorsque l'entraînement est en marche, il existe un risque de mort, blessures graves ou dommages matériels importants. L'installateur doit donc veiller à ce que les consignes de sécurité dans ce manuel sont lues, comprises et respectées par tout les le personnel responsable de commander l'entraînement.

1.2 Symbols used

	WARNING: Hazard that may result in death or serious injury
	Hazard that may result in minor injury and/or material damage
	Important information

1.3. Contents

A DR2020 includes:

- A DR2020 module

Note: a connectors' kit (see page 6) or a connection cable between DR2020 modules, must be ordered separately, specifying the needed length.

1.4. Qualifications of recipients

This manual is intended for qualified personnel, i.e. with the following skills, depending on their functions:

Transport: personnel shall have knowledge of handling electrostatically sensitive components

Unpacking: personnel shall have knowledge of handling electrostatically sensitive components that are sensitive to impact

Installation: personnel shall have knowledge of installing electrical equipment

Start-up: personnel shall have extensive technical knowledge of electrical drive technology.



INFORMATION

Qualified personnel shall be familiar with and observe the following standards:

IEC 60364, IEC 60664 and national accident prevention regulations.



WARNING

When the drive is operating, there is a risk of death, serious injury or serious material damage.

The installer shall therefore make sure that the safety instructions in this manual are read, understood and observed by all personnel responsible for operating the drive.



AVERTISSEMENT

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1.5. Reference standards

The DR2020 drives conform to the Low Voltage Directive (2014/35/EC) and EMC Directive (2014/30/EC).

The "Safe Torque Off" (STO) safety function built into the drive conforms to the Machinery Directive (2006/42/EC).

To conform to European Directives, the product meets the requirements of the relevant harmonised installation standards EN61800-5-1 (LVD), EN61800-3 (EMC) and EN 61800-5-2 (Safety of machinery), EN60034-1, EN60034-5 (Electric Rotary Machines).

The DR2020 drives are CE certified.

2. DESCRIPTION OF THE SYSTEM

2.1. Product structure

2.1.1. Product description

The DR2020 drive is the new generation of digital servo drives manufactured by Moog-Casella for controlling brushless synchronous or asynchronous motors. It's a decentralized servo drive that can be positioned directly on the machinery with a DC power supply module.

- The power supply of the DM2020 supplies the "power" in direct current (+ AT and -AT) to the different DR2020 through the connection cable applied on the terminal board
- The first two upper connectors of the power supply terminal board carry the auxiliary power supply + 24Vdc
- The second two connectors at the bottom carry the power supply +/- AT (ATTENTION HIGH VOLTAGE 560VDC or higher)
- There are two standard power supply models (those of the DM2020 multi-axis drive)
- Each DR2020 axis module is only available in the single axis version
- The current flows of the various DR2020 axes range from 2 Arms to 8 Continuous Arms and 4 Arms to 16 Peak Arms
- Sizes are 4

Size	Rated Current Arms	Peak Current Arms
2/4	2,0	4.0
4/8	4,0	8.0
6/15	6,0	12.0
8/16	8,0	16,0

- Compatible feedback devices (to be specified on the order)
 - Serial RESOLVER
 - USB RESOLVER
 - Sincos Serial ENCODER
 - Sincos USB ENCODER

- The control modes are 3

Mode	Note
Analog input	Opzionale (*)
Can Bus Fieldbus	Opzionale (*)
EtherCat Fieldbus	Standard version

(*) *under development*

- The DR2020 is equipped with the circuit for controlling a stationary brake integrated in the motor.

- The modules can be cooled by natural convention or by a radiating back surface
- Ethernet interface on which the EtherCAT Real Time protocol is implemented with the DS402 profile (standard)
- Standard CANOpen interface (under development) on which the CANOpen protocol is implemented with the DS402 profile
- "Safe Torque Off" (STO) (protection against accidental start-up) incorporated into each DR2020 module
- Configuration/commissioning via GUI: Dx2020GUI, with USB interface (X6 connector), located at the side of the Fieldbus connectors allows users to configure, calibrate and control the drive
- Alarm diagnostics: Via GUI or Field Bus
- Accessories:
 - EMC filters (supplied with the power supply)
 - Power and signal cables
 - Brake resistor (supplied with the power supply)

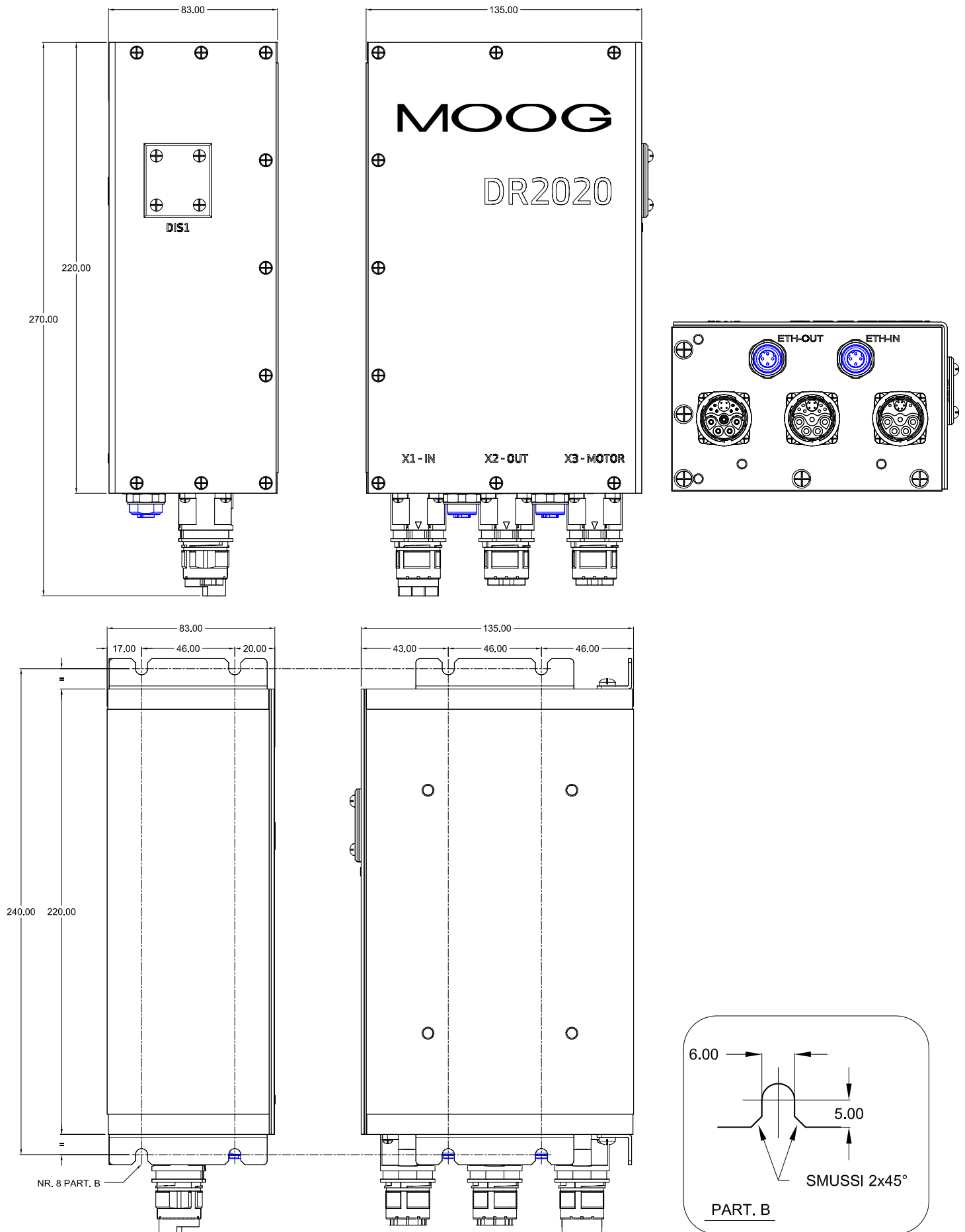
Note: High voltage power can be obtained from the DM2020 Power Supply.

2.1.2. Operating and storage conditions

Ambient operating temperature	from 0 °C to 40 °C
Storage temperature	from -25 °C to 55 °C
Transport temperature	from -25 °C to 70 °C
Humidity permitted during operation	5...95 % condensation not allowed
Humidity permitted for storage	5...95 %
Humidity permitted for transport	95 % a 40 °C
Operating height	Up to 1000 m above AMSL, over 1000 m above AMSL with reduced current (-2%/100 m) max. 2000 m above AMSL
Certification	CE, UL (pending)
IP Protection rating	IP65
Mechanical resistance in compliance with EN 60721-3-3	CLASS 3M7 Vibration: stat/sinusoidal: <ul style="list-style-type: none"> • 10mm for frequencies between 2...9 • 30 m/s² for non-stationary vibration Non-stationary vibration and Type II impacts: <ul style="list-style-type: none"> • 250 m/s² (25 g) for 6
Machine Safety	STO (Safe Torque Off) SILCL 3 PL "e" (pending)

Tab 2.1 Environmental conditions

Drive Dimensions



Connectors and Cable coding

Connerctors' coding

X1 input connector with terminals (to the power supply)
 X2 output connector (to the next DR2020 module)
 X3 motor connector
 X4 e X5 EtherCat connectors

BR8904-R
 BR8905-R
 BR8907-R
 BR8906-R

Connertors Kit:
 it includes 4 connectors: X1, X2, X4 e X5 **Cables Coding*)**

BR8903-R

To the Power Supply
 To the DR2020
 To the Motor

CVAMM
 CVDMM
 CVMMM

Nota: "MM" *refers to the cables length in meters*

Wire Terminal Code

X2 Connector ended for STO Feedback

BR8901-R

Cap X5 ended for EtherCat
 Cap for X2 not ended

BR8902-R
 BR8900-R

() under development*

Model/Code	CC201xxxxx	CC202xxxxx
Mechanical dimensions	50 mm/1.97 inches	150 mm/5.9 inches
Type	L50	L150
Electrical line power supply	3-phase, from 200 to 528 V AC, 50/60 Hz	
Auxiliary busbar power supply	24 V DC +/- 10% (supplied externally)	
Arms rated current	54	128
Arms peak current	130	256
Protection	NTC and bi-metallic thermal protection to 85°C Detection of loss during input phase Detection of insufficient input voltage or overvoltage	
Communication	CANopen for sharing data with the drives	
Cooling	Incorporated ventilation	
Weight (kg)	5.1	13.5
Connector code	BC0004R	BC0006R

The power supply model code is shown on two plates: One located on the front above the protector for the module's terminal block and the other on the right-hand side of each axis module.

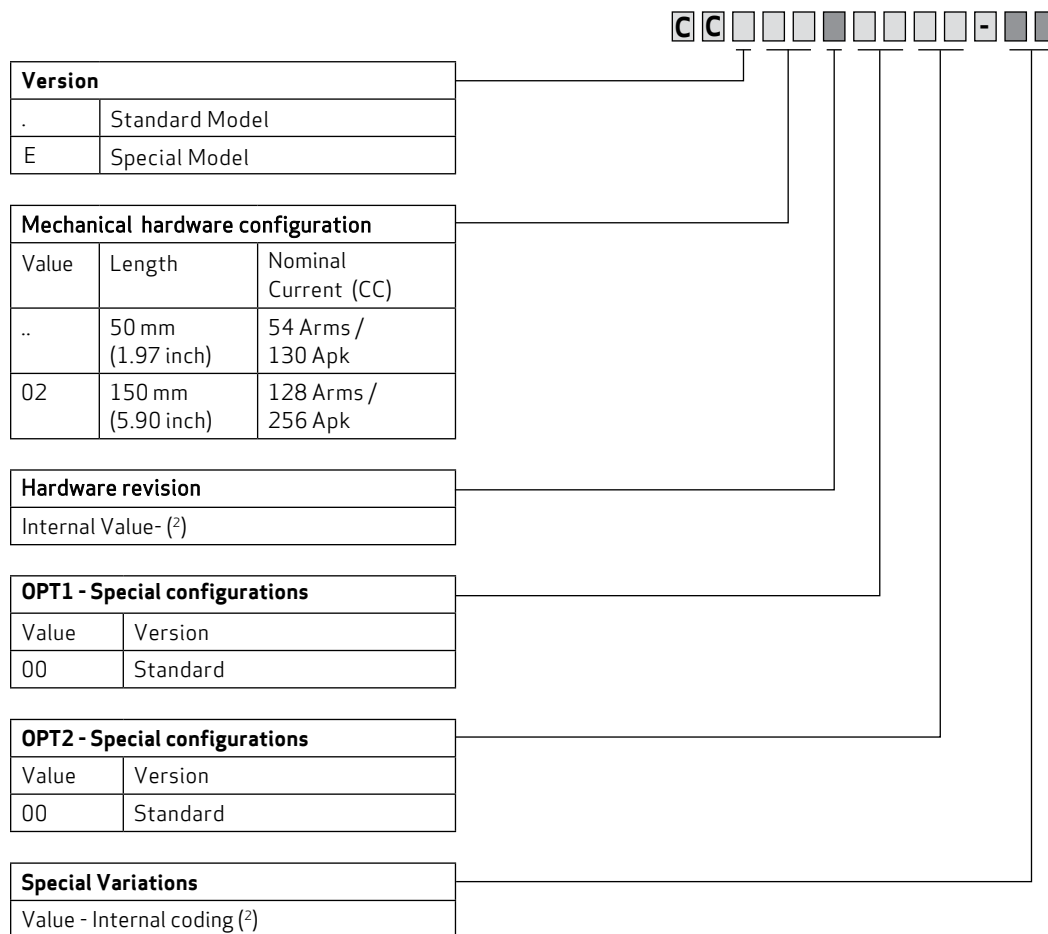
To request any kind of information about a specific power supply, the details on the side plate identifying each individual power supply must be communicated to Moog-Casella.

Nota: a 32Arms power supply module is under development



Fig 2.2 Example of power supply side plate (A) and front plate (B)

2.1.4. Power supply coding



⁽²⁾ Values assigned by Moog

Fig 2.3 The first two characters are "CC" and refer to the family (DM2020)

Example: The code CC201A0000 identifies the standard 54 A standard power supply in the production version, with no special variant.

2.1.5. DR2020 standard axis modules

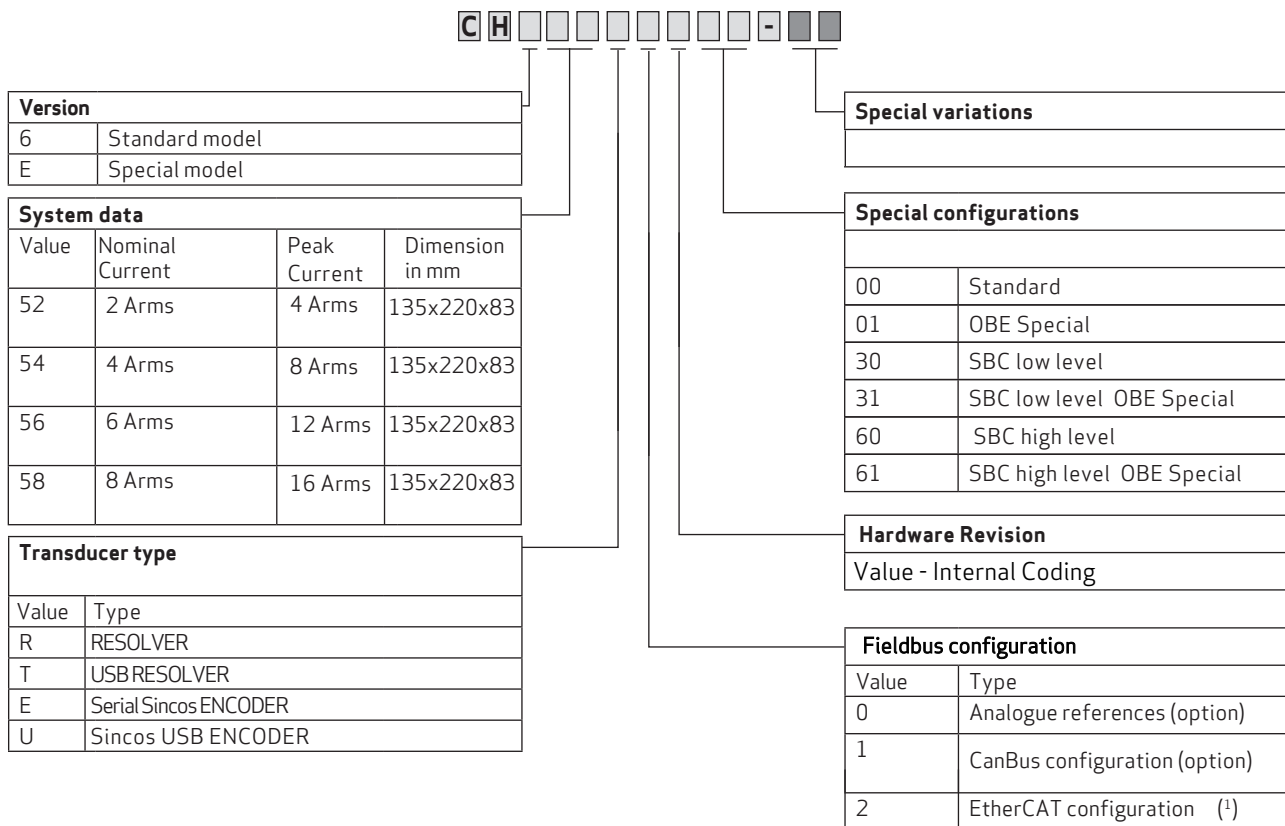
Model/Code	CH6 52 X X X XX XX	CH6 54 X X X XX XX	CH6 56 X X X XX XX	CH6 58 X X X XX XX
Mechanical dimensions	135 L * 83 P * 222 H mm (H = 270 mm with connectors)			
Configuration	Single			
Type	L1	L2	L3	L4
Module current @ 8 kHz	2	4	4	8
Arms rated current	2	4	6	8-
Arms peak current	4	8	12	16
Cooling	Natural	Dissipation on the plate		
Weight	4.4	4.4	4.4	4.4
Connector code	See p. 8			

The module code is shown on the plate near the Fieldbus connectors.

To request any kind of information about a specific module, the details on the side plate identifying each individual module must be communicated to Moog-Casella.



Fig 2.4 Example of a DR2020 axis module plate



Note: Serial interface for drive setup is under development.

⁽¹⁾ Standard Version

⁽²⁾ Values assigned by Moog

2.1.7. Models and coding capacitor modules (ABC Auxiliary Bus Capacitor module)

Model	Code	Capacity (μF)	Dimension
DM2020 ABC5	CC55000	5400	50 mm (1.97 in)
DM2020 ABC4	CC55012	4500	
DM2020 ABC3	CC55013	3600	
DM2020 ABC2	CC55014	2700	
DM2020 ABC1	CC55015	1800	

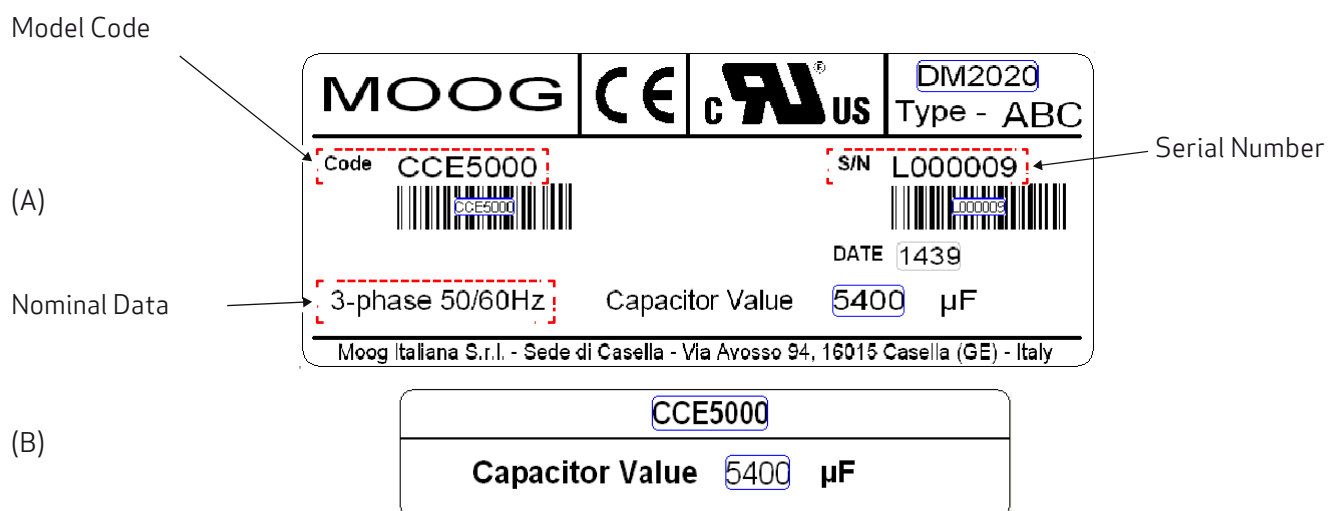


Fig 2.5 Example of capacitor module side plate (A) and front plate (B))

The capacitive module can be placed alongside the power supply and the DR2020 in order to recover kinetic energy in the braking phases; in this way, in the presence of repeated cycles of acceleration and load braking, it is avoided to dissipate energy on the braking resistor.

2.2 Components characteristics and details

2.2.1. Power supply unit electrical data

The main function of the power supply module is to directly convert (without a transformer) mains voltage to direct voltage, which powers the various modules that operate the servo-system motors via busbars.

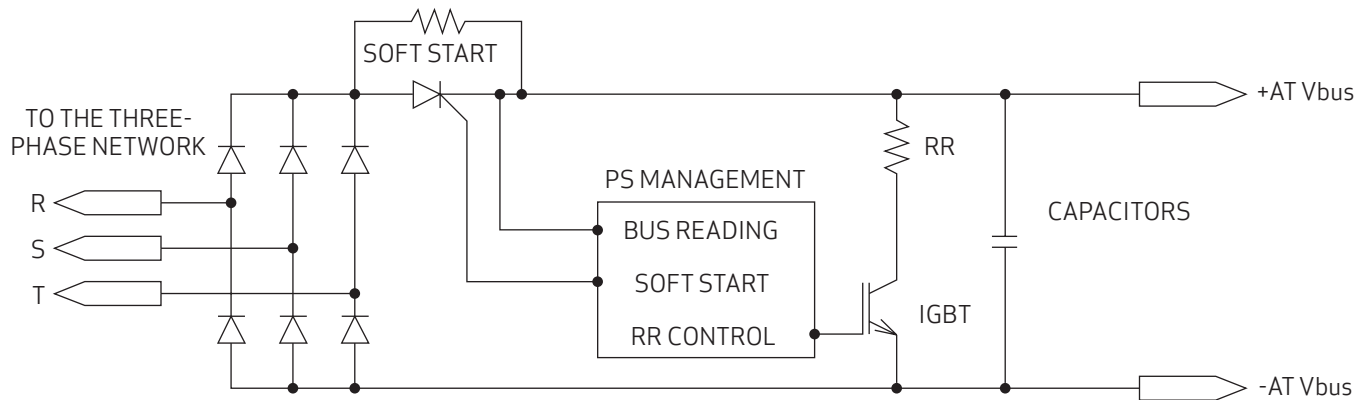


Fig 2.6 Power supply block diagram (power components)

Model	Type L50 (M)	Type L150 (L)
ELECTRICAL DATA		
Mains voltage	Three-phase from 200 to 528 V AC 50/60 Hz	
Auxiliary voltage	24 V DC +/-10%, 1 A (supplied externally)	
Rated output current, DC BUS side	54 A	128 Arms
Peak output current, DC BUS side	130 A	256 Arms
DC-link voltage (Vout)	From 282 to 744 V DC	-
Protection	NTC and bi-metallic thermal protection on heat sink to 85°C Identification of absense of input phase Identification of insufficient voltage (undervoltage) or excessive voltage (overvoltage)	
Communication	CANopen for sharing data with the drives	
Cooling	Incorporated ventilation	
MECHANICAL DATA		
Weight	5.1 kg	13.5 kg
Height	455 mm (17.91 inches)	455 mm (17.91 inches)
Width	50 mm/1.97 inches	150 mm/5.91 inches
Depth	249 mm (9.80 inches)	249 mm (9.80 inches)

Tab 2.4 Power supply characteristics

FUNCTIONS
Soft-start circuit
Braking circuit
BUS cc voltage monitoring
Mains voltage presence and value monitoring
Power supply internal temperature monitoring

2.2.2. Power supply unit mechanical data

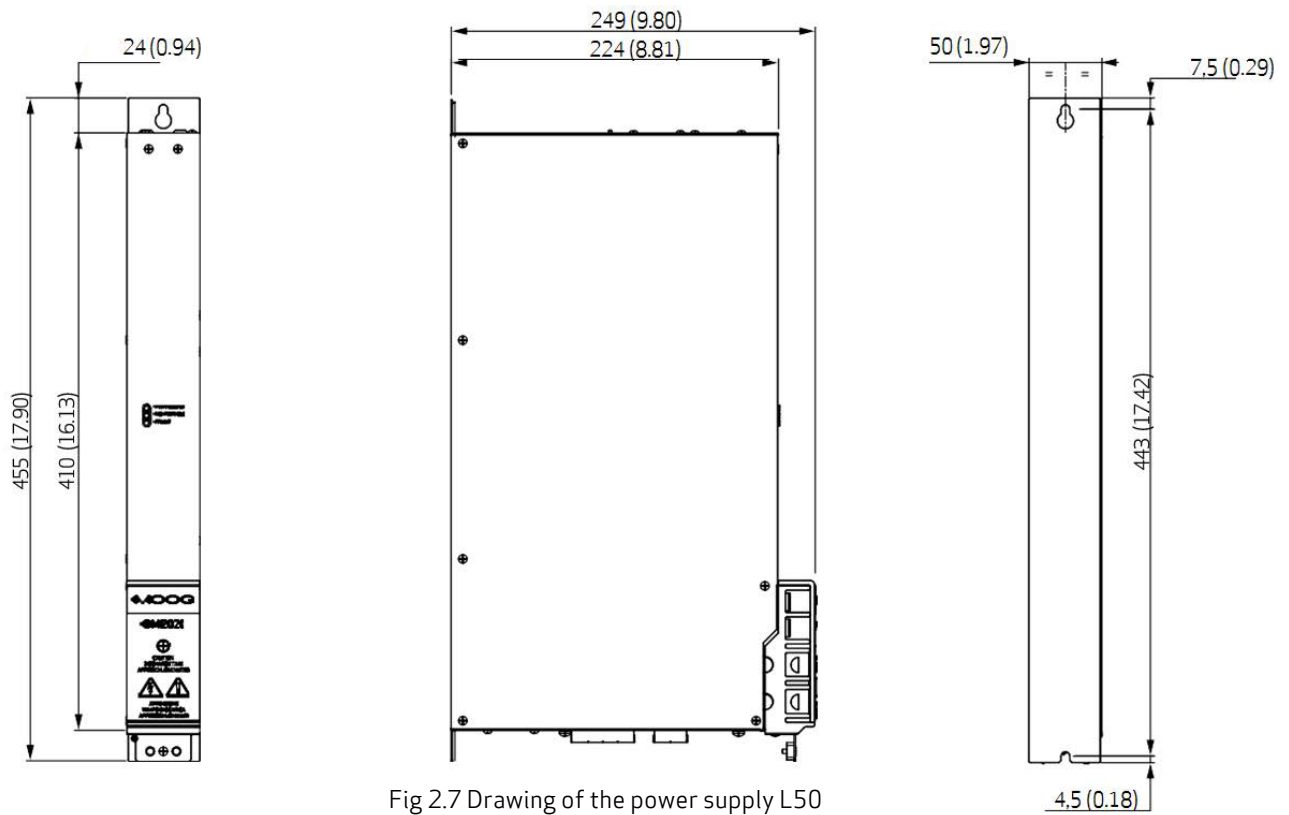


Fig 2.7 Drawing of the power supply L50

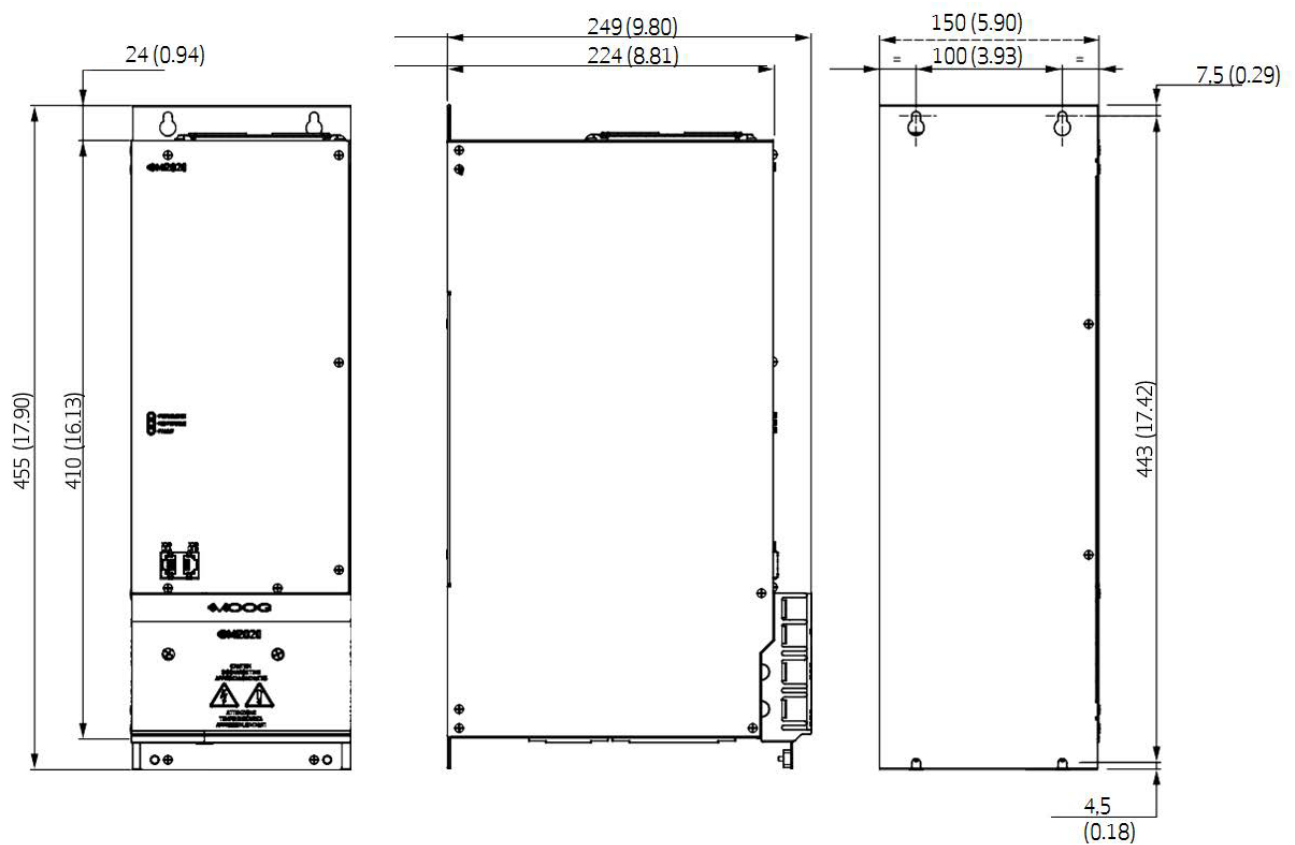


Fig 2.8 Drawing of the power supply L150

2.2.3. Power supply connectors

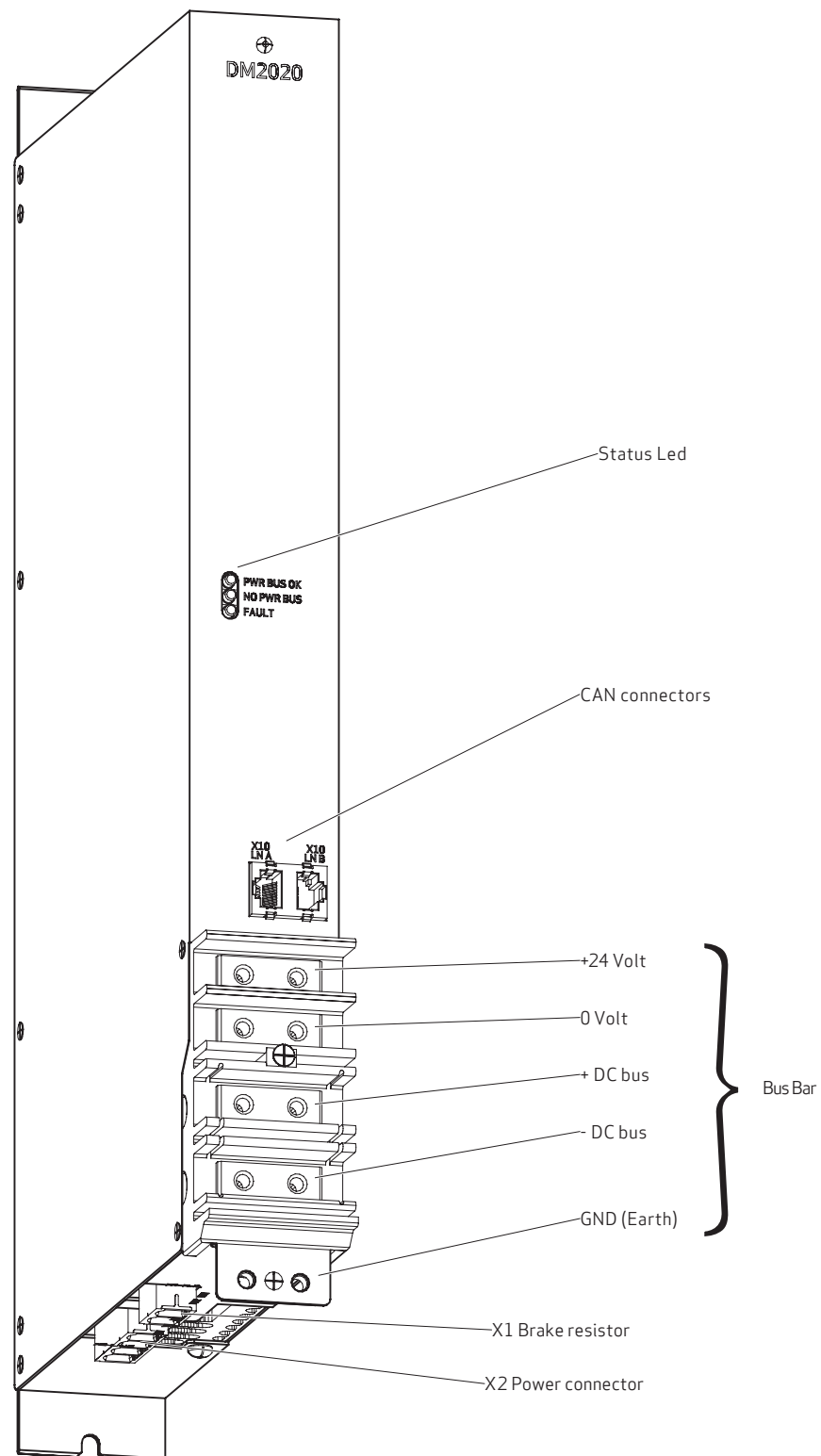
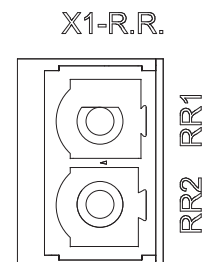


Fig 2.9 Connection layout

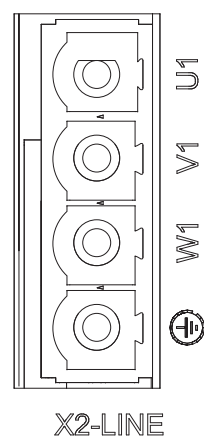
2.2.3.1. Connectors layout

The tables below give details of connectors

X1: brake resistor	
1	+RR1
2	-RR2



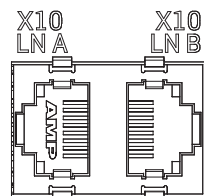
X2: mains	
1	U1
2	V1
3	W1
4	Earth



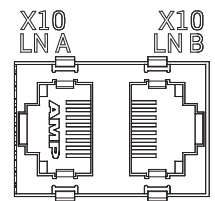
The tables below give details of connectors and the meaning of signalling LEDs

YELLOW LED	GREEN LED	RED LED	Status
Off	Off	Off	Power supply off or failed
Off	On, fixed light	Off	24 Volt applied
Flashing	Flashing	Off	Three-phase power supply present, BUS charging
On, fixed light	Flashing	Off	BUS stable, axes ready to be enabled
Off	Off	On, fixed light	Power supply fault

X10 LN A CAN connector (according to CIA 402 CAN on RJ45 connector)		
Pin	Designation	Function
1	Can_H	CAN line positive terminal
2	Can L	CAN line negative terminal
3	0V_Can	CAN line 0 logic
4	Aux_Ps_Fault_neg	Signal (denied) of power supply status
5	Addr_sx_dx	Address for internal communications
6	Ps_out	Power supply command output
7	nc	
8	+5V_Can	CAN line power supply (supplied by power supply)



X10 LNB CAN connector (according to CIA 402 CAN on RJ45 connector)		
Pin	Designation	Function
1	Can_H	CAN line positive terminal
2	Can L	CAN line negative terminal
3	0V_Can	CAN line 0 logic
4	Aux_Ps_Fault_neg	Signal (denied) of power supply status
5	Addr_sx_dx	Address for internal communications
6	Ps_out	Power supply command output
7	nc	
8	+5V_Can	CAN line power supply (supplied by power supply)



2.2.4 Filters

If the motor power cables are shorter than 50 m, an EMC filter (code AT6013/AT6014 or equivalent) can be positioned between the network and the drive.

If cables are no longer than 50 m, we recommend contacting Moog-Casella's Application Dept.

Filter code	AT6013 (power supply M) / AT6014 (power supply L)
Rated voltage	3 x (400/480 V), 50/60 Hz, at 50 °C
Overload	1.5x per 60 s, repeatable every 60 min.
Ambient temperature	From -25 °C to +100 °C, with current reduction starting from 60 °C (1.3%/°C)
Assembly height	1000 m, with current reduction of up to 4000 m (6%/1000 m)
Relative air humidity	15 - 85% (condensate not permitted)
Storage temperature	From -25 °C to +70 °C
IP protection rating	IP20
Acceptance test	Complies with EC
Non-industrial environment - EN61800-3 complies with radio shielding	Cable length permitted between the drive and motor up to 50 m
Industrial environment - EN61800-3 complies with radio shielding	Cable length permitted between the drive and motor up to 100 m

Code	Suitable for power supply	Type	Rated current [A]	Total current loss [W]	Current on contact [mA]	Weight [kg]	Connection [mm²]
AT6013	L50	A 1	55	26	33.4	1.8	13 mm² ex. PE M6 bolt
AT6014	L150	B 1	130	50	39	2.6	Up to 50 mm² PE M10 bolt

If the application requires a direct current less than the maximum that can be managed by the power supply, filters with lower rated current values may be used.

Contact the Application Service for ratings and a selection of alternative models to those described above.

2.2.5 Brake resistor


When the motor decelerates, braking resistance converts energy into heat.

There are two different brake resistors for the L50 power supply:

Code	Power (W)	Ohm	Notes
Standard	370	15	Supplied
AR5974	500	16	Available as an option to be ordered separately

The braking resistor is not provided for the L150 power supply. The recommended resistor is 4.7 ohms/1000 watts (to be ordered separately using code AR5988).

 **INFORMATION**
If the dissipated power exceeds 1000 W, contact the Applications Service at Moog-Casella for component sizing

 **CAUTION**
For the L50 model, the braking resistor must always be connected as it also features a soft-start function. In the absence of this, the system will not start up; moreover, it will not be possible to stop the rotating motors in a controlled manner.

ATTENTION
Pour le modèle L50, la résistance de freinage doit toujours être raccordée car il dispose également d'une fonction de démarrage progressif. A défaut de cela, le système ne démarrera pas; en outre, il ne sera pas possible d'arrêter les moteurs rotatifs d'une manière contrôlée.

2.2.6. Line inductors

For normal operation, inductors do not have to be used at the power supply input.

However, if using a low-inductance network (below 100 μ H, it is advisable to fit a line inductor to the network in order to protect the power supply.

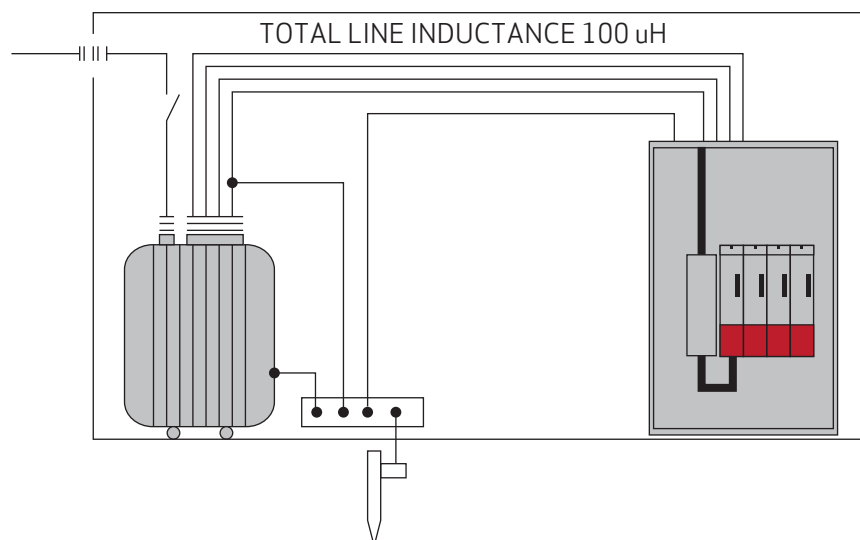
Systems with a very low line inductance produce dV/dt values above 1000 V/ μ S of the three-phase input voltage applied to the drive. This is a limit value for thyristors, which IN THESE PARTICULAR CONDITIONS may become conductive, even without controlled triggering by the internal circuit.

Specifically, if switched on early, they may cause the fuses in the soft-start circuit to break (the soft-start circuit is designed to limit starting current caused by the DC BUS capacitors preventing uncontrolled currents).

To define an approximate value for line inductance, the cable length between the three-phase input of the drive and MV/LV transformer cabin must be considered, using 0.6 μ H/m as a typical inductance value per metre of wiring, and summing the inductance of the transformer cabin.

To limit possible dV/dt , the effect of limiting the value induced by the input EMC filter should also be considered, checking the filter inductance value.

 **INFORMATION**
The inductor must be fitted between the transformer of the cab and the drive



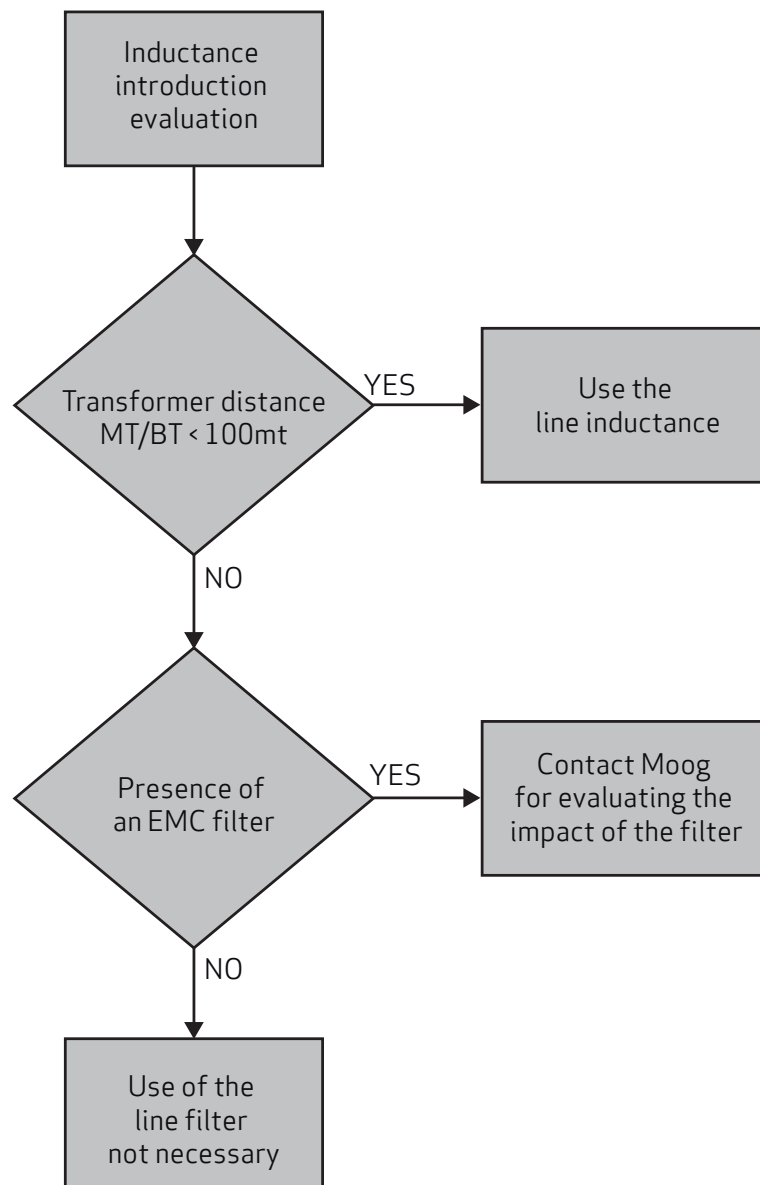
DM2020_D_005

Fig 2.10 Diagram of a three-phase input inductor connection

Power supply size	Inductance value	Current	Frequency
Type L50	0.1 mH	Inom. 60 A	50/60 Hz
Type L150	0.1 mH	Inom. 130 A	50/60 Hz

Tab 2.6 Example of external three-phase inductor dimensioning

How to assess whether an inductor is needed:



Contact the Applications Service at Moog-Casella for more information.

2.2.7. Cables



INFORMATION

The power and control cables (apart from the cables which run from the network to the filter) must be shielded and kept separate from each other if possible, at a distance of more than 200 mm



INFORMATION

The shielded power cables may be interrupted and connected to earth by a copper bar using a terminal with a cross-section that ensures an effective electrical contact with a greater cross-section than the earthing cable

Power supply cable cross-section

Power supply model	Type L50 (54 A)	Type L150 (128 A)
Network	13 mm ² (AWG6)	33 mm ² (AWG2)
Brake resistor	13 mm ² (AWG6)	33 mm ² (AWG2)
24 V DC	0.8 mm ² AWG 18	
Earth	13 mm ² (AWG6)	33 mm ² (AWG2)

For the overall + 24Vdc power supply, generally consider adding 0.5 mm² for each DM2020 module up to the power supply module and then at least 2.5 mm² for the DR2020 series as a general rule, check whether to increase the section according to the layout of the installation.

The maximum section accepted by the DR2020 power terminals is 4 mm²

Information for PS L50 = 54arms

To supply all the rated current of the power supply, the DC BUS → DR2020 terminal block connection cable must have the following characteristics up to the possible junction box:

We suggest an AWG 6 copper cable, shielded or at least twisted, having a minimum temperature classification of the conductor of 90 ° C.

To terminate the cable it is possible to use NON-INSULATED 16mmq TERMINALS for M6 model BM 01531 screw (alternatively CEMBRE A3-M6) or equivalent.

They must be protected in case of accidental contact (insulating or heat-shrinking tube), with INSULATING CAP FOR NON-ISOLATED TERMINALS Model BM 81016, or alternatively with VW-1 UL-DIA.9,5 THERMOR-EXTRACTION TUBE Model PANDUIT HSTTV38 or equivalent.

Information for the PS L150 = 128arms

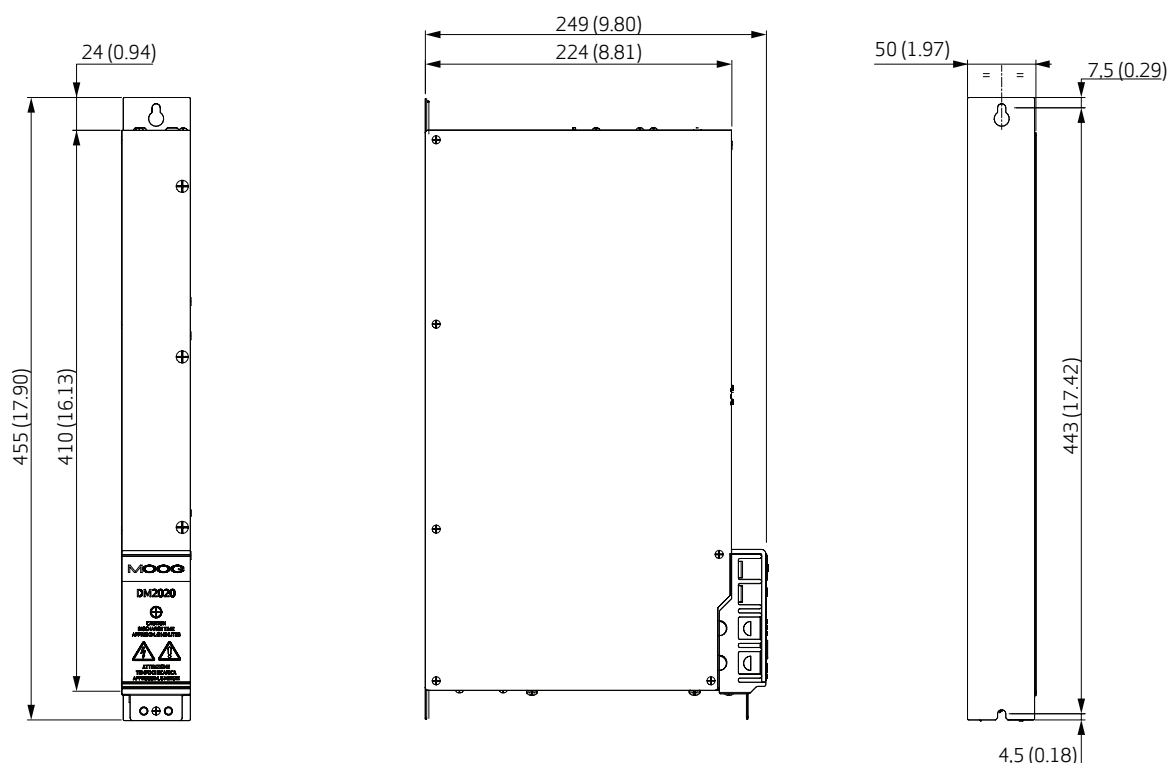
To supply all the rated current of the power supply, the DC BUS → DR2020 connection cable must have the following characteristics up to the possible junction box:

We suggest an AWG 6 copper cable, shielded or at least twisted, with a minimum temperature classification of the conductor of 90 ° C.

The maximum external encumbrance value of the cable lug cannot exceed 15mm and to terminate the cables use the 35mmq NON-INSULATED TERMINAL for M6 screw Model BM 017313 (alternatively CEMBRE A9-M6 / 15 or A7 B-M6 / 11.5) or equivalent. They must be protected against accidental contact with a specific protection (insulating or heat-shrinking tube), with INSULATING CAP FOR NON-ISOLATED TERMINALS Model BM 81035 or alternatively with VW-1 UL-DIA.12-THERMO-THERMO-PIPE Model PANDUIT HSTTV50 or equivalent.

2.2.8 Capacitor module (ABC)

A capacitor module is available to increase the energy stored in the braking phase:



Model/Code	ABC5/CCE5000	ABC4/CCE5012	ABC3/CCE5013	ABC2/CCE5014	ABC1/CCE5015
Capacity (μF)	5400	4500	3600	2700	1800
Width (mm)	50				
Depth (mm)	249				
Height (mm)	455				

The following table summarises the total capacity of the other modules:

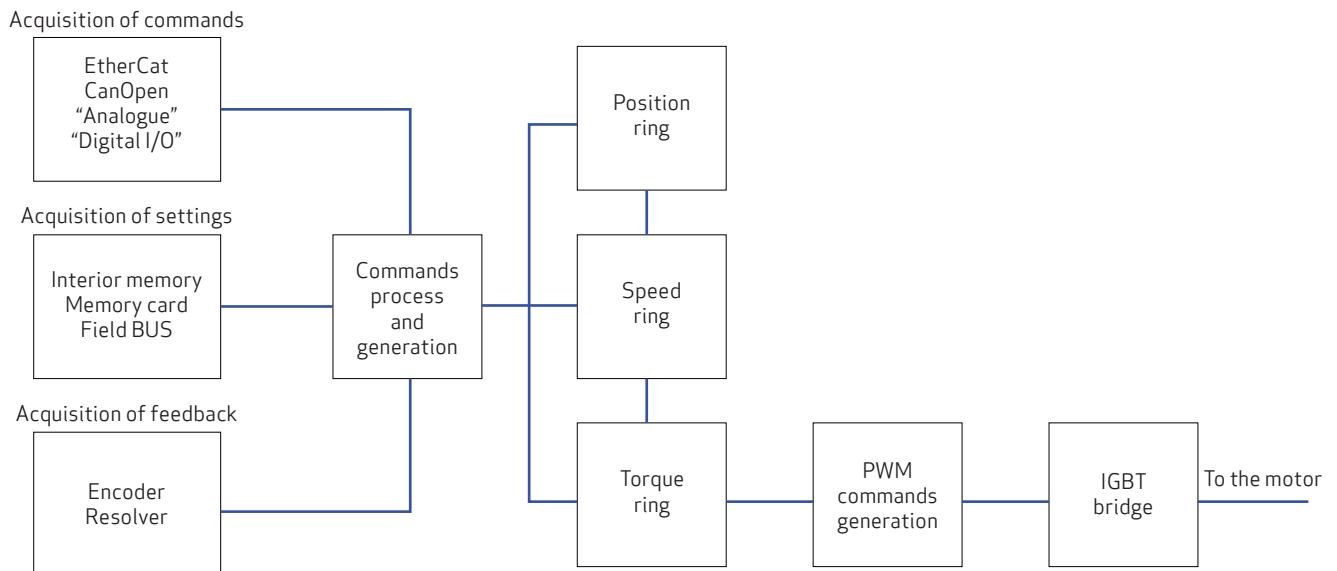
Module ID	Total cap. uF
L50 power supply	1800
L150 power supply	4500
DR2020	120

For machines with a fast cycle and movement, the amount of energy dispersed by the brake resistor can be reduced.

At 200 cycles/min, the addition of an ABC module can save up to 3 kW in braking energy; an explanatory note will help the machine designer to decide whether to add ABCs in the DM2020 configuration (and if so, how many).

2.3. Axis module

2.3.1. General description of functions



FUNCTIONS
Position controller
Velocity controller
Torque controller
RS232 serial interface
EtherCAT interface
CANOpen interface
Analogue reference
Simulated encoder generation
Analogue I/O management
Digital I/O management
Sensorless mode
Data recording

Model	DR2020
ELECTRICAL DATA	
Auxiliary voltage	24 Vdc +/- 10 %
DC-link voltage	from 282 to 744 Vcc
Arms rated current	from 2 to 8 Arms
Arms peak current	from 4 to 16 Arms
Protection	NTC and bi-metallic thermal protection on heat sink to 85 °C Identification of insufficient voltage (undervoltage) or excessive voltage
Cooling	Natural or with dissipation plate
MECHANICAL DATA	
Weight	4.1 Kg

2.3.2. Mechanical Dimensions

The dimensions of the DR2020 are the same for all sizes. See mechanical data on page 8.

2.3.3. Position Transducers

The DR2020 can be equipped with the following position transducers mounted on the motor :

- Serial RESOLVER
- USB RESOLVER
- Serial Sincos ENCODER
- Sincos USB ENCODER

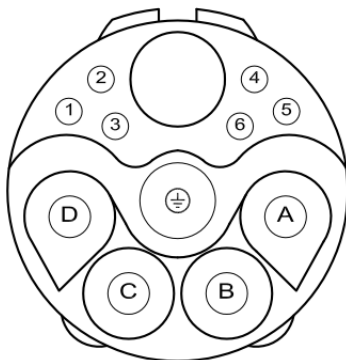
Note: the selection of the transducer involves the assembly of the DR2020 with different hardware. As a result, it is not possible to replace a motor with a different transducer outside our factory.

2.3.4. Interfaces to the power supply, the other DR2020 modules and the fieldbus

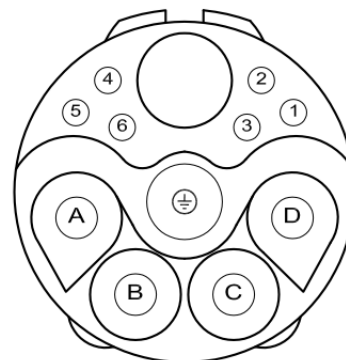
The figure shows all the connectors of the axis module:

Power connector, X1 input and X2 output.

X1 (male)



X2 (female)



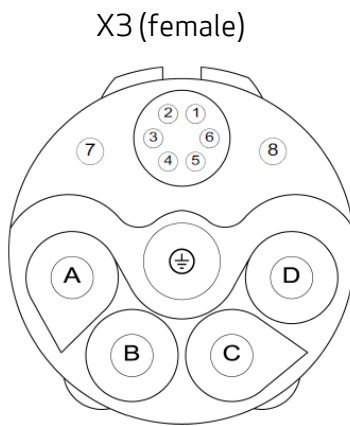
The pinouts of the two mirror-like connectors are shown in the following table.

Reference	Description	Minimum recommended section
1	24 V S1 STO	0.35 mm ²
2	24 V S2 STO	0.35 mm ²
3	FB BK STO	0.35 mm ²
4	Spare	
5	Spare	
6	Spare	
A	0 VDC	2.5 mm ²
B	+24 VDC	2.5 mm ²
C	+AT	2.5 mm ²
D	-AT	2.5 mm ²
GND	EARTH	2.5 mm ²

Note:

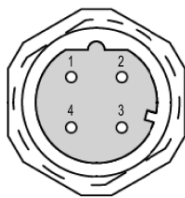
this connector is replicated between the X1 (IN) and X2 (OUT) connectors. Attention: the two connectors are specular to each other and are "pass-through" connectors for the connection of several DR2020 modules.

Motor Connector X3



Reference	Description	Minimum recommended section
1	Up Power Supply	0.20 mm ²
2	OV Power Supply	0.20 mm ²
3	Data	0.20 mm ²
4	Data NEG	0.20 mm ²
5	Clock	0.20 mm ²
6	Clock NEG	0.20 mm ²
7	OV BRAKE	0.35 mm ²
8	BRAKE	0.35 mm ²
A	PHASE U	1.50 mm ²
B	PHASE V	1.50 mm ²
C	PHASE W	1.50 mm ²
GND	EARTH	1.50 mm ²

EtherCat Connector (X4 input, X5 output)



Connector Pin-out

N° pin	Description
1	Tx +
2	Tx -
3	Rx +
4	Rx -

The input and output EtherCat connectors have the same Pin-out.

2.4. Safety and instructions

2.4.1. General safety description

Only qualified personnel may operate when the equipment is working.

The power supply from the drive to the motor can be turned off “safely”. In this way, the motor can no longer generate torque when the safe power stage is disabled.

The drives may have uncovered live parts during operation, depending on the level of mechanical protection offered by the installation in the distribution board. During normal operation, equipment must not be accessible, and all covers and hatches of the distribution board must be kept closed.

Control and power connections may be live, even though the motor is not rotating.

During operation, the drives may reach temperatures as high as 80 °C.

Voltage arcs may occur and cause damage to people and contacts; this means that electrical connections must not be loosened or disconnected when the drives are live, and that operators must wait at least six minutes after the power has been turned off before touching live components or loosening connections.

Capacitors may still have dangerous voltages up to six minutes after switching off the mains voltage. To be sure that conditions are safe, measure the voltage on the direct-current (BUS) circuit and wait until it has dropped below 40 V.

2.4.2. STO safety function

2.4.2.1. Description

DR2020 drives are equipped with the STO (Safety Torque Off) function as standard, which protects (personnel) against the drive stalling up unintentionally.

The standard version of the DR2020 has the STO function to use as an interlock against accidental motor restarts. The STO function may be used to turn off the power supply, to prevent accidental start-up.

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

By using this function, short-term operations and/or maintenance can be carried out on non-electrical parts of equipment without turning off the power supply.

This function must be enabled by a safe external control (mechanical or semiconductor) or by a dedicated external safety board. See section “7.3. Safe Torque Off function” for more information.



WARNING

Suspended loads must always be mechanically secured in a safe way. If enabled, the STO function does not guarantee that suspended loads will be held



WARNING

Turning off the 24 V DC from the two STO connector inputs means that the motor is not controlled



WARNING

The STO function is not electrically independent of the power output. If you need to work on the motor cable, turn off the power supply to the drive and wait for the intermediate circuit discharge time to finish



CAUTION

When using the STO function, observe the following operating sequence

ATTENTION

Lorsque vous utilisez la fonction STO, observez la séquence d'exploitation suivante

1. Stop movement in a regulated manner, setting the nominal velocity value to zero/
Arrêter le mouvement de manière régulée, définissant la valeur de vitesse nominale à zéro
2. Once zero speed has been reached, and in the case of suspended loads, mechanically secure the load/
Une fois la vitesse zéro a été atteinte, et dans le cas de charges suspendues, fixer mécaniquement la charge
3. Disable the drive and, at this point, activate the STO function/
Désactiver l'unité et, à ce point, activer la fonction STO

Input voltage	24 V DC +/- 10 %
Maximum input current	50 mA

Tab. 2.7 Electrical specifications - STO functions

2.4.3. Directives on the use of the drives

It is extremely important that the module's technical data and information about connections (plate and documentation) are always available and complied with.

Only qualified technical personnel familiar with transport, installation, assembly and commissioning may carry out these activities.

Qualified personnel shall be familiar with and observe the following standards:

- IEC 60364 and IEC 60664
- National accident prevention regulations

The drives contain electro-statically sensitive components, which may be damaged by handling if touching a conductive object that is earthed.

Electrostatic charge should be discharged before handling the drive and positioning it on a conductive surface.

2.4.3.1. Use as directed

Drives are safety devices that are built into electrical plants or machines, and can only be operated as integral components of such plants or machines.

The manufacturer must produce a risk analysis for the machine, and take appropriate measures to prevent unforeseen movements that can cause injury or damage to persons or property.

If the drives are used in residential areas, in business areas, or in small industrial operations, then additional filters must be implemented by the user after full system measures.

2.4.3.2. Distribution board and connections

The drives must only operate in distribution boards or closed control cabinets. Ventilation or cooling may be required depending on the external environmental conditions.

Use only copper conductors for wiring.

Conductor cross-sections must conform to the IEC 60204 standard.

2.4.3.3. Power supply

The DM2020 series drives (overvoltage category III according to EN 61800-5-1) may be powered by three-phase earthed industrial electric networks (TN system, TT system with earthed neutral point, no more than 10 KA symmetrical rated current at 208 V -10%, 230 V, 240 V, 400 V or 480 V +10%).

Overvoltages between phases and the drive housing must not be higher than the peak of 1000 V.

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

Voltage transient peaks (< 50 μ s) between a phase and housing must not exceed 2000 V.

2.4.3.4. Motors

The DM2020 drives have been designed for operating brushless synchronous motors and asynchronous motors with torque, velocity and/or position control. The rated voltage of the motors must be at least as high as the DC-link voltage divided by two produced by the drive.

2.4.3.5. Prohibited use

Usage which differs from that described in section "2.4.3.1. Use as directed" are not recommended, and could cause damage to persons, equipment or other items.

Use of the drive is normally prohibited in the following environments:

- potentially explosive areas
- areas with corrosive and/or electrically conductive acids, alkaline solutions, oils, vapours,
- directly on unearthed electrical networks or on asymmetrically earthed power supplies with a voltage above 240 V
- on ships or offshore installations

Installing and starting up the drive is prohibited if the machine in which it is to be installed:

- does not conform to the requirements of the EC Machinery Directive
- does not conform to the EMC Directive or Low Voltage Directives
- does not conform to national regulations

The control of brake holding by the DM2020 drive alone may not be used in applications where personnel security is to be ensured with the motor brake.

2.4.3.6 In house storage duration

Storing DM2020 drives under prescribed conditions and for a consecutive period of up to one year does not require specific limitations and requirements; in the case where the storage period is longer than 1 year prior to proceeding to the phases of installation and commissioning of the module perform the following steps:

- Apply gradually a voltage of 300VDCp limited current connecting the positive pole to the connector "X11-RRext" and the negative pole to the connector "X11-V1"
- Keep the voltage value for about 20 minutes
- Disconnect the power source and wait for the discharge time before handling the module

2.4.3.7 Maintenance / cleaning

The DM2020 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 grille: clean with a dry brush

2.4.3.8 Decommissioning

To remove and put out of order a servo drive DM2020 (replacement, dismantling) follow the procedure below:

- Disconnect the supply voltage of the electrical panel and wait
- Check that the heat sink and the mechanical parts temperatures aren't still too high
- Loosen all connections and disconnect them
- Remove the module from the electrical panel

2.4.3.9 Repairs

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

Perform decommissioning procedure and send it back to the address of the manufacturer indicated on the product nameplate; if available use the original packaging material.

2.4.3.10 Disposal

In accordance to the 2012/19 / EC Directive all electronic devices are "special waste" and should receive proper professional disposal treatment; after notification, the old modules and their accessories may be returned, at the sender's expense, to be treated and sent to the right disposal facility.

3. TYPE APPROVALS

3.1. EC

According to EU directives, drives shall conform to:

- the EMC Directive 2004/108/EC
- the Low Voltage Directive 2006/95/EC

The DM2020 has been tested in an authorised laboratory to check the parameters on the basis of which conformity to the above Directives is declared.

As regards electromagnetic compatibility, the DR2020 refers to C3 category industrial environments.



CAUTION

In a domestic environment, the DR2020 may emit radio frequency disturbance

ATTENTION

Dans un environnement domestique, le DR2020 peut émettre des perturbations des fréquences radio



INFORMATION

The manufacturer of the end machine or equipment **MUST NOT** use drives without documentation guaranteeing conformity to the requirements of the Machinery Directive 2006/42/EC

MOOG

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CENELEC

Memorandum N°3

DICHIARAZIONE CE DI CONFORMITA' / EU DECLARATION OF CONFORMITY

Il sottoscritto, rappresentante il seguente costruttore / The undersigned, representing the following manufacturer

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

dichiara qui di seguito che i prodotti / herewith declares that the products

Marchio / Brand : **MOOG**

Azionamenti Decentralizzati Serie / Decentralized Drives Series: **DR2020**

risultano in conformità' a quanto previsto dalle seguenti direttive comunitarie / are in conformity with the provisions of the following EC directives
(comprese tutte le modifiche applicabili / including all applicable amendments)

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 / and that the following harmonized standards, or parts thereof, have been applied

nr	issue	titolo / title
EN 61800-5-1	2009	Adjustable speed electrical power drive systems. Part 5-1 Safety requirements. Electrical thermal and energy
EN 61800-3: 2004 A1	2012	Adjustable speed electrical power drive systems. Part 3: EMC product standard including specific test methods Amendment 1

Altri riferimenti o informazioni richiesti dalle direttive comunitarie applicabili / Other references or information required by the applicable EC directives: La conformità dei prodotti è subordinata al rispetto delle procedure contenute nel "Manuale di installazione". L'utilizzatore ha la responsabilità primaria nel seguire le raccomandazioni del costruttore riguardo alle problematiche EMC. / 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.

Ultime due cifre dell'anno in cui e' stata affissa la marcatura CE / Last two digits of the year in which the CE marking was affixed: 16

Casella, 25 Novembre , 2016

Gianfranco Costa

OPERATION MANAGER

CENELEC

Memorandum N°3

Fig 3.1 EC declaration of conformity

3.2. Safety and Safe Torque Off (Blocking on restart)

The DR2020 includes the Safe Torque Off (STO) function, according to standards EN 61800-5-2; EN/ISO 13849-1:2006. (SILCL 3 PL “e” (as certified below). The function also corresponds to an uncontrolled stop, according to the 0 stop category of IEC/EN 60204-1.

Function validation is based on:

- a guarantee that a single failure does not result in loss of the safety function
- some, but not all, possible failures may be identified
- the sum of several unidentified failures may result in loss of the safety function

The residual risk if two failures occur concurrently in the same power section is that the motor rotates at an angle dependent on the number of polar pairs of the motor; for example, a 6-pole motor will generate a maximum rotation of 60°.



WARNING

The manufacturer of the end machine and/or equipment must carry out and provide results of a risk analysis of the machine according to ISO12100 and ISO14121 and take all measures necessary to prevent unforeseen movements that may harm persons or damage property. In particular the manufacturer of the end machine and/or equipment must ensure conformity to relative product standards.

AVERTISSEMENT

Le fabricant de la machine et / ou de l'équipement final doit exécuter et fournir les résultats d'une analyse de risque de la machine selon ISO12100 et ISO14121 et prendre toutes les mesures nécessaires pour empêcher des mouvements imprévus qui peuvent nuire aux personnes ou endommager des biens. En particulier, le fabricant de la machine et / ou de l'équipement final doit assurer la conformité à toute norme spécifiques relatives aux produits mêmes.

Where safety functions are based on electrical/electronic devices (SCRF), the safety integrity levels (SIL) and functional requisites must be indicated for these functions.

Based on CEI EN 62061, this specification must include all data that may affect design of the electrical/electronic device, including, where applicable:

- Operating conditions of the machine
- The priority of functions that may be enabled concurrently and cause conflictual actions
- The operating frequency of each SCRF
- The required response time of each SCRF
- A description of each SCRF
- The interface of each SCRF with other machine functions
- A description of the reactions to failure and constraints relative to machine restart, when the reaction to failure causes the machine to stop
- A description of the operating environment
- Tests and associated equipment (e.g. access hatches)
- The frequency of operating cycles and factor of use in operating cycles

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MOOG

EC DECLARATION OF CONFORMITY
(TRANSLATION OF THE ORIGINAL DECLARATION)
 according to Annex II A of Directive 2006/42/EC

We,

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

herewith declare that the logic unit to ensure the safety function “**Safe Torque Off**” integrated in the drives series **DR2020**

is in conformity with the provisions of the Machinery Directive 2006/42/EC

and is in conformity with the model submitted to EC type-examination, which achieved the EC certificate n. n. 14CMAC0030 dated 13/Nov/2014 issued by the following notified body:

I.C.E.P.I. S.p.A. (Istituto Certificazione Europea Prodotti Industriali)
 Via Paolo Belizzi, 29/31/33 - 29122 Piacenza - Italy
 Identification number: 0066

and that the Technical File has been compiled by:

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

and that the following standards have been applied:

harmonized standards

EN 61800-5-2:2007, EN ISO 13849-1:2008

Casella, November 25th, 2016

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 Malnate (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.

Fig 3.2 EC declaration of conformity (original)

4. MECHANICAL AND ELECTRICAL INSTALLATION

4.1. Tools and instruments

Tools:

Keep the following tools available to install the modules:

- Tork T25 screwdriver (fixing connecting BUS BAR of the power supply)
- M4 crosshead screwdriver (for fixing DM2020 power supplies to the wall)
- M3 crosshead screwdriver (BUSBAR protection of the power supply)
- Tool for M4 screws (fixing the DR2020 to the machine)

Instruments:

No specific instruments are necessary. However a digital multimeter is advisable, to check voltage, continuity, make comparisons and take readings.

4.2. Mechanical installation

4.2.1. Assembly of components



INFORMATION

DR2020 modules have been designed and manufactured for vertical assembly, with a clearance of at least 100 mm above and below, to ensure sufficient air circulation

4.2.1.1. Assembling the power supply

Standard vertical assembly.

Assembly material: 2 M6 cheese-headed screws.

In the case of horizontal assembly, please contact the Applications Department to verify the application.

4.2.1.2. Assembling the DR2020 axes

Standard vertical assembly.

Assembly material: 2 M6 cheese-headed screws.

In the case of horizontal assembly, please contact the Applications Department to verify the application.

4.2.1.3. EMC Filter installation

To install filters, follow the instructions for installing the drives.

4.2.1.4. Inductor installation



INFORMATION

When these are to be used, given their considerable weight, install the inductors at the bottom of the cabinet, if possible near the EMC filter, to reduce emissions in the distribution board

4.2.1.5. Positioning of brake resistors

Position at the top of the distribution board to facilitate the loss of heat produced.

Installation with brackets supplied for a standard resistor.

Installation on the heat sink (not supplied) for the optional resistor (armoured).

4.3. Electrical installation and thermal sizing

4.3.1. Safety and general instructions for the board



WARNING

When the drive is operating, there is a risk of death, serious injury or serious material damage

AVERTISSEMENT

Lorsque l'entraînement est en marche, il existe un risque de mort, blessures graves ou dommages matériels importants.

TO THE THREE-PHASE NETWORK

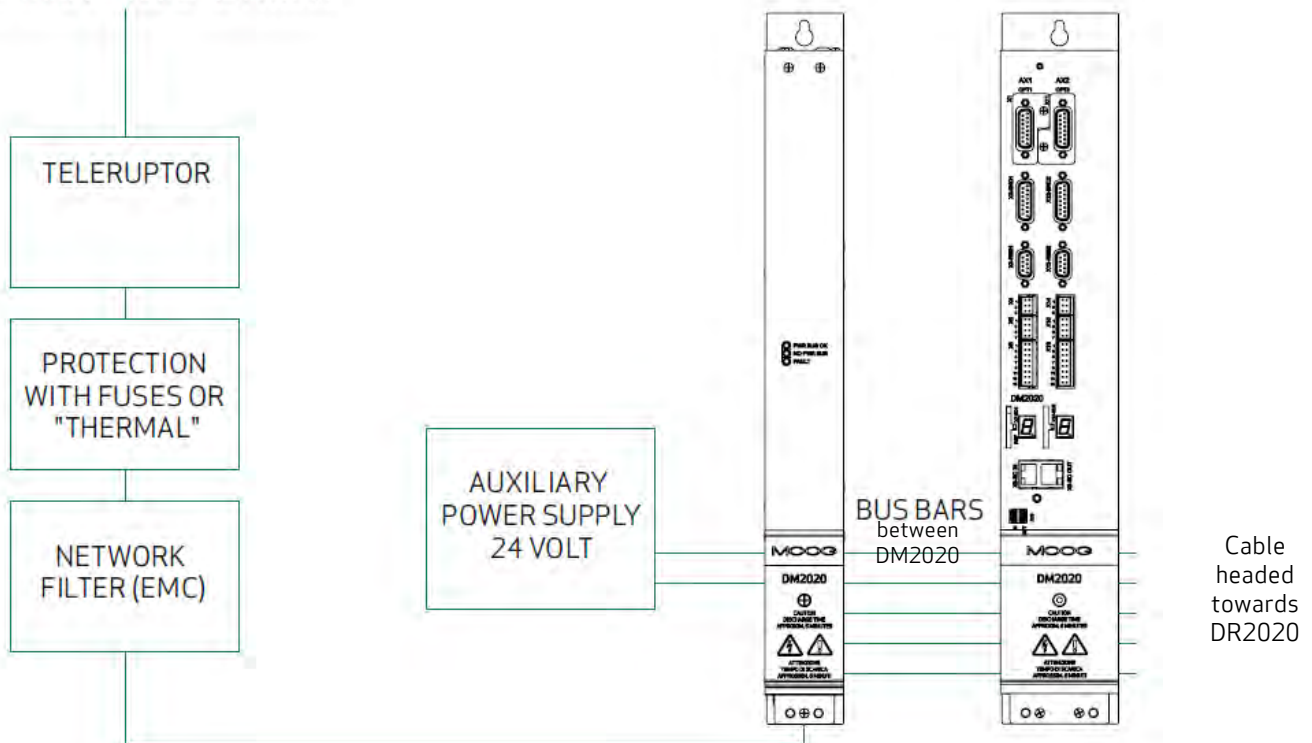


Fig 4.1 Diagram of the distribution board with components for a servo system

Special attention must be paid to the earthing, shielding, use of the filter to reduce or stop particularly steep voltage edges (resulting from PWM modulation) that can generate significant unwanted current through electrostatic couplings and earthing systems. These voltage edges can also generate high frequency irradiated disturbance, above all through the motor cable.

Filters installed on the network will reduce conducted disturbance: See section "2.2.3.1. Filters" for recommended models.

There are usually two types of problems regarding earthing in boards:

- The (high frequency) EMC earth comprising a portion of an unpainted metal wall, where the drives are positioned, and the filters, creating an electrical contact that is adequate for attenuating high frequency disturbance.
- Protective earth (PE) according to EN60204-1, using conductors with a minimum cross-section equal to 10 mm².

All power and control cables must be shielded except for cables running from the mains to the power filter; the shielding of these is linked to the layout of the board, and may not be necessary.

Usually the shield must be connected at each end. In some cases, control cable shielding may be connected at one end only, to eliminate network noise that could interfere with the control signal.

Indications for laying connection cables:

- The shielding cover must be greater than 70%
- Do not lay power and signal cables side by side, in particular not close to the power filter, and make sure they are physically separate
- Avoid crossing power cables with signal cables if they are not in the same cable (for example for DR2020)
- Make sure no loops form in the cables. Keep the cables as short as possible and close the common potential correctly
- Keep the input power supply cables separate from those of the output power (for the DR2020)

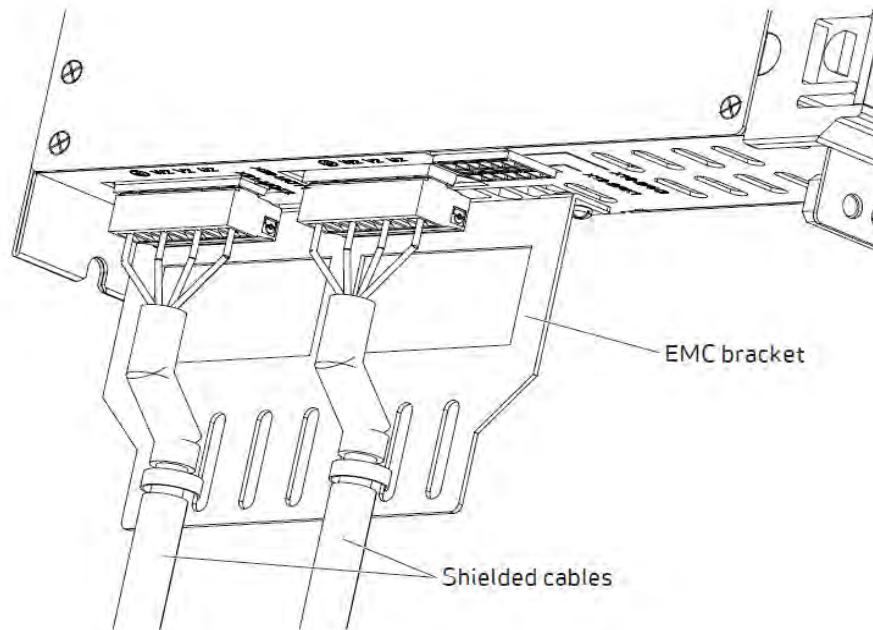


Fig 4.2 Detail of connection between cables and EMC bracket

4.3.2. Thermal sizing of the board

4.3.2.1. Dissipation of the power supply unit

% Rated current	Type L50	Type L150
0	25	35
25	75	150
50	125	250
75	175	350
100	225	450

4.3.2.2. Dissipation of DR2020 axes (in Watt)

% Rated Current	CH6 52 X X X XX	CH6 54 X X X XX	CH6 56 X X X XX	CH6 58 X X X XX
0	17	17	17	17
25	43	69	95	121
50	69	121	173	226
75	95	173	252	330
100	121	226	330	434
	<i>2/4 Amp</i>	<i>4/8 Amp</i>	<i>6/12 Amp</i>	<i>8/16 Amp</i>

Note: the DR2020 normally installed externally to the panel must not be considered in the thermal calculation of the panel itself.

4.3.3 Thermal dissipation of the accessories

Device	Dissipated power (W)
Network filter for power supply L50	30
Network filter for power supply L150	50
Standard brake resistor	370 or 1000 (maximum)
Optional brake resistor	500 maximum



INFORMATION

If possible, the brake resistors should be assembled outside the distribution board, adequately protected from accidental contact, to avoid having to eliminate the heat they generate in the distribution board

4.3.3. Auxiliary power supply characteristics

The auxiliary power supply must be 24 V with a tolerance of +/-10% and a ripple below 200 mV.

The current absorbed will depend on which and how many modules are used in the system.

The maximum current necessary will be taken from the sum of the voltage required from each of the components.

Place the brakes in the DR2020 chain as close as possible to the DM2020 power supply

The current absorbed by the brake can reach up to 2 Arms and depends on the brake model that the motor uses. The value of 750 mA refers to the brakes of the FASH motors, 100 mm and 115 mm.

Module	Absorbed current (A)
Power supply L50	1,0
Power supply L150	2,0
DR2020 axis	700 mA
Motor brake	750 mA

Tab 4.1 Auxiliary circuits input



CAUTION

Where a dedicated power supply for the motor brake is absent, it is important to ensure that the general auxiliary power supply system is correctly dimensioned and that the tolerances comply with those required by the brake which is being controlled

4.3.4. Connection to the mains (Section related to the connection of the DM2020 power supply to mains)



WARNING

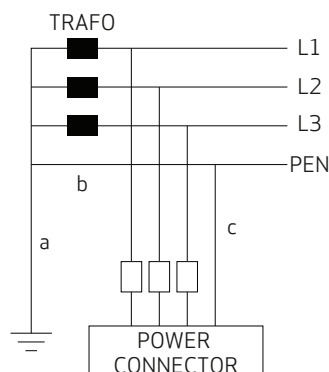
The drive must be correctly earthed to prevent injury or death. An insulation transformer must be fitted in mains networks which are not earthed or earthed asymmetrically

4.3.4.1. Types of mains networks

TN-C network

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

- Direct mains connection (earthing point)
- The control unit neutral and earthing of the entire plant are connected to a single connector: the PEN
- All parts exposed to contact and shielding must be connected to earth



TN-S network

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

- a) Direct mains connection (earthing point)
- b) NA
- c) All parts exposed to contact and shielding must be connected to earth

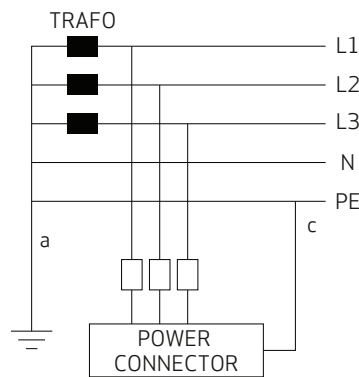


Fig 4.4 TN-S network

TT network

The mains in the figure is not very common and has problems with EMC requirements, which can only be fully met with in-situ measures. The main characteristics are shown below:

- a) Direct mains connection (earthing point)
- b) NA
- b) All parts exposed to contact and shielding must be connected to earth

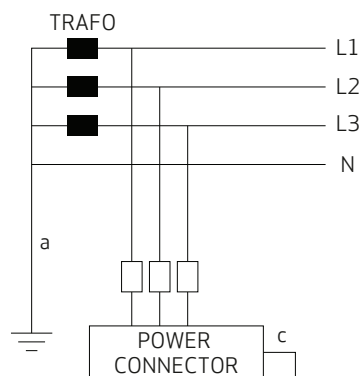


Fig 4.5 TT network diagram

4.3.4.2. Protection components

Fuses

Sizing network fuses: The size of fuses must be immediately greater than the sum of the currents of each module connected to the power supply (with a limit of 54 A, as per the power supply size L50 and 128 for a size L150).

Example: In a system comprising three modules (one size 50 mm 4+6 A module, one size 75 mm 24 A module) a fuse with a size immediately greater than $4+6+24 \text{ A}=34$ or a 36 A fuse will be used, in the instance that both axes are being used at once.

Safety switches for fault currents

According to EN60204-1 on the electrical equipment of machinery, a safety switch can be used for fault currents, provided it complies with applicable regulations.

To protect from direct accidental contact, a safety switch for fault currents (dispersion) with a sensitivity of 30 mA must be installed on each axis-module/power supply system

The DR2020 does not require fuses on the auxiliary power supply and on the DC BUS

4.3.4.3. Earth connection

Two types of earth are usually present in distribution boards:

- (High-frequency) EMC earth comprising an unpainted metal wall, to which the drives and filters are connected, creating an adequate electrical contact
- Protective earth (PE) according to EN60204-1 using conductors with a minimum cross-section of 10 mm²

The length of the individual cables which connect to the earth must be minimal; for this reason, it is advisable to position an earth bar as close as possible to the drives.

4.3.5. Power supply unit wiring

4.3.5.1. Earthing

Connect the filter and power supply housing to the structure of the board, making sure the contact surface is adequate and the connection has low resistance and low inductance.

Avoid fitting the filter and power supply housing on painted surfaces.

4.3.5.2. Power supply cable connection

See section "2.2.3.3. Cables" of DM2020 manual for cable selection.

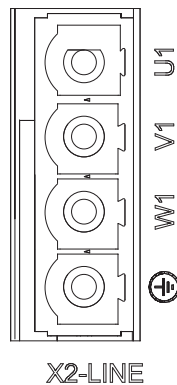


Fig 4.6 Connector X2

4.3.5.3. Brake resistor connection

See section "2.2.3.4. Brake resistor" for resistor selection.

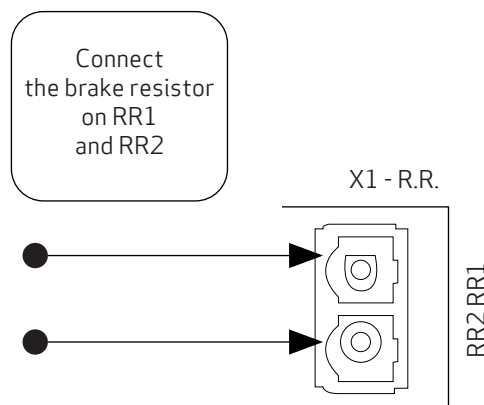


Fig 4.7 Fixed brake resistor connector

Use a shielded cable for the connection, with shielding closed on the drive side.

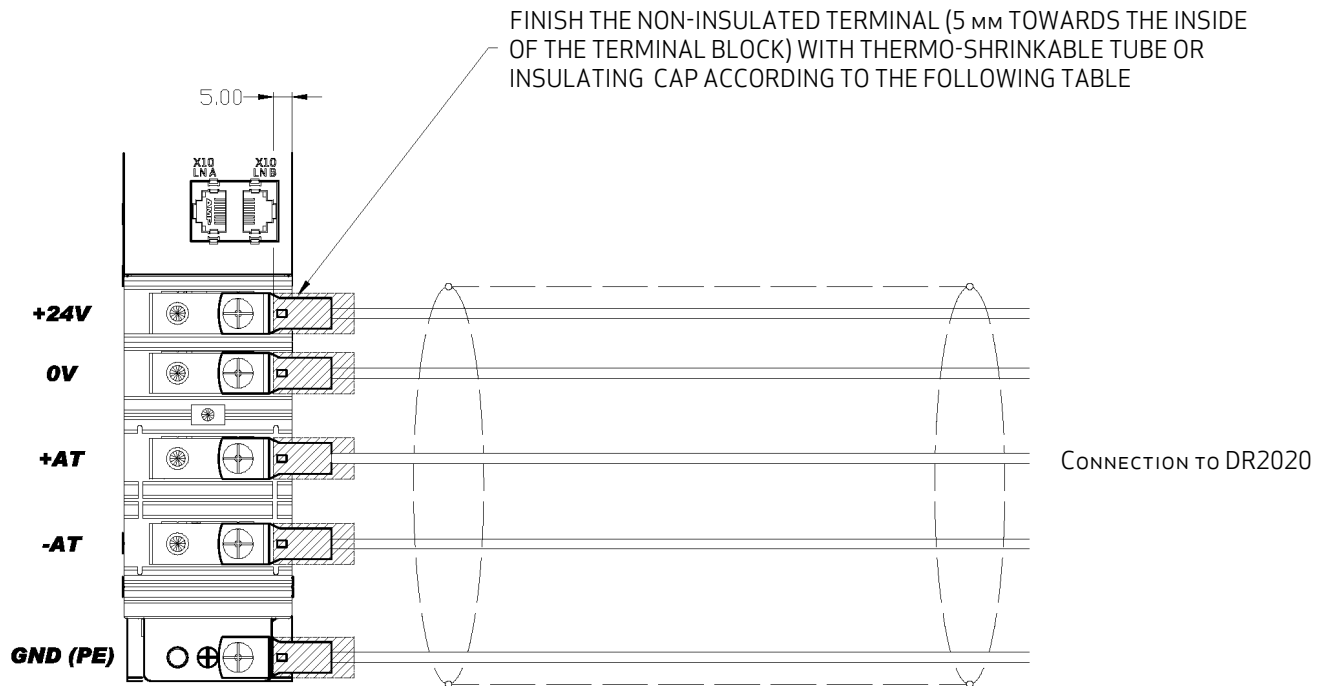
4.3.5.4. BUSBAR connection

The +DC bus and -DC bus terminals of the power supply and axis modules must be connected in parallel. In this way, the power from the power supply and power from regeneration are divided between all axis modules. Only the BUSBARs provided with the drive must be used for connections.



WARNING

The user is responsible for the physical protection of the BUSBARs and other safety devices intended to prevent harm to persons: For this purpose, the front cover or two side covers provided with the drive must be used (on the two modules at each side of the system). Connect the power supplies of the DR2020 with a cable terminated with eyelet "terminals"



CABLE SECTION	16mm ²	35mm ²
Type of lug	BM 01531	BM 017313
Thermo-shrinkable tube	TE VERSAFIT 318-0	TE VERSAFIT 112-0
Isolating cap	BM 81016	BM 81035

Note: with regard to terminals and heat-shrinking tubes, alternative brands may be used provided they are equivalent. The insulating cap is an alternative to the heat-shrink tube.

4.3.5.5. Auxiliary voltage and signal connection

The 24 V DC auxiliary voltage must be provided from an external source to the +24 V and 0 V terminals on the front panel.

4.3.5.6. Power supply signal connection

The power supply has a CAN connector (X10) that feeds the CAN line of the drives directly; the pinout is the same as the Axis modules. See paragraph "2.2.2. Connectors and LEDs ". Do not use in case of Ethercat.

4.3.6. Axis module cabling

Connect the DR2020 to the DM2020 power supply using shielded cables with a cross section that ensures a negligible voltage drop towards the connected modules (2.5 mm² minimum recommended section for power supply and auxiliary power supply).

4.3.6.1. Earthing

Connect the module housing to the structure of the board, making sure the contact surface is adequate and the connection has low resistance and low inductance. Avoid fitting the module housing on painted or insulated surfaces.

4.362 Use of the integrated brake in the motor

WARNING



When defining the brake connections, take into account the possible voltage drop on the cables that carry the power supply even to the logical sections of the DR2020.



WARNING

the brake supply is NOT obtained inside the drive. It is brought via the 24V auxiliary power supply; take into account that it must provide for the brake feeds. When many DR2020 modules are installed, make sure to place, if possible, the modules with the brake at the beginning of the system.

The figure shows the functional and time relations between enabling, activation signal and velocity command. Motor brake times vary depending on the motor models, and reference shall be made to motor model data.

The external brake activation command must reach the drive when the motor speed is close to or equal to 0. The delay introduced by the drive between receiving the command and its transmission to the brake is less than 125 μ s. The delay in brake activation depends on the type of brake and is specified by the motor manufacturer.

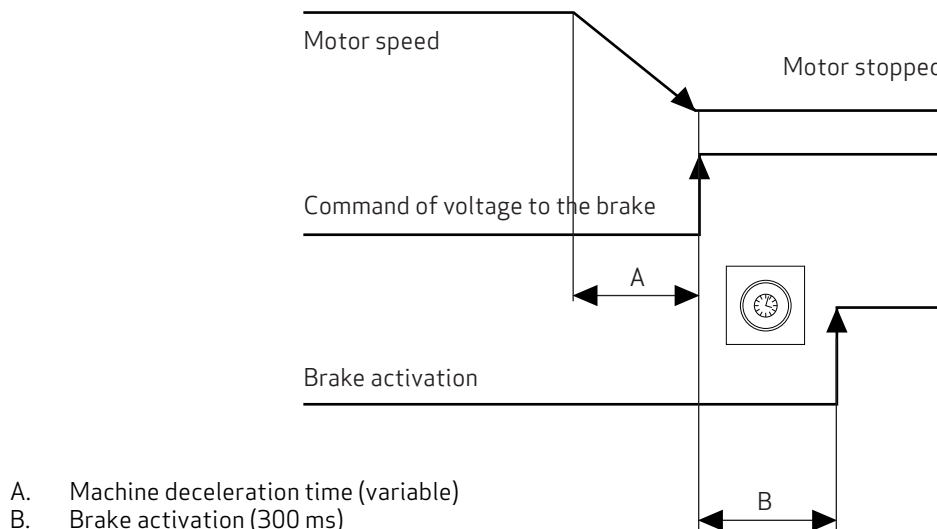


Fig 4.11 Diagram of brake activation times



WARNING

The same information given for the motor cable applies, so particular care should be paid with shielding, even if the conductors are not already incorporated in the motor cable.



WARNING

The use of the motor brake does not guarantee any personal safety. Vertical loads in particular require an additional mechanical brake to operate safely; using safety boards, for example.

4363. I/O Signal connection

In the standard versions of the DR2020, the analog and digital I/Os are not wired to the outside.

4364. STO signals connection

Here below is the basic diagram, repeated in the chapter dedicated to the STO function

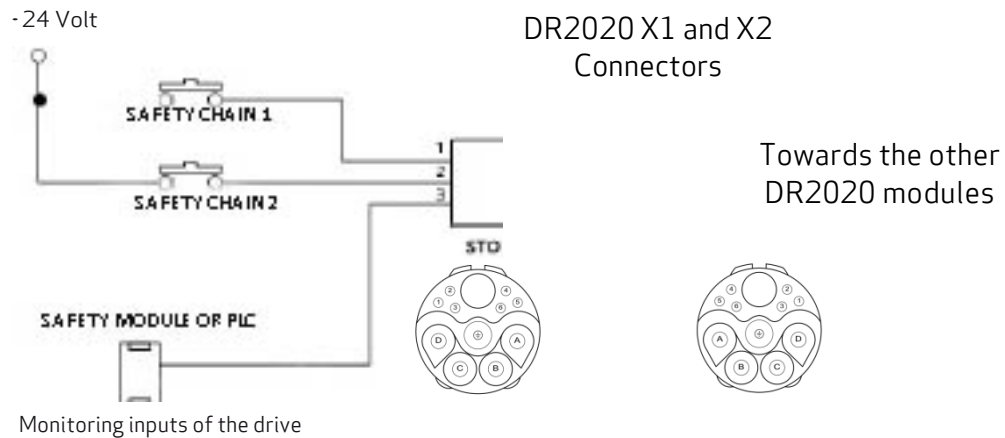
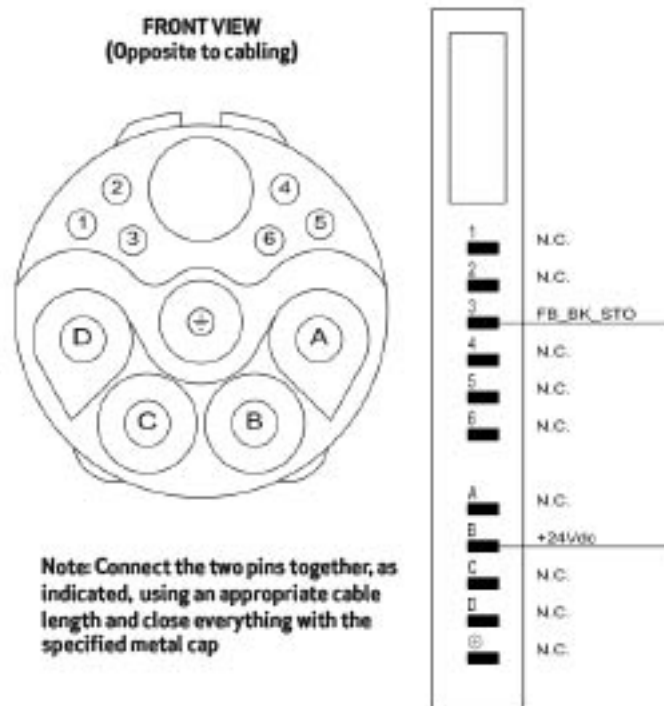


Fig 4.12 Basic diagram for connection to the PLC

Note:

Feedback from the STO is the series of feedbacks of the various DR2020 modules; as long as one of the drives does not correctly acquire the two pins S1 and S2, the chain is interrupted and the safety PLC intervenes by cutting the power supply to the drives.

Final cap for connecting the last DR2020 to the end of the safety feedback



By including the two STO commands in series in the “safety device” circuit, the axis enable command is operated only when the PLC controls both S1 and S2 signals, and at the same time all machine safety devices are “closed”. When a “safety” contact is opened, the axis is released without control; in situations where this is not compatible with machine movement (for example axes that are interpolated or cause mechanical interference), appropriate delayed safety contacts should be used to release the axis only after movement has fully stopped in a position that does not damage the machine. The double channel comprises two separate, independent circuits; each command line is independent but acts on devices connected to each other in series; motor movement can only take place when both commands are supplied correctly. Absorption on the S1 and S2 inputs is below 50 mA at 24 V. As feedback of the two commands, the drive relays corresponding S1 and S2 feedback (3.3 V, 1 kOhm) to the PLC to check that commands are correct and consistent, and to operate movements with an adequate sequence. The delay between Command application (S1 or S2) and Feedback, which signals that the command has been executed, is below 50 ms; the delay between removal of the command and feedback signalling is below 20 ms. In any case, wait for at least 50 ms before moving the axes after executing commands, and 20 ms before checking that the drive is in a “safe” condition.

4.365. Transducers Connection

The DR2020 can handle most of the common feedback transducers in the table below:

- 2-pole RESOLVER
- Single-turn Capacitive Sincos Hiperface ENCODER
- Multi-turn Capacitive Sincos Hiperface ENCODER
- Single-turn Endat 22 optical ENCODER
- Multi-turn Endat 01 optical ENCODER
- Multi-turn Endat 22 optical ENCODER
- Single-turn Endat 01 optical ENCODER
- Single-turn Endat 22 inductive ENCODER
- Multi-turn Endat 22 inductive ENCODER

The connection is made internally and is carried out in the factory: it is not possible to change the coupling of electronics and motor outside our factory.

4366. Fieldbus Connection

The connectors related to the Fieldbus are X4 (In) and X5 (Out)



INFORMATION

Depending on type of fieldbus, a different type of hardware and firmware must be installed. If the connection is via EtherCat, the file extension will be "_ecat" if via CanBus, it will be "_can".



INFORMATION

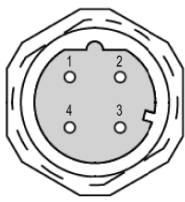
If the connection to the drive is via EtherCat or CanOpen, the USB port is always available as a service port for PC-drive connection.

- EtherCat Connection

The EtherCat connector is also used for the Ethernet interface. The installed software manages communication with the EtherCat network.

IN Connector X4 and OUT EtherCat Connector X5

EtherCat Connector



Connector Pin-out

N° pin	Description
1	Tx +
2	Tx -
3	Rx +
4	Rx -

The input and output fieldbus connectors have the same pin-out.

- CAN Connection (*)

The same connector is used for CAN interface.

A cable with a 120 ohm resistor at each end must be used for the connection. The cable length that may be used to guarantee safe communication decreases as transmission speed increases. Refer to the following table: FOR LENGTHS OF OVER 100 meters, contact the assistance service in order to verify the relationship between length/speed.

Transmission speed (kBaud)	Maximum length of the cable (m)
1000	10
500	60
250	100

(*) under development

Notes on the power supply of the DR2020 for the dimensioning of the application

The DM2020 PS M power supply (L50 mm) can supply a nominal current of 54 Arms on the DC BUS line with a peak of 130 Arms on the DC BUS line.

The DM2020 PSL power supply (L150 mm) can supply a nominal current of 128 Arms with a peak of 256 Arms on the DC BUS line.

The total number of DR2020 and DM2020 modules that can be connected at the same time is limited only by these values according to the machine cycle.

The power supply is thermally protected from exceeding the maximum rms current that can be supplied by it.

The current that the power cable of the "chain" of the DR2020 is bound by the maximum current that the connector manufacturer places as a constraint for the single power terminal; this value is 30 Arms.

This current limit value reflects the CE certification of the connector and of the DR2020 product.

The maximum section of the cable that the power terminal is able to house is equal to 4 mm² (AWG12) (terminals A-B-C-D).

The theoretical maximum number of DR2020 modules connectable in the chain is equal to about 20, considering to divide the 30 Arms on the auxiliary power supply 700 mA on the auxiliary power supply and 750 mA on the brake power supply (to be verified according to the brake mounted on the motor) . However, it is advisable to check the voltage drop of the auxiliary power supply on the last DR2020 module and then check that the voltage remains higher than 22.5 Volt. If necessary, split the supply line into two separate lines.

The maximum cable cross-section at the signal terminals is 1 mm² (AWG18) (terminals 1 to 6) with maximum current of 1.2 A

It is always advisable to use a shielded cable also from the power supply in order to limit EMC emissions in the cabinet.

The overall cable length between the electrical panel and the last DR2020 module should remain within 50 meters; for longer lengths, a functional check of the required configuration is advisable.

5. COMMISSIONING USING THE GUI

The system is commissioned via the Dx2020 GUI operator interface.

For a detailed description of menus and procedures, please refer to the “Help” guide on the GUI itself.

5.1. Safety

WARNING

**The drive may generate voltages up to 900 V, which are potentially lethal
Make sure all live parts are protected from contact with the human body**



AVERTISSEMENT

L'entraînement peut générer des tensions jusqu'à 900 V, qui sont potentiellement létales. Assurez que toutes les parties électrifiées soient protégées de tout contact avec le corps humain



CAUTION

Changes to parameters without previous checks may cause unexpected and incorrect machine movement

CAUTION

Only qualified personnel are authorised to configure the parameters of a drive in operation



CAUTION

Before making the drive operative, it is advisable to make sure all parameters are configured correctly

ATTENTION

Les changements de paramètres sans contrôles précédents peuvent provoquer un mouvement inattendu et incorrecte de la machine



ATTENTION

Seul le personnel qualifié est autorisé à configurer les paramètres d'un entraînement en fonctionnement

ATTENTION

Avant de procéder à l'opérateur d'entraînement, il est conseillé de vous assurer que tous les paramètres sont configurés correctement



WARNING

When the drives are live, do not loosen the electrical connections. After removing the power supply voltage, capacitors may still have dangerous voltages up to 6 minutes after switching off the mains. To ensure that conditions are safe, measure the voltage on the intermediate direct-current circuit and wait until it has dropped below 40 V



WARNING

During operation, the heat sink and rear panel may reach very high temperatures of up to 80 °C and are therefore a hazard for the operator's safety. Before operating, make sure the heat sink temperature is below 40 °C



WARNING

Before installation, the machine manufacturer must carry out an accurate risk assessment and take all measures necessary so that unforeseen movement of the machine does not harm persons or damage property

5.2. Dx2020 GUI

5.2.1. General description

For the setup and "troubleshooting" operations a graphic interface software called Dx2020 GUI is available, which allows to set and modify the parameters, the configuration of the drives and the upgrade of the SW versions if necessary. The main features are:

- System configuration with access to the basic system parameters (transducers, digital and analogue I/Os, motor parameters, etc.)
- Calibration of the speed and position loops to personalise and optimise the drive response
- Direct control of the drive (jog mode, speed profile with internal generator)
- Commissioning
- Diagnostics
- Monitoring of the drive's internal variables and of the I/O signals
- Registration of the centre distance sizes via external memory support (SD card available only for DM2020)
- Signal visualisation on 4-track digital oscilloscope
- Firmware updating, drive parameter management (saving, backup, etc.)

5.2.2. Minimum PC requirements

- Pentium® 1 GHz processor or higher
- 512 MB of RAM
- 150 MB of free disk space
- Architectures supported x86 and x64
- Network connection for software download
- USB port, Ethernet port, CAN interface (IXXAT)

In order to function, the GUI uses the libraries .NET Framework 4.0, which have the following minimum space requirements

- x86: 600 MB of free disk space
- x64: 1.5 MB of free disk space

Operating systems

- Windows XP Home eEdition (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
- Windows 10



INFORMATION

There are some versions of Windows XP that are NOT supported by the .NET Framework 4.0; in this case it is not possible to install the GUI or use it.

Windows 8 and Windows 8.1, have already pre-installed the .NET Framework 4.5 libraries which are nothing more than a update of 4.0.; Therefore, users who own these versions of Windows can download the installer in "no_net" version, without the .NET Framework 4.0.



INFORMATION

Some PCs may require administration rights, both for installing and running the program



INFORMATION

If the SW system configuration does not satisfy the requirements indicated, it can be updated via the Microsoft Update site or via the update utility installed on the operating system

The following notes refer to a single-axis configuration; For a dual-axis configuration, the same considerations apply.

5.2.3. Dx2020 GUI Installation

Once the installer has been downloaded, launch by double clicking on it. Windows OSs after Windows XP have a more advanced application startup control system called UAC (User Account Control). Each time a program that needs additional administrative rights is started, the system asks the user if he wants to proceed.

The installation software must be requested to the Moog-Casella technical assistance office.

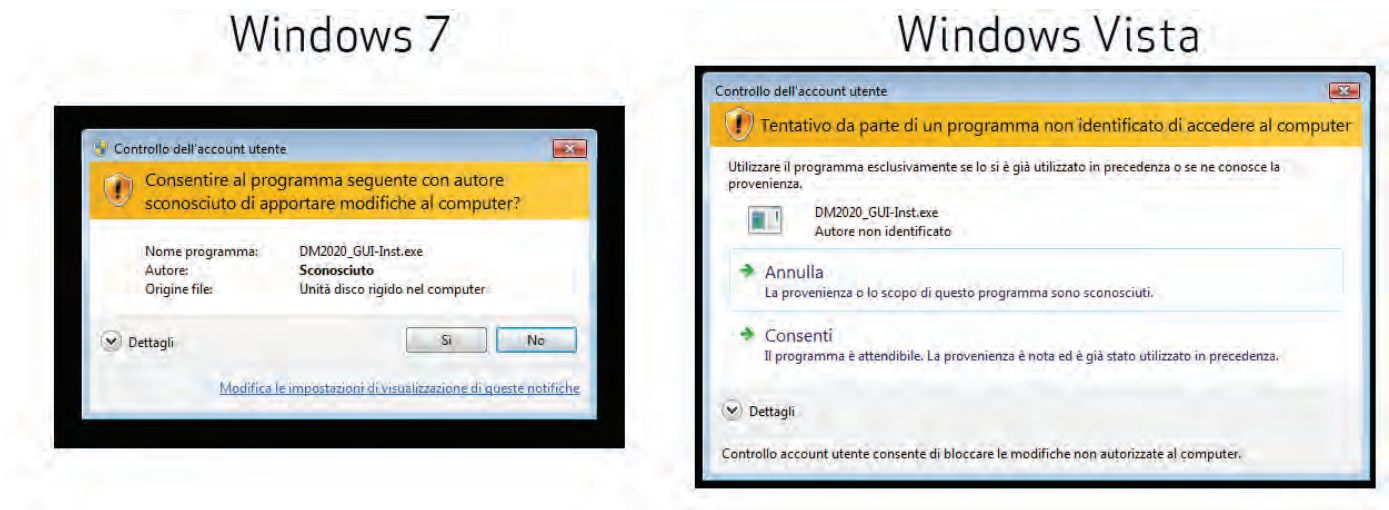


Fig 5.1 Differences in UAC notices

Click on **yes** or **agree** to proceed with the installation.

If the software is being installed for the first time on the PC, the user will be asked for language preferences on start-up.

As a default, if available, the program will automatically select the same language as that of the operating system as the first choice.

This setting is applied to both the installer language and the Dx2020 GUI application language.

The languages available are English and Italian.

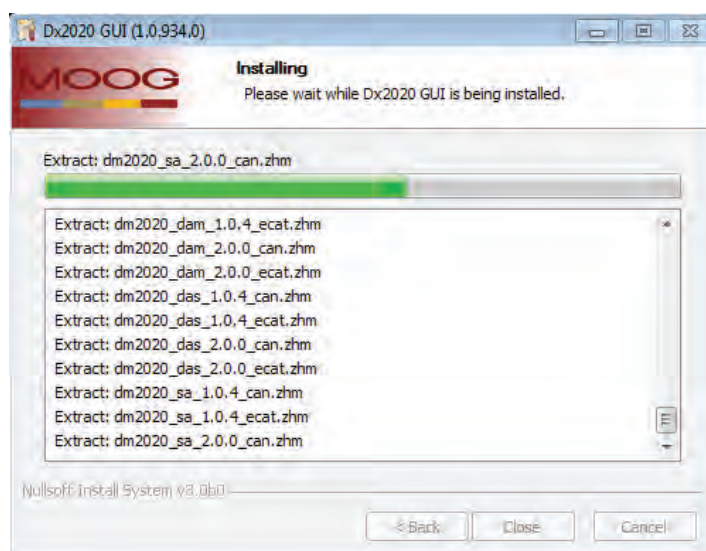
In any case, the language can also be changed from the GUI (Graphics User Interface) at a later time.

After the update, the program will proceed with the installation of the .Net, FrameWork 4, where this is not already present.

Installation of this last package will take between 5 and 10 minutes depending on the PC.

The installer will request the installation of additional components; some are installed automatically whereas others require user permission.

During installation, the steps performed by the installer and any installation errors can be viewed in a LOG window.



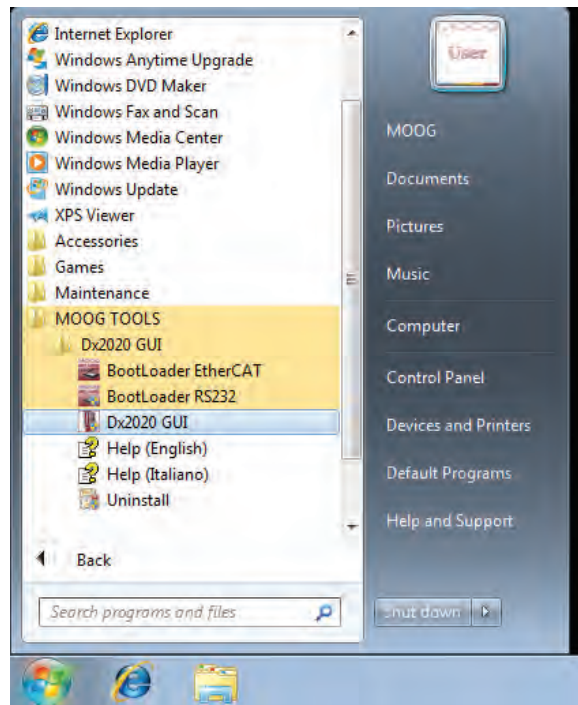
Once the installation has finished, click on **finish**.

Where errors occur during installation, pass the error message on to the Technical Assistance Service.

Once the program is installed, the Dx2020 GUI program icon will be visible.

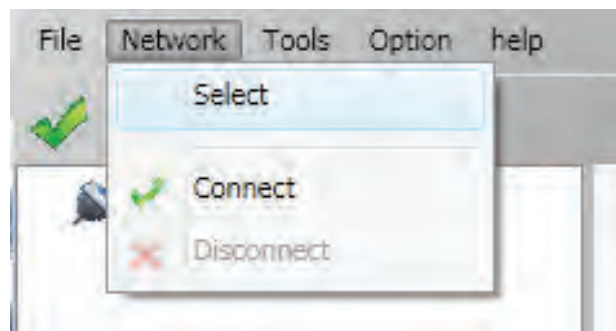
5.2.4. Connection GUI-drive

Launch the executable Dx2020 GUI.




The GUI can connect to the drive via the RS232 serial (X5 connector) or via EtherCAT (connectors X8 - X9) or via CAN BUS (connector X10) (see section "2.3.4. interfaces with "field" and the other modules for details on connectors).

From the **Network** menu, click on the **Select** to select the type of communication protocol.



Refer to the pages on this in the **Online Help** guide for more information (see section "5.2.7. How to access the Online Help" for details on how to access this)

To make the connection, supply the driver with 24 V of power and wait for three seconds until the display on the front panel lights up and shows an alphanumeric digit (I, F, S, E).

Select the **Connect** command on the toolbar or via the **Network**  drop-down menu.

The status bar LED will turn green.

Wait for the GUI to connect to the drive and automatically upload the parameters.

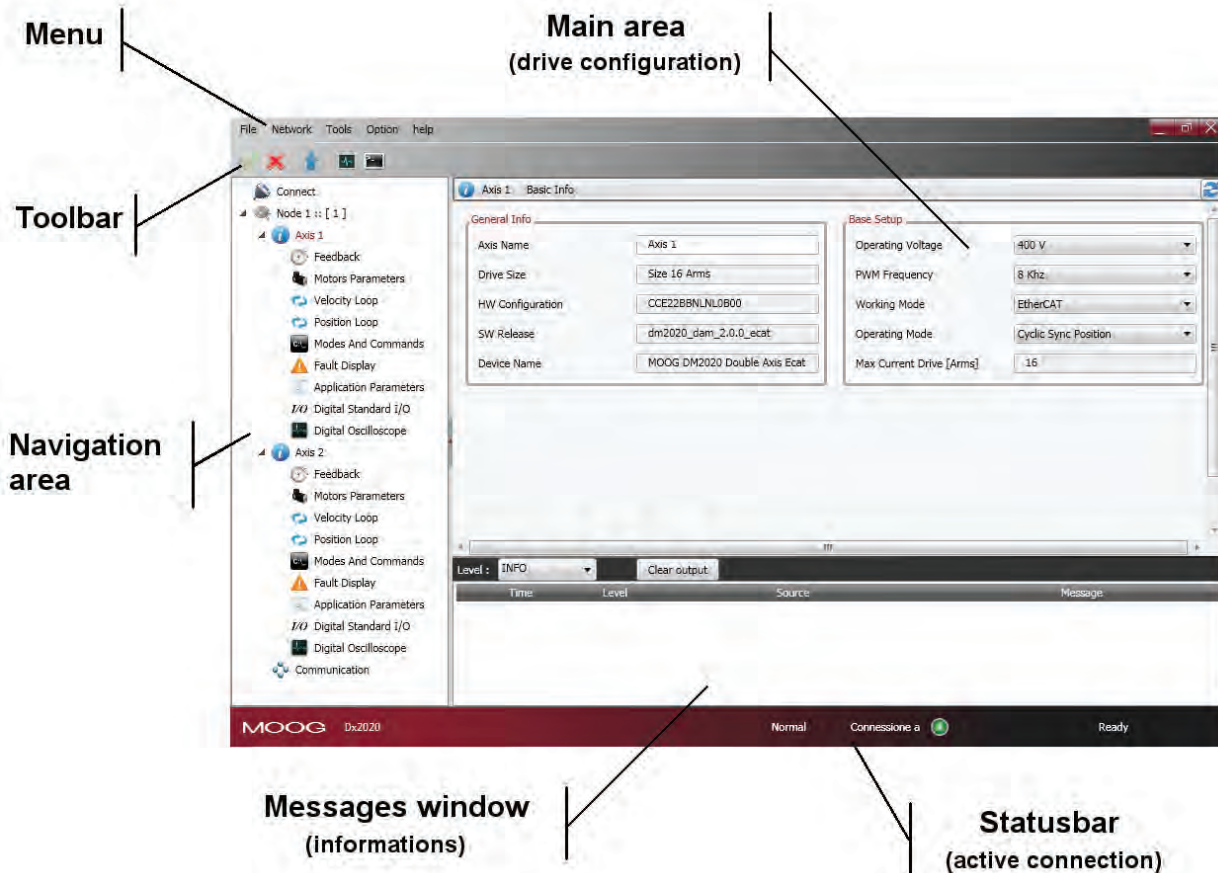


INFORMATION

In the event of anomalies during connection, refer to the "Trouble Shooting" chapter and follow the recommended steps

5.2.5. Layout

When making the connection, the screen will display the following.



- **Menu:** The following menus are present: **File, Network, Tools, Options** and ? Refer to the Online Help on the application for more information.

- **Toolbar:**



Connect: Open the communication port selected



Disconnect: Close the communication port



Load all: Update all of the parameters of the connected axes



Monitor: Open the monitoring window



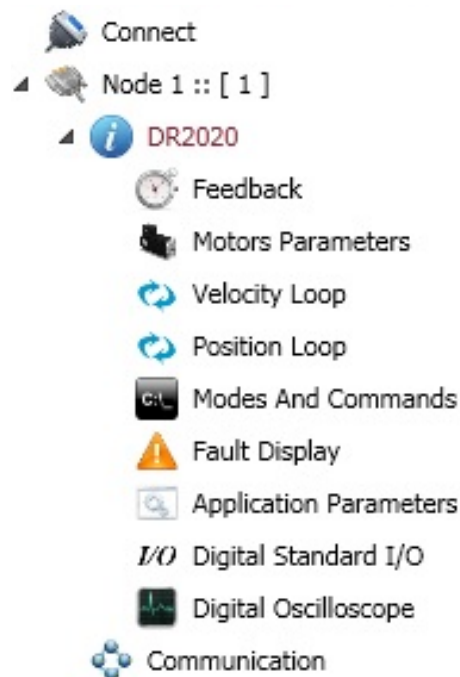
Terminal: Open the terminal form manual access



Load view: Update the parameters in the current view only

- **Navigation area:**

The intuitive, organised structure of this area allows users to access all of the information they need, divided into views. Connections can be made to multiple DR2020 modules on the same EtherCat line or to a single-axis module through the USB port. For dual-axis modules, the first axis shown is axis 1 (master), followed by axis 2 (slave). Each axis has a sub-menu which groups the parameters by function (transducer, motor, velocity loop, etc.). Clicking on the sub-menu in the main area will display the associated graphics window. The last element of the menu relates to the EtherCAT or CAN communication parameters (one per module).



- **Main area:**

This area displays the information and parameters relating to the view selected in the navigation area. This window allows users to view and set DR2020 drive parameters. Refer to the Online Help on the application for more information.

- **Message window:**



This area allows users to view messages which may have various meanings. A filter can be set so that messages are viewed according to type (ERROR, WARNING, INFO, DEBUG).



- **Status bar:**

The status bar displays information on the status of the application.

It indicates which protocol is currently in use, whether a connection is present, and the progress of operations across all views.



Refer to the Online Help present on the application for more information on the DM2020 program.

5.2.6. Updating firmware (BootLoader)

The firmware can be updated either via the RS232 serial or via the EtherCAT. The file to be downloaded has the extension *.zhm. The firmware is updated via dedicated applications (Bootloader EtherCAT and Bootloader RS232) that are installed at the same time as the Dx2020 GUI.

- The firmware can only be downloaded if the GUI is disconnected from the driver
- The procedure is accessed from the Menu/Tools tab on the menu bar
- Follow the relevant instructions on the Online Help present on the operator interface

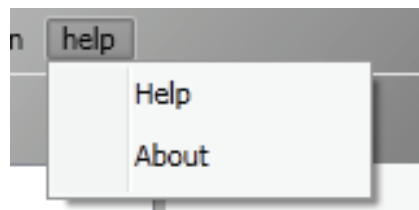
To access the dedicated tools: Go to PC Start/Programs/MoogTools/Dx2020 GUI/Bootloader/...

See the Online Help for details.

5.2.7. How to access the Online Help

This can be accessed in two ways:

- 1) Via the Dx2020 GUI operator interface: From the menu bar, select ?



- 2) From the PC Start menu/Programs/MoogTools/Dx2020 GUI/Help, in this case, it is not necessary to have launched the operator interface.

After defining the communication and connecting to the drive, the following steps must be followed:

1. Identification of the single-axis modules
2. Configuration of I/O (*)
3. Configuration of control loops (torque, speed, position)
4. Configuration of faults
5. Application parameters
6. Definition of modes and commands
7. Power supply
8. Enabling the STO
9. Enabling

Nota: The configuration of the motor parameters and of the transducers is carried out at the factory.

() under development*

5.3.1. Axis modules identification

Follow the instructions in the Online Help Guide on connections.

5.3.2. Motor parameters configuration (CARRIED OUT IN THE FACTORY, NOT ESSENTIAL)

The DR2020 can control synchronous motors with permanent magnets (brushless) and asynchronous motors with V/F control (open loop) and IFOC (closed loop).

A motor database is available and can be accessed by clicking on the [View Motor Data Base link](#).
The motor database can be edited and additional models of motor can be added.

The file is called DBMotors.xml located in the Installation version folder of the Dx2020 GUI.



INFORMATION

If the timing angle is not known at first, once all the other parameters have been entered, follow the autophasing procedure as described in section "5.3.2.1. "Autophasing" procedure"

Thermal protection can be activated for all three motor types. The thermal model parameters will need to be entered.



INFORMATION

Defluxing can be activated when a synchronous permanent magnet motor is being used.

Defluxing ("Field Weakening Algorithm")

If you require a maximum speed which is considerably higher than the nominal speed stated on the motor, click on "Activate deflux" which will allow the speed to increase beyond the nominal value, to the detriment of the continual torque generated, due to greater losses in the rotor at high speed. This function can be exploited automatically by enabling "Deflux"; contact the Applications Service for guidance on the maximum speed that can be set.

Where asynchronous IFOC motors are being used, the correct current I_d and flow S_g can be requested from the Applications Service, providing the motor's electrical parameters to be checked.

The motor brake (if present) can be configured from the Motor Parameters tab. Link [View Motor Brake](#).

Refer to the Online Help for more information on configuration, selecting **Configuration Views/Motor Parameter**

5.3.3. Transducers configuration (CARRIED OUT IN FACTORY, NOT ESSENTIAL)

The DR2020 can manage various types of feedback transducers to close the control loops. This configuration is carried out at the factory. It is not essential to repeat it when starting the DR2020.

To proceed with the configuration, follow the instructions in the Online Help, select **Configuration / Feedback View**



INFORMATION

The timing angle must be entered. If this is not known, please start the Autophasing procedure.

5.3.3.1. Sensorless

II DR2020 features the Sensorless operating mode, with no speed transducer; it is usually not used in the field except for motor test purposes without using the position transducer. To enable it, select **Feedback** from the Navigation area.

Under the tab **Feedback sources**, set the fields as indicated in the figure.

Make sure you also activate the "sensorless" calculation in the check on the right

In tab 1 STD interface (X2), set the fields as shown in the figure.

Finally set the fault (from **Fault Display / Fault Configuration**) Interface STD - Missing Transducer Configuration to "None".

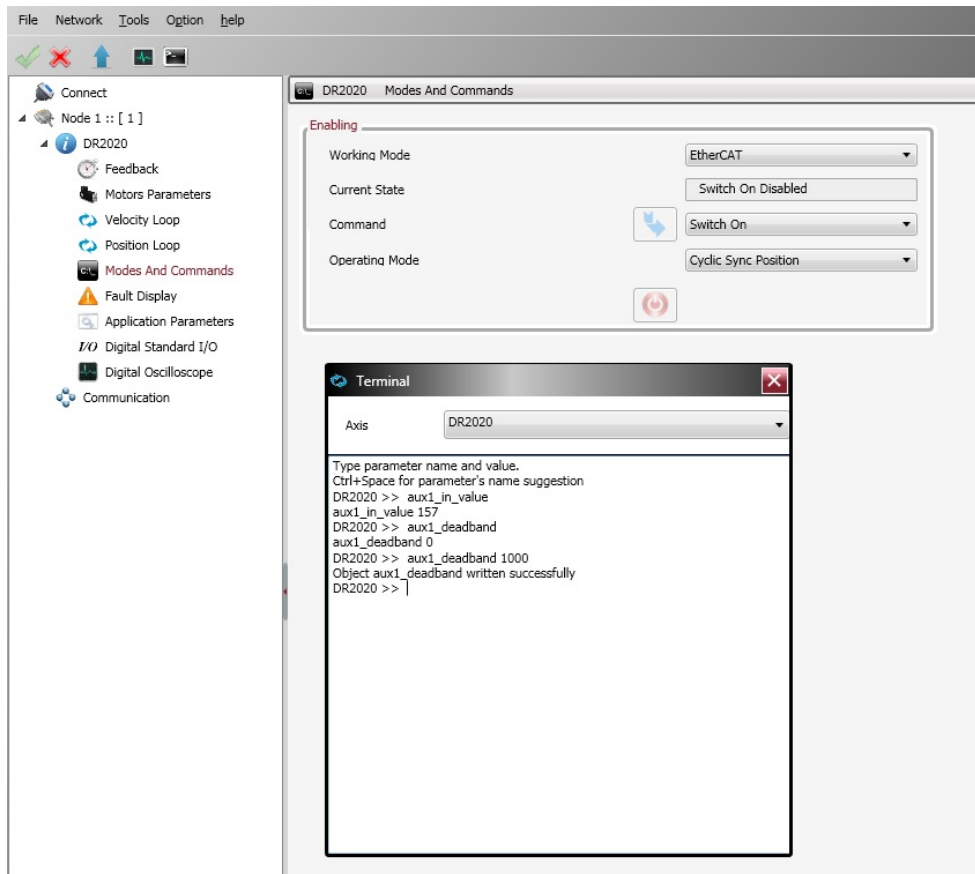
5.3.4. I/O Configuration (*)

For configuration of the I/Os, go to the Online Help and select **Configuration views / I/O standard digital**.



INFORMATION

A “deadband” can be applied to all analogue inputs; this is a band of signal beneath which the two inputs will be ignored. This is set on the terminal



The unit of measurement is in internal units from 0 to 215, corresponding to 11 volts, meaning that 100 units correspond to a deadband of 33.5 millivolts.



INFORMATION

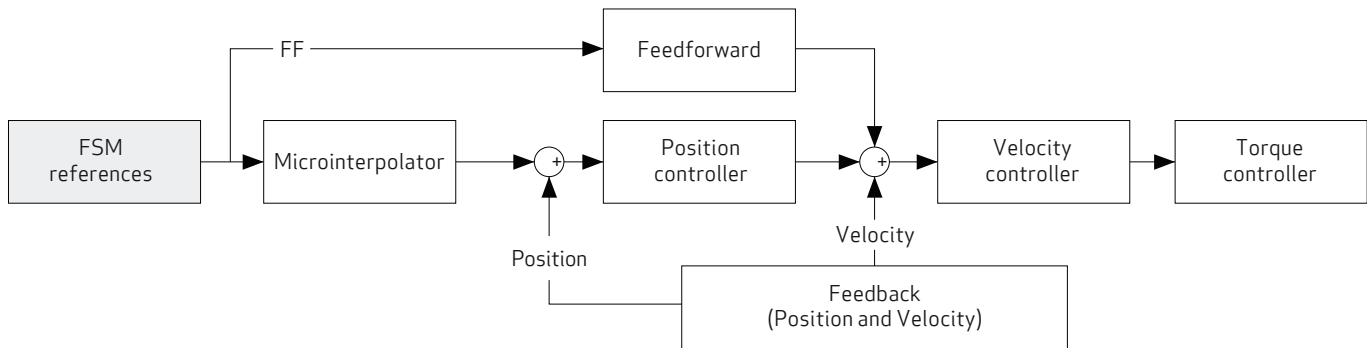
The digital outputs are active if supplied with a +24 power supply on X6-X16 connector on pin 7 and earth on pin 8.

(*) *under development*

5.3.5.1. Control mode configuration

The DM2020 manages up to three control loops depending on the operating mode of the drive: The torque, velocity and position loop, each inside the other, with the torque loop innermost, the velocity loop intermediate and position loop outermost, so that the output of each loop is the reference for the next internal loop.

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



Depending on the structure chosen, the user will have to provide the reference torque, speed or position.



INFORMATION

The control loops must be calibrated by qualified personnel.

5.3.5.2. Torque loops parameters configuration

The torque loop (or current, given the direct proportionality) is the innermost. The parameters are set automatically from the motor data, which in turn is set via the **Motor Parameters** menu.

The user can configure the bandwidth passing through the closed torque loop via the Terminal window, setting the “**bandPass**” variable; the possible values are 3000 (default), 2000.1000, 600.400 in Hz.



INFORMATION

Changing the bandwidth with regard to the default value may result in reduced motor performance.

5.3.5.3. Speed loops and filters parameters configuration

The speed control must ensure that the motor speed follows the speed reference as closely as possible, both in static and dynamic conditions. The quality of response from the system depends on the loop parameter settings.

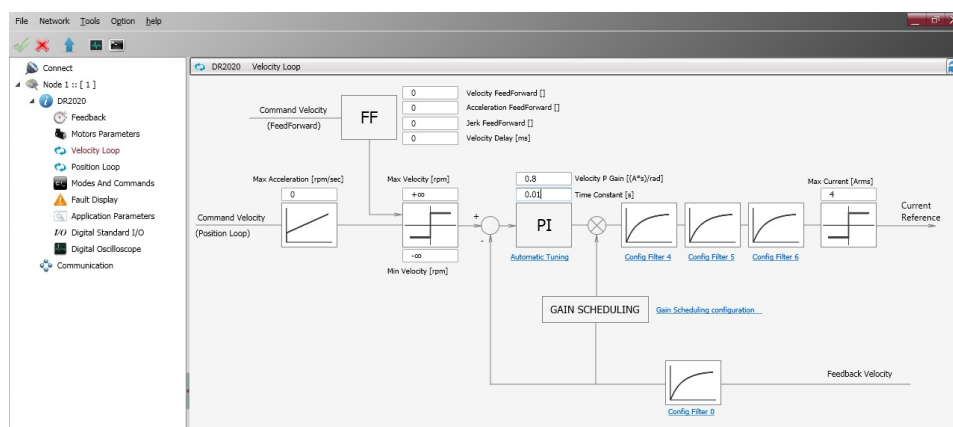
Basic velocity control is PI (proportional-integral) with an additional Feedforward (ff_calc) command, torque compensation and variable saturation (SATVARIABLE).

The proportional term produces an action; this is stronger the bigger the error, while the integral term (velocity error) corrects small errors that remain in time, due to constant disturbance and enables required targets to be reached.

The Feedforward block is used to minimise the velocity error in the case of disturbance known beforehand, directly contributing to the velocity reference processed by the PI regulation, with the linear combination of velocity, acceleration, jerk and delayed velocity in n samples references, calculated downstream the microinterpolator and makes it possible to minimise errors during transients.

The variable saturation block prevents the formation of fixed axis position instability (zero velocity reference, acting as a “low pass” filter with an extremely limited band).

To set the parameters, select **Velocity loop** from the **Navigation area**: A window will open showing the block diagram of the loop in question.



The standard network corrector (PI) is recognised, characterised by two parameters. Subsequently, there is a sequence of filters and one filter on the feedback chain; this allows for the use of more complex control structures, as well as filtering of known disorders (notch filter).

5.3.5.3.1. Filter Configuration

The four filters all have the same basic 2nd order IIR structure. They can be configured according to requirements (to access the configuration menu for each filter, click on the Config Filter link underneath each block)

Users can choose from the following types:

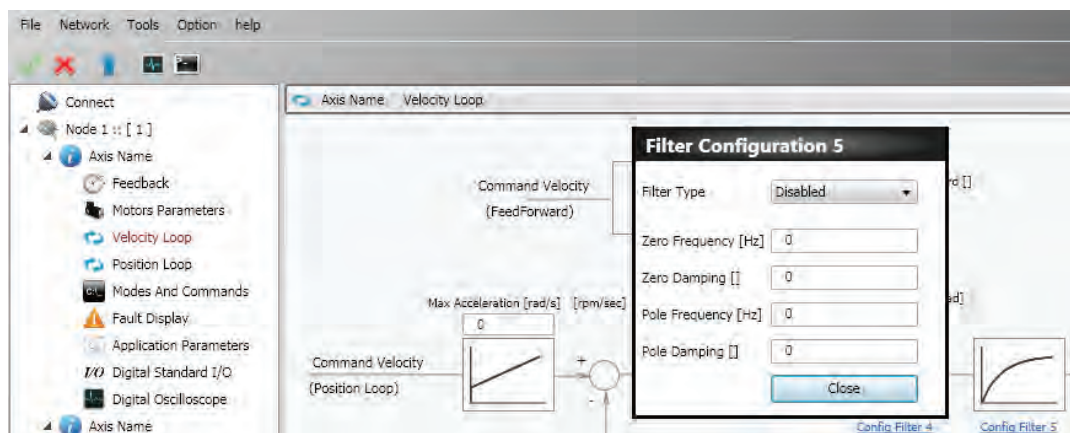
- **Lag**: The filter consists of a real pole and a real zero. The frequency of the pole and zero are entered, and have to be positive or zero.
- **Bq**: This is a standard biquad filter, with a pair of complex combined zeros and a pair of complex combined poles. The parameters that must be specified are:
 - Frequency of the zero
 - Damping of the zero
 - Frequency of the pole
 - Dampening of the pole

The frequencies must be positive or zero. The damping factors must be between -1 and 1.

- **Pole**: The filter has a single real pole. The parameter to be specified is the pole frequency, which must be positive or zero.
- **DbPole**: The filter has two complex combined poles. The parameters that must be specified are:
 - Frequency of the pole
 - Dampening of the pole

The frequency must be positive. The damping factor must be between -1 and 1.

- **Dircoef**: Enter the coefficients of the filter numerator and denominator (rarely used)
- Filter 4 has also a Notch Filter



INFORMATION
Keep the filter deactivated until all other filter parameters have been entered

INFORMATION
The parameters must be entered according to an established order:

1. Damping
2. Frequency
3. Type of filter

Example of a notch filter configuration. You want enter a notch filter centered at 30 Hz

Filter Configuration 3

Filter Type:

Zero Frequency [Hz]:

Zero Damping []:

Pole Frequency [Hz]:

Pole Damping []:

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

Filter Configuration 6

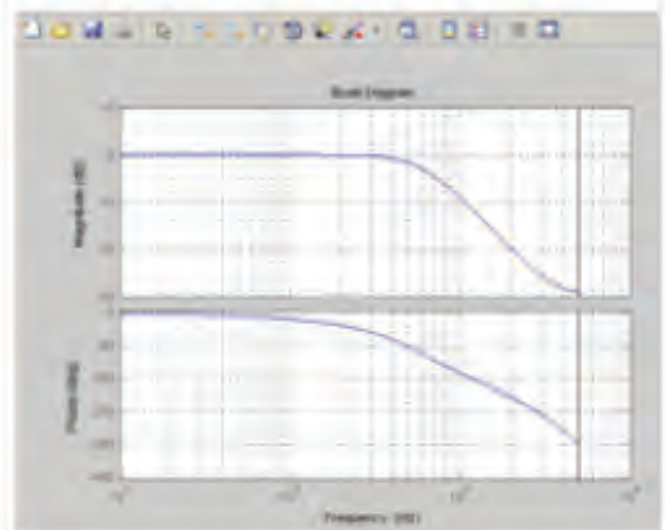
Filter Type:

Zero Frequency [Hz]:

Zero Damping []:

Pole Frequency [Hz]:

Pole Damping []:



5.3.5.4. Position loops parameters configuration

The position control must ensure that the motor speed follows the position reference as closely as possible. The quality of response from the system depends on the loop parameter settings.

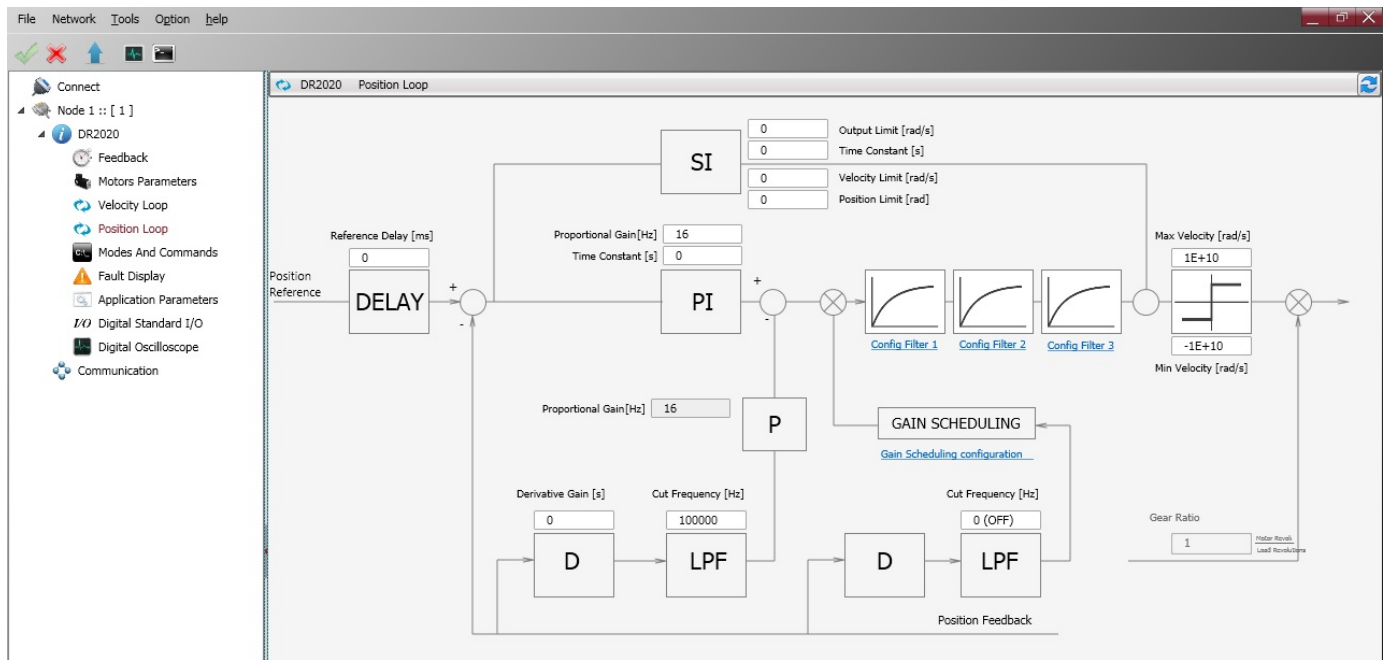
The position control is PID-type (proportional-integral-derivative).

The proportional term products an action that is stronger the bigger the error.

The derivative term observes whether the error is increasing or decreasing, damping system behaviour.

The integral term cancels the steady-state error.

To set the parameters, select **Position loop** from the **Navigation area**: A window will open showing the block diagram of the loop in question.



The standard network corrector (PID) is characterised by four parameters. There is subsequently a sequence of filters which allows more complex control structures to be implemented. See section "Configuration of filters" for setting filter parameters.

5.3.6. Fault configuration

From the **Navigation area**, select **View Fault**

The screen relating to the fault in question will appear. Any alarms active at that time will be listed on the left-hand side of the window (active fault list) and a list of the 8 most recent alarms will appear on the right-hand side (fault history).


Active Faults List		Fault History		
Fault		Number	Fault	Time
Interface X3 - Resolver signals fault		1/8	Interface X3 - Resolver signals fault	34d - 21h - 57m
		2/8	motor_over_temperature	34d - 21h - 17m
		3/8	Interface X2 - Missing transducer configuration	34d - 21h - 5m
		4/8	Interface X2 - Missing transducer configuration	34d - 21h - 5m
		5/8	Interface X2 - General Fault	34d - 21h - 5m
		6/8	Interface X2 - Missing transducer configuration	34d - 21h - 4m
		7/8	Interface X3 - Resolver signals fault	34d - 21h - 1m
		8/8	Interface X3 - Missing transducer configuration	34d - 21h - 1m

The reaction of the drive to each alarm can be configured individually by selecting the Fault Configuration link

A window will open with a list of the faults which can be managed: A reaction can be chosen for each fault from a drop-down menu.

Fault	Reazione	Stato
motor_over_temperature	DISABLE	✓
Interface STD - Missing transducer configuration	DISABLE	⚠
Interface STD - General Fault	Disabilita	✓
Interface STD - Erroneous value of sincos signals	Nessuna	✓
Interface STD - Hiperface position conflict	Disabilita	✓
Interface STD - Hiperface status error	Stop	✓
Interface STD - Hiperface transmit error	Parcheggio	✓
Interface STD - Hiperface receive error	DISABLE	✓

There are four options:

Reaction	Effect
None	<div> The alarm is ignored  <div> WARNING <i>Only during commissioning or troubleshooting. Settings to be avoided with the machine in normal operating conditions</i> AVERTISSEMENT <i>Seulement au cours de mise en service ou de dépannage. Paramètres à éviter avec la machine dans des conditions normales de fonctionnement</i> </div> </div>
Emergency	The drive sends an emergency message but is not stopped or disabled
Disabling	Disables the drive and carries out the configured stop procedure (from Application Parameters/Fault Reactions)
Stop	Immediate disabling; The drive stops motor control, if the moving axis continues to move due to inertia.

The most appropriate reaction must be programmed for each alarm, based on the machine's characteristics.

For some alarms, the Dx2020GUI prevents some reactions from being selected in order to guarantee the integrity of the drive (for example, it is not possible to activate emergency braking after "overvoltage").

Here the screen of some of the DR2020 alarms

Fault Configuration		
Fault	Reaction	Status
Interface STD - Erroneous value of sincos signals	DISABLE	✓
Interface STD - Hiperface position conflict	DISABLE	✓
Interface STD - Hiperface status error	DISABLE	✓
Interface STD - Hiperface transmit error	DISABLE	✓
Interface STD - Hiperface receive error	DISABLE	✓
Interface STD - Endat22 warning message	DISABLE	✓
Interface STD - Endat22 error1 message	DISABLE	✓
Interface STD - Endat22 error2 message	DISABLE	✓
Interface STD - Endat22 crc error	DISABLE	✓
Interface STD - Endat22 position not ready	DISABLE	✓
Interface STD - Endat22 not ready for strobe	DISABLE	✓
Interface STD - Resolver synchronization fault	DISABLE	✓
Interface STD - Resolver signals fault	DISABLE	✓
synchronization_error	DISABLE	✓
interrupt_time_exceeded	DISABLE	✓
task_time_exceeded	DISABLE	✓
velocity_control_monitoring	EMERGENCY	✓
following_error	EMERGENCY	✓
position_reference_limit	EMERGENCY	✓
EtherCAT_link_fault	DISABLE	✓
EtherCAT_communication_fault	DISABLE	✓
EtherCAT_rpdo_time_out	DISABLE	✓
EtherCAT_rpdo_data	DISABLE	✓

Close

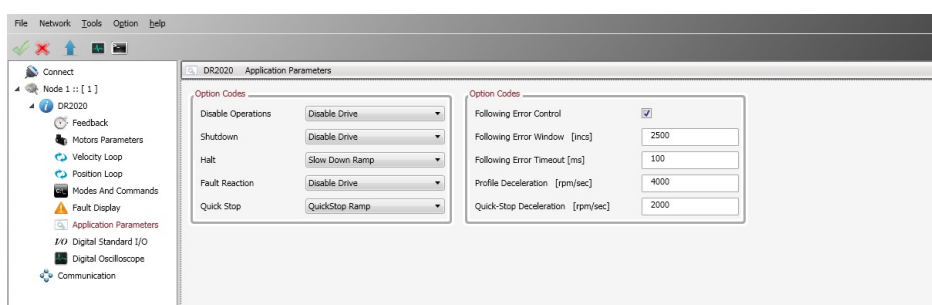
The faults listed below cannot be configured and the reaction is always “STOP”:

- 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 Moog-Casella's Service Centre for suggestions or specific checks.

5.3.7. Application parameters

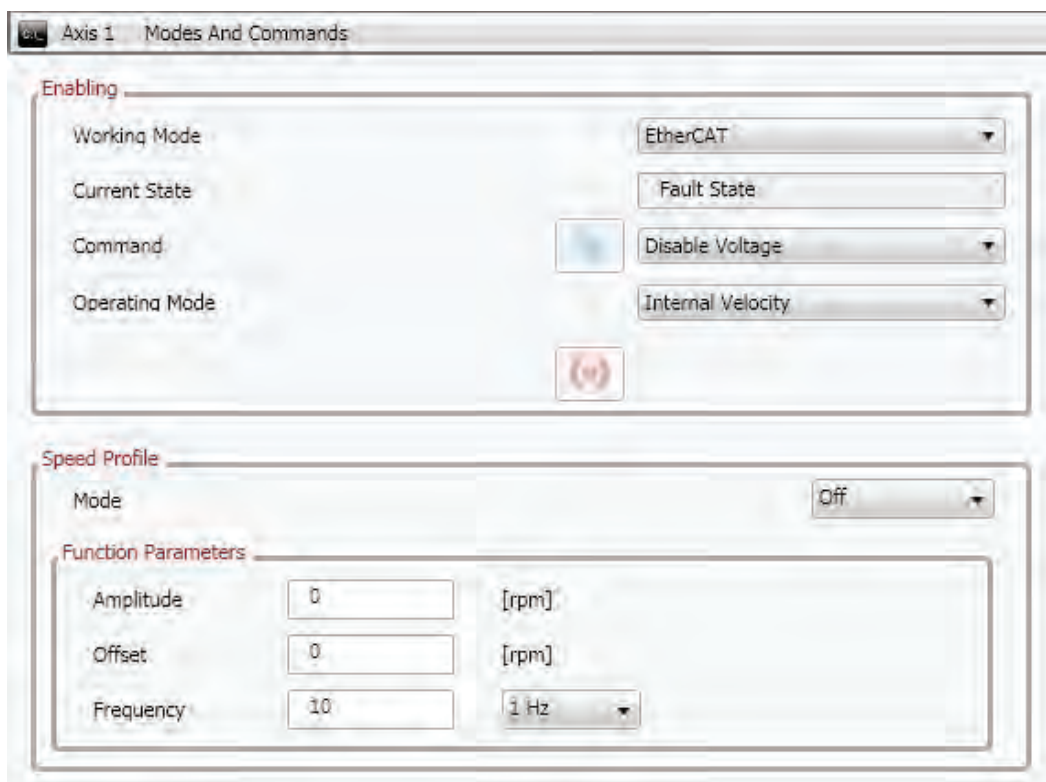
From this menu, it is possible to configure the drive reaction when specific events occur.



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

5.3.8. Configuration of modes and commands

This menu allows users to determine the origin of the controls and the function performed by the drive.



Operating mode



Make sure the firmware installed supports the selected files (with EtherCAT fieldbuses, the firmware will have the filename extension `_ecat`, and with CAN fieldbuses, the firmware will have the extension `_can`).

The drive command source will be set. The following values can be chosen:

- EtherCAT
The drive receives commands/set-points remotely via the EtherCAT fieldbus (standard)
- CANopen: the drive receives commands/set-points remotely via the CAN bus (*)
- Local: the drive receives commands/set-points from Dx2020 GUI
- Analogue: the drive receives commands/set-points through configured digital and analogue inputs (see Online Help, Configuration Views / I/O standard digital, for more information)

(*) *under development*

Current status

View the current status of the state machine (FSA - Finite State Automaton), defined in line with the standard DS402 which governs the drive (see below - state machine).

Command

Select the command which will be processed by the state machine of the drive. The command will essentially will be sent when the Send key is pressed; this key will only be enabled if the operating mode is set to "Local"

Operating mode

The operating mode – or the function performed by the drive – will be set. The following values can be chosen:

- Analogue speed
The drive runs a speed control following a reference from an analogue input. A variable torque limit can also be set, again from the analogue input. Typical operating mode: Analogue)
- Analogue torque
The drive runs a torque control following a reference from an analogue input (Typical operating mode: Analogue)
- Analogue torque
The drive runs a torque control following a reference from an analogue input (Typical operating mode: Analogue)
- Internal speed
The drive runs a speed control following a reference generated inside the drive itself (see function generator) (typical operating mode: Local)
- Internal torque
The drive runs a torque control following a reference generated inside the drive itself (see function generator) (Typical operating mode: Local)
- Cyclic Synch Position
The drive runs a position control following a reference generated cyclically by a device/remote control. This is the Cyclic Synchronous Position Mode, as defined in the DS402 standard (Typical operating mode: EtherCAT/CANOpen)
- Cyclic Synch Velocity
The drive runs a speed control following a reference generated cyclically by a device/remote control. This is the Cyclic Synchronous Velocity Mode, as defined in the DS402 standard (Typical operating mode: EtherCAT/CANOpen)
- Cyclic Synch Torque
The drive runs a torque control following a reference generated cyclically by a device/remote control. This is the Cyclic Synchronous Torque Mode, as defined in the DS402 standard (Typical operating mode: EtherCAT/CANOpen).



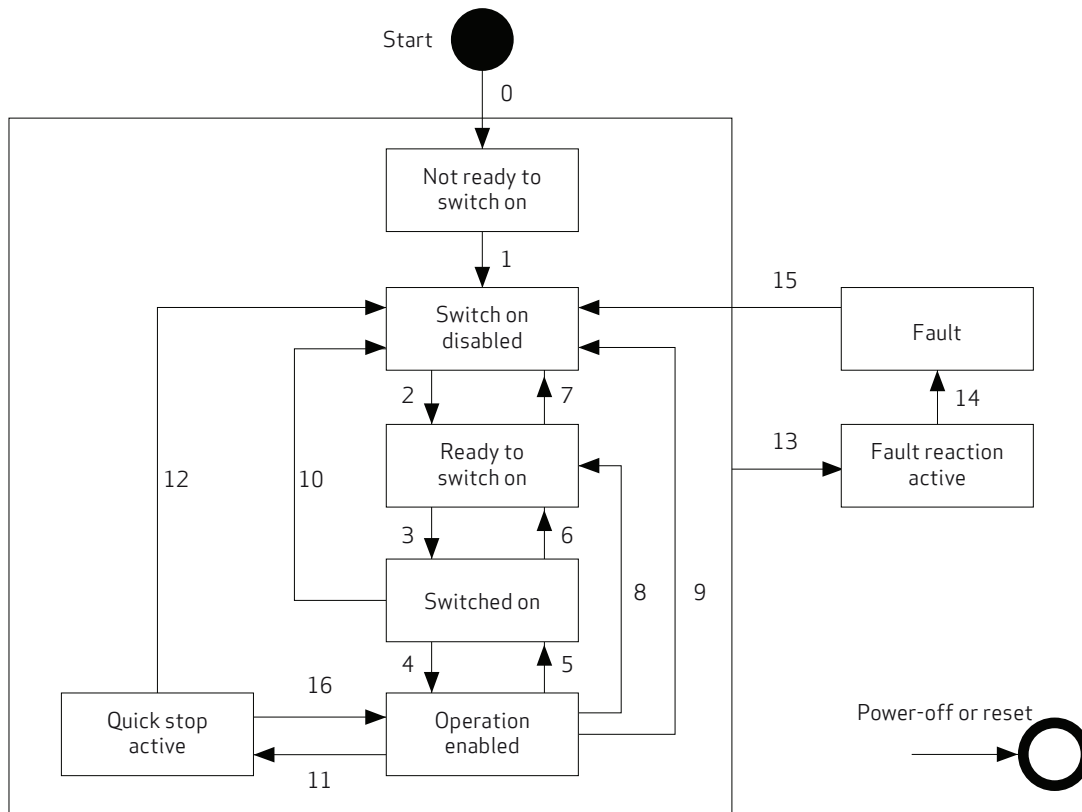
INFORMATION

There are other modes relating to specific applications; these are not described in this document ; the drive supports those described by the EtherCat / CanOpen DS402 profile.

When the commands to the drive are of internal origin (e.g: Operating mode = Local, Operative mode = Internal speed) the different reference profiles can be categorised (Square, Triangle, Sawtooth, Keystone, Breast, Profile, Jog).

DR2020 state machine

Please refer to the Online Help, **Configuration views/Modes and Commands**, for details on the FSA



Function	FSA states							
	Not ready to switch on	Switch on disabled	Ready to switch on disabled	Switched on	Operation enabled	Quick stop active	Fault reaction active	Fault
Brake applied, if present	Yes	Yes	Yes	Yes	Yes/No	Yes/No	Yes/No	Yes
Low-level power applied	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes
High-level power applied	Yes/No	Yes/No	Yes/No	Yes	Yes	Yes	Yes	Yes/No
Drive function enabled	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 power-on or reset application	Drive device self-test and/or self initialisation shall be performed.
1	Automatic transition	Communication shall be activated.
2	Shutdown command from control device or local signal	None
3	Switch on command received from control device or local signal	The high-level power shall be switched on, if possible.
4	Enable operation command received from control device or local signal	The drive function shall be enabled and all internal set-points cleared.
5	Disable operation command received from control device or local signal	The drive function shall be disabled.
6	Shutdown command received from control device or local signal	The high-level power shall be switched off, if possible.
7	Quick stop or disable voltage command from control device or local signal	None
8	Shutdown command from control device or local signal	The drive function shall be disabled, and the high-level power shall be switched off, if possible.
9	Disable voltage command from control device or local signal	The drive function shall be disabled, and the high-level power shall be switched off, if possible.
10	Disable voltage or quick stop command from control device or local signal	The high-level power shall be switched off, if possible.
11	Quick stop command from control device or local signal	The quick stop function shall be started.
12	Automatic transition when the quick stop function is completed and quick stop option code is 1, 2, 3 or 4, or disable voltage command received from control device (depends on the quick stop option code)	The drive function shall be disabled, and the high-level power shall be switched off, if possible.
13	Fault signal (see also IEC 61800-7-301)	The configured fault reaction function shall be executed.
14	Automatic transition	The drive function shall be disabled; the highlevel power shall be switched off, if possible.
15	Fault reset command from control device or local signal	A reset of the fault condition is carried out, if no fault exists currently on the drive device; after leaving the Fault state, the Fault reset bit in the controlword shall be cleared by the control device.
16	Enable operation command from control device, if the quick stop option code is 5, 6, 7, or 8	The drive function shall be enabled.

NOTE: It is not recommended to support transition 16.

5.4. Power supply

Provide three-phase power to the system and verify the correct sequence of LEDs on the power supply module (see section "2.2.2. Connectors and LEDs") and use the "Monitor" function on the GUI to verify the correct value of the DC BUS voltage (about 560 V) (see section "Layout").



INFORMATION

The charging time of the DC bus depends on the number of modules and the value of the soft-start resistance used; with standard resistance, the time is around three seconds with two DR2020 modules connected.

5.5. Enabling the STO

The STO circuit must be activated to enable the axis

The 24 V power supply to the STO circuit must be integrated with the chain of emergencies.

See dedicated chapter.



WARNING

After working on connections, replacing parts and on initial plant start-up, the STO function should always be checked

WARNING

Do not access the protected area and do not touch any live part or high-voltage part of the drive

Opening of a protective door must cause the chain of emergencies to intervene (interruption of motor power), along with the STO

If the STO signal is not removed with the correct sequence, "F" (fault) is displayed

AVERTISSEMENT

Après avoir travaillé sur les connexions, le remplacement des pièces et le démarrage initial, la fonction STO doit toujours être vérifiée

AVERTISSEMENT

Ne pas accéder à la zone protégée et ne toucher aucune partie électrisée ou la partie en haute tension de l'entraînement

L'ouverture d'une porte de protection doit provoquer la chaîne des urgences à intervenir (interruption de l'alimentation du moteur), avec le STO.

Si le signal de STO n'est pas annulé avec la séquence correcte, "F" (défaut) va apparaître.

5.5.1. “Autophasing”



INFORMATION

The motor must be free to rotate.



INFORMATION

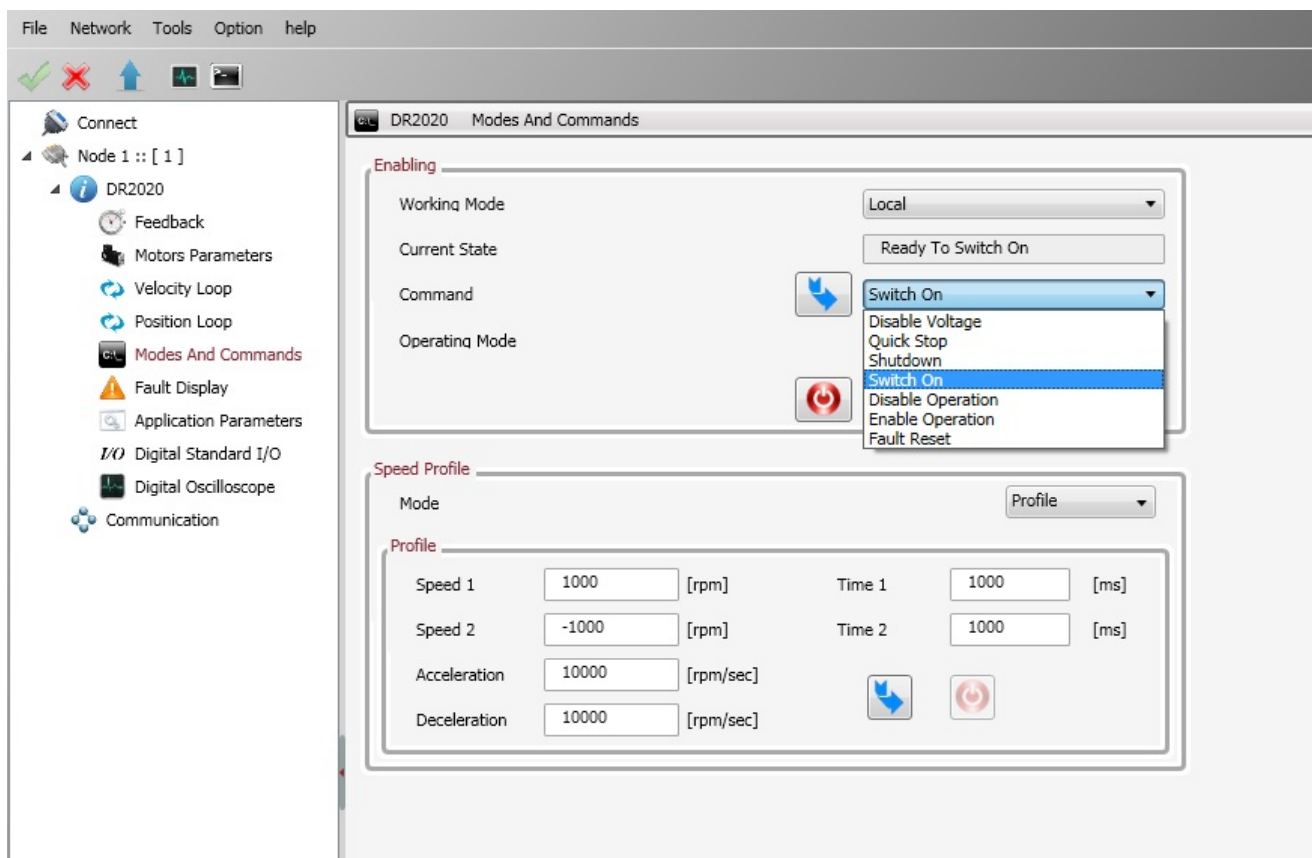
The release of the brake, when present, is part of the autophasing procedure, both when configuring the automatic brake control and the manual control.

Autophasing is run by Dx2020 GUI software.

Once the motor parameters have been set, select “**Modes and Commands**” in the navigation area.

Check that the power supply and the STO are then press the following in sequence in the “Command” field:

- “Power off”
- “Power on”, leaving the drive in this status



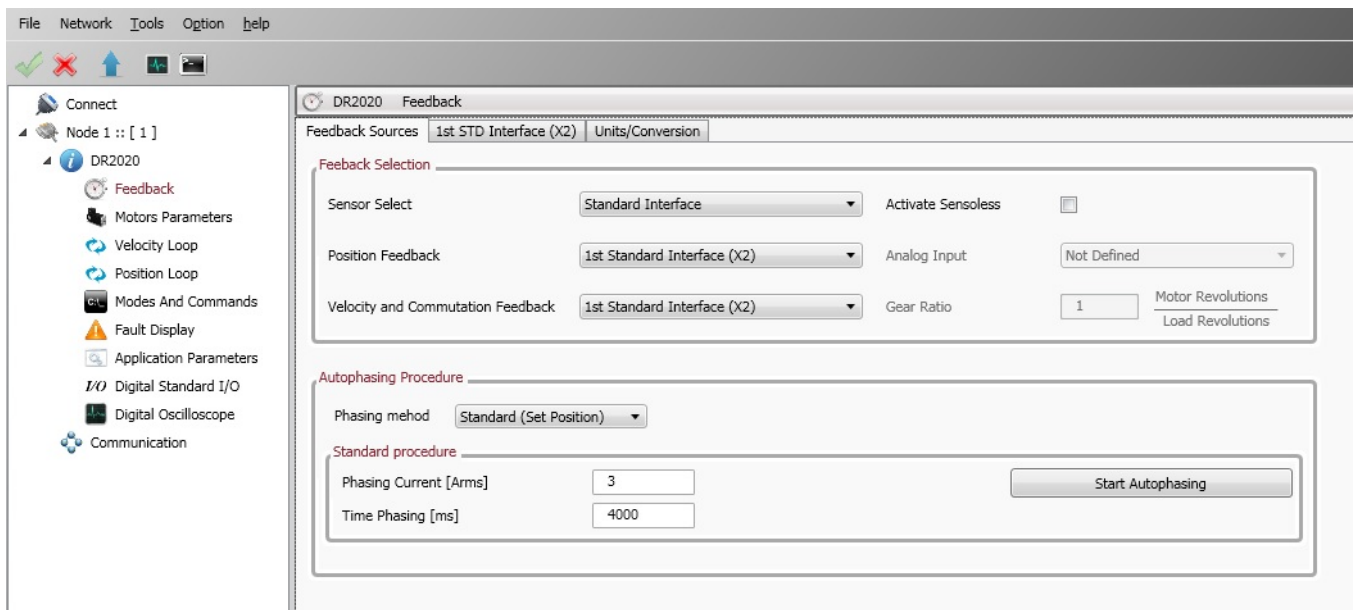
From the navigation area, select “**Feedback**”: Select the tab “**Feedback sources**”.

Configure the timing current with a value equal to the rated motor current (**Timing Current** field).

Configure the **timing time** as required (set to a maximum value of 4 seconds).

Press the “**Begin timing**” button: The progress indicator will be displayed (green if OK, red if there are alarms).

By selecting the tab “**1° STD interface**”, the timing values for before and after the operation can be viewed in order to ensure that this process is taking place correctly.



5.6. Enabling the axis

The drive implements the DS402 profile (standard CiA). The enabling of the drive depends on the application of a command which can be received remotely (fieldbus (EtherCAT or CAN)), via HW (analogue function) or from the GUI (Local operation).

- Fieldbus (EtherCAT or CAN): Enabling is carried out by the Master (PLC) via Control-Word
- Analogue: Enabling is carried out by hardware, configuring the I/Os at the same time
- Local: Enabling is carried out by a command from the GUI (**Mode and Commands/Command**)

The sequence of commands for enabling is as follows:

- 1) Fault reset (if fault present)
- 2) Power off
- 3) Power on
- 4) Enable operation

See the Online Help for more details.

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

It is possible to record and view numerous variables within the drive.

From the **Navigation area**, select **"Digital oscilloscope"**.

5.7.1. Configure recording

Select the **"Channels"** tab. For each channel, choose the variable you want to view from the drop-down menu.

The number of variables that can be accessed depends on the user access mode ("Advanced" or "Normal").

To change the access mode, select "Options/modes" from the toolbar and continue with your choice.

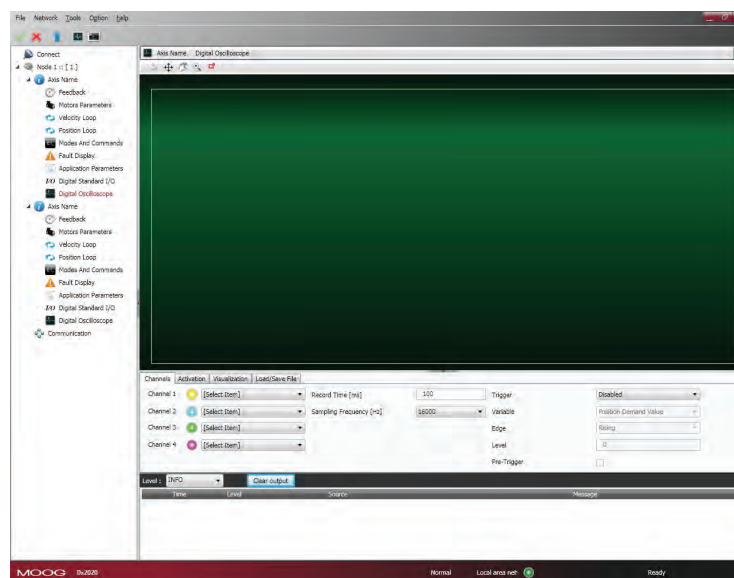
A maximum of four tracks can be viewed..

Set the duration of the recording in msec (**"Recording time"**) and the **"Sampling frequency"** in Hz.

It is possible to trigger viewing (and recording) on a specific event by choosing **"Enabled"** from the **"Trigger"** field (choosing **"Continuous"** will automatically provide repeated views of the same event).

To configure the trigger: Choose the trigger variable from those which appear in the drop-down menu in the **"Variable"** field. Next, choose the front ("Ascent"/"Descent" in the **"Front"** field) and the level of activation of the trigger (numeric value, in the **"Level"** field).

The setting of the **"Pre Trigger"** allows users to view up to 512 bytes before the signal is triggered.

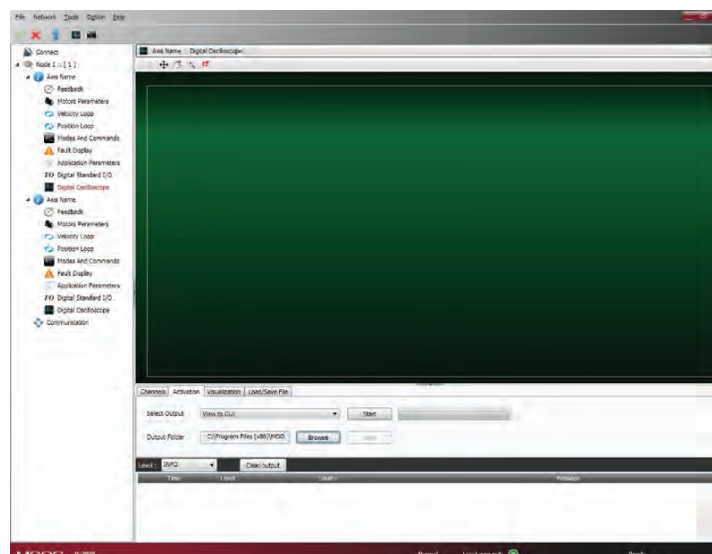


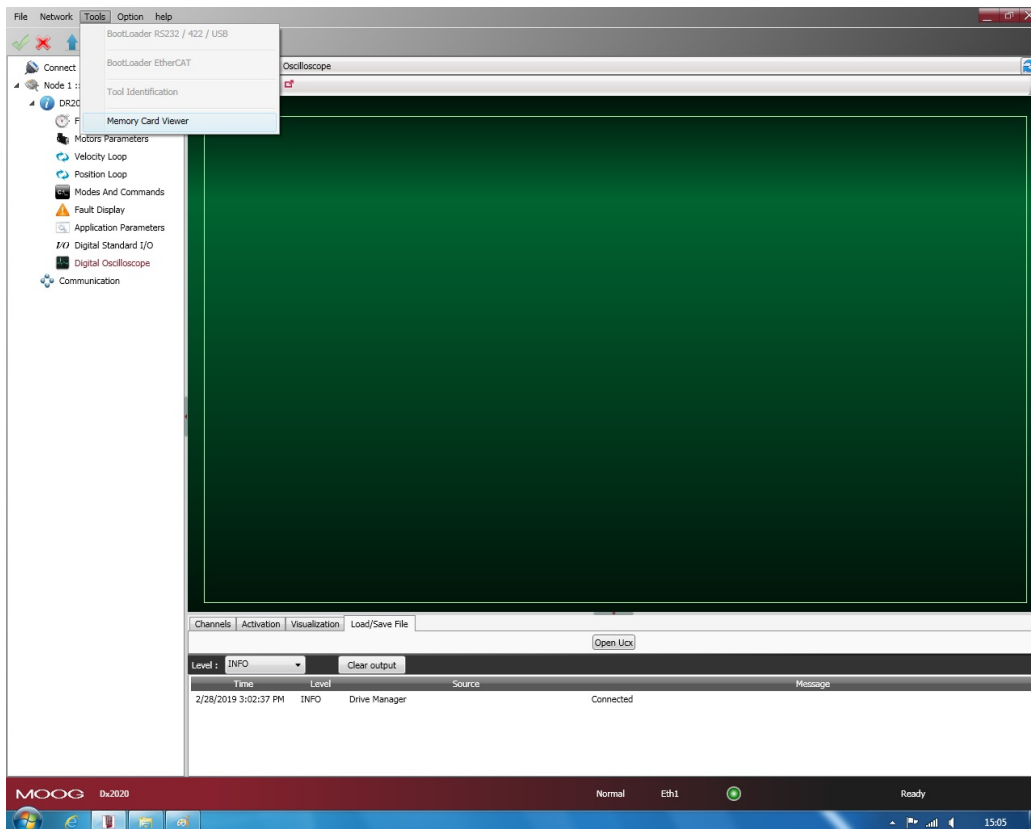
5.7.2. Launch recording





Select the **"Activation"** tab.

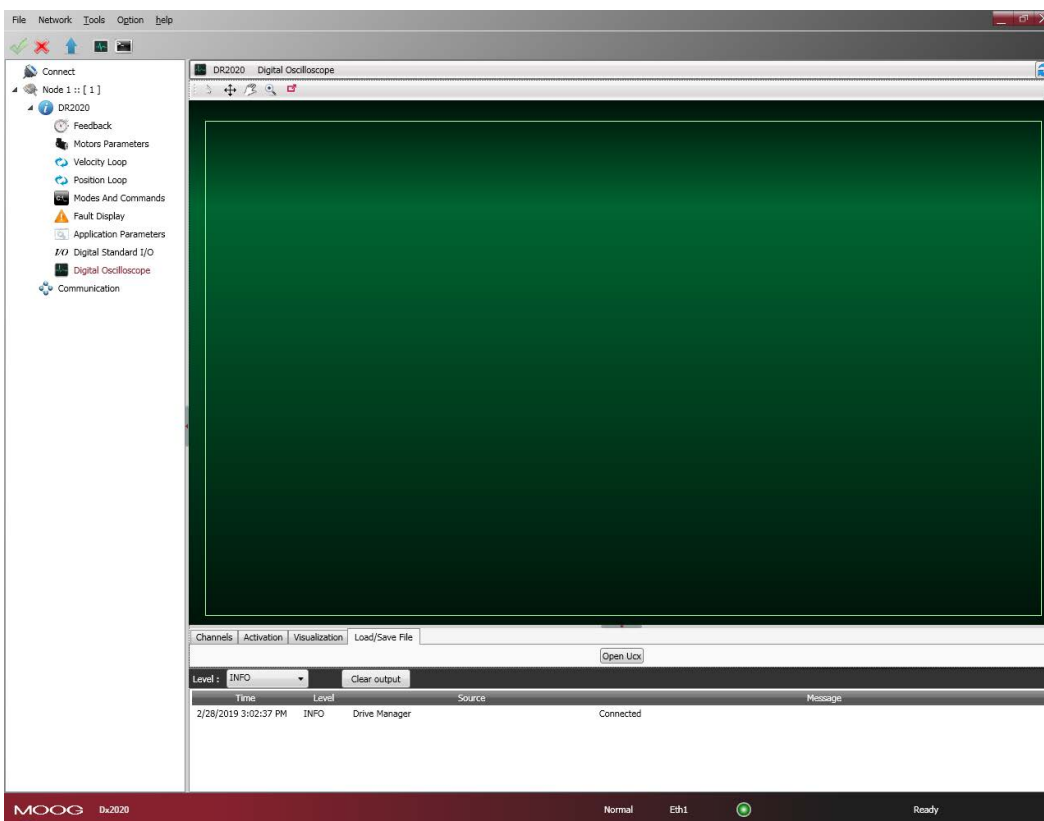
From the **"Select output"** field, choose one of the three options from the drop-down menu:

- See in GUI: The sizes are only viewed and not recorded
 - Local save: The sizes are viewed and saved on the PC in the directory indicated in the **"Output folder"** field
- Launch recording by pressing the **"Start"** button and stop by pressing the **"Stop"** button.





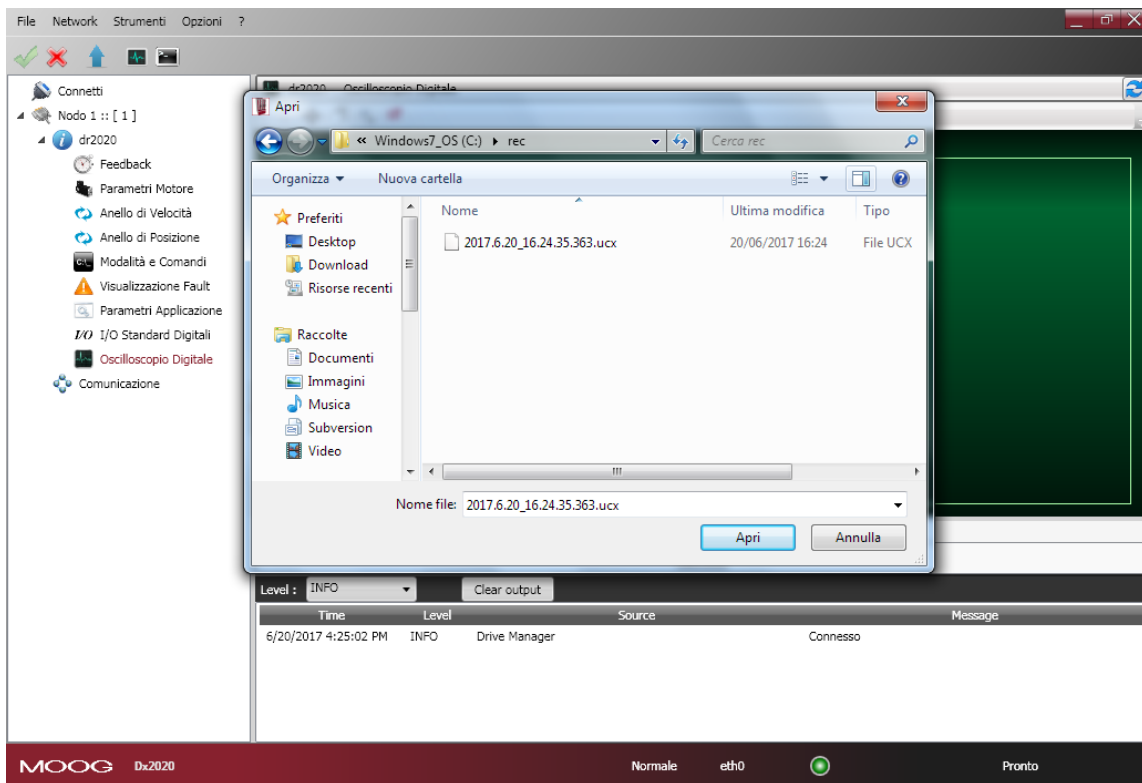
In the top-left corner are the functions Cursor Activation (Cursor ) , Moving the Graphic (Pan ) , Magnification of Details (Zoom ) and automatic printing of the image (Screenshot ) ; The mouse cursor reveals the legend of each of the four buttons when it hovers over each of them.



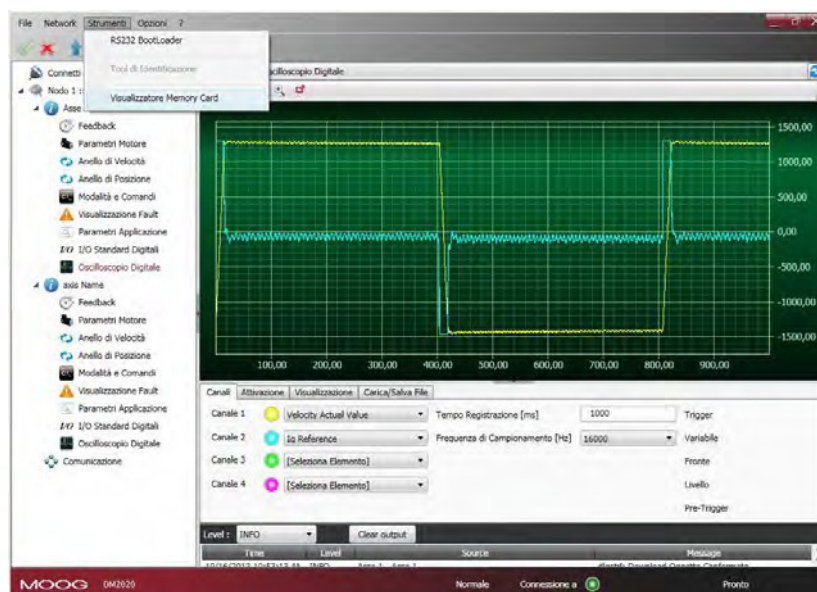
By selecting Auto Range, each signal is shown in the window; otherwise the data is displayed in the scale in which it is obtained, unless it is changed by varying the scale via the Scale command.

5.7.4. UCX file management

When data is saved in Local, a file is created with the name, date and time that this occurs. The extension of these files is “.UCX”. To view archived recordings, go to the “Load/Save file” tab and then access the file system via the “Open UCX” button.



The GUI also allows users to read data on the memory card directly. From the toolbar, select “View memory card”. (function not available for DR2020)

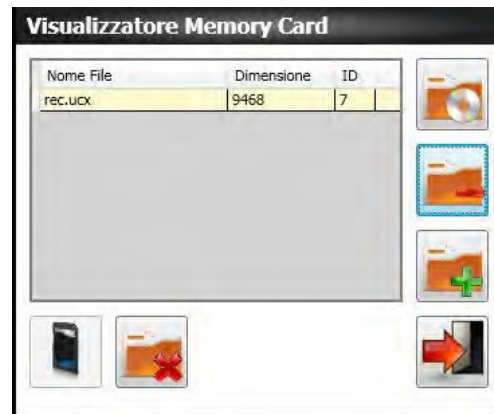


A dialogue box will open with buttons which allow users to open and process files; by selecting the icon with the memory car, the content can be viewed. The name of file is fixed: rec.ucx

Warning: The name of the file cannot be changed.

Each time a recording is made, the file on the SD card will be overwritten.

The copy on the PC automatically changes the file name.



Download files

Delete files

Add files

Exit

WARNING
In all cases, in order to record/view, the memory card must be in the drive (only for DM2020) The card has its own specific formatting; Windows formatting overwrites the data written by the drive; do not format the card with Windows, otherwise data will be lost when used in the DM2020.

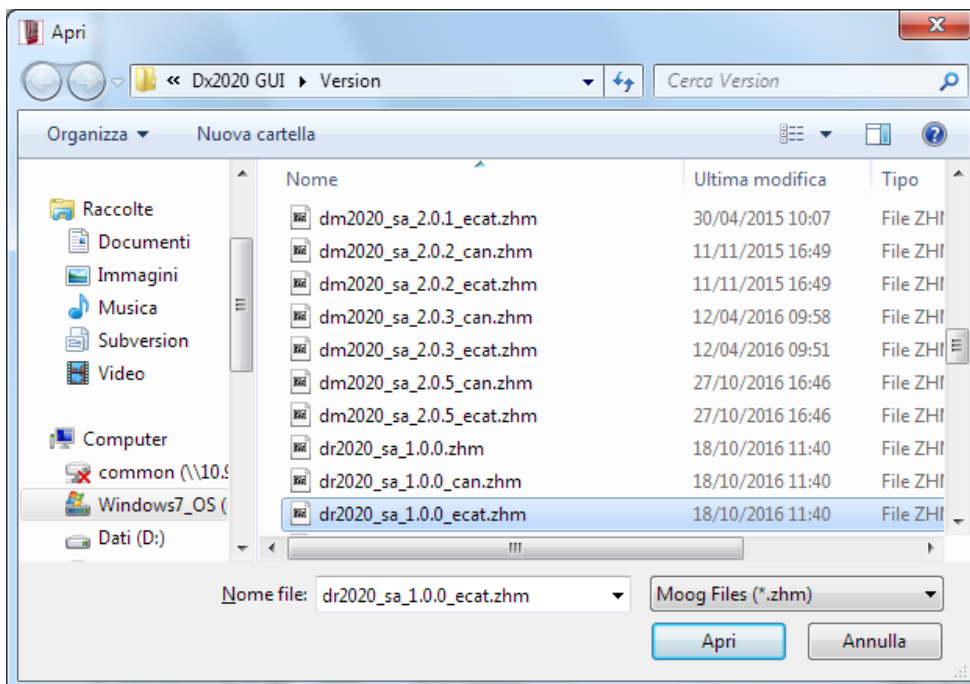
INFORMATION
The default GUI creates a REC folder in the temporary Windows folder without having permission issues
Saving to different folders may not be possible depending on the user's permissions

5.8. Use of the GUI in OFF-LINE mode

The GUI can also be used in offline mode, without the drive to prepare the drive configuration files, or to edit them or to check their contents.

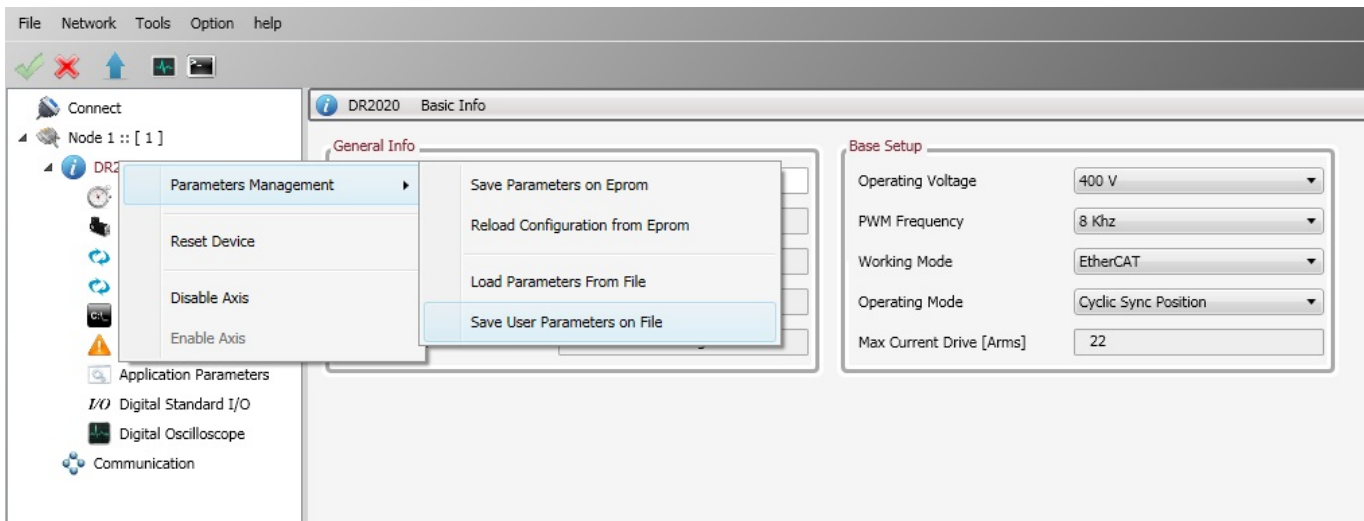
To go into offline mode, select **File/OFF LINE** from the menu toolbar.

Select **File/Open** for the SW release with which to work.



Alternatively, by selecting a file without having connected the drive, the GUI suggests switching to the OFF LINE mode

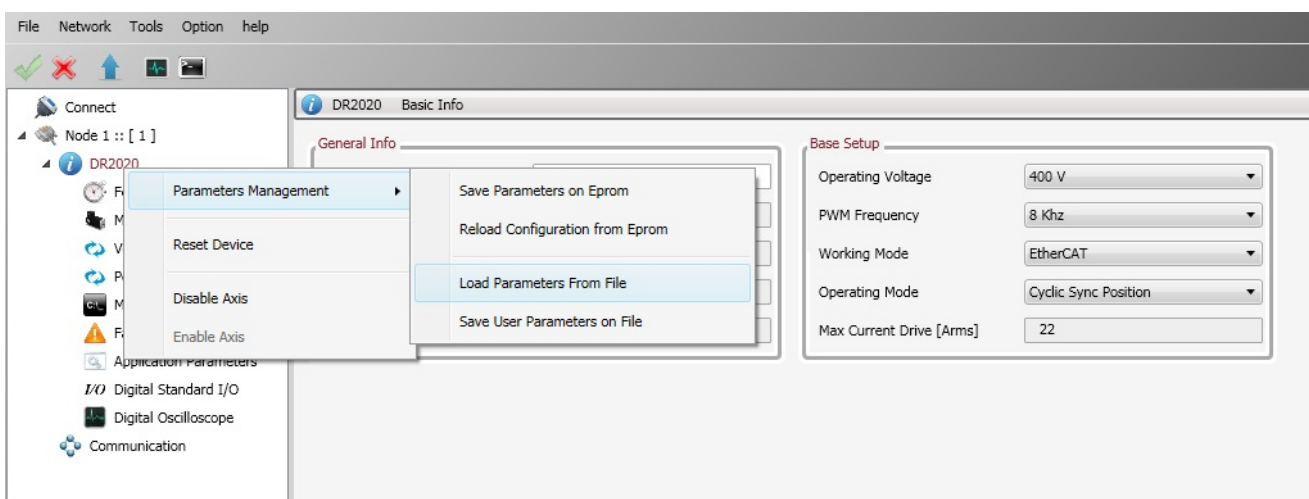
To check a file's parameters, from the main menu select the axis with the right button of the mouse, load the parameters as if there were a real drive connected, change them if needed and save the new configuration file to the new parameters.



5.9. Parameters management menu

Clicking once on the right mouse button on the axis name will open the menu. The following operations can be carried out:

- **Manage parameters:**
 - Save the current configuration on the internal memory of the drive
 - Restore a saved configuration from the internal memory
 - Upload a configuration saved onto a file (download file parameters)
 - Save the current configuration onto the file (upload file parameters)
- **Reset item:** Reset the selected device
- **Disable axis:** Disable the axis selected
- **Enable axis:** Enable the axis selected



6. TROUBLESHOOTING

6.1. Introduction

The main malfunctions are listed and described below, along with a set of instructions on how to resolve them. If any problem persists, contact the Moog-Casella Service Centre.

6.2. Power supply unit anomalies

YELLOW LED	GREEN LED	RED LED	Status
Off	Off	On - red light	Power supply fault

Cause	Check
The drive temperature is high	<ul style="list-style-type: none"> Check the direct current being delivered to the axes Check the effectiveness of the fans
Correcting the fault	Check the brake resistor
Overvoltage	

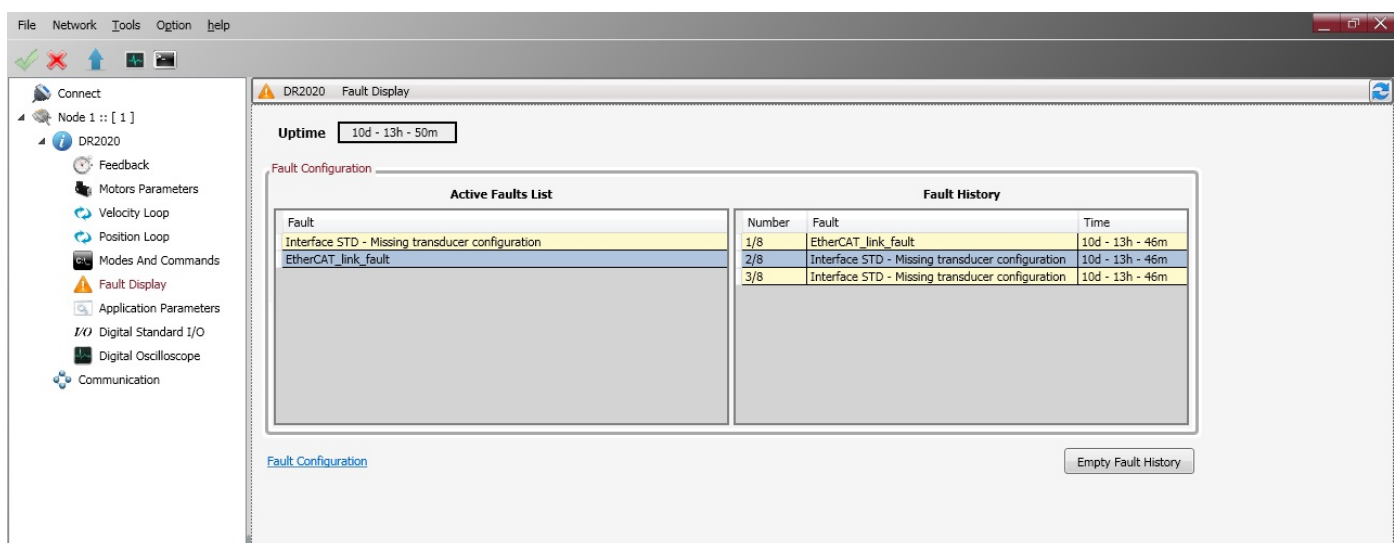
6.3. Axis module anomalies

In the standard version (with EtherCat) the drive settings can be managed on the EtherCat line from the EtherCat Master Controller which can perform the same functions as the GUI for parameter setup.

The GUI can coexist on a line with another EtherCat master without hindering the control of the machine (make sure that the EtherCat controller supports this connection).

The axis module alarms are indicated on the axis display with the letter F. For a detailed analysis, connect to the Dx2020 GUI software, select "Fault display" from the main menu, then proceed with anomaly analysis:

Any alarms active at that time will be listed on the left-hand side of the window (active fault list) and a list of the 8 most recent alarms will appear on the right-hand side (fault history).



6.3.1. Power section alarms

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

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

This type of alarm occurs when the drive identifies excess current or a short circuit on one of the six output stage IGBTs.

Possible causes of this type of alarm are listed in the table:

Cause	Check
Motor short circuit	Use a multimeter or other suitable instrument to check motor insulation. Alternatively: <ul style="list-style-type: none"> Remove the motor power cable Enable the axis again If the problem is remedied, replace the motor
Short circuit between the motor cables.	Disconnect the cable from the motor and drive and use a multimeter or other suitable instrument to check cable insulation. Alternatively: <ul style="list-style-type: none"> Remove the motor power cable on the drive side Enable the axis again
Wrong current loop regulation	Check the motor parameters entered in the drive configuration.
Damaged internal drive components	If the problem persists after carrying out all checks, replace the drive.

6.3.2. Alarm due to VBUS voltage not within tolerance limits

Fault	Cause	Check
DC_Link_Under Voltage	Voltage beneath minimum threshold set	Circuit reading fault
DC_Link_Over Voltage	Voltage higher than the maximum value permitted.	Brake resistor is not connected to the power supply module or is faulty



WARNING

In the case of controlled braking, the kinetic energy available is regenerated on the BUS DC and partly stored in the capacitors; the excess, if not dissipated by the braking resistor (RR on the power supply), can result in DC_Link_Over Voltage. It is advisable to disable the axis to avoid any damage to the drives.

AVERTISSEMENT

Dans le cas de freinage contrôlé, l'énergie cinétique disponible est régénérée sur le bus DC et en partie stockée dans les condensateurs; l'excès, sinon dissipé par la résistance de freinage (RR sur l'alimentation), peut entraîner "DC_Link_Over_Voltage". Il est conseillé de désactiver l'axe pour éviter d'endommager les unités

6.3.3. Drive or motor over-temperature

- **excess_temperature_drive**
- **motor_temperature_warning**
- **motor_over_temperature**

If a drive or motor over-temperature is reported, the cause of the problem must be analysed based on the table:

Cause	Check
The drive temperature is high (above 50 °C)	<ul style="list-style-type: none"> Check the efficiency of the cooling fans; replace if they do not work; Check the direct current of the module axes; if above the required value, check the operating status of the machine
The motor temperature is high (above 85 °C on the motor structure)	<ul style="list-style-type: none"> Check there are no variations in the machine operating cycle; check whether control parameters are no longer suitable for the application Check that motor timing has not changed
The drive temperature is low (below 50 °C)	Possible fault in the temperature reading inside the circuit
The motor temperature is low (below 60 °C on the motor structure)	Possible fault on the internal thermal sensor or a thermal protection configuration (using software)

6.3.4. STO signal removal

Safety_stage_low_voltage: STO protection intervention

If the power to the STO circuit is disconnected, the drive releases the axis, disabling the output power.

If there is a conflict between the command and signal feedback, the STO circuit inside the drive could be damaged; check that 24 V DC absorption on the two inputs is approximately 50 mA per input. If absorption is different from this value, replace the module.

6.3.5. Memory device errors

eeeprom_fault

The drive's internal memory is damaged or inaccessible. The drive module must be replaced.

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 saved data is corrupted, the drive reports an alarm. To solve the problem, try checking the drive configuration using the GUI and saving the parameters in advanced mode, then 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 brake circuit.

The drive checks that the output voltage is consistent with the command. The alarm may be caused by a mismatch between the command and output voltage.

The internal circuit is protected from short circuits and the protection is enabled if current to the motor brake exceeds 2 A. If this occurs, the causes may be:

Cause	Check
Short circuit on the cable connecting to the brake	Use a multimeter or other suitable instrument to check for short circuits in the brake cable or between the brake cable and earth, or: <ul style="list-style-type: none"> • Disconnect the brake cable on the drive side and try to enable again • If the problem is not remedied, replace the brake cable
Short circuit in the brake	Use a multimeter or other suitable instrument to check for short circuits in the brake or between the brake and earth: Alternatively: <ul style="list-style-type: none"> • Disconnect the brake cable on the motor side and try to enable again • If the problem is not remedied, replace the motor
Detection circuit fault	<ul style="list-style-type: none"> • Send the drive away for analysis and repairs

6.3.8. Feedback device errors

For correct operation, all feedback signals must reach the drive in an appropriate way; if this does not happen, the causes are indicated by the alarm which identifies in detail which transducer function is wrong or missing. First check the cable is wired properly, is not interrupted and settings are correct. Repeat this analysis for all the situations described below.
On the Fault configuration screen, errors on feedback are identified by:

- **Interface STD**

Fault Configuration		
Fault	Reaction	Status
Interface STD - Missing transducer configuration	DISABLE	✓
Interface STD - General Fault	DISABLE	✓
Interface STD - Erroneous value of sincos signals	DISABLE	✓
Interface STD - Hiperface position conflict	DISABLE	✓
Interface STD - Hiperface status error	DISABLE	✓
Interface STD - Hiperface transmit error	DISABLE	✓
Interface STD - Hiperface receive error	DISABLE	✓
Interface STD - Endat22 warning message	DISABLE	✓
Interface STD - Endat22 error1 message	DISABLE	✓
Interface STD - Endat22 error2 message	DISABLE	✓
Interface STD - Endat22 crc error	DISABLE	✓
Interface STD - Endat22 position not ready	DISABLE	✓
Interface STD - Endat22 not ready for strobe	DISABLE	✓
Interface STD - Resolver synchronization fault	DISABLE	✓
Interface STD - Resolver signals fault	DISABLE	✓
synchronization_error	DISABLE	✓
interrupt_time_exceeded	DISABLE	✓
task_time_exceeded	DISABLE	✓
velocity_control_monitoring	EMERGENCY	✓
following_error	EMERGENCY	✓
position_reference_limit	EMERGENCY	✓
EtherCAT_link_fault	DISABLE	✓
EtherCAT_communication_fault	DISABLE	✓

Close

Fig 6.1 Screen showing errors on feedback devices

Fault	Cause	Check
Missing Transducer Configuration	Interface STD is enabled, but transducer configuration is missing.	Configure.
Resolver Signals Fault	Signal resolver level error (amplitude)	Carrying out cable compensation
Erroneous value of sincos signals	Each alarm describes the problem in detail. Except in cases of incorrect or missing configuration of the device, replace the DR2020 module	
Hiperface position conflict		
Hiperface status error		
Hiperface transmit error		
Hiperface 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 and Task Time Error

Fault	Cause	Check
synchronization_error	Irregular internal frequency interrupt	Reprogramming of 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 time limit	

6.3.10. EtherCAT fault

Fault	Cause	Check
EtherCAT_communication_fault	Communication error	Check the wiring configuration of the communication of the drive and/or the EtherCAT master
EtherCAT_link_fault	Eth link not present	
EtherCAT_rpdo_data	PDO data received not correct	
EtherCAT_rpdo_time_out	PDO data not received or received after time-out	
EtherCAT_tpdo_data	PDO data received not transmitted	
EtherCAT_tpdo_time_out	PDO data not transmitted or transmitted after time-out	
Internal_transmit_pdo_time_out	Error in internal PDO communication error (dual-axis)	
Internal_receive_pdo_time_out	PDO internal communication time-out (dual-axis)	

6.3.11. Alarms related to the control loops

Fault	Cause	Check
Velocity Control Monitoring	The maximum speed allowed by the application has been exceeded	Check command signals and their consistency with configured data and correct operation of the drive.
Following Error	The maximum follow error allowed by the application has been exceeded	Check: <ul style="list-style-type: none"> • The command signals and their consistency with configured data • The correct functioning of the drive and of the machine being commanded

6.3.13. CAN bus alarms

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

6.4. Alarms identification

If the drive is used in fieldbus mode (EtherCat / Can), the error code will be transmitted via an EMERGENCY message (according to the CANOpen standard) consisting of ErrorCode and ErrorRegister

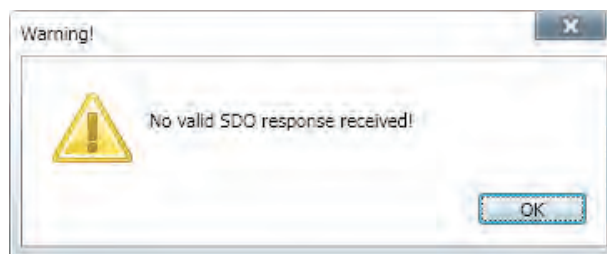
Fault index	Error code	Error register	Fault	Fault
1	0x2344	0x04	short_circuit_phase_U_low	IGBT fault phase U lower arm
2	0x2345	0x04	short_circuit_phase_U_hi	IGBT fault phase U upper arm
3	0x2346	0x04	short_circuit_phase_V_low	IGBT fault phase U lower arm
4	0x2347	0x04	short_circuit_phase_V_hi	IGBT fault phase U upper arm
5	0x2348	0x04	short_circuit_phase_W_low	IGBT fault phase W lower arm
6	0x2349	0x04	short_circuit_phase_W_hi	IGBT fault phase W upper arm
7	0x3220	0x04	dc_link_under_voltage	Bus undervoltage
8	0x3210	0x04	dc_link_over_voltage	Bus overvoltage
9	0x4310	0x08	excess_temperature_drive	Excessive drive temperature (IGBT module protection)
10	0x5114	0x04	safety_stage_low_voltage	STO power circuit not detected (this fault is detected only in "operation Enable")
11	0x5530	0x01	eeeprom_fault	Error reading EEPROM memory from the power block or invalid content.
12	0x5540	0x01	sd_memory_fault	External memory card not detected.
13	0x6010	0x01	software_watchdog	Software alarm
14	0x6320	0x01	parameter_initialisation_error	Initialisation error
15	0x6311	0x01	node_identifier_data_memory_corrupted	Not used
16	0x6312	0x01	user_data_memory_corrupted	Parametric user memory corrupt/not configured
17	0x6313	0x01	restore_data_memory_corrupted	Not used
18	0x6314	0x01	factory_data_memory_corrupted	Constructor parameter memory corrupt/not configured
19	0x6315	0x01	calibration_data_memory_corrupted	Not used
20	0x6316	0x01	diagnosis_data_memory_corrupted	Not used
21	0x7110	0x01	brake_feedback_fault	Brake status signal inconsistent
22	0x7124	0x08	motor_temperature_warning	Motor temperature warning
23	0x7125	0x08	motor_over_temperature	Motor temperature fault
24	0x7380	0x01	Interface X3 - Missing transducer configuration	Interface X3 transducer enabled but not configured
25	0x7381	0x01	Interface X3 - General fault	Not used
26	0x738D	0x01	Interface X3 - Resolver synchronisation fault	Resolver signal synchronisation error (phase)
27	0x738E	0x01	Interface X3 - Resolver signals fault	Signal resolver level error (amplitude)
28	0x7390	0x01	Interface X2 - Missing transducer configuration	Interface X2 transducer enabled but not configured
29	0x7391	0x01	Interface X2 - General fault	Initialisation error or transducer not detected
30	0x7392	0x01	Interface X2 - Erroneous value of sincos signals	Sinusoidal signal amplitude inconsistent

Fault index	Error code	Error register	Fault	Fault
31	0x7393	0x01	Interface X2 - Hiperface position con ict	Digital position (Hiperface protocol) inconsistent with calculated position
32	0x7394	0x01	Interface X2 - Hiperface status error	Encoder status error (Hiperface protocol)
33	0x7395	0x01	Interface X2 - Hiperface transmit error	Encoder transmission error (Hiperface protocol)
34	0x7396	0x01	Interface X2 - Hiperface receive error	Encoder reception error (Hiperface protocol)
35	0x7397	0x01	Interface X2 - EnDat22 warning message	Warning message from EnDat 22 encoder
36	0x7398	0x01	Interface X2 - EnDat22 error1 message	Type 1 error message from EnDat 22 encoder
37	0x7399	0x01	Interface X2 - EnDat22 error2 message	Type 2 error message from EnDat 22 encoder
38	0x739A	0x01	Interface X2 - EnDat22 crc error	CRC error from EnDat 22 encoder
39	0x739B	0x01	Interface X2 - EnDat22 position not ready	Position error - not ready from EnDat 22 encoder
40	0x739C	0x01	Interface X2 - EnDat22 not ready for strobe	Strobe error - not ready from EnDat 22 encoder
41	0x73A0	0x01	Interface X1 - Missing transducer con guration	Optional interface X1 transducer enabled but not configured
42	0x73A1	0x01	Interface X1 - General fault	Initialisation error or transducer not detected (optional interface X1)
43	0x73A2	0x01	Interface X1 - Erroneous value of sincos signals	Amplitude of sinusoidal signals inconsistent (optional interface X1)
44	0x73A3	0x01	Interface X1 - Hiperface position con ict	Digital position (Hiperface protocol) inconsistent with calculated position (optional interface X1)
45	0x73A4	0x01	Interface X1 - Hiperface status error	Encoder status error (Hiperface protocol - optional interface X1)
46	0x73A5	0x01	Interface X1 - Hiperface transmit error	Encoder transmission error (Hiperface protocol - optional interface X1)
47	0x73A6	0x01	Interface X1 - Hiperface receive error	Encoder reception error (Hiperface protocol - optional interface X1)
48	0x73A7	0x01	Interface X1 - EnDat22 warning message	Warning message from EnDat 22 encoder (optional interface X1)
49	0x73A8	0x01	Interface X1 - EnDat22 error1 message	Type 1 error message from EnDat 22 encoder (optional interface X1)
50	0x73A9	0x01	Interface X1 - EnDat22 error2 message	Type 2 error message from EnDat 22 encoder (optional interface X1)
51	0x73AA	0x01	Interface X1 - EnDat22 crc error	CRC error from EnDat 22 encoder (optional interface X1)
52	0x73AB	0x01	Interface X1 - EnDat22 position not ready	Position error - not ready from EnDat 22 encoder (optional interface X1)
53	0x73AC	0x01	Interface X1 - EnDat22 not ready for strobe	Strobe error - not ready from EnDat 22 encoder (optional interface X1)
54	0x73AD	0x01	Interface X1 - Resolver synchronization fault	Not used
55	0x73AE	0x01	Interface X1 - Resolver signals fault	Not used
56	0x8700	0x01	synchronization_error	Irregular internal frequency interrupt
57	0x6102	0x01	interrupt_missing(era Interrupt_time_exceeded)	Internal interrupt signal not detected
58	0x6103	0x01	Task_time_exceeded	The execution of the task has exceeded the maximum time limit

Fault index	Error code	Error register	Fault	Fault
59	0x8400	0x01	velocity_control_monitoring	Error - maximum speed exceeded
60	0x8611	0x01	following_error	Error following position
61	0x8612	0x01	position_reference_limit	Not used
62	0x8101	0x10	EtherCAT_link_fault	EtherCAT link not found
63	0x8100	0x10	EtherCAT_communication_fault	Generic EtherCAT communication fault
64	0x8231	0x10	EtherCAT_rpdo_time_out	PDO reception time-out
65	0x8241	0x10	EtherCAT_rpdo_data	Error PDO reception data
66	0x8235	0x10	EtherCAT_tpdo_time_out	PDO transmission time-out
67	0x8245	0x10	EtherCAT_tpdo_data	Error PDO transmission data
68	0x8181	0x10	Internal_communication_fault	Generic internal communication fault (dual-axis module)
69	0x8182	0x10	Internal_communication_heartbeat_error	Internal communication fault – the axis 1(2) does not detect the presence of the axis 2(1) (dual-axis module)
70	0x8183	0x10	internal_receive_pdo_time_out	Internal communication fault - PDO reception time-out (dual-axis module)
71	0x8184	0x10	internal_transmit_pdo_time_out	Internal communication fault - PDO transmission time-out (dual-axis module)
72	0x3100	0x10	Phases_not_ok	Not used
73	0x3200	0x04	Overcurrent	Overcurrent fault
74	0x8100	0x04	CAN_communication_fault	Generic CAN communication fault
75	0x8231	0x10	CAN_rpdo0_time_out	PDO0 reception time-out
76	0x8232	0x10	CAN_rpdo1_time_out	PDO1 reception time-out
77	0x8233	0x10	CAN_rpdo2_time_out	PDO2 reception time-out
78	0x8234	0x10	CAN_rpdo3_time_out	PDO3 reception time-out
79	0x8241	0x10	CAN_rpdo0_data	Error PDO0 reception data
80	0x8242	0x10	CAN_rpdo1_data	Error PDO1 reception data
81	0x8243	0x10	CAN_rpdo2_data	Error PDO2 reception data
82	0x8244	0x10	CAN_rpdo3_data	Error PDO3 reception data
83	0x8235	0x10	CAN_tpdo0_time_out	PDO0 transmission time-out
84	0x8236	0x10	CAN_tpdo1_time_out	PDO1 transmission time-out
85	0x8237	0x10	CAN_tpdo2_time_out	PDO2 transmission time-out
86	0x8238	0x10	CAN_tpdo3_time_out	PDO3 transmission time-out
87	0x8245	0x10	CAN_tpdo0_data	Error PDO0 transmission data
88	0x8246	0x10	CAN_tpdo1_data	Error PDO1 transmission data
89	0x8247	0x10	CAN_tpdo2_data	Error PDO2 transmission data
90	0x8248	0x10	CAN_tpdo3_data	Error PDO3 transmission data
91	0x8130	0x10	CAN_life_guard_error	Error on life guardian error
92	0x823A	0x10	CAN_sync_consumer_time_out	Time out sync

6.5. Anomalies during GUI - drive connection

In cases where communication between the PC and the drive fails, an error message will appear.



The cause could be the PC buffer that needs to be emptied; try again and if the problem is not solved, check the status of the connection cable of the PC communication interface



INFORMATION

For the _EtherCat firmware version the default baud rate is 1Mbps even if the drive supports up to 100Mbps, while for the _CAN firmware version the default value is 500 Kbps. The default node is 127 for both firmware versions.

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

- Connect to the drive.
- Read the baud rate value from the terminal (locbdr parameter for the firmware _ecat version or canbdr parameter for the firmware _can version);
- Read the node ID from the terminal (locmodide parameter for the _ecat version or the modide parameter for the firmware _can version).

If the connection is made via EtherCAT:

- Check that the correct network card is selected;
- Check that the cable being used is appropriate.



INFORMATION

The EtherCAT CAT5 cable must be STRAIGHT and NOT CROSSED.

7. SAFE TORQUE OFF SAFETY FUNCTION (TRANSLATION OF ORIGINAL INSTRUCTIONS)

7.1. Application

The Safe Torque Off (STO) safety function of the DR2020 has been manufactured with a redundant circuit incorporated into the control board.

The STO function must only be used according to the instructions in this Manual.

7.2. Risk assessment of the installation

The functional safety requirements of a drive depend on the application, and must be considered during the overall risk assessment of the installation. Where the supplier of the drive is not responsible for powered devices, the subject designing the installation is responsible for a risk assessment, and for specifying requirements relative to the functional integrity levels 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 table below, identical to Table 4 of UNI EN ISO 13849-1:2008, shows the relationship between PL and SIL.

PL	SIL (IEC 61508-1, by way of example) high/continual operating mode
a	No correspondence
b	1
c	1
d	2
e	3

Tab 7.1 Relationship between performance levels (PL) and safety integrity levels (SIL)



INFORMATION

SIL 4 refers to catastrophic events,; Therefore it does not involve risks relative to machines.

The risk assessment of the machine must be carried out according to the Machinery Directive 2006/42/EC, referring to UNI EN ISO 12100:2010 and must contain the configuration of the safety circuit relative to the complete machine, considering all components incorporated in the safety system, including the drive.

7.3. Funzione Safe Torque Off

The Safe Torque Off safety function of the DR2020 has been validated according to the SIL 3 safety integrity level as defined in the CEI EN 61800-5-2: 2008 product standard proving that:

the chance for dangerous failures per hour (PFHd) is 9×10^{-10} hours⁻¹ (see 7.3.1 / 2).

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

Compliance with the UNI EN ISO 13849-1: 2008 has also been verified using the PFHd calculated with reference to the CEI EN 61800-5-2: 2008 standard. According to this standard, the STO function respects the performance level (PL) "and"(see 7.3.1).

The STO function is located in a subsystem as defined by the CEI EN 62061: 2005 standard, with a SIL limit required SILCL3.

The DR2020 STO safety function can also be used to safely stop injection molding machines, interlocked guards in the mold area and other less dangerous areas in compliance with the UNI EN 201: 2010 standard.

7.3.1. CHARACTERISTIC VALUES ACCORDING TO UNI EN ISO 13849-1

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

	Value	Observation
Performance level	PL e	
Category	4	External subsystems must be able to perform diagnostics at the same time as or before the subsequent safety function request, for example immediately when turned on, or at the end of a machine operating cycle.
MTTFd	> 100 years	According to UNI EN ISO 13849-1, a maximum value of 100 years may be considered.
Coverage of diagnostics	DC=99%	External systems that perform diagnostics must use technologies that can provide a $DC \geq 99\%$
Duration	20 years	Replace the drive
Repair time	8 hours	
Diagnostic test interval	maximum 8 hours	See also observations relative to the category

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

	Value	Observation
Performance level	PL e	
Category	4	External subsystems must be able to perform diagnostics at the same time as or before the subsequent safety function request, for example immediately when turned on, or at the end of a machine operating cycle.
MTTFd	> 100 years	According to UNI EN ISO 13849-1, a maximum value of 100 years may be considered.
Coverage of diagnostics	DC=99%	External systems that perform diagnostics must use technologies that can provide a $DC \geq 99\%$
Duration	20 years	Replace the drive
Repair time	8 hours	
Diagnostic test interval	maximum 8 hours	See also observations relative to the category

7.3.2 Characteristic values according to CEI EN 62061

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

	Value
Safety integrity levels	SIL 3
PFHd	9×10^{-10} ore-1
Test interval	20 years

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

	Value
Safety integrity levels	SIL 3
PFHd	9×10^{-10} ore-1
Test interval	20 years

7.4. Safety requirements

- Complete stop The Safe Torque Off functions prevents the unexpected start-up of a motor when stopped. This circuit may be used in the “safe stop” machine function. When the motor is rotating and the Safe Torque Off function is enabled, an uncontrolled stop is generated (category 0 according to EN 60204- 1: 2006). When a category 1 controlled stop is requested, according to EN 60204-1: 2006, the motor must stop within defined deceleration limits or after a delay in the application. The end machine must be able to stop the motor.



WARNING

During risk assessment, the engineer must evaluate the machine stop time. The Safe Torque Off safety function operating time must be greater than the braking time of the deceleration ramp set with maximum speed and maximum load on the axis. The assessment should allow for the possibility of a fault. The machine may have a hazardous overload in the event of motor failure and additional protective measures may be required to attain safer conditions.

AVERTISSEMENT

Au cours de l'évaluation des risques, l'ingénieur doit évaluer le temps d'arrêt de la machine. Le temps de fonctionnement de la fonction de sécurité Safe Torque Off doit être supérieur au temps de freinage de la rampe de décélération défini par vitesse maximale et charge maximale sur l'axe. L'évaluation devrait prévoir la possibilité d'un défaut. La machine peut avoir une surcharge dangereuse en cas de panne de moteur et des mesures de protection supplémentaires peuvent être nécessaires pour atteindre des conditions plus sûres.

- Response time: The maximum response time for STO safety function enabling and disabling is 10 ms.
- Environmental conditions (the following conditions have been validated for safety purposes. Other conditions are indicated in Chapter 2 of this Manual)
 - Ambient temperature: From 0 to +40 °C
 - EMC immunity: according to EN 61800-3:2004, second (industrial) environment, category C3, (not suitable for use in a prime environment which includes domestic environments)
 - Resistance to vibrations: from 2 to 9 Hz, with an amplitude of 3 mm (peak); from 9 to 200 Hz, acceleration 1 g, according to EN 60721-3-3:1995, Class 3 M4
 - Resistance to impact: 10 g, semi-sinusoidal, 11 ms, according to EN 60721-3-3:1995, class 3 M4
- Casing. Electronic device to install in a casing with a minimum IP rating of 54.
- Pollution degree 2. The device must be installed in an environment with a pollution degree of 2, where only non-conductive pollution is usually present. However, temporary conductivity caused by condensation, when the electronic device is not operating, may occasionally be present.

**WARNING**

When the Safe Torque Off circuit is enabled, the motor can no longer generate torque. When external forces act on the axis (e.g. the force of gravity on the vertical axis), adequate protection must be provided, such as an automatic mechanical blocking system or weight equalisation system

**WARNING**

The Safe Torque Off function does not provide any electrical insulation. It does not provide any protection against electric shock. The machine or complete system must be electrically insulated from the power line using the main disconnecting device, locked in an open position, before carrying out any work on the machine or system, for example maintenance, servicing or cleaning (see EN 60204-1: 2006, section 5.3). Personnel must be aware that the busbars may have hazardous voltages after being turned off (capacitive voltage) and the discharge time is approximately 6 minutes

7.5. Safe Torque Off circuit

The Safe Torque Off function has been designed using redundant blocking devices that act independently of the power module controls. The function makes it possible to keep the drive to be turned off powered, to avoid the normal re-start procedure.

WARNING

The STO function is automatically restarted when safety inputs are enabled. The machine manufacturer is responsible for checking and installing a manual reset function, if necessary, that prevents the motor from restarting automatically

AVERTISSEMENT

La fonction STO est automatiquement redémarrée lorsque les entrées de sécurité sont activées. Le fabricant de la machine est responsable de la vérification et de l'installation d'une fonction de réinitialisation manuelle, si nécessaire, qui puisse empêcher le redémarrage automatique du moteur.

The DR2020 drive controls the movements of an AC three-phase motor by generating a rotating magnetic field. For this purpose the microprocessor generates a complex pulse model (PWM), which are amplified and used to drive the power semiconductors. The Safe Torque Off function of the DR2020 operates through hardware with two channels that interrupt pulses directed to IGBT.

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

7.6. SafeTorqueOff Connection

The management channels, including the "hardware feedback" signal, of the Safe Torque Off circuit are monitored using the X1 connector. Both monitoring channel work modes are always available; the user has the right to choose the type of monitoring; the "Hardware feedback" type or the "Software feedback" type or both the functions at the same time.

Pin	Name	Function
1	+“Channel1”	Input +24Vdc of channel 1. This input must be high (+24Vdc) to power the motor. When the input is low (0V) the motor is not powered.
2	+“Channel 2”	Input +24Vdc of channel 2. This input must be high (+24Vdc) to power the motor. When the input is low (0V) the motor is not powered.
3	Monitoring Channel	The "hardware feedback" electrical contact consists of a "Photo-Mos" relay protected by a fuse. When both control channels "Channel 1" and "Channel 2" are at low logic level (0V), the STO circuit is in safe mode (safety function enabled), the monitoring signal is active and provides closed contact. In all remaining cases the monitoring signal is always off, and provides open contact. The monitoring channel of the complete system must include this signal to execute the plausibility check correctly
A	-“Channel 1/2”	0V of Channel 1/2

**ATTENTION**

In order to be validated according to categories 1 to 4, on the basis of safety principles in UNI EN ISO 13849-2:2008, table D.2, external cables that run into the X1 connector must have shields connected to the earthing circuit

**WARNING**

To prevent short circuits between the input and the test signal, the multi-strand cables of the two channels must terminate with a cable terminal or other appropriate device

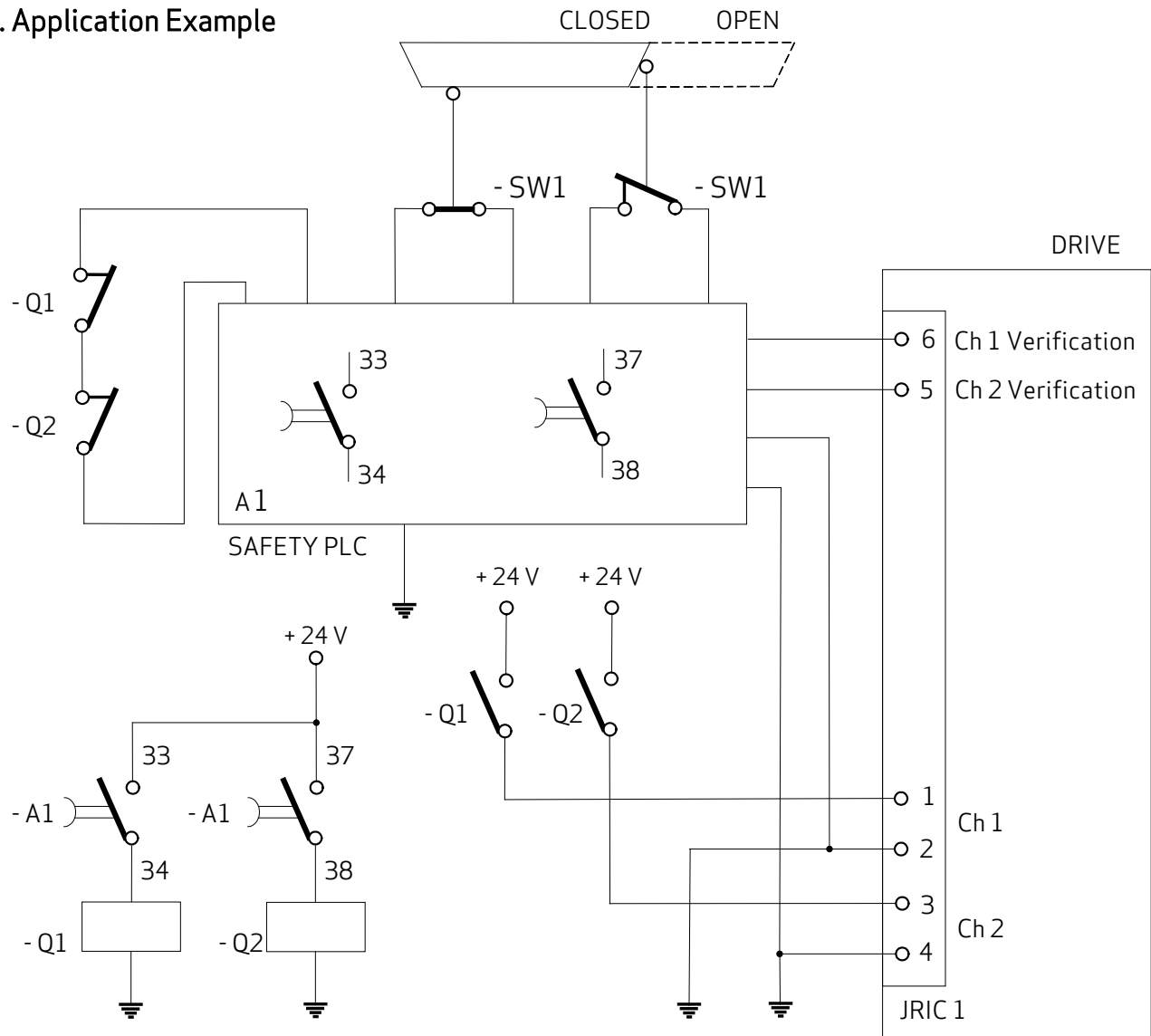
**WARNING**

The test signal wiring of the two channels must be protected from short circuits to voltage sources; external voltage must never be applied to the test signal, not even in the case of failure

Input/output electrical specifications

Input channel	$I_{nom} = 50\text{mA} (\pm 10\%)$ $V_{nom} = 24V_{CC} (\pm 10\%)$ $V_{max} = 30 V_{CC}$
Output – Channel testing	$I_{max} = 200 \text{ mA}$ $V_{max} = 30 \text{ Vdc}$

7.7. Application Example



Example of Safe Torque Off after a controlled stop

Description

Two redundant channels are used. The SW1 and SW2 repair switches are connected to the A1 safety PLC which controls the two Q1 and Q2 contactors with linked contacts. The NO contacts of Q1 and Q2 control the two input safety channels of DR2020 to turn off motor power connections. The NC contacts of Q1 and Q2 are used in series to control the A1 safety PLC in the case that an NO contact is welded. The two output safety channels of the DM2020 are connected to the A1 safety PLC to provide diagnostics coverage of the DR2020 subsystem.



INFORMATION

In the example, a controlled stop may be obtained by using the delayed outputs of A1. The controlled stop is not a safety function incorporated in the drive, so the relative circuit is not shown in the figure.



According to UNI EN ISO 13849-1:2008, the subsystem relative to input and output devices can attain a PL of “e” because:

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

The subsystems:

- A1 safety PLC has a PL of “e”
- The DM2020 drive (STO circuit) has a PL of “e”

The safety system can attain a PL of “e”, and a category of 4.

According to UNI EN ISO 62061:2005, the subsystem relative to input and output devices can attain a PL of “3” because:

- All safety-related devices have a PFHd < 10^{-7}

The subsystems:

- The A1 safety PLC has a SIL of 3
- The DM2020 drive (STO circuit) has a SIL of 3

The safety system may attain a SIL of 3.

Requirements of the example

- Before activating the STO function, the motor must be stopped while maintaining the power supply (controlled stop)
- The delay of the A1 outputs that activate the Q1 and Q2 contactors must be > T (general time of the stop system)
- The A1 safety PLC must conform to PL requirements and to EN ISO 13849-1
- The Q1 and Q2 safety contactors must have linked contacts according to IEC 60947-5-2, Attachment L (“mirror contacts”)
- When a person is able to fully enter the hazardous area, guards must be installed in addition to a detection system, or restart must only be possible after a separate restart which occurs after the guards have closed and ensured that no person remains in the hazardous area, in line with risk analysis guidance
- A short circuit between conductors connected to 33-34 A1 and between conductors connected to 37-38 A1 and between those connected to pins 1 and 2 of the drive must be prevented
- The signal paths must be physically separated
- Multi-strand cables connected to multi-pin connectors must terminate with a cable terminal or other appropriate device
- The test signal wiring of the two channels must be protected from short circuits to voltage sources; external voltage must never be applied to the test signal, not even in the case of failure
- The safety system must be validated according to EN ISO 13949-2:2008

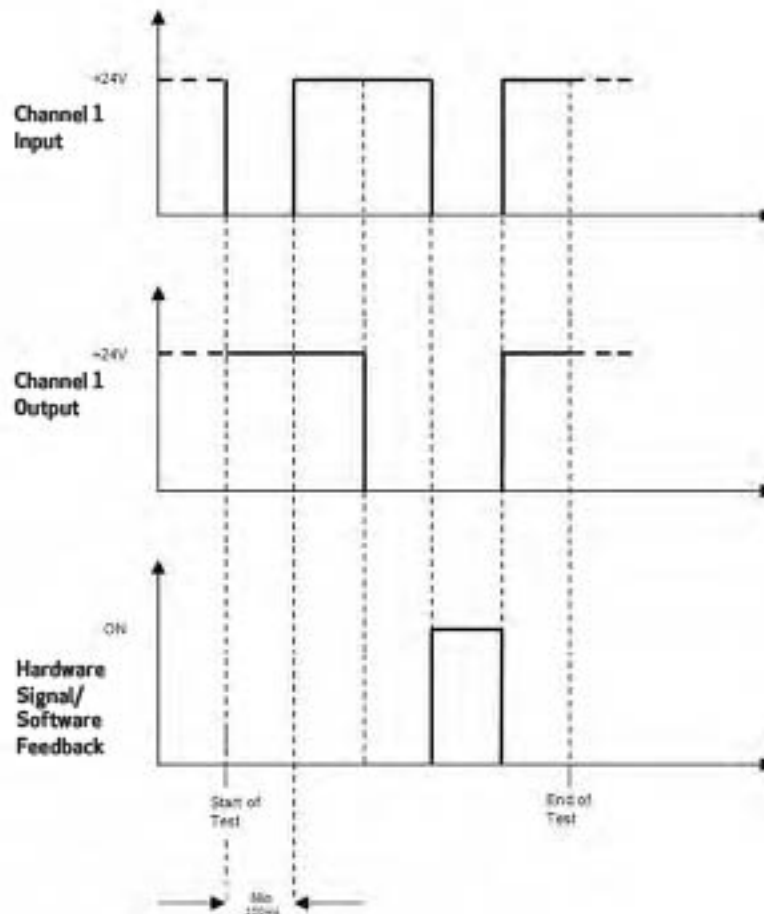
7.8. Safe Torque Off Installation and maintenance procedures

The following installation and maintenance procedures must always be carried out as indicated by qualified personnel who adopt the safety measures required by current regulation:

- on start-up
- on restart in case a fault has been detected and removed
- in any case at least every 8 hours

Run the activation / deactivation switching sequence shown in the figure below by supplying + 24Vdc and 0V on the two input channels connected to connector X1 and perform a plausibility check with the monitoring signals:

- **Hardware feedback:** on connector X1 check closed electrical contact (ON) or open contact (OFF)
- **Software feedback:** check the value of the "INTERLOCK STATUS" parameter object 60FD (digital inputs) bit3 defined by the IEC61800-7-201 standard, CIA 402



Mandatory sequence of STO circuit test



WARNING

If one of the above conditions is not met, the STO function may not be used. After remedying the fault, repeat the procedure.

AVERTISSEMENT

Si l'une des conditions précédentes n'est pas remplie, la fonction STO ne peut pas être utilisée. Après la panne est réparée, répétez la procédure.

- Stop Category1
Disable the protection devices, for example opening the guards while the motor is operating, and check that the motor stops.
- If the stop is category 1 according to EN 60204-1: 2006, check that the motor has stopped in a controlled mode, and that the Safe Torque Off function is enabled after the stop. This must not cause hazardous situations.

7.10. Assembly and production testing

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

7.11. Identification of the STO function on the drive's side plate

The new Safe Torque Off (STO) circuit is identified by the legend "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.
Regulator P	Regulating circuit functioning in a purely proportional manner.
Regulator PI	Control circuit running in a proportional and integral way.
Regulator 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