DM2020

USE AND MAINTENANCE MANUAL

MULTI-AXIS DIGITAL SERVO DRIVE

MOOG

INDEX

1.   OVERVIEW

1.1.   Contents

This manual provides information on the correct installation and optimal operation of the DM2020 series of digital multi-axis servo drives.

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The following are available at www.moog.it:

- 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'entrainement 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

This manual uses the following symbols to alert users to hazardous situations or give them useful information.

⚠ **WARNING**
Hazard that may result in death or serious injury
AVERTISSEMENT
Danger qui peut causer la mort ou des blessures graves

🛈 *CAUTION*
Hazard that may result in minor injury and/or material damage
ATTENTION
Danger qui peut entraîner des blessures mineures et / ou des dommages matériels

🔍 INFORMATION
Important information

1.3.   Contents of packaging

DM2020 servo drives include:

- A power supply
- An axis modules unit, which is single or double depending on system configuration
- A busbar number appropriate for connecting the system
- Busbar covers

🔍 INFORMATION
Components and relative accessories can be supplied individually as replacement parts.

1.4. Qualifications of recipients

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

Lorsque l'entrainement 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 le personnel responsable de commander l'entraînement.

1.5. Reference standards

The DM2020 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 drive meets the requirements of the relevant harmonised installation standards EN50178 (LVD), EN61800-3 (EMC) and EN 61800-5-2 (Safety of machinery).
The DM2020 drives are CE certified.

2.   DESCRIPTION OF THE SYSTEM

2.1. Product structure

2.1.1. Product description

The DM2020 drive is a new generation of digital servo drives manufactured by Moog-Casella for controlling brushless synchronous or asynchronous motors. The drives have a multi-axis rack configuration with a power supply module and various control modules positioned side by side.
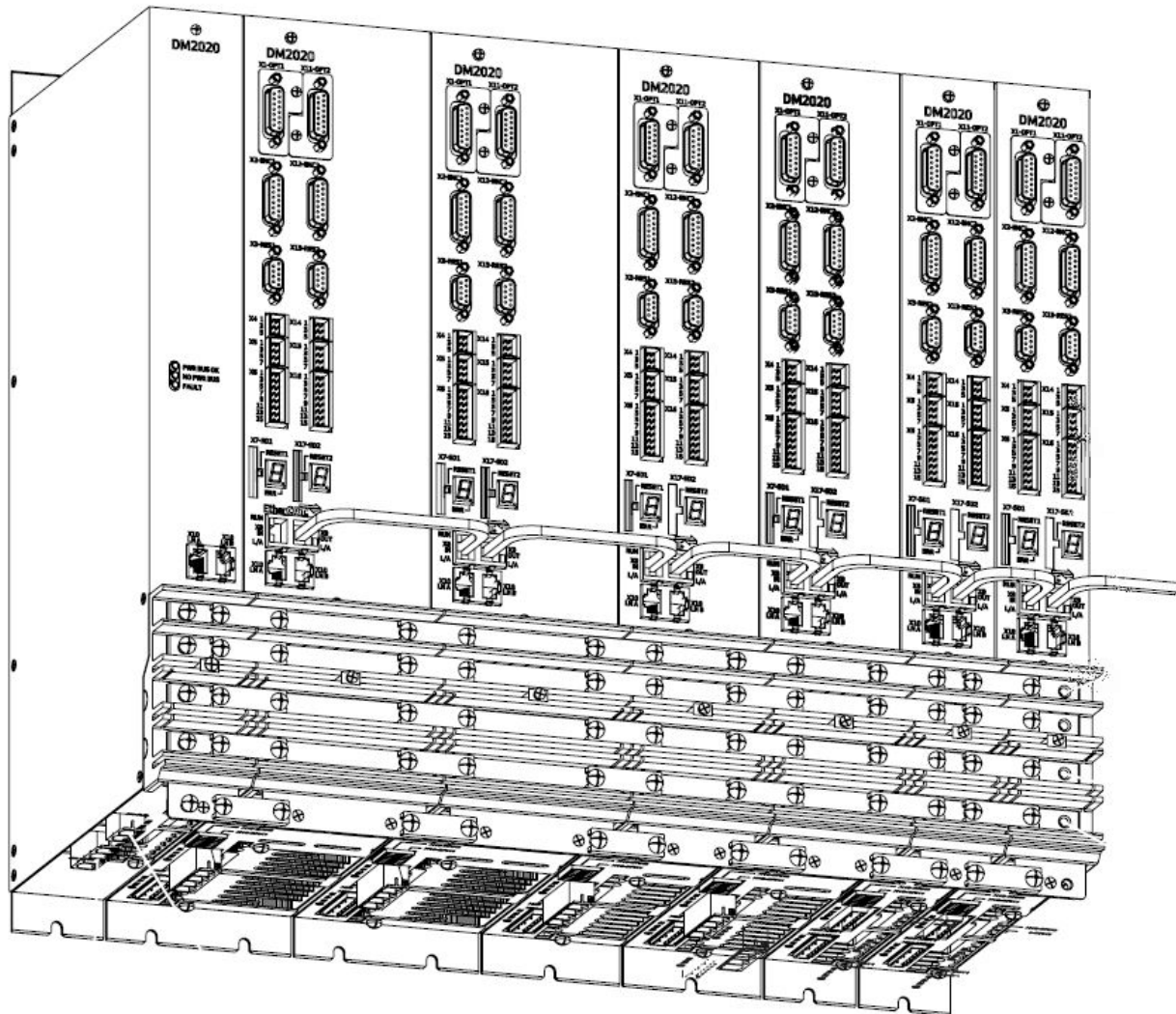
Fig 2.1 General view

- The power supply supplies direct current to the various modules via connecting BUSBARs housed on the front connectors
- There are two standard power supply models
- Each module is available as a single- or dual-axis module
- The current ratings of the various axes range from 2 to 128 Arms of direct current and 4 to 256 Arms of peak current
- Compatible feedback systems:
  - Resolver
  - Stegmann absolute single-turn sinusoidal encoder with and without hiperface
  - Stegmann absolute multi-turn sinusoidal encoder with and without hiperface
  - TTL incremental encoder
  - Heidenhain absolute single-turn sinusoidal encoder with and without EnDAT
  - Heidenhain absolute multi-turn sinusoidal encoder with and without EnDAT
  - Heidenhain EnDat 22 full digital encoder
  - Heidenhain linear encoder with EnDAT

- The modules are cooled by forced air, with fans incorporated in each module
- Ethernet interface on which the EtherCAT Real Time protocol is implemented with the DS402 profile
- Standard CANOpen interface on which the CANOpen protocol is implemented with the DS402 profile
- "Safe Torque Off" (STO) (protection against accidental start-up) incorporated into each axis
- Configuration/commissioning via GUI: Dx2020GUI allows users to configure, calibrate and control the drive
- Alarm diagnostics: Via GUI
- Accessories:
    - EMC filters
    - Power and signal cables
    - Brake resistor

2.1.2.   Operating and storage conditions

Ambient operating temperature	from 0 °C to 40 °C up to 55 °C with an output current reduction (-2%/°C)
Storage temperature	from -25 °C to 55 °C
Transport temperature	from -25 °C to 70 °C
Humidity permitted during operation	5…85% Condensate not permitted
Humidity permitted for storage	5…95 %
Humidity permitted for transport	95% at 40 °C
Assembly 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 (E194181)
IP protection rating	IP20
Pollution degree	2 or less (only non-conductive pollution is usually permitted. Temporary conductivity caused by condensation may occasionally be expected, but only when the drive is not in operation or attached to a power supply)
Mechanical resistance in compliance with EN 60721-3-3	Vibration: 3 mm for frequencies between 2…9 Hz Vibration: 9.8 m/s^2 (1 g) for frequencies between 9 and 200 Hz Shock: 98 m/s^2 (10 g) for 11 ms
Machine safety	STO (Safe Torque Off) SILCL 3 PL "e" (as certified below)

Tab 2.1 Environmental conditions

2.1.3.   Standard power supply models

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.

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

2.1.4. Power supply coding

C C ☐ ☐ ☐ ☐ ■ ☐ ☐ ☐ ☐ - ■ ■

Version	
2	Standard model
E	Special model
X	Test model

Mechanical hardware configuration

Value	Power supply model	Width	Rated current (CC)
00	DM2020-PS "S"	50 mm/ 1.97 inches	32 Arms/90 Apk
01	DM2020-PS "M"	50 mm/ 1.97 inches	54 Arms/130 Apk
02	DM2020-PS "L"	150 mm/ 5.90 inches	128 Arms/256 Apk

Hardware revision

Value - Internal coding (4)	
Value	Power supply model
A	DM2020-PS "L"
B	DM2020-PS "S" DM2020-PS "M"

OPT1 - Special configurations

Value - Internal coding (4)	
Value	Version
00	Standard

Special variations

Value - Internal coding (4)	
Value	Description
01	Special Reg. Res. (16 ohm/500 W Armoured)
02	With power connectors & without R.R. on kit
03	With power connectors & Special Reg. Res. (18 ohm/350 W armoured)

OPT2 - Special configurations

Value - Internal coding (4)	
Value	Version
00	Standard
C0	Conformal coating for standard "00" configuration
50	UL LISTED for standard "00" configuration
L0	- Conformal coating for version "50"

(4) Values assigned by Moog

The first two characters are "CC" and indicate the family (DM2020).

Example: The code CC201A0000 identifies the standard power supply available in 54 A DC in the final production version without special versions.

2.1.5. Standard axis modules

Model/Code	CC111SNNLNNxxxx		CC111ANNLNNxxxx		CC121SSNLNxxxxx		CC112BNNLNNxxxx		CC122ASNLNxxxxx	
Mechanical dimensions	50 mm/1.97 inches									
Configuration	Single		Single		Double		Single		Double	
Type	L50A		L50A		L50A		L50B		L50B	
Module current @ 8 kHz	2		4		4		8		6	
Arms rated current	2	-	4	-	2	2	8	-	4	2
Arms peak current	4	-	8	-	4	4	16	-	8	4
Cooling	Natural						Incorporated ventilation			
Weight	4.4		4.4		5.0		5.2		5.8	
Connector code	BC7111R		BC7111R		BC7221R		BC7111R		BC7221R	

Model/Code	CC122AANLNxxxxx		CC122BSNLNxxxxx		CC122BANLNxxxxx		CC114CNNLNNxxxx		CC124BBNLNxxxxx	
Mechanical dimensions	50 mm/1.97 inches									
Configuration	Double		Double		Double		Single		Double	
Type	L50B		L50B		L50B		L50C		L50C	
Module current @ 8 kHz	8		10		12		16		16	
Arms rated current	4	4	8	2	8	4	16	-	8	8
Arms peak current	8	8	16	4	16	8	32	-	16	16
Cooling	Incorporated ventilation									
Weight	5.8		5.8		5.8		5.8		5.8	
Connector code	BC7221R		BC7221R		BC7221R		BC7113R		BC7221R	

Model/Code	CC116DNNLNNxxxx		CC116ENNLNNxxxx		CC126CSNLNxxxxx		CC126CANLNxxxxx		CC126CBNLNxxxxx	
Mechanical dimensions	75 mm/2.52 inches									
Configuration	Single		Single		Double		Double		Double	
Type	L75		L75		L75		L75		L75	
Module current @ 8 kHz	24		32		18		20		24	
Arms rated current	24	-	32	-	16	2	16	4	16	8
Arms peak current	48	-	64	-	32	4	32	8	32	16
Cooling	Incorporated ventilation									
Weight	6.6		6.6		7.2		7.2		7.2	
Connector code	BC7113R		BC7113R		BC7225R		BC7225R		BC7225R	

Tab 2.2 Standard axis modules

Model/Code	CC126CCNLNxxxxx		CC126DSNLNxxxxx		CC126DANLNxxxxx		CC126DBNLNxxxxx	
Mechanical dimensions	75 mm/2.52 inches							
Configuration	Double		Double		Double		Double	
Type	L75		L75		L75		L75	
Module current @ 8 kHz	32		26		28		32	
Arms rated current	16	16	24	2	24	4	24	8
Arms peak current	32	32	48	4	48	8	48	16
Cooling	Incorporated ventilation							
Weight	7.2		7.2		7.2		7.2	
Connector code	BC7225R		BC7225R		BC7225R		BC7225R	

Model/Code	CC118FNNLNNxxxx		CC118GNNLNNxxxx		CC128DCNLNxxxxx		CC128DDNLNxxxxx		CC128ESNLNxxxxx	
Mechanical dimensions	100 mm/3.94 inches									
Configuration	Single		Single		Double		Double		Double	
Type	L100		L100		L100		L100		L100	
Module current @ 8 kHz	48		64		40		48		34	
Arms rated current	48	-	64	-	24	16	24	24	32	2
Arms peak current	96	-	128	-	48	32	48	48	64	4
Cooling	Incorporated ventilation									
Weight	8.0		8.0		8.6		8.6		8.6	
Connector code	BC7113R		BC7114R		BC7225R		BC7225R		BC7225R	

Model/Code	CC128EANLNxxxxx		CC128EBNLNxxxxx		CC128ECNLNxxxxx		CC128EDNLNxxxxx		CC128EENLNxxxxx	
Mechanical dimensions	100 mm/3.94 inches									
Configuration	Double		Double		Double		Double		Double	
Type	L100		L100		L100		L100		L100	
Module current @ 8 kHz	36		40		48		56		64	
Arms rated current	32	4	32	8	32	16	32	24	32	32
Arms peak current	64	8	64	16	64	32	64	48	64	64
Cooling	Incorporated ventilation									
Weight	8.6		8.6		8.6		8.6		8.6	
Connector code	BC7225R		BC7225R		BC7225R		BC7225R		BC7225R	

Table 2.2 Standard axis modules

Model/Code	CC128FSNLNxxxxx		CC128FANLNxxxxx		CC128FBNLNxxxxx		CC128FCNLNxxxxx	
Mechanical dimensions	100 mm/3.94 inches							
Configuration	Double		Double		Double		Double	
Type	L100		L100		L100		L100	
Module current @ 8 kHz	50		52		56		64	
Arms rated current	48	2	48	4	48	8	48	16
Arms peak current	96	4	96	8	96	16	96	32
Cooling	Incorporated ventilation							
Weight	8.6		8.6		8.6		8.6	
Connector code	BC7225R		BC7225R		BC7225R		BC7225R	

Model/Code	CC130HNNLNNxxxx		CC130JNNLNNxxxx		CC140FDNLNxxxxx		CC140FENLNxxxxx		CC140FFNLNxxxxx	
Mechanical dimensions	200 mm (7.87 inches)									
Configuration	Single		Single		Double		Double		Double	
Type	L200		L200		L200		L200		L200	
Module current @ 8 kHz	96		128		72		80		96	
Arms rated current	96	-	128	-	48	24	48	32	48	48
Arms peak current	192	-	256	-	96	48	96	64	96	96
Cooling	Incorporated ventilation									
Weight	17.5		17.5		17.5		17.5		17.5	
Connector code	BC7115R		BC7115R		BC7225R		BC7225R		BC7225R	

Model/Code	CC140GSNLNxxxxx		CC140GANLNxxxxx		CC140GBNLNxxxxx		CC140GCNLNxxxxx	
Mechanical dimensions	200 mm (7.87 inches)							
Configuration	Double		Double		Double		Double	
Type	L200		L200		L200		L200	
Module current @ 8 kHz	66		68		72		80	
Arms rated current	64	2	64	4	64	8	64	16
Arms peak current	128	4	128	8	128	16	128	32
Cooling	Incorporated ventilation							
Weight	17.5		17.5		17.5		17.5	
Connector code	BC7226R		BC7226R		BC7226R		BC7226R	

Table 2.2 Standard axis modules

Model/Code	CC140GDNLNxxxxx		CC140GENLNxxxxx		CC140GFNLNxxxxx		CC140GGNLNxxxxx	
Mechanical dimensions	200 mm (7.87 inches)							
Configuration	Double		Double		Double		Double	
Type	L200		L200		L200		L200	
Module current @ 8 kHz	88		96		112		128	
Arms rated current	64	24	64	32	64	48	64	64
Arms peak current	128	48	128	64	128	96	128	128
Cooling	Incorporated ventilation							
Weight	17.5		17.5		17.5		17.5	
Connector code	BC7226R		BC7226R		BC7226R		BC7226R	

Table 2.2 Standard axis modules

The module 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 module, the details on the side plate identifying each individual module must be communicated to Moog-Casella.
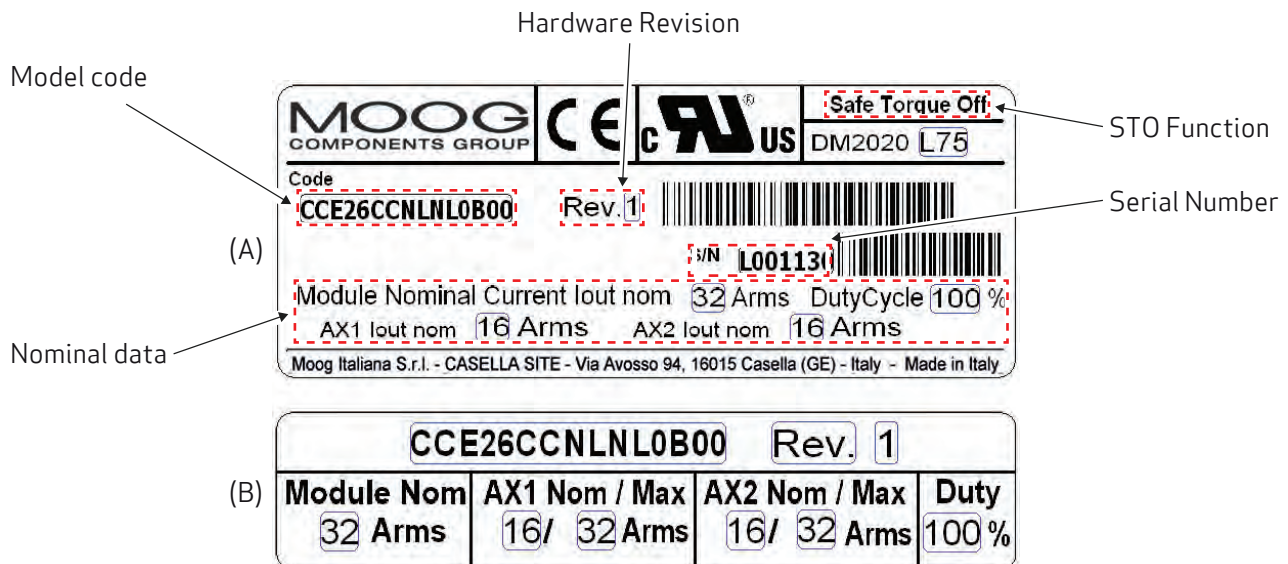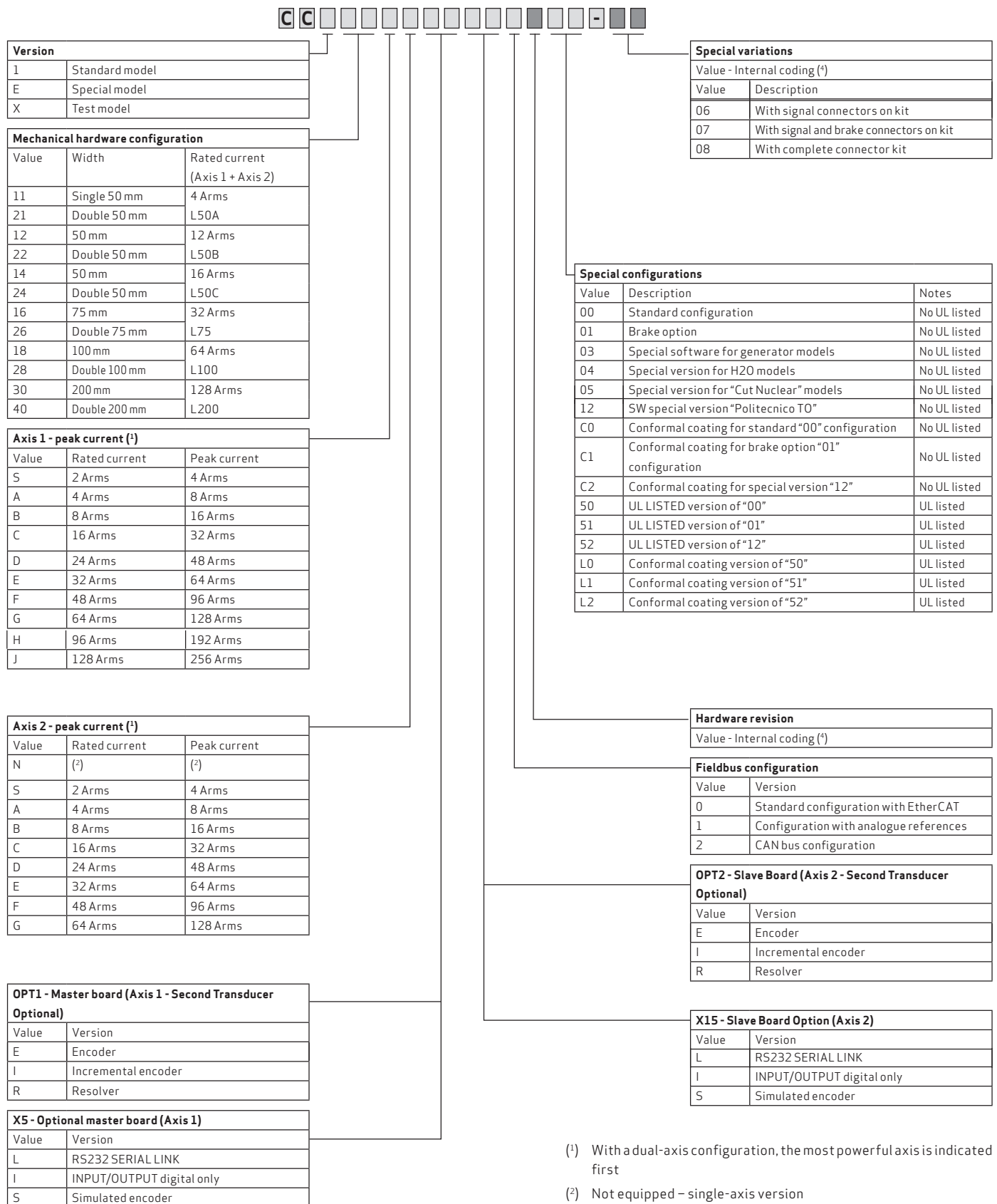

Fig 2.4 Example of axis module side plate (A) and front plate (B)

2.1.6. Axis modules coding

To identify the axes models, refer to the following coding

Version	
1	Standard model
E	Special model
X	Test model

Mechanical hardware configuration		
Value	Width	Rated current (Axis 1 + Axis 2)
11	Single 50 mm	4 Arms
21	Double 50 mm	L50A
12	50 mm	12 Arms
22	Double 50 mm	L50B
14	50 mm	16 Arms
24	Double 50 mm	L50C
16	75 mm	32 Arms
26	Double 75 mm	L75
18	100 mm	64 Arms
28	Double 100 mm	L100
30	200 mm	128 Arms
40	Double 200 mm	L200

Axis 1 - peak current ([1])		
Value	Rated current	Peak current
S	2 Arms	4 Arms
A	4 Arms	8 Arms
B	8 Arms	16 Arms
C	16 Arms	32 Arms
D	24 Arms	48 Arms
E	32 Arms	64 Arms
F	48 Arms	96 Arms
G	64 Arms	128 Arms
H	96 Arms	192 Arms
J	128 Arms	256 Arms

Axis 2 - peak current ([1])		
Value	Rated current	Peak current
N	([2])	([2])
S	2 Arms	4 Arms
A	4 Arms	8 Arms
B	8 Arms	16 Arms
C	16 Arms	32 Arms
D	24 Arms	48 Arms
E	32 Arms	64 Arms
F	48 Arms	96 Arms
G	64 Arms	128 Arms

OPT1 - Master board (Axis 1 - Second Transducer Optional)	
Value	Version
E	Encoder
I	Incremental encoder
R	Resolver

X5 - Optional master board (Axis 1)	
Value	Version
L	RS232 SERIAL LINK
I	INPUT/OUTPUT digital only
S	Simulated encoder

Special variations	
Value - Internal coding ([4])	
Value	Description
06	With signal connectors on kit
07	With signal and brake connectors on kit
08	With complete connector kit

Special configurations		
Value	Description	Notes
00	Standard configuration	No UL listed
01	Brake option	No UL listed
03	Special software for generator models	No UL listed
04	Special version for H2O models	No UL listed
05	Special version for "Cut Nuclear" models	No UL listed
12	SW special version "Politecnico TO"	No UL listed
C0	Conformal coating for standard "00" configuration	No UL listed
C1	Conformal coating for brake option "01" configuration	No UL listed
C2	Conformal coating for special version "12"	No UL listed
50	UL LISTED version of "00"	UL listed
51	UL LISTED version of "01"	UL listed
52	UL LISTED version of "12"	UL listed
L0	Conformal coating version of "50"	UL listed
L1	Conformal coating version of "51"	UL listed
L2	Conformal coating version of "52"	UL listed

Hardware revision	
Value - Internal coding ([4])	

Fieldbus configuration	
Value	Version
0	Standard configuration with EtherCAT
1	Configuration with analogue references
2	CAN bus configuration

OPT2 - Slave Board (Axis 2 - Second Transducer Optional)	
Value	Version
E	Encoder
I	Incremental encoder
R	Resolver

X15 - Slave Board Option (Axis 2)	
Value	Version
L	RS232 SERIAL LINK
I	INPUT/OUTPUT digital only
S	Simulated encoder

([1]) With a dual-axis configuration, the most powerful axis is indicated first

([2]) Not equipped – single-axis version

([3]) Standard version

([4]) Values assigned by Moog

The first two characters are "CC" and indicate the family (DM2020)

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

Model	Code	Capacity (µF)	Dimensions
DM2020 ABC5	CCE5000	5400	
DM2020 ABC4	CCE5012	4500	
DM2020 ABC3	CCE5013	3600	50 mm/1.97 inches
DM2020 ABC2	CCE5014	2700	
DM2020 ABC1	CCE5015	1800	
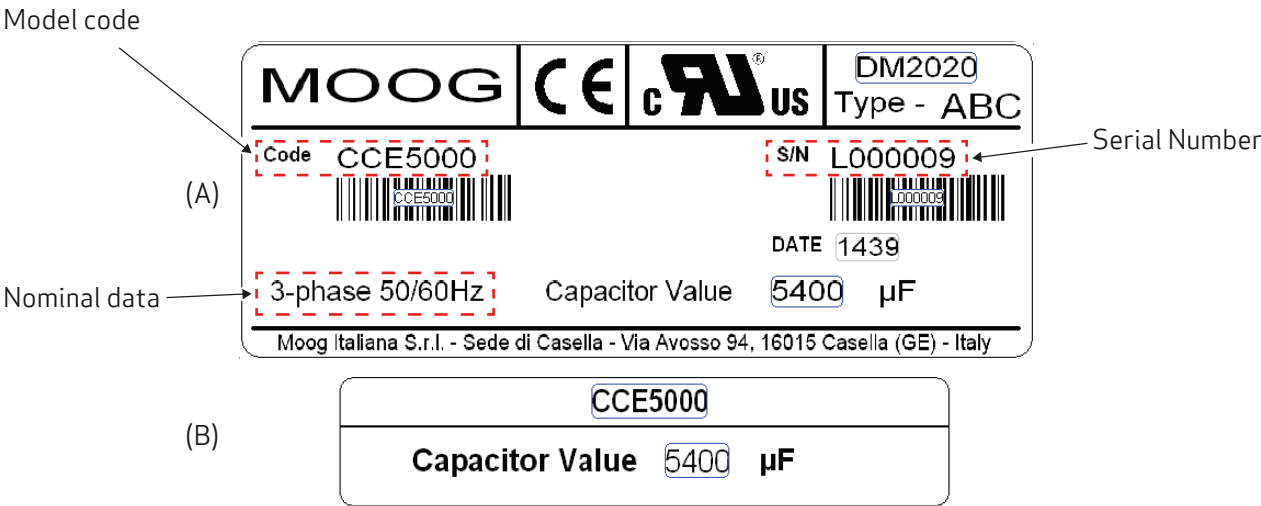
Fig 2.5 Example of capacitor module side plate (A) and front plate (B)

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.
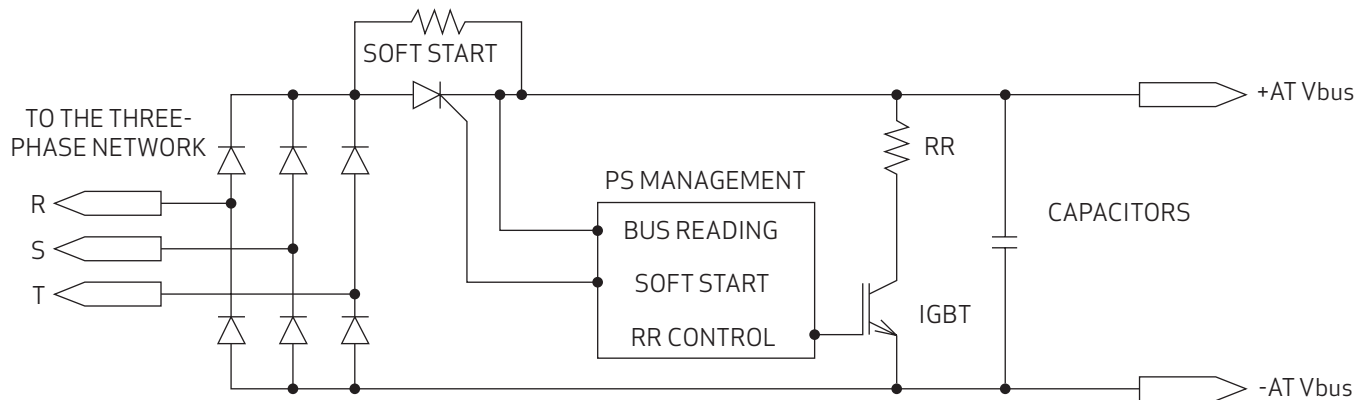
Fig 2.6 Power supply block diagram (power components)

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 absence 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
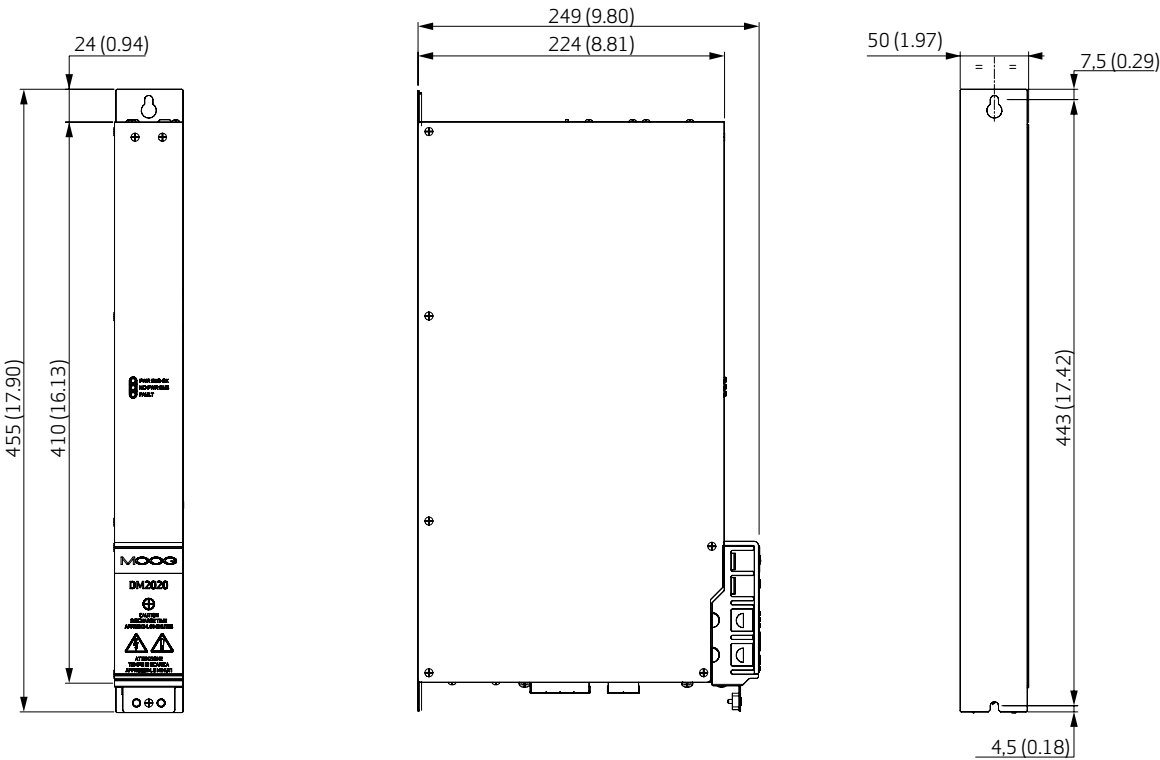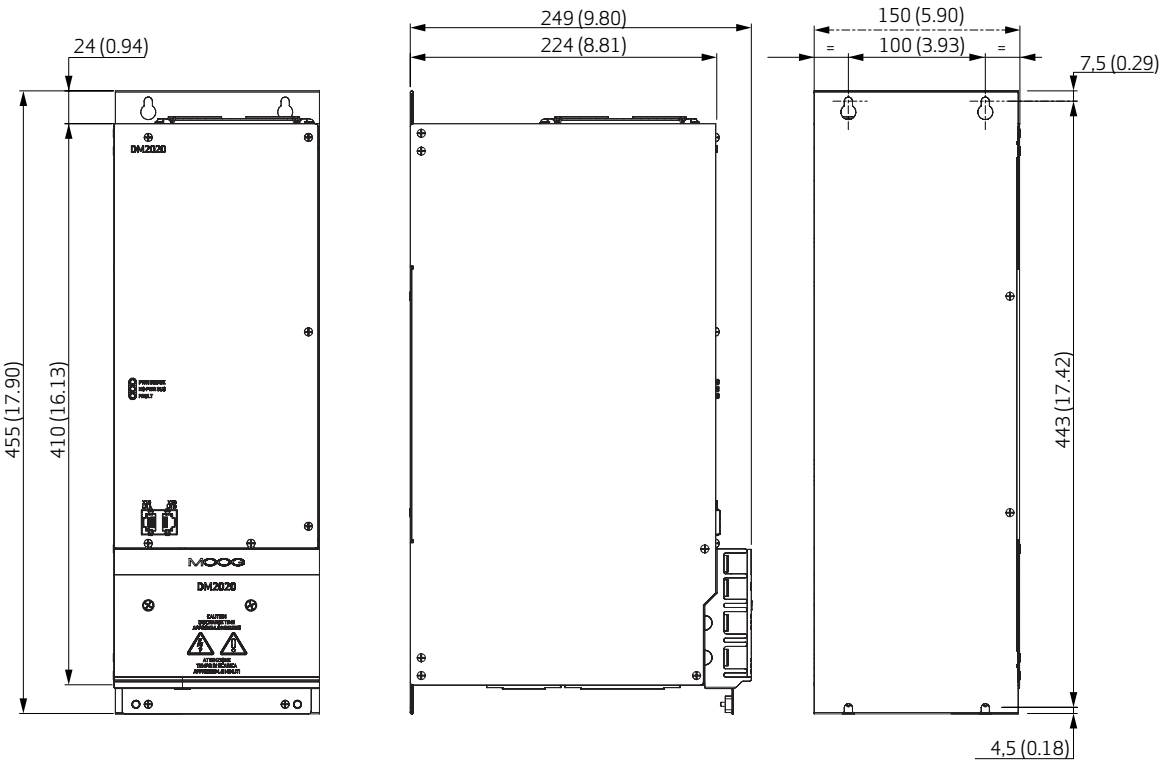

Fig 2.7 Drawing of the power supply L50

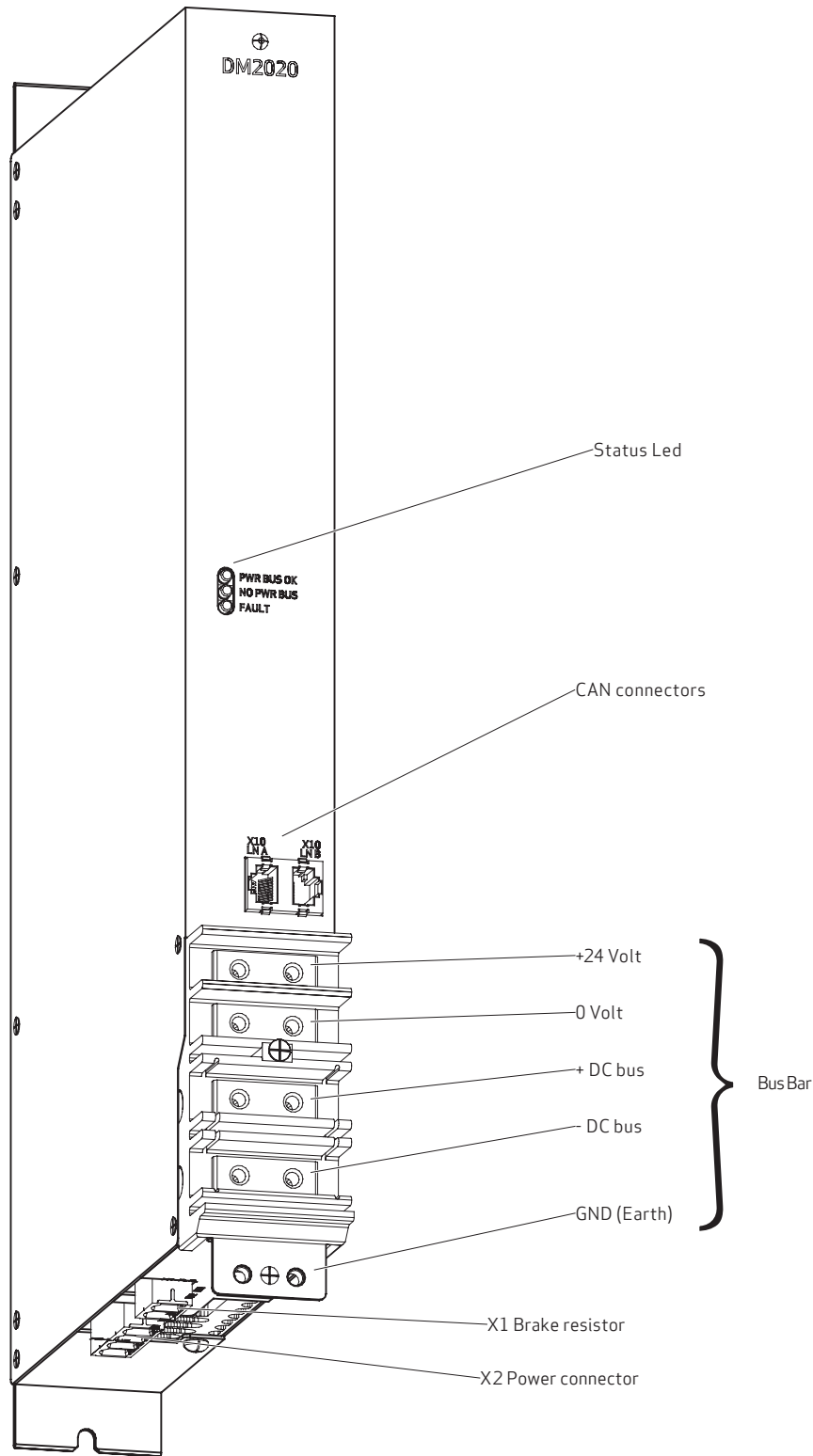Fig 2.8 Drawing of the power supply L150

2.2.3   Connectors

- Status Led
- PWR BUS OK
- NO PWR BUS
- FAULT
- CAN connectors
- X10 LN A
- X10 LN B
- +24 Volt
- 0 Volt
- + DC bus
- DC bus
- GND (Earth)
- Bus Bar
- X1 Brake resistor
- X2 Power connector

Fig 2.9 Connection layout

2.2.3.1. Connectors layout

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

X1: brake resistor	
1	+RR1
2	-RR2

X1-R.R.

RR2   RR1
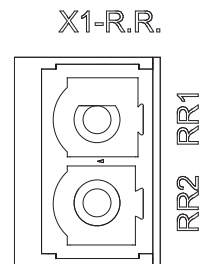
X2: mains	
1	U1
2	V1
3	W1
4	Earth

U1
V1
W1

X2-LINE
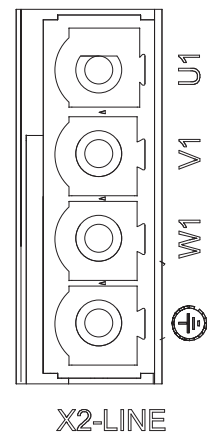
BUSBAR connection	
1	+24 V
2	0 V DC
3	+DC BUS
4	-DC BUS

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 LN A   X10 LN B

AMP

X10 LN B 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 longer than 50 m, we recommend contacting Moog-Casella's Applications department.

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 flex. PE M6 bolt
AT6014	L150	B 1	130	50	39	2.6	Up to 50 mm² PE M10 bolt

Tab 2.5 Main electrical characteristics of filters

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 Applications 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 uH, 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/uS 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 uH/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
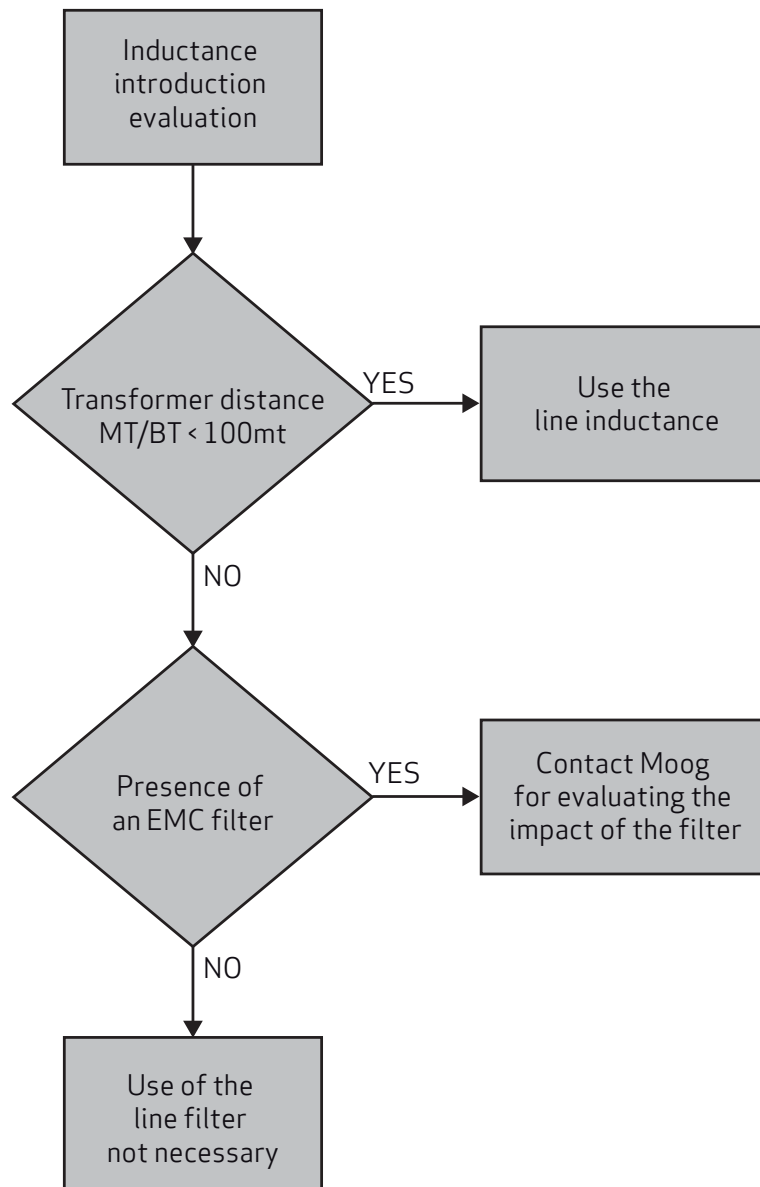The inductor must be fitted between the transformer of the cab and the drive

TOTAL LINE INDUCTANCE 100 uH
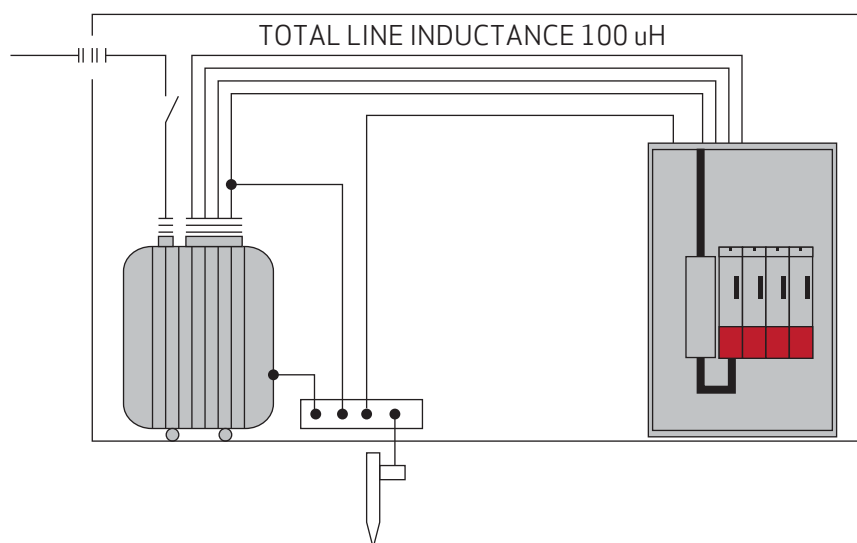
DM2020_D_005

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:

```
                    ┌──────────────────┐
                    │    Inductance    │
                    │   introduction   │
                    │    evaluation    │
                    └────────┬─────────┘
                             │
                             ▼
                    ◇─────────────────◇
                    │                 │        YES    ┌──────────────────┐
                    │   Transformer   ├──────────────▶│     Use the      │
                    │    distance     │               │  line inductance │
                    │  MT/BT < 100mt  │               └──────────────────┘
                    ◇────────┬────────◇
                             │ NO
                             ▼
                    ◇─────────────────◇
                    │                 │        YES    ┌──────────────────┐
                    │   Presence of   ├──────────────▶│   Contact Moog   │
                    │   an EMC filter │               │ for evaluating the│
                    │                 │               │ impact of the filter│
                    ◇────────┬────────◇               └──────────────────┘
                             │ NO
                             ▼
                    ┌──────────────────┐
                    │    Use of the    │
                    │    line filter   │
                    │   not necessary  │
                    └──────────────────┘
```

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 mm² (AWG6)	33 mm² (AWG2)
Brake resistor	13 mm² (AWG6)	33 mm² (AWG2)
24 V DC	0.8 mm² AWG 18	
Earth	13 mm² (AWG6)	33 mm² (AWG2)

See section "8.2. Metric/AWG conversion table" for the metric/AWG conversion table.

2.2.8 Capacitor module (ABC)

A capacitor module is available to increase the energy stored in the braking phase:
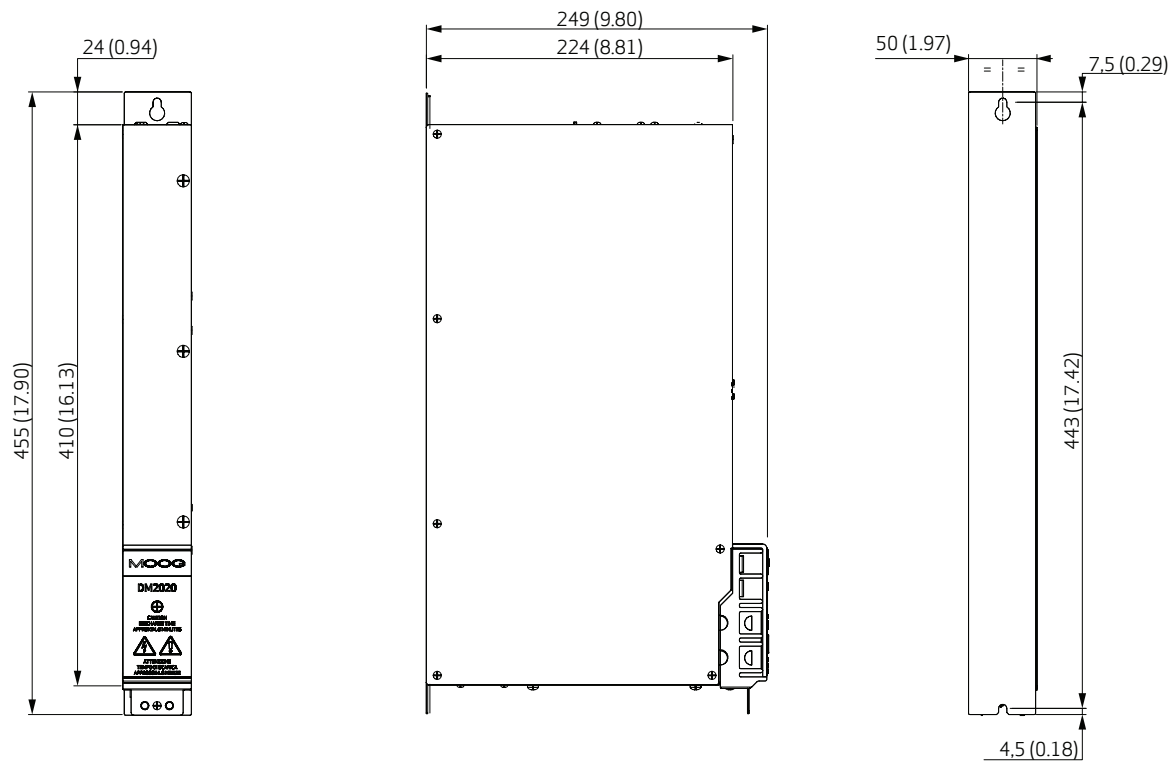
Model/Code	ABC5/CCE5000	ABC4/CCE5012	ABC3/CCE5013	ABC2/CCE5014	ABC1/CCE5015
Capacity (µF)	5400	4500	3600	2700	1800
Width (mm)	50				
Depth (mm)	249				
Height (mm)	455				

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

Module ID	Total cap. uF
L50 power supply	1800
L150 power supply	4500
Size L50	130
Size L75	340
Size L100	340
Size L200	2720

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

Acquisition of commands

Acquisition of settings

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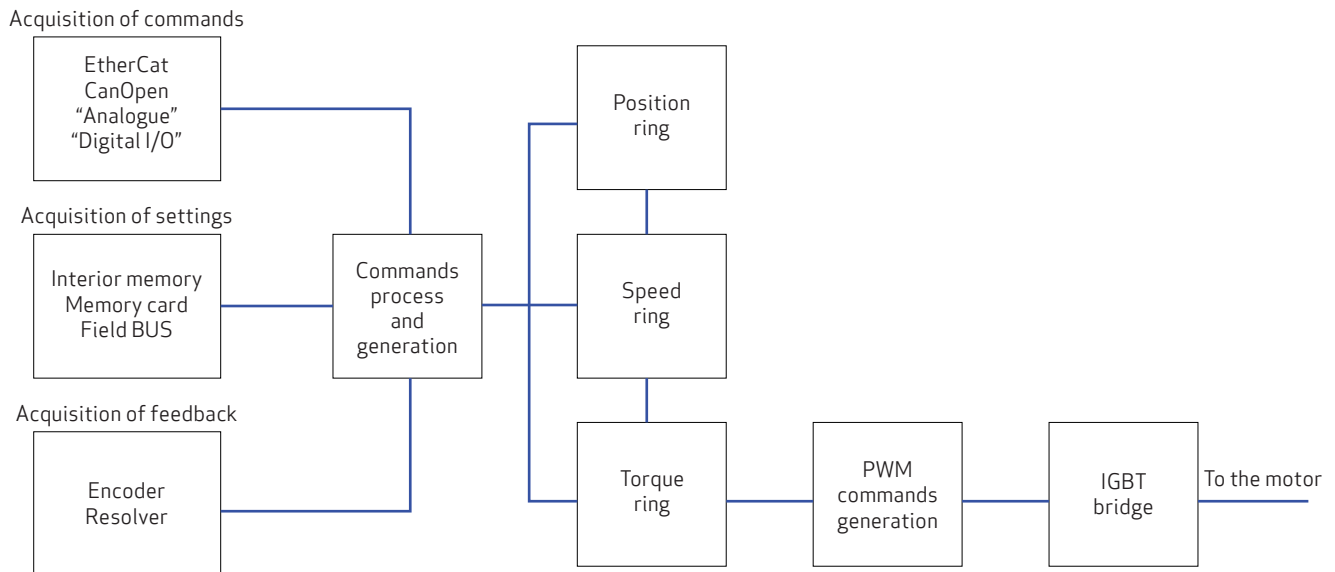
FUNCTIONS
Position controller
Velocity controller
Torque controller
RS232 serial interface
EtherCAT interface
CANOpen interface
Analogue reference
Simulated encoder generation
Analogue I/O management
Digital I/O management
Sensorless mode
Data recording

Model	L50	L75	L100	L200
ELECTRICAL DATA				
Auxiliary voltage	24 V DC +/- 10 %			
DC-link voltage	From 282 to 744 V DC			
Rated current	From 2 to 16 Arms	From 24 to 32 Arms	From 48 to 64 Arms	From 96 to 128 Arms
Arms peak current	From 4 to 32 Arms	From 48 to 64 Arms	From 96 to 128 Arms	From 192 to 256 Arms
Protection	NTC and bi-metallic thermal protection on heat sink to 85 °C Identification of insufficient voltage (undervoltage) or excessive voltage (overvoltage)			
Cooling	Natural/incorporated ventilation	Incorporated ventilation		
MECHANICAL DATA				
Weight	4.4/5.8 kg	7.2/8.6 kg	8.6 kg	17.5 kg
Height	455 mm (17.91 inches)			
Width	50 mm/1.97 inches	75 mm (2.95 inches)	100 mm/3.94 inches	200 mm (7.87 inches)
Depth	249 mm (9.80 inches)			

2.3.2.   Dimensions

Module L50 (1.97 inches)
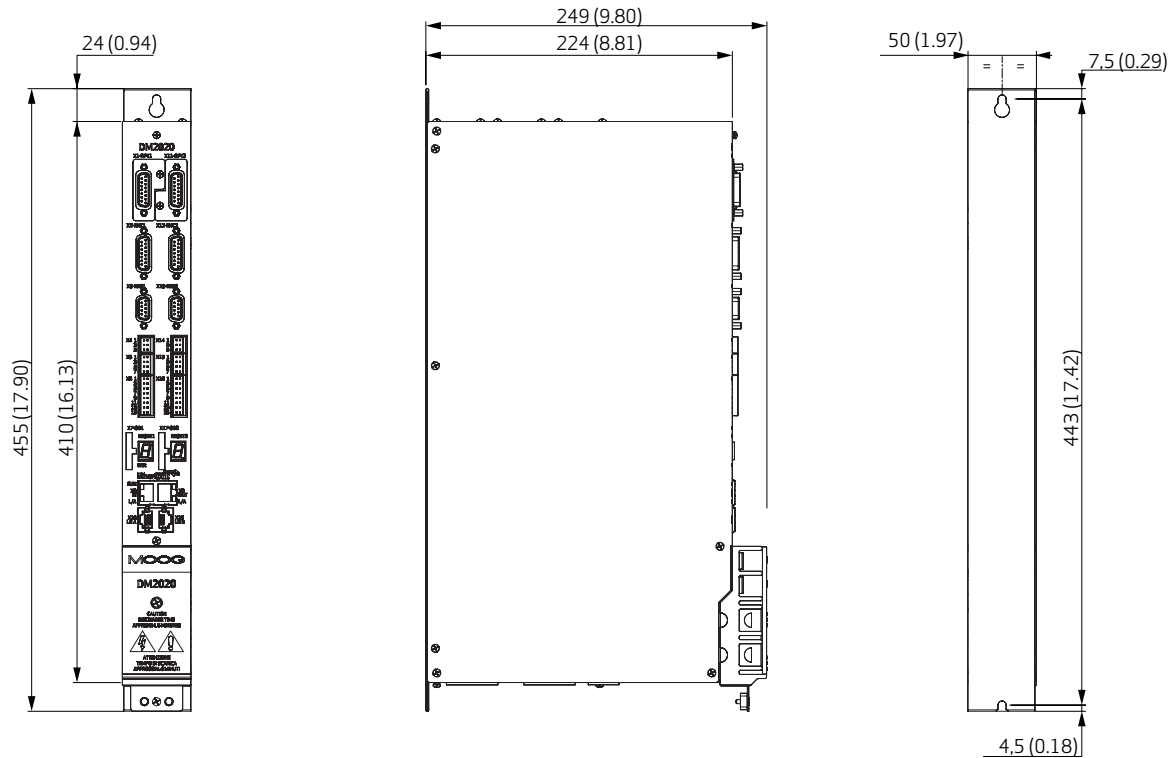
Module L75 (2.95 inches)
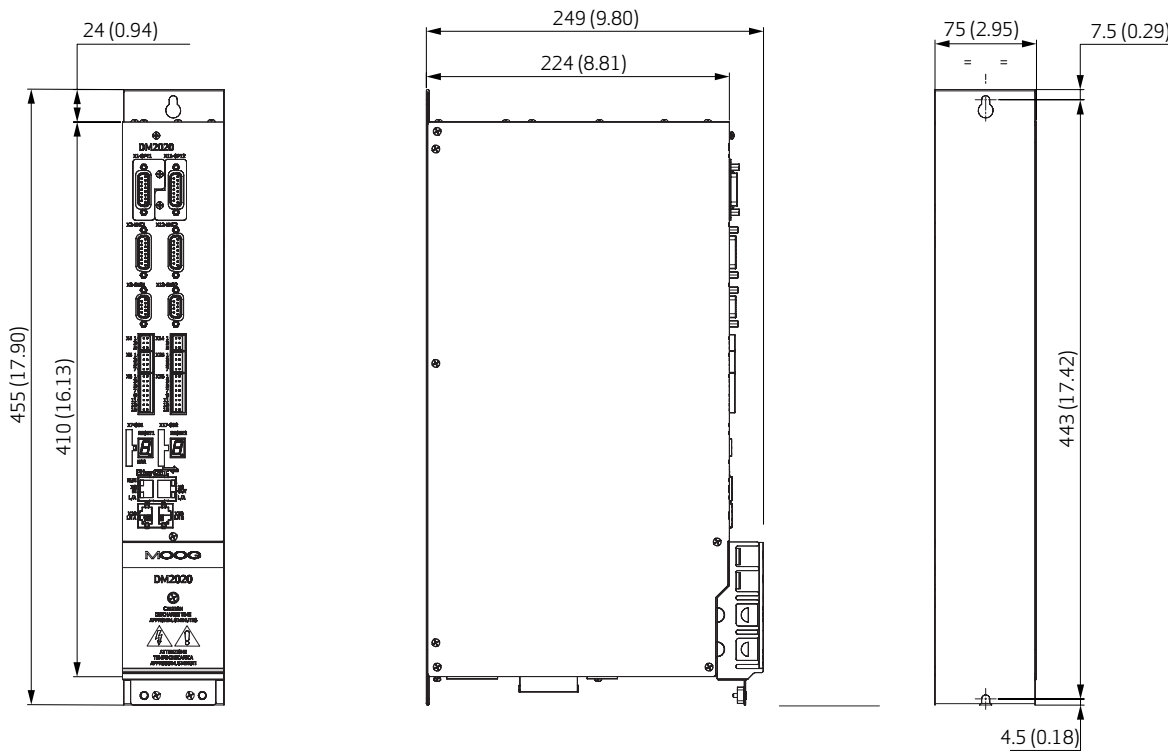
Module L100 (3.94 inches)
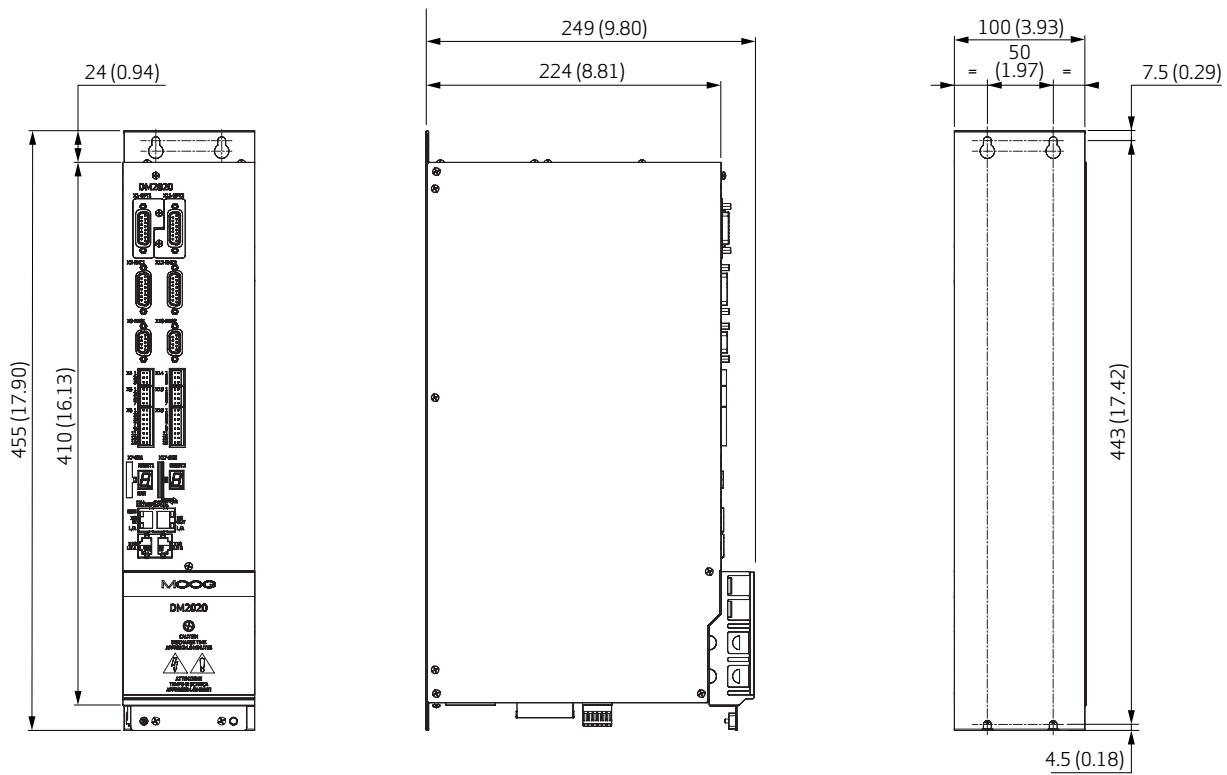
Module L200 (7.87 inches)
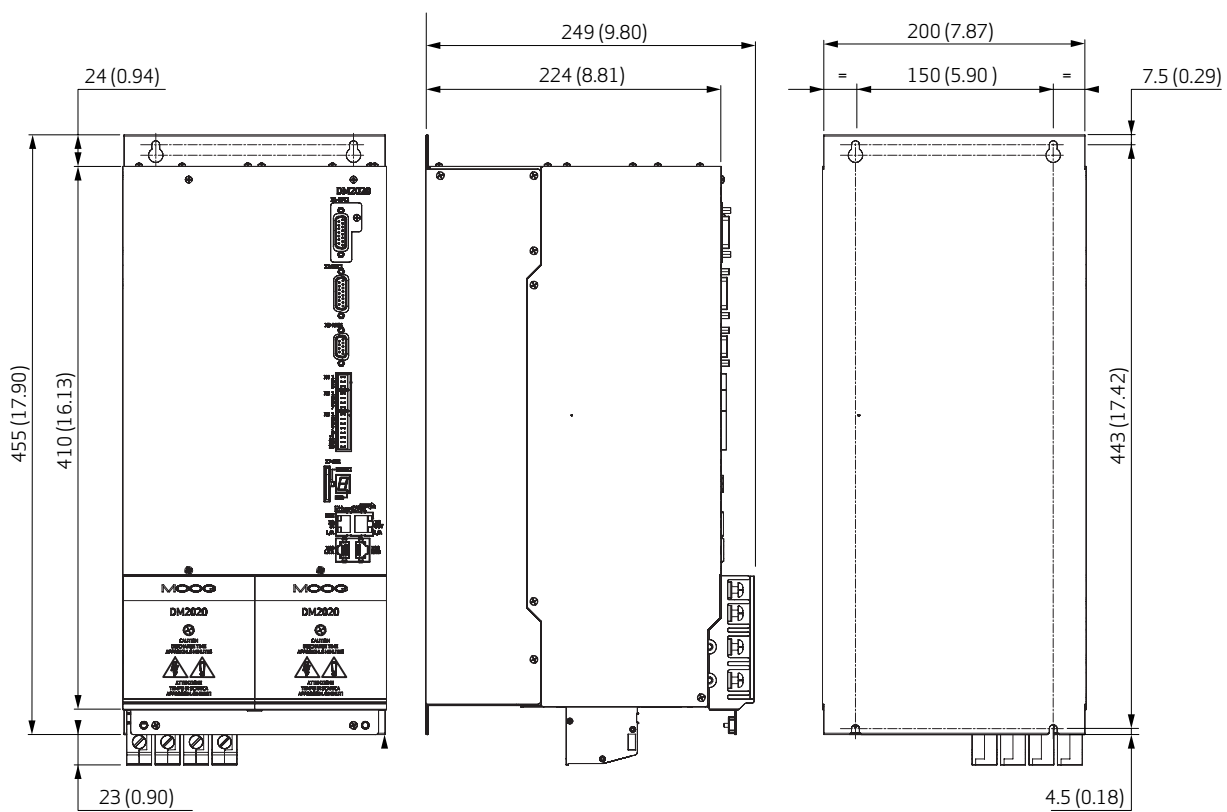
2.3.3.   Position transducers

The DM2020 can manage the following position transducers, both when these are fitted on the motor and when they are positioned on the machine and used as secondary transducers:

• Resolver
• Stegmann absolute single-turn sinusoidal encoder with and without hiperface
• Stegmann absolute multi-turn sinusoidal encoder with and without hiperface
• Heidenhain absolute single-turn sinusoidal encoder with and without EnDat
• Heidenhain absolute multi-turn sinusoidal encoder with and without EnDat
• Heidenhain EnDat 22 full digital encoder
• Incremental TTL encoder (available as an option on X1).
• Heidenhain linear encoder with EnDat

2.3.4.   Interfaces with "field" and other modules

The figure shows all axis module connectors with reference to a "dual-axis" structure:

The connectors that allow interfacing with the field and with other modules are listed in the table.

Code	Power (W)	Notes
X1	X11	Optional encoder (can have the same functionality as the X2 in addition to the TTL incremental encoder)
X2	X12	Motor or machine encoder
X3	X13	Motor resolver
X4	X14	STO interface
X5	X15	Programmable digital interface
X6	X16	I/O interface: Analogue I/O, digital I/O, driver OK, restart
X7	X17	Memory card and display
X8	X9	EtherCAT interface
X10A	X10B	CANOpen interface
X18	X19	Brake connectors
X20	X21	Motor connector
24 Volt		
0 Volt		
BUS +DC		
BUS −DC		
GND connection		
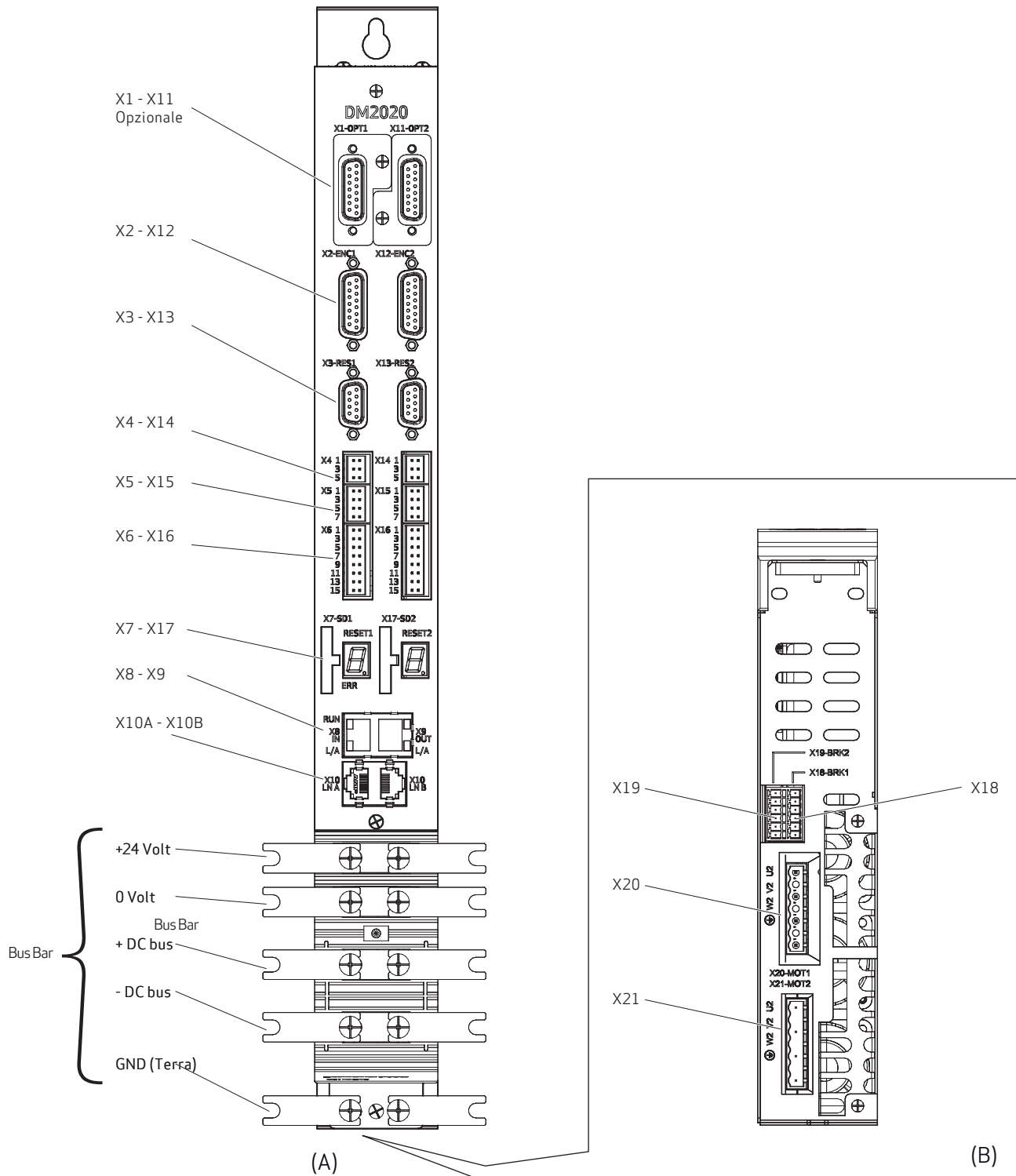
Fig 2.11 Dual-axis module: View from the front (A) and bottom (B)

Note that the arrangement of the connectors remains unchanged in the L75 and L100 sizes (front and bottom) and L200 (only front, see Figure 2.12 for a detail of the bottom)
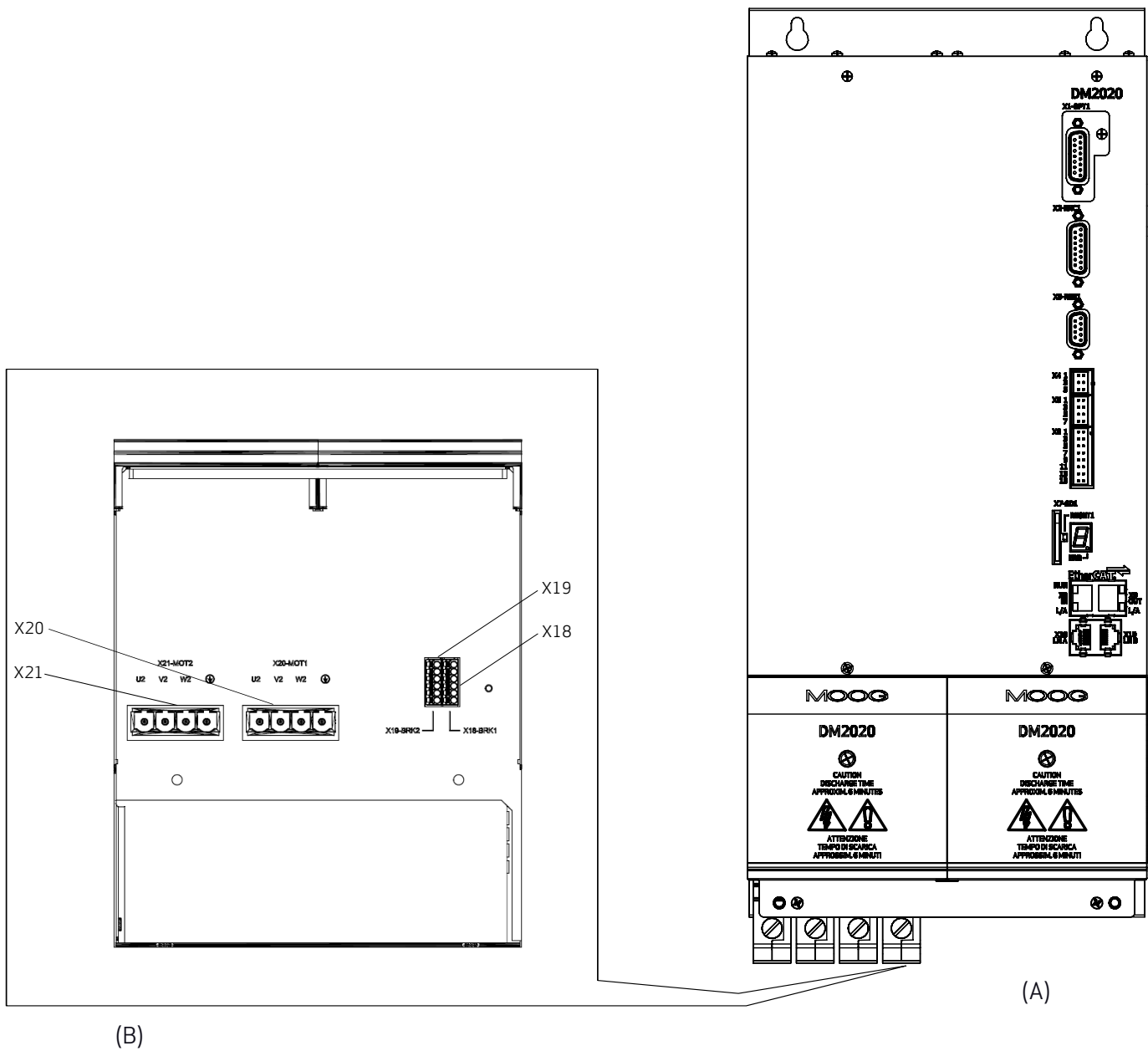
Fig 2.12 Module L200 double axis: front (A) and bottom (B) view.

Note that the arrangement of the front connector remains unchanged as in L50, L75 and L100 modules (See Figure 2.11 for details)

2.3.5.   Layout of connectors and other interfaces on the axis module

The tables of connector pins relative to the axis module are shown below in the various possible configurations.

X1 (X11) connector (*)

PIN	TTL incremental encoder function	Sinusoidal encoder function
1	+5 V (max 100 mA)	B
2	GND (encoder and PTC)	0 V supply
3	W-	A
4	W+	Up supply
5	V+	Date+
6	V	n.c.
7	A+	Term A
8	A-	CLOCK +
9	C+	B+
10	C-	0 V Sense
11	U+	A+
12	U-	Up Sense
13	B-	Date
14	B+	Term B
15	PTC	CLOCK
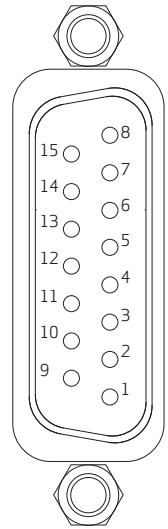
Use the X1(X11) connector to connect Hall sensors as indicated in the table below:

PIN	Differential Hall sensor connector	Hall sensor connector Single-ended
1	+5 Volt	+5 Volt
2	0 V supply	0 V supply
3	W-	n.c.
4	W+	W+
5	V+	V+
6	V	n.c.
7	n.c.	n.c.
8	n.c.	n.c.
9	n.c.	n.c.
10	n.c.	n.c.
11	U+	U+
12	U-	n.c.
13	n.c.	n.c.
14	n.c.	n.c.
15	PTC-NTC-Mot	PTC-NTC-Mot
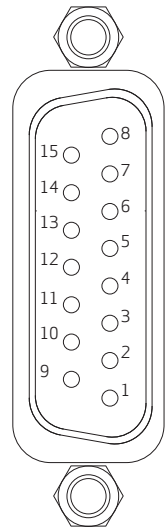
(*) The use of the X1 (X11) connector is optional.

X2 (X12) connector

PIN	Digital encoder function	"Full digital" encoder function
1	B	n.c.
2	0 V supply	0 V supply
3	A	n.c.
4	Up supply	Up supply
5	Date+	Date+
6	n.c.	n.c.
7	Term A	Term A
8	CLOCK +	CLOCK +
9	B+	n.c.
10	0 V Sense	0 V Sense
11	A+	n.c.
12	Up Sense	Up Sense
13	Date	Date
14	Term B	Term B
15	CLOCK	CLOCK
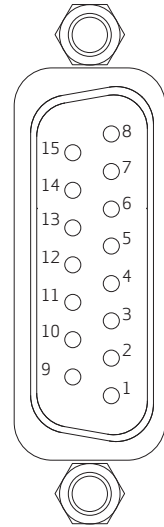
Connector X3 (X13) resolver interface

PIN	FUNCTION
1	COS
2	COS+
3	GND
4	SIN
5	SIN+
6	TERM A
7	8 kHz
8	TERM B
9	8 kHz+
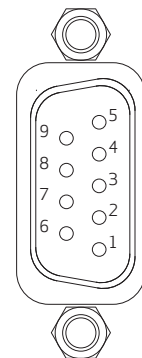
Connector X4 (X14) STO interface

PIN	Designation	Function
1	+24 V S1	STO power input
2	0 V S1	0 Volt corresponding
3	+24 V S2	STO power input
4	0 V S2	0 Volt corresponding
5	S2 FEEDBACK	Channel S2 output
6	S1 FEEDBACK	Channel S1 output

Connector X5 (X15), programmable interface

MODE	FUNCTION
0	RS232 with 2 digital inputs
1	RS232 with 1 digital input and 1 digital output
2	The simulated encoder
3	EtherCAT network synchronisms monitor
4	3 digital inputs
5	3 digital outputs
6	1 digital input and 2 digital outputs
7	2 digital inputs and 1 digital output
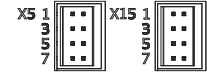
No. of pins	CONFIGURATION MODE							
	0	1	2	3	4	5	6	7
1	+24 Volt output							
2	INP A +	OUT A +	A+	SYNC 0 +	INP A +	OUT A +	INP A +	OUT A +
3	INP A -	OUT A -	A-	SYNC 0 -	INP A -	OUT A -	INP A -	OUT A -
4	INP B+	INP B+	B+	SYNC 1 +	INP B+	OUT B+	OUT B+	INP B+
5	INP B -	INP B -	B-	SYNC 1 -	INP B -	OUT B -	OUT B -	INP B -
6	RX	RX	C +	SM 2 +	INP C +	OUT C +	OUT C +	INP C +
7	TX	TX	C -	SM 2 -	INP C -	OUT C -	OUT C	INP C -
8	0 Volt							

INFORMATION
The maximum current that can be drawn from PIN 1 (output +24 V) is 200 mA

DETAILS OF MODES:

Description of mode 0

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

Description of mode 1

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

Description of mode 2

In this mode, incremental encoder signals are generated on the connector using internal drive information (instantaneous position of the motor), with which it is possible to close the position control of the machine via an external PLC, leaving the drive to control speed with analogue reference.

The number of encoder pulses can be configured in multiples of 2, starting from 128 pulses/rev, up to 8192 pulses/rev.

Marker amplitude on output C can be configured as ¼, ½ and 1 pulse.

The basic configuration is 4096 pulses per mechanical revolution of the motor with a ¼ marker.

Description of mode 3

Mode 3 enables users to monitor EtherCAT network synchronism signals used for the synchronisation of the various modules, functioning with the distributed clock.

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

The SYNC 1 signal has a period equal to the communication period configured for the EtherCAT network and is used to synchronise data package reception devices.

The SM2 signal indicates the actual time the device receives the data package.

Description of modes 4-5-6-7

Each individual digital input (TTL line driver, differential) can be configured as follows:
• Drive enable
• Reference enable
• Quick stop
• Reset alarm
• Limit switch (CCW and CW)

Each individual digital output can be configured as follows:
• Limit switch copy (if programmed on digital input available on J6).
• Motor temperature warning
• I^2T motor warning
• Drive temperature warning

⚠ **WARNING**
The X5 (X15) connector is not opto-isolated

AVERTISSEMENT
Le connecteur X5 (X15) n'est pas opto-isolé

🔍 INFORMATION
The 24 V power supply available on the connector can be used to power external devices

🔍 INFORMATION
A twisted shielded cable is recommended for the connection between the various devices and the drive

X6, X16 connector

Analogue and digital I/Os are present:

PIN	Designation	Function
1	IN AN 1 +	Positive analogue input 1, 12-bit resolution, sampling 3.9 us (256 kHz)
2	IN AN 1 -	Negative analogue input 11, 12-bit resolution, sampling 3.9 us (256 kHz)
3	IN AN 2 +	Positive analogue input 2, 12-bit resolution, sampling 3.9 us (256 kHz)
4	IN AN 2 -	Negative analogue input 2, 12-bit resolution, sampling 3.9 us (256 kHz)
5	OUT AN 1	Analogue output 1, 12-bit resolution
6	OUT AN 2	Analogue output 2, 12-bit resolution
7	+24 VOLT	24 V input for power supply to digital outputs
8	0 VOLT	Common earth of the digital I/Os
9	OUT DIG 1	Digital output 1, opto-isolated
10	OUT DIG 2	Digital output 2, opto-isolated
11	DRIVE_OK	Contact drive OK
12	DRIVE_OK	Contact drive OK
13	IN DIG 1	Digital input 1, fast, opto-isolated
14	IN DIG 2	Digital input 2, fast, opto-isolated
15	RESTART	Module reset
16	0 VOLT	Common earth of analogue inputs
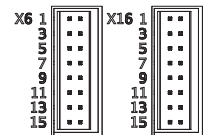
INFORMATION
The two earths on pins 8 and 16 are separated in order to increase the electric noise rejection from the wiring

Programming of digital and analogue I/O (connector X6):

Analogue Input 1 and 2 options
- Torque reference
- Velocity reference
- Current limitation (maximum torque deliverable)

Analogue Out 1 and 2 options
- Current reference
- Present velocity
- Phase current (measured on the U and V phases).
- Velocity error
- Position error

Digital Out 1/2 options
- Halt is active
- Stop is active
- Motor dir. clockwise
- Motor dir. anticlockwise
- Motor null speed

Digital Input options
- Drive enable
- Reference enable
- Quick stop
- Reset alarm
- Limit switch (CCW and CW)
- Position " capture" with dedicated procedures enabled (touch probe)

X7 (X17) connector
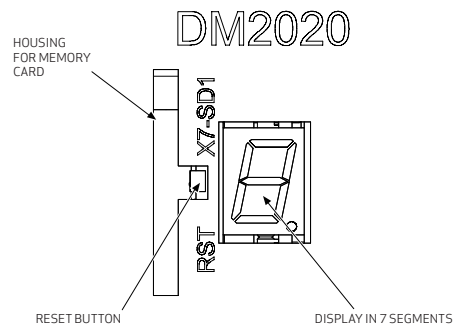
Housing for memory card

Inserting an SD card enables the information to be saved in several ways: Log files and/or parameters.

Reset button

Situated alongside the memory card; triggers the activation of the drive control section when pressed. When pressed and held (> 3 seconds), it triggers access to the drive's Boot routine and the possibility to download a different version of the control SW via the GUI.

LED display in 7 segments

Indicates the status of the axis after the addition of the 24 V auxiliary.

The meaning of messages is shown in the table below:

Display message	Status ID	Notes
I	Setup	The drive has completed setup
S	Ready	The drive is ready to be enabled
E	Enabled	The drive is controlling the motor
F	Fault	The drive has an alarm status
8 flashing	Boot via Serial	The drive is being programmed via the RS 232 serial line
b flashing	Boot via EtherCAT	The drive is being programmed via EtherCAT

INFORMATION
If the operating mode chosen is "Analogue", in the event of a fault, a two-digit code will be displayed after the letter F which will identify the alarm. The codes can be consulted in section "6.3.1. Viewing alarms in the "Analogue" operating mode".

X8 (X9) connector: EtherCAT interface

The cable is a standard EtherCAT cable and the connector is an RJ45.

LED	Name	Description	
X8 - RUN	EtherCAT run indicator	OFF	Drive status is INIT
		FLASHING	Drive status is PRE-OPERATIONAL
		FLASHING	Drive status is SAFE-OPERATIONAL
		ON	Drive status is OPERATIONAL
		FLICKERING	Drive status is BOOTSTRAP
X8 - L/A	EtherCAT Link/ Activity	OFF	The Ethernet input port is closed
		ON	The Ethernet input port is open
		FLICKERING	The Ethernet input port is open and network activity is present
X9 - L/A	EtherCAT Link/ Activity	OFF	The Ethernet input port is closed
		ON	The Ethernet input port is open
		FLICKERING	The Ethernet input port is open and network activity is present
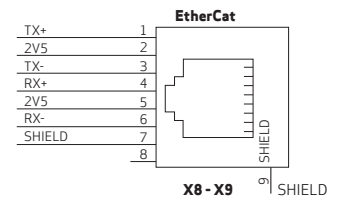
X10A (X10B) connector: CANOpen interface

The connector is an RJ45 and the pin is specified in the table which follows:

No. of pins	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	Signal (denied) of power supply status
5	Addr_dx	DX address for internal communications
6	Ps_out	Power supply command output
7	Addr_sx	SX Address for internal communications
8	+5VCan	CAN line power supply (supplied by power supply).
SH	Shield	Shield

INFORMATION
The PC-drive connection via CAN currently uses a VCI V3 model USB CAN adapter by IXXAT Automation (www.ixxat.com); other models or devices may be added to the GUI on request.
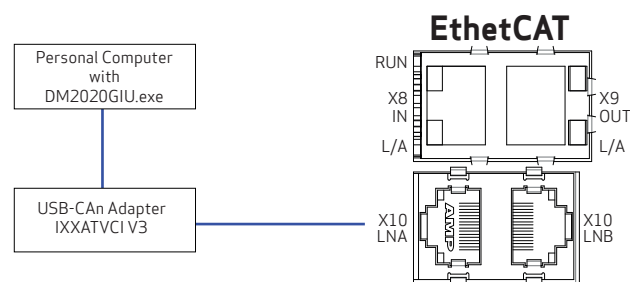
Fig 2.12 Dedicated PC-Axis connection via CAN
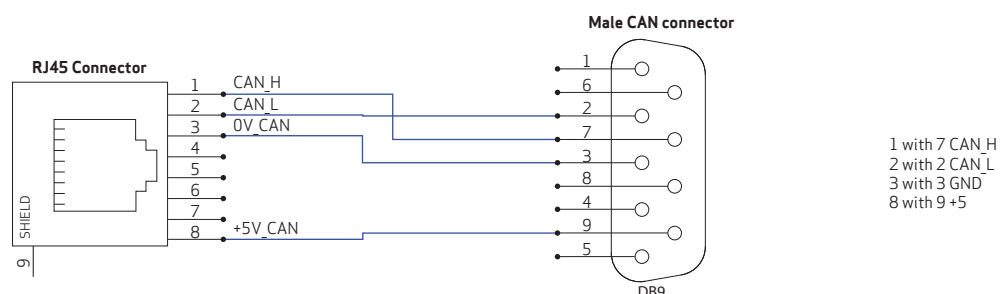
Fig 2.13 CAN RJ45 DB9 connection diagram

Connector X20 and connector X21

Motor power supply

Pin	Function
1	phase U
2	phase V
3	phase W
4	GND
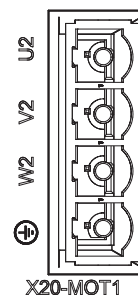
The cable must be shielded. The connection of the shield to the earth can be closed with a conduction clamp, with which the cable can be connected to the metal bracket to be fixed under the drive.

X18 (X19) connector – Motor brake management

The presence of this connector is optional.

The drive can control the brake, if present on the motor, via an item of dedicated optional hardware.
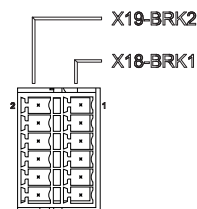
⚠️ **WARNING**
Where the brake power supply is external, if this fails, the DM2020 automatically ensures that the brake is connected to an auxiliary power supply system
WARNING
The motor brake connection does not provide a certified guarantee of personal safety.
Vertical loads in particular require an additional mechanical brake to operate safely; using safety boards, for example

ℹ️ *CAUTION*
Where a dedicated power supply is absent, it is important to ensure that the auxiliary power supply system is correctly dimensioned and that the tolerances comply with those required by the brake which is being controlled
CAUTION
When using "long" cables or cables that have a reduced cross-section, on which a drop in voltage can have a major effect on the active brake, measure the voltage at the brake input and check that it works correctly on release and on braking

⚠️ **AVERTISSEMENT**
Lorsque l'alimentation du frein est externe, si cela échoue, le DM2020 assure automatiquement que le frein est relié à un système d'alimentation auxiliaire
AVERTISSEMENT
La connexion du frein moteur ne fournit pas une garantie certifiée de sécurité personnelle.
Les charges verticales en particulier exigent un frein mécanique supplémentaire pour fonctionner en toute sécurité; utilisant des planches de sécurité, par exemple

ℹ️ *ATTENTION*
Si une alimentation dédiée est absent, il est important de veiller à ce que le système d'alimentation en énergie auxiliaire soit correctement dimensionné et les tolérances conformes à celles requises par le frein qui est contrôlé
ATTENTION
Lors de l'utilisation de câbles «longues» ou des câbles qui ont une section réduite, sur lesquels une chute de tension peut avoir un effet majeur sur le frein actif, mesurer la tension à l'entrée du frein et vérifier que cela fonctionne correctement sur la libération et lors du freinage

The brake can be enabled in four different modes:

1. According to a logical condition defined by the user (disabling/enabling of the axis)
2. Using a fieldbus command
3. Using appropriately programmed digital input
4. Using a command via the GUI software

🔍 INFORMATION
If the brake is running from an internal power supply within the drive, it should be noted that the current drawn from the brake is considered in the calculation of the system's absorption

2.3.6. Cables

Cable cross-sections for axis modules

Axis module	Axis1 X20 connector Axis2 X21 connector	Brake Axis1 connector X18 Brake Axis2 connector X19	Max length of motor cables per axis	Maximum capacity of cables	I/O (X6-X16)
2A	2.1 mm² AWG14	1 mm² AWG16	100 m	< 150 pF/m	0.22-1 mm² (AWG16)
4A					
6A					
8A					
16A	5.3 mm² AWG10				
24A	8.4 mm² AWG8				
32A					
48A	13 mm² AWG6				
64A	16 mm² AWG4				
96 A	26 mm² AWG3				
128 A	33 mm² AWG2				

See section "8.2. Metric/AWG conversion table" for the metric/AWG conversion table.

Class F or higher motors must be used, suitable for being powered by high-frequency PWM modulated waveforms. Particular attention must be paid to using adequate cables.

The cable and motor winding, with the final stage of the drive, may generate an oscillating circuit that increases the maximum voltage of the system; the parameters that determine this maximum voltage are cable capacity and length, motor inductance, and the frequency and leading edges of PWM modulation. These parameters should therefore be analysed to prevent voltage that is too high for applications with particular problems.

Please contact our Applications Department for assistance.

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

DM2020 drives are equipped with the STO (Safety Torque Off) function as standard, which protects (personnel) against the drive stating up unintentionally.
The standard version of the DM2020 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.

2.4.2.2. Safety instructions

⚠️ **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

AVERTISSEMENT
Charges en suspension doivent toujours être fixés mécaniquement d'une manière sûre. Si elle est activée, la fonction STO ne garantit pas que des charges suspendues seront tenues

AVERTISSEMENT
La désactivation de la 24 V DC à partir des entrées de connecteur à deux STO signifie que le moteur n' est pas commandé

AVERTISSEMENT
La fonction STO n'est pas électriquement indépendant de la puissance de sortie. Si vous avez besoin de travailler sur le câble moteur, coupez l'alimentation électrique et attendez le temps de décharge du circuit intermédiaire avant de commencer

🛈 *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 STO function electrical specifications

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 µs) 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 DM2020 refers to C3 category industrial environments.

CAUTION
In a domestic environment, the DM2020 may emit radio frequency disturbance
ATTENTION
Dans un environnement domestique, le DM2020 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

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CENELEC   Memorandum N°3

DICHIARAZIONE CE DI CONFORMITA'/ EC 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 Serie / *Drives Series*: DM2020 |

risultano in conformita' 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 50178	1997	*Electronic equipment for use in power installations*
EN 61800-3	2004	*Adjustable speed electrical power drive systems. Part 3: EMC product standard including specific test methods*
EN 61800-3: 2004 A1	2012	*Adjustable speed electrical power drive systems. Amendment 1*

Altri riferimenti o informazioni richiesti dalle direttive comunitarie applicabili / *Other references or information required by the applicable EC directives:* La conformità dei prodotti è subordinata al rispetto delle procedure contenute nei rispettivi "Manuale di installazione". L'utilizzatore ha la responsabilità primaria nel seguire le raccomandazioni del costruttore riguardo alle problematiche EMC./ *The conformity of products is subjected to comply with procedures included in the proper "Installation Manual". The user has the primary EMO 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*: 11

Casella, 20 Aprile , 2016

Gianfranco Costa

OPERATIONS MANAGER

CENELEC   Memorandum N°3

Fig 3.1 EC declaration of conformity

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

The DM2020 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

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

Noi,

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

dichiariamo sotto la nostra esclusiva responsabilità che il blocco logico per la funzione di sicurezza **"Coppia Disinserita in Sicurezza"** (**"Safe Torque Off "**) integrato nei nostri azionamenti serie **DM2020**

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

ed è conforme al modello sottoposto ad esame CE del tipo, che ha ottenuto la certificazione CE n. 17CMAC0002 del 11/01/2017 rilasciata dal seguente organismo notificato:

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

e che il Fascicolo Tecnico è stato costituito da:

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

Inoltre sono state applicate le seguenti:
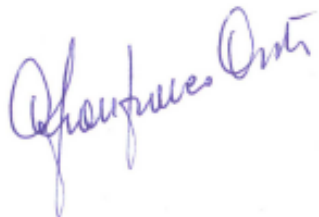
norme armonizzate

EN 61800-5-2:2007, EN ISO 13849-1:2015, EN62061:2005 +A1:2013 +A2:2015

Casella, 25 Gennaio , 2017

Gianfranco Costa

OPERATION MANAGERS

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

Fig 3.2 EC declaration of conformity (original)

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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 **DM2020**

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. 17CMAC0002 dated 11/Jan/2017 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:
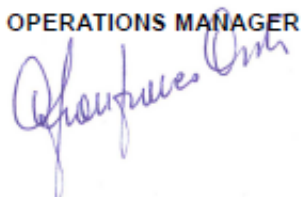
harmonized standards

EN 61800-5-2:2007, EN ISO 13849-1:2015, EN62061:2005 +A1:2013 +A2:2015

Casella, January 25th, 2017

Gianfranco Costa

OPERATIONS MANAGER

Fig 3.3 EC declaration of conformity (translation)

i CE pi

Istituto Certificazione Europea Prodotti Industriali S.p.A.

organismo notificato n. 0066

CERTIFICATO D'ESAME CE DI TIPO
EC-TYPE EXAMINATION CERTIFICATE

11DM4SL01

■ Nome e indirizzo del detentore del certificato ❏ Name and address of the certificate owner	**MOOG ITALIANA S.r.l.** **Via Avosso, 94** **16015 CASELLA (GE)**
■ Costruttore ❏ Manufacturer	**MOOG ITALIANA S.r.l.** **Via Avosso, 94** **16015 CASELLA (GE)**
■ Genere prodotto ■ Product designation	**Funzione di coppia disinserita in sicurezza (STO)** **per convertitore di frequenza** Safe torque off (STO) function for frequency converter
■ Serie / Tipo ❏ Series / Type	**DM2020**
■ Numero e data del rapporto di verifica ❏ Date and number of test report	**11RT0914 - 08.09.2011**
■ Direttiva(e) della Comunità Europea ■ EC - Directive(s)	**2006/42/CE - All. IV 21** 2006/42/EC / Annex IV 21
■ Risultato dell'esame ■ Examination result	La funzione di sicurezza esaminata nel contesto delle specifiche e dei limiti riportati nel rapporto di verifica di cui sopra risulta conforme ai Requisiti Essenziali di Sicurezza e Salute ad esso applicabili contenuti nella Direttiva Macchine 2006/42/CE, Allegato I. The safety function examined under the specifications and limits stated in the above test report complies with the related Essential and Safety Requirements listed in the Machinery Directive 2006/42/EC, Annex I.
■ Note ■ Remarks	Norme utilizzate per la verifica: EN 61800-5-2:2007; EN ISO 13849-1:2008. Standard adopted for the examination: EN 61800-5-2:2007; EN ISO 13849-1:2008. La funzione STO risulta conforme ai requisiti della norma EN 61800-5-2:2007, SILCL 3, e della norma EN ISO 13849-1:2008, PL "e", se l'azionamento è installato ed utilizzato conformemente al relativo Manuale Istruzioni. The STO function fulfils the requirements of SILCL 3 EN 61800-5-2:2007 and PL "e" EN ISO 13849-1:2008 if the frequency converter is installed and used according to the Instruction Manual.
■ Condizioni di validità ■ Validity conditions	Le condizioni di validità della certificazione ICEPI sono indicate ai punti 4 e 5 del contratto per l'attività di certificazione intervenuto tra il Contraente ed ICEPI. ICEPI certification validity terms are written in clauses 4 and 5 of the EC certification activity contract between Contractor and ICEPI. La validità del certificato cessa il 04.10.2016 o anticipatamente in caso di cambiamenti normativi significativi. The certificate expires on 04.10.2016 or before in case of standard major changes.

Piacenza, 05.10.2011

Il Direttore Generale
Dott. Ing. Andrea Guido Esposito

Fig 3.4 ICEPI certificate

3.3. UL

REQUIREMENTS (original)

- The "modular servo-drive Systems – DM2020 series", specifically servo-drive systems which use a common "power supply (AC/DC converter)" to "multiple modules (power inverters)", are intended exclusively for application with each other.
  The UL certification does not cover "standalone power supplies (AC/DC converters)" or "modules (power inverters)" supplied by other "power supply (AC/DC converter)" (different models or manufacturer).

Short-circuit protection

- "The power supply model no. PS-S and PS-M are suitable for use on a circuit capable of delivering not more than 5000 RMS symmetrical amperes, 480 V AC +10% maximum", when protected by the external (recommended) semiconductor fuse type as per the following table"
- "The power supply model no. PS-L is suitable for use on a circuit capable of delivering not more than 10,000 RMS symmetrical amperes, 480 V AC +10% maximum", when protected by the external (recommended) semiconductor fuse type as per the following table"

Power supply (converter) Model no.	External (recommended) semiconductor fuses					
	R/C fuses manufactured by					
	Bussmann Div Cooper (UK) Ltd (200 kARMS Symmetrical A.I.C.)					
	Mod. no.	Ratings				Qty
		Current ARMS	Peak let-through current	I2t @480 V A2sec	V AC	
CC201(L50)	160 FEE	160	2142	5218	690	3
CC202(L150)	315 FM	315	6000	60820	690	

Please note: The brushless AC motor servo drives "DM2020 series" may be protected by any equivalent UL listed (JDDZ) or UL recognised external semiconductor fuses (JFHR2). These fuses must have the same ratings as the above fuses evaluated during the short circuit test and in particular with "peak-let-through current Ip" and "clearing I2t" equal or lower than tested fuse.

Wiring

- This equipment is suitable for factory wiring only; the terminal blocks and the connectors for power connection wiring are not suitable for field wiring.
- The wire connectors shall be any listed (ZMVV) or R/C wire connectors and soldering lugs (ZMVV2), used with 60 °C/75 °C copper (CU) conductor only, within electrical ratings and used with its appropriately evaluated crimping tool.
- The wiring terminals shall be used with the tightening torque values specified in this manual.
- In particular the "power supply (converter)" and "modules (inverters)" interconnection wiring shall be obtained only with the DC bus terminal blocks and with the DC bus interconnection bars, made with close eyelet wire terminals. These particular DC bus wiring components are provided by the manufacturer and described in this manual.

Overvoltage control

- In the equipment open-type brushless AC motor servo drives "DM2020 series", the transient overvoltage in the power supply primary circuit of the end-use applications, is controlled by the following transient-voltage-surge suppressors devices:
  - Internal (provided) devices (power supply (converter)). According to the United States Standard UL508C. Suppressive device/component: R/C surge-protective device (VZCA2) and CSA-certified.

Power supply (converter) model no.	Manufacturer	Mod. no.	Ratings				Qty
			Maximum continuous operating voltage (V AC)	Voltage protection rating (VPR)(Vpk)	Cat.type SPD appl. / Nom.dis current (in, kA)	Max op. Temp.	
CC201 (L50)	LITTELFUSE Inc	V20 E550 P20V550	550 Vrms max	2500 V #1	5 5 kA	105 °C	3
CC202 (L150)	LITTELFUSE Inc	V25 S550P P25S550	550 Vrms max	2000 V #2	1 10 kA		

- External (recommended) devices. According to the Canadian Standard C22.2-No.14-10. Suppressive device/component: R/C surge-protective device (VZCA2) and CSA-certified.

Power supply (converter) model no.	Manufacturer	Mod. no.	Ratings			Qty
			Maximum continuous operating voltage (V AC)	Voltage protection rating (VPR)(Vpk)	Cat.type SPD appl. / Nom.dis current (in, kA)	
All	ABB France	OVR T2 3L 40 550PTSU	L-G 550 Vrms max L-G 1100 Vrms max	L-G 1800 Vrms max L-G 4000 Vrms max #1 - #2)	1 10 kA	1
	Phoenix contact	L-G 350 Vrms max L-G 700 Vrms max	550 Vrms max	L-G 1200 Vrms max L-G 2000 Vrms max #3 - #4	2 10 kA	

Please note: The brushless AC motor servo drives "DM2020 series" may be protected by any equivalent external UL listed (VZCA) or UL recognised surge protective device (VZCA2) and CSA certified. These SPDs shall have the same or better ratings as the ratings of the SPDs recommended in the above table.

Overload protection

- The equipment does not incorporate internal overload protection for the motor load. The drive is intended to be used with motors that have integral thermal protection.

Over-current protection

- The drive is provided with a current limiting circuitry.

Installation environmental conditions

- "Maximum surrounding air temperature 40 °C"
- The open-type brushless motor servo drive must be placed in a pollution degree 2 environment.

Dynamic brake unit

- The maximum current and the related duty cycle of the dynamic brake unit are as follows.

Model no.	Max current amps		Max duty cycle (%)
	Peak	RMS	
CC201(L50)	52.6	0.47 A	0.89 %
CC202(L150)	168	1.26 A	0.75 %

Please note: the Duty Cycle (D.C.) is referred to % of total time = 1 sec.

4.   ELECTRICAL AND MECHANICAL INSTALLATION

4.1.   Tools and instruments

Tools:

Keep the following tools available to install the modules:

- Tork T25 screwdriver (fixing connecting BUS BAR)
- M2 flathead screwdriver (insertion connectors)
- M3 flathead screwdriver (for fixing screws and connectors on the front)
- M4 flathead screwdriver (for fixing power connectors)
- M6 crosshead screwdriver

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

The 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 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. 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'entrainement est en marche, il existe un risque de mort, blessures graves ou dommages
matériels importants.
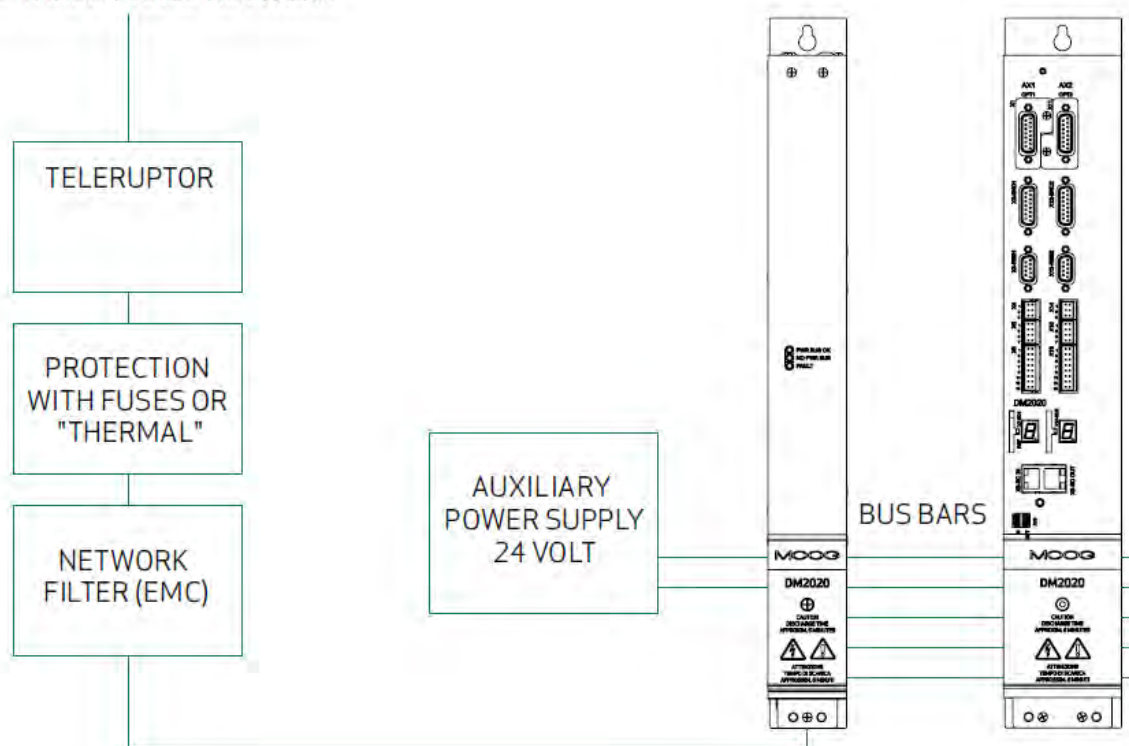
Fig 4.1 Diagram of the distribution board with components for a servo system

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 problem 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 mm^2.

As regards shielding, 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:

- Do not overlap power cables with signal 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
- Make sure no loops form in the cables. Keep cables as short as possible and close the potential correctly.
- Keep power supply cables separate from the motor cables
- If the motor is equipped with a stop brake, keep the 24 V brake cables separate from the signal cables; (feedback) unless these are already incorporated in the motor power cable.
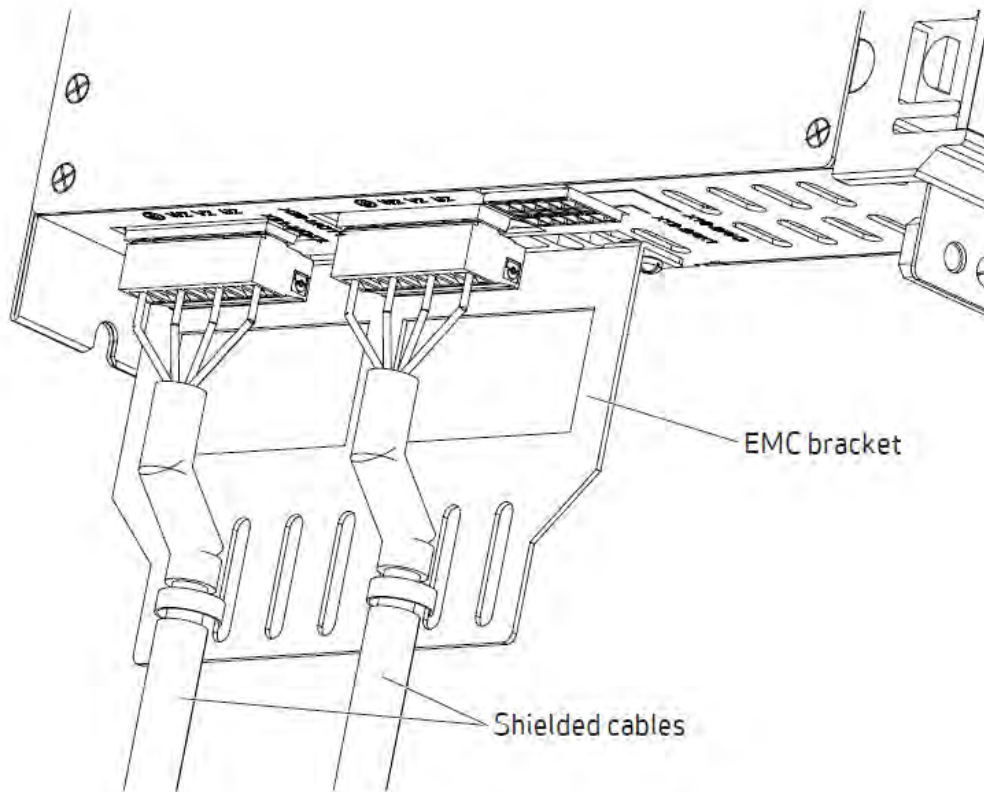
Fig 4.2 Detail of connection between cables and EMC bracket

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

The first column shows the percentage of current delivered compared to the rated current. The second column shows dissipation data in watts in operating conditions.

4.3.2.3. Dissipation of the axes

% Rated current	Type L50	Type L150	Type L100	Type L200
0	25	38	50	70
25	113	213	313	500
50	200	388	575	750
75	288	563	838	1100
100	375	738	1100	1750

4.3.2.5. 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
Optional brake resistor	500

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.

Module	Absorbed current (A)
Power supply L50	1.0
Power supply L150	2.0
Axis size L50	1.0
Axis size L75	1.5
Axis size L100	2.0
Axis size L200	2.5
Motor brake	2.0

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

ATTENTION
Lorsqu'une alimentation dédiée pour le frein moteur est absent, il est important de veiller à ce que le système général auxiliaire d'alimentation est correctement dimensionné et les tolérances conformes à celles requises par le frein qui est contrôlé

4.3.4. Connection to the 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

AVERTISSEMENT
L'entraînement doit être correctement mis à la terre pour éviter tout risque de blessure ou mort. Un transformateur d'isolation doit être installé dans les conduites maîtresses des réseaux qui ne sont pas mis à la terre ou avec mise à la terre asymétrique

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:
a)   Direct mains connection (earthing point)
b)   The control unit neutral and earthing of the entire plant are connected to a single connector, the PEN
c)   All parts exposed to contact and shielding must be connected to earth
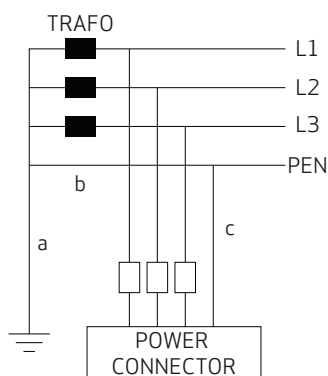
Fig 4.3 TN-C network

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
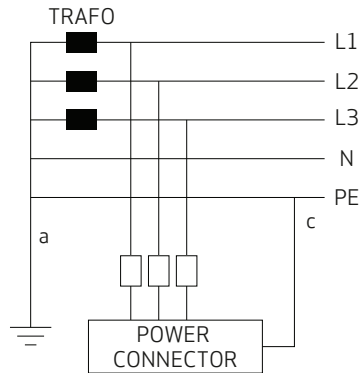
Fig 4.4 TN-S network

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
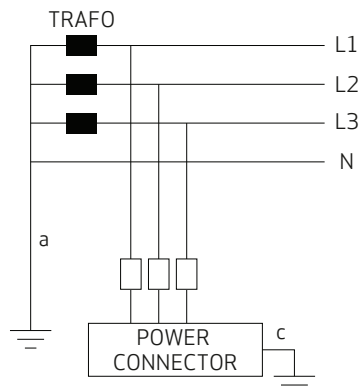
Fig 4.5 TT network diagram

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 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

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 mm^2

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" for cable selection.
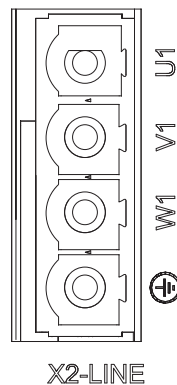
Fig 4.6 Connector X2

4.3.5.3. Brake resistor connection

See section "2.2.3.4. Brake resistor" for resistor selection.
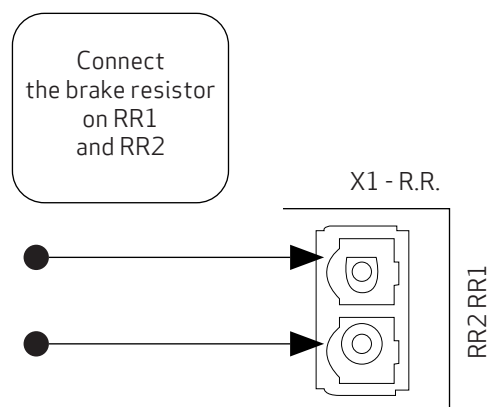
Fig 4.7 Fixed brake resistor connector

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).

AVERTISSEMENT

L'utilisateur est responsable de la protection physique des BUSBAR et autres dispositifs de sécurité destinés à prévenir les dommages aux personnes: A cet effet, le capot avant ou le deux couvercles latéraux fournis doivent être utilisés (sur les deux modules de chaque côté)
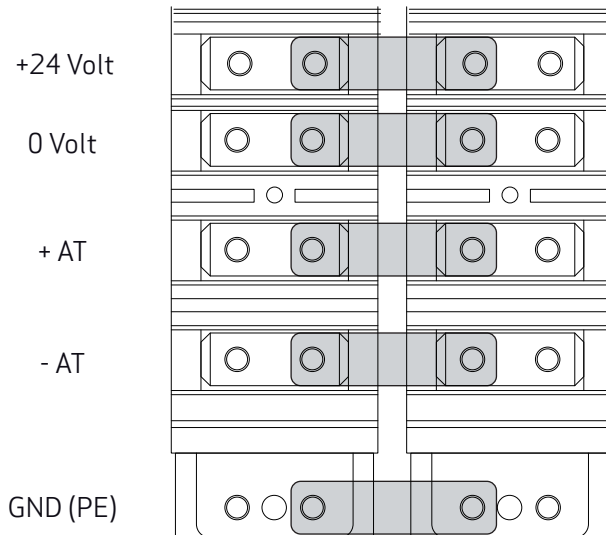
Fig 4.8 Connecting the power (+/- AT) and auxiliary voltage via BUSBAR

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.

The power supply is equipped with a CAN (X10) connector which provides direct power to the drives' CAN line; the pin is the same as that one the axis modules. See section "2.2.2. Connectors and LEDs".

4.3.6.   Axis module wiring

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.

4.3.6.2. Motor cable connection

See section "2.3.4. Interfaces with "field" and other modules".
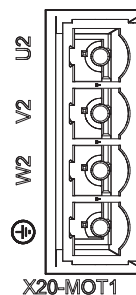
Fig 4.9 Connector X20 (X21)

🔍 INFORMATION

If power cables for the motor are longer than 50 m and have a capacity above 150 pF/m, dispersion currents could cause erroneous alarms with the power sections of the drives. This can be remedied using an inductor in series for the power cable, positioned as close as possible to the drive. Please contact the Applications Department for any necessary inductor sizing

4.3.6.3. Motor brake cable connection

> **CAUTION**
> *While defining the brake connections, consider the potential for a drop in voltage for connections over 10 m with cables that do not have an adequate cross-section*
> **MISE EN GARDE**
> *En définissant les connexions de frein, envisager la possibilité d'une chute de tension pour les connexions de plus de 10 m avec des câbles qui ne dispose pas d'une section suffisante*

24 Volt Power Supply
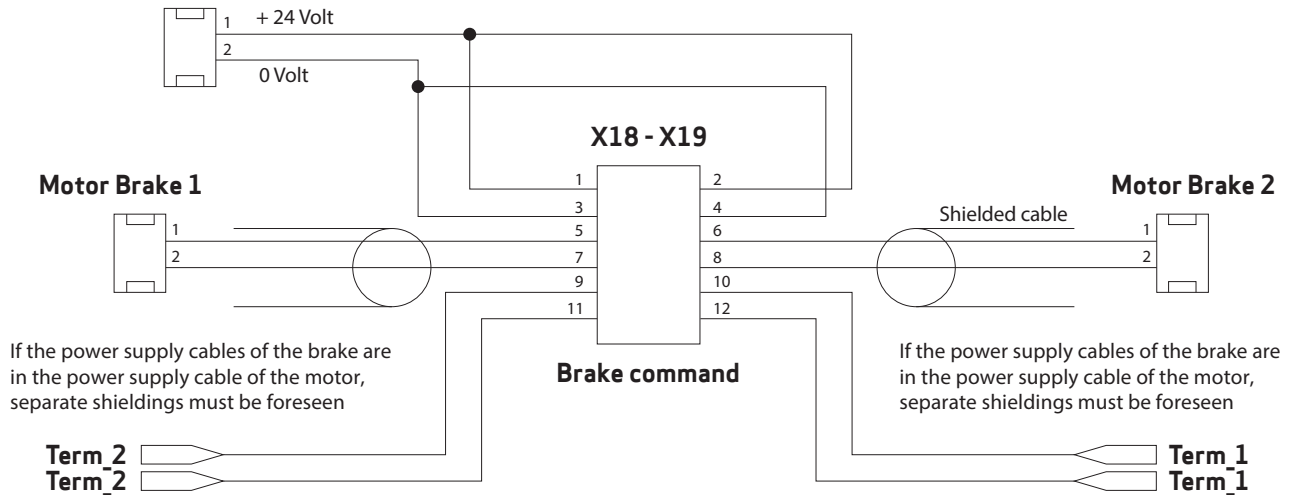
Fig 4.10 Layout of the X18-X19 brake connector and connection instructions

- Power must be supplied externally (on pins 1 and 2 with a 24 Volt connection, and on pins 3 and 4 with a 0 Volt return).
- Overload protection is provided with a delayed fuse (maximum 4 A), to protect both internal devices and the power supply, to be installed externally on the 24 V line if not otherwise protected.
- The interface manages currents from 2 A to 24 V.
- The internal devices are protected from short circuits between the terminals (between 5 and 7 and between 6 and 8) and to earth.
- The drive identifies whether the command has been executed correctly along with any short circuit conditions, reported as an absence of output on terminal 5 (6 for axis 2).
- The same connector has an input for a motor protection thermal sensor, with the same characteristics as the sensor on position feedback connectors (X1-X2 and X3 etc.).

> **WARNING**
> **In the absence of an external power supply, the power to the brake is taken from the drive.**

> **AVERTISSEMENT**
> **A défaut d'une alimentation externe, la puissance du frein est prise de l'unité.**

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 us. The delay in brake activation depends on the type of brake and is specified by the motor manufacturer.
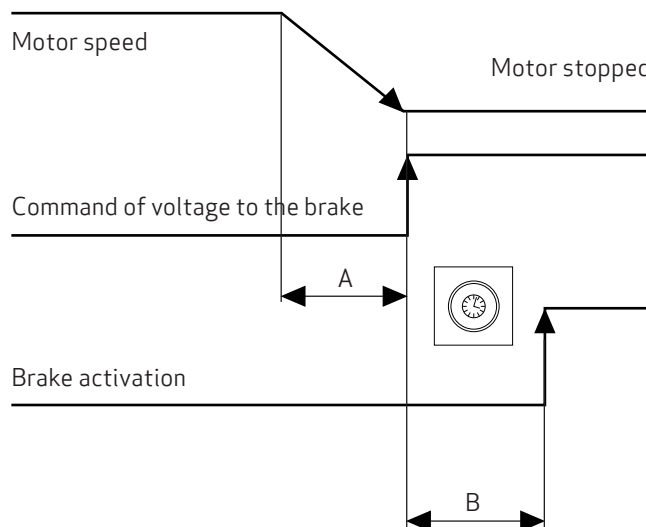
Fig 4.11 Diagram of brake activation times

A   Machine deceleration time (variable)
B   Brake activation (300 ms)

⚠️ **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
AVERTISSEMENT
La même information donnée pour le câble du moteur s'applique ici, donc un soin particulier doit être payé à la protection, même si les conducteurs ne sont pas encore intégrés dans le câble moteur
AVERTISSEMENT
L'utilisation du frein moteur ne garantit pas la sécurité personnelle. Les charges verticales en particulier exigent un frein mécanique supplémentaire pour fonctionner en toute sécurité; en utilisant des planches de sécurité, par exemple

4.3.6.4. I/O signals connection

Connectors X5, X15, X6, X16

See section "2.3.4. Interfaces with "field" and other modules" for information on connector fastenings.

ℹ️ *CAUTION*
Analogue inputs are referred to 0 Volt an. earth on pin 16; the 0 Volt dig. earth is used for the power supply for the digital outputs
ATTENTION
Les entrées analogiques sont appelées 0 Volt terre analogique sur la broche 16; la terre numérique 0 Volt est utilisée pour les alimentation des sorties numériques

Note on analogue inputs:
- These are two programmable differential inputs for nominal analogue values. As the potential reference, connect pin 8 to the corresponding earth pin of the control unit; standard configurations are the nominal velocity value for pins 1 and 2 and the torque limit for pins 3 and 4 when the drive is used in "analogue" mode
- Maximum differential voltage: ±10 V
- Reference earth: pin 16
- Input resistance: 22 kOhm
- Scanning velocity: 32.5 usec
- Resolution:12 bit

Notes on digital inputs:
- The programmable digital inputs, DIG_INP 1 and 2, are also suitable for "latch" functions or for the quick feedback ("capture") of specific positions or events
- The possible functions linked to the X5, X15 connector pins can be configured using the program Dx2020GUI and consist of:
    1. The RS232 serial interface with inputs and/or outputs
    2. The simulated encoder
    3. Digital I/O line drivers which may be programmed as inputs or outputs

4.3.6.5. STO signals connection
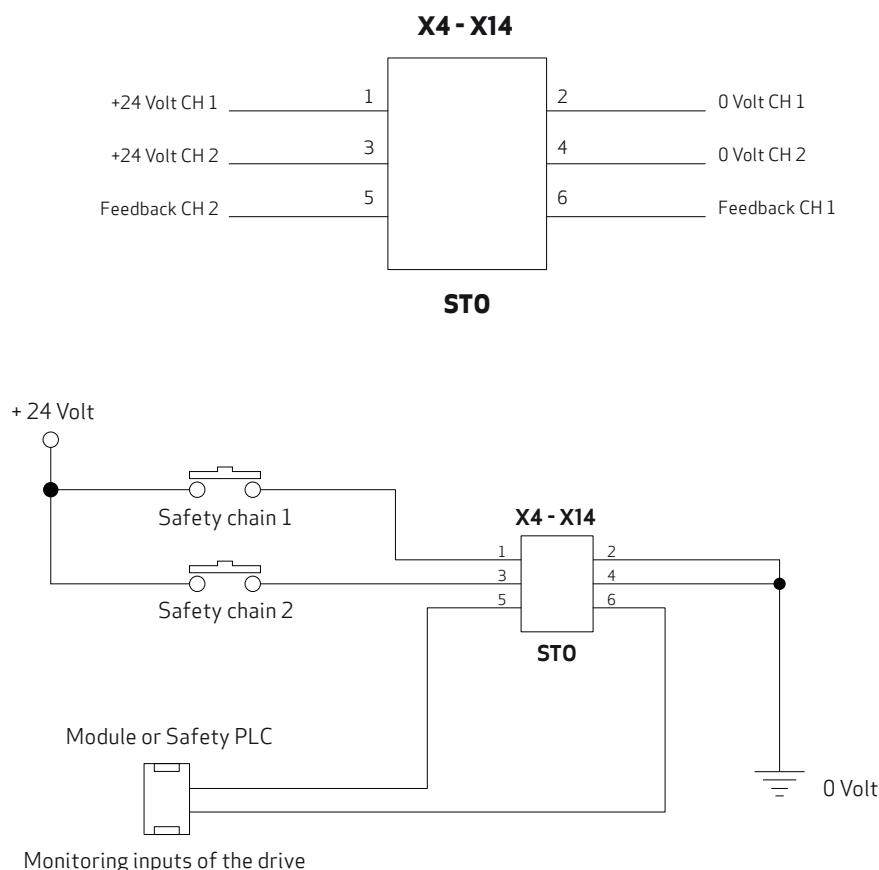
Fig 4.12 Basic diagram for connection to the PLC

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.

The STO function is certified to SIL 3 (EN62061) and PL e (EN13849-1), and allows for simpler wiring of machine safety devices.

⚠️ **WARNING**

If the connection cables of the STO function are outside the installation site, they must be protected from external damage (for example using a raceway) and laid in a fixed position.

ATTENTION

Si les câbles de raccordement de la fonction STO sont à l'extérieur du site d'installation, ils doivent être protégés contre les dommages externes (par exemple en utilisant un chemin de roulement) et mis en position fixe.

4.3.6.6. Transducers Connection

The DM2020 is able to handle most of the common position motor transducers in the table below:

Resolver	X3- / X13
Stegmann absolute single-turn sinusoidal encoder with/without hiperface	X2-X12
Stegmann absolute multi-turn sinusoidal encoder with/without hiperface	X2-X12
Heidenhain absolute single-turn sinusoidal encoder with EnDAT/without EnDAT	X2-X12
Heidenhain absolute multi-turn sinusoidal encoder with EnDAT/without EnDAT	X2-X12
Heidenhain EnDAT 21 or 22 full digital encoder	X2-X12
Heidenhain linear encoder with EnDAT	X2-X12
TTL incremental encoder	X1-X11

See section "2.3.4. Interfaces with "field" and other modules"

CAUTION

The cable for the incremental encoder must be composed of at least six individually shielded twisted pairs for the encoder signals

ATTENTION

Le câble du codeur incrémental doit être composé d'au moins six paires torsadées blindées individuellement pour les signaux du codeur

INFORMATION

Contact the Applications Service for connections longer than 50 m

4.3.6.7. Connecting fieldbus

Connectors X8, X9, X10,

INFORMATION

Depending on the type of fieldbus, a different type of firmware may need to be installed. If the connection is via EtherCAT, the file extension will be _ecat, and if it is via CAN bus, the file extension will be _can

INFORMATION

If the connection is via EtherCAT, the CAN port is available as a service port for connecting the PC to the drive. Conversely, if the connection is via CAN bus, the EtherCAT port is not available

- EtherCAT connection

  The X8 (X9) connector can be used for the Ethernet interface. The software installed manages communication with the EtherCAT network.

  See section "2.3.4. Interfaces with "field" and other modules" for details on the connector

- CAN connection

  The X10 connector may be used with the CAN interface.

  See section "2.3.4. Interfaces with "field" and other modules" for details on the connector

  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 cable length (m)
1000	10
500	60
250	100

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 létale Assurez que toutes les parties électrifiées soient protégés 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 ℃ and are therefore a hazard for the operator's safety. Before operating, make sure the heat sink temperature is below 40 ℃

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

AVERTISSEMENT
Lorsque les entraînements sont électrifiés, ne pas desserrer les connexions électriques. Après avoir enlevé la tension d'alimentation, les condensateurs peuvent encore avoir des tensions dangereuses jusqu'à 6 minutes après la mise hors circuit. Pour assurer que les conditions soient sécuritaires, mesurer la tension sur le circuit de courant continu intermédiaire et attendre jusqu'à ce qu'il ait chuté en dessous de 40 V

AVERTISSEMENT
Pendant le fonctionnement, le dissipateur de chaleur et le panneau arrière peuvent atteindre des températures très élevées, allant jusqu'à 80 ° C et sont donc un danger pour la sécurité de l'opérateur. Avant de commencer, assurez-vous que la température du dissipateur de chaleur soit inférieure à 40 ° C

AVERTISSEMENT
Avant l'installation, le fabricant de la machine doit effectuer une évaluation précise des risques et prendre toutes les mesures nécessaires pour que le mouvement imprévu de la machine ne nuise pas à personnes ou puisse endommager des biens

5.2. Dx2020 GUI

5.2.1.   General description

In addition to the drive, the device comes equipped with a graphical interface software called Dx2020 GUI, which allows the user to set and change the parameters and the configuration of the drives.

The main functions 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 (memory card)
* Signal visualisation on 4-track digital oscilloscope
* Firmware updating, drive parameter management (saving, backup, etc.)

5.2.2.   Minimum PC requirements

* Pentium® II 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
* Onboard serial port, PCI adapter or USB-serial adapter, 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 Home eEdition (Service Pack 3)
* Windows XP Home eEdition (Service Pack x64 3)
* Windows Vista
* Windows 7
* Windows 8
* Windows 8.1

INFORMATION
There are other versions of Windows XP which are NOT supported by the .NET Framework 4.0.

Windows 8 and Windows 8.1 already have the .NET Framework 4.5 libraries installed, which are simply an update of the 4.0 version. Therefore users with these versions of Windows can download the installer without the .NET Framework 4.0.

INFORMATION
Users must have 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 Vista and Windows 7 have a more advanced control system for starting applications than that on Windows XP, called UAC (User Account Control). Every time that any program is launched necessitating further administration rights, this system asks the user if they want to proceed.

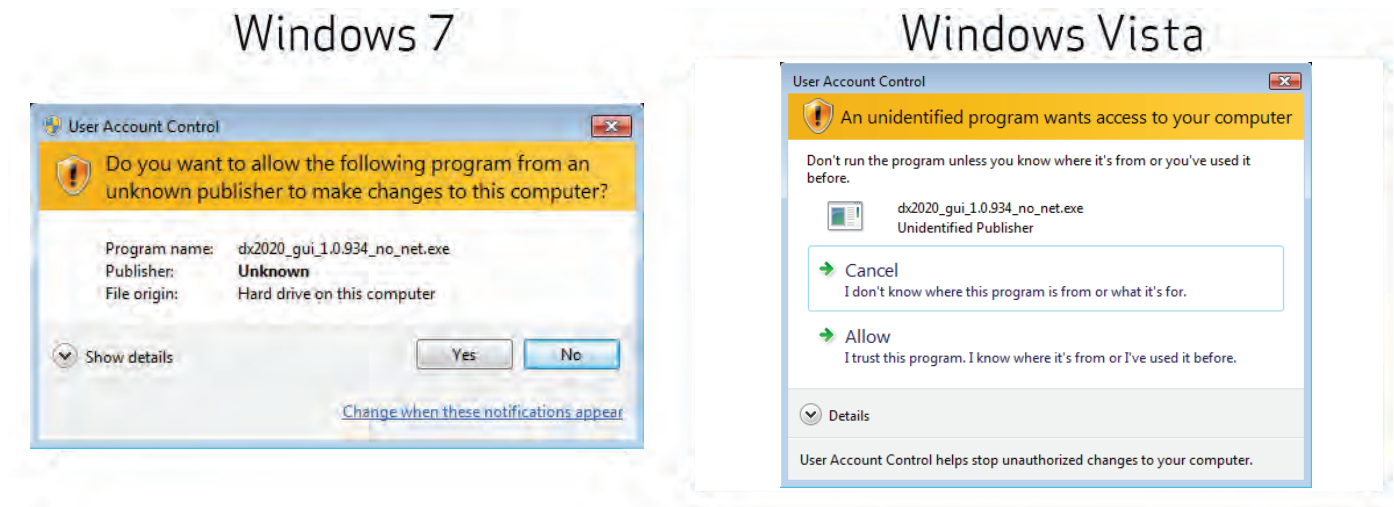The installation software must be requested from the Technical Assistance Service at Moog-Casella.

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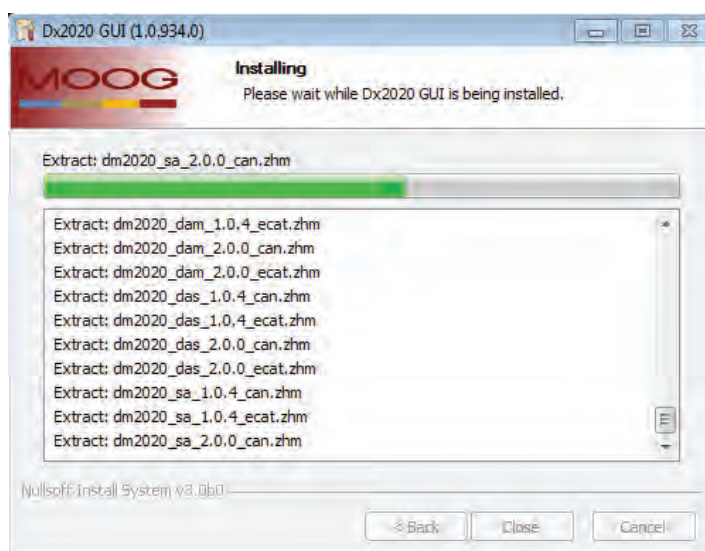
Once the installation has finished, click on **finish**.

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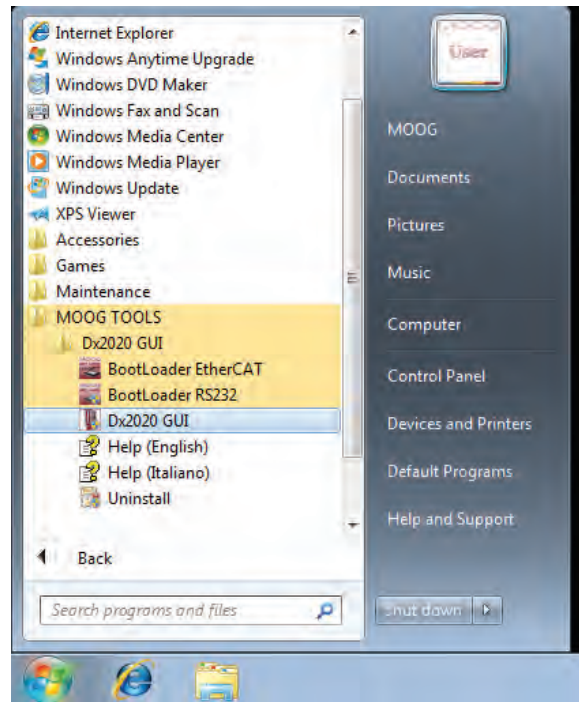
The GUI can connect to the drive via the RS232 serial (X5 connector) or via EtherCAT (connectors X8-X9) or via CAN BUS (connector X10) (see section "2.3.4. Interfaces with "field" and other modules" for details on connectors).

From the **Network** menu, click on **Select** to select the type of communication protocol.
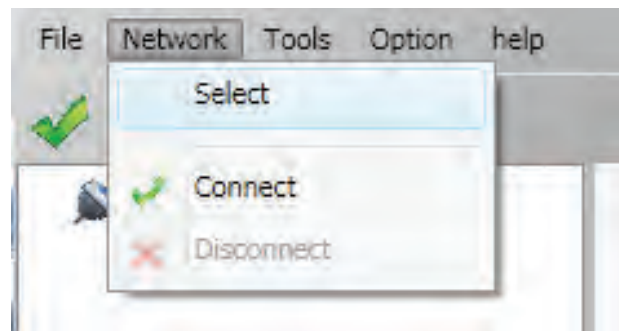
Refer to the pages on this in the **Online Help** guide for more information (see section "5.2.7. How to access the Online Help" for details on how to access this)

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 steps recommended

5.2.5. Layout

When making the connection, the screen will display the following.
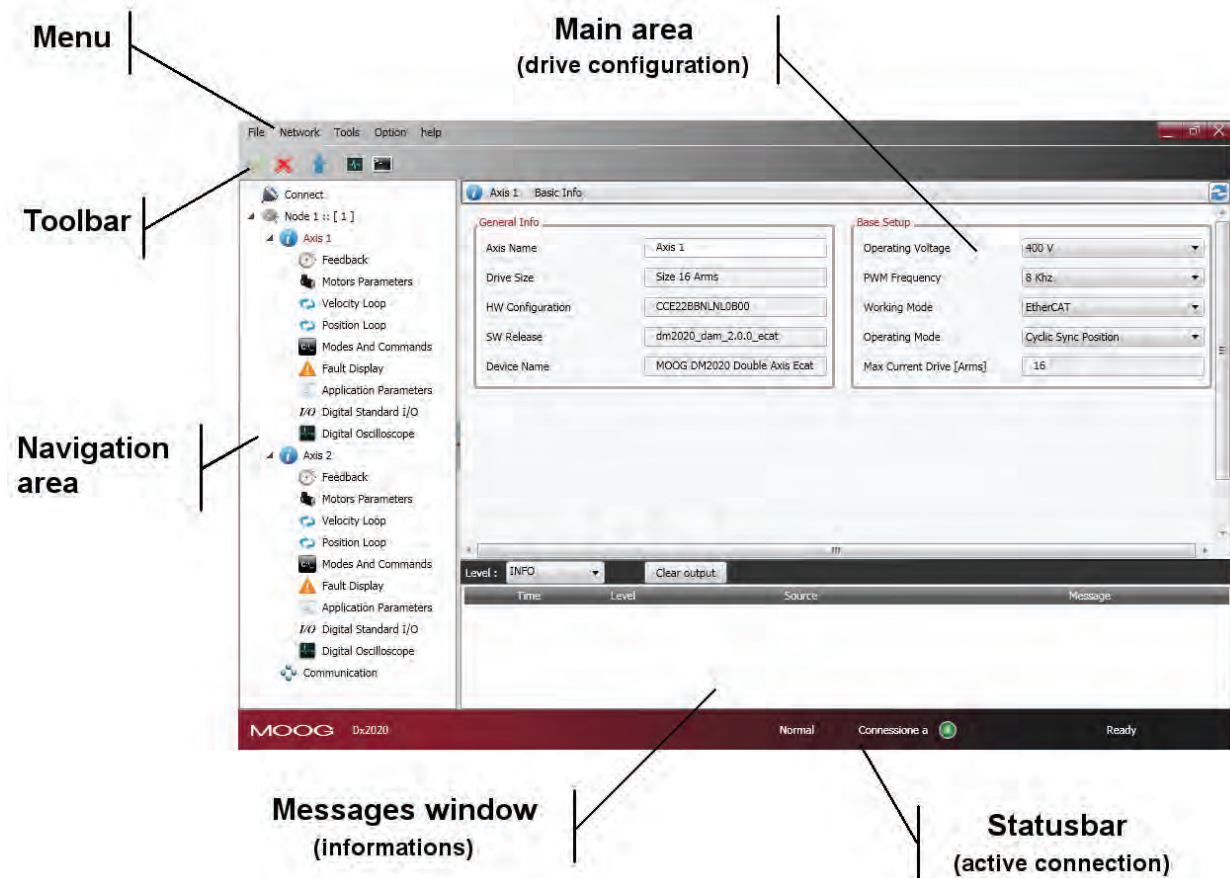
- **Menu**: The following menus are present: **File**, **Network**, **Tools**, **Options** and **?**
  Refer to the Online Help on the application for more information.
- **Toolbar**:

	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 single-axis modules or dual-axis modules. 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).
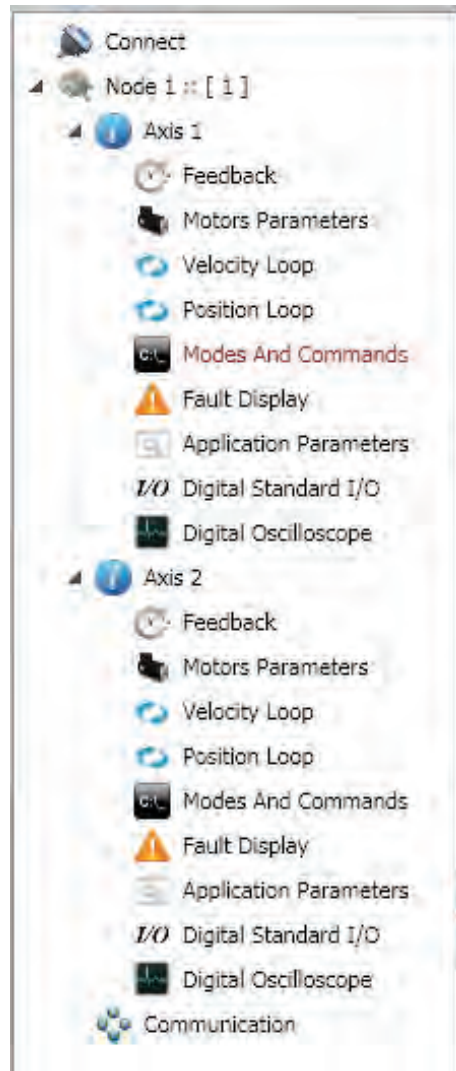
- **Main area**:

  This area displays the information and parameters relating to the view selected in the navigation area.

  This window allows users to view and set DM2020 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 **?**
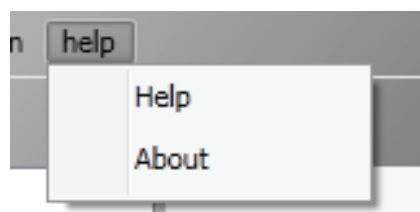
2) From the PC Start menu/Programs/MoogTools/Dx2020 GUI/Help, in this case, it is not necessary to have launched the operator interface.

5.3. System configuration

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 motor parameters
3. Configuration of transducers
4. Configuration of I/O
5. Configuration of control loops (torque, speed, position)
6. Configuration of faults
7. Application parameters
8. Definition of modes and commands
9. Power supply
10. Enabling the STO
11. Enabling

5.3.1. Axis modules identification

Follow the instructions in the Online Help Guide on connections.

5.3.2. Motor parameters configuration

The DM2020 can control:
- Synchronous motors with permanent magnets (brushless)
- Asynchronous motors with IFOC control (impressed current)
- Asynchronous motors with V/F control

A motor database is available and can be accessed by clicking on the **View Motor Database** link.

The motor database can be edited and additional models of motor can be added.

The relevant file is called DBMotors.xml and is present in the Version installation folder in the DM2020 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 Id and flow Sg 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 Parameters**.

5.3.3.   Transducers configuration

The DM2020 can manage various types of feedback transducers to close the control loops.

Resolver
Stegmann absolute single-turn sinusoidal encoder with/without hiperface
Stegmann absolute multi-turn sinusoidal encoder with/without hiperface
Heidenhain absolute single-turn sinusoidal encoder with EnDAT/without EnDAT
Heidenhain absolute multi-turn sinusoidal encoder with EnDAT/without EnDAT
Heidenhain EnDAT 21 or 22 full digital encoder
Heidenhain linear encoder with EnDAT
TTL incremental encoder

Follow the instructions set out in the Online Help section to proceed to configuration, selecting **Configuration Views/Feedback**.

🔍
> INFORMATION
> By using a 2° position transducer, it is possible to enter the transmission ratio between motor and load (**Transmission Ratio** field)

🔍
> INFORMATION
> The timing angle must be entered; if this is not known, follow the procedure for autophasing (paragraph 5.3.2.1)

5.3.3.1.   Sensorless

The DM2020 features the Sensorless operating mode, with no speed transducer.
In order to enable it, select **Feedback** from the navigation area.
Under the tab **Feedback sources**, set the fields as indicated in the figure.
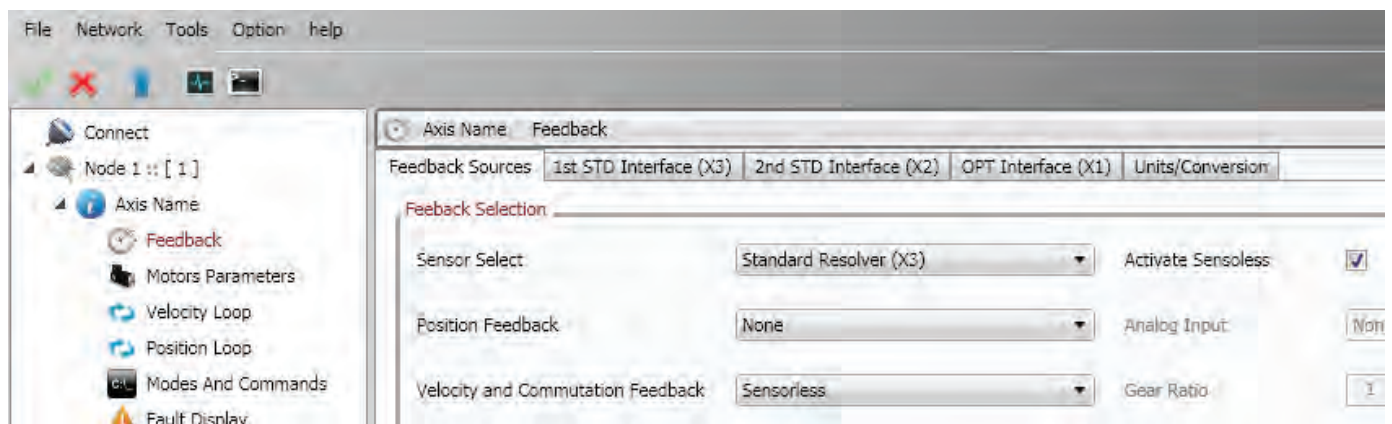
Under the tab **1 STD interface (X3)**, set the fields as indicated in the figure.
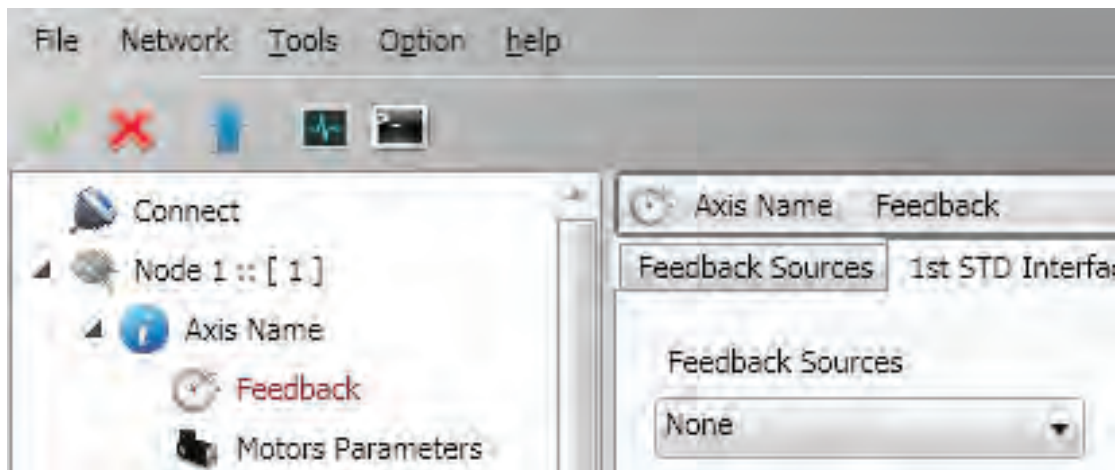
Finally, set the fault (in **View Fault/Fault Configuration**) Interface X3 - Missing Transducer Configuration to "None".
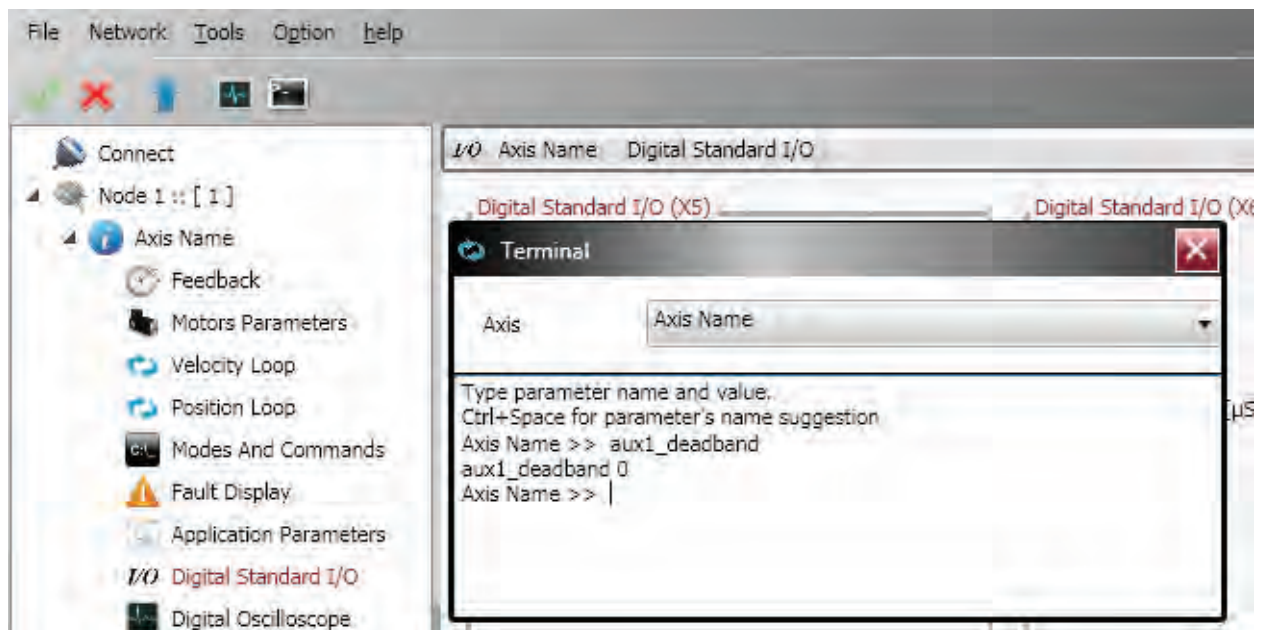
5.3.4. I/O configuration

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 2^{15}, 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.

5.3.5. Control loops configuration

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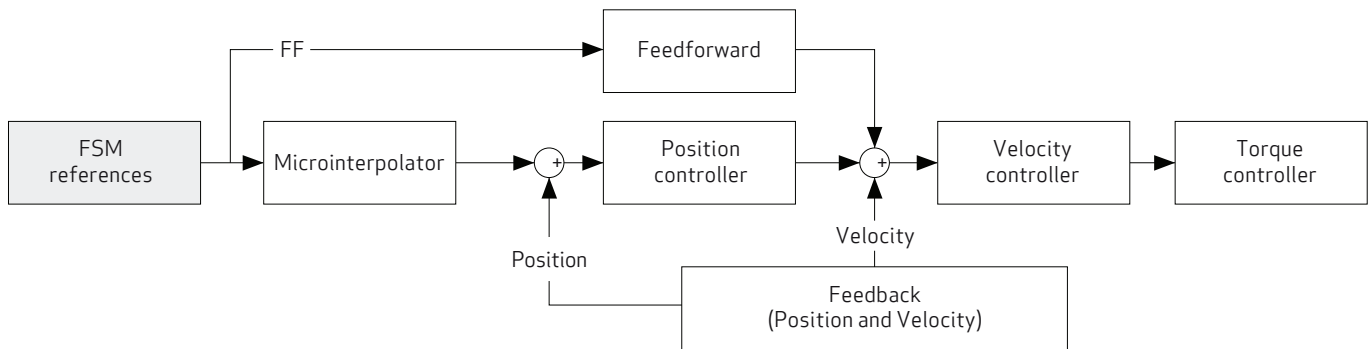
Depending on the structure chosen, the user will have to provide the reference torque, speed or position.

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 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 (SAT_VARIABLE).

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.
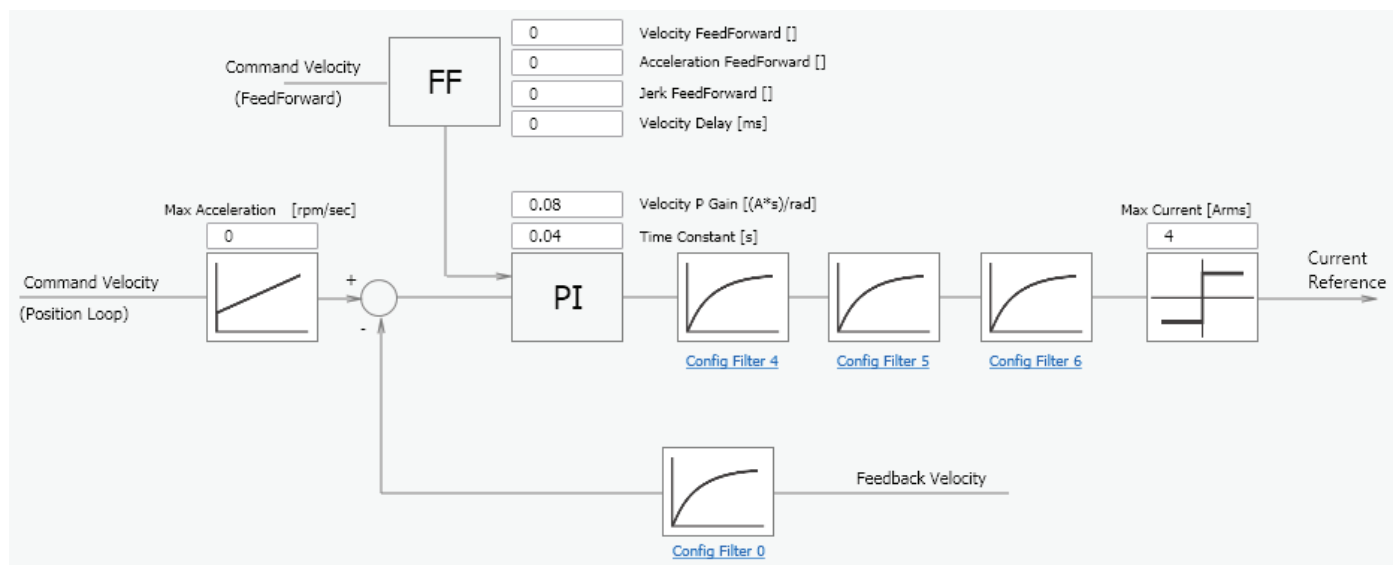

The standard network corrector (PI) is recognised, characterised by two parameters. Subsequently, there is a sequence of filters and one filter on the feedback chain; this allows for the use of more complex control structures, as well as filtering of known disorders (notch filter).

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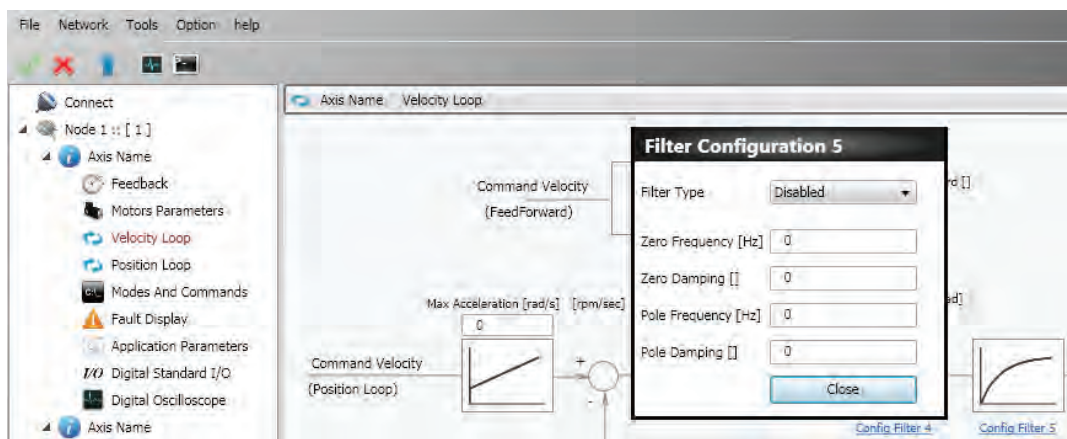
🔍   INFORMATION
Keep the filter deactivated until all other filter parameters have been entered

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

1. Damping

2. Frequency

3. Type of filter

Examples of filters

Example of a notch filter configuration: You want to enter a notch filter centred at 30 Hz
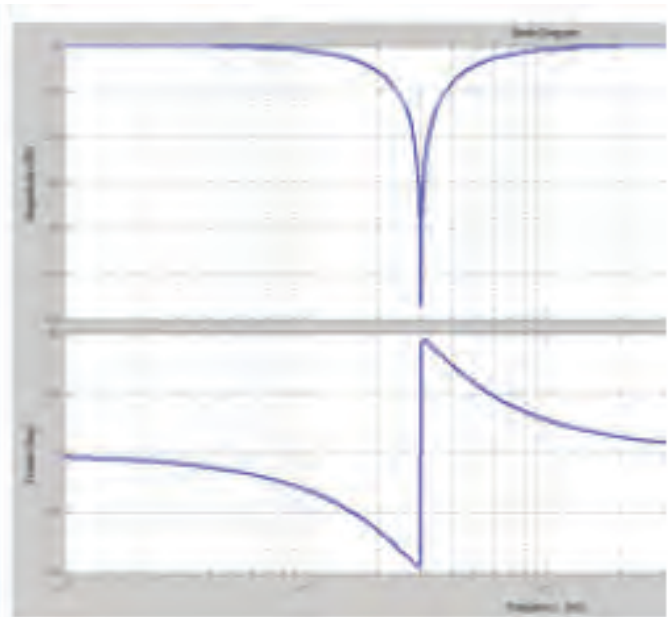

Example of configuration of a 2nd order low-pass filter
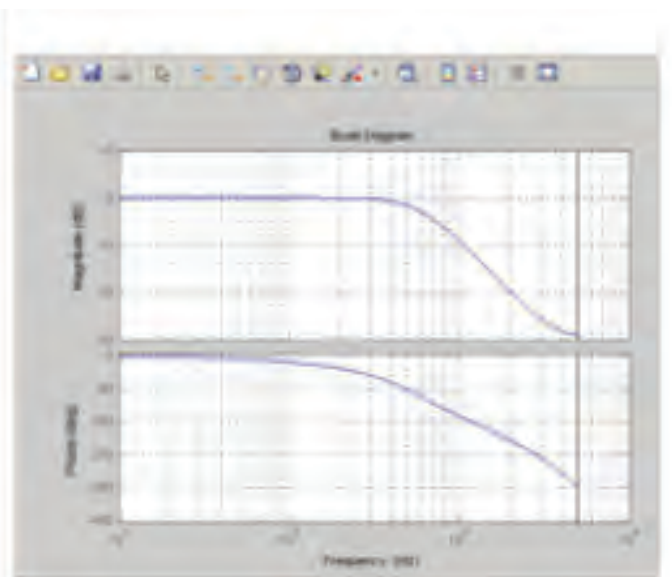
5.3.5.4.   Position loops parameters configuration

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.
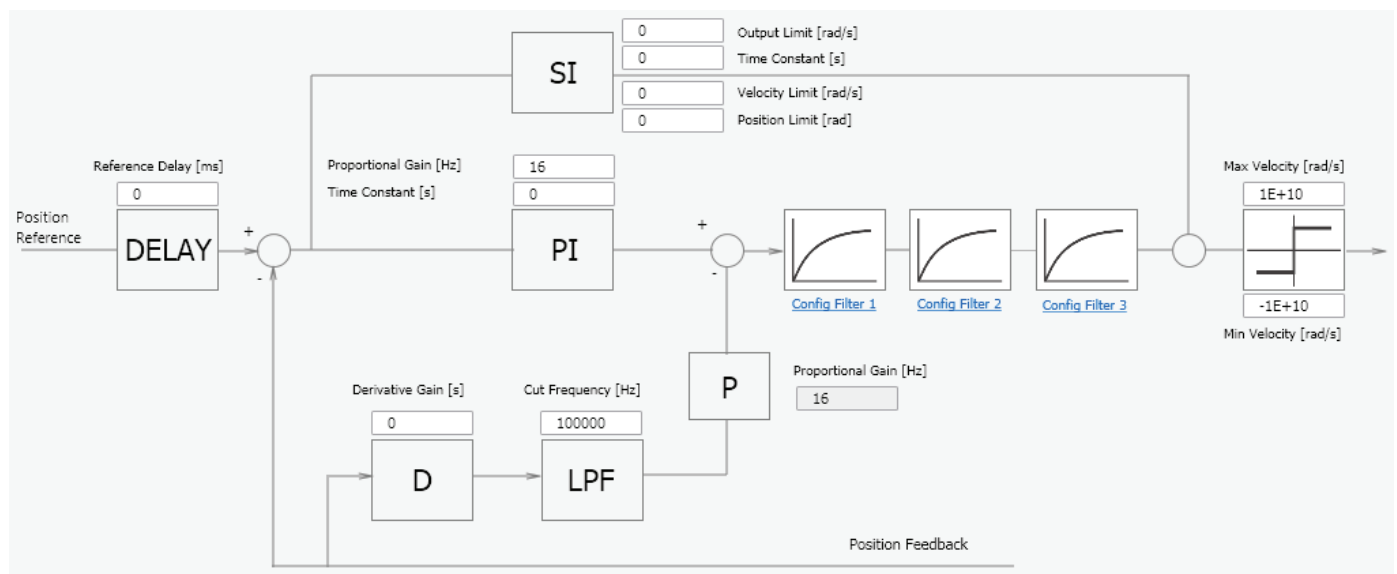
The standard network corrector (PID) is recognised, characterised by four parameters. There is subsequently a sequence of filters which allows more complex control structures to be implemented. See section "5.3.5.3.1. Configuration of filters" for setting filter parameters.

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).

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.

There are four options:

Reaction	Effect
None	The alarm is ignored ⚠ **WARNING** *Only during commissioning or troubleshooting. Settings to be avoided with the machine in normal operating conditions* **AVERTISSEMENT** *Seulement au cours de mise en service ou de dépannage. Paramètres à éviter avec la machine dans des conditions normales de fonctionnement*
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").
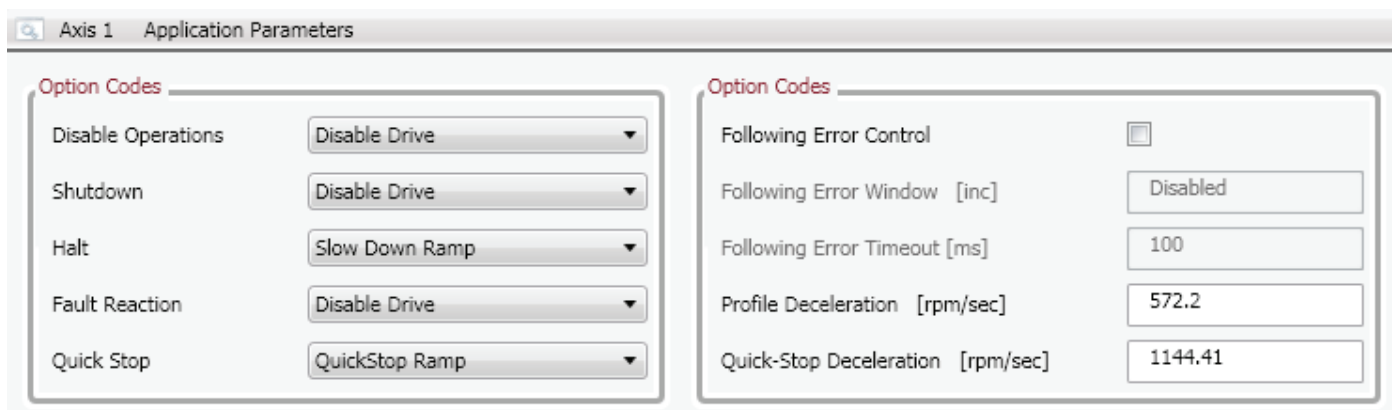
The faults listed below cannot be configured and the reaction is always "STOP":
- short_circuit_phase_U_low
- short_circuit_phase_U_hi
- short_circuit_phase_V_low
- short_circuit_phase_V_hi
- short_circuit_phase_W_low
- short_circuit_phase_W_hi
- restore_data_memory_corrupted
- factory_data_memory_corrupted
- 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.
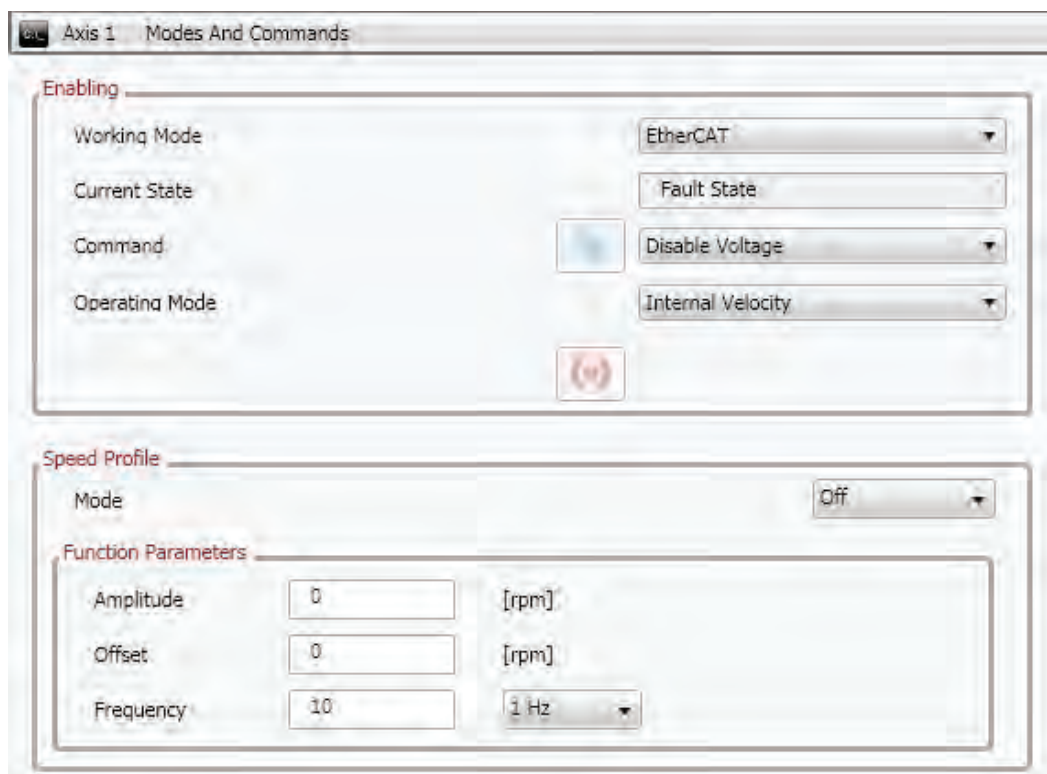

5.3.8. Configuration of modes and commands

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

Operating mode

INFORMATION
Check that the firmware installed supports the selected fieldbus (with EtherCAT fieldbuses, the firmware will have the filename extension _ecat, and with CAN fieldbuses, the firmware will have the file 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 (if supported by the drive)
- CANopen

  The drive receives commands/set-points remotely via the CAN bus (if supported by the drive)
- 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)

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 operates 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

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).

DM2020 state machine

Please refer to the Online Help, **Configuration views/Modes and Commands**, for details on the FSA
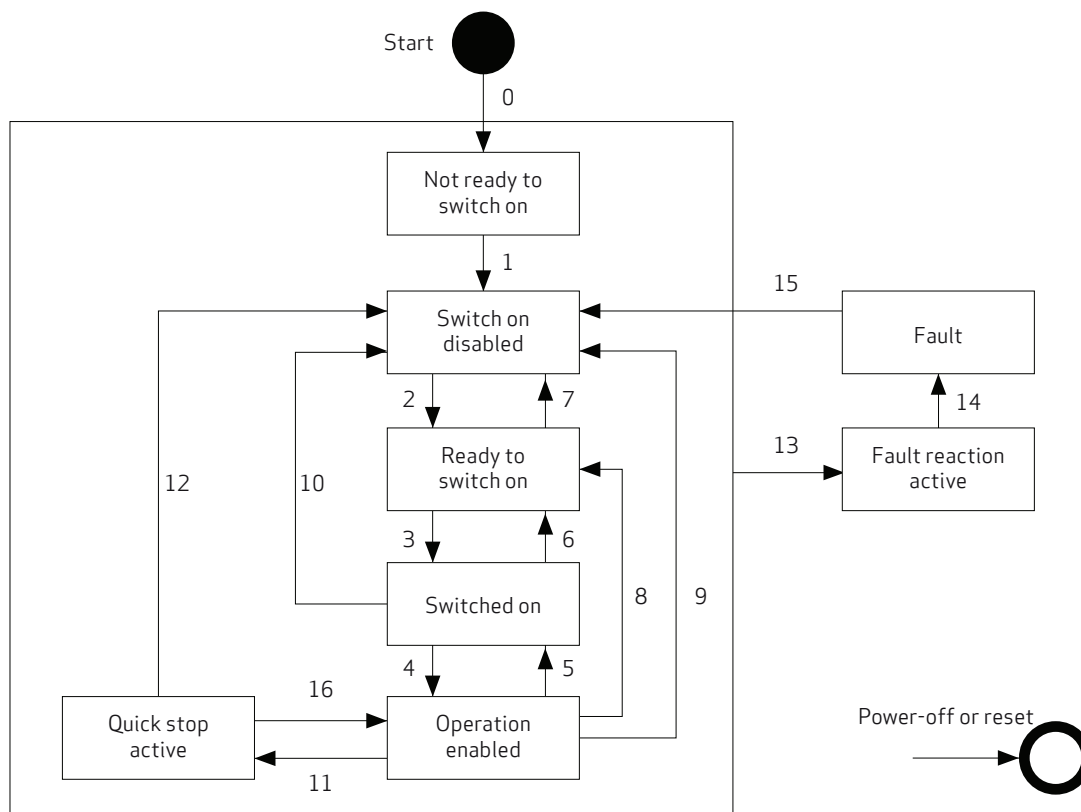
	FSA states							
Function	**Not ready to switch on**	**Switch on disabled**	**Ready to switch on disabled**	**Switched on**	**Operation enabled**	**Quick stop active**	**Fault reaction active**	**Fault**
Brake applied, if present	Yes	Yes	Yes	Yes	Yes/No	Yes/No	Yes/No	Yes
Low-level power applied	Yes	Yes	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 "5.2.5. 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 50 mm 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 chapter 7.

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 électrifiée 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 annullé 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.
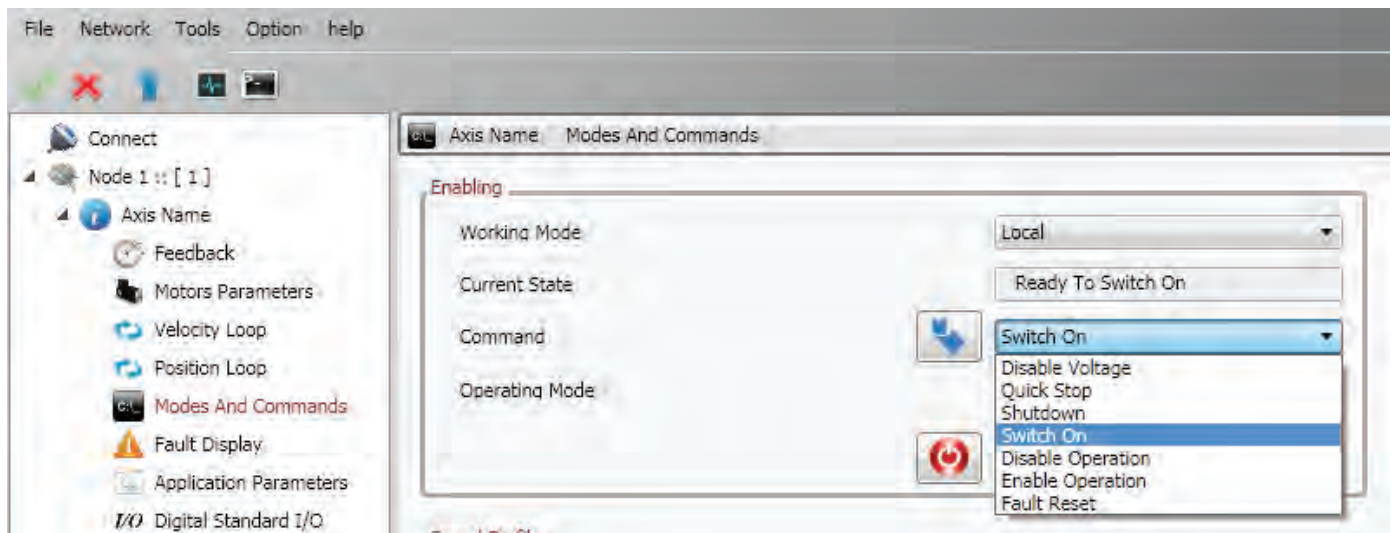
Autophasing is run by Dx2020 GUI software.

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

The drive will indicate enabling with an "S" on the display.

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**" or "**2° STD interface**" or "**Optional Interface**", the timing values for before and after the operation can be viewed in order to ensure that this process is taking place correctly.
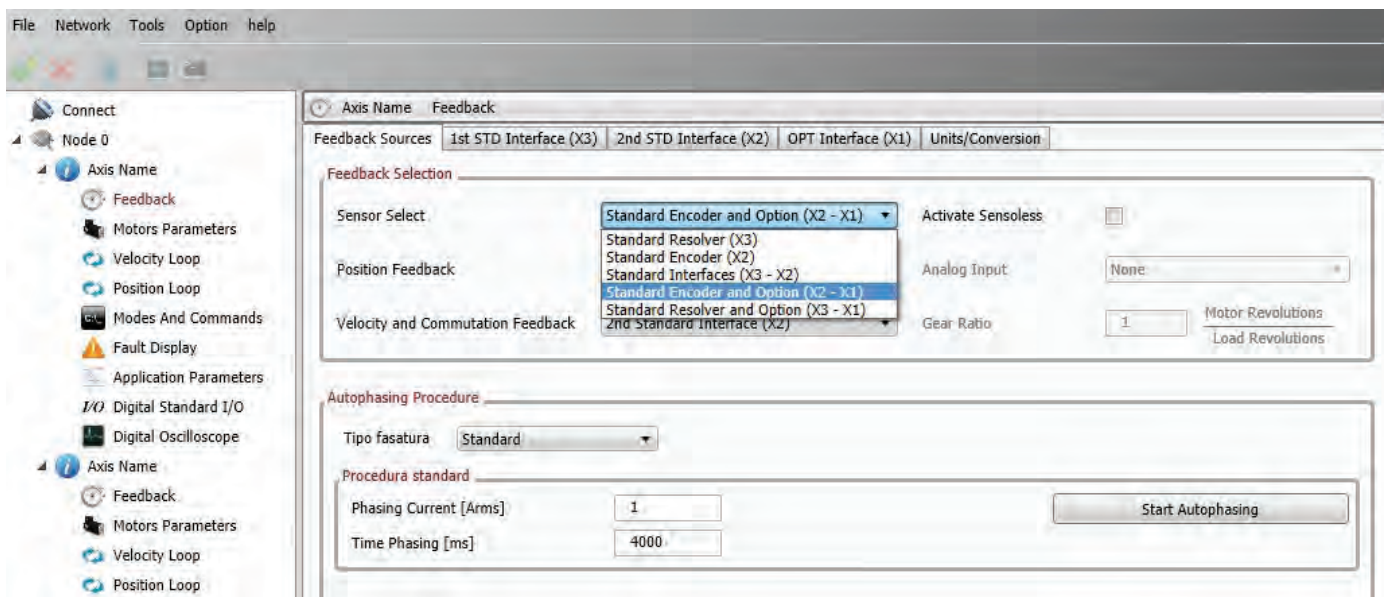
5.6.   Enabling the axis

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.
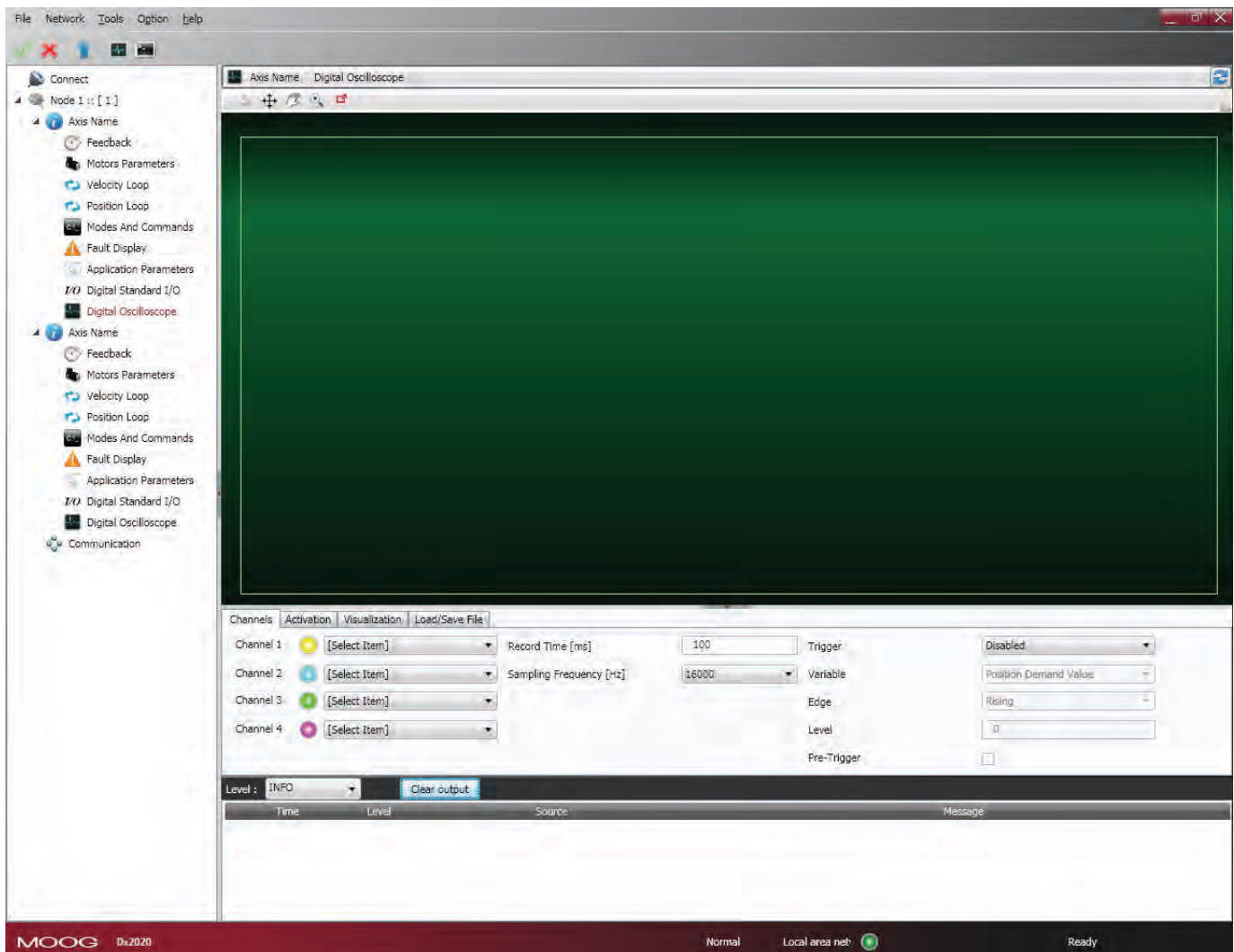
5.7.2.   Launch recording

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
- Save on memory card: The sizes are viewed and saved on the SD card inserted into the front slot

Launch recording by pressing the "**Start**" button and stop by pressing the "**Stop**" button.
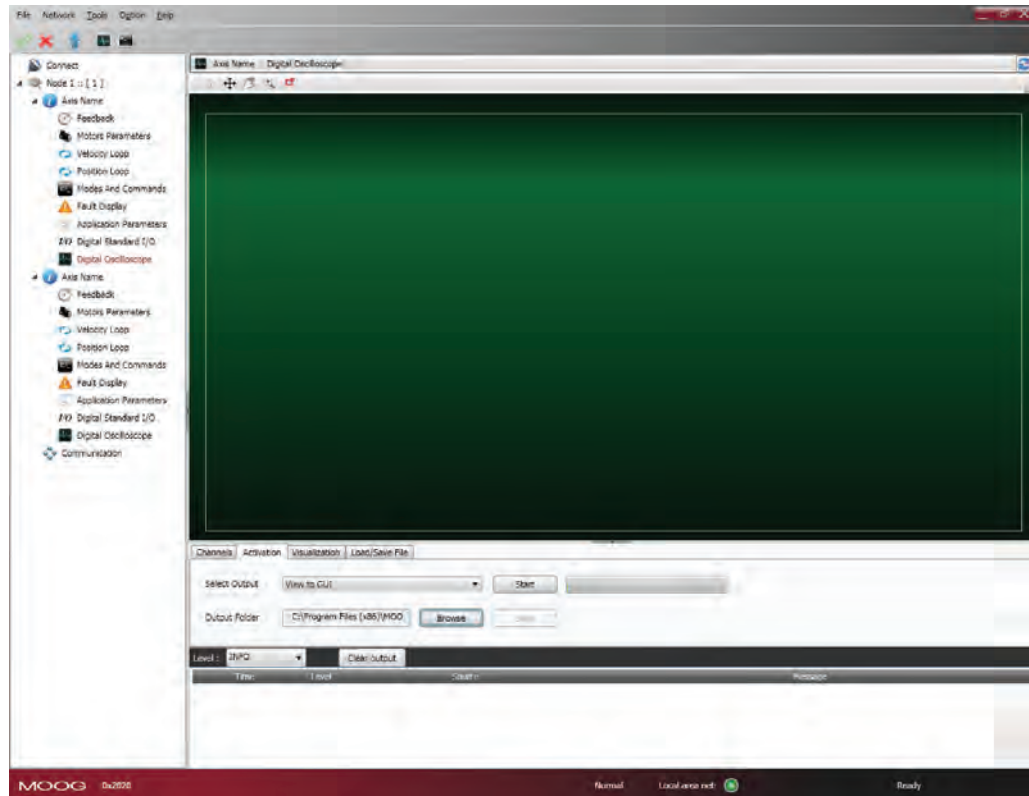
5.7.3.   View the record

Select the "**View**" tab
Once they have been retrieved, the data will be shown on the display.
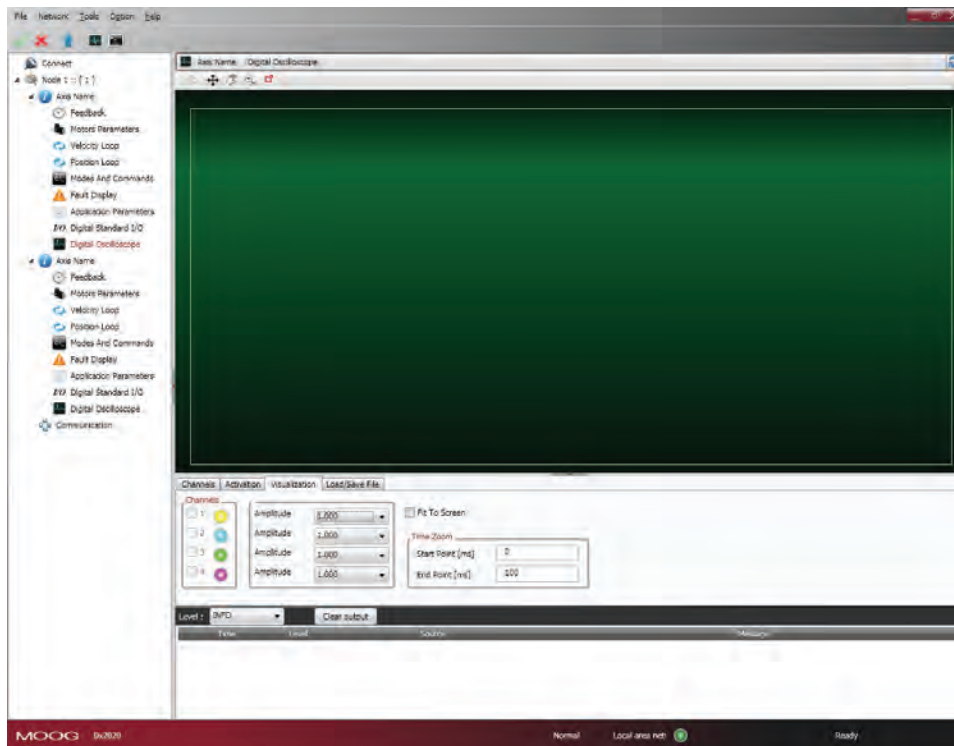
In the top-left corner are the functions Cursor Activation (Cursor ✛), Moving the Graphic (Pan), Magnification of Details

(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.
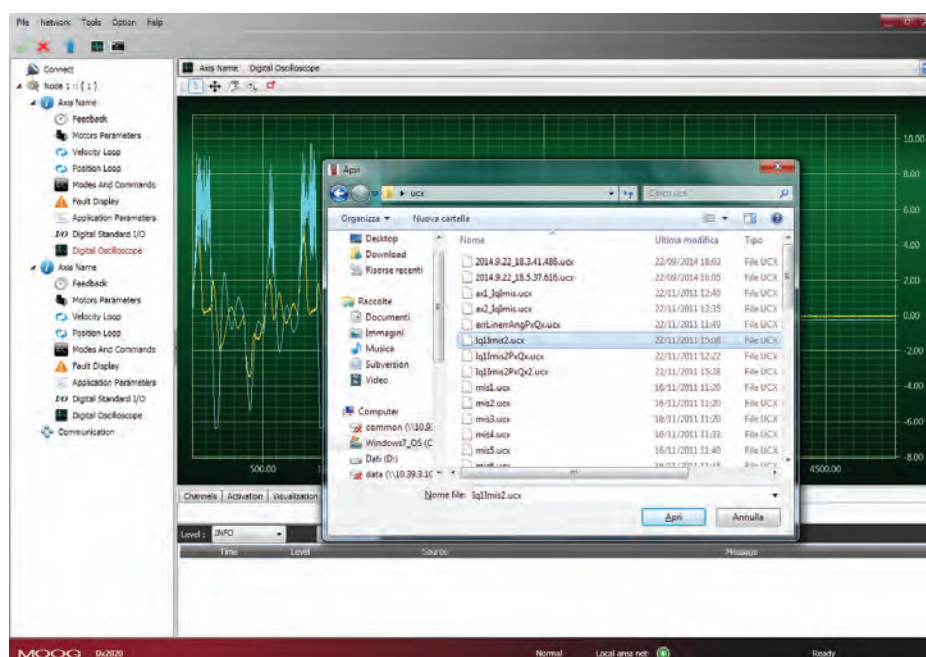
The GUI also allows users to read data on the memory card directly.
From the toolbar, select "**View memory card**".
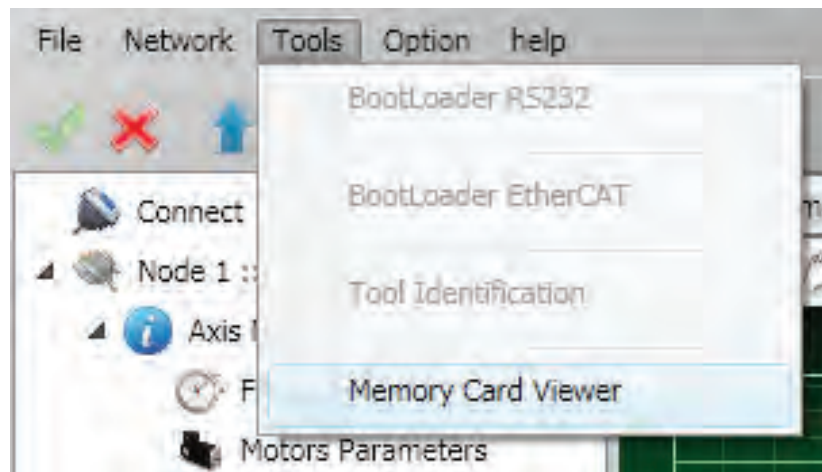
A dialogue box will open with buttons which allow users to open and process files; by selecting the icon with the memory car, the content can be viewed. The name of file is fixed: rec.ucx

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.
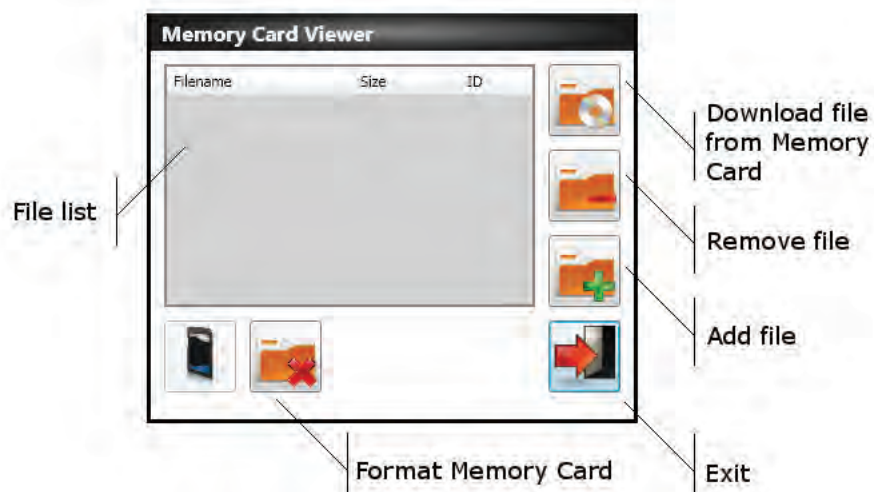
INFORMATION
In all cases, in order to record/view, the memory car must be in the drive

INFORMATION
In cases where the user does not have administration rights, the GUI is not able to record/view signals. Contact the IT department for the creation of a dedicated folder with rights of access in terms of both reading and writing.
After doing this, select the folder by clicking on the **Browse** button

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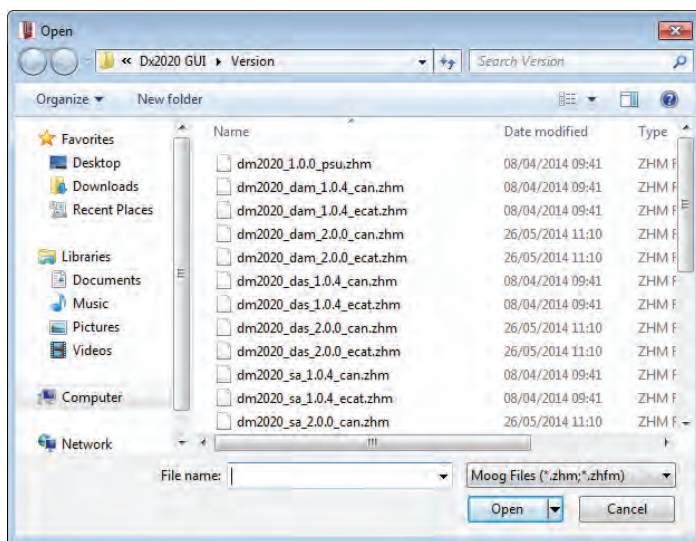
To check a file's parameters, from the main menu select the axis with the right button of the mouse, load the parameters as if there were a real drive connected, change them if needed and save the new configuration file to the new parameters.
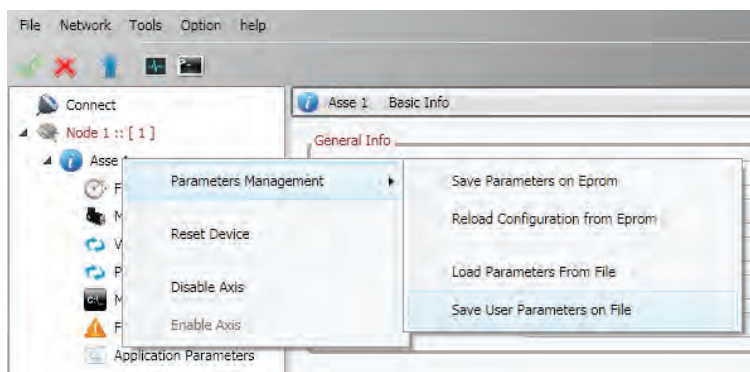
5.9. Parameters management menu

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
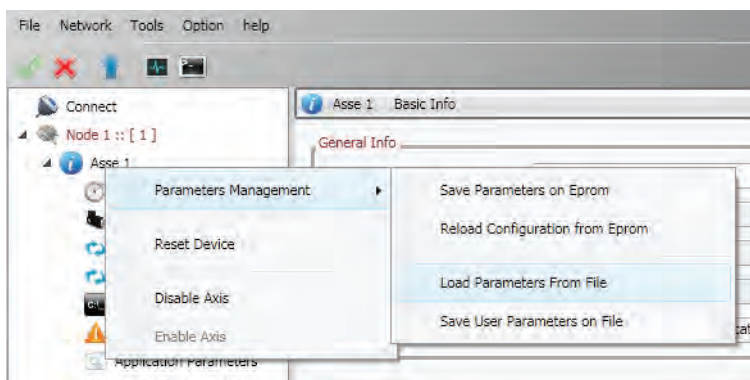
6. TROUBLESHOOTING

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, fixed light	Power supply fault

Cause	Check
The drive temperature is high	• 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

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.

Probable 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: • 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: • 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	Measure the voltage on the DC BUS and compare with that measured by the drive.
DC_Link_Over Voltage	Voltage higher than the maximum value permitted.	Brake resistor is not connected to the power supply module or is faulty	Measure the ohmic value of the resistor and replace it if necessary.

Tab 6.2 Analysis of problems due to VBUS voltage not within tolerance limits

⚠️ **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 and damage 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 "et 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)	• 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)	• 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 error (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

eeprom_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: • 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: • 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	• 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 X3-XXX**
- **Interface X2-XXX**
- **Interface X1-XXX**

Fig 6.1 Screen showing errors on feedback devices

Fault	Cause	Check
Missing Transducer Configuration	Interface X3 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 motor	
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. Internal communication fault

Fault	Cause	Check
Internal_communication_fault	Generic internal communication fault (dual-axis module)	Reprogramme the drive (firmware and parameters) of the two cards. If the fault persists, send away for repairs
Internal_communication_heartbeat_error	Internal communication fault – the axis 1(2) does not detect the presence of the axis 2(1) (dual-axis module)	

6.3.12. Control loop alarms

Fault	Cause	Check
Velocity Control Monitoring	The maximum velocity permitted 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 permitted by the application has been exceeded	Check: • 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. Viewing alarms in the "Analogue" operating mode

If the drive is in "Analogue" operating mode (Mode and Commands/Operating Mode: Analogue), the display on the front will signify an error index along with an alarm, formed from two numbers. In this way, the user can identify the cause of the error(s) present without using the PC. For example, in the case of an **eeprom_fault** (index 11), the sequence F-1-1 will be displayed.

If the drive is used in fieldbus mode (EtherCAT/CAN, the display will show a fixed F, and the error code will be transmitted via an EMERGENCY message (according to the CANopen standard) composed of an error code and error register

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	eeprom_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 conflict	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 configuration	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 conflict	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.
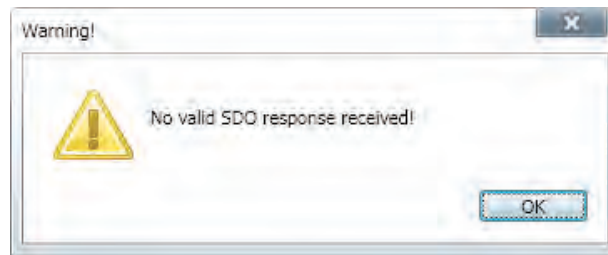
If the connection is made via serial:
• Check that the correct COM port is selected and the baud rate is set to 115200.

If the connection is made via CAN:
• Make sure that the CAN line is terminated correctly;
• Make sure that the IXXATe converters is used and that the drivers are properly installed on the PC;
• Make sure that the baud rate and the node are configured as per the settings on the drive.

🔍   INFORMATION
For the firmware _ecat version, the default baud rate is 1 Mbps, while for the firmware _can version, the predefined 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 using another network (serial or EtherCAT if supported);
• 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 DM2020 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.

⚠ **WARNING**
Even in cases where the STO function is not to be used in any way, it is nonetheless important that the supply voltage to the STO circuit remains switched on. In such cases, the STO circuit should not be included in the emergency chain.

AVERTISSEMENT
Même dans les cas où la fonction STO n'est pas utilisée en aucune manière, il est néanmoins important que la tension d'alimentation au circuit de STO reste activée. Dans de tels cas, le circuit de STO ne doit pas être inclus dans la chaîne des emergences.

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
As SIL 4 refers to catastrophic events, it does not concern 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. Safe Torque Off function

The Safe Torque Off function of the DM2020 has been validated based on a SIL 3 as defined in CEI EN 61800-5-2:2008 demonstrating that:

- The probability of hazardous faults/hour (PFHd) is 1.5 x 10^{-10} hours^{-1} (see section "7.3.2. Characteristic values according to CEI EN 62061")

Conformity to UNI EN ISO 13849-1:2008 was also tested using the PFHd calculated referring to CEI EN 61800-5-2:2008. According to this standard, the STO function conforms to performance level (PL) "e" (see section "7.3.1. Characteristic values according to UNI EN ISO 13849-1").

The STO function is located in a subsystem as defined by CEI EN 62061:2005, with the requested SIL limit, SILCL 3.

The STO safety function of the DM2020 may also be used to safely stop moulding and injection moulding machines, for interlocked repairs in the moulding area and in other less hazardous areas in compliance with UNI EN 201:2010.

7.3.1. 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 ≥ 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

	Value	Observation
Safety integrity levels	SIL 3	
PFHd	1.5 x 10^{-10} hours-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

AVERTISSEMENT
Lorsque le circuit Safe Torque Off est activé, le moteur ne peut plus développer de couple. Lorsque des forces extérieures agissent sur l'axe (par exemple, la force de gravité sur l'axe vertical), une protection adéquate doit être fournie, par exemple un système de blocage mécanique automatique ou un système d'égalisation de poids

AVERTISSEMENT
La fonction Safe Torque Off ne fournit aucune isolation électrique. Elle ne fournit pas de protection contre les chocs électriques. Le système de la machine doit être isolé électriquement de la ligne d'alimentation en utilisant le dispositif de déconnexion principal, enfermé dans une position ouverte, avant d'effectuer tout travail sur la machine, par exemple entretien ou nettoyage (voir EN 60204-1: 2006, section 5.3). Le personnel doit être conscient que les barres bus peuvent avoir des tensions dangereuses après avoir été désactivées (tension capacitive) et le temps de décharge est d'environ 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 drive controls the movements of a three-phase AC motor by generating a rotating magnetic field. To this end, the microprocessor generates a complex model of pulses (PWM, that are amplified and used to control the power semiconductors. The Safe Torque Off function of the DM2020 operates using hardware with two channels that interrupt direct pulses to the IGBT.

Two monitoring channels are supplied to detect hazardous faults.

7.6.   Safe Torque Off connections

The hardware channels of the Safe Torque Off circuit are controlled using the X4 (X14) JRC1 connector.

X4 - X14

+24 Volt CH 1 — 1		2 — 0 Volt CH 1
+24 Volt CH 2 — 3		4 — 0 Volt CH 2
Feedback CH 2 — 5		6 — Feedback CH 1

STO
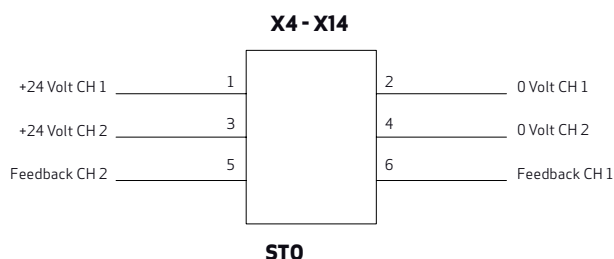
Free-hanging connector pin: 6 contacts, model B2 3.50/06/180 SN BK BX, manufactured by Weidmuller

Pin	Name	Function
1	+ "Channel 1"	Input +24Vdc of channel 1. This input must be high (+24Vdc) to power the motor. When the input is low.
2	- "Channel 1"	0V of Channel 1
3	+ "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.
4	- "Channel 2"	0V of Channel 2
5	Testing "Channel 2"	Feedback Channel 2. With Channel 2 high (+24Vdc), this output is high, at +3.3Vdc with reference to pin 4. When Channel 2 is low (0V), this output is low (0V), when it is high, output is high again. The external testing system must check the plausibility of this low and high test signal.
6	Testing "Channel 1"	Feedback Channel 1. With Channel 1 high (+24Vdc), this output is high, at +3.3Vdc with reference to pin 2. When Channel 1 is low (0V), this output is low (0V) and when it is high, output is high again. The external testing system must check the plausibility of this low and high test signal.

Tab 7.2 JRC1 connector description

⚠ **WARNING**
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 JRC1 connector must have shields connected to the earthing circuit
WARNING
To avoid common causes of failure, the "Channel 1" cable (at pins 1, 2 and 6 of JRC1) must be separate from the "Channel 2" cable (at pins 3, 4 and 5 of JRC1) during installation
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

AVERTISSEMENT
Pour être validé selon les catégories de 1 à 4, sur la base des principes de sécurité UNI norme EN ISO 13849-2: 2008, tableau D.2, les câbles externes qui fonctionnent dans le connecteur de JRC1 doivent avoir des boucliers connectés au circuit de mise à la terre
AVERTISSEMENT
Pour éviter des causes communes d'échec, le câble "Channel 1" (broches 1, 2 et 6 de JRC1) doit être séparé du câble "Channel 2" (au niveau des broches 3, 4 et 5 de JRC1) lors de l'installation
AVERTISSEMENT
Pour éviter des courts-circuits entre l'entrée et le signal de test, les câbles multi-brins des deux canaux doivent se terminer avec un terminal de câble ou autre dispositif approprié
AVERTISSEMENT
Le câblage du signal de test des deux canaux doit être protégé contre les courts-circuits aux source de tension; l'alimentation externe ne doit jamais être appliquée au signal de test, pas même dans le cas d'échec

7.7.   Application examples
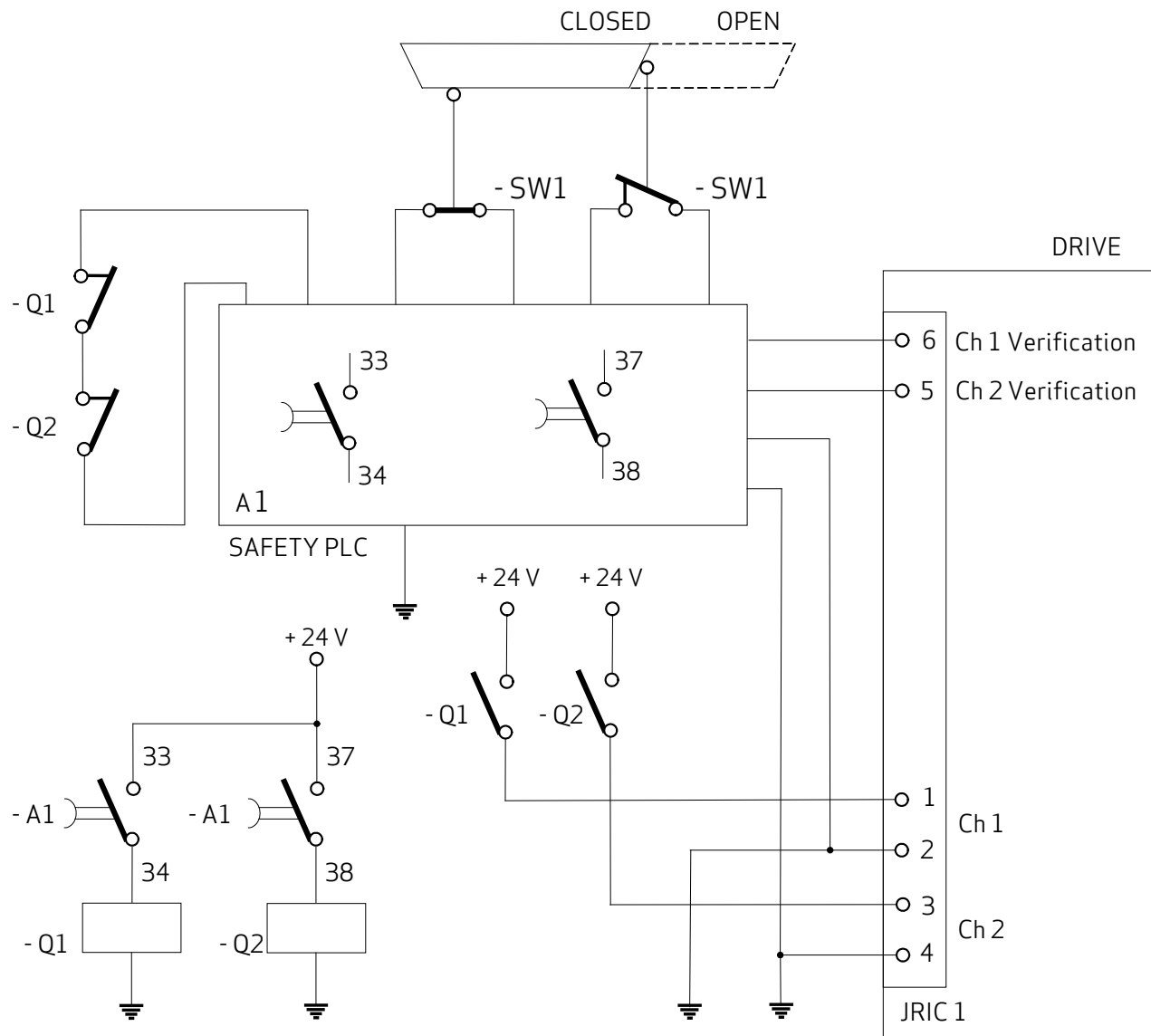
Fig 7.2 Example of Safe Torque Off after a controlled stop

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 DM2020 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 DM2020 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.

INFORMATION
A voltage level repeater can be used to change test signals from 3.3 V DC to a standard 24 V DC.

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

Input channel	I_{nom} -30 mA (± 10 %)
	V_{nom} = -24 V DC (± 10%)
	V_{max} = -30 V DC
Output – Channel testing	I_{max} = -3 mA
	V_{nom} = -3.3 V DC

Tab 7.3 Input/output electrical specifications

7.8.   Safe Torque Off function testing

The following installation and maintenance procedures must always be carried out on initial start-up, or on restart if a fault has been detected and remedied. Controls must also be carried out after long production downtimes. Each drive must be tested.

Tests must be carried out by qualified personnel following safety procedures of regulations in force.

Channel 1

- Send a velocity reference signal to the motor and check that the motor rotates
- Stop the motor
- Check that the motor has stopped
- Inhibit the IGBTs eliminating voltage to pin 1 (Channel 1) of the JRC1 connector. The drive must not deliver output current.
- Check that the "Channel 1" test signal is low (0 V)
- Put the drive in start conditions. Send a velocity reference signal to the motor and check that the motor does not rotate
- Disable the reference signal
- Restore Channel 1
- Check that the "Channel 1" test signal is high (3.3 V)

Channel 2

- Send a velocity reference signal to the motor and check that the motor rotates
- Stop the motor
- Check that the motor has stopped
- Inhibit the IGBTs eliminating voltage to pin 3 (Channel 2) of the JRC1 connector. The drive must not deliver output current.
- Check that the "Channel 2" test signal is low (0 V)
- Put the drive in start conditions. Send a velocity reference signal to the motor and check that the motor does not rotate
- Disable the reference signal
- Restore Channel 2
- Check that the "Channel 2" test signal is high (3.3 V)

> ⚠ **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 Category 1

- 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.

7.9. External plausibility tests

The following plausibility tests must be automatically carried out externally from the drive (e.g. using a PLC), during operation.

Testing "Channel 1"

The external system must monitor the plausibility of the test signal (the low and high states) in relation to the input signal of Channel 1.

Testing "Channel 2"

The external system must monitor the plausibility of the test signal (the low and high states) in relation to the input signal of Channel 2.

Minimum functional requirements

- Automatic monitoring must disconnect the line contactor and safety inputs when a fault is detected, and prevent start-up, until the fault has been remedied.
- The change in the monitoring signal must be automatic:
    - on start-up
    - during each stop and start sequence, and in any case at a maximum test interval of 8 hours

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.
For information on the previous version of the STO circuit, please see the manual DM2020 REV.1.
The year and week of manufacture are specified by the "Date" field; the first two figures of the number refer to the year, and the second two to the week (for example, DATE 1439: year 2015, week 39).
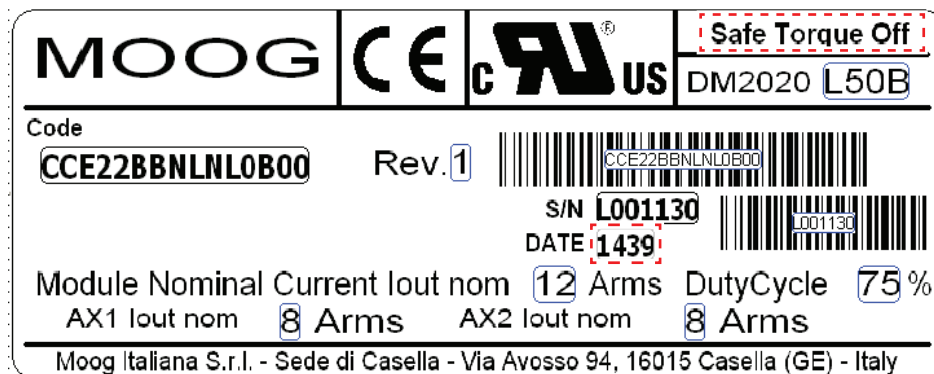

Fig 7.3 Example of STO function identification

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)	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. The essential electromagnetic compatibility requirements are met by applying the harmonized technical standards published in the EU Official Journal. The harmonized standards can be essentially divided into: • Product standards • Generic standards • Basic standards

E

Electric Drive	Electric power converter for controlling torque speed and position of a motor. It consists of four main parts: • Rectifier of AC mains voltage • DC link voltage rectified and leveled • Inverter of the rectified voltage in voltage with frequency and voltage variables • Control circuit that transmits signals for the switching of the power semiconductors of the inverter
Electric noise	Set of unwanted signals or current that overlap the useful signal typically transmitted on a communication channel between electronic devices.
EMC	Radio frequency emitted during the electronic power equipment operation, likely to generate or induce disturbances in other electronic equipment.
Emissions	Electromagnetic interference caused by electronic equipment operating at frequencies likely to generate or induce disturbances.
Enable	Signal that enables the drive.
Encoder	Motor component that detects the value of the position of the shaft and transmits it to the drive to operate the control.
Encoder incremental	Motor component that detects the incremental changes in the position of the shaft and transmits them to drive to operate the control with information the current position.
Encoder simulated	TTL encoder signals (A, B and C) differential line drivers generated by the drive, starting from internal information, to emulate an encoder.
Encoder sinusoidal	Motor component that detects the incremental changes in the position of the shaft and transmits the drive to operate the control with information the current position The information is acquired through the reading of two sinusoidal signals sampled from the drive.
EnDat 22	Serial protocol for communication with Heidenhain encoder. Allows the reading of the position of absolute encoders, as well as updating and saving data stored in the encoder. It is compatible with the previous version 21 offering advantages such as the transfer of other data together with that of position without a separate request.
EtherCAT	communication protocol implemented on the Ethernet the network for the synchronous transmission of information
Ethernet	High speed data communication network.

F

Filter (Network)	Device that reduces noise generated by the power supply cables.
FMEA	Failure Mode and Effects Analysis.

FieldBus	Structure that allows communication between different devices; are connection lines on which the digital information is transferred from one or more sources to one or more destinations. Their aim is therefore to reduce the number of interconnections required. The bus techniques are of great importance in microprocessor systems but it is necessary to regulate this flow of data in order to allow for a single communication at a time by disabling other possible data sources at that moment.
Fuses	Overcurrent protection devices

G	
Grade of protection (Protection grade)	Security level of the system components.
Ground	Connection of the conductor or the frame to the ground connector.
GUI	Graphical User Interface.

H	
Hyperface	Fully digital, synchronous two-way, multi-channel protocol to transfer position information and speed that requires minimal wiring between drive and feedback from the motor (2-wire).

I	
IGBT	semiconductor devices for the control of PWM switching..
Interface Fieldbus	EtherCAT or CANopen
IFOC (control)	Indirect Field Oriented Control

M	
Machine	Set of mechanical devices, connected to each other of which at least one is in motion.
Multiaxis system	Machine with several axes with independent transmission.

R	
Rectifier	Circuit that converts an AC voltage into a DC voltage.
Regolator P	Regulating circuit functioning in a purely proportional manner.
Regolator PI	Control circuit running in a proportional and integral way.
Regolator PID	Proportional adjustment circuit functioning, integral and derivative way
Reset	Restart the microprocessor.
Braking resistor	When the motor decelerates, a braking resistor converts the kinetic energy of the motor into heat. The braking resistor is automatically connected to the DC bus voltage when the bus voltage exceeds its threshold and intervenes in the braking circuita.
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	mm²	Ω/km	g/m
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