INSTALLATION AND STARTUP

MULTI AXIS DIGITAL SERVO SYSTEM

DM2020 TECHNOLOGY

PN: L-MAM2-E-201

THIS DOCUMENT DESCRIBES THE INSTALLATION AND STARTUP FOR THE DM2020 SYSTEM

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Foreword

The DM2020 drives meet the Low Voltage Directive (2014/35/EU) and EMC Directive (2014/30/EU). The safety function "Safe Torque Off" (STO) integrated in the drive complies with the Machinery Directive (2006/42 / EC).

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

The DM2020 drives are CE, EAC and UL certified. Contact Moog for further details.

The manual was written and checked by technical experts at Moog.

About Moog

The Moog Industrial Group designs and manufactures high performance motion control solutions combining electric, hydraulic, and hybrid technologies with expert consultative support in a range of applications including test, simulation, plastics, metal forming, and power generation.

Customers of Moog include leading automotive manufacturers, aerospace manufacturers, testing labs and global automotive racing teams.

We help performance-driven companies design and develop their next-generation machines.

The Moog Industrial Group is part of Moog Inc.

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Document Version

The following table shows the version of this document and all other possible versions:

ES	DA	DE	EL	EN	FR	IT	NL	PT	FL	SV	CS	ET	LV	HU	MT	PL	SK	SL	BG	RO	GA
				X																	

The language of documents and drawings are subject to contractual negotiations with the Customer.

In case of "Translation of the Original Instructions", the manufacturer of the machinery must also supply the "Original Instructions".

Revision Record

The following table shows the revision record:

Revision	Description	Date
A	First release	November 2020
B	Update	February 2021

Reader Instructions

The following table shows the symbols adopted in Moog documents:

⚠ DANGER
DANGER indicates a hazardous situation which, if not avoided, will result in death or serious injury.

WARNING indicates a hazardous situation which, if not avoided, could result in death or serious injury.

CAUTION indicates a hazardous situation which, if not avoided, could result in minor or moderate injury.

NOTE indicates possible property damage.

The following table shows the structure of a warning:

SIGNAL WORD
Type and source of hazard Possible consequences of not avoiding the potential hazard ➢ How to avoid the hazardous situation

The following table shows other typographic elements:

Symbol	Explanation
	Electrical hazard alert symbol.

Symbol	Explanation
	Thermal hazard alert symbol.
	Mechanical hazard alert symbol.
	General hazard alert symbol.
	Notes about important operations and other useful information.
➢	This is an action to be carried out.
• / -	This is a bullet list.
1., 2., ...	These are steps in a procedure that must be performed in consecutive order.

The following table shows the abbreviations adopted in Moog documents:

Abbreviation	Explanation
EMA	Electro Mechanical Actuator
EH	Electro Hydraulic Actuator
EHA	Electro Hydrostatic Actuator

1.1 Contents

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

1.2 Related Documents

The following related documents are also available:

- USER AND INSTALLATION MANUAL (this document)
- DM2020 Quickstart Guide (shipped in the box with the drive and also available on the Moog Casella website)
- FIELDBUS MANUAL
- CONFIGURATION SOFTWARE Dx2020 GUI

1.3 Package Contents

A complete DM2020 system includes:

- One DM2020 drive modules and PSU unit
- Anchoring support for the shields
- Interconnect cables

1.4 Required Qualifications of Personnel

WARNING: Personal injury and property damage risk.

Failure to follow all safety precautions when the drive is installed, operated or maintained may pose a risk of death or serious injury to personnel, or serious damage to property.

- The system builder and end-use company are required to ensure that the safety instructions detailed in this manual and in the DM2020 *Safety Guide* are available to, read, understood and observed by all personnel responsible for the installation, operation and maintenance of the DM2020 system.

In addition to the following information, also follow the instructions in Safety and Usage Guidelines of this manual.

This manual and the equipment described in it are intended only for qualified personnel who have proper training and expertise in the following:

- **Transport:** All personnel must have knowledge and experience handling components that are sensitive to mechanical shock and electrostatic discharge (ESD).
- **Unpacking:** All personnel must have knowledge and experience handling components that are sensitive to mechanical shock and electrostatic discharge (ESD).
- **Installation and Maintenance:** All personnel must have extensive technical knowledge and experience with the installation and maintenance of AC- and DC-powered electrical and electro-mechanical equipment.
- **Startup:** All personnel must have extensive technical knowledge and experience with electrical drives, motors and their technology.

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

1.5 Applicable Laws

The DM2020 drives meet the Low Voltage Directive (2014/35/EU) and EMC Directive (2014/30/EU). The safety function "Safe Torque Off" (STO) integrated in the drive complies with the Machinery Directive (2006/42 / EC).

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

The DM2020 drives are CE certified; certain models are also UL certified. Contact Moog for details.

Standard products has been configured as No Dual Use device.
Output current frequency has been limited to an absolute max parameter >600 Hz to meet ECCN-3A225 / AL-3A225 requirements.

Other references or information required by the applicable EC directives:
The conformity of products is subjected to observation of the procedures included in the proper "Installation and Startup Manual".
The user has the primary EMC responsibility in following the recommendations of the manufacturer.

1.6 Getting Started

The process for getting the DM2020 system installed, configured and operational looks like this:

1. Read this guide.
2. Read the related documents that are supplied with the DM2020 system,
3. Install the DM2020 drive, see Mechanical Installation section of this manual.
4. Install the supplied Moog motor, see the motor installation guide for your motor.
5. Install the cables and connect power, see Electrical Installation and Thermal Rating
6. Provide a PC in the work area for the Dx2020 software.
7. Commission the system with the Dx2020 software, see Commissioning with Dx2020 Software

2 Safety Information

2.1 Safety and Usage Guidelines

Do not attempt to install, operate, maintain or inspect the DM2020 system until you have carefully read this guide and the other supplied documents, and you are properly trained in the correct use of the equipment. The DM2020 system may only be set up and operated in conjunction with this manual and the supplied documentation.

Human safety and equipment safety must be the first considerations when performing the installation, operation or maintenance procedures for the drive system. When it comes to electronics in your factory or workplace, you want to make sure both your facility and its employees are safe. The following gives safety instructions that must be followed when you are working on the DM2020 system.

WARNING: Risk of death or serious injury to personnel, or damage to equipment.
AVERTISSEMENT: Risque de mort ou de blessures graves pour le personnel ou de dommages matériels.

Failure to follow the safety and usage guidelines in this chapter can result in death or serious injury to personnel, or damage to equipment.

- In addition to the *DM2020 Installation and Startup Guide* (the guide you are cur-rently reading), you must read the guides listed in Related Documents chapter.

- Observe and adhere to the technical data and, in particular, the information given on the system component nameplates.
- The installation must comply with the local regulations and use of equipment and installation practices that promote electromagnetic compatibility and safety.
- Safety equipment - To protect yourself against personal injury, always wear suitable safety equipment, such as safety glasses, work shoes, and other safety equipment required by the operation.

2.2 Qualified Personnel

WARNING: Risk of death or serious injury to personnel, or damage to equipment. -
AVERTISSEMENT: Risque de mort ou de blessures graves pour le personnel ou de dommages matériels.

Only qualified, properly trained and certified personnel are permitted to operate and interact with the system.

This manual and the equipment described in it are intended only for qualified personnel who have proper training and expertise.

Qualified personnel are those who are specialized with required knowledge and experience, who have been trained to perform such work and are authorized to commission, systems and circuits in accordance with established safety practices and standards. The qualified personnel must know and observe the following standards and regulations:

- IEC 60364
- IEC 60664
- Accident prevention national, regional and local regulations for the site where the system or machine will be operated

2.3 Electrical Hazards

WARNING: Electrical hazard - AVERTISSEMENT: risque électrique
High voltage may be present, which can result in death or serious injury to personnel, or damage to equipment.

➢ Follow these safety instructions.

Certain electrical systems have to be maintained and cleaned by staff. Before they can be accessed, the systems have to be disconnected from the mains supply to eliminate electrical hazards to operating staff. According to the state of technology, this is accomplished with the five safety rules of DIN VDE 0105-100.

1. Disconnect the mains.
2. Secure against reconnection.
3. Verify that the system is dead.
4. Carry out earthing and short circuiting.
5. Provide protection from adjacent live parts.

2.3.1 Voltage Arcs and High Voltage

Voltage arcs may occur and/or high voltage may be present that can fatally or seriously harm personnel or damage equipment. Additionally, the drive's capacitors can have dangerous voltages present up to eight minutes after the removal of the mains voltage.

- Never attempt to remove safety covers, or loosen or disconnect the electrical connections when the DM2020 system is powered up,
- Never attempt to perform any cleaning or maintenance operations when the DM2020 system is powered up.
- Always ensure that the mains power supply is disconnected and locked out before attempting any work on the system.
- Always wait at least eight minutes after disconnecting and locking out the AC mains power before attempting to work on the DM2020 system equipment. The DM2020 capacitors can still have dangerous voltages present up to eight minutes after power is switched off.
- Always measure the voltage of the direct current circuit (BUS) and wait until the voltage drops below 40V.
- Always measure the voltage of any other contact point(s) to ensure the power is off and there is no voltage present.

- Never attempt to remove safety covers, or loosen or disconnect the electrical connections when the DM2020 system is powered up,
- Never attempt to perform any cleaning or maintenance operations when the DM2020 system is powered up.

2.3.2 General Hazards and Safeguards

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

During normal operation, the equipment should not be accessible (i.e., protected as described in the Risk Assessment by covers, guards, barriers, and safety interlocked gates/doors, etc.), all covers/guards must be installed, and cabinet doors must be kept closed/locked.

During the operation of the drives, there may be uncovered live parts in the control cabinet installation, depending on the degree of mechanical protection required by regulations governing the site where the equipment is operated.

At the drive and/or motor, the power and control connections may be live, even when the motor is stopped.

2.4 Thermal Hazards

CAUTION: Burn hazard - ATTENTION: risque de brûlure.

The surface temperature of the drive may reach a temperature of 80 °C, and the motor may reach up to 100 °C (212 °F), and may become very hot in operation, according to their protection category.

- ➢ Do not touch hot surfaces, measure the temperature, and wait until the drive and motor has cooled down below 40 °C (104 °F) before touching it.
- ➢ It is recommended to always wear gloves when attempting to handle DM2020 system components that have been recently operating.

2.5 Mechanical Hazards

WARNING: Mechanical hazard - AVERTISSEMENT: risque mécanique
Large motors can generate very high torque and impact or trapping hazards, which can result in death or serious injury to personnel, or damage to equipment.

- ➢ Follow these safety instructions.

The motor must be properly mounted and anchored as specified in the Moog motor installation guide supplied with the DM2020 system motor. For details, consult the Moog motor installation guide.

2.6 STO Safety Feature

2.6.1 Description

The DM2020 drives include the STO (Safe Torque Off) function as a standard feature to ensure protection for personnel and equipment against accidental restart and re-enabling of the drive.

The STO function acts as an interlock against accidental motor rotations.

The STO function can be used as a power turn-off command to prevent accidental starts.

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

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

2.6.2 Directives on Safety

WARNING: Electrical hazard - AVERTISSEMENT: risque électrique
High voltage may be present, which can result in death or serious injury to personnel, or damage to equipment.

- Follow these safety instructions.

WARNING: Mechanical hazard - AVERTISSEMENT: risque mécanique
Large motors can generate very high torque and impact or trapping hazards, which can result in death or serious injury to personnel, or damage to equipment.

- Follow these safety instructions.

Suspended loads must always be securely mechanically locked. The STO function, if activated, does not ensure against movement of suspended loads.

The interruption of the 24 VDC supply of the STO circuit causes an uncontrolled arrest of the motor.

The STO function does not guarantee an electrical disconnection from the power output to the motor. If the motor power cable requires service, always disconnect and lock out the mains power supply, wait for eight minutes for the complete discharge of the intermediate circuit, and then check for residual voltages at any contact point.

When using the STO function, it is necessary to perform the following sequence of operations.

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

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

2.7 Safe Use of the DM2020 System

The technical data (nameplate) and documentation for the -DM2020 system and how to install its components must be available to and observed by all personnel.

The drives contain electrostatically sensitive components, which can be damaged by electrostatic discharge (ESD) through improper handling. It is recommended to follow proper ESD procedures to discharge any electrostatic charge before handling the DM2020 system components (e.g., using ESD straps, ESD mats or other protective surfaces, etc).

2.7.1 Risk Assessment

The drives are safe industrial devices that are placed in electrical systems or machines and can only be operated as integrated parts of those systems or machines. The builder/manufacturer of the system or machine must generate a risk assessment, and take appropriate measures to avoid unexpected movements that could cause death or injury to personnel and/or damage to equipment or other property. The risk assessment must comply with all national, regional and local regulations for the site where the system or machine will be operated. For more details, see Risk Assessment on page 24.

2.7.2 Electrical Connections

The drives must operate only inside an enclosed control cabinet. Additional ventilation or cooling may be necessary based on the external environmental conditions.

Use only copper conductors for wiring all connections. The conductor cross sections must comply with IEC 60204.

2.7.3 Motor Selection

The DM2020 drives have been designed to control brushless asynchronous and synchronous motors with torque control, speed and/or position. The rated voltage of the motors must be at least the same level as:

$$V_{DCbus}/\sqrt{2}$$

produced by the drive. For more details on selecting the proper motor, see Motors on page 48.

2.7.4 Power Supply

The drives of the DM2020 series (overvoltage category III according to EN 61800-5-1) can be powered by three-phase industrial AC supply, earthing systems (TN system, TT with grounded neutral and symmetrical rated current not more than 10KA 120V to 480V ± 10%).

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

According to EN61800-3 transient voltage spikes (<50ms) between the phases must not exceed 1000 V. Transient voltage surge (<50µs) between a phase and the housing must not exceed 2000V.

2.7.5 Prohibited Use

WARNING: Risk of death or serious injury to personnel, or damage to equipment - AVERTISSEMENT: Risque de mort ou de blessures graves pour le personnel ou de dommages matériels.

Uses other than those described above (safe use) can lead to death or serious injury to personnel, or damage to equipment.

➢ Avoid the prohibited use cases described below.

The use of the DM2020 system is normally prohibited in the following environments:

- Hazardous areas
- Areas subject to corrosive and/or electrically conductive acids, alkaline solutions, vapors, oils
- Directly on electrical supplies/circuits not connected to the ground, or on asymmetrically grounded power supplies with a voltage exceeding 240 VAC
- On ships or offshore installations

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

- Does not comply with the requirements of the EC Machinery Directive
- Does not comply with the Directives on EMC or Low Voltage Directives
- Does not conform to national, regional and local regulations for the site where the system or machine will be operated
- Does not conform to the machine's Risk Assessment.

The control of the brake by the DM2020 drive alone is prohibited in applications where the safety of personnel must be ensured through the brake.

2.8 Risk Assessment

In order to protect personnel from any safety hazards in the machine or system, the machine/system builder must perform a "Risk Assessment", which is often based on ISO standards. The design/implementation of barriers, emergency stop (E-stop) mechanisms and other safeguards will be driven by the Risk Assessment and the safety standards specified by the governing authority (for example, ISO, OSHA, UL, etc.) for the site where the machine is being installed and operated. The methodology and details of such an assessment are beyond the scope of this manual. However, there are various sources of Risk Assessment information available in print and on the internet.

The following list is an example of items that would be evaluated when performing the Risk Assessment. Additional items may be required. The safeguards must ensure the safety of all personnel who may come in contact with or be in the vicinity of the machine.

2.8.1 Installation Risk Assessment

The safety functional requirements of a DM2020 system depend on the application and should be considered during the evaluation of the overall risk of the installation. The designer of the installation is responsible for the risk assessment, and the specification of requirements for levels of functional integrity and safety integrity levels (SIL) of the drive according to CEI EN 62061: 2005 +A1:2013 +A2:2015 and/or performance levels (PL) according to UNI EN ISO 13849-1: 2016.

The following table, which is identical to Table 4 of the UNI EN ISO 13849-1: 2016, shows the relationship between performance levels (PL) and safety integrity levels (SIL).

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

Because SIL 4 level refers to catastrophic events, it does not cover the risks relating to machinery. The risk assessment presented by the machine must be carried out in accordance with Directive 2006/42 / EC, referring to UNI EN ISO 12100: 2010 and must contain the safety circuit configuration relating to the entire machine by taking into account all components of the integrated safety system, including the drive.

2.8.2 General Machine/System Safeguards Information

In general, the machine/system safeguards must:

- Provide a barrier to prevent unauthorized entry or access to the machine or system. The barrier must be designed so that personnel cannot reach into any identified danger zones.
- Position the control panel so that it is outside the barrier area but located for an unrestricted view of the moving mechanism. The control panel must include an E-stop mechanism. Buttons that start the machine must be protected from accidental activation.
- Provide E-stop mechanisms located at the control panel and at other points around the perimeter of the barrier that will stop all machine movement when tripped.
- Provide appropriate sensors and interlocks on gates or other points of entry into the protected zone that will stop all machine movement when tripped.
- Ensure that if a portable control/programming device is supplied (for example, a hand-held operator/programmer pendant), the device is equipped with an E-stop mechanism.

  A portable operation/programming device requires *many* additional system design considerations and safeguards beyond those listed in this section. For details, see the safety standards specified by the governing authority (for example, ISO, OSHA, UL, etc.) for the site where the machine is being installed and operated.

- Prevent contact with moving mechanisms (for example, arms, gears, belts, pulleys, tooling, etc.).
- Prevent contact with a part that is thrown from the machine tooling or other part-handling equipment.
- Prevent contact with any electrical, hydraulic, pneumatic, thermal, chemical or other hazards that may be present at the machine.
- Prevent unauthorized access to wiring and power-supply cabinets, electrical boxes, etc.
- Provide a proper control system, program logic and error checking to ensure the safety of all personnel and equipment (for example, to prevent a run-away condition). The control system must be designed so that it does not automatically restart the machine/system after a power failure. Refer to the next section.
- Prevent unauthorized access or changes to the control system or software.

NOTE
In order to comply with all the certifications of the drive, the motor connected to it must have specific electrical and insulation characteristics:
Low voltage components / circuits (such as temperature sensors, holding brakes and feedback systems) integrated within the motor must be designed to ensure a "reinforced insulation" (as defined by EN 61800-5-1 standards) separating them from all high voltages components.

All Moog motor products meet these requirements.

2.8.3 Safeguards Related to SCRF (Safety-Related Control Function)

The manufacturer of the machine and/or final apparatus must perform, maintain and make available a Risk Assessment (risk analysis) of the machine in accordance with the ISO12100 and ISO14121 standards, and implement all necessary measures to avoid unforeseen movements that can cause damage to persons or objects. In particular, the manufacturer of the machine and/or final apparatus has to comply with the relevant product standards. Where it has been chosen to perform safety functions by means of electrical/electronic devices (SCRF), the safety integrity levels (SIL) and the functional requirements of each device must be specified clearly. According to TECHNICAL STANDARD IEC EN CEI EN 62061: 2005 +A1:2013 +A2:2015, this specification must include all information likely to influence the design of the electrical/electronic device, including, where applicable:

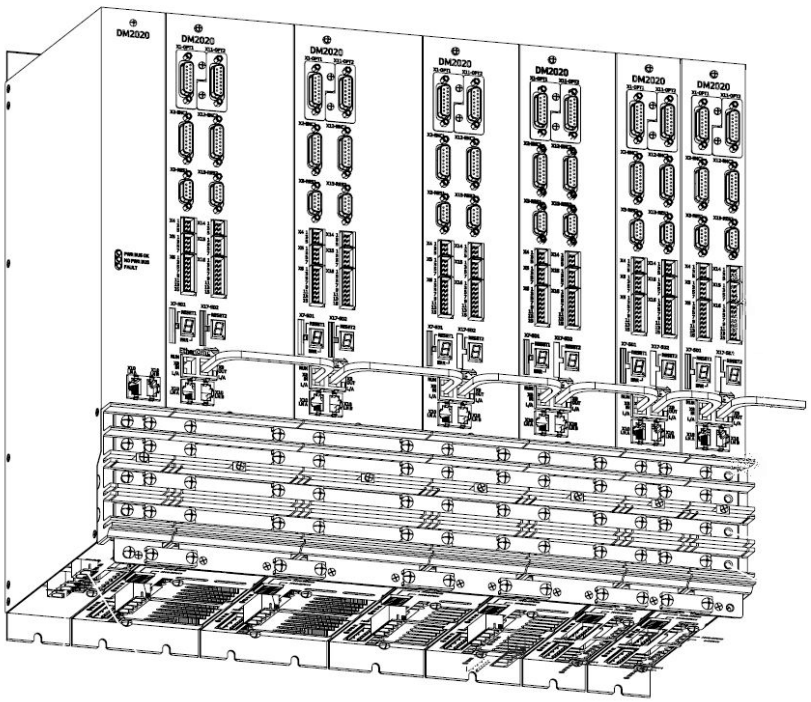
- The machine operating conditions
- Prioritization of functions that can be active simultaneously and cause conflicting actions
- The frequency of operation of each SCRF
- Requested response time of each SCRF
- Description of each SCRF
- SCRF interface with other functions of the machine
- Description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

3 System Overview

3.1 ProductStructure

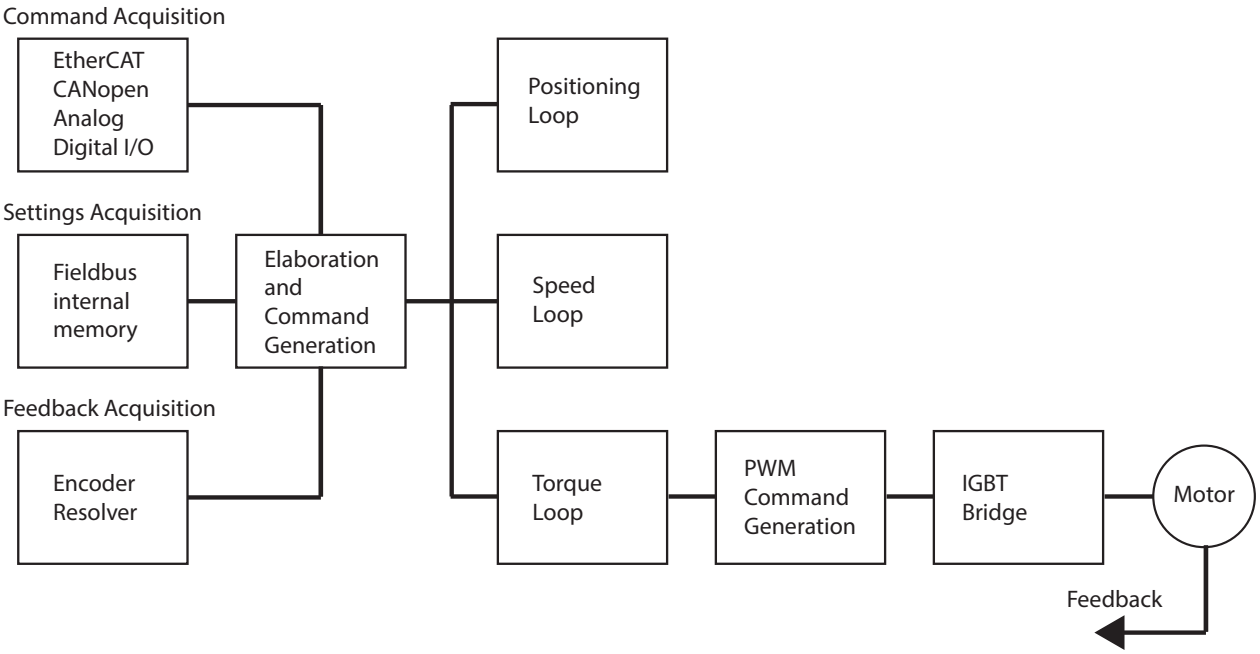
3.1.1. Product description

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.



Front 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 proile
- Standard CANOpen interface on which the CANOpen protocol is implemented with the DS402 proile
- “Safe Torque Off” (STO) (protection against accidental start-up) incorporated into each axis
- configuration/commissioning via GUI: Dx2020GUI allows users to conigure, calibrate and control the drive
- Alarm diagnostics: Via GUI
- Accessories:
  - EMC filters
  - Power and signal cables
  - Brake resistor



DM2020 System Theory of Operation Flow Chart

3.1.2 Storage and Working 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 in 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), EAC
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 certiied below)

3.1.3. 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 insuficient 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.

3.1.4 DM2020 Standard Models

The following table shows the standard axis modules sizes.

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	

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	

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	

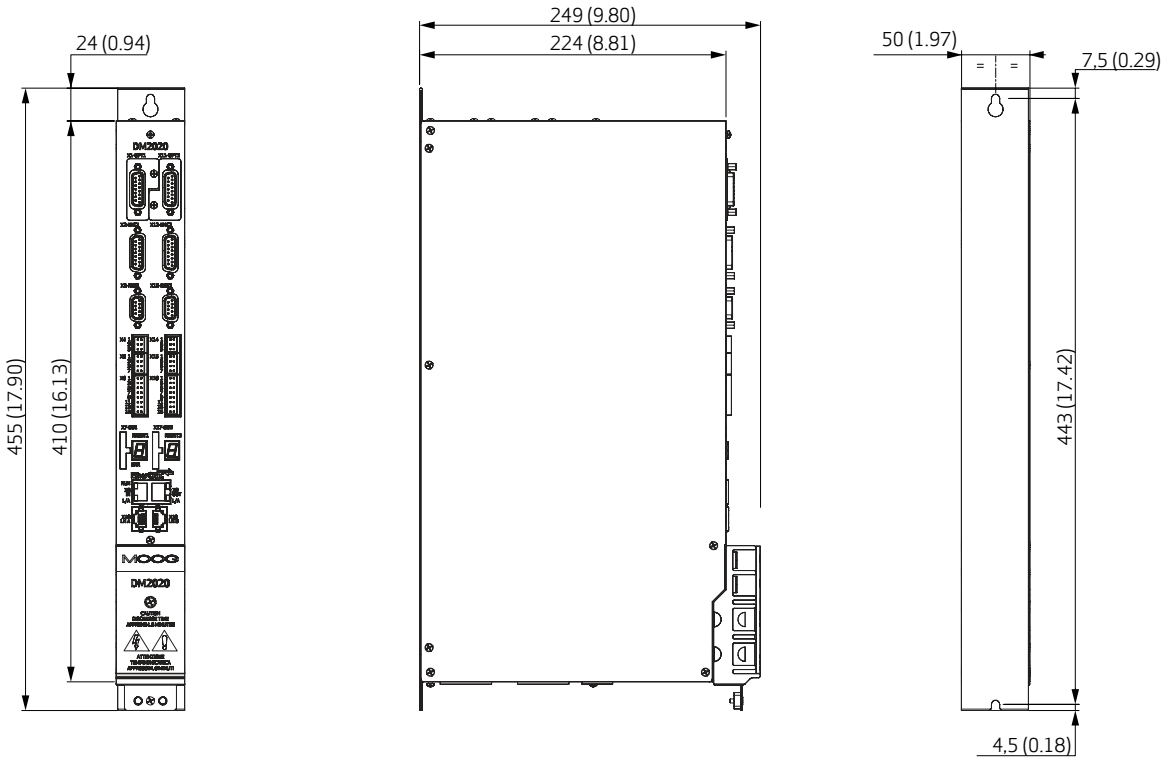
Model/Code	CC140GDNLNxxxxx		CC140GENLNxxxxx		CC140GFNLNxxxxx		CC140GGNLNxxxxx	
Mechanical dimensions	200 mm (7.87 inches)							
Configuration	Double		Double		Double		Double	
Type	L200		L200		L200		L200	
Module current @ 8 kHz	88		96		112		128	
Arms rated current	64	24	64	32	64	48	64	64
Arms peak current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

3.1.4.1 Models and coding auxiliary bus capacitor (ABC) modules

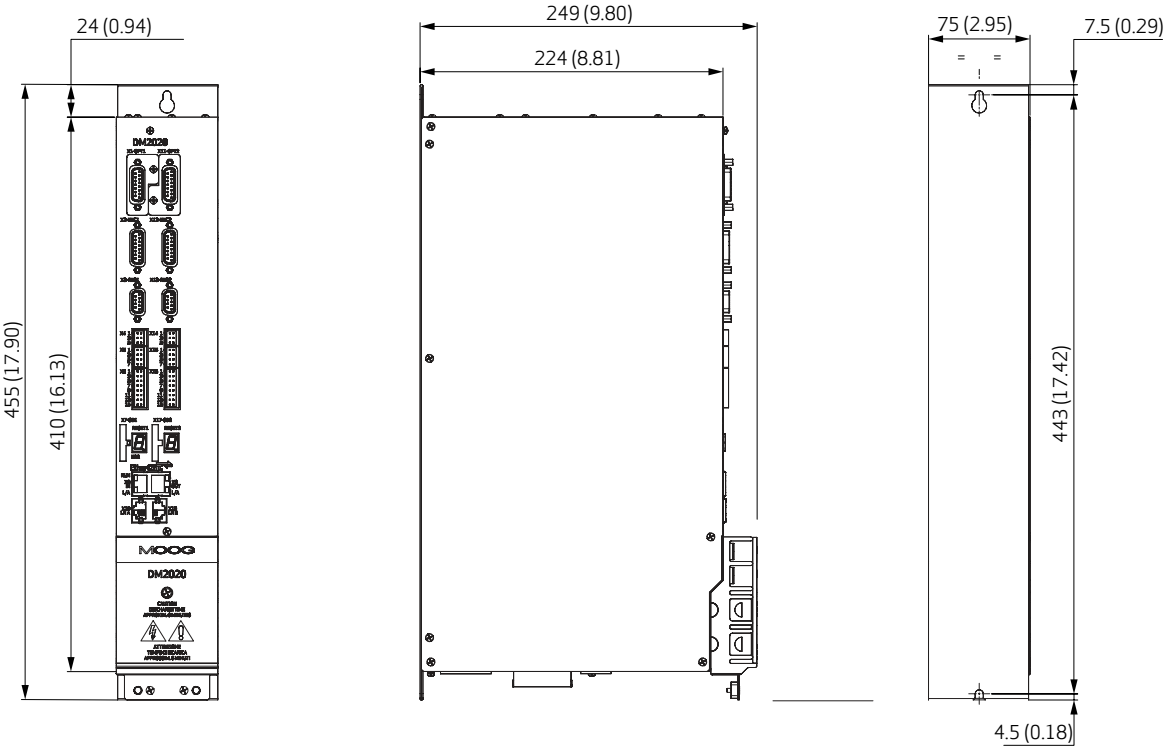
Model	Code	Capacity (µF)	Dimensions
DM2020 ABC5	CCE5000	5400	50 mm/1.97 inches
DM2020 ABC4	CCE5012	4500	
DM2020 ABC3	CCE5013	3600	
DM2020 ABC2	CCE5014	2700	
DM2020 ABC1	CCE5015	1800	

3.1.4.2 Mechanical Dimensions

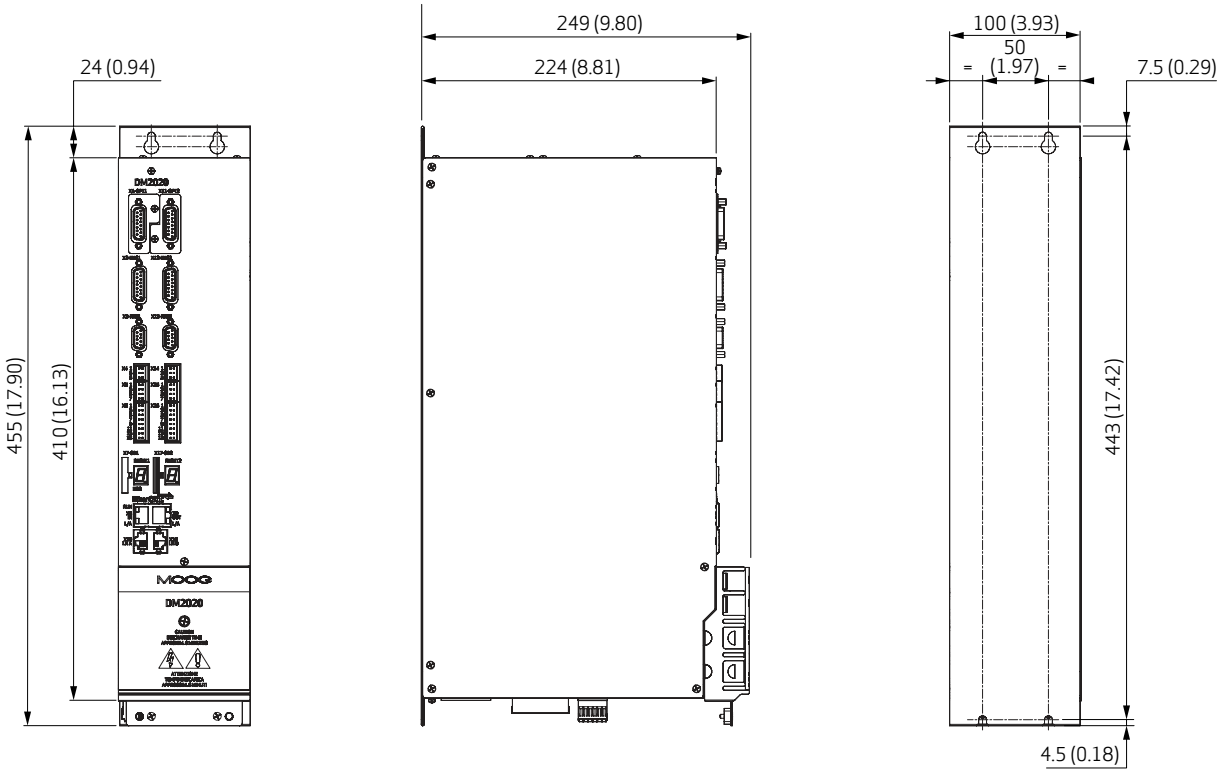
Module L50 (1.97 inches)



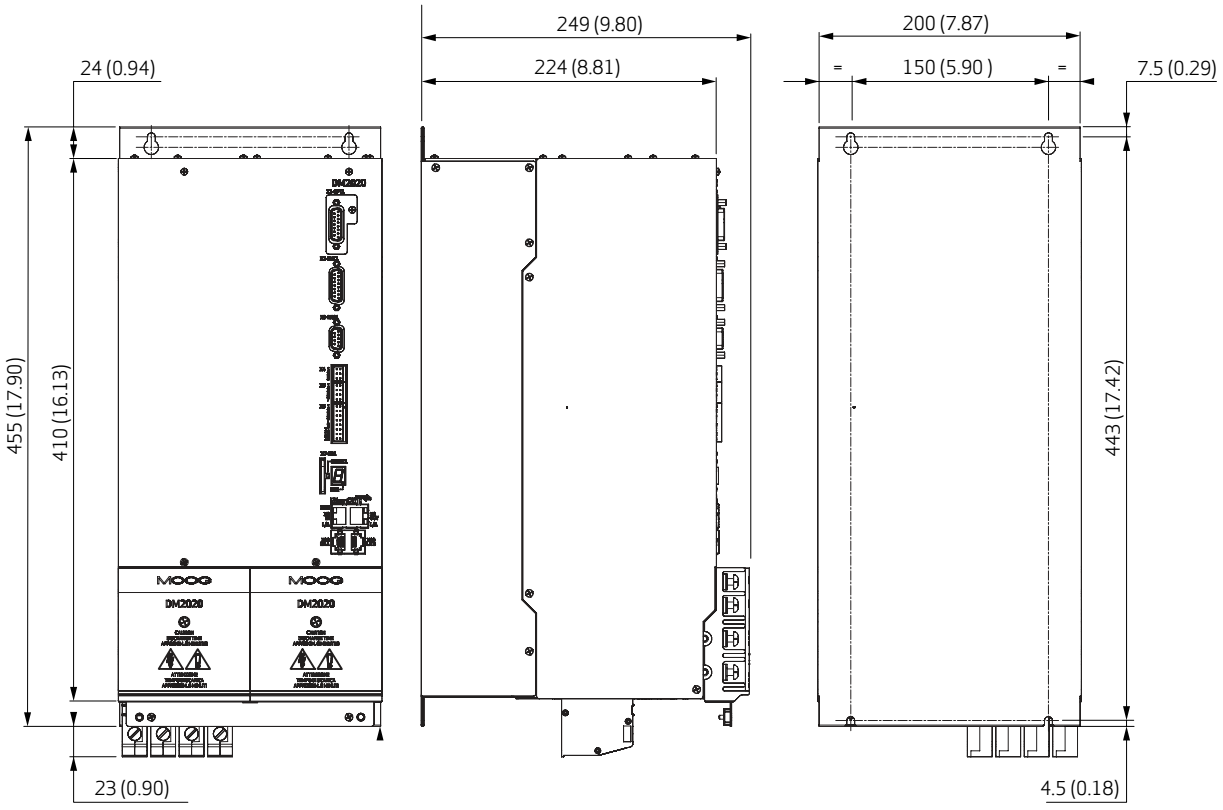
Module L75 (2.95 inches)



Module L100 (3.94 inches)



Module L200 (7.87 inches)



3.1.5 Axis Module coding

To identify the axis models, refer to the following coding

Version	
1	Standard model
E	Special model
X	Test model

Mechanical hardware conifiguration		
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

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

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

3.1.6 Power supply units coding

Version	
2	Standard model
E	Special model
X	Test model

Mechanical hardware conig uration			
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 coni gurations	
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 coni gurations	
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.

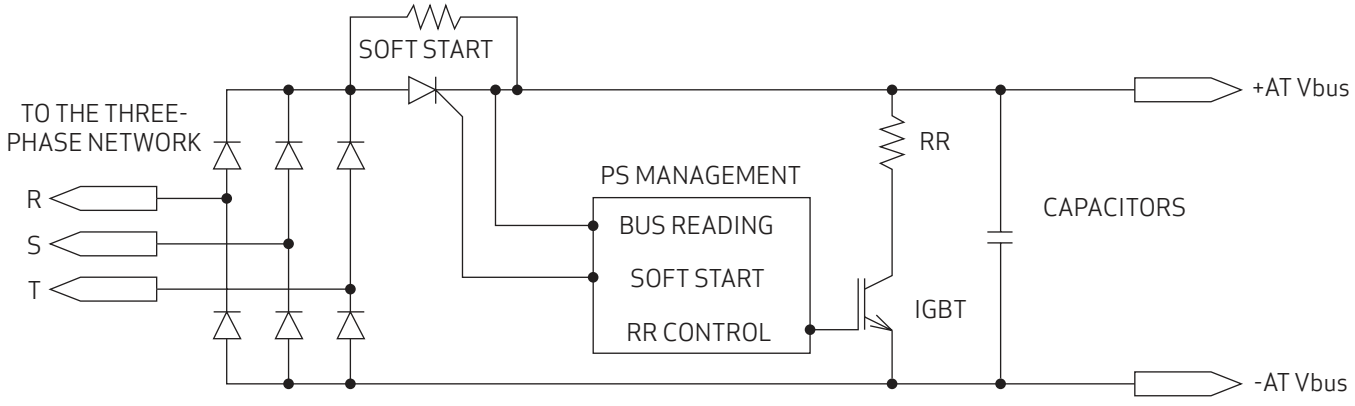
3.2 PSU Features and Details

This section provides details on the features and components of the DM2020 power supply unit.

3.2.1 Electrical and Mechanical Data

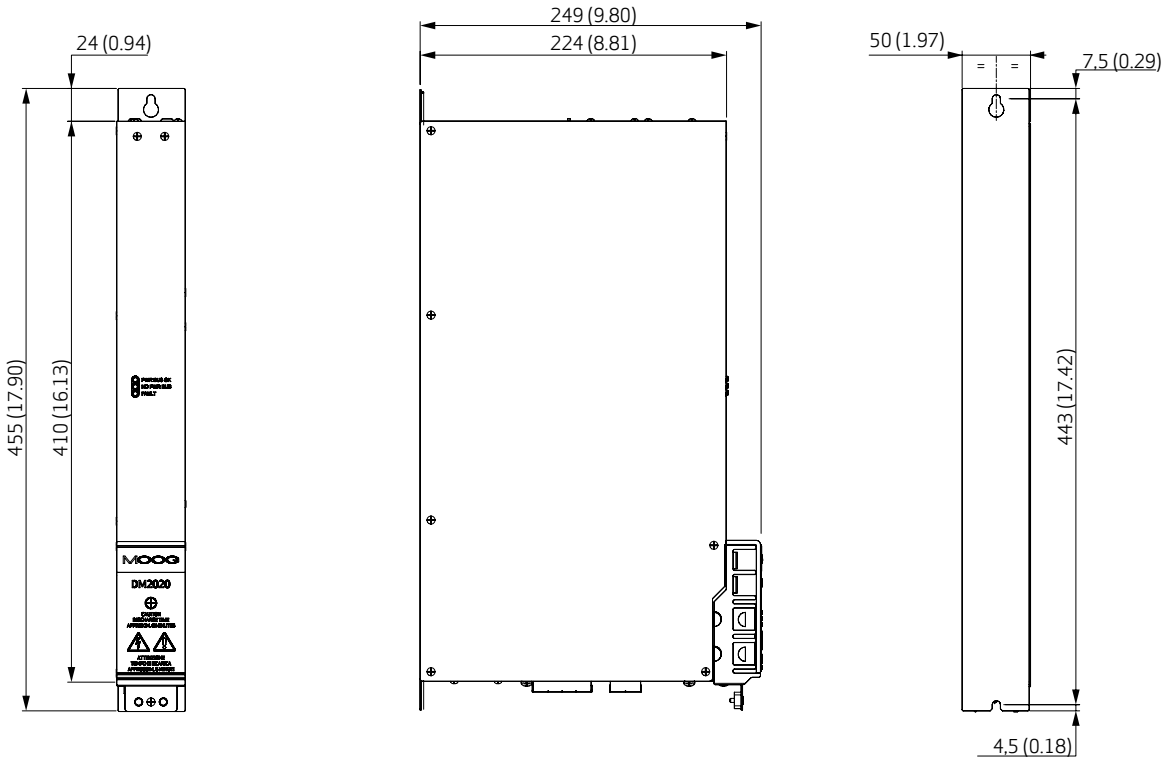
Model	Type L50 (M)	Type L150 (L)
ELECTRICAL DATA		
Mains voltage	Three-phase from 200 to 528 V AC 50/60 Hz	
Auxiliary voltage	24 V DC +/-10%, 1 A (supplied externally)	
Rated output current, DC BUS side	54 A	128 Arms
Peak output current, DC BUS side	130 A	256 Arms
DC-link voltage (Vout)	From 282 to 744 V DC	-
Protection	NTC and bi-metallic thermal protection on heat sink to 85 °C Identii cation of absence of input phase Identii cation of insufi cient 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)

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

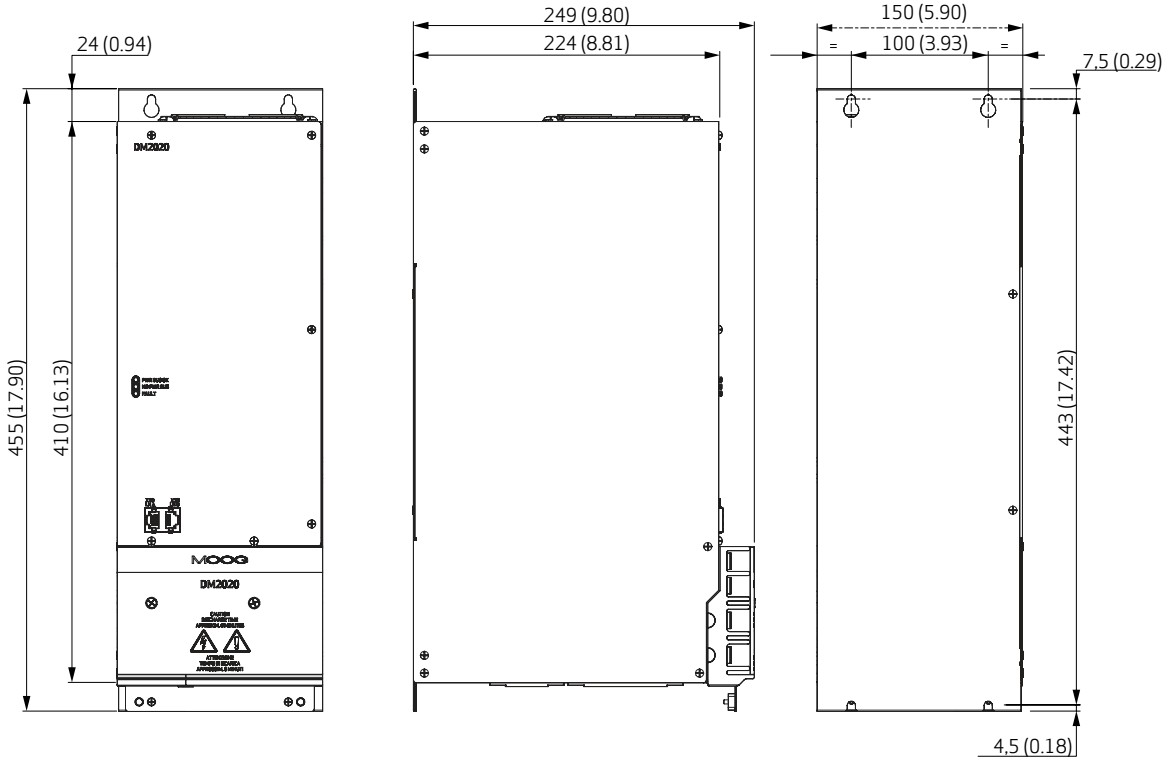


Mechanical Dimensions

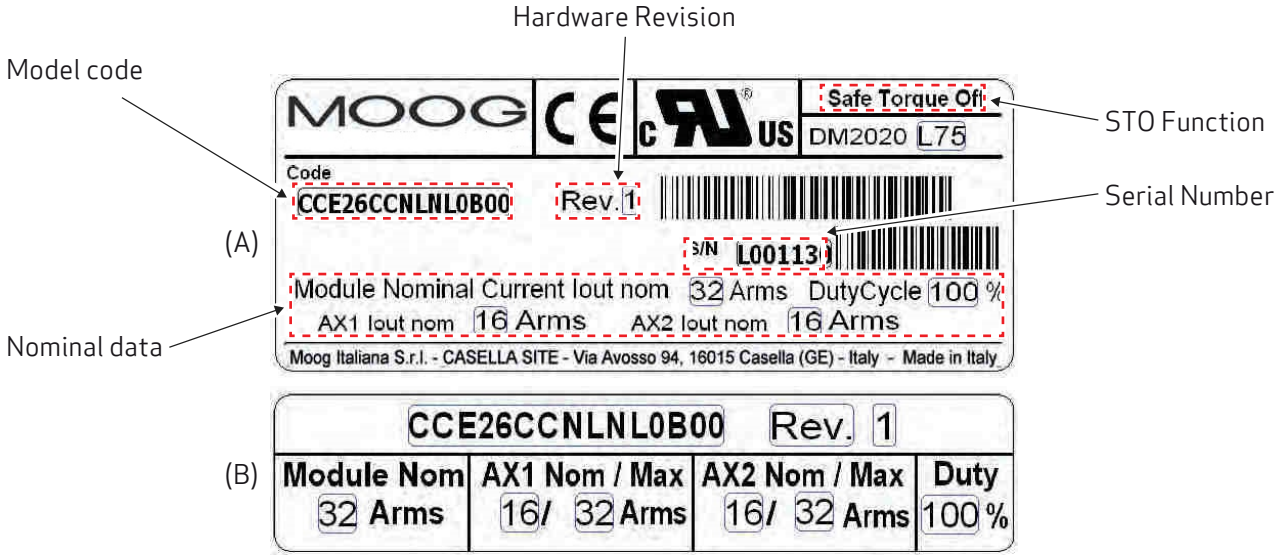
PSU Module L50



PSU Module L150

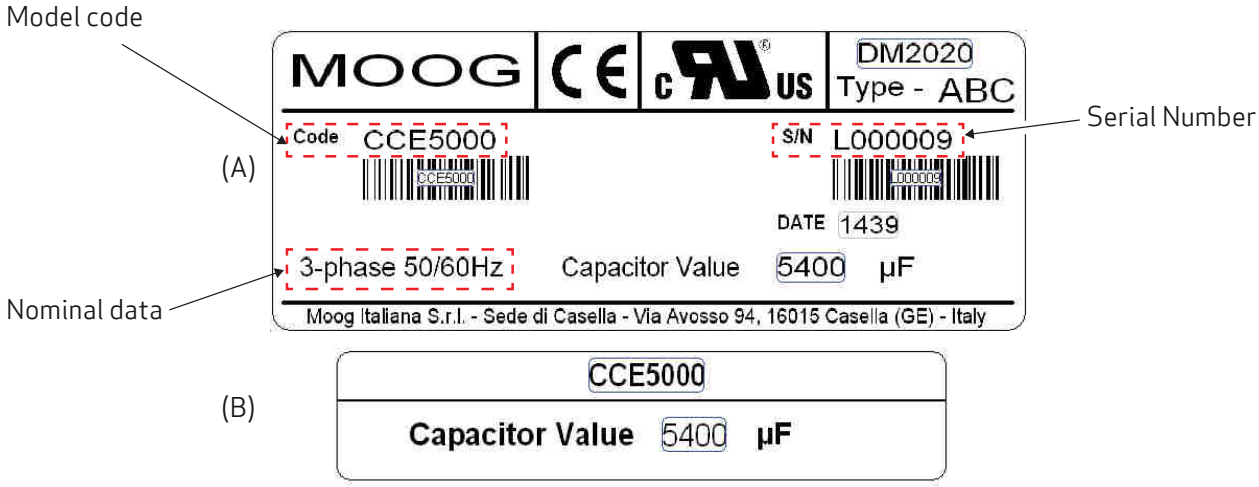


3.2.2 Module Side Plate Types



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

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



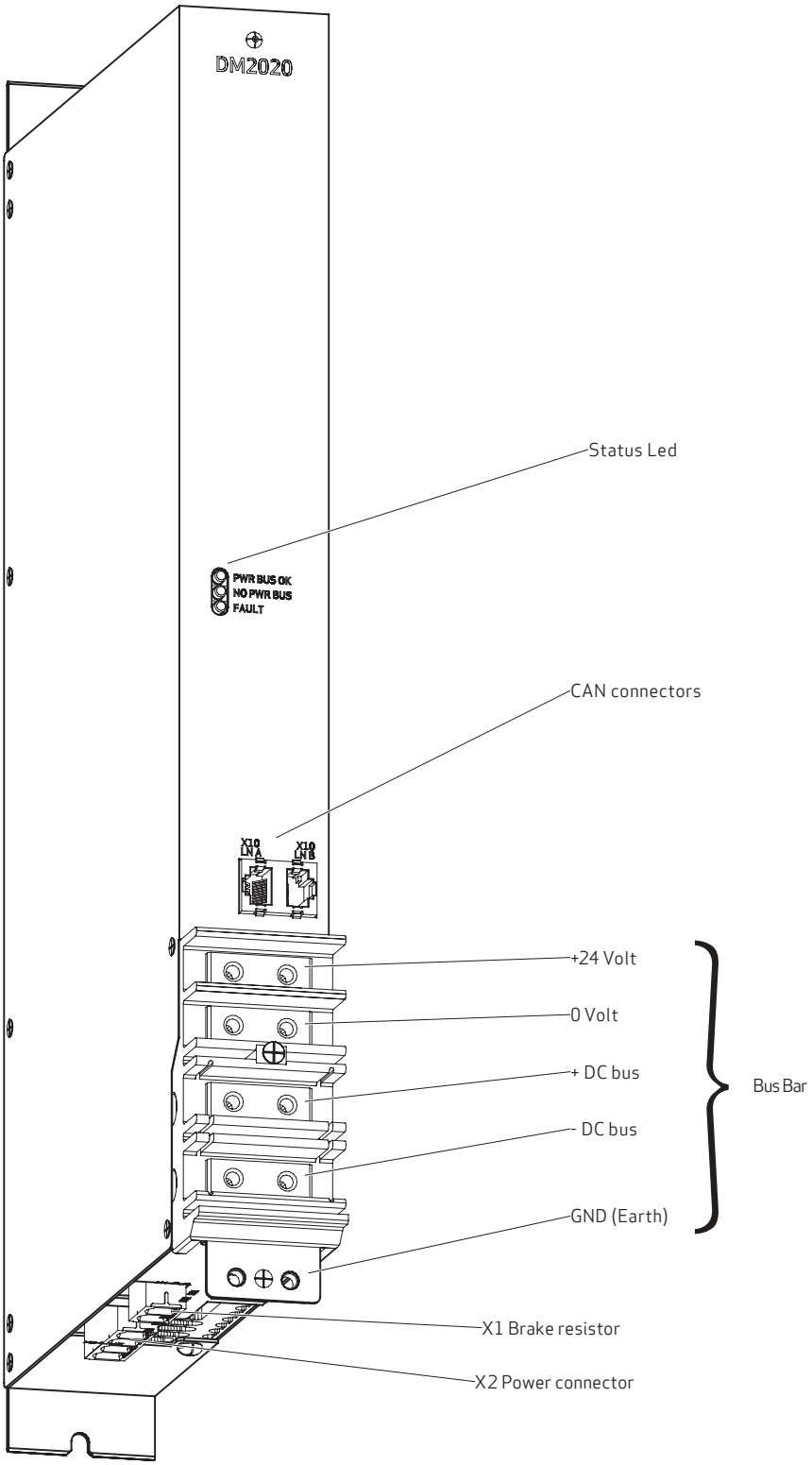
Example of capacitor module side plate (A) and front plate (B)

3.2.3 Transducers

The DM2020 system can manage the following transducers:

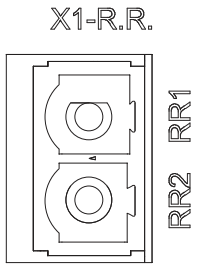
- Resolver (standard)
- Encoder Incremental TTL
- Encoder, Stegmann Sinusoidal Absolute Single/Multi-Turn with Hiperface communication
- Encoder, Heidenhain Sinusoidal Absolute Single/Multi-Turn with ENDAT communication
- BISS Absolute Encoder
- Sensorless mode

3.2.4 Connectors

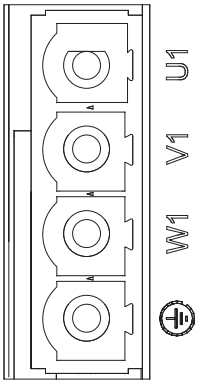


3.2.4.1 Connector layout

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



X1: brake resistor	
1	+RR1
2	-RR2

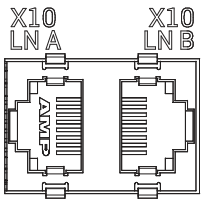


X2: mains	
1	U1
2	V1
3	W1
4	Earth

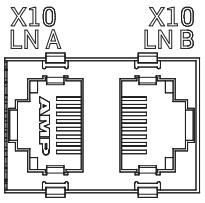
BUSBAR connection	
1	+24 V
2	0 V DC
3	+DC BUS
4	-DC BUS

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(active low) 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 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 (active low) 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)



3.2.5 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**	**Rated current [A]**	**Total current loss [W]**	**Current on contact [mA]**	**Weight [kg]**	**Connection [mm^2]**
AT6049	L50	55	29.3	6.6	2.5	Up to 16 mm^2
AT6054	L150	137	42.2	7.1	5	From 10 to 50 mm^2

Main electrical characteristics of filters

For special installation requirements, alternative versions of the filters are also available. Please contact Moog for further information.

3.2.6 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.

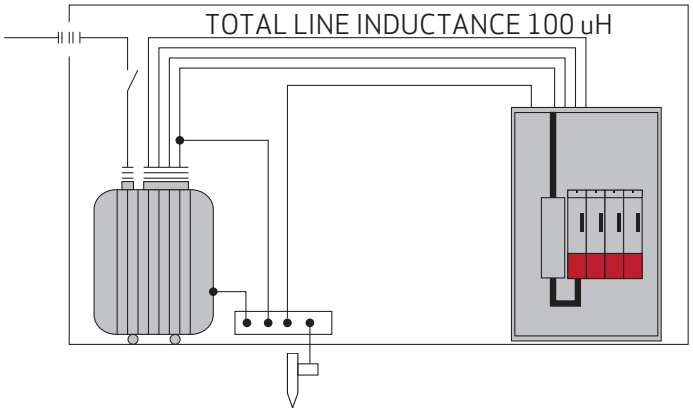
3.2.7 Line inductors

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 it 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

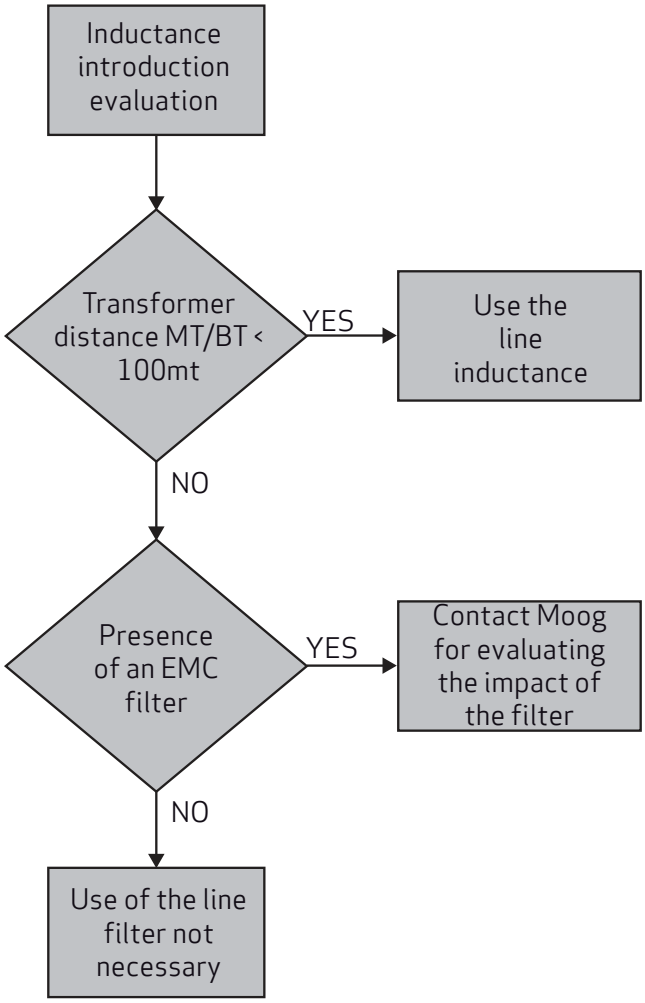


DM2020_D_005

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

How to assess whether an inductor is needed:



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

3.2.7.1 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

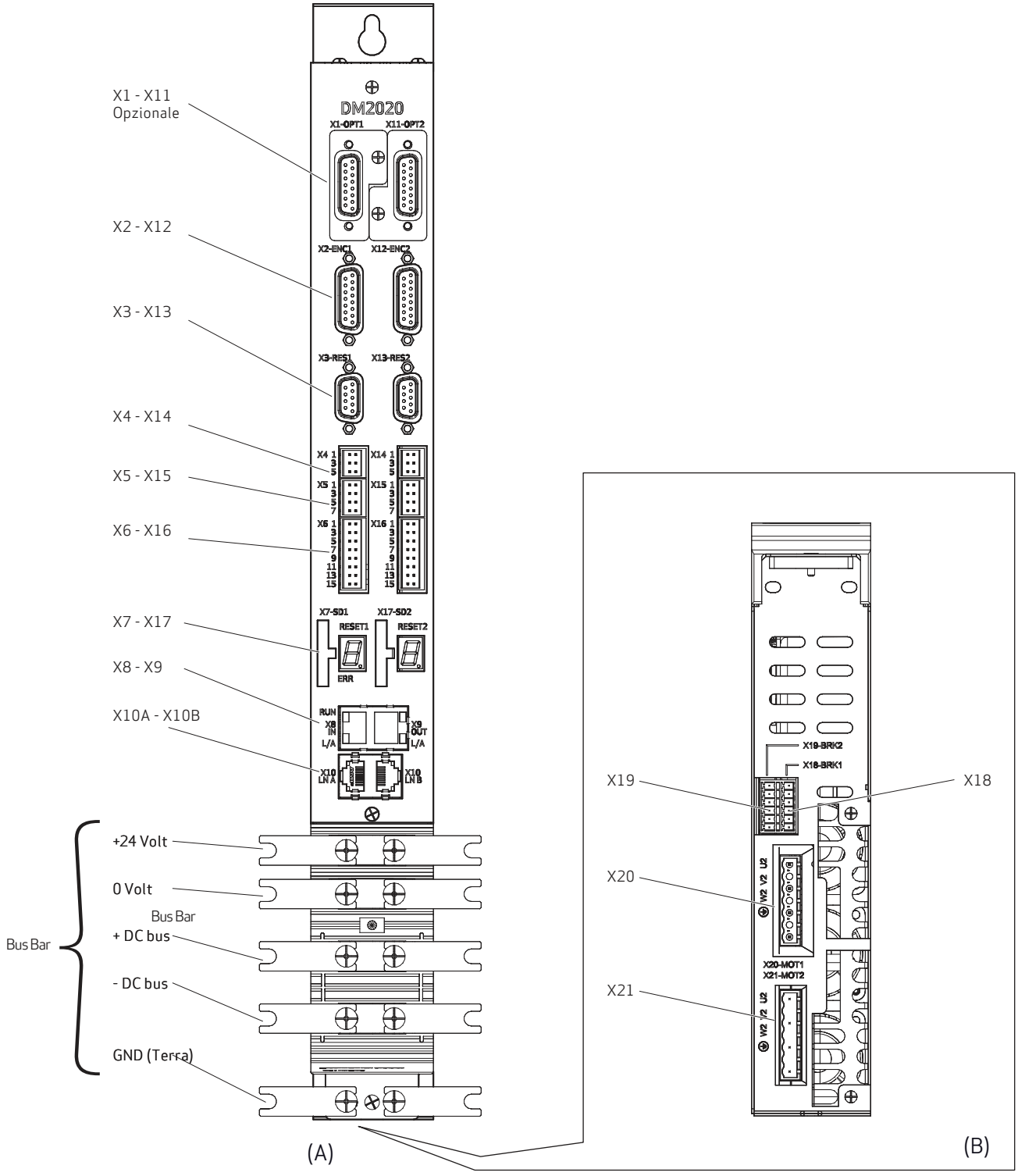
3.2.7.2 Interfaces with "field" and other modules

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.

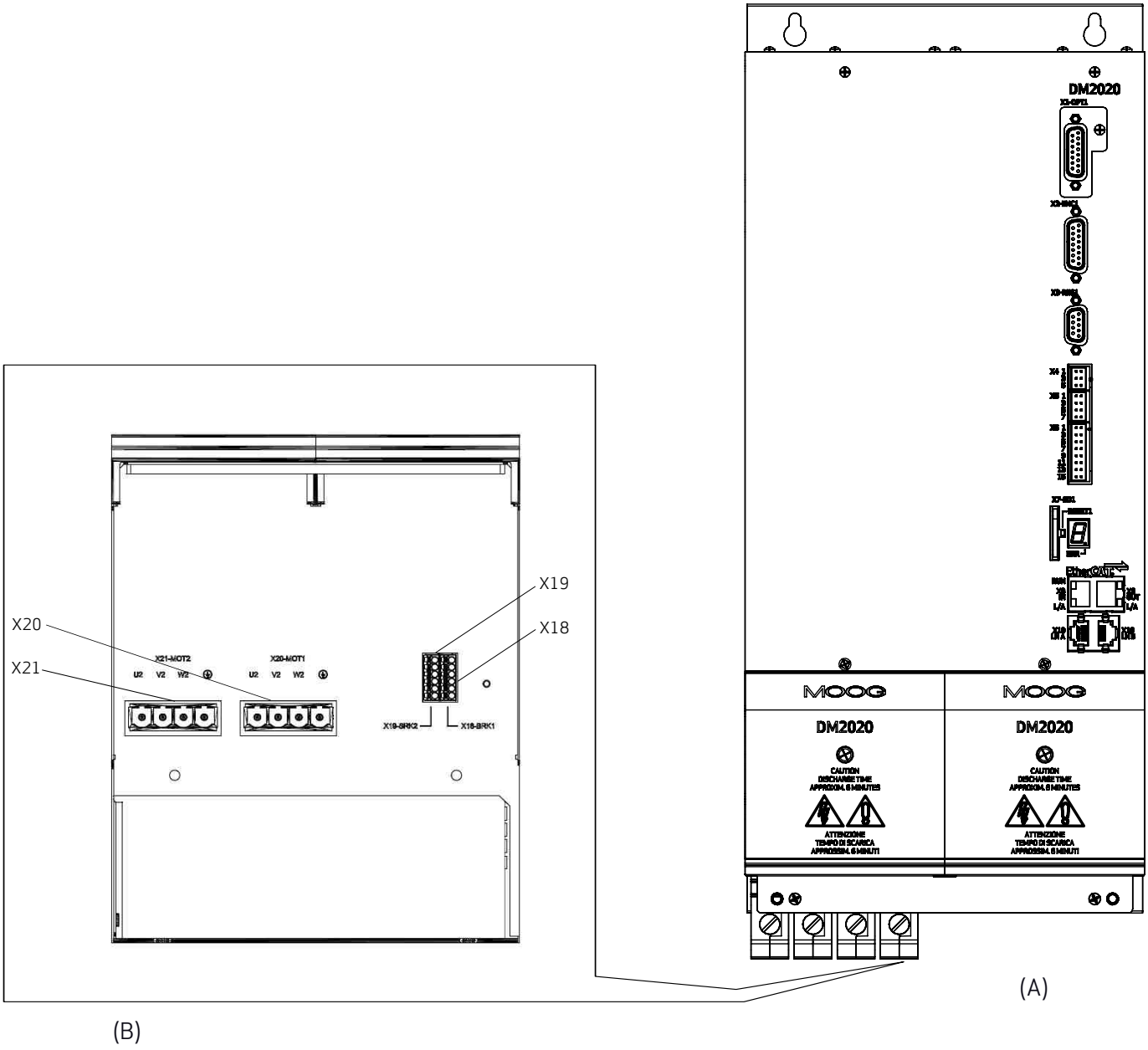
Master	**Slave**	**Notes**
X1	X11	Optional encoder (can have the same functionality as the X2 in addition to the TTL incremental encoder)
X2	X12	Motor or machine encoder
X3	X13	Motor resolver
X4	X14	STO interface
X5	X15	Programmable digital interface
X6	X16	I/O interface: Analogue I/O, digital I/O, driver 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		

3.2.7.3 Connector view



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 next page for the bottom).



Module L200 double axis: front (A) and bottom (B) view.

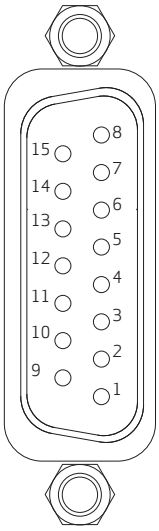
Note that the arrangement of the front connector remains unchanged as in L50, L75 and L100 modules (See previous page for details)

3.3 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 coni gurations.

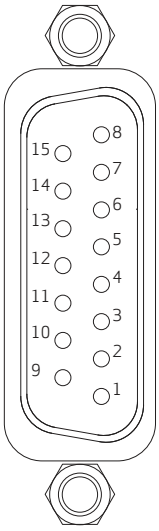
X1 (X11) connector (*)

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:

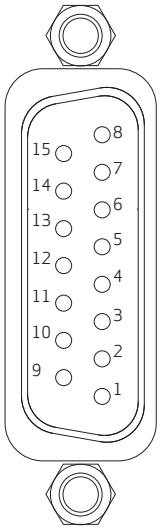
PIN	Differential Hall sensor connector	Hall sensor connector Single-ended
1	+5 Volt	+5 Volt
2	0 V supply	0 V supply
3	W-	n.c.
4	W+	W+
5	V+	V+
6	V	n.c.
7	n.c.	n.c.
8	n.c.	n.c.
9	n.c.	n.c.
10	n.c.	n.c.
11	U+	U+
12	U-	n.c.
13	n.c.	n.c.
14	n.c.	n.c.
15	PTC-NTC-Mot	PTC-NTC-Mot



(*) The use of the X1 (X11) connector is optional.

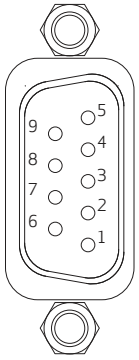
X2 (X12) connector

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	Data +	Data +
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	Data	Data -
14	Term B	Term B
15	CLOCK	CLOCK -



Connector X3 (X13) resolver interface

PIN	FUNCTION
1	S4
2	S2
3	GND
4	S3
5	S1
6	TERM
7	R2
8	TERM
9	R1



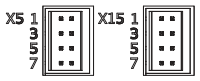
Connector X4 (X14) STO interface

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

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							

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



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

If you need more details or clarifications on motor/drive connections, please contact Moog assistance.

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

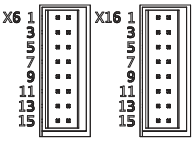
INFORMATION
The 24 V power supply available on the connector can be used to power external devices

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
- Actual speed
- Phase current (measured on the U and V phases).
- Speed error
- Position error

CAUTION
Analogue inputs are referred to 0 Volt analogue earth on pin 16; the 0 Volt digital earth is used for the power supply for the digital outputs

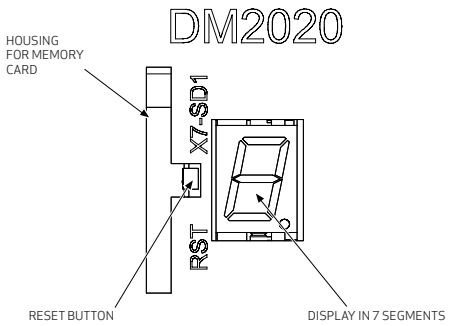
ATTENTION
Les entrées analogiques sont appelées 0 Volt terre analogique sur la broche 16; la terre numérique 0 Volt est utilisée pour les alimentation des sorties numériques

Note on analogue inputs:

Digital Out 1/2 options
- Halt is active
- Stop is active
- Motor dir. clockwise
- Motor dir. counterclockwise
- 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 iles 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:

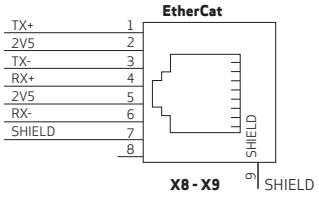
Display message	Status ID	Notes
I	Setup	The drive has completed setup
S	Ready	The drive is ready to be enabled
E	Enabled	The drive is controlling the motor
F	Fault	The drive has an alarm status
8 flashing	Boot via Serial	The drive is being programmed via the RS 232 serial line
b flashing	Boot via EtherCAT	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 FLASHING FLASHING ON FLICKERING	Drive status is INIT Drive status is PRE-OPERATIONAL Drive status is SAFE-OPERATIONAL Drive status is OPERATIONAL Drive status is BOOTSTRAP
X8 - L/A	EtherCAT Link/ Activity	OFF ON FLICKERING	The Ethernet input port is closed The Ethernet input port is open The Ethernet input port is open and network activity is present
X9 - L/A	EtherCAT Link/ Activity	OFF ON FLICKERING	The Ethernet input port is closed The Ethernet input port is open The Ethernet input port is open and network activity is present

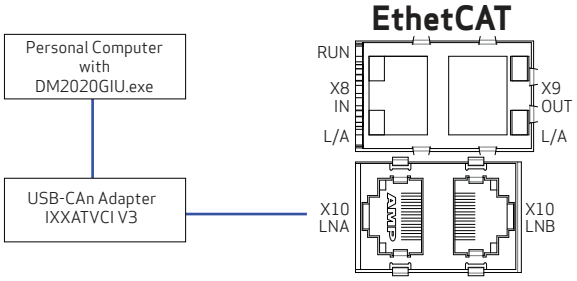


X10A (X10B) connector: CANOpen interface

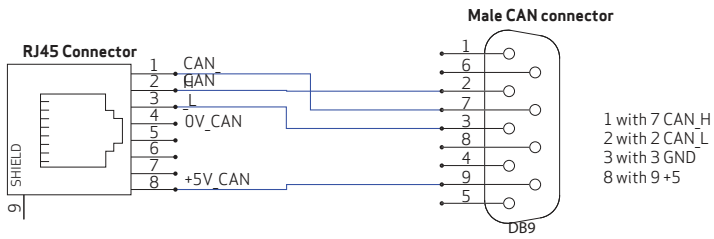
The connector is an RJ45 and the pin is specified in the table which follows:

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.



Dedicated PC-Axis connection via CAN

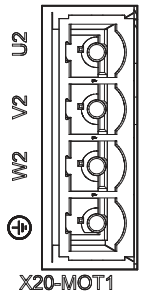


CAN RJ45 DB9 connection diagram

Connector X20 and connector X21

Motor power supply

Pin	Function
1	phase U
2	phase V
3	phase W
4	GND

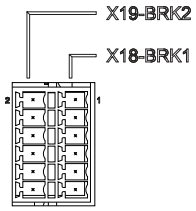


The cable must be shielded. The connection of the shield to the earth can be closed with a conduction clamp, with which the cable can be connected to the metal bracket to be fixed under the drive.

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

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

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

3.4 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 connectors
2A	2.1 mm^2 AWG14	1 mm^2 AWG16	100 m	< 150 pF/m	0.22 -1 mm^2 (AWG16)
4A					
6A					
8A					
16A	5.3 mm^2 AWG10				
24A	8.4 mm^2 AWG8				
32A					
48A	13 mm^2 AWG6				
64A	16 mm^2 AWG4				
96 A	26 mm^2 AWG3				
128 A	33 mm^2 AWG2				

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.

	The power and control cables (except those that go from the AC power supply to the filter) must be shielded. To minimize noise, it is recommended that they are separated from each other at a distance greater than 200 mm.

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

Particular attention should be given to the use of appropriate cables.

The cables and the motor winding may interact with the drive output stage to create an oscillating circuit that increases the maximum voltage of the system. The parameters that contribute to determining this maximum voltage are: the capacity and the length of the cables, the motor inductance, and the frequency and rising edges of the PWM modulation. An analysis of these parameters is recommended to prevent excessive voltages for the application. For applications assistance, contact Applications Engineering.

Cable cross-sections for power supply modules

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

4 Certifications

4.1 CE Certificate

According to the European Community Directives, drives must conform to:

- EMC 2014/30/EU directive
- Low Voltage Directive 2014/35/EU

The DM2020 system has been tested in a laboratory for the verification of the parameters of compliance with the above Directives.

Regarding electromagnetic compatibility, the DM2020 system refers to C3 industrial environments.

The DM2020 system can emit radio frequency that might interfere with non-industrial electric and electronic devices.

The machine manufacturer MUST NOT use the DM2020 system or its components if there is no documentation that ensures the fulfillment of the requirements of Directive 2006/42/EC.

MOOG

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www.moog.it

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

rif./ *ref* nr	titolo / *title*
2014/30/EC	Direttiva Compatibilità Elettromagnetica/ EMC Directive
2014/35/EC	Direttiva Bassa Tensione/ *Low Voltage Directive*

e che sono state applicate le norme armonizzate, o parti di esse, indicate di seguito / *and that the following harmonized standards, or parts thereof, have been applied*

nr	*issue*	titolo / *title*
EN 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 EMC responsibility in following the recommendations of the manufacturer.*

Ultime due cifre dell'anno in cui e' stata affissa la marcatura CE / *Last two digits of the year in which the CE marking was affixed*: 11

Casella, 20 Aprile , 2016

Gianfranco Costa

OPERATIONS MANAGER

CENELEC Memorandum N°3

CE Declaration of Conformity

4.2 Safe Torque Off (STO)

The DM2020 integrates the Safe Torque Off (STO) function according to standards EN 61800-5-2; UNI EN ISO 13849-1:2016. SILCL 3 PL "e" (as per certificate). The function also corresponds to an uncontrolled stop in accordance with stop category 0 of IEC/EN 60204-1 standard.

The validation of the function is based on:

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

In case of the occurrence of two simultaneous faults in the power section, the residual risk is for the motor to rotate by an angle dependent on the number of its pole pairs. So, for example, a 6-pole motor can result in 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 conflicting actions
- The operating frequency of each SCRF
- The required response time of each SCRF
- A description of each SCRF
- The interface of each SCRF with other machine functions
- A description of the reactions to failure and constraints relative to machine restart, when the reaction to failure causes the machine to stop
- A description of the operating environment
- Tests and associated equipment (e.g. access hatches)
- The frequency of operating cycles and factor of use in operating cycles

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MOOG

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

We,

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

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

CE "Safe Torque Off" Certificate of Conformity

4.3. UL

4.3.1 REQUIREMENTS

- 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”

External (recommended) semiconductor fuses						
Power supply (converter) Model no.	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 ield 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.

4.3.2 Overvoltage control

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-certiied.

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-certiied.

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.

4.3.3 Dynamic Brake Unit Ratings

- 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.

5 Electrical and Mechanical Installation

5.1 Tools and Equipment

This section lists the special tools and equipment needed to install the DM2020 system components. Note that other tools may be needed, for example, to work in the control panel, terminate cables, mount safety and/or mechanical components at the machine, etc.

5.1.1 Tools

Have the following tools available for the installation of the DM2020 system:

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

5.1.2 Electronic Equipment

Have the following electronic equipment available:

- Digital multimeter (measurement/verification of voltage, amperage, continuity, etc.)

There is no need for any other specialized electronic equipment.

5.2 Mechanical Installation

This section provides information about the mechanical installation of the DM2020 system.

5.2.1 Assembly of System Components

5.2.1.1. Assembling the power supply

Standard vertical assembly.
Assembly material: 2 M6 cheese-head screws.
In the case of horizontal assembly, please contact the Applications Department to verify the application.

5.2.1.2. Assembling the axes

Standard vertical assembly.
Assembly material: 2 M6 cheese-head screws.
In the case of horizontal assembly, please contact the Applications Department to verify the application.

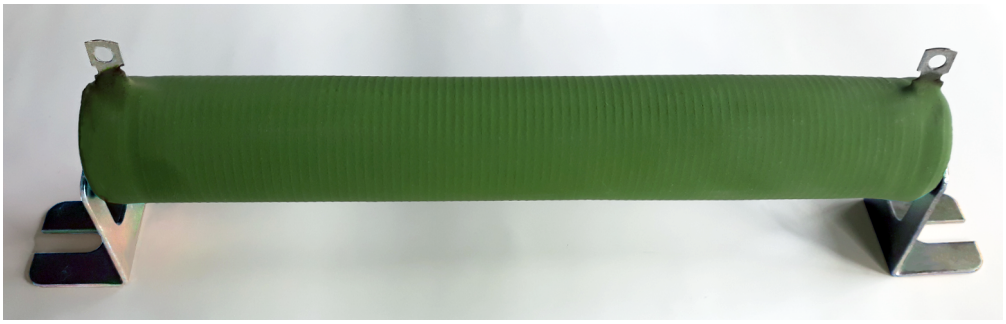
INFORMATION
When these are to be used, given their considerable weight, install the inductors at the bottom of the cabinet, if possible near the EMC filter, to reduce emissions in the distribution board

5.2.1.3 Braking Resistor Positioning

WARNING: Electrical hazard - AVERTISSEMENT: risque électrique
High voltage may be present, which can result in death or serious injury to personnel, or damage to equipment.

- The external resistor must be properly guarded to prevent accidental contact.

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).



External Braking Resistor (with brackets)

5.3 Electrical Installation and Thermal Rating

This section provides information on the electrical installation and thermal rating of the DM2020 system.

5.3.1 Safety and General Instructions

WARNING: Electrical hazard - AVERTISSEMENT: risque électrique

The DM2020 system and connected motor may present an electrical hazard if the safety precautions are not observed, which may result in death or serious injury to personnel, or damage to equipment.

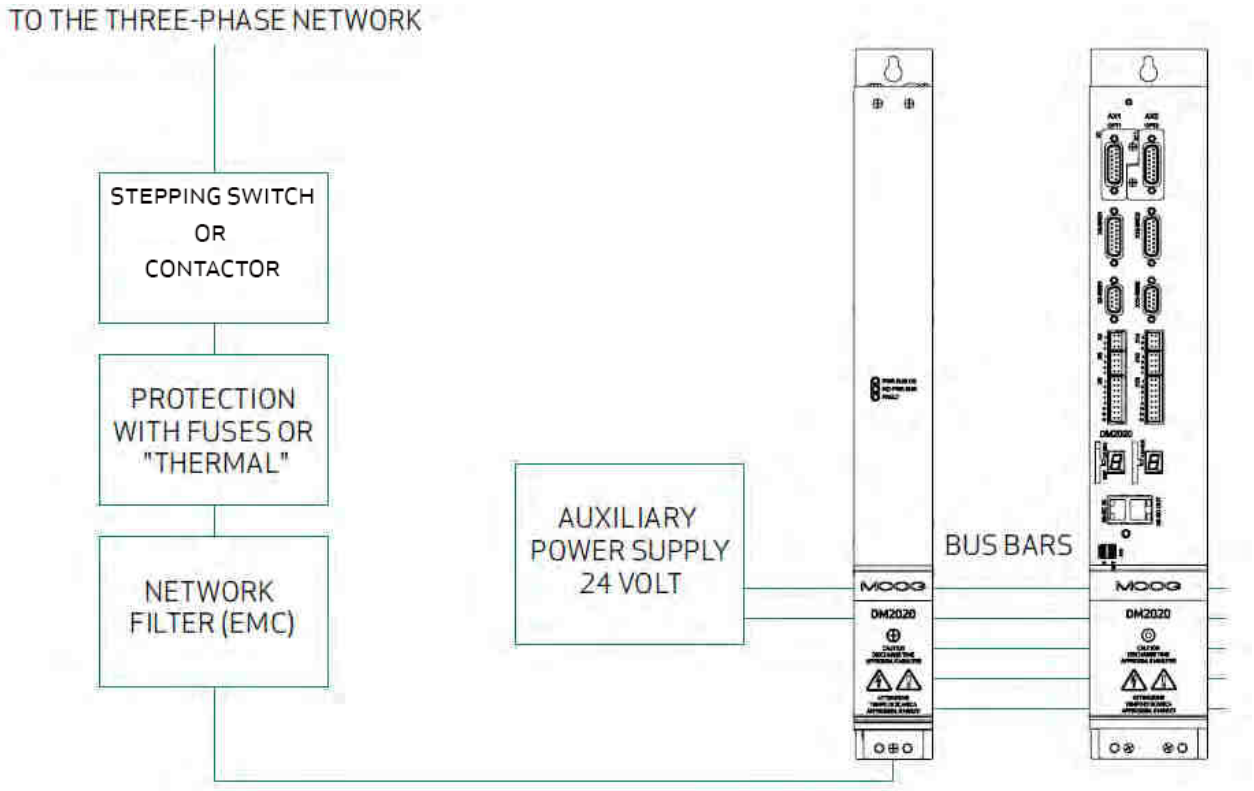
- Before attempting this operation, follow the safety information and procedures in General Hazards and Safeguards on page 20.

WARNING: Mechanical hazard - AVERTISSEMENT: risque mécanique

The DM2020 system and connected motor may present a mechanical hazard if the safety precautions are not observed, which may result in death or serious injury to personnel, or damage to equipment.

- Before attempting this operation, follow the safety information and procedures in General Hazards and Safeguards.

5.3.2 Electrical Installation



Structure of the Electrical Panel with the Components of a Servo System

Particular attention should be given to grounding, shielding and the use of the filter to reduce or suppress particularly steep voltage surges (derived by PWM modulation), which are capable of generating significant unwanted currents through capacitive couplings and grounded systems. These voltage surges can also generate high-frequency radiation mainly through the motor cable. Filters can be installed to reduce conducted disturbances; see Power Line Filters on page 47 for the recommended models.

Regarding the grounding in the panels, there are typically two types of problems:

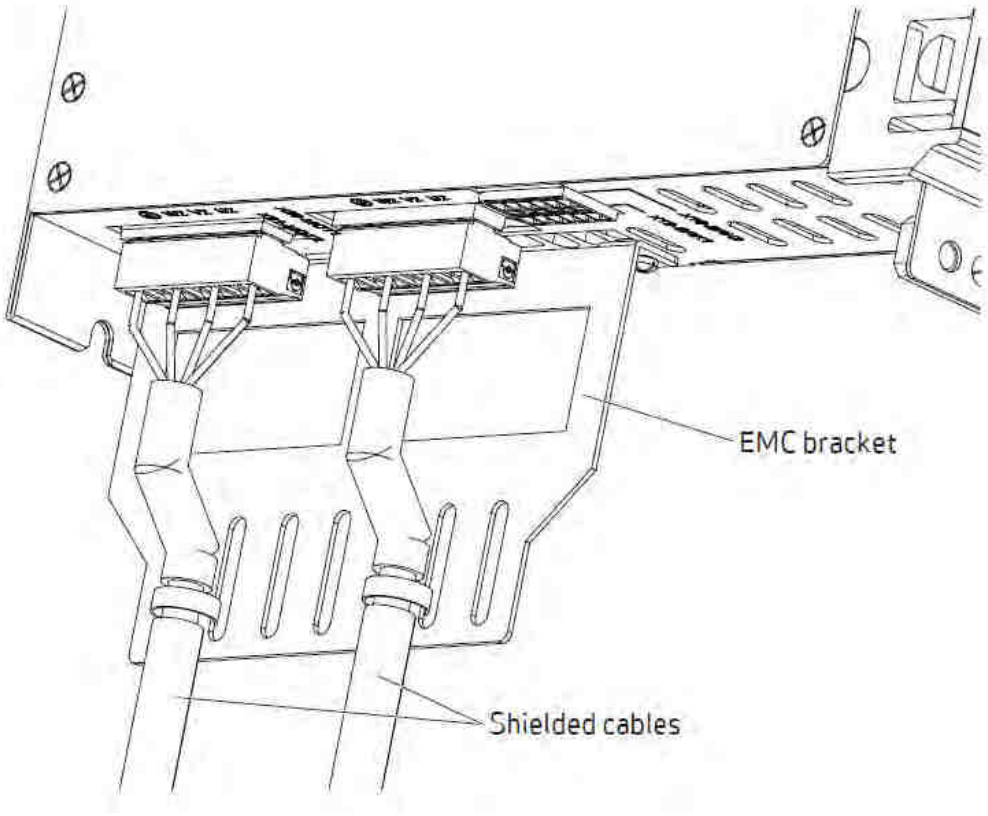
- EMC Ground (high frequency) using unpainted areas of the metal panel, where the drives and the filters are positioned, to create an adequate electrical contact for the mitigation of high frequency noise.
- Safety Ground (PE = protective earth) according to standard EN 60204-1, to be performed with a minimum wire cross section of 10 mm^2.

Regarding the shielding, all power and control cables must be shielded except those from the mains to the EMC filter, as its separate shielding is connected to the body of the electrical panel and consequently does not require further protection.

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

Requirements for laying the connecting cables:

- Avoid crossing power cables with signal cables
- Use a shielding cover that is greater than 70%
- Avoid laying the power and signal cables side by side with each other, especially near the line filter — always maintain physical separation
- Avoid the formation of "loops" in the cables, keep the wiring as short as possible and close the common potential correctly
- Keep the power cables of the input power separate from those of the motor
- If the motor is equipped with a brake, keep the 24 V brake cables separated from the signal (feedback) cables



Connection Cables EMC Bracket

5.3.3 Thermal Rating of the Electrical Panel

For a thermal rating of the electrical panel, refer to the following table. The first column indicates the value of the maximum power that can be dissipated from the radiator, The second column indicates the value of the power dissipated by the DM2020 system under nominal operating conditions. The value of maximum power that can be dissipated from the radiator is useful to estimate the power dissipated on the internal braking resistors.

In the application, if the dissipated power (W) values in the loop are higher than the values indicated in the following table, contact Applications Engineering.

5.3.3.1 Drive Axis Power Dissipation

% 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

5.3.3.2 Power Supply Unit (PSU) Dissipation

% 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.

5.3.3.3 Thermal Dissipation of 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

If possible (i.e., permitted by the safety regulations and Risk Assessment), mount the braking resistors outside the control cabinet, suitably protected against accidental contact, to avoid having to remove the heat generated by them from the electrical panel.

5.3.4 Control Power Requirements

The control power supply must provide 24 VDC with a tolerance of +/- 10%, and "ripple" of less than 200 mV. The current consumption will depend on number and type of DM2020 drives in the system.

The maximum required current will be the sum of the currents required by all components. Refer to the following table.

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

If a dedicated power supply for the motor brake is not used, the current requirements for the control power supply must be correctly calculated. Additionally, its tolerances must comply with those required by the motor brake.

5.3.5 AC Mains Power/Ground Connection

WARNING: Electrical hazard - AVERTISSEMENT: risque électrique
High voltage may be present, which can result in death or serious injury to personnel, or damage to equipment.

➢ Follow these safety instructions.

- **It is necessary to properly ground the DM2020 system to avoid risk of injury or death to personnel.**
- **In the case of AC power supply circuits that are ungrounded or asymmetrically grounded, you must insert an isolation transformer.**

5.3.5.1 Types of Earthing (Grounding) Systems

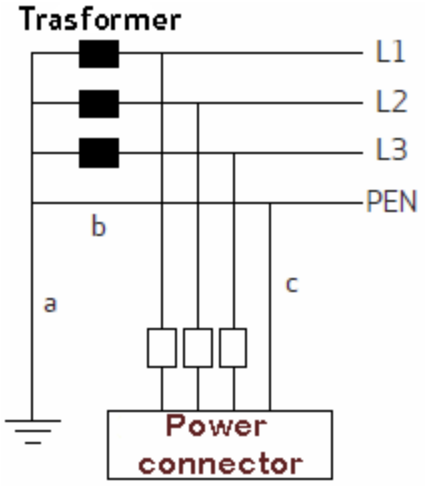
TN-C system

The TN-C earthing system, shown in the following figure, is common to many industrial facilities and has the following characteristics:

a. Direct connection to ground (ground point)

b. The neutral and grounding of the whole system are wired in a single connector, i.e., the PEN

c. Connection to ground of all parts exposed to contact and all shields



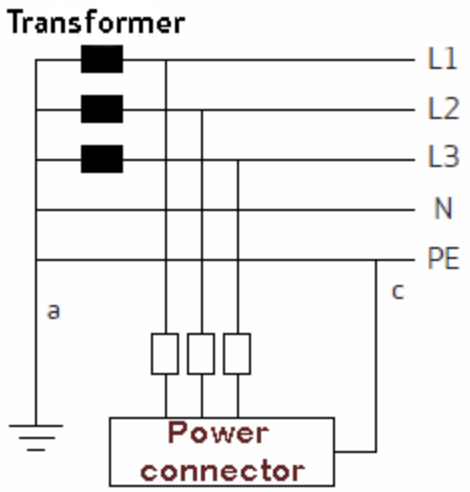
TN-S system

The TN-S earthing system, shown in the following figure, is the most widespread in Europe and has the following characteristics:

a. Direct connection to ground (ground point)

b. NA

c. Connection to the ground of all parts exposed to contact and all shields



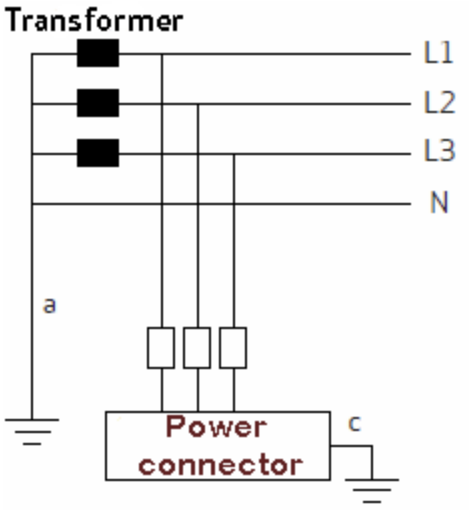
TT system

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

a. Direct connection to ground (ground point)

b. NA

c. Connection to the ground of all parts exposed to contact and all shields



5.3.5.2 Protection Components

Fuses

It is recommended to implement protection against short circuit in the final application using external semiconductor type fuses, 660 VAC, 200 kA M.A.H., or other with the same characteristics.

The sizing of the mains fuses can be achieved using the next size larger than the DM2020 system current.

To use a single protection with three fuses on the input line to a system consisting of several DM2020, the size required will be the one that is the next size larger than the sum of the currents of the individual systems.

Safety switches for fault currents

According to the EN 60204-1 standard for electrical equipment of machinery, a safety switch for fault currents can be used provided it meets all applicable regulations and provisions. To protect against direct accidental contact, a fault currents (leakage) safety switch with 30 mA sensitivity needs to be installed on each power supply system/modules-axis.

5.3.5.3 Ground Connection

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

- EMC Ground (high frequency) using unpainted areas of the metal panel, where the drives and the filters are positioned, to create an adequate electrical contact for the mitigation of high frequency noise.
- Safety Ground (PE = protective earth) according to standard EN 60204-1, to be performed with a minimum wire cross section of 10 mm^2.

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

5.3.6 Drive Wiring

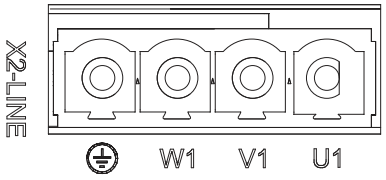
The steps for wiring the DM2020 drive are as follows:

5.3.6.1 Grounding

Mount the DM2020 drive to the control cabinet's metal structure, ensuring that the contact surface is adequate and that the connection is at low resistance and inductance. Do not mount the DM2020 drive on painted or insulated surfaces.

5.3.6.2 Power Cord and Braking resistor Connection

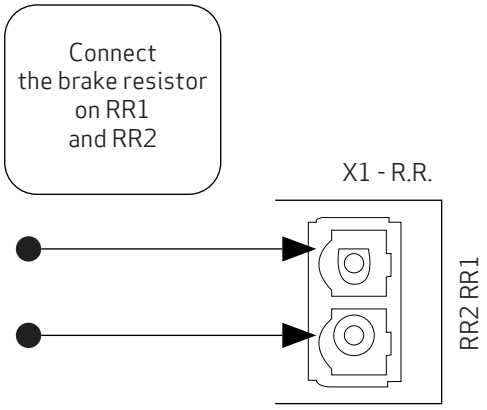
For the power cord selection information, see the Cables section.



Connector X2

Braking Resistor Connection

The following figures show the braking resistor connection points. Use a shielded cable for the connection, with shielding closed on the drive side.



5.3.6.3 BUSBAR connection

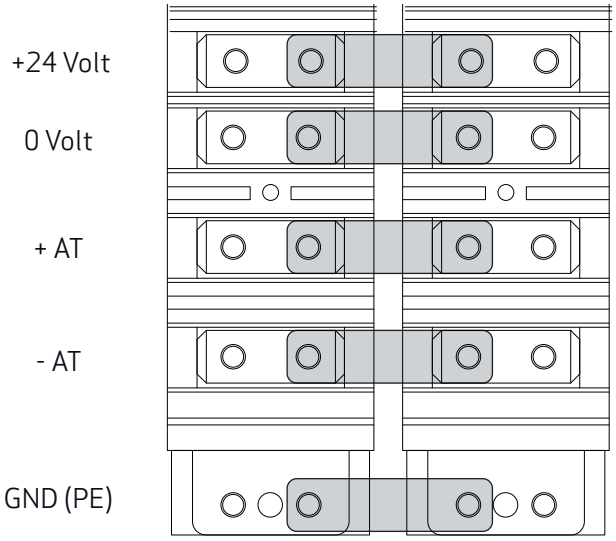
The +DC bus and -DC bus terminals of the power supply and axis modules must be connected in parallel. In this way, the power from the power supply and power from regeneration are divided between all axis modules. Only the BUSBARs provided with the drive must be used for connections.

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

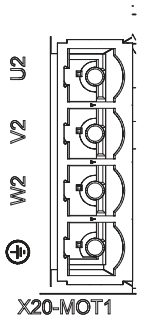
L'utilisateur est responsable de la protection physique des BUSBAR et autres dispositifs de sécurité destinés à prévenir les dommages aux personnes: A cet effet, le capot avant ou le deux couvercles latéraux fournis doivent être utilisés (sur les deux modules de chaque côté)



Connecting the power (+/- AT) and auxiliary voltage via BUSBAR

5.3.6.4. 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”.



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

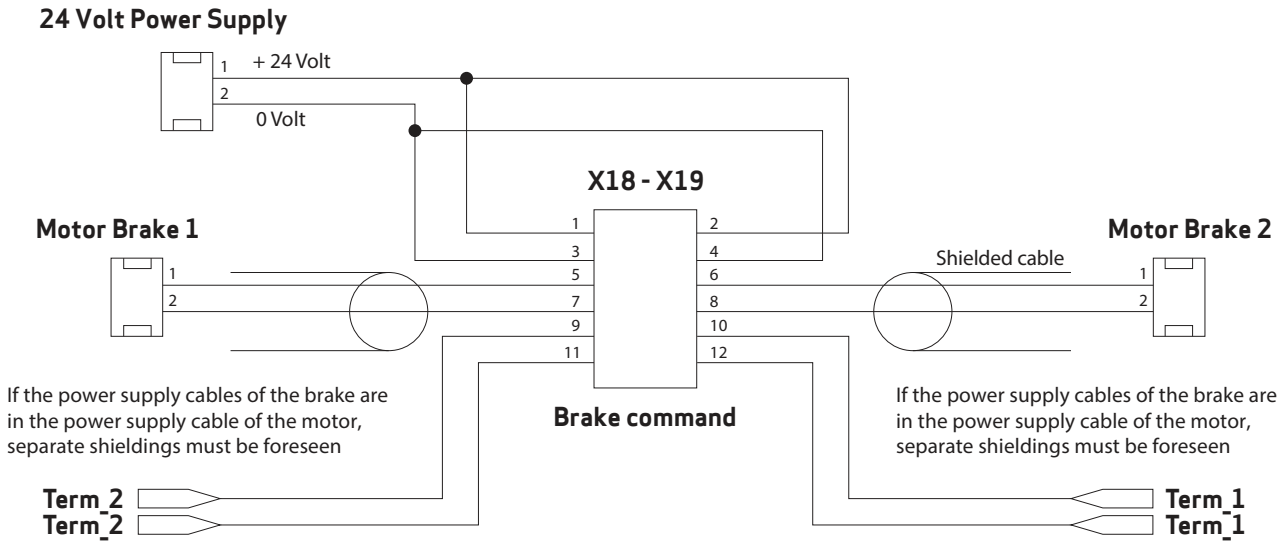
5.3.6.5 Signal Connection

For more details on signal connectors X5, X15, X6, X16, see *Layout of connectors and other interfaces on the axis module* section

5.3.6.6 Motor Cable Connection Details

The following figures show the motor cable connection points. For the motor cable specifications, see *Cables* section.

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



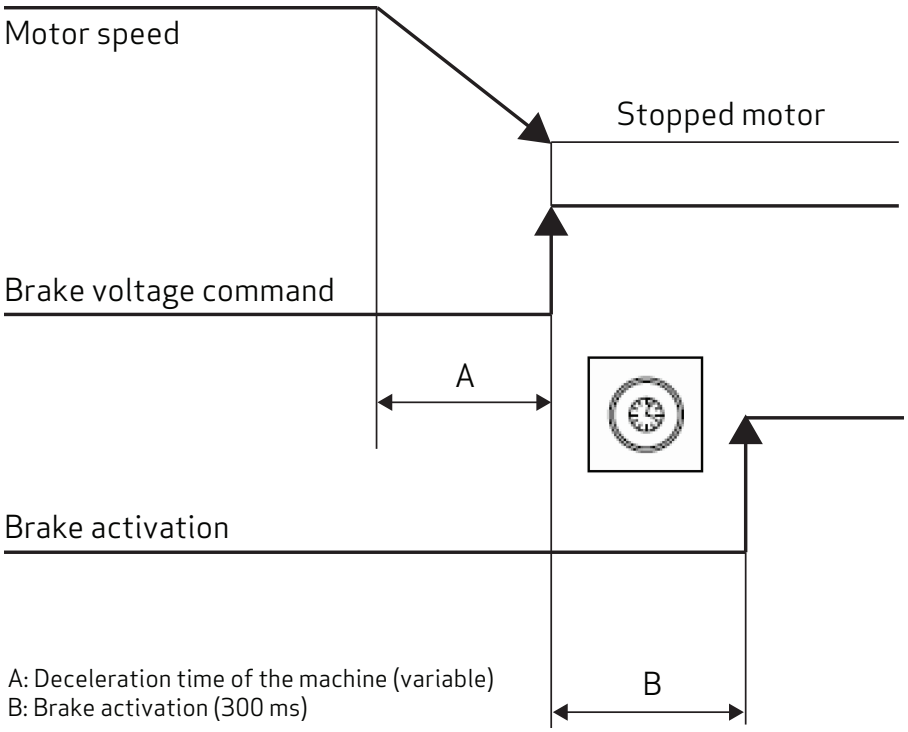
- Power must be supplied externally (on pins 1 and 2 with a 24 Volt connection, and on pins 3 and 4 with a 0 Volt return).
- Overload protection is provided with a delayed fuse (maximum 4 A), to protect both internal devices and the power supply, to be installed externally on the 24 V line if not otherwise 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.

5.3.6.7 Brake Cable Connection



Brake Activation Timing Diagram

The same considerations relating to the motor cable also applies. Therefore, pay special attention to the use of shielding, even if the conductors are not already incorporated in the motor cable.

WARNING: Mechanical hazard - AVERTISSEMENT: risque mécanique
Relying on the motor brake alone does not guarantee the safety of personnel or equipment, and may result in death or serious injury to personnel or damage to equipment.

- It is the responsibility of the machine manufacturer to specify an appropriate braking mechanism for the application to ensure safe operation.
- In particular, vertical loads require an additional mechanical brake to operate in a certifiably safe manner.

The brake cannot be autonomously monitored if there is an insufficient voltage level. Consequently, it is necessary to measure the voltage on the input of the brake, and always verify the functionality when releasing and braking. In particular, examine connections with long cables or cables with reduced cross section, which are subject to significant voltage drops.

5.3.6.8 I/O Signal Connection

Connectors X5, X15, X6, X16

CAUTION
Analogue inputs are referred to 0 Volt analogue earth on pin 16; the 0 Volt digital 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 (X6-X16):

- These are two programmable differential inputs for nominal analogue values. As the potential reference, connect pin 16 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
- Sampling rate: 32.5 usec
- Resolution: 12 bit

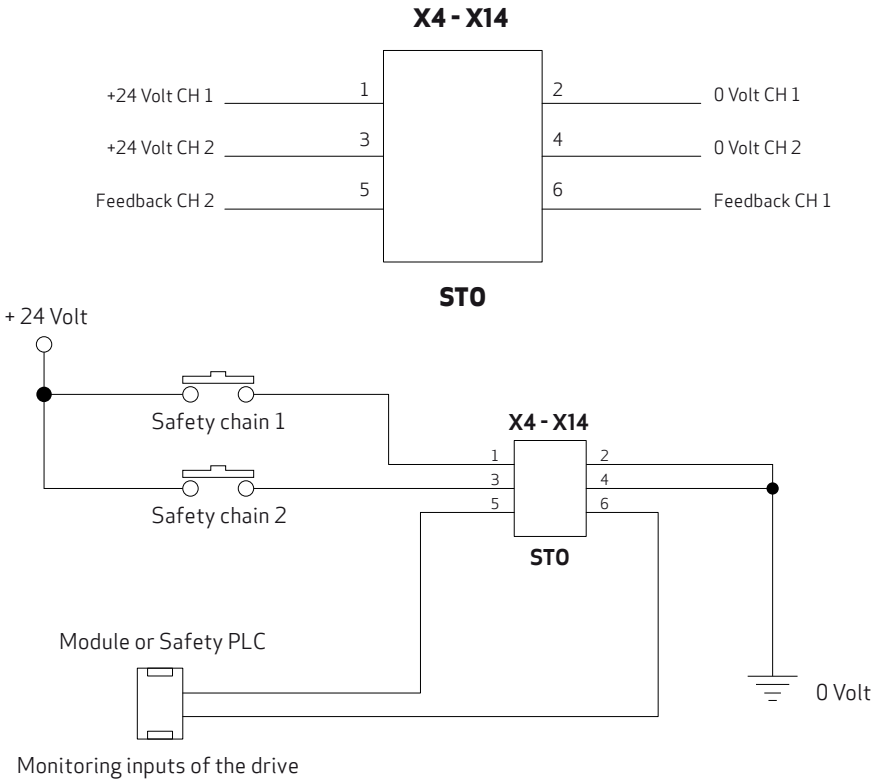
Notes on digital inputs (X6-X16):

- The programmable digital inputs on X6, DIG_INP 1 and 2, are also suitable for "latch" functions or for the quick feedback ("capture") of specific positions or events

Notes on digital inputs (X5-X15):

- The possible functions linked to the 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

5.3.6.9 STO signals connection



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.

By inserting the two commands in series to the circuit of the STO "safeties", the axis enable is controlled only when the master (e.g., PLC) controls both the S1 and S2 signals, and all the safeties of the machine are simultaneously closed.

CAUTION: Mechanical hazard.
Note that the opening of a "safety" contact may cause an axis to drop uncontrollably. which could cause damage to equipment.

- In situations where this behavior is not compatible with the machine movements (for example with interpolated axes or ones that interfere mechanically), it is recommended to use appropriate delayed safety contacts to release the axis only after full stopping of the movement in a position that will not cause any damage to the machine.

The dual channel consists of two separate, independent circuits; each control line is independent but acts on devices connected in series with each other. Both commands must be properly provided to enable motor movements.

5.3.6.10 Transducer 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

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

WARNING: Electrical hazard - AVERTISSEMENT: risque électrique
High voltage may be present, which can result in death or serious injury to personnel, or damage to equipment.

- If the connection cables of the STO function are located beyond the area of the machine installation, the cables must be installed in a "fixed" manner and protected (for example through a raceway).

5.3.6.11 Connecting the Fieldbus - X8, X9, X10 Connectors

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.

- CAN connection
  The X10 connector may be used with the CAN interface.
  A cable with a 120 ohm resistor at each end must be used for the connection. The cable length that may be used to guarantee safe communication decreases as transmission speed increases. Refer to the following table: FOR LENGTHS OF OVER 100 meters, contact the assistance service in order to verify the relationship between length/speed.

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

6 Commissioning with Dx2020 Software

6.1 Safety

WARNING: Electrical hazard - AVERTISSEMENT: risque électrique
High voltage may be present, which can result in death or serious injury to personnel, or damage to equipment.

- Follow these safety instructions.

WARNING: Mechanical hazard - AVERTISSEMENT: risque mécanique
Large motors can generate very high torque and impact or trapping hazards, which can result in death or serious injury to personnel, or damage to equipment.

- Follow these safety instructions.

Before attempting to commission the DM2020 system, you must review the Safety and Usage Guidelines. In addition, be aware that:

- Only qualified, properly trained and certified personnel are authorized to set the parameters of a running drive.
- Changing parameters without prior verification may result in unexpected, unsafe and/or incorrect machine movements.
- Before operating the drive, verify that the settings of all parameters are correct.

6.2 Dx2020 GUI

6.2.1 Overview

A graphic interface software called Dx2020 GUI is associated with each drive. It provides controls for setting and changing the parameters, and configuring the drives.

The main features are:

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

The installer/programmer should have "Power User" or "Admin" access rights to the OS. This is necessary, because of a limitation related to the writing access permits of the file.

6.2.2 Minimum PC Requirements

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

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

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

Supported OS:

- Windows 8
- Windows 8.1
- Windows 10

	Windows 8 and Windows 8.1, already have pre-installed the .NET Framework 4.5 libraries that are an update of the 4.0 ones.

	You must have administrative rights to install and run the program.

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

6.2.3 Dx2020 GUI Installation

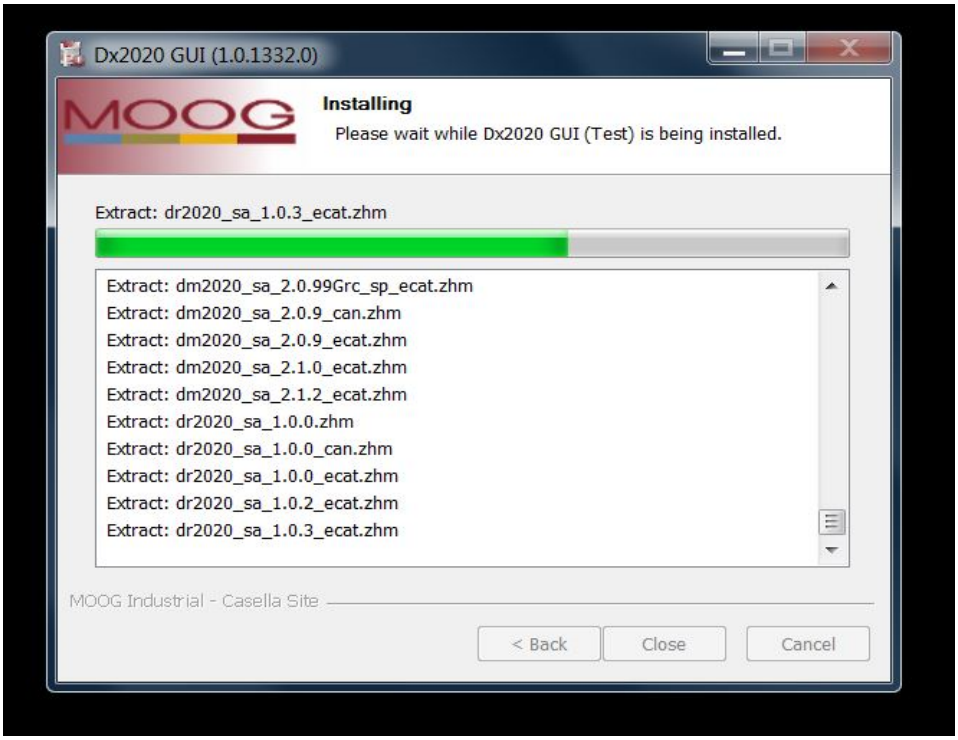
After downloading the installer, start by double clicking it. ,

The installation software may be obtained from Moog Casella.

If the software is installed for the first time on the PC, you are prompted for the desired language. By default, if available, the program will automatically select the operating system language as the first choice. This setting applies to both the Installer and for the application Dx2020 GUI. Available languages are English and Italian.

Note that you can also change the language through the GUI at a later time.

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

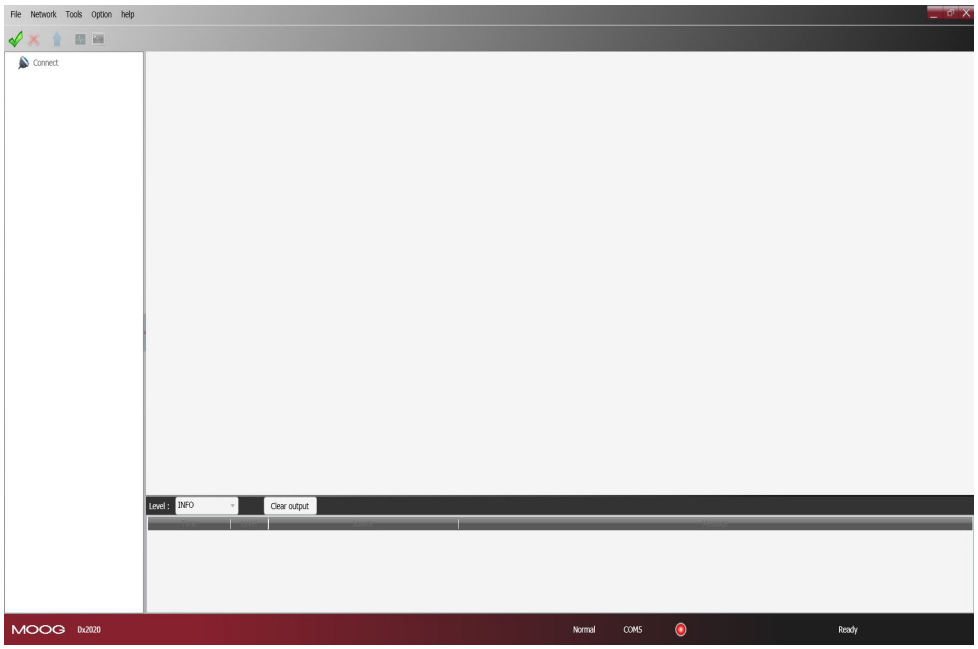


After installation, click Finish to close the installer.

If an error occurs during installation, report the error message to Applications Engineering. Once the program is installed, the Dx2020 GUI icon will be displayed on the desktop.

6.2.4 GUI Drive Connection

Run the executable Dx2020 GUI with the DM2020 system powered up.



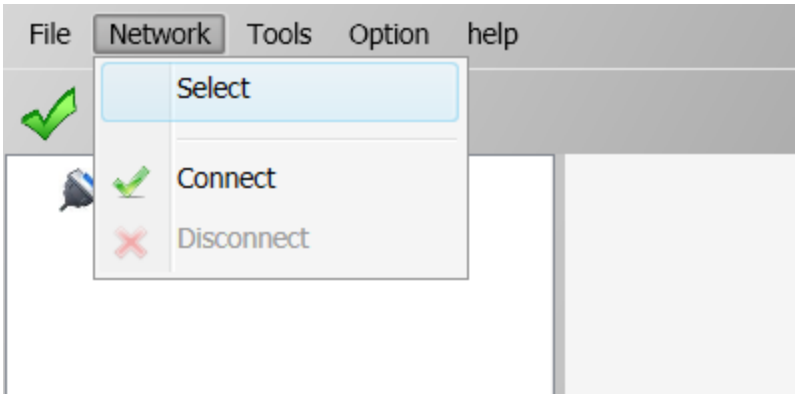
The GUI can connect to the drive through:

- Serial RS-422/RS-232 or USB (connector X3); the GUI automatically detects whether it is used on RS-422 or RS-232.
- EtherCAT* (X9-IN)
- CAN bus* (connector X7-IN)

  *The EtherCAT and CAN bus interfaces are optional.

For details on connectors see the Connectors section.

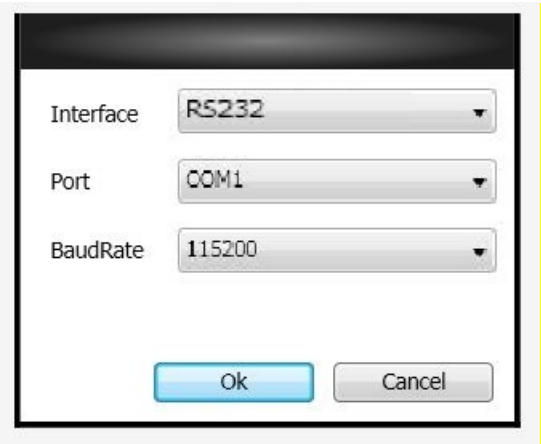
From the Network menu, click Select to choose the communication protocol.

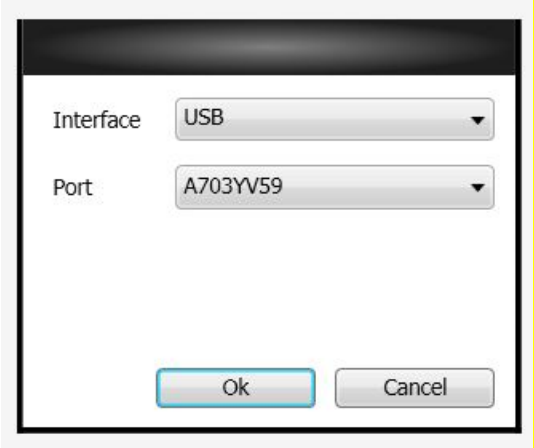


For more details, see *Accessing the Dx2020 GUI help on-line*.

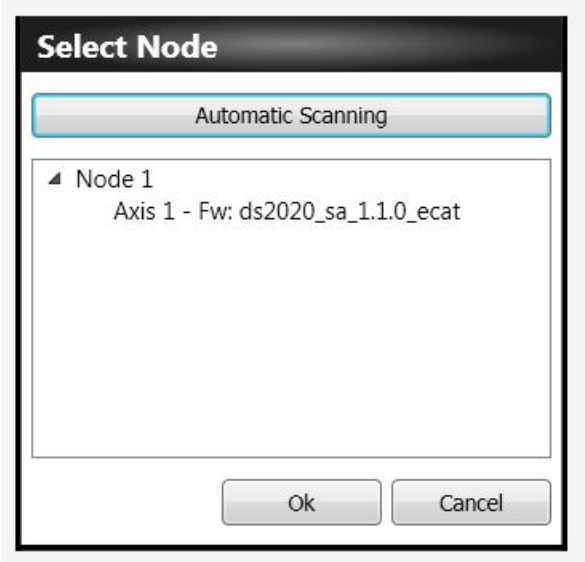
Select the Connect command from the toolbar or through the drop-down menu Network. The LED in the Statusbar turns green if the connection is successful; otherwise, it is red. Depending on the type of connection:

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

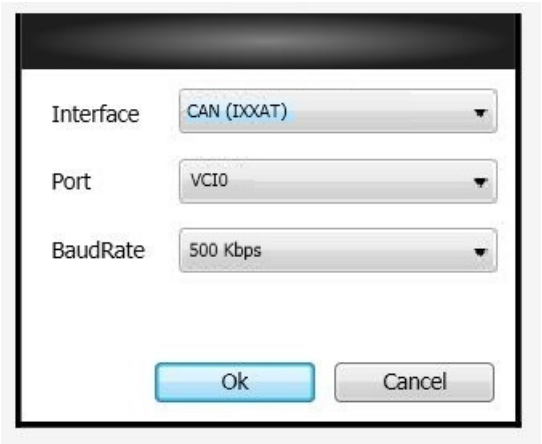




- **EtherCAT:** Click Auto Scan to detect available nodes. Then click OK. The GUI connects and uploads the parameters of all nodes.



- **CAN Bus:** from the connection selection window, choose the Port and Baud Rate. Then click OK.

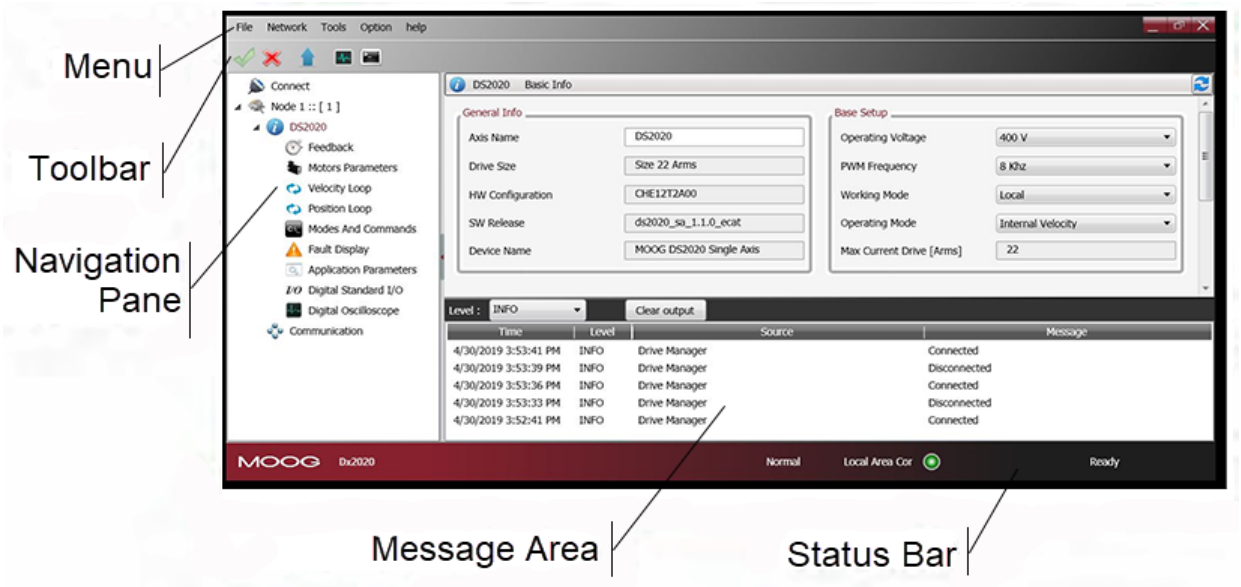


In the Select Node window, confirm the Node and ID values, then click OK

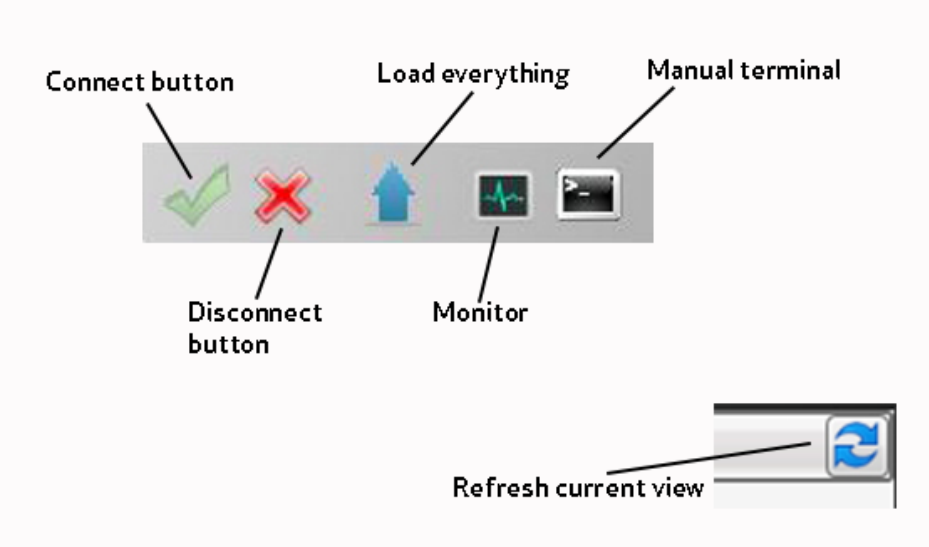
	In case of failure during connection, refer to the Troubleshooting section and follow the suggested actions.

6.2.5 Layout

After connecting, the following screen opens:

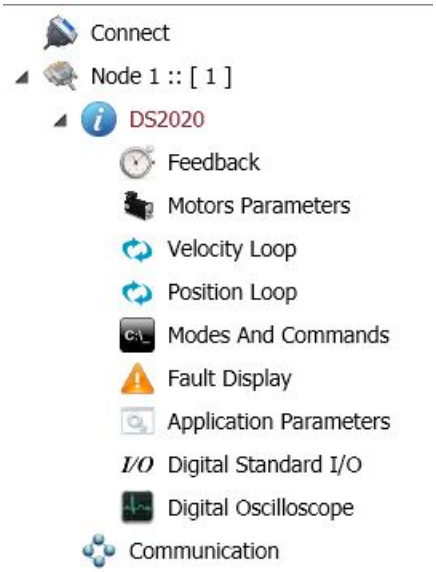


- **Menu:** Contains the following menus: File, Network, Tools, Options, ? For more information, refer to the Dx2020 GUI help on-line.
- **Toolbar:**



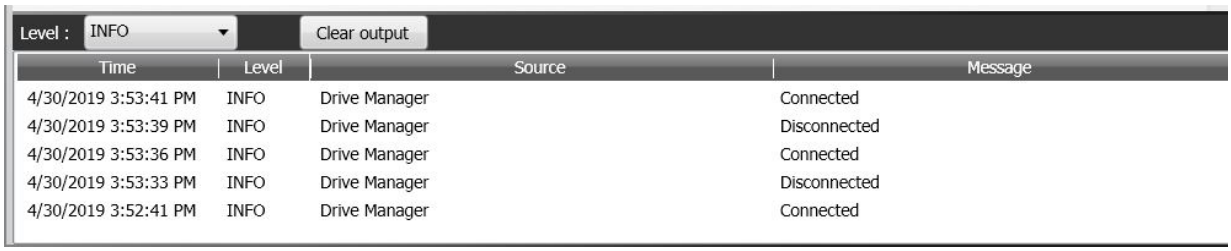
- **Navigation area:** This area provides access to all information organized into views. The axis has a submenu that lists the parameters by function (transducer, motor, speed loop, etc.) Clicking submenus in the main area displays the associated graphic window.

- **Communication parameters:** The last menu item is related to the EtherCAT or CAN communication parameters.



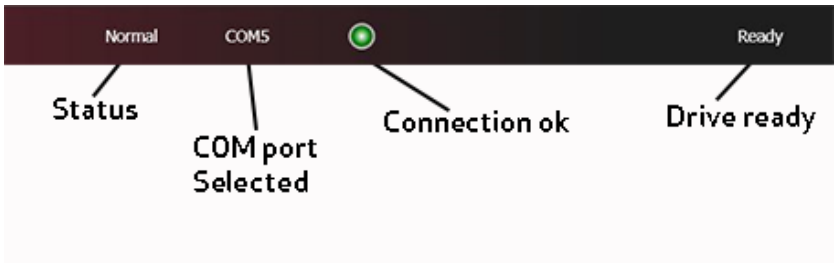
- **Main area:** This area displays the information and the parameters associated with the selected view in the navigation area. This window is used to view and set the DM2020 drive parameters. For more information, refer to the Dx2020 GUI help on-line.

- **Notification window:** This area is dedicated to display messages that may have different meanings. A filter can be applied to display messages based on the type (ERROR, WARNING, INFO, DEBUG).



ERROR	Messages indicating an error sent by the device or related to the connection (e.g. transmission errors)
WARNING	Messages usually caused by an error when accessing parameters (eg "object not found") and require your attention
INFO	Messages relating to the data exchange between the device and the application and showing the progress of the operations
DEBUG	Messages with program control information

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



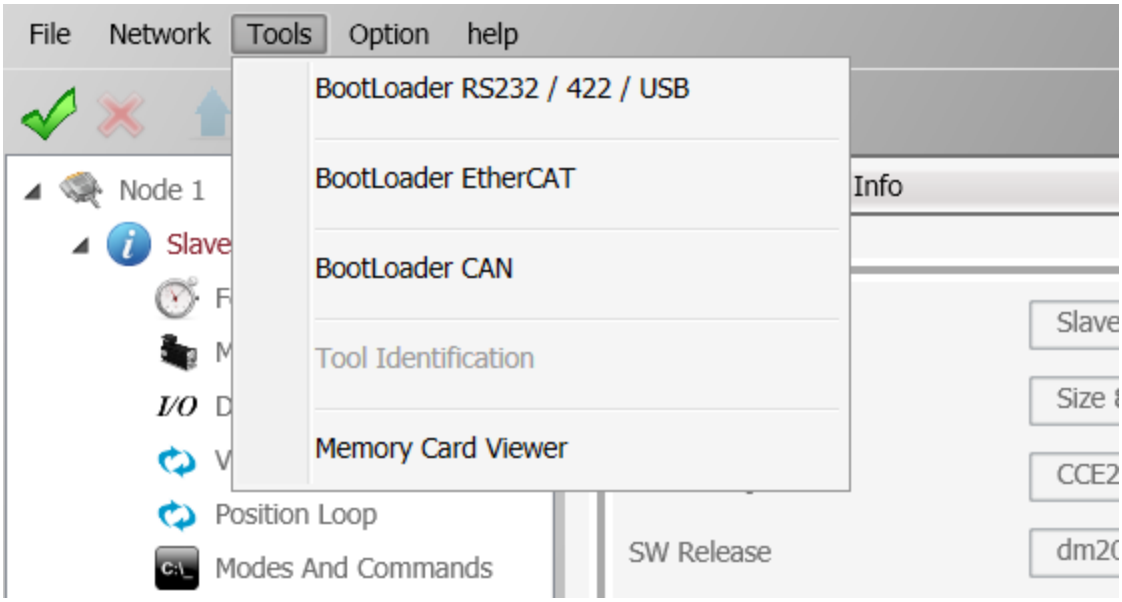
6.2.6 Firmware Update (BootLoader)

The firmware update can take place through serial RS-422, USB or EtherCAT. The download file extension is *.zhm.

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

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

You can access the BootLoader tools from the PC, as a normal program from your Program menu or folder, or directly from the GUI using the Tools menu:

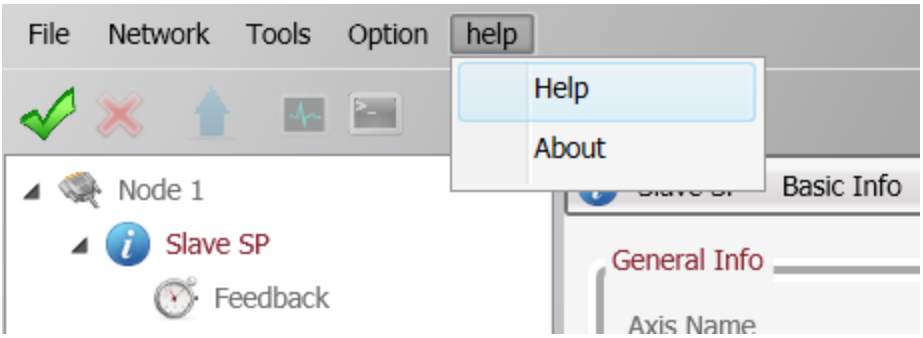


For more information, refer to the Dx2020 GUI help on-line.

6.2.7 Accessing the Dx2020 GUI help on-line

The Dx2020 GUI help on-line can be accessed as follows:

- Use Interface Dx2020 GUI: from the Menu bar, select "?" (Help)



6.3 Activate Power

Activate power to the system (AC power and DC power supplies). For installation information, see Electrical Installation and Thermal Rating.

Use the monitor function on the GUI to verify the correct value of the DC bus voltage (560 V).

6.4 System Configuration

The following steps are used for the DM2020 system configuration:

- Axis Identification
- Motor Parameter Configuration
- Transducer Configuration
- I/O Configuration
- Control Loops Configuration
- Fault Configuration
- Application Parameters Configuration
- Commands and Modes Configuration
- Activate Power
- STO Activation
- Drive (Axis) Enable and Limit Switch Enable/Disable

6.4.1 Axis Identification

Follow the instructions in the Dx2020 GUI help on-line related to the specific modes of communication and identification.

For multiple axis DM2020 systems that are simultaneously connected, there must be a correspondence between the nodes listed in the "Navigation Area" of the GUI and the physically installed DM2020 drives in the application.

6.4.2 Motor Parameter Configuration

The DM2020 drive can be used to control:

- Synchronous motors with permanent magnets (brushless)
- Asynchronous motors with IFOC control
- Asynchronous motors with V/F control

There is a motor database, which can be accessed by clicking View Motors database. The database is editable, allowing addition of more motor models. The file DBMotors.xml is present in the Version installation folder of the GUI.

If the phasing angle is not known in advance, after entering all other motor parameters, perform the Autophasing procedure.

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

If the drive is connected while the motor is hot, the thermal image provided by the Dx2020 GUI will return a false estimate. This protection supports but doesn't completely replace the thermal switch in the motor.

In the case of permanent magnet synchronous motor, you can activate the Field Weakening algorithm, refer to the following information.

Field Weakening Algorithm

This algorithm is available as a "torque increase function" at high speed, allowing increased torque available above the nominal speed. Obviously, this takes place at the expense of a greater output current and, consequently, lower yield of the system.

To enable this feature click the "Enable field weakening". By enabling the "weakening", you can automatically take advantage of this feature without having to set any parameters. It will prompt you to select the type of algorithm to use depending on the type of application required; contact Applications Engineering for assistance.

Brake configuration

In the case of an application with motor control that includes a parking brake on board, through the "Motor parameters" screen, select the Brake window view sub-menu, in this way an additional drop-down window will appear relating to the brake control configuration.
The available modes are listed below:

Brake not present
Brake circuit not available

Auto FSM
Activation / deactivation of the motor parking brake in automatic mode in relation to the execution of the transitions of the Cia 402 state machine
It is possible to insert a delay in the activation and deactivation of the circuit

Total Control Word Brake
Brake circuit with control with complete dependence on specific commands received from the DM2020 drive and from the master PLC

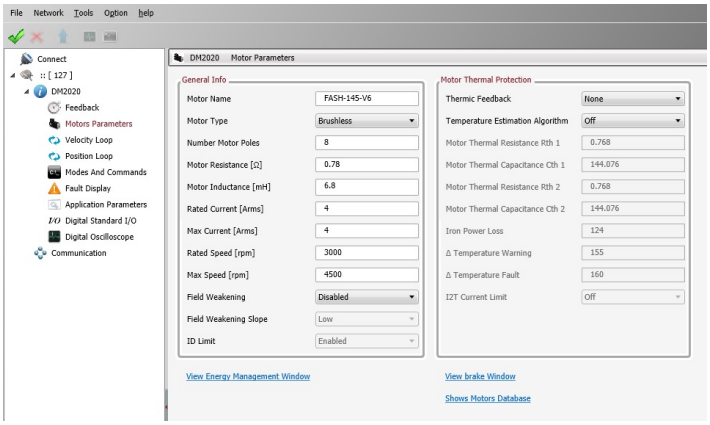
Semi-automatic Control Word Brake
Special brake circuit with control in combination of commands received from the communication channel with the PLC and integration / limitations depending on the operation of the machine.

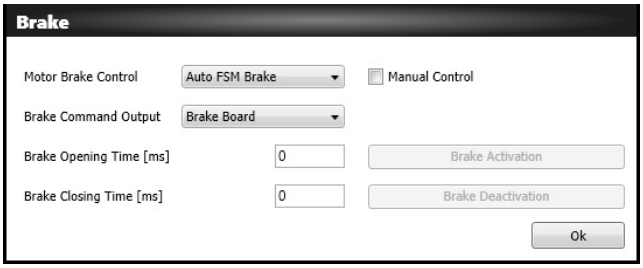
Manual control
By checking the box on the right, the brake circuit control can be further configured and fine tuned

For example:
In the case of **Auto FSM** mode, it is possible to manually control from the GUI by clicking on the two activation and deactivation buttons in the same window.
In **Total Control Word Brake** mode, it is possible to activate / deactivate according to two specific parameters available within the communication system with PLC
The brake control function has two modes of actuation

Brake board
The parking brake is connected, controlled and powered by the brake circuit board inside the DM2020 drive module.

Channel 1 and Channel 2 digital output
The control signals of the motor holding brake module are generated by a channel that is part of the digital output circuit.
The motor brake circuit is not directly connected to the DM2020 product; the power supply of the brake module is performed by a circuit external to the DM2020 system, appropriately sized and suitable for delivering the electrical performance required by the brake itself.





6.4.3 Transducer Configuration

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

- Resolver (standard)
- Encoder Incremental TTL
- Encoder, Stegmann Sinusoidal Absolute Single/Multi-Turn with Hiperface communication
- Encoder, Heidenhain Sinusoidal Absolute Single/Multi-Turn with ENDAT communication
- BISS Absolute Encoder
- Sensorless mode

To configure it, follow the instructions in the Dx2020 GUI help on-line, select Dx2020 GUI › Configuration views › Feedback.

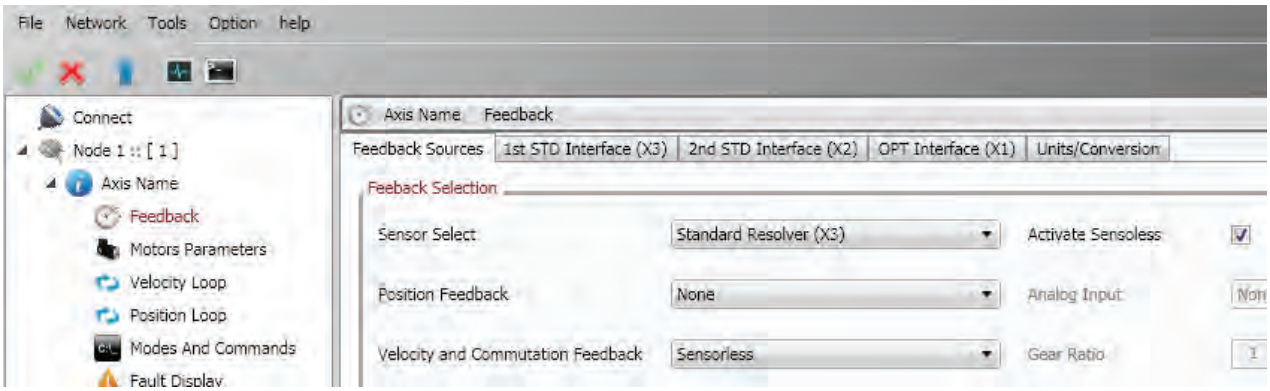
> It is necessary for some encoders to insert the Theta angle. If this is not known, perform the STO Activation procedure

6.4.3.1 Sensorless

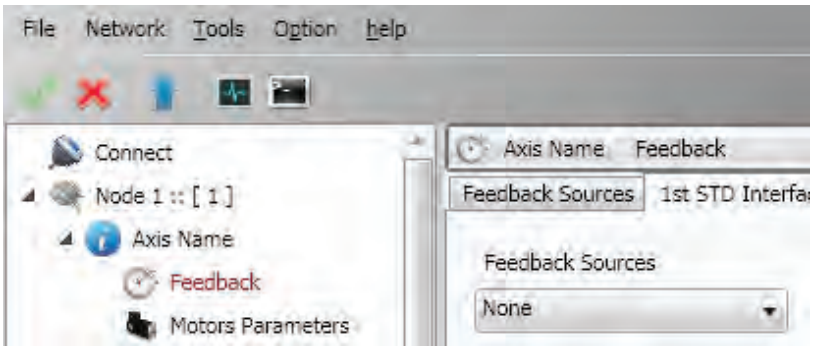
The DM2020 provides a sensorless mode, i.e., without a speed transducer.

To enable it,

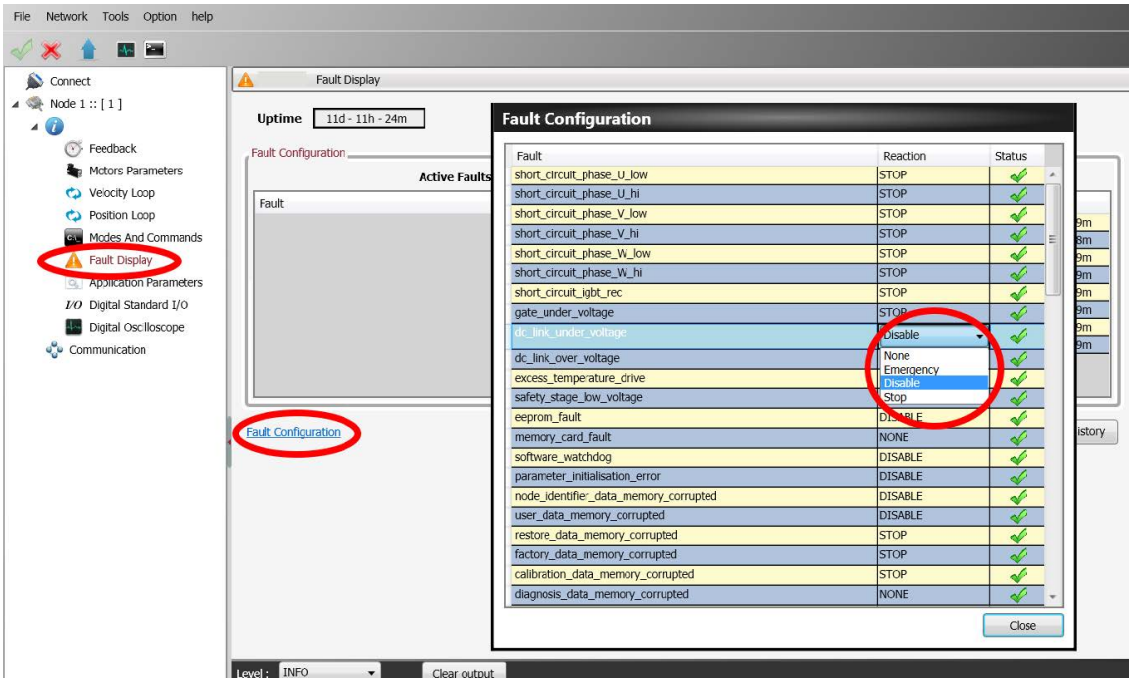
1. Select Feedback from the Navigation Area.
2. In Tab Sources feedback, set the fields as indicated in the following figure.



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

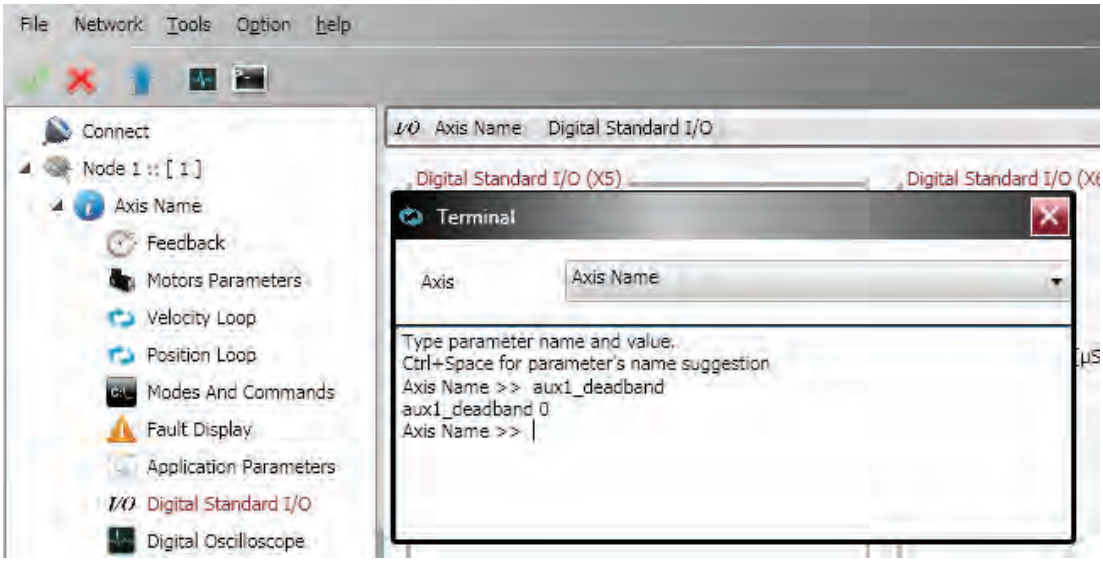


4. Finally, set the fault interface X3 - Missing Transducer Configuration to "None" as shown in the following figure.



6.4.4 I/O Configuration

INFORMATION
A "deadband" can be applied to all analogue inputs; this is a band of signal below 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.

6.4.4.1 Details of Possible Configurations

Configuration description 0

In this mode, the three channels are configured as 2 digital inputs plus the serial line RS-232.

Configuration description 1

In this mode, the three channels are configured as 1 digital output, 1 digital input, and the RS-232 serial line.

Configuration description 2

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

The amplitude of the marker on the output C is configurable as ¼ , ½ and 1 impulse.

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

Configuration description 3

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

- SYNC 0 signal has a period of 62.5 µs (16 kHz) and corresponds to the basic servo time.
- SYNC 1 signal has a period equal to that set for the EtherCAT communication network and is used to synchronize the devices on the reception of the data packet.
- SM2 signal indicates the actual time of receipt of the data packet by the device.

Configuration description 4-5-6-7

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

- Drive enable
- Reference enable
- Quick stop
- Reset alarm
- Limit switch (CCW and CW)
- Reset fault
- No reference signal
- Emergency Stop activated
- CW
- CCW
- Axis stopped

All digital outputs can be configured as follows:

- Copy of limit switch (if programmed on the digital inputs, available on J6).
- Warning motor temperature
- Warning for motor I^2T
- Warning drive temperature

6.4.4.2 Programming Analog and Digital I/O Connector

Analog Input 1 and 2

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

Analog Output 1 and 2

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

Digital Output 1

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

Digital Input

- Signal command
- Points deactivation
- Reset fault command
- Drive enable command

- Reference enable command
- Quick stop command
- DX limit switch
- SX limit switch

Each analog input can be configured with a different parameter.

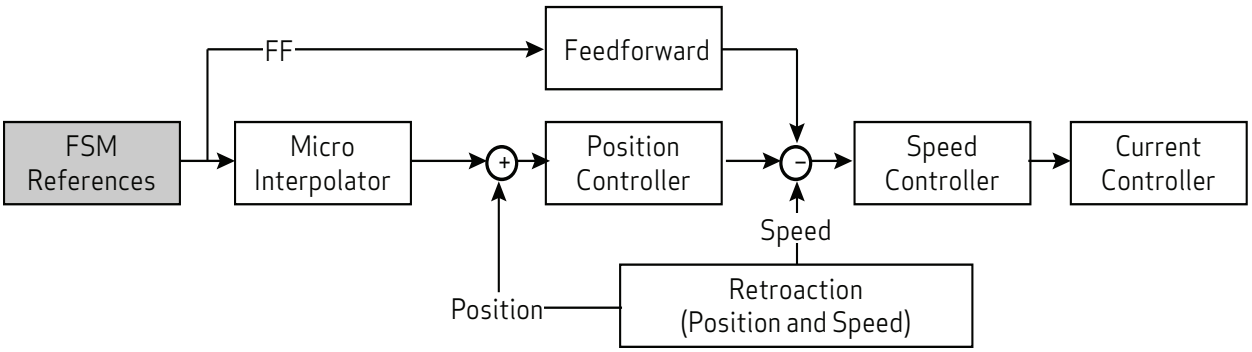
The digital outputs are active if +24 V power is supplied on the X5 connector pin 7 with ground on pin 8.

6.4.5 Control Loops Configuration

6.4.5.1 Control mode configuration

The DM2020 operates up to three control loops according to the drive operation mode: torque, speed, and position. These are nested so that torque is the inner loop, speed is intermediate loop, and position is the outermost loop. The output of each nested loop will become the reference for the next one.

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



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

Control loop settings must be adjusted by qualified personnel. Incorrect settings can adversely affect motor performance.

6.4.5.2 Torque loop parameter configuration

The torque loop is the innermost. Parameters are assigned automatically starting with the motor setup data with the menu Parameters Motor.

The user can configure the bandwidth of the closed loop of torque through the Terminal window. When setting the variable 'bandPass', the possible values are 3000 (default), 2000, 1000, 600, 400 in Hz.

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

6.4.5.3 Speed loop parameter configuration

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

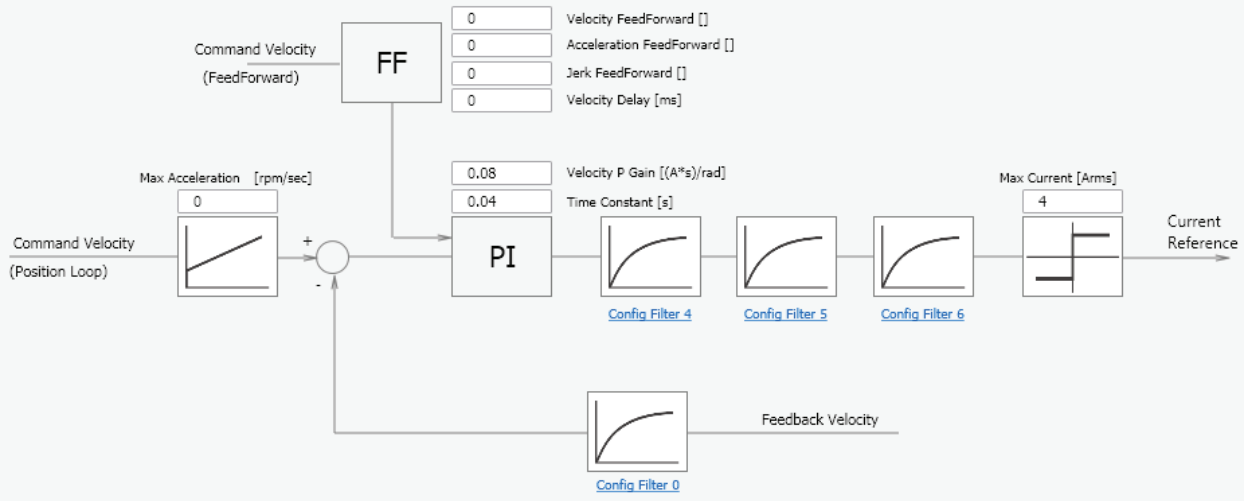
The base rate is a PI (proportional-integral) type control with the addition of a feedforward control (ff_ calc) and a Saturation Variable (SAT_VARIABLE).

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

The Feedforward block minimizes the velocity error in cases of disturbances as they occur. This contributes directly to the reference for speed processed by the PI controller, with the linear combination of the speed references, acceleration, jerk, delayed speed of n samples, calculated at the microinterpolator valley, and minimizes errors during transients.

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

To set the parameters, from the Navigation Area, select "Speed loop". This opens a window that shows the block diagram of the loop.



A standard correcting block (PI in the above image) is characterized by two parameters. It is followed by a sequence of filters, and a filter on the feedback chain. This allows the implementation of more complex control structures as well as filtering of known disturbances (Notch filter).

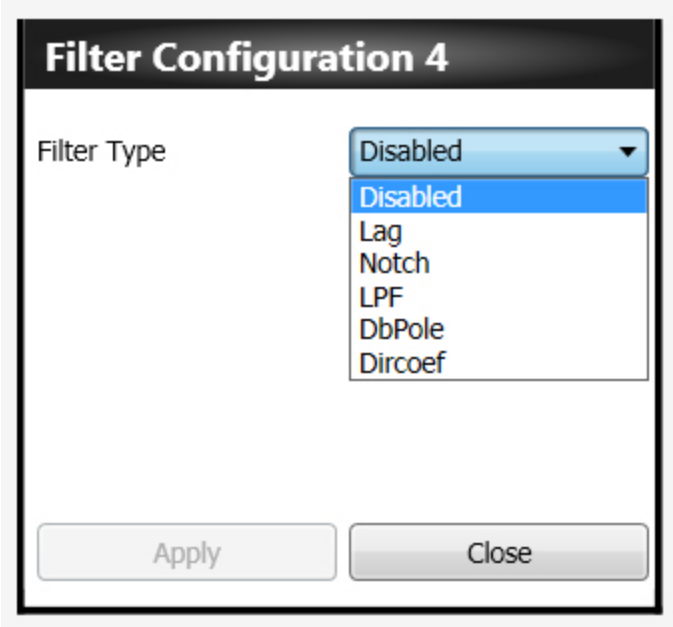
Filter configuration

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

- Lag: The filter consists of a real pole and a real zero. Put the pole and zero frequency that must be positive or null.
- Bq: It is a standard biquadratic filter, with a pair of complex conjugate zeros and a pair of complex conjugate poles. The parameters are:
    - Zero frequency
    - Zero damping
    - Pole frequency
    - Pole damping

  Frequencies must be positive or null. The damping must be between -1 and 1.
- Pole: The filter has a single real pole. The parameter specified is the frequency of the pole, which will be positive or null.
- DbPole: The filter has two complex conjugate poles. The parameters are:
    - Pole frequency
    - Pole damping

  Frequencies must be positive or null. The damping must be between -1 and 1.
- Dircoef: insert the coefficients of the numerator and denominator of the filter (rarely used)



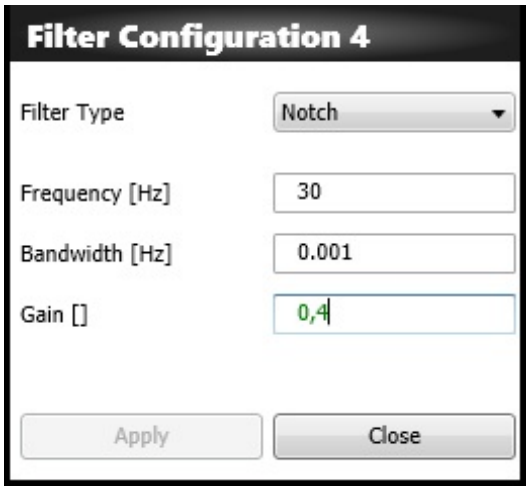
Keep the filter disabled until all the other parameters of the filter are entered.

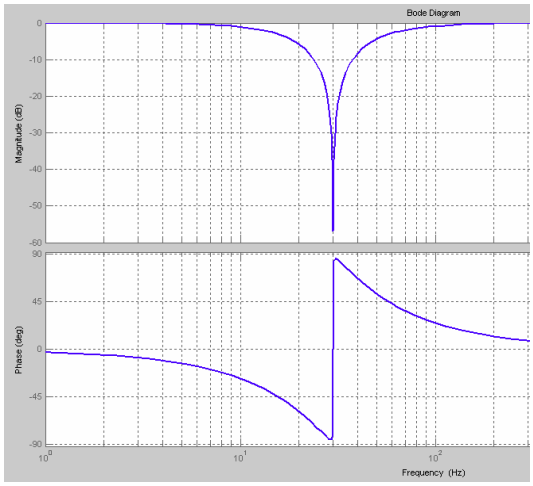
You must enter the parameters in the following order:

1. Damping
2. Frequency
3. Filter type

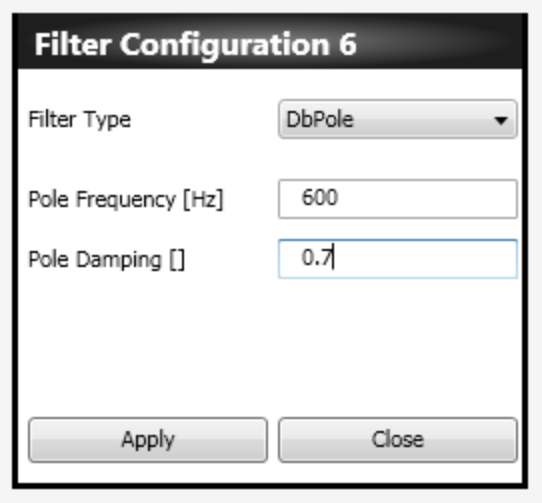
Examples of filters

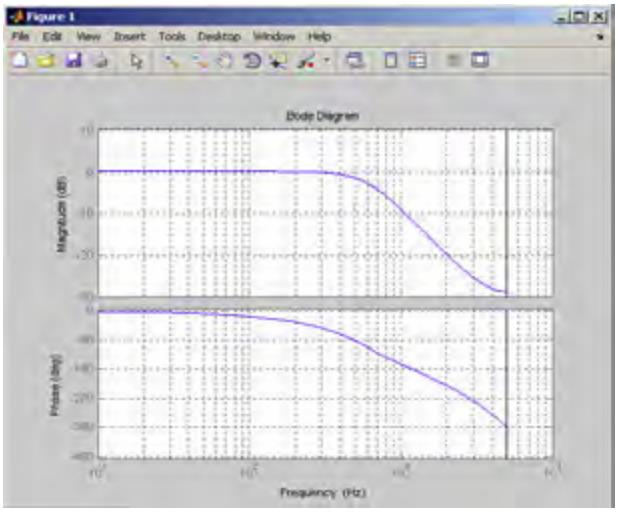
Example of a Notch filter configuration: insert a Notch filter centered at 30 Hz.





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



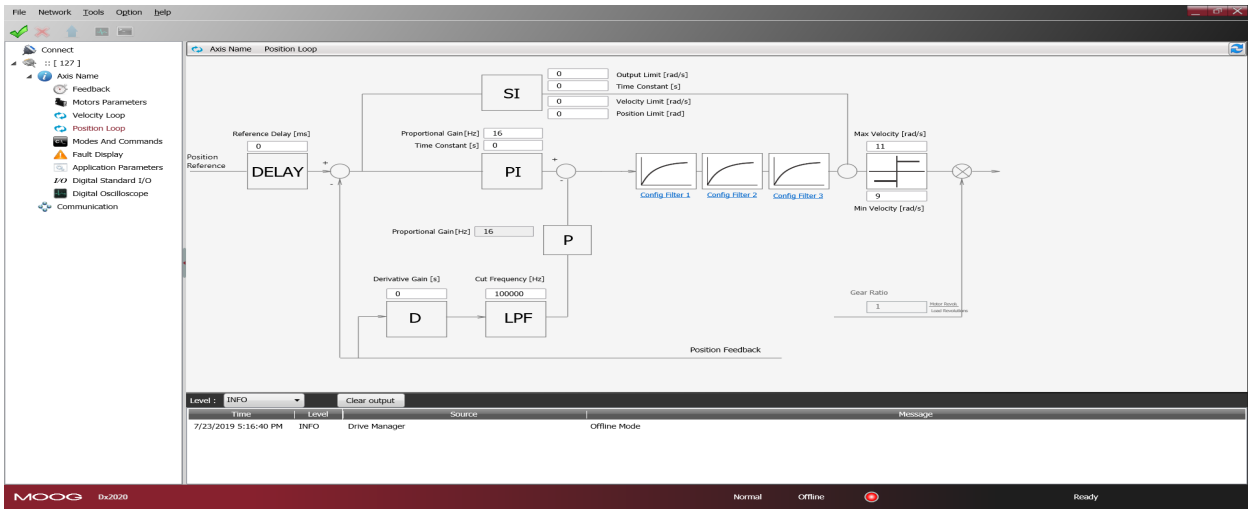


6.4.5.4 Configuration of the position loop parameters

The position control must ensure that the motor position follows, as faithfully as possible, the position reference. The response quality of the system depends on the loop parameterization. The position control is PID (proportional-integral-derivative).

- The proportional term provides an action as strong as the error is large.
- The derivative term notes if the error is increasing or decreasing the dampening behavior of the system.
- The integral term cancels the steady-state error.

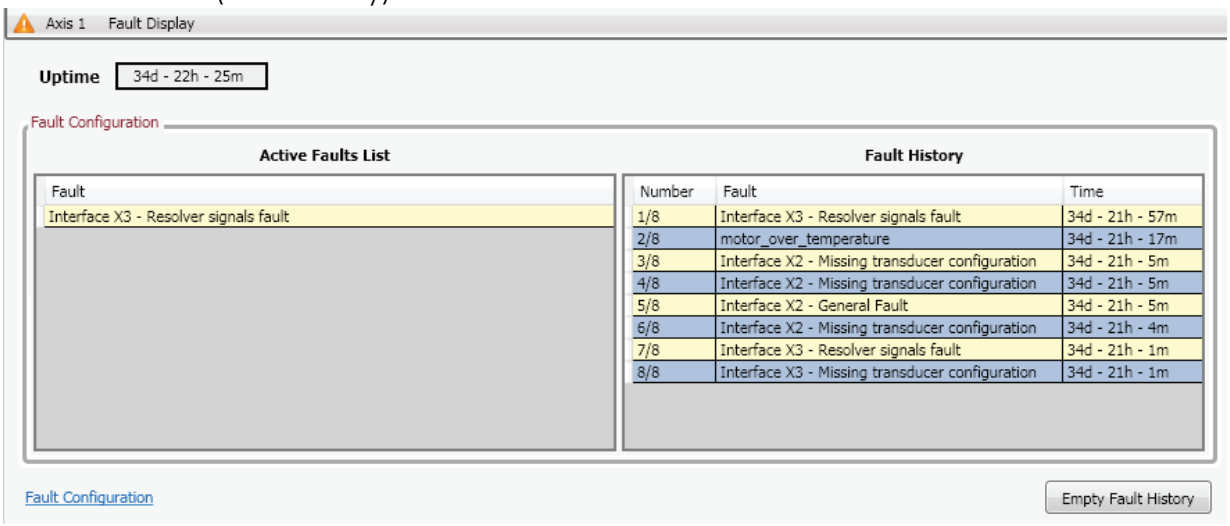
To set the parameters, from the Navigation Area select "Position loop": it will open the window showing the loop diagram in question.



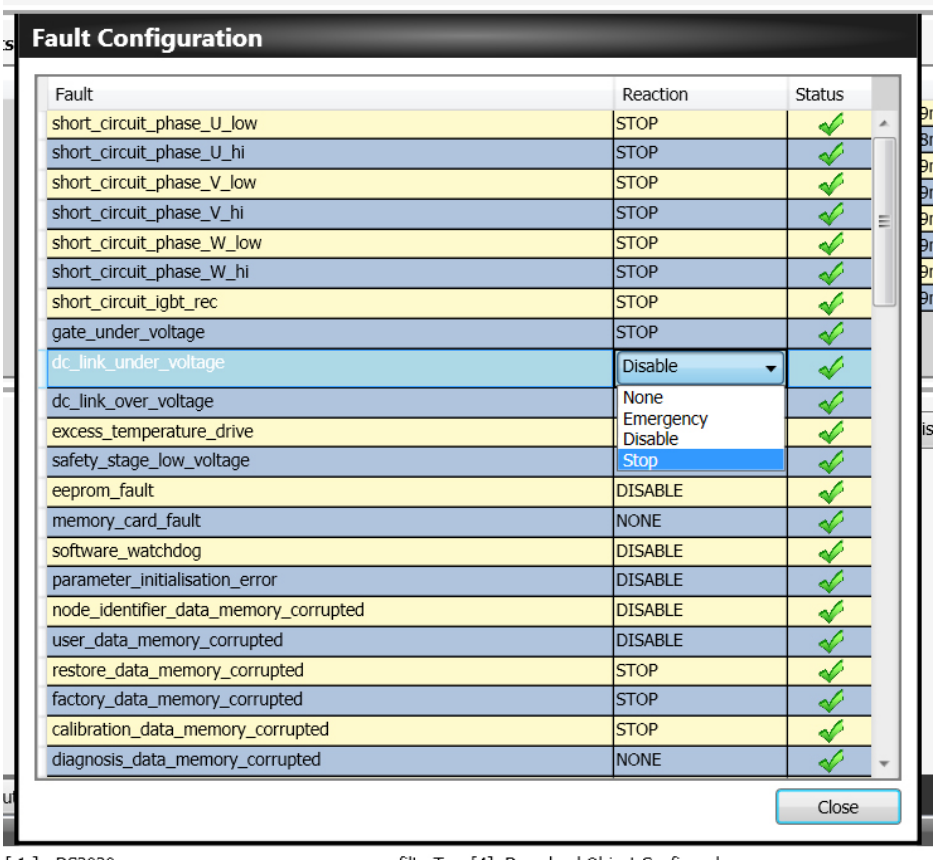
It recognizes the standard control loop (PID) characterized by four parameters. That is followed by a sequence of filters that the implementation of more complex control structures. For parameterization of the filters, see Filter configuration on page 103.

6.4.6 Fault Configuration

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



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



There are four options:

Reaction	Effect
None	The alarm is ignored **CAUTION:** For use during commissioning or troubleshooting only. Not to be used in normal working or operating conditions.
Emergency	The drive sends an emergency message but does not stop or disable.
Disable	Disables the drive and executes the stop procedure configured by the Application/Fault Response parameters.
Stop	Immediate disabling; the drive releases the motor control. If the axis was in motion, it continues to move by inertia.

For each alarm, the most appropriate response must be programmed based on the characteristics of the machine.

For some alarms, the Dx2020 GUI software prevents the selection of some reactions to ensure the integrity of the drive (for example, you cannot enable emergency braking due to "overvoltage").

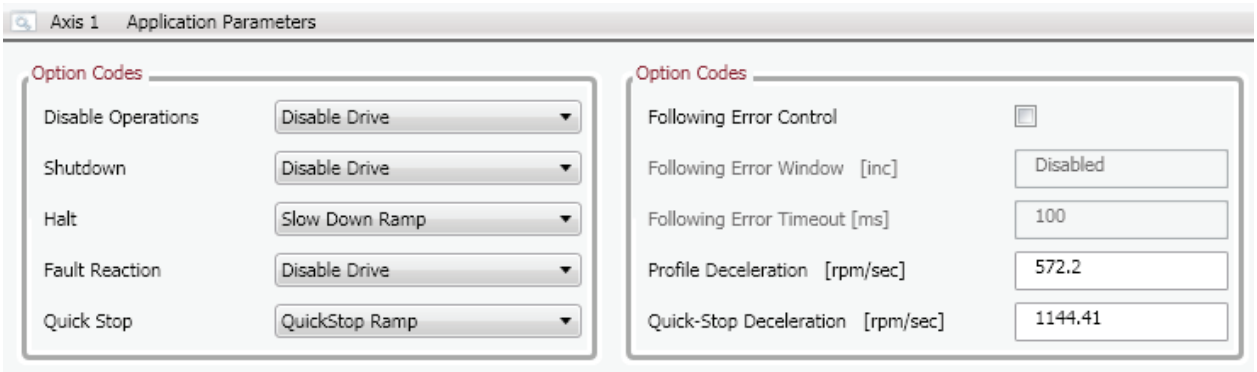
The following Fault listed are not configurable and the reaction is always 'STOP':

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

Contact Applications Engineering for further assistance.

6.4.7 Application Parameters Configuration

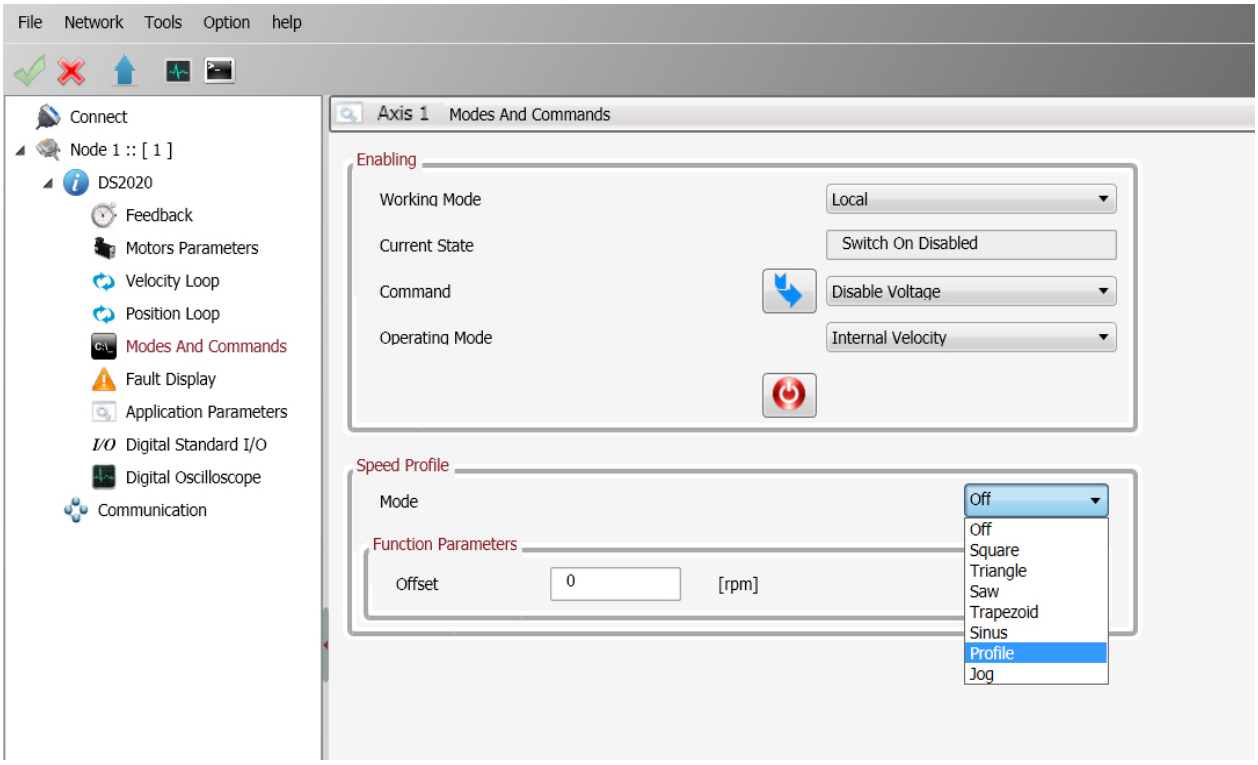
From this menu, you can configure the reaction of the drive to particular events.



Details about the events and reactions are described in the Dx2020 GUI help on-line.

6.4.8 Commands and Modes Configuration

This menu allows to set the source of commands/controls and the drive operating mode.



Operating mode

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

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

- **EtherCAT:** the drive receives the commands/setpoints remotely through the EtherCAT fieldbus (if supported by the drive)
- **CANopen:** the drive receives the commands/setpoints remotely through CAN bus (if supported by the drive)
- **Local:** the drive receives the commands/setpoints from the Dx2020 GUI
- **Analog:** the drive receives the commands/setpoints through digital and analog inputs configured (for more information see Dx2020 GUI help on-line: Dx2020 GUI > Configuration view > I/O Standard Digital)

Current status

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

Command

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

Operating mode

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

- **Analog speed:** the drive operates a speed control following a reference coming from an analog input. You can set a variable torque limit also coming from the analog input.
  (Typical operating mode: Analog)
- **Analog torque:** the drive operates a torque control following a reference coming from an analog input. You can set a variable torque limit also coming from the analog input.
  (Typical operating mode: Analog)
- **Internal speed:** the drive operates a speed control following an internally generated reference, see Function Generator
  (Typical operating mode: Local)
- **Internal torque:** the drive operates a torque control following an internally generated reference, see Function Generator
  (Typical operating mode: Local)
- **Sync Cyclic position:** the drive operates a position control following a cyclical reference generated by a device/remote control. This is the Cyclic Synchronous Position Mode defined in the DS402 standard.
  (Typical operating mode: EtherCAT/CANopen)
- **Cyclic Sync Speed**: the drive operates a speed control following a cyclical reference generated by a device/remote control. This is the Cyclic Synchronous Speed Mode defined in the DS402 standard.
  (Typical operating mode: EtherCAT/CANopen)
- **Cyclic Sync Torque:** the drive operates a torque control following a cyclical reference generated by a device/remote control. This is the Cyclic Synchronous Torque Mode defined in the DS402 standard.
  (Typical operating mode: EtherCAT/CANopen)

Additional application-specific modes are available and are not described in this document.

When the drive commands are internally generated (e.g., Operating mode = Local, Operational Mode = Internal speed) is possible to characterize different reference profiles (Square, Triangle, Sawtooth, Sin, Profile, Jog).

Function Generator

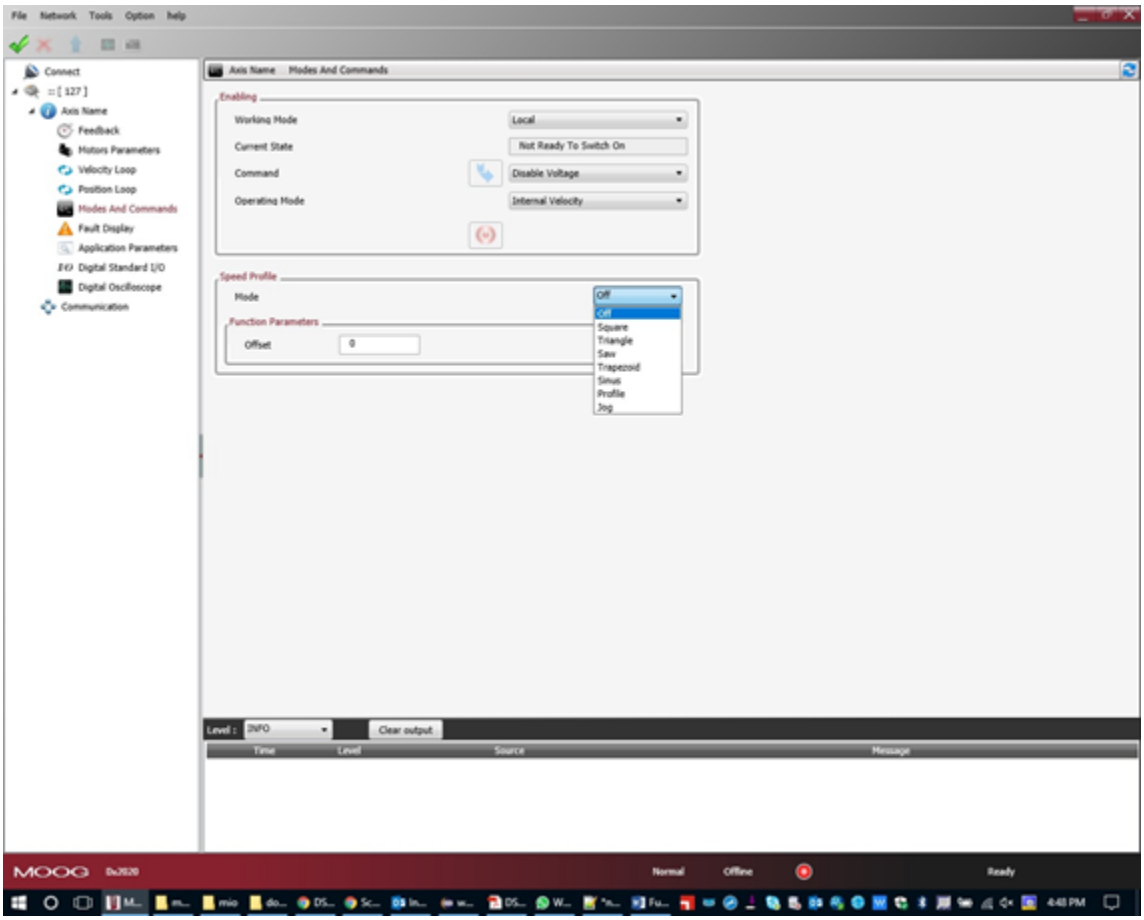
The Dx2020 GUI includes a mode called "Function Generator": this type of control mode can be used only as "Local" and requires manually setting and generating the operations required for the movement of the motor with different types of waveforms. The internal function generator produces speed reference profiles when set on “Internal speed” and torque profiles when set on “Internal torque”.

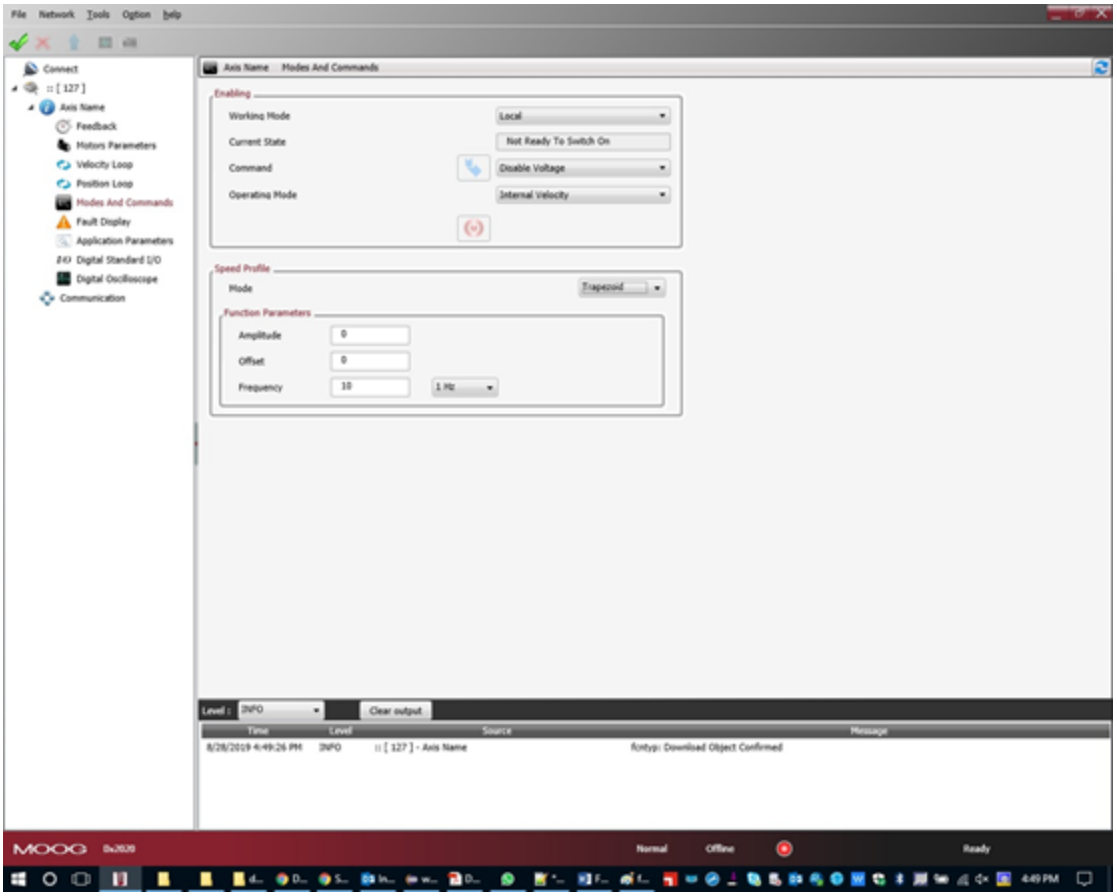
Through a drop-down sub-menu, it is possible to choose different types of references: constant (offset level), square, sinusoidal, trapezoidal, saw tooth, etc.; for each type of waveform it is possible to define the parameters of offset, square, frequency level.

In addition to generic waveforms, two further types of reference are available:

- Profile: Speed profile completely adjustable according to speed, deceleration, acceleration and period.
- Jog: Manual speed control reference adjustable according to the parameters: direction, acceleration and speed.

Refer to the following figures.





Quick Stop Command

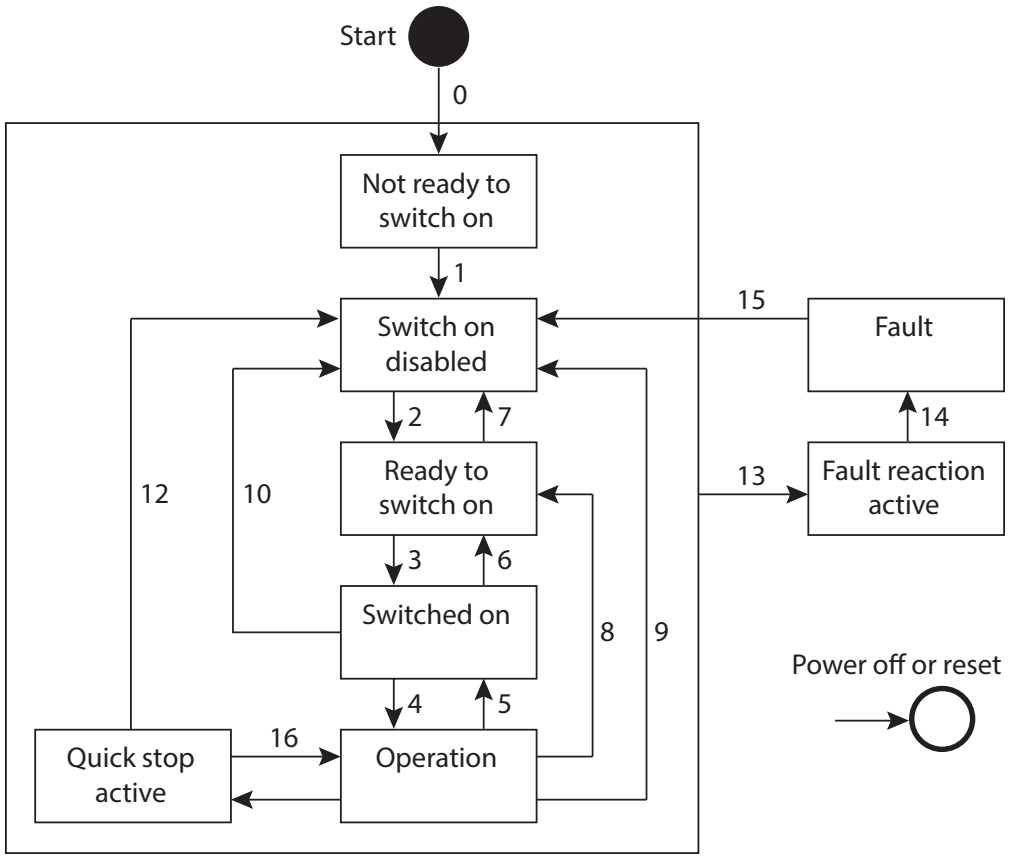
The command called "quick stop" initiates the function of a controlled, rapid stop of motion. In other words, following a "quick stop" command, a rapid deceleration ramp is performed in a controlled manner and then the drive is placed in a disabled state.

The function has been implemented as defined by the EtherCAT profile DS402 reference regulation of motion control.

DM2020 State Machine

For details on the FSA, refer to the Dx2020 GUI help on-line, Dx2020 Gui > Configuration View > Modes and Commands.

The following figure shows the DM2020 drive state machine.



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

Transition	Event(s)	Action(s)
0	Automatic transition after switching on or resetting the application	Automatic verification of drive and/or automatic initialization is performed
1	Automatic transition	Communication is activated.
2	Shutdown command sent from the drive or from the GUI	-

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

6.5 STO Activation

To enable the axis, you must enable the STO circuit. The 24 V power of the STO circuit must be integrated within the emergency fail-safe loop. See Safe Torque Off Safety Function on page 140.

WARNING: Electrical hazard - AVERTISSEMENT: risque électrique.

The DM2020 system and connected motor may present an electrical hazard if the safety precautions are not observed, which may result in death or serious injury to personnel, or damage to equipment.

- Before attempting this operation, follow the safety information and procedures in General Hazards and Safeguards on page 20.

WARNING: Mechanical hazard - AVERTISSEMENT: risque mécanique.

The DM2020 system and connected motor may present a mechanical hazard if the safety precautions are not observed, which may result in death or serious injury to personnel, or damage to equipment.

- Before attempting this operation, follow the safety information and procedures in General Hazards and Safeguards on page 20.

- **Always check the STO function at the first system start up or after any system maintenance.**
- **Do not attempt to access a protected area (safety interlocked cover, door, barrier, etc.) while the machine is powered up or operating. Doing so triggers the emergency stop chain, which interrupts motor power, and causes the intervention of the STO.**
- **If the STO signal is not removed following the correct sequence, the display will show "F" (Fault).**

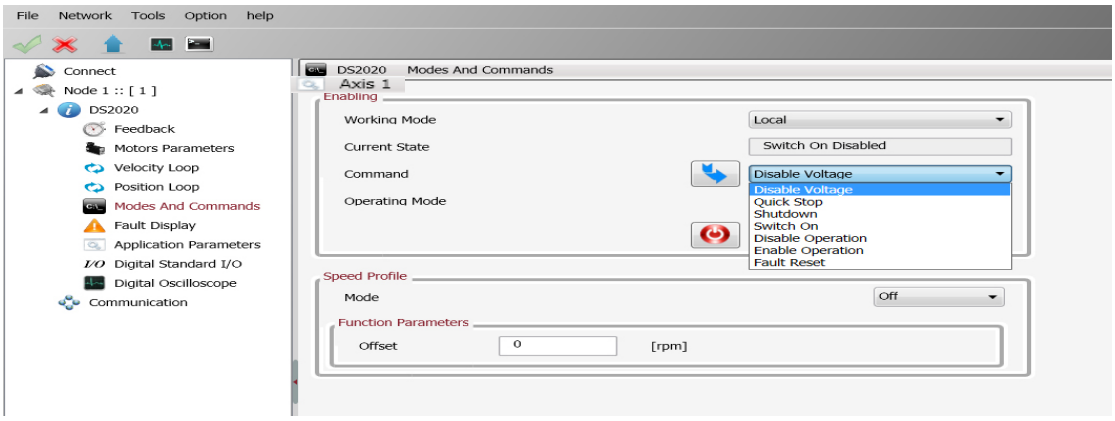
6.6 Auto-Phase Procedure

The auto-phasing is set through the Dx2020 GUI software.

The DM2020 system provides an auto-phasing procedure that is useful for unknown motors. This procedure finds the right phasing angle (THETA) to properly run the motor. At the end of the procedure the THETA parameter is automatically set. It can be done also to check the correct wiring of the motor.

The motor must be free to move during the auto-phasing procedure.

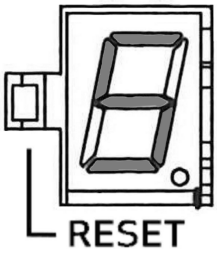
To set the autophasing, select "Modes and Commands" in the Navigation Area.



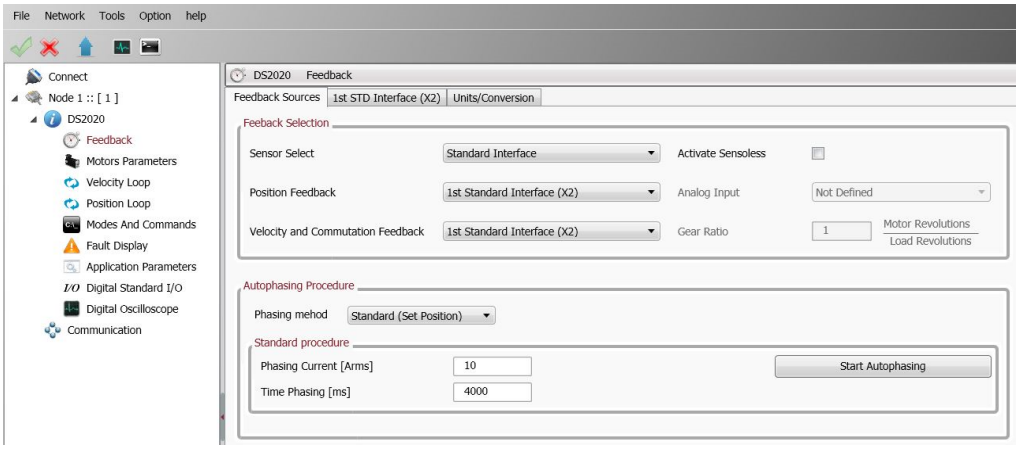
Check that the power supply and STO are present, then from the "Command" field, select in sequence:

1. “Shutdown”.
2. “Switch On”, leaving the drive in this state.

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



1. From the Navigation Area, select "Feedback": choose the tab "Feedback Sources".
2. Set the timing. Use a current value at or below the rated motor current in order to prevent warm up of the motor, in case the procedure must be repeated. Later, this value can be increased if applied to the motor load (Field current timing).
3. Set Time of Phasing according to the application requirements (set to the maximum allowed value of 4 seconds).
4. Click "Start Phasing": it shows the progress indicator (green if everything OK, red if there are alarms). By selecting the tab "1st STD interface", "2nd STD interface" or "Interface Option", you can acquire the phasing value before and after the operation in order to check the angular change that occurred during the process (angle Theta).



6.7 Drive (Axis) Enable and Limit Switch Enable/Disable

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

- Fieldbus (EtherCAT or CAN): enabled by the master (PLC) through the Control Word
- Analog: enabled through the hardware by configuring the I/O
- Local: enabled through the GUI (Modes and Commands > Command)

The following is the sequence of commands to enable:

1. Fault reset (if fault is present)
2. Shutdown
3. Switch on
4. Enable operation

To disable, repeat the previous procedure in reverse order, or select the "Quick Stop" command (see Quick Stop Command section).

Refer to the Dx2020 GUI help on-line for more details.

6.8 Oscilloscope Function and Log File (.UCX)

It is possible record and display numerous drive internal variables from the Dx2020 GUI by selecting "Digital Oscilloscope".

6.8.1 Log Configuration

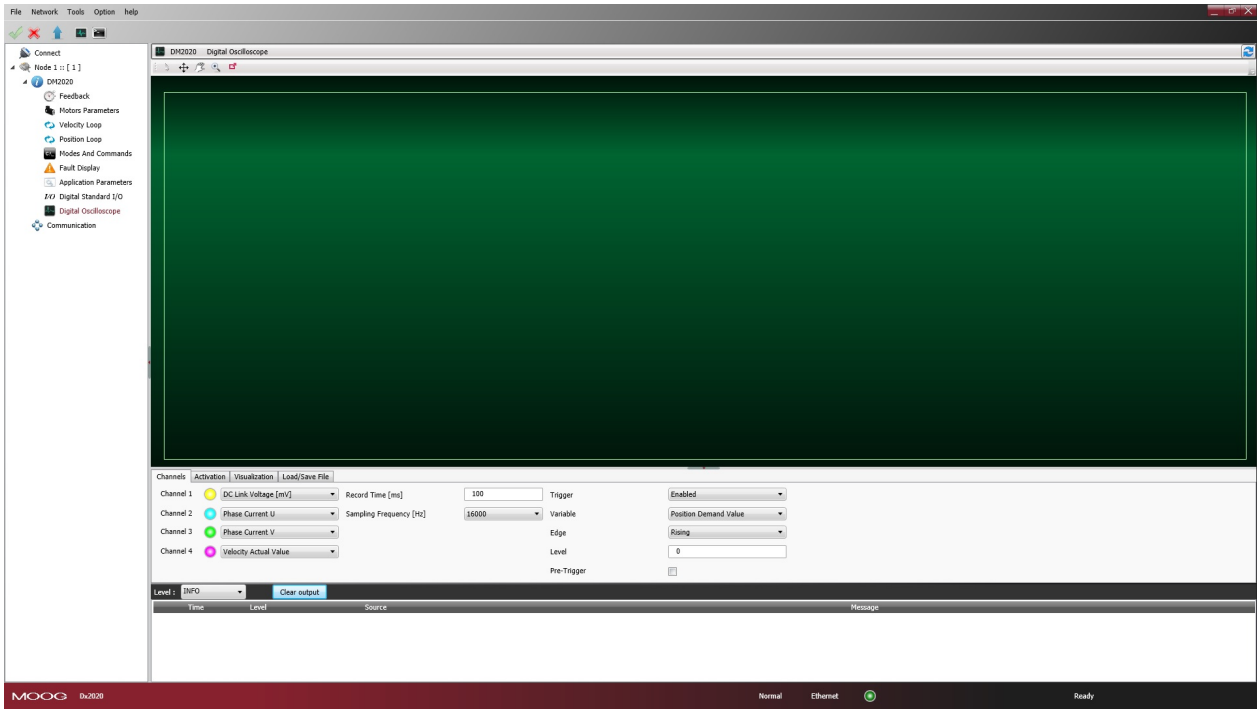
Select the Channels tab for each channel in the drop down menu to choose the variable to display. The number of accessible variables depends on the mode of access (Advanced or Normal).

To change the access mode, from the toolbar, select Options > Modes and proceed with the choice. You can display up to four tracks.

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

Triggering is possible. To display (and record) on an event, choose Enabled in the Trigger field (choose Continuous for repeated display of the same event automatically).

The Pre Trigger setting lets you view 512 bytes before the signal is triggered.



6.8.2 Start Logging

Select the Activation tab.

From Select Output, choose from the following options:

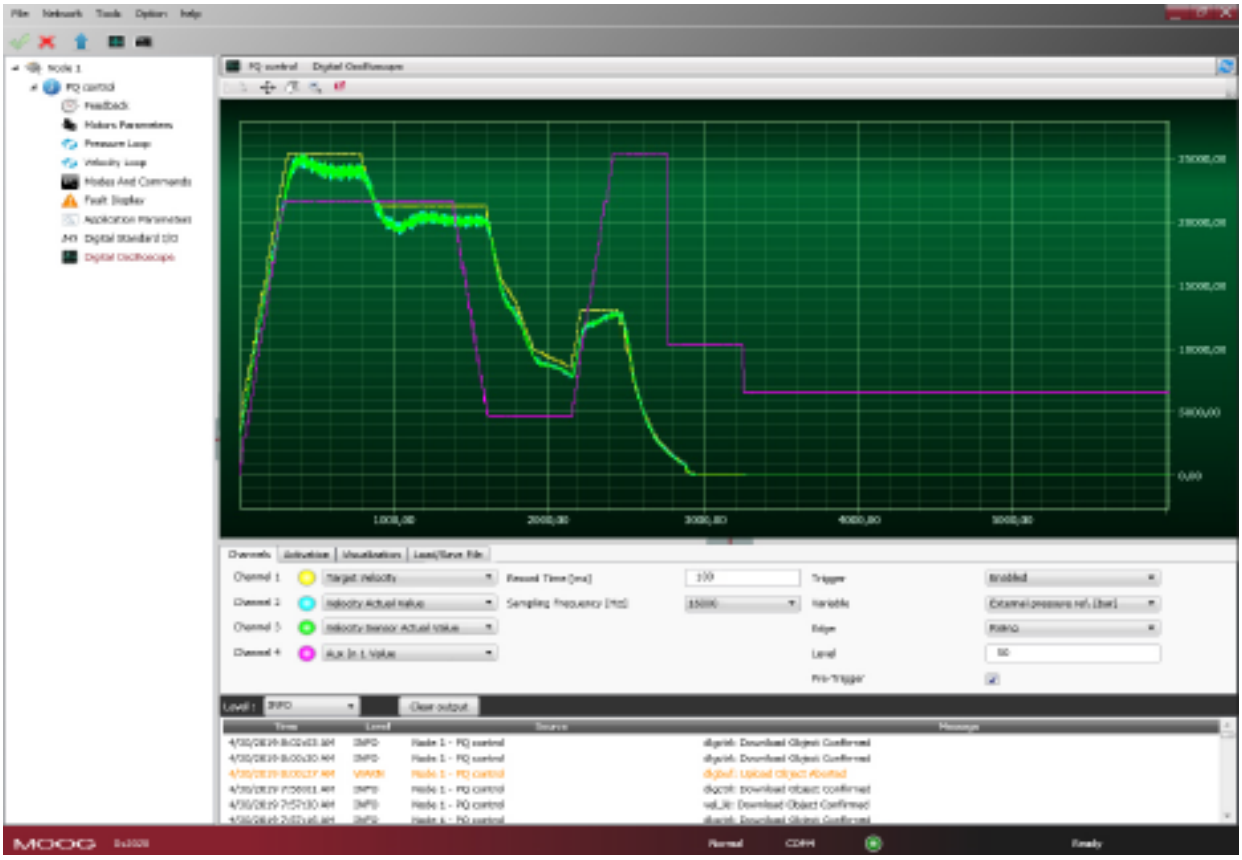
- Displays on the GUI: the data are only displayed and not recorded
- Save Locally: the data are displayed and saved on the PC in the directory specified in Output Folder

To start recording, click Start; to stop recording, click Stop.

6.8.3 View Logs

Select the View tab.

After acquisition, the data is shown on the display.



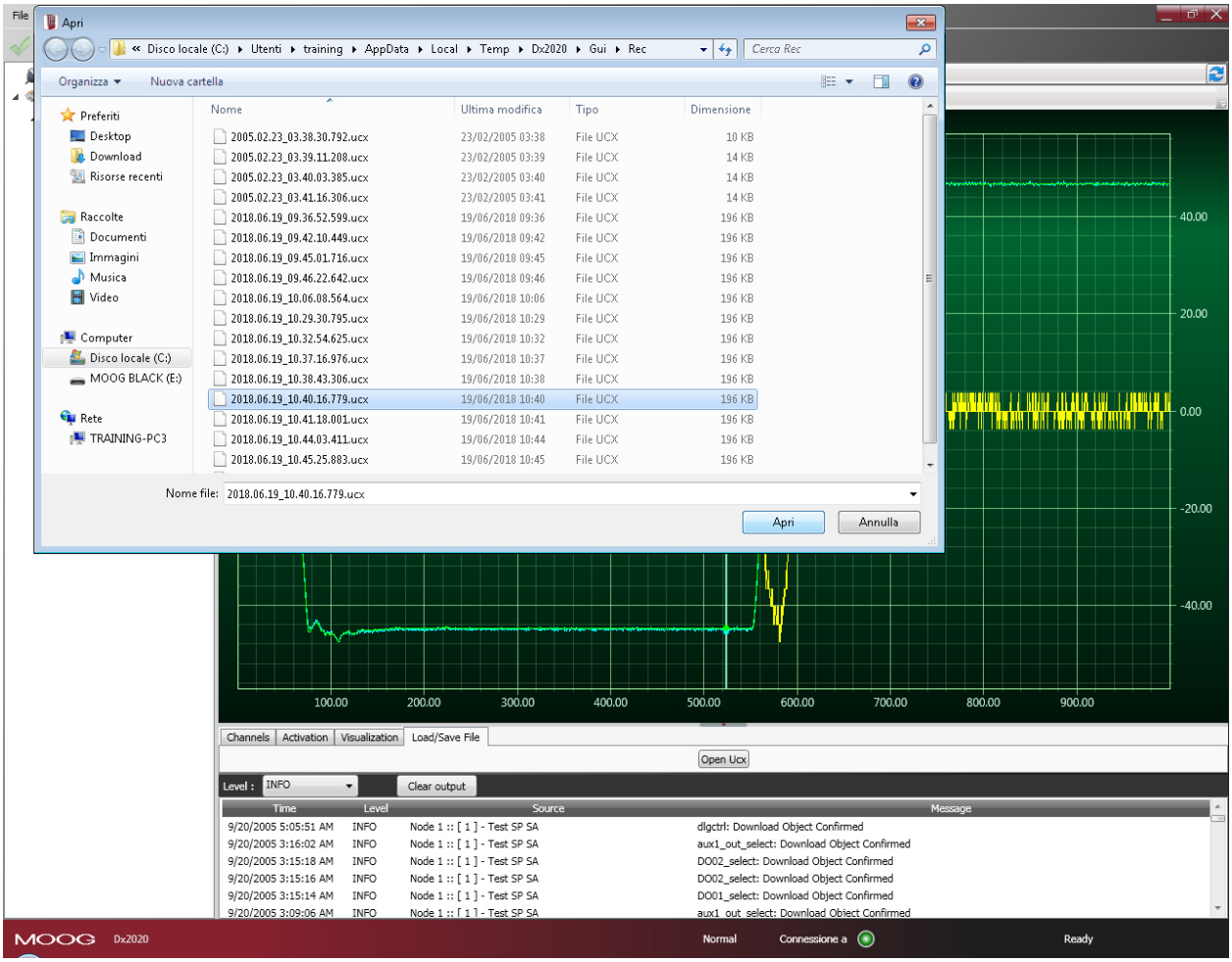
On the top left are the Cursor Activation (Cursor) and Displacement of the Graph (Pan) functions.

Magnification of the details (Zoom) and printing of the image (Screenshot); mouse cursor shall show the legend of the 4 buttons when hovering above them.

If the Auto Range check box is selected, each signal is shown in the window; otherwise, the data appear at the acquired scale unless you modify them with the Amplitude command.

6.8.4 UCX File Management

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

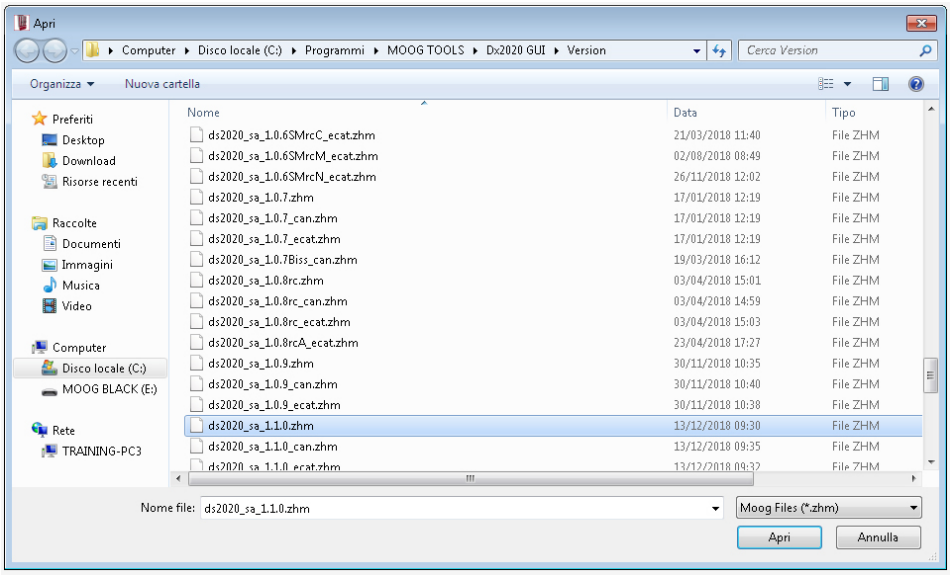


6.9 Using the GUI in Offline Mode

The Dx2020 GUI can be used in offline mode, in the absence of the drive, to create the drive configuration file, edit the file, or verify its contents.

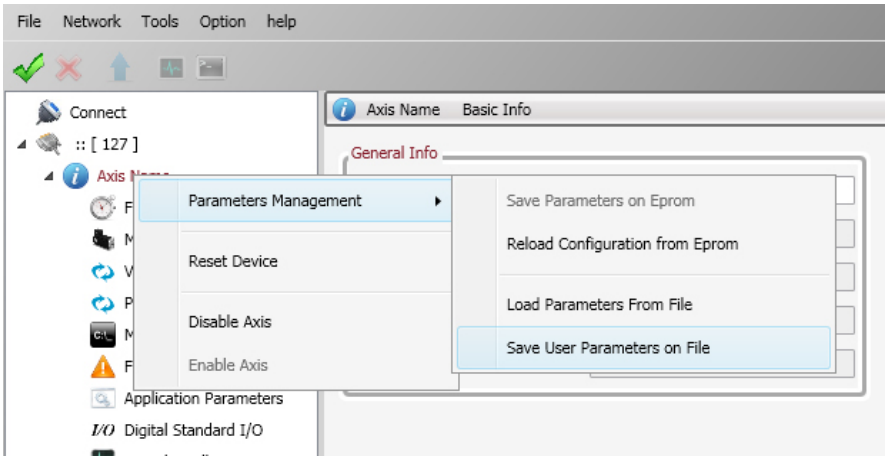
To enter Offline mode, select File > Offline.

To select the SW release you need to use, Select File > Open.



To check a parameter file, from the main menu:

1. Select the axis with the right mouse button.
2. Load the parameters as if there was a real drive connected.
3. Modify them if needed.
4. Save the new configuration to the new parameter file.



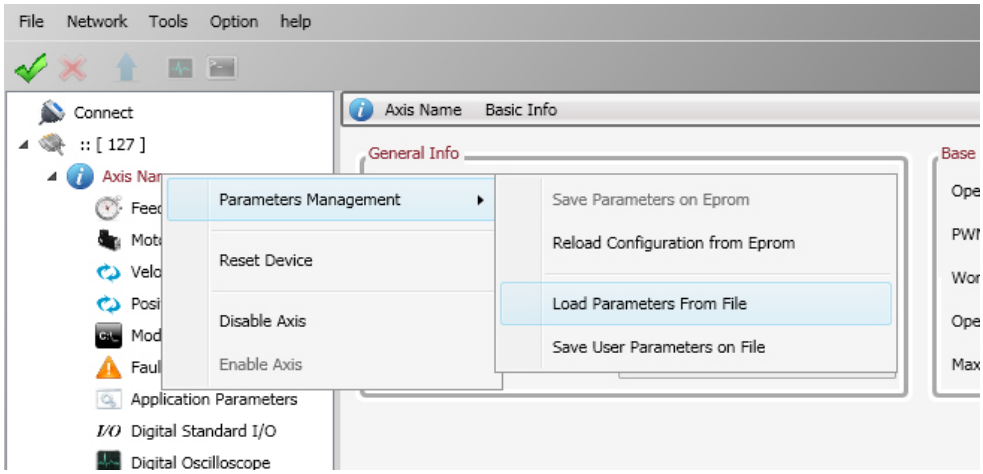
6.10 Contextual Help For Parameter Management

A context menu is available for parameter management. With it, the following operations are possible:

- Parameter Management:
  - Save the current configuration on the internal memory of the drive
  - Restore configuration previously saved in the internal memory
  - Load a saved configuration file (parameter download file)
  - Save the current configuration file (parameter file upload)
- Reset Device: Reset device selected

- Disable Axis: Disable axis selected
- Enable Axis: Enable axis selected

To open the menu, right click on the drive (axis) name.



6.11 Decommissioning Procedure

WARNING: Electrical hazard - AVERTISSEMENT: risque électrique.

The DM2020 system and connected motor may present an electrical hazard if the safety precautions are not observed, which may result in death or serious injury to personnel, or damage to equipment.

➢ Before attempting this operation, follow the safety information and procedures in General Hazards and Safeguards

WARNING: Mechanical hazard - AVERTISSEMENT: risque mécanique.

The DM2020 system and connected motor may present a mechanical hazard if the safety precautions are not observed, which may result in death or serious injury to personnel, or damage to equipment.

➢ Before attempting this operation, follow the safety information and procedures in General Hazards and Safeguards

To disable a DM2020 (replacement, dismantling) follow the procedure below:

1. Disconnect and lock out the mains supply voltage of the electrical panel and wait at least eight minutes.
2. Measure for voltage at all contact points to ensure there is none present.
3. Check that the temperatures of the heat sink and of the mechanical parts are not too high; use gloves as needed.
4. Loosen all connections and disconnect all connectors.

5. Remove the DM2020 drive from the electrical panel.
6. To decommission the DM2020 system's motor, follow the decommissioning procedure described in the motor's installation guide.
7. Repackage the system components in their shipping containers for safe storage or return.

7 Shipment and Storage

Use the following guidelines when receiving or storing the shipment.

7.1 Receiving and Checking the Shipment

When the shipment is received:

1. Inspect the exterior of the shipping container for any signs of damage. Immediately report any damage to the shipping carrier.
2. Open the shipping container and check that the contents of delivery are as ordered. Immediately report any discrepancies to Moog Casella.
3. After removing the drive from its shipping box, check that no damage has occurred during transit. Immediately report any discrepancies to Moog Casella.

	Retain all packing materials that the DM2020 system was shipped in, as those must be used if the system components need to be sent to Moog Casella for service. This will ensure that they arrive safely.

7.2 Storage

DM2020 system components can be stored for a consecutive period of up to one year without special requirements or actions. If you have retained the original packing materials that the DM2020 system was shipped in, the system components should be repackaged in those materials for safe storage.

7.2.1 Regenerating the Electrolytic Capacitors after Storage

When the storage period is longer than one year, before installing and commissioning the drive, please contact Applications Engineering to perform the regeneration procedure of the electrolytic capacitors.

8 Maintenance

There are no user-serviceable parts inside the DM2020 system. Do not attempt to disassemble the DM2020 drive or motor, as doing so will void the warranty.

- If your DM2020 drive needs to be serviced, return the faulty component(s) to the factory. See the next section.

WARNING: Electrical hazard - AVERTISSEMENT: risque électrique.

The DM2020 system and connected motor may present an electrical hazard if the safety precautions are not observed, which may result in death or serious injury to personnel, or damage to equipment.

- Before attempting this operation, follow the safety information and procedures in General Hazards and Safeguards on page 20.

WARNING: Mechanical hazard - AVERTISSEMENT: risque mécanique.

The DM2020 system and connected motor may present a mechanical hazard if the safety precautions are not observed, which may result in death or serious injury to personnel, or damage to equipment.

- Before attempting this operation, follow the safety information and procedures in General Hazards and Safeguards on page 20.

8.1 Periodic Maintenance

Periodically, check the following items:

Component	Inspect	Frequency
Exterior case	Do not immerse or spray the drive with water or any cleaning agents. Check for accumulated dust/dirt. If the surface is dirty, clean with a dry cloth. If the ventilation grids are dirty, clean with a dry brush.	Application specific (depends on operating environment, frequency of use, etc.)
Signal and power cables	Check for wear, damaged jacket, loose connectors; ensure that all connectors are properly tightened. Note that all M-style connectors must be finger tightened only, do not use tools.	

8.2 What to Do If Repairs Are Required?

If repair of a Moog drive is needed, an RMA (Return Material Authorization) number is required to return the motor. Instructions for packaging and shipping the drive back to Moog will be provided with the RMA. Contact your Moog Casella representative for more information.

	Retain all packing materials that the DM2020 system was shipped in, as those must be used if the system components need to be sent to Moog Casella for service. This will ensure that they arrive safely.

9 Troubleshooting

WARNING: Electrical hazard - AVERTISSEMENT: risque électrique.

The DM2020 system and connected motor may present an electrical hazard if the safety precautions are not observed, which may result in death or serious injury to personnel, or damage to equipment.

- Before attempting this operation, follow the safety information and procedures in General Hazards and Safeguards

WARNING: Mechanical hazard - AVERTISSEMENT: risque mécanique.

The DM2020 system and connected motor may present a mechanical hazard if the safety precautions are not observed, which may result in death or serious injury to personnel, or damage to equipment.

- Before attempting this operation, follow the safety information and procedures in General Hazards and Safeguards on page 20.

Troubleshooting of the DM2020 system is primarily done through the Dx2020 GUI software, The following sections describe typical malfunctions and provides a series of recommendations on how to fix them. If the problem persists, contact Applications Engineering.

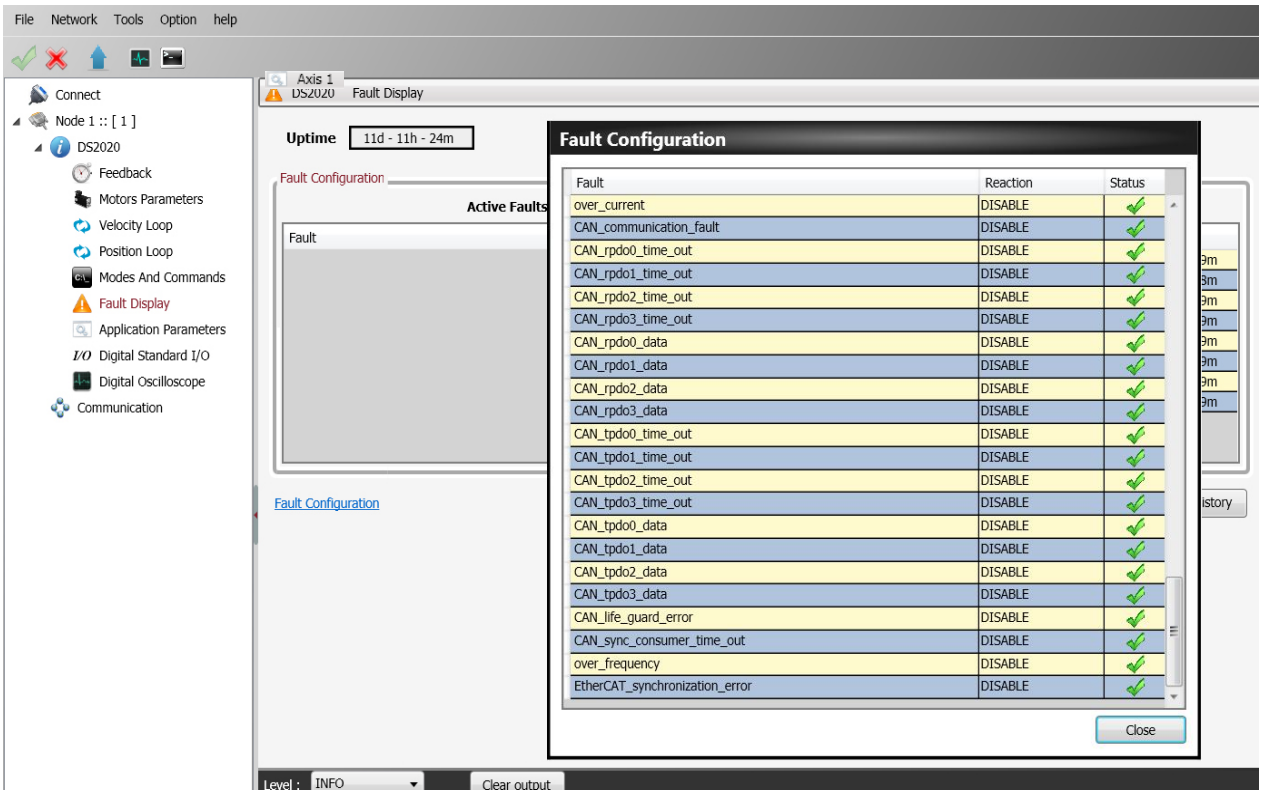
9.1 Power Supply Section Anomalies

Cause	Action
The PSU temperature is high	Check the continuous current supplied to the axes Check the efficiency of the fans
Failure recovery	Check the braking resistor
Overvoltage	

If any of the above problems persist after implementing the suggested actions, please contact Moog Service

9.2 Drive Alarms (Faults)

The drive-axis alarms (faults) are shown on the axis display by the letter F; to troubleshoot the condition, connect to the Dx2020 GUI software, in the software, select the item Fault Display, and then proceed with the analysis of the anomalies.



9.2.1 Alarms on the Power Section

The following alarms identify the IGBT (Insulated Gate Bipolar Transistor) affected by the phase x: (U, V or W):

- Short_Circuit_Phase_x_Low
- Short_Circuit_Phase_x_Hi

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

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

The probable causes of this type of alarm are listed in the following table.

Cause	Suggested action
Short circuit in the motor	Check the motor insulation with a multimeter or other suitable tool. Alternatively: • unplug the power cable from the motor • re-enable the axis • If the problem persists, the drive needs to be checked and/or replaced
Short circuit between the motor cables	Disconnect the cable from the motor and from the drive, then check the cable insulation with a multimeter or other suitable tool. Alternatively: • unplug the power cable from the motor side • re-enable the axis • if the problem persists, both drive and cables need to be checked
Wrong setting of the current loop	Check the motor parameters stored in the drive configuration.
Damaged internal drive components	• Unplug the power cable from the drive side • Re-enable the axis • If the problem persists, the drive needs to be replaced

9.2.2 Alarm for VBUS Voltage Out of Tolerance

Fault		Cause	Action
DC_Link_Under Voltage	Voltage lower than the minimum threshold set	Sensing circuit 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 threshold set	Brake resistor not connected to the power supply or faulty	Measure the ohm value of the resistor and replace it if necessary

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

9.2.3 Drive or Motor Overtemperature

- Excess_temperature_drive
- Motor_temperature_warning
- Motor_over_temperature

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

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

9.2.4 Removal of STO Signal

- Safety_stage_low_voltage: STO protection intervention

When the STO circuit removes power, it releases the axis, disabling the output power. If there is a discrepancy between the command and the feedback signal, the STO circuit inside the drive may be damaged. Therefore, verify at both inputs that the absorption at 24 VDC is approximately 50 mA per input. If the absorption is different from that value (null or greater than 200 mA), replace the drive.

9.2.5 Errors on Memory Devices

- eeprom_fault

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

9.2.6 Data Corrupted Fault

- parameter_initialization_error
- node_identifier_data_memory_corrupted
- user_data_memory_corrupted
- restore_data_memory_corrupted
- factory_data_memory_corrupted
- calibration_data_memory_corrupted
- diagnosis_data_memory_corrupted

If there is invalid information in the memory, the drive signals an alarm. To solve the problem:

- Use the Dx2020 GUI software to verify the correct configuration of the drive, and then save the parameters.
- Reset the drive and restart the Dx2020 GUI software.

If the problem persists, replace the drive.

9.2.7 Brake Feedback Fault

- brake_feedback_fault

This alarm indicates a fault in the motor braking circuit.

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

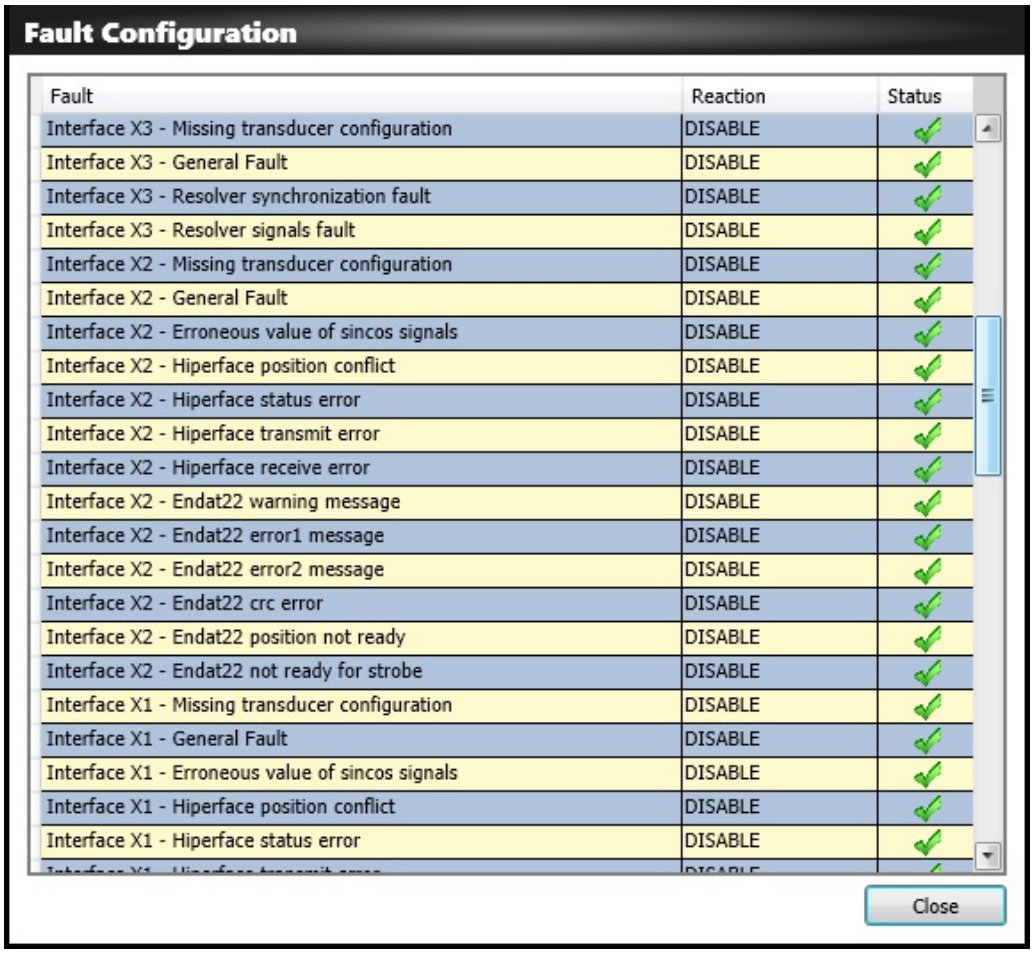
The internal circuit is protected against short circuits, and the protection is triggered if the output current exceeds 2 A for the motor brake. If this happens, the causes can be:

Cause	Action
Short circuit on the connection cable to the brake	Check for short circuits in the brake cable or between the brake cable and ground using a multimeter or other appropriate tool, or: • Disconnect the brake cable on the drive side and enable • If the problem does not reoccur, replace the brake cable
Brake short circuit	Check for short circuits in the brake cable or between the brake and ground using a multimeter or other appropriate tool, or: • Disconnect the brake cable on the motor side and enable • If the problem does not reoccur, replace the motor
Failure detection circuit	• Send the drive for analysis and possible repair

9.2.8 Errors on Feedback Devices

For correct operation, all the feedback signals must arrive at the drive in an appropriate manner. If this does not happen, the causes are indicated by the alarm that specifically identifies what functionality of the transducer is wrong or missing.

To analyze a feedback signal problem, check that the cable is wired correctly, that the signal path is not interrupted, and that the settings are correct. This analysis must be repeated for all the situations described below.



Fault	Cause	Action
Missing Transducer Configuration	Interface transducer enabled but not configured	Configure it
Resolver Signals Fault	Error resolver signal level (amplitude)	Perform compensation of the cable
Resolver synchronization fault	Resolver signal synchronization error (phase)	Check that the cable connections are correct
Erroneous value of sincos signals	Each of these alarms details a problem with the transducer. After investigating and eliminating the lack of feedback or the wrong configuration as the cause, replace the motor.	
Hiperface position conflict		
Hiperface status error		
Hiperface transmit error		
Hiperface receive error		
EnDat22 warning message		
EndDat22 error1 message		
EndDat22 error2 message		
EndDat22 CRC error		
EndDat22 position not ready		
EndDat22 not ready for strobe		

9.2.9 Synchronization , Interrupt Time and Task Time Error

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

9.2.10 EtherCAT Fault

Fault	Cause	Action
EtherCAT_communication_fault	Communication error	Check wiring configuration of the drive communication and/or EtherCAT master
EtherCAT_link_fault	Link to Ethernet not present	
EtherCAT_rpdo_data	PDO data received incorrectly	
EtherCAT_rpdo_time_out	PDO data not received or received after the time out	
EtherCAT_tpdo_data	Data received not transmitted	
EtherCAT_tpdo_time_out	Data not transmitted or transmitted after the time out	
Internal_transmit_pdo_time_out	Communication error, PDO internal data (double axle)	
Internal_receive_pdo_time_out	Timeout, internal PDO communication (dual axis)	

9.2.11 Alarms Related to the Control Loops

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

9.2.12 CAN Bus Alarms

Fault	Cause	Action
CAN_communication_fault	PDO data not received or received	Check wiring configuration of

9.2.12 CAN Bus Alarms

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

9.3 Alarm Display in Analog Operating Mode

If the drive is operating in "Analog" mode (Mode and Commands / Mode Operation: Analog), the LED display on the front panel indicates the presence of an alarm and an additional error index, consisting of 2 numerical digits. This allows the operator to identify the cause of the error present without a PC. For example, in the case of an EEPROM fault (Fault Index 13), it will display error F-1-3.

If the drive is used in fieldbus mode (EtherCAT/CAN), the display will show a fixed F, the error code will be transmitted through an EMERGENCY message (according to the CANopen standard) using ErrorCode and ErrorRegister.

If CANopen is used, an emergency message is transmitted according to the CANopen Emergency protocol using the Error Code and the Error Register (so there is no "F" character).

The following table lists the set of available faults and their descriptions. Note that the hard faults (the first 8 bold rows) are not configurable; the reaction is always "Disable". For details on configuring fault reactions, see *System Configuration*.

Fault Index	Error Code	Error Register	Fault	Description
1	0x2344	0x04	short_circuit_phase_U_low	IGBT fault, phase U, low arm
2	0x2345	0x04	short_circuit_phase_U_hi	IGBT fault, phase U, high arm

Fault Index	Error Code	Error Register	Fault	Description
3	0x2346	0x04	short_circuit_phase_V_low	IGBT fault, phase V, low arm
4	0x2347	0x04	short_circuit_phase_V_hi	IGBT fault phase V, high arm
5	0x2348	0x04	short_circuit_phase_W_low	IGBT fault, phase W, low arm
6	0x2349	0x04	short_circuit_phase_W_hi	IGBT fault, phase W, high arm
7	0x2351	0x04	short_circuit_lgbt_rec	Recovery IGBT fault
8	0x2350	0x04	gate_under_voltage	Under voltage of IGBT gate
9	0x3220	0x04	dc_link_under_voltage	Bus under voltage
10	0x3210	0x04	dc_link_over_voltage	Bus over voltage
11	0x4310	0x08	excess_temperature_drive	Excessive temperature of the drive (IGBT module fuse)
12	0x5114	0x04	safety_stage_low_voltage	Supply of STO circuit not detected (fault active only in Operation Enabled state)
13	0x5530	0x01	eeprom_fault	Error reading the EEPROM or content not valid
14	0x5540	0x01	sd_memory_fault	External memory card not detected.
15	0x6010	0x01	software_watchdog	Software alarm
16	0x6320	0x01	parameter_initialization_ error	Initialization error
17	0x6311	0x01	node_identifier_data_ memory_corrupted	Memory of the user parameters corrupted or not configured
18	0x6312	0x01	user_data_memory_ corrupted	Memory of the user parameters corrupted or not configured
19	0x6313	0x01	restore_data_memory_ corrupted	Not used
20	0x6314	0x01	factory_data_memory_ corrupted	“factory parameters” region of the memory corrupted or not configured
21	0x6315	0x01	calibration_data_memory_ corrupted	Not used
22	0x6316	0x01	diagnosis_data_memory_ corrupted	Not used
23	0x7110	0x01	brake_feedback_fault	Brake status signal inconsistent
24	0x7124	0x08	motor_temperature_warning	Warning - motor temperature

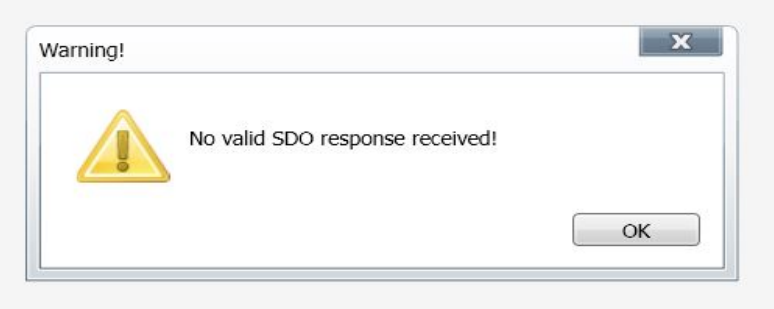
Fault Index	Error Code	Error Register	Fault	Description
25	0x7125	0x08	motor_over_temperature	Fault - motor temperature
26	0x73A2	0x01	Interface STD - Erroneous value of sincos signals	Sinusoidal signal amplitude inconsistent (optional interface X1)
27	0x73A3	0x01	Interface STD - Hiperface position conflict	Digital position (Hiperface protocol) inconsistent with the calculated position (optional interface X1)
28	0x73A4	0x01	Interface STD - Hiperface status error	Error - encoder status (Hiperface protocol) (optional interface X1)
29	0x73A5	0x01	Interface STD - Hiperface transmit error	Transmission error encoder (Hiperface protocol) (optional interface X1)
30	0x73A6	0x01	Interface STD - Hiperface receive error	Reception error encoder (Hiperface protocol) (optional interface X1)
31	0x73A7	0x01	Interface STD - EndDat22 warning message	Warning from encoder EnDat 22 (optional interface X1)
32	0x73A8	0x01	Interface STD - EndDat22 error 1 message	Error - type 1 encoder EnDat 22 (optional interface X1)
33	0x73A9	0x01	Interface STD - EndDat22 error 2 message	Error - type 2 encoder EnDat 22 (optional interface X1)
34	0x73AA	0x01	Interface STD - EndDat22 crc error	Error - CRC encoder EnDat 22 (optional interface X1)
35	0x73AB	0x01	Interface STD - EndDat22 position not ready	Error - position not ready encoder EnDat 22 (optional interface X1)
36	0x73AC	0x01	Interface STD - EndDat22 not ready for strobe	Error - strobe not ready encoder EnDat 22 (optional interface X1)
37	0x73AD	0x01	Interface STD - Resolver synchronization fault	Resolver signal synchronization error (phase)
38	0x73AE	0x01	Interface STD - Resolver signals fault	Resolver level signal error (amplitude)

Fault Index	Error Code	Error Register	Fault	Description
39	0x8700	0x01	synchronization_error	Internal interrupt frequency irregular
40	0x6102	0x01	interrupt_missing (was Interrupt_time_exceeded)	Internal interrupt frequency not detected
41	0x6103	0x01	Task_time_exceeded	Execution time of the task exceeded maximum time
42	0x8400	0x01	velocity_control_monitoring	Error - maximum speed exceeded
43	0x8611	0x01	following_error	Position tracking error
44	0x8612	0x01	position_reference_limit	Not used
45	0x8101	0x10	EtherCAT_link_fault	EtherCAT link not detected
46	0x8100	0x10	EtherCAT_communication_ fault	EtherCAT communication generic error
47	0x8231	0x10	EtherCAT_rpdo_time_out	Time out received PDO (EtherCAT)
48	0x8241	0x10	EtherCAT_rpdo_data	Data error received PDO (EtherCAT)
49	0x8235	0x10	EtherCAT_tpdo_time_out	Time out transmitted PDO (EtherCAT)
50	0x8245	0x10	EtherCAT_tpdo_data	Data error transmitted PDO (EtherCAT)
51	0x8181	0x10	Internal_comunication_fault	Generic Fault internal communication (double-axis module)
52	0x8182	0x10	Internal_comunication_ heartbeat_error	Fault - internal communication - the axis 1 (2) does not detect the presence of axis 2 (1) (dual-axis module)
53	0x8183	0x10	internal_receive_pdo_time_ out	Fault - internal communication - PDO reception timeout (double-axis module)
54	0x8184	0x10	internal_transmit_pdo_time_ out	Fault - internal communication - timeout PDO transmission (Double-axis module)
55	0x3100	0x10	Phases_not_ok	Not used
56	0x3200	0x04	over_current	Overcurrent fault
57	0x8100	0x04	CAN_communication_fault	Generic CAN communication fault
58	0x8231	0x10	CAN_rpdo0_time_out	Time out - PDO0 reception (CAN)
59	0x8232	0x10	CAN_rpdo1_time_out	Time out - PDO1 reception (CAN)

Fault Index	Error Code	Error Register	Fault	Description
60	0x8233	0x10	CAN_rpdo2_time_out	Time out - PDO2 reception (CAN)
61	0x8234	0x10	CAN_rpdo3_time_out	Time out - PDO3 reception (CAN)
62	0x8241	0x10	CAN_rpdo0_data	PDO0 data reception error (CAN)
63	0x8242	0x10	CAN_rpdo1_data	PDO1 data reception error (CAN)
64	0x8243	0x10	CAN_rpdo2_data	PDO2 data reception error (CAN)
65	0x8244	0x10	CAN_rpdo3_data	PDO3 data reception error (CAN)
66	0x8235	0x10	CAN_tpdo0_time_out	Time out- PDO0 data transmission (CAN)
67	0x8236	0x10	CAN_tpdo1_time_out	Time out - PDO1 transmission (CAN)
68	0x8237	0x10	CAN_tpdo2_time_out	Time out - PDO2 data transmission (CAN)
69	0x8238	0x10	CAN_tpdo3_time_out	Time out - PDO3 data transmission (CAN)
71	0x8246	0x10	CAN_tpdo1_data	Error - PDO1 data transmission (CAN)
72	0x8247	0x10	CAN_tpdo2_data	Error - PDO2 data transmission (CAN)
73	0x8248	0x10	CAN_tpdo3_data	Error - PDO3 data transmission
74	0x8130	0x10	CAN_life_guard_error	Life guard time expired (CAN)
75	0x823A	0x10	CAN_sync_consumer_time_out	Sync message timeout (CAN)

9.4 Faults During the GUI – Drive Connection

If the communication between the PC and DM2020 system fails, an error message will appear.



Note: Other error messages are possible. See the GUI software help on-line for details.

For a serial connection, verify that:

- The correct COM port is selected
- The baud rate to 115200

For a CAN connection, verify that:

- The CAN bus is properly terminated
- The IXXATe CAN USB adapter is installed along with the appropriate drivers on the PC
- The baud rate and the node are configured to match the settings on the drive

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

To check the values set on the drive:

- Connect to the drive using another network
- From the terminal, read the value of the baud rate (canbdr parameter)
- From the terminal, read the ID of the node (modide parameter)

For an EtherCAT connection, verify that:

- The correct network adapter is selected
- The appropriate cable is used

Cat 5 EtherCAT cable must be straight, not crossover.

10 Safe Torque Off Safety Function

10.1 Application

The DM2020 system's safety function, Safe Torque Off (STO), has been designed with an integrated redundant circuit in the control board.

It is considered misuse to use the STO function outside of the instructions provided in this guide.

10.2 Installation Risk Assessment

The safety functional requirements of a DM2020 drive depend on the application and should be considered during the evaluation of the overall risk of the installation. If the drive manufacturer is also liable for the operated equipment, the designer of the installation is responsible for the risk assessment, and the specification of requirements for levels of functional integrity and safety integrity levels (SIL) of the drive according to CEI EN 62061: 2005 +A1:2013 +A2:2015 and/or performance levels (PL) according to UNI EN ISO 13849-1: 2016.

The following table, identical to Table 4 of the UNI EN ISO 13849-1: 2016, shows the relationship between performance levels (PL) and safety integrity levels (SIL).

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

Relationship Between Performance Levels (PL) and Safety Integrity Levels (SIL)

Because SIL 4 level refers to catastrophic events, it does not cover the risks relating to machinery. The risk assessment presented by the machine must be carried out in accordance with Directive 2006/42 / EC, referring to UNI EN ISO 12100: 2010 and must contain the safety circuit configuration relating to the entire machine by taking into account all components of the integrated safety system, including the drive.

Also, refer to Risk Assessment on page 24.

10.3 Safe Torque Off Function

The Safe Torque Off safety function of the DM2020 has been validated according to the level of safety integrity SIL 3 as defined in the product standard CEI EN 61800-5-2: 2008 showing that:

- The probability of dangerous failure per hour (PFHd) is 9×10^{-10} hours-1 (see the tables in the following subsections).

The validation of the function and the relative STO circuit involve the use of two distinct types of monitoring: the first consists of a normally closed electric contact (referred to as "Hardware Feedback"), the second is identified by a binary type digital signal (referred to as "Software Feedback") defined by the standard IEC 61800-7-201, CIA 402, Object 60FD (digital inputs), bit 3.

Also, compliance with UNI EN ISO 13849-1: 2016 has been verified using the PFHd calculated by reference to CEI EN 61800-5-2: 2008. According to this standard, STO complies with performance level (PL) "e" (see the tables in the next subsection).

The STO function is located in a subsystem as defined by the Standard CEI EN 62061: 2005 +A1:2013 +A2:2015, with a SIL limit requested SILCL3.

The STO safety function of the DM2020 can also be used to ensuring the safe stop of the injection molding machines, for the interlocked guards in the area of the mold and in other less hazardous areas in compliance with the standard UNI EN 201:2010.

10.3.1 Characteristic Values According to UNI EN ISO 13849-1

Hardware Feedback standard values according to UNI EN ISO 13849-1:2016:

	Value	Observations
Level of performance	PL e	
Category	4	The external subsystems must be capable of carrying out the diagnostic function in correspondence with, or before, the next request of the safety function, for example immediately at power up or at the end of an operating cycle of a machine
MTTFd	> 100 years	According to the UNI EN ISO 13849-1:2016, it can be taken into account a maximum value of 100 years
Diagnostic coverage	DC=99%	The external subsystems that perform the diagnostic function must use techniques capable of providing a DC ≥ 99%
Service life	20 years	Change the drive
Repair Time	8 hours	
Diagnostic test interval	8 hours max	See also the observation relative to the category

Software Feedback standard values according to UNI EN ISO 13849-1:2016:

	Value	Observations
Level of performance	PL e	
Category	4	The external subsystems must be capable of carrying out the diagnostic function in correspondence with, or before, the next request of the safety function, for example immediately at power up or at the end of an operating cycle of a machine
MTTFd	> 100 years	According to the UNI EN ISO 13849-1:2016, it can be taken into account a maximum value of 100 years
Diagnostic coverage	DC=99%	The external subsystems that perform the diagnostic function must use techniques capable of providing a DC ≥ 99%
Service life	20 years	Change the drive
Repair Time	8 hours	
Diagnostic test interval	8 hours max	See also the observation relative to the category

10.3.2 Characteristic Values According to CEI EN 62061

Hardware Feedback standard values according to CEI EN 62061: 2005 +A1:2013 +A2:2015:

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

Software Feedback standard values according to CEI EN 62061: 2005 +A1:2013 +A2:2015:

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

10.4 Safety Requirements

This section describes the requirements for the Safe Torque Off safety function.

10.4.1 Full Stop

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

WARNING: Electrical hazard - AVERTISSEMENT: risque électrique

The DM2020 system and connected motor may present an electrical hazard if the safety precautions are not observed, which may result in death or serious injury to personnel, or damage to equipment.

- Observe the following safety precautions.

WARNING: Mechanical hazard - AVERTISSEMENT: risque mécanique.

The DM2020 system and connected motor may present a mechanical hazard if the safety precautions are not observed, which may result in death or serious injury to personnel, or damage to equipment.

- Observe the following safety precautions.

- **During the risk assessment, the designer must evaluate the stopping time of the machine. The safety function Safe Torque Off time of intervention must be greater than the deceleration ramp braking time set by the drive with maximum speed and maximum load on the axle. The**

assessment should include the possibility of a fault. The machine may have a dangerous overload in the event of failure of the motor and additional protective measures may be required to achieve a more secure state.

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

- **When the Safe Torque Off circuit is activated, the motor can no longer produce torque. When external forces are acting on the axis (e.g., through the vertical force of gravity), suitable protection must be provided such as a mechanical automatic lock or a weight equalization system.**
- **The Safe Torque Off function does not provide electrical isolation. There is no protection against electric shock. The machine or the system must always be electrically isolated from the power line through the main disconnection device and locked (lockout/tagout) in the disconnect position, before performing any work on the machine or system, such as maintenance, service or cleaning (refer to EN 60204-1: 2006). The staff must be aware that exposed connection surfaces can carry dangerous voltages even after power off (capacitive voltage), and that the discharge time is about 6 minutes.**

10.5 Safe Torque Off Circuit

The Safe Torque Off function is designed with redundant blocking devices, which act independently on the power modules. This is advantageous because it does not disable the power supply of the drive and avoids the normal restart process.

WARNING: Personal injury and property damage risk.

The restart of the STO function is automatic when the safety inputs are active, which may cause death or serious injury to personnel or damage to equipment.

- ➢ It is the responsibility of the machine manufacturer to check and install, if necessary, a manual reset function to prevent the automatic restart of the motor.

The DM2020 system controls the movements of a three-phase AC motor through the generation of a rotating magnetic field. To this end, the microprocessor generates a complex pattern of pulses (PWM), which are amplified and used to pilot the power semiconductors. The Safe Torque Off function of the DSM020 system operates through hardware with two channels that interrupt the direct impulses to IGBT.

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

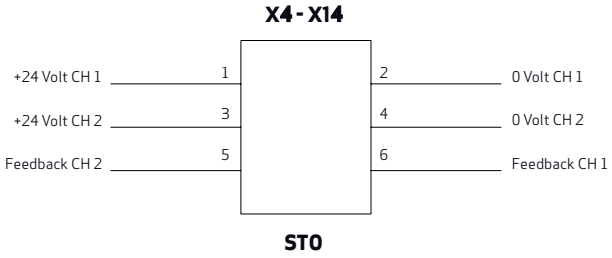
10.6 Safe Torque Off Connections

Management channels, including the "Hardware feedback" of the Safe Torque Off circuit, are controlled using the X4 (X14) Connector, also referred to as JRC1. Optional circuit delivering a dry feedback contact can be connected through connector X1-X11.

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

10.6.1 ConnectorX4(X14)

The following figure and table describes the connector pinouts: 6 contacts, Weidmüller model B2 3.50 / 06/180 SN BK BX. Note that the drive's power stage cannot start until STO signals are not active.



Connector Pinout: 6 Contacts, Model B2 3.50 / 06/180 SN BK BX Weidmuller

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.

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

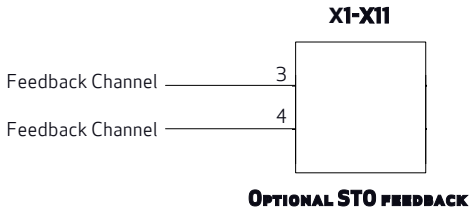
WARNING
To avoid common causes of failure, the "Channel 1" cable (at pins 1, 2 and 6 of JRC1) must be separate from the "Channel 2" cable (at pins 3, 4 and 5 of JRC1) during installation

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

10.6.2 ConnectorX1-X11 (Option)

The following figure and table describes the connector pinouts: 4 contacts, Weidmüller model BLZF 3.50/04/180 SN BK BX.



Connector Pinout: 4 Contacts, Model BLZF 3.50/04/180 SN BK BX Weidmuller

Free-hanging connector pin: 4 contacts, model BLZF 3.50/04/180 SN BK BX, manufactured by Weidmuller

Pin	Name	Function
3	Monitoring Channel	The "hardware feedback" electrical contact uses a "Photo-Mos"fuse protected relay . When both control channels, "Channel 1"and "Channel 2", are low (0V), the STO circuit is in a safe state (safety function enabled), the monitoring signal is active and provides closed contact. In all other cases, the tracking signalis always off and provides open contact. To properly run the plausibility check, the Monitoring Channel of the complete system must include this signal.
4	Dry contact feedback	

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

WARNING: Electrical hazard - AVERTISSEMENT: risque électrique

The DM2020 system and connected motor may present an electrical hazard if the safety precautions are not observed, which may result in death or serious injury to personnel, or damage to equipment.

➢ Observe the following safety precautions.

WARNING: Mechanical hazard - AVERTISSEMENT: risque mécanique.

The DM2020system and connected motor may present a mechanical hazard if the safety precautions are not observed, which may result in death or serious injury to personnel, or damage to equipment.

➢ Observe the following safety precautions.

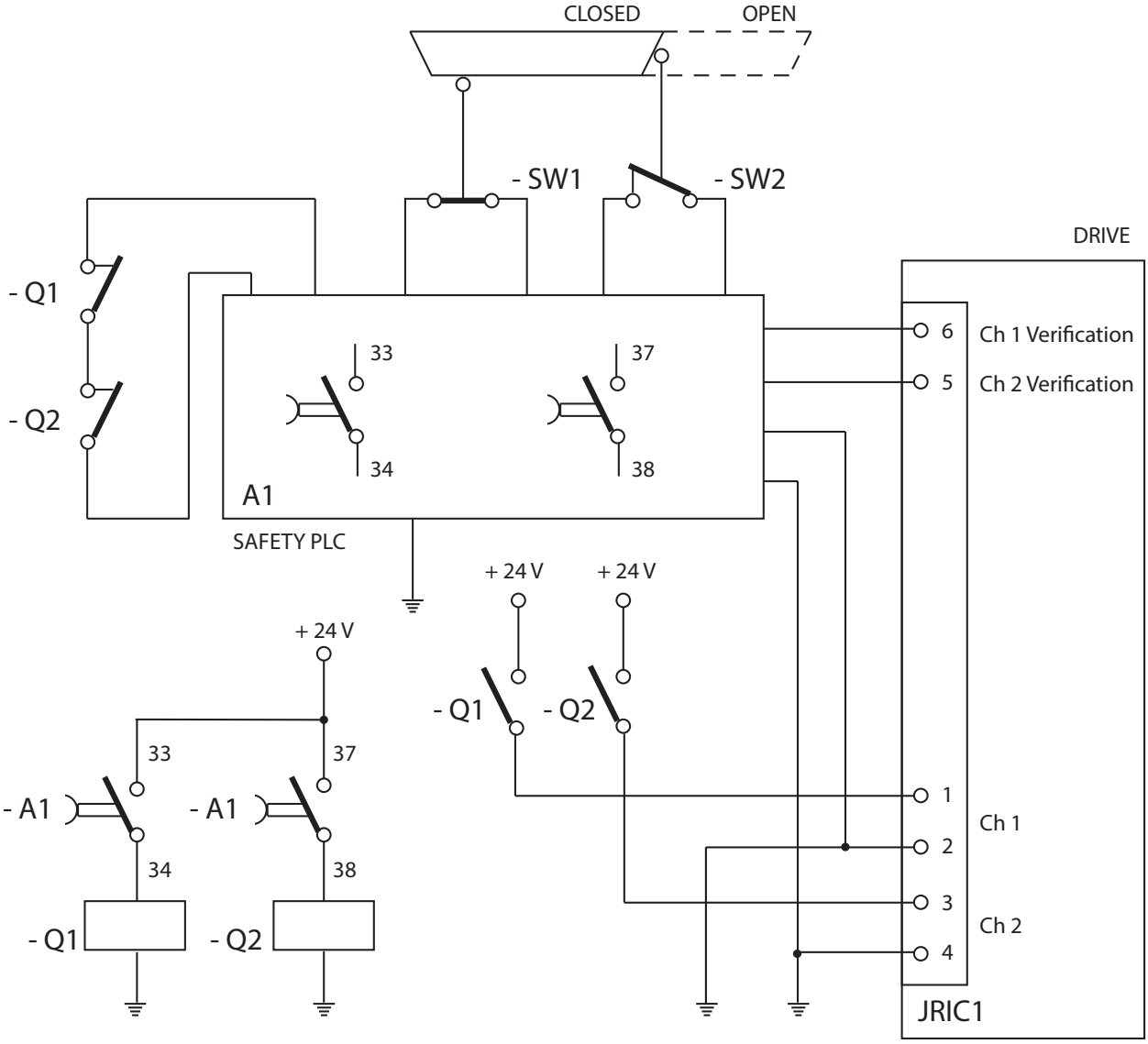
- To be validated according to categories 1 to 4, according to the basic safety principles of the UNI EN ISO 13849-2: 2013, tab. D.2, the external cables entering connector must have the screens connected to the grounding circuit.
- To avoid common failure causes, the cable of the "Channel 1" (pins 1, 2 and 6) must be separated from the cable of the "Channel 2" (pins 3, 4 and 5) during the installation.
- To prevent a short circuit between the input and the verification signal, the multi-strand wires of the two channels should be terminated with cable lugs or other appropriate devices.
- The verification of the two channels of the signal wiring must be protected against short circuits from the voltage sources. Never apply external power to the verification signal, even in case of failure.

10.6.2 Electrical Input/Output Specifications

Input Channel	Inom = 30 mA (± 10%) Vnom = 24 Vcc (± 10%) Vmax = 30 Vcc
Output – Verification Channel (Dry contact)	Imax = 200 mA Vmax = 30 Vdc
Output – Verification Channel (Control voltage)	Imax = 3 mA Vnom = 3.3 Vdc

10.7 Example Application

The following figure illustrates an example circuit for Safe Torque Off after a controlled stop.



Example of Safe Torque Off After a Controlled Stop

10.7.1 Description

Two redundant channels are used. The switches SW1 and SW2 are connected to an A1 safety PLC that controls two contactors, Q1 and Q2, with associated contacts. The NO contacts of Q1 and Q2 control the two input channels of the DM2020 safety for the shutdown of the motor power connections. The NC contacts of Q1 and Q2 are used in series to control the A1 safety PLC in the event of welding of a NO contact. The two output safety channels of the DM2020 are connected to an A1 safety PLC to allow the diagnostic coverage of the DM2020 subsystem.

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

According to UNI EN ISO 13849-1:2016, the subsystem to the input and output devices can reach PL=e because:

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

Subsystems:

- PLC A1 has PL = e
- DM2020 drive (STO circuit) has PL = e

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

According to CEI EN 62061: 2005 +A1:2013 +A2:2015, the subsystem to the input and output devices can achieve SIL 3 because:

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

Subsystems:

- Safety PLC A1 has SIL 3
- DM2020 drive (STO circuit) has SIL 3

The safety system can reach SIL 3.

10.7.2 Example Requirements

- Before activating the STO function, it is necessary to stop the motor while maintaining the power supply during the stop (controlled stop).
- Delay of outputs A1, which operate the contactors Q1 and Q2, should be > T (general shutdown capability).
- The A1 safety PLC has to fulfill the requirements for PL e according to UNI EN ISO 13849-1:2016.
- The Q1 and Q2 safety contactors should be linked to contacts according to IEC 60947-5-2, Annex L ("mirror contacts").
- In accordance with the risk assessment, when it is possible that personnel can physically enter the danger zone, i.e., beyond the protective cover or barrier: either a detection system must be installed; or, the restart must be available only after the safety guards are back in place and it is confirmed that no personnel is in the danger zone.
- A short circuit between conductors connected to 33-34 A1, between conductors connected to 37-38 A1, and between those connected to pins 1 and 2 of the drive must be avoided.
- There must be physical separation between signal paths.

- The multi-wired cables connected to the multi-pole connectors must be terminated with cable lugs or other appropriate devices.
- The verification of the two channels of the signal wiring must be protected from short circuit to voltage sources and should never be exposed to voltage external to the verification signal, even in case of failure.
- The safety system must be validated according to UNI EN ISO 13949-2: 2013

10.8 Safe Torque Off Installation and Maintenance Procedure

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

- On the first start
- At restart in the event that a fault has been detected and removed
- Otherwise, at least every 8 hours

Run the sequence of on/off commutation shown in the following figure by providing +24 VDC and 0V on the two input channels connected to the X4-X14 connector; perform a plausibility check with monitoring signals:

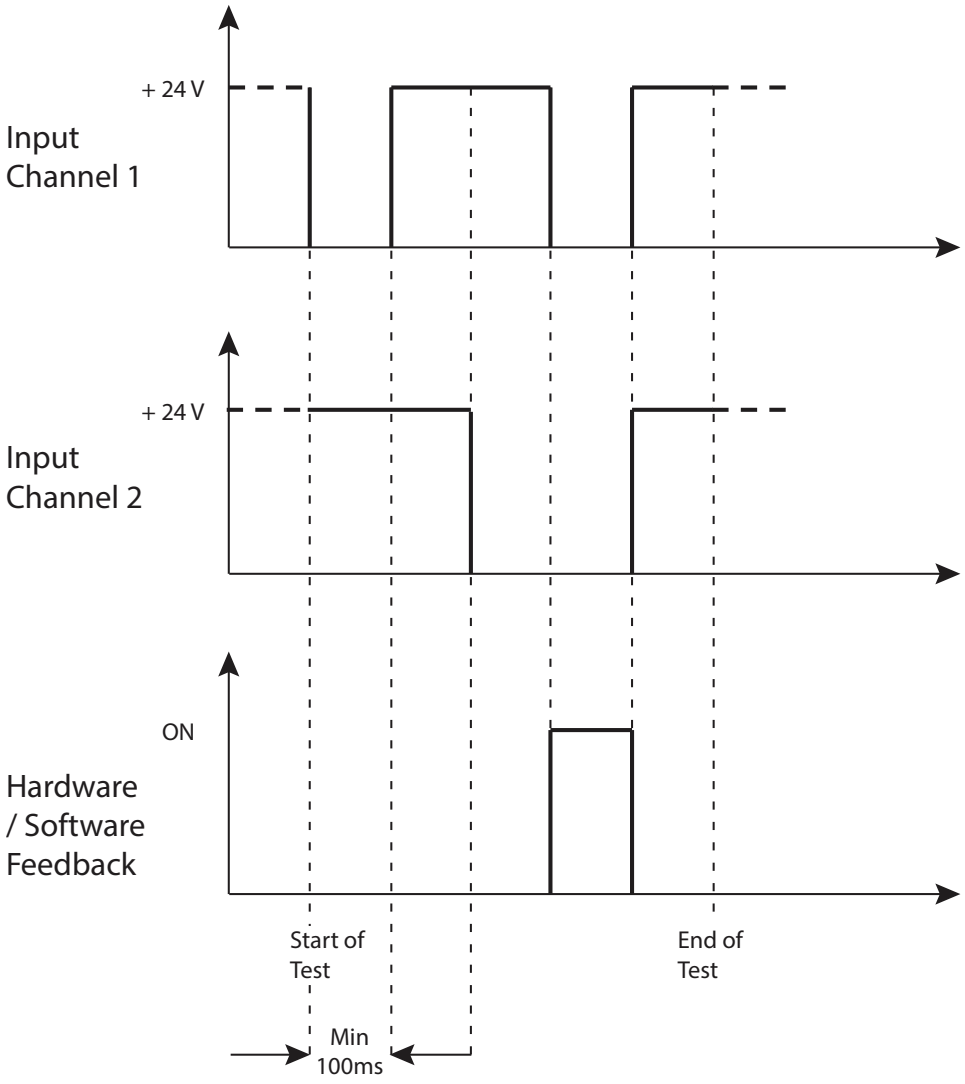
- Hardware feedbacks: on the connectors, check electrical contact and /or voltage levels
- Software feedback: check the "INTERLOCK STATUS" parameter value, object 60FD (digital inputs), bit 3, defined by the standard IEC 61800-7-201, CIA 402

WARNING: Personal injury and property damage risk.

If one of the conditions in the following figure is not met, the STO function cannot be used, which may result in death or serious injury to personnel, or damage to equipment.

➢ After the fault has been removed, the procedure must be repeated.

The following figure illustrates the STO mandatory sequence circuit test.



STO Mandatory Sequence Circuit Test

Stop Category 1

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

10.9 Assembly and Serial Tests

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

10.10 Identification of the STO Function on the Drive Plate

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

11 System Disposal

In accordance to Directive 2012/19 / EC electronic devices are "special waste" and should receive treatment and professional disposal.

- After notification, the old system components and related accessories can be returned at the sender's expense to Moog Casella for the correct disposal.

When disposing of a DM2020 system, recycle the components per the regulations applicable for your site (National/International standards or regulations).

Alternatively, you may choose to return the components to Moog Casella for disposal. Contact your Moog Casella representative for information on motor disposal.

11.1 What to Do If Repairs Are Required?

If repair of a Moog drive or motor is needed, an RMA (Return Material Authorization) number is required to return the motor. Instructions for packaging and shipping the motor back to Moog will be provided with the RMA. Contact your Moog Casella representative for more information.

12 Appendix

12.1 Glossary

A	
Acceleration	The rate of increase of velocity with respect to time
Alarms	Irregular operating situations highlighted by LED or display message, with subsequent analysis through the Dx2020 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	Class of motors that operate using electronic commutation of phase currents rather than electromechanical (brush-type) commutation. Brushless motors typically have a permanent magnet rotor and a wound stator.
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 CiA 301. The motion control is specified in CiA 402.
Capacitance to 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. This provides a low impedance connection for high frequency current dispersion.
DC bus	Circuit composed of the rectified and flattened supply voltage.
Braking Circuit	Circuit that converts the excess energy regenerated by the motor into heat during the deceleration phase.
Circuit, short	Typically unintended electrical conduction between two phases or conductors with different polarity of an alternating or continuous voltage.
Clock	Timing signal.
Controller	A term describing a functional block containing an amplifier, power supplies and possibly position-control electronics for operating a servomotor or step motor.
Control loops	Set of hardware and firmware circuits that determine the control of the quantities relating to torque, speed and position on the basis of the values measured by the relative sensors. They can be closed or open. 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	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.
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 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 • Control circuit that transmits signals for the switching of the power semiconductors of the inverter
Electrical 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 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 feedback component that detects a change in position of the shaft and transmits it to the drive for controlling the motor.
Encoder, incremental	Motor feedback component that detects incremental changes in the position of the shaft and transmits that to drive for controlling the motor.
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 feedback component that detects incremental changes in the position of the shaft and transmits that to the drive for controlling the motor. The information is acquired through the reading of two sinusoidal signals that are 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, EnDat 21, but offers advantages such as the transfer of other data together with that of position without a separate request.
EtherCAT	Communication protocol implemented on the Ethernet network for the synchronous transmission of information.
Ethernet	High speed data communication network.
F	
Filter, EMC	Device that reduces noise generated by the power supply cables.
FMEA	Failure Mode and Effects Analysis.
Fieldbus	An industrial network structure that allows communication between different devices. The digital information is transferred from one or more sources to one or more destinations using network topologies like ring, star, daisy chain, etc., as defined by the specific fieldbus protocol.
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	
Hiperface	Fully digital, synchronous, two-way, multi-channel protocol to transfer position information and speed; it requires minimal wiring between the 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 two or more axes that can be driven/controlled independently.
R	
Rectifier	Circuit that converts an AC voltage into a DC voltage.
Regulator, P	Control circuit functioning in a purely proportional manner.
Regulator, PI	Control circuit functioning in a proportional and integral manner.
Regulator, PID	Control circuit functioning in a proportional, integral and derivative manner.
Reset	Restart the microprocessor.
Resistor, braking	When the motor decelerates, a braking resistor converts the kinetic energy of the motor into heat. The braking resistor automatically intervenes in the braking circuit when the DC bus voltage exceeds its threshold.
Resolver	Analog motor feedback component that detects a change in position of the shaft and transmits it to the drive for controlling the motor.
RS-232	A common standard that defines the serial 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 (i.e., one after the other).
Shield	Devices designed to reduce electromagnetic emissions.
Servodrive	Drive that operates the regulation of torque, speed and position of a servomotor.
Safety	All necessary protective and operational measures to prevent death or injury to personnel and prevent damage to property.
Soft-start	Circuit for limiting the power from the supply to the system during 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.

12.2 Metric/AWG Conversion Table

AWG	Diameter		Cross-section		Ohmic resistance at 20 °C	Weight
	mils	mm	Circ. mils	mm2	W/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

AWG	Diameter		Cross-section		Ohmic resistance at 20 °C	Weight
	mils	mm	Circ. mils	mm2	W/km	g/m
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

TAKE A CLOSER LOOK

Moog designs a range of products that complement the performance of those featured in this guide. Visit our website for more information and the Moog facility nearest you.

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