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1. OVERVIEW

1.1. Content of the manual

This manual provides information to the user to ensure proper installation and optimal functioning of the digital servo drives, DI2020 series. All information contained herein, including methods, techniques and concepts are the exclusive property of Moog Casella and may be neither copied nor used without specific authorization. Moog reserves the right to modify products, and related documentation, at any time, without notice. The following materials are also available:

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

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

1.2. Utilized symbols

<table>
<thead>
<tr>
<th>Symbol</th>
<th>Description</th>
</tr>
</thead>
<tbody>
<tr>
<td>!</td>
<td>Danger that can result in death or serious injury</td>
</tr>
<tr>
<td>⚠️</td>
<td>Danger that can result in minor injury and / or property damage</td>
</tr>
<tr>
<td>🕵️‍♂️</td>
<td>Notification of an important information</td>
</tr>
</tbody>
</table>

1.3. Package contents

The complete supply of DI2020 drives includes:

- One DI2020 module

Note: a possible connector kit must be ordered individually and is supplied separately.
1.4. Required qualifications of the users

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

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

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

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

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

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

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

1.5. Applicable laws


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 DI2020 drives are CE certified.
2. SYSTEM OVERVIEW

2.1. Product structure

2.1.1. Product description

The DI2020 is part of the new generation of decentralized Moog digital servo drives for the control of synchronous brushless or asynchronous motors; Moog’s OBE (On Board Electronics) solution consists of a drive integrated with the DC-powered DM2020 power supply module.

<table>
<thead>
<tr>
<th>Drive coupled to Size 100 motor</th>
<th>Number of modules</th>
<th>L (no brake)</th>
<th>L (with brake)</th>
<th>LT (no brake)</th>
<th>LT (with brake)</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>2</td>
<td>220mm/8.66in</td>
<td>263mm/10.35in</td>
<td>274mm/10.79in</td>
<td>317mm/12.48in</td>
</tr>
<tr>
<td></td>
<td>4</td>
<td>263mm/10.35in</td>
<td>306mm/12.05in</td>
<td>317mm/12.48in</td>
<td>360mm/14.17in</td>
</tr>
</tbody>
</table>

![Fig 2.1a View of DI2020 with H100 size motor](image1)

<table>
<thead>
<tr>
<th>Drive coupled to Size 100 motor</th>
<th>Number of modules</th>
<th>L (no brake)</th>
<th>L (with brake)</th>
<th>LT (no brake)</th>
<th>LT (with brake)</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>2</td>
<td>218mm/8.58in</td>
<td>261mm/10.28in</td>
<td>271mm/10.67in</td>
<td>314mm/12.36in</td>
</tr>
<tr>
<td></td>
<td>4</td>
<td>261mm/10.28in</td>
<td>304mm/11.97in</td>
<td>314mm/12.36in</td>
<td>357mm/14.06in</td>
</tr>
</tbody>
</table>

![Fig 2.1b View of DI2020 with H115 size motor](image2)
Cables and connector coding

Connector codes
- X1 complete input connector with contacts (power supply)
- X2 complete output connector with contacts (DI2020 connection)
- X4 and X5 Ethercat connectors
- Full connector Kit (includes all 4 connectors X1, X2, X4 and X5)

Cable codes
- Power supply: CVAMM
- DI2020 connection power: CVDMM

Note: "MM" indicates cable length in meters

Wiring terminals code
- X2 connector STO status: BR8901-R
- Cap for X5 EtherCat: BR8902-R
- Cap for X2 not crimped: BR8900-R

- The DM2020 power supply supplies "DC" power (+ AT and - AT) to the various DI2020 drives through the connection cable applied to the terminal board
- Each DI2020 axis module is only available in the single axis version
- The current flows of the various axes range from 2 Arms to 4 Arms Continuous and from 4 Arms to 8 Arms of Peak
- The sizes of the DI2020 drives currently available are 4

<table>
<thead>
<tr>
<th>Size</th>
<th>Torque rms at 0 speed (Nm)</th>
<th>Torque rms at rated speed (Nm)</th>
<th>Rated speed (rpm)</th>
</tr>
</thead>
<tbody>
<tr>
<td>122</td>
<td>2.0</td>
<td>1.7</td>
<td>3000</td>
</tr>
<tr>
<td>142</td>
<td>3.5</td>
<td>2.1</td>
<td>3000</td>
</tr>
<tr>
<td>222</td>
<td>2.7</td>
<td>1.9</td>
<td>3000</td>
</tr>
<tr>
<td>242</td>
<td>5.1</td>
<td>2.0</td>
<td>3000</td>
</tr>
</tbody>
</table>

- Compatible feedback systems (to be specified when ordering):
  - RESOLVER 2 poles
  - ENCODER Sincos Hiperface Single turn Capacitive
  - ENCODER Sincos Hiperface Multi turn Capacitive
  - ENCODER Endat 22 Single turn Optical
  - ENCODER Endat 01 Multi turn Optical
  - ENCODER Endat 22 Multi turn Optical
  - ENCODER Endat 01 Single turn Optical
  - ENCODER Endat 22 Single turn Inductive
  - ENCODER Endat 22 Multi turn Inductive

- The control modes are 3:

<table>
<thead>
<tr>
<th>Mode</th>
<th>Note</th>
</tr>
</thead>
<tbody>
<tr>
<td>Analogic reference</td>
<td>Optional (*)</td>
</tr>
<tr>
<td>Fieldbus Can Bus</td>
<td>Optional (*)</td>
</tr>
<tr>
<td>Fieldbus EtherCat</td>
<td>Standard</td>
</tr>
</tbody>
</table>

(*) in development
The motor can be equipped with a parking brake and its functional control circuit. An optional mode is available with a safety brake control circuit (integrated / separate) available with different performance levels.

<table>
<thead>
<tr>
<th>Description</th>
<th>Note</th>
</tr>
</thead>
<tbody>
<tr>
<td>Standard (Brakeless motor)</td>
<td>-</td>
</tr>
<tr>
<td>Motor with brake</td>
<td>With functional control of the internal parking brake</td>
</tr>
<tr>
<td>Motor without brake and with function SBC Low Level</td>
<td>Funzione Safety Brake Command (Low Level)</td>
</tr>
<tr>
<td>Motor with brake and with function SBC Low Level</td>
<td>Funzione Safety Brake Command (Low Level)</td>
</tr>
<tr>
<td>Motor without brake and with function SBC High Level</td>
<td>Funzione Safety Brake Command (High Level)</td>
</tr>
<tr>
<td>Motor with brake and with function SBC High Level</td>
<td>Funzione Safety Brake Command (High Level)</td>
</tr>
</tbody>
</table>

Key:
Funzione SBC Low Level: Safe Break Control Function Medium Performance Level
Funzione SBC High Level: Safe Break Control Function High Performance Level

- Cooling of the modules by natural convection
- Ethernet Interface with EtherCAT Real Time Protocol according to DS402 (Standard)
- CANopen interface (option under development) with CANopen protocol according to profile DS402
- "Safe Torque Off" (STO) integrated in each DI2020
- Configuration / Commissioning via GUI: Dx2020GUI, via USB interface (X6 connector), located at the side of the Fieldbus connectors allows you to configure, calibrate and control the drive
- Diagnostics Alarms: Through GUI or Fieldbus:
  - EMC filters (with power supply kit)
  - Cabling (Hybrid Signal-Power and Communication)
  - Braking resistor (supplied with the power supply)

2.1.2. Working conditions and storage

| Operating environment temperature | from 0 °C to 40 °C |
| Storage temperature               | from -25 °C to 55 °C |
| Transport temperature             | from -25 °C to 70 °C |
| Relative humidity                 | 5...95 % without condensation |
| Allowed storage humidity          | 5...95 % |
| Allowed transport humidity        | 95 % at 40 °C |
| Working altitude                  | Up to 1000 m above AMSL rated performance, over 1000 m over AMSL with reduced current |
| Certifications                    | CE, UL (pending) |
| Protection                        | IP65 |

CLASS 3M7
Stationary / Sinewave Vibration:
- 10mm for frequencies between 2...9
- 30 m/s² for non-stationary vibrations

Non-stationary vibration and Type II shocks:
- 250 m/s² (25 g) for 6 ms

Machine safety
STO (Safe Torque Off) SILCL 3 PL “e” (waiting for certificate)
<table>
<thead>
<tr>
<th>Model/Code</th>
<th>CC201xxxx</th>
<th>CC202xxxx</th>
</tr>
</thead>
<tbody>
<tr>
<td>Mechanical dimensions</td>
<td>50 mm/1.97 inches</td>
<td>150 mm/5.9 inches</td>
</tr>
<tr>
<td>Type</td>
<td>L50</td>
<td>L150</td>
</tr>
<tr>
<td>Electrical line power supply</td>
<td>3-phase, from 200 to 528 V AC, 50/60 Hz</td>
<td></td>
</tr>
<tr>
<td>Auxiliary busbar power supply</td>
<td>24 V DC +/- 10% (supplied externally)</td>
<td></td>
</tr>
<tr>
<td>Arms rated current</td>
<td>54</td>
<td>128</td>
</tr>
<tr>
<td>Arms peak current</td>
<td>130</td>
<td>256</td>
</tr>
<tr>
<td>Protection</td>
<td>NTC and bi-metallic thermal protection to 85 °C</td>
<td></td>
</tr>
<tr>
<td></td>
<td>Detection of loss during input phase</td>
<td></td>
</tr>
<tr>
<td></td>
<td>Detection of insufficient input voltage or overvoltage</td>
<td></td>
</tr>
<tr>
<td>Communication</td>
<td>CANopen for sharing data with the drives</td>
<td></td>
</tr>
<tr>
<td>Cooling</td>
<td>Incorporated ventilation</td>
<td></td>
</tr>
<tr>
<td>Weight (kg)</td>
<td>5.1</td>
<td>13.5</td>
</tr>
<tr>
<td>Connector code</td>
<td>BC0004R</td>
<td>BC0006R</td>
</tr>
</tbody>
</table>

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.

*Note: A 32Arms power supply is currently under development*
2.1.4. Power supply coding

### OPT1 - Special configurations

<table>
<thead>
<tr>
<th>Value</th>
<th>Description</th>
</tr>
</thead>
<tbody>
<tr>
<td>01</td>
<td>Special Reg. Res. (16 ohm/500 W Armoured)</td>
</tr>
<tr>
<td>02</td>
<td>With power connectors &amp; without R.R. on kit</td>
</tr>
<tr>
<td>03</td>
<td>With power connectors &amp; Special Reg. Res. (18 ohm/350 W armoured)</td>
</tr>
</tbody>
</table>

### OPT2 - Special configurations

<table>
<thead>
<tr>
<th>Value</th>
<th>Description</th>
</tr>
</thead>
<tbody>
<tr>
<td>C0</td>
<td>Conformal coating for standard configuration</td>
</tr>
<tr>
<td>50</td>
<td>UL LISTED for standard “00” configuration</td>
</tr>
<tr>
<td>L0</td>
<td>- Conformal coating for version “50”</td>
</tr>
</tbody>
</table>

(\(^*)\) Values assigned by Moog

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

Example: The code CC201A0000 identifies the standard power supply available in 54 A DC in the final production version without special versions.
2.1.5. Standard DI2020 module

<table>
<thead>
<tr>
<th>Model/Code</th>
<th>CR6 122 X X XX XX</th>
<th>CR6 142 X X XX XX</th>
<th>CR6 222 X X XX XX</th>
<th>CR6 242 X X XX XX</th>
</tr>
</thead>
<tbody>
<tr>
<td>Configuration</td>
<td>Single</td>
<td>Single</td>
<td>Single</td>
<td>Single</td>
</tr>
<tr>
<td>Type</td>
<td>122</td>
<td>142</td>
<td>222</td>
<td>242</td>
</tr>
<tr>
<td>Current @ 8 kHz</td>
<td>2</td>
<td>4</td>
<td>3</td>
<td>5</td>
</tr>
<tr>
<td>Rated torque Nm</td>
<td>2</td>
<td>3.5</td>
<td>2.7</td>
<td>5.1</td>
</tr>
<tr>
<td>Peak torque Nm</td>
<td>4</td>
<td>7</td>
<td>5.4</td>
<td>10</td>
</tr>
<tr>
<td>Cooling</td>
<td>Natural</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Mass (kg) with brake+0.5 kg</td>
<td>6</td>
<td>7</td>
<td>8</td>
<td>10</td>
</tr>
</tbody>
</table>

The module code is located on the nameplate behind the Fieldbus connectors. To request any type of information on a specific module it is essential to communicate to Moog-Casella the data on the side plate, which uniquely identify each module.

Fig 2.4 Example of DI2020 module plate
2.1.6. DI2020 modules coding

Code structure

<table>
<thead>
<tr>
<th>Value</th>
<th>Description</th>
</tr>
</thead>
<tbody>
<tr>
<td>00</td>
<td>Flange 100 mm (3.94 in), standard shaft</td>
</tr>
<tr>
<td>02</td>
<td>Flange 100 mm (3.94 in), shaft with key</td>
</tr>
<tr>
<td>10</td>
<td>Flange 115 mm (4.53 in), standard shaft</td>
</tr>
<tr>
<td>12</td>
<td>Flange 115 mm (4.53 in), shaft with key</td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>Value</th>
<th>Description</th>
</tr>
</thead>
<tbody>
<tr>
<td>2</td>
<td>RESOLVER 2 poles</td>
</tr>
<tr>
<td>C</td>
<td>ENCODER Sincos Hyperface Single turn Capacitive</td>
</tr>
<tr>
<td>D</td>
<td>ENCODER Sincos Hyperface Multiturn Capacitive</td>
</tr>
<tr>
<td>E</td>
<td>ENCODER Endat 22 Single turn Optical</td>
</tr>
<tr>
<td>F</td>
<td>ENCODER Endat 01 Multiturn Optical</td>
</tr>
<tr>
<td>G</td>
<td>ENCODER Endat 22 Multiturn Optical</td>
</tr>
<tr>
<td>L</td>
<td>ENCODER Endat 01 Single turn Optical</td>
</tr>
<tr>
<td>I</td>
<td>ENCODER Endat 22 Single turn Inductive</td>
</tr>
<tr>
<td>N</td>
<td>ENCODER Endat 22 Multiturn Inductive</td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>Value</th>
<th>Description</th>
</tr>
</thead>
<tbody>
<tr>
<td>0</td>
<td>Analogue references (option)</td>
</tr>
<tr>
<td>1</td>
<td>CanBus configuration (option)</td>
</tr>
<tr>
<td>2</td>
<td>EtherCAT configuration</td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>Value</th>
<th>Description</th>
</tr>
</thead>
<tbody>
<tr>
<td>00</td>
<td>Flange 100 mm (3.94 in), standard shaft</td>
</tr>
<tr>
<td>02</td>
<td>Flange 100 mm (3.94 in), shaft with key</td>
</tr>
<tr>
<td>10</td>
<td>Flange 115 mm (4.53 in), standard shaft</td>
</tr>
<tr>
<td>12</td>
<td>Flange 115 mm (4.53 in), shaft with key</td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>Value</th>
<th>Description</th>
</tr>
</thead>
<tbody>
<tr>
<td>2</td>
<td>RESOLVER 2 poles</td>
</tr>
<tr>
<td>C</td>
<td>ENCODER Sincos Hyperface Single turn Capacitive</td>
</tr>
<tr>
<td>D</td>
<td>ENCODER Sincos Hyperface Multiturn Capacitive</td>
</tr>
<tr>
<td>E</td>
<td>ENCODER Endat 22 Single turn Optical</td>
</tr>
<tr>
<td>F</td>
<td>ENCODER Endat 01 Multiturn Optical</td>
</tr>
<tr>
<td>G</td>
<td>ENCODER Endat 22 Multiturn Optical</td>
</tr>
<tr>
<td>L</td>
<td>ENCODER Endat 01 Single turn Optical</td>
</tr>
<tr>
<td>I</td>
<td>ENCODER Endat 22 Single turn Inductive</td>
</tr>
<tr>
<td>N</td>
<td>ENCODER Endat 22 Multiturn Inductive</td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>Value</th>
<th>Description</th>
</tr>
</thead>
<tbody>
<tr>
<td>0</td>
<td>Analogue references (option)</td>
</tr>
<tr>
<td>1</td>
<td>CanBus configuration (option)</td>
</tr>
<tr>
<td>2</td>
<td>EtherCAT configuration</td>
</tr>
</tbody>
</table>

(1) Standard Version
(2) Values assigned by Moog
(3) In development
### 2.1.7. Capacitive modules models (ABC Auxiliary Bus Capacitor)

<table>
<thead>
<tr>
<th>Model</th>
<th>Code</th>
<th>Capacity (µF)</th>
<th>Dimensions</th>
</tr>
</thead>
<tbody>
<tr>
<td>DM2020 ABC5</td>
<td>CC55000</td>
<td>5400</td>
<td></td>
</tr>
<tr>
<td>DM2020 ABC4</td>
<td>CC55012</td>
<td>4500</td>
<td>50 mm (1.97 in)</td>
</tr>
<tr>
<td>DM2020 ABC3</td>
<td>CC55013</td>
<td>3600</td>
<td></td>
</tr>
<tr>
<td>DM2020 ABC2</td>
<td>CC55014</td>
<td>2700</td>
<td></td>
</tr>
<tr>
<td>DM2020 ABC1</td>
<td>CC55015</td>
<td>1800</td>
<td></td>
</tr>
</tbody>
</table>

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

A capacitive module can be coupled to the power supply unit and DI2020 for energy recovery in the presence of repeated cycles of acceleration and braking of the payload, avoiding dissipating energy on the braking resistor.
2.2. Detailed features and components

2.2.1. Power supply electrical data

The power module has the main function of directly converting (without transformer) the mains voltage into a continuous voltage, which is distributed via the bus bars, providing power to the modules controlling the different axes of the system.

![Block diagram of the power supply (power components)](image)

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

<table>
<thead>
<tr>
<th>FUNCTIONS</th>
</tr>
</thead>
<tbody>
<tr>
<td>Soft-start circuit</td>
</tr>
<tr>
<td>Braking circuit</td>
</tr>
<tr>
<td>BUS cc voltage monitoring</td>
</tr>
<tr>
<td>Mains voltage presence and value monitoring</td>
</tr>
<tr>
<td>Power supply internal temperature monitoring</td>
</tr>
</tbody>
</table>
2.2.2. DM2020 power supply mechanical data

Fig 2.7 L50 power supply

Fig 2.8 L150 power supply
2.2.3. Connectors

Fig 2.9 Connection layout

- Status Led
- CAN connectors
- 24 Volt
- 0 Volt
- DC bus
- DC bus
- GND (ground)
- Brake resistor
- Power connector
- Bus Bar
2.2.3.1. Connectors layout

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

X1: brake resistor

<table>
<thead>
<tr>
<th>Pin</th>
<th>Designation</th>
<th>Function</th>
</tr>
</thead>
<tbody>
<tr>
<td>1</td>
<td>+RR1</td>
<td></td>
</tr>
<tr>
<td>2</td>
<td>-RR2</td>
<td></td>
</tr>
</tbody>
</table>

X2: mains

<table>
<thead>
<tr>
<th>Pin</th>
<th>Designation</th>
<th>Function</th>
</tr>
</thead>
<tbody>
<tr>
<td>1</td>
<td>U1</td>
<td></td>
</tr>
<tr>
<td>2</td>
<td>V1</td>
<td></td>
</tr>
<tr>
<td>3</td>
<td>W1</td>
<td></td>
</tr>
<tr>
<td>4</td>
<td>Earth</td>
<td></td>
</tr>
</tbody>
</table>

BUSBAR connection

<table>
<thead>
<tr>
<th>Pin</th>
<th>Designation</th>
<th>Function</th>
</tr>
</thead>
<tbody>
<tr>
<td>1</td>
<td>+24 V</td>
<td></td>
</tr>
<tr>
<td>2</td>
<td>0 V DC</td>
<td></td>
</tr>
<tr>
<td>3</td>
<td>+DC BUS</td>
<td></td>
</tr>
<tr>
<td>4</td>
<td>-DC BUS</td>
<td></td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>YELLOW LED</th>
<th>GREEN LED</th>
<th>RED LED</th>
<th>Status</th>
</tr>
</thead>
<tbody>
<tr>
<td>Off</td>
<td>Off</td>
<td>Off</td>
<td>Power supply off or failed</td>
</tr>
<tr>
<td>Off</td>
<td>On fixed</td>
<td>Off</td>
<td>24 Volt applied</td>
</tr>
<tr>
<td>Flashing</td>
<td>Flashing</td>
<td>Off</td>
<td>Three-phase power supply present, BUS charging</td>
</tr>
<tr>
<td>On fixed</td>
<td>Flashing</td>
<td>Off</td>
<td>BUS stable, axes ready to be enabled</td>
</tr>
<tr>
<td>Off</td>
<td>On fixed</td>
<td>Light</td>
<td>Power supply fault</td>
</tr>
</tbody>
</table>

X10 LN A CAN connector (according to CIA 402 CAN on RJ45 connector)

<table>
<thead>
<tr>
<th>Pin</th>
<th>Designation</th>
<th>Function</th>
</tr>
</thead>
<tbody>
<tr>
<td>1</td>
<td>Can_H</td>
<td>CAN line positive terminal</td>
</tr>
<tr>
<td>2</td>
<td>Can_L</td>
<td>CAN line negative terminal</td>
</tr>
<tr>
<td>3</td>
<td>0V_Can</td>
<td>CAN line 0 logic</td>
</tr>
<tr>
<td>4</td>
<td>Aux_Ps_Fault_neg</td>
<td>Signal (denied) of power supply status</td>
</tr>
<tr>
<td>5</td>
<td>Addr_sx_dx</td>
<td>Address for internal communications</td>
</tr>
<tr>
<td>6</td>
<td>Ps_out</td>
<td>Power supply command output</td>
</tr>
<tr>
<td>7</td>
<td>nc</td>
<td></td>
</tr>
<tr>
<td>8</td>
<td>+5V_Can</td>
<td>CAN line power supply (supplied by power supply)</td>
</tr>
</tbody>
</table>
2.2.4. Filters

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

If cables are longer than 50 m, we recommend contacting Moog-Casella’s Applications department.

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

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

Tab 2.5 Main electrical characteristics of filters

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

Contact the Applications Service for ratings and a selection of alternative models to those described above.
2.2.5 Brake resistor

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

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

<table>
<thead>
<tr>
<th>Code</th>
<th>Power (W)</th>
<th>Ohm</th>
<th>Notes</th>
</tr>
</thead>
<tbody>
<tr>
<td>Standard</td>
<td>370</td>
<td>15</td>
<td>Supplied</td>
</tr>
<tr>
<td>AR5974</td>
<td>500</td>
<td>16</td>
<td>Available as an option to be ordered separately</td>
</tr>
</tbody>
</table>

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

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

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

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

2.2.6. Line inductors

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

However, if using a low-inductance network (below 100 uH, it is advisable to 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/μs 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.

---

![Fig 2.10 Diagram of a three-phase input inductor connection](image)

<table>
<thead>
<tr>
<th>Power supply size</th>
<th>Inductance value</th>
<th>Current</th>
<th>Frequency</th>
</tr>
</thead>
<tbody>
<tr>
<td>Type L50</td>
<td>0.1 mH</td>
<td>Inom. 60 A</td>
<td>50/60 Hz</td>
</tr>
<tr>
<td>Type L150</td>
<td>0.1 mH</td>
<td>Inom. 130 A</td>
<td>50/60 Hz</td>
</tr>
</tbody>
</table>

Tab 2.6 Example of external three-phase inductor dimensioning
How to assess whether an inductor is needed:

1. Inductance introduction evaluation
2. Transformer distance MT/BT < 100mt
   - YES: Use the line inductance
   - NO: Presence of an EMC filter
     - YES: Use of the line filter not necessary
     - NO: Contact Moog for evaluating the impact of the filter

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

2.2.7. Cables

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

The cables for the connection between the power supply and the DI2020 can be ordered separately from the DI2020, using the reference table.

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

<table>
<thead>
<tr>
<th>Power supply model</th>
<th>Type L50 (54 A)</th>
<th>Type L150 (128 A)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Network</td>
<td>13 mm² (AWG6)</td>
<td>33 mm² (AWG2)</td>
</tr>
<tr>
<td>Brake resistor</td>
<td>13 mm² (AWG6)</td>
<td>33 mm² (AWG2)</td>
</tr>
<tr>
<td>24 V DC</td>
<td></td>
<td>0.8 mm² AWG 18</td>
</tr>
<tr>
<td>Earth</td>
<td>13 mm² (AWG6)</td>
<td>33 mm² (AWG2)</td>
</tr>
</tbody>
</table>

See “Metric/AWG conversion table” for the metric/AWG conversion table.

For a + 24 Vdc overall power supply, generally consider 1 mm² for each DM2020 module to the power supply unit and then at least 4 mm² for the DI2020 series (to be checked according to the layout of the installation).

2.2.8 Capacitive Module (ABC)

For high-speed and high-mobility machines, it is possible to reduce most of the energy dissipated by the braking resistor. A capacitive module is available to increase the energy stored in the braking phase:

<table>
<thead>
<tr>
<th>Model/Code</th>
<th>ABC5/CCE5000</th>
<th>ABC4/CCE5012</th>
<th>ABC3/CCE5013</th>
<th>ABC2/CCE5014</th>
<th>ABC1/CCE5015</th>
</tr>
</thead>
<tbody>
<tr>
<td>Capacity (µF)</td>
<td>5400</td>
<td>4500</td>
<td>3600</td>
<td>2700</td>
<td>1800</td>
</tr>
<tr>
<td>Width (mm)</td>
<td>50</td>
<td>50</td>
<td>50</td>
<td>50</td>
<td>50</td>
</tr>
<tr>
<td>Depth (mm)</td>
<td>249</td>
<td>249</td>
<td>249</td>
<td>249</td>
<td>249</td>
</tr>
<tr>
<td>Height (mm)</td>
<td>455</td>
<td>455</td>
<td>455</td>
<td>455</td>
<td>455</td>
</tr>
</tbody>
</table>

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

<table>
<thead>
<tr>
<th>Module ID</th>
<th>Total cap. µF</th>
</tr>
</thead>
<tbody>
<tr>
<td>L50 power supply</td>
<td>1800</td>
</tr>
<tr>
<td>L150 power supply</td>
<td>4500</td>
</tr>
<tr>
<td>DI2020</td>
<td>110</td>
</tr>
</tbody>
</table>
2.3. Axis module

2.3.1. General description of functions

<table>
<thead>
<tr>
<th>Acquisition of commands</th>
</tr>
</thead>
<tbody>
<tr>
<td>EtherCAT</td>
</tr>
<tr>
<td>CanOpen</td>
</tr>
<tr>
<td>&quot;Analogue&quot;</td>
</tr>
<tr>
<td>&quot;Digital I/O&quot;</td>
</tr>
<tr>
<td>Acquisition of settings</td>
</tr>
<tr>
<td>Interior memory</td>
</tr>
<tr>
<td>USB</td>
</tr>
<tr>
<td>Field BUS</td>
</tr>
<tr>
<td>Acquisition of feedback</td>
</tr>
<tr>
<td>Encoder</td>
</tr>
<tr>
<td>Resolver</td>
</tr>
<tr>
<td>Functions</td>
</tr>
<tr>
<td>Position controller</td>
</tr>
<tr>
<td>Velocity controller</td>
</tr>
<tr>
<td>Torque controller</td>
</tr>
<tr>
<td>USB interface</td>
</tr>
<tr>
<td>EtherCAT interface</td>
</tr>
<tr>
<td>CANOpen interface (optional) Analog reference (optional)</td>
</tr>
<tr>
<td>Parking brake control (on relevant models) Analog</td>
</tr>
<tr>
<td>I/O management (optional)</td>
</tr>
<tr>
<td>Digital I/O management (optional)</td>
</tr>
<tr>
<td>Sensorless mode</td>
</tr>
<tr>
<td>Data recording</td>
</tr>
</tbody>
</table>

**ELECTRICAL DATA**

<p>| | |</p>
<table>
<thead>
<tr>
<th></th>
<th></th>
</tr>
</thead>
<tbody>
<tr>
<td>Auxiliary voltage</td>
<td>24 Vdc +/- 10 %</td>
</tr>
<tr>
<td>DC-link voltage</td>
<td>from 282 to 744 Vcc</td>
</tr>
<tr>
<td>Rated torque Nm (0 rpm)</td>
<td>from 2 to 5.1 Nm</td>
</tr>
<tr>
<td>Peak torque Nm</td>
<td>from 8 to 22 Nm</td>
</tr>
<tr>
<td>Protection</td>
<td>Thermal protection of the heat sink, thermal sensor on the control board, undervoltage or overvoltage detection</td>
</tr>
<tr>
<td>Cooling</td>
<td>Natural</td>
</tr>
</tbody>
</table>

**MECHANICAL DATA**

| Weight                  | between 7 kg and 10 kg           |
2.3.2. Mechanical Dimensions

The dimensions of the DI2020 are derived from the size of the motor to which the drive is associated. The motors’ measurements in turn vary according to their characteristics, as evidenced by the following reference tables:

<table>
<thead>
<tr>
<th>Number of Modules</th>
<th>L (no brake)</th>
<th>L (brake)</th>
<th>LT (no brake)</th>
<th>LT (brake)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Motor size 100</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>2</td>
<td>220mm/8.66in</td>
<td>263mm/10.35in</td>
<td>274mm/10.79in</td>
<td>317mm/12.48in</td>
</tr>
<tr>
<td>4</td>
<td>263mm/10.35in</td>
<td>306mm/12.05in</td>
<td>317mm/12.48in</td>
<td>360mm/14.17in</td>
</tr>
<tr>
<td>Motor size 115</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>2</td>
<td>218mm/8.58in</td>
<td>261mm/10.28in</td>
<td>271mm/10.67in</td>
<td>314mm/12.36in</td>
</tr>
<tr>
<td>4</td>
<td>261mm/10.28in</td>
<td>304mm/11.97in</td>
<td>314mm/12.36in</td>
<td>357mm/14.06in</td>
</tr>
</tbody>
</table>

2.3.3. Positioning transducers

The DI2020 can be equipped with the following position transducers mounted on the motor:

- RESOLVER 2 poles
- ENCODER Sincos Hiperface Single turn Capacitive
- ENCODER Sincos Hiperface Multi turn Capacitive
- ENCODER Endat 22 Single turn Optical
- ENCODER Endat 01 Multi turn Optical
- ENCODER Endat 22 Multi turn Optical
- ENCODER Endat 01 Single turn Optical
- ENCODER Endat 22 Single turn Inductive
- ENCODER Endat 22 Multi turn Inductive

*Note: The choice of the transducer implies different hardware: it is not possible to change a motor transducer outside of our production plant*
2.3.4. DI2020 connectors

The figure shows hybrid power-signal connectors:
Power connector, input X1 and output X2.

![Diagram of X1 and X2 connectors]

The pin assignment of the two mirroring connectors is shown in the following table.

<table>
<thead>
<tr>
<th>PIN</th>
<th>Description</th>
<th>Recommended minimum section</th>
</tr>
</thead>
<tbody>
<tr>
<td>1</td>
<td>24 V S1 STO</td>
<td>0.35 mm²</td>
</tr>
<tr>
<td>2</td>
<td>24 V S2 STO</td>
<td>0.35 mm²</td>
</tr>
<tr>
<td>3</td>
<td>FB BK STO</td>
<td>0.35 mm²</td>
</tr>
<tr>
<td>4</td>
<td>Spare</td>
<td></td>
</tr>
<tr>
<td>5</td>
<td>Spare</td>
<td></td>
</tr>
<tr>
<td>6</td>
<td>Spare</td>
<td></td>
</tr>
<tr>
<td>A</td>
<td>0 VDC</td>
<td>2.5 mm²</td>
</tr>
<tr>
<td>B</td>
<td>+24 VDC</td>
<td>2.5 mm²</td>
</tr>
<tr>
<td>C</td>
<td>+AT</td>
<td>2.5 mm²</td>
</tr>
<tr>
<td>D</td>
<td>-AT</td>
<td>2.5 mm²</td>
</tr>
<tr>
<td>GND</td>
<td>GROUND</td>
<td>2.5 mm²</td>
</tr>
</tbody>
</table>

Note: The table refers to both connectors. The pin assignment on the two connectors is specular. X1 contacts are male and correspond to the female contacts on X2.

Ethercat Fieldbus Connector (X4 input, X5 output)

![Diagram of Ethercat Fieldbus Connector]

Connector pin-out

<table>
<thead>
<tr>
<th>Pin</th>
<th>Description</th>
</tr>
</thead>
<tbody>
<tr>
<td>1</td>
<td>Tx+</td>
</tr>
<tr>
<td>2</td>
<td>Rx+</td>
</tr>
<tr>
<td>3</td>
<td>Rx-</td>
</tr>
<tr>
<td>4</td>
<td>Tx-</td>
</tr>
</tbody>
</table>

Note: The table refers to both connectors.
X6 USB Communication connector

<table>
<thead>
<tr>
<th>Pin</th>
<th>Description</th>
</tr>
</thead>
<tbody>
<tr>
<td>1</td>
<td>USB +5Volt</td>
</tr>
<tr>
<td>2</td>
<td>USB Data M</td>
</tr>
<tr>
<td>3</td>
<td>USB Data P</td>
</tr>
<tr>
<td>4</td>
<td>USB 0Volt</td>
</tr>
<tr>
<td>5</td>
<td>Shield</td>
</tr>
<tr>
<td>6</td>
<td>Shield</td>
</tr>
</tbody>
</table>

Note: You must use a shielded USB cable

**Additional notes on DI2020 power supply**

The overall number of modules simultaneously mounted, and the resulting number of separate lines that can be fed, is limited by the performance limits of the power supply module detailed above. These limits are ensured by an integrated thermal protection that intervenes when the maximum rated current is exceeded.

The following elements also contribute to limiting the number of DI2020 that can be put in series through a single line:

- The maximum section of the power cord that the power terminal can hold is 4 mm² (AWG12 - terminals A-B-C-D) and the maximum current rating supported by the power wiring (cable + connector) is 30 Arms (according to the CE Certification of the Connector).

- The maximum cross section of the power cable on the signal terminals is 1 mm² (AWG18 - terminals 1 to 6) and the maximum nominal current rating supported by the wiring (cable + connector) of the supply is 1.2 Arms (according to the CE certification of the connector).

INFO

Depending on the type of fieldbus you must install a different hardware and firmware. If the connection is via Ethercat, the file will have suffix "_ecat" if through CanBus the file will have suffix "_can".
2.4. Safety and usage guidelines

2.4.1. General description of safety features

Power and control connections can also be powered while the motor is stationary. During operation, the drives can reach high temperatures with the risk of injury.

In addition, voltage strikes can occur with a risk to people's safety and damage to electrical contacts.

Caution: Wait at least six minutes after interrupting the power supply before loosening the connections. As an additional safety measure, however, it is advisable to verify instrumentally that DC BUS voltage values have fallen below 40 V before any interaction with contacts and connections.

2.4.2. STO Safety feature

2.4.2.1. Description

The DI2020 drives include as standard the STO function (Safe Torque Off) that shall ensure personnel protection against accidental restart of the drive.

The DI2020 standard version contains the STO function to be used as interlock against accidental motor starts.

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

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

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

2.4.2.2. Directives on safety

**Attention**

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

**Attention**

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

**Attention**

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

**Notice**

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

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

<table>
<thead>
<tr>
<th>Input voltage</th>
<th>24 V +/- 10 %</th>
</tr>
</thead>
<tbody>
<tr>
<td>Max input current</td>
<td>30 mA +/- 10 %</td>
</tr>
</tbody>
</table>

Tab 2.7 Electrical Features STO Function
2.4.3. Directives on the use of the drives
It is extremely important that the module’s technical data and information about connections (plate and documentation) are always available and complied with. Only qualified technical personnel familiar with transport, installation, assembly and commissioning may carry out these activities. Qualified personnel shall be familiar with and observe the following standards

- IEC 60364 e IEC 60664
- Accident prevention national regulations
- Safety instructions of the present manual

The drives contain electro-statically sensitive components, which may be damaged by handling if touching a conductive object that is earthed. Electrostatic charge should be discharged before handling the drive and positioning it on a conductive surface.

2.4.3.1. Use as directed
Drives are safety devices that are built into electrical plants or machines, and can only be operated as integral components of such plants or machines. The manufacturer must produce a risk analysis for the machine, and take appropriate measures to prevent unforeseen movements that can cause injury or damage to persons or property. If the drives are used in residential areas, in business areas, or in small industrial operations, then additional filters must be implemented by the user after full system measures.

2.4.3.2. Power supply
The DI2020 series drives have to be powered via DM2020 power supply modules connected to three-phase earthed industrial electric networks (TN system, TT system with earthed neutral point, no more than 10 KA symmetrical rated current at 208 V -10%, 230 V, 240 V, 400 V or 480 V +10%). Overvoltages between phases and the drive housing must not be higher than the peak of 1000 V. According to the EN61800-3 standard, voltage transient peaks (< 50 ms) between phases must not exceed 1000 V. Voltage transient peaks (< 50 µs) between a phase and housing must not exceed 2000 V.

2.4.3.3. Prohibited use
Usage which differs from that described in section “Use as directed” are not recommended, and could cause damage to persons, equipment or other items. Use of the drive is normally prohibited in the following environments:

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

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

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

The control of brake holding by the DI2020 drive alone may not be used in applications where personnel security is to be ensured with the motor brake.
2.4.3.4 In house storage duration

Storing DI2020 drives under prescribed conditions and for a consecutive period of up to one year does not require specific limitations and requirements; in the case where the storage period is longer than 1 year prior to proceeding to the phases of installation and commissioning of the module perform the following steps:

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

2.4.3.5 Maintenance / cleaning

The DI2020 drives and DM2020 power supply modules are maintenance-free; the opening of the modules will void your warranty.

Cleaning
Do not immerse or spray the module
If the surface is dirty: clean with a dry cloth
In case of dirty ventilation grids: clean with a dry brush

2.4.3.6 Decommissioning

To remove and put out of order a servo drive DI2020 (replacement, dismantling) follow the procedure below:

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

2.4.3.7 Repairs

The servo drive can be repaired only by the manufacturer; the opening of the modules will void your warranty. Perform decommissioning procedure and send it back to the address of the manufacturer indicated on the product nameplate; if available use the original packaging material.

2.4.3.8 Disposal

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

3.1. EC

According to EU directives, drives shall conform to:

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

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

As regards electromagnetic compatibility, the DM2020 refers to C3 category industrial environments.

**CAUTION**

In a domestic environment, the DI2020 may emit radio frequency disturbance

**ATTENTION**

Dans un environnement domestique, le DI2020 peut émettre des perturbations des fréquences radio

**INFORMATION**

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

---

**MOOG ITALIANA S.r.l.**
Sede di Casella
via Avosso 94, Casella (Genova), Italy

**Marchio / Brand:** MOOG

**Aziopianti Integrai / Series / Integrated Drive Series:** DI2020

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

<table>
<thead>
<tr>
<th>nr. ref.</th>
<th>Titolo / Title</th>
</tr>
</thead>
<tbody>
<tr>
<td>2014/30/EC</td>
<td>Direttiva Compatibilità Elettromagnetica / EMC Directive</td>
</tr>
<tr>
<td>2014/35/EC</td>
<td>Direttiva Bassa Tensione / Low Voltage Directive</td>
</tr>
</tbody>
</table>

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:

<table>
<thead>
<tr>
<th>Codice / Code</th>
<th>Titolo / Title</th>
</tr>
</thead>
<tbody>
<tr>
<td>EN 61800-5-1</td>
<td>2006 Adjustable speed electrical power drive systems. Part 5-1: Safety requirements. Electrical thermal and energy characteristics. Part 5.1: Prescrizioni - Sicurezza elettrica, termica ed energetica</td>
</tr>
</tbody>
</table>

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

Ultima data affixa dell’anno in cui è stata affissa la marcatura CE / Last two digits of the year in which the CE marking was affixed: 17

Casella, 17 Marzo, 2017

Gianfranco Costa

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

The DI2020 includes the Safe Torque Off (STO) function, according to standards EN 61800-5-2; EN/ISO 13849-1:2006. (SILCL 3 PL “e” (as certified below). The function also corresponds to an uncontrolled stop, according to the 0 stop category of IEC/EN 60204-1.

Function validation is based on:
• a guarantee that a single failure does not result in loss of the safety function
• some, but not all, possible failures may be identified
• the sum of several unidentified failures may result in loss of the safety function

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

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

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

Based on CEI EN 62061, this specification must include all data that may affect design of the electrical/electronic device, including, where applicable:
• Operating conditions of the machine
• The priority of functions that may be enabled concurrently and cause conflictual actions
• The operating frequency of each SCRF
• The required response time of each SCRF
• A description of each SCRF
• The interface of each SCRF with other machine functions
• A description of the reactions to failure and constraints relative to machine restart, when the reaction to failure causes the machine to stop
• A description of the operating environment
• Tests and associated equipment (e.g. access hatches)
• The frequency of operating cycles and factor of use in operating cycles
4. ELECTRICAL AND MECHANICAL INSTALLATION

4.1. Tools and instruments

We recommend that you have the following tools for installing the various modules:

- Screwdriver Tork T25 (fixing BUS BAR feeder link)
- M4 Cross screwdriver (wall mount for DM2020 power supply)
- M3 Phillips screwdriver (BUS BAR Feeder Protection)
- M8 screws for mounting the DI2020 to the machine

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

4.2. Mechanical installation

4.2.1. Assembly of components

4.2.1.1. Assembling the power supply

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

4.2.1.2. Positioning of brake resistors

Position at the top of the distribution board to facilitate the loss of heat produced.
Installation with brackets supplied for a standard resistor.
Installation on the heat sink (not supplied) for the optional resistor (armoured).

4.2.1.3. Assembling the axes

Mounting Material:
4 screws M8 for fastening to the machine through the appropriate slots of the motor flange.

4.2.1.4. EMC Filters installation

To install filters, follow the instructions to install the power supply.
4.3. Electrical installation and thermal sizing

4.3.1. Safety and general instructions for the board

**WARNING**

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

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

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

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

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

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

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

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

Usually the shield must be connected at each end. In some cases, control cable shielding may be connected at one end only, to eliminate network noise that could interfere with the control signal.
Indications for laying connection cables:
- Do not overlap power cables with signal cables
- The shielding cover must be greater than 70 %
- Do not lay power and signal cables side by side, in particular not close to the power filter, and make sure they are physically separate
- Make sure no loops form in the cables. Keep cables as short as possible and close the potential correctly.
- Keep power supply cables separate from the motor cables
- If the motor is equipped with a stop brake, keep the 24 V brake cables separate from the signal cables; (feedback) unless these are already incorporated in the motor power cable.

Fig 4.2 Detail of connection between cables and EMC bracket

4.3.1.1. Thermal sizing of the board

4.3.1.2. Dissipation of the power supply unit

<table>
<thead>
<tr>
<th>% Rated current</th>
<th>Type L50</th>
<th>Type L150</th>
</tr>
</thead>
<tbody>
<tr>
<td>0</td>
<td>25</td>
<td>35</td>
</tr>
<tr>
<td>25</td>
<td>75</td>
<td>150</td>
</tr>
<tr>
<td>50</td>
<td>125</td>
<td>250</td>
</tr>
<tr>
<td>75</td>
<td>175</td>
<td>350</td>
</tr>
<tr>
<td>100</td>
<td>225</td>
<td>450</td>
</tr>
</tbody>
</table>

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

4.3.2.3. Dissipation of the axes

<table>
<thead>
<tr>
<th>% Rated Current</th>
<th>CR6 122 X X X X X X</th>
<th>CR6 142 X X X X X X</th>
<th>CR6 222 X X X X X X</th>
<th>CR6 242 X X X X X X</th>
</tr>
</thead>
<tbody>
<tr>
<td>0</td>
<td>25</td>
<td>25</td>
<td>25</td>
<td>25</td>
</tr>
<tr>
<td>25</td>
<td>50</td>
<td>75</td>
<td>100</td>
<td>125</td>
</tr>
<tr>
<td>50</td>
<td>75</td>
<td>125</td>
<td>150</td>
<td>150</td>
</tr>
<tr>
<td>75</td>
<td>100</td>
<td>175</td>
<td>200</td>
<td>200</td>
</tr>
<tr>
<td>100</td>
<td>125</td>
<td>225</td>
<td>250</td>
<td>275</td>
</tr>
</tbody>
</table>

Warning: the DI2020 normally are installed externally to the board and should not be considered in the thermal calculation of the board itself.
4.3.1.4. Thermal dissipation of the accessories

<table>
<thead>
<tr>
<th>Device</th>
<th>Dissipated power (W)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Network filter for power supply L50</td>
<td>30</td>
</tr>
<tr>
<td>Network filter for power supply L150</td>
<td>50</td>
</tr>
<tr>
<td>Standard brake resistor</td>
<td>370 or 1000</td>
</tr>
<tr>
<td>Optional brake resistor</td>
<td>500</td>
</tr>
</tbody>
</table>

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

4.3.2. Auxiliary power supply features

Auxiliary power must be 24 V with tolerance +/- 10% and "Ripple" less than 200 mV.

The absorbed current will depend on which and how many modules make up the system. The maximum required current will be the sum of the currents required by each component. Place the DI2020 with the brake as close as possible to the DM2020

<table>
<thead>
<tr>
<th>Modulo</th>
<th>Corrente assorbita (A)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Alimentatore L50</td>
<td>1,00</td>
</tr>
<tr>
<td>Alimentatore L150</td>
<td>2,00</td>
</tr>
<tr>
<td>DI2020 - 122/222</td>
<td>0,70</td>
</tr>
<tr>
<td>DI2020 142/242</td>
<td>0,70</td>
</tr>
<tr>
<td>Circuito Freno Motore</td>
<td>0,75</td>
</tr>
</tbody>
</table>

Tab 4.1 Auxiliary circuits input

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

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

4.3.4. Connection to the mains

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

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

4.3.4.1. Types of mains networks

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

a) Direct mains connection (earthing point)
b) The control unit neutral and earthing of the entire plant are connected to a single connector, the PEN
c) All parts exposed to contact and shielding must be connected to earth
The type of network shown in the figure is the most widespread in Europe and has the following characteristics:

a) Direct mains connection (earthing point)

b) NA

c) All parts exposed to contact and shielding must be connected to earth

**TN-S network**

![Fig 4.4 TN-S network](image)

**TT network**

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

a) Direct mains connection (earthing point)

b) NA

b) All parts exposed to contact and shielding must be connected to earth

![Fig 4.5 TT network diagram](image)

### 4.3.4.2. Protection components

**Fuses**

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

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

**Safety switches for fault currents.**

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

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

The DI2020 does not require fuses on the auxiliary power supply and DC BUS.
4.3.4.3. Earth connection

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

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

4.3.5. Power supply unit wiring

4.3.5.1. Earthing

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

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

4.3.5.2. Power supply cable connection

See section “Cables” for cable selection.

4.3.5.3. Brake resistor connection

See section “Brake resistor” for resistor selection.

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

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

**WARNING**
The user is responsible for the physical protection of the BUSBARs and other safety devices intended to prevent harm to persons: For this purpose, the front cover or two side covers provided with the drive must be used (on the two modules at each side of the system).

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

---

**CONNECT TERMINAL NOT ISOLATED (5mm TO INTERNAL CLAMP) WITH HEAT SHRINKABLE TUBE OR INSULATION HOODS AS PER THE TABLE BELOW**

<table>
<thead>
<tr>
<th>Cable section</th>
<th>16mm²</th>
<th>35mm²</th>
</tr>
</thead>
<tbody>
<tr>
<td>Closure type</td>
<td>BM 01531</td>
<td>BM 01731</td>
</tr>
<tr>
<td>Heat shrinkable tube</td>
<td>TE VERSAFIT 318-0</td>
<td>TE VERSAFIT 112-0</td>
</tr>
<tr>
<td>Insulating hood</td>
<td>BM 81015</td>
<td>BM 81035</td>
</tr>
</tbody>
</table>

**Note:** For heat-shrinkable terminals and tubes, alternative brands may be used provided they are equivalent. The insulating hood is an alternative to the heat shrinkable tubing.

---

4.3.4.5. Auxiliary voltage and signal connection

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

4.3.4.6. Connecting Signals to the Power Supply

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 “Connectors and LEDs”.

4.3.5. Axis module wiring

Connect the DI2020 to the DM2020 power supply using shielded cables with a sufficient section such as to ensure a negligible voltage drop towards the chain of connected modules (2.5 mm² minimum section recommended).

4.3.5.1. Earthing

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

**INFORMATION**
During the definition of the brake connections, take into account the possible voltage drop across the cables that carry the power supply also to the logic sections of DI2020.

**WARNING**
Brake power is NOT derived from the drive, but is powered by a 24Volt auxiliary power supply. Keep in mind that it must provide braking power. In case of DI2020 in “cascade”, if possible, place the modules with the brake at the beginning of the series.

The figure shows the functional and timing ratios between enable, activate and speed control signals. Engine brake times vary depending on the engine models to which the data is to be referenced. 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 the command reception and its transmission to the brake is less than 125 us. The brake activation delay depends on the type of brake and is specified by the Manufacturer.

---

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

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

**AVERTISSEMENT**
La même information donnée pour le câble du moteur s’applique ici, donc un soin particulier doit être payé à la protection, même si les conducteurs ne sont pas encore intégrés dans le câble moteur.

**AVERTISSEMENT**
L’utilisation du frein moteur ne garantit pas la sécurité personnelle. Les charges verticales en particulier exigent un frein mécanique supplémentaire pour fonctionner en toute sécurité; en utilisant des planches de sécurité, par exemple.

---

**Fig 4.11 Diagram of brake activation times**

A. Machine deceleration time (variable)
B. Brake activation (300 ms)
4.3.5.3. Connecting the Fieldbus

Fieldbus dedicated connectors are X4 (In) and X5 (Out)

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

- CAN connection (*)
The same connector is used for the CAN interface.

For connection, use a cable end terminated with two 120 ohm resistors (first and last drive of the "chain"). The length of the cable that can be used to ensure secure communication diminishes as transmission speed increases. The following table can be referenced; FOR LENGTHS OVER 100 METERS please contact our Service for specific length / speed tests.

(*) in development

<table>
<thead>
<tr>
<th>Transmission speed (kBaud)</th>
<th>Max cable length (m)</th>
</tr>
</thead>
<tbody>
<tr>
<td>1000</td>
<td>10</td>
</tr>
<tr>
<td>500</td>
<td>60</td>
</tr>
<tr>
<td>250</td>
<td>100</td>
</tr>
</tbody>
</table>
5. COMMISSIONING USING THE GUI

The system is commissioned via the Dx2020 GUI operator interface. For a detailed description of menus and procedures, please refer to the “Help” guide on the GUI itself.

5.1. Safety

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

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

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

**ATTENTION**
Les changements de paramètres sans contrôles précédents peuvent provoquer un mouvement inattendu et incorrect de la machine.

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

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

**ATTENTION**
Seul le personnel qualifié est autorisé à configurer les paramètres d’un entraînement en fonctionnement.

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

**ATTENTION**
Les changements de paramètres sans contrôles précédents peuvent provoquer un mouvement inattendu et incorrect de la machine.

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

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

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

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

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

**AVERTISSEMENT**
Avant l’installation, le fabricant de la machine doit effectuer une évaluation précise des risques et prendre toutes les mesures nécessaires pour que le mouvement imprévu de la machine ne nuise pas à personnes ou puisse endommager des biens.
5.2. Dx2020 GUI

5.2.1. General description

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

The main functions are:

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

5.2.2. Minimum PC requirements

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

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

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

Operating systems

- Windows XP Home Edition (Service Pack 3)
- Windows XP Home Edition (Service Pack 3)
- Windows XP Home Edition (Service Pack 64 3)
- Windows Vista
- Windows 7
- Windows 8
- Windows 8.1
- Windows 10

**INFORMATION**

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

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

**INFORMATION**

Users must have administration rights, both for installing and running the program

**INFORMATION**

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

The following notes refer to a single-axis configuration; For a dual-axis configuration, the same considerations apply.
5.2.3. Dx2020 GUI Installation

Once the installer has been downloaded, launch by double clicking on it. Windows Vista and Windows 7 have a more advanced control system for starting applications than that on Windows XP, called UAC (User Account Control). Every time that any program is launched necessitating further administration rights, this system asks the user if they want to proceed. The installation software must be requested from the Technical Assistance Service at Moog-Casella.

Click on yes or agree to proceed with the installation.

If the software is being installed for the first time on the PC, the user will be asked for language preferences on start-up. As a default, if available, the program will automatically select the same language as that of the operating system as the first choice.

This setting is applied to both the installer language and the Dx2020 GUI application language. The languages available are English and Italian. In any case, the language can also be changed from the GUI (Graphics User Interface) at a later time.

After the update, the program will proceed with the installation of the .Net, FrameWork 4, where this is not already present. Installation of this last package will take between 5 and 10 minutes depending on the PC.

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

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

Once the installation has finished, click on finish.

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

Once the program is installed, the Dx2020 GUI program icon will be visible.
5.2.4. Connection GUI-drive

Launch the executable Dx2020 GUI.

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

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

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

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

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

The status bar LED will turn green.

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

INFORMATION

In the event of anomalies during connection, refer to the “Trouble Shooting” chapter and follow the steps recommended.
5.2.5. Layout

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

- **Menu**: The following menus are present: File, Network, Tools, Options and ? Refer to the Online Help on the application for more information.
- **Toolbar**: 
  - Connect: Open the communication port selected
  - Disconnect: Close the communication port
  - Load all: Update all of the parameters of the connected axes
  - Monitor: Open the monitoring window
  - Terminal: Open the terminal form manual access
  - Load view: Update the parameters in the current view only
• Navigation area:
The intuitive, organised structure of this area allows users to access all of the information they need, divided into views. Connections can be made to single-axis modules or dual-axis modules. For dual-axis modules, the rst axis shown is axis 1 (master), followed by axis 2 (slave). Each axis has a sub-menu which groups the parameters by function (transducer, motor, velocity loop, etc.). Clicking on the sub-menu in the main area will display the associated graphics window. The last element of the menu relates to the EtherCAT or CAN communication parameters (one per module).

• Main area:
This area displays the information and parameters relating to the view selected in the navigation area. This window allows users to view and set DI2020 drive parameters. Refer to the Online Help on the application for more information.

This area is dedicated to displaying messages that may have different meanings. You can set a filter to display messages by type (ERROR, WARNING, INFO, DEBUG).
• **Status bar:**
The status bar displays information on the status of the application.
It indicates which protocol is currently in use, whether a connection is present, and the progress of operations across all views.

![Status bar diagram]

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

### 5.2.6. Updating firmware (Bootloader)

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

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

To access the dedicated tools: Go to PC Start/Programs/MoogTools/Dx2020 GUI/Bootloader/...
See the Online Help for details.

### 5.2.7. How to access the Online Help

This can be accessed in two ways:

1. **Via the Dx2020 GUI operator interface:** From the menu bar, select ?

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

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

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

(*) in development

Note: Configuration of motor parameters and transducers is carried out at the factory

5.3.1. Axis modules identification

Follow the instructions in the Online Help Guide on connections

5.3.2. Defluxing (“Field Weakening Algorithm”)

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

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

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

Refer to the Online Help for more information on configuration, selecting Configuration Views/Motor Parameters.
5.3.3.1. Sensorless

The DM2020 features the Sensorless operating mode, with no speed transducer. In order to enable it, select Feedback from the navigation area. Under the tab Feedback sources, set the fields as indicated in the figure.

Under the tab 1 STD interface (X3), set the fields as indicated in the figure.
5.3.4. Control loops configuration

5.3.4.1. Control mode configuration

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

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

![Control Structure Diagram]

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

**INFORMATION**
The control loops must be calibrated by qualified personnel.

5.3.4.2. Torque loops parameters configuration

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

The user can configure the bandwidth passing through the closed torque loop via the Terminal window, setting the “bandPass” variable; the possible values are 3000 (default), 2000, 1000, 600, 400 in Hz.

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

5.3.4.3. Speed loops parameters configuration

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

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

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

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

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

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

![Velocity Loop Diagram]

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

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

Users can choose from the following types:

- **Lag**: The filter consists of a real pole and a real zero. The frequency of the pole and zero are entered, and have to be positive or zero.
- **Bq**: This is a standard biquad filter, with a pair of complex combined zeros and a pair of complex combined poles. The parameters that must be specified are:
  - Frequency of the zero
  - Damping of the zero
  - Frequency of the pole
  - Damping of the pole
  The frequencies must be positive or zero. The damping factors must be between -1 and 1.
- **Pole**: The filter has a single real pole. The parameter to be specified is the pole frequency, which must be positive or zero.
- **DbPole**: The filter has two complex combined poles. The parameters that must be specified are:
  - Frequency of the pole
  - Damping of the pole
  The frequency must be positive. The damping factor must be between -1 and 1.
- **Dircoef**: Enter the coefficients of the filter numerator and denominator (rarely used)

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

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

1. Damping
2. Frequency
3. Type of filter
Examples of filters

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

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

The position control must ensure that the motor speed follows the position reference as closely as possible. The quality of response from the system depends on the loop parameter settings.
The position control is PID-type (proportional-integral-derivative).
The proportional term products an action that is stronger the bigger the error.
The derivative term observes whether the error is increasing or decreasing, damping system behaviour.
The integral term cancels the steady-state error.
To set the parameters, select Position loop from the Navigation area: A window will open showing the block diagram of the loop in question.

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

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

The reaction of the drive to each alarm can be configured individually by selecting the Fault Configuration link. A window will open with a list of the faults which can be managed: A reaction can be chosen for each fault from a drop-down menu.

There are four options:

<table>
<thead>
<tr>
<th>Reaction</th>
<th>Effect</th>
</tr>
</thead>
<tbody>
<tr>
<td>None</td>
<td>The alarm is ignored</td>
</tr>
<tr>
<td>Emergency</td>
<td>The drive sends an emergency message but is not stopped or disabled</td>
</tr>
<tr>
<td>Disabling</td>
<td>Disables the drive and carries out the configured stop procedure (from Application Parameters/Fault Reactions)</td>
</tr>
<tr>
<td>Stop</td>
<td>Immediate disabling; The drive stops motor control, if the moving axis continues to move due to inertia.</td>
</tr>
</tbody>
</table>

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

For some alarms, the Dx2020GUI prevents some reactions from being selected in order to guarantee the integrity of the drive (for example, it is not possible to activate emergency braking after "overvoltage").
Here below some alarms on the DI2020:

The faults listed below cannot be configured and the reaction is always “STOP”:
- short_circuit_phase_U_low
- short_circuit_phase_U_hi
- short_circuit_phase_V_low
- short_circuit_phase_V_hi
- short_circuit_phase_W_low
- short_circuit_phase_W_hi
- restore_data_memory_corrupted
- factory_data_memory_corrupted
- calibration_data_memory_corrupted

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

5.3.7. Application parameters

From this menu, it is possible to configure the drive reaction when specific events occur.
5.3.8. Configuration of modes and commands

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

Operating mode

**INFORMATION**
Check that the firmware installed supports the selected fieldbus (with EtherCAT fieldbuses, the firmware will have the filename extension _ecat, and with CAN fieldbuses, the firmware will have the file extension _can).

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

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

Current status

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

Command

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

Operating mode

The operating mode – or the function performed by the drive – will be set. The following values can be chosen:
• Analogue speed
  The drive runs a speed control following a reference from an analogue input. A variable torque limit can also be set, again from the analogue input. Typical operating mode: Analogue)

• Analogue torque
  The drive runs a torque control following a reference from an analogue input. Typical operating mode: Analogue)

• Internal speed
  The drive runs a speed control following a reference generated inside the drive itself (see function generator) (typical operating mode: Local)

• Internal torque
  The drive runs a torque control following a reference generated inside the drive itself (see function generator) (typical operating mode: Local)

• Cyclic Synch Position
  The drive runs a position control following a reference generated cyclically by a device/remote control. This is the Cyclic Synchronous Position Mode, as defined in the DS402 standard. Typical operating mode: EtherCAT/CANOpen)

• Cyclic Synch Velocity
  The drive runs a speed control following a reference generated cyclically by a device/remote control. This is the Cyclic Synchronous Velocity Mode, as defined in the DS402 standard. Typical operating mode: EtherCAT/CANOpen)

• Cyclic Synch Torque
  The drive runs a torque control following a reference generated cyclically by a device/remote control. This is the Cyclic Synchronous Torque Mode, as defined in the DS402 standard. Typical operating mode: EtherCAT/CANOpen)

INFORMATION
  There are other modes relating to specific applications; these are not described in this document

When the commands to the drive are of internal origin (e.g. Operating mode = Local, Operative mode = Internal speed) the different reference profiles can be categorised (Square, Triangle, Sawtooth, Keystone, Breast, Profile, Jog).
DI2020 state machine

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

<table>
<thead>
<tr>
<th>Transition</th>
<th>Event(s)</th>
<th>Action(s)</th>
</tr>
</thead>
<tbody>
<tr>
<td>0</td>
<td>Automatic transition after power-on or reset application</td>
<td>Drive device self-test and/or self-initialisation shall be performed.</td>
</tr>
<tr>
<td>1</td>
<td>Automatic transition</td>
<td>Communication shall be activated.</td>
</tr>
<tr>
<td>2</td>
<td>Shutdown command from control device or local signal</td>
<td>None</td>
</tr>
<tr>
<td>3</td>
<td>Switch on command received from control device or local signal</td>
<td>The high-level power shall be switched on, if possible.</td>
</tr>
<tr>
<td>4</td>
<td>Enable operation command received from control device or local signal</td>
<td>The drive function shall be enabled and all internal set-points cleared.</td>
</tr>
<tr>
<td>5</td>
<td>Disable operation command received from control device or local signal</td>
<td>The drive function shall be disabled.</td>
</tr>
<tr>
<td>6</td>
<td>Shutdown command received from control device or local signal</td>
<td>The high-level power shall be switched off, if possible.</td>
</tr>
<tr>
<td>7</td>
<td>Quick stop or disable voltage command from control device or local signal</td>
<td>None</td>
</tr>
<tr>
<td>8</td>
<td>Shutdown command from control device or local signal</td>
<td>The drive function shall be disabled, and the high-level power shall be switched off, if possible.</td>
</tr>
<tr>
<td>9</td>
<td>Disable voltage command from control device or local signal</td>
<td>The drive function shall be disabled, and the high-level power shall be switched off, if possible.</td>
</tr>
<tr>
<td>10</td>
<td>Disable voltage or quick stop command from control device or local signal</td>
<td>The high-level power shall be switched off, if possible.</td>
</tr>
<tr>
<td>11</td>
<td>Quick stop command from control device or local signal</td>
<td>The quick stop function shall be started.</td>
</tr>
<tr>
<td>12</td>
<td>Automatic transition when the quick stop function is completed and quick stop option code is 1, 2, 3 or 4, or disable voltage command received from control device (depends on the quick stop option code)</td>
<td>The drive function shall be disabled, and the high-level power shall be switched off, if possible.</td>
</tr>
<tr>
<td>13</td>
<td>Fault signal (see also IEC 01800-7-301)</td>
<td>The configured fault reaction function shall be executed.</td>
</tr>
<tr>
<td>14</td>
<td>Automatic transition</td>
<td>The drive function shall be disabled; the high-level power shall be switched off, if possible.</td>
</tr>
<tr>
<td>15</td>
<td>Fault reset command from control device or local signal</td>
<td>A reset of the fault condition is carried out, if no fault exists currently on the drive device; after leaving the Fault state, the Fault reset bit in the controlword shall be cleared by the control device.</td>
</tr>
<tr>
<td>16</td>
<td>Enable operation command from control device, if the quick stop option code is 5, 6, 7, or 8</td>
<td>The drive function shall be enabled.</td>
</tr>
</tbody>
</table>

NOTE: It is not recommended to support transition 16.
5.4. Power supply

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

**INFORMATION**
The charging time of the DC bus depends on the number of modules and the value of the soft-start resistance used; with standard resistance, the time is around three seconds with two 50 mm modules connected.

5.5. Enabling the STO

The STO circuit must be activated to enable the axis

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

See chapter 7.

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

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

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

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

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

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

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

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

InformatiOn
The motor must be free to rotate.

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

Autophasing is run by Dx2020 GUI software.
Once the motor parameters have been set, select “Modes and Commands” in the navigation area.
Check that the power supply and the STO are then press the following in sequence in the “Command field:
• “Power off”
• “Power on”, leaving the drive in this status
The drive will indicate enabling with an “S” on the display.
From the navigation area, select “Feedback”: Select the tab “Feedback sources”. Configure the timing current with a value equal to the rated motor current (Timing Current field). Configure the timing time as required (set to a maximum value of 4 seconds). Press the “Begin timing” button: The progress indicator will be displayed (green if OK, red if there are alarms). By selecting the tab “1° STD interface” or “2° STD interface” or “Optional Interface”, the timing values for before and after the operation can be viewed in order to ensure that this process is taking place correctly.

5.6. Enabling the axis

The drive implements the DS402 profile (standard Cia). The enabling of the drive depends on the application of a command which can be received remotely (fieldbus (EtherCAT or CAN)), via HW (analogue function) or from the GUI (Local operation).
- Fieldbus (EtherCAT or CAN): Enabling is carried out by the Master (PLC) via Control-Word
- Analogue: Enabling is carried out by hardware, configuring the I/Os at the same time
- Local: Enabling is carried out by a command from the GUI (Mode and Commands/Command)

The sequence of commands for enabling is as follows:
1) Fault reset (if fault present)
2) Power off
3) Power on
4) Enable operation

See the Online Help for more details.
5.7. Oscilloscope function and log files ("UCX")

From the Navigation area, select “Digital oscilloscope”.

5.7.1. Configure recording

Select the “Channels” tab. For each channel, choose the variable you want to view from the drop-down menu. The number of variables that can be accessed depends on the user access mode (“Advanced” or “Normal”). To change the access mode, select “Options/modes” from the toolbar and continue with your choice. A maximum of four tracks can be viewed.

Set the duration of the recording in msec (“Recording time”) and the “Sampling frequency” in Hz. It is possible to trigger viewing (and recording) on a specific event by choosing “Enabled” from the “Trigger” field (choosing “Continuous” will automatically provide repeated views of the same event).

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

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

5.7.2. Launch recording

Select the “Activation” tab.

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

• See in GUI: The sizes are only viewed and not recorded
• Local save: The sizes are viewed and saved on the PC in the directory indicated in the “Output folder field
• Save on memory card: The sizes are viewed and saved on the SD card inserted into the front slot

Launch recording by pressing the “Start” button and stop by pressing the “Stop” button.
5.7.3. View the record

Select the “View” tab
Once they have been retrieved, the data will be shown on the display.

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

By selecting Auto Range, each signal is shown in the window; otherwise the data is displayed in the scale in which it is obtained, unless it is changed by varying the scale via the Scale command.
5.7.4. UCX file management
When data is saved in Local, a file is created with the name, date and time that this occurs. The extension of these files is ".UCX". To view archived recordings, go to the "Load/Save file" tab and then access the file system via the "Open UCX" button.

The GUI also allows users to read data on the memory card directly.
From the toolbar, select "View memory card".
A dialogue box will open with buttons which allow users to open and process the content can be viewed. The name of the file is fixed: rec.ucx. Warning: The name of the file cannot be changed. Each time a recording is made, the file on the SD card will be overwritten. The copy on the PC automatically changes the file name.

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

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

### 5.8. Use of the GUI in OFF-LINE mode

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

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

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

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

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

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

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

6.2. Power supply unit anomalies

<table>
<thead>
<tr>
<th>YELLOW LED</th>
<th>GREEN LED</th>
<th>RED LED</th>
<th>Status</th>
</tr>
</thead>
<tbody>
<tr>
<td>Off</td>
<td>Off</td>
<td>On fixed light</td>
<td>Power supply fault</td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>Cause</th>
<th>Check</th>
</tr>
</thead>
</table>
| The drive temperature is high      | • Check the direct current being delivered to the axes  
• Check the effectiveness of the fans |
| Correcting the fault               | Check the brake resistor                   |
| Overvoltage                        |                                            |

6.3. Axis module anomalies
The axis module alarms are indicated on the axis display with the letter F. For a detailed analysis, connect to the Dx2020 GUI software, select “Fault display” from the main menu, then proceed with anomaly analysis:
Any alarms active at that time will be listed on the left-hand side of the window (active fault list) and a list of the 8 most recent alarms will appear on the right-hand side (fault history).
6.3.1. Power section alarms

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

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

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

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

<table>
<thead>
<tr>
<th>Cause</th>
<th>Check</th>
</tr>
</thead>
<tbody>
<tr>
<td>Motor short circuit</td>
<td>Use a multimeter or other suitable instrument to check motor insulation. Alternatively:</td>
</tr>
<tr>
<td></td>
<td>• Remove the motor power cable</td>
</tr>
<tr>
<td></td>
<td>• Enable the axis again</td>
</tr>
<tr>
<td></td>
<td>• If the problem is remedied, replace the motor</td>
</tr>
<tr>
<td>Short circuit between the</td>
<td>Disconnect the cable from the motor and drive and use a multimeter or other suitable</td>
</tr>
<tr>
<td>motor cables.</td>
<td>instrument to check cable insulation. Alternatively:</td>
</tr>
<tr>
<td></td>
<td>• Remove the motor power cable on the drive side</td>
</tr>
<tr>
<td></td>
<td>• Enable the axis again</td>
</tr>
<tr>
<td>Wrong current loop</td>
<td>Check the motor parameters entered in the drive configuration.</td>
</tr>
<tr>
<td>regulation</td>
<td>Damaged internal drive components</td>
</tr>
<tr>
<td></td>
<td>If the problem persists after carrying out all checks, replace the drive.</td>
</tr>
</tbody>
</table>

6.3.2. Alarm due to VBUS voltage not within tolerance limits

<table>
<thead>
<tr>
<th>Fault</th>
<th>Voltage beneath minimum threshold set</th>
<th>Voltage higher than the maximum value permitted.</th>
</tr>
</thead>
<tbody>
<tr>
<td>DC_Link_Under Voltage</td>
<td>Circuit reading fault</td>
<td>Brake resistor is not connected to the power supply module or is faulty</td>
</tr>
<tr>
<td>DC_Link_Over Voltage</td>
<td>Measure the voltage on the DC BUS and compare with that measured by the drive.</td>
<td>Measure the ohmic value of the resistor and replace it if necessary.</td>
</tr>
</tbody>
</table>

**WARNING**

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

**AVERTISSEMENT**
Dans le cas de freinage contrôlé, l'énergie cinétique disponible est régénérée sur le bus DC et en partie stockée dans les condensateurs; l'excès, sinon dissipé par la résistance de freinage (RR sur l'alimentation), peut entraîner DC_Link_Over Voltage et endommager les unités.

6.3.3. Drive or motor over-temperature

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

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

<table>
<thead>
<tr>
<th>Cause</th>
<th>Check</th>
</tr>
</thead>
<tbody>
<tr>
<td>The drive temperature is high (above 50 °C)</td>
<td>• Check the efficiency of the cooling fans; replace if they do not work;</td>
</tr>
<tr>
<td></td>
<td>• Check the direct current of the module axes; if above the required value, check the operating status of the machine</td>
</tr>
<tr>
<td>The motor temperature is high (above 85 °C on the motor structure)</td>
<td>• Check there are no variations in the machine operating cycle; check whether control parameters are no longer suitable for the application</td>
</tr>
<tr>
<td></td>
<td>• Check that motor timing has not changed</td>
</tr>
<tr>
<td>The drive temperature is low (below 50 °C)</td>
<td>Possible fault in the temperature reading inside the circuit</td>
</tr>
<tr>
<td>The motor temperature is low (below 60 °C on the motor structure)</td>
<td>Possible fault on the internal thermal sensor or a thermal protection configuration error (using software)</td>
</tr>
</tbody>
</table>
6.3.4. STO signal removal

Safety stage low voltage: STO protection intervention
If the power to the STO circuit is disconnected, the drive releases the axis, disabling the output power.
If there is a conflict between the command and signal feedback, the STO circuit inside the drive could be damaged; check that 24 V DC absorption on the two inputs is approximately 50 mA per input. If absorption is different from this value, replace the module.

6.3.5. Memory device errors

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

6.3.6. Data Corrupted Fault

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

If saved data is corrupted, the drive reports an alarm. To solve the problem, try checking the drive configuration using the GUI and saving the parameters in advanced mode, then reset the drive and restart the GUI. If the problem persists, replace the drive.

6.3.7 Brake Chopper Fault

brake_feedback_fault

This alarm indicates a fault in the motor brake circuit.
The drive checks that the output voltage is consistent with the command. The alarm may be caused by a mismatch between the command and output voltage.
The internal circuit is protected from short circuits and the protection is enabled if current to the motor brake exceeds 2 A. If this occurs, the causes may be:

- Short circuit on the brake connection cable
- Short-circuit in the brake
- Fault in the detection circuit

Since the brake is integrated into the drive, it is necessary to send the DI2020 to the Assistance service for correction of braking circuit problems.
6.3.8. Feedback device errors

For correct operation, all feedback signals must reach the drive in an appropriate way; if this does not happen, the causes are indicated by the alarm which identifies in detail which transducer function is wrong or missing.

Since the connection is integrated into the drive, send the DI2020 to our Service for the appropriate checks.

In the Fault Configuration screen, feedback errors are identified by:

- Interface STD

![Fig 6.1 Screen showing errors on feedback devices](image)

### Configurazione Fault

<table>
<thead>
<tr>
<th>Fault</th>
<th>Cause</th>
<th>Check</th>
</tr>
</thead>
<tbody>
<tr>
<td>motor_over_temperature</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Interface STD - Missing transducer configuration</td>
<td>Interface X3 is enabled, but transducer configuration is missing.</td>
<td>Configure .</td>
</tr>
<tr>
<td>Interface STD - General Fault</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Interface STD - Error of value of sincos signals</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Interface STD - Hiperface position conflict</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Interface STD - Hiperface status error</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Interface STD - Hiperface transmit error</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Interface STD - Hiperface receive error</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Interface STD - Endat22 warning message</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Interface STD - Endat22 error1 message</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Interface STD - Endat22 error2 message</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Interface STD - Endat22 crc error</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Interface STD - Endat22 position not ready</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Interface STD - Endat22 not ready for strobe</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Interface STD - Resolver synchronization fault</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Interface STD - Resolver signals fault</td>
<td></td>
<td></td>
</tr>
<tr>
<td>synnovation error</td>
<td></td>
<td></td>
</tr>
<tr>
<td>interrupt_time_exceeded</td>
<td></td>
<td></td>
</tr>
<tr>
<td>task_time_exceeded</td>
<td></td>
<td></td>
</tr>
<tr>
<td>velocity_control_monitoring</td>
<td></td>
<td></td>
</tr>
<tr>
<td>following_error</td>
<td></td>
<td></td>
</tr>
<tr>
<td>position_reference_limit</td>
<td></td>
<td></td>
</tr>
<tr>
<td>EnDat22 fault</td>
<td>Each alarm describes the problem in detail. Except in cases of incorrect or missing configuration of the device, replace the motor</td>
<td></td>
</tr>
</tbody>
</table>

![Table of feedback device errors](image)
### 6.3.9. Synchronization, Interrupt Time and Task Time Error

<table>
<thead>
<tr>
<th>Fault</th>
<th>Cause</th>
<th>Check</th>
</tr>
</thead>
<tbody>
<tr>
<td>synchronization_error</td>
<td>Irregular internal frequency interrupt</td>
<td>Reprogramming of drive (firmware and parameters); if the alarm persists, replace the drive</td>
</tr>
<tr>
<td>Interrupt_time_exceeded</td>
<td>Internal interrupt signal not detected</td>
<td></td>
</tr>
<tr>
<td>Task_time_exceeded</td>
<td>The execution of the task has exceeded the maximum time limit</td>
<td></td>
</tr>
</tbody>
</table>

### 6.3.10. EtherCAT fault

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

### 6.3.11. Internal communication fault

<table>
<thead>
<tr>
<th>Fault</th>
<th>Cause</th>
<th>Check</th>
</tr>
</thead>
<tbody>
<tr>
<td>Internal_communication_fault</td>
<td>Generic internal communication fault (dual-axis module)</td>
<td>Reprogramme the drive (firmware and parameters) of the two cards. If the fault persists, send away for repairs</td>
</tr>
<tr>
<td>Internal_communication_heartbeat_error</td>
<td>Internal communication fault – the axis 1(2) does not detect the presence of the axis 2(1) (dual-axis module)</td>
<td>Reprogramme the drive (firmware and parameters) of the two cards. If the fault persists, send away for repairs</td>
</tr>
</tbody>
</table>
### 6.3.1.2. CAN bus alarms

<table>
<thead>
<tr>
<th>Fault</th>
<th>Cause</th>
<th>Check</th>
</tr>
</thead>
<tbody>
<tr>
<td>CAN_communication_fault</td>
<td>PDO data not received or received after time-out</td>
<td></td>
</tr>
<tr>
<td>CAN_rpdo0_time_out</td>
<td></td>
<td></td>
</tr>
<tr>
<td>CAN_rpdo1_time_out</td>
<td>PDO data not received or received after time-out</td>
<td></td>
</tr>
<tr>
<td>CAN_rpdo2_time_out</td>
<td></td>
<td></td>
</tr>
<tr>
<td>CAN_rpdo3_time_out</td>
<td></td>
<td></td>
</tr>
<tr>
<td>CAN_rpdo0_data</td>
<td>PDO data received not correct</td>
<td>Check the wiring and the configuration of the communication of the drive and/or the CAN master</td>
</tr>
<tr>
<td>CAN_rpdo1_data</td>
<td></td>
<td></td>
</tr>
<tr>
<td>CAN_rpdo2_data</td>
<td></td>
<td></td>
</tr>
<tr>
<td>CAN_rpdo3_data</td>
<td></td>
<td></td>
</tr>
<tr>
<td>CAN_tpdo0_time_out</td>
<td>PDO data not transmitted or transmitted after time-out</td>
<td></td>
</tr>
<tr>
<td>CAN_tpdo1_time_out</td>
<td></td>
<td></td>
</tr>
<tr>
<td>CAN_tpdo2_time_out</td>
<td></td>
<td></td>
</tr>
<tr>
<td>CAN_tpdo3_time_out</td>
<td>PDO data not transmitted</td>
<td></td>
</tr>
<tr>
<td>CAN_tpdo0_data</td>
<td></td>
<td></td>
</tr>
<tr>
<td>CAN_tpdo1_data</td>
<td>PDO data not transmitted</td>
<td></td>
</tr>
<tr>
<td>CAN_tpdo2_data</td>
<td></td>
<td></td>
</tr>
<tr>
<td>CAN_tpdo3_data</td>
<td></td>
<td></td>
</tr>
<tr>
<td>CAN_sync_consumer_time_out</td>
<td>Sync not received or received after time-out</td>
<td></td>
</tr>
<tr>
<td>CAN_life_guard_error</td>
<td>Error on life guarding protocol</td>
<td>Check the configuration</td>
</tr>
</tbody>
</table>
6.4. Viewing alarms in the “Analogue” operating mode

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

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

<table>
<thead>
<tr>
<th>Fault index</th>
<th>Error code</th>
<th>Error register</th>
<th>Fault</th>
</tr>
</thead>
<tbody>
<tr>
<td>1</td>
<td>0x2344</td>
<td>0x04</td>
<td>short_circuit_phase_U_low IGBT fault phase U lower arm</td>
</tr>
<tr>
<td>2</td>
<td>0x2345</td>
<td>0x04</td>
<td>short_circuit_phase_U_hi IGBT fault phase U upper arm</td>
</tr>
<tr>
<td>3</td>
<td>0x2346</td>
<td>0x04</td>
<td>short_circuit_phase_V_low IGBT fault phase U lower arm</td>
</tr>
<tr>
<td>4</td>
<td>0x2347</td>
<td>0x04</td>
<td>short_circuit_phase_V_hi IGBT fault phase U upper arm</td>
</tr>
<tr>
<td>5</td>
<td>0x2348</td>
<td>0x04</td>
<td>short_circuit_phase_W_low IGBT fault phase W lower arm</td>
</tr>
<tr>
<td>6</td>
<td>0x2349</td>
<td>0x04</td>
<td>short_circuit_phase_W_hi IGBT fault phase W upper arm</td>
</tr>
<tr>
<td>7</td>
<td>0x3220</td>
<td>0x04</td>
<td>dc_link_under_voltage Bus undervoltage</td>
</tr>
<tr>
<td>8</td>
<td>0x3210</td>
<td>0x04</td>
<td>dc_link_over_voltage Bus overvoltage</td>
</tr>
<tr>
<td>9</td>
<td>0x4310</td>
<td>0x08</td>
<td>excess_temperature_drive Excessive drive temperature (IGBT module protection)</td>
</tr>
<tr>
<td>10</td>
<td>0x5114</td>
<td>0x04</td>
<td>safety_stage_low_voltage STO power circuit not detected (this fault is detected only in “operation Enable”)</td>
</tr>
<tr>
<td>11</td>
<td>0x5530</td>
<td>0x01</td>
<td>eeprom_fault Error reading EEPROM memory from the power block or invalid content.</td>
</tr>
<tr>
<td>12</td>
<td>0x5540</td>
<td>0x01</td>
<td>sd_memory_fault External memory card not detected.</td>
</tr>
<tr>
<td>13</td>
<td>0x6010</td>
<td>0x01</td>
<td>software_watchdog Software alarm</td>
</tr>
<tr>
<td>14</td>
<td>0x6320</td>
<td>0x01</td>
<td>parameter_initialisation_error Initialisation error</td>
</tr>
<tr>
<td>15</td>
<td>0x6311</td>
<td>0x01</td>
<td>node_identifier_data_memory_corrupted Not used</td>
</tr>
<tr>
<td>16</td>
<td>0x6312</td>
<td>0x01</td>
<td>user_data_memory_corrupted Parametric user memory corrupt/not Configured</td>
</tr>
<tr>
<td>17</td>
<td>0x6313</td>
<td>0x01</td>
<td>restore_data_memory_corrupted Not used</td>
</tr>
<tr>
<td>18</td>
<td>0x6314</td>
<td>0x01</td>
<td>factory_data_memory_corrupted Constructor parameter memory corrupt/not Configured</td>
</tr>
<tr>
<td>19</td>
<td>0x6315</td>
<td>0x01</td>
<td>calibration_data_memory_corrupted Not used</td>
</tr>
<tr>
<td>20</td>
<td>0x6316</td>
<td>0x01</td>
<td>diagnosis_data_memory_corrupted Not used</td>
</tr>
<tr>
<td>21</td>
<td>0x7110</td>
<td>0x01</td>
<td>brake_feedback_fault Brake status signal inconsistent</td>
</tr>
<tr>
<td>22</td>
<td>0x7124</td>
<td>0x08</td>
<td>motor_temperature_warning Motor temperature warning</td>
</tr>
<tr>
<td>23</td>
<td>0x7125</td>
<td>0x08</td>
<td>motor_over_temperature Motor temperature fault</td>
</tr>
<tr>
<td>24</td>
<td>0x7380</td>
<td>0x01</td>
<td>Interface X3 - Missing transducer configuration Interface X3 transducer enabled but not Configured</td>
</tr>
<tr>
<td>25</td>
<td>0x7381</td>
<td>0x01</td>
<td>Interface X3 - General fault Not used</td>
</tr>
<tr>
<td>26</td>
<td>0x738D</td>
<td>0x01</td>
<td>Interface X3 - Resolver synchronisation fault Resolver signal synchronisation error (phase)</td>
</tr>
<tr>
<td>27</td>
<td>0x738E</td>
<td>0x01</td>
<td>Interface X3 - Resolver signals fault Signal resolver level error (amplitude)</td>
</tr>
<tr>
<td>28</td>
<td>0x7390</td>
<td>0x01</td>
<td>Interface X2 - Missing transducer configuration Interface X2 transducer enabled but not Configured</td>
</tr>
<tr>
<td>29</td>
<td>0x7391</td>
<td>0x01</td>
<td>Interface X2 - General fault Initialisation error or transducer not detected</td>
</tr>
<tr>
<td>30</td>
<td>0x7392</td>
<td>0x01</td>
<td>Interface X2 - Erroneous value of sincos signals Sinusoidal signal amplitude inconsistent</td>
</tr>
<tr>
<td>Fault index</td>
<td>Error code</td>
<td>Error register</td>
<td>Fault</td>
</tr>
<tr>
<td>-------------</td>
<td>------------</td>
<td>----------------</td>
<td>-------</td>
</tr>
<tr>
<td>31</td>
<td>0x7393</td>
<td>0x01</td>
<td>Interface X2 - Hiperface position conflict</td>
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<tr>
<td>32</td>
<td>0x7394</td>
<td>0x01</td>
<td>Interface X2 - Hiperface status error</td>
</tr>
<tr>
<td>33</td>
<td>0x7395</td>
<td>0x01</td>
<td>Interface X2 - Hiperface transmit error</td>
</tr>
<tr>
<td>34</td>
<td>0x7396</td>
<td>0x01</td>
<td>Interface X2 - Hiperface receive error</td>
</tr>
<tr>
<td>35</td>
<td>0x7397</td>
<td>0x01</td>
<td>Interface X2 - EnDat22 warning message</td>
</tr>
<tr>
<td>36</td>
<td>0x7398</td>
<td>0x01</td>
<td>Interface X2 - EnDat22 error1 message</td>
</tr>
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<td>0x7399</td>
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<td>Interface X2 - EnDat22 error2 message</td>
</tr>
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<td>0x01</td>
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<td>41</td>
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<td>0x01</td>
<td>Interface X1 - Missing transducer configuration</td>
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<tr>
<td>42</td>
<td>0x73A1</td>
<td>0x01</td>
<td>Interface X1 - General fault</td>
</tr>
<tr>
<td>43</td>
<td>0x73A2</td>
<td>0x01</td>
<td>Interface X1 - Erroneous value of sincos signals</td>
</tr>
<tr>
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<td>Interface X1 - Hiperface position conflict</td>
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<td>52</td>
<td>0x73AB</td>
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<td>53</td>
<td>0x73AC</td>
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<td>Interface X1 - EnDat22 not ready for strobe</td>
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<tr>
<td>54</td>
<td>0x73AD</td>
<td>0x01</td>
<td>Interface X1 - Resolver synchronization fault</td>
</tr>
<tr>
<td>55</td>
<td>0x73AE</td>
<td>0x01</td>
<td>Interface X1 - Resolver signals fault</td>
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<td>0x01</td>
<td>synchronization_error</td>
</tr>
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<td>0x6102</td>
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<td>0x01</td>
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<tr>
<td>Fault index</td>
<td>Error code</td>
<td>Error register</td>
<td>Fault</td>
</tr>
<tr>
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<td>------------</td>
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<td>------------------------------</td>
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<td>59</td>
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<td>0x8611</td>
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<td>following_error</td>
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<td>0x8612</td>
<td>0x01</td>
<td>position_reference_limit</td>
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<td>0x10</td>
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<td>0x10</td>
<td>EtherCAT_rpdo_time_out</td>
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<tr>
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<td>0x8241</td>
<td>0x10</td>
<td>EtherCAT_rpdo_data</td>
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<tr>
<td>66</td>
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<td>0x10</td>
<td>EtherCAT_tpdo_time_out</td>
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<td>67</td>
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<td>EtherCAT_tpdo_data</td>
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<tr>
<td>68</td>
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<td>0x10</td>
<td>Internal_communication_fault</td>
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<td>Internal_communication_heartbeat_error</td>
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<td>0x3200</td>
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<td>CAN_rpdo2_data</td>
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<tr>
<td>82</td>
<td>0x8244</td>
<td>0x10</td>
<td>CAN_rpdo3_data</td>
</tr>
<tr>
<td>83</td>
<td>0x8235</td>
<td>0x10</td>
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</tr>
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<td>92</td>
<td>0x823A</td>
<td>0x10</td>
<td>CAN_sync_consumer_time_out</td>
</tr>
</tbody>
</table>
6.5. Anomalies during GUI - drive connection

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

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

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

**INFORMATION**

For the firmware _ecat version, the default baud rate is 1 Mbps, while for the firmware _can version, the predefined value is 500 Kbps. The default node is 127 for both firmware versions.

To check the values set on the drive, proceed as follows:
- Connect to the drive using another network (serial or EtherCAT if supported);
- Read the baud rate value from the terminal (locbdr parameter for the firmware _ecat version or canbdr parameter for the firmware _can version);
- Read the node ID from the terminal (locmodide parameter for the _ecat version or the modide parameter for the firmware _can version).

If the connection is made via EtherCAT:
- Check that the correct network card is selected;
- Check that the cable being used is appropriate.
7. **SAFE TORQUE OFF SAFETY FUNCTION**

*(TRANSLATION OF ORIGINAL INSTRUCTIONS)*

7.1. **Application**

The Safe Torque Off (STO) safety function of the DM2020 has been manufactured with a redundant circuit incorporated into the control board.

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

---

**WARNING**

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

**AVERTISSEMENT**

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

7.2. **Risk assessment of the installation**

The functional safety requirements of a drive depend on the application, and must be considered during the overall risk assessment of the installation. Where the supplier of the drive is not responsible for powered devices, the subject designing the installation is responsible for a risk assessment, and for specifying requirements relative to the functional integrity levels and safety integrity levels (SIL) of the drive according to CEI EN 62061:2005 and/or performance levels (PL) according to EN ISO 13849-1:2008.

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

<table>
<thead>
<tr>
<th>PL</th>
<th>SIL (IEC 61508-1, by way of example) high/continual operating mode</th>
</tr>
</thead>
<tbody>
<tr>
<td>a</td>
<td>No correspondence</td>
</tr>
<tr>
<td>b</td>
<td>1</td>
</tr>
<tr>
<td>c</td>
<td>1</td>
</tr>
<tr>
<td>d</td>
<td>2</td>
</tr>
<tr>
<td>e</td>
<td>3</td>
</tr>
</tbody>
</table>

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

---

**INFORMATION**

As SIL 4 refers to catastrophic events, it does not concern risks relative to machines.

The risk assessment of the machine must be carried out according to the Machinery Directive 2006/42/EC, referring to UNI EN ISO 12100:2010 and must contain the configuration of the safety circuit relative to the complete machine, considering all components incorporated in the safety system, including the drive.
73. **Assembly and production testing**
The Safe Torque Off (STO) circuit is assembled and tested at Moog-Casella.

74. **Identification of the STO function on the drive's side plate**
The new Safe Torque Off (STO) circuit is identified by the legend "Safe Torque Off" on the plate.

![Fig 7.3 Example of identification of the STO function (in this case without "safe brake control")](image)

*NOTE: Due to the certification process, at this time, this chapter will be subject to changes and modifications. For any information, please contact Moog Casella.*
## 8 Annexes

### 8.1 Glossary

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

Dispersion towards ground  
Current (usually of reduced intensity) flowing from a wire to the ground.

Dynamic braking  
The energy accumulated by the motor during the acceleration is converted into heat through the braking resistor.

Directive (EMC)  
The EMC Directive requires that all electrical and electronic devices placed on the market from 1 January 1996 must satisfy the essential requirements of electromagnetic compatibility.

The essential electromagnetic compatibility requirements are met by applying the harmonized technical standards published in the EU Official Journal.

The harmonized standards can be essentially divided into:
- Product standards
- Generic standards
- Basic standards

E  

Electric Drive  
Electric power converter for controlling torque speed and position of a motor. It consists of four main parts:
- Rectifier of AC mains voltage
- DC link voltage rectified and leveled
- Inverter of the rectified voltage in voltage with frequency and voltage variables
- Control circuit that transmits signals for the switching of the power semiconductors of the inverter

Electric noise  
Set of unwanted signals or current that overlap the useful signal typically transmitted on a communication channel between electronic devices.

EMC  
Radio frequency emitted during the electronic power equipment operation, likely to generate or induce disturbances in other electronic equipment.

Emissions  
Electromagnetic interference caused by electronic equipment operating at frequencies likely to generate or induce disturbances.

Enable  
Signal that enables the drive.

Encoder  
Motor component that detects the value of the position of the shaft and transmits it to the drive to operate the control.

Encoder incremental  
Motor component that detects the incremental changes in the position of the shaft and transmits them to drive to operate the control with information the current position.

Encoder simulated  
TTL encoder signals (A, B and C) differential line drivers generated by the drive, starting from internal information, to emulate an encoder.

Encoder sinusoidal  
Motor component that detects the incremental changes in the position of the shaft and transmits the drive to operate the control with information the current position. The information is acquired through the reading of two sinusoidal signals sampled from the drive.

EnDat 22  
Serial protocol for communication with Heidenhain encoder. Allows the reading of the position of absolute encoders, as well as updating and saving data stored in the encoder. It is compatible with the previous version 21 offering advantages such as the transfer of other data together with that of position without a separate request.

EtherCAT  
Communication protocol implemented on the Ethernet the network for the synchronous transmission of information.

Ethernet  
High speed data communication network.
### F

<table>
<thead>
<tr>
<th>Term</th>
<th>Definition</th>
</tr>
</thead>
<tbody>
<tr>
<td>Filter (Network)</td>
<td>Device that reduces noise generated by the power supply cables.</td>
</tr>
<tr>
<td>FMEA</td>
<td>Failure Mode and Effects Analysis.</td>
</tr>
<tr>
<td>FieldBus</td>
<td>Structure that allows communication between different devices; are connection lines on which the digital information is transferred from one or more sources to one or more destinations. Their aim is therefore to reduce the number of interconnections required. The bus techniques are of great importance in microprocessor systems but it is necessary to regulate this flow of data in order to allow for a single communication at a time by disabling other possible data sources at that moment.</td>
</tr>
<tr>
<td>Fuses</td>
<td>Overcurrent protection devices.</td>
</tr>
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### G

<table>
<thead>
<tr>
<th>Term</th>
<th>Definition</th>
</tr>
</thead>
<tbody>
<tr>
<td>Grade of protection (Protection grade)</td>
<td>Security level of the system components.</td>
</tr>
<tr>
<td>Ground</td>
<td>Connection of the conductor or the frame to the ground connector.</td>
</tr>
<tr>
<td>GUI</td>
<td>Graphical User Interface.</td>
</tr>
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</table>

### H

<table>
<thead>
<tr>
<th>Term</th>
<th>Definition</th>
</tr>
</thead>
<tbody>
<tr>
<td>Hyperface</td>
<td>Fully digital, synchronous two-way, multi-channel protocol to transfer position information and speed that requires minimal wiring between drive and feedback from the motor (2-wire).</td>
</tr>
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</table>

### I

<table>
<thead>
<tr>
<th>Term</th>
<th>Definition</th>
</tr>
</thead>
<tbody>
<tr>
<td>IGBT</td>
<td>Semiconductor devices for the control of PWM switching.</td>
</tr>
<tr>
<td>Interface Fieldbus</td>
<td>EtherCAT or CANopen</td>
</tr>
<tr>
<td>IFOC (control)</td>
<td>Indirect Field Oriented Control</td>
</tr>
</tbody>
</table>

### M

<table>
<thead>
<tr>
<th>Term</th>
<th>Definition</th>
</tr>
</thead>
<tbody>
<tr>
<td>Machine</td>
<td>Set of mechanical devices, connected to each other of which at least one is in motion.</td>
</tr>
<tr>
<td>Multiaxis system</td>
<td>Machine with several axes with independent transmission.</td>
</tr>
</tbody>
</table>

### R

<table>
<thead>
<tr>
<th>Term</th>
<th>Definition</th>
</tr>
</thead>
<tbody>
<tr>
<td>Rectifier</td>
<td>Circuit that converts an AC voltage into a DC voltage.</td>
</tr>
<tr>
<td>Regolator P</td>
<td>Regulating circuit functioning in a purely proportional manner.</td>
</tr>
<tr>
<td>Regolator PI</td>
<td>Control circuit running in a proportional and integral way.</td>
</tr>
<tr>
<td>Regolator PID</td>
<td>Proportional adjustment circuit functioning, integral and derivative way</td>
</tr>
<tr>
<td>Reset</td>
<td>Restart the microprocessor.</td>
</tr>
<tr>
<td>Braking resistor</td>
<td>When the motor decelerates, a braking resistor converts the kinetic energy of the motor into heat. The braking resistor is automatically connected to the DC bus voltage when the bus voltage exceeds its threshold and intervenes in the braking circuit.</td>
</tr>
<tr>
<td>RS232</td>
<td>Very common standard hardware for the transmission of signals with the same voltage level. Suitable for low transmission rates and limited distances.</td>
</tr>
</tbody>
</table>

### S

<table>
<thead>
<tr>
<th>Term</th>
<th>Definition</th>
</tr>
</thead>
<tbody>
<tr>
<td>Serial Communication</td>
<td>Transmission based on sending each signal at different times.</td>
</tr>
<tr>
<td>Shield</td>
<td>Devices designed to reduce electromagnetic emissions.</td>
</tr>
<tr>
<td>Servodrive</td>
<td>Drive that operates the regulation of torque, speed and position of a servomotor.</td>
</tr>
<tr>
<td>Safety</td>
<td>All necessary measures to avoid damage to property or to persons.</td>
</tr>
<tr>
<td>Soft-start</td>
<td>Circuit for limiting the power from the network to the system during the power up</td>
</tr>
<tr>
<td>Stiffness</td>
<td>Capacity of a mechanical system to withstand the stresses or disorders that are applied from outside.</td>
</tr>
<tr>
<td>STO</td>
<td>Safe Torque Off: protection against unexpected restart. The STO function safely interrupts the power supply to the motor.</td>
</tr>
</tbody>
</table>
### 8.2 Conversion table Metric/AWG

<table>
<thead>
<tr>
<th>AWG</th>
<th>Diameter</th>
<th>Cross-section</th>
<th>Ohmic resistance at 20 °C</th>
<th>Weight</th>
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<tbody>
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<td></td>
<td>mils</td>
<td>mm</td>
<td>Circ. mils</td>
<td>mm²</td>
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<td>4.00</td>
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