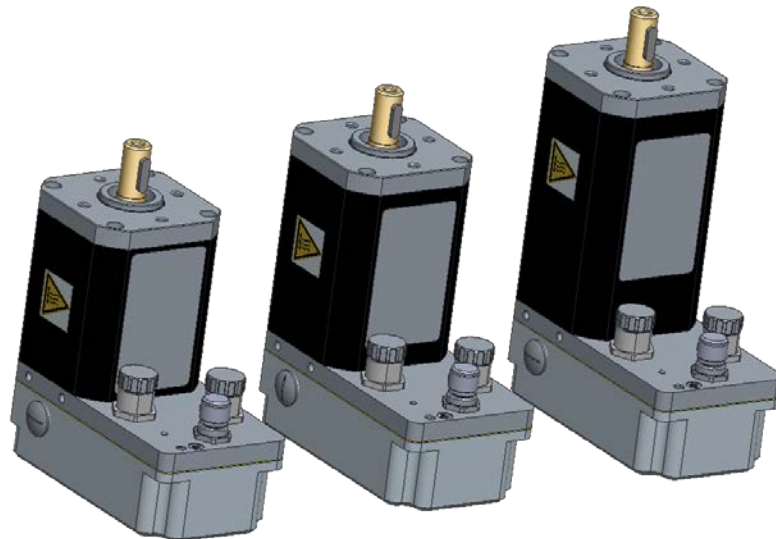# PRODUCT USER MANUAL

SMI22 CANopen

Important Notes

- This manual is part of the product.
- Read and follow the instructions in this manual.
- Keep this manual in a safe place.
- Give this manual and any other documents relating to the product to anyone that uses the product.
- Read and be sure to comply with all the safety instructions and the section "Before you Begin - Safety-Related Information" in the document "Safety User Manual"
- Please consult the latest catalogue to find out about the product's technical specifications.
- We reserve the right to make modifications without prior notification.

Table of Contents

About This Manual

This manual applies to SQ75 CANopen brushless products:
- 80350,
- 80360,
- 80370,
  And all gearboxes adaptation.

Reference source for manuals
The manuals can be downloaded from our website at the following address:
http://www.crouzet-motors.com/

Units
SI units are the default values.

Risk Categories

In this manual, safety instructions are identified by warning symbols.
Depending on how serious the situation is, the safety instructions are split into 3 risk categories.

⚠️ **DANGER**

DANGER indicates a directly dangerous situation which, if the instructions are not followed, will **inevitably** lead to a serious or fatal accident.

⚠️ **WARNING**

WARNING indicates a possibly dangerous situation which, if the instructions are not followed, will **in some cases** lead to a serious or fatal accident or cause damage to equipment.

⚠️ **CAUTION**

CAUTION indicates a potentially dangerous situation which, if the instructions are not followed, will **in some cases** lead to an accident or cause damage to equipment.

1. INTRODUCTION

1.1. Motor Family

SQ75 brushless motors are brushless DC motors, with a control circuit board integrated in the motor.

1.2. Characteristics

SQ75 brushless motors are intelligent servomotors for speed, position and torque control applications. They can be configured via a Human-Machine Interface (HMI) with CANopen or USB communication bus.
They are equipped with 3 industrial connectors, 1 for power, 1 for the control signals and 1 for the CANopen communication.

1.3. Identification Label

The label contains the following data:
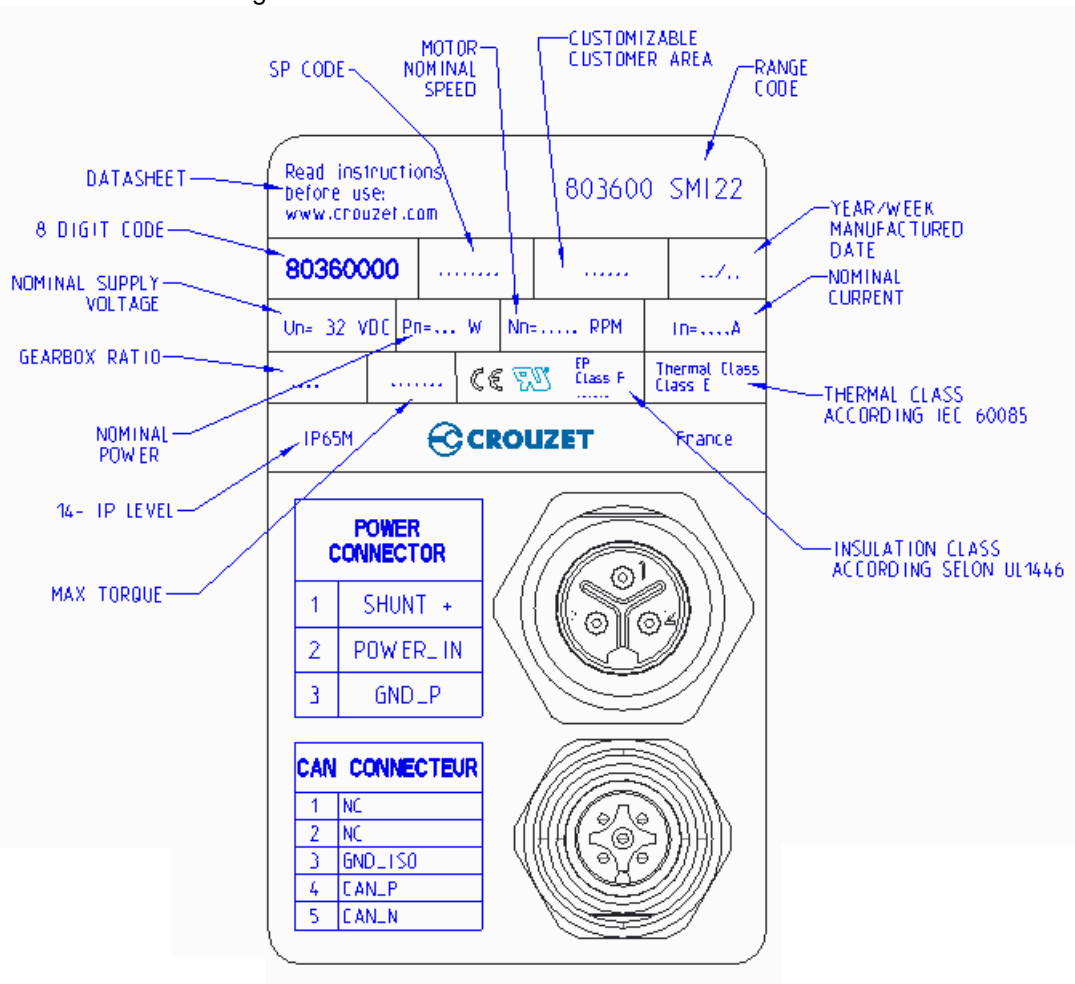
1.4. Product Coding

Three firsts digits	4th digit	5th digit	6th digit	7th digit	8th digit
803	**5** = Rotor 37,5mm	**0** : direct motor IP69	**0** : with integrated drive	0 à 3: SMi22 CAN (if 6th digit = 0 ou 1)	from 0 to 9
	6 = Rotor 50mm	**D** : P72	**1** : with integrated drive + brake	4 à 6: SMi22 (without CAN) (if 6th digit = 0 ou 1)	
	7 = Rotor 75mm	**E** : P81	*4 : hall effects*		
		2 : RAD20	*5 : Hall effects + brake*		

1.5. Standards and concepts

The product is ROHS confirmed following European Directive 2011/65/CE. Following this confirmation, the product is CE marked.
The electrical design follows the IEC 60335-1 and IEC 60950-1 standards.

2. OPTIONS AND ACCESSORIES

The motors can be supplied with options, such as:
- Different gearboxes
- A failsafe holding brake
- Different motor output shaft versions

2.1.1. Holding brake

SQ75 brushless motors can be equipped as standazromechanical brake.
The holding brake is designed to lock the motor shaft in a de-energized state.
The holding brake is not a safety function.
A motor with a holding brake needs a corresponding control logic which releases the holding brake at the start of the rotation movement, locking the motor shaft in time when the motor stops.
Nota : Outputs are able to drive the electromechanical brake.
Nota : Motor has to be completely stopped before activation of the brake.

2.1.2. Gearboxes

SQ75 brushless motors can be equipped with different types of gearbox.
The gearboxes offered as standard in the catalogue are planetary gearboxes which combine compact size and robust design, and worm gearboxes that allow a shaft output at right-angles to the motor shaft.

2.1.3. Other

Other types of adaptation are possible on request, please contact the sales department.

2.1.4. Starter Kit

This kit consists of:
- a 2-meter long micro USB B to USB A (MOLEX 68784-0003) connecting cable **27 526 005**
- a power cable : this cable can be obtained by ordering part number **79 298 664**
- an I/O cable : this cable can be obtained by ordering part number **79 513 106**
- a CAN cable M12 M/F : this cable can be obtained by ordering part number **27 358 015**
- a bus terminating resistor : this resistor can be obtained by ordering part number **27 358 014**
- a D-Sub bus connector **27 358 017**
- an USB to CAN converter (PEAK System reference IPEH-002021) **27 358 016**
- an USB stick containing the "DCmind Soft + CANopen Interface" parameter-definition software and installation drivers for this HMI.
- A T (F-M/F) CAN connector **27 358 020**

This starter kit can be obtained by ordering part number **79 513 105**

3. PRECAUTIONS FOR USE CONCERNING THE MECHANICS

3.1. Data specific to the motor shaft

⚠️ **WARNING**

MOTOR MECHANISM
Exceeding the maximum permissible forces on the shaft leads to rapid bearing wear, a broken shaft or damage to any accessories (encoder, brake, etc.)
• Never exceed the maximum axial and radial forces.
• Protect the shaft from any impact.
• When press-fitting components, do not exceed the maximum permissible axial force.
Failure to comply with these precautions can result in death, serious injury or damage to equipment.

Radial load on the shaft
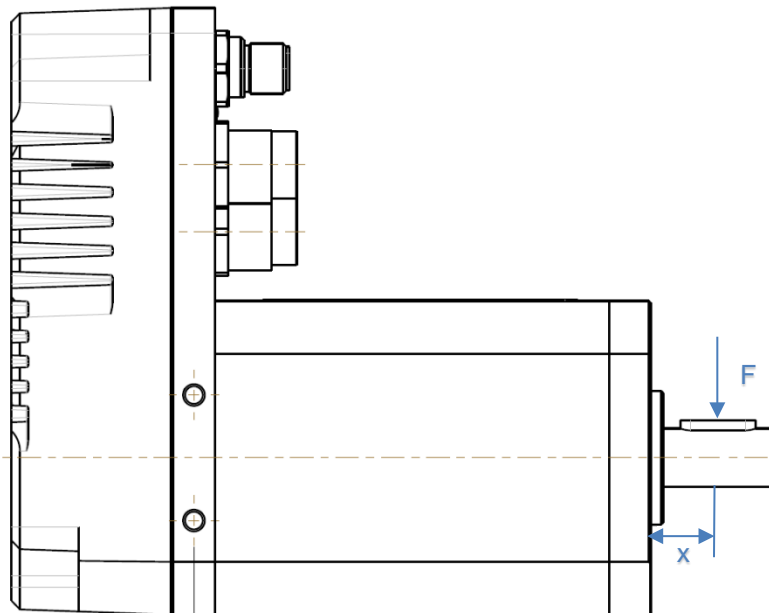
The application point **X** of the radial force **F** depends on the motor size.
This information appears in the motor technical data sheet.

The maximum axial and radial loads must not be applied simultaneously.

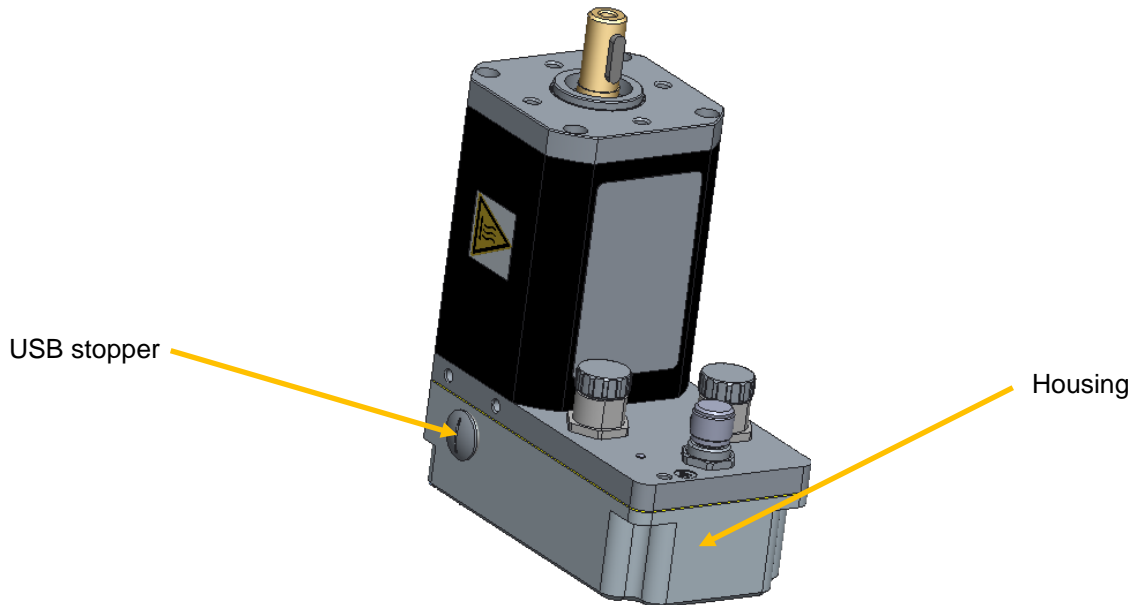## 3.2. USB Connector

USB stopper

Housing

The motor is equipped with a micro USB connector, which can be accessed by removing the stopper from the housing.
The stopper prevents penetration of foreign bodies or fluids inside the motor.
The stopper prevents fingers or any inappropriate object making contact with the micro USB connector.

For any other connector, when not used, stoppers have to be mounted.

⚠ WARNING
UNEXPECTED MOVEMENT DUE TO ELECTROSTATIC DISCHARGES Electrostatic discharges (ESD) on the micro USB connector can, in some cases, lead to deterioration or destruction of some system components and generate unexpected motor operation. • Never touch the connector with your fingers or any inappropriate object. **Failure to comply with these precautions can result in death, serious injury or damage to equipment.**

⚠ CAUTION
LOSS OF SEALING The stopper ensures the motor is sealed. • Replace it after completing parameter definition. • Make a visual check to ensure it is in place. **Failure to comply with these precautions can result in injury or damage to equipment.**

3.3. Fixings

Fixing of the product has to be done by using 4 M6 screws with a screwing torque of 7N.m.

4. PRODUCT OVERVIEW

4.1. Description of the Product

Output shaft

3-pin power supply M16 connector

Label

18-pin logic M16 connector (Inputs/Outputs)

USB-B micro-connector (Parameter definition via HMI)

SMI22 CANopen integrated electronics

CAN communication M12 connector
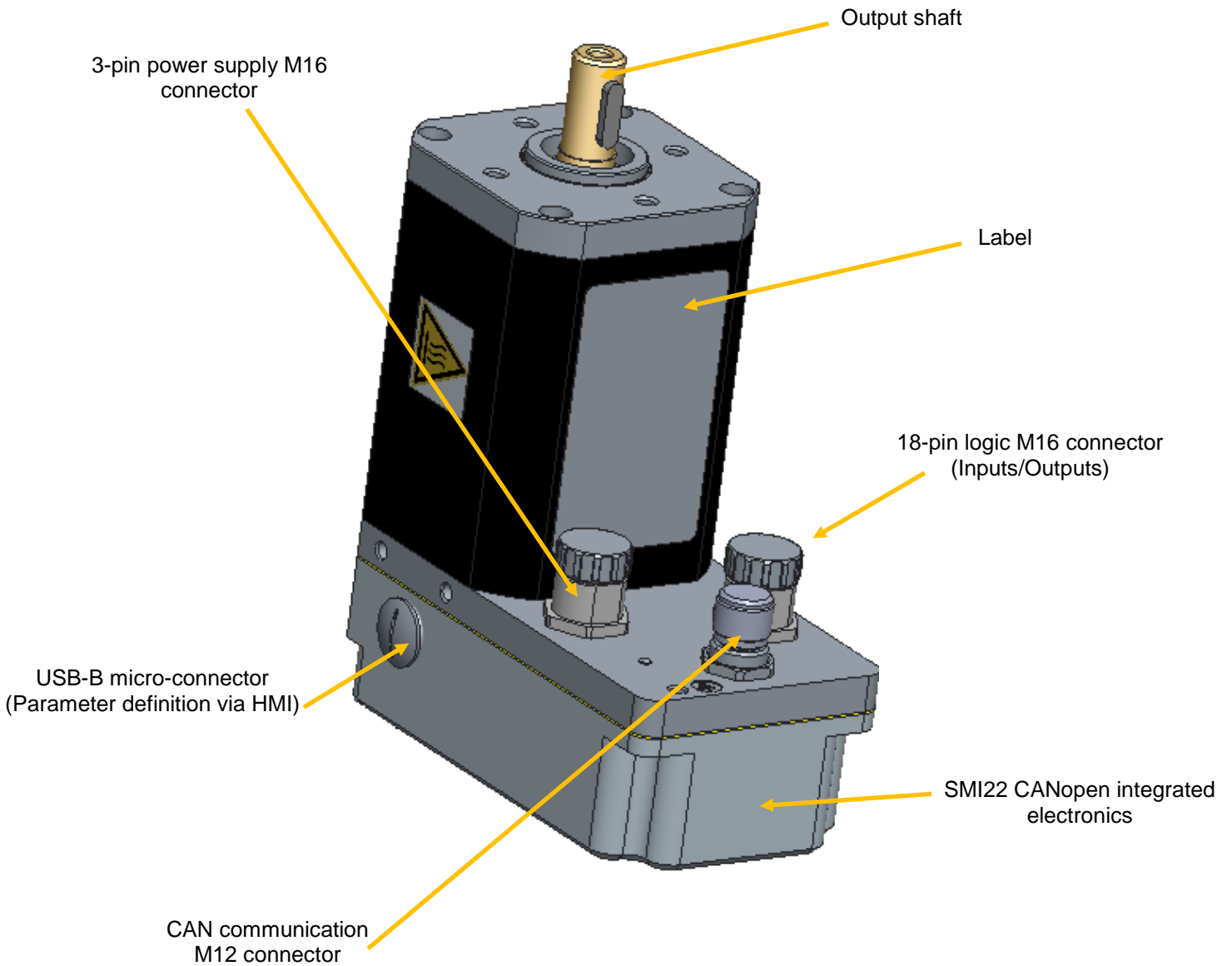
4.2. SMI22 CANopen Control Electronics

The SQ75 CANopen electronic control board contains the control electronics for a brushless motor, integrated in the motor body.

This electronics is used for:
- Power switching of the motor in sine mode (field-oriented control (FOC)) or trapezoidal mode.
- Position-Speed-Torque and Current control algorithms.
- CANopen CiA 301 standard – Application layer and communication profile
- CANopen CiA 402 standard – Drive and motion control device profile
- Use of preconfigured programs which can perform numerous routine applications (DCmind programs).
- Management of different types of operation:
  - "Stand-alone" motor without external PLC.
  - Use with other motors incorporating SMI22 or SMI21 electronics.
  - Use with a programmable controller, with the SMI22 simplifying motor management.
- The interface with parameter-definition software installed on the PC:
  - Easy to use, even by a layman, thanks to simplified application programs that are quick to get up and running.
  - Wide choice of expert programs covering a wide range of applications.
  - CAN connection via a commercially-available standard cable (can be supplied on request).
  - USB connection via a commercially-available standard cable (can be supplied on request).
- Management of 6 inputs,4 outputs and 2 STO inputs (for safety) to control the motor:
  - 2 inputs that can be configured for 0-10 V 10-bit analog or PWM or digital control
  - 4 digital inputs
  - 2 isolated differential STO inputs (4 leads)
  - 1 output that can be configured as PWM or frequency or digital
  - 1 output that can be configured as PWM or digital
  - 2 digital outputs

As standard, the motors have an internal encoder with 4096 points per revolution that can reach high positioning and control resolutions.

Note : For reset the motor by CANOpen (e.g. when Bootloader mode is required), index 0x2FFF sub index 0x00 has to be set at value=0x64747372.

4.3. "DCmind-Soft + CANopen" PC Parameter-Definition Software

This software can be downloaded from the Internet at the following address: http://www.crouzet-motors.com/
It can also be supplied as a kit, see "Starter Kit" section.

This "DCmind-Soft + CANopen" software is needed the first time the motor is used and for debugging if you don't have a CANopen master.

It is used for:
- Selecting the motor operating program:
  - Position
  - Speed
  - Torque
  - Homing
  - Quick and easy starting using preprogrammed applications.
  - Use of "expert" programs that provide access to all settings.

- The various settings needed for the application to work correctly.
- Updating the "firmware" motor program using the bootloader function.

For more information, see the HMI user manual dedicated for the "DCmind Soft + CANopen"

5. TECHNICAL SPECIFICATIONS

5.1. Electrical Data

Maximum Product Specifications			
Parameters	Value		Unit
Supply voltage V_{DC_MAX}	75		V
Maximum current $I_{DC\_MAX \text{ (2seconds)}}$	75		A
Maximum input voltage V_{IN_MAX}	90		V
Maximum output voltage V_{OUT_MAX}	24		V
Maximum output current I_{OUT_MAX}	10		mA

Operating Specifications				
Parameters	Min	Typical	Max	Unit
Supply voltage V_{DC}	9	24 / 32 / 48	75	V
Current I_{DC}	-	15	-	A
Motor consumption when stopped without holding W_0	-	1	-	W

Input Specifications				
Parameters	Min	Typical	Max	Unit
Input impedance In1 to In4	-	200	-	kΩ
Input impedance AN5 to AN6	-	107.2	-	kΩ
Low logic level on inputs In1 to In4	-90	-	2.4	V
High logic level on inputs In1 to In4	4.5	-	90	V
Low logic level on inputs AN5 to AN6	-90	-	2	V
High logic level on inputs AN5 to AN6	4.6	-	90	V
Low logic level on STO1 & 2	-2	-	4	V
High logic level on STO1 & 2	4.6	-	75	V
CAN Low level	0.5	1.5	2.25	V
CAN High level	2.75	3.5	4.5	V

| Output Specifications				
Parameters	Min	Typical	Max	Unit
Low logic level on outputs Out1 to Out4 V_{OL} R_L = 4 K7Ω, V_{DC} = 24 V	-	5	10	mV
High logic level on outputs Out1 to Out4 V_{OL} R_L = 4 K7Ω, V_{DC} = 24 V = voltage supply added from eventual rejective voltage	-	-	24	V

5.2. Generic Data

General Specifications		
Parameters	Value	Unit
Ambient motor temperature	-30 to +70	°C
Insulation class (compliant with directive IEC 60085)	E	/
Ingress protection (excluding output shaft)	IP67 + IP69	/
CANopen compliance	CiA DS 301 and CiA DS 402	/

5.3. Logic M16 connector

It's a M16 18-pin industrial male connector
Recommended AWG for the associated cable: AWG24 for wires inside a shielded cable.
(See part "Starter Kit" of this document).
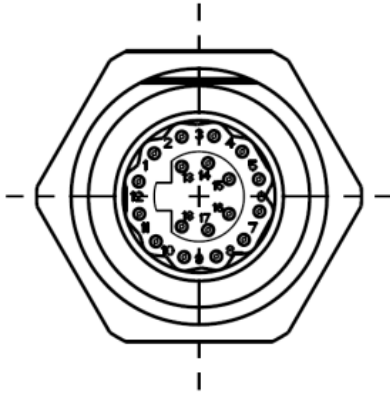
I/O CONNECTOR	
Header : HUMMEL 7.850.000.000	
Pin : HUMMEL 7.010.980.801	
Insulation : HUMMEL 7.003.988.101	
1	VLOGIC
2	GND_D
3	AN_1
4	AN_2
5	INPUT_1
6	INPUT_2
7	INPUT_3
8	INPUT_4
9	GND_D
10	OUTPUT_1
11	OUTPUT_2
12	OUTPUT_3
13	OUTPUT_4
14	GND_D
15	STO 2-
16	STO 2+
17	STO 1-
18	STO 1+

With cables more than 3 m long, tests must be performed in situ.

5.4. Power Supply M16 connector

It's a M16 3-pin industrial male connector.
Recommended AWG for the associated cable: AWG14 for wires inside a shielded cable.
(See part "Starter Kit" of this document).
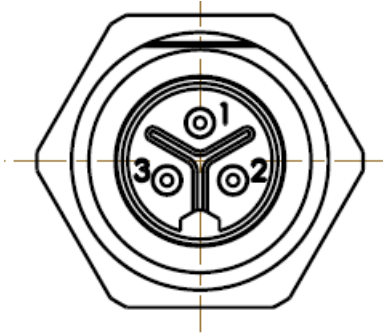
POWER CONNECTOR	
Header : HUMMEL 7.850.000.000 Pin : HUMMEL 7.010.982.001 Insulation : HUMMEL 7.003.983.101	
1	SHUNT +
2	POWER_IN
3	GND_P

With cables more than 3 m long, tests must be performed in situ.

5.5. CAN communication M12 connector

It's a M12 5-pin industrial male connector with standard pinout according to CiA 303-1 recommendations.
Recommended AWG for the associated cable: AWG24 for wires inside a shielded cable.
(See part "Starter Kit" of this document).
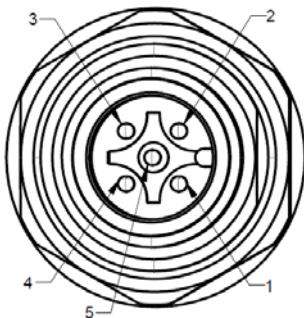
CAN CONNECTEUR	
M12/PG9 : MOLEX 1200708205	
1	NC
2	NC
3	GND_ISO
4	CAN_P
5	CAN_N

Note that the maximum baud rate depends of the cable length.

5.6. Connectors part numbers

		MOTOR	CABLE	
I/O connector	Panel connector	HUMMEL 7.850.000.000	All HUMMEL M16	AWG24 cable
	Insert	HUMMEL 7.003.988.101	HUMMEL 7.003.988.102	
	Contact	HUMMEL 7.010.980.801	HUMMEL 7.010.980.802	
Supply connector	Panel connector	HUMMEL 7.850.000.000		AWG14 cable
	Insert	HUMMEL 7.003.983.101	HUMMEL 7.003.983.102	
	Contact	HUMMEL 7.010.982.001	HUMMEL 7.010.982.002	
CAN connector	MOLEX M12/PG9 1200708205		any compatible connectors (i.g : Weidmüller SAIL-M12GM12G-5S3.0U)	

6. MOTOR ELECTRICAL CONNECTION

These motors are not intended to be directly connected to the line supply.
It is the responsibility of the installer to define the electrical protections to be implemented according to the regulations applicable to the end product range of application.
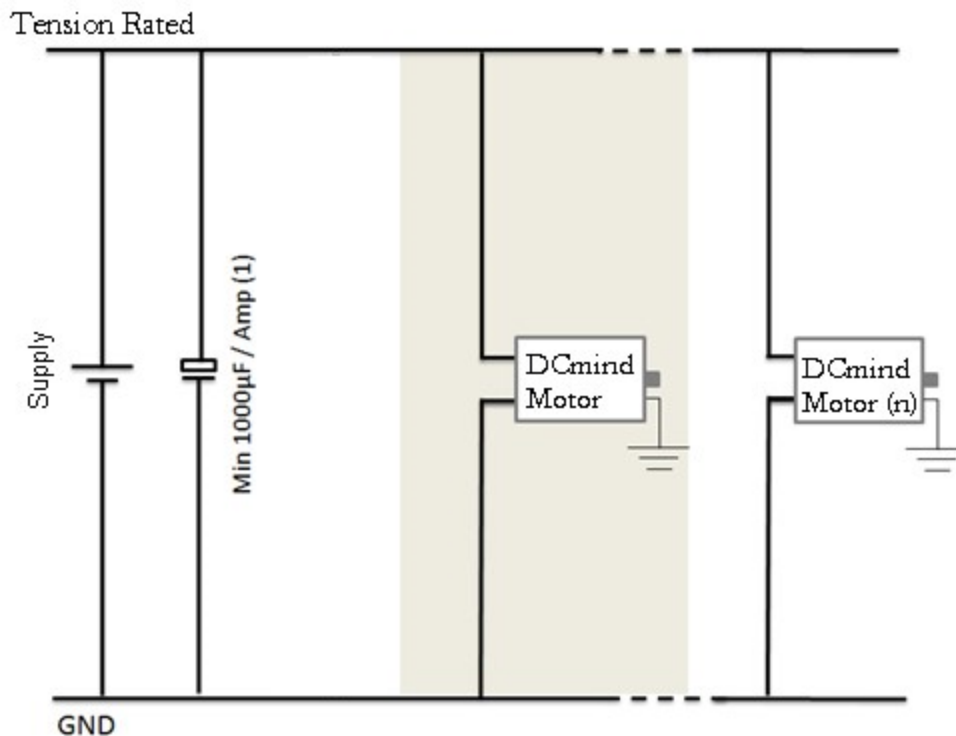We recommend the use of fuses in accordance with UL248-5 Test 1.3 & 5.
Supply power must be a stabilized power supply with double electrical insulation.

6.1. Power Connection

We recommend grounding the motor housing.

Power connection diagram.

(1) Include capacitors to smooth out inrush currents. Recommended value 1000 µF/A drawn.

6.1.1. Ballast Circuit

When the motor brakes, the kinetic energy stored in the inertias during rotation is returned to the power supply and generates a voltage surge. This voltage surge can be destructive for the motor or for devices connected to the power supply.
In the event of frequent braking, **an external ballast resistor must be used**, all the circuitry is integrated in the product. Ballast parameters are available through CANopen communication.
For more information, see the HMI user manual dedicated for the "DCmind Soft + CANopen"

It is always necessary to conduct tests to check what size it should be.

6.1.2. EMC Protection

In order to ensure that the product is compatible with EMC standards IEC 61000-6-1, IEC 61000-6-2, IEC 61000-6-3, IEC 61000-6-4, EN55022 Class B we recommend:
- Connecting the motor to ground while limiting length of the grounding strip,
- Adding capacitors on the main power supply.
     We recommend 1000 µF per amp drawn.
-

6.1.3. Earth connection

A taped hole on the housing is dedicated to the earth connection. Use M5x6mm screw class 8.8 to connect product with a screwing torque of 4N.m±15%. Use AWG12 gauge lead for earth connection.

6.2. Protection

⚠ DANGER
PROTECTION The product has internal protection devices that switch off the motor power supply when activated. As the motor is no longer controlled, driving loads can decrease. • The system manufacturer is responsible for complying with all the applicable safety rules in the event of product failure. **Failure to comply with these precautions will result in death or serious injury.**

6.2.1. Voltage Protection

The product incorporates protection against voltage surges and undervoltages.

Protection against voltage surges:
The voltage surge threshold can be set in the HMI.
When the supply voltage exceeds the threshold, the product automatically switches to ERROR mode. In ERROR mode the motor is no longer controlled.
To reset the motor:
- The supply voltage must be at least 1 V below the threshold value.
- It is necessary to pass in DISABLE mode then ENABLE mode.

Protection against undervoltages:
The under voltage threshold can be set in the HMI.
When the supply voltage falls below this threshold, the product automatically switches to ERROR mode. In ERROR mode the motor is no longer controlled.
To reset the motor:
- The supply voltage must be at least 1V higher than the threshold value
- It is necessary to pass in DISABLE mode then ENABLE mode.

6.2.2. Temperature Protection

- The product incorporates a first temperature protection in the form of a temperature sensor on the motor pilot control card.

Temperature protection:
The under and over temperature thresholds can be set in the HMI (set at -40°C and +110°C by default).
In this case, when the internal temperature exceeds 110°C (or is below than -40°C), the product automatically switches to ERROR mode. In ERROR mode the motor is no longer controlled.
To reset the motor:
- The temperature must be between the 2 thresholds.
- The motor inputs must be set to DISABLE mode then ENABLE mode.

- The product incorporates second temperature protection with 3 thermistors into the stator coils.

Temperature protection:
In this case, when the stator temperature exceeds 120°C, the product automatically switches to ERROR mode. In ERROR mode the motor is no longer controlled.
To reset the motor:
- The temperature must be under 120°C.
- The motor inputs must be set to DISABLE mode then ENABLE mode.
- .

6.2.3. Current Limiting

The product incorporates internal current limiting. This limiting directly affects the motor in terms of hardware. If this limit is reached, it results in a loss of motor performance.

This product is not designed to operate continuously with this limiting (see the "Electrical Data" section).
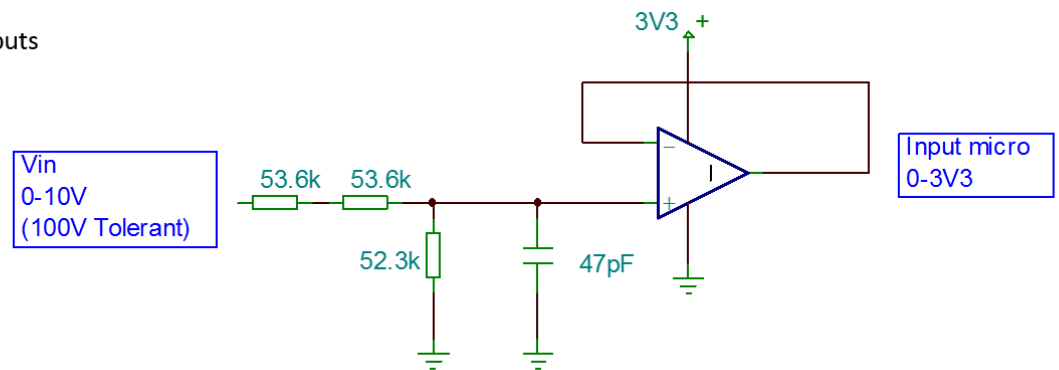
6.3. Input/Output Connection
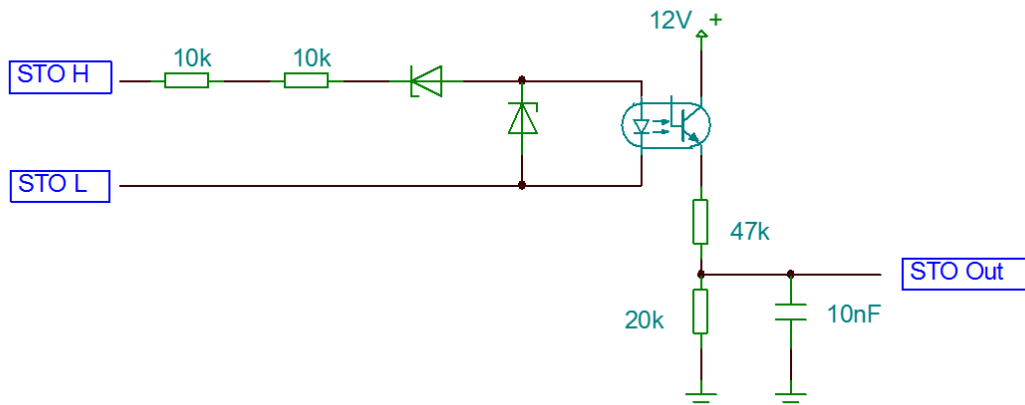
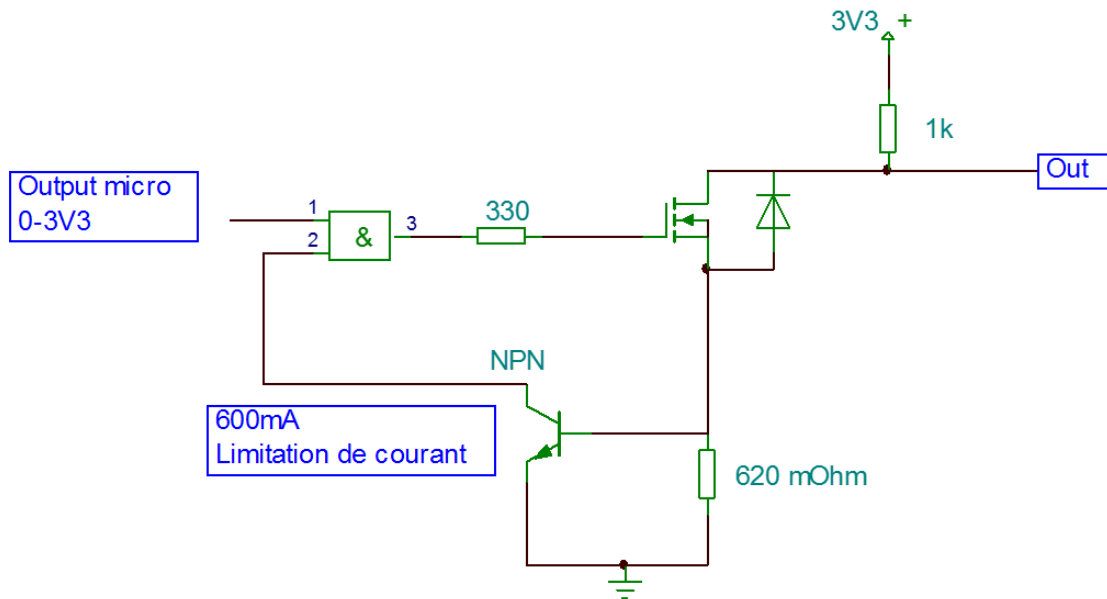### 6.3.1. Equivalent Input Diagram

Digital Inputs
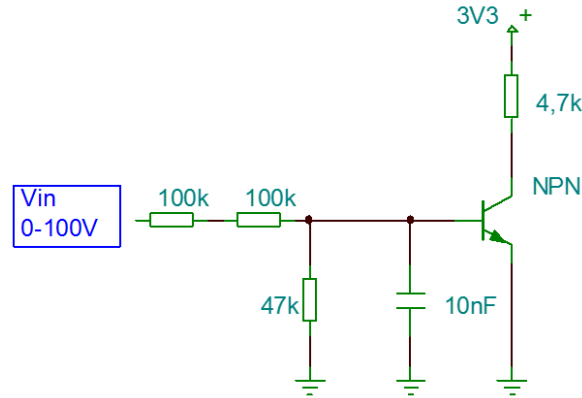
Analog Inputs

STO inputs

6.3.2. Equivalent Output Diagram

Digital Outputs

6.4. Terminology and Abbreviations

Encoder
Mounted on the motor, the angular position sensor provides frequency pulses proportional to the motor speed.

Degree of protection
The degree of protection is a standard definition used for electrical equipment that aims to describe the protection against penetration of solids and liquids inside the motor casing (for example IP54M). The M indicates that the tests are conducted with the motor running.
This value cannot take account of the seal around the output shaft, for which the installer must take responsibility.

Axial forces
Longitudinal traction or compression forces affecting the shaft.

Radial forces
 Radial forces affecting the shaft.

Direction of rotation
Positive or negative direction of rotation of the motor shaft. The positive direction of rotation is clockwise rotation of the motor shaft, when looking at the motor from the output shaft.

Nominal speed
Motor speed of rotation when nominal torque is applied.

Nominal current
Current drawn by the motor when nominal torque is applied.

Nominal torque
Maximum applicable torque in continuous duty on the motor shaft.

Firmware
Control software embedded in the motor.

Bootloader
Function available in the HMI which can be used to update the firmware.

Commonly used abbreviations:
HMI: Human-Machine Interface
SMI22:   Trade name of the new CROUZET brushless range
Homing: Initialization phase for finding the limits
AON: Type of digital inputs/outputs (All Or Nothing)
PWM: Pulse Width Modulation
FWD: Forward
REV: Reverse
NO: Normally Open
NC: Normally Closed
EMC: Electromagnetic Compatibility