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# SMi21 DCMIND BRUSHLESS MOTORS

## USER AND SAFETY MANUAL





# SMi21 DCmind Brushless Motors

## User Manual and Safety Notice



### 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".
- Please consult the latest catalogue to find out about the product's technical specifications.
- We reserve the right to make modifications without prior notification.

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## About This Manual

This manual applies to SMi21 DCmind brushless products:

- 801400SMi21, 801495SMi21, 801496SMi21, 801410SMi21
- 801800SMi21, 801896SMi21, 801897SMi21, 801810SMi21
- 802800SMi21, 802896SMi21, 802897SMi21, 802810SMi21

### *Reference source for manuals*

The manuals can be downloaded from our website at the following address:

<http://www.crouzet.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

SMi21 DCmind brushless motors are brushless DC motors, with a control circuit board integrated in the motor.

### 1.2. Characteristics

SMi21 DCmind brushless motors are intelligent servomotors for speed, position and torque control applications. They can be configured via a Human-Machine Interface (HMI). They are equipped with 2 unshielded cables as standard, 1 for the power, 1 for the control signals.

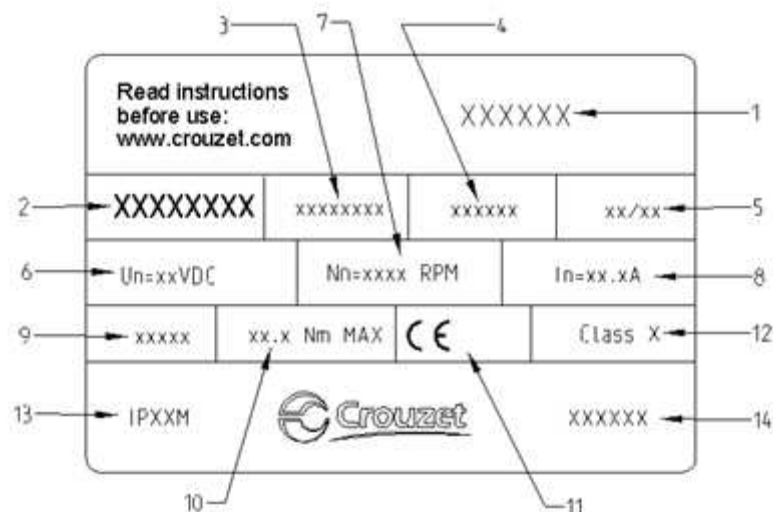
### 1.3. Options

The motors can be supplied with options, such as:

- Different gearboxes
- A failsafe holding brake
- Different motor output shaft versions

### 1.4. Identification Label

The label contains the following data:



1. Product family code.
2. Product part number.
3. Reserved zone.
4. Zone reserved for specific customer marking.
5. Week/year manufacturing date.
6. Operating voltage.
7. Nominal motor speed at 24 V.
8. Nominal motor current.
9. Reduction ratio (for geared motor versions).
10. Maximum nominal torque applicable to the gearbox (for geared motor versions).
11. Motor approvals.
12. Insulation system temperature class.
13. Product degree of protection (sealing) during operation (excluding output shaft).
14. Country of origin.



### 1.5. Product Coding

**80 XX XX SMi21:** Product family on SMi21 electronic base

PRODUCT REFERENCE	8 0	X X	X X	X X
Motor				
Type of stator:				
14: 30mm brushless stator				
18: 50 mm brushless stator				
28: 50 mm brushless stator high torque				
Gearbox adaptation				
00: no gearbox				
10: RAD10 gearbox				
95: P52 gearbox				
96: P62 gearbox				
97: P81 gearbox				
Increment numbers				

## **2. BEFORE YOU BEGIN - SAFETY-RELATED INFORMATION**

### **2.1. Personnel Qualifications**

Only qualified personnel who are familiar with and fully understand the contents of this manual are authorized to work on and with this product.

Qualified personnel must be familiar with current standards, regulations and requirements concerning prevention of accidents during work undertaken on and with this product.

These qualified personnel must have undergone safety training in order to be able to detect and avoid related hazards.

Their professional training, knowledge and experience renders such qualified personnel capable of preventing and recognizing potential hazards that might be generated through use of the product, modifying settings and the mechanical, electrical and electronic equipment in the whole installation.

### **2.2. Use in Compliance with Industry Practice**

As demonstrated in these instructions, this product is a component designed for use in industrial environments.

The current safety instructions, specified conditions and technical specifications must be complied with at all times.

Before starting to use the product, undertake a risk analysis using actual examples. Depending on the result, the necessary safety measures must be implemented.

Since the product is used as a component in an overall system, it is the user's responsibility to guarantee people's safety through the concept of the overall system (e.g. concept of a machine).

Only use original manufacturer accessories and spare parts.

The product must not be used in explosive atmospheres (Ex zone).

All other types of use are deemed to be non-compliant and can be dangerous.

Only qualified personnel are authorized to install, operate, maintain and repair electrical equipment.

### 2.3. Basic Information

 **DANGER****DANGEROUS PHENOMENON LINKED TO ELECTRIC SHOCK, EXPLOSION OR EXPLOSION DUE TO AN ELECTRIC ARC**

- Only qualified personnel who are familiar with and fully understand the contents of this manual are authorized to work on this product. Only qualified personnel are authorized to undertake installation, setting, repair and maintenance.
- The installation manufacturer is responsible for complying with all the applicable requirements and regulations with regard to grounding the drive system.
- It is the user's responsibility to define whether it is necessary to ground the motor, depending on its intended use.
- Do not touch unprotected live parts.
- Only use electrically-isolated tools.
- AC voltages can be connected to unused conductors in the motor cable. Isolate unused conductors at both ends of the motor cable.
- The motor produces a voltage when the shaft turns. Protect the motor shaft from any external drive operation before working on the drive system:
  - De-energize all connections.
  - Attach a notice saying "DO NOT START UP" on all the switches.
  - Protect all the switches from switching on.
  - Wait for the internal motor capacitors to discharge. Measure the voltage on the power cable and check that it is less than 12 VDC.
- Install protective covers and ensure they are closed before energization.

**Failure to comply with these precautions will result in death or serious injury.**

 **WARNING****LOSS OF COMMAND CONTROL**

- When perfecting the command concept, the installation manufacturer must take account of the possibilities for potential failure of command paths and provide, for certain critical functions, the means of returning to safe states during and after the failure of a command path.

Examples of critical command functions are:

EMERGENCY STOP, end position limiting, network outage and restarting.

- Separate or redundant command paths must be available for critical functions.
- Comply with the accident prevention instructions and all current safety directives.
- Any installation in which the product described in this manual has a central role must be carefully and meticulously checked prior to commissioning to ensure it is working properly.

**Failure to comply with these precautions can result in death or serious injury.**

 **WARNING****UNBRAKED MOVEMENT**

In the event of a power outage and errors resulting in disconnection of the power stage, the motor is no longer braked in a controlled way and can cause damage.

- Prevent access to the hazardous zone.
- If necessary, use a damped mechanical stop or a service brake.

**Failure to comply with these precautions can result in death, serious injury or damage to equipment.**

## 2.4. 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.

### 3. PRECAUTIONS FOR USE CONCERNING THE MECHANICS

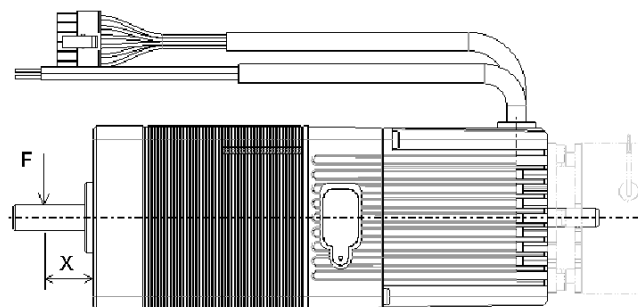
#### 3.1. Data specific to the motor shaft

##### 3.1.1. Press-fit force

 <b>WARNING</b>
<p><b>MOTOR MECHANISM</b></p> <p>Exceeding the maximum permissible forces on the shaft leads to rapid bearing wear, a broken shaft or damage to any accessories (encoder, brake, etc.)</p> <ul style="list-style-type: none"> <li>• Never exceed the maximum axial and radial forces.</li> <li>• Protect the shaft from any impact.</li> <li>• When press-fitting components, do not exceed the maximum permissible axial force.</li> </ul> <p><b>Failure to comply with these precautions can result in death, serious injury or damage to equipment.</b></p>

The maximum press-fit force is limited by the maximum permissible axial force on the ball bearings. This maximum axial force is stated in the motor technical data sheet. Alternatively, the component to be fixed in position can be clamped, glued or shrunk-fit.

##### 3.1.2. 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. Options

### 3.2.1. Holding brake

SMi21 DCmind brushless motors can be equipped as standard with a failsafe electromechanical brake. The holding brake is designed to lock the motor shaft in a de-energized state. The holding brake is not a safety function. How it is controlled is described in the "Connecting the Holding Brake" section.

### 3.2.2. Gearboxes

SMi21 DCmind 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.

### 3.2.3. Other

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

## 4. ACCESSORIES

### 4.1. Starter Kit

This kit consists of a 2-meter long micro USB B to USB A (MOLEX 68784-0003) connecting cable and a USB stick containing the "Crouzet Interface" parameter-definition software and installation drivers for this HMI.

This starter kit can be obtained by ordering part number **79 298 008**.

## 5. INSTALLATION

Installation must, as a general rule, be performed in accordance with good practice.

 **WARNING****HEAVY WEIGHT AND FALLING PARTS**

The motor can be extremely heavy.

- When mounting, take the weight of the motor into account.
- Mounting (screw tightening torque) must be performed in such a way that the motor cannot become detached, even if subjected to strong accelerations or constant jolting.

**Failure to comply with these precautions can result in death, serious injury or damage to equipment.**

 **WARNING****STRONG ELECTROMAGNETIC FIELDS**

Motors can generate locally powerful electrical and magnetic fields. These can cause sensitive equipment to fail.

- Keep people with implants such as pacemakers away from the motor.
- Do not place sensitive equipment in the immediate vicinity of the motor.

**Failure to comply with these precautions can result in death, serious injury or damage to equipment.**

 **WARNING****UNEXPECTED BEHAVIOR CAUSED BY DAMAGE OR FOREIGN BODIES**

Following damage to the product or the presence of foreign bodies, deposits or penetration of fluid, unexpected behavior can occur.

- Do not use damaged products.
- Make sure that no foreign body has been able to penetrate the product.
- Check that the power supply lead seals and cable entries have been positioned correctly.
- Check that the stopper protecting the USB B to USB A micro connector has been positioned correctly.

**Failure to comply with these precautions can result in death, serious injury or damage to equipment.**

 **WARNING****HOT SURFACES**

The product's metal surface can heat up to more than 70°C in certain types of use.

- Avoid all contact with the metal surface.
- Do not place flammable or heat-sensitive components in the immediate vicinity.
- Assemble components in the best way for heat dissipation.

**Failure to comply with these precautions can result in injury or damage to equipment.**

 **WARNING****DAMAGE AND DESTRUCTION OF THE MOTOR CAUSED BY STRESS**

The motor is not designed to carry loads. If subjected to stress, the motor can be damaged, or even fall.

- Do not use the motor as a step.
- Prevent the motor from being used in any way other than its intended purpose by installing guards or displaying safety instructions.

**Failure to comply with these precautions can result in injury or damage to equipment.**

 **CAUTION****VOLTAGE SURGES**

During braking phases, the motor generates voltage surges.

- Check that these voltage surges are acceptable to other devices connected on the same power supply.
- If possible, use an external circuit to limit voltage surges. if the brake is used intensively.

**Failure to comply with these precautions can result in injury or damage to equipment.**


## 5.1. Overview of the Installation Procedure

The installation procedure is described in the following sections:

- Electromagnetic Compatibility (EMC)
- Prior to Mounting
- Mounting the Motor
- Electrical Installation
- Connecting the USB cable to Set the Motor Parameters

Check that these sections have been read and understood, and that installation has subsequently been executed correctly.

## 5.2. Electromagnetic Compatibility (EMC)

 **DANGER**

**INTERFERENCE AFFECTING SIGNALS AND EQUIPMENT**  
 Disturbed signals can cause equipment to behave unpredictably.

- Wire up products in compliance with the specific EMC recommendations for each device.
- Make sure that these EMC recommendations are executed correctly.

**Failure to comply with these precautions can result in death, serious injury or damage to equipment.**

*Recommendations in terms of EMC: Installing the motor power supply leads*

When planning the wiring, take account of the fact that the motor power supply leads must be kept separate from line supplies or cables carrying signals.

Comply with the following measures as concerns EMC.

Measures relating to EMC	Effect
Keep the cables as short as possible. Do not install unnecessary cable loops.	Reduces stray couplings, both capacitive and inductive.
Ground the product.	Reduces emissions, improves immunity to interference.
If using shielded cables, install the cable shielding so that it is in contact with the widest possible surface area, use cable grips and ground strips.	Reduces emissions.
Keep the motor power supply leads separate from cables carrying signals or use shielding plates.	Reduces stray cross-couplings.
If using shielded cables, install the cables without any disconnection points. <sup>1)</sup>	Reduces stray radiation.

<sup>1)</sup> When a cable is disconnected for installation, the cables must be connected at the disconnection point via a shielding connection and a metal box.

#### *Equipotential bonding conductors*

If using shielded cables, differences in potential can generate unauthorized currents on the cable shielding. Use equipotential bonding conductors to minimize currents on the cable shielding.

### 5.3. Prior to Mounting

#### *Look for any damage*

Damaged drive systems must neither be mounted nor used.

⇒ Check the drive system prior to mounting, looking out for any visible signs of damage.

#### *Clean the shaft*

On leaving the factory, the motor shaft extensions are coated with a film of oil.

If transmission devices are to be glued on, it may be necessary to remove the film of oil and clean the shaft. If necessary, use degreasing products in accordance with the glue manufacturer's instructions.

⇒ Avoid any direct contact between the skin or sealing materials and the cleaning product used.

#### *Flange mounting surface*

The mounting surface must be stable, flat and clean.

⇒ In regards to installation, make sure that all dimensions and tolerances are respected.

#### *Specification of power supply leads*

The power supply leads for the motor and its accessories must be selected carefully on the basis of their length, the motor supply voltage, the ambient temperature, the current level circulating therein, and their environment.



## WARNING

#### **DAMAGE AND FIRE DUE TO INCORRECT INSTALLATION**

Repeated force and movement around the grommets can damage the cables.

- Comply with the stated bend radius.
- Avoid subjecting the grommets to repeated force or movement.
- Attach the power supply cables close to the grommets using a strain relief.

**Failure to comply with these precautions can result in injury or damage to equipment.**



## 5.4. Mounting the Motor

 **DANGER****HOT SURFACES**

The motor's surface can heat up to more than 70°C in certain types of use.

- Avoid contact with hot surfaces.
- Do not place flammable or heat-sensitive components in the immediate vicinity.
- Assemble components in the best way for heat dissipation.
- Check the temperature when performing a test.

**Failure to comply with these precautions can result in injury or damage to equipment.**

 **WARNING****UNEXPECTED MOVEMENT DUE TO ELECTROSTATIC DISCHARGES**

Electrostatic discharges (ESD) on the shaft can, in rare cases, lead to encoder system failures and generate unexpected motor movements.

- Use conductive parts (e.g. antistatic straps) or other appropriate measures to avoid a static charge due to movement.

**Failure to comply with these precautions can result in death, serious injury or damage to equipment.**

 **WARNING****UNINTENDED BEHAVIOR CAUSED BY MECHANICAL DAMAGE TO THE MOTOR**

Exceeding the maximum permissible forces leads to rapid bearing wear, a broken shaft or damage to the internal encoder.

- 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.**

### Mounting position

The motor can be mounted in any position.

### Mounting

When mounting the motor on the flange, the motor must be aligned precisely in both the axial and radial directions. All the fixing screws must be tightened to the tightening torque stipulated by the application, taking care not to generate any warping.

### Install the transmission devices

If the transmission device is installed incorrectly, this can damage the motor.

Transmission devices such as pulleys and gears must be mounted in compliance with the maximum axial and radial loads defined in each motor's technical data sheet.

Follow the transmission device manufacturer's assembly instructions.

The motor and the transmission device must be aligned precisely both axially and radially. If this is not done, it will result in abnormal operation, damage to the bearings and significant wear.

## 5.5. Electrical Installation

These motors are not designed to be connected directly to the line supply.

It is the installer's responsibility to define the electrical protection devices to be implemented according to the regulations applicable to the end product range of application.

For the power supply to the power part we recommend using a double-insulated stabilized power supply.

The motor is not protected against polarity reversals on the power part.

The motor is regenerative, in other words it can feed back energy to the power supply during braking phases. Voltage surges created in this way can reach levels that risk destroying the motor itself or devices placed on the same power supply.

### DANGER

#### ELECTRIC SHOCK

High voltages can appear unexpectedly on the motor connection.

- The motor produces a voltage when the shaft turns. Protect the motor shaft from any external drive operation before working on the drive system.

- The system manufacturer is responsible for complying with all applicable regulations with regard to grounding the drive system.

**Failure to comply with these precautions will result in death or serious injury.**

### WARNING

#### UNEXPECTED MOVEMENT

As a result of incorrect wiring or other error, the drives can execute unexpected movements.

- Do not start up the installation if there is anybody or any obstacle in the danger zone.

- Execute the initial test movements without loads connected.

- Do not touch the motor shaft or related drive elements.

**Failure to comply with these precautions can result in death, serious injury or damage to equipment.**

 **WARNING****VOLTAGE SURGES**

During braking phases, the motor generates voltage surges.

- Check that these voltage surges are acceptable to other devices connected on the same power supply.
- If possible, use an external circuit to limit voltage surges if the brake is used intensively.

**Failure to comply with these precautions can result in death, serious injury or damage to equipment.**

 **CAUTION****FIRE CAUSED BY BAD CONTACTS**

If the connector is not properly inserted the motor connector can overheat, causing the contacts to melt due to an electric arc.

- Incorrect connection can cause overheating due to an electric arc.

**Failure to comply with these precautions can result in injury or damage to equipment.**

 **CAUTION****IRREPARABLE PRODUCT DAMAGE CAUSED BY REVERSED POLARITY**

Incorrect connection of the power can result in reversed polarity, resulting in destruction of the circuit board inside the motor.

- Check the conformity of the power connections.
- Place a slow-blow fuse on the power supply that is appropriately sized for the current the motor needs to absorb in the application.

**Failure to comply with these precautions can result in injury or damage to equipment.**

*Connecting the protection conductor*

It is the installer's responsibility to define whether the motor needs to be grounded.

The mounting flange should be used for this purpose.

Never connect or disconnect the product power supply leads while the voltage is applied.

### 5.5.1. Connecting the Holding Brake (Optional)

 **WARNING**

**LOSS OF BRAKING FORCE DUE TO WEAR OR HIGH TEMPERATURE**  
Engaging the holding brake while the motor is running leads to rapid wear and loss of braking force.

- Do not use the brake as a service brake.
- Note that "emergency stops" can also cause wear.

**Failure to comply with these precautions can result in death, serious injury or damage to equipment.**

 **WARNING**

**UNEXPECTED MOVEMENT**  
Releasing the holding brake can result in unexpected movement on the installation.

- Make sure this cannot cause any damage.
- Do not continue with the test if there is anybody or any obstacle in the danger zone.

**Failure to comply with these precautions can result in death, serious injury or damage to equipment.**

 **CAUTION**

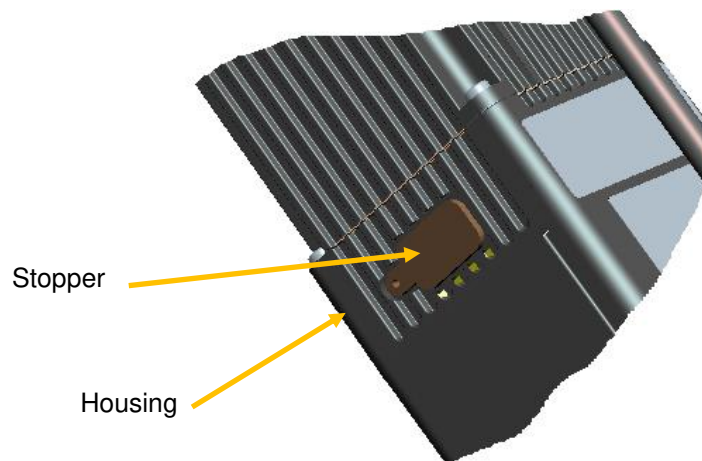
**MALFUNCTION OF THE HOLDING BRAKE DUE TO INAPPROPRIATE VOLTAGE**

- If the voltage is too low, the holding brake cannot release, resulting in wear.
- In the event of voltages higher than the specified value, the holding brake will be subject to significant overheating.

**Failure to comply with these precautions can result in injury or damage to equipment.**

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.

## 5.6. USB Connector



The motor is equipped with a USB B to USB A micro 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 USB B to USB A micro connector.

It must be replaced carefully after use, in order to keep the motor sealed.

### **WARNING**

#### **UNEXPECTED MOVEMENT DUE TO ELECTROSTATIC DISCHARGES**

Electrostatic discharges (ESD) on the USB B to USB A micro 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.**



## 6. OPERATION

### 6.1. Preparation for Operating

Prior to operating:

- ⇒ Check that the mechanical installation is correct.
- ⇒ Check that the electrical installation has been carried out professionally: pay special attention to the protective conductor connections and the grounding connections. Check that all the junctions are correct, properly connected and that the screws are fully tightened.
- ⇒ Check the ambient conditions and operating conditions: make sure that the stipulated ambient conditions are adhered to and that the drive solution conforms to the expected operating conditions.
- ⇒ Check that any transmission devices that are already mounted are balanced and aligned precisely.
- ⇒ Check that the operating conditions do not generate abnormal voltage surges for the product or the application.
- ⇒ Check that the holding brake can withstand the maximum load. After applying the braking voltage, make sure that the holding brake is fully released. Make sure that the holding brake is fully released before initiating a movement.
- ⇒ Check that the USB micro connector's protective stopper has been replaced correctly.

 **WARNING****UNEXPECTED MOVEMENT**

As a result of incorrect wiring or other error, the drives can execute unexpected movements.

- Check the wiring.
- Do not start up the installation if there is anybody or any obstacle in the danger zone.
- Execute the initial test movements without loads connected.
- Do not touch the motor shaft or related drive elements.

**Failure to comply with these precautions can result in death, serious injury or damage to equipment.**

 **WARNING****ROTATING PARTS**

Rotating parts can cause injuries, trap clothing or hair. Separate parts or unbalanced parts can be ejected.

- Check that all rotating parts are fitted properly.
- Use a protective cover for rotating parts.

**Failure to comply with these precautions can result in death, serious injury or damage to equipment.**

 **WARNING****FALLING PARTS**

The motor can move due to the reaction torque; it can topple over and fall.

- Fix the motor firmly in place so that it cannot become detached during rapid acceleration.

**Failure to comply with these precautions can result in death, serious injury or damage to equipment.**

**CAUTION****HOT SURFACES**

The motor's surface can heat up to more than 70°C in certain types of use.

- Avoid contact with hot surfaces.
- Do not place flammable or heat-sensitive components in the immediate vicinity.
- Assemble components in the best way for heat dissipation.
- Check the temperature when performing a test.

**Failure to comply with these precautions can result in injury or damage to equipment.**

**CAUTION****VOLTAGE SURGES**

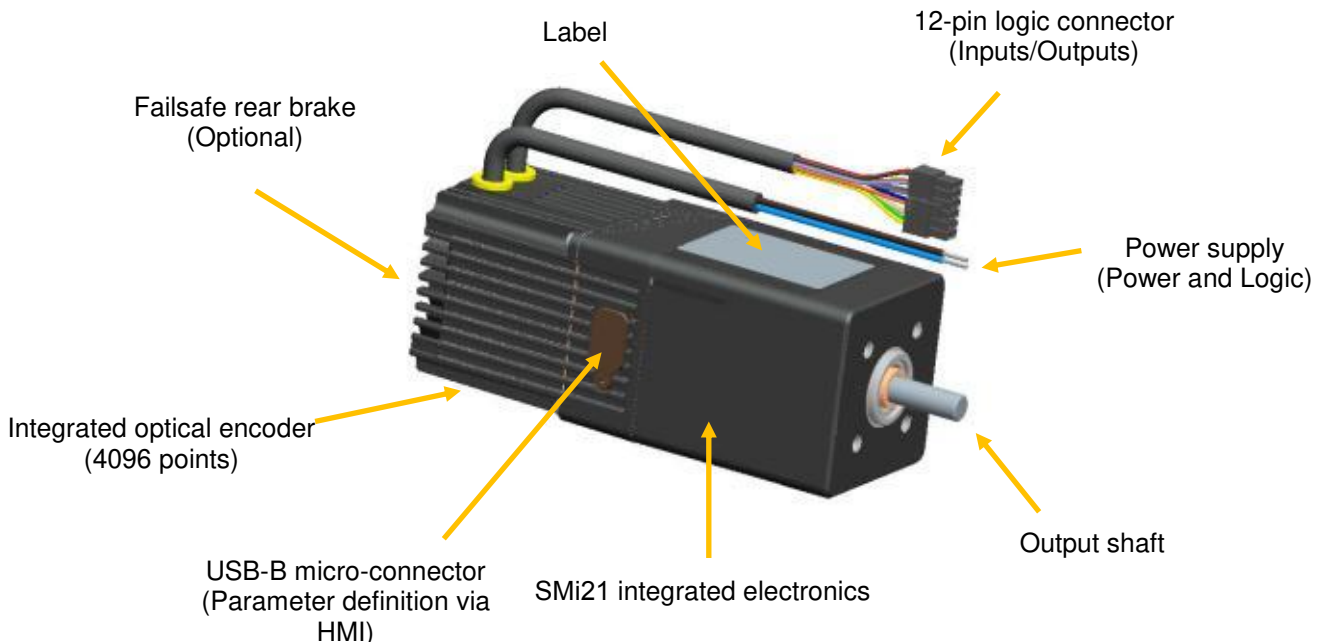
During braking phases, the motor generates voltage surges.

- Check that these voltage surges are acceptable to other devices connected on the same power supply.
- If possible, use an external circuit to limit voltage surges if the brake is used intensively.

**Failure to comply with these precautions can result in injury or damage to equipment.**

## 7. PRODUCT OVERVIEW

### 7.1. Description of the Product



**Figure 1**

### 7.2. SMi21 Control Electronics

The SMi21 electronic control card 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)).
- Position-Speed-Torque and Current control algorithms.
- Use of preconfigured programs which can perform numerous routine applications.
- Management of different types of operation:
  - "Stand-alone" motor without external PLC.
  - Use with other motors incorporating SMi21 or TNI21 or Motomate electronics.
  - Use with a programmable controller, with the SMi21 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.
  - USB connection via a commercially-available standard cable (can be supplied on request).
- Management of 6 inputs and 4 outputs 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
  - 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.