MC24 Hardware Manual

Release 1.0

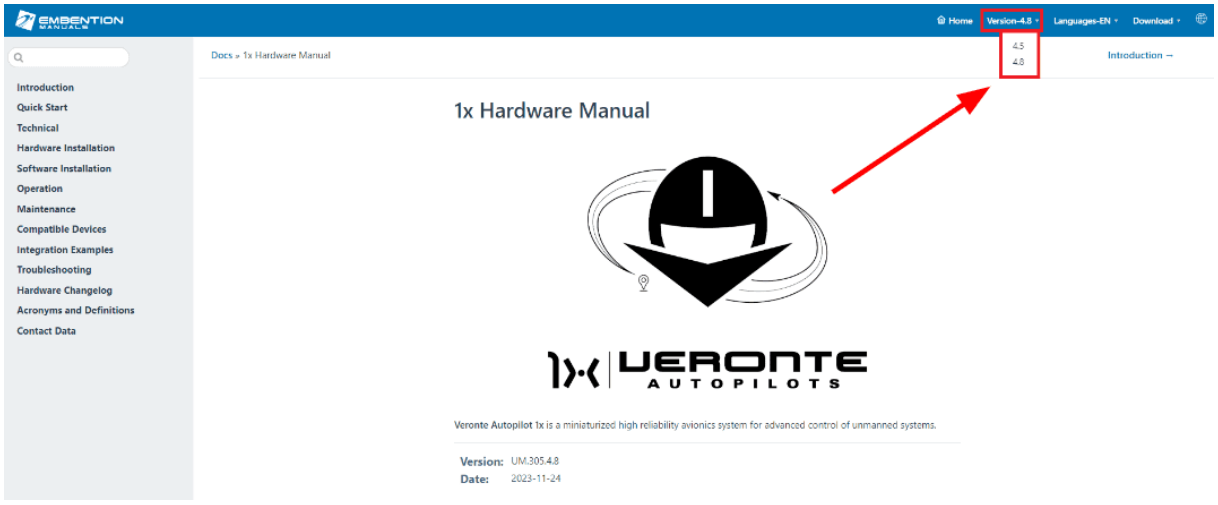
Embention

2024-12-13

CONTENTS

Veronte MC24 is a motor controller designed for aircraft motors up to 24 kW.

Warning: Select your version before reading any user manual. The following image shows where to select a version from any Embention user manual.



CHAPTER

ONE

INTRODUCTION

Fig. 1: **MC24 front view**

Fig. 2: **MC24 rear view**

Veronte MC24 speed controller is capable of driving any type of 3-phase PMSM motor. It can be used with a wide variety of UAVs or eVTOL vehicles and also in automotive applications (Bikes, Karts, Cars). The **MC24** uses FOC

algorithm for motor control together with MOSFET technology.

MC24 Speed Controller offers IP68 protection, allowing the operation under rain and extreme humidity environments.

MC24 Speed Controller working voltage range is 60-120 V with a maximum input continuous current of 200 A (up to 24kW).

The system has a temperature range of -40 to 55 ºC.

CHAPTER

TWO

QUICK START

This document describes the main functionalities of the **MC24** Speed Controller.

2.1 Warnings

When installing the **MC24** speed controller in the vehicle, the following limitations shall be considered:

- The distance between the battery, the controller system and the motor should be as short as possible in order to maximize the efficiency. It is preferable to place the controller system as close to the battery as possible and extend the cables from the controller to the motor. Calibration will be needed depending on the final setup.
- The wire connections type between the power items must be crimped not soldered.
- The system must be placed in a ventilated place with proper air flow. If this is not possible, it is necessary to install an external fan.
- The vehicle must have an inrush current limiter when powering **MC24** for the first time.
- PID tuning is strongly not recommended, since it nullifies the warranty.
- An unappropriated use of the **MC24** exempts Embention from responsabilities related to any damage.
- Embention shall have no responsibility, obligation or liability in any manner for and in respect of any inappropriate use by the client, such as (including but not limited to) not implementing sufficient *cooling airflow*, applying according to the indications given by Embention.

Note: When working voltage is higher than 60 V, use of insulating gloves are mandatory for installation and the system **must have** a chassis fault detection system.

Warning:  **Careful!** The system slowly discharges the voltage on the input terminals when the battery is disconnected. Capacitors may remain charged unless enough time has passed.

2.2 Requirements

2.2.1 Cooling Airflow

To dissipate the heat from the **MC24** properly, it is required to provide 16 m/s of air speed through the heatsink.

Fig. 1: **Airflow dissipation**

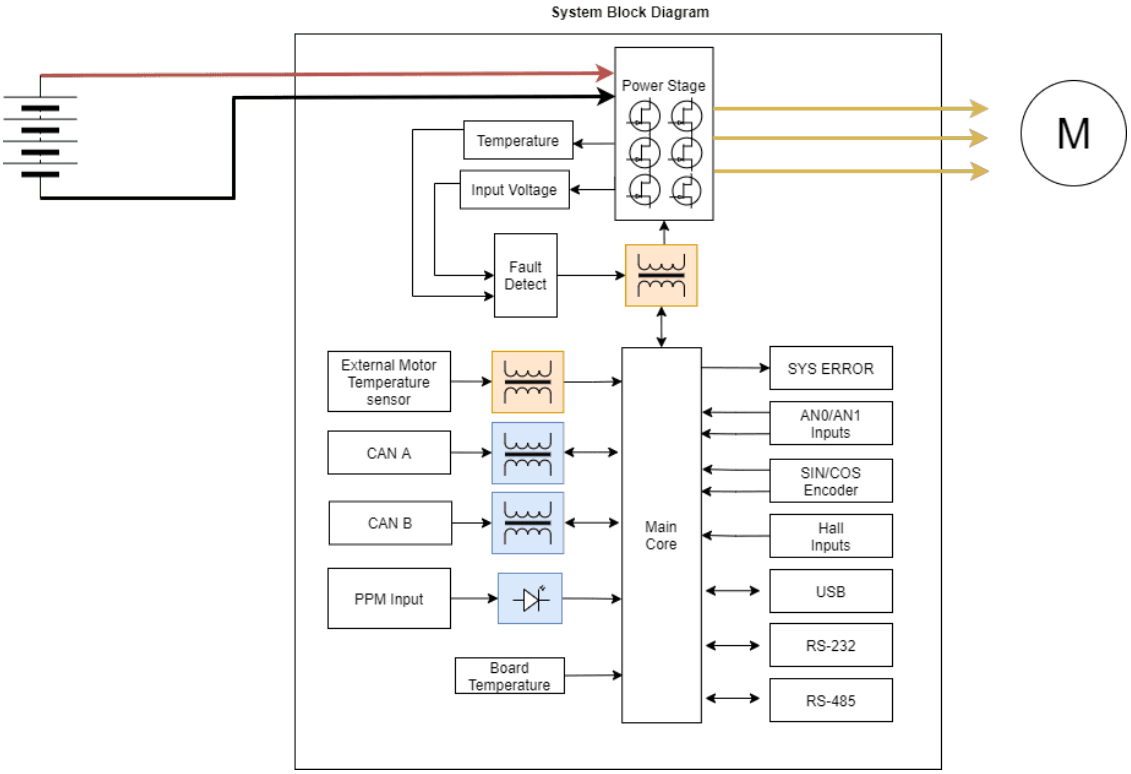
CHAPTER

THREE

TECHNICAL

3.1 Main Features

The block diagram of the system is shown below.



Peripheral used for motor control

- Opto Isolated PWM
- CAN bus

Peripheral use for ESC telemetry

- Serial RS-232
- Serial RS-485
- USB

Any of the **serial interfaces** can be used to configure the internal variables of the **MC24**.

The ESC includes an internal SD memory which is used to record operating logs. The variables to store can be selected through the corresponding interface.

Note: If **serial interface** is used for motor control, it cannot also be used to send telemetry, and vice versa.

On the contrary, with **CAN bus** users can control and send telemetry at the same time.

3.2 Mechanical Specifications

- **Weight**: 2430 g.
- **Operating temperature**: -40°C to 55 °C.
- **Dimensions**:

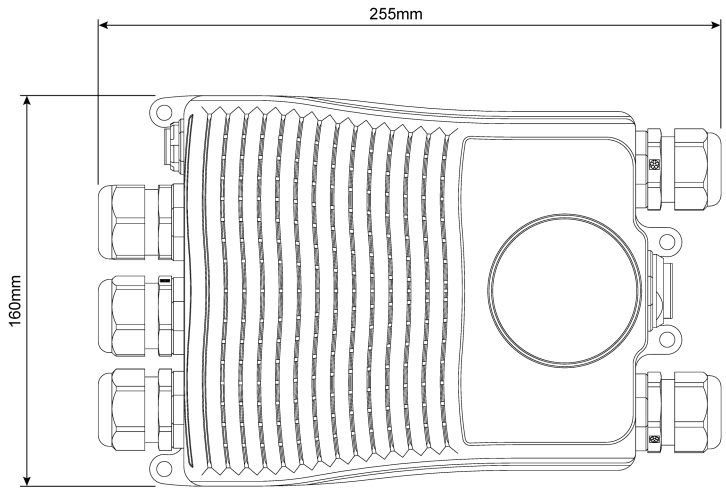


Fig. 1: **Dimensions in mm**

3.3 Electrical Specifications

Specification	Value
Voltage	60-120 V DC
Current	Input from battery: 200 A
	Output to motor: 200 A (rms value)
Peak current (< 5 s)	Input from battery: 400 A
	Output to motor: 400 A (rms value)
Maximum speed (1 pole)	600000 ERPM
PWM frequency	10 kHz

3.4 Interfaces

3.4.1 VCC

This is the main power input for the secondary part of the driver. It must be powered with a voltage of 8 to 20 V.

The consumption of this pin also depends on the loads connected to 5 V pin.

Status	Value
Standby	6.6 W
Active	13.2 W

Note: No load on 5 V output.

3.4.2 HALL Inputs

Warning: The employed hall sensors must not exceed 5 V.

These inputs are used to add to the system a feedback in sensored mode (incremental type, usually magnetic).

The 3 Hall effect sensors must be placed at 120° (electrical degrees) from each other. The following is a simple formula for obtaining the mechanical degrees of separation when installing the sensors:

$$Electrical\ Degrees = Pole\ Pairs \times Mechanical\ Degrees$$

So the sensors must be placed one of each other at:

$$Mechanical\ Degrees\ () = \frac{120}{Pole\ Pairs}$$

For example, for 10 pole pairs:

$$\frac{120}{Pole\ Pairs} = \frac{120}{10} = 12$$

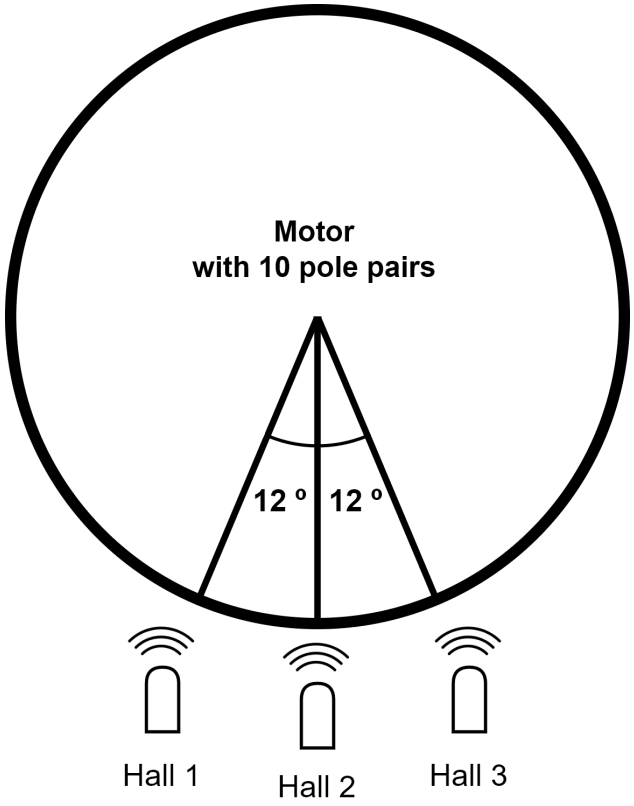


Fig. 2: **Example diagram**

Tip: The arc length between sensors can be calculated as follows:

$$Arc\ Length = \frac{2 \times \pi \times Motor\ Radius \times Mechanical\ Degrees\ ()}{360}$$

3.4.3 FAN_PWM

This 0-3.3V output is used to control an external fan in case it is needed.

3.4.4 Opto PWM Input

This input is an optocoupled control digital signal.

The input is interpreted as 0-100 % of the maximum RPM. An initial dead band can be configured to prevent the engine from starting.

Table 1: Electrical Characteristics

Type	Specification
Input voltage range	0-5 V
Minimum input current	2.5 mA
Maximum frequency	250 Hz

3.4.5 NTC/PTC Input (External Temperature Sensing)

A PTC or NTC sensor can be integrated. The maximum voltage on this pin is 2 V.

The PTC/NTC should be connected on the low side of an external resistor divider. This is the configuration by default. A high side connection can be used too, but a custom modification is needed.

The isolated Voltage_ref output should be left floating in default mode. The iso_ground is the return path of the NTC/PTC sensor.

3.4.6 ERROR_SIGNAL

This signal indicates if there is an error within the **MC24**. A positive voltage of 3.3 V means that there is no problem.

3.4.7 SIN/COS_SIGNAL

These signals are those dedicated to the SIN / COS type analog sensor. There is a 100 kohms resistor to act as divider so the maximum voltage on the pin does not exceed ±250 mV.

3.4.8 USB

This is the interface normally used to configure the **MC24** internal parameters.

The connection and disconnection of the USB related signals should always be done when the power supply (via the VCC input) is on.

Note: Not recommended for sending telemetry by default.

3.4.9 RS-232

Single ended serial type protocol:

Table 2: Electrical Characteristics

Type	Specification
ESD Protection	±15 kV (HBM)
Requirements	TIA/EIA-232-F and ITU v.28
Speed	Max. 250 kbit/s
Input Voltage	-25 to 25 V
Output Voltage	-13.2 to 13.2V

3.4.10 RS-485

Differential serial type protocol:

Table 3: Electrical Characteristics

Type	Specification
ESD Protection	±15 kV (HBM)
Requirements	TIA/EIA-485-A
Speed	Max. 25 Mbit/s
Input Voltage(D)	-0.5 to 7 V
Output Voltage (D)	1.5 to 2.4 V

3.4.11 CAN

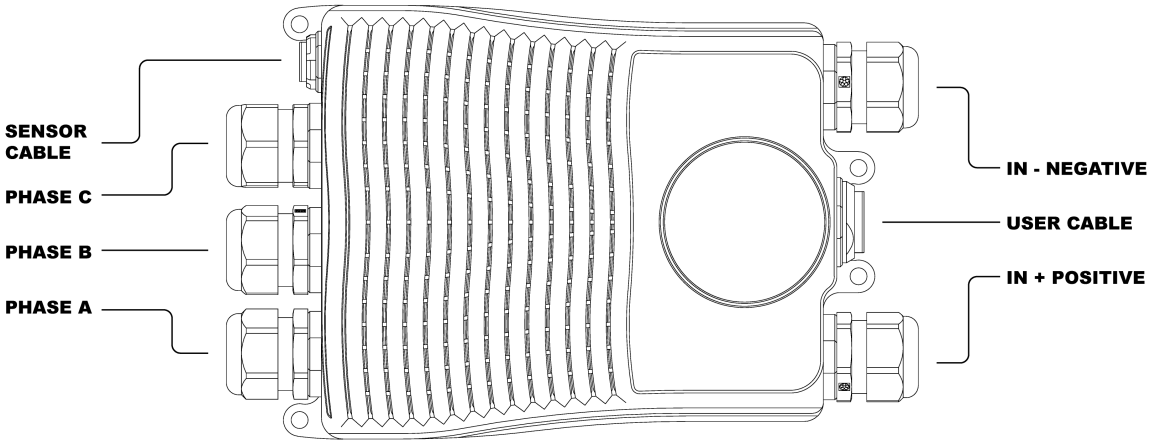
Differential communication protocol:

Table 4: Electrical Characteristics

Type	Specification
ESD Protection	±4 kV (HBM)
Requirements	ISO11898-2
Speed	Max. 5 Mbit/s
Input Voltage(D)	-12 to 12 V
Output Voltage (D)	2.9 to 4.5 V

3.4.12 Mating connectors

The connectors references are shown in the next figure and table.



Name	Embention reference
Sensor cable	P001635
Phase C	P005590
Phase B	
Phase A	
In negative	
In positive	
User cable	P001634

CHAPTER

FOUR

HARDWARE INSTALLATION

MC24 system has the following positions of mounting holes:

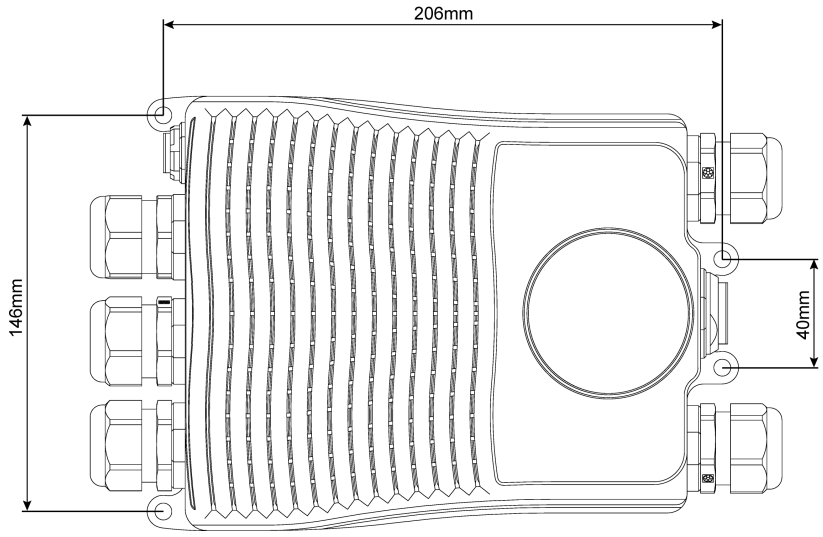


Fig. 1: **Mounting Holes**

4.1 Pinout

The user connector pinout is shown in the following figures and table:

Fig. 2: **Point of view**

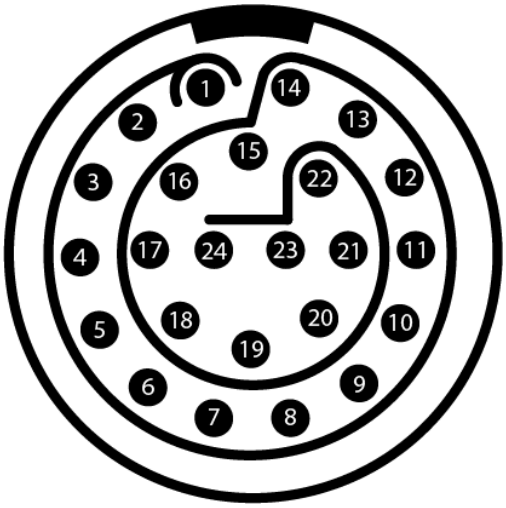


Fig. 3: **Pin numbers of user connector**

Table 1: User Connector

PIN	Signal	Type	Description
1	ERROR_SIGNAL	Digital Status Signal	High: OK, Low: NO OK
2	OPTO_PWM	Optocoupled Digital Input	
3	VCC	Digital Supply	8-20 V
4	GND	Digital Ground	
5	CANA_P	CAN Communications	
6	CANA_N	CAN Communications	
7	CANB_N	CAN Communications	
8	GND	Digital Ground	
9	RS485_OUT_P	RS-485 Communication	
10	RS485_OUT_N	RS-485 Communication	
11	FAN_PWM	Digital Output	
12	GND	Digital Ground	
13	RS485_IN_P	RS-485 Communication	
14	RS485_IN_N	RS-485 Communication	
15	RS485_GND	RS-485 Communication	
16	OPTO_RETURN	Optocoupled Return	
17	GND	Digital Ground	
18	CANB_P	CAN Communications	
19	USB_N	USB Communication	
20	RS232_RX	RS-232 Communication	
21	GND	Digital Ground	
22	RS232_TX	RS-232 Communication	
23	USB_P	USB Communication	
24	CAN_GND	CAN Ground	

The sensors connector pinout is shown in the following figures and table:

Fig. 4: **Point of view**

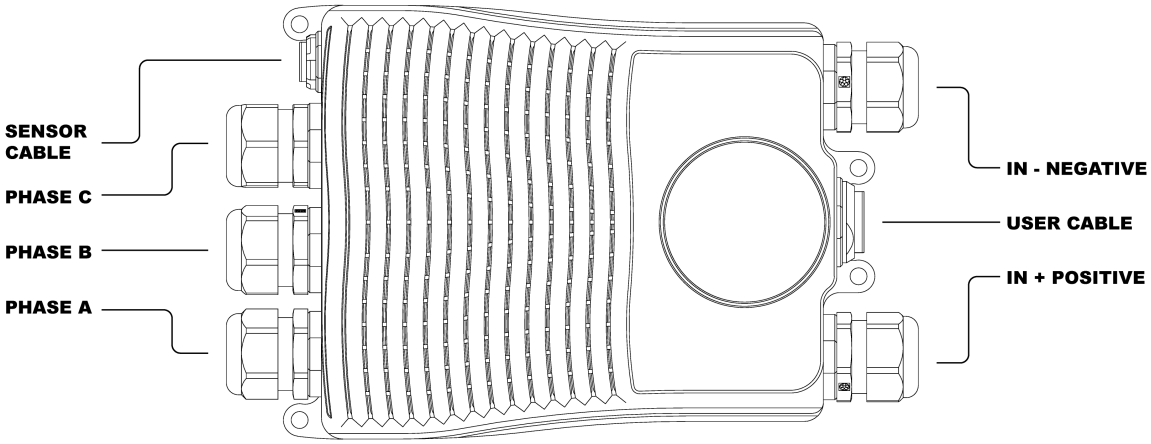
Fig. 5: **Pin numbers of sensor connector**

Table 2: Sensors Connector

PIN	Signal	Type	Description
1	HALL_1	Hall Sensor 1 Input	
2	NC	No Connect	
3	NC	No Connect	
4	NC	No Connect	
5	COS_SIGNAL	Cosine Input	SIN/COS Encoder
6	SIN_SIGNAL	Sine Input	SIN/COS Encoder
7	ISO_GND	Isolated Ground	
8	NTC/PTC	NTC/PTC Input	
9	ISO_GND	Isolated Ground	
10	HALL_3	Hall Sensor 3 Input	
11	HALL_2	Hall Sensor 2 Input	
12	ISO_GND	Isolated Ground	
13	ISO_GND	Isolated Ground	
14	5V	Isolated 5 V	
15	VOLTAGE_REF	Voltage Reference Output	Use for NTC
16	ISO_GND	Isolated Ground	

4.2 ESC-Motor Wiring

The polarity and connection is indicated in the following image.



The section of the cables must be dimensioned according to input/output max power

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Note: The polarity connection of the input must be respected, otherwise a short circuit may occour. Connection of the phases can be done freely, however, it will affect the direction of rotation of the motor.

CHAPTER

FIVE

SOFTWARE INSTALLATION

In order to configure **Veronte MC24**, connect it to a computer via USB with the harness cable.

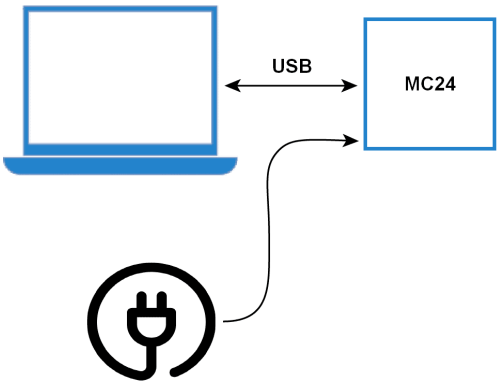

Fig. 1: **USB connection**

Then, to install the required software and configure **MC24**, read its software manual.

CHAPTER

SIX

MAINTENANCE

Apart from cleaning, no extra maintenance is required to guarantee the correct operation of the **Veronte MC24**.

In order to clean **Veronte MC24** properly follow the next recommendations.

- Turn off the device before cleaning.
- Use a clean, soft, damp cloth to clean the unit.
- Do not immerse the unit in water to clean it.

CHAPTER

SEVEN

ACRONYMS AND DEFINITIONS

PWM	Pulse Width Modulated signal
PMSM	Permnent Magnet Synchronous Motor
UAV	Unmaned Aerial Vehicle
VTOL	Vertical Take Off and Landing
FOC	Field Oriented Control
MOSFET	Metal Oxide Semiconductor Field Effect Transistor
CAN	Controller Area Network
RS-232	Recommended Standard 232
RS-485	Recommended Standard 485
rms	Root Mean Squared
VCC	Voltage Continuous Current
RPM	Revolutions Per Minute
NTC	Negative Temperature Coefficient (temperature sensor)
PTC	Positive Temperature Coefficient (temperature sensor)
ESD	ElectroStatic Discharge
HBM	Human Body Model
pk	Peak (maximum value)
GND	Electrical ground
COM	COMmunications
PM	Permamnent Magnet (motor)
DC	Direct Current
PI	Poportional Integral controller
I/O	Input/Output
ESC	Electronic Speed Control

CHAPTER

EIGHT

CONTACT DATA

For support-related inquiries, customers have access to a dedicated portal through the Joint Collaboration Framework. This platform facilitates communication and ensures traceability of all support requests, helping us to address your needs efficiently.

For other questions or general inquiries, you can reach us via email at sales@embention.com or by phone at (+34) 965 115 421