MC110 Hardware Manual

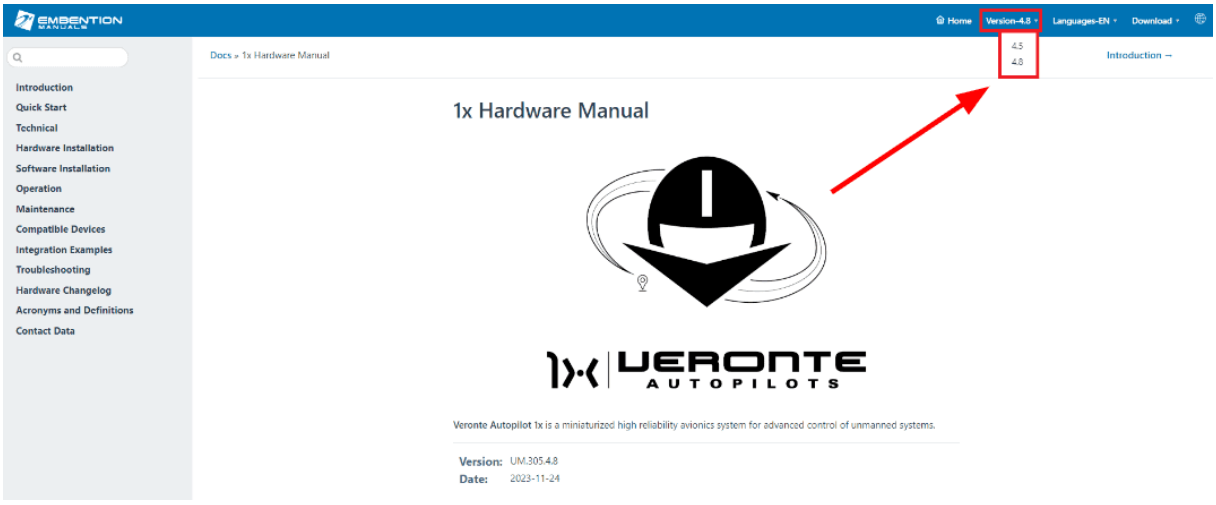
Release 1.2

Embention

2023-12-04

CONTENTS

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: **MC110 front view**

Fig. 2: **MC110 rear view**

Veronte MC110 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 MC110 uses FOC algorithm for motor control together with IGBT (Insulated Gate Bipolar Transistor) technology.

MC110 Speed Controller offers IP68 protection, allowing the operation under rain and extreme humidity environments.

MC110 Speed Controller working voltage range is 100-550V with a maximum continuous current of 200A (up to 55kW).

The system has a temperature range of -20 to 65ºC.

CHAPTER

TWO

QUICK START

2.1 First steps

To connect the MC110 to a PC, use the USB_N, USB_P AND A GND. These pins for MC110 are explained in the *Pinout* section.

The USB pins are summarized as follows:

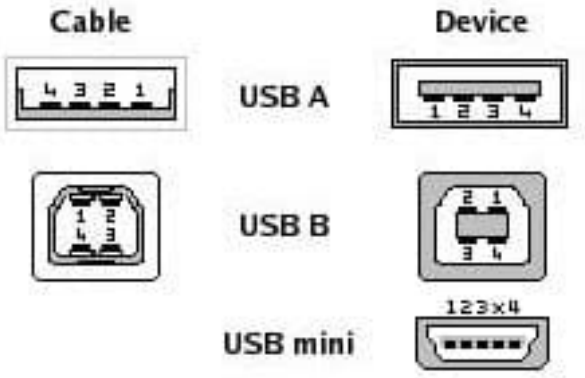


Fig. 1: **USB pins**

Number	Name	Cable color	Pin
1	VCC	Red	+5 VDC
2	D-	White	Data -
3	D+	Green	Data +
4	GND	Black	Ground

2.2 Warnings

When installing the MC110 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 MC110 for the first time.
- PID tuning is strongly not recommended, since it nullifies the warranty.
- An unappropriated use of the MC110 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.

2.3 Requirements

Cooling airflow: a fan or any other ventilation method is required to refrigerate the MC110.

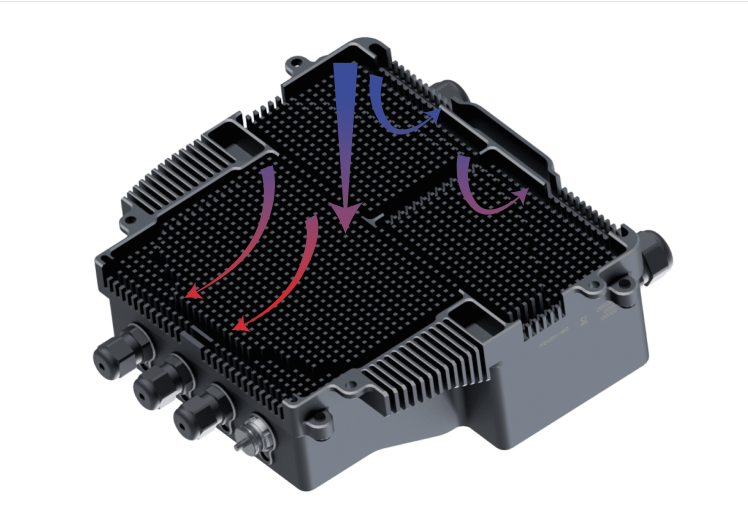


Fig. 2: **Airflow dissipation**

CHAPTER

THREE

TECHNICAL

3.1 Part List

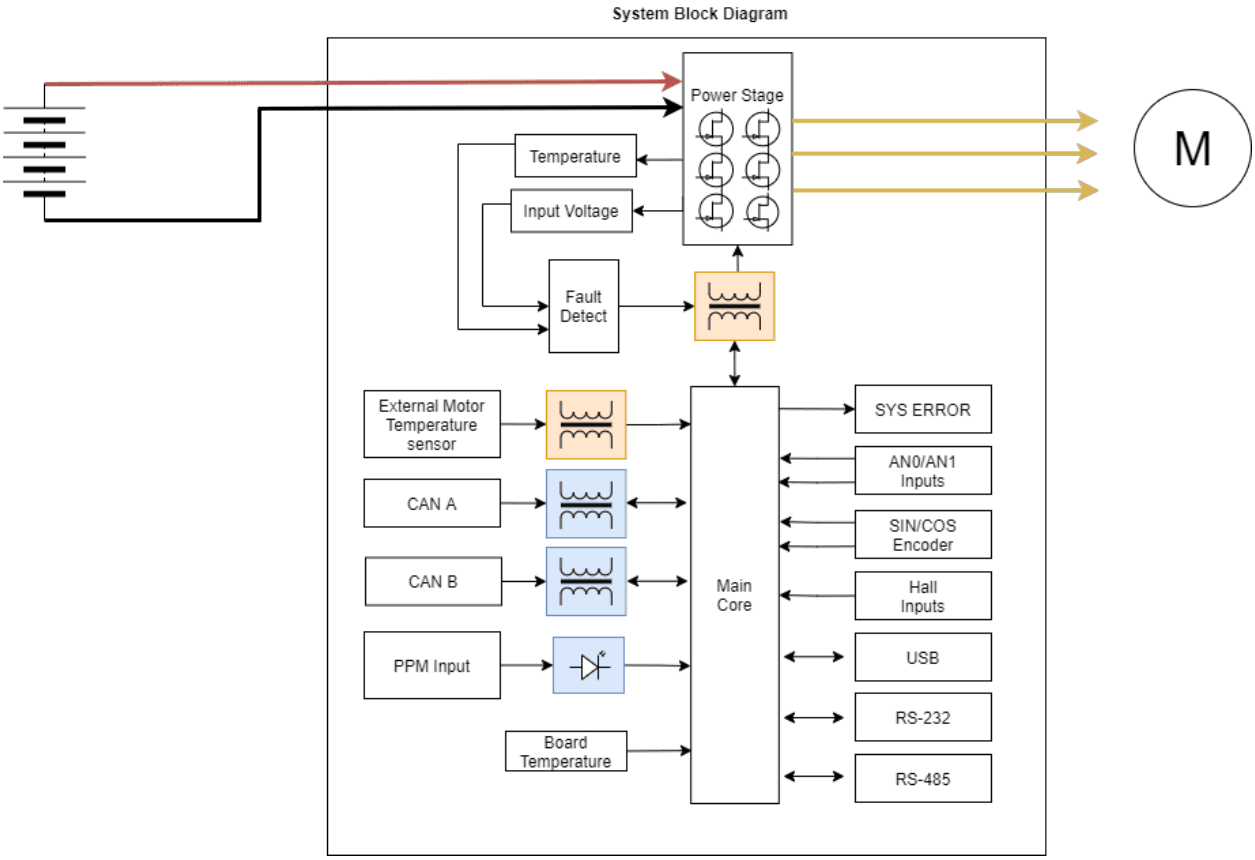
Veronte MC110 includes the following connectors:

- Veronte Harness of 24 pins for *user connector*. Embention reference: P001634.
- Veronte Harness of 16 pins for *sensor connector*. Embention reference: P001635.

3.2 Main Features

- **IP68 Waterproof**
- **Voltage:** between 100 and 550 V
- **Configuration parameters:** for reduced power consumption

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 MC110.

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: The selected configuration interface cannot be used to send telemetry.

3.3 Mechanical Specifications

- **Protection:** IP65 Aluminium
- **Weight:** 2700 g
- **Maximum speed (1 pole):** 300000 RPM
- **Dimensions:** 27 x 26 x 8 cm

3.4 Electrical Specifications

- **Voltage:** 100-550 V DC
- **Power:** up to 55 kW

Note: Power depends on kind of motor, motor speed, battery voltage and current comsuption).

Please note that the maximum power is reached at maximum voltage (550 V), even at maximum switching frequency (16 kHz) and at 50 ºC ambient temperature.

- **Peak Current (<5 s):** 400 A
- **PWM Frequency:** 10-16 kHz
- **Input current (continuous):** 200 A
- **Regenerative brake**
- **Sensorless mode:** MC110 is able to operate with sensorless motors with maximum efficiency.

Note: The sensorless mode does not require a minimum speed to measure it and operate, as long as MC110 provides current to the motor phases (since the speed is measured with the current)

- **Sensored motors:**
  - Hall sensors
  - Digital incremental encoders
  - Analog SIN/COS
- **Reverse rotation:** MC110 can operate in any direction of rotation without additional configuration.
- **Configurable:**
  - Type of Observer
  - Programmable acceleration curve
  - Motor direction
  - Overvoltage threshold
  - Overcurrent threshold
  - Overtemperature threshold
  - Max. RPM (limit)
  - Braking force

  - Duty Cycle
- **Communications:**
  - 2x Isolated CAN Bus
  - 3x PWM
  - Opto PWM
  - RS232
  - RS485
  - USB
- **Redundant control**
- **Telemetry:**
  - Motor & ESC temperature
  - RPM
  - Input voltage
  - Input/Output current
- **Data recording**

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 5V output.

3.5 Interfaces

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 efffect sensors must be placed at 120º (Electrical degrees) of 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:

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

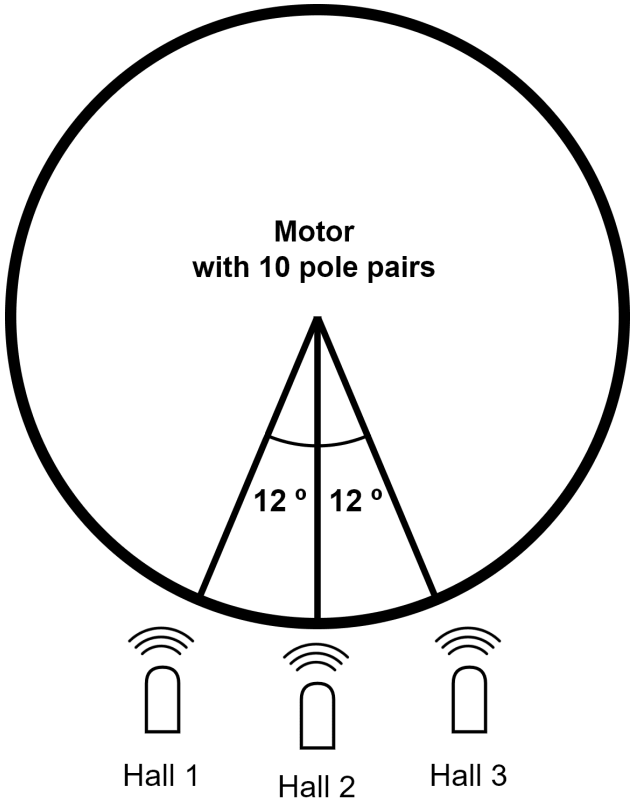


Fig. 1: **Example diagram**

Tip: The arc length between sensors can be calculated with the following equation:

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

3.5.1 FAN_PWM

This 0-3.3 V output is used to control an external fan if needed. External power for the fan is required, and it is important that the GND connection of this supply is the same as the GND connection for the supply of the *control group (user connector)*.

3.5.2 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
Pulse length	1-2 ms
Frequency	40-250 Hz

3.5.3 NTC/PTC Input (External Temperature Sensing)

A PTC or NTC can be integrated.

Warning: The PTC or NTC must not exceed 5 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.

3.5.4 ERROR SIGNAL

This signal indicates if there is an error within the MC110. A positive voltage of 3.3 V means that there is no problem.

3.5.5 SIN/COS_SIGNAL

These signals are those dedicated to the SIN / COS type analog sensor.

Warning: SIN/COS signals must not exceed 5 V.

3.5.6 USB

This is the interface normally used to configure the MC110 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.

3.5.7 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 13.2 V

3.5.8 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

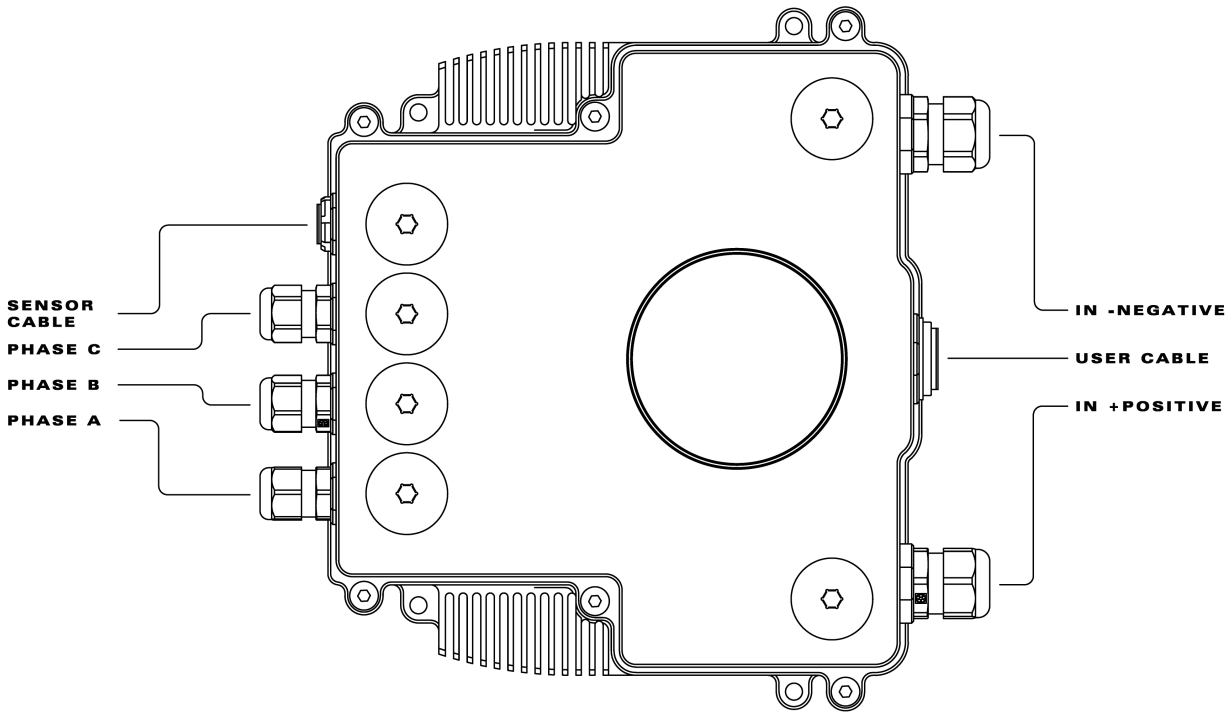
3.5.9 CAN

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

3.5.10 Mating connectors



Separated connectors

Name	Embention reference
Sensor cable	P001635
Phase C	P005639
Phase B	
Phase A	
In negative	P005640
In positive	
User cable	P001634

Included connectors with MC110

Name	Embention reference
Veronte Harness of 24 pins for *user connector*	P001634
Veronte Harness of 16 pins for *sensor connector*	P001635

CHAPTER

FOUR

HARDWARE INSTALLATION

Note: When working voltage is higher than 60V, 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.

The MC110 system has the following positions of mounting holes:

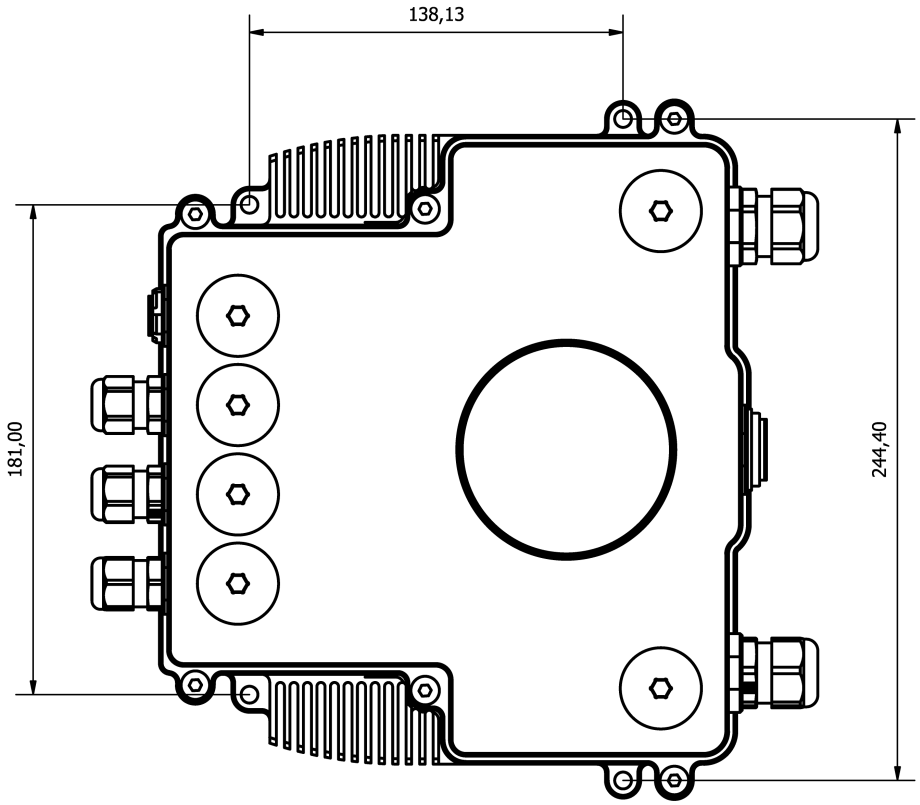


Fig. 1: **Mounting Holes**

To dissipate the heat from the MC110 properly, there is a need to provide 16m/s of air speed against the heatsink.

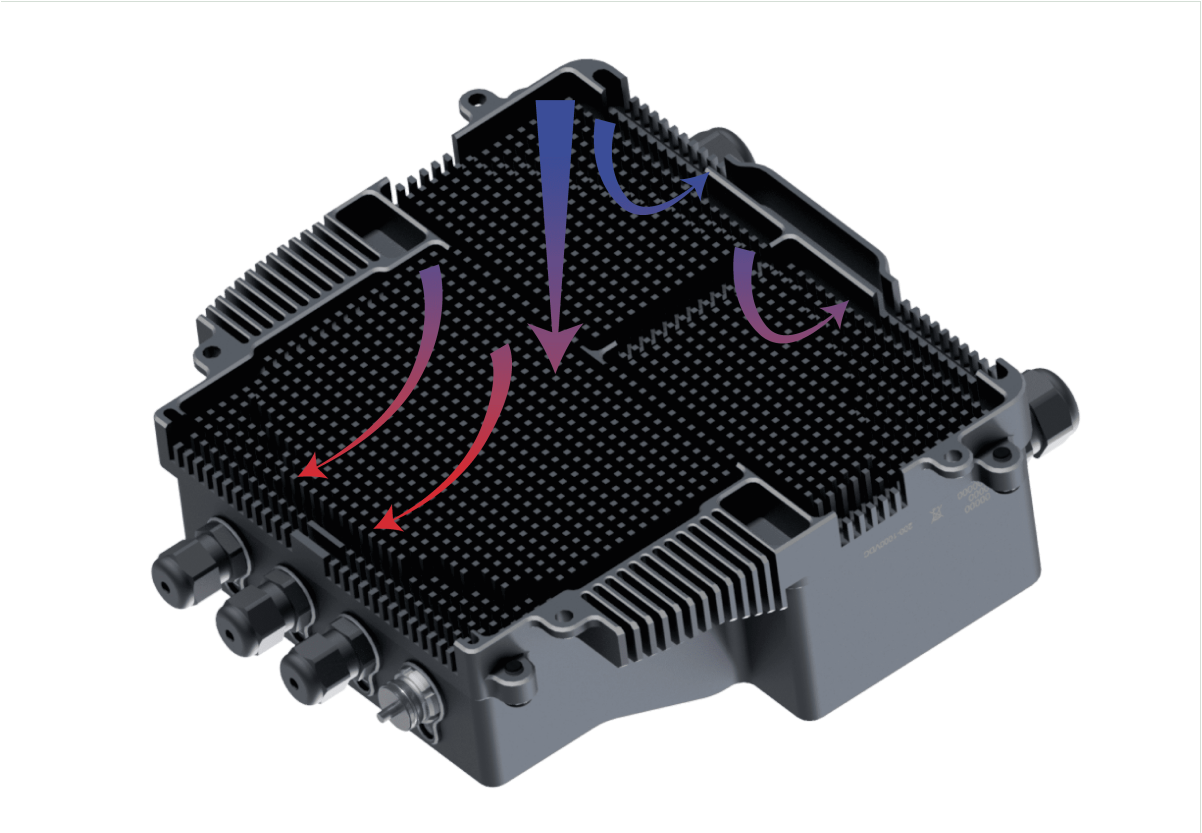
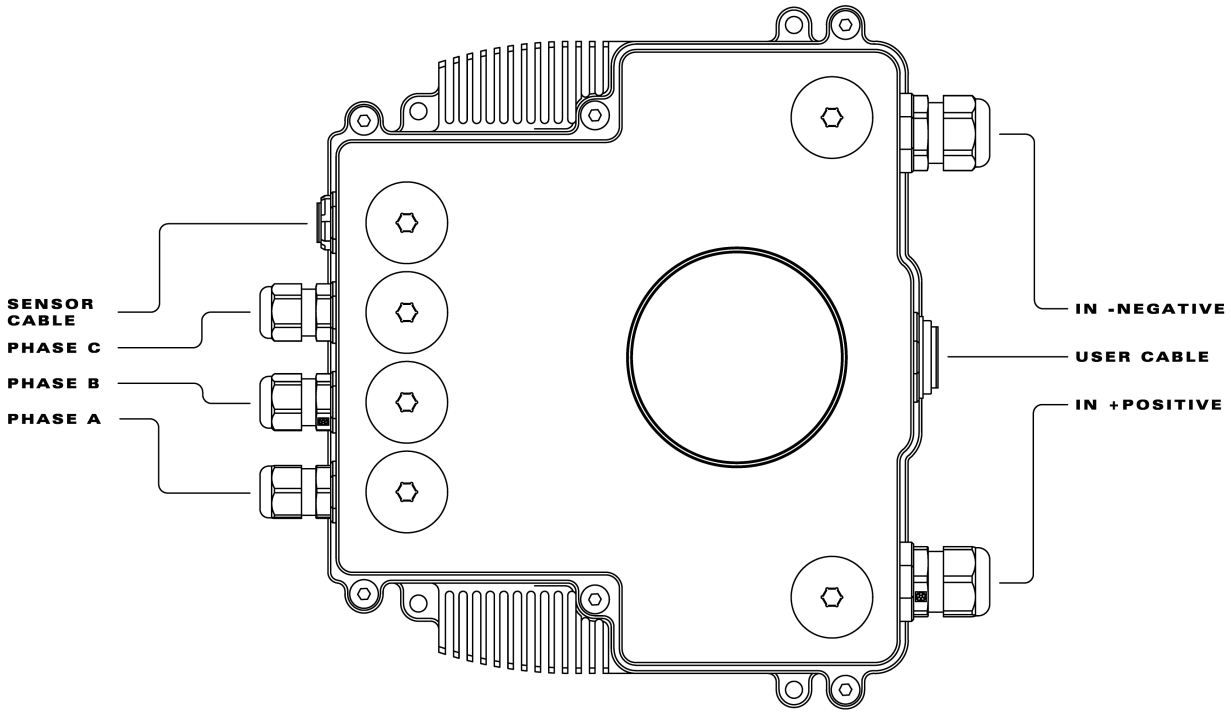


Fig. 2: **Airflow dissipation**

4.1 ESC-Motor Wiring

Warning: The polarity connection of the input must be respected, otherwise a short circuit may occur.

The polarity and connection is indicated in the following image.



In order to access the connections remove the caps near each connector.

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

Connection of the phases can be done freely, however, it will affect the direction of rotation of the motor. Hence, if the motor is spinning in the opposite direction, switch any 2 phases around.

4.2 Pinout

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

Fig. 3: **Point of view**

User connector	Connector EEG.3k.324.CLN
Matching connector	Connector FGG.3K.324.CLAC90

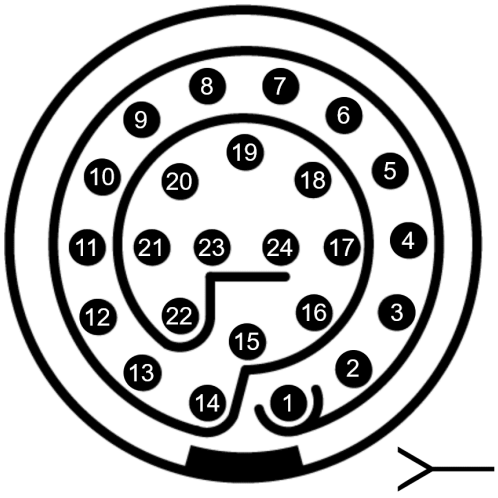


Fig. 4: **User connector (frontal view)**

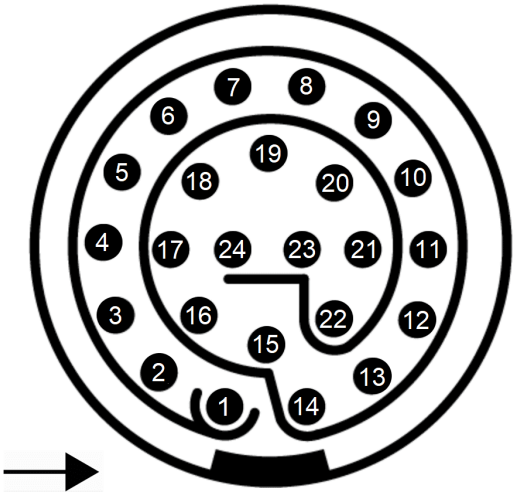


Fig. 5: **Matching connector (frontal view)**

Table 1: User Connector

Pin	Signal	Type	Comment
1	ERROR_SIGNAL	Digital Status Signal	High: OK, Low: NO OK
2	OPTO_PWM	Optocoupled Digital Input	
3	VCC	Digital Supply	8-20V
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. 6: **Point of view**

Sensor connector	Connector EEG.1K.316.CLN
Matching connector	Connector FGG.1K.316.CLAC65Z

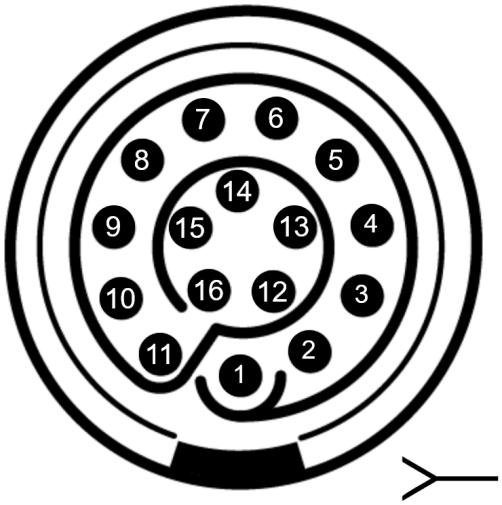


Fig. 7: **Sensor connector (frontal view)**

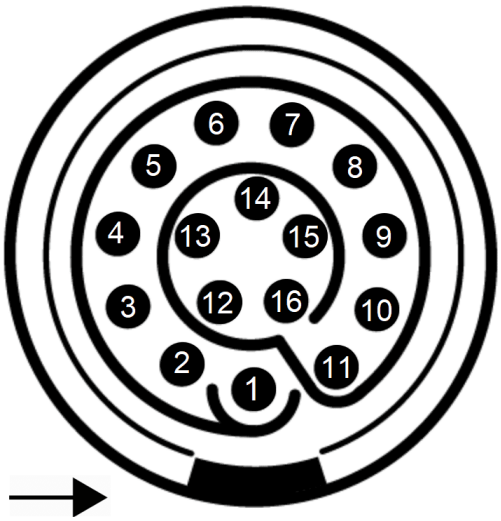


Fig. 8: **Matching connector (frontal view)**

Table 2: Sensors Connector

Pin	Signal	Type	Comment
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 5V	
15	VOLTAGE_REF	Voltage Reference Output	Use for NTC
16	ISO_GND	Isolated Ground	

4.3 How to Turn On and Off

MC110 has two electric circuits: **control** and **power**. To turn on the voltage supply (with devices such as switches, relays or MOSFETs), it is mandatory to do it with the following order: first of all the **control** group, and then the **power** group.

The **control** group is in the user cable. The power circuit is in the negative and positive cables. Then the enabling order is summarized in the following figure:

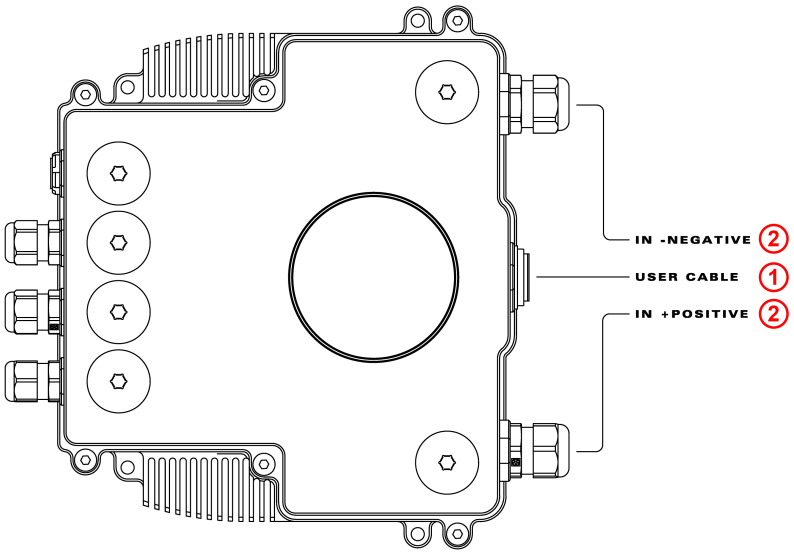


Fig. 9: **Turn on order**

To turn off the **MC110**, the disabling order is reversed: first power circuit (input negative and positive), then the control circuit (user cable).

4.4 How to connect MC110 for CAN communication

Connect three cables to CAN A positive, CAN A negative and GND from the user cable. These pins are indicated in the *Pinout* section. There is not any resistor termination, so the connection is direct.

CHAPTER

FIVE

SOFTWARE INSTALLATION

In order to configure **Veronte MC110**, connect it to a computer via USB with the harness cable.

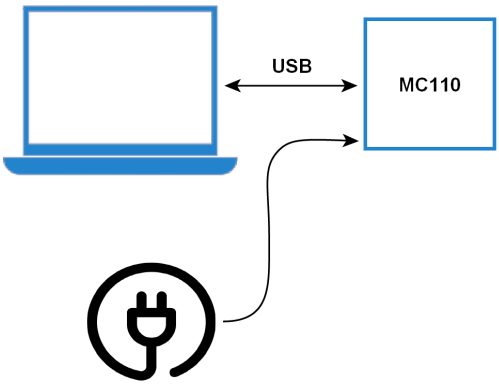


Fig. 1: **USB connection**

Then, to install the required software and configure **MC110**, read its software manual.

CHAPTER

SIX

MAINTENANCE

Apart from cleaning, no extra maintenance is required to guarantee the correct operation of the Veronte MC110.

In order to clean Veronte MC110 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

TROUBLESHOOTING

7.1 How to confirm that the MC110 is able to read a PWM signal

> **Warning:** For safety reasons, it is better to do this test without the motor connected or powered.

Power up the controller via user cable, without connecting the motor or the input power. If the input command is higher than the deadband, the MC will start to control (even though there is no motor connected). Then, a noise of 16 kHz will sound due to the PWM switching. If the input command is reduced to below the deadband, the MC and its noise will stop.

CHAPTER

EIGHT

FAQ

8.1 Is it possible to use a standard PWM servo tester to control the MC110?

MC110 is thought to be controlled via CAN. PWM signal should be used for testing purposes. In case to desire using a transmitter, connect a receiver and use just one control channel (just one PWM signal).

CHAPTER

NINE

ACRONYMS AND DEFINITIONS

ATP	Acceptance Test Report
CAN	Controller Area Network
COC	Certificate Of Compliance
COM	COMmunications
ESC	Electronic Speed Control
ESS	Environmental Stress Screening
eVTOL	electric Vertical Take-Off and Landing
FAQ	Frequently Asked Questions
FOC	Field Oriented Control
GND	Electrical Ground
HBM	Human Body Model
IGBT	Insulated Gate Bipolar Transistor
MC	Motor Controller
MTBF	Mean Time Between Failure
NTC	Negative Temperature Coefficient thermistor
OPTO PWM	OPTO-coupled PWM
PMSM	Permanent Magnet Synchronous Motor
PTC	Positive Temperature Coefficient thermistor
PWM	Pulse Width Modulation signal
RPM	Revolutions Per Minute
RS-232	Recommended standard 232
RS-485	Recommended standard 485
SD	Secure Digital
SIN/COS	Sine/Cosine
SN	Serial Number
UAV	Unmanned Aerial Vehicle
VCC	Voltage Continuous Current
VDC	Voltage Direct Current

CHAPTER

TEN

CONTACT DATA

You can contact Embention if you need further help and support.

Embention contact data is as follows:

Email: support@embention.com

Telephone: (+34) 965 421 115

Address: Polígono Industrial Las Atalayas, C/ Chelín, Nº 16, CP 03114, Alicante (España).