MCx Hardware Manual

Release 2.2/1.1

Embention Sistemas Inteligentes, S.A.

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Contents

Scope of Changes

- Version 1.0
  - Added:
    - First version issued.
- Version 1.1
  - Added:
    - Heatsink voltage in Electrical Specifications section.
  - Fixed:
    - Motor voltage range in Electrical Specifications section.

Introduction

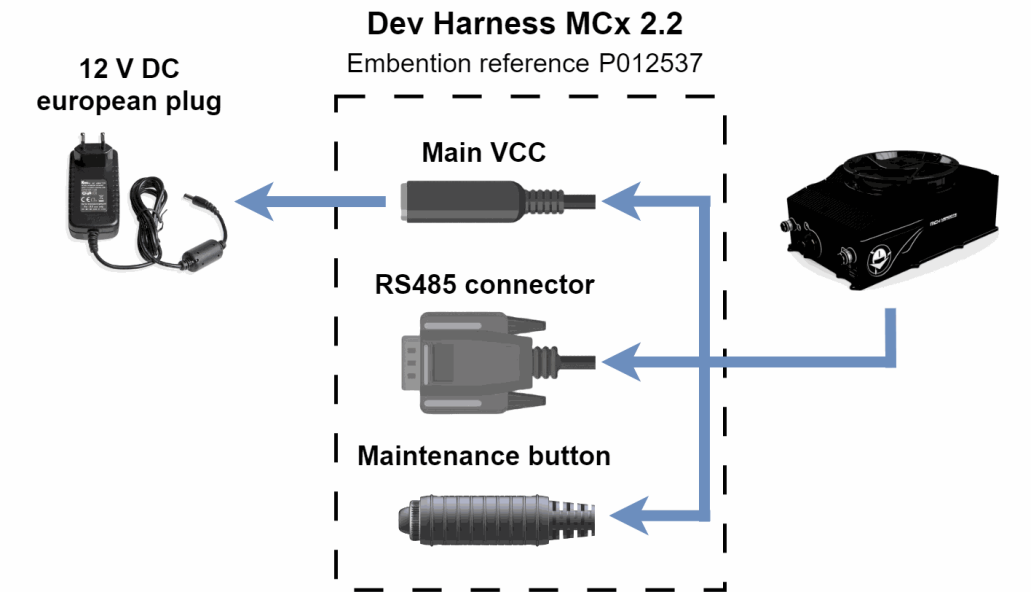
Veronte MCx speed controller is capable of driving any type of 3-phase PMSM motor. It can be used with a wide variety of UAVs or eVTOL vehicles. **MCx** uses FOC algorithm for motor control together with IGBTs.

Quick Start

First Steps

To connect the **MCx** to a PC, use the RS-485 port. If the computer has not a serial port, a RS-485 to USB converter can be employed. The serial pins are explained in the Pinout section

Basic Connection Diagram



For further information on the **Dev Harness MCx** connectors, refer to the Dev Harness MCx - Hardware Installation section of the present manual.

Warnings

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

- It is highly recommended to reduce the distance between the MCx and the motor in order to reduce the high rate of voltage changes (dV/dt) and the electromagnetic radiation. Additionally it is highly recommended to shield the phase cables and connect this shield to the motor stator and to the MCx metal case.

- Wire connections between power devices must be crimped not soldered.
- PID tuning is an extremely delicate operation that requires specific technical expertise. Performing this procedure without the necessary skills poses a concrete risk of irreversibly damaging or burning the motor controllers. Should the customer decide to proceed independently with tuning, the **company shall assume NO liability** for any resulting damage to the unit. To ensure optimal performance and maximum safety, professional integration and custom tuning services are available. Please contact the support team by creating a Ticket.
- An unappropriated use of the MCx 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.

Technical

Main Features

The following diagram summarizes the architecture of the MCx. The unit filters the incoming DC power (hw_Input Filter), uses a microcontroller (hw_MCC) to execute the motor-control algorithms and safety functions, and drives the three-phase motor through the switching stage (hw_PWRMOS).

Mechanical Specifications

- Weight: < 1.6 kg without heatsink; 3.2 kg with heatsink.
- Dimensions:

Dimensions in mm

Electrical Specifications

- Input voltage (low voltage): 6.5 to 36 V
- Input voltage (motor): 100 to 800 V
- Input voltage (heatsink fan): 24 V
- Maximum battery current (RMS): 120 A (continuous); 160 A (peak 5 s)
- Maximum phase current (RMS): 110A (25º)
- Switching frequency: 5 to 24 kHz
- Regenerative brake: Enabled during motor deceleration
- Startup protection: Inrush control for high-voltage and low-voltage lines

Control and Performance

- Control modes: Torque, thrust, speed, and PWM
- Startup logic: Open-loop or closed-loop supported
- Motor types: Sensorless and sensored
- Encoder support: Hall, incremental, SinCos, and Back-EMF
- Maximum speed: Up to 120,000 eRPM
- Custom profiles: User-defined motor behavior presets
- Telemetry: Voltage, current, RPM, and temperature
- Protection logic: Overvoltage, overcurrent, sensor loss, and inrush current

- Safety features: Ground fault, short-circuit, and current imbalance

Thermal and Environmental Specifications

- Cooling: Air
- Cooling plate: Custom heatsink
- Operating temperature: -40 to +80ºC
- Humidity: Up to 95% RH

Interfaces

- PWM input: 1 opto-isolated PWM input
- CAN interfaces: 1 CAN FD and 1 CAN 2.0
- Serial ports: RS-485
- Digital I/O: Fault and status indicators
- Configuration tools: CAN and RS-485

Connector Layout

	Index	Connector
Power	1	HV negative
	3	HV positive
	4	Phase U Connector

	Index	Connector
	5	Phase V Connector
	6	Phase w Connector
Electronic	2	User Connector
	7	Signal Connector

Mating Connectors

	Index	MC110 Connector	Mating Connector
Power	1	HV negative	M6 Cable lug Wire gauge: 16 mm^2 Ref: LCMA 16-6-C
	3	HV positive	
	4	Phase U Connector	
	5	Phase V Connector	
	6	Phase W Connector	
Electronic	2	User Connector	Mating harnesses available on demand:

	Index	MC110 Connector	Mating Connector
			• Veronte Motor Controllers: Dev Harness MCX 2.2 (Embention reference **P012537**) • Veronte Harness - 22P MIL-DTL-38999 - Male - 50cm (Embention reference **P016323**)
	7	Signal Connector	Mating harness available on demand: Veronte Connector 16P (Embention reference **P006993**)

Hardware Installation

Mechanical

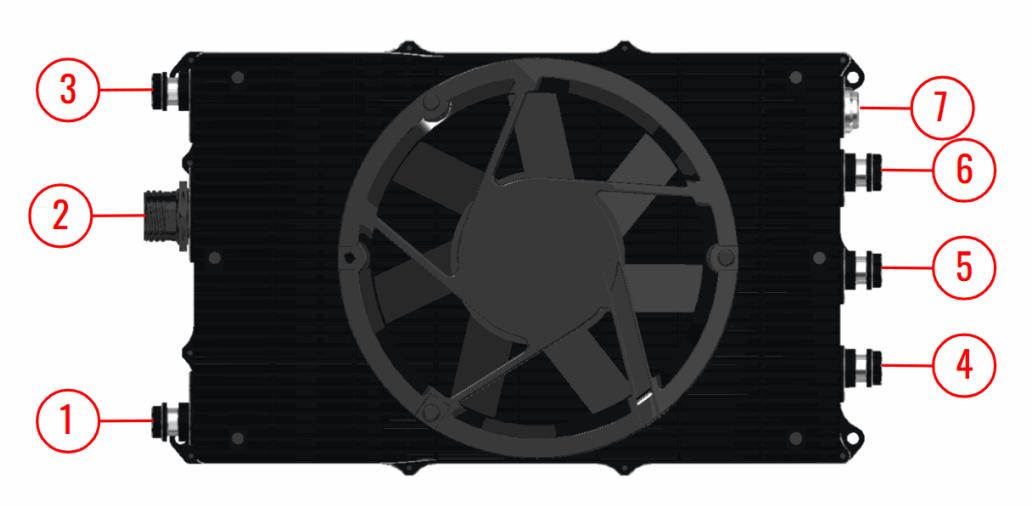
To fix the **MCx** to an aircraft frame, take a look to the dimensions and screws positions in Mechanical Specifications. Screw holes must be deeper than 6 mm with M6

Electrical

Power Wiring

> ⚠ **Warning**
>
> The input power polarity must be respected; otherwise, a short circuit may occur.

The polarity and connections are indicated in the following image and table.



	Index	Connector	Description
Power	1	HV negative	HV DC input power 100 to 800 V DC
	3	HV positive	

	Index	Connector	Description
	4	Phase U Connector	Output power to motor
	5	Phase V Connector	
	6	Phase W Connector	
Electronic	2	User Connector	Communications, telemetry and control signals
	7	Signal Connector	Encoders and sensor temperature signals

> ⓘ **Note**
>
> The **section** of the cables must be dimensioned according to the **maximum** power that will be used

Cable installation

Install each cable as follows:

1. Open the bottom enclosure. Keep the enclosure seal in place.

Cable installation - Step 1.

1. Remove the cable gland nuts from the cable entries to be used.

Cable installation - Step 2

1. Prepare and connect the cable:

Cable installation - Step 3a

a. Install the shielding, pass the cable through the cable gland nut and O-ring, and feed it into the enclosure through the hole.

b. Crimp the cable to the cable lug.

c. Position the cable lug over its terminal by bringing the screw closer to the hole, then tighten the screw.

Cable installation - Step 3b and 3c

d. Tighten the cable gland nut to the enclosure and secure the cable shielding to the cable gland.

Cable installation - Step 3d

> ⓘ **Note**
>
> Fix the cable shielding to the cable nut where the surface has no anodize protection, Using a metal clamp like the one shown in the image is recommended.

1. Close the enclosure, ensuring that the enclosure seal remains correctly seated.

Cable installation - Step 5

Pinout

There are two pinouts: one for the User Connector and one for the Signal Connector.

User Connector

Pin	Signal	Type	Description
1	IN_485_P	INPUT	RS-485 input positive
2	IN_485_N	INPUT	RS-485 input negative
3	OUT_485_N	OUTPUT	RS-485 output negative
4	OUT_485_P	OUTPUT	RS-485 output positive
5	GND	GROUND	Ground
6	CN_VIN	POWER	

Pin	Signal	Type	Description
			Positive Power Rail of the Battery
7	CN_VIN	POWER	Positive Power Rail of the Battery
8	CN_GND	GROUND	Negative Power Rail of the Battery
9	CN_GND	GROUND	Negative Power Rail of the Battery
10	GND_CAN	GROUND	Ground reference for CAN and CAN FD
11	CANFD_P	BIDIRECTIONAL	CAN FD positive pin
12	CANFD_N	BIDIRECTIONAL	CAN FD negative pin
13	GND_CAN	GROUND	Ground reference for CAN and CAN FD
14	CANB_P	BIDIRECTIONAL	CAN B positive pin

Pin	Signal	Type	Description
15	CANB_N	BIDIRECTIONAL	CAN B negative pin
16	GND_CAN	GROUND	Ground reference for CAN and CAN FD
17	ISO_PWM	INPUT	Positive PWM Control Input
18	FAN	OUTPUT	Output Power Signal for External Fan
19	SYNC_OUT	OUTPUT	Sync Out GPIO Signal
20	SYNC_IN	INPUT	Sync In GPIO Signal
21	HEARTBEAT	OUTPUT	Heartbeat Signal
22	Digital_GND	GROUND	Negative Power Rail of the Battery

Signal Connector

Pin	Signal	Type	Description
1	ENC_Z	INPUT	

Pin	Signal	Type	Description
			Input signal from encoder - Z
2	ENC_B	INPUT	Input signal from encoder - B
3	ENC_A	INPUT	Input signal from encoder - A
4	GND_ISO	GROUND	Isolated negative power rail
5	ISO_TEMP	INPUT	Motor temperature sensor
6	+1V	POWER	+1 V isolated voltage supply
7	GND_ISO	GROUND	Isolated negative power rail
8	+5V	POWER	+5 V isolated voltage supply
9	+5V	POWER	

Pin	Signal	Type	Description
			+5 V isolated voltage supply
10	ENC_COS	INPUT	Cosine signal from SinCos encoder
11	ENC_SIN	INPUT	Sine signal from SinCos encoder
12	GND_ISO	GROUND	Isolated negative power rail
13	GND_ISO	GROUND	Isolated negative power rail
14	GND_ISO	GROUND	Isolated negative power rail
15	GND_ISO	GROUND	Isolated negative power rail
16	GND_ISO	GROUND	Isolated negative power rail

Compatible Connectors

The following connectors are compatible with the User and Signal Connectors.

Compatible with	Connector	Description	Embention Reference
User Connector	Veronte Motor Controllers: Dev Harness MCX 2.2	Development harness with connectors.	P012537
	Veronte Harness - 22P MIL-DTL-38999 - Male - 50 cm	Amphenol connector with loose wires for aircraft integration.	P016323
Signal Connector	Veronte Connector 16P	LEMO connector with crimp contacts for aircraft integration.	P006993

User Connector Harnesses

Dimensions

- Cables length: 50 cm

Pinout

Veronte Harness - 22P MIL-DTL-38999 - Male - 50cm

The pinout of the Veronte Harness is the same as the pinout above. The color code of the harness wires is given below.

Pin	Color code	Pin	Color code
1	White	12	Red - Blue
2	Brown	13	White - Green
3	Green	14	Brown - Green
4	Yellow	15	White - Yellow
5	Gray	16	Yellow - Brown
6	Pink	17	White - Gray
7	Blue	18	Gray - Brown
8	Red	19	White - Pink
9	Black	20	Pink - Brown

Pin	Color code	Pin	Color code
10	Violet	21	White - Blue
11	Gray - Pink	22	Brown - Blue

Veronte Motor Controllers: Dev Harness MCX 2.2

The pinout of this harness is the same as the pinout above. In addition, this harness has some connectors already implemented for easy operation. Below is detailed information on which pins these connectors are connected to:

Connector	PIN	Signal
RS-485	1	IN_485_P
	2	IN_485_N
	3	OUT_485_N
	4	OUT_485_P
	5	GND
Power Input	6 and 7	CN_VIN
	8 and 9	CN_GND
Maintenance button	19	SYNC_OUT
	20	SYNC_IN

Electrical Diagram of CAN Bus

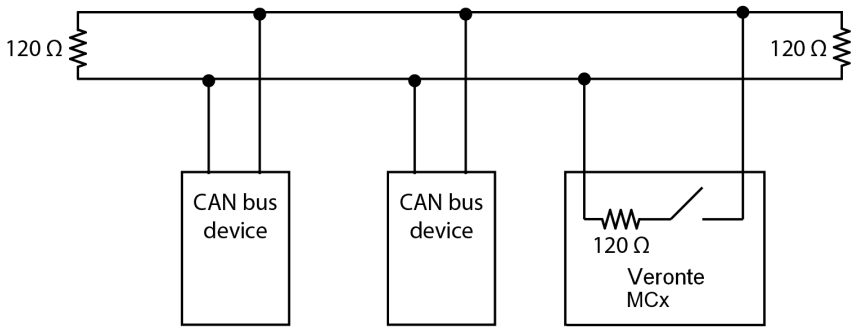
Like any other CAN device, **Veronte MCx** requires a termination resistor to allow the connection of multiple **MCxs** or other CAN bus devices to the same

line. For this termination resistor, users can add an external resistor or simply activate the 120 Ω resistor that MCx has **internally** (this is activated via software).

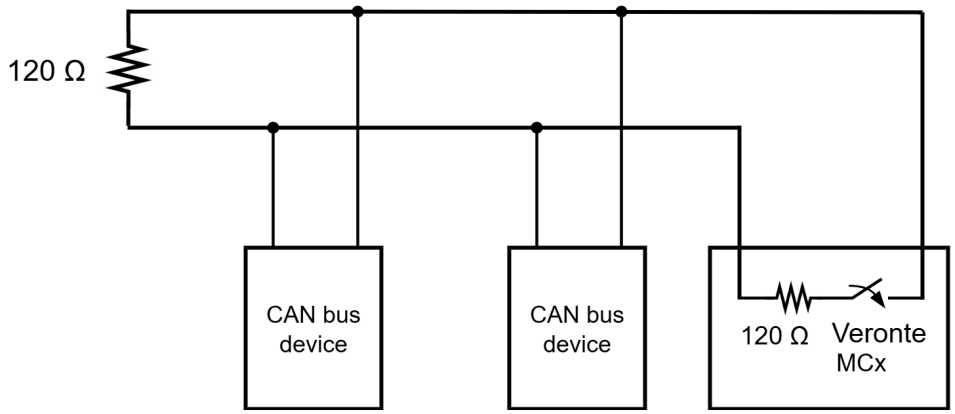
Below are some of the different configurations according to users preference.

> **Important**
>
> The scenarios described below are provided as examples of common setups. Users are free to implement custom wiring configurations that best suit their vehicle's design.
>
> The critical principle for any valid setup is that the CAN bus line must be terminated with a 120 Ω resistor at its two physical ends: one at the beginning and one at the end. As long as this rule is followed, any combination of internal or external resistors may be used.

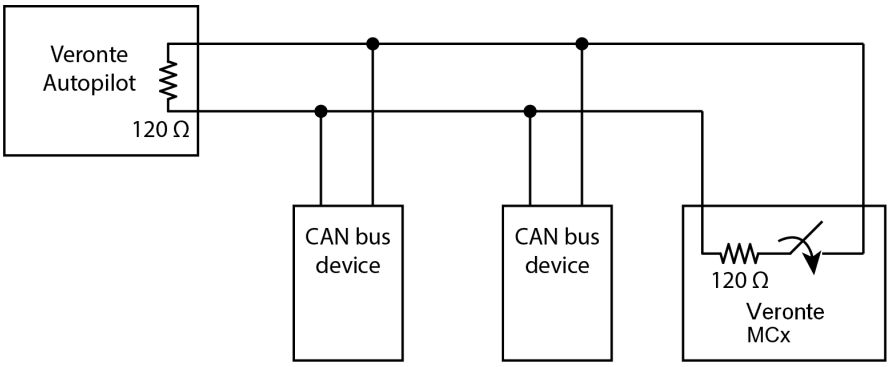
In this setup, the **MCx's internal resistor is not used**. Instead, **two external 120 Ω resistors** are placed at the physical ends of the CAN bus to provide termination. The MCx can be located anywhere on the bus, including at the end, but its internal resistor must remain disabled in the software.



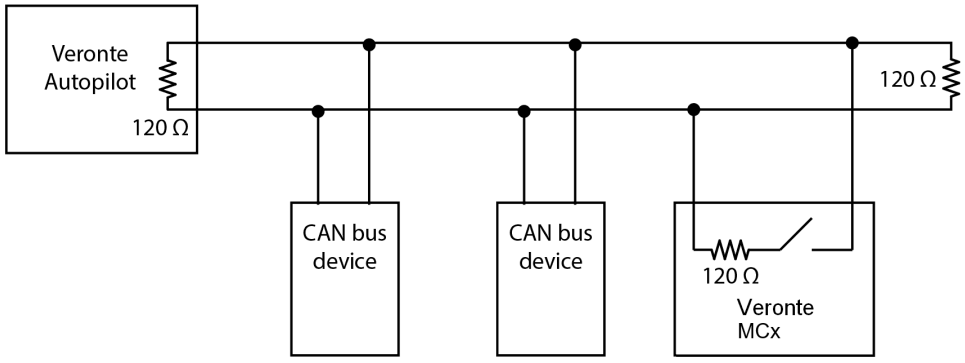
This configuration uses the MCx's built-in termination feature for one end of the bus. The Veronte MCx is placed at one physical end of the line, and its **internal 120 Ω resistor is enabled** via software. **A single external 120 Ω resistor** is then installed at the opposite end of the bus to complete the termination.



Considering **Veronte Autopilot** includes one entrance resistor of 120 Ω, for the simplest wiring, this configuration uses the internal resistors of both the Veronte Autopilot and the Veronte MCx. The Veronte Autopilot, which includes a 120 Ω resistor, is placed at one end of the bus. The Veronte MCx is placed at the other end, and its internal 120 Ω resistor is enabled via software. This setup provides full bus termination without requiring any external components.



In this latter case, the 120 Ω internal resistor of the Veronte Autopilot is placed at one end of the bus and an external 120 Ω resistor is installed at the end of the CAN bus, leaving the internal resistor of the Veronte MCx disabled, as shown in below:



Software Installation

In order to configure **Veronte MCx**, connect it to a computer via USB (through an RS485-USB converter) with the DEV harness MCx 2.2 (Embention reference: P012537).

To install the required software and configure **MCx**, read the MCx Software Manual.

Maintenance

In order to clean **Veronte MCx** properly, follow the guidelines below:

- 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.

Acronyms and Definitions

Acronym	Description
Back-EMF	Back Electromotive Force
CAN	Controller Area Network
CAN FD	Controller Area Network Flexible Data-Rate
DC	Direct Current
eVTOL	electric Vertical Take-Off and Landing
eRPM	electrical Revolutions Per Minute
FOC	Field-Oriented Control
GND	Electrical Ground
GPIO	General-Purpose Input/Output
HV	High Voltage
I/O	Input/Output
IGBT	Insulated Gate Bipolar Transistor
MIL-DTL	Military Detail Specification
PC	Personal Computer
PID	Proportional-Integral-Derivative
PMSM	

Acronym	Description
	Permanent Magnet Synchronous Motor
PWM	Pulse-Width Modulation
RH	Relative Humidity
RMS	Root Mean Square
RPM	Revolutions Per Minute
RS-485	Recommended Standard 485
SinCos	Sine/Cosine
UAV	Unmanned Aerial Vehicle
USB	Universal Serial Bus

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