# CEX Hardware Manual

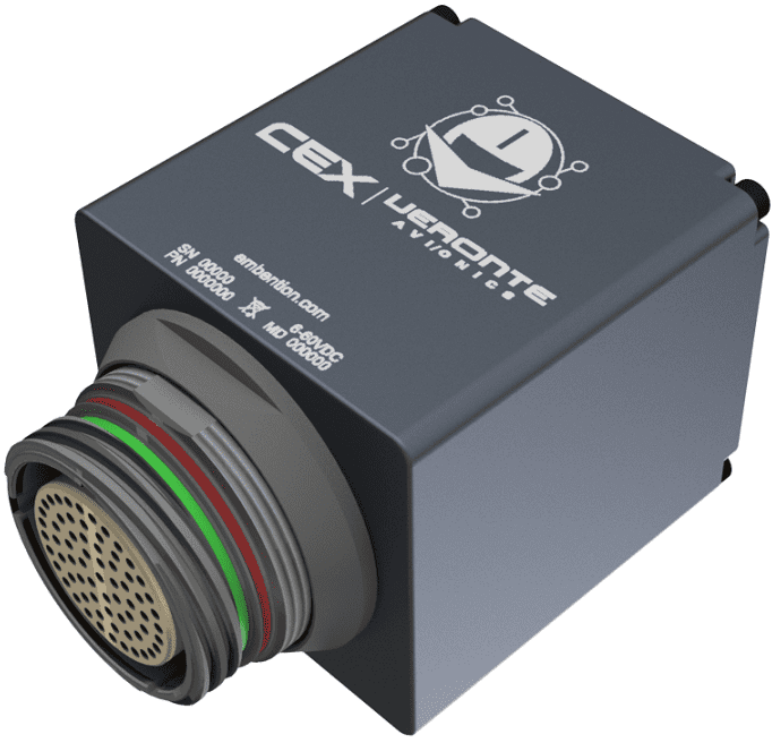
**Release 2.0**

Embention Sistemas Inteligentes, S.A.

2025-02-24

# Contents

# Introduction




**CEX**

**CEX** stands as a powerful peripheral to ease the reduction of wire in autonomous vehicles at the time it permits to increase the number of devices in the system. It makes possible to relocate and to group sensors, actuators, payloads, motor controllers... enhancing the I/O connectivity in the **Veronte Autopilot**. With its easy integration, **CEX** becomes a quick solution for increasing connectivity capacity and allowing wiring optimization, especially in large systems.

## Wiring Optimization

It is especially in large vehicles, where wire optimization plays a critical role permitting a significant weight reduction. This upgrade is achieved thanks to the reduction of cable length and because of the added flexibility so the right device can be installed in the right location. Another advantage of the use of **CEX** is the robustness of the CAN Bus, being resistant to electromagnetic interferences and permitting the installation of long cables with no signal loss.

Furthermore, it includes redundancy with CAN bus isolation, making it fail operational even in case of a CAN bus line break.

## Extended I/O

With the use of **CEX**, the data capacity for input and output in **Veronte Autopilots** is increased in a great manner. The advanced design makes possible to control several peripherals (PWM, UART, Digital Output, I2C, Analog Inputs...) through the CAN Bus. It can be used for both, expanding the I/O capacity in **Veronte Autopilot**, or for controlling peripherals with a robust communications protocol. In case it is needed, multiple **CEX** boards can be installed in the same network for increasing the number of I/O ports or because of system architecture needs.

## Applications

In aviation, a field where weight means such an important agent in design, struggling with wiring is one of the most common issues faced during the vehicle design. With the use of **CEX**, not only this issue would be reduced, but a bunch of opportunities for different sensors and payload could arise:

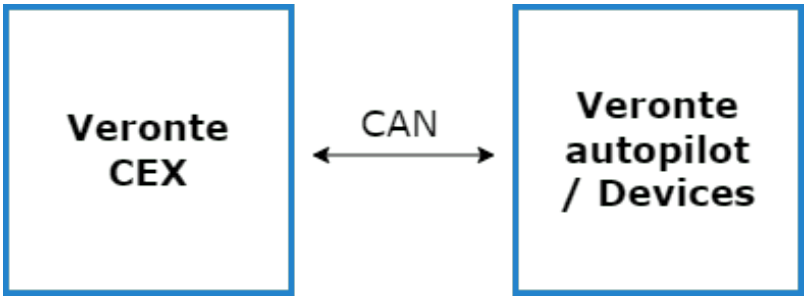
- By adding more I/O interfaces, a more complex payload control can be achieved, improving connectivity.
- Advanced control of actuators and peripherals becomes feasible, being possible to condensate the connection of control, feedback, sensors... in a single board.
- Devices can be installed at long distances from the autopilot with no signal degradation thanks to the robustness of the CAN Bus.

# Quick Start

This document describes how to install and use the **CEX**, including its technical specifications.

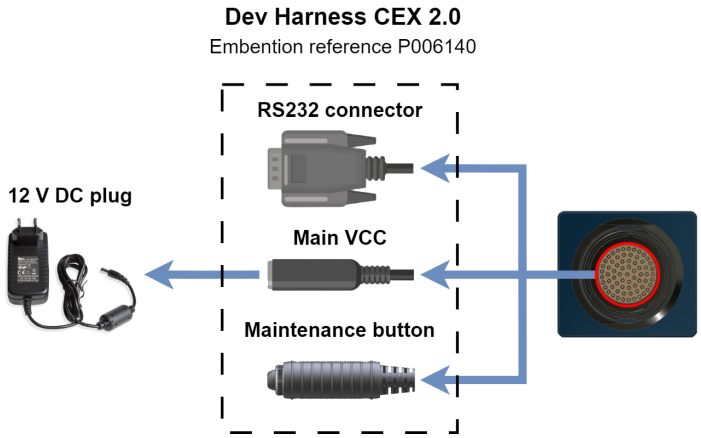
## System Layout

The following image shows the standard **CEX** system layout for operation:




**CEX standard layout**

## Basic Connection Diagram




For further information on the Dev Harness CEX 2.0 connectors, refer to the Dev Harness CEX 2.0 - Hardware Installation section of the present manual.

## Warnings

- Disassembling, improper installations or bad connections may invalidate the warranty. Please contact Technical Support if you suspect a faulty or defective component.
- **CEX** will always produce heat as a by-product of its operation. Keep in mind an adequate heat dissipation on installation.

- RS-485 has internal termination resistor.
- I2C is equiped with 4.7K internal pull-ups.
- Pins 1 and 2 (see Pinout) can be powered by 2 power supplies with different voltages as they are independent. Although they do have to share the Ground.
- Not to exceed the values of any of the Electrical specification.
- **CEX** does not integrate a termination resistance in order to allow the connection of multiple **CEX** or other CAN Bus devices to the same line. To do this, visit section CAN assembly of this manual.

## Requirements

- Veronte Link (v6.8.X or higher).
- CEX firmware version/CEX PDI Builder (v6.8.X or higher).
- Veronte Autopilot firmware (v6.4.X or higher).
- Veronte Updater (v6.8.X or higher).

# Technical

## Features

- **Communications**
  - 2x Isolated CAN buses
  - 1x ARINC 429 output
  - 5x ARINC 429 inputs
  - 1x RS485 port
  - 2X RS232 ports
  - 1x I2C port
  - Over CAN or RS232 firmware update
- **Electrical**
  - Redundant power supply input
  - Reverse polarity protection
  - ESD protection
  - Transient protection
- **Signals**
  - 8x 5V PWM
  - 9x 3.3V GPIO convertible to PWM
  - 4x 3.3V and 5V ECAPs
  - 2x 0V to 3.3V analog inputs
  - 2x 0V to 5V analog inputs
  - 2x 0V to 12V analog inputs
  - 2x 0V to 36V analog inputs

## Mechanical Specifications

| | |
|---|---|
| Weight | 117 g |
| Operating temperature | -40 to 60ºC |
| | -55 to 60ºC |

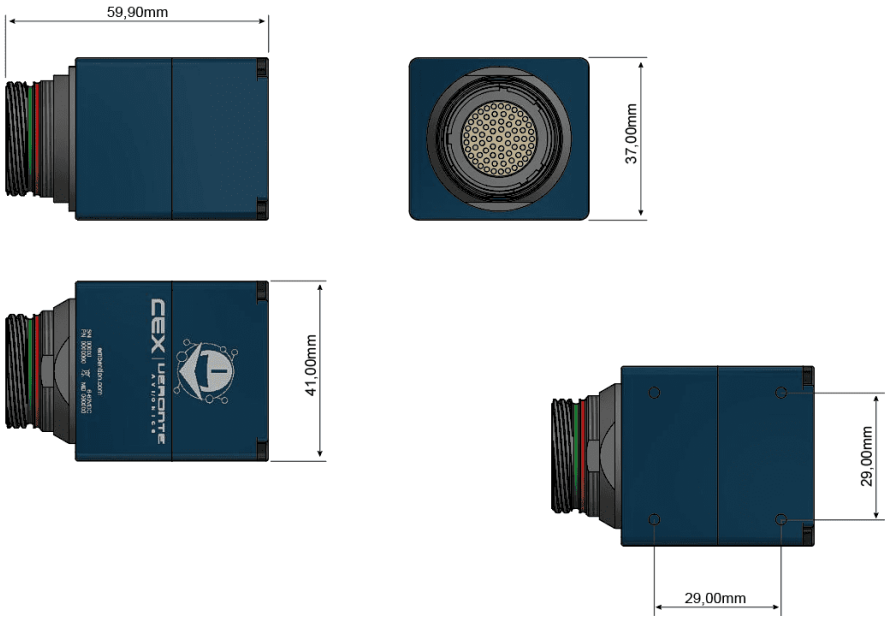
| | |
|---|---|
| Storage temperature | |
| Environmental protection | IP68 |
| Enclosure material | Anodized-Aluminium 6061-T6 |
| Fixation | 4 x M3 screws |

## Dimensions

**CEX** is provided using an anodized-aluminium enclosure with enhanced EMI shielding.

There are no navigation sensors built into the **CEX**, which means there are no restrictions on vibration isolation, location or orientation of the **CEX**.

The following figure shows the dimensions of the enclosure. The mounting holes of the enclosure are **4 mm deep** M3 threads.




**CEX dimensions (mm)**

# Electrical Specifications

## Power Supply

| | |
|---|---|
| DC input | 6.5V to 60V |
| Power Consumption | 3.5W |

## I/O Specifications

### Input voltage/current

- Power input: 6.5V to 60V (DC)
- Two different input voltages possible

### CAN

- Complies with CAN Bus 2.0A and 2.0B Standards
- Opto-Isolated (4kV)
- Speed up to 1Mbps

### RS-232

- Meets the requirements from TIA/EIA-232-F and ITU v.28 standards
- Speed up to 112.5 KHz

### RS-485

- Voltage level from -7V to 12V
- Meets the requirements from ANSI TIA/EIA-485-A
- RS-422 compatible
- Speed up to 112.5 KHz

### ARINC 429

- Compliance with RTCA/DO-160G, Section 22 Level 3 Pin Injection
- Voltage level from -5V to 5V

#### I2C

- 3.3V Signals up to 400KHz

#### 3.3V Output

- 100 mA fuse protected

#### 5V Output

- 100 mA fuse protected

#### PWM Output

- Voltage: 5V
- Current I (oh): 22mA / I (ol): -22mA
- Micro Edge Positioning (MEP) step size = 150ps

#### Digital Inputs (ECAP)

- Maximum voltage: 5V
- Maximum input current: 2.5mA
- Sampling rate: up to 1us

#### Digital Input/Output (GPIO)

- Voltage: 3.3V
- Current I (oh): 1.6mA and I (ol) = -1.6mA

#### Analog signals

- Input impedance: 10GOhm
- Resolution:
  - 0-3.3V pins: 0.00080V
  - 0-5V pins: 0.0012V
  - 0-12V pins: 0.0029V
  - 0-36V pins: 0.0087V

## Interfaces

**CEX** only requires one interface connection.

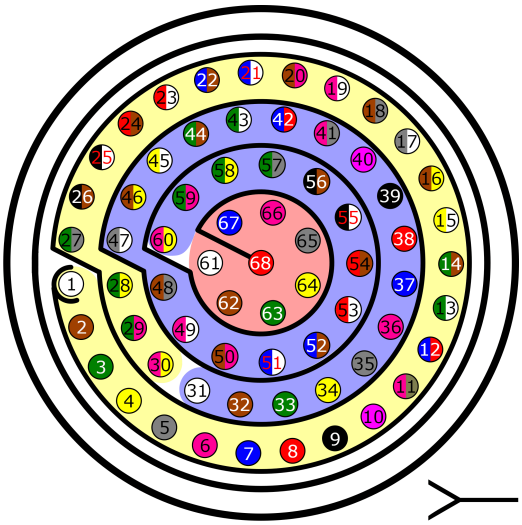
| CEX Connector | Mating Connector |
| --- | --- |
| Connector HEH.LM.368.XLNP | Mating connector: **Veronte Connector Green 68P** (FGH.LM.368.XLCT) (Embention reference **P005653**)<br><br>Mating harnesses are available on demand:<br>• Veronte Harness Green 68P (Embention reference **P001623**)<br>• Veronte Avionics: Dev Harness CEX 2.0 (Embention reference **P006140**) |

> ⓘ **Note**
>
> Please contact sales@embention.com for more information on the different harnesses.

# Hardware Installation

## Pinout

The 68 pin main connector has the distribution of input/output channels as follows:



**Connector HEW.LM.368.XLNP (mounted in CEX)**

> ⚠ **Warning**
>
> Check the pin number before connecting. The color code is repeated 3 times due to the amount of pins. First section corresponds to pins 1-30, the second section to pins 31-60 and the third one to pins 61-68. Pin number increases following the black line of the pictures above: counterclockwise for the connector and clockwise for the plug.

| PIN | Signal | Color Code | Descriptio |
|---|---|---|---|
| 1 | Power supply 1 | White | Power supply for the main system, rec |
| 2 | Power supply 2 | Brown | Power supply for the main system, rec |
| 3 | GND | Green | Ground for su |
| 4 | GND | Yellow | Ground for su |

| PIN | Signal | Color Code | Descriptio |
|---|---|---|---|
| 5 | CAN (A) P | Gray | CAN bus interface. Supports data rates up to recommend |
| 6 | CAN (A) N | Pink | |
| 7 | CAN GND | Blue | Ground for CAN |
| 8 | CAN (B) P | Red | CAN bus interface. Supports data rates up to recommend |
| 9 | CAN (B) N | Black | |
| 10 | OUT RS-485 (P) | Violet | Non-inverted output fro |
| 11 | OUT RS-485 (N) | Gray - Pink | Inverted output from |
| 12 | IN RS-485 (N) | Red - Blue | Inverted input to RS |
| 13 | IN RS-485 (P) | White - Green | Non-inverted input to |
| 14 | RS-485 GND | Brown - Green | Ground for RS |
| 15 | RS-232 (A) TX | White - Yellow | RS-232 A Out |
| 16 | RS-232 (A) RX | Yellow - Brown | RS-232 A Inp |
| 17 | GND | White - Gray | Ground for digital |
| 18 | RS-232 (B) TX | Gray - Brown | RS-232 B Out |
| 19 | RS-232 (B) RX | White - Pink | RS-232 B Inp |

| PIN | Signal | Color Code | Descriptio |
|---|---|---|---|
| 20 | I2C SCL | Pink - Brown | Clock line for I2 |
| 21 | I2C SDA | White - Blue | Data line for I2 |
| 22 | 3.3V Output | Brown - Blue | 3.3V-100 mA powe |
| 23 | GND | White - Red | Ground for power |
| 24 | 5V Output | Brown - Red | 5V - 100 mA powe |
| 25 | GND | White - Black | Ground for power |
| 26 | ATX (0) N | Brown - Black | ARINC 429 inverted o |
| 27 | ATX (0) P | Gray - Green | ARINC 429 non-inverted |
| 28 | ARX (0) P | Yellow - Green | ARINC 429 non-inverte |
| 29 | ARX (0) N | Pink - Green | ARINC 429 inverted i |
| 30 | ECAP 0 | Yellow - Pink | Encoder quadratu |
| 31 | ECAP 1 | White | Encoder quadratu |
| 32 | ECAP 2 | Brown | Encoder quadratu |
| 33 | ECAP 3 | Green | Encoder quadratu |
| 34 | PWM 0 | Yellow | |

| PIN | Signal | Color Code | Descriptio |
|---|---|---|---|
| 35 | PWM 1 | Gray | PWM/DIGITAL output / DIGITA<br><br>**Warning**<br>Each pin withstands a maxim |
| 36 | PWM 2 | Pink | |
| 37 | PWM 3 | Blue | |
| 38 | PWM 4 | Red | |
| 39 | PWM 5 | Black | |
| 40 | PWM 6 | Violet | |
| 41 | PWM 7 | Gray - Pink | |
| 42 | GND | Red - Blue | Ground for digital/ana |
| 43 | ANALOG (0) 3.3V | White - Green | Analog input 0- |
| 44 | ANALOG (1) 3.3V | Brown - Green | Analog input 0- |
| 45 | ANALOG (2) 5V | White - Yellow | Analog input 0 |
| 46 | ANALOG (3) 5V | Yellow - Brown | Analog input 0 |
| 47 | ANALOG (4) 12V | White - Gray | Analog input 0- |
| 48 | ANALOG (5) 12V | Gray - Brown | Analog input 0- |
| 49 | | White - Pink | Analog input 0- |

| PIN | Signal | Color Code | Descriptio |
|---|---|---|---|
| | ANALOG (6) 36V | | |
| 50 | ANALOG (7) 36V | Pink - Brown | Analog input 0 |
| 51 | GND | White - Blue | Ground for digital/ana |
| 52 | ARX (1) P | Brown - Blue | ARINC 429 non-inverte |
| 53 | ARX (1) N | White - Red | ARINC 429 inverted i |
| 54 | ARX (2) P | Brown - Red | ARINC 429 non-inverte |
| 55 | ARX (2) N | White - Black | ARINC 429 inverted i |
| 56 | ARX (3) P | Brown - Black | ARINC 429 non-inverte |
| 57 | ARX (3) N | Gray - Green | ARINC 429 inverted i |
| 58 | ARX (4) P | Yellow - Green | ARINC 429 non-inverte |
| 59 | ARX (4) N | Pink - Green | ARINC 429 inverted i |
| 60 | GPIO 8 | Yellow - Pink | DIGITAL output / DIGITAL inp |
| 61 | GPIO 9 | White | |
| 62 | GPIO 10 | Brown | |
| 63 | GPIO 11 | Green | |

**Warning**

Each pin withstands a maximu

| PIN | Signal | Color Code | Descriptio |
|---|---|---|---|
| 64 | GPIO 12 | Yellow | |
| 65 | GPIO 13 | Gray | |
| 66 | GPIO 14 | Pink | |
| 67 | GPIO 15 | Blue | |
| 68 | GPIO 16 | Red | |

## Harness

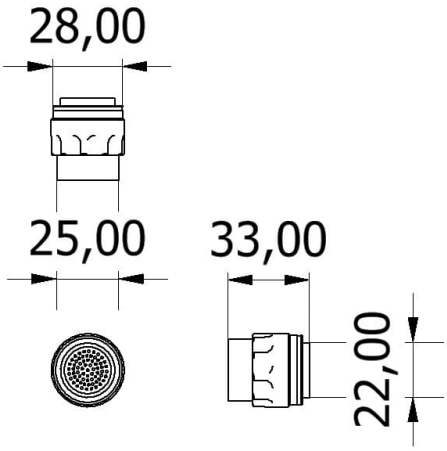
A wire harness is a structured assembly of cables and connectors used to organize and manage wiring in electrical and electronic systems. It is designed to ensure a tidy and secure installation of cables, preventing tangles, electromagnetic interference, and facilitating maintenance.

**CEX 2.0** has two compatible harnesses:

| Veronte Harness Green 68P | Dev Harness CEX 2.0 |
|---|---|
|  |  |
| Harness available on demand with the Embention reference **P001623** | Harness available on demand with the Embention reference **P006140** |

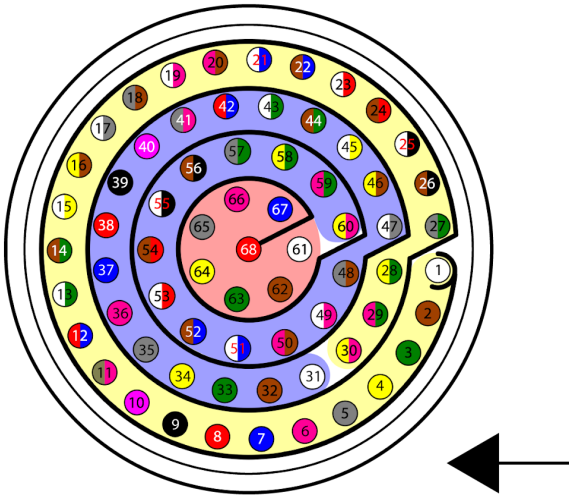
## Dimensions

- **Harness Green 68P wire gauge:** 22 AWG
- **Cables length:** 52 cm
- **Harness plug dimensions:**




**Connector FGW.LM.368.XLCT dimensions (cm)**

## Pinout



**Harness plug - FGH.LM.368.XLCT (frontal view)**

### Veronte Harness Green 68P

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

> **⚠ Warning**
>
> Check the pin number before connecting. The color code is repeated 3 times due to the amount of pins. First section (yellow) corresponds to pins 1-30, the second section (blue) to pins 31-60 and the third one (red) to pins 61-68. Pin number increases following the black line of the pictures above: counterclockwise for the connector and clockwise for the plug.

| PIN | Color code | PIN | Color code |
|---|---|---|---|
| 1 | White | 35 | Gray |
| 2 | Brown | 36 | Pink |
| 3 | Green | 37 | Blue |
| 4 | Yellow | 38 | Red |
| 5 | Gray | 39 | Black |
| 6 | Pink | 40 | Violet |
| 7 | Blue | 41 | Gray - Pink |
| 8 | Red | 42 | Red - Blue |
| 9 | Black | 43 | White - Green |
| 10 | Violet | 44 | Brown - Green |
| 11 | Gray - Pink | 45 | White - Yellow |

| PIN | Color code | PIN | Color code |
|---|---|---|---|
| 12 | Red - Blue | 46 | Yellow - Brown |
| 13 | White - Green | 47 | White - Gray |
| 14 | Brown - Green | 48 | Gray - Brown |
| 15 | White - Yellow | 49 | White - Pink |
| 16 | Yellow - Brown | 50 | Pink - Brown |
| 17 | White - Gray | 51 | White - Blue |
| 18 | Gray - Brown | 52 | Brown - Blue |

### Dev Harness CEX 2.0

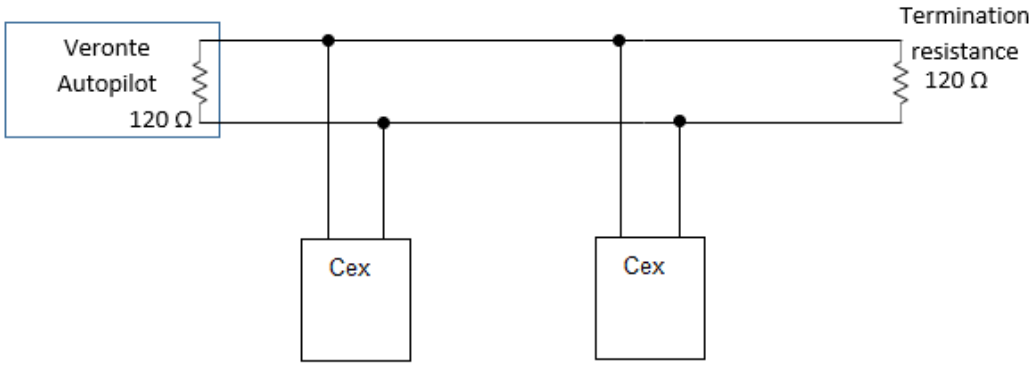
This harness has some connectors already implemented for easy operation. Below is detailed information on which pins these connectors are connected to:

| Connector | PIN | Signal |
|---|---|---|
| **Main VCC** | 1 | Power supply 1 |
| | 2 | Power supply 2 |
| | 3 | GND |

| Connector | PIN | Signal |
|---|---|---|
| | 4 | GND |
| **RS232 connector** | 15 | RS-232 (A) TX |
| | 16 | RS-232 (A) RX |
| | 17 | GND |
| **Maintenance button** | 20 | I2C SCL |
| | 21 | I2C SDA |

## CAN Assembly

As described in Warnings section, **CEX** itself does not allow the connection of multiple **CEX** or other CAN Bus devices to the same line. It is therefore possible to use a **Veronte Autopilot** for this purpose. Considering **Veronte Autopilot** includes one entrance resistance of 120 Ω, a second resistance needs to be placed at the end of the line (again 120 Ω). This resistance may be placed on the cable or on another PCB.

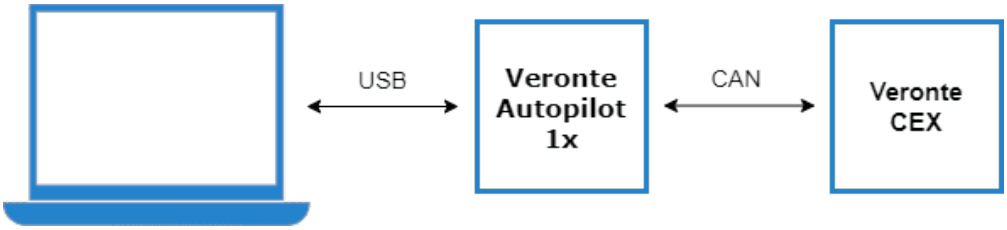



**CAN assembly diagram example**

# Software Installation

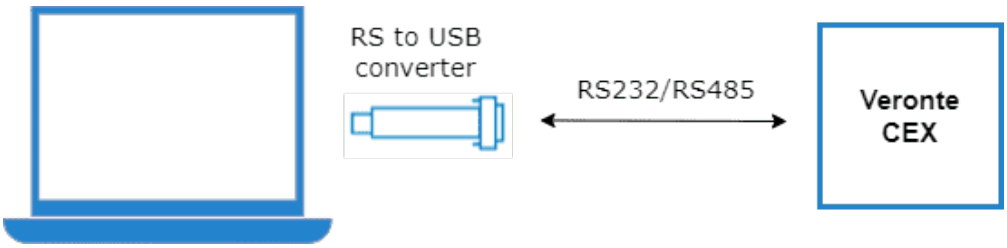
There are two ways to make the connection to configure **CEX**: via **Veronte Autopilot 1x** or direct connection.

- **Via Veronte Autopilot 1x**
  It is usual to have a **CEX** in a system that does not allow to directly connect **CEX** to a PC. In that situation, we can configure a **Veronte Autopilot 1x** that is connected via CAN with **CEX**. To be able to establish a connection between **1x PDI Builder** and **CEX**, please see the Integration examples section of the **CEX PDI Builder** user manual.




**CEX connection through Veronte Autopilot 1x**

- **Direct connection**
  By default **CEX** can establish VCP communications over its SCI-A and SCI-B ports. Using any of these connection will be possible to connect it to a PC.




**Direct CEX connection**

The **CEX** software configuration is explained in the CEX Software Manual.

# Maintenance

## Preventive maintenance

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

In order to clean **CEX** 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 if the connector is connected.

## Software update

To update the software, an additional app is required: Veronte Updater.

> ⓘ **Note**
>
> The file with the new software version will be shared with the customer in the **Joint Collaboration Framework** when it is requested.
>
> For more information about the **Joint Collaboration Framework**, read its user manual.

# Integration examples

Examples of how to set up a configuration for **CEX** can be seen in Integration examples section of the **CEX PDI Builder** user manual.

- Veronte products

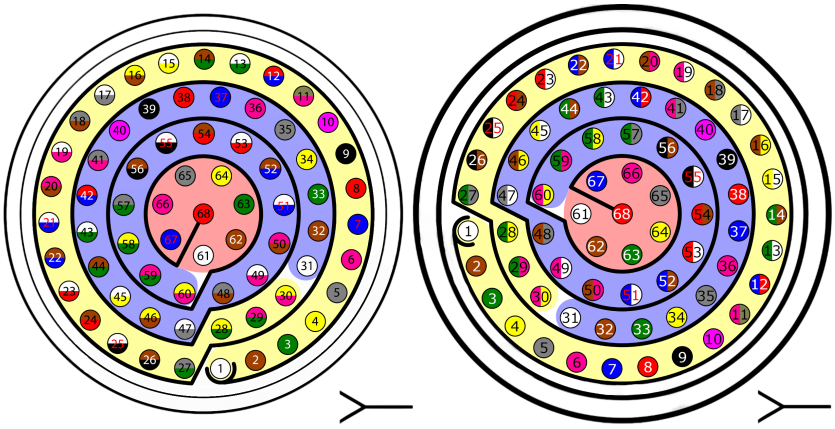
## Veronte products

This section explains how to integrate **CEX** with Veronte products.

### Autopilot 1x connection

When communication is established between the PC and the **CEX** using the **Veronte Autopilot 1x** as a tunnel, the connection between the **CEX** and **Autopilot 1x** is via CAN.

The pin connection between the two devices should be like this:



Connector for Autopilot 1x - HEW.LM.368.XLNP (frontal view)

Connector for CEX - HEW.LM.368.XLNP (frontal view)

| Autopilot 1x connector | | | CEX connector | | |
|---|---|---|---|---|---|
| **PIN** | **Signal** | **Color code** | **PIN** | **Signal** | **Color code** |
| 25 | CANA_P | White-Black | 5 | CAN (A) P | Gray |

| Autopilot 1x connector | | | CEX connector | | |
|---|---|---|---|---|---|
| **PIN** | **Signal** | **Color code** | **PIN** | **Signal** | **Color code** |
| 26 | CANA_N | Brown-Black | 6 | CAN (A) N | Pink |
| 28 | CANB_P | Yellow-Green | 8 | CAN (B) P | Red |
| 29 | CANB_N | Pink-Green | 9 | CAN (B) N | Black |
| 30 | GND | Yellow-Pink | 7 | CAN GND | Blue |

> ⓘ **Note**
>
> If only CAN A or CAN B has been configured in the software for communications, only the corresponding pins must be connected. For more information on CAN connection, please visit CAN Assembly - Hardware Installation.

> ⚠ **Warning**
>
> **Remember!!** In **Autopilot 1x**, all GND pins are common. Note that pin 54 is not a common GND pin.

> **Important**
>
> Integration is also possible by connecting CAN A of the **Autopilot 1x** to CAN B of the **CEX** and vice versa, i.e. it does not necessarily have to be CAN A-CAN A or CAN B-CAN B. However, any connections made must be **consistent** with the **configuration** made at software level in 1x PDI Builder and CEX PDI Builder.

# Troubleshooting

In case of any issue with software, read the Troubleshooting section of the **CEX PDI Builder** user manual.

## Forcing maintenance mode

If a mistake was made when building the configuration and communication with the device has been lost, it is possible to force the device to boot into maintenance mode in order to modify its configuration.

There are two ways to force the maintenance mode: using power supply or using the I2C pins.

### Power supply

When communication with the unit is lost, it is possible to active **maintenance mode by** power input.

In order to active **maintenance mode**, power cycle **CEX** repetively with periods of 700 ms (with a margin range between 380 and 965 ms). After **30 cycles**, **CEX** will enter in maintenance mode.

### I2C pins

To enter in maintenance mode with **I2C**:

1. Unplug **CEX**
2. Connect both I2C pins each other
3. Then, power up **CEX**
4. Finally, disconnect both pins

Both pins are I2C SCL (number 20) and I2C SDA (number 21) according to the pinout.

> **Note**
>
> **Veronte Avionics: Dev Harness CEX 2.0** (Embention reference `P006140`) has already included a button with this 2 pins to easily enter maintenance mode. The procedure is the same as for the pins, but instead of connecting and disconnecting the pins, press and release the button.

# Acronyms and Definitions

| Abbreviation | Description |
|---|---|
| ARINC | Aeronautical Radio, Inc. |
| BEC | Battery Eliminating Circuit |
| CAN | Controller Area Network |
| CAP | Capture Module |
| CEX | CAN Expander |
| COM | Communications |
| DC | Direct Current |
| ECAP | Enhanced CAP |
| EQEP | Enhanced Quadrature Encoder Pulse sensor |
| ESC | Electronic Speed Control |
| ESD | ElectroStatic Discharge |
| GND | Ground |
| GPIO | General Purpose Input/ Output |

| Abbreviation | Description |
|---|---|
| I/O | Input/Output |
| I2C | Inter-Integrated Circuit |
| JTAG | Joint Test Action Group |
| Mbps | Megabits Per Second |
| MEP | Micro Edge Positioning |
| MPU | Micro-Processor Unit |
| OEM | Original Equipment Manufacturer |
| PCB | Printed Circuit Board |
| PDI | Parameter Data Items |
| PPM | Pulse Position Modulation |
| PWM | Pulse Width Modulated signal |
| RPM | Revolutions Per Minute |
| RS-232 | Recommended Standard 232 |
| RS-485 | |

| Abbreviation | Description |
| --- | --- |
| | Recommended Standard 485 |
| SCI | Serial Communications Interface |
| SCL | Serial Clock line |
| SDA | Serial Data line |
| SN | Serial Number |
| SW | Software |
| UART | Universal Asynchronous Receiver Transmitter |
| VCP | Virtual Communication Port |

# 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