# CEX Hardware Manual

*Release 2.0*

**Embention**

**2024-07-04**

# CONTENTS

**CEX** is a CAN expander and communication manager, which allows to reduce wires in autonomous vehicles and increase the number of devices.

**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

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.

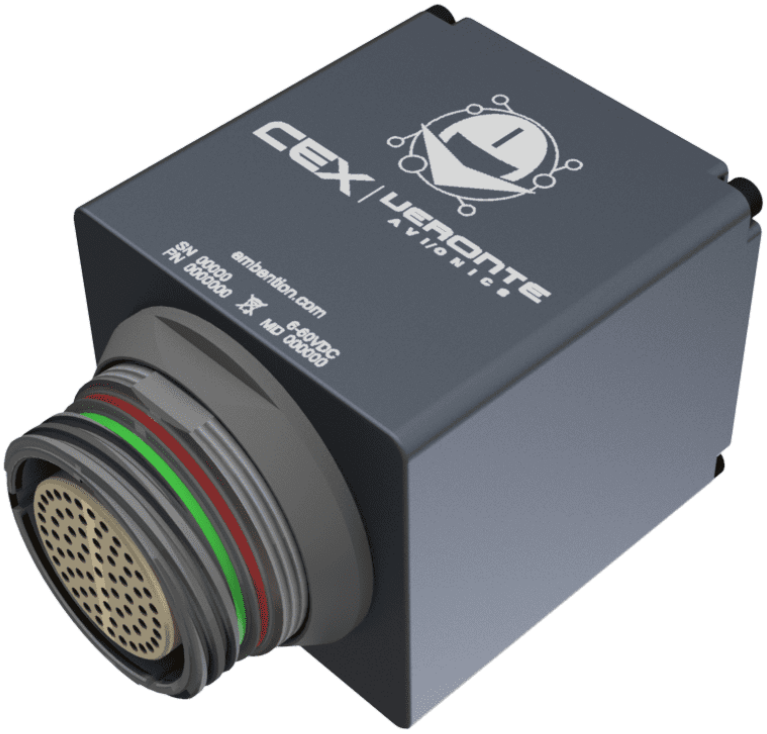


Fig. 1: **CEX**

## 1.1 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.

## 1.2 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.

## 1.3 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.

CHAPTER

TWO

# QUICK START

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

## 2.1 System Layout

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

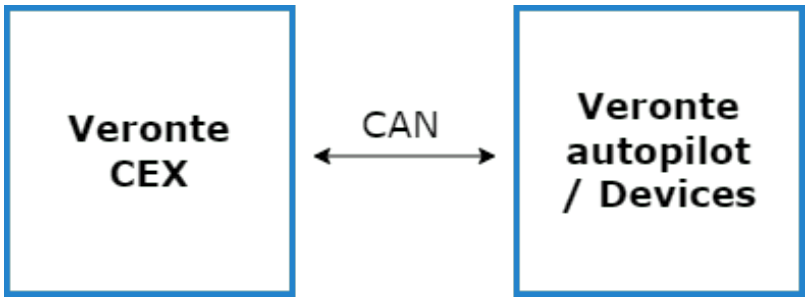


Fig. 1: **CEX standard layout**

## 2.2 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 specifications*.
- 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.

## 2.3 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).

CHAPTER

THREE

# TECHNICAL

## 3.1 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

## 3.2 Mechanical Specifications

| | |
|---|---|
| Weight | 115 g |
| Operating temperature | -40 to 60°C |
| Storage temperature | -55 to 85°C |
| Environmental proteciton | IP68 |
| Enclosure material | Anodized-Aluminium 6061-T6 |
| Fixation | 4 x M3 screws |

### 3.2.1 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.

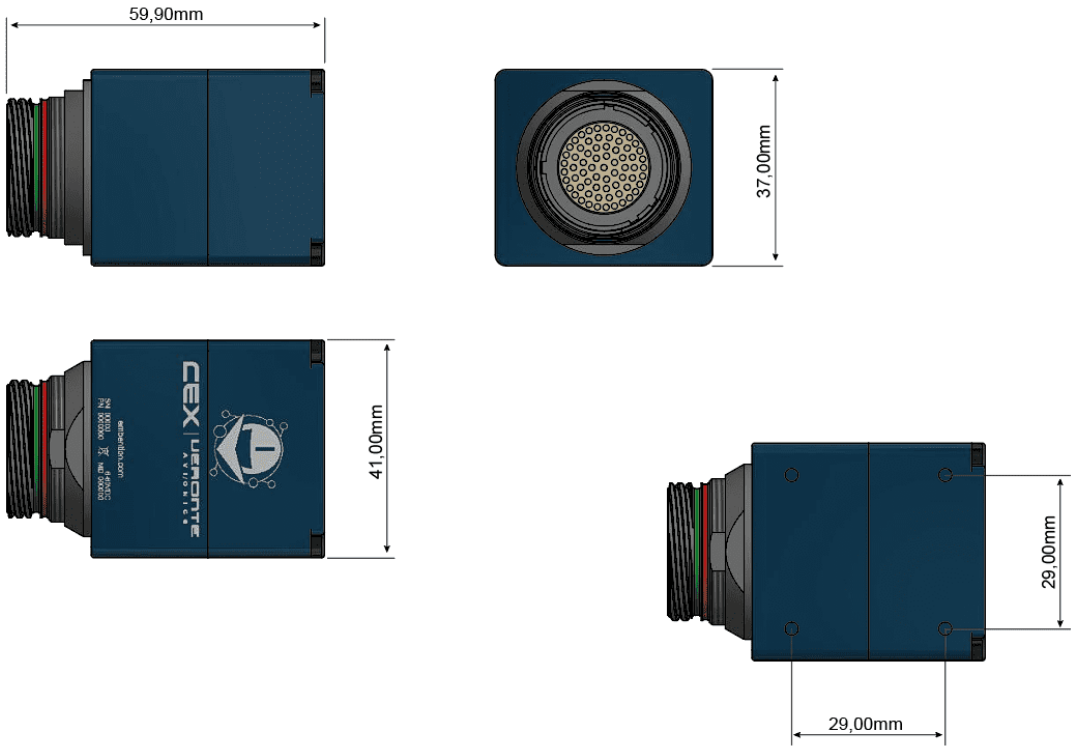


Fig. 1: **CEX dimensions**

## 3.3 Electrical Specifications

### 3.3.1 Power Supply

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

### 3.3.2 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

## 3.4 Interfaces

CEX only requires one interface connection, employing one of the following connectors:

| Name | Embention reference | External reference | Cables included |
|---|---|---|---|
| Veronte Harness Green 68P | P001623 | LLE.23143774 | YES |
| Veronte Connector Green 68P | P005653 | FGH.LM.368.XLCT | NO |

**Note:** Both connectors are sold separately. Please contact with sales@embention.com for more information.

The connector mounted in CEX has the external reference **HEH.LM.368.XLNP** from LEMO.

CHAPTER

FOUR

# HARDWARE INSTALLATION

## 4.1 Pinout

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

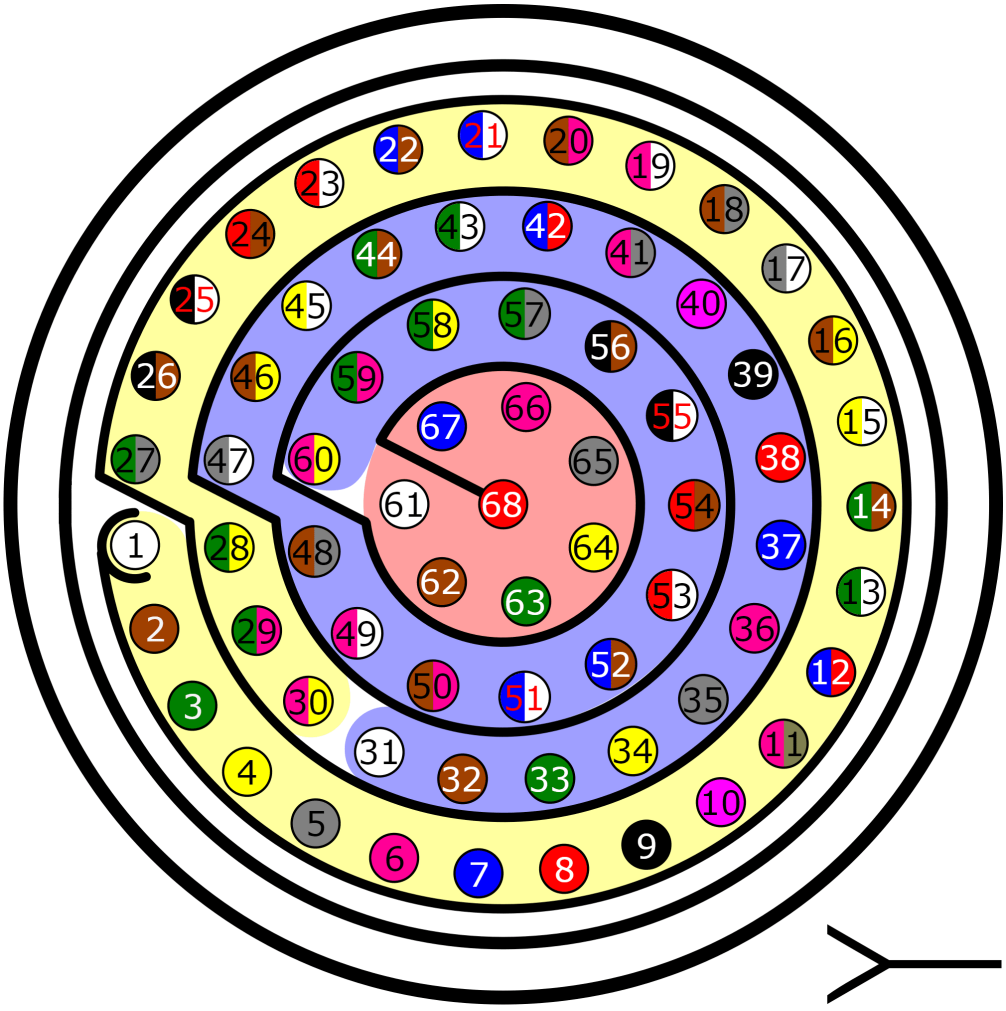


Fig. 1: **Connector HEW.LM.368.XLNP (mounted in CEX)**

**Warning:** Check the pin number before connecting. The colour 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.

| Main Connector - HEX.LM.368.XLNP | | | |
|---|---|---|---|
| PIN Nº | I/O | Color | Comments |
| 1 | Power supply 1 | White | Power supply for the main system, redundant with Power supply 2 |
| 2 | Power supply 2 | Brown | Power supply for the main system, redundant with Power supply 1 |
| 3 | GND | Green | Ground for supply |
| 4 | GND | Yellow | Ground for supply |
| 5 | CAN (A) P | Gray | CAN bus interface. It supports data rates up to 1 Mbps |
| 6 | CAN (A) N | Pink | Twisted pair with a 120 Ω Zo recommended |
| 7 | CAN GND | Blue | Ground for CAN busses |
| 8 | CAN (B) P | Red | CAN bus interface. It supports data rates up to 1 Mbps |
| 9 | CAN (B) N | Black | Twisted pair with a 120 Ω Zo recommended |
| 10 | OUT RS-485 (P) | Violet | Non-inverted output from RS-485 bus |
| 11 | OUT RS-485 (N) | Gray – Pink | Inverted output from RS-485 bus |
| 12 | IN RS-485 (N) | Red – Blue | Inverted input to RS-485 bus |
| 13 | IN RS-485 (P) | White – Green | Non-inverted input to RS-485 bus |
| 14 | RS-485 GND | Brown – Green | Ground for RS-485 |
| 15 | RS-232 (A) TX | White – Yellow | RS-232 A Output |
| 16 | RS-232 (A) RX | Yellow – Brown | RS-232 A Input |
| 17 | GND | White – Gray | Ground for digital busses |
| 18 | RS-232 (B) TX | Gray – Brown | RS-232 B Output |
| 19 | RS-232 (B) RX | White – Pink | RS-232 B Input |
| 20 | I2C SCL | Pink – Brown | Clock line for I2C bus |
| 21 | I2C SDA | White – Blue | Data line for I2C bus |
| 22 | 3.3V Output | Brown – Blue | 3.3V-100 mA power supply |
| 23 | GND | White – Red | Ground for power supply |
| 24 | 5V Output | Brown – Red | 5V – 100 mA power supply |
| 25 | GND | White – Black | Ground for power supply |
| 26 | ATX (0) N | Brown – Black | ARINC 429 inverted output Port 0 |

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Table 1 – continued from previous page

| Main Connector - HEX.LM.368.XLNP | | | |
|---|---|---|---|
| PIN Nº | I/O | Color | Comments |
| 27 | ATX (0) P | Gray – Green | ARINC 429 non-inverted output Port 0 |
| 28 | ARX (0) P | Yellow – Green | ARINC 429 non-inverted input Port 0 |
| 29 | ARX (0) N | Pink – Green | ARINC 429 inverted input Port 0 |
| 30 | ECAP 0 | Yellow – Pink | Encoder quadrature input |
| 31 | ECAP 1 | White | Encoder quadrature input |
| 32 | ECAP 2 | Brown | Encoder quadrature input |
| 33 | ECAP 3 | Green | Encoder quadrature input |
| 34 | PWM 0 | Yellow | PWM/DIGITAL output /DIGITAL input signal (0-5V)<br><br>**Warning:** Each pin withstands a maximum current of 8 mA |
| 35 | PWM 1 | Gray | |
| 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/analog signals |
| 43 | ANALOG (0) 3.3V | White – Green | Analog input 0-3.3 V |
| 44 | ANALOG (1) 3.3V | Brown – Green | Analog input 0-3.3 V |
| 45 | ANALOG (2) 5V | White – Yellow | Analog input 0-5 V |
| 46 | ANALOG (3) 5V | Yellow – Brown | Analog input 0-5 V |
| 47 | ANALOG (4) 12V | White – Gray | Analog input 0-12 V |
| 48 | ANALOG (5) 12V | Gray – Brown | Analog input 0-12 V |
| 49 | ANALOG (6) 36V | White – Pink | Analog input 0-36 V |
| 50 | ANALOG (7) 36V | Pink – Brown | Analog input 0-36 V |
| 51 | GND | White – Blue | Ground for digital/analog signals |
| 52 | ARX (1) P | Brown – Blue | ARINC 429 non-inverted input Port 0 |
| 53 | ARX (1) N | White – Red | ARINC 429 inverted input Port 0 |
| 54 | ARX (1) P | Brown – Red | ARINC 429 non-inverted input Port 1 |
| 55 | ARX (1) N | White – Black | ARINC 429 inverted input Port 1 |
| 56 | ARX (2) P | Brown – Black | ARINC 429 non-inverted input Port 2 |
| 57 | ARX (2) N | Gray – Green | ARINC 429 inverted input Port 2 |
| 58 | ARX (3) P | Yellow – Green | ARINC 429 non-inverted input Port 3 |
| 59 | ARX (3) N | Pink – Green | ARINC 429 inverted input Port 3 |

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| Main Connector - HEX.LM.368.XLNP | | | |
|---|---|---|---|
| PIN Nº | I/O | Color | Comments |
| 60 | GPIO 8 | Yellow – Pink | DIGITAL output /DIGITAL input signal (0-3.3V)<br><br>**Warning:** Each pin withstands a maximum current of 1.65 mA |
| 61 | GPIO 9 | White | |
| 62 | GPIO 10 | Brown | |
| 63 | GPIO 11 | Green | |
| 64 | GPIO 12 | Yellow | |
| 65 | GPIO 13 | Gray | |
| 66 | GPIO 14 | Pink | |
| 67 | GPIO 15 | Blue | |
| 68 | GPIO 16 | Red | |

## 4.2 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.

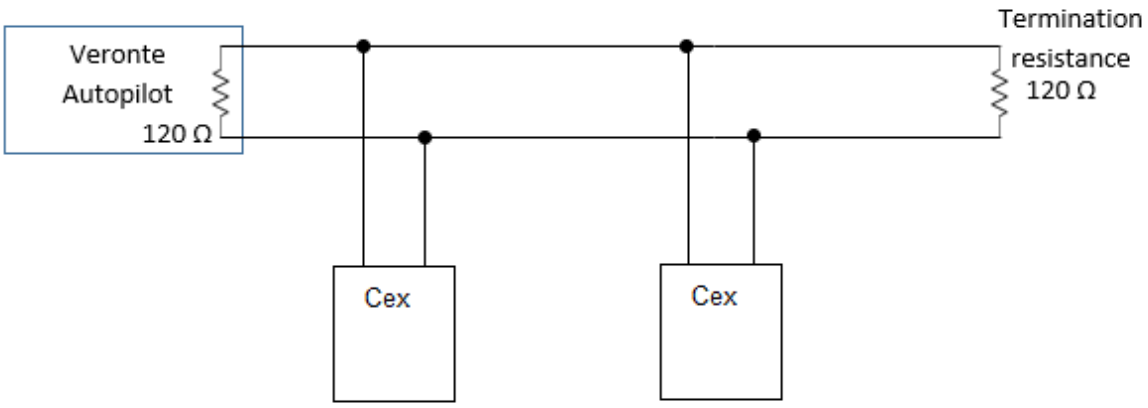



Fig. 2: **CAN assembly diagram example**

CHAPTER

FIVE

# SOFTWARE INSTALLATION

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

- **Via Veronte** 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** manual.

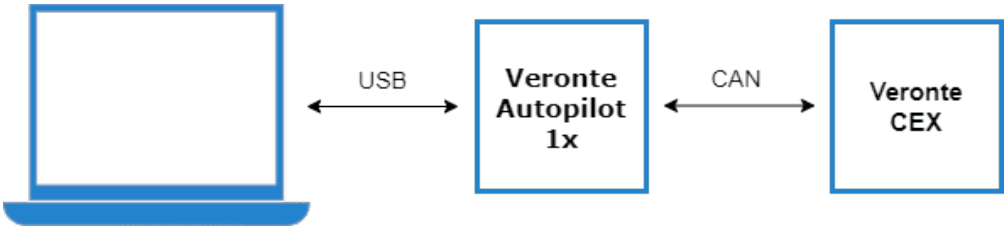



Fig. 1: **CEX connection through Veronte Autopilot 1x**

- **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.

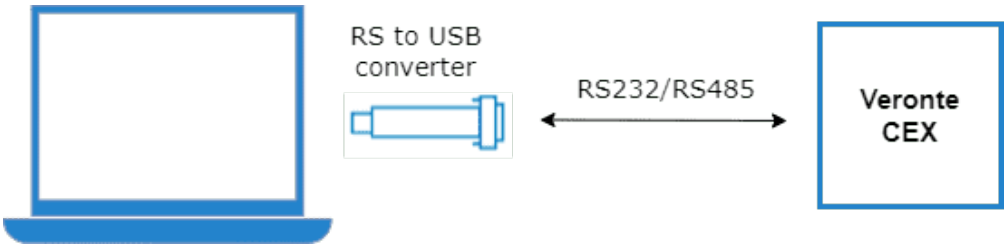



Fig. 2: **Direct CEX connection**

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

CHAPTER

SIX

# MAINTENANCE

## 6.1 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.

## 6.2 Software update

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

**Warning:** Select your version before reading any user manual for software.

**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.

CHAPTER

SEVEN

# INTEGRATION EXAMPLES

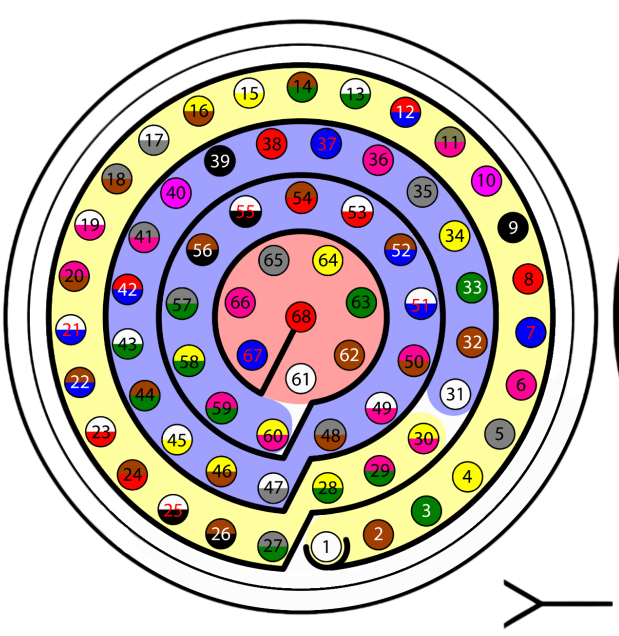
Examples of how to set up a configuration for CEX can be seen in Integration examples section of the **CEX PDI Builder** user manual.

- *Veronte products*

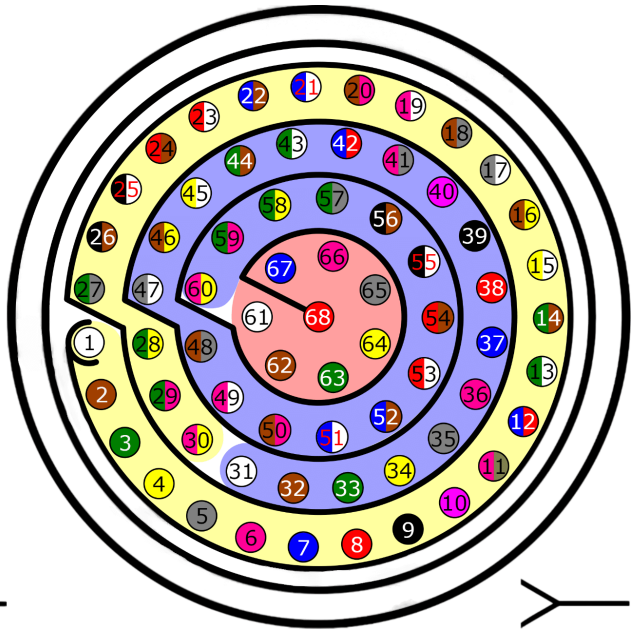
## 7.1 Veronte products

This section explains how to integrate CEX with Veronte products.

### 7.1.1 Autopilot 1x connection



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



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

For proper operation, the connection between CEX and Autopilot 1x pins should be like this:

| Autopilot 1x | | | CEX | | |
|---|---|---|---|---|---|
| **PIN Nº** | **Signal** | **Color** | **PIN Nº** | **Signal** | **Color** |
| 25 | CANA_P | White-Black | 5 | CAN(A) P | Gray |
| 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.

**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.

CHAPTER

EIGHT

# TROUBLESHOOTING

In the following section there are examples of issues that can be found while integrating CEX and how to troubleshoot them.

- If a mistake was made when building the configuration and the 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. For **forcing Maintenance mode**, create a loopback on both I2C pins (I2C SCL and I2C SDA signals). When powered, CEX will boot in maintenance mode.

CHAPTER

NINE

# ACRONYMS AND DEFINITIONS

| | |
|---|---|
| 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 |
| 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 | 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 |

CHAPTER

TEN

# CONTACT DATA

You can contact Embention in any moment 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).