CEX Hardware Manual

Release 2.0

Embention

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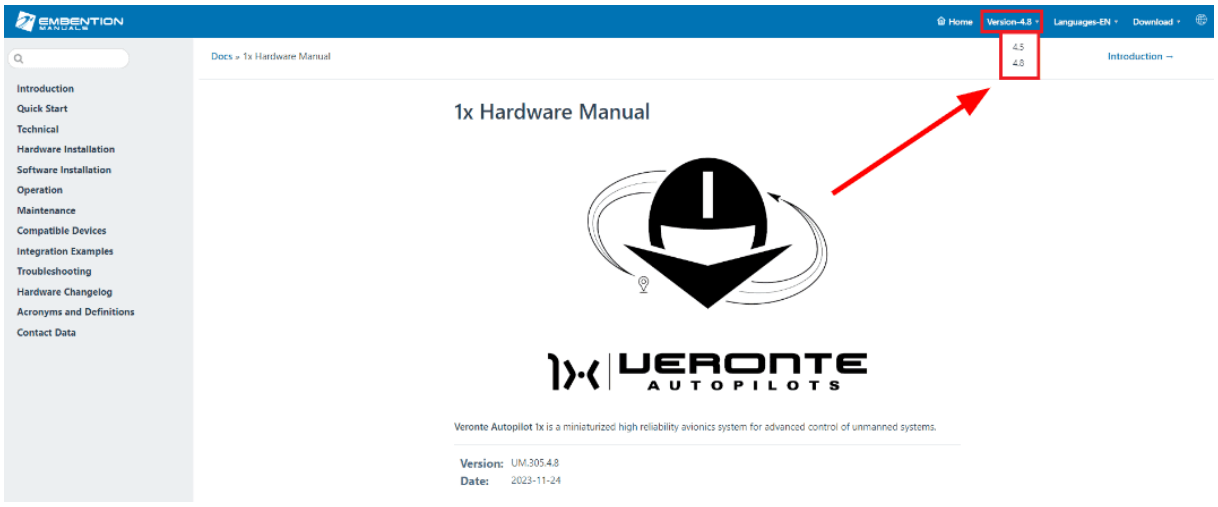
CEX is a CAN expander and communication manager, which allows to reduce wires in autonomous vehicles and increase the number of devices.

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.

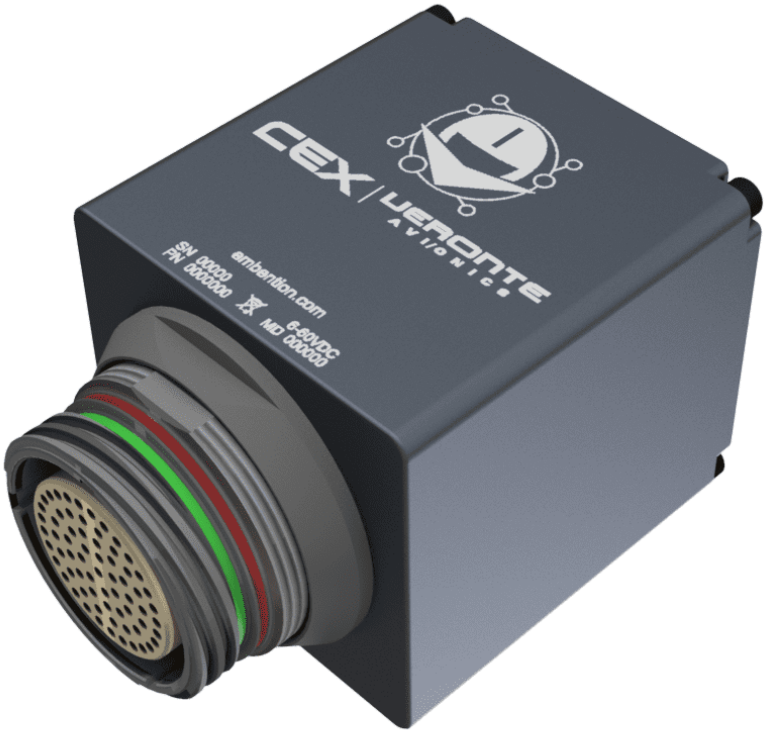


Fig. 1: **CEX**

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:

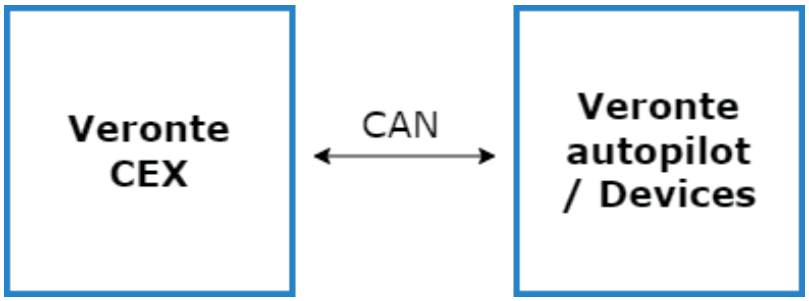


Fig. 1: **CEX standard layout**

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

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.

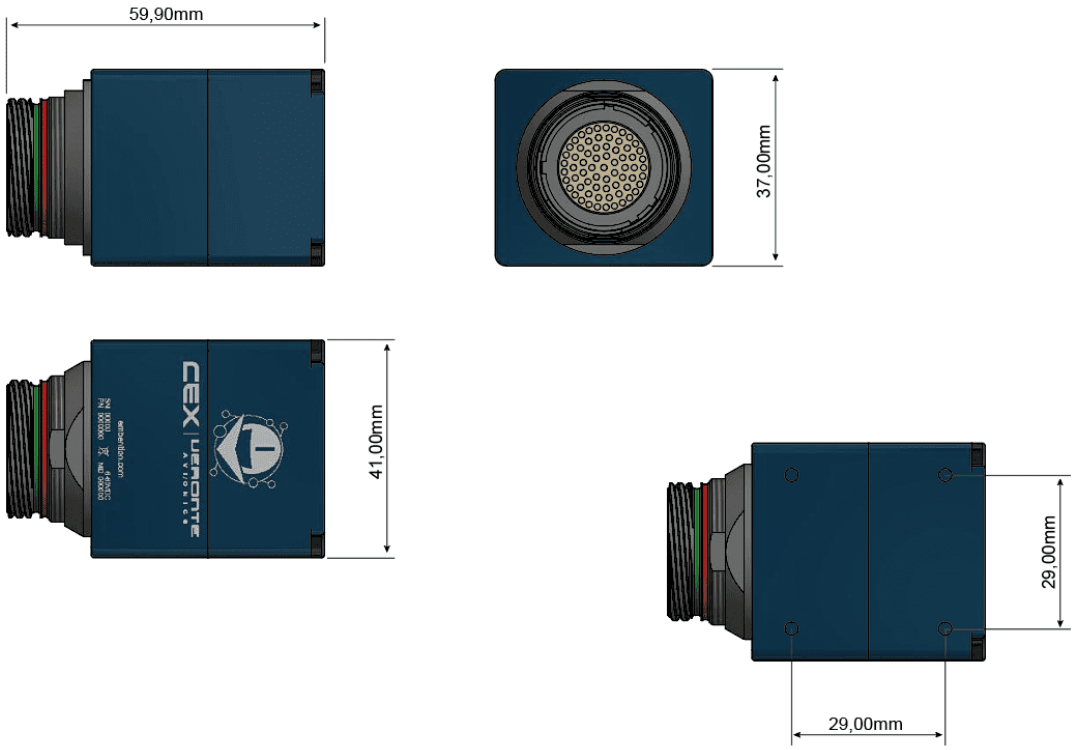


Fig. 1: **CEX dimensions**

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:

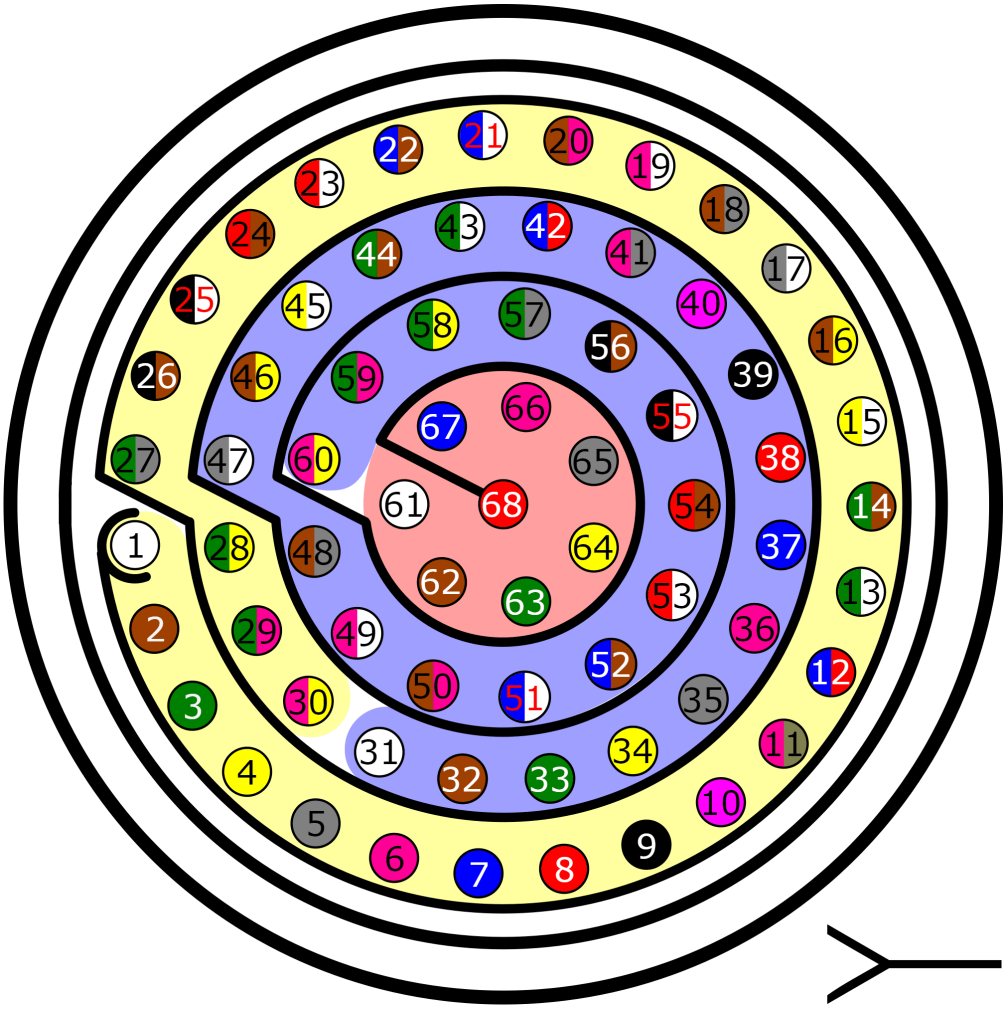


Fig. 1: **Connector HEW.LM.368.XLNP (mounted in CEX)**

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	Grey – 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)
35	PWM 1	Gray	PWM/DIGITAL output /DIGITAL input signal (0-5V)
36	PWM 2	Pink	PWM/DIGITAL output /DIGITAL input signal (0-5V)
37	PWM 3	Blue	PWM/DIGITAL output /DIGITAL input signal (0-5V)
38	PWM 4	Red	PWM/DIGITAL output /DIGITAL input signal (0-5V)
39	PWM 5	Black	PWM/DIGITAL output /DIGITAL input signal (0-5V)
40	PWM 6	Violet	PWM/DIGITAL output /DIGITAL input signal (0-5V)
41	PWM 7	Gray – Pink	PWM/DIGITAL output /DIGITAL input signal (0-5V)
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 (0) P	Brown – Blue	ARINC 429 non-inverted input Port 0

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Table 1 – continued from previous page

Main Connector - HEX.LM.368.XLNP			
PIN Nº	I/O	Color	Comments
53	ARX (0) 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
60	GPIO 8	Yellow – Pink	DIGITAL output /DIGITAL input signal (0-3.3V)
61	GPIO 9	White	DIGITAL output /DIGITAL input signal (0-3.3V)
62	GPIO 10	Brown	DIGITAL output /DIGITAL input signal (0-3.3V)
63	GPIO 11	Green	DIGITAL output /DIGITAL input signal (0-3.3V)
64	GPIO 12	Yellow	DIGITAL output /DIGITAL input signal (0-3.3V)
65	GPIO 13	Grey	DIGITAL output /DIGITAL input signal (0-3.3V)
66	GPIO 14	Pink	DIGITAL output /DIGITAL input signal (0-3.3V)
67	GPIO 15	Blue	DIGITAL output /DIGITAL input signal (0-3.3V)
68	GPIO 16	Red	DIGITAL output /DIGITAL input signal (0-3.3V)

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.

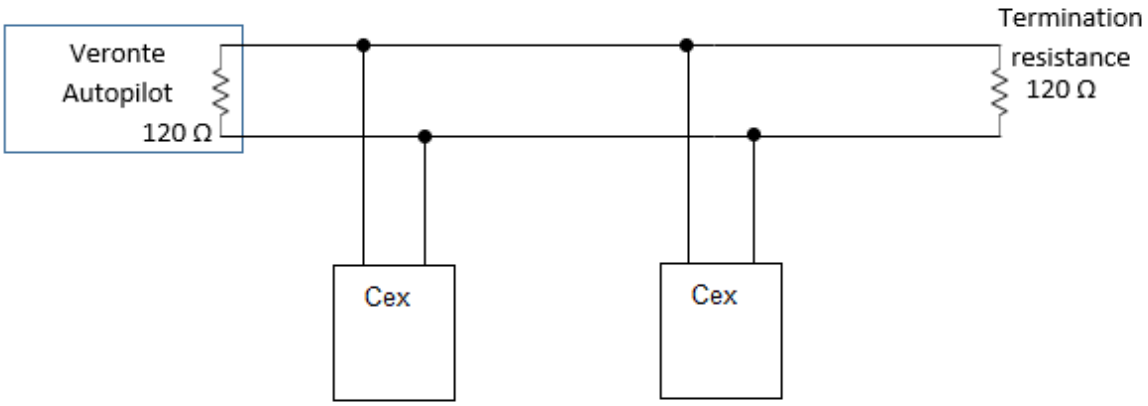

Fig. 2: **CAN assembly diagram example**

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.

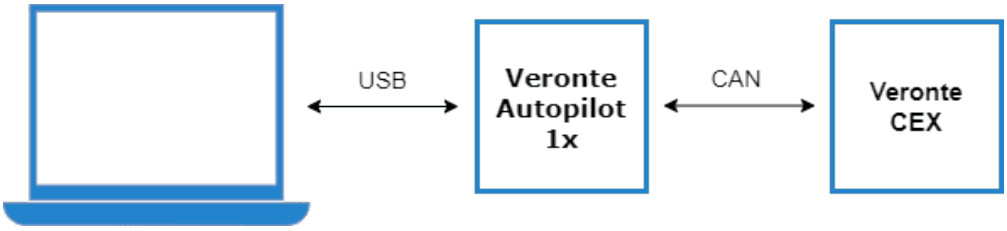

Fig. 1: **CEX connection through Veronte Autopilot 1x**

- **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.

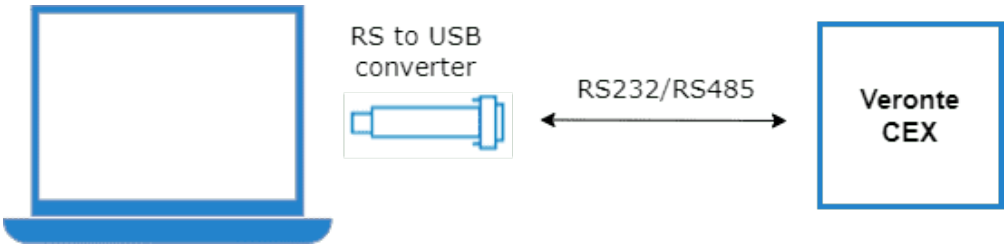

Fig. 2: **Direct CEX connection**

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 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).