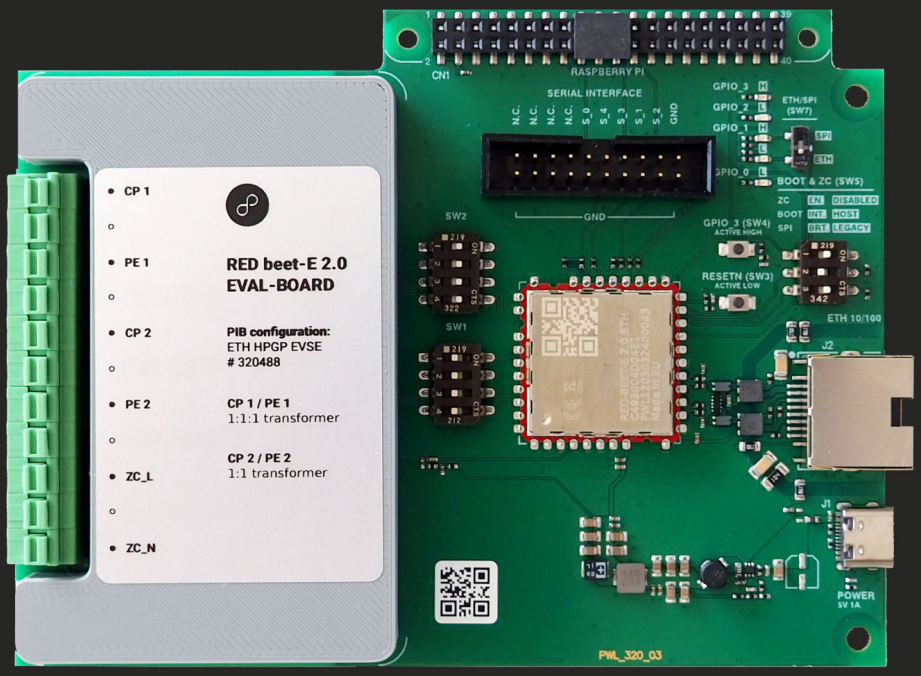


RED-BEET-EVAL-BOARD 2.0 allows testing and evaluation of RED-BEET 2.0 modules. There are various versions of the boards for e-mobility (EVSE and PEV) as well as long reach applications.

*Available for purchase from CODICO GmbH

Quick specs

- Based on RED-BEET 2.0 modules pre-configured for Ethernet host controller interface
- Contains either 1:1:1 and 1:1 transformers for EVSE/PEV application or with 1:5:4 transformer for long reach applications (e.g. AC mains with HomePlug AV support)
- Dedicated pin header for direct connection to a Raspberry Pi
- Header with SPI interface for connection to a host MCU

Table of Contents

1. Features

The RED-BEET-EVAL-BOARD 2.0 allows testing and evaluation of the RED-BEET 2.0 modules for either e-mobility application on EVSE or PEV side as well as HomePlug AV for long reach applications.
The different versions are as follows:

- RED-BEET-EVAL-BOARD-E 2.0 - EVSE (EV supply equipment) with selectable 1:1:1 and 1:1 transformers
- RED-BEET-EVAL-BOARD-P 2.0 - PEV (plug-in EV) with selectable 1:1:1 and 1:1 transformers
- RED-BEET-EVAL-BOARD-H 2.0 - HomePlug AV for long reach applications with 1:5:4 transformer

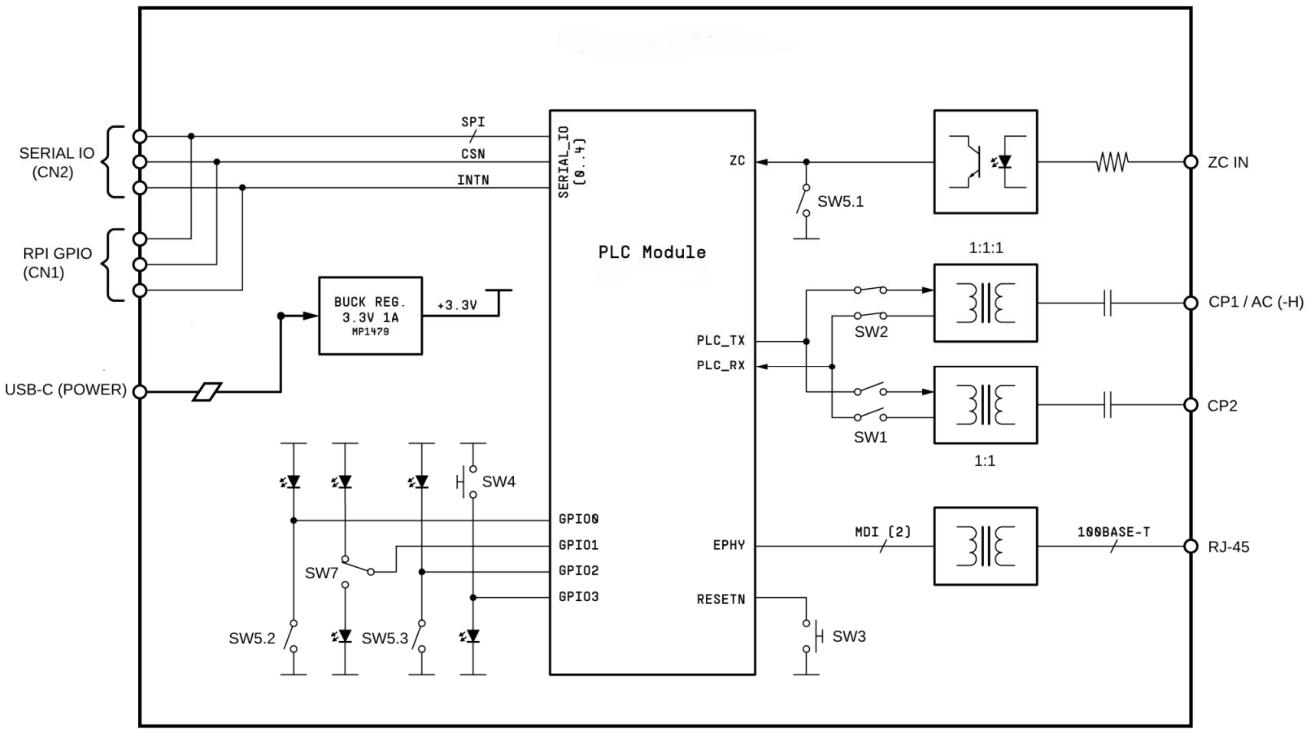
The RED-BEET-EVAL-BOARD 2.0 includes a zero-cross detection circuit for synchronization with the mains frequency.
SPI host controller interface on a standard 20-pin double row header pin-compatible with PL16 Qualcomm evaluation board
Dedicated Raspberry Pi 40-pin GPIO header.
LEDs for activity and status monitoring.
A plastic enclosure covers all potentially high voltage parts of the evaluation board.

TABLE 1-1. RED-BEET-EVAL-BOARD 2.0 FEATURES

	RED-BEET-EVAL-BOARD-E/-P 2.0	RED-BEET-EVAL-BOARD-H 2.0
Firmware version	HomePlug GreenPHY FW v.3.3.0-00	HomePlug AV FW v.3.3.0-00
Configuration (PIB)	HomePlug GreenPHY EVSE (with RED-BEET-E 2.0 module) or PEV (with RED-BEET-P 2.0 module)	HomePlug AV (Ethernet) HomePlug GreenPHY (SPI)
Host interface	Ethernet (default) SPI (configurable)	
Power supply	5V	
Power consumption	1W (at 25 ºC)	
Max data rate	9.8 Mbps PHY rate 4.6 Mbps UDP payload	200 Mbps PHY rate 94 Mbps UDP payload (HomePlug AV) 9.8 Mbps PHY rate 4.6 Mbps UDP payload (HomePlug GreenPHY)
Temperature range	-40 ºC to + 105 ºC (board temperature)	
Size	129 x 95.5 x 20.1 mm	
Weight	72 +/-3g	

2. Block diagram

FIGURE 2-1. RED-BEET-EVAL-BOARD 2.0 BLOCK DIAGRAM



3. Operating conditions

TABLE 3-1. RECOMMENDED OPERATING CONDITIONS

Parameter		Min	Typical	Max	Units
V_{in}		4.75	5	5.25	V
SPI, GPIO	Low-level input voltage	-	-	0.8	V
	High-level input voltage	2.0	-	-	V
	Low-level output voltage	-	-	0.4	V
	High-level output voltage	2.4	-	-	V
Ambient temperature		-40	-	85	°C

TABLE 3-2. ABSOLUTE MAXIMUM RATINGS

Parameter	Min	Typical	Max	Units
V_{in}	4.5	5	5.5	V
SPI, GPIO	-0.3	-	3.6	V
RESETN active pulse duration	100	-	-	us

TABLE 3-3. RED-BEET 2.0 MODULE POWER CONSUMPTION (+25 °C AMBIENT TEMPERATURE)

Operation mode	Typical	Units
Transmit Mode SPI Transmit Mode Ethernet	1000 1200	mV
Receive Mode SPI Receive Mode Ethernet	700 1000	mW
Idle Mode SPI (no communication) Idle Mode Ethernet (no communication)	290 330	mW
RESETN Active Mode	200	mW
Sleep Mode (power saving mode)	100	mW

NOTE: Operation at maximum temperature limit may increase power consumption up to 25%.

TABLE 3-4. ZERO-CROSS DETECTOR INPUT SIGNAL SPECIFICATION

Parameter	Pin	Min	Typical	Max	Units
Zero-cross frequency	ZC_L / ZC_N	48.4 57.7	50 60	51.6 62.3	Hz
Peak to peak voltage	ZC_L / ZC_N		230	253	Vp-p

4. Evaluation board view

FIGURE 4-1. PIN ASSIGNMENTS (TOP VIEW)

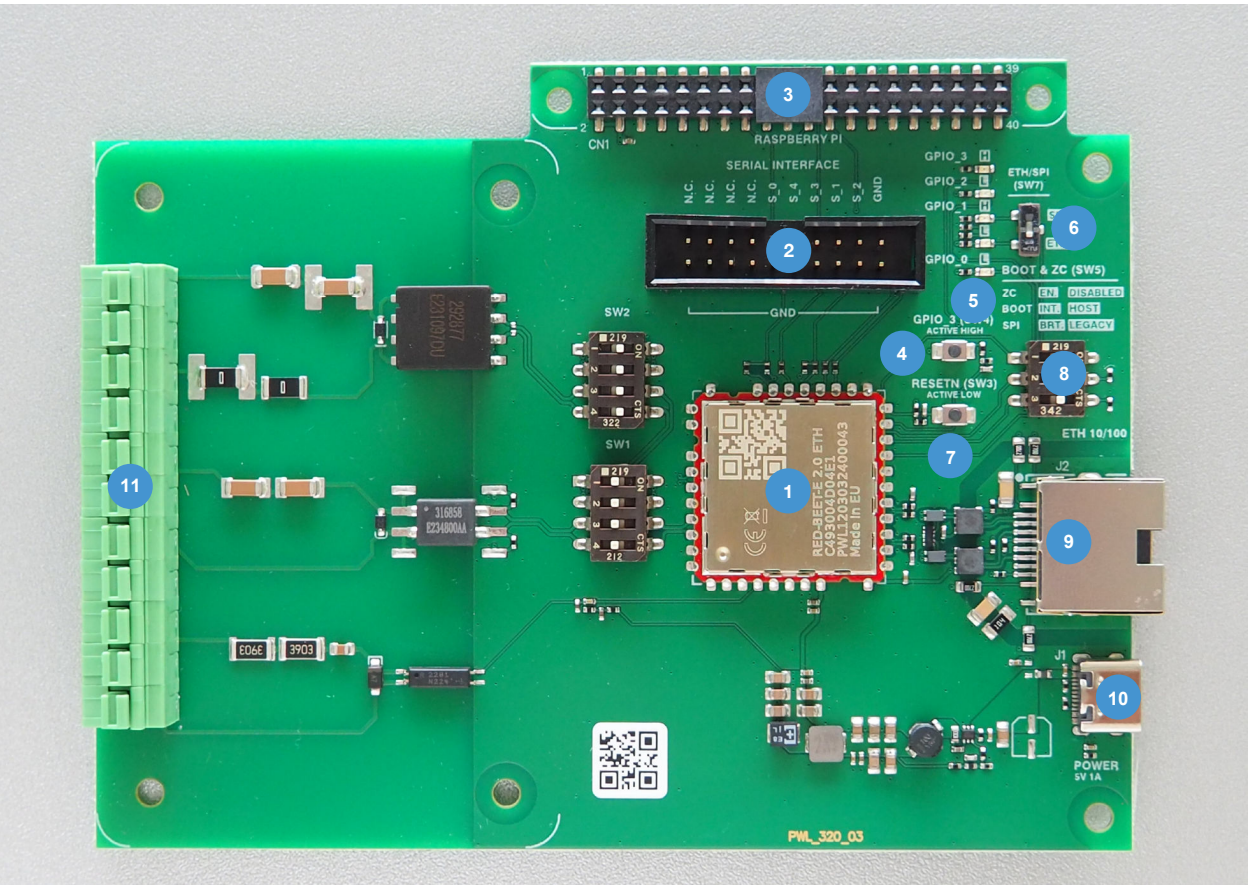


TABLE 4-2. EVALUATION BOARD COMPONENTS

Item reference number	Name
1	RED-BEET 2.0 module
2	SPI and GPIO connector compatible with Qualcomm PL16 20-pin connector (TABLE 4-3)
3	**CN1** Raspberry PI GPIO header (TABLE 4-7)
4	**SW4** GPIO_3 button, active low
5	LEDs for status and activity indication (TABLE 4-6)
6	**SW7** ETH/SPI button, set to Ethernet as default
7	**SW3** Reset button, active low
8	**SW5** switch for configuration and boot-strap settings (TABLE 4-4)
9	Ethernet RJ45 connector
10	USB Type-C connector for power supply only (5V)
11	PLC connector (TABLE 4-5)

Further details are in the following tables.

TABLE 4-3 SPI and GPIO connector pinout

Pin	Description
1	GND
2	GND
3	SERIAL_2 (SPI_CS) / ETH ACT LED (GPIO_6)
4	GND
5	SERIAL_1 (SCLK)
6	GND
7	SERIAL_3 (MISO)
8	GND
9	SERIAL_4 (MOSI)
10	GND
11	SERIAL_0 (INTR) / ETH LINK LED (GPIO_4)
12	GND
13	Not connected
14	GND
15	Not connected
16	GND
17	Not connected
18	GND
19	Not connected
20	GND

TABLE 4-4 BOOT STRAPPING AND ZERO-CROSS DETECTION CIRCUIT SELECTION (SW5)

Pin	Position	Description
1	OFF	Zero-cross detection circuit enabled
	ON	Zero-cross detection circuit disabled
2	OFF	Boot from internal flash
	ON	Boot from host device
3	OFF	Burst SPI mode
	ON	Legacy SPI mode

TABLE 4-5 PLC CONNECTOR PINOUT

Pin	Description RED-BEET-EVAL-BOARD-E/-P	Description RED-BEET-EVAL-BOARD-H
1	E-mobility coupling Control Pilot (CP 1)	Mains coupling AC line (AC_L)
2	Not connected	Not connected
3	E-mobility coupling Protective Earth (PE 1)	Mains coupling AC neutral (AC_N)
4	Not connected	Not connected
5	E-mobility coupling Control Pilot (CP 2)	Not connected
6	Not connected	Not connected
7	E-mobility coupling Protective Earth (PE 2)	Not connected
8	Not connected	Not connected
9	Zero-cross detection AC line (ZC_L)	Zero-cross detection AC line (ZC_L)
10	Not connected	Not connected
11	Zero-cross detection AC neutral (ZC_N)	Zero-cross detection AC neutral (ZC_N)

TABLE 4-6 LED INDICATION

Pin	Description
RESETN	Reset status LED, default level high
GPIO_3	GPIO_3 status LED, default level high
GPIO_2	GPIO_2 status LED, default level low
GPIO_1	GPIO_1 status LED, default level high
GPIO_0	GPIO_0 status LED, default level low

TABLE 4-7 RASPBERRY PI GPIO PINOUT

Pin	Name	Pin	Name	Pin	Name
1	-	15	-	29	-
2	+5V PRI	16	SERIAL_0 (INTR)	30	GND
3	-	17	-	31	-
4	+5V PRI	18	-	32	-
5	-	19	SERIAL_4 (MOSI)	33	-
6	GND	20	GND	34	GND
7	-	21	SERIAL_3 (MISO)	35	-
8	-	22	SERIAL_0 (INTR)	36	-
9	GND	23	SERIAL_1 (SCLK)	37	-
10	-	24	SERIAL_2 (CS)	38	-
11	-	25	GND	39	GND
12	-	26	-	40	-
13	-	27	-		
14	GND	28	-		

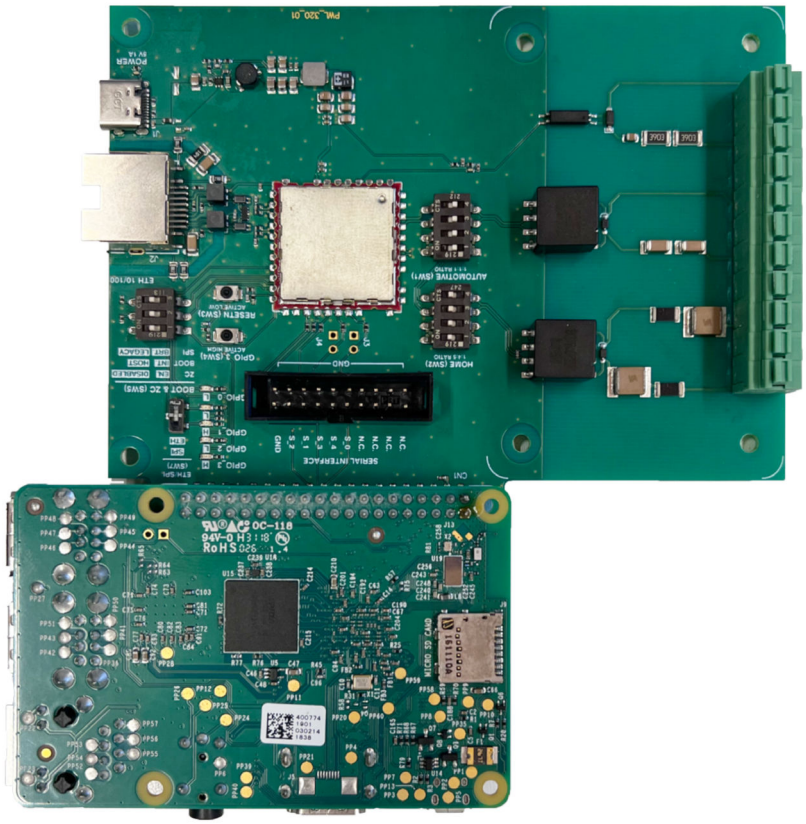
5. Host interfaces

Connection to Raspberry Pi 3/4

The 40-pin GPIO header designed for connection to a Raspberry Pi board.
The Raspberry Pi board with Raspbian OS contains QCA700x SPI driver which could be enabled as an overlay in the config.txt file on SD card. In order to enable QCA7006 driver, please add the following line to the end of the config.txt file (please note the parameter speed to define SPI clock and optional parameter to define the interrupt GPIO pin):

```
dtoverlay=qca7000,speed=12000000,int_pin=23
```

FIGURE 5-1. RED-BEET-EVAL-BOARD 2.0 CONNECTION TO RASPBERRY PI



After QCA700x SPI driver is enabled and evaluation board is connected to Raspberry Pi, power on the evaluation board and the Raspberry Pi. The booting up sequence is important as QCA700x SPI driver does not have the hot plug option enabled.

After Raspberry Pi is booted, verify the QCA700x SPI driver probe was successful with the command:

```
> dmesg | grep qca
```

```
pi@raspberrypi:~ $ dmesg | grep qca
[    5.868420] qcaspi spi0.0: ver=0.2.7-i, clkspeed=1000000, burst_len=5000, pluggable=0
[    5.868460] qcaspi spi0.0: Using random MAC address: 22:07:65:1b:09:08
[    9.029097] qcaspi spi0.0 eth1: SPI thread created
```

You can check if the ethernet port eth1 was created:

```
> ifconfig eth1
```

```
pi@raspberrypi:~ $ ifconfig eth1
eth1: flags=4163<UP,BROADCAST,RUNNING,MULTICAST>  mtu 1500
        inet 169.254.9.238  netmask 255.255.0.0  broadcast 169.254.255.255
        inet6 fe80::27fd:a494:92a5:f692  prefixlen 64  scopeid 0x20<link>
        ether 22:07:65:1b:09:08  txqueuelen 100  (Ethernet)
        RX packets 0  bytes 0 (0.0 B)
        RX errors 0  dropped 0  overruns 0  frame 0
        TX packets 28  bytes 4928 (4.8 KiB)
        TX errors 0  dropped 0 overruns 0  carrier 0  collisions 0
```

In order to control QCA7006 on the evaluation board you need to install open-plc-utilities, you can get it from Github repository:
GitHub - qca/open-plc-utils: Qualcomm Atheros Open Powerline Toolkit.

To get firmware version running of QCA7006 and system information run a plctool command, e.g.:

```
> plctool -eth1 -rI
```

```
pi@raspberrypi:~ $ plctool -ieth1 -rI
eth1 00:B0:52:00:00:01 Request Version Information
eth1 C4:93:00:1C:FB:6B QCA???? MAC-QCA7005-1.2.5.3207-00-20180927-CS
eth1 00:B0:52:00:00:01 Device Identity
eth1 C4:93:00:1C:FB:6B -------
        PIB 0-0 8836 bytes
        MAC C4:93:00:1C:FB:6B
        DAK 68:9F:07:4B:8B:02:75:A2:71:0B:0B:57:79:AD:16:30 (HomePlugAV)
        NMK 50:D3:E4:93:3F:85:5B:70:40:78:4D:F8:15:AA:8D:B7 (HomePlugAV)
        NID B0:F2:E6:95:66:6B:03
        NET Qualcomm Atheros Enabled Network
        MFG 8devices
        USR YELLOW-BEET-E
        CCo Always
        MDU N/A
```

6. Coupling circuitries

FIGURE 6-1. RED-BEET-EVAL-BOARD-E/-P 2.0 COUPLING CIRCUIT

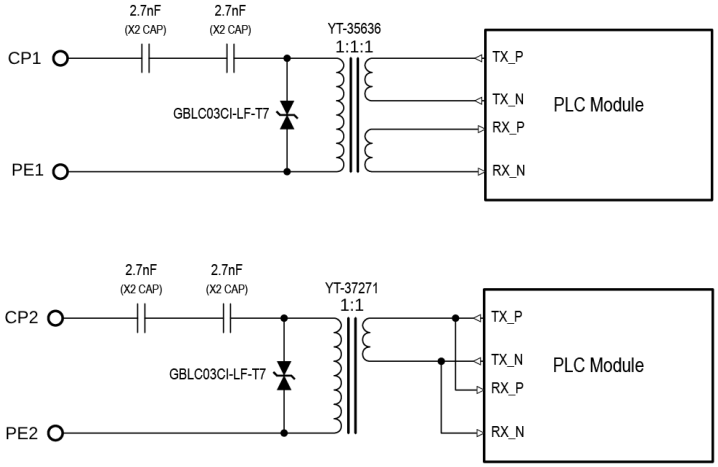
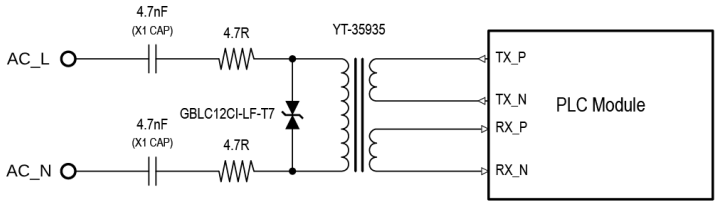
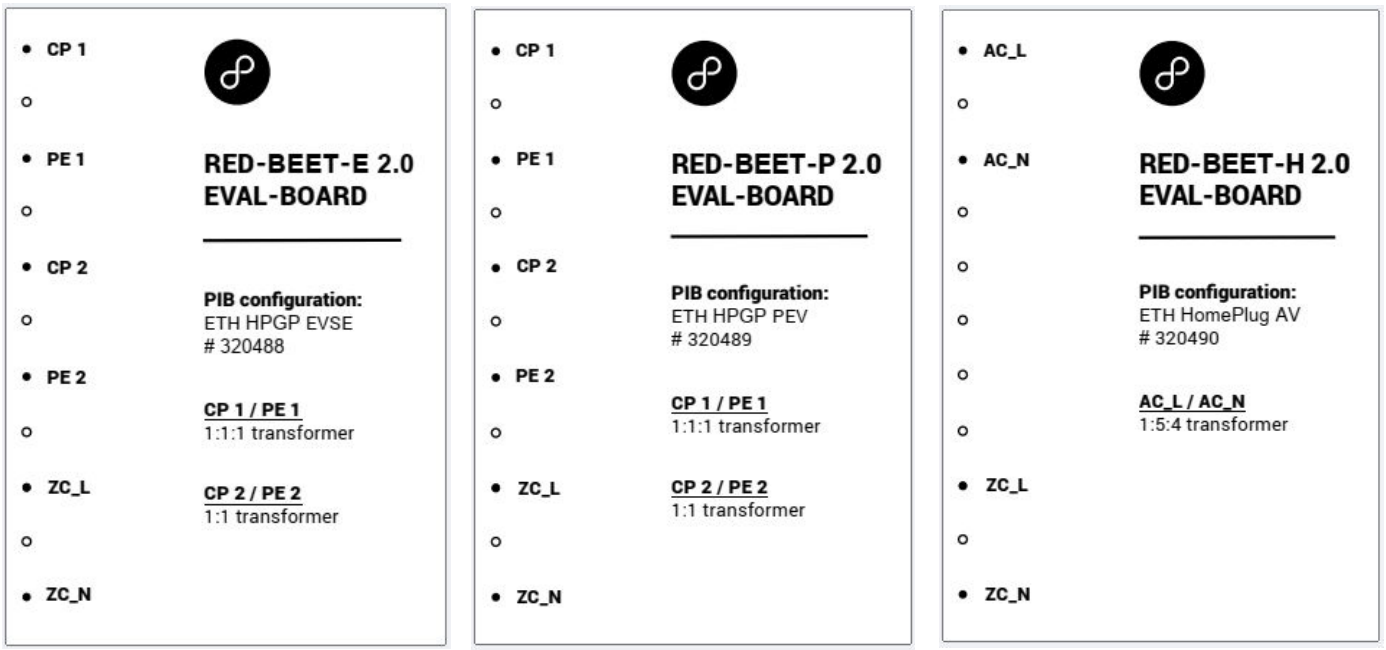


FIGURE 6-2. RED-BEET-EVAL-BOARD-H 2.0 COUPLING CIRCUIT

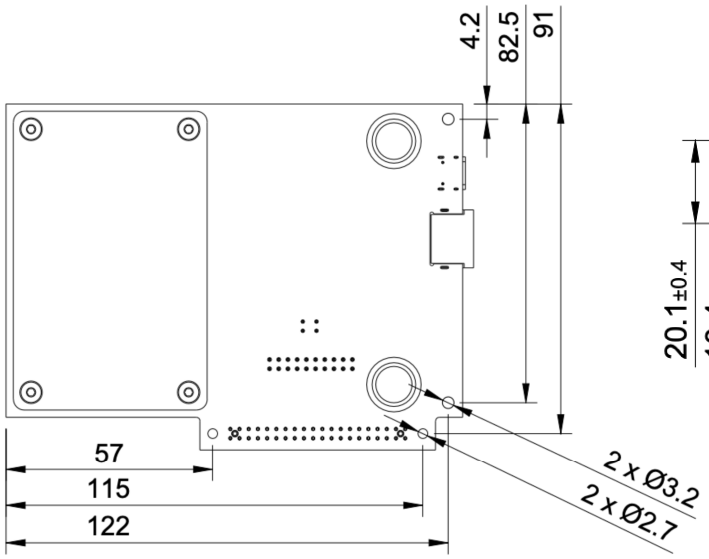


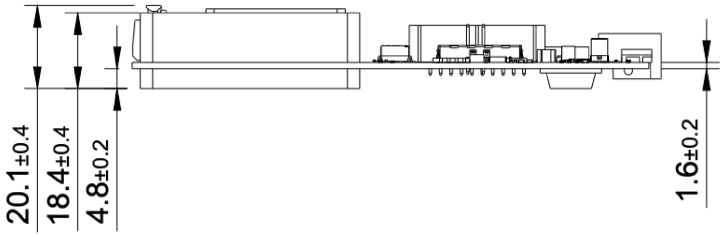
7. Evaluation board label

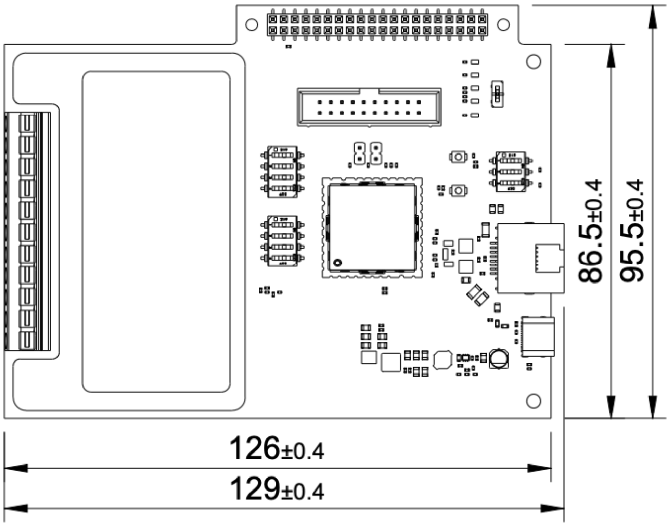
FIGURE 7-1. RED-BEET-EVAL-BOARD 2.0 LABELS

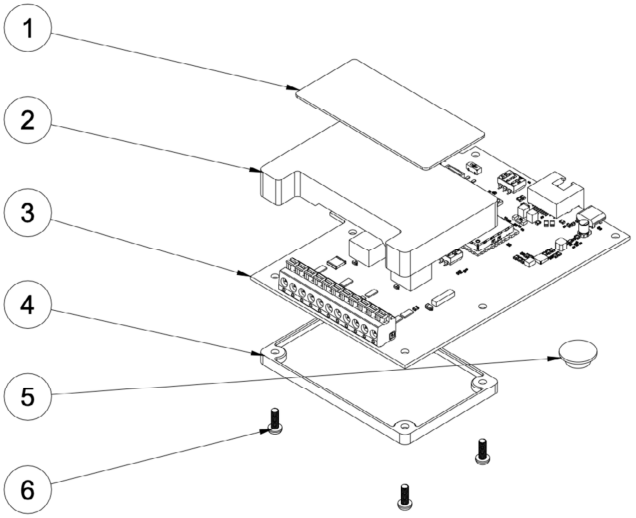


8. Mechanical characteristics









9. Ordering information

FIGURE 9-1. ORDERING PART NUMBERS

Article number	Part number
#320488	RED-BEET-EVAL-BOARD-E 2.0
#320489	RED-BEET-EVAL-BOARD-P 2.0
#320490	RED-BEET-EVAL-BOARD-H 2.0

More PLC products configured for various applications can be found in the CODICO Sample Shop: https://www.codico.com/en/products/powerline-communication

10. Document revision history

Revision	Revision Date	Description
1.00	2024.03.20	Initial draft
1.02	2024.05.22	Public release

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