

Carrier board allows testing and evaluation of RED and YELLOW beet modules in all applications starting from e-Mobility (EVSE and PEV) to other enterprise and home applications requiring long-range communication like smart grid, smart meter, IoT, home control and etc.

**Available for purchase from CODICO GmbH*

Quick specs

- Based on RED beet E module
- Contains coupling transformers with 1:1:1 and 1:5:4 winding ratio
- Header with SPI and GPIO interfaces for connection to a host MCU
- Comes in 3 different configurations: PEV (plug-in electric vehicle), EVSE (electric vehicle supply equipment) and EN50561-1 (long range powerline communication)

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1. Features and block diagramm

Carrier board allows testing and evaluation of RED and YELLOW beet modules in all applications starting from e-Mobility (EVSE and PEV) to other enterprise and home applications requiring long-range communication like smart grid, smart meter, IoT, home control, etc. It comes with micro switches to configure different line coupling ratios for mains and e-Mobility applications including the grounding of zero cross required for PEV configuration. A standard 20-pin double row connector is available to link with external MCU via SPI. External LEDs are available for the activity and status monitoring. In order to comply to a safety type approval, a specific spacing between all mains traces is applied and plastic enclosure covers all high voltage parts of the CARRIER board. It is also used to connect the COMM board for a full evaluation of our solution.

FIGURE 1-1. CARRIER BOARD BLOCK DIAGRAM

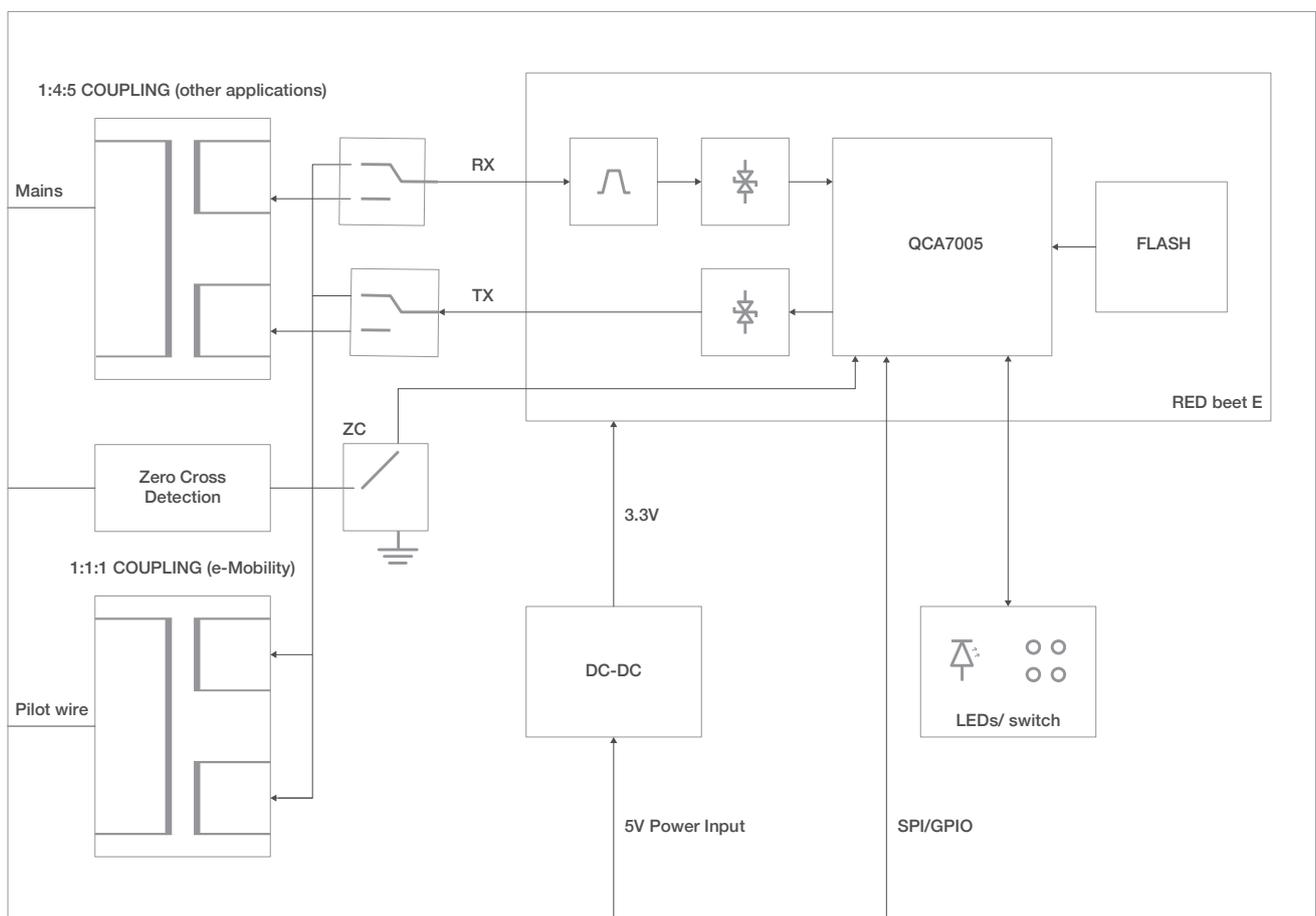
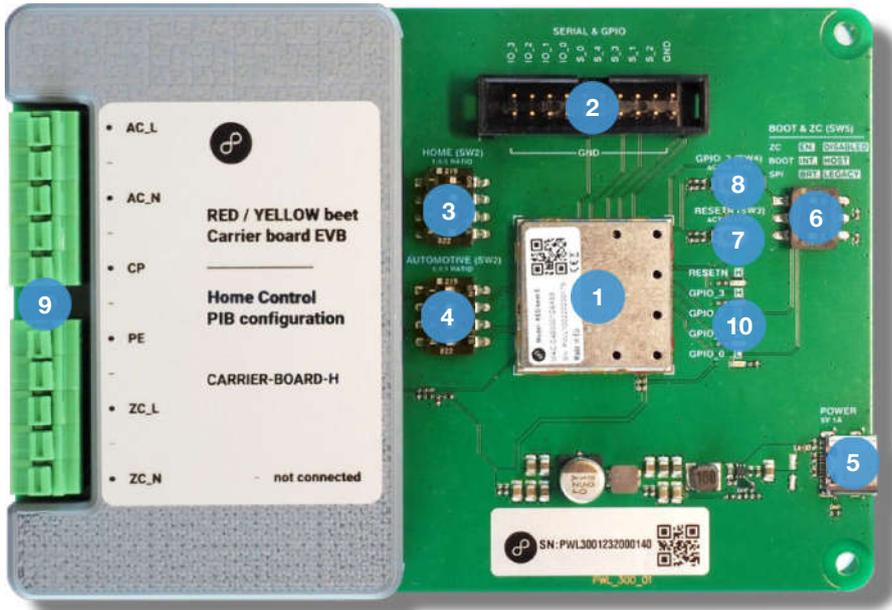


FIGURE 1-2. CARRIER BOARD VIEW



- 1 RED beet E module
- 2 SPI/UART and GPIO connector compatible with Qualcomm PL16 20 pin connector (2 rows, 2.54 mm pitch)

TABLE 1-1. SPI/UART AND GPIO CONNECTOR PINOUT

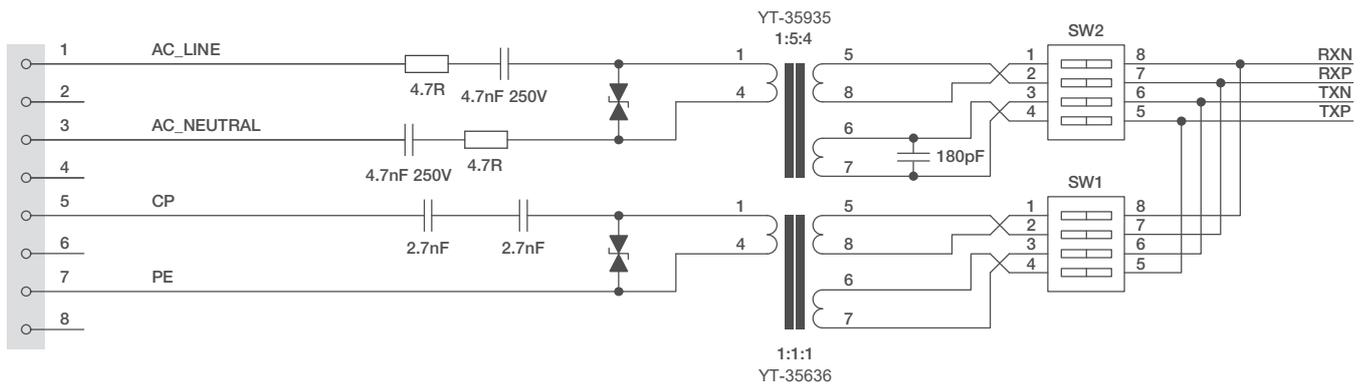
Pin	Description (SPI function)	Pin	Description (SPI function)
1	GND	2	GND
3	SERIAL_2 (SPI_CS)	4	GND
5	SERIAL_1 (SCLK)	6	GND
7	SERIAL_3 (MISO)	8	GND
9	SERIAL_4 (MOSI)	10	GND
11	SERIAL_0 (INTR)	12	GND
13	GPIO_0	14	GND
15	GPIO_1	16	GND
17	GPIO_2	18	GND
19	GPIO_3	20	GND

- 3 SW1 switch to select Home Control coupling to mains (transformer with 1:5:4 winding ratio)
- 4 SW2 switch to select Automotive coupling to control pilot (transformer with 1:1:1 winding ratio)

TABLE 1-2. SELECTION OF PLC COUPLING CIRCUIT (SW1 &SW2)

Switch	Pin	AUTOMOTIVE applications	Home Contol applications
SW1	1	off	ON
	2	off	ON
	3	off	ON
	4	off	ON
SW2	1	ON	off
	2	ON	off
	3	ON	off
	4	ON	off

FIGURE 1-3. COUPLING SELECTION



- 5 USB Type-C connector for 5V 1A power supply only
- 6 SW5 switch for configuration and boot-strap settings

TABLE 1-3. BOOT STRAPPING AND ZERO-CROSS DETECTION CIRCUIT SELECTION (SW5)

Pin	Position	Description
1	OFF	Zero crossing detection ENABLED
	ON	Zero crossing detection DISABLED
2	OFF	Boot from internal flash
	ON	Boot from host device
3	OFF	SPI mode burst
	ON	SPI mode legacy

NOTE: SW5 settings changes have to be done when power supply voltage is not applied

- 7 SW3 Reset button, active low
- 8 SW4 GPIO_3 button, active low
- 9 PLC connector

TABLE 1-4. PLC CONNECTOR

Pin	Description
1	Home control coupling AC line (AC_L)
2	Not connected
3	Home control coupling AC neutral (AC_N)
4	Not connected
5	Automotive coupling Control Pilot (CP)
6	Not connected
7	Automotive coupling Protective Earth (PE)
8	Not connected
9	Zero cross detection AC line (ZC_L)
10	Not connected
11	Zero cross detection AC neutral (ZC_N)

- 10 LEDs for status and activity indication

TABLE 1-5. LED INDICATION

LED	Description (SPI function)
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

2. Connection to a host processor

Carrier board has RED beet E module soldered on PCB, which could be controlled by a host processor. The 20 pin header connector (2x10 pin configuration) is used to provide connectivity to a host processor using 20 pins ribbon flat cable. The length of the cable should be not longer than 10 cm.

There are few options for a host processor board:

1. COMM board based on STM32F7 processor and has configurations targeted for various applications such as simple bridging between SPI interface of HomePlug GreenPHY QCA7005 and common processor interfaces (Ethernet, USB), or automotive EV charging applications (EVSE and PEV side) with and without ISO/IEC 15118 stack, home control and industrial automation applications.

Please refer to the ordering information for various COMM-board options in this document.

Please refer to COMM-board datasheet for more details.

FIGURE 2-1. CONNECTION CARRIER BOARD TO COMM BOARD



2. The second option to get control of CARRIER board is to use Raspberry Pi 3/4. You require a custom cable for that, please refer to the Table 2-1 for pinouts details.

Raspberry board with RaspbianOS contains HomePlug GreenPHY QCA7000/5 driver which could be enabled as overlay in config.txt file on SD card. In order to enable QCA7000/5 driver, please add the following line to the end of config.txt file and save it afterwards (please note the parameter speed to define SPI clock):

```
dtoverlay=qca7000,speed=12000000
```

TABLE 2-1. CUSTOM CABLE PINOUTS FOR CONNECTING CARRIER BOARD TO RASPBERRY PI 3/4

CARRIER board 2x10 pin connector	Raspberry Pi 2x20 pin GPIO connector
1 (GND)	25
3 (SPI_CS)	24
5 (SCLK)	23
7 (MISO)	21
9 (MOSI)	19
11 (INTR)	16

After QCA7000/5 driver is enabled and CARRIER board is connected to Raspberry Pi with a custom cable, power on the CARRIER board and after that power on Raspberry Pi. The booting up sequence is important as QCA7000/5 driver does not have hot plug option enabled.

After Raspberry Pi is booted, verify the QCA7000/5 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, clk speed=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 also that 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 QCA7005 on the CARRIER board you need to install open-plc-utilities, you can get it from Github repository: <https://github.com/qca/open-plc-utils>

Then run plctool command to get firmware version running of QCA7005 and some system parameters:

```
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
```

3. Ordering information

Evaluation boards are available from stock at CODICO.

Part number	Description
CARRIER-BOARD-H #292204	Carrier board for development and testing with line coupling and SPI interface for external MCU with home control configuration
CARRIER-BOARD-E #295015	Carrier board for development and testing with line coupling and SPI interface for external MCU with EVSE configuration
CARRIER-BOARD-P #295016	Carrier board for development and testing with line coupling and SPI interface for external MCU with PEV configuration
COMM-BOARD-S #292205	Interface converter and ISO/IEC 15118-3 communication board is based on STM32F745 microcontroller for e-mobility applications with transparent or SLAC bridging software.
COMM-BOARD-I #295305	Interface converter and ISO/IEC 15118-3 communication board is based on STM32F745 microcontroller for e-mobility applications with ISO/IEC 15118 software stack.
COMM-BOARD-O #295307	Interface converter and ISO/IEC 15118-3 communication board is based on STM32F745 microcontroller for e-mobility applications with open SDK.

More PEV / EVSE - configured eMobility related products can be found in CODICO Sample Shop:

<https://www.codico.com/en/products/powerline-communication>

4. Document revision history

Revision	Revision Date	Description
1.0	2020.06.09	Initial release
1.01	2020.06.15	Formatting and grammar correction
1.03	2020.07.13	Data correction
1.04	2020.12.11	Ordering information correction

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