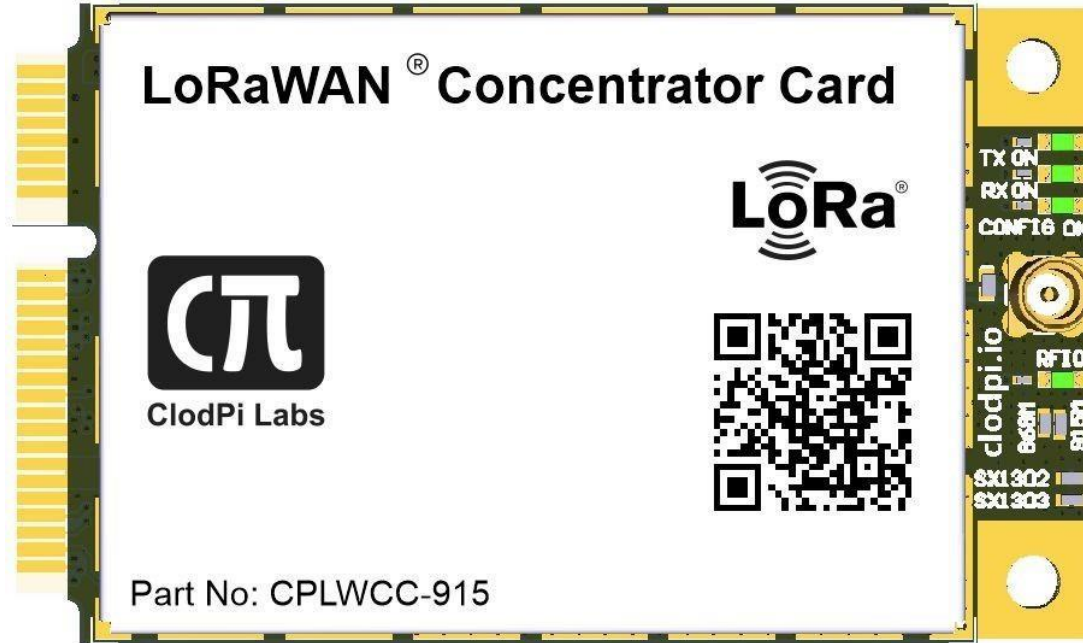# LoRaWAN Concentrator miniPCIe - CPLWCC-915

LoRaWAN® Concentrator miniPCIe – USB / SPI

Description

LoRaWAN Concentrator miniPCIe – USB / SPI

LoRa® Corecell Gateway for Listen Before Talk (LBT) and Spectral Scan Based on SX1302 / SX1303 and SX1250 for LoRa Core™

The CPLWCC-915 is a LoRaWAN® concentrator in mini PCIe form factor based on Semtechs's SX1302 / SX1303. The card matches with standard miniPCIe pinout. It can be retrofitted to any Industrial gateway / EDGE / Router. Compact in size and 10x power reduction compared to legacy gateway products.

Overview

Features:
- LoRaWAN, Class A/B/C, all regions
- 125 kHz LoRa reception with:
  - 8 x 8 channels LoRa® packet detectors
  - 8 x SF5-SF12 LoRa® demodulators
  - 8 x SF5-SF10 LoRa® demodulators
- 125 /250 / 500 kHz LoRa® demodulator
- (G)FSK demodulator
- USB Interface - Plug & Play
- Listen Before Talk (LBT)
- Spectral Scan
- Simultaneously receive 8 LoRa® channels multi-data rates (SF5 ~ SF12 / 125 kHz) + 2 mono-data rate (LoRa® 250 / 500 kHz and FSK 50 kbps)

Applications:
- Smart Metering
- Security Sensors Network
- Agriculture Monitoring
- Internet of Things (IoT)

miniPCIe Pinout
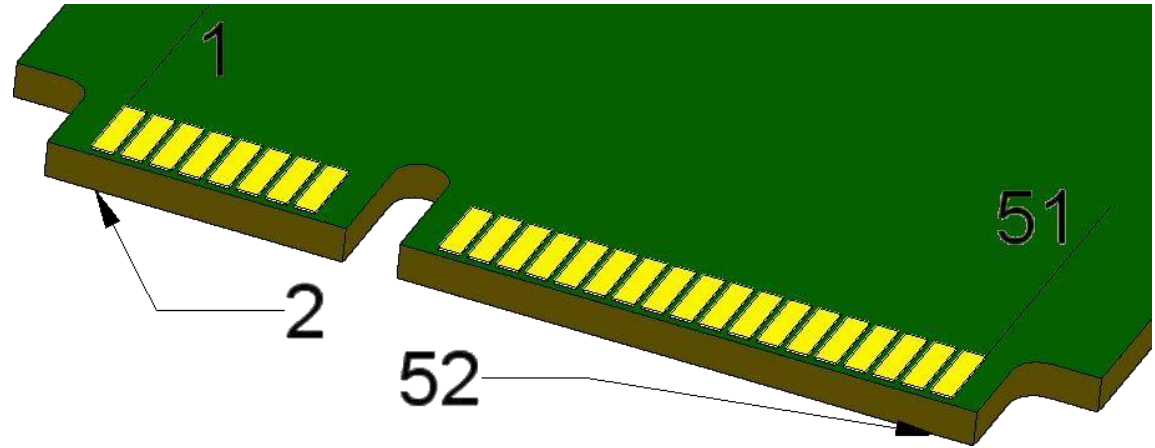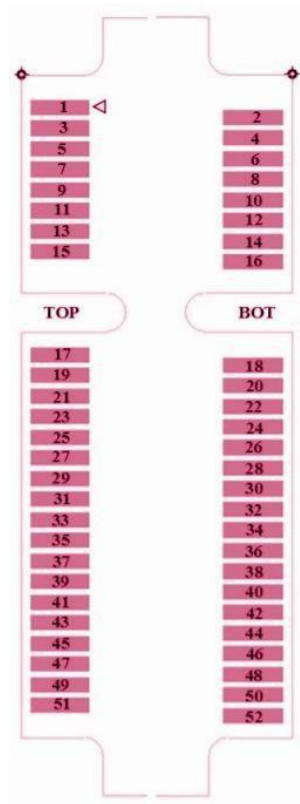
miniPCIe Pinout ... contd

	Top	Bottom	
VCC	2	1	NC
GND	4	3	NC
GPIO(6) / NC	6	5	NC
NC	8	7	NC
NC	10	9	GND
NC	12	11	NC
NC	14	13	NC
POWER_EN / NC	16	15	GND
GND	18	17	NC / HOST_SCK
NC	20	19	NC / HOST_SCK
SX130X_GPIO_8 / NC	22	21	GND
SX130X_BUSY / NC	24	23	NC / HOST_SCK
GND	26	25	NC / HOST_SCK
SX130X_GPIO_8 / NC	28	27	GND
I2C_SCL / NC	30	29	GND
I2C_SDA / NC	32	31	PPS
GND	34	33	NC
USB_DM	36	35	GND
USB_DP	38	37	GND
GND	40	39	VCC
NC	42	41	VCC
SX1261_NSS / NC	44	43	GND
SX1261_DIO1 / NC	46	45	NC / DEBUG_JTCK-SWCLK
SX1261_NRESET / NC	48	47	NC / MCU_DEBUG_JTMS-SWDIO
GND	50	49	NC / MCU_RESET
VCC	52	51	NC / MCU_BOOT0

VCC - 3.3 V
GND - Ground
NC - Not Connected

Specifications

Radio	1x SX1302, 2x SX1250, 1x SX1261
Host Interface	USB
RF Connector	MMCX
TX Power (IN865/EU868/US915)	+25 dBm
Sensitivity (IN865/EU868/US915)	-141 dBm at SF12 BW 125 kHz -127 dBm at SF7 BW 125 kHz -111 dBm at FSK 50 kbps
Modulation	LoRa®
VCC	3.3 VDC

Antenna

Name	868-915MHz Antenna,
Model Number:	**CW-868-915MHz195B-SMAMM**
Frequency	915 MHz
Typical Antenna Gain	3.0±0.5dBi
RF Connector	MMCX
Polarization	Linear
Impedance	50 Ohm
SWR	<=2.0
Type	Omnidirectional

The antenna connector can't be the standard SMA, it shall be RP-SMA

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Software Overview

The Corecell software can be divided into four main parts:

- The **packet forwarder** is a program running on the host of a LoRa® gateway that forwards RF packets received by the concentrator to a server through an IP/UDP link, and emits RF packets that are sent by the server.

- The **sx1302_hal** is a host driver/HAL to build a Corecell reference design which communicates through SPI or USB interface with a concentrator board based on Semtech SX1302 multi-channel modem and SX1250 RF transceivers.

- The **utils_boot** and **dfu-util** (Firmware Updater) tools run on the host of LoRa® gateway and are used to program the STM32 MCU.

- The **spectral_scan** tool runs on the host gateway and it provides details of the wireless signals present in the surrounding area. The spectrum scan results are stored in a csv file which can be plotted using a python script.

The packet_forwarder (gateway application), Spectral Scanner, STM32 MCU firmware updater and sx1302_hal (SX1302 control library) source code can be found in LoRa® Github: https://github.com/Lora-net/sx1302_hal

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Software Overview

For more details see the readme.md file in the following directories:
- sx1302_hal
- sx1302_hal/libloragw
- sx1302_hal/packet_forwarder
- sx1302_hal/util_net_downlink
- sx1302_hal/util_chip_id
- sx1302_hal/util_boot
- sx1302_hal/util_spectral_scan

For basic testing, utilities such as test_loragw_hal_tx (FSK/LoRa modulation as well as CW), test_loragw_hal_rx, are provided on the LoRa® Github repository: https://github.com/Lora-net/sx1302_hal/libloragw

Notice!
- The default configuration file global_conf.json.sx1250 is given as an example and may need to be adapted to your design.
- Several configuration file examples are in this directory: [PATH]/sx1302_hal/packet_forwarder.
- If the Corecell is configured to use the USB interface be sure to use the files with the extension ".USB".

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Software Setup - (Ex Raspberry PI)

1. **Update**: Enter the following commands:

```
$ sudo apt-get update
```

```
$ sudo apt-get upgrade
```
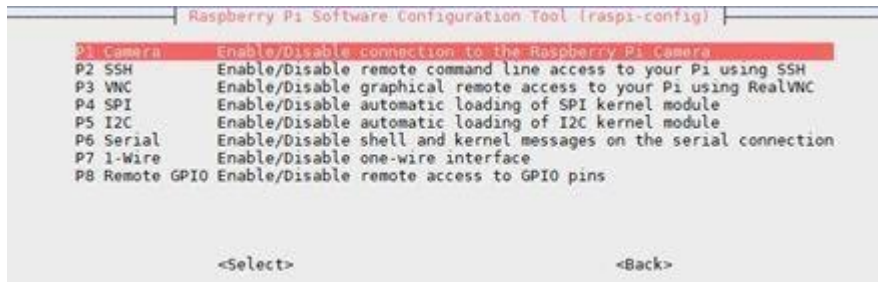
```
$ sudo apt-get dist-upgrade
```

```
$ sudo rpi-update
```

2. **Install Git:** Enter the following command: `$ sudo apt install git`

3. **Enable SPI/I2C/UART**: Enter the following command: `$ sudo raspi-config`

Interfacing options: `SPI / I2C / Serial`

Compile Semtech HAL + Packet Forwarder

1. Get the latest Semtech software package from LoRa® Github (requires a connection to internet):
   ```
   $ git clone https://github.com/Lora-net/sx1302_hal.git
   $ cd ~/sx1302_hal/
   $ make clean all
   ```
2. The target.cfg file located in the project's root directory configures where the executables must be installed.

   TARGET_IP: sets the IP address of the host of the gateway. In case the project is compiled on the gateway host itself (Raspberry Pi), this can be left set to localhost.

   TARGET_DIR: sets the directory on the gateway host file system in which the executables must be copied. The directory MUST exist when invoking the install command. By default it is: /home/pi/sx1302_hal/bin

   TARGET_USR: sets the Linux user to be used to perform the SSH/SCP command for copying the executables. By default it is: pi
3. Execute the next two commands to avoid entering the user password when installing the files:
   ```
   $ ssh-keygen -t rsa
   $ ssh-copy-id -i ~/.ssh/id_rsa.pub pi@localhost
   ```
4. Now install:
   ```
   $ make install
   $ make install_conf
   ```

Compile Semtech HAL + Packet Forwarder

The Corecell reference design has a unique ID assigned at the time of production. This ID can be used as a 64-bit MAC address for the Corecell reference design.

Toget the ID:

```
$ cd ~/sx1302_hal/bin

./chip_id -u -d /dev/ttyACM0
```

The gateway ID should be then replaced (in order have an unique ID) in

```
~/sx1302_hal/bin/global_conf.json.sx1250
```

Compile Semtech HAL + Packet Forwarder

The Packet Forwarder program runs on the host of a LoRa® Gateway that forwards RF packets received by the concentrator to a server through an IP/UDP link, and emits RF packets that are sent by the server.

```
$ cd ~/sx1302_hal/bin/
$ ./lora_pkt_fwd -c global_conf.json.sx1250.USB
```

FCC Compliance Statement (USA)

FCC ID: 2A334-CPLWCC-915V3

Compliance Statements: This device complies with Part 15 of the FCC Rules. Operation is subject to the following two conditions:

1. This device may not cause harmful interference.
2. This device must accept any interference received, including, an interference that may cause undesired operation.

Caution Statements:
•Any changes or modifications not expressly approved by the party responsible for compliance could void the user's authority to operate this equipment.
•This equipment should be installed and operated with a minimum distance of 20 cm between the radiator and your body.

This module is labelled with its own FCC ID. The end product using this module is required to display a label on itself referring to the enclosed module details. The final must be labelled with the following "Contains FCC ID:2A334-CPLWCC-915V3"

The OEM using this product should not provide information to the end user regarding the installation or removal of the transmitter RF Module or information to change RF related parameters in the user manual or by any means, with the end product.

The OEM shall integrate the module as per the module integration guidelines and grant conditions.

The OEM is responsible for ensuring compliance with the applicable FCC rules for the transmitters operating individually and simultaneously.

The module grantee shall provide a notice that any deviation(s) from the defined parameters of the antenna trace, as described by the instructions, require that the host product manufacturer must notify the module grantee that they wish to change the antenna trace design. In this case, a Class II permissive change application is required to be filed by the grantee, or the host manufacturer can take responsibility through the change in FCC ID (new application) procedure followed by a Class II permissive change application.

RF exposure considerations

It is essential for module grantees to clearly and explicitly state the RF exposure conditions that permit a host product manufacturer to use the module. Two types of instructions are required for RF exposure information: (1) to the host product manufacturer, to define the application conditions (mobile, portable – 20 cm from a person's body); and (2) additional text needed for the host product manufacturer to provide to end users in their end-product manuals. If RF exposure statements and use conditions are not provided, then the host product manufacturer is required to take responsibility of the module through a change in FCC ID (new application).

Label and compliance information

Grantees are responsible for the continued compliance of their modules to the FCC rules. This includes advising host product manufacturers that they need to provide a physical or e-label stating "Contains FCC ID" with their finished product.

Industry Canada (IC) Compliance Statement
IC : **28110-CPLWCC915Z3**
Compliance Statements: This device complies with Industry Canada license-exempt RSS standard(s). Operation is subject to the following two conditions: 1) This device may not cause interference., 2) This device must accept any interference, including interference that may cause undesired operation of the device.
Déclarations de conformité: Le présent appareil est conforme aux CNR d'Industrie Canada applicables aux appareils radio exempts de licence. L'exploitation est autorisée aux deux conditions suivantes : (1) l'appareil ne doit pas produire de brouillage, et (2) l'utilisateur de l'appareil doit accepter tout brouillage radioélectrique subi, même si le brouillage est susceptible d'en compromettre le fonctionnement.

Caution Statements:
•This equipment complies with radio frequency exposure limits set forth by Industry Cananda for an uncontrolled environment.
•This equipment should be installed and operated with a minimum distance of 20 cm between the device and the user or bystanders.
Déclarations de mise en garde:
•Cet équipement est conforme aux limites d'exposition aux radiofréquences défines par Indstrie Canada pourun environment non contrôlé.
•Cet équipement doit être installé et utilisé aven un minimum de 20 cm de distance dispositif et l'utilisateur ou des tiers.

INFORMATION TO THE USER

For Class A and Class B digital devices, information to the user is required to include the following statements (Section 15.105):

For a Class A digital device or peripheral, the instructions furnished to the user shall include the following or similar statement, placed in a prominent location in the text of the manual:

NOTE: This equipment has been tested and found to comply with the limits for a Class A digital device, pursuant to part 15 of the FCC Rules. These limits are designed to provide reasonable protection against harmful interference when the equipment is operated in a commercial environment. This equipment generates, uses, and can radiate radio frequency energy and, if not installed and used in accordance with the instruction manual, may cause harmful interference to radio communications. Operation of this equipment in a residential area is likely to cause harmful interference in which case the user will be required to correct the interference at his own expense.

For a Class B digital device or peripheral, the instructions furnished to the user shall include the following or similar statement, placed in a prominent location in the text of the manual:

NOTE: This equipment has been tested and found to comply with the limits for a Class B digital device, pursuant to part 15 of the FCC Rules. These limits are designed to provide reasonable protection against harmful interference in a residential installation. This equipment generates, uses and can radiate radio frequency energy and, if not installed and used in accordance with the instructions, may cause harmful interference to radio communications. However, there is no guarantee that interference will not occur in a particular installation. If this equipment does cause harmful interference to radio or television reception, which can be determined by turning the equipment off and on, the user is encouraged to try to correct the interference by one or more of the following measures:

- Reorient or relocate the receiving antenna.
- Increase the separation between the equipment and receiver.
- Connect the equipment into an outlet on a circuit different from that to which the receiver is connected.
- Consult the dealer or an experienced radio/TV technician for help.

Thank You!

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