WIRELESS & SENSING PRODUCTS

User Guide to the LoRa® PicoCell Gateway V1.0

Table of Contents

List of Figures

1 Introduction

This user guide introduces the Semtech LoRa® PicoCell Gateway V1.0 reference design and how to set it up with a Raspberry Pi 2.

Figure 1: LoRa® PicoCell Gateway V1.0

The LoRa® PicoCell Gateway V1.0 (called here after "PicoCell GW") is a multi-channel high performance transceiver designed to simultaneously receive several LoRa® packets using random spreading factors.

Three hardware reference designs are made available to address:

- Europe 868 MHz ISM band [863 MHz - 870 MHz]
- USA/Australia 915 MHz ISM band [902 MHz - 928 MHz]
- China 470 MHz ISM band [470 MHz - 510 MHz]

For countries with a comparable regulatory framework (no LBT), choose the design corresponding to the right frequency.

2 Hardware Presentation

2.1 Absolute Maximum Ratings

Table 1: Absolute Maximum Ratings

Item	Minimum	Typical	Maximum	Unit
Maximum Supply Voltage	-0.3	5.0	6.0	V
Operating Temperature	0	25	70	°C
Maximum RF Input Level			-10	dBm

Notice!

The PicoCell Gateway V1.0 with SX1308 chip is designed for indoor applications with a metal alloy housing. It is strongly recommended to maintain the ambient operating temperature below 40 °C, to ensure that an ambient operating temperature of 70 °C is not exceeded in the housing.

The operating temperature range can be extended to "-40 °C to 85 °C" if the PicoCell uses a SX1301 chip instead of a SX1308 chip. See *Section 2.4 LoRa® PicoCell Gateway Block Diagram 2.4*.

2.2 External Host Processor Connection

The LoRaWAN protocol can be run through an external host processor. On the PicoCell GW reference design, there is a USB port type A to interface with the external host processor. This USB port is also used to provide the main 5.0 V power supply:

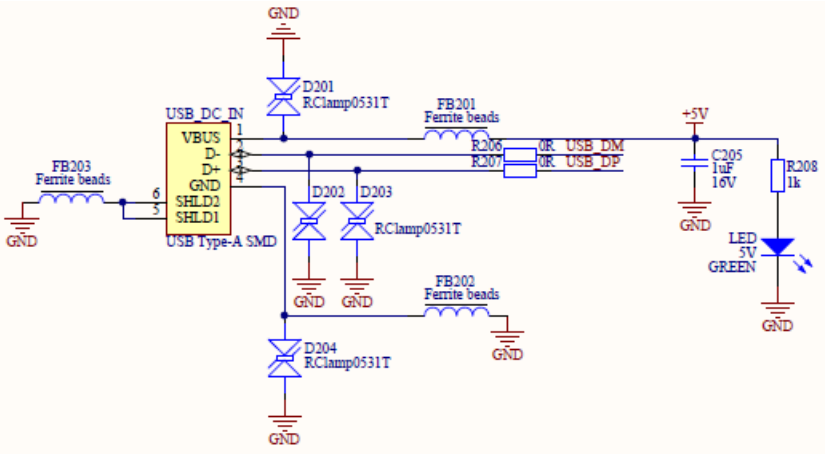

Figure 2: USB Port Type A for External Host Processor and Power Supply

2.3 RF Front-End Architecture

The RF front-end architecture of the PicoCell GW displays the following characteristics:

- Half-duplex mode i.e. can't receive and transmit simultaneously
- Simultaneously receive 8 LoRa® channels multi-data rates (SF7 ~ SF12 / 125 kHz) + 2 mono-data rate (LoRa® 250 / 500 kHz and FSK 50 kbps)
- 3 ISM bands
    - Europe 868MHz ISM band [863 MHz - 870 MHz
    - USA/Australia 915MHz ISM band [902 MHz - 928 MHz]
    - China 470MHz ISM band [470 MHz - 510 MHz]
- Maximum transmit output power = +20dBm
- Typical sensitivity level:
    - -139 dBm at SF12 BW 125 kHz
    - -125 dBm at SF7 BW 125 kHz
    - -109 dBm at FSK 50 kbps
- Ability to work in hostile RF environments such as close to cellular mobile phones, WiFi routers, Bluetooth devices

2.4 PicoCell Gateway Block Diagram

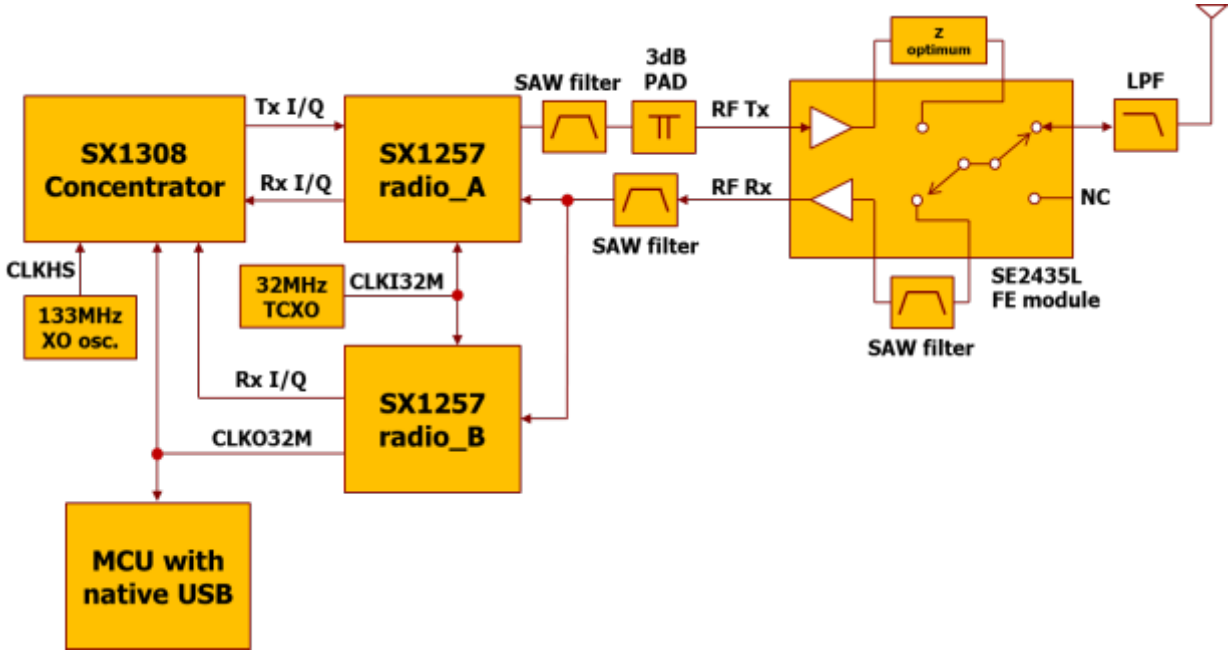

Figure 3: PicoCell Gateway V1.0 RF Block Diagram

- The SX1308 digital baseband chip is a massive digital signal processing engine which integrates the LoRa® Concentrator IP
- The two SX1257 transceivers are highly integrated RF front-end to digital I and Q modulator and demodulator. Two transceivers are used instead of one to be able to simultaneously receive 8 LoRa® 200 kHz channels. To address the Chinese market (470 MHz band), SX1255 transceivers are used instead of SX1257 transceivers.

2.5 Hardware Control Signals

The control signals from/to the MCU and the SX1308 device are described below:

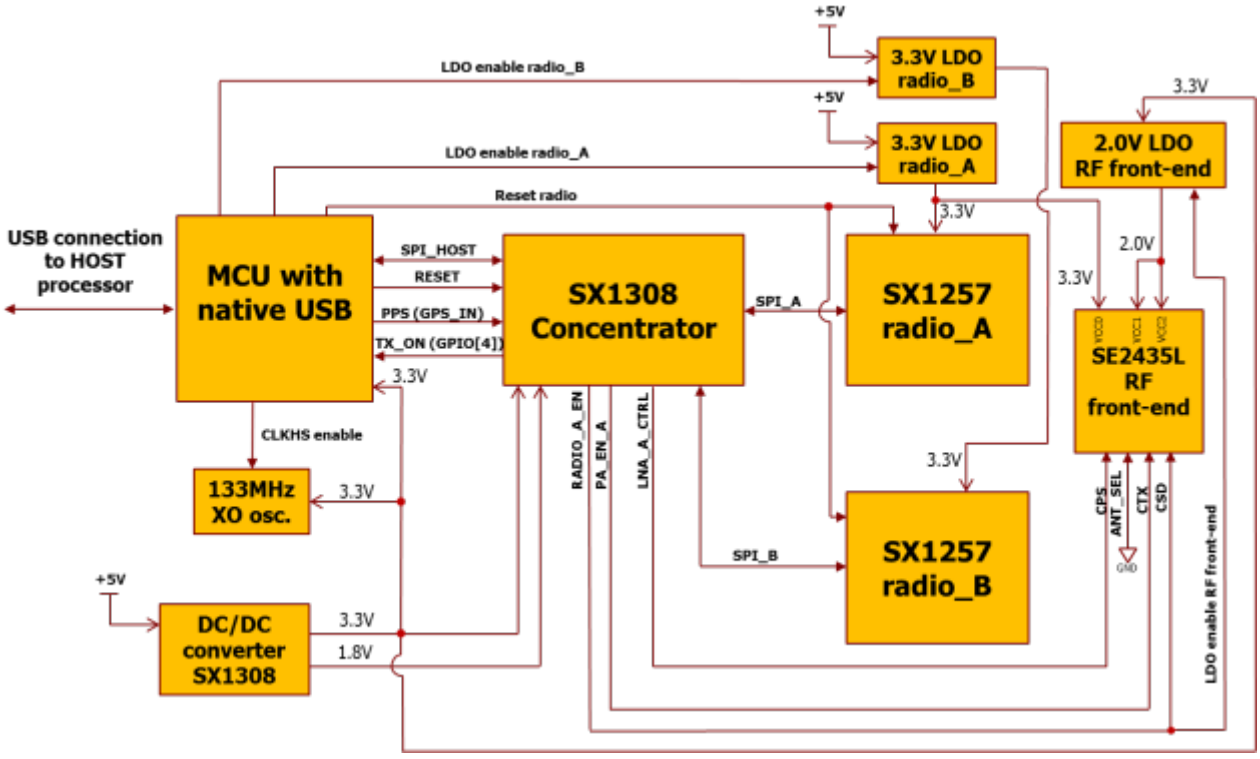

Figure 4: PicoCell GW V1.0 HW Control Signals

Add an on-board MCU with native USB:

- To implement a USB CDC (virtual com port) protocol to bridge commands coming from host to the SX1308 SPI interface
- SX1308 power management during downlink to meet 500 mA USB plug max power constraint

On-board MCU main requirements:

- 1 x USB
- 1 x SPI
- 1 x I2C
- 96 kbytes RAM to support future features
- 1 x 32-bits timer
- Allow 32 MHz input clock
- IRQ management
- 10 x GPIO

2.6 Power Consumption

Table 2: Typical Current Consumption at 5.0 V

Mode	Description	Typical Current Consumption	Unit
8 Rx channels ON Tx OFF	HAL packet_forwarder	330	mA
8 Rx channels OFF Tx ON at 20 dBm	HAL util_tx_continuous	230	mA

The maximum current consumption (mA) in Rx mode with 8 channels ON is displayed in the table below:

Table 3: Maximum Current Consumption per Supply Rail in Rx Mode

Maximum current consumption (mA) in Rx mode with 8 channels ON

Part	Description	Current consumption per supply rail [mA]					Total	
		1.8V	3.3V	3.3V	3.3V	2.0V		
		VCCDIG18	VCCDIG33	VCC_A	VCC_B	VCC_FEM		
SX1308	Baseband processor	800	10					
END4643A	133MHz oscillator		60					
END4243A	32MHz TCXO			2				
SX1257	Receiver A			25				
SX1257	Receiver B				25			
SE2435*	Front-end module (PA, LNA, switch)					7		
STM32F401CDU6	MCU		25					
Current on individual power supply [mA]		800	95	27	25	7		
Main Voltage [V]		5	5	5	5	5		
Regulator Voltage [V]		1.8	3.3	3.3	3.3	3.3		
Regulator efficiency** [%]		85	90	-	-	-		
Current @ +5.0V [mA]		339	70	27	25	7	**468**	[mA]
Power @ +5.0V [mW]		1695	350	135	125	35	**2340**	[mW]

* Maximum estimated Current consumption with 20% margin taken on typical current value when max. not specified

** Semtech SC283 step-down regulator

The maximum current consumption (mA) in Tx mode i.e. when downlink packet is sent by the concentrator board is displayed in the table below:

Table 4: Maximum Current Consumption per Supply Rail in Tx Mode

Maximum current consumption (mA) in Tx mode @ 20 dBm

Device	Description	Current consumption per supply rail [mA]					Total	
		1.8V	3.3V	3.3V	3.3V	2.0V		
		VCCDIG18	VCCDIG33	VCC_A	VCC_B	VCC_FEM		
SX1308	Baseband processor	400	10					
END4643A	133MHz oscillator		0					
END4243A	32MHz TCXO			2				
SX1257	Receiver A			85				
SX1257	Receiver B				2			
SE2435*	Front-end module (PA, LNA, switch)					150		
STM32F401CDU6	MCU		25					
Current on individual power supply [mA]		400	35	87	2	150		
Main Voltage [V]		5	5	5	5	5		
Regulator Voltage [V]		1.8	3.3	3.3	3.3	3.3		
Regulator efficiency** [%]		85	90	-	-	-		
Current @ +5.0V [mA]		169	26	87	2	150	**434**	[mA]
Power @ +5.0V [mW]		845	130	435	10	750	**2170**	[mW]

* Maximum estimated Current consumption with 20% margin taken on typical current value when max. not specified

** Semtech SC283 step-down regulator

3 Software Overview

The PicoCell GW software can be split in three 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 **picoGW_hal** is a host driver/HAL to build a PicoCell GW which communicates through USB or UART with a concentrator board based on Semtech SX1308 multi-channel modem and SX1257/SX1255 RF transceivers. The library implements a USB CDC (virtual com port) to communicate with the embedded MCU.
- The **picoGW_mcu** is an MCU driver/HAL for the PicoCell GW concentrator board. This program runs on MCU (STM32-F401CD). The embedded firmware takes in charge the power management of the SX1308 during the downlink to respect the 500 mA max power constraint in the USB plug. It also implements a USB CDC protocol to bridge commands coming from host to the SX1308 SPI interface.

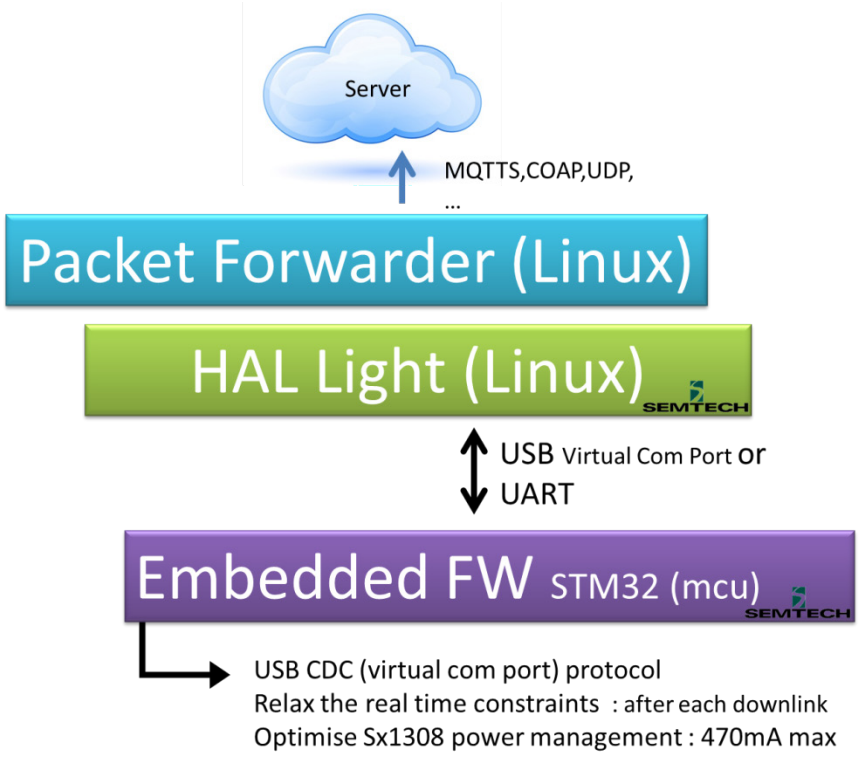

Figure 5: GW Software Overview

The **packet_forwarder** (gateway application) source code can be found under LoRa® Github:
https://github.com/Lora-net/picoGW_packet_forwarder
For more details see the readme.md file in the picoGW_packet_forwarder directory.

The **picoGW_hal** (SX130x control library) source code can be found under LoRa® Github:
https://github.com/Lora-net/picoGW_hal
For more details see the readme.md file in the picoGW_hal directory.

The **picoGW_mcu** driver/HAL source code can be found under LoRa® Github:
https://github.com/Lora-net/picoGW_mcu
For more details see the readme.md file in the picoGW_mcu directory.

The [PATH]/picoGW_mcu/bin/ directory contains the precompiled binary files in .hex or .dfu ("Device Firmware Update") formats. To load the binary file into the STM32F401CD target MCU, you can use a tool such as "dfu-util": http://dfu-util.sourceforge.net/

For basic testing, utilities such as packet logger, util_tx_test, util_tx_continuous, are provided on the LoRa® Github repository:
https://github.com/Lora-net/picoGW_hal
https://github.com/Lora-net/picoGW_packet_forwarder)

Notice!

The default configuration file "global_conf.json" is given as an example and may need to be adapted to your design. Several configuration file examples are located in the following directory:
[PATH]/picoGW_packet_forwarder/lora_pkt_fwd/cfg/

4 Use with Raspberry Pi

The Semtech LoRa® Concentrator reference design has been tested with Raspberry Pi 2 model B, Pi 3 model B as well as Pi zero w:

https://www.raspberrypi.org/products/

4.1 Raspberry Pi Connection

Simply connect the PicoCell GW to the Raspbery Pi through any of the USB Type A connectors as depicted on the picture below:

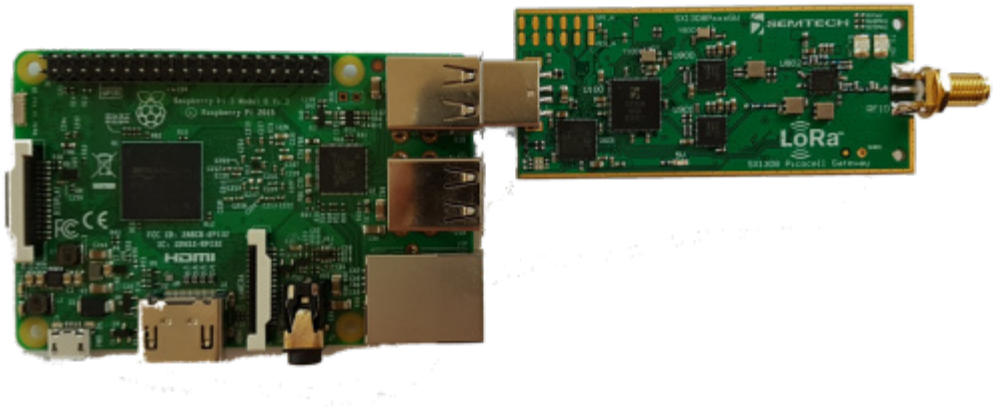

Figure 6: Raspberry Pi and PicoCell GW Connection

4.2 Raspberry Pi Image Software Installation

- Download the Raspbian image:
  - Go to address https://www.raspberrypi.org/downloads/raspbian/
  - Choose “RASPBIAN JESSIE LITE”
- Refer to following guide to setup your SD card with the downloaded image:

  https://www.raspberrypi.org/documentation/installation/installing-images/
  - Format the SD card:

    https://www.sdcard.org/downloads/formatter_4/

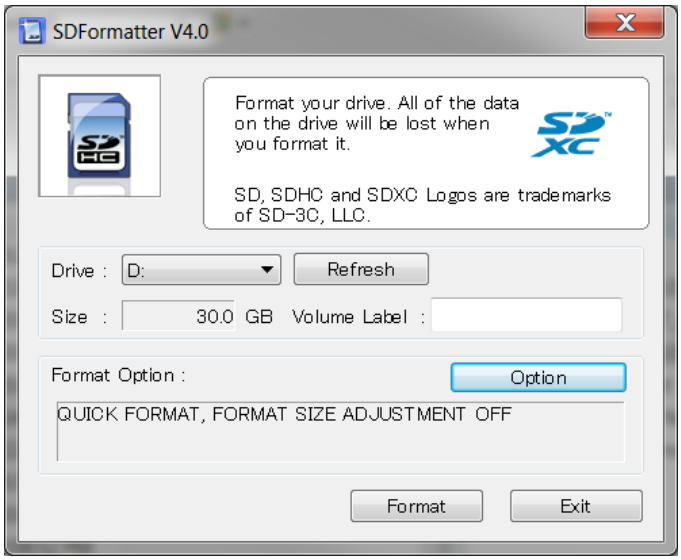

Figure 7: SDFormatter

  - Write the image previously downloaded on the SD card:

    https://sourceforge.net/projects/win32diskimager/

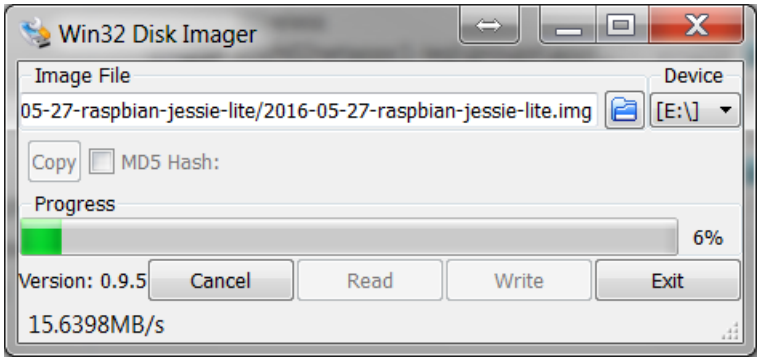

Figure 8: Win32 Disk Imager

4.3 Starting Raspberry Pi

Once the SD card is burned, insert it in the Raspberry Pi and choose a way to login Raspberry Pi:

- HDMI monitor and USB keyboard
- UART terminal (thanks to an extra USB to serial adapter)

Below is the description through an SSH client enabled from *raspi-config* tool, *Interfacing Option*

4.3.1 Login: pi and Password: raspberry

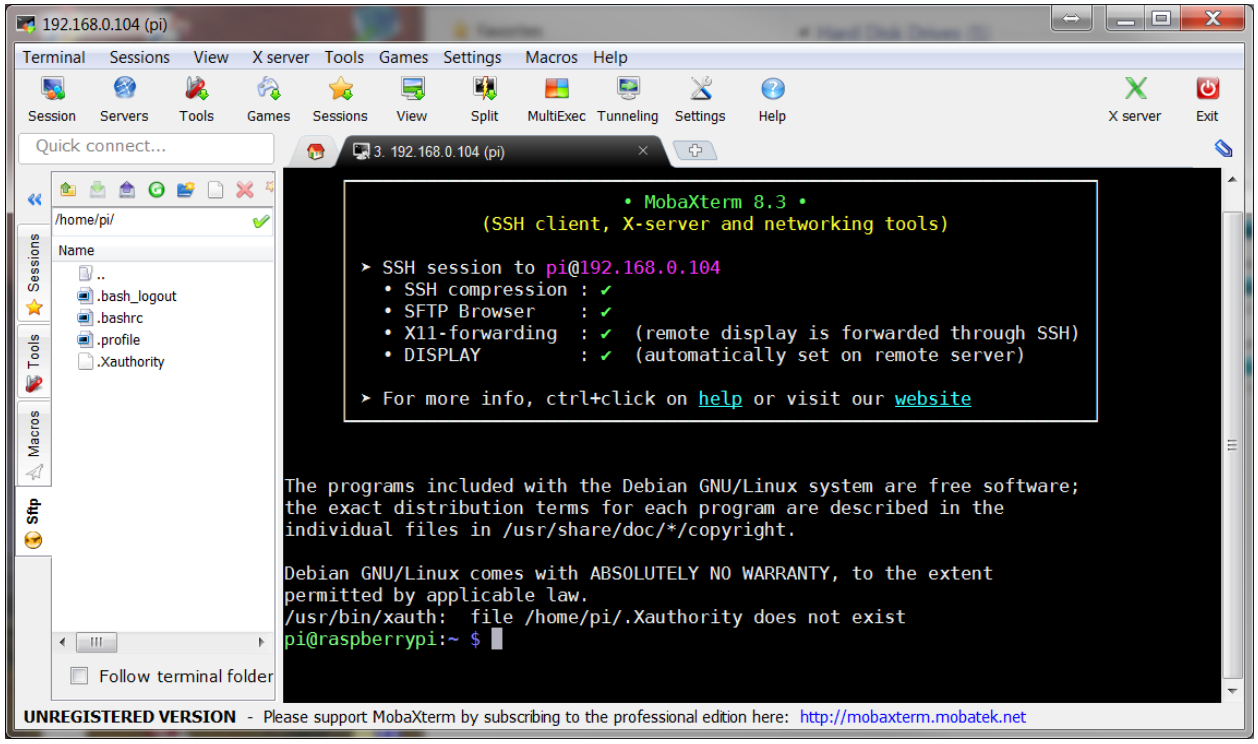

Figure 9: MobaXterm SSH Client

4.3.2 Resize Partition / FS

- On larger SD cards, the root partition can be resized to use extra space, using the *Expand Filesystem* option from raspi-config menu:

  $ sudo raspi-config

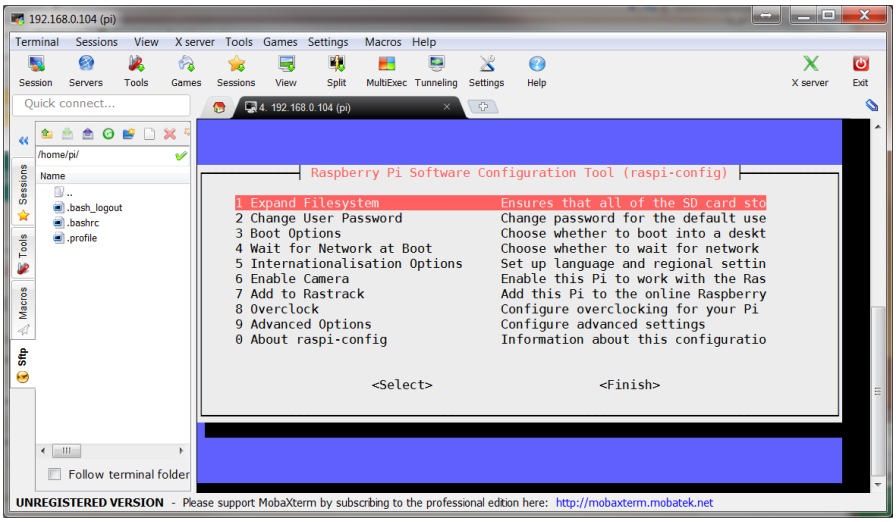

Figure 10: raspi-config Menu

- Select *1 Expand Filesystem* from raspi-config menu and press Enter:

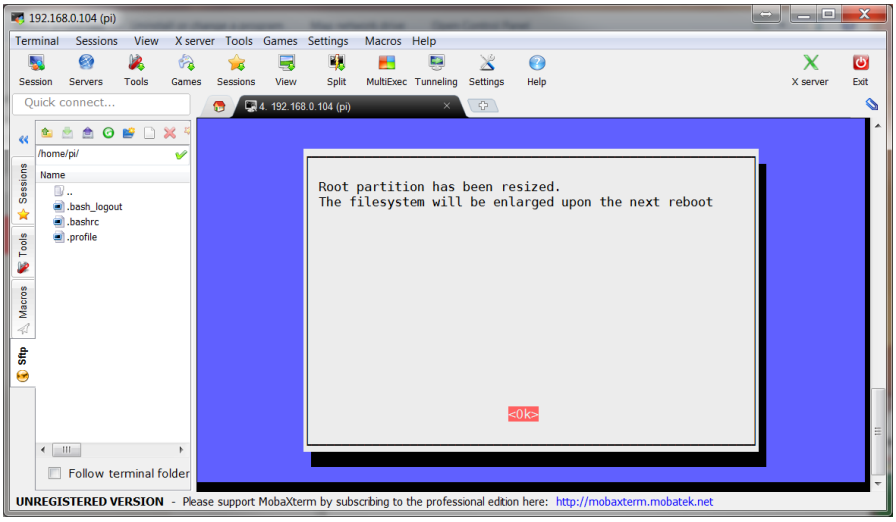

Figure 11: raspi-config "Expand Filesystem"

- The system must be then rebooted:

  $ sudo reboot

For more details, go to the following address:
https://www.raspberrypi.org/documentation/configuration/raspi-config.md

Get the latest Semtech software package from LoRa® Github (requires a connection to internet):

- *$ mkdir lora-net*
- *$ cd lora-net*
- *$ sudo apt-get update*
- *$ sudo apt-get install git*
- *$ git clone* https://github.com/Lora-net/picoGW_packet_forwarder.git
- *$ git clone* https://github.com/Lora-net/picoGW_mcu.git
- *$ git clone* https://github.com/Lora-net/picoGW_hal.git

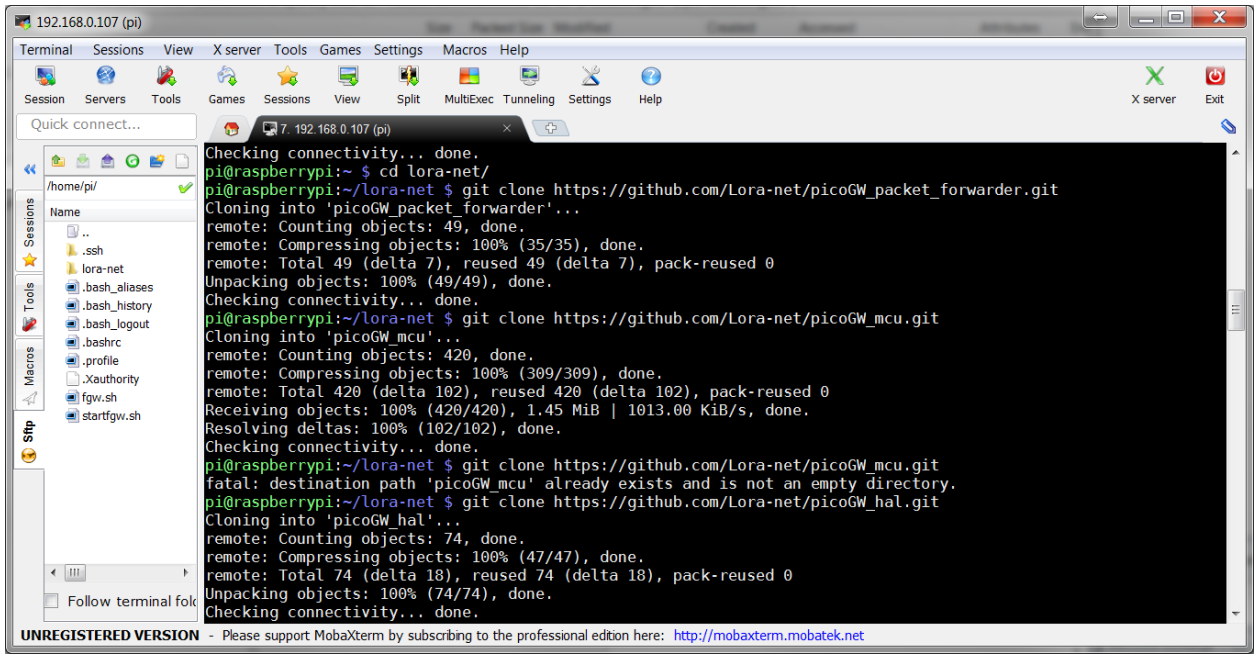

Figure 12: Git Clones

4.3.3 Install dfu-util Tool

- *$ cd ~/lora-net/*
- *$ sudo apt-get install autoconf*
- *$ git clone* https://git.code.sf.net/p/dfu-util/dfu-util
- *$ cd dfu-util*
- *$ ./autogen.sh*
- *$ sudo apt-get install libusb-1.0-0-dev*
- *$ ./configure*
- *$ make*
- *$ sudo make install*

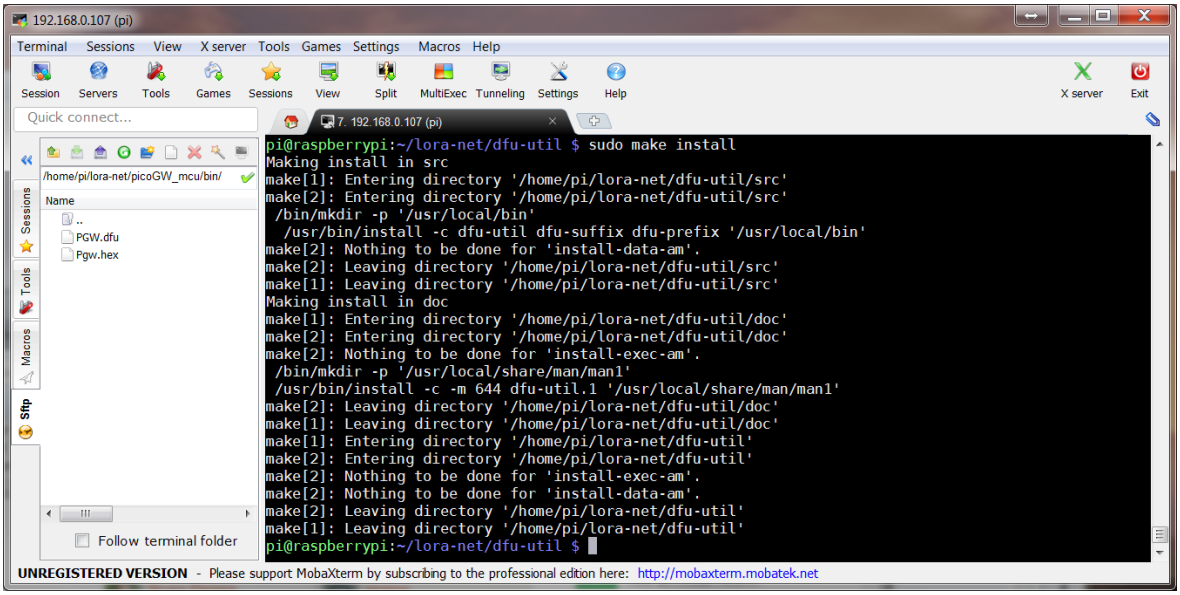

Figure 13: Dfu-util Make Install

4.3.4 Load STM32F401CD MCU Binary

For the first time only, load the STM32F401CD MCU binary:

1. Press the "BOOT0" button of the PicoCell GW while plugging it to any USB port of the Raspberry Pi board:

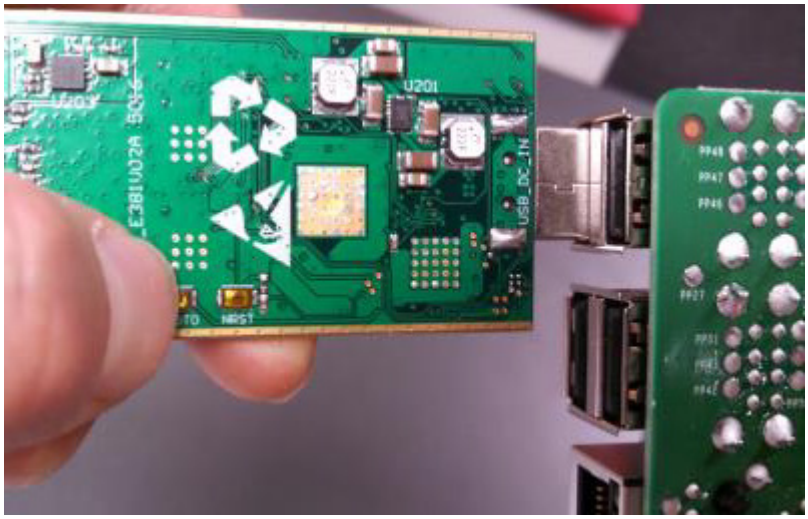

Figure 14: STM32 MCU Boot0 Button

2. On the Raspberry Pi, load the binary into the STM32F401CD MCU with the following command:

   $ sudo /usr/local/bin/dfu-util -a 0 -D ~/lora-net/picoGW_mcu/bin/pgw_fw_usb.dfu

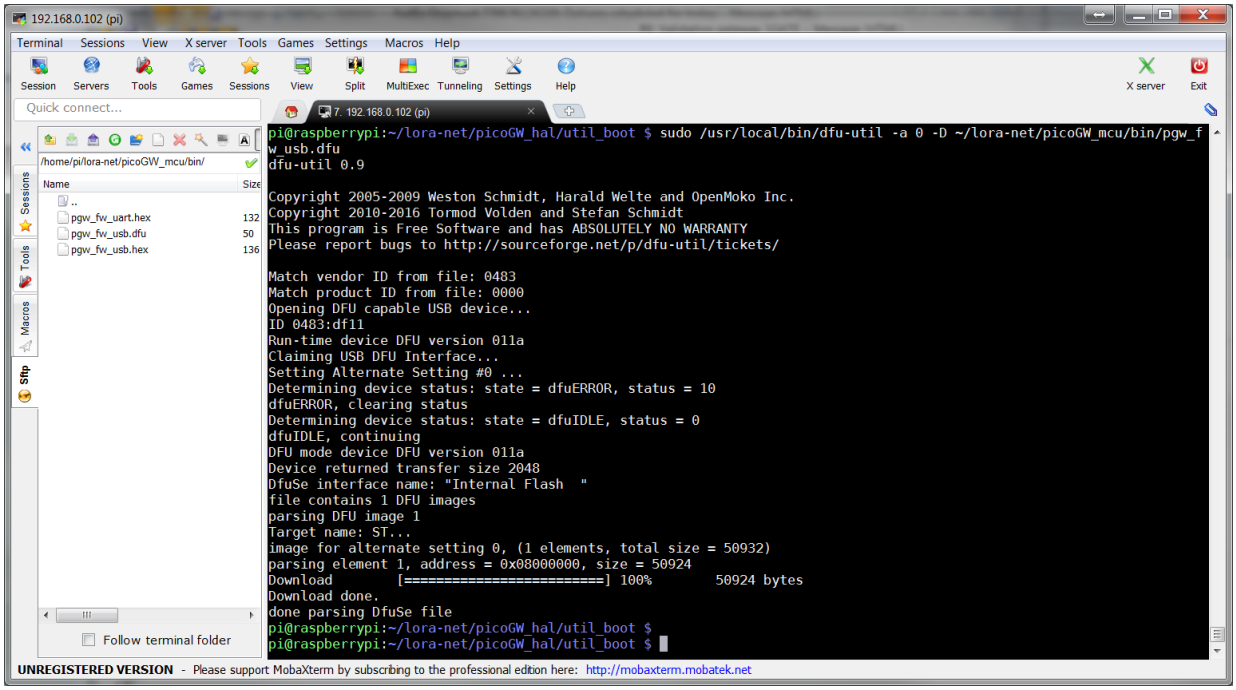

Figure 15: Load STM32F401CD MCU Binary

For any future STM32F401CD MCU binary update, there should be no need to press the “BOOT0” button, simply connect the PicoCell GW to any USB port of the Raspberry Pi and type following commands:

- *$ lsusb*

  To check Pico GW is recognized:

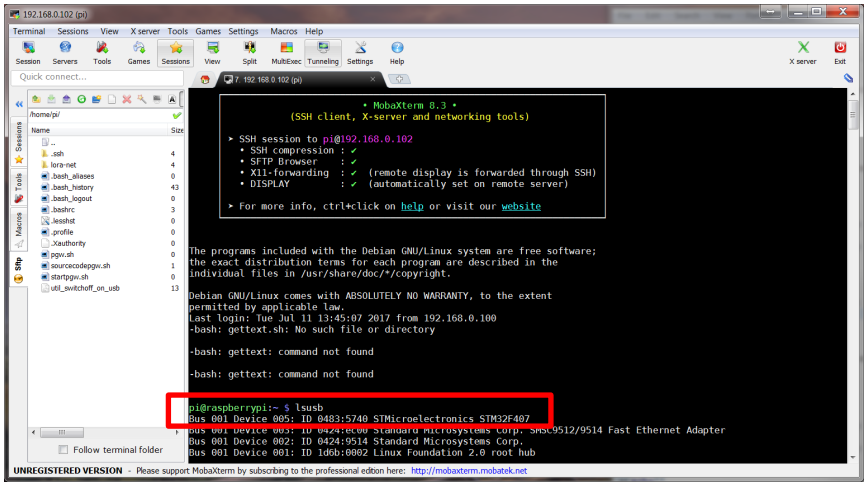

Figure 16: “lsusb” Command Result

- *$ dmesg*

  To know the COM device to be used to access to the Pico GW (here “ttyACMo”):

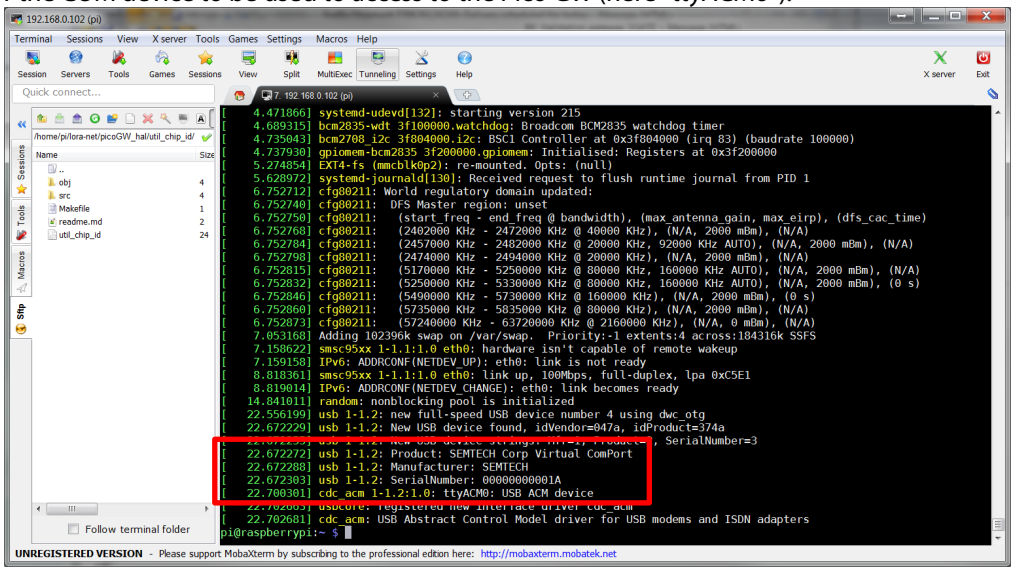

Figure 17: “dmesg” Command Result

- *$ cd ~/lora-net/picoGW_hal/util_boot*

- *$ make*

- *$ ./util_boot –d /dev/ttyACM0*
- *$ lsusb*

To check Pico GW is in DFU (Device Firmware Update) mode:

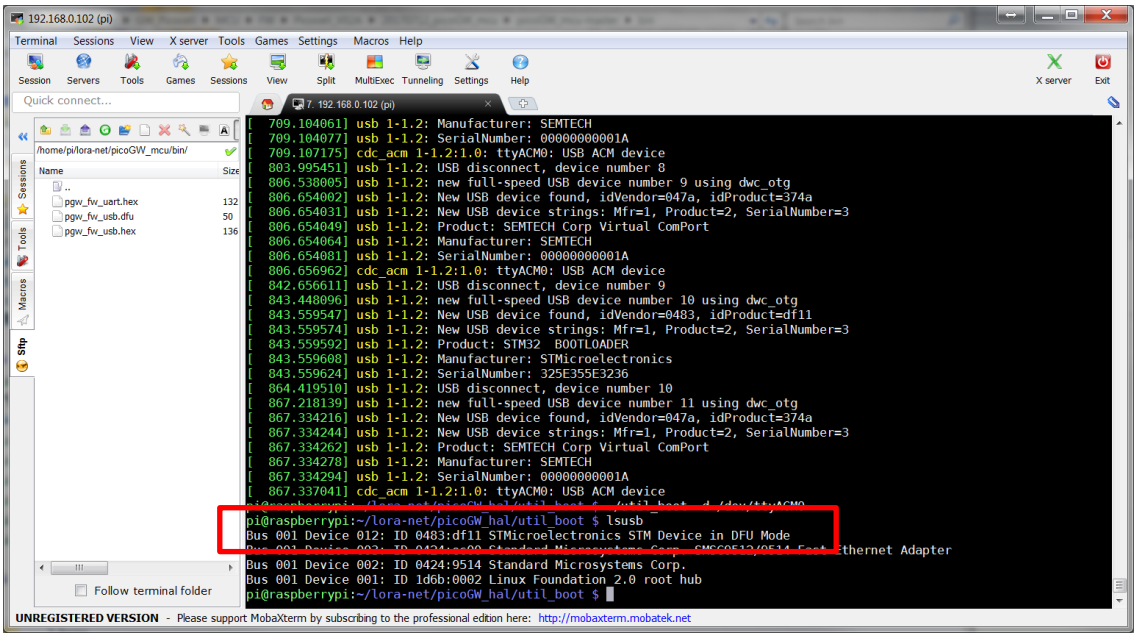

Figure 18: DFU Mode

- *$ sudo /usr/local/bin/dfu-util -a 0 -D ~/lora-net/picoGW_mcu/bin/pgw_fw_usb.dfu*

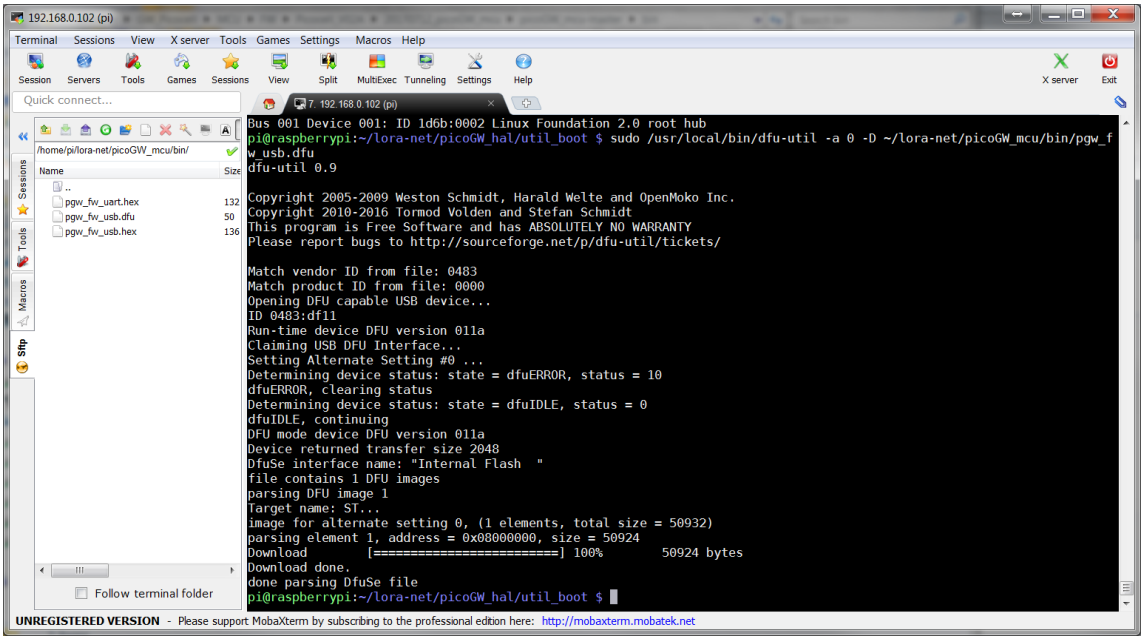

Figure 19: Update STM32F401CD MCU Binary

Notice!

To exit the DFU (Device Firmware Update) mode, you need to unplug and plug again the PicoCell GW to the Raspberry Pi board. You can also do it by controlling the USB power of the Raspberry Pi board through a tool such as "hub-ctrl": https://github.com/codazoda/hub-ctrl.c

4.3.5 Compile Semtech HAL + Packet Forwarder

- *$ cd ~/lora-net/picoGW_hal*
- *$ make clean all*
- *$ cd ~/lora-net/picoGW_packet_forwarder*
- *$ make clean all*

4.3.6 Semtech HAL Compilation Check

The program *util_com_stress* is used to check the reliability of the link between the host platform (on which the program is run) and the LoRa® concentrator register file that is the interface through which all interactions with the LoRa® concentrator happen.

The tests run endlessly or until an error is detected: press Ctrl+C to stop the application.

- *$ cd ~/lora-net/picoGW_hal/util_com_stress*
- *$ ./util_com_stress -t 4 -d /dev/ttyACM0*

The output looks like this:

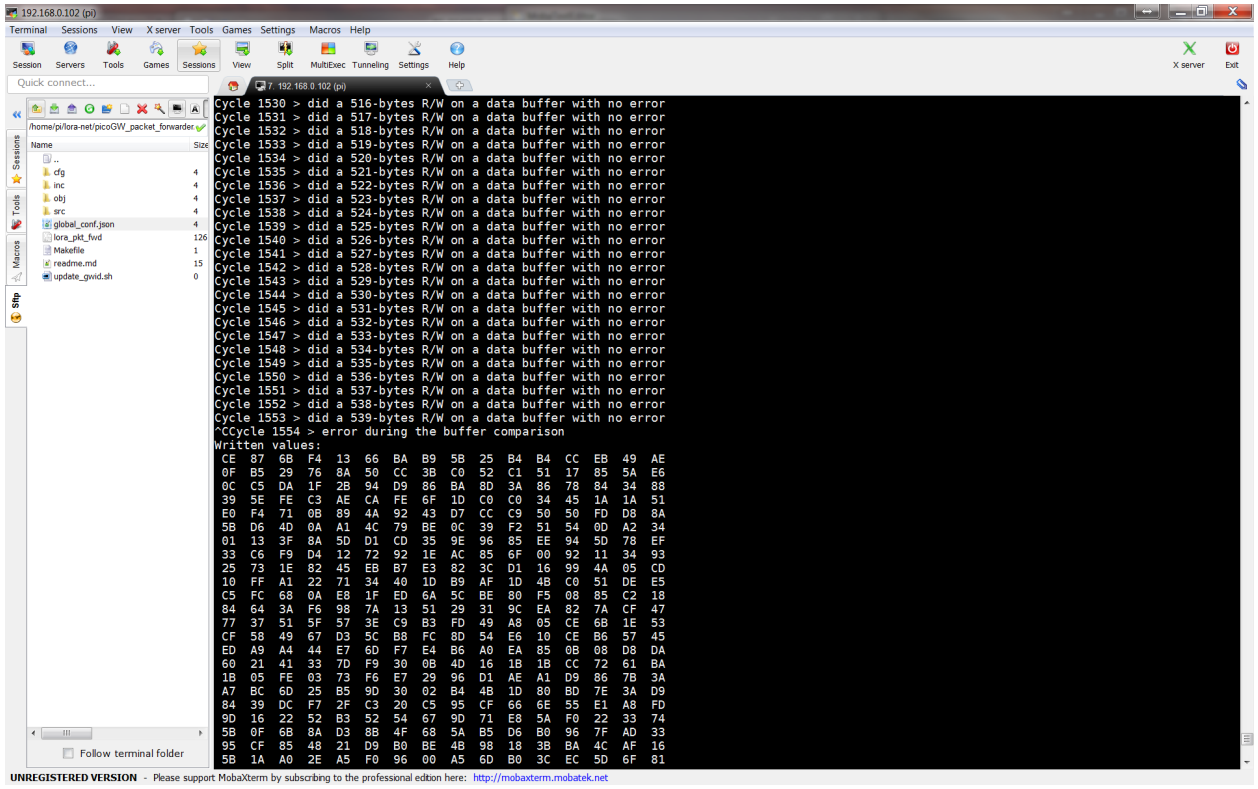

Figure 20: Util_com_stress

4.3.7 Set a Unique ID to the Gateway

The PicoCell GW has a unique ID given at production. This ID can be used as a 64-bit MAC address for the PicoCell GW.

$ cd ~/lora-net/picoGW_hal/util_chip_id

$ ./util_chip_id -d /dev/ttyACM0

Return a unique ID like the following:

3535303229002e00

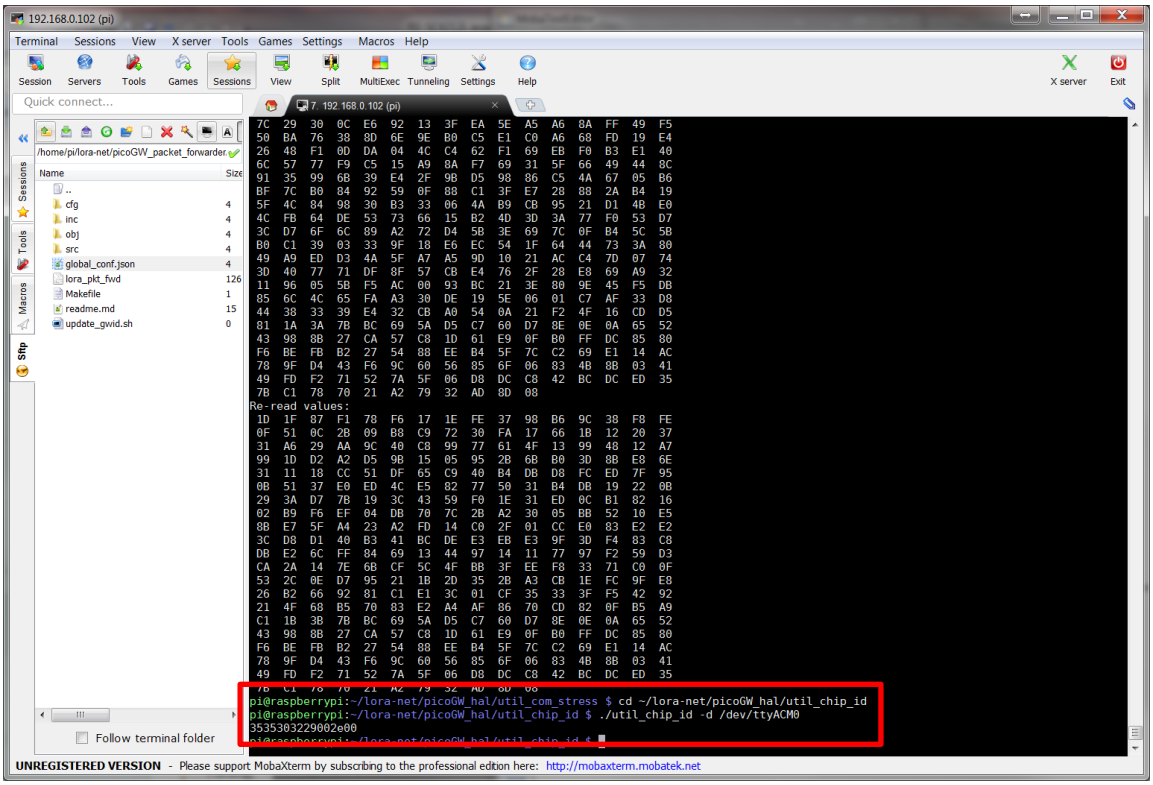

Figure 21: Util_chip_id

The gateway ID could be then replaced in the global_conf.json file within the repository:

~/lora-net/picoGW_packet_forwarder/lora_pkt_fwd

```
{"gateway_conf":{
    "gateway_ID": "3535303229002e00"
    }
}
```

The user can also create a local_conf.json file in the repository:

~/lora-net/picoGW_packet_forwarder/lora_pkt_fwd

with the following line

```
{"gateway_conf":{
    "gateway_ID": "3535303229002e00"
    }
}
```

4.3.8 Run Basic Packet Forwarder

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

Run Basic Packet Forwarder for a functional check:

$ cd ~/lora-net/picoGW_packet_forwarder/lora_pkt_fwd/

$ ./lora_pkt_fwd -d /dev/ttyACM0

The output looks like this:

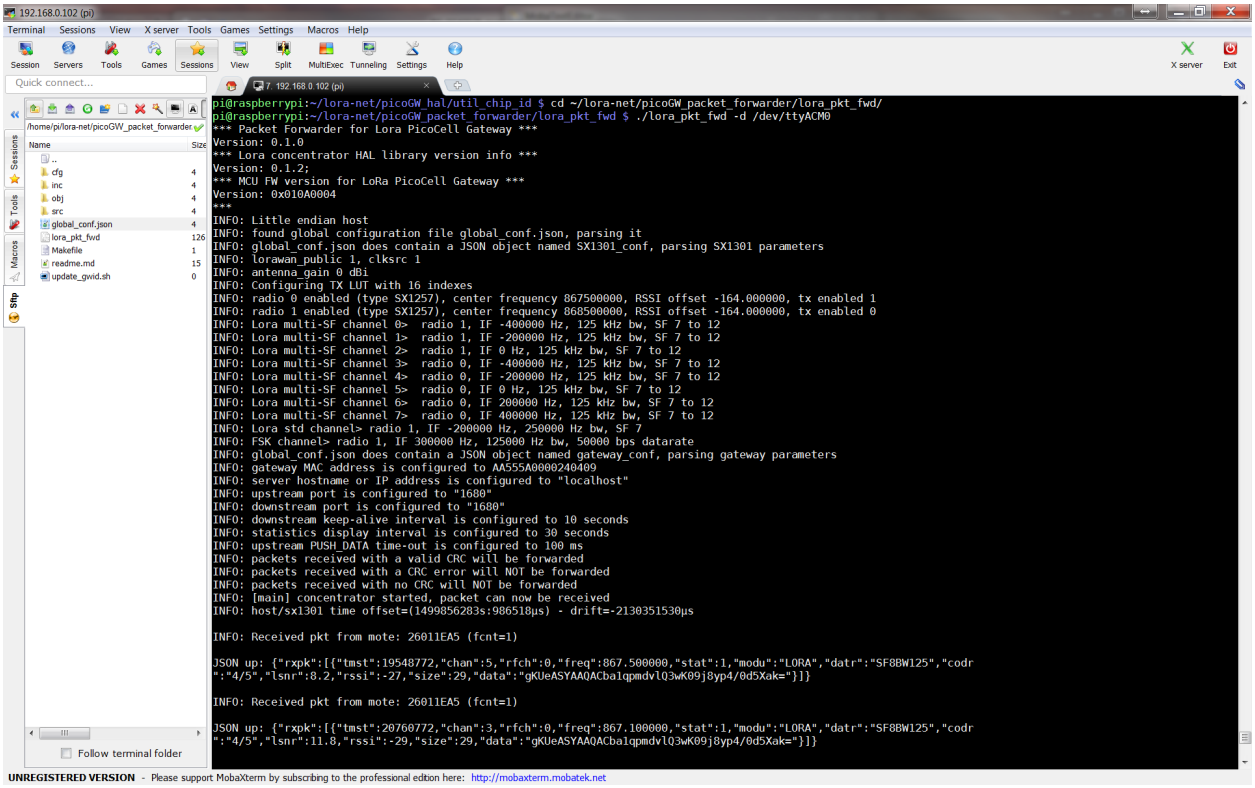

Figure 22: Basic Packet Forwarder

5 JSON file for RF Parameter Tuning

Edit the file *~/lora-net/picoGW_packet_forwarder/lora_pkt_fwd/global_conf.json* to update the following RF parameters:

- *freq*, *radio* and *if* to set frequency channels
    - Frequency channels = [*freq* of selected *radio* + *if*] in Hz
- *rssi_offset* to tune SX1257 + SX1308 RSSI
- 16 available gain tables *tx_lut_0* until *tx_lut_15* to tune Tx output power thanks to the 4 following parameters:
    - *pa_gain* : no possible PA gain setting on PicoCell GW V1.0, so keep it to 0
    - *mix_gain* : 11 possible mixer gain settings from 5 (min. gain) to 15 (max. gain)
    - *rf_power* : RF output power target in dBm
    - *dig_gain* : 4 possible digital gain settings from 0 (max. gain) to 3 (min. gain)

Within a Tx gain table index, the setting {*pa_gain*, *mix_gain*, *dig_gain*} must correspond to the RF output power target defined in the parameter *rf_power*.

A typical PicoCell GW *global_conf.json* file looks like this:

```
{
   "SX1301_conf": {
      "lorawan_public": false,
      "clksrc": 1, /* radio_1 provides clock to concentrator */
      "antenna_gain": 0, /* antenna gain, in dBi */
      "radio_0": {
         "enable": true,
         "type": "SX1257",
         "freq": 867500000,
         "rssi_offset": -164.0,
         "tx_enable": true,
         "tx_freq_min": 863000000,
         "tx_freq_max": 870000000
      },
      "radio_1": {
         "enable": true,
         "type": "SX1257",
         "freq": 868500000,
         "rssi_offset": -164.0,
         "tx_enable": false
      },
      "chan_multiSF_0": {
         /* Lora MAC channel, 125kHz, all SF, 868.1 MHz */
         "enable": true,
         "radio": 1,
         "if": -400000
      },
      "chan_multiSF_1": {
```

```
        /* Lora MAC channel, 125kHz, all SF, 868.3 MHz */
        "enable": true,
        "radio": 1,
        "if": -200000
    },
    "chan_multiSF_2": {
        /* Lora MAC channel, 125kHz, all SF, 868.5 MHz */
        "enable": true,
        "radio": 1,
        "if": 0
    },
    "chan_multiSF_3": {
        /* Lora MAC channel, 125kHz, all SF, 867.1 MHz */
        "enable": true,
        "radio": 0,
        "if": -400000
    },
    "chan_multiSF_4": {
        /* Lora MAC channel, 125kHz, all SF, 867.3 MHz */
        "enable": true,
        "radio": 0,
        "if": -200000
    },
    "chan_multiSF_5": {
        /* Lora MAC channel, 125kHz, all SF, 867.5 MHz */
        "enable": true,
        "radio": 0,
        "if": 0
    },
    "chan_multiSF_6": {
        /* Lora MAC channel, 125kHz, all SF, 867.7 MHz */
        "enable": true,
        "radio": 0,
        "if": 200000
    },
    "chan_multiSF_7": {
        /* Lora MAC channel, 125kHz, all SF, 867.9 MHz */
        "enable": true,
        "radio": 0,
        "if": 400000
    },
    "chan_Lora_std": {
        /* Lora MAC channel, 250kHz, SF7, 868.3 MHz */
        "enable": true,
        "radio": 1,
        "if": -200000,
        "bandwidth": 250000,
        "spread_factor": 7
    },
    "chan_FSK": {
        /* FSK 50kbps channel, 868.8 MHz */
        "enable": true,
        "radio": 1,
        "if": 300000,
        "bandwidth": 125000,
        "datarate": 50000
    },
    "tx_lut_0": {
/* TX gain table, index 0 */
        "pa_gain": 0,
        "mix_gain": 5,
        "rf_power": 9,
        "dig_gain": 3
    },
    "tx_lut_1": {
        /* TX gain table, index 1 */
```

```
    "pa_gain": 0,
    "mix_gain": 5,
    "rf_power": 9,
    "dig_gain": 3
},
"tx_lut_2": {
    /* TX gain table, index 2 */
    "pa_gain": 0,
    "mix_gain": 5,
    "rf_power": 9,
    "dig_gain": 3
},
"tx_lut_3": {
    /* TX gain table, index 3 */
    "pa_gain": 0,
    "mix_gain": 5,
    "rf_power": 9,
    "dig_gain": 3
},
"tx_lut_4": {
    /* TX gain table, index 4 */
    "pa_gain": 0,
    "mix_gain": 5,
    "rf_power": 9,
    "dig_gain": 3
},
"tx_lut_5": {
    /* TX gain table, index 5 */
    "pa_gain": 0,
    "mix_gain": 5,
    "rf_power": 9,
    "dig_gain": 3
},
"tx_lut_6": {
    /* TX gain table, index 6 */
    "pa_gain": 0,
    "mix_gain": 5,
    "rf_power": 9,
    "dig_gain": 3
},
"tx_lut_7": {
    /* TX gain table, index 7 */
    "pa_gain": 0,
    "mix_gain": 6,
    "rf_power": 11,
    "dig_gain": 3
},
"tx_lut_8": {
    /* TX gain table, index 8 */
    "pa_gain": 0,
    "mix_gain": 5,
    "rf_power": 13,
    "dig_gain": 2
},
"tx_lut_9": {
    /* TX gain table, index 9 */
    "pa_gain": 0,
    "mix_gain": 8,
    "rf_power": 14,
    "dig_gain": 3
},
"tx_lut_10": {
    /* TX gain table, index 10 */
    "pa_gain": 0,
    "mix_gain": 6,
    "rf_power": 15,
```

```
            "dig_gain": 2
        },
        "tx_lut_11": {
            /* TX gain table, index 11 */
            "pa_gain": 0,
            "mix_gain": 6,
            "rf_power": 16,
            "dig_gain": 1
        },
        "tx_lut_12": {
            /* TX gain table, index 12 */
            "pa_gain": 0,
            "mix_gain": 9,
            "rf_power": 17,
            "dig_gain": 3
        },
        "tx_lut_13": {
            /* TX gain table, index 13 */
            "pa_gain": 0,
            "mix_gain": 10,
            "rf_power": 18,
            "dig_gain": 3
        },
        "tx_lut_14": {
            /* TX gain table, index 14 */
            "pa_gain": 0,
            "mix_gain": 11,
            "rf_power": 19,
            "dig_gain": 3
        },
        "tx_lut_15": {
            /* TX gain table, index 15 */
            "pa_gain": 0,
            "mix_gain": 12,
            "rf_power": 20,
            "dig_gain": 3
        }
    },

    "gateway_conf": {
        "gateway_ID": "AA555A0000240409",
        /* change with default server address/ports, or overwrite in local_conf.json */
        "server_address": "localhost",
        "serv_port_up": 1680,
        "serv_port_down": 1680,
        /* adjust the following parameters for your network */
        "keepalive_interval": 10,
        "stat_interval": 30,
        "push_timeout_ms": 100,
        /* forward only valid packets */
        "forward_crc_valid": true,
        "forward_crc_error": false,
        "forward_crc_disabled": false
    }
}
```

This radio transmitter IC: 27239-LRWCC1915 has been approved by Innovation, Science and Economic Development Canada. For regulatory adherence the maximum granted TX power must not be exceeded in any direction. Therefore, the TX power must be reduced by the maximum gain of the chosen antenna accordingly.

6 References

[1] SX1308 information: http://www.semtech.com/wireless-rf/rf-transceivers/sx1308/

[2] SX1257 datasheet: http://www.semtech.com/images/datasheet/sx1257.pdf

This device complies wit Part 15 of the FCC Rules. Operation is subject to the following two conditions (1) This device may not cause harmful interference, and (2) this device must accept any interference received, including interference that may cause undesired operation.

The grantee is not responsible for any changes or modifications not expressly approved by the party responsible for compliance. Such modifications could voice the user's authority to operate the equipment.

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.

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, and (2) this device must accept any interference, including interference that may cause undesired operation of the device.

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.

To satisfy RF exposure requirements, this device and its antenna must operate with a seperation distance of at least 20 cm from all persons and must not be colocated or operating in conjunction with any other antenna or transmitter.

Pour satisfaire aux exigences d'exposition RF, cet appareil et son antenne doivent fonctionner avec une distance de séparation d'au moins 20 cm de toutes les personnes et ne doivent pas être colocalisés ou fonctionner en conjonction avec une autre antenne ou émetteur.

7 Revision History

Version	Date	Modifications
1.0	May 2017	First Release
1.1	July 2017	Section 3: addition of of UART support Figure 5 updated accordingly "SX1301" replaced by "SX1308" Section 4.3.4, step 2: linux command change Figure 15 updated accordingly New Figure 16: "lsusb" command result New Figure 17: "dmesg" command result New linux command to get the COM device New Figure 18: DFU mode New Figure 19: Update STM32F401CD MCU Binary Linux commands change (add –d option parameter + .dfu name) Section 4.3.6: linux command change (add –d option parameter) + Figure 20: Util_com_stress updated accordingly Section 4.3.7: linux command change (add –d option parameter) Figure 21: Util_chip_id updated accordingly Section 4.3.8: linux command change (add –d option parameter) Figure 22: Basic Packet Forwarder updated accordingly

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8 Glossary

BB	BaseBand
BoM	Bill Of Materials
BW	BandWidth
CLK	Clock
CW	Continuous Wave
ETSI	European Telecommunications Standard Institute
DFU	Device Firmware Update
EU	Europe
EUI	Extended Unique Identifier
GB	GigaByte
GPS	Global Positioning System
GW	GateWay
HAL	Hardware Abstraction Layer
HDMI	High-Definition Multimedia Interface
HW	HardWare
IP	Intellectual Property
ISM	Industrial, Scientific and Medical applications
LAN	Local Area Network
LBT	Listen Before Talk
LO	Local Oscillator
LoRa®	LOng RAnge modulation technique
LoRaWAN	LoRa® low power Wide Area Network protocol
LPF	Low Pass Filter
LSB	Least Significant Bit
LUT	Look Up Table
MAC	Media Access Control address
MCU	Micro-Controller Unit
MPU	Micro-Processing Unit
PA	Power Amplifier
RSSI	Received Signal Strength Indication
RF	Radio-Frequency
RX	Receiver
SAW	Surface Acoustic Wave filter
SD Card	Secure Digital Card
SF	Spreading Factor
SPI	Serial Peripheral Interface
SPDT	Single-Pole, Double-Throw switch
SSH	Secure SHell
SW	SoftWare
TX	Transmitter
UART	Universal Asynchronous Receiver/Transmitter
UDP	User Datagram Protocol
USB	Universal Serial Bus

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