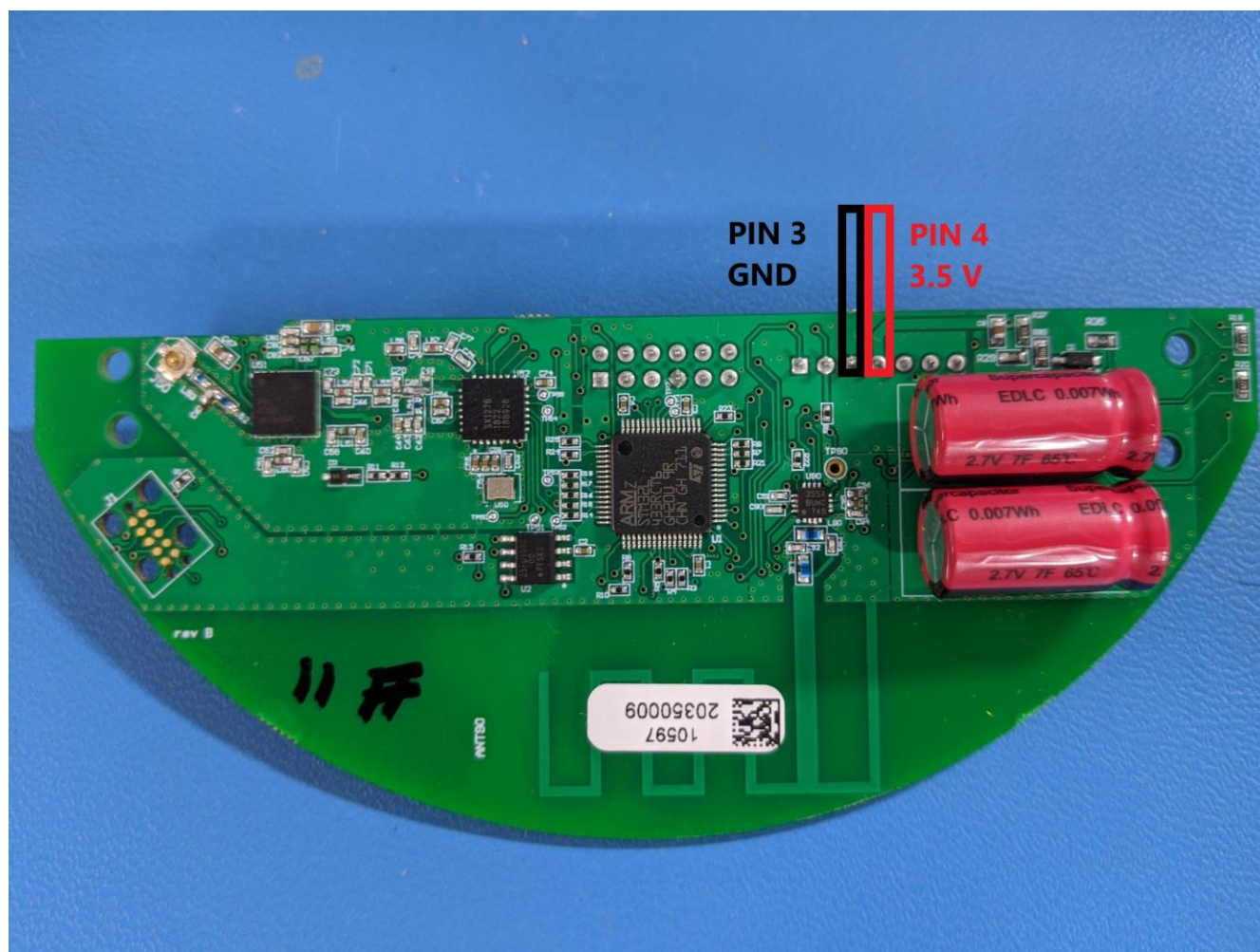


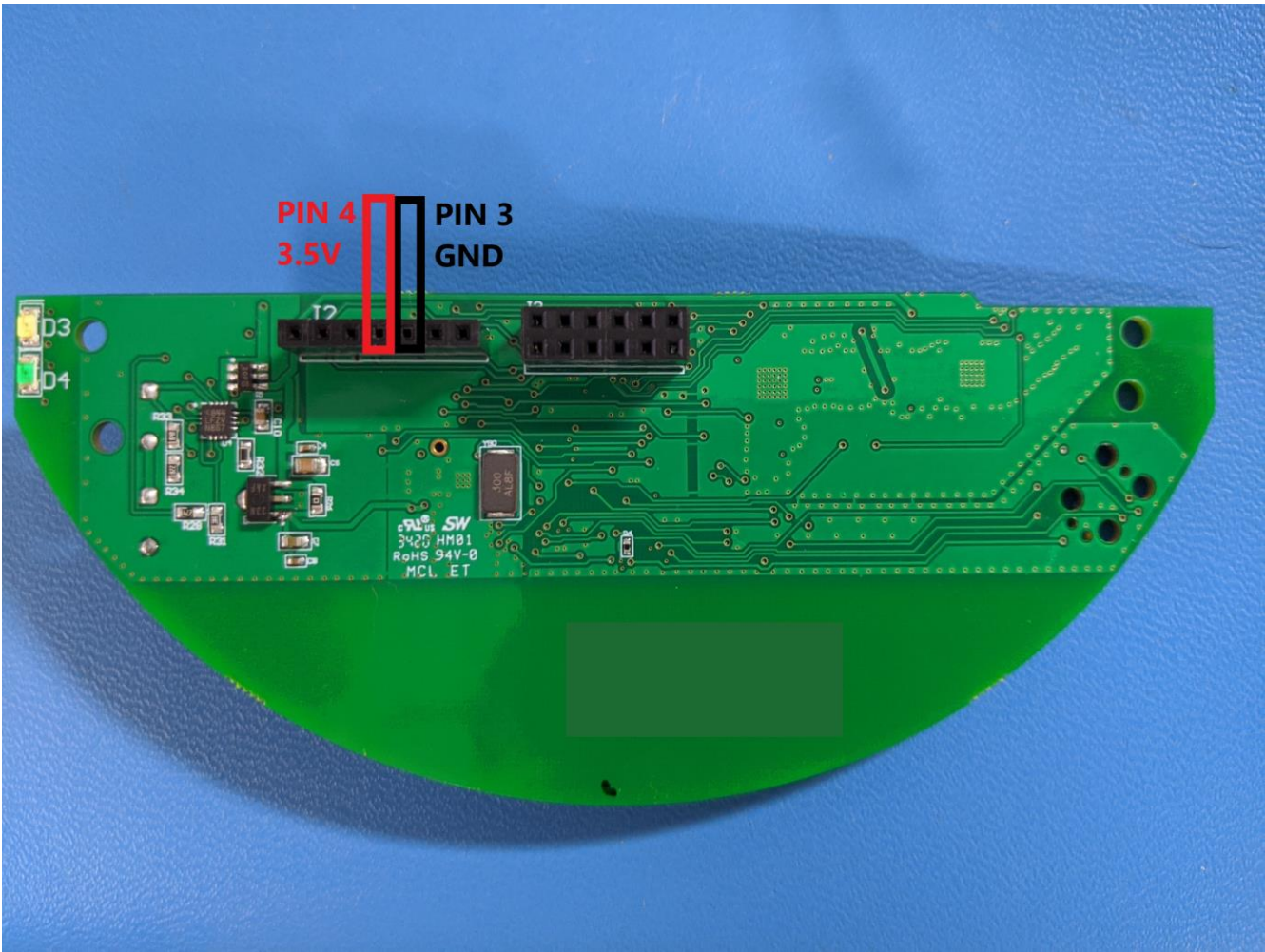
User Manual for VM 1W LoRa modem with dual receiver

Last updated on: 10/12/2020

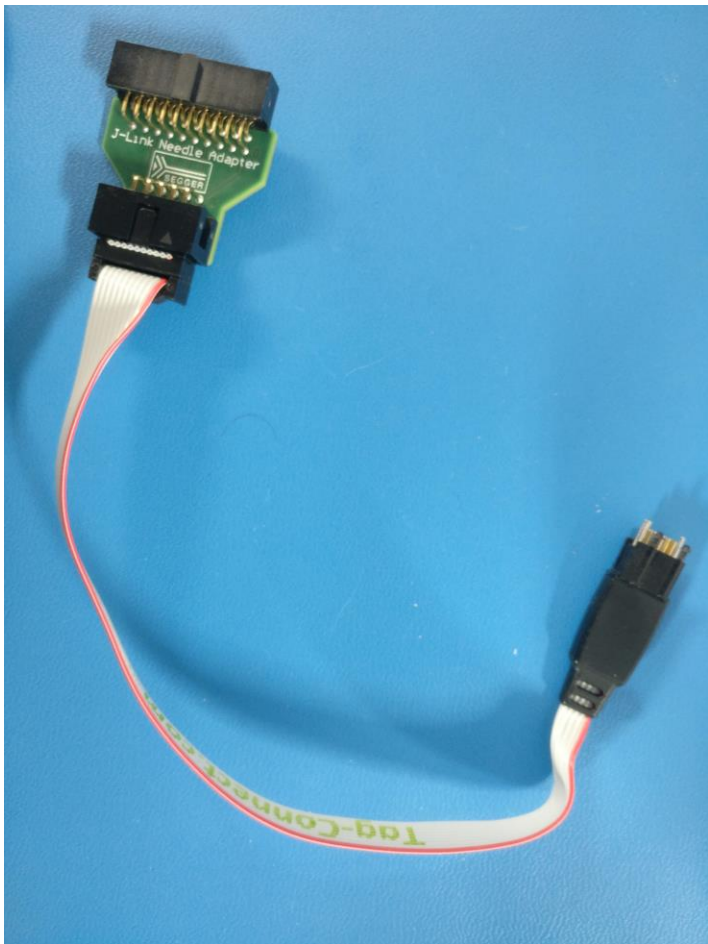
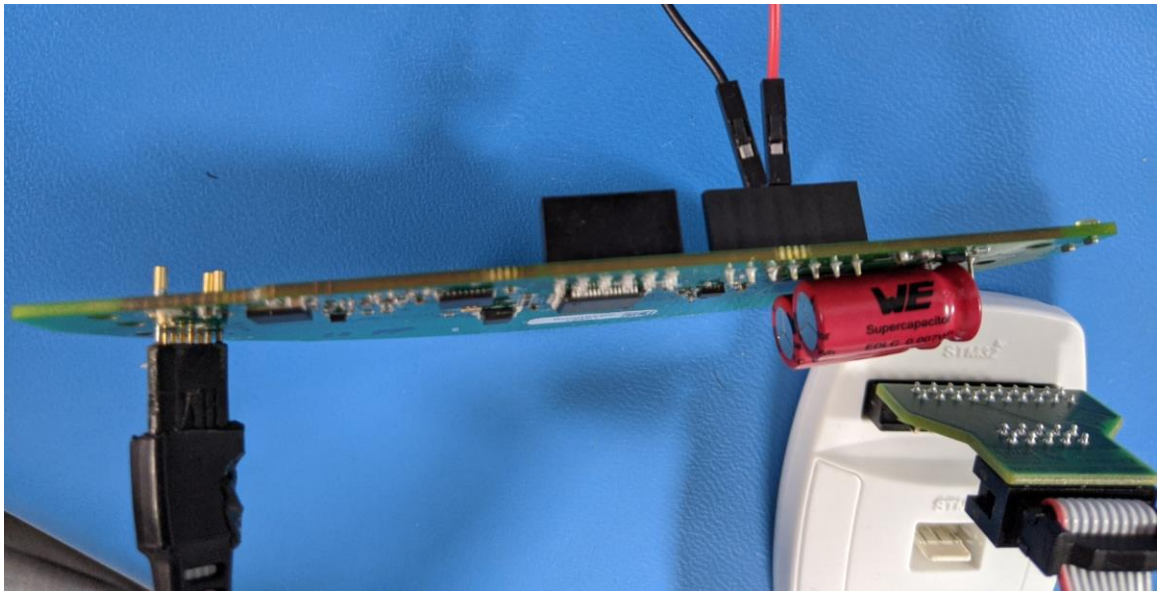
Power pin outs for the module

Power Pin 3: GND; Power Pin 4: 3.5V





Programming header and programming cable

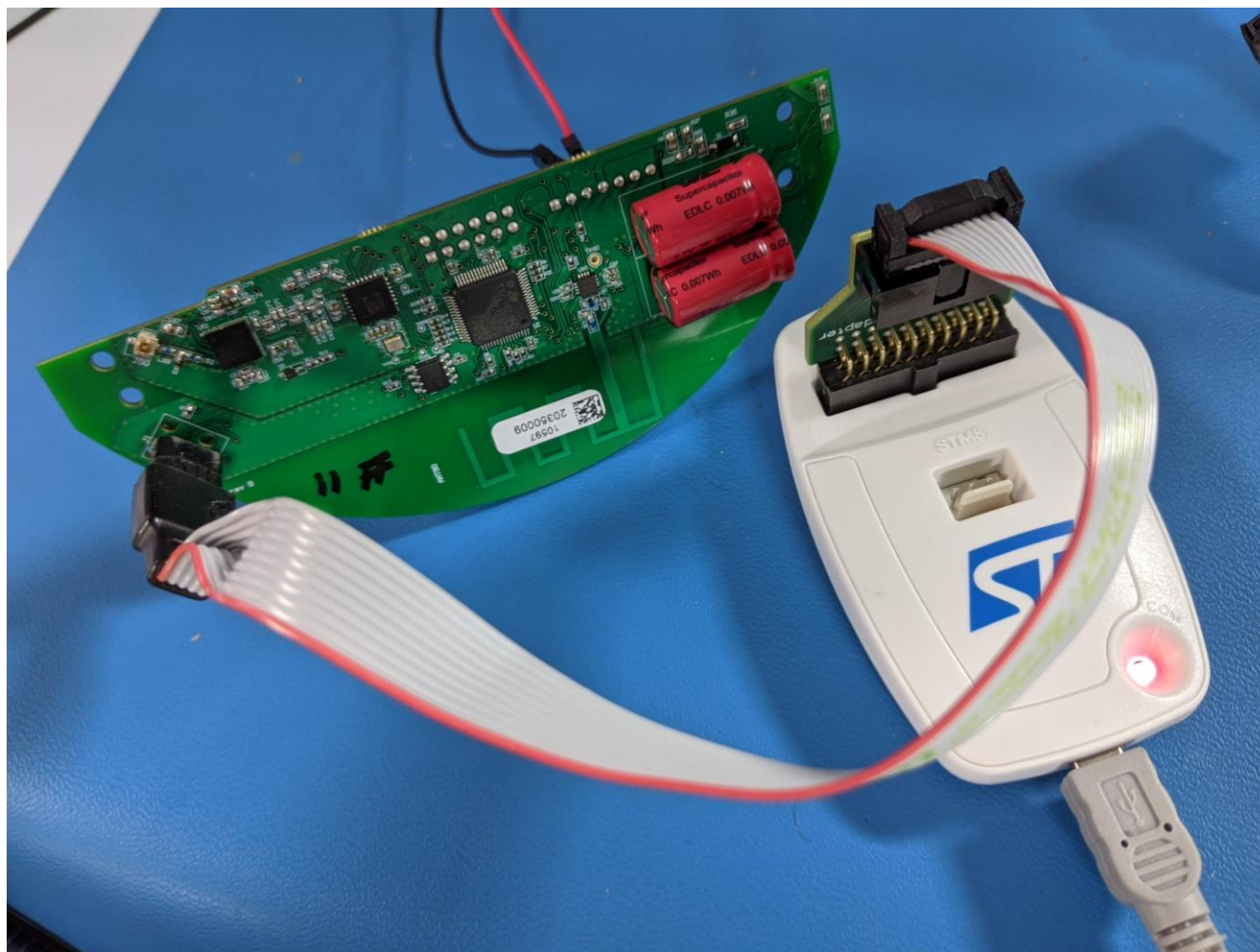


Programming instructions

Download and install ST-LINK/V2 in-circuit debugger/programmer for STM8 and STM32 from this link :

<https://www.st.com/en/development-tools/stsw-link004.html#sw-tools-scroll>

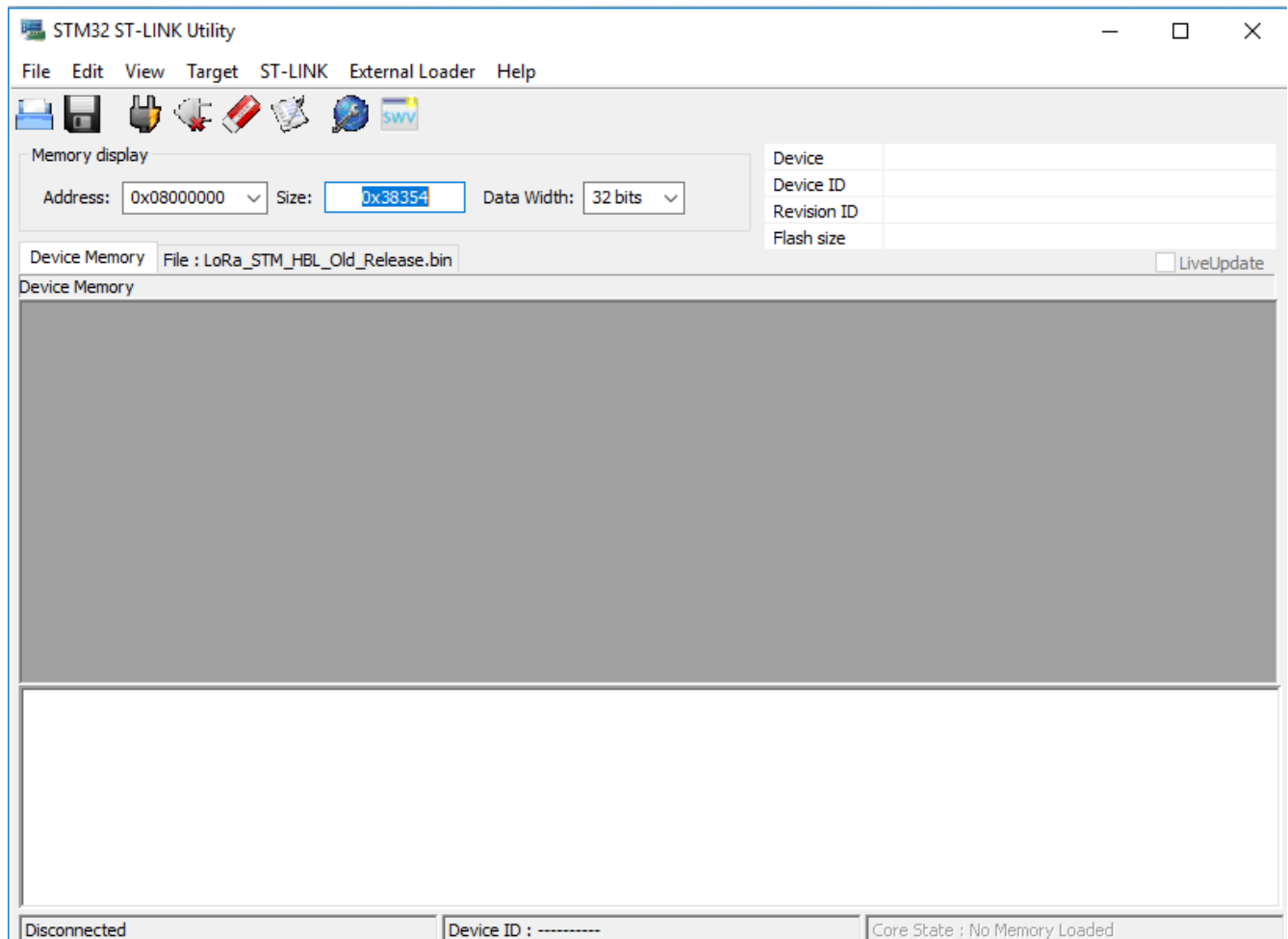
Programmer setup:



Power up the modem and connect the ST link/V2 programmer to the module as shown in the picture. The mini USB connector of the programmer is connected directly to a PC or laptop.

Software instructions:

- ST link utility software layout



- click 'connect to target button'.
- If the connection is successful the debug window looks like this :



- Go to file- → open file and load the firmware bin file. If the firmware is loaded successfully the debug window looks like this.

```

17:35:34 : Connected via SWD.
17:35:34 : SWD Frequency = 4,0 MHz.
17:35:34 : Connection mode : Normal.
17:35:34 : Debug in Low Power mode enabled.
17:35:34 : Device ID:0x435
17:35:34 : Device flash Size : 256KBytes
17:35:34 : Device family :STM32L4x3
17:35:39 : [LoRa_STM_Tx_Continuous_902.3.hex] opened successfully.
           Address Ranges [0x08000000 0x08000188] [0x080001C0 0x0802CE14]
17:35:39 : [LoRa_STM_Tx_Continuous_902.3.hex] checksum : 0x010FD10C

```

Debug in Low Power mode enabled. Device ID:0x435

- Click 'program verify' icon



- A window appears, verify if the settings are similar to what's shown in the picture

Download [LoRa_STM_Tx_Continuous_902.3.hex]

Start address: 0x08000000

File path: C:\Users\darrell\Desktop\STL_Firmware\LoRa_STM_Tx_I [Browse]

Extra options:

☐ Skip Flash Erase ☐ Skip Flash Protection verification

Verification:

☒ Verify while programming ☐ Verify after programming

Click "Start" to program target.

After programming:

☒ Reset after programming ☐ Full Flash memory Checksum

[Start] [Cancel]

- click start, this will start flashing the firmware. If successful the debug window looks like this

```

17:35:34 : Debug in Low Power mode enabled.
17:35:34 : Device ID:0x435
17:35:34 : Device flash Size : 256KBytes
17:35:34 : Device family :STM32L4x3
17:35:39 : [LoRa_STM_Tx_Continuous_902.3.hex] opened successfully.
           Address Ranges [0x08000000 0x08000188] [0x080001C0 0x0802CE14]
17:35:39 : [LoRa_STM_Tx_Continuous_902.3.hex] checksum : 0x010FD10C
17:41:59 : Memory programmed in 12s and 641ms.
17:41:59 : Verification...OK
17:41:59 : Programmed memory Checksum: 0x010FD10C

```

Debug in Low Power mode enabled. Device ID:0x435

- click 'disconnect from device' icon.



- Now the programming cable can be removed from the module and the module is ready for testing.

Firmware bin file details:

The firmware files that will enable transmissions in fixed frequencies are named as follows:

- VM_HALFMOON_FCC_LOW (transmit at 902.3Mhz)
- VM_HALFMOON_FCC_MID (transmit at 908.5Mhz)
- VM_HALFMOON_FCC_HIGH (transmit at 914.9Mhz)

The firmware file that will enable the module to hop in 64 channels between (902.3 and 914.9) is named as follows:

- VM_HALFMOON_FCC_TXHOP_PWR11

Chirp Spread Spectrum

Chirp Spread Spectrum was developed for radar applications in the 1940's. Traditionally used in a number of military and secure communications applications; over the past twenty years this modulation technique has seen increased adoption in a number of data communications applications due to its relatively low transmission power requirements and inherent robustness from channel degradation mechanisms such as multipath, fading, Doppler and in-band jamming interferers.

A CSS PHY was adopted by the IEEE for the Low-Rate Wireless Personal Area Networks (LR-WPANs) standard 802.15.4 for applications requiring longer range and mobility than that achievable with the OQPSK DSSS PHY mode.

LoRa Spread Spectrum

Semtech's LoRa modulation addresses all of the issues associated with DSSS systems to provide a low cost, low-power, yet above all robust alternative to the traditional spread-spectrum communications Techniques.

In LoRa modulation the spreading of the spectrum is achieved by generating a chirp signal that continuously varies in frequency. An advantage of this method is that timing and frequency offsets between transmitter and receiver are equivalent, greatly reducing the complexity of the receiver design. The frequency bandwidth of this chirp is equivalent to the spectral bandwidth of the signal.

Modulation method

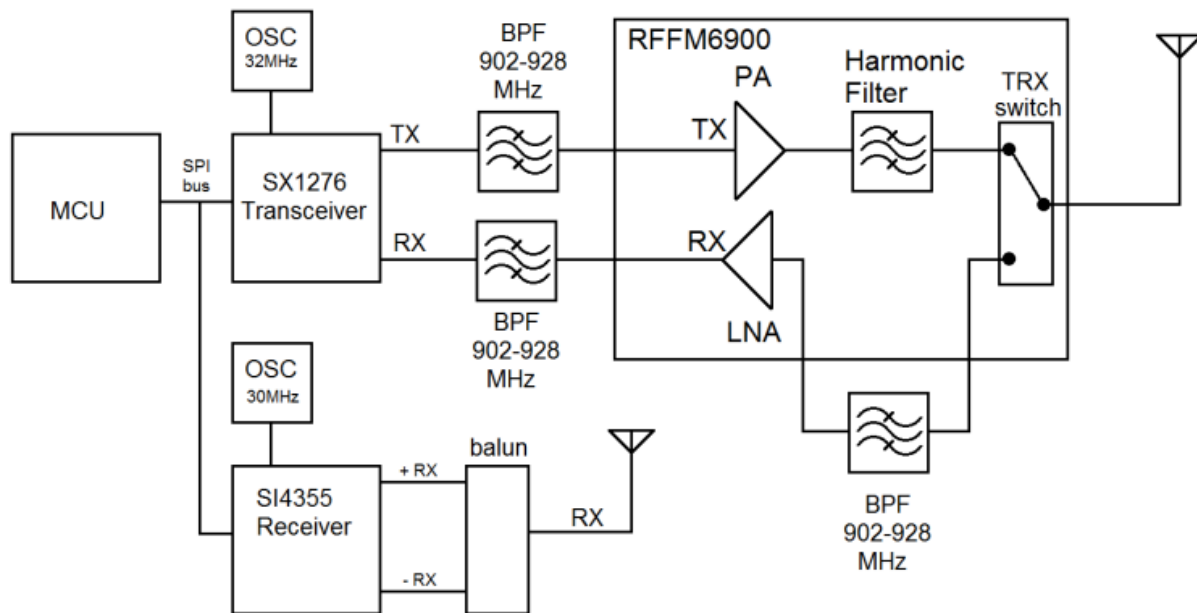
This Device uses Frequency Hopping Spread Spectrum (FHSS) as its modulation technique. The list of frequencies are as follows:

| Frequency in Mhz | | | | | | | |
|------------------|-------|-------|-------|-------|-------|-------|-------|
| 902.3 | 903.9 | 905.5 | 907.1 | 908.7 | 910.3 | 911.9 | 913.5 |
| 902.5 | 904.1 | 905.7 | 907.3 | 908.9 | 910.5 | 912.1 | 913.7 |
| 902.7 | 904.3 | 905.9 | 907.5 | 909.1 | 910.7 | 912.3 | 913.9 |
| 902.9 | 904.5 | 906.1 | 907.7 | 909.3 | 910.9 | 912.5 | 914.1 |
| 903.1 | 904.7 | 906.3 | 907.9 | 909.5 | 911.1 | 912.7 | 914.3 |
| 903.3 | 904.9 | 906.5 | 908.1 | 909.7 | 911.3 | 912.9 | 914.5 |
| 903.5 | 905.1 | 906.7 | 908.3 | 909.9 | 911.5 | 913.1 | 914.7 |
| 903.7 | 905.3 | 906.9 | 908.5 | 910.1 | 911.7 | 913.3 | 914.9 |

The FCC regulations for systems using frequency hopping spread spectrum (FHSS) techniques can be summarized as follows:

- Frequency hopping systems shall have hopping channel carrier frequencies separated by a minimum of 25 kHz or the 20 dB bandwidth of the hopping channel, whichever is greater. The system shall hop to channel frequencies that are selected at the system hopping rate from a pseudo randomly ordered list of hopping frequencies. Each frequency must be used equally on the average by each transmitter (Ref: 15.247(a)(1))
- If the 20 dB bandwidth of the hopping channel is less than 250 kHz, the system shall use at least 50 hopping frequencies and the average time of occupancy on any frequency shall not be greater than 400ms within a 20 second period ($= 0.4 * 50$ channels). If the 20 dB bandwidth of the hopping channel is 250 kHz or greater, the system shall use at least 25 hopping frequencies and the average time of occupancy on any frequency shall not be greater than 400 ms within a 10 second period ($= 0.4 * 25$ channels). In addition the maximum allowable 20 dB bandwidth of any hopping channel is 500 kHz (Ref: 15.247(a)(1)(i))
- The maximum peak conducted output power shall not exceed 1 W (+30 dBm) for systems employing at least 50 hopping channels and 250 mW (+24 dBm) for systems employing less than 50 hopping channels, but at least 25 hopping channels. As opposed to systems employing digital modulation, averaging measurement methods are not permitted (Ref: 15.247(b)(2))

Simplified Block Diagram



MCU STM32L433xx

The STM32L433xx devices are the ultra-low-power microcontrollers based on the high performance Arm® Cortex®-M4 32-bit RISC core operating at a frequency of up to 80 MHz. The Cortex-M4 core features a Floating point unit (FPU) single precision which supports all Arm® single-precision data-processing instructions and data types. It also implements a full set of DSP instructions and a memory protection unit (MPU) which enhances application security.

The STM32L433xx devices embed high-speed memories (Flash memory up to 256 Kbyte, 64 Kbyte of SRAM), a Quad SPI flash memories interface (available on all packages) and an extensive range of enhanced I/Os and peripherals connected to two APB buses, two AHB buses and a 32-bit multi-AHB bus matrix.

The STM32L433xx operates in the -40 to +85 °C (+105 °C junction), -40 to +105 °C (+125 °C junction) and -40 to +125 °C (+130 °C junction) temperature ranges from a 1.71 to 3.6 V VDD power supply when using internal LDO regulator and a 1.05 to 1.32V VDD12 power supply when using external SMPS supply. A comprehensive set of power-saving modes allows the design of low-power applications.

RF Transceiver SX1276

LoRa® Modem

- 168 dB maximum link budget
- +20 dBm - 100 mW constant RF output vs. V supply
- +14 dBm high efficiency PA
- Programmable bit rate up to 300 kbps
- High sensitivity: down to -148 dBm
- Bullet-proof front end: IIP3 = -11 dBm
- Excellent blocking immunity
- Low RX current of 9.9 mA, 200 nA register retention
- Fully integrated synthesizer with a resolution of 61 Hz
- FSK, GFSK, MSK, GMSK, LoRa® and OOK modulation
- Built-in bit synchronizer for clock recovery
- Preamble detection
- 127 dB Dynamic Range RSSI

- Automatic RF Sense and CAD with ultra-fast AFC
- Packet engine up to 256 bytes with CRC
- Built-in temperature sensor and low battery indicator

Power amplifier RFFM6900

2.5V TO 4.2V, ISM BAND, 1W

915MHz Transmit/Receive Module

The RFFM6900 is a single-chip front end module (FEM) for applications in the 900MHz and 868MHz ISM Bands. The RFFM6900 contains an integrated 1 Watt PA, SP3T antenna switch, integrated Tx harmonic filter, Tx thru path, LNA with bypass mode, and matching components. The RFFM6900 is packaged in a 28-pin, 6.0mm x 6.0mm x 0.975mm over-molded laminate package with backside ground.

Absolute Maximum Ratings

| Parameter | Rating | Unit |
|--------------------------------------|-------------|------|
| Voltage | 5.25 | V |
| Storage Temperature Range | -40 to +150 | °C |
| Operating Temperature Range | -40 to +85 | °C |
| Receive RF Input Power (SAW2) | +5 | dBm |
| Transmit RF Input Power (PA Enabled) | +15 | dBm |
| Transmit RF Input Power (PA Bypass) | +20 | dBm |
| Receive RF Input Power (ANT) | +33 | dBm |
| T/R Port Load VSWR in Transmit Mode | 10:1 | |
| ESD, HBM | 350 | V |
| ESD, CDM | 300 | V |
| Moisture Sensitivity Level | MSL3 | |

Antenna

The Taoglas FXP290 915 MHz ISM Antenna covers from 902-928 MHz used in the 915 MHz ISM (Industrial Scientific Medical) Band. The antenna has been designed in a flexible material with a square form-factor and cable connection for an easy installation. The antenna works on different plastic materials and thickness. We have selected a piece of ABS with 2 mm of thickness as a baseline for testing.

Spec No. : **FXP290**

Part No. : **FXP290.07.0100A**

Model : 915MHz ISM Band Flex Circuit Antenna

Features : 75*45*0.1mm

100mm Ø1.13 cable



| Parameter | Specification |
|------------------------|-------------------------|
| Frequency Range | 902MHz to 928MHz |
| Return Loss (dB) | -20 |
| Efficiency (%) | 40 |
| Gain (dBi) | 1.5 |
| Impedance | 50 Ω |
| VSWR | $\leq 2:1$ |
| Polarization | Linear |
| Power Handled | 5W |
| Operation Temperature | -40°C ~ +85°C |
| Storage Temperature | -40°C ~ +85°C |
| Dimensions | 75*45*0.1mm |
| Weight | 1.5g |
| Connector | MHFII (U.FL Compatible) |
| Cable Standard | Mini-Coax 1.13 mm |
| Cable Length and color | 100mm, Black |
| RoHS Compliant | Yes |
| Adhesive | 3M 467 |

Integration instructions for host product manufacturers according to KDB 996369 D03

2.2 List of applicable FCC rules

CFR 47 FCC PART 15 SUBPART C has been investigated. It is applicable to the modular Transmitter

2.3 Specific operational use conditions

This module is stand-alone modular. If the end product will involve the Multiple simultaneously transmitting condition or different operational conditions for a stand-alone modular transmitter in a host, host manufacturer have to consult with module man

2.4 Limited module procedures

This module is Limit single modular.

2.5 Trace antenna designs

Not applicable

2.6 RF exposure considerations

This equipment complies with FCC radiation exposure limits set forth for an uncontrolled environment. This equipment should be installed and operated with minimum distance 20cm between the radiator & your body.

2.7 Antennas

This radio transmitter Y8E-VMDR has been approved by Federal Communications Commission to operate with the antenna types listed below, with the maximum permissible gain indicated. Antenna types not included in this list that have a gain greater than the maximum gain indicated for any type listed are strictly prohibited for use with this device.

| Operating frequency band | Antenna type | Maximum Antenna gain |
|--------------------------|------------------|----------------------|
| 902-928Mhz | External Antenna | 1.5dbi |

2.8 Label and compliance information

The final end product must be labeled in a visible area with the following" Contains FCC ID: Y8E-VMDR.

2.9 Information on test modes and additional testing requirements

Host manufacturer is strongly recommended to confirm compliance with FCC requirements for the transmitter when the module is installed in the host.

2.10 Additional testing, Part 15 Subpart B disclaimer

Host manufacturer is responsible for compliance of the host system with module installed with all other applicable requirements for the system such as Part 15 B.

INSTRUCTION TO THE USER

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 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 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.

FCC CAUTION: Any changes or modifications not expressly approved by the party responsible for compliance could void the user's authority to operate this equipment.