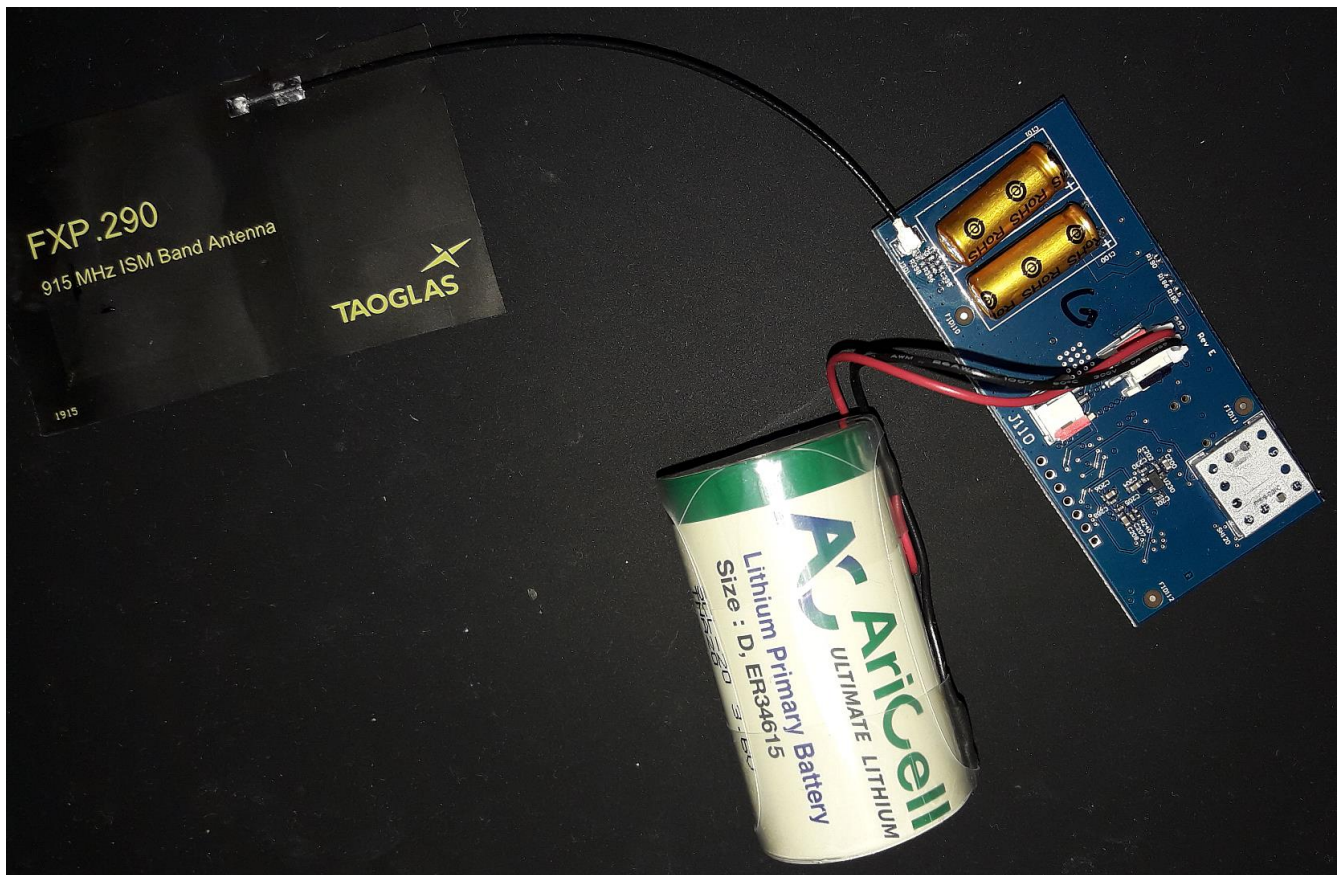


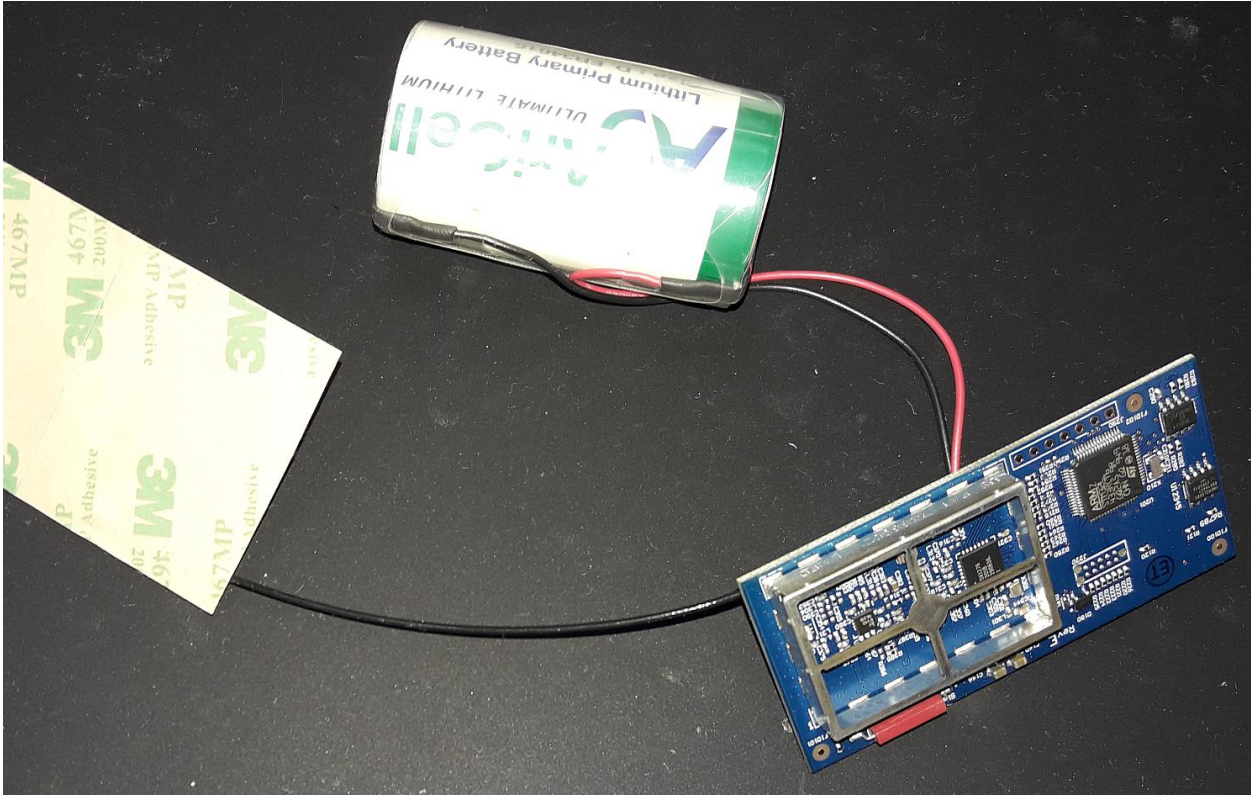
User Manual for VM 1W LoRa Water/Gas module

Last updated on: 11/04/2020

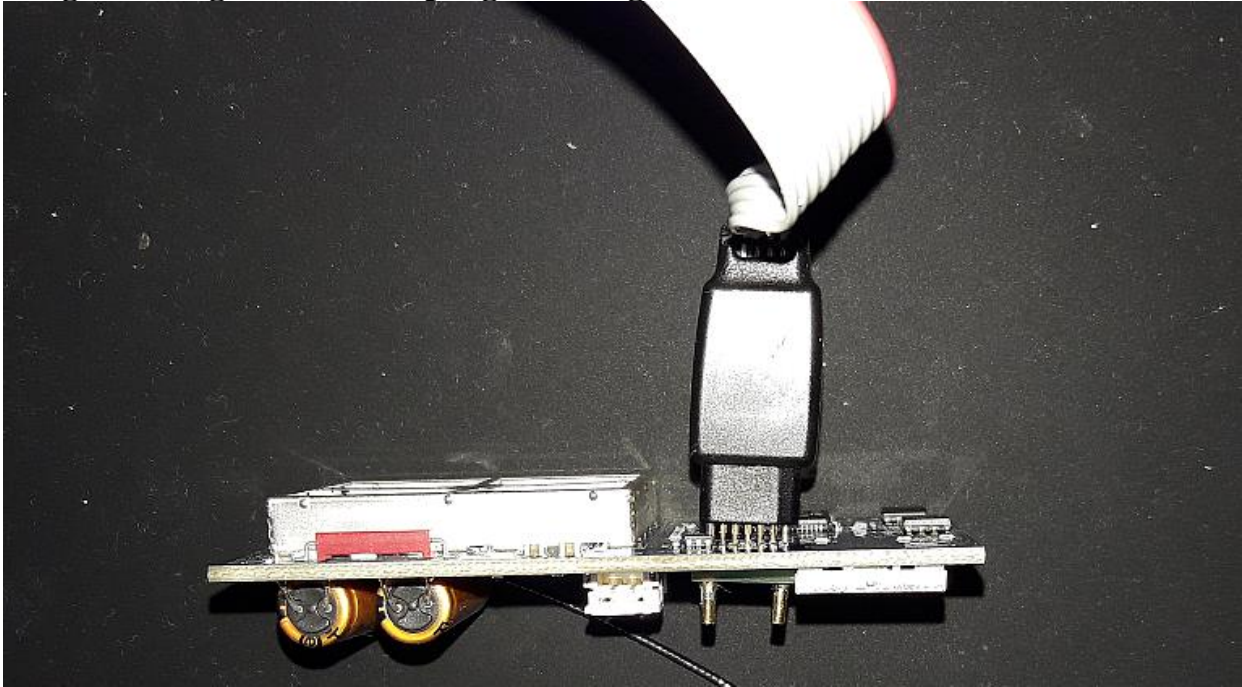
Power connection for the module

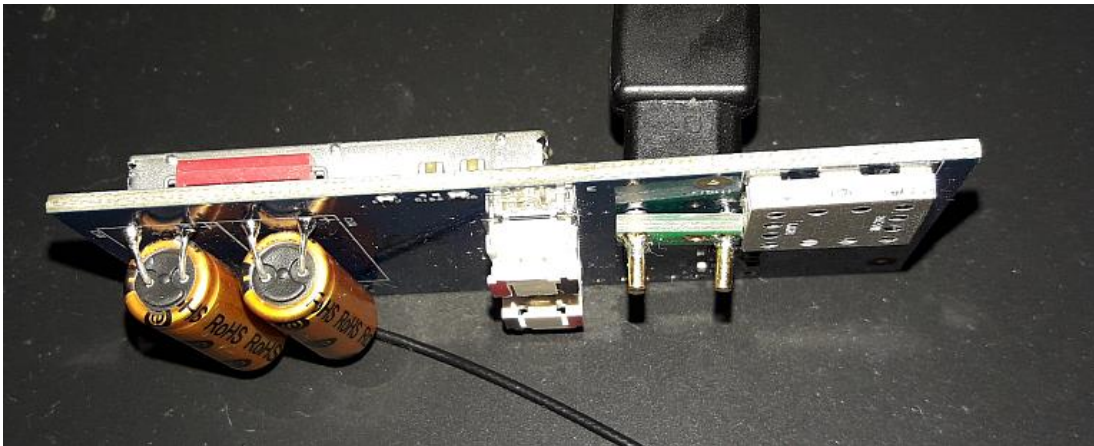
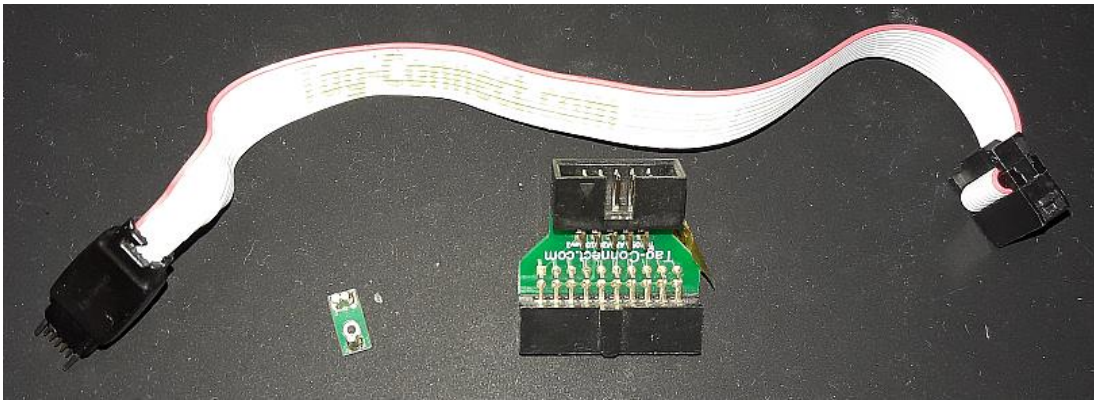
The power connection utilizes a 2-pin connector (part S2B-PH-SM4-TB) that is normally used to connect a 3.6V battery. There are 2 such connectors in opposing orientation. The polarity is marked in the picture below (black = ground, red = positive, 3.6V).





Programming header and programming cable



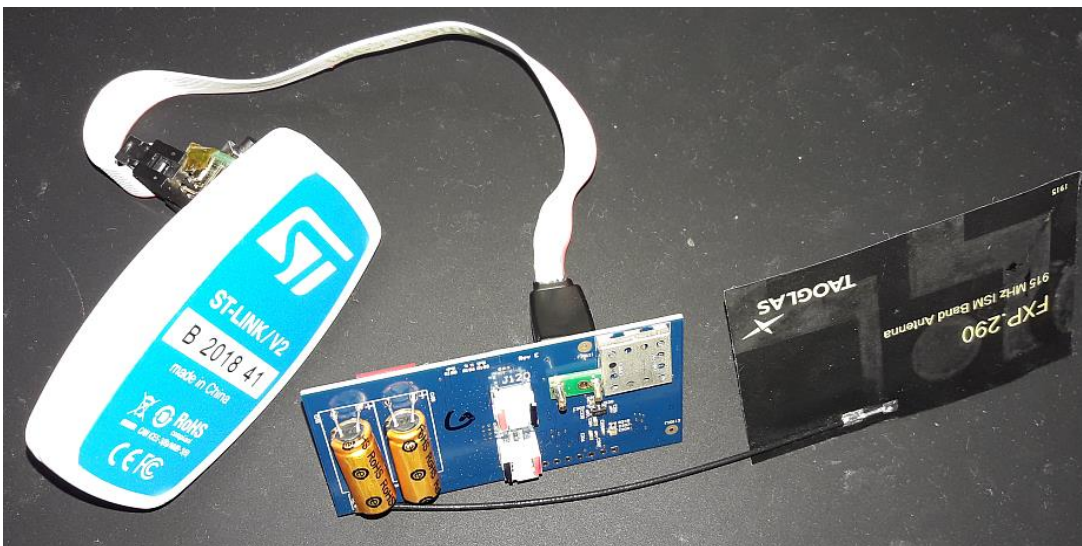


Programming instructions

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>

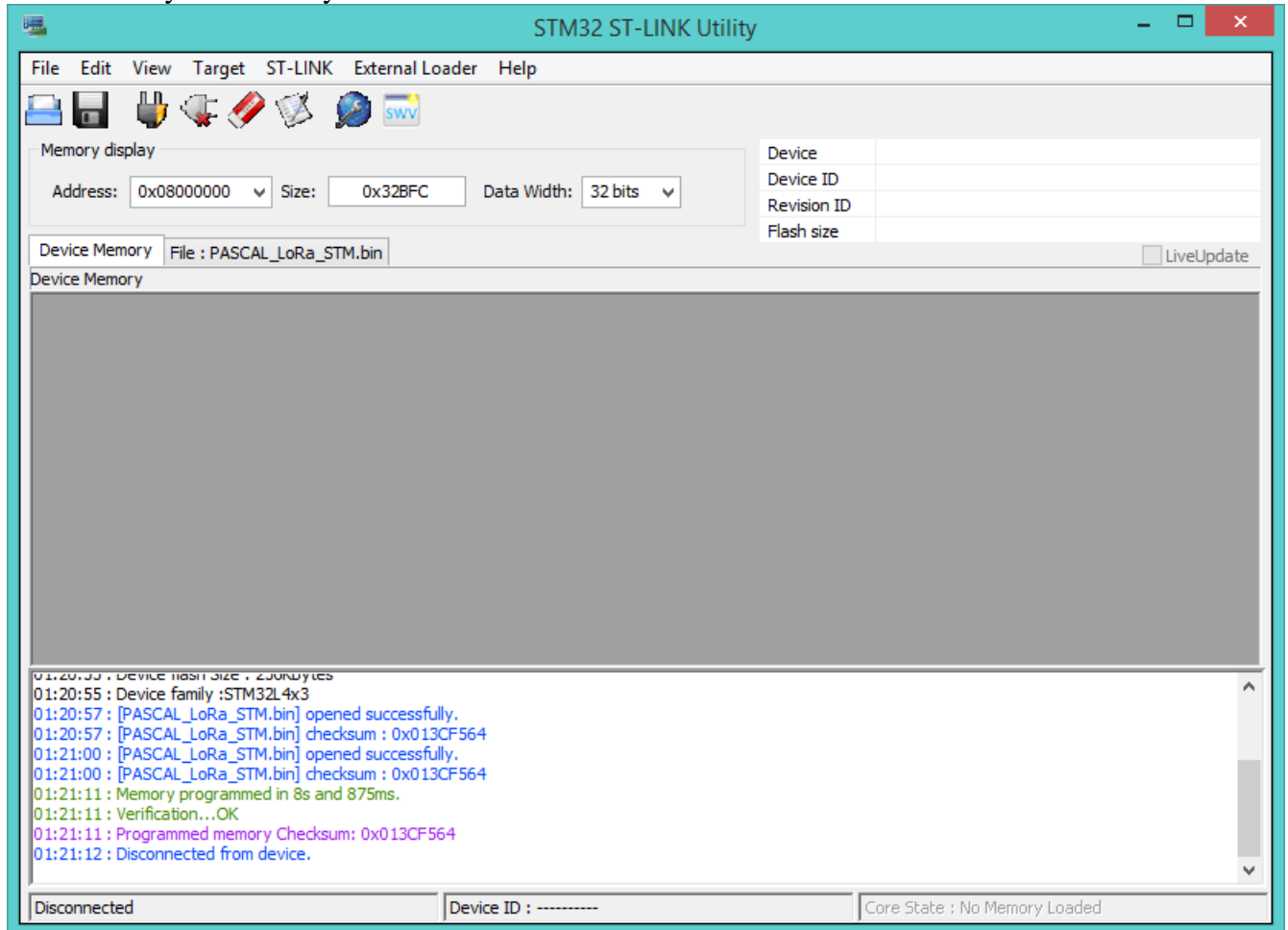
Programmer setup:



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 [VM_WTRGAS_FCC_MID.bin]

Start address:

File path:

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

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

```

11:55:02 : Connection mode : Connect Under Reset.
11:35:03 : Device ID:0x435
11:35:03 : Device flash Size : 256KBytes
11:35:03 : Device family :STM32L4x3
11:49:35 : Flash memory erased.
11:49:43 : [VM_WTRGAS_FCC_MID.bin] opened successfully.
11:49:43 : [VM_WTRGAS_FCC_MID.bin] checksum : 0x013CF564
11:51:11 : Memory programmed in 8s and 968ms.
11:51:11 : Verification...OK
11:51:11 : Programmed memory Checksum: 0x013CF564
  
```

Connection mode : Connect Under Reset. Device ID:0x435 Core State : Live Update Disabled

- 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_WTRGAS_FCC_LOW (transmit at 902.3Mhz)
- VM_WTRGAS_FCC_MID (transmit at 908.5Mhz)
- VM_WTRGAS_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_WTRGAS_FCC_TXHOP_PWR1

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))

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 RF5110G

2.8V TO 3.6V, ISM BAND, 32 dBm.

150MHz to 960MHz (used for TX only).

Absolute Maximum Ratings

Parameter	Rating
Storage Temperature	-55 to +150 °C
Device Voltage (V _{CC} , V _{CC1} , V _{CC2})	-0.5 V to +6.0 V
Control Voltage (V _{APC1} , V _{APC2})	-0.5 V to +3.0 V
Device Current (I _{CC} , I _{CC1} , I _{CC2})	2400 mA
RF Input Power	+13 dBm
Duty Cycle at Max Power	50%

Exceeding any one or a combination of the Absolute Maximum Rating conditions may cause permanent damage to the device. Extended application of Absolute Maximum Rating conditions to the device may reduce device reliability. This rating specified for GSM operation.

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 manufacturer.

2.4 Limited module procedures

This module is Limited module procedures.

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-VM-LORA-2 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-VM-LORA-2.

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.