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LoRa IoT Agriculture Sensor

User Guide

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1 Product Description

1.1 Overview

The Agricultural Sensor is a multi-purpose LoRaWAN IoT sensor intended for agricultural use. The Sensor supports up to four Analog and Digital inputs allowing for the remote capture of data. When the Greenhouse Probe is equipped the device becomes the "Greenhouse" model, this addition uses two inputs. Table 1 presents the Agricultural Sensor models. Without the Greenhouse probe the device becomes the "Farm" model.

Table 1: Agricultural LoRa IoT Sensor Models

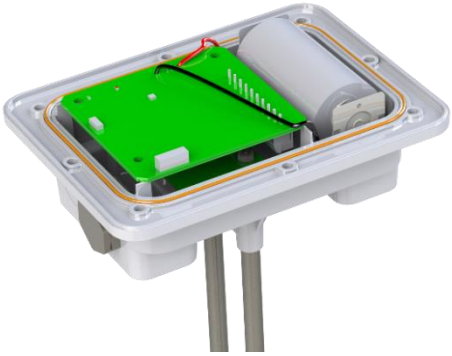
Product Code & Revision	Description	RF Region	Tx Band (MHz)	Rx Band (MHz)
T0005986	MODULE, AGRICULTURAL SENSOR & PROBE, FARM, LORA, NA	US 902-928 MHz (ISM Band)	923-928	902-915
T0005982	MODULE, AGRICULTURAL PROBE, GREENHOUSE, LORA, NA	US 902-928 MHz (ISM Band)	923-928	902-915

The main features of the Agricultural Sensor are the following:

- **Temperature & Relative Humidity Sensor:** Reports temperature and relative humidity of the local environment.
- **Accelerometer:** High sensitivity device that can measure any shock or movement events. The primary purpose is to measure impact alarms.
- **Light Sensor:** Reports the amount of light in the local environment.
- **Battery Gauge:** Fuel gauges for non-rechargeable lithium batteries that can provide accurate results with ultra-low average power consumption.
- **Watermark Probe:** Option to receive data on the water tension within the soil.
- **Greenhouse Probe:** Option to measure the soils moisture content and temperature.

Figure 1 illustrates the Agricultural Sensor Greenhouse Model in the enclosure.

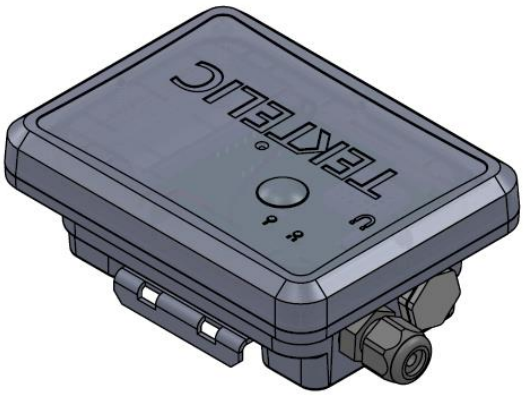
a) Exterior view



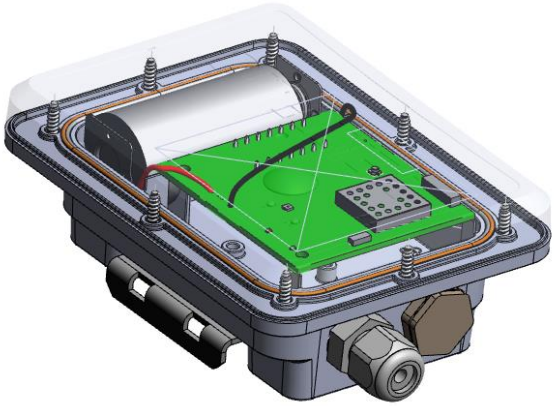
b) Inside view

Figure 1: Agricultural Sensor Greenhouse Model

Figure 2 illustrates the Agricultural Sensor Farm Model in the Enclosure.



a) Exterior view



b) Inside view

Figure 2 Agriculture Sensor Farm Model

1.2 Physical Interfaces

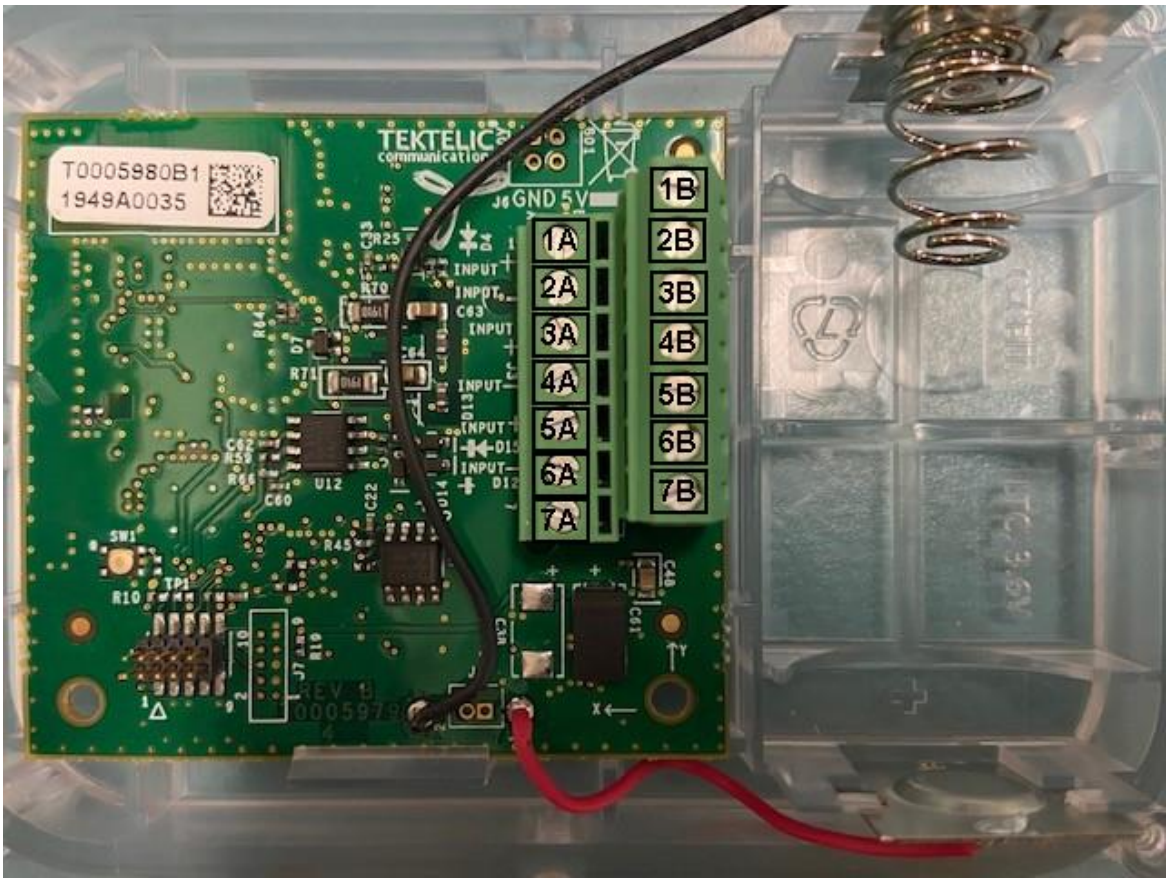
Legend:

1A = Input 2+ (RES)	1B = Input 1+ (RES)
2A = Input 2-	2B = Input 1-
3A = Input 3+ (RFU)	3B = Moisture 1+
4A = Input 3- (RFU)	4B = Moisture 1-
5A = Input 4+ (RFU)	5B = Moisture 2+
6A = Input 4- (RFU)	6B = Moisture 2-
7A = GND (RES)	7B = Power (RES)

RES = Reserved pins for Greenhouse Module Only

RFU = Reserved for future use

3 illustrates the customer accessible interfaces for the Agricultural Sensor. All models share the same layout.



Legend:

1A = Input 2+ (RES) 1B = Input 1+ (RES)

2A = Input 2-	2B = Input 1-
3A = Input 3+ (RFU)	3B = Moisture 1+
4A = Input 3- (RFU)	4B = Moisture 1-
5A = Input 4+ (RFU)	5B = Moisture 2+
6A = Input 4- (RFU)	6B = Moisture 2-
7A = GND (RES)	7B = Power (RES)

RES = Reserved pins for Greenhouse Module Only

RFU = Reserved for future use

Figure 3 Agriculture Sensor Connector Block

1.3 Specifications

The Agricultural Sensor specifications are listed in Table 2.

Table 2: Agricultural Sensor Specifications

Attribute	Specification
Use Environment	Outdoor
Environmental Rating	IP67
Operating Temperature	-40°C–85°C
Storage Temperature for Optimal Battery Life	-40°C–75°C
Operating Relative Humidity	0%–100%, condensing
Storage Relative Humidity	0%–100%, condensing
Size	Greenhouse Sensor: 120 mm x 90 mm x 58 mm (H=161mm with probes) Farm Sensor: 120 mm x 90 mm x 47 mm
Weight	Greenhouse Sensor: 224g Farm Sensor: 220g (233g with mounting plate)
Power Source	Battery powered: 1x C-cell Lithium Thionyl Chloride (LTC)
Network technology/Frequency band	LoRaWAN in multiple variants (see Table 1): US 902-928 MHz
Air Interface	LoRa
Battery Lifetime	At least 10 years with a baseline use case: transmission at maximum power every 15 minutes at room temperature.

Maximum Tx Power	22 dBm
LED	Green: Joining the network activity Red: LoRa Tx or Rx activity
Sensing Functions	MCU temperature, ambient temperature, ambient humidity, ambient light, accelerometer, battery gauge, water tension, soil moisture, soil temperature
MCU Temperature Measurement Accuracy	$< \pm 5$°C between -40°C and 85°C
Ambient Temperature Measurement Accuracy	± 0.2°C and ± 2% RH within temperature measurement range of -40°C to 125°C
Soil Moisture, Input 1	1.33 – 1.37MHz
Soil Temperature, Input 2	0.5 – 1.5V
Input 3	Not used.
Input 4	Not used.
Watermark (Input 5 & 6)	80 – 8000 Hz

†From the manufacturer datasheet.

2 Installation

2.1 Included Product and Installation Material

The following items are shipped with each sensor:

- LoRa IoT Agriculture Sensor with battery installed.
- A magnet to wake up the sensor from DEEP SLEEP.

2.2 Safety Precautions

The following safety precautions should be observed:

- The Agriculture Sensor is not a toy, KEEP AWAY FROM CHILDREN.
- Use only the specified Lithium Thionyl Chloride (LTC) cells.
- Do not exceed the maximum specified terminal voltages.
- All installation practices must be in accordance with the local and national electrical codes.
- Sensor inputs do not provide electrical isolation between each other.

2.3 Unpacking and Inspection

The following should be considered during the unpacking of a new Agricultural Sensor:

- Inspect the shipping carton and report any significant damage to TEKTELIC.
- Unpacking should be conducted in a clean and dry location.
- Do not discard the shipping box or inserts as they will be required if a unit is returned for repair or re-configuration.

2.4 Equipment Required for Installation

The following tools are required to install the Agricultural Sensor:

- Torx T10 screwdriver (8 x enclosure screws)
- Slotted screwdriver (internal terminal block connections)
- Wire Stripper
- Wire Cutter

2.5 Agricultural Farm Sensor Mounting

On the Farm model of the Agricultural Sensor, there is a mounting bracket on the bottom of the unit. See Figure 4. These mounting holes can be used to screw the enclosure to a solid surface. The recommended mounting screw size is M3 or #6. Mounting screws are not provided with the sensor.

Figure 4 Mounting Holes

The mounting surface must be capable of holding > 2 kg [4.5 lbs]. Clearance must be provided for the modules cable gland and input cable.

2.6 Cable Installation

The Agriculture Sensor enclosure is provided with a waterproof cable gland through which all connections must be routed. The supplied cable gland size is PG-7. This gland supports cables with a jacket outside diameter of 3.0 mm to 4.3 mm (0.118" to 0.169").

The I/O terminal blocks accept 30-16 AWG wire. Select a cable that meets the application requirements and local and national electrical codes.

Figure 3 shows the terminal block wiring connections. To install the cable, first make the appropriate connections between the input cable and the terminal block. Next dress the internal wires so that the cable gland seals against the outer cable jacket. Finally, tighten the cable gland.

See Figure 3 on Page 9 for input connections. Signal connections should be connected to the positive terminal (labeled '+'). Similarly, the return path should be connected to the negative terminal (labeled '-') of the matching I/O channel.

NOTE: Agricultural Sensor I/O are referenced to the sensor ground and are not isolated.

3 Power Up, Commissioning and Monitoring

3.1 Awakening Procedure

The Agriculture Sensor is shipped in closed enclosure with the batteries installed and engaged. However, the Agriculture Sensor is in a state of DEEP SLEEP where it draws infinitesimal current, until it is woken up (activated) by the provided magnet[1].

The Agriculture Sensor does not need to get opened for activation. Assuming that the Agriculture Sensor has been commissioned on the NS, use the magnet to wake up the Agriculture Sensor as illustrated in Figure 6. A magnet presence is achieved by bringing the magnet close to the magnet sign on the top of the enclosure (or by attaching the magnet to the enclosure at the magnet sign). See Figure 5 below. A magnet absence is achieved by taking the magnet at least 2 cm away from the enclosure.

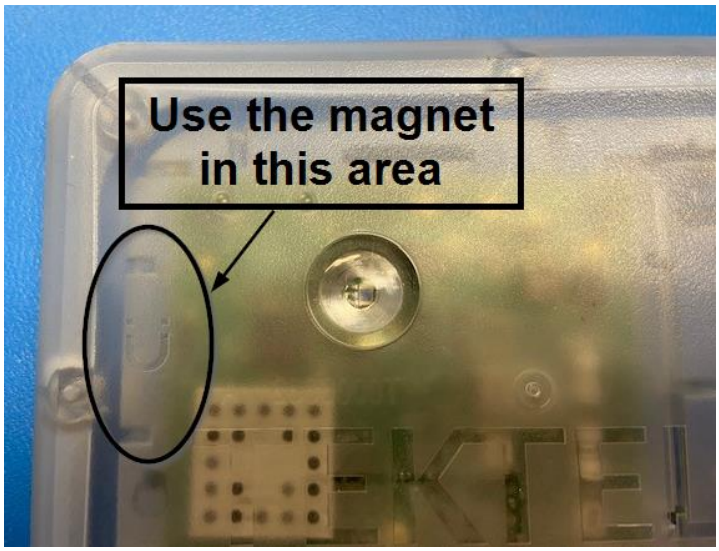


Figure 5 Magnet Location

Here are the steps as illustrated in Figure **Error! Reference source not found.**6:

1. Bring the magnet close, then take it away, then bring it back again, all at a normal pace.
2. Keep magnet attached to the enclosure at the magnet sign for at least 3 sec but less than 10 sec.
3. Keep the magnet away for at least 3 sec.

[1] Any magnet almost as strong as Standex-Meder M4, M5, or M13 can be used as well.

As soon as the specified magnetic pattern is applied to the Agriculture Sensor, the Agriculture Sensor is reset and tries to join the network. See section 4.3 for the expected LED behaviour of the Agriculture Sensor during the join process. It may take about 10 sec from the Agriculture Sensor reset to seeing the LED activity showing join attempts. Therefore, as step 2 in the above is completed, it takes about 13 seconds before observing the LED activity (provided that step 3 is respected).

Note that the specified magnetic pattern always triggers a module reset, even during normal operation. Such a reset also activates an already in-DEEP-SLEEP module.

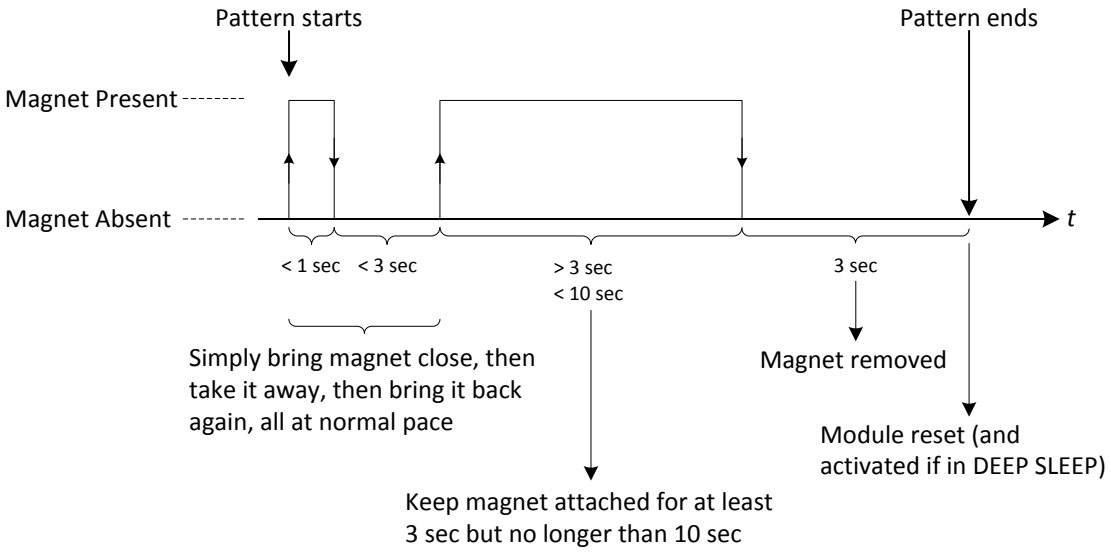


Figure 6 Agriculture Sensor Magnetic Reset/Wake-Up Pattern

The Agriculture Sensor can be put into DEEP SLEEP at any time by opening it up and pressing the internal sleep button labeled as SW1 and located visibly on top of the Agriculture Sensor PCBA. See Figure 7 below.

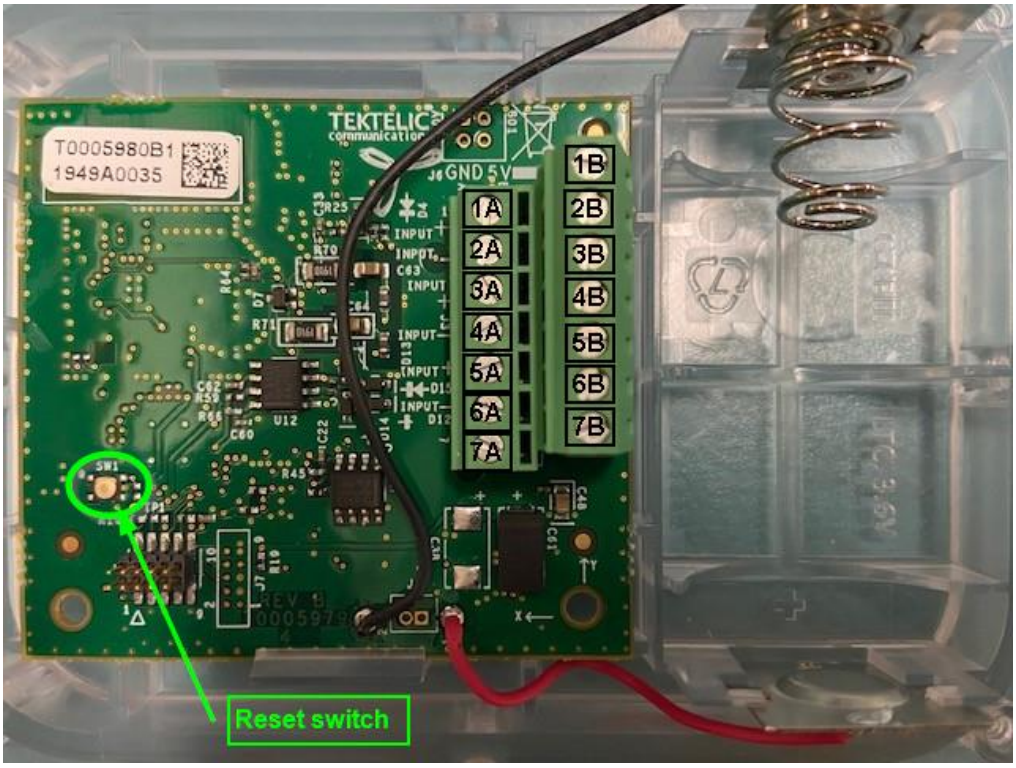


Figure 7 Reset Switch Location

If put to DEEP SLEEP, the Agriculture Sensor can be woken up (activated) again using the same procedure explained above, i.e. by the use of the magnet. Removing and reinserting the batteries can also activate the Agriculture Sensor.

Note: Replacing the batteries of the Agriculture Sensor does not cause the Agriculture Sensor to go to DEEP SLEEP. As soon as a new battery is inserted, the Agriculture Sensor boots up and tries to join a LoRaWAN network.

3.2 Commissioning

To add your sensor to the Network Server, you will need to enter the DevEUI, AppEUI and AppKey that were provided for your device from Tektelic.

4 Battery Replacement

Open up the Agriculture Sensor using a #10 Torx screwdriver. The Agriculture Sensor has 8x enclosure Torx screws at the bottom. Be careful not to misplace the silicone cover gasket from the top lid.

Replace the battery. The Agriculture Sensor accepts C-size, 3.6 V, LTC batteries. The allowed replacement batteries are as follows:

- Xeno Energy, part number: XL-145F
- Tadiran Battery, part number TL-4920/S
- Tadiran Battery, part number TL-5920/S

Once the Agriculture Sensor is powered and tries to join (see Section 5.3 for LED behavior), replace the cover and gasket. Make sure that the gasket is properly seated in the cover before placing on the Agriculture Sensor housing. Tighten the 8 cover screws to 2.5 lbf-in (30 N-cm).

5 Operation, Alarms, and Management

5.1 Configuration

The Agricultural Sensor supports a full range of Over-the-Air (OTA) configuration options. Specific technical details are available in the Agricultural Sensor Technical Reference Manual. All configuration commands need to be sent OTA during a sensor's downlink windows.

5.2 Default Configuration

The default configuration on the Agricultural Sensor is:

- Report the remaining battery lifetime every day.
- Report ambient temperature every 15 minutes.
- Report ambient RH every 15 minutes.
- Report ambient light every 15 minutes.
- In the Sensor and Probe model only: Report soil moisture every 15 minutes.
- In the Sensor and Probe model only: Report soil temperature every 15 minutes.

5.3 LED Behaviour

The LED's are located on the top of the Agricultural Sensor. See Figure 8.

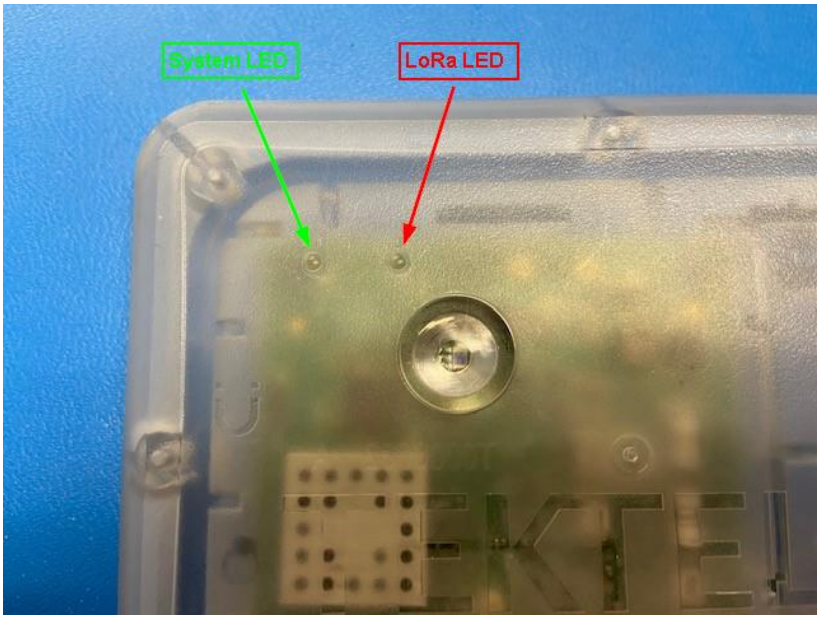


Figure 8 LED Location

During the boot and join procedure:

- Both LEDs will come on briefly when power is first applied.
- After a small delay (< 1 second) the LEDs will turn off and one of them will blink briefly.
    - If the System (green) LED blinks, then all health checks on the board have passed.
    - If the LoRa LED (red) blinks, then one of the health checks has failed. Consider replacing the battery, or moving the sensor to an environment within the temperature range.
- Immediately after the delay, the join procedure will begin. During the time the System LED will blink continuously until the sensor joins a network.
- The LoRa LED will now blink whenever LoRa activity occurs on the sensor (transmitting or receiving packets).

During normal operation:

- The LoRa LED will blink whenever LoRa activity occurs on the sensor (transmitting or receiving packets)
- The System LED can be controlled via the downlink command interface.

6 Compliance Statements

Federal Communications Commission

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.

To comply with FCC exposure limits for general population / uncontrolled exposure, this device should be installed at a distance of 20 cm from all persons and must not be co-located or operating in conjunction with any other transmitter.
Changes or modifications not expressly approved by the party responsible for compliance could void the user's authority to operate the equipment. 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 in an industrial 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 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.

Innovation, Science and Economic Development Canada:

This device contains licence-exempt transmitter(s)/receiver(s) that comply with Innovation, Science and Economic Development Canada's licence-exempt RSS(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.

This device should be installed and operated with minimum distance 0.2 m from human body.
L'émetteur/récepteur exempt de licence contenu dans le présent appareil est conforme aux CNR d'Innovation, Sciences et Développement économique Canada applicables aux appareils radio exempts de licence. L'exploitation est autorisée aux deux conditions suivantes:
a. L'appareil ne doit pas produire de brouillage.

b. L’appareil doit accepter tout brouillage radioélectrique subi, même si le brouillage est susceptible d’en compromettre le fonctionnement.

Cet appareil doit être installé et utilise à une distance minimale de 0.2 m du corps humain. “

Proposition 65

⚠ WARNING: This product can expose you to chemicals including lead, nickel & carbon black, which is known to the State of California to cause cancer, birth defects or other reproductive harm. For more information, go to www.P65Warnings.ca.gov.

References

[1] LoRa Alliance, "LoRaWAN 1.1 Regional Parameters," ver. 1.1, rev. B, Jan 2018.

[2] TEKTELIC Communications Inc., " LoRa IoT Agricultural Sensor System Design Specification" ver. 1.2, May 2019.