TEKTELIC Communications Inc.
7657 10th Street NE Calgary, Alberta
Canada, T2E 8X2

LoRa IoT Smart Room Sensor

User Guide

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TEKTELIC Communications Inc.
7657 10th Street NE
Calgary, AB, Canada T2E 8X2
Phone: (403) 338-6900

Revision History

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0.1	Jun 12, 2019	Draft	Emma Tholl	Initial Draft.
0.2	Jun 17, 2019	Release	Emma Tholl	Added region info, made corrections.
0.3	Aug 7, 2019	Release	Shawn Morrison	Updated battery warning statements.
0.4	Aug 15, 2019	Release	Maheeka Wijesinghe	Added P65 warning.
1.0	Jul 30, 2019	Release	Reza Nikjah	• Release for NA and DN certification: • Updated for cable clip in Base model. • Updated for digital and analog modes of External Connector. • Updated for battery type. • Updated for maximum output power. • Updated for Light Transducer operation. • Updated for Accelerometer operation. • Updated for PIR sense pattern for ceiling-mount and wall-mount lenses.
1.1	Aug 13, 2019	Release	Reza Nikjah	Compliance statements for Industry Canada were updated and also given in French.
1.2	Aug 14, 2019	Release	Reza Nikjah	Added to compliance statements.
1.3	Oct 16, 2019	Release	Reza Nikjah	• Added EU and CN regional variants • Added more information about the cable clip attached on Base models.
1.4	Nov 7, 2019	Release	Reza Nikjah	• Updated based on internal reviews. • Included missing info from versions 0.3 and 0.4. • Updated the document format.
1.5	February 25, 2020	Release	Carter Mudryk	Updated LED Behaviour section to include typical dead battery behaviour.

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1 Product Description

1.1 Overview

The Smart Room Sensor is a multi-purpose LoRaWAN IoT sensor packed into a very small form factor. The Smart Room Sensor is ideal for monitoring and reporting temperature, humidity, light, shock and open/closed doors and windows in an indoor environment. Additional sensing features such as leak and motion detection, as well as counting pulses from an external device, are also supported with the appropriate Room Sensor model.

Table 1-1 presents the available Smart Room Sensor models with their corresponding order codes. The T-Code is a TEKTELIC specified code for each HW variant. Each HW variant can have different FW making it suitable for a specific LoRaWAN region as indicated in Table 1-1. The Tx and Rx frequency plan for each model is a function of the LoRaWAN RF region, and has been explained in [1].

Each sensor has two labels at the back. One label indicates the module T-Code, module revision, module serial number, and applicable certifications. The other label has a QR code containing the module AppEUI, DevEUI, and order code.

The Smart Room Sensor has two *functional* variants, Base (or non-PIR) and PIR (as can also be observed in Table 1-1). Table 1-2 presents the features available in the Base and PIR variants.

Table 1-1: Smart Room Sensor Models

Module HW Variant	Module T-Code	Module FW Variant (LoRaWAN RF Regional Variant)	Order Code
NA Base (non-PIR)	T0006115	US915	TBD
		AS923	TBD
		AU915	TBD
		KR920	TBD
NA PIR	T0006116	US915	TBD
		AS923	TBD
		AU915	TBD
		KR920	TBD
EU Base (non-PIR)	T0006117	EU868	TBD
		IN865	TBD
		RU864	TBD
EU PIR	T0006118	EU868	TBD
		IN865	TBD
		RU864	TBD
CN Base (non-PIR)	T0006161	CN470	TBD
CN PIR	T0006162	CN470	TBD

DN Base (non-PIR)	T0006163	DN915	TBD
DN PIR	T0006164	DN915	TBD

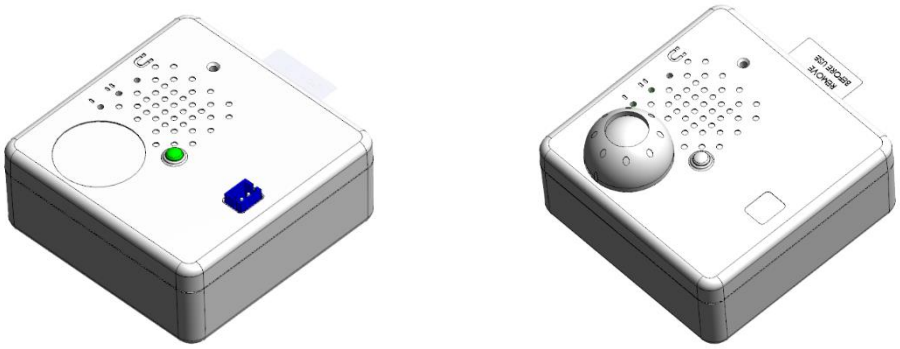
Table 1-2: Smart Room Sensor Functional Variants

Sensor Function	Base Model	PIR Model
Temperature	X	X
Relative Humidity	X	X
Accelerometer	X	X
Light Detection	X	X
Human Motion Detection (PIR)		X
Magnetic Switch	X	X
External Connection	X	
Moisture Detection	X	

The functions indicated in Table 1-2 are as follows:

- **Temperature & Relative Humidity:** Transducer reports temperature and relative humidity of the local environment.
- **Accelerometer:** Configurable triggers allow the sensor to detect if it has been moved.
- **Light Detection:** Light transducer reports the presence or absence of light using a configurable intensity threshold.
- **Motion Detection (PIR):** A top mounted PIR transducer detects people moving within the sensor's field of view (FoV).
- **Magnetic Switch:** Digital On/Off sensing with an internal magnetic switch.
- **External Connection:** In the digital mode, external contacts connected with a short cable can be monitored for on/off states or used to count events. In the analog mode, a thermistor can be connected for remote temperature sensing.
- **Moisture Detection:** Capacitive transducer mounted in the sensor case detects pooling water under the device for flood or leak detection.

Figure 1-1 illustrates the two Smart Room Sensor functional variants. Both variants share the same external dimensions (42mm x 42mm x 17mm).



Base Model **PIR Model**

Figure 1-1: The Smart Room Sensor models.

1.2 Physical Interfaces

Figure 1-2 illustrates the customer accessible interfaces for the Smart Room Sensor. All models share the same layout, though only functional interfaces are exposed in the case of each model. For example, a Base model has been shown in Figure 1-2, which does not have the PIR element (the PIR transducer indicated in the figure is the location for the actual PIR transducer in the PIR variant). Also, the PIR variant does not have the External Connector. Not shown in Figure 1-2, the Base variant has two internal moisture probes for moisture (leak) detection. The PIR variant does not have these probes and does not offer moisture detection.

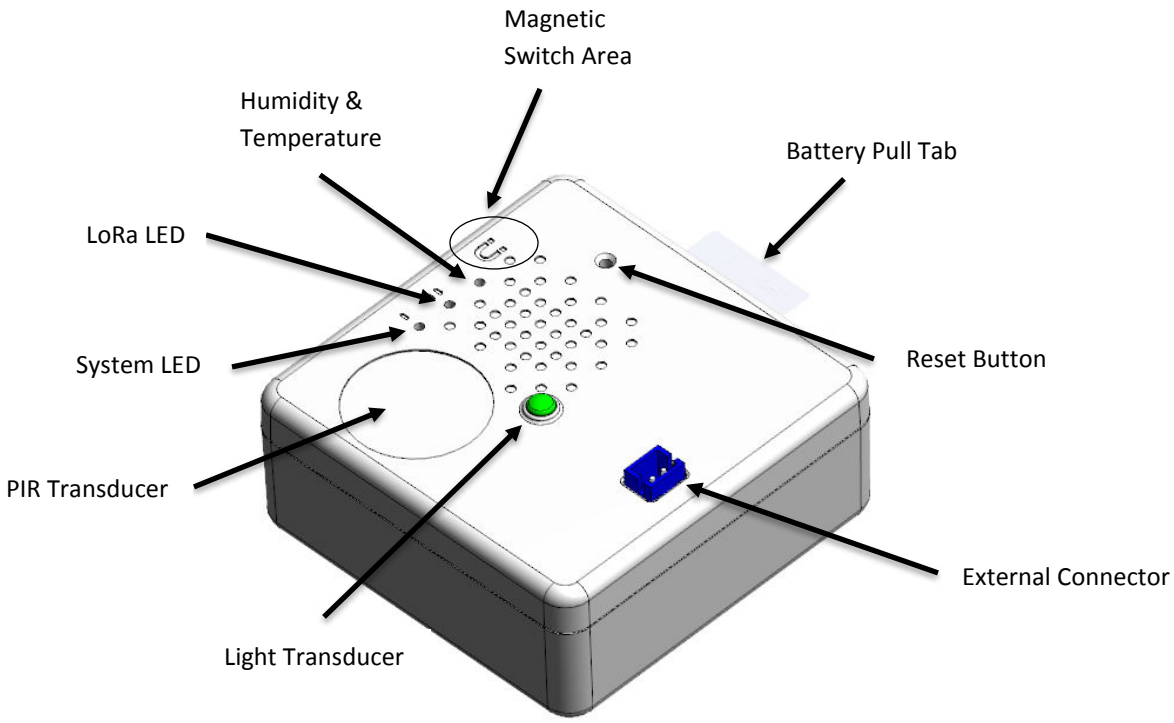


Figure 1-2: The Smart Room Sensor external interface layout.

1.3 Specifications

The Smart Room Sensor specifications are listed in Table 1-3.

Table 1-3: Smart Room Sensor Specifications

Parameter	Requirement
Use environment	Indoor commercial/residential only
Operating temperature	0°C–60°C 10°C–40°C for optimal battery life
Storage temperature	-30°C–60°C 0°C–30°C for optimal battery life
RH	5%–95%, non-condensing
Size	42 mm x 42 mm x 17 mm (enclosure) 42 mm x 42 mm x 20 mm (with bracket assembly)
Weight	25 g
Power source	CR2477 Battery operated, with FET based reverse polarity protection.
Network technology/Frequency band	LoRaWAN in the following regions:

	EU868, US915, AU915, CN470, DN915, AS923, , IN865, KR920, DN915, RU864
Air interface	LoRa
Lifetime	$>$ 5 years Base model with the baseline use case[1] $>$ 3.5 years PIR model with the baseline use case
Maximum transmit power	14 dBm
Number of indicator LEDs	2 (red)
Measurement sensing functions	Temperature, humidity, light, acceleration, remote temperature sensing
Detection sensing functions	Moisture, movement, magnetic field, external connector
Temperature measurement accuracy	$<\pm 0.3$°C between 0°C and 5°C ± 0.2°C between 5°C and 60°C
Humidity measurement accuracy	$<\pm 4$% between 0% and 100% ± 2% between 20% and 80%
Light sensitivity	Detection of weak light to typical light conditions (5 lux to 1000 lux) Peak sensitivity at 500 nm
Accelerometer sensitivity	16 m*g*/LSB, 32 m*g*/LSB, 64 m*g*/LSB, 192 m*g*/LSB corresponding to measurement ranges of ± 2 *g*, ± 4 *g*, ± 8 *g*, ± 16 *g*
Moisture detection	Capacitive moisture detection Range: ~ 0 mm from bottom surface of sensor case
Motion detection	Pyroelectric infrared sensor, four-element Two lens type options: ○ Ceiling mount • X-angle: 86° • Y-angle: 74° • Height: 2.67 m ○ Wall mount • X-angle: 94° • Y-angle: 20° • Z-range: 4 m
Magnetic switch actuation distance	Operating range: 5-15 AT Requires about 10 gauss at edge of sensor to activate

[1] The baseline use case:
Temperature: 23°C
Tx power: 14 dBm
LoRa SF: 10
Tx periodicity: 4 times/hour for 10 hours and 2 times/hour for 14 hours (= 68 times/day)

	Actuation distance at least 15 mm
External Connection	Designed to connect to an open-drain output 1.8 V compliant input with pull-up Input pulse frequency <= 20 Hz
Remote Temperature Sense	A remote temperature probe (thermistor)—recommended 10-kΩ—can be connected to External Connector Measurement range: -55°C–125°C (CWF3AA103G3380) -25°C–105°C (NTCAIMME3)

1.3.1 Temperature and Relative Humidity Transducer

The Room Sensor models contain a Temperature and Relative Humidity Transducer. Details on the transducer range and accuracy are listed in Table 1-3. Note that because the transducer element is located inside the Sensor housing sense response time will not be immediate. An opening in the top cover surface directly over the transducer is designed to allow ambient air to contact the transducer. Response time can be reduced by forcing air to move over the Sensor in the region of the transducer opening. MCU temperature is also reported. This is a less accurate temperature measurement using a transducer located in the Room Sensor microprocessor.

The Sensor can be configured to report temperature and RH values or to report alarms based on a customer configured normal operating window. High and low alarm points can be set individually for temperature, humidity and MCU temperature. The sample rate for checking the transducers is user configurable with different sample rates settable if the measured value is inside or outside the normal operating window.

1.3.2 Acceleration Transducer

The Acceleration sensing is provided by an integrated 6-axis accelerometer, which can be disabled to conserve battery life. The Room Sensor supports two independent interrupt-based accelerometer events with configurable thresholds: acceleration event and impact alarm event.

The acceleration event is based on exceeding an acceleration threshold. The accelerometer is disabled for a configurable debounce time after an acceleration event such that there will not be multiple reports for a single event. The impact alarm event is raised when an impact alarm threshold is exceeded for a configurable number of times within a configurable period. The impact alarm is cleared after a grace period of no impact alarms. Both acceleration and impact alarm functions can be independently disabled or enabled.

Accelerometer readings can be in the form of the X-Y-Z acceleration vector or the magnitude of such vector, and can be reported periodically. The X, Y, and Z axes can be independently disabled or enabled. The output value for a disabled axis is zero.

The rate at which acceleration is sampled is configurable to 1 Hz, 10 Hz, 25 Hz, 50 Hz, 100 Hz, 200 Hz, or 400 Hz. Higher sample rates allow the detection of shorter acceleration events at the cost of shorter battery life. This is an important consideration when configuring the acceleration and impact alarm functions. The default sample rate is 1 Hz.

1.3.3 Ambient Light Transducer

The Smart Room Sensor models contain an ambient light sensor. Light is measured through a light pipe located on the top surface of the Sensor. The Sensor can report both the light intensity (periodically) and the light status (dark or bright) based on a configurable light threshold. The transducer is sensitive to human visible light with a peak sensitivity at 550 nm. The approximate light intensity sensing range is 5 lux to 1000 lux.

The light threshold is customer settable over the range of 1 to 63. If the light status is dark and a light intensity greater than the set point is detected, or if the light status is bright and a light intensity smaller than the threshold is detected, an event is reported. The event-based reporting can be disabled or enabled. The customer needs to test their application for the appropriate trigger point. The sample rate is also customer settable with higher sample rates increasing battery consumption.

1.3.4 Motion Detection (PIR) Transducer

The Room Sensor PIR model contains a Motion Detector. The Motion Detection Transducer contains PIR elements and is configured to sense human motion within its field of view (FoV). The transducer has ceiling-mount and wall-mount Fresnel lens options. Combined with the ceiling-mount lens, the sense range for a ceiling height of 2.7 m is a rectangular area of 5 m x 4 m. Figure 1-4 and Figure 1-4 show the (theoretical) sense pattern for the ceiling-mount and wall-mount lenses[2]. The rectangular boxes inside the pattern shown in Figure 1-4 appear in

[2] This is the theoretical maximum sense range as claimed by the transducer manufacturer. The sense range is determined as the projection of the transducer FoV on the ground, and therefore, should not be interpreted as the coverage area where the sensor can detect moving people. In general, due to the conical nature of the transducer FoV, people need to be closer to the sensor to be detected. The amount of IR radiation from a moving person, which is also impacted by the person's clothing or type of skin cover, also plays an important role at determining the detection range. In a test performed at the TEKTELIC lab, the sensor was mounted on the ceiling with a height of **2.67 m**. The coverage area for a person moving around with business casual clothing was obtained as an area of about **5 m x 4 m**. This corresponds to X-angle and Y-angle being approximately **86°** and **74°**. In another test, the Z-range with the wall-mount lens for a walking person within the center of the FoV was measured to be about **4 m**.

pairs and represent sensor element beams (the pattern shown correspond to a dual-element PIR transducer). To be most effective at detecting motion, the subject must move across sensor element beams. The Room Sensor should be mounted so that the subjects move across its FoV and not towards or away from the Sensor. The sense pattern alignment to the Room Sensor body for the ceiling-mount lens is shown in Figure 1-5. The X and Y ranges shown in Figure 1-5 are for a ceiling height of 2.7 m.

Note: Avoid exposing the PIR lens to strong UV light such as direct sunlight. Do not paint the surface of the lens or attempt to clean it. Any deformation of the lens will distort the sense pattern.

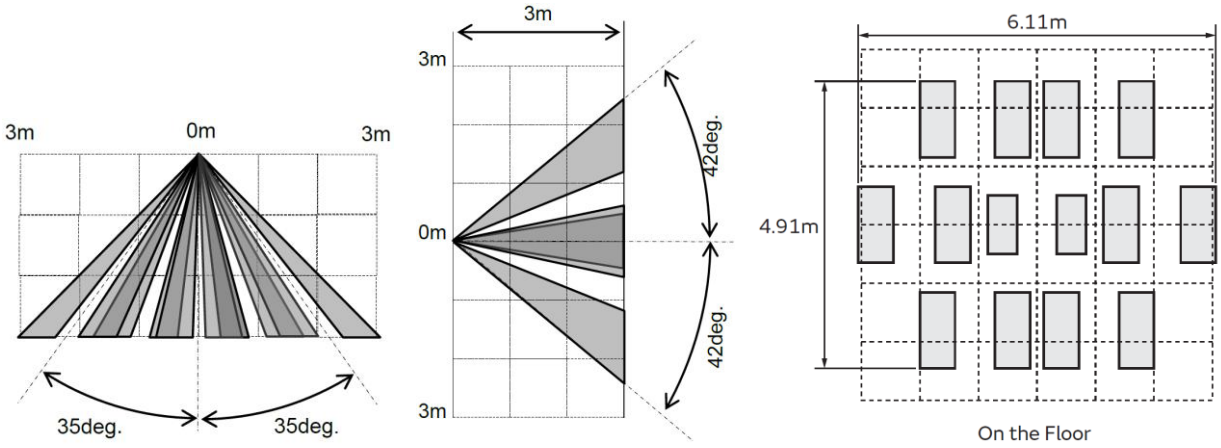


Figure 1-3: The PIR Transducer theoretical sense pattern with the ceiling-mount lens.

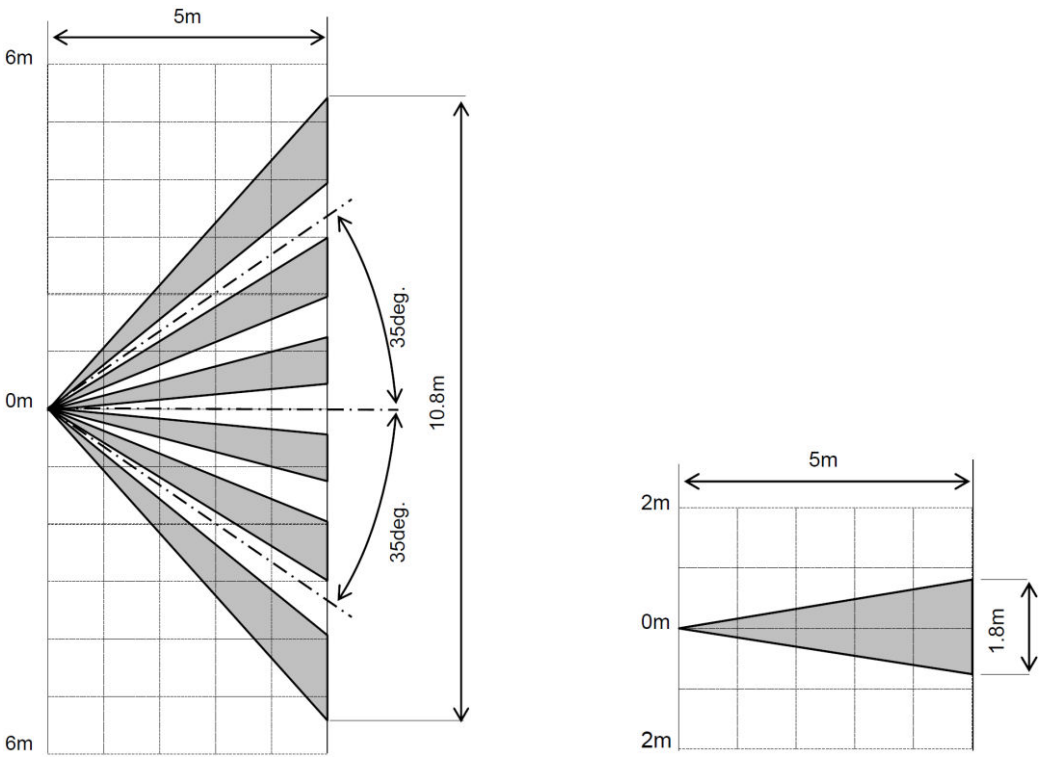


Figure 1-4: The PIR Transducer theoretical sense pattern with the wall-mount lens.

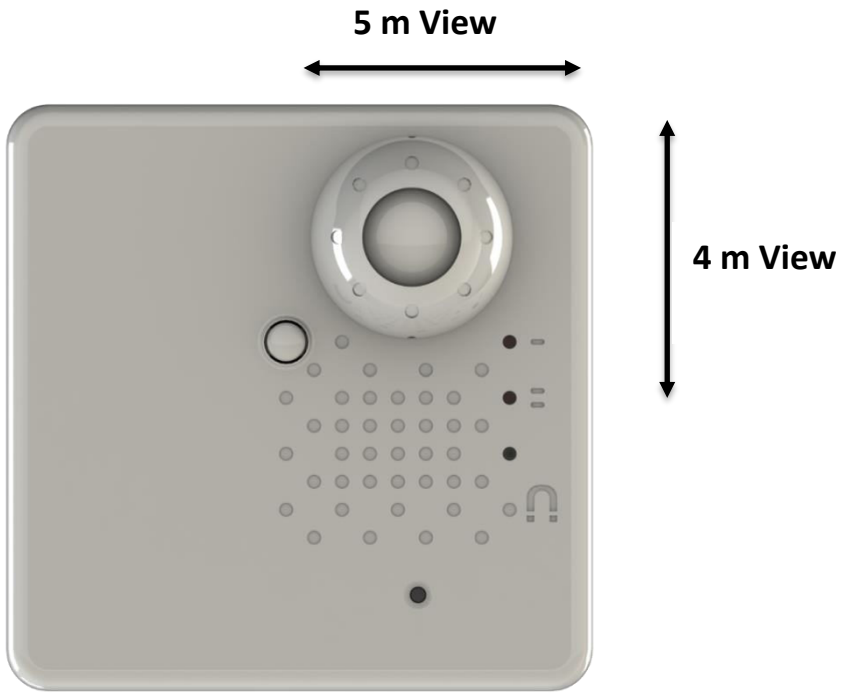


Figure 1-5: The alignment of PIR sense pattern with the ceiling-mount lens to the Room Sensor body.

To conserve battery usage, the Room Sensor only reports motion when it is first detected and when motion has not been detected for a configurable grace period. See Section 3.3.7 in the Room Sensor Technical Reference Manual [2] for a detailed description of how the motion function is configured.

1.3.5 Magnetic Switch

All Room Sensor models contain a reed magnetic switch. The location of the switch is shown in Figure 1-2. The Room Sensor can be configured to activate based on the state of this switch and to report after a customer settable count of switch events.

A customer supplied magnet is required to activate the switch. To activate the switch, a magnetic field of about 10 gauss (1 milli-tesla) must be applied to the edge of Sensor. Standex-Meder M4, M5 or M13 magnets are suggested but any magnet of sufficient strength can be used. Stronger magnets are required as the distance between the magnet and sensor increases. The customer must test their selected magnet in their application to verify functionality.

The switch function can be configured to sense open to close events, close to open events or both types of events. For example, if the Sensor is being used for sensing access to a door and is set to read both event types, it will record an event each time the door is opened and each time it is closed. The reporting of these events be set by the customer to report after a number of events has occurred. If it is set to 0, no events are reported. If it is set to 1, it reports after each event. If it is set to n, it will report after n events. This setting has a range of (n =) 0 to 65535 events.

1.3.6 External Connection

The Room Sensor Base model contains an External Connector, which has two modes, digital and analog. In the digital mode, the internal, control, and reporting interfaces of the External Connector are similar to, but independent from, the Magnetic Switch in the Base model. See Section 1.3.5 for a description of the event function configuration and reporting count feature, which are similar to those of External Connector.

In the digital mode, the External Connector electrical interface is designed to be connected to an open-drain output; however, the signal line can also be driven with digital signals at 1.8 V logic levels.

In the analog mode, the External Connector is connected to a 10-kΩ thermistor (recommended CWF3AA103G3380 or NTCAIMME3) for remote temperature sensing. The Sensor in this mode

of the External Connector reports voltages in mV, which can then be converted to temperatures. The conversion formula (voltage to temperature) can be obtained in one of the following ways:

1. Calibrating Thermistor and Performing Curve Fitting:
   A number of voltage-temperature pairs can be obtained for a given thermistor, then the following curve fitting formula can be used:

$$T = \frac{-B}{\ln\left(\frac{a}{V} - b\right)} - 273.15$$

   where *T* is in °C and *V* is in mV, and where *B* is the B-value of the thermistor (e.g. 3380 K for CWF3AA103G3380 or 3984 K for NTCAIMME3), to obtain the best *a* and *b* based on a desired criterion, e.g. MMSE (minimum mean square error) or minmax criterion.
   For example, for CWF3AA103G3380 and NTCAIMME3, using the MMSE criterion, the conversion formulas

$$T = \frac{-3380}{\ln\left(\frac{0.00314}{V} - 0.0000018\right)} - 273.15$$

   and

$$T = \frac{-3984}{\ln\left(\frac{0.000416}{V} - 0.00000024\right)} - 273.15$$

   are obtained, respectively.
2. Quick and Approximate Conversion Formula:
   Another easier, though less accurate, way to quickly characterize any NTC (negative temperature coefficient) thermistor is to use the following conversion formula:

$$T = \frac{-B}{\ln\left(\frac{26.43}{V} - \frac{1}{68.1}\right) + \ln\left(R_0\right) - \frac{B}{T_0}} - 273.15$$

   Where *T* is in °C and *V* is in mV, and where *B* is the B-value of the thermistor, and R_0 is the reference resistance, in *k*Ω, of the thermistor at the reference temperature T_0, in *K*. For example, for CWF3AA103G3380, $B = 3380$, $R_0 = 10$ and $T_0 = 273.15 + 25 = 298.15$.

3. Steinhart–Hart Equation:
   In this method the temperature of the thermistor, in K, is given as:

$$\frac{1}{T} = A + B\ln\left(\frac{R}{R_0}\right) + C\ln^2\left(\frac{R}{R_0}\right) + D\ln^3\left(\frac{R}{R_0}\right)$$

where R_0 is the reference resistance, in *k*Ω, of the thermistor (e.g. 10 *k*Ω), and where *R* is the thermistor resistance at temperature *T*, which can be obtained as

$$R = \frac{68.1 \times V}{1800 - V}$$

where *V* is the reported voltage from the sensor in mV.

Coefficients A, B, C, D are usually given by the thermistor manufacturer. If not given, the coefficients can be determined by measuring 4 voltage-temperature pairs from the thermistor, and forming 4 linear equations with 4 unknowns (i.e. A, B, C, D).

The physical connector and its mating connector of the External Connector are listed in Table 1-4. The Room Sensor is not supplied with an external connection jumper cable. The link in Table 1-4 is a suggested cable. It is the customer's responsibility to modify the cable harness for their application.

Should an external cable be connected to the External Connector, the external cable MUST be routed through a cable clip, characterized in Section 2.6, and the cable length MUST NOT exceed 3 meters. See Section 2.6 for the connector pin assignment and cable installation.

Table 1-4: Smart Room Sensor Interface Connector Types

Interface	Sensor Connector	Mating Jumper Cable (300mm)
External Connector	JST B2B-ZR(LF)(SN)	JST A02ZR02ZR28H305B

1.3.7 Moisture Detection Transducer

The Room Sensor Base model contains a Moisture Detector. The Moisture Detection Transducer is built into the bottom surface of the Base model housing (screw side). The transducer senses changes in capacitance at the bottom surface of the Sensor housing in the presence of moisture. In other words, the moisture is detected at 0 mm range from the bottom surface (the bottom surface should get moist). This transducer is best suited to sensing the presence of water. The transducer is sensitive materials in the sensing region so the trigger set point for reporting the presence of water must be calibrated for each application. This transducer can also be used to sense liquids other than water or skin. The customer must evaluate each application and configure the trigger point as required.

A calibration command can be sent to the Sensor to set a "dry" condition. The alarm point can also be set directly as a value. Sample period for moisture detection can be set to one of 4

values: 16, 32, 64, or 128 seconds. Smaller sample periods (faster sampling) uses more energy and shortens battery life. The default sample period is 32 seconds.

2 Installation

2.1 Included Product and Installation Material

The following items are included with each sensor:

- Smart Room Sensor
- Mounting Bracket Kit

2.2 Safety Precautions

The following safety precautions should be observed:

- The Smart Room Sensor is intended for indoor use only.
- The Smart Room Sensor contains a lithium coin cell battery.

Do not ingest battery, Chemical Burn Hazard.

If a battery is swallowed, it can cause severe internal burns in just 2 hours and can lead to death.

Keep new and used batteries away from children.

If the battery compartment does not close securely, stop using the product and keep it away from children.

If you think batteries might have been swallowed or placed inside any part of the body, seek immediate medical attention.

- To reduce risk of fire, explosion or chemical burns: replace only with approved 3 V CR2477 coin batteries; DO NOT recharge, disassemble, heat above 100°C (212°F) or incinerate battery.
- The Smart Room Sensor requires an external magnet for use with the internal magnetic switch.
- Keep magnets away from all children. Small magnets can pose a serious choking hazard. If multiple magnets are swallowed, immediately seek medical attention.

2.3 Unpacking and Inspection

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

1. Inspect the shipping carton and report any significant damage to TEKTELIC.
2. Unpacking should be conducted in a clean and dry location.

3. 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 Required Equipment for Installation

There are no tools required for Smart Room Sensor installation.

2.5 Smart Room Sensor Mounting

Smart Room Sensor is designed to be mounted using the supplied mounting bracket. The bracket can be attached using screws (not included) or double-sided tape (included).

2.6 External Connector Cable Installation

The Smart Room Sensor with external connection installation requires connection to an external device. The external device cable attaches to the 2-pin connector located on the top of the sensor.

Figure 2-1 shows the external connector pinout. In the digital mode, the connector is designed to be attached to an open-drain output; however, the signal line can also be driven with digital signals at 1.8 V logic levels. In the analog mode, the two pins of the External Connector are polarity agnostic, and are connected to a thermistor.

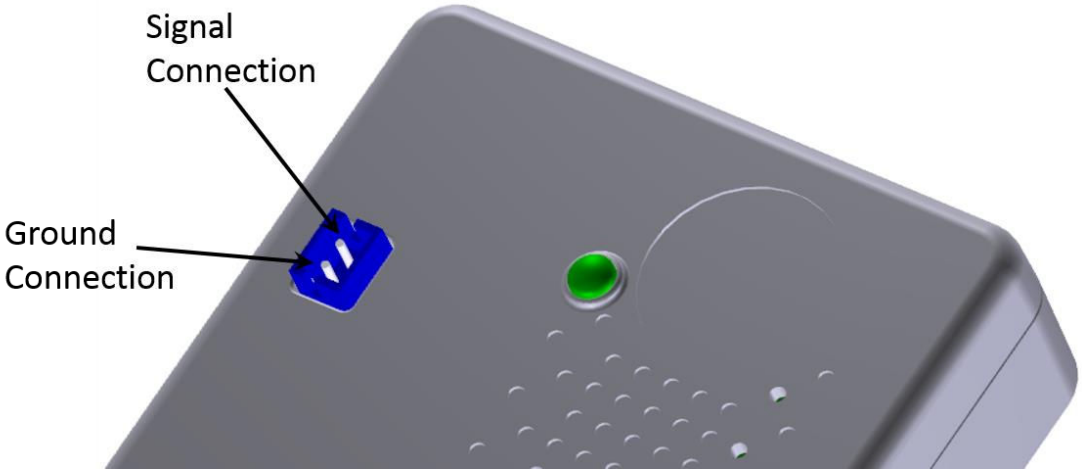


Figure 2-1: The Smart Room Sensor external connector signals.

In the digital or analog mode, the connection cable MUST be routed through a cable clip shown in Figure 2-2. The cable clip is not provided with the module. The clip Essentra MWSB-1-01A-RT is recommended for this usage. Routing the connected external cable through the cable clip leads to the best EMI performance of the Sensor. The cable length in any mode MUST NOT exceed 3 meters. Also ensure that the cable connection is not routed outdoors.

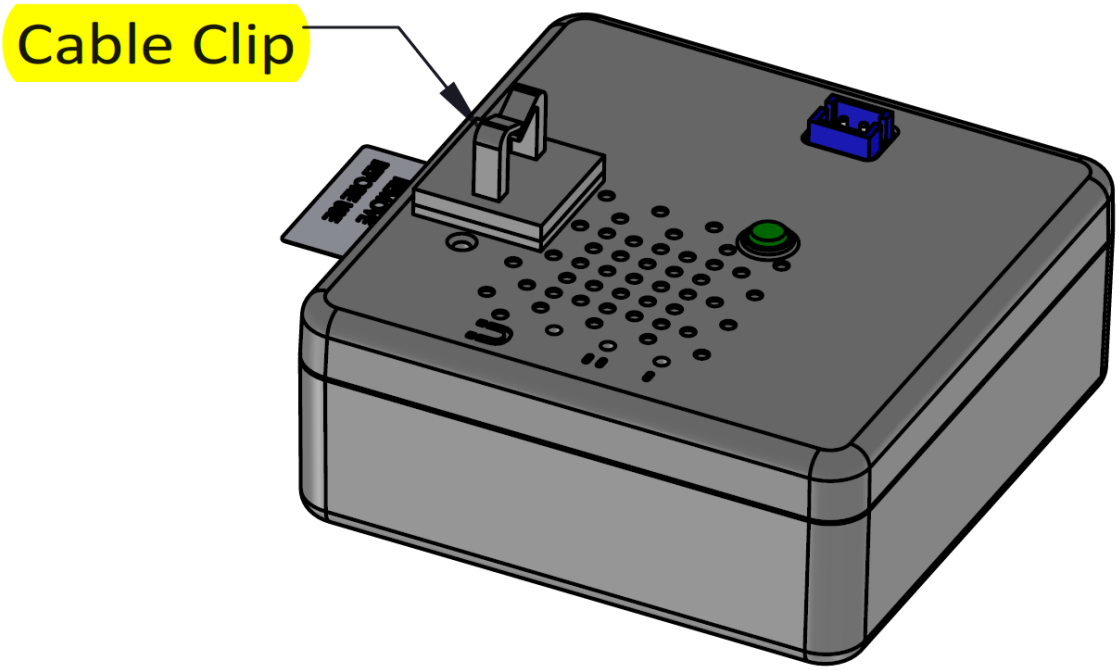


Figure 2-2: The cable clip to be attached to the Base model as shown, should a cable be connected to the External Connector.

3 Power UP and Commissioning, and Monitoring

3.1 Required Equipment

No special equipment is required to power on the Smart Room Sensor.

3.2 Power Up/Down Procedure

Once the sensor information has been added to the Network Server, pull out the battery tab to engage the battery. To turn off the device the battery must be removed, but to simply reset the device, the external reset button can be pushed; see Section 4.4 for description of the reset function. Refer to Section 5 Battery Replacement for instructions on battery removal.

4 Operation, Alarms, and Management

4.1 Configuration

The Smart Room Sensor supports a full range of Over-the-Air (OTA) configuration options. Specific technical details are available in the Room Sensor Technical Reference Manual [2]. All configuration commands need to be sent OTA during a sensor's downlink windows.

4.2 Default Configuration

The default configuration on the Base and External Connection Room Sensor is:

- Report Temperature, Humidity, and Battery Voltage every one (1) hour.
- Report actuation of the Magnetic Switch and the Digital Input (i.e. External Connector in the digital mode) every one (1) actuation.

The default configuration on the PIR Room Sensor is:

- Report Temperature, Humidity, and Battery Voltage every one (1) hour.
- Report the PIR status:
    - When PIR first detects motion.
    - When PIR has stopped detecting motion for more than five (5) minutes.
- Report actuation of the Magnetic Switch every one (1) actuation.

4.3 LED Behaviour

See Figure 1-2 for the location and identification of the sensor LEDs.

The boot and join LED procedure is as follows.

1. Both LEDs will come on briefly when power is first applied.
2. After a small delay (< 1 second) the LEDs will turn off and one of them will blink briefly.
    a. If the System LED blinks, then all health checks on the board passed.
    b. If the LoRa LED blinks, then one of the health checks failed. Consider replacing the battery, or moving the sensor to an environment within temperature range.
3. Immediately after the boot pattern, the join procedure will begin. During this time the System LED will blink continuously until the sensor has joined a network.

4. The LoRa LED will now blink whenever LoRa activity occurs on the sensor (transmitting or receiving packets, including the join request 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.

NOTE: Any other LED pattern behaviour not described above most likely indicates a low battery. For example, if steps 1-2 repeat continuously, the battery no longer has enough charge to power the join procedure.

4.4 Reset Button Function

There is a reset button on the device, that can be pushed by a pin, such as a paper clip (see Figure 1-2). The button should not be pushed hard. The reset is instant, i.e. the button does not need to be kept pushed. The reset restarts the microprocessor. All the FW load and configuration parameters in the Flash are remembered during the reset.

5 Battery Replacement

The Smart Room Sensor is powered by a standard CR2477 coin cell.

Warning

The Kona Smart Room Sensor contains a coin cell battery.

Do not ingest battery, Chemical Burn Hazard.

If a battery is swallowed, it can cause severe internal burns in just 2 hours and can lead to death.

Keep new and used batteries away from children.

If the battery compartment does not close securely, stop using the product and keep it away from children.

If you think batteries might have been swallowed or placed inside any part of the body, seek immediate medical attention.

Use only approved CR2477 cells when replacing the battery. The following are approved replacement cells:

- Panasonic (model CR2477)
- Sony (model CR2477)
- EVE Energy (model CR2477)
- Jauch (model CR2477)

In order to access the battery, remove the two screws securing the case. The screws are accessible on the bottom of the sensor case and require a Phillips screwdriver PH1:

- Remove the two screws on the bottom of the case.
- While holding the sensor with the bottom facing up, remove the bottom of the case by gently prying the case apart.

- With the bottom removed, the coin cell holder is accessible.

- Remove the coin cell from the holder by gently pushing the cell a little outwards (e.g. by a small screwdriver), then taking the cell from the other end and pulling it out as indicated in the image below:

- Place the new cell in the holder. The top of the coin cell is marked with a + symbol indicating the positive terminal. This positive terminal must face up when replacing the cell. Push the cell into the holder until it hits the closed end of the holder.
- Check for LED activity. If the LEDs are lit, the battery replacement was successful.
- Replace the sensor cover and insert the two screws.

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 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 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:

(1) L'appareil ne doit pas produire de brouillage.
(2) 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.

California Proposition 65:

⚠ **WARNING:** This product can expose you to chemicals including lead, nickel & carbon black, which are known to the State of California to cause cancer, birth defects or other reproductive harm. For more information, go to www.p65warnings.ca.gov.

7 References

[1] LoRa Alliance, "LoRaWAN 1.02 Regional Parameters," Revision B, Feb 2017.

[2] TEKTELIC Communications Inc., "LoRa IoT Smart Room Sensor Technical Reference Manual (TRM)," ver. 1.0.

[3] LoRa Alliance, "LoRaWAN Specification," ver. 1.0.2, rev. B, Jul 2016.