TEKTELIC COMMUNICATIONS INC.

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Product Name:	**Kona All-in-One Home Sensor**
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†Only applicable to module revisions after Rev C. Some new features are not backward compatible with modules Rev C and below. Module revisions after Rev C only include Base and PIR models (Base model and External Connector model Rev C have been merged into a single Base model Rev D).

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Revision History

Version	Date	Editor	Comments
0.1	Jan. 31, 2018	D. Smith	First release.
0.2	Feb. 12, 2018	Z. Herasymiuk	Added Compliance Statements.
0.3	Feb. 14, 2018	D. Smith	Added extra safety disclaimers, installation equipment, and removed network server provisioning guide.
0.4	Mar 29, 2018	K. Strom	Added section for battery replacement
0.5	Apr. 02, 2018	S. Morrison	Added more battery information.
0.6	Jun 27, 2018	R. Nikjah	Updated Operating Temperature, added Storage Temperature.
1.0	Sep 7, 2018	R. Nikjah	Released for Kona All-in-One Home Sensor Modules after Rev C.
1.1	Sep 25, 2018	R. Nikjah	Updated based on internal feedbacks.

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1 Product Description

1.1 Overview

The Kona All-in-One Home Sensor is a multi-purpose LoRaWAN IoT sensor packed into a very small form factor. The Home Sensor is ideal for monitoring and reporting temperature, humidity, light, shock and open/closed doors and windows in the home 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 Home Sensor model. Table 1 presents the available Kona All-in-One Home Sensor models (Rev D), regional variants, corresponding LoRa channel plan [1], order codes, and production statuses. Table 2 presents the features available in each model.

Table 1: Kona All-in-One Home Sensor Models

Family	Module T-Code, Revision	Region	LoRa Channel Plan	Order Code	Production Status
Home Base, NA	T0004893, Rev D	US915	US902-928 MHz	SENBNNUS915	Default
		AU915	AU915-928 MHz	SENBNNAU915	Special Order
		KR920	KR920-923 MHz	SENBNNKR920	Special Order
		AS923	AS923 MHz	SENBNNAS923	Special Order
Home PIR, NA	T0004885, Rev D	US915	US902-928 MHz	SENPNNUS915	Default
		AU915	AU915-928 MHz	SENPNNAU915	Special Order
		KR920	KR920-923 MHz	SENPNNKR920	Special Order
		AS923	AS923 MHz	SENPNNAS923	Special Order
Home Base, EU	T0004895, Rev D	EU868	EU863-870 MHz	SENBNNEU868	Default
		IN865	IN865-867 MHz	SENBNNIN865	Special Order
		RU864	RU864-870 MHz	SENBNNRU864	Under Development
Home PIR, EU	T0004896, Rev D	EU868	EU863-870 MHz	SENPNNEU868	Default
		IN865	IN865-867 MHz	SENPNNIN865	Special Order
		RU864	RU864-870 MHz	SENPNNRU864	Under Development

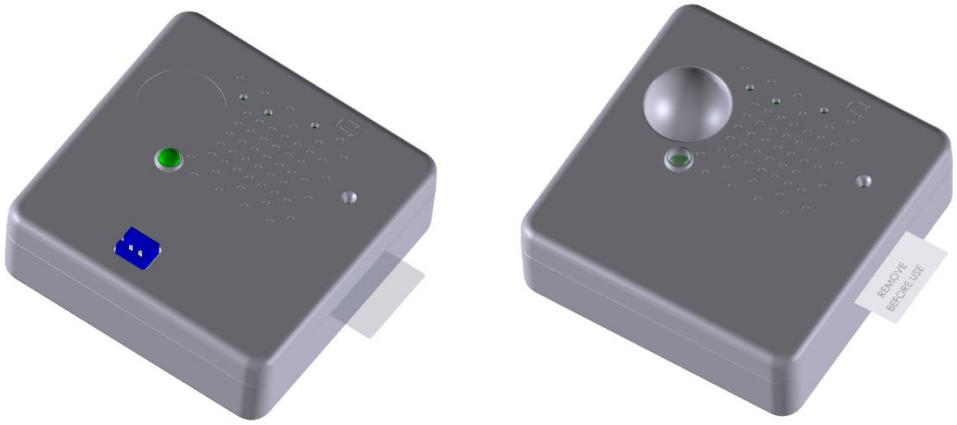
Table 2: Kona All-In-One Home Sensor Feature Map

Feature	Base Model	PIR Model
Temperature & Relative Humidity	X	X
Accelerometer	X	X
Light Detection	X	X
Motion Detection (PIR)		X
Magnetic Switch	X	X

External Connection	X	
Moisture Detection	X	

- **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.
- **Magnetic Switch:** Digital On/Off sensing with an internal magnetic switch.
- **External Connection:** External contacts connected with a short cable can be monitored for on/off states or used to count events.
- **Moisture Detection:** Capacitive transducer mounted in the sensor case detects pooling water under the device for flood or leak detection.

Figure 1 illustrates the two Kona All-in-One Home Sensor models[1]. Both models share the same external dimensions (42mm x 42mm x 14mm).



Base Model **PIR Model**

Figure 1: The Kona All-in-One Home Sensor models.

[1] Rev C modules have three variants: Base, PIR, and External Connector. In Rev D, Base and External Connector models were merged into a single Base model that supports both a magnetic reed switch and an external connector.

1.2 Physical Interfaces

Figure 2 illustrates the customer accessible interfaces for the Kona All-in-One Home Sensor. All models share the same layout, though only functional interfaces are exposed in the case of each model.

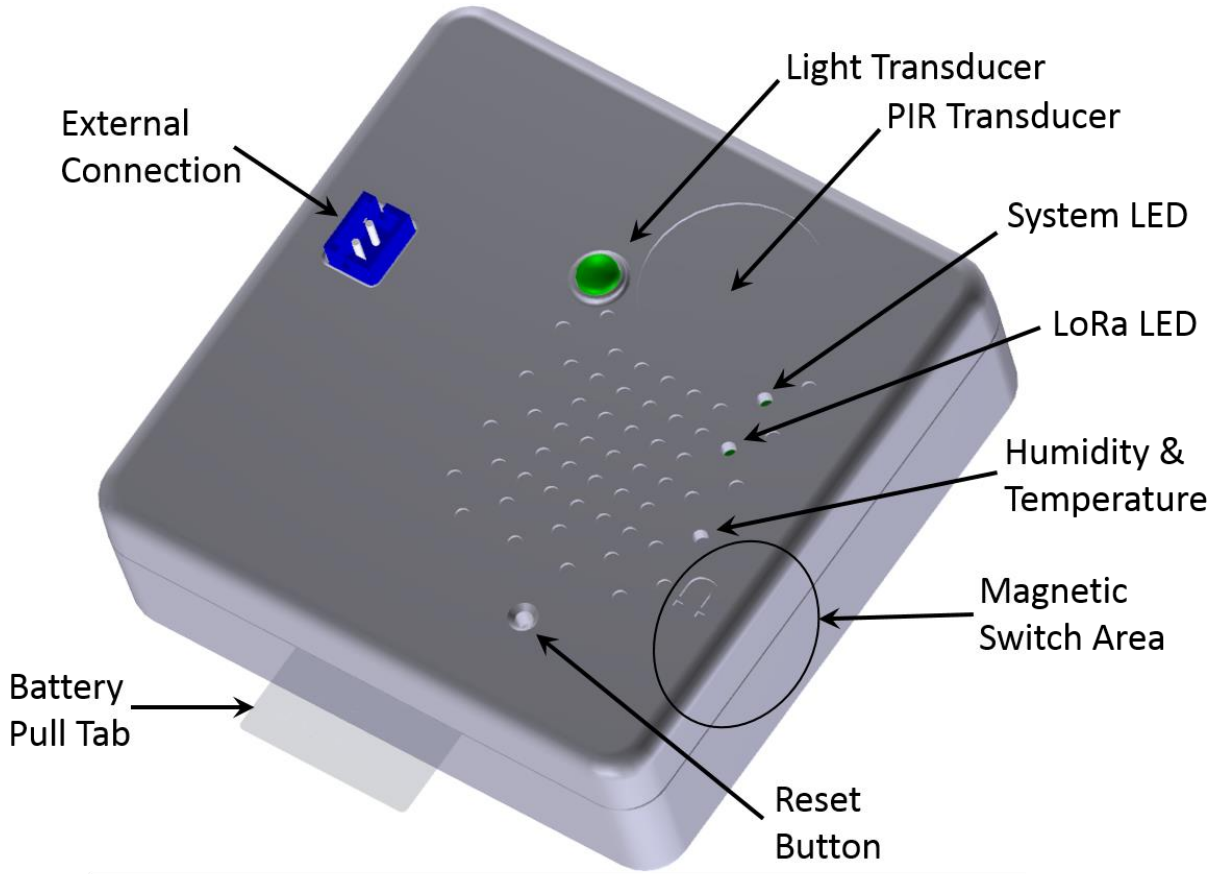


Figure 2: The Kona All-in-One Home Sensor external interface layout.

1.3 Specifications

The Kona All-in-One Home Sensor specifications are listed in Table 3.

Table 3: Kona All-in-One Home Sensor Specifications

Attribute	Specification
Dimensions	42 mm (1.65”) wide x 42 mm (1.65”) deep x 14 mm (0.55”) tall

<table>
<tr><td>Weight</td><td>20 grams</td></tr>
<tr><td>Operating Temperature</td><td>0°C to 60°C
10°C to 40°C for optimal battery life</td></tr>
<tr><td>Storage Temperature</td><td>-30°C to 60°C
0°C to 30°C for optimal battery life</td></tr>
<tr><td>Ingress Protection</td><td>IP30</td></tr>
<tr><td>Temperature & Relative Humidity Transducer</td><td>Humidity resolution: 0.5% RH
Humidity range: 0% to 100% RH
Humidity accuracy (from the manufacturer datasheet):
±3.5% RH between 20% and 80% RH
±5% RH between 0% and 100% RH

Temperature resolution: 0.1°C
Temperature range: -40°C to +120°C
Temperature accuracy (from the manufacturer datasheet):
±0.5°C between +15°C and +40°C
±1°C between 0°C and 60°C</td></tr>
<tr><td>MCU Temperature Transducer</td><td>Resolution: 0.1°C
Range: -40°C to 85°C
Accuracy: Not calibrated, estimated at ±3°C</td></tr>
<tr><td>Acceleration Transducer</td><td>3-axis sensor
Sample rate: 1 Hz, 10 Hz, 25 Hz, 50 Hz, 100 Hz, 200 Hz, 400 Hz
<table>
<tr><td>Range</td><td>±2 g</td><td>±4 g</td><td>±8 g</td><td>±16 g</td></tr>
<tr><td>Resolution</td><td>15.6 mg</td><td>31.2 mg</td><td>62.5 mg</td><td>187.5 mg</td></tr>
</table></td></tr>
<tr><td>Light Transducer</td><td>Visible light sensing
Peak sensitivity: 550 nm
Approximate sensing range: 5 lux to 1000 lux</td></tr>
<tr><td>Motion Detection (PIR) Transducer (on applicable models)</td><td>Pyroelectric infrared sensor, dual element
See Section 1.3.4 for details</td></tr>
<tr><td>Magnetic Switch (on applicable models)</td><td>Operating range: 5–15 AT
Requires about 10 gauss at edge of Sensor to activate
See Section 1.3.5 for details</td></tr>
</table>

External Connection (on applicable models)	1.8 V compliant input with pull-up See Section 1.3.6 for details
Moisture Transducer (on applicable models)	Custom capacitive transducer Range: ~0 mm from bottom surface of Sensor case
Battery, replaceable	CR2450, Lithium/Manganese Dioxide (Li/MnO2) Panasonic – Model CR2450 Sony – Model CR2450B EVE Energy – Model CR2450 FDK Corporation – Model CR2450
Regulatory Compliance	IEC 60950-1 (CE) ETSI EN 300 019-2-1, 300 019-2-2 ETSI EN 300 019-2-3, 300 019-2-4 FCC 15.247, FCC 15.209 RSS-247, RSS-Gen

1.3.1 Temperature and Relative Humidity Transducer

All Home Sensor models contain a Temperature and Relative Humidity Transducer. Details on the transducer range and accuracy are listed in Table 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 Home 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 3 axis accelerometer. The Home Sensor has 3 built in functions: Break-In detect, Impact detect and read acceleration. Each function can

be configured to function in the customer's application and can be used individually or in combination. This transducer can also be disabled to conserve battery life.

Break-In detection is a function that senses repeated (4 or more) acceleration events and toggles an alarm if tripped. The magnitude of event acceleration and event collection time window are user settable. This function can be enabled or disabled.

Impact detection is a function that senses a single acceleration events and toggles an alarm if tripped. The magnitude of event acceleration is user settable. This function can be enabled or disabled.

Acceleration readings can be reported by the Sensor as X/Y/Z vector magnitudes or as a scalar net magnitude.

The rate at which acceleration is sampled is customer settable 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 Break-In and Impact detection functions. The default sample rate is 1 Hz.

1.3.3 Light Detection Transducer

All Home Sensor models contain an ambient light sensor. Light is measured through a light pipe located on the top surface of the Sensor. The Sensor is intended to detect the presence of light not to measure and report light intensity. 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.

Light intensity event trigger points are customer settable over the range of 1 to 63. 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. If a light intensity greater than the set point is present, an event is reported.

1.3.4 Motion Detection (PIR) Transducer

The Home Sensor PIR model contains a Motion Detector. The Motion Detection Transducer contains dual sense PIR elements and is configured to sense human motion within its field of view. When the transducer is combined with the Home Sensor PIR lens, the sense range is 2.5 m covering a rectangular area of 6.0 m by 7.5 m. Figure 3 shows the sense pattern[2]. The

[2] The sense range is as claimed by the transducer manufacturer. The sense range is determined as the projection of the transducer field of view 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 field of view, people need to be closer to the sensor to be detected. The amount of IR radiation from a moving person, which is also

rectangular boxes inside the pattern connected with X marks represent sensor element beams. To be most effective at detecting motion, the subject must move across sensor element beams. The Home Sensor should be mounted so that the subjects move across its field of view and not towards or away from the Sensor. The sense pattern alignment to the Home Sensor body is shown in Figure 4.

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.

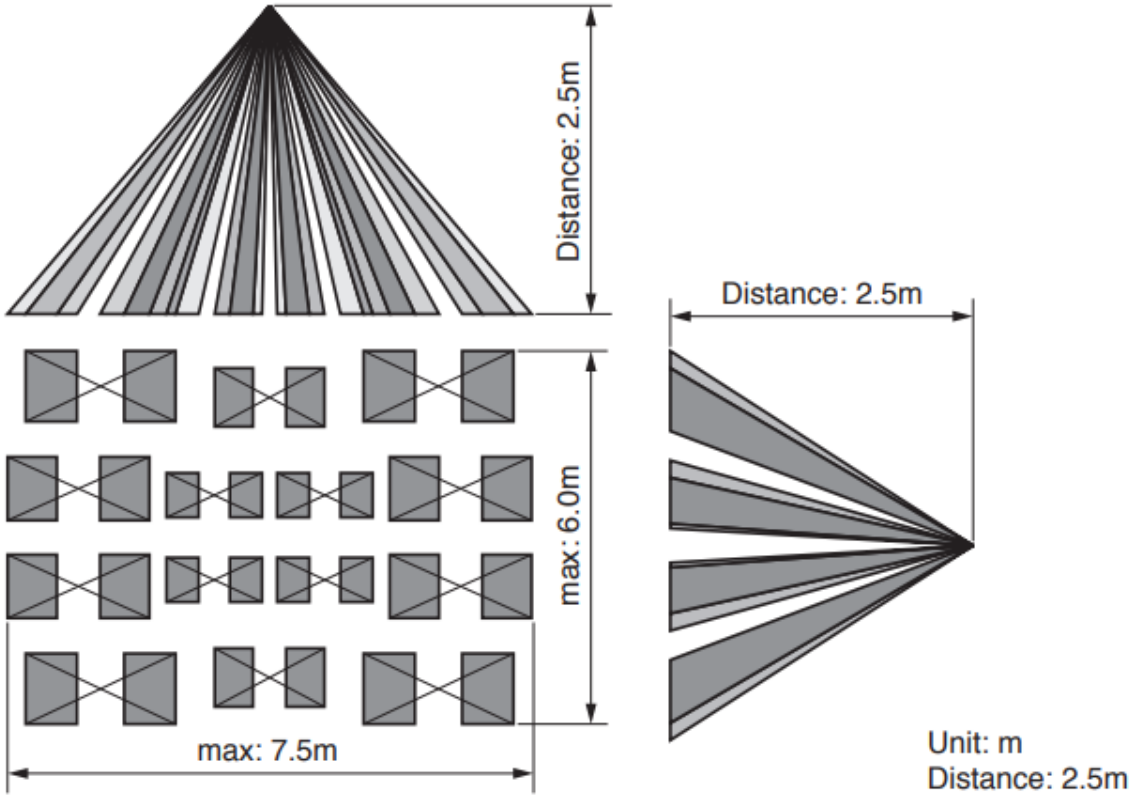


Figure 3: The PIR Transducer sense pattern.

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 5.0 m x 5.5 m.

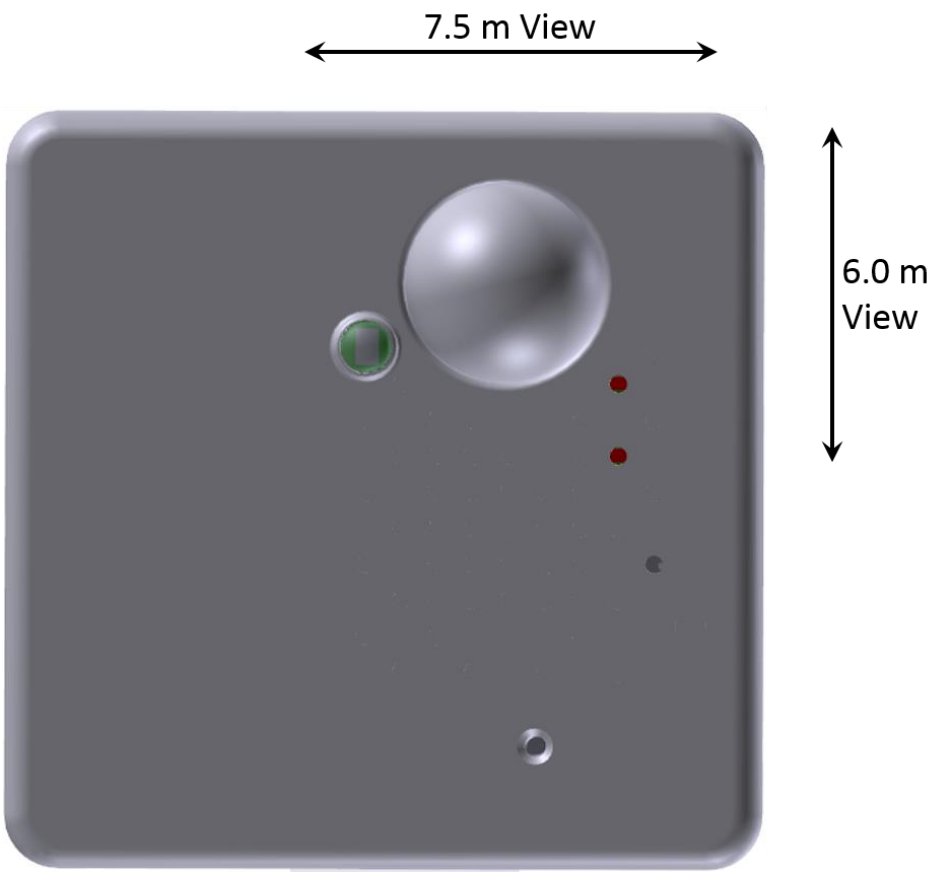


Figure 4: The alignment of PIR sense pattern to the Home Sensor body.

To conserve battery usage, the Home Sensor only reports motion when it is first detected and when motion has not been detected for a configurable Grace Period. See Section 3.4.6 in the Home Sensor Technical Reference Manual [2] for a detailed description of how the motion function is configured.

1.3.5 Magnetic Switch

All Home Sensor models contain a Magnetic Switch. The location of the switch is shown in Figure 2. The Home 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 active 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 Home Sensor Base model contains an External Connection. The internal, control, and reporting interfaces of the External Connection are similar to, but independent from, the Magnetic Switch in the Base model[3]. See Section 1.3.5 for a description of the event function configuration and reporting count feature, which are similar to those of External Connection.

The External Connection 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. The physical connector used and its mating connector are listed in Table 4. The Home Sensor is not supplied with an external connection jumper cable. The link in Table 4 is a suggested cable. It is the customer's responsibility to modify the cable harness for their application. The connection cable length should NOT exceed 3 meters. Do not connect to an outdoor device. See Section 2.6 for connector pin assignment.

Table 4: Kona All-in-One Home 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 Home 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

[3] The Magnetic Switch and External Connection are no longer linked in Rev D modules (as they were in previous revisions), and have independent circuits.

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:

- Kona All-In-One Home Sensor
- Mounting Bracket
- User Guide

2.2 Safety Precautions

The following safety precautions should be observed:

- The Kona All-in-One Home Sensor is intended for indoor use only.
- The Kona All-in-One Home Sensor contains a lithium coin cell battery.
- NEVER allow small children near batteries: if a battery is swallow, immediately seek medical attention.
- To reduce risk of fire, explosion or chemical burns: replace only with approved 3 V CR2450 coin batteries; DO NOT recharge, disassemble, heat above 100°C (212°F) or incinerate battery.
- The Kona All-in-One Home 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 Kona All-in-One Home 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 Kona All-in-One Home Sensor installation.

2.5 Kona All-In-One Home Sensor Mounting

Kona All-in-One Home Sensor is designed to be mounted using the supplied mounting bracket. The bracket can be attached using screws or double-sided tape (not included).

When mounting on a vertical surface, ensure that the Home Sensor will not be orientated with the case retaining screws towards the ceiling. This could cause the Home Sensor to accidently slip off the mount and fall. There are no orientation concerns when the Home Sensor is mounted to a horizontal surface.

2.6 External Connector Cable Installation

The Kona All-In-One Home 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 5 shows the external connector signal locations. 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. The connection cable length should NOT exceed 3 meters. Also ensure that the cable connection is not routed outdoors.

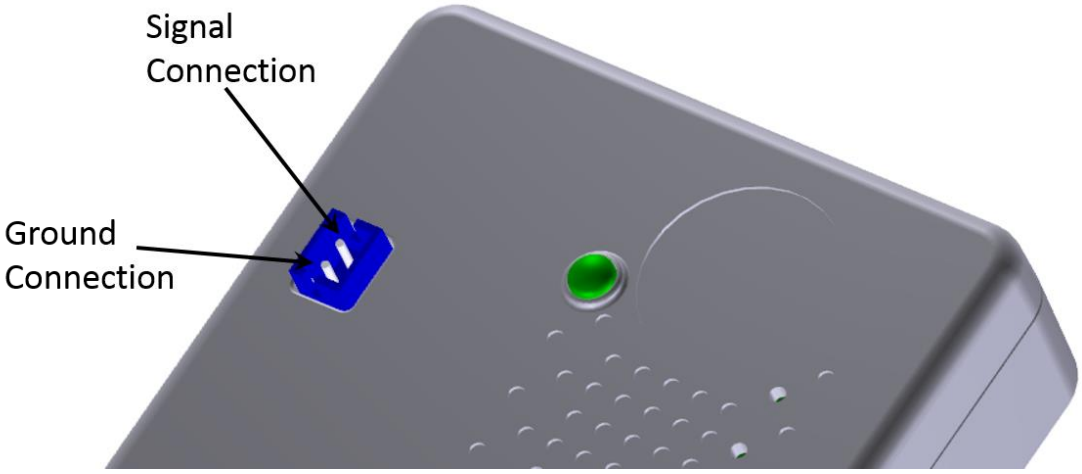


Figure 5: The Kona All-in-One Home Sensor external connector signals.

3 Power UP and Commissioning, and Monitoring

3.1 Required Equipment

No special equipment is required to power on the Kona All-in-One Home 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 Kona All-In-One Home Sensor supports a full range of Over-the-Air (OTA) configuration options. Specific technical details are available in the Home 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 Home 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 Connection) every one (1) actuation.

The default configuration on the PIR Home 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 2 for the location and identification of the sensor LEDs.

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 LED blinks, then all health checks on the board passed.
    - 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.
- Immediately after, the join procedure will begin. During the time the System LED will blink continuously until the sensor has joined 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.

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 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 Kona All-In-One Home Sensor is powered by a standard CR2450 coin cell. Use only approved CR2450 cells when replacing the battery. The following are approved replacement cells:

- Panasonic (Model CR2450)
- Sony (Model CR2450B)
- EVE Energy (Model CR2450)
- FDK Corporation (Model CR2450)

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.

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.

Industry Canada

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.

Under Industry Canada regulations, this radio transmitter may only operate using an antenna of a type and maximum (or lesser) gain approved for the transmitter by Industry Canada. To reduce potential radio interference to other users, the antenna type and its gain should be so chosen that the equivalent isotropically radiated power (EIRP) is not more than that necessary for successful communication.

This radio transmitter (identify the device by certification number, or model number if (Category II) has been approved by Industry Canada to operate with the antenna types listed below with the maximum permissible gain and required antenna impedance for each antenna type indicated. Antenna types not included in this list, having a gain greater than the maximum gain indicated for that type, are strictly prohibited for use with this device.

References

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

[2] TEKTELIC Communications Inc., "Home Sensor Technical Reference Manual," ver 1.0.