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TUNDRA COLD STORAGE MONITORING

User Guide

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Contents

1 Product Description

1.1 Overview

TUNDRA is designed to precisely measure ambient temperature (down to -40°C) and relative humidity, tailored for cold storage applications. Offering versatile mounting options (refer to Table 1-1 and Table 1-2), TUNDRA sensors are can be deployed directly into a cold storage environment, or placed outside with a digital or analog probe wired in.

TUNDRA is connected via LoRaWAN, enabling seamless transmission and reception across various frequency bands: AS923, AU915, EU868, IN865, KR920, RU864, and US915.

This document provides comprehensive descriptions of each TUNDRA variant, along with detailed guidance on their hardware capabilities. For insights into the functional operation and software behavior of each variant, please consult the Technical Reference Manual (TRM) document.

There are four main TUNDRA variants, each distinguished by specific features outlined in Table 1-1 below.

Table 1-1: HW and Mechanical Capabilities of the TUNDRA Variants

Feature / Transducer				
Module Product Names	TUNDRA, Base	TUNDRA, Wall-Mount	TUNDRA, Probe	TUNDRA, Probe, Wall-Mount
Enclosure and mounting				
Module Product Codes	T0006778	T0007334	T0007380	T0006779
Mounting	None	Wall	None	Wall
Operating Environment	Outdoor (IP67)		Outdoor (IP67)	
External Probe			✓	
Battery	C-cell LTC			
Battery Gauge	✓			
Magnetic Sensor	✓			
Temperature + RH Transducer	✓			
Accelerometer	✓			
Activity LEDs	✓			

1.2 Specifications

TUNDRA specifications are listed in **Error! Reference source not found.**. The main sensing functions are described in the following subsections.

Table 1-2: TUNDRA Specifications

Parameter	Specification
Environmental Rating	IP67
Enclosures and mounting	Custom design by TEKTELIC
Operating Temperature	-40°C to 70°C
Storage Temperature	-25° to 55°C
Operating Relative Humidity	5% - 95% non-condensing
Storage Relative Humidity	10% - 100% non-condensing
Dimensions	65 mm x 45 mm x 41 mm (with bracket) 65 mm x 43 mm x 41 mm (without bracket)
Weight	63.5 g enclosure + 56.5 g battery = 120 g total (without bracket or probe)
Power Source	Battery-powered: 1x C-cell LTC (3.6 V)
Network technology/Frequency band	LoRaWAN in the following Global ISM bands: AS923, AU915, EU868, IN865, KR920, RU864, US915
Air Interface	LoRa
Maximum Tx Power	15 dBm (TUNDRA, all bands not listed below) 20 dBm (TUNDRA: AU915, IN865, US915)
Sensing Elements	accelerometer, thermometer, hygrometer, magnetic sensor, battery gauge
LoRa RF Sensitivity	Up to -137 dBm (SF12, 125 kHz BW)
Accelerometer Sensitivity	Sample rate: 1, 10, 25, 50, 100, 200, 400 Hz Measurement range: ±2, ±4, ±8, ±16 *g* Precision: 16, 32, 64, 192 m*g*
LEDs	Green: Joining the network activity Red: LoRa Tx or Rx activity
Battery Gauge Features	Measures remaining capacity [%] and remaining lifetime [days]
Battery Lifetime	Up to 15 years

Table 1-3: TUNDRA Battery Life Estimation

Messages Per Day	Report Period [min]	Estimated Battery Lifetime [years]
144	10	15
288	5	13.1
1440	1	3.7

The following table is estimated assuming NA region, SF7/DR3, and room temperature.

2 Operating Instructions

2.1 Included Product and Accessories

The following items are shipped with each sensor:

- 1x sensor inside an enclosure with 3.6 V C-cell LTC battery installed.
- 1x corresponding sensor Quick Start Guide.
- 1x mounting bracket (only for variants with mounting).

NOTE: to ensure devices safe installation and maintenance please read Safety Precautions.

2.2 Unpacking and Inspection

The following should be considered during the unpacking of a new 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.

2.3 Commissioning

Each sensor has a set of commissioning information that must be entered into the network server for the sensor to be able to join the network and begin normal operation once activated. For instructions on how to do this please refer to the Network Server Quick Start Guide you get in the box with the device (also available online in the *Knowledge Base*).

You can find the commissioning keys inside the box. If you don't have the box, please raise a ticket in our support portal and provide the Tcode and serial number on the tag placed on the device.

Figure 2-1 TUNDRA Commissioning Keys

2.4 Activation

The sensor is shipped in a secured enclosure with the battery preinstalled in a state of DEEP SLEEP.

> **NOTE:** Activation requires use of a magnet that is not provided. Suggested magnet: Sintered Ferrite Magnet, Br = 3800-3900 Gauss, Grade 5 = Grade Y30, or Grade 8 = Gradey30h-1.

To activate/reset the device:

1. Place magnet for **3 to 10 seconds** against the enclosure at the magnetic activation site as shown in Figure 2-2 below.
2. Sensor activation will be displayed by **GREEN** and **RED** LEDs turning on.
3. Once activated, the sensor will automatically begin the join process.

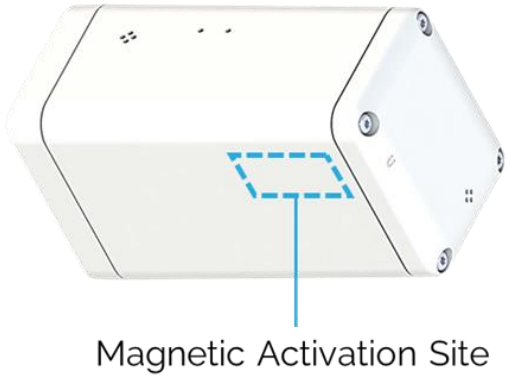

Figure 2-2 TUNDRA Magnetic Activation Site

To return to DEEP SLEEP there are two options:

1. Send a Downlink to port 99 (must be joined to network)
2. Apply the magnet for **3-10 seconds** while device is in state of network search (process is indicated by **GREEN** LED active blinking)

2.5 Default Configuration

Table 2-1 lists the default reporting behaviour of TUNDRA. Reporting behaviour can be changed from default through OTA DownLink commands (see how to do it in Basic Downlinks section).

Table 2-1: Default Reporting Periods

Reported Data	TUNDRA
Battery Data	24 hours
Ambient Temperature	1 hour
Relative Humidity	1 hour
Probe Data	1 hour (probe variants)
Acceleration Vector	Disabled
MCU Temperature	Disabled
Motion alarm	On event

2.6 Reconfiguration

TUNDRA variants support a full range of OTA configuration options once the sensor has joined the network. Specific technical details are available in the corresponding TRM documents. All configuration commands need to be sent OTA during the sensor's DownLink Rx windows.

2.7 Installation

Depending on version TUNDRA enables precise temperature and humidity monitoring by:

a. Placing TUNDRA directly in the cold storage environment
b. Mounting TUNDRA outside the cold storage environment and connecting an external probe that goes into the chamber.

2.8 Mounting

The mounting bracket needs to be secured to a wall or another solid surface by using an adhesive or mounting screws. The mounting bracket can be seen in the back view in Figure 2-3 below.

Figure 2-3 Securing the Mounting Bracket to a Surface

After the bracket has been secured, the sensor can be mounted to the bracket via the mounting feature on the main body of the sensor (see Figure 2-4). Slide the bottom hook of the mounting bracket into the mounting feature until it is fully inserted.

Figure 2-4 Attaching the Sensor to the Mounting Bracket

Using a fifth screw inserted through both holes on the top side of the bracket as shown in Figure 2-5, clamp the top flange of the bracket until it is flush with the top surface of the sensor.

Figure 2-5 Securing the Sensor in the Mounting Bracket with a Fifth Screw

2.9 Battery Replacement

The battery cover is marked with a battery symbol and uses Phillips Head H1 screws. This cover needs to be removed to replace the battery.

1. Remove the battery cover by unscrewing the 4x Phillips head screws using a size #1 Phillips head screwdriver (see **Error! Reference source not found.**).

Figure 2-6 Removing the Battery Cover Screws

2. Remove the used battery and replace it with a new 3.6V XENO XL-145F battery **ONLY**. When inserting the new battery, insert the negative terminal side first. The battery contact on the battery cover is the positive contact and is marked with a plus-sign (**+**) as shown in **Error! Reference source not found.**.

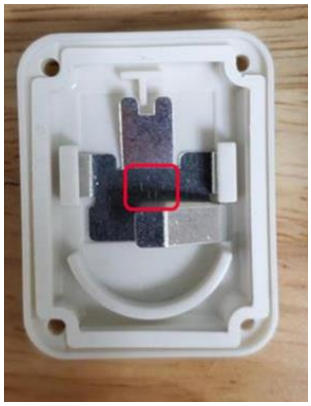

Figure 2-7 Polarity Marker and Battery Insertion

3. Before reattaching the battery cover, ensure the proper orientation of the cover by placing the battery symbol next to the mounting feature.as seen in Figure 2-8.

Figure 2-8 Proper Replacement Orientation of the Battery Cover

4. Reassemble the cover to the chassis by using the 4x Phillips head screws, using a #1 size screwdriver and up to 0.3 Nm of torque.

2.10 Reset Function

To physically reset TUNDRA perform same steps as to get in out of DEEP SLEEP state**:**

1. Place magnet against the enclosure at the magnetic activation site as shown in **Error! Reference source not found.**.
2. Sustain magnet for **3 to 10 seconds**. Sensor activation will be displayed by **GREEN** and **RED** LEDs turning on (described in Section 2-11).
3. Once activated, the sensor will automatically begin the join process.

NOTE: Shutting down or resetting the sensor will cause all unsaved user configurations to be lost. Save the desired configuration to the sensor flash before powering off or resetting.

2.11 RF LED Behaviour

The LEDs are normally off and the main patterns are summarized in Table 2-2. The detailed sequence and timings for each are described in the following subsections

Table 2-2: Summary of LED Patterns

LED Pattern	Meaning
GREEN blinking rapidly and single **RED** flash every 10 s	JOIN mode; attempting to join the network
Single **RED** flash	UpLink sent
Single **GREEN** flash	DownLink received
3 quick **RED** flashes	Entering DEEP SLEEP

2.11.1 Normal Operation Patterns

After the Sensor has joined the network:

a. **RED** flashes after transmitting an uplink.
b. **GREEN** flashes after receiving a downlink.

2.11.2 Power-On and Network Join Patterns

When the sensor is activated or reset:

Condition	Green LED	Red LED	Duration	Notes
Initial activation/reset	OFF	OFF	0.5 sec	Both LEDs are off upon activation/reset.
Power-On Self Test (POST) starts	ON	ON	-	Both LEDs turn on signaling the start of POST.
POST ends	OFF	OFF	~2 sec	LEDs turn off after POST completes.
POST pass	Blink 3 times	OFF	-	Green blinks 3 times if POST is successful.
POST fail	OFF	Blink 3 times	-	Red blinks 3 times if POST fails, and the process restarts.
JOIN mode	Actively blinks	Flashes twice per cycle	Until device joins. Will timeout after 1-hour	Green actively blinks; Red flashes twice: once after sending JOIN REQUEST, and once after receiving JOIN ACCEPT. Normal operation begins after JOIN ACCEPT.
Unsuccessful network join after 1 hour	OFF	Flash twice	Every 8 s	Green stops blinking; Red flashes twice every 8 seconds during join back-off to conserve power.

3 Sensing Functions

3.1 Magnetic Sensor

TUNDRA variants are equipped with a magnetic hall-effect sensor to address these purposes:

1. To wake the device from sleep as described in Section 2.4.
2. To put the device to sleep.
3. To reset the device.
4. To force a LoRaWAN UpLink.

The position on the exterior of the enclosure on which the magnet must be placed to activate the reed switch is shown in Figure 3.1 below.

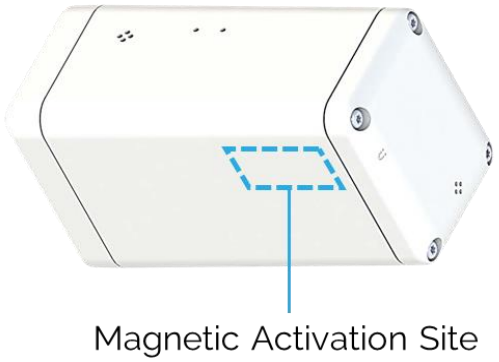

Figure 3-1 Magnetic Activation Site

For more information on how to use the magnetic sensor for the other purposes, refer to the TRM document.

3.2 Temperature and Relative Humidity Transducer

TUNDRA contains a temperature and relative humidity (RH) transducer. Vents on the enclosure allow air to contact the transducer. Response time can be reduced by forcing air to move over the vent as in Figure 3.2.

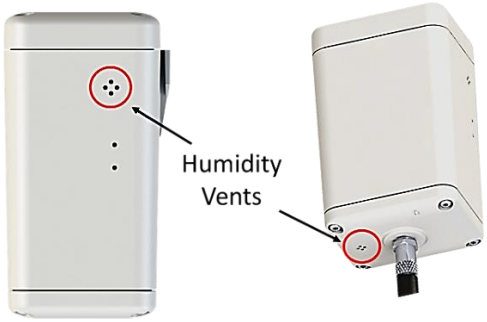

Figure 3-2 Humidity vents

TUNDRA supports reporting ambient temperature, MCU temperature and RH values on a user-defined threshold basis. Alarm points can be set individually for ambient temperature, RH, and MCU temperature. The frequency of measurements can be user configurable with different sample rates if the measured value is within the normal operating window (see Section 5).

Average ambient temperature error is described in Figure 3-3.

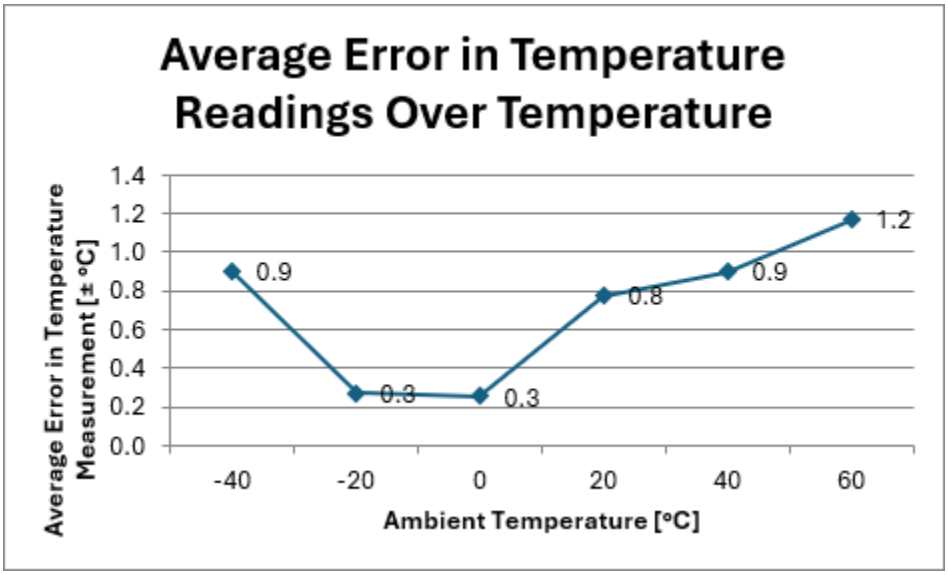

Figure 3-3 Average ambient temperature error

3.3 Accelerometer Transducer

TUNDRA has integrated 3-axis accelerometer that can be used to detect and report movement events, or trigger an additional temperature report upon detecting motion. The feature is optional and can be disabled (see Section 5).

It generates customizable acceleration alarms triggered by defined thresholds within a specified period. Detected motion can prompt transitions between geolocation update periods with enabled by default Accelerometer Assist, ensuring timely tracking. Enabled by default, it adjusts update rates for asset tracking: faster when moving and slower when stationary. The accelerometer's output acceleration vector can also be periodically polled for orientation-based applications.

3.4 External Probe

TUNDRA Probe variants can be ordered with the choice of either a digital reed switch or an analog thermistor. The default input mode (digital or analog) depends on whether a digital or analog Sensor variant was ordered. The input mode is a configurable parameter, meaning that it can be toggled by the user at any time (see Section 5). Possible probe temperature error is ±2°C.

3.4.1 Digital Probe Operation

In the digital input mode, the external reed switch probe has only two values or states:

- Open (magnet absent) with a value of 0x 01.
- Closed (magnet present) with a value of 0x 00.

This mode of operation supports periodic and event-based (edge-triggered) reporting.

The input is edge-triggered and can be set to be triggered by the rising edge (Low/Closed to High/Open), falling edge (High/Open to Closed/Low), or both (default setting).

Application Examples for Digital Input Mode:

- Door Open/Close detection would use both rising and falling triggers to detect when the door was opened and when it was closed.
- Pulse counting from a water meter would use a single edge trigger, depending on the resting state of the connected device (positive pulse would use rising edge, negative pulse would use falling edge).

3.4.2 Analog Probe Operation

In the analog input mode, one probe pin is grounded, and the other pin is pulled up to VMCU (2.0 V) by a 68.1 kΩ resistor. The analog input has values in units of mV from 0 to VMCU (the precision is 1 mV[1]). The included probe is a custom 10 kΩ NTC thermistor.

The sensor FW can convert the measured probe voltage to temperature and report either the raw voltage or converted temperature. By default, the sensor reports probe temperature.

[1] The actual ADC output has a resolution of 0.61 mV.

4 Basic Downlinks

TUNDRA use a "tick" system for reporting data. Generally, the sensor will report most important data every tick. A tick can be measured in seconds.

There are two sets of settings that must be configured in conjunction - "Core reporting tick in seconds" and "Ticks per [data/report]".

"Core reporting tick in seconds" will determine the interval between ticks. For example, you may set it to 30 seconds or 180 seconds (3 minutes) for each tick.

"Ticks per [data/report]" determines how many ticks it will take before the sensor reports any data. For example, if you set "Ticks per Battery report" to 2, it will take 2 ticks before the sensor reports battery data.

To Change The Core Report To Every Minute

With LeapX application (you can get it on Google Play or App Store): write number 1 in the field minutes between reports, then click on save changes.

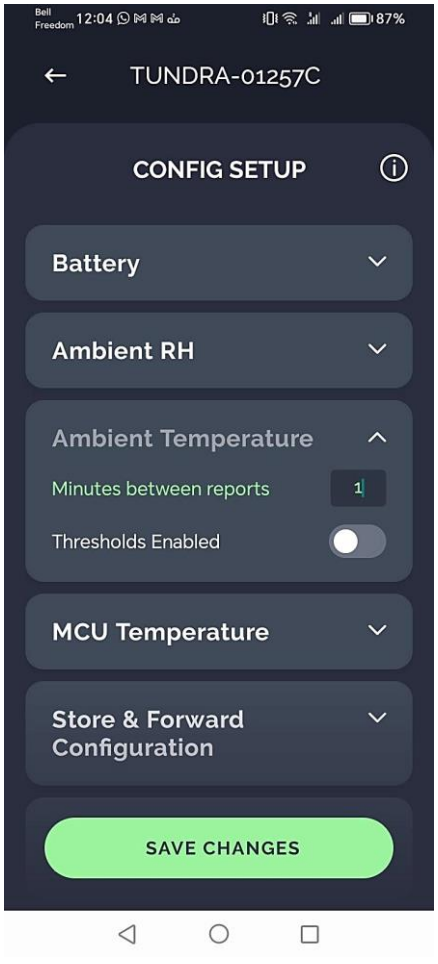

Figure 4-1 LeapX application

With ATLAS (www.atlas.tektelic.com): check the box for Core report tick in seconds and ticks between ambient temperature reports. Write the values shown in the Figure 4-2 and click send.

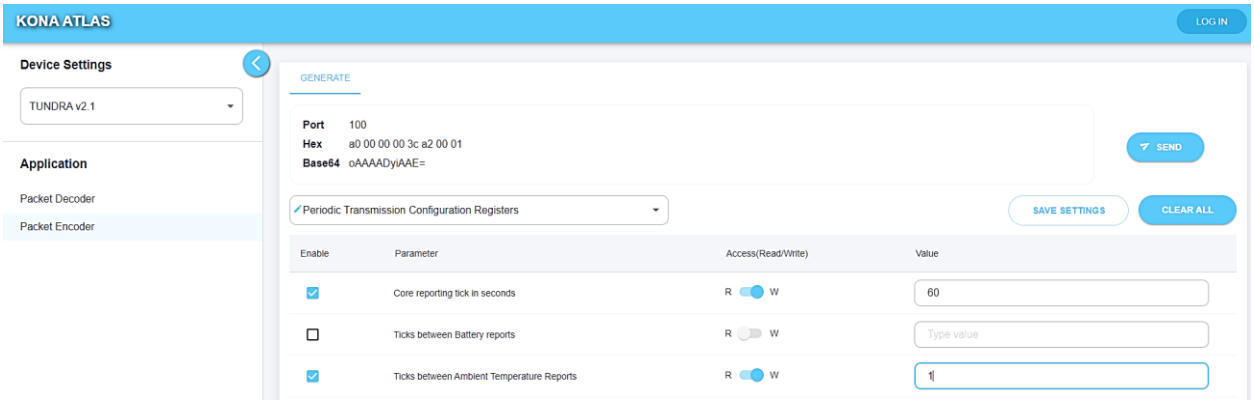

Figure 4-2 ATLAS

Examples Of Uplinks

Example 1

```
"data": { "raw": "07 CE 03 67 00 CE 04 68 24",
"fPort": 32,
"tag_entry": 1998,
 "tagged_ambient_temperature": "20.6",
"tagged_relative_humidity": "18.0" },
```

```
Example 2
"data": { "raw": "02 67 00 C8",
"fPort": 10,
 "ext_probe_temperature": "20.0" },
```

5 Device Configuration with ATLAS

To perform more configuration or read the data of TUNDRA device you can use TEKTELIC's complementary service, ATLAS at www.atlas.tektelic.com.

There are two ways to access ATLAS:

1) Using in Offline mode

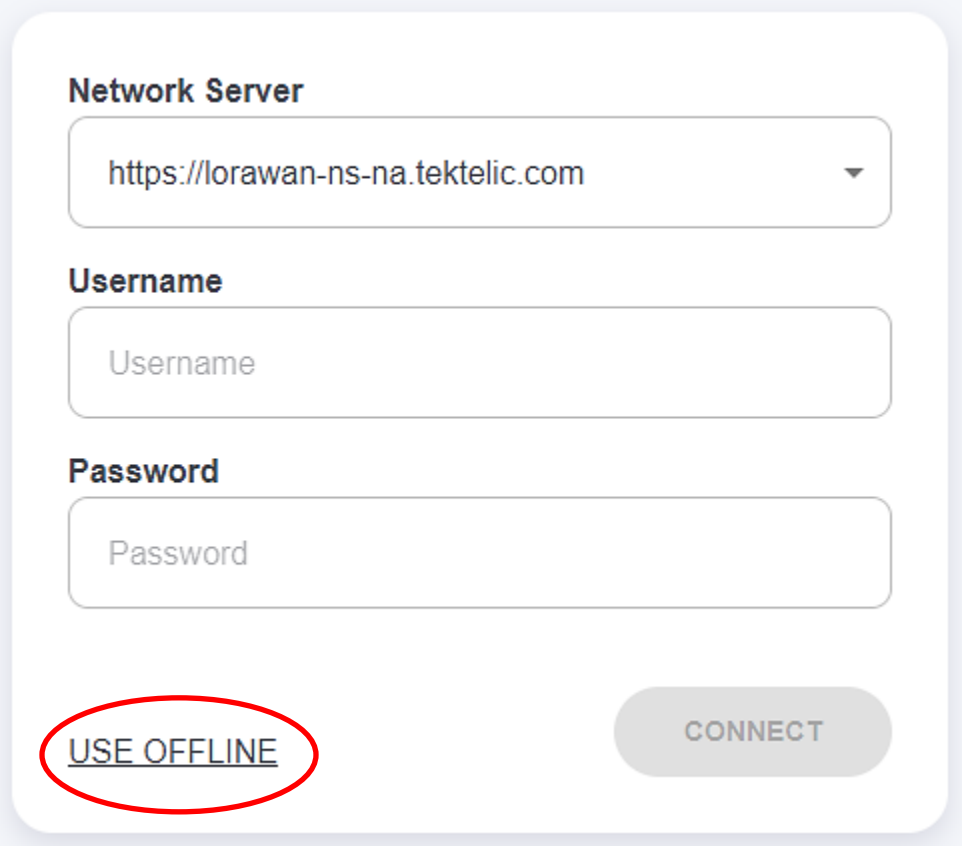

Figure 5-1 Login as offline mode

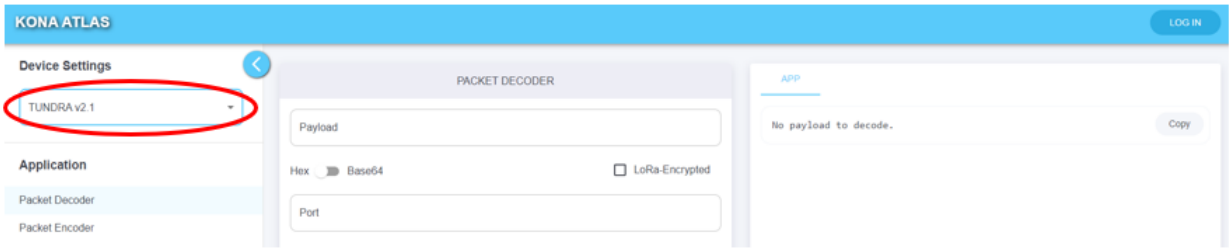

Figure 5-2 Select TUNDRA decoder

2) with your TEKTELIC Network Server Credentials

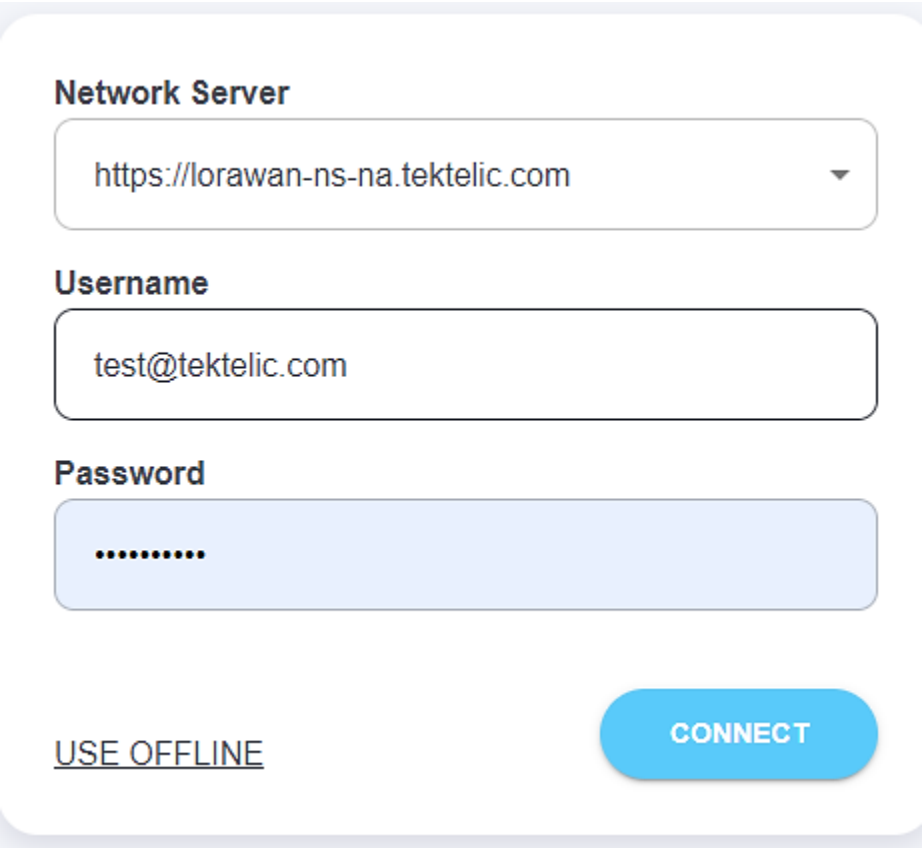

Figure 5-3 Login with Network server credentials

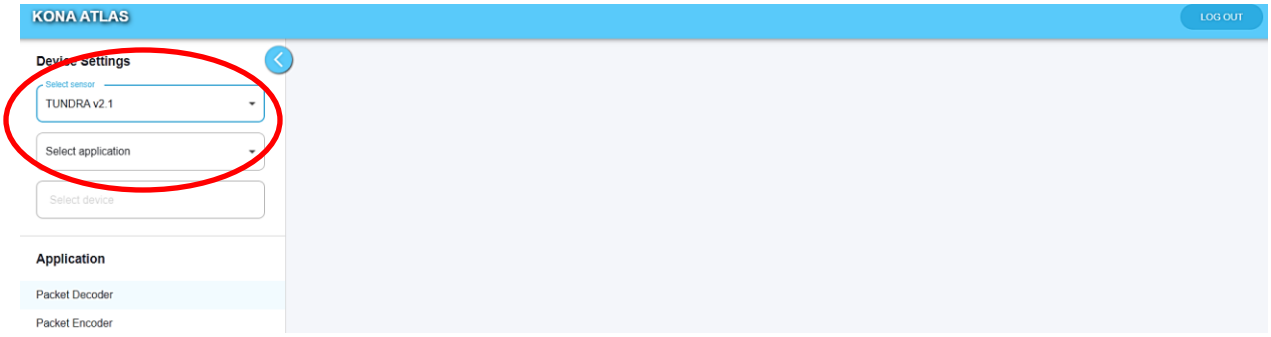

Figure 5-4 Select TUNDRA Decoder, application and the device

For more information follow this link https://support.tektelic.com/portal/en/kb/articles/kona-atlas

6 Data converters

Please follow this link: https://github.com/TektelicCommunications/data-converters/tree/master for the data converters that are to be used on TEKTELIC & other Network Server for TEKTELIC Sensors. These data converters can be used as a reference for other platforms.

TEKTELIC's data converters conform to the LoRa Alliance Payload Codec Specification and can be used with any 3rd party Network Server / Application Server that supports this specification.

https://resources.lora-alliance.org/technical-specifications/ts013-1-0-0-payload-codec-api

7 Safety Precautions

The following safety precautions should be observed for all TUNDRA sensor variants:

- All installation practices must be in accordance with the local and national electrical codes.
- Replace only with approved batteries (see Section 2.9).
- The following sensor variants are intended for indoor use only: T0006779, T0007380.
- The sensor contains a single LTC C-cell battery. The following are recommended safety precautions for battery usage.

  - **Keep batteries out of the reach of children.**
  - **Do not allow children to replace batteries without adult supervision.**
  - **Do not insert batteries in reverse.**
  - **Do not short-circuit batteries.**
  - **Do not charge batteries.**
  - **Do not force discharge batteries.**
  - **Do not mix batteries.**
  - **Do not leave discharged batteries in equipment.**
  - **Do not overheat batteries.**
  - **Do not weld or solder directly to batteries.**
  - **Do not open batteries.**
  - **Do not deform batteries.**
  - **Do not dispose of batteries in fire.**
  - **Do not expose contents to water.**
  - **Do not encapsulate and/or modify batteries.**
  - **Store unused batteries in their original packaging away from metal objects.**
  - **Do not mix or jumble batteries.**

8 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 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 (Industry 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:

i. This device may not cause interference, and

ii. 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.

California Proposition 65:

⚠ **WARNING:** This product can expose you to chemicals including lead, nickel, and 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.

List of Acronyms

EOS ..... End Of Service
EU ..... European Union
FCC..... Federal Communications Commission
FW ..... FirmWare
HW ..... HardWare
IoT ..... Internet of Things
IP ..... Ingress Protection
ISM ..... Industrial, Scientific, and Medical
LED ..... Light-Emitting Diode
LoRa ..... Long-Range
LoRaWAN..... Long-Range Wide-Area Network
LoS..... Line-of-Sight
LTC..... Lithium-Thionyl Chloride
MCU ..... MicroController Unit
NA ..... North America
NS ..... Network Server
OTA ..... Over The Air
PCB ..... Printed Circuit Board
PCBA..... Printed Circuit Board Assembly
POST ..... Power-on Self-Test
Rev ..... Revision
RF ..... RadioFrequency
RSSI ..... Received Signal Strength Indicator
Rx ..... Receive, receiver, etc.
SW..... SoftWare
TRM..... Technical Reference Manual
Tx..... Transmit, Transmitter, etc.
UG ..... User Guide
UL ..... UpLink
US ..... United States
v..... Version

Troubleshooting

Question	Answer
Why is the System LED rapidly blinking on my sensor?	While a sensor is not joined to a network it will continuously blink the System LED to indicate its unconnected status to the user. Ensure your LoRaWAN gateway is connected to your Network Server and verify the DevEUI, AppEUI and AppKey for the device.
Why does my LoRa LED blink periodically?	The LoRa LED indicates LoRa traffic being sent or received by the device. A short blink indicates the sensor has just transmitted, while a longer blink indicates the sensor has received a message.
How do I add my sensor to a Network Server?	Provisioning a sensor on a Network Server will vary based on your Network Server provider. An example of how to perform this on the TEKTELIC Network Server is available in your sensors user manual. Most network server providers will require you to enter the DevEUI, AppEUI and AppKey of your device on their service.
What version of LoRaWAN do the sensors implement?	All TEKTELIC Sensor products run LoRaWAN 1.0.2
The serial numbers on my case are different from the serial numbers on the circuit board. Did my order get mixed up?	All TEKTELIC products have multiple serial numbers so we can track the devices at each stage of production. It is normal that you sensor board and sensor assembly have different numbers.
What can I find the commissioning values for my sensors? (DEVEUI, APPEUI and APPKEY)	We keep the commissioning values for each sensor secure on our own server. We send the commissioning values for each sensor sent with a shipment but if this was misplaced please send the serial number the revision and the Tcode of the sensor and we can get the information for you.
Why is my sensor sending more packets than the Network Server receives?	This occurs when the channel plan does not reflect the number of channels accepted by the gateway. By default, all sensors come up in 64 channel mode which results in lost packets if a gateway with less than 64 channels is used. If you have an 8 channel gateway for example, ensure this is configured in the device settings in the Network Server. In the TEKTELIC NS under the "advanced network settings" tab change the configuration of the "default channel mask" to reflect the number of channels used by the gateway used.

Document Revision

Revision	Issue Date	Status	Editor	Comments
0.1	May 4, 2021	Obsolete	Carter Mudryk	Initial draft based on full BLE Gen2 UG (including ATEX) T0006940_UG_v0.1
0.2	June 1, 2021	Obsolete	Maheeka Wijesinghe	Updated Lighthouse variants T0007296 and T0007381 to be indoor use only (non-IP67) as per CSA results.
1.0	June 11, 2021	Obsolete	Carter Mudryk	Corrected the default battery UL interval for TUNDRA sensors to 1 hour.
1.1	August 10, 2022	Released	Shawn Morrison	Corrected model T-code (T00006909 should be T00006906)
2.0	December 5, 2023	Draft	Carter Mudryk	• Updated to include only information relating to PELICAN and TUNDRA variants to reflect updated mechanical design. • Updated specifications. • Added information about the probe function. • Minor grammatical and formatting changes.
2.1	December 8, 2023	Released	Carter Mudryk	• Updated photos to reflect actual enclosure. • Minor grammatical and formatting changes.
2.2	April 1, 2024	Released	Abigail Trujillo	• Removed content describing Pelican set of products. Focused content on TUNDRA only. • Added a picture with physical dimensions. • Added the use of accelerometer • Added a section detailing basic downlinks • Added section for Kona Atlas • Added section for converters • Updated reference 6