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# LoRa IoT Industrial GPS Asset Tracker

## User Guide

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## Revision History

Revision	Issue Date	Editor	Comments
0.1	May 31, 2019	Emma Tholl	<ul style="list-style-type: none"><li>• Initial draft.</li></ul>
0.2	Sep 23, 2019	Reza Nikjah	<ul style="list-style-type: none"><li>• Added the resetting, awakening, powering off, and putting into DEEP SLEEP procedures. It is assumed now that the modules are shipped in closed IP67 enclosures with already installed and engaged batteries.</li><li>• Added Acronyms and Glossary section</li><li>• Completed the specification table</li><li>• Edited the compliance statements</li><li>• Made some general, minor edits</li></ul>
0.3	Oct 15, 2019	Conor Karperien	<ul style="list-style-type: none"><li>• Updated design</li></ul>
1.0	Nov 5, 2019	Reza Nikjah	<ul style="list-style-type: none"><li>• Released</li></ul>
1.1	Nov 13, 2019	Reza Nikjah	<ul style="list-style-type: none"><li>• Removed Industrial Tracker variant models not yet available</li></ul>

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## Acronyms and Glossary

<b>BeiDou</b> .....	BeiDou Navigation Satellite System (BDS), a Chinese satellite navigation system
<b>BER</b> .....	bit error rate
<b>BLE</b> .....	Bluetooth low energy
<b>bps</b> .....	bits per second
<b>DL</b> .....	downlink
<b>EIRP</b> ...	equivalent isotropically radiated power
<b>EOS</b> .....	end of service
<b>FCC</b> .....	Federal Communications Commissions
<b>GLONASS</b> .....	GLObal NAVigation Satellite System
<b>GNSS</b> ...	global navigation satellite system
<b>GPS</b> .....	Global Positioning System
<b>Industrial Tracker</b> .....	any variant of the LoRa IoT Industrial Tracker
<b>IoT</b> .....	Internet of things
<b>IP</b> .....	ingress protection
<b>LED</b> .....	light emitting diode
<b>LoRa</b> ..	a patented “long-range” IoT technology acquired by Semtech
<b>LoRaWAN</b> .....	LoRa wide area network (a network protocol based on LoRa)
<b>LTC</b> .....	lithium thionyl chloride (chemistry of LTC batteries)
<b>MCU</b> ..	microcontroller unit
<b>NS</b> .....	network server
<b>OTA</b> .....	over the air
<b>PCBA</b> ..	printed circuit board assembly
<b>QZSS</b> ..	Quasi-Zenith Satellite System
<b>RF</b> .....	radio frequency
<b>RSS</b> .....	Radio Standards Specifications
<b>RSSI</b> .....	received signal strength indicator
<b>Rx</b> .....	receiver, receive
<b>SBAS</b> ..	Satellite-based Augmentation System
<b>Tracker</b> .....	Industrial Tracker
<b>TTF</b> ...	time to first fix
<b>TRM</b> ...	technical reference manual
<b>Tx</b> .....	transmitter, transmit
<b>UG</b> .....	user guide (this document)
<b>UTC</b> .....	Coordinated Universal Time
<b>UV</b> .....	ultraviolet
<b>ver.</b> .....	version

# 1 Product Description

## 1.1 Overview

This User Guide is intended to be a user manual for *the LoRa IoT Industrial Tracker*, henceforth referred to as *the Industrial Tracker* or *the Tracker*, developed by TEKTELIC Communications Inc.

The Industrial Tracker is a multi-purpose LoRaWAN IoT Tracker intended to allow assets to be located via a LoRaWAN network. The location is obtained from a GNSS receiver. The Industrial Tracker is equipped with an IoT targeted MCU that has Bluetooth compatibility, a LoRa-based radio, a GNSS device, an accelerometer, and three battery gauges. Table 1-1 presents the available Industrial Tracker model.

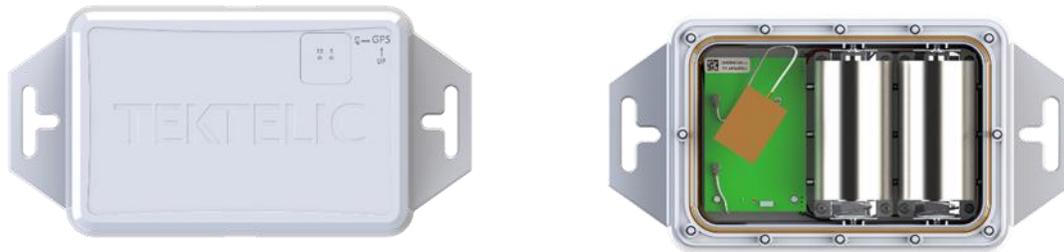
**Table 1-1: Industrial Tracker Model**

Product Code	Description	RF Region	Tx Band (MHz)	Rx Band (MHz)
T0006129	Industrial Tracker Module, 2X D-Cell	US915 EU868	923-928 863-870	902-915 863-870

The main features of the Industrial Tracker are the following:

- **GNSS:** Supports GPS, Galileo, GLONASS, BeiDou, QZSS, and SBAS.
- **BLE:** Bluetooth as a backup positioning system.
- **Accelerometer:** High sensitivity device that can measure any shock or movement events.
- **Battery Gauges:** Fuel gauges for LTC batteries that can provide accurate results with ultra-low average power consumption.

Figure 1-1 illustrates the Industrial Tracker in the enclosure.



a) Top View

b) Top Inside View



c) Bottom View



d) Isometric Top View

**Figure 1-1: The Industrial Tracker module.**

## 1.2 Specifications

The Industrial Tracker specifications are listed in Table 1-2.

**Table 1-2: Industrial Tracker Specifications**

Parameter	Specification
Use Environment	Industrial Indoor/outdoor commercial/residential
Environmental Rating	IP67
Enclosure	Custom design by TEKTELIC
Humidity Vent	Mobi 3-FJ-S1-00-055 UV rated as part of other safety filings
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	195 mm x 101 mm x 50 mm
Weight	300 g without battery; add 95 g per battery.
Power Source	Battery powered: 1x or 2x D-cell LTC (or 3.0 V–3.7 V DC) with reverse polarity protection
Network technology/Frequency band	LoRaWAN in two variants (see Table 1-1): US915, EU868
Air Interface	LoRa
Maximum Tx Power	22 dBm
Sensing Functions	GNSS, Accelerometer, BLE, Temperature, Battery Fuel Gauge
GNSS Features	Support of GPS/QZSS, GLONASS, Galileo, BeiDou Support of 3 concurrent GNSSs Data logging up to 15,000 entries Geofencing up to 4 circular geofences 2.5 m position accuracy TTFF: <ul style="list-style-type: none"> <li>• 26 sec cold start</li> <li>• 1 sec hot start</li> </ul>

	<p>Sensitivity:</p> <ul style="list-style-type: none"> <li>• -164 dBm tracking and navigation</li> <li>• -148 dBm cold start</li> <li>• -157 dBm hot start</li> </ul>
Accelerometer Sensitivity	<p>Sample rate: 1 Hz, 10 Hz, 25 Hz, 50 Hz, 100 Hz, 200 Hz, 400 Hz</p> <p>Measurement range: <math>\pm 2 g</math>, <math>\pm 4 g</math>, <math>\pm 8 g</math>, <math>\pm 16 g</math></p> <p>Precision: 16 mg, 32 mg, 64 mg, 192 mg</p>
Bluetooth Compatibility	BLE base on Bluetooth 5
BLE Sensitivity (0.1% BER)	<p>125 kbps: -103 dBm</p> <p>500 kbps: -98 dBm</p> <p>2 Mbps: -91 dBm</p>
Temperature Measurement Accuracy	<p><math>&lt; \pm 1^{\circ}\text{C}</math> between <math>-20^{\circ}\text{C}</math> and <math>85^{\circ}\text{C}</math></p> <p>Between <math>-40^{\circ}\text{C}</math> to <math>-20^{\circ}\text{C}</math></p>
LED	<p>Green: Joining the network activity</p> <p>Red: LoRa Tx or Rx activity</p>
Battery Fuel Gauge Features	<p>3x gauges for up to three LTC batteries</p> <p>Measuring battery voltage, battery current, temperature</p> <p>EOS alert for each battery (when the capacity is at 5%)</p>
Battery Lifetime	5 years per battery

## 2 Installation

### 2.1 Included Product and Installation Material

The following items are shipped with each tracker:

- LoRa IoT Industrial Tracker in a ruggedized IP67 polycarbonate enclosure with D-cell LTC batteries installed
- Magnet to wake up the Tracker from deep sleep

### 2.2 Safety Precautions

The following safety precautions should be observed:

- Use only LTC cells.
- Should the Tracker be opened and powered externally, do not exceed the maximum specified terminal voltages.
- All installation practices must be in accordance with the local and national electrical codes.

### 2.3 Unpacking and Inspection

The following should be considered during the unpacking of a new Industrial Tracker:

- 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.

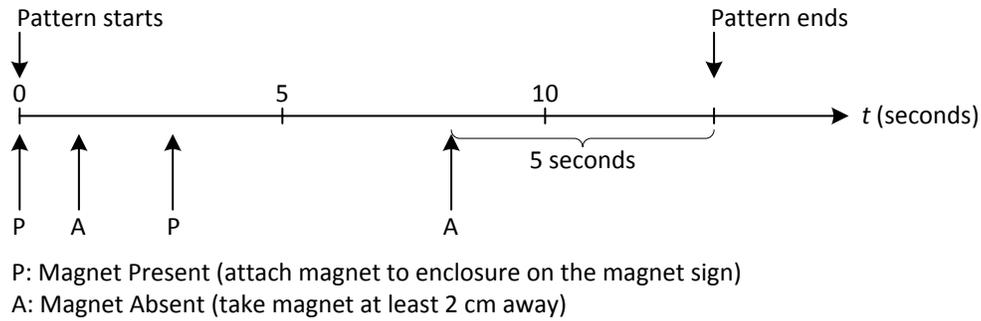
### 2.4 Commissioning and Awakening

The Tracker is shipped in closed enclosure with the batteries installed and engaged. However, the Tracker is in a state of DEEP SLEEP where it draws infinitesimal current, until it is woken up by the provided magnet<sup>1</sup>.

The Tracker does not need to get opened to be awakened. Assuming that the Tracker has been commissioned on the NS, use the magnet to wake up the Tracker as illustrated in Figure 2-1. The wake-up pattern has a 3-1 or PAP-P code. The magnet sign can be seen at the bottom of the enclosure. As soon as the specified magnetic pattern is applied to the Tracker, the Tracker is reset and tries to join the network. See section 4.3 for the expected LED behaviour of the Tracker during the join process.

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<sup>1</sup> Any magnet as strong as, or stronger than, Standex-Meder M4, M5, or M13 can be used as well.



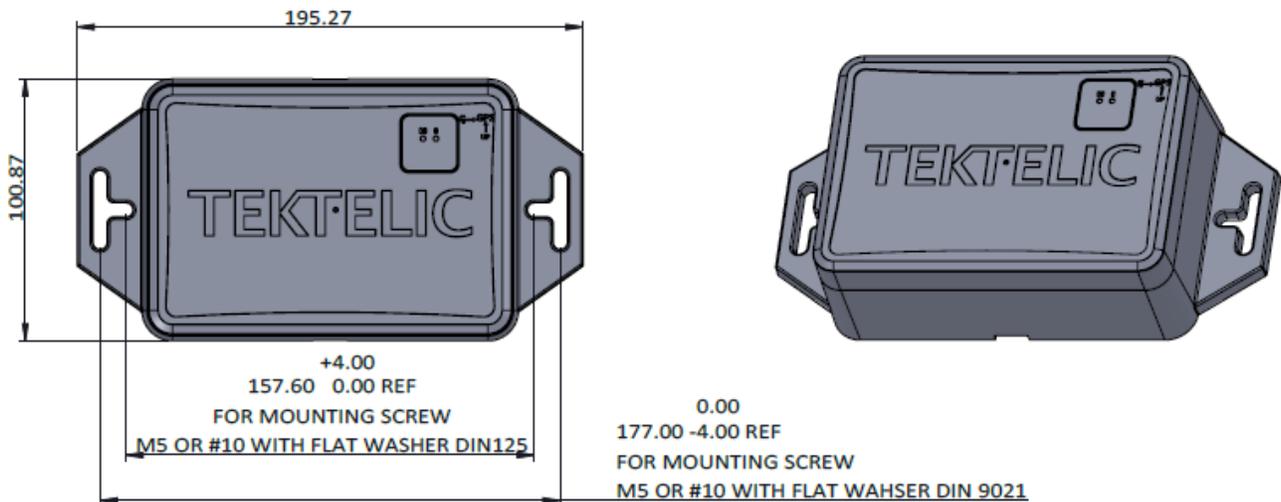
**Figure 2-1: The Industrial Tracker magnetic wake-up pattern.**

The Tracker can be put into the DEEP SLEEP state at anytime by opening it up and pressing the internal reset button located visibly on the Tracker PCBA. If put to DEEP SLEEP, the Tracker can be woken up again using the same procedure explained above, i.e. by the use of the magnet. Removing the batteries for a minute and replacing the batteries can also awaken the Tracker.

**Note:** Replacing the batteries of the Tracker does not cause the Tracker to go to DEEP SLEEP. As soon as new batteries are inserted, the Tracker boots up and tries to join a LoRaWAN.

## 2.5 Mounting

On either side of the enclosure there are two mounting holes, see Figure 2-2. These mounting holes can be used to screw the enclosure to a solid surface. The mounting holes are T-shaped slots so the device can be secured with ropes, zip ties or screws depending on the user's needs. The recommended mounting screw size is M3. Mounting screws are not provided with the Tracker.



**Figure 2-2: The mounting holes and enclosure screw holes.**

The mounting surface must be capable of holding > 2 kg (4.5 lbs).

## 2.6 Battery Replacement

Open up the Industrial Tracker using a #2 Phillips screwdriver. The Tracker has 12x enclosure Philips screws at the bottom. Be careful not to misplace the silicone cover gasket.

Replace the battery(-ies). The Industrial Tracker accepts D-size, 3.6 V, LTC batteries. The Tracker can operate with one or two batteries. One battery yields half the capacity of a two-battery module. In the case of one battery, the battery can be inserted in any of the two battery holders. Suggested replacement batteries include,

- Tadiran TL-4930/S or TL-5930/S
- Xeno Energy XL-205F STD
- Saft LS33600

Once the Tracker is powered and tries to join (see Section 3.3 for LED behavior), replace the cover and gasket. Make sure that the gasket is properly seated in the cover before placing on the Tracker housing. Tighten the 12 cover screws to 2.5 lbf-in (30 N-cm).

To completely turn off the Tracker, the batteries must be uninstalled. To reset the Tracker, the Tracker must remain unpowered (removing the batteries) for at least 1 minute. Another way to reset the Tracker is to press the internal reset button on the Tracker PCBA. In this case, after bootup the Tracker goes to DEEP SLEEP, and can be woken up by applying the magnetic pattern described in Section 2.4, or by turning the Tracker off (removing the batteries) and on.

## 3 Operation, Alarms, and Management

### 3.1 Configuration

The Industrial Tracker supports a full range of OTA configuration options. Specific technical details are available in the Industrial Tracker TRM. All configuration commands need to be sent OTA during a Tracker's DL windows.

### 3.2 Default Configuration

The default configuration on the Industrial Tracker is:

- Report the battery voltages once every day.
- Report UTC and GNSS position fix coordinates once every hour.
- Scan and report up to 4 discovered BLE devices with the largest RSSIs once every hour.

### 3.3 LED Behaviour

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

During the boot and join process:

- 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 (red) LED blinks, then one of the health checks has failed. Consider replacing the battery, or moving the Tracker to an environment within the temperature range.
- Immediately after the delay, the join procedure will begin. During this time the System LED will blink continuously until the tracker joins a network.
- The LoRa LED will now blink whenever LoRa activity occurs on the Tracker (transmitting or receiving packets).

During normal operation:

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

### 3.4 Resetting, Powering Off, Deep Sleeping, Awakening

To reset the Tracker, do *one* of the following:

- Use a magnet to apply the specified magnetic pattern describe in Section 2.4 to the Tracker
- Open up the Tracker, then press the reset button on the PCBA, then use a magnet to apply the specified magnetic pattern describe in 2.4 to the Tracker
- Open up the Tracker, remove the batteries for a minute, then replace the batteries

To completely power off the Tracker:

- Open up the Tracker and remove the batteries

To put the Tracker to DEEP SLEEP:

- Open up the Tracker, then press the reset button on the PCBA

To awaken the Tracker from DEEP SLEEP, do *one* of the following:

- Use a magnet to apply the specified magnetic pattern describe in Section 2.4 to the Tracker
- Open up the Tracker, remove the batteries for a minute, then replace the batteries

**NOTE:** Any resetting of the Tracker will cause all unsaved user configurations to be lost. Save your desired configuration to the Tracker flash before powering off, putting to DEEP SLEEP, or resetting the Tracker.

## 4 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 (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:

- (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.

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 utilisé 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, 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](http://www.P65Warnings.ca.gov).

## References

- [1] LoRa Alliance, "LoRaWAN Specification," ver. 1.0.2, July 2016.
- [2] LoRa Alliance, "LoRaWAN 1.0.2 Regional Parameters," rev. B, Feb 2017.