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BLE Asset Tracker

User Guide

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0.2	March 11, 2020	Draft	Carter Mudryk	• Minor corrections based on feedback. • Confirmed operational temperature range and battery life. • Corrected temperature transducer from battery gauge to on-board MCU thermometer.
1.0	March 11, 2020	Release	Carter Mudryk	Confirmed upper operating temperature at 45°C.
1.1	April 6, 2020	Release	Conor Karperien	Updates to compliance statement and IP change.
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BER ..... Bit Error Rate
BLE..... Bluetooth Low-Energy
CNR..... Cahiers des charges sur les Normes Radioélectriques (RSS)
DL ..... DownLink
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
Rev ..... Revision
RF ..... RadioFrequency
RSS..... Radio Standards Specifications (CNR)
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
Ver..... Version

1 Product Description

1.1 Overview

This document provides a user manual for the *BLE Asset Tracker* (formerly known as the *LoRa IoT BLE Tracker*) developed by TEKTELIC Communications Inc. Henceforth in this document it will be referred to as the *BLE Tracker,* or simply, the *Tracker*.

The Tracker is a BLE-capable LoRaWAN IoT sensor that is powered by a single AA-cell LTC battery and packed into a compact IPX0 enclosure. The Tracker is intended for scanning and reporting neighboring BLE peripherals (devices) up to a range of approximately 100 m (LoS). The Tracker can be utilized for a wide variety of asset-locating applications; for example, as a proximity sensor to provide location information in indoor or outdoor environments. The Tracker is also equipped with an accelerometer that detects movement to trigger a report. The accelerometer output vector can also be reported periodically if knowledge of the Tracker orientation is of interest. Additional sensing functions on the Tracker include on-board temperature and battery voltage. The battery lifetime of the Tracker has been estimated to be up to 5 years or more, depending on usage. Table 1-1 presents the available Tracker models.

Table 1-1: BLE Asset Tracker Models.

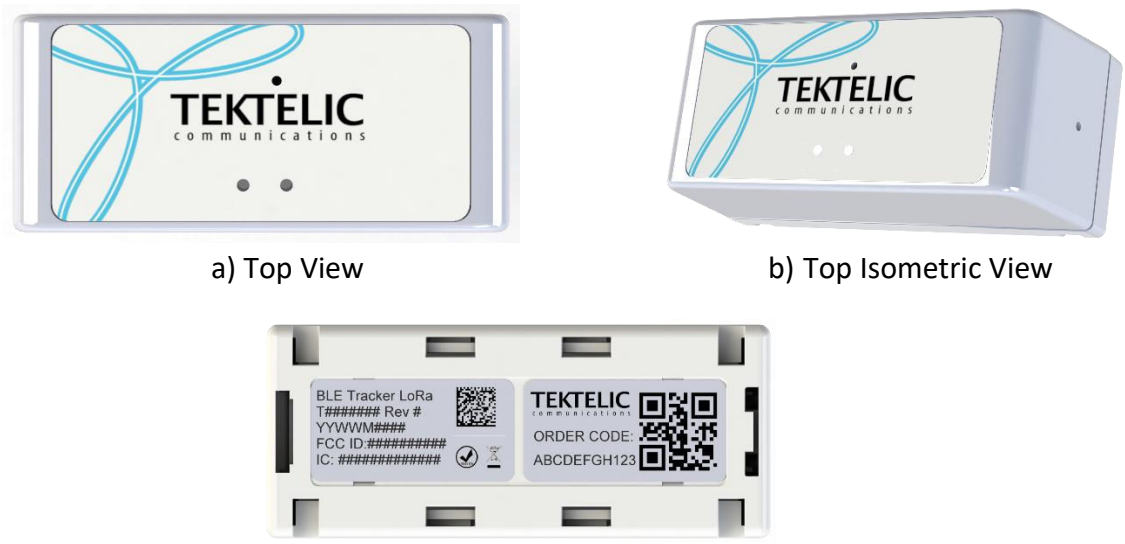
Product Code	Description	RF Region	Tx Band [MHz]	Rx Band [MHz]
T0005944	BLE Asset Tracker, NA	US915	923-928	902-915
T0005945	BLE Asset Tracker, EU	EU868	863-870	863-870

The main features of the Tracker are summarized as follows.

- **BLE:** Low-Energy Bluetooth scanning and reporting of nearby BLE-equipped devices to function as a proximity sensor.
- **Accelerometer:** A high-sensitivity device that can measure any shock or movement events. Can be used as an on/off switch for the Tracker to report location data only when motion is detected.
- **Thermometer:** the temperature is measured from the on-board MCU transducer.
- **Function Button:** Externally accessible button for triggering ULs and opening a receive window for DLs.
- **Battery Gauge:** Fuel gauge for the LTC batteries that can provide accurate results with ultra-low average power consumption.

- **Battery EOS Alarm:** An automatic alert that is sent when the battery life reaches 5% capacity.

Figure 1-1 illustrates the Tracker in the enclosure. Figure 1-2 illustrates the LED, Reset Button, Push Button, and Case-Release Hole placements.



a) Top View

b) Top Isometric View

c) Bottom View

Figure 1-1: The BLE Asset Tracker Module.

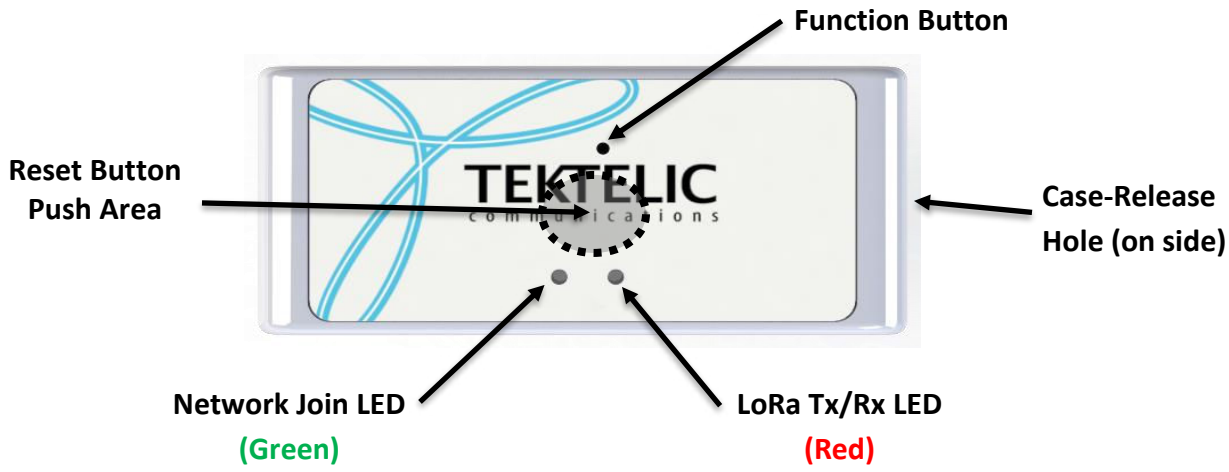


Figure 1-2: The BLE Asset Tracker External Interface Layout.

1.2 Specifications and Sensing Functions

The Tracker specifications are listed in Table 1-2.

Table 1-2: BLE Asset Tracker Specifications.

Parameter	Specification
Use Environment	Indoor Industrial/commercial/residential
Environmental Rating	IPX0
Enclosure	Custom design by TEKTELIC
Operating Temperature	5°C – 45°C
Storage Temperature for Optimal Battery Life	-40° - 85°C
Operating Relative Humidity	5% - 95% (Non condensing)
Storage Relative Humidity	5% - 95% (Non condensing)
Size	63 mm x 26.5 mm x 27 mm
Weight	18 g module; 18 g battery; 36 g total
Power Source	Battery-powered: 1x AA-cell LTC (3.6 V)
Network technology/Frequency band	LoRaWAN in two variants (see Table 1-1): US915, EU868
Air Interface	LoRa, BLE
Maximum Tx Power	15 dBm
Sensing Elements	BLE scanner, accelerometer, thermometer, battery gauge
Bluetooth Compatibility	BLE based on Bluetooth 5
BLE Sensitivity (0.1% BER)	125 kbps: -103 dBm 500 kbps: -98 dBm 2 Mbps: -91 dBm
Accelerometer Sensitivity	Sample rate: 1 Hz, 10 Hz, 25 Hz, 50 Hz, 100 Hz, 200 Hz, 400 Hz Measurement range: ±2 *g*, ±4 *g*, ±8 *g*, ±16 *g* Precision: 16 m*g*, 32 m*g*, 64 m*g*, 192 m*g*
Function Button	Configurable operation Used to force an UL and open a DL window
LED	Green: Joining the network activity Red: LoRa Tx or Rx activity
Battery Fuel Gauge Features	Measures battery voltage, current, and temperature EOS alert when the capacity is at 5%
Battery Lifetime	5 years per battery (with nominal use case of 15 BLE scans and transmissions per day)

1.2.1 Bluetooth Low-Energy Scanner

The Tracker is equipped with a BLE module that is embedded in the MCU. It serves as a BLE central device that periodically searches to discover nearby BLE peripherals. It can be used as a standalone proximity sensor that can also help at positioning.

The BLE scan can be disabled entirely or enabled at any time. Figure 1-3 shows the BLE scan scheme when the BLE scan is enabled. As shown in the figure, BLE scans are performed periodically. Each scan duration is divided into scan intervals. The BLE scan is performed only in the scan window portion of the scan interval. The ratio of the scan window to the scan interval shows the scan duty cycle. In the case of the scan window equalling the scan interval, the scan duty cycle is 100%. This represents a continuous scan over each scan duration. This will increase the likelihood of finding more beacons, but at the expense of consuming more power. The scan period, duration, interval, and window are all configurable (see the TRM document for configuration details [1]).

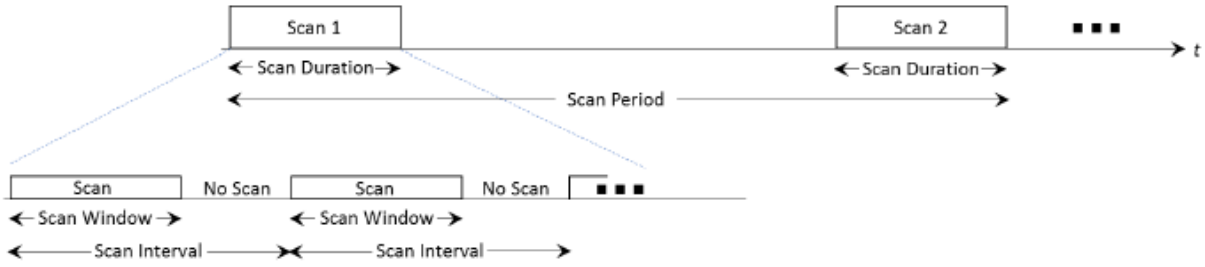


Figure 1-3: The BLE Scan Schematic Procedure.

At the end of each scan duration, up to *n* discovered BLE devices with the strongest RSSIs are reported over LoRaWAN. The value *n* is user configurable (see TRM) [1]. If no devices are found, an empty list is uplinked. Over each scan duration, a BLE device beacon may be observed (discovered) more than once, in which case the RSSI associated with the BLE device at the end of the scan duration is the average value over all observed RSSIs.

The Tracker supports BLE of Bluetooth 5.0. The BLE scan is performed in the passive mode only, i.e. the Tracker listens to surrounding beacons, but does not transmit to them to request additional information.

NOTE: The BLE scan is exclusive to LoRa radio transmission; i.e. they do not overlap. If any reporting becomes due at the same time of a BLE scan, the reporting will be done after the BLE scan is complete.

1.2.2 Accelerometer Transducer

Acceleration sensing is provided by an integrated 3-axis accelerometer which can be disabled to conserve battery life. The main role of the accelerometer in the Tracker is to detect motion that can indicate a change of the Tracker's status from stillness to mobility, or vice versa. In this role, the accelerometer generates an acceleration alarm when a motion event is detected that may or may not be reported OTA (user-configurable).

An acceleration event report is based on exceeding a defined acceleration alarm threshold count in a defined alarm threshold period. These thresholds can be customized such that there will not be multiple reports for a single event, depending on the definition of an event in a particular use case. An alarm event can only be registered after a configurable grace period elapses since the last registered alarm event. Carefully setting the grace period is important and prevents from repeatedly registering an accelerometer event.

The accelerometer can also be polled periodically for its output acceleration vector for applications in which the Tracker orientation is of interest.

1.2.3 Temperature Transducer

The Tracker includes an on-board thermometer that functions with the specifications listed in Table 1-2 and supports threshold-based transmission. The temperature is measured from the built-in MCU transducer. When the temperature thresholds are enabled, the Tracker reports the temperature when it leaves the configured threshold window, and once again when the temperature re-enters the threshold window. The Threshold mode is compatible with periodic reporting of the temperature.

2 Installation

2.1 Included Product and Installation Material

The following items are shipped with each Tracker.

- BLE Asset Tracker in an IPX0 polycarbonate enclosure with AA-cell LTC battery installed.
- The BLE Asset Tracker Quick Start Guide [2].

2.2 Safety Precautions

The following safety precautions should be observed.

- The Tracker is intended for indoor use only.
- All installation practices must be in accordance with the local and national electrical codes.
- Replace only with approved batteries (see section 2.6).
- The Tracker contains an LTC AA-cell battery. When used correctly, lithium batteries provide a safe and dependable source of power. However, if they are misused or abused, leakage, venting, explosion, and/or fire can occur. The following are recommended safety precautions for battery usage [3].

  - **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.**

2.3 Unpacking and Inspection

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

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 Commissioning and Activation

The Tracker is shipped in a secured enclosure with the battery preinstalled but disengaged by a pull tab.

The Tracker enclosure does not need to be opened for activation. Assuming that the Tracker has been commissioned on the NS, pull out the battery tab to engage the battery. The Tracker will automatically begin the join process. To turn off the device the battery must be removed. To reset the device, the external reset button can be pushed; see Section 3.4 for a description of the reset function.

Refer to Section 3.3 for the expected LED behaviour of the Tracker during the join process. It may take up to 10 seconds between the time the Tracker was reset and the beginning of the LED join attempt pattern.

Removing and reinserting the battery will reset the Tracker. As soon as new batteries are inserted, the Tracker boots up and tries to join a LoRaWAN.

2.5 Mounting

There is a mounting hole on each corner on the bottom side of the Tracker enclosure (see Figure 2-1).

Figure 2-1: The Mounting Hole Locations on the Bottom of the Tracker.

These mounting holes can be used to fasten the enclosure to a solid surface, cable, etc. The mounting holes are slots so the device can be secured with ropes, zip ties, or hooks depending on the user's needs. If using cables or zip ties, they can be threaded through both slots on either side of the enclosure as shown in Figure 2-2. The recommended zip tie width is 3 mm. Mounting fasteners are not provided with the Tracker.

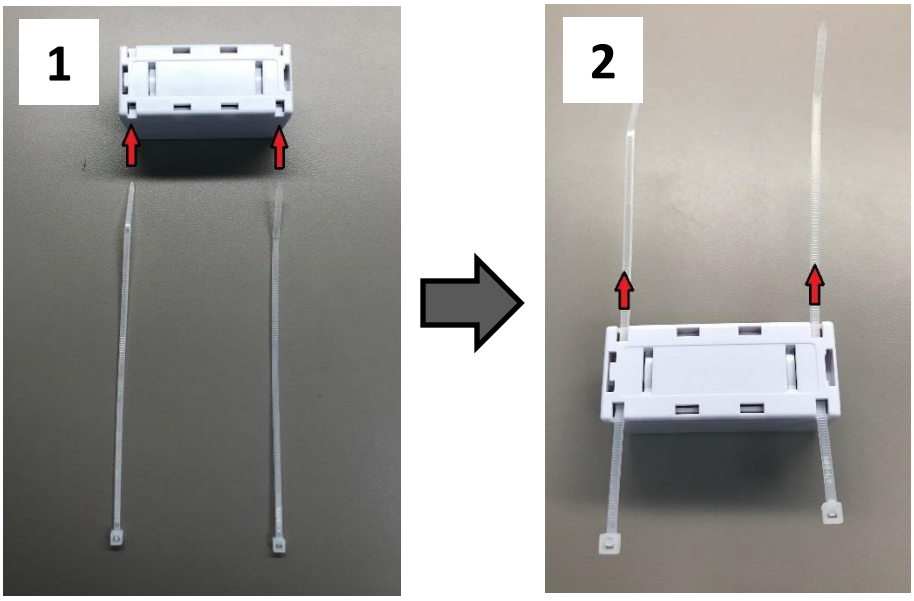


Figure 2-2: Threading Zip Ties Through the Mounting Holes to Fasten the Tracker.

2.6 Battery Replacement

The process for replacing the battery in the Tracker is as follows.

1. Insert the end of a paper clip or similarly thin object into the case-release hole on the right side of the Tracker. Push the paper clip straight in while simultaneously squeezing the middles of the sides of the top portion of the enclosure as shown in Figure 2-3. The top and bottom should unclip from each other and separate.

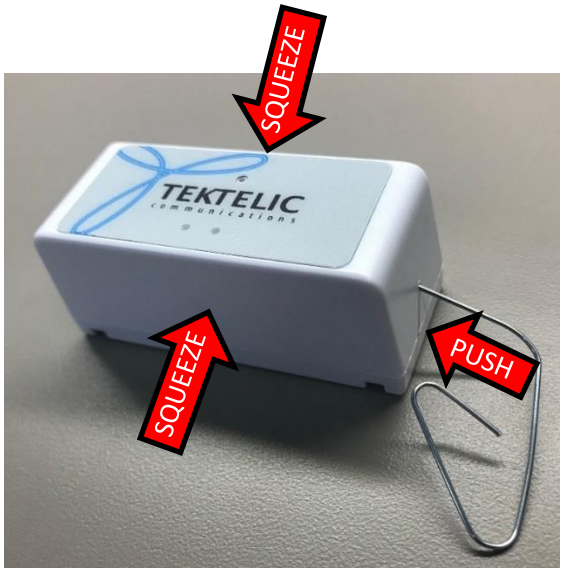


Figure 2-3: Opening the BLE Tracker Enclosure.

Remove the battery and replace with a new one as shown in Figure 2-4. Suggested replacement batteries are:

- Saft SA LS14500 [4]
- Tadiran SL-360/S [5]
- Tadiran TL-4903/S [6]
- Tadiran TL-5903/S [7]
- Xeno Energy XL-060F STD [8]

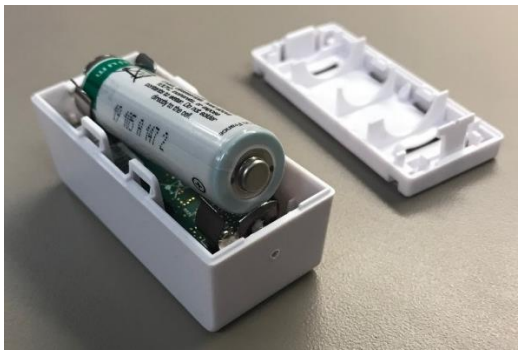


Figure 2-4: Replacing the Battery After Opening the Tracker Enclosure.

2. Once the Tracker is powered and tries to join (see Section 3.3 for LED behavior), replace the bottom enclosure piece by inserting the side with the long snap tab first, as shown in Figure 2-5. Push the other side of the bottom enclosure piece in until both the top and bottom fully snap together.

Figure 2-5: Left: Location of the Long Snap Tab. Right: Inserting the Long Snap Tab Side First to Reattach Enclosure Bottom.

3 Operation, Alarms, and Management

3.1 Configuration

The Tracker supports a full range of OTA configuration options. Specific technical details are available in the Tracker TRM [1]. All configuration commands need to be sent OTA during a Tracker's DL windows.

3.2 Default Configuration

By default, the Tracker is configured to:

- Report the battery voltage once per day,
- Perform a BLE Scan and report up to 8 discovered devices once every hour.
- Perform a BLE scan and report up to 8 discovered devices when the function button is pressed.

3.3 LED Behaviour

See Figure 1-2 for the location and identification of the Tracker 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 s) the LEDs will turn off and one of them will blink briefly.
    a. If the green system LED blinks, then all health checks on the board passed.
    b. If the red 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 green system LED will blink continuously until the sensor has joined a network.
4. The red 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 red LoRa LED will blink whenever LoRa activity occurs on the sensor (transmitting or receiving packets), and
- The green 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.

3.4 Reset Button Function

There is an externally-accessible function 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 main objective of the push button is to trigger the Tracker to send an uplink such that the Tracker (which acts as a Class-A LoRaWAN sensor) will open receive windows to receive DL commands.

The definition of when a push button event is registered is user configurable. The default configuration is pushing and releasing the button at least 1 time within 1 second. Alternatively, the button can be configured to register an event by keeping the button pushed for a defined number of seconds. In either case, when the event is registered, the Tracker sends an uplink. The uplink can be empty or configured to contain the battery voltage, acceleration vector, temperature, BLE scan results, or any combination of these.

3.5 Push Button Function

The Tracker has an externally-accessible push button, actuated by pushing against the enclosure on a designated area. The reset is instant, i.e. the button does not need to be held. The reset restarts the microprocessor. All the FW load and configuration parameters in the Flash are remembered during the reset.

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

4 Compliance Statements

Federal Communications Commission:

This device complies with Part 15 of the FCC Rules [9]. 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) [10]. 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 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, 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 [11].

References

[1] TEKTELIC Communications Inc., "BLE Asset Tracker: Technical Reference Manual T0005946_TRM_v0.4," TEKTELIC Communications Inc., Calgary, 2019.

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