Hardware Configuration and Installation Guide

Sentrius™ BT610 I/O Sensor

Version 1.0

REVISION HISTORY

Version	Date	Notes	Contributor(s)	Approver
1.0	30 Nov 2021	Initial Release	Greg Leach	Chris Boorman

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CONTENTS

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1 OVERVIEW

Remove the front cover of the BT610 by unscrewing the four corner screws and setting the cover aside. The screws do not need to be completely removed from the front cover.

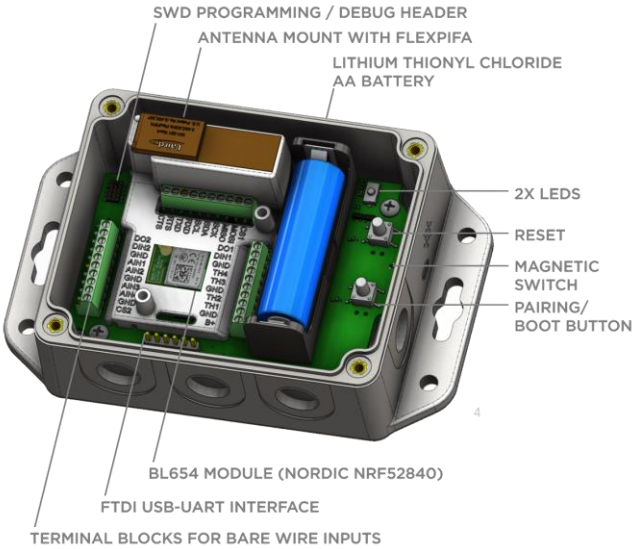

Figure 1: Sentrius™ BT610 I/O sensor

The BT610 includes three 10-port terminal blocks for external sensor connections, a SWD ARM programming header, separate RESET and pairing buttons, as well as an installed battery.

Notes:

- The BT610 is shipped with a non-conductive tab preventing the installed battery from powering the unit.
- Before proceeding with the following HW configuration, be sure to keep the non-conductive tab installed or remove the battery entirely to power down the BT610.
- The BT610 battery type is a 3.6V non-rechargeable Lithium Thionyl Chloride AA cell (ER14505).
- Replacement of the battery with an incorrect type can permanently damage and render the BT610 inoperable.
- Do not recharge, crush, disassemble, or expose the battery to water in any situation.
- Do not dispose of a battery in a fire or hot oven, which can result in an explosion.
- Leaving a battery in an extremely high temperature environment can result in an explosion or the leakage of flammable liquid or gas.
- A battery subjected to extremely low air pressure may result in an explosion or the leakage of flammable liquid or gas.
- Properly dispose of used batteries according to local regulations.

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2 Installing Cable Glands

The Sentrius™ BT610 has four M12 openings on the side walls of the enclosure for routing sensor cables out of the housing.

Figure 2: Sentrius™ BT610 enclosure openings

Each BT610 kit comes with four waterproof cable glands for wiring sensor cables into the enclosure and three waterproof plugs for capping unused inputs.

Note: Each sensor cable connected to the BT610 requires its own cable gland. Do not route more than one sensor cable through each opening.

2.1 Select Proper Cable Seal Size

Each cable gland provided in the kit is assembled as in Figure 3.

Figure 3: IP67 cable gland

Figure 4: Two sizes of seals

To select the proper cable seal size, follow these steps:

1. The cable gland assembly comes with two sizes of seals (Figure 4). Remove and set aside the gland sealing nut.
2. Select the appropriate seal to fit the outer diameter of the sensor cable being installed.
   - A gray seal for sensor cable diameters of 1.5 to 3.1 mm is inserted inside the larger black seal.
   - For sensor cable diameters of 3 to 6 mm, remove the gray seal from inside the gland body/black seal (Figure 5).

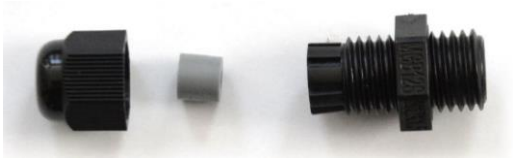

Figure 5: Gray seal removed from cable gland assembly

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2.2 Mount Cable Gland on Enclosure

To mount a cable gland onto the enclosure, follow these steps:

1. Connect the cable gland to the BT610 enclosure for each sensor being installed.

   You may use any opening on the BT610 housing. It may be easier to hold the nut in place and tighten by turning the gland body. The sensor cable routing inside the enclosure depends on the selected opening.
2. Insert the gland body and washer from the exterior of the housing.
3. Tighten the M12 x 1.5 plastic nut on the interior to attach the gland body and washer to the enclosure.
4. Tighten the gland nut until finger tight.
5. Tighten the nut ¼ to ½ turn more to ensure that the rubber washer is compressed and properly sealing.

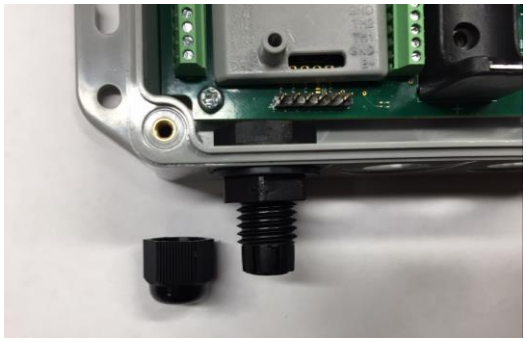

Figure 6: Cable gland and plastic nut installation

2.3 Unused Openings

On installations using less than the maximum four sensors, do the following:

1. Attach one of the waterproof plugs provided in the kit on each unused enclosure openings.
2. Insert the plug and washer from the exterior of the housing and use a M12 x 1.5 plastic nut on the interior.
3. Tighten the gland nut until finger tight.
4. Tighten the nut ¼ to ½ turn more to ensure that the rubber washer is compressed and sealing properly.

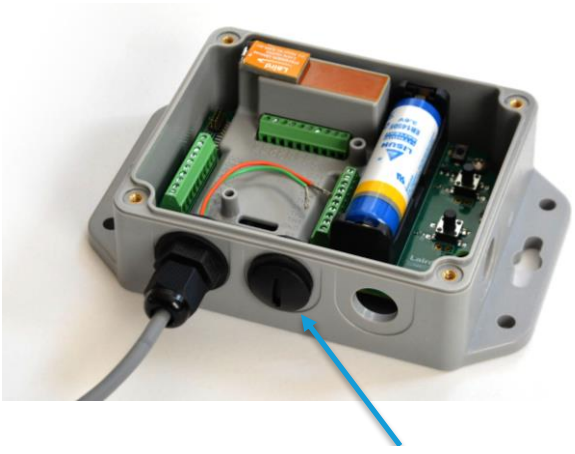

Figure 7: Waterproof plug and installation

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2.4 Running the Sensor Cable into the BT610

Once the cable gland/seal, washer, and nut are fitted, run the applicable sensor cable through the connector by doing the following:

1. Pass the cable through the gland sealing nut.
2. Feed the tinned leads of the cable through the cable gland/seal and into the BT610.

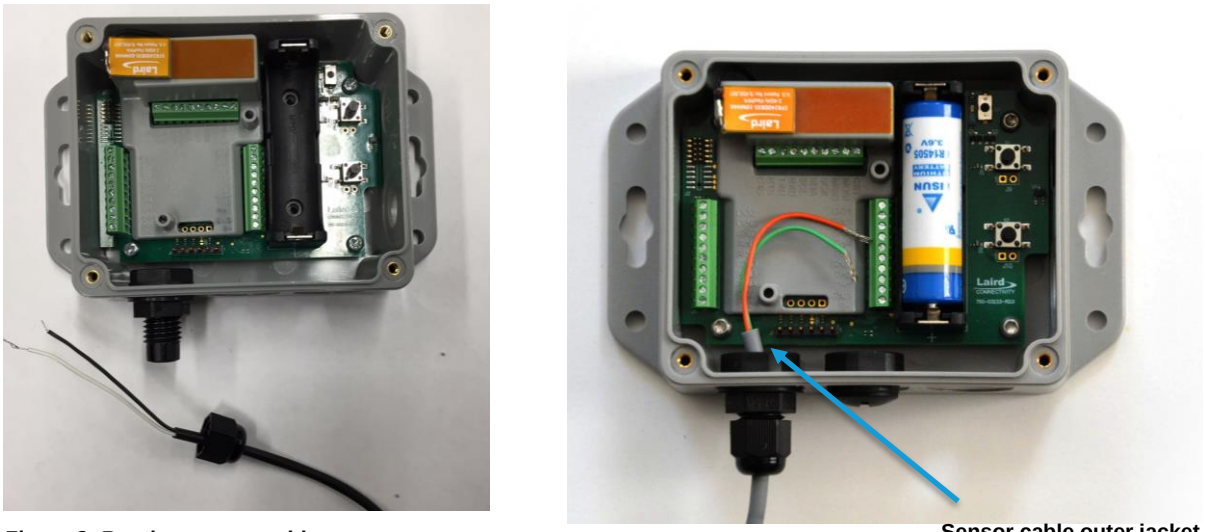

Figure 8: Routing sensor cable

Note: Make sure the sensor outer cable jacket extends through the gland and into the housing to ensure a tight seal to maintain the IP67 rating (Figure 8). The exposed wires must be fully located inside the housing.

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3. Tighten the gland sealing nut to hold the cable in place until the initial internal cable routing is determined.

   Do not fully tighten the gland sealing nut until the wires are attached to the proper terminals (refer to the following section of this guide) and the final internal sensor cable routing is completed.

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3 Sensor Wiring Connections

The sensor cable wires are connected to the BT610 via screw terminals. To complete this, follow these steps:

1. (Recommendation) Expose at least 5 mm of stripped and tinned wire.
2. Fully insert the tinned wire into the terminal.
3. Use a flat head screwdriver to tighten the terminal screw clockwise.
4. Confirm a good connection with a gentle tug on the wire.

3.1 Analog Sensors

The Sentrius™ BT610 provides four analog input (AIN) ports for connecting to analog sensors/meters. Each AIN port supports either 0–10V voltage sensing or 4–20 mA current sensing.

Because the BT610 cannot detect the type of analog input device connected, you must properly connect each sensor and then configure the analog input type, measurement parameters, reporting method, and name for each port through the Sentrius BT610 mobile app (available on the iTunes App Store or Google Play Store).

Each analog sensor consists of two wire connections to the terminal block. The analog connections must use the following voltage polarity or current flow direction to operate properly (Figure 9):

Figure 9: Voltage polarity or current flow direction

Note: Reverse polarity connections will be reported as a voltage of 0V or current of 0mA.
The BT610 is a passive (2-wire receiver) current sensor only. It cannot provide power for the current loop.

You may use any of the four analog input ports **[AIN1:AIN4]** and six ground ports **[GND]** indicated in Figure 10. Use the mobile app to configure each port to the sensor attached.

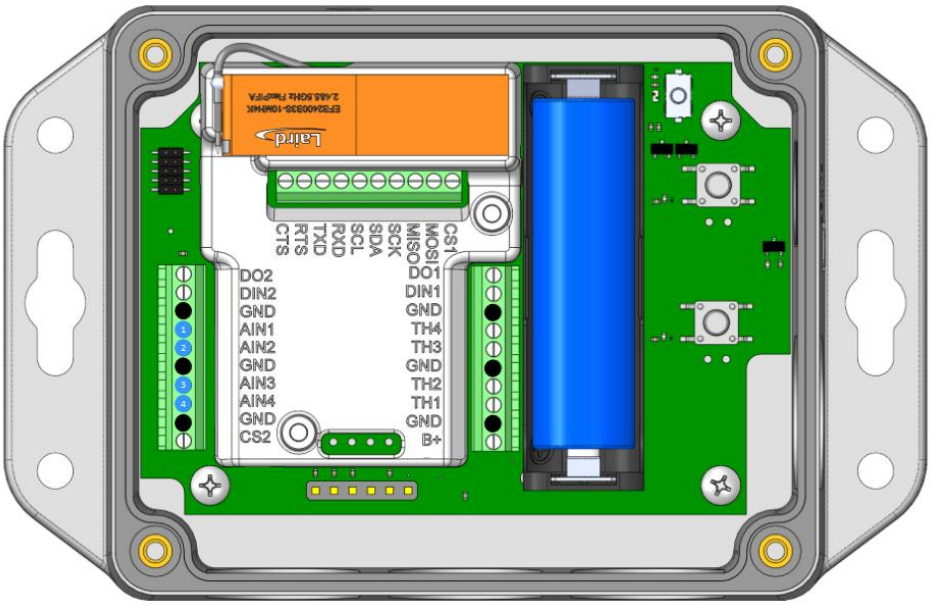

Figure 10: Analog sensor terminals

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3.2 Digital Input/Dry-Contact

The Sentrius™ BT610 provides two digital input (DIN) ports for monitoring occurrences of events from external sources (such as dry-contact inputs and tact switches).

Note: The digital input ports only support sinking.

Each digital input connection consisted of two wires forming a connection between DIN# and ground as indicated in the following image (Figure 11).

Figure 11: connection between DIN# and ground

You may use either of the two digital input ports **[DIN1,DIN2]** and six ground ports **[GND]** indicated in Figure 12. Use the mobile app to configure each port to the input attached.

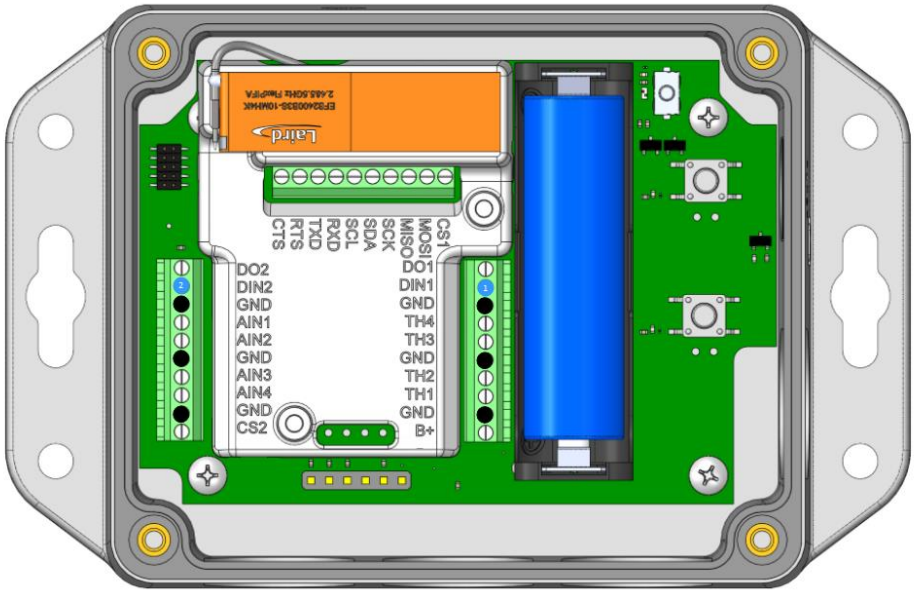

Figure 12: Digital input terminals

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3.3 Digital Outputs

The Sentrius™ BT610 provides two digital outputs (DO) for external indication or switching (non-relay). Each DO port uses an open-drain configuration and requires an external voltage (3 – 30V) and resistive load (<500 mA) to operate.

Each digital output consists of a pull-up (resistive load) to an external supply on DO# and a connection to ground for reference as indicated in the following image (Figure 13).

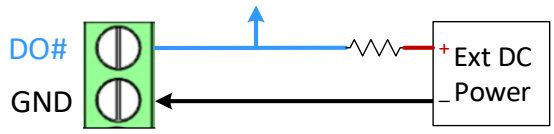
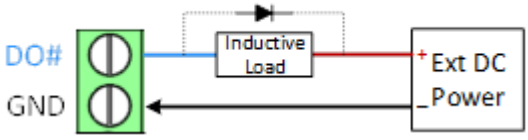


Figure 13: Pull-up (resistive load) to an external supply on DO# and a connection to ground

Note: The digital output can support inductive loads but requires an external 1A fly-back diode to eliminate back EMF when the DO is turned off.



You may use either of the two digital output ports **[DO1,DO2]** and six ground ports **[GND]** indicated in Figure 14. Use the mobile app to configure each port to the output attached.

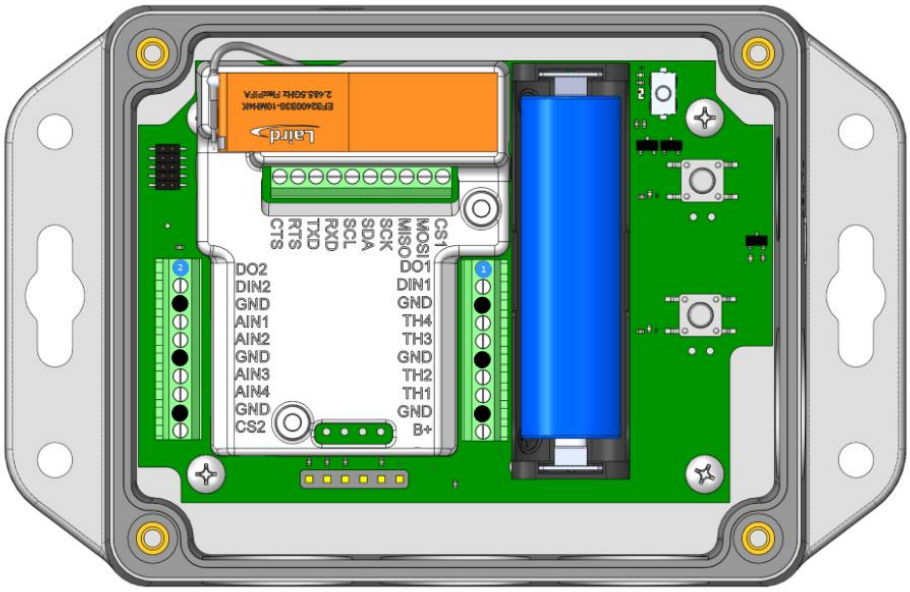


Figure 14: Digital output terminals

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3.4 Sensor Power Source (B+)

The Sentrius™ BT610 provides a single terminal port **(B+)** for powering external sensors. The port is configurable via the mobile app to source either VBAT (3 – 3.6V) or +5V. The output current is limited to 20 mA, 50 mA peak (<100 msec).

Each wired power connection requires a second wire connection to ground for reference.

Note: A maximum of two external wire connections to **B+** is allowed.

You may use any of the six ground ports [GND] indicated in Figure 15.

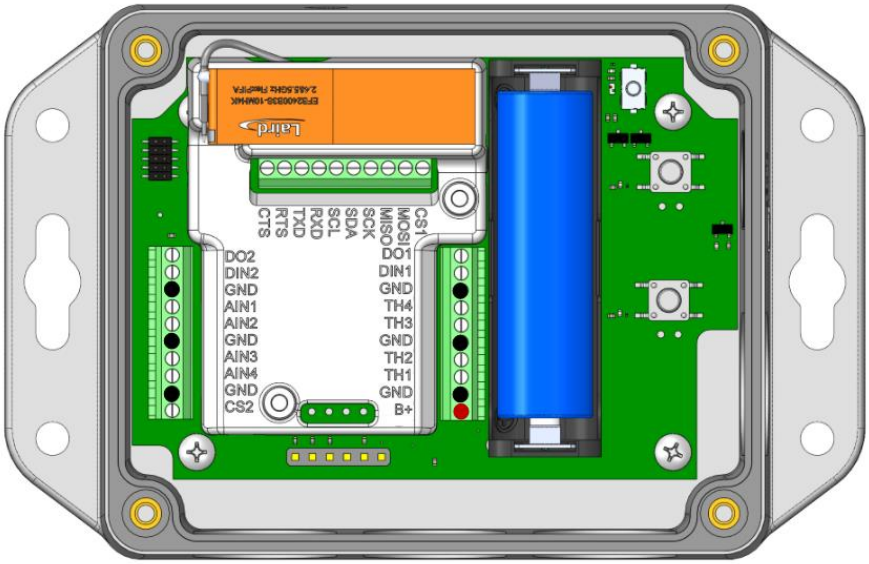
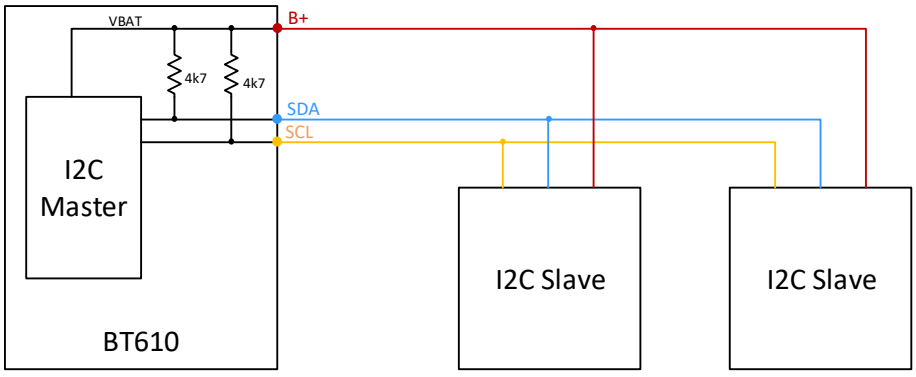


Figure 15: Sensor power source

3.5 Serial Interface – I2C

The Sentrius™ BT610 provides an I2C interface for connecting to external sensors or devices. The BT610 operates as the I2C master and a maximum of two I2C slave devices can share the bus. The BT610 contains 4.7 kΩ pull-up resistors to VBAT on the **SDA** and **SCL** lines.



Note: The I2C interface only supports VBAT logic levels (3 – 3.6V). You must connect to the **B+** terminal (configured for VBAT output) to either power the I2C device or supply the BT610 logic level to an external level shifter.

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You may use any of the six ground ports **[GND]** indicated in Figure 16.

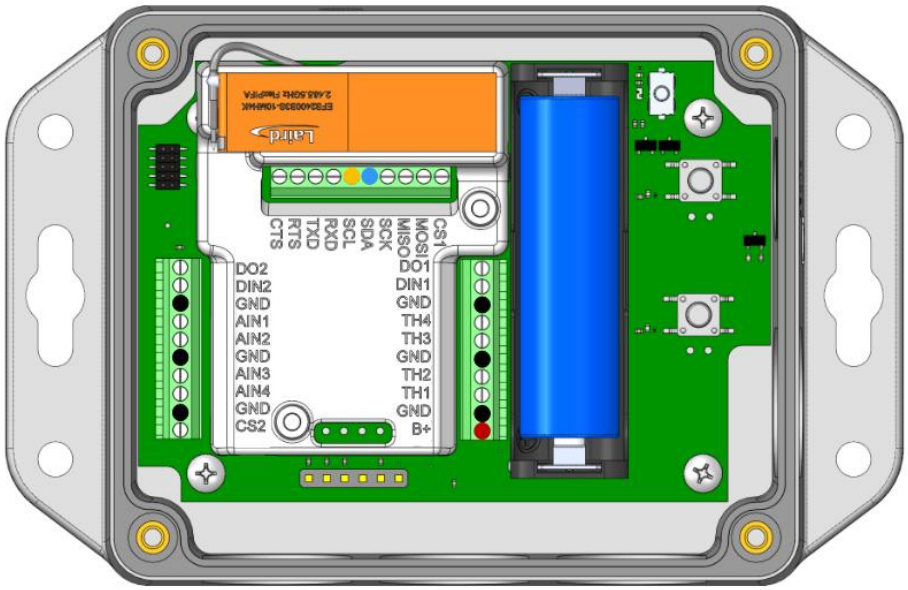

Figure 16: I2C interface connections

3.6 Serial Interface - SPI

The Sentrius™ BT610 provides a SPI interface for connecting to external sensors or devices. The BT610 can support two devices as two individual SPI select lines are available. The connections are defined as follows (Figure 17):

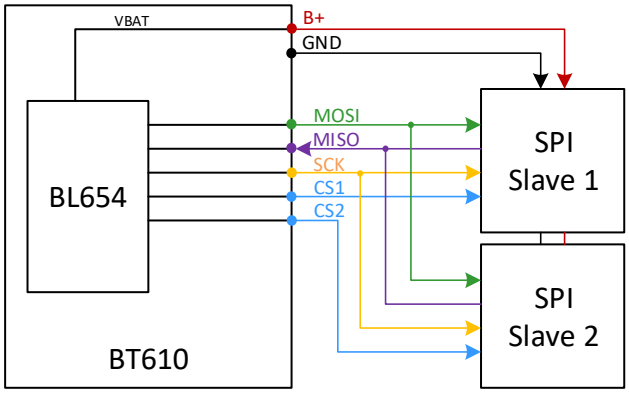

Figure 17: Connections for external sensors or devices

Note: The SPI interface only supports VBAT logic levels (3 – 3.6V). You must connect to the **B+** terminal (configured for VBAT output) to either power the SPI devices or supply the BT610 logic level to an external level shifter.

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You may use any of the six ground ports **[GND]** indicated in Figure 18.

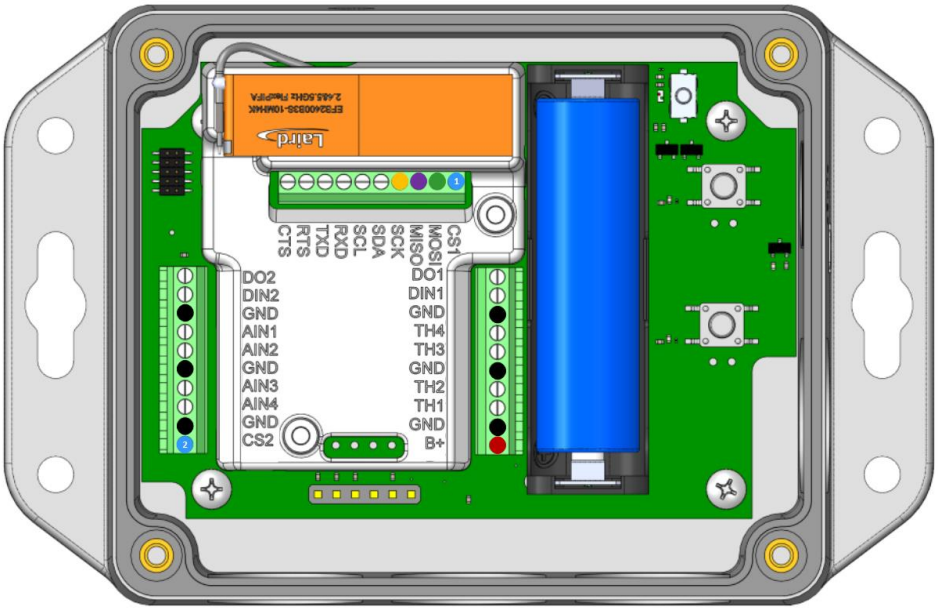

Figure 18: SPI interface connections

3.7 Serial Interface – UART

The Sentrius™ BT610 provides full-duplex UART interface for connecting to external devices. The connections are labeled with respect to the external device and the signal directions are defined as follows (Figure 19):

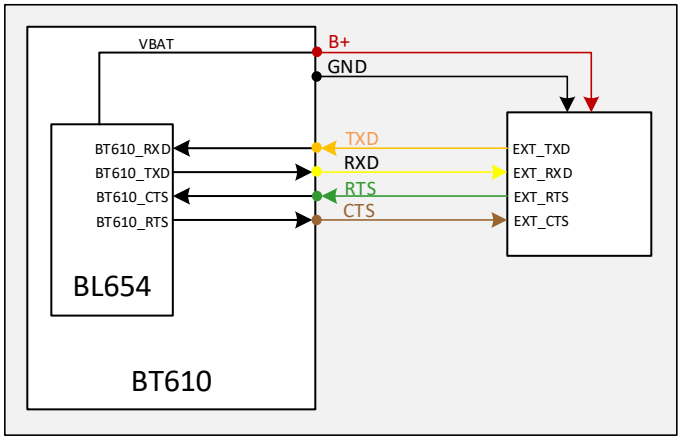

Figure 19: Signal direction definitions

Note: The UART interface only supports VBAT logic levels (3 – 3.6V). You must connect to the **B+** terminal (configured for VBAT output) to either power the external device or supply the BT610 logic level to an external level shifter.

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You may use any of the six ground ports **[GND]** indicated in Figure 20.

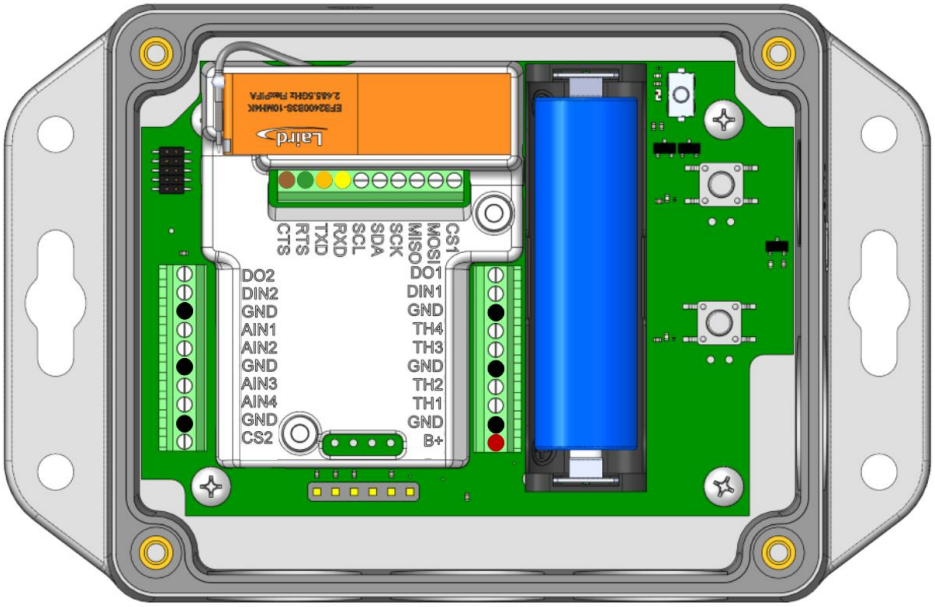

Figure 20: UART interface connections

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3.8 Programmer Port

A 9-way Cortex-M Debug connector is available for programming and debugging of the nRF52840 MCU. This is located as shown in Figure 21. Further details of the connector and a suitable programmer can be found at Appendix A – References [A].

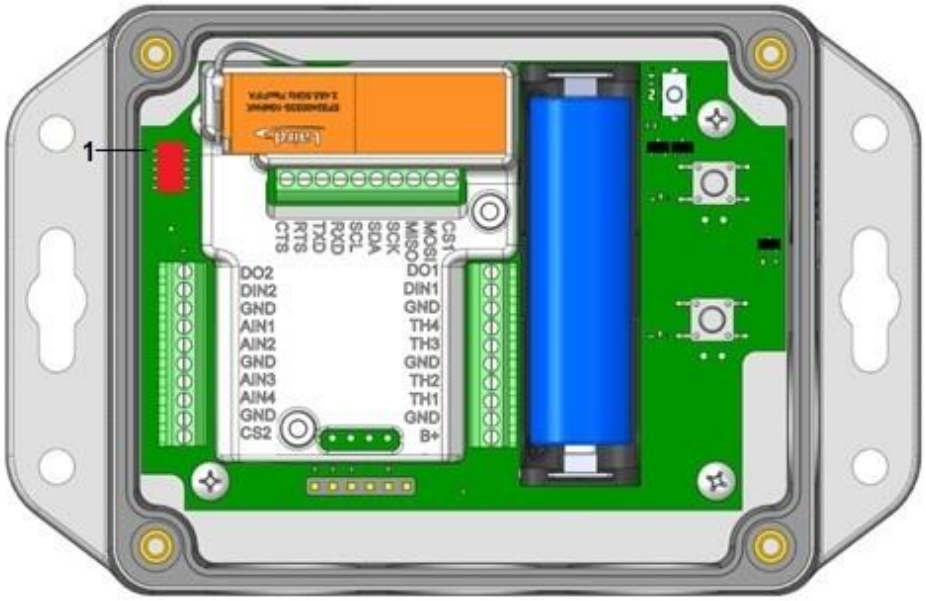

Figure 21: Programming Port connections

Important! Orientation of Programmer cable must be observed as indicated in Figure 21.

Important! Platform developers must consider the inherent vulnerability with exposing the Programming Port and should consider implementing read back protection of the MCU to ensure debugger access is disabled for released firmware versions.

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4 Laird Connectivity Sensor Connections

4.1 Sentrius™ BT6xx Thermistor Sensor Cable Assembly

Laird Connectivity offers individual thermistor sensor probes (sold separately) for operation with the BT610. The BT610 supports connection of 1–4 of these probes for a pre-canned temperature monitoring solution.

Each thermistor sensor has two sensor leads (blue wires) which connect between a **TH#** terminal and GND terminal as indicated in Figure 22. In addition, the thermistor sensor has a cable shield lead which must be connected to a GND terminal on the BT610.

Each TH# terminal supports only a single sensor connection. There is no polarity requirement for the sensor wire connections. You must properly connect each thermistor sensor and then configure the measurement parameters and identifier for each thermistor port through the mobile app.

Note: By default, the BT610 only supports the Sentrius™ thermistor sensor cable assembly. A different 10k NTC thermistor sensor can be used, but you must input the corresponding Steinhart-Hart coefficients for this sensor in order to accurately report the temperature readings. Laird provides a coefficient calculator on our website and the entry of the new coefficients can be completed through the mobile app.

Note: The BT610 requires calibration of the ADC to ensure accurate temperature readings with the thermistors. By default, these ADC calibration coefficients are determined at manufacture and are stored in non-volatile memory on every BT610. In the event these coefficients are lost or not provided, refer to Appendix A – References [B] for the method of determining the ADC calibration coefficients and [C] for writing the values to non-volatile memory.

The user is free to use any of the six ground ports **[GND]** indicated in Figure 22. It is recommended to use the GND connections on the left side terminal header for the cable shield GND connections as shown in Figure 23.

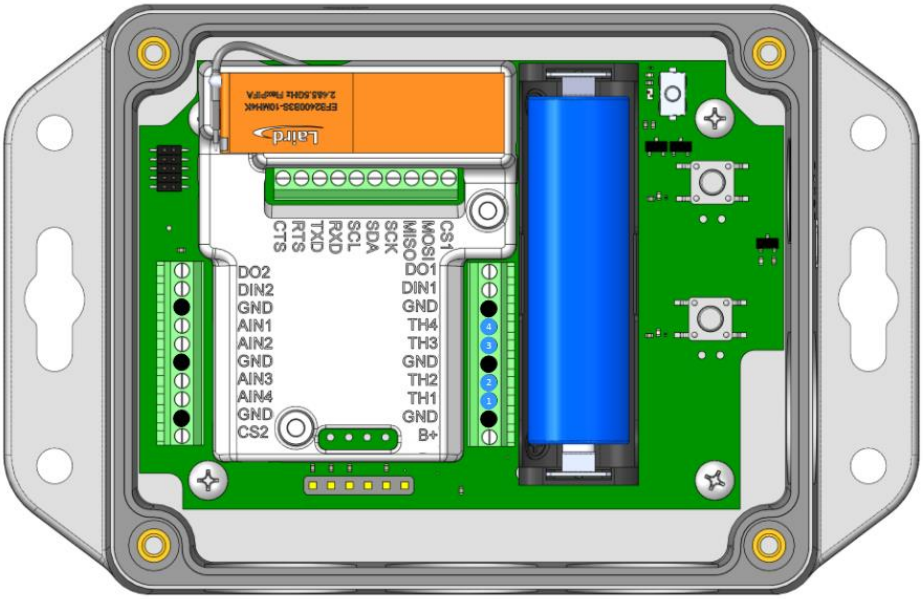

Figure 22: Thermistor sensor connections

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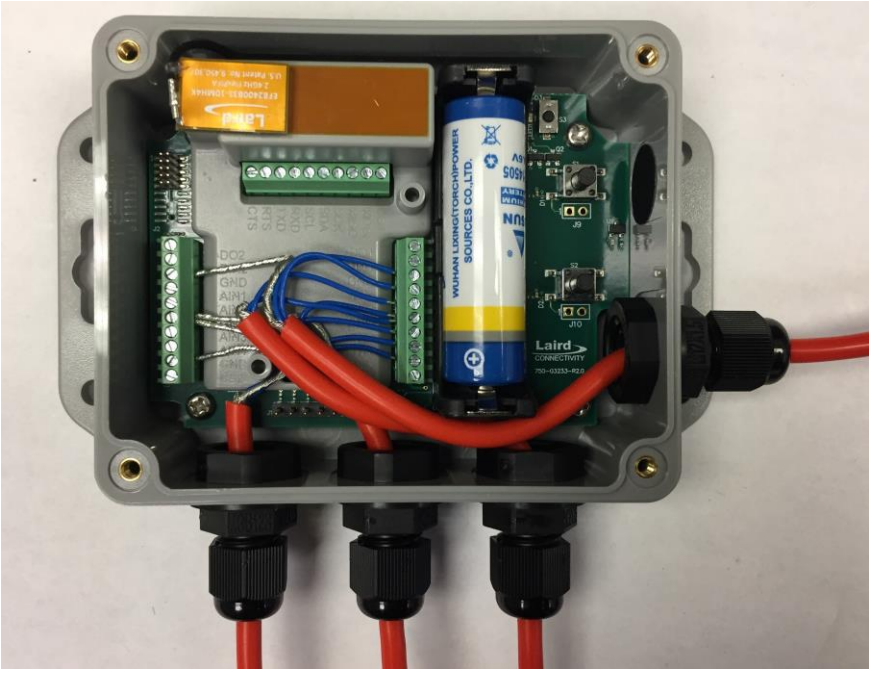

Figure 23: Recommended Thermistor sensor connections

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4.2 Sentrius™ BT6xx AC Current Sensor Cable Assemblies

Laird Connectivity offers three versions of AC current sensor probes (sold separately) for operation with the BT610. The BT610 supports connection of 1–3 of these sensors for a pre-canned AC current monitoring solution.

Each AC current sensor connects between an analog input [AIN#] terminal and GND terminal as indicated in Figure 24. Each AC current sensor attached requires an individual AIN terminal – they cannot share an analog input port. The White wire goes to the AIN# terminal, the Black wire goes to the GND terminal. The user must properly connect each AC current sensor and then configure the sensor current rating, measurement parameters and identifier for each analog port through the mobile app.

The user is free to use any of the **6 ground ports [GND]** indicated in Figure 24.

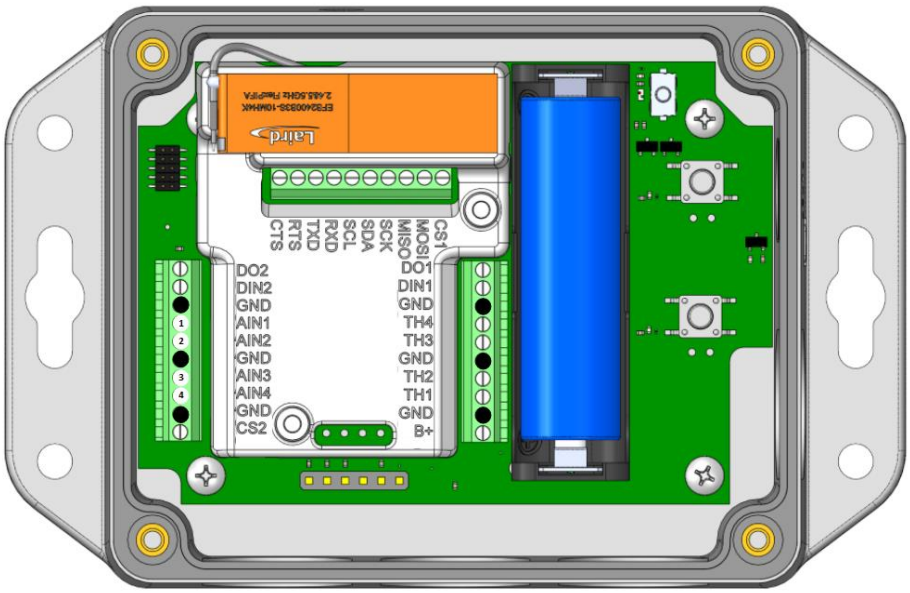

Figure 24: AC current sensor connections

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4.3 Sentrius™ BT6xx Ultrasonic Sensor Cable Assembly

The ultrasonic sensor assembly enables the BT610 to measure the distance between the sensor and objects or surfaces. The BT610 can support a maximum of one individual ultrasonic sensor connections.

4.3.1 BT6xx Ultrasonic Sensor Modifications

Each ultrasonic sensor cable assembly is provided with seven wires, a cable wire, and shield foil. The BT610 only uses the brown, red, and black wires. You must trim the foil, blue, green, orange, white, and cable wires down to the outer sleeve (Figure 25).

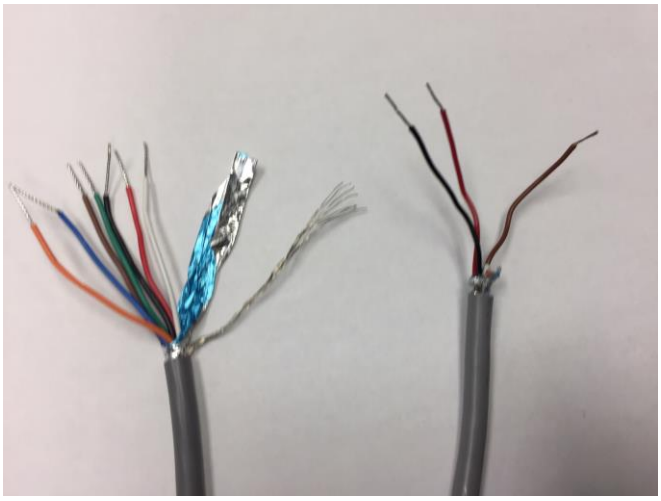

Figure 25: Ultrasonic cable wires untrimmed and trimmed

4.3.2 BT6xx Ultrasonic Sensor Connections

The brown wire connects to any analog input **[AIN#]** terminal, the red wire connects to **B+**, and the black wire connects to a GND terminal as indicated in Figure 26. Use the mobile app to configure the selected analog port.

You may use any of the six ground ports **[GND]** indicated in Figure 26.

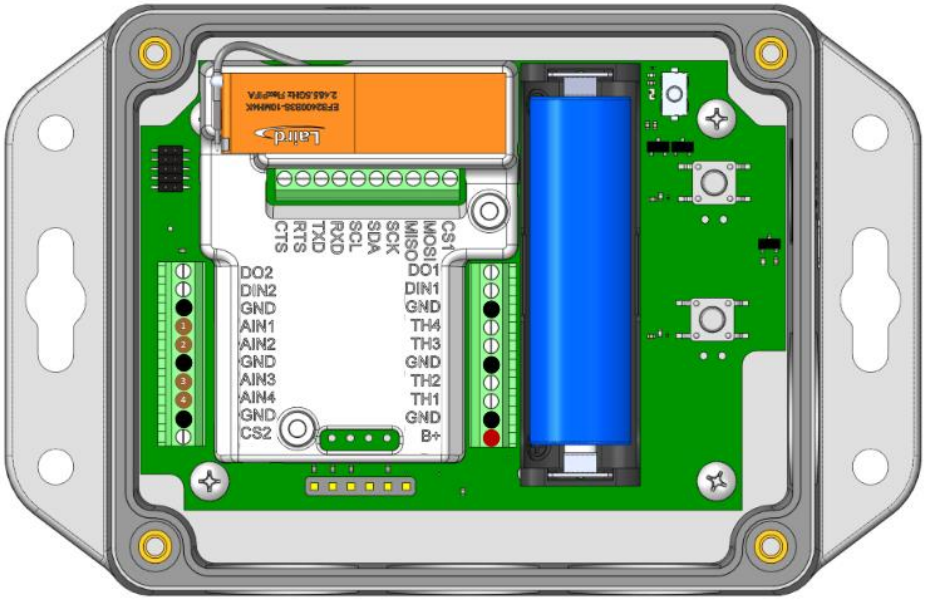

Figure 26: Ultrasonic cable connections

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4.4 Sentrius™ BT6xx Pressure Sensor Cable Assembly

Laird Connectivity offers a pressure sensor (sold separately) for operation with the BT610. The BT610 supports connection of one or two of these sensors for a pre-canned pressure monitoring solution.

Note: A single pressure sensor can be combined with an ultrasonic sensor for a tank monitoring solution. If an ultrasonic sensor is not used, the BT610 supports connection of a second pressure sensor.

Each pressure sensor has four wires to be connected. The terminal connections are highlighted in Figure 27.

- Red wire: **B+**
- Green wire: **GND**
- Yellow wire: **AIN#**
- Black wire: **GND**

Each sensor must use a unique AIN# connection. Use the mobile app to select and configure the applicable analog port.

You may use any of the six ground ports **[GND]** indicated in Figure 27.

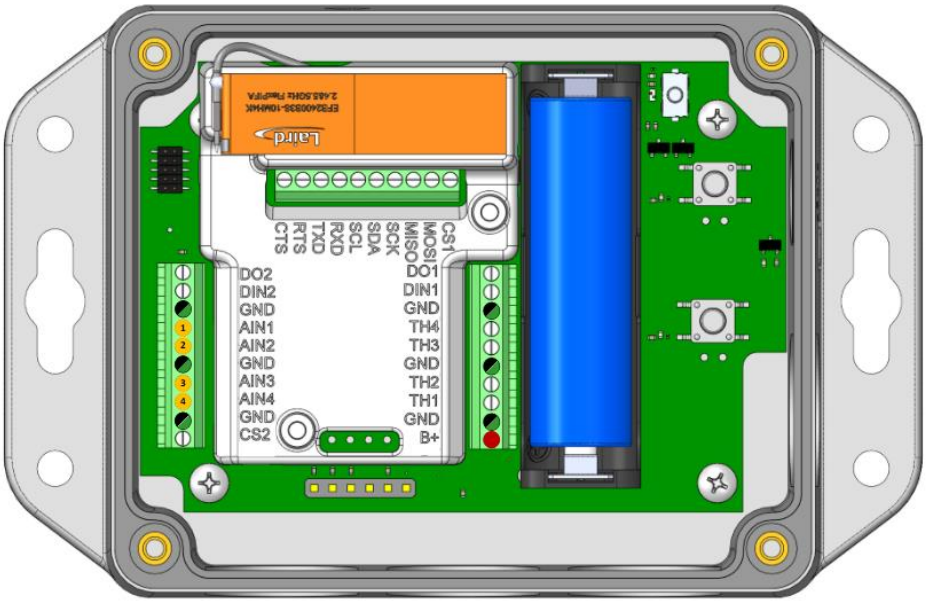

Figure 27: Pressure sensor cable connections

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5 Final Steps

5.1 Sensor Cable Routing Guidance

Route sensor cables in the yellow region highlighted in Figure 28.

DO NOT route cables over the battery.

DO NOT route cables over or near the antenna

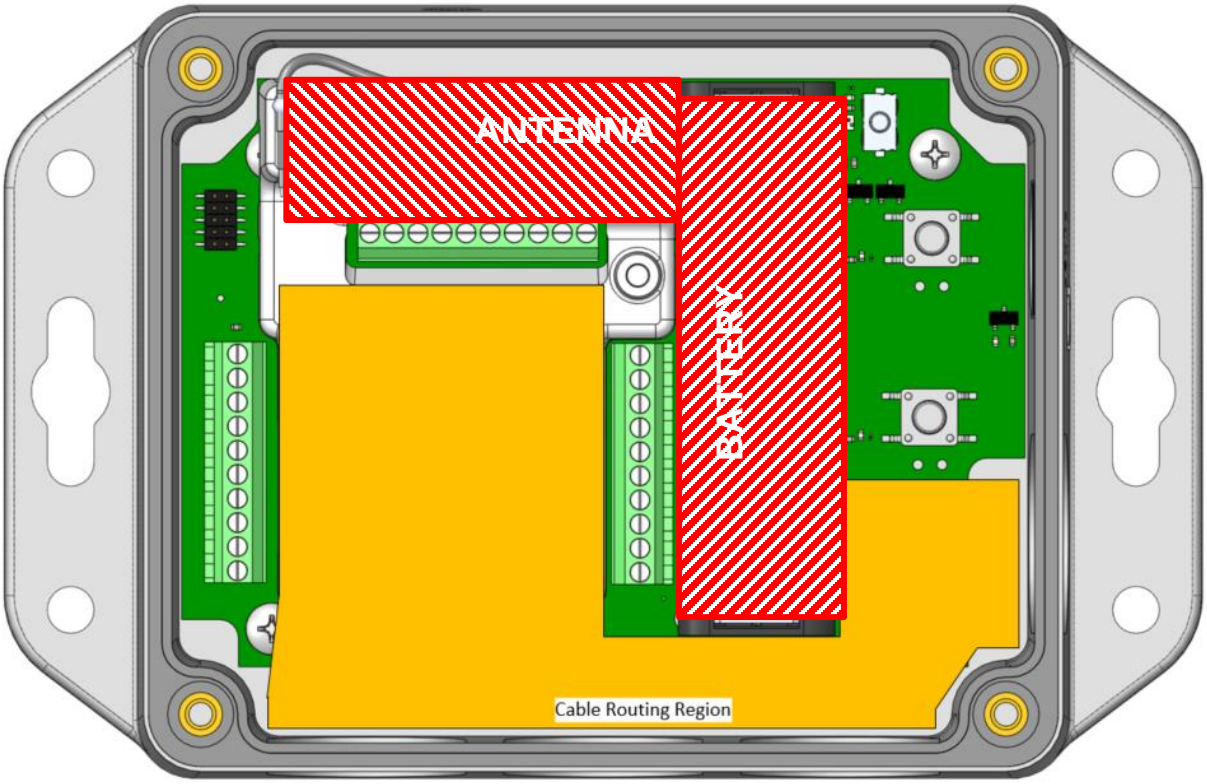

Figure 28: Sensor cable routing region

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5.2 Reinstall Cover and Tighten Connectors

Once all of the connections are completed, close the enclosure by screwing the cover back onto the BT610. Follow these steps:

1. Make sure gasket seal is properly positioned in the cover.
2. Re-install battery or remove non-conductive battery tab to power the unit.
3. Confirm that the installed cable glands are fully tightened.
4. Securely tighten the covers screws to enable the full sealing and IP67 protection level and to activate the tamper detection switch.

   Tighten the screws in a crisscross pattern shown in Figure 29. Tighten each screw until the gaskets starts to compress. Move to the next screw in this pattern. Then repeat pattern tightening each screw one half of a rotation (180 degrees). Repeat pattern until all 4 corners are fully compressed and there is no gap between the housing and the lid at each corner.

Figure 29: Screw-tightening pattern

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5.3 Installation and Use Guidelines

To optimize the radio performance/range, do the following:

1. Position the BT610 as high as possible above the floor or ground. We recommend a height of at least two meters, if possible.
2. Position the BT610 away from obstacles such as machinery, air ducts, cabling, beams, metal cabinets, etc. Keep in mind that metal and concrete are materials that attenuate radio signals.
3. Mount the BT610 so the cables route out the bottom of the unit.
4. Do not place the BT610 near other wireless devices, in particular Wi-Fi access points and devices. Also do not place units near microwave ovens.

   Positioning the BT610 near doorways and openings helps increase the communication range.
5. Using predrilled holes in the mounting surface, screw the sensor to the surface using two or more of the mounting holes or slots shown in Figure 30. The provided anchors and screws can be used for mounting to wood, sheet metal, concrete and wall board. The polyethylene anchors shall be used for mounting to concrete or wall board. For anchor use, predrill a 1/4inch diameter hole that is at least 1 inch deep. Push anchor into drilled hole and use provided screws to secure housing through holes in mounting flange. The screws provided are nickel plated steel and are 1.25 inch in length shown in Figure 31 and Figure 32.

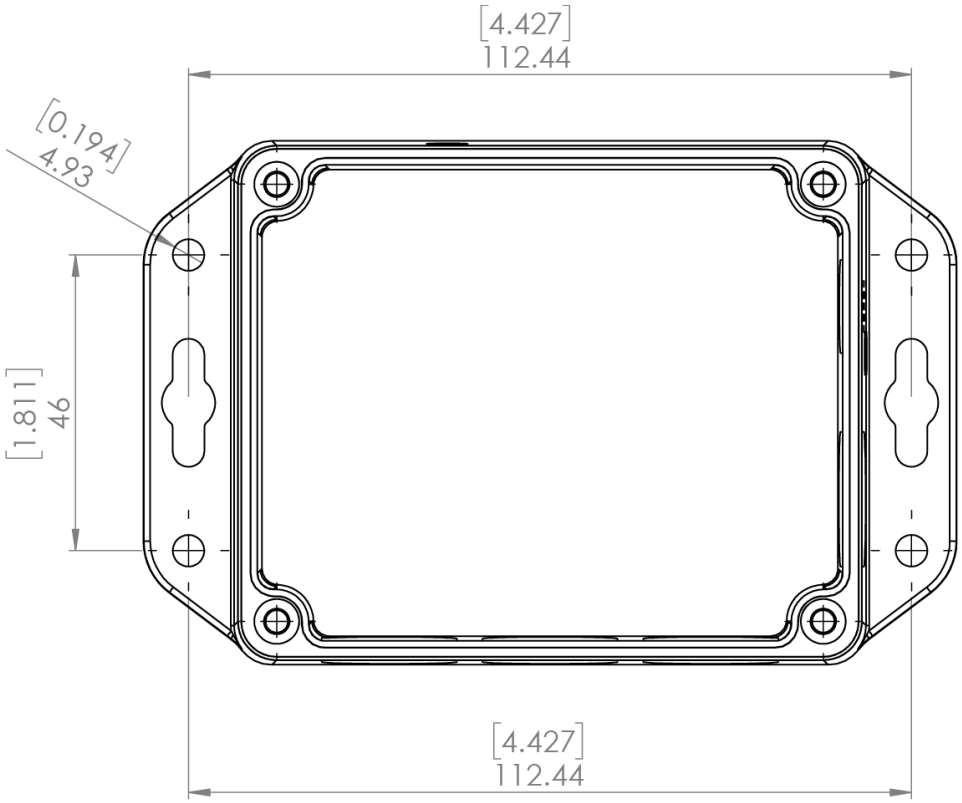

Figure 30: Mounting hole dimensions

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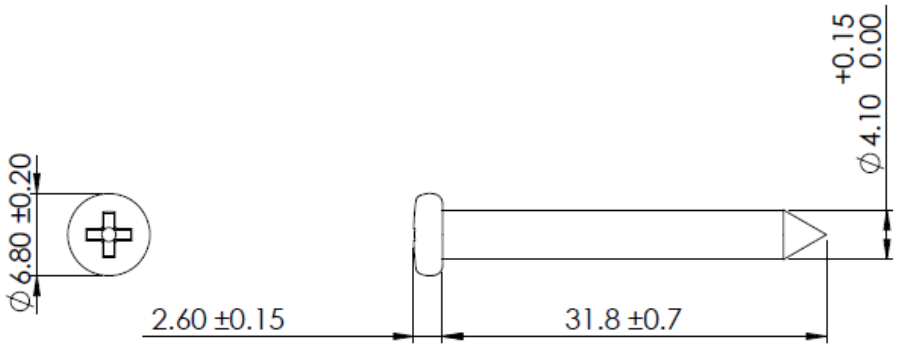

Figure 31: Wall Mounting Screw Dimensions

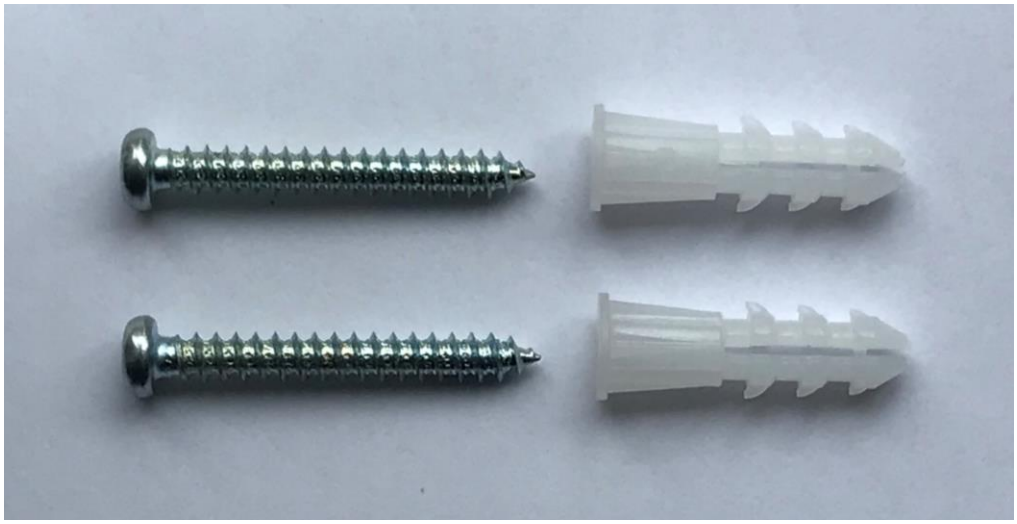

Figure 32: Photo of Wall Mount Screw and Anchors Provided

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6 Appendix A – References

Please see the following documents for more information.

Ref	Name
[A]	https://www.segger.com/products/debug-probes/j-link/accessories/adapters/9-pin-cortex-m-adapter/ 9-Way Cortex-M adapter & debugger details
[B]	**Application Note - BT610 Thermistor ADC Calibration**
[C]	**BT610 Communications Specification Guide**

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