

# Hardware Guide

## Sentrius<sup>™</sup> MG100 Gateway Series

*Version 2.0*

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## REVISION HISTORY

Version	Date	Notes	Contributor(s)	Approver
1.0	17 Aug 2020	Initial version	Peter Scharpf	Jonathan Kaye
1.1	09 Sept 2020	Added new product photos	Sue White	Jonathan Kaye
1.2	16 Nov 2020	Fixed some text errors	Peter Scharpf	Jonathan Kaye
2.0	21 Feb 2021	Transferred detailed regulatory information to a separate document	Sue White	Jonathan Kaye

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## 1 OVERVIEW

The Sentrius™ MG100 Gateway offers a compact, out-of-the-box Bluetooth to Cellular IoT gateway solution.

The Sentrius MG100 Gateway is an out-of-the-box product allowing the end user to develop a fully featured IoT solution with minimum effort. With the addition of the optional battery backup, it provides uninterrupted reporting of sensor data. Based on Laird Connectivity's Pinnacle™ 100 modem, the Sentrius MG100 Gateway captures data from Bluetooth 5 sensors and sends it to the cloud via a global low power cellular (LTE-M/NB-IoT) connection. It is based on the innovative integration of Nordic Semiconductor nRF52840 and the Sierra Wireless HL7800 module. This enables the MG100 to support LTE-M/NB-IoT (supports LTE bands 1, 2, 3, 4, 5, 8, 12, 13, 20, and 28) as well as Bluetooth 5 features like CODED PHY, 2M PHY, and LE Advertising Extensions.



- LTE-M/NB-IoT support
- Bluetooth 5 support
- NFC support, including antenna
- Cortex-M4F microcontroller with 1M flash and 256k RAM
- Hostless operation with Zephyr RTOS
- Local data storage
- Optional rechargeable battery backup (Li-Ion 18650)
- Available with fully integrated internal antenna or external antennas

## 2 SENTRIUS MG100 GATEWAY – PCB HARDWARE

This section describes the Sentrius MG100 Gateway PCBA hardware. The Sentrius MG100 Gateway PCBA is delivered with the Pinnacle™ 100 modem pre-programmed with Zephyr Out of Box (OOB) example code. It contains all of the electronics required to interface to the Pinnacle™ 100 modem.

### 2.1 Key Hardware Features

The Sentrius MG100 gateway has the following features:

- Pinnacle™ 100 modem integrated
  - Integrated antenna option provides low cost, low profile product packaging
  - External antenna option provides long range connectivity for cellular and Bluetooth networks
- Optional battery backup with battery charger enables additional operating time without external power (specific duration is use case dependent)
  - Battery charger auto detects charging capability of external power source
  - Load sharing charger allows for normal operation while charging
- 3 LEDs providing a user programmable visual interface of gateway operating status
- NFC interface, including antenna
- microSD card connector for flexible memory expansion

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**Note:** microSD memory card not included, as standard.

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- Integrated accelerometer for detecting movement of MG100 unit
- Integrated temperature sensor measures gateway electronics operating temperature
- External accessible tactile button for user configurable functionality
- Integrated USB to UART converter creates virtual comm port when external USB port is connected to the gateway
- Protected on/off switch for Power On Reset and transporting battery backup versions

### 3 SENTRIUS™ MG100 – PRODUCT VARIANTS

#### 3.1 External Antenna Variants

Part Number	Description
450-00039-K1	Sentrius MG100 micro-gateway, LTE-M and NB1 modem, BLE, external antenna, MVNO SIM
450-00054-K1	Sentrius MG100 micro-gateway, LTE-M and NB1 modem, BLE, external antenna, battery backup, MVNO SIM
455-00120	IoT starter kit, Sentrius MG100 (part # 450-00054-K1), BT510 (part # 455-00083 x 3), and power supplies

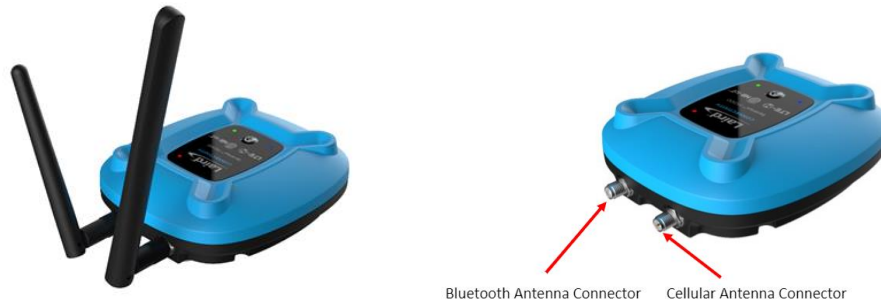


Figure 1: Micro-gateway with external antenna

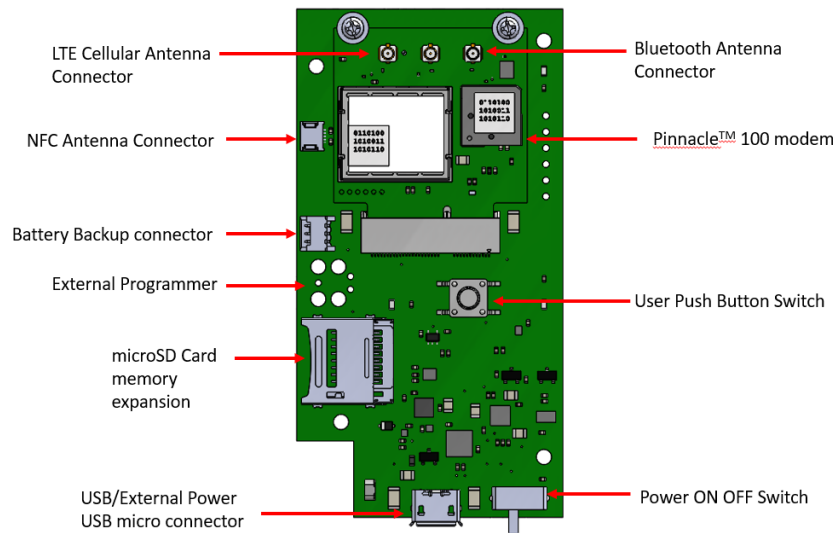


Figure 2: Micro-gateway PCBA with Pinnacle™ 100 modem – external antenna variant

#### 3.1.1 Power Supplies (sold separately)

Table 1: Micro-gateway power supplies

Part Number	Description
223-00010	AC adapter, 5V-2A, US, 5-pin micro-B USB plug
223-00011	AC adapter, 5V-2A, EU, 5-pin micro-B USB plug
223-00012	AC adapter, 5V-2A, UK, 5-pin micro-B USB plug

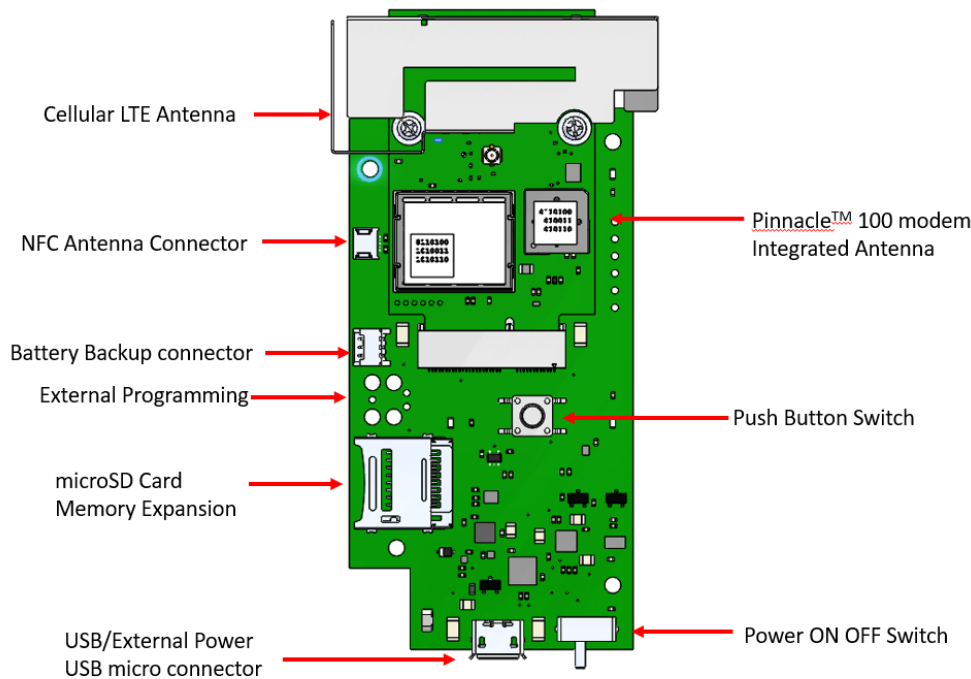
## 3.2 Internal Antenna Variants

**Table 2: Micro-gateway internal antenna variants**

Part Number	Description
450-00011-K1	Sentrius MG100 micro-gateway, LTE-M and NB1 modem, BLE, MVNO SIM
450-00038-K1	Sentrius MG100 micro-gateway, LTE-M and NB1 Modem, BLE, battery backup, MVNO SIM



**Figure 3: Micro-gateway with integrated antenna**



**Figure 4: Micro-gateway PCBA with Pinnacle™ 100 modem – integrated antenna**

### 3.2.1 Power Supplies (sold separately)

**Table 3: Micro-gateway power supplies**

Part Number	Description
223-00010	AC adapter, 5V-2A, US, 5-pin micro-B USB plug
223-00011	AC adapter, 5V-2A, EU, 5-pin micro-B USB plug
223-00012	AC adapter, 5V-2A, UK, 5-pin micro-B USB plug

## 4 GATEWAY FUNCTIONAL BLOCKS

### 4.1 Micro-Gateway Options - External Power Only

Part # 450-00011-K1 and 450-00039-K1

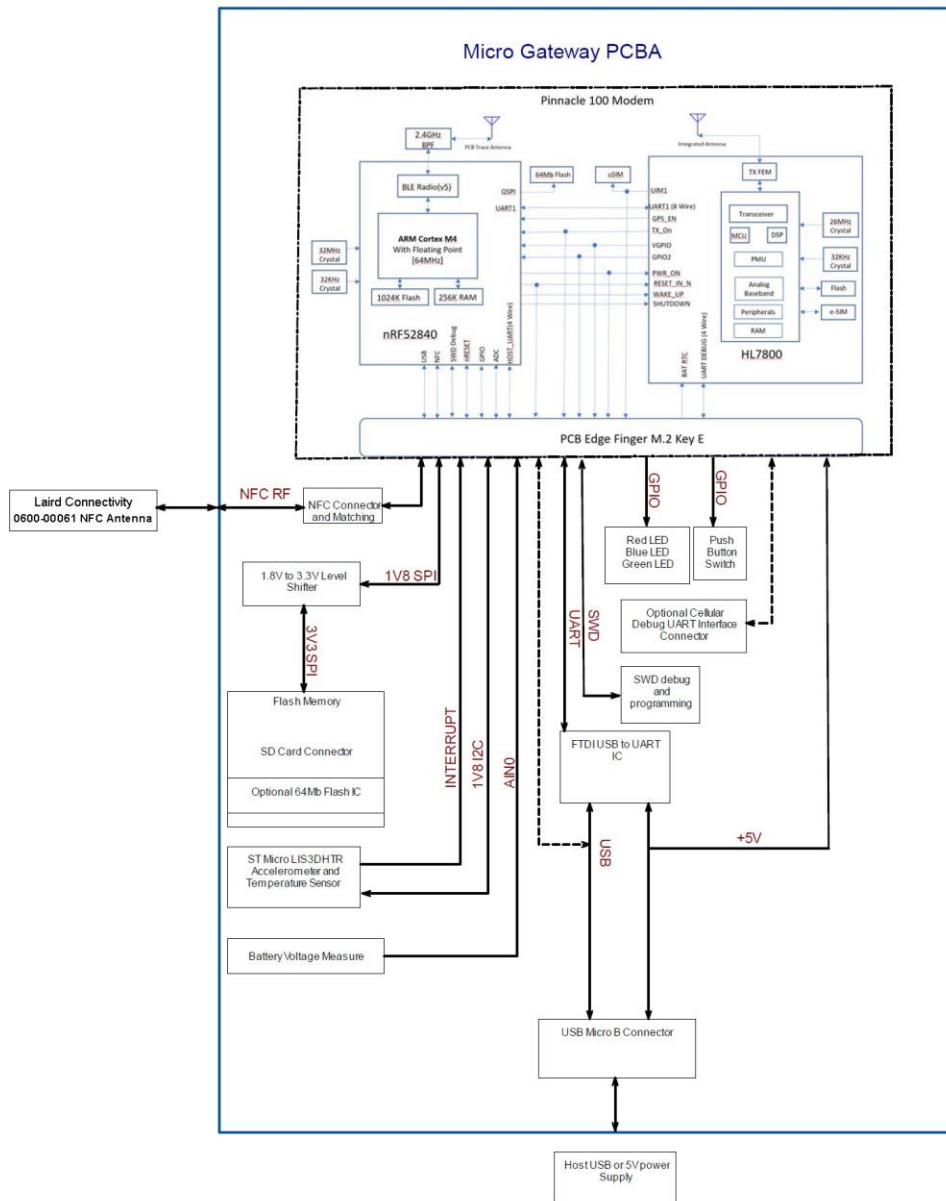


Figure 5: Micro-gateway external power only

## 4.2 Micro-Gateway Options with Battery Backup

### Part # 450-00038-K1 and 450-00054-K1

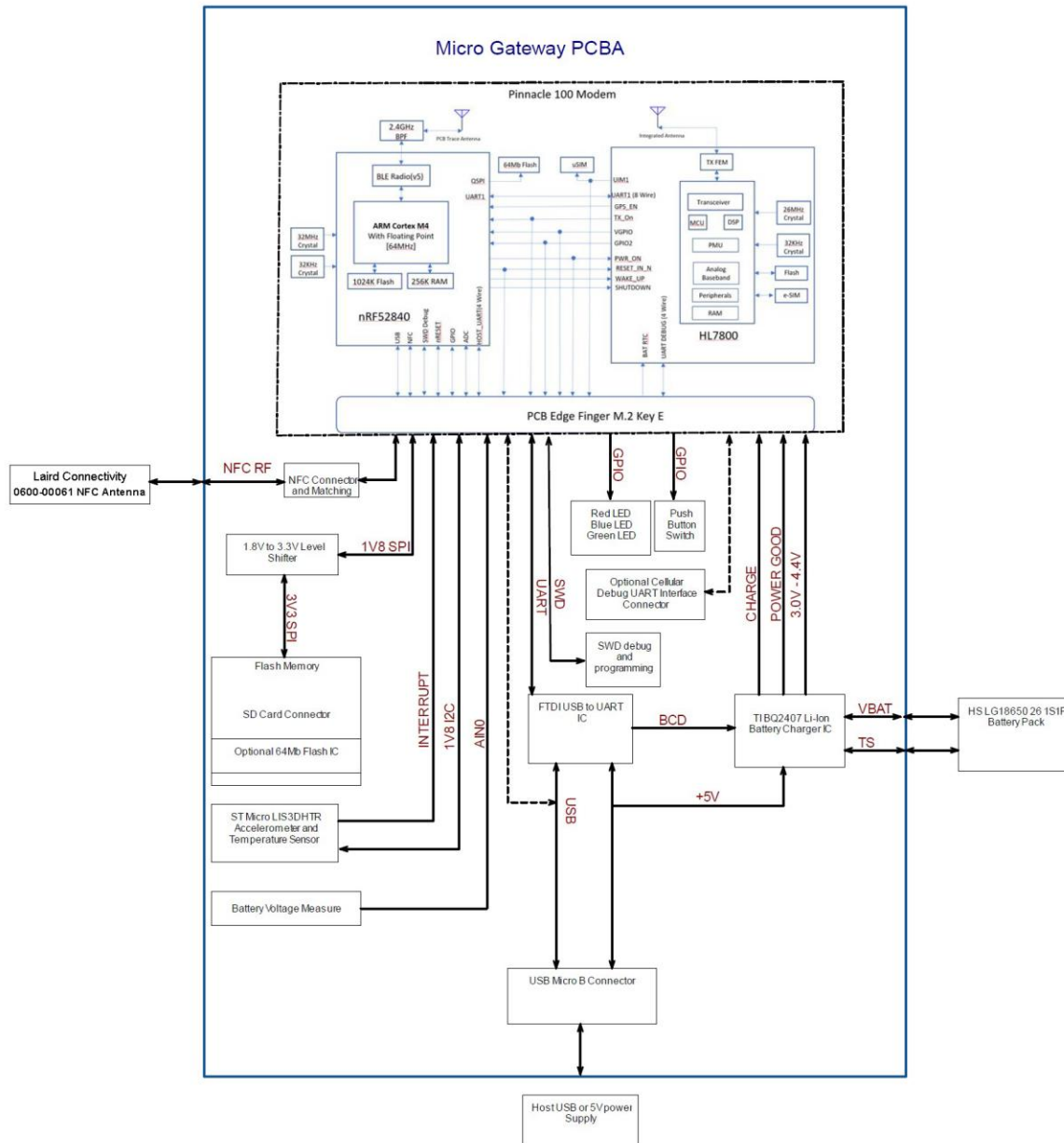


Figure 6: Micro-gateway with battery backup



## 5 MICRO-GATEWAY DETAILED DESCRIPTION

### 5.1 Pinnacle 100 Modem Connector

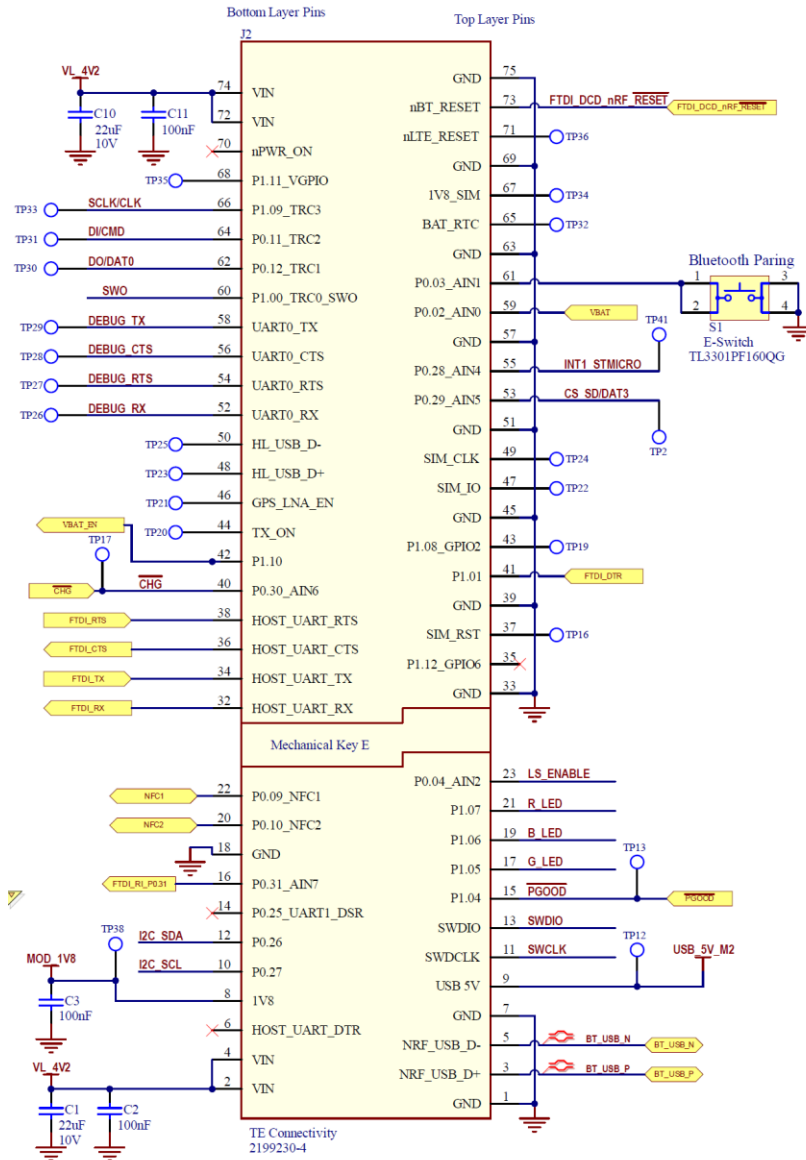


Figure 7: Pinnacle 100 modem PCIE connector

- The Pinnacle 100 modem plugs into J2. All micro-gateway peripherals are routed to modem through J2.
- SW1 provides an externally accessible user input to the modem for paring Bluetooth devices.

## 5.2 USB and Power Input

PCBAs with battery backup include all the necessary circuitry to charge the Lithium ion battery, maintain a charge, and manage operational load while charging.



Figure 8: Power input and power switch

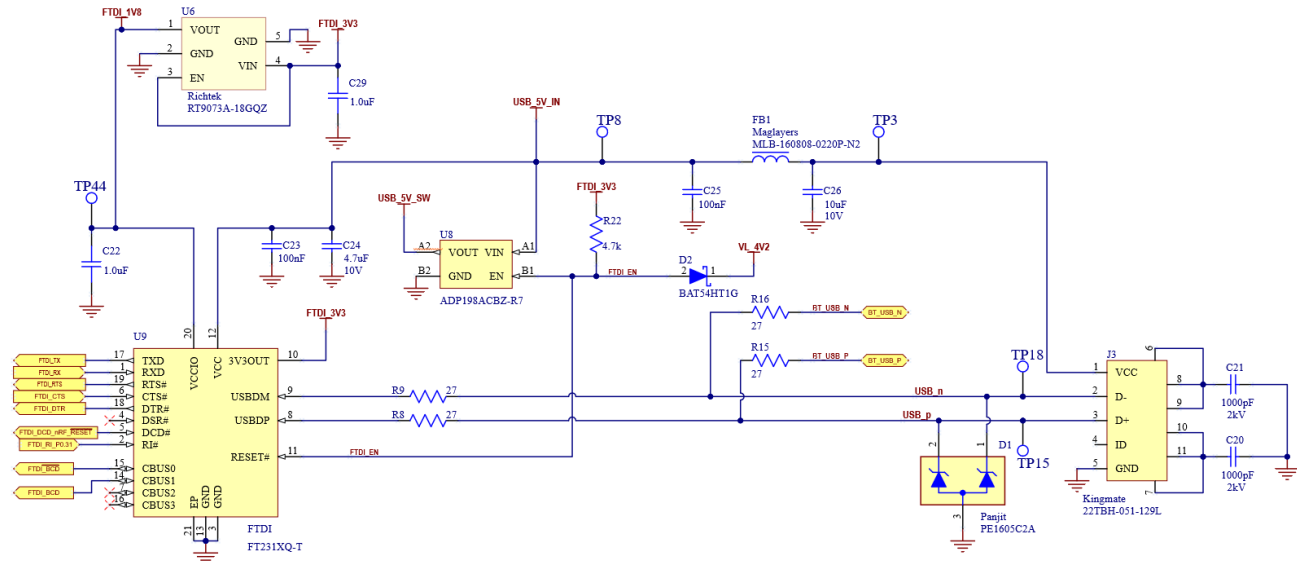


Figure 9: Power input

- External power is supplied to the unit via a USB micro connector J3.
- Laird Connectivity specified a line of 5V, 2A AC power adapters with micro USB connectors and dedicated charge device identification for use with the external power only and battery backup variants. See [Table 4](#).
  - The charging current is controlled by detecting the USB device that is connected to J3. If a USB 2.0 or higher host is connected, charging current is limited to 500mA. If a power supply, such as the line of power supplies specified, is connected, the charger IC, U7 will draw up to but not exceed the max charge current setting of U7 (1.5A). If load requirements for the Modem and peripherals exceeds the USB capabilities, the charger IC U7 also provides load sharing with the battery.
- For the external power only and battery backup variants, power can be supplied by the USB host device while the external power supply is disconnected allowing for UART communication to the unit.
- U9 is an FTDI FT231XQ-T USB to UART converter and is the main source of communication between a USB host and the Pinnacle 100 modem. When connected to a host PC, a virtual COM port is created on the host allowing serial communication between the host and the Pinnacle 100 modem. U9 also provides USB power information to the battery charger IC via the CBUS0 and CBUS1 lines.
- U8 is a load switch to remove 5V power to all gateway circuitry.
- U6 provides 1.8V power to the IO power rail on U9. All UART I/O going to the Pinnacle 100 modem must be at 1.8V logic levels.

## 5.3 Battery Charging and Power Management

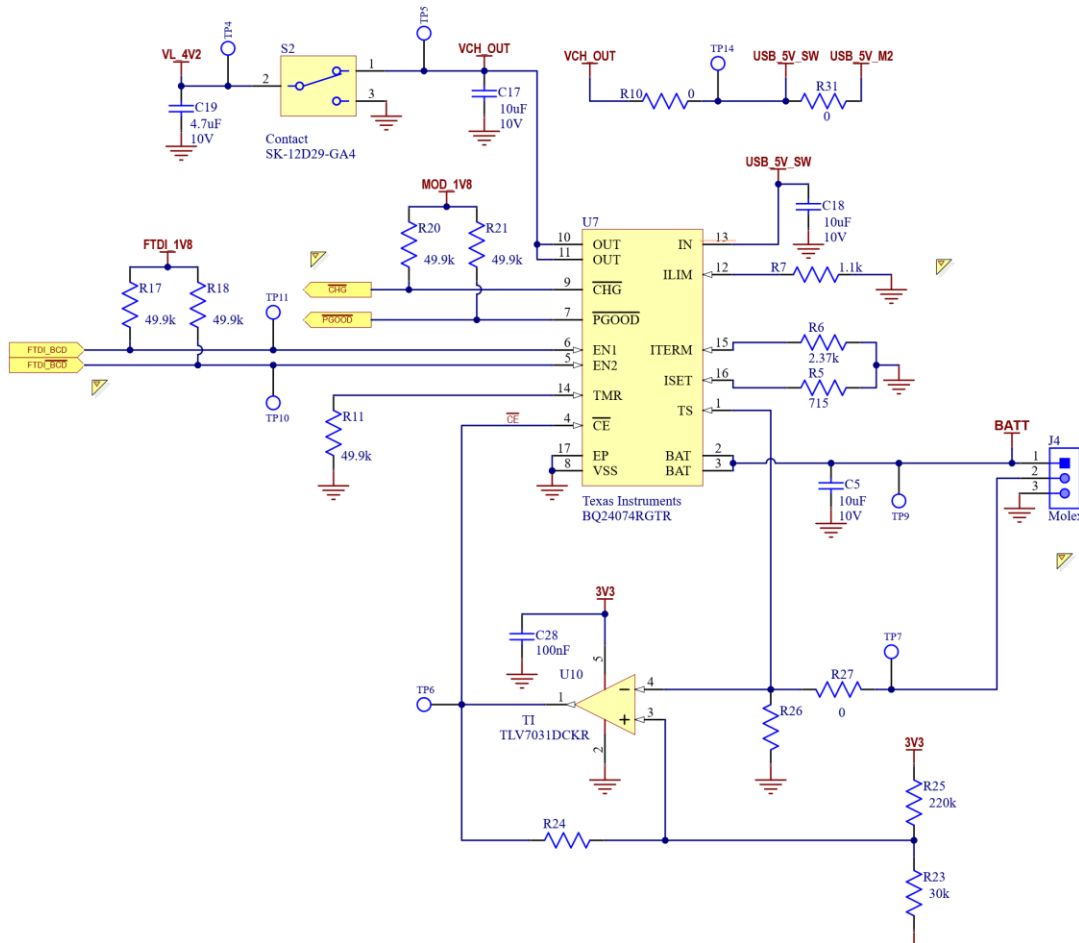


Figure 10: Battery management circuitry (Battery Backup Variant Only)

- S2 is the main power ON/OFF switch. It disconnects both external power and battery power from all circuitry. The external battery is connected to J4. Pin 2 of J4 is the thermistor of the battery. During charging and discharging, battery temperature is closely monitored by U7; charging terminates if the battery temperature is beyond charging temperature specifications.
- The battery backup variant includes circuitry to charge the backup battery. U7 is the main charge controller for the battery. It manages all aspects of charging and load management of the Li-ion battery. Coupled with the previously mentioned USB to UART IC, charge current is controlled by inputs EN1 and EN2 on the FTDI chip (U9 in Power Input Figure 9). It prevents the charger from crashing incorrectly configured USB sources. See [USB and Power Input](#).

**Note:** When S2 is in the OFF position, the battery charging circuit is disconnected from power and will not charge the battery.

- U10 disables charging when battery temperature exceeds +40 °C.

**Note:** The MG100 PCBA can pull more than 100mA during TX pulses and therefore we do not recommend running from a device less than USBv1.1 specification. The minimum USB Host current needs to be able to supply at least 200mA.

**Table 4: External power capability**

EN1	EN2	Maximum External Power Current
0	0	Host USB, 100 mA. USB100 mode* <i>For USB 1.1 and earlier host devices, unit functionality will be limited.</i>
0	1	Host USB, 500 mA. USB500 mode
1	0	Dedicated Charger, 1.5A. (Set by external resistor R7)
1	1	Standby (USB suspend mode)

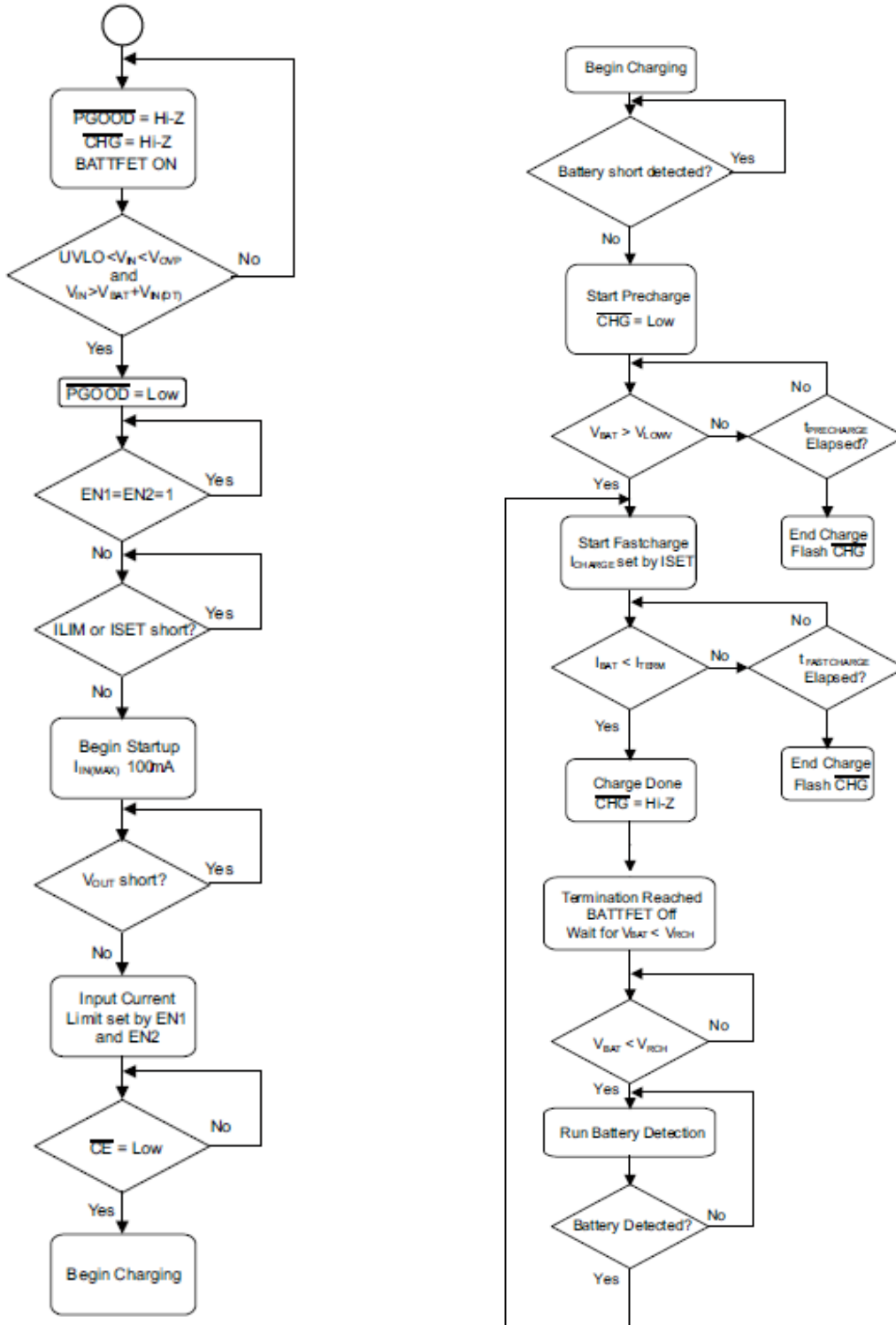


Figure 11: Battery charging flow diagram

## 5.4 Additional Interfaces and Peripherals

### 5.4.1 Battery Voltage Measurement

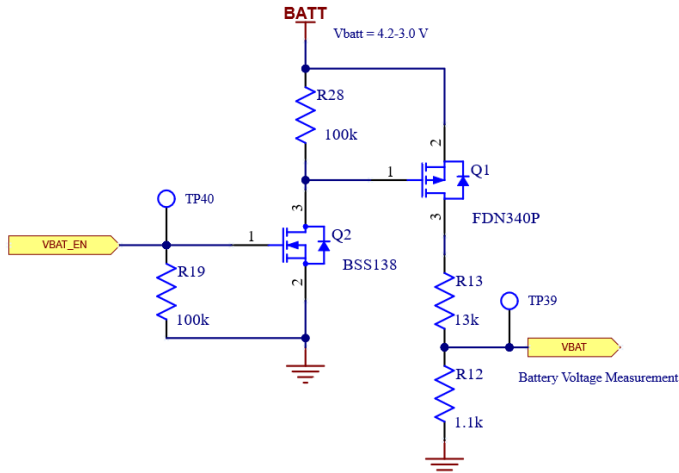


Figure 12: Battery voltage measurement

- Q1 and Q2 allow battery voltage, VBAT, to be measured by the Pinnacle™ 100 modem. When enabled, battery voltage is presented to P0.02\_AIN0 of the modem.
- Voltage divider R13 R12 scales the battery voltage to levels compatible with the modem's analog-to-digital converter (ADC)

### 5.4.2 Accelerometer/Temperature Sensor

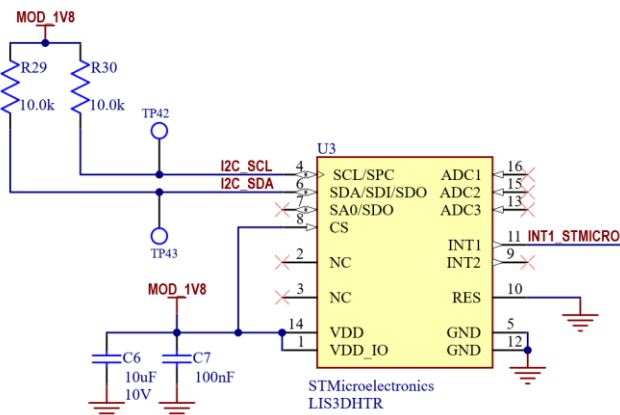


Figure 13: Internal sensor

- U3 is an ST Microelectronics part # LIS3DHRT device - [https://www.st.com/content/st\\_com/en/products/mems-and-sensors/accelerometers/lis3dh.html](https://www.st.com/content/st_com/en/products/mems-and-sensors/accelerometers/lis3dh.html)
- U3 is an ultra-low-power high performance three-axis linear accelerometer with digital I2C serial interface.
  - Additionally, U3 includes an embedded temperature sensor, which provides device temperature information to the modem over the digital I2C serial interface12:

### 5.4.3 microSD card Holder

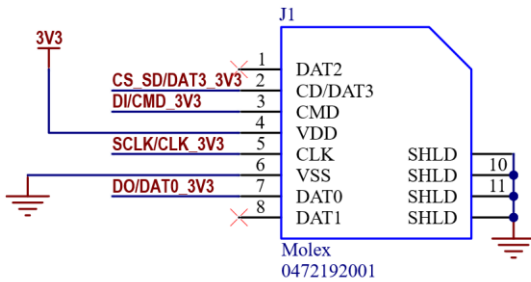


Figure 14: microSD card connector

- J1 is a microSD card connector for microSD card memory expansion.
- A SPI interface is provided to the modem for read write operation.

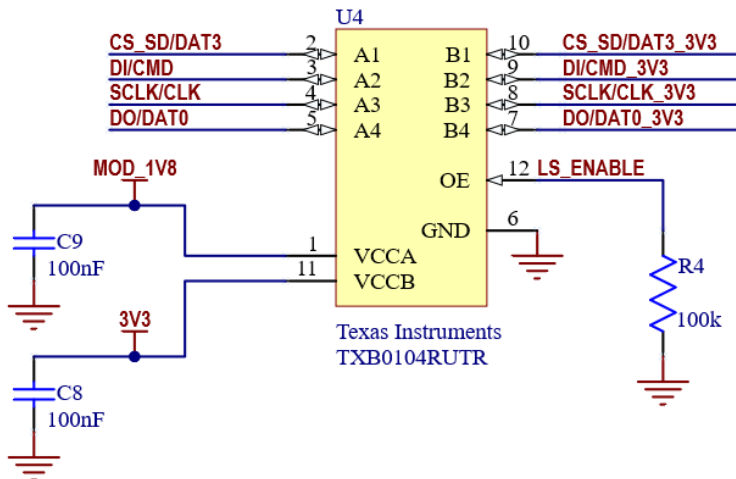


Figure 15: Logic level shifter

- U4 converts 1.8V logic levels to and from the modem to 3.3V logic levels required by the SD micro card

### 5.4.4 SWD Programming Interface

- J5 allows external programmers to be connected to the modem for SWD programming and debugging.

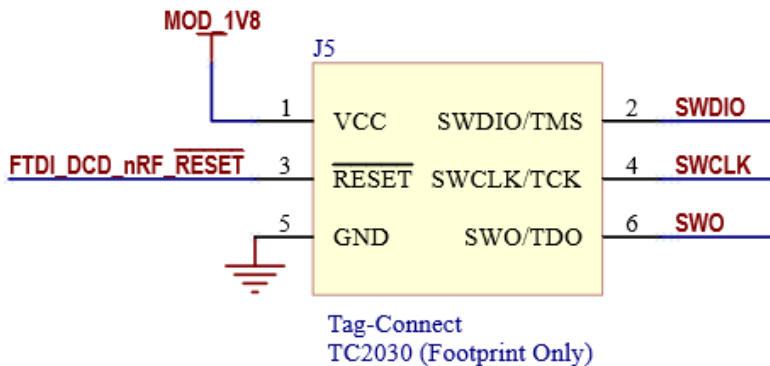


Figure 16: External programmer connections

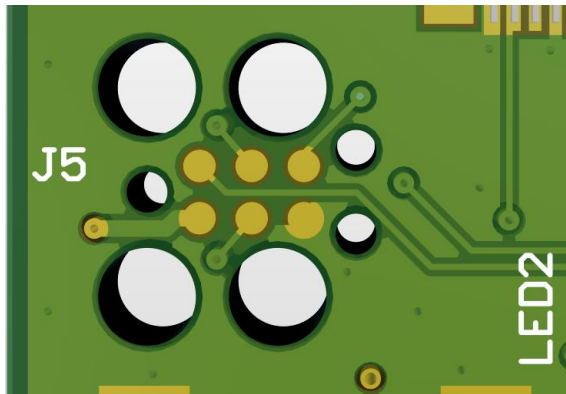


Figure 17: J5 Single wire programming connector

- J5 is compatible with Tag-Connect TC2030-IDC or TC2030-CTX ARM® Cortex™-M4 CPU line of plug-of-nail cables and requires this ARM20-CTX Adapter or J-Link 9-Pin Cortex-M Adapter.

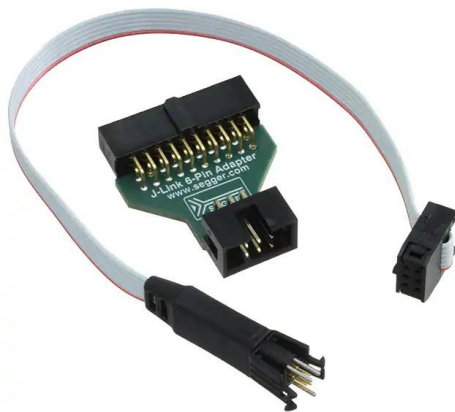


Figure 18: Tag-Connect TC2030-IDC with ARM20-CTX six-pin adapter

### 5.4.5 NFC Interface

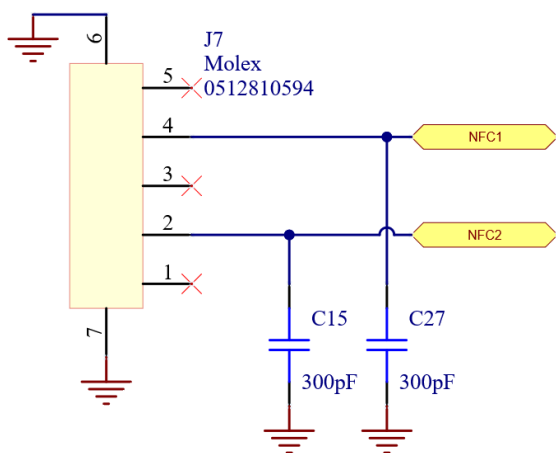


Figure 19: NFC interface

- The NFC input connector J7 allows the Laird Connectivity supplied flex-PCB NFC antenna (Laird Connectivity part # 0600-00061) to be plugged into the gateway.
- C15 (300pF) and C27 (300pF) are RF tuning elements for the flexi-PCB NFC antenna.



## 5.4.6 LEDs

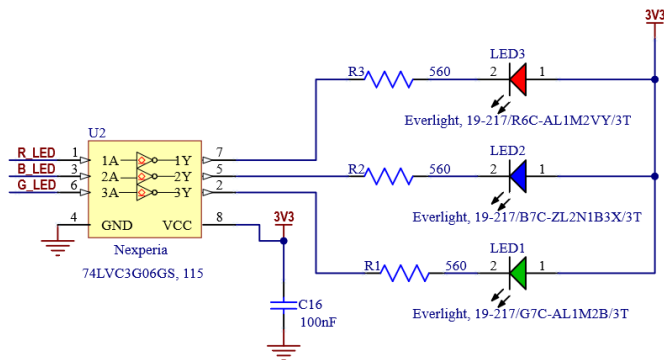


Figure 20: Status indicator LEDs

- The MG100 has 3 LEDs.

**Note:** The following overview highlights the use of the LEDs in the sample OOB application

- LED1 – LED3 are all on when the modem is booting.
- The Blue LED (LED1) blinks once a second when the MG100 is searching for a BL654 sensor board
  - When it finds a sensor and successfully connects to it, the LED remains on.
- The Red LED (LED2) turns on when connected to AWS.
  - When data is sent to AWS the LED turns off and then turns back on.
  - When disconnected from AWS, the LED remains off.
- The Green LED (LED3) blinks when the MG100 is searching for a cellular network.
  - It remains on and does not blink when connected to a network.
  - If there is an error with the SIM card or network registration, then the LED remains off.
- U2 provides drive current to the LEDs. I/O from the modem provide control of the LEDs.

## 5.4.7 Button

In the first production FW release (version 2.0.0) the button on the MG100 does not do anything. The current version of software has the MG100 configured to always be advertising and connectable.

In a subsequent FW release it will trigger the device to advertise so it can be detected by the smartphone application.

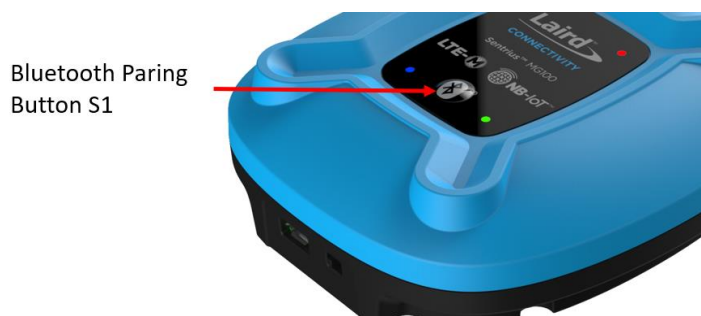


Figure 21: Future Bluetooth pairing button

## 5.4.8 Debug UART

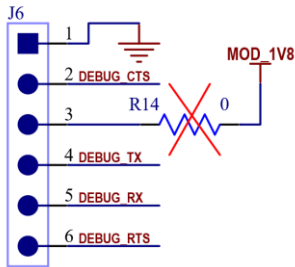


Figure 22: Debug UART interface

- J6 provides an interface to the Pinnacle 100 modems debug UART. This can be used to manually update the HL7800 firmware.

## 6 BACKUP BATTERY PACK

The MG100 micro-gateway variants 450-00038-K1 and 450-00054-K1 include a 3.7V, 2600mAh Li-Ion back up battery pack. The battery pack is comprised of a standard 18650 Li-Ion cell, 10K NTC thermistor, PCM (protection circuit module), and cable.

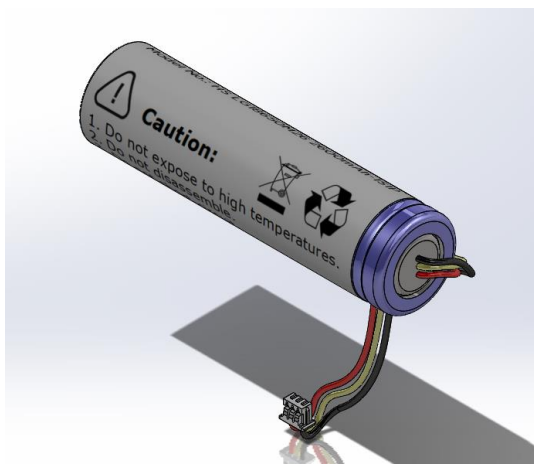


Figure 23: Li-Ion battery pack

**Warning:** This product contains a Li-ion battery. There is a risk of fire and burns if the battery pack is handled improperly. Do not attempt to open or service the battery pack. Do not disassemble, crush, puncture, short external contacts or circuits, dispose of in fire or water, or expose a battery pack to temperatures higher than 60°C (140°F). The Sentrius MG100 gateway was designed to use the supplied battery pack only. Contact Laird Connectivity Technical support if a replacement is required.

### 6.1 Battery Pack Protection Circuit Module (PCM)

The PCM is a safety device built into the battery pack. Regulatory agencies require a PCM to protect each Li-Ion battery cell. A PCM is comparable to a resettable fuse in that it disconnects the battery cell from the load when any of the following conditions occur.

- Over charge detection voltage: 4.28V  $\pm$ 0.025V
- Over discharge detection voltage: 2.3V +0.058V/cell
- Output over current detection: >2A

The PCM reconnects the load once the condition that disconnected the load is returned to within normal limits.

## 7 SIM CARD

The Sentrius MG100 gateway includes a Pinnacle™ 100 modem. The SIM card holder (Nano 4FF size) is located on the bottom of the Pinnacle™ 100 modem. To aid customers and speed initial testing and development, Laird Connectivity includes a MVNO SIM card from Truphone, already installed into the SIM card holder. The SIM card is Truphone part # SIMS-S-IO3-TRI-2-LP.

**The customer must choose a data plan and activate it on the Truphone portal – [truphone.com/ConnectIt](http://truphone.com/ConnectIt)**

**Note:** No cellular data plan is activated or data allowance pre-enabled on the SIM.

### 7.1 Pinnacle Modem Attachment / Detachment

To attach / detach the Pinnacle modem, follow these steps:

1. Place the Pinnacle modem into connector J2.
2. Use the two provided M2 screws to thread into the standoffs to hold the modem down.

Both screws must be securely tightened to the modem and standoffs for proper modem operation. The standoffs provide additional RF grounding for the modem. Loose screws can affect antenna performance.



Figure 24: Attaching a 453-00011 Pinnacle™ 100 modem to the Sentrius MG100 Gateway

### 7.2 SIM Card Replacement

To remove the nano SIM, push the SIM from the back to the metal edge (arrow 1), grab the edge of the SIM card (arrow 2), and pull it out (**Error! Reference source not found.**).

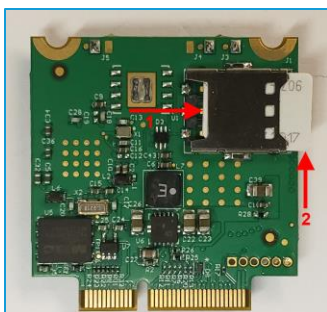


Figure 25: Removing nano SIM from Pinnacle™ 100 modem

To replace an existing SIM card, the Pinnacle 100 modem must first be removed from the Sentrius MG100 PCBA. This allows access to the SIM card holder located on the bottom of the Pinnacle 100 modem (Figure ).

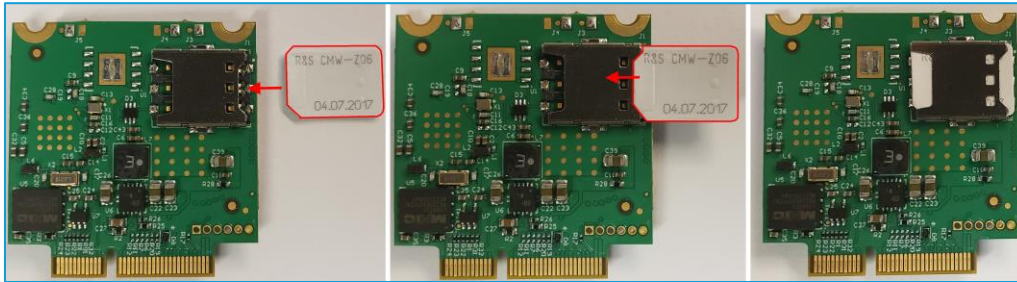


Figure 24: Insertion of nano SIM into a Pinnacle™ 100 modem (image of 453-00011)

## 8 GATEWAY COMMUNICATIONS

The gateway PCBA connects the Sentrius MG100 to a USB port of a PC or other device. When connected to a PC, a virtual COM port is created by the on board FTDI USB to UART IC. See [USB to UART](#) section for more information

This virtual COM port can be used to view debug output, as is done in the OOB demo, or to output information to the USB Host in the customer application. You can communicate with the on-board Pinnacle 100 modem using any terminal program or [Laird Connectivity's UwTerminalX](#) (cross platform software available for Windows, Mac, and Linux). The UwTerminalX utility allows connections to serial devices using any combination of the communications parameters listed in [Error! Reference source not found.](#)

Table 5: UwTerminalX communication parameters for Sentrius MG100 Gateway

<b>Port (Windows)</b>	1 to 255
<b>Port (Mac/Linux)</b>	Any /dev/tty device
<b>Baud Rate</b>	1200 to 1000000 <b>Note:</b> Baud rate default is 115200 for Sentrius MG100 Gateway running the OOB Demo.
<b>Parity</b>	None
<b>Data Bits</b>	8
<b>Stop Bits</b>	1
<b>Handshaking</b>	None or CTS/RTS

The benefits of using UwTerminalX include the following:

- Continually displayed status of DSR, CTS, DCD, and RI
- Direct control of DTR on the host PC via a check box
- Direct control of RTS, if CTS / RTS Handshaking is disabled when UWTerminalX is launched
- Sending UART BREAK signals. Following provides explanation UART Break.  
([https://en.wikipedia.org/wiki/Universal\\_asynchronous\\_receiver/transmitter#Break\\_condition](https://en.wikipedia.org/wiki/Universal_asynchronous_receiver/transmitter#Break_condition))

## 9 REGULATORY

**Note:** For complete regulatory information, refer to the [Pinnacle 100 Regulatory Information](#) document which is also available from the [MG100 product page](#).

The Sentrius™ MG100 hosts the Pinnacle 100 module which holds current certifications in the following countries:

Country/Region	Regulatory ID
USA (FCC)	SQG-PINNACLE1
Canada (ISED)	3147A-PINNACLE1
EU	N/A

## 10 BLUETOOTH SIG QUALIFICATION

The Sentrius™ MG100 series is certified on the Bluetooth SIG website as a Bluetooth 5.1 qualified End Product [QDID 145483](#).

## 11 PTCRB AND GCF

The Sentrius MG100 utilizes the Pinnacle 100 modem, as a 'Socket Modem' and is certified by PTCRB and GCF by those current certifications listed below.

### 11.1 PTCRB

- Sentrius MG100 part numbers 450-450-00011-K1 and 450-00038-K1 use:-
  - Pinnacle 100 Modem – Integrated Antenna (453-00010)
  - <https://www.ptcrb.com/certified-devices/device-details/?model=43744>
- Sentrius MG100 part numbers 450-450-00039-K1 and 450-00054-K1 use:-
  - Pinnacle 100 Modem – External Antenna (453-00011)
  - <https://www.ptcrb.com/certified-devices/device-details/?model=43743>

### 11.2 GCF

- Sentrius MG100 part numbers 450-450-00011-K1 and 450-00038-K1 use:-
  - Pinnacle 100 Modem – Integrated Antenna (453-00010)
  - [https://www.globalcertificationforum.org/pub\\_product/8933.html](https://www.globalcertificationforum.org/pub_product/8933.html)
- Sentrius MG100 part numbers 450-450-00039-K1 and 450-00054-K1 use:-
  - Pinnacle 100 Modem – External Antenna (453-00011)
  - [https://www.globalcertificationforum.org/pub\\_product/8934.html](https://www.globalcertificationforum.org/pub_product/8934.html)

## 12 CARRIER CERTIFICATION

### 12.1 AT&T

The Sentrius MG100 utilizes the Pinnacle 100 modem, as a 'Socket Modem' certification from AT&T and so is covered by that current certification. Search 'Pinnacle 100' at <https://iotdevices.att.com/certified-devices.aspx> to view approval.

### 12.2 Verizon (Pending)

## 13 PRODUCT LABELING



Figure 26: Product label

## 14 ADDITIONAL DOCUMENTATION

Laird Connectivity offers a variety of documentation and ancillary information to support our customers. Additional documentation can be accessed from the Documentation tab of the [Laird Connectivity Sentrius MG100 Gateway Product Page](#).

For any additional questions or queries, or to receive technical support for this Development Kit or for the Sentrius MG100 Gateway or Pinnacle™ 100 modem, please contact Embedded Wireless Solutions Support:  
<https://www.lairdconnect.com/resources/support>

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