Agora

4G LTE Cellular Modem + MCU, GNSS, Bluetooth, LoRa, & Sensors

Product User Manual

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www.embeddedplanet.com

About This Manual

The **Agora User Manual** provides detailed information encompassing the design, description, and integration of the Agora device. For elaboration on drawings, software, or other specific product details there may be other sources of information to which this document points as reference. For the latest documentation, including document & certification updates, please always refer to the Embedded Planet documentation page: https://www.embeddedplanet.com/product-documentation

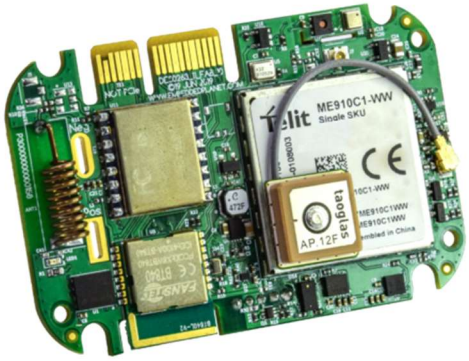
Product Web Page

The **Agora product page** by Embedded Planet provides description & resources related to this product. This page can be located at https://www.embeddedplanet.com/agora

Contents

1. Introduction

The Agora wireless platform is a multi-sensor modem assembly with integrated MCU designed to be used as a versatile solution for the rapid integration of Cellular, Bluetooth, and/or LoRa connectivity to all kinds of new or existing product designs. It is capable of hosting a variety of environmental sensors and communicating sensor data wirelessly over 2.4GHz Bluetooth, 868/915MHz LoRa or 4G LTE Cat1 depending on configuration. Leveraging Agora helps cut design time, complexity, and R&D effort, getting end-user products to market faster. Sensor options can accommodate the monitoring of temperature, relative humidity, barometric pressure, VOC gas, air quality, audio, distance (Time of Flight / ToF), and inertial forces (accelerometer/gyroscope/magnetometer). Agora can be available as a PCBA (printed circuit board assembly) or as a full module which includes a custom-designed plastic enclosure, LiPo battery, and LiPo charging circuit with a micro-USB input. The Agora board itself can be integrated into your own system using either a standard twin 10-pin header modem footprint or its specialized Tectonic Edge™ board-edge connector. Choose whether to power it from a dedicated LiPo battery, ac/dc wall-wart, or your own hardware. Certifications include PTCRB, Verizon, AT&T TRENDI, and ARM MBED Enabled.



2. Orderable Part Numbers

Table 1 and Table 2 demonstrate the flexibility of possible device configurations. Availability of specific configurations depend on current stocking & ordering conditions. The Embedded Planet shop is hosted at shop.embeddedplanet.com. Please contact Embedded Planet sales to ask about a configuration not found in the Embedded Planet shop: sales@embeddedplanet.com.

TABLE 1 – PART NUMBER CONFIGURATOR

Design/Long Part Number:	263B	9	NA	4	G	B	6	N	S	I	R	P	H	J	N

	Design = 263B
1	LoRa module
2	**Cellular module**
3	SIM
4	**GNSS**
5	Environmental Sensor
6	**Inertial Sensor**
7	Reserved
8	**Time of Flight Sensor**
9	Microphone
10	**LED Indicator**
11	Pushbutton input
12	**Modem headers**
13	Battery connector
14	**Switch**

An example configuration for Agora would be 263B-**9EWW4GB9NSIRPNJS** which, according to the following Table 2, would include the following:

1. 915MHz LoRa module with antenna
2. 4G LTE Cat M1 “Worldwide” module
3. 4FF/”nano” SIM card connector
4. GNSS hardware
5. BME680 temp/humidity sensor
6. 9-axis IMU
7. Time-of-Flight sensor
8. Microphone
9. Red LED
10. Pushbutton
11. Battery connector
12. Slide-style on/off switch

Table 2 – Part Number Options

Option	Designator	Description
1 LoRa	**N**	No LoRa
	9	915MHz LoRa module
	9E	915MHz LoRa module, external antenna
	8	868MHz LoRa module
2 Cellular	**N**	No cell
	NA	4G LTE Cat M1 AT&T / Verizon module
	WW	4G LTE Cat M1 "Worldwide" module
3 SIM	**N**	No SIM
	4	4FF (Nano) SIM (to match cell)
	E	Reserved
4 GNSS (Requires Option 2)	**N**	No GNSS
	G	GNSS hardware
5 Environment	**N**	No environmental sensor
	B	Bosch BME680: temp, humidity, pressure, gas
	S	SiLabs Si7021-A20: temp, humidity
6 Inertia	**N**	No inertial sensor
	6	InvenSense ICM-20602: 3-axis accel, 3-axis gyro
	9	ST LSM9DS1: 3-axis accel, 3-axis gyro, 3-axis mag
7 Reserved	**N**	
8 Time of Flight	**N**	No time of flight sensor
	S	ST VL53L0X
9 Microphone	**N**	No microphone
	I	InvenSense ICS-43432
10 LED Indicator	**N**	No LED indicator
	R	Red LED
	B	Blue LED
11 Pushbutton	**N**	No pushbutton
	P	Pushbutton
12 Modem headers	**N**	No modem headers
	H	Modem headers
13 Battery Connector	**N**	No battery connector (powered through Tectonic Edge™)
	J	JST battery connector
14 On/Off Switch	**S or Blank**	ON/OFF switch populated
	C	No switch (powered through Tectonic Edge™)

3. Additional Resources

- Agora page:
  https://www.embeddedplanet.com/agora
- Additional Documentation (including Quick Start materials):
  https://www.embeddedplanet.com/product-documentation
- Flidor Programmer & Debugger:
  https://www.embeddedplanet.com/flidor
- Telit ME910 cellular & GNSS module:
  https://www.telit.com/product-series/me910/

4. Feature Callouts

4.1. Feature Callouts | Wireless Modules

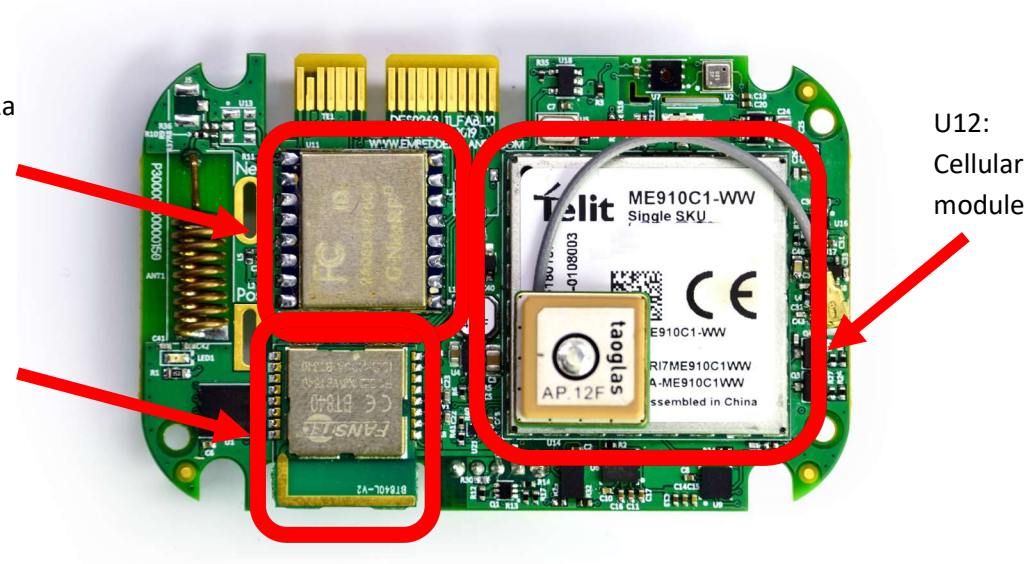


TABLE 3 – WIRELESS MODULES

Category	Reference	Functionality	Description / Purpose
Wireless Module	U11	LoRaWAN transceiver	LoRaWAN module (**915MHz** or 868MHz)
Wireless Module	U3	Bluetooth transceiver	nRF52840 BLE + MCU module
Wireless Module	U12	Cellular transceiver	Telit ME910 cellular + GNSS module

4.2. Feature Callouts | Antennae

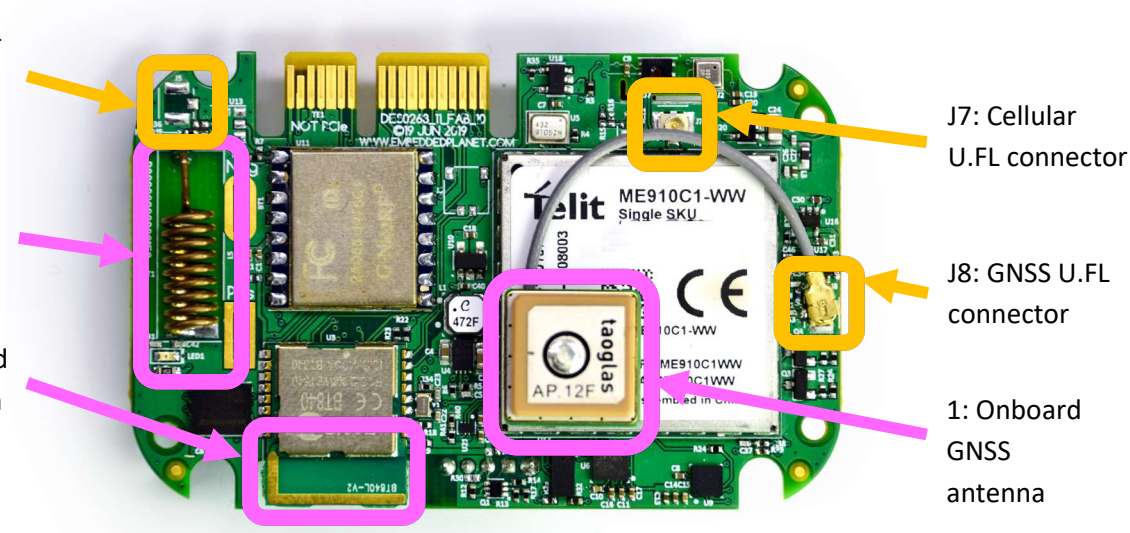


TABLE 4 - ANTENNAE

Category	Reference	Functionality	Description / Purpose
Antenna	ANT1	LoRaWAN antenna	Onboard antenna. See Antenna section for more.
Antenna	U3	Bluetooth antenna	Onboard, no offboard connections
Antenna	n/a	GNSS antenna	Adhesive-backed, mounting optional
Connector	J8	GNSS U.FL connector	Offboard antenna supported
Connector	J7	Cellular U.FL connector	Offboard antenna supported
Connector	J5	LoRa U.FL connector	Offboard antenna supported

4.3. Feature Callouts | Connectors

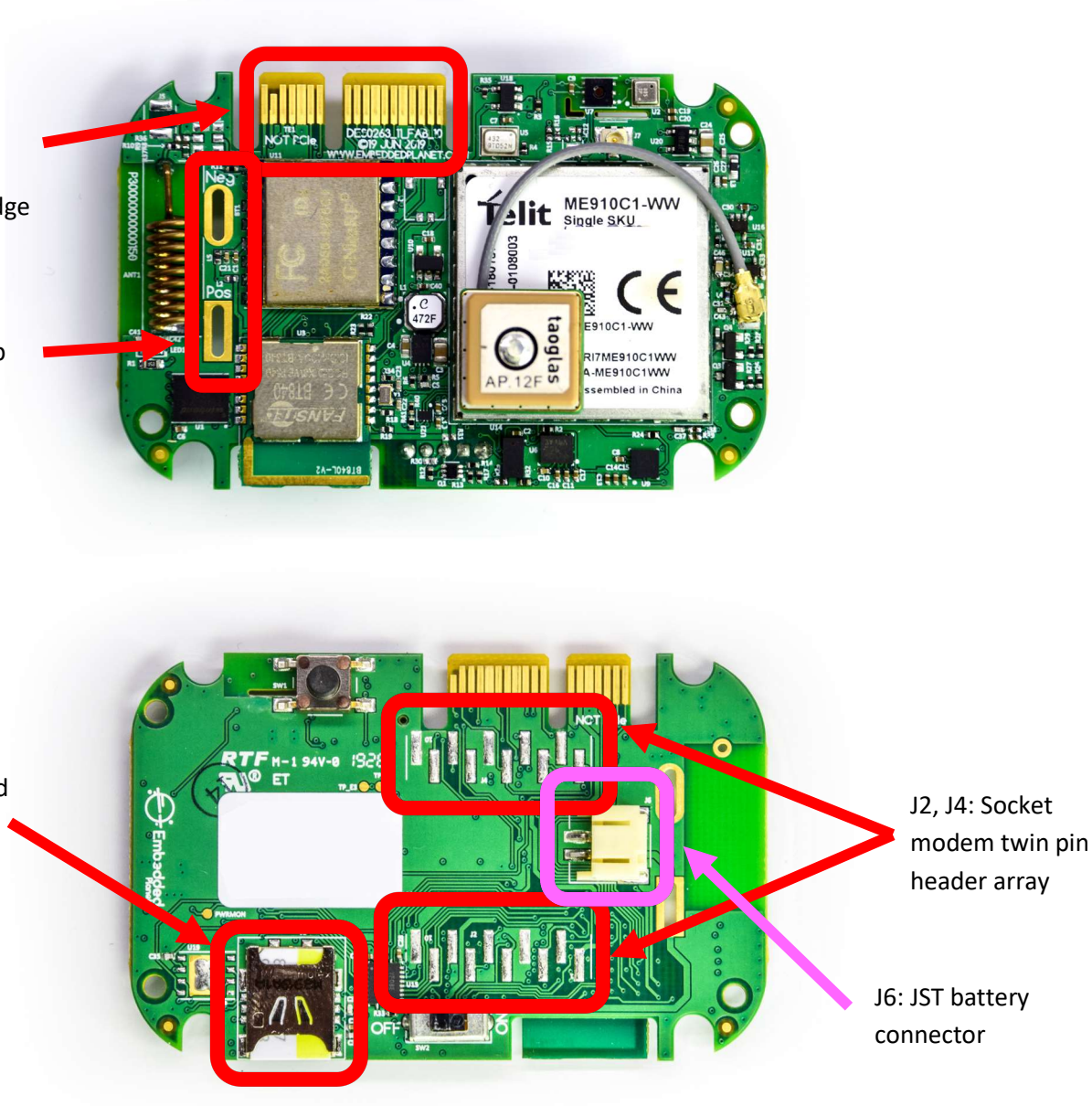


TABLE 5 – CONNECTORS

Category	Reference	Functionality	Description / Purpose
Board Interface	TE1	Board edge/finger	Tectonic Edge™ programming & debug
Connector	BT1	Battery tab connector	Optional battery tab connection
Connector	J1	SIM card connector	SIM card interface (eSIM option also available)
Connector	J2, J4	Socket modem pin headers	Drop-in 20-pin header modem applications
Connector	J6	JST battery connector	Optional JST battery connection (LiPo)

4.4. Feature Callouts | Sensors

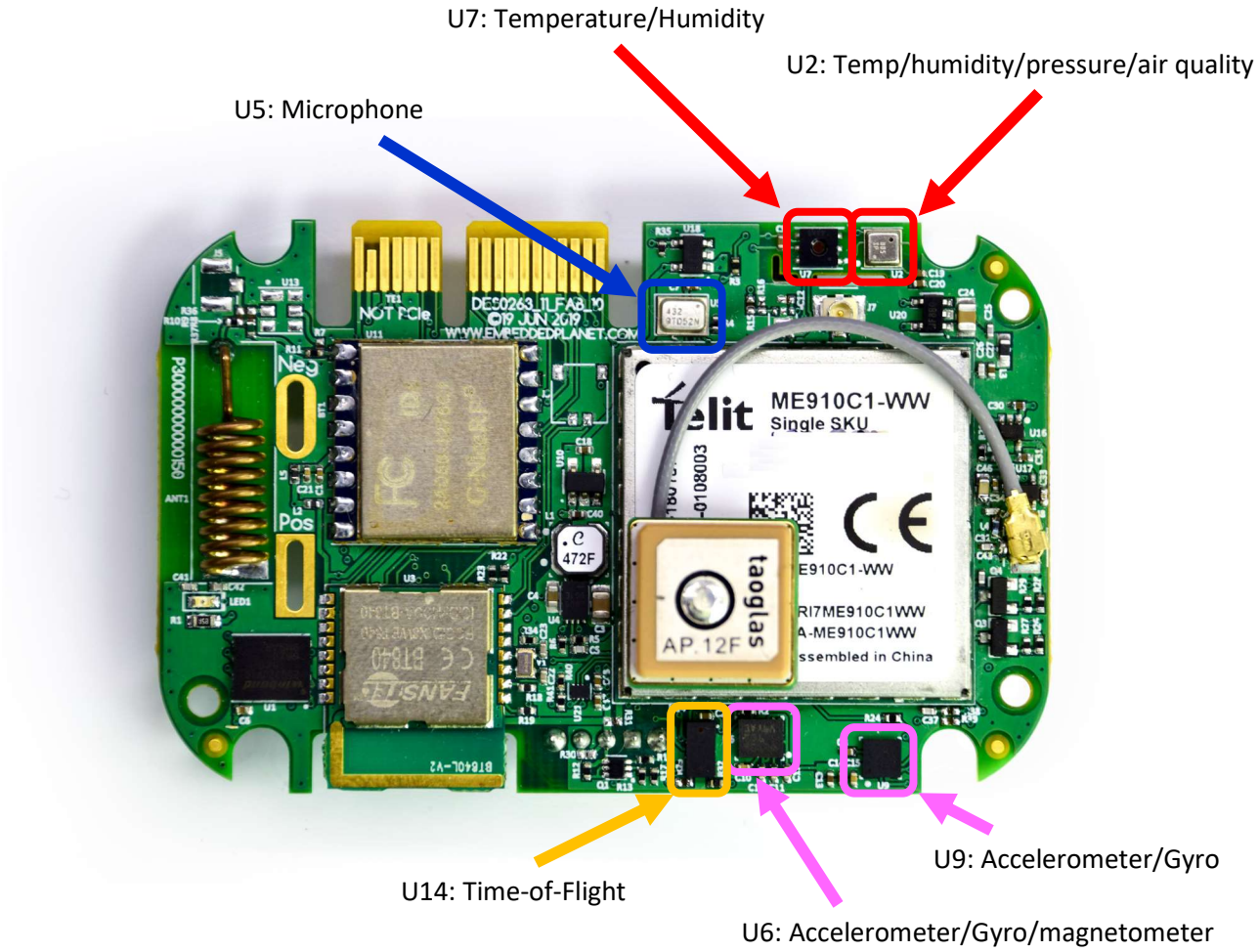


TABLE 6 – SENSORS

Category	Reference	Functionality	Description / Purpose
Sensor	U5	Microphone	ICS-43432 | Sound sensor
Sensor	U7	Temperature/Humidity	Si7021-A20 | Environmental sensor
Sensor	U2	Temperature/Humidity/Pressure/Air Quality	BME680 | Environmental sensor
Sensor	U9	Accelerometer/Gyroscope	ICM-20602 | Inertial sensor
Sensor	U6	Accelerometer/Gyroscope/Magnetometer	LSM9DS1 | Inertial sensor
Sensor	U14	Time-of-Flight (ToF)	VL53L0X | Distance sensor

4.5. Feature Callouts | Mounting & Interaction

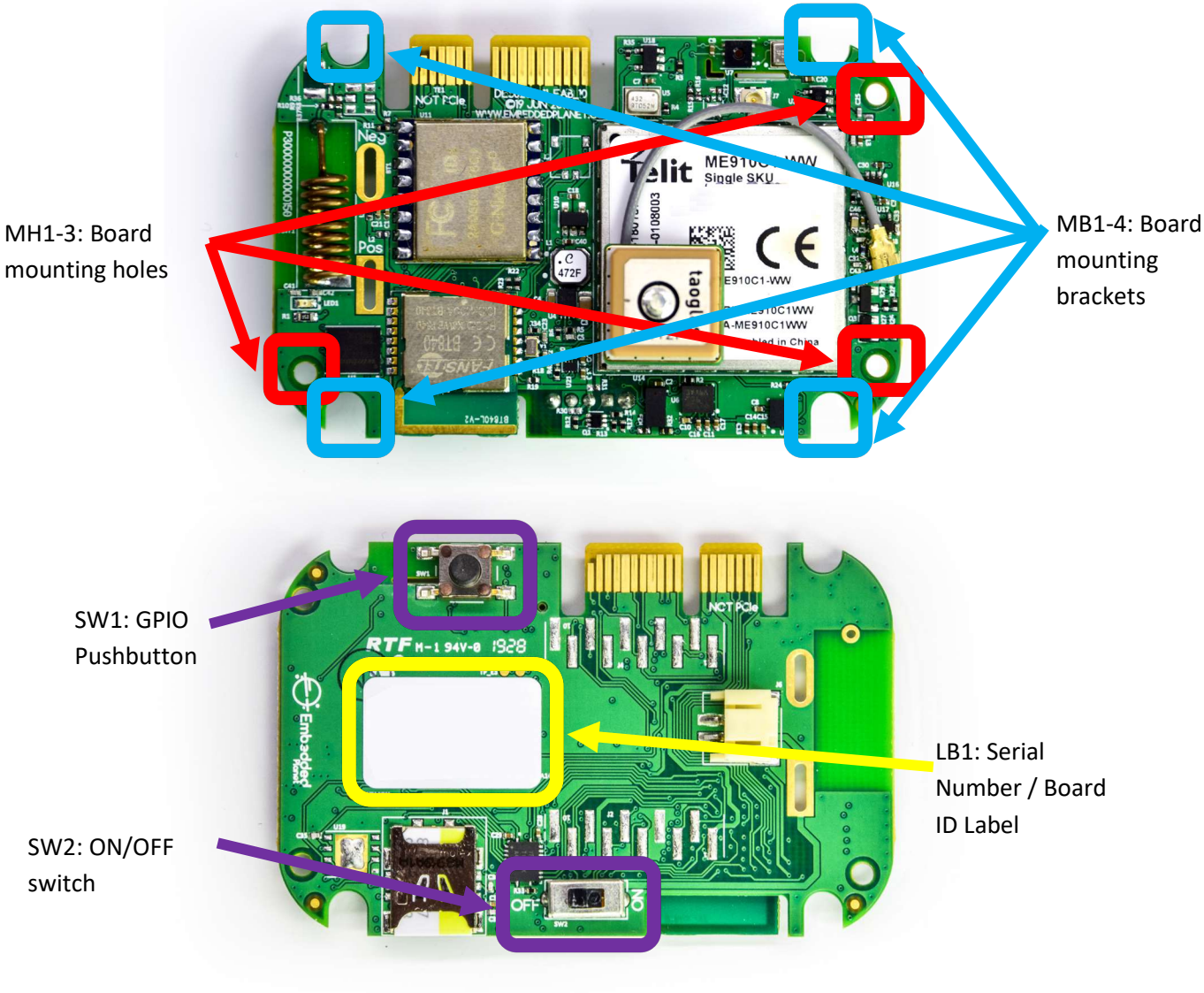
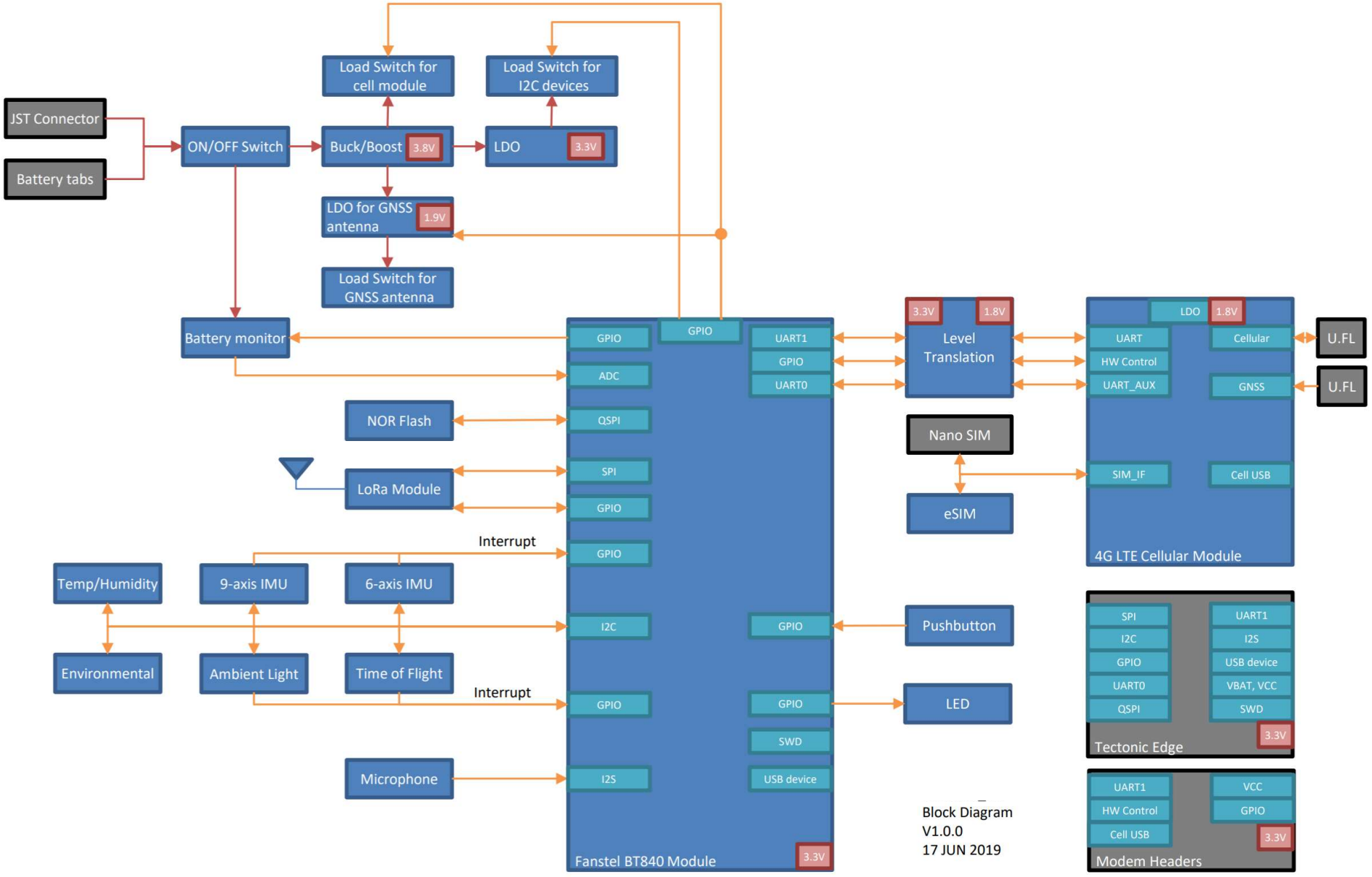


TABLE 7 – MOUNTING & INTERACTION

Category	Reference	Functionality	Description / Purpose
Mounting	MB1-4	Mounting bracket	For use with the Agora plastic housing
Mounting	MH1-4	Mounting hole	For mounting the Agora
Pushbutton	SW1	Pushbutton for GPIO usage	User programmable functionality
Switch	SW2	ON/OFF switch to the board	Power switch to the Agora
Label	LB1	Board ID Label	Identification & serialization reference

5. Block Diagram



6. Device Specifications

TABLE 8 – DEVICE SPECIFICATIONS

Feature/Specification	Description
Cellular Capabilities	**Cellular Technologies**: LTE-M (LTE CAT M1), SMS **Lower power modes**: PSM, eDRX **Operating Frequencies**: 699MHz to 1980MHz **Cellular Operating Mode**: Half-duplex FDD **RF Output Power:** Up to +23 ±2 dBm (Power Class 3)
Internet Protocols	IPv4/IPv6 stack with TCP and UDP protocols TLS/DTLS
LTE CAT M1 Specification	**Bands (WW)**: B1(2100), B2(1900), B3(1800), B4(AWS1700), B5(850), B8(900), B12(700), 13(700), B18(800), B19(800), B20(800), B26(850), B28(700) **Bands (NA):** B2(1900), B4(AWS1700), B12(700) B13(700) **Uplink**: up to 375 kbps **Downlink**: up to 300 kbps
SIM	**Removable**: 4FF (nano) SIM card slot **Board-mounted**: MFF2 **Internal**: Telit simWISE™
Cellular Certifications	**PTCRB**: Complete **AT&T**: Complete **Verizon**: Complete
GNSS Specifications	**Constellations**: GPS, GLONASS, BeiDou, Galileo, QZSS **Tracking Sensitivity**: -161dBm **Navigation Sensitivity**: -158dBm **Cold Start Sensitivity**: -146dBm
Input Voltage	**Nominal Voltage:** 3.7 VDC **Voltage Range:** 1.7-5 VDC **LiPo Specification:** 3.2-4.2 VDC
Dimensions	**Board-only, fully populated:** 70 mm x 45 mm x 16.3 mm (2.75 in x 1.77 in x 0.64in) **Plastic housing assembly**: 102.3 mm x 59.3 mm x 43 mm (4.03 in x 2.33 in x 1.69 in)
Environmental	**Operating Temperature Range (PCBA only)**: -40°C to +85°C **Storage Temperature Range (PCBA only)**: -40°C to +85°C **Operating Temperature Range (with battery)**: -20°C to +60°C **Storage Temperature Range (with battery)**: -20°C to +60°C **Humidity Range**: 20% RH to 90% RH

7. Modules

7.1. Modules | Bluetooth + MCU

The MCU on the Agora is Nordic's nRF52840 which is incorporated into the Fanstel BT840 module (U3). The BT840 contains the nRF52840 along with its supporting hardware and an integrated Bluetooth PCB antenna. Features of the Fanstel BT840 include the nRF52840 SoC, ARM® Cortex®-M4 32-bit processor with FPU 64MHz, 128-bit AES/ECB/CCM/AAR co-processor, ARM® TrustZone® Cryptocell 310 security subsystem, Bluetooth 5 IEEE 802.15.1-2006 2.4GHz transceiver, integrated PCB trace antenna, 1MB on-chip flash, 256kB on-chip RAM, USB 2.0 full speed (12Mbps) controller, QPSI 32MHz interface, and 12-bit 200ksps ADC (up to 8 channels).

Agora supports the development of the nRF52840 MCU via the Tectonic Edge™ board edge connection system used throughout Embedded Planet products. Flidor, a programming & debug host board with Tectonic Edge™ compatibility, is the choice development tool for use with Agora. Flidor supports drag-and-drop programming along with streamlined debug features that make it the go-to method for programming Agora. Some configurations of Agora assemblies, such as the Agora Development Kit available in the Embedded Planet online shop, include a Flidor for development. The Agora Development Kit is strongly recommended for users who want to development on Agora.

More on Flidor can be found at https://www.embeddedplanet.com/product-documentation/#flidor

U3: Fanstel BT840 module containing an nRF52840 (MCU+BLE)

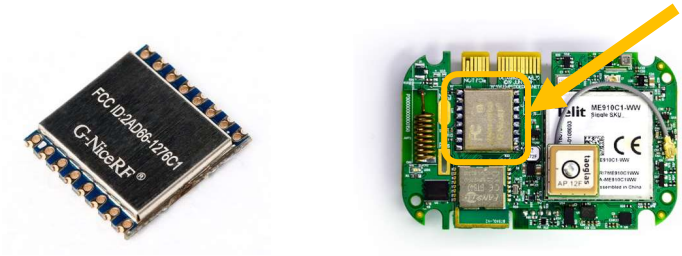
Further details on the Nordic nRF52840 can be found here:
https://www.nordicsemi.com/Products/Low-power-short-range-wireless/nRF52840

Further details on the Fanstel BT840 module can be found here:
https://www.fanstel.com/bt840

7.2. Modules | LoRaWAN

LoRaWAN is supported on Agora by the NiceRF LoRa1276-C1-915 module. This module contains a Semtech SX1276 transceiver. This module is available in either 868MHz or 915MHz center frequency configuration; the default used for Agora is 915MHz. Using this module along with the NiceRF SW915-TH12 antenna maintains the certifications that come with the NiceRF module. Specifications for this antenna include the following:

- Frequency range: 915MHz ±5MHz
- VSWR: ≤ 1.5
- Input impedance: 50ohms
- Maximum input power: 5W
- Gain: 2.15dBi



For more information on the NiceRF LoRa1276-C1-915 (915MHz) module, please see:
https://www.nicerf.com/products/detail/lora-wireless-transceiver-module-lora1276-c1-915.html

For more information on the NiceRF LoRa1276-C1-868 (868MHz) module, please see:
https://www.nicerf.com/products/detail/lora-wireless-transceiver-module-lora1276-c1-868.html

7.3. Modules | Cellular + GNSS

The Agora device leverages the Telit ME910C1 family of modules for cellular connectivity and GNSS functionality. The ME910 modules supported by Agora are the ME910C1-NA and the ME910C1-WW.

- ME910C1-NA
  - Cat M1: bands B2, B4, B12, B13
  - North America, AT&T, and Verizon

- ME910C1-WW
  - Cat M1, NB-IoT: bands B1, B2, B3, B4, B5, B8, B12, B13, B18, B19, B20, B26, B28
  - 2G fallback: bands B2, B3, B5, B8
  - Worldwide coverage

More information on the Telit ME910 series modules can be found at:
https://www.telit.com/me910c1/

A U.FL connector is provided for use with external cellular antennae, along with additional U.FL connector provided for connection to an external GNSS antenna. The GNSS antenna connection supports active GNSS antenna usage.

The recommended cellular antenna is Taoglas MFX3.07.0150C. This antenna has the following specifications:

- 698MHz to 3GHz
- >45% efficiency on all bands
- Input impedance: 50ohms
- Maximum input power: 5W
- 5dBi peak gain

More on the Taoglas MFX3.07.0150C can be found at:
https://www.taoglas.com/product/mfx3-07-cat-m1-wideband-flexible-antenna-150mm-o1-37mm-coax-cable/

https://www.taoglas.com/datasheets/MFX3.07.0150C.pdf

8. Sensors

Agora supports up to 9 different sensor data type parameters across 4 different sensor categories and 6 sensor selection options. Table 9 describes the different sensor options available. See section 4.4 Feature Callouts | Sensors of this manual for reference of where each sensor is located on the Agora board.

TABLE 9 – DEVICE SPECIFICATIONS

Category	Module	Capabilities	Ref
Environmental	Bosch BME680	Temperature, humidity, barometric pressure, VOC gas	U2
Environmental	SiLabs Si7021-A20	Temperature, humidity	U7
Inertial	InvenSense ICM-20602	6-axis IMU: 3-axis accelerometer, 3-axis gyroscope	U7
Inertial	ST LSM9DS1	9-axis IMU: 3-axis accelerometer, 3-axis gyroscope, 3-axis magnetometer	U6
Distance	ST VL53L0X	Range measurement (Time-of-Flight) (ToF)	U14
Sound	InvenSense ICS-43432	Microphone	U5

8.1. Sensors | Temp/Humidity/Pressure/Gas (U2)

The Agora design supports the Bosch BME680 environmental sensor. This sensor has the ability to measure data regarding temperature, humidity, barometric pressure, and VOC gas. Features of this sensor include:

- Temperature sensor: ±1°C temperature accuracy (0°C to +65°C), up to 20-bit resolution
- Humidity sensor: ±3% relative humidity accuracy (20-80% RH), 16-bit resolution
- Pressure sensor: ±0.6hPa pressure accuracy (300-1000hPa), up to 20-bit resolution
- VOC gas sensor:
  - Ethane: 5% accuracy
  - Isoprene / 2-methyl-1,3 Butadiene: 5% accuracy
  - Ethanol: 5% accuracy
  - Acetone: 5% accuracy
  - Carbon Monoxide: 2% accuracy

This sensor communicates with the nRF52840 MCU over I^2C using the address **1110110b (0x76).**

For more information on the Bosch BME680 please see:
https://www.bosch-sensortec.com/products/environmental-sensors/gas-sensors/bme680/

8.2. Sensors | Temp/Humidity (U7)

The Agora design supports the Silicon Labs Si7021-A20 temperature & humidity sensor. Features of this sensor include:

- Integrated ADC: up to 14-bit for temperature and up to 12-bit for humidity
- ±0.4°C temperature accuracy (-10°C to +85°C)
- ±3% relative humidity accuracy (0-80% RH)

This sensor communicates with the nRF52840 MCU over I^2C using the address **1000000b (056x40).**

For more information on the Silicon Labs Si7021-A20, please see:
https://www.silabs.com/sensors/humidity/si7006-13-20-21-34/device.si7021-a20-gm

8.3. Sensors | 6-Axis IMU (U9)

The Agora design supports the InvenSense ICM-20602 6-axis IMU sensor. This sensor is comprised of an accelerometer and a gyroscope. Features of this sensor include:

- Integrated 16-bit ADC
- 3-axis gyroscope
  - Programmable ranges of ±250dps, ±500dps, ±1000dps and ±2000dps
  - Sensitivity error: ±1%
  - Noise: $\pm$4mdps/$\sqrt{}$Hz
- 3-axis accelerometer
  - Programmable ranges of ±2g, ±4g, ±8g, ±16g
  - Sensitivity error ±1%
  - Noise: 100µg/$\sqrt{}$Hz

This sensor communicates with the nRF52840 MCU over I^2C using the address (**1101000b, 0x68).**

For more information on the InvenSense ICM-20602, please see:
https://invensense.tdk.com/products/motion-tracking/6-axis/icm-20602/

8.4. Sensors | 9-Axis IMU (U6)

The Agora design supports the ST LSM9DS1 9-axis IMU sensor. This sensor is comprised of an accelerometer, a gyroscope, and a magnetometer. Features of this sensor include:

- Integrated 16-bit ADC
- 3-axis gyroscope
  - Programmable ranges of ±245dps, ±500dps and ±2000dps
- 3-axis accelerometer
  - Programmable ranges of ±2g, ±4g, ±8g, ±16g
- 3-axis magnetometer
  - Programmable ranges of ±2gauss, ±4gauss, ±8gauss, ±16gauss

This sensor communicates with the nRF52840 MCU over I^2C using the address (**1101010b, 0x6A)** for the accelerometer/gyroscope, and **0011100b, 0x1C** for the magnetometer.

For more information on the ST LSM9DS1, please see:
https://www.st.com/en/mems-and-sensors/lsm9ds1.html

8.5. Sensors | Time-of-Flight/ToF (U14)

The Agora design supports the ST VL53L0X time of flight (ToF) sensor. Features of this sensor include:

- Distances measurement up to 2 meters
- Ability to provide distance measurements despite target reflectance
- White target max range: minimum 120cm indoor (4% accuracy), 60cm outdoor overcast (7% accuracy)
- Grey target max range: minimum 70cm indoor (7% accuracy), 40cm outdoor overcast (12% accuracy)
- SPAD array (Single Photon Avalanche Diodes) with embedded FlightSense technology
- Laser invisible to the human eye

This sensor communicates with the nRF52840 MCU over I^2C using the address **0101001b (0x29).**

For more information on the ST VL53L0X, please see:
https://www.st.com/en/imaging-and-photonics-solutions/vl53l0x.html

8.6. Sensors | Microphone (U5)

The Agora design supports the InvenSense ICS-43432 microphone module. Features of this sensor include:

- -26dB sensitivity
- 65dBA SNR
- 50Hz to 20kHz frequency response range
- 24-bit I^2S interface
- Low current consumption

This sensor communicates with the nRF52840 MCU over **I^2S** using pins B1 (P25: SD), B4 (P06: SCK), and B5 (P08: WS).

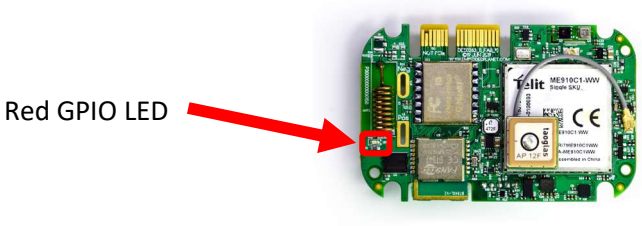
For more information on the InvenSense ICS-43432, please see:
https://invensense.tdk.com/products/digital/ics-43432/

9. GPIO Elements

A pushbutton and an LED are included as options on Agora. Both of these components are application-controlled; they can be programmed to function in whatever way the application calls for. These features can be used for development and/or in end-product applications.

9.1. GPIO Elements | Red LED

Agora features an onboard red LED controlled by programmable a GPIO pin on the nRF52840 MCU. This LED is useful for development & debugging as well as for some end-product applications. The LED consumes a nominal current of 4.4mA. The control signal for the LED is active-low and is connected to pin A4 (P05) of the nRF52840.



9.2. GPIO Elements | Pushbutton

Agora features an onboard pushbutton connected to a GPIO pin on the nRF52840 MCU. This pushbutton is useful for development & debugging as well as for some end-product applications. This pushbutton signal is active-low. The pushbutton GPIO pin is pulled high to 3.3V through an external 1M ohm resistor. When pressed, the pushbutton connects the GPIO pin to COM (0V). The pushbutton GPIO pin is A2 (P29) of the nRF52840.

10. Memory

Agora supports onboard NOR flash packages controlled by the nRF52840 module. The flash module used in the default Agora configuration is the 32Mb QSPI NOR flash W25Q32JVZPIQ by Winbond. This flash module includes the following features:

- Supports JEDEC standard manufacturer and device ID and SFDP
- 128-bit unique serial number
- Four 256-byte Dedicated Security Area with OTP user-lockable bits

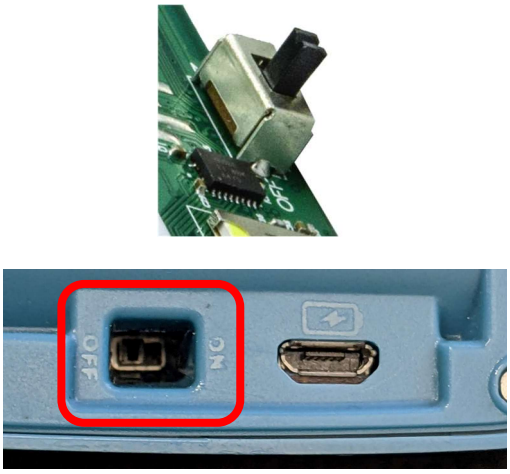
This flash module communicates with the nRF52840 MCU over QSPI lines using pins E1 (P20: IO0), E2 (P21: IO1), C2 (P22: IO2), D1 (P23: IO3), D2 (P19: CLK), and C3 (P17: CS#).

For more information on the Winbond W25Q32JV series, please see:
https://www.winbond.com/hq/product/code-storage-flash-memory/serial-nor-flash/?__locale=en&partNo=W25Q32JV

11. Power

Agora is capable of receiving power from a variety of sources across its different configurations. These may include a LiPo battery, an ac/dc wall-wart, or externally regulated input voltage over Tectonic Edge™. Power may be derived from any 1.7 VDC to 5 VDC power supply over the battery connection. For non-cellular applications, the supply must be capable of supplying at least 200mA. For cellular applications, the supply must be capable of supplying at least 800mA. It should be noted that the cellular module may use momentary spikes of high current during its operations, while overall current consumption may not be as demanding. Some configurations of the Agora board (including the default configuration) include a slide switch for controlling power to the board coming from the battery input (VBAT).

- *Agora should **never** be powered through the 3.3V VCC line.*
- ***Always** power Agora through the VBAT battery input line.*



Shown above: The Agora ON/OFF switch

3.8V is the output of the main supply on the Agora board. It is regulated by an ADI LTC3539 which receives its input from the battery voltage terminals. For Agora configurations using the LiPo battery, the battery voltage is directly fed into the input of the LTC3539. Using this regulator provides a steady 3.8V supply across input voltage levels that are both above and below the 3.8V supply line, allowing LiPo batteries to function well with the board. The 3.8V supply supplies power to the Telit ME910 cellular module along with to the 3.3V supply and to the 1.9V supply.

The onboard 3.3V supply is generated from the 3.8V supply using the ON Semi NCP115. This 3.3V supply is used for all components other than the cellular module and is the default board I/O reference voltage. This supply is capable of an output current of 300mA which includes the processes of the Agora module itself.

The onboard 1.9V supply is generated from the 3.8V supply using the Microchip MIC5378C5. This 1.9V supply is used to power the active GNSS antenna. A switch (TI TS5A3166) is used to control the connection between 1.9V and the GNSS antenna line. The GNSS LNA enable pin on the nRF52840 (pin R7, GNSS_LNA_ENA) controls the switch's enable.

11.1. Power | Battery

The Agora board is designed to operate with power from a battery connected to its JST connector. The battery must be a secondary, 1SxP lithium battery. A 3.7 VDC nominal lithium-ion/lithium-polymer battery is the suggested battery choice for Agora. The battery should be chosen with the consideration that the minimum required voltage is 3.2V and the charge termination voltage is 4.2V. The capacity of the battery may vary based on the needs of the end application. The battery charger has a charge current limit of 500mA which should be taken into consideration when the capacity and maximum allowable charge current of the battery are determined. Configurations of Agora that include a LiPo battery conform to the suggested specifications. The current default LiPo battery model provided with Agora is a 3.7V model with a 4400 mAh capacity. If a battery is not available, the operator may apply a DC voltage (such as from a bench power supply) within the battery operating voltage range specification (3.2V-4.2V, nominally 3.7V).

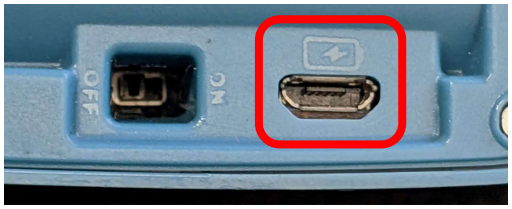
11.2. Power | Battery Charging

The Agora board (PCBA) does not support LiPo charging. Configurations of Agora that include the custom plastic housing & LiPo battery, however, include a LiPo charging circuit. The LiPo charging interface in the Agora module configuration is a Micro-B USB port on the underside of the plastics module that can connect to standard USB host devices. The charging port features two LEDs: one red LED, and one green LED.

The **red** LED illuminates to indicate the battery is **charging**.

The **green** LED illuminates to indicate the battery is **fully charged** (*trickle charge state*)

The battery charging process begins with a preconditioning charge. The charger then moves to a constant-current quick charge for the bulk of the charge process. A constant-voltage trickle charge completes the charge cycle and keeps the battery voltage topped-up while the voltage source of the charger (USB cable) remains connected. The maximum charge current is 500mA.



11.3. Power | Battery Monitor

Agora supports an integrated battery voltage monitor feature so that the system can react to changes to or threshold levels of the battery voltage. The battery voltage monitor output that goes to the nRF52840's analog input (ADC) is set to one-half of the battery voltage. The battery voltage monitor is controlled by a GPIO on the nRF52840 so that it can be disconnected from the battery if needed. Since the battery voltage may be as high as 4.2V, the ADC reference must be set for at least 2.4V. With the battery voltage monitor characterized as a high impedance circuit, the ADC sample time must be set to the maximum setting.

11.4. Power | Sensor Power Control

The onboard nRF52840 MCU controls power to the sensor devices via a load switch (Diodes, Inc. AP22802AW5). This provides maximum flexibility for balancing power consumption and data acquisition to empower as many application needs as possible. Overall battery life can be maximized by using the *sensor power enable* function to turn off power to the sensor devices while they're not in use. These sensors are all controlled through a single I^2C bus; this load switch controls the voltage line supplying power collectively to all devices on this bus. Toggling the power to one sensor means toggling the power to all sensors. For applications sensitive to current consumption, one solution may be to power the sensor bus only while a sensor is taking the required reading(s), then disabling power to the sensor bus while no sensors are in use.

- The *sensor power enable* pin on the nRF52840 is **B3 (P0.31)**
- The *sensor power enable* signal is **active-high**
- The *sensor power enable* signal is **pulled low** using an external 1M ohm resistor

    - Components collectively powered by the *Sensor power enable* function:
        - Temp/humidity/pressure/VOC (U2)
        - Temp/humidity (U7)
        - 6-axis IMU (U9)
        - 9-axis IMU (U6)
        - Time-of-Flight (U14)
        - Microphone (U5)

11.5. Power | Cell Power Control

The onboard nRF52840 MCU controls power to the Telit ME910 cellular module via a load switch (Diodes, Inc. AP22802AW5). This provides maximum flexibility for balancing power consumption and data acquisition to empower as many application needs as possible. Overall battery life can be maximized by using the cellular power enable function to turn off power to the cellular device while not in use.

- The *cellular power enable* pin on the nRF52840 is **A1 (P0.28)**
- The *cellular power enable* signal is **active-high**
- The *cellular power enable* signal is **pulled low** using an external 1M ohm resistor

11.6. Power | Battery Life

Agora is able to use battery power to remain powered for data acquisition & transmission over considerable intervals of time. The Telit ME910 cellular module used on Agora supports a Power Savings Mode (PSM) feature that can help extend battery life by controlling the restriction of power to the Telit ME910 cellular module while not in use. The nRF52840 MCU on Agora can also help extend battery life by controlling power to the sensors & peripheral devices on the device while not in use (see Section 11.4 and Section 11.5).

For any additional content regarding power consumption or battery details, please refer to: https://www.embeddedplanet.com/product-documentation

12. Development

Agora is designed to support the deployment of standard hardware/software configurations as well as the development of custom hardware or software solutions. Whether Agora is being used as an integrated component within an end product or it's being used for development to clear the way for a custom integration solution, hardware and software development are essential parts of Agora's time-to-market solution success.

12.1. Development | Programming & Flidor Development Board

Development of the Agora board is supported by the Flidor programming & debugging board. This host board connects to the Agora using the Tectonic Edge™ interface and acts as a drag-and-drop programming interface, debug interface, and hardware breakout interface. Power to an Agora board can be supplied through many different interfaces using Flidor, including USB-micro, barrel jacks, JST LiPo battery connector, and more. Programming through Flidor can be done over USB or through ARM Cortex headers. Flidor also provides breakout lines of power lines, GPIO, and signal lines (UART, I^2C, QSPI, and more). Current measurements can be accommodated through Flidor for some signals through the use of optional pin headers and/or cut traces.

A Flidor board is included in the Agora Development Kit for the operator to program and develop on their Agora. For more information on Flidor, please visit https://www.embeddedplanet.com/product-documentation/#flidor.

12.2. Development | Programming & Debugging

Agora supports a diverse range of software applications to accommodate & compliment the various features available through the Agora platform. Sample applications are provided by Embedded Planet as github resources and referenced in Quick Start Guides & other development/support materials.

To view available Quick Start Guides & other supporting documentation, please refer to: https://www.embeddedplanet.com/product-documentation

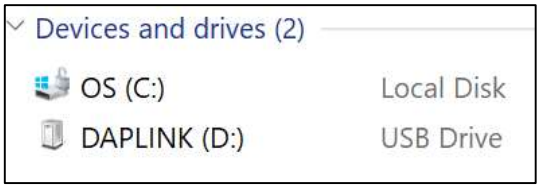
To directly access available sample application & other github documentation, please refer to: https://github.com/orgs/EmbeddedPlanet/repositories

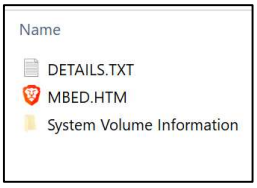
Shown above: Agora Development Kit including Agora PCBA and Flidor board

To Program Agora Using Flidor (Agora Development Kit)…

1. Connect the Agora board to the Flidor board over Tectonic Edge™ (directly or using right-angle adapter)

2. Connect the Flidor board to a PC using the "DHD USB" micro-USB port.
3. Wait for the Flidor to enumerate as a USB device on the PC. It should show up as a removable storage device (e.g. "DAPLINK") under "My PC" or the equivalent external hardware interface connection directory.





4. Locate/generate the hex file of the application you want to program
5. Drag-and-drop the application hex file onto the Flidor removable storage device.
    a. This is an interface. The file will not actually show up in the Flidor like it would on a storage device.
    b. If programming fails for any reason, the debug details will be generated as a .txt file in this directory.
6. Power cycling the Agora/Flidor is recommended after programming

12.3. Development | Software

The nRF52840 MCU on the Agora opens the door to a plethora of application possibilities by combining a platform of diverse onboard wireless connectivity options with the control of a powerful MCU. Designed to streamline & expedite development, Agora is a powerful tool for bringing applications to life. The nRF52840 supports development through mbed OS. It is recommended to use Linux for development with Agora.

To development on Agora, obtain the following tools:

- IDE (e.g. Visual Studio Code)
- Linux box or Linux virtual machine
  - Ubuntu in combination with Vagrant Virtual Machine, for example, may be used for development.
- Mbed CLI
- Agora drivers/BSP files

The IDE & Linux tools of choice may be obtained from their respective preferred sources.

The mbed CLI tool can be obtained from https://os.mbed.com/docs/mbed-os/v6.15/build-tools/install-and-set-up.html.

The Agora drivers & Board Support Packages (BSPs) can be obtained from https://github.com/EmbeddedPlanet/ep-oc-mcu. Some development tools included are drivers for sensors, extra features like GNSS, and DSP support.

The agora-sensor-reference-app repo contains a development guide for Agora and mbed.

Example demo applications include:

https://github.com/EmbeddedPlanet/agora-sensor-reference-app
Sensor demonstration

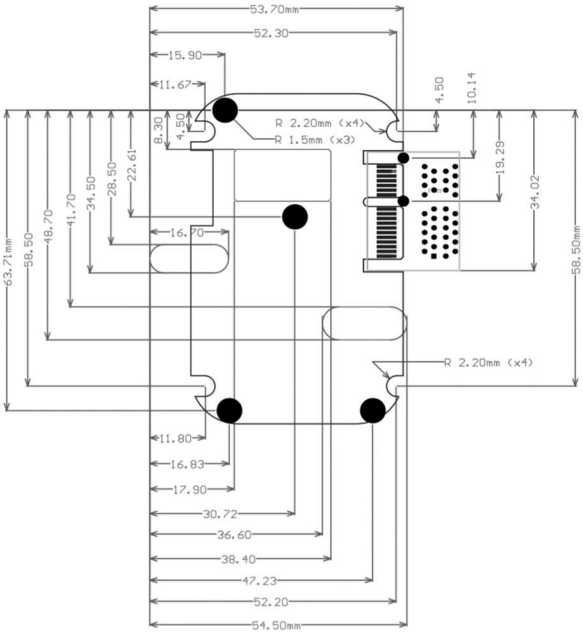
https://github.com/EmbeddedPlanet/ep-agora-lorawan-reference-app
LoRaWAN demonstration

https://os.mbed.com/teams/mbed-os-examples/code/mbed-os-example-blinky/
mbed OS demonstration

12.4. Development | Hardware Integration

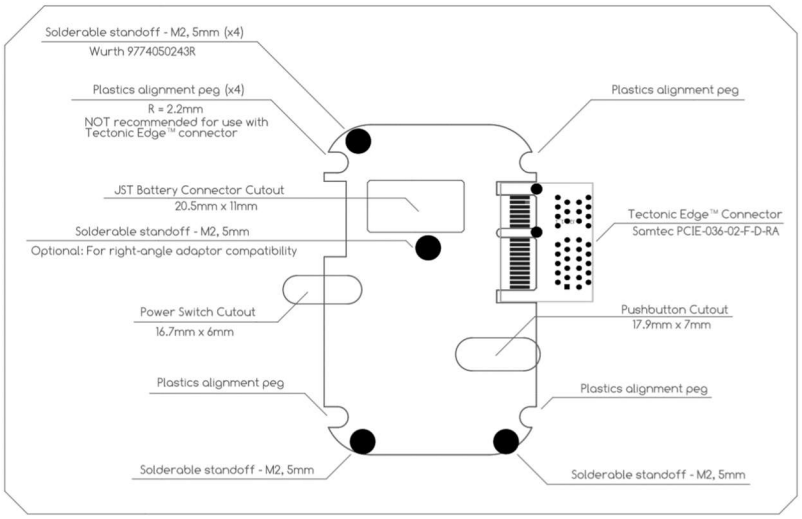
Agora can be integrated into new hardware designs as well as existing ones. The recommended interface for Agora's hardware integration is the Tectonic Edge™ connection system. This manual specifies detail on the pinout, connectors, and more in the Tectonic Edge™ section. Additional documentation, including Tectonic Edge™ PCB footprint integration & modem header integration, is available at https://www.embeddedplanet.com/product-documentation.

Below is an example of some available documentation that supports Agora hardware integration:



Suggested Layout for Agora (Dimensions)

All dims in mm



Suggested Host Board Layout for Agora (Feature Reference)

13. Pinouts

13.1. MCU Pinout (BT840)

TABLE 10 – MCU PINOUT (BT840)

Fanstel Pin	nRF52840 pin	Function	Connected to	Tectonic Edge™ Pin
1	P0.26/SDA	SDA	Sensors	B7
2	P0.27/SCL	SCL	Sensors	B6
3	P0.00/XL1	32.768kHz	Crystal	-
4	P0.01/XL2	32.768kHz	Crystal	-
5	P0.02/AIN0	Battery Voltage ADC	Battery Voltage Monitor	-
6	P0.03/AIN1	Board ID ADC	Board ID resistor divider	-
7	P0.09/NFC1	NFC	JST connector	-
8	P0.10/NFC2	NFC	JST connector	-
9	VDD	Power	Vin	A12
10	GND	Common	COM	A5
11	P0.11/TRACEDATA2	LoRa_MOSI/TRACEDATA2	LoRa Module	B2
12	P1.00/TRACEDATA0	SWO/TRACEDATA0	EP Debug Header	A18
13	P0.13	Debug_TX	EP Debug Header and cell aux UART	B12
14	P0.18/nRESET	BT840 Reset	EP Debug Header	A17
15	SWCLK	SWD clock	EP Debug Header	A16
16	SWDIO	SWD data	EP Debug Header	A15
A0	VSS	Common	COM	A8
A1	P0.28/AIN4	CELL_PWR_EN	Telit cell module	-
A2	P0.29/AIN5	PB	Pushbutton	-
A3	P0.04/AIN2	INT_LIGHT_TOF	Light sensor INT and ToF sensor INT	-
A4	P0.05/AIN3	LED_RED	LED	-
A5	P0.07/TRACECLK	LoRa_SCLK/TRACECLK	LoRa Module	B3
A6	P1.08	CELL_CTS	Telit cell module	A4
B0	VSS	Common	COM	A14
B1	P0.25	I2S_SD	Microphone	B11
B2	P0.30/AIN6	CELL_ON_OFF	Telit cell module	B9
B3	P0.31/AIN7	SENSOR_PWR_EN	Load Switch	B10
B4	P0.06	I2S_SCK	Microphone	A7
B5	P0.08	I2S_WS	Microphone	A6
B6	P1.03	CELL_DSR	Telit cell module	-
C0	VSS	Common	COM	B5
C1	P0.24	CELL_HW_SHUTDOWN	Telit cell module	-
C2	P0.22	QSPI IO2	QPSI Flash	-
C3	P0.17	QSPI CS#	QPSI Flash	B15
C4	P0.15	CELL_DCD	Telit cell module	-
C5	P1.02	CELL_TX	Telit cell module	A1
C6	P1.04	CELL_DTR	Telit cell module	-
D0	VSS	Common	COM	B8

D1	P0.23	QSPI IO3	QPSI Flash	-
D2	P0.19	QSPI CLK	QPSI Flash	B18
D3	P0.16	Debug_RX	EP Debug Header and cell aux UART	B13
D4	P0.14	CELL_RTS	Telit cell module	A2
D5	P1.01	CELL_RX	Telit cell module	A3
D6	P1.05	INT_ACCEL	6-axis or 9-axid INT	-
E0	P1.07	LoRa_DIO0	LoRa Module	-
E1	P0.20	QSPI IO0	QPSI Flash	B17
E2	P0.21	QSPI IO1	QPSI Flash	B16
E3	P1.09/TRACEDATA3	LoRa_SS#/TRACEDATA3	LoRa Module	B4
E4	D+	USB	EP Debug Header	A9
E5	D-	USB	EP Debug Header	A10
E6	P0.12/TRACEDATA1	LoRa_MISO/TRACEDATA1	LoRa Module	B1
F0	VSS	Common	COM	B14
F1	VSS	Common	COM	-
F2	VSS	Common	COM	-
F3	VSS	Common	COM	-
F4	VDDH	Power	Vin	-
F5	DCCH	Power	NC	-
F6	VBUS	USB	EP Debug Header	A11
Z0	P1.11	BATT_MON_EN	Battery Voltage Monitor	-
Z1	P1.12	LoRa_DIO1	LoRa Module	-
Z2	P1.13	LoRa_DIO2	LoRa Module	-
Z3	P1.14	LoRa_DIO3	LoRa Module	-
Z4	P1.15	LoRa_DIO4	LoRa Module and cell module PWRMON	-
Z5	P1.10	LoRa_RESET#	LoRa Module	-
Z6	P1.06	Board ID EN#	Board ID resistor divider	-

13.2. Tectonic Edge™ Pinout

Agora uses the specialized Tectonic Edge™ board finger connection system as developed by Embedded Planet as a streamlined way to power, program, and debug the board as well as break out various data lines. The pinout for the Tectonic Edge™ connector is included in this section. The target device with Tectonic Edge™ board fingers (in this case, Agora) is mating-compatible with a standard PCIe (PCI-express) connector. Recommended connectors for use with Agora are PCIE-036-02-F-D-RA by Semtec (right-angle) or 10018784-10000TLF by Amphenol (vertical). See the Hardware Integration section of this manual for more detail on integrating Agora into another design using the Tectonic Edge™ interface. Additional footprint and hardware integration details are available at https://www.embeddedplanet.com/product-documentation.

In the following diagrams, the red image (first) represents the *top* side of the Agora board *with* the ME910 cell module, while the blue image (second) represents the *bottom* side of the Agora board *without* the ME910 cellular module. Each diagram is shown looking physically at the side of interest, shown with the real-world image corresponding to it. Note that in the CAD images, the board reverses its x-axis with the change in view sides - corresponding to the view of the physical board itself being flipped over .

Tectonic Edge™: Top View

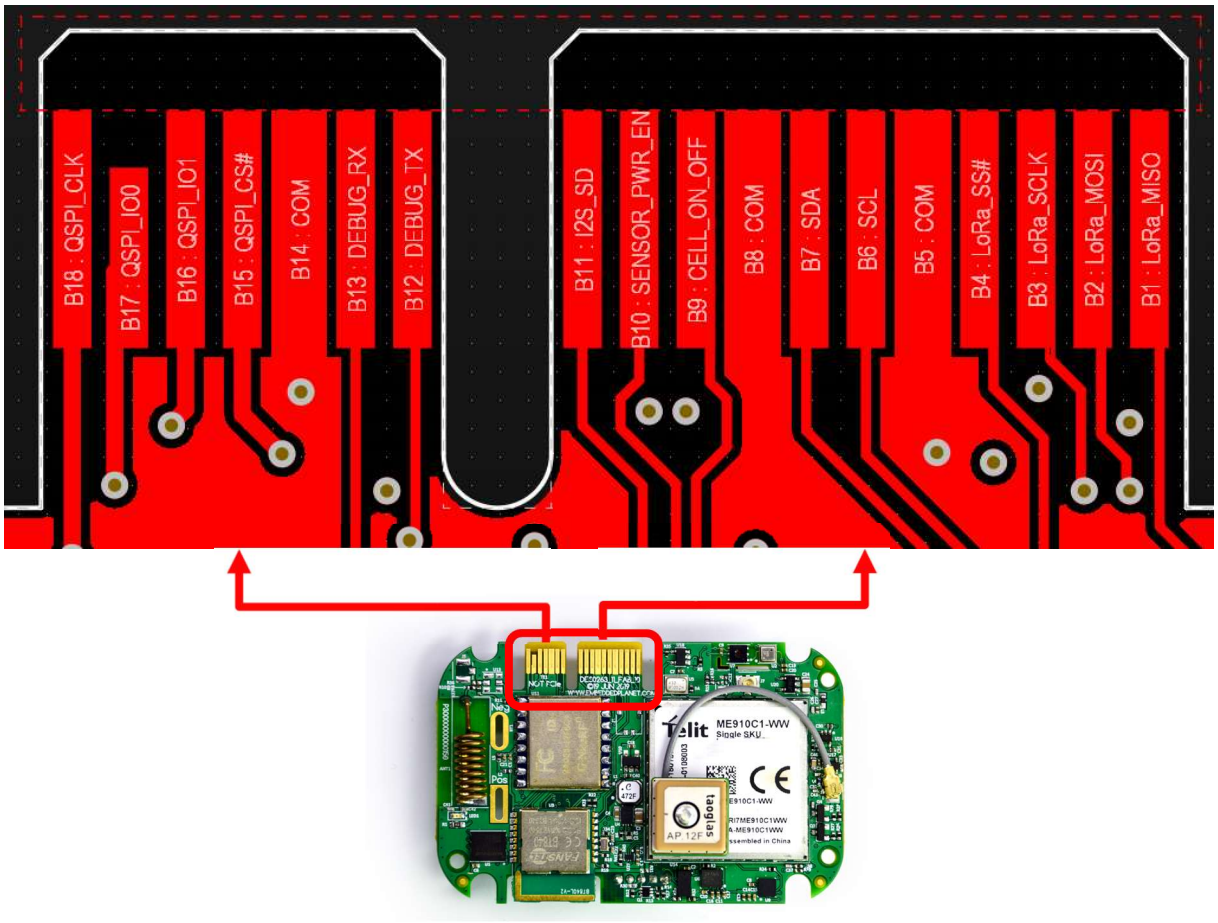


Table 11 – Tectonic Edge Pinout (Top)

Tectonic Edge™ Pin	Function	Connected to	nRF52840 Pin	Voltage
B1	LoRa_MISO/TRACEDATA1	LoRa Module	P0.12	3.3 VDC
B2	LoRa_MOSI/TRACEDATA2	LoRa Module	P0.11	3.3 VDC
B3	LoRa_SCLK/TRACECLK	LoRa Module	P0.07	3.3 VDC
B4	LoRa_SS#/TRACEDATA3	LoRa Module	P1.09	3.3 VDC
B5	**Common**	**COM**	**n/a**	**COM**
B6	SCL	Sensors	P0.27	3.3 VDC
B7	SDA	Sensors	P0.26	3.3 VDC
B8	**Common**	**COM**	**n/a**	**COM**
B9	CELL_ON_OFF	Telit cell module	P0.30	3.3 VDC
B10	SENSOR_PWR_EN	Load Switch	P0.31	3.3 VDC
B11	I2S_SD	Microphone	P0.25	3.3 VDC
B12	Debug_TX	EP Debug Header & cell aux UART	P0.13	3.3 VDC
B13	Debug_RX	EP Debug Header & cell aux UART	P0.16	3.3 VDC
B14	**Common**	**COM**	**n/a**	**COM**
B15	QSPI CS#	QPSI Flash	P0.17	3.3 VDC
B16	QSPI IO1	QPSI Flash	P0.21	3.3 VDC
B17	QSPI IO0	QPSI Flash	P0.20	3.3 VDC
B18	QSPI CLK	QPSI Flash	P0.19	3.3 VDC

Tectonic Edge™: Bottom View

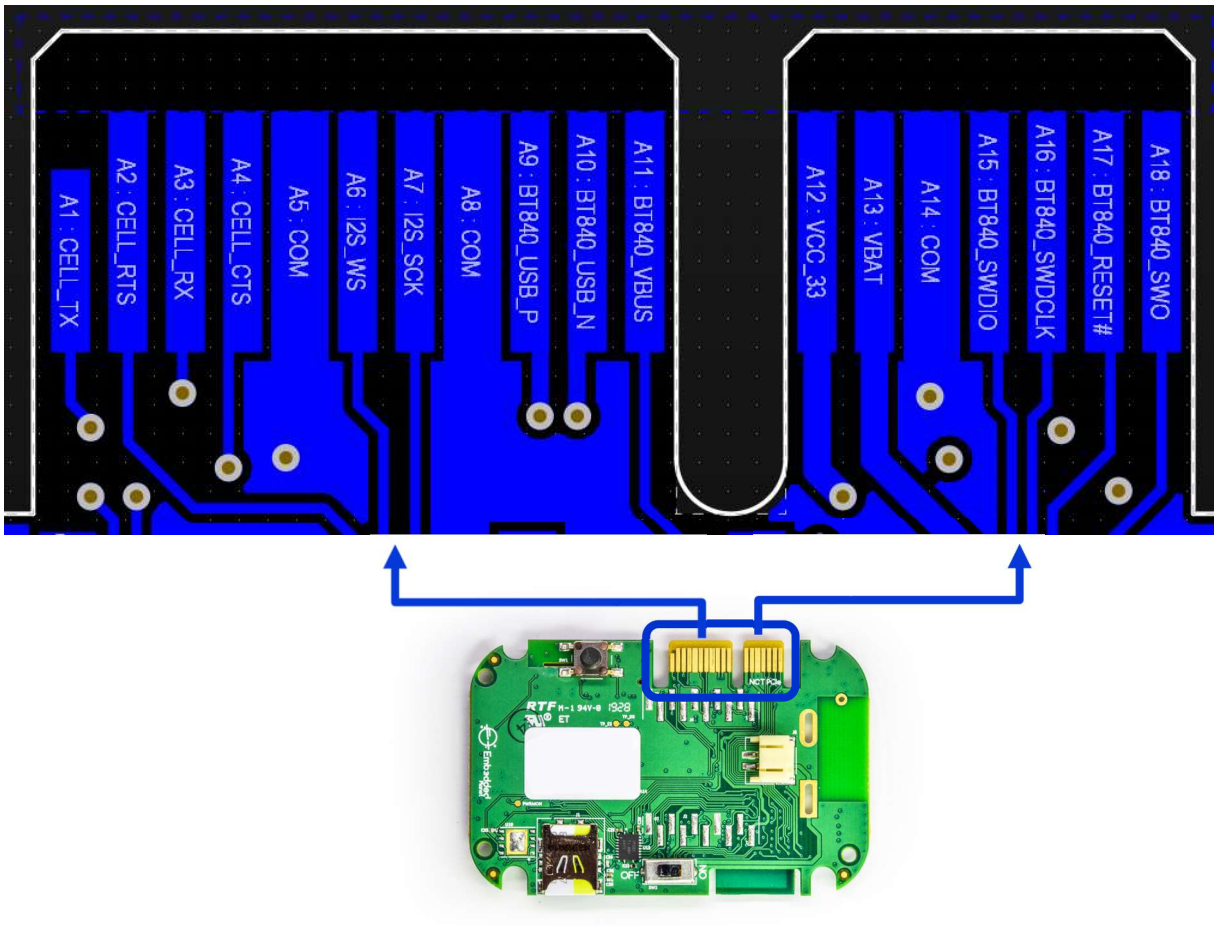
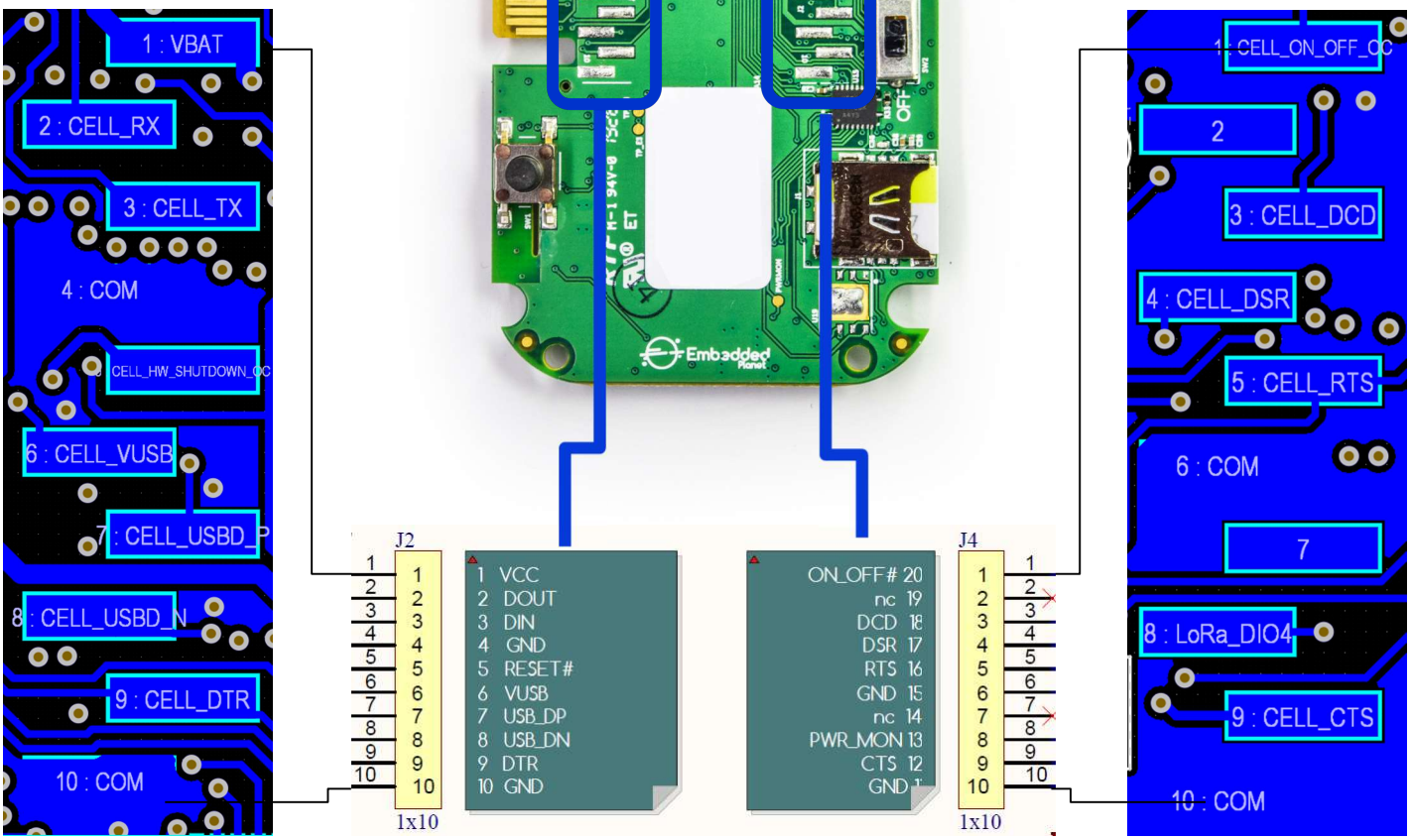


Table 12 – Tectonic Edge Pinout (Bottom)

Tectonic Edge™ Pin	Function	Connected to	nRF52840 Pin	Voltage
A1	CELL_TX	Telit cell module	P1.02	3.3 VDC
A2	CELL_RTS	Telit cell module	P0.14	3.3 VDC
A3	CELL_RX	Telit cell module	P1.01	3.3 VDC
A4	CELL_CTS	Telit cell module	P1.08	3.3 VDC
A5	**Common**	**COM**	**n/a**	**COM**
A6	I2S_WS	Microphone	P0.08	3.3 VDC
A7	I2S_SCK	Microphone	P0.06	3.3 VDC
A8	**Common**	**COM**	**n/a**	**COM**
A9	USB_P	D+ (nRF52840)	P0.14	3.3 VDC
A10	USB_N	D- (nRF52840)	P1.01	3.3 VDC
A11	VUSB	VBUS (nRF52840)	VBUS	5 VDC
A12	Power	Vin	VDD	3.3 VDC
A13	VBAT	Battery voltage	n/a	1.7-5 VDC
A14	**Common**	**COM**	**n/a**	**COM**
A15	SWD data	EP Debug Header	SWDIO	3.3 VDC
A16	SWD clock	EP Debug Header	SWCLK	3.3 VDC
A17	BT840 Reset	EP Debug Header	P0.18	3.3 VDC
A18	SWO/TRACEDATA0	EP Debug Header	P1.00	3.3 VDC

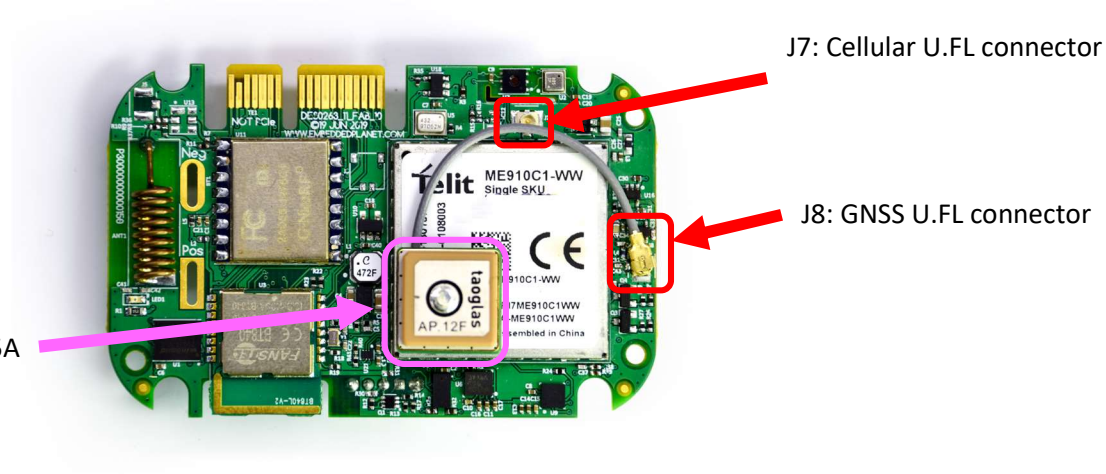
13.3. Modem Header Pinout

Agora can be used as a drop-in modem device using the twin 1x10 pin header footprint common to modem devices. Configurations of Agora that include the population of these pin headers use a pair of 1x10-pos, 2mm pitch, SMD, male pin headers. In this format the nRF52840 does not control the host board. Rather, the entire Agora acts as a cellular modem.



14. Antennae

The Agora PCBA supports three external antenna types: a cellular antenna, a GNSS antenna, and a LoRa antenna. Connections to each of the external antennae are provided onboard as U.FL connectors. If a corresponding onboard antenna is not provided for each desired wireless function on a given configuration of Agora, the operator must attach external antennae to the board via the U.FL connectors in order for the cellular, GNSS, or LoRa operations to work. Some configurations of Agora include the recommended cellular and/or GNSS antennae. Agora is also compatible with combination antennae as long as they follow the appropriate specifications according to their corresponding wireless module requirements. Configurations of Agora that include the custom plastic housing may include external/off-board antenna solutions internal to the housing by using the specified antenna models in the following subsections. For cases where Agora is used without a plastic housing, one could use either separate antennae or a combination antenna. The recommended combination antenna in such applications would be the **MA140.A.LB.001** by Taoglas.



14.1. Antennae | Cellular Antenna

The recommended cellular antenna for use with Agora is the MFX3.07.0150C by Taoglas. This flexible antenna can be fully contained & secured with an adhesive backing inside the Agora plastic housing for configurations of Agora that include the custom plastic housing. The U.FL connector J7 is the connection between the Telit ME910 module and the cellular antenna.

Required Antenna Specifications:

- **Impedance:**
  - 50 ohms
- **Input power:**
  - >24dBm (250mW) Average power
- **VSWR (absolute maximum):**
  - ≤ 10:1 [above this limit, permanent damage to the module may occur]
- **VSWR (recommended maximum):**
  - ≤ 2:1 [to fulfill all regulatory requirements]
- **Recommended antennae:**
  - Taoglas MFX3.07.0150C
- **Minimum bandwidth, per LTE frequency band**:

Bandwidth	250 MHz in LTE Band 1 140 MHz in LTE Band 2, PCS1900 170 MHz in LTE Band 3, DCS1800 445 MHz in LTE Band 4 70 MHz in LTE Band 5, GSM850 80 MHz in LTE Band 8, GSM900 47 MHz in LTE Band 12 41 MHz in LTE Band 13 60 MHz in LTE Band 18 60 MHz in LTE Band 19 71 MHz in LTE Band 20 145 MHz in LTE Band 25 80 MHz in LTE Band 26 62 MHz in LTE Band 27 100 MHz in LTE Band 28 490 MHz in LTE Band 66 81 MHz in LTE Band 71 48 MHz in LTE Band 85

MFX3.07.0150C device specifications & features:

- NB-IoT / CAT M1 Bands
- 698-3000 MHz
- >45% Efficiency on all bands
- 5 dBi Peak Gain
- Ground Plane Independent

TABLE 13 – MFX3.07.0150C ELECTRICAL SPECIFICATIONS

Electrical						
Frequency (MHz)	Band 2		Band 4		Band 12	
	Tx	Rx	Tx	Rx	Tx	Rx
	1850-1910	1930-1990	1710-1755	2110-2155	699-716	729-746
Peak Gain (dBi)	3.07	3.10	3.68	4.51	0.36	0.21
Efficiency (%)	75.98	71.07	68.22	82.01	45.59	44.35
Average Gain (dB)	-1.19	-1.48	-1.66	-0.86	-3.41	-3.53
Radiation Properties	Omni-directional					
Max Input Power (Watts)	5					
Polarization	Linear					
Impedance (Ohms)	50 Ohms					

More on the Taoglas MFX3.07.0150C can be found at:
https://www.taoglas.com/product/mfx3-07-cat-m1-wideband-flexible-antenna-150mm-o1-37mm-coax-cable/

14.2. Antennae | GNSS Antenna

Citing the Telit ME910 Hardware User Guide:

The ME910C1 module includes a state-of-art receiver that can simultaneously search and track satellite signals from multiple satellite constellations. This multi-GNSS receiver uses the entire spectrum of GNSS systems available: GPS, GLONASS, BeiDou, Galileo, and QZSS.

The recommended GNSS antenna for use with Agora is the AP.12F.07.0045A by Taoglas. This antenna can be mounted directly to the Telit ME910 module using its adhesive surface. This is the default method used for configurations of Agora that include the custom plastic housing. The U.FL connector J8 is the connection between the Telit ME910 module and the GNSS antenna.

The onboard 1.9V supply is generated from the 3.8V supply using the Microchip MIC5378C5. This 1.9V supply is used to power the active GNSS antenna. A switch (TI TS5A3166) is used to control the connection between 1.9V and the GNSS antenna line. The GNSS LNA enable pin on the nRF52840 (pin R7, GNSS_LNA_ENA) controls the switch's enable.

The GNSS antenna requirements of the Telit ME910 are as follows:

Item	Value
Frequency range	1559.0 ~ 1610.0 MHz
Gain	20 ~ 30dB
Impedance	50 ohm
Noise Figure of LNA	< 1.5 (recommended)
DC supply voltage	DC 1.8 ~ 3.3V
VSWR	≤ 3:1 (recommended)

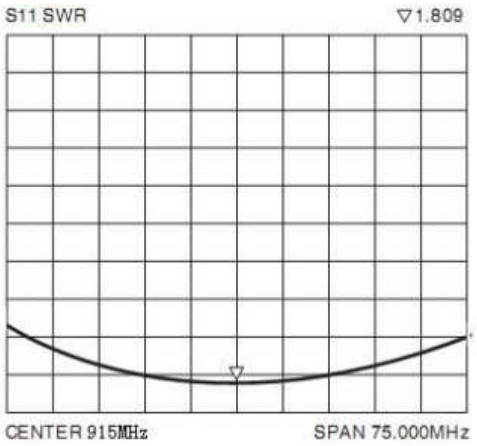
More on the Taoglas AP.12F.07.0045A can be found at:
https://www.taoglas.com/product/ap-12f-gps-2-stage-active-patch-12mm-2/

14.3. Antennae | LoRa Antenna

The onboard LoRa antenna used on Agora is the SW915-TH12 by NiceRF. This is a board-soldered spiral antenna that can come permanently mounted to the Agora board as part of the LoRa configuration wireless option.

This antenna's specifications are as follows:

Frequency Range	915±5 MHz
VSWR	≤ 1.5
Gain	2.15 dBi
Input Impedance	50 Ω
Max Power	5 W



Typical VSWR

To review more information on the SW915-TH12, please visit:
https://www.nicerf.com/products/detail/915mhz-spring-antenna-sw915-th12.html

Alternatively, an external antenna may be used for Agora's LoRa features. The recommended external antenna for such applications is the ANT-916-CW-HWR-RPS by Linx Technologies.

Note that this antenna has an SMA connection. For use with Agora, an SMA-to-U.FL adapter cable is required.

More on the ANT-916-CW-HWR-RPS can be found at:
https://linxtechnologies.com/wp/product/hwr-series-antennas/

15. Electrical Specifications

15.1. Absolute Maximum & Minimum Ratings

TABLE 14 – ABSOLUTE MAXIMUM & MINIMUMS

Board Pin	Min (V)	Max (V)	Notes
VBUS	-0.3	5.8	USB bus voltage
VBAT	-0.3	6	Main regulator input voltage
VCC	-0.3	3.9	System reference voltage
I/O pins (Tectonic Edge™)	-0.3	VCC + 0.3	System I/O pins

15.2. Recommended Operating Conditions

TABLE 15 – RECOMMENDED OPERATING CONDITIONS

Net	Min (V)	Typ (V)	Max (V)	Notes
VBUS	4.35	5.0	5.5	USB bus voltage
VBAT	1.7	3.7	5	Power to the board. Labeled as “Pos”
VBAT (LiPo)	3.2	3.7	4.2	LiPo battery voltage used on VBAT
VCC	1.7	3.3	3.6	Regulated output, nRF52840 system voltage.
I/O pins (Tectonic Edge™)	0	-	3.3	I/O pins (Tectonic Edge™)
VOH	2.9	-	3.3	Output high voltage
VOL	0	-	0.4	Output low voltage
VIH	2.31	-	3.3	Input high voltage
VIL	0	-	1.0	Input low voltage
COM	-	0	-	Reference

- *Agora should **never** be powered through the 3.3V VCC line.*
- ***Always** power Agora through the VBAT battery input line.*

16. Mechanical Specifications

16.1. Configuration Form Factors

The Agora platform is designed to accommodate an expansive range of applications. As a way to streamline development and minimize time-to-market, Agora may be available in a number of purchasable form factors.

Some form factors may include:

- **OEM/PCBA**
  - Agora board with selected sensor/wireless options


- **Plastics/Production-Ready**
  - Agora board with selected sensor/wireless options + plastics + battery


- **US-Style Mains**
  - Agora board with selected sensor/wireless options + plastics + US-style mains converter


- **& More**

Please refer to https://www.embeddedplanet.com/agora for available Agora form factor configurations.

Agora can also be integrated into new or existing hardware designs. For more information on integrating Agora into your design, please contact Embedded Planet at info@embeddedplanet.com.



16.2. Physical Parameters

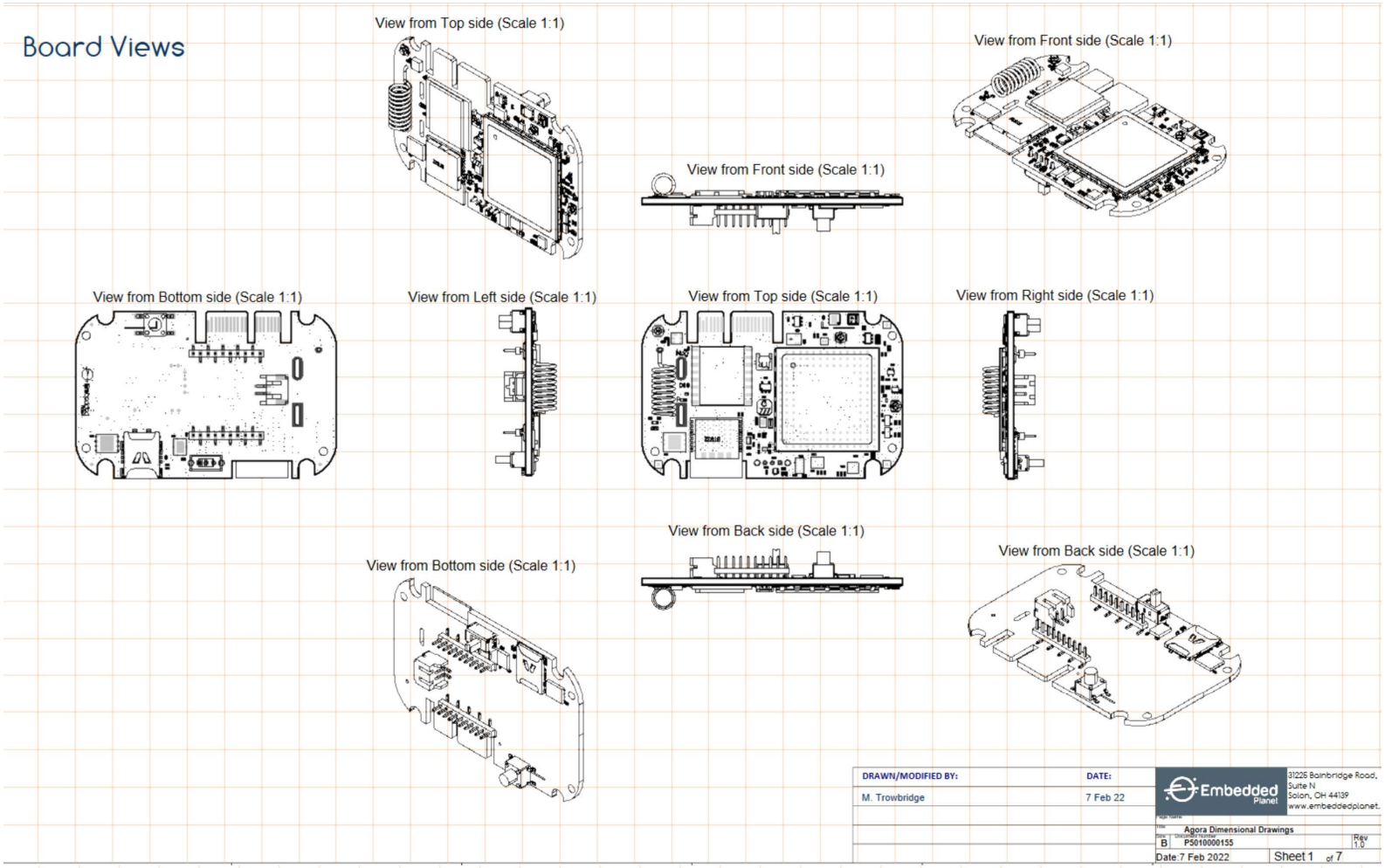
TABLE 16 – PHYSICAL PARAMETERS

Parameter	Description	Measurement
Length (Fully Populated PCBA)	Board (PCBA) length	70.00 mm
Width (Fully Populated PCBA)	Board (PCBA) width	45.00 mm
Height (Fully Populated PCBA)	Board (PCBA) height *Including all population options (measured from LoRa antenna to power switch)*	16.32 mm
Weight (Fully Populated PCBA)	Module weight *Including all population options*	19.5 g ± 0.1 g
Length (PCBA In Plastics)	Module length	102.3 mm ± 0.3 mm
Width (PCBA In Plastics)	Module width	59. 3 mm ± 0.3 mm
Height (PCBA In Plastics)	Module height	43.0 mm ± 1 mm
Weight (PCBA In Plastics)	Module weight *Including LiPo + Cell + GNSS antennae + fully populated PCBA*	0.2 kg

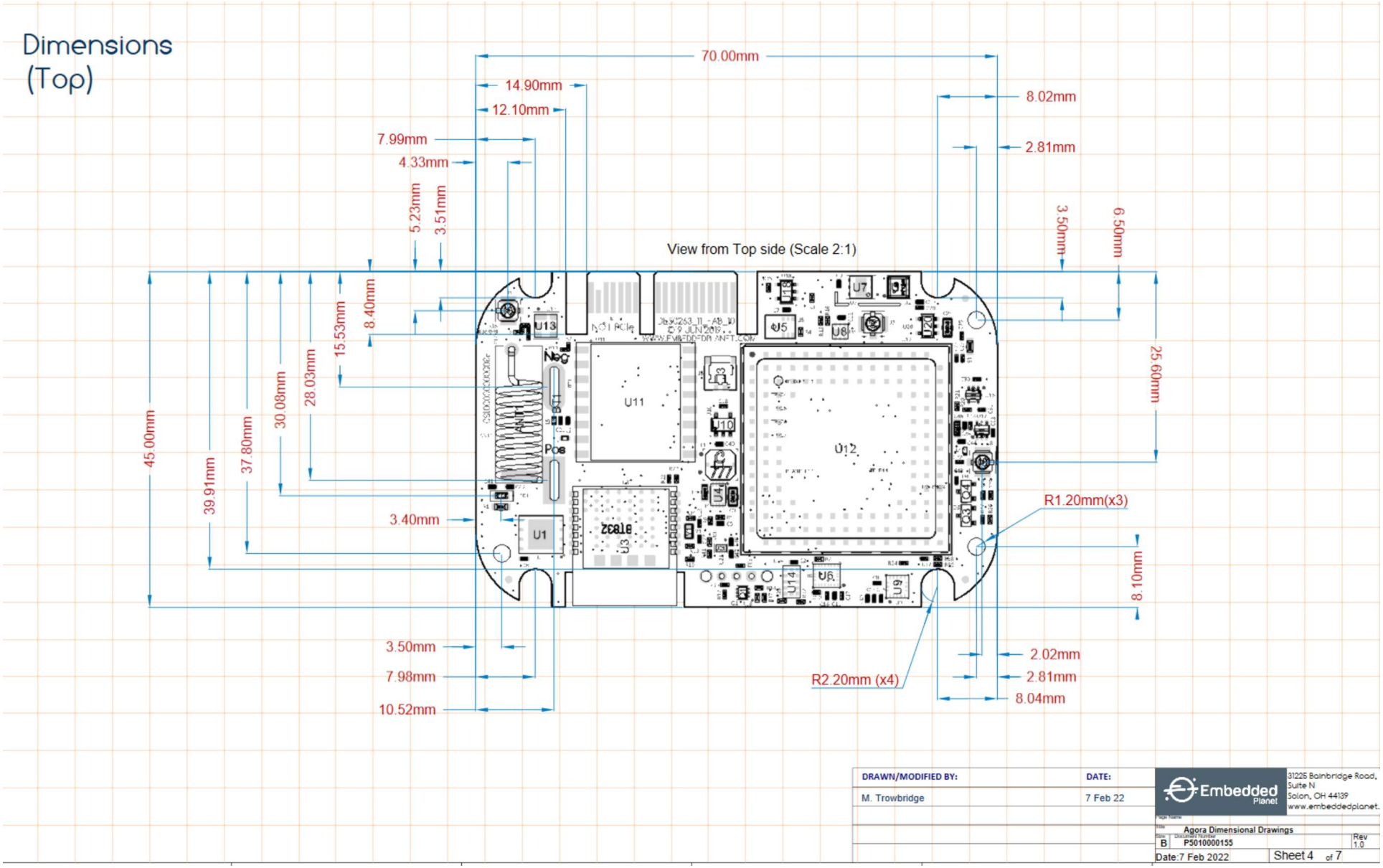
16.3. Mechanical Drawings

Within this section are mechanical drawings provided for the purpose of understanding the general size, shape, and layout of the Agora device. For the most complete & up-to-date documentation on mechanical drawings, along with more on the Agora device, please refer to the materials provided at https://www.embeddedplanet.com/product-documentation.

16.3.1. Mechanical Drawings | Assembly Views



16.3.2. Mechanical Drawings | Dimensions (Top)



16.4. Environmental Specifications

TABLE 17 – ENVIRONMENTAL SPECIFICATIONS

Parameter	Min	Typ	Max
Operating Temperature	-20°C	+25°C	+85°C
Storage Temperature	-20°C	+25°C	+85°C
Operating Humidity, non-condensing	20% RH		90% RH

17. Regulatory Information

17.1. Cellular Certifications & Endorsements

Certifications

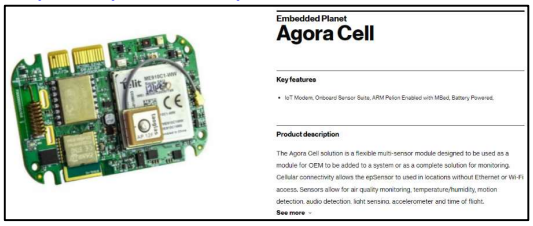
PTCRB:
https://www.ptcrb.com/device-details/?model=43504

Manufacturer	Model Name / Number	Device Type	Technologies
Embedded Planet	EPM2M-AG-CELL	Integrated Device	4G, LPWA

AT&T TRENDI:
https://marketplace.att.com/certified-devices

Embedded Planet	EP-CHRONOS
	EPM2M-AG-CELL

Verizon ODI:
https://opendevelopment.verizonwireless.com/device-showcase/device/10940



Endorsements/Compatibilities

- ARM MBED Enabled
  https://os.mbed.com/platforms/AGORA-DEV/
  https://os.mbed.com/teams/Embedded-Planet/
- Edge Impulse
  https://docs.edgeimpulse.com/docs/agora-product-development-kit
- Amazon AWS Qualified
- Microsoft Azure

Portal Recommendations

Thingsboard is the current nominally recommended portal for setting up & viewing IoT data. An example instance of Thingsboard using Agora-collected sensor data in real-time can be viewed here: https://demo.thingsboard.io/dashboard/0f3c20a0-3bde-11ec-a0a8-5356543a831d?publicId=62c6b9c0-58f7-11ec-8f43-1d800e6c37b6

17.2. RoHS Compliance

The Agora device complies with the RoHS (Reduction of Hazardous Substances) directive of the European Union, EU Directive 2011/65/EU.

17.3. Interferance Statement

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 or more 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.

17.4. FCC and ISED Compliance

If the antenna for the Agora device is located farther than 20cm from the human body and there are no adjacent transmitters, the FCC and ISED approvals of the device's Telit ME910C1 cellular module can be reused by the end product.

If the device's antenna is mounted closer than 20cm from the human body, or if there are adjacent transmitters, additional FCC/ISED testing may be required for the end device.

Orderable Device	FCC ID	ISED ID
Telit ME910C1-WW	RI7ME910C1WW	5131A-ME910C1WW
Telit ME910C1-NA	RI7ME910C1NA	5131A-ME910C1NA

17.4.1. FCC and ISED Compliance | FCC Certificate

The FCC ID certificate for the Telit ME910C1-WW/NA can be viewed through the portal in the links below:

ME910C1-WW
https://fcc.report/FCC-ID/RI7ME910C1WW
https://fccid.io/RI7ME910C1WW

ME910C1-NA
https://fcc.report/FCC-ID/RI7ME910C1NA
https://fccid.io/RI7ME910C1NA

17.4.2. FCC and ISED Compliance | ISED Certificate

The ISED ID certificate for Agora is available at the link below:

https://sms-sgs.ic.gc.ca/equipmentSearch/searchRadioEquipments

- **For ME910C1-WW** *(5131A-ME910C1NA)*

Enter "ME910C1-WW" in *the Product Marketing Name (PMN)* field to find the entry for **ME910C1-WW**

- **For ME910C1-NA** *(5131A-ME910C1NA)*

Enter "ME910C1-NA" in *the Product Marketing Name (PMN)* field to find the entry for **ME910C1-NA**

17.5. Wireless Notice

The Agora device complies with FCC/ISED radiation exposure limits set forth for an uncontrolled environment and meets the FCC radio frequency (RF) Exposure Guidelines and RSS-102 of the ISED radio frequency (RF) Exposure rules. This transmitter must not be co-located or operating in conjunction with any other antenna or transmitter. The antenna should be installed and operated with minimum distance of 20 cm between the radiator and your body.

17.6. Antenna Notice: FCC & ISED

The Agora radio transmitter has been approved by the FCC & ISED to operate with the antenna types listed below with the maximum permissible gain indicated. Antenna types not included in this list, having a gain greater than the maximum gain indicated for that type, are strictly prohibited for use with that device.

TABLE 18 – FCC & ISED MAX GAIN BY BAND

Antenna Gain: 2.14 dBi (Omnidirectional type)		
Band	Max Gain for FCC (dBi): NA	Max Gain for FCC (dBi): WW
FDD 2	9.01	9.0
FDD 4	6.00	8.7
FDD 5	- -	7.1
FDD 12	6.6	6.6
FDD 13	6.9	6.9
FDD 26	- -	7.0

17.7. End-Product Labeling Requirements

The Agora module contains an ME910 module which has an FCC ID label on it pertaining to its FCC certification. Consequently, with Agora used in any host assemblies, the OEM host end product manufacturer must display a label on the exterior of the assembly referring to the enclosed module. The exterior label will read as follows:

For ME910C1-**WW** ("**Worldwide**") models:

> **Device Uses Approved Radio: ME910C1-WW**
> **Contains FCC ID: RI7ME910C1WW**
> **Contains IC: 5131A-ME910C1WW**
>
> **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.**

17.8. FCC Additional Testing, Part 15 Subpart B Disclaimer

The modular transmitter is only FCC authorized for the specific rule parts (i.e., FCC transmitter rules) listed on the grant, and that the host product manufacturer is responsible for compliance to any other FCC rules that apply to the host not covered by the modular transmitter grant of certification. If the grantee markets their product as being Part 15 Subpart B compliant (when it also contains unintentional-radiator digital circuity), then the grantee shall provide a notice stating that the final host product still requires Part 15 Subpart B compliance testing with the modular transmitter installed. The end product with an embedded module may also need to pass the FCC Part 15 unintentional emission testing requirements and be properly authorized per FCC Part 15.

18. Revision History

TABLE 19 – REVISION HISTORY

Revision	Author	Description	Date
1.0.0	M. Trowbridge	Initial Release (preliminary)	8 Feb 2022

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