Embedded Planet

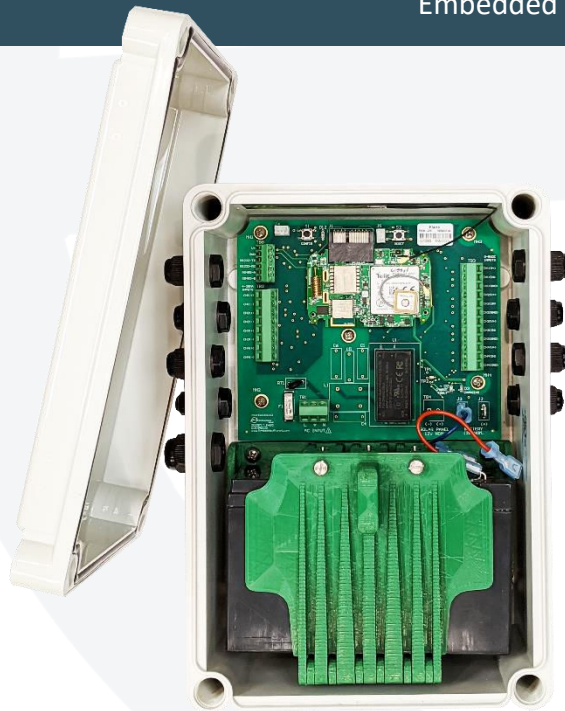# epConnected Equipment
C1D2 Industrial Data Acquisition + 4G LTE-M Cellular, GNSS, Bluetooth, & Sensors

Product User Manual

www.embeddedplanet.com

About This Manual

The **epConnected Equipment User Manual** provides detailed information encompassing the design, description, and integration of the epConnected Equipment 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 **epConnected Equipment product page** by Embedded Planet provides description & resources related to this product. This page can be located at https://www.embeddedplanet.com/connected-equipment

Acrynyms & Abbreviations

Term	Description
EPI	Embedded Planet, Inc.
IoT	Internet of Things
PCBA	Printed Circuit Board Assembly
epCE	epConnected Equipment
I/O	Inputs/Outputs
GPIO	General Purpose Inputs / Outputs
IC	Integrated Circuit [component]
BT	Bluetooth
BLE	Bluetooth Low Energy
IMU	Inertial Measurement Unit [sensor]
LiPo	Lithium-Ion Polymer

Contents

1. INTRODUCTION

The epConnected Equipment product provides a solution for bringing wireless data collection & management to industrial settings. The assembly allows for data acquisition from industrial 4-20mA or 0-5V analog sensors and subsequent data transmission over cellular LTE Cat-M1. The epConnected Equipment product is intended for use in Class I Division 2 hazardous areas, and voltage sources for the transducer inputs are current-limited to prevent the possibility of sparking during fault conditions of the field wiring. The board can be configured to receive power from a universal 120VAC/240VAC source or from a solar panel array. The device is provided with a lead acid backup battery.
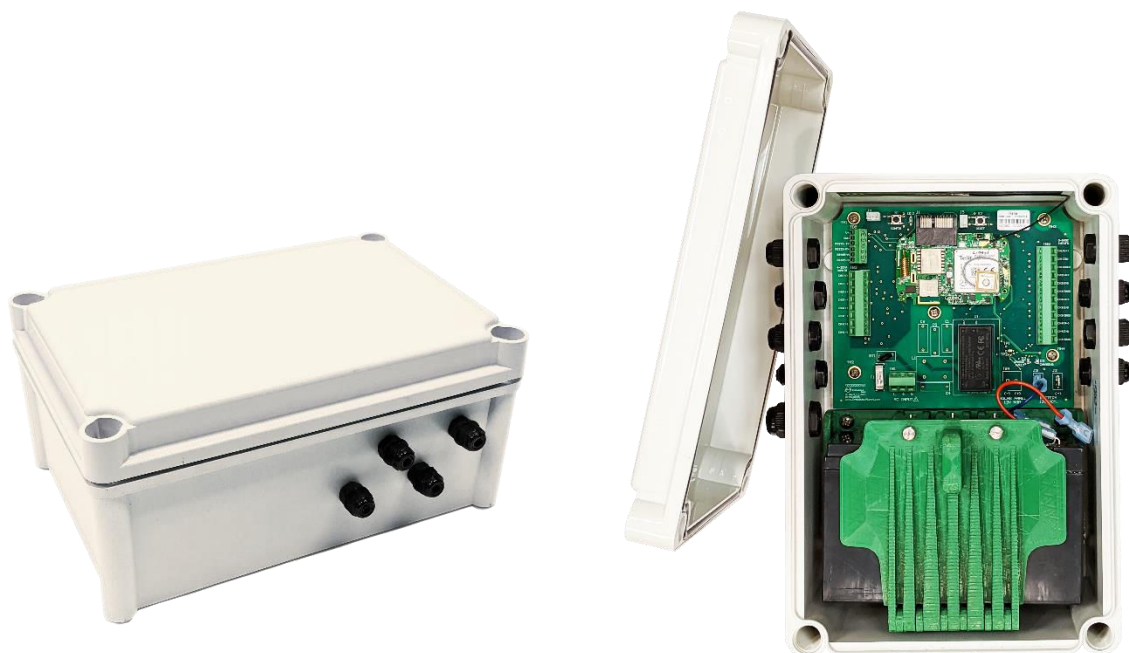
Powered by Agora

epConnected Equipment leverages the capabilities of the Agora module by Embedded Planet. To learn more about Agora & how to leverage its capabilities, visit https://www.embeddedplanet.com/agora.

1.1. Contact Information, Support

For general contact, technical assistance, technical questions contact Embedded Planet at:

- Sales: sales@embeddedplanet.com
- Information Requests: info@embeddedplanet.com
- Technical Support: support@embeddedplanet.com

1.2. Ordering Information

The orderable part number for epConnected Equipment is "EPM2M-CE-1.1". Availability is contingent on current stocking & ordering conditions. Please contact Embedded Planet sales for questions: sales@embeddedplanet.com. The Embedded Planet shop is hosted at https://shop.embeddedplanet.com. During the ordering process, a phone number and/or email address will be needed to direct alarms to the proper location.

2. PRODUCT DESCRIPTION

2.1. Overview

epConnected Equipment collects sensor data from internal environmental and inertial sensors, up to four external 4-20mA analog sensors and up to four external 0-5V ratiometric analog sensors every 10 minutes. This data is then transmitted over a cellular network and displayed on a cloud service along with location information if available.

2.2. Main Features

Feature/Specification	Description
Cellular Capabilities	**Cellular Technologies**: LTE-M (LTE CAT M1) **Operating Frequencies**: 699MHz to 1980MHz **RF Output Power:** Up to +23 ±2 dBm (Power Class 3) **Region:** Worldwide
LTE CAT M1 Specification	**Bands (WW)**: B1(2100), B2(1900), B3(1800), B4(AWS1700), B5(850), B8(900), B12(700), B13(700), B18(800), B19(800), B20(800), B26(850), B28(700) **Bands (NA):** B2(1900), B4(AWS1700), B12(700) B13(700)
Cellular Certifications	**PTCRB**: Complete **AT&T**: Complete
Wireless Protocols	HTTP
SIM	**Removable**: 4FF (nano) SIM card slot
GNSS Specifications	**Constellations**: GPS, GLONASS, BeiDou, Galileo, QZSS **Tracking Sensitivity**: -161dBm **Navigation Sensitivity**: -158dBm **Cold Start Sensitivity**: -146dBm
Input Voltage	**AC Input:** 90VAC - 240VAC **Solar Panel**: 12V DC nominal **Sealed Lead-Acid Battery**: 12V DC nominal
Dimensions	**Enclosure with cable glands:** 224 x 280 x 128 (mm) | 8.82 x 11.02 x 5.04 (in)
Environmental	**Operating Temperature Range**: -20°C to +60°C **Storage Temperature Range**: -20°C to +60°C
Internal Sensors	**Environmental:** Temperature, humidity, barometric pressure, VOC gas **Inertial**: 6-axis IMU (accelerometer, gyroscope)
External Sensor Inputs	4x 4-20mA input channels 4x 0-5VDCinput channels
SMS/Email Alerts	Yes – default low battery. Others available upon request.

2.3. Internal Sensors

The epConnected Equipment device includes 7 sensor data types across two sensors onboard the Agora board. Other Agora sensor configurations are available upon request. Refer to the Agora documentation for further details on sensor options https://www.embeddedplanet.com/agora.

Category	Module	Capabilities
Environmental	Bosch BME680	Temperature, humidity, barometric pressure, VOC gas
Inertial	InvenSense ICM-20602	6-axis IMU: 3-axis accelerometer, 3-axis gyroscope

2.3.1. Sensors | Temp/Humidity/Pressure/Gas

The epConnected Equipment device includes 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)
- Humidity sensor: ±3% relative humidity accuracy (20-80% RH)
- Pressure sensor: ±0.6hPa pressure accuracy (300-1000hPa)
- VOC gas sensor

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

2.3.2. Sensors | 6-Axis IMU

The epConnected Equipment device includes the InvenSense ICM-20602 6-axis IMU sensor. This sensor is comprised of an accelerometer and a gyroscope. Features of this sensor include:

- 3-axis gyroscope
  - ±250dps (default), ±500dps, ±1000dps and ±2000dps
  - Sensitivity error: ±1%
- 3-axis accelerometer
  - ±2g (default), ±4g, ±8g, ±16g
  - Sensitivity error ±1%

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

2.4.   External Sensors

2.4.1. 4-20mA Inputs

The epConnected Equipment device features 4 separate 4-20mA input channels. Access to the 4-20mA input channels is provided through terminal block component TB2. These channels are designed to interface with 4-20mA sensors and are routed through cable glands in the enclosure. Each channel contains a positive terminal and negative terminal for the current loop.
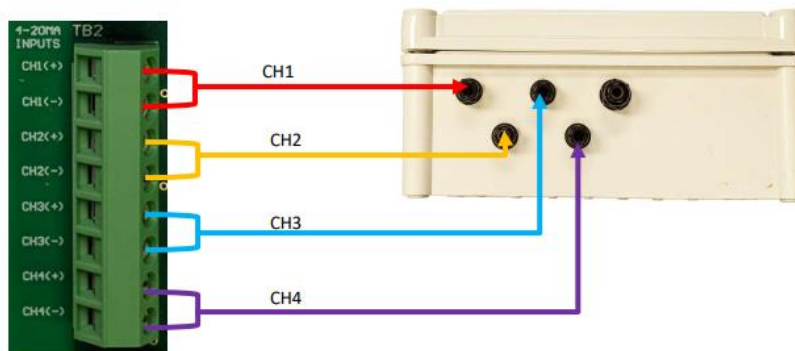
The I/O wiring to the board is designed to be suitable for use in a CID2 hazardous area without requiring special consideration for the transducer wiring methods. The current limiting circuits clamp the current in each sensor just above the 4-20mA operating range and can be given entity parameters when connected to CID2 rated sensors. These same individual sensor protection circuits can be used in ordinary locations without issue and prevent high current flow (which would shorten battery life and/or prevent system operation) if sensor leads becomes shorted.

2.4.2. 0-5VDC Inputs

The epConnected Equipment device features 4 channels of 0-5VDC inputs for connection to ratiometric sensors. These channels are hosted through terminal block component TB3. Each channel has a 5V supply line, a 0-5V input line, and a ground reference line. Like the 4-20mA interface, the 5V out interface is designed to incorporate a current limiting circuit and is also routed through cable glands in the enclosure.
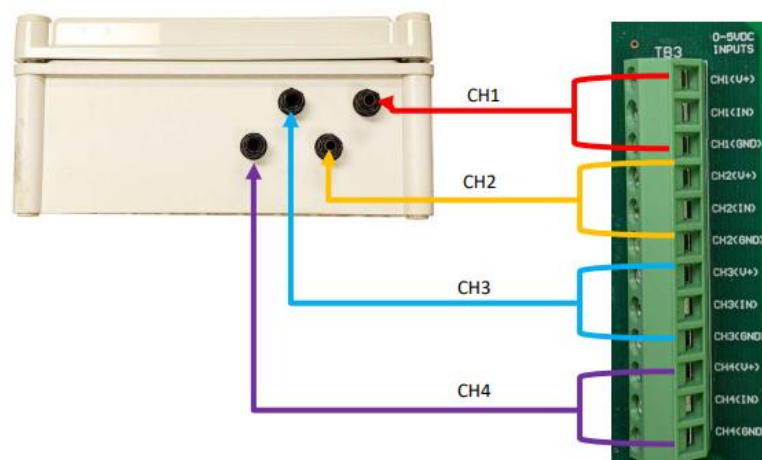
2.5.   User I/O

2.5.1. Pushbuttons

Button Designation	Function
S1	Unused
S2	System reset

2.5.2. LED Indicators

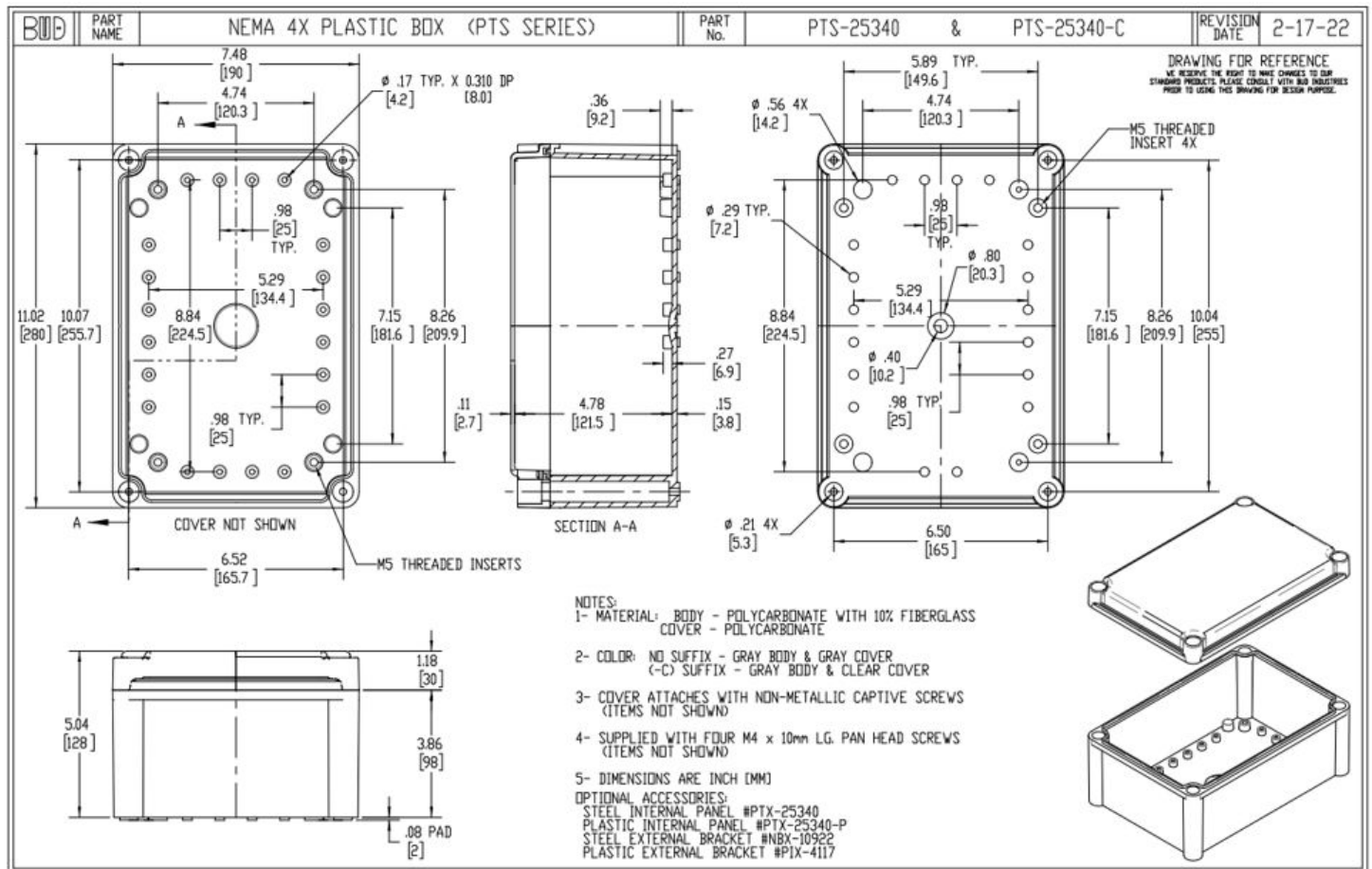| LED Designation	Flash Pattern	Meaning
LED1 (Agora module)	One flash per second	Strong cell signal strength
LED1 (Agora module)	Two flashes per second	Sufficient cell signal strength
LED1 (Agora module)	Three flashes per second	Poor signal strength
LED1 (Agora module)	Undefined	Internal use
D6 (epConnected Equipment)	Solid blue	Battery is charging
D5 (epConnected Equipment)	Solid green	Battery is fully charged
D12 (epConnected Equipment)	Undefined	Internal use

2.5.3. Power Input Connections

Input Designation	Input Type
TB1	AC input 85VAC to 264VAC, 47Hz to 440Hz
TB4	Solar Panel 12V nominal input
J3/J2	Battery 12V nominal input

3. MECHANICAL SPECIFICATION

3.1. Enclosure

The enclosure for the epConnected Equipment is a modified Bud PTS-25340. This enclosure features a polycarbonate resin material with 10% fiberglass filling. 9 cable gland pieces have been added to two of the enclosure faces for safely routing data & power cables into the enclosure. The cover is a solid polycarbonate material. The enclosure is designed for industrial applications with notable strength and durability. The cover includes a gasketed seal and is secured by 4 non-metallic screws. For more information on the enclosure, including detailed drawings, please refer to:
 https://www.budind.com/product/nema-ip-rated-boxes/pts-series-fiberglass-box/pts-25340/#group=series-products&external_dimensions_group=0&internal_dimensions=0&cover_style_group=0

NOTES:

1.) MATERIAL: BUD INDUSTRIES PTS-25340. MODIFIED AS DESCRIBED ON THIS DRAWING.

2.) TOP OF BOX AND BAG OF HARDWARE NOT SHOWN.

HOLES:

A - 8 X Ø10.5, TAP FOR M12x1.5 THRU

B - 1 X Ø14.5, TAP FOR M16x1.5 THRU

TITLE: MODIFIED POLYCARBONATE BOX

DWG. NO. P12100000000377 | REV B

B SIZE | SCALE 1:2 | SHEET 1 OF 1
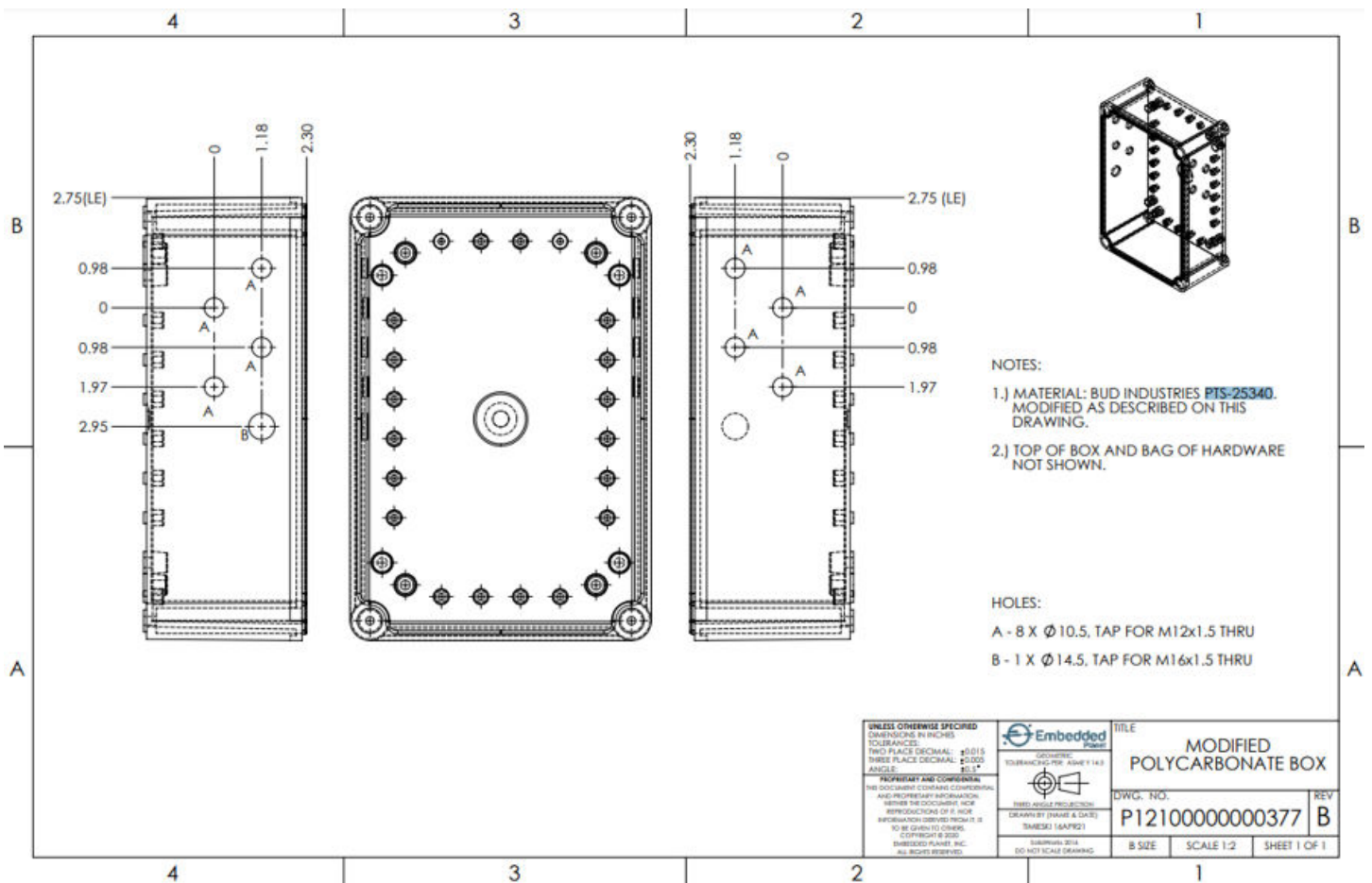
3.2. Cable Glands

The cables glands used are M12 for the data inputs and M16 for the power input.

The Davies GC1000-A (M12x1.5) is designed to pass wires of 2.5 mm to 6.5 mm in diameters (I/O cable).

The Davies GC1000-B (M16x1.5) is designed to pass wires of 3.5 mm to 8.0 mm in diameter (power cable).

For more detail on these cable glands, please refer to:
https://daviesmolding.com/catalog/series/cable-glands/metric/
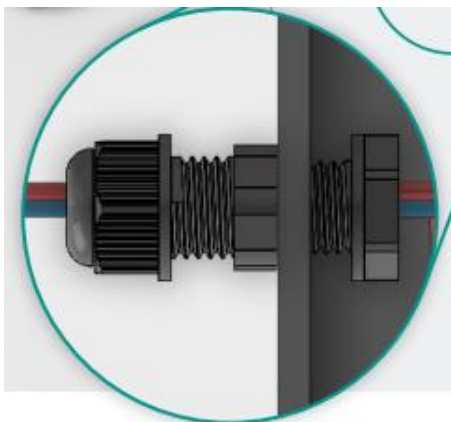
3.3.   Environmental Specifications

Parameter	Min	Typ	Max
Operating Temperature	-20°C	+60°C	Operating Temperature
Storage Temperature	-20°C	+60°C	Storage Temperature

4.   GETTING STARTED

4.1.   Product Contents

The product box contains:
- 1 epConnected Equipment with AC power cord

4.2.   Installing

Once the user has removed the contents from the box, the installation process can be started:

1. Remove the lid from the epConnected Equipment device.
2. Feed applicable sensor leads through the cable glands and connect to the appropriate terminals.
3. If solar is to be used, remove the AC power cord from TB1 and connect your solor panel power leads to TB4.
4. Plug the red (positive) battery lead into the J2 terminal. Plug the black (negative) battery lead into the J3 terminal.
5. Replace the lid and tighten the screws.
6. Plug in the AC power plug if used.
7. Navigate to the provided dashboard URL to start seeing data. Initial data will appear within 10 minutes, which is the default transmission interval.

4.3.   Dashboard

The dashboard is hosted on ThingsBoard Cloud. The box contents will include a link to the dashboard for accessing the sensor data and information. Sensor data is viewable by selecting the device in the device list on the left side of the dashboard.

You can also view the device location (if GNSS satellites are present) by clicking the device pin on the map at the bottom of the dashboard.
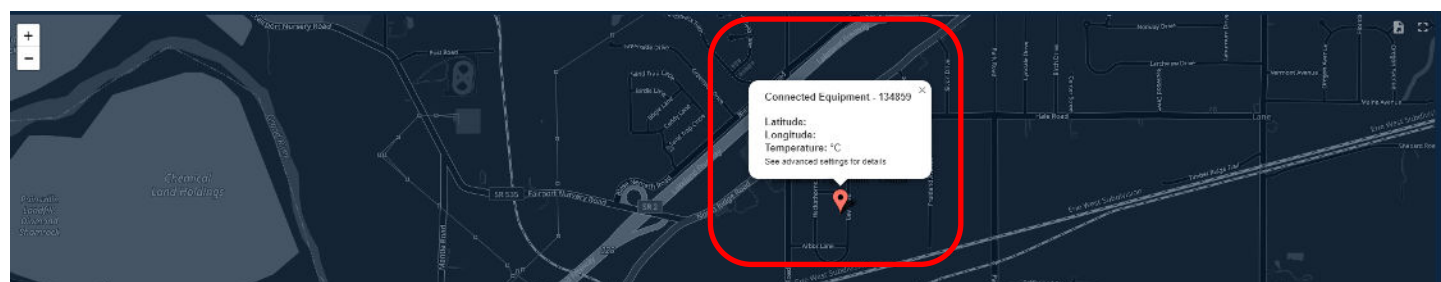
4.4.   Channel Mapping

By default, your device's dashboard will show the raw 4-20mA or 0-5V channel values. Contact Embedded Planet support at support@embeddedplanet.com with the sensor details if you would like these raw values mapped to user values.

4.5.   Alarms

By default, the only enabled alarm condition is that of a low battery. The alarms for all devices are displayed on the dashboard as well as through email and/or text message. Custom alarm conditions based on sensor data are available upon request. Inquire for details at support@embeddedplanet.com.

5. CUSTOM FEATURES

Embedded Planet can work with your team to customize the product software, hardware, and cloud connectivity. Additional configurations of the epConnected Equipment are available, as well as custom hardware solutions based on your needs. Reach out to us to discuss the possibilities. Some of these features may include:

- **General**
  - Adjustable transmission intervals
  - Exterior antennas

- **Dashboard**
  - Changes to configuration of widgets and sensor data
  - Additional alarm conditions and thresholds

- **Wireless Protocols:**
  - Support of 3rd party BLE sensors
  - LoRa
  - NB-IoT

- **Internal Sensors:**
  - Magnetometer
  - Time of flight

- **Cellular Carriers:**
  - AT&T
  - Verizon
  - Roaming

- **Cellular Regions:**
  - Worldwide

6. FAQ & Troubleshooting

1. **Why is the dashboard not showing any sensor data:**
   a. The device takes about 90s to go through its initialization process before data will be sent to the dashboard.
   b. Sensor data is transmitted at 10-minute intervals by default. If you are not seeing data, wait at least 10-minutes after powerup.
   c. Remove the cover of the device to view the red LED flash pattern and compare with the LED flash pattern table in section 2.

2. **Why is dashboard showing sensor data but not location:**
   a. The GNSS capabilities are limited by obstructions between the device and GNSS satellites. Move the device outside or near a window or exterior wall to increase the likelihood of detecting satellites.

3. **Why are no alarms being received through SMS/email:**
   a. Verify proper email/phone number on file with Embedded Planet

7. Additional Resources

- epConnected Equipment
  https://www.embeddedplanet.com/connected-equipment/

- Agora module:
  https://www.embeddedplanet.com/agora

- Embedded Planet Documentation:
  https://www.embeddedplanet.com/product-documentation

8.   Regulatory Information

8.1.   Cellular Certifications & Endorsements

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	(IoT)

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

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Manufacturer	Model Name/Number	Device Type	LTE Technology	Technology Category	5G Technology	Certification Type	FirstNet
Embedded Planet	EP-CHRONOS	Modem – Embedded	4G LTE	CAT M1		IoT	Firstnet Capa
Embedded Planet	EPM2M-AG-CELL	Modem – Embedded	4G LTE	CAT M1		IoT	Firstnet Capa

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

8.2.   RoHS Compliance

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

8.3.   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.

8.4. 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

8.4.1. FCC and ISED Compliance | FCC Certificate

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

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

8.4.2. 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**

8.5. 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.

8.6.   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 1 – 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

8.7.   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.**

8.8.   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.

9. Document History

Revision	Author	Description	Date
1.0.0	M. Trowbridge	Initial Release (preliminary)	8 Feb 2022
1.0.1	M. Trowbridge	Formatting updates	11 Feb 2022
2.0.0	D. Maher	Updated for release	09 Aug 2023

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