



LoRa miniPOC Kit

USER GUIDE

DEVICE REGISTRATION

1. Unbox the gateway and sensor.



2. Using the BLUE connector, connect the gateway to the internet. Select port 1780/UDP.



3. Connect the device via USB-C to the PC (the miniPOC will only use it as a power source, so a standard USB-C to USB-A adapter cable is fine).

4. Note the module registration parameters (DevEUI) which you will find on the label on the underside of the module.



5. Go to <https://loraminipoc.iotconnect.io/signup> and enter your details to access the dashboard.

AVNETSILICA

| | |
|---|--|
| First Name * | Last Name * |
| <input type="text" value="Enter First Name *"/> | <input type="text" value="Enter Last Name *"/> |
| Email Address * | Company Name * |
| <input type="text" value="Enter Email *"/> | <input type="text" value="Enter Company Name *"/> |
| Postal Code * | Country * |
| <input type="text" value="Enter Postal Code *"/> | <input type="text" value="---Country---"/> |
| State * | City * |
| <input type="text" value="---State---"/> | <input type="text" value="Enter City *"/> |
| Phone Number * | Are you currently working on a design? * |
| +01 * <input type="text" value="Enter Phone No *"/> | <input type="radio"/> Yes <input type="radio"/> No |

6. You will receive an email with login credentials; log in using the credentials provided.

7. Add your device on IOTConnect®

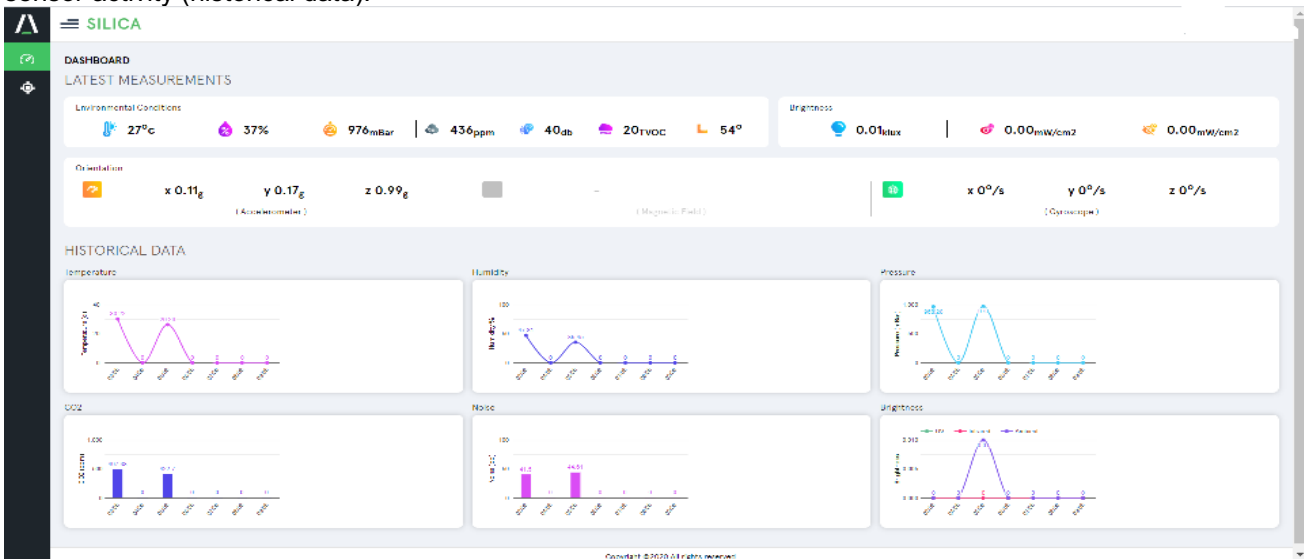
| DEVICES | Home > Devices | Search Device | <input type="button" value="ADD DEVICE"/> | | | |
|------------------|----------------|---------------|---|---------------|--------|---------|
| Device Unique ID | Name | Customer Name | Last Update | Device Status | Status | Actions |

ADD DEVICE

Unique Id *

Device Name *

8. The dashboard will show on one page the latest data from the sensor and a graph of the last week's sensor activity (historical data).



9. On the left-hand side there is a “device” tab: click on it to see your device.

The screenshot shows the SILICA dashboard with the 'DEVICES' tab selected. A search bar for devices is visible at the top right. The main content is a table listing device information:

| Device Unique ID | Name | Customer Name | Last Update | Device Status | Status |
|------------------|--------------------|----------------|---------------------|---------------|--------|
| 0550C2FFED51DEF | 0050421f0-00-ad-bf | alcoradio.rail | 03/05/2020 11:45:04 | Asleep | Active |

At the bottom right of the table, there are navigation controls: '1 / 1', 'Items per page', and a dropdown menu set to '10'.

10. Click on the “Device Unique ID” number to see the device details.

The screenshot shows the SILICA web interface. The breadcrumb navigation is: Home > Devices > View Device > 00:80:c2:ff:fe:99:ad:b1:f. There are two tabs: HISTORICAL DATA and DEVICE SETTINGS. The main content area is titled 'DEVICE INFORMATION' and contains the following data:

| | | | |
|-----------------|---------------------------|----------------|---------------------------|
| Dev Unique ID : | 00:80:c2:ff:fe:99:ad:b1:f | Display Name : | 00:80:c2:ff:fe:99:ad:b1:f |
| Customer Name : | alexandra.rosti | Last Update : | 08/05/2020 11:49 AM |
| Frequency : | 867.5 MHz | Data Rate : | 597 Kb/195.1/S |
| RSSI : | -60 dBm | SNR : | 0.5 dB |
| FCNT : | 76 | Port : | 2 |
| CMD : | 80 | ACK : | 1 case |

Below this is the 'GATEWAY INFORMATION' section:

| | | | |
|------------------|------------------------|--------------|---------------------------------------|
| Gateway ID : | 00-70-0b-1-1-1-0-0c-14 | Created at : | 01/09/2020 |
| Gateway Status : | Active | Uptime : | 3 days 11 hours 40 minutes 40 seconds |
| Last Update : | 08/05/2020 11:53 AM | | |

At the bottom, there is a 'LIVE DATA' section with a dropdown menu set to 'Acceleration X' and a message: 'No Data Available.'

11. The Historical Data tab on the upper right lets you download a file with the sensor activity data between two dates; with the Device Settings tab, you can set some parameters in the device operation (see below).

The screenshot shows the SILICA web interface. The breadcrumb navigation is: Home > Devices > View Device > Device Settings > alex ADBF. There is a 'WELCOME' notification and a 'DEVICE INFORMATION' tab. The main content area is titled 'SCAN TIME SETTINGS' and contains the following settings:

| | | | | | | | |
|-------------|--------|-------------|--------|--------------|--------|----------------|--------|
| Temperature | 30 Sec | Air Quality | 30 Sec | Acceleration | 30 Sec | Magnetic Field | 30 Sec |
| Humidity | 30 Sec | Brightness | 30 Sec | Angle | 30 Sec | Battery | 30 Sec |
| Pressure | 30 Sec | Noise | 30 Sec | Gyroscope | 30 Sec | | |

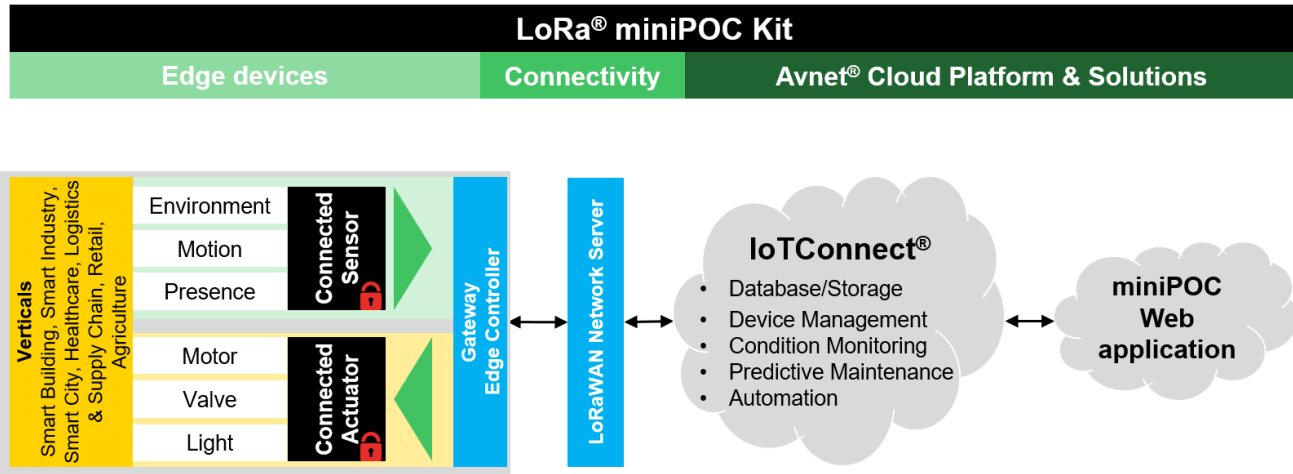
Below this is the 'LED SETTINGS' section with a radio button selection for 'Set LED Color': Red (selected), Green, Blue.

At the bottom, there are two buttons: 'RESET SETTINGS' and 'APPLY SETTINGS'.

KIT DESCRIPTION

The kit includes:

- A sensor node
- A LoRa Gateway, able to generate a local LoRa network to which the sensor will connect
- The capability to connect to the backend

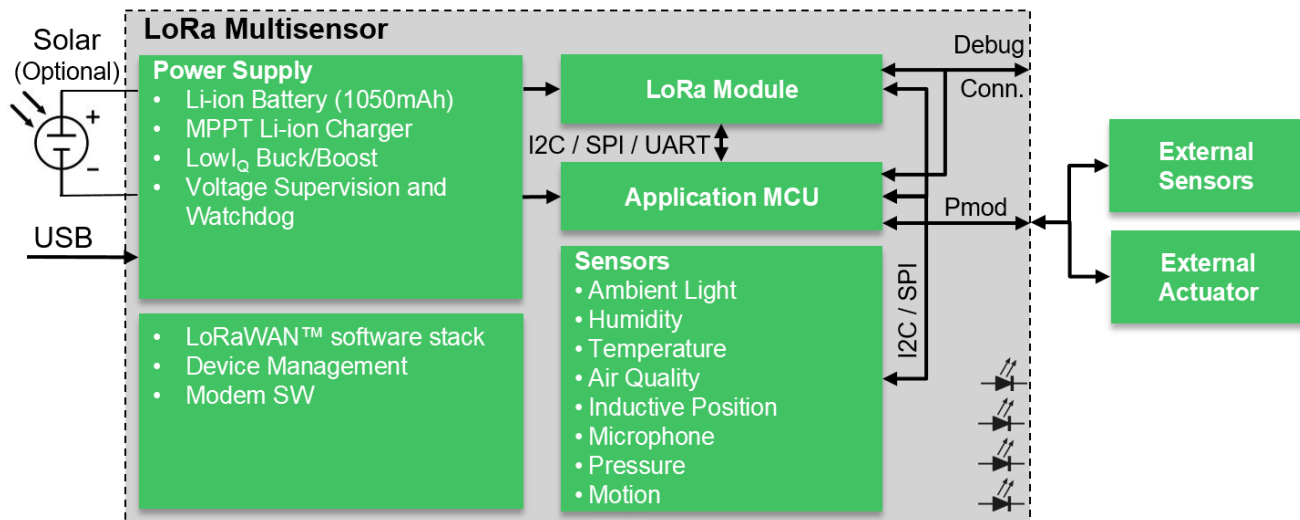


For the production phase, you will need to create your own LoRa network or connect to an existing LoRa network provider.

To do so, please ask AVNET Silica to release the registration of your Gateway and device from Lorient.

At the same time, you will also need to discuss the production environment for the backend with AVNET.

BLOCK DIAGRAM



HARDWARE DESCRIPTION

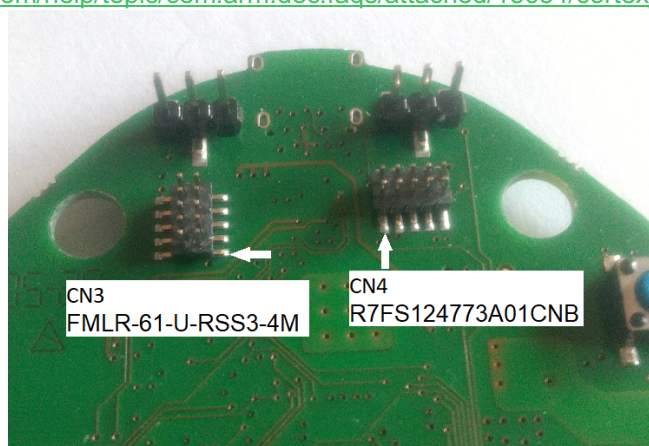


SPECIFICATIONS

| | |
|-------------------|---|
| Temperature range | 0-45°C |
| Humidity | 10-90% |
| Power consumption | 45mA TX mode, < 1mA standby with gas sensor active |
| Battery | Rechargeable Li-Ion 1050mAh LP-922543-1S-3 |
| Input power | 5V from USB-C connector to power the device and recharge the battery ISL9122 ISL 88014 |
| | OPTIONAL solar cell 3V-100mA SPV1040T |
| LoRa module | FMLR-61-U-RSS3 |
| Sensors | Light 0-1000Lux (sensor has 64kLux intensity) ISL29035 |
| | Humidity 10-90% HS3004 |
| | Temperature -10°C to +80°C HS3004 |
| | Air quality: estimated CO2 and total organic compounds ZMOD4410 |
| | Inductive position ZMID5202 |
| | Microphone 40-130dB RMS evaluated on 20ms frame over the 50Hz-6kHz frequency range (not A-filtered) IM69D130 |
| | Pressure 300-1200hPa DPS368 |
| | Acceleration 3 axis ±2g FS LSM6DSOX |
| | Gyroscope ±2000°/s FS LSM6DSOX |
| | Sensor sampling rate |
| LED on board | Programmable from cloud |

EMULATION CAPABILITIES

A standard 10 pin Jtag connector is available on both for the application MCU and for the LoRa module MCU.
(http://infocenter.arm.com/help/topic/com.arm.doc.faqs/attached/13634/cortex_debug_connectors.pdf)



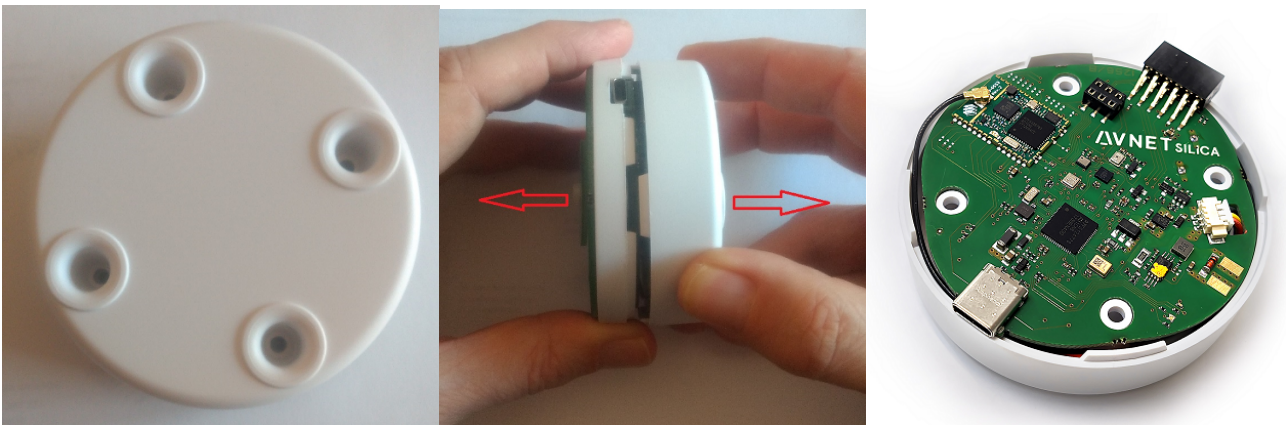
USE OF SENSORS

The sensor is normally closed in order to enable access to the inductive rotary device, which is fitted on the upper cover of the sensor.



Many of the other sensors will fit on the PCB, which is located inside the module casing.

There are 4 screws on the bottom of the casing that enable you to open it. Simply unscrew them and take off the cover: there is a sliding contact between the cover PCB and main PCB that will release the cover and the inductive sensor PCB.



The board can run without the cover but this will lose the inductive sensor data.

JUMPER TX/NO TX

The board does not have a power-on switch. The firmware will prevent data transmission when not in use and when the battery is connected via the short circuit pin 10-11 of the PMOD connector.

| | |
|---------------|-----------------------------|
| Jumper OPEN | Normal operation |
| Jumper CLOSED | No sensor data will be sent |

This is good to disable data transmission when shipping the part.

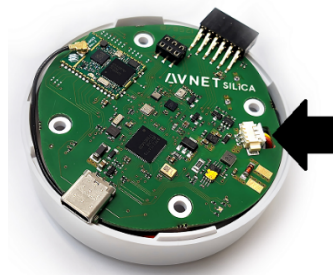


BATTERY OPERATION

The sensor can be powered by battery only. Due to the constraints in shipping Li-Ion batteries, the battery is not connected to the board.

To connect the battery:

- Insert the jumper TX/NO TX on PMOD
- Plug in the battery connector on the PCB: the blue LED will flash and the board will start working
- Remove the jumper TX/NO TX on PMOD
- The sensor should start sending data.



APPLICATION DESCRIPTION

After a full reset, the miniPOC powers up and a blue led lights up for half a second.

After about 30", the green led will light up and the device will try to register to the LoRa network (LoRa calls this the Join process).

Before sending data, the miniPOC **must** have joined the LoRa network. If it is not able join the LoRa network before the join timeout expires (about 250"), the LoRa module on board will restart and retry the join operation. The miniPOC green led will stay on till the Join process is complete, and if Join continues to fail the led will stay green.

While the module is sending data; the green led on the Miromico module will also be flashing. The module LED is inside the box and not visible from the outside.

At the end of the join process, the green led will turn off. It turns on again when the miniPOC needs to read sensor data and turns off again when data has been sent.

You can change the led colour and sensor scan time here: <https://LoRaMiniPOC.iotconnect.io/dashboard>.



In normal operation, the miniPOC will wake up every second and check:

- If any sensor needs to be scanned (based on the programmed sensor scanning time) and if any new data is available to send
- The gas sensor, which must be managed periodically to provide reliable data
- Whether anything else needs doing; if not, the system will go back to sleep
- If any data is available; if so, the LED comes on (the colour can be programmed via the Avnet interface and the default is green) and the LoRa radio is taken out of the low power state. The data is sent and the green led will stay on until the radio confirms that data has been sent (this typically takes a few seconds).
- If there is any downlink data, return to sleep mode.

This cycle will run continuously when the sensor is powered.

Downlink

The dashboard at <https://LoRaMiniPOC.iotconnect.io/dashboard> enables you to:

- Trace and verify miniPOC sensor data (this is called uplink in LoRa terms)
- Check the “scan time” setting and “led” settings (this is called downlink in LoRa terms)

As the miniPOC is a standard LoRaWAN Class A device, it can only receive data after sending a data frame (to keep power consumption low, the receiver is only activated for a short time after sending a data frame).

This means any new “scan time” or “led” setting will be received by the miniPOC device when the next scheduled data frame is sent.

The default scan time is 30”: note that you will need to wait 30” to see the effect of any command.

There is no confirmation of reception of data from miniPOC and LoRa standard admits the loss of downlink data. If required, you can add a confirmation that data has been sent by changing the source code of the application.

Timing

With <https://LoRaMiniPOC.iotconnect.io/dashboard> you can set the scan time for sensors.

The miniPOC reads a sensor when the corresponding scan time expires; the device will transmit a complete data frame each time a scan time expires. The sent frame will include the data from all the sensors (there is almost no energy difference in sending a very small frame or a slightly larger one) but only the data corresponding to the expired scan time sensor is updated.

The idea behind this scan time is to optimise the energy consumed by reading each sensor.

The timers for the different sensors are all reset when a new scan time is received by the miniPOC.

Led Colours

The led colour management currently only provides options to turn on or off for each colour. *Led brightness options are not implemented yet.*

ISL29035IROZ-T7

The light sensor is mounted inside the miniPOC box; open the box to use ambient light. The miniPOC will also work without the cover and will not generate any functional exceptions.

LoRa Transmission

The LoRa module can sometimes take more than 2 minutes to join the LoRa network at startup. If the device does not join before the internal join timeout expires (about 250s), the miniPOC will reset the LoRa module and retry the join operation. It will continue to try until the join operation succeeds.

Once joined, the module may take up to 10 seconds to send data. It is not a good idea to set a shorter timeout for reading/sending sensor data is not a good choice. A good compromise is to have a timeout greater than 30”.

Low power mode

The miniPOC wakes up from LPM every second and checks whether some timeouts have expired. If so, it proceeds to read the corresponding sensor and then it sends the relevant data.

Top encoder

The encoder mounted on the top of the miniPOC box and the cover of the miniPOC box can be unmounted (for example, if you want to use the light sensor mounted on the miniPOC main board).

If the box cover is unmounted, no flashing code error is generated for the missing angle sensor.

In the picture below, you can see the miniPOC led and LoRa module led:

1. The LoRa module led flashes during the network join process; once the module has joined the network, the led turns off
2. The miniPOC led stays on and steady during data transmission



GAS SENSOR

This sensor must be read every 6s: this is due to constraints present in the low power management of the sensor. But sensor data values are sent in accordance with the scan time set in the <https://LoRaMiniPOC.iotconnect.io/dashboard>.

The sensor's firmware includes a management function for the IDT gas sensor. This requires some power (about 1mA) and the gas sensor cannot be put in power-down mode.

The gas sensor firmware is based on a library that is under NDA. The firmware provided does not include these libraries, which must be obtained from IDT.

DIAGNOSTIC

Fault reports are generated using a blink code on the miniPOC led; regardless of the colour you set for the led, the blink code is always RED.

The following lists the implemented faults:

- FAULT_RW_I2C_S1: 1 blink, fault on HS3001;
- FAULT_RW_I2C_S2: 2 blink, fault on DPS368XTSA1;
- FAULT_RW_I2C_S3: 3 blink, fault on LSM6DSO;
- FAULT_RW_I2C_S4: 4 blink, fault on ISL29035IROZ-T7;
- FAULT_RW_I2C_S5: 5 blink, fault on ZMOD441AI1;
- FAULT_RW_MIC1: 6 blink, fault on IM69D130V01XTSA1;
- FAULT_R_ZMID5202: 7 blink, fault on ZMID5202;
- FAULT_RW_I2C_RG1: 8 blink, fault on ISL9122AIRNZ-T);
- FAULT_INIT_UART: 9 blink, fault on S124 uart initialization;
- FAULT_CLOSE_UART: 10 blink, fault on S124 uart closing;
- FAULT_SEND_UART: 11 blink, fault on S124 uart transmission;
- FAULT_STOP_AGT: 12 blink, fault on S124 general purpose timer;
- FAULT_START_AGT: 13 blink, fault on S124 general purpose timer;
- FAULT_START_RTC: 14 blink, fault on S124 RT timer;
- FAULT_START_I2C: 15 blink, fault on S124 i2c bus;
- FAULT_RESET_I2C: 16 blink, fault on S124 i2c bus;

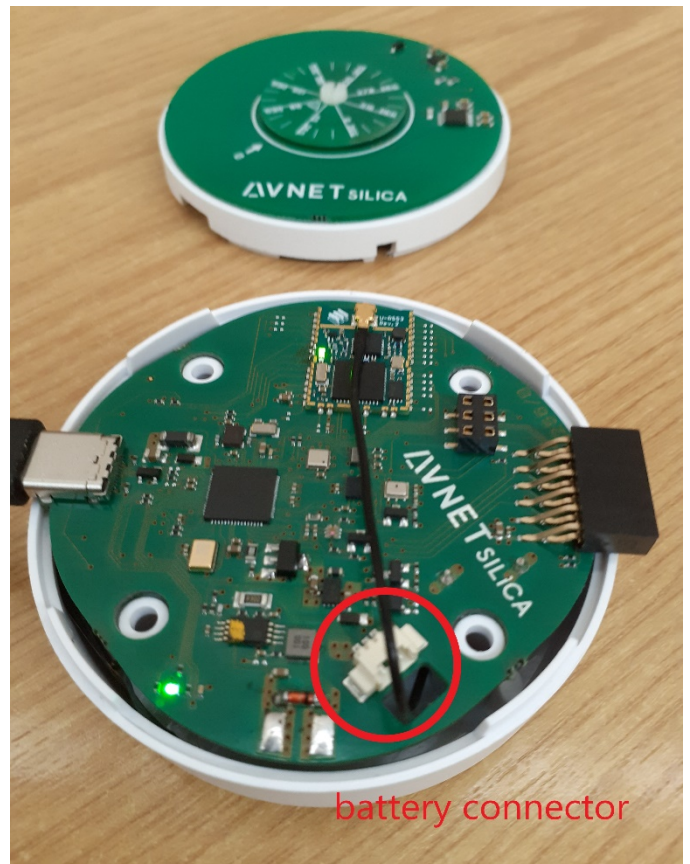
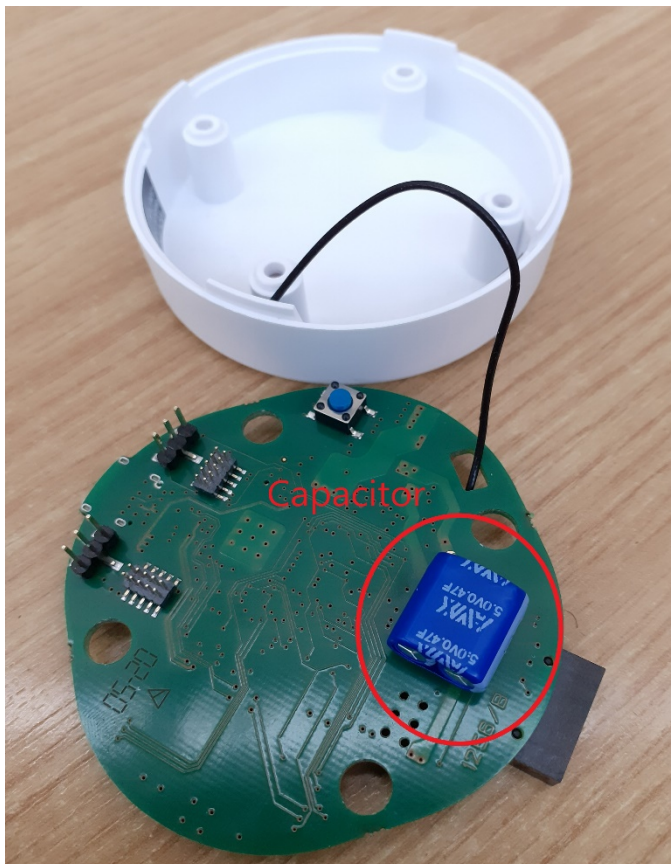
After the blink code there is a pause of 3 seconds; after that the error blink code starts again.

When the miniPOC enters the fault mode, it will never exit so please reset the miniPOC.

RESET

The only way to reset the module is to remove both the battery and the USB-C power. There is a large capacitor on the board to manage peak current from the module's TX so the power will diminish very slowly.

There is no visual indication of reset, so please wait at least a minute before reconnecting power.

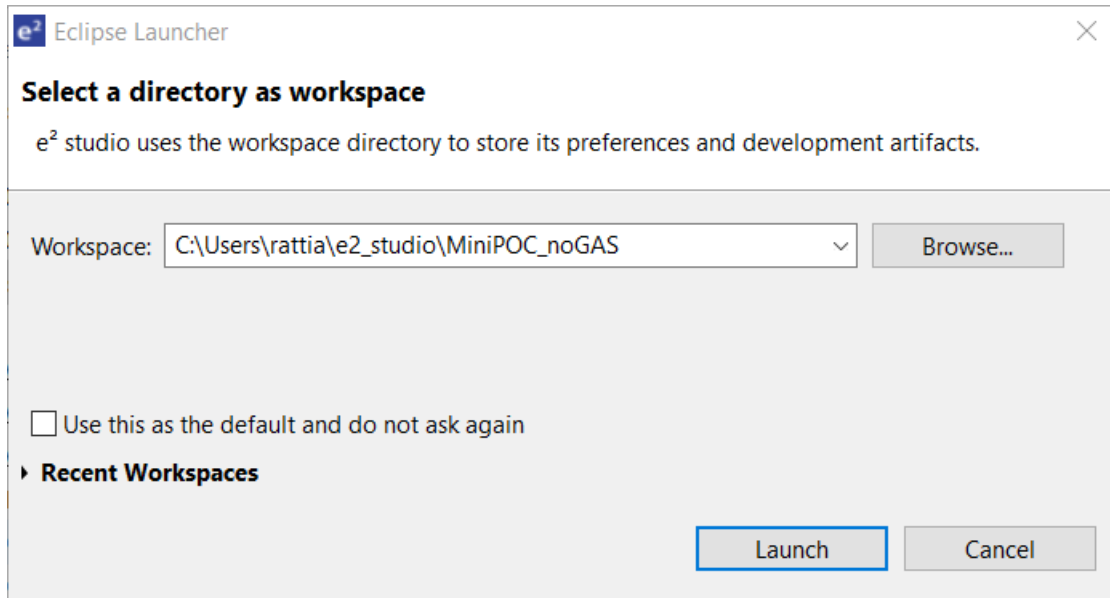


FIRMWARE: LOADING THE PROJECT

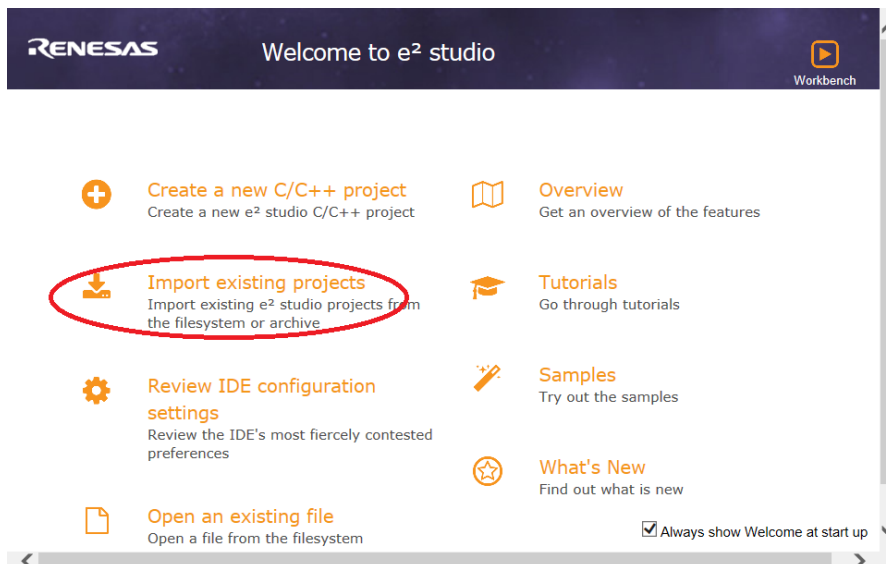
The project files are available in the miniPOC_noGAS_202000402.zip file.

The compilation requires e2studio 7.5.1 and SSP 1.7.0.

Open e2studio and select a workspace directory:



To import an existing project:



Import the project .zip file.

Import Projects

Select a directory to search for existing Eclipse projects.



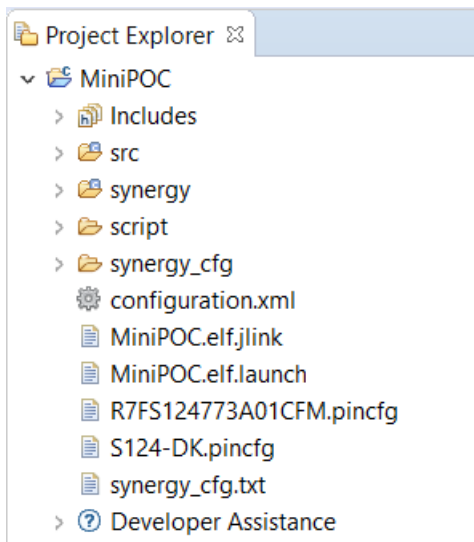
Select root directory:

Select archive file:

Projects:

| | | |
|-------------------------------------|----------------------------------|---|
| <input checked="" type="checkbox"/> | MiniPOC (MiniPOC_noGAS/MiniPOC/) | <input type="button" value="Select All"/> |
| | | <input type="button" value="Deselect All"/> |
| | | <input type="button" value="Refresh"/> |

This is the project structure:



Run the project → build all.

```

CDT Build Console [MiniPOC]
. .
'Invoking: Cross ARM GNU Create Flash Image'
arm-none-eabi-objcopy -O ihex "MiniPOC.elf" "MiniPOC.hex"
'Invoking: Cross ARM GNU Print Size'
arm-none-eabi-size --format=berkeley "MiniPOC.elf"
  text  data  bss  dec  hex filename
102564  615  12624  115803  1c45b MiniPOC.elf
'Finished building: MiniPOC.hex'
'Finished building: MiniPOC.siz'
. .
. .

18:47:11 Build Finished. 0 errors, 9 warnings. (took 9s.608ms)
  
```


PAYLOAD SPECIFICATION

The sensor board that has been designed for the Edge node boards will broadcast the sensor information based on an internal (design choice) timer.

The LoRa has a minimum frame size of 51 bytes in the worst case (see the “RP002-1.0.0 LoRaWAN Regional Parameters” table for EU863-870 maximum payload size).

To make the payload flexible, it is built using fields where each field identifies a specific sensor type.

THIS IS NOT intended to be a full specification for a comprehensive data exchange protocol. Instead, it provides a simple and very compact implementation of devices with very constrained communication links, limited to Avnet-specific demo examples. If you require full details of a protocol, please refer to examples such as those described on <https://www.openmobilealliance.org>.

FIELD FORMAT FOR TRANSMITTED DATA

Each field comprises a sequence of bytes.

The first byte will identify the field type (4 MSB) and the field scale factor (4 LSB).

The following bytes (up to 3 bytes) will indicate the value for the field, where the basic units of measurement are multiplied by $2^{(\text{scale_factor} - 8)}$ to obtain the effective value of the measurement. They apply to all the following measurements; for a specific sensor implementation, the scaling factor will not change between measurements. A payload can include one or more sensor data items. If the sensor sampling time is faster than the data transmission interval, one payload can include more data from the same sensor, where each data item is a sampled value.

The following is a list of the available fields:

| Field name | Filed ID (MSB) | Parameter byte 1 | Parameter byte 2 | Parameter byte 2 |
|----------------|----------------|--|---|--|
| Reserved | 0000 | | | |
| Acceleration | 0001 | X-value, 2' complement value in units of 0.01g - signed | Y-value, 2' complement value in units of 0.01g - signed | Z-value, 2' complement value in units of 0.01g - signed |
| Gyroscope | 0010 | X-value 2' complement value in units of 1deg/s – signed | Y-value 2' complement value in units of 1deg/s – signed | Z-value 2' complement value in units of 1deg/s – signed |
| Magnetic field | 0011 | X-value 2' complement value in units of $10^{-6}T$ – signed | Y-value 2' complement value in units of $10^{-6}T$ –signed | Z-value 2' complement value in units of $10^{-6}T$ – signed |
| Light | 0100 | Ambient light units ok klux – unsigned | Infrared light units of mW/cm^2 - unsigned | UV light units of mW/cm^2 - unsigned |
| Temperature | 0101 | Ambient temperature unit of Celsius – signed | | |
| Noise | 0110 | Noise level units of dB (referred to the standard | | |

| | | | | |
|--|------|---|--|---------------------------------|
| | | audio scale, 0dB = 20μPa) - unsigned | | |
| Battery voltage Battery charge | 0111 | Battery voltage, units of 0.01V - unsigned | Battery charge in %, 0-100%, unit of 1% - unsigned | |
| RF signal level from the sensor radio (RSSI) | 1000 | Signal level from the radio, in units of dBm, offset 60dbm (0 = - 60dBm) - signed | | |
| Cap. Sens | 1001 | X-cap coordinate 0-100% in units of 1% - unsigned | Y-cap coordinate 0-100% in units of 1% - unsigned | |
| Humidity | 1010 | Humidity in %, scale 100%, unit 1% - unsigned | | |
| Pressure | 1011 | Pressure is in mBar - unsigned | Temperature measured by the pressure sensor - signed | |
| Angle | 1100 | Angle from inductive sensor, unit of 2 degrees - unsigned | | |
| Air Quality | 1101 | CO2 value - unsigned | Total VOC – unsigned | Internal temperature in Celsius |
| Timestamp | 1110 | MSB - unsigned | Middle byte - unsigned | LSB (unit of Sec) - unsigned |
| Extend | 1111 | (byte ID for new sensor data) – NOT USED CURRENTLY | | |

EXAMPLES OF PAYLOAD FORMAT FOR TRANSMISSION

Payload is simply a sequence of fields; there is no specific field order and any field is optional. The application MUST scan the payload to find the fields and identify their values. If it scans more than one field with the same name, it reports sequential scan values for the sensor.

The Renesas sensor demo has many different sensors with this payload (max. 29 bytes). The data in parentheses is only a comment, no data is added to the payload

0x18, X-acc, Y-acc, Z-acc, (LSM6SD0X)

0x28, X-rot, Y-rot, Z-rot, (LSM6SD0X)

0x48, Ambient, 0x00, 0x00 (ISL29035)

0x68, Noise (IM69D130)

0xA8, Humidity (HS3001)

0x58, Temperature (HS3001)

0xBA, Pressure, temperature (DPS368)

0xD8, eCO2, VOC, temperature (ZMOD4410)

0xC8, Angle (ZMID5202)

0xE8, Timestamp bits 23-16, timestamp bits 15-8, timestamp bits 7...0

When the scan time is faster than the data delivery interval (e.g. LoRa 0.1% max. duty cycle), the data from the sensors is put in a buffer and all the sensors can be transmitted in a single frame.

FIELD FORMAT FOR DATA RECEIVED

Each field is built by a sequence of records with 4 bytes per record.

The first byte will identify the field type (4 MSB) and the field scale factor for scanning time (4 LSB).

The following bytes (up to 3 bytes) will indicate the value for the field, where the first byte is always the scan interval for the sensor data. The scanning time is obtained by this byte multiplied by the scaling factor in units of 1s. For example, 0x01 with a scaling factor of 0x08 is 1"; 0x01 with a scaling factor of 0x00 is 1/256" (fastest scanning time). If the scan time is 0x00, the sensor is disabled and the reserved bytes are set to 0x00.

The record is always sent in full and all the record data will change based on the data received by the sensor device.

The threshold values for "send" will use the same scaling factor as the sensor when sending data. The threshold set to -128 (0x80) indicates that no threshold is set.

The payload can include one or more records and the application must scan the payload to recover the records required. The field order is freely configurable and any field is optional. When a record is not included in a payload, the parameters are kept to their previous value.

The following is a list of the available fields:

| Field name | Filed ID (MSB) | Parameter byte 1 | Parameter byte 2 | Parameter byte 2 |
|----------------|----------------|------------------|------------------------------------|------------------|
| Reserved | 0000 | | | |
| Acceleration | 0001 | Scan time | Threshold value for acceleration | Reserved |
| Gyroscope | 0010 | Scan time | Threshold value for gyroscope | Reserved |
| Magnetic field | 0011 | Scan time | Threshold value for magnetic field | Reserved |
| Light | 0100 | Scan time | Reserved | Reserved |

| | | | | |
|-----------------------------------|------|---|--|--|
| Temperature | 0101 | Scan time | Threshold value for temperature | Reserved |
| Noise | 0110 | Scan time | Threshold value for noise | Reserved |
| Battery voltage Battery charge | 0111 | Scan time | Threshold value for battery | Reserved |
| TBD | 1000 | | | |
| LED drive | 1001 | Red brightness (integer value representing the % of the RED intensity, from 0 to 0x64 -100%) | Blue brightness (integer value representing the % of the GREEN intensity, from 0 to 0x64 -100%) | Green brightness (integer value representing the % of the BLUE intensity, from 0 to 0x64 -100%) |
| Humidity | 1010 | Scan time | Threshold value for humidity | Reserved |
| Pressure | 1011 | Scan time | Threshold value for pressure | Reserved |
| Angle | 1100 | Scan time | Threshold value for angle | Reserved |
| Air Quality | 1101 | Scan time | reserved | Reserved |
| TDB | 1110 | | | |
| TDB | 1111 | | | |