# Hardware Documentation

# Table of Contents

1. Hardware introduction ..... 3
1.1 Main PCB ..... 3
1.1.1 Block diagram: ..... 4
1.1.2 Dimensions of PCB ..... 4
1.2 Components of PCB ..... 5
1.2.1: nRF5340 ..... 5
1.2.2 Flash Memory ..... 6
1.2.3 Buck Converter 3.9 V ..... 7
1.2.4 4G Module ..... 8
1.2.5 SD Card ..... 10
1.2.6 Power Management Board ..... 11
1.2.7 Battery ..... 12
1.3 LED Indicators and Interpretation: ..... 13
1. Power Indicator: ..... 13
2. Camera Indicator: ..... 13
3. Cloud connection: ..... 13
4. Data Transmission Indicator: ..... 13
2 Troubleshooting and FAQ ..... 14
2.1 Check Power LED Colour ..... 14
2.1.1 Troubleshooting Power LED ..... 14
2.1.2 Troubleshooting Camera Functionality ..... 14
2.1.3 Troubleshooting Green LED for Network Connectivity ..... 14
2.1.4 Troubleshooting Data Transmission to AWS ..... 14
2.2 Inner LEDs ..... 15
2.2.1 Yellow LED Status ..... 15
2.2.2 Blue LED Status ..... 15
3. Device Enclosure ..... 16
3.1 Assembly ..... 16
3.2 Components ..... 17
3.2.1 Solar panel ..... 18
3.2.2 5V adapter ..... 18
3.2.3 Extender for tripod stand ..... 18
3.3 Dimensions ..... 19
4. Technical Files ..... 19

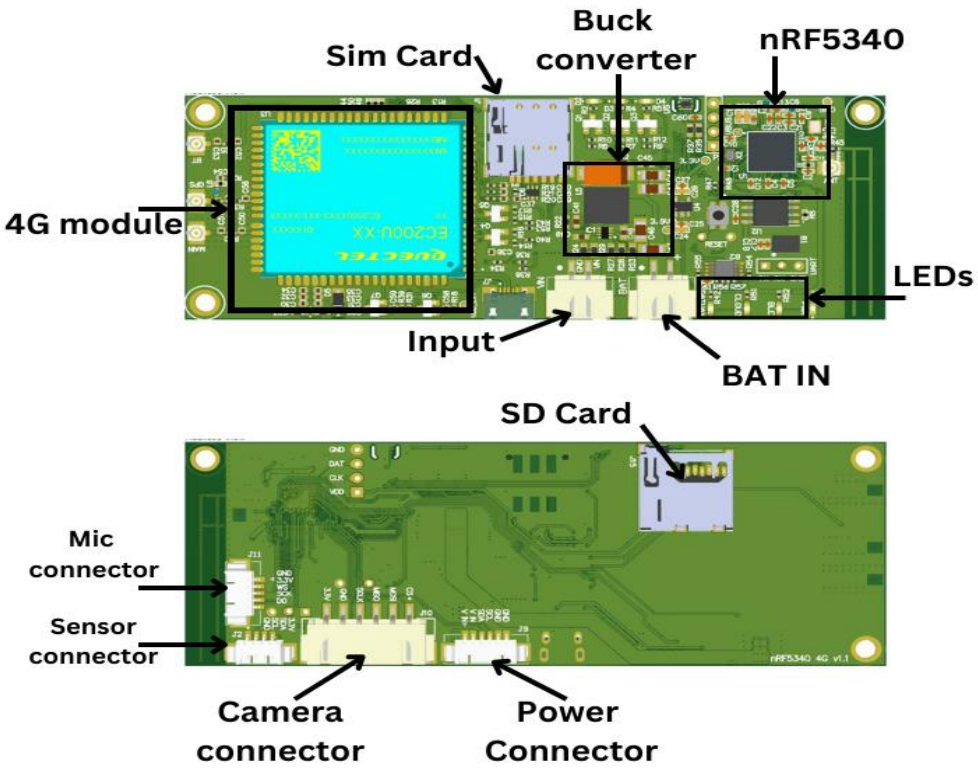
# 1. Hardware introduction

This hardware was developed by IIT Ropar for the Biodiversity Sensor Project of Syngenta Group, as a prototype R&D biodiversity monitoring technology to gather insect species training data for building robust AI models. The device is autonomous, but hardy: weatherproof, solar-powered and cost-efficient.

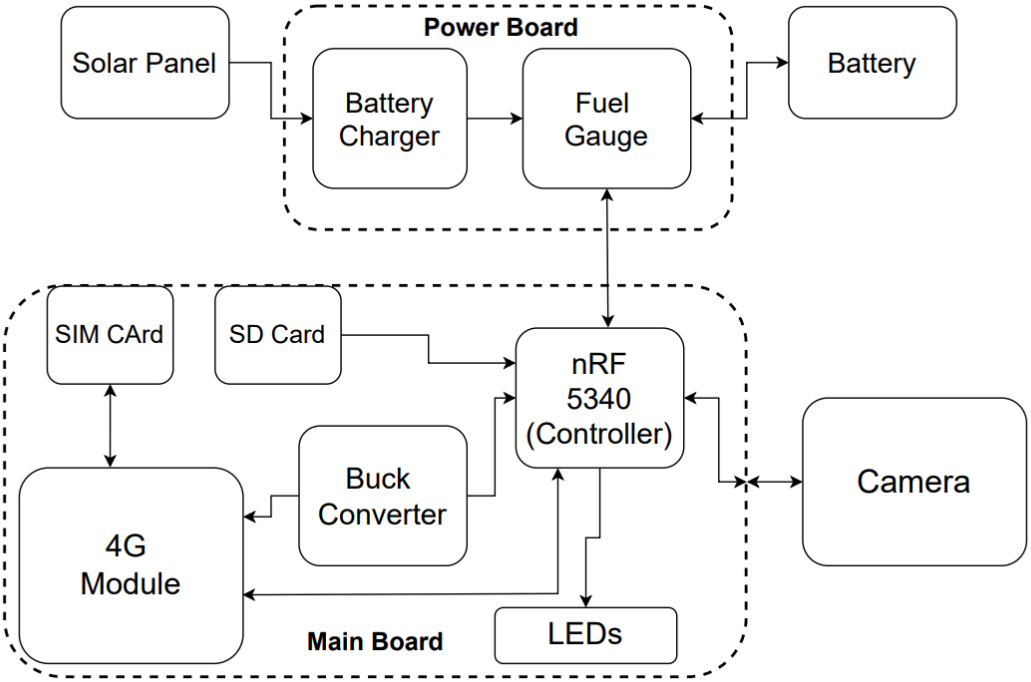
A camera is connected to capture the images of the insects, with data being transferred real-time to the cloud via 4G connectivity. The process of transferring data from device to cloud is from IOT core to S3 Bucket. The data of the camera are further stored in the SD card as well. A power section is provided to control and manage the power of the sensor.

## 1.1 Main PCB

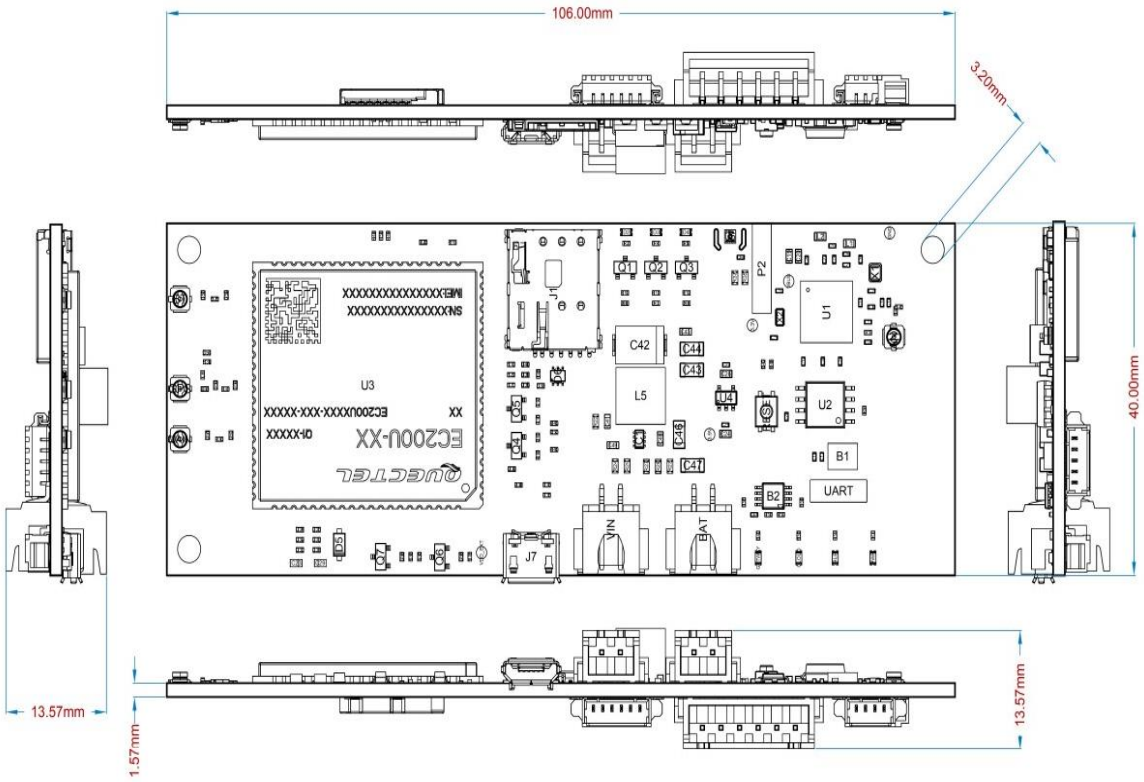
Main PCB comprises Controller, 4G Module, SD card, SIM card and buck converter as shown in below figure.



### 1.1.1 Block diagram:



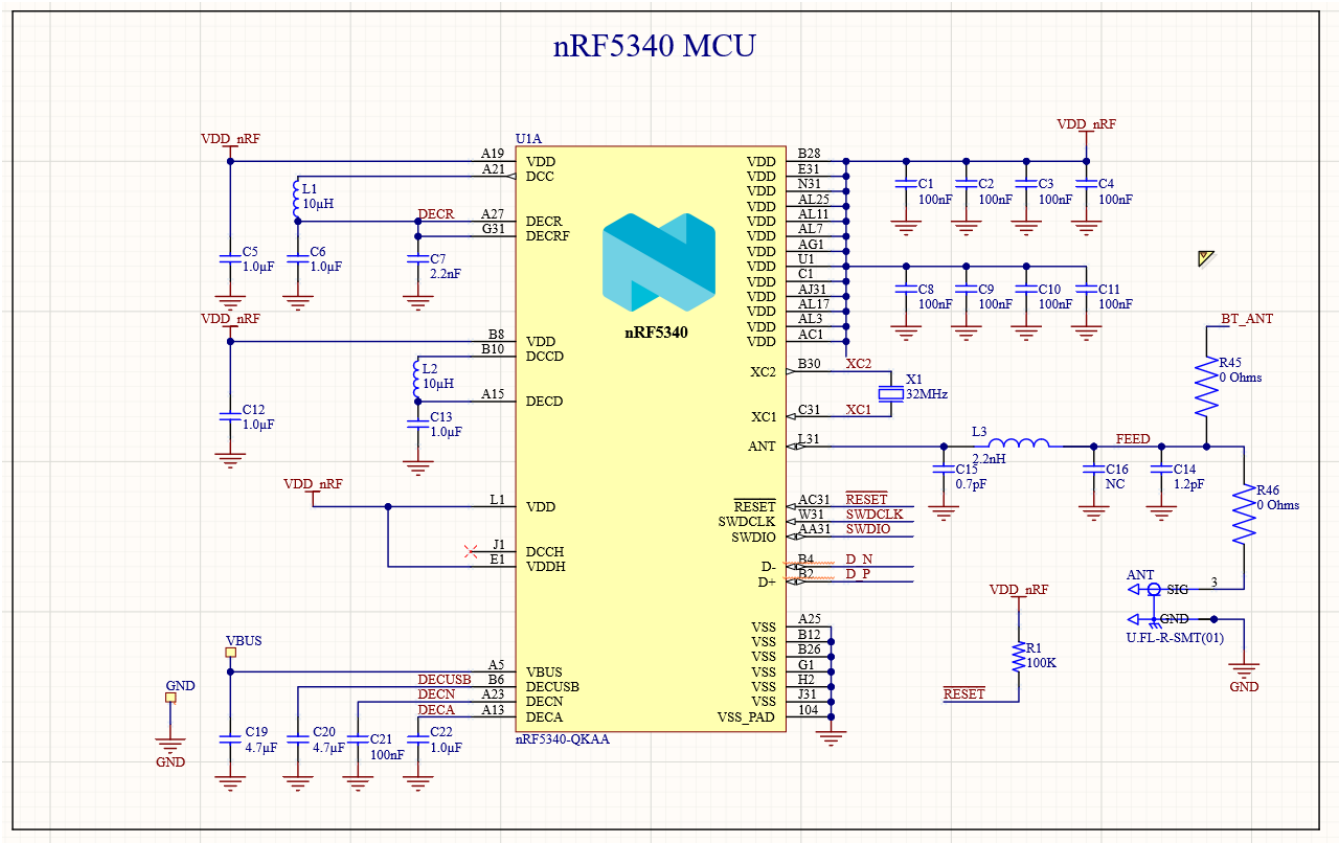

### 1.1.2 Dimensions of PCB



## 1.2 Components of PCB

### 1.2.1: nRF5340

The nRF5340 is a powerful and versatile dual-core wireless System-on-Chip (SoC) developed by Nordic Semiconductor. This advanced chip is designed to meet the demands of modern wireless applications, offering a combination of high-performance processing, low power consumption, and a comprehensive set of features suitable for a wide range of applications.


*Schematic of nRF5640 MCU*

**Features:**

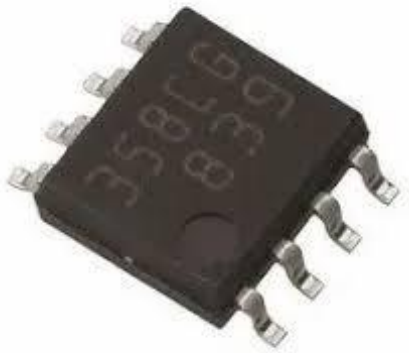
- Enables efficient multitasking and real-time processing, enhancing overall system performance.

- Supports a variety of wireless protocols, including Bluetooth Low Energy (BLE), Bluetooth mesh, Thread, and ZigBee.
- The dual-core architecture allows the simultaneous operation of multiple wireless protocols for increased flexibility.
- Optimised power management ensures energy-efficient operation, extending the battery life for battery-powered devices.
- Suitable for applications requiring long-term deployment in IoT, wearables, and other battery-constrained devices.
- Implements advanced security features, including a dedicated Arm Trust Zone for secure execution of sensitive functions
- Provides flexibility for interfacing with a wide range of sensors, actuators, and other external devices.
- Enhances the range and reliability of wireless connections in diverse applications. Simplifies the process of designing and prototyping applications, reducing time-to-market.
- Designed to cater to the requirements of Internet of Things (IoT) applications, ranging from smart home devices to industrial IoT solutions.

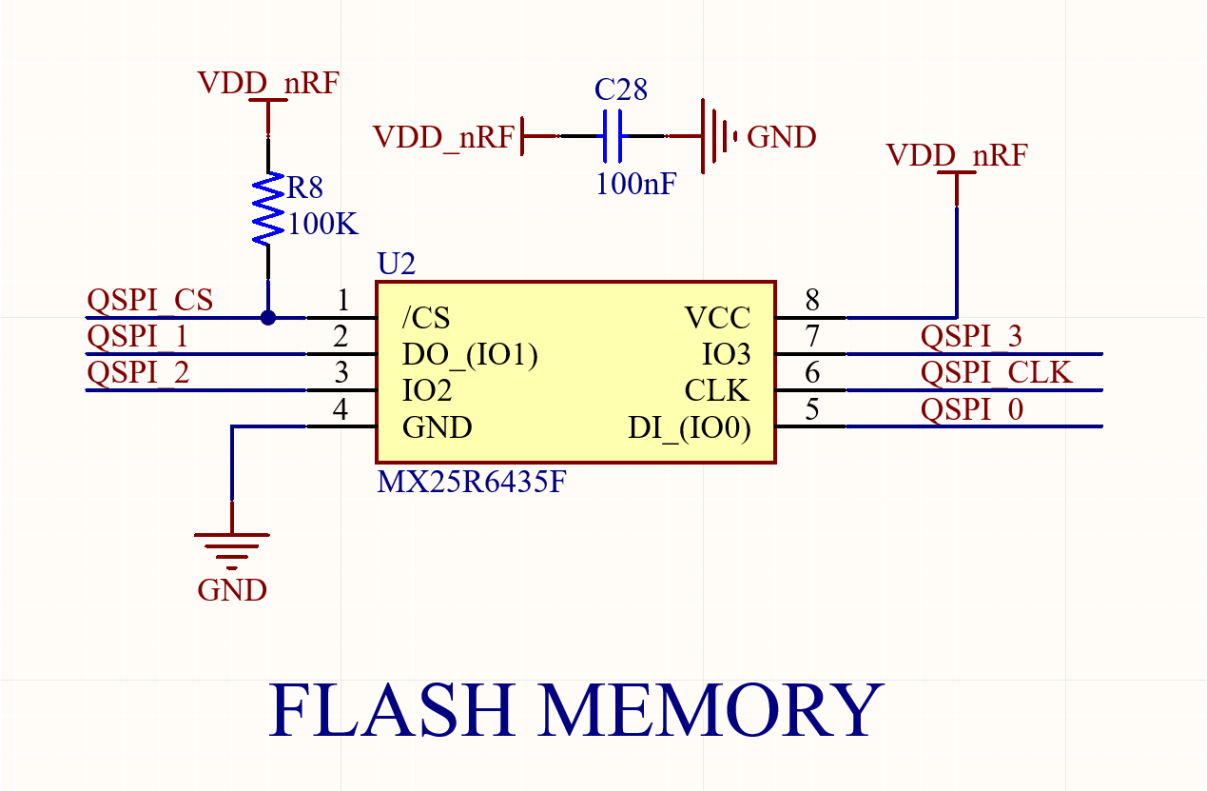
*For more information you can take the reference from* nRF5340 Hardware Documentation

### 1.2.2 Flash Memory

MX25L12835FM2I is a serial NOR flash memory device that is primarily used to store non-volatile data in electronic systems. Stores digital data persistently even when power is turned off. It supports byte or page programming, allowing users to update specific portions of the memory without erasing the entire content. The MX25L12835FM2I communicates with a host microcontroller or system through the Serial Peripheral Interface (SPI). This interface enables high-speed and synchronous data transfer between the memory and the controlling device. MX25L12835FM2I is used for storing firmware, configuration data, and other critical information.



*Click here: Datasheet of MX25L12835F*



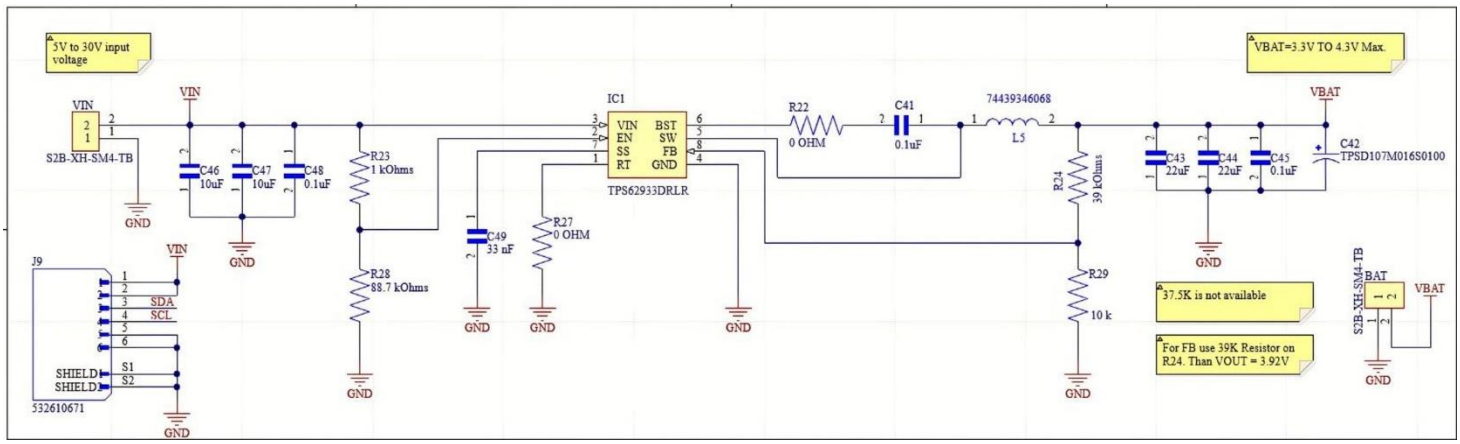

*Schematic Of Flash Memory*

### 1.2.3 Buck Converter 3.9 V

The TPS62933DRLR is a synchronous buck converter, which means it steps down the input voltage to a lower output voltage with high efficiency. The TPS62933DRLR can be employed to provide a stable and regulated power supply to various components within a biodiversity sensor, such as microcontrollers, sensors, and communication modules. The high efficiency of the buck converter is beneficial in battery-powered biodiversity sensors, where energy efficiency is critical for extending battery life. TPS62933DRLR can help optimise power usage and extend the overall operational life of the sensor.

The TPS6293x is a high-efficiency, easy-to-use synchronous buck converter with a wide input voltage range of 3.8 V to 30 V, and supports up to 2-A (TPS62932) and 3-A (TPS62933 and TPS62933x) continuous output.

*Click here:- Datasheet of TPS62933DRLR*




*Schematic Of Buck Converter*

### 1.2.4 4G Module

**1.EG21-G**


- EG21-G belongs to the category of LTE Cat 1 modules, which means it supports 4G LTE technology for data transmission.
- The EG21-G cellular module is a globally used module.

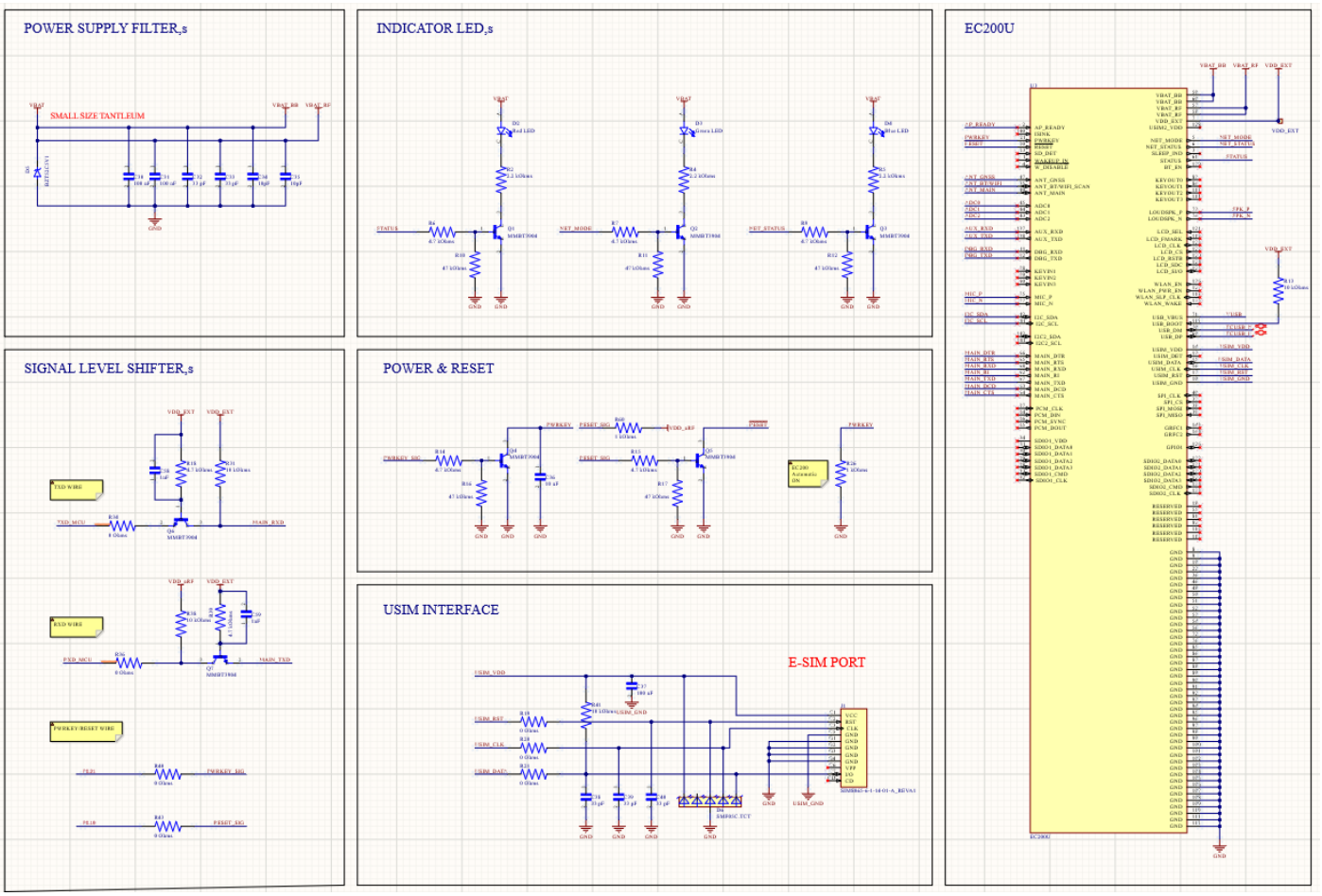
**Features:**

- EG21-G supports LTE, WCDMA, and GSM networks, providing versatile connectivity options.
- It is designed for applications that require moderate data rates, making it suitable for various IoT (Internet of Things) and M2M (Machine-to-Machine) applications.
- It has a compact form factor, making it suitable for integration into small devices with limited space.

| **General Parameters** | |
|---|---|
| Voltage | 3.3 to 4.3 V |
| Current | 0.013 to 22 mA |
| Power | 23 to 33 dBm |
| Software | Windows 7, 8, 8.1, 10, Linux 2.6–5.14, Android 4.x–11.x |

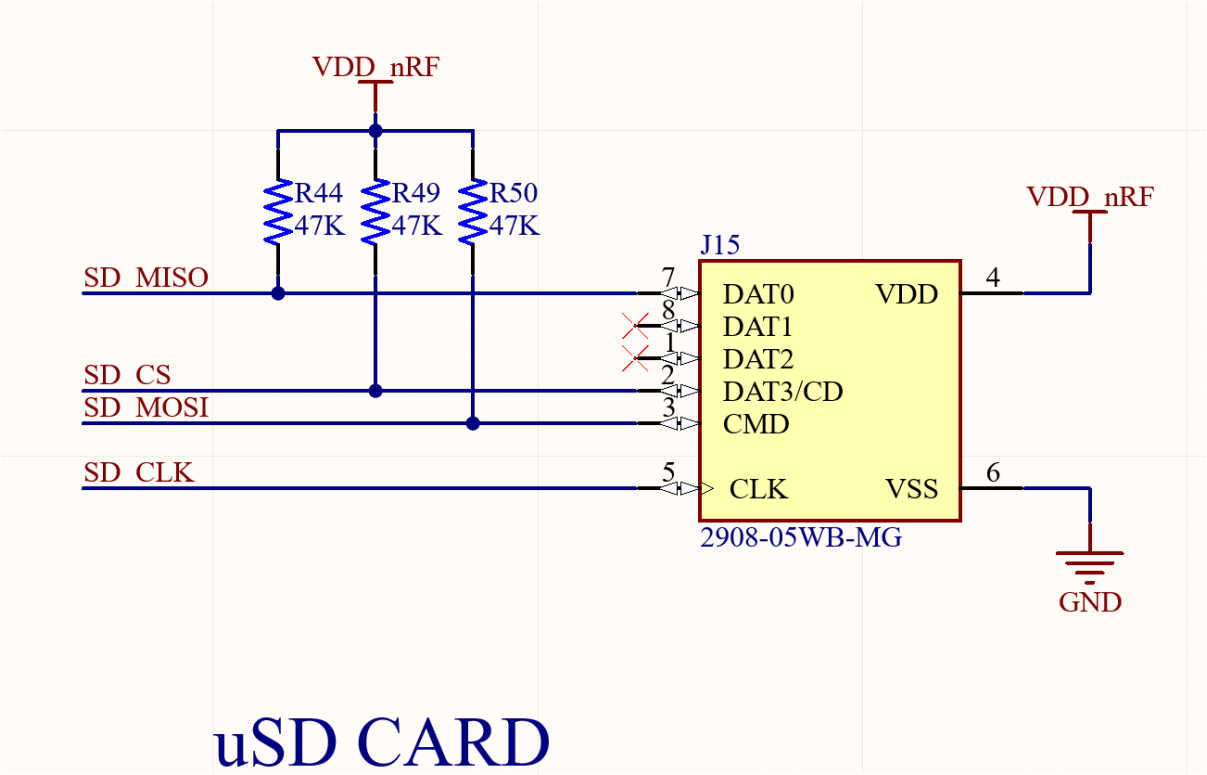
| | |
|---|---|
| Size | 30.0 x 51.0 x 4.9 mm |
| Operating Temperature | -35 to 75 Degree C |
| Storage Temperature | -40 to 85 Degree C |
| Package Type | Surface Mount |
| ROHS | Yes |
| Protocols | TCP, UDP, PPP, FTP, HTTP, NTP, PING, QMI, NITZ, SMTP, MQTT, CMUX, HTTPS, FTPS, SMTPS, SSL, MMS, FILE |
| SMS | No |
| Voice | Yes |

*Click Here:* [*Datasheet of EG21-G*]



### 1.2.5 SD Card

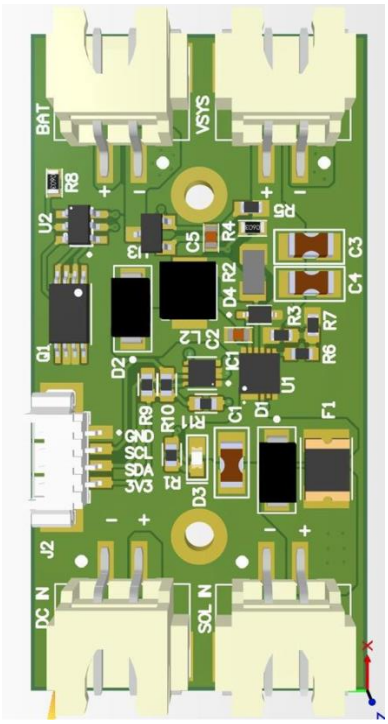

An SD (Secure Digital) card can be used as a data storage medium to store the sensor's observations, measurements, or other relevant data. Instead of relying solely on internal memory or transmitting data in real time, the biodiversity sensor can save this collected data onto an SD card for storage. This allows for the accumulation of data over time. SD cards allow for long-term monitoring by providing ample storage capacity. The biodiversity sensor can continue to collect and store data over extended periods, even in locations without immediate access to power or network infrastructure.




*Schematic Of USD Card*

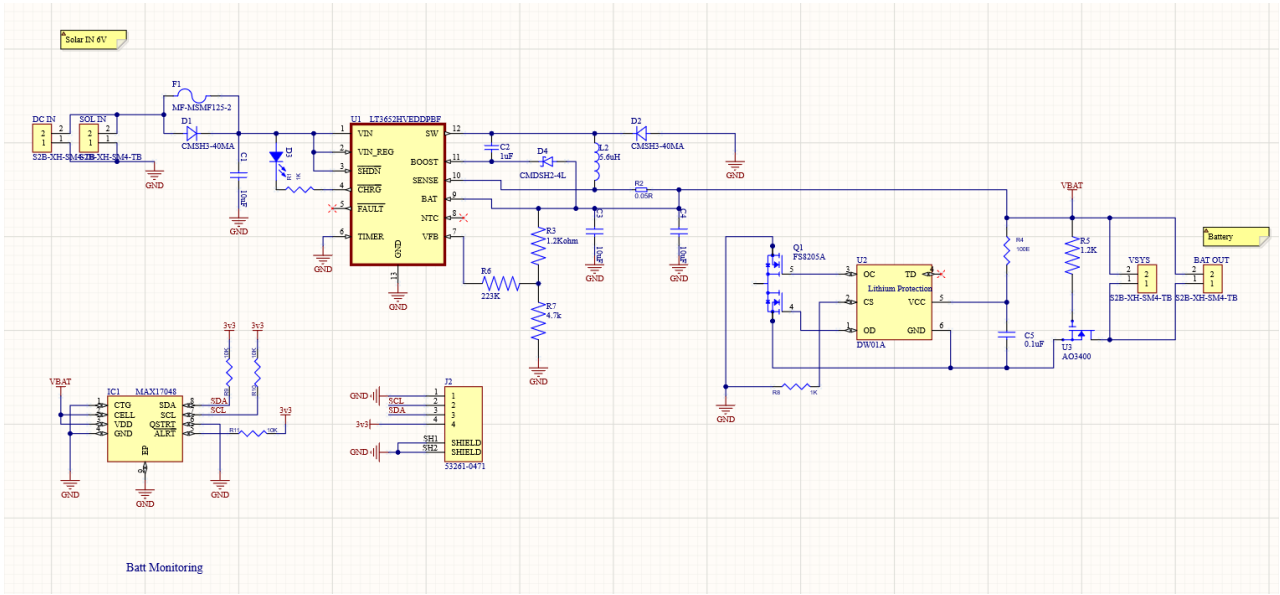
### 1.2.6 Power Management Board

The power management board consists of 2 sections: Battery charging and discharging, and battery monitoring system. For battery charging and discharging, an IC named LT3652 is used. LT3652 is a complete monolithic step-down battery charger that operates over a 4.95V to 12V input range. The LT3652HV provides a constant-current/constant-voltage charge characteristic, with maximum charge current externally programmable up to 2A. The charger employs a 3.3V float voltage feedback reference, so any desired battery float voltage up to 18V can be programmed with a resistor divider.




**Features:**

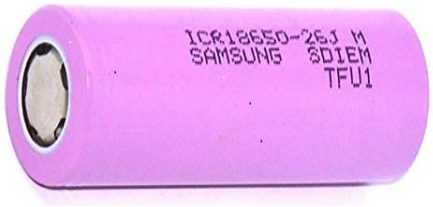
- Input Supply Voltage Regulation Loop for Peak Power Tracking in (MPPT) Solar Applications
- Wide Input Voltage Range: 4.95V to 34V (40V Abs Max)
- Programmable Charge Rate Up to 2A
- User Selectable Termination: C/10 or On-Board Termination Timer
- Resistor Programmable Float Voltage Up to 18V Accommodates 4-Cell Li-Ion/Polymer, 5-Cell LiFePO4, Lead-Acid Chemistries
- Parallelable for Higher Output Current




*Schematic Of Power Management Board*

### 1.2.7 Battery

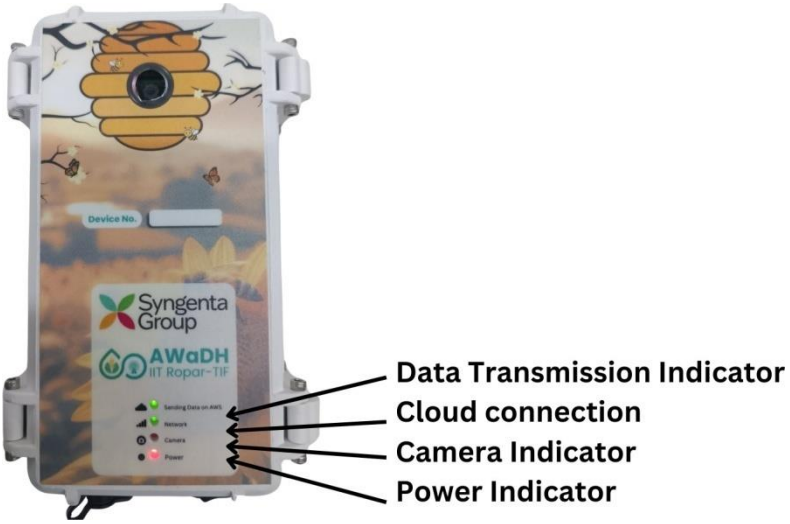
A small size, light weight battery shown below has been used. The shape is cylindrical and the battery type is Lithium-ion battery.




## Specifications

| Model No. | I CR18650 |
|---|---|
| Capacity (mAh) | 2600 |
| Charge Rate (C) | 2 |
| Discharge Rate | 2C |
| Nominal Voltage (V) | 3.7 |
| Maximum ChargeVoltage (V) | 4.2 |
| Maximum Discharge Current(A) | 5.2 |
| Chemistry | ICR |
| Length (mm): | 65 |
| Width (mm): | 18 |
| Height (mm): | 18 |
| Weight (g): | 44 |
| Shipping Weight | 7 kg |

## 1.3 LED Indicators and Interpretation:




**1. Power Indicator:**

- Red LED is continuously ON means device is powered on and operational.
- Red LED Off means Power issue or low battery.

**2. Camera Indicator:**

- Blue LED will Blink every 20-seconds to capture images (depends on time interval given to capture image).
- If blue LED does not blink in a given time interval it means the camera is not working properly.

**3. Cloud connection:**

- Green LED: Device is connected to the cloud.
- Off: Device not connected.

**4. Data Transmission Indicator:**

- Green LED: Data is being transmitted.
- Off: No data transmission.

# 2 Troubleshooting and FAQ

## 2.1 Check Power LED Colour

### 2.1.1 Troubleshooting Power LED

Ensure that the Power LED remains continuously red in color, indicating a stable power supply. If the LED fails to display red, it suggests a potential issue with the battery connections. In such cases, it's imperative to inspect the battery connections with the wires. Check for any loose connections or disconnections and reattach them securely to maintain uninterrupted power flow.

### 2.1.2 Troubleshooting Camera Functionality

Upon powering on the device, verify that the camera blinks after every 20 seconds, indicating its operational status. If the camera fails to blink, several factors may be at play. First, ensure that the device is receiving adequate power. Then, inspect the camera connection to the device, ensuring it's firmly secured. If the issue persists, consider testing the camera separately to assess its functionality independently of the device.

### 2.1.3 Troubleshooting Green LED for Network Connectivity

The green LED should be illuminated to signify successful network connectivity. If the green LED remains off, it indicates a potential network connection issue. In such instances, exercise patience as the device may require time to establish a network connection. Alternatively, try power cycling the device by turning it off and then on againto reset it. Ensure that the device is connected to the correct network and that the networksignal is stable.

### 2.1.4 Troubleshooting Data Transmission to AWS

Verify that the blue LED is on, indicating successful data transmission to AWS. If the blue LED remains off, it suggests that data is not being published to AWS. In such cases, waiting patiently is often necessary as data transmission processes may take some time. Additionally, ensure a stable network connection and double-check AWS credentials and settings to resolve any potential issues with data transmission.

## 2.2 Inner LEDs

### 2.2.1 Yellow LED Status

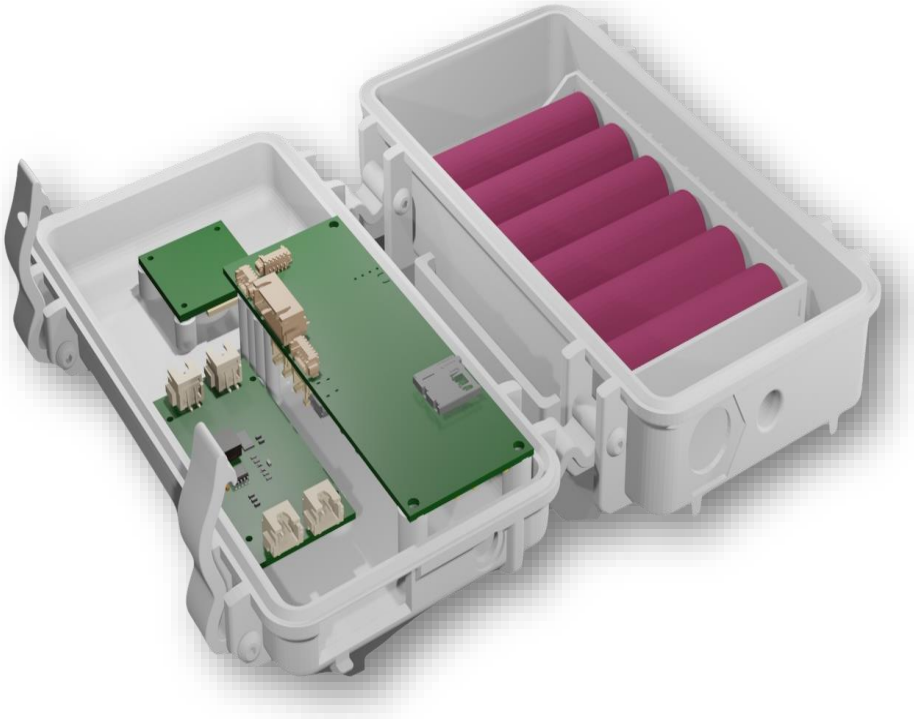
When troubleshooting the biodiversity sensor, the yellow LED indicates SIM card detection. If illuminated, the SIM card is detected; if off, there's a potential issue. Re-insert the SIM card carefully after inspecting for damage or debris. Check LED status again for resolution.

### 2.2.2 Blue LED Status

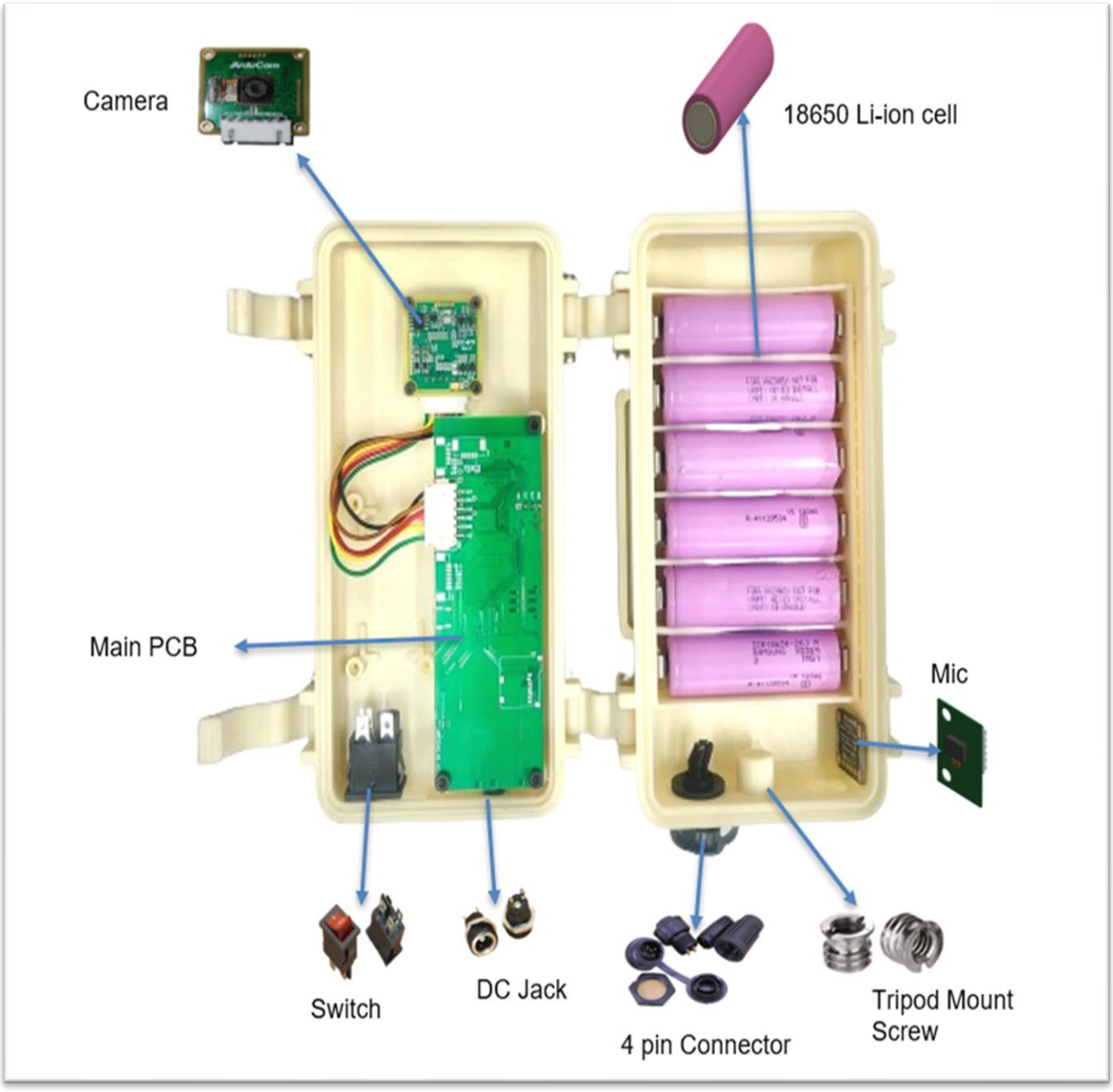
Monitoring the blue LED on the biodiversity sensor indicates data publication to AWS. A fast blink confirms successful transmission, while a slow blink suggests publicationissues. Verify AWS connectivity, network, and credentials. Review error logs for further insight into the problem.

# 3. Device Enclosure

## 3.1 Assembly



## 3.2 Components



### 3.2.1 Solar panel

Specifications:

- Brand: Solar Universe India
- Panel Type: Polycrystalline
- Rated Power: 200 W
- Voltage: 12 V
- Cables Length: 3 m

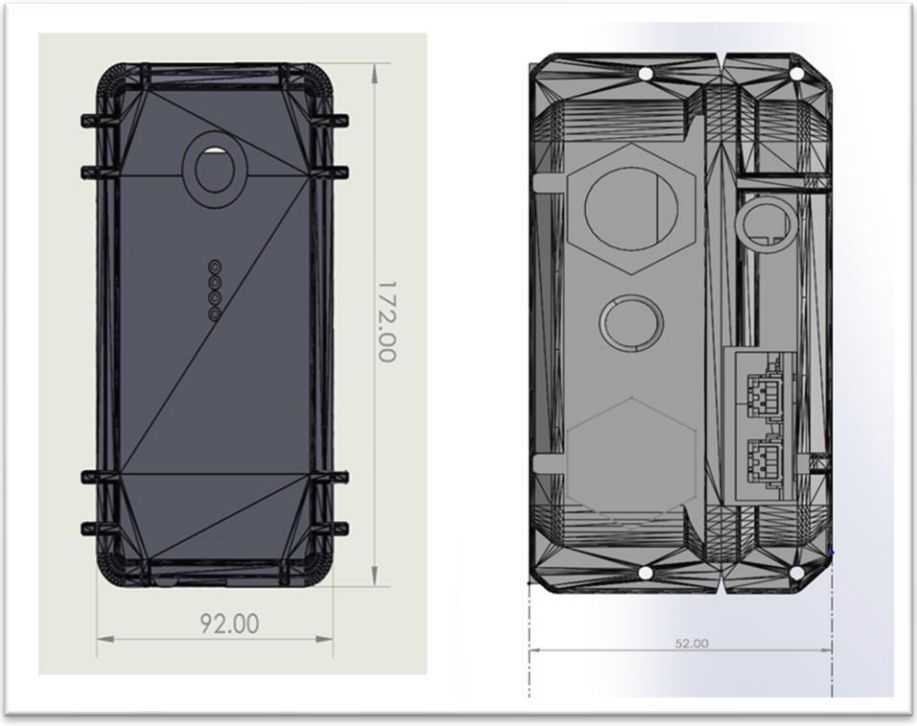
### 3.2.2 5V adapter

Specifications:

AC input voltage: 100V - 240V,
50Hz / 60HzOutput DC Voltage: 5V
Output Current: 2A

### 3.2.3 Extender for tripod stand

## 3.3 Dimensions




Length = 172 mm

Breadth = 92 mm

Height = 52 mm

# 4. Technical Files:

The PCB and Management Board are also in this repository