



**International Centre for Free and Open Source
Software**

**Integrating ULPLoRa Board with BMP180
Sensor for Pressure Monitoring and
Visualization.**

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1 INTRODUCTION

This documentation presents a comprehensive guide for integrating the ULPLoRa board with the BMP180 sensor for pressure monitoring and visualization in IoT applications. The ULPLoRa board amalgamates an Arduino Pro Mini with an RFM95W LoRa module, offering a versatile platform for wireless communication, while the BMP180 sensor provides precise atmospheric pressure measurements.

The primary objective of this document is to outline a systematic approach to establishing a robust system capable of capturing pressure data, wirelessly transmitting it via LoRa to the ChirpStack server, storing it in InfluxDB, and subsequently visualizing it using Grafana.

The documentation provides detailed guidance on hardware setup, firmware development, ChirpStack configuration, InfluxDB integration, and Grafana visualization.

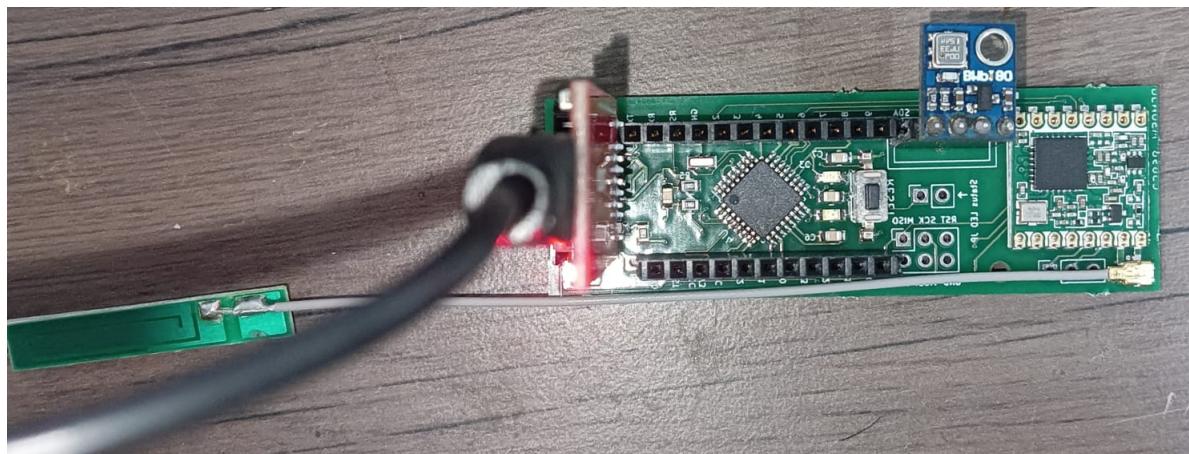


Figure 1

2 COMPONENTS USED

2.1 Hardware Components:

2.1.1 ULPLoRa Board:

- The ULPLoRa board integrates an Arduino Pro Mini with an RFM95W LoRa module, enabling wireless communication for IoT applications.
- Number of Pins: 14 digital pins and 8 analog pins.
- Working Voltage: 3.3V
- Microcontroller: ATmega328P
- Clock Speed: 8MHz.
- Explore the ICFOSS gitlab repository to access comprehensive documentation, including schematics, pinouts, and setup instructions for the ULPLoRa board. (<https://gitlab.com/icfoss/OpenIoT/ulplora>)

2.1.2 BMP180 Sensor:

- Number of Pins: 4 (VCC, GND, SDA, SCL)
- Working Voltage: 1.8V to 3.6V (typically powered by 3.3V)
- Working: The BMP180 sensor measures atmospheric pressure and temperature. It communicates with the Arduino Pro Mini via I2C protocol (SDA and SCL pins) to provide pressure data for monitoring purposes.

2.1.3 FTDI FT232RL USB to Serial Adapter:

- The FTDI FT232RL USB to Serial Adapter is used for serial communication between the ULPLoRa board and a computer. It facilitates programming and debugging tasks.
- Number of Pins: 6 (typically: TXD, RXD, DTR, 5V, GND, CTS).
- Working Voltage: 5V.

2.2 Software Components:

2.2.1 Libraries Used:

• MCCI LoRaWAN LMIC Library:

- The MCCI LoRaWAN LMIC library is utilized to interface with the ULPLoRa board's RFM95W LoRa module and implement LoRaWAN communication.
- This library simplifies LoRaWAN development by providing functions for sending and receiving LoRaWAN messages and managing LoRaWAN parameters.
- To access this library, clone the ULPLoRa repository from the ICFOSS GitLab repository and navigate to the software folder: <https://gitlab.com/icfoss/OpenIoT/ulplora>

- **Adafruit BMP085 Library:**

- The Adafruit BMP085 library is used to interface with the BMP180 sensor for pressure and temperature measurements.
- Install this library using the Arduino IDE’s Library Manager by searching for “Adafruit BMP085” and following the installation instructions.

2.2.2 ChirpStack Server:

ChirpStack serves as an open-source LoRaWAN Network Server, facilitating communication between LoRa devices and applications. It acts as the central hub for receiving and processing data from the ULPLoRa board.

2.2.3 InfluxDB:

InfluxDB is an open-source time series database optimized for handling high write and query loads. It is utilized to store the pressure data received from the ULPLoRa board via ChirpStack.

2.2.4 Grafana:

Grafana is an open-source analytics and visualization platform designed for creating and sharing dashboards and data visualizations. It enables the visualization of the pressure data stored in InfluxDB, providing insights into atmospheric pressure trends over time.

3 HARDWARE CONNECTIONS SETUP

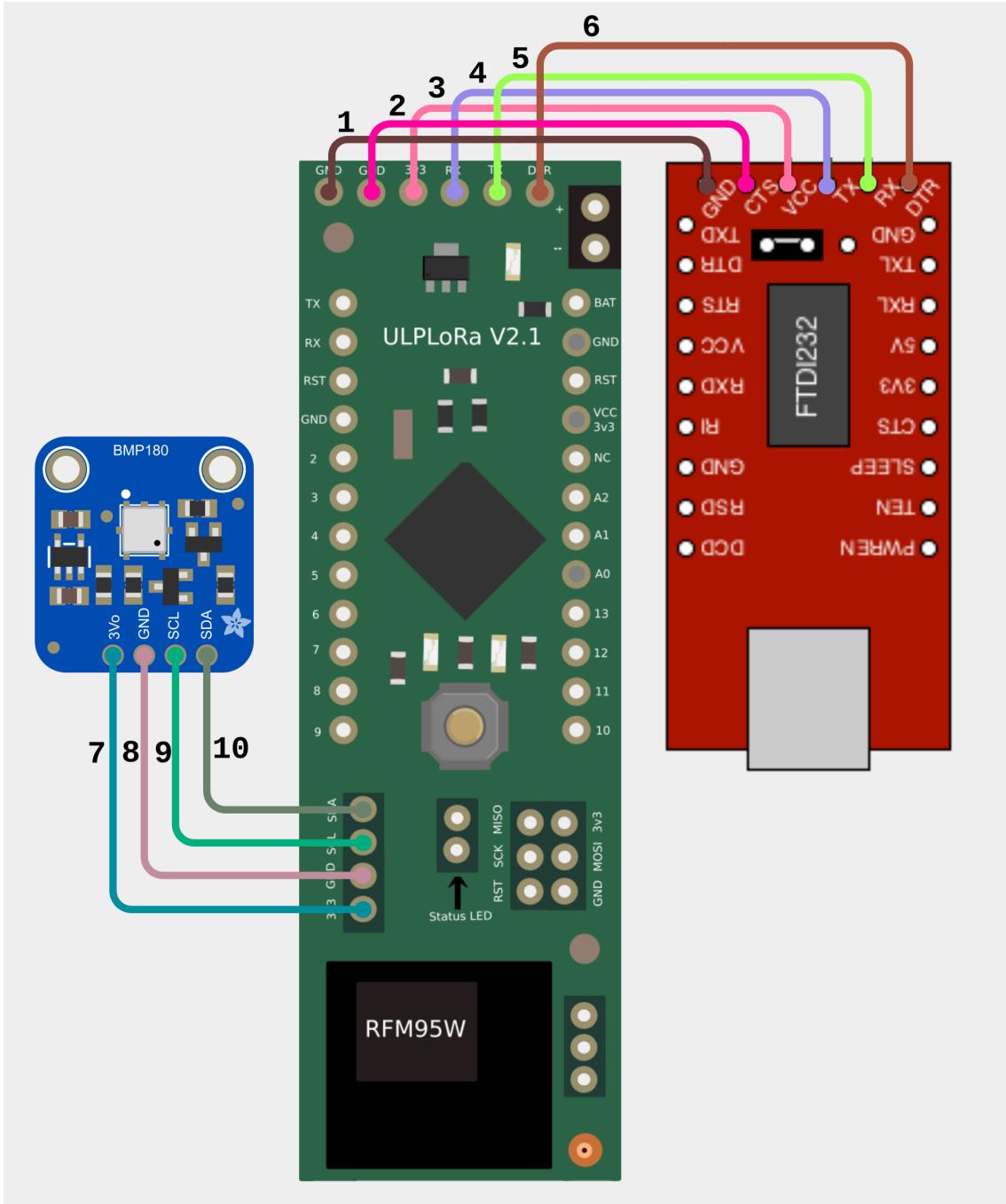


Figure 2: Hardware Connections Setup Circuit Diagram

3.1 ULPLoRa Board (Arduino Pro Mini 3.3V 8MHz) and FTDI FT232RL USB to Serial Adapter:

1. Connect the GND pin of the FTDI adapter to the GND pin of the ULPLoRa board.
2. Connect the CTS pin of the FTDI adapter to the GND pin of the ULPLoRa board.
3. Connect the 5V pin of the FTDI adapter to the VCC pin of the ULPLoRa board.
4. Connect the RX pin of the ULPLoRa board to the TX pin of the FTDI adapter.

5. Connect the TX pin of the ULPLoRa board to the RX pin of the FTDI adapter.
6. Connect the DTR pin of the FTDI adapter to the DTR pin of the ULPLoRa board.

3.2 ULPLoRa Board and BMP180 Sensor:

7. Connect the VCC pin of the BMP180 sensor to the 3.3V output pin of the ULPLoRa board.
8. Connect the GND pin of the BMP180 sensor to the GND pin of the ULPLoRa board.
9. Connect the SCL pin of the BMP180 sensor to SCL pin of the ULPLoRa board.
10. Connect the SDA pin of the BMP180 sensor to the SDA pin of the ULPLoRa board.

4 CONFIGURING CHIRPSTACK, INFLUXDB, AND GRAFANA

BLOCK DIAGRAM

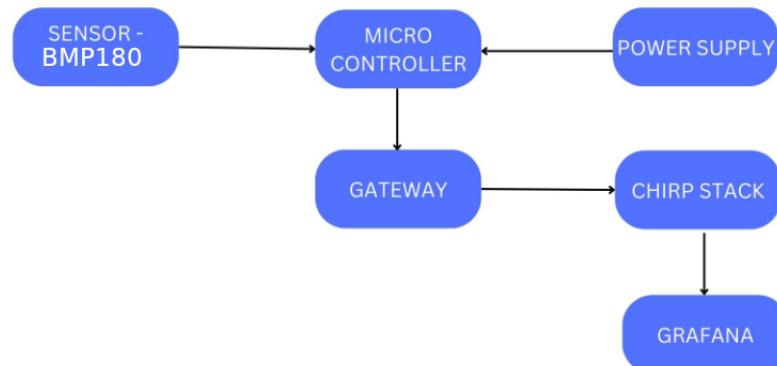


Figure 4: Block diagram

4.1 ChirpStack Configuration:

1. Log in to the ChirpStack web interface (<https://lorawandev.icfoss.org>).

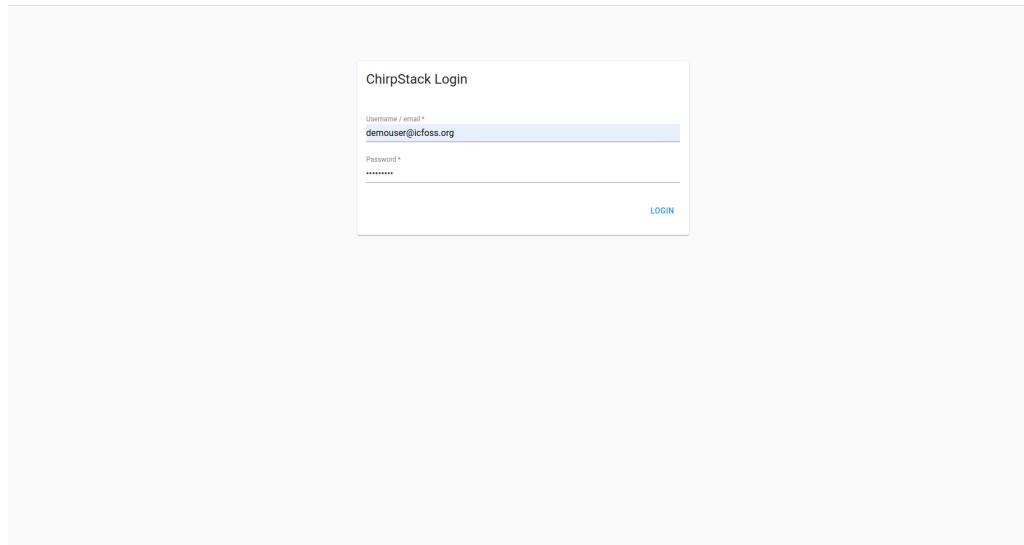


Figure 4.1: Login

2. Navigate to the "Device Profile" section
3. Click on "Create Device Profile" and provide necessary details such as name, description, and LoRaWAN parameters.

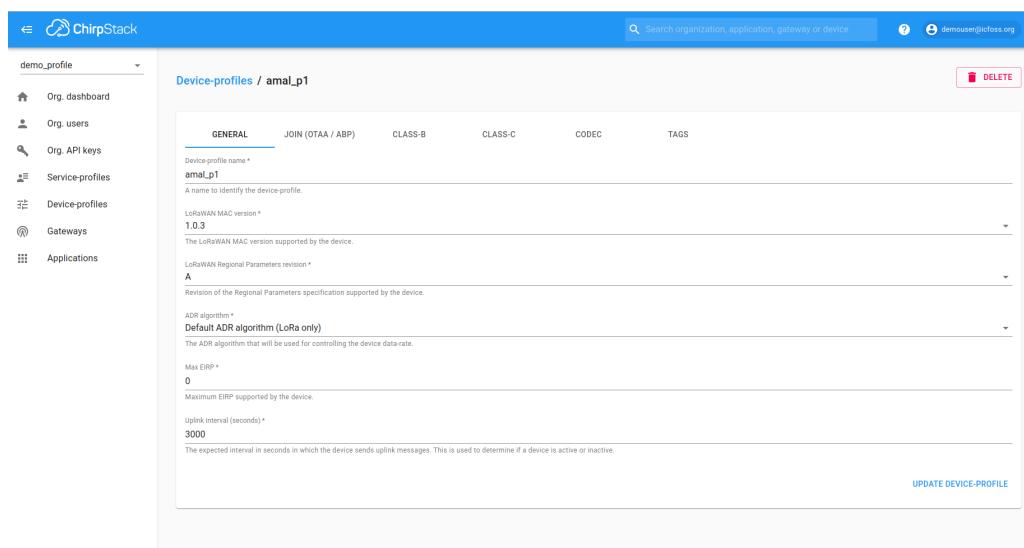


Figure 4: Device profile creation

Device-profiles / amal_p1

GENERAL **JOIN (OTAA / ABP)** **CLASS-B** **CLASS-C** **CODEC** **TAGS**

Device supports OTAA

RX1 delay *

0

RX1 delay (valid values are 0 - 15).

RX1 data-rate offset *

0

Please refer the LoRaWAN Regional Parameters specification for valid values.

RX2 data-rate *

0

Please refer the LoRaWAN Regional Parameters specification for valid values.

RX2 channel frequency (Hz) *

0

Factory-preset frequencies (Hz) *

List of factory-preset frequencies (Hz), comma separated.

UPDATE DEVICE PROFILE

Figure 5: Device profile creation

4. Save the device profile.
5. After creating the device profile, navigate to the "Applications" section.
6. Click on "Create Application" and enter the required information such as name and description.

Applications / Create

Application name *

amal_p1

The name may only contain words, numbers and dashes.

Application description *

training

Service profile *

demo_profile

The service profile to which this application will be attached. Note that you can't change this value after the application has been created.

CREATE APPLICATION

Figure 6: Creating new application

The screenshot shows the ChirpStack web interface for managing applications. On the left, a sidebar lists organization profiles: Org. dashboard, Org. users, Org. API keys, Service-profiles, Device-profiles, Gateways, and Applications. The main area is titled 'Applications / amal_p1' and shows the 'DEVICES' tab selected. A table displays one device entry:

Last seen	Device name	Device EUI	Device profile	Link margin	Battery
3 days ago	amal_p1	7bb1da84ec31d6dc	amal_p1	n/a	n/a

At the bottom right of the table, there are buttons for 'Rows per page' (set to 10), '1-1 of 1', and navigation arrows.

Figure 7: Creating new application

The screenshot shows the ChirpStack web interface for managing devices. On the left, a sidebar lists organization profiles: Org. dashboard, Org. users, Org. API keys, Service-profiles, Device-profiles, Gateways, and Applications. The main area is titled 'Applications / amal_p1 / Devices / amal_p1' and shows the 'CONFIGURATION' tab selected. Under the 'GENERAL' sub-tab, the following fields are filled:

- Device name: **amal_p1**
- Device description: **training**
- Device-profile: **amal_p1**
- Disable frame-counter validation
- Device is disabled

At the bottom right, there is a blue 'UPDATE DEVICE' button.

Figure 8: Creating new application

7. Save the application configuration.

8. Obtain network session key and application session key (as hex array) from the activation tab of the created application and paste it in the code.

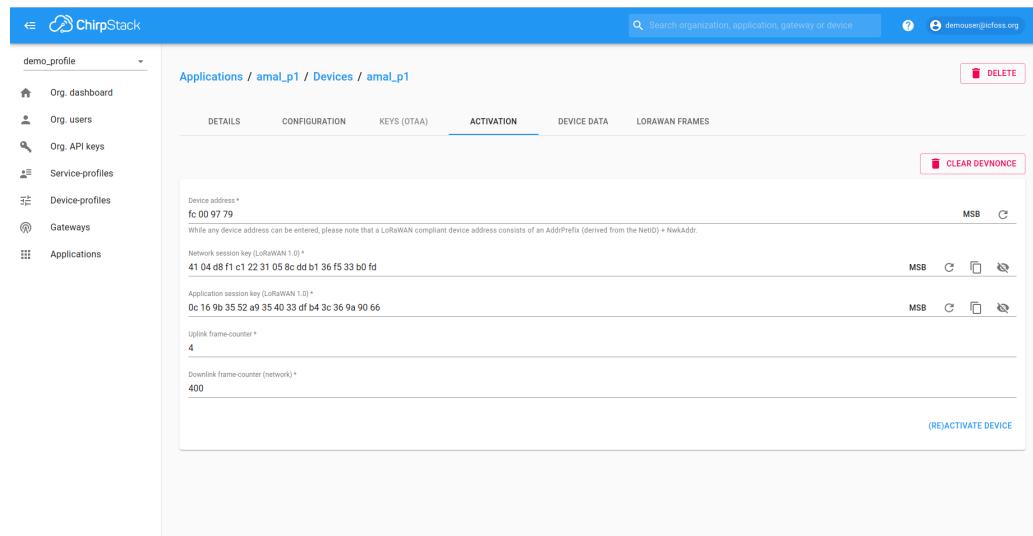


Figure 9: Obtain network session key and application session key

4.2 InfluxDB Configuration:

1. Log in to InfluxDB (<http://117.223.185.200:8086/signin>).

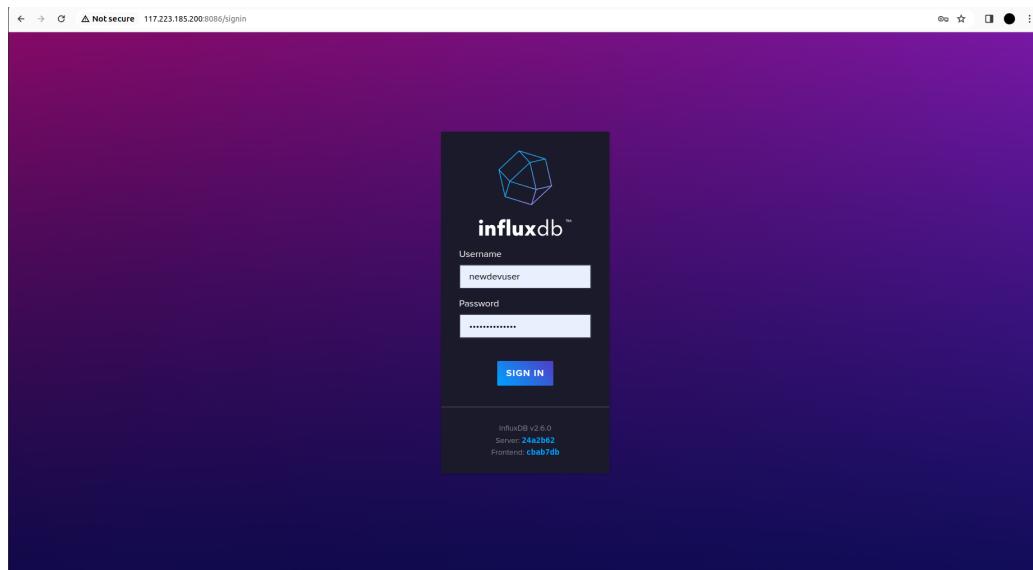


Figure 10: influxDB login

2. Create a new API token.

The screenshot shows the 'Load Data' interface with the 'API TOKENS' tab selected. A modal window titled 'Describe this API Token' is open, listing four existing API tokens: 'apitockendatabase', 'BMP180', 'cyber_security', and 'cybersec'. Each token entry includes a 'Created at' timestamp, owner information, and a 'Last Modified' timestamp. At the top right of the modal, there is a 'GENERATE API TOKEN' button.

Figure 11: create API token step 1

The screenshot shows the 'Load Data' interface with the 'API TOKENS' tab selected. A modal window titled 'Generate a Custom API Token' is open. In the 'Description' field, the value 'training' is entered. Under the 'Resources' section, the 'Buckets' category is expanded, showing several buckets: 'csey', 'davistb', 'end_node', 'ESP32', 'loradevdb', 'lorawandevtestbucket', and 'range_mapper'. For 'loradevdb', both 'Read' and 'Write' checkboxes are checked. The 'Telegraf' and 'Other Resources' sections are collapsed. At the bottom of the dialog, there are 'CANCEL' and 'GENERATE' buttons, with 'GENERATE' being the active button.

Figure 12: create API token step 2

3. Copy the generated token

The screenshot shows the 'Load Data' interface with the 'API TOKENS' tab selected. A modal window titled 'You've successfully created an API Token' is open, displaying a newly generated API token: 'DImSMpvlg591ATWG0TEBFCLrmqCtNoDm9G1qHv95-UIMPK1xsepX6DNuHTKw08fQH3T5dhPglum5FzJFBdwA=='. Above the modal, a green success message reads 'API token was created successfully'. Inside the modal, a note says 'Make sure to copy your new custom API token now. You won't be able to see it again!' and features a 'COPY TO CLIPBOARD' button.

Figure 13: Token generated

4.3 Integrating ChirpStack with InfluxDB:

1. Return to ChirpStack server and navigate to the created application.
2. Select the integration tab and choose InfluxDB.
3. Enter the InfluxDB details and paste the API Token.

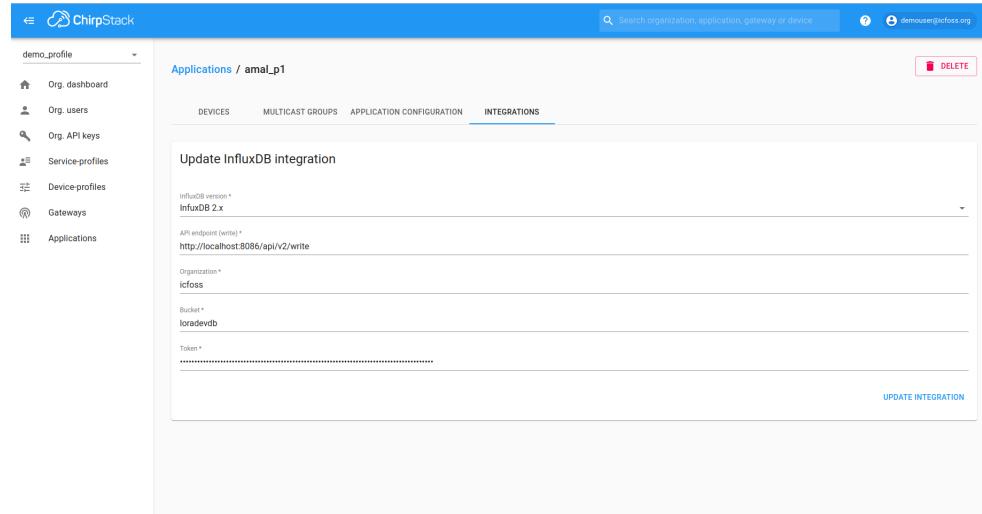


Figure 14: Integrating ChirpStack with InfluxDB

4.4 Integrating InfluxDB with Grafana:

1. Open a web browser and navigate to the InfluxDB interface (<http://117.223.185.200:8086/signin>).
2. Log in using your credentials to access the InfluxDB dashboard.
3. Once logged in, locate and select the appropriate bucket(loradevdb).

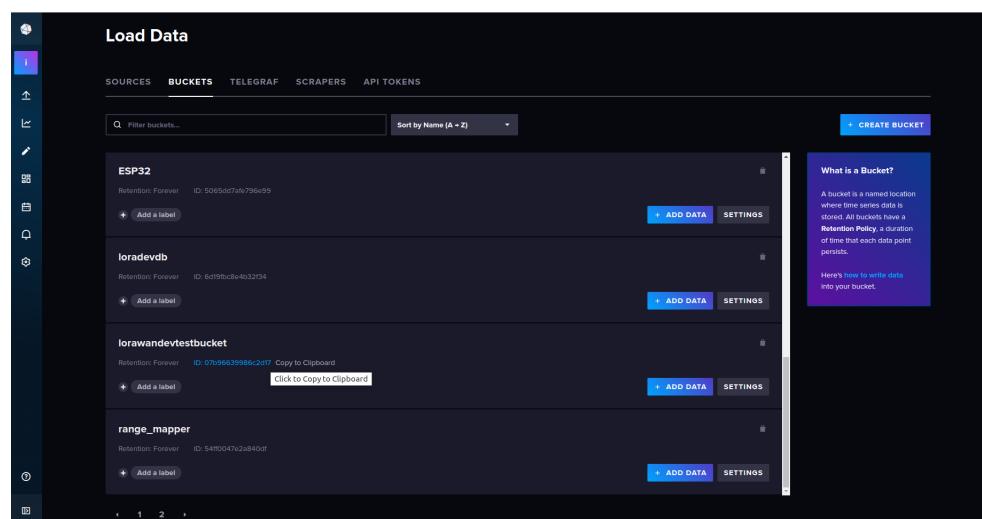


Figure 15: Select Bucket

4. Navigate to the specific data source(Pressure Data).

The screenshot shows the Data Explorer interface with a dark theme. On the left is a sidebar with icons for search, filter, sort, and other data management functions. The main area is titled "Data Explorer" and has a "Graph" button at the top. Below the graph button are several filter panels. The first panel has "application_name" set to "emal_p1". The second panel has "_field" set to "value". The third panel has "_measurement" set to "device_fmpayload_data.pressure". The fourth panel has "dev_eui" set to "7bb1da84ec1dd4c". The fifth panel has "device_name" set to "emal_p1". The sixth panel has "t_port" set to "auto (mp)". The "SCRIPT EDITOR" tab is selected, showing the following query:

```
1 from(bucket: "loradevdb")
2 |> range(start: v.timeRangeStart, stop: v.timeRangeStop)
3 |> filter(fn: (r) => r["application_name"] == "emal_p1")
4 |> filter(fn: (r) => r["_field"] == "value")
5 |> filter(fn: (r) => r["_measurement"] == "device_fmpayload_data.pressure")
6 |> filter(fn: (r) => r["dev_eui"] == "7bb1da84ec1dd4c")
7 |> filter(fn: (r) => r["device_uplink"] == true)
8 |> aggregateWindow(every: v.windowPeriod, fn: last, createEmpty: false)
9 |> yield(name: "last")
```

At the bottom right, there are buttons for "View Raw Data", "CSV", "Post 3h", "SCRIPT EDITOR", and "SUBMIT".

Figure 16: Data Source

5. Switch to query builder and copy the query.

This screenshot shows the same Data Explorer interface, but the "QUERY BUILDER" tab is now selected. The query window contains the same code as Figure 16. To the right of the query window is a sidebar with various data processing functions listed under "Transformations". These include "aggregate.rate", "chainedMomentumOscill...", "columns", "cov", "covariance", and "cumulativeSum".

Figure 17: Query Builder

4.5 Grafana Configuration:

1. Log in to Grafana (<https://visualizedev.icfoss.org/login>).

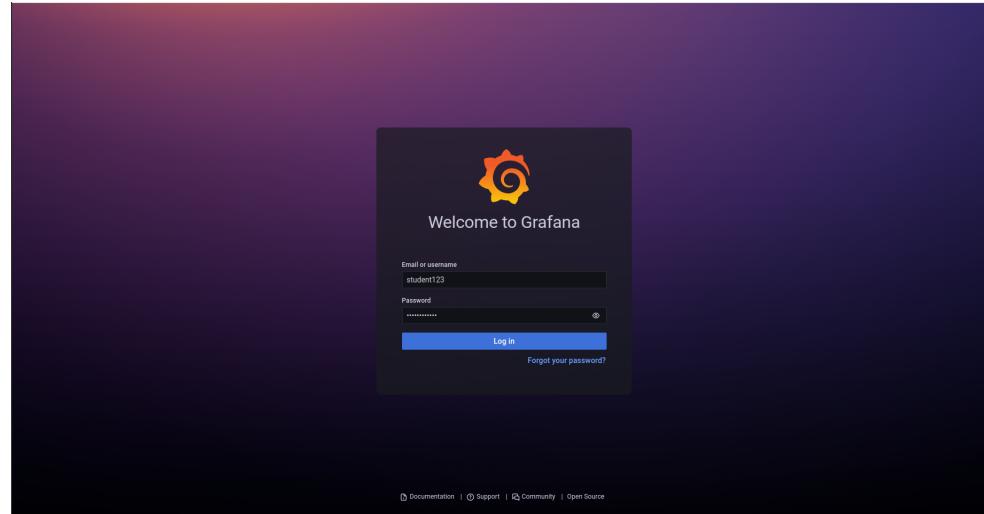


Figure 18: Grafana Login

2. Create a new Dashboard.

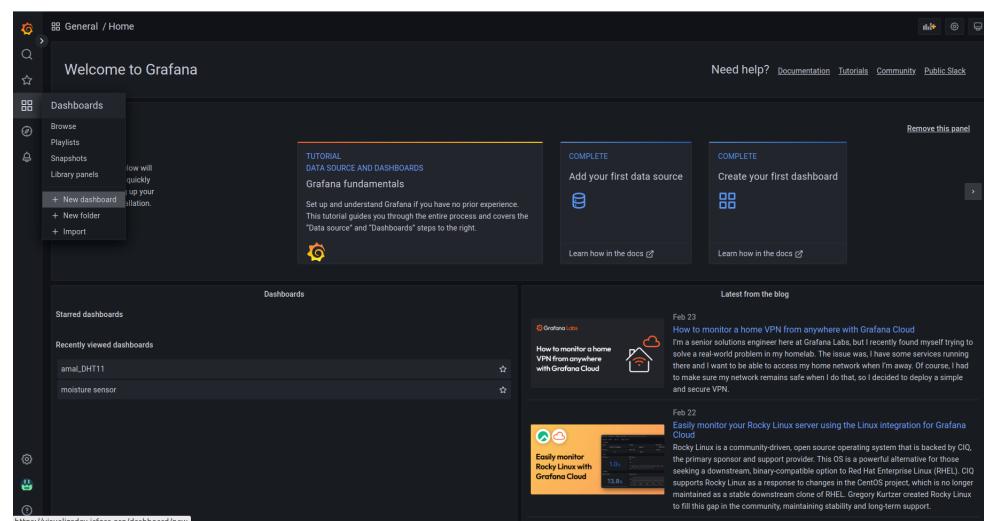


Figure 19: New Dashboard

3. Create a new panel, choose stats, and paste the copied query.

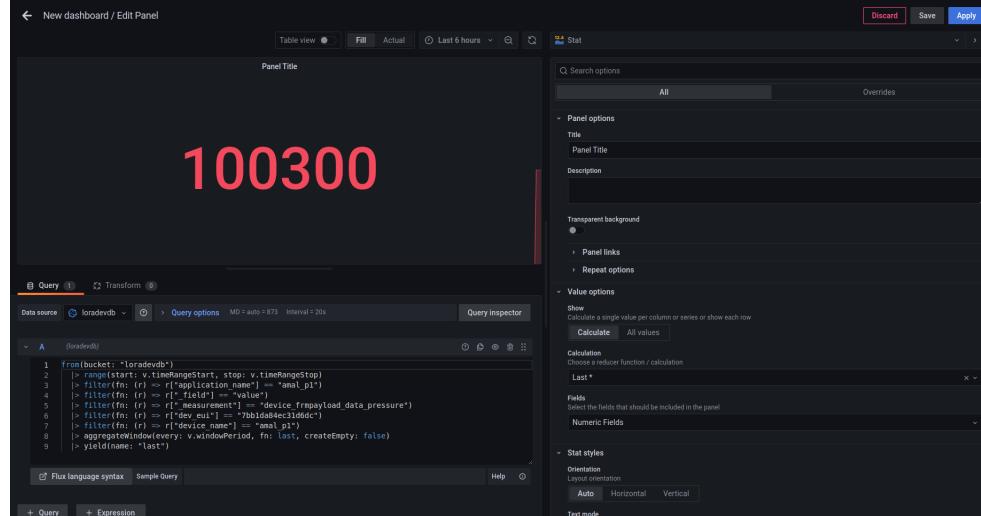


Figure 20: Panel for Pressure

4. Add Heading and unit.

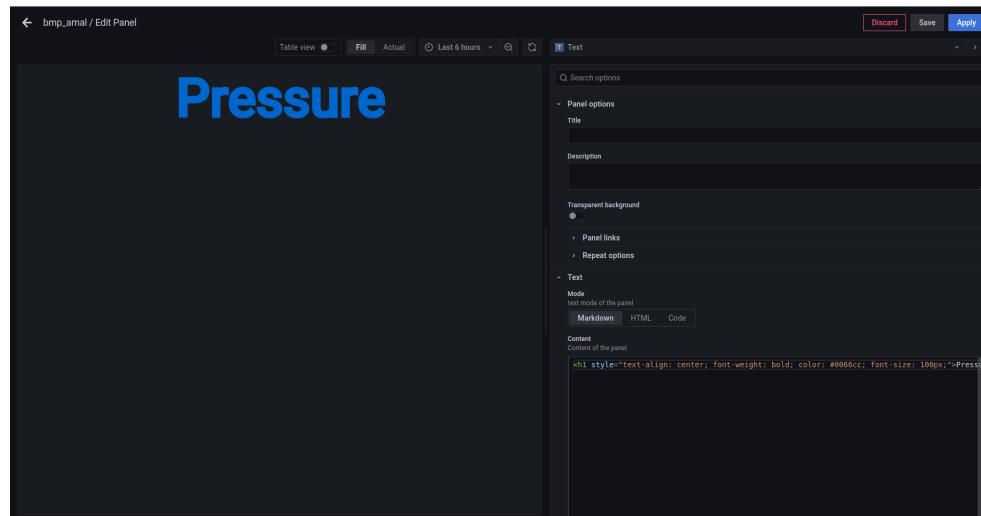


Figure 21: Panel for Heading

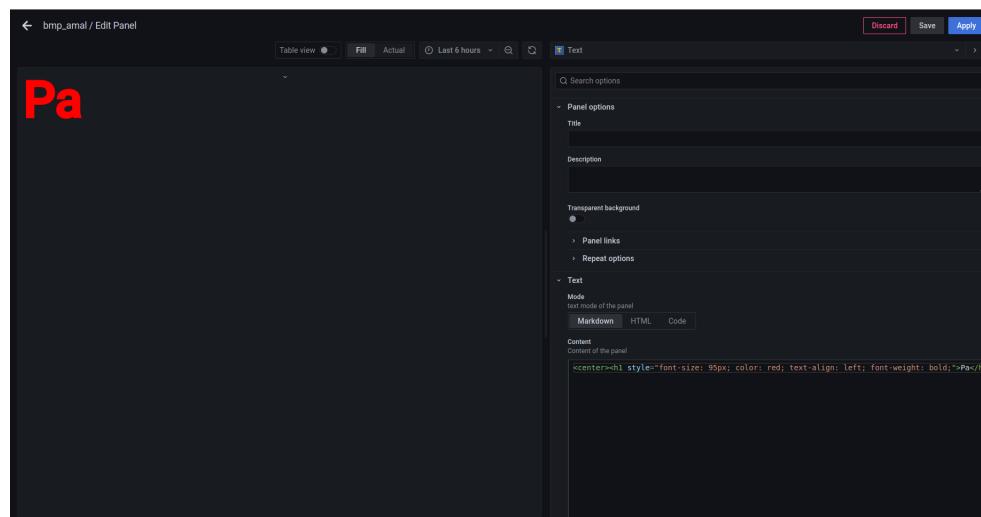


Figure 22: Panel for Unit

5. Save the Dashboard.

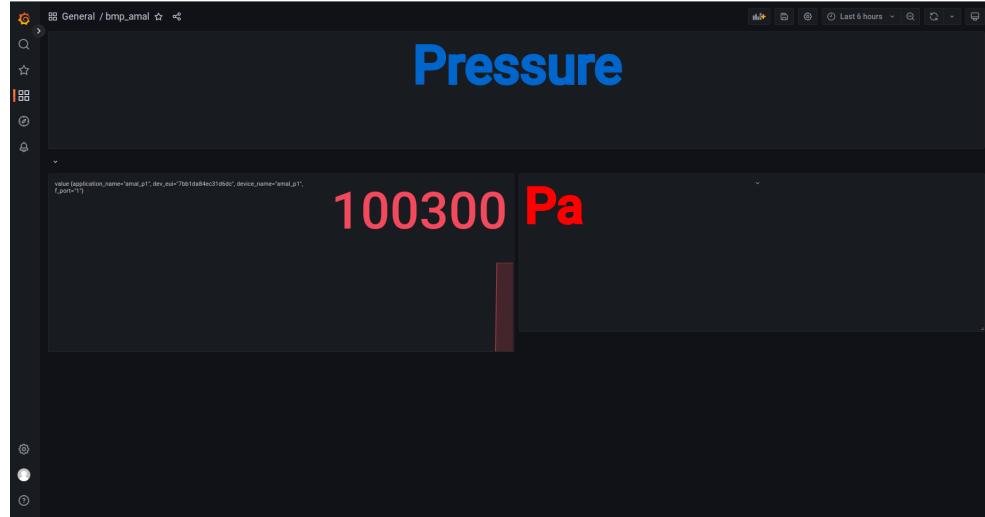


Figure 23: Final Dashboard

5 RESULT

The integration of the ULPLoRa board and BMP180 sensor, coupled with the utilization of the MCCI LoRaWAN LMIC library for LoRaWAN communication and the Adafruit BMP085 library for sensor interfacing, enables seamless data capture and transmission within IoT applications. This setup facilitates accurate monitoring of atmospheric pressure and temperature readings, empowering users to gather valuable environmental data efficiently. Furthermore, the integration with ChirpStack for LoRaWAN network management, InfluxDB for data storage, and Grafana for data visualization enhances the system's capability to monitor and analyze environmental metrics effectively.