

LOW COST LEVEL SENSING FOR DOMESTIC LPG CANISTERS

Team: Matthew Carmichael • Pragash Balachandran • Thomas Whyte-Venables • William Sparrow • Zhe Koh
Customer: Steve Braithwaite • **Supervisor:** Professor Steve Gunn • **Second Examiner:** Dr Yoshishige Tsuchiya

29th January 2021
GDP Group 43

WHY CREATE THE PRODUCT?

- Increased availability of LPG removes need for wood fires, which can have negative health effects.^[1]
- Autonomous level reporting eliminates need for customers to report that their cylinder is empty.
- Complete combustion of LPG has less environmental impact than wood.

PROBLEM STATEMENT

- Product seeks to aid rental companies with the process of recovering and exchanging LPG cylinders.
- Product must be battery-operated, and last for up to 6 months.
- Data from the cylinder must be available to view on a web or mobile application.

PROBLEM SOLUTION

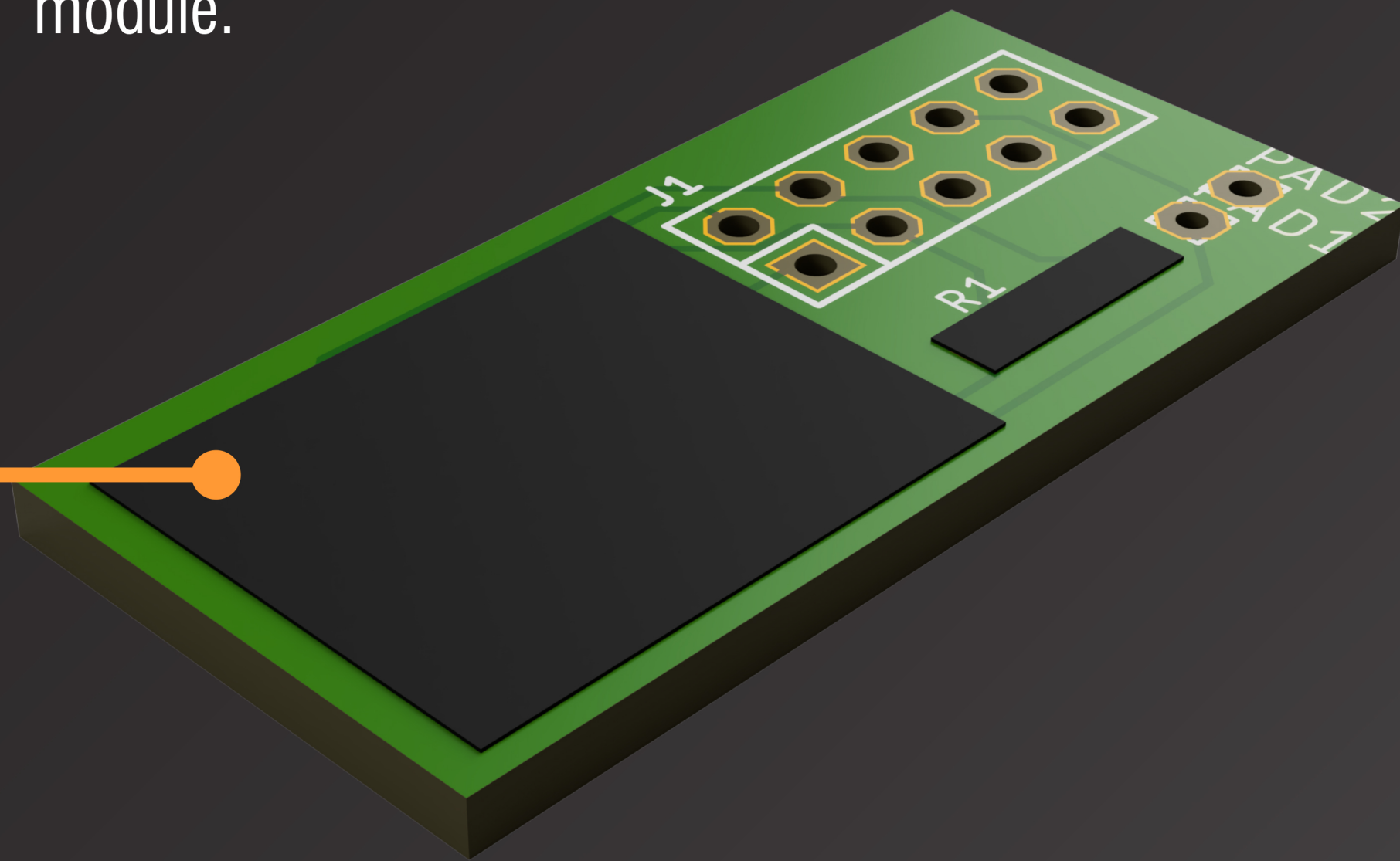
- A float sensor sealed inside the cylinder transmits a binary fill level of ‘full’ or ‘empty’ to a device on the outside of the cylinder via Bluetooth®.
- External device sends the data over a LoRaWAN system to be processed by a cloud database.

LEVEL SENSING

A float level sensor is used to measure the fill state of the LPG cylinder. The float uses a lever mechanism to hold down a switch while the fill level is above the fill threshold. The fill level threshold is 150mm above the bottom of the cylinder. When the fill level drops below this threshold, the switch will no longer be pressed. This change is registered by the nRF52840 chip.

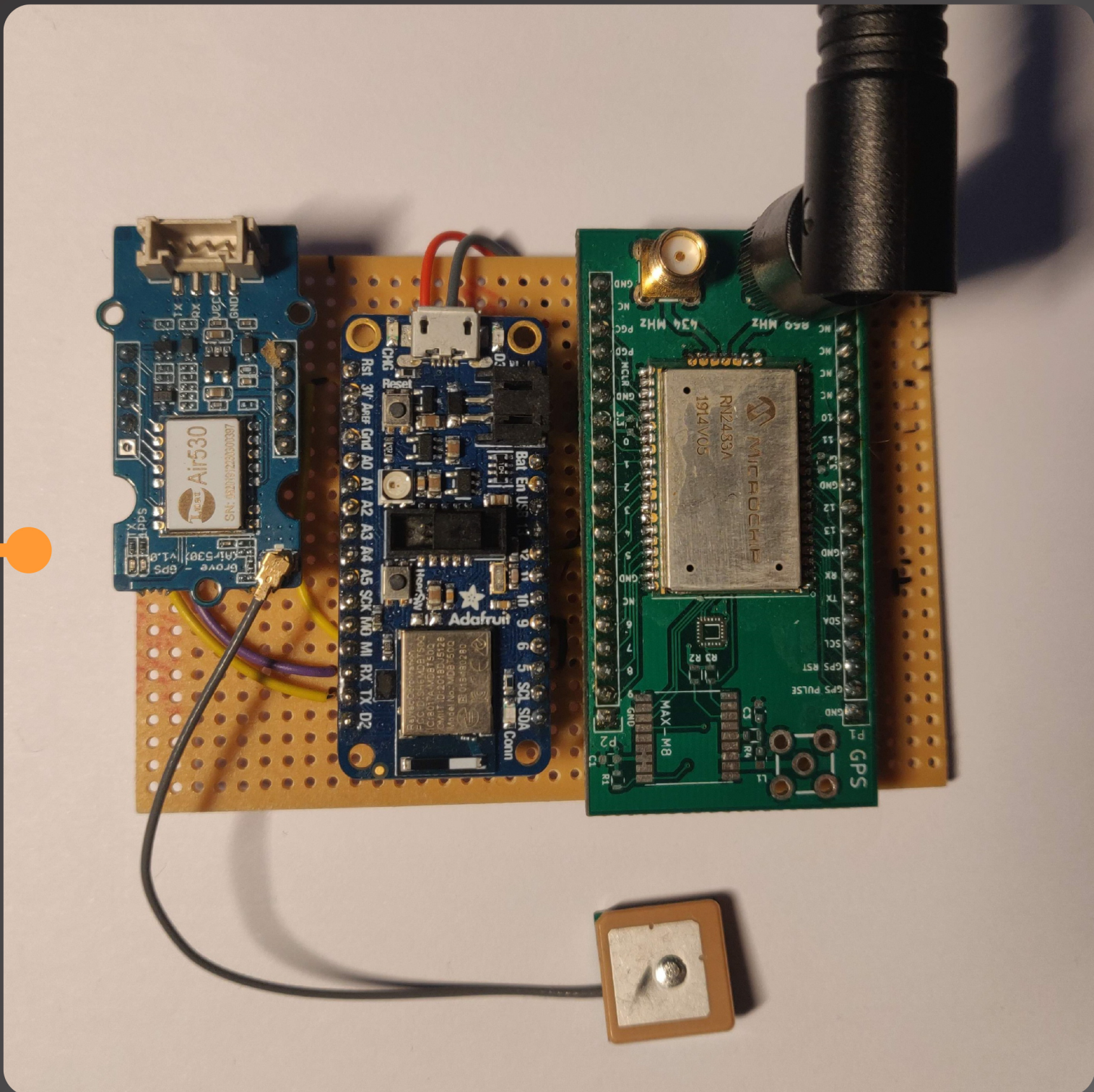
INTERNAL MODULE

A CR123A battery powers a custom designed circuit board mounted inside the cylinder. Once a day the nRF52840 chip sends the fill state to the external module.



EXTERNAL MODULE

The prototype of the external module consists of the RN2483 LoRa chip, the Adafruit Feather, and the Grove-GPS (Air530) connected by stripboard and female headers. The antennae for the LoRa and the GPS are also attached to the board.



FLOAT MATERIAL

The float is made of Nitrile Butadiene Rubber (NBR) which has a density of 1.15g/ml. The NBR contains pores which are filled with air to reduce its density to below 0.525g/ml, the density of LPG. The float will be weighted such that when submerged it holds the switch closed, and when the LPG level drops below the threshold, the float moves and opens the switch.



INTERNAL STABILISATION

When the float is placed inside the cylinder, three spring-loaded arms deploy and brace against the walls of the cylinder. This keeps the system upright and stable, even during transportation.

TESTING AND CONCLUSION

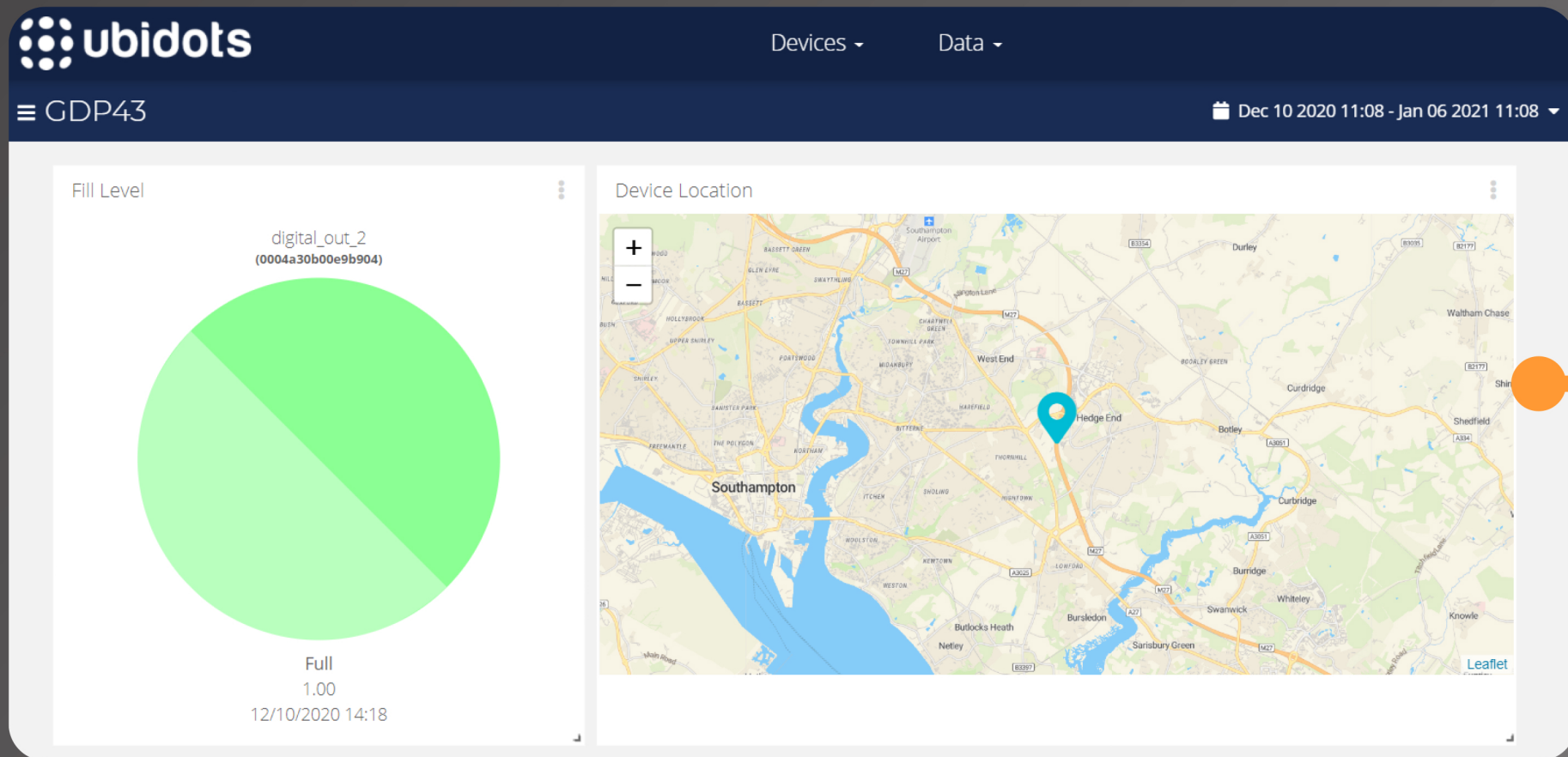
- Graph shows the current consumption over a typical cycle.
- To reduce this, external components will not be included in the end product.
- Adjusted power output uses a daily charge consumption of 344.5C, allowing it to be supported by a 20.7Ah battery for up to 6 months.
- To minimise internal module power consumption, the Bluetooth® advertising signal strength is -16dB and advertising duration is 25ms.
- Image to the left shows the internal float mechanism operating the switch, resulting in the red LED being on.
- This test was performed in a mineral oil testing medium.

LORAWAN COMMUNICATIONS

The LoRa module transmits the location and fill level of the cylinder to a base station up to 20Km away. The base station then uploads the data to The Things Network.

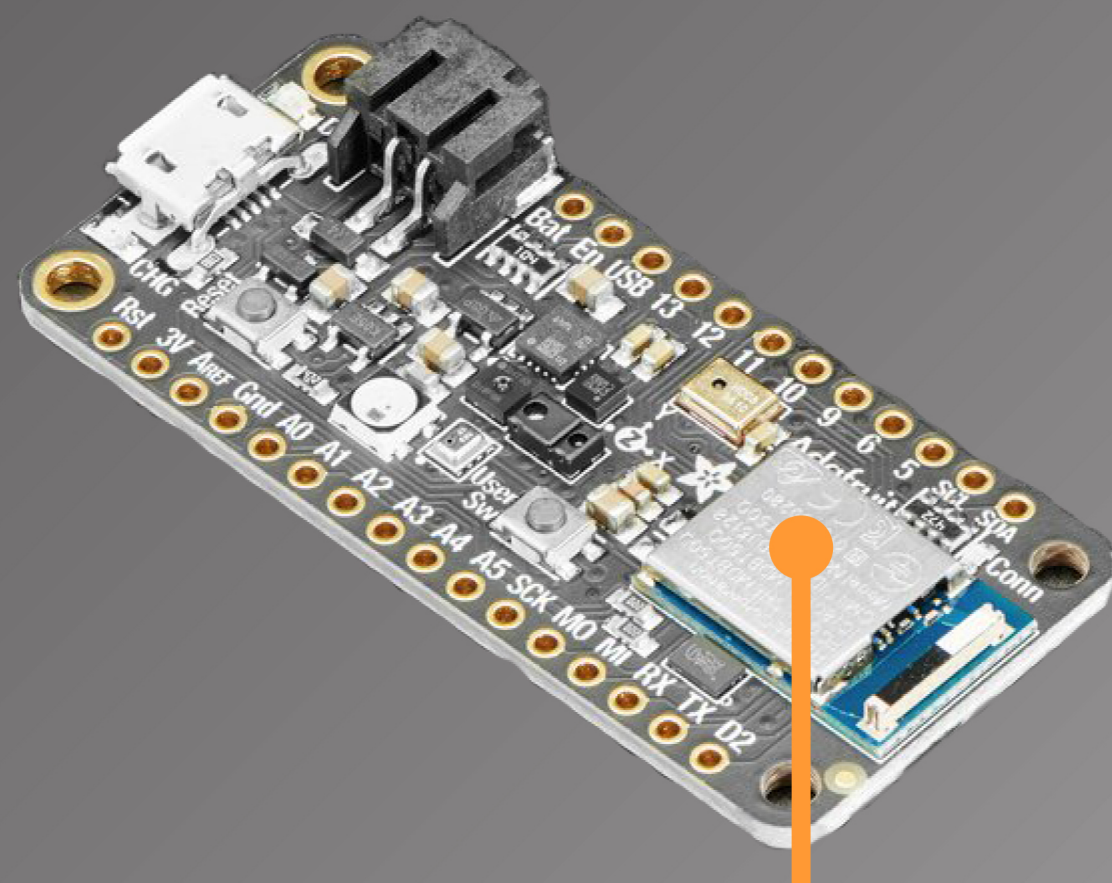
CLOUD INFRASTRUCTURE

The Things Network takes the fill level and location of the cylinder and sends them to Ubidots, where they are displayed on a dashboard.



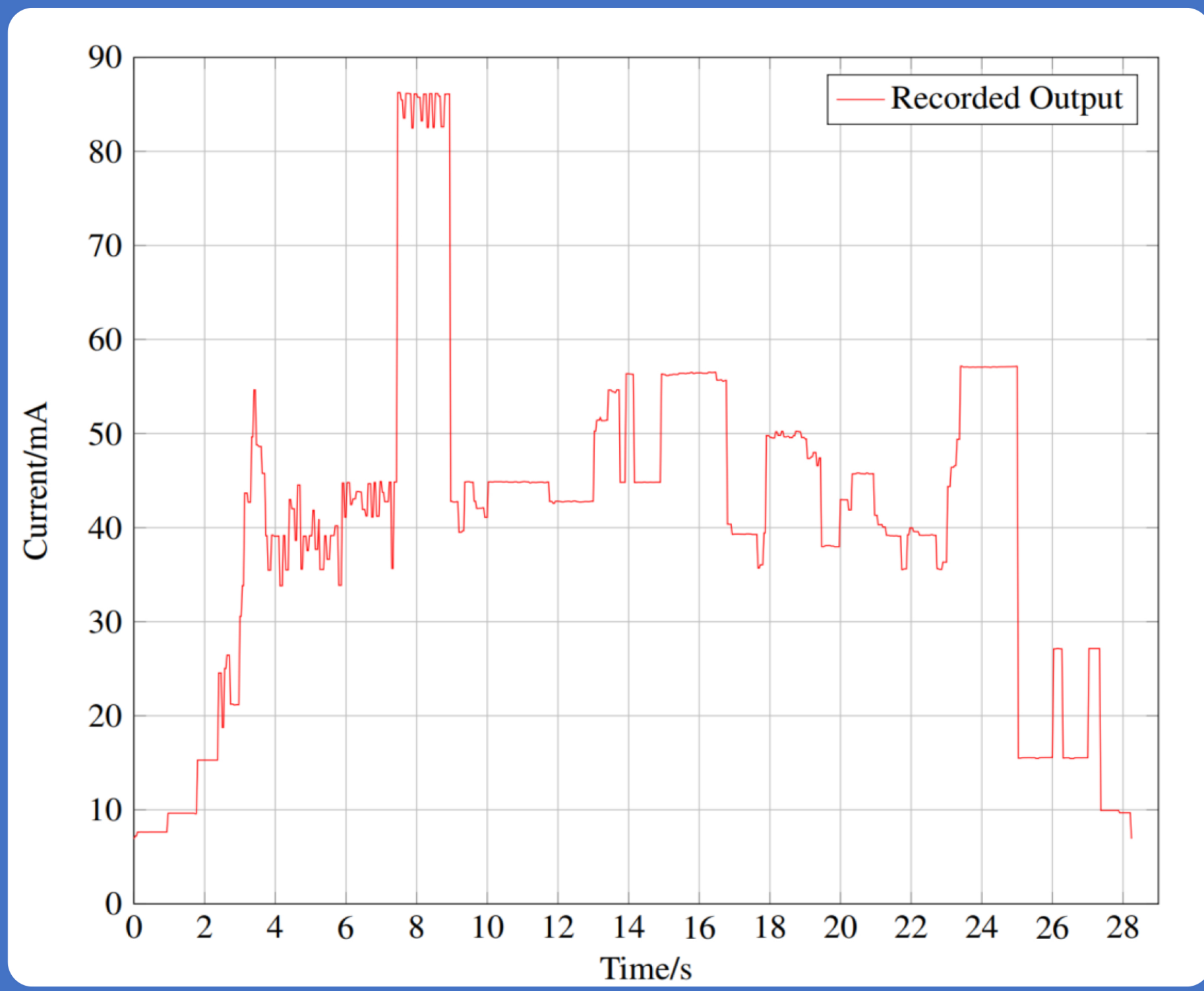
BLUETOOTH® COMMUNICATIONS

The Bluetooth® Low Energy communication system on the nRF52840 chip sends the fill state from the internal module to the external module once per day.^[2]



LOCATION TRACKING

The Grove-GPS (Air530) records the longitude and latitude of the cylinder, and transmits that information to the external microcontroller over a serial connection.



[1] <https://www.epa.gov/burnwise/wood-smoke-and-your-health>
[2] <https://cdn-shop.adafruit.com/970x728/4516-08.jpg>

