System on a Chip Microcontroller for End Station Deployments

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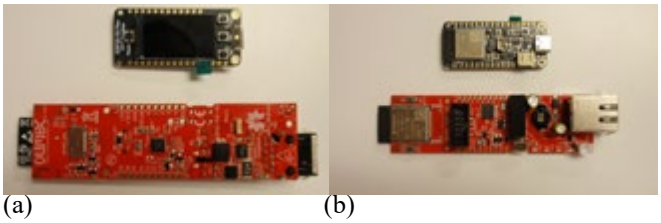
This note explains the selection process of the hardware to be integrated into the Hall B Gas System to monitor the ambient pressure and temperature.

The planned ambient pressure and temperature measurement sensors (Bosch BMP390) were tested and developed using an Adafuit Feather S3-TFT Reverse board—similar to the ones used for the field mapping units.

The only network connectivity available on Adafuit Feather S3-TFT Reverse board is WiFi. Both the field mapping units and these boards were deployed on the jlab_guest SSID (service set identifier—a network name), which uses a WPA (WiFi Protected Access) passphrase, changed monthly for security, thereby making SSID unsuitable for production deployment. The two other networks available in the end station are jlab and jlab_hallb, which require a username and a password; to use these networks a CUE (common user environment) account is issued by Jefferson Lab for each user.

As using a personal CUE account is not appropriate, a generic/general CUE account is not available, and there could be possible issues with wireless connectivity during beam operations, it was decided to switch to a wired ethernet connection for network access.

The Olimex ESP32-POE-ISO was selected as the replacement board. ESP32-POE-ISO offers the same family of system on chip (SOC) as the Adafruit board and the same programming environment, Arduino. While Olimex ESP32-POE-ISO lacks the display of the Adafruit, it has PoE (power over ethernet) for powering and network connectivity. Additionally, the ESP32-POE-ISO has galvanic isolation between the ethernet power and rest of the board. Figures 1a and b show the top and the bottom sides of the two boards.



(a) (b)

FIG. 1. (a) Top side of Adafruit board (top) and Olimex board (bottom), (b) bottom side of the Adafruit board (top) and Olimex board (bottom).

Software development consisted of a snippet of code to display the network MAC (machine access control) address, which is a unique identifier, in order for the board to be added to the Jefferson Lab network and get IP (internet protocol) assignments via DHCP (dynamic host control protocol). Additionally, the pin assignments for the I^2C bus were modified in the code, as these were different between the two boards.

The new development boards can successfully communicate with the pressure sensor and have been deployed on the Hall B development subnet. The remaining tasks are to fabricate adapter cables for the sensors (old board used STEMMA QT connectors, new one uses 0.1” headers), develop an enclosure, and integrate the board with the existing ActiveMQ message broker currently deployed to use MQTT to convert the sensor readings to EPICS PVs.

To conclude, a new microcontroller that is more appropriate for production deployment in Hall B has been selected and tested.