

ASSURE REU 2025

Electronics Workshop

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Version 1

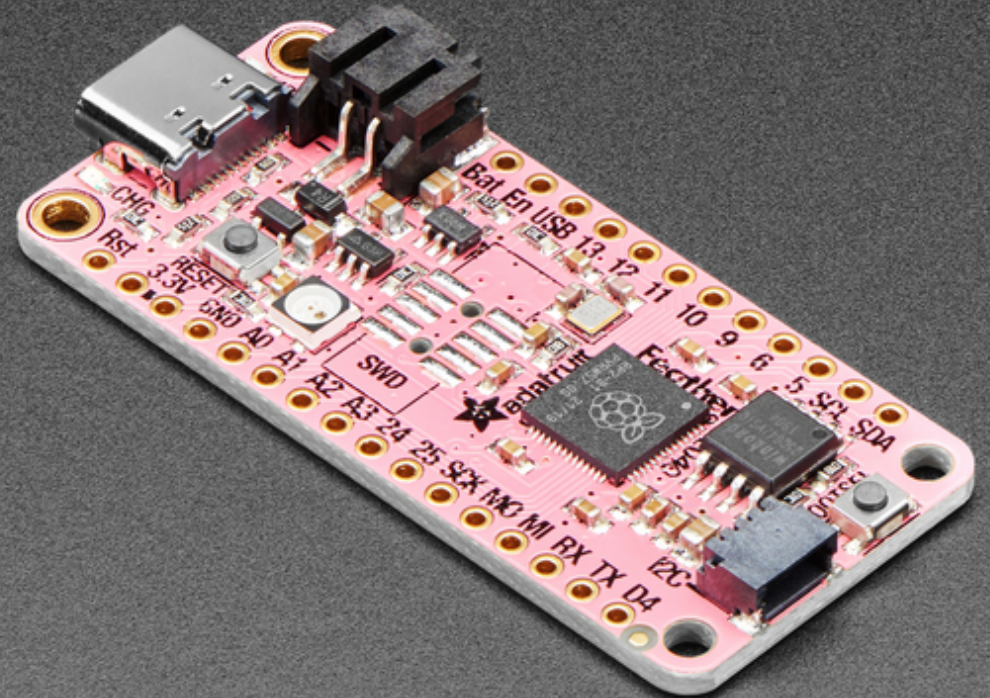
Overview

- Electronics for space science
- Balloon projects ([COSI](#))
- What is a microcontroller
- How do we **debug** electronics
- Using microcontroller
- Making our own kite experiment



Microcontroller

- RP2040 microcontroller from Adafruit
- Programming it with CircuitPython (We will teach you)
- One task at a time looping forever
- Interacts with the world easily



Tools for electronics debugging

How to tell what is happening at this moment? Digital multimeter!

- Black probe is ground (GND), reference point for voltage
- Red probe is measurement



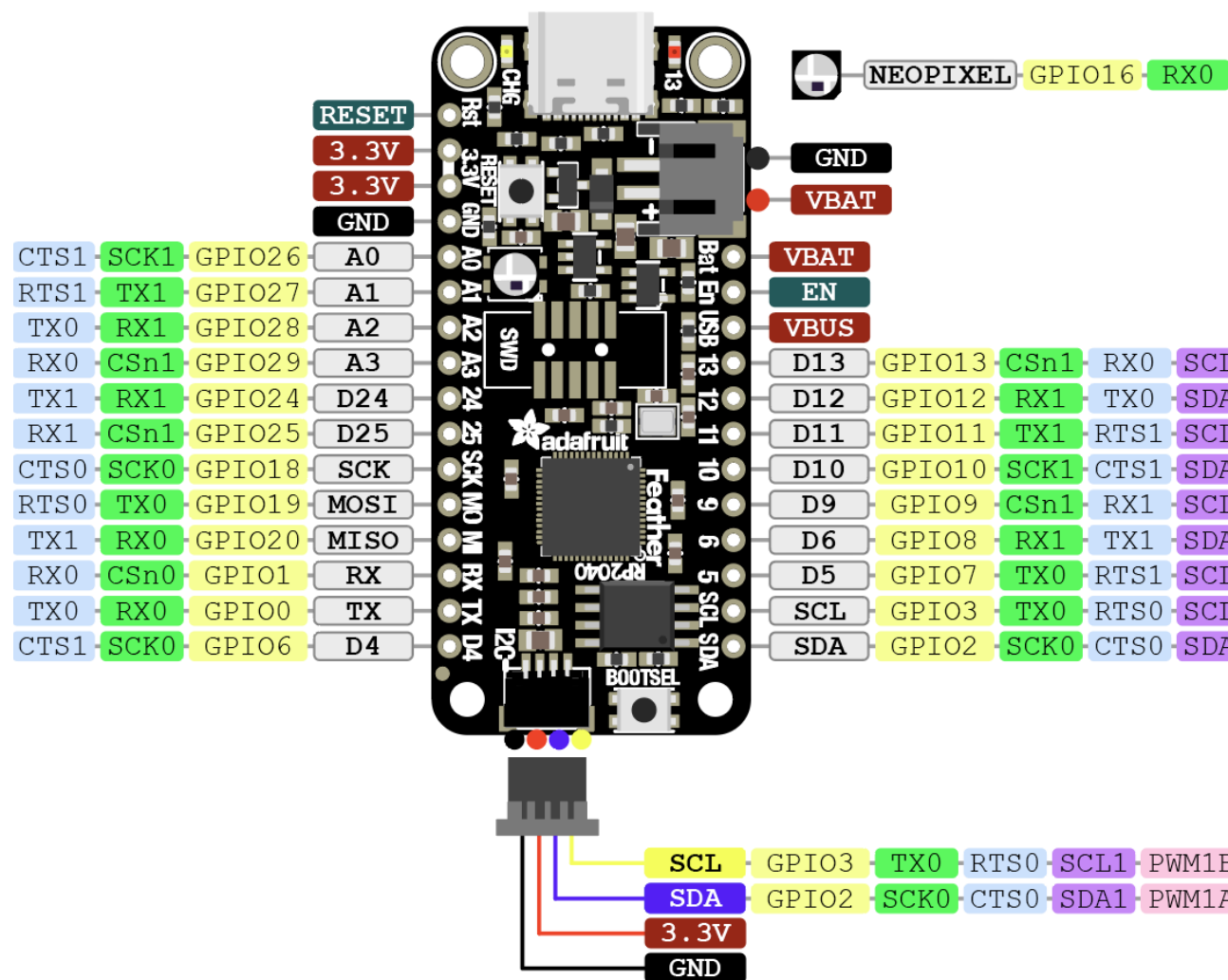
Using digital multimeter

- Plug in the microcontroller
- Black probe always touches the GND pin on the top left
- Try touching red probe to 3.3V, VBAT/BAT, and VBUS/USB
- What voltages do you measure for each?

on Name

Feather RP

<https://www.adafruit.com/pr>



Programming the microcontroller

Using the wonderful tutorials from Adafruit:

- [Install the Mu editor \(Listening to the code\)](#)
- Write "Hello World" equivalent: [Blinky](#)
- Talk/Listen to the board with the [serial console](#)

Code Structure (Python)

Library

(Code that other people wrote for you)

```
# Write your code here :-)
import board
import digitalio
import time

led = digitalio.DigitalInOut(board.LED)
led.direction = digitalio.Direction.OUTPUT

while True:
    led.value = True
    time.sleep(2)
    led.value = False
    time.sleep(0.5)
```

Code Structure (Python)

Library

(Code that other people wrote for you)

Variables

(Assign values to words)

```
# Write your code here :-)  
import board  
import digitalio  
import time  
  
led = digitalio.DigitalInOut(board.LED)  
led.direction = digitalio.Direction.OUTPUT  
  
while True:  
    led.value = True  
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    led.value = False  
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```


Code Structure (Python)

Library

(Code that other people wrote for you)

Variables

(Assign values to words)

Loop

(Do this as long as conditions is met)

```
# Write your code here :-)  
import board  
import digitalio  
import time  
  
led = digitalio.DigitalInOut(board.LED)  
led.direction = digitalio.Direction.OUTPUT  
  
while True:  
    led.value = True  
    time.sleep(2)  
    led.value = False  
    time.sleep(0.5)
```

Files for the Experiment

- `code.py` includes main loop, mostly editing this
- `boot.py` runs on startup
- `lib` contains libraries for talking to sensors

Computer: Operating system allows you to run several processes at the same time

Microcontroller: Execute whatever code it will find on its memory

.uf2-file: bootloader files/ nuke files (USB Flashing Format)

.py-file: Scripts to execute (Python)

Sensors

- BME680 is a temperature, pressure, humidity, and gas sensor
- LSM6DSO32 is an accelerometer and gyrometer

Plug in both in a chain, then copy code from repository to microcontroller to get measurements from them printed out on the screen

Preparing the microcontroller

- Download all the relevant files from [github](#)
- Delete all files on the system ('[nuke it](#)') and flash latest the [bootloader](#)
- Install the circuitpython (.uf2 file) for microcontroller
- Test the system with [Blinky](#) (Copy the code and hit reset)
- Use Mu editor (Mode: circuit python), modify the code and add print statements
and listen to the code using the Serial interface

Setting up the kite experiment!

- (Optional) Factory reset the system and reload circuit python
- Copy over the code (`boot.py`, `code.py`) and the library files
- Plug in the sensors, hit reset button, and watch the serial output
- Wave the sensors around and watch changes in serial output
- Connect Pin GND and Pin A0 to allow computer access
- Hit reset, and copy the data in `measurement.csv` file and plot them
- Repeat experiment with battery instead of USB as power source

Assembly of kite experiment

- Disconnect microcontroller from computer, leave battery attached
- Kapton tape microcontroller, sensors, and battery into a bundle ("payload") with a loop for attaching string
- Tie knot in string through payload loop
- Bring payload and kite outside

Running kite experiment

- Countdown!
- Right before launch, press reset button
- Slowly release string to allow kite to ascend
- Mark down important times in seconds from pressing reset
 - Try pulling string up and down sharply
 - Hover at various altitudes
- Return to Earth
- Bring payload and kite back inside for analysis
- Dismantle payload

Data analysis

- Jump A0 and GND to allow computer read access
- Connect microcontroller to computer
- Press reset button to return control to computer
- Copy `measurements.csv` to your computer
- Open Excel/google sheets
- Make graphs of time vs. our various measurements
- Experiment with various types of graph or combined measurements on one graph