ASSURE REU 2024

Electronics Workshop

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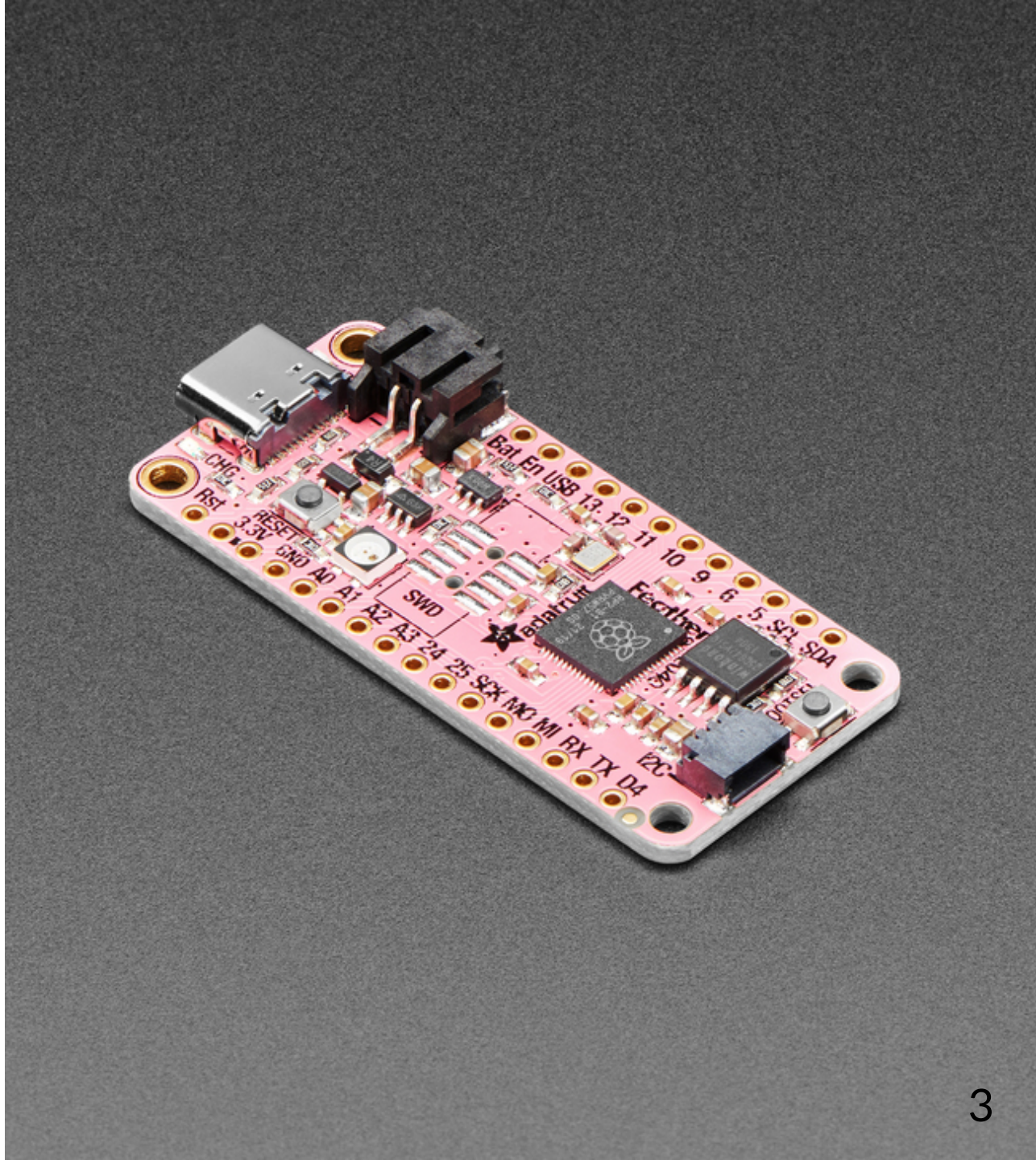
Overview

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

Microcontroller

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



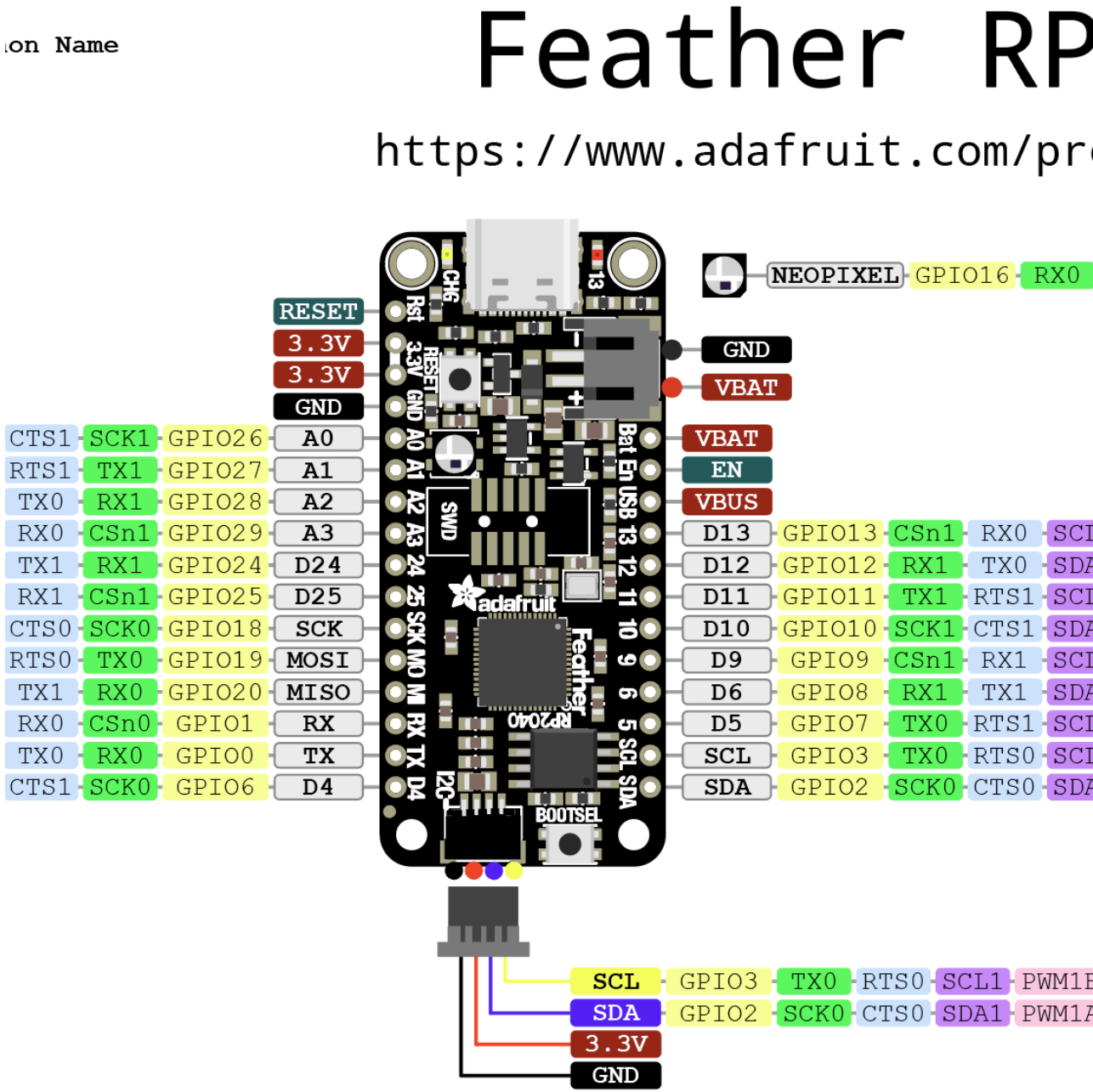
Tools for electronics debugging

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

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

Using digital multimeter

- 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?



Programming the microcontroller

Using the wonderful tutorials from Adafruit:

- Install the Mu editor (istenin to the code)
- Write "Hello World" equivalent: Blinky
- Talk 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)

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(Assign values to words)

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Code Structure (Python)

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Loop

(Do this as long as conditions is met)

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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 (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

- o nload all the rele ant iles rom ithub
- lash the system (nu e it) usin the bootloader
- nstall the latest bootloader or microcontroller
- est the system ith lin y (opy the code and hit reset)
- se lin y to rite SOS ( )

Testing the kite experiment!

- Flash the system again, install bootloader, and delete old files
- opy o er the code from kitecode (boot py, code py) and the lib folder
- lu in the battery, unplu the S cable, hit reset button
- a e the accelerometers around or seconds
- onnect in and in to allo computer access
- lu S cable bac in, open and plot the data in the measurement cs ile

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 ite outside

Running kite experiment

- Countdown!
- Right before launch, press reset button
- Slowly release string to allow ite 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 ite back inside for analysis
- Dismantle payload

Data analysis

- Connect microcontroller to computer, open serial monitor
- on irm the e periment or ed as intendet
- Press reset button to return control to computer
- Copy `measurements.csv` to a safe place on your computer
- Disconnect microcontroller from computer, put aside
- Open jupyter notebook using Anaconda
- Make graphs of time vs. our various measurements
  - Experiment with various types of graph or combined measurements on one graph