CircuitPython Libraries on Linux and the 96Boards DragonBoard 410c

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https://learn.adafruit.com/circuitpython-libraries-on-linux-and-the-96boards-dragonboard-410c

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Here at Adafruit we're always looking for ways to make making easier - whether that's making breakout boards for hard-to-solder sensors or writing libraries to simplify motor control. Our new favorite way to program is CircuitPython.

Why CircuitPython?

CircuitPython is a variant of MicroPython, a very small version of Python that can fit on a microcontroller. Python is the fastest-growing programming language. It's taught in schools, used in coding bootcamps, popular with scientists and of course programmers at companies use it a lot!

CircuitPython adds the Circuit part to the Python part. Letting you program in Python and talk to Circuitry like sensors, motors, and LEDs!

CircuitPython on Microcontrollers

For a couple years now we've had CircuitPython for microcontrollers like our SAMD21 series with Feather/Trinket/CircuitPlayground/Metro M0, as well as the ESP8266 WiFi microcontroller, nRF52 bluetooth microcontroller and SAMD51 series.
All of these chips have something in common - they are microcontrollers with hardware peripherals like SPI, I2C, ADCs etc. We squeeze Python into 'em and can then make the project portable.

But sometimes you want to do more than a microcontroller can do. Like HDMI video output, or camera capture, or serving up a website, or just something that takes more memory and computing than a microcontroller board can do...

CircuitPython & DragonBoard

CircuitPython Libraries on Linux & 96Boards DragonBoard

The next obvious step is to bring CircuitPython ease of use back to 'desktop Python'. We've got tons of projects, libraries and example code for CircuitPython on microcontrollers, and thanks to the flexibility and power of Python its pretty easy to get it working with microcomputers like the DragonBoard or other 'Linux with GPIO pins available' single board computers.

We'll use a special library called adafruit_blinka (https://adafruit.it/BJS) (named after Blinka, the CircuitPython mascot (https://adafruit.it/BJT)) to provide the layer that translates the CircuitPython hardware API to whatever library the Linux board provides. For example, on the DragonBoard we use the python libgpiod bindings. For any I2C interfacing we'll use ioctl messages to the /dev/i2c device. These details don't matter so much because they all happen underneath the adafruit_blinka layer.
The upshot is that any code we have for CircuitPython will be instantly and easily runnable on Linux computers like the DragonBoard.

In particular, we'll be able to use all of our device drivers - the sensors, led controllers, motor drivers, HATs, bonnets, etc. And nearly all of these use I2C or SPI!

Wait, isn't there already something that does this - libgpiod?

libgpiod is a python hardware interface class (https://adafru.it/FNd) that works on the DragonBoard. It works just fine for I2C, SPI and GPIO but doesn't work with our drivers as it's a different API.

By letting you use CircuitPython libraries on the DragonBoard via adafruit_blinka, you can unlock all of the drivers and example code we wrote! And you can keep using libgpiod if you like. We save time and effort so we can focus on getting code that works in one place, and you get to reuse all the code we've written already.

What about other Linux SBCs?

Yep! Blinka can easily be updated to add other boards. We've started with the ones we've got, so we could test them thoroughly. If you have other SBC board you'd like to adapt check out the adafruit_blinka code on github (https://adafru.it/BJX), pull requests are welcome as there's a ton of different Linux boards out there!

Initial Setup

Right now, Blinka only supports the DragonBoard 410c (because that's the only board we've got for testing).

Install Linaro on your DragonBoard 410c

We decided to try getting Blinka running in Linaro Debian because that's the recommended Debian installation available for the DragonBoard410c. Other distros could be made to work but you'd probably need to figure out how to detect the platform. Using other operating systems and CircuitPython is your call, we cannot provide support for that.
Download and install the latest linaro, for example we're using https://www.96boards.org/documentation/consumer/dragonboard/dragonboard410c/downloads/debian.md.html (https://adafru.it/F8N)

There's some documentation to get started at https://www.96boards.org/documentation/consumer/dragonboard/dragonboard410c/installation/ (https://adafru.it/F8O)

Blinka only supports Linaro on the DragonBoard because that's the recommended OS we could find and it's easy to detect which board you have

Preparing the Board

If you are booting from an SD card, there's one small step you'll need to take before you can do that. There's a DIP switch on the underside labeled SD BOOT that you'll need to move to the ON position.

Logging in

We've found the easiest way to connect is through a console cable, wired to the UART Serial port through a logic level shifter, and then on your computer, use a serial monitor at 115200 baud.

The DragonBoard 410c pin layout is different than Raspberry Pi and uses 1.8 Volt Logic Levels. Running with anything high could destroy your board.
USB to TTL Serial Cable - Debug / Console Cable for Raspberry Pi

The cable is easiest way ever to connect to your microcontroller/Raspberry Pi/WiFi router serial console port. Inside the big USB plug is a USB<->Serial conversion chip and at...

https://www.adafruit.com/product/954

4-channel I2C-safe Bi-directional Logic Level Converter

Because the Arduino (and Basic Stamp) are 5V devices, and most modern sensors, displays, flashcards, and modes are 3.3V-only, many makers find that they need to perform level...

https://www.adafruit.com/product/757
Half-size breadboard

This is a cute half-size breadboard, good for small projects. It's 2.2" x 3.4" (5.5 cm x 8.5 cm) with a standard double-strip in the middle and two power rails on both...

https://www.adafruit.com/product/64

Once powered correctly and with the right SD card you should get a command prompt as root. You may need to press enter if it appears to stop.

You may want to create a new username, we recommend pi - if our instructions end up adding gpio access for the pi user, you can copy and paste them. You can do this by typing:

```
adduser pi
```

and then add the new user to the sudo group:

```
usermod -aG sudo pi
```
Just to secure the board, we also recommend you change the linaro user's password, which by default is linaro:

```
$ passwd linaro
```

Be sure to keep the password in a safe place in case you need it.

Once installed, you may want to enable mdns so you can ssh `pi@linaro-developer` instead of needing to know the IP address. First you will need to update, then install:

```
$ sudo apt update
$ sudo apt install avahi-daemon
```

then reboot

## Connecting to the Network

Before you can use your DragonBoard 410c, you will need to connect to a network. The DragonBoard 410c does not come with any ethernet ports, but there's still a couple of different options available. The first option is to get a USB hub with an ethernet line.
USB 2.0 and Ethernet Hub - 3 USB Ports and 1 Ethernet

One can never have enough socks, or USB ports. Add some more USB and Ethernet capability to your Raspberry Pi or, really, any kind of computer with this USB 2.0 and...

https://www.adafruit.com/product/2909

Connecting to WiFi

The other option is to connect to an access point with the onboard WiFi.

To see a list of WiFi Access point SSIDs, type:

```
nmcli dev wifi list
```

To connect to a WIFI access point, first create the connection, replacing YOUR_SSID with your WiFi name:

```
nmcli con add con-name WiFi ifname wlan0 type wifi ssid YOUR_SSID
```

Then set up the password for your access point by enabling WPA PSK. Change this to the appropriate type if your connection is different.

```
nmcli con modify WiFi wifi-sec.key-mgmt wpa-psk
```

And add your password, replacing YOUR_PASSWORD with your WiFi password:

```
nmcli con modify WiFi wifi-sec.psk YOUR_PASSWORD
```

Finally enable the connection:

```
nmcli con up WiFi
```

You can check the connection status by typing:

```
nmcli connection show
```
Set your Python install to Python 3 Default

There's a few ways to do this, we recommend something like this:

- `sudo apt install -y python3 git python3-pip`
- `sudo update-alternatives --install /usr/bin/python python /usr/bin/python2.7 1`
- `sudo update-alternatives --install /usr/bin/python python /usr/bin/python3.7 2`
- `sudo update-alternatives --config python`

Of course, change the version numbers if a newer version of Python is distributed.

Update Your Board and Python

Run the standard updates:

- `sudo apt update`
- `sudo apt upgrade`

Choose UTF-8 for character set if prompted

and

- `sudo pip3 install --upgrade setuptools`

Update all your Python 3 packages with

- `pip3 freeze -l | grep -v '^\-e' | cut -d = -f 1 | xargs -n1 pip3 install -U`
and

```bash
sudo bash
```

```bash
pip3 freeze - local | grep -v '^\-e' | cut -d = -f 1 | xargs -n1 pip3 install -U
```

Install libgpiod

libgpiod is what we use for gpio toggling. Fortunately it's available for the DragonBoard 410c. You can install it with the following command:

```bash
sudo apt install libgpiod2 python3-libgpiod gpiod
```

After installation, you should be able to `import gpiod` from within Python 3:

```
root@linaro-developer:~# python
Python 3.7.3 (default, Apr  3 2019, 05:39:12)
[GCC 8.3.0] on linux
Type "help", "copyright", "credits" or "license" for more information.
>>> import gpiod
```

Enable UART, I2C and SPI

A vast number of our CircuitPython drivers use UART, I2C and SPI for interfacing, so you'll want to get those enabled.
You only have to do this once per board, unfortunately by default the SPI interface is disabled!

Install the support software with:

- `sudo apt install -y python-smbus python-dev i2c-tools`
- `sudo adduser pi i2c`

To use SPI, you will need to enable SPIDEV by running the following commands to modify the device tree node:

```
cd ~
git clone https://github.com/96boards/dt-update
cd dt-update
make
sudo scripts/db410c/enable-spidev.sh
```

Once you're done with both and have rebooted, verify you have the I2C and SPI devices with the command `ls /dev/i2c* /dev/spi*`

You should see at least one i2c device and one spi device.
You can test to see what I2C addresses are connected by running `sudo i2cdetect -r -y 0` (on pins 15/17) or `sudo i2cdetect -r -y 1` (on pins 19/21).

In this case I do have a sensor on the 'standard' I2C port i2c-0 under address 0x77.

The UART1 Serial Console on the DragonBoard 410c is connected to /dev/ttyMSM0. The UART1 GPIO Serial Port is connected to /dev/ttyMSM1.

Install Python Libraries

Now you're ready to install all the Python support.

Run the following command to install wheel and flask:

```
sudo pip3 install wheel flask
```

Next, run the following command to install adafruit_blinka:

```
sudo pip3 install adafruit-blinka
```
The computer will install a few different libraries such as adafruit-pureio (our ioctl-only i2c library), Adafruit-GPIO (for detecting your board) and of course adafruit-blinka.

That's pretty much it! You’re now ready to test.

Create a new file called blinkatest.py with nano or your favorite text editor and put the following in:

```python
import board
import digitalio
import busio

print("Hello blinka!")

# Try to great a Digital input
pin = digitalio.DigitalInOut(board.GPIO_A)
print("Digital IO ok!")

# Try to create an I2C device
i2c = busio.I2C(board.SCL, board.SDA)
print("I2C ok!")

# Try to create an SPI device
spi = busio.SPI(board.SCLK, board.MOSI, board.MISO)
print("SPI ok!")

print("done!")
```

Save it and run at the command line with

```bash
sudo python3 blinkatest.py
```

You should see the following, indicating digital i/o, I2C and SPI all worked

```
pi@linaro-developer:~$ sudo python3 blinkatest.py
Hello blinka!
Digital IO ok!
I2C ok!
SPI ok!
done!
pi@linaro-developer:~$
```

Digital I/O

The first step with any new hardware is the 'hello world' of electronics - blinking an LED. This is very easy with CircuitPython and DragonBoard410c. We'll extend the example to also show how to wire up a button/switch.
The DragonBoard 410c pin layout is different than Raspberry Pi and uses 1.8 Volt Logic Levels. Connecting anything higher could destroy your board.

Pin 28 is labeled as reserved because it is not attached to the primary GPIO controller. However, we mapped it to the proper location, so it is completely usable.

Parts Used

Any old LED will work just fine as long as it's not an IR LED (you can't see those) and a 470 to 2.2K resistor

Diffused Blue 10mm LED (25 pack)

Need some big indicators? We are big fans of these huge diffused blue LEDs. They are really bright so they can be seen in daytime, and from any angle. They go easily into a breadboard...

https://www.adafruit.com/product/847
Through-Hole Resistors - 470 ohm 5% 1/4W - Pack of 25

ΩMG! You're not going to be able to resist these handy resistor packs! Well, axially, they do all of the resisting for you! This is a 25 Pack of...
https://www.adafruit.com/product/2781

Some tactile buttons or switches:

Tactile Switch Buttons (12mm square, 6mm tall) x 10 pack

Medium-sized clicky momentary switches are standard input "buttons" on electronic projects. These work best in a PCB but
https://www.adafruit.com/product/1119

Because the DragonBoard 410c uses 1.8V logic levels, you will need a logic level converter to interface with most peripherals.

4-channel I2C-safe Bi-directional Logic Level Converter

Because the Arduino (and Basic Stamp) are 5V devices, and most modern sensors, displays, flashcards, and modes are 3.3V-only, many makers find that they need to perform level...
https://www.adafruit.com/product/757

We recommend using a breadboard and some male-male wires.
Premium Male/Male Jumper Wires - 40 x 6" (150mm)
Handy for making wire harnesses or jumpering between headers on PCB's. These premium jumper wires are 6" (150mm) long and come in a 'strip' of 40 (4 pieces of each of...
https://www.adafruit.com/product/758

Half-size breadboard
This is a cute half-size breadboard, good for small projects. It's 2.2" x 3.4" (5.5 cm x 8.5 cm) with a standard double-strip in the middle and two power rails on both...
https://www.adafruit.com/product/64

Wiring

• Connect the DragonBoard Ground pin to the blue ground rail on the breadboard
• Connect the DragonBoard +5V pin to the red 5V rail on the breadboard.
• Connect the DragonBoard +1.8V pin to the LV pin on the Logic Level Converter
• Connect the HV pin on the Logic Level Converter to the 5V rail
• Connect the Ground pin on the Logic Level Converter to the blue ground rail on the breadboard
• Connect one side of the tactile switch to the B1 pin on the Logic Level Converter
• Connect a ~10K pull up resistor from B1 to the 5V rail
• Connect the other side of the tactile switch to the ground rail
• Connect the longer/positive pin of the LED to the B2 pin on the Logic Level Converter
• Connect the shorter/negative pin of the LED to a 470ohm to 2.2K resistor, the other side of the resistor goes to ground rail
• Connect the DragonBoard GPIO_B pin (GPIO 12) to the A1 pin on the Logic Level Converter
• Connect the DragonBoard GPIO_A pin (GPIO 36) to the A2 pin on the Logic Level Converter
Double-check you have the right wires connected to the right location, it can be tough to keep track of GPIO pins as there are forty of them!

No additional libraries are needed so we can go straight on to the example code.

However, we recommend running a pip3 update!

```
sudo pip3 install --upgrade adafruit_blinka
```

**Blinky Time!**

The finish line is right up ahead, let's start with an example that blinks the LED on and off once a second (half a second on, half a second off):

```python
import time
import board
import digitalio

print("hello blinky!")

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

while True:
    led.value = True
    time.sleep(0.5)
```
Verify the LED is blinking. If not, check that it’s wired to the correct Logic Level Converter channel, that the Logic Level channel is connected to GPIO_A or GPIO_36, the resistor is installed correctly, and you have a Ground wire to the DragonBoard. Also, be sure to check the Power and Ground wires to the Logic Level Converter.

Type Control-C to quit

**Button It Up**

Now that you have the LED working, let's add code so the LED turns on whenever the button is pressed:

```python
import time
import board
import digitalio

print("press the button!")

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

button = digitalio.DigitalInOut(board.GPIO_B)
button.direction = digitalio.Direction.INPUT
# use an external pullup since we don't have internal PU's
#button.pull = digitalio.Pull.UP

while True:
    led.value = not button.value # light when button is pressed!
```

Press the button - see that the LED lights up!

Type Control-C to quit

**I2C Sensors & Devices**

The most popular electronic sensors use I2C to communicate. This is a 'shared bus' 2 wire protocol, you can have multiple sensors connected to the two SDA and SCL pins as long as they have unique addresses (check this guide for a list of many popular devices and their addresses (https://adafruit.it/BK0))

Let's show how to wire up a popular BME280. This sensor provides temperature, barometric pressure and humidity data over I2C
We're going to do this in a lot more depth than our guide pages for each sensor, but the overall technique is basically identical for any and all I2C sensors.

Honestly, the hardest part of using I2C devices is figuring out the I2C address (https://adafruit.it/BK0) and which pin is SDA and which pin is SCL!

**Parts Used**

[Adafruit BME280 I2C or SPI Temperature Humidity Pressure Sensor](https://www.adafruit.com/product/2652)

Bosch has stepped up their game with their new BME280 sensor, an environmental sensor with temperature, barometric pressure and humidity! This sensor is great for all sorts...


Because the DragonBoard 410c uses 1.8V logic levels, you will need a logic level converter to interface with most peripherals.

[4-channel I2C-safe Bi-directional Logic Level Converter](https://www.adafruit.com/product/757)

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Wiring

- Connect the DragonBoard Ground pin to the ground on the Logic Level Converter
- Connect the DragonBoard +5V pin to the red 5V rail on the breadboard.
- Connect the DragonBoard +1.8V pin to the LV pin on the Logic Level Converter
- Connect the HV pin on the Logic Level Converter to the 5V rail
- Connect the Vin pin on the BME280 to the red 5V rail on the breadboard
- Connect the Ground pin on the BME280 to the ground on the Logic Level Converter
- Connect the B1 pin on the Logic Level Converter to the BME280 SCK
- Connect the B2 pin on the Logic Level Converter to the BME280 SDI
- Connect the DragonBoard I2C0 SCL to the A1 pin on the Logic Level Converter
- Connect the DragonBoard I2C0 SDA to the A2 pin on the Logic Level Converter

The DragonBoard 410c pin layout is different than Raspberry Pi and uses 1.8 Volt Logic Levels. Connecting anything higher could destroy your board.
Double-check you have the right wires connected to the right location, it can be tough to keep track of header pins as there are forty of them!

After wiring, we recommend running I2C detection with `sudo i2cdetect -r -y 0` to verify that you see the device, in this case its address 77.
Install the CircuitPython BME280 Library

OK onto the good stuff, you can now install the Adafruit BME280 CircuitPython library.

As of this writing, not all libraries are up on PyPI so you may want to search before trying to install. Look for circuitpython and then the driver you want.

(If you don’t see it [you can open up a github issue on circuitpython to remind us](http://adafru.it/tB7))!

Once you know the name, install it with

```
    sudo pip3 install adafruit-circuitpython-bme280
```

![sudo pip3 install adafruit-circuitpython-bme280]

You'll notice we also installed a dependancy called adafruit-circuitpython-busdevice. This is a great thing about pip, if you have other required libraries they'll get installed too!

We also recommend an adafruit-blinka update in case we've fixed bugs:
Run that code!

The finish line is right up ahead. You can now run one of the (many in some cases) example scripts we've written for you.

Check out the examples for your library by visiting the repository for the library and looking in the example folder. In this case, it would be [https://github.com/adafruit/Adafruit_CircuitPython_BME280/tree/master/examples](https://adafruit.it/BK1)

As of this writing there's only two examples. Here's the first one:

```python
import time
import board
import busio
import adafruit_bme280

# Create library object using our Bus I2C port
i2c = busio.I2C(board.SCLK, board.SDA)
bme280 = adafruit_bme280.Adafruit_BME280_I2C(i2c)

# OR create library object using our Bus SPI port
#spi = busio.SPI(board.SCK, board.MOSI, board.MISO)
#bme_cs = digitalio.DigitalInOut(board.D10)
#bme280 = adafruit_bme280.Adafruit_BME280_SPI(spi, bme_cs)

# change this to match the location's pressure (hPa) at sea level
bme280.sea_level_pressure = 1013.25

while True:
    print("Temperature: %0.1f C" % bme280.temperature)
    print("Humidity: %0.1f %" % bme280.humidity)
    print("Pressure: %0.1f hPa" % bme280.pressure)
    print("Altitude = %0.2f meters" % bme280.altitude)
    time.sleep(2)
```

Save this code to your DragonBoard by copying and pasting it into a text file, downloading it directly from the DragonBoard, etc.

Then in your command line run

```
sudo python3 bme280_simplestest.py
```
The code will loop with the sensor data until you quit with a Control-C

Here's the second example:

```python
# Example showing how the BME280 library can be used to set the various
# parameters supported by the sensor.
# Refer to the BME280 datasheet to understand what these parameters do
import time
import board
import busio
import adafruit_bme280

# Create library object using our Bus I2C port
i2c = busio.I2C(board.SCLK, board.SDA)
bme280 = adafruit_bme280.Adafruit_BME280_I2C(i2c)

# OR create library object using our Bus SPI port
#spi = busio.SPI(board.SCK, board.MOSI, board.MISO)
#bme_cs = digitalio.DigitalInOut(board.D10)
#bme280 = adafruit_bme280.Adafruit_BME280_SPI(spi, bme_cs)

# change this to match the location's pressure (hPa) at sea level
bme280.sea_level_pressure = 1013.25
bme280.mode = adafruit_bme280.MODE_NORMAL
bme280.standby_period = adafruit_bme280.STANDBY_TC_500
bme280.iir_filter = adafruit_bme280.IIR_FILTER_X16
bme280.overscan_pressure = adafruit_bme280.OVERSCAN_X16
bme280.overscan_humidity = adafruit_bme280.OVERSCAN_X1
bme280.overscan_temperature = adafruit_bme280.OVERSCAN_X2

# The sensor will need a moment to gather initial readings
time.sleep(1)

while True:
    print("Temperature: %0.1f C" % bme280.temperature)
    print("Humidity: %0.1f %" % bme280.humidity)
```
print("Pressure: %0.1f hPa" % bme280.pressure)
print("Altitude = %0.2f meters" % bme280.altitude)
time.sleep(2)

Save this code to your DragonBoard by copying and pasting it into a text file, downloading it directly from the DragonBoard, etc.

Then in your command line run

```bash
sudo python3 bme280_normal_mode.py
```

The code will loop with the sensor data until you quit with a Control-C

That's it! Now if you want to read the documentation on the library, what each function does in depth, visit our readthedocs documentation at


### SPI Sensors & Devices

SPI is less popular than I2C but still you'll see lots of sensors and chips use it. Unlike I2C, you don't have everything share two wires. Instead, there's three shared wires (clock, data in, data out) and then a unique 'chip select' line for each chip.
The nice thing about SPI is you can have as many chips as you like, even the same kind, all share the three SPI wires, as long as each one has a unique chip select pin.

The formal/technical names for the 4 pins used are:

- **SPI clock** - called SCLK, SCK or CLK
- **SPI data out** - called MOSI for Microcontroller Out Serial In. This is the wire that takes data from the Linux computer to the sensor/chip. Sometimes marked SDI or DI on chips
- **SPI data in** - called MISO for Microcontroller In Serial Out. This is the wire that takes data to the Linux computer from the sensor/chip. Sometimes marked SDO or DO on chips
- **SPI chip select** - called CS or CE

Remember, connect all SCK, MOSI and MISO pins together (unless there's some specific reason/instruction not to) and a unique CS pin for each device.

**WARNING! SPI on Linux/DragonBoard**

SPI on microcontrollers is fairly simple, you have an SPI peripheral and you can transfer data on it with some low level command. Its 'your job' as a programmer to control the CS lines with a GPIO. That's how CircuitPython is structured as well. `busio` does just the SPI transmit/receive part and `busdevice` handles the chip select pin as well.

Linux, on the other hand, doesn't let you send data to SPI without a CS line, and the CS lines are fixed in hardware as well. For example on the DragonBoard 410c, there's only one CS pin available for the hardware SPI pins - SPI_CS - and you have to use it. (In theory there's an ioctl option called `no_cs` but this does not actually work)

The upshot here is - to let you use more than 1 peripheral on SPI, we decided to let you use any CS pins you like, CircuitPython will toggle it the way you expect. But when we transfer SPI data we always tell the kernel to use SPI_CS. SPI_CS will toggle like a CS pin, but if we leave it disconnected, its no big deal

The upshot here is basically never connect anything to SPI_CS. Use whatever chip select pin you define in CircuitPython and just leave the CS pin alone, it will toggle as if it is the chip select line, completely on its own, so you shouldn't try to use it as a digital input/output/whatever.
Parts Used

OK now that we've gone thru the warning, let's wire up an SPI MAX31855 thermocouple sensor, this particular device doesn't have a MOSI pin so we'll not connect it.

**Thermocouple Amplifier MAX31855 breakout board (MAX6675 upgrade)**
Thermocouples are very sensitive, requiring a good amplifier with a cold-compensation reference. The MAX31855K does everything for you, and can be easily interfaced with any...
https://www.adafruit.com/product/269

**Thermocouple Type-K Glass Braid Insulated**
Thermocouples are best used for measuring temperatures that can go above 100 °C. This is a bare wires bead-probe which can measure air or surface temperatures. Most inexpensive...
https://www.adafruit.com/product/270

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https://www.adafruit.com/product/757

We recommend using a breadboard and some male-male wires.

Premium Male/Male Jumper Wires - 40 x 6" (150mm)
Handy for making wire harnesses or jumpering between headers on PCB's. These premium jumper wires are 6" (150mm) long and come in a 'strip' of 40 (4 pieces of each of...
https://www.adafruit.com/product/758

Half-size breadboard
This is a cute half-size breadboard, good for small projects. It's 2.2" x 3.4" (5.5 cm x 8.5 cm) with a standard double-strip in the middle and two power rails on both...
https://www.adafruit.com/product/64

Wiring

- Connect the DragonBoard Ground pin to the blue ground rail on the breadboard
- Connect the DragonBoard +5V pin to the red 5V rail on the breadboard.
- Connect the DragonBoard +1.8V pin to the LV pin on the Logic Level Converter
- Connect the HV pin on the Logic Level Converter to the MAX3185 3Vo
• Connect the Ground pin on the Logic Level Converter to the blue ground rail on the breadboard
• Connect the Vin pin on the MAX31855 to the red 5V rail on the breadboard
• Connect the Ground pin on the MAX31855 to the blue ground rail on the breadboard
• Connect the B1 pin on the Logic Level Converter to the MAX31855 DO
• Connect the B2 pin on the Logic Level Converter to the MAX31855 CS
• Connect the B3 pin on the Logic Level Converter to the MAX31855 CLK
• Connect the DragonBoard SPI MISO to the A1 pin on the Logic Level Converter
• Connect the DragonBoard GPIO 12 to the A2 pin on the Logic Level Converter
• Connect the DragonBoard SPI CLK to the A3 pin on the Logic Level Converter

The DragonBoard 410c pin layout is different than Raspberry Pi and uses 1.8 Volt Logic Levels. Running with anything high could destroy your board.

Double-check you have the right wires connected to the right location, it can be tough to keep track of Header pins as there are forty of them!
Install the CircuitPython MAX31855 Library

OK onto the good stuff, you can now install the Adafruit MAX31855 CircuitPython library.

As of this writing, not all libraries are up on PyPI so you may want to search before trying to install. Look for circuitpython and then the driver you want.

(If you don't see it you can open up a github issue on circuitpython to remind us (https://adafru.it/tB7))

Once you know the name, install it with

```
sudo pip3 install adafruit-circuitpython-max31855
```

You'll notice we also installed a few other dependancies called spidev, adafruit-pureio, adafruit-circuitpython-busdevice and more. This is a great thing about pip, if you have other required libraries they'll get installed too!
We also recommend an adafruit-blinka update in case we've fixed bugs:

```
sudo pip3 install --upgrade adafruit_blinka
```

Run that code!

The finish line is right up ahead. You can now run one of the (many in some cases) example scripts we've written for you.

Check out the examples for your library by visiting the repository for the library and looking in the example folder. In this case, it would be https://github.com/adafruit/Adafruit_CircuitPython_MAX31855/tree/master/examples

As of this writing there's only one example. But that's cool, here it is:

```
# SPDX-FileCopyrightText: 2021 ladyada for Adafruit Industries
# SPDX-License-Identifier: MIT

import time
import board
import digitalio
import adafruit_max31855

spi = board.SPI()
cs = digitalio.DigitalInOut(board.D5)
max31855 = adafruit_max31855.MAX31855(spi, cs)

while True:
    tempC = max31855.temperature
    tempF = tempC * 9 / 5 + 32
    print("Temperature: {} C {} F ".format(tempC, tempF))
    time.sleep(2.0)
```

Save this code to your DragonBoard by copying and pasting it into a text file, downloading it directly from the Pi, etc.

Change the line that says

```
cs = digitalio.DigitalInOut(board.D5)
```

to

```
cs = digitalio.DigitalInOut(board.GPIO_12)
```

Then in your command line run

```
sudo python3 max31855_simpletest.py
```
The code will loop with the sensor data until you quit with a Control-C

Make sure you have a K-type thermocouple installed into the sensor breakout or you will get an error like the one below!

That's it! Now if you want to read the documentation on the library, what each function does in depth, visit our readthedocs documentation at


UART / Serial

After I2C and SPI, the third most popular "bus" protocol used is serial (also sometimes referred to as 'UART'). This is a non-shared two-wire protocol with an RX line, a TX line and a fixed baudrate. The most common devices that use UART are GPS units, MIDI interfaces, fingerprint sensors, thermal printers, and a scattering of sensors.

One thing you'll notice fast is that most Linux computers have minimal UARTs, often only 1 hardware port. And that hardware port may be shared with a console.

There are two ways to connect UART / Serial devices to your DragonBoard. The easy way, and the hard way.

We'll demonstrate wiring up & using an Ultimate GPS with both methods.
Adafruit Ultimate GPS Breakout - 66 channel w/10 Hz updates
We carry a few different GPS modules here in the Adafruit shop, but none that satisfied our every desire - that's why we designed this little GPS breakout board. We believe this is...
https://www.adafruit.com/product/746

The Easy Way - An External USB-Serial Converter

By far the easiest way to add a serial port is to use a USB to serial converter cable or breakout. They're not expensive, and you simply plug it into the USB port. On the other end are wires or pins that provide power, ground, RX, TX and maybe some other control pads or extras.

Here are some options, they have varying chipsets and physical designs but all will do the job. We'll list them in order of recommendation.

The first cable is easy to use and even has little plugs that you can arrange however you like, it contains a CP2102

USB to TTL Serial Cable - Debug / Console Cable for Raspberry Pi
The cable is easiest way ever to connect to your microcontroller/Raspberry Pi/WiFi router serial console port. Inside the big USB plug is a USB to Serial conversion chip and at...
https://www.adafruit.com/product/954

The CP2104 Friend is low cost, easy to use, but requires a little soldering, it has an '6-pin FTDI compatible' connector on the end, but all pins are broken out the sides.
Adafruit CP2104 Friend - USB to Serial Converter
Long gone are the days of parallel ports and serial ports. Now the USB port reigns supreme! But USB is hard, and you just want to transfer your every-day serial data from a...
https://www.adafruit.com/product/3309

Both the FTDI friend and cable use classic FTDI chips, these are more expensive than the CP2104 or PL2303 but sometimes people like them!

FTDI Friend + extras
Long gone are the days of parallel ports and serial ports. Now the USB port reigns supreme! But USB is hard, and you just want to transfer your every-day serial data from a...
https://www.adafruit.com/product/284

FTDI Serial TTL-232 USB Cable
Just about all electronics use TTL serial for debugging, bootloading, programming, serial output, etc. But it's rare for a computer to have a serial port anymore. This is a USB to...
https://www.adafruit.com/product/70

There is also a GPS module with integrated serial available which works like the GPS breakout connected to the USB to TTL Serial cable.
Adafruit Ultimate GPS with USB - 66 channel w/10 Hz updates

The Ultimate GPS module you know and love has a glow-up to let it be easily used with any computer, not just microcontrollers! With the built-in USB-to-Serial converter, you...

[Link to product page](https://www.adafruit.com/product/4279)

You can wire up the GPS by connecting the following:

- GPS Vin to USB 5V or 3V (red wire on USB console cable)
- GPS Ground to USB Ground (black wire)
- GPS RX to USB TX (green wire)
- GPS TX to USB RX (white wire)

Once the USB adapter is plugged in, you'll need to figure out what the serial port name is. You can figure it out by unplugging-replugging in the USB and then typing `dmesg | tail -10` (or just `dmesg`) and looking for text like this:

```
pi@RodriDC2:~$ dmesg | tail -10
[ 475.687284] usb 1-1.1: new full-speed USB device number 5 using dwc2
[ 475.688349] usb 1-1.1: New USB device found, idVendor=10c4, idProduct=8809, ifd=0, le=0
[ 475.691066] usb 1-1.1: New USB device strings: MfVer=1, Product=2, SerialNumber=3
[ 475.694077] usb 1-1.1: Product: CP2102 USB to UART Bridge Controller
[ 475.695086] usb 1-1.1: Manufacturer: Silicon Labs
[ 475.696083] usb 1-1.1: Product: USB Device
[ 475.697909] usb 1-1:1.1: SerialNumber: 0001
[ 475.701064] usbcore: registered new interface driver cp210x
[ 475.702065] usbserial: USB Serial support registered for cp210x
[ 475.703077] cp210x 1-1.1.1.0: cp210x converter detected
[ 475.705083] cp210x: USB-Serial converter now attached to /dev/ttyUSB0
```

At the bottom, you'll see the 'name' of the attached device, in this case its `/dev/ttyUSB0`, that means our serial port device is available at `/dev/ttyUSB0`
The Hard Way - Using Built-in UART

If you don't want to plug in external hardware to the DragonBoard you can use the built in UART on the RX/TX pins. Unlike the Raspberry Pi, the DragonBoard isn't using the RX/TX pins for a console, those are on a different UART peripheral, so you should be good to go!

You can use the built in UART via /dev/ttyMSM1

Wire the GPS as follows:

- Connect the DragonBoard Ground pin to the blue ground rail on the breadboard
- Connect the DragonBoard +5V pin to the red 5V rail on the breadboard.
- Connect the DragonBoard +1.8V pin to the LV pin on the Logic Level Converter
- Connect the HV pin on the Logic Level Converter to the red 5V rail
- Connect the Ground pin on the Logic Level Converter to the blue ground rail on the breadboard
- Connect the Vin pin on the GPS to the red 5V rail on the breadboard
- Connect the Ground pin on the GPS to the blue ground rail on the breadboard
- Connect the B1 pin on the Logic Level Converter to the GPS RX pin
- Connect the B2 pin on the Logic Level Converter to the GPS TX pin
- Connect the DragonBoard UART0 TX to the A1 pin on the Logic Level Converter
- Connect the DragonBoard UART0 RX to the A2 pin on the Logic Level Converter

The DragonBoard 410c pin layout is different than Raspberry Pi and uses 1.8 Volt Logic Levels. Running with anything high could destroy your board.
OK onto the good stuff, you can now install the Adafruit GPS CircuitPython library.

As of this writing, not all libraries are up on PyPI so you may want to search before trying to install. Look for circuitpython and then the driver you want.

(If you don't see it [you can open up a github issue on circuitpython to remind us](https://adafru.it/tB7))

Once you know the name, install it with

```
sudo pip3 install pyserial adafruit-circuitpython-gps
```
You'll notice we also installed a dependancy called pyserial. This is a great thing about pip, if you have other required libraries they'll get installed too!

We also recommend an adafruit-blinka update in case we've fixed bugs:

```
sudo pip3 install --upgrade adafruit_blinka
```

Run that code!

The finish line is right up ahead. You can now run one of the (many in some cases) example scripts we've written for you.

Check out the examples for your library by visiting the repository for the library and looking in the example folder. In this case, it would be https://github.com/adafruit/Adafruit_CircuitPython_GPS/tree/master/examples (https://adafru.it/Ca9)

Let's start with the simplest, the echo example:

```
# SPDX-FileCopyrightText: 2021 ladyada for Adafruit Industries
# SPDX-License-Identifier: MIT

# Simple GPS module demonstration.
# Will print NMEA sentences received from the GPS, great for testing connection
# Uses the GPS to send some commands, then reads directly from the GPS

import time
import board
import busio
import adafruit_gps

# Create a serial connection for the GPS connection using default speed and
# a slightly higher timeout (GPS modules typically update once a second).
# These are the defaults you should use for the GPS FeatherWing.
# For other boards set RX = GPS module TX, and TX = GPS module RX pins.
uart = busio.UART(board.TX, board.RX, baudrate=9600, timeout=10)

# for a computer, use the pyserial library for uart access
# import serial
# uart = serial.Serial("/dev/ttyUSB0", baudrate=9600, timeout=10)

# If using I2C, we'll create an I2C interface to talk to using default pins
# i2c = board.I2C()

# Create a GPS module instance.
gps = adafruit_gps.GPS(uart)  # Use UART/pyserial
gps = adafruit_gps.GPS_GtopI2C(i2c)  # Use I2C interface

# Initialize the GPS module by changing what data it sends and at what rate.
# These are NMEA extensions for PMTK_314_SET_NMEA_OUTPUT and
# PMTK_220_SET_NMEA_UPDATERATE but you can send anything from here to adjust
# the GPS module behavior:
# https://cdn-shop.adafruit.com/datasheets/PMTK_A11.pdf

gps.send_command(b"PMTK314,0,1,0,1,0,0,0,0,0,0,0,0,0,0,0,0,0,0,0"

# Turn on the basic GGA and RMC info (what you typically want)
gps.send_command(b"PMTK314,0,1,0,1,0,0,0,0,0,0,0,0,0,0,0,0,0,0,0"
# Turn on just minimum info (RMC only, location):
```
# Turn off everything:
gps.send_command(b'PMTK314,0,0,0,0,0,0,0,0,0,0,0,0,0,0,0,0,0,0,0,0')
# Main loop runs forever printing data as it comes in

```
timestamp = time.monotonic()
while True:
    data = gps.read(32)  # read up to 32 bytes
    print(data)  # this is a bytearray type
    if data is not None:
        # convert bytearray to string
        data_string = ''.join([chr(b) for b in data])
        print(data_string, end=''

    if time.monotonic() - timestamp > 5:
        # every 5 seconds...
        gps.send_command(b'PMTK605')  # request firmware version
        timestamp = time.monotonic()
```

We'll need to configure this code to work with our UART port name.

- If you're using a USB-to-serial converter, the device name is probably /dev/ttyUSB0 - but check dmesg to make sure.
- If you're using the built-in UART on the DragonBoard, the device name is /dev/ttyMSM1.

Comment out the lines that reference `board.TX, board.RX` and `busio.uart` and uncomment the lines that import `serial` and define the `serial` device, like so:

```
# Define RX and TX pins for the board's serial port connected to the GPS.
# These are the defaults you should use for the GPS FeatherWing.
# For other boards set RX = GPS module TX, and TX = GPS module RX pins.
#RX = board.RX
#TX = board.TX

# Create a serial connection for the GPS connection using default speed and
# a slightly higher timeout (GPS modules typically update once a second).
#uart = busio.UART(TX, RX, baudrate=9600, timeout=3000)

# for a computer, use the pyserial library for uart access
import serial
uart = serial.Serial("/dev/ttyUSB0", baudrate=9600, timeout=3000)
```

And update the `/dev/ttyUSB0` device name if necessary to match your USB interface.
Whichever method you use, you should see output like this, with $GP "NMEA sentences" - there probably won't be actual location data because you haven't gotten a GPS fix. As long as you see those $GP strings sorta like the below, you've got it working!

More To Come!

That's just a taste of what we've got working so far

We're adding more support constantly, so please hold tight and visit the adafruit_blinka github repo (https://adafruit.it/BJX) to share your feedback and perhaps even submit some improvements!

If you'd like to contribute, but aren't sure where to start, check out the following guides:

- Adding a Single Board Computer to PlatformDetect for Blinky (https://adafruit.it/JFy)
- Adding a Single Board Computer to Blinky (https://adafruit.it/KEF)

FAQ & Troubleshooting

There's a few oddities when running Blinky/CircuitPython on linux. Here's a list of stuff to watch for that we know of!
This FAQ covers all the various platforms and hardware setups you can run Blinka on. Therefore, some of the information may not apply to your specific setup.

**Update Blinka/Platform Libraries**

Most issues can be solved by forcing Python to upgrade to the latest `blinka` / `platform-detect` libraries. Try running

```
sudo python3 -m pip install --upgrade --force-reinstall adafruit-blinka Adafruit-PlatformDetect
```

**Getting an error message about "board" not found or "board" has no attribute**

Somehow you have ended up with either the wrong board module or no board module at all.

DO NOT try to fix this by manually installing a library named `board`. There is one out there ([https://adafruit.it/NCE](https://adafruit.it/NCE)) and it has nothing to do with Blinka. You will break things if you install that library!

The easiest way to recover is to simply force a reinstall of Blinka with:

```
python3 -m pip install --upgrade --force-reinstall adafruit-blinka
```

**Mixed SPI mode devices**

Due to the way we share an SPI peripheral, you cannot have two SPI devices with different 'mode/polarity' on the same SPI bus - you'll get weird data.

95% of SPI devices are mode 0, check the driver to see mode or polarity settings. For example:

- **LSM9DS1 is mode 1** ([https://adafruit.it/NCF](https://adafruit.it/NCF)), please use in I2C mode instead of SPI
- **MAX31865 is phase 1** ([https://adafruit.it/NCG](https://adafruit.it/NCG)), try using this on a separate SPI device, or read data twice.
Why am I getting AttributeError: 'SpiDev' object has no attribute 'writebytes2'?

This is due to having an older version of spidev (https://adafru.it/JEi). You need at least version 3.4. This should have been taken care of (https://adafru.it/NCH) when you installed Blinka, but in some cases it does not seem to happen.

To check what version of spidev Python is using:

```
$ python3
Python 3.6.8 (default, Oct 7 2019, 12:59:55) 
[GCC 8.3.0] on linux
Type "help", "copyright", "credits" or "license" for more information.
>>> import spidev
>>> spidev.__version__
'3.4'
```  

If you see a version lower then 3.4 reported, then try a force upgrade of spidev with (back at command line):

```
sudo python3 -m pip install --upgrade --force-reinstall spidev
```  

No Pullup/Pulldown support on some linux boards or MCP2221

Some linux boards, for example, AllWinner-based, do not have support to set pull up or pull down on their GPIO. Use an external resistor instead!

Getting OSError: read error with MCP2221

If you are getting a stack trace that ends with something like:

```
return_self._hid.read(64)
File "hid.pyx", line 122, in hid.device.read
OSError: read error
```  

Try setting an environment variable named BLINKA_MCP2221_RESET_DELAY to a value of 0.5 or higher.
Windows:

```
set BLINKA_MCP2221_RESET_DELAY=0.5
```

Linux:

```
export BLINKA_MCP2221_RESET_DELAY=0.5
```

This is a value in seconds to wait between resetting the MCP2221 and the attempt to reopen it. The reset is seen by the operating system as a hardware disconnect/reconnect. Different operating systems can need different amounts of time to wait after the reconnect before the attempt to reopen. Setting the above environment variable will override the default reset delay time, allowing it to be increased as needed for different setups.

---

Using FT232H with other FTDI devices.

Blinka uses the libusbk driver to talk to the FT232H directly. If you have other FTDI devices installed that are using the FTDI VCP drivers, you may run into issues. See here for a possible workaround:


---

Getting "no backend available" with pyusb on Windows

This is probably only an issue for older versions of Windows. If you run into something like this, see this issue thread:

https://github.com/pyusb/pyusb/issues/120

which describes copying the 32bit and 64bit DLLs into specific folders. (example for Win7)

---

I can't get neopixel, analogio, audioio, rotaryio, displayio or pulseio to work!

Some CircuitPython modules like may not be supported.

- Most SBCs do not have analog inputs so there is no analogio
• Few SBCs have neopixel support so that is only available on Raspberry Pi (and any others that have low level neopixel protocol writing)
• Rotary encoders (rotaryio) is handled by interrupts on microcontrollers, and is not supported on SBCs at this time
• Likewise pulseio PWM support is not supported on many SBCs, and if it is, it will not support a carrier wave (Infrared transmission)
• For display usage, we suggest using python Pillow library or Pygame, we do not have displayio support

We aim to have, at a minimum, digitalio and busio (I2C/SPI). This lets you use the vast number of driver libraries

For analog inputs, the MCP3xxx library (https://adafru.it/CPN) will give you AnalogIn objects. For PWM outputs, try the PCA9685 (https://adafru.it/tZF). For audio, use pygame or other Python3 libraries to play audio.

Some libraries, like Adafruit_CircuitPython_DHT (https://adafru.it/Beq) will try to bit-bang if pulsein isn't available. Slow linux boards (<700MHz) may not be able to read the pins fast enough, you'll just have to try!

Help, I'm getting the message "error while loading shared libraries: libgpiod.so.2: cannot open shared object file: No such file or directory"

It looks like libgpiod may not be installed on your board.

Try running the command: sudo apt-get install libgpiod2

When running the libgpiod script, I see the message: configure: error: "libgpiod needs linux headers version &gt;= v5.5.0"

Be sure you have the latest libgpiod.sh script and run it with the -l or --legacy flag:

./libgpiod.sh --legacy
All Raspberry Pi Computers Have:

- 1 x I2C port with busio (but clock stretching is not supported in hardware, so you must set the I2C bus speed to 10KHz to 'fix it')
- 2 x SPI ports with busio
- 1 x UART port with serial - note this is shared with the hardware console
- pulseio.pulseIn using gpiod
- neopixel support on a few pins
- No AnalogIn support (Use an MCP3008 or similar to add ADC)
- No PWM support (Use a PCA9685 or similar to add PWM)

Google Coral TPU Dev Boards Have:

- 1 x I2C port with busio
- 1 x SPI ports with busio
- 1 x UART port with serial - note this is shared with the hardware console
- 3 x PWMOut support
- pulseio.pulseIn using gpiod
- No NeoPixel support
- No AnalogIn support (Use an MCP3008 or similar to add ADC)

Orange Pi PC Plus Boards Have:

- 1 x I2C port with busio
- 1 x SPI ports with busio
- 1 x UART port with serial
- pulseio.pulseIn using gpiod
- No NeoPixel support
- No AnalogIn support (Use an MCP3008 or similar to add ADC)
- No PWM support (Use a PCA9685 or similar to add PWM)
Orange Pi R1 Boards Have:

- 1 x I2C port with busio
- 1 x SPI port with busio
- 1 x UART port with serial
- No NeoPixel support
- No AnalogIn support (Use an MCP3008 or similar to add ADC)
- No PWM support (Use a PCA9685 or similar to add PWM)

Odroid C2 Boards Have:

- 1 x I2C port with busio
- No SPI support
- 1 x UART port with serial - note this is shared with the hardware console
- No NeoPixel support
- No AnalogIn support (Use an MCP3008 or similar to add ADC)
- No PWM support (Use a PCA9685 or similar to add PWM)

DragonBoard 410c Boards Have:

- 2 x I2C port with busio
- 1 x SPI port with busio
- 1 x UART port with serial
- No NeoPixel support
- No AnalogIn support (Use an MCP3008 or similar to add ADC)
- No PWM support (Use a PCA9685 or similar to add PWM)
NVIDIA Jetson Nano Boards Have:

- 2 x I2C port with `busio`
- 2 x SPI ports with `busio`
- 2 x UART port with serial - note one of these is shared with the hardware console
- No NeoPixel support
- No AnalogIn support (Use an MCP3008 or similar to add ADC)
- No PWM support (Use a PCA9685 or similar to add PWM)

FT232H Breakouts Have:

- 1x I2C port OR SPI port with `busio`
- 12x GPIO pins with `digitalio`
- No UART
- No AnalogIn support
- No AnalogOut support
- No PWM support

If you are using Blinka in FT232H mode (https://adafruit.io/FWD), then keep in mind these basic limitations.

- SPI and I2C cannot be used at the same time since they share the same pins.
- GPIO speed is not super fast, so trying to do arbitrary bit bang like things may run into speed issues.
- There are no ADCs.
- There are no DACs.
- UART is not available (its a different FTDI mode)
MCP2221 Breakouts Have:

- 1x I2C port with busio
- 4x GPIO pins with digitalio
- 3x AnalogIn with analogio
- 1x AnalogOut with analogio
- 1x UART with pyserial
- No PWM support
- No hardware SPI support

If you are using Blinka in MCP2221 mode, then keep in mind these basic limitations.

- GPIO speed is not super fast, so trying to do arbitrary bit bang like things may run into speed issues.
- UART is available via `pyserial`, the serial COM port shows up as a second USB device during enumeration.