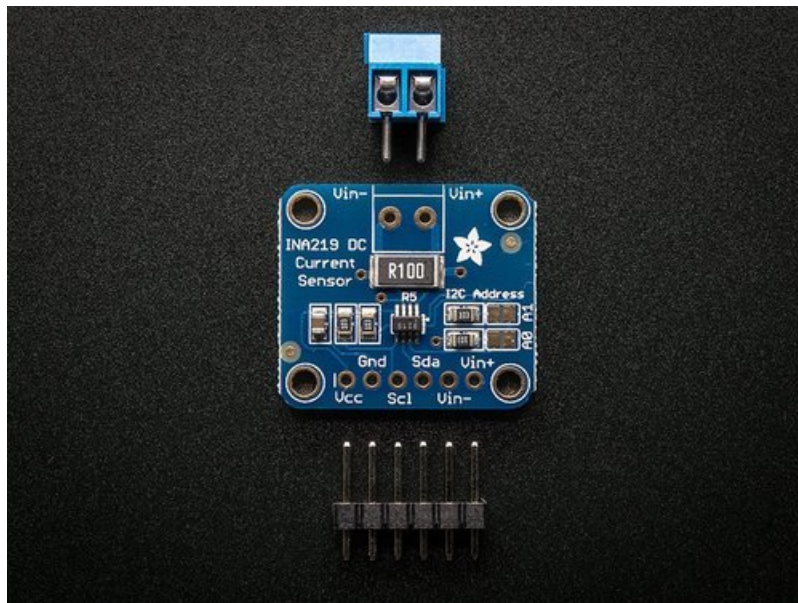


Adafruit INA219 Current Sensor Breakout

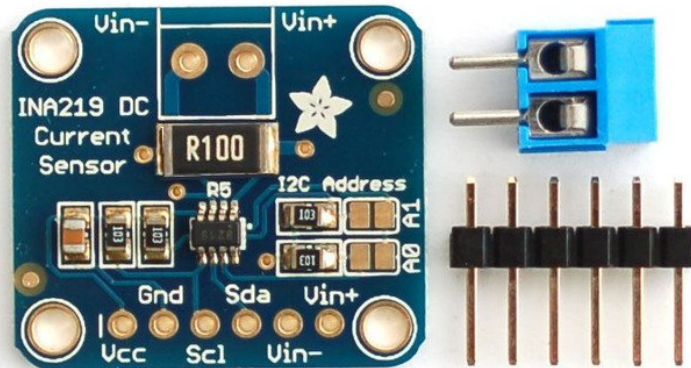
Created by lady ada



Last updated on 2019-11-14 10:32:40 PM UTC

Overview

The INA219B breakout board and the INA219 FeatherWing will solve all your power-monitoring problems. Instead of struggling with two multimeters, you can use this breakout to measure both the high side voltage and DC current draw over I2C with 1% precision.

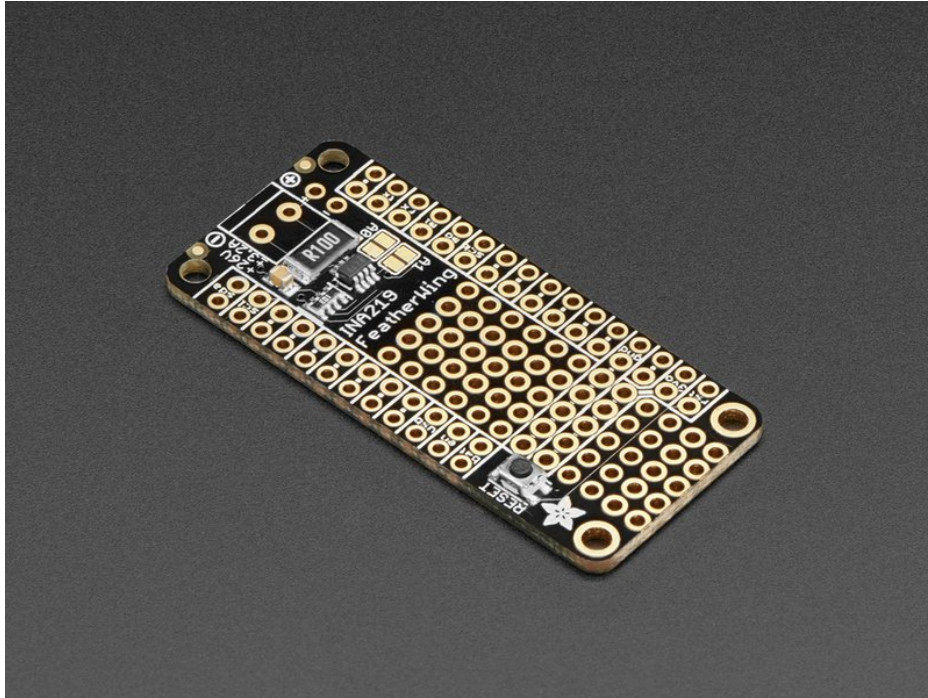


Why the High Side?

Most current-measuring devices such as our current panel meter are only good for *low side* measuring. That means that unless you want to get a battery involved, you have to stick the measurement resistor between the target ground and true ground.

Since the voltage drop across the resistor is proportional to the current draw, this means that the ground reference will change with varying current. Having a shifting ground reference can cause problems for many circuits.

The INA219B chip is much smarter - it can handle high side current measuring, up to +26VDC, even though it is powered with 3 or 5V. It will also report back that high side voltage, which is great for tracking battery life or solar panels.



How does it work?

A precision amplifier measures the voltage across the 0.1 ohm, 1% sense resistor. Since the amplifier maximum input difference is $\pm 320\text{mV}$ this means it can measure up to ± 3.2 Amps. With the internal 12 bit ADC, the resolution at $\pm 3.2\text{A}$ range is 0.8mA. With the internal gain set at the minimum of div8, the max current is $\pm 400\text{mA}$ and the resolution is 0.1mA. Advanced hackers can remove the 0.1 ohm current sense resistor and replace it with their own to change the range (say a 0.01 ohm to measure up 32 Amps with a resolution of 8mA)

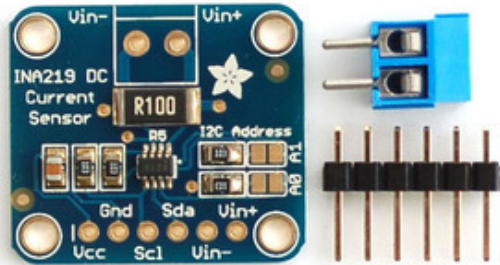


Note that when switching inductive loads, the instantaneous voltage levels may greatly exceed steady-state levels due to inductive kickback. Chip damage can occur if you do not take precautions to protect against inductive spikes.

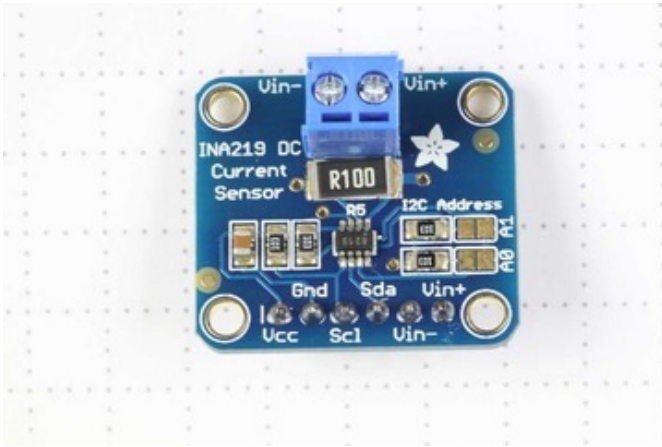
Assembly

Breakout Assembly

The board comes with all surface-mount components pre-soldered. Additional parts are included to help integrate the INA219 breakout board into your project.

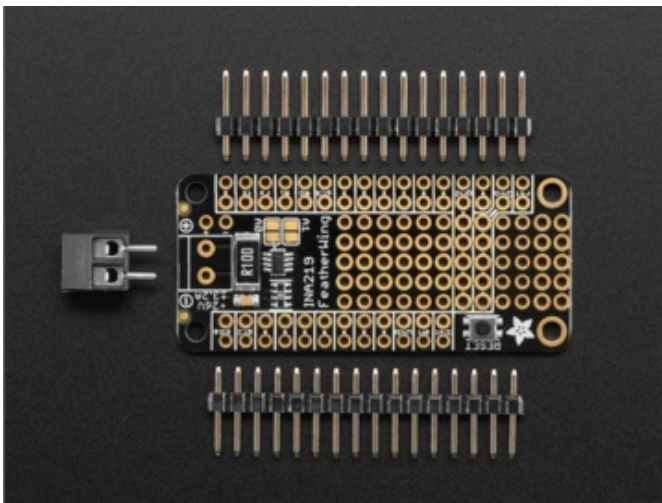


Wires can be soldered directly to the holes on the edge of the board. But for breadboard use, you will want to solder on the included 6-pin header.



The load can be connected via the header, or using the included 2-pin screw-terminal.

FeatherWing Assembly

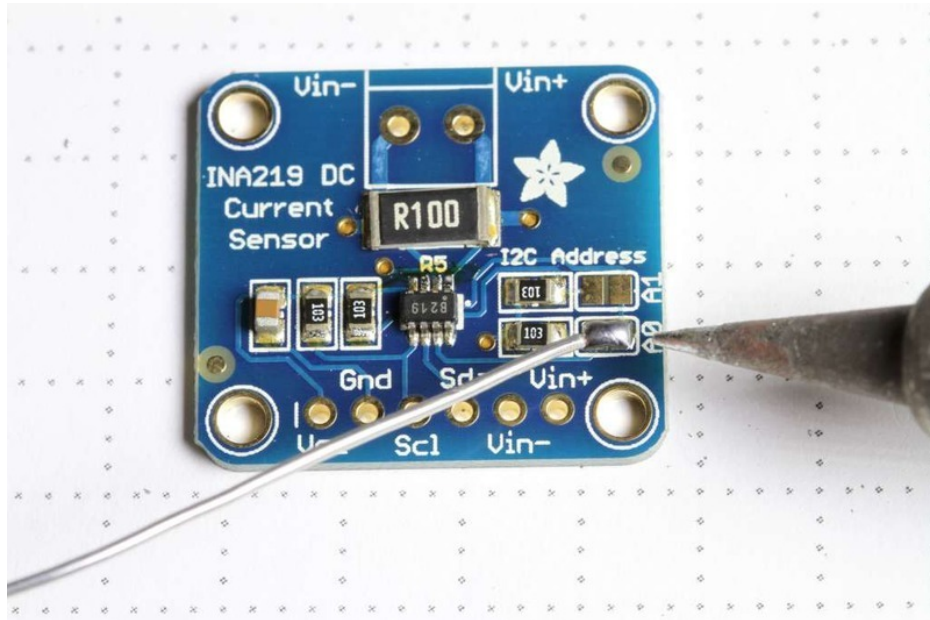


Solder the headers and the screw terminal to the board in the appropriate locations.

Addressing the Boards

If more than one INA219 breakout board is used, each board must be assigned a unique address. This is done with the address jumpers on the right edge of the board. The I2C base address for each board is 0x40. The binary address that you program with the address jumpers is added to the base I2C address.

To program the address offset, use a drop of solder to bridge the corresponding address jumper for each binary '1' in the address.



Up to 4 boards may be connected. Addressing is as follows:

Board 0: Address = 0x40 Offset = binary 00000 (no jumpers required)

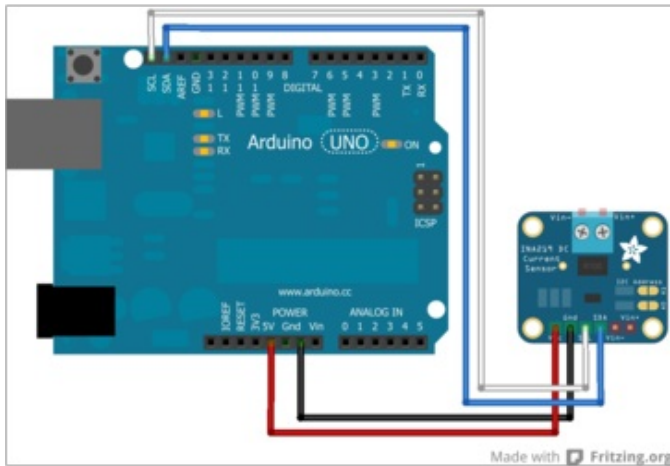
Board 1: Address = 0x41 Offset = binary 00001 (bridge A0 as in the photo above)

Board 2: Address = 0x44 Offset = binary 00100 (bridge A1)

Board 3: Address = 0x45 Offset = binary 00101 (bridge A0 & A1)

Wiring

The INA219 breakout board can be powered by the 5V or 3V pin on your Arduino and communicates via I2C.

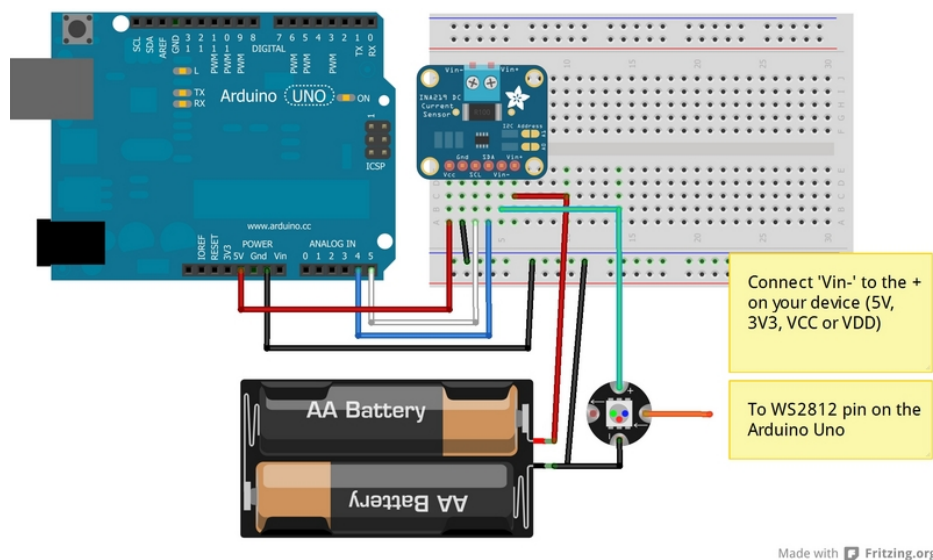


Connect to the microprocessor

- Connect GND to GND
- Connect VCC to 5v
- Then connect SDA to SDA (Analog pin 4 on pre-R3 Arduinos)
- And connect SCL to SCL (Analog pin 5 on pre-R3 Arduinos)

On R3 and later Arduinos, you can connect to the new dedicated SDA & SCL pins next to the AREF pin. On pre-R3 Megas, SDA & SCL are on pins 20 & 21.

Next we must insert the INA219 current sensor into the circuit we want to measure:

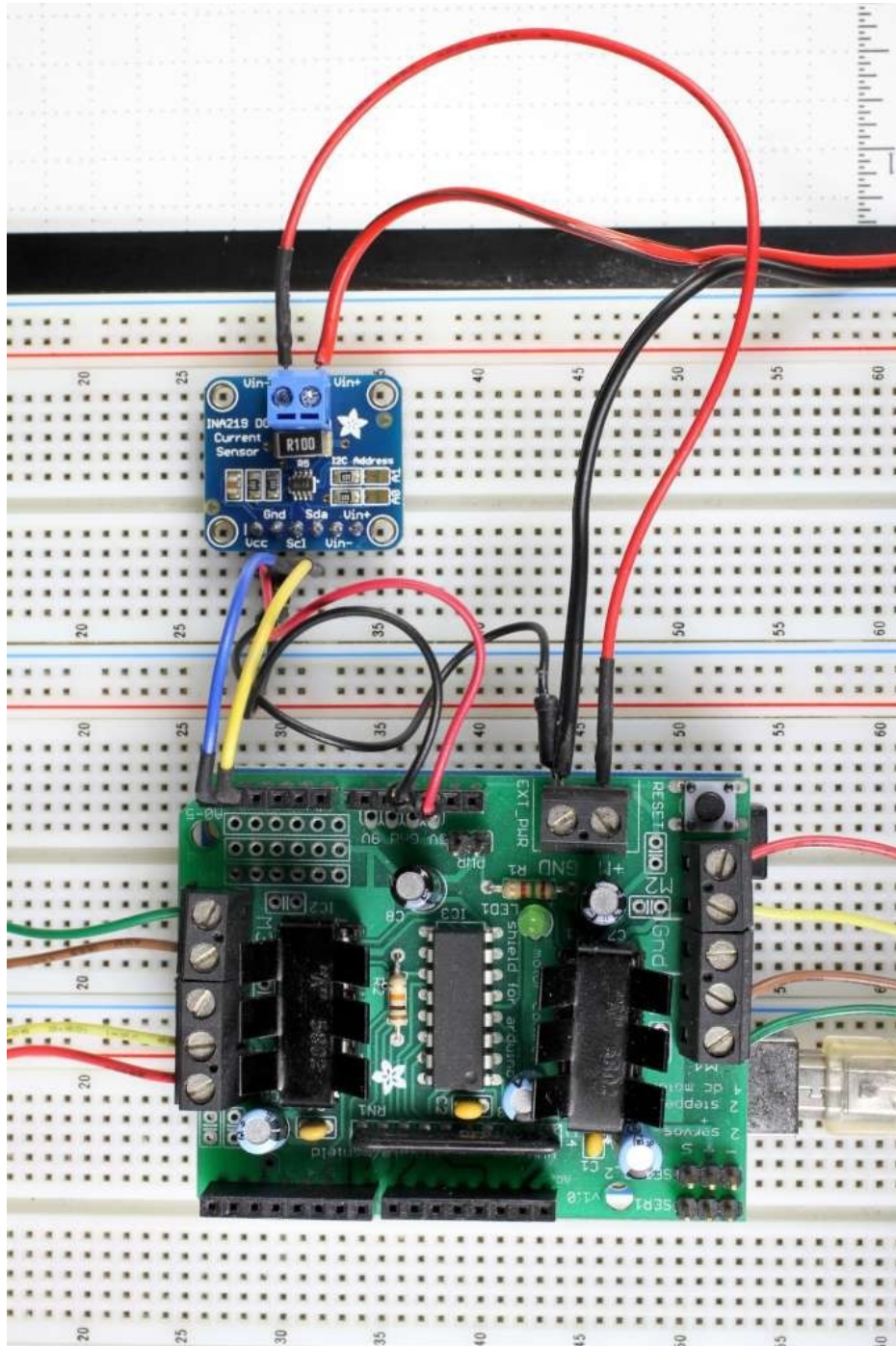


Be careful inserting noisy loads that can cause a sharp current draw, such as DC motors, since they can cause problems on the power lines and may cause the INA219 to reset, etc. When using a DC motor or a similar device, be sure to include a large capacitor to decouple the motor from the power supply and use a snubber diode to protect against inductive spikes.

Connect to the circuit

- Connect V+ to the positive terminal of the power supply for the circuit under test.
- Connect V- to the positive terminal or lead of the load. This puts the sense resistor in-line with the circuit.
- Finally, connect a wire from the negative terminal of the power supply to GND. This allows the sensor to measure the load voltage as well as the load current.

The photo below shows an INA219 breakout board configured to measure the motor supply current on an Adafruit Motor Shield.

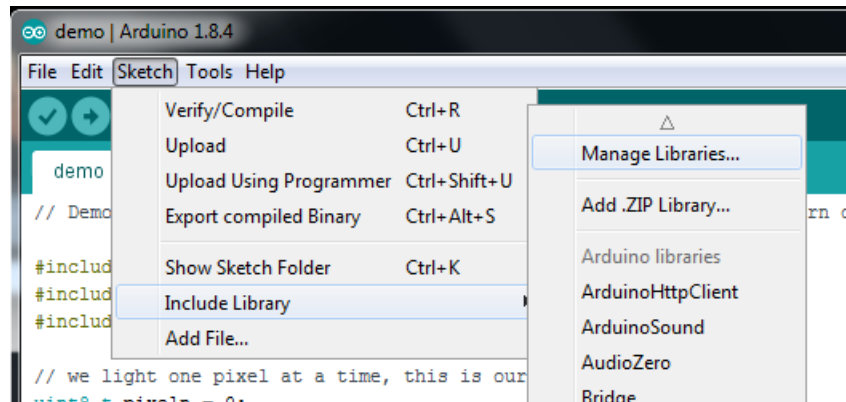


Arduino Code

Programming the Adafruit INA219 breakout board is simple using our library:

Install the Library

Open up the Arduino library manager:



Search for the **Adafruit INA219** library and install it

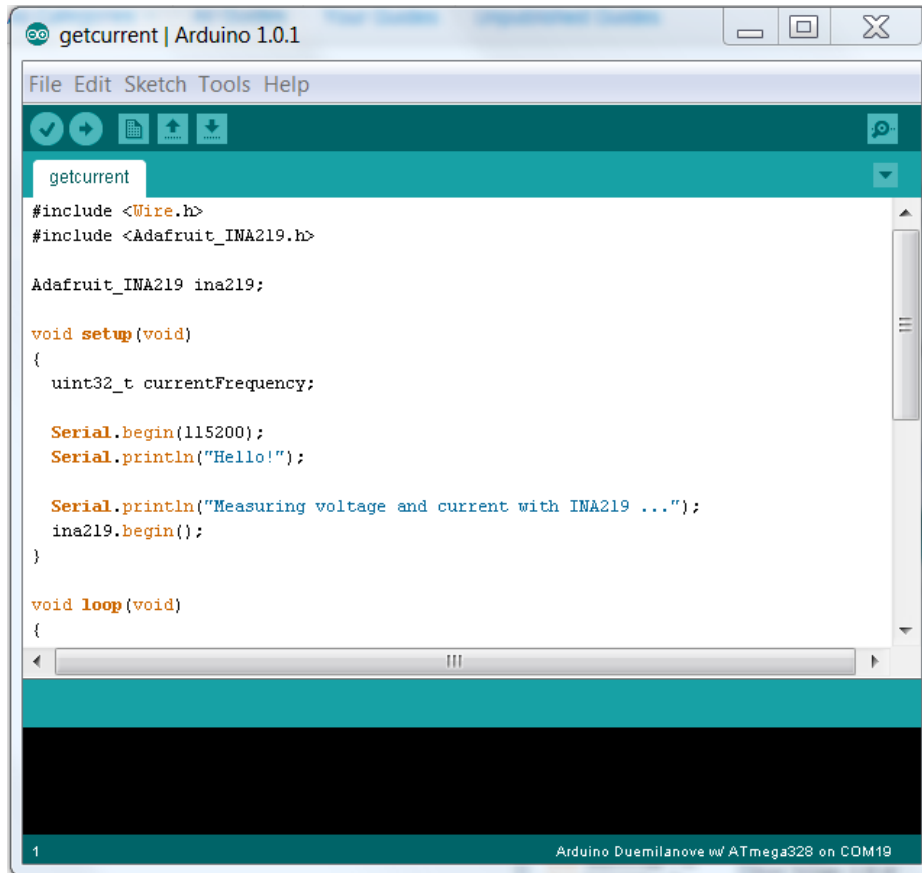


We also have a great tutorial on Arduino library installation at:

<http://learn.adafruit.com/adafruit-all-about-arduino-libraries-install-use> (<https://adafru.it/aYM>)

Load the Example

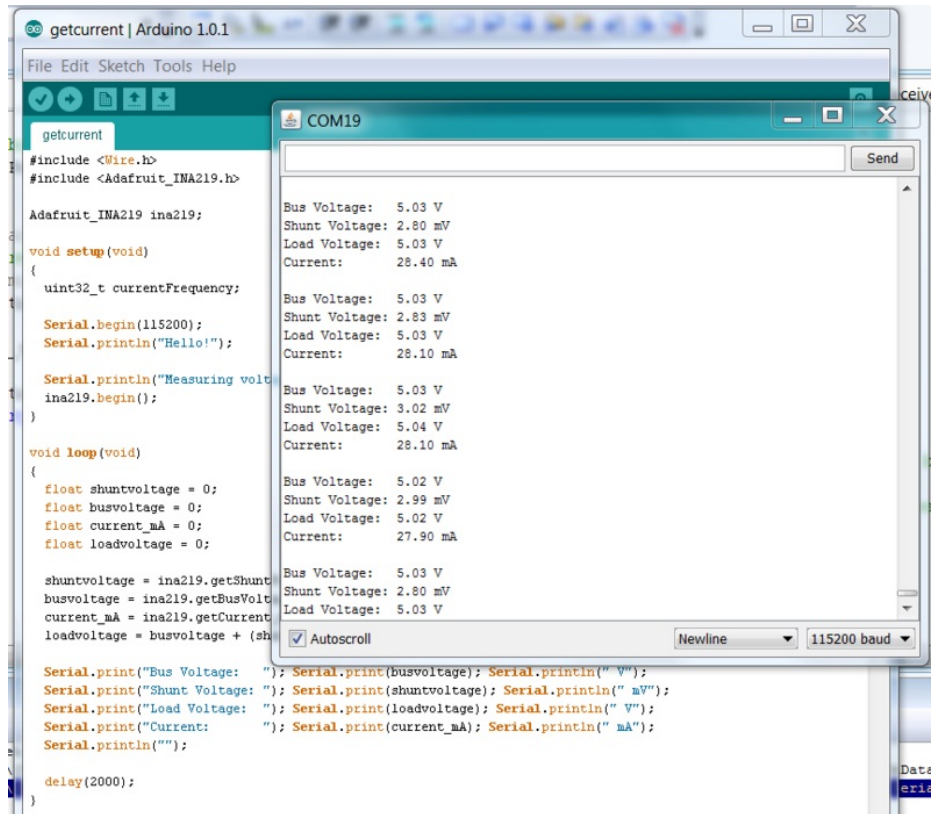
- Select "*File->Examples->Adafruit_INA219->getcurrent*"
- The "getcurrent" example code should open in a new IDE window.



Run it!

- Click on the upload button in the IDE. When it is "done uploading"
- Open your Serial Monitor and set the speed to 115200 baud.

The output should appear similar to the sample below:



Customize it

You can adapt, expand or modify the example code to suit your project requirements. For a detailed description of the available library functions, see the [Library Reference](#) on the next page:

Library Reference

Construction and Initialization Functions:

Adafruit_INA219(uint8_t addr = INA219_ADDRESS);

Constructs an instance of the Adafruit_INA219. If no address is specified, the default address (0x40) is used. If more than one INA219 module is connected, it should be addressed as shown on the Assembly page and the configured address passed to the constructor.

void begin(void);

Initializes I2C communication with the Adafruit_INA219 device using the default configuration values.

Example:

```
#include <Wire.h>
#include <Adafruit_INA219.h>

Adafruit_INA219 ina219_A;
Adafruit_INA219 ina219_B(0x41);

void setup(void)
{
  ina219_A.begin(); // Initialize first board (default address 0x40)
  ina219_B.begin(); // Initialize second board with the address 0x41
}
```

Sensor Reading Functions:

float getBusVoltage_V(void);

Reads the voltage between GND and V-. This is the total voltage seen by the circuit under test. (Supply voltage - shunt voltage).

The return value is in Volts.

float getShuntVoltage_mV(void);

Reads the voltage between V- and V+. This is the measured voltage drop across the shunt resistor.

The return value is in Millivolts.

float getCurrent_mA(void);

Reads the current, derived via Ohms Law from the measured shunt voltage.

The return value is in Milliamps.

Example:

```
float shuntvoltage = 0;
float busvoltage = 0;
float current_mA = 0;
float loadvoltage = 0;

shuntvoltage = ina219.getShuntVoltage_mV();
busvoltage = ina219.getBusVoltage_V();
current_mA = ina219.getCurrent_mA();
loadvoltage = busvoltage + (shuntvoltage / 1000);

Serial.print("Bus Voltage:  "); Serial.print(busvoltage); Serial.println(" V");
Serial.print("Shunt Voltage: "); Serial.print(shuntvoltage); Serial.println(" mV");
Serial.print("Load Voltage:  "); Serial.print(loadvoltage); Serial.println(" V");
Serial.print("Current:      "); Serial.print(current_mA); Serial.println(" mA");
Serial.println("");
```

Arduino Library Docs

[Arduino Library Docs \(https://adafru.it/DYv\)](https://adafru.it/DYv)

Python & CircuitPython

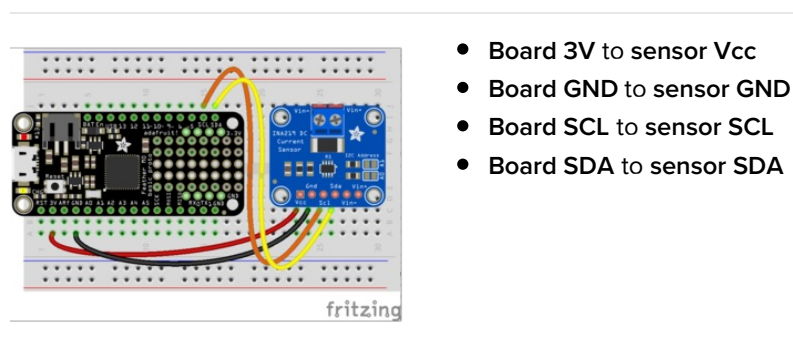
It's easy to use the INA219 sensor with Python and CircuitPython, and the [Adafruit CircuitPython INA219 \(https://adafru.it/BHQ\)](https://adafru.it/BHQ) module. This module allows you to easily write Python code that reads the current and more from the sensor.

You can use this sensor with any CircuitPython microcontroller board or with a computer that has GPIO and Python thanks to [Adafruit_Blinka, our CircuitPython-for-Python compatibility library \(https://adafru.it/BSN\)](https://adafru.it/BSN).

CircuitPython Microcontroller Wiring

First wire up a INA219 to your board exactly as shown on the previous pages for Arduino using an I2C interface. In addition connect some load to measure the current from in series to the sensor's **Vin-** and **Vin+** pins as [mentioned on the wiring page \(https://adafru.it/BHR\)](https://adafru.it/BHR).

Here's an example of wiring a Feather M0 to the sensor with I2C:

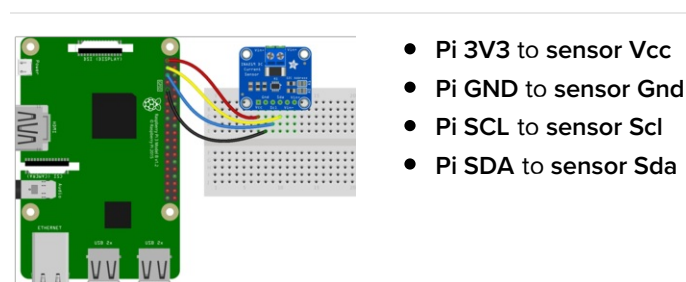


Python Computer Wiring

Since there's *dozens* of Linux computers/boards you can use we will show wiring for Raspberry Pi. For other platforms, [please visit the guide for CircuitPython on Linux to see whether your platform is supported \(https://adafru.it/BSN\)](https://adafru.it/BSN).

In addition connect some load to measure the current from in series to the sensor's **Vin-** and **Vin+** pins as [mentioned on the wiring page \(https://adafru.it/BHR\)](https://adafru.it/BHR).

Here's the Raspberry Pi wired with I2C:



CircuitPython Installation of INA219 Library

Next you'll need to install the [Adafruit CircuitPython INA219 \(https://adafru.it/BHQ\)](https://adafru.it/BHQ) library on your CircuitPython board.

First make sure you are running the [latest version of Adafruit CircuitPython \(https://adafru.it/tBa\)](https://adafru.it/tBa) for your board.

Next you'll need to install the necessary libraries to use the hardware--carefully follow the steps to find and install these libraries from [Adafruit's CircuitPython library bundle \(https://adafru.it/zdx\)](https://adafru.it/zdx). For example the Circuit Playground Express guide has [a great page on how to install the library bundle \(https://adafru.it/ABU\)](https://adafru.it/ABU) for both express and non-express boards.

Remember for non-express boards like the Trinket M0, Gemma M0, and Feather/Metro M0 basic you'll need to manually install the necessary libraries from the bundle:

- `adafruit_ina219.mpy`
- `adafruit_bus_device`

Before continuing make sure your board's lib folder or root filesystem has the `adafruit_ina219.mpy`, and `adafruit_bus_device` files and folders copied over.

Next [connect to the board's serial REPL \(https://adafru.it/Awz\)](https://adafru.it/Awz) so you are at the CircuitPython >>> prompt.

Python Installation of INA219 Library

You'll need to install the Adafruit_Blinka library that provides the CircuitPython support in Python. This may also require enabling I2C on your platform and verifying you are running Python 3. [Since each platform is a little different, and Linux changes often, please visit the CircuitPython on Linux guide to get your computer ready \(https://adafru.it/BSN\)](https://adafru.it/BSN)!

Once that's done, from your command line run the following command:

- `sudo pip3 install adafruit-circuitpython-ina219`

If your default Python is version 3 you may need to run 'pip' instead. Just make sure you aren't trying to use CircuitPython on Python 2.x, it isn't supported!

CircuitPython & Python Usage

To demonstrate the usage of the sensor we'll initialize it and read the current and more from the board's Python REPL. Run the following code to import the necessary modules and initialize the I2C connection with the sensor:

```
import board
import busio
import adafruit_ina219
i2c = busio.I2C(board.SCL, board.SDA)
sensor = adafruit_ina219.INA219(i2c)
```

Now you're ready to read values from the sensor using any of these functions:

- `shunt_voltage` - The shunt voltage in volts.
- `bus_voltage` - The bus voltage in volts.
- `current` - The current in milliamps.


```
print("Bus Voltage:   {} V".format(ina219.bus_voltage))
print("Shunt Voltage: {} mV".format(ina219.shunt_voltage / 1000))
print("Current:      {} mA".format(ina219.current))
```

That's all there is to using the INA219 with CircuitPython!

Here's a full example to print the voltage and current every second. Save this as **code.py** on your board's filesystem and check the output from the serial REPL.

Full Example Code

```
"""Sample code and test for adafruit_ina219"""

import time
import board
from adafruit_ina219 import ADCResolution, BusVoltageRange, INA219

i2c_bus = board.I2C()

ina219 = INA219(i2c_bus)

print("ina219 test")

# display some of the advanced field (just to test)
print("Config register:")
print(" bus_voltage_range:   0x%1X" % ina219.bus_voltage_range)
print(" gain:                 0x%1X" % ina219.gain)
print(" bus_adc_resolution:   0x%1X" % ina219.bus_adc_resolution)
print(" shunt_adc_resolution: 0x%1X" % ina219.shunt_adc_resolution)
print(" mode:                 0x%1X" % ina219.mode)
print("")

# optional : change configuration to use 32 samples averaging for both bus voltage and shunt voltage
ina219.bus_adc_resolution = ADCResolution.ADCRES_12BIT_32S
ina219.shunt_adc_resolution = ADCResolution.ADCRES_12BIT_32S
# optional : change voltage range to 16V
ina219.bus_voltage_range = BusVoltageRange.RANGE_16V

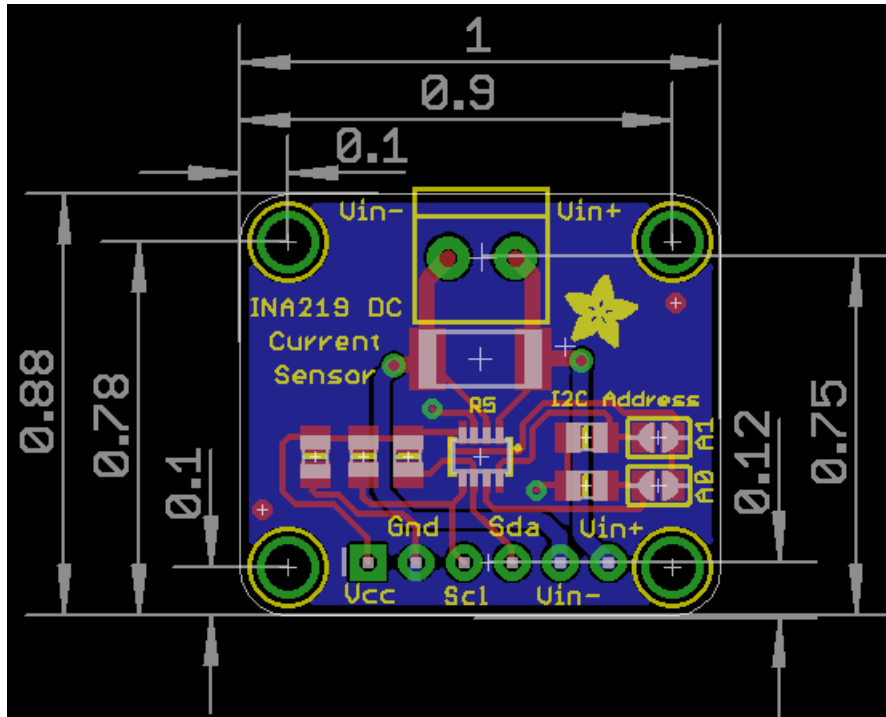
# measure and display loop
while True:
    bus_voltage = ina219.bus_voltage      # voltage on V- (load side)
    shunt_voltage = ina219.shunt_voltage  # voltage between V+ and V- across the shunt
    current = ina219.current              # current in mA

    # INA219 measure bus voltage on the load side. So PSU voltage = bus_voltage + shunt_voltage
    print("PSU Voltage:   {:.3f} V".format(bus_voltage + shunt_voltage))
    print("Shunt Voltage:  {:.6f} V".format(shunt_voltage))
    print("Load Voltage:   {:.3f} V".format(bus_voltage))
    print("Current:        {:.6f} A".format(current/1000))
    print("")

    time.sleep(2)
```

Python Docs

[Python Docs \(https://adafru.it/C4O\)](https://adafru.it/C4O)



FeatherWing Schematic & Fabrication Print

