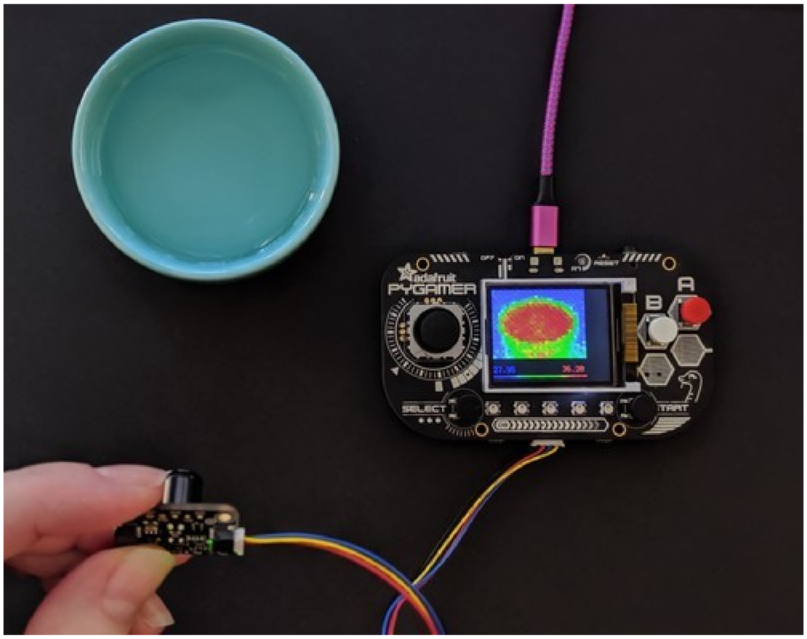
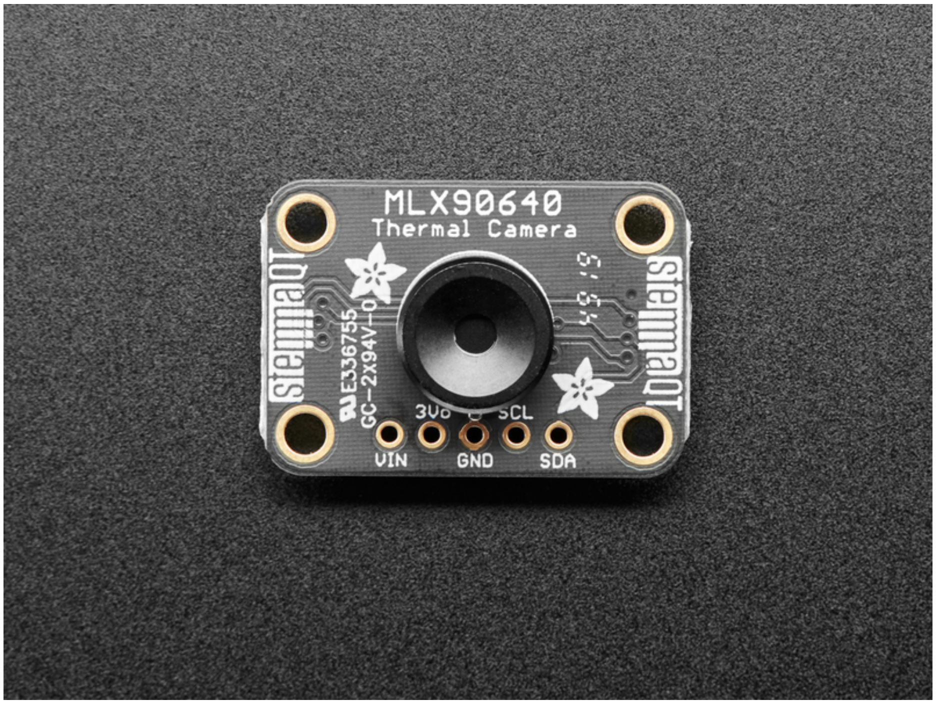
Adafruit MLX90640 IR Thermal Camera

Created by Kattni Rembor

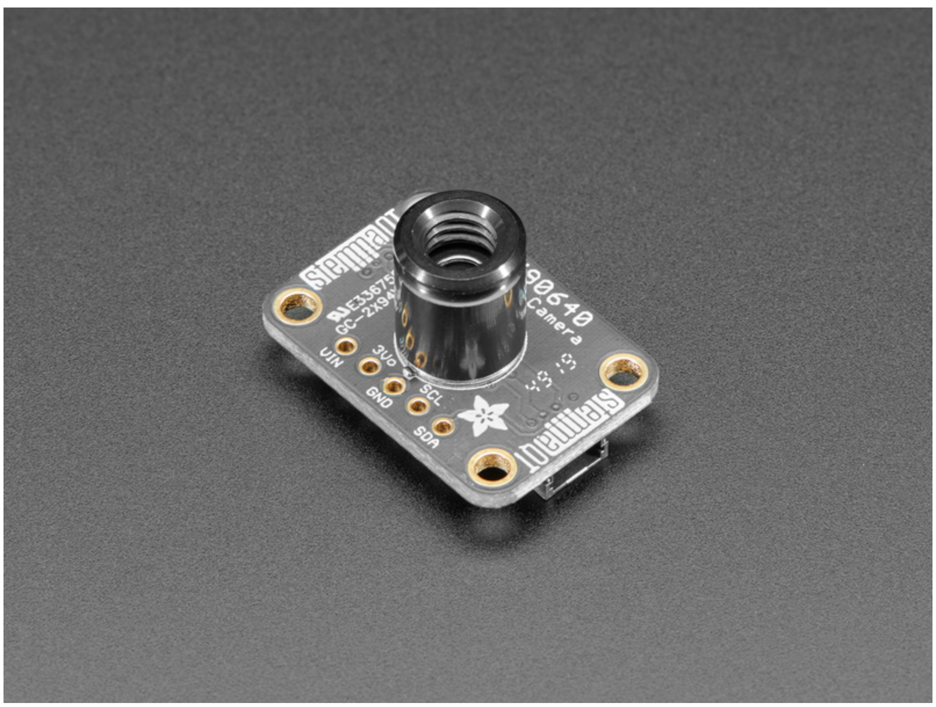


Last updated on 2020-01-29 08:52:52 PM UTC

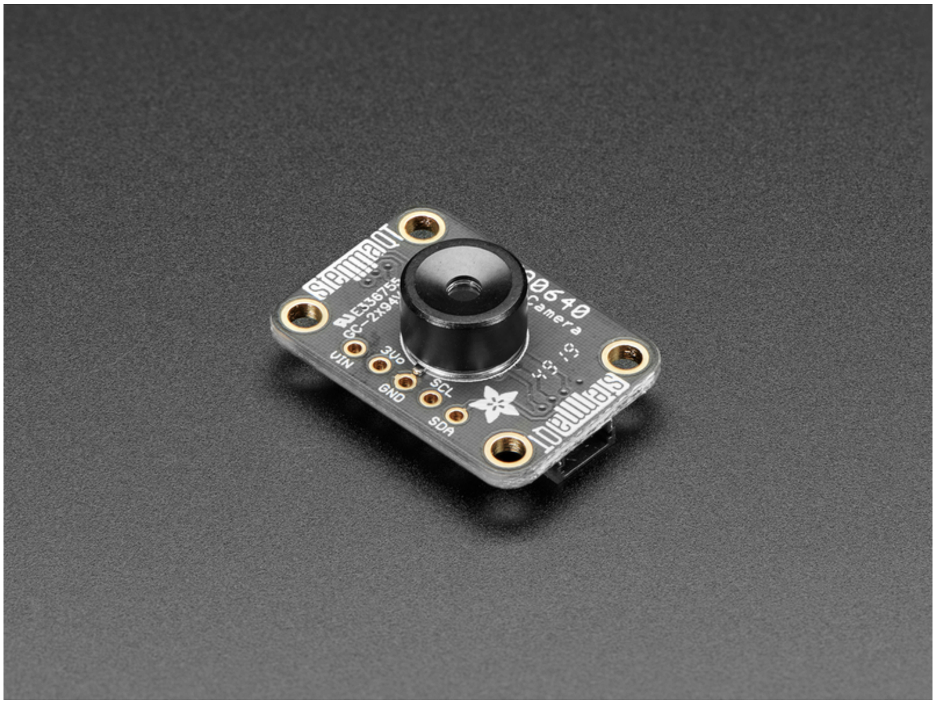
Overview



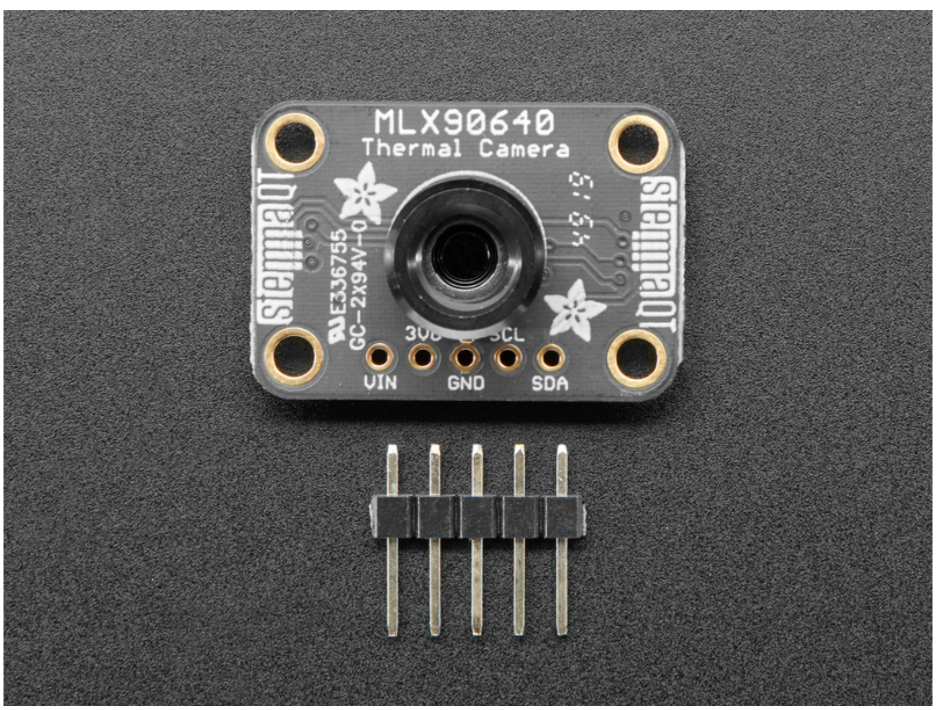
You can now add affordable heat-vision to your project with an Adafruit MLX90640 Thermal Camera Breakout. This sensor contains a 24x32 array of IR thermal sensors. When connected to your microcontroller (or Raspberry Pi) it will return an array of 768 individual infrared temperature readings over I2C. It's like those fancy thermal cameras, but compact and simple enough for easy integration.



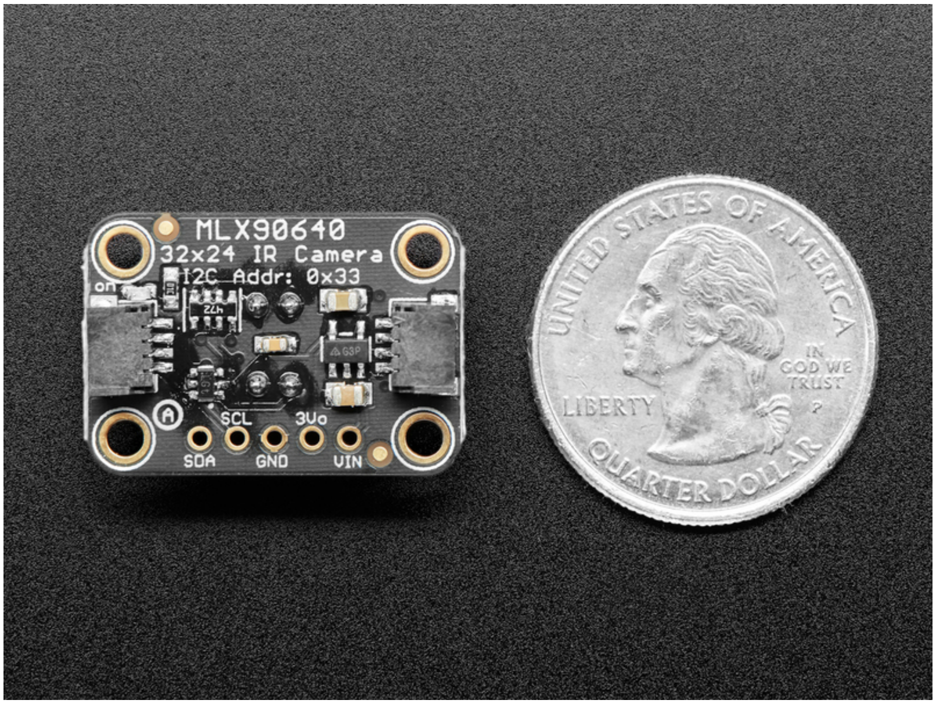
There are two versions: one with a wider **110°x70° field of view** (https://adafru.it/IDi) and one with a narrower **55°x35° field of view** (https://adafru.it/HNe).



This part will measure temperatures ranging from **-40°C to 300°C** with an accuracy of +- 2°C (in the 0-100°C range). With a maximum frame rate of 16 Hz (the theoretical limit is 32Hz but we were not able to practically achieve it), It's perfect for creating your own human detector or mini thermal camera. We have code for using this sensor on an Arduino or compatible (the sensor communicates over I2C) or on a Raspberry Pi with Python. If using an Arduino-compatible, you'll need a processor with at least 20KB RAM - a SAMD21 (M0) or SAMD51 (M4) chipset will do nicely. On the Pi, you can even perform interpolation processing with help from the SciPy python library and get some pretty nice results!



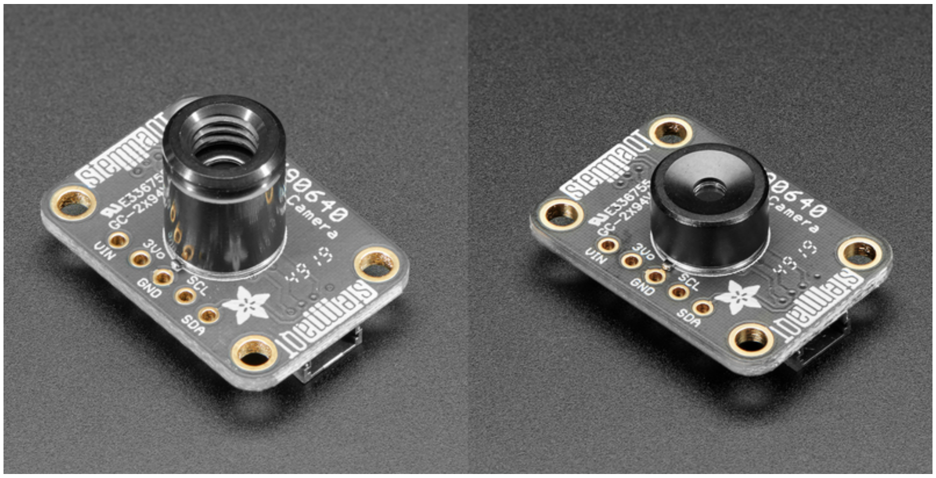
This sensor reads the data twice per frame, in a checker-board pattern, so it's normal to see a checker-board dither effect when moving the sensor around - the effect isn't noticeable when things move slowly.



To make it easy to use, we hand-soldered it on a breakout board with a 3.3V regulator and level shifting. So you can use it with any 3V or 5V microcontroller or computer. We've even included SparkFun qwiic (https://adafru.it/Fpw) compatible **STEMMA QT (https://adafru.it/Ft4)** connectors for the I2C bus so **you don't even need to solder!** Just plug-n-play with any of our STEMMA QT (JST SH) cables.

Even better - We've done all the hard work here, with example code and supporting software libraries to get you up in running in just a few lines of Arduino (https://adafru.it/IDj) or Python code (https://adafru.it/IBv).

Pinouts



There is no difference between the breakout for the 55°x35° field of view and the 110°x70° field of view thermal cameras. There is also no difference in the code used with either thermal camera. **The only difference is the length of the lens.** The only way to tell which thermal camera breakout you have is to identify the length of the lens. The longer lens, shown above on the left, is on the 55°x35° field of view thermal camera and is approximately 11.25mm long. The shorter lens, shown above on the right, is on the 110°x70° field of view thermal camera and is approximately 5.7mm long.

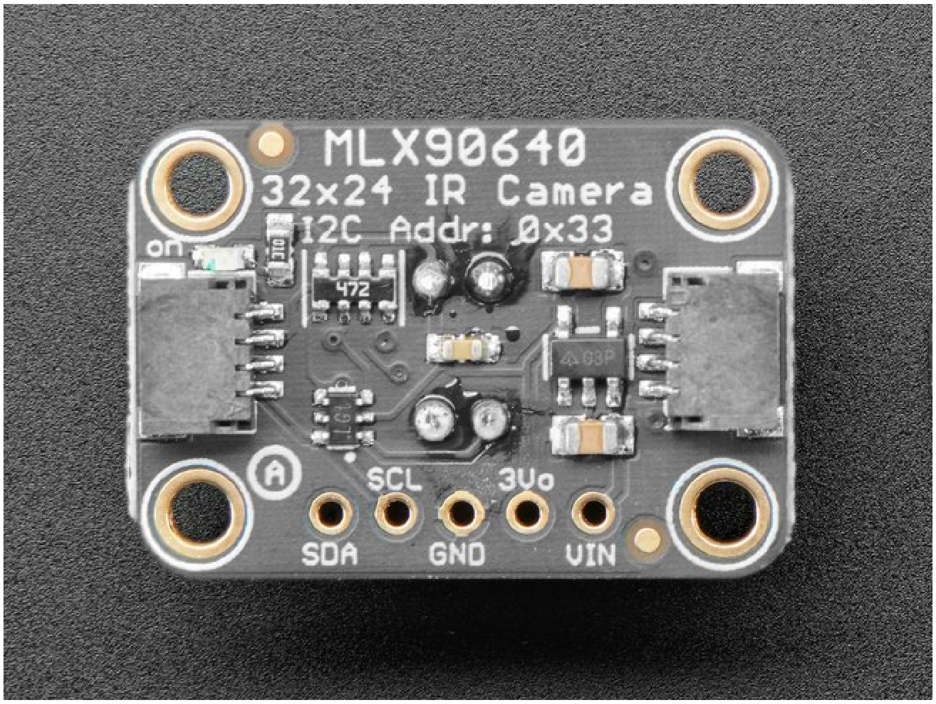
Power Pins

- **VIN** - this is the power pin. Since the sensor chip uses 3 VDC, we have included a voltage regulator on board that will take 3-5VDC and safely convert it down. To power the board, give it the same power as the logic level of your microcontroller - e.g. for a 5V microcontroller like Arduino, use 5V
- **3V** - this is the 3.3V output from the voltage regulator, you can grab up to 100mA from this if you like

- **GND** - common ground for power and logic

I2C Logic Pins

- **SCL** - I2C clock pin, connect to your microcontroller I2C clock line. This pin is level shifted so you can use 3-5V logic, and there's a **4.7K pullup** on this pin.
- **SDA** - I2C data pin, connect to your microcontroller I2C data line. This pin is level shifted so you can use 3-5V logic, and there's a **4.7K pullup** on this pin.



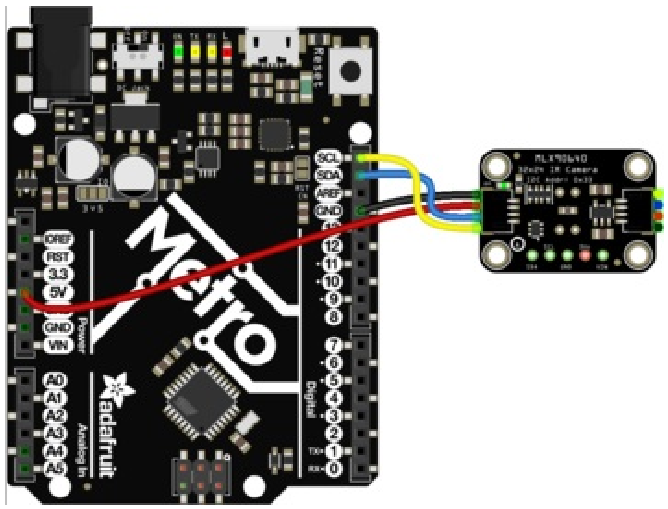
STEMMA Connectors

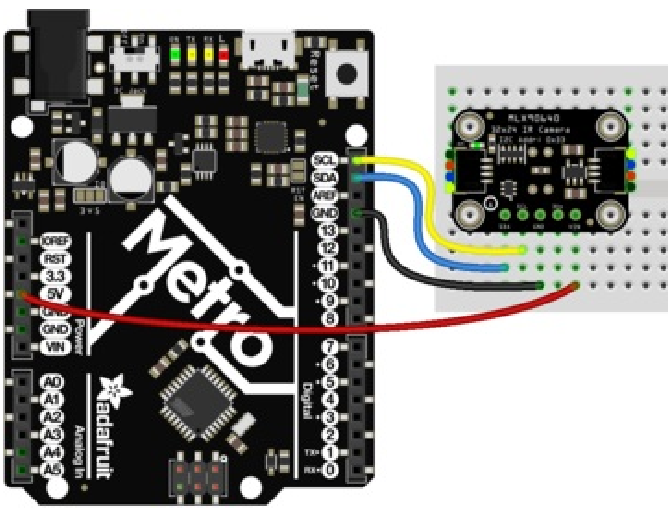
- **STEMMA QT (https://adafru.it/Ft4) -** These connectors on the back of this breakout allow you to connect to dev boards with **STEMMA QT** connectors or to other things with various associated accessories (https://adafru.it/Ft6)

Arduino

I2C Wiring

Use this wiring to connect via I2C interface.



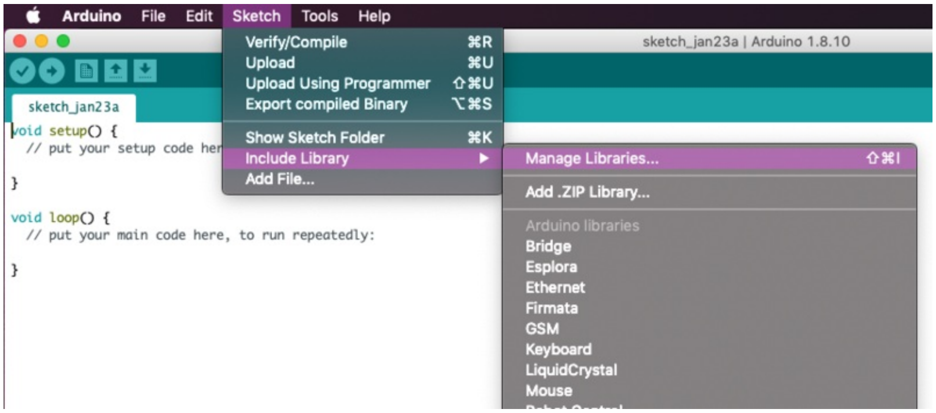


- Connect **board VIN (red wire)** to **Arduino 5V** if you are running a **5V** board Arduino (Uno, etc.). If your board is **3V,** connect to that instead.
- Connect **board GND (black wire)** to **Arduino GND**
- Connect **board SCL (yellow wire)** to **Arduino SCL**
- Connect **board SDA (blue wire)** to **Arduino SDA**

The final results should resemble the illustration above, showing an Adafruit Metro development board.

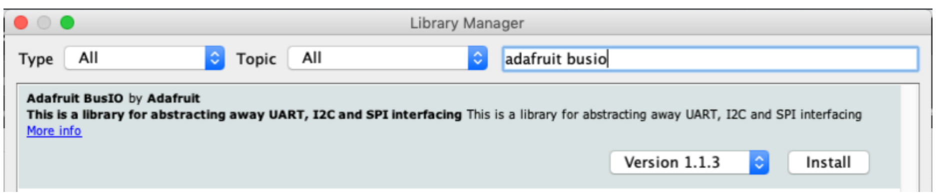
Library Installation

You can install the **Adafruit MLX90640 Library** for Arduino using the Library Manager in the Arduino IDE.

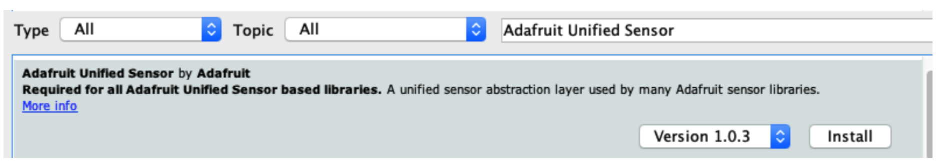


Click the **Manage Libraries...** menu item, search for **Adafruit MLX90640**, and select the **Adafruit MLX90640** library:

Then follow the same process for the **Adafruit BusIO** library.



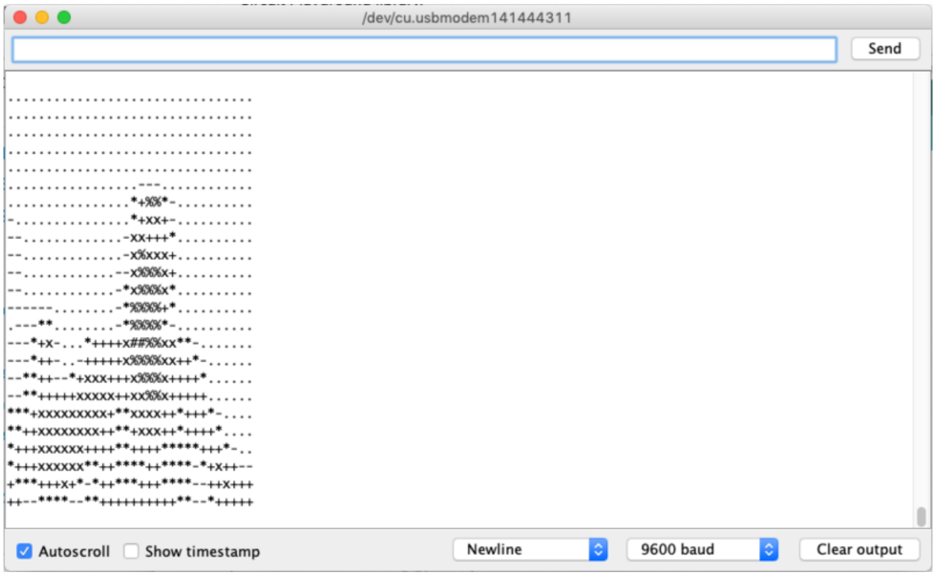
Finally follow the same process for the **Adafruit Unified Sensor** library:



Load Example

Open up **File -> Examples -> Adafruit MLX90640 -> MLX90640_simpletest** and upload to your Arduino wired up to the sensor.

Once you upload the code and open the Serial Monitor (**Tools->Serial Monitor**) at **115200** baud, you will see an ASCII representation of the thermal camera printed. You should see something similar to this:

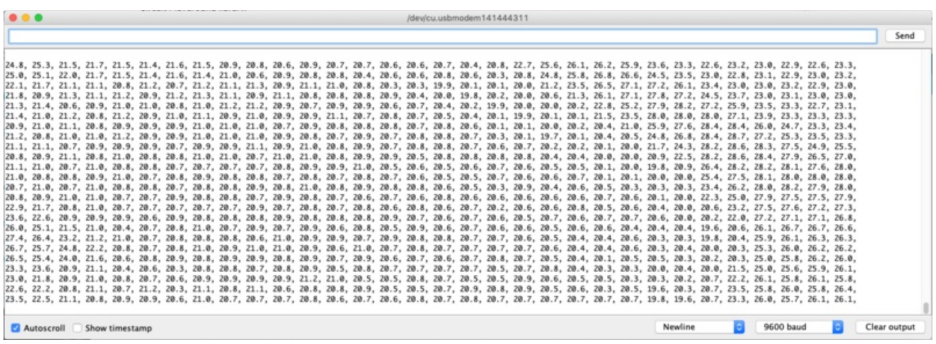


Point the thermal camera at objects of differing temperatures to see the ASCII image change!

You also have the option to see the temperatures printed out in a grid. Change the lines below `// uncomment *one* of the below` to comment out the `ASCIIART` line and uncomment the `TEMPERATURES` line so that they match below:

```
// uncomment *one* of the below
#define PRINT_TEMPERATURES
//#define PRINT_ASCIIART
```

Upload the code and open the Serial Monitor (**Tools->Serial Monitor**) at **115200** baud, and you will see an a grid of temperatures in Celsius printed. To fit the entire grid, you may need to resize the serial monitor window.



Point the thermal camera at objects of differing temperatures to see the printed temperatures change.

```
#include <Adafruit_MLX90640.h>

Adafruit_MLX90640 mlx;
float frame[32*24]; // buffer for full frame of temperatures

// uncomment *one* of the below
//#define PRINT_TEMPERATURES
#define PRINT_ASCIIART

void setup() {
  while (!Serial) delay(10);
```

```
  Serial.begin(115200);
  delay(100);

  Serial.println("Adafruit MLX90640 Simple Test");
  if (! mlx.begin(MLX90640_I2CADDR_DEFAULT, &Wire)) {
    Serial.println("MLX90640 not found!");
    while (1) delay(10);
  }
  Serial.println("Found Adafruit MLX90640");

  Serial.print("Serial number: ");
  Serial.print(mlx.serialNumber[0], HEX);
  Serial.print(mlx.serialNumber[1], HEX);
  Serial.println(mlx.serialNumber[2], HEX);

  //mlx.setMode(MLX90640_INTERLEAVED);
  mlx.setMode(MLX90640_CHESS);
  Serial.print("Current mode: ");
  if (mlx.getMode() == MLX90640_CHESS) {
    Serial.println("Chess");
  } else {
    Serial.println("Interleave");
  }

  mlx.setResolution(MLX90640_ADC_18BIT);
  Serial.print("Current resolution: ");
  mlx90640_resolution_t res = mlx.getResolution();
  switch (res) {
    case MLX90640_ADC_16BIT: Serial.println("16 bit"); break;
    case MLX90640_ADC_17BIT: Serial.println("17 bit"); break;
    case MLX90640_ADC_18BIT: Serial.println("18 bit"); break;
    case MLX90640_ADC_19BIT: Serial.println("19 bit"); break;
  }

  mlx.setRefreshRate(MLX90640_2_HZ);
  Serial.print("Current frame rate: ");
  mlx90640_refreshrate_t rate = mlx.getRefreshRate();
  switch (rate) {
    case MLX90640_0_5_HZ: Serial.println("0.5 Hz"); break;
    case MLX90640_1_HZ: Serial.println("1 Hz"); break;
    case MLX90640_2_HZ: Serial.println("2 Hz"); break;
    case MLX90640_4_HZ: Serial.println("4 Hz"); break;
    case MLX90640_8_HZ: Serial.println("8 Hz"); break;
    case MLX90640_16_HZ: Serial.println("16 Hz"); break;
    case MLX90640_32_HZ: Serial.println("32 Hz"); break;
    case MLX90640_64_HZ: Serial.println("64 Hz"); break;
  }
}

void loop() {
  delay(500);
  if (mlx.getFrame(frame) != 0) {
    Serial.println("Failed");
    return;
  }
  Serial.println();
  Serial.println();
  for (uint8_t h=0; h<24; h++) {
    for (uint8_t w=0; w<32; w++) {
      float t = frame[h*32 + w];
```

```
      float t = frame[h*32 + w];
#ifdef PRINT_TEMPERATURES
      Serial.print(t, 1);
      Serial.print(", ");
#endif
#ifdef PRINT_ASCIIART
      char c = '&';
      if (t < 20) c = ' ';
      else if (t < 23) c = '.';
      else if (t < 25) c = '-';
      else if (t < 27) c = '*';
      else if (t < 29) c = '+';
      else if (t < 31) c = 'x';
      else if (t < 33) c = '%';
      else if (t < 35) c = '#';
      else if (t < 37) c = 'X';
      Serial.print(c);
#endif
    }
    Serial.println();
  }
}
```

Arduino Docs

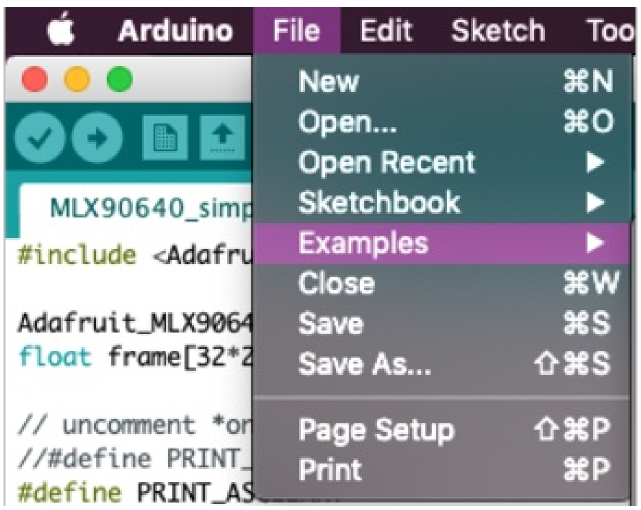
Arduino Docs (https://adafru.it/IzA)

Arduino Thermal Camera

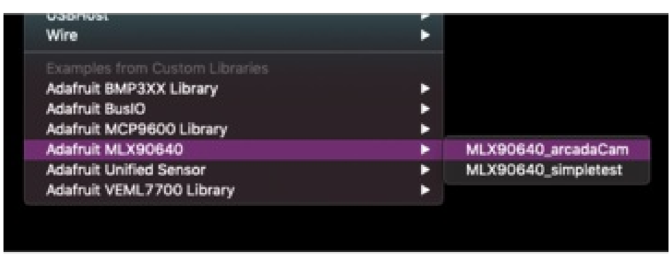
The PyBadge and PyGamer boards both have displays built in, as well as STEMMA I2C connectors. The MLX90640 comes with STEMMA QT/QWIIC connectors to allow for attaching the board easily to projects with no soldering required. Adafruit sells a STEMMA to STEMMA QT cable (https://adafru.it/IDk) that allows you to plug this breakout into the STEMMA connector found on a number of Adafruit microcontroller boards, including PyBadge and PyGamer. The following example uses the PyBadge or PyGamer and the MLX90640 to create a super easy-to-assemble thermal camera with a display!

Start by following your board's guide on installing Arduino IDE, and support for the board you have. Then, follow the instructions on the Arduino page in this guide (https://adafru.it/IDl) to install the base libraries needed for this breakout. Finally, install the Adafruit Arcada libraries (https://adafru.it/EUk) (there's a *lot* of em!).

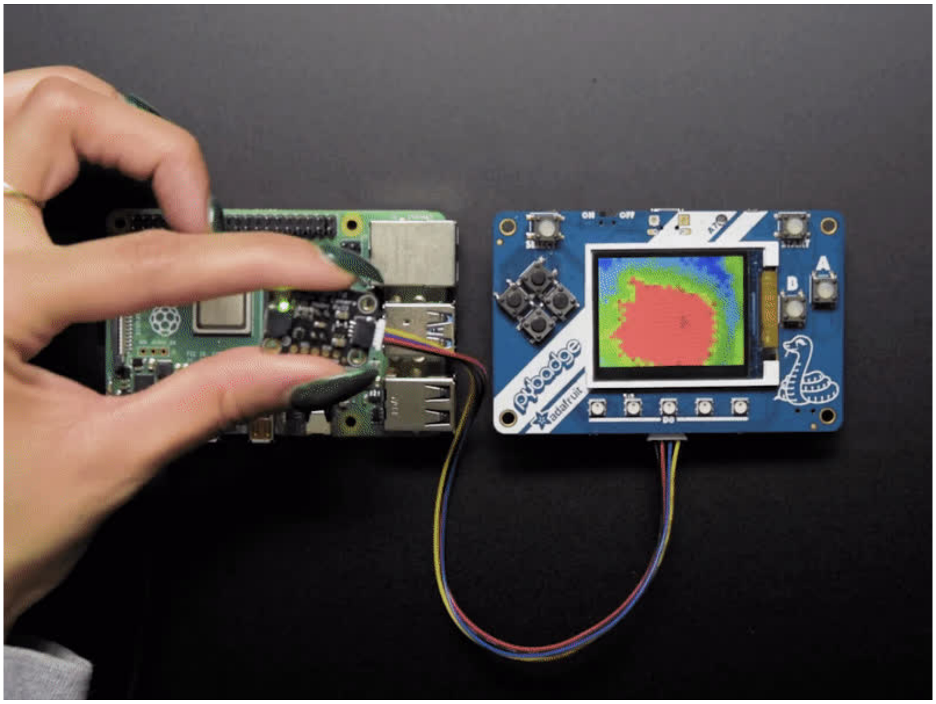
Loading the Example



Go to **File** > **Examples** > **Adafruit MLS90640** > **MLX90640_arcadacam** to open the ArcadaCam Arduino thermal camera example, and then load it onto your PyBadge or PyGamer.



Now point the thermal camera at various objects to see a heat map displayed on your board!




```
#include <Adafruit_MLX90640.h>
#include "Adafruit_Arcada.h"
Adafruit_Arcada arcada;


Adafruit_MLX90640 mlx;
float frame[32*24]; // buffer for full frame of temperatures

//low range of the sensor (this will be blue on the screen)
#define MINTEMP 20

//high range of the sensor (this will be red on the screen)
#define MAXTEMP 35

//the colors we will be using
const uint16_t camColors[] = {0x480F,
0x400F,0x400F,0x400F,0x4010,0x3810,0x3810,0x3810,0x3810,0x3010,0x3010,
0x3010,0x2810,0x2810,0x2810,0x2810,0x2010,0x2010,0x2010,0x1810,0x1810,
0x1811,0x1811,0x1011,0x1011,0x1011,0x0811,0x0811,0x0811,0x0011,0x0011,
0x0011,0x0011,0x0011,0x0031,0x0031,0x0051,0x0072,0x0072,0x0092,0x00B2,
0x00B2,0x00D2,0x00F2,0x00F2,0x0112,0x0132,0x0152,0x0152,0x0172,0x0192,
0x0192,0x01B2,0x01D2,0x01F3,0x01F3,0x0213,0x0233,0x0253,0x0253,0x0273,
0x0293,0x02B3,0x02D3,0x02D3,0x02F3,0x0313,0x0333,0x0333,0x0353,0x0373,
0x0394,0x03B4,0x03D4,0x03D4,0x03F4,0x0414,0x0434,0x0454,0x0474,0x0474,
0x0494,0x04B4,0x04D4,0x04F4,0x0514,0x0534,0x0534,0x0554,0x0554,0x0574,
0x0574,0x0573,0x0573,0x0573,0x0572,0x0572,0x0572,0x0571,0x0591,0x0591,
0x0590,0x0590,0x058F,0x058F,0x058F,0x058E,0x05AE,0x05AE,0x05AD,0x05AD,
0x05AD,0x05AC,0x05AC,0x05AB,0x05CB,0x05CB,0x05CA,0x05CA,0x05CA,0x05C9,
0x05C9,0x05C8,0x05E8,0x05E8,0x05E7,0x05E7,0x05E6,0x05E6,0x05E6,0x05E5,
0x05E5,0x0604,0x0604,0x0604,0x0603,0x0603,0x0602,0x0602,0x0601,0x0621,
0x0621,0x0620,0x0620,0x0620,0x0620,0x0E20,0x0E20,0x0E40,0x1640,0x1640,
0x1E40,0x1E40,0x2640,0x2640,0x2E40,0x2E60,0x3660,0x3660,0x3E60,0x3E60,
0x3E60,0x4660,0x4660,0x4E60,0x4E80,0x5680,0x5680,0x5E80,0x5E80,0x6680,
0x6680,0x6E80,0x6EA0,0x76A0,0x76A0,0x7EA0,0x7EA0,0x86A0,0x86A0,0x8EA0,
0x8EC0,0x96C0,0x96C0,0x9EC0,0x9EC0,0xA6C0,0xAEC0,0xAEC0,0xB6E0,0xB6E0,
```

```
0xBEE0,0xBEE0,0xC6E0,0xC6E0,0xCEE0,0xCEE0,0xD6E0,0xD700,0xDF00,0xDEE0,
0xDEC0,0xDEA0,0xDE80,0xDE80,0xE660,0xE640,0xE620,0xE600,0xE5E0,0xE5C0,
0xE5A0,0xE580,0xE560,0xE540,0xE520,0xE500,0xE4E0,0xE4C0,0xE4A0,0xE480,
0xE460,0xEC40,0xEC20,0xEC00,0xEBE0,0xEBC0,0xEBA0,0xEB80,0xEB60,0xEB40,
0xEB20,0xEB00,0xEAE0,0xEAC0,0xEAA0,0xEA80,0xEA60,0xEA40,0xF220,0xF200,
0xF1E0,0xF1C0,0xF1A0,0xF180,0xF160,0xF140,0xF100,0xF0E0,0xF0C0,0xF0A0,
0xF080,0xF060,0xF040,0xF020,0xF800,};

uint16_t displayPixelWidth, displayPixelHeight;

void setup() {
  if (!arcada.arcadaBegin()) {
    Serial.print("Failed to begin");
    while (1);
  }
  arcada.displayBegin();
  // Turn on backlight
  arcada.setBacklight(255);

  Serial.begin(115200);
  //while (!Serial);

  arcada.display->fillScreen(ARCADA_BLACK);
  displayPixelWidth = arcada.display->width() / 32;
  displayPixelHeight = arcada.display->width() / 32; //Keep pixels square

  delay(100);

  Serial.println("Adafruit MLX90640 Camera");
  if (! mlx.begin(MLX90640_I2CADDR_DEFAULT, &Wire)) {
    arcada.haltBox("MLX90640 not found!");
  }
  Serial.println("Found Adafruit MLX90640");

  Serial.print("Serial number: ");
  Serial.print(mlx.serialNumber[0], HEX);
  Serial.print(mlx.serialNumber[1], HEX);
  Serial.println(mlx.serialNumber[2], HEX);

  mlx.setMode(MLX90640_CHESS);
  mlx.setResolution(MLX90640_ADC_18BIT);
  mlx.setRefreshRate(MLX90640_8_HZ);
  Wire.setClock(1000000); // max 1 MHz
}


void loop() {
  uint32_t timestamp = millis();
  if (mlx.getFrame(frame) != 0) {
    Serial.println("Failed");
    return;
  }

  int colorTemp;
  for (uint8_t h=0; h<24; h++) {
    for (uint8_t w=0; w<32; w++) {
      float t = frame[h*32 + w];
      // Serial.print(t, 1); Serial.print(", ");

      t = min(t, MAXTEMP);
```

```
      t = min(t, MAXTEMP);
      t = max(t, MINTEMP);

      uint8_t colorIndex = map(t, MINTEMP, MAXTEMP, 0, 255);

      colorIndex = constrain(colorIndex, 0, 255);
      //draw the pixels!
      arcada.display->fillRect(displayPixelWidth * w, displayPixelHeight * h,
                               displayPixelHeight, displayPixelWidth,
                               camColors[colorIndex]);
    }
  }
  Serial.print((millis()-timestamp) / 2); Serial.println(" ms per frame (2 frames per display)");
  Serial.print(2000.0 / (millis()-timestamp)); Serial.println(" FPS (2 frames per display)");
}
```

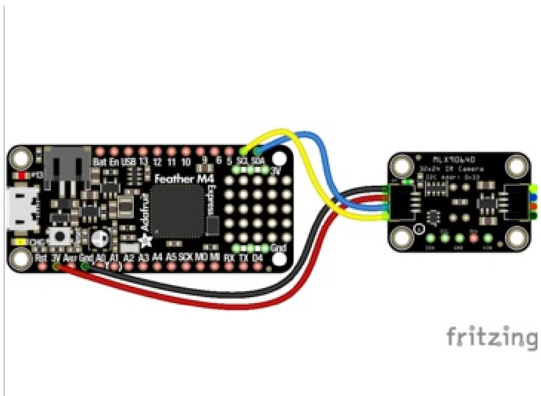
Python & CircuitPython

It's easy to use the MLX90640 sensor with Python and CircuitPython, and the Adafruit CircuitPython MLX90640 (https://adafru.it/IBv) module. This module allows you to easily write Python code that reads temperature using the thermal camera.

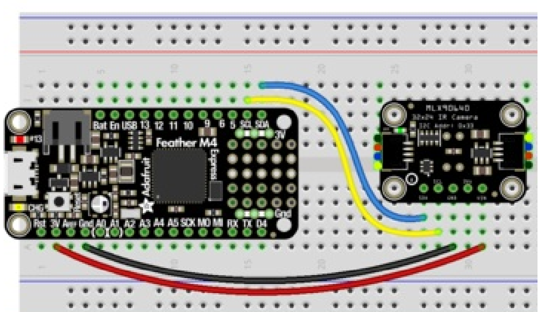
You can use this sensor with any CircuitPython microcontroller board or with a computer that has GPIO and Python thanks to Adafruit_Blinka, our CircuitPython-for-Python compatibility library (https://adafru.it/BSN).

CircuitPython Microcontroller Wiring

First wire up a MLX90640 to your board for an I2C connection, exactly as shown below. Here's an example of wiring a Feather M4 to the sensor with I2C:



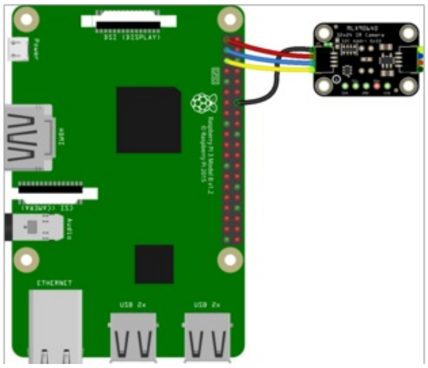
- **Board 3V** to **sensor VIN (red wire)**
- **Board GND** to **sensor GND (black wire)**
- **Board SCL** to **sensor SCL (yellow wire)**
- **Board SDA** to **sensor SDA (blue wire)**

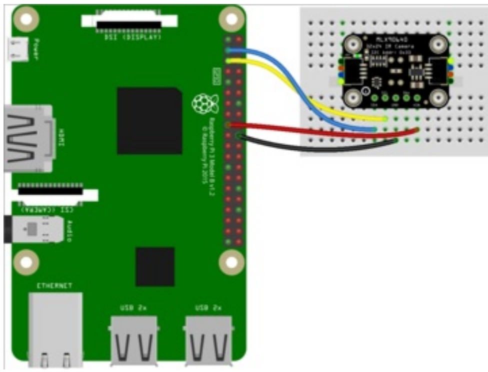


Python Computer Wiring

Since there are *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).

Here's the Raspberry Pi wired with I2C:





- **Pi 3V** to **sensor VCC (red wire)**
- **Pi GND** to **sensor GND (black wire)**
- **Pi SCL** to **sensor SCL (yellow wire)**
- **Pi SDA** to **sensor SDA (blue wire)**

CircuitPython Installation of MLX90640 Library

You'll need to install the Adafruit CircuitPython MLX90640 (https://adafru.it/IBv) library on your CircuitPython board.

First make sure you are running the latest version of Adafruit CircuitPython (https://adafru.it/Amd) 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/ENC). Our CircuitPython starter guide has a great page on how to install the library bundle (https://adafru.it/ABU).

You'll need to manually install the necessary libraries from the bundle:

- **adafruit_mlx90640.mpy**
- **adafruit_bus_device**

Before continuing, make sure your board's **lib** folder has the **adafruit_mlx90640.mpy,** and **adafruit_bus_device** files and folders copied over.

Python Installation of MLX90640 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)!

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

- `sudo pip3 install adafruit-circuitpython-mlx90640`

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

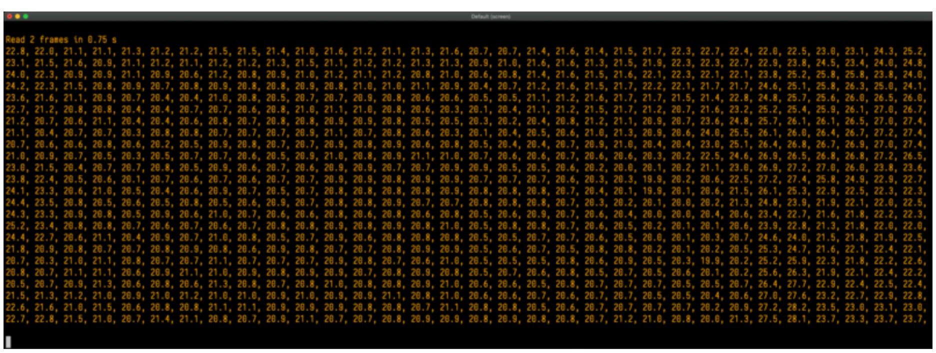
To demonstrate the usage of the sensor we'll run the `mlx90640_simpletest.py` program which prints the temperatures or shows them as ASCII. As this example is too complicated to run from the REPL, you'll save the following code to your board as **code.py** and connect to the serial console to see the output.

```
import time
import board
import busio
import adafruit_mlx90640

PRINT_TEMPERATURES = False
PRINT_ASCIIART = True

i2c = busio.I2C(board.SCL, board.SDA, frequency=800000)

mlx = adafruit_mlx90640.MLX90640(i2c)
print("MLX addr detected on I2C")
print([hex(i) for i in mlx.serial_number])

mlx.refresh_rate = adafruit_mlx90640.RefreshRate.REFRESH_2_HZ

frame = [0] * 768
while True:
    stamp = time.monotonic()
    try:
        mlx.getFrame(frame)
    except ValueError:
        # these happen, no biggie - retry
        continue
    print("Read 2 frames in %0.2f s" % (time.monotonic()-stamp))
    for h in range(24):
        for w in range(32):
            t = frame[h*32 + w]
            if PRINT_TEMPERATURES:
                print("%0.1f, " % t, end="")
            if PRINT_ASCIIART:
                c = '&'
                # pylint: disable=multiple-statements
                if t < 20: c = ' '
                elif t < 23: c = '.'
                elif t < 25: c = '-'
                elif t < 27: c = '*'
                elif t < 29: c = '+'
                elif t < 31: c = 'x'
                elif t < 33: c = '%'
                elif t < 35: c = '#'
                elif t < 37: c = 'X'
                # pylint: enable=multiple-statements
                print(c, end="")
        print()
    print()
```

If you change the values for the variables at the top of the program, you can switch from printing out an ASCII image to printing out the temperatures in a grid. Change `PRINT_TEMPERATURES` to `True` and `PRINT_ASCIIART` to `False`, so that the two lines are as follows:

```
PRINT_TEMPERATURES = True
PRINT_ASCIIART = False
```

Connect to the serial console to see the temperatures printed out in a grid. Fitting them all in a proper grid involved making my terminal window significantly larger than the default size.



That's all there is to using the MLX90640 with CircuitPython!

Python Docs

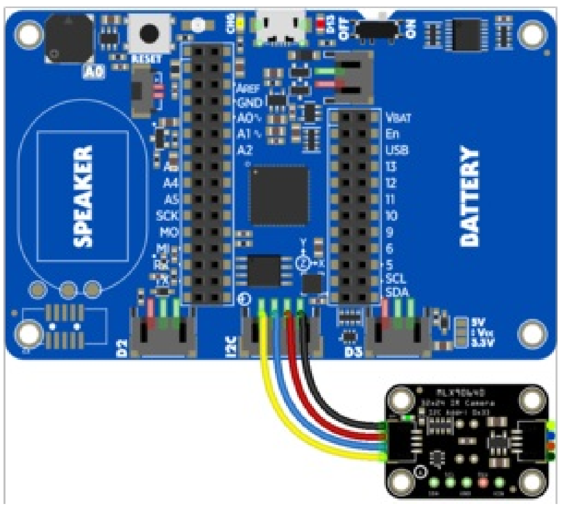
Python Docs (https://adafru.it/IxD)

CircuitPython Thermal Camera

The MLX90640 comes with STEMMA QT/QWIIC connectors which makes it super simple to plug into projects with no soldering needed. Adafruit sells a STEMMA to STEMMA QT cable (https://adafru.it/IDk) that allows you to plug this breakout into the STEMMA connector found on a number of Adafruit microcontroller boards, including PyBadge and PyGamer. The following example uses the PyBadge or PyGamer and the MLX90640 to create a super easy-to-assemble thermal camera with a display!

CircuitPython Microcontroller Wiring

First wire up a MLX90640 to your PyBadge or PyGamer exactly as shown below. Here's an example of wiring a PyBadge to the sensor with I2C using the STEMMA to STEMMA QT cable (https://adafru.it/IDk):



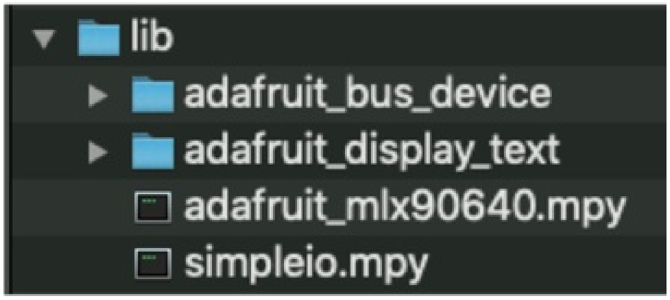
- **Plug the larger end (STEMMA/Grove) of the cable into the PyBadge/PyGamer.**
- **Plug the smaller end (STEMMA QT) of the cable into the MLX906740.**

CircuitPython Installation of Additional Libraries

On the previous page, you installed the Adafruit CircuitPython MLX90640 (https://adafru.it/IBv) library on your CircuitPython board.

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

Next you'll need to install the necessary libraries to use this example -- carefully follow the steps to find and install these libraries from Adafruit's CircuitPython library bundle (https://adafru.it/ENC). Our CircuitPython starter guide has a great page on how to install the library bundle (https://adafru.it/ABU).



You'll need to manually install **two additional** libraries from the bundle:

- **adafruit_display_text**
- **simpleio.mpy**

Before continuing, make sure your board's **lib** folder has the **adafruit_mlx90640.mpy, adafruit_bus_device, adafruit_display_text** and **simpleio.mpy** files and folders copied over.

CircuitPython PyBadge/PyGamer Thermal Camera

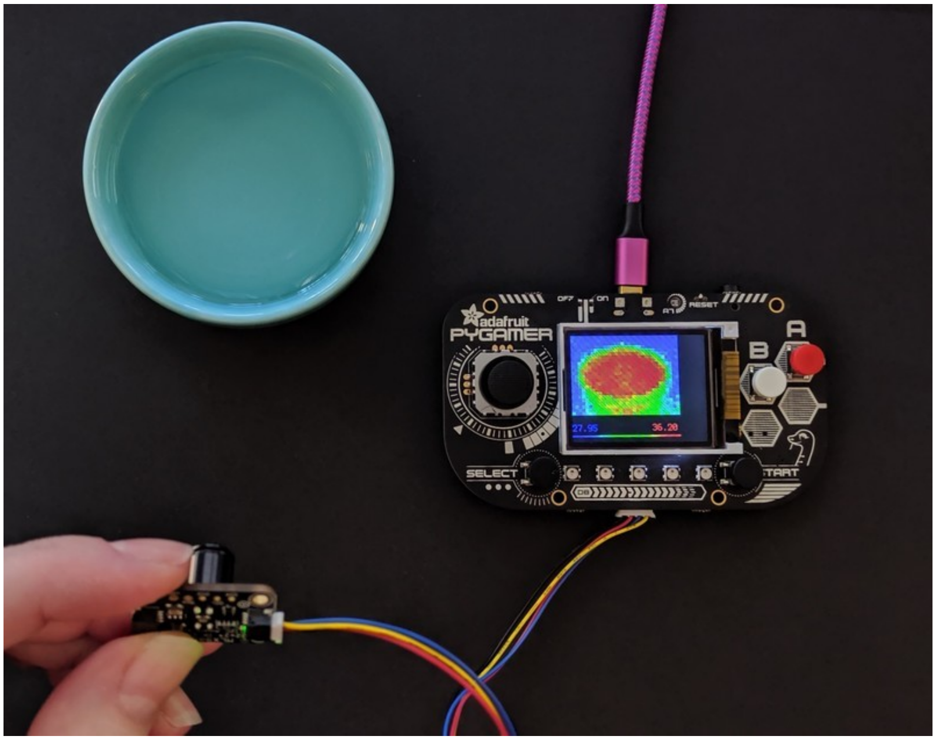
Save the following code to your PyBadge or PyGamer as **code.py**.

```
import time
import board
import busio
import adafruit_mlx90640
import displayio
import terminalio
from adafruit_display_text.label import Label
from simpleio import map_range

number_of_colors = 64                          # Number of color in the gradian
last_color = number_of_colors-1                # Last color in palette
palette = displayio.Palette(number_of_colors)  # Palette with all our colors

## Heatmap code inspired from: http://www.andrewnoske.com/wiki/Code_-_heatmaps_and_color_gradients
color_A = [[0, 0, 0], [0, 0, 255], [0, 255, 255], [0, 255, 0], [255, 255, 0], \
    [255, 0, 0], [255, 255, 255]]
color_B = [[0, 0, 255], [0, 255, 255] , [0, 255, 0], [255, 255, 0], [255, 0, 0]]
color_C = [[0, 0, 0], [255, 255, 255]]
color_D = [[0, 0, 255], [255, 0, 0]]

color = color_B
NUM_COLORS = len (color)

def MakeHeatMapColor():
```

```
def MakeHeatMapColor():
    for c in range(number_of_colors):
        value = c * (NUM_COLORS-1) / last_color
        idx1  = int(value)              # Our desired color will be after this index.
        if idx1 == value :              # This is the corner case
            red   = color[idx1][0]
            green = color[idx1][1]
            blue  = color[idx1][2]
        else:
            idx2  = idx1+1                  # ... and before this index (inclusive).
            fractBetween = value - idx1     # Distance between the two indexes (0-1).
            red   = int(round((color[idx2][0] - color[idx1][0]) * fractBetween + color[idx1][0]))
            green = int(round((color[idx2][1] - color[idx1][1]) * fractBetween + color[idx1][1]))
            blue  = int(round((color[idx2][2] - color[idx1][2]) * fractBetween + color[idx1][2]))
        palette[c]= ( 0x010000 * red ) + ( 0x000100 * green ) + ( 0x000001 * blue )

MakeHeatMapColor()

# Bitmap for colour coded thermal value
image_bitmap = displayio.Bitmap( 32, 24, number_of_colors )
# Create a TileGrid using the Bitmap and Palette
image_tile= displayio.TileGrid(image_bitmap, pixel_shader=palette)
# Create a Group that scale 32*24 to 128*96
image_group = displayio.Group(scale=4)
image_group.append(image_tile)

scale_bitmap = displayio.Bitmap( number_of_colors, 1, number_of_colors )
# Create a Group Scale must be 128 divided by number_of_colors
scale_group = displayio.Group(scale=2)
scale_tile = displayio.TileGrid(scale_bitmap, pixel_shader=palette, x = 0, y = 60)
scale_group.append(scale_tile)

for i in range(number_of_colors):
    scale_bitmap[i, 0] = i            # Fill the scale with the palette gradian

# Create the super Group
group = displayio.Group()

min_label = Label(terminalio.FONT, max_glyphs=10, color=palette[0], x = 0, y = 110)
max_label = Label(terminalio.FONT, max_glyphs=10, color=palette[last_color], x = 80, y = 110)

# Add all the sub-group to the SuperGroup
group.append(image_group)
group.append(scale_group)
group.append(min_label)
group.append(max_label)

# Add the SuperGroup to the Display
board.DISPLAY.show(group)

min_t = 20       # Initial minimum temperature range, before auto scale
max_t = 37       # Initial maximum temperature range, before auto scale

i2c = busio.I2C(board.SCL, board.SDA, frequency=800000)

mlx = adafruit_mlx90640.MLX90640(i2c)
print("MLX addr detected on I2C")
print([hex(i) for i in mlx.serial_number])

#mlx.refresh_rate = adafruit_mlx90640.RefreshRate.REFRESH_2_HZ
```

```
mlx.refresh_rate = adafruit_mlx90640.RefreshRate.REFRESH_4_HZ

frame = [0] * 768

while True:
    stamp = time.monotonic()
    try:
        mlx.getFrame(frame)
    except ValueError:
        # these happen, no biggie - retry
        continue

#    print("Time for data aquisition: %0.2f s" % (time.monotonic()-stamp))

    mini = frame[0]       # Define a min temperature of current image
    maxi = frame[0]       # Define a max temperature of current image

    for h in range(24):
        for w in range(32):
            t = frame[h*32 + w]
            if t > maxi:
                maxi = t
            if t < mini:
                mini = t
            image_bitmap[w, (23-h)] = int(map_range(t, min_t, max_t, 0, last_color ))

    min_label.text="%0.2f" % (min_t)

    max_string="%0.2f" % (max_t)
    max_label.x=120-(5*len(max_string))      # Tricky calculation to left align
    max_label.text=max_string

    min_t = mini                  # Automatically change the color scale
    max_t = maxi
#    print((mini, maxi))           # Use this line to display min and max graph in Mu
#    print("Total time for aquisition and display %0.2f s" % (time.monotonic()-stamp))
```

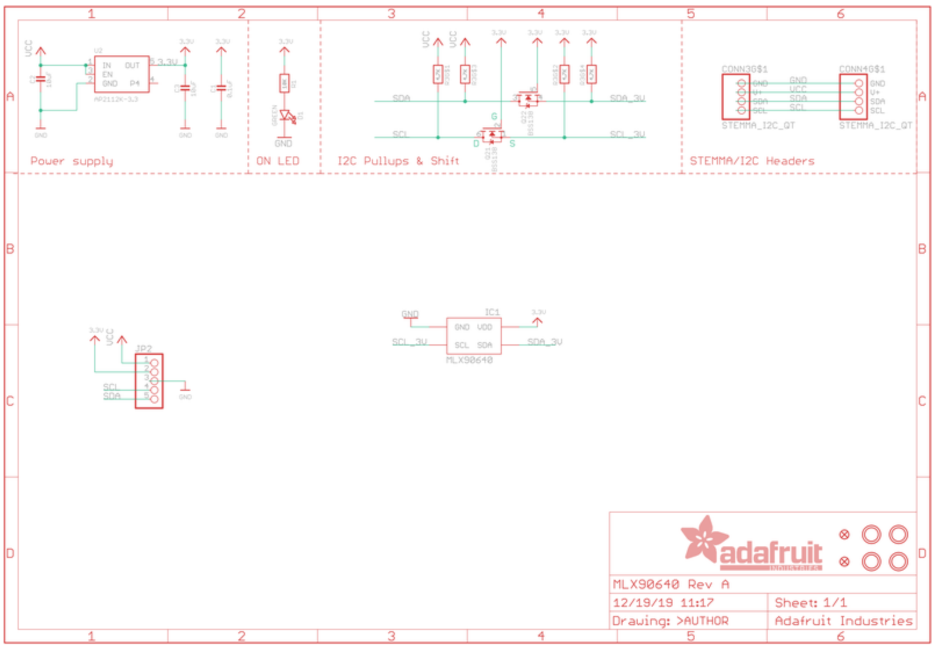
Now point the thermal camera at various objects to see a heat map displayed on your board!


adafruit
PYGAMER
27.95
36.20
SELECT
START
RESET
B
A

Files

- MLX90640 datasheet (https://adafru.it/IAR)
- EagleCAD files on GitHub (https://adafru.it/IAS)
- Fritzing object in Adafruit Fritzing Library (https://adafru.it/IAT)

Schematic



Fab Print