adafruit learning system

Adafruit Mini TFT - 0.96" 160x80

Created by lady ada

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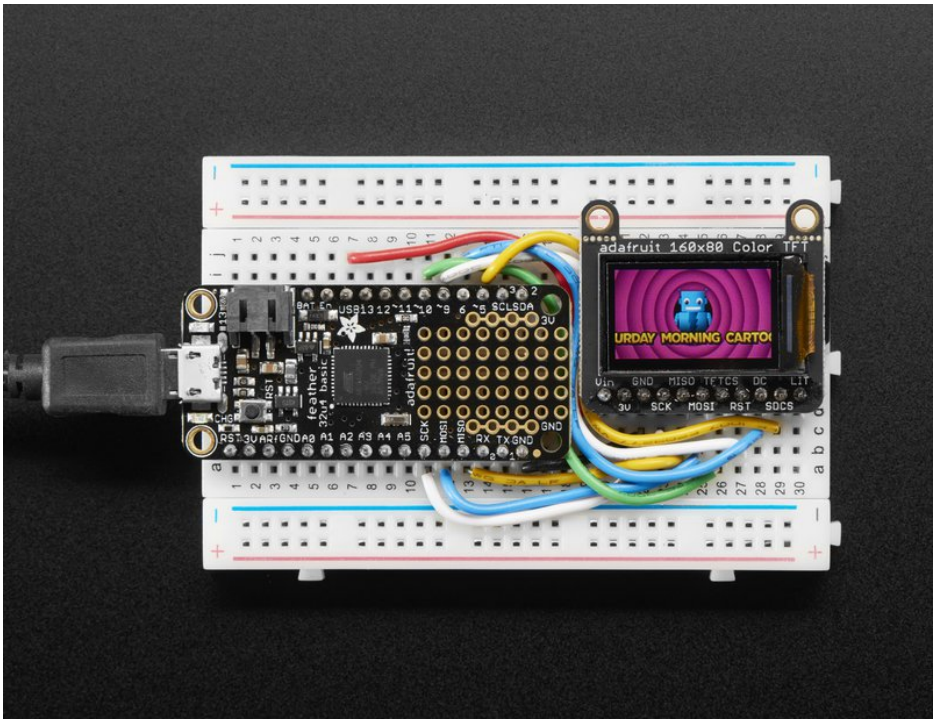
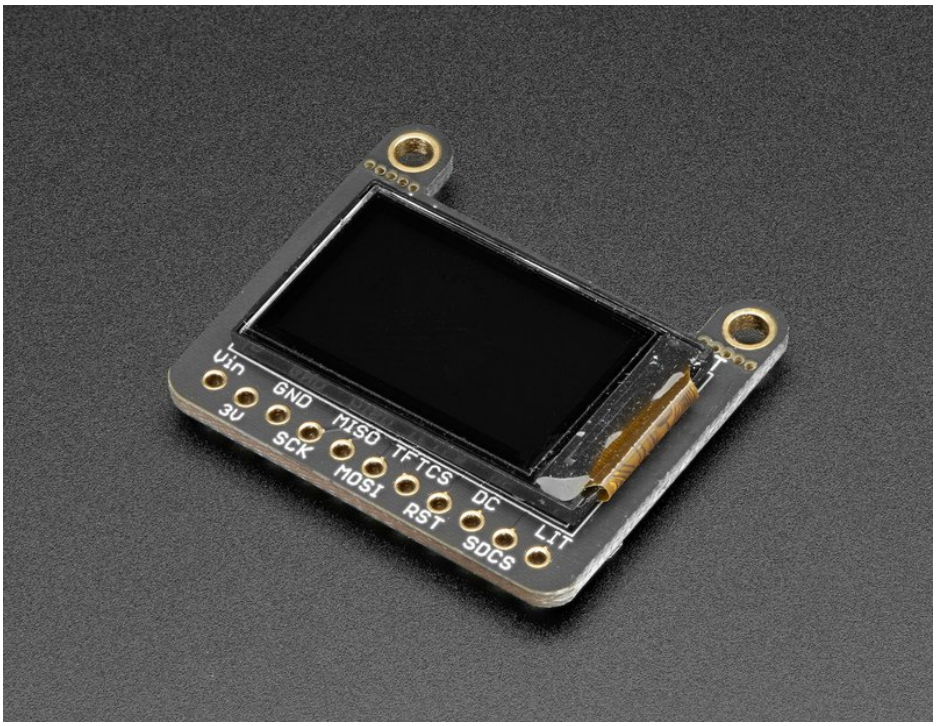
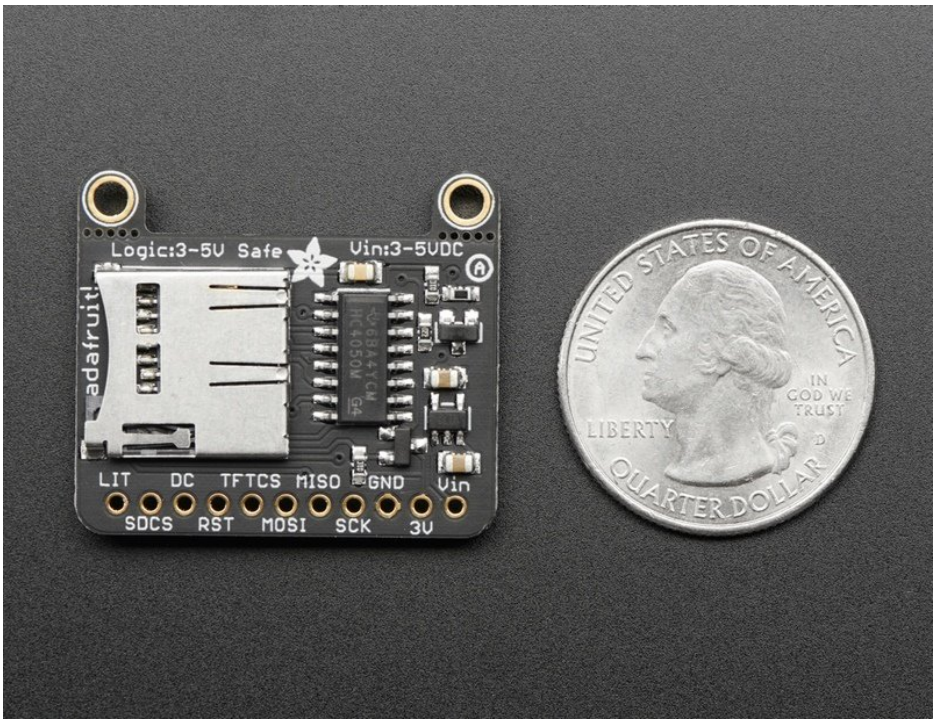
Overview



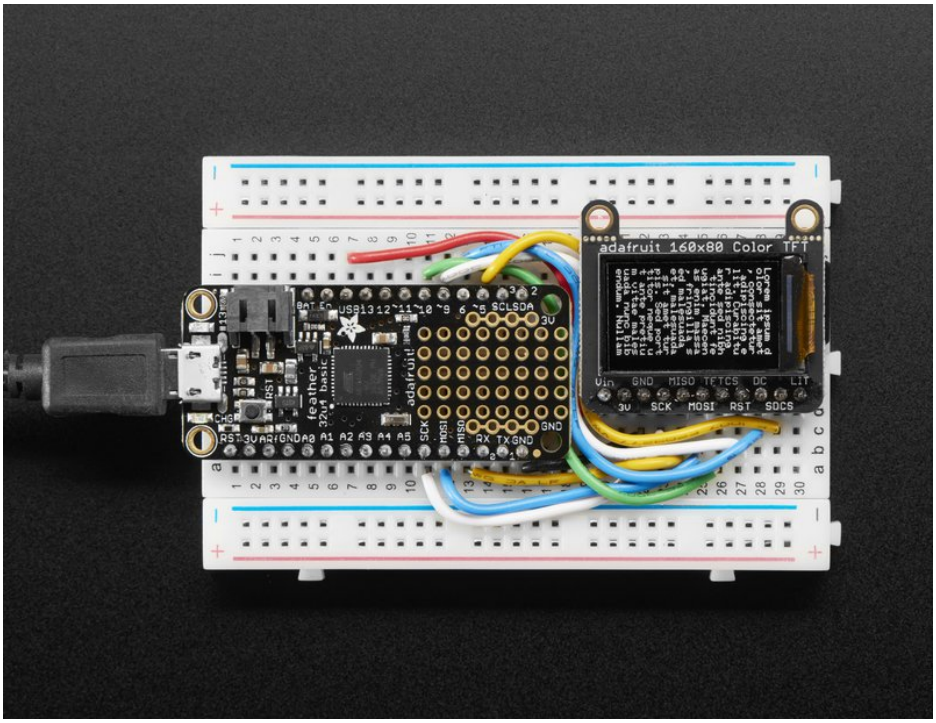
It's the size of your thumbnail, with glorious 160x80 pixel color... it's the Adafruit Mini TFT Breakout! This very very small display is only 0.96" diagonal, packed with RGB pixels, for making very small high-density displays.



The display uses 4-wire SPI to communicate and has its own pixel-addressable frame buffer, it can be used with every kind of microcontroller. Even a very small one with low memory and few pins available!



The breakout has the TFT display soldered on (it uses a delicate flex-circuit connector) as well as a ultra-low-dropout 3.3V regulator and a 3/5V level shifter so you can use it with 3.3V or 5V power and logic. We also had a little space so we placed a microSD card holder so you can easily load full color bitmaps from a FAT16/FAT32 formatted microSD card. The microSD card is not included, but you can pick one up here (http://adafru.it/102).

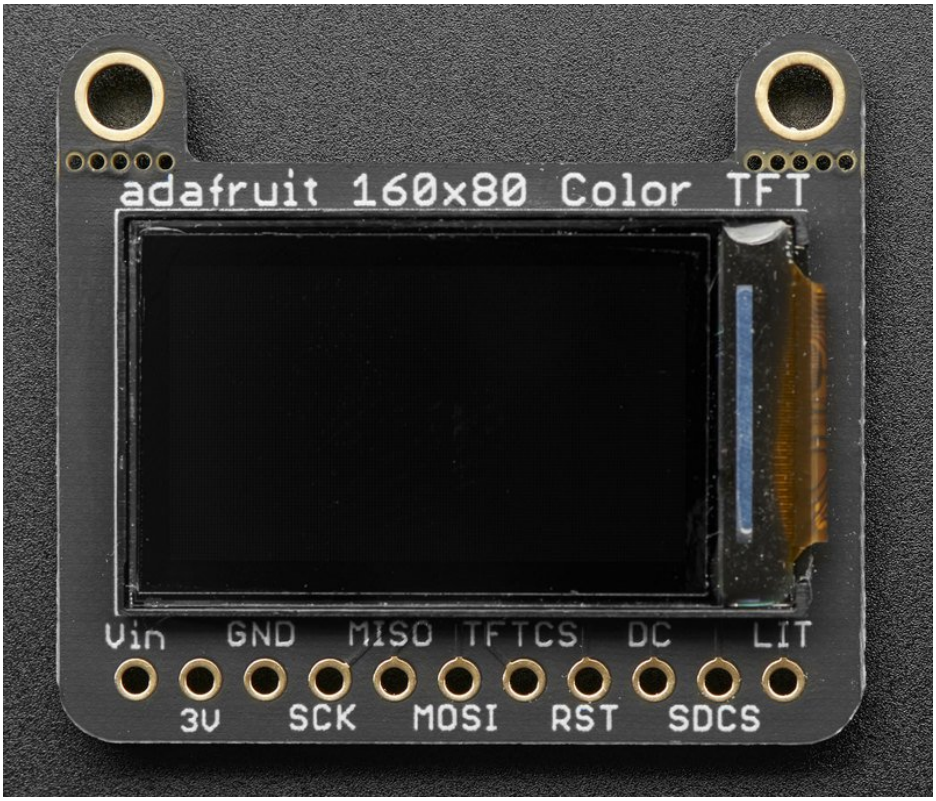


Of course, we wouldn't just leave you with a datasheet and a "good luck!" - we've written a full open source graphics library that can draw pixels, lines, rectangles, circles, text and bitmaps as well as example code and a wiring tutorial. The code is written for Arduino but can be easily ported to your favorite microcontroller!

Specifications:

- 0.96" diagonal LCD TFT display
- 160x80 resolution, 16-bit color
- 4 wire SPI digital interface - SCK, MOSI, CS and DC pins.
- Built-in microSD slot - uses 2 more digital lines
- 5V compatible! Use with 3.3V or 5V logic
- Onboard 3.3V @ 150mA LDO regulator
- 1 white LED backlight, transistor connected so you can PWM dim the backlight
- 0.1" pitch header for easy breadboarding
- 2 removable mounting holes in corners
- Current draw is based on LED backlight usage: with full backlight draw is ~25mA

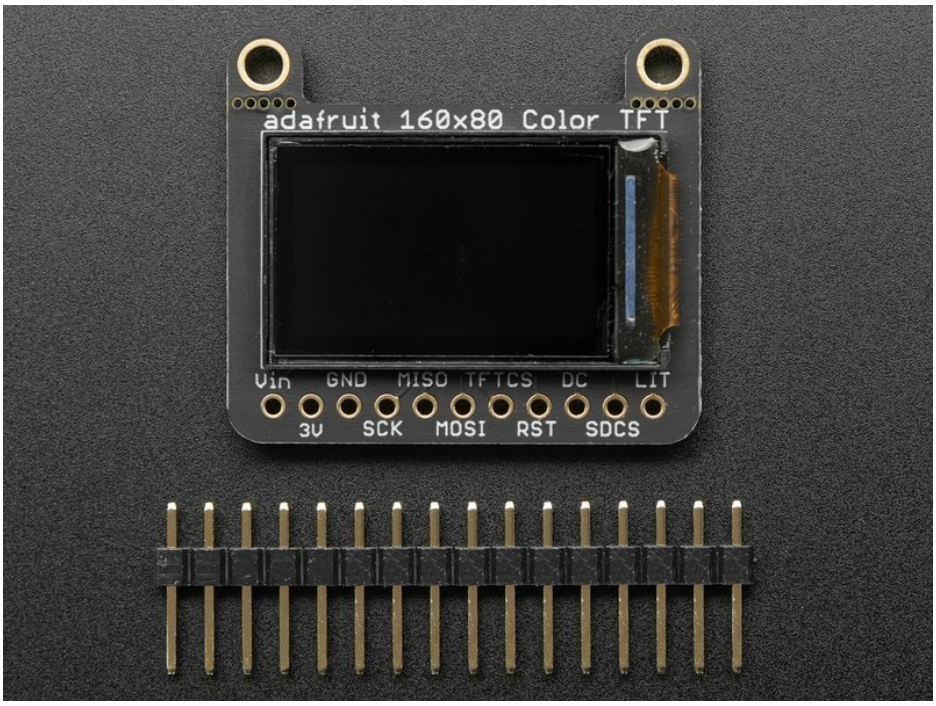
Pinouts



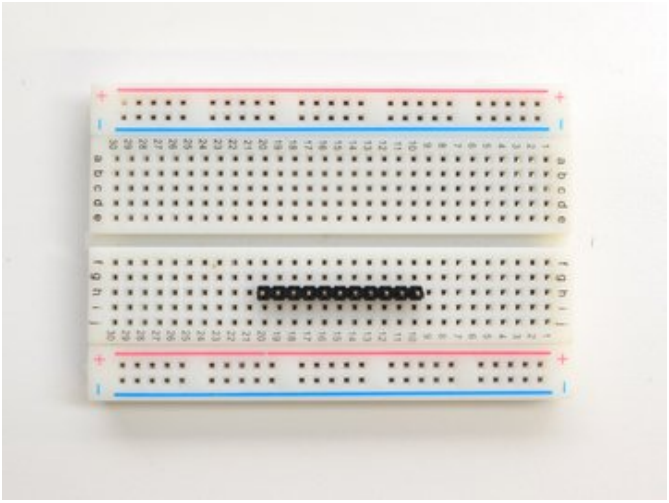
This color display uses SPI to receive image data. That means you need at least 4 pins - clock, data in, tft cs and d/c. If you'd like to have SD card usage too, add another 2 pins - data out and card cs. However, there's a couple other pins you may want to use, lets go thru them all!

- **3-5V / Vin** - this is the power pin, connect to 3-5VDC - it has reverse polarity protection but try to wire it right!
- **3.3V** - this is the 3.3V output from the onboard regulator
- **GND** - this is the power and signal ground pin
- **SCK** - this is the SPI clock input pin. Use 3-5V logic level
- **MISO** - this is the SPI Master In Slave Out pin, its used for the SD card. It isn't used for the TFT display which is write-only. It is 3.3V logic out (but can be read by 5V logic)
- **MOSI** - this is the SPI Master Out Slave In pin, it is used to send data from the microcontroller to the SD card and/or TFT. Use 3-5V logic level
- **TFT_CS** - this is the TFT SPI chip select pin. Use 3-5V logic level
- **RST** - this is the TFT reset pin. Connect to ground to reset the TFT! Its best to have this pin controlled by the library so the display is reset cleanly, but you can also connect it to the Arduino Reset pin, which works for most cases. There is an automatic-reset chip connected so it will reset on power-up. Use 3-5V logic level
- **D/C** - this is the TFT SPI data or command selector pin. Use 3-5V logic level
- **SD Card CS / SDCS -** this is the SD card chip select, used if you want to read from the SD card. Use 3-5V logic level
- **Lite** - this is the PWM input for the backlight control. It is by default pulled high (backlight on) you can PWM at any frequency or pull down to turn the backlight off. Use 3-5V logic level

Assembly

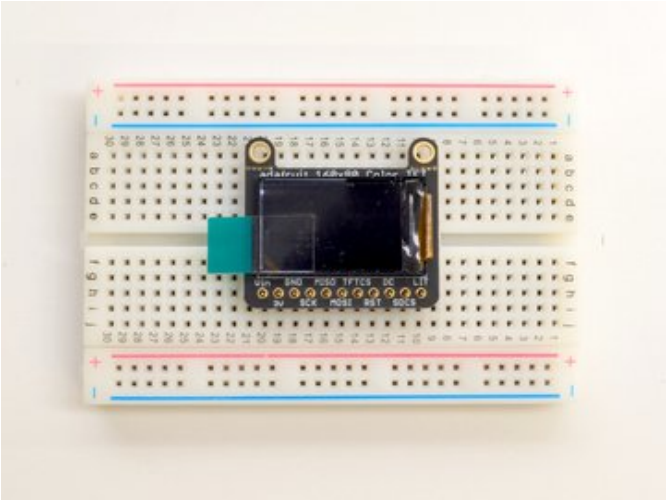


The board comes with all surface-mount components pre-soldered. The included header strip can be soldered on for convenient use on a breadboard or with 0.1" connectors. You can also skip this step and solder on wires.



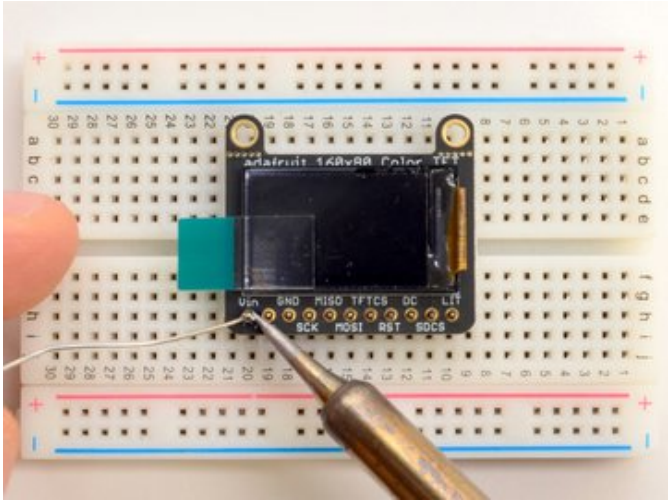
Prepare the header strip:

Cut the strip to length if necessary. It will be easier to solder if you insert it into a breadboard - **long pins down**



Add the breakout board:

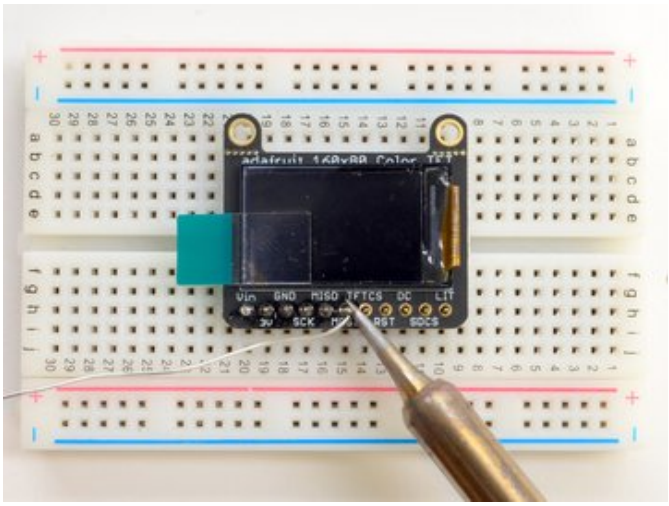
Place the breakout board over the pins so that the short pins poke through the breakout pads

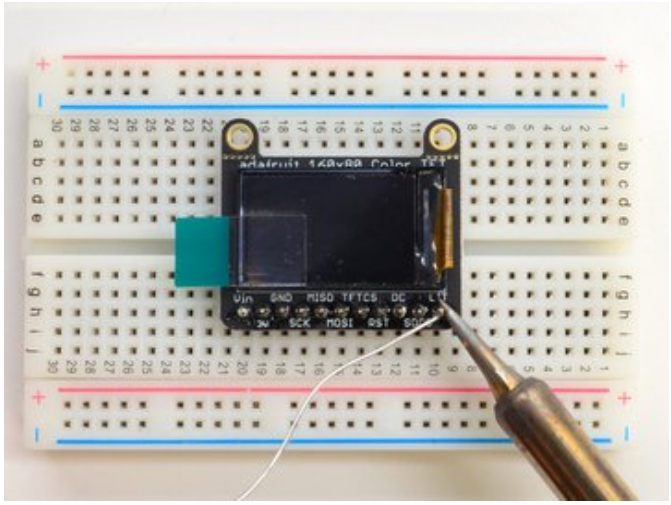


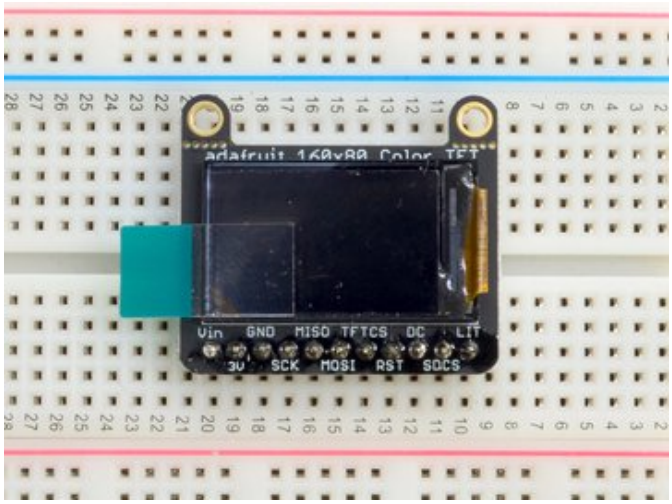
And Solder!

Be sure to solder all 5 pins for reliable electrical contact.

(For tips on soldering, be sure to check out our Guide to Excellent Soldering (https://adafru.it/aTk).

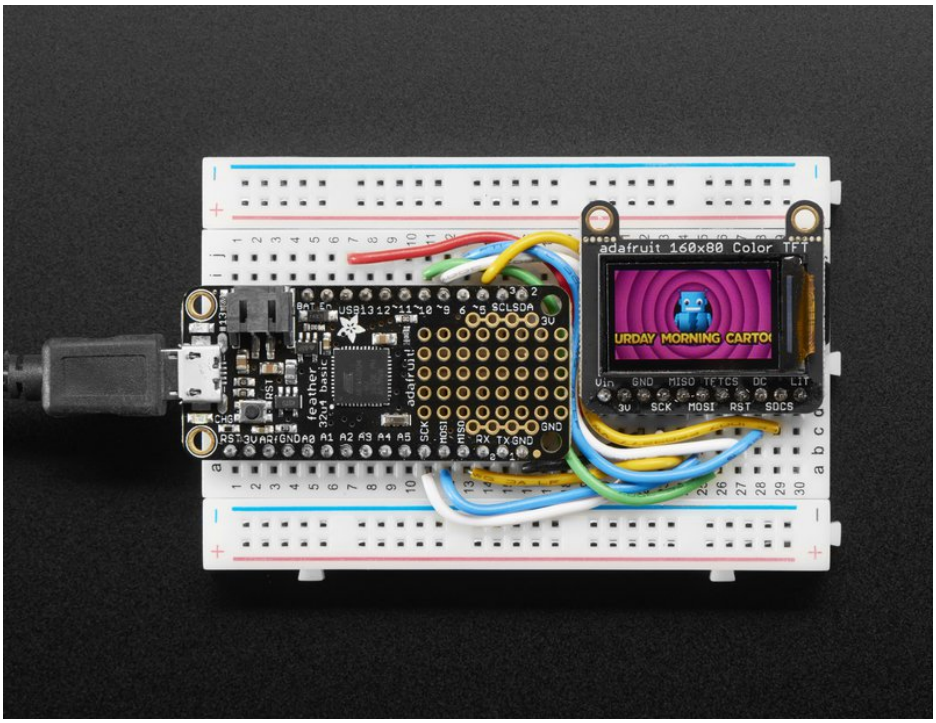






You're done! Check your solder joints visually and continue onto the next steps

Wiring & Test

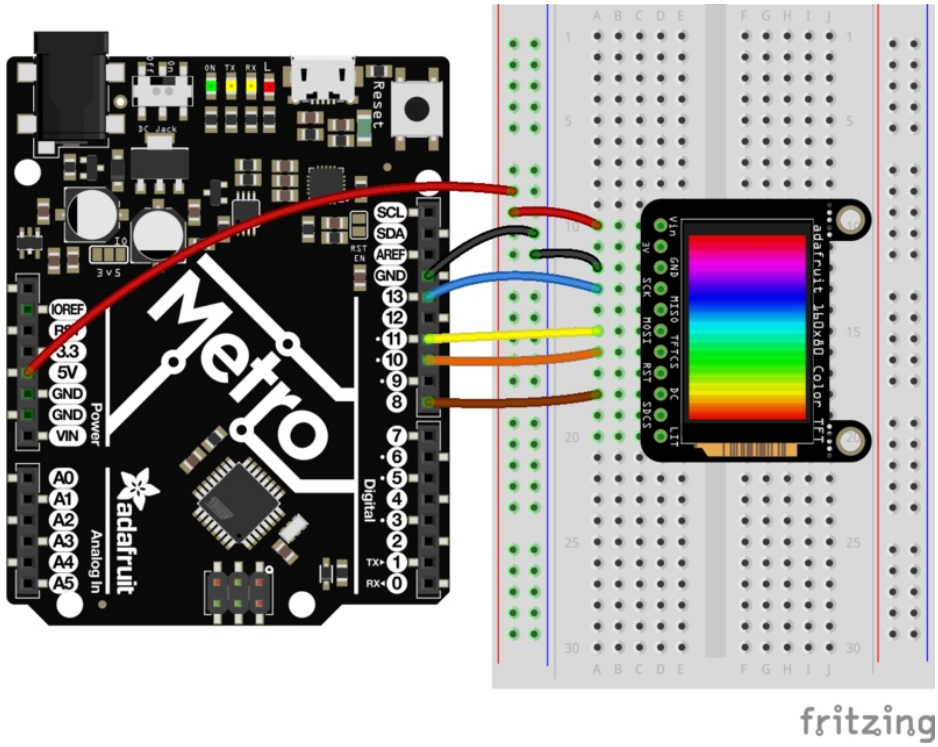


Basic Graphics Test Wiring

Wiring up the display in SPI mode is pretty easy as there's not that many pins! We'll be using hardware SPI, but you can also use software SPI (any pins) later. Start by connecting the power pins

- **3-5V Vin** connects to the microcontroller **5V** pin
- **GND** connects to Arduino ground
- **CLK** connects to SPI clock. On Arduino Uno/Duemilanove/328-based, thats **Digital 13**. On Mega's, its **Digital 52** and on Leonardo/Due its **ICSP-3** (See SPI Connections for more details (https://adafru.it/d5h))
- **MISO** is not connected
- **MOSI** connects to SPI MOSI. On Arduino Uno/Duemilanove/328-based, thats **Digital 11**. On Mega's, its **Digital 51** and on Leonardo/Due its **ICSP-4** (See SPI Connections for more details (https://adafru.it/d5h))
- **CS** connects to our SPI Chip Select pin. We'll be using **Digital 10** but you can later change this to any pin
- **RST** is not connected
- **D/C** connects to our SPI data/command select pin. We'll be using **Digital 8** but you can later change this pin too.

For the level shifter we use the CD74HC4050 (https://adafru.it/CgA) which has a typical propagation delay of ~10ns



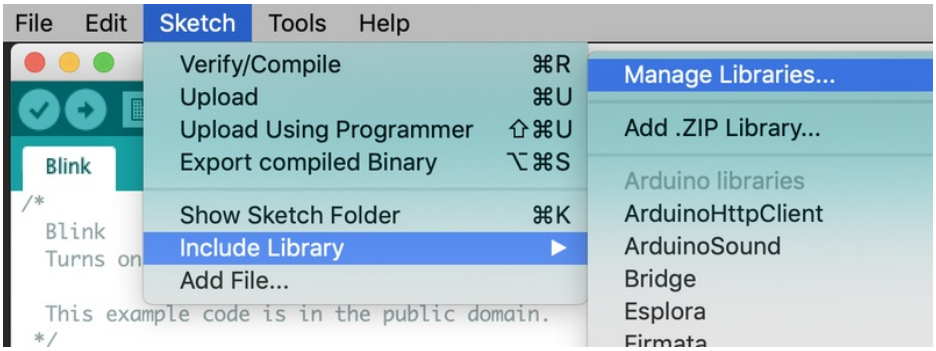
https://adafru.it/xct

https://adafru.it/xct

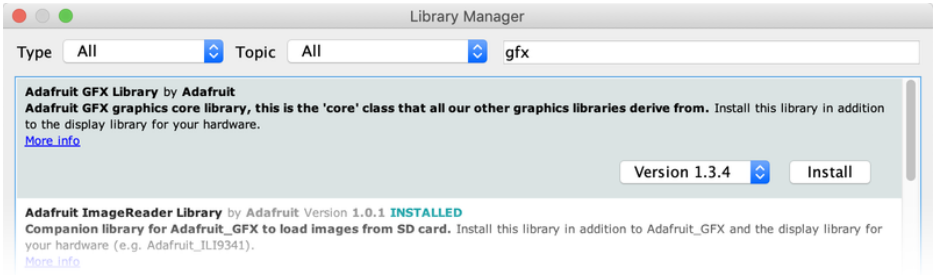
Install Arduino Libraries

We have example code ready to go for use with these TFTs. It's written for Arduino, which should be portable to any microcontroller by adapting the C++ source.

Three libraries need to be installed using the **Arduino Library Manager**...this is the preferred and modern way. From the Arduino "Sketch" menu, select "Include Library" then "Manage Libraries..."

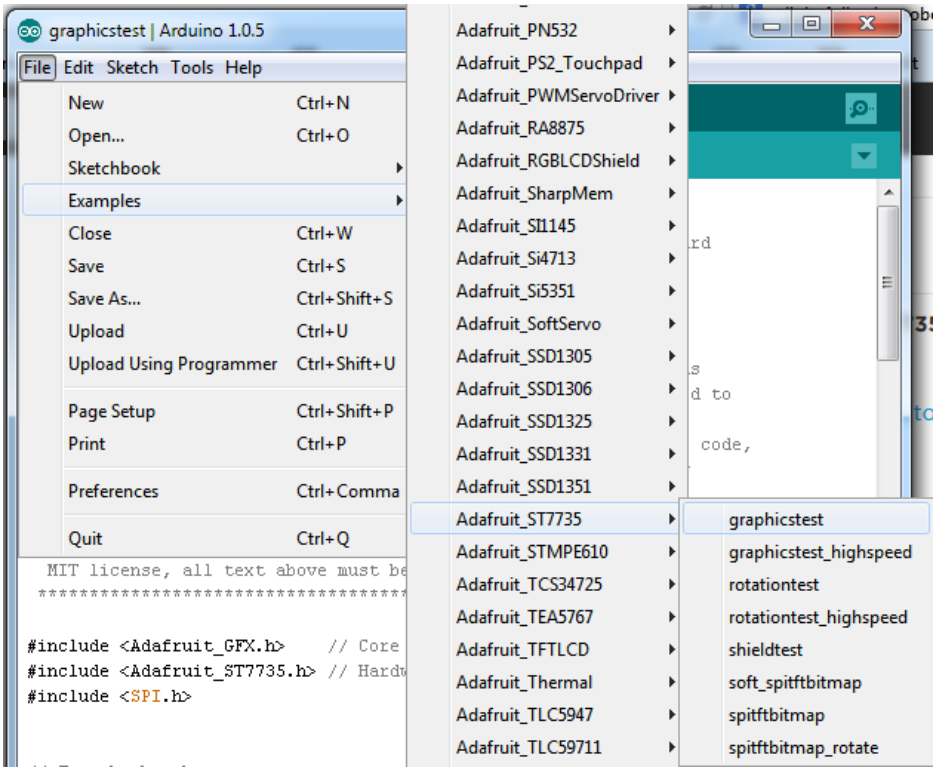


Type "gfx" in the search field to quickly find the first library — **Adafruit_GFX**:



Repeat the search and install steps, looking for the **Adafruit_ZeroDMA** and **Adafruit_ST7735** libraries.

After restarting the Arduino software, you should see a new **example** folder called **Adafruit_ST7735,** and inside, an example called **graphicstest**.



In the graphicstest source code, look for the lines as follows:

```
// Use this initializer if you're using a 1.8" TFT
tft.initR(INITR_BLACKTAB);   // initialize a ST7735S chip, black tab

// Use this initializer (uncomment) if you're using a 1.44" TFT
//tft.initR(INITR_144GREENTAB);   // initialize a ST7735S chip, black tab

// Use this initializer (uncomment) if you're using a 0.96" 180x60 TFT
//tft.initR(INITR_MINI160x80);   // initialize a ST7735S chip, mini display
```

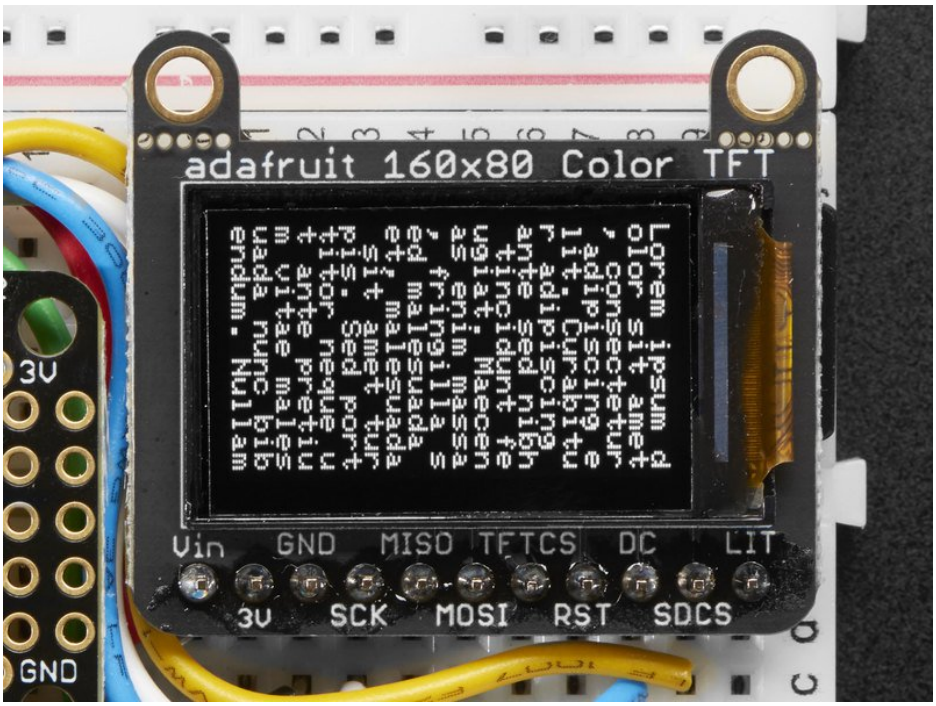
comment out the first line, and uncomment the third, so it looks like:

```
// Use this initializer if you're using a 1.8" TFT
//tft.initR(INITR_BLACKTAB);   // initialize a ST7735S chip, black tab

// Use this initializer (uncomment) if you're using a 1.44" TFT
//tft.initR(INITR_144GREENTAB);   // initialize a ST7735S chip, black tab

// Use this initializer (uncomment) if you're using a 0.96" 180x60 TFT
tft.initR(INITR_MINI160x80);   // initialize a ST7735S chip, mini display
```

Now upload the sketch to your Arduino. You may need to press the Reset button to reset the arduino and TFT. You should see a collection of graphical tests draw out on the TFT.



Changing Pins

Now that you have it working, there's a few things you can do to change around the pins.

If you're using Hardware SPI, the CLOCK and MOSI pins are 'fixed' and cant be changed. But you can change to software SPI, which is a bit slower, and that lets you pick any pins you like. Find these lines:

```
// Option 1 (recommended): must use the hardware SPI pins
// (for UNO thats sclk = 13 and sid = 11) and pin 10 must be
// an output. This is much faster - also required if you want
// to use the microSD card (see the image drawing example)
Adafruit_ST7735 tft = Adafruit_ST7735(TFT_CS,  TFT_DC, TFT_RST);

// Option 2: use any pins but a little slower!
#define TFT_SCLK 13   // set these to be whatever pins you like!
#define TFT_MOSI 11   // set these to be whatever pins you like!
//Adafruit_ST7735 tft = Adafruit_ST7735(TFT_CS, TFT_DC, TFT_MOSI, TFT_SCLK, TFT_RST);
```

Comment out option 1, and uncomment option 2. Then you can change the **TFT_** pins to whatever pins you'd like!

The 0.96" TFT has a auto-reset circuit on it so you probably dont need to use the **RST** pin. You can change

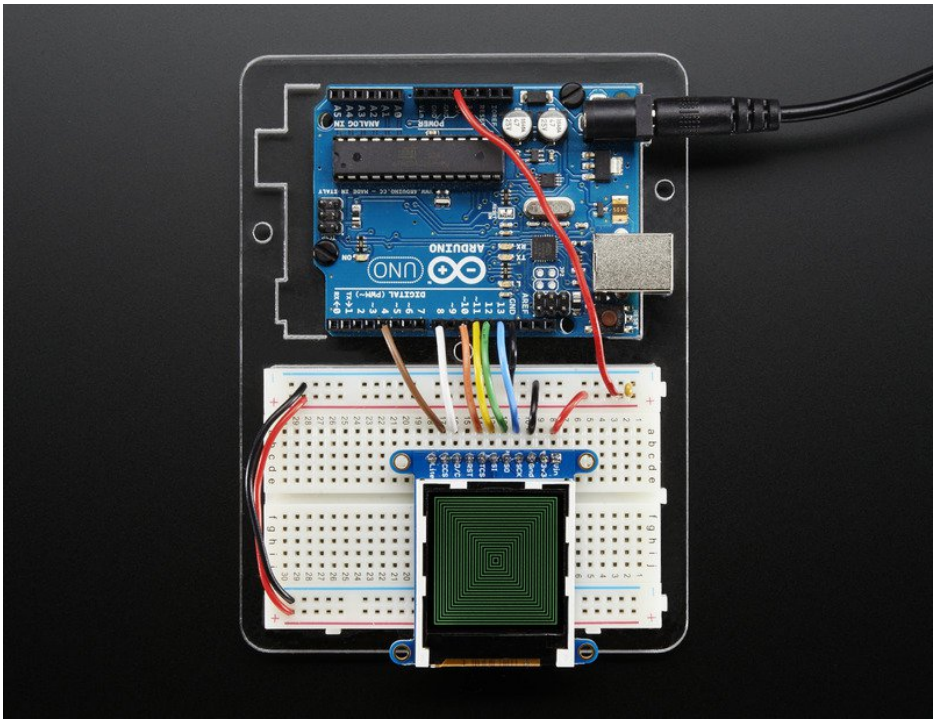
```
#define TFT_RST   9
```

to

```
#define TFT_RST   -1
```

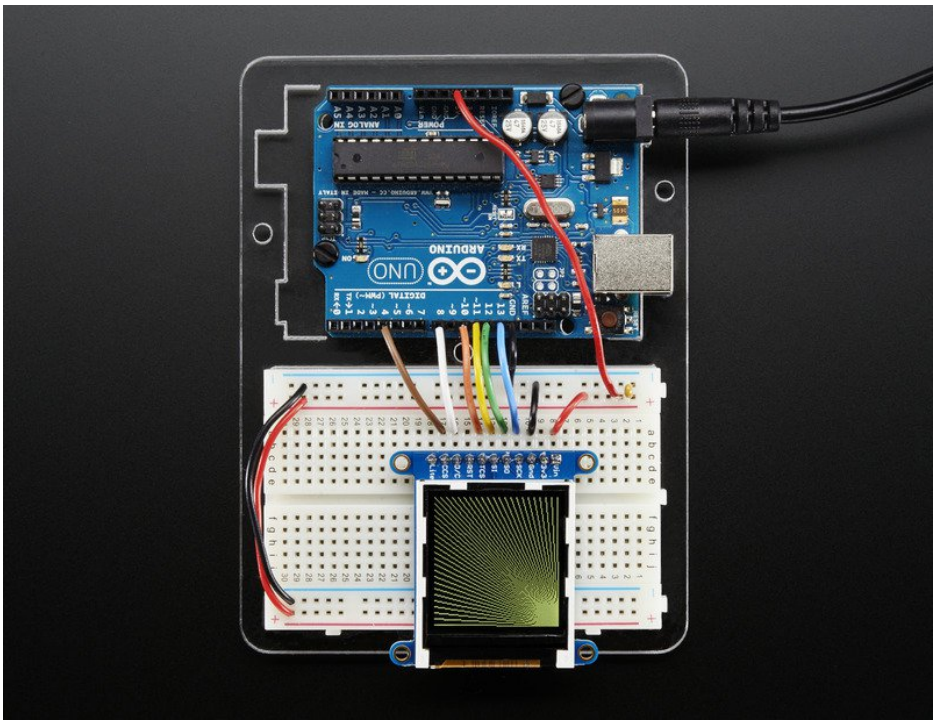
so that pin isn't used either. Or connect it up for manual TFT resetting!

Adafruit GFX library



The Adafruit_GFX library for Arduino provides a common syntax and set of graphics functions for all of our TFT, LCD and OLED displays. This allows Arduino sketches to easily be adapted between display types with minimal fuss...and any new features, performance improvements and bug fixes will immediately apply across our complete offering of color displays.

The GFX library is what lets you draw points, lines, rectangles, round-rects, triangles, text, etc.



Check out our detailed tutorial here http://learn.adafruit.com/adafruit-gfx-graphics-library (https://adafru.it/aPx) It covers the latest and greatest of the GFX library!

Drawing Bitmaps

There is a built in microSD card slot into the breakout, and we can use that to load bitmap images! You will need a microSD card formatted **FAT16 or FAT32** (they almost always are by default).

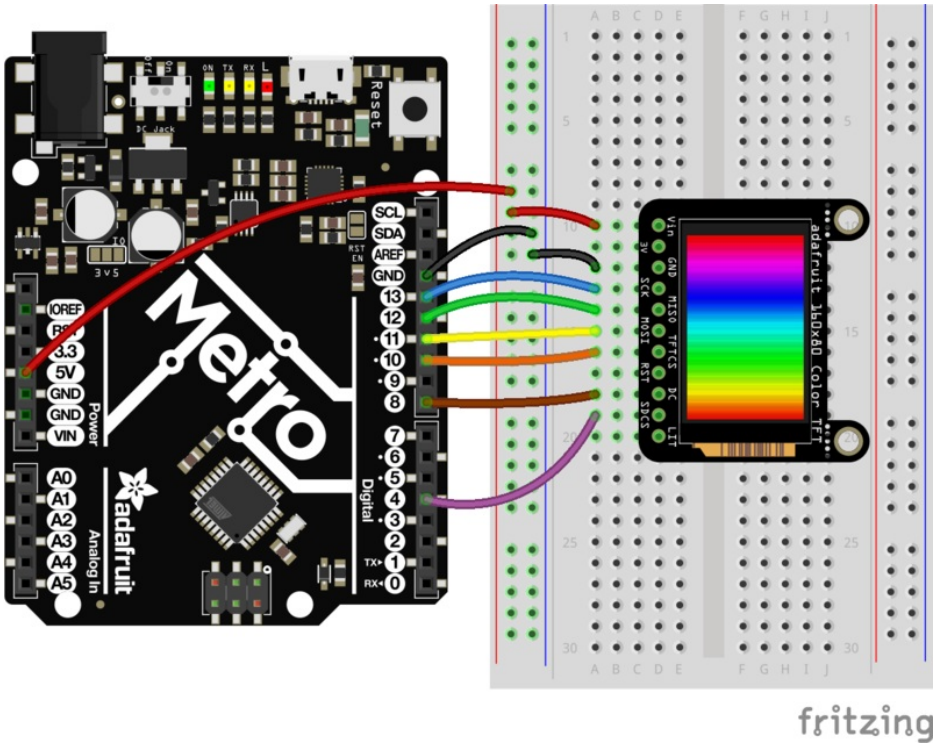
Its really easy to draw bitmaps! Lets start by downloading this image of ADABOT

Notice its rotated because the screen is 'naturally' portrait but we want the image to be landscape

Copy **minibot.bmp** into the base directory of a microSD card and insert it into the microSD socket in the breakout.

Two more wires are required to interface with the onboard SD card:

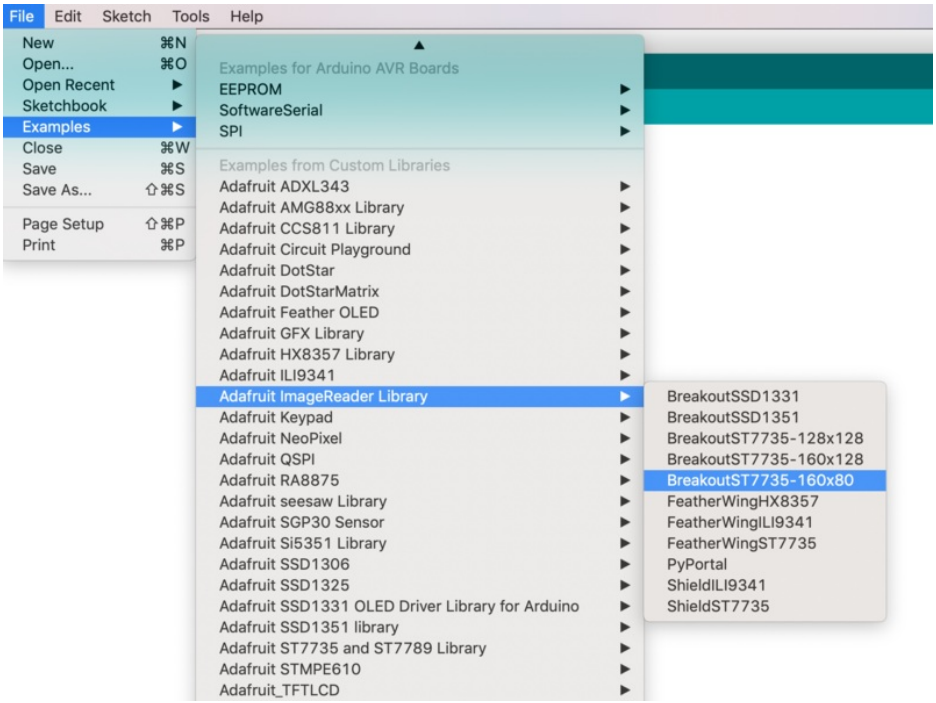
- You'll need to connect up the **MISO** pin to the SPI MISO line on your microcontroller. On Arduino Uno/Duemilanove/328-based, thats **Digital 12**. On Mega's, its **Digital 50** and on Leonardo/Due its **ICSP-1** (See SPI Connections for more details (https://adafru.it/d5h))
- Also, **SDCS** pin to **Digital 4** on your Arduino as well. You can change this pin later, but stick with this for now.



https://adafru.it/xcu

You may want to try the **SD library** examples before continuing, especially one that lists all the files on the SD card

Open the **File→examples→Adafruit ImageReader Library→BreakoutST7735 - 160x80** example:



Now upload the example sketch to the Arduino. You should see ADABOT appear! If you have any problems, check the serial console for any messages such as not being able to initialize the microSD card or not finding the image.

To make new bitmaps, make sure they are less than 160 by 80 pixels and save them in **24-bit BMP format**! They must

be in 24-bit format, even if they are not 24-bit color as that is the easiest format for the Arduino. You can rotate images using the **setRotation()** procedure

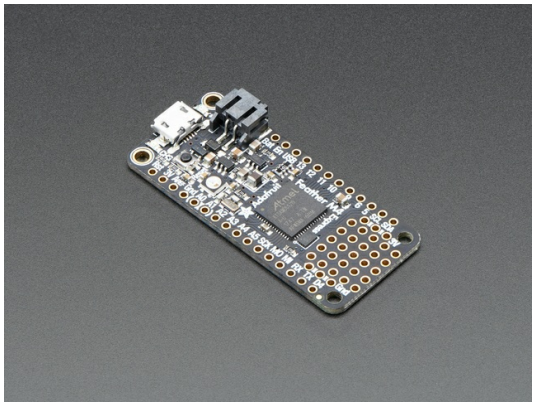
You can draw as many images as you want - dont forget the names must be less than 8 characters long. Just copy the BMP drawing routines below loop() and call

> **bmpDraw(bmpfilename, x, y);**

For each bitmap. They can be smaller than 160x80 and placed in any location on the screen.

CircuitPython Displayio Quickstart

You will need a board capable of running CircuitPython such as the Metro M0 Express or the Metro M4 Express. You can also use boards such as the Feather M0 Express or the Feather M4 Express. We recommend either the Metro M4 or the Feather M4 Express because it's much faster and works better for driving a display. For this guide, we will be using a Feather M4 Express. The steps should be about the same for the Feather M0 Express or either of the Metros. If you haven't already, be sure to check out our Feather M4 Express (https://adafru.it/EEm) guide.



Adafruit Feather M4 Express - Featuring ATSAMD51

$22.95
IN STOCK

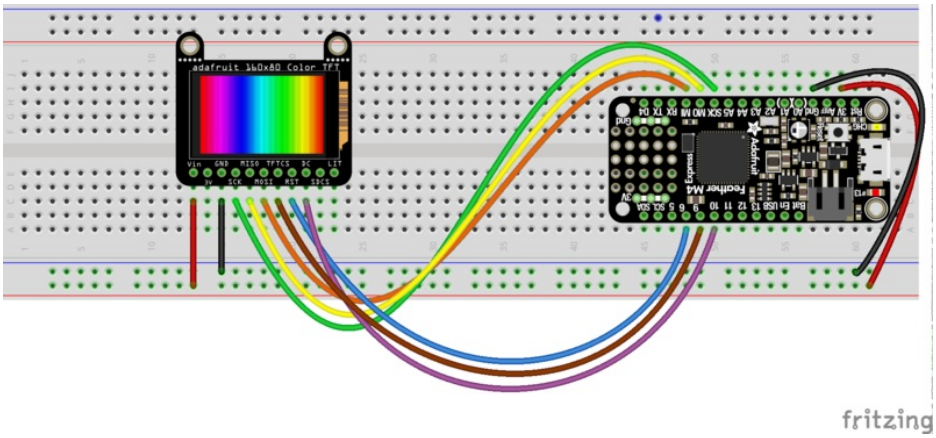
ADD TO CART

Preparing the Breakout

Before using the TFT Breakout, you will need to solder the headers or some wires to it. Be sure to check out the Adafruit Guide To Excellent Soldering (https://adafru.it/drl). After that the breakout should be ready to go.

Wiring the Breakout to the Feather

- **3-5V VIN** connects to the Feather **3V** pin
- **GND** connects toFeather ground
- **SCK** connects to SPI clock. On the Feather that's **SCK**.
- **MISO** connects to SPI MISO. On the Feather that's **MI**
- **MOSI** connects to SPI MOSI. On the Feather that's **MO**
- **TFTCS** connects to our SPI Chip Select pin. We'll be using **Digital 9** but you can later change this to any pin
- **DC** connects to our SPI data/command select pin. We'll be using **Digital 10** but you can later change this pin too.
- **RST** connects to our reset pin. We'll be using **Digital 6** but you can later change this pin too.



https://adafru.it/Fza

https://adafru.it/Fza

Required CircuitPython Libraries

To use this display with `displayio`, there is only one required library.

https://adafru.it/EGk

https://adafru.it/EGk

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/zdx). Our introduction guide has a great page on how to install the library bundle (https://adafru.it/ABU) for both express and non-express boards.

Remember for non-express boards, you'll need to manually install the necessary libraries from the bundle:

- **adafruit_st7735r**

Before continuing make sure your board's lib folder or root filesystem has the **adafruit_st7735r** file copied over.

Code Example Additional Libraries

For the Code Example, you will need an additional library. We decided to make use of a library so the code didn't get overly complicated.

https://adafru.it/FiA

https://adafru.it/FiA

Go ahead and install this in the same manner as the driver library by copying the **adafruit_display_text** folder over to the **lib** folder on your CircuitPython device.

CircuitPython Code Example

```
"""
This test will initialize the display using displayio and draw a solid green
background, a smaller purple rectangle, and some yellow text.
"""

import board
import displayio
import terminalio
from adafruit_display_text import label
from adafruit_st7735r import ST7735R

spi = board.SPI()
tft_cs = board.D5
tft_dc = board.D6

displayio.release_displays()
display_bus = displayio.FourWire(spi, command=tft_dc, chip_select=tft_cs, reset=board.D9)

display = ST7735R(display_bus, width=160, height=80, colstart=24, rotation=270, bgr=True)

# Make the display context
splash = displayio.Group(max_size=10)
display.show(splash)

color_bitmap = displayio.Bitmap(160, 80, 1)
color_palette = displayio.Palette(1)
color_palette[0] = 0x00FF00 # Bright Green

bg_sprite = displayio.TileGrid(color_bitmap,
                               pixel_shader=color_palette,
                               x=0, y=0)
splash.append(bg_sprite)

# Draw a smaller inner rectangle
inner_bitmap = displayio.Bitmap(150, 70, 1)
inner_palette = displayio.Palette(1)
inner_palette[0] = 0xAA0088 # Purple
inner_sprite = displayio.TileGrid(inner_bitmap,
                                  pixel_shader=inner_palette,
                                  x=5, y=5)
splash.append(inner_sprite)

# Draw a label
text_group = displayio.Group(max_size=10, scale=2, x=11, y=40)
text = "Hello World!"
text_area = label.Label(terminalio.FONT, text=text, color=0xFFFF00)
text_group.append(text_area) # Subgroup for text scaling
splash.append(text_group)

while True:
    pass
```

Let's take a look at the sections of code one by one. We start by importing the board so that we can initialize `SPI`, `displayio`, `terminalio` for the font, a `label`, and the `adafruit_st7735r` driver.

```
import board
import displayio
import terminalio
from adafruit_display_text import label
from adafruit_st7735r import ST7735R
```

Next, we set the SPI object to the board's SPI with the easy shortcut function `board.SPI()`. By using this function, it finds the SPI module and initializes using the default SPI parameters.

```
spi = board.SPI()
tft_cs = board.D5
tft_dc = board.D6
```

In the next two lines, we release the displays. This is important because if the Feather is reset, the display pins are not automatically released and this makes them available for use again. We set the display bus to FourWire which makes use of the SPI bus.

```
displayio.release_displays()
display_bus = displayio.FourWire(spi, command=tft_dc, chip_select=tft_cs, reset=board.D9)
```

Finally, we initialize the driver with a width of 160 and a height of 80. If we stopped at this point and ran the code, we would have a terminal that we could type at and have the screen update. Because we want to use the display horizontally and the default orientation is vertical, we rotate it **270** degrees. One other parameter that we provide is `bgr=True` and the reason for this is that the color ordering of certain displays is Blue, Green, Red rather than the usual Red, Green, Blue. It tell displayio the correct color ordering for this particular display. This display also has **24** empty columns, so we pass it the `colstart` parameter.

```
display = ST7735R(display_bus, width=160, height=80, colstart=24, rotation=270, bgr=True)
```

Next we create a background splash image. We do this by creating a group that we can add elements to and adding that group to the display. In this example, we are limiting the maximum number of elements to 10, but this can be increased if you would like. The display will automatically handle updating the group.

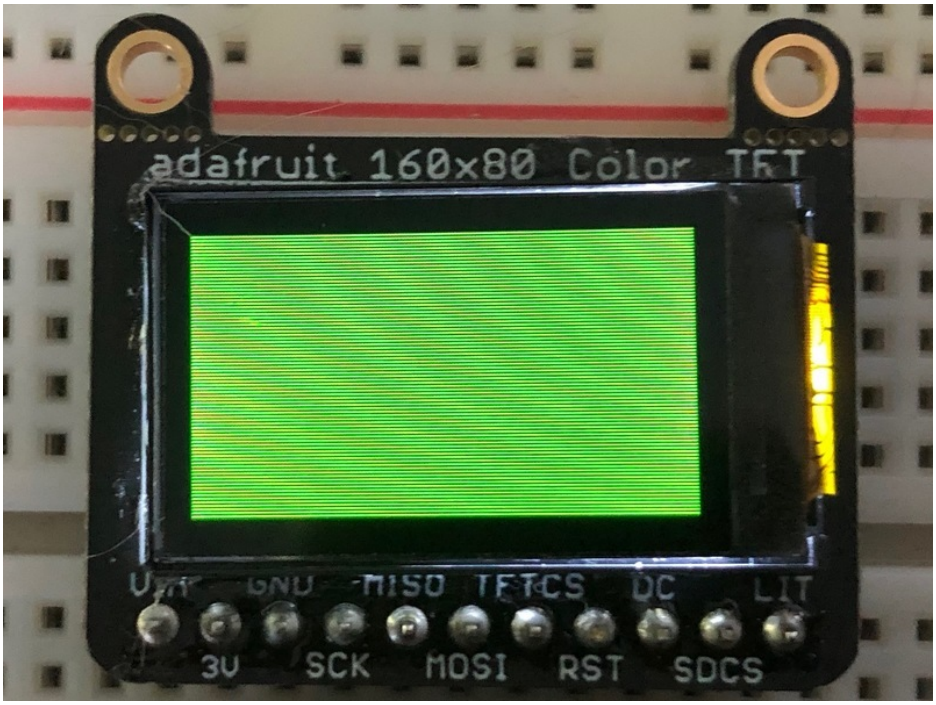
```
splash = displayio.Group(max_size=10)
display.show(splash)
```

Next we create a Bitmap which is like a canvas that we can draw on. In this case we are creating the Bitmap to be the same size as the screen, but only have one color. The Bitmaps can currently handle up to 256 different colors. We create a Palette with one color and set that color to 0x00FF00 which happens to be green. Colors are Hexadecimal values in the format of RRGGBB. Even though the Bitmaps can only handle 256 colors at a time, you get to define what those 256 different colors are.

```
color_bitmap = displayio.Bitmap(160, 80, 1)
color_palette = displayio.Palette(1)
color_palette[0] = 0x00FF00 # Bright Green
```

With all those pieces in place, we create a TileGrid by passing the bitmap and palette and draw it at `(0, 0)` which represents the display's upper left.

```
bg_sprite = displayio.TileGrid(color_bitmap,
                               pixel_shader=color_palette,
                               x=0, y=0)
splash.append(bg_sprite)
```

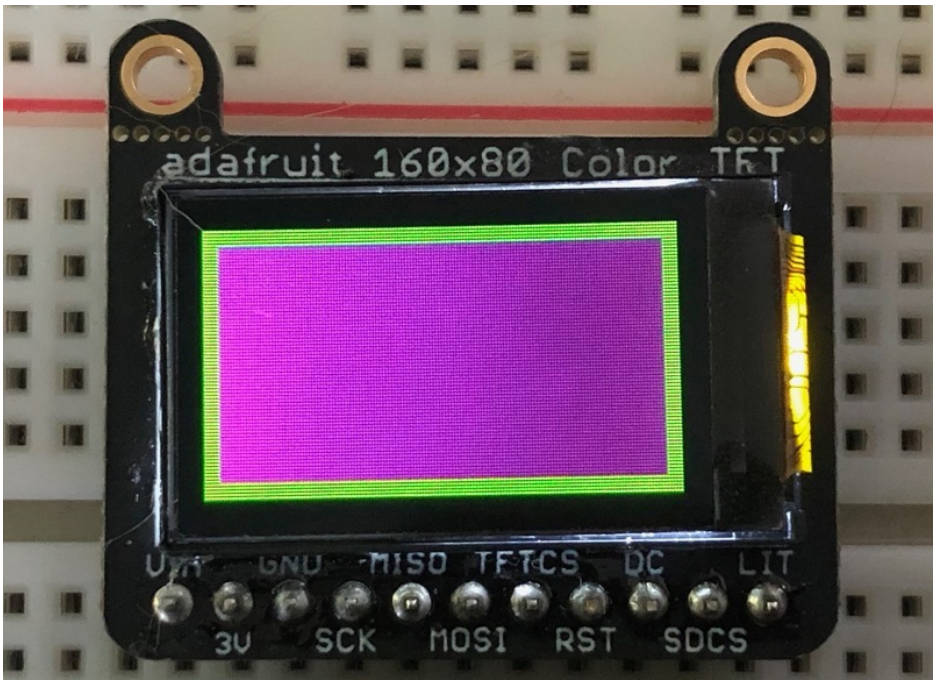


Next we will create a smaller purple square. The easiest way to do this is the create a new bitmap that is a little smaller than the full screen with a single color and place it in a specific location. In this case, we will create a bitmap that is 5 pixels smaller on each side. The screen is **160x80**, so we'll want to subtract 10 from each of those numbers.

We'll also want to place it at the position `(5, 5)` so that it ends up centered.

```
inner_bitmap = displayio.Bitmap(150, 70, 1)
inner_palette = displayio.Palette(1)
inner_palette[0] = 0xAA0088 # Purple
inner_sprite = displayio.TileGrid(inner_bitmap,
                                  pixel_shader=inner_palette,
                                  x=5, y=5)
splash.append(inner_sprite)
```

Since we are adding this after the first square, it's automatically drawn on top. Here's what it looks like now.



Next let's add a label that says "Hello World!" on top of that. We're going to use the built-in Terminal Font and scale it up by a factor of two. To scale the label only, we will make use of a subgroup, which we will then add to the main group.

Labels are centered vertically, so we'll place it at 40 for the Y coordinate, and around 11 pixels make it appear to be centered horizontally, but if you want to change the text, change this to whatever looks good to you. Let's go with some yellow text, so we'll pass it a value of `0xFFFF00`.

```
text_group = displayio.Group(max_size=10, scale=2, x=11, y=40)
text = "Hello World!"
text_area = label.Label(terminalio.FONT, text=text, color=0xFFFF00)
text_group.append(text_area) # Subgroup for text scaling
splash.append(text_group)
```

Finally, we place an infinite loop at the end so that the graphics screen remains in place and isn't replaced by a terminal.

```
while True:
    pass
```

Where to go from here

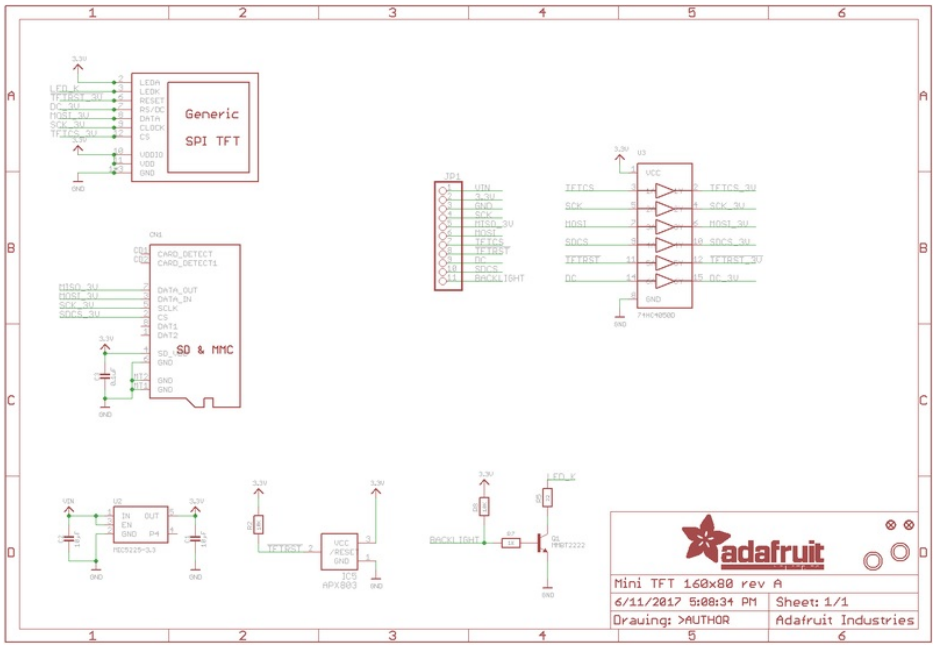
Be sure to check out this excellent guide to CircuitPython Display Support Using displayio (https://adafru.it/EGh)

Downloads

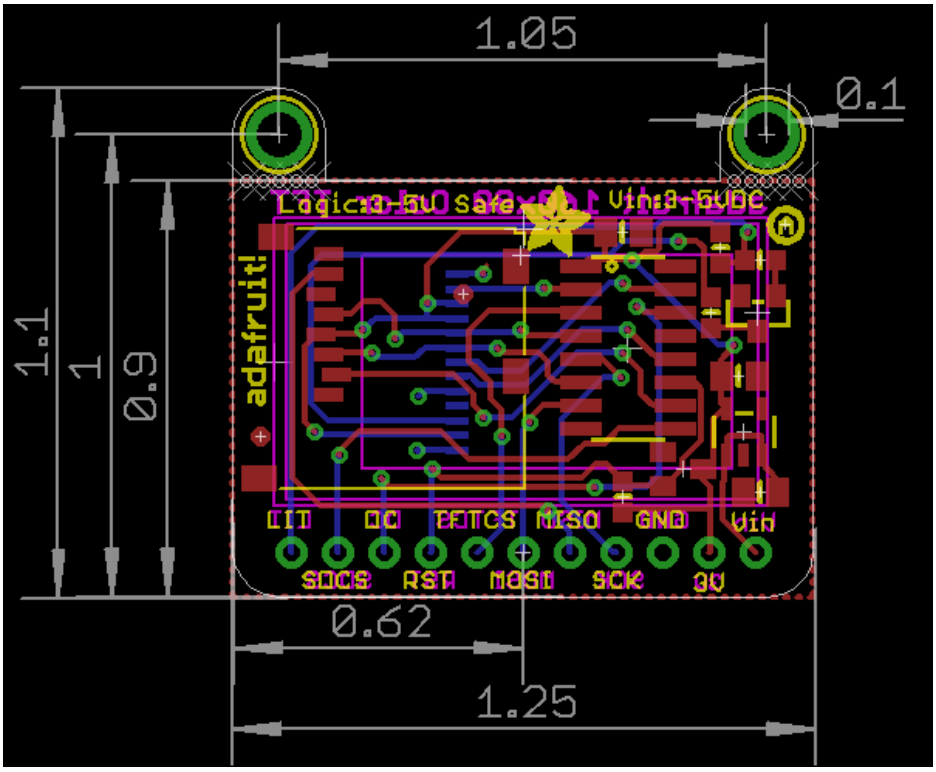
Files:

- Fritzing Object in Adafruit Fritzing library (https://adafru.it/aP3)
- EagleCAD files on GitHub (https://adafru.it/xDI)
- Raw TFT Display datasheet (https://adafru.it/xDJ)

Schematics and Fabrication Print



For the level shifter we use the CD74HC4050 (https://adafru.it/CgA) which has a typical propagation delay of ~10ns


1.05
0.1
1.1
1
0.9
adafruit!
Vin=3-5VDC
LITE
DC
TFTCS
MISO
GND
Vin
SDCS
RST
MOSI
SCK
0V
0.62
1.25