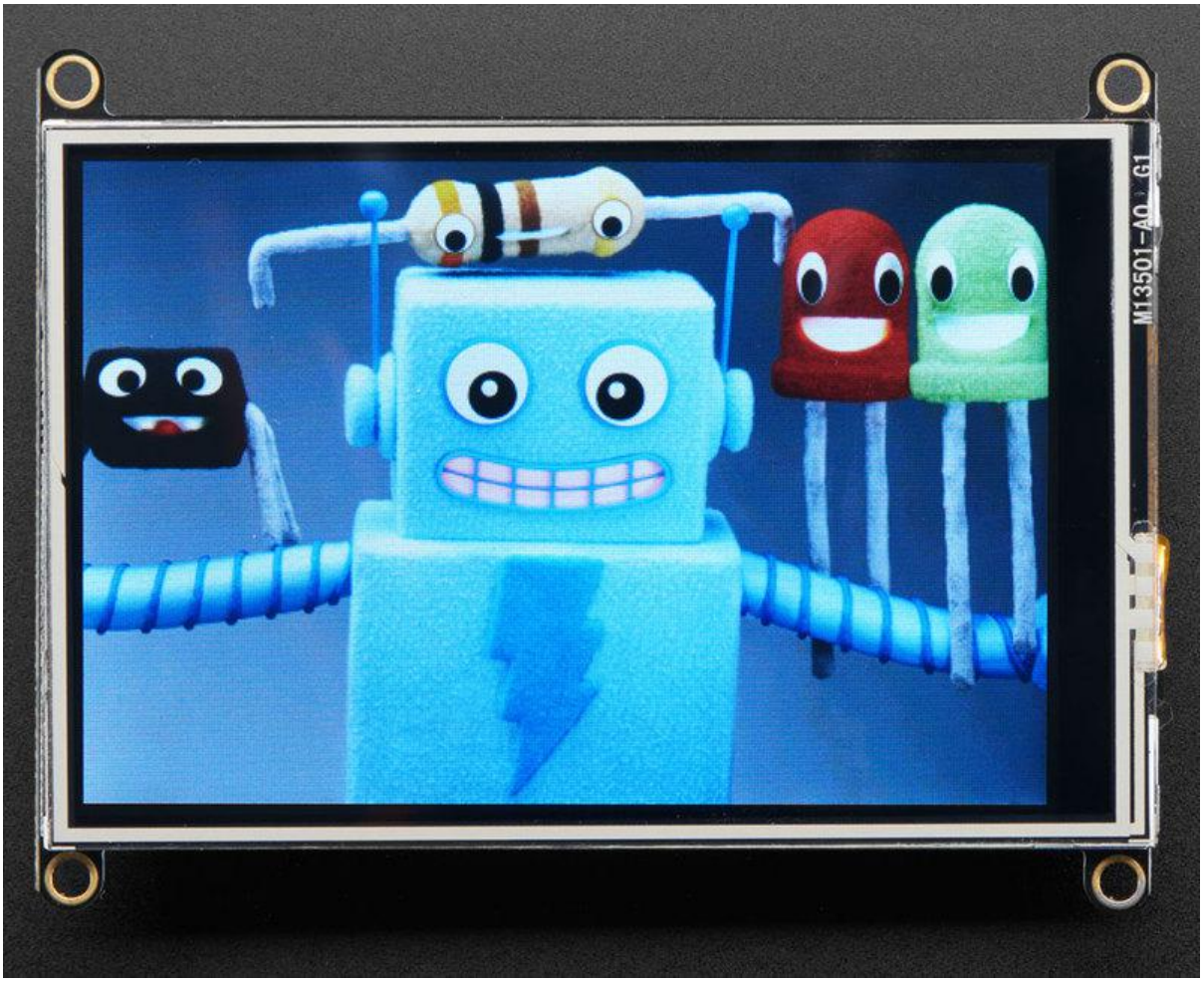
Adafruit 3.5" 480x320 TFT FeatherWing

Created by lady ada



https://learn.adafruit.com/adafruit-3-5-tft-featherwing

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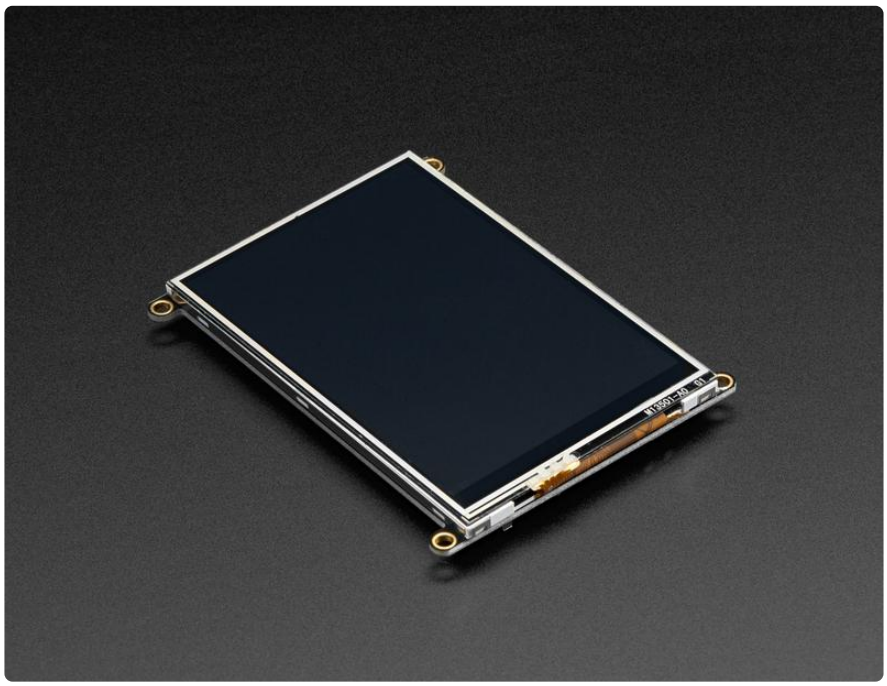
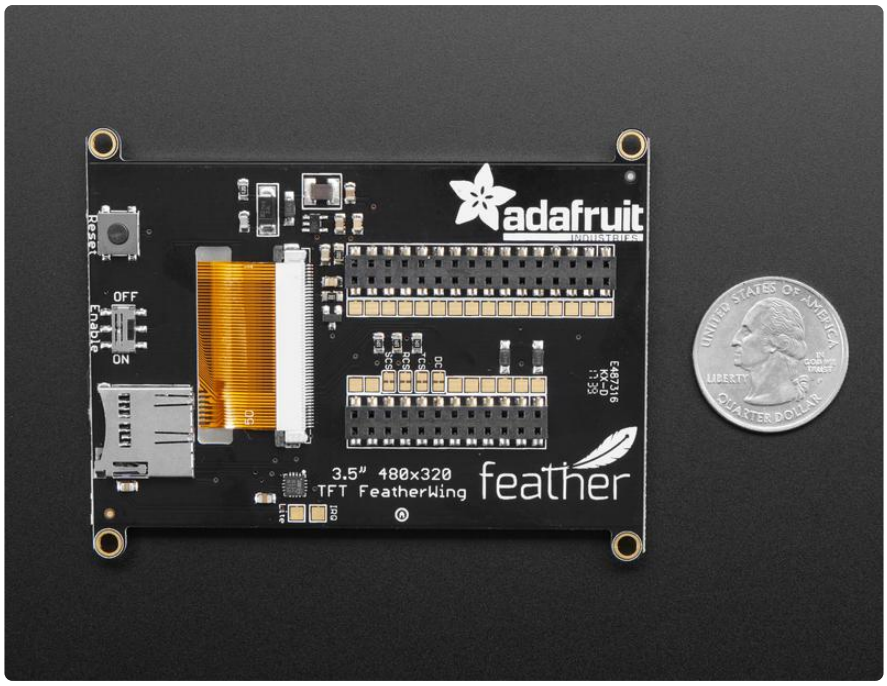
Overview

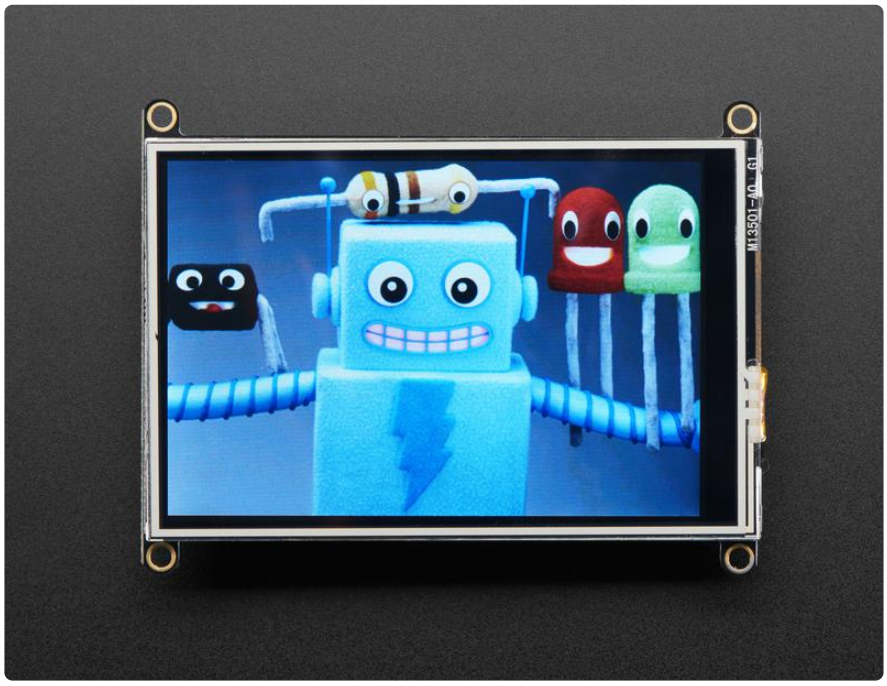
A Feather board without ambition is a Feather board without FeatherWings! Spice up your Feather project with a beautiful 3.5" touchscreen display shield with built in microSD card socket. This TFT display is 3.5" diagonal with a bright 6 white-LED backlight. You get a massive 480x320 pixels with individual 16-bit color pixel control. It has way more resolution than a black and white 128x64 display, and twice as much as our 2.4" TFT FeatherWing. As a bonus, this display comes with a resistive touchscreen attached to it already, so you can detect finger presses anywhere on the screen.



This FeatherWing uses a SPI display, touchscreen and SD card socket. It works with any and all Feathers but given the large display it works best with our faster boards like the ESP8266, ESP32, M4, M0, nRF52, WICED, and Teensy. We also include an SPI resistive touchscreen controller so you only need one additional pin to add a high quality touchscreen controller. One more pin is used for an optional SD card that can be used for storing images for display.



This Wing comes fully assembled with dual sockets for your Feather to plug into. You get two sockets per pin so you can plug in wires if you want to connect to Feather pins. Alternatively, each pin has a large square pad on the PCB for direct soldering.



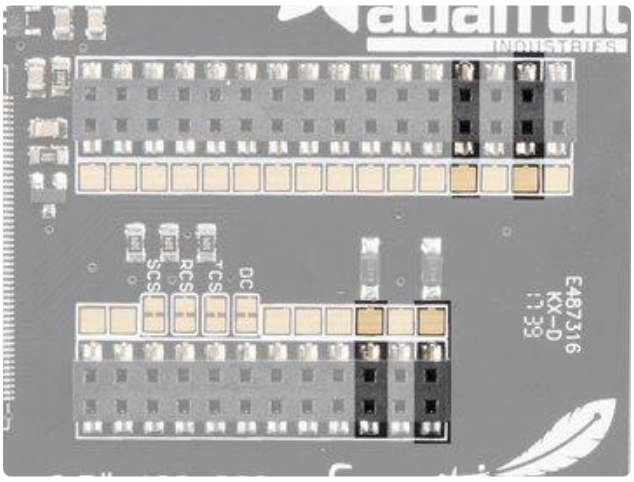
Pinouts

Unlike most FeatherWings, the TFT FeatherWing is fully assembled and has a dual socket set for your Feather to plug into.

This makes it really easy to use, but a little different to change if you don't want the default setup

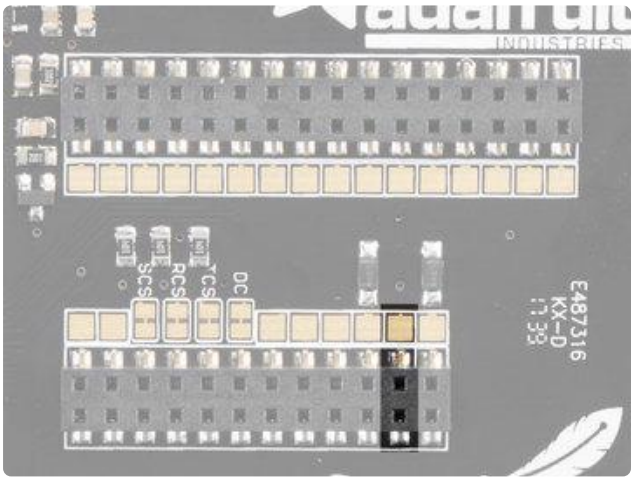
The FeatherWing has an ENABLE switch which will disable both Feather and Wing - so make sure it is turned ON while you're using it

Power Pins



The 3.5" TFT FeatherWing has a really beefy backlight, and we don't want to overwhem the 3.3V regulator on the Feather so we use two Schottkey diodes to take the higher of VBAT and VUSB to feed into the backlight boost converter.

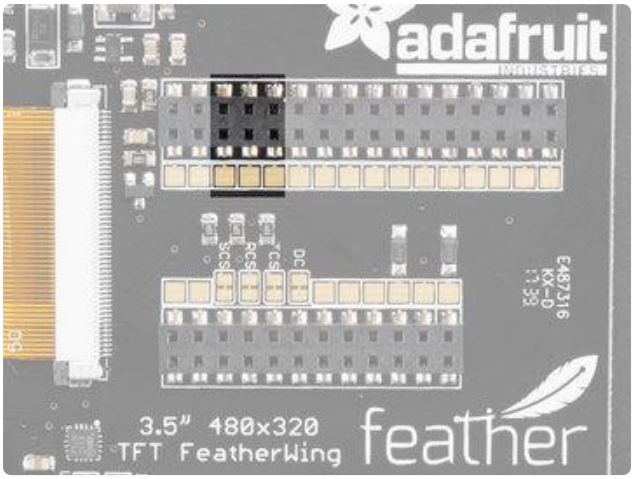
The GND and 3.3V pins are used for powering the rest of the device such as the TFT and touchscreen controller



You can turn off the 3.3V power supply with the EN pin or the switch attached to that pin. The enable/disable switch on the bottom of the Wing will also deactivate the backlight

Note that on the Teensy 3x Feather Adapter, this pin doesn't do anything and on the FONA feather, this will not disable the VBAT power supply which is used to power the cellular module.

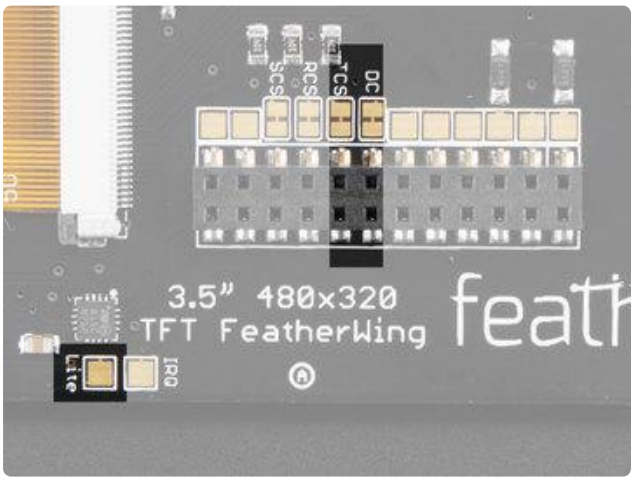
SPI Pins



The TFT display, SD card and touch screen use the SPI interface to communicate. That means MISO, MOSI and SCK are used whenever either are accessed.

(Ooops the highlighted pins are off by one, they should be shifted to the right one pin!)

In addition, for the TFT display there is are D/C (Data/Command) and CS (Chip Select) pins. These are used to select the display and tell it what kind of data is being sent. These pins can theoretically be changed by cutting the jumper trace and soldering a small wire from the farther-from-the-socket-header pad to the pin you'd like to use.



On the ESP8266, TFT_CS is pin #0, TFT_DC is pin #15

On the ESP32, TFT_CS is pin #15, TFT_DC is pin #33

On the Atmega32u4, ATmega328p, M4 or M0 Feather, TFT_CS is pin #9, TFT_DC is pin #10

On the Teensy Feather, TFT_CS is pin #4, TFT_DC is pin #10

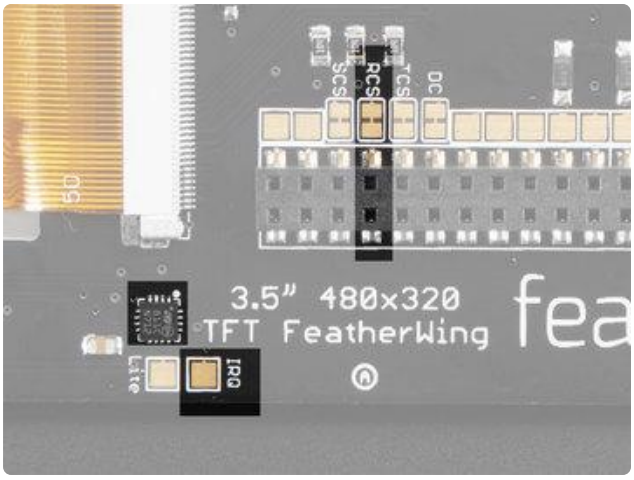
On the WICED Feather, TFT_CS is PA15 and TFT_DC is PB4

On the nRF52 Feather, TFT_CS is #31 and TFT_DC is #11

There is also LITE pin which is not connected to any pads but you can use to control the backlight. Pull low to turn off the backlight. You can connect it to a PWM output pin.

Note: Pin 9 is used for communication with the SIM800 chip on the Feather Fona. You will have to remap pin 9 to an unused pin when using with a Feather Fona.

Touch Screen control pins



The touch screen also has a Chip Select line, labeled RT. This pin can theoretically be changed by cutting the jumper trance and soldering a small wire from the right-hand pad to the pin you'd like to use.

On the ESP8266, RT is pin #16

On the ESP32, RT is pin #32

On the Atmega32u4, ATmega328p, M4 or M0 Feather, RT is pin #6

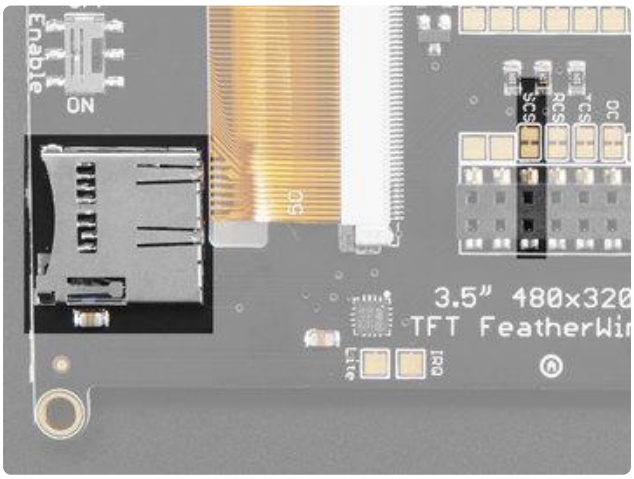
On the Teensy Feather, RT is pin #3

On the WICED Feather, RT is PC7

On the nRF52 Feather, RT is #30

There is also an IRQ pin which is not connected to any pads but you can use to detect when touch events have occured.

SD Card control pins



The SD Card also has a Chip Select line, labeled SD. This pin can theoretically be changed by cutting the jumper trance and soldering a small wire from the right-hand pad to the pin you'd like to use.

On the ESP8266, SD is pin #2

On the ESP32 SD is pin #14

On the Atmega32u4, ATmega328p, M4 or M0 Feather, SD is pin #5

On the Teensy Feather, SD is pin #8

On the WICED Feather, SD is PC5

On the nRF52 Feather, SD is pin #27

TFT Graphics Test

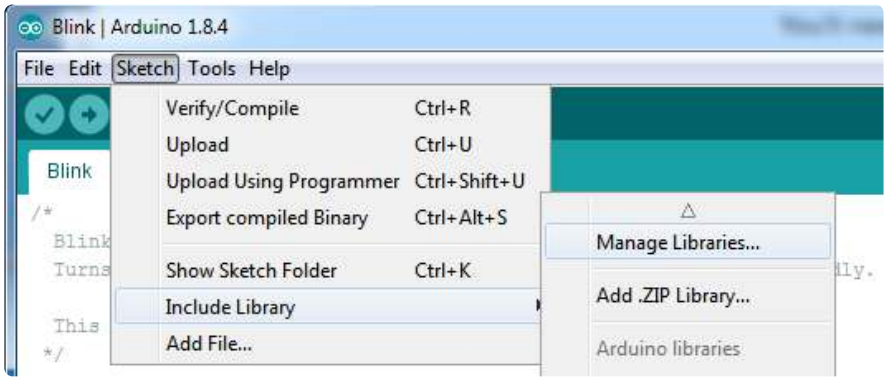
The TFT FeatherWing is basically a combination of our 3.5" TFT Breakout () with the STMPE610 resistive touch-screen breakout attached (http://adafru.it/1571).

Before you continue, make sure the FeatherWings's ENABLE switch is turned ON! If it's OFF, the Feather won't work and you will be very confused :)

Install Libraries

You'll need a few libraries to use this FeatherWing!

From within the Arduino IDE, open up the Library Manager...



Install Adafruit HX8357D TFT Library

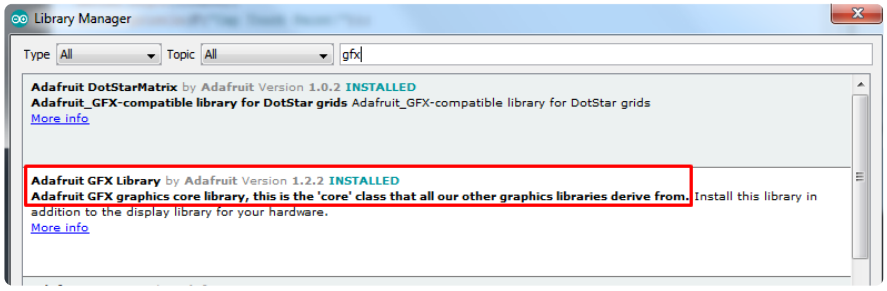
We have example code ready to go for use with these TFTs.

Two libraries need to be downloaded and installed: first is the Adafruit HX8357 library () (this contains the low-level code specific to this device), and second is the Adafruit GFX Library () (which handles graphics operations common to many displays we carry). If you have Adafruit_GFX already, make sure its the most recent version since we've made updates for better performance

Search for HX8357 and install the Adafruit HX8357 library that pops up!

Next up, search for Adafruit GFX and locate the core library. A lot of libraries may pop up because we reference it in the description so just make sure you see Adafruit GFX Library in bold at the top.

Install it!



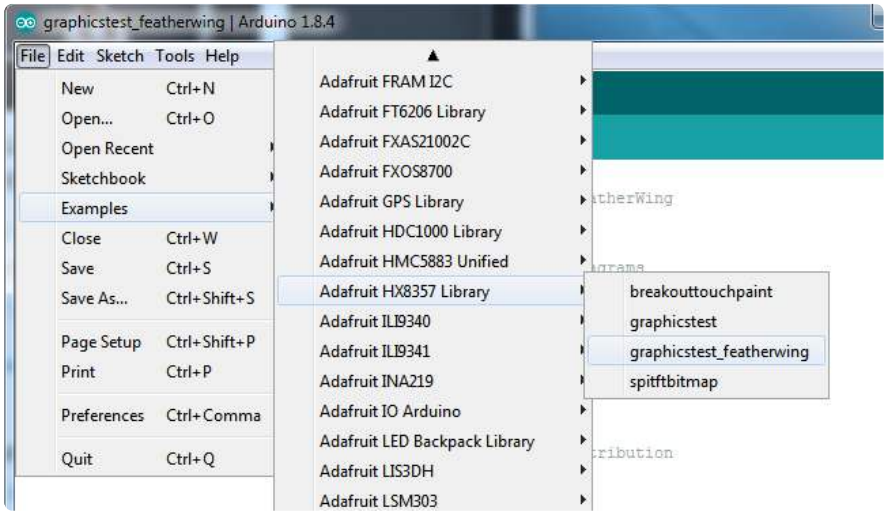
If using an earlier version of the Arduino IDE (pre-1.8.10), locate and install Adafruit_BusIO (newer versions handle this prerequisite automatically).

Repeat the search and install steps for the Adafruit_ImageReader library.

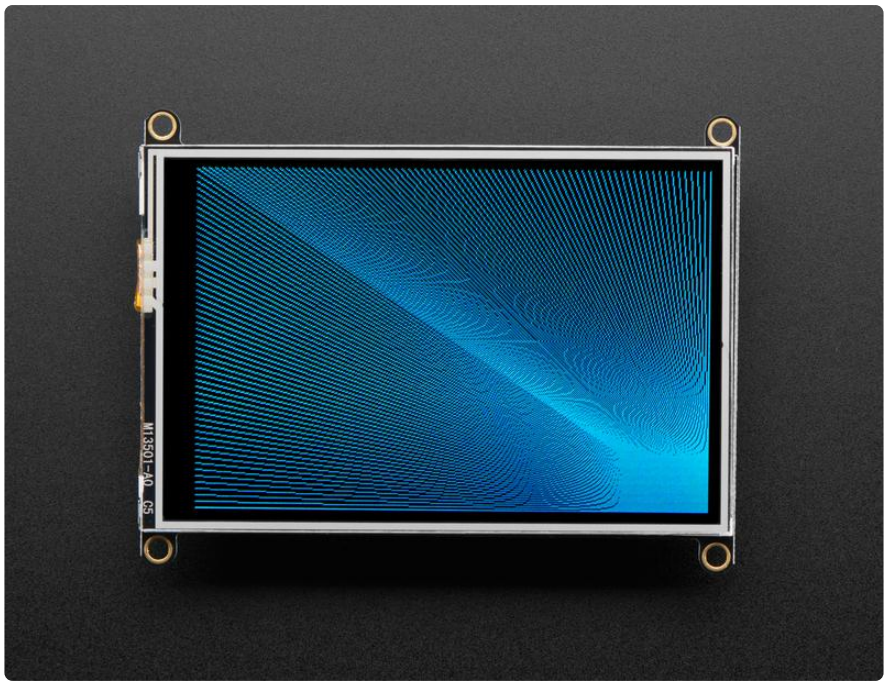
For more details about this process, we have a tutorial introducing Arduino library concepts and installation ().

Basic Graphics Test

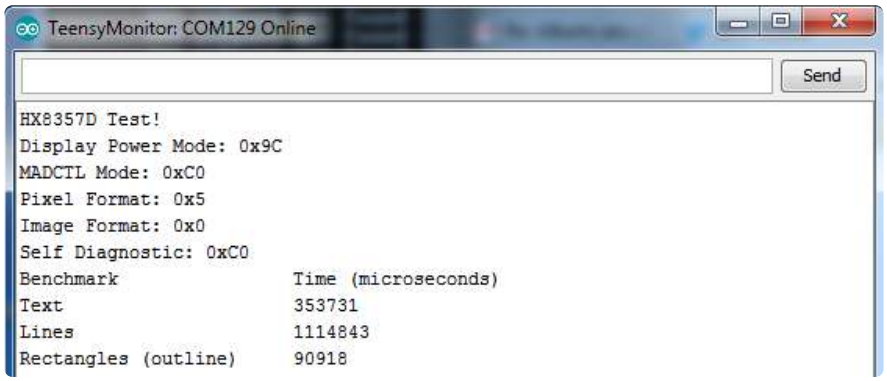
After restarting the Arduino software, you should see a new example folder called Adafruit_HX8357 and inside, an example called graphicstest_featherwing.



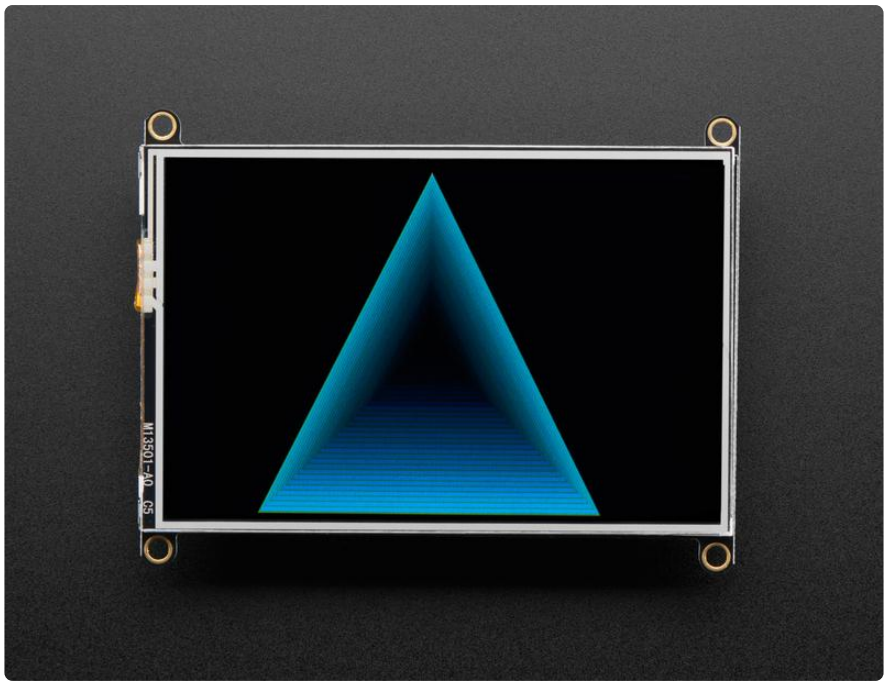
Upload that sketch to your Feather. You should see a collection of graphical tests draw out on the TFT.



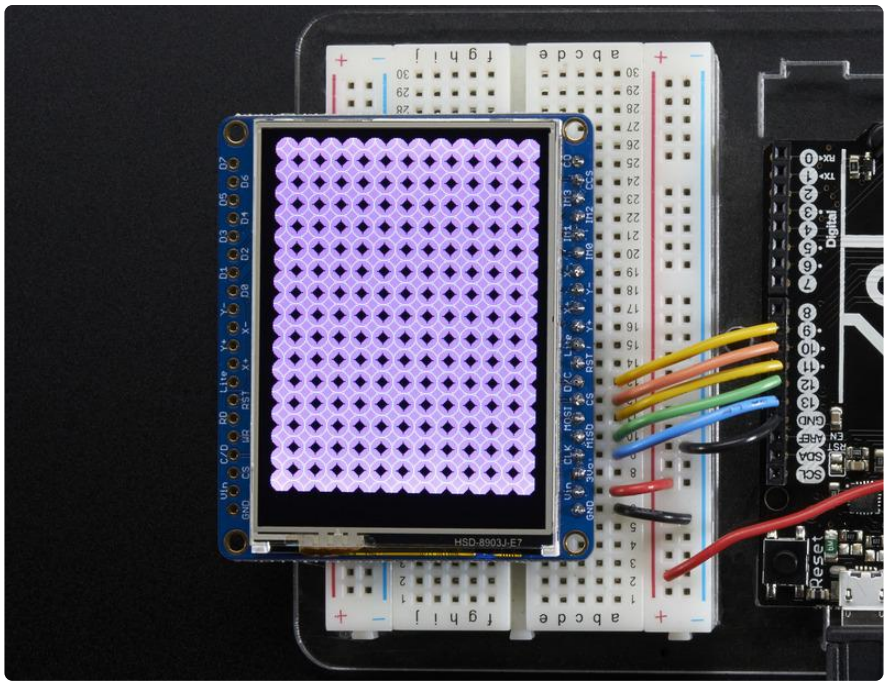
If you're having difficulties, check the serial console. The first thing the sketch does is read the driver configuration from the TFT, you should see the same numbers as below. That will help you determine if the TFT is found, if not, check your Feather soldering!



Once you've got the demo working, check out the detailed documentation over at http://learn.adafruit.com/adafruit-gfx-graphics-library () for more information on how to use the GFX library to draw whatever you like!

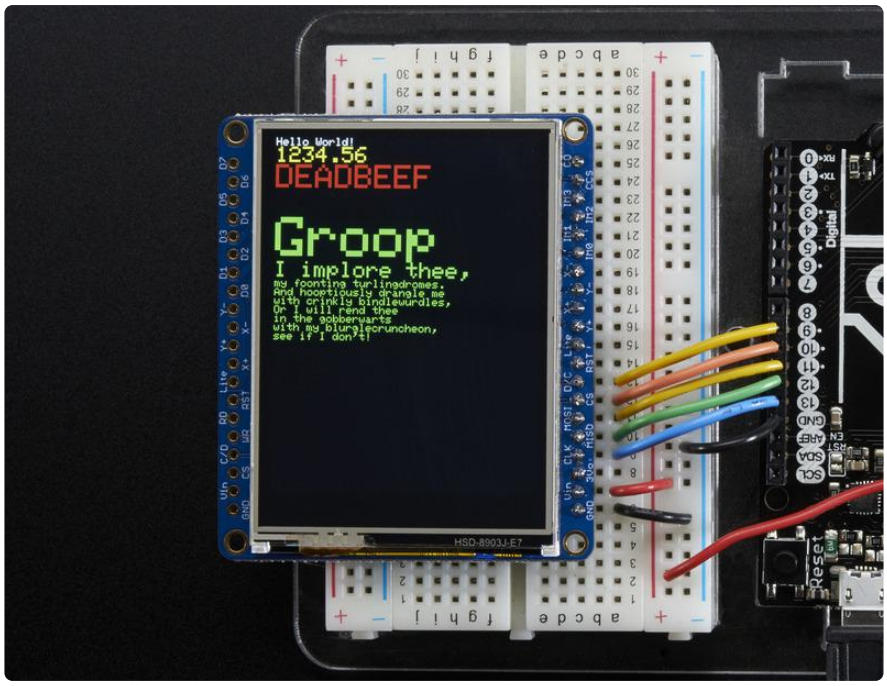


Adafruit GFX Library



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 ()

It covers the latest and greatest of the GFX library. The GFX library is used in both 8-bit and SPI modes so the underlying commands (drawLine() for example) are identical!

Resistive Touch Screen

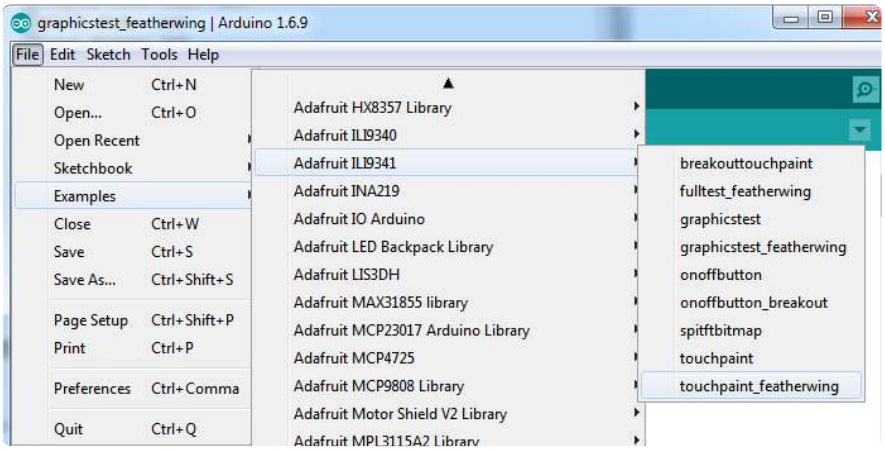
The LCD has a 4-wire resistive touch screen glued onto it. You can use this for detecting finger-presses, stylus', etc. Normally, you'll need 4 pins to talk to the touch panel but we decided to go all snazzy and put a dedicated touch screen driver onto the shield. The driver shares the SPI pins with the TFT and SD card, so only one extra pin is needed. This allows you to query the controller when you're ready to read touchscreen data, and saves 3 pins.

To control the touchscreen you'll need one more library () - the STMPE610 controller library which does all the low level chatting with the STMPE610 driver chip. Use the library manager to install the Adafruit STMPE610 library

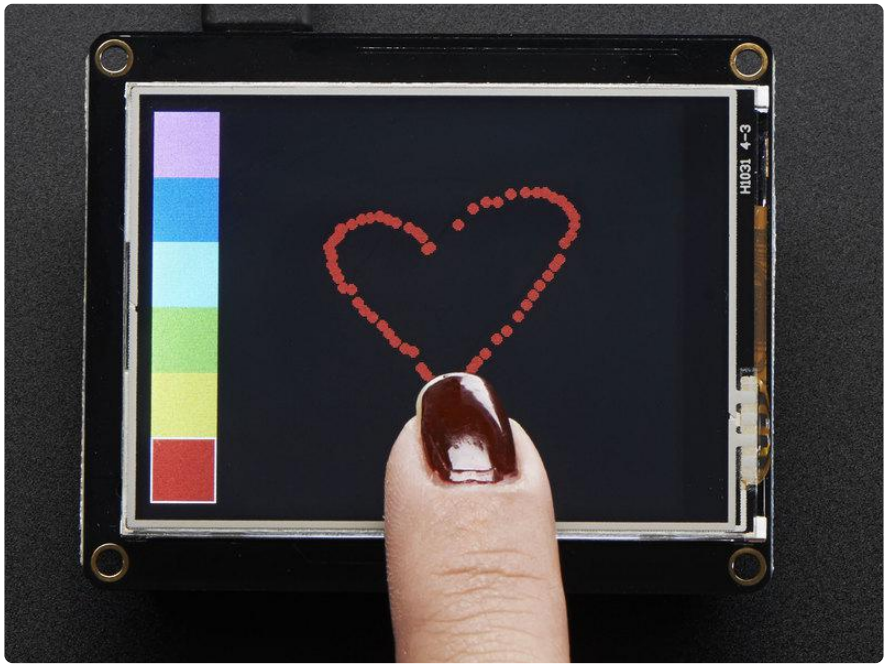
Touchscreen Paint Demo

Now that you've got the basic TFT graphics demo working, let's add in the touchscreen. Run and upload the touchpaint_featherwing demo

- If you have the 2.4" TFT Featherwing, run the Adafruit ILI9341->touchpaint_featherwing demo
- If you have the 3.5" TFT Featherwing, run the Adafruit HX8357->touchpaint_featherwing demo



Upload to your Feather and have fun!



The touch screen is made of a thin glass sheet, and its very fragile - a small crack or break will make the entire touch screen unusable. Don't drop or roughly

handle the TFT and be especially careful of the corners and edges. When pressing on the touchscreen, sometimes people can use the tip of their fingers, or a fingernail. If you don't find the touchscreen responds well to your fingers, you can use a rounded stylus which will certainly work. Do not press harder and harder until the screen cracks!

Getting data from the touchscreen is fairly straight forward. Start by creating the touchscreen object with

```
Adafruit_STMPE610 ts = Adafruit_STMPE610(STMPE_CS);
```

We're using hardware SPI so the clock, mosi and miso pins are not defined here. Then you can start the touchscreen with

```
ts.begin()
```

Check to make sure this returns a True value, which means the driver was found. If it wasn't, make sure you have the Feather soldered right and the correct CS pin!

Now you can call

```
if (! ts.bufferEmpty())
```

to check if there's any data in the buffer. The touchscreen driver will store touchpoints at all times. When you're ready to get the data, just check if there's any data in the buffer. If there is, you can call

```
TS_Point p = ts.getPoint();
```

To get the oldest point from the buffer. TS_Point has .x .y and .z data points. The x and y points range from 0 to 4095. The STMPE610 does not store any calibration data in it and it doesn't know about rotation. So if you want to rotate the screen you'll need to manually rotate the x/y points! The z point is 'pressure' and ranges from 0 to 255, we don't use it here but you can experiment with it on your own, the harder you press, the lower the number.

Since data from the STMPE610 comes in 0-4095 but our screen is 320 pixels by 240 pixels, we can use map to convert 0-4095 to 0-320 or 0-240. Something like

```
p.x = map(p.x, 0, 4095, 0, tft.width());
p.y = map(p.y, 0, 4095, 0, tft.height());
```

However, the touchscreen is a bit bigger than the screen, so we actually need to ignore presses beyond the touchscreen itself. We found that these numbers reflected the true range that overlaps the screen

```
#define TS_MINX 150
#define TS_MINY 130
#define TS_MAXX 3800
#define TS_MAXY 4000
```

So we use

```
p.x = map(p.x, TS_MINX, TS_MAXX, 0, tft.width());
p.y = map(p.y, TS_MINY, TS_MAXY, 0, tft.height());
```

instead.

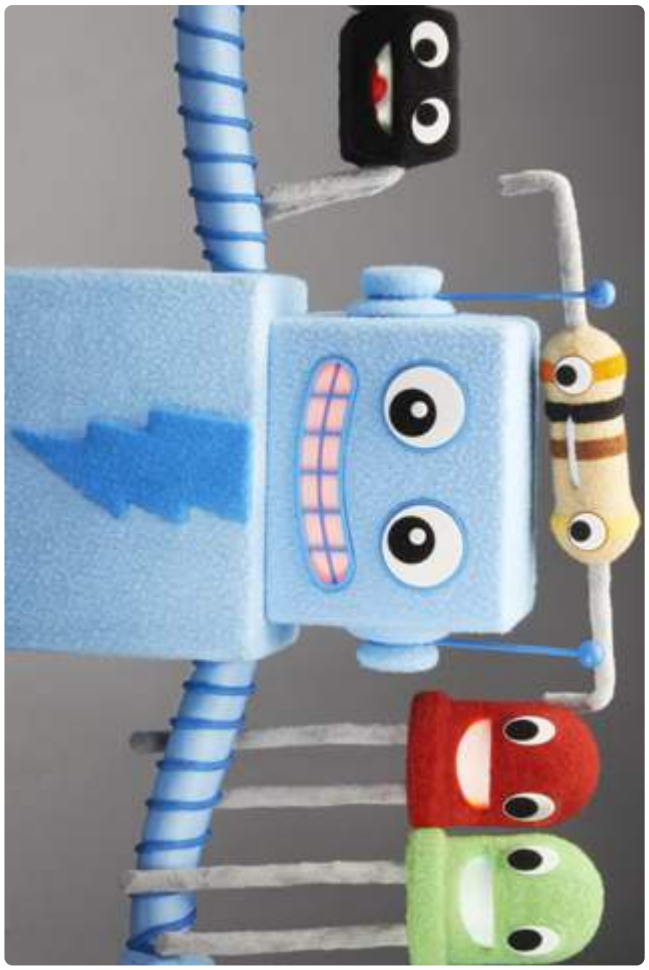
One last point (pun intended!) since the touchscreen driver stores points in a buffer, you may want to ask the driver "is the touchscreen being pressed RIGHT NOW?" You can do that with

```
if (ts.touched())
```

Drawing Bitmaps

There is a built-in microSD card slot on the FeatherWing, 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), and an SD card reader on whatever computer you're currently reading this with.

It's really easy to draw bitmaps. Lets start by downloading this image of Adabot and friends:



Download these two smaller images as well:

The files should be renamed (if needed) to “adabot.bmp”, “parrot.bmp” and “wales.bmp”, respectively, and copied to the base directory of the microSD card (not inside a folder).

(If it’s easier, you can also find these images in the “images” folder within the Adafruit_ImageReader library folder.)

Insert the microSD card into the socket in the shield. Now select the sketch file→examples→Adafruit_ImageReader→FeatherWingHX8357 and upload this example to your Feather + Wing. You will see the your electronic friends appear! (Plus parrots...and if you're using one of the more powerful Feather boards, a whole lot of dragons.)

The Adafruit_ImageReader library, which is being used here to display .BMP images, is fully explained in its own page of the Adafruit_GFX guide ().

CircuitPython Displayio Quickstart

The steps to get the 3.5" TFT FeatherWing, which has an HX8357 display on it, are very similar to the 2.4" TFT FeatherWing. If you would like more information on this display, be sure to check out our Adafruit 3.5" TFT FeatherWing guide ().

Parts

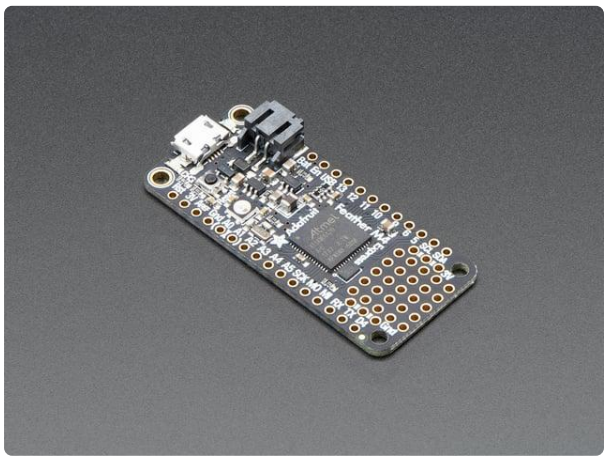
To use this display with displayio, you will only need two main parts. First, you will need the TFT FeatherWing itself. One thing to note with this display is because of the increased resolution, updates will be a little slower for this display than for the other displays.

Adafruit TFT FeatherWing - 3.5" 480x320 Touchscreen for Feathers

Spice up your Feather project with a beautiful 3.5" touchscreen display shield with built in microSD card socket. This TFT display is 3.5" diagonal with a bright 6 white-LED...

https://www.adafruit.com/product/3651

And second, you will need a Feather such as theFeather M0 Express or the Feather M4 Express. We recommend the Feather M4 Express because it's much faster and works better for driving a display.

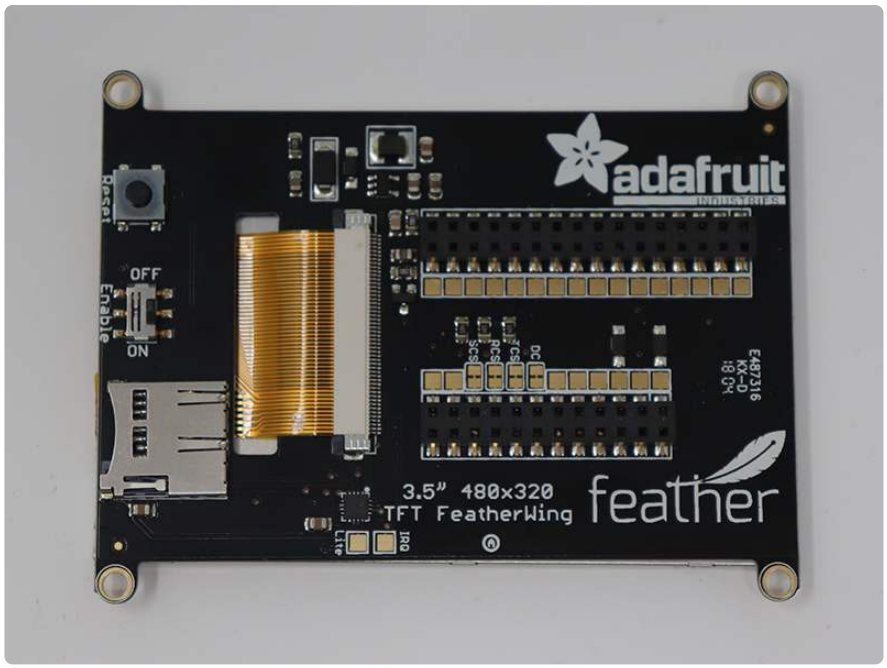


Adafruit Feather M4 Express - Featuring ATSAMD51

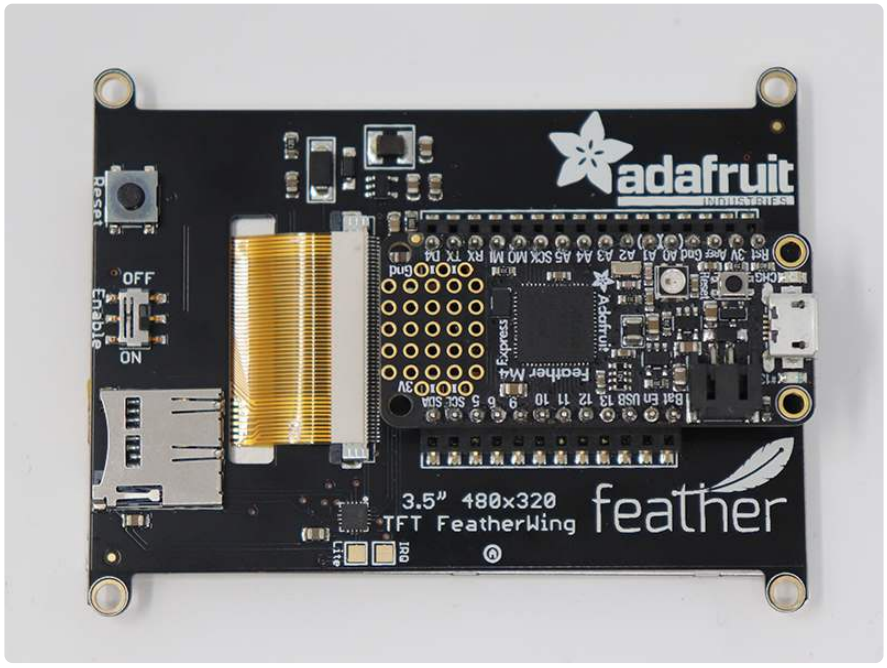
It's what you've been waiting for, the Feather M4 Express featuring ATSAMD51. This Feather is fast like a swift, smart like an owl, strong like a ox-bird (it's half ox,...

https://www.adafruit.com/product/3857

For this guide, we'll assume you have a Feather M4 Express. The steps should be about the same for the Feather M0 Express. To start, if you haven't already done so, follow the assembly instructions for the Feather M4 Express in our Feather M4 Express guide (). We'll start by looking at the back of the 3.5" TFT FeatherWing.



After that, it's just a matter of inserting the Feather M4 Express into the back of the TFT FeatherWing.



Required CircuitPython Libraries

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

Adafruit_CircuitPython_HX8357

First, make sure you are running the latest version of Adafruit CircuitPython () 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 (). Our introduction guide has a great page on how to install the library bundle () 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_hx8357

Before continuing make sure your board's lib folder or root filesystem has the adafruit_hx8357 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.

Adafruit_CircuitPython_Display_Text

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

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

"""
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 terminalio
import displayio
from adafruit_display_text import label
from adafruit_hx8357 import HX8357

# Release any resources currently in use for the displays
displayio.release_displays()

spi = board.SPI()
```

```
tft_cs = board.D9
tft_dc = board.D10

display_bus = displayio.FourWire(spi, command=tft_dc, chip_select=tft_cs)

display = HX8357(display_bus, width=480, height=320)

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

color_bitmap = displayio.Bitmap(480, 320, 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(440, 280, 1)
inner_palette = displayio.Palette(1)
inner_palette[0] = 0xAA0088  # Purple
inner_sprite = displayio.TileGrid(inner_bitmap, pixel_shader=inner_palette, x=20,
y=20)
splash.append(inner_sprite)

# Draw a label
text_group = displayio.Group(scale=3, x=137, y=160)
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_hx8357` driver.

```
import board
import displayio
import terminalio
from adafruit_display_text import label
from adafruit_hx8357 import HX8357
```

Next we release any previously used 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.

```
displayio.release_displays()
```

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. Next we set the Chip Select and Data/Command pins that will be used.

```
spi = board.SPI()
tft_cs = board.D9
tft_dc = board.D10
```

In the next line, we set the display bus to FourWire which makes use of the SPI bus.

```
display_bus = displayio.FourWire(spi, command=tft_dc, chip_select=tft_cs)
```

Finally, we initialize the driver with a width of 480 and a height of 320. 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.

```
display = HX8357(display_bus, width=480, height=320)
```

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. The display will automatically handle updating the group.

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

After that 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(480, 320, 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)
```

This creates a solid green background which we will draw on top of.

Next we will create a smaller purple rectangle. 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 20 pixels smaller on each side. The screen is 480x320, so we'll want to subtract 40 from each of those numbers.

We'll also want to place it at the position `(20, 20)` so that it ends up centered.

```
# Draw a smaller inner rectangle
inner_bitmap = displayio.Bitmap(440, 280, 1)
inner_palette = displayio.Palette(1)
inner_palette[0] = 0xAA0088 # Purple
inner_sprite = displayio.TileGrid(inner_bitmap,
```

```
                                    pixel_shader=inner_palette,
                                    x=20, y=20)
splash.append(inner_sprite)
```

Since we are adding this after the first rectangle, 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 three. 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 160 for the Y coordinate, and around 137 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`.

```
# Draw a label
text_group = displayio.Group(scale=3, x=137, y=160)
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
```

Using Touch

We won't be covering how to use the touchscreen on the shield with CircuitPython in this guide, but the library required for enabling resistive touch is the Adafruit_CircuitPython_STMPE610 () library.

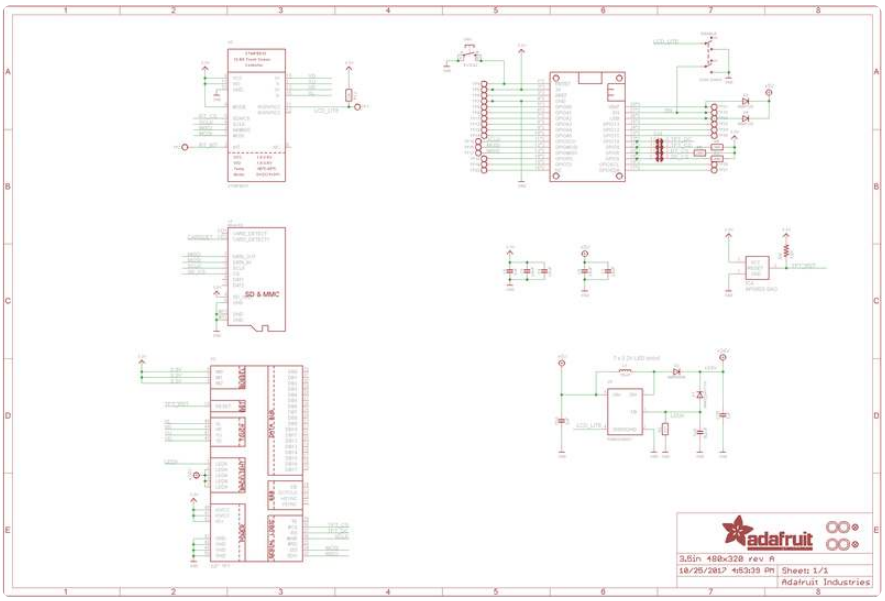
Where to go from here

Be sure to check out this excellent guide to CircuitPython Display Support Using displayio ()

Downloads

Datasheets & More

- STMPE610 Touch Controller Datasheet ()
- Datasheet for the HX8357D chipset controller ()
- Datasheet for the 3.5" TFT display (raw) ()
- EagleCAD PCB files on GitHub ()
- Fritzing object in Adafruit Fritzing library ()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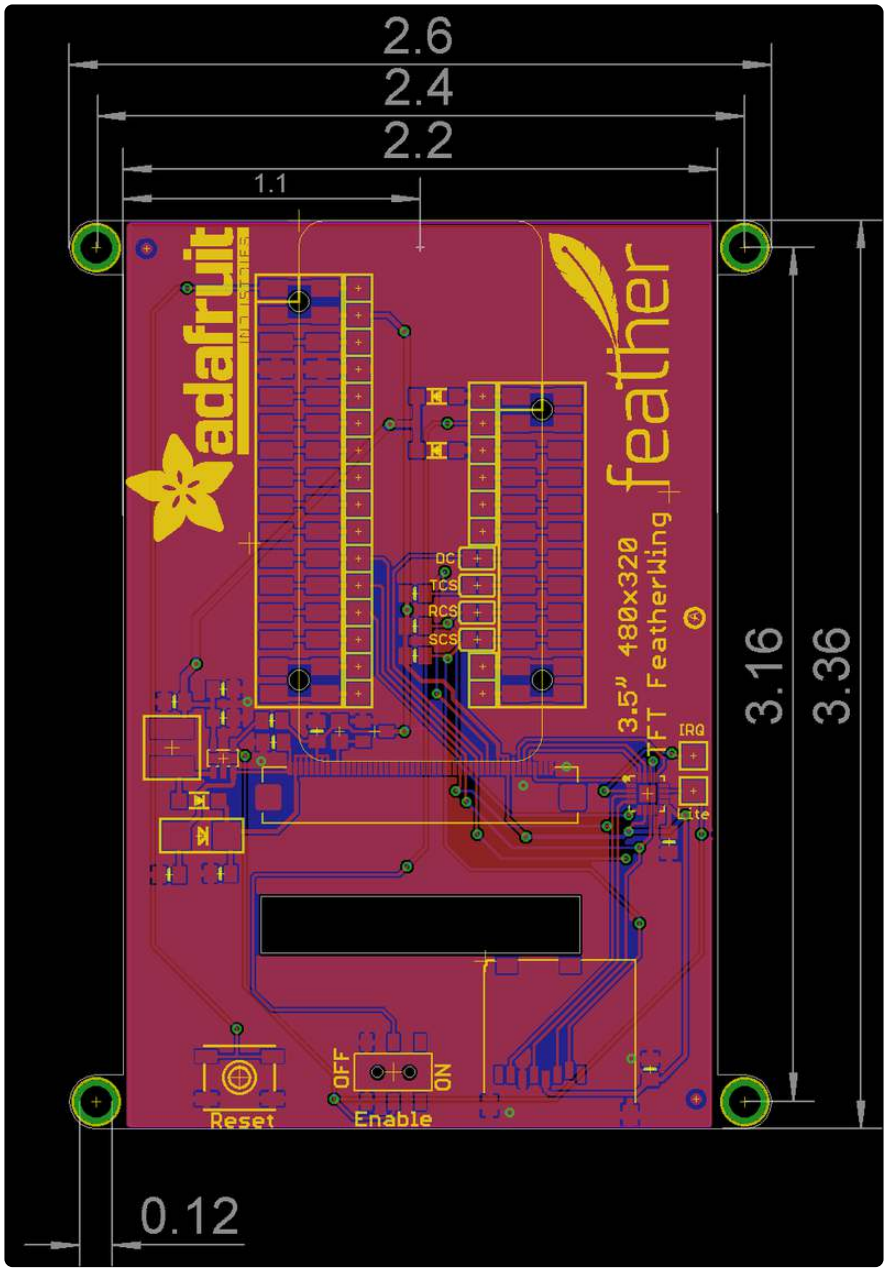
2.6
2.4
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3.36
0.12
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INDUSTRIES
feather
3.5" 480x320
TFT FeatherWing
DC
TCS
RCS
SCS
IRQ
Lite
Reset
OFF
ON
Enable

Troubleshooting

Display does not work on initial power but does work after a reset.

The display driver circuit needs a small amount of time to be ready after initial power. If your code tries to write to the display too soon, it may not be ready. It will work on reset since that typically does not cycle power. If you are having this issue, try adding a small amount of delay before trying to write to the display.

In Arduino, use delay() to add a few milliseconds before calling tft.begin(). Adjust the amount of delay as needed to see how little you can get away with for your specific setup.