Lab #3 — Setting up the Hardware (Pi Pico and Breadboard)
Week of 16 February 2026

1   Introduction

In this lab you will set up various pieces of hardware onto a breadboard. You will use this for future labs. The objectives for this lab are to:

1. Wire up the new hardware onto your breadboard

2. Program the Pico with the provided test program to verify your wiring

2   Materials

You were previously provided with the following hardware:

- Breadboard with jumper wires

- Raspberry Pi Pico

- micro USB B cable

You will be provided with the following additional hardware:

- Keypad

- LED Bargraph

- TFT LCD

- Speaker

- 18 Resistors, all 510 ohms (green brown brown)

- 8 Pin male to male header

3   Assemble the Hardware

- After obtaining the parts start assembling the breadboard. This will be used in future labs.
- Make sure to read all of the directions carefully before getting started!
- Do not power up your board with the USB connector unless you've had the TA verify your wiring first. It is in theory possibly to damage some of the components if you have things wired incorrectly.
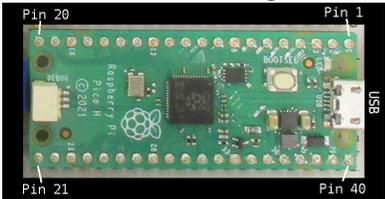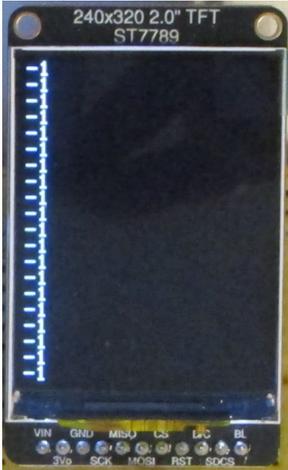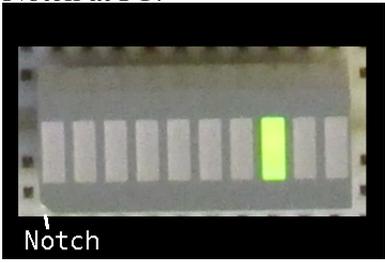
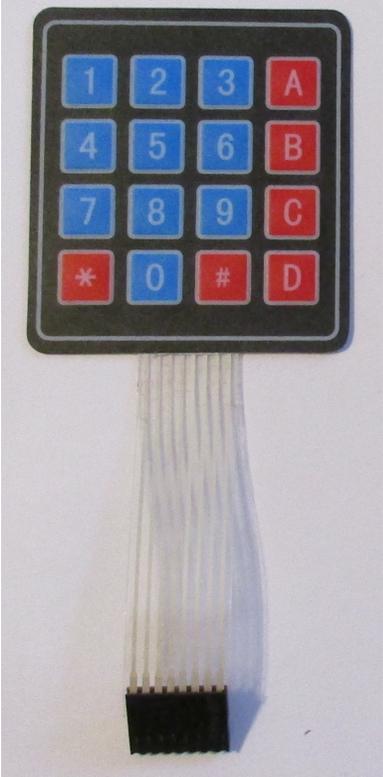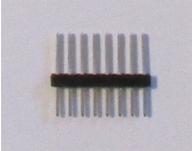## 3.1 Initial Parts Placement and Breadboard Notes

Orient the breadboard such that the red horizontal line (with + sign) is at the top. See Figure 1 for reference.

Note! The breadboards used for in Spring 2026 are strange and new and so they don't match exactly the drawings, and the co-ordinate system is different from previous years. I've done my best to update things, but the row/column numbers in the diagrams aren't going to match exactly what you have. Use the row A...I values from the left side not the right.

Also note the jumper wire colors also changed so they aren't going to match either. Use whatever wire seems to fit properly.

Place the following components.

Part	Location	Notes
RPi Pico	C42-C61 top and H42-H61 bottom	USB connector on right
TFT Display	I29-I39	The TFT covers the bottom part of the breadboard. Wait to put in until after wiring is complete
LED Bargraph	E17-E26 top and F17-F26 bottom	Notch at F17

Part	Location	Notes
Keypad	C4-C11	Keys should be visible when the keypad is laying down. Use the supplied 8 pin header to connect the keypad to the breadboard
Speaker	Plug in to J55 and to Bottom Blue 55 Note it doesn't matter which wire goes where	
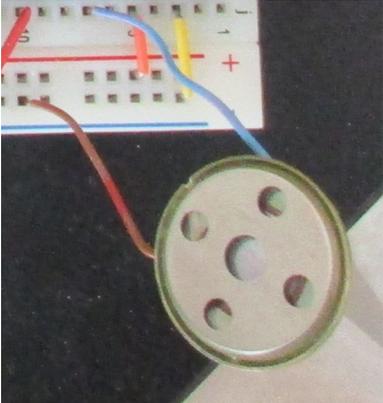
3.2 Resistor Placement

You will need to place some resistors on the board. The example here is using 510 Ohm resistors (green brown brown gold) but in the actual lab we might use a slightly different resistance.
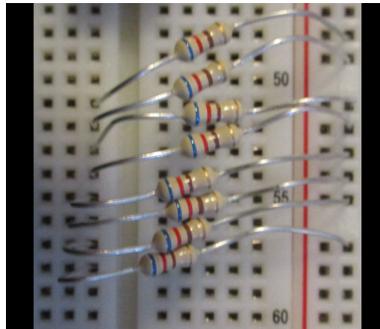
Place the resistors in the following locations (note: resistors are symmetrical, meaning it doesn't matter which direction you orient them). Try to avoid shorts caused by their metal legs touching each other.

In the connection tables "Start" is the location to put the first pin (if you look closely there's a marked grid on the breadboards). "End" is where to put the other pin. In this case "Top Blue" means the horizontal blue row at the top of the board. See Figure 1 for reference.

Start	End
C26	Top Blue 26
C25	Top Blue 25
C24	Top Blue 23
C23	Top Blue 22
C22	Top Blue 21
C21	Top Blue 20
C20	Top Blue 19
C19	Top Blue 17
C18	Top Blue 16
C17	Top Blue 15
E11	Bottom Blue 13
E10	Bottom Blue 12
E9	Bottom Blue 11
E8	Bottom Blue 10
E7	Bottom Blue 8
E6	Bottom Blue 7
E5	Bottom Blue 5
E4	Bottom Blue 4

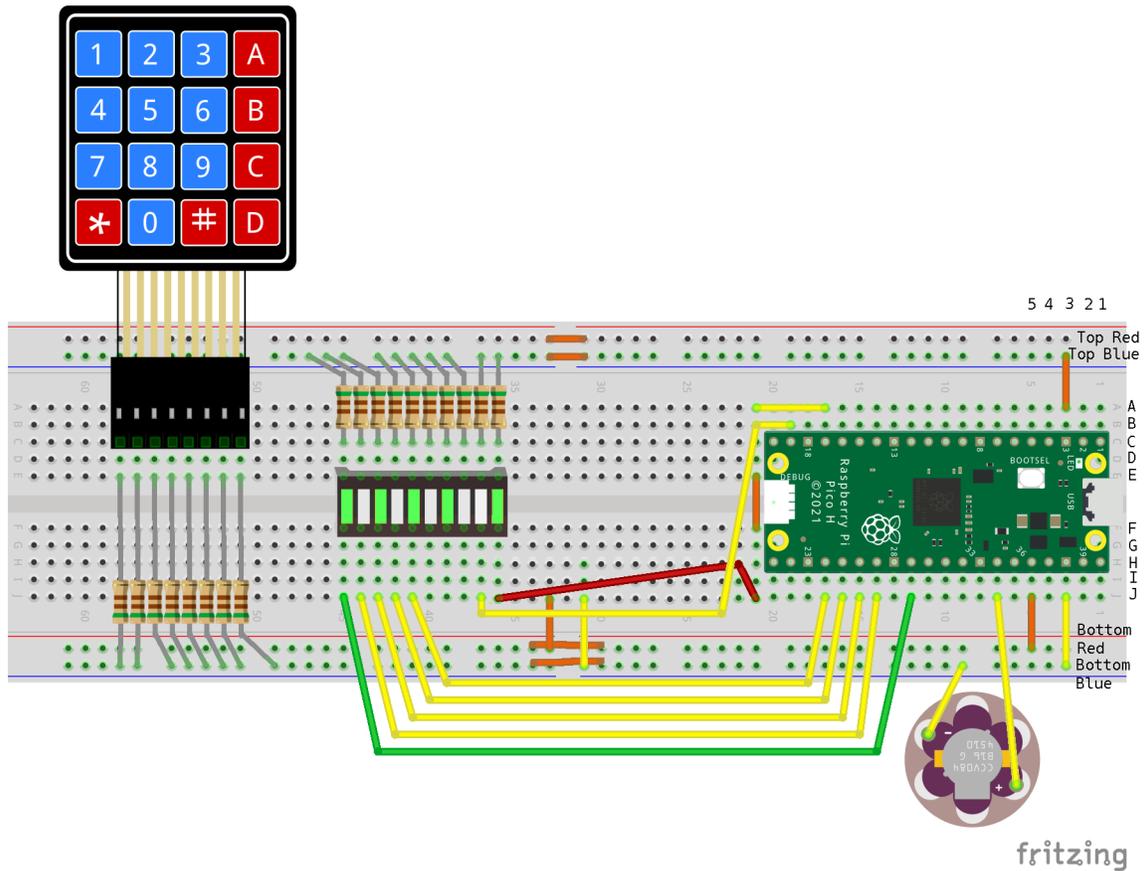## 3.3 Wiring Phase 1 — Power, Ground, and LED Bargraph

Figure 1: Fritzing diagram showing layout after Wiring Phase 1

Place breadboard jumper wires at the following locations:

Start	End	Wire Color	Purpose
Top Red 28	Top Red 33	Short Orange	Top Vdd Bridge
Top Blue 28	Top Blue 33	Short Orange	Top Ground bridge
Bottom Red 28	Bottom Red 33	Short Orange	Bottom Vdd Bridge
Bottom Red 28	Bottom Blue 33	Short Orange	Bottom Ground Bridge
A59	Top Blue 59	Short Orange	Pico Ground
A45	A41	Short Yellow	LED10
E41	F41	Short Orange	LED10
J59	Bottom Blue 59	Short Yellow	Pico Ground
J57	Bottom Red 57	Short Orange	Pico 3.3V Out
J29	Bottom Red 29	Short Orange	TFT power
J31	Bottom Red 31	Short Yellow	TFT ground
J50	J17	Green	LED 1
J44	J18	Yellow	LED 2
J47	J19	Yellow	LED 3
J46	J20	Yellow	LED 4
J45	J21	Yellow	LED 5
J41	J26	Red	LED 10
B43	J25	Yellow	LED 9

3.4 Wiring Phase 2 — Complete LED Bargraph

Remove the TFT display and add the following wires

Start	End	Wire Color	Purpose
B42	J24	Yellow	LED8
J42	J23	Orange	LED7
J43	J22	Orange	LED6

Leave the TFT display unplugged for now.
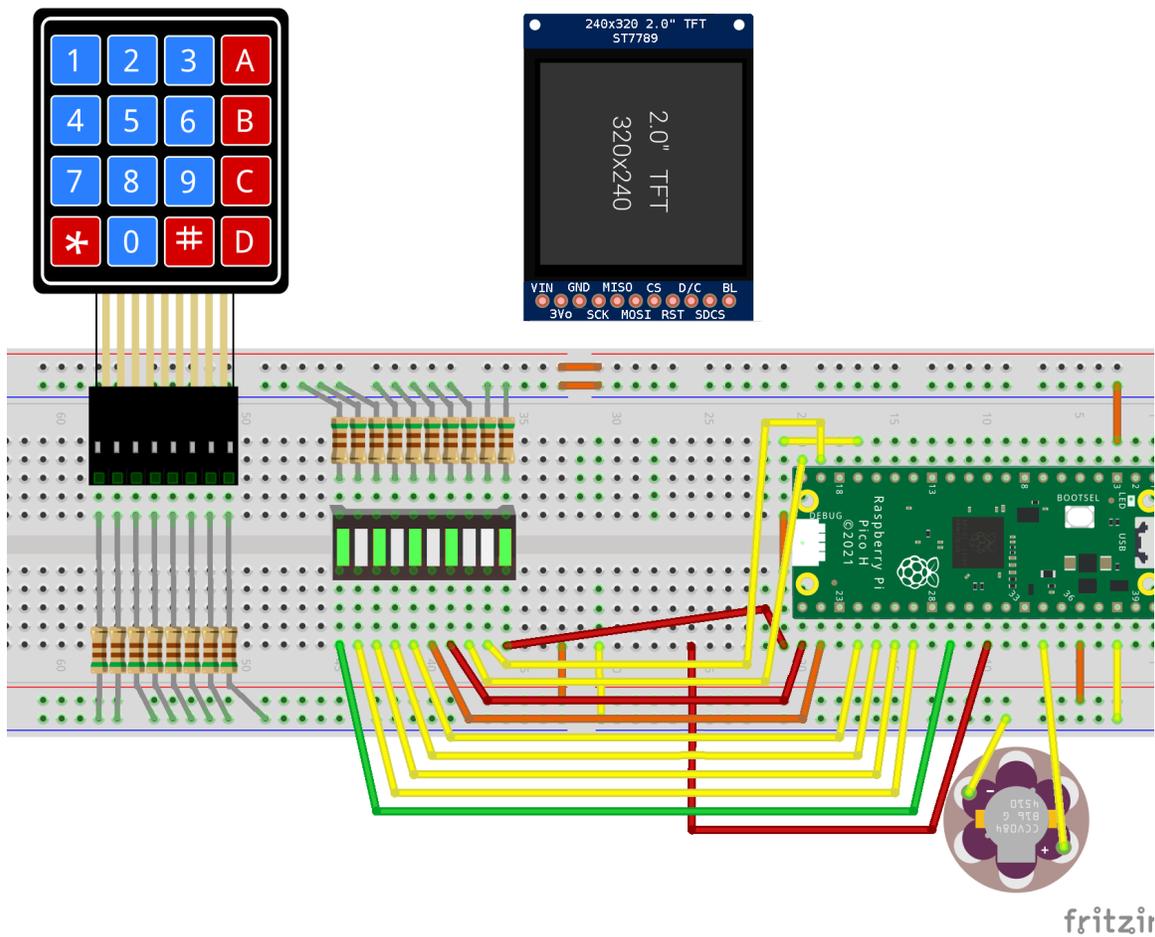
Figure 2: Fritzing diagram showing layout after Wiring Phase 2

3.5   Wiring Phase 3 — Complete TFT

Figure 3: Fritzing diagram showing layout after Wiring Phase 3

Add the following wires to the breadboard

Start	End	Wire Color	Purpose
A60	F35	Yellow	SPI Chip Select
A57	F34	Orange	SPI MOSI
A58	F32	Orange	SPI Clock
A56	F37	Orange	TFT Display/Command
J52	J36	Red	TFT Reset

3.6   Wiring Phase 4 — Keypad

Figure 4: Fritzing diagram showing layout after Wiring Phase 4

Unplug the keypad and add the following wires to the breadboard

Start	End	Wire Color	Purpose
A55	A11	Green	Row 1
A53	A10	Green	Row 2
A52	A9	Green	Row 3
A51	A8	Green	Row 4
A50	A7	Green	Column 1
A48	A6	Green	Column 2
A47	A5	Green	Column 3
A46	A4	Green	Column 4

3.7 Wiring Phase 5 — Final Assembly

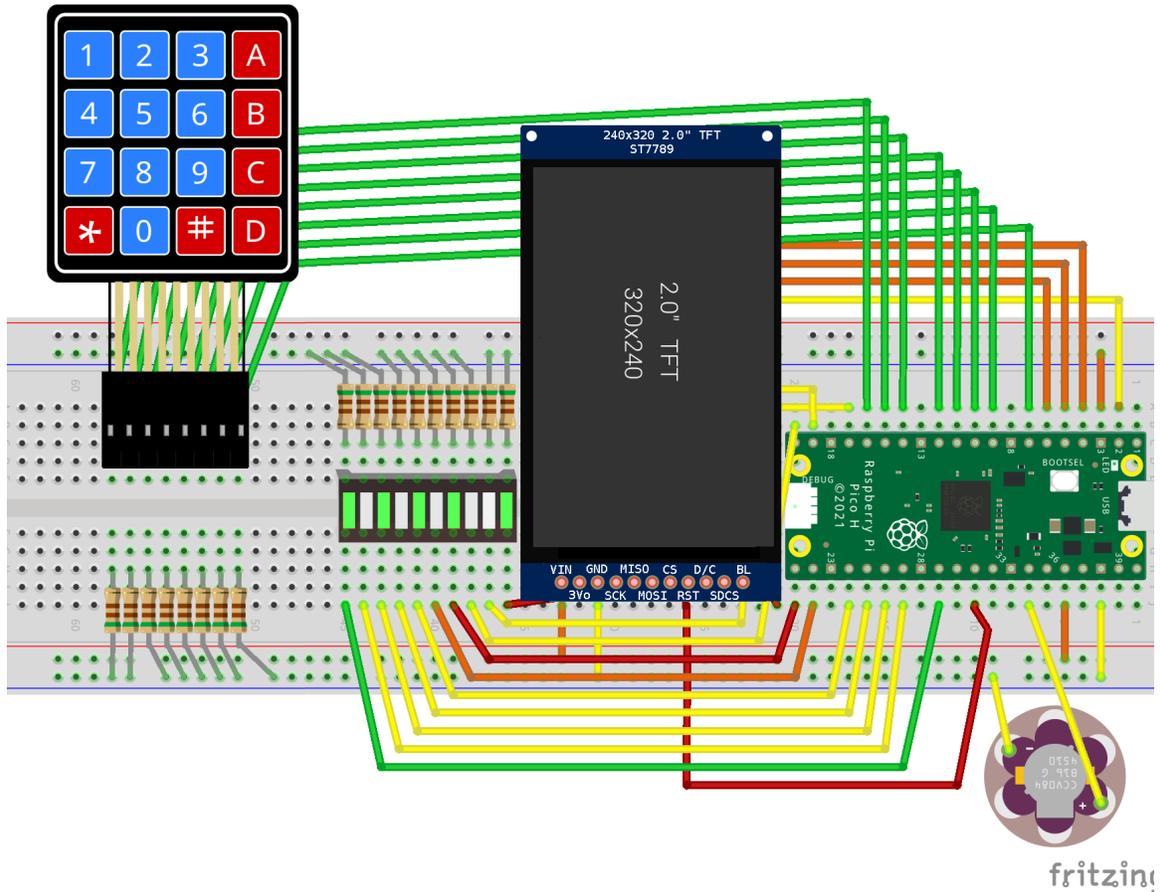Plug the TFT display back into the breadboard at I22-I33. Plug the keypad back into C51-C58.

Figure 5: Fritzing diagram showing final layout

4 Test The Hardware

Before proceeding to the next step, have a TA check the wiring using the following criteria

Points	Accuracy
4	No errors
3	One error
2	Two errors
1	More than two errors

Please fix any wiring issues before continuing.

4.1   Installing the Test Code

1. Download the test code:
   `https://web.eece.maine.edu/~vweaver/classes/ece177/labs/lab03_code.zip`

2. Uncompress this and you should get the file `lab03.uf2` which is a pre-compiled test program we will load onto the Pi Pico

3. Plug in the Raspberry Pi Pico into your laptop while holding down the white "BOOTSEL" button

4. If you do this, your Pi Pico should appear as an external drive on your computer. (On windows this is often the D: drive)

5. In this mode you can program the pico by dragging a .uf2 file into this drive

6. Program the Raspberry Pi Pico by copying the `lab03.uf2` file into this drive (On Windows you can do this by dragging `lab03.uf2` into the drive folder)

4.2   Running the Test Code

If all went well the following should be happening:

- The Raspberry Pi Pico should now have a green blinking LED.
- The LED bar graph should be sequentially blinking and all bars should be able to light up.
- The LCD display should be displaying "-1".

If this does not happen, and especially if any part gets hot, immediately unplug the USB cable and re-check your wiring!

4.3 Test the Keypad

Verify the functionality of the keypad by pressing each button and comparing the output with the following table.

Input	Output
0	2 0
1	15 1
2	14 2
3	13 3
4	11 4
5	10 5
6	9 6
7	7 7
8	6 8
9	5 9
A	12 12
B	8 13, Start speaker
C	4 14, Stop speaker
D	0 15
*	3 10
#	1 11

5 Some Last Notes

- You will need this assembled board for all future labs
- It might be useful to have some sort of case to protect it so the wires don't come lose
- Please do not bend severely or crease the keypad ribbon cable as it can break

6 Grading/Checkoff

1. Please upload a picture of your completed board running the test code to brightspace.

2. TAs will check the wiring of your breadboard and then ask you to demonstrate the working code on your hardware. The TAs will enter grades after verifying your hardware is working with the lab03 code.

3. TAs: Enter grades only after verifying full functionality of all LEDs, keypad buttons, TFT display, and speaker sound.

7 Troubleshooting

Here are just some notes on what to check if your wiring looks good but various parts aren't working after programming.

- **Pi Pico won't program**
  - Try pulling the Pi out and programming it not in the breadboard. If that works there's something wrong with your wiring
  - The big thing to check is if the power and ground lines are connected properly. The most common mistake is having the wire in the lower right that is supposed to be connected to ground going to the wrong pin

- **Pi powers up (green LED blinks) but LCD Display does not Print -1**
  - This means some of the wires going to the LCD are hooked up wrong. Take if off the board and make sure the wires are going to the right holes, it's easy to be off-by-one here

- **Pi powers up, but the LED bargraph does nothing**
  - Be sure the top ground plane (horizontal blue line) is jumpered across so that the resistors are getting proper ground
  - Be sure the bargraph is installed in the right orientation (if installed backwards an LED will not light up)

- **Some of the keypad rows/columns are not working**
  - Try running with a "known good" keypad. If a good one works, it means yours might be broken (this happens sometimes)
  - If the known good one fails the same way then double check your wiring