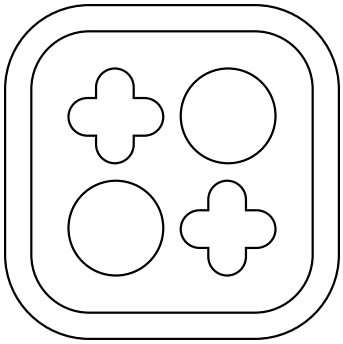

Control Lab IO Interface C
Assembly Instructions &
Instruction Manual

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Assembly Instructions

Bill of materials

Part	Included in Interface C PCB Kit	#	Link
1	Interface C PCB	1	Tindie
2	Push Button 4-pin 6x6x5mm	1	Amazon
3	2-pin Screw Terminal Block Connector 2.54mm	1	Amazon
4	15-pin Female Single Row Straight Header	2	Amazon
5	M3(6mm) Nylon Hex Double-Pass Spacer	4	Amazon
6	M3(10mm) Nylon Hex Double-Pass Spacer	4	Amazon
7	M3 Steel Nuts	4	Amazon
8	M3 (30mm) Steel Hex Socket Head Screws	4	Amazon
9	M5 (10mm) Computer Case Fan Screws	4	Amazon
10	Rubber Feet 1/2” Round	4	Amazon
11	Double Sided Foam Tape (2mm) - 15x10mm, 15x20mm, 10x30mm	1	Amazon
12	Vinyl Stickers Black 3/4” Round	2	Amazon
13	Power Functions Cable	1	Amazon
14	Flat Top Green LED VAOL-5701DE4	1	DigiKey

Part	Included in Interface C Full Kit	#	Link
-	Interface C PCB Kit	1	Tindie
15	I2C OLED 128x32 0.91”	1	Amazon
16	DRV8871 DC Motor H-Bridge	1	Adafruit
17	Resistor 100kΩ ±1%	1	DigiKey
18	Resistor 470Ω ±1%	1	DigiKey
19	Resistor 22kΩ ±1%	1	DigiKey
20	0.1 uF 50V Ceramic Capacitor Radial	2	DigiKey
21	1.8-2.2k uF 16V Capacitor Radial - Height Seated (15mm)	1	DigiKey
22	Rotary Encoder Bourns PER281-P115-N0015	1	DigiKey
23	PTC Reset Fuse 30V 1.1A Radial	1	DigiKey
24	MOSFET P-CH 60V 27A FQP27P06	1	DigiKey
25	Power Barrel Connector Jack 2.50mm	1	DigiKey
26	Dial [3d Printed]	1	MakerWorld
27	Button [3d Printed]	1	MakerWorld
28	Top case [3d Printed]	1	MakerWorld
29	Middle case [3d Printed]	1	MakerWorld
30	Bottom case [3d Printed]	1	MakerWorld
31	1x3 Plate - Dark Blueish Gray [LEGO®]	4	BrickLink
32	3x3 Plate - Dark Blueish Gray [LEGO®]	2	BrickLink
33	1x8 Plate - Dark Blueish Gray [LEGO®]	1	BrickLink
34	6x8 Plate - Light Blueish Gray [LEGO®]	1	BrickLink

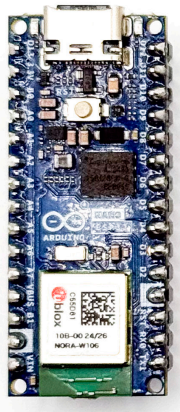
Part	Included in Interface C Full Kit + Microcontroller	#	Link
-	Interface C Full Kit	1	Tindie
35	Arduino Nano ESP32	1	Amazon

Inventory

2
3
24
25
4
8
15
GND VCC SCK SDA
9
6
7
5
14
20
18
19
17
23
16
DRV8833
IN2
VM
IN1
GND
nichicon
2200µF 16V
21
22

Inventory

(35)



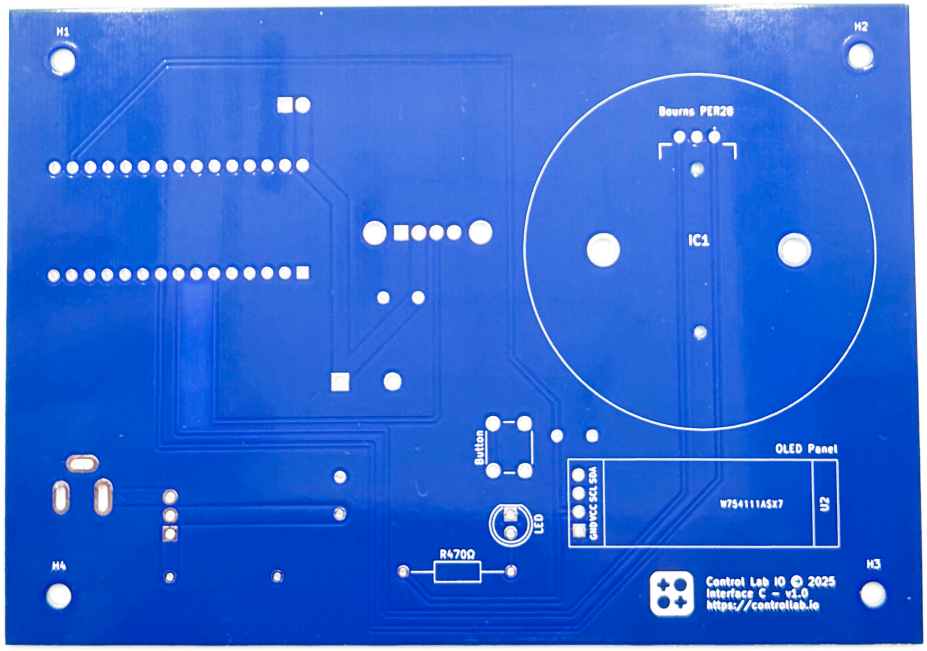
(32)

(31)

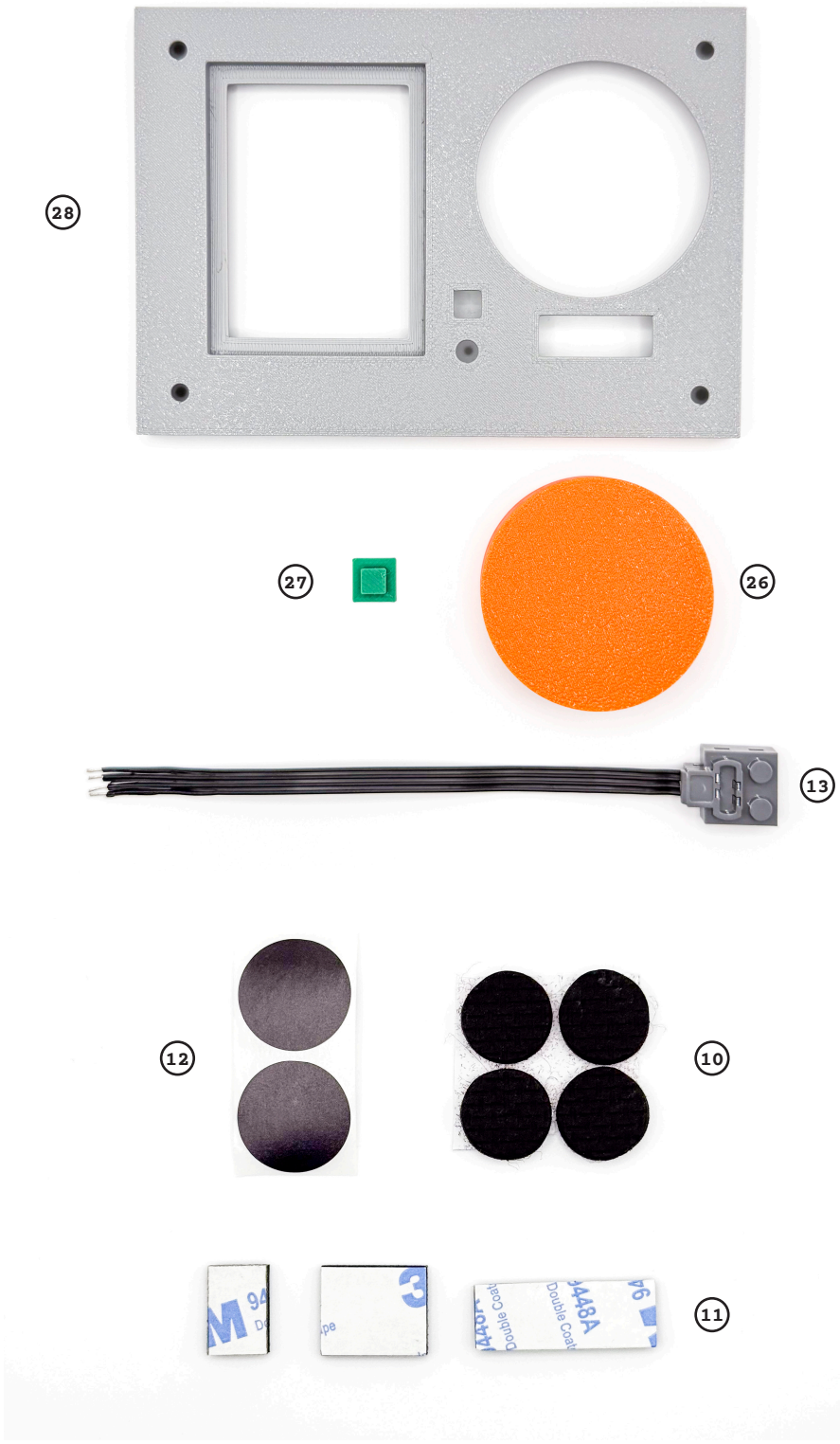
(33)

(34)

(1)



Inventory



Inventory

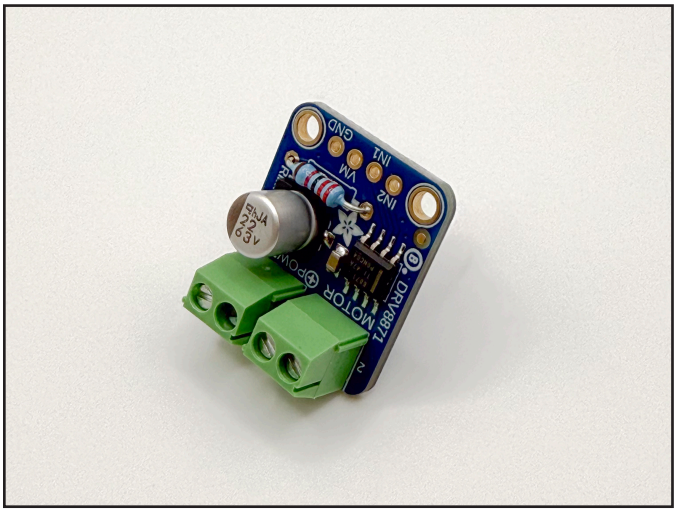
29

30

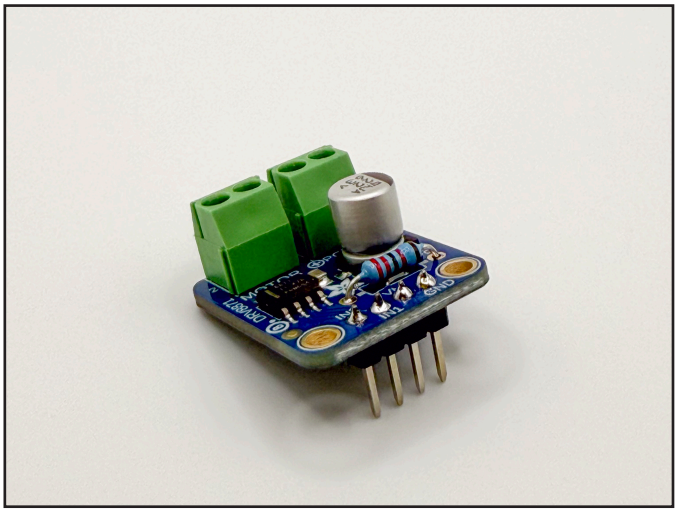
Tools

Tool	Recommended tools for assembly	Link
A	Soldering Iron	Amazon
B	Solder Wire 60-40 Rosin Core Solder 0.6mm	Amazon
C	Silicone Soldering Mat	Amazon
D	Soldering Iron Tip Cleaner	Amazon
E	#2 Philips Screw Driver	Amazon
F	2.5mm Hex Screw Driver	Amazon
G	1.5mm Flathead Screw Driver	Amazon
H	5.5mm Wrench	Amazon
I	Wire Cutter	Amazon
J	Wire Stripper	Amazon

Assembly

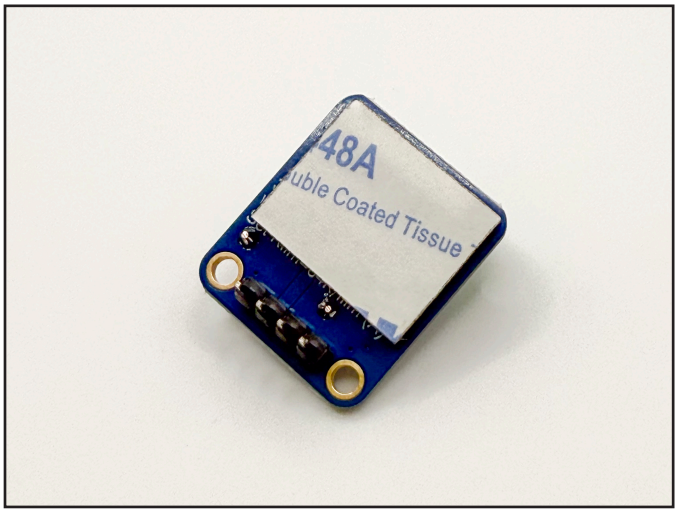


Step 1
Solder the [19] 22kΩ resistor onto the [16] DRV8871 DC Motor H-Bridge. The orientation does not matter. Once soldered, trim the excess leads using wire cutters.

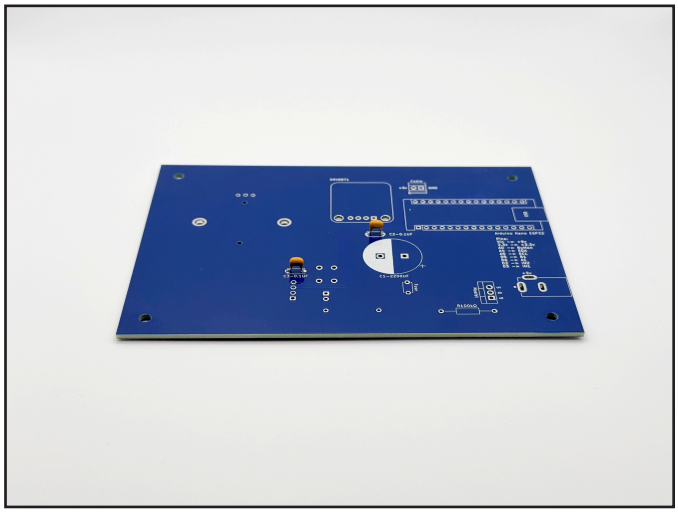


Step 2
Solder the 4-pin header onto the [16] DRV8871 DC Motor H-Bridge. The short pins of the header go through the board upwards, and the long pins should point downward, sticking out from the bottom of the board. This allows the DRV8871 to be mounted flat onto the PCB later with the long pins available for soldering.

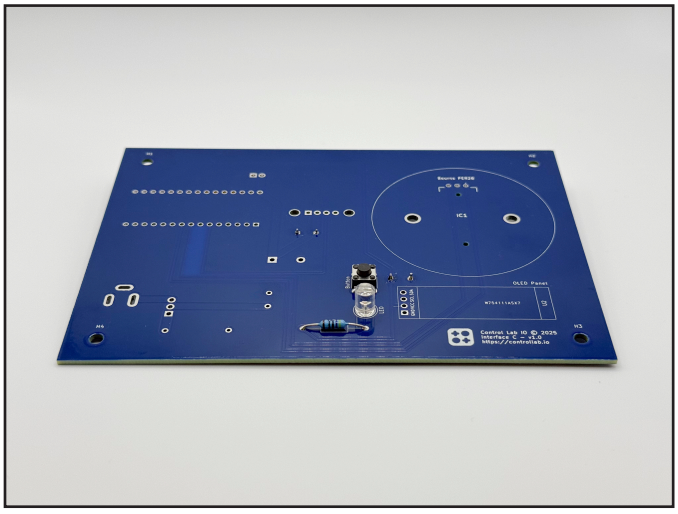
Assembly



Step 3
Attach a piece of the [11] 15x20mm double-sided foam tape to the underside of the [16] DRV8871. Do not peel the second side of the tape yet.



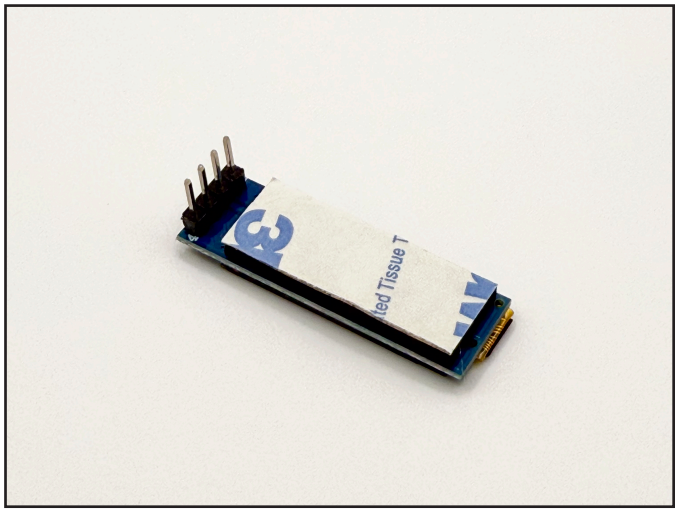
Step 4
Flip the [1] Interface C PCB to the bottom side (the side without the logo). Solder both [20] 0.1uF 50V ceramic capacitors into place—orientation doesn't matter. After soldering, trim the excess leads with wire cutters.



Step 5
Flip the PCB back to the top side (with the Interface C logo). Solder the following components:

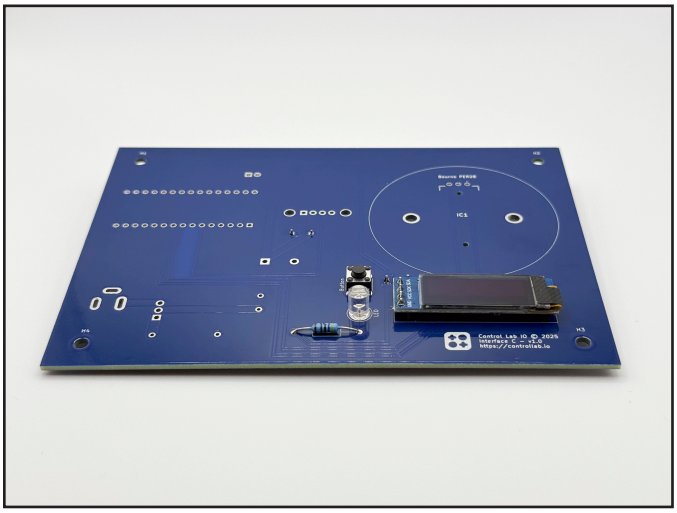
- [2] 4-pin Push Button - orientation doesn't matter
- [14] Flat Top Green LED - shorter leg goes into the square pad (GND), and the longer leg into the circular pad (positive voltage)
- [18] 470Ω resistor - orientation doesn't matter

Trim all excess leads after soldering.

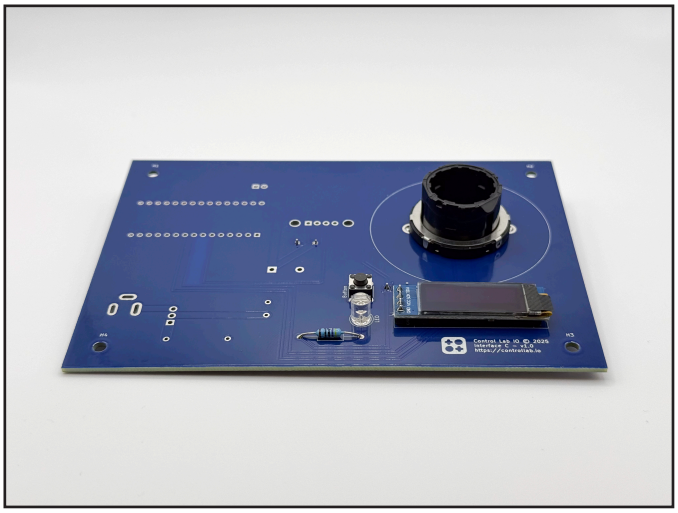


Step 6
Attach a piece of [11] 10x30mm double-sided foam tape to the underside of the [15] OLED Screen. Leave one side unpeeled for now.

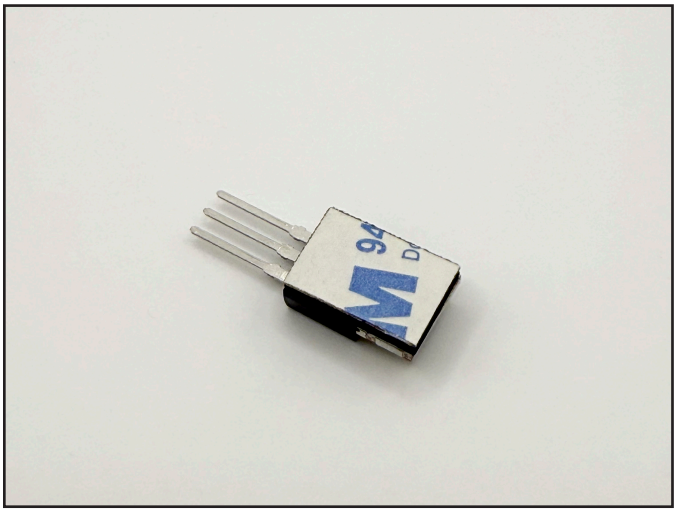
Assembly



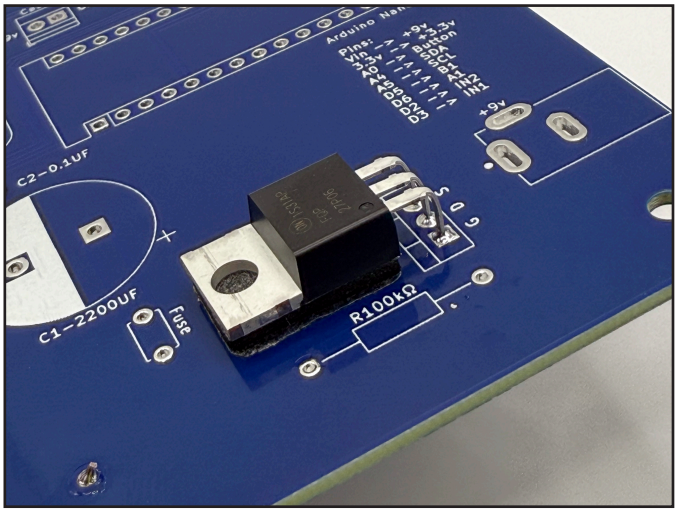
Step 7
Peel the remaining side of the foam tape and solder the [15] OLED screen to the [1] Interface C PCB, ensuring it is firmly adhered and properly aligned.



Step 8
Solder the [22] Rotary Encoder into place on the [1] Interface C PCB.

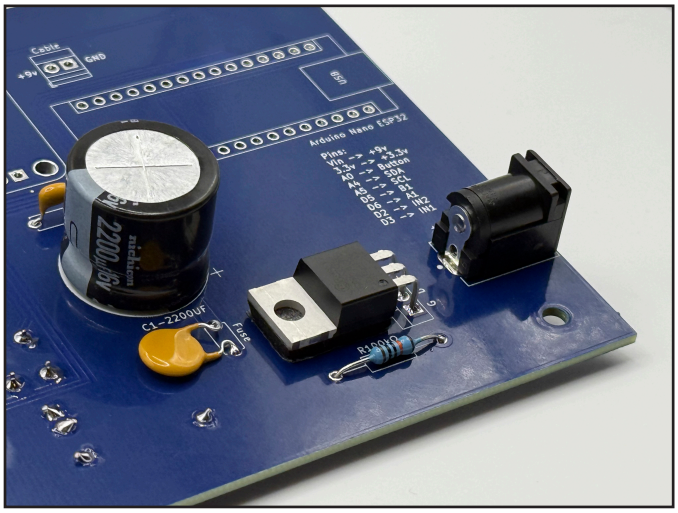


Step 9
Stick a piece of [11] 10x15mm double-sided foam tape to the back of the [24] MOSFET.



Step 10
Flip the PCB to the bottom side. Insert the [24] MOSFET leads through the appropriate holes so that the taped side can lay flat against the PCB. Peel the remaining tape, bend the leads inward, and solder the MOSFET in place. Trim any excess leads with wire cutters.

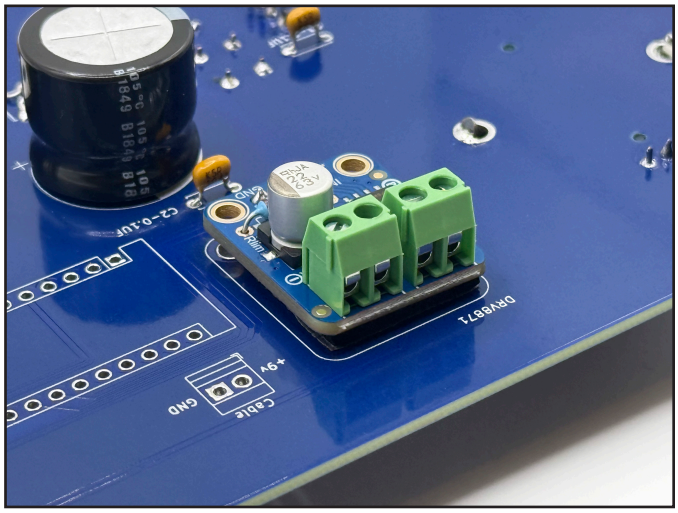
Assembly



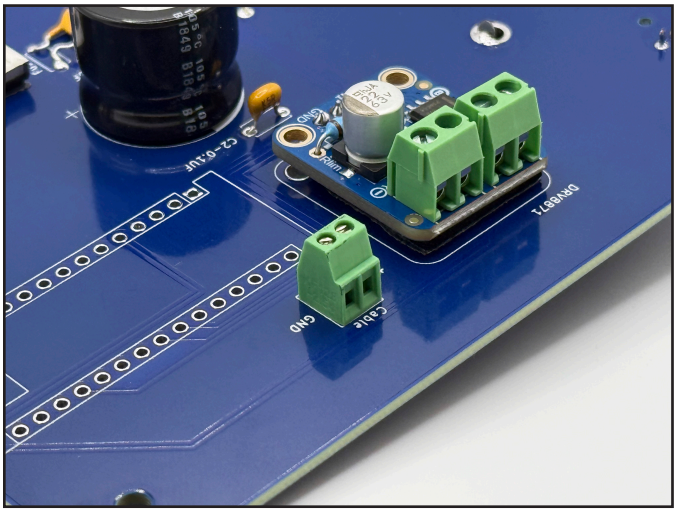
Step 11
Solder the remaining bottom-side components onto the PCB:

- [17] 100kΩ Resistor - orientation doesn't matter
- [23] PTC Reset Fuse - orientation doesn't matter
- [21] 1.8-2.2k uF 16V Capacitor - the shorter leg goes to the negative side, and the longer leg to the positive side
- [25] Power Barrel Connector

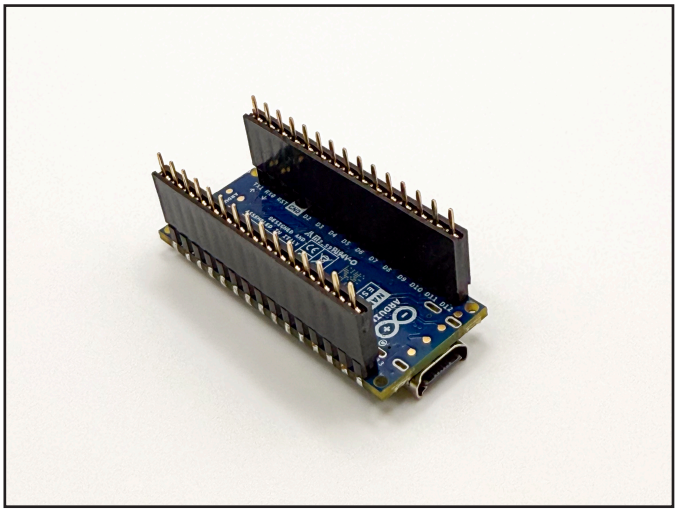
Trim all leads after soldering.



Step 12
Now peel the second side of the foam tape under the [16] DRV8871 and solder it into place on the PCB. Trim all leads after soldering.

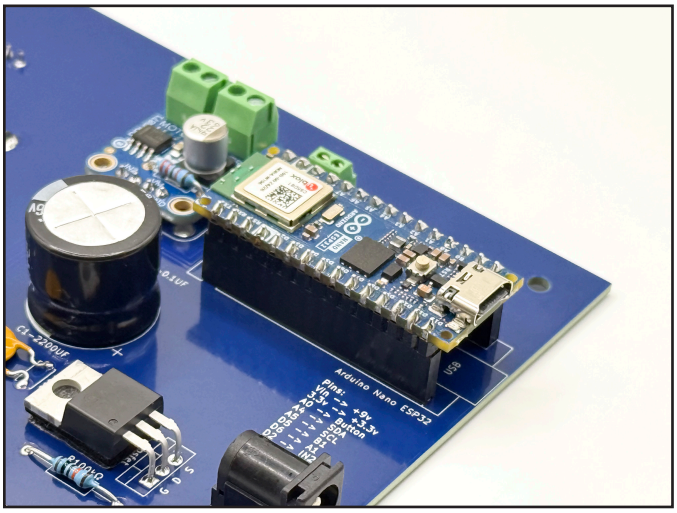


Step 13
Solder the [3] 2-pin Screw Terminal Block Connector onto the PCB. Ensure the wire holes face the direction labeled "Cable" on the PCB.

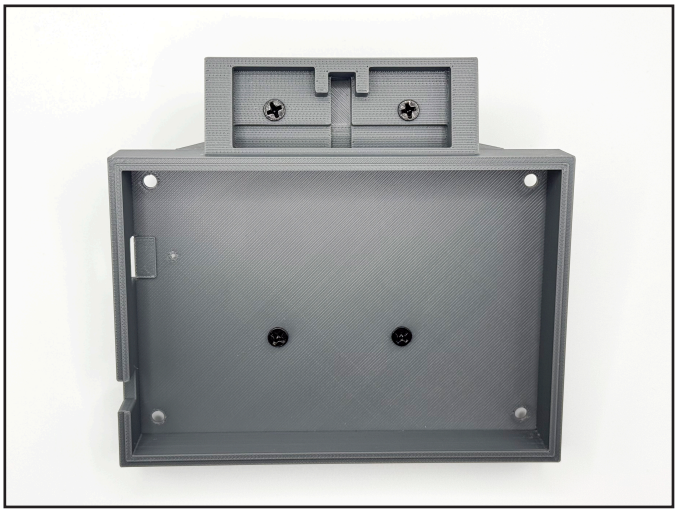


Step 14
Insert the [4] 15-pin Female Single Row Straight Headers onto the [35] Arduino Nano ESP32.

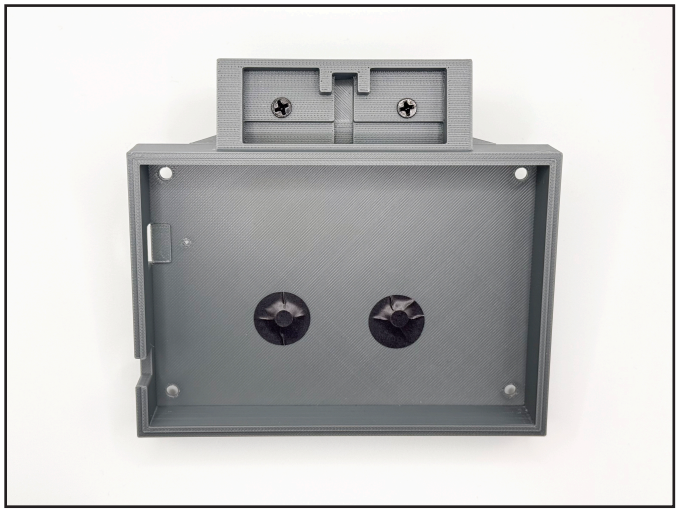
Assembly



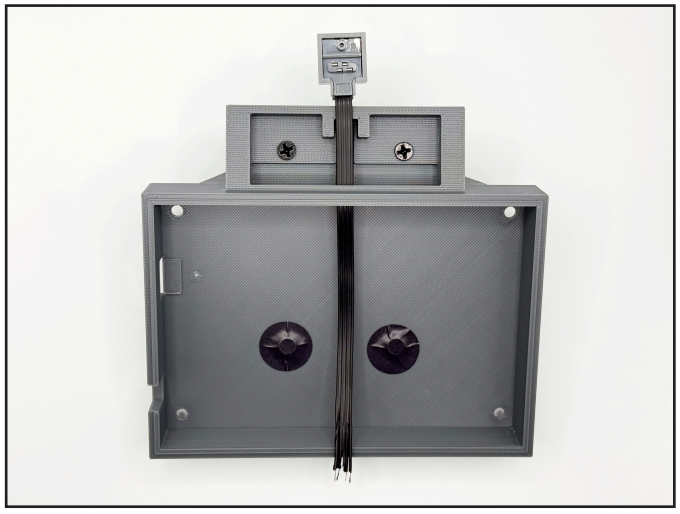
Step 15
Solder the headers attached to the Arduino Nano ESP32 to the [1] Interface C PCB, ensuring that the USB-C port is facing the correct direction as indicated on the PCB.



Step 16
Use the four [9] M5 (10mm) Computer Case Fan Screws to secure the [30] Bottom Case to the [29] Middle Case.



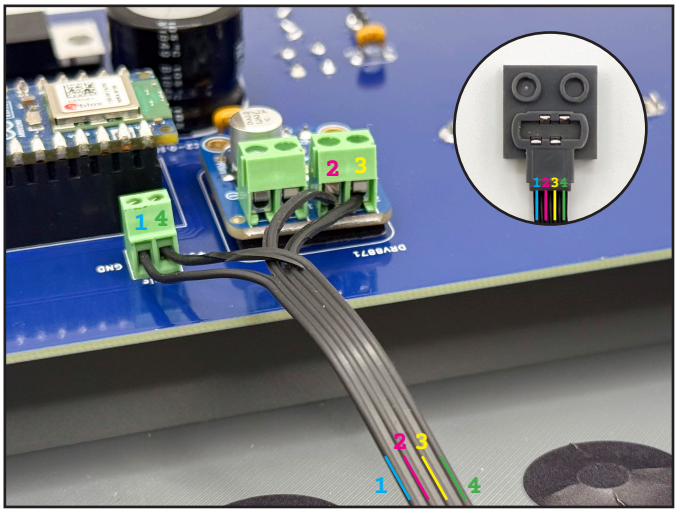
Step 17
Place the two [12] Vinyl Stickers over the screw holes in the larger opening of the [29] Middle Case (see image).



Step 18
Separate the four strands of the [13] Power Functions Cable by approximately 40mm, then strip about 5mm of insulation from the end of each strand to expose the bare wire. After preparing the wires, feed the cable through the opening between the larger and smaller sections of the [29] Middle Case.

Assembly

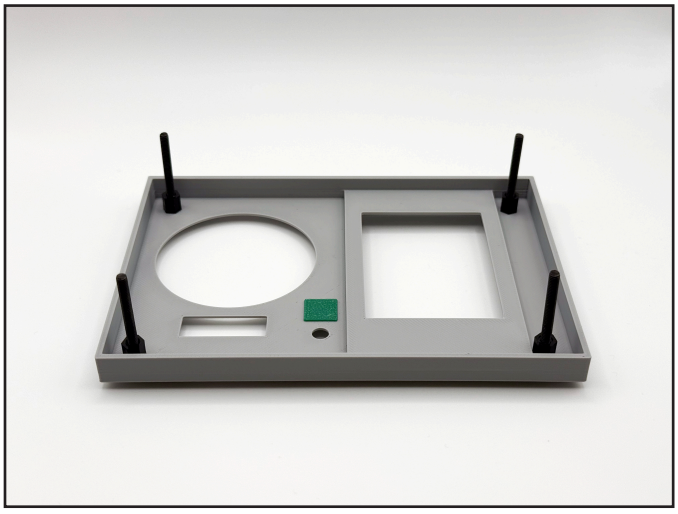
Step 19
Insert the [33] LEGO® 1x8 Plate - Dark Bluish Gray - into the smaller opening of the [29] Middle Case. Make sure the [13] Power Functions Cable is routed underneath the 1x8 Plate, and connect the Power Functions plug into the center studs of the 1x8 Plate to ensure it sits securely.



Step 20
Connect the wires from the [13] Power Functions Cable as follows:

- Wires 1 and 4 go into the [3] 2-pin Screw Terminal Block
- Wires 2 and 3 go into the [16] DRV8871 Motor H-Bridge

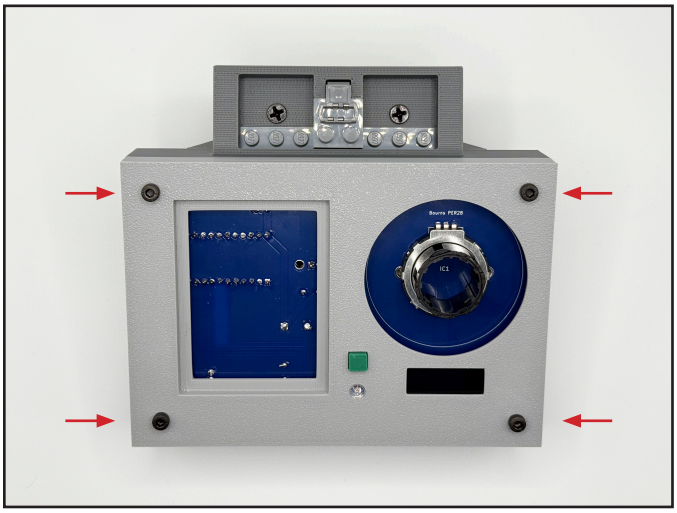
Follow the labels above each terminal hole for correct placement (see image).



Step 21
Insert the four [8] M3 (30mm) Steel Hex Screws through the [28] Top Case from the top side. Then, screw on four [5] M3 (6mm) Nylon Hex Double-Pass Spacers to hold the screws in place. Finally, insert the [27] Button into its designated opening on the [28] Top Case, ensuring it is properly seated.

Step 22
Carefully align the [1] Interface C PCB over the four exposed screws, ensuring that the LED and OLED screen are properly centered within their corresponding cutouts on the [28] Top Case. Once aligned, secure the PCB in place by fastening four [6] M3 (10mm) Nylon Hex Double-Pass Spacers onto the screws.

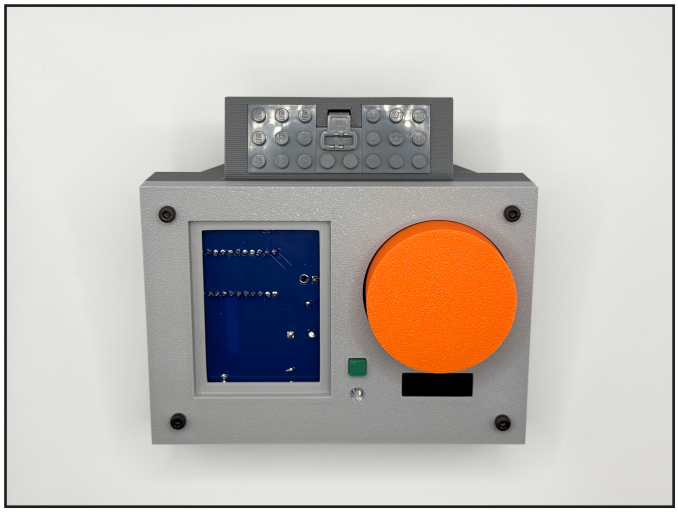
Assembly



Step 23
Tuck any remaining length of the [13] Power Functions Cable inside, and lower the assembled [28] Top Case with the [1] Interface C PCB into the [29] Middle Case. Secure it using four [7] M3 Steel Nuts.

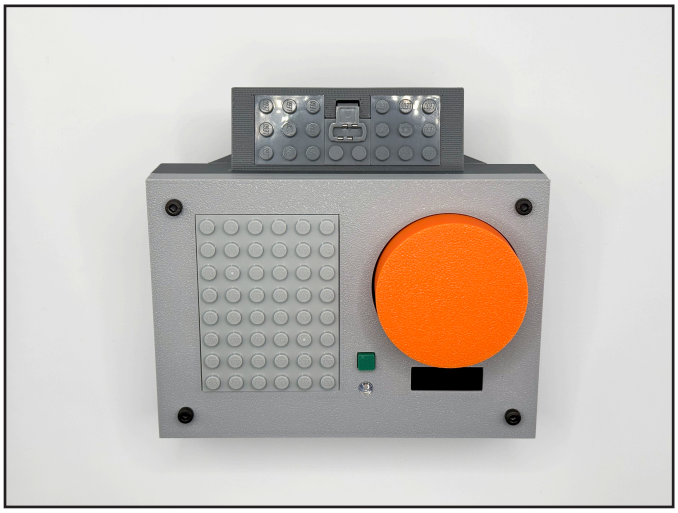
Step 24
Place the [26] Dial onto the [22] Rotary Encoder. The encoder uses a ring-style interface rather than a traditional shaft. Align the notch on the [26] Dial with one of the openings facing upward on the encoder ring to ensure proper fit and rotation (see image).

Step 25
Attach the four [31] LEGO® 1x3 Plates - Dark Bluish Gray - on top of the [33] LEGO® 1x8 Plate.

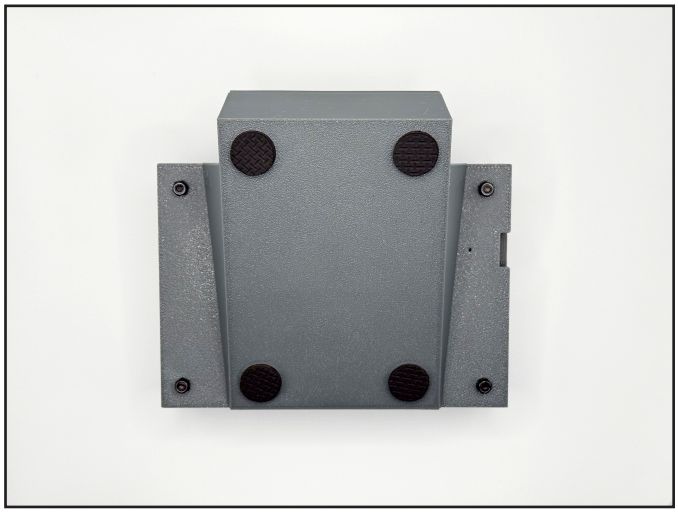


Step 26
Attach the two [32] LEGO® 3x3 Plates - Dark Bluish Gray - on top of the [31] LEGO® 1x3 Plates.

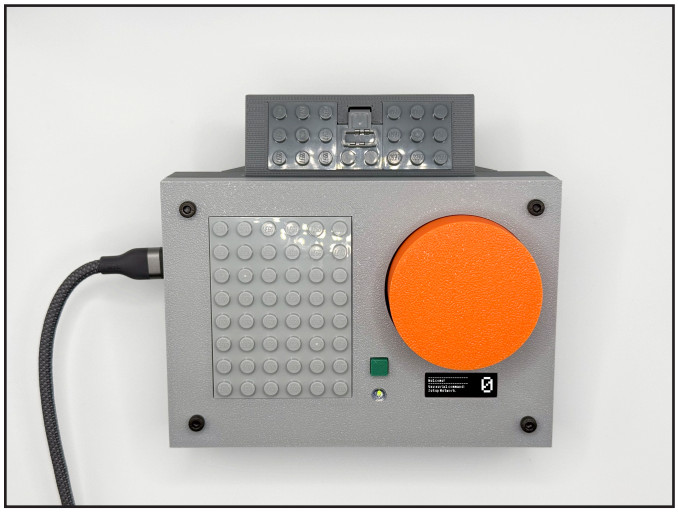
Assembly



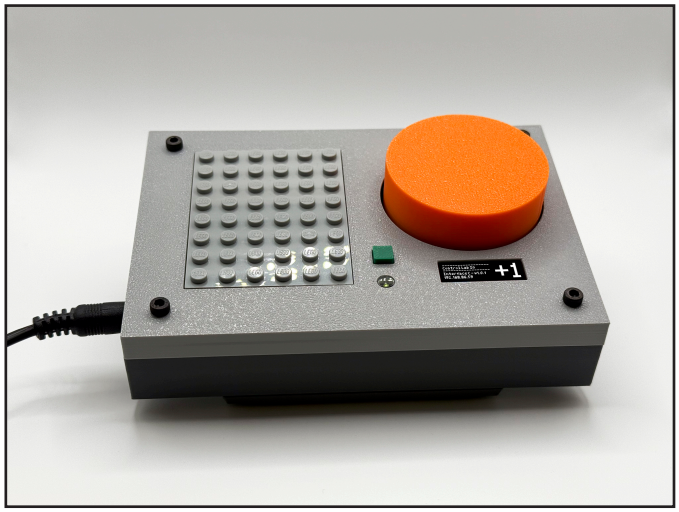
Step 27
Place the [34] LEGO® 6x8 Plate - Light Bluish Gray - over the rectangular opening in the [28] Top Case.



Step 28
Turn the Interface C device upside down and stick the four [10] Rubber Feet into the round holes for grip and stability.



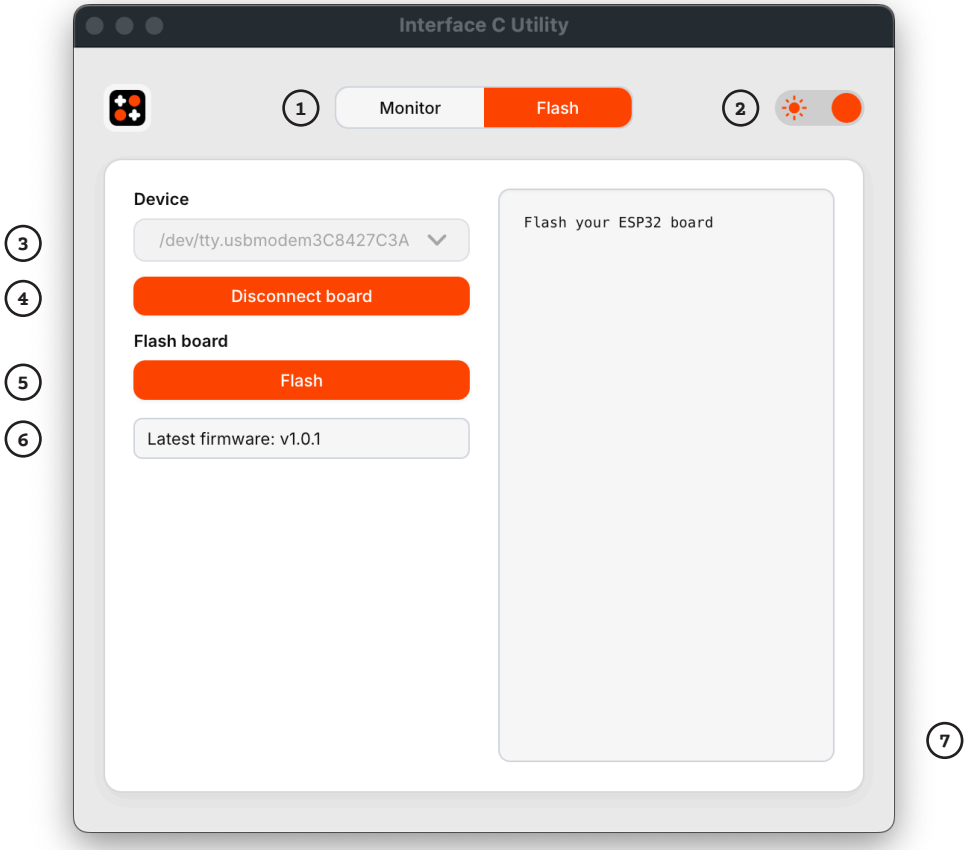
Step 29
Connect the [35] Arduino Nano ESP32 to a computer using a USB-C cable, and flash the firmware using the Interface C Utility application (available for Mac or PC). Refer to page 18 of this manual for detailed instructions on flashing the firmware.



Step 30
Once flashing is complete, connect a 9V 27W AC/DC power supply (rated at 3A) [Amazon] to the [25] Power Barrel. You may safely leave the USB-C cable connected at the same time, although it is not required for operation. Note that the Interface C cannot run solely from the USB-C connection—it requires the 9V power supply for normal operation. If you prefer, you can disconnect the USB-C cable once flashing is finished.

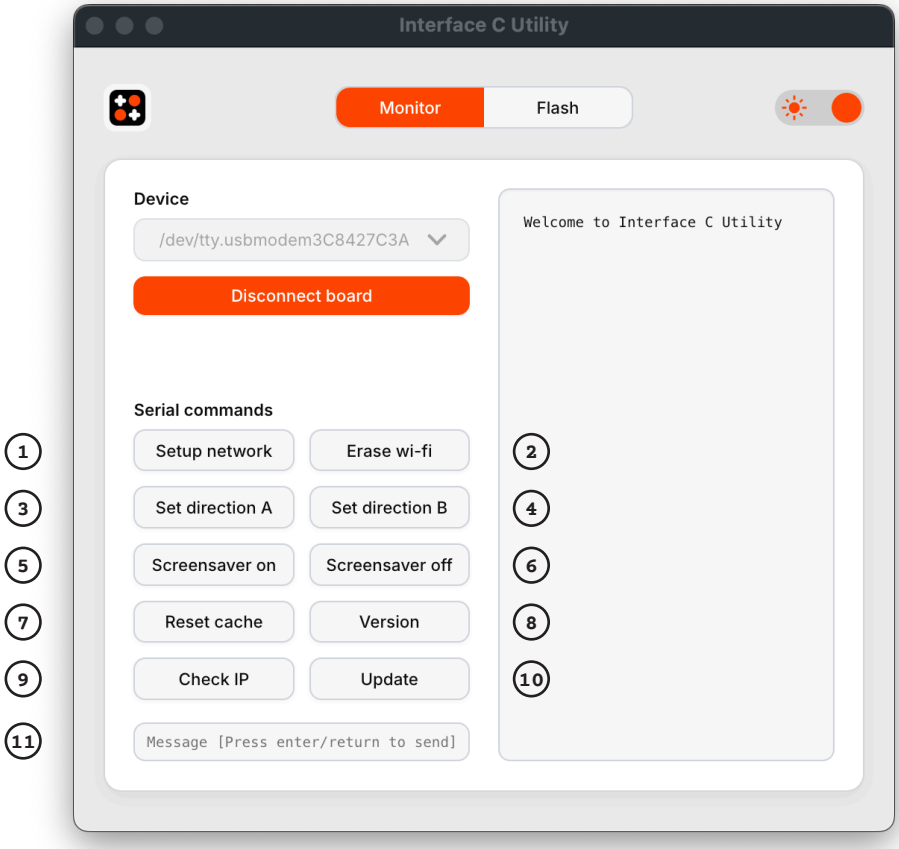
Instruction Manual

Flash operation



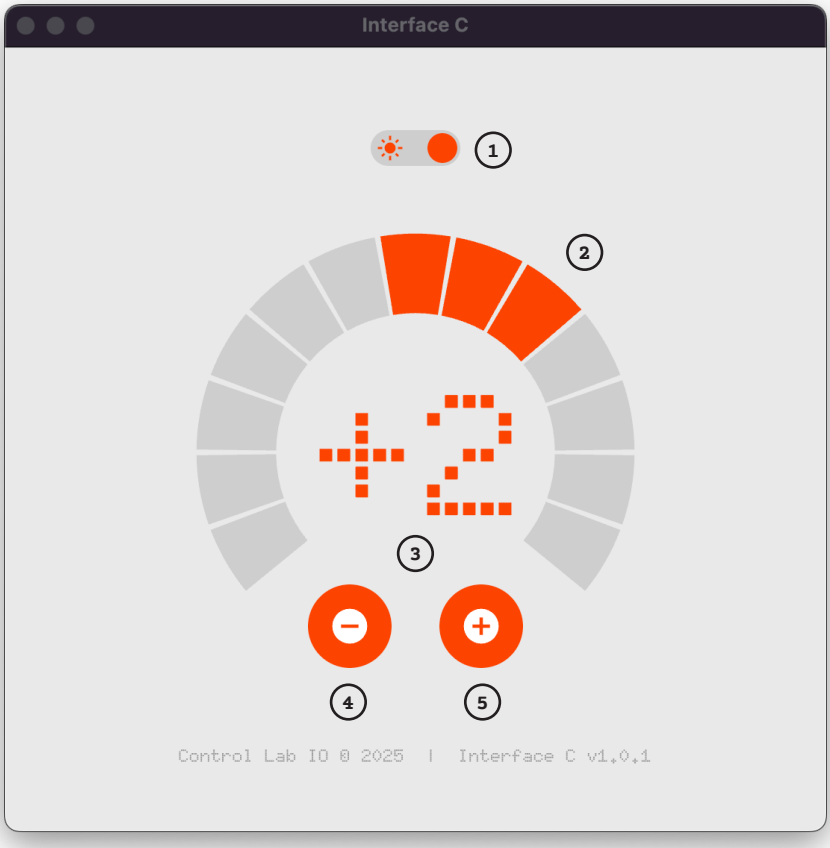
1	Mode Toggle	Toggles between Monitor and Flash modes. Monitor lets you view serial commands and real-time messages from the ESP32 board. Flash mode allows you to update the board with the latest firmware.
2	Theme Toggle	Tap to switch between Light Mode and Dark Mode for improved visibility and personal preference.
3	Device Dropdown	Displays a list of connected ESP32 boards. Select the desired board you wish to connect to monitor or flash.
4	Refresh / Disconnect Button	Use the Refresh button to rescan and update the list of available devices. The Disconnect button safely disconnects the currently selected board.
5	Flash Button	Initiates the firmware flashing process. When pressed, the selected ESP32 board is reset, memory is cleared, and the latest firmware is installed.
6	Firmware	Shows the version number of the latest available firmware release that will be flashed directly to the board.
7	Viewport	Displays real-time output from the ESP32, including serial messages, error logs, and firmware flashing progress.

Monitor operation



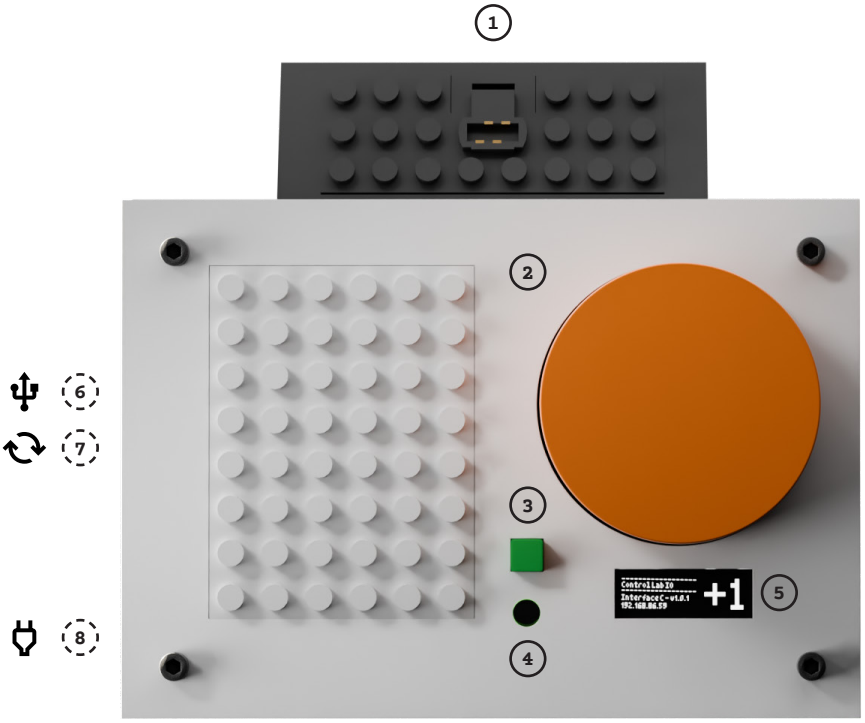
1	Setup Network	Launches the Wi-Fi setup wizard to connect the ESP32 device to a wireless network. Follow the prompts to configure network credentials.
2	Erase Wi-Fi	Clears the saved Wi-Fi credentials from the ESP32. This allows a new network to be set up from scratch using the Setup Network option.
3	Set Direction A	Configures the motor so that positive speed values rotate it clockwise and negative values rotate it counterclockwise.
4	Set Direction B	Configures the motor so that negative speed values rotate it clockwise and positive values rotate it counterclockwise.
5	Screensaver On	Enables screensaver. After 3 minutes of inactivity, a screensaver animation is shown. After 30 minutes, the screen turns off completely to save power.
6	Screensaver Off	Disables the screensaver and keeps the display always on, regardless of activity or time elapsed.
7	Reset Cache	Clears the cached firmware version from memory. This forces the system to check for and fetch the latest version on the next update.
8	Version	Displays the currently installed firmware version that is actively running on the connected ESP32 board.
9	Check IP	Shows the current IP address of the connected ESP32 device, useful for network troubleshooting or remote access.
10	Update	Updates the ESP32 to the latest firmware without performing a full flash. This preserves current settings and only refreshes the firmware payload.
11	Input Box	A text field where you can type and send custom serial commands directly to the connected ESP32 board for manual control or debugging.

Web operation



1	Theme Toggle	Tap to switch between Light Mode and Dark Mode for improved visibility and personal preference.
2	Speed Gauge	A visual dial showing speed levels from -6 (reverse) to +6 (forward). Tap directly on a segment to instantly change the motor speed.
3	Speed Number	Displays the current motor speed as a numeric value, ranging from -6 to +6.
4	Speed Increase Button	Tap to incrementally increase the motor speed by one level.
5	Speed Decrease Button	Tap to incrementally decrease the motor speed by one level.

Hardware operation



1	Power Functions Plug	The Power Functions plug allows you to connect LEGO® Power Functions M, L, XL, Servo motors, and Lights. For best results, it is recommended not to plug in more than two motors at once to ensure consistent power delivery and avoid overloading the system.
2	Dial	The dial is used to control motor speed manually. Rotating it clockwise increases speed, while rotating it counterclockwise decreases it. This control is only active when Web Mode is turned off.
3	Green Button	The green button serves multiple functions. Pressing it once toggles Web Mode, which disables the dial and transfers control to the web interface. Pressing and holding the button for three seconds will restart the device, while holding it for six seconds will initiate a firmware update check.
4	LED Light	The LED light turns on whenever Interface C is powered on, providing a quick visual indicator that the device is receiving power and is operational.
5	OLED Screen	The OLED screen displays various status information about Interface C, including motor speed, network state, Web Mode status, and firmware update messages. It is the main visual feedback interface for the device.
6	USB Plug	Located on the left side of the device, the USB plug is used exclusively for flashing new firmware onto Interface C. It should not ever be used as a power source for the device itself.
7	Reset Hole	On the bottom of the device is a small reset hole. Using a pin or paperclip, you can gently press the hidden reset button inside, which immediately restarts the ESP32 microcontroller. This action may occasionally be required during certain firmware flashing operations or troubleshooting steps.
8	9V Power Jack	Located on the left side of the device, the 9V power jack is the main power input for Interface C. To operate the device, use a 9V 27W AC/DC power supply rated at 3A. Supplying appropriate power is essential for stable performance, especially when running multiple motors.

Hardware operation

1) Welcome Screen
Displayed after flashing the controller when no network is set up. Prompts the user to configure Wi-Fi using the setup wizard, but no IP is shown.

2) Default Screen
The standard operating screen when the network is configured. The current device IP address is prominently displayed, confirming that Interface C is connected and ready.

3) Update Available
An asterisk * appears next to “Control Lab IO” indicating that a newer firmware version is available. Press and hold the green button to begin the update process.

4) Reversed Motor
An R is displayed next to the IP address. This signifies that the motor direction has been reversed—now, negative speeds result in clockwise motor rotation.

5) Web Mode
[ON] is displayed beside the IP address when Web Mode is enabled. In this mode, the physical hardware dial is disabled, and control is handed over to the web interface.

6) Sleep Mode
After 3 minutes of inactivity, the screen displays “Z z z …” and enters a low-power screen saver mode. The screen turns off completely after 30 minutes.

7) Restart
Press and hold the green button for 3 seconds to restart Interface C. A confirmation message appears before restarting.

8) Update
To initiate a firmware update, press and hold the green button for 6 seconds (3 seconds for restart + 3 more seconds). Release when prompted to begin the update check.

9) Restarting
This screen confirms that Interface C is restarting. No action is required; the device will reboot automatically.

10) Release to Update
Displayed after holding the green button for 6 seconds. Release the button now to initiate a firmware update check.

11) Looking for Updates
Interface C is actively checking for available firmware updates. This process usually takes a few seconds.

12) No Updates
Displayed when the device confirms that the latest firmware version is already installed. No action is needed.

13) Updating Firmware
A new firmware version has been found. The device will now begin the update process. Do not unplug or restart during this stage.

14) Wi-Fi Saved
Displayed after successfully completing the network setup wizard. The Wi-Fi credentials have been saved, and the device is automatically restarted to apply settings.

15) Wi-Fi Erased
Shown when Wi-Fi credentials are deleted. The device will restart automatically, requiring a new network setup on next boot.

FAQ

Q: How do I flash my ESP32?
A: Connect your Interface C to a computer using a reliable USB-C data cable. Open the Interface C Utility application (available for Mac or PC), select your device from the dropdown list, switch to Flash mode, and click the Flash button. This process will automatically reset the ESP32, erase its existing memory, and install the latest firmware version available. Once complete, the device will reboot and be ready for use. Refer to the Flash Operation section for detailed step-by-step instructions (see page 18).

Q: How do I set up Wi-Fi on my device?
A: Using the Interface C Utility, switch to Monitor mode and click Setup Network. Follow the prompts to enter your Wi-Fi credentials. Once complete, the device will save the credentials and restart automatically. You can verify the connection by checking the IP address on the OLED screen.

Q: What happens when the device shows -.-.-.- as the IP?
A: This indicates that the device is not receiving a valid IP address—often because the previous network lease has expired or the router has not assigned a new one. The simplest solution is to restart Interface C. To do a standard restart, press and hold the green button for about 3 seconds until the OLED screen displays the restart confirmation, then release it. The device will reboot automatically. If the issue persists after restarting, you may need to re-run Setup Network in the Interface C Utility to reconnect to Wi-Fi.

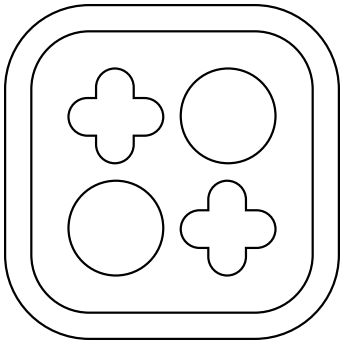
Q: How do I connect to the web server?
A: Once the device is connected to Wi-Fi and an IP address is displayed on the OLED screen, enter that IP address into any modern web browser on the same network. This will open the Interface C Web Control page, where you can adjust motor speed and settings remotely.

Q: How many motors can I connect at once?
A: Interface C supports LEGO® Power Functions M, L, XL, Servo motors, and Lights. For stable performance, it is recommended not to connect more than two motors at the same time.

Q: What Power Functions motors does Interface C support?
A: Interface C supports LEGO® Power Functions M, L, XL, and Servo motors, as well as LEGO® Power Functions Lights.

Q: How do I update my device?
A: You can update firmware in three ways:
1. Quick Update (No Flash): In the Interface C Utility, go to Monitor mode and click Update. This refreshes firmware without erasing settings.
2. Full Flash: In Flash mode, click Flash to completely reinstall the latest firmware.
3. From the device: Hold the green button for 6 seconds until prompted to start an update directly from the device.

Q: Can I power the device using USB-C?
A: No. The USB-C port is only for flashing firmware and cannot power Interface C. A 9V 27W AC/DC power supply rated at 3A is required for normal operation.



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