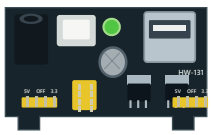
START HERE

01

Understand before you power

Learn five habits that protect your build, your hearing and your hands. This is a **10-minute safety lesson**. The practice uses disconnected parts; do not energize a circuit to test a hazard.

Recognize the power-related parts



Breadboard power module

Has a DC socket and voltage selectors. A selector position is not proof of the actual output.



Battery-to-DC lead

Carries battery voltage. It does not reduce voltage or establish polarity by its color.



ESP32-S3 board

Runs your code. USB and external power are different possible sources.



USB cable

Can supply power even when no program is running.

The five rules

1 · Unplug before changes

Remove every source.

2 · Match the power

Check voltage, polarity and capacity.

3 · Prevent shorts

Inspect parts and battery contacts.

4 · Begin audio quietly

Protect hearing before testing.

5 · Clear moving parts

Unplug and wait before adjustment.

No electronics background is needed. Speaker and motor drawings later are hazard examples; you do not need to connect those parts for this lesson.

RULE 1

Unplug before changing a wire

02

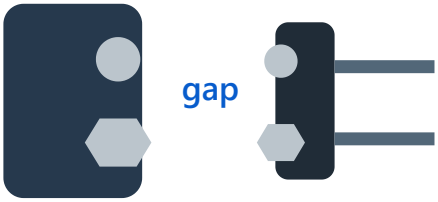
A program stopped on screen can still leave the board powered. **Reset is not power off.** Remove every supply before moving wires, jumpers or modules.

USB: unplug the cable



Power light off ≠ isolated

Battery: detach the lead



OFF switch ≠ unplugged

Remove every source before moving a wire.

The important result is a physical gap. The drawings show disconnected connectors, not a battery hookup.

Follow the complete sequence

1. Stop the activity and place the build on a dry, clear surface.
2. Unplug USB and disconnect any battery or external supply.
3. Wait for moving parts to stop. Keep away from hot or damaged parts.
4. Only then change the wiring. Inspect it again before restoring power.

OFF switch

A switch may disable only part of a device. A second cable or battery can still supply power.

RST button

Restarts the ESP32-S3. It does not physically separate a source from the circuit.

Do this with your disconnected parts: point to USB and the battery connection. Explain how you would remove each source before moving one jumper.

RULE 2

03

Match the power before connecting

Voltage must match what the device accepts. **Polarity** tells you which contact is positive and which is negative. A plug fitting into a socket proves neither.

Practice device: 3.3 V only

3.3 V	5 V	9 V
✓	✗	✗

A matching plug does not prove a matching voltage.

A passive battery lead does not reduce voltage.

These are practice choices for an imaginary 3.3 V-only device, not instructions for an ESP32 header.

> **Your turn:** choose the supply for the 3.3 V-only practice device. More current capacity does not make 5 V or 9 V a safe voltage choice.

Next, check polarity and the exact connector before any physical connection.

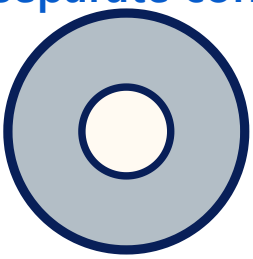
RULE 2 · CONTINUED

04

Check polarity, not just the plug

A barrel connector has two separate contacts. **Polarity** identifies which is positive and which is negative. Two plugs can look the same and have different polarity.

Two separate contacts



Center and outer sleeve

Match these first

Voltage

Polarity (+ / −)

Connector fit

Unknown polarity? Leave it disconnected and get help.

Identify the center and sleeve, then verify which is positive in the exact part's instructions before connecting.

Before using a supply: check the exact device input, the supply output, connector polarity and available current. Have a competent helper verify unknown facts and any required voltage measurement before connecting the load.

Keep an uncertain battery lead unplugged. Never guess from wire color, a similar board, a jumper label or a connector's shape. A 9 V battery lead does not turn 9 V into 3.3 V.

Current capacity

The supply must provide the current the build needs at the correct voltage. Do not read current capacity as permission to use the wrong voltage.

Use the exact instructions

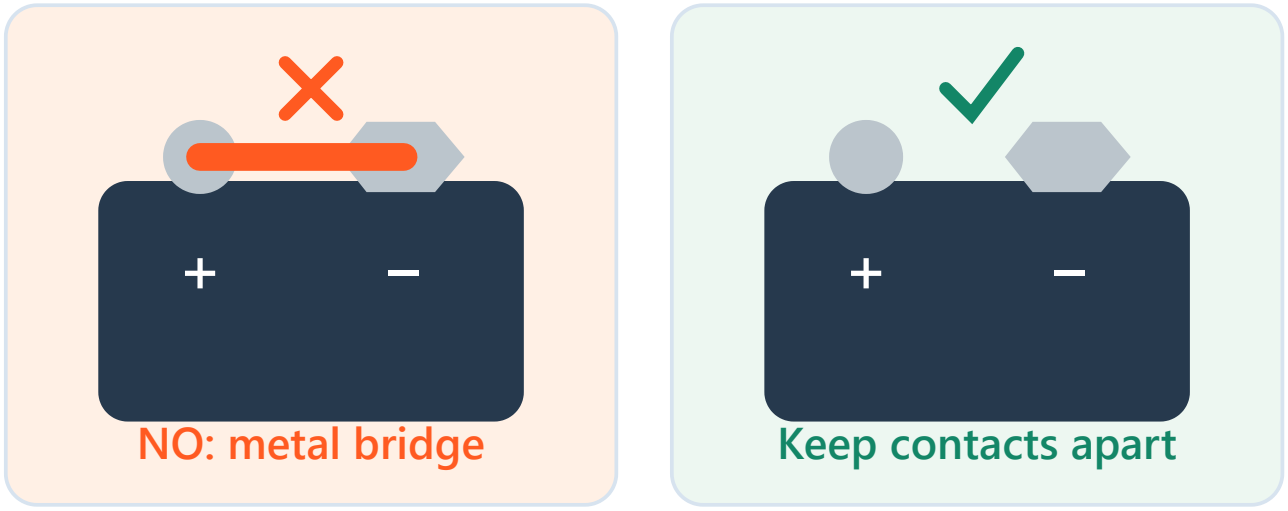
A module label or matching connector shape is not a complete power plan. Keep different supplies disconnected until the permitted power path is clear.

RULE 3

05

Keep metal away from battery contacts

A **short circuit** is an unintended low-resistance path, such as metal joining the two supply contacts. It can draw a large current and heat the battery, wire or part.



Never make a short circuit as an experiment.

This is a hazard illustration. Never reproduce the metal bridge.

Inspect before applying power

- Remove loose screws, wire clippings and metal tools from the build.
- Keep exposed battery contacts apart and away from metal objects.
- Do not use damaged, leaking, swollen or unusually hot batteries.
- Use only the battery type and charger approved for the device. Do not recharge disposable batteries.

Unexpected heat, smell, smoke or repeated resets? Stop. Disconnect the source if it is safe to do so, keep away from hot parts and tell your instructor. Do not touch a component to test whether it is hot, and do not keep retrying power.

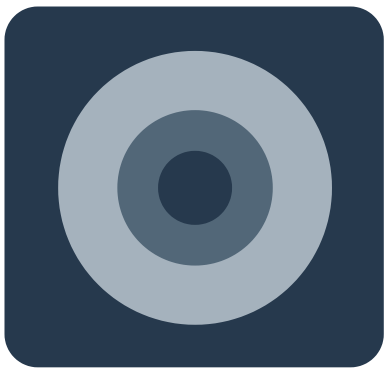
Point and explain: find the loose metal bridge in the drawing. Why does removing it come before another power test?

RULE 4

Start audio quietly

06

A speaker can become loud as soon as code starts or power returns. Begin with mute or the lowest practical volume, with the speaker away from ears.



Speaker: face away from ears



Keep distance. Stop if sound is uncomfortable.

A speaker and a volume control are shown as recognizable examples, not an amplifier wiring diagram.

Use a small first test

1. With power removed, check the amplifier and speaker connection instructions for the exact parts.
2. Set software playback and any volume control low before the first test.
3. Keep people away from the speaker. Use a short, quiet test signal.
4. Increase cautiously only as needed. Stop or mute immediately if the sound is uncomfortable.

Distance and duration matter

Reduce loudness, move away and keep exposure short. A quick loud burst can still be harmful.

Rewire only unplugged

Disconnect before changing speaker or amplifier connections. Do not assume a speaker terminal is ground.

Predict: you changed the audio program. What should be low before pressing Run?
Check: playback level and any volume control; place the speaker away from ears.

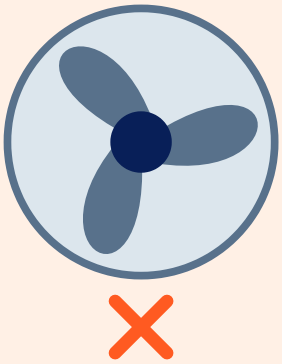
RULE 5

07

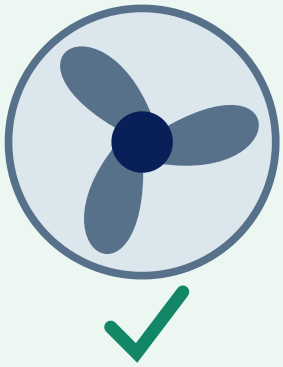
Make space around moving parts

Motors, fans, wheels and servo arms can move suddenly when power returns. A program saying “stop” is not a physical disconnection.

NO: reach while powered



Unplug → wait → adjust



Secure the mechanism; keep hands, hair and leads clear.

A fan is one example. Apply the same unplug-and-wait habit to gears, wheels and servo arms.

Before a motion test

- Secure the mechanism so it cannot roll or jump off the table.
- Keep hands, hair, loose clothing and cables outside its path.
- Use appropriate guards and the device’s movement limits.
- Know how to disconnect power without reaching through the moving area.

Before adjustment: disconnect every supply, wait for motion to stop, and only then approach the mechanism. A stopped shaft may restart if the system remains powered.

Do not hold or stall a motor as a test. Unexpected noise, a jam or repeated resets means stop and investigate before another attempt.

For this lesson, explain the sequence using the drawing. You do not need to power a motor.

UNPOWERED PRACTICE

08

Choose the safe next action

For each picture situation, decide whether to continue or stop. Name the action that must happen next.

USB unplugged; battery still attached

STOP · Unplug the battery too.

Plug fits; polarity is unknown

STOP · Leave it disconnected.

Audio starts loud beside an ear

STOP · Mute, move away, retest quietly.

All three situations need a change before the build can continue.

Check your own work area

- ☐ I can identify every possible power source and disconnect it.
- ☐ I can explain why matching voltage and polarity come before connection.
- ☐ I can spot loose metal and keep battery contacts separated.
- ☐ I would start an audio test quietly and away from ears.
- ☐ I would unplug and wait before adjusting moving parts.

Show your habit: with all parts disconnected, point to a power entrance, a setting to check and a place where a metal object must not lie. Explain your next safe action to another learner.

One unresolved item means wait. Leave power disconnected and get help. A tidy build or a successful software check does not prove that its power connections are correct.

Use ML-C02 when making a power plan. Return to this five-rule check whenever you change a circuit.