# Power Adapter, Step-Down

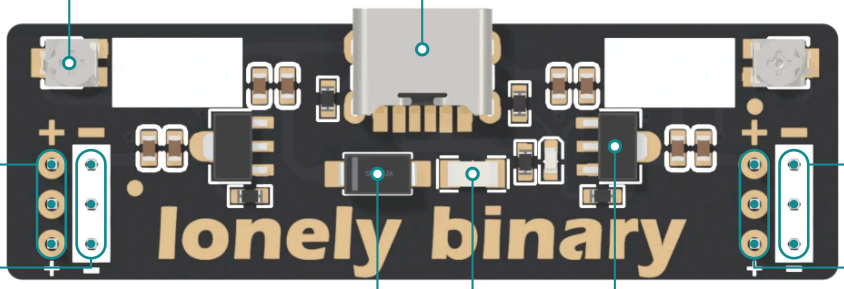
Two breadboard rails from one USB-C socket: 1.25 to about 3.5 V a side, by trimmer.

**Line each + up with a +**

Both ends print **+ –** reading left to right, so + is the outer column at the left end and the inner one at the right: the board fits a breadboard one way round. On a breadboard printed mirror-image, one side is backwards whichever way round it goes. Nothing on the adapter shorts, **but every part wired by the printing gets its supply reversed.**

## Twelve pins, four groups of three

Drawn from above with the USB-C socket at the top. Each end prints **+ –** left to right: + is the outer column at the left end and the inner column at the right. The three pins in a column are one net.




**Trimmer, one per side (2 kΩ)**
1.25 V at zero. Only the first fifth of its travel does anything.

**USB-C socket, power only**
5.1 kΩ on CC1 and CC2, so a USB-C charger switches 5 V on.

**Left +, 3 pins**
1.25 to 3.5 V, left trimmer

**Left –, 3 pins**
Ground: all six – are one

**Right –, 3 pins**
Ground: all six – are one

**Right +, 3 pins**
1.25 to 3.5 V, right trimmer

**SS24 Schottky diode**
Takes about 0.3 V at 100 mA. Stops a second supply feeding back.

**AMS1117-ADJ, one per side**
A linear regulator: it drops the rest of the input as heat.

**Fuse: 0.5 A resettable (PPTC)**
Trips by 1 A. One fuse for both sides together.

**Only the first fifth of the trimmer does anything**

The regulator makes at most its input less about 1.1 V: about 3.5 V from USB. The trimmer can ask for up to 13 V, so past the first fifth of its travel the output stops rising.

## A linear regulator makes heat

### 3.3 V at 150 mA

**0.20** W of heat in one regulator

4.66 V in, 1.36 V dropped, times 150 mA.

### 2.5 V at 200 mA

**0.43** W of heat in one regulator

4.64 V in, 2.14 V dropped, times 200 mA.

### 1.8 V at 300 mA

**0.84** W of heat in one regulator

4.60 V in, 2.80 V dropped, times 300 mA.

Heat is what the regulator drops times what it carries, so a lower voltage is the hotter job. The first card is warm. The last is more than a small SOT-89 on a board this size can shed: the regulator cuts back, and the rail sags, recovers and sags again.

Worked out, not measured: the input is a 5.00 V port less the SS24's typical forward voltage and the fuse at 0.15 Ω, at that current; the heat is (input – output) × current, in one regulator. The fitted parts are second sources, so treat every figure as about. A lower port voltage lowers the input and the heat with it.

## Watch the rail with an ESP32

Arduino IDE · Board: ESP32 Dev Module · No libraries

```
// Watch a breadboard power rail. Wiring: table on the right.
const int PIN = 34;              // ADC1, input only
const float TOP_OHMS = 10000;  // 100000 for a booster
const float BOTTOM_OHMS = 10000;
const float SCALE = (TOP_OHMS + BOTTOM_OHMS) / BOTTOM_OHMS;

float lo = 99, hi = 0, sum = 0;
int n = 0;
uint32_t last = 0;

void setup() {
  Serial.begin(115200);
  delay(500);
  Serial.println("rail watch: average, lowest, highest");
}

void loop() {
  float v = analogReadMilliVolts(PIN) / 1000.0 * SCALE;
  sum += v;
  n++;
  if (v < lo) lo = v;
  if (v > hi) hi = v;

  if (millis() - last >= 1000) {
    last = millis();
    Serial.printf("%.2f V   low %.2f   high %.2f\n",
                  sum / n, lo, hi);
    lo = 99; hi = 0; sum = 0; n = 0;
  }
  delay(1);
}
```

```
rail watch: average, lowest, highest
```

Then once a second at 115200: the average of about a thousand readings, the lowest and the highest, in volts. It reads the voltage you set.

## Wiring

| | FROM | TO |
|---|---|---|
| 1 | Rail + | 10 kΩ, first end |
| 2 | 10 kΩ, second end | the junction |
| 3 | The junction | 10 kΩ to rail – |
| 4 | The junction | GPIO 34 |
| 5 | ESP32 GND | Rail – |

Power the ESP32 from its own USB cable, and plug it in before the adapter. Share ground only: never wire the rail to the ESP32's 5V or 3V3 pin as well. GPIO 34 is on ADC1 and input only, so a slip in the sketch cannot drive the rail. Two 10 kΩ halve the rail. Turn the trimmer while it prints: where the number stops rising is the ceiling.

## Heat, and one shared fuse

A lower voltage from a linear regulator is always the hotter job. For hundreds of milliamps at a low voltage, use a switching step-down instead. Both regulators take their input through the same 0.5 A fuse, so 0.5 A is the total for both sides together. The back's MAX 1A@3V8 is the AMS1117-ADJ's own rating, not this board's: 1 A would trip the fuse, and 3.8 V needs light load and a charger at the top of the USB range.

## When it does not work

### I plugged it in the wrong way round

The adapter is almost certainly fine: nothing shorts, and + and – swap names. Parts wired to those rails may not be. Turn it round and check each part.

### I turn the trimmer and nothing changes

Probably past the ceiling: turn the other way until the meter moves. No change at either end: check the red LED near the middle is lit.

### The back says 3.8 V. I only get 3.5

The AMS1117-ADJ needs about 1.1 V of its input for itself. With a normal charger and a real load, 3.4 to 3.7 V is the real top.

### One side works and the other does not

Everything before the regulators is shared, so the input is fine. Measure that side while turning its trimmer: no change points at its regulator or trimmer.

### The rail sags, recovers, and sags again

The regulator is overheating and cutting back. Work out (input – output) × current; lower the current, or raise the voltage if the part allows.

### The rail died and came back a minute later

The fuse tripped and reset: something drew more than it holds. If it keeps happening, measure what the circuit draws, or look for the short.

## Specifications

| | | | |
|---|---|---|---|
| **Input** | USB-C, power only; 5.1 kΩ on CC1, CC2 | **Current** | 0.5 A in total, both sides; trips by 1 A |
| **Diode** | SS24 Schottky, about 0.3 V at 100 mA | **Outputs** | 1.25 V to about 3.5 V per side, by trimmer |
| **Regulators** | 2 × AMS1117-ADJ, linear, SOT-89 | **Trimmer** | 2 kΩ per side, 220 Ω from OUT to ADJ |
| **Pins** | 2 × (3 +, 3 –), 2.54 mm pitch, one way round | **Board** | 53.34 × 16.36 mm, pins 7.9 mm below |