

What this unit does

A handheld tester that measures fencing gear in **real ohms** and says pass or fail against the FIE limits. It does everything the Build A lamp tester does (continuity, shorts) and adds the part that matters to a scoring box: **how much resistance** each wire, weapon and lame actually has. It also catches the faults the lamps cannot see: an A to C short, wires crossed in a plug, leaky (damp or dirty) insulation, and brief breaks while you flex a cord.

No modes, no numbers to read. Plug in a cord, a weapon on a cord, or touch the probe to a lame: it works out which it is. The answer is a **red / yellow / green light** and a **sound** (a chirp for pass, a buzz for fail, a tick for every tip press, a click for every break while you flex), so your hands can stay on the gear. The screen adds a big word (PASS, FAIL, PRESS TIP, BREAKS 3) and bars that show how close each reading is to its limit.

	Build A lamp tester	This tester (Build C)	Commercial
Body cord continuity	yes	yes, each wire in ohms	yes
Shorts A-B, B-C	yes (separate plug-in)	yes, with both ends plugged	yes
Short A-C, crossed wires, leaky	no	yes	some
Weapon resistance (2 ohm / 1 ohm)	no	yes, cord subtracted	yes
Lame / mask (5 ohm)	no	yes, with weighted probe	yes
Flex test (counts breaks)	watch the lamp	clicks for every break of 0.2 ms+	some
Reading it	two lamps	traffic light + sounds, picks the test itself	screen, menus
Cost	about \$35	about \$33 budget, \$64 all-Mouser	\$150 to \$300+

The limits it checks (FIE Material Rules, August 2026)

What	Limit	Rule
Body cord, each wire, plug to plug or plug to clip	1 ohm max	m.29.1c, m.31.1b
Foil and epee weapon circuit	2 ohm max	m.5.4a
Sabre weapon	1 ohm max	m.5.4a
Lame, any two points (500 g probe with a 4 mm radius end)	5 ohm max	m.28.5a
Sabre mask, clip to any point	under 5 ohm	m.32.5
Mask wire, clip to clip	1 ohm max	m.27.1, m.32

Insulation (wires that must not touch): under 1 k = **SHORT**, 1 k to 100 k = **LEAKY** (damp, dirt, worn insulation), over 100 k = ok.

How accurate

About 0.001 ohm at 1 ohm, with 0.0001 ohm resolution (4-wire sensing against a precision 10 ohm reference, read by a 16-bit converter). The limits are 1, 2 and 5 ohm, so this is far more than enough. The plug-to-jack contact resistance is part of the reading, exactly as it is for a scoring box.

Cheap "ADS1115" modules: some are really the 12-bit ADS1015. The tester detects this at power-on and tells you. It still works, in 0.03 ohm steps, which is still fine for 1 ohm limits.

Bill of materials (one unit)

Qty	Part	Where	Each	Budget each
1	Raspberry Pi Pico (or Pico 2) SC0915 (\$4.00) or Pico 2 SC1631 (\$5.00), no headers needed	Mouser	\$4.00	\$4.00
4	8-channel analog mux, DIP-16 CD74HC4051E (TI)	Mouser	\$1.04	\$1.04
1	ADS1115 16-bit ADC module Blue breakout, I2C, 10 pins (VDD GND SCL SDA ADDR ALRT A0-A3)	Amazon multipack	\$3.00	\$3.00
1	0.96 in OLED, SSD1306, I2C 128 x 64, 4 pins (GND VCC SCL SDA)	Amazon multipack	\$3.00	\$3.00
1	10 ohm 0.1 % resistor (R_REF) Vishay RN55C10R0BRE6. A 1 % 10 ohm also works: readings 1 % of value	Mouser	\$1.68	\$0.10
1	330 ohm 1 % resistor (R_LIM) YAGEO MFR-25F52-330R	Mouser	\$0.11	\$0.11
1	10 k resistor (pull-up) any 1/4 W	Mouser / kit	\$0.10	\$0.10
4	100 nF ceramic capacitor K104K15X7RF53L2, one per mux chip	Mouser	\$0.25	\$0.05
1	1N5817 Schottky diode Diotec 1N5817	Mouser	\$0.30	\$0.30
1	Slide switch (power) Same Sky SLW-874744-6A-RA-N-D	Mouser	\$0.51	\$0.27
1	6 mm tactile push button any through-hole 6 x 6 mm	Mouser / kit	\$0.15	\$0.05
1	5 mm red LED, diffused Kingbright WP7113ID	Mouser	\$0.21	\$0.05
1	5 mm yellow LED, diffused Kingbright WP7113YD	Mouser	\$0.23	\$0.05
1	5 mm green LED, diffused Kingbright WP7113SGD (568 nm; a blue-green 3 V LED would be dim)	Mouser	\$0.25	\$0.05
3	150 ohm resistor (LEDs) any 1/4 W	Mouser / kit	\$0.10	\$0.02
1	Passive piezo buzzer, 12 mm Same Sky CPT-1206-3TH-T (passive: the Pico plays the tones)	Mouser	\$0.54	\$0.40
8	4 mm panel banana jack 108-0740-001 (as Build A), or generic 4 mm panel sockets	Mouser / Amazon	\$3.10	\$0.50
1	TP4056 charge module, protected USB-C, DW01A + FS8205 fitted (same as Build A)	Amazon multipack	\$0.80	\$0.80
1	18650 holder, wire leads Keystone 1042 or generic	Mouser / Amazon	\$5.63	\$0.60
1	18650 cell, protected, 2000+ mAh reputable brand	Amazon	\$6.00	\$6.00
1	Perfboard ~5 x 7 cm 0.1 in pitch; 4 x DIP-16 sockets optional	Amazon multipack	\$0.60	\$0.60
1	Probe: banana plug + hardware CT2002A plug (\$2), M8 bolt, M8 acorn nut, steel washers, ring terminal	Mouser + hardware store	\$5.00	\$4.00

1	Wire, heat-set inserts, screws 26 AWG silicone in 4+ colours; M2 inserts (kits cover many units)	Amazon kits	\$1.50	\$1.50
Total per unit			\$63.87	\$33.40

Mouser prices checked live on 2026-10-08 (single quantity). "Budget" uses generic jacks, holder and 1 % reference from Amazon multipacks; the jacks are most of the difference. Amazon listings change often, so search the part description rather than a link.

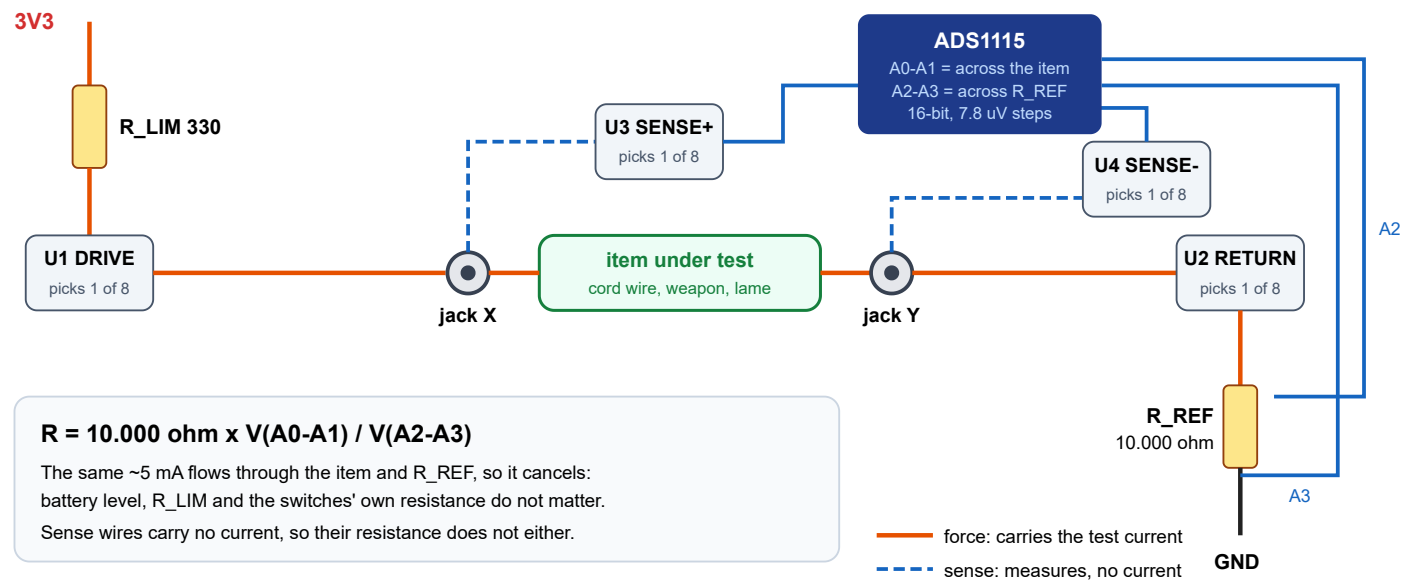
Already built the Build A lamp tester? Its jacks (six of the eight), charge module, cell and holder move straight over. New parts then come to about **\$23**.

Build order

Step	Doc	Do this
1	Doc 34	Flash the Pico first (drag one file onto it), with nothing else connected
2	Case	Print the jack spacing coupon from Build A and confirm a real cord plugs in. Read <code>case/CASE_NOTES.md</code> (what to measure, where tall parts may not sit on the perfboard), then print the case
3	Doc 32	Wire it, step by step, ticking each numbered wire
4	Doc 34	Bring-up checks: lights and beep at power-on, ADC found, READY with nothing in, known resistors read right
5	Doc 33	Test known good gear, then your real gear

Doc 31 explains the circuit. You do not need it to build, but read the first page: it is why two wires go to every jack.

How one measurement works



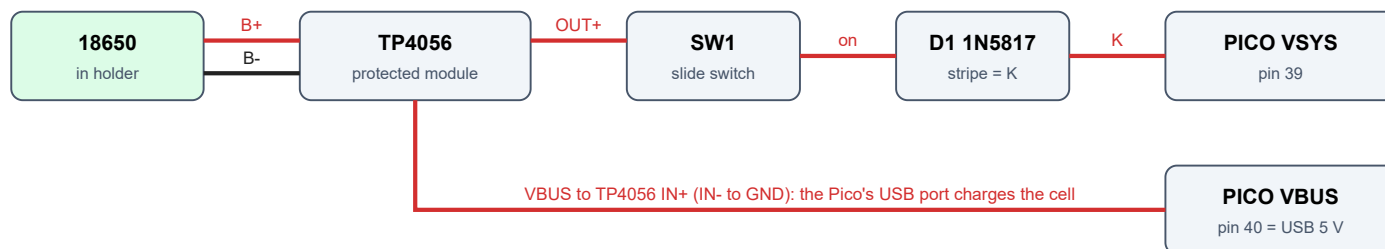
The Pico picks two terminals, X and Y, by setting two 3-bit addresses. Four 8-channel switch chips do the rest:

Chip	Job	Address	Enable
U1	DRIVE: connects the 330 ohm feed to terminal X	X bus (GP10-12)	GP16, low = current on
U2	RETURN: connects terminal Y to R_REF and ground	Y bus (GP13-15)	always on
U3	SENSE+: connects terminal X to ADC input A0	X bus	always on
U4	SENSE-: connects terminal Y to ADC input A1	Y bus	always on

For each reading the firmware takes four conversions: across the item and across R_REF with the current on, then both again with it off, which removes the converter's own offset. Above about 40 ohm it switches to a wider range; with no measurable current (over about 1 Mohm) it reports OPEN.

Why two wires per jack. The FORCE wire carries the 5 mA; the SENSE wire carries none, so its resistance and the switch chips' resistance (about 100 ohm each!) never reach the reading. Joining them at the jack lug is what makes 0.001 ohm accuracy possible from parts this cheap.

Power



The diode stops USB power flowing back into the cell through VSYS. With USB plugged in the tester runs and charges even with SW1 off.
Take power only from the TP4056 OUT pads so its over-discharge and short protection stays in circuit.

Terminal channels (same on all four chips)

Channel	Chip pin	Terminal
ch0	13	J1-A
ch1	14	J1-B
ch2	15	J1-C
ch3	12	J2-A
ch4	1	J2-B
ch5	5	J2-C
ch6	2	CLIP
ch7	4	PROBE

CD74HC4051 pins: 16 VCC (3V3), 8 GND, 7 VEE (to GND), 6 /E (enable, low = on), 11 S0, 10 S1, 9 S2, 3 COM. A 100 nF capacitor sits straight across pins 16 and 8 of each chip.

Pico connections

Pin	Name	Net	What it does
3	GND	REF_BOT	Ground star at R_REF
6	GP4	SDA	I2C data to ADC and screen
7	GP5	SCL	I2C clock to ADC and screen
14	GP10	XS0	X address bit 0 (U1, U3)
15	GP11	XS1	X address bit 1
16	GP12	XS2	X address bit 2
17	GP13	YS0	Y address bit 0 (U2, U4)
19	GP14	YS1	Y address bit 1
20	GP15	YS2	Y address bit 2
21	GP16	DRV_EN	Test current on/off (U1 /E)
22	GP17	LED_R	Red light (FAIL)
24	GP18	LED_Y	Yellow light (CHECK)
25	GP19	LED_G	Green light (PASS)
26	GP20	BTN	Mode button
27	GP21	BUZ	Piezo tones
31	GP26	REF_TOP_P	Break detector (FLEX)
33	AGND	AGND	Analog ground to the star
36	3V3	3V3	3.3 V for all the logic
38	GND	GND	Ground
39	VSYS	VSYS	Battery in, via D1
40	VBUS	VBUS	USB 5 V out to the charger

ADS1115 module: VDD to 3V3, GND and ADDR to ground (address 0x48), SCL/SDA shared with the OLED (address 0x3C), A0 SENSE+ (U3 COM), A1 SENSE- (U4 COM), A2 and A3 on the two legs of R_REF. ALRT is not used.

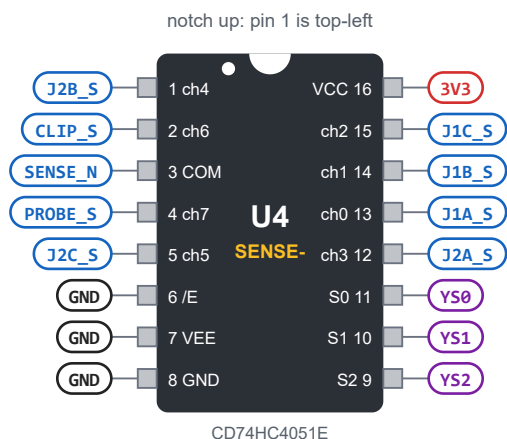
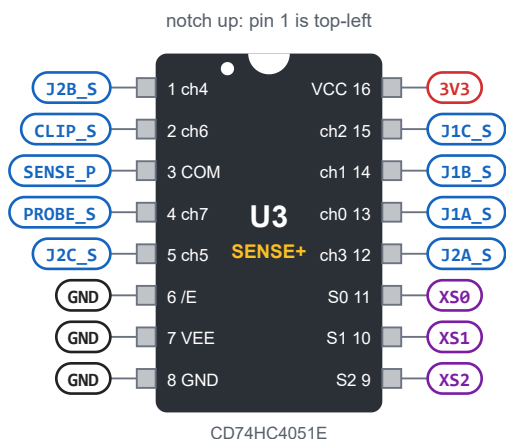
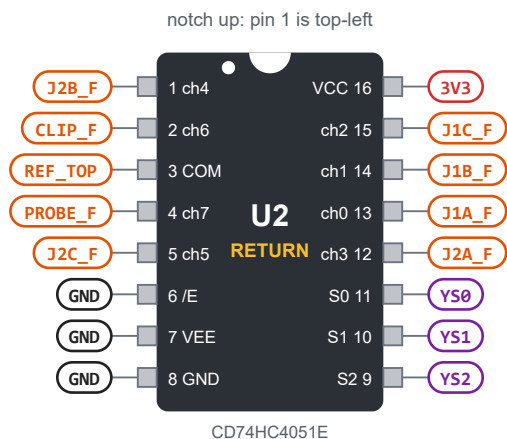
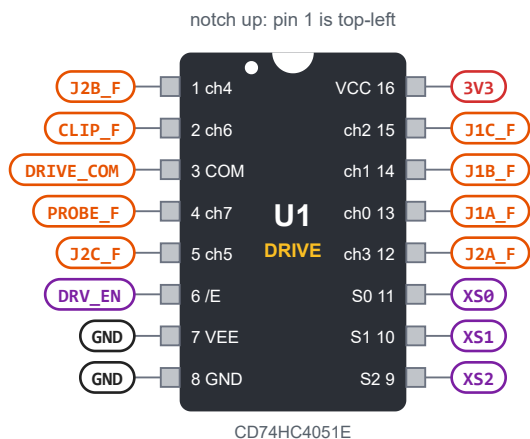
Lights, sound, button

Each LED runs from its own Pico pin through a 150 ohm resistor (about 8 mA, the pins are set to 12 mA drive); the three cathodes share one ground wire. The piezo is passive: the Pico plays tones on GP21, so pass, fail, tick and break each sound different. The one button is tap = start over, hold = sound on / off. There are no modes: the firmware scans the terminals about eight times a second and decides what is plugged in (Doc 33).

Build A's lamps worked without any code. This one needs firmware, but you never have to compile it: Doc 34 has a ready-made file you drag onto the Pico.

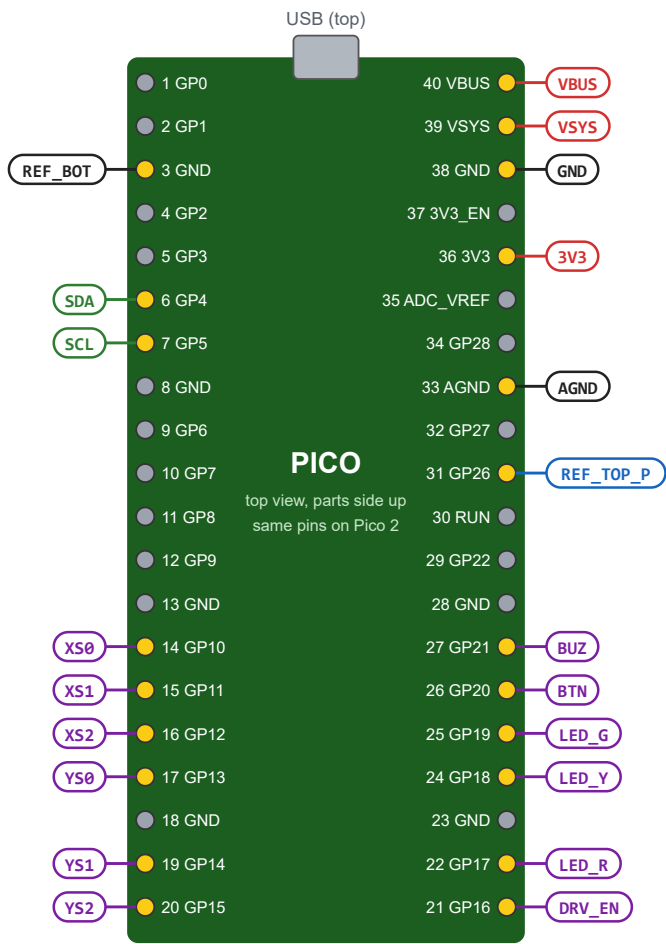
Every pin is labelled with its **net**. Pins with the same net label get joined. The numbered checklist from sheet 4 on lists every wire in solder order; tick each one. Wire colours: — power — ground — control — force (current) — sense (no current) — I2C data.

The four switch chips (top view)



Tip: put U1 next to U2 and U3 next to U4. Each terminal's FORCE wire lands on U1, then a short hop joins the same pin of U2. Each SENSE wire lands on U3, then a hop to U4. Same pin numbers, so the hops are short. Use DIP sockets if you have them.

Pico (top view)



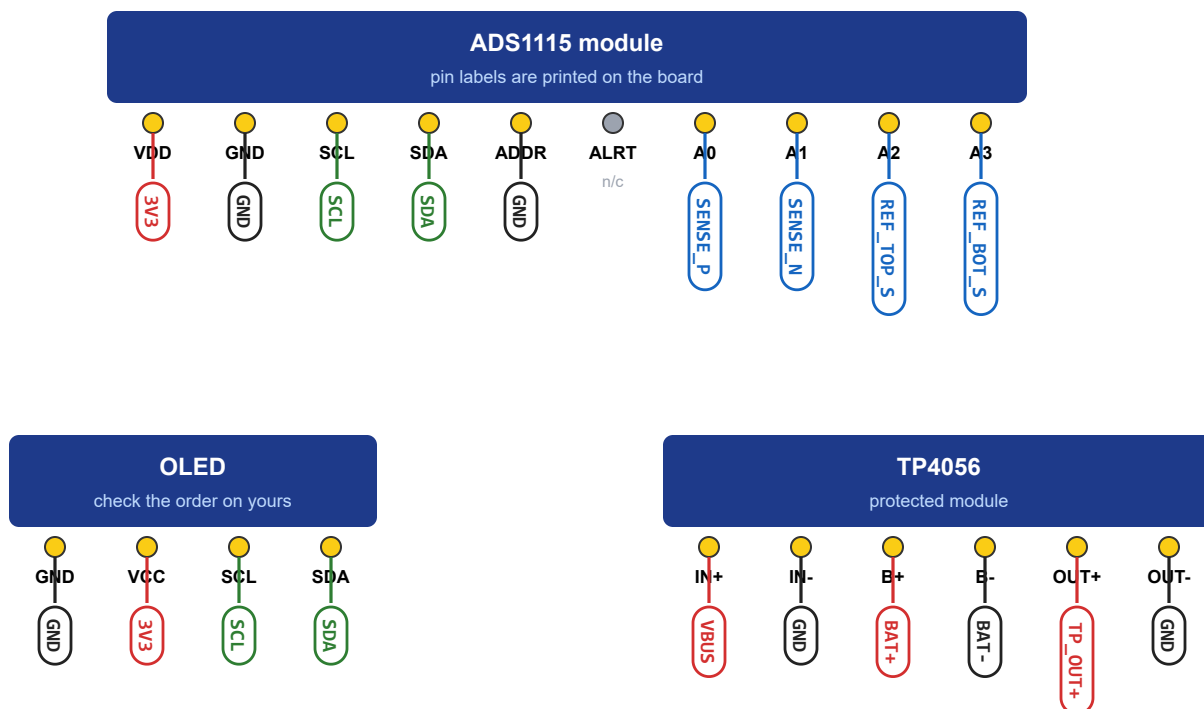
Yellow pins are used, grey are not.

Solder wires straight to the pads; no header pins needed.

GND appears on several pins: use pin 38 for the main ground, pin 3 for the R_REF ground star, pin 33 (AGND) to the same star.

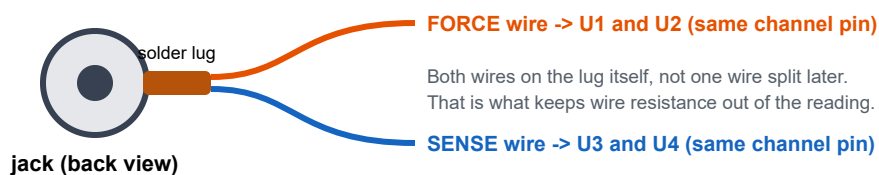
The Pico 2 has exactly the same pinout. Flash the matching file (Doc 34).

Modules

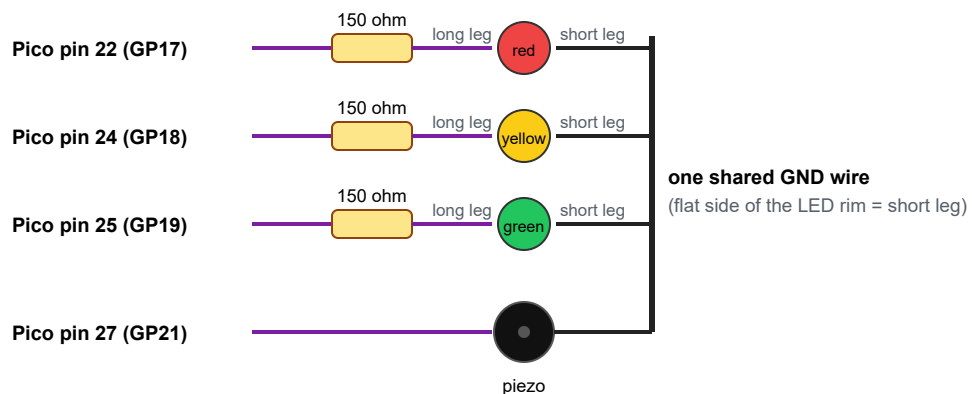


OLED modules come with VCC and GND in either order. Read the labels on yours; do not go by position.

Two wires per jack



Lights and piezo (on the lid)



They sit in the lid, so give these wires (and the screen's and J2's) about 10 cm of slack. The case notes say how far to trim the LED legs.

Wiring checklist

Step 1: Power: cell, charger, switch, diode

#	Net	From	To	Note
☐ 1	 BAT+	cell +	TP4056 B+	Cell holder red lead
☐ 2	 BAT-	cell -	TP4056 B-	Cell holder black lead
☐ 3	 TP_OUT+	TP4056 OUT+	switch middle lug	Slide switch middle lug
☐ 4	 SW_ON	switch outer lug	diode A (plain end)	Either outer lug of the switch
☐ 5	 VSYS	diode K (stripe)	Pico pin 39 (VSYS)	Diode stripe (K) towards the Pico
☐ 6	 VBUS	Pico pin 40 (VBUS)	TP4056 IN+	One USB port charges the cell

Step 2: 3V3 and ground to the chips and modules

#	Net	From	To	Note
☐ 7	 3V3	Pico pin 36 (3V3)	U1 pin 16 (VCC)	
☐ 8	 3V3	U1 pin 16 (VCC)	U2 pin 16 (VCC)	
☐ 9	 3V3	U2 pin 16 (VCC)	U3 pin 16 (VCC)	
☐ 10	 3V3	U3 pin 16 (VCC)	U4 pin 16 (VCC)	
☐ 11	 3V3	U4 pin 16 (VCC)	R_LIM 330 leg 1 (3V3 side)	
☐ 12	 3V3	R_LIM 330 leg 1 (3V3 side)	10 k leg 1 (3V3 side)	
☐ 13	 3V3	10 k leg 1 (3V3 side)	ADS1115 VDD	
☐ 14	 3V3	ADS1115 VDD	OLED VCC	
☐ 15	 GND	Pico pin 38 (GND)	U1 pin 8 (GND)	U2/U3/U4 pin 6 (/E) to ground keeps them always on; ADS ADDR to ground sets address 0x48
☐ 16	 GND	U1 pin 8 (GND)	U1 pin 7 (VEE)	
☐ 17	 GND	U1 pin 7 (VEE)	U2 pin 8 (GND)	
☐ 18	 GND	U2 pin 8 (GND)	U2 pin 7 (VEE)	
☐ 19	 GND	U2 pin 7 (VEE)	U2 pin 6 (/E)	
☐ 20	 GND	U2 pin 6 (/E)	U3 pin 8 (GND)	
☐ 21	 GND	U3 pin 8 (GND)	U3 pin 7 (VEE)	
☐ 22	 GND	U3 pin 7 (VEE)	U3 pin 6 (/E)	
☐ 23	 GND	U3 pin 6 (/E)	U4 pin 8 (GND)	
☐ 24	 GND	U4 pin 8 (GND)	U4 pin 7 (VEE)	
☐ 25	 GND	U4 pin 7 (VEE)	U4 pin 6 (/E)	
☐ 26	 GND	U4 pin 6 (/E)	ADS1115 GND	
☐ 27	 GND	ADS1115 GND	ADS1115 ADDR	
☐ 28	 GND	ADS1115 ADDR	OLED GND	
☐ 29	 GND	OLED GND	button leg 2 (ground)	
☐ 30	 GND	button leg 2 (ground)	red LED short leg	
☐ 31	 GND	red LED short leg	yellow LED short leg	

☐	32	 GND	yellow LED short leg	green LED short leg
☐	33	 GND	green LED short leg	piezo lead 2
☐	34	 GND	piezo lead 2	TP4056 OUT-
☐	35	 GND	TP4056 OUT-	TP4056 IN-

Step 3: Address buses and drive enable

#	Net	From	To	Note
☐	36	 XS0	Pico pin 14 (GP10)	U1 pin 11 (S0)
☐	37	 XS0	U1 pin 11 (S0)	U3 pin 11 (S0)
☐	38	 XS1	Pico pin 15 (GP11)	U1 pin 10 (S1)
☐	39	 XS1	U1 pin 10 (S1)	U3 pin 10 (S1)
☐	40	 XS2	Pico pin 16 (GP12)	U1 pin 9 (S2)
☐	41	 XS2	U1 pin 9 (S2)	U3 pin 9 (S2)
☐	42	 YS0	Pico pin 17 (GP13)	U2 pin 11 (S0)
☐	43	 YS0	U2 pin 11 (S0)	U4 pin 11 (S0)
☐	44	 YS1	Pico pin 19 (GP14)	U2 pin 10 (S1)
☐	45	 YS1	U2 pin 10 (S1)	U4 pin 10 (S1)
☐	46	 YS2	Pico pin 20 (GP15)	U2 pin 9 (S2)
☐	47	 YS2	U2 pin 9 (S2)	U4 pin 9 (S2)
☐	48	 DRV_EN	Pico pin 21 (GP16)	U1 pin 6 (/E)
				Pull-up keeps the test current off while the Pico boots
☐	49	 DRV_EN	U1 pin 6 (/E)	10 k leg 2

Wiring checklist (continued)

Step 4: Measuring core: R_LIM, R_REF, ADC inputs

#	Net	From	To	Note
☐ 50	 DRIVE_COM	R_LIM 330 leg 2	U1 pin 3 (COM)	
☐ 51	 REF_TOP	U2 pin 3 (COM)	R_REF 10 top leg	Current wire into the top of R_REF
☐ 52	 REF_TOP_S	R_REF 10 top leg	ADS1115 A2	Own wire, soldered at the R_REF leg (Kelvin)
☐ 53	 REF_TOP_P	R_REF 10 top leg	Pico pin 31 (GP26)	Pico GP26 watches for breaks in FLEX mode
☐ 54	 REF_BOT	R_REF 10 bottom leg	Pico pin 3 (GND)	R_REF bottom to a Pico GND pin: the ground star
☐ 55	 REF_BOT_S	R_REF 10 bottom leg	ADS1115 A3	Own wire, soldered at the R_REF leg (Kelvin)
☐ 56	 AGND	R_REF 10 bottom leg	Pico pin 33 (AGND)	Pico analog ground to the star
☐ 57	 SENSE_P	U3 pin 3 (COM)	ADS1115 A0	
☐ 58	 SENSE_N	U4 pin 3 (COM)	ADS1115 A1	

Step 5: Display, ADC data lines, button, lights, piezo

#	Net	From	To	Note
☐ 59	 SDA	Pico pin 6 (GP4)	ADS1115 SDA	
☐ 60	 SDA	ADS1115 SDA	OLED SDA	
☐ 61	 SCL	Pico pin 7 (GP5)	ADS1115 SCL	
☐ 62	 SCL	ADS1115 SCL	OLED SCL	
☐ 63	 BTN	Pico pin 26 (GP20)	button leg 1	
☐ 64	 LED_R	Pico pin 22 (GP17)	150 (red) leg 1	GP17 to the red LED's resistor
☐ 65	 LED_R_A	150 (red) leg 2	red LED long leg	Resistor to the long leg (anode)
☐ 66	 LED_Y	Pico pin 24 (GP18)	150 (yellow) leg 1	GP18 to the yellow LED's resistor
☐ 67	 LED_Y_A	150 (yellow) leg 2	yellow LED long leg	Resistor to the long leg (anode)
☐ 68	 LED_G	Pico pin 25 (GP19)	150 (green) leg 1	GP19 to the green LED's resistor
☐ 69	 LED_G_A	150 (green) leg 2	green LED long leg	Resistor to the long leg (anode)
☐ 70	 BUZ	Pico pin 27 (GP21)	piezo lead 1	GP21 to the piezo (either lead if unmarked)

The four 100 nF capacitors are not wires: solder each one straight across pins 16 and 8 of its chip, on the underside of the board.

Wiring checklist (jacks)

Step 6: Jacks: two wires each (force + sense)

#	Net	From	To	Note
☐ 71	 J1A_F	J1-A jack lug	U1 pin 13 (ch0)	J1-A force (ch0)
☐ 72	 J1A_F	U1 pin 13 (ch0)	U2 pin 13 (ch0)	
☐ 73	 J1A_S	J1-A jack lug	U3 pin 13 (ch0)	J1-A sense (ch0)
☐ 74	 J1A_S	U3 pin 13 (ch0)	U4 pin 13 (ch0)	
☐ 75	 J1B_F	J1-B jack lug	U1 pin 14 (ch1)	J1-B force (ch1)
☐ 76	 J1B_F	U1 pin 14 (ch1)	U2 pin 14 (ch1)	
☐ 77	 J1B_S	J1-B jack lug	U3 pin 14 (ch1)	J1-B sense (ch1)
☐ 78	 J1B_S	U3 pin 14 (ch1)	U4 pin 14 (ch1)	
☐ 79	 J1C_F	J1-C jack lug	U1 pin 15 (ch2)	J1-C force (ch2)
☐ 80	 J1C_F	U1 pin 15 (ch2)	U2 pin 15 (ch2)	
☐ 81	 J1C_S	J1-C jack lug	U3 pin 15 (ch2)	J1-C sense (ch2)
☐ 82	 J1C_S	U3 pin 15 (ch2)	U4 pin 15 (ch2)	
☐ 83	 J2A_F	J2-A jack lug	U1 pin 12 (ch3)	J2-A force (ch3)
☐ 84	 J2A_F	U1 pin 12 (ch3)	U2 pin 12 (ch3)	
☐ 85	 J2A_S	J2-A jack lug	U3 pin 12 (ch3)	J2-A sense (ch3)
☐ 86	 J2A_S	U3 pin 12 (ch3)	U4 pin 12 (ch3)	
☐ 87	 J2B_F	J2-B jack lug	U1 pin 1 (ch4)	J2-B force (ch4)
☐ 88	 J2B_F	U1 pin 1 (ch4)	U2 pin 1 (ch4)	
☐ 89	 J2B_S	J2-B jack lug	U3 pin 1 (ch4)	J2-B sense (ch4)
☐ 90	 J2B_S	U3 pin 1 (ch4)	U4 pin 1 (ch4)	
☐ 91	 J2C_F	J2-C jack lug	U1 pin 5 (ch5)	J2-C force (ch5)
☐ 92	 J2C_F	U1 pin 5 (ch5)	U2 pin 5 (ch5)	
☐ 93	 J2C_S	J2-C jack lug	U3 pin 5 (ch5)	J2-C sense (ch5)
☐ 94	 J2C_S	U3 pin 5 (ch5)	U4 pin 5 (ch5)	
☐ 95	 CLIP_F	CLIP jack lug	U1 pin 2 (ch6)	CLIP force (ch6)
☐ 96	 CLIP_F	U1 pin 2 (ch6)	U2 pin 2 (ch6)	
☐ 97	 CLIP_S	CLIP jack lug	U3 pin 2 (ch6)	CLIP sense (ch6)
☐ 98	 CLIP_S	U3 pin 2 (ch6)	U4 pin 2 (ch6)	
☐ 99	 PROBE_F	PROBE jack lug	U1 pin 4 (ch7)	PROBE force (ch7)
☐ 100	 PROBE_F	U1 pin 4 (ch7)	U2 pin 4 (ch7)	
☐ 101	 PROBE_S	PROBE jack lug	U3 pin 4 (ch7)	PROBE sense (ch7)
☐ 102	 PROBE_S	U3 pin 4 (ch7)	U4 pin 4 (ch7)	

Before closing the case, meter every jack lug to its four chip pins with the cell out.

Just plug it in

There are no modes. The tester looks at what is connected about eight times a second and runs the right test:

You plug in	It tests
A body cord: one end in J1 (top), the other in J2 (front). A 2-prong foil / sabre plug goes in J2's B and C, its alligator clip on the CLIP post.	Body cord: every wire, every short, crossed wires, and breaks while you flex it
A good cord in J1 with a weapon on its far end	Foil / sabre straight away (B to C closed). Epee as soon as you press the tip
The probe (PROBE jack) touching a lame or mask that is clipped to the cord in J1 or to the CLIP post	Lame / mask , and mask wires

Test the cord first. It remembers the last good cord and subtracts it, so weapon and lame readings are the item alone ("cord subtracted" on screen).

The light

	Means
 green	Passes
 yellow, steady	Borderline: leaky insulation (dry and clean it), or a probe reading between 1 and 5 ohm (fine for a lame or mask, too high for a mask wire)
 yellow, blinking	Do the next step: press the foil tip, or let go of the epee tip
 red	Fails. The screen's big word says why
 off	Nothing connected yet (an epee at rest counts as nothing until you press its tip)

The light keeps the last answer for 30 seconds after you unplug, so you can unplug first and look after.

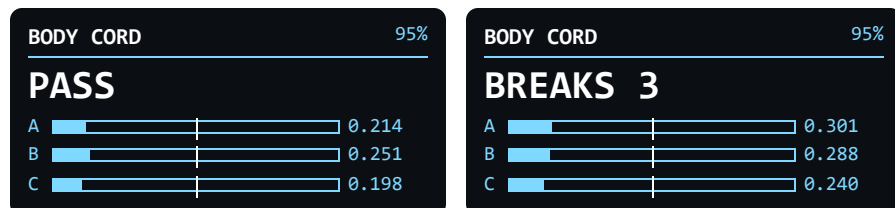
The sounds

Sound	Means
Rising double chirp	Just turned green
Low double buzz	Just turned red (on the probe: a new worst spot over 5 ohm)
Short tick	A tip press registered, like a scoring box would see it
Click	A break while you flex a cord: every click is a fault

The button: tap = start over. Hold for a second = sound off (the header shows "mute") or back on.

Body cord

Plug both ends in. Wait for the chirp and green. Then bend and twist the cord along its whole length, hardest where it enters each plug: **any click is a break** and turns the light red. A wire that ever read high stays counted until you tap the button.



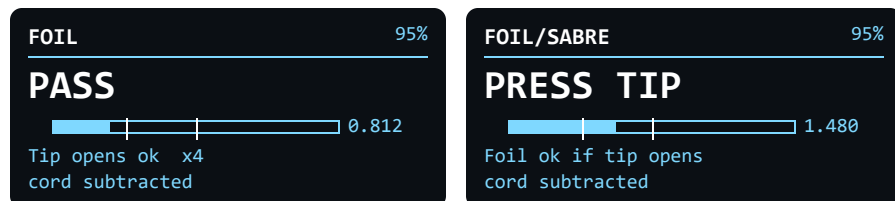
Big word	Meaning	Usual cause
PASS	every wire 1 ohm or less, no shorts, no breaks	
FAIL (a bar past the line)	a wire is over 1 ohm	corroded pins, broken strands, a loose screw in the plug
FAIL (OPEN)	a wire does not conduct	broken wire, usually right at a plug
FAIL (to J2-x)	a wire reaches the wrong pin	plug wired wrong after a repair
SHORT A-B / B-C / A-C	two wires touch, under 1 k	crushed cord, stray strand in a plug
LEAKY ... (yellow)	1 k to 100 k between wires	sweat or damp inside a plug, dirt between pins
BREAKS n	n breaks while flexing	a wire about to fail; replace or re-terminate

Foil and sabre

A tested cord in J1, the weapon on its far end. At rest a foil and a sabre look the same (B to C closed), so the tester judges against both limits until you press the tip:

Light	Means
● green, "Sabre ok. Foil: press tip"	1 ohm or less: passes as a sabre. A foil: press the tip, you hear a tick and it says "Tip opens ok"
● blinking, PRESS TIP	1 to 2 ohm: too high for a sabre, fine for a foil if the tip opens. Press it: green when it does
● FAIL	over 2 ohm, or (sabre) the probe found over 1 ohm on the blade
● DIRTY TIP	the press gives tens of ohms instead of open: grit in the barrel

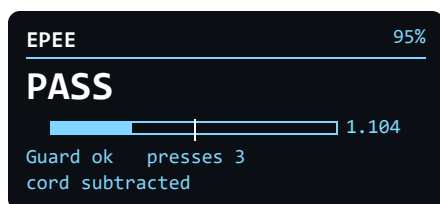
No tick when you press a foil tip = it never opens: the blade wire is shorted to the blade. Sabre: also touch the probe to the tip, the forte and the bell; tape or paint shows up as red.



Epee

A tested cord in J1, the epee on its far end. At rest it reads as nothing (an epee is open at rest). Press the tip: tick, and green if it is 2 ohm or less. Every press ticks. The tip wires are checked against the guard all the time.

Light	Means
● PASS	opens at rest, 2 ohm or less pressed, guard insulated
● blinking, LET GO	it was closed when first seen: let go; if it stays, the tip is stuck or the spring too short
● FAIL	over 2 ohm pressed: dirty contacts, loose tip screws, a wire breaking at the guard
● SHORT	a tip wire touches the blade or guard



Changing weapons? Unplug one, wait a couple of seconds, plug in the next: a pause starts a fresh test.

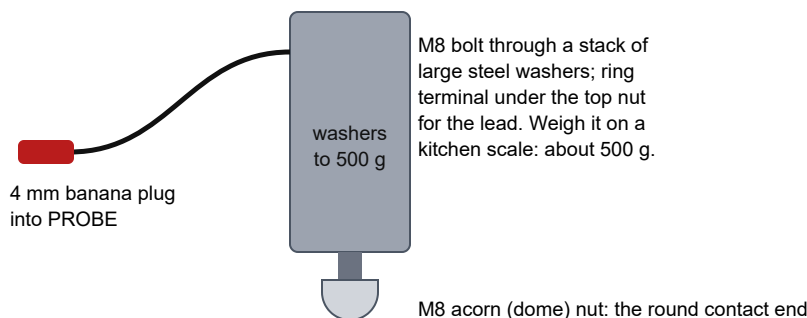
Lame, mask and mask wires

Clip the lame (or mask) to the cord in J1, or straight onto the CLIP post. Slide the probe slowly over the whole target. The light follows the probe: ● under 1 ohm, ● 1 to 5 ohm (fine for a lame or mask), ● over 5 ohm, with a buzz each time it finds a new worst spot. The screen keeps the worst steady reading, marked under the bar; landing bounces are ignored. Lifting the probe between strokes is fine for up to 10 seconds. Tap to start a new sweep.

Mask wire: clip one end to CLIP, touch the probe to the other clip. It must be ● green (1 ohm or less).



FIE checks lames with a **500 g weight with a rounded 4 mm radius end**. Contact pressure changes the reading, so a pen probe pressed by hand gives numbers you cannot compare with the armory's. Build the weighted probe:



What it does not test: tip spring weights (foil 500 g, epee 750 g), epee tip travel (0.5 mm and 1.5 mm shims) and blade flex. Those are mechanical; an armorer still checks them.

Put the firmware on the Pico (no programming needed)

1. Pick the file that matches your board, from `fencingohmtester/firmware/` :

Board	File
Raspberry Pi Pico (RP2040)	<code>ohm_tester_PICO.uf2</code>
Raspberry Pi Pico 2 (RP2350)	<code>ohm_tester_PIC02.uf2</code>

2. Hold down the white **BOOTSEL** button on the Pico and plug it into your computer with a USB cable. Let go. A drive called **RPI-RP2** (or **RP2350**) appears.
3. Drag the .uf2 file onto that drive. It copies, the drive disappears, and the Pico restarts running the tester.

Do this before wiring anything, and again any time a new version comes out: same three steps, wiring stays.

Wrong file for the board? Nothing breaks: it just does not start. Hold BOOTSEL and drag the other one.

Bring-up checks, in order

Check	Expect	If not
☐ 1. Cell in, switch on	Red, yellow, green flash in turn, one beep, then OHM TESTER	A light stays dark: LED backwards (long leg to the resistor). No beep: piezo wires. Blank screen: OLED VCC/GND or SDA/SCL swapped
☐ 2. Start screen ADC line	"ADC: ADS1115 16-bit" (or "12-bit (ADS1015)", also fine)	"ADC NOT FOUND" and the red light: ADS SDA/SCL, VDD, or ADDR not grounded
☐ 3. Nothing plugged in	READY, all lights off	Something shows: a jack touches its neighbour or a chip pin is bridged
☐ 4. Banana lead from CLIP to PROBE	LAME / MASK, green, 0.0 to 0.05 ohm	Nothing happens: check U1/U2 power, R_LIM, R_REF, the DRV_EN pull-up
☐ 5. A 1 ohm 1 % resistor between CLIP and PROBE (clip leads)	1.00 ohm, +/- 0.02 (the light may sit on the green / yellow line)	Way off: a SENSE wire on the wrong chip, or A2/A3 not on the R_REF legs
☐ 6. Same with a 10 ohm 1 % resistor	10.0 ohm +/- 0.1, red light + buzz	Reads 1 % off on both: R_REF is a 1 % part, which is fine
☐ 7. A cord you know is good, both ends	BODY CORD, chirp, green, all bars short of the line	One wire OPEN: that jack's FORCE wire; nonsense values: its SENSE wire
☐ 8. Same cord, leave it still for 10 s	No clicks, stays green	Clicks while still: loose jack or a bad joint on the lug
☐ 9. Hold the button 1 s, then again	"mute" appears in the header, then a beep and it goes	Nothing: button wire to Pico pin 26, other leg to ground
☐ 10. Switch on, then unplug USB	Keeps running; battery % replaces USB	Goes dark: SW1 off, D1 backwards, or the cell is flat

What is in the firmware

File	What it is
ohm_tester/ohm_tester.ino	Hardware: chips, ADC, screen, lights, piezo, button, the fast break sampler on the Pico's second core
ohm_tester/ohm_logic.h / .cpp	All the measuring arithmetic, the "what is plugged in" detection, pass / fail, which light and which sound. Plain C++, no Arduino needed
test_ohm_logic.cpp	43 automated tests: accuracy model, cords, shorts, crossed, leaky, flex, foil / sabre / epee, lame, and whole scenarios (plugging in, unplugging, swapping weapons, sweeping a lame) checked for the light and sound you would get
firmware/*.uf2	Ready-to-drag builds of the above

The tests model real gear as resistor networks and solve them, so a crushed cord or a dead lame patch reads in the test exactly as the switch chips would see it. Run them on any PC:

```
g++ -std=c++17 -O2 -o test test_ohm_logic.cpp ohm_tester/ohm_logic.cpp && ./test
```

(no g++? `pip install ziglang`, then `python -m ziglang c++` with the same arguments.)

Building it yourself (only if you change the code)

1. Arduino IDE, Boards Manager URL: `https://github.com/earlephilhower/arduino-pico/releases/download/global/package_rp2040_index.json`, install "Raspberry Pi Pico/RP2040/RP2350".
2. Library Manager: install **U8g2**.
3. Open `ohm_tester/ohm_tester.ino`, board "Raspberry Pi Pico" or "Raspberry Pi Pico 2", Upload.

Tested with arduino-pico 6.2.0 and U8g2 2.36. The release .uf2 files were built from exactly the source in this folder.

Prototype. The logic passes its tests and the firmware compiles cleanly for both boards, but the first physical unit has not been built yet. Expect to check step 5 above carefully on the first build.