

Three weapon fencing scoring box

STM32F401 front end

Bright lamp upgrade

Doc 12 Rev A 2026-08-29

Why and how

The base design's 5 mm indicator LEDs run a few milliamps from GPIO pins - fine on a desk, invisible across a gym. Real scoring boxes have lamp *panels*. This upgrade keeps the exact same four GPIO pins and firmware, but each pin now switches a logic-level MOSFET driving a segment of 5 V LED strip: a glowing zone per lamp, running hundreds of milliamps from the 5 V supply instead of the microcontroller.

Zero firmware changes. The pins still just go HIGH; the MOSFET does the lifting. Deliberately NOT addressable (WS2812/NeoPixel) strips: updating those disables interrupts for a millisecond or more per refresh, which would blow the 10-30 μ s scan loop that all the timing verification rests on. Dumb strips + MOSFETs cost the loop nothing.

Lamp zones

Zone	Pin (unchanged)	Strip colour	Suggested size	Approx. current
On target A	PB12	Green	10-15 cm (6-9 LEDs, 5050)	~120-180 mA
Off target A	PB13	White	8-10 cm (5-6 LEDs)	~250-300 mA
Off target B	PB14	White	8-10 cm (5-6 LEDs)	~250-300 mA
On target B	PB15	Red	10-15 cm (6-9 LEDs, 5050)	~120-180 mA

Mode and fault stay on their little 5 mm LEDs - they are for the operator at the table, not the gym. Keep (or drop) the original four 5 mm lamps as table-side repeaters; both can share the pins.

Driver circuit, one per zone

From	To	Note
GPIO pin (PB12..PB15)	MOSFET gate via 220 R	Use four of the 220 R spares already in the BOM
MOSFET gate	GND via 10 k	Pulldown so lamps stay dark during boot
MOSFET source	GND	Common ground with the Black Pill
MOSFET drain	Strip segment negative (-)	Low-side switch
5 V supply	Strip segment positive (+)	Straight to 5 V, not through the MCU

Power budget: all four zones lit together (lamp test) is ~0.8-1 A plus the Black Pill. Feed the box from a 5 V / 2 A USB supply or power bank into the Black Pill's 5 V pin and the strips in parallel. Do not power strips from the 3V3 regulator. Note some power banks auto-off below ~100 mA - the box idles well under that, so prefer a wall adapter or a bank with an always-on mode.

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Bill of materials (adds to Doc 10)

Qty	Part	Notes
4	IRLZ44N logic-level MOSFET, TO-220	Mouser 942-IRLZ44NPBF, ~\$1.70. Massive overkill at these currents - which means it never gets warm. Gate is happy at 3.3 V for strip loads.
4	10 k resistor (gate pulldown)	CFR-25JB-52-10K
4	220 R resistor (gate series)	Already spares in the Doc 10 BOM
1	5 V LED strip, white, 60 LED/m	Amazon: "5V USB LED strip white". One metre makes many boxes' white zones
1	5 V LED strip, red + green	Amazon: "5V LED strip red" / green, or one RGB strip wired per-colour (R and G channels used as the two zones, B unused)
1	5 V / 2 A USB supply or power bank	Powers Black Pill 5 V pin + strips
-	Diffuser	A strip of white acrylic or even paper over each zone turns points of light into a solid glowing bar - this is most of the "real box" look

An RGB-strip variant worth considering

A single analog RGB strip (four wires: +5 V, R, G, B) can serve both ON-target zones with only two MOSFETs: the R channel is fencer B's red lamp, the G channel is fencer A's green - mounted as a split bar with an opaque divider in the middle. White zones still want their own dedicated white strip; RGB "white" is dimmer and bluish.

Build and verify

- ☐ Bench-test one driver first: gate to 3.3 V by hand, strip segment lights hard; gate open, dark.
- ☐ Power the strips and the Black Pill from the same 5 V rail, grounds common.
- ☐ Power-up lamp test (already in the firmware) now sweeps the big zones - confirm all four fire in order and the supply holds 5 V while they do.
- ☐ Confirm the lamps are DARK during boot (that is the 10 k pulldowns doing their job).
- ☐ Run a bout on epee mode and check a double touch lights both big zones simultaneously with no supply sag - that is the worst realistic case.
- ☐ If a zone glows faintly when off, the gate pulldown is missing or the wrong pin is wired.

Brightness control, if ever wanted: PB12-PB15 are timer-capable pins, so PWM dimming is a firmware option later - but the whole point of this upgrade is that no firmware change is needed today.