LASER PSU ADAPTER BOARD — FAIL-SAFE PWM / TTL / WP INTERFACE AND FOUR NG PROTECT LOOPS — STUDY v01

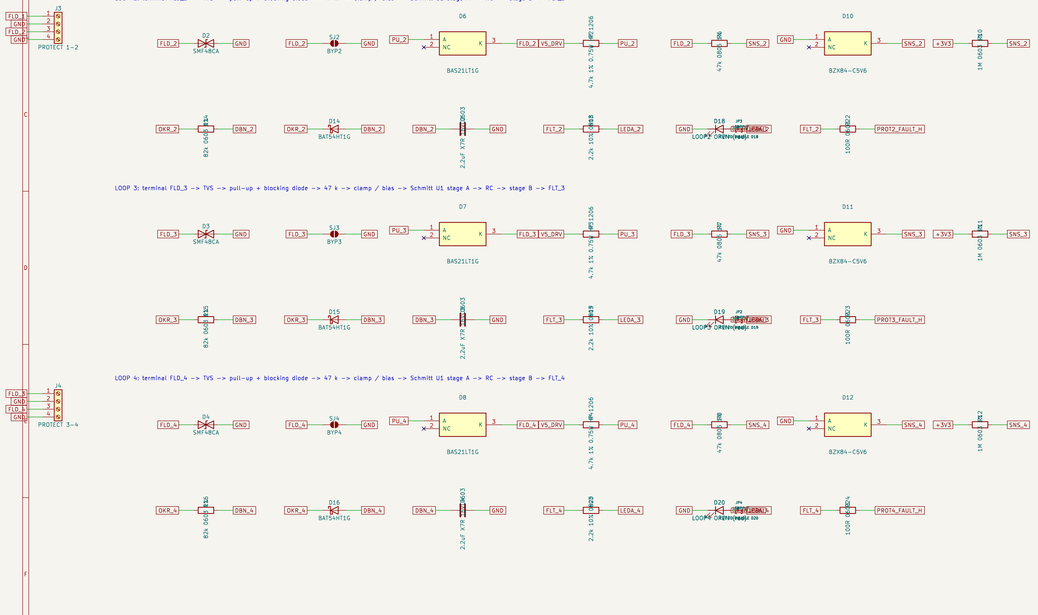
01 / PROTECT LOOP INPUT NETWORKS, DEBOUNCE, LED AND HOST DIAGNOSTIC (four identical rows)

LOOP 1: terminal FLD_1 -> TVS -> pull-up + blocking diode -> 47 k -> clamp / bias -> Schmitt U1 stage A -> RC -> stage B -> FLT_1

LOOP 2: terminal FLD_2 -> TVS -> pull-up + blocking diode -> 47 k -> clamp / bias -> Schmitt U1 stage A -> RC -> stage B -> FLT_2

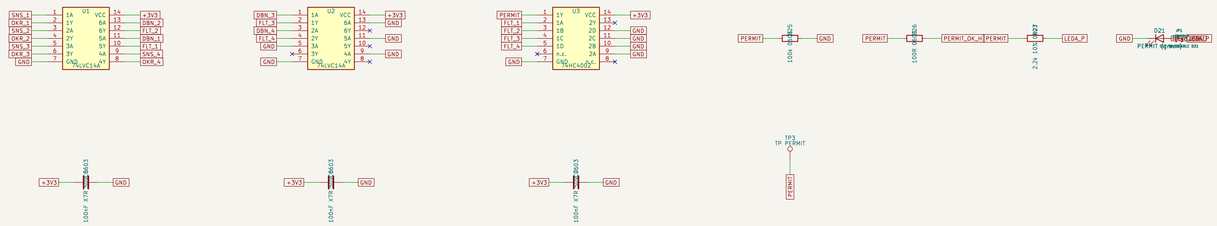
LOOP 3: terminal FLD_3 -> TVS -> pull-up + blocking diode -> 47 k -> clamp / bias -> Schmitt U1 stage A -> RC -> stage B -> FLT_3

LOOP 4: terminal FLD_4 -> TVS -> pull-up + blocking diode -> 47 k -> clamp / bias -> Schmitt U1 stage A -> RC -> stage B -> FLT_4

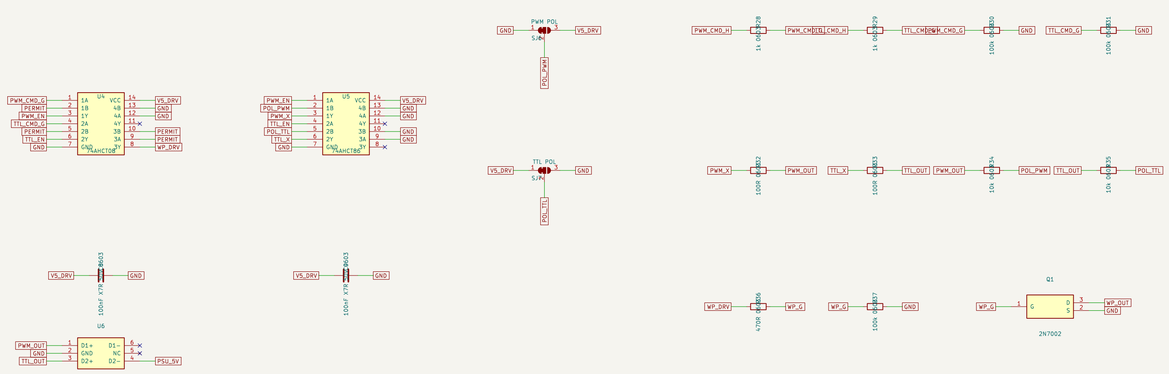


02 / SCHMITT STAGES U1 (A, loops 1–4; B, loops 1–2) AND U2 (B, loops 3–4), PERMIT NOR U3, DECOUPLING

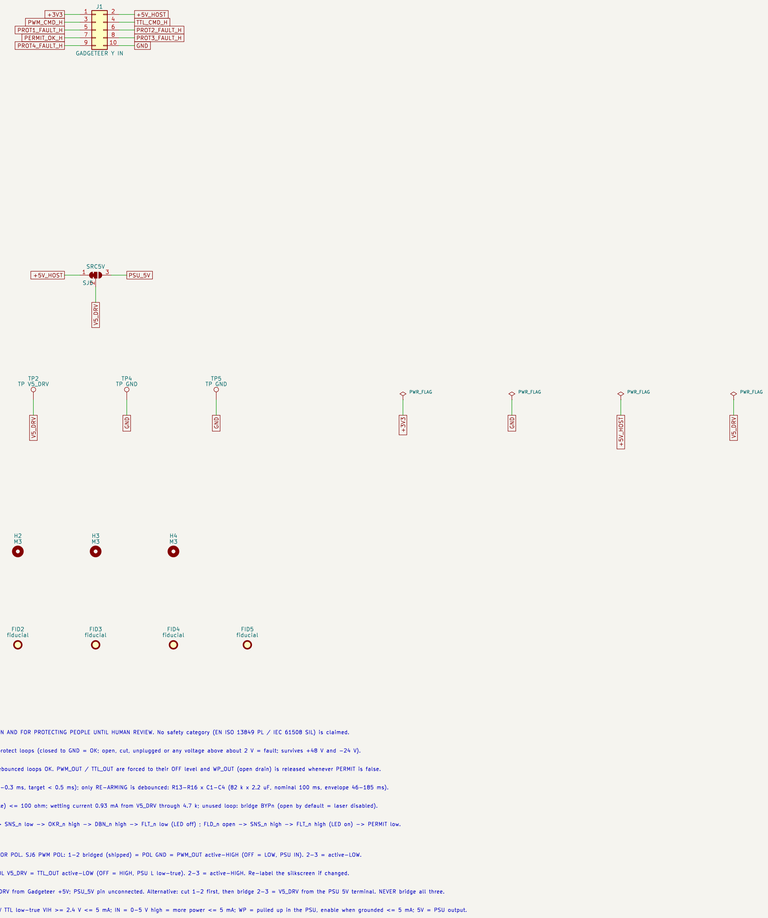
PERMIT group: pull-down, host status resistor, green LED



03 / OUTPUT STAGE: AHCT AND (U4) + XOR (U5), POLARITY JUMPERS, SERIES RESISTORS, ESD U6, OPEN-DRAIN WP (Q1)



04 / GADGETEER Y SOCKET, SOURCE SELECT, TEST POINTS, MECHANICAL



STUDY v01 — UNSUITABLE FOR FABRICATION AND FOR PROTECTING PEOPLE UNTIL HUMAN REVIEW. No safety category (EN ISO 13849 PL / IEC 61508 SIL) is claimed.

Function: four fail-safe dry-contact NC protect loops (closed to GND = OK; open, cut, unplugged or any voltage above about 2 V = fault; survives +48 V and −24 V).

PERMIT = NOR(FLT_1..FLT_4) = all four debounced loops OK. PWM_OUT / TTL_OUT are forced to their OFF level and WP_OUT (open drain) is released whenever PERMIT is false.

Fault propagation is fast (calculated 0.15–0.3 ms, target < 0.5 ms); only RE-ARMING is debounced: R13–R16 x C1–C4 (82 k x 2.2 uF, nominal 100 ms, envelope 46–185 ms).

Loop wiring: closed loop (contacts + cable) <= 100 ohm; wetting current 0.93 mA from VS_DRV through 4.7 k; unused loop: bridge BYPn (open by default = laser disabled).

Loop truth: FLD_n low (closed to GND) -> SNS_n low -> OKR_n high -> DBN_n high -> FLT_n low (LED off) ; FLD_n open -> SNS_n high -> FLT_n high (LED on) -> PERMIT low.

Output stage: OUT = (CMD AND PERMIT) XOR POL. SJ6 PWM POL: 1–2 bridged (shipped) = POL GND = PWM_OUT active-HIGH (OFF = LOW, PSU IN). 2–3 = active-LOW.

SJ7 TTL POL: 1–2 bridged (shipped) = POL VS_DRV = TTL_OUT active-LOW (OFF = HIGH, PSU L low-true). 2–3 = active-HIGH. Re-label the silkscreen if changed.

SJ5 SRC5V: 1–2 bridged (shipped) = VS_DRV from Gadgeteer +5V; PSU_5V pin unconnected. Alternative: cut 1–2 first, then bridge 2–3 = VS_DRV from the PSU 5V terminal. NEVER bridge all three.

Assumed PSU table (UNVERIFIED): L = 5 V TTL low-true VIH >= 2.4 V <= 5 mA; IN = 0–5 V high = more power <= 5 mA; WP = pulled up in the PSU, enable when grounded <= 5 mA; 5V = PSU output.

PWR_FLAG on VS_DRV: VS_DRV is a jumper-selected copy of +5V_HOST (SJ5 is passive), so U4/U5 power-input pins need a declared source; deviation logged in questions.md.

WP_OUT has no ESD clamp (PSU WP level unknown, may exceed the 5.5 V TPD4E1U06 working voltage). The 60 V 2N7002 drain is the only exposed element.

NOT A CERTIFIED SAFETY DEVICE. LED OFF IS NOT SAFE. CERN-OHL-S-2.0. KiCad only, black solder mask, white silkscreen.

Generated from design-contract.json by tools/create_schematic.py; no hand edits
STUDY v01: unsuitable for fabrication and for protecting people until human review
Smoothieware / CERN-OHL-S-2.0

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Title: Laser PSU adapter board (fail-safe PWM/TTL/WP interface and four NG

Size: A1	Date: 2026-10-01	Rev: v26
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