





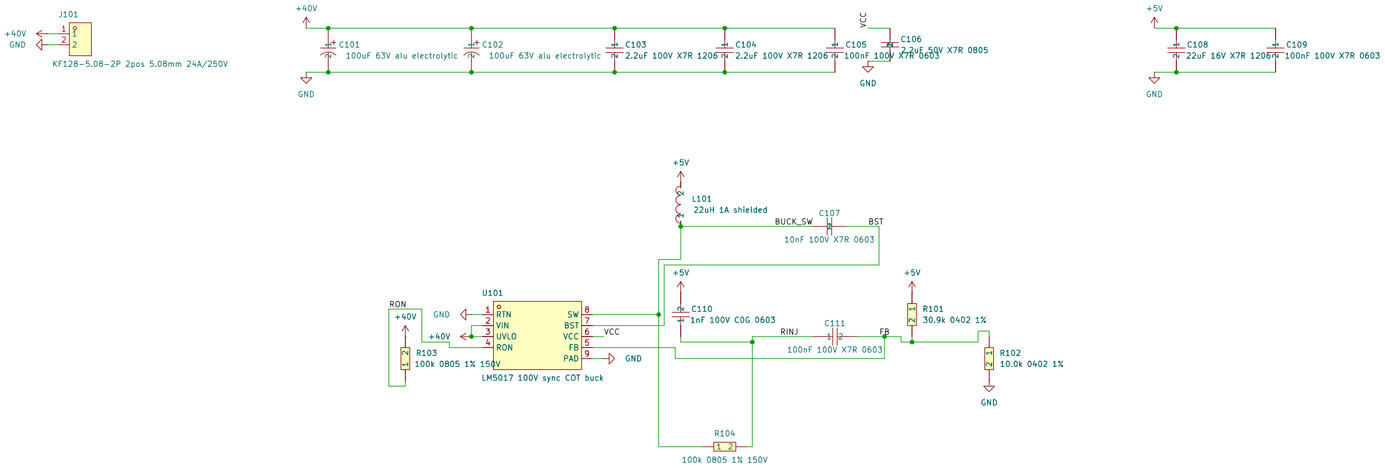
ROOT SHEET — NO PARTS BY DESIGN (sheets.md s1).

The ONLY inter-sheet signal net is /SW (the drain node, 142.5 V pk, 9.17 A rms). Its bare /SW spelling comes from the root-local labels written by add_sheet, and six constraints.json entries depend on it. Both `stage` and `tank` expose it, which is what keeps the root label connected — a root label with only ONE sheet pin raises label_dangling in KiCad 10.

GND / +40V / +5V are global POWER SYMBOLS inside the sheets and are deliberately absent here. All three PWR_FLAGs live on `hk`; a second flag anywhere else collides power_out <-> power_out.

Every other net is sheet-internal on purpose and carries its /<sheet>/ prefix. Do not 'tidy' them into bare names.

ai-ee		
Sheet: /		
File: PCB-0007-A_rf-de-20m.kicad_sch		
Title: rf-de-20m: root — 20 MHz Class E GaN stage, 200 W into 50 ohm		
Size: A3	Date: 2026-08-07	**Rev: 1**
KiCad E.D.A. 10.0.6		Id: 1/4



THIS SHEET OWNS THE PWR_FLAGS for GND, +40V and +5V. Every rail enters through passive pins (J101) or a passive inductor (L101). Do NOT add a second flag on another sheet: PWR_FLAG is a power_out pin and two of them collide as power_out <-> power_out.

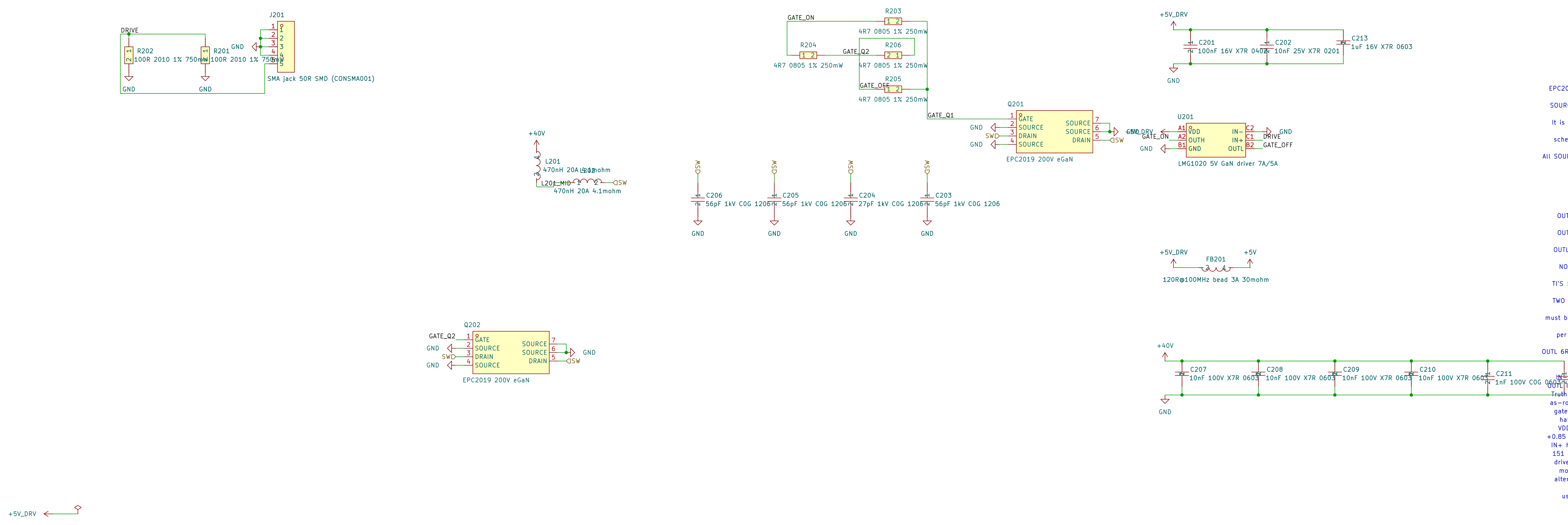
TYPE 3 RIPPLE INJECTION IS MANDATORY, NOT OPTIONAL. LM5017 is a COT regulator and needs >=25 mV of IN-PHASE ripple at FB (s7.3.1/s7.3.11). A 22 uF ceramic COUT gives almost none, and the regulator multi-pulses. R104/C110/C111 synthesise the ramp from the SW node so the +5 V rail keeps low ripple - which matters, because +5V feeds a driver whose VDD abs max is 5.75 V.
FB ripple 78.6 mV pk-pk at 40 V bus (3.1x the floor); Rr.Cr is 3.1x inside Eq 7.

THE BUCK SWITCH NODE IS /hk/BUCK_SW. It is NOT called SW: /SW is the RF drain node and is named in six constraints.json entries.

UVLO (pin 3) IS TIED TO VIN. Datasheet s7.3.9 sanctions it explicitly; no bus-undervoltage threshold is specified anywhere in the architecture, so a divider would be an invented requirement. Abs max 100 V.

C101/C102 ARE POLARIZED: pin 1 = ANODE (+). SETTLED 2026-08-08 against the manufacturer drawing (JIERR RVT series, parts/C51953411.pdf p.2): the 'Positive' leader points at the CHAMFERED-corner end of the base, and the footprint's two chamfers are on the pad-1 side. The symbol's '+' at pin 1 is therefore CORRECT. (The usual 'cut corner = cathode' rule does NOT hold on this family: the can's black top stripe sits on the SQUARE-cornered end. Cross-checked against Lumimax SMDGP/RVT, same conclusion.)
NO PROTECTION PARTS ON THIS BOARD. No TVS, fuse, NTC, OVP, OCP or thermal shutdown. Owner-acknowledged at P0 Q11.
VOLTAGE RATING (every +40V part >=63 V) The -51 V turn-on ring is handled by the overshoot WORSE (blocks.md B1). The footprint still carries NO silk polarity marker - P6 MUST add a '+' outside the 10.46 mm body square (the base hides it) and an F.Fab body outline with a marker.

ai-ee
Sheet: /hk/
File: hk.kicad_sch
Title: rf-de-20m: hk - 40 V bus entry, bulk, +5 V buck
Size: A2 | Date: 2026-08-07 | **Rev: 1**
KiCad E.D.A. 10.0.6 | Id: 2/4



EPC2019 PIN 7 IS SUBSTRATE AND IS TIED TO SOURCE. The datasheet states it three times. It is NOT expressible in the footprint – this schematic is the only place it is enforced. All SOURCE pins (2/4/6/7) –> GND; both DRAIN pins (3/5) –> /SW.

OUTH AND OUTL ARE SEPARATE OUTPUTS.
OUTH sources only and floats when idle;
OUTL sinks only and is held low otherwise.
NO steering diode is needed or wanted.
TI'S >=2 OHM MANDATE IS AT THE PIN, AND
TWO FETs SHARE EACH PIN, so each branch
must be >= 2 x 2 = 4 ohm. ONE 0805 per leg
per FET: OUTH 4R7 –> 2.35R at the pin,
OUTL 6R8 –> 3.40R. Peak drive 2.13 A / 1.47 A.
Do NOT parallel these back down.
IN– IS TIED TO GND, DRIVE GOES TO IN+.
OUTL IS 6R8, NOT 4R7, ON PURPOSE (P7): the
Truth table: only (IN–=L, IN+=H) drives the
as–routed turn–off loop is 7.03 nH and 6R8
gate high. IN– has an internal pull–UP to
halves the ring to 5.9% (zeta 0.67) for
VDD, so floating it holds the stage OFF;
+0.85 W. 10R would give 0.02% but puts Tj on
IN+ has an internal pull–DOWN, so an open
151 C vs a 150 C max – rejected. See the
drive input fails SAFE. TI's ground–bounce
module docstring and route–notes s14.
alternative (drive IN–, IN+ to VDD) is NOT
used: it inverts, and duty cycle is the
primary ZVS trim.

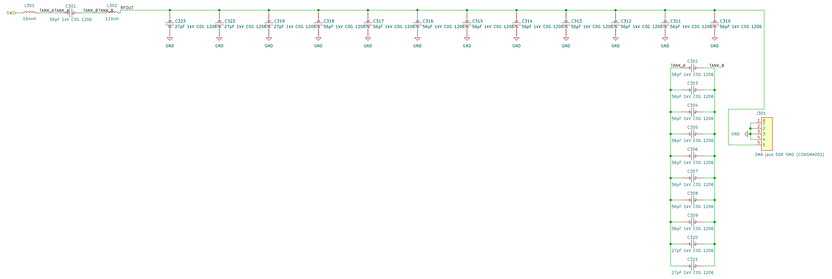
THE DRIVE INPUT IS DC–COUPLED – RULING D8.
Do not add a series blocking capacitor 'for safety': AC coupling's DC restore pins the average at the bias point and at D=0.4 both logic levels sit above the 1.4 V threshold, so the FETs never turn off.
Generator MUST be unipolar 0 to +5 V – the input abs max is –0.3 V to VDD+0.3 V, so +/–2.5 V bipolar violates it (OPEN–1).

C203–C206 ARE 56/27 pF, NOT 33 pF. No 33 pF part exists on this BOM; parts.json maps these sites onto the same 1 kV C0G parts as the tank.
P8 FIX a3: ONLY C204 (27 pF) IS POPULATED.
C203, C205 AND C206 ARE ALL DNP.
The ZVS–optimal shunt DEPENDS ON THE TANK, and
C_s fell 504 –> 419 pF to cancel the ~30 nH
un–imaged zone–B bridge (see the tank sheet).
With that tank the optimum bank is 27 pF:
bank 83 pF –> Vds 15.6 V at turn–on, 53 W
bank 27 pF –> Vds 1.41 V, 113.8 W
GATE LOOPS: aim for <= 0.48 nH per FET,
bank 56 pF –> Vds 3.94 V (next step, also OK)
matched +/–0.1 nH, geometrically MIRRORED
Do NOT re–populate C203 without re–running
about the U201 axis. The CRITICAL–DAMPING
kicad/sims. The bank still EMPTIES for a
budget is 1.70 nH on the TURN–ON side
max–Coss pair – at that corner it runs out at
(EPC WP008 Eq.1 at R = 4.7 + 0.4 + 0.75 =
8.87 V and the remaining knob is DUTY (D 42–46 %
5.85 ohm, C_GS 199 pF) and 6.19 nH on the
measures 4.8 V), not a part.
TURN–OFF side at the P7 6R8 value. The
as–routed turn–off loop is 7.03 nH, i.e.
still over even the relaxed budget – but at
zeta 0.67 the overshoot is 5.9%, VGS –0.30 V
against a –4 V floor. Keep aiming at 0.48 nH.
Do NOT length–match electrically – FR4 is
L201 + L202 ARE ONE CHOKE, IN SERIES.
6.7 ps/mm and skew is benign in a soft–
0.94 uH total – the architecture's own
switched topology; matching damps the
pre–authorised escape. A smaller single
differential mode and equalises sharing.
choke is NOT authorised: it breaks the
ideal Class E equations and RAISES the
required shunt capacitance.

NO PROTECTION PARTS. No TVS on /SW, no gate clamp, no negative bias. Owner–acknowledged at P0 Q11. The 1.40x derate on a 200 V part is protected by POWER LOOP AREA at P6/P7. FB201 IS A FILTER, NOT PROTECTION.

+5V IS SPLIT AT FB201: +5V (buck) feeds the bead, +5V_DRV feeds U201.A1 and C201/C202/C213 only. That containment is the point – the 72–100 mA of gate charge at 20 MHz must return inside the local 1.1 uF, not across the board to C108. P6: bead and all three caps stay on the DRIVER side, at the ball. +5V_DRV carries its OWN PWR_FLAG here; that is not a duplicate of hk's – different net.

ai–ee
Sheet: /stage/
File: stage.kicad_sch
Title: rf–de–20m: stage – drive, LMG1020, EPC2019 pair, C_shunt trim, cho
Size: A1 | Date: 2026–08–07 | **Rev: 1**
KiCad E.D.A. 10.0.6 | Id: 3/4



L301 AND L302 ARE ETCHED PCB AIR-CORE SPIRALS — THE COPPER IS
THE PART. No LCSC code; excluded from the BOM. The winding
lives inside the footprint (kicad/gen/spirals.py); see
reports/spiral-design.md for both inductance derivations.
L301 was SPIRAL_L184N 3T OD 33.10mm, 2.5/1.0 trace/gap
L302 was SPIRAL_L110N 2T OD 32.57mm, 2.5/1.0 trace/gap
Both are KiCad NET TIES: pads 1–2 are joined by the winding,
which is what an inductor is at DC. Do not 'fix' the short.
SPIRAL-2 is TAKEN: F.Cu and B.Cu carry identical windings in
parallel, stitched 14 vias per terminal. Inner terminal out
on a 5 mm in1×n2 radial bridge (SPIRAL-A1: Q 398 // 325,
2.6 W // 2.1 W — not the 10 W the power tree budgeted.
SPIRAL-5: centre-to-centre >= 38 mm. At 38 mm the computed
mutual is −2.0 nH (k 1.53), i.e. −4.1 nH // −1.5% on the
series total. PB folds it in; the kim sites cover it.
C_RF0G0-0-[illegible]-at325.pf1.0[illegible] pcm73cpf RF0G0AT1Cw.with
C7Ah-0kPkPfOwr3E0rE/Y0-mrr4wv-Q2Q/ Tmv!0SOETZ.E-2WNr-wmtk-n
MCAS1/EQ@w4-Zy4fL4-y-6Wk0rd fl!n tmwb!nsivtmv tbnrrwtmtn0-0, not
the match: 9 + 56 tmv2Rtm. 5Q0-q0fTQrHR2 4v5kfR'mF, worse than the
560 fpR-h-tfmr2Rtm'k wvdmrtth (3w0!=n-!Qu0!-rtm=v-RyFC-fp!Qu=038 W),
475 rF4R_tow fWQrptr!n-%Qk rrthQ!Y-n0!N-[2R0 tmm=0Rtm pf.
Zone B's blanket in1/n2 ow4 is still required beyond that.
C_a IS 7 + 56 + C320 27 pF = 419 pF (PR FIX a3, 2026-08-08).
C308 AND C309 ARE DNP AND MUST STAY DNP. This is NOT the 518 pF
ideal-network value and it is NOT a mistake; zone B carries NO
NO jK8Rr4QPWrHC NC.yRp-9rRi-tRWtv fQ0yRvPR0 or4qtvtrd'N'Rtm'jcnRe@mmd
TkMWQbrrmCyw-n04RRCJRrtv+tRbw-n-n-wtwrr-tMrmgtwmN-/QKPRnQ0rn
-30 nH (2Rv=R0 rnQ tRk QHtRv-k=tmnQvkr-k=R3TRk-RQPES L IS
/!wrfJMWXNLkJHMCWES!SRPW'bH'c-3Rp-fQ/pmtk-rrwm-CkrtMWtkmrd.
50% pF = 78 nH RRRR tRW -RURC/2Rb-tRWrtR3 nF #Rturn-on. 53 W
419 pF × 30 nH bridge => R/R 1.2R. Vds 1.41 V, 115.8 W
Do NOT 'restore' the two 56 pF parts. Measured in kicad/sims/:
reports/kim-notes.md s3 has the whole derivation.

REMAINING TRIM: C321 (C_a, +27 pF) and C322/C323 (C_m) are DNP;
C320 is SPENT by the fix. Depopulate for −27 (C319/C320) or
−56 pF. The spirals' realised L is the tank's largest unknown
and OPEN-15 says MEASURE the bridge stray on the first article
before finalising this bank.