FULL WIRING SHEET 6 — BED-BATTERY COMBINER DEEP-DIVE: contactor + pre-charge, pin-by-pin (rev 3.31 — driven by the BED board, Option B)
WHY: two big low-ESR LiFePO4 banks + the inverter's input capacitors. Slam the contactor closed at a 0.5V difference and the only resistance is ~15 milliohm of cable -> a 30-60A+ spike and the caps look like a dead short for milliseconds = arcing, welded contacts, BMS overcurrent trips. The 5R resistor makes the worst case a gentle 2.7A.
HOW IT SWITCHES TO FULL POWER: nothing 'switches over' — the contactor (milliohms) simply closes IN PARALLEL with the 5R resistor; current naturally takes the metal path. Then the pre-charge relay opens to take the resistor out.
LEGEND: red thick = 2 AWG battery power · red thin = 16 AWG pre-charge branch · dark-red = coil power · purple dashed = controller DO · blue = voltage sense · black = ground

SEQUENCE (state machine in ESPHome)

0 ISOLATED — both relays off. Contactor is NO -> ESP32 dead / power lost = bed isolated. FAIL-SAFE.
1 COMBINE REQUEST (auto or app) — read ADC1 vs ADC2.
2 PRE-CHARGE — O6 on -> current through the 5R: I = deltaV/5 (fault/0V case -> 2.7A / 36W <- WHY the 25-50W rating). FIXES IN SECONDS: inverter caps (tau = 5R x ~10mF = 50ms) + surface charge (recent charge/discharge froth). CANNOT FIX EVER: a real SoC difference — 0.1-0.4A into 100-440Ah moves SoC ~0.05%/hr. deltaV still there after ~15s = a GENUINE SoC gap; more waiting will not close it.
3 DECIDE at ~15s, by deltaV band (inrush ~ deltaV / R_loop, R_loop ~ 15-25 milliohm of cable + cell resistance):
deltaV <= 0.3V -> CLOSE. Inrush ~10-20A blip. Trivial. (the COMMON case — LiFePO4 rests 13.0-13.4V over most of SoC, healthy banks usually land here)
0.3-0.7V AND charge source ON -> CLOSE = managed merge: brief 20-50A into the low bank, decays to charger rate (~0.1C on 300-440Ah — battery is fine).
> 0.7V -> STAY ISOLATED + alert (default). 80-120A+ inrush is hard on contacts over cycles, and the FRONT bank would dump into the bed.
FORCE-MERGE OVERRIDE (the stored-bed-battery, leaving-now case): allowed ONLY if ignition ON + DC-DC active + user confirms (PWA gate / override switch). Profile: ~100-120A for the first 1-2 min (the SoC cliff lifts bed V fast), then 30-60A with the DC-DC backfilling 40A. The close itself is cheap (contactor make-rated for 1000s of such cycles) — keep it RARE because the inrush is UNCONTROLLED (ratings headroom, not regulation) and because the 0-5% STORAGE habit it implies is what actually harms the pack (low-SoC aging + BMS drain -> brick risk). Store at 50-60% instead -> every reinstall is a normal merge, routine forever.
TRUNK FUSE MUST BE 125A (100A = nuisance blow). REFUSE below ~11V pack (damaged/BMS-tripped -> bench supply only, doc 5.10).
4 CLOSE — O5 on -> contactor closes (milliohm path in parallel with the 5R; it just takes over).
5 0.5s later: O6 off -> resistor out of circuit. COMBINED.
6 SEPARATE — O5 off (UVD, fault, request) -> back to 0.
7 SEPARATE-ON-CHARGE-LOSS (key-off / DC-DC + solar gone): if the bed is still BELOW the flat band (rest < ~13.0V, i.e. a force-merge that isn't done) -> OPEN the contactor. Otherwise the paralleled banks MUST equalize: the front 100Ah bleeds 60-80Ah into a low bed overnight (15-25A tapering) until both sit ~20% — no damage (charge just moves), but the critical front reserve is silently gone. Healthy banks (both flat-band, OCVs ~equal) -> negligible cross-current -> staying combined parked is fine/intended. Re-merge automatically when a charge source returns (morning solar counts).

ESP32 REBOOT (watchdog / brownout / EVERY OTA update): DOs go dark during reboot -> both relays drop -> contactor opens -> banks isolate. Mid-PRECHARGE: trivial. Mid-COMBINED: contactor breaks under load (rated for it), front bank carries everything ~5-15s, boot re-reads ADCs, deltaV ~0 -> band 1 recombine. SELF-HEALING — IF the firmware:
· restore_mode ALWAYS_OFF on O5/O6 (NEVER restore relay state from flash — battery may have been swapped)
· force-merge confirm does NOT persist across reboot
· ~10s boot settle before energizing anything (also kills brownout relay-chatter): no O5 until ADCs read + banded

DEEPLY-DEPLETED RULE (the >0.7V band): the resistor CANNOT fill a dead bank (0.2A into 440Ah ~ forever). Combine only while a CHARGE SOURCE is active: the charger raises the bed bank toward charge voltage; banks meet there, THEN pre-charge + close. The SOURCE fills the bank, not the front battery.

STORAGE TIP: store the bed pack at ~50-60% (rest 13.2V), top up quarterly — never face the 12.0V morning. Check the BMS is awake (meter the SB175 pins) + no charge below 0 C.

PLUG-IN TIMELINE (no user action needed)
· contactor is OPEN -> SB175 mates onto a dead circuit (only the ~110k sense, ~0.1mA) -> NO SPARK
· ADC2 jumps to pack V instantly; firmware waits ~5s stable
· auto-sequence -> COMBINED in ~15-25s (common case, banks within 0.3V); bigger gaps follow the deltaV bands
· announce over MQTT/PWA (+ TTS if the 5080 is awake)

UNPLUG RULE: separate FIRST (PWA / override switch / rotary OFF), THEN pull the SB175. While COMBINED, ADC2 reads BUS voltage through the closed contactor -> the ESP32 cannot see a yank, and the connector would break load current (arc).

SHOPPING LIST (combiner subsystem)

· 150-200A 12V continuous-duty NO contactor
· 5R 25-50W aluminum-shell resistor
· 2x Bosch relay (already in box: O5 + PC slots)
· 1N4007 diode (across contactor coil)
· MRBF/ANL 100-150A fuse + holder (battery post)
· Anderson SB175 pair + handle
· 275A rotary battery disconnect (red key)
· divider resistors (100k/10k) + 1A fuse (sense)
· wire: 2 AWG (battery/studs/bus) · 16 AWG (pre-charge branch) · 16-18 (coil) · 22 (sense)