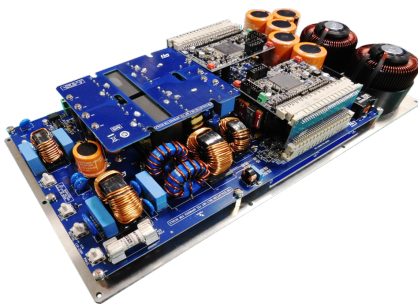


7 kW on-board charger (OBC) reference design



Fully assembled board developed for performance evaluation only, **not available for sale**

Features

- Front-end PFC stage using 2-channel interleaved totem pole topology operating at 70 kHz
- Digital inrush current control
- DC-DC stage using FB LLC resonant topology with 140 kHz resonant frequency
- Constant current and constant voltage mode
- Control stage based on [SPC58NN84E7RMHBR](#) MCU
- 12 V input supply voltage galvanically isolated from output voltage GND (high voltage battery)
- Bus bar interconnection possibility
- PFC stage:
 - Key products: [TN3050H-12GY-TR](#) SCRs, [STBR3012G2Y](#) bypass diodes, [SCTH35N65G2V-7AG](#) SiC power MOSFET
 - Input: 85 to 265 V_{AC}, 45 to 65 Hz
 - Digital inrush current limiter
 - Max. input current: 32 A_{rms}
 - Switching frequency: 70 kHz
 - Average current mode control in continuous conduction mode (CCM)
 - PID or 2p2z 2x independent current loop regulators
 - PID or 2p2z voltage regulator
 - [SPC58NN84E7RMHBR](#) MCU controller
- DC-DC stage:
 - Key products: [STB47N60DM6AG](#) power MOSFET, [STPSC20065GY-TR](#) output diodes, [A6387](#) gate driver
 - Output voltage: 250 to 450 V_{DC}
 - Switching frequency: 92 to 250 kHz with start-up at 350 kHz
 - Two independent current loops (CC)
 - One voltage loop plus current balancing (CV)
 - PID regulators
 - [SPC58NN84E7RMHBR](#) MCU controller
- RoHs compliant

Product summary	
7 kW on-board charger (OBC) reference design	STDES-7KWOBBC
32-bit Power Architecture MCU	SPC58NN84E7RMHBR
Automotive-grade silicon carbide Power MOSFET 650 V	SCTH35N65G2V-7AG
1200 V, 30 A Automotive Grade AEC-Q101 SCR Thyristor	TN3050H-12GY-TR
Automotive-grade N-channel 600 V, 70 mOhm typ., 36 A MDmesh DM6 Power MOSFET	STH47N60DM6-7AG
Applications	On board charger

Description

The [STDES-7KWOBBC](#) is an on-board charger (OBC) reference design that allows charging the battery of electric vehicles (EV) through your home AC mains plug or a private/public outlet (AC charging station).

The reference design embeds two sections: an interleaved totem pole PFC with SiC and a dual galvanic isolated full bridge LLC DC-DC ZVS resonant converter, based on MDmesh DM6 super-junction power MOSFETs.

The power platform is a 7 kW module able to deliver a constant current (CC) or constant voltage (CV) on the output to be used as standalone (1 PH+ N), in parallel or in 3-phase mode (3Ph + N) to reach 21 kW.

The underlying insulated metal substrate (IMS) on aluminum base plate enables very effective heat dissipation, forced air or liquid cooling.

Each module composing the reference design allows an easy interconnection among modules of the same type through wires or bus bar connection, reaching a higher output power.

This reference design key factor is the efficiency and high-power density gained thanks to SiC and SJ power MOSFETs, silicon and SiC diodes, gate drivers, the [SPC58NN84E7RMHBR](#) power architecture automotive-grade microcontroller, and SCR thyristors for inrush current limitation.

The [STDES-7KWBC](#) is a fully assembled kit developed for performance evaluation only, not available for sale.

1 Schematic diagrams

Figure 1. Mother board circuit schematic - AUX PS

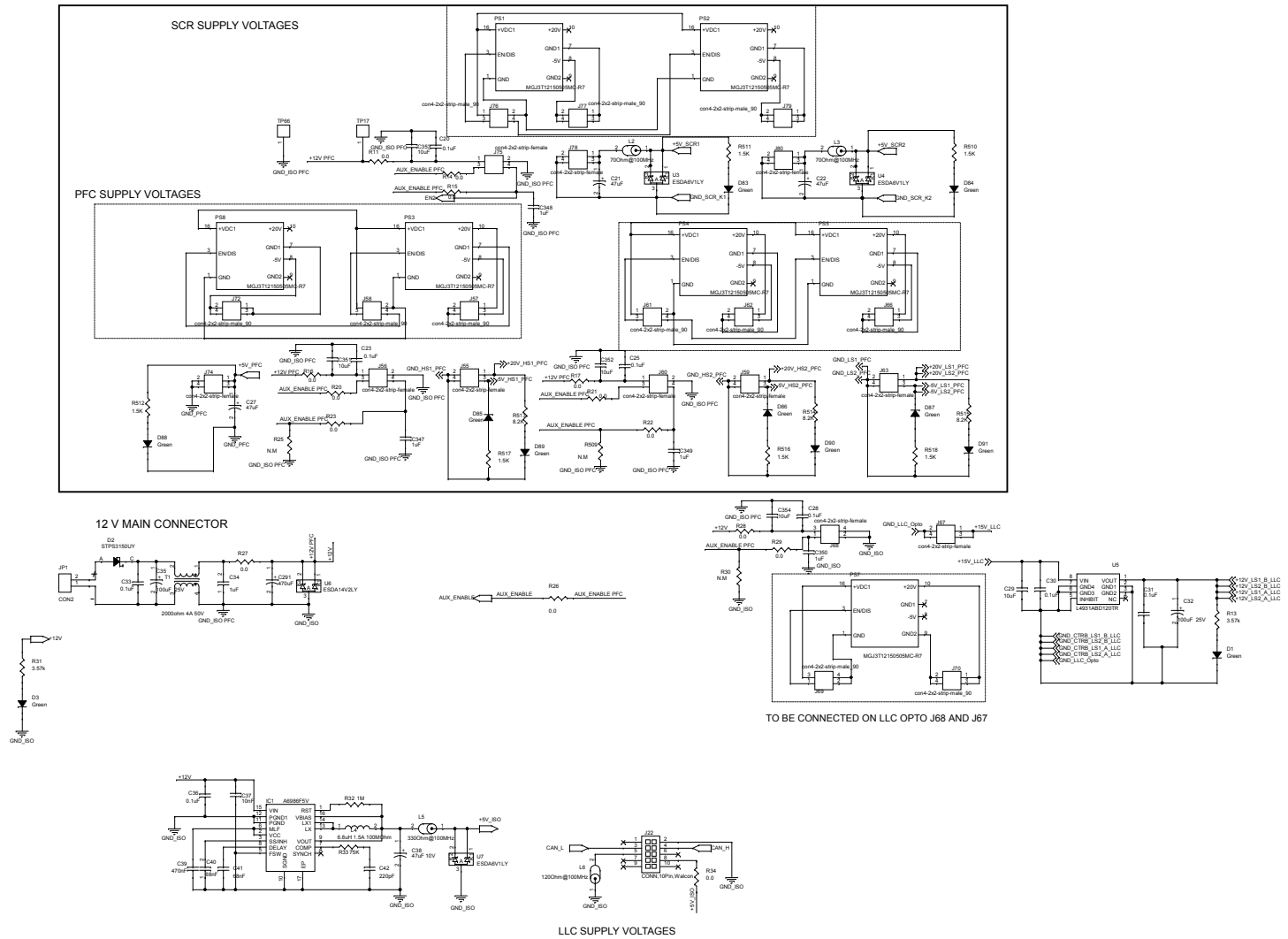


Figure 2. Mother board circuit schematic - bus monitoring

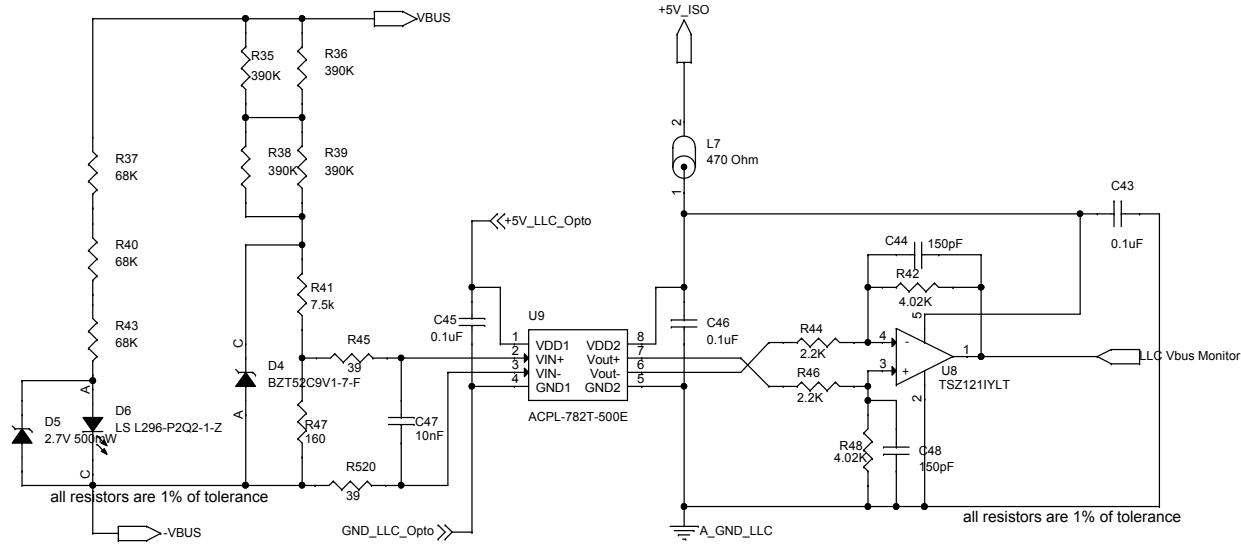


Figure 3. Mother board circuit schematic - HV discharge circuit

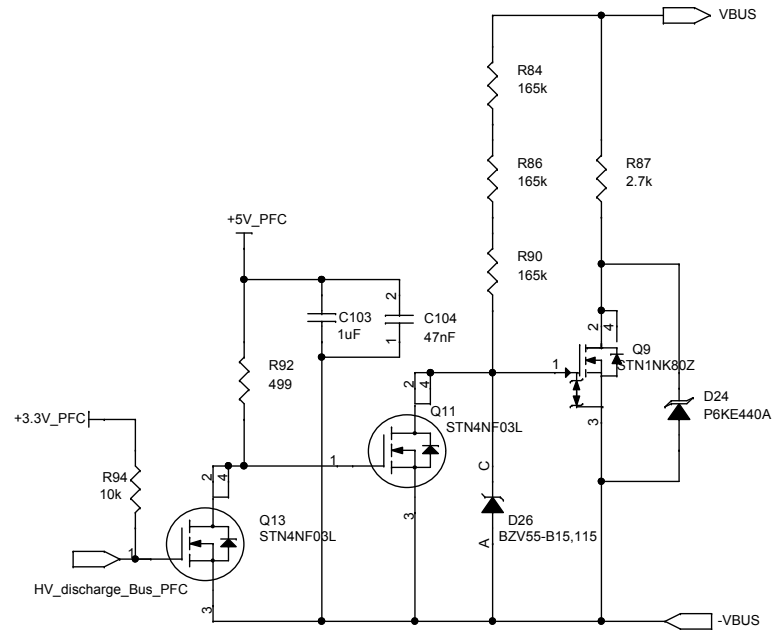


Figure 4. Mother board circuit schematic - input section

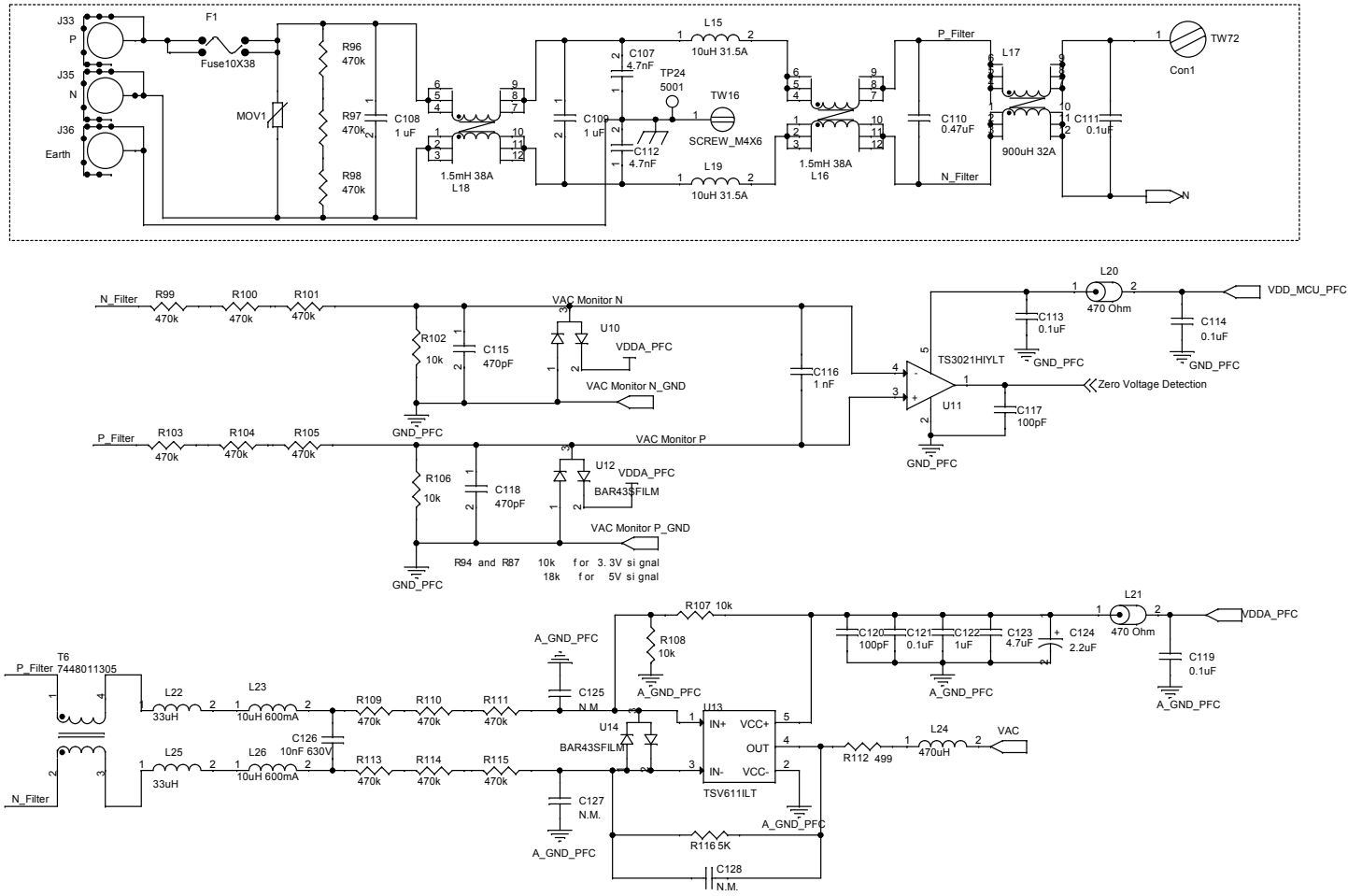


Figure 5. Mother board circuit schematic - LLC control

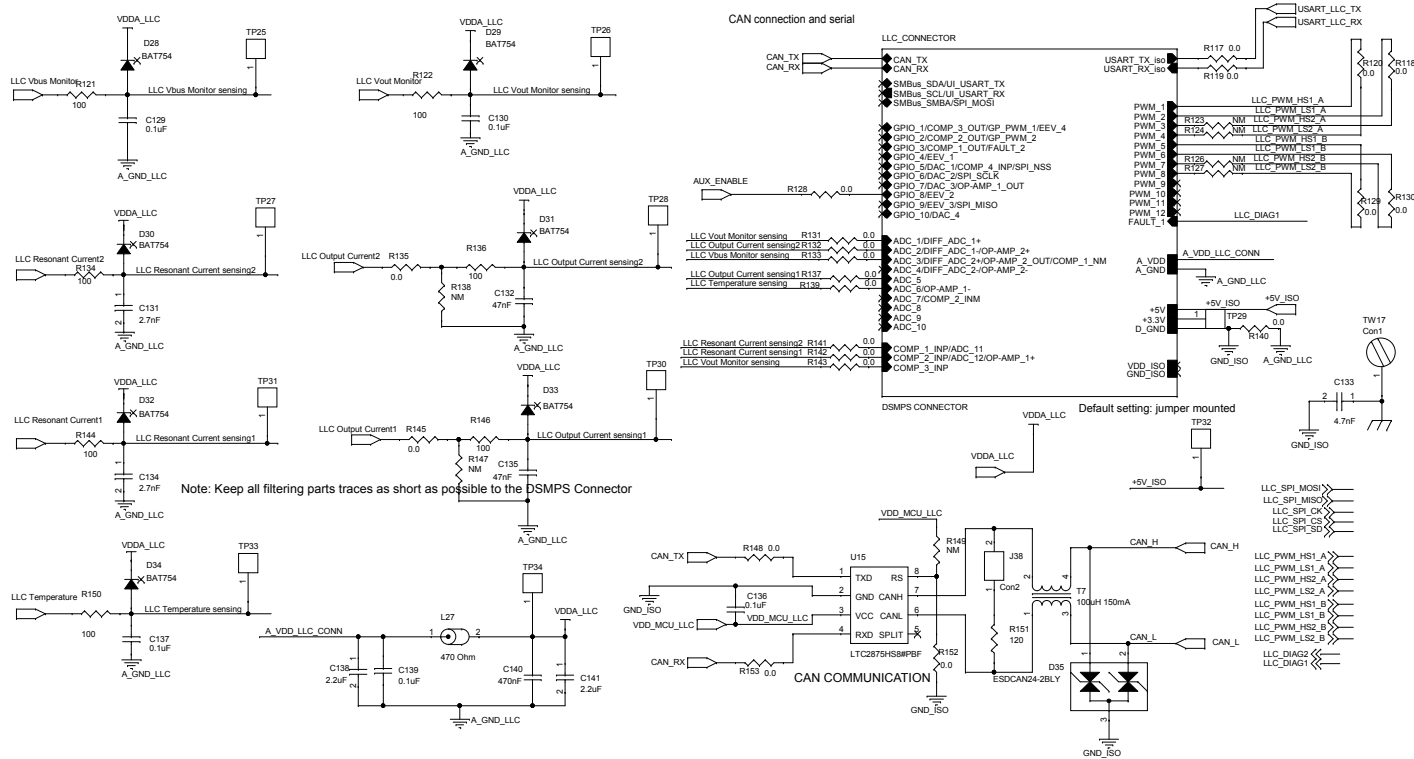
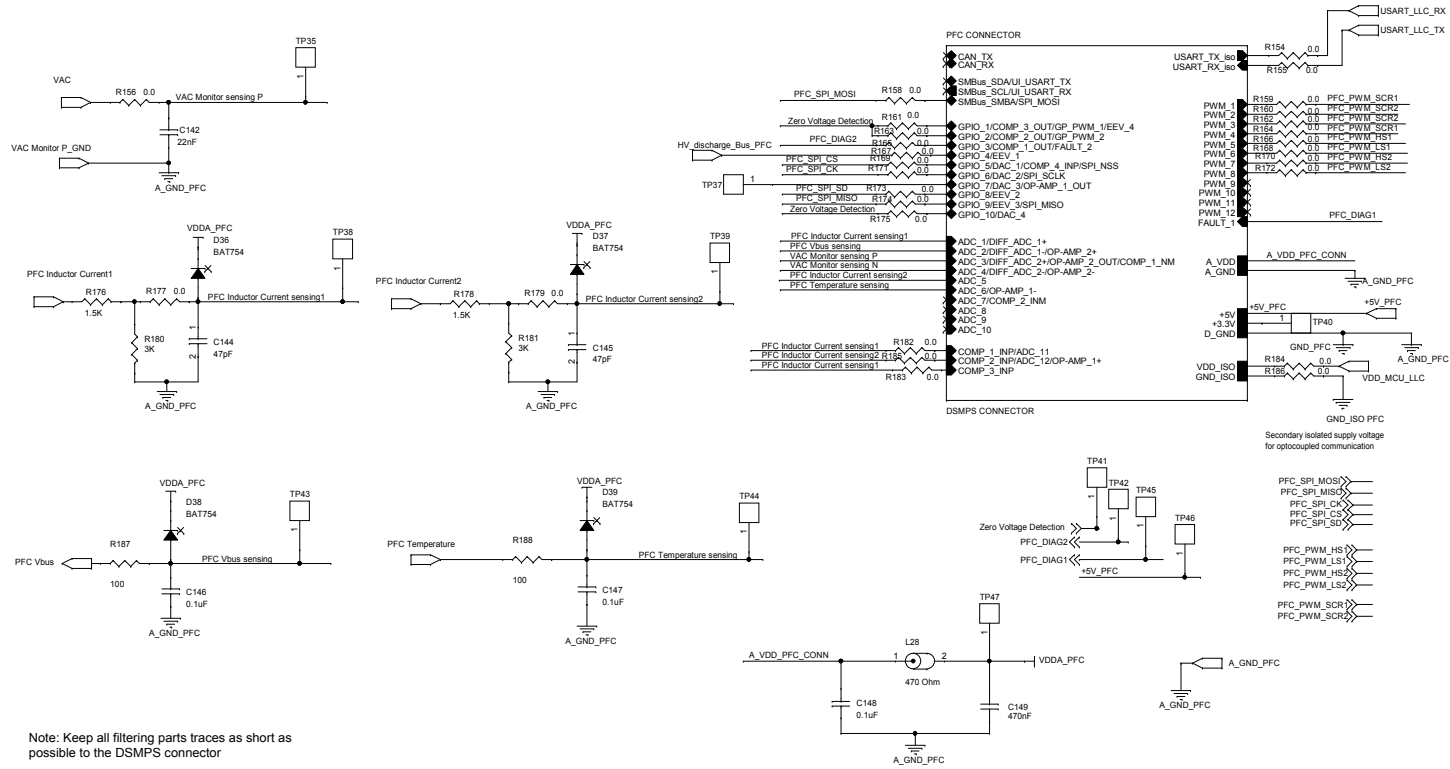


Figure 6. Mother board circuit schematic - PFC control



Note: Keep all filtering parts traces as short as possible to the DSMPS connector

Figure 7. Mother board circuit schematic - vertical adapter

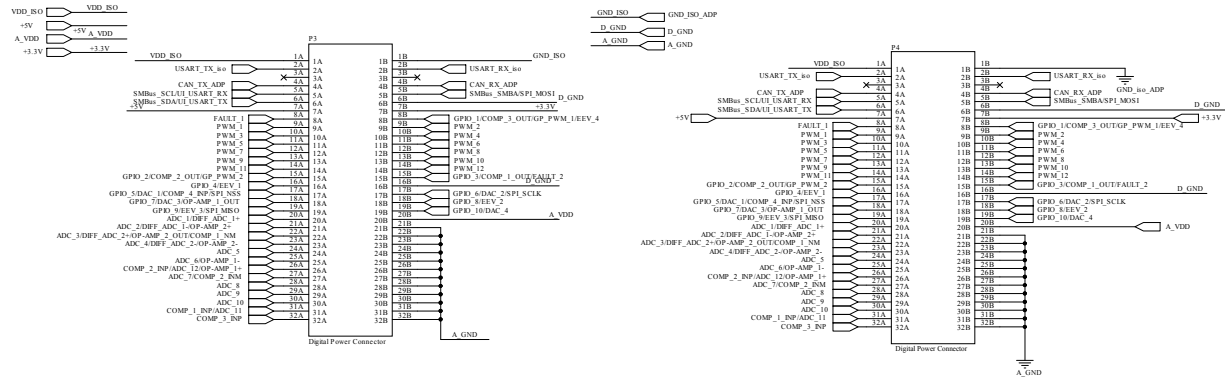


Figure 8. Mother board circuit schematic - DSMP5 connector

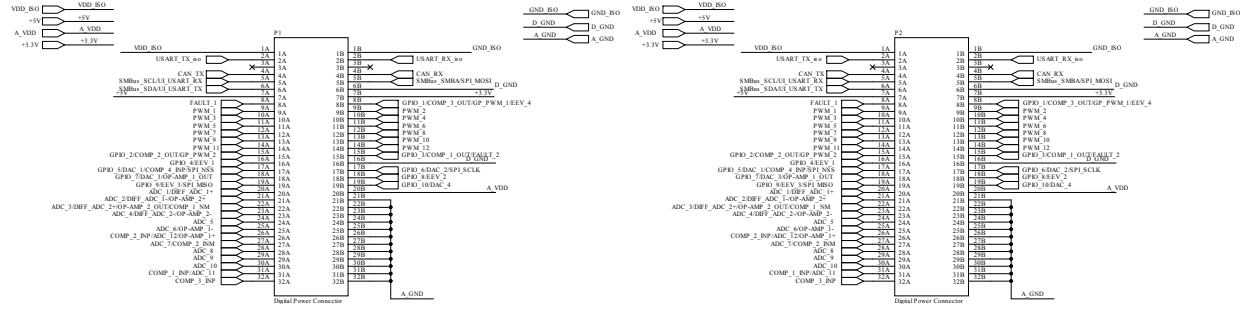


Figure 9. Mother board circuit schematic - A6387 LLC (1 of 4)

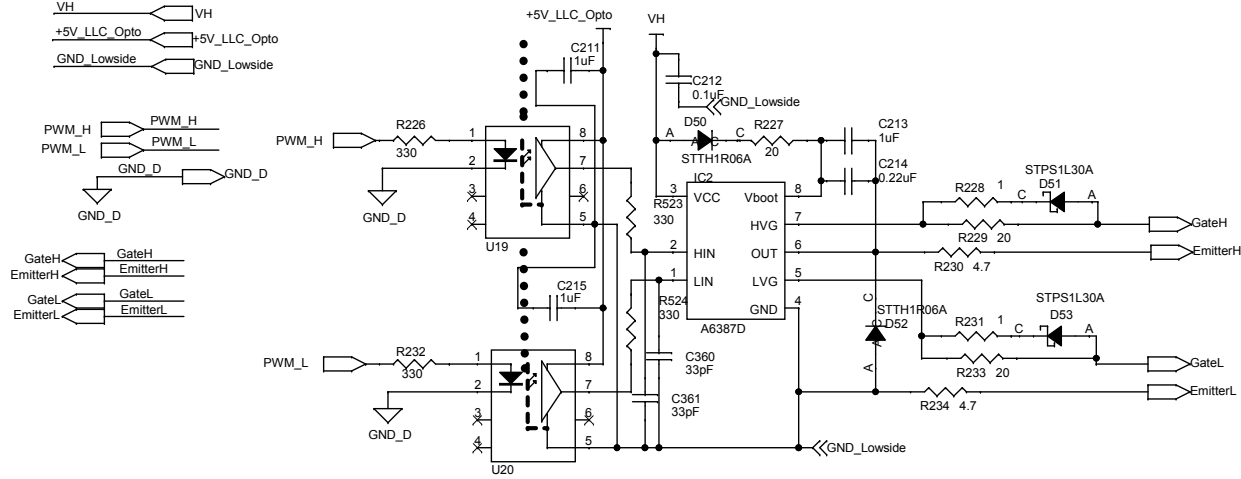


Figure 10. Mother board circuit schematic - A6387 LLC (2 of 4)

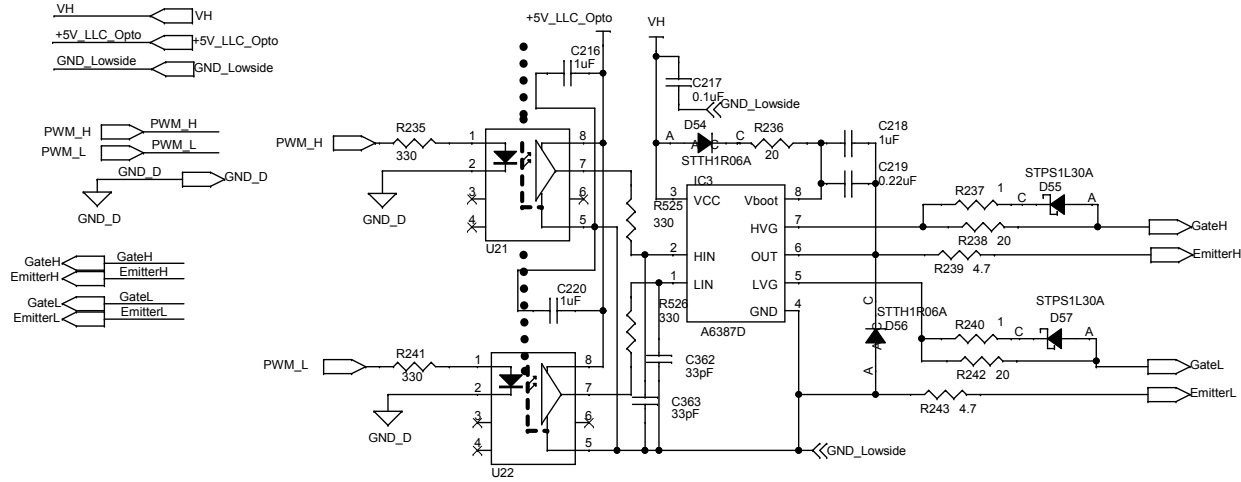


Figure 11. Mother board circuit schematic - A6387 LLC (3 of 4)

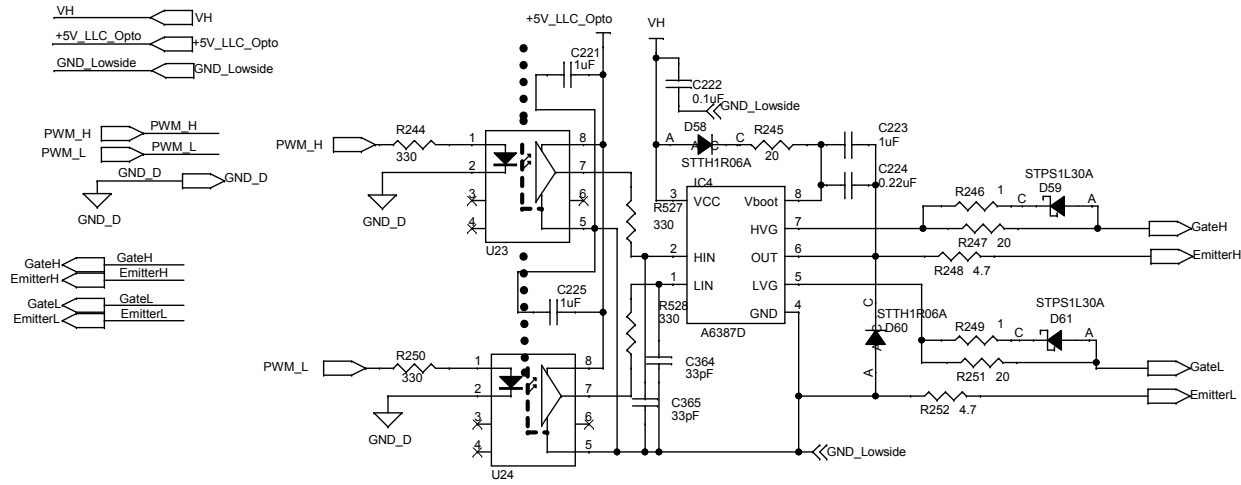


Figure 12. Mother board circuit schematic - A6387 LLC (4 of 4)

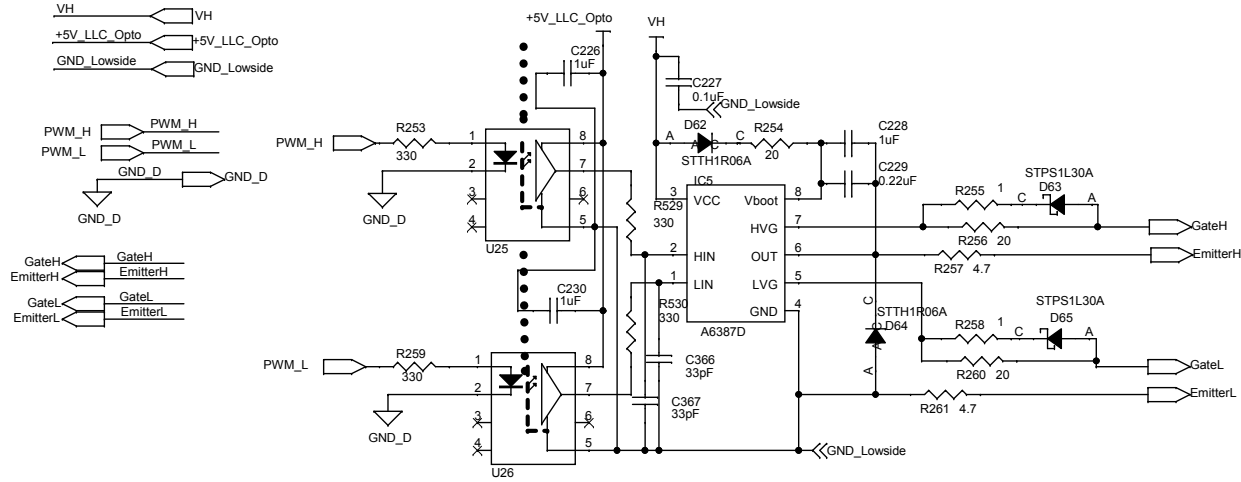


Figure 13. Mother board circuit schematic - STGAP1AS PFC (1 of 4)

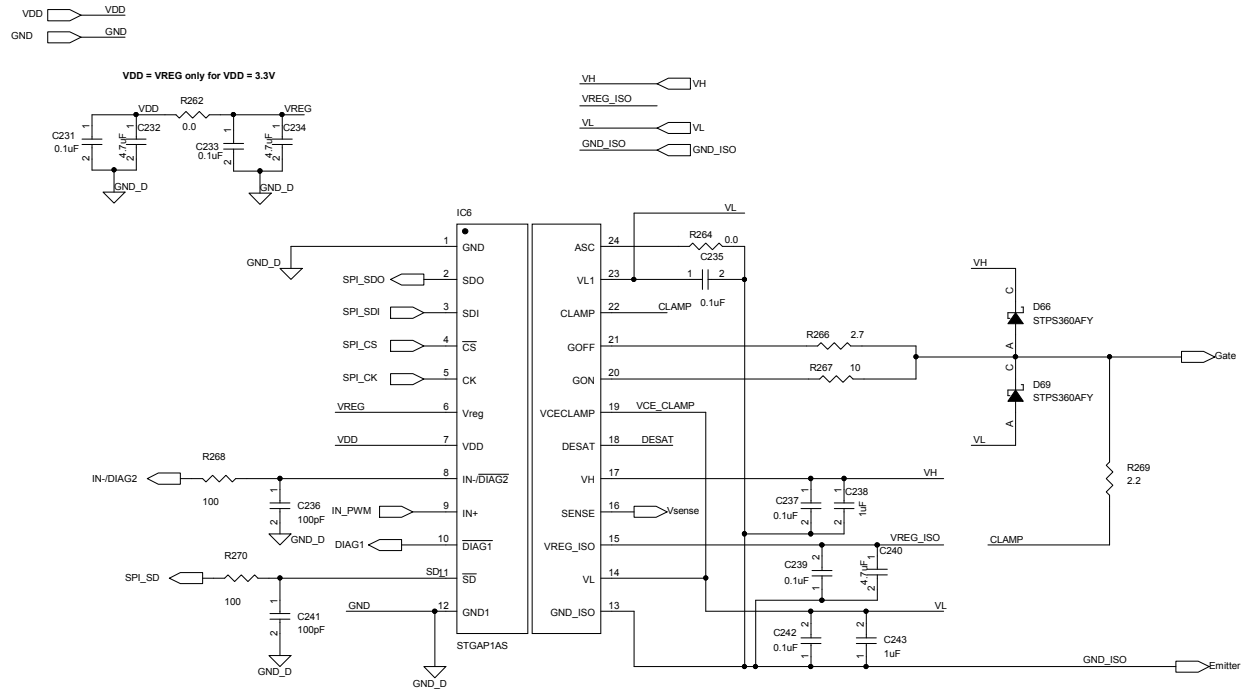


Figure 14. Mother board circuit schematic - STGAP1AS PFC (2 of 4)

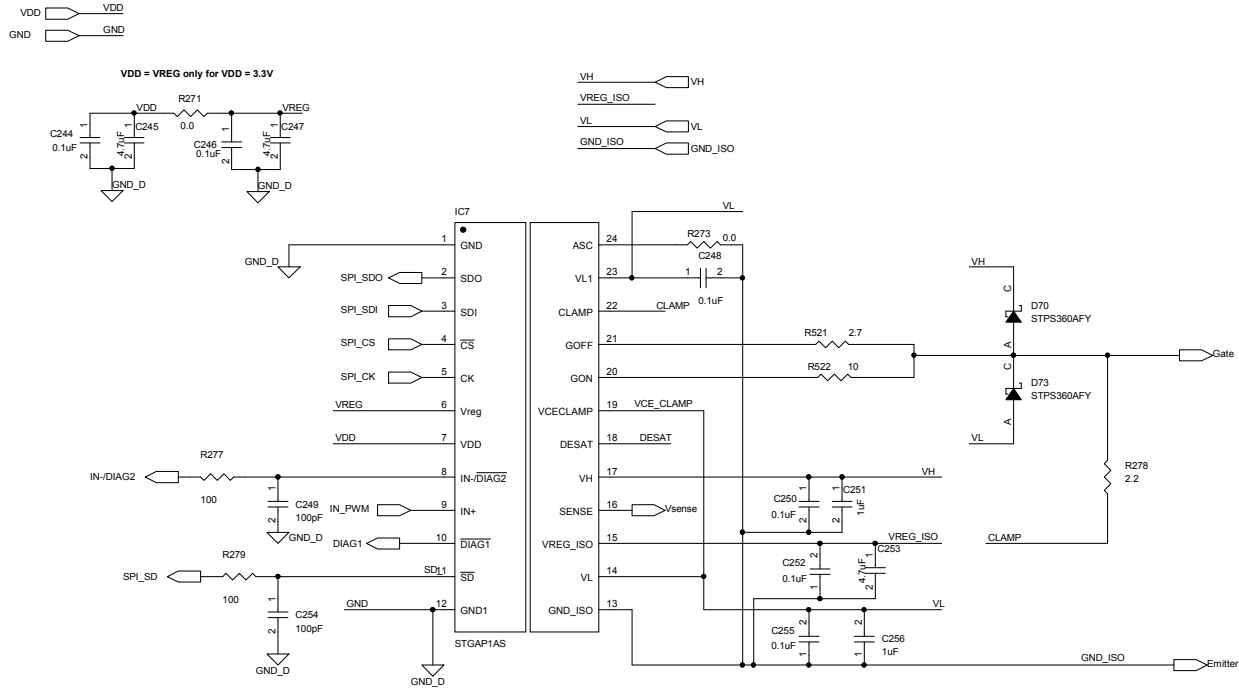


Figure 15. Mother board circuit schematic - STGAP1AS PFC (3 of 4)

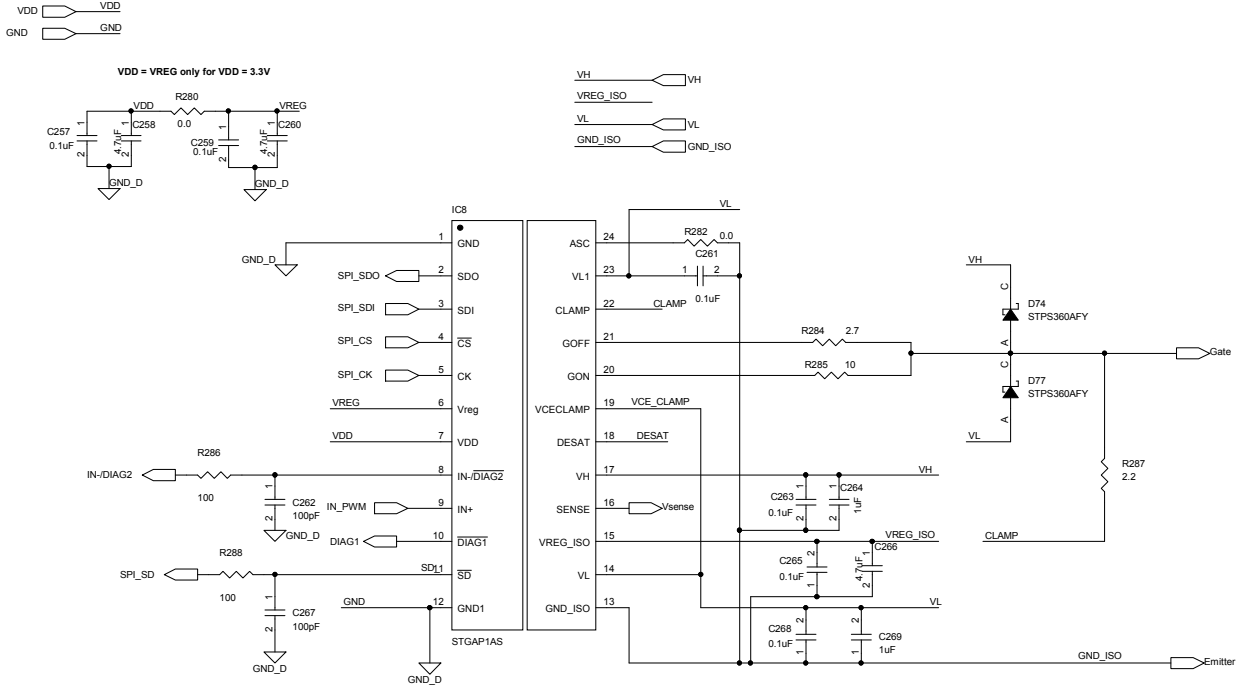


Figure 16. Mother board circuit schematic - STGAP1AS PFC (4 of 4)

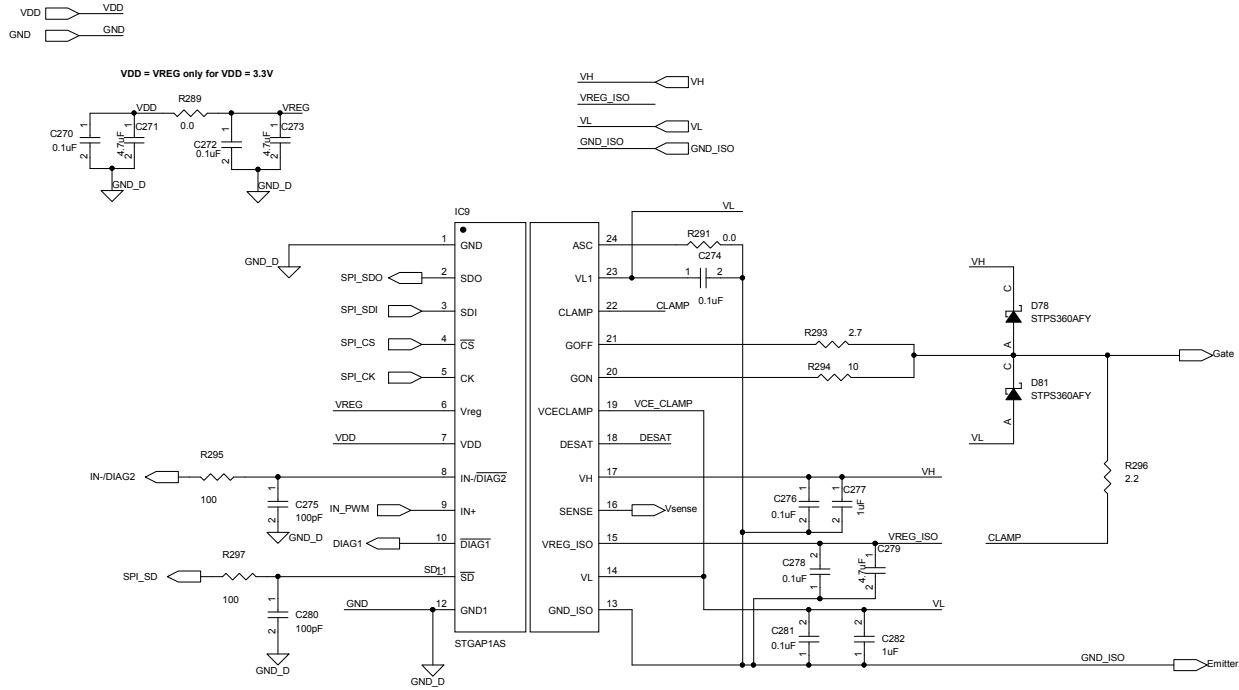


Figure 17. Mother board circuit schematic - A6387 drivers plus IMS connector

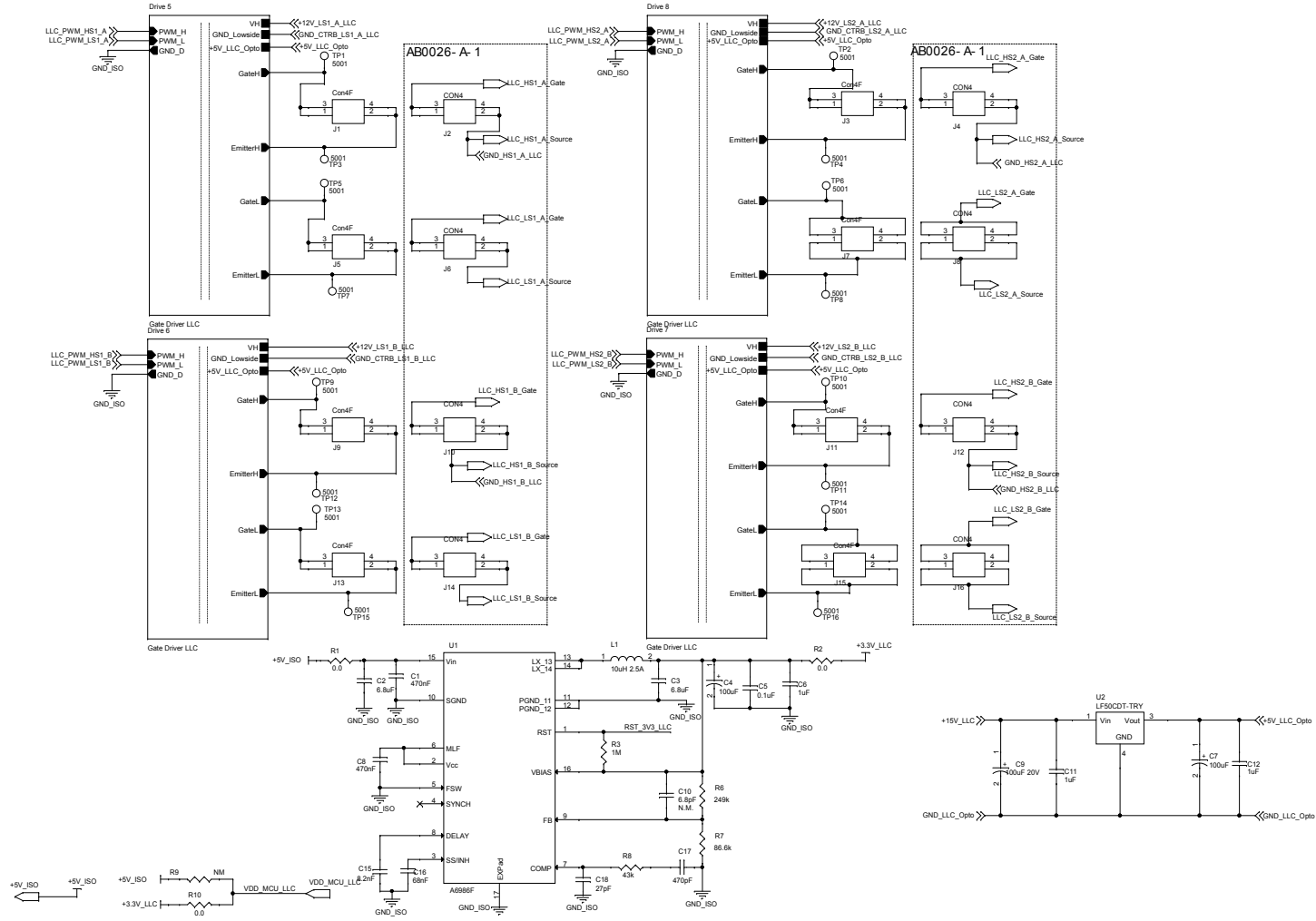


Figure 18. Mother board circuit schematic - full bridge LLC plus diodes on IMS

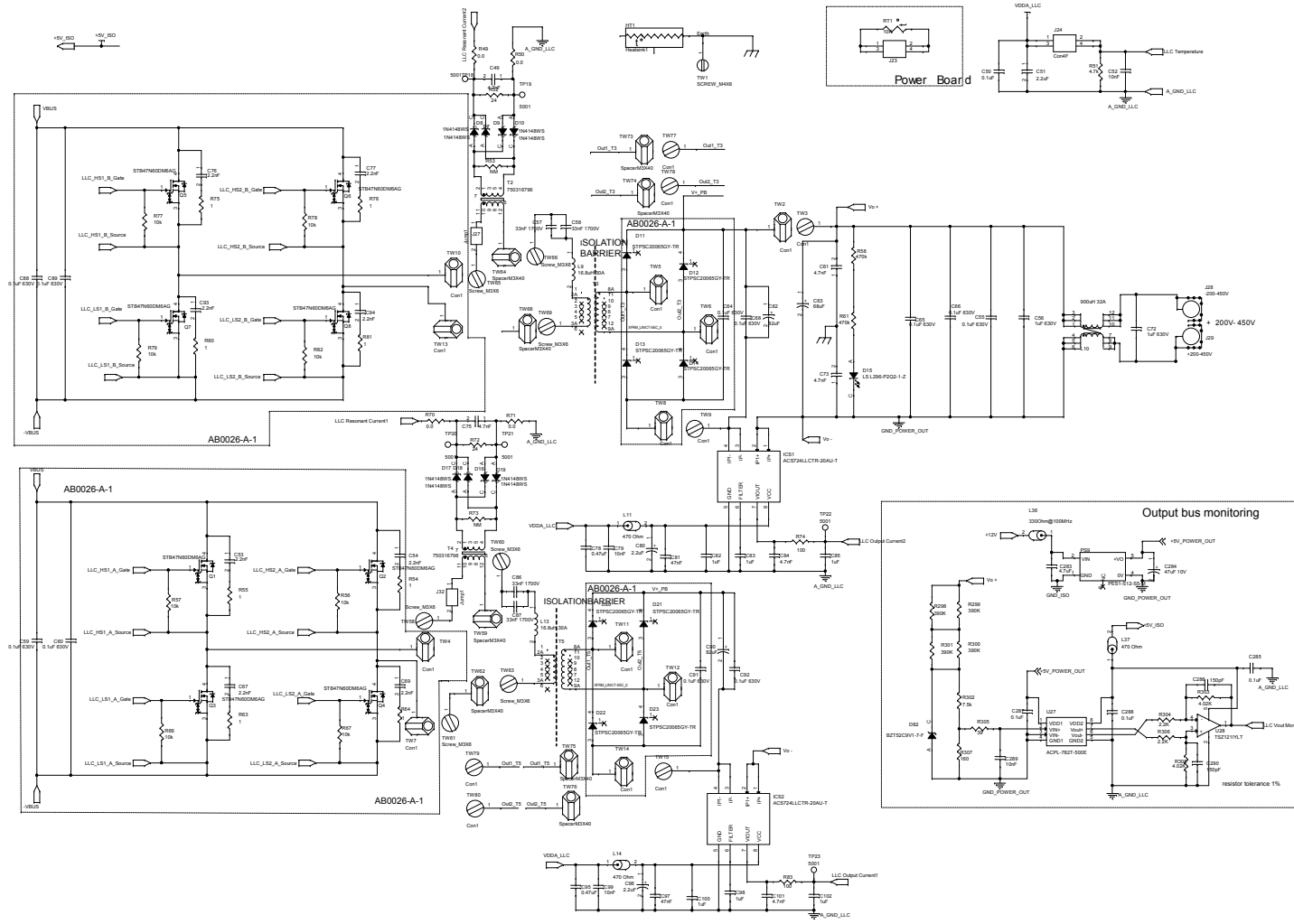
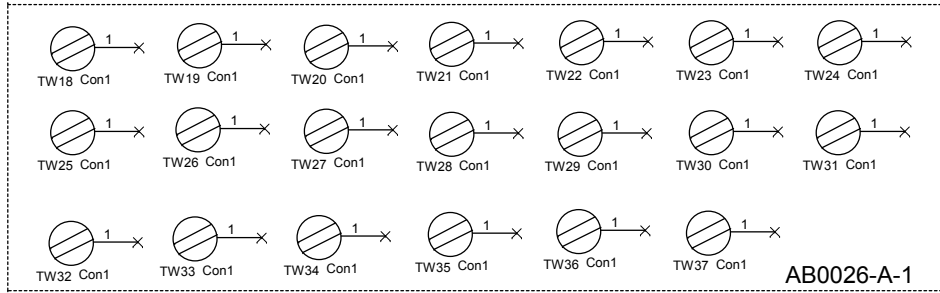


Figure 19. IMS board and mother board mechanical parts



Clips 455-2522-1-ND

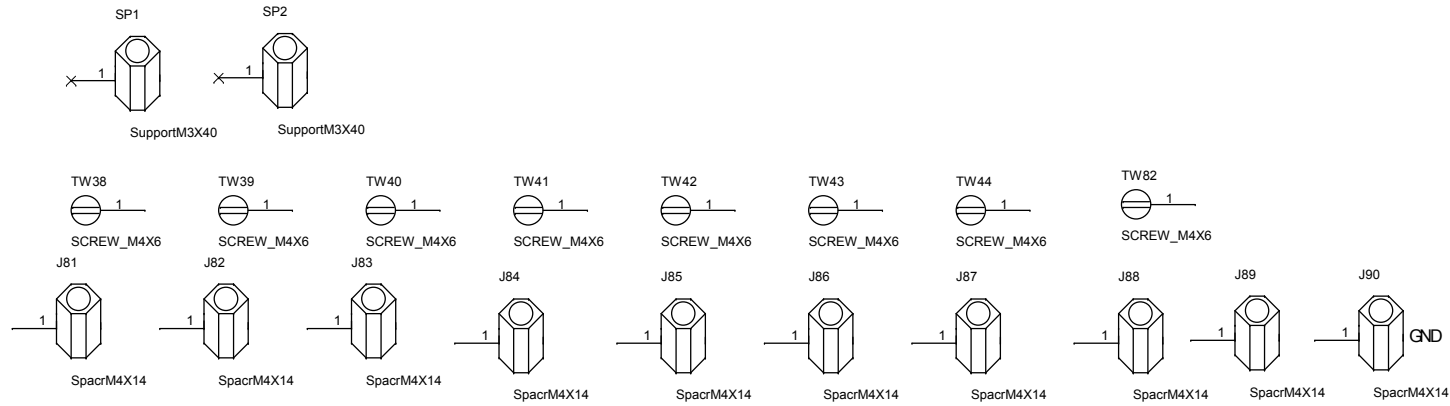


Figure 20. Mother board circuit schematic - PFC GAP drivers plus IMS connector

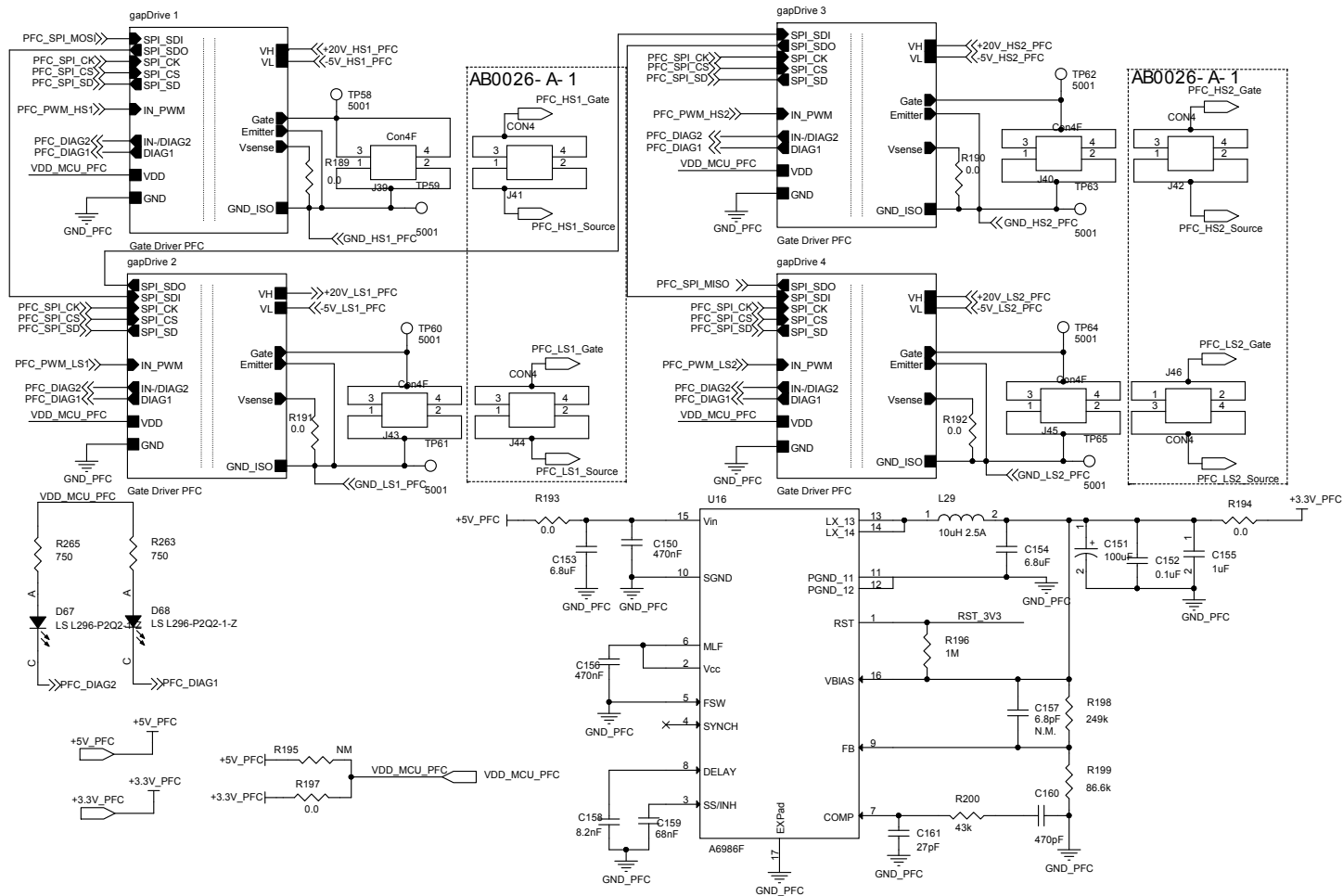


Figure 21. IMS board circuit schematic - SCR drivers plus IMS connectors

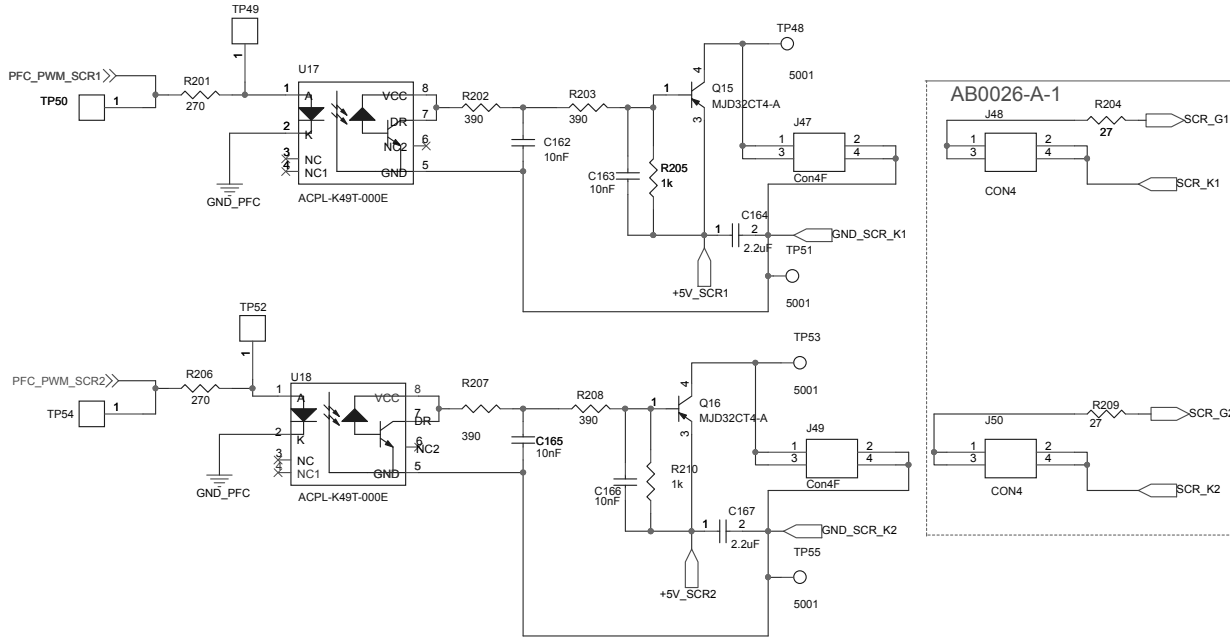


Figure 22. IMS board circuit schematic - totem pole PFC and current sensors

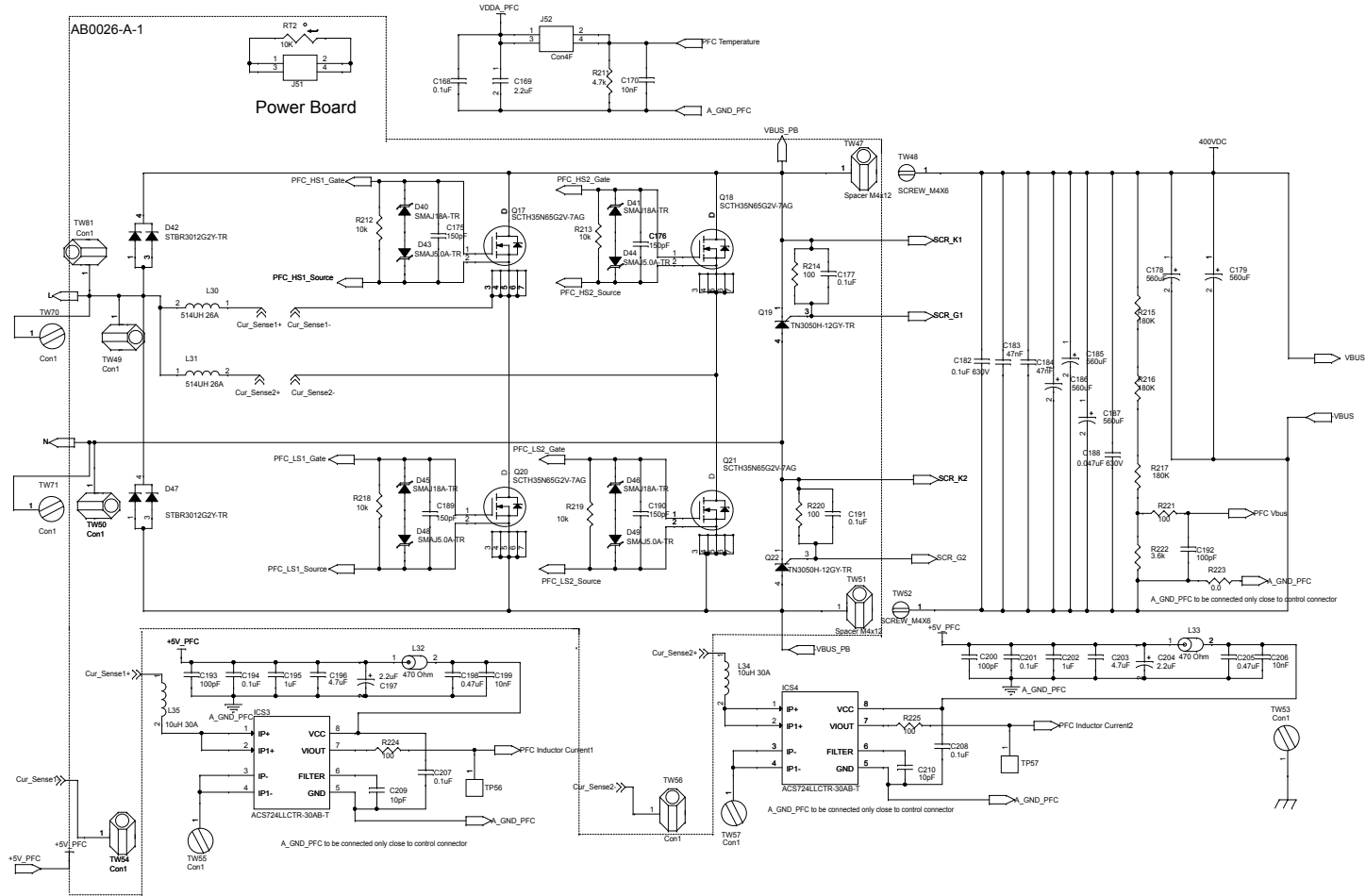


Figure 23. Control board circuit schematic - communication

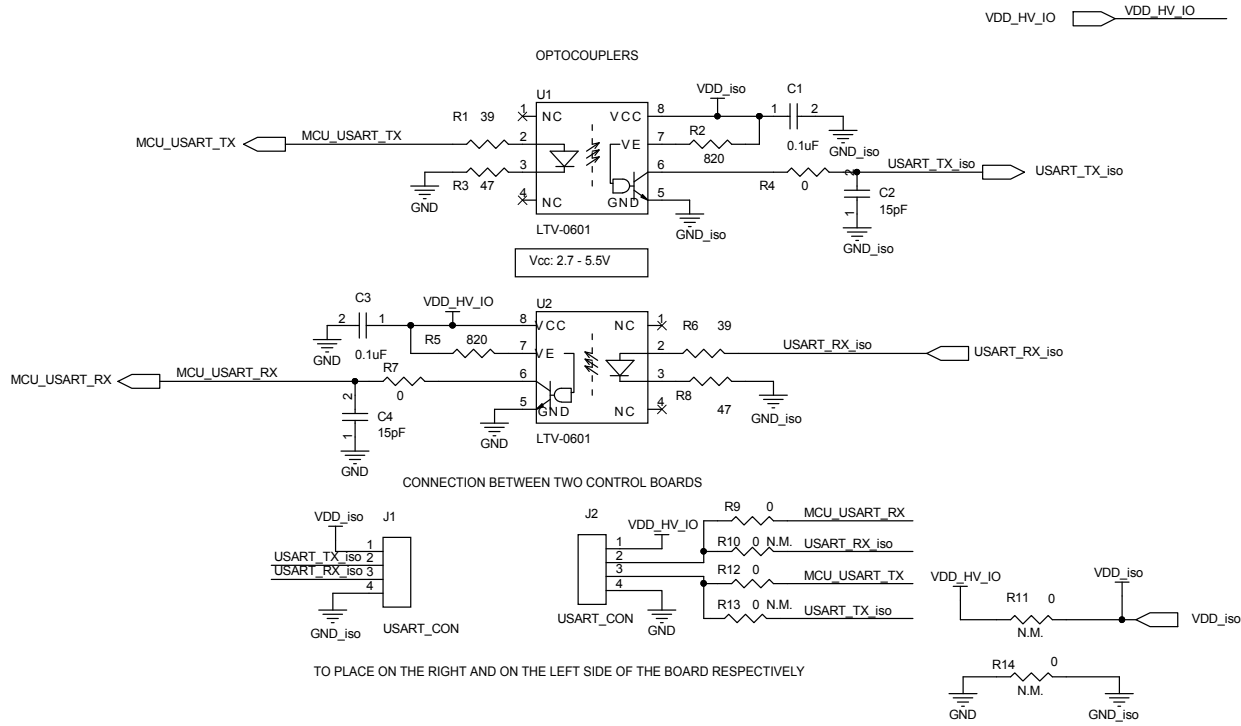


Figure 24. Control board circuit schematic - comparators

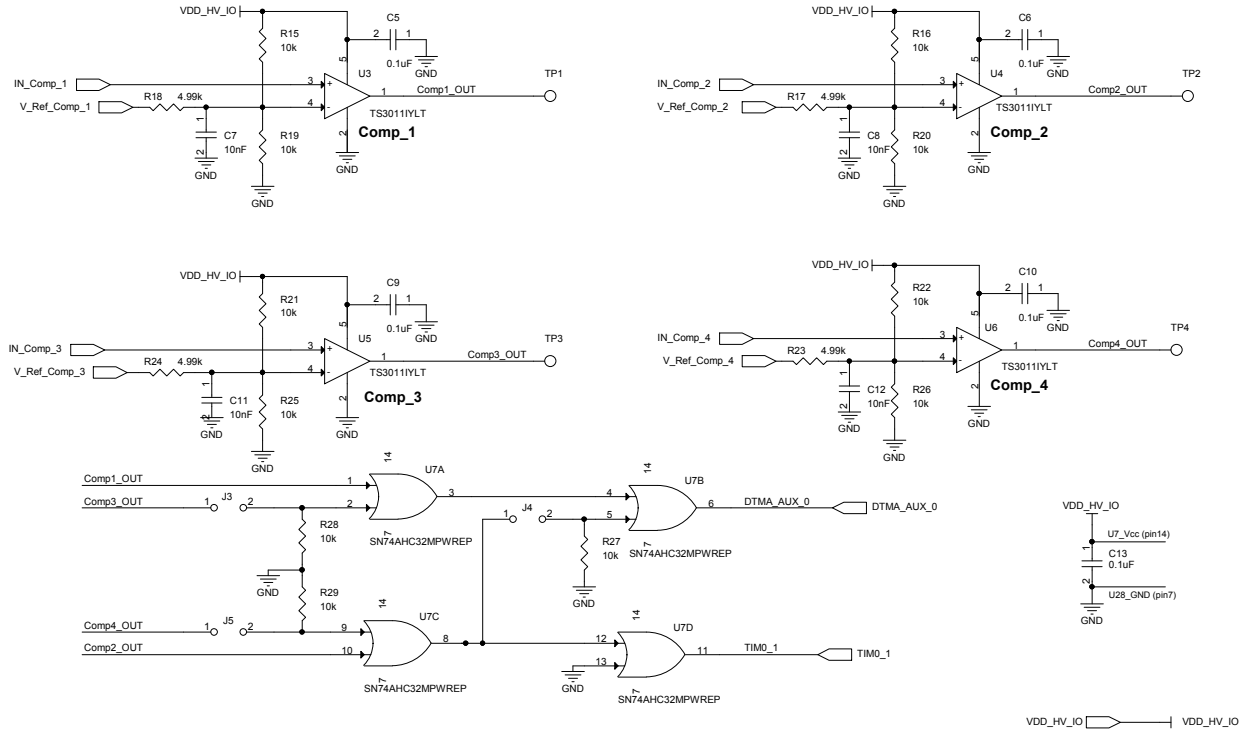


Figure 25. Control board circuit schematic - DSMPS connector

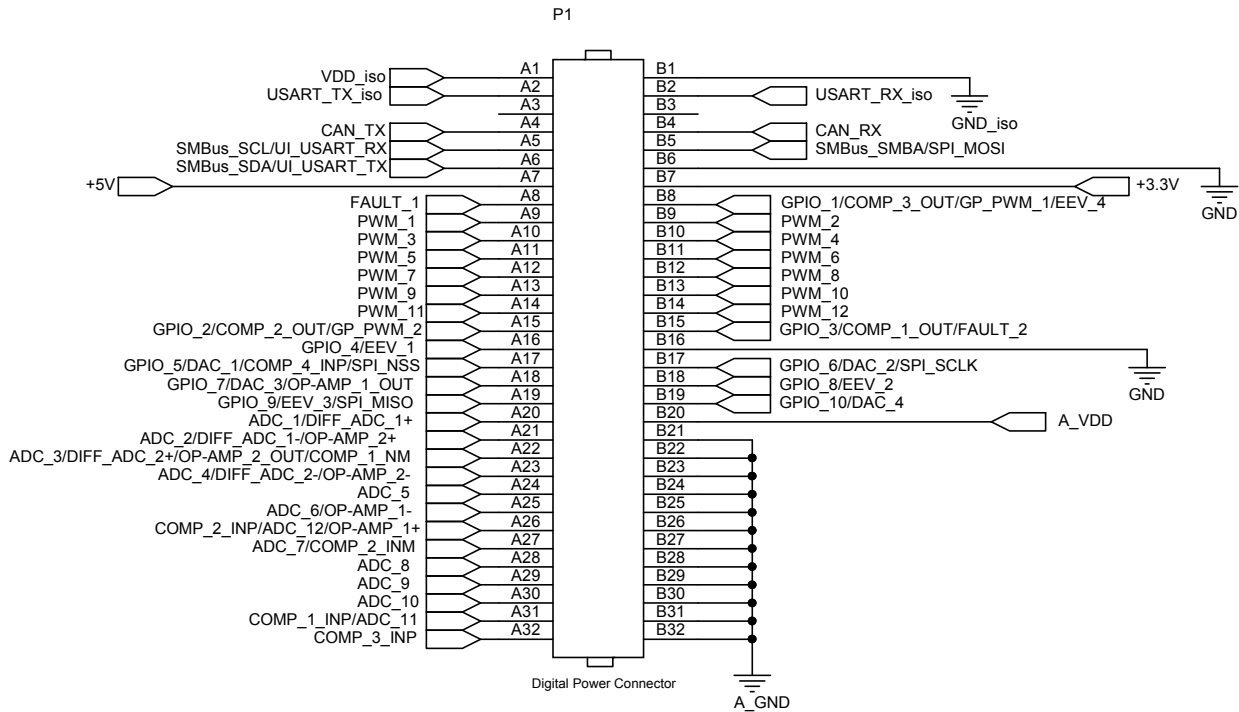


Figure 26. Control board circuit schematic - SPC58NN84E7 MCU IO

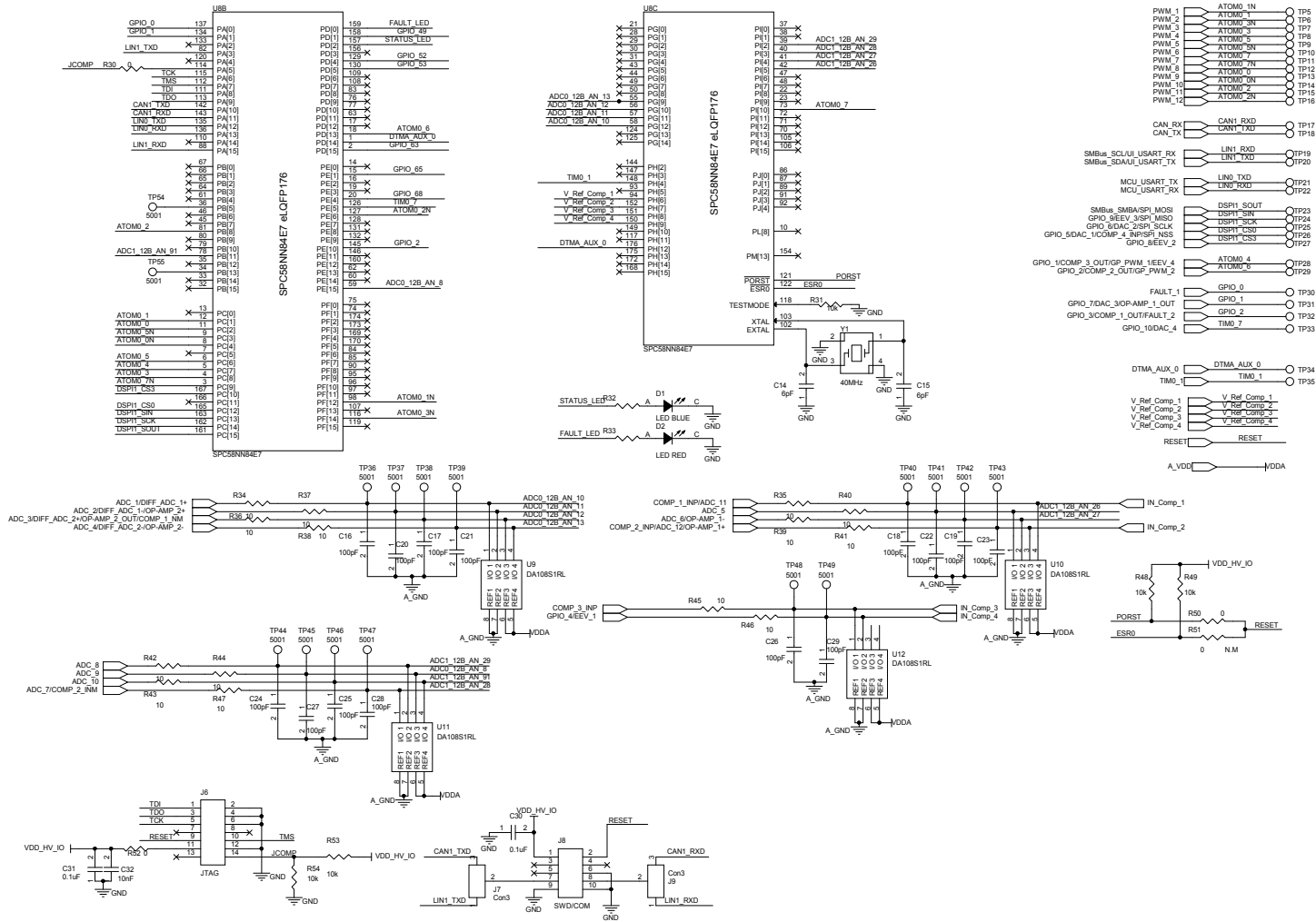


Figure 27. Control board circuit schematic - SPC58NN84E7 MCU PSU

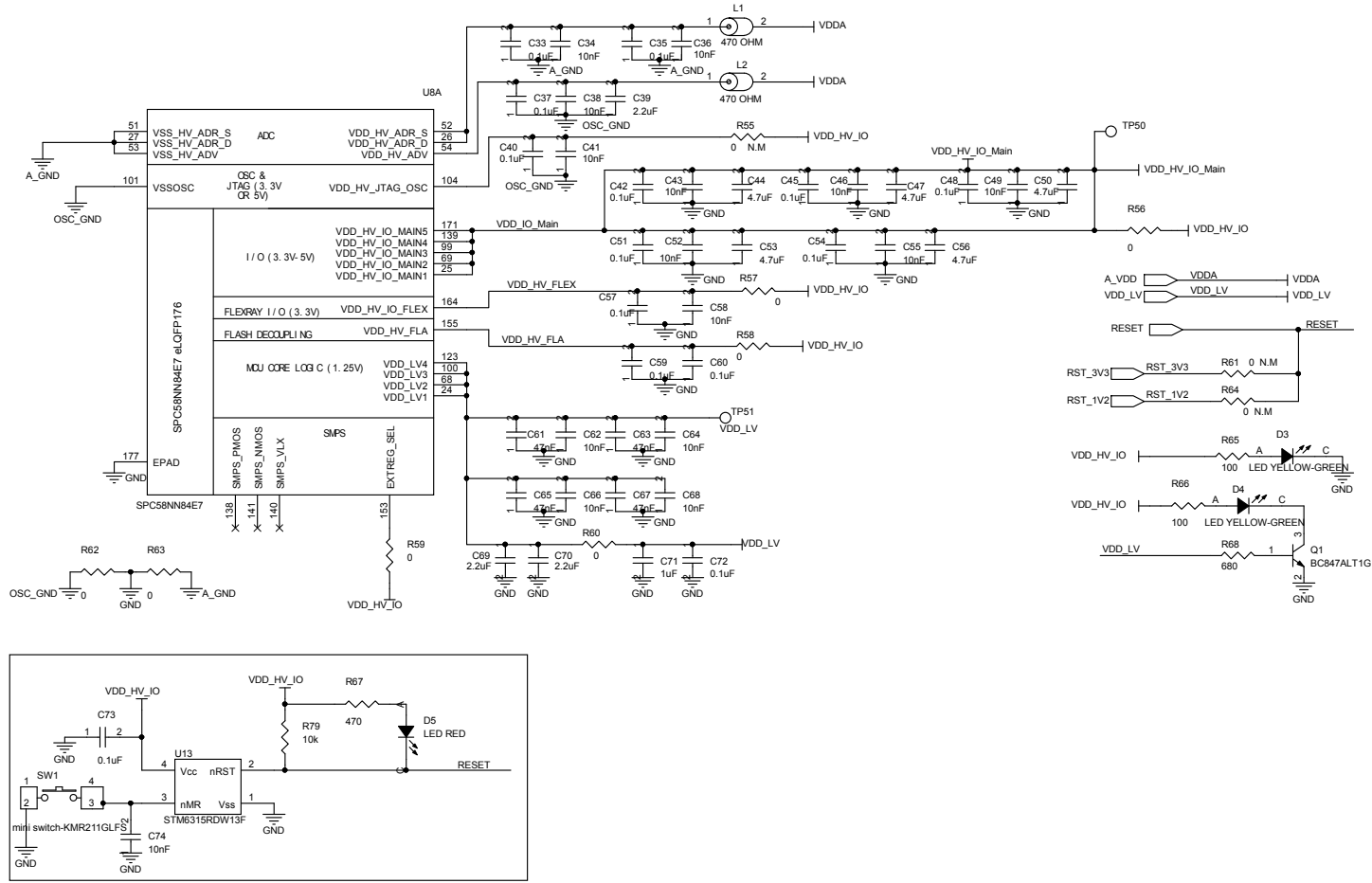
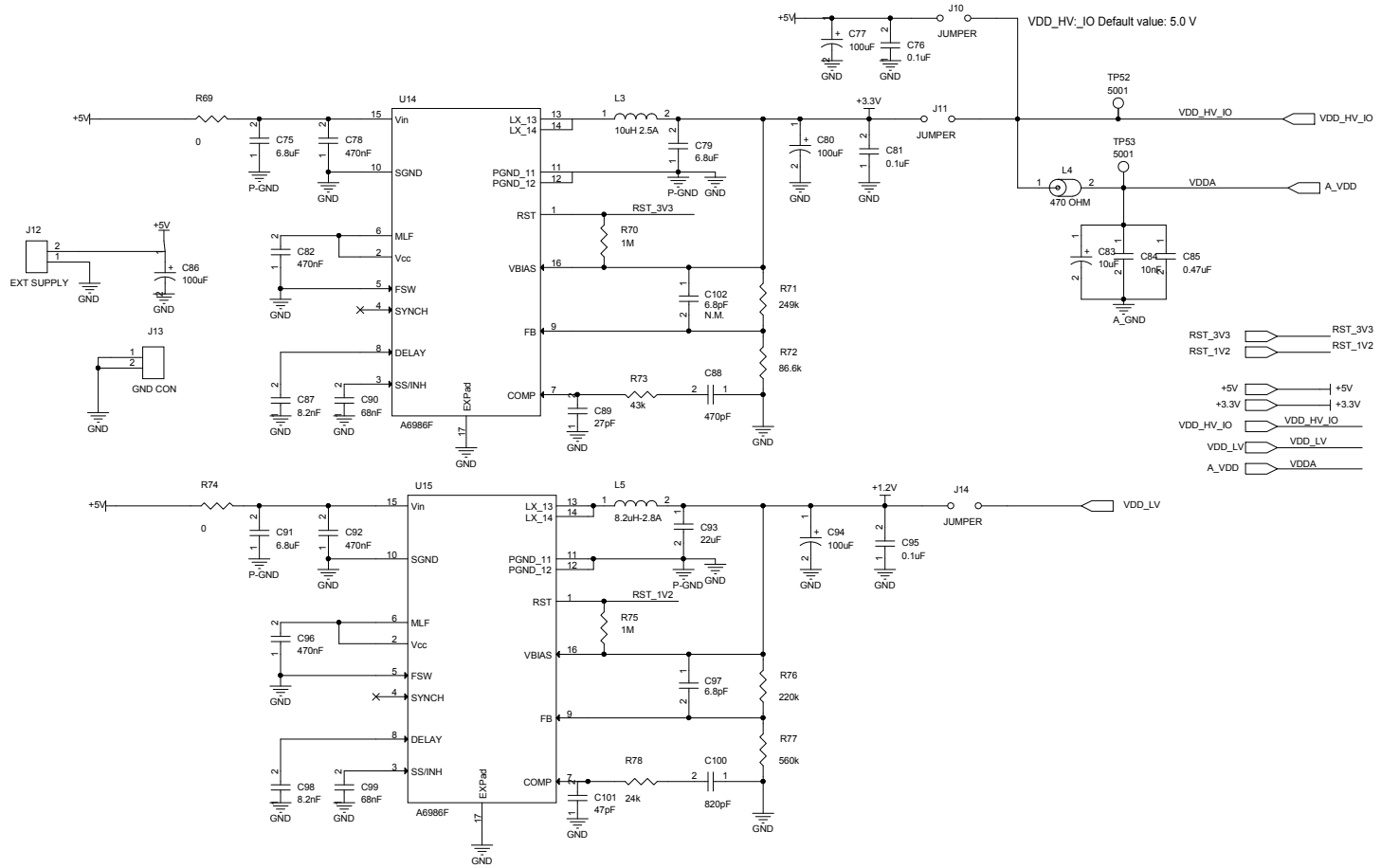


Figure 28. Control board circuit schematic - power supply



Revision history

Table 1. Document revision history

Date	Revision	Changes
06-Aug-2021	1	Initial release.
24-Jan-2022	2	Added reference to SPC58NN84E7RMHBR. Updated Section 1 Schematic diagrams .

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