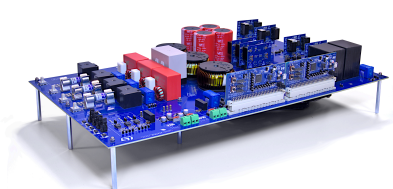


11 kW bidirectional battery charger based on three phase two level PFC and isolated DC-DC converter



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

Features

- PFC stage: 3-phase, 2-level bidirectional AC-DC power converter
 - Rated nominal AC voltage: 400 Vac at 50Hz
 - Rated nominal DC voltage: 800 Vdc
 - Nominal power: 11 kW
 - Rectifier mode:
 - Power factor: $PF > 0.99$
 - Inrush current control and soft startup
 - Inverter mode:
 - Active and reactive power control
 - Integrated grid connection solution
- DC-DC stage: dual active bridge (DAB)/CLLC power converter
 - Nominal DC input voltage: 800 V
 - Nominal DC output voltage: 550 to 850 V
 - DAB switching frequency: 100 kHz
 - CLLC switching frequency range: 82 to 235 kHz
- Power section based on SiC power modules
 - ACEPACK DMT-32 power module for high integration level
 - High frequency operation for weight and size reduction
 - Bidirectional capabilities
 - DAB soft switching behavior enabled by enhanced modulation techniques management

Description

The **STDES-BCBIDIR** is an 11 kW bidirectional battery charger and represents a complete solution for high voltage charging in both the industrial and automotive fields.

It consists of two power stages: a PFC and an isolated DC-DC stage. The PFC is based on a three-phase full-bridge topology.

The structure of the DC-DC section can be configured in DAB or CLLC topologies thanks to the external connection of the resonant cell.

Both stages are based on the ACEPACK DMT-32 SiC power module. The solution uses two control boards for the PFC and DC-DC stages respectively. The control board is based on the **STM32G474RE** microcontroller.

The PFC stage operating frequency is 70 kHz. The DC-DC stage is operating at fixed switching frequency (100kHz) or variable switching frequency (82 to 235 kHz), respectively in DAB or CLLC topology.

A system peak efficiency greater than 96% was achieved for the design in direct mode.

Product summary	
11 kW bidirectional battery charger based on three phase two-level PFC and isolated DC-DC converter	STDES-BCBIDIR
Firmware for STDES-BCBIDIR, bidirectional power converter for battery charging applications	STSW-BCBIDIR
Automotive-grade ACEPACK DMT-32 power module, fourpack topology, 1200 V, 47.5 mOhm typ. SiC Power MOSFET with NTC	M1F45M12W2-1LA
Mainstream Arm Cortex-M4 MCU 170 MHz with 512 Kbytes of Flash memory, Math Accelerator, HR Timer, High Analog level integration	STM32G474RET3
Galvanically isolated 4 A dual gate driver	STGAP2SiCD
Applications	Battery Storage Systems for Home On Board Charger (OBC)

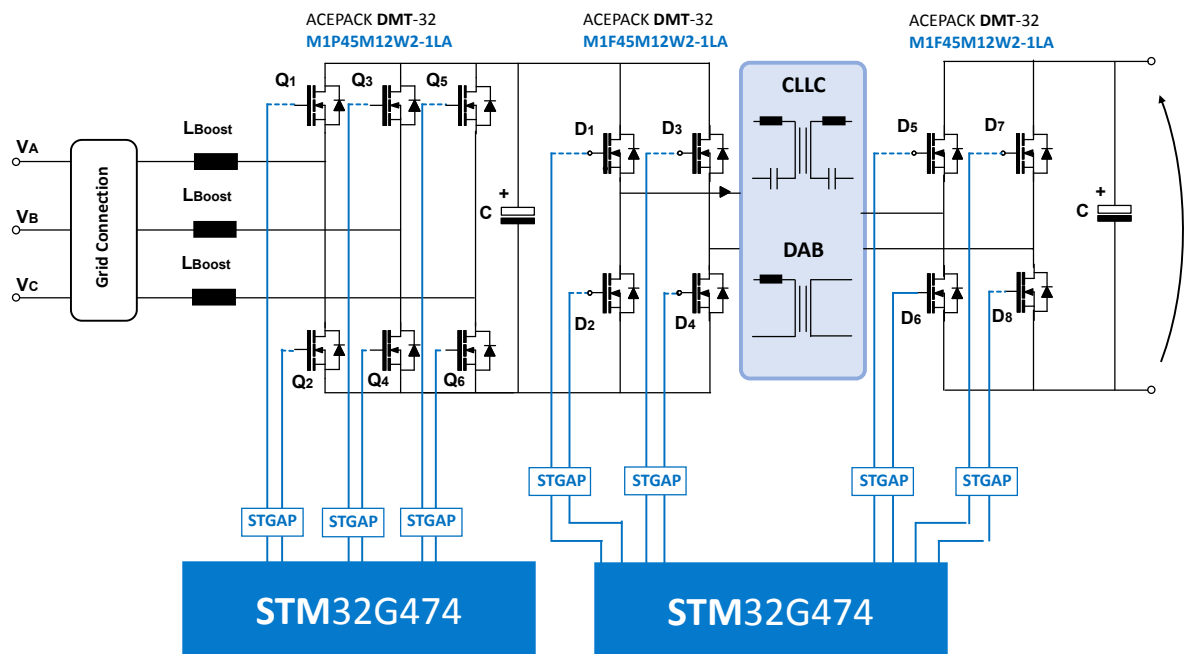
1 Block diagrams

STDES-BCBIDIR consists of two power stage and an 11 kW single magnetic component, including the isolation transformer and the resonant inductances (CLLC) or isolation transformer and the leakage inductance (DAB).

The HW modular structure consists of the following building blocks:

- A main power board with ACEPACK DMT-32 SiC power modules, sixpack topology M1P45M12W2-1LA for PFC stage, and two full bridge M1F45M12W2-1LA for the two sides of DC-DC stage. In addition to the power modules, bulk capacitor, sensing sections and auxiliary power supply are also present.
- A driver board for full bridge and sixpack ACEPACK DMT-32 SiC power modules based on STGAP2SiCD galvanically isolated 4 A dual gate driver for SiC MOSFETs.
- A control board based on the STM32G474RE series of microcontroller with connectors for communication and programming, testpoints and status indicators for debugging and monitoring.

Figure 1. Block diagram for high visual impact

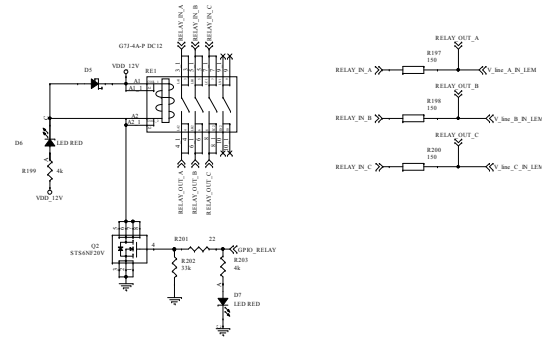


2

Schematic diagrams

Figure 2. STDES-BCBIDIR circuit schematic (1 of 18) - Power board

INRUSH RELAY SECTION



GRID RELAY DRIVING SECTION

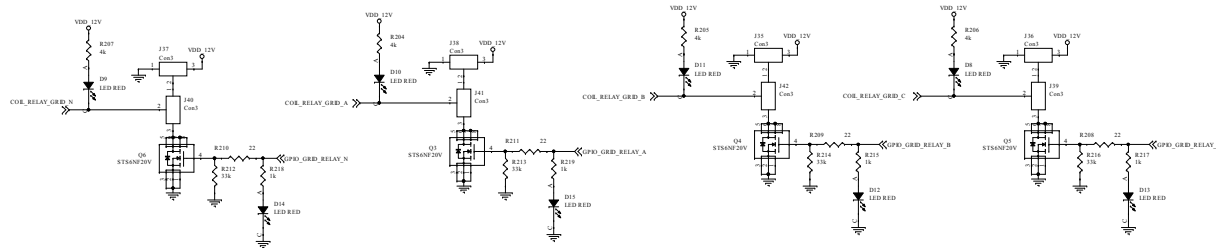


Figure 3. STDES-BCBIDIR circuit schematic (2 of 18) - Power board

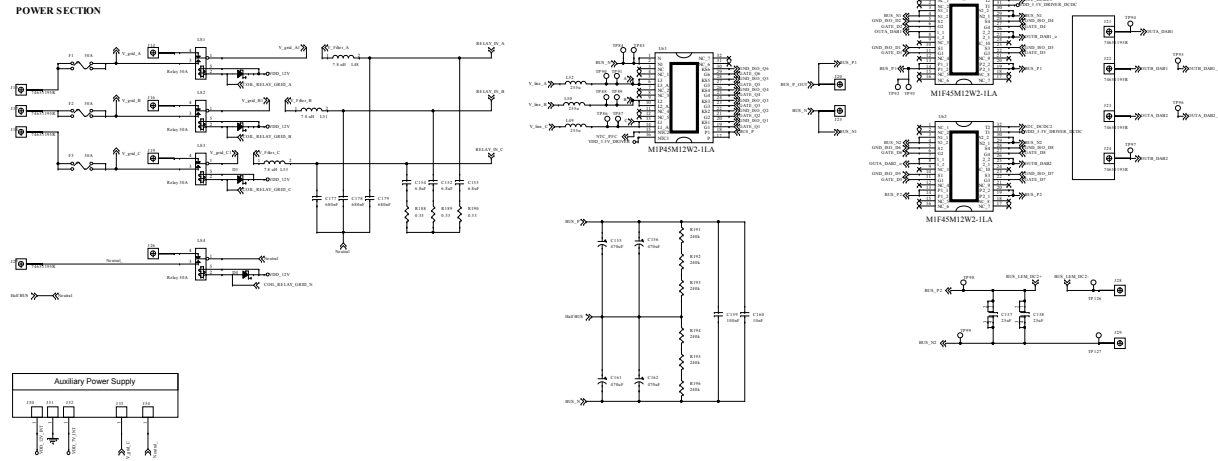


Figure 4. STDES-BCBIDIR circuit schematic (3 of 18) - Power board

LINE VOLTAGE SENSING

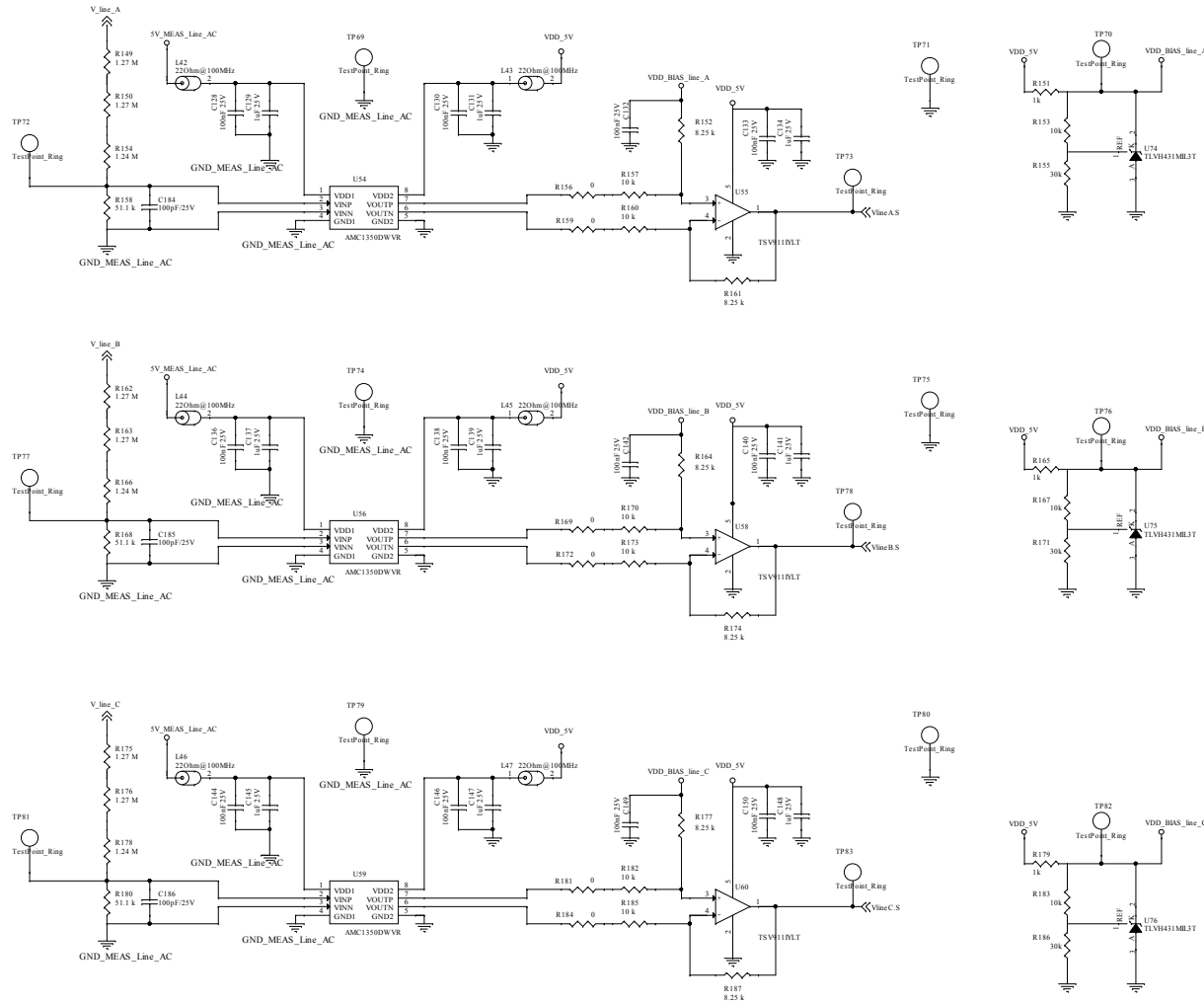


Figure 5. STDES-BCBIDR circuit schematic (4 of 18) - Power board

GRID VOLTAGE SENSING

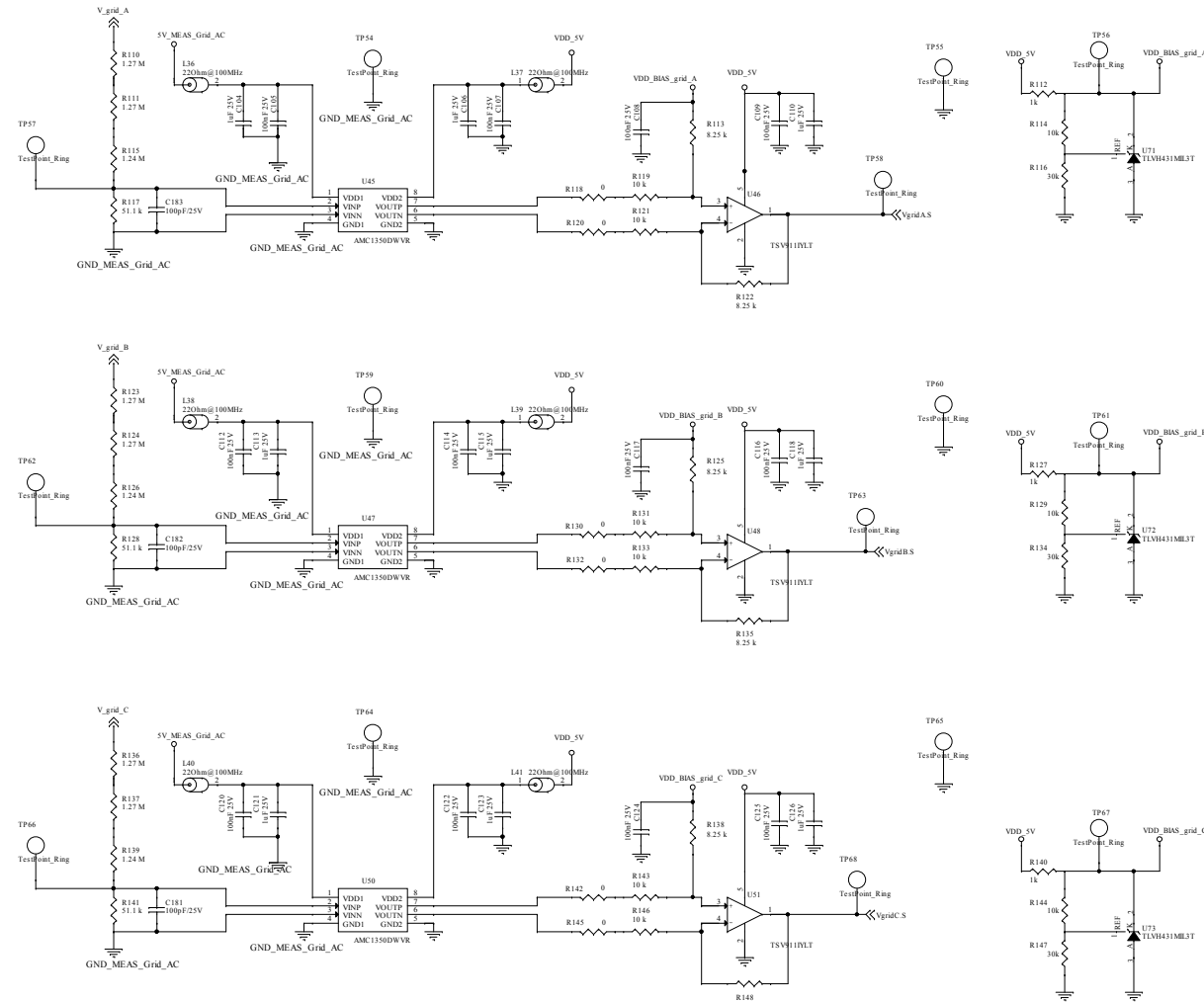


Figure 6. STDES-BCBIDIR circuit schematic (5 of 18) - Power board

GRID CURRENT SENSING

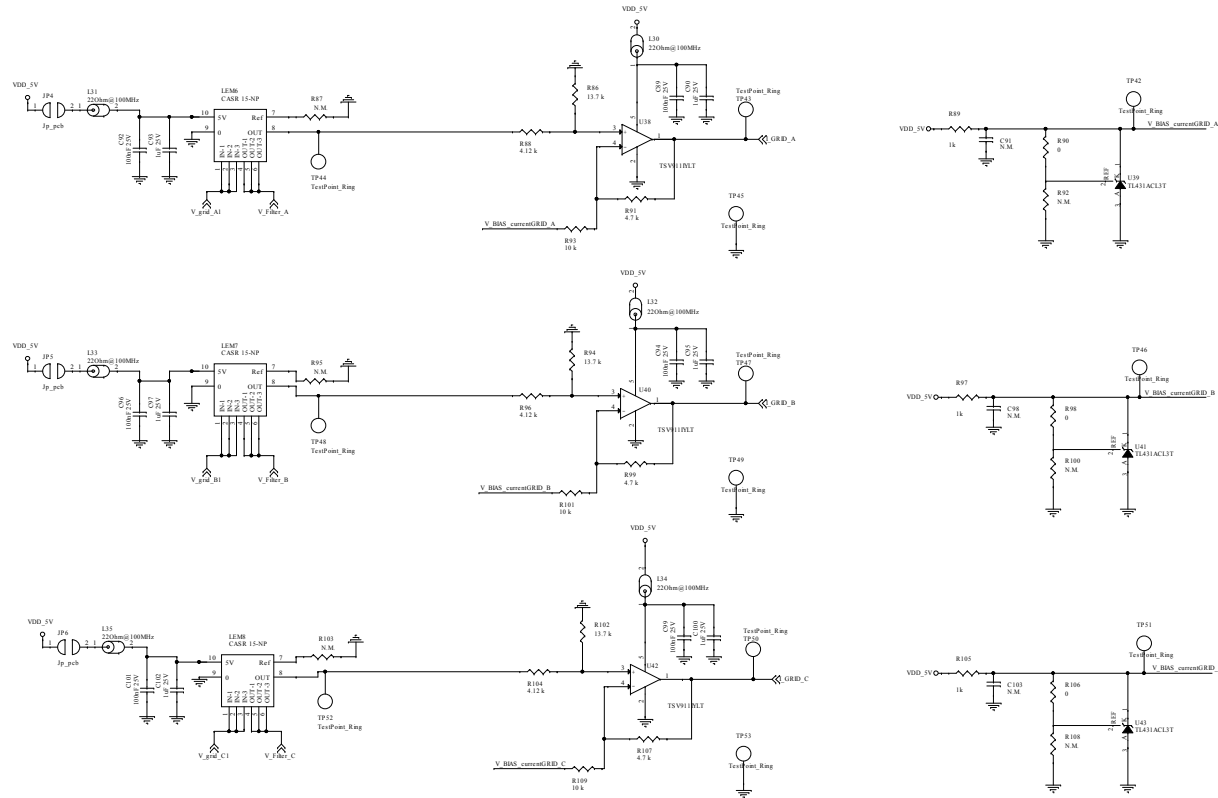


Figure 7. STDES-BCBIDIR circuit schematic (6 of 18) - Power board

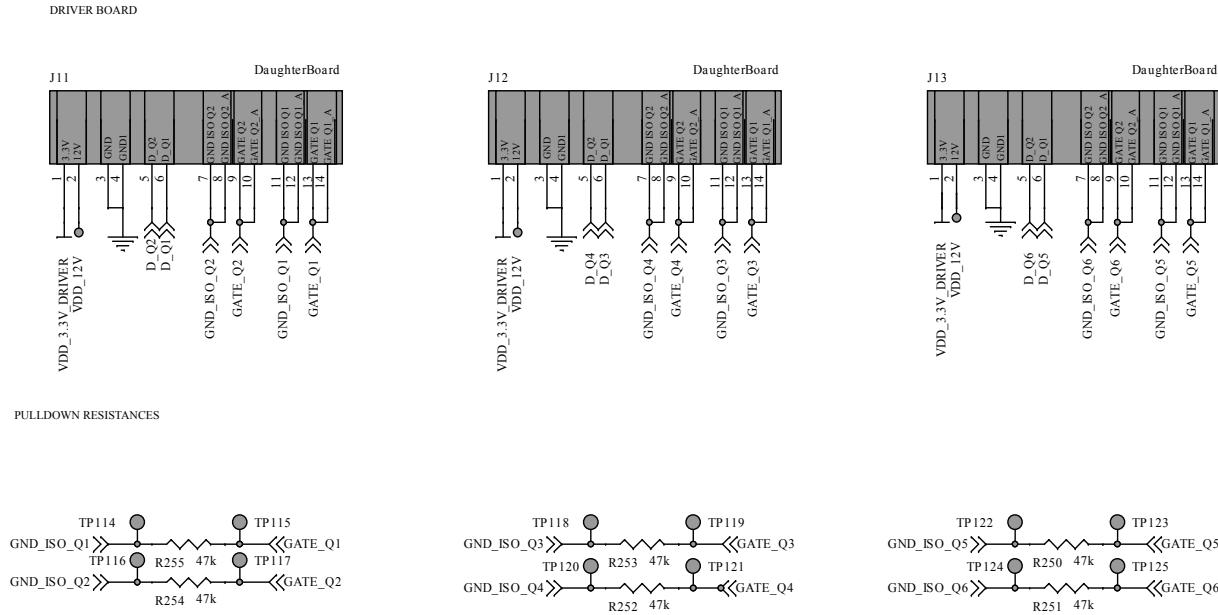


Figure 8. STDES-BCBIDIR circuit schematic (7 of 18) - Power board

PFC DC VOLTAGE SENSING

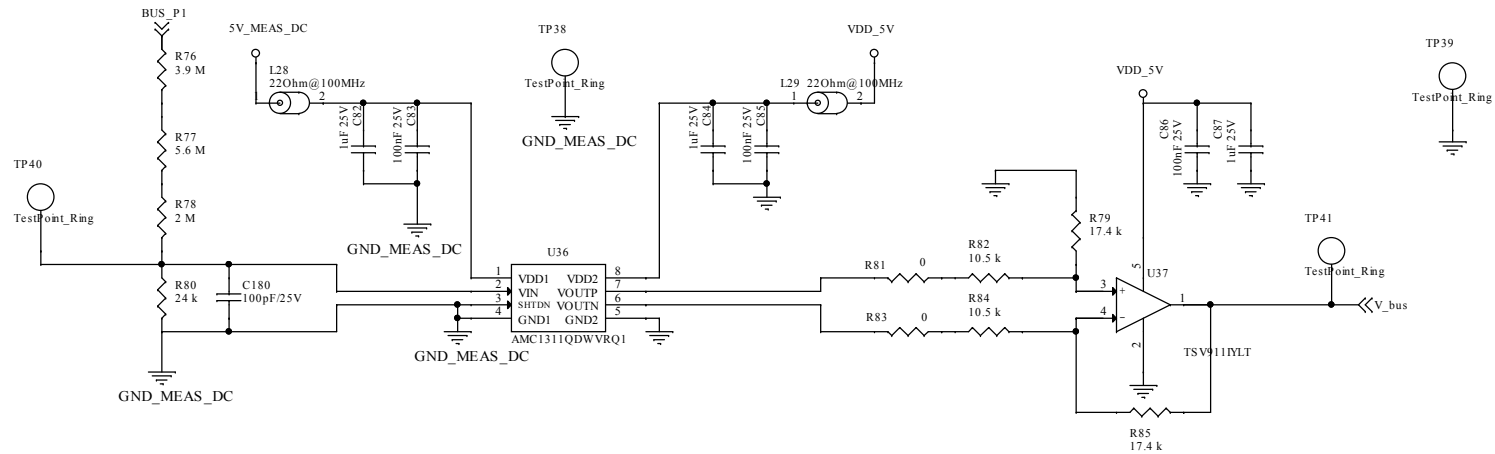


Figure 9. STDES-BCBIDIR circuit schematic (8 of 18) - Power board

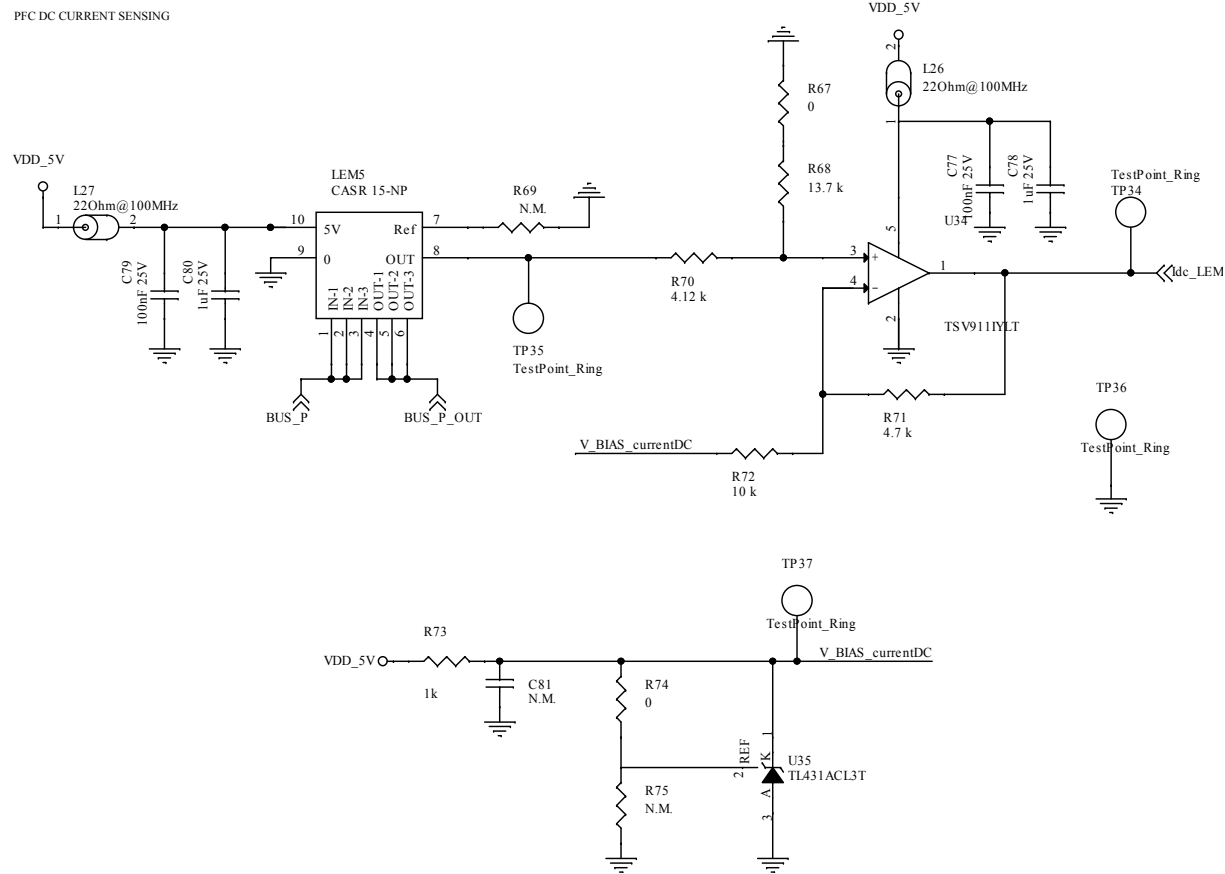


Figure 10. STDES-BCBIDIR circuit schematic (9 of 18) - Power board

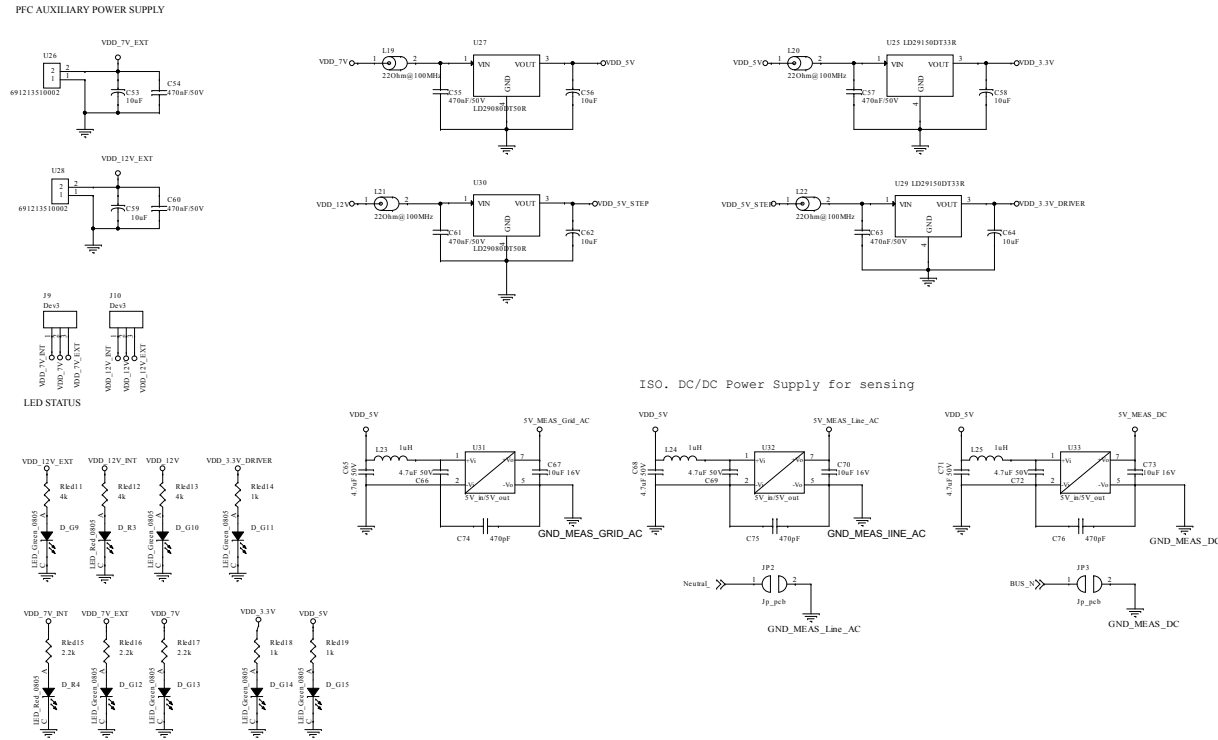


Figure 11. STDES-BCBIDIR circuit schematic (10 of 18) - Power board

AC CURRENT SENSING

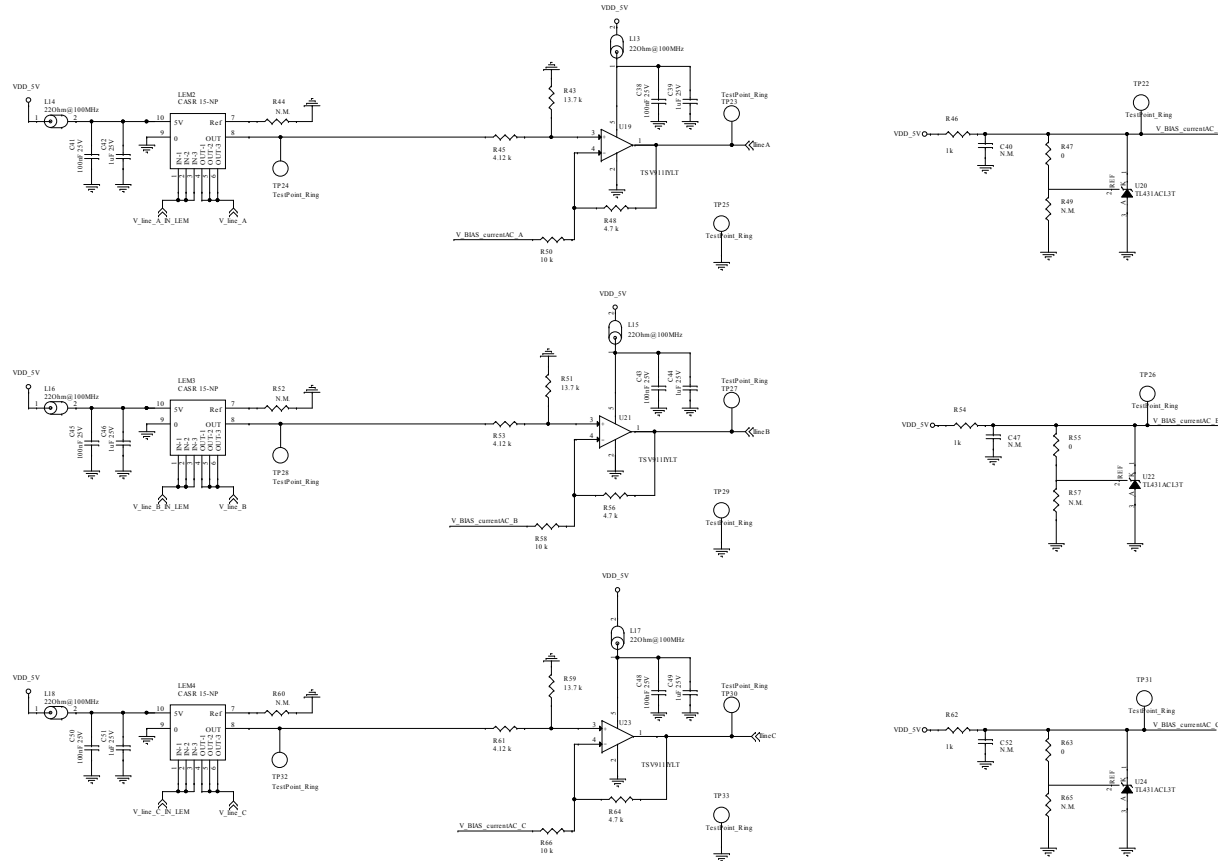


Figure 12. STDES-BCBIDIR circuit schematic (11 of 18) - Power board

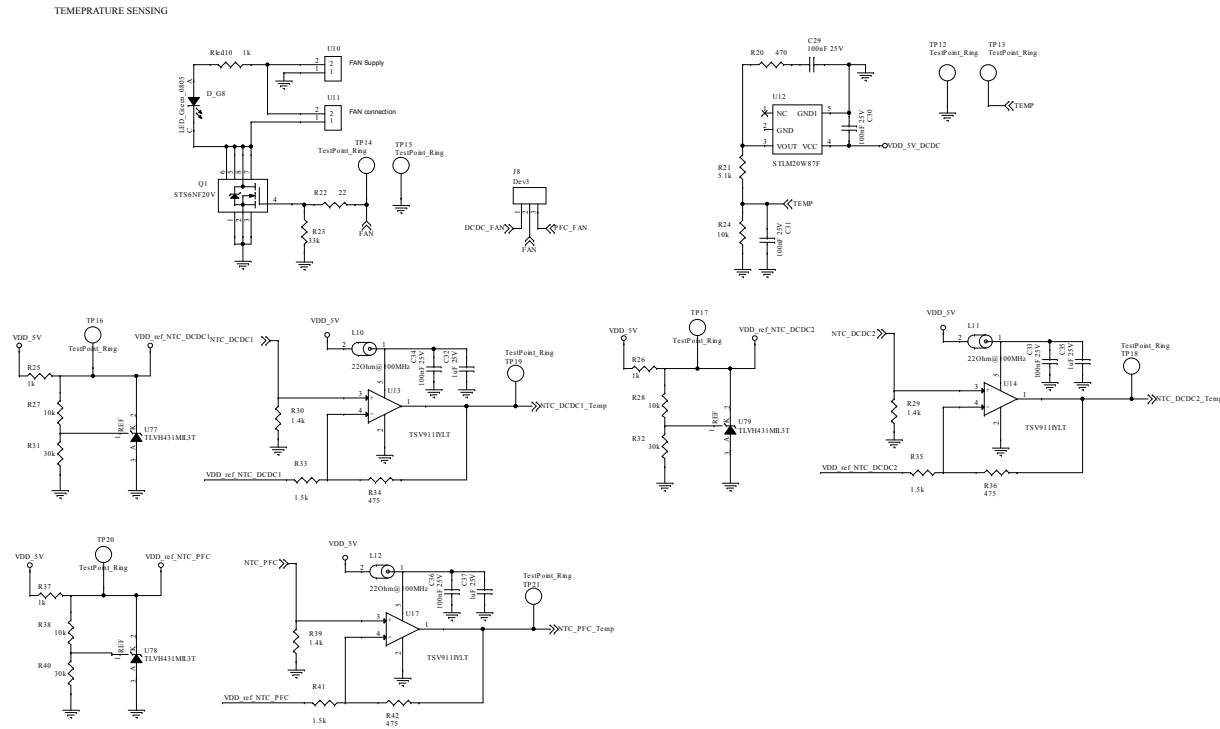
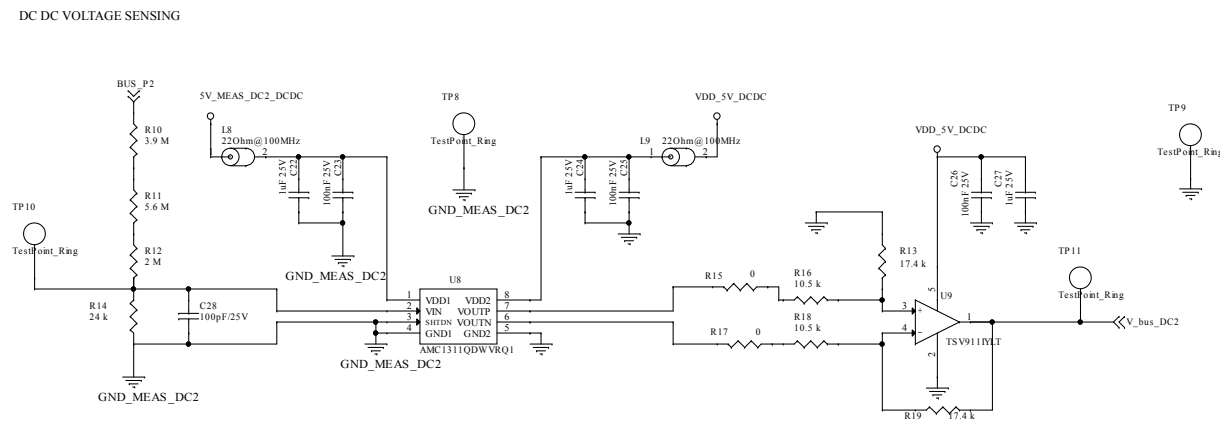


Figure 13. STDES-BCBIDIR circuit schematic (12 of 18) - Power board



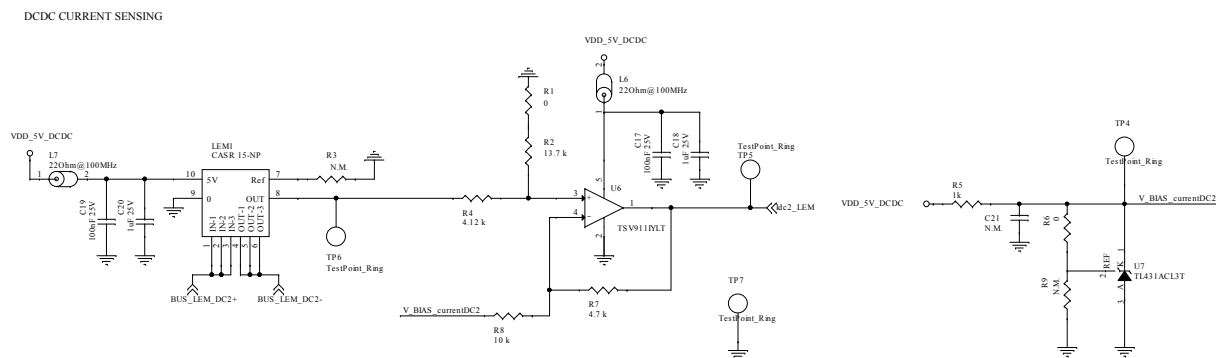
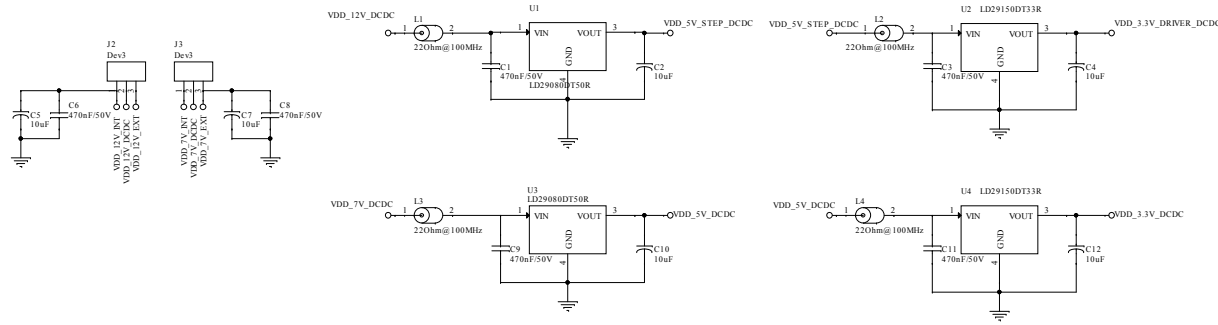


Figure 16. STDES-BCBIDIR circuit schematic (15 of 18) - Power board

DCDC AUXILIARY POWER SUPPLY



LED STATUS

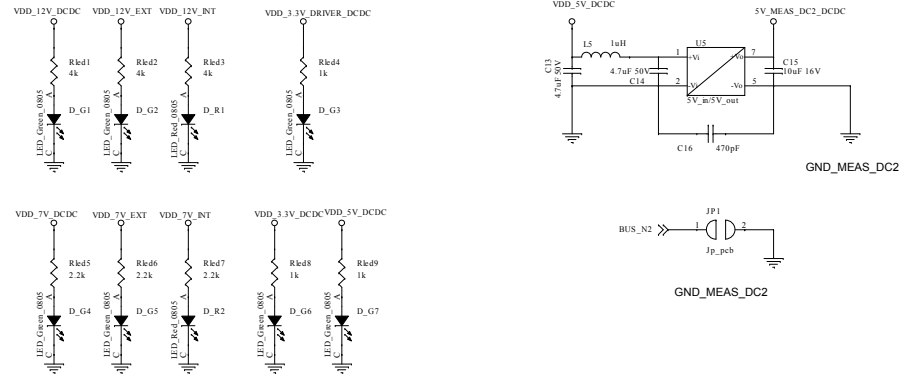


Figure 17. STDES-BCBIDIR circuit schematic (16 of 18) - Power board

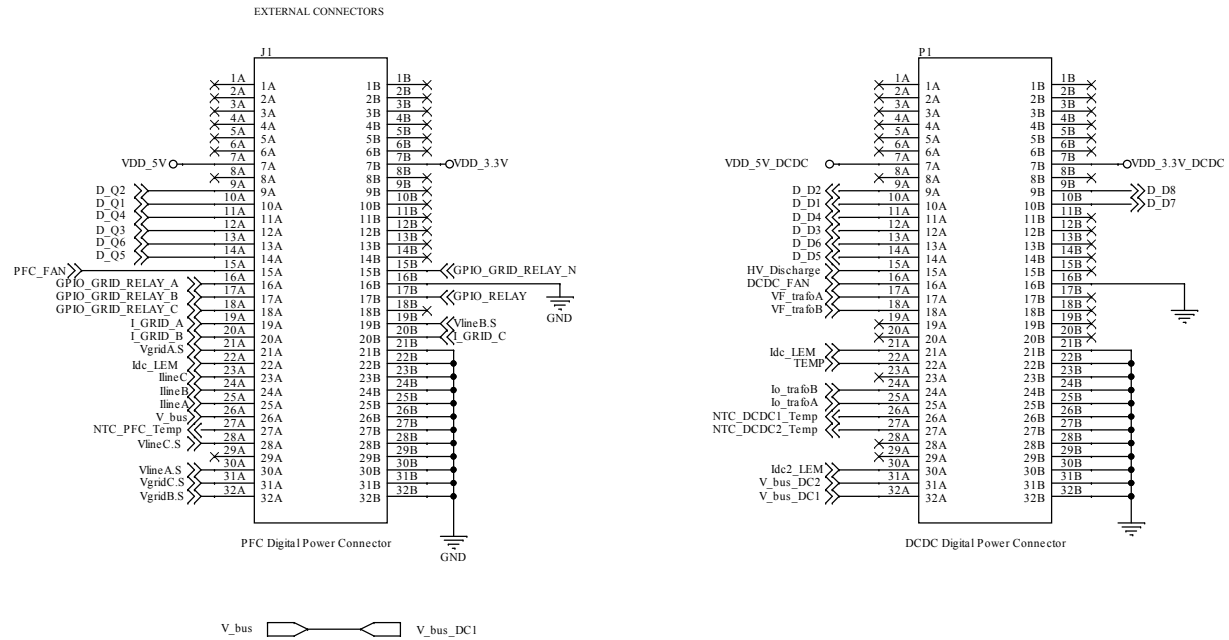


Figure 18. STDES-BCBIDIR circuit schematic (17 of 18) - Power board

TRANSFORMER CURRENT SENSING

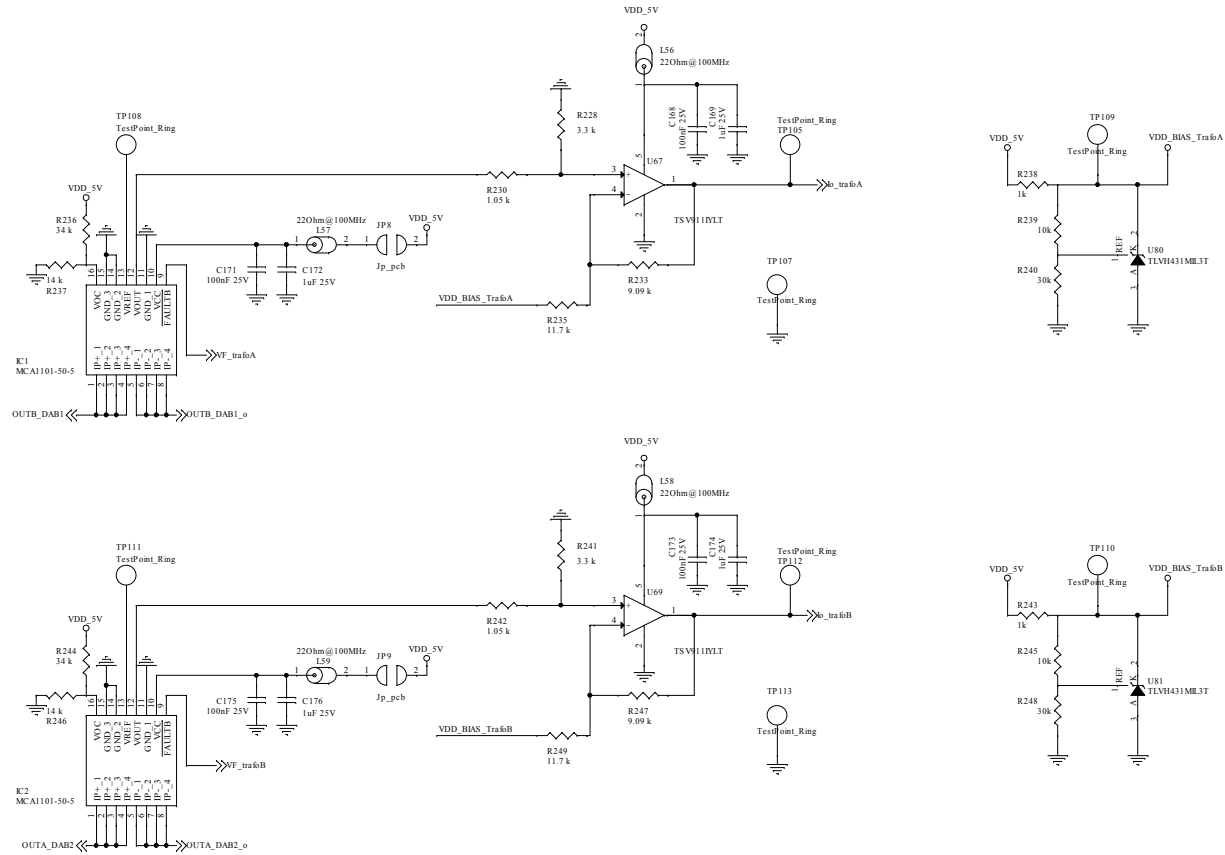


Figure 19. STDES-BCBIDIR circuit schematic (18 of 18) - Power board

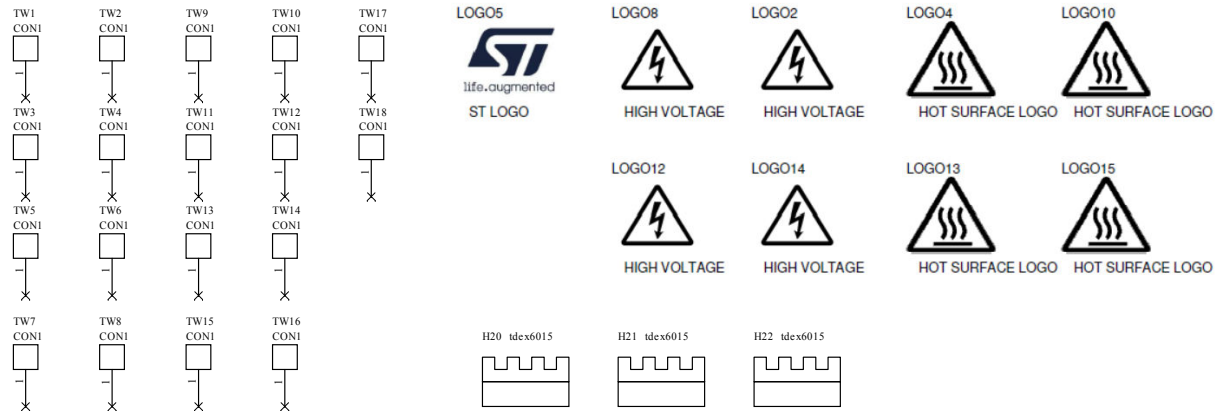
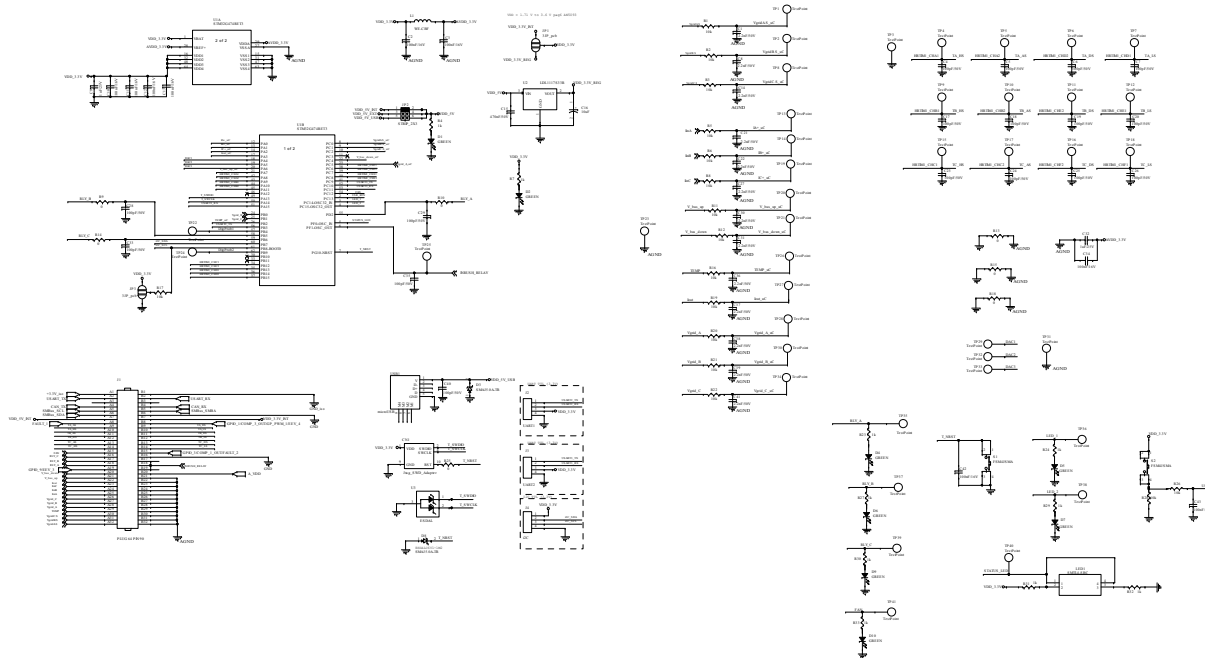
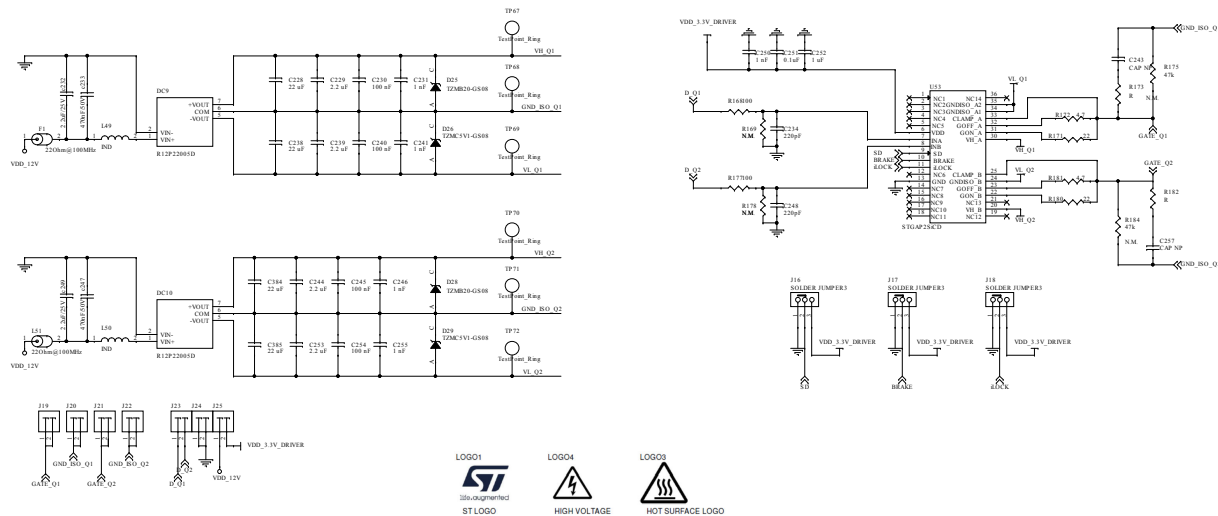


Figure 20. STDES-BCBIDIR circuit schematic - Control board



STDES-BCBIDIR

Schematic diagrams



Revision history

Table 1. Document revision history

Date	Revision	Changes
20-Dec-2023	1	Initial release.

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