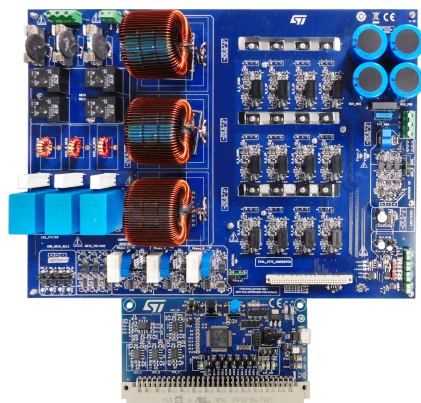


15 kW, three-phase, three-level active front end (AFE) bidirectional converter for industrial and electric vehicle DC fast charging applications



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



Features

- 3-phase, 3-level bidirectional AC-DC power converter:
 - Rated nominal DC voltage: 800 V_{DC}
 - Rated nominal AC voltage: 400 V_{AC} at 50 Hz
 - Nominal power: 15 kW
- AC to DC rectifier mode:
 - Power factor: PF >0.99
 - Inrush current control and soft startup
- DC to AC inverter mode:
 - Active and reactive power control
 - Integrated grid connection solution
- Power section based on SiC MOSFETs:
 - High frequency operation (100 kHz)
 - High efficiency: >98%
 - Passive element weight and size reduction
- Control section based on [STM32G474RET3](#) microcontroller:
 - P2P compatible with different power converters solutions
 - Four integrated high-performance op-amps
 - Control and monitoring interfaces: SWD, UART, I²C, DACs
 - 64-pin digital power connector
 - Overcurrent and overvoltage protection

Description

This reference design represents a complete solution for three-phase AC/DC and DC/AC (800 V_{DC} to 400 V_{AC}) applications based on a digital platform optimized for power conversion.

It is well suited for the Active Front End (AFE) stage in high power charging stations, industrial battery chargers and UPS. The high switching frequency of the SiC MOSFETs and the multilevel structure allow nearly 99% efficiency as well as the optimization of passive power components in terms of size and cost.

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

Product summary	
15 kW, 3-level, 3-phase bidirectional converter	STDES-PFCBIDIR
Firmware for active front end (AFE) bidirectional converter for industrial and electric vehicle DC fast charging applications	STSW-PFCBIDIR
Mainstream Arm Cortex-M4 core with DSP and FPU, 170MHz with 512Kbytes of Flash memory, Math Accelerator, HR Timer, High Analog level integration	STM32G474RET3

Product summary	
SiC Power MOSFET 650 V, 45 A, 55 mΩ in HiP247 package	SCTW35N65G2V
Automotive-grade SiC Power MOSFET 1200 V, 33 A, 75 mΩ in HiP247 package	SCTW40N120G2VAG
Galvanically isolated 4 A single gate driver	STGAP2SM
Fixed frequency VIPer plus family	VIPER26HD
Applications	PFC Converter - Three Phase Input DC Fast Charging Station

1 Bidirectional converter reference design overview

This reference design consists of the following separate components:

- A board with the power converter, LCL filter, sensing circuit, inrush circuit, grid connection management circuit and on-board auxiliary power supply.
- A control module based on the **STM32G4 Series** microcontroller with connectors for communication and test-points and status indicators for testing and debugging.

The input and output current and voltage measurements necessary for responsive control are acquired through isolated measurement blocks, and the STM32 microcontroller manages connection and disconnection with the AC electrical network, as well as load and source DC management in either inverter or rectifier mode.

The driving signals for the switching devices are managed by corresponding **STGAP2S** gate drivers to ensure independent management of switching frequencies and dead time.

The hardware math accelerator in the MCU boosts the trigonometric operations of the voltage oriented control (VOC) algorithm, allowing the power converter to achieve very high power quality.

Figure 1. Bidirectional converter block diagram

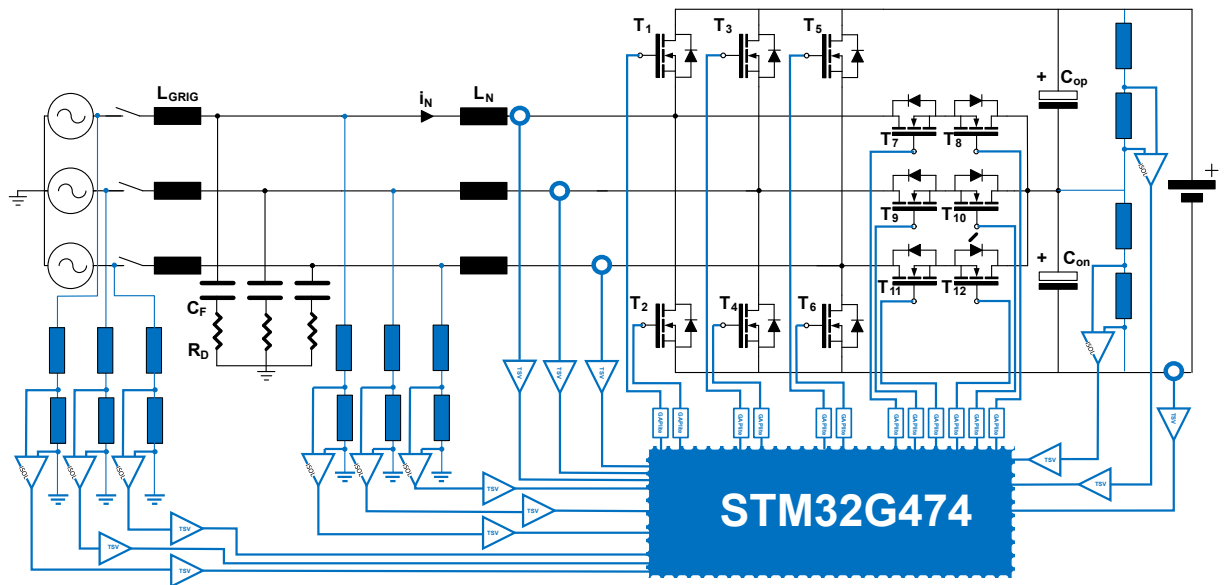
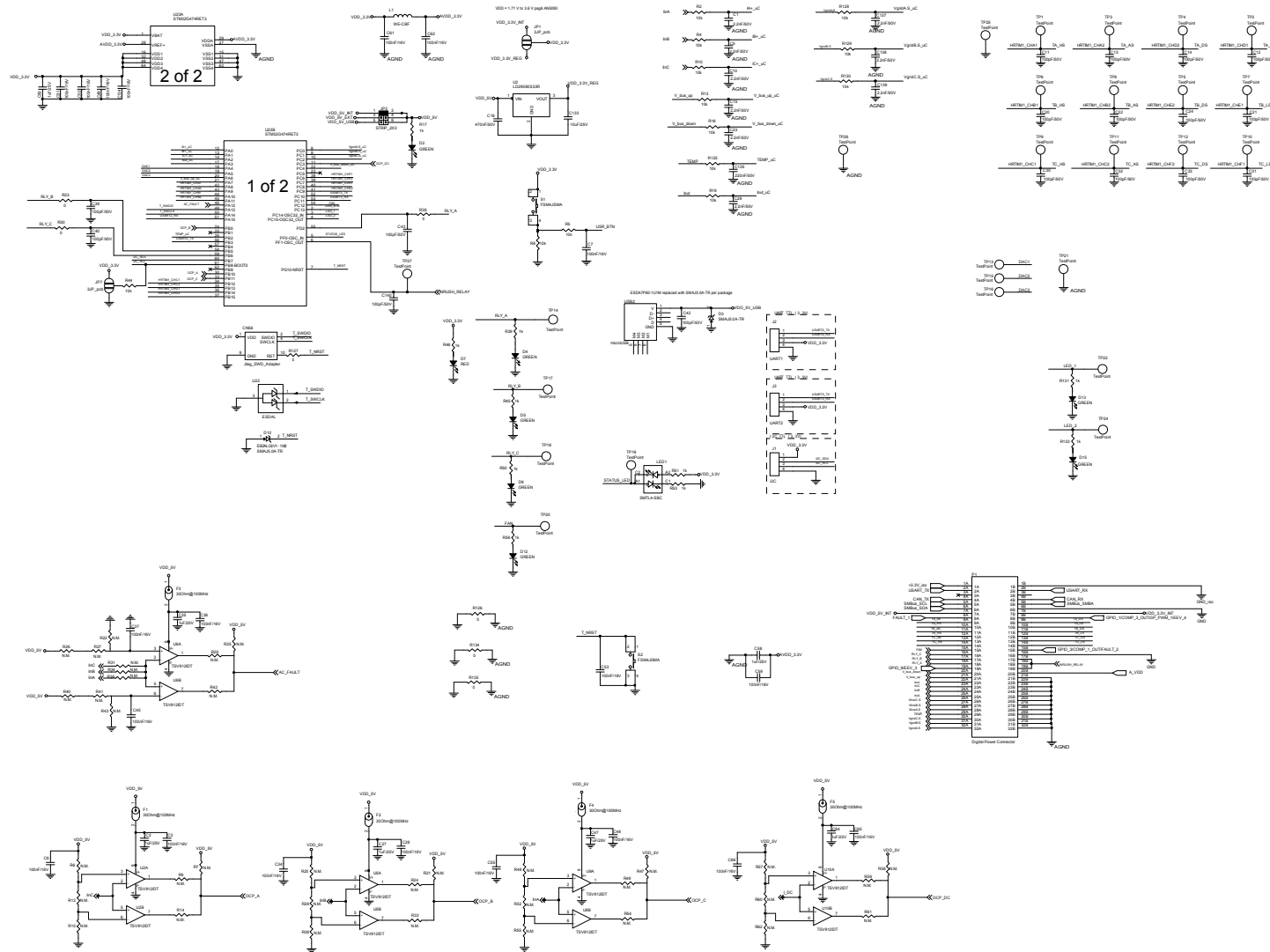


Figure 2. STDES-PFCBIDIR schematic diagram - control board



- Refer to datasheet for PCB orientation of the LED1
- Solder a 22µF / 10V electrolytic capacitor in parallel to C133
- 32A-28A | 31A-27A | 30A-26A of P1 connector must be shorted.

Figure 3. STDES-PFCBIDIR schematic diagram - power board: AC current sensing

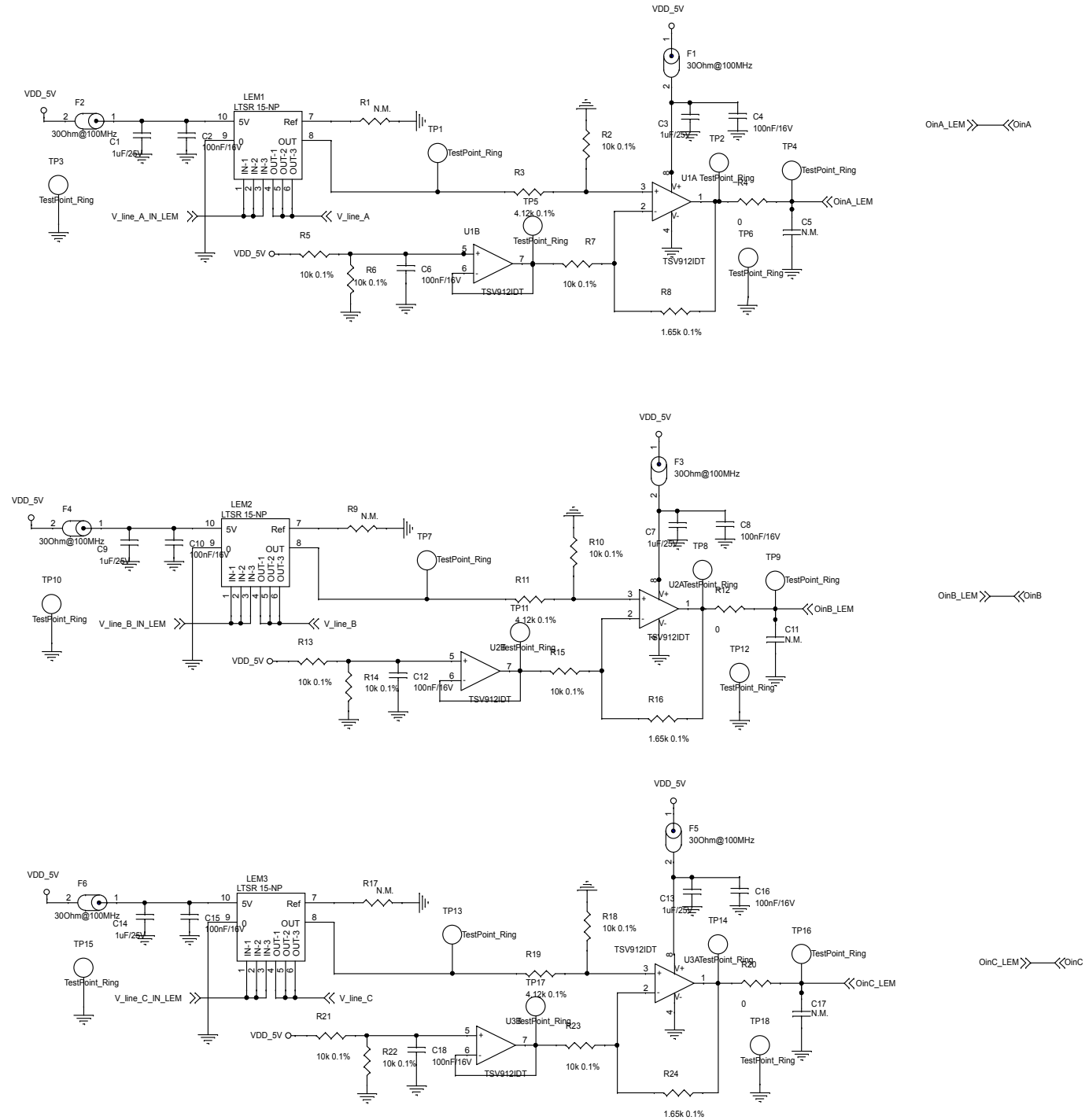
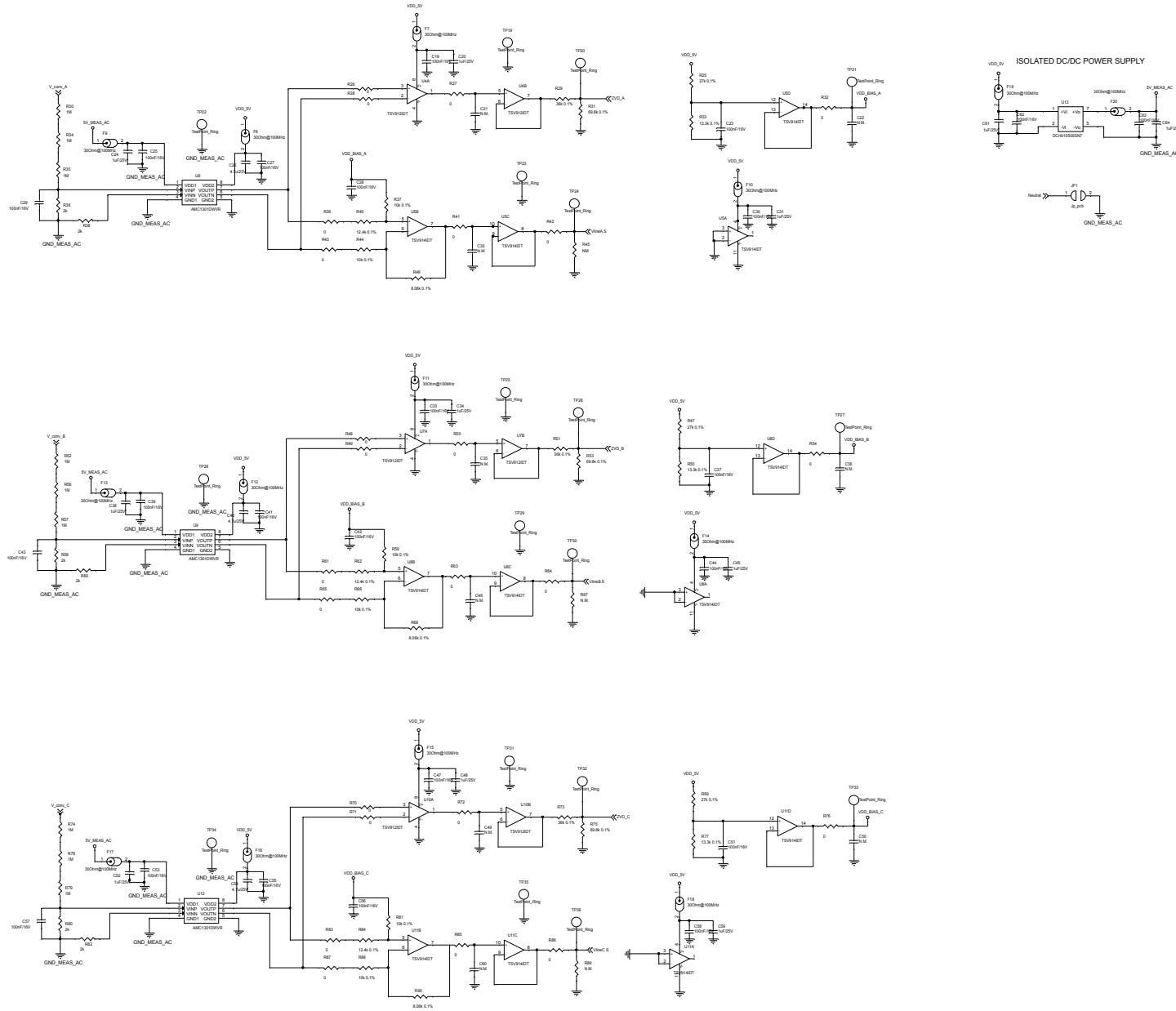


Figure 4. STDES-PFCBIDR schematic diagram - power board: AC voltage sensing



STDES-PFCBIDIR

Schematic diagrams

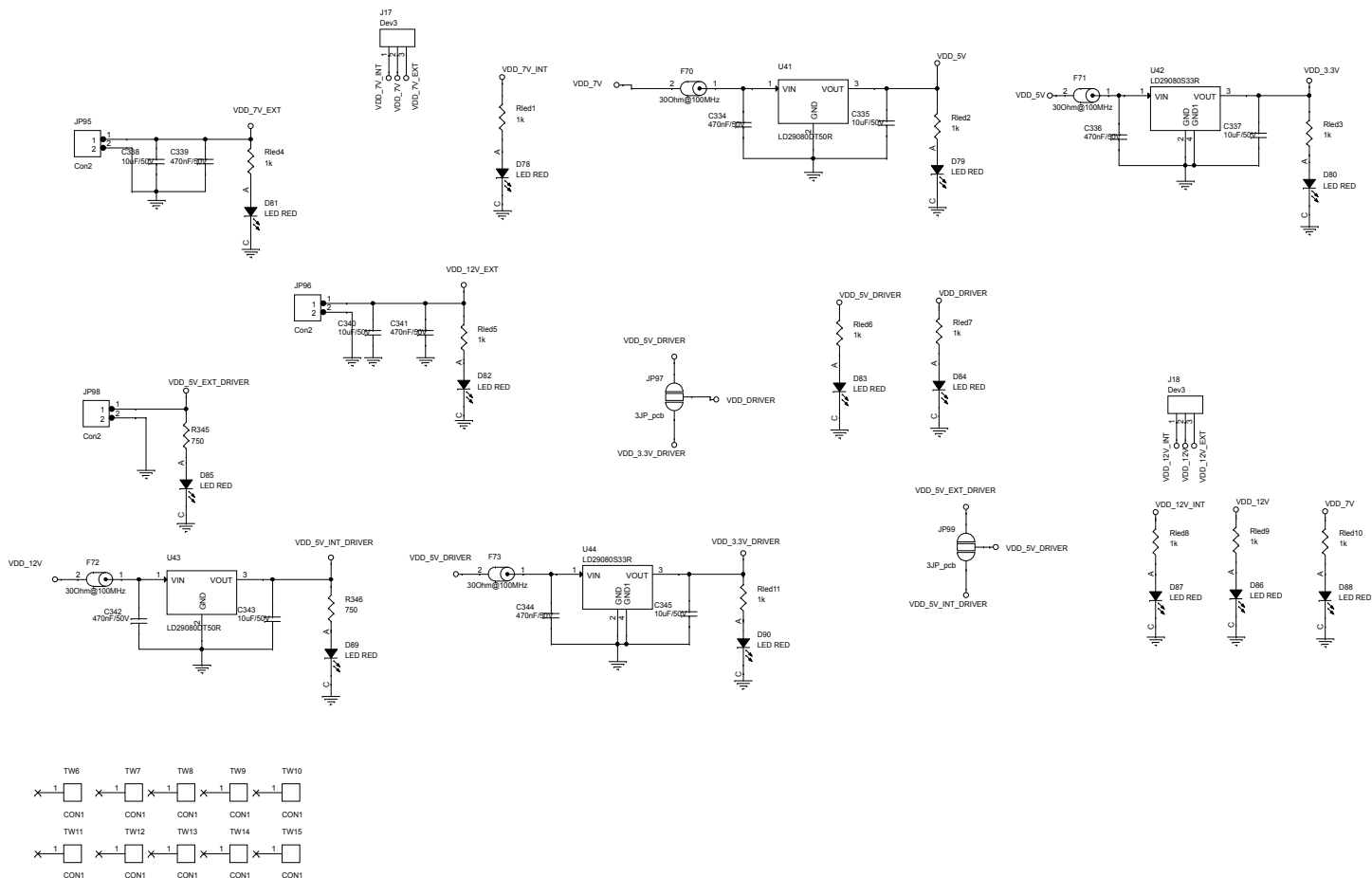


Figure 6. STDES-PFCBIDIR schematic diagram - power board: aux power VIPER

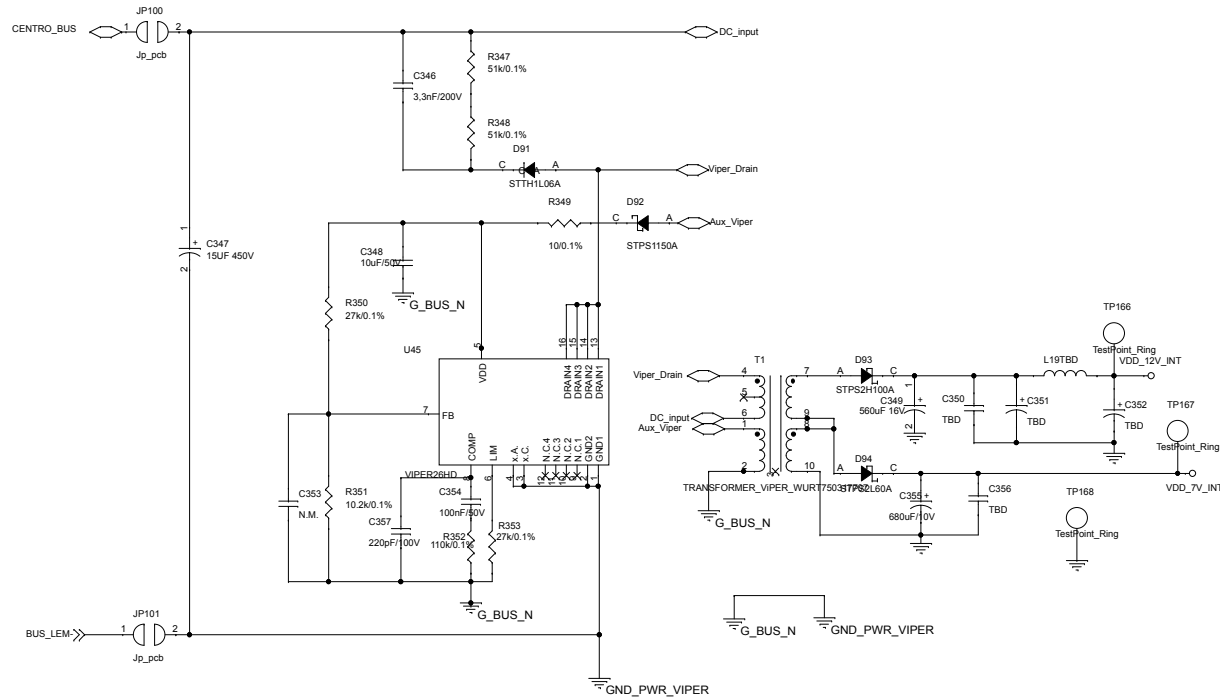


Figure 7. STDES-PFCBIDIR schematic diagram - power board: connector

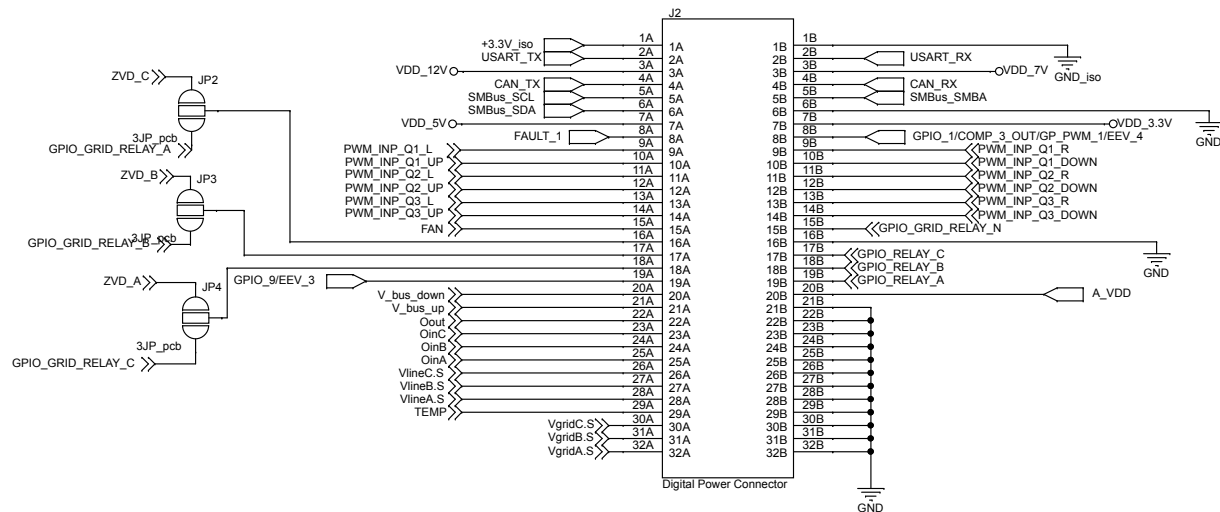


Figure 8. STDES-PFCBIDIR schematic diagram - power board: DC current sensing

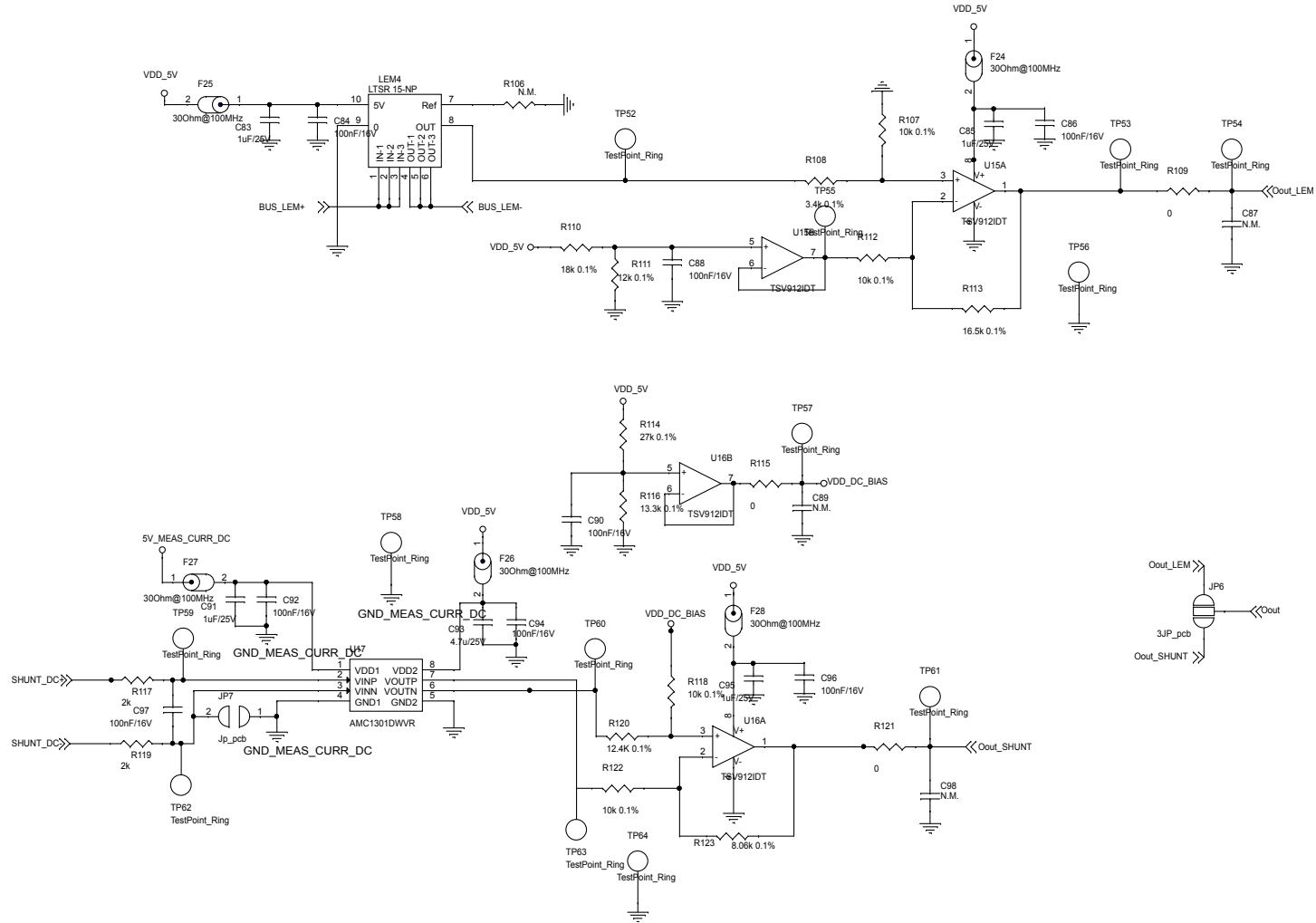
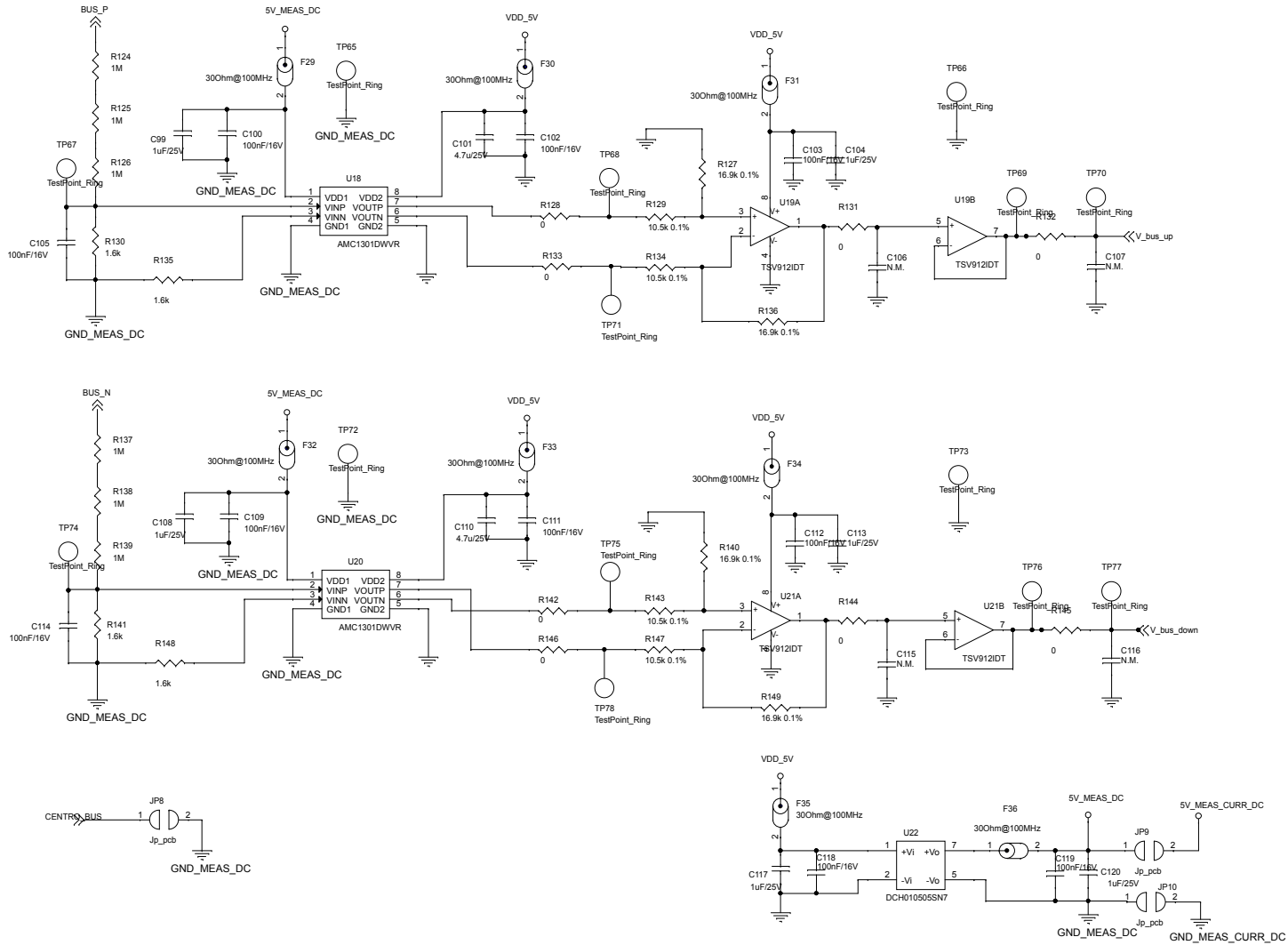


Figure 9. STDES-PFCBIDIR schematic diagram - power board: DC voltage sensing



STDES-PFCBIDIR

Schematic diagrams

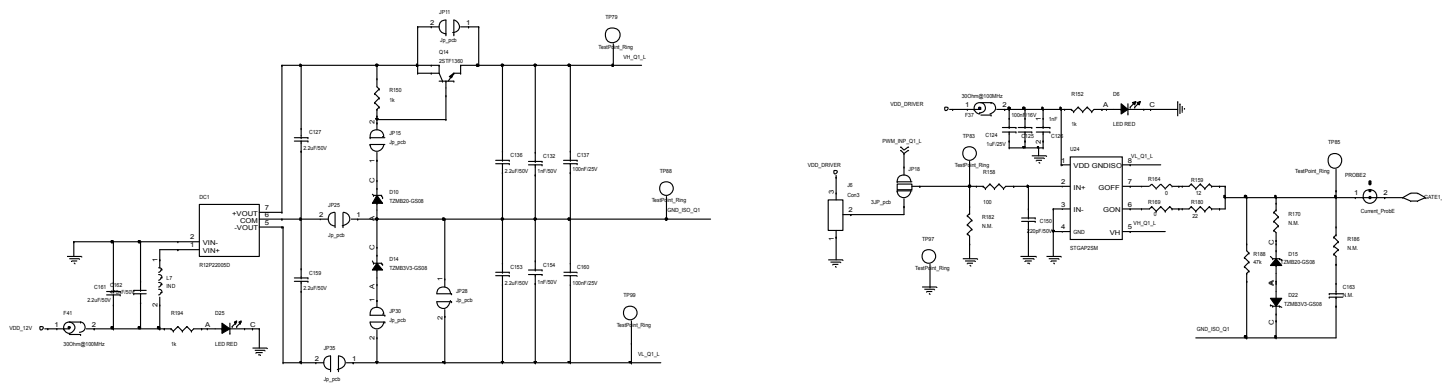


Figure 11. STDES-PFCBIDR schematic diagram - power board: grid voltage sensing

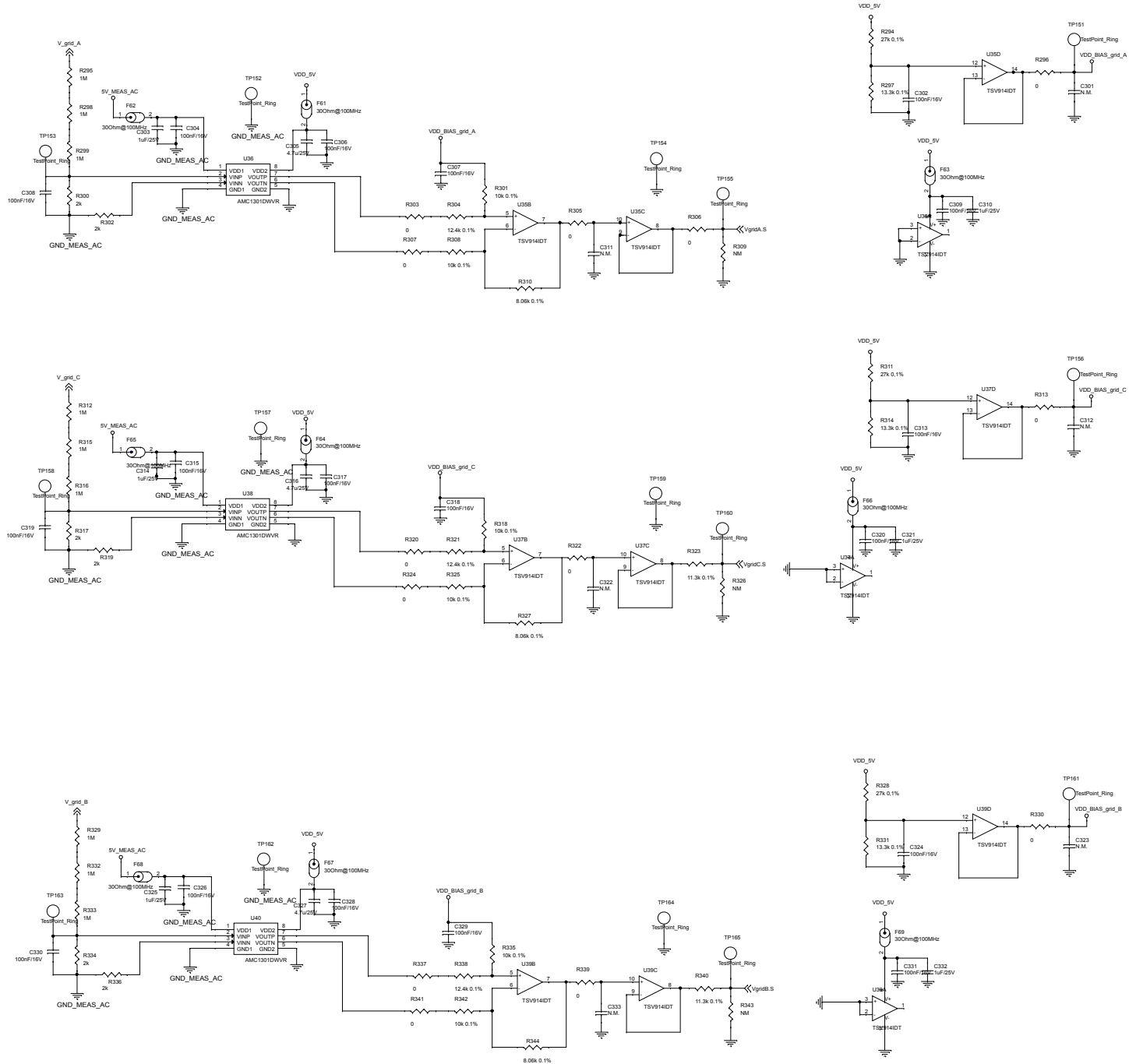


Figure 12. STDES-PFCBIDIR schematic diagram - power board: power section

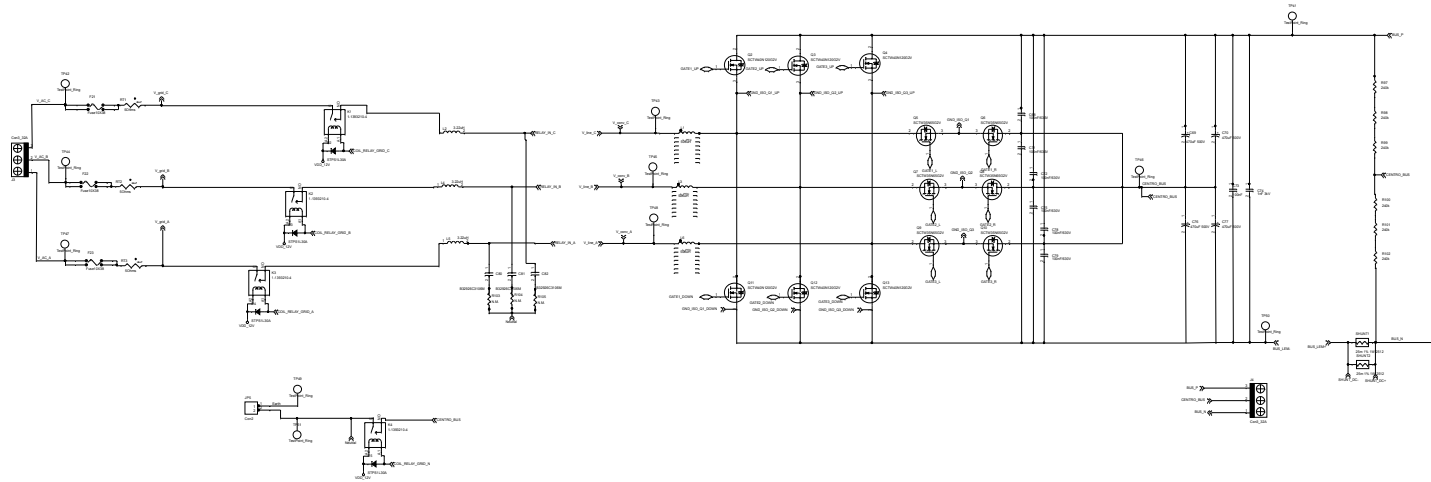
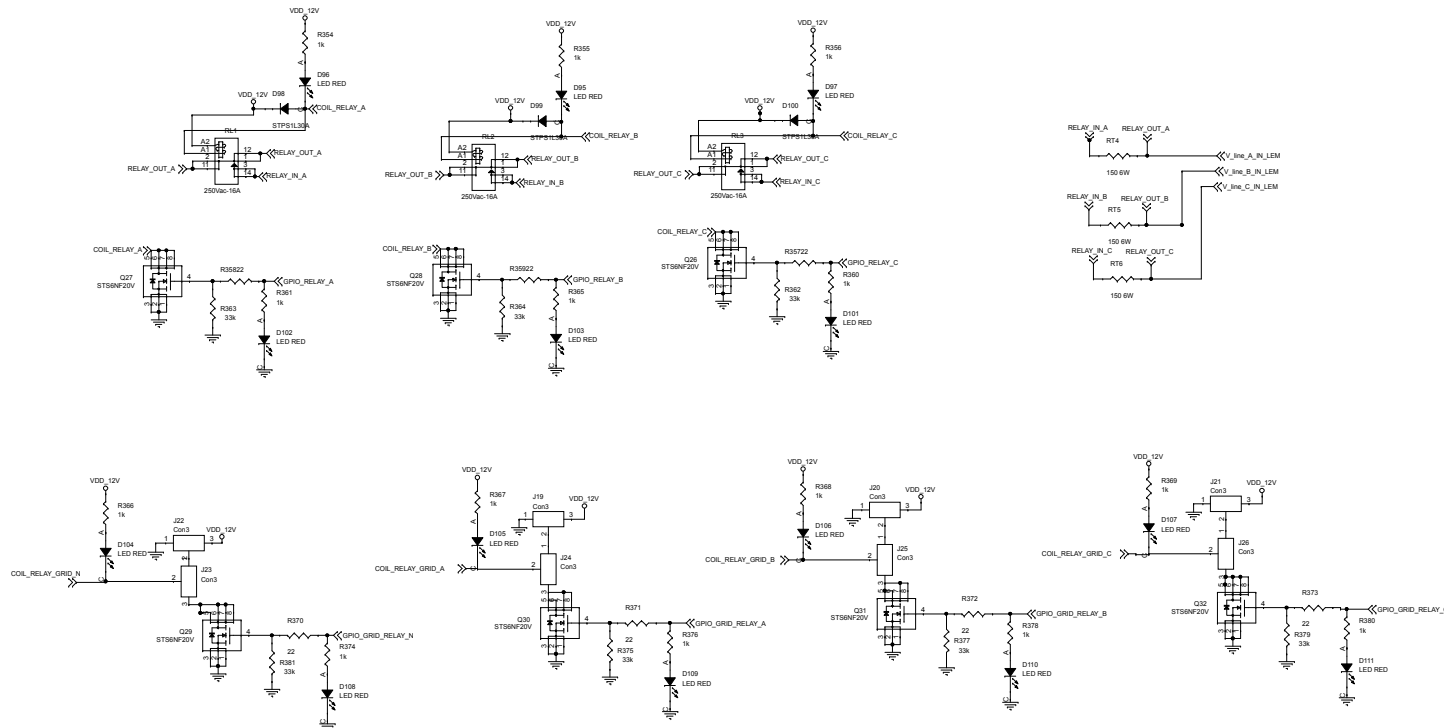
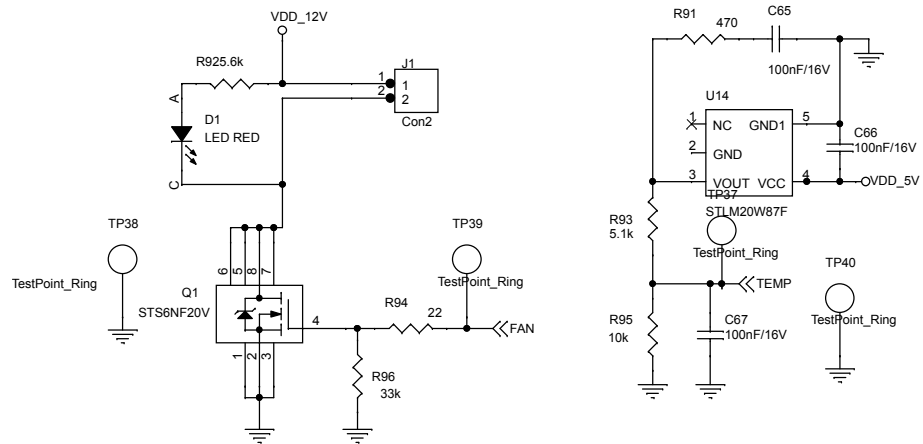


Figure 13. STDES-PFCBIDIR schematic diagram - power board: active inrush current and AC grid connection management



STDES-PFCBIDIR

Schematic diagrams



Revision history

Table 1. Document revision history

Date	Version	Changes
05-Nov-2019	1	Initial release.
08-Mar-2022	2	Added logo. Updated cover page features, product summary and Section 2: Schematic diagrams
09-Oct-2025	3	Updated Section Features .

IMPORTANT NOTICE – READ CAREFULLY

STMicroelectronics NV and its subsidiaries ("ST") reserve the right to make changes, corrections, enhancements, modifications, and improvements to ST products and/or to this document at any time without notice.

In the event of any conflict between the provisions of this document and the provisions of any contractual arrangement in force between the purchasers and ST, the provisions of such contractual arrangement shall prevail.

The purchasers should obtain the latest relevant information on ST products before placing orders. ST products are sold pursuant to ST's terms and conditions of sale in place at the time of order acknowledgment.

The purchasers are solely responsible for the choice, selection, and use of ST products and ST assumes no liability for application assistance or the design of the purchasers' products.

No license, express or implied, to any intellectual property right is granted by ST herein.

Resale of ST products with provisions different from the information set forth herein shall void any warranty granted by ST for such product.

If the purchasers identify an ST product that meets their functional and performance requirements but that is not designated for the purchasers' market segment, the purchasers shall contact ST for more information.

ST and the ST logo are trademarks of ST. For additional information about ST trademarks, refer to www.st.com/trademarks. All other product or service names are the property of their respective owners.

Information in this document supersedes and replaces information previously supplied in any prior versions of this document.

© 2025 STMicroelectronics – All rights reserved