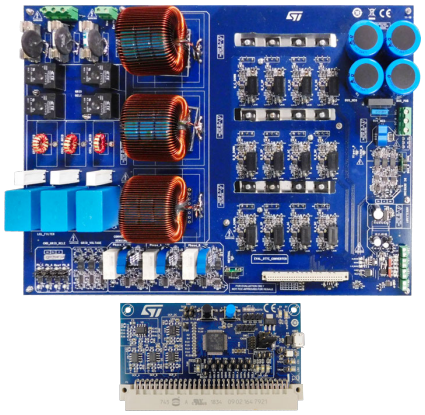
STDES-PFCBIDIR

Data brief

15 kW, three-phase, three-level Active Front End (AFE) bidirectional converter for industrial and electric vehicle DC fast charging applications



Features

- 3-phase, 3-level bidirectional AC/DC power converter:
  - Rated nominal DC voltage: 800 V_{DC}
  - Rated nominal AC voltage: 400 V_{AC} @ 50 Hz
  - Nominal power: 15 kW
- AC to DC rectifier mode:
  - Power factor control (PFC) PF > 0.99
  - Inrush current control and soft start-up
- 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, η = 99%
  - Passive element weight and size reduction
- Control section based on STM32G474RE microcontroller:
  - P2P compatible with other STDES 3-phase power converters
  - 4 integrated high-performance op-amps
  - Control and monitoring interfaces: SWIM, UART, I²C, DACs
  - 64-pin Digital Power connector
  - Overcurrent and overvoltage protection
  - Configurable topology (2 – 3 levels)

Product summary	
15 kW, 3-level, 3-phase bidirectional converter	STDES-PFCBIDIR
firmware for 15 kW, 3-lvl, 3-ph, bidirectional converter	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	STM32G474RE
SiC Power MOSFET 650 V, 45 A, 55 mΩ in HiP247 package	SCTW35N65G2V

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.

Product summary	
Automotive-grade SiC Power MOSFET 1200 V, 33 A, 75 mΩ in HiP247 package	SCTW40N120G2VAG
galvanically isolated 4 A single gate driver	STGAP2SM
energy saving 12W high voltage converter with direct feedback	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:

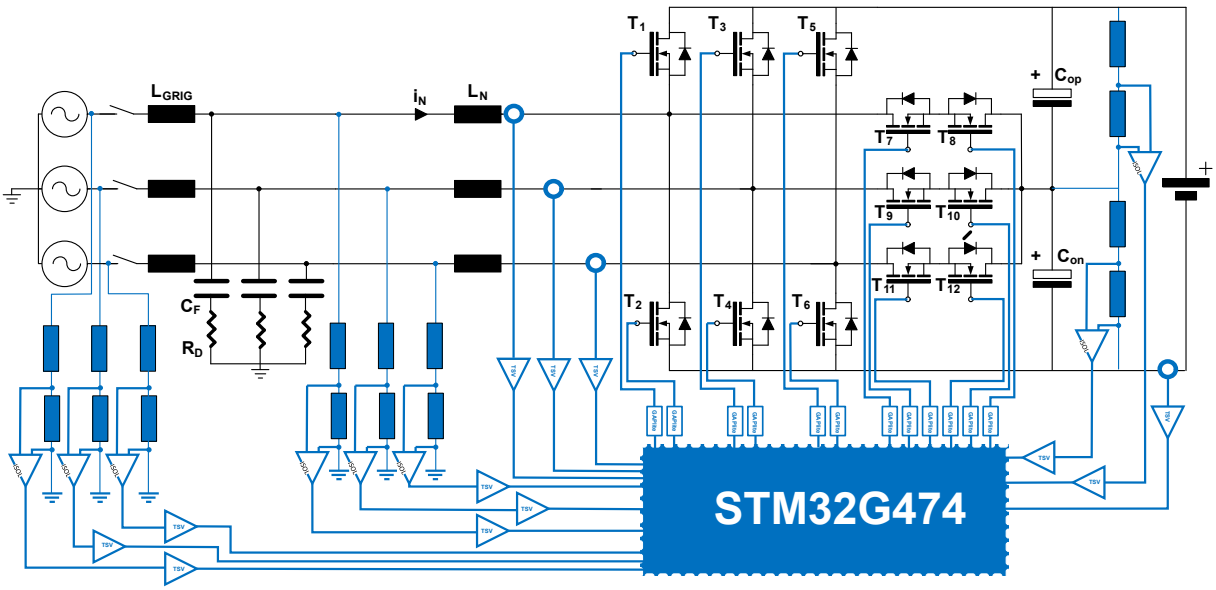
- A board with the power converter, LCL filter, sensing circuit, inrush circuit, grid connection management circuit and on-board auxiliary power supply.
- A control module based on the STM32G4 Series microcontroller with connectors for communication and test-points and status indicators for testing and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



2 Schematic diagrams

Figure 2. **STDES-PFCBIDIR schematic diagram - control board**

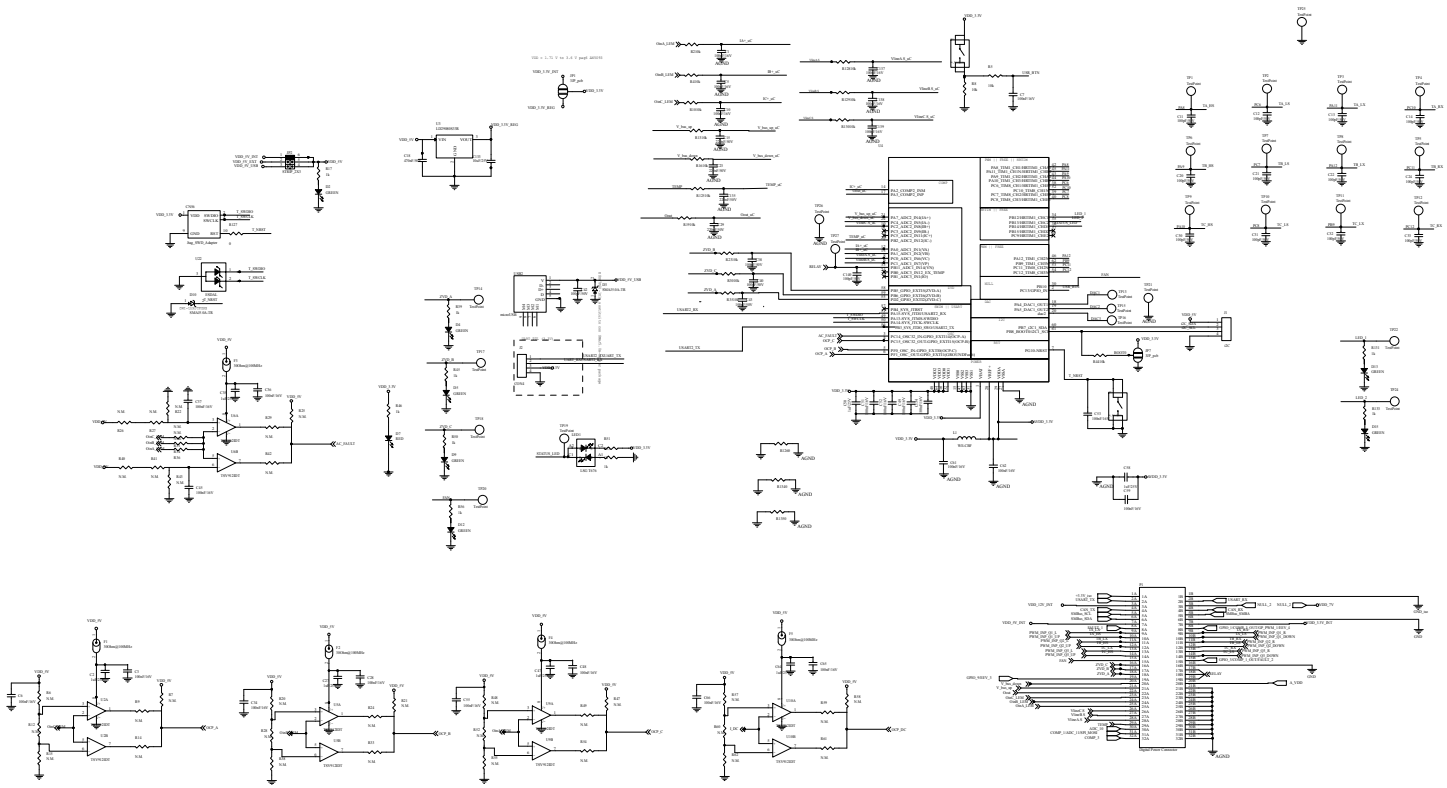


Figure 3. STDES-PFCBIDIR schematic diagram - power board: AC current sensing

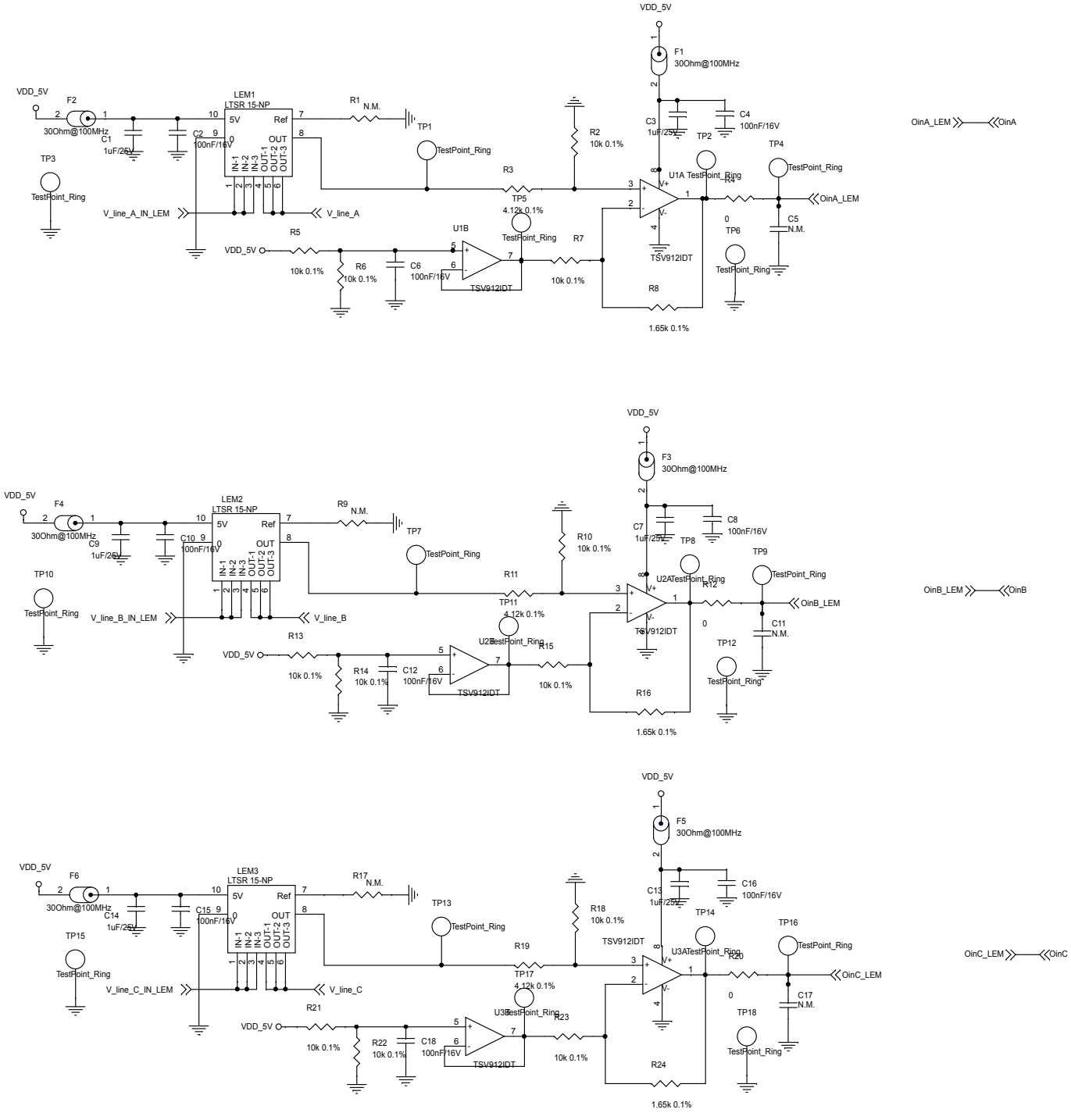


Figure 4. STDES-PFCBIDIR schematic diagram - power board: AC voltage sensing

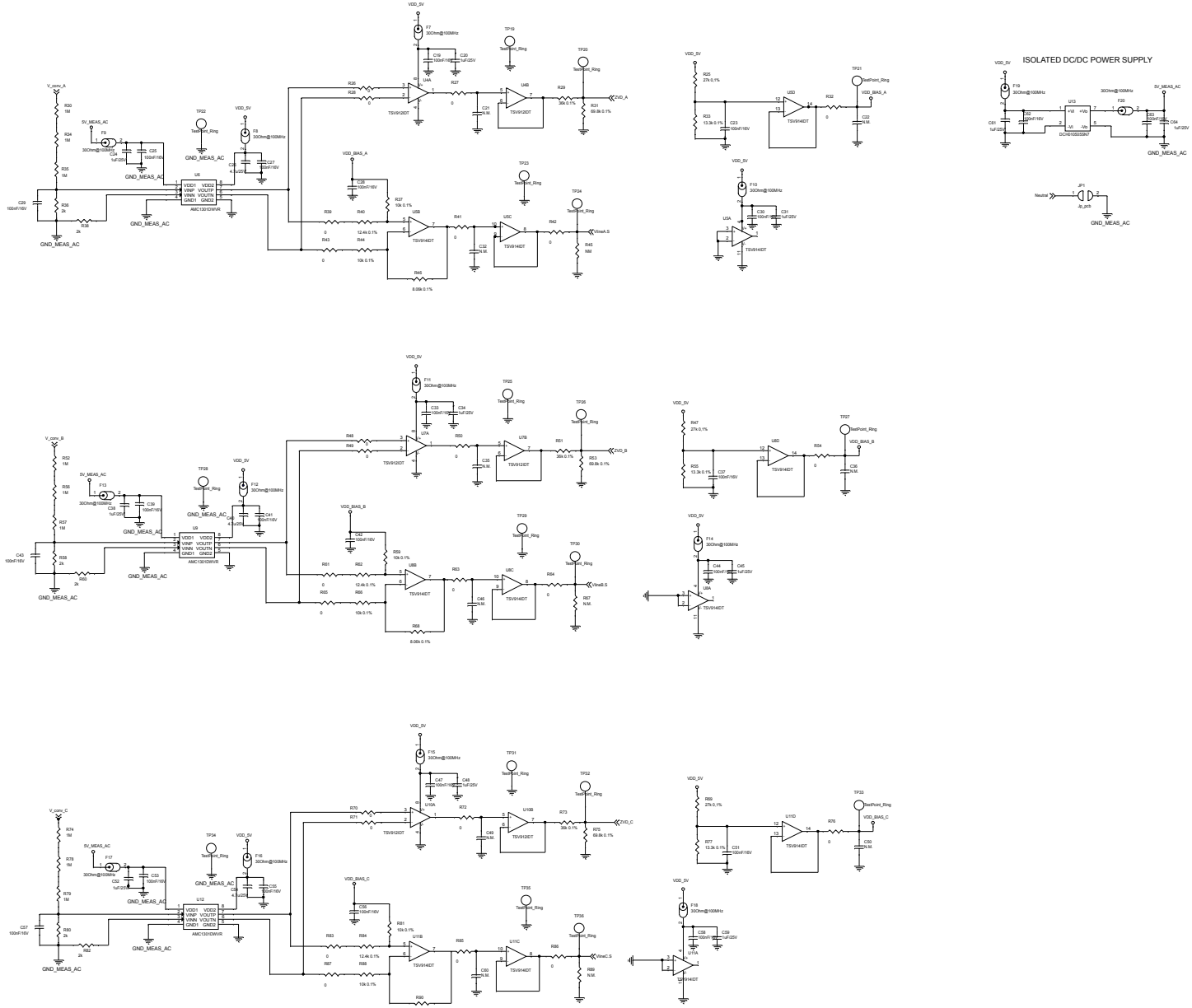


Figure 5. STDES-PFCBIDIR schematic diagram - power board: aux power DC/DC

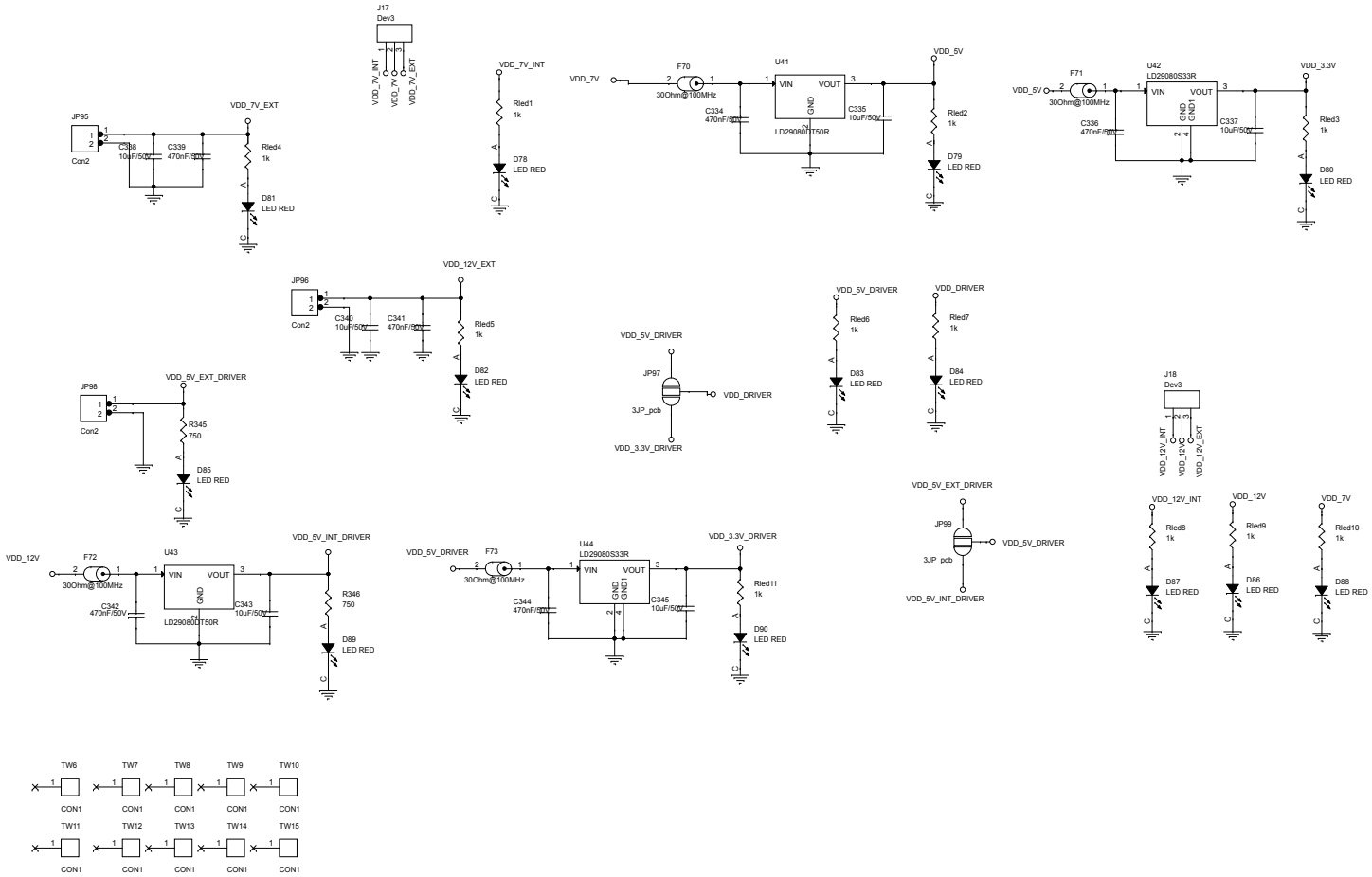


Figure 6. STDES-PFCBIDIR schematic diagram - power board: aux power VIPER

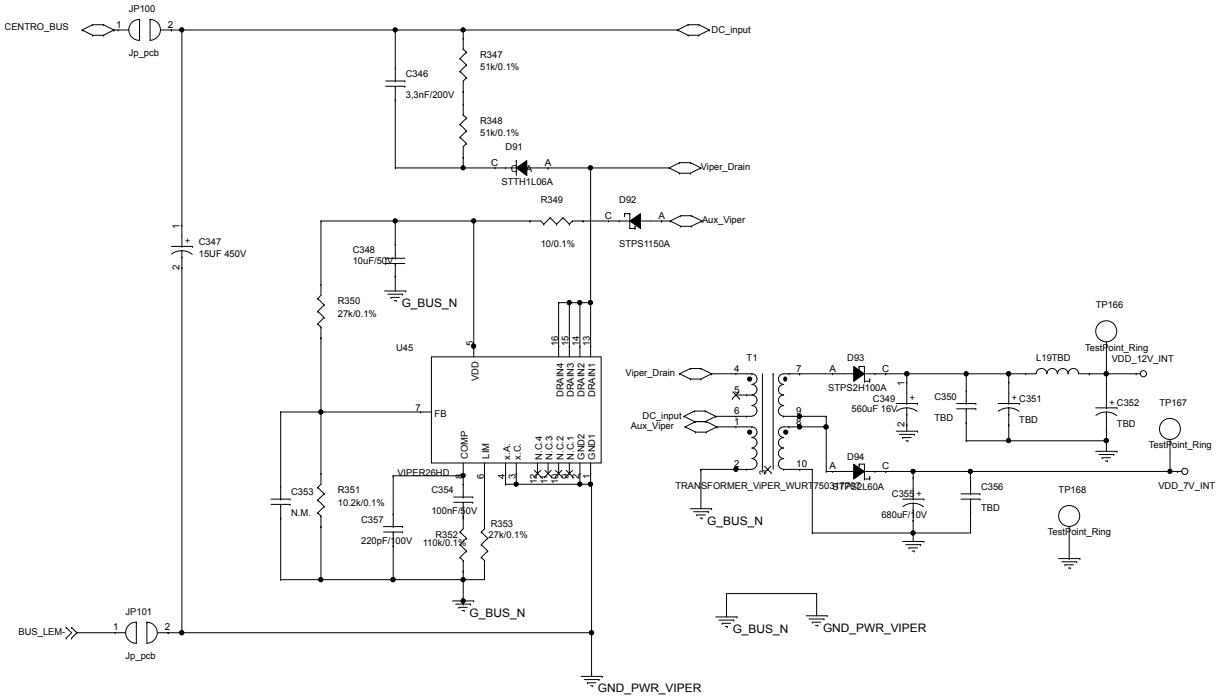


Figure 7. STDES-PFCBIDIR schematic diagram - power board: connector

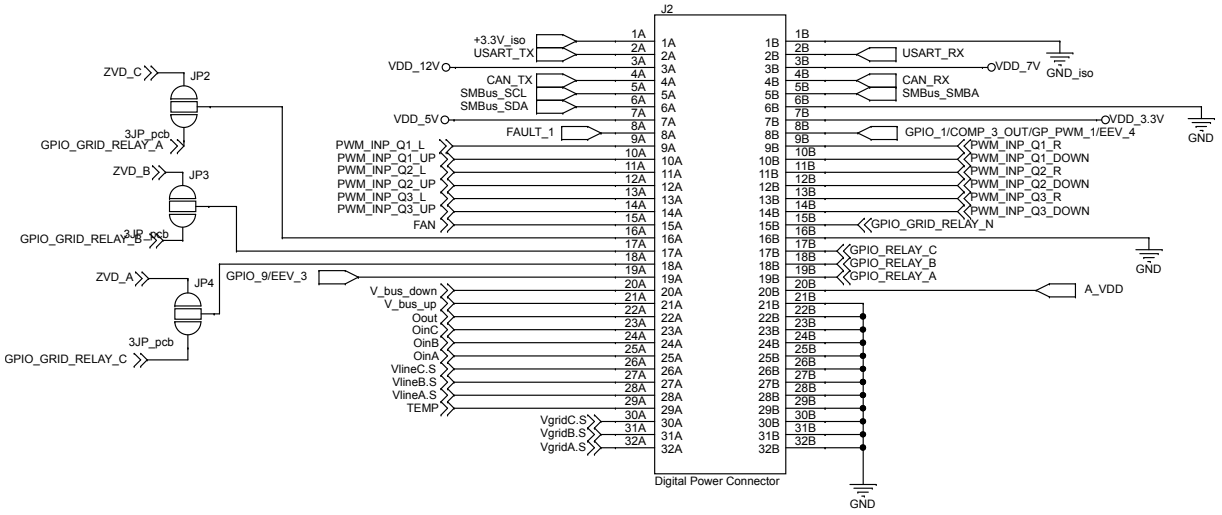


Figure 8. STDES-PFCBIDIR schematic diagram - power board: DC current sensing

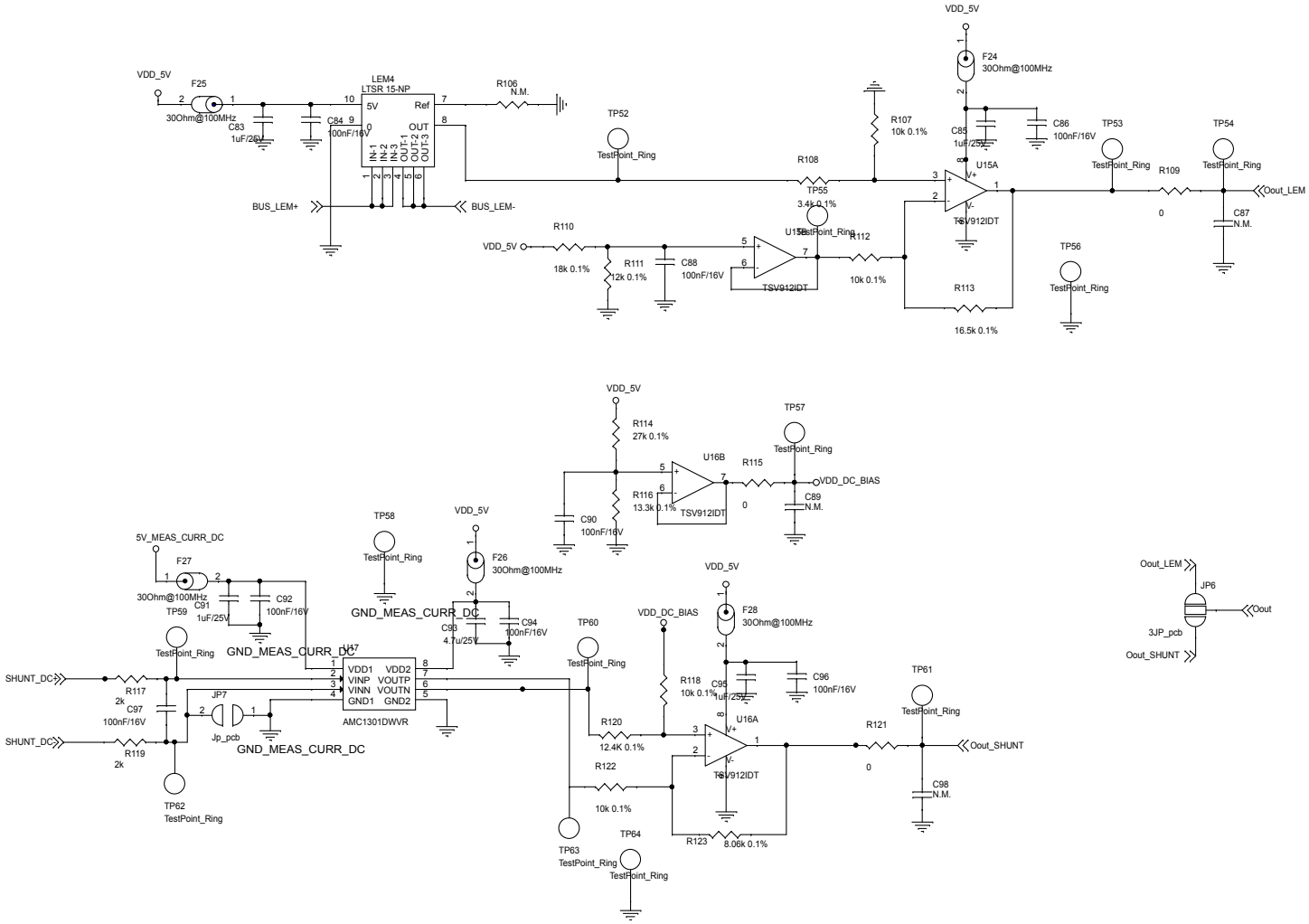


Figure 9. STDES-PFCBIDIR schematic diagram - power board: DC voltage sensing

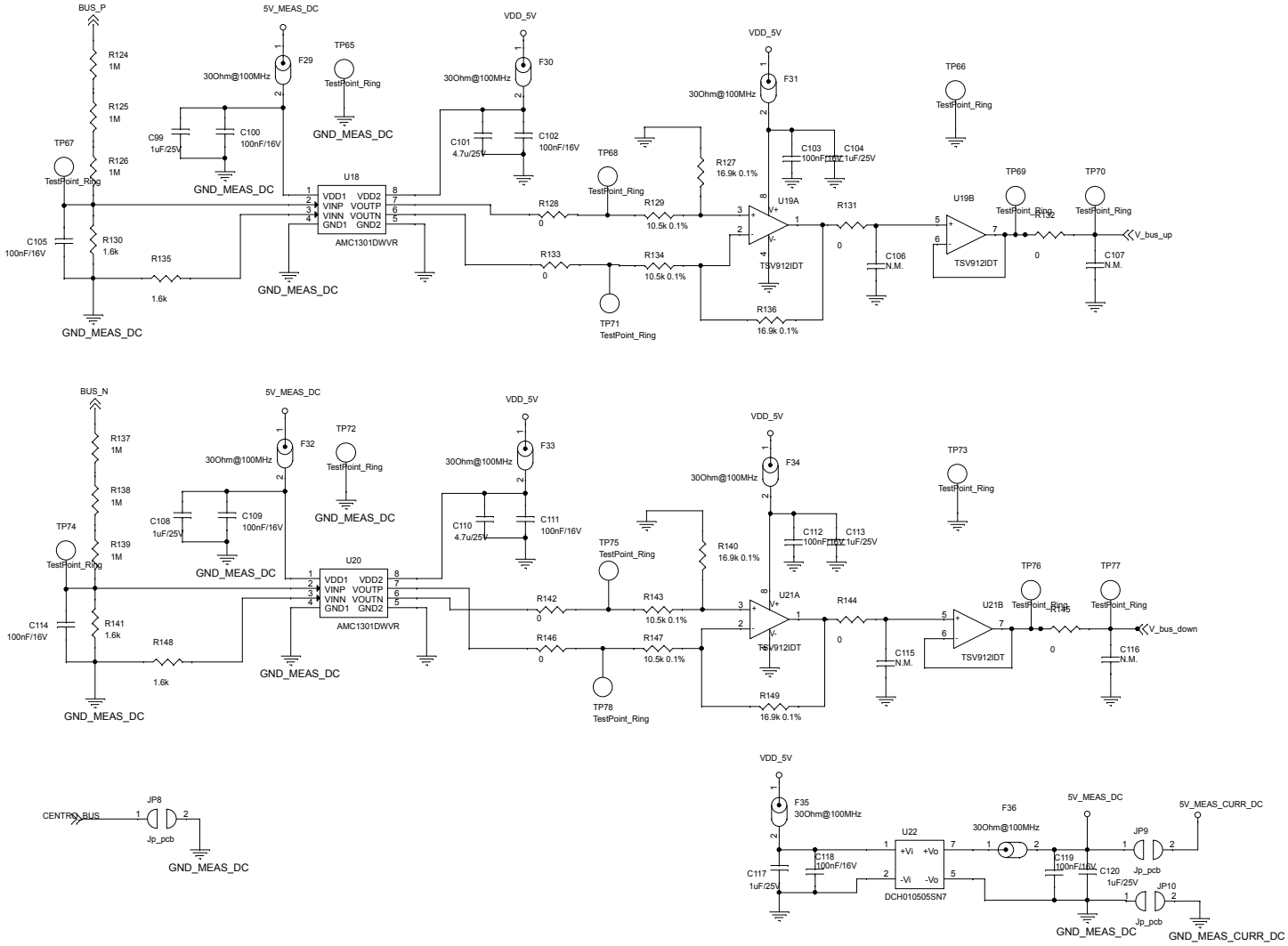


Figure 10. STDES-PFCBIDIR schematic diagram - power board: gate drivers (x12)

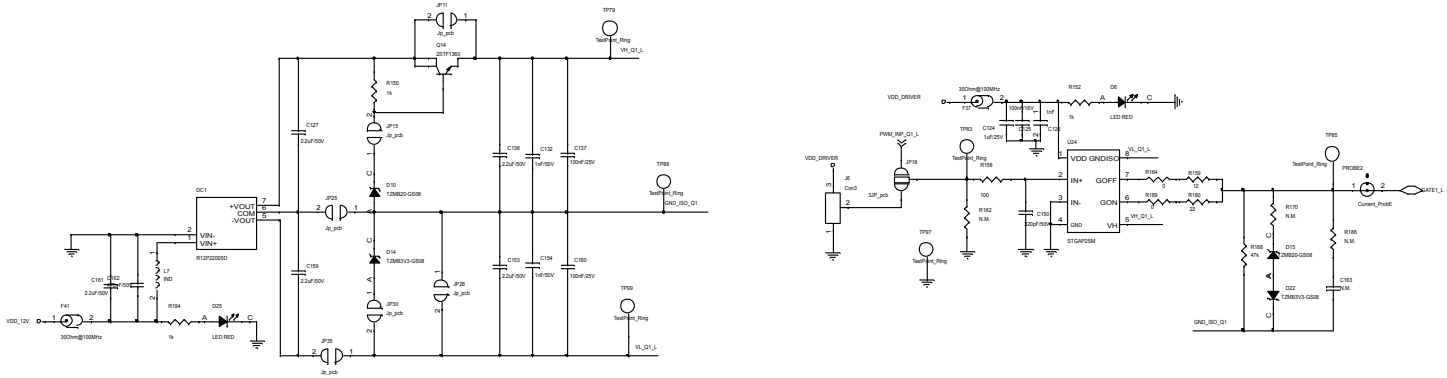


Figure 11. STDES-PFCBIDIR schematic diagram - power board: grid voltage sensing

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

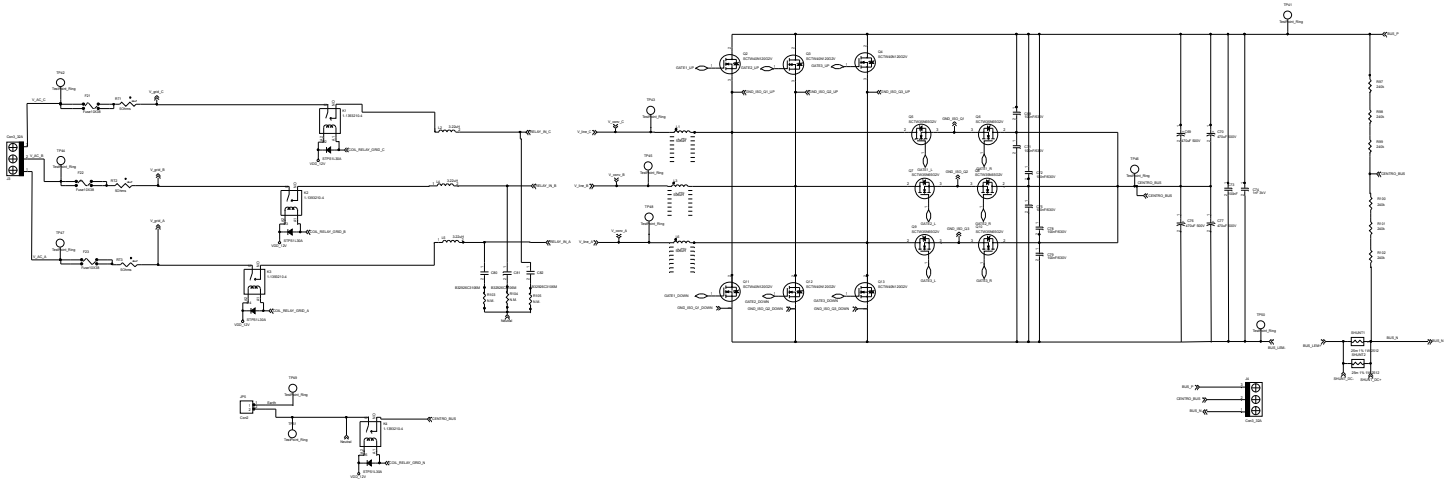


Figure 13. **STDES-PFCBIDIR schematic diagram - power board: active inrush current and AC grid connection management**

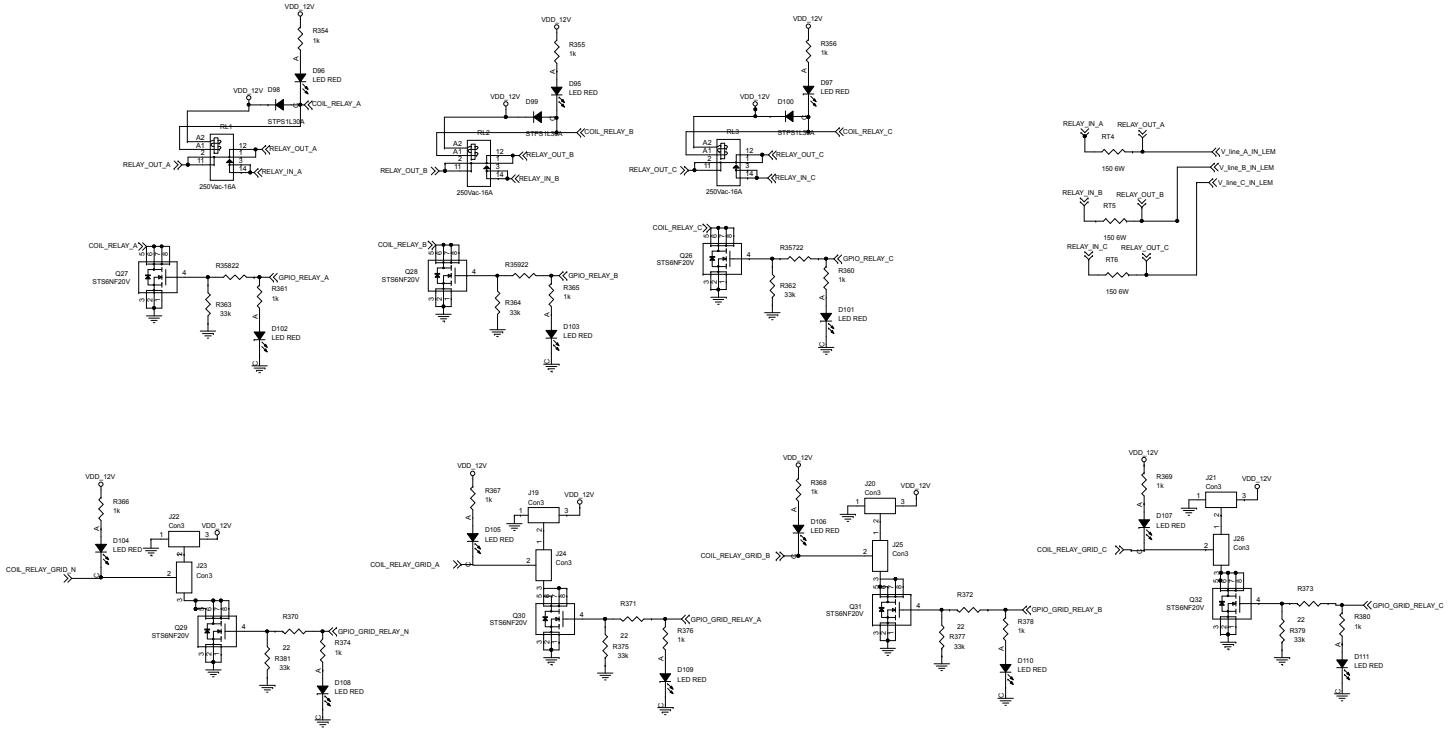
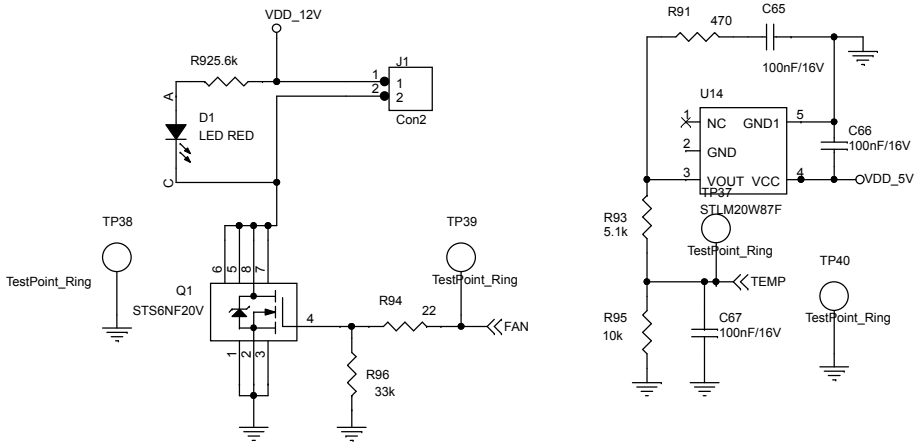


Figure 14. STDES-PFCBIDIR schematic diagram - power board: temp control



Revision history

Table 1. **Document revision history**

Date	Version	Changes
05-Nov-2019	1	Initial release.