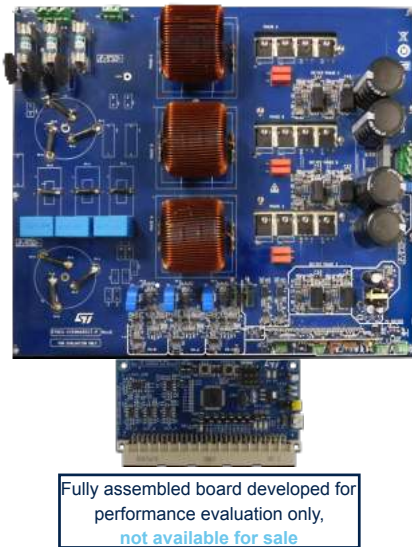


15 kW, three-level, three-phase Vienna rectifier with digital control for power factor correction



Features

- Three-phase, three-level AC-DC power converter
 - Nominal rate for DC voltage: 800 V_{DC}
 - Nominal rate for AC voltage: 400 V_{AC} at 50 Hz
 - Maximum power: 15 kW
 - Power factor: >0.99
 - Inrush current control and soft start-up
 - THD lower than 5% at nominal operation
- Power section based on SiC MOSFETs and SiC diodes:
 - High frequency operation (70 kHz)
 - High efficiency: >98%
 - Passive element weight and size reduction
- Control section based on the [STM32G474RET3](#) microcontroller:
 - Control and monitoring interfaces: SWD–UART, I²C, and DACs
 - 64-pin digital power connector
 - LED status as UI
 - Four integrated high-performance op-amps for additional features

Description

The [STDES-VRECTFD](#) reference design is a complete solution for high-power three-phase AC/DC rectifier applications based on the Vienna topology.

It features full digital control through the [STM32G474RET3](#) MCU and provides both digital output voltage regulation and continuous conduction mode (CCM) current regulation for the maximum power quality related to total harmonic distortion (THD) and power factor (PF).

The high switching frequency of the [SCTW35N65G2V](#) SiC MOSFETs (70 kHz) and the multilevel structure allow a nearly 99% efficiency as well as the optimization of passive power components in terms of size and cost.

This high efficiency Vienna rectifier is designed for several end applications, such as electric vehicle (EV) and industrial battery chargers, and industrial equipment that requires a very high PF and a low THD.

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

Product summary	
15 kW, three-level, three-phase Vienna rectifier with digital control for power factor correction	STDES-VRECTFD
Firmware for STDES-VRECTFD	STSW-VRECTFD
Mainstream Arm® Cortex® -M4 MCU	STM32G474RET3
Silicon carbide power MOSFET	SCTW35N65G2V
Galvanically isolated gate driver for SiC MOSFETs	STGAP2SICS
Silicon carbide power Schottky diode	STPSC20H12WL
Applications	PFC Converter - Three Phase Input / Digital Power / DC Fast Charging Station

1 Detailed description

The **STDES-VRECTFD** reference design consists of a power board and a control module.

The power board contains a power section, an EMI filter, a sensing circuit, an inrush current circuit, and an auxiliary power supply.

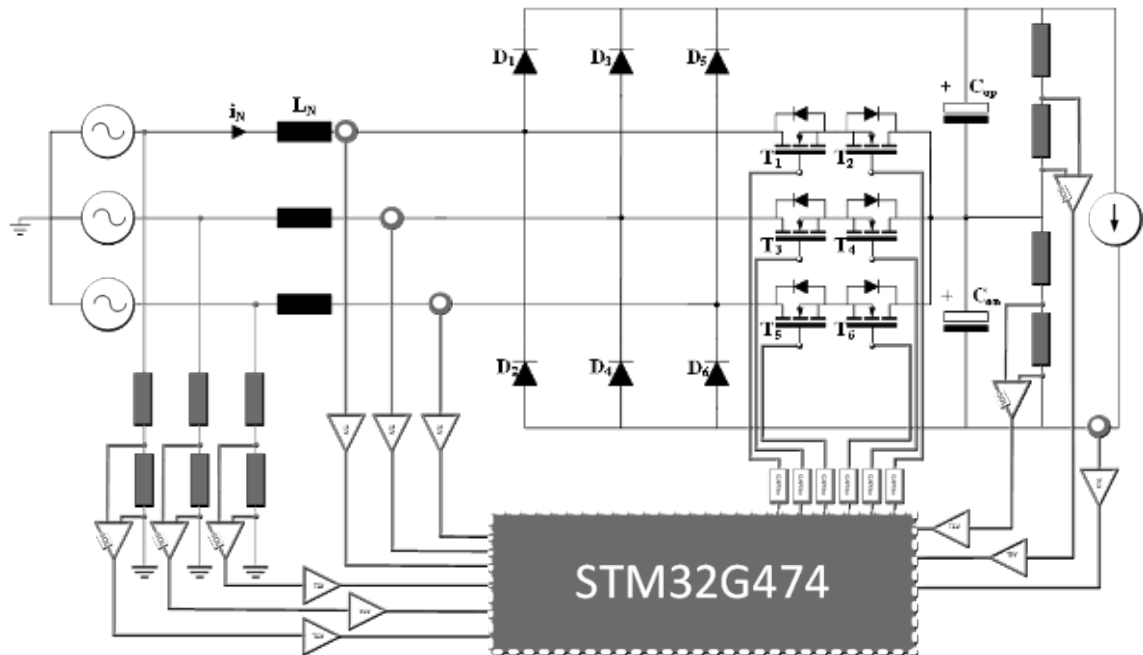
The control module is based on the **STM32G474RET3** microcontroller that features connectors for communication, test points, and status indicators for testing and debugging.

The input and output current and the voltage measurements necessary for responsive control are acquired through isolated measurement blocks. The **STM32G474RET3** microcontroller manages the CCM current regulation for power factor control and DC bus voltage regulation.

The **STM32G474RET3** also provides a comprehensive control of the application AC current and DC voltage, as well as monitoring and protection, including the start-up sequence and the load connection and disconnection.

A high-resolution timer peripheral determines the driving signals of the switching devices to maximize the performance at high-frequency operations.

Figure 1. Converter block diagram



2 Schematic diagrams

Figure 2. STDES-VRECTFD circuit schematic - power board (1 of 11)

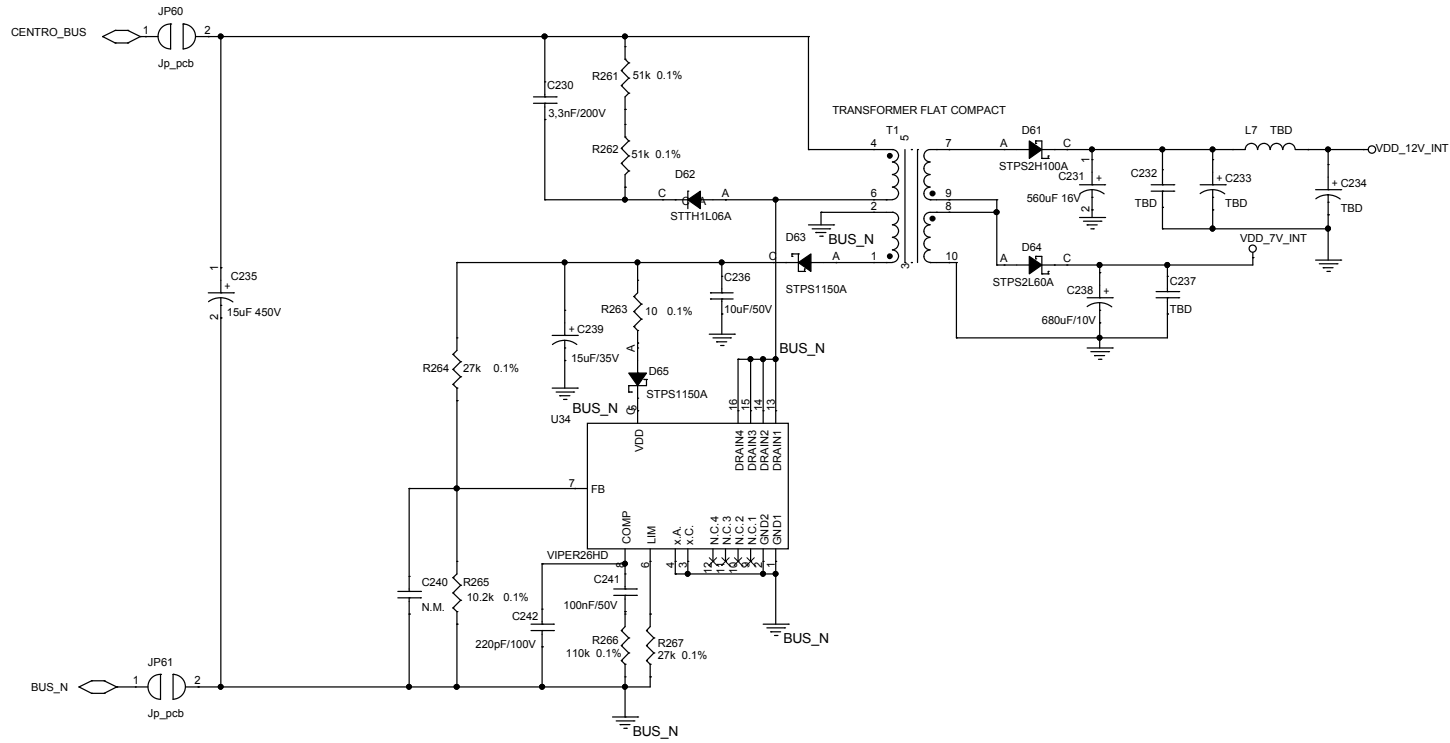


Figure 3. STDES-VRECTFD circuit schematic - power board (2 of 11)

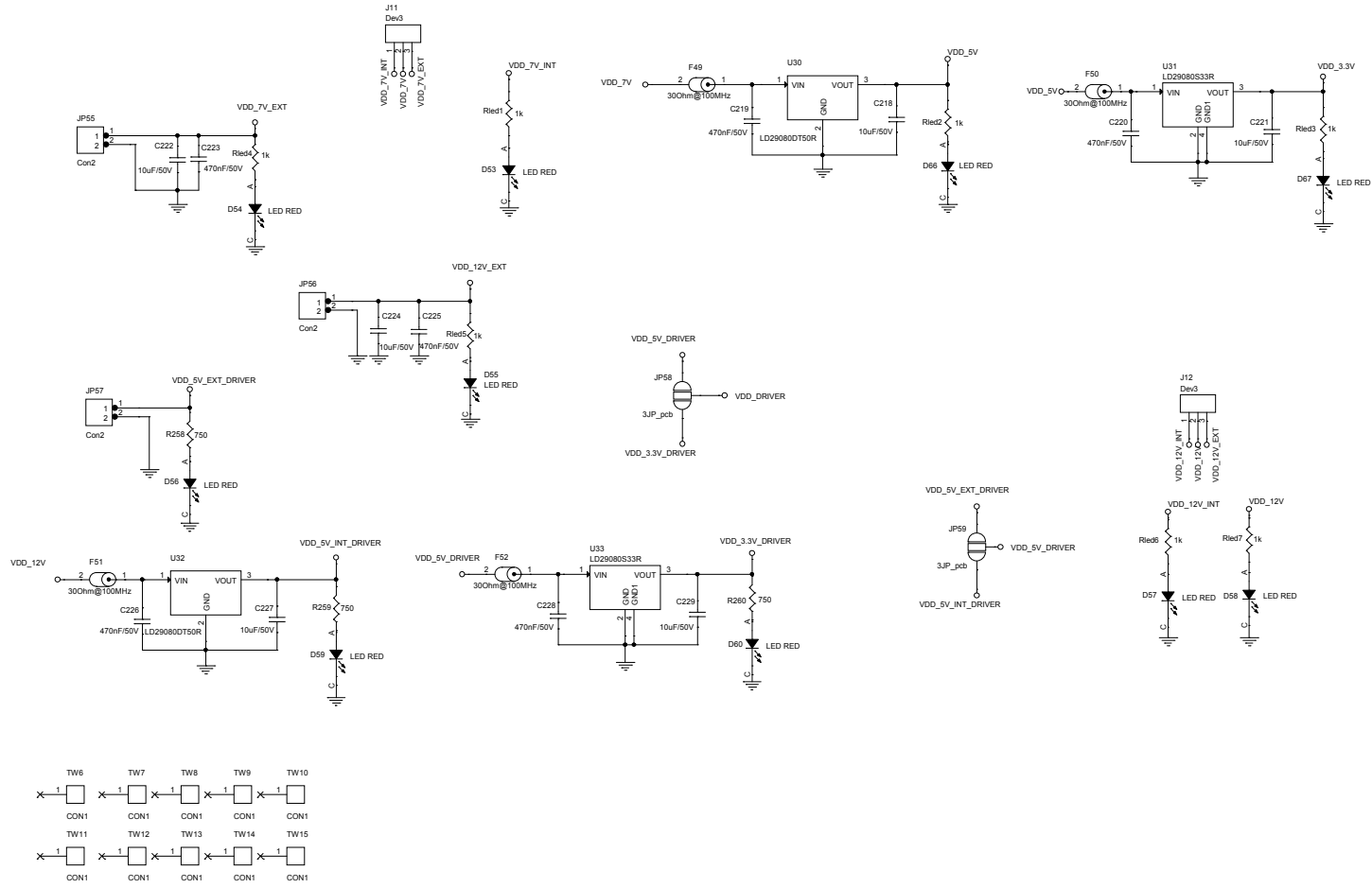


Figure 4. STDES-VRECTFD circuit schematic - power board (3 of 11)

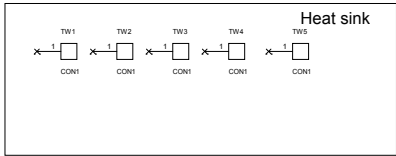
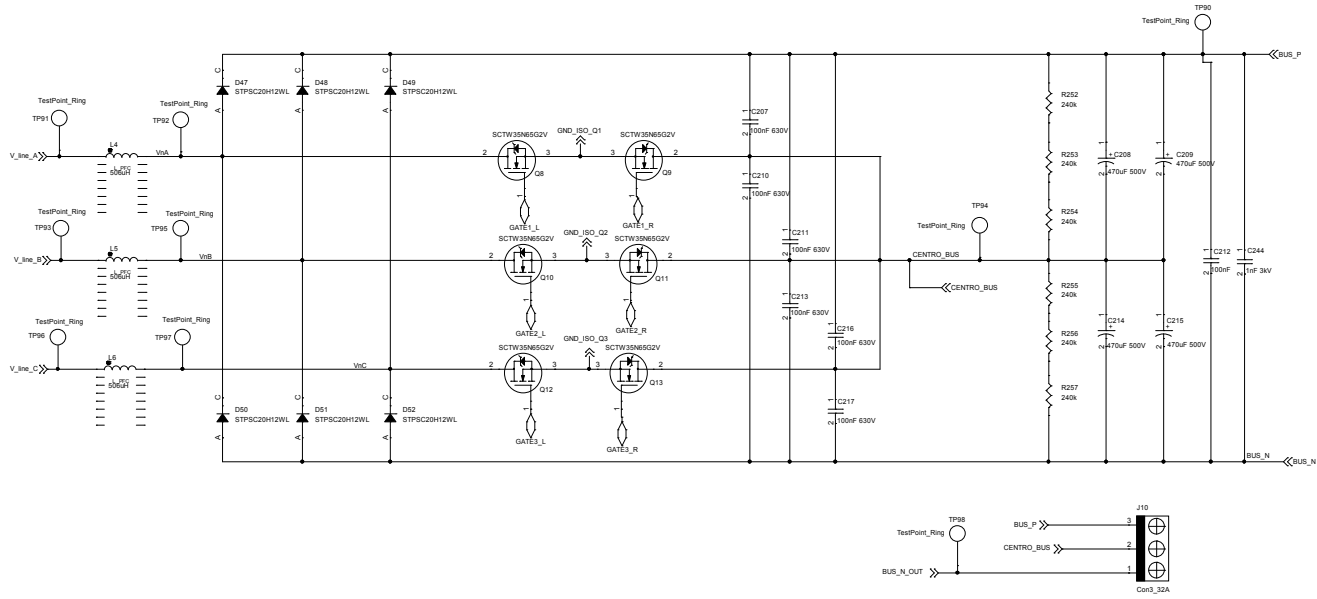


Figure 5. STDES-VRECTFD circuit schematic - power board (4 of 11)

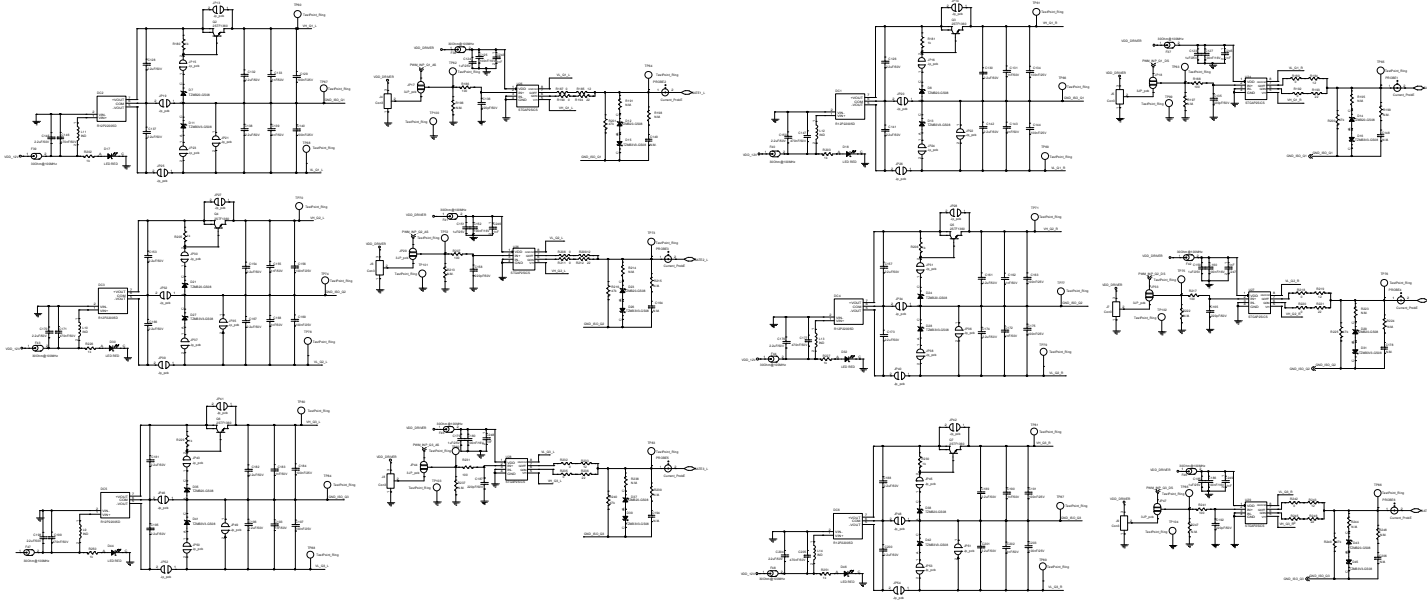


Figure 6. STDES-VRECTFD circuit schematic - power board (5 of 11)

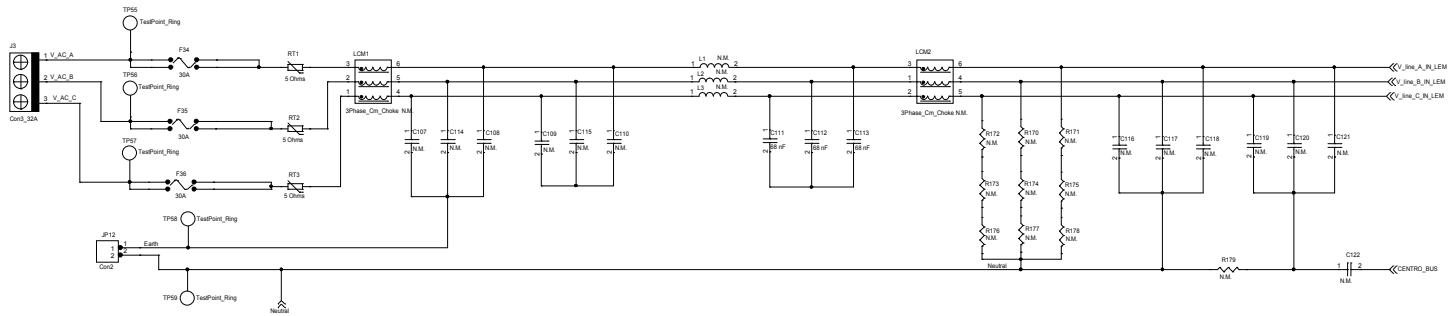


Figure 7. STDES-VRECTFD circuit schematic - power board (6 of 11)

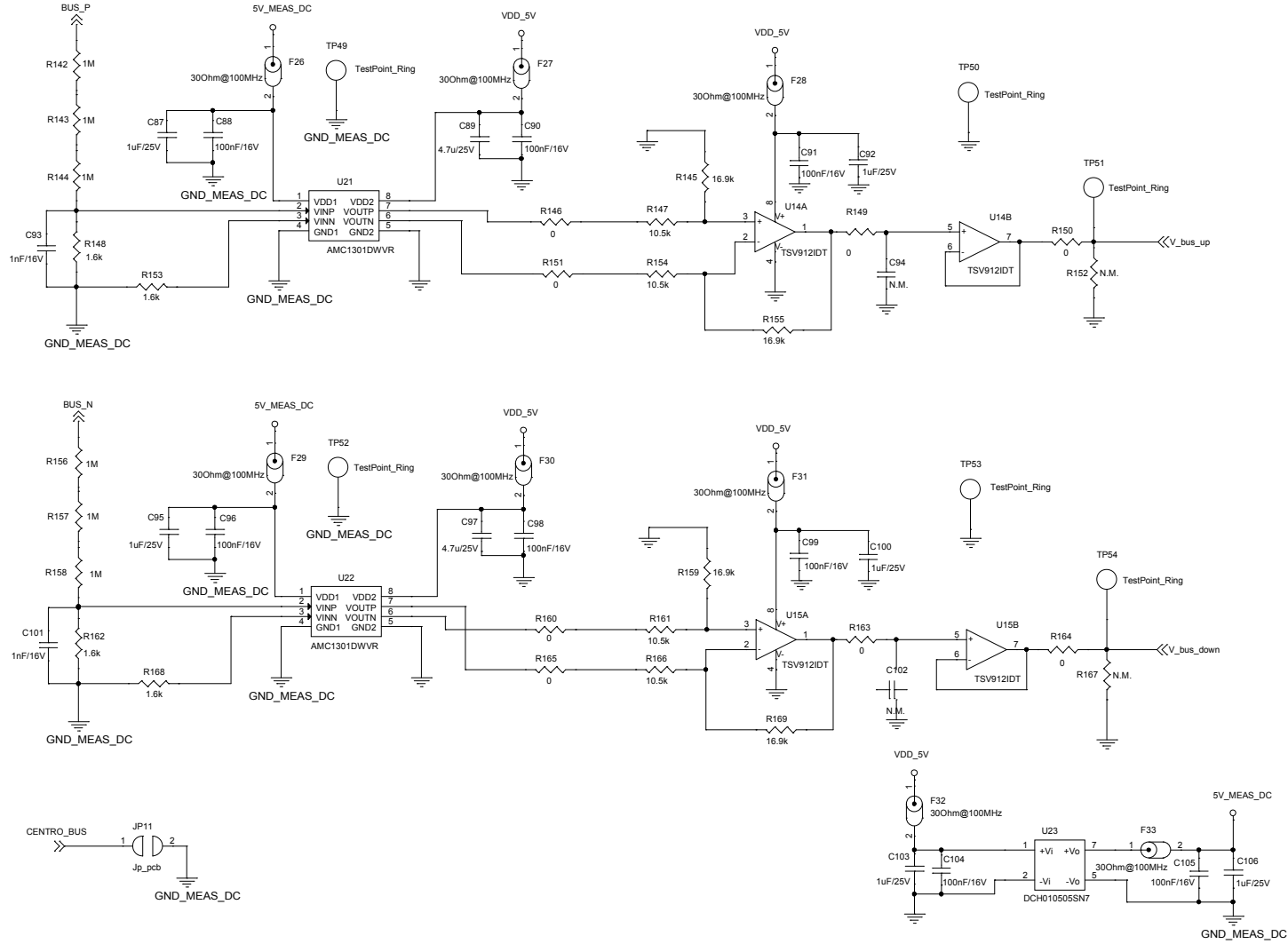


Figure 8. STDES-VRECTFD circuit schematic - power board (7 of 11)

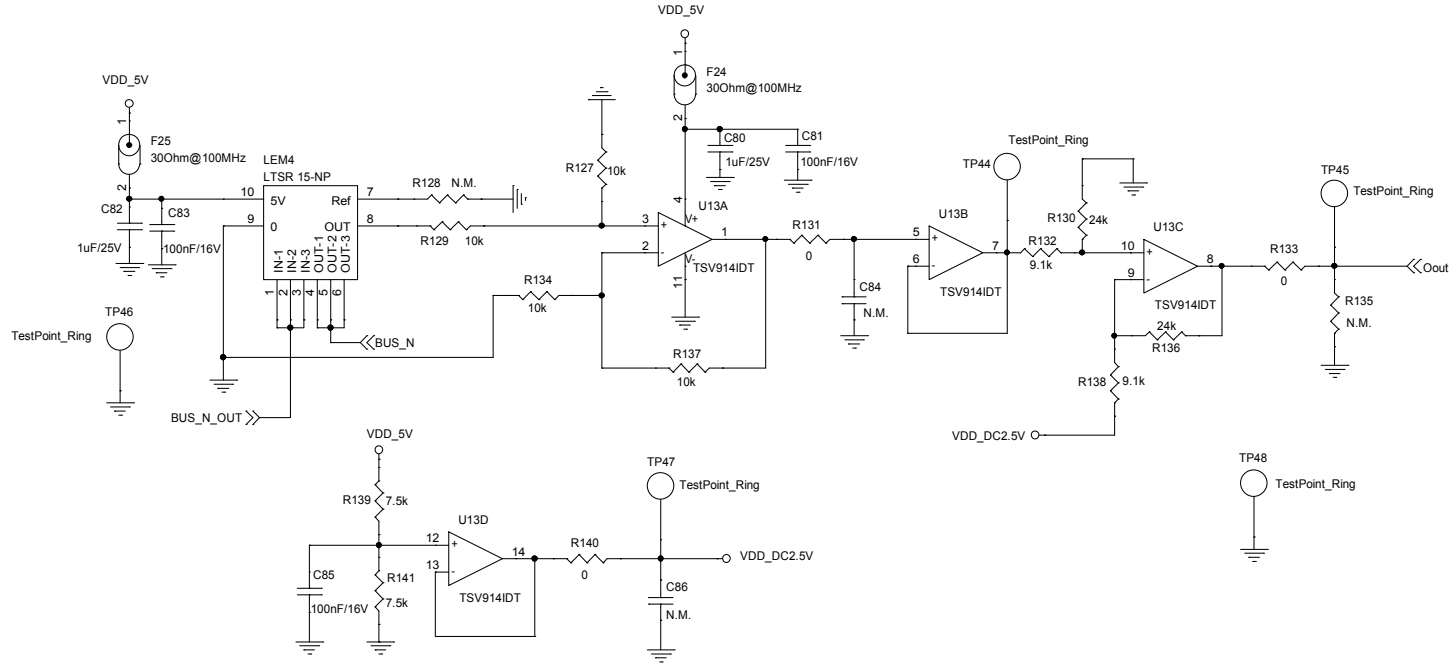


Figure 9. STDES-VRECTFD circuit schematic - power board (8 of 11)

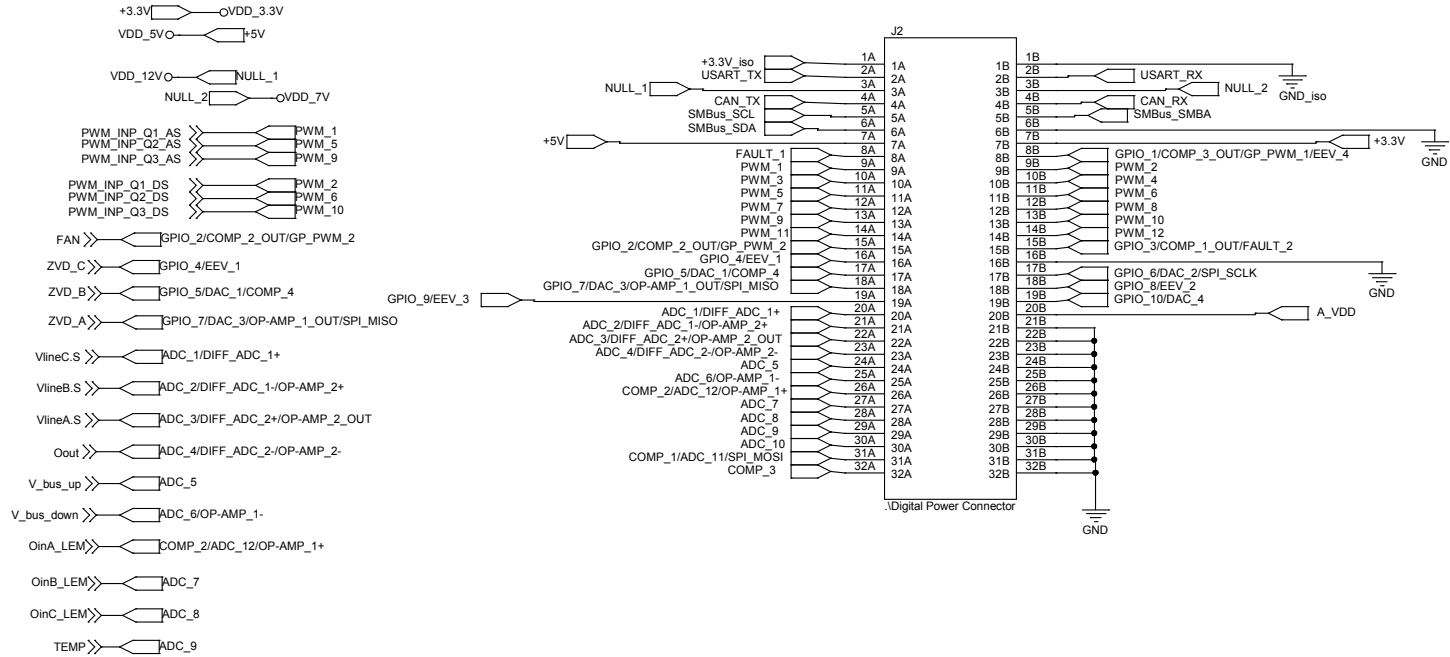


Figure 10. STDES-VRECTFD circuit schematic - power board (9 of 11)

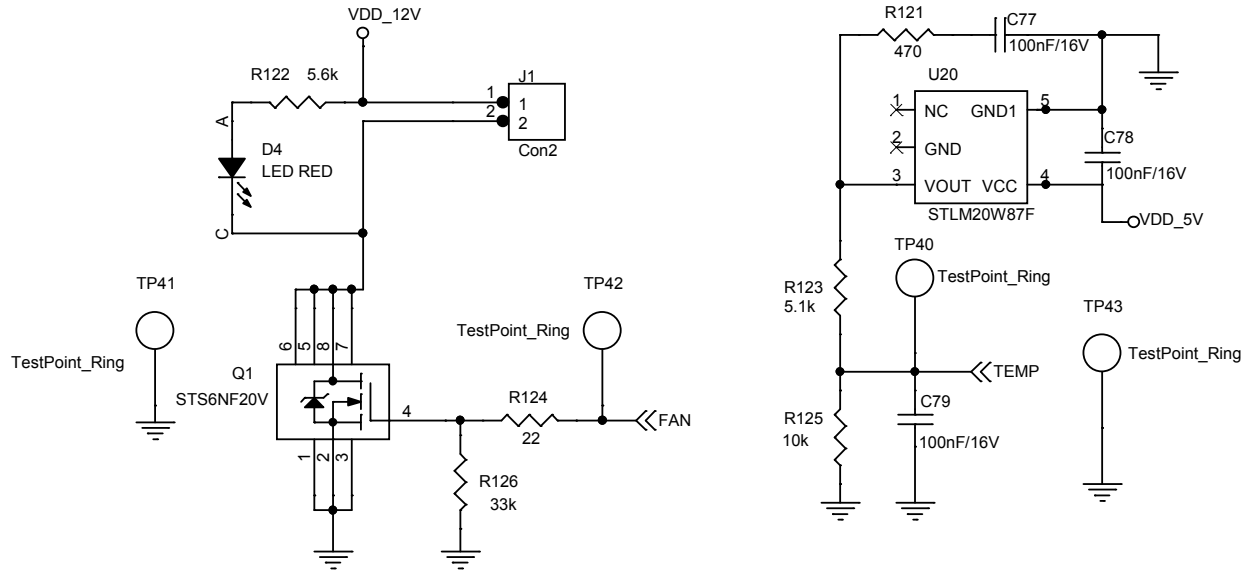


Figure 11. STDES-VRECTFD circuit schematic - power board (10 of 11)

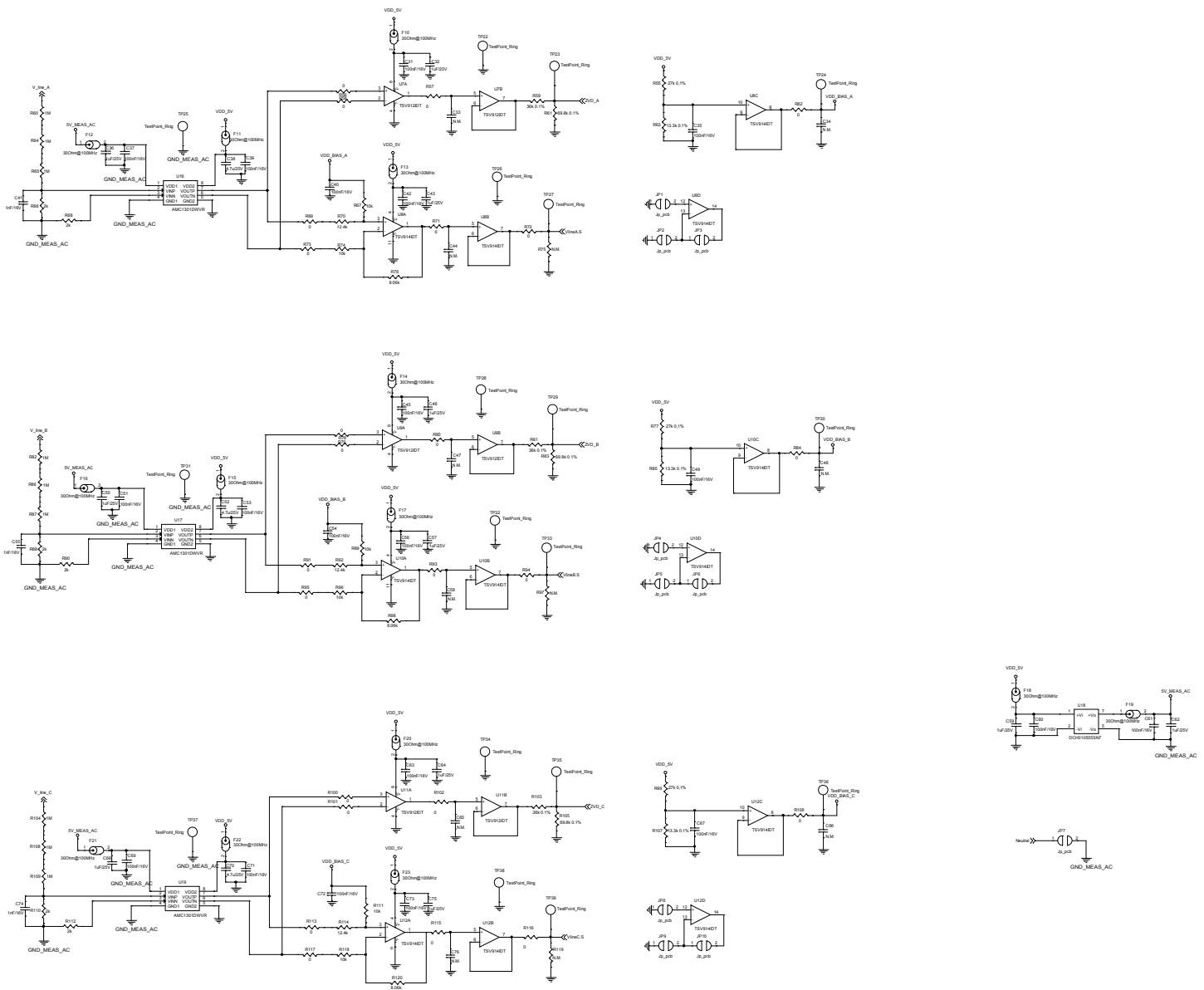
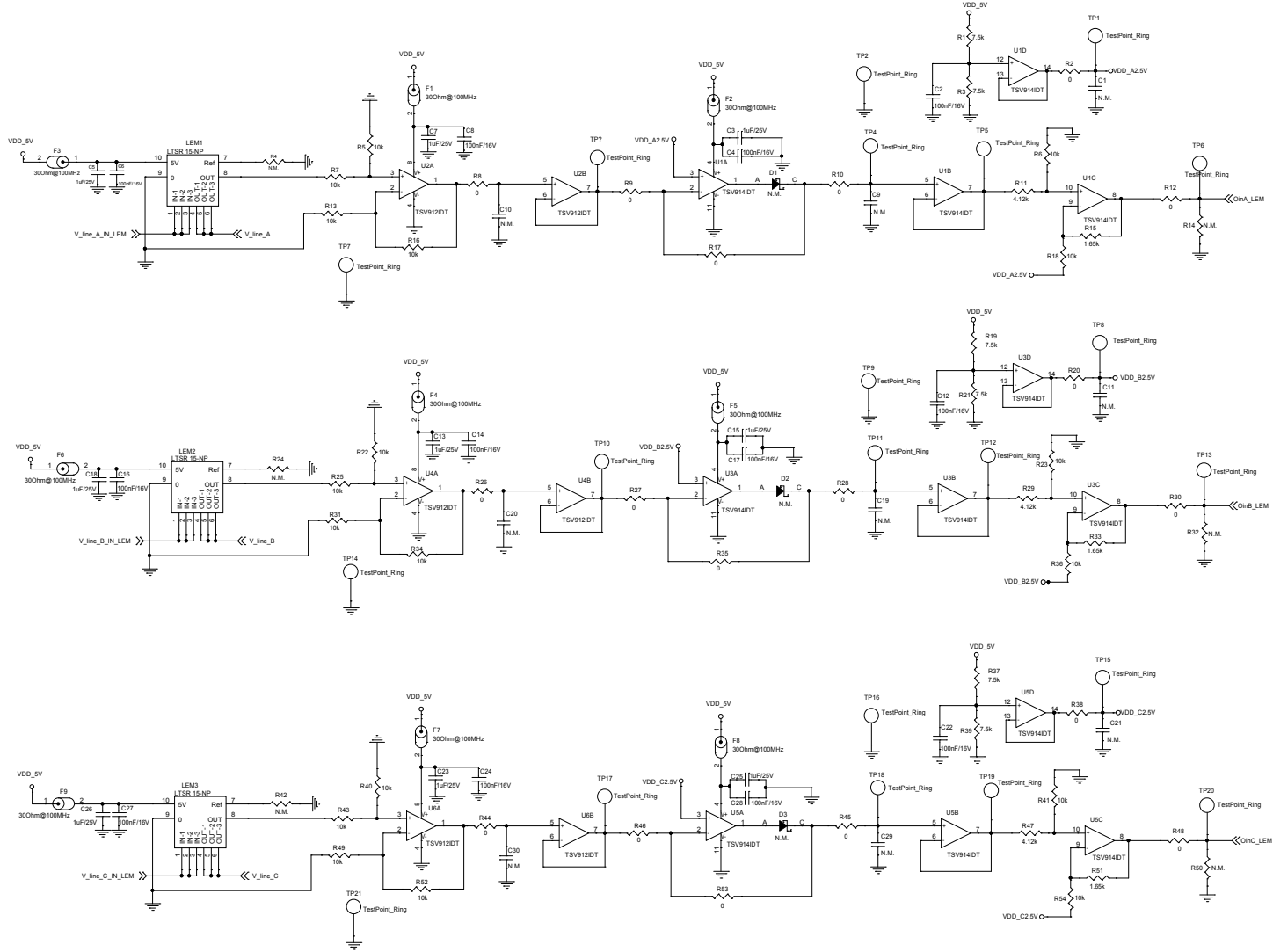


Figure 12. STDES-VRECTFD circuit schematic - power board (11 of 11)



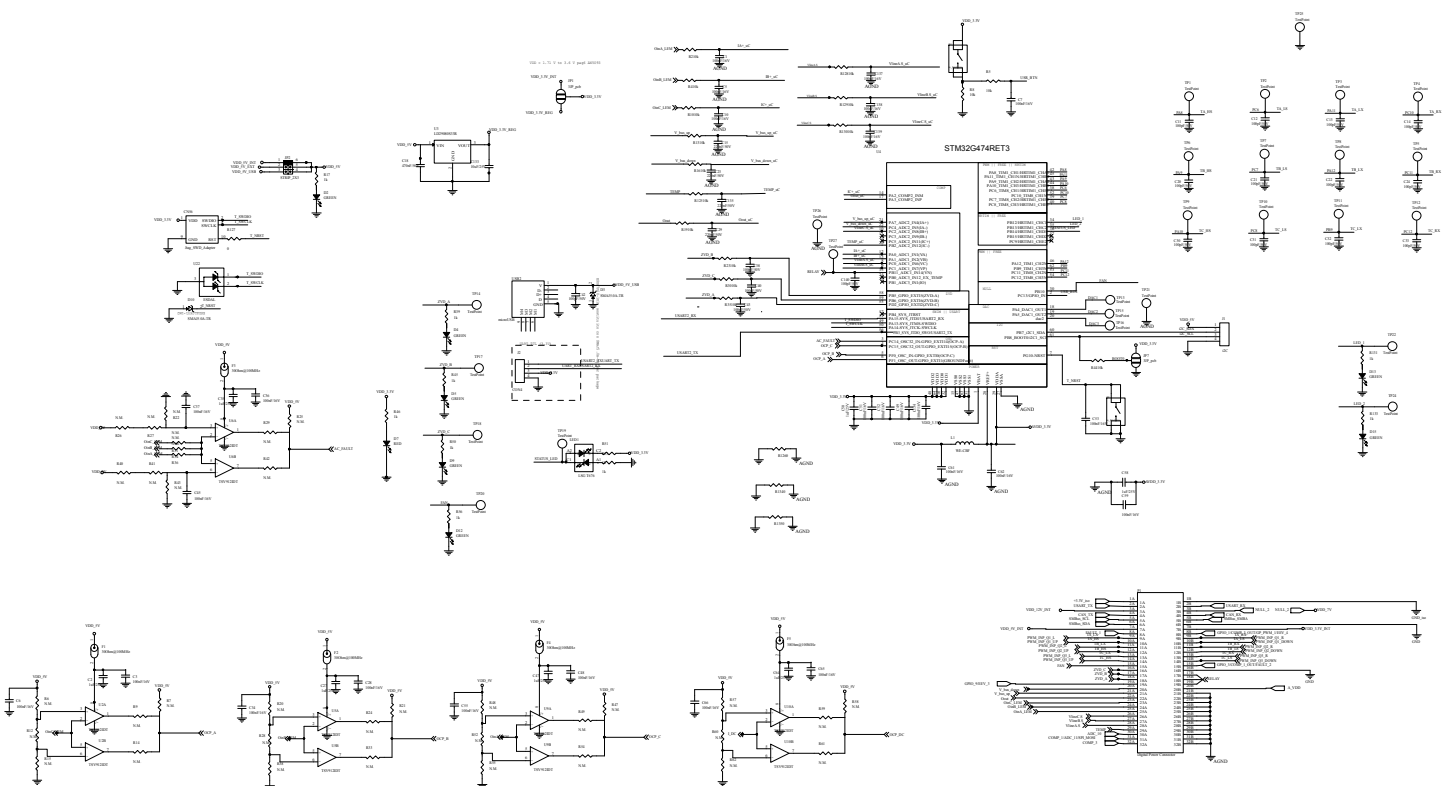


Figure 13. STDES-VRECTFD circuit schematic - control board

Revision history

Table 1. Document revision history

Date	Revision	Changes
21-Dec-2021	1	Initial release.

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