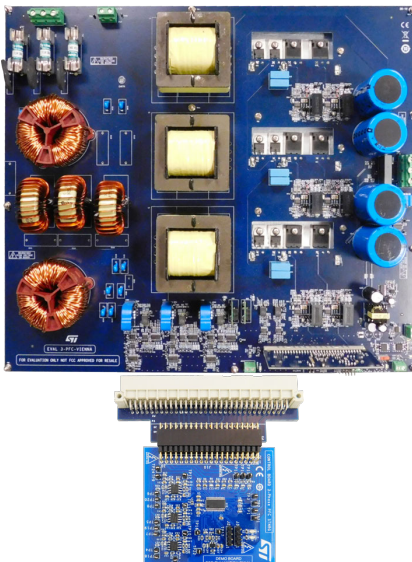


# 15 kW, three-phase Vienna rectifier with low cost mixed-signal control for power factor correction



## Features

- 3-phase, 3-level AC/DC power converter
  - Rated nominal output DC voltage:  $800 V_{DC}$
  - Rated nominal input AC voltage:  $400 V_{AC}$  at 50 Hz
  - Nominal output power AC/DC: 15 kW
  - Power factor,  $PF > 0.99$
  - Inrush current control and soft start-up
  - THD lower than 5% at nominal operation
- Power section based on SiC MOSFETs and diodes:
  - High frequency operation (70 kHz)
  - High peak efficiency greater than 98%
  - Passive element weight and size reduction
- Control section based on programmable [STNRG388A](#) digital controller
  - Low cost mixed-signal control
- Overcurrent and overvoltage protections

## Description

This reference design represents a complete solution for high power three-phase AC/DC rectifier applications based on the Vienna topology. It features mixed-signal control, with the [STNRG388A](#) controller providing digital output voltage regulation, and dedicated analog circuitry providing high bandwidth continuous conduction mode (CCM) current regulation for maximum power quality in terms of total harmonic distortion (THD) and power factor (PF).

The high switching frequency of the SiC MOSFETs (70 kHz) and the multilevel structure allow 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 requiring very high PF and low THD.

Product summary	
15 kW, 3-phase Vienna rectifier for PFC	<a href="#">STDES-VIENNARECT</a>
Firmware for 15 kW, 3-phase Vienna rectifier	<a href="#">STSW-VIENNARECT</a>
digital controller for power conversion with up to 6 prog. PWM generators, 96 MHz PLL	<a href="#">STNRG388A</a>
SiC Power MOSFET 650 V, 45 A, 55 mΩ in HiP247 package	<a href="#">SCTW35N65G2V</a>
1200 V, 20 A High surge Silicon Carbide Power Schottky Diode	<a href="#">STPSC20H12</a>
galvanically isolated 4 A single gate driver	<a href="#">STGAP2SM</a>
energy saving 12W high voltage	<a href="#">VIPER26HD</a>

Product summary	
converter with direct feedback	
Applications	PFC Converter - Three Phase Input DC Fast Charging Station

# 1 Vienna rectifier with mixed mode control reference design overview

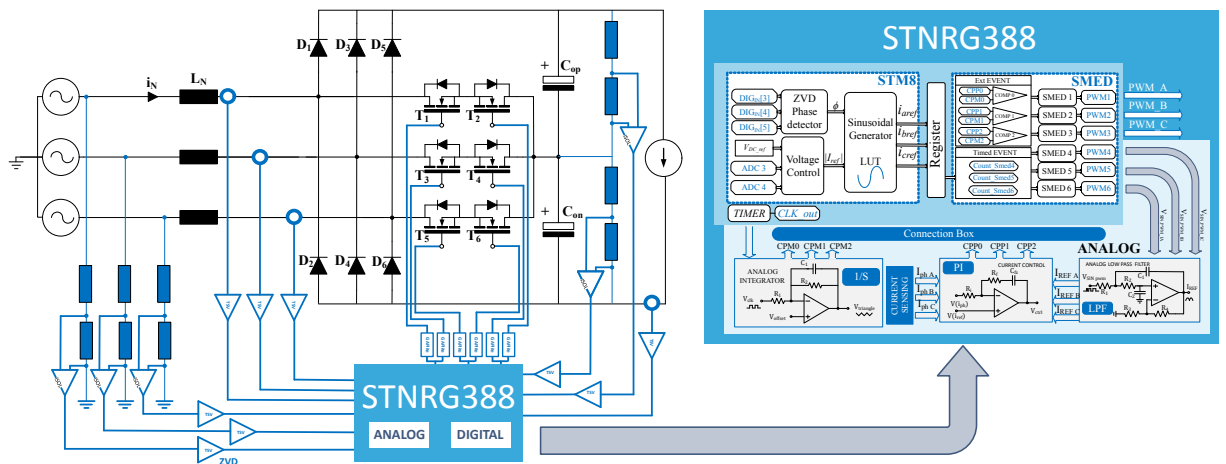
This reference design consists of the following separate components:

- Power board with power section, EMI filter, sensing circuit, inrush circuit and auxiliary power supply.
- Control board based on the **STNRG388A** 8-bit digital controller for power conversion applications, along 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 control section allows analog implementation of CCM current regulation for power factor correction, while the bus voltage is regulated through digital control.

The **STNRG388A** provides comprehensive control of the application currents and voltages as well as monitoring and protection, plus the start-up sequence and load variation control. The driving signals of the switching devices are determined by an internal State Machine Event Driven (SMED), ensuring that time critical tasks are never interrupted.

**Figure 1. 3-phase mixed-signal rectifier block diagram**



# 2 Schematic diagrams

Figure 2. STDES-VIENNARECT schematic diagram - control board

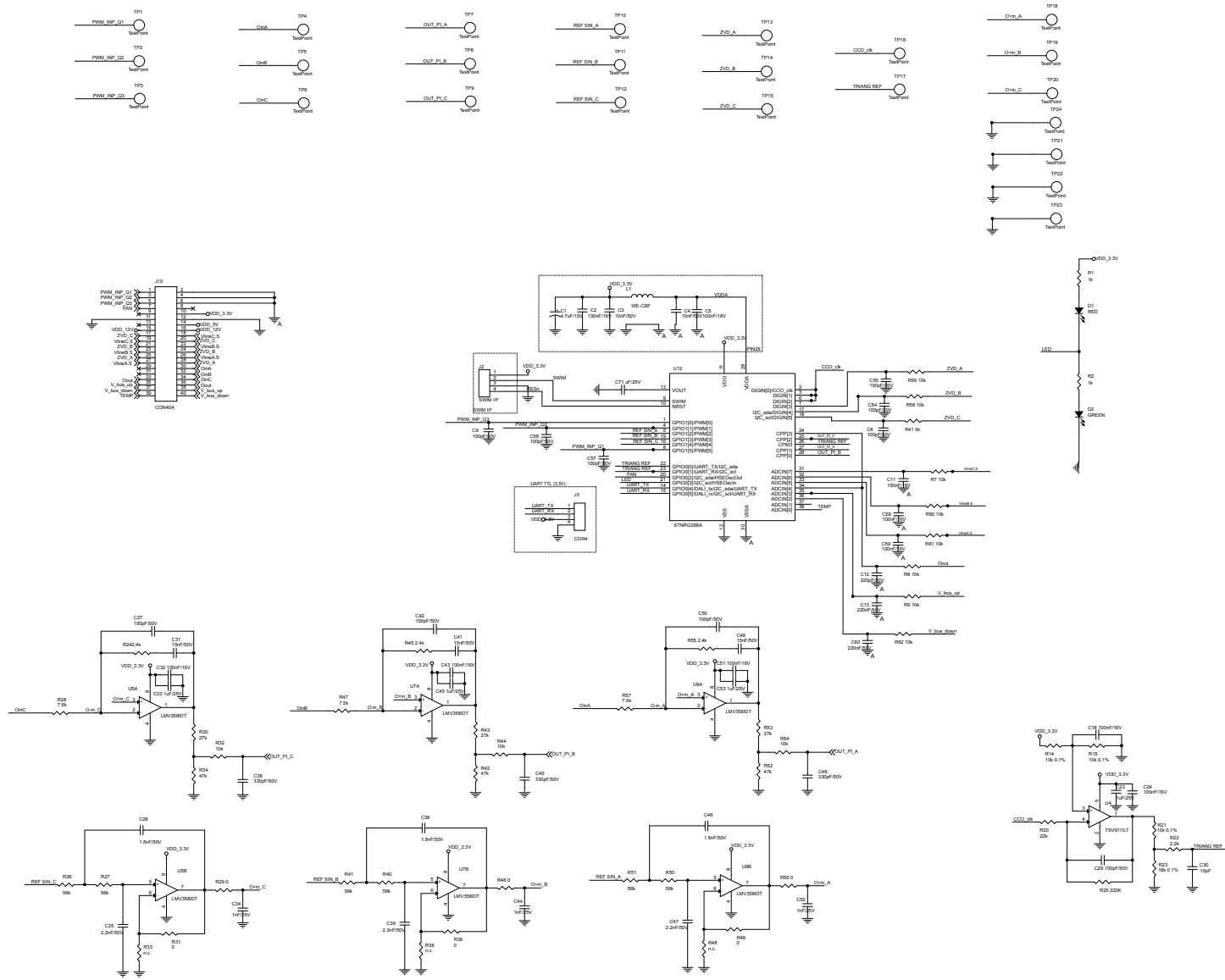


Figure 3. STDES-VIENNARECT schematic diagram - power board: AC current sensing

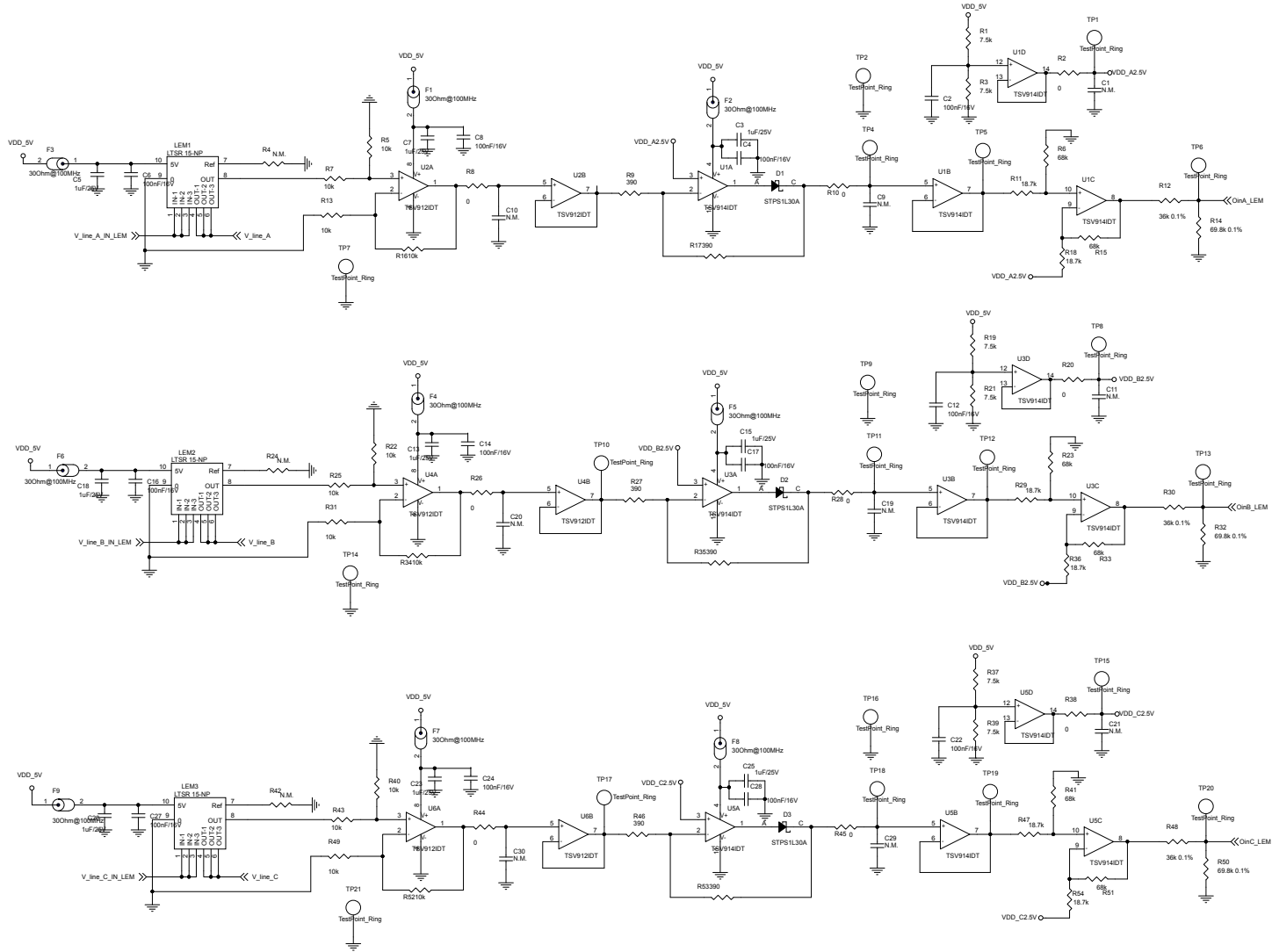


Figure 4. STDES-VIENNARECT schematic diagram - power board: AC voltage sensing

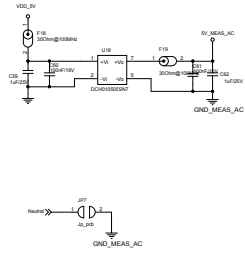
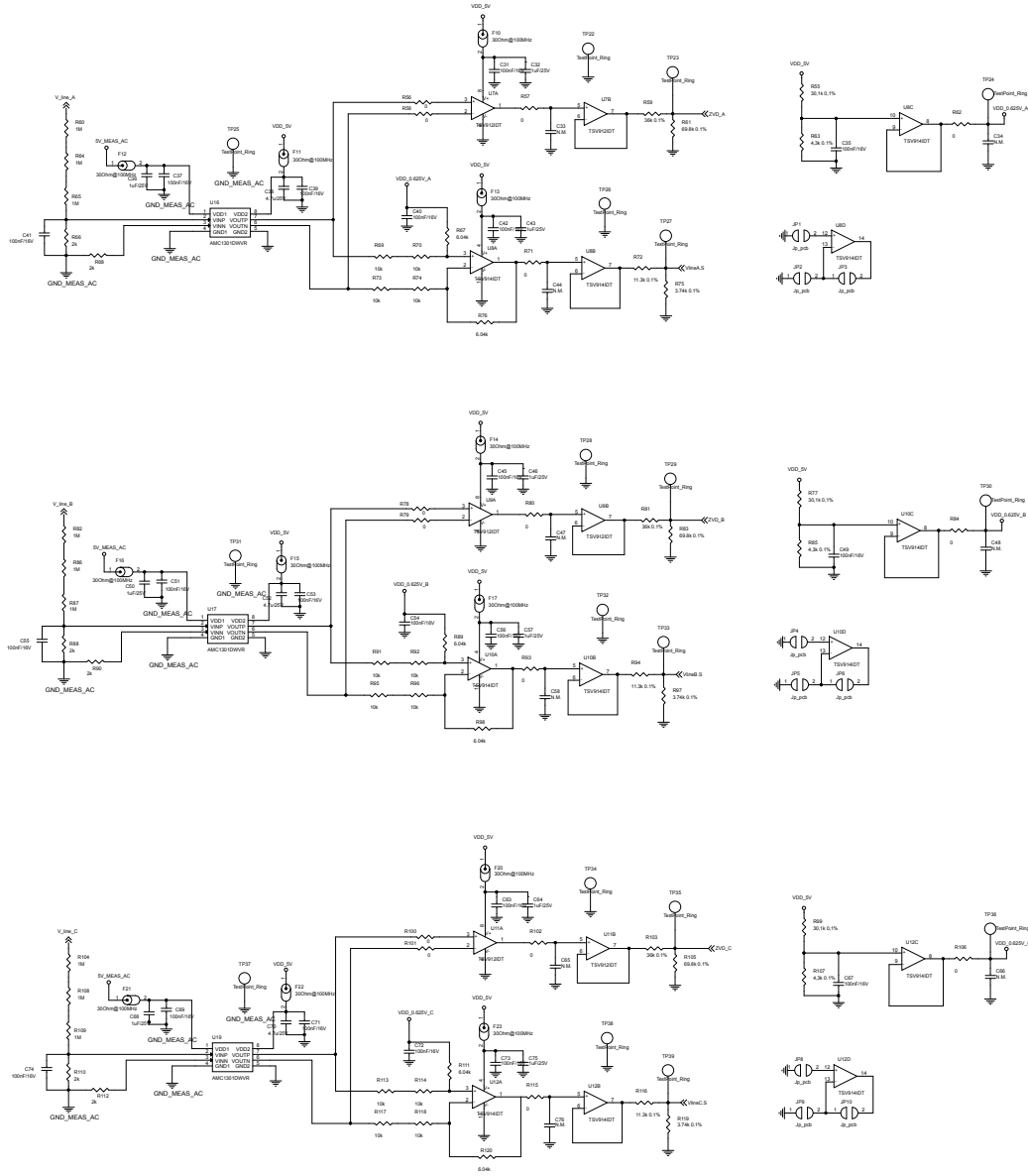


Figure 5. STDES-VIENNARECT schematic diagram - power board: temp control

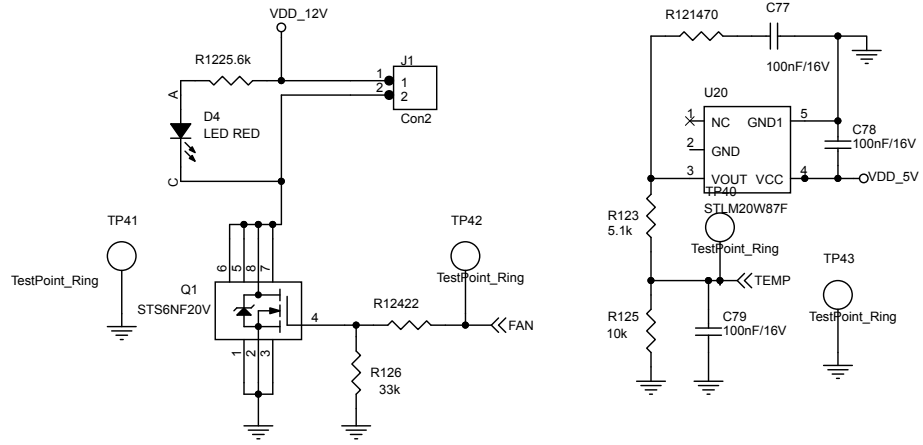


Figure 6. STDES-VIENNARECT schematic diagram - power board: connectors

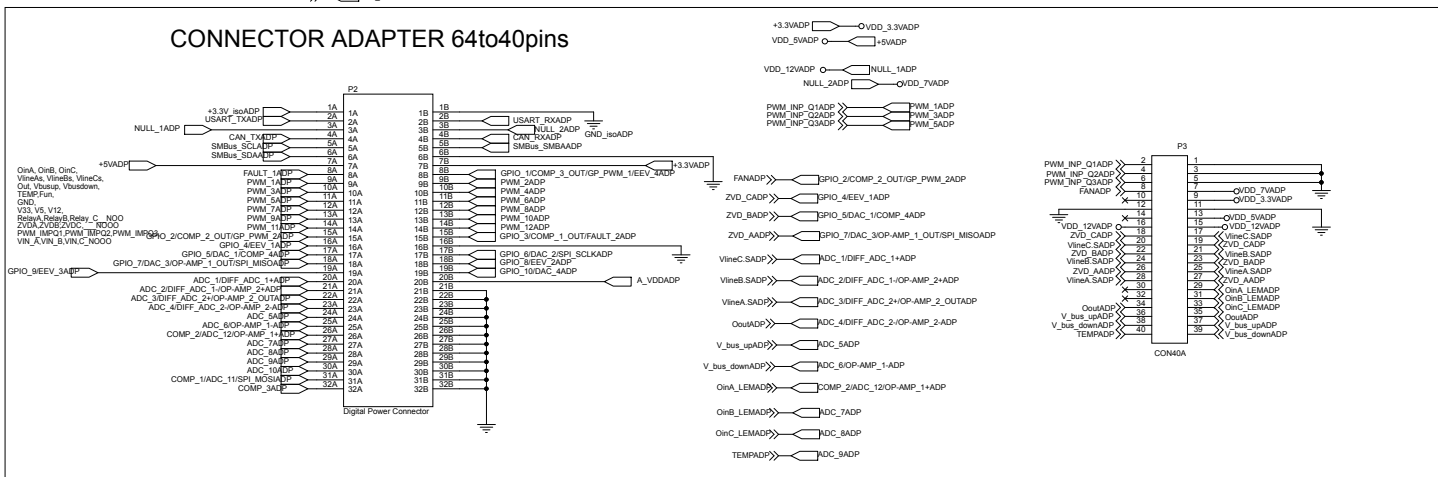
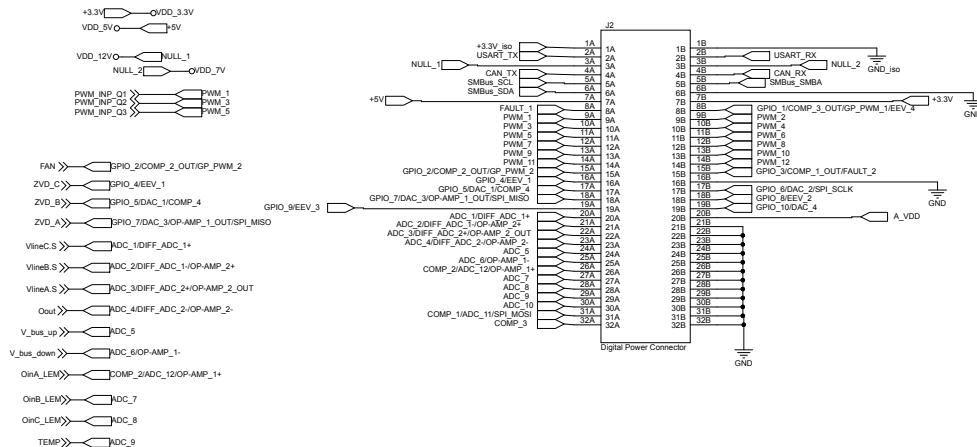




Figure 7. STDES-VIENNARECT schematic diagram - power board: DC current sensing

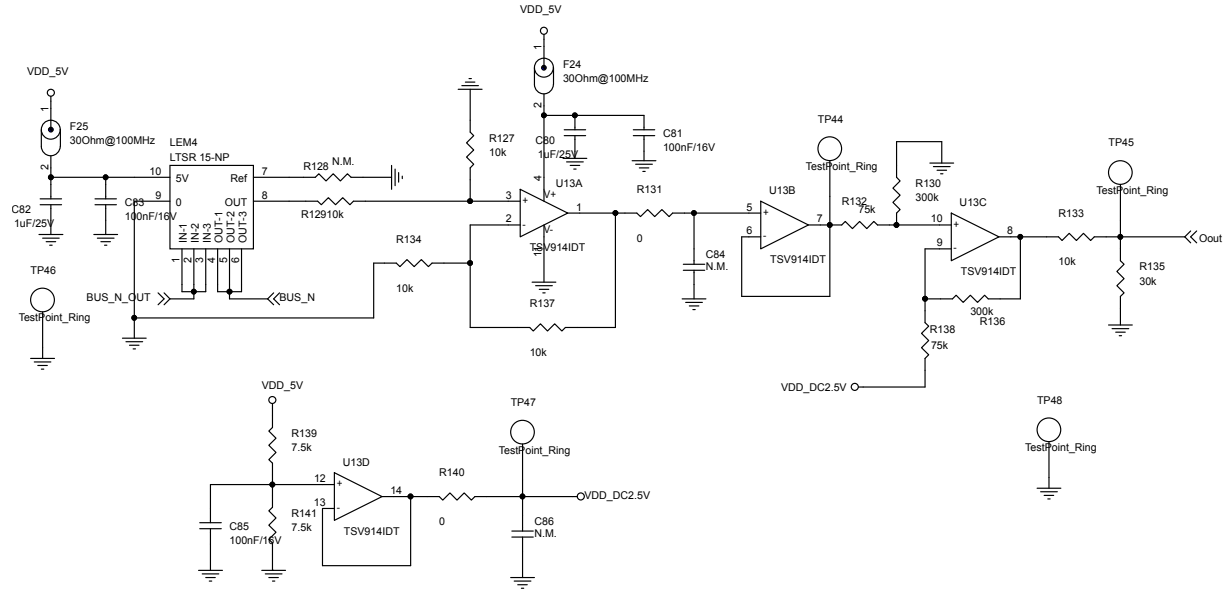


Figure 8. STDES-VIENNARECT schematic diagram - power board: DC voltage sensing

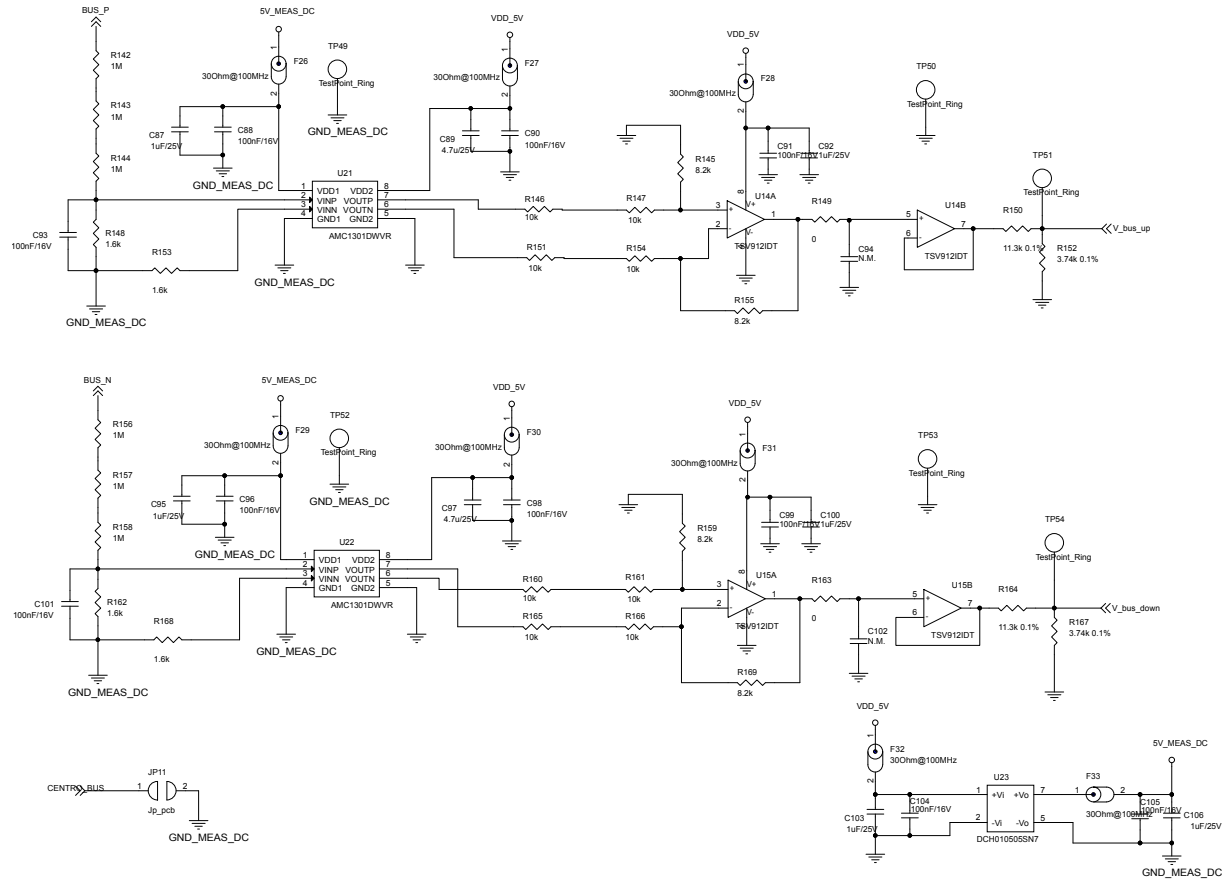


Figure 9. STDES-VIENNARECT schematic diagram - power board: input EMI filter

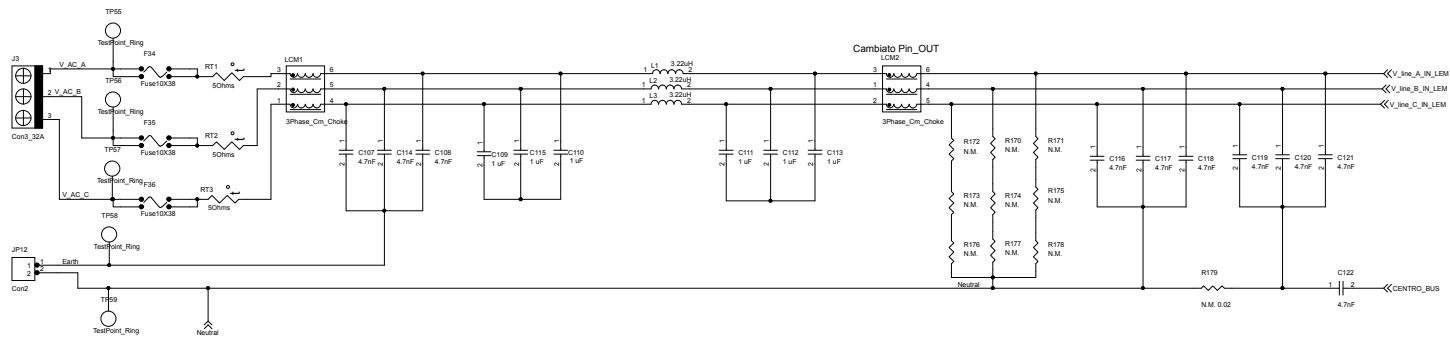


Figure 10. STDES-VIENNARECT schematic diagram - power board: gate drivers (x6)

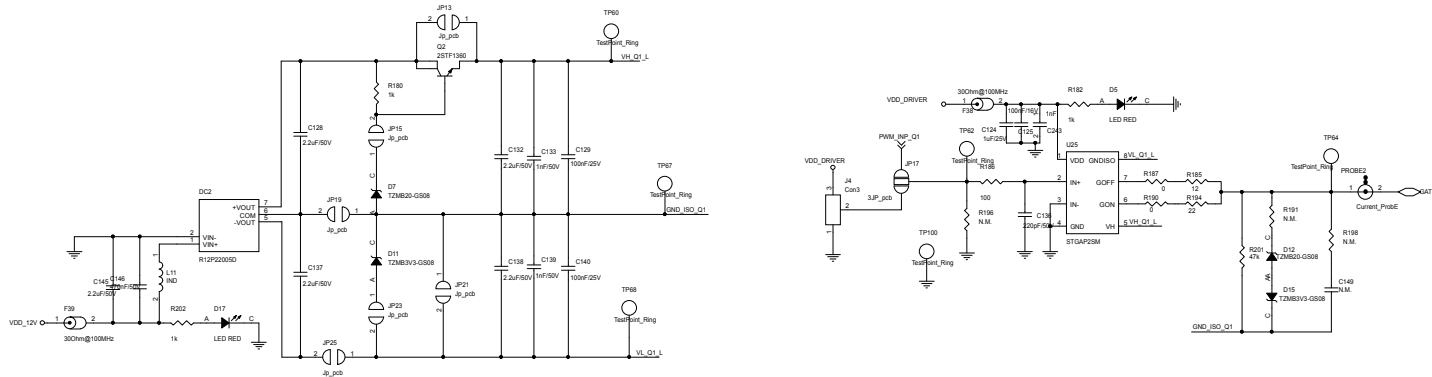


Figure 11. STDES-VIENNARECT schematic diagram - power board: power section

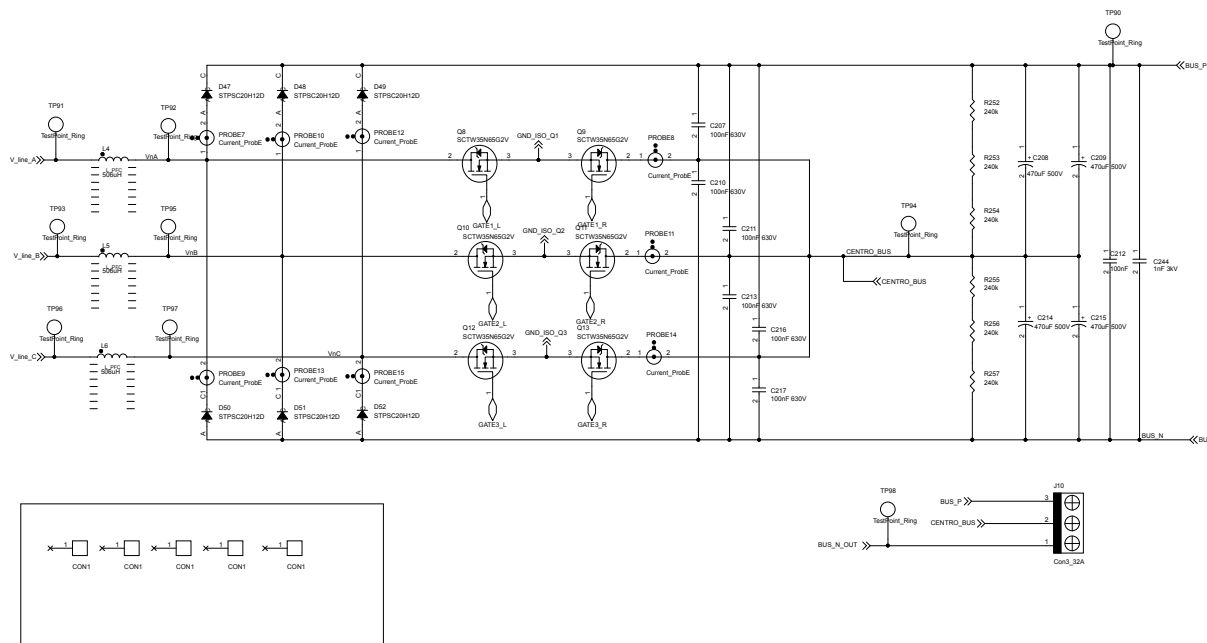


Figure 12. STDES-VIENNARECT schematic diagram - power board: aux power DC/DC

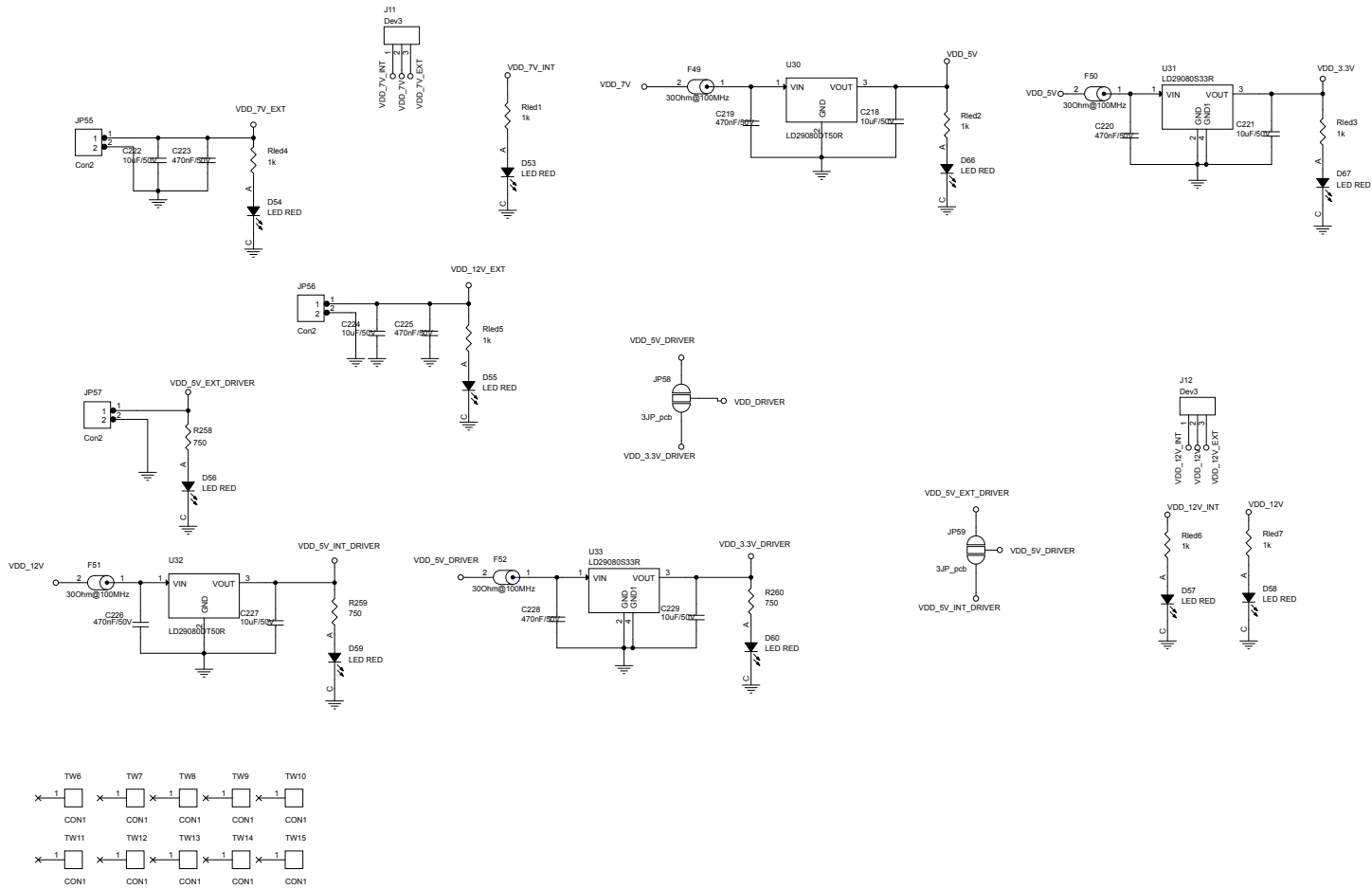
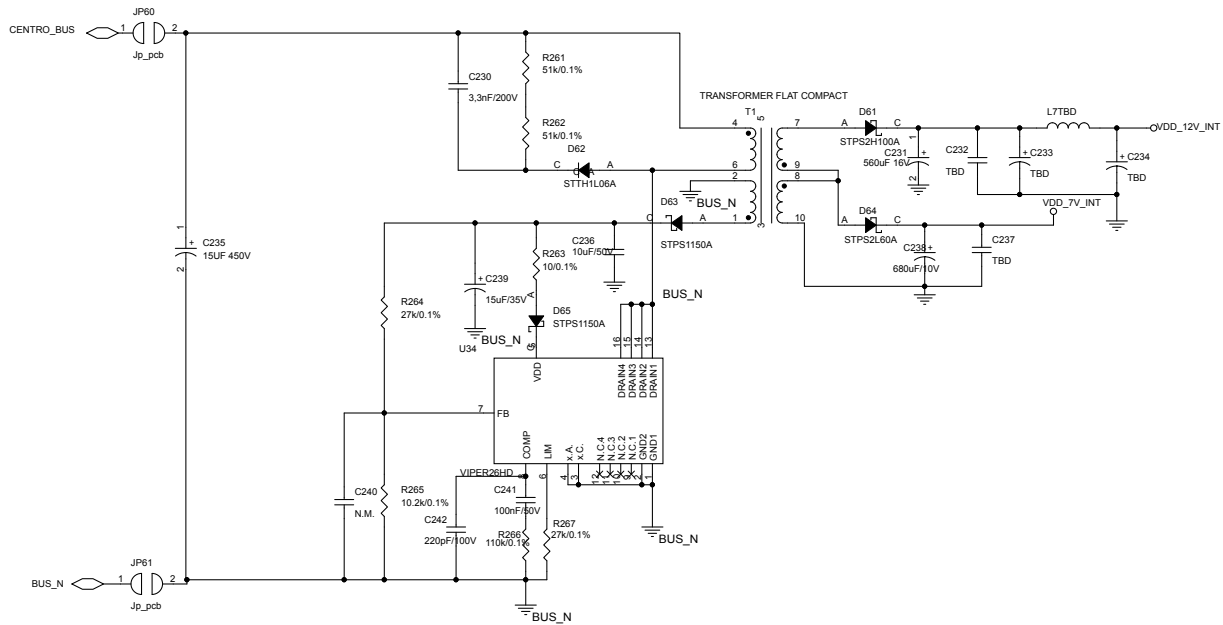


Figure 13. STDES-VIENNARECT schematic diagram - power board: aux power VIPER



## Revision history

**Table 1. Document revision history**

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

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