User's Guide

TPS536C7 DCAP+, DC/DC Step-down Controller Evaluation Module for CPU/ASIC Core Rail Applications

ABSTRACT

The TPS536C7EVM implements a typical application for a low-voltage, high current dual output power converter, operating from a nominal 12-V input rail to produce a 0.88-V output rail at up to 400A(12-phases) of load current and a 1-V rail at up to 50 A(2-phases). The EVM includes test points for evaluating the performance of the TPS536C7 controller and CSD95410 power stages

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Trademarks

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1 Introduction

For ease of evaluation, the EVM requires only one (12-V) input supply and an output load to get started with testing, however the user can opt to independently provide 5-V for greater control over the Power Stage voltage. With the addition of the Fusion Digital Power™ Designer software, the EVM's PMBus™ interface allows access to the controller NVM for evaluation of additional configuration, control and monitoring possibilities. Refer to the TPS536C7 datasheet for complete information on configuring multi-phase operation with this controller.

2 Features

- Dual regulated high current outputs
- Configurable as maximum phases 12+0, 11+1 and 10+2.
- Programmable settings available through PMBus™ interface
  - Output voltage trim
  - Output voltage margin levels (High / Low) within a maximum range
  - UVLO protection threshold
  - Soft-start slew-rate
  - Device enable and disable
  - Overcurrent warning and fault limits
  - Switching frequency
  - BOOT voltage
  - Monitoring of input and output voltage, current, power, and power stage temperature
- Convenient test points for probing critical waveforms

3 Applications

- High current ASIC and FPGA core power in the following equipment:
  - Wired and Wireless Networking
  - Enterprise Server and Storage Networks
  - Test and Measurement
  - Smart Grid Infrastructure
  - Aerospace and Defense
  - Merchant Power Supplies

4 System Description

The TPS536C7EVM-051 is a 12-phase comprehensive evaluation module (EVM) for CPU/ASIC core power rail applications using the TPS536C7 controller. Figure 4-1 shows the top side of the EVM and Figure 4-2 shows the bottom side of the EVM. The EVM possesses several hooks for placing meters and probes by providing appropriate test points on various nodes .

The copper lugs T1 and T2 are the conversion input terminals to the step-down DC/DC converter. Input terminals are the point of connection of the input DC voltage.

With J5 closed, an on-board buck converter (TPS62133) generates the 5-V power stage VDD voltage. With J5 open, TPS62133 is disabled, and the 5-V supply must be applied to J1 externally. A 5-V to 3.3-V LDO (TLV75733) generates the 3.3-V controller bias voltage, and also supplies auxiliary circuits and LEDs on the EVM.

The output terminals T3, T4, T5, T6,T7,T8,T9,T10 and T11 are copper lugs providing a connection point for the high-current load. Figure 4-3 shows the location of all component details in the EVM. The setup is explained in detail in next section.

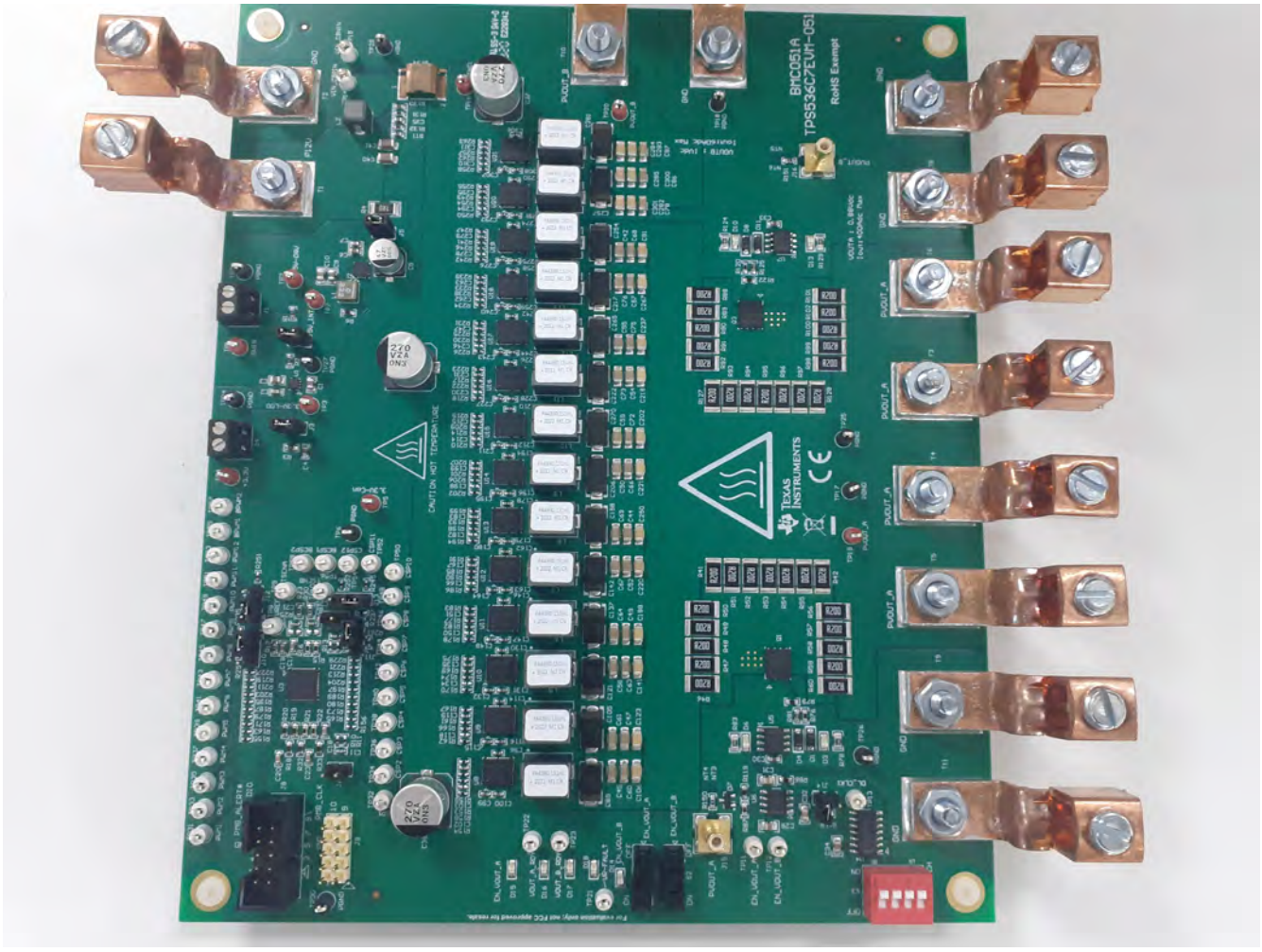


Figure 4-1. EVM Top View

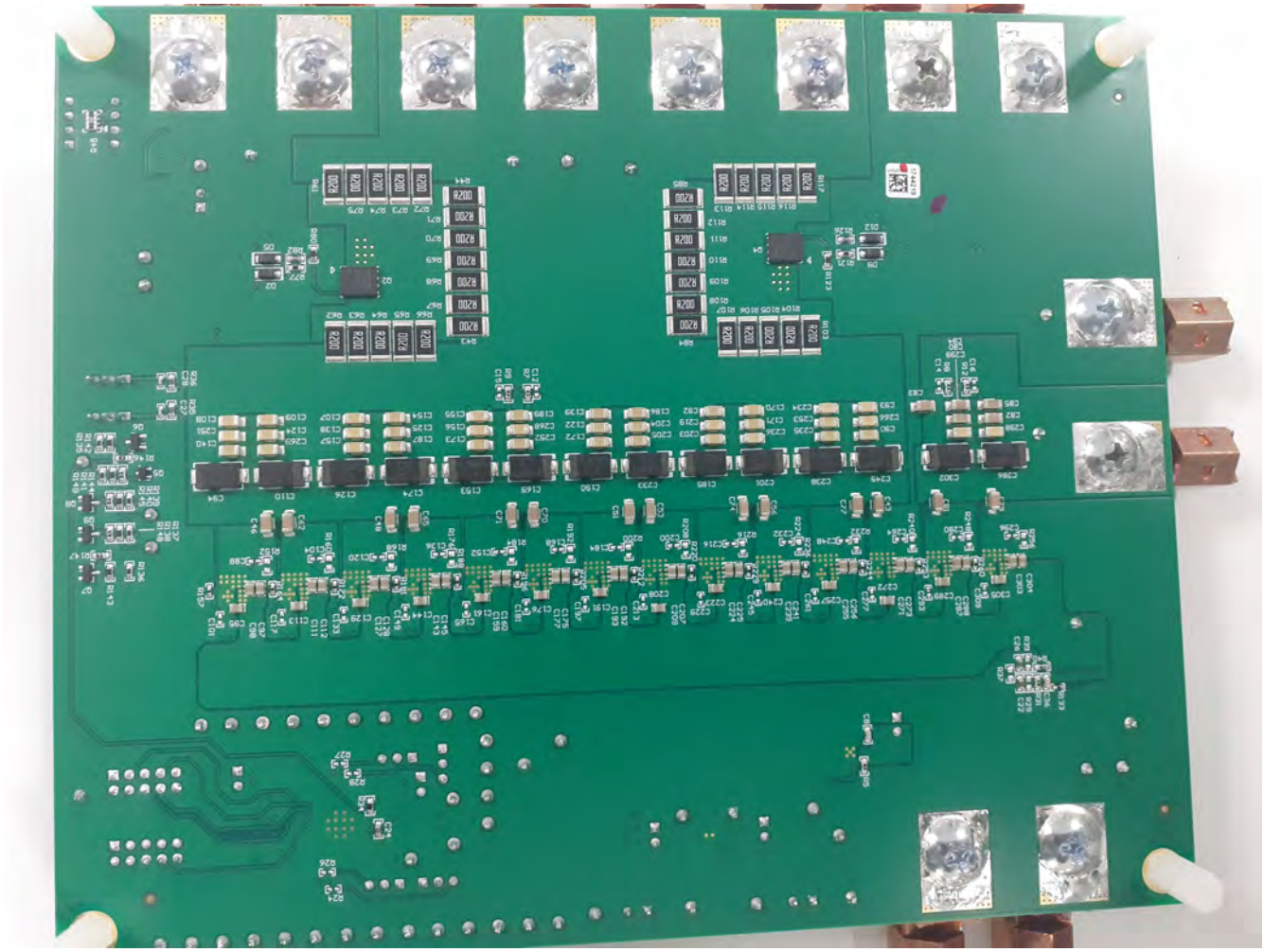


Figure 4-2. EVM Bottom View

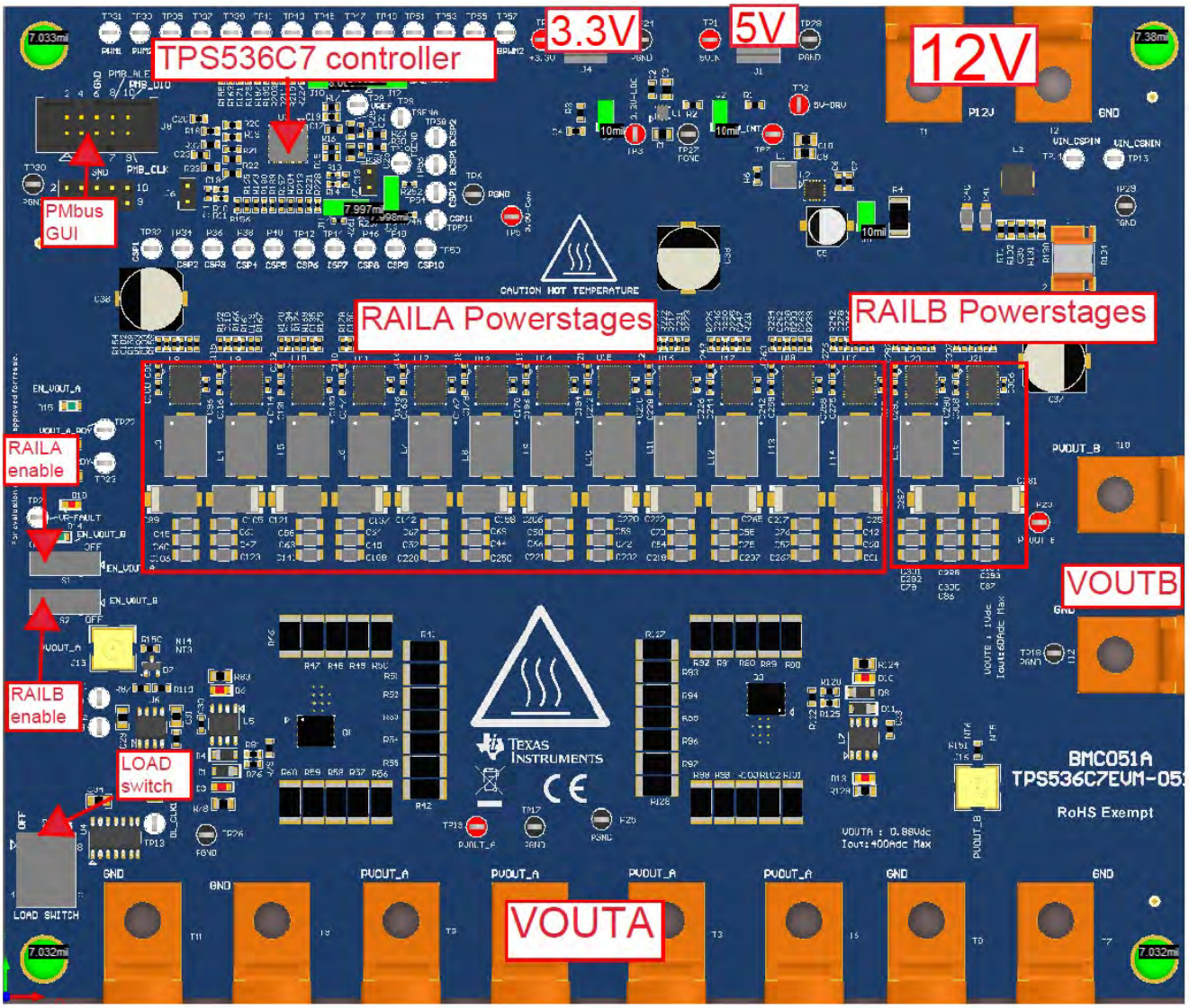


Figure 4-3. EVM Options

4.1 Phase configuration Selection

This EVM supports testing of both rails (RAILA and RAILB). The maximum number of phases available for RAIL A is 12-phases and for RAILB is 2 phases . PWM11 and PWM12 pins share control for both rails. Select the jumper settings for phase configuration 12+0,11+1,10+2 as shown in Phase configuation selection

Table 4-1. Phase configuation selection

Phase configuartion	Jumper J10	Jumper J11	Jumper J12	Jumper J13
12+0 (Default)	1-2 short	1-2 short	1-2 short	1-2 short
11+1	1-2 short	1-2 short	2-3 short	2-3 short
10+2	2-3 short	2-3 short	2-3 short	2-3 short

4.2 Jumper details

All Jumper description as follows

Table 4-2. Jumper

Jumper	Description	Default
J1	5V External Supply Input	No external supply
J2	Internal 5V Supply Input	short
J3	3V3 VCC External Supply Input	No external supply
J4	LDO output 3V3 supply	short
J5	5V Supply selector either 12V derived(short) or external(open)	short
J6	VOUTA Sense	Open
J7	VOUTB Sense	Open
J8	PMBUS Connector	Open
J9	Placehodler	Open
J10	Phase configuration selection	Short(pin1-2)
J11	Phase configuration selection	Short(pin1-2)
J12	Phase configuration selection	Short(pin1-2)
J13	Phase configuration selection	Short(pin1-2)
J14	VOUTA Onboard Transient Load Signal Generator Selector	Open

Table 4-3. Connector function

Connector	Description
T1	VIN + Connector
T2	VIN - Connector
T3,T4,T5,T6	VOUTA + Connectors
T7,T8,T9,T11	VOUTA - Connectors
T10	VOUTB - Connectors
T12	VOUTB - Connectors
TP13	External Function generator connector
J15	VOUTAOutput Measurement Point
J16	VOUTB Output Measurement Point

4.3 On-board load transient

EVM board has option of load transient test. There are 4 parallet loads connected for RAILA as shown in Figure 4-4. Each load can be turned-ON/OFF indepedntly with SWITCH S3. Placed Jumper J14 in order to provide drive signal from onboard 555 timer (~1.2 kHz, 8% Duty cycle) or inject drive signal in TP13 from signal generator. The resistor (0.2ohm) packahe is 2502 and maximum power dissipation 2W. so External signal duty cycle shoud not to exceed 20% duty cycle as thermal rating. Each load resistance(R1) is 11.7mohm and Switch RDS(ON) is 2mohm. Total resistance per load bank is 13.7mohm. The total resistance value with all 4 load bank is ~3.8mohm with including board parasitics. so if RAILA output output voltgae is 0.88V, load step is 230A(0.88/3.8m)

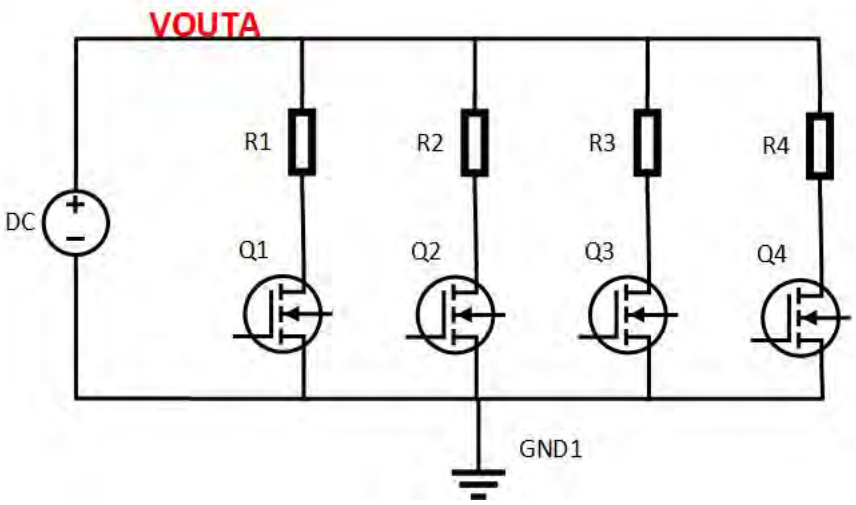


Figure 4-4. On Board Load transient

5 Test Equipment

Table 5-1. Required Test Equipment

Voltage sources	Only one DC input voltage sources is needed (VIN). The VIN input voltage source should be a 0 V to 14 V variable DC source capable of supplying 50 Adc. Connect VIN to terminals J6 and J7 as shown in #unique_13/unique_13_Connect_42_GUID-E4E7EEE8-3440-4623-B755-7451DD1BE9A4. For greater control during testing, one can remove jumpers from J2 and J4 to bypass the onboard 5-V power supply. This external supply should be limited to 1 Adc
Multimeters	Recommended to use two separate multimeters, one meter to measure VIN and the other to measure VOUT.
Output Load	An electronic load is recommended for the test setup shown in #unique_13/unique_13_Connect_42_GUID-E4E7EEE8-3440-4623-B755-7451DD1BE9A4. To observe the Rail A at full load the electronic load should be capable of sinking 400 A at 0.88-V (Rail B, 50 A at 1V)
Oscilloscope	Use an oscilloscope to measure output noise and ripple. Use a coaxial cable to measure output ripple across J15(VOUTA) and J16(VOUTB)
USB-to-GPIO InterfaceAdapter	A communications adapter is required between the EVM and the host computer. This EVM is designed to use the Texas Instruments USB-to-GPIO adapter connected to J12. To purchase this adapter visit the TI USB-to_GPIO tool page
Fan	During prolonged operation at high load (More than 300 A), it is necessary to provide forced air cooling with a small fan aimed at the EVM. Maintain the temperature of the devices on the EVM under115°C

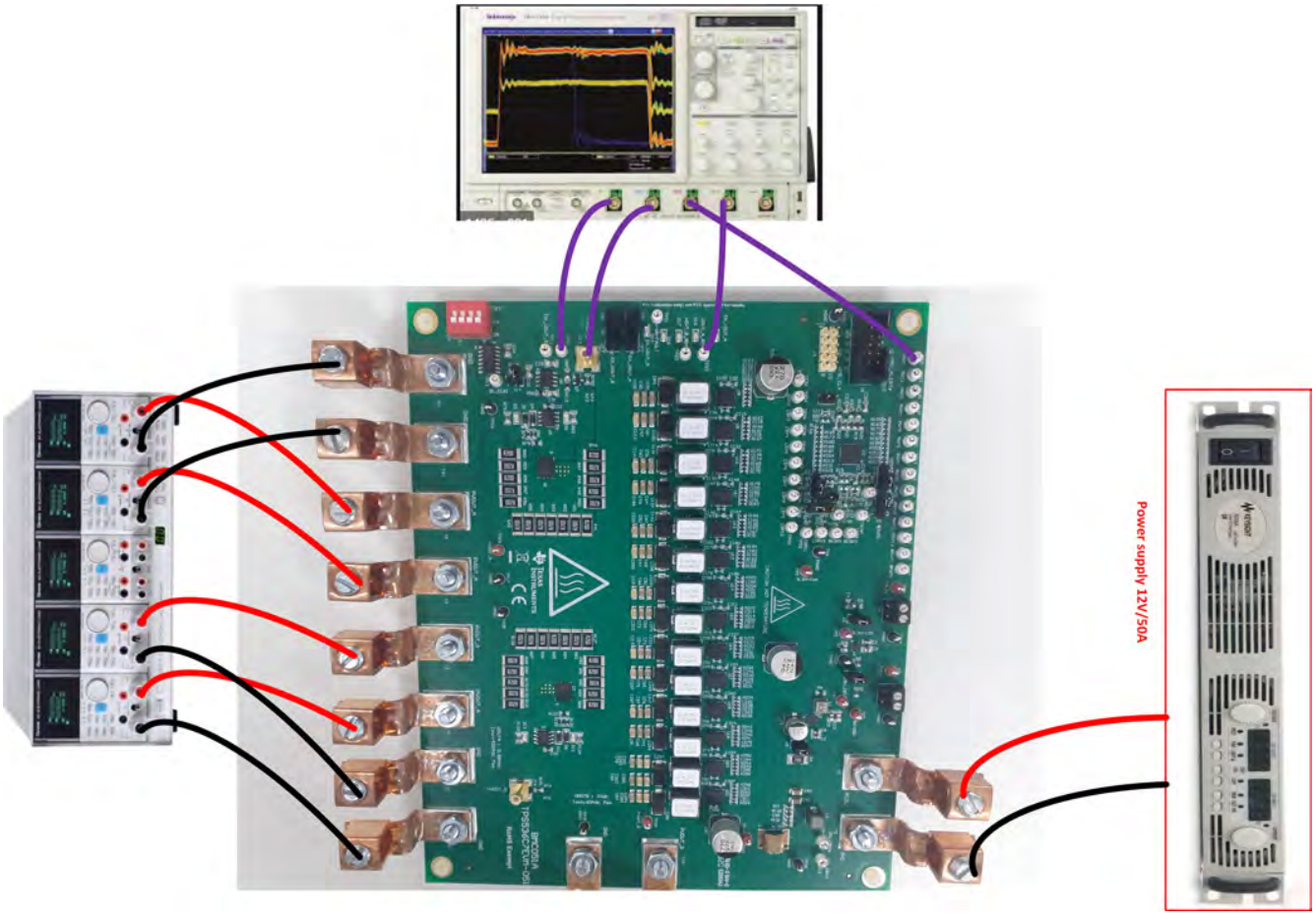


Figure 5-1. EVM Test Setup Showing the Power Supply, Load, and Oscilloscope Connections

Table 5-2. Recommended Wire Size

VOLTAGE (V)	CONNECT	RECOMMENDED WIRE SIZE	MAXIMUM TOTAL WIRE LENGTH (FEET)		
			RETURN	INPUT	OUTPUT
12	VIN to T1, GND to T2	2 × AWG #8	2	2	n/a
5 (if J2 open)	5VIN to J1	2 × AWG #18	2	2	n/a
0.88(RAILA)	Load+ to T3, T4, and T5, Load- to T7, T8, and T9	6 × AWG #4	3	n/a	3
1(RAILB)	Load+ to T10, Load- to T9 and T12	2 × AWG #8	1	n/a	1

6 Test Procedure

All the below tests are done with 10+2 configuration. So refer to Table 4-1 for jumper setting selection and keep same jumper positions (J10, J11, J12 and J13) for the following tests.

6.1 Start-up Test

Use the following procedure for the start-up test.

RAILA:

1. Set the load current to 50 A.
2. Make sure all default jumpers(J1 to J9) settings as shown in Table 4-2.
3. Connect probes Enable(TP11), VOUTA(J15, BNC cable),PWM1(TP31) and VOUT_A_RDY(TP22).
4. Set up the time / div on the oscilloscope to: 500 µs/div.
5. Set the trigger to channel 1 ‘Enable_A’ on the rising edge at about 1 V.
6. Turn on the power supply (with the voltage set to 12 V and the current limit set to 10 A).
7. Slide the enable switch ‘S1’ to the ON position .

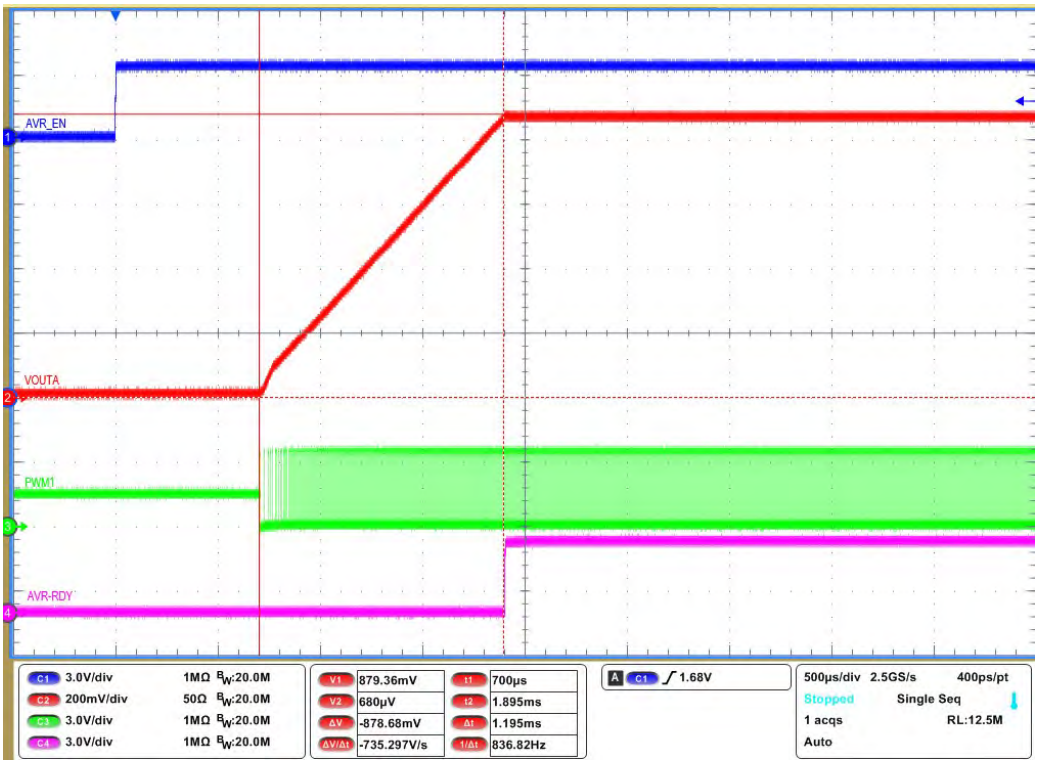


Figure 6-1. VOUTA Enable startup with TON delay=0ms

RAILB:

1. Set the load current to 10 A.
2. Make sure all default jumpers(J1 to J9) settings as shown in Table 4-2.
3. Connect probes Enable_B(TP12), VOUTB(J16, BNC cable), BPWM1(TP55) and VOUT_B_RDY(TP23).
4. Set up the time / div on the oscilloscope to: 500 µs/div.
5. Set the trigger to channel 1 ‘Enable_B’ on the rising edge at about 1 V.

6. Turn on the power supply (with the voltage set to 12 V and the current limit set to 5 A).
7. Slide the enable switch ‘S2’ to the ON position .

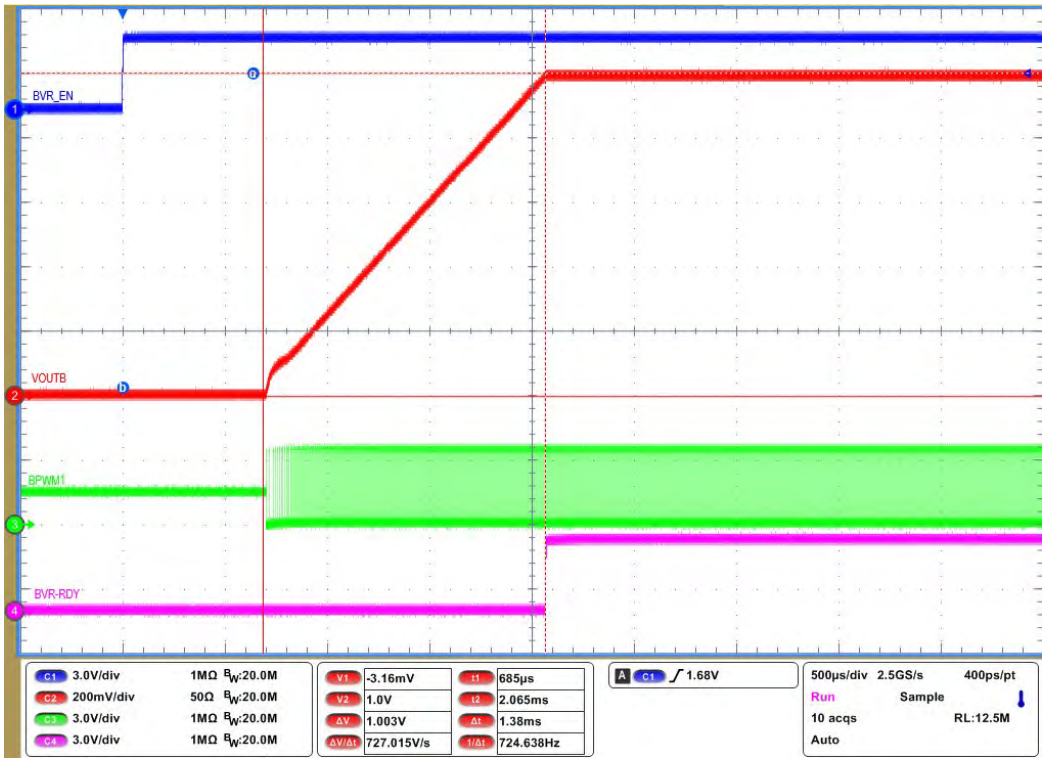


Figure 6-2. VOUTB Enable startup with TON delay=0ms

6.2 Shut down Test

Use the following procedure for the shut down test:

RAILA:

1. Set the load current to 50 A.
2. Make sure all default jumpers(J1-J9) settings as shown in Table 4-2 .
3. Connect probes Enable(TP11), VOUTA(J15, BNC cable),PWM1(TP31) and VOUT_A_RDY(TP22).
4. Set up the time / div on the oscilloscope to: 500 µs/div.
5. Set the trigger to channel 1 ‘Enable_A’ on the falling edge at about 1 V.
6. Turn on the power supply (with the voltage set to 12 V and the current limit set to 10 A).
7. Slide the enable switch ‘S1’ to the ON position and measure output voltage as 0.88V.
8. Turn-off the switch "S1" to OFF position.

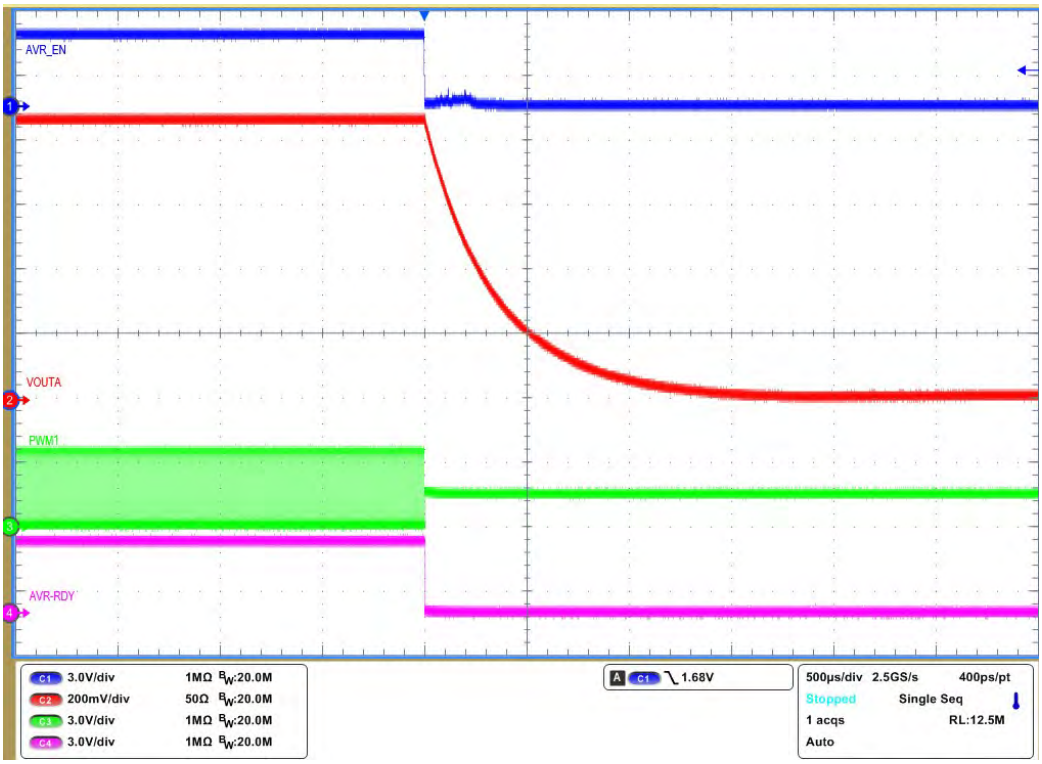


Figure 6-3. VOUTA Enable OFF, Immediate-off

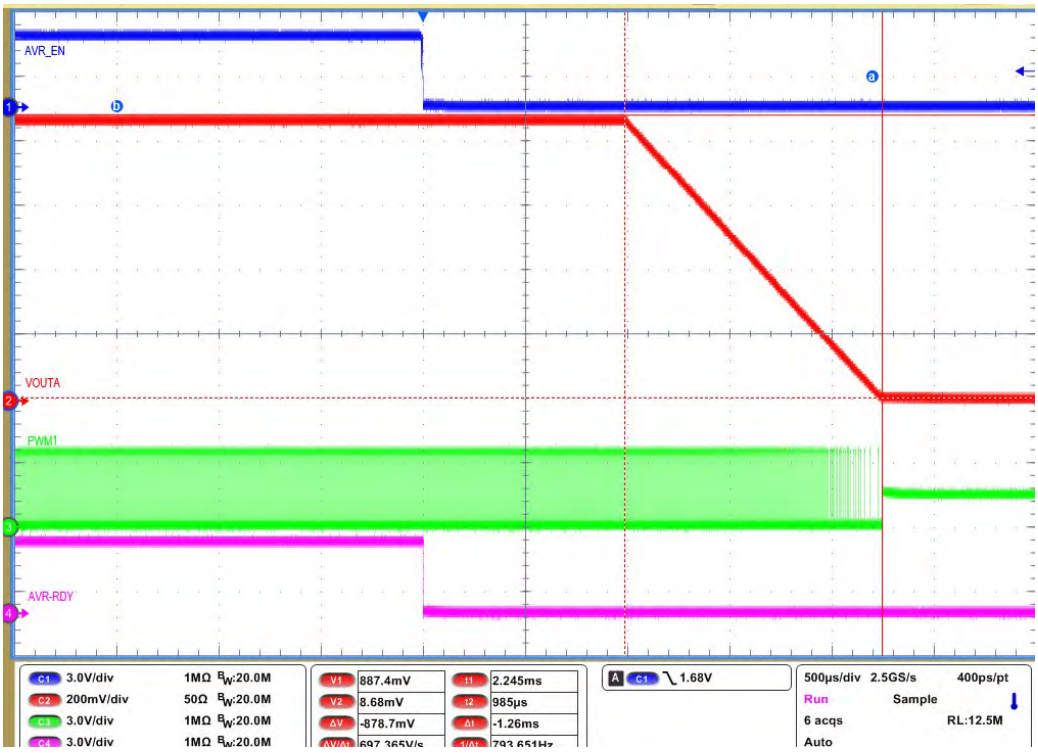


Figure 6-4. VOUTA Enable OFF Soft-off with TOFF delay=1ms

RAILB:

1. Set the load current to 10 A.

2. Make sure all default jumpers (J1-J9) settings as shown in Table 4-2.
3. Connect probes Enable_B(TP12), VOUTB(J16, BNC cable), BPWM1(TP55) and VOUT_B_RDY(TP23).
4. Set up the time / div on the oscilloscope to: 500 µs/div.
5. Set the trigger to channel 1 ‘Enable_B’ on the falling edge at about 1 V.
6. Turn on the power supply (with the voltage set to 12 V and the current limit set to 5 A).
7. Slide the enable switch ‘S2’ to the ON position and measure output voltage as 1V.
8. Turn-off the switch "S2" to OFF position.

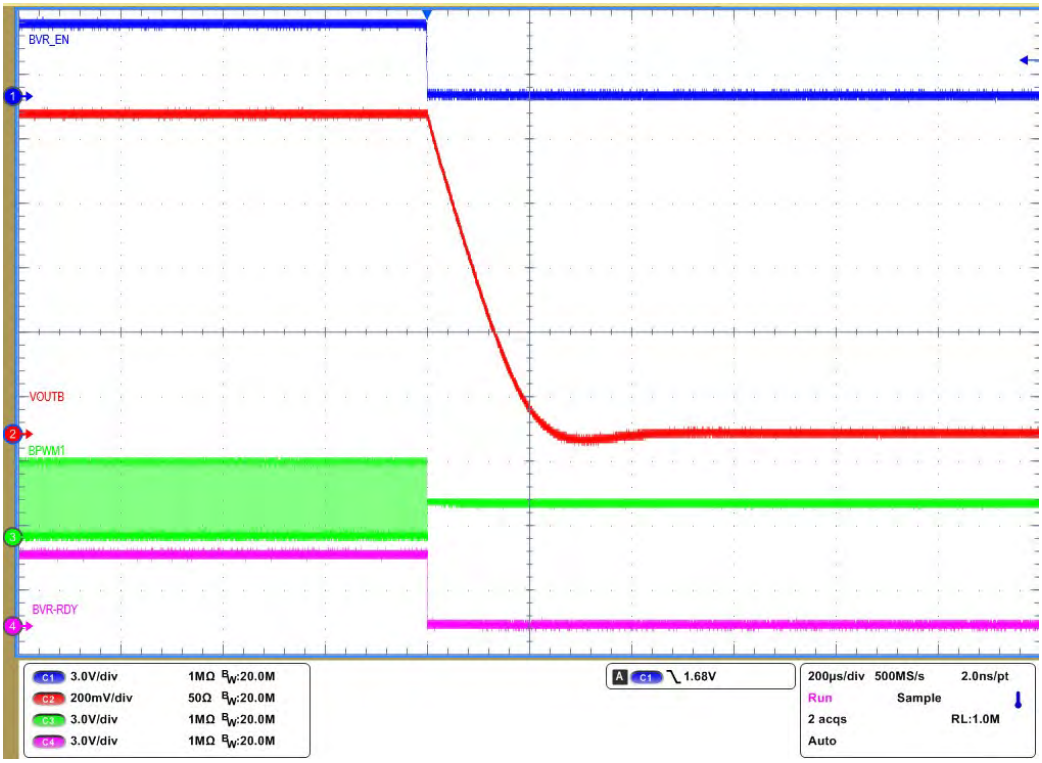


Figure 6-5. VOUTB Enable OFF, Immediate-off

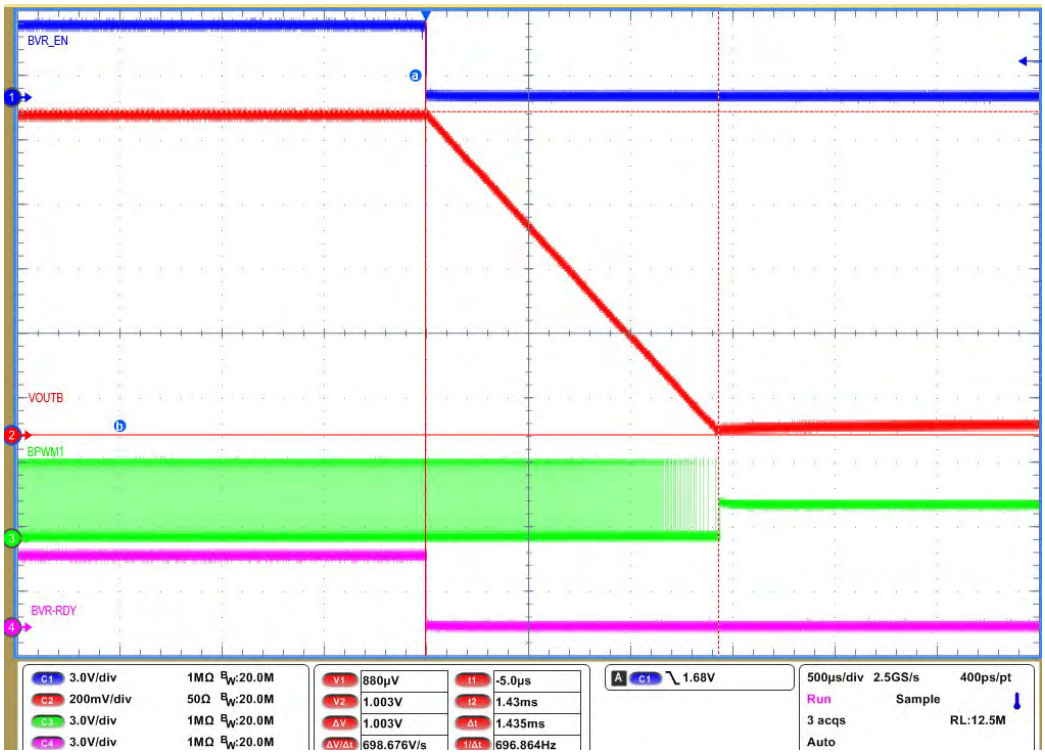


Figure 6-6. VOUTB Enable OFF Soft-off with TOFF delay=1ms

6.3 Steady-state Test

Use the following procedure for the steady-state test:

RAILA:

1. Set the load current to 50 A.
2. Make sure all default jumpers(J1 to J9) settings as shown in Table 4-2.
3. Connect probes VOUTA(J15, BNC cable),PWM1(TP31), PWM2(TP32) and PWM3(TP33).
4. Add offset to VOUTA signal as 0.88V, and 4mV/div.
5. Set up the time / div on the oscilloscope to: 1 µs/div.
5. Turn on the power supply (with the voltage set to 12 V and the current limit set to 10 A).
6. Slide the enable switch ‘S1’ to the ON position and measure output voltage as 0.88V.
7. Measure output voltge rippe and phase interleaving.
8. Jitter can be measured with set scope in"Fast aquaition mode".

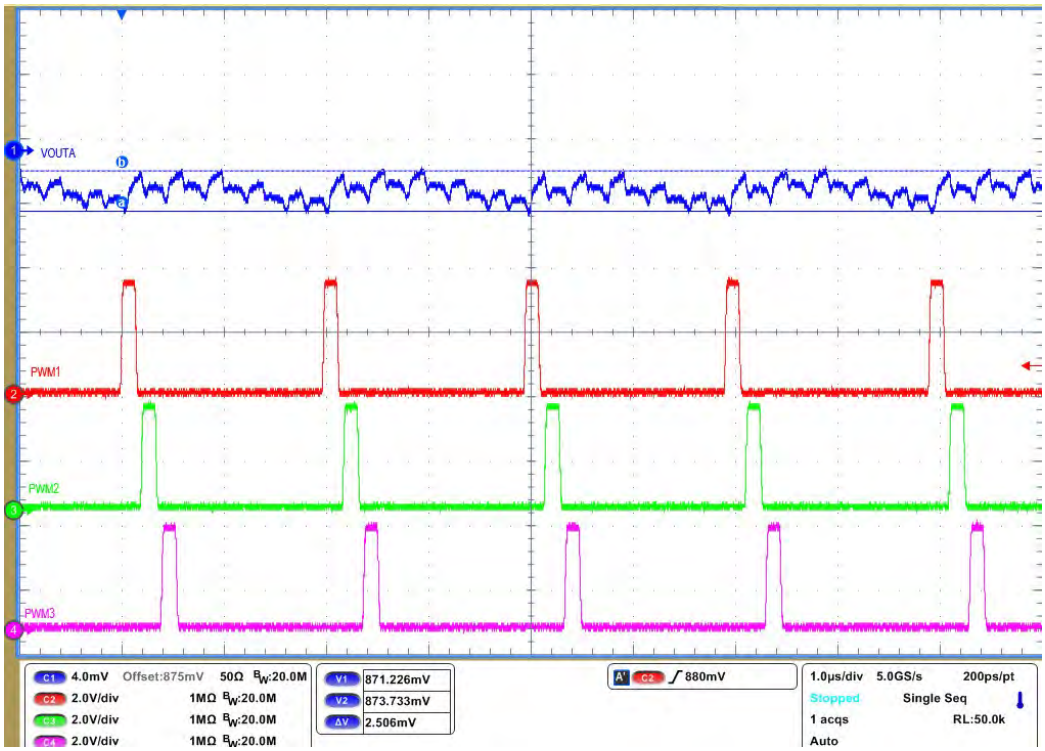


Figure 6-7. VOUTA Steady-state Output voltage Ripple

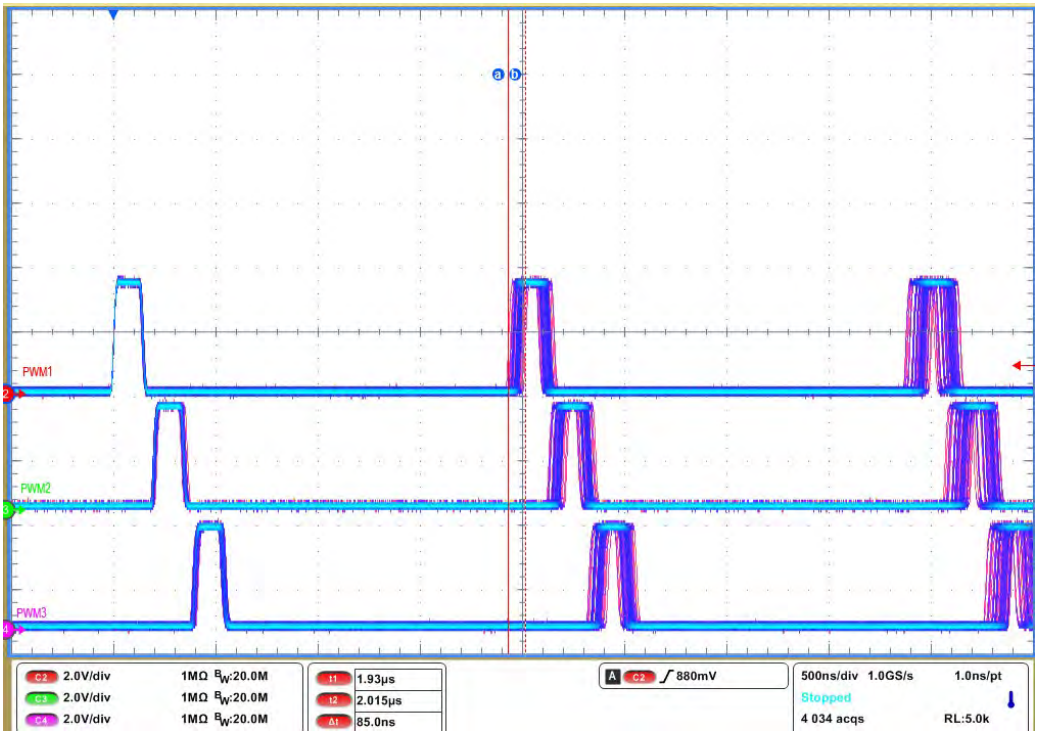


Figure 6-8. VOUTA PWM Jitter

RAILB:

1. Set the load current to 10 A.

2. Make sure all default jumpers(J1 to J9) settings as shown in Table 4-2.
3. Connect probes VOUTB(J16, BNC cable),BPWM1(TP31), BPWM2(TP55) and PWM3(TP57) as shown.
4. Add offset to VOUTB signal as 1V, and 4mV/div.
5. Set up the time / div on the oscilloscope to: 1 µs/div.
5.Turn on the power supply (with the voltage set to 12 V and the current limit set to 10 A) .
6. Slide the enable switch ‘S2’ to the ON position and measure output voltage as 1V.
7. Measure output voltge rippe and phase interleaving.
8. Jitter can be measured with set scope in "Fast aquaition mode".

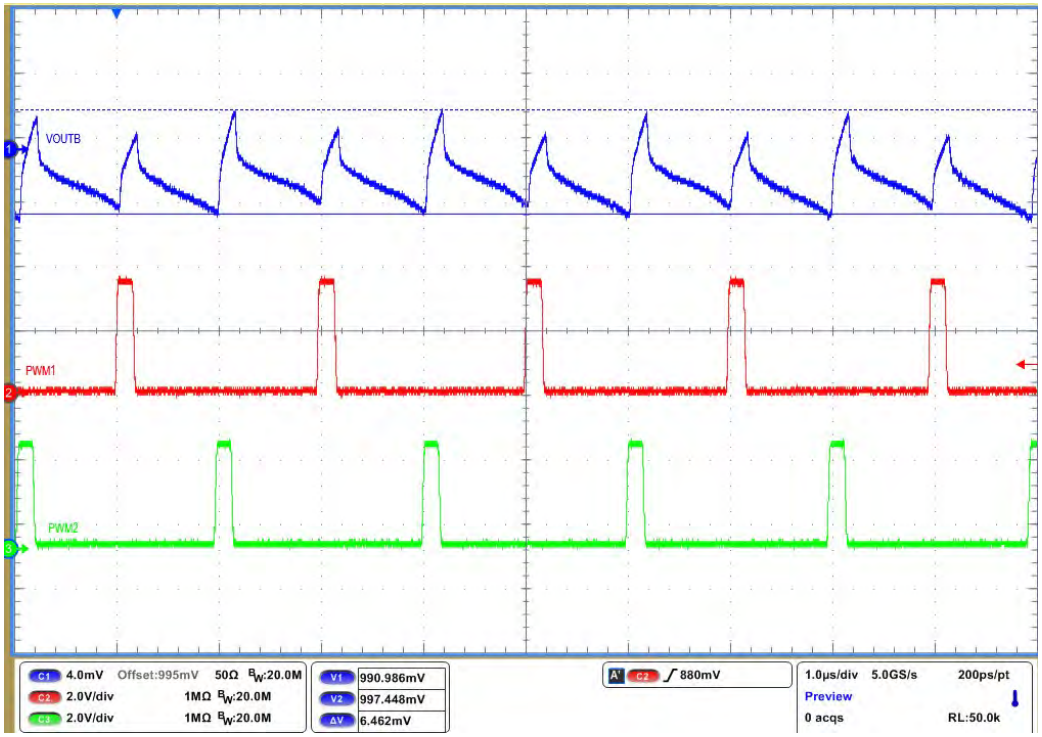


Figure 6-9. VOUTB Steady-state Output voltage Ripple

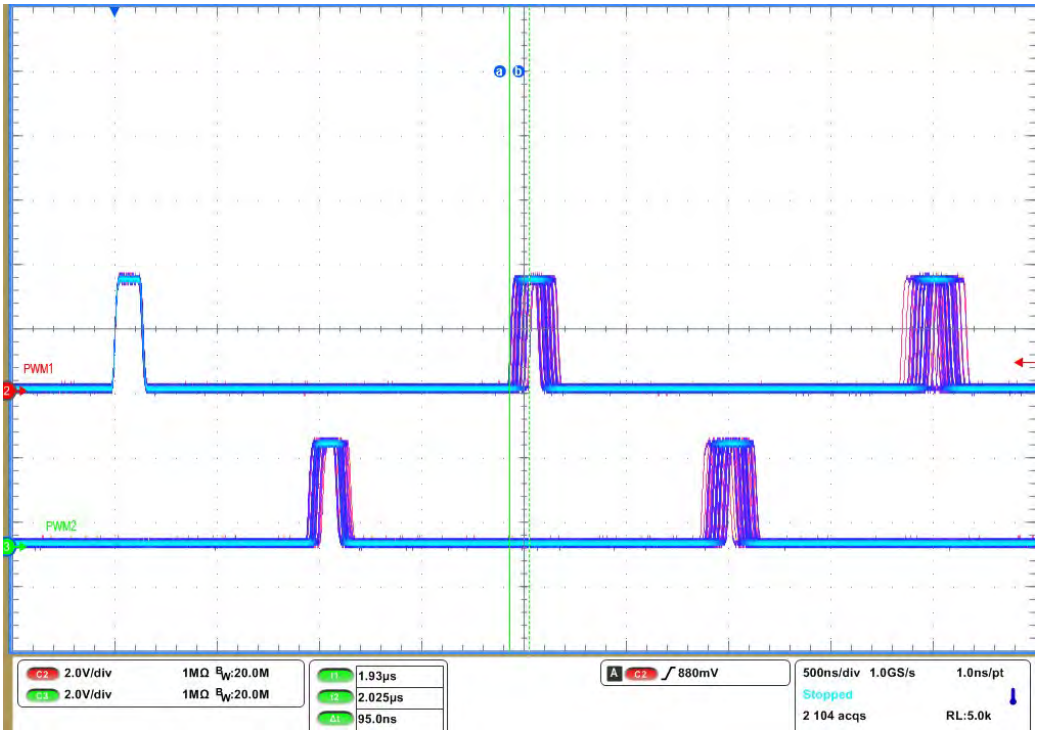


Figure 6-10. VOUTB PWM jitter

6.4 Load Transient Test

The EVM is equipped with an onboard load transient generator for testing fast transients that is seen in processor type loads. To generate a load transient, it can be used as internal 555 timer or external repetitive pulse function generator. This pulse height must be 5V. Please refer to the Section 4.3 section for details

1. Connect jumper J14 to use internal signal or apply external function gernerator at TP13.
2. Set the required steady-state load current(50A).
3. Connect probes VOUTA(J15, BNC cable), PWM1(TP31), PWM2(TP32).
4. Add offset to VOUTA signal as 0.88V, and 20mV/div.
5. Meaure output current at one resistor bank. so connect differntial probe paraleel to R60 and 700mV/div.
6. Turn on the power supply (with the voltage set to 12 V and the current limit set to 20 A)
7. Slide the enable switch ‘S1’ to the ON position and measure output voltage as 0.88V.
8. Turn on all 4 switches at load switch(S3) to get 225A load step at 0.88V.

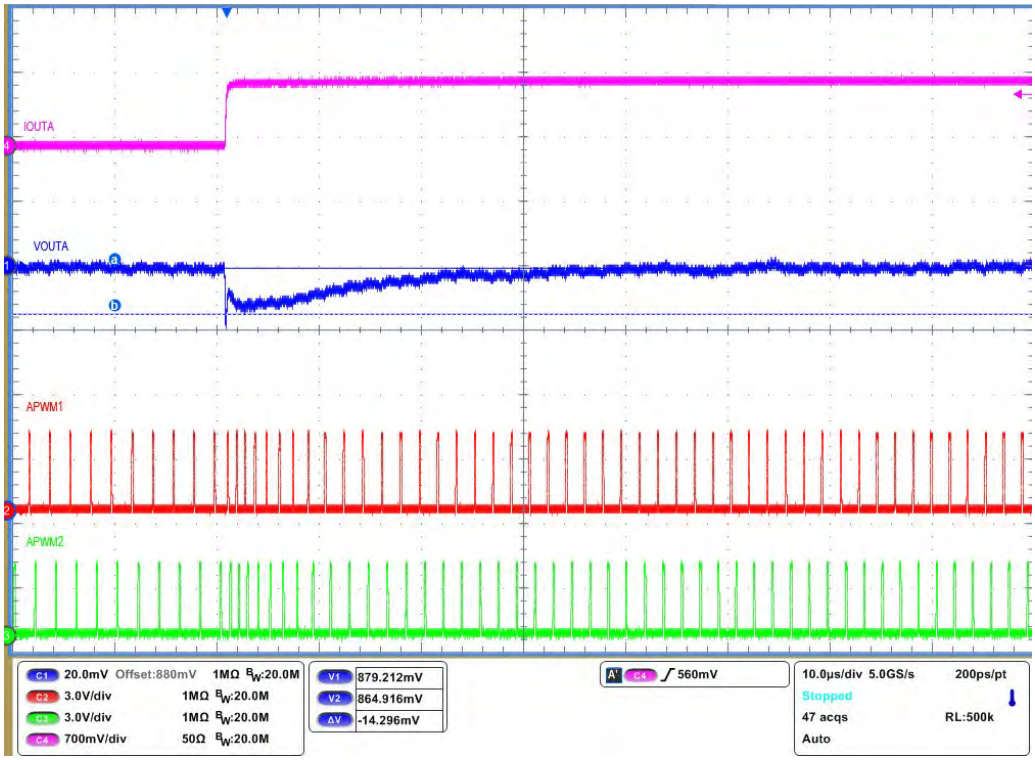


Figure 6-11. VOUTA Load transient, Load step=50A to 275A

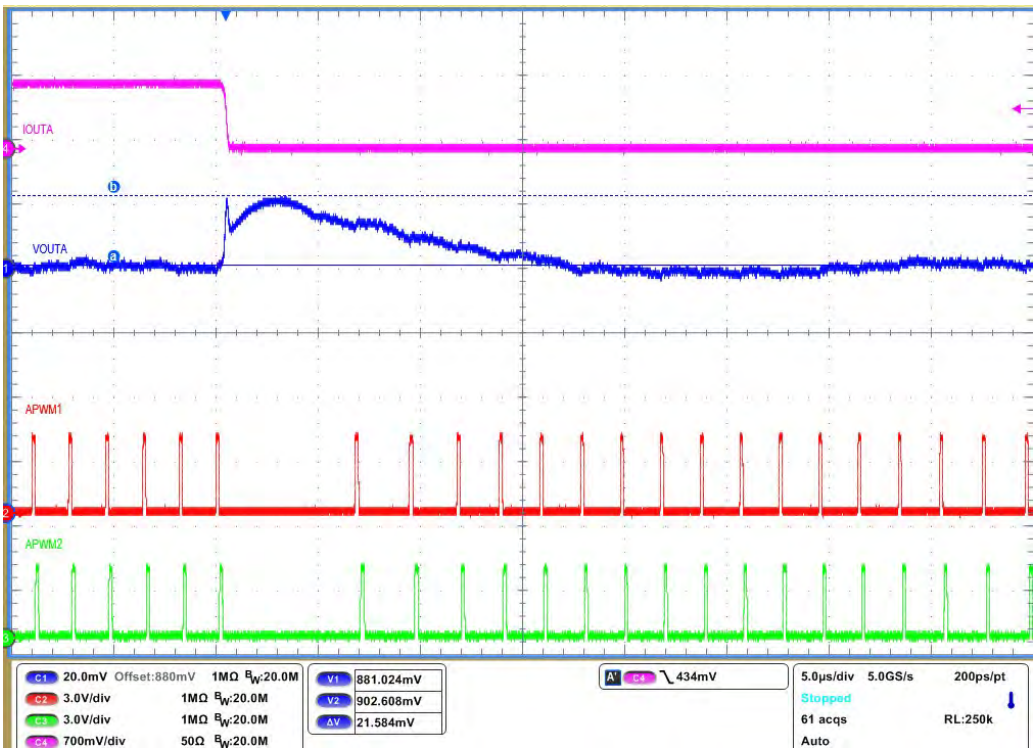
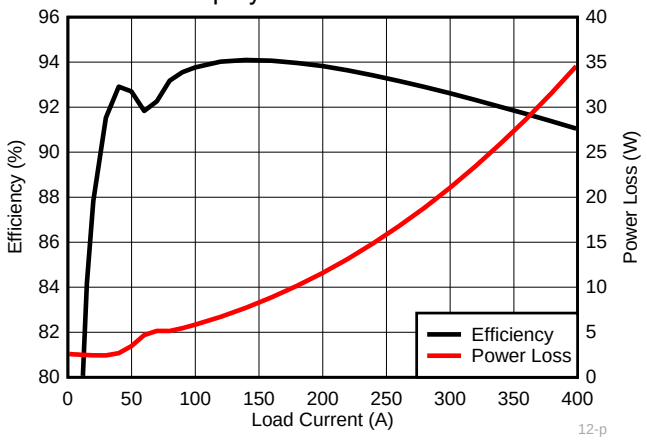


Figure 6-12. VOUTA Load transient, Load release=275A to 50A

6.5 Efficiency Plot

RAILA is configurared for 12-phases and refer to Table 4-1 for jumper setting (J10,J11,J12,J13)

1. Make sure all default jumpers(J1 to J9) settings as shown in Table 4-2.
2. Coneect three multimeters to measure Input voltage, Input current, output voltage.
3. Meaure Input voltage near powerstage VIN pin capacitor (C96)
4. Input current can be measured as volatge between TP14 and TP15 using Rsense(0.5mohm).
5. Measure Output voltage on one of the top ceramic capacitor close to center phase (C221).
6. Output current is same as electronic load display.



Note

V_{IN} = 12 V, V_{OUT} = 880 mV, f_{SW} = 500 kHz, L_{OUT} = 150 nH, DPS disabled

Figure 6-13. RAILA, 12+0 configuration, Converter Efficiency and Power Loss Plot

6.6 Bode plot

The EVM includes a provision to also perform a Bode plot to examine the control loop stability. To perform this test, a Spectrum analyzer is required. The resistor R10 (RAILA) or R13 (RAILB) must be replaced with an appropriate terminating resistor (usually 10 Ω or 20 Ω). The signal must be connected to parallel to R10 or R13. The loop gain is measured using the spectrum analyzer . Figure 6-14 and Figure 6-15 shows a measurement of the Bode plot made on this EVM for RAILA and RAILB.

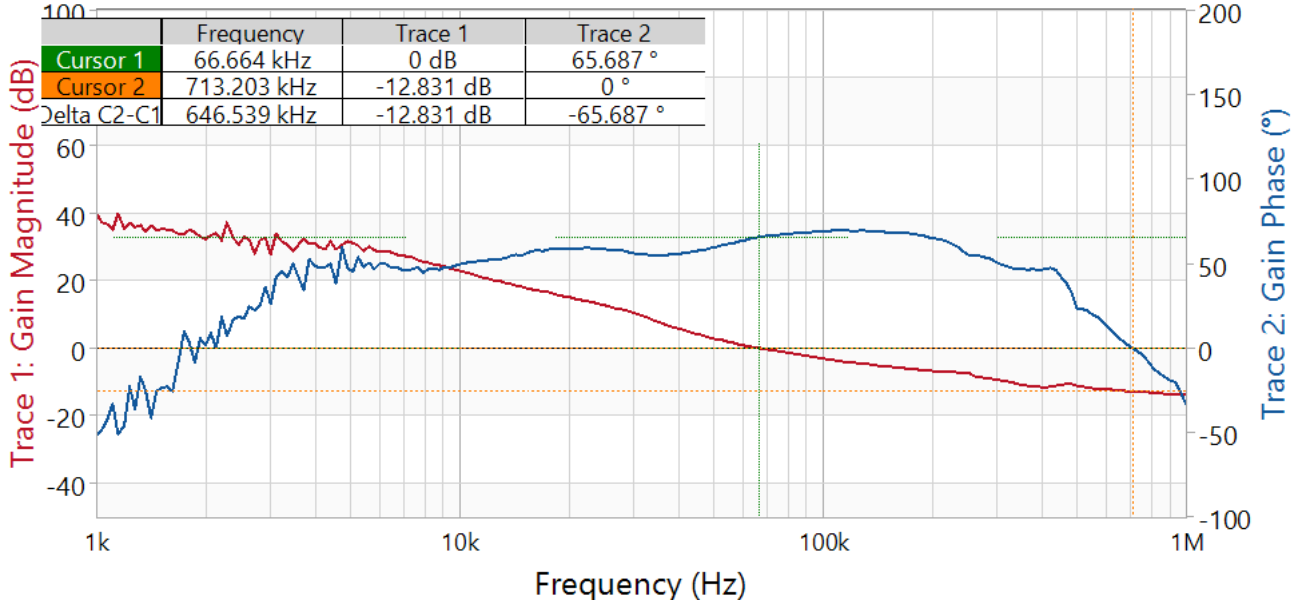


Figure 6-14. VOUTA Bode plot, Load current=50A

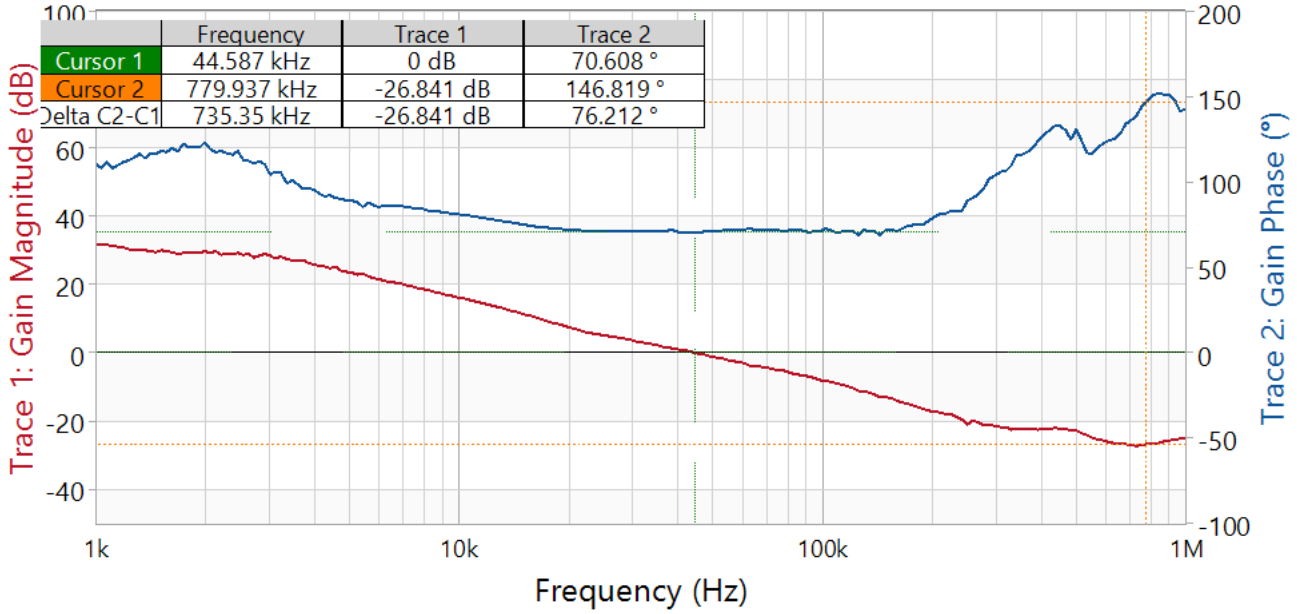


Figure 6-15. VOUTA Bode plot, Load current=20A

7 Fusion GUI

The allows the user to change several parameters of the TPS536C7 controller.

What follows is a brief introduction to familiarize users with the Fusion interface. For more details on the parameters one can modify, please refer to the datasheet.

When the Fusion GUI launches, it restores user preferences and data.

Figure 7-1. Launch Fusion GUI

The Fusion GUI will open with the rail associated with the TPS536C7 controller on the [System View] screen as shown in Figure 7-2. If this were a power system that was populated with multiple Fusion GUI compatible devices, all of them would show up in the System View window. if TPS536C7 controller configured for only RAIL#1 like N+0, only RAIL#1 display as shown in Figure 7-2. For two rail N+M configuration display as shown in Figure 7-3

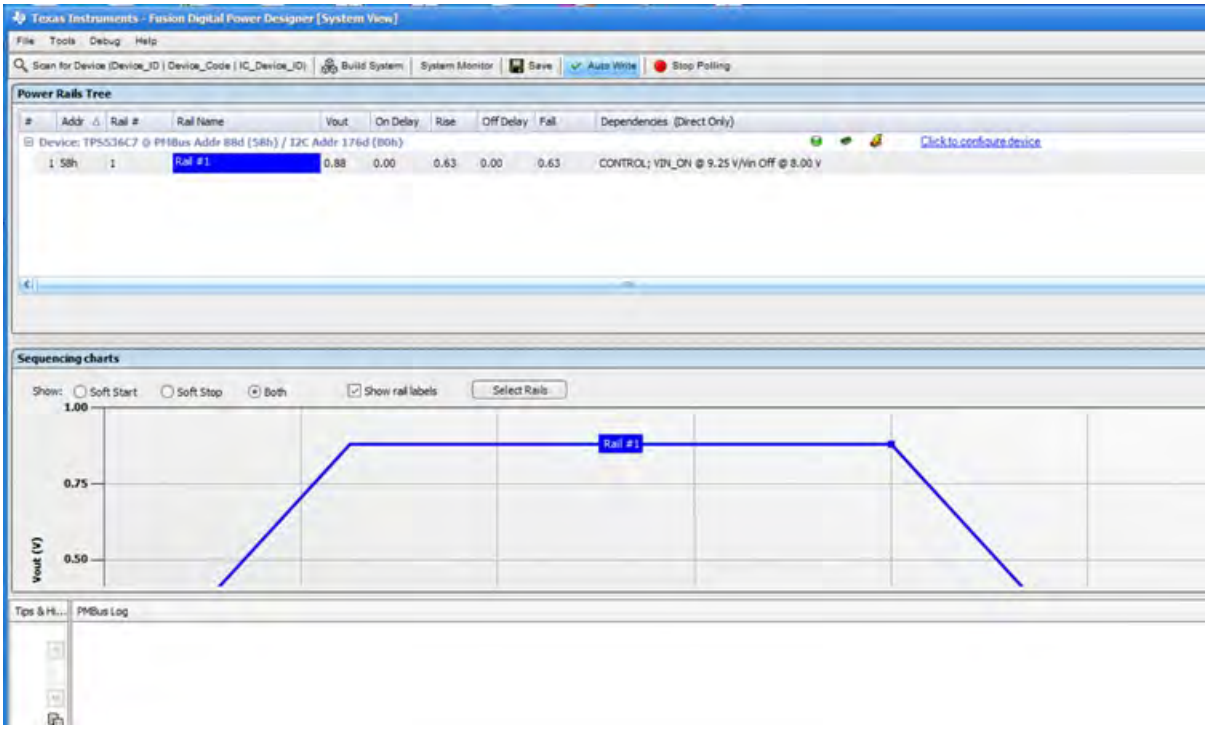


Figure 7-2. System View for N+0 phase configuration

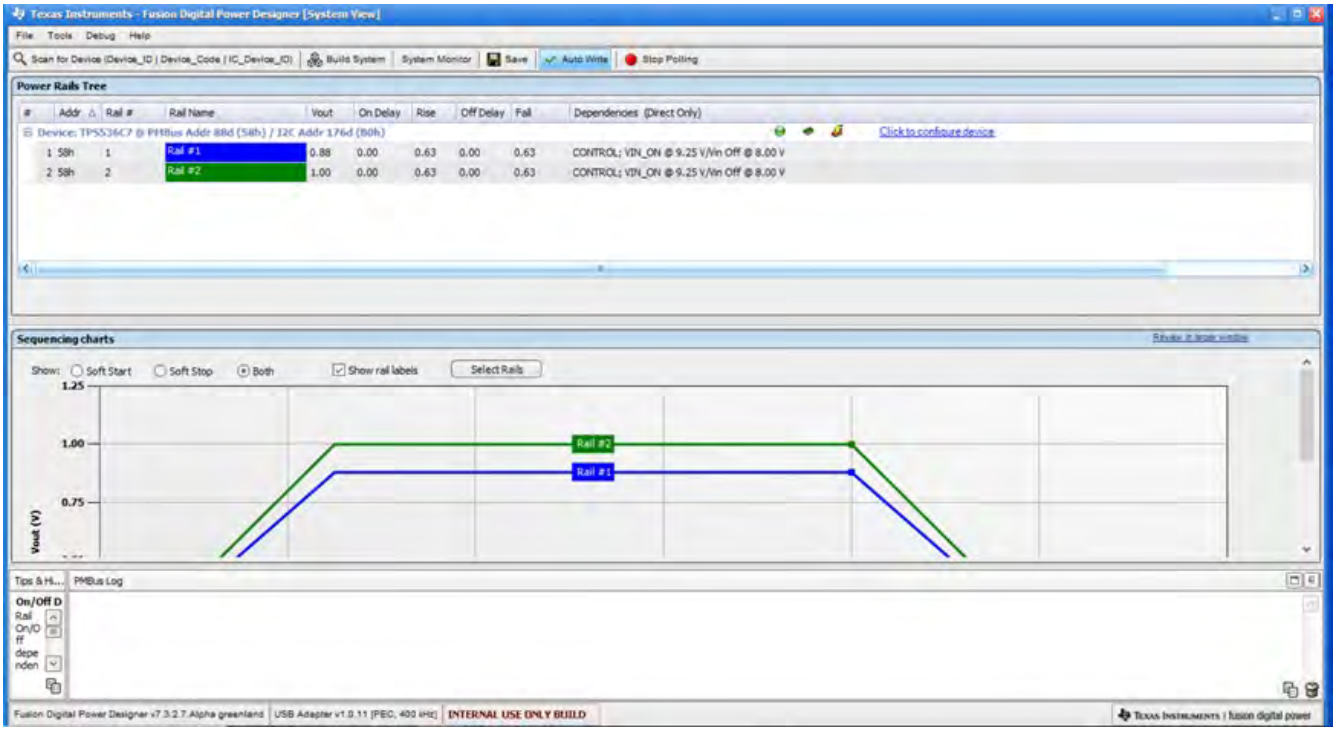


Figure 7-3. System View for N+M phase configuration

Selecting [System Monitor] tab from the System View adds a new window which displays real-time system level information about all Fusion compatible devices connected as shown in Figure 7-5.

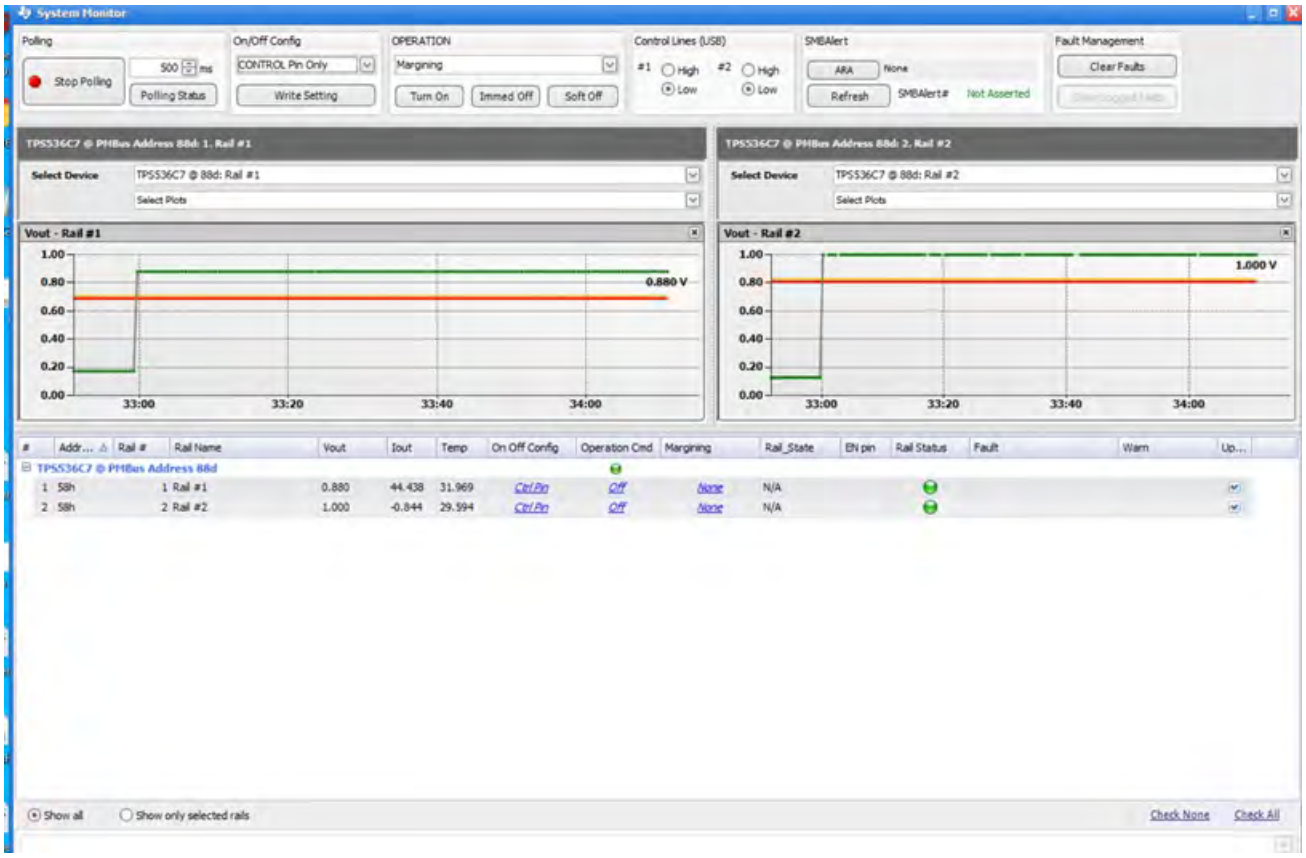


Figure 7-4. System Monitor for N+M phase configuration

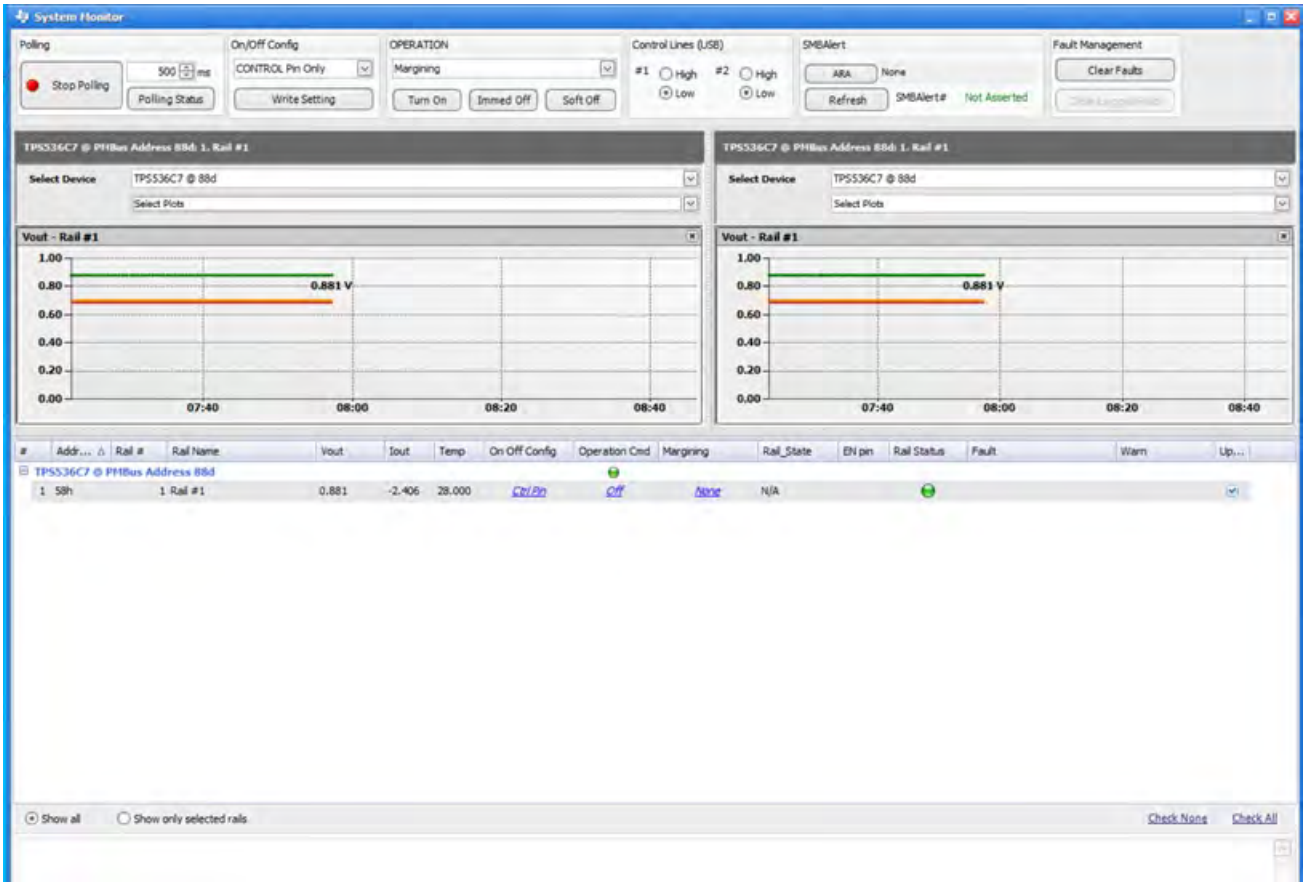


Figure 7-5. System Monitor for N+0 phase configuration

The configuration of a specific device can be accessed through the [Click to Configure Device] link associated with the device in the System View. A new window will open to the [General] tab on the [System Configuration] page of the GUI as shown in Figure 7-6. One can switch between several tabs in the [Rail Configuration] menu to change different parameters of a Rail. The illustrations below show Rail A's parameters. To configure the these parameters on the other Rail, simply change options in the drop-down menu on the top- right corner.

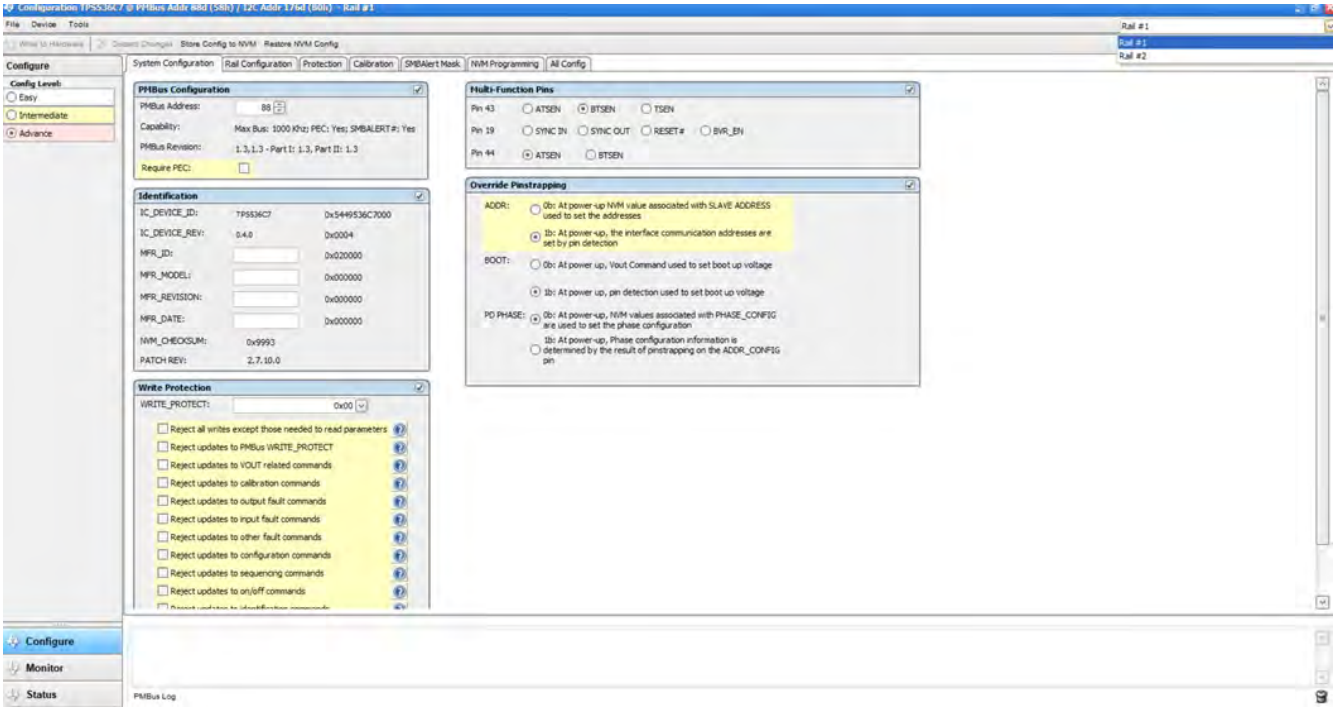


Figure 7-6. General System Configure Tab

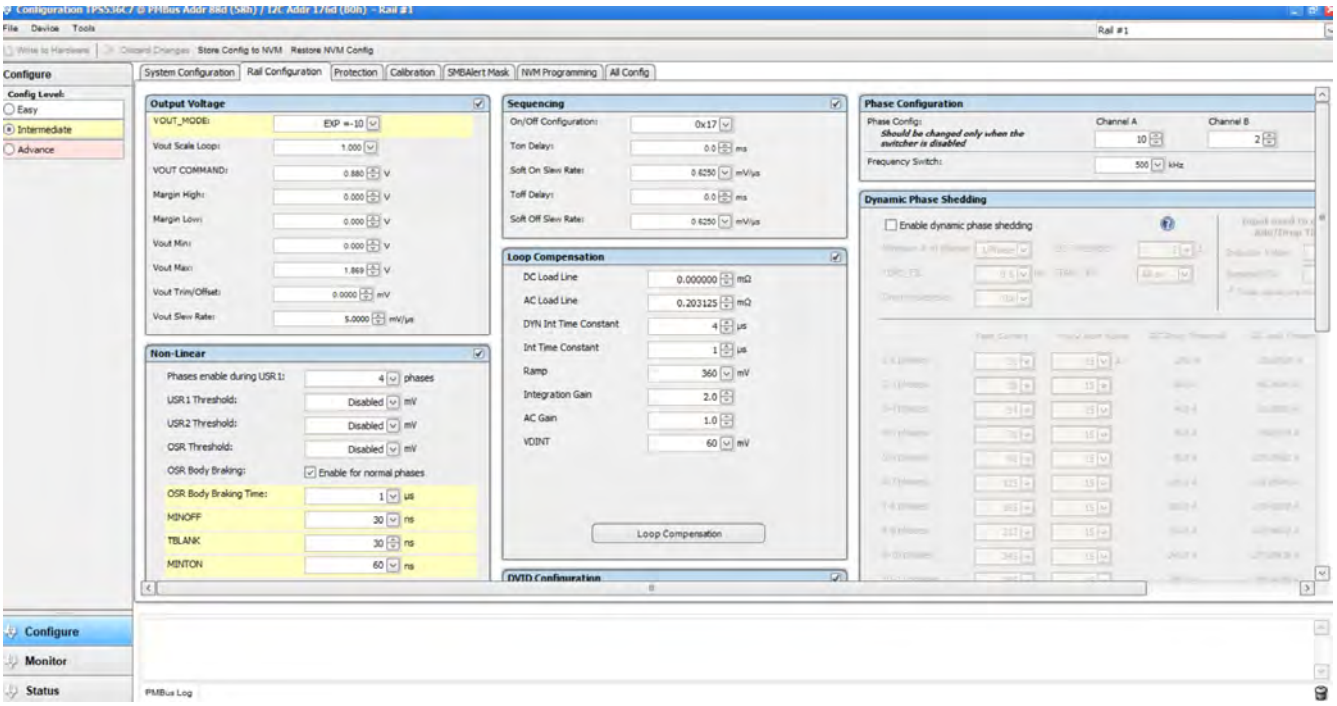


Figure 7-7. Rail Configuration Tab

Phase configuarion: It can be selected by clicking Advace option on top right side as shown in Figure 7-8. Each phase can be selected as enabled/disabled, RAIL0/RAIL1 and firing order. More details refer to TPS536C7 datasheet.

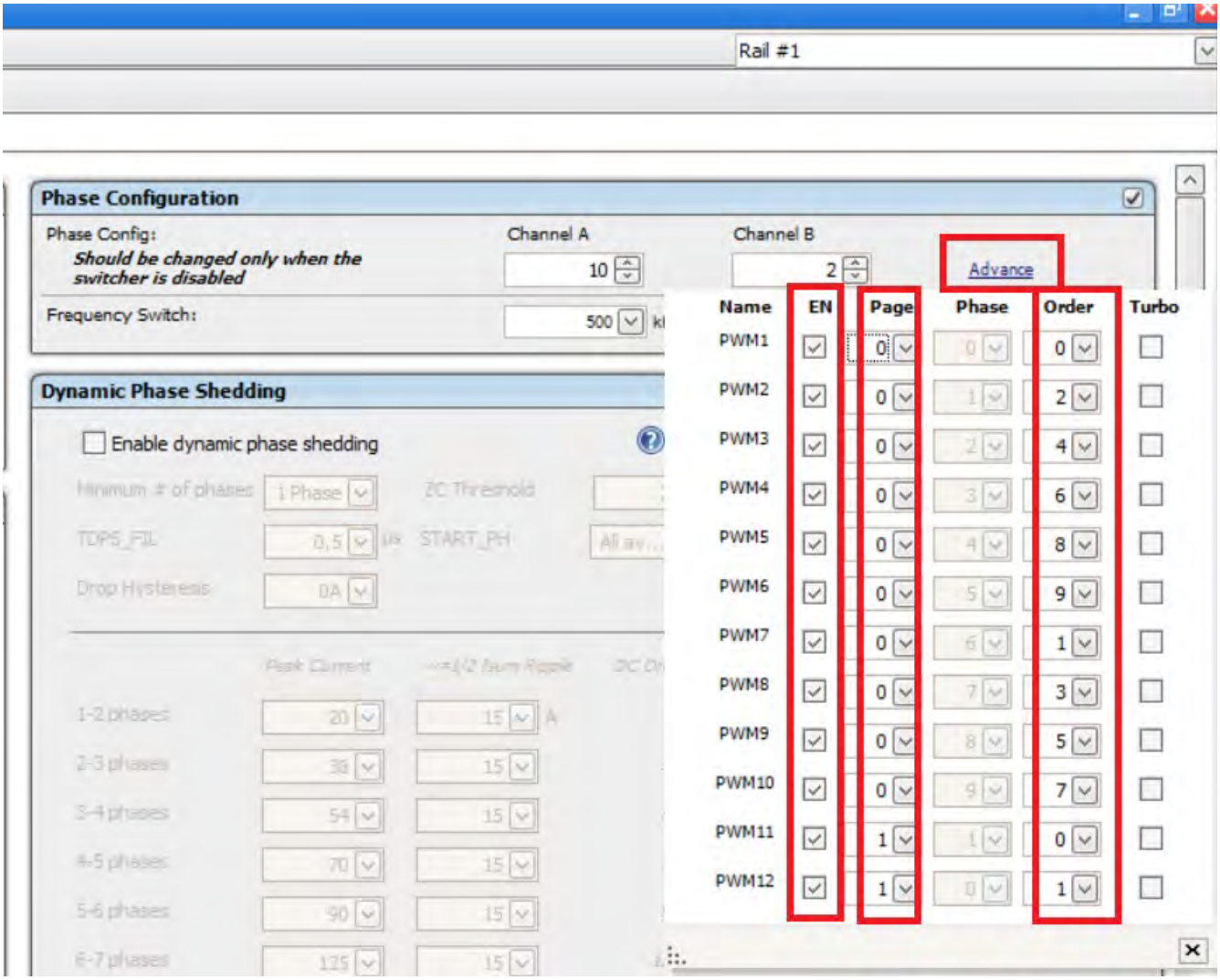


Figure 7-8. Phase N+M Configuration

Protection tab: Depending on applictaions, All protection parametres for Output voltage/current, Input voltage/ current, Temperature can be selected as shown in Figure 7-9.

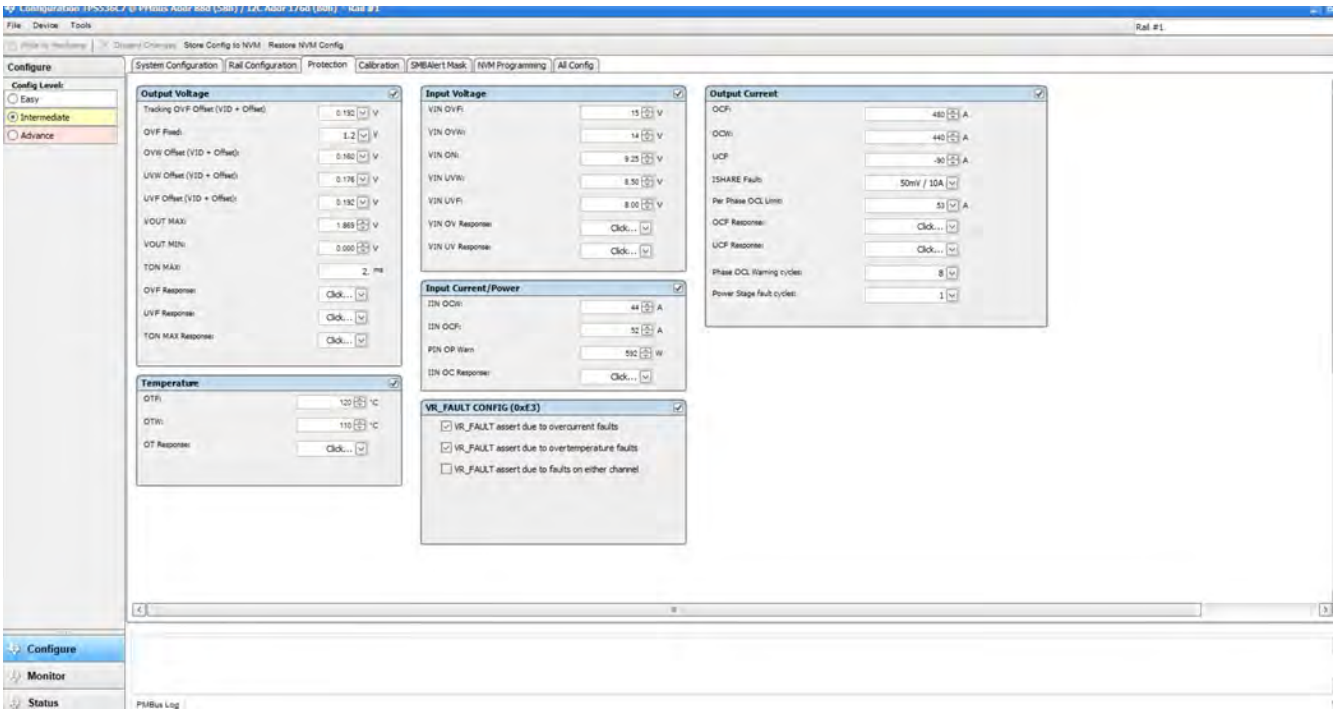


Figure 7-9. System Protection parameters config

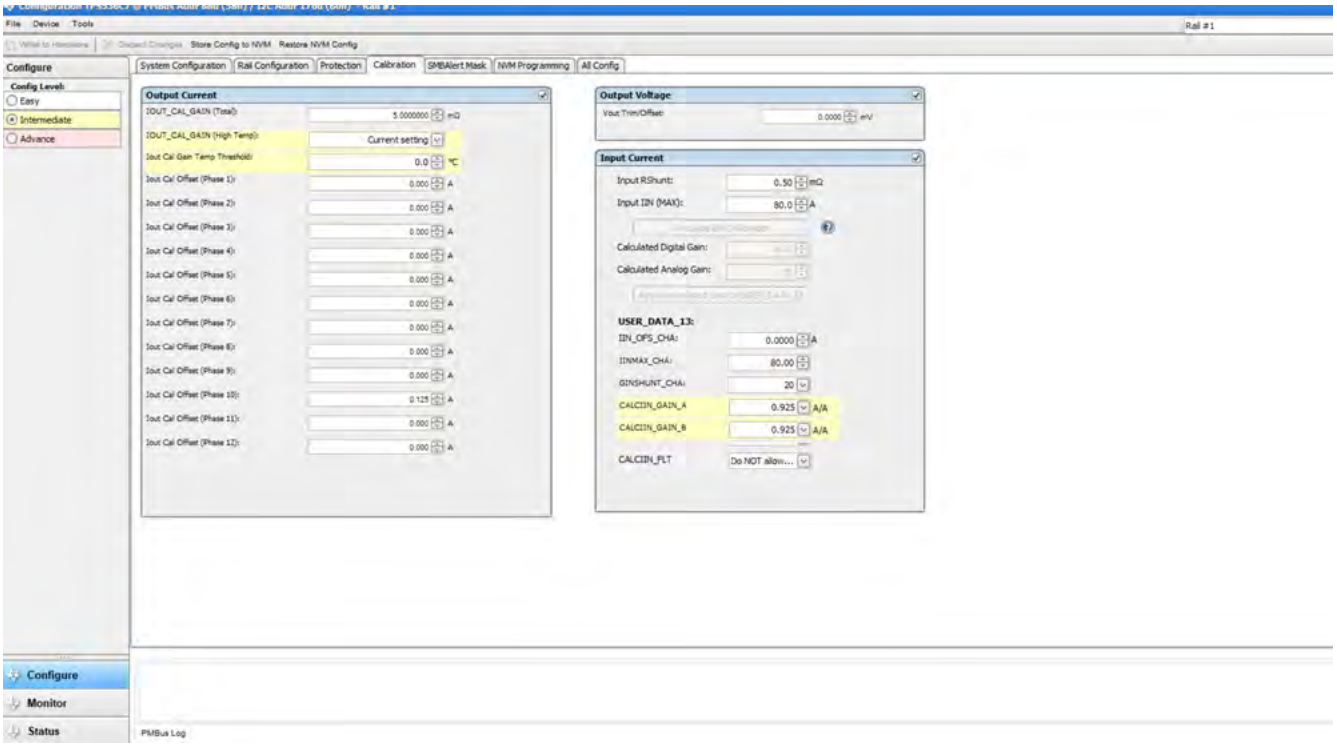


Figure 7-10. Calibration tab

The [All Config] tab on the [Configure] page as shown in Figure 7-11 summarizes all the configurable parameters. This screen contains additional details such as the Hexadecimal encoding for the parameters.

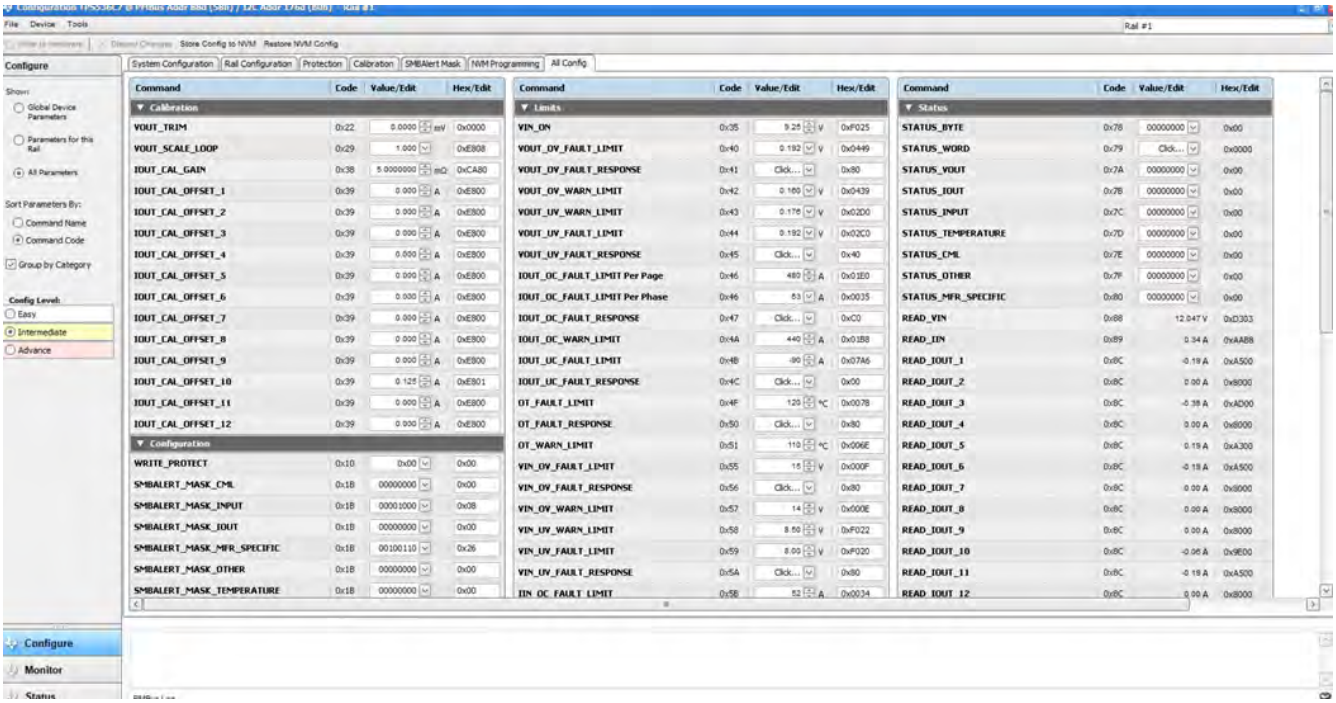


Figure 7-11. All Configuration tab

If the user selects to change a parameter then the GUI will display an orange “U” icon, which is offering an [Undo Change] option, as shown in Figure 7-12. The software will not update the controller with the change until the user performs a [Write to Hardware].

When a [Write to Hardware] is performed, the change will be implemented in the controller and stored in it's volatile memory. Given that the parameter is stored in volatile memory, if the EVM is power cycled, the parameter will revert back to the previous setting.

If the user wishes to make this the new default value for the parameter then a [Store Config to NVM] must be performed, which commits the value to non-volatile memory.

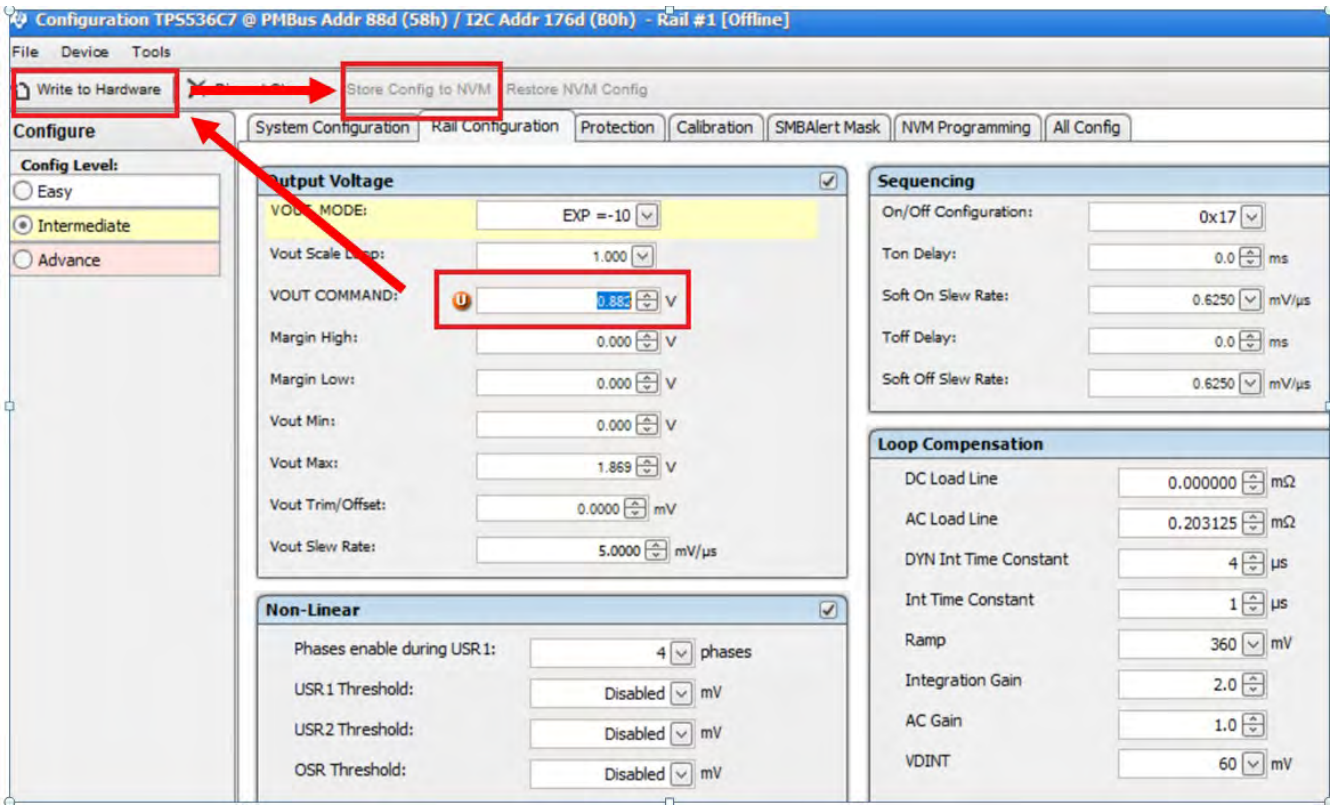


Figure 7-12. Static Configure Pop-Up

Selecting the [Monitor] page from the lower left corner of the TPS536C7 Configuration window will display the Figure 7-13 which shows real-time parameter data as measured by the controller. Note that one can switch between monitoring Rail A and Rail B. This screen provides access to the following parameters:

- Graphs of
  - V_{IN}
  - I_{IN}
  - V_{OUT}
  - I_{OUT}
  - Temperature
- Start/Stop Polling controls the updating of the real-time display of data
- Quick access to ON or OFF configuration
- Control pin activation and OPERATION command
- Margin control
- Clear Fault clears any prior fault flags

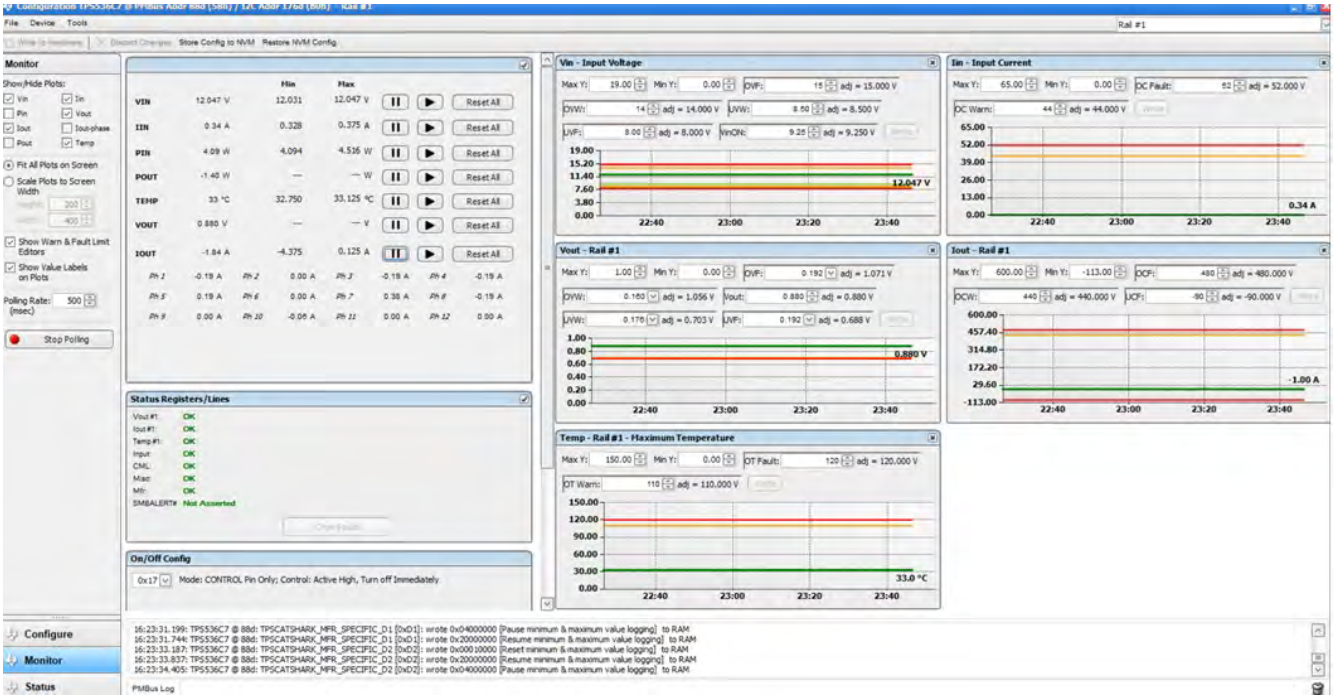


Figure 7-13. Monitor tab

Selecting [Status] from lower left corner shows the current status of the controller as well as any prior faults or warnings which had not been cleared, as shown on the Figure 7-14.

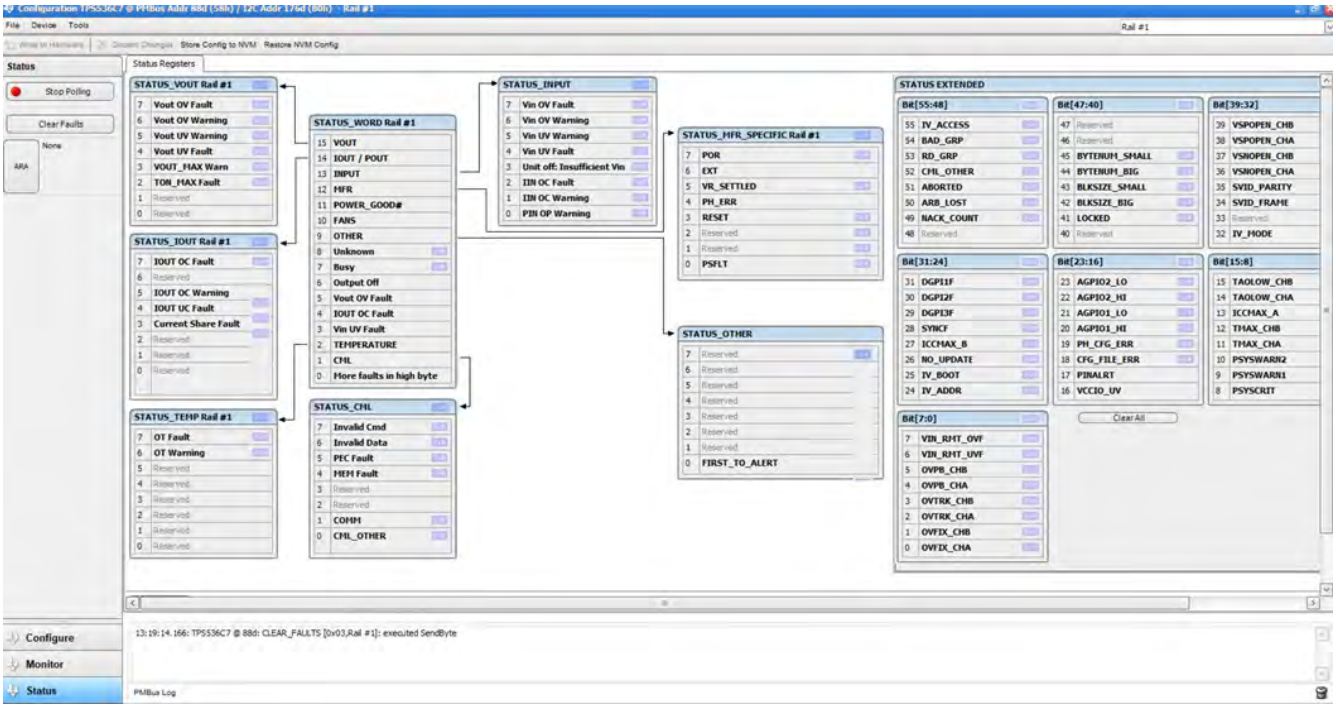


Figure 7-14. Status tab

8 Evaluation Module (EVM) Hardware

Board Layout

Figure 8-1 through Figure 8-16 show the TPS536C7EVM-051 assembly drawings and TPS536C7EVM-051 PCB layout images .

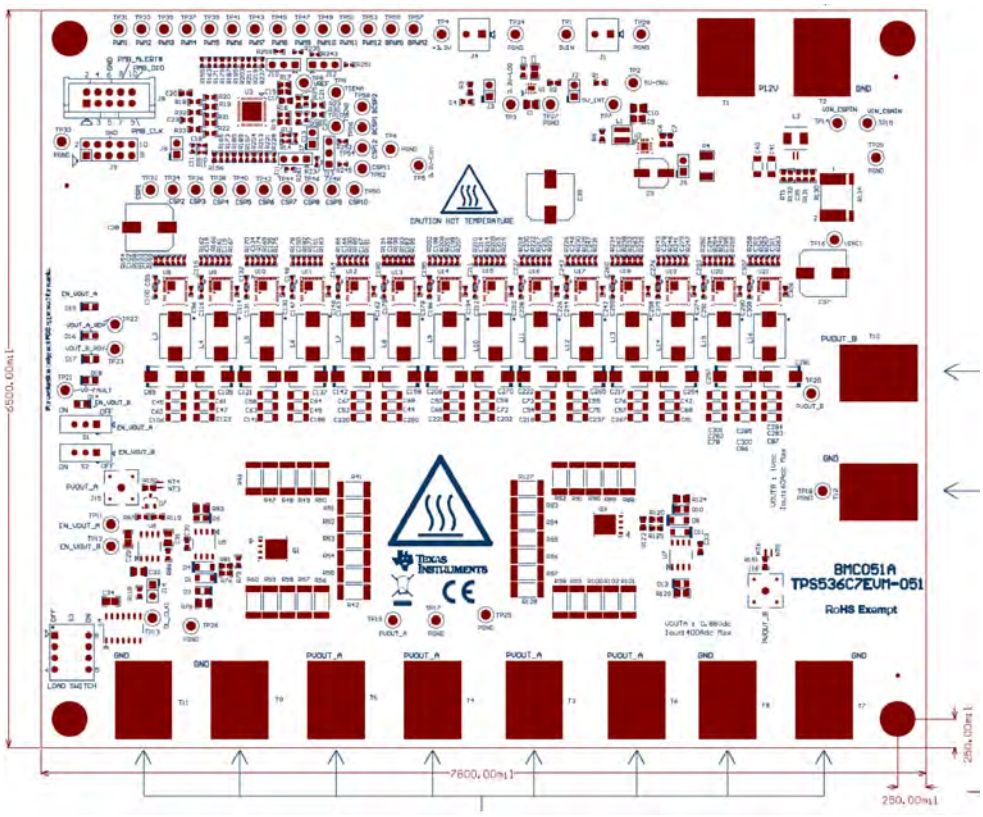


Figure 8-1. TPS536C7EVM-051 Assembly Drawing Top View

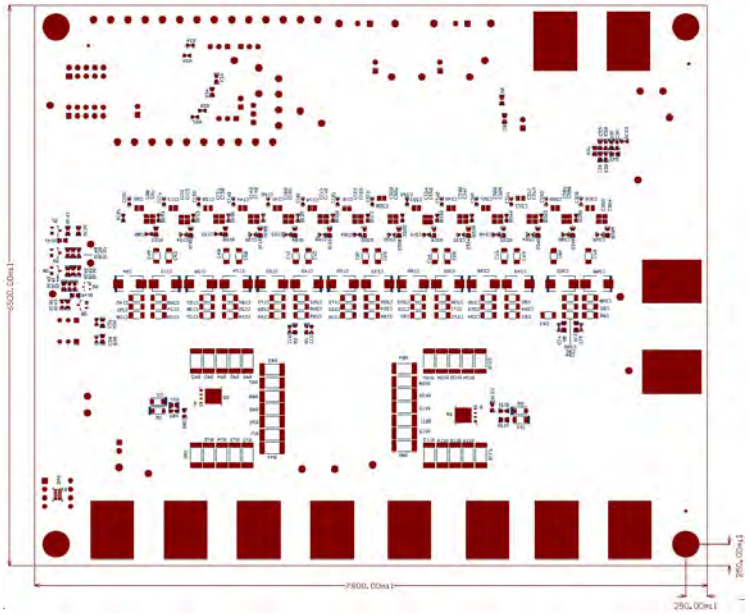


Figure 8-2. TPS536C7EVM-051 Assembly Drawing Bottom View

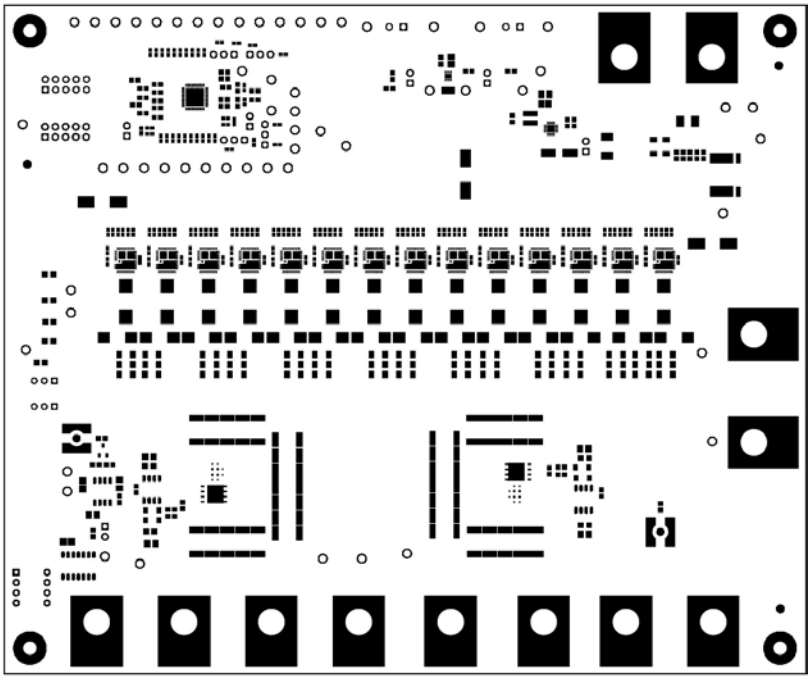


Figure 8-3. TPS536C7EVM-051 PCB Top Solder

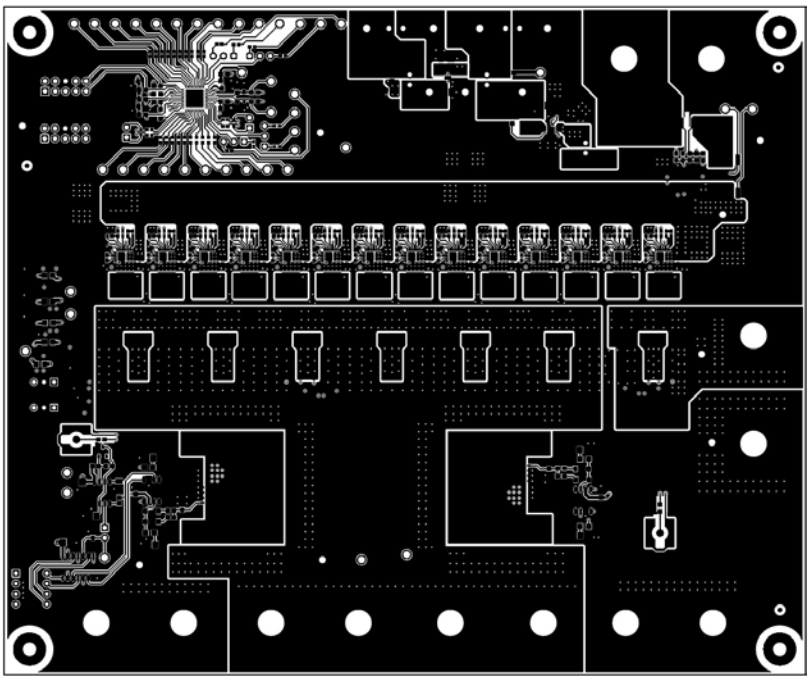


Figure 8-4. TPS536C7EVM-051 PCB Top layer

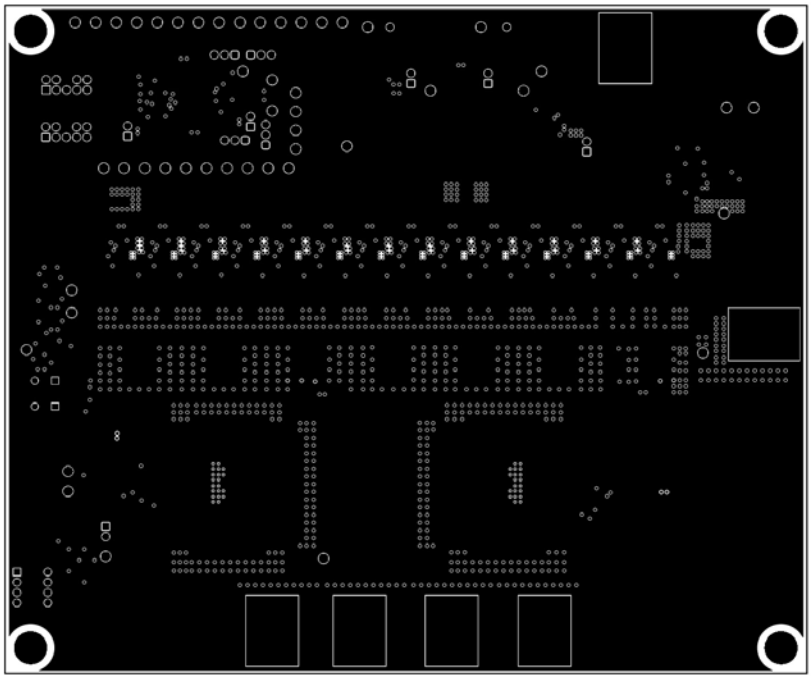


Figure 8-5. TPS536C7EVM-051 PCB Layer2-GND

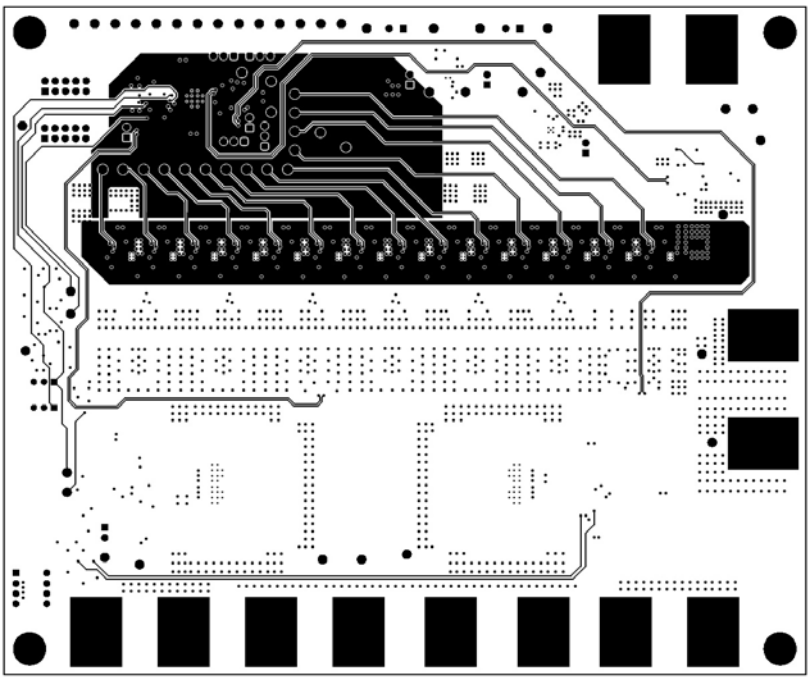


Figure 8-6. TPS536C7EVM-051 PCB Layer03-Signal

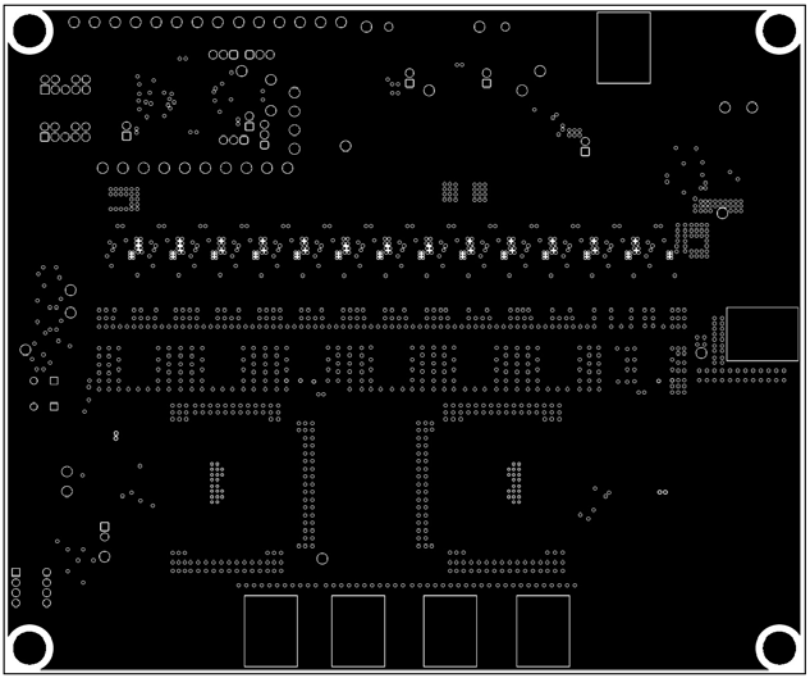


Figure 8-7. TPS536C7EVM-051 PCB Layer04-GND

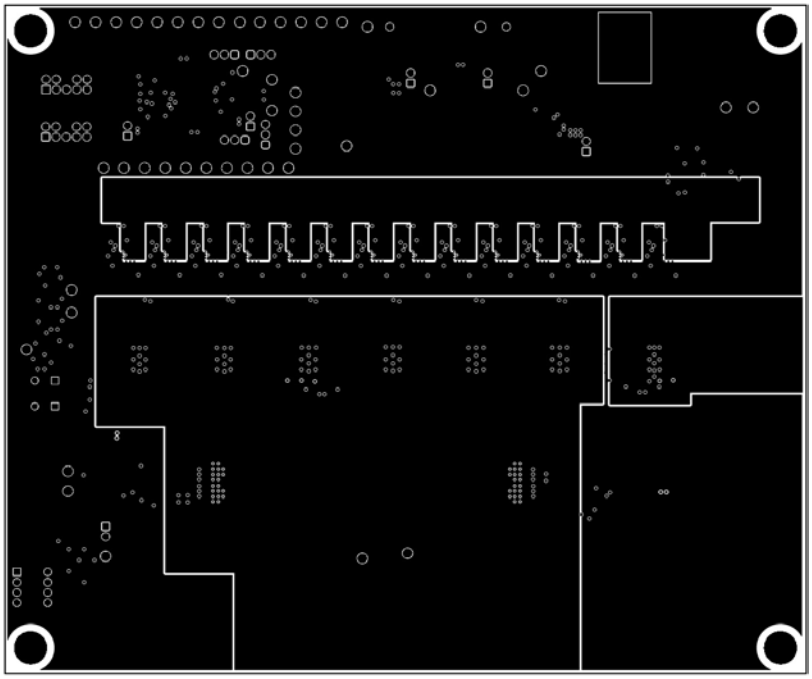


Figure 8-8. TPS536C7EVM-051 PCB Layer05-Power

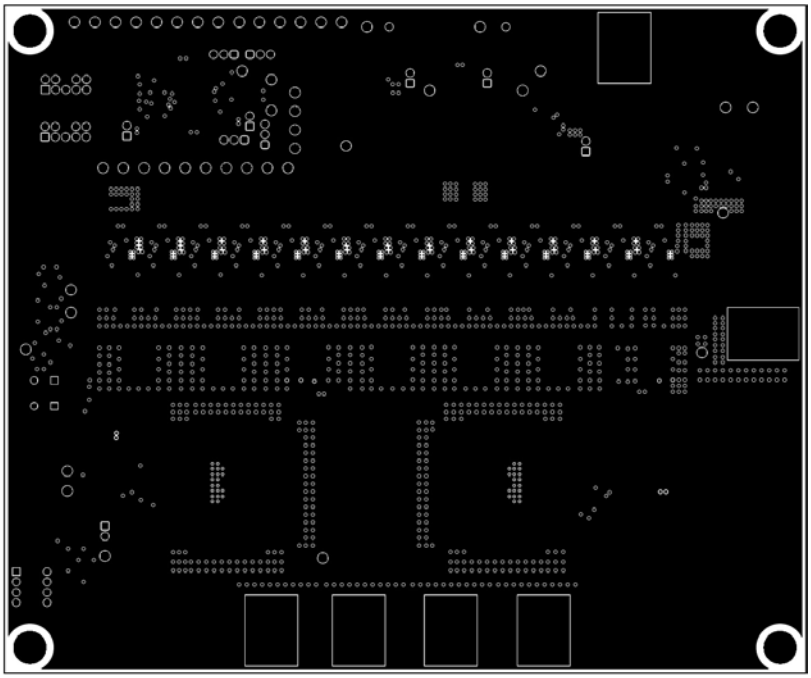


Figure 8-9. TPS536C7EVM-051 PCB Layer06-GND

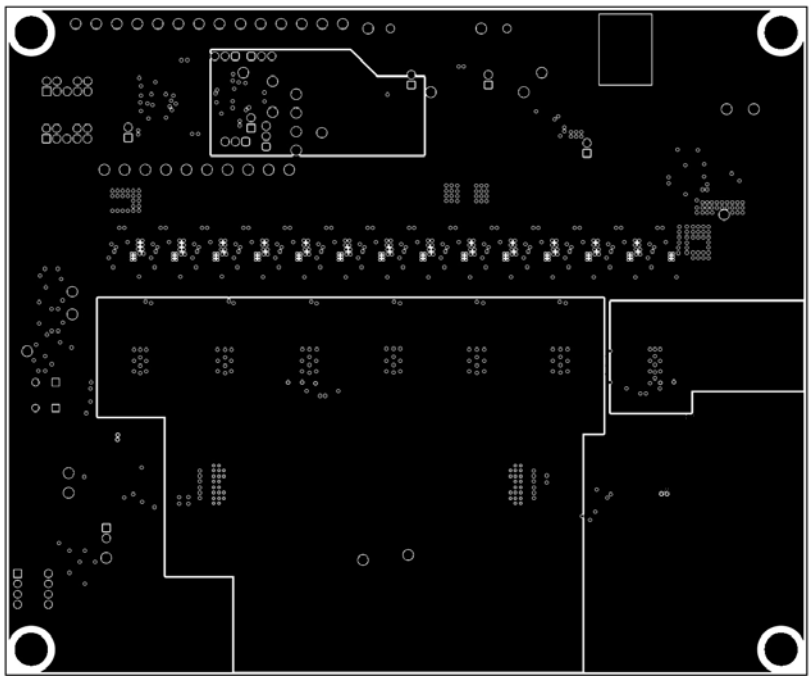


Figure 8-10. TPS536C7EVM-051 PCB Layer07-Power

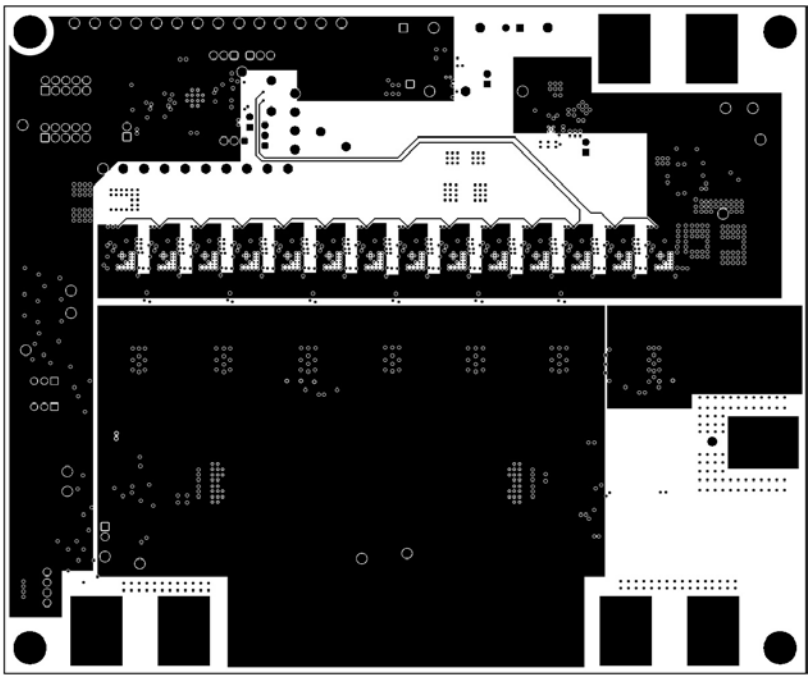


Figure 8-11. TPS536C7EVM-051 PCB Layer08-Power

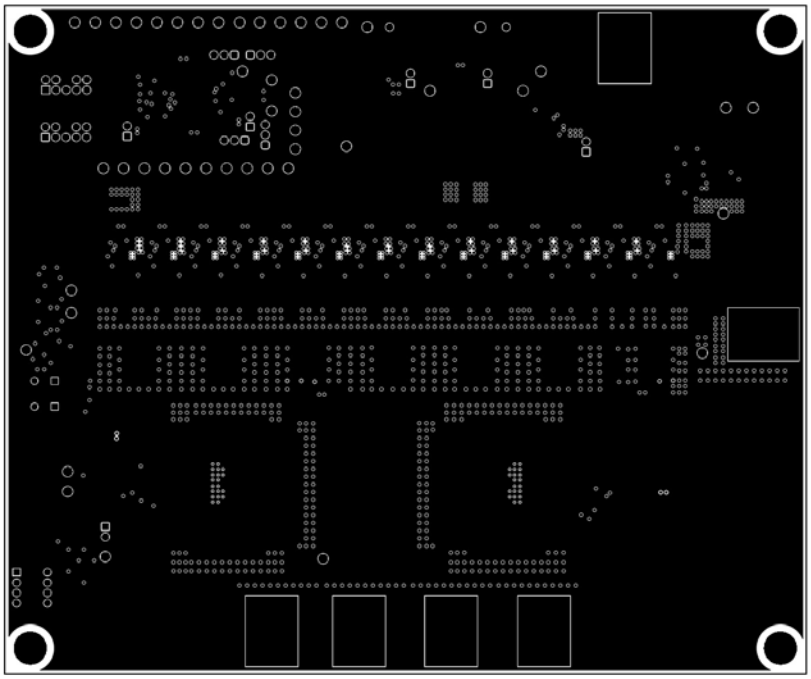


Figure 8-12. TPS536C7EVM-051 PCB Layer09-GND

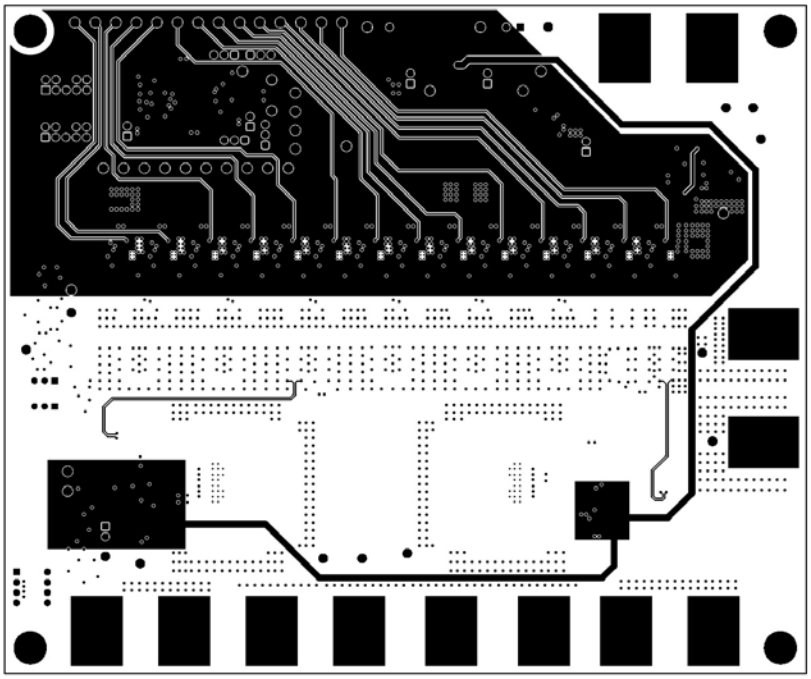


Figure 8-13. TPS536C7EVM-051 PCB Layer10-Signal

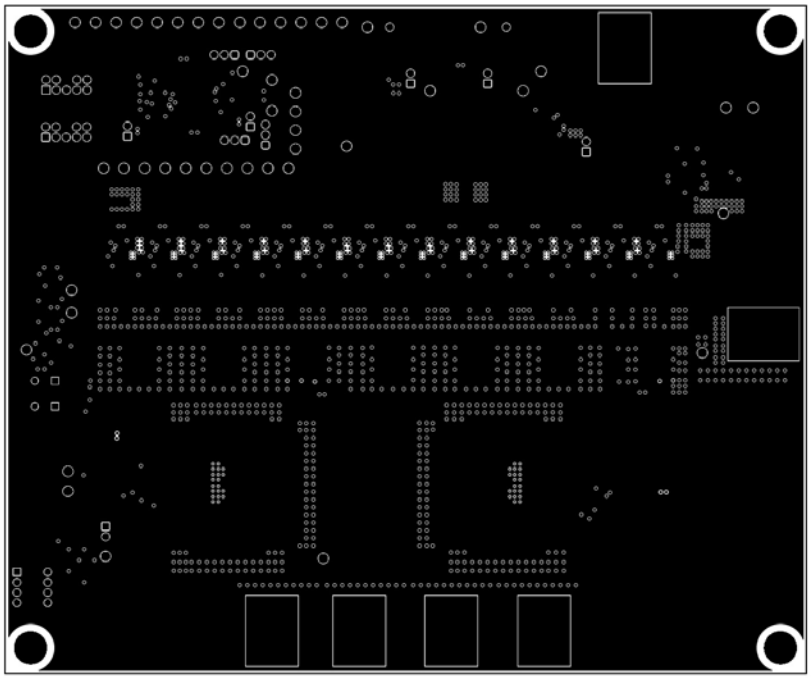


Figure 8-14. TPS536C7EVM-051 PCB Layer11-GND

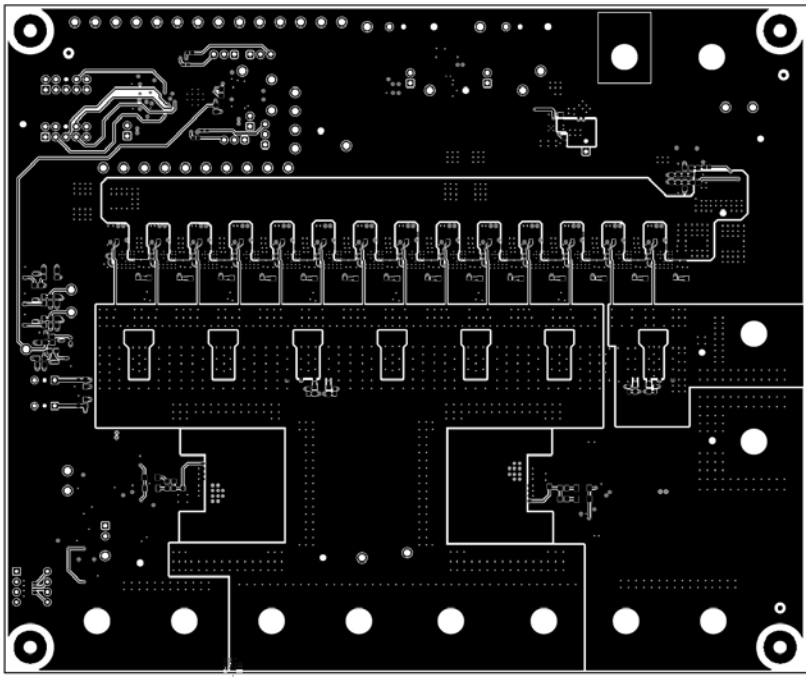


Figure 8-15. TPS536C7EVM-051 PCB Bottom layer

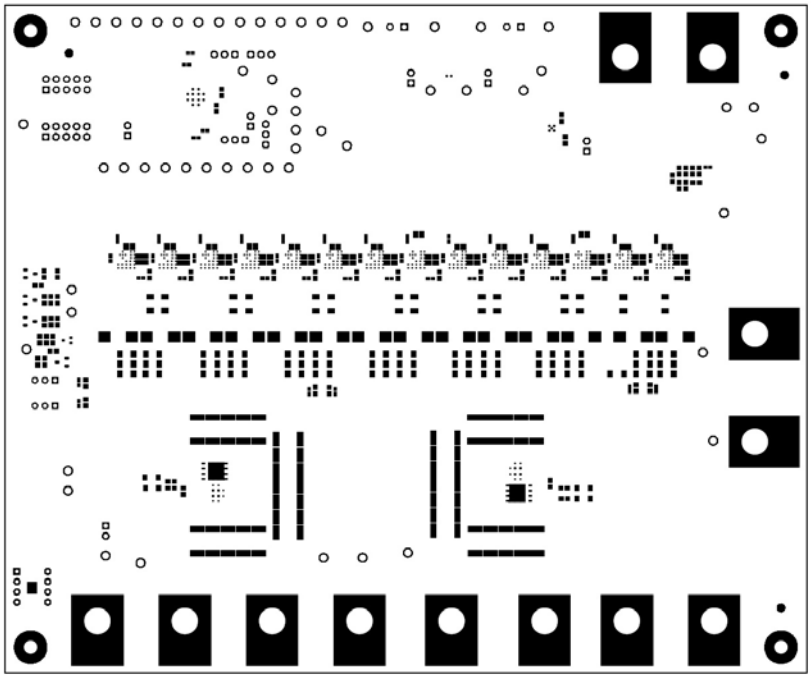


Figure 8-16. TPS536C7EVM-051 PCB Bottom solder

9 Schematic and Bill of Materials

Figure 9-1 through Figure 9-10 show the TPS536C7EVM-051 schematics.

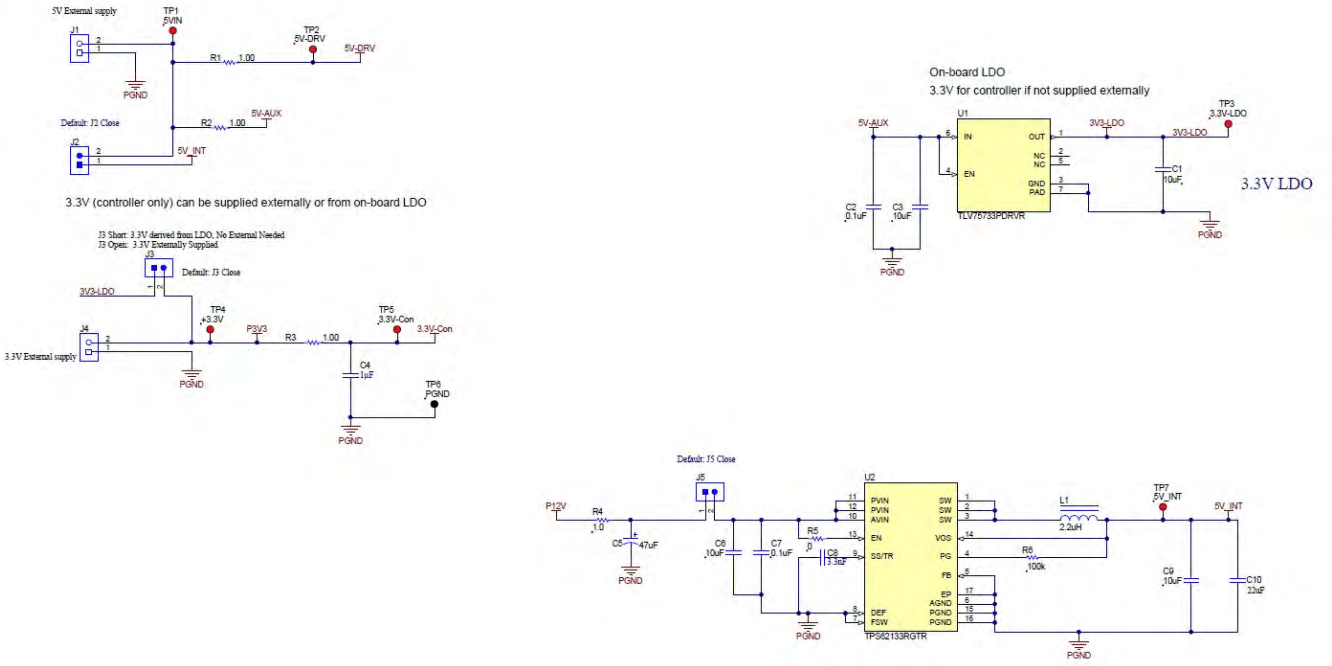


Figure 9-1. TPS536C7EVM-051 Aux power

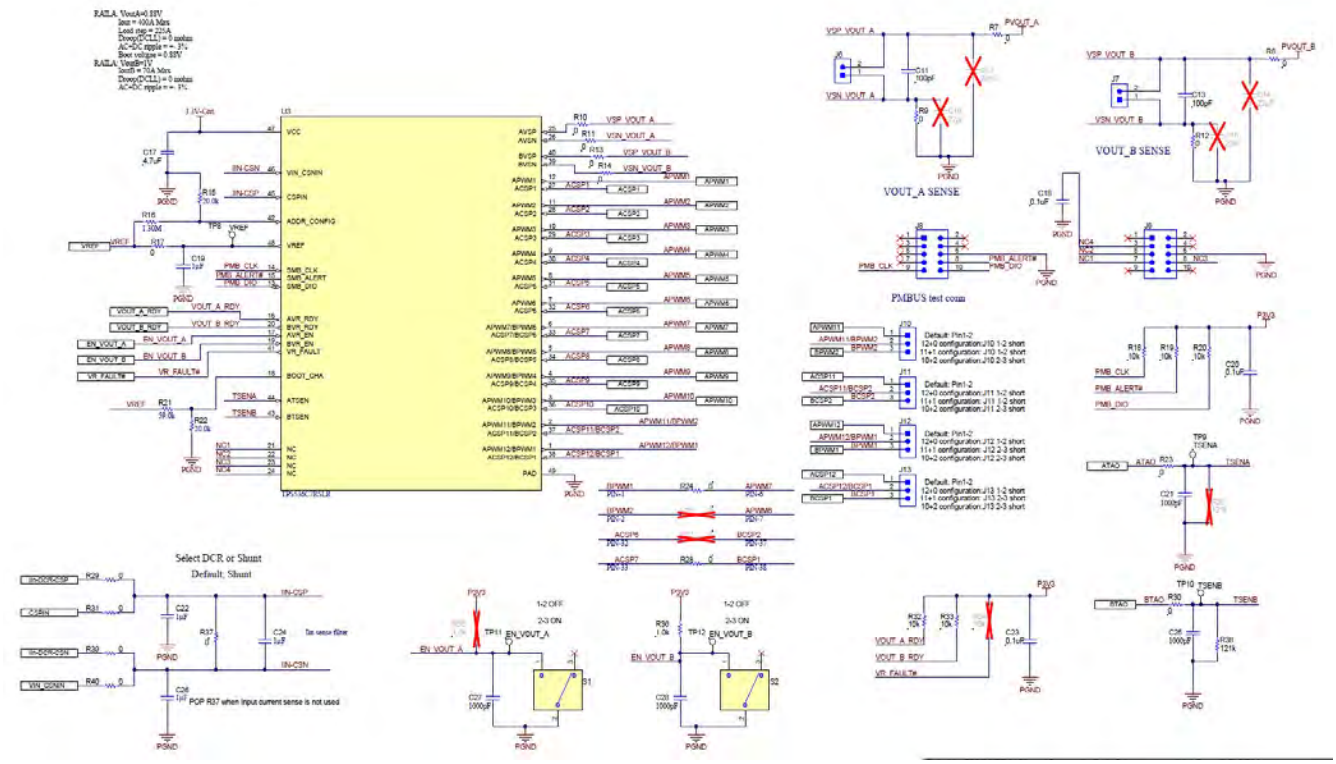


Figure 9-2. TPS536C7EVM-051 Controller Schematic

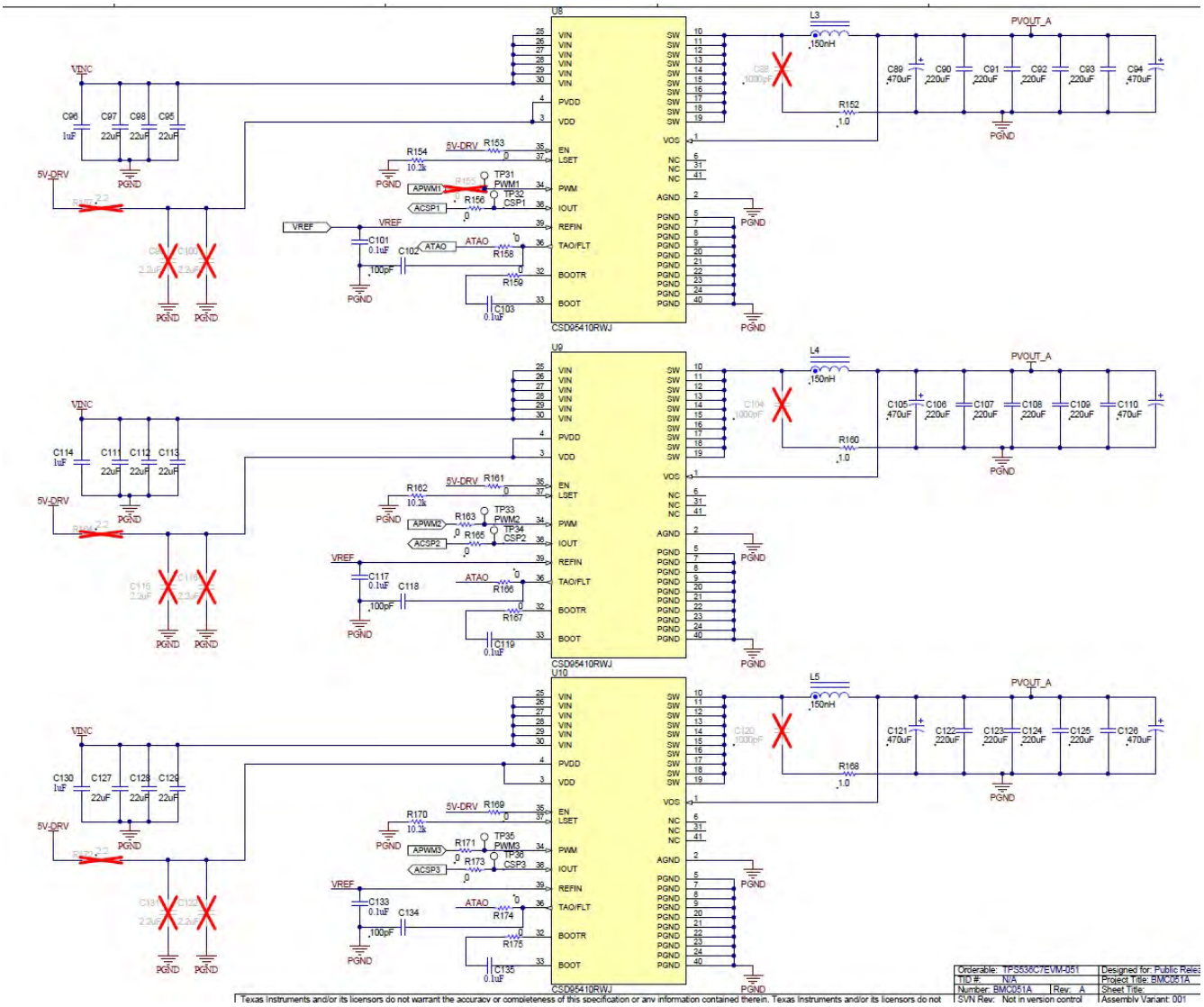


Figure 9-3. TPS536C7EVM-051 Rail A Power Stages 1-2-3 Schematic

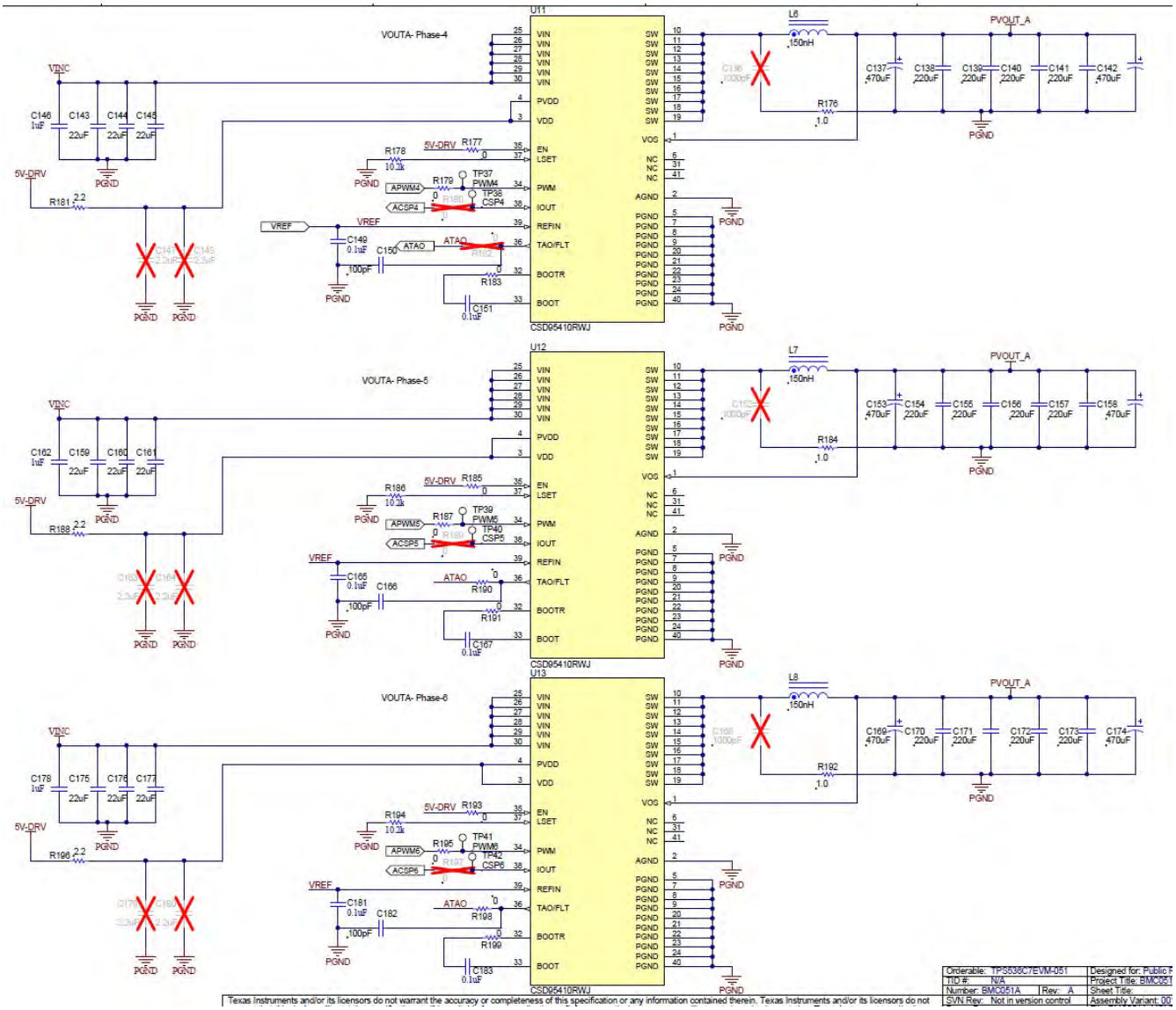


Figure 9-4. TPS536C7EVM-051 Rail A Power Stages 4-5-6 Schematic

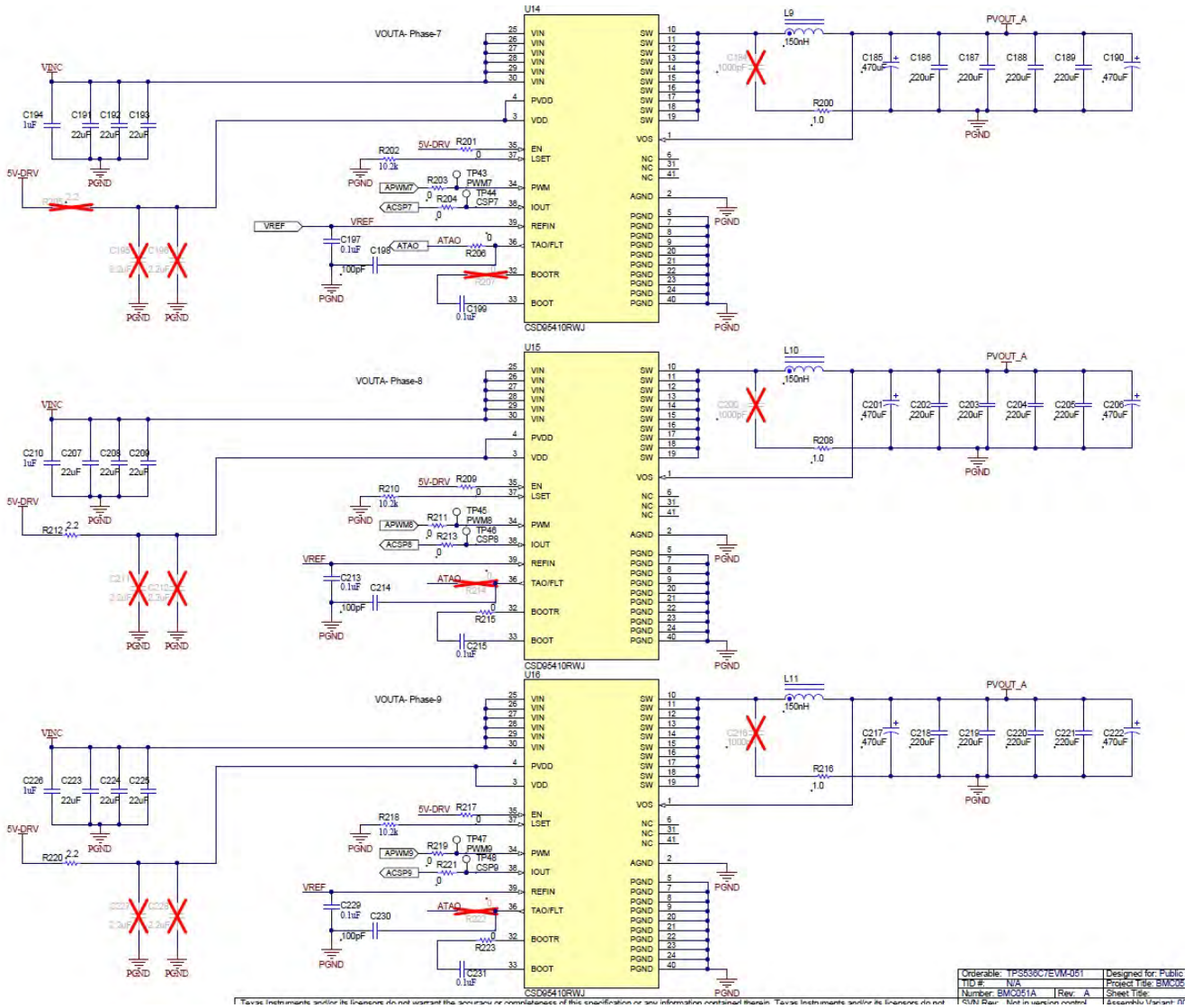


Figure 9-5. TPS536C7EVM-051 Rail A Power Stages 7-8-9 Schematic

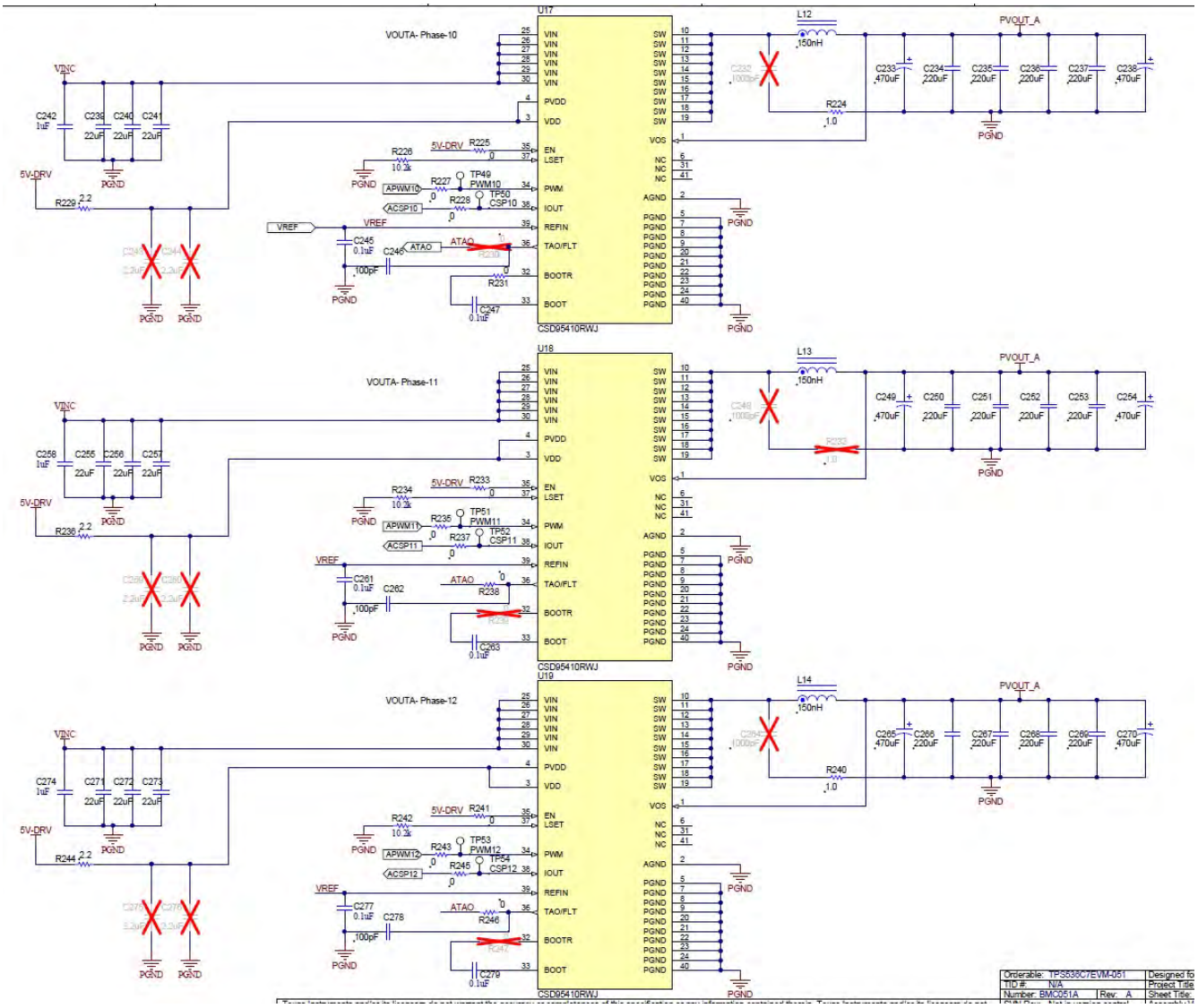


Figure 9-6. TPS536C7EVM-051 Rail A Power Stages 10-11-12 Schematic

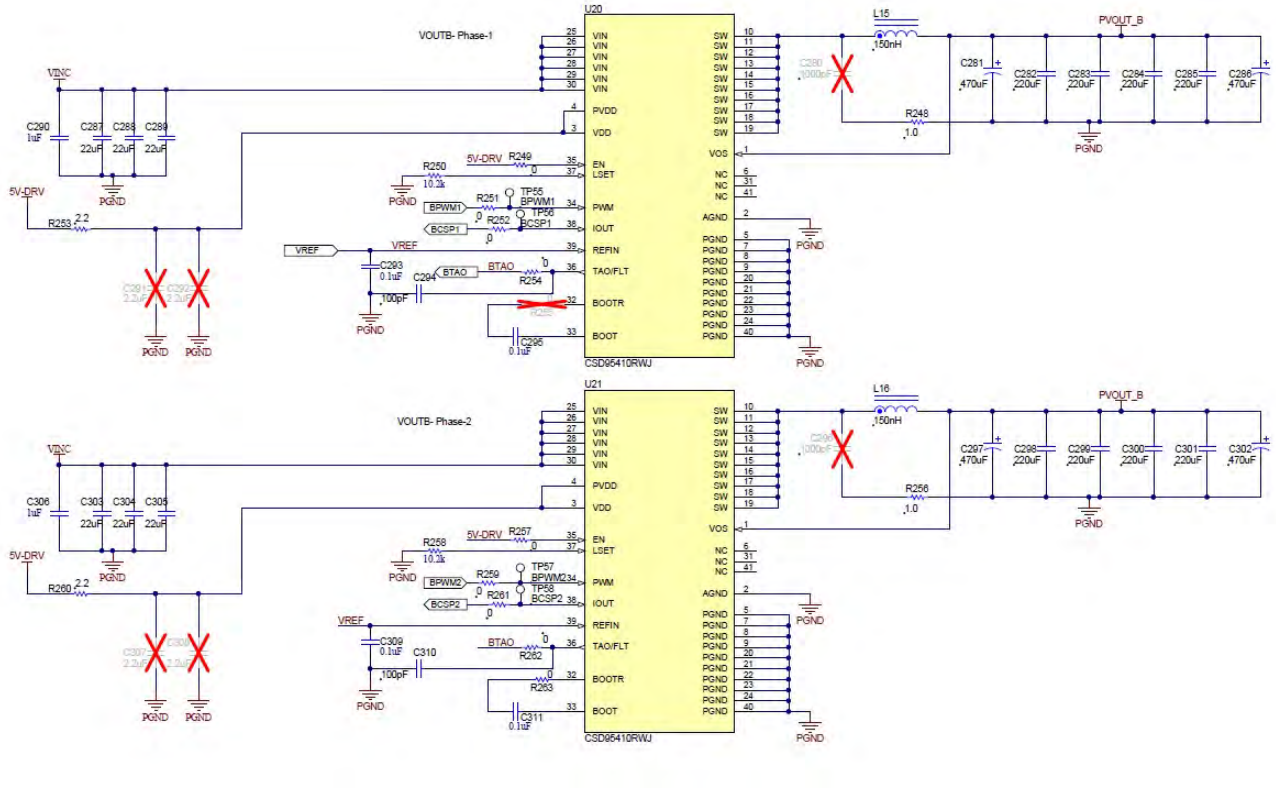


Figure 9-7. TPS536C7EVM-051 Rail B Power Stages 1-2 Schematic

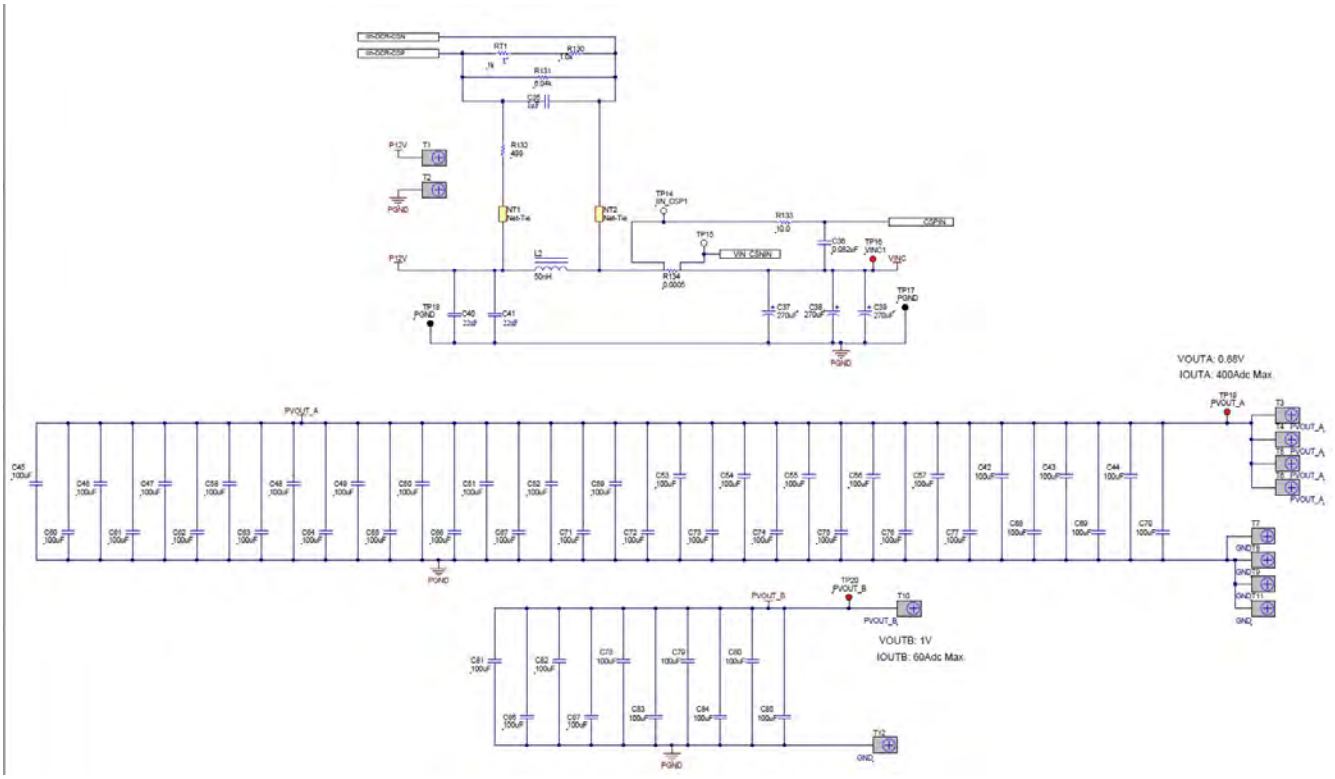


Figure 9-8. TPS536C7EVM-051 Input and output filter Schematic

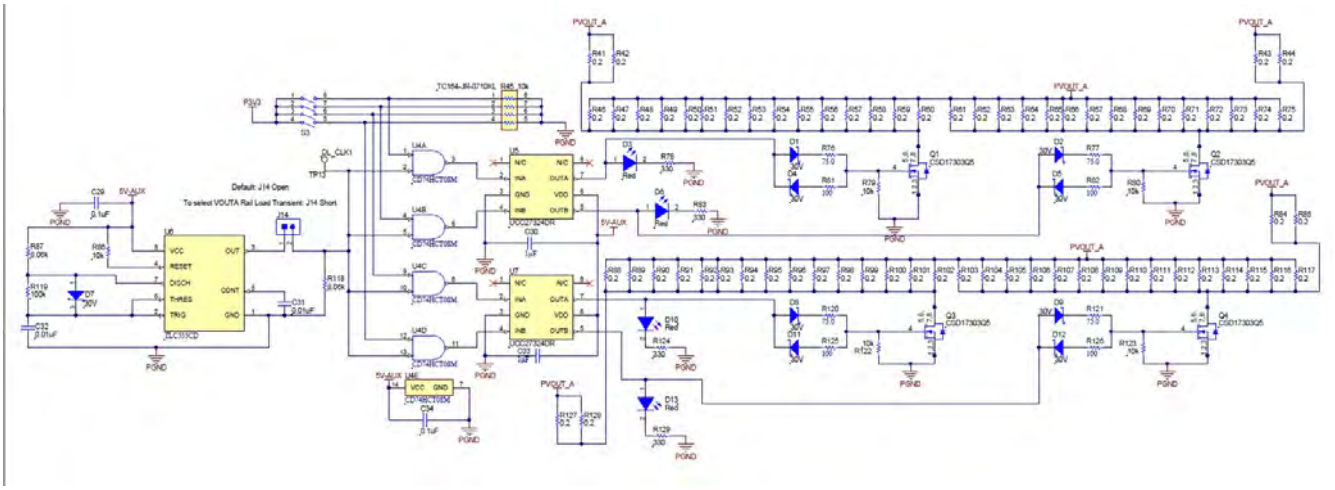


Figure 9-9. TPS536C7EVM-051 On Board transient Load Schematic

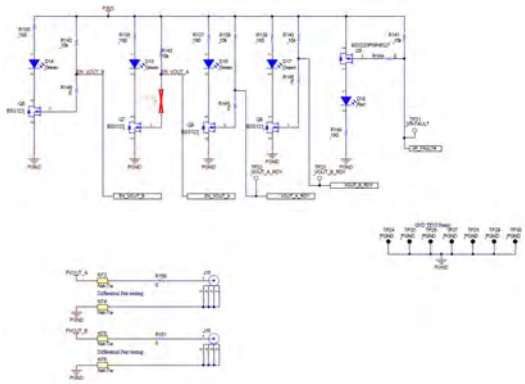


Figure 9-10. TPS536C7EVM-051 Helper Circuits and Indicators Schematic

Table 9-1. Bill of Materials

Designator	Qty Value	Description	Package	Reference	Part Number	Manufacturer
C1, C3, C9	3	10uF	CAP, CERM, 10 uF, 25 V, +/- 10%, X5R, 0805	805	C2012X5R1E106K125AB	TDK
C2, C7, C18, C20, C23	5	0.1uF	CAP, CERM, 0.1 uF, 50 V, +/- 10%, X7R, 0603	603	06035C104KAT2A	AVX
C4, C19, C22, C24, C26, C30, C33, C35	8	1uF	CAP, CERM, 1 uF, 16 V, +/- 10%, X7R, AEC-Q200 Grade 1, 0603	603	GCM188R71C105KA64D	MuRata

Table 9-1. Bill of Materials (continued)

Designator	Qty Value	Description	Package	Reference	Part Number	Manufacturer
C5	1	47uF	CAP, Polymer Hybrid, 47 uF, 35 V, +/- 20%, 60 ohm, 6.3x5.8 SMD	6.3x5.8	EEHZC1V470P	Panasonic
C6	1	10uF	CAP, CERM, 10 uF, 25 V, +/- 20%, X5R, 0603	603	C1608X5R1E106M080AC	TDK
C8	1	3300pF	CAP, CERM, 3300 pF, 50 V, +/- 10%, X7R, 0603	603	C0603X332K5RACTU	Kemet
C10	1	22uF	CAP, CERM, 22 uF, 16 V, +/- 20%, X5R, 0805	805	GRM21BR61C226ME44L	MuRata
C11, C13	2	100pF	CAP, CERM, 100 pF, 25 V, +/- 5%, C0G/NP0, 0402	402	C0402C101J3GACTU	Kemet
C17	1	4.7uF	CAP, CERM, 4.7 uF, 10 V, +/- 10%, X5R, 0603	603	C0603C475K8PACTU	Kemet
C21, C25, C27, C28	4	1000pF	CAP, CERM, 1000 pF, 50 V, +/- 10%, X7R, 0402	402	C0402C102K5RACTU	Kemet
C29, C34	2	0.1uF	CAP, CERM, 0.1 uF, 25 V, +/- 10%, X7R, 0805	805	08053C104KAT2A	AVX
C31, C32	2	0.01uF	CAP, CERM, 0.01 uF, 100 V, +/- 5%, X7R, 0805	805	08051C103JAT2A	AVX
C36	1	0.082uF	CAP, CERM, 0.082 uF, 16 V, +/- 10%, X7R, 0603	603	0603YC823KAT2A	AVX
C37, C38, C39	3	270uF	CAP, Polymer Hybrid, 270 uF, 35 V, +/- 20%, 20 ohm, 10x10 SMD	10x10	EEHZA1V271P	Panasonic
C40, C41	2	22uF	CAP, CERM, 22 uF, 35 V, +/- 20%, X5R, 1206	1206	C3216X5R1V226M160AC	TDK
C42, C43, C44, C45, C46, C47, C48, C49, C50, C51, C52, C53, C54, C55, C56, C57, C58, C59, C60, C61, C62, C63, C64, C65, C66, C67, C68, C69, C70, C71, C72, C73, C74, C75, C76, C77, C78, C79, C80, C81, C82, C83, C84, C85, C86, C87	46	100uF	CAP, CERM, 100 uF, 4 V, +/- 20%, X5R, 1206	1206	GRM31CR60G107ME39L	MuRata
C89, C94, C105, C110, C121, C126, C137, C142, C153, C158, C169, C174, C185, C190, C201, C206, C217, C222, C233, C238, C249, C254, C265, C270, C281, C286, C297, C302	28	470uF	CAP, Aluminum Polymer, 470 uF, 2.5 V, +/- 20%, 0.003 ohm, SMD_7.3x1.9x4.3mm SMD	SMD_7.3x1.9x4.3mm	EEF-GX0E471R	Panasonic

Table 9-1. Bill of Materials (continued)

Designator	Qty Value	Description	Package	Reference	Part Number	Manufacturer
C90, C91, C92, C93, C106, C107, C108, C109, C122, C123, C124, C125, C138, C139, C140, C141, C154, C155, C156, C157, C170, C171, C172, C173, C186, C187, C188, C189, C202, C203, C204, C205, C218, C219, C220, C221, C234, C235, C236, C237, C250, C251, C252, C253, C266, C267, C268, C269, C282, C283, C284, C285, C298, C299, C300, C301	56	220uF	CAP, CERM, 220 uF, 4 V, +/- 20%, X5R, 1206_190	1206_190	GRM31CR60G227ME11L	MuRata
C95, C97, C98, C111, C112, C113, C127, C128, C129, C143, C144, C145, C159, C160, C161, C175, C176, C177, C191, C192, C193, C207, C208, C209, C223, C224, C225, C239, C240, C241, C255, C256, C257, C271, C272, C273, C287, C288, C289, C303, C304, C305	42	22uF	CAP, CERM, 22 uF, 16 V, +/- 20%, X5R, 0805	805	GRM21BR61C226ME44	MuRata
C96, C114, C130, C146, C162, C178, C194, C210, C226, C242, C258, C274, C290, C306	14	1uF	CAP, CERM, 1 uF, 25 V, +/- 10%, X5R, 0402	402	GRM155R61E105KA12D	MuRata
C99, C100, C115, C116, C131, C132, C147, C148, C163, C164, C179, C180, C195, C196, C211, C212, C227, C228, C243, C244, C259, C260, C275, C276, C291, C292, C307, C308	28	2.2uF	CAP, CERM, 2.2 uF, 10 V, +/- 10%, X5R, 0402	402	C1005X5R1A225K050BC	TDK
C103, C119, C135, C151, C167, C183, C199, C215, C231, C247, C263, C279, C295, C311	14	0.1uF	CAP, CERM, 0.1 uF, 50 V, +/- 10%, X7R, AEC-Q200 Grade 1, 0402	402	GCM155R71H104KE02D	MuRata
D1, D2, D4, D5, D8, D9, D11, D12	8	30V	Diode, Schottky, 30 V, 0.5 A, SOD-123	SOD-123	MBR0530T1G	ON Semiconductor
D3, D6, D10, D13, D18	5	Red	LED, Red, SMD	Red 0805 LED	LTST-C170KRKT	Lite-On
D7	1	30V	Diode, Schottky, 30 V, 0.2 A, SOT-23	SOT-23	BAT54-7-F	Diodes Inc.
D14, D15, D16, D17	4	Green	LED, Green, SMD	LED_0805	LTST-C170KGKT	Lite-On
H1, H2, H3, H4, H5, H6, H7, H8, H9, H10, H11, H12	12		Machine Screw Pan Philips 10-32		PMSSS 102 0050 PH	B&F Fastener Supply

Table 9-1. Bill of Materials (continued)

Designator	Qty Value	Description	Package	Reference	Part Number	Manufacturer
H13, H14, H15, H16, H17, H18, H19, H20, H21, H22, H23, H24	12		Machine Screw Nut, Hex, 3/8', Stn, Steel, 10-32		HNSS 102	B&F Fastener Supply
H25, H26, H27, H28	4		Machine Screw, Round, #4-40 x 1/4, Nylon, Philips panhead	Screw	NY PMS 440 0025 PH	B&F Fastener Supply
H29, H30, H31, H32, H33, H34, H35, H36, H37, H38, H39, H40	12		Washer, Split Lock, #10		1477	Keystone
H41, H42, H43, H44	4			Standoff	1902C	Keystone
J1, J4	2		Terminal Block, 3.5 mm, 2x1, Tin, TH	Terminal Block, 3.5 mm, 2x1, TH	39357-0002	Molex
J2, J3, J5, J6, J7, J14	6		Header, 100mil, 2x1, Gold, TH	2x1 Header	TSW-102-07-G-S	Samtec
J8	1		Header (shrouded), 100mil, 5x2, Gold, TH	5x2 Shrouded header	5103308-1	TE Connectivity
J9	1		Header, 100mil, 5x2, Gold, TH	5x2 Header	TSW-105-07-G-D	Samtec
J10, J11, J12, J13	4		Header, 100mil, 3x1, Gold, TH	3x1 Header	TSW-103-07-G-S	Samtec
J15, J16	2		Connector, SMT, SMB Jack Assembly 50 ohm	Connector, SMT, SMB Jack Assembly	131-3711-201	Cinch Connectivity
L1	1	2.2uH	Inductor, Shielded, Composite, 2.2 uH, 3.7 A, 0.02 ohm, SMD	4x2x4mm	XFL4020-222MEB	Coilcraft
L2	1	50nH	Inductor, Ferrite, 50 nH, 53 A, 0.0002889 ohm, SMD	5.2x5mm	AH2026A-R05LHF	Inter-Technical Group
L3, L4, L5, L6, L7, L8, L9, L10, L11, L12, L13, L14, L15, L16	14	150nH	Inductor, 150 nH, 68 A, 0.0002035 ohm, SMD	10x7x10mm	PA4390.151HLT	Pulse Engineering
Q1, Q2, Q3, Q4	4	30V	MOSFET, N-CH, 30 V, 100 A, DQH0008A (VSON-CLIP-8)	DQH0008A	CSD17303Q5	Texas Instruments
Q5	1	-20V	MOSFET, P-CH, -20 V, -0.39 A, SOT-323	SOT-323	BSS223PWH6327	Infineon Technologies
Q6, Q7, Q8, Q9	4	100V	MOSFET, N-CH, 100 V, 0.17 A, SOT-23	SOT-23	BSS123	Fairchild Semiconductor
R1, R2, R3	3	1	RES, 1.00, 1%, 0.1 W, 0603	603	RC0603FR-071RL	Yageo America
R4	1	1	RES, 1.0, 5%, 1 W, 2010	2010	CRCW20101R00JNEFHP	Vishay-Dale
R5, R7, R8, R9, R12, R17, R23, R30, R31, R40, R144, R145, R146, R147, R148, R150, R151	17	0	RES, 0, 5%, 0.1 W, 0603	603	CRCW06030000Z0EA	Vishay-Dale
R6, R119	2	100k	RES, 100 k, 1%, 0.1 W, 0603	603	CRCW0603100KFKEA	Vishay-Dale
R10, R11, R13, R14	4	0	RES, 0, 5%, 0.063 W, 0402	402	CRCW04020000Z0ED	Vishay-Dale
R15, R22	2	20.0k	RES, 20.0 k, 1%, 0.1 W, AEC-Q200 Grade 0, 0603	603	CRCW060320K0FKEA	Vishay-Dale

Table 9-1. Bill of Materials (continued)

Designator	Qty Value	Description	Package	Reference	Part Number	Manufacturer
R16	1	1.30Meg	RES, 1.30 M, 1%, 0.1 W, AEC-Q200 Grade 0, 0603	603	CRCW06031M30FKEA	Vishay-Dale
R18, R19, R20, R32, R33, R34, R79, R80, R86, R122, R123, R138, R140, R141, R142, R143	16	10k	RES, 10 k, 5%, 0.1 W, 0603	603	CRCW060310K0JNEA	Vishay-Dale
R21	1	59.0k	RES, 59.0 k, 1%, 0.1 W, AEC-Q200 Grade 0, 0603	603	CRCW060359K0FKEA	Vishay-Dale
R35, R36, R130	3	1.0k	RES, 1.0 k, 5%, 0.1 W, 0603	603	CRCW06031K00JNEA	Vishay-Dale
R41, R42, R43, R44, R46, R47, R48, R49, R50, R51, R52, R53, R54, R55, R56, R57, R58, R59, R60, R61, R62, R63, R64, R65, R66, R67, R68, R69, R70, R71, R72, R73, R74, R75, R84, R85, R88, R89, R90, R91, R92, R93, R94, R95, R96, R97, R98, R99, R100, R101, R102, R103, R104, R105, R106, R107, R108, R109, R110, R111, R112, R113, R114, R115, R116, R117, R127, R128	68	0.2	RES, 0.2, 1%, 2 W, 2512	2512	CSRN2512FKR200	Stackpole Electronics Inc
R45	1	10k	RES, 10 k, 5%, 0.0625 W, 3.2x1.6mm	3.2x1.6mm	TC164-JR-0710KL	Yageo America
R76, R77, R120, R121	4	75	RES, 75.0, 1%, 0.1 W, AEC-Q200 Grade 0, 0603	603	CRCW060375R0FKEA	Vishay-Dale
R78, R83, R124, R129	4	330	RES, 330, 5%, 0.125 W, 0805	805	CRCW0805330RJNEA	Vishay-Dale
R81, R82, R125, R126	4	100	RES, 100, 1%, 0.1 W, AEC-Q200 Grade 0, 0603	603	CRCW0603100RFKEA	Vishay-Dale
R87, R118	2	8.06k	RES, 8.06 k, 1%, 0.1 W, 0603	603	CRCW06038K06FKEA	Vishay-Dale
R131	1	6.04k	RES, 6.04 k, 1%, 0.1 W, 0603	603	CRCW06036K04FKEA	Vishay-Dale
R132	1	499	RES, 499, 1%, 0.1 W, 0603	603	CRCW0603499RFKEA	Vishay-Dale
R133	1	10	RES, 10.0, 1%, 0.063 W, 0402	402	CRCW040210R0FKED	Vishay-Dale
R134	1	0.0005	RES, 0.0005, 1%, 3 W, 4026	4026	WSL4026L5000FEB	Vishay-Dale
R135, R136, R137, R139, R149	5	180	RES, 180, 5%, 0.1 W, 0603	603	CRCW0603180RJNEA	Vishay-Dale

Table 9-1. Bill of Materials (continued)

Designator	Qty Value	Description	Package	Reference	Part Number	Manufacturer
R153, R155, R156, R158, R159, R161, R163, R165, R166, R167, R169, R171, R173, R174, R175, R177, R179, R180, R182, R183, R185, R187, R189, R190, R191, R193, R195, R197, R198, R199, R201, R203, R204, R206, R207, R209, R211, R213, R214, R215, R217, R219, R221, R222, R223, R225, R227, R228, R230, R231, R233, R235, R237, R238, R239, R241, R243, R245, R246, R247, R249, R251, R252, R254, R255, R257, R259, R261, R262, R263	70	0	RES, 0, 5%, 0.063 W, AEC-Q200 Grade 0, 0402	402	CRCW04020000Z0ED	Vishay-Dale
R154, R162, R170, R178, R186, R194, R202, R210, R218, R226, R234, R242, R250, R258	14	10.2k	RES, 10.2 k, 0.1%, 0.063 W, AEC-Q200 Grade 1, 0402	402	ERA-2AEB1022X	Panasonic
R157, R164, R172, R181, R188, R196, R205, R212, R220, R229, R236, R244, R253, R260	14	2.2	RES, 2.2, 5%, 0.063 W, AEC-Q200 Grade 0, 0402	402	CRCW04022R20JNED	Vishay-Dale
RT1	1	1k	Thermistor NTC, 1.0k ohm, 5%, 0603	603	NCP18XQ102J03RB	MuRata
S1, S2	2		Switch, SPDT, Slide, On-On, 2 Pos, TH	4x11.6mm	EG1218	E-Switch
S3	1		DIP Switch, SPST 4Pos, Slide, TH	DIP Switch, 4 Pos	78B04ST	Grayhill
SH-J1, SH-J2, SH-J3, SH-J4, SH-J5, SH-J6, SH-J7, SH-J8	8	1x2	Shunt, 100mil, Flash Gold, Black	Closed Top 100mil Shunt	SPC02SYAN	Sullins Connector Solutions
T1, T2, T3, T4, T5, T6, T7, T8, T9, T10, T11, T12	12		Terminal 90A Lug	CB70-14-CY	CB70-14-CY	Panduit
TP1, TP2, TP3, TP4, TP5, TP7, TP16, TP19, TP20	9		Test Point, Compact, Red, TH	Red Compact Testpoint	5005	Keystone
TP6, TP17, TP18, TP24, TP25, TP26, TP27, TP28, TP29, TP30	10		Test Point, Compact, Black, TH	Black Compact Testpoint	5006	Keystone

Table 9-1. Bill of Materials (continued)

Designator	Qty Value	Description	Package	Reference	Part Number	Manufacturer
TP8, TP9, TP10, TP11, TP12, TP13, TP14, TP15, TP21, TP22, TP23, TP31, TP32, TP33, TP34, TP35, TP36, TP37, TP38, TP39, TP40, TP41, TP42, TP43, TP44, TP45, TP46, TP47, TP48, TP49, TP50, TP51, TP52, TP53, TP54, TP55, TP56, TP57, TP58	39		Test Point, Compact, White, TH	White Compact Testpoint	5007	Keystone
U1	1		1A Low-Quiescent-Current Low-Dropout (LDO) Regulator, DRV0006A (WSON-6)	DRV0006A	TLV75733PDRVR	Texas Instruments
U2	1		Buck Step Down Regulator with 3 to 17 V Input and 5 V Output, -40 to 85 degC, 16-Pin QFN (RGT), Green (RoHS & no Sb/Br)	RGT0016C	TPS62133RGTR	Texas Instruments
U3	1		Dual-Channel D-CAP +™ , Dual-Channel (12+0, 11+1, 10+2, 9+3, 8+4, 7+5, 6+6 Phases) Step-Down, Multiphase Controller, RSL0048B (VQFN-48)	RSL0048B	TPS536C7RSLR	Texas Instruments
U4	1		High Speed CMOS Logic Quad 2-Input AND Gates, D0014A, TUBE	D0014A	CD74HCT08M	Texas Instruments
U5, U7	2		Dual 4 A Peak High Speed Low-Side Power MOSFET Drivers, D0008A (SOIC-8)	D0008A	UCC27324DR	Texas Instruments
U6	1		2.1-MHz, 250-uA, Low-Power Timer, D0008A (SOIC-8)	D0008A	TLC555CD	Texas Instruments
U8, U9, U10, U11, U12, U13, U14, U15, U16, U17, U18, U19, U20, U21	14		Synchronous Buck NexFET Smart Power Stage, RWJ0041A (VQFN-CLIP-41)	RWJ0041A	CSD95410RWJ	Texas Instruments
C12, C14, C15, C16	0	22pF	CAP, CERM, 22 pF, 50 V, +/- 5%, C0G/NP0, 0402	402	GRM1555C1H220JA01D	MuRata
C88, C104, C120, C136, C152, C168, C184, C200, C216, C232, C248, C264, C280, C296	0	1000pF	CAP, CERM, 1000 pF, 50 V, +/- 10%, X7R, 0402	402	GRM155R71H102KA01D	MuRata
C101, C117, C133, C149, C165, C181, C197, C213, C229, C245, C261, C277, C293, C309	0	0.1uF	CAP, CERM, 0.1 uF, 50 V, +/- 10%, X7R, AEC-Q200 Grade 1, 0402	402	GCM155R71H104KE02D	MuRata

Table 9-1. Bill of Materials (continued)

Designator	Qty Value	Description	Package	Reference	Part Number	Manufacturer
C102, C118, C134, C150, C166, C182, C198, C214, C230, C246, C262, C278, C294, C310	0	100pF	CAP, CERM, 100 pF, 25 V, +/- 5%, C0G/NP0, 0402	402	C0402C101J3GACTU	Kemet
FID1, FID2, FID3, FID4, FID5, FID6	0		Fiducial mark. There is nothing to buy or mount.	N/A	N/A	N/A
R24, R26, R27, R28	0	0	RES, 0, 5%, 0.063 W, AEC-Q200 Grade 0, 0402	402	CRCW04020000Z0ED	Vishay-Dale
R25, R38	0	121k	RES, 121 k, 1%, 0.1 W, 0603	603	CRCW0603121KFKEA	Vishay-Dale
R29, R37, R39	0	0	RES, 0, 5%, 0.1 W, 0603	603	CRCW06030000Z0EA	Vishay-Dale
R152, R160, R168, R176, R184, R192, R200, R208, R216, R224, R232, R240, R248, R256	0	1	RES, 1.0, 5%, 0.1 W, AEC-Q200 Grade 0, 0603	603	CRCW06031R00JNEA	Vishay-Dale

10 Read This First

10.1 About This Manual

This document describes the hardware architecture of the TPS536C7 Evaluation Module (EVM).

10.2 Glossary

TI Glossary This glossary lists and explains terms, acronyms, and definitions.

10.3 Related Documentation From Texas Instruments

For product information, visit the Texas Instruments website at http://www.ti.com.

SLUSDI9 TPS536C7 Data sheet

10.4 Support Resources

TI E2E™ support forums are an engineer's go-to source for fast, verified answers and design help — straight from the experts. Search existing answers or ask your own question to get the quick design help you need.

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