

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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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.

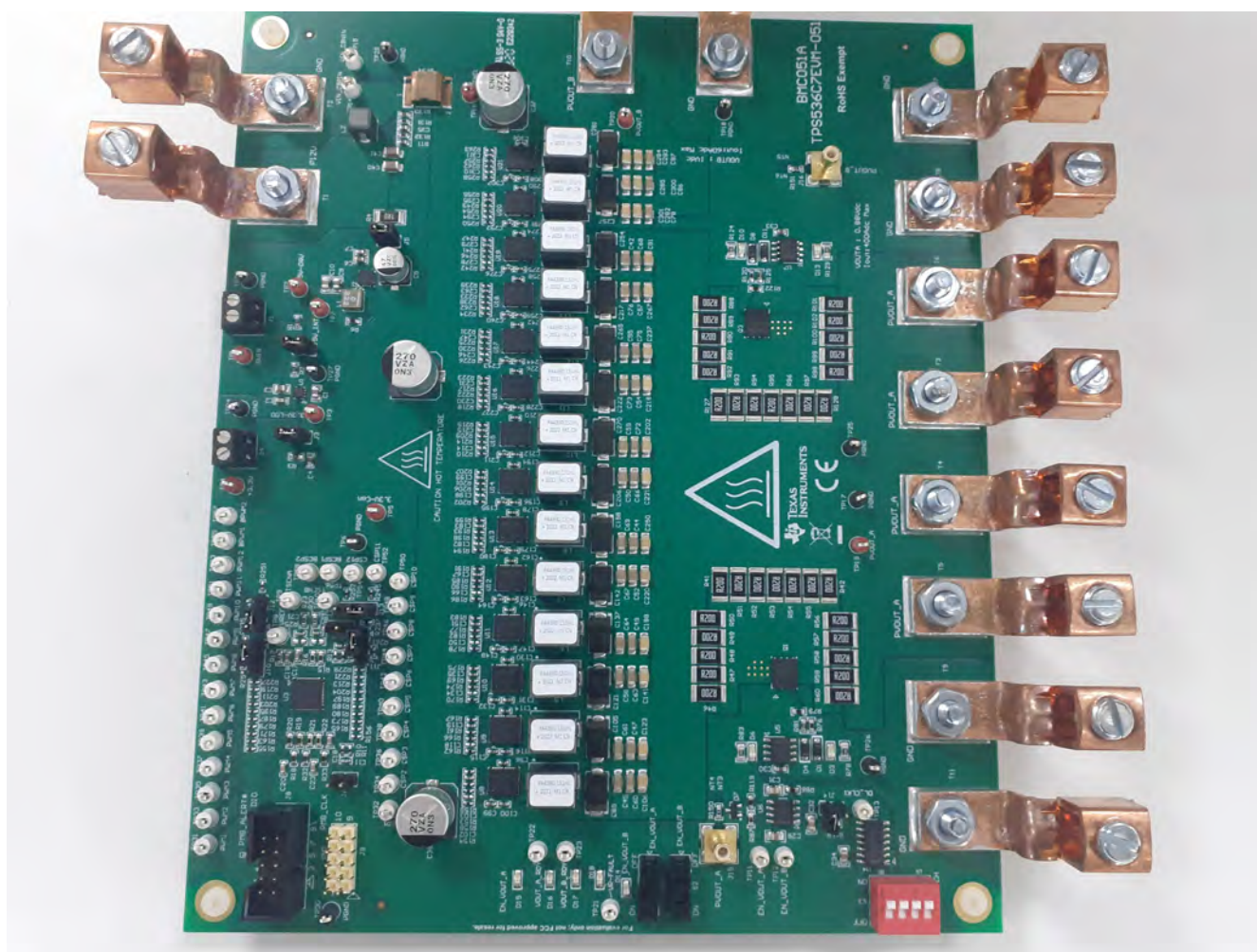


Figure 4-1. EVM Top View

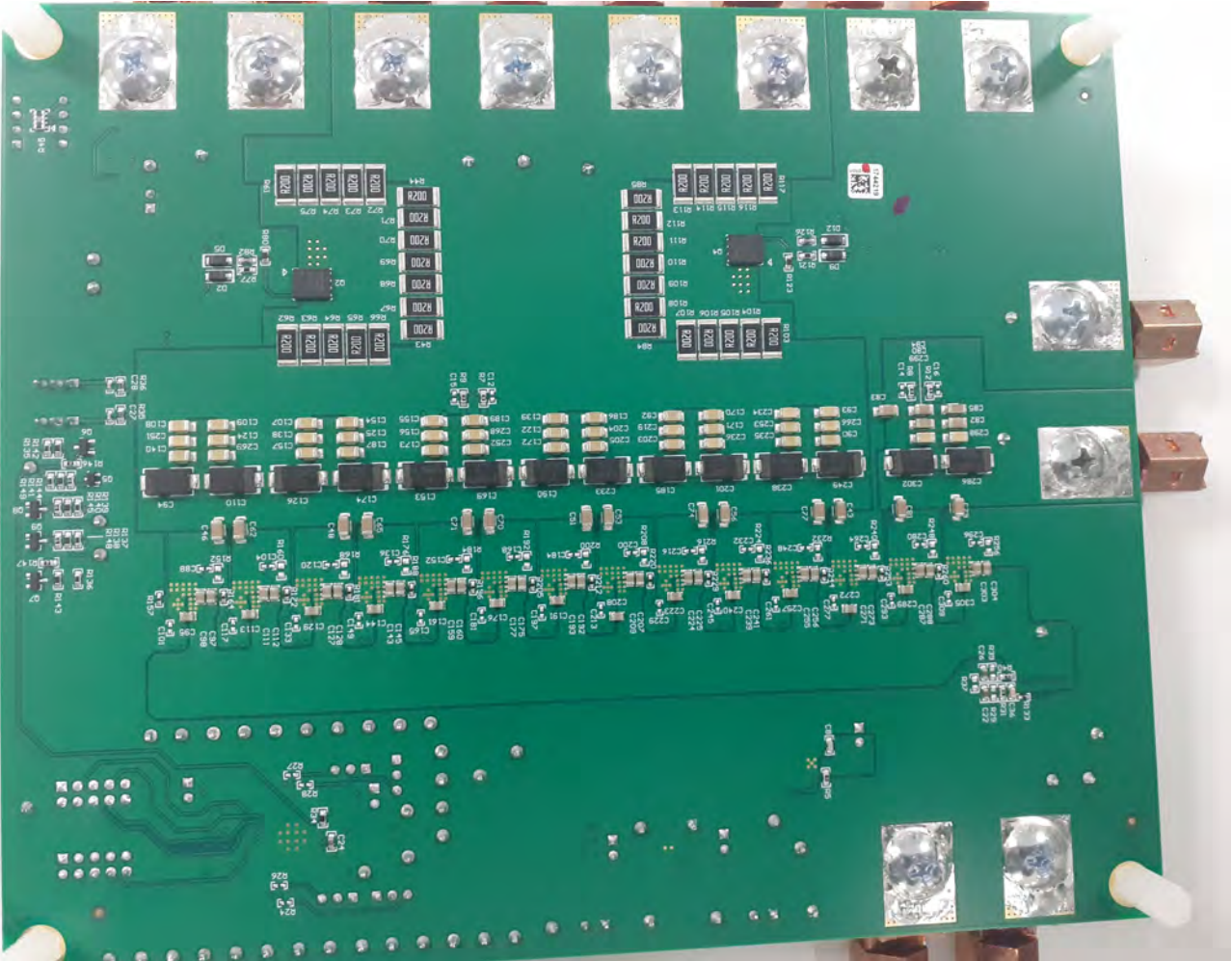


Figure 4-2. EVM Bottom View

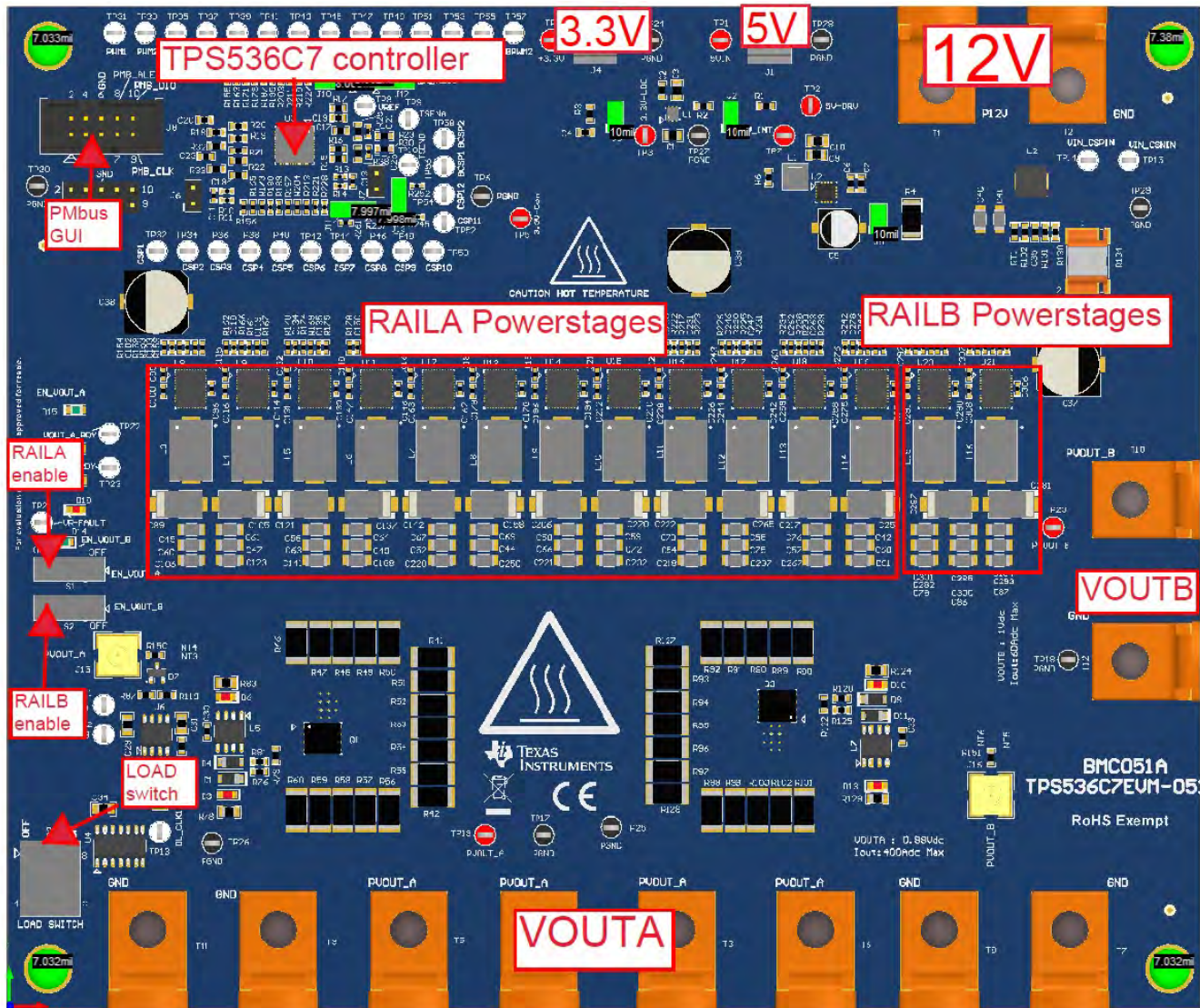


Figure 4-3. EVM Options

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 configuration selection](#)

Table 4-1. Phase configuration selection

Phase configuration	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	Placeholder	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	VOUTA Output Measurement Point
J16	VOUTB Output Measurement Point

4.3 On-board load transient

EVM board has option of load transient test. There are 4 parallel loads connected for RAILA as shown in [Figure 4-4](#). Each load can be turned-ON/OFF independently 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) package is 2502 and maximum power dissipation 2W. so External signal duty cycle should 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 voltage is 0.88V, load step is 230A(0.88/3.8m)

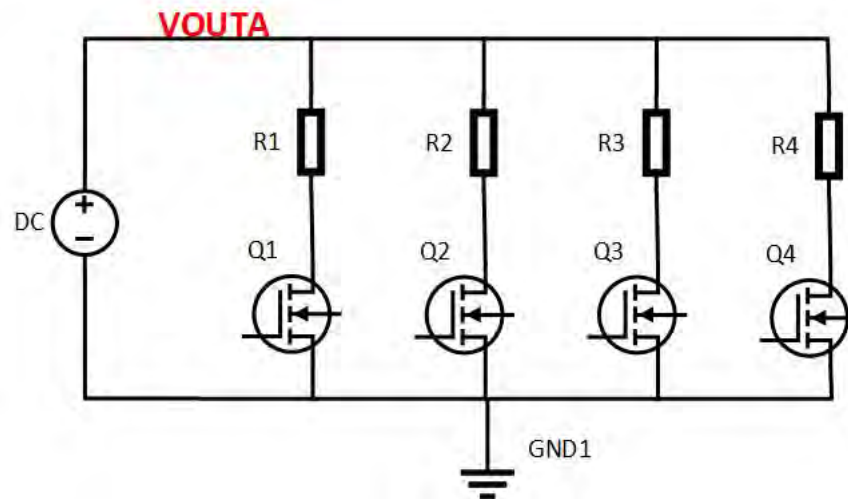


Figure 4-4. On Board Load transient

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

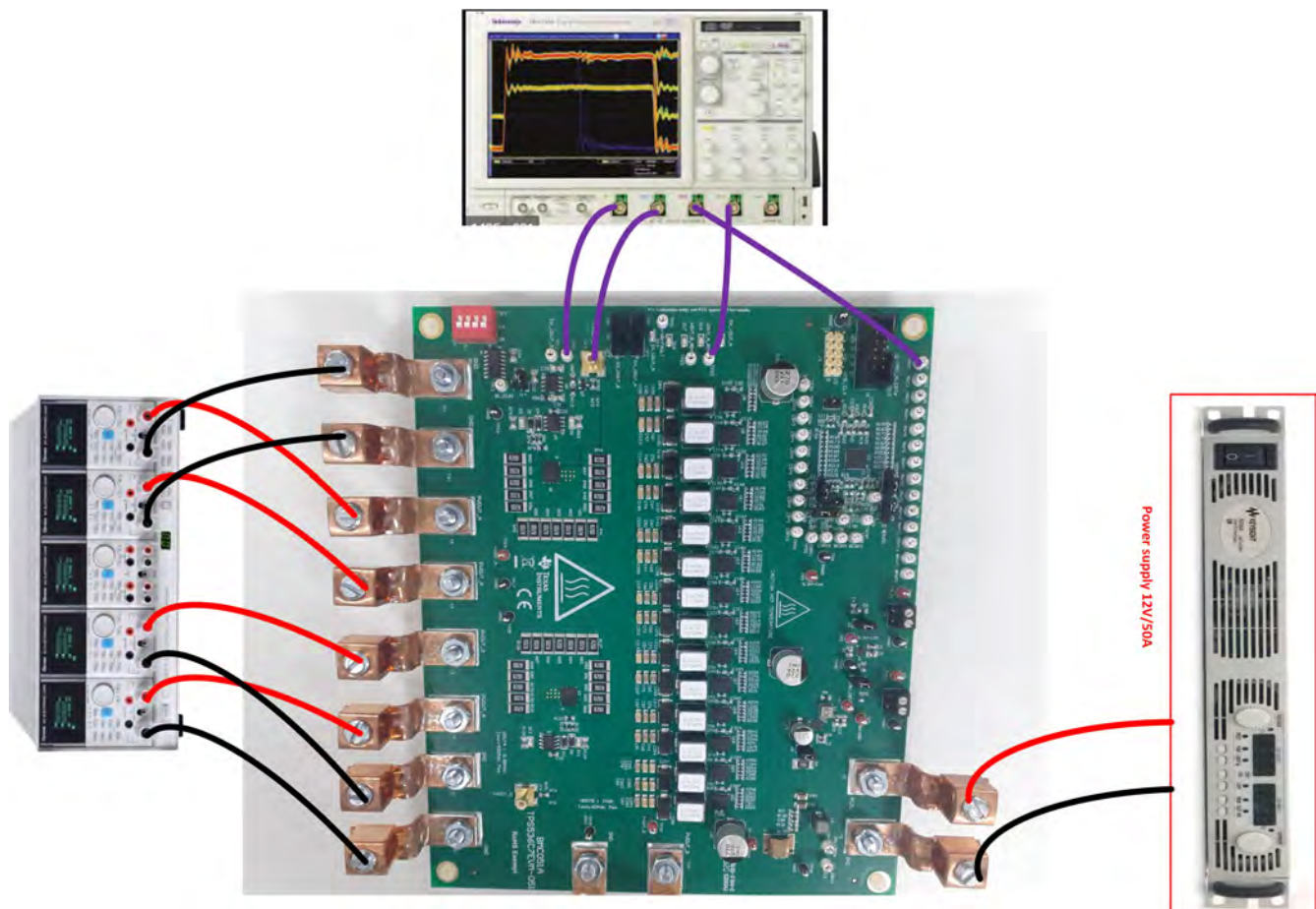


Figure 5-1. EVM Test Setup Showing the Power Supply, Load, and Oscilloscope Connections

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 μ s/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 .

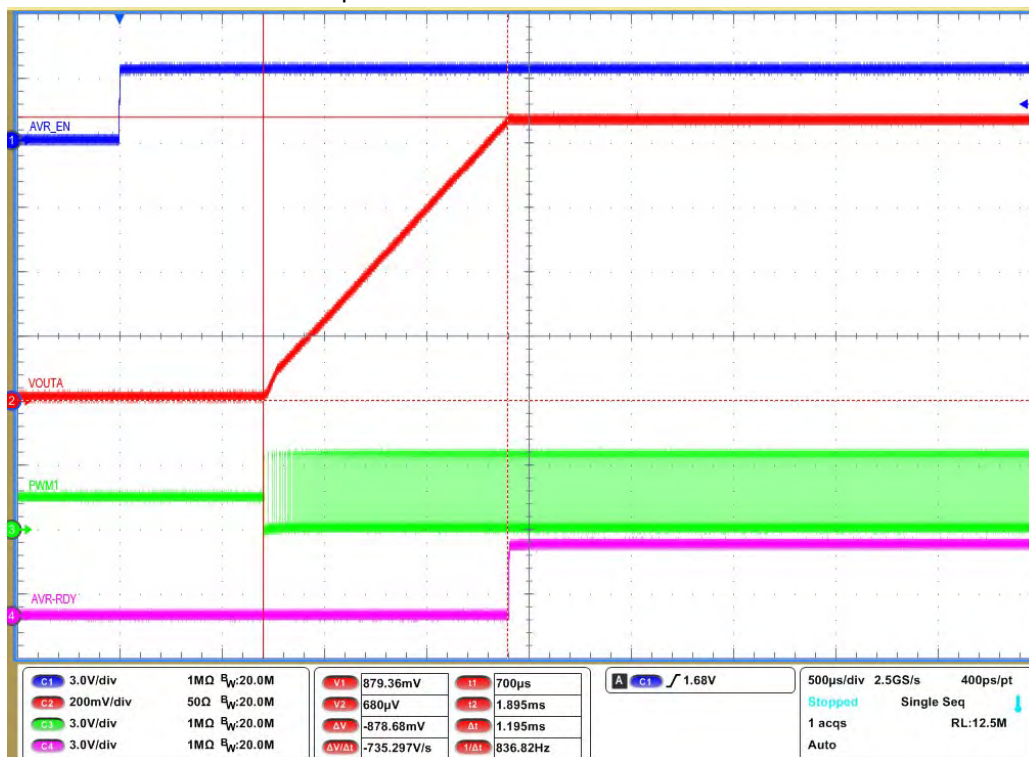


Figure 6-1. VOUTA Enable startup with TON delay=0ms

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 μ s/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 .

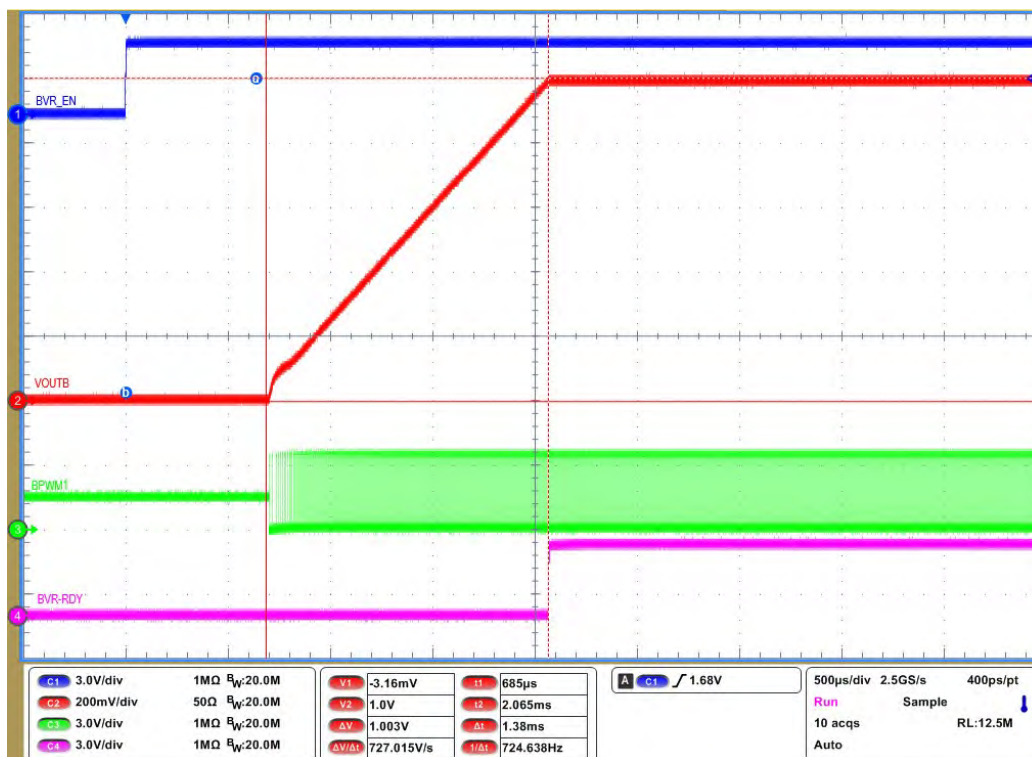


Figure 6-2. VOUTB Enable startup with TON delay=0ms

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.

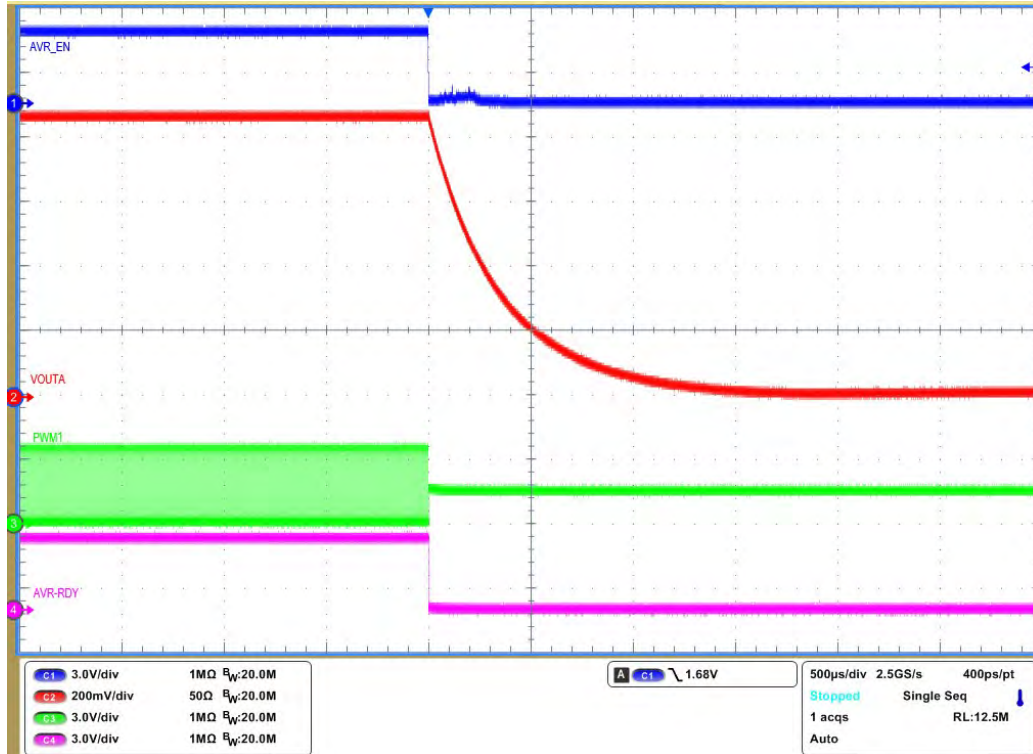


Figure 6-3. VOUTA Enable OFF, Immediate-off



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 μ s/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.

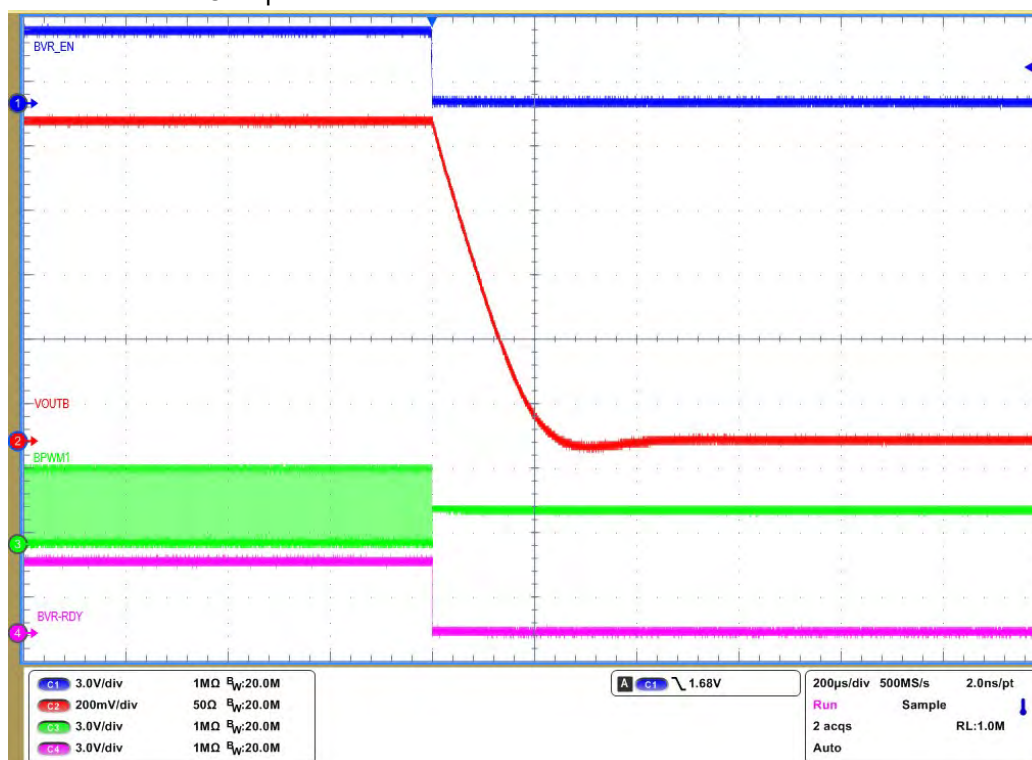


Figure 6-5. VOUTB Enable OFF, Immediate-off

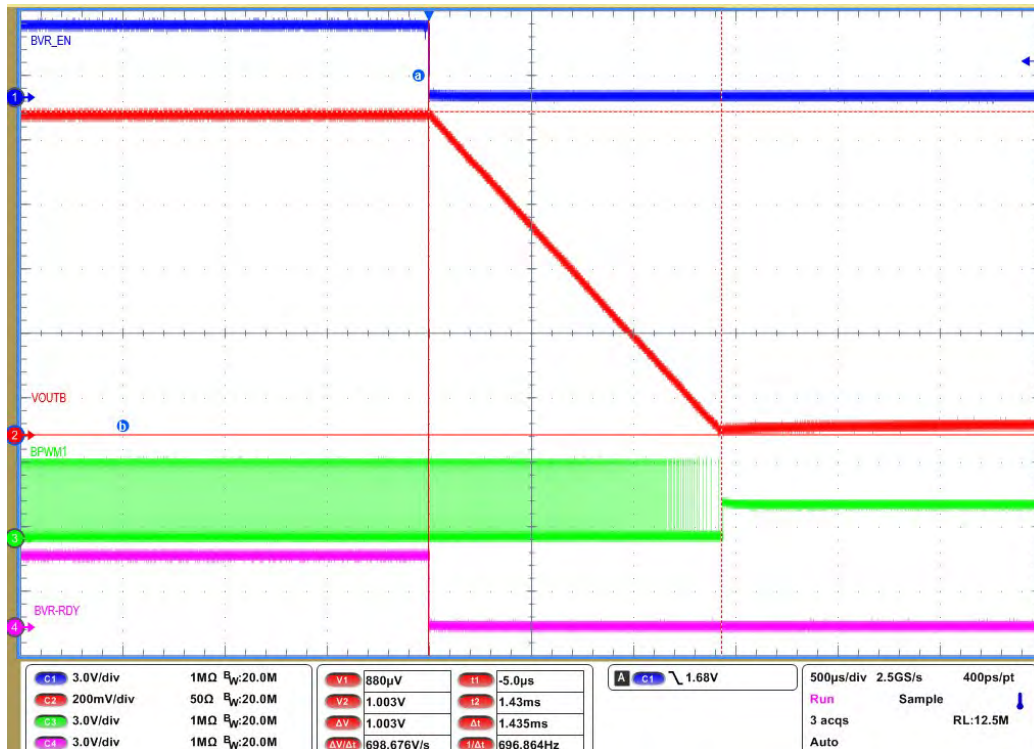


Figure 6-6. VOUTB Enable OFF Soft-off with TOFF delay=1ms

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 voltage ripple and phase interleaving.
8. Jitter can be measured with set scope in "Fast acquisition mode".

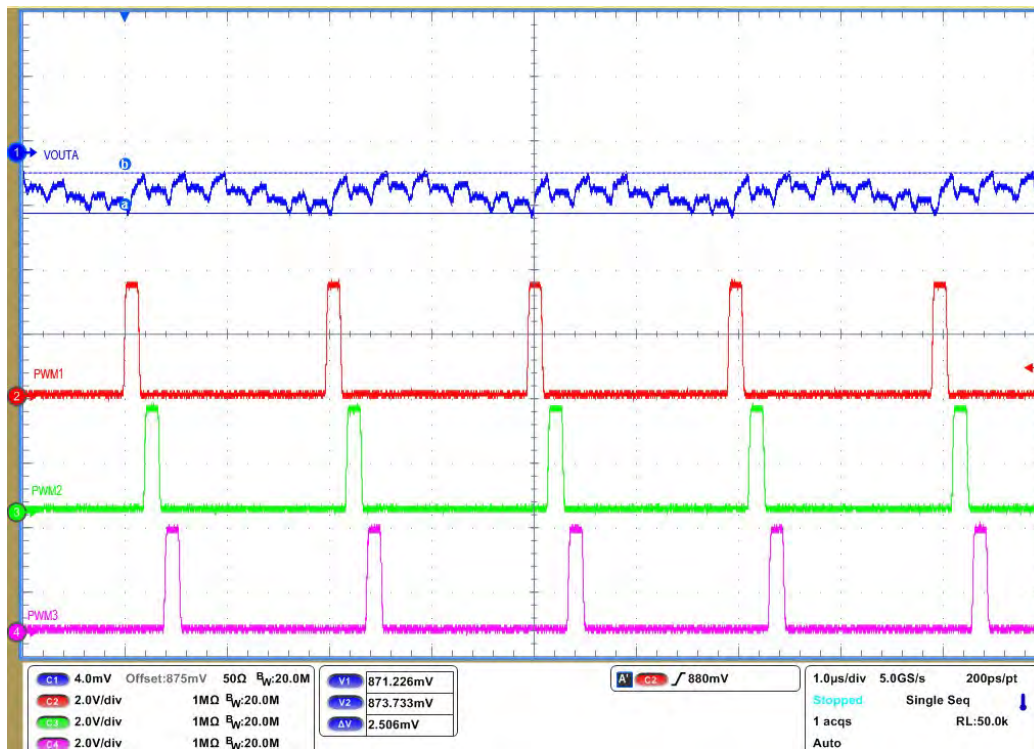


Figure 6-7. VOUTA Steady-state Output voltage Ripple

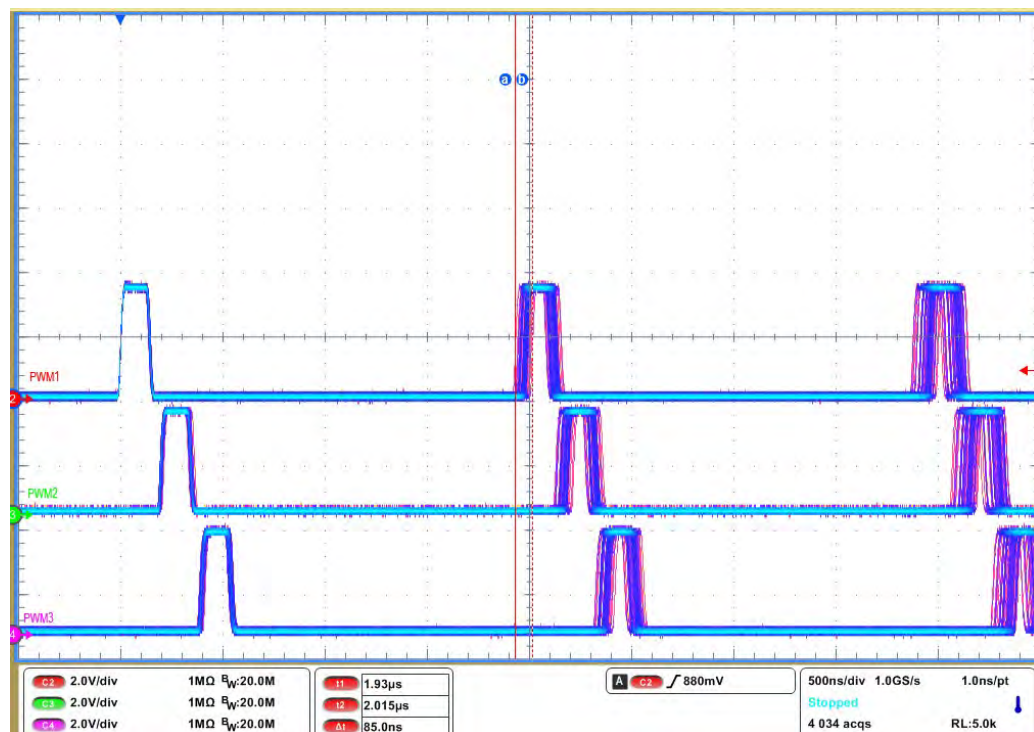


Figure 6-8. VOUTA PWM Jitter

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 μ s/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 voltage ripple and phase interleaving.
8. Jitter can be measured with set scope in "Fast acquisition mode".

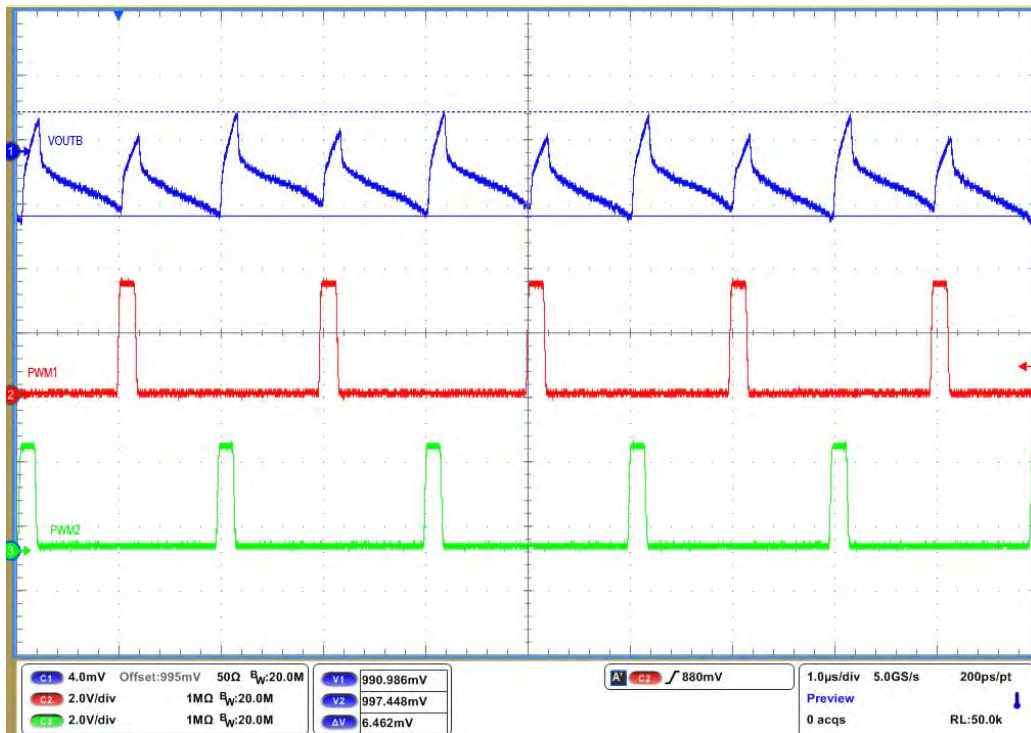


Figure 6-9. VOUTB Steady-state Output voltage Ripple

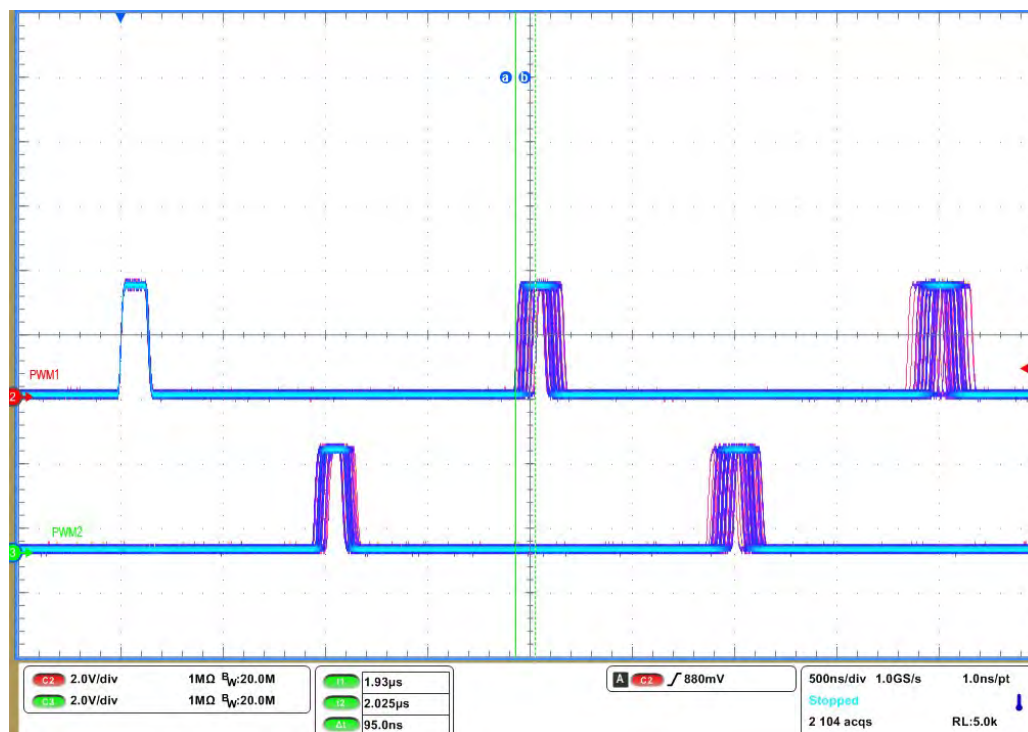


Figure 6-10. VOUTB PWM jitter

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 generator 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. Measure output current at one resistor bank. so connect differential probe parallel 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.

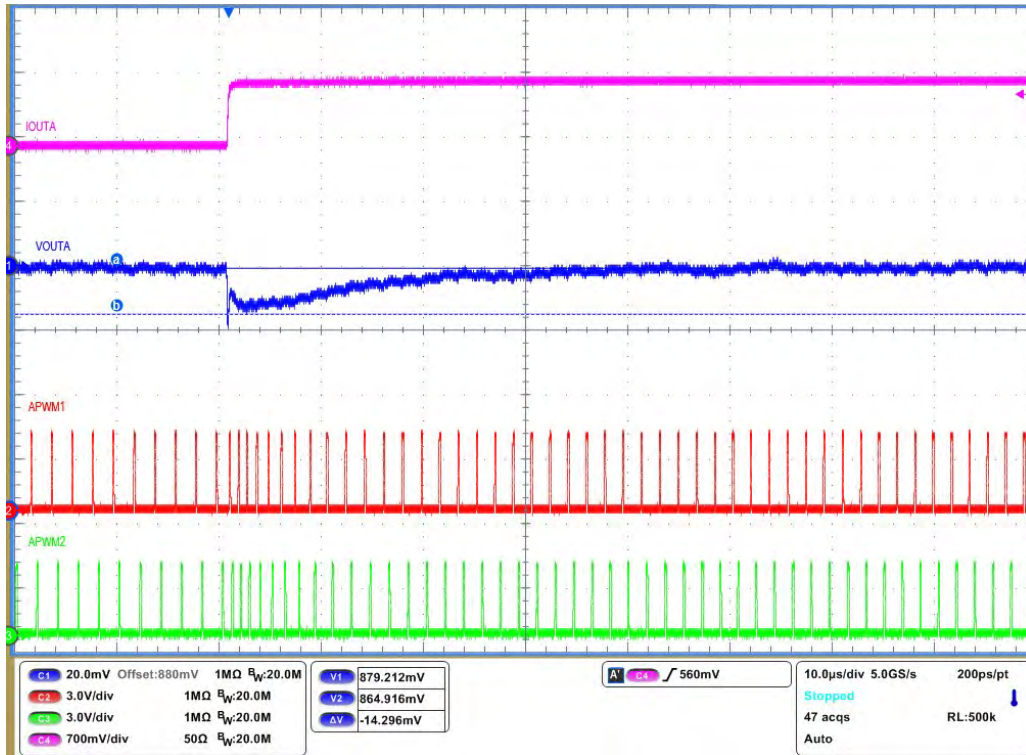


Figure 6-11. VOUTA Load transient, Load step=50A to 275A

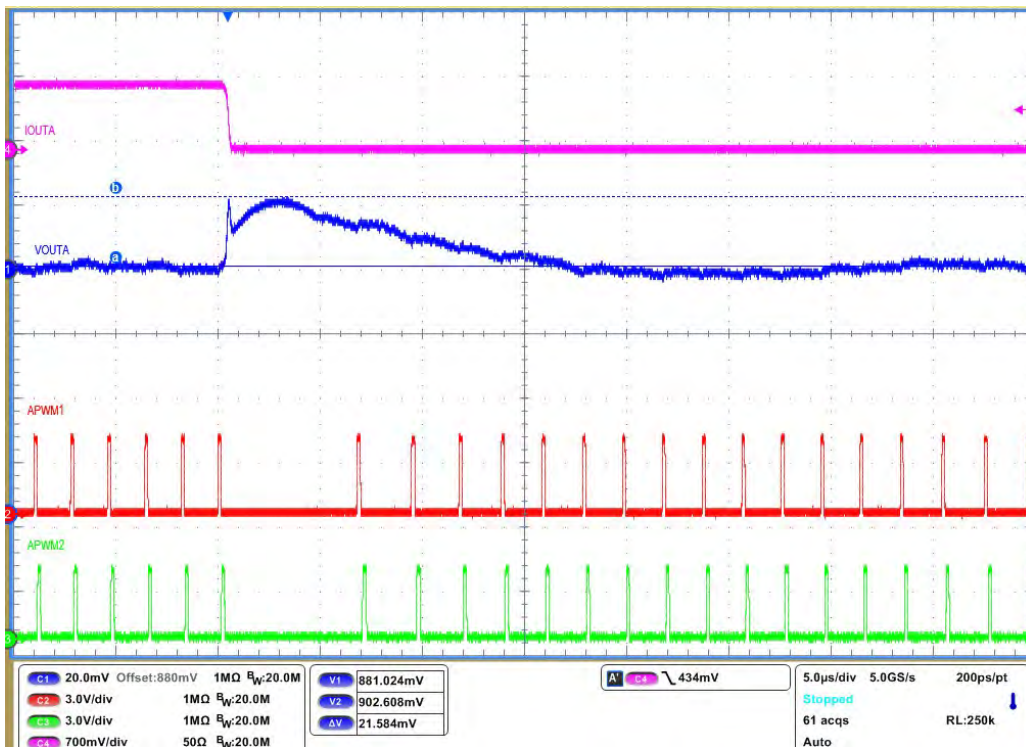
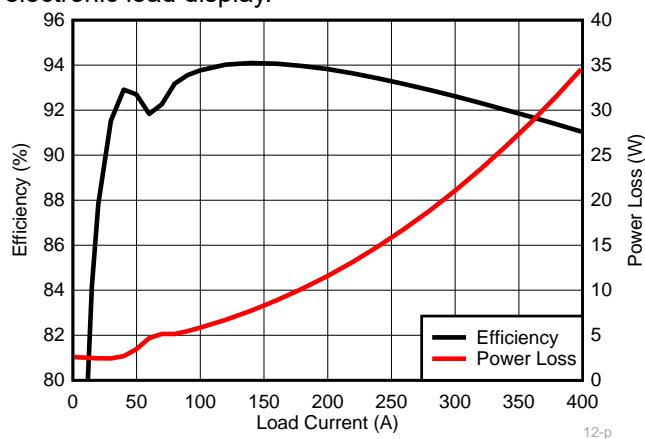


Figure 6-12. VOUTA Load transient, Load release=275A to 50A

6.5 Efficiency Plot

RAILA is configured 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

$V_{IN} = 12\text{ V}$, $V_{OUT} = 880\text{ mV}$, $f_{SW} = 500\text{ kHz}$, $L_{OUT} = 150\text{ nH}$, 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 $10\ \Omega$ or $20\ \Omega$). 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.

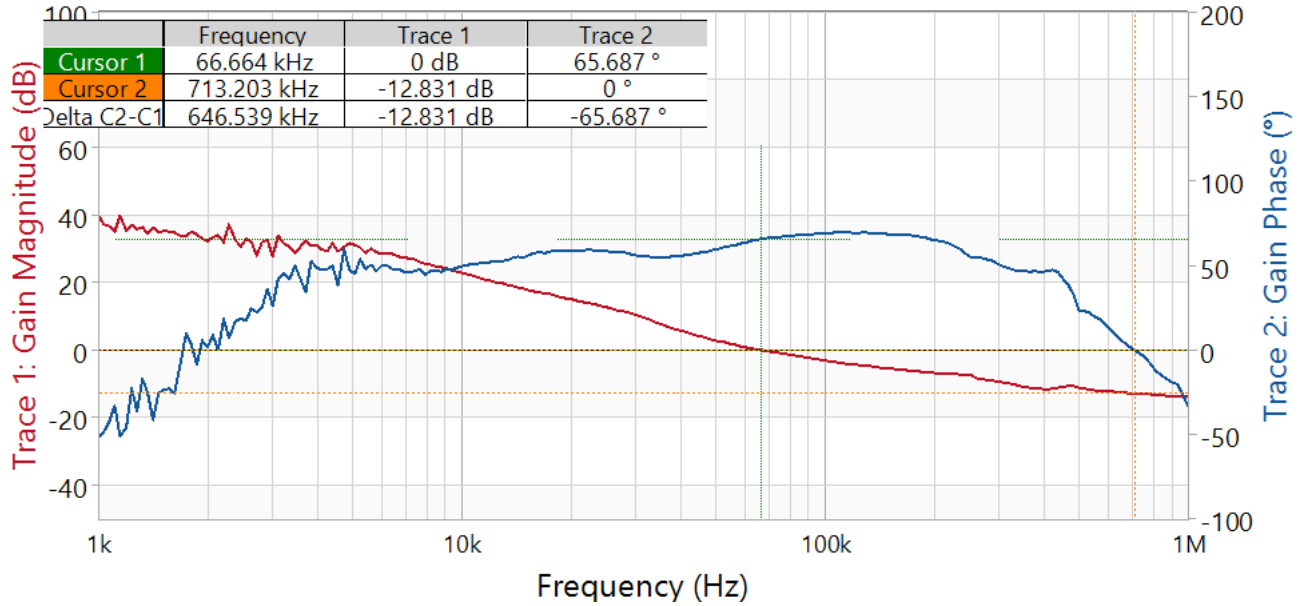


Figure 6-14. VOUTA Bode plot, Load current=50A

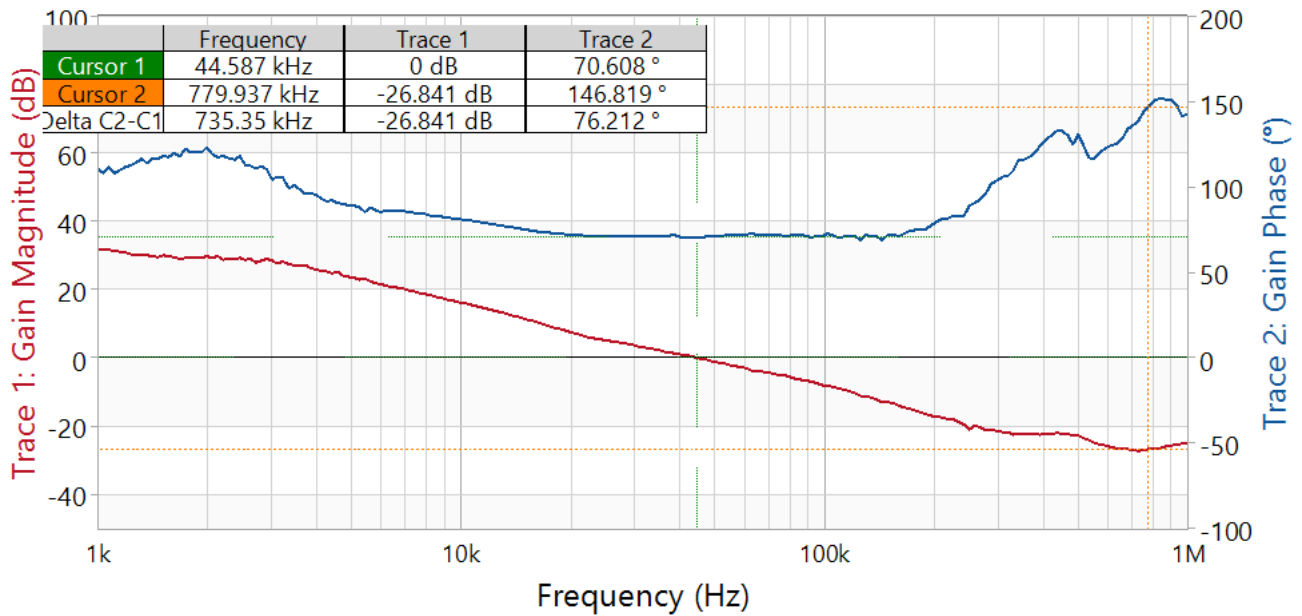


Figure 6-15. VOUTA Bode plot, Load current=20A

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](#)

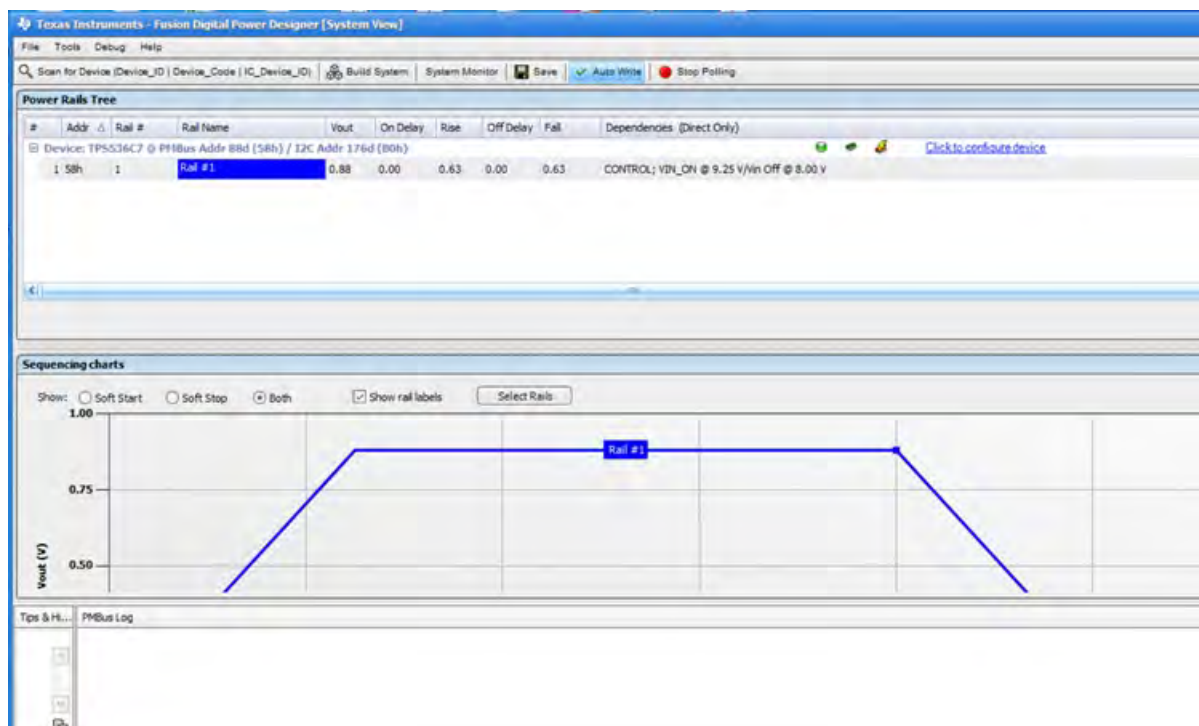


Figure 7-2. System View for N+0 phase configuration

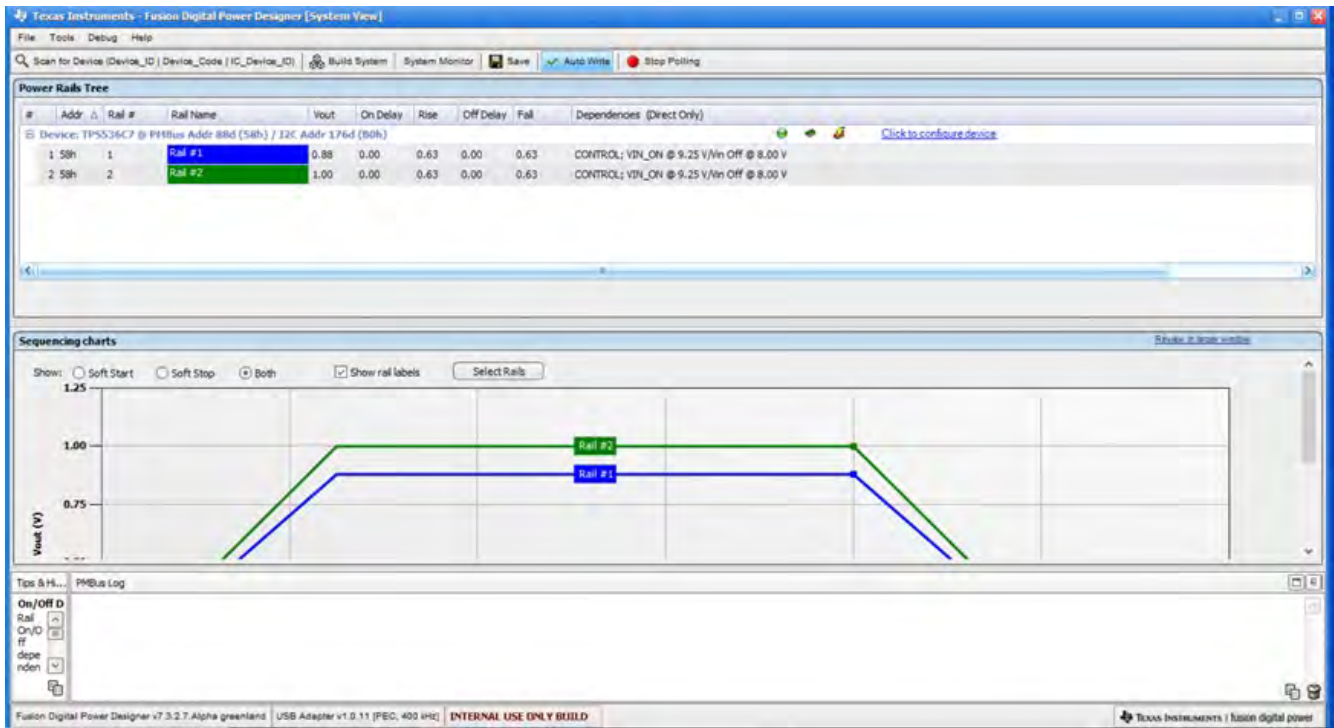


Figure 7-3. System View for N+M phase configuration

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.

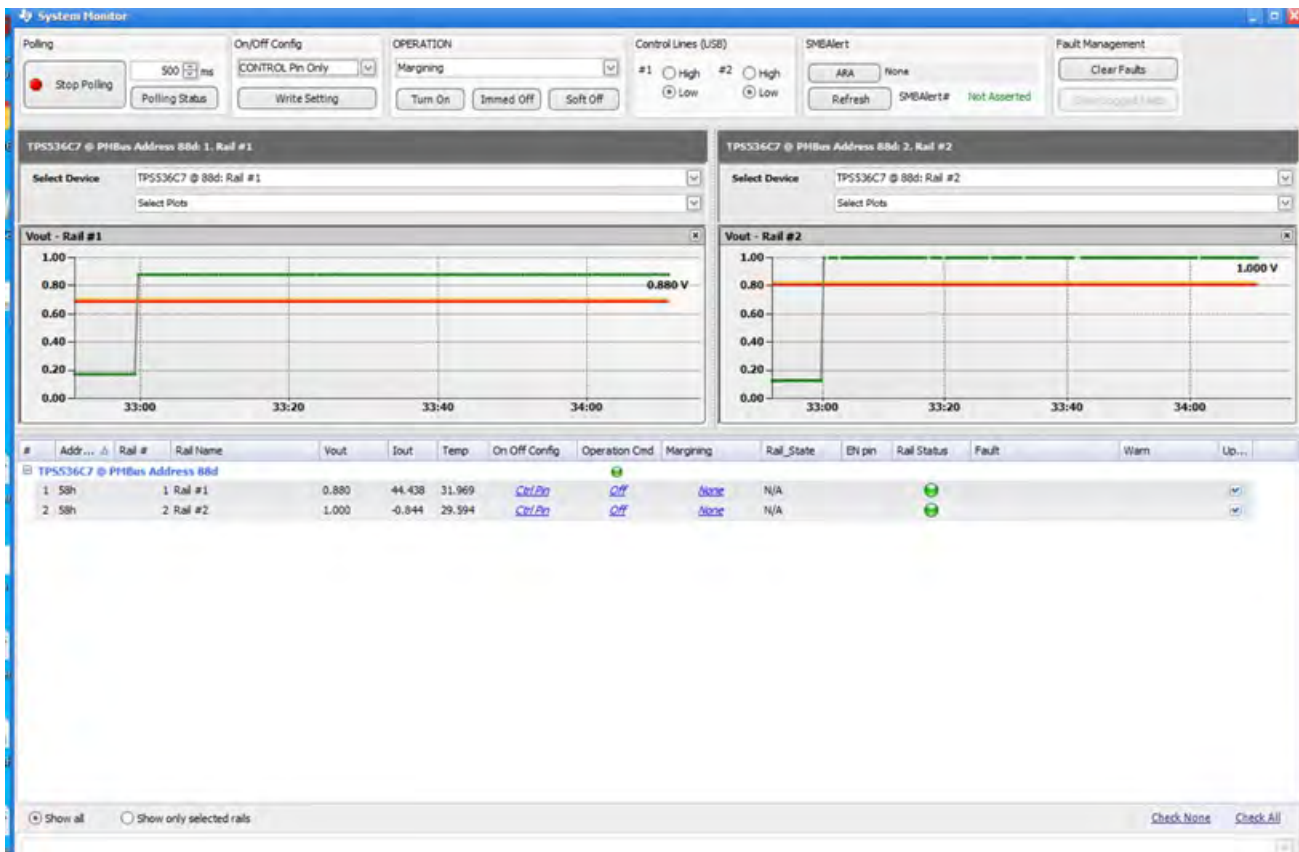


Figure 7-4. System Monitor for N+M phase configuration

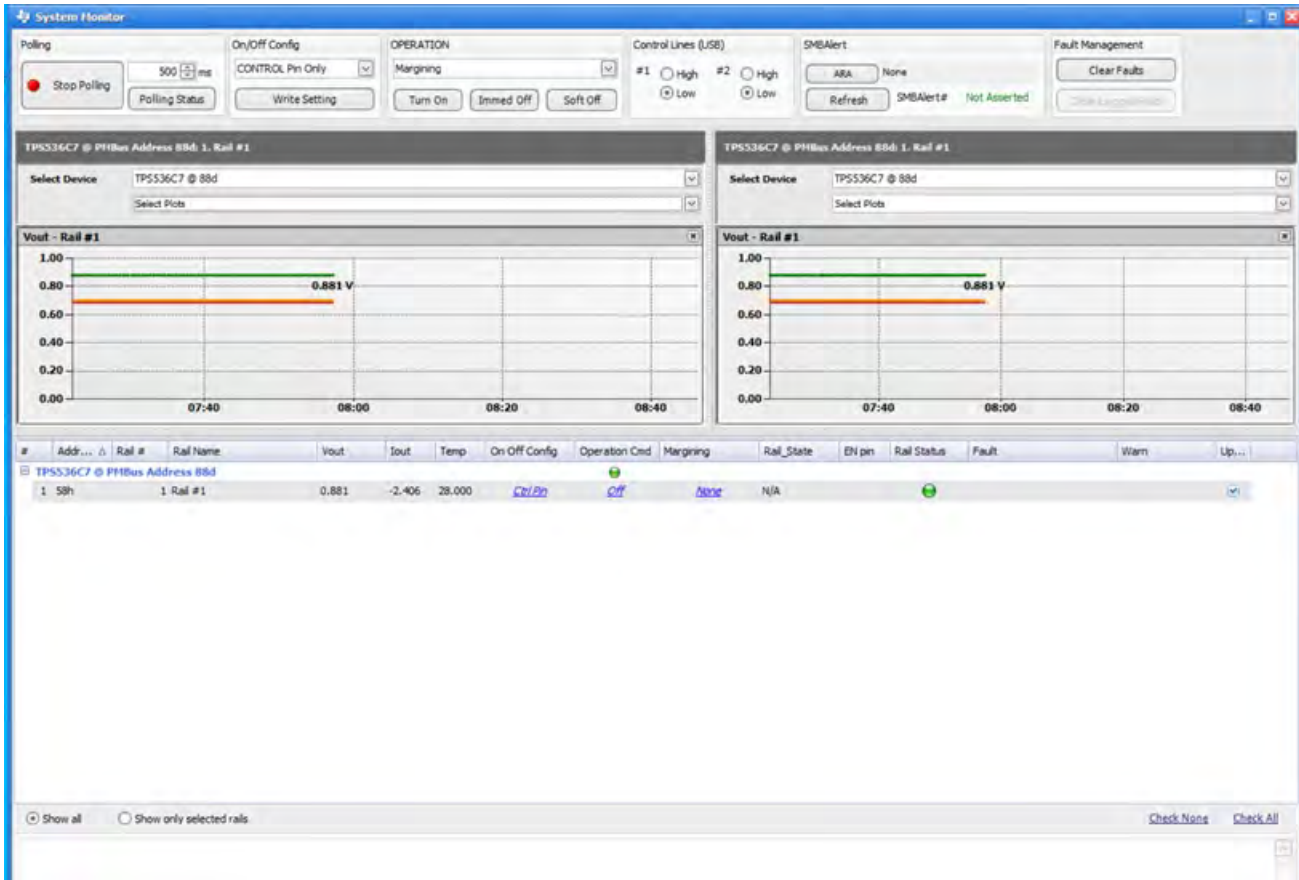


Figure 7-5. System Monitor for N+0 phase configuration

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 these parameters on the other Rail, simply change options in the drop-down menu on the top-right corner.

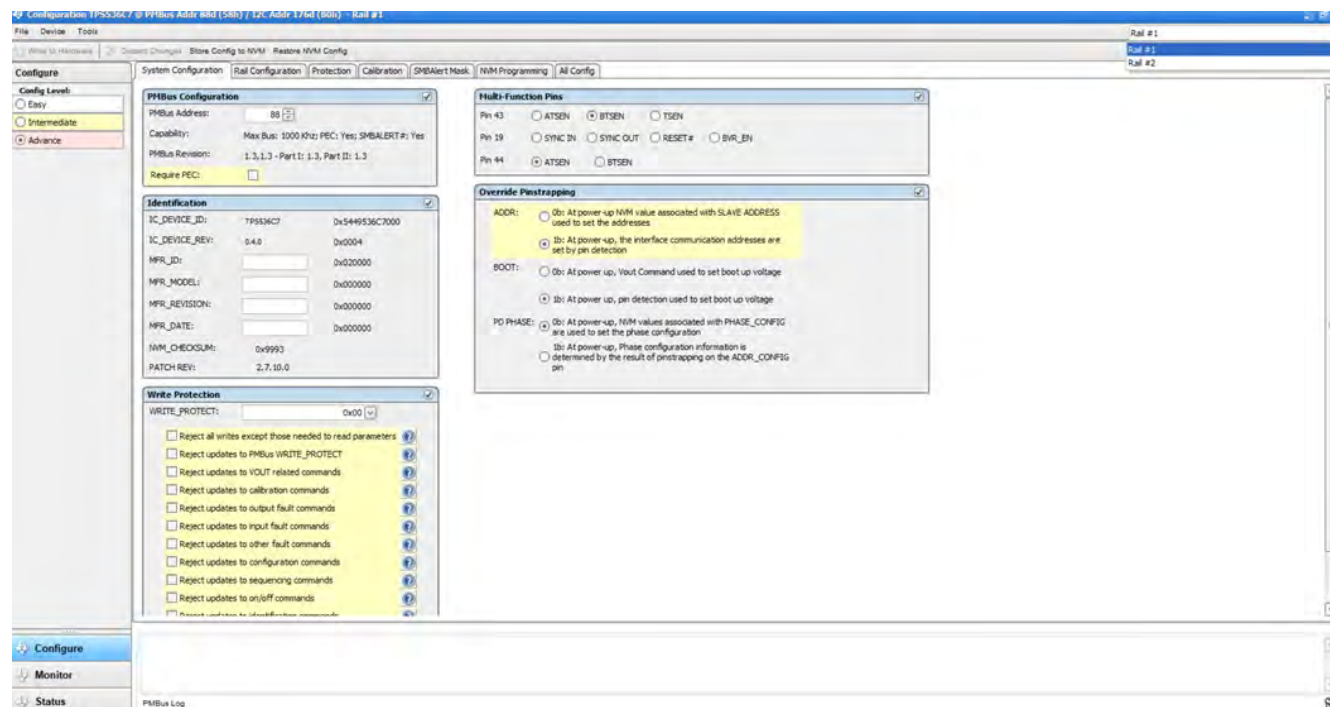


Figure 7-6. General System Configure Tab

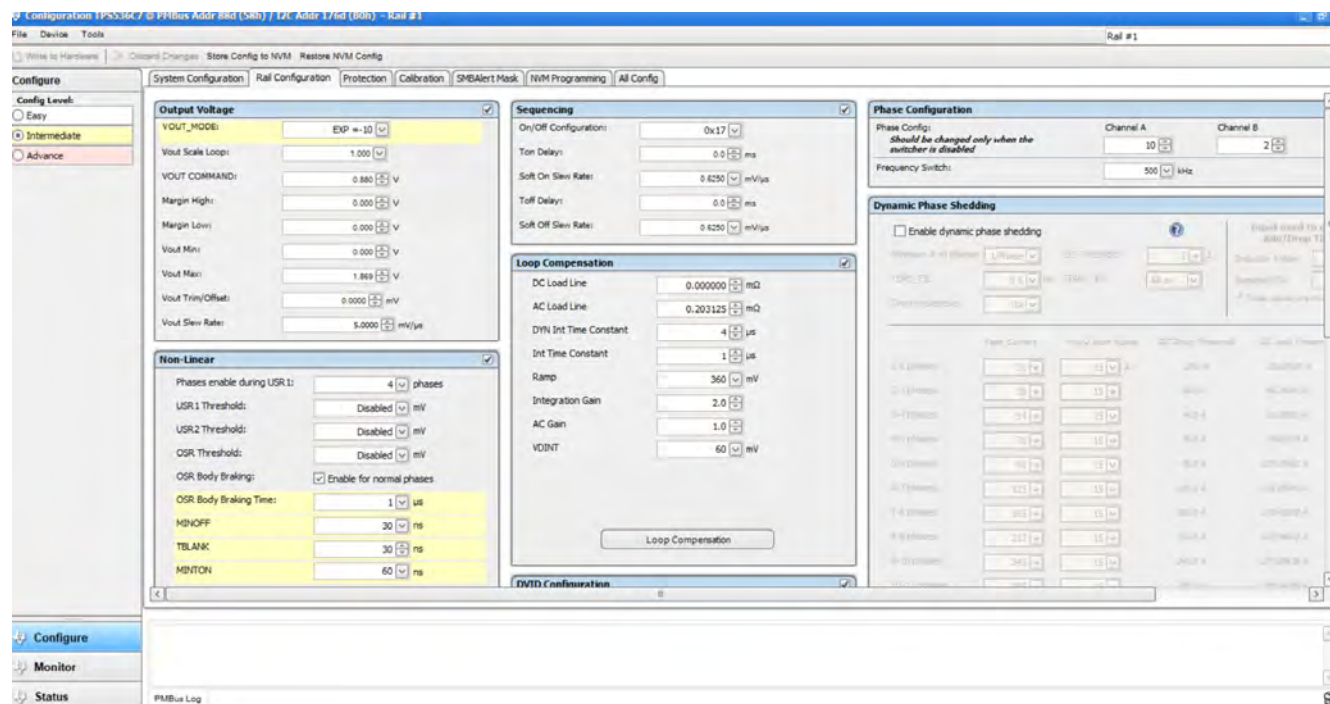


Figure 7-7. Rail Configuration Tab

Phase configuration: It can be selected by clicking Advance 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.

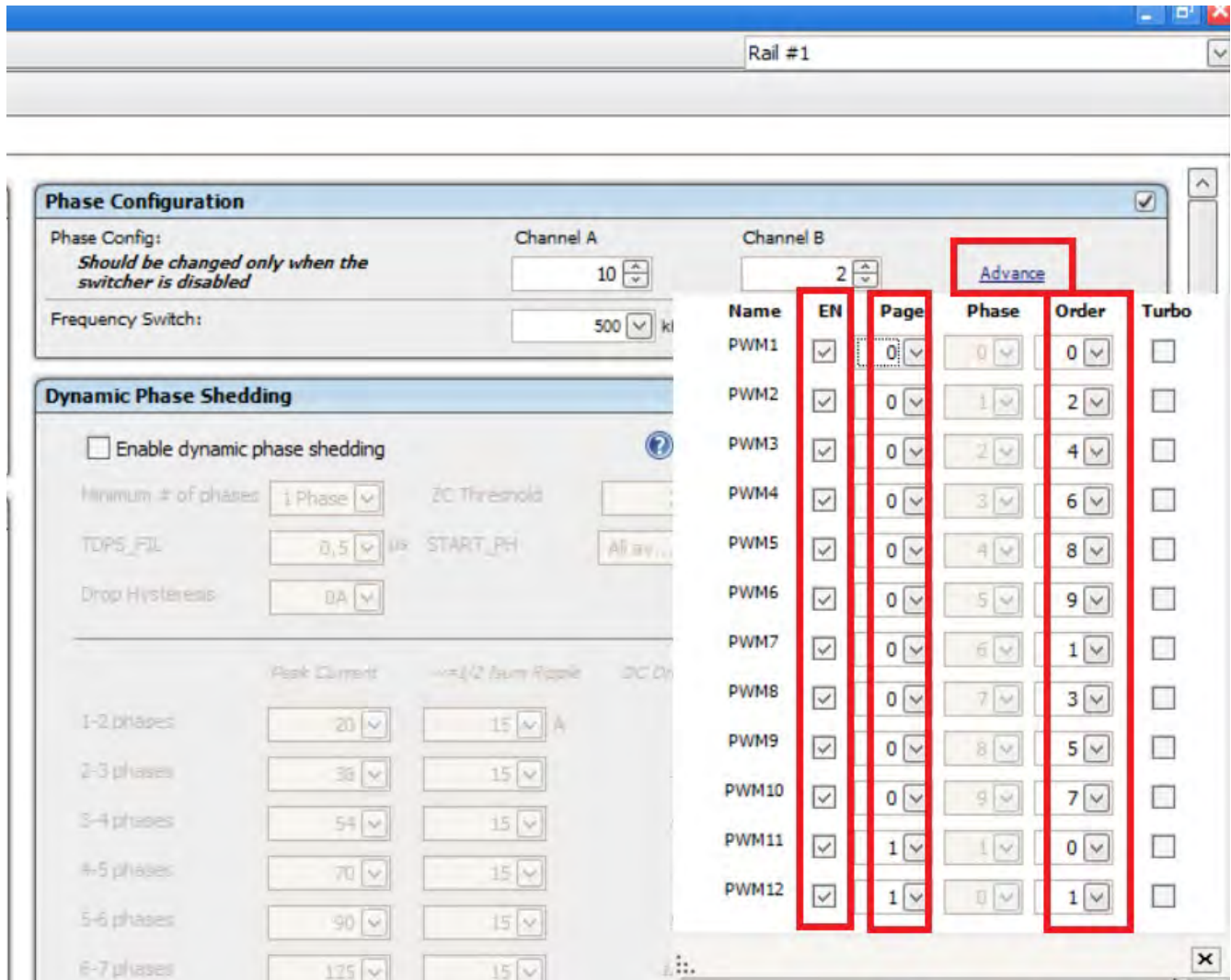


Figure 7-8. Phase N+M Configuration

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

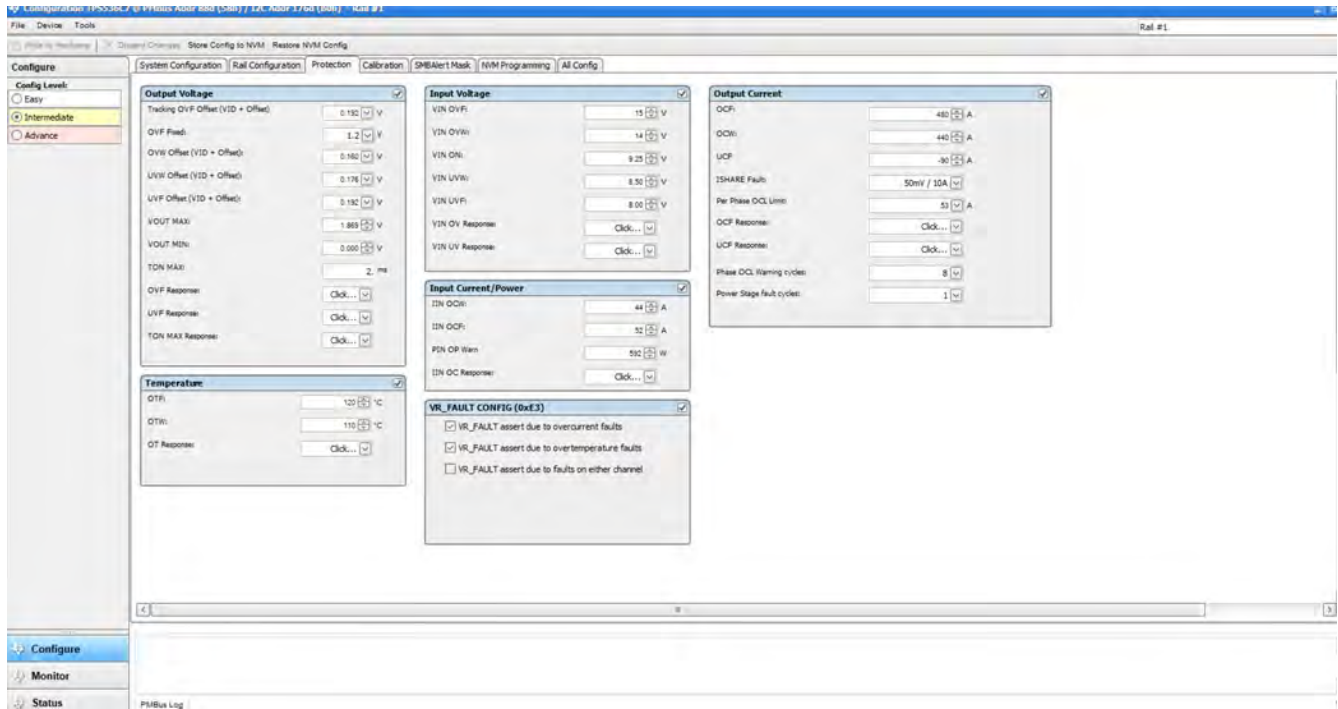


Figure 7-9. System Protection parameters config

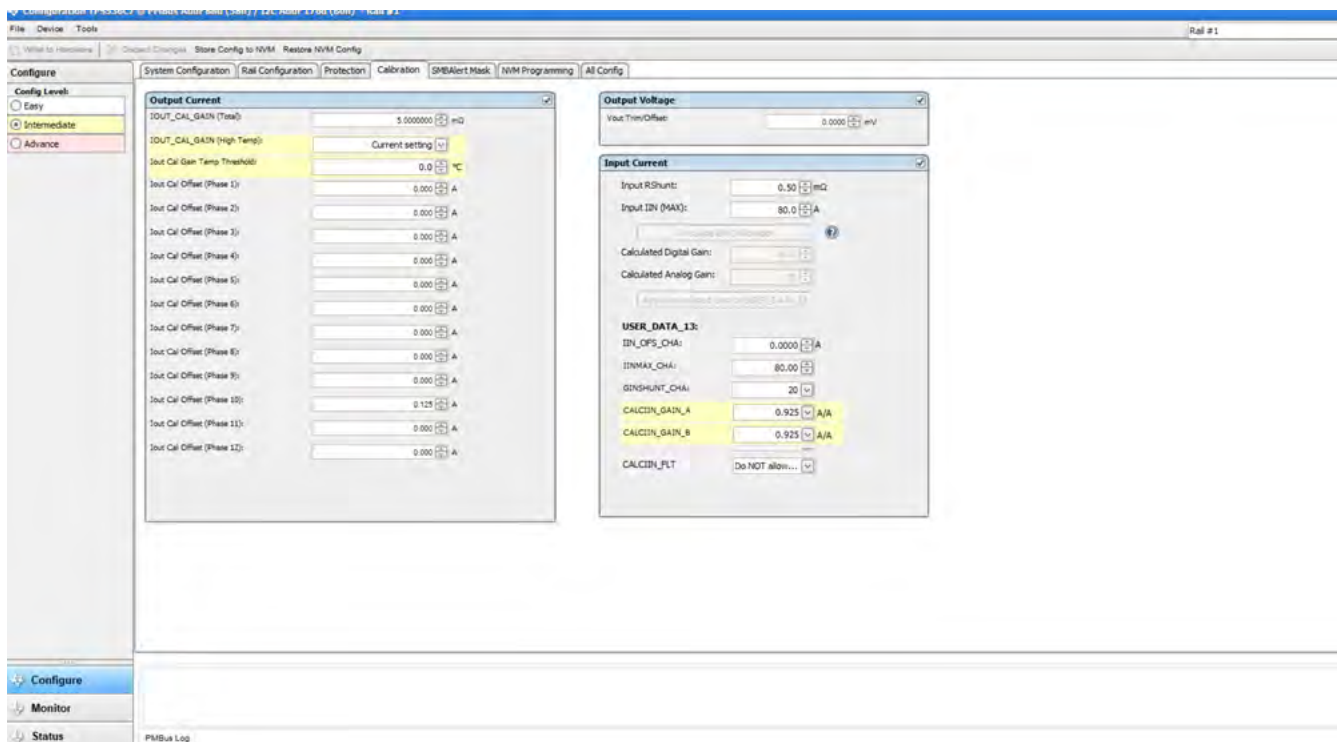


Figure 7-10. Calibration tab

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.

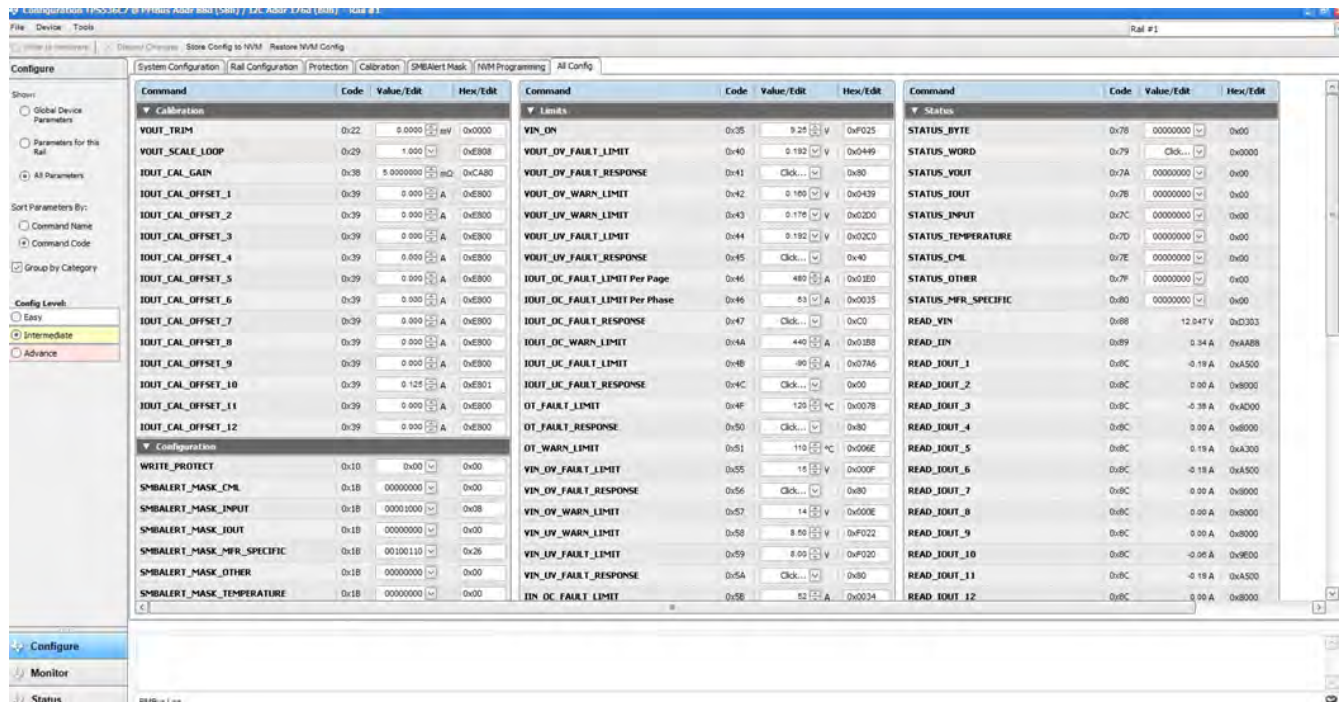


Figure 7-11. All Configuration tab

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 its 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.

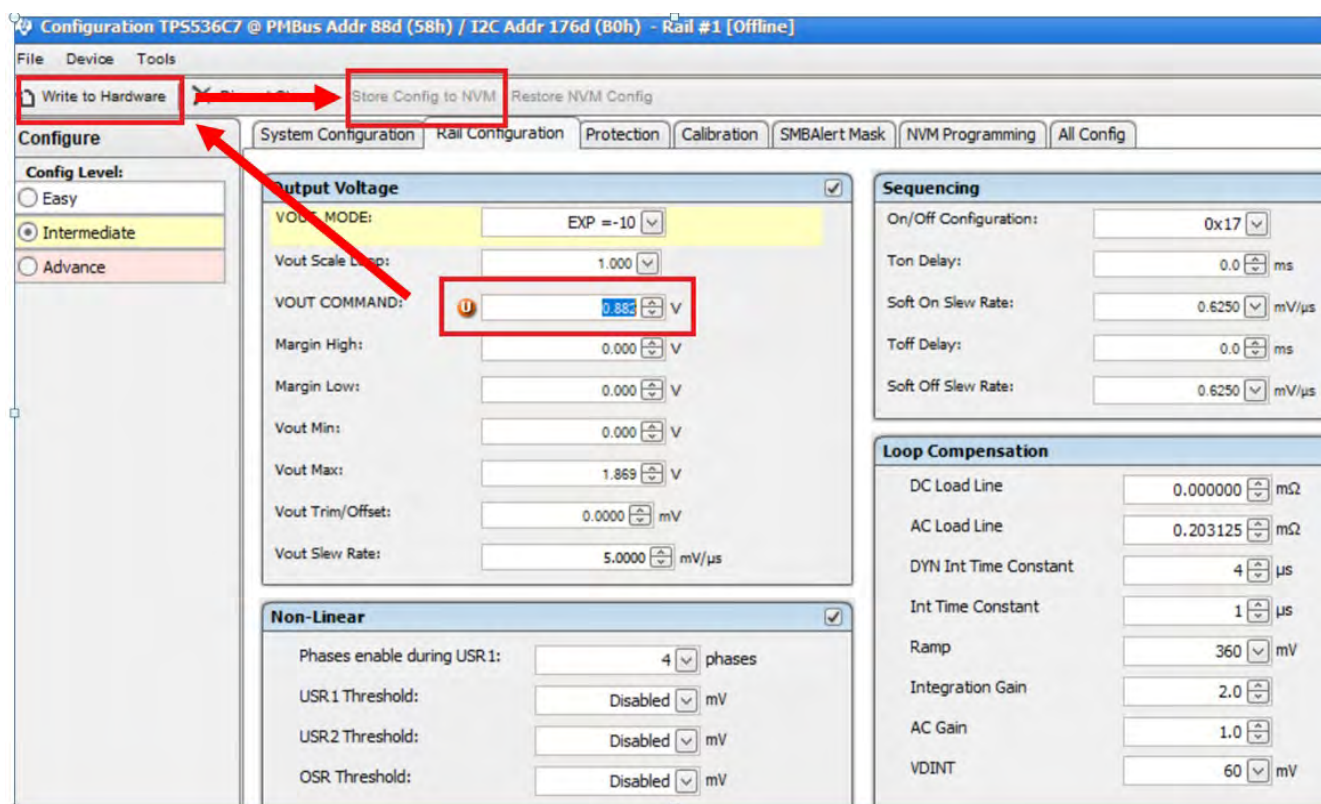


Figure 7-12. Static Configure Pop-Up

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

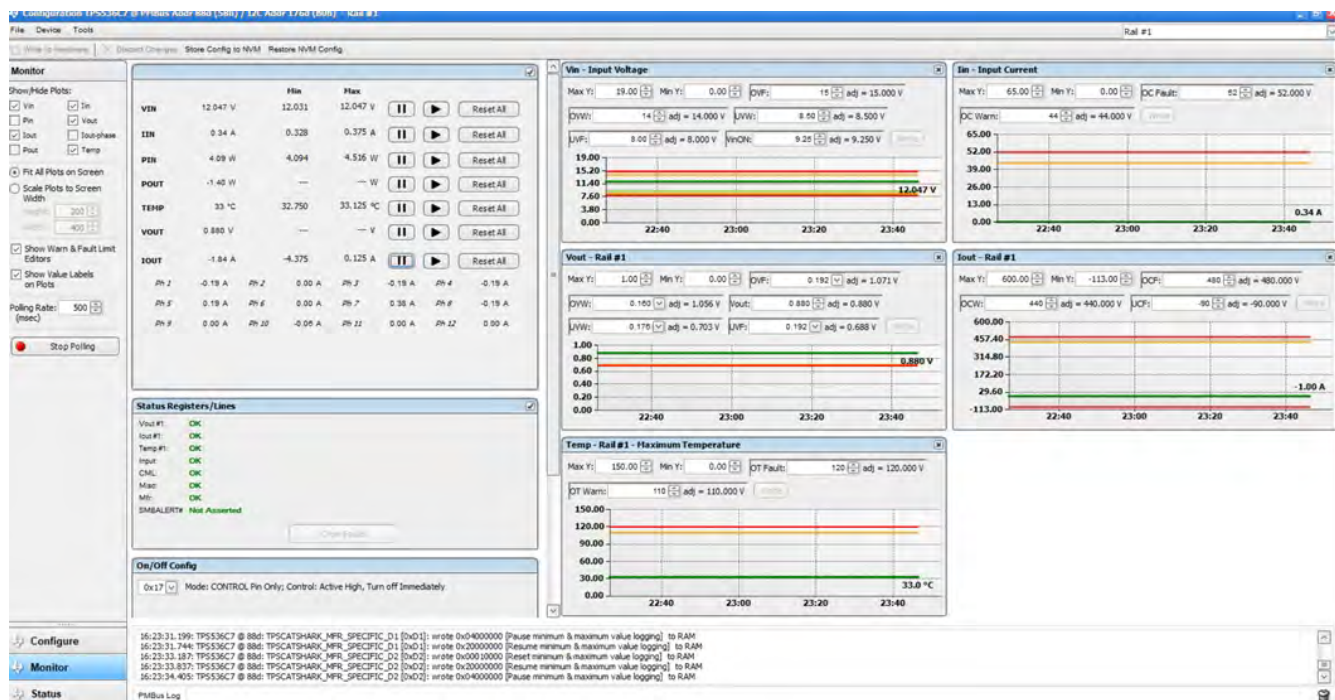


Figure 7-13. Monitor tab

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](#).

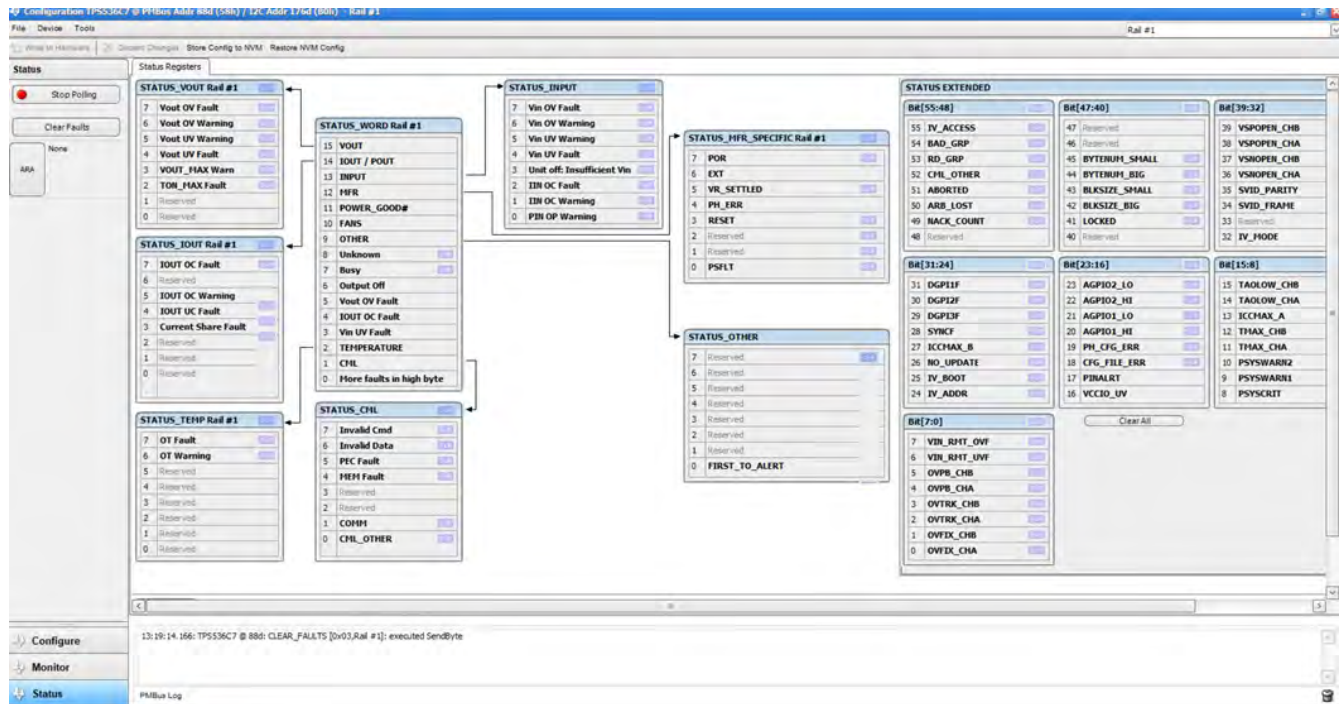


Figure 7-14. Status tab

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 .

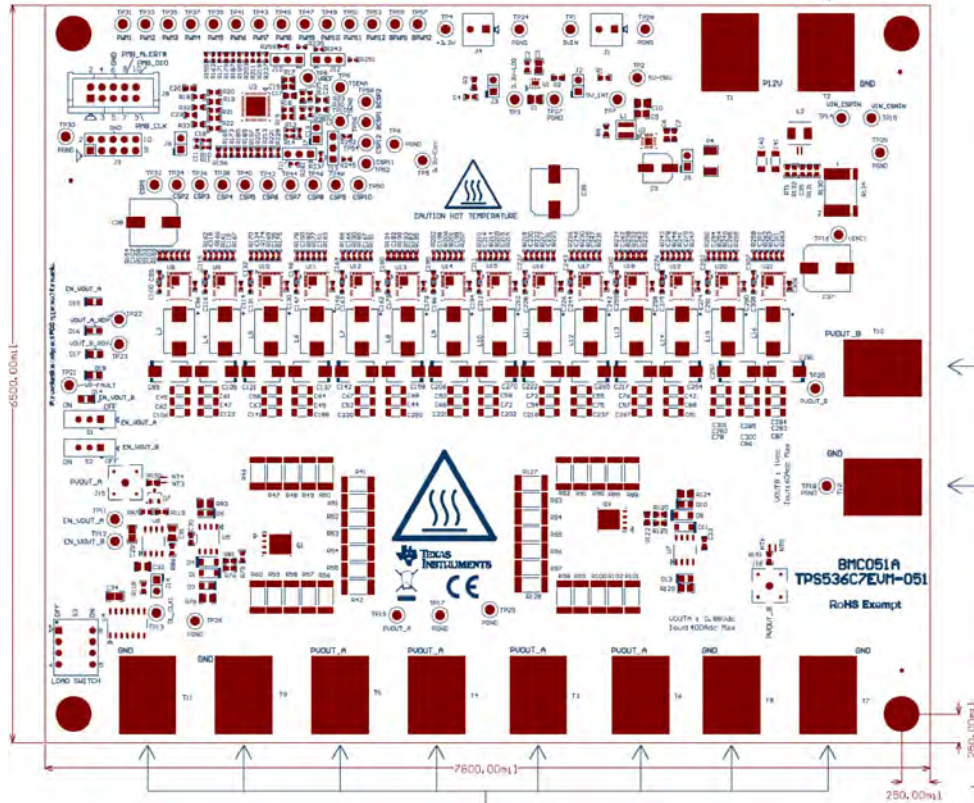


Figure 8-1. TPS536C7EVM-051 Assembly Drawing Top View

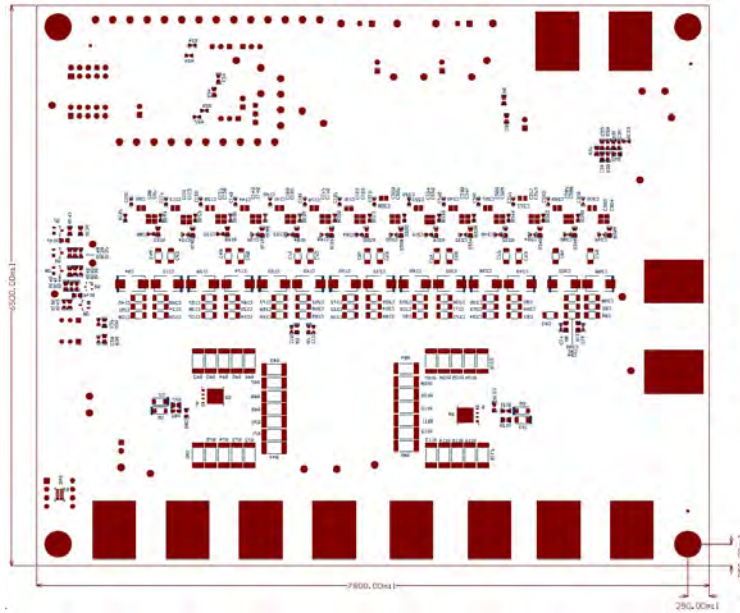


Figure 8-2. TPS536C7EVM-051 Assembly Drawing Bottom View

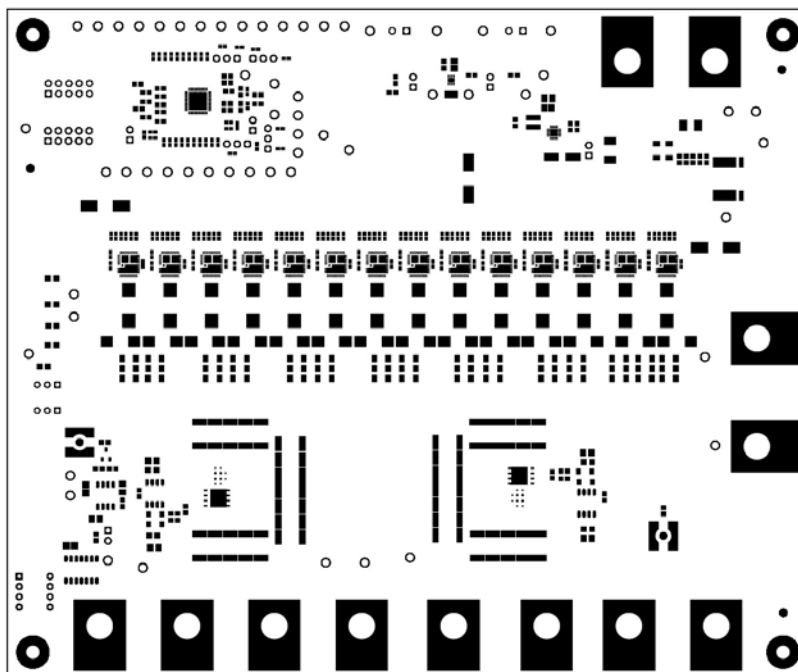


Figure 8-3. TPS536C7EVM-051 PCB Top Solder

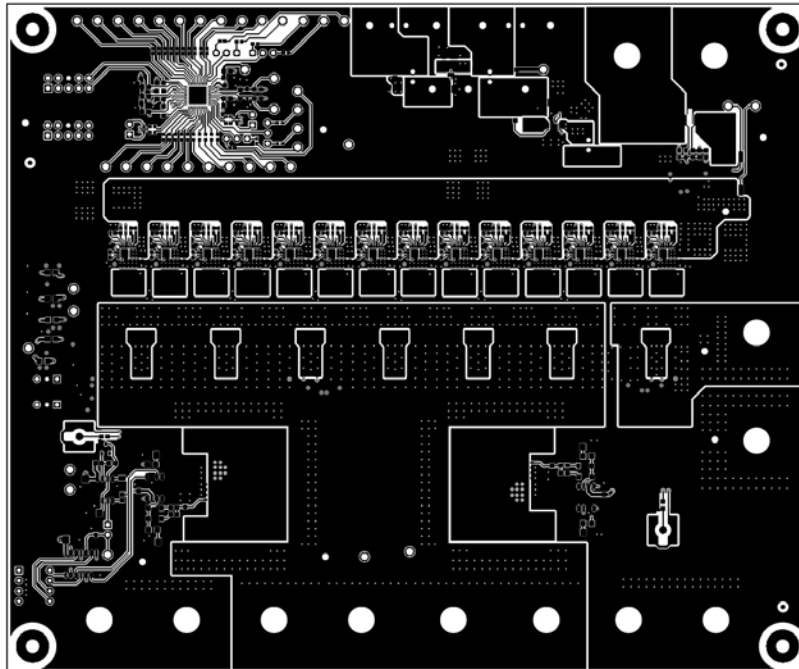


Figure 8-4. TPS536C7EVM-051 PCB Top layer

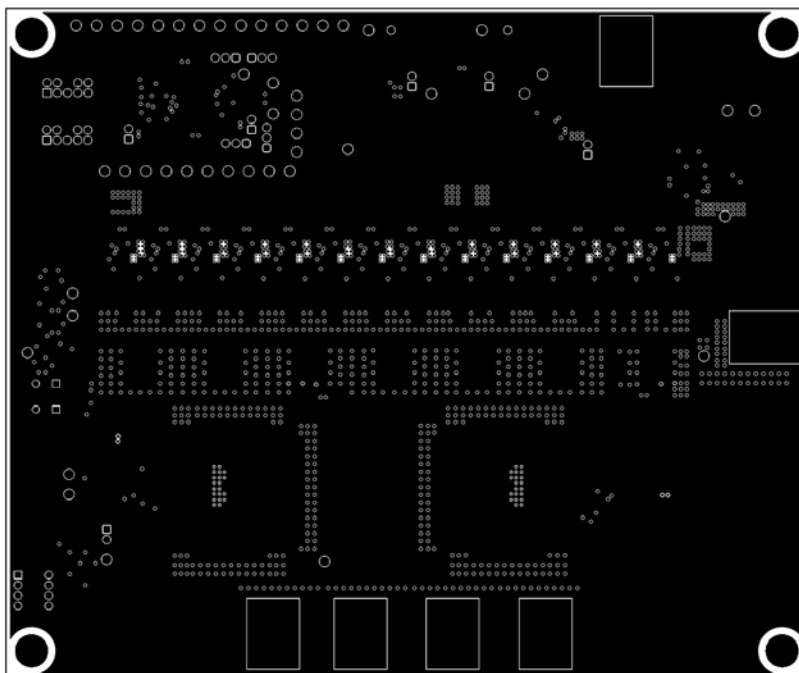


Figure 8-5. TPS536C7EVM-051 PCB Layer2-GND

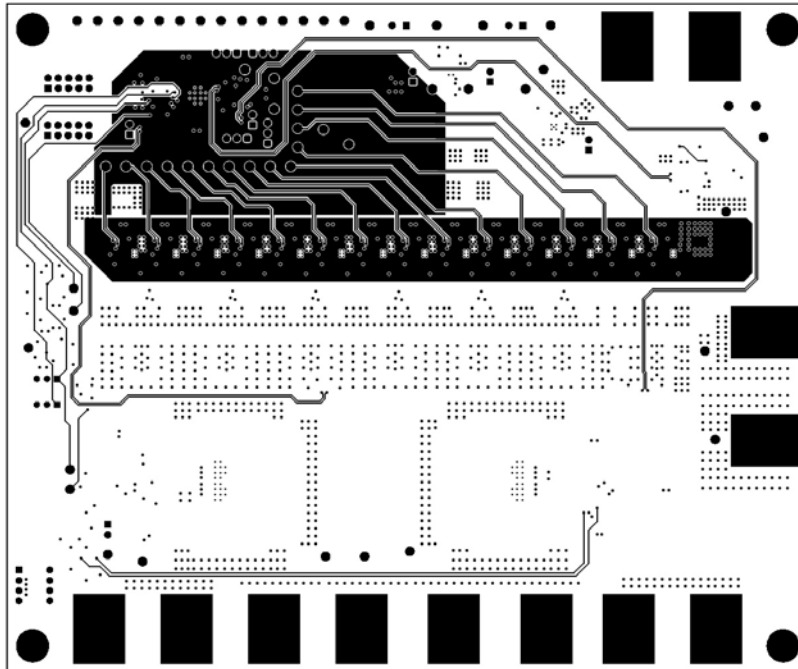


Figure 8-6. TPS536C7EVM-051 PCB Layer03-Signal

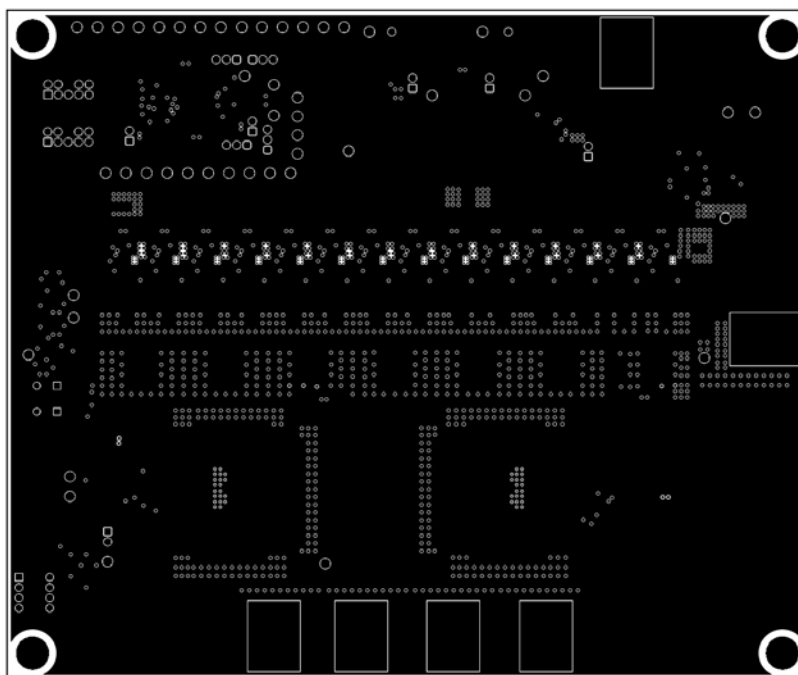


Figure 8-7. TPS536C7EVM-051 PCB Layer04-GND

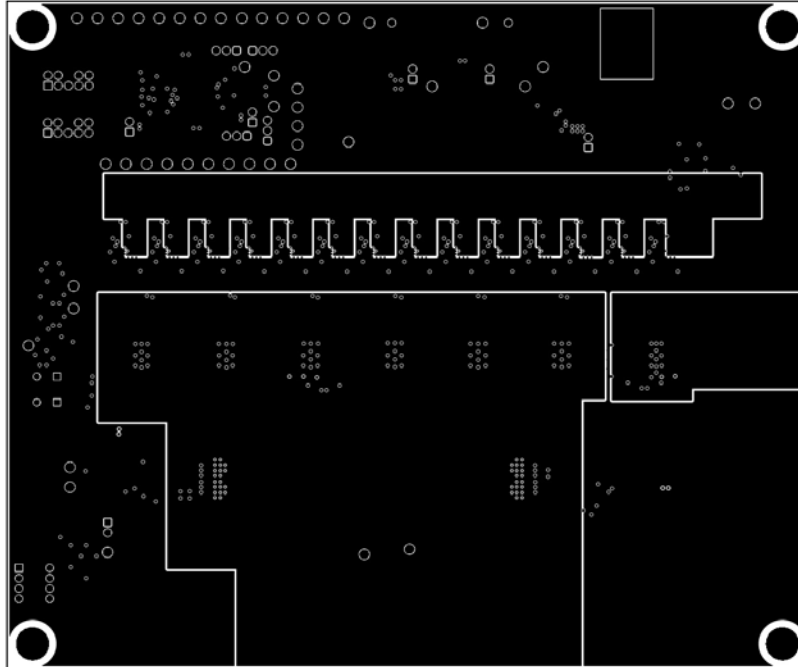


Figure 8-8. TPS536C7EVM-051 PCB Layer05-Power

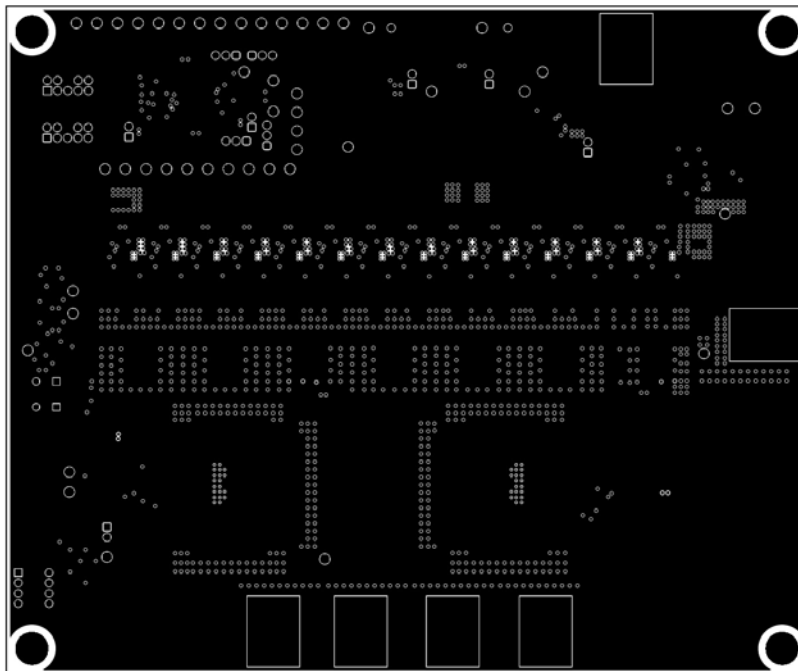


Figure 8-9. TPS536C7EVM-051 PCB Layer06-GND

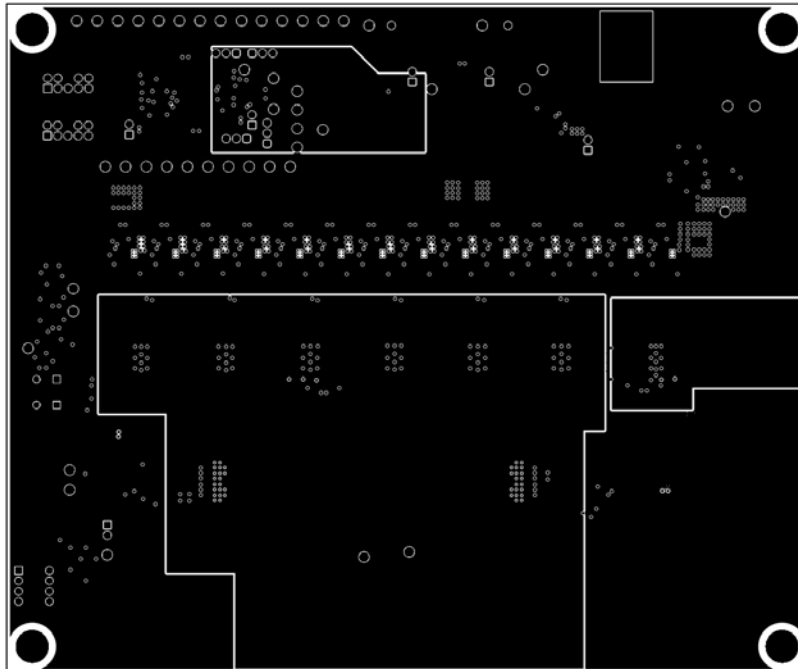


Figure 8-10. TPS536C7EVM-051 PCB Layer07-Power

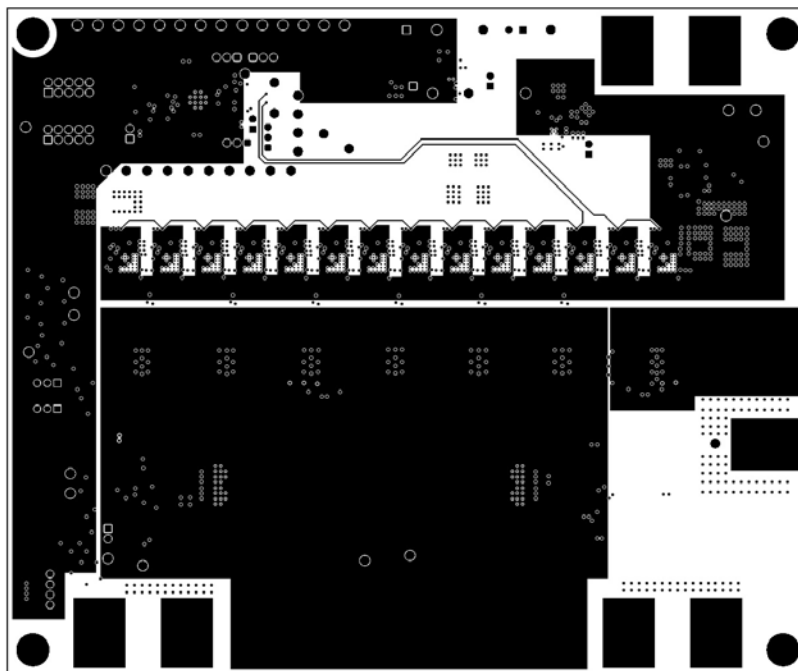


Figure 8-11. TPS536C7EVM-051 PCB Layer08-Power

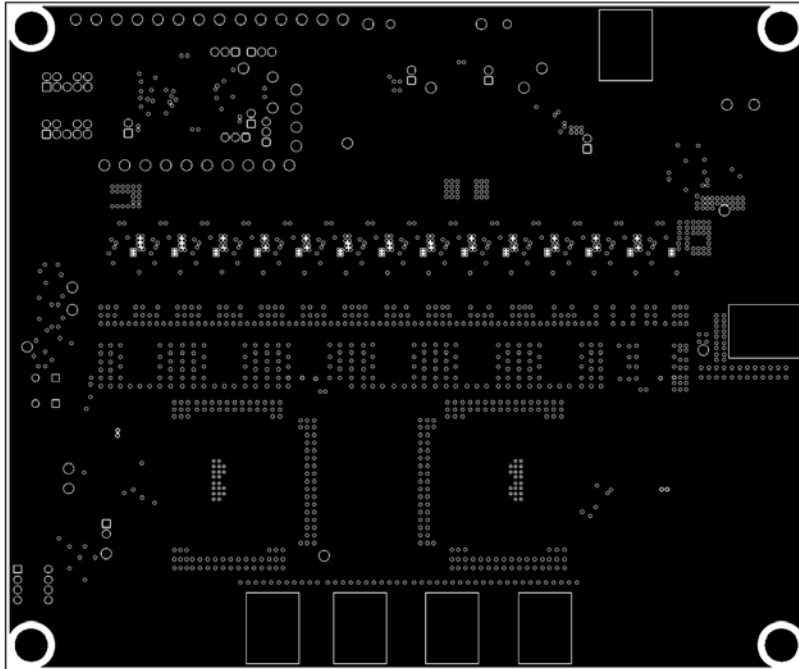


Figure 8-12. TPS536C7EVM-051 PCB Layer09-GND

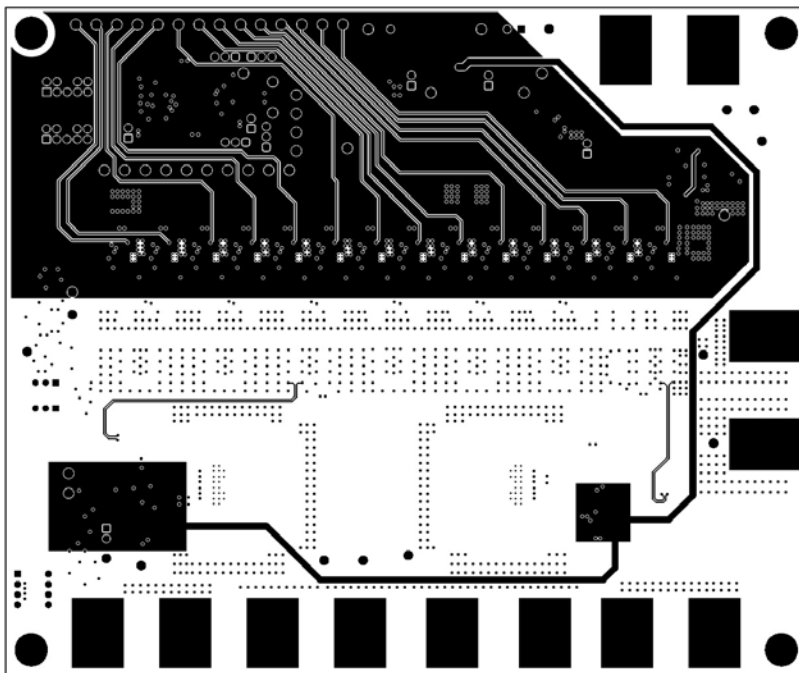


Figure 8-13. TPS536C7EVM-051 PCB Layer10-Signal

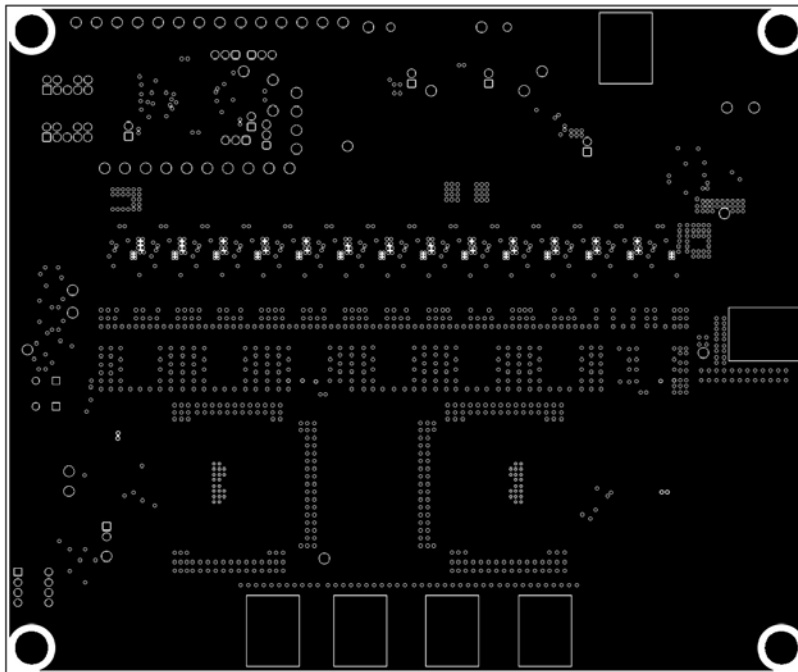


Figure 8-14. TPS536C7EVM-051 PCB Layer11-GND

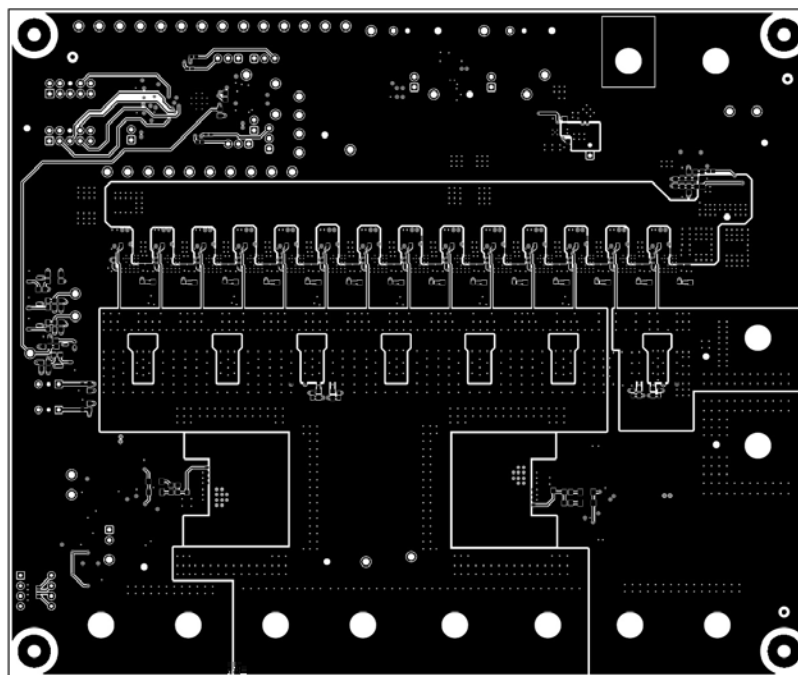


Figure 8-15. TPS536C7EVM-051 PCB Bottom layer

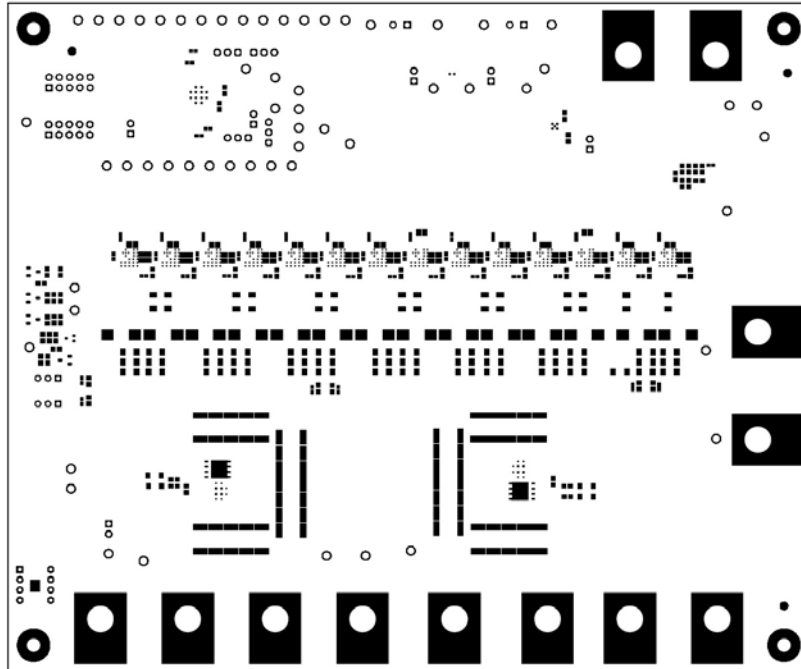


Figure 8-16. TPS536C7EVM-051 PCB Bottom solder

9 Schematic and Bill of Materials

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

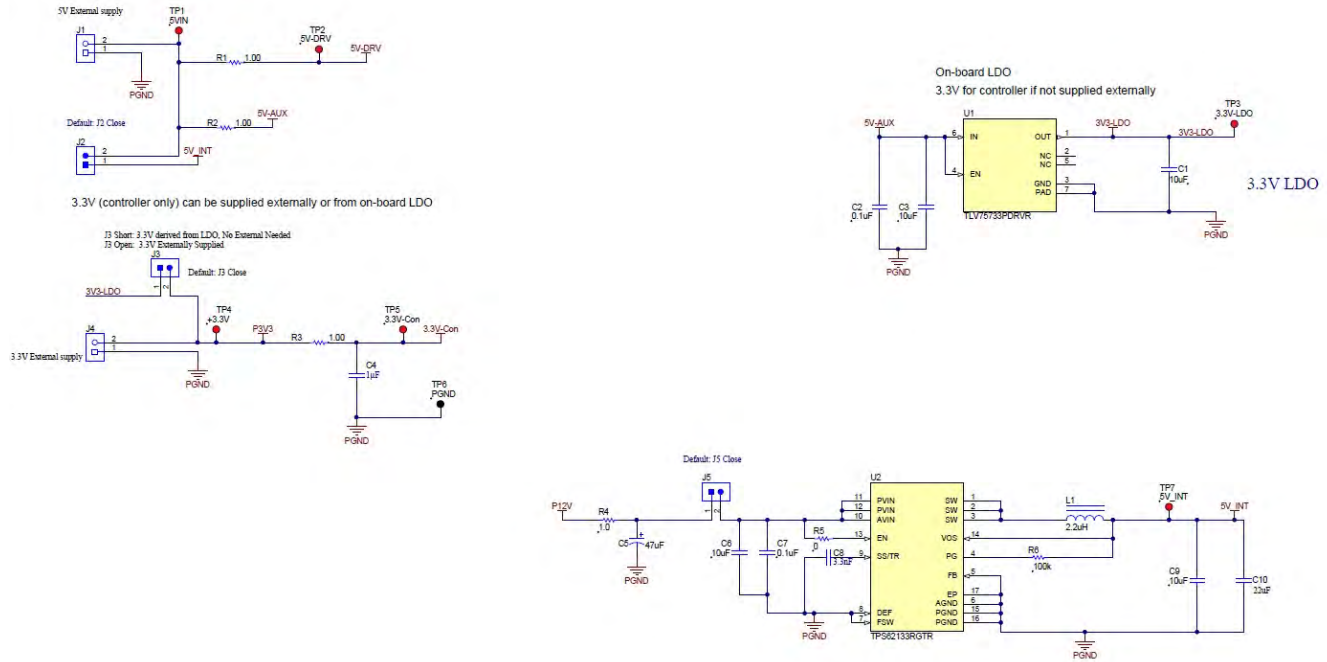


Figure 9-1. TPS536C7EVM-051 Aux power

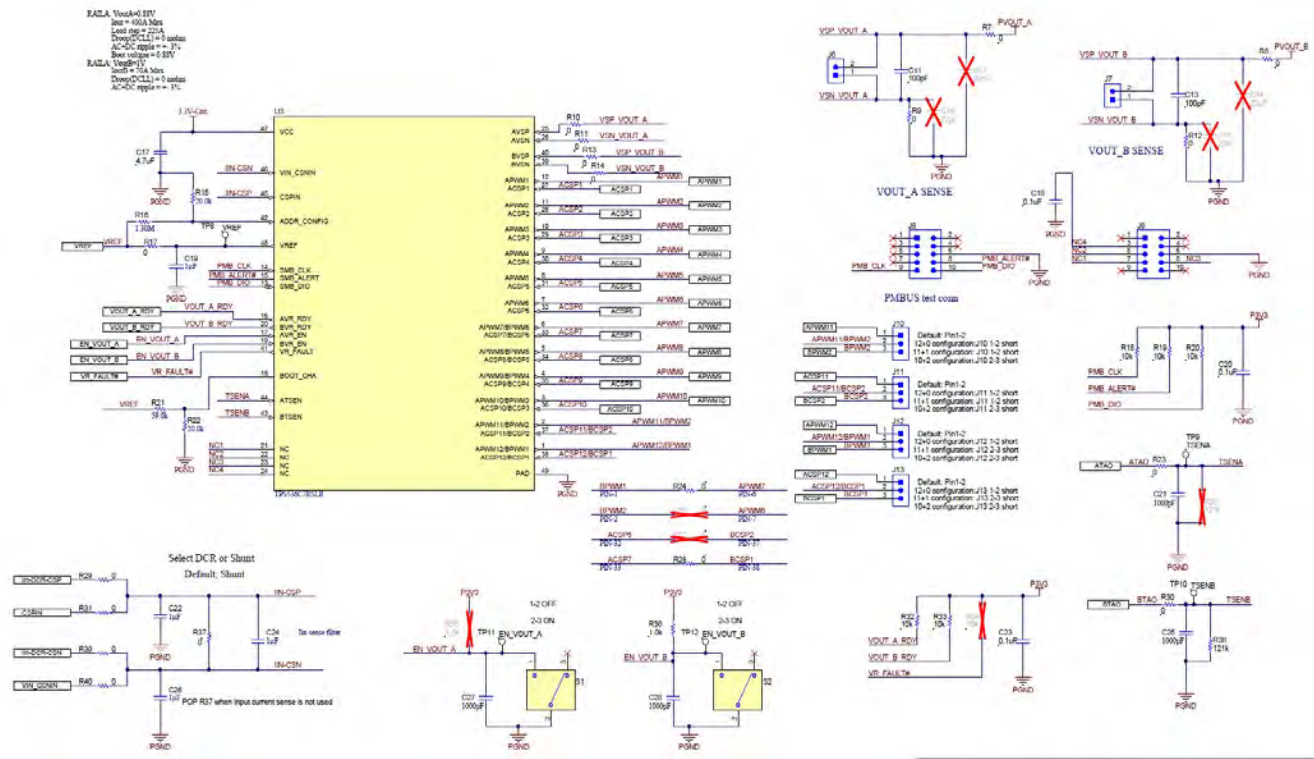


Figure 9-2. TPS536C7EVM-051 Controller Schematic

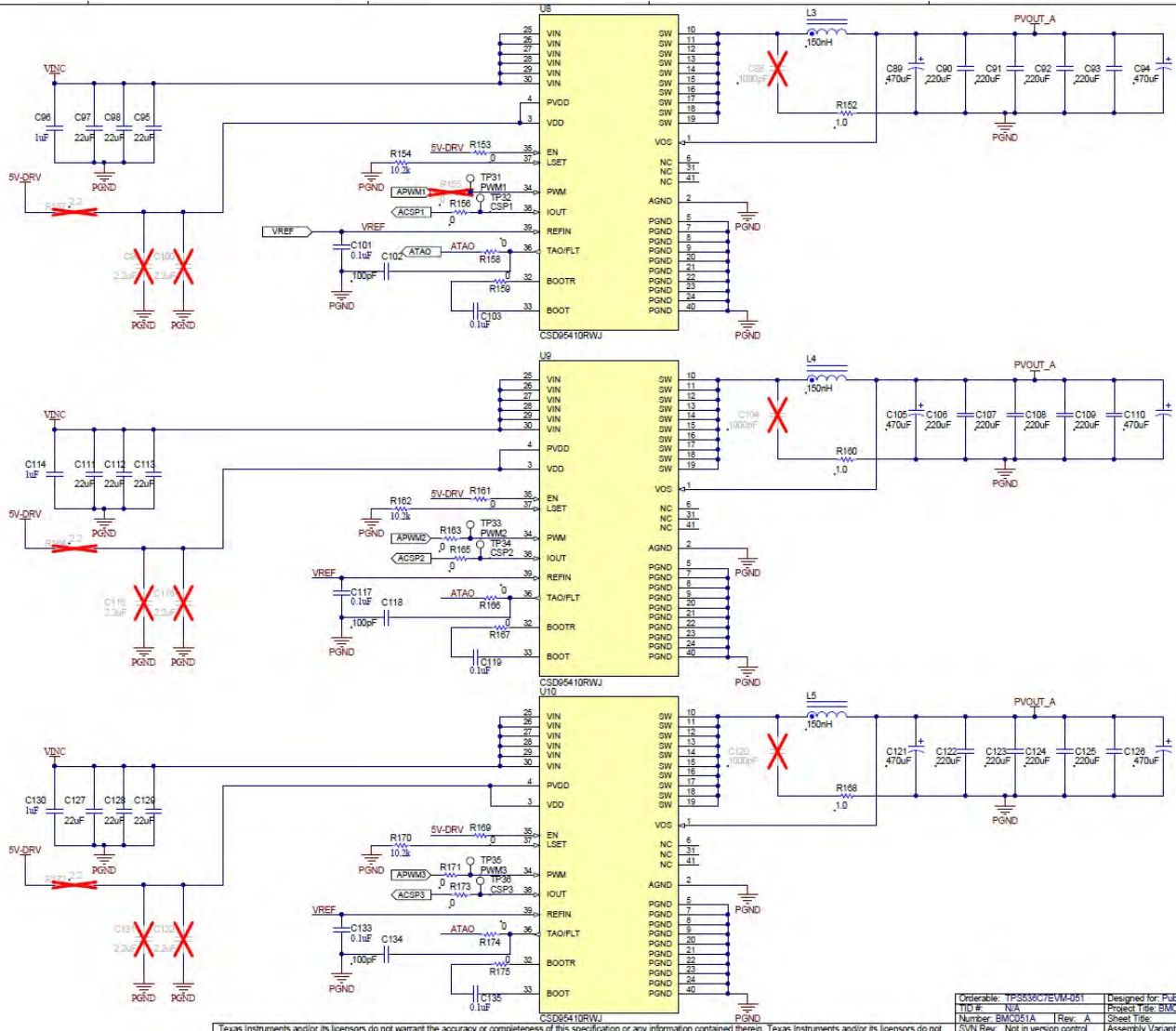
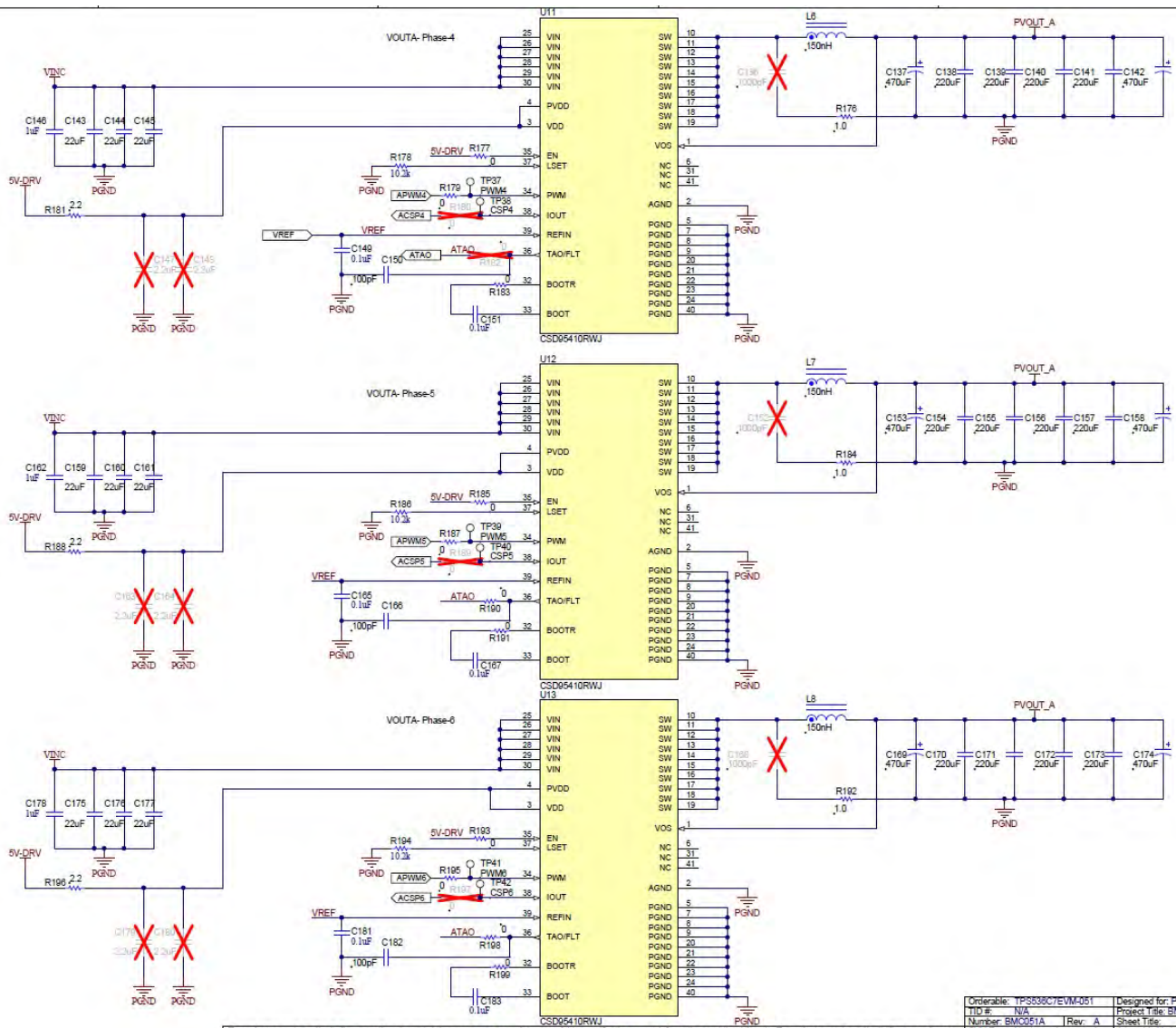


Figure 9-3. TPS536C7EVM-051 Rail A Power Stages 1-2-3 Schematic

Orderable: TPS536C7EVM-051	Designed for Public Release
TIID #: N/A	Project Title: BMC051A
Number: BMC051A	Rev: A
SVN Rev: Not in version control	Sheet Title: Assembly Variant: 001

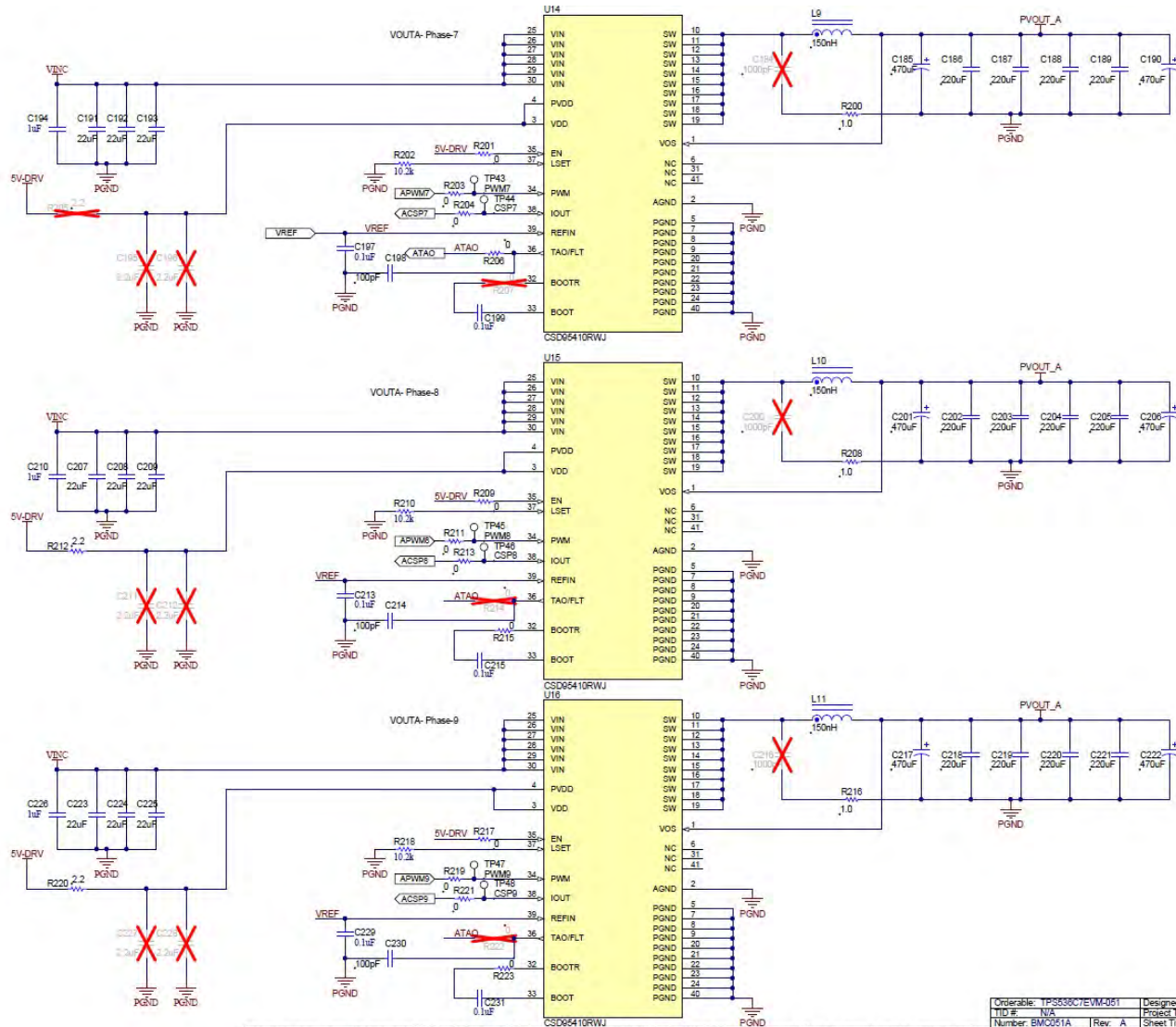
†Texas Instruments and/or its licensors do not warrant the accuracy or completeness of this specification or any information contained therein. Texas Instruments and/or its licensors do not



Texas Instruments and/or its licensors do not warrant the accuracy or completeness of this specification or any information contained therein. Texas Instruments and/or its licensors do not

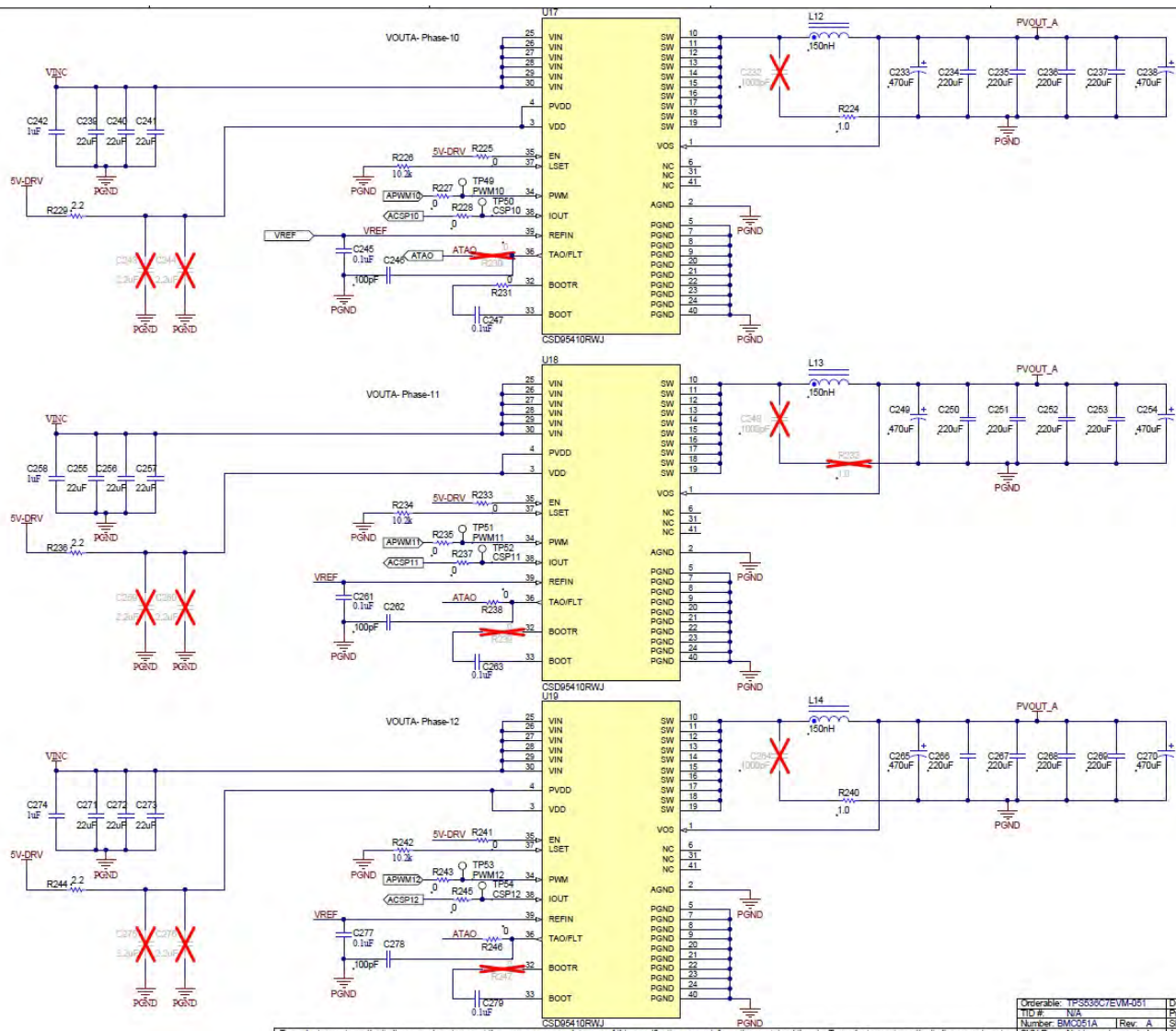
Orderable:	TPS536C7EVM-051	Designed for:	Public
TIID#:	N/A	Project Title:	BMC051
Number:	BMC051A	Rev.:	A
SVN Rev.:	Not in version control	Sheet Title:	Assembly Variant: 00

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



Orderable: TPS536C7EVM-051	Designed for: Public
TI# #: N/A	Project Title: BMO25
Number: BMO251A	Rev: A
RSUN Rev: Not in current control	Sheet Title: Assembly Variant 11

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



Orderable:	TPS536C7EVM-051	Designed By:	
TID #:	N/A	Project Title:	
Number:	BMC051A	Rev:	A
		Sheet Title:	

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

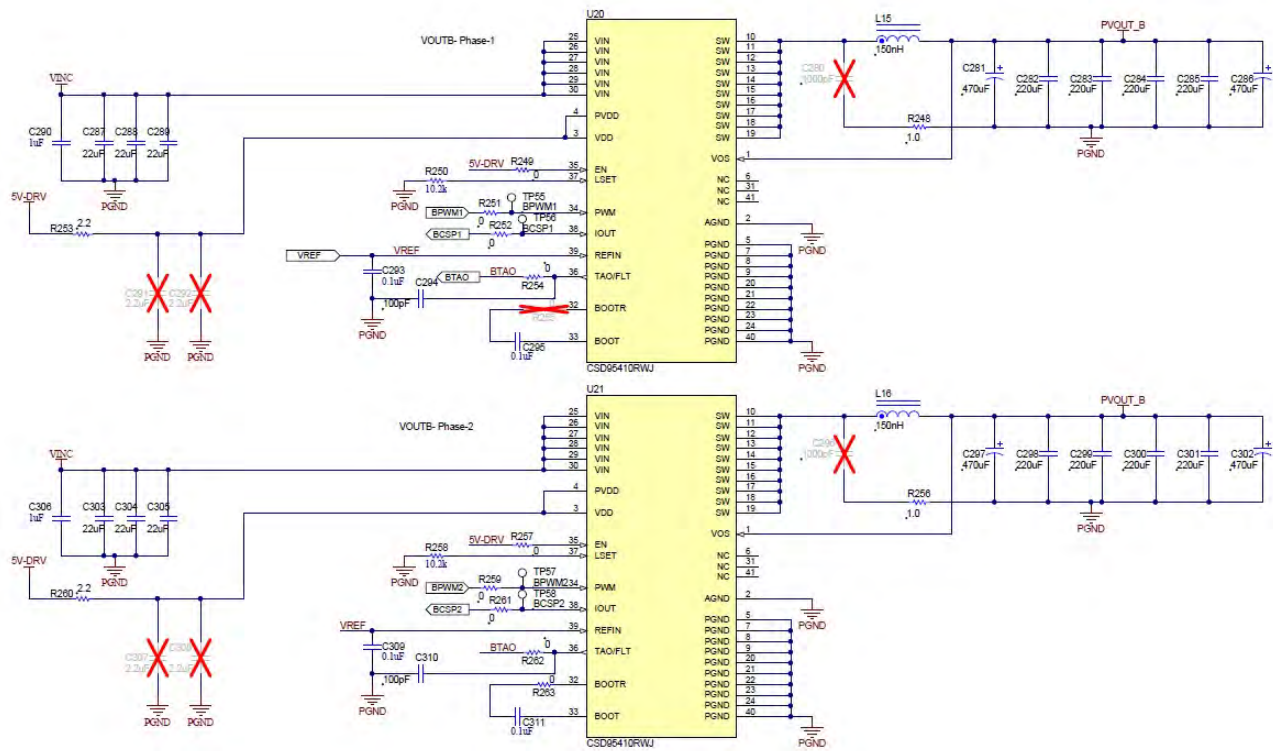


Figure 9-7. TPS536C7EVM-051 Rail B Power Stages 1-2 Schematic

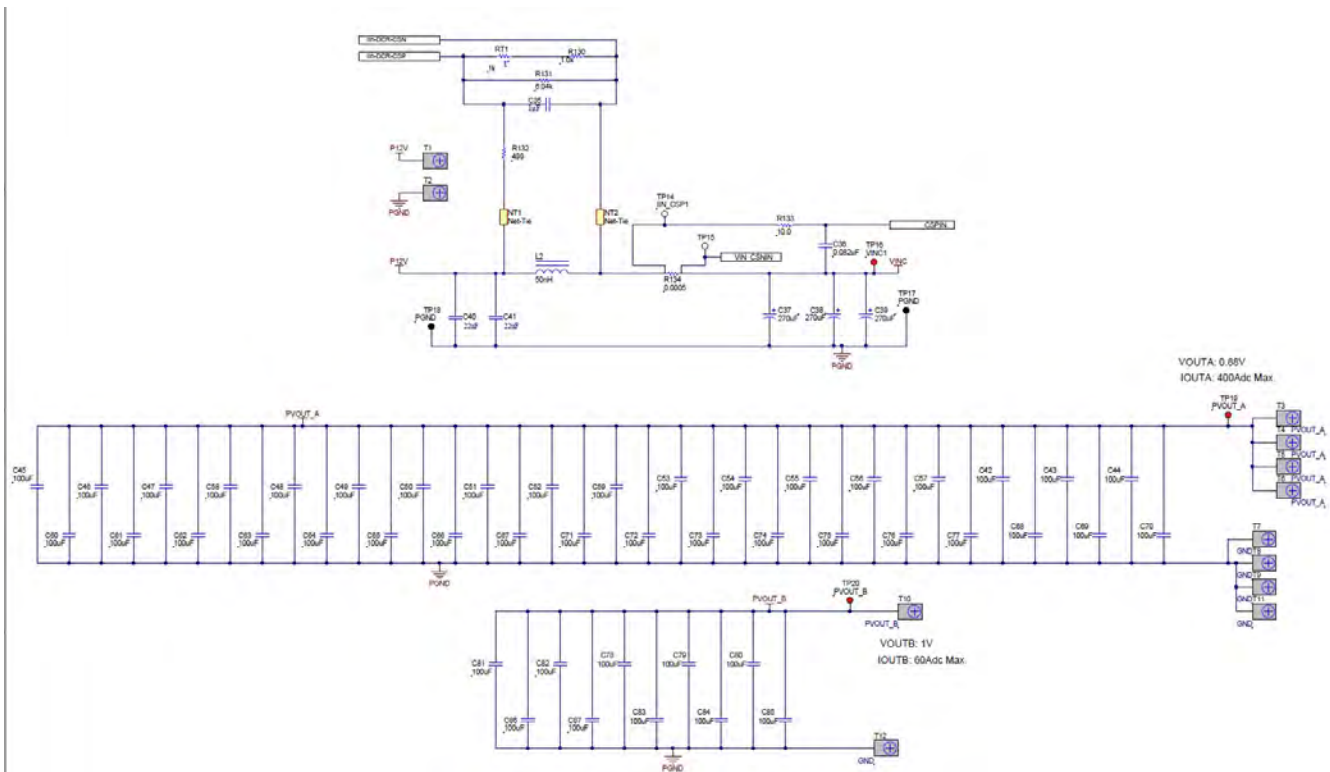


Figure 9-8. TPS536C7EVM-051 Input and output filter Schematic

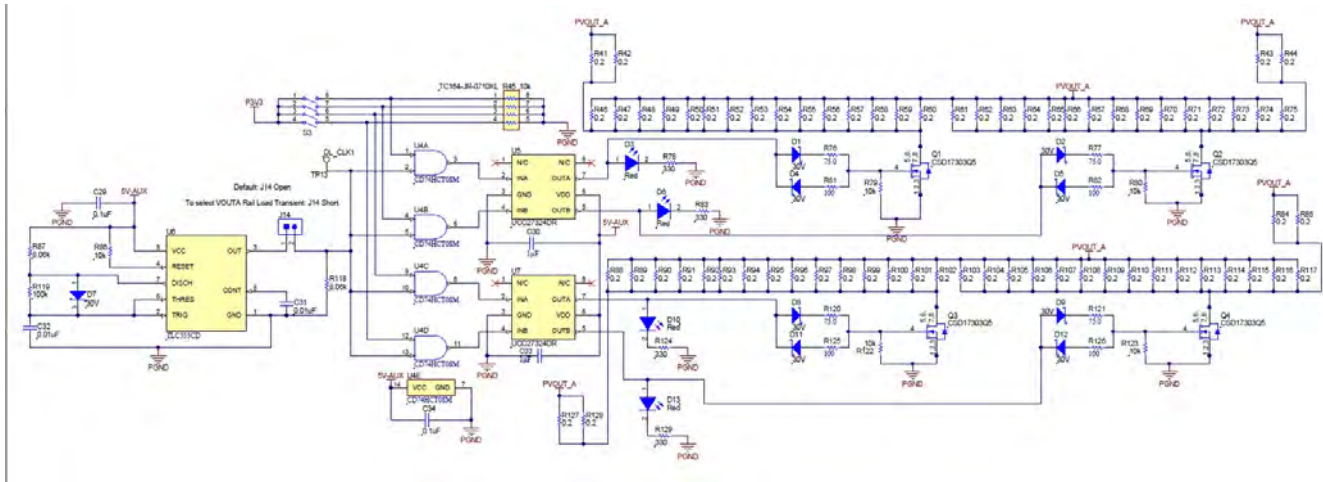


Figure 9-9. TPS536C7EVM-051 On Board transient Load Schematic

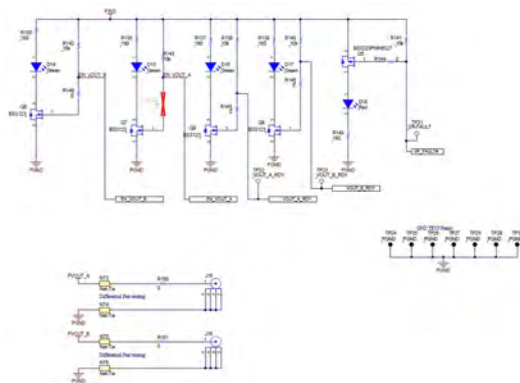


Figure 9-10. TPS536C7EVM-051 Helper Circuits and Indicators Schematic

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	C2012X5R1E10 6K125AB	TDK
C2, C7, C18, C20, C23	5	0.1uF	CAP, CERM, 0.1 uF, 50 V, +/- 10%, X7R, 0603	603	06035C104KAT2 A	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	GCM188R71C1 05KA64D	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/NPO, 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	GRM31CR60G2 27ME11L	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	GRM21BR61C2 26ME44	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	GRM155R61E10 5KA12D	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	C1005X5R1A22 5K050BC	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	GCM155R71H1 04KE02D	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	XFL4020-222ME B	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	BSS223PWH63 27	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-071 RL	Yageo America
R4	1	1	RES, 1.0, 5%, 1 W, 2010	2010	CRCW20101R0 0JNEFHP	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	CRCW06030000 Z0EA	Vishay-Dale
R6, R119	2	100k	RES, 100 k, 1%, 0.1 W, 0603	603	CRCW0603100 KFKEA	Vishay-Dale
R10, R11, R13, R14	4	0	RES, 0, 5%, 0.063 W, 0402	402	CRCW04020000 Z0ED	Vishay-Dale
R15, R22	2	20.0k	RES, 20.0 k, 1%, 0.1 W, AEC-Q200 Grade 0, 0603	603	CRCW060320K 0FKEA	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	CRCW04020000 Z0ED	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-2AEB1022 X	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	CRCW04022R2 0JNED	Vishay-Dale
RT1	1	1k	Thermistor NTC, 1.0k ohm, 5%, 0603	603	NCP18XQ102J0 3RB	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%, COG/NPO, 0402	402	C0402C101J3G ACTU	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	CRCW04020000 Z0ED	Vishay-Dale
R25, R38	0	121k	RES, 121 k, 1%, 0.1 W, 0603	603	CRCW0603121 KFKEA	Vishay-Dale
R29, R37, R39	0	0	RES, 0, 5%, 0.1 W, 0603	603	CRCW06030000 Z0EA	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	CRCW06031R0 0JNEA	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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STANDARD TERMS FOR EVALUATION MODULES

1. *Delivery:* TI delivers TI evaluation boards, kits, or modules, including any accompanying demonstration software, components, and/or documentation which may be provided together or separately (collectively, an "EVM" or "EVMs") to the User ("User") in accordance with the terms set forth herein. User's acceptance of the EVM is expressly subject to the following terms.
 - 1.1 EVMs are intended solely for product or software developers for use in a research and development setting to facilitate feasibility evaluation, experimentation, or scientific analysis of TI semiconductors products. EVMs have no direct function and are not finished products. EVMs shall not be directly or indirectly assembled as a part or subassembly in any finished product. For clarification, any software or software tools provided with the EVM ("Software") shall not be subject to the terms and conditions set forth herein but rather shall be subject to the applicable terms that accompany such Software
 - 1.2 EVMs are not intended for consumer or household use. EVMs may not be sold, sublicensed, leased, rented, loaned, assigned, or otherwise distributed for commercial purposes by Users, in whole or in part, or used in any finished product or production system.
2. *Limited Warranty and Related Remedies/Disclaimers:*
 - 2.1 These terms do not apply to Software. The warranty, if any, for Software is covered in the applicable Software License Agreement.
 - 2.2 TI warrants that the TI EVM will conform to TI's published specifications for ninety (90) days after the date TI delivers such EVM to User. Notwithstanding the foregoing, TI shall not be liable for a nonconforming EVM if (a) the nonconformity was caused by neglect, misuse or mistreatment by an entity other than TI, including improper installation or testing, or for any EVMs that have been altered or modified in any way by an entity other than TI, (b) the nonconformity resulted from User's design, specifications or instructions for such EVMs or improper system design, or (c) User has not paid on time. Testing and other quality control techniques are used to the extent TI deems necessary. TI does not test all parameters of each EVM. User's claims against TI under this Section 2 are void if User fails to notify TI of any apparent defects in the EVMs within ten (10) business days after delivery, or of any hidden defects with ten (10) business days after the defect has been detected.
 - 2.3 TI's sole liability shall be at its option to repair or replace EVMs that fail to conform to the warranty set forth above, or credit User's account for such EVM. TI's liability under this warranty shall be limited to EVMs that are returned during the warranty period to the address designated by TI and that are determined by TI not to conform to such warranty. If TI elects to repair or replace such EVM, TI shall have a reasonable time to repair such EVM or provide replacements. Repaired EVMs shall be warranted for the remainder of the original warranty period. Replaced EVMs shall be warranted for a new full ninety (90) day warranty period.

WARNING

Evaluation Kits are intended solely for use by technically qualified, professional electronics experts who are familiar with the dangers and application risks associated with handling electrical mechanical components, systems, and subsystems.

User shall operate the Evaluation Kit within TI's recommended guidelines and any applicable legal or environmental requirements as well as reasonable and customary safeguards. Failure to set up and/or operate the Evaluation Kit within TI's recommended guidelines may result in personal injury or death or property damage. Proper set up entails following TI's instructions for electrical ratings of interface circuits such as input, output and electrical loads.

NOTE:

EXPOSURE TO ELECTROSTATIC DISCHARGE (ESD) MAY CAUSE DEGRADATION OR FAILURE OF THE EVALUATION KIT; TI RECOMMENDS STORAGE OF THE EVALUATION KIT IN A PROTECTIVE ESD BAG.

3 Regulatory Notices:

3.1 United States

3.1.1 Notice applicable to EVMs not FCC-Approved:

FCC NOTICE: This kit is designed to allow product developers to evaluate electronic components, circuitry, or software associated with the kit to determine whether to incorporate such items in a finished product and software developers to write software applications for use with the end product. This kit is not a finished product and when assembled may not be resold or otherwise marketed unless all required FCC equipment authorizations are first obtained. Operation is subject to the condition that this product not cause harmful interference to licensed radio stations and that this product accept harmful interference. Unless the assembled kit is designed to operate under part 15, part 18 or part 95 of this chapter, the operator of the kit must operate under the authority of an FCC license holder or must secure an experimental authorization under part 5 of this chapter.

3.1.2 For EVMs annotated as FCC – FEDERAL COMMUNICATIONS COMMISSION Part 15 Compliant:

CAUTION

This device complies with part 15 of the FCC Rules. Operation is subject to the following two conditions: (1) This device may not cause harmful interference, and (2) this device must accept any interference received, including interference that may cause undesired operation.

Changes or modifications not expressly approved by the party responsible for compliance could void the user's authority to operate the equipment.

FCC Interference Statement for Class A EVM devices

NOTE: This equipment has been tested and found to comply with the limits for a Class A digital device, pursuant to part 15 of the FCC Rules. These limits are designed to provide reasonable protection against harmful interference when the equipment is operated in a commercial environment. This equipment generates, uses, and can radiate radio frequency energy and, if not installed and used in accordance with the instruction manual, may cause harmful interference to radio communications. Operation of this equipment in a residential area is likely to cause harmful interference in which case the user will be required to correct the interference at his own expense.

FCC Interference Statement for Class B EVM devices

NOTE: This equipment has been tested and found to comply with the limits for a Class B digital device, pursuant to part 15 of the FCC Rules. These limits are designed to provide reasonable protection against harmful interference in a residential installation. This equipment generates, uses and can radiate radio frequency energy and, if not installed and used in accordance with the instructions, may cause harmful interference to radio communications. However, there is no guarantee that interference will not occur in a particular installation. If this equipment does cause harmful interference to radio or television reception, which can be determined by turning the equipment off and on, the user is encouraged to try to correct the interference by one or more of the following measures:

- Reorient or relocate the receiving antenna.
- Increase the separation between the equipment and receiver.
- Connect the equipment into an outlet on a circuit different from that to which the receiver is connected.
- Consult the dealer or an experienced radio/TV technician for help.

3.2 Canada

3.2.1 For EVMs issued with an Industry Canada Certificate of Conformance to RSS-210 or RSS-247

Concerning EVMs Including Radio Transmitters:

This device complies with Industry Canada license-exempt RSSs. Operation is subject to the following two conditions:

(1) this device may not cause interference, and (2) this device must accept any interference, including interference that may cause undesired operation of the device.

Concernant les EVMs avec appareils radio:

Le présent appareil est conforme aux CNR d'Industrie Canada applicables aux appareils radio exempts de licence. L'exploitation est autorisée aux deux conditions suivantes: (1) l'appareil ne doit pas produire de brouillage, et (2) l'utilisateur de l'appareil doit accepter tout brouillage radioélectrique subi, même si le brouillage est susceptible d'en compromettre le fonctionnement.

Concerning EVMs Including Detachable Antennas:

Under Industry Canada regulations, this radio transmitter may only operate using an antenna of a type and maximum (or lesser) gain approved for the transmitter by Industry Canada. To reduce potential radio interference to other users, the antenna type and its gain should be so chosen that the equivalent isotropically radiated power (e.i.r.p.) is not more than that necessary for successful communication. This radio transmitter has been approved by Industry Canada to operate with the antenna types listed in the user guide with the maximum permissible gain and required antenna impedance for each antenna type indicated. Antenna types not included in this list, having a gain greater than the maximum gain indicated for that type, are strictly prohibited for use with this device.

Concernant les EVMs avec antennes détachables

Conformément à la réglementation d'Industrie Canada, le présent émetteur radio peut fonctionner avec une antenne d'un type et d'un gain maximal (ou inférieur) approuvé pour l'émetteur par Industrie Canada. Dans le but de réduire les risques de brouillage radioélectrique à l'intention des autres utilisateurs, il faut choisir le type d'antenne et son gain de sorte que la puissance isotrope rayonnée équivalente (p.i.r.e.) ne dépasse pas l'intensité nécessaire à l'établissement d'une communication satisfaisante. Le présent émetteur radio a été approuvé par Industrie Canada pour fonctionner avec les types d'antenne énumérés dans le manuel d'usage et ayant un gain admissible maximal et l'impédance requise pour chaque type d'antenne. Les types d'antenne non inclus dans cette liste, ou dont le gain est supérieur au gain maximal indiqué, sont strictement interdits pour l'exploitation de l'émetteur.

3.3 Japan

3.3.1 *Notice for EVMs delivered in Japan:* Please see http://www.tij.co.jp/llds/ti_ja/general/eStore/notice_01.page 日本国内に輸入される評価用キット、ボードについては、次のところをご覧ください。

<https://www.ti.com/ja-jp/legal/notice-for-evaluation-kits-delivered-in-japan.html>

3.3.2 *Notice for Users of EVMs Considered "Radio Frequency Products" in Japan:* EVMs entering Japan may not be certified by TI as conforming to Technical Regulations of Radio Law of Japan.

If User uses EVMs in Japan, not certified to Technical Regulations of Radio Law of Japan, User is required to follow the instructions set forth by Radio Law of Japan, which includes, but is not limited to, the instructions below with respect to EVMs (which for the avoidance of doubt are stated strictly for convenience and should be verified by User):

1. Use EVMs in a shielded room or any other test facility as defined in the notification #173 issued by Ministry of Internal Affairs and Communications on March 28, 2006, based on Sub-section 1.1 of Article 6 of the Ministry's Rule for Enforcement of Radio Law of Japan,
2. Use EVMs only after User obtains the license of Test Radio Station as provided in Radio Law of Japan with respect to EVMs, or
3. Use of EVMs only after User obtains the Technical Regulations Conformity Certification as provided in Radio Law of Japan with respect to EVMs. Also, do not transfer EVMs, unless User gives the same notice above to the transferee. Please note that if User does not follow the instructions above, User will be subject to penalties of Radio Law of Japan.

【無線電波を送信する製品の開発キットをお使いになる際の注意事項】 開発キットの中には技術基準適合証明を受けていないものがあります。技術適合証明を受けていないものご使用に際しては、電波法遵守のため、以下のいずれかの措置を取っていただく必要がありますのでご注意ください。

1. 電波法施行規則第6条第1項第1号に基づく平成18年3月28日総務省告示第173号で定められた電波暗室等の試験設備でご使用いただく。
2. 実験局の免許を取得後ご使用いただく。
3. 技術基準適合証明を取得後ご使用いただく。

なお、本製品は、上記の「ご使用にあたっての注意」を譲渡先、移転先に通知しない限り、譲渡、移転できないものとします。

上記を遵守頂けない場合は、電波法の罰則が適用される可能性があることをご留意ください。日本テキサス・イ

ンスツルメンツ株式会社

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3.3.3 *Notice for EVMs for Power Line Communication:* Please see http://www.tij.co.jp/llds/ti_ja/general/eStore/notice_02.page

電力線搬送波通信についての開発キットをお使いになる際の注意事項については、次のところをご覧ください。 <https://www.ti.com/ja-jp/legal/notice-for-evaluation-kits-for-power-line-communication.html>

3.4 European Union

3.4.1 *For EVMs subject to EU Directive 2014/30/EU (Electromagnetic Compatibility Directive):*

This is a class A product intended for use in environments other than domestic environments that are connected to a low-voltage power-supply network that supplies buildings used for domestic purposes. In a domestic environment this product may cause radio interference in which case the user may be required to take adequate measures.

-
4. *EVM Use Restrictions and Warnings:*
 - 4.1 EVMS ARE NOT FOR USE IN FUNCTIONAL SAFETY AND/OR SAFETY CRITICAL EVALUATIONS, INCLUDING BUT NOT LIMITED TO EVALUATIONS OF LIFE SUPPORT APPLICATIONS.
 - 4.2 User must read and apply the user guide and other available documentation provided by TI regarding the EVM prior to handling or using the EVM, including without limitation any warning or restriction notices. The notices contain important safety information related to, for example, temperatures and voltages.
 - 4.3 *Safety-Related Warnings and Restrictions:*
 - 4.3.1 User shall operate the EVM within TI's recommended specifications and environmental considerations stated in the user guide, other available documentation provided by TI, and any other applicable requirements and employ reasonable and customary safeguards. Exceeding the specified performance ratings and specifications (including but not limited to input and output voltage, current, power, and environmental ranges) for the EVM may cause personal injury or death, or property damage. If there are questions concerning performance ratings and specifications, User should contact a TI field representative prior to connecting interface electronics including input power and intended loads. Any loads applied outside of the specified output range may also result in unintended and/or inaccurate operation and/or possible permanent damage to the EVM and/or interface electronics. Please consult the EVM user guide prior to connecting any load to the EVM output. If there is uncertainty as to the load specification, please contact a TI field representative. During normal operation, even with the inputs and outputs kept within the specified allowable ranges, some circuit components may have elevated case temperatures. These components include but are not limited to linear regulators, switching transistors, pass transistors, current sense resistors, and heat sinks, which can be identified using the information in the associated documentation. When working with the EVM, please be aware that the EVM may become very warm.
 - 4.3.2 EVMs are intended solely for use by technically qualified, professional electronics experts who are familiar with the dangers and application risks associated with handling electrical mechanical components, systems, and subsystems. User assumes all responsibility and liability for proper and safe handling and use of the EVM by User or its employees, affiliates, contractors or designees. User assumes all responsibility and liability to ensure that any interfaces (electronic and/or mechanical) between the EVM and any human body are designed with suitable isolation and means to safely limit accessible leakage currents to minimize the risk of electrical shock hazard. User assumes all responsibility and liability for any improper or unsafe handling or use of the EVM by User or its employees, affiliates, contractors or designees.
 - 4.4 User assumes all responsibility and liability to determine whether the EVM is subject to any applicable international, federal, state, or local laws and regulations related to User's handling and use of the EVM and, if applicable, User assumes all responsibility and liability for compliance in all respects with such laws and regulations. User assumes all responsibility and liability for proper disposal and recycling of the EVM consistent with all applicable international, federal, state, and local requirements.
 5. *Accuracy of Information:* To the extent TI provides information on the availability and function of EVMs, TI attempts to be as accurate as possible. However, TI does not warrant the accuracy of EVM descriptions, EVM availability or other information on its websites as accurate, complete, reliable, current, or error-free.
 6. *Disclaimers:*
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