User's Guide

TPS51219 Buck Controller Evaluation Module User's Guide

ABSTRACT

The TPS51219EVM evaluation module (EVM) uses the TPS51219. The TPS51219 is a small-size, single buck controller with adaptive on-time D-CAP2™ providing 1.05-V output at up to 20 A from input voltage ranging 8 V to 20 V.

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Trademarks

D-CAP2™ is a trademark of Texas Instruments.

All trademarks are the property of their respective owners.

1 Description

The TPS51219EVM evaluation module (EVM) is designed to use a regulated voltage ranging 8 V to 20 V to produce 1.05-V output at up to 20 A of load current. The TPS51219EVM demonstrates the TPS51219 in a typical low-voltage application with D-CAP2™ mode operation. The EVM also provides test points to evaluate the performance of the TPS51219.

1.1 Typical Applications

- Notebook computers
- I/O supplies
- System power supplies

1.2 Features

The TPS51219EVM features:

- D-CAP2™-mode operation with low-ESR output capacitance
- 2% tolerance 1.05-V output voltage
- 20-Adc, steady-state output current
- Support prebias output voltage start-up
- 500-kHz switching frequency
- SW1 for enable function
- Convenient test points for probing critical waveforms

2 Electrical Performance Specifications

Table 2-1. TPS51219EVM-630-001 Electrical Performance Specifications

Parameter	Test Conditions	Min	Typ	Max	Unit
Input Characteristics					
Voltage range	VIN voltage	8	12	20	V
Maximum input current	V_{IN} = 8 V, I_{OUT} = 20 A		3		A
No load input current	V_{IN} = 8 V, I_{OUT} = 0 A		0.2		mA
Voltage range	V5IN voltage	4.5	5	5.5	V
Maximum input current	V_{5IN} = 5 V, V_{IN} = 12 V, I_{OUT} = 20 A		20		mA
No load input current	V_{5IN} = 5 V, V_{IN} = 12 V, I_{OUT} = 0 A		0.5		mA
Output Characteristics					
Output voltage, V_{OUT}	V_{IN} = 12 V, I_{OUT} = 10 A		1.05		V
Output load current, I_{OUT}			20		A
Output voltage regulation	Line regulation: V_{IN} = 8 V to 20 V, V_{OUT} = 1.05 V, I_{OUT} = 20 A		0.2%		
	Load regulation: V_{IN} = 12 V, V_{OUT} = 1.05 V, I_{OUT} = 1 mA to 20 A		0.2%		
Output voltage ripple	At V_{IN} = 12 V, V_{OUT} = 1.05 V, I_{OUT} = 20 A		15		mVpp
Output over current			27		A
System Characteristics					
Switching frequency	V_{IN} = 8 V, V_{OUT} = 1.05 V, I_{OUT} = 10 A		500		kHz
Peak efficiency	V_{IN} = 12 V, V_{OUT} = 1.05 V		89.3%		
Full load efficiency	V_{IN} = 12 V, V_{OUT} = 1.05 V, I_{OUT} = 20 A		85.4%		
Operating temperature			25		°C

3 Schematic

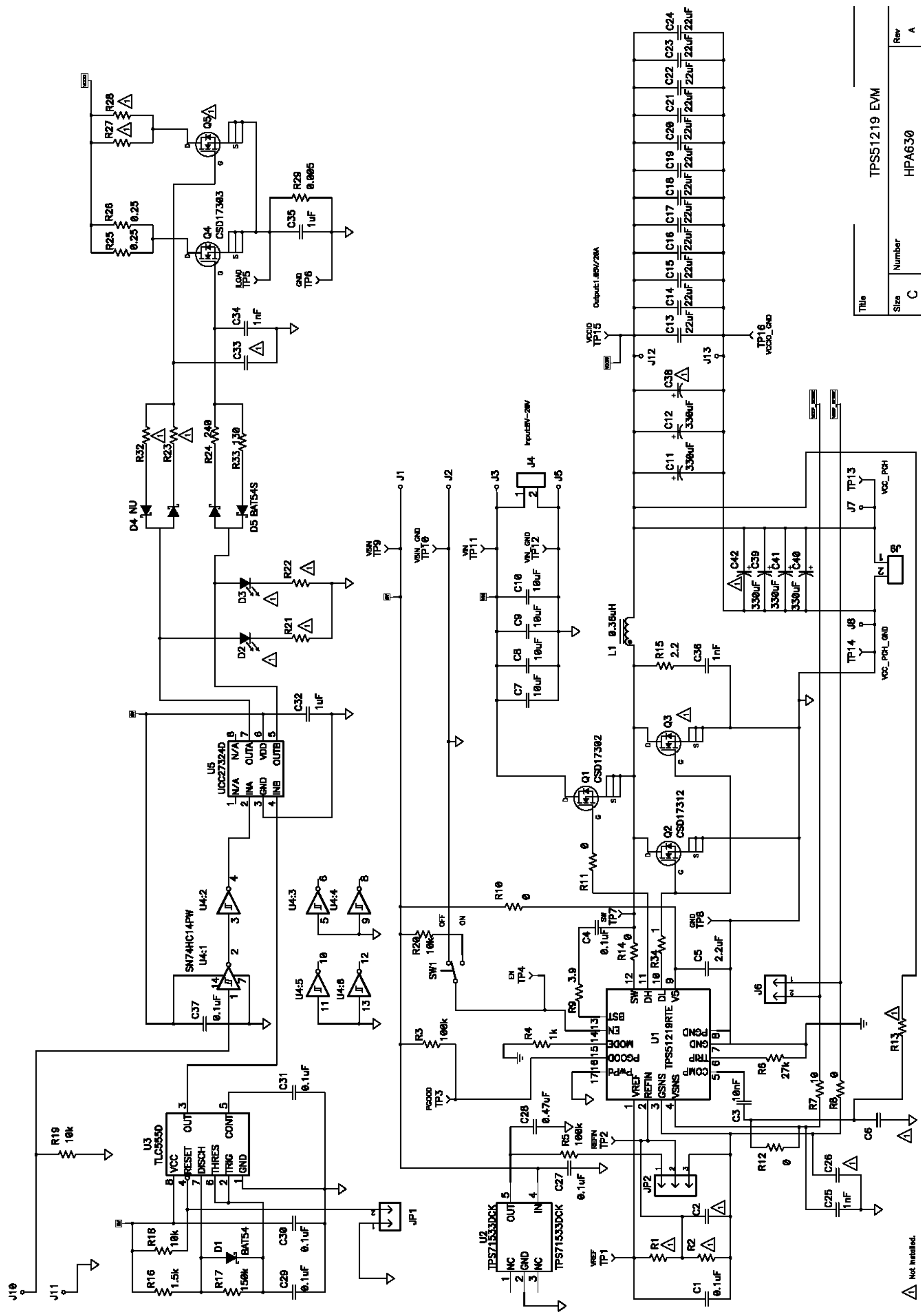

Figure 3-1. TPS51219EVM-630 Schematic, Sheet 1 of 2

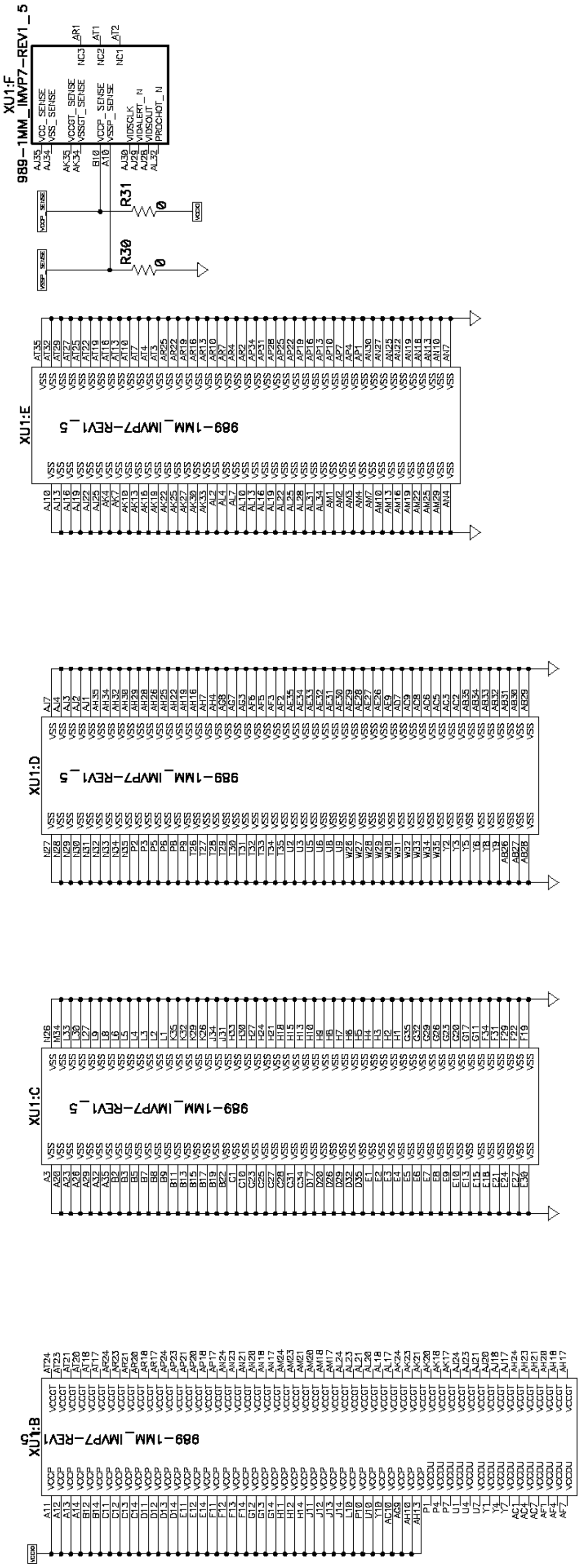

Figure 3-2. TPS51219EVM-630 Schematic, Sheet 2 of 2

4 Test Setup

4.1 Test Equipment

Voltage Source VIN: The input voltage source VIN must be a 0-V to 20-V variable DC source capable of supplying 10 A_{DC}. Connect VIN to J4 as shown in Figure 4-2.

Voltage Source V5IN: The input voltage source V5IN must be a 0-V to 5-V variable DC source capable of supplying 1 A_{DC}. Connect V5IN to J1 as shown in Figure 4-2.

Multimeters:

- V1: VIN at TP11 (VIN) and TP12 (VIN_GND)
- V2: V5IN at TP10 (V5IN) and TP9 (V5IN_GND)
- V3: VSNS at J6-2 and GSNS at J6-1
- A1: VIN input current
- A2: V5IN input current

Output Load: The output load must be an electronic constant-resistance mode load capable of 0 A_{DC} to 30 A_{DC} at 1.05 V.

Oscilloscope: A digital or analog oscilloscope can be used to measure the output ripple. The oscilloscope must be set for the following:

- 1-MΩ impedance
- 20-MHz bandwidth
- AC coupling
- 1-µs/division horizontal resolution
- 20-mV/division vertical resolution

Test point J6 can be used to measure the differential output ripple voltage, using a passive probe with the shortest leaded ground clip. For switch node voltage measurement, TP7 and TP8 can be used by placing the passive probe tip through TP7 and holding the ground barrel TP8 as shown in Figure 4-1. In this case, using a leaded ground connection may induce additional noise due to the large ground loop.

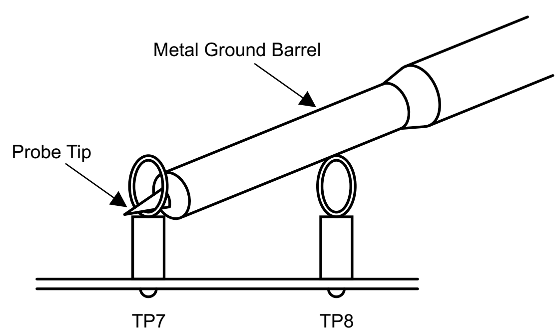

Figure 4-1. Tip and Barrel Measurement for Switch Node Voltage

Fan: Some of the components in this EVM can get hot, approaching temperatures of 60°C during operation. A small fan capable of 200–400 LFM is recommended to reduce component temperatures while the EVM is operating. The EVM must not be probed when the fan is not running.

Recommended Wire Gauge:

1. VIN to J4 (8-V to 20-V input)
   The recommended wire size is 1× AWG 14 per input connection, with the total length of wire less than four feet (2-foot input, 2-foot return).
2. V5IN to J1 (5-V input)
   The recommended wire size is 1× AWG 18 per input connection, with the total length of wire less than four feet (2-foot input, 2-foot return).
3. J12 to LOAD
   The minimum recommended wire size is 2× AWG 14, with the total length of wire less than four feet (2-foot input, 2-foot return).

4.2 Recommended Test Setup

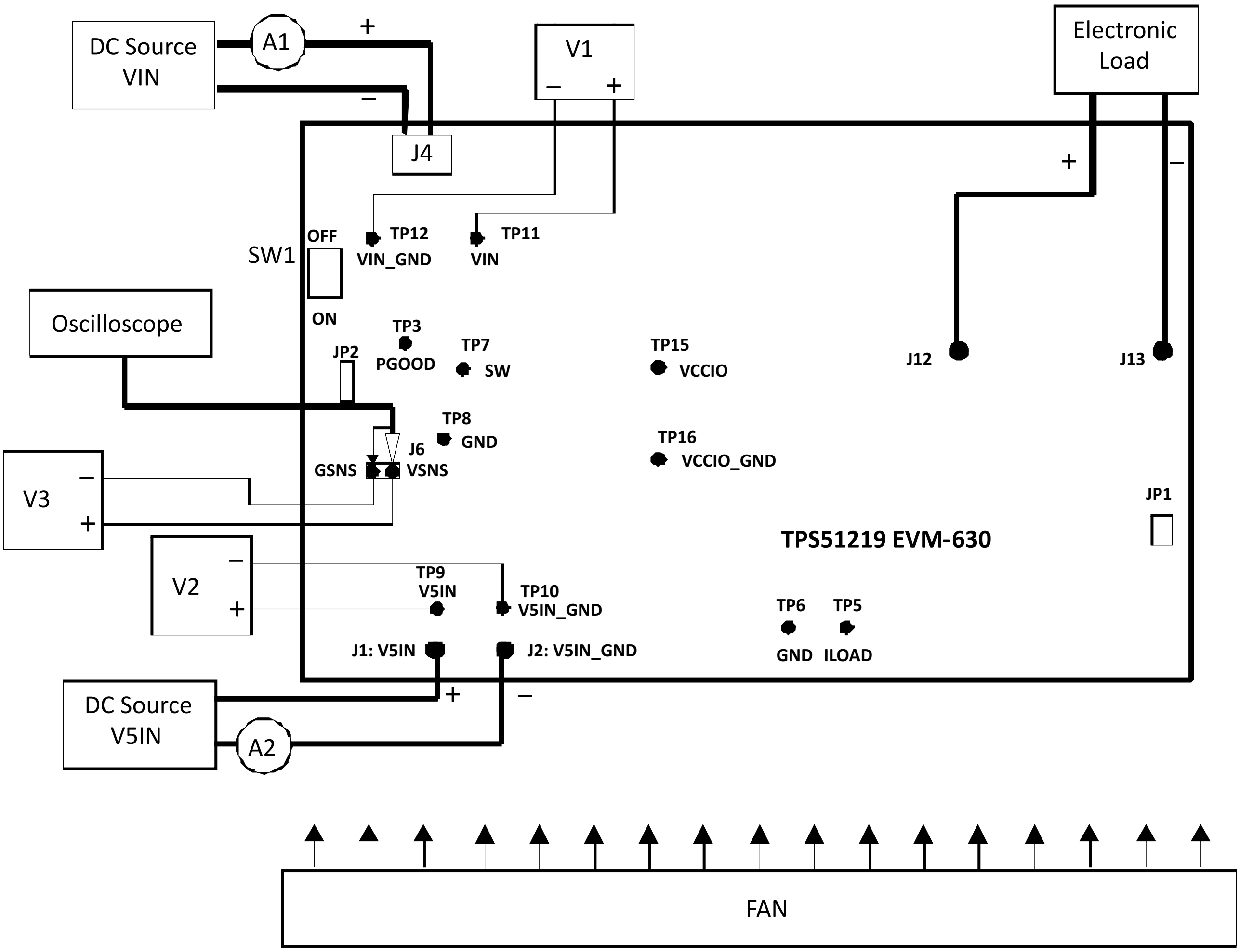

Figure 4-2. TPS51219EVM-630 Recommended Test Setup

Figure 4-2 is the recommended test setup to evaluate the TPS51219EVM. Working at an ESD workstation, ensure that any wrist straps, bootstraps, or mats are connected referencing the user to earth ground before power is applied to the EVM.

Input Connections:

1. Prior to connecting the DC source VIN, it is advisable to limit the source current from VIN to 10 A maximum. Ensure that VIN is initially set to 0 V and connected as shown in Figure 4-2.
2. Prior to connecting the DC source V5IN, it is advisable to limit the source current from V5IN to 1 A maximum. Ensure that V5IN is initially set to 0 V and connected as shown in Figure 4-2.
3. Connect a voltmeter V1 at TP11 (VIN) and TP12 (VIN_GND) to measure VIN voltage, V2 at TP9 (V5IN), and TP10 (V5IN_GND) to measure V5IN voltage as shown in Figure 4-2.
4. Connect a current meter A1 between DC source VIN and J4 to measure the input current.
5. Connect a voltmeter V2 between DC source V5IN and J1 to measure the 5-V input current.

Output Connections:

1. Connect the load to J12 and J13, and set load to constant resistance mode to sink 0 A_{DC} before VIN and V5IN are applied.
2. Connect a voltmeter V3 at J6-2 (VSNS) and J6-1 (GSNS) to measure the output voltage.

Other Connections:

Place a fan as shown in Figure 4-2 and turn it on, ensuring that air is flowing across the EVM.

5 Test Procedure

5.1 Line/Load Regulation and Efficiency Measurement Procedure

1. Ensure the load is set to constant resistance mode and to sink 0 A_{DC}.
2. Ensure SW1 on the EVM is at the OFF position before VIN and V5IN are applied.
3. Increase VIN from 0 V to 8 V. Use V1 to measure input voltage.
4. Increase V5IN from 0 V to 5 V. Use V2 to measure input voltage.
5. Turn SW1 to the ON position to enable the controller.
6. Vary the load from 0 A_{DC} to 20 A_{DC}; VOUT must remain in load regulation.
7. Vary VIN from 8 V to 20 V; VOUT must remain in line regulation.
8. Decrease the load to 0 A.
9. Turn SW1 to the OFF position to disable the controller.
10. Decrease V5IN to 0 V.
11. Decrease VIN to 0 V.

5.2 List of Test Points

Table 5-1. Functions of Each Test Point

Test Point	Name	Description
TP1	VREF	VREF voltage
TP2	REFIN	REFIN voltage
TP3	PGOOD	Power good
TP4	EN	Output enable
TP5	ILOAD	Built-in dynamic load current
TP6	GND	GND for ILOAD
TP7	SW	Switch node
TP8	GND	GND for SW
TP9	V5IN	5-V supply
TP10	V5IN_GND	GND for 5-V supply
TP11	VIN	VIN supply
TP12	VIN_GND	GND for VIN supply
TP13	VCC_PCH	Output for VCC_PCH
TP14	VCC_PCH_GND	GND for VCC_PCH
TP15	VCCIO	VCCIO
TP16	VCCIO_GND	GND for VCCIO
J6-1	GSNS	Differential sensing (low)
J6-2	VSNS	Differential sensing (high)

5.3 Equipment Shutdown

1. Shut down the load.
2. Shut down V5IN and VIN.
3. Shut down the fan.

6 Performance Data and Typical Characteristic Curves

Figure 6-1 through Figure 6-9 present typical performance curves for TPS51219EVM-630.

6.1 Efficiency

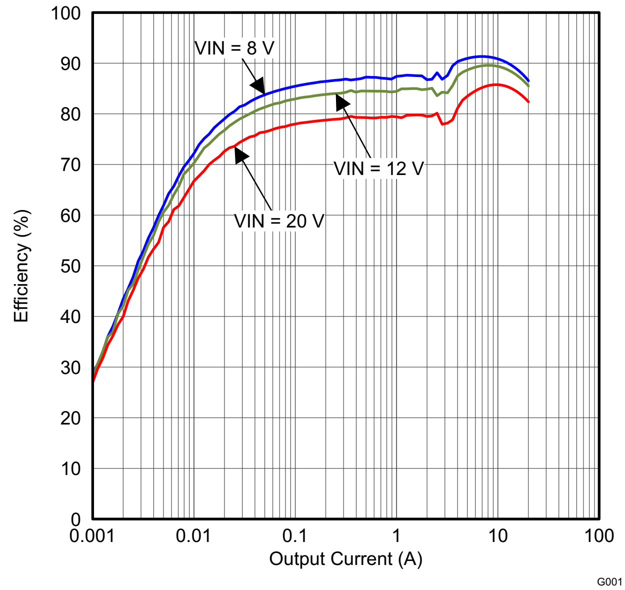

Figure 6-1. TPS51219EVM-630 Efficiency

6.2 Load Regulation

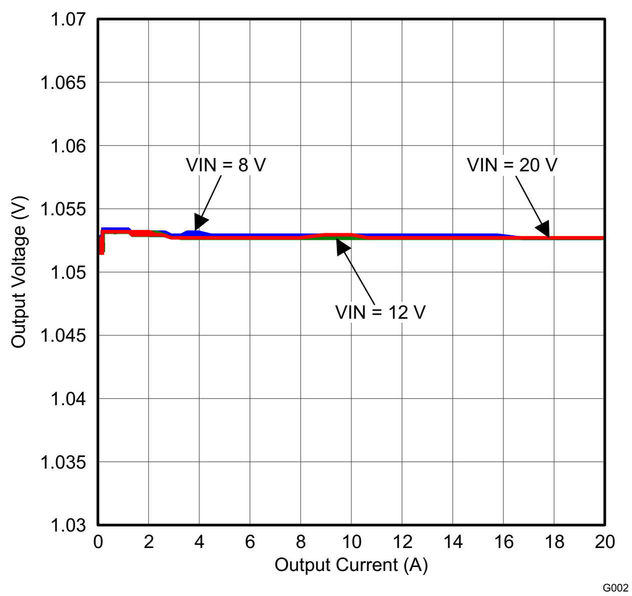

Figure 6-2. TPS51219EVM-630 Load Regulation

6.3 Line Regulation

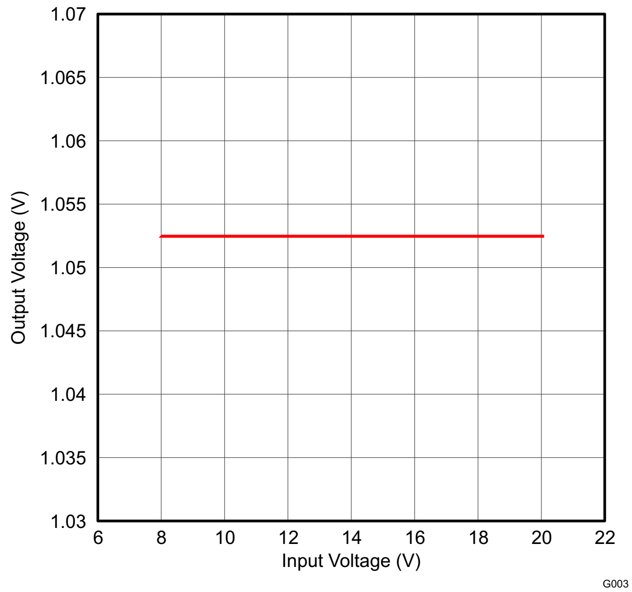

Figure 6-3. TPS51219EVM-630 Line Regulation

6.4 Load Transient

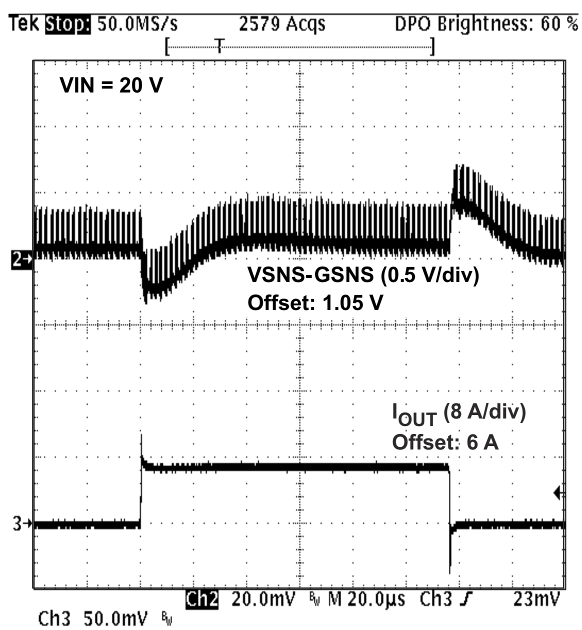

Figure 6-4. TPS51219EVM-630 Load Transient (V_{OUT} = 1.05 V)

6.5 Output Ripple

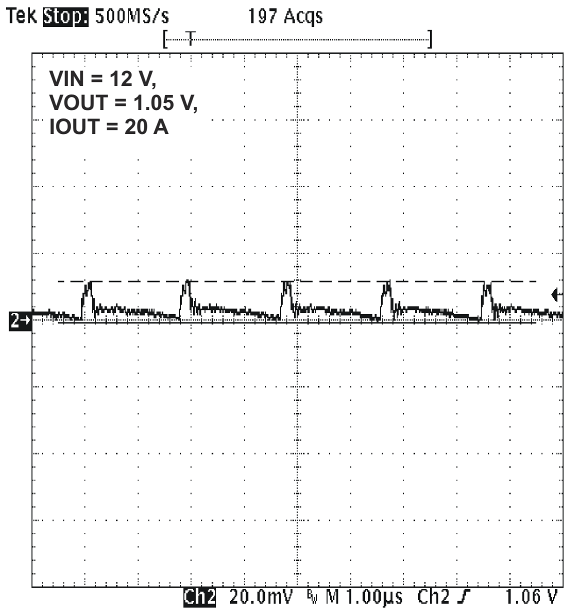

Figure 6-5. Output Ripple

6.6 Switch Node Voltage

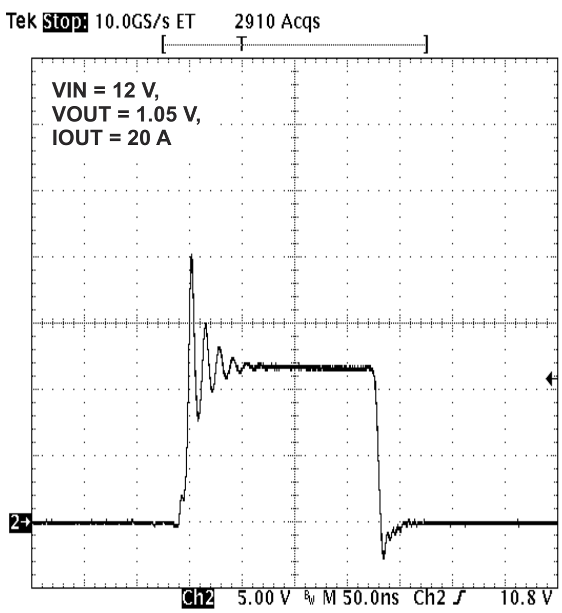

Figure 6-6. Switching Node Waveform

6.7 Turn-On/Turn-Off Waveform

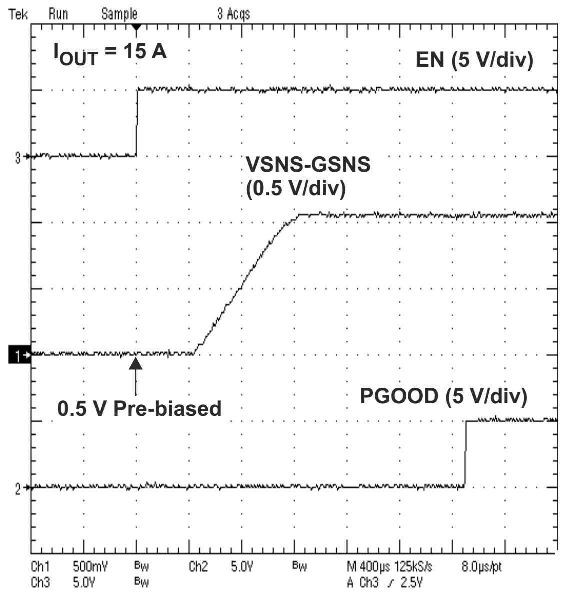

Figure 6-7. Enable Turn-On

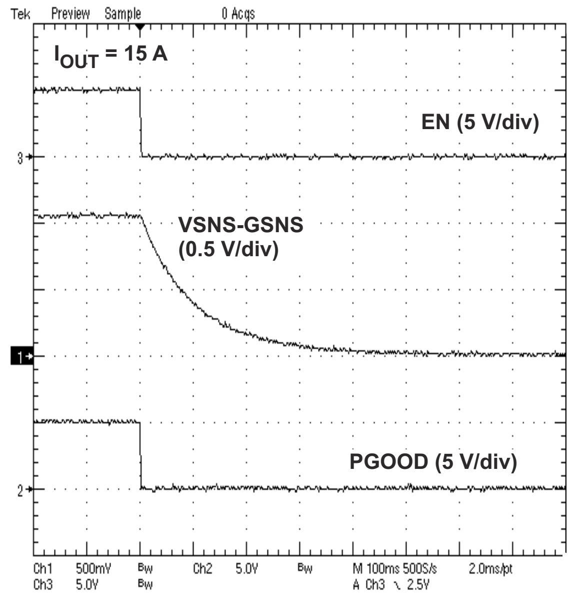

Figure 6-8. Enable Turn-Off

6.8 Output 0.5-V Prebias Turnon Waveform

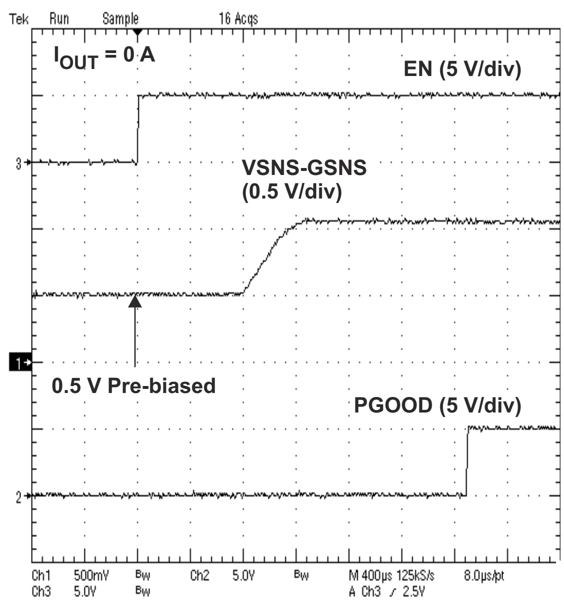

Figure 6-9. Output 0.5-V Prebias Turnon Waveform

7 EVM Assembly Drawing and PCB Layout

The following figures (Figure 7-2 through Figure 7-6) show the design of the TPS51219EVM-630 printed-circuit board (PCB). The EVM has been designed using four-layer, 2-oz copper circuit board.

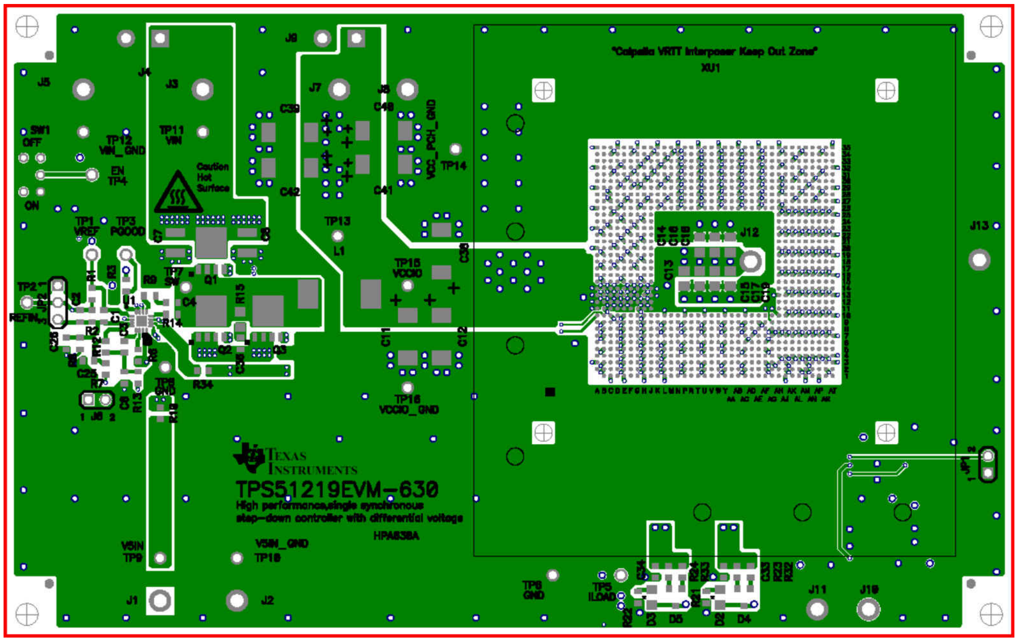

Figure 7-1. TPS51219EVM-630 Top Layer Assembly Drawing (Top View)

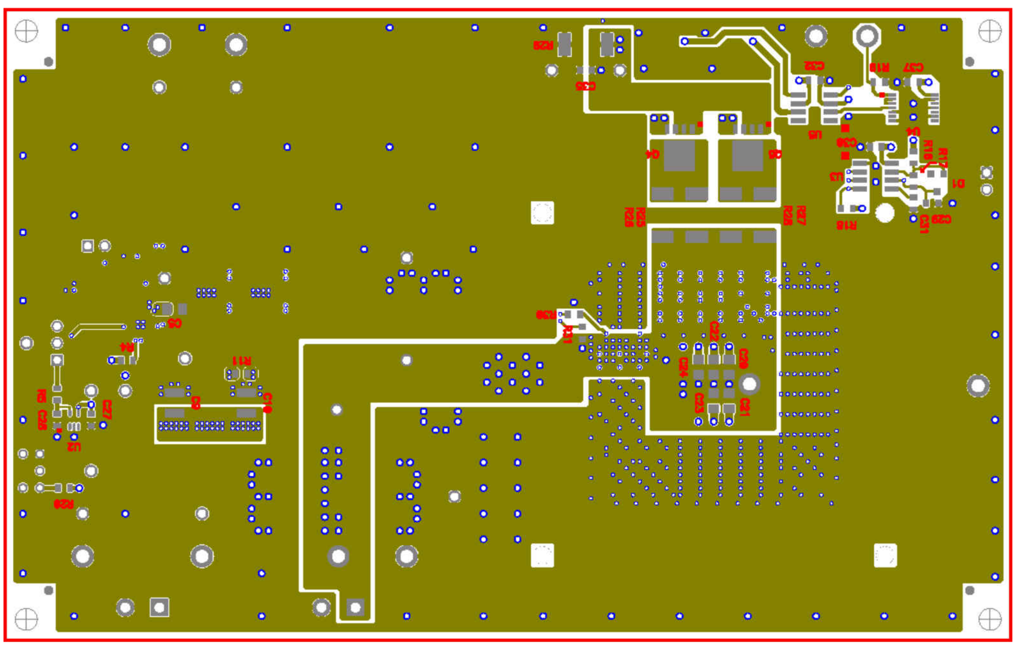

Figure 7-2. TPS51219EVM-630 Bottom Layer Assembly Drawing (Bottom View)

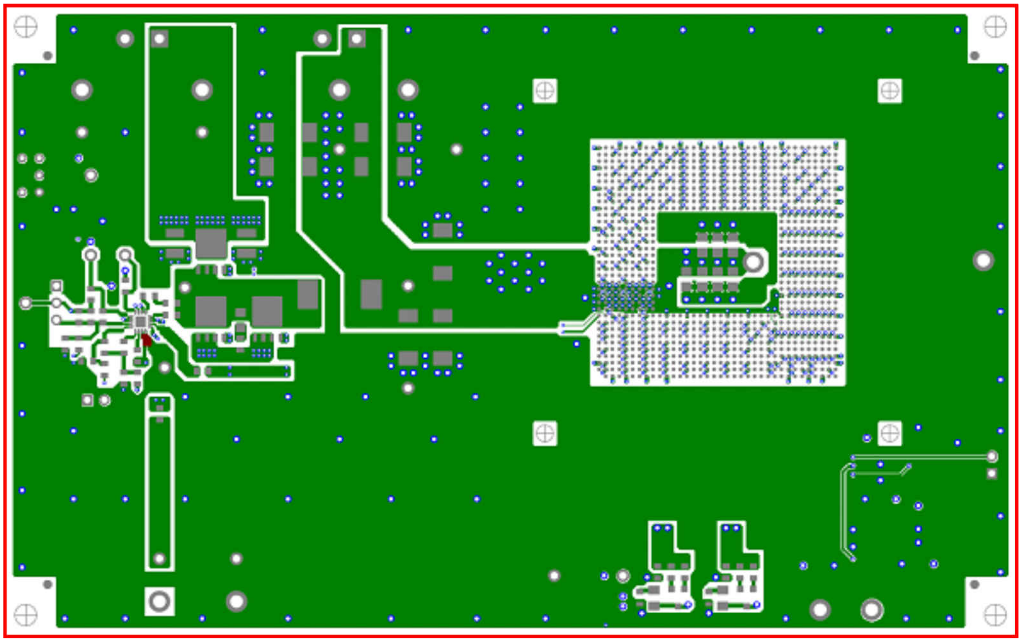

Figure 7-3. TPS51219EVM-630 Top Copper Layer (Top View)

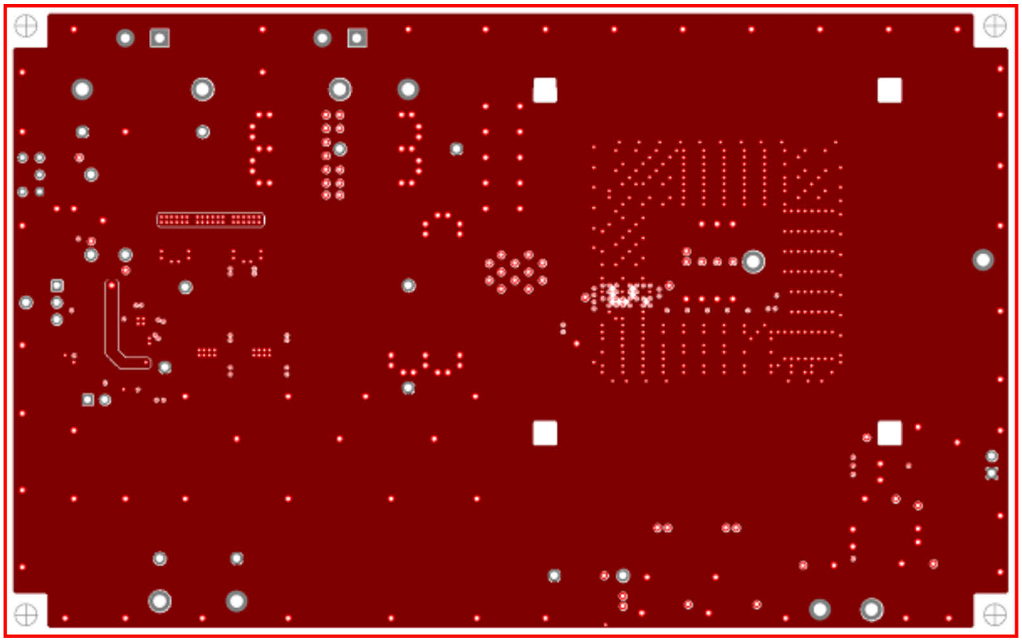

Figure 7-4. TPS51219EVM-630 Internal Layer 1 (Top View)

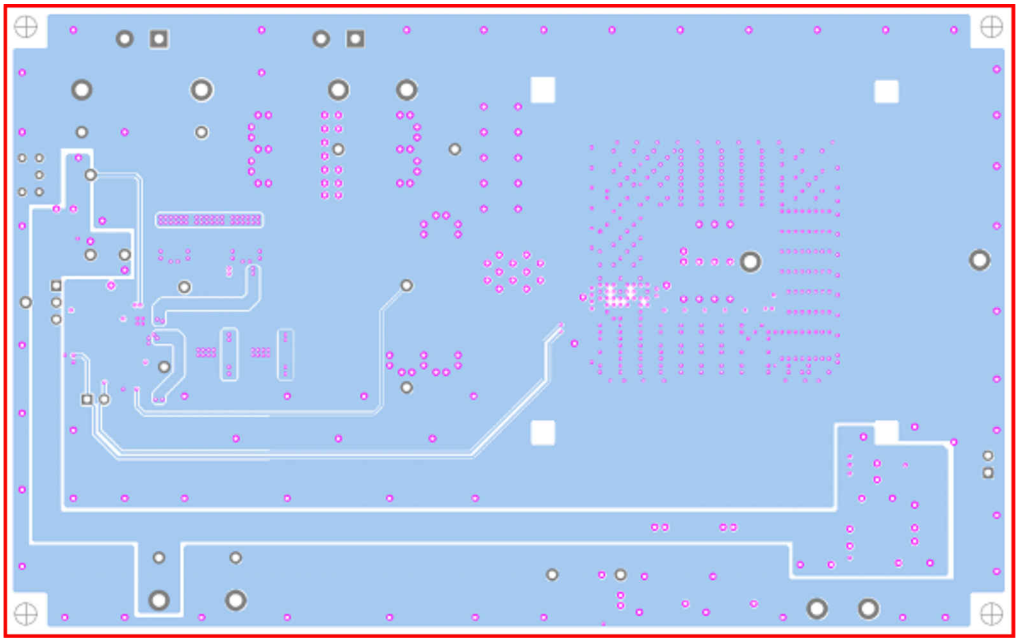

Figure 7-5. TPS51219EVM-630 Internal Layer 2 (Top View)

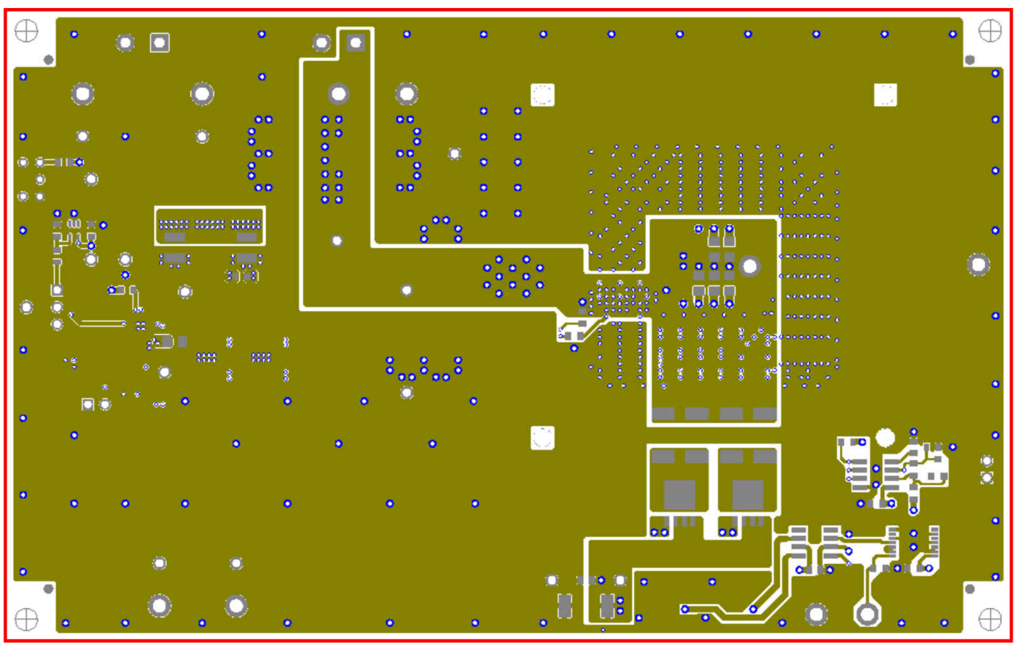

Figure 7-6. TPS51219EVM-630 Bottom Copper Layer (Top View)

8 Bill of Materials

Table 8-1. EVM Components List According to Schematic Shown in Figure 1

QTY	Ref Des	Value	Description	Part Number	MFR
7	C1, C4, C27, C29–C31, C37	0.1 µF	Capacitor, Ceramic, 50 V, X5R, 10%	STD	STD
1	C3	10 nF	Capacitor, Ceramic, 50 V, X5R, 10%	STD	STD
1	C5	2.2 µF	Capacitor, Ceramic, 10 V, X5R, 10%	GRM188R61A225KE34	muRata
4	C7, C8, C9, C10	10 µF	Capacitor, Ceramic, 25 V, X5R, 20%	TMK325BJ106MM-T	Taiyo Yuden
5	C11, C12, C39–C41	330 µF	Capacitor, Aluminum, 2 V, 6 mΩ, 20%	EEFSX0D331XE	Panasonic
12	C13–C24	22 µF	Capacitor, Ceramic, 6.3 V, X5R, 10%	JMK212BJ226MG-T	Taiyo Yuden
1	C28	0.47 µF	Capacitor, Ceramic, 50 V, X5R, 10%	STD	STD
2	C32, C35	1 µF	Capacitor, Ceramic, 10 V, X5R, 10%	C1608X5R1A105K	TDK
3	C25, C34, C36	1 nF	Capacitor, Ceramic, 50 V, CH, 10%	STD	STD
0	C2, C6, C26, C33, C38, C42	NU			
1	D1	BAT54	Diode, Schottky, 200 mA, 30 V	BAT54	STD
0	D2–D4	NU			
1	D5	BAT54S	Diode, Dual Schottky, 200 mA, 30 V	BAT54S	STD
1	L1	0.36 µH	Inductor, Power Choke SMT, 30 A, 1.05 mΩ	MPCG1040LR36	NEC Tokin
1	Q1	CSD17302Q5A	MOSFET, NChan, 30 V, 87 A, 7.3 mΩ	CSD17302Q5A	TI
1	Q2	CSD17312Q5	MOSFET, NChan, 30 V, 100 A, 1.4 mΩ	CSD17312Q5	TI
1	Q4	CSD17303Q5	MOSFET, NChan, 30 V, 100 A, 2 mΩ	CSD17303Q5	TI
0	Q3, Q5	NU			
2	R3, R5	100 kΩ	Resistor, Chip, 1/16 W, 1%	STD	STD
1	R4	1 kΩ	Resistor, Chip, 1/16 W, 1%	STD	STD
1	R6	27 kΩ	Resistor, Chip, 1/16 W, 1%	STD	STD
7	R8, R10, R11, R12, R14, R30, R31	0 Ω	Resistor, Chip, 1/16 W, 1%	STD	STD
1	R9	3.9 Ω	Resistor, Chip, 1/16 W, 1%	STD	STD
1	R15	2.2 Ω	Resistor, Chip, 1/10 W, 1%	STD	STD
1	R16	1.5 kΩ	Resistor, Chip, 1/16 W, 1%	STD	STD
1	R17	150 kΩ	Resistor, Chip, 1/16 W, 1%	STD	STD
3	R18–R20	10 kΩ	Resistor, Chip, 1/16 W, 1%	STD	STD
1	R24	240 Ω	Resistor, Chip, 1/16 W, 1%	STD	STD
2	R25, R26	0.25 Ω	Resistor, Chip, 1 W, 1%	WSL2512R2500FEA	Vishay
1	R29	0.005 Ω	Resistor, Chip, 1 W, 1%	ERJM1WSF5M0U	Panasonic
1	R7	10 Ω	Resistor, Chip, 1/16 W, 1%	STD	STD
1	R33	130 Ω	Resistor, Chip, 1/16 W, 1%	STD	STD
1	R34	1 Ω	Resistor, Chip, 1/16 W, 1%	STD	STD
0	R1, R2, R13, R21–R23, R27, R28, R32	NU			
1	SW1	G12AP	Switch, ON-ON Mini Toggle	G12AP	Nikkai
1	U1	TPS51219RTE	IC, High Performance, Single Synchronous Step-Down Controller	TPS51219RTE	TI
1	U2	TPS71533DCK	IC, Regulator, LDO, 50 mA, 24 V	TPS71533DCK	TI
1	U3	TLC555CD	IC, Timer, Low-Power CMOS	TLC555D	TI
1	U4	SN74HC14PW	IC, HEX Schmitt Trigger Inverters.	SN74HC14PW	TI
1	U5	UCC27324D	IC, Dual 4 A High Speed MOSFET Driver	UCC27324D	TI

9 Revision History

NOTE: Page numbers for previous revisions may differ from page numbers in the current version.

Changes from Revision * (April 2012) to Revision A (February 2022) **Page**

- Changed user's guide title.. 3
- Updated the numbering format for tables, figures, and cross-references throughout the document. 3