

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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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:

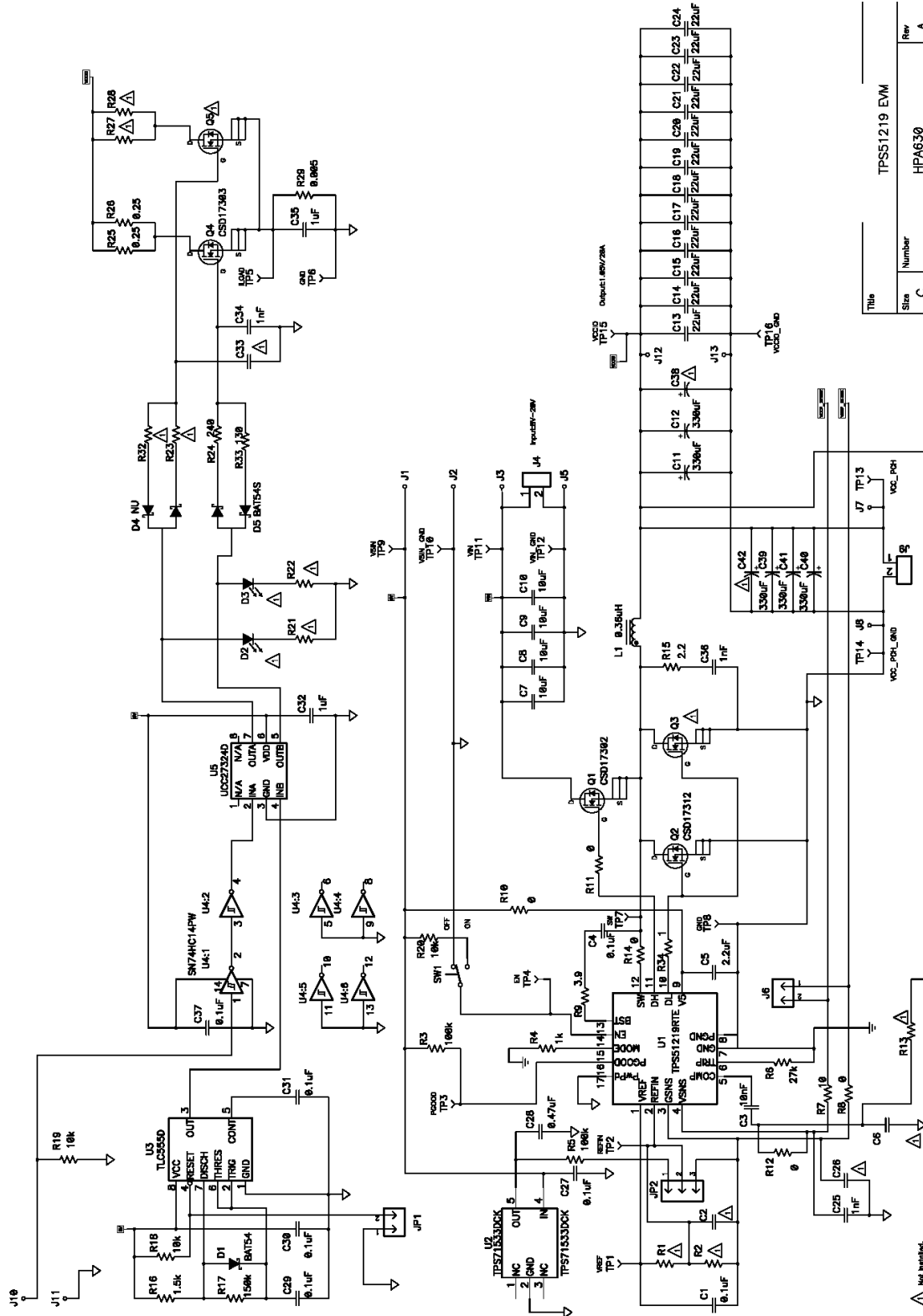
- D-CAP2™-mode operation with low-ESR output capacitance
- 2% tolerance 1.05-V output voltage
- 20-Adc, steady-state output current
- Support prebias output voltage start-up
- 500-kHz switching frequency
- SW1 for enable function
- Convenient test points for probing critical waveforms

2 Electrical Performance Specifications

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

| Parameter | Test Conditions | Min | Typ | Max | Unit |
|---------------------------------------|---|-----|-------|-----|------|
| Input Characteristics | | | | | |
| Voltage range | V _{IN} 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 | V _{5IN} 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



| Title | Size | Number | Rev |
|--------------|------|--------|-----|
| TPS51219 EVM | C | HPA630 | A |

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

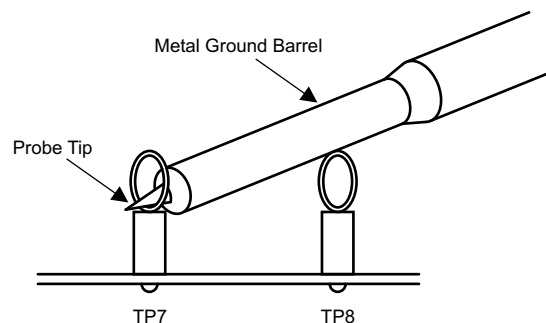


Figure 4-1. Tip and Barrel Measurement for Switch Node Voltage

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

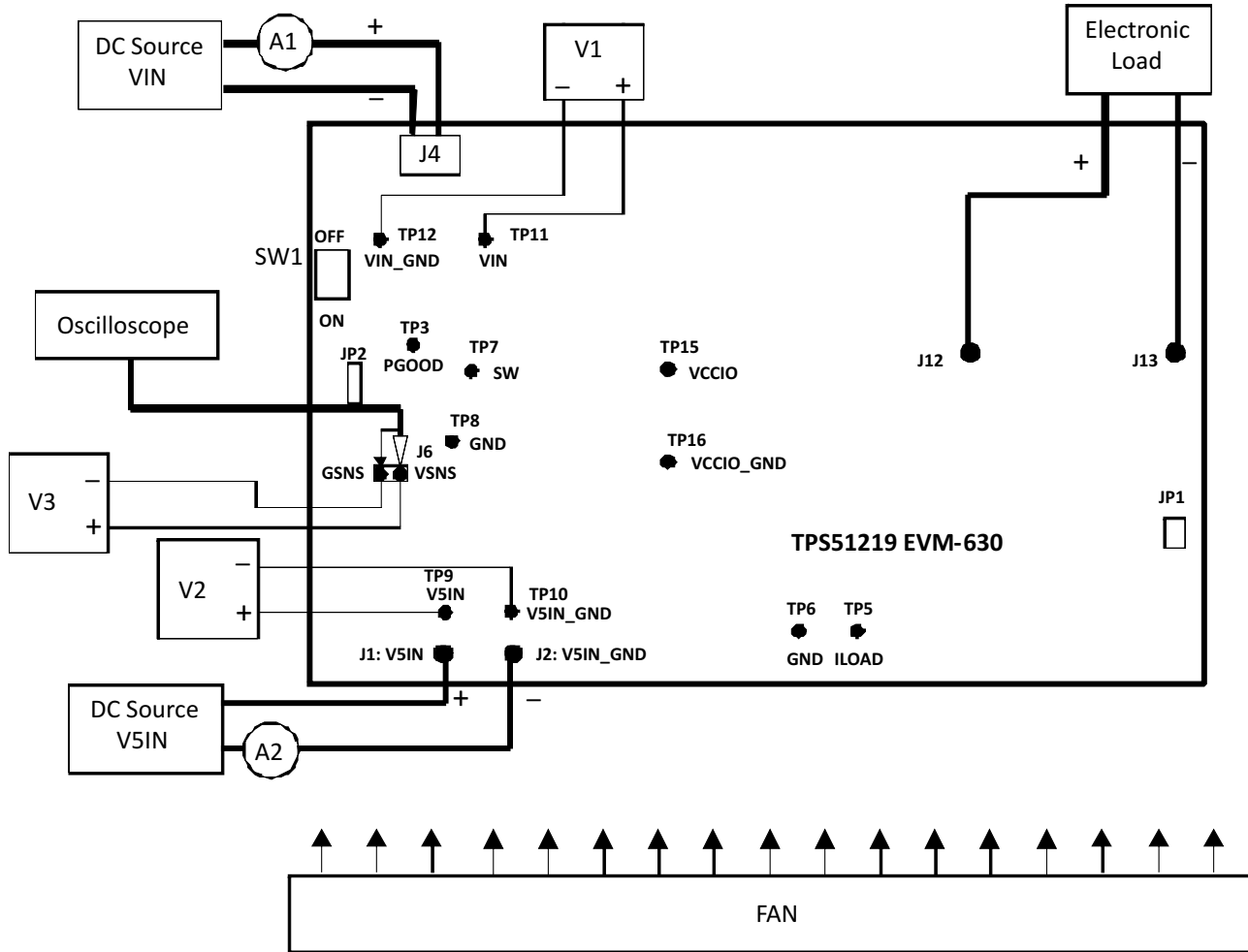


Figure 4-2. TPS51219EVM-630 Recommended Test Setup

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

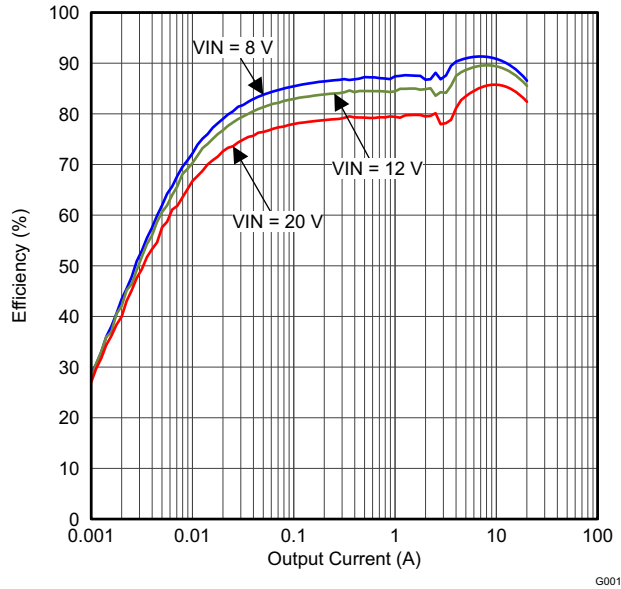


Figure 6-1. TPS51219EVM-630 Efficiency

6.2 Load Regulation

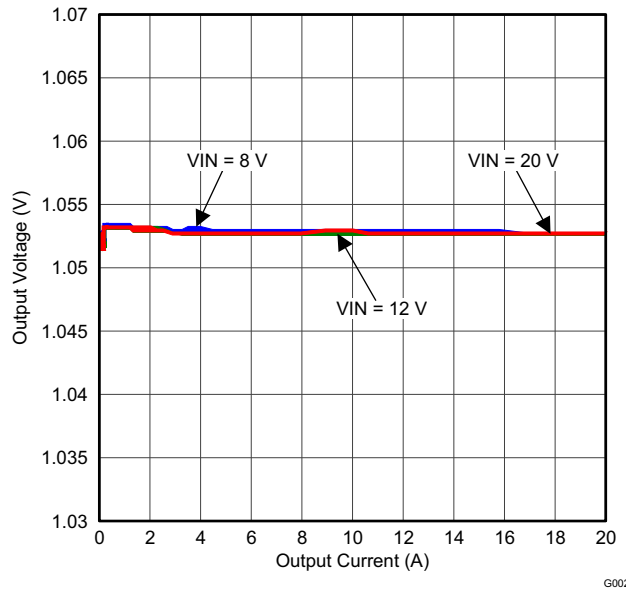


Figure 6-2. TPS51219EVM-630 Load Regulation

6.3 Line Regulation

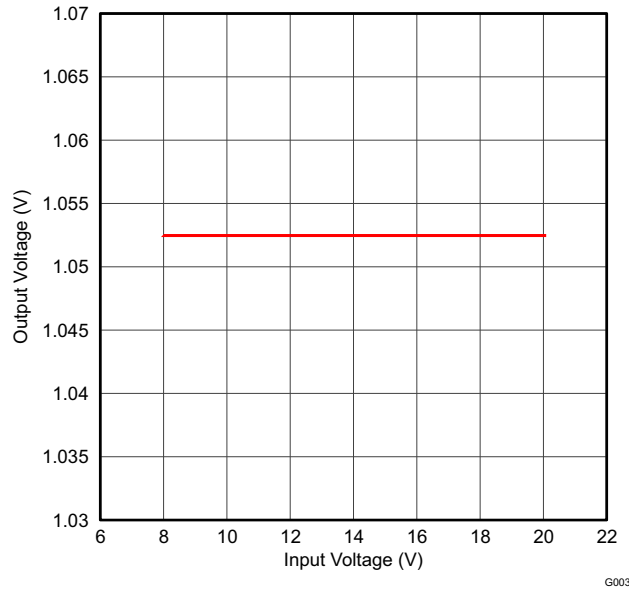


Figure 6-3. TPS51219EVM-630 Line Regulation

6.4 Load Transient

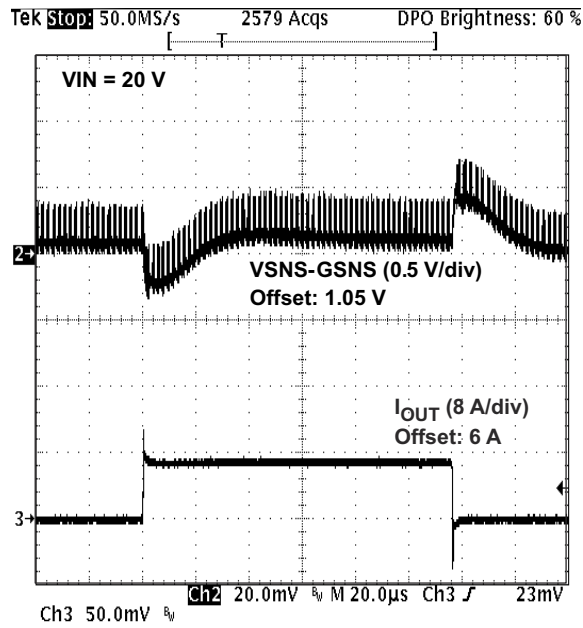


Figure 6-4. TPS51219EVM-630 Load Transient ($V_{OUT} = 1.05\text{ V}$)

6.5 Output Ripple

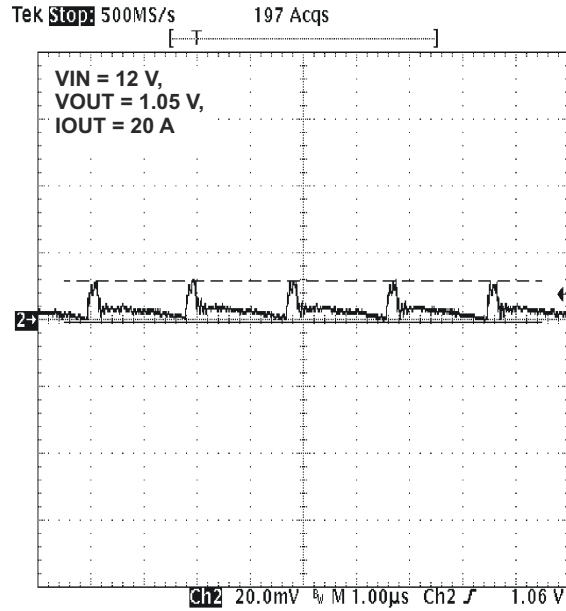


Figure 6-5. Output Ripple

6.6 Switch Node Voltage

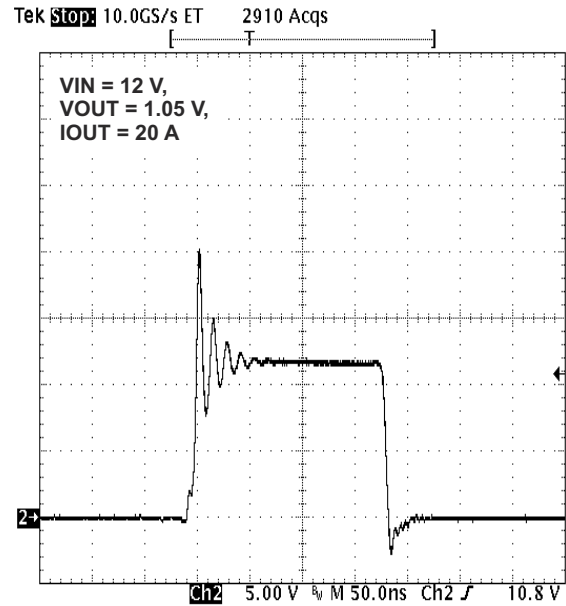
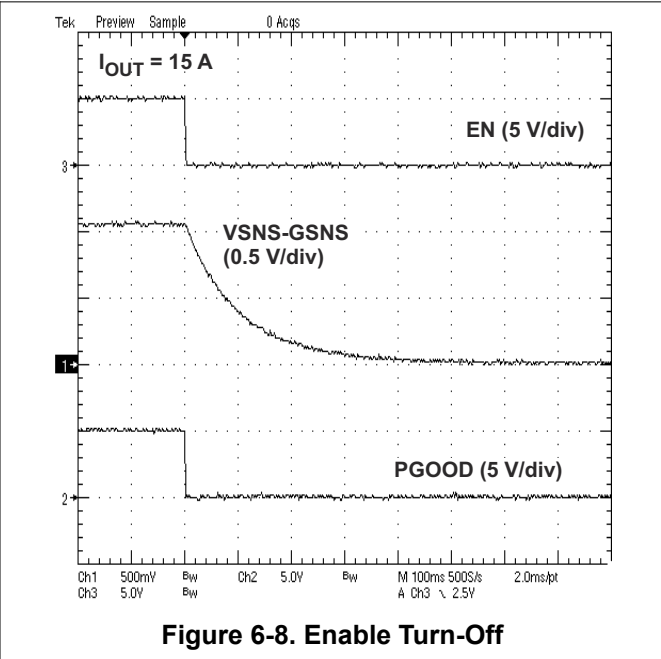
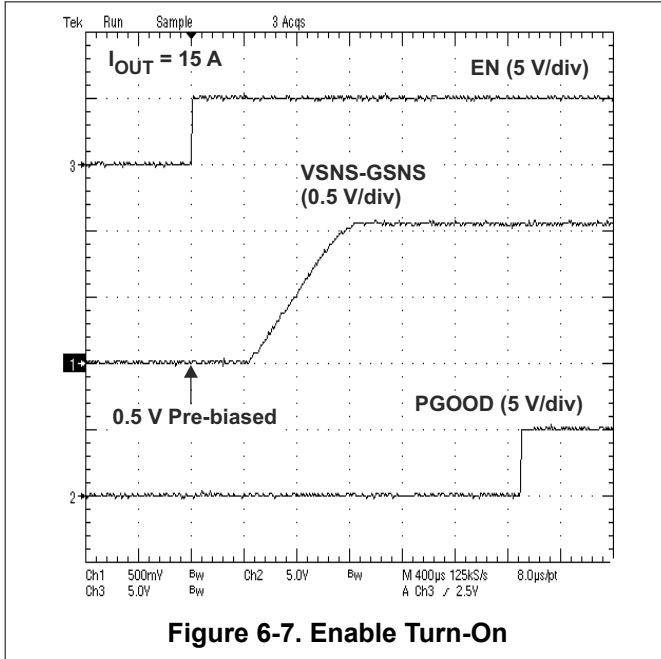
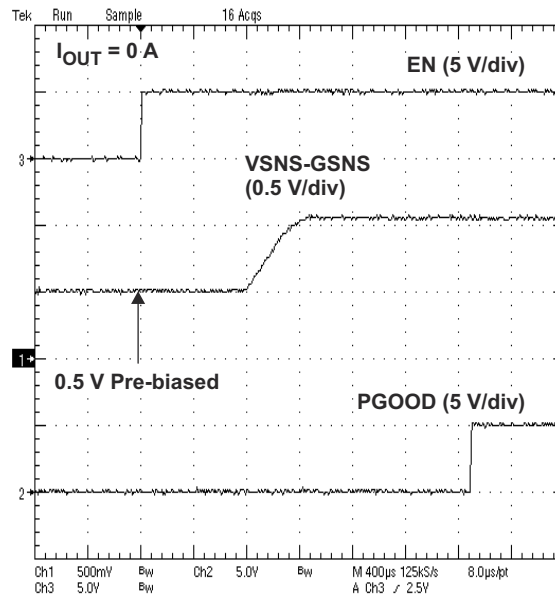


Figure 6-6. Switching Node Waveform

6.7 Turn-On/Turn-Off Waveform



6.8 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.

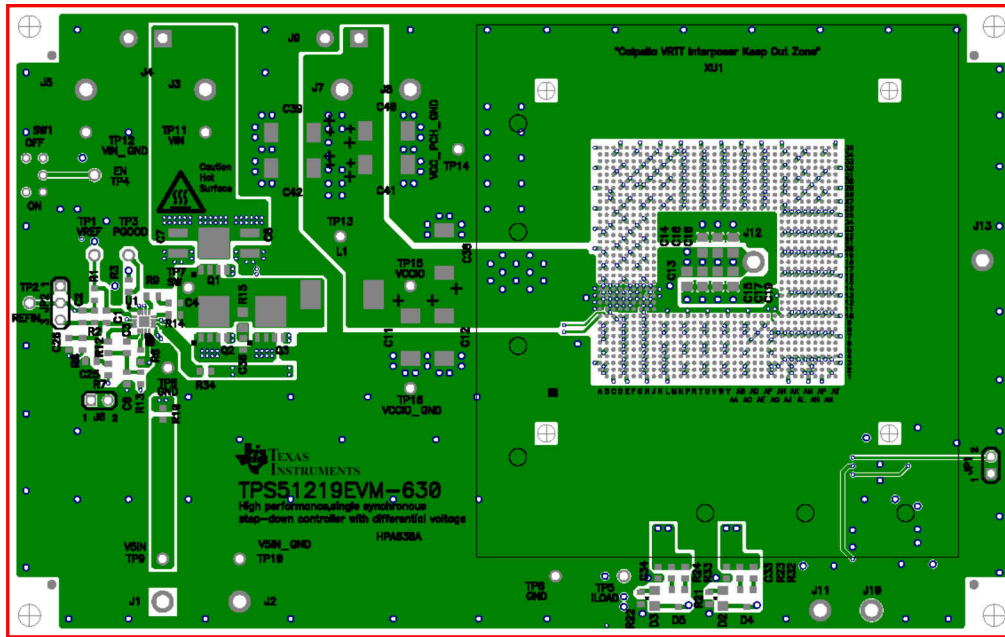


Figure 7-1. TPS51219EVM-630 Top Layer Assembly Drawing (Top View)

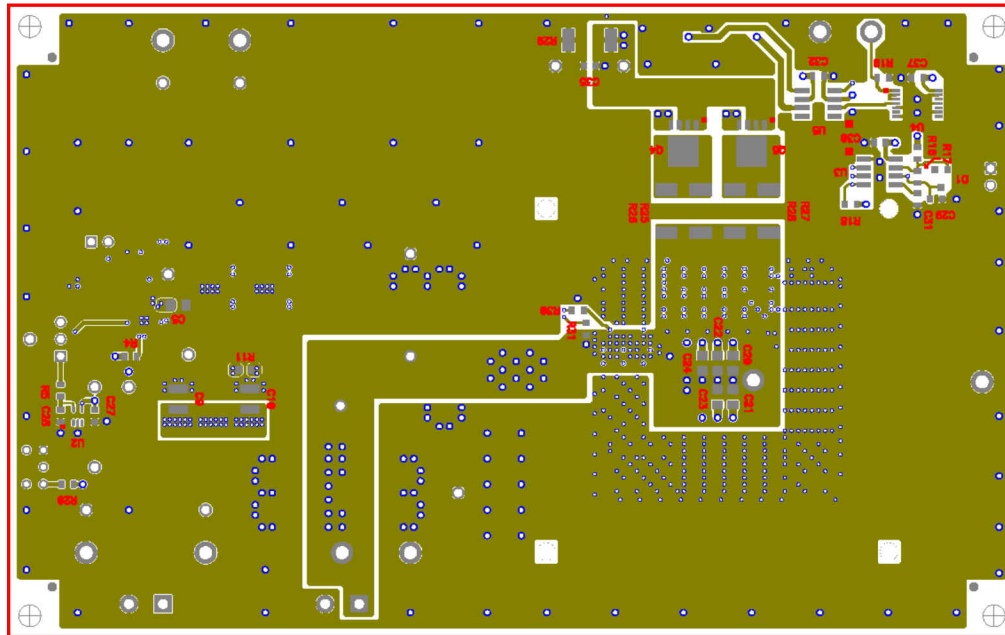


Figure 7-2. TPS51219EVM-630 Bottom Layer Assembly Drawing (Bottom View)

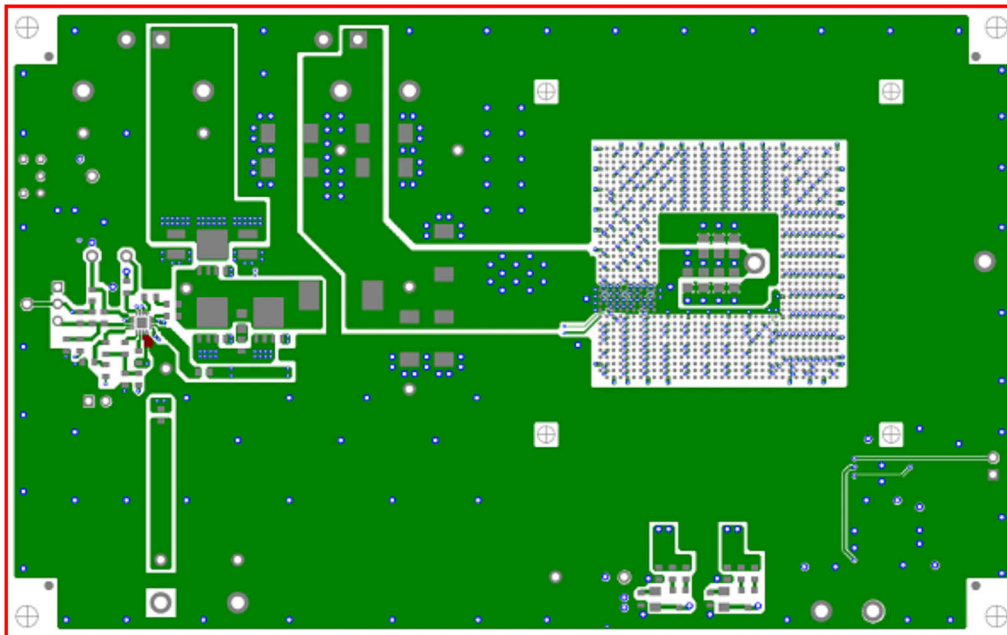


Figure 7-3. TPS51219EVM-630 Top Copper Layer (Top View)

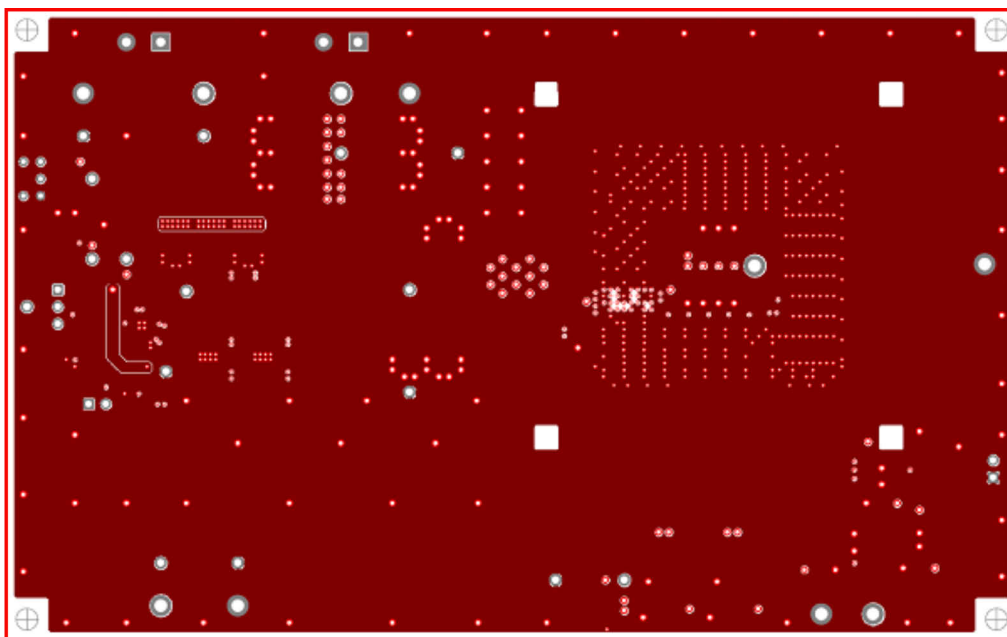


Figure 7-4. TPS51219EVM-630 Internal Layer 1 (Top View)

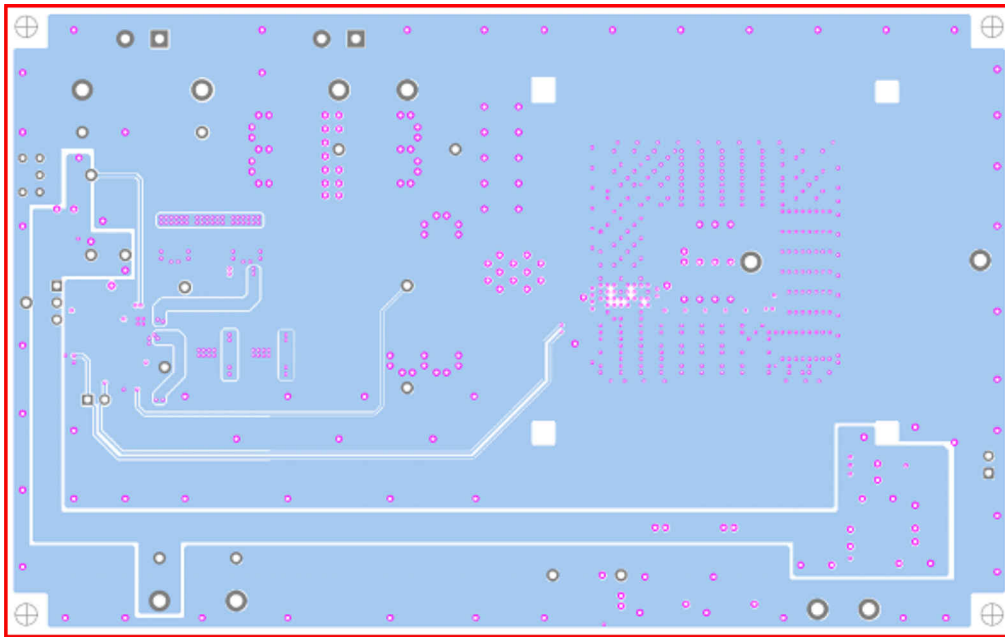


Figure 7-5. TPS51219EVM-630 Internal Layer 2 (Top View)

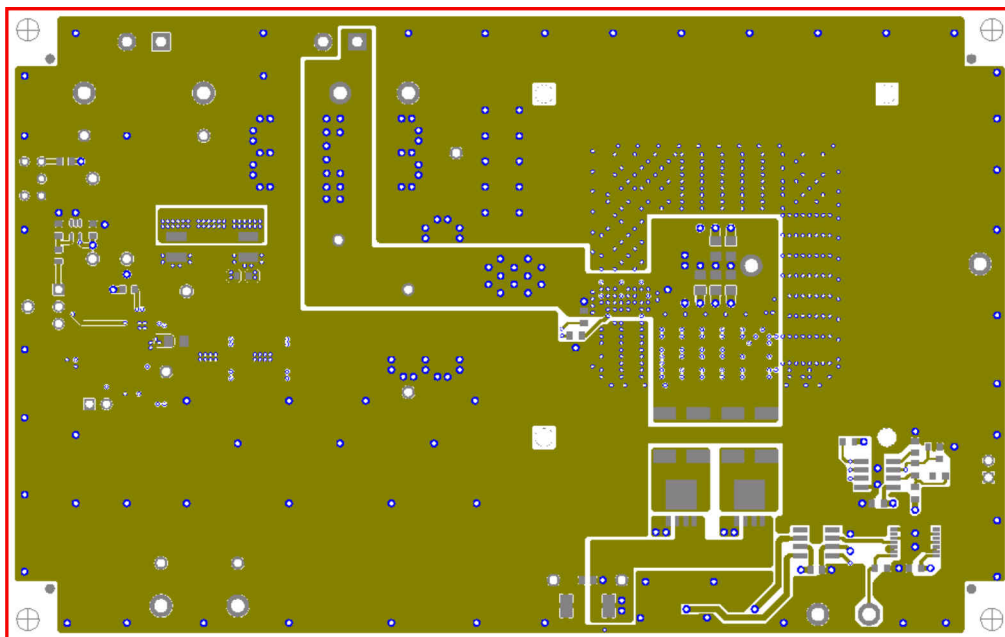


Figure 7-6. TPS51219EVM-630 Bottom Copper Layer (Top View)

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 μ F | Capacitor, Ceramic, 50 V, X5R, 10% | STD | STD |
| 1 | C3 | 10 nF | Capacitor, Ceramic, 50 V, X5R, 10% | STD | STD |
| 1 | C5 | 2.2 μ F | Capacitor, Ceramic, 10 V, X5R, 10% | GRM188R61A225KE34 | muRata |
| 4 | C7, C8, C9, C10 | 10 μ F | Capacitor, Ceramic, 25 V, X5R, 20% | TMK325BJ106MM-T | Taiyo Yuden |
| 5 | C11, C12, C39–C41 | 330 μ F | Capacitor, Aluminum, 2 V, 6 m Ω , 20% | EEFSX0D331XE | Panasonic |
| 12 | C13–C24 | 22 μ F | Capacitor, Ceramic, 6.3 V, X5R, 10% | JMK212BJ226MG-T | Taiyo Yuden |
| 1 | C28 | 0.47 μ F | Capacitor, Ceramic, 50 V, X5R, 10% | STD | STD |
| 2 | C32, C35 | 1 μ F | 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 μ H | Inductor, Power Choke SMT, 30 A, 1.05 m Ω | MPCG1040LR36 | NEC Tokin |
| 1 | Q1 | CSD17302Q5A | MOSFET, NChan, 30 V, 87 A, 7.3 m Ω | CSD17302Q5A | TI |
| 1 | Q2 | CSD17312Q5 | MOSFET, NChan, 30 V, 100 A, 1.4 m Ω | CSD17312Q5 | TI |
| 1 | Q4 | CSD17303Q5 | MOSFET, NChan, 30 V, 100 A, 2 m Ω | CSD17303Q5 | TI |
| 0 | Q3, Q5 | NU | | | |
| 2 | R3, R5 | 100 k Ω | Resistor, Chip, 1/16 W, 1% | STD | STD |
| 1 | R4 | 1 k Ω | Resistor, Chip, 1/16 W, 1% | STD | STD |
| 1 | R6 | 27 k Ω | 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 k Ω | Resistor, Chip, 1/16 W, 1% | STD | STD |
| 1 | R17 | 150 k Ω | Resistor, Chip, 1/16 W, 1% | STD | STD |
| 3 | R18–R20 | 10 k Ω | 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 |

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