User's Guide

LMR12020 Step-Down Converter Evaluation Module User's Guide

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Trademarks

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1 Introduction

The LMR12020 evaluation module is designed to provide the power supply design engineer with a fully functional regulator design, which can be synchronized to an external clock between 1000 kHz and 2350 kHz. The evaluation module provides two output voltage options viz. 3.3 V and 5 V with a 2-A current capability. Without an external synchronization signal, the design operates at 2000 kHz, reducing the solution size and keeping switching noise out of the AM radio band. The PCB consists of four layers of copper on FR4 material. The first middle layer is a solid ground layer, which helps in minimizing the AC current loop. The LMR12020 is thermally tied to the other layers by thermal vias directly underneath the device. This user's guide contains the evaluation module schematic, a quick setup procedure, and a bill-of-materials (BOM). For complete circuit design information, see the *LMR12015/LMR12020 SIMPLE SWITCHER 20Vin, 1.5A/2A Step-Down Voltage Regulator in WSON-10 Data Sheet*.

2 Features

Parameter	3.3-V Output Voltage Option	5-V Output Voltage Option
Input range	5 V to 20 V	7 V to 20 V
Output voltage	3.3 V	5 V
Output current	0 A to 2 A	0 A to 2 A
Frequency of operation	1000 kHz to 2350 kHz	1000 KHz to 2350 KHz
Default frequency of operation	2000 kHz	2000 kHz
Board size	1.944 × 1.35 inches (49.37 × 34.29 mm)	1.944 × 1.35 inches (49.37 × 34.29 mm)

3 Evaluation Module Schematic

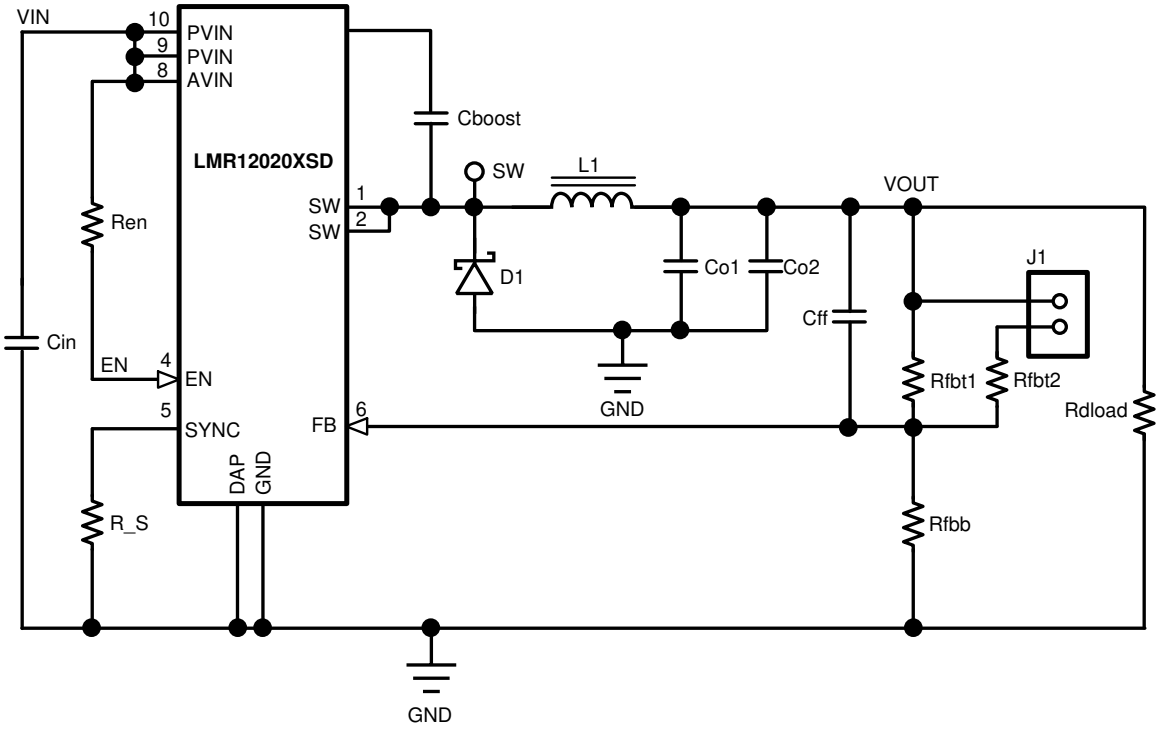

Figure 3-1. LMR12020 Evaluation Module Schematic

4 Powering and Loading Considerations

Read this entire section prior to attempting to power the evaluation board.

4.1 Quick Start Procedure

Step 1: Set the bench power supply current limit to 2 A. Set the power supply voltage to 12 V. Turn off the power supply output. Connect the power supply to the LMR12020 demo board. Positive connection to V_{IN} and negative connection to GND

Step 2: Connect a load, as high as 2 A, to the V_{OUT} terminal. Positive connection to V_{OUT} and negative connection to GND

Step 3: Turn on the bench power supply with no load applied to the LMR12020 and the shunt for the jumper J1 in place. The V_{OUT} would be in regulation at a nominal 3.3-V output. With the shunt out, a minimum load of 10 mA would be required to have the V_{OUT} in regulation at 5 V.

Step 4: Gradually increase the load and V_{OUT} should remain in regulation as the load is increased up to 2 Amps. The V_{OUT} should also be regulated when the input is swept from the minimum input to 20 V.

4.2 Starting Up

The EN pin is tied to V_{IN} to simplify start-up. The pullup resistor allows the power supply design engineer to toggle EN independently, if desired, and observe the start-up behavior of the LMR12020. Use the EN post to disable the device by pulling this node to GND. A logic signal can be applied to the post to test start-up and shutdown of the device.

4.3 Synchronization

A SYNC pin has been provided on the evaluation board. This pin can be used to synchronize the regulator to an external clock or multiple evaluation boards can be synchronized together by connecting their SYNC pins together. For complete information, see the *LMR12015/LMR12020 SIMPLE SWITCHER 20Vin, 1.5A/2A Step-Down Voltage Regulator in WSON-10 Data Sheet*.

4.4 No Load Start-Up at High Output Voltage

The LMR12020 cannot start-up at no load when the output voltage goes above 3.3 V. Refer to the LMR12020 data sheet for more information regarding minimum load requirements. A position for a dummy load is provided on the board. Populating that with a 500-Ω resistor facilitates the start-up at no load for the 5-V output voltage options.

4.5 Adjusting the Output Voltage

The output voltage is set using the following equation where R_{fbb} is connected between the FB pin and GND, and R_{fbt} is connected between V_{OUT} and FB.

$$V_{OUT} = V_{FB}(1 + (R_{fbt}/R_{fbb})) \quad (1)$$

Adjusting the output voltage will affect the performance of the LMR12020. In addition, output capacitors might not be rated for the new output voltage. For more information, see the *LMR12015/LMR12020 SIMPLE SWITCHER 20Vin, 1.5A/2A Step-Down Voltage Regulator in WSON-10 Data Sheet*.

4.6 Typical Test Setup

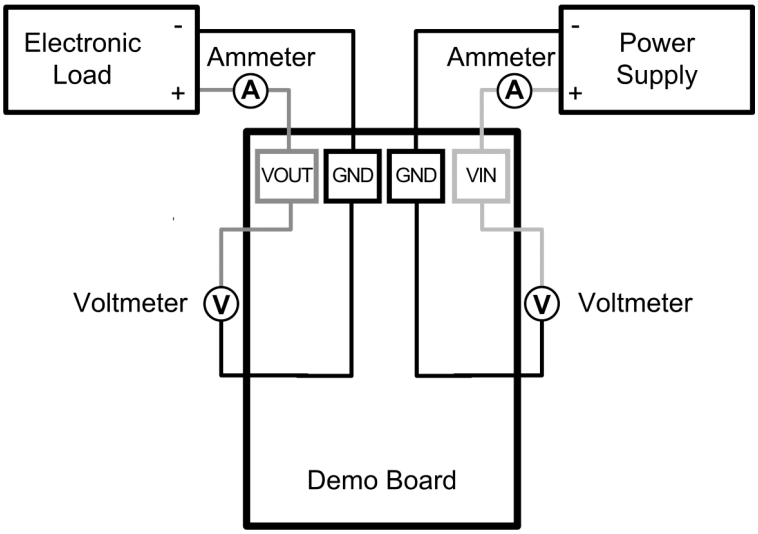

Figure 4-1. Efficiency Measurements

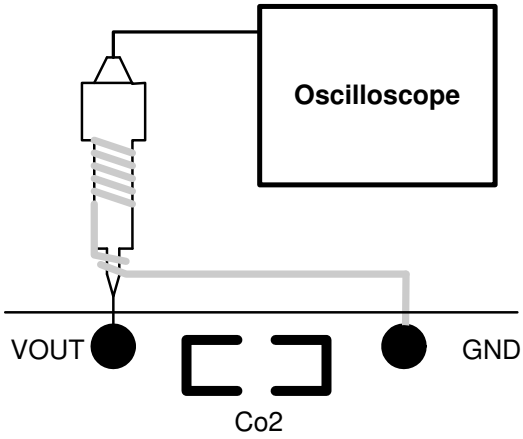

Figure 4-2. Voltage Ripple Measurements

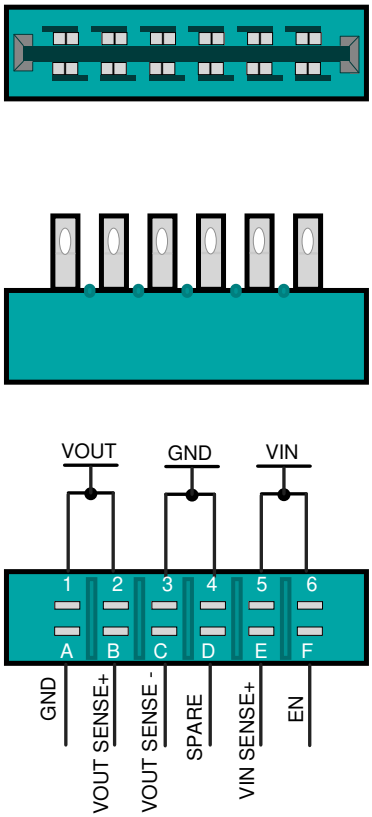

Figure 4-3. Edge Connector Schematic

5 Board Images

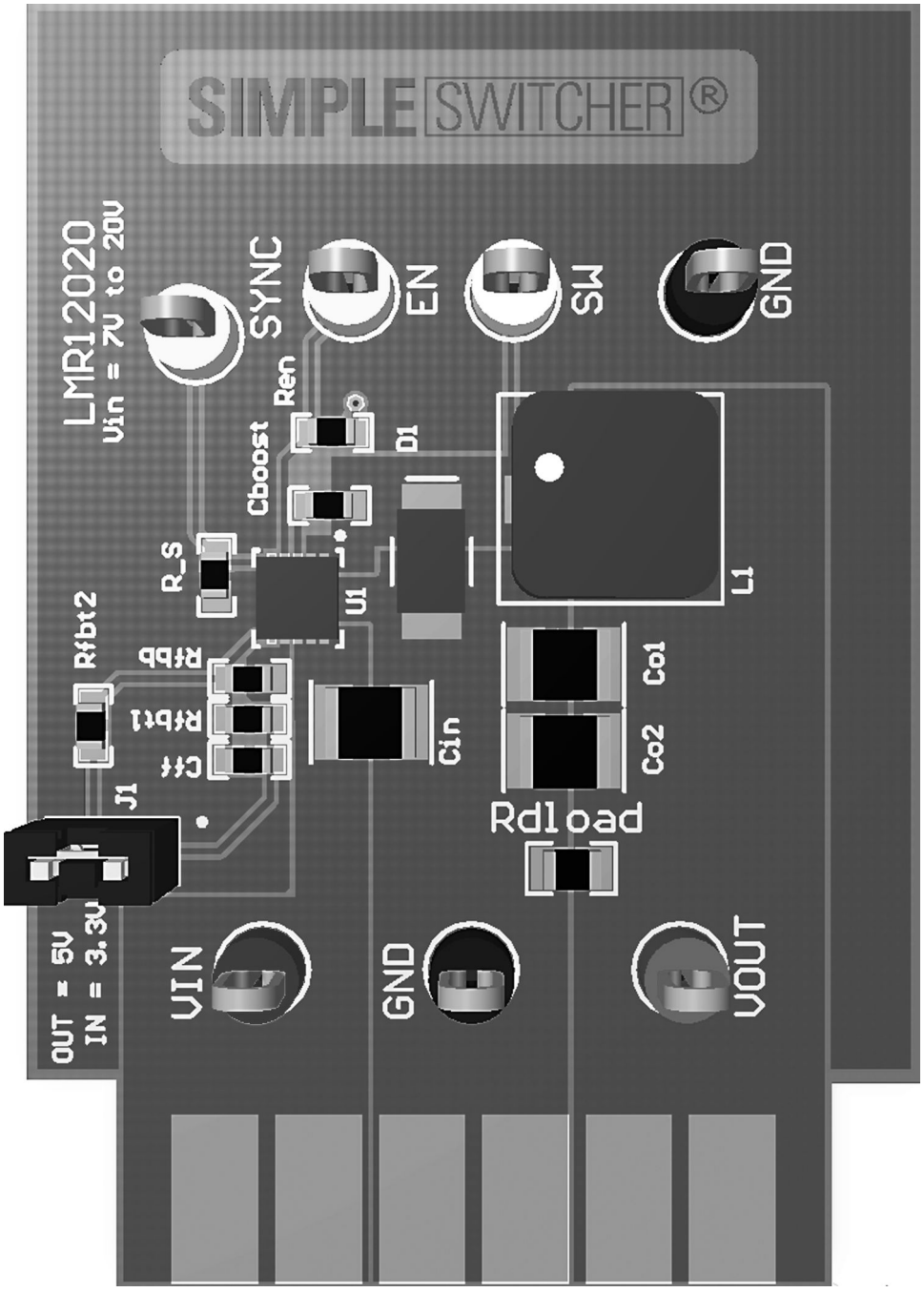

Figure 5-1. Top Side

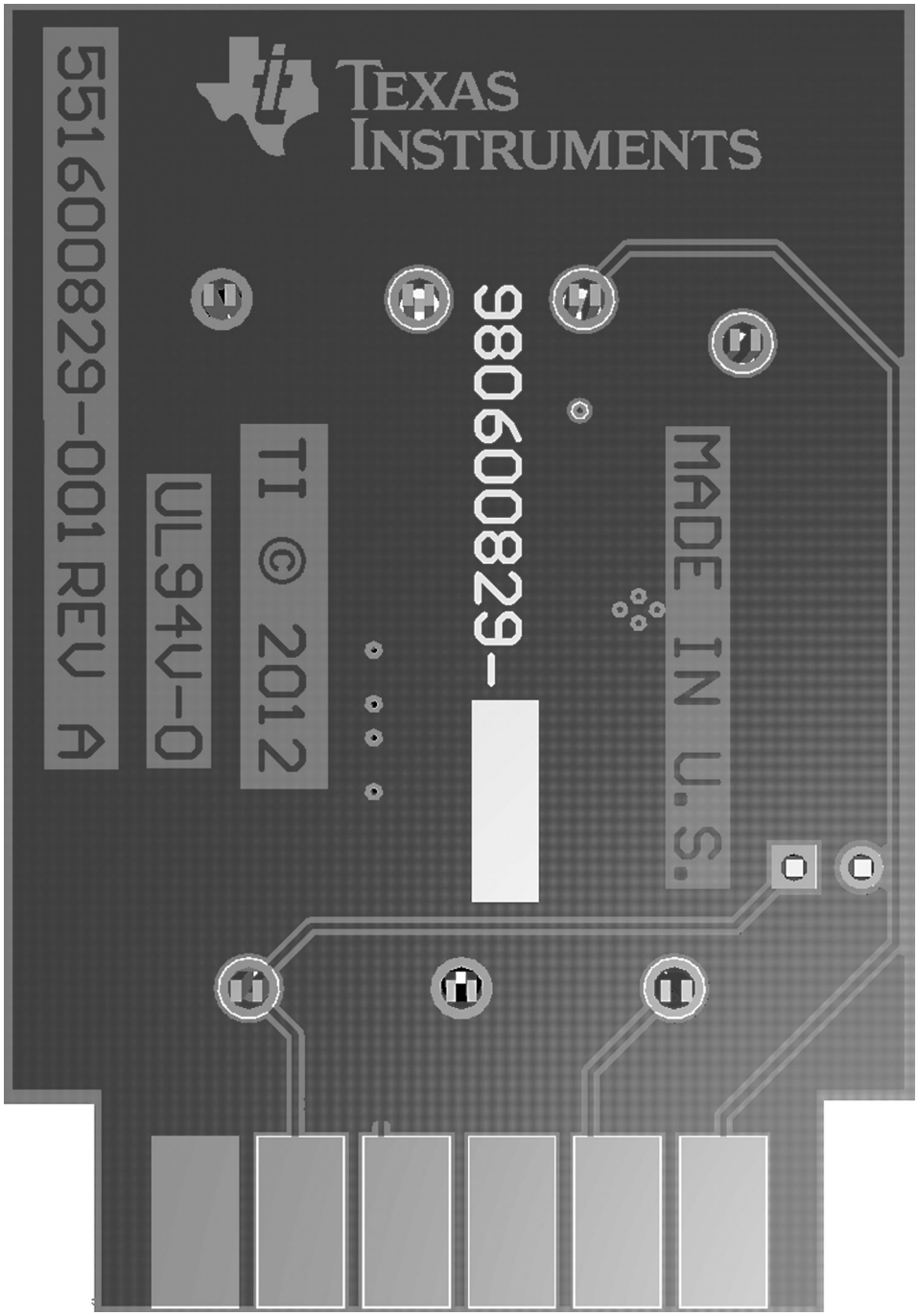

Figure 5-2. Bottom Side

6 Performance Characteristics

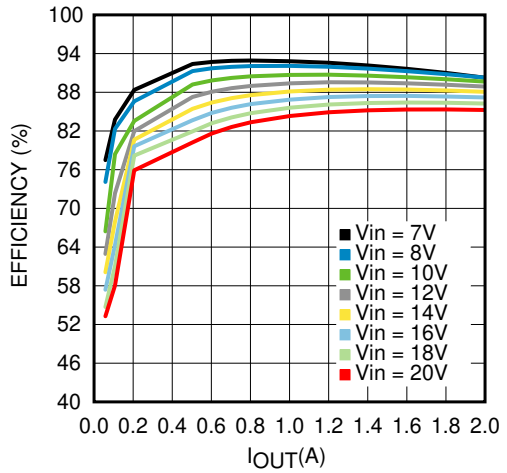

Figure 6-1. Efficiency vs. Load Current LMR12020 V_{OUT} = 5 V

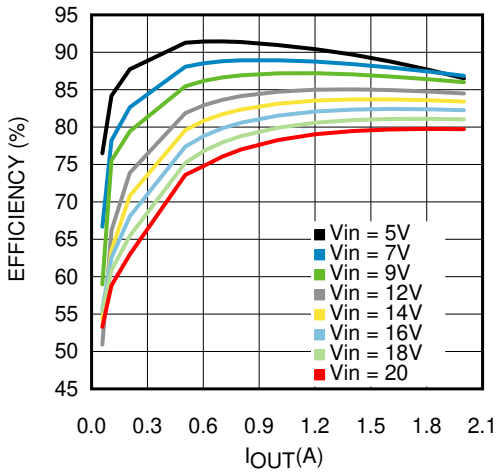

Figure 6-2. Efficiency vs. Load Current LMR12020 V_{OUT} = 3.3 V

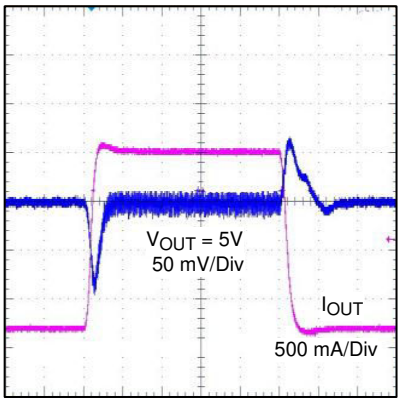

Figure 6-3. Load Transient Waveforms LMR12020, V_{OUT} = 5 V, V_{IN} = 12 V, I_{OUT} = 200 mA to 2 A

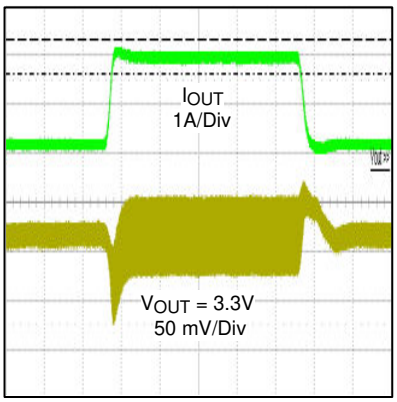

Figure 6-4. Load Transient Waveforms LMR12020, V_{OUT} = 3.3 V, V_{IN} = 12 V, I_{OUT} = 200 mA to 2 A

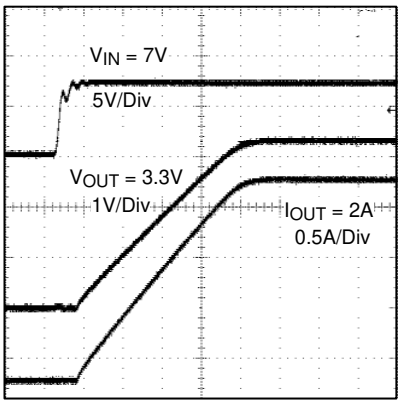

Figure 6-5. Start-Up Waveform, V_{OUT} = 3.3 V

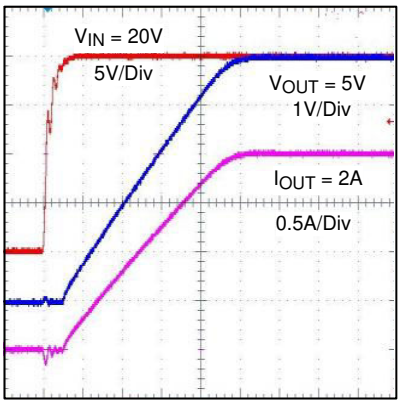

Figure 6-6. Start-Up Waveform, V_{OUT} = 5 V

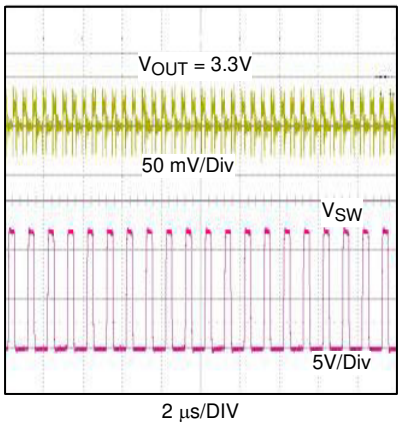

Figure 6-7. Switching Node and Output Voltage Waveforms V_{IN} = 12 V, I_{OUT} = 2 A

7 Bill of Materials

Part Name	Part ID	Part Value	Part Number	Manufacturer
Buck Regulator	U1	2-A Buck Regulator	LMR12020	Texas Instruments
Input Capacitor	Cin	10 µF	C1210C106K8PACTU	Kemet
Bootstrap Capacitor	Cboost	0.1 µF	C0603C104K8RACTU	Kemet
Output Capacitor	Co1	22 µF	GRM32ER71C226KE18L	Murata
Output Capacitor	Co2	22 µF	GRM32ER71C226KE18L	Murata
Catch Diode	D1	Schottky Diode Vf = 0.32 V	CMS01	Toshiba
Inductor	L1	3.3 µH	7447789003	Wurth Elektronik eiSos
Feedback Resistor	Rfbt1	4.02 kΩ	CRCW06034K02FKEA	Vishay-Dale
Feedback Resistor	Rfbt2	5.49 kΩ	CRCW06035K49FKEA	Vishay-Dale
Feedback Resistor	Rfbb	1.02 kΩ	CRCW06031K02FKEA	Vishay-Dale
Pull-up Resistor	Ren	4.75 kΩ	CRCW06034K75FKEA	Vishay-Dale
Pull-down Resistor	R_S	4.75 kΩ	CRCW06034K75FKEA	Vishay-Dale
Test Point	VIN	Test Point Loop	5010	Keystone
Test Point	SW	Test Point Loop	5012	Keystone
Test Point	GND	Test Point Loop	5011	Keystone
Test Point	GND	Test Point Loop	5011	Keystone
Test Point	VOUT	Test Point Loop	5013	Keystone
Test Point	EN	Test Point Loop	5014	Keystone
Test Point	SYNC	Test Point Loop	5014	Keystone
Header	J1	2 × 1 Header, TH, 100mil	TSW-102-07-G-S	Samtec, Inc.
Shunt	SH-J1	Black 100-mil Gold Plated Shunt	969102-0000-DA	3M

8 PCB Layout

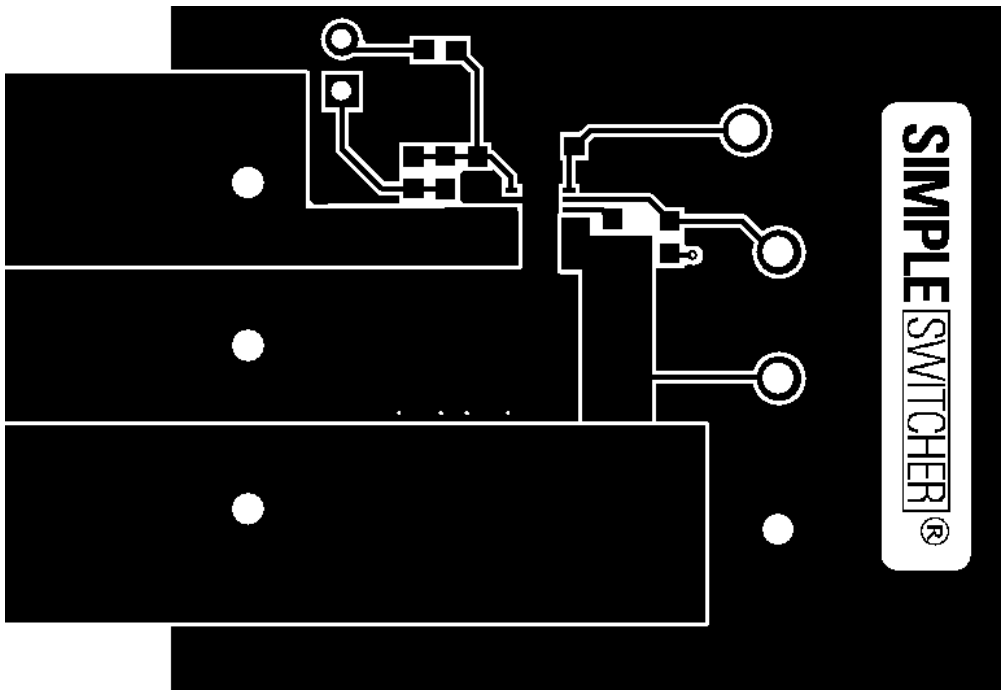

Figure 8-1. Top Copper

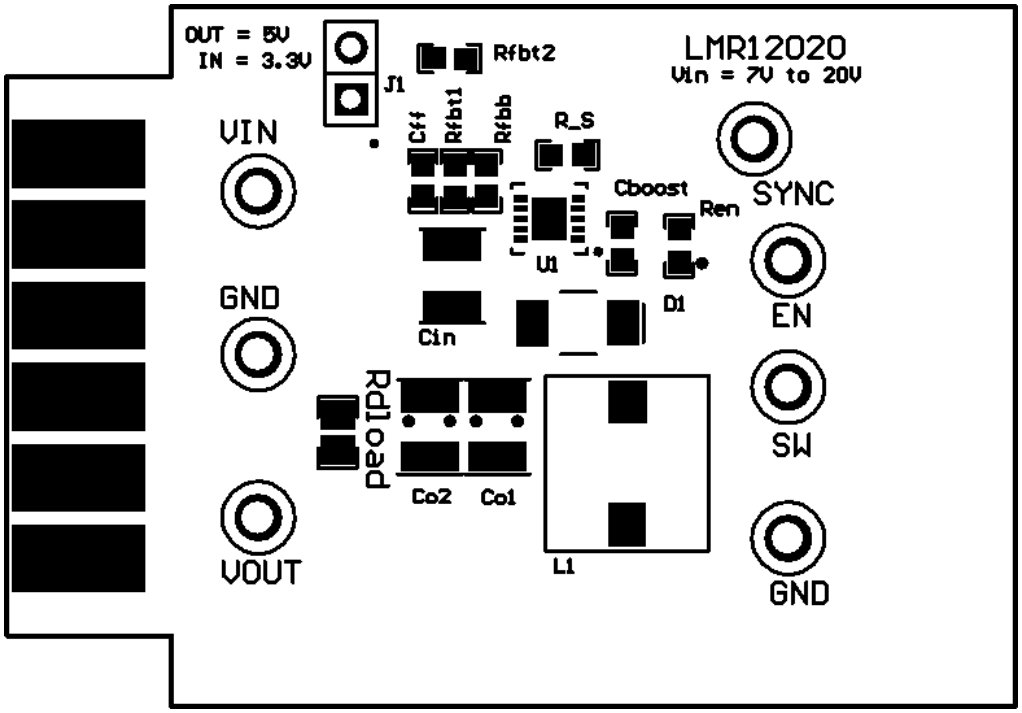

Figure 8-2. Top Overlay

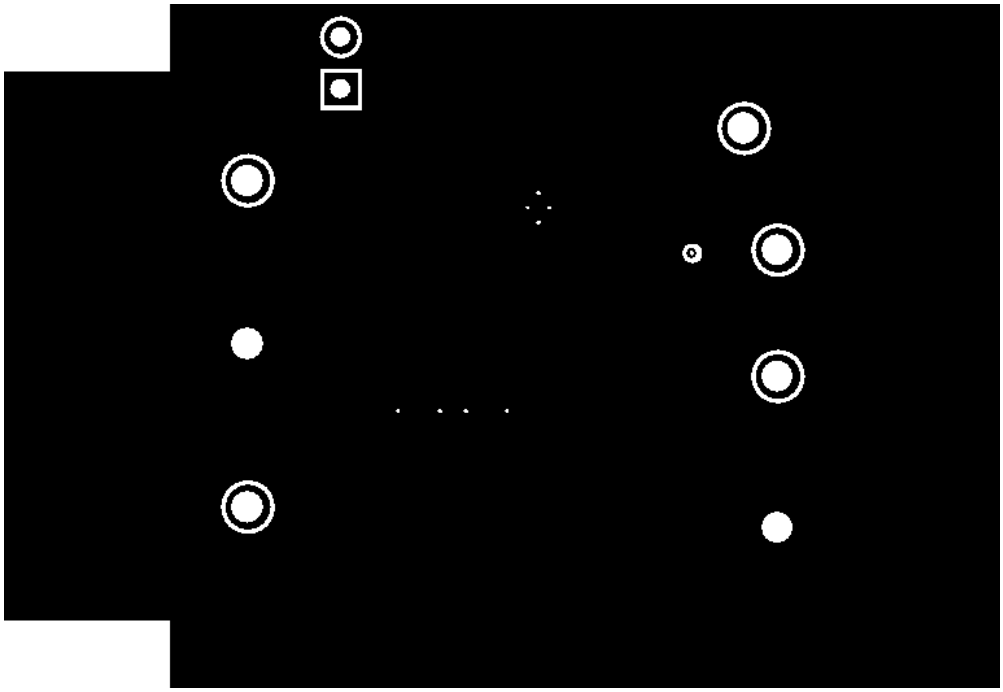

Figure 8-3. Internal Layer 1

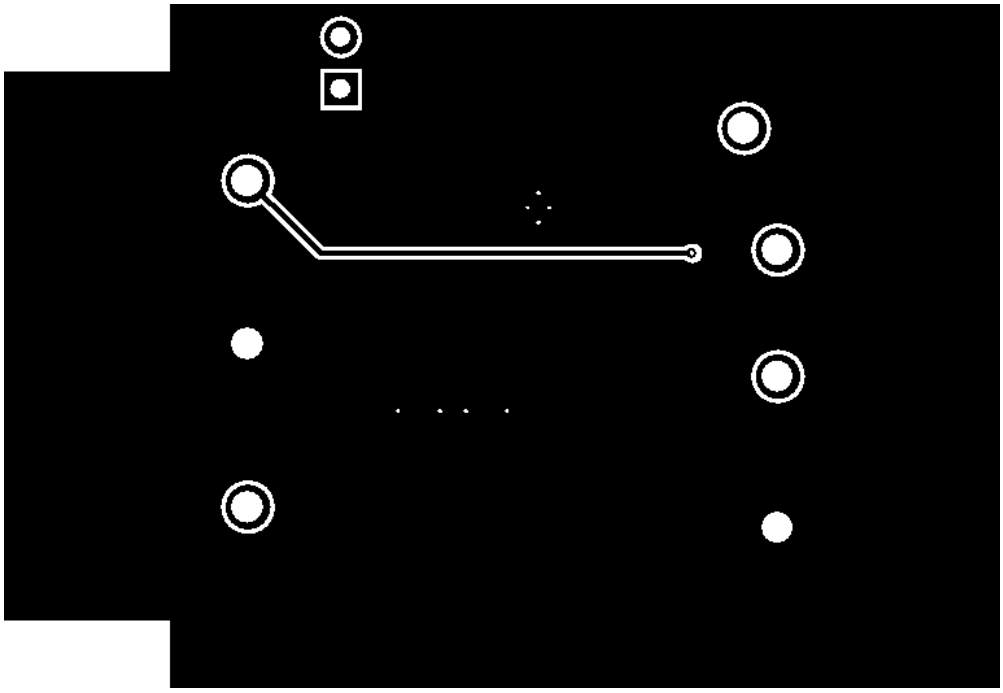

Figure 8-4. Internal Layer 2

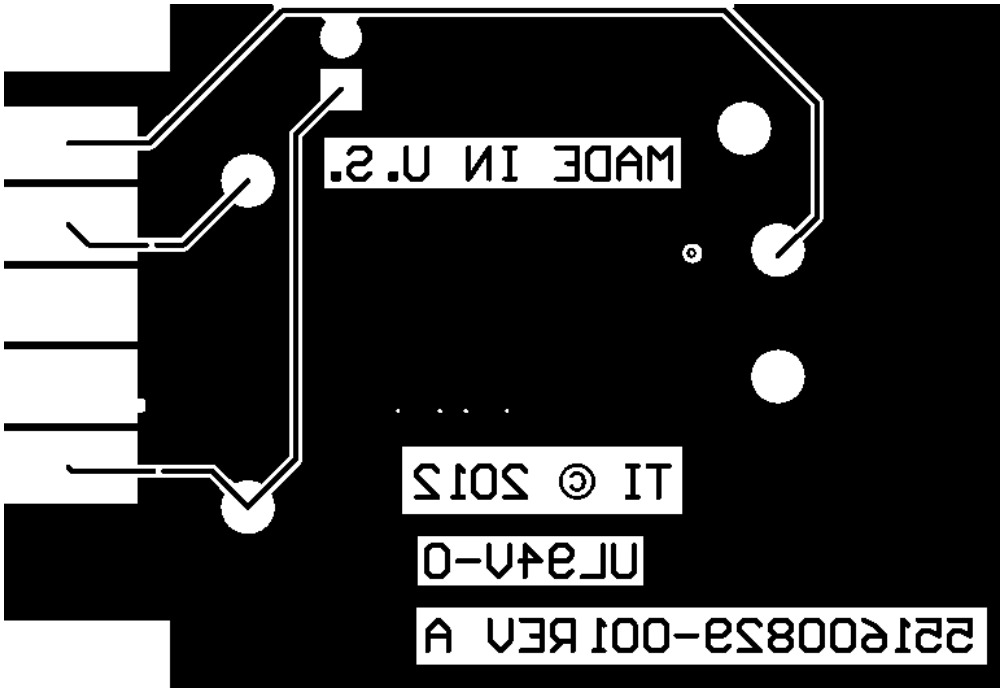

Figure 8-5. Bottom Copper

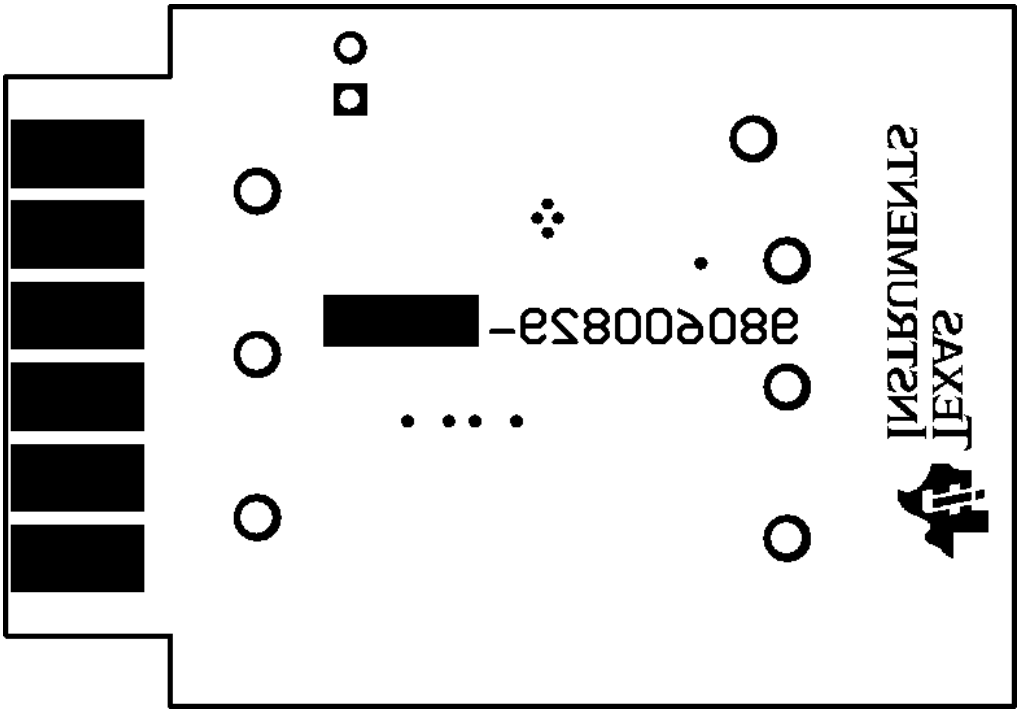

Figure 8-6. Bottom Overlay

9 Revision History

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

Changes from Revision A (April 2013) to Revision B (December 2021)	Page
• Updated the numbering format for tables, figures, and cross-references throughout the document.	2

- Updated the user's guide title..... 2
- Edited user's guide for clarity.....2

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