ISL81100EVAL2Z

100V Buck Controller 2-Phase Evaluation Board

The ISL81100EVAL2Z 2-phase evaluation board (shown in Figure 4) features the ISL81100, a 100V high-voltage synchronous buck controller that offers external soft-start, independent enable functions, and integrates UV/OV/OC/OT protection. A programmable switching frequency ranging from 100kHz to 1MHz helps to optimize inductor size while the strong gate driver delivers up to 20A for the buck output.

Specifications

The ISL81100EVAL2Z 2-phase evaluation board is designed for high current applications. The current rating of ISL81100EVAL2Z is limited by the FETs and inductor selected. The ISL81100EVAL2Z electrical ratings are shown in Table 1.

Table 1. Electrical Rating

Parameter	Rating
Input Voltage	18V to 100V
Switching Frequency	250kHz
Output Voltage	12V
Output Current	20A
OCP Set Point	Minimum 24A at ambient room temperature

Features

- Wide input range: 18V to 100V
- High light-load efficiency in pulse skipping DEM operation
- Programmable soft-start
- Optional DEM/PWM operation
- Peak current limit and constant current OCP
- Supports pre-bias output with soft-start
- PGOOD indicator
- OVP, OTP, and UVP protection
- Back biased from output to improve efficiency

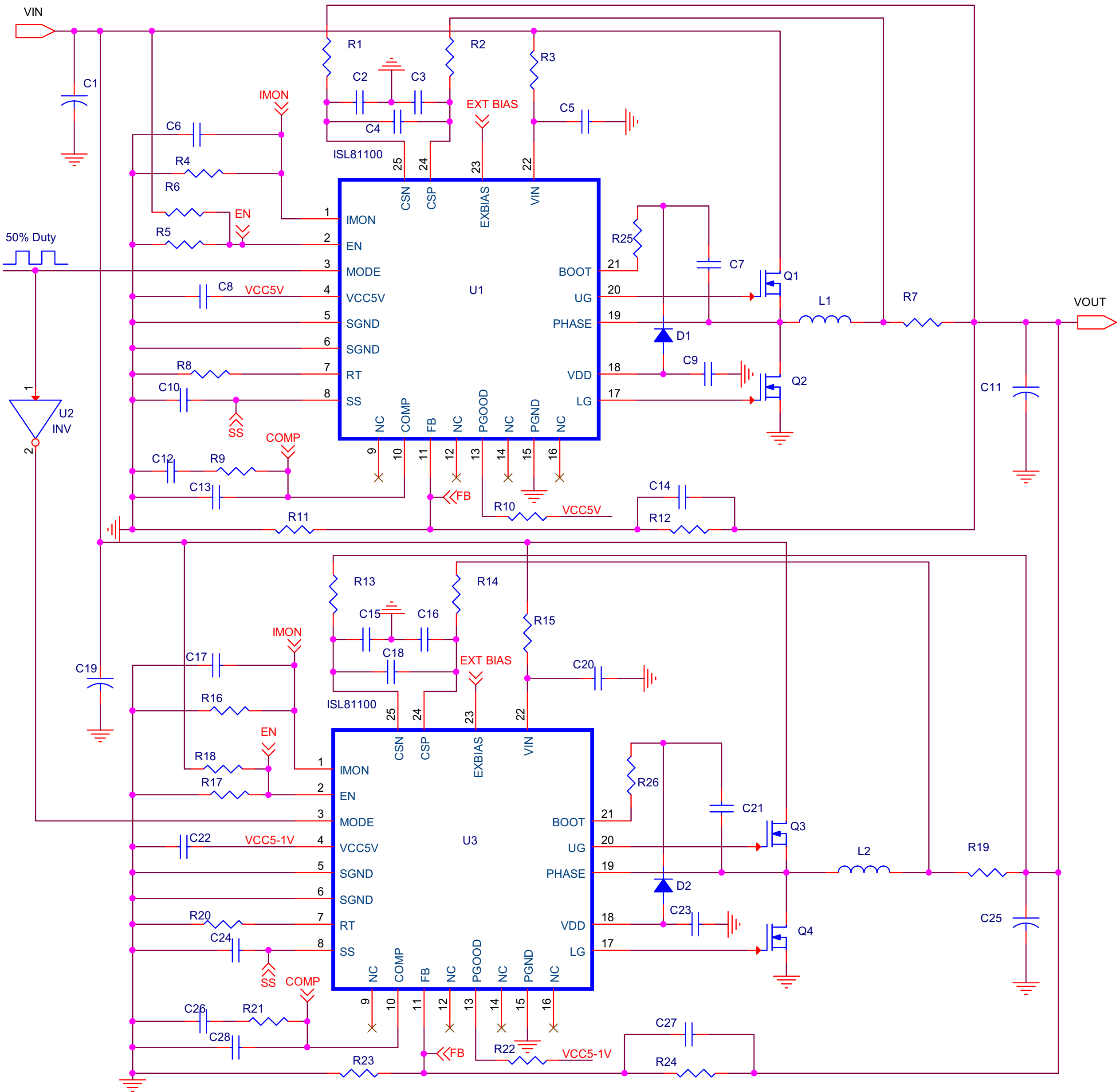

Figure 1. Block Diagram

Contents

1. Functional Description

The ISL81100EVAL2Z is the same test board used by Renesas application engineers and IC designers to evaluate the performance of the ISL81100 TQFN IC. The board provides an easy and complete evaluation of all the IC and board functions.

As shown in Figure 2, 18V to 100V VIN is supplied to J17 (+) and J18 (-). The regulated 12V output on J22 (+) and J21 (-) can supply up to 20A to the load. Because of the high power efficiency, the evaluation board can run at 20A continuously without airflow at room temperature ambient conditions.

Test points TP1 through TP47 provide easy access to the IC pin and external signal injection terminals.

An external synchronization signal with a frequency higher than 520kHz (>2 times of Fsw) should be applied to the BNC terminal (J25) to make the two ISL81100 ICs work in a 180-degree phase shift. The ISL81100EVAL2Z board would be set to Forced PWM mode and constant current OCP mode in parallel operation. Connector J24 allows disabling all the converters by shorting their pins 1 and 2.

1.1 Recommended Testing Equipment

The following materials are recommended for testing:

- 0V to 100V power supply with at least 25A source current capability
- Electronic loads capable of sinking current up to 25A
- Digital Multimeters (DMMs)
- 100MHz quad-trace oscilloscope

1.2 Operational Characteristics

The input voltage range is from 18V to 100V for an output voltage of 12V. If the output voltage is set to a lower value, the minimum V_{IN} can be set to a lower value by changing the ratio of R_{12} and R_{15} and the ratio of R_{46} and R_{47}.

The rated load current is 20A, with the OCP point set at a minimum of 24A at ambient room temperature. The operating temperature range of this board is -40°C to +85°C.

Note: Airflow is needed for higher temperature ambient conditions.

1.3 Setup and Configuration

Complete the following steps to set up and configure the board properly.

1. Connectors J24 provides an option to disable all the converters. See Table 2 for the operating options. Ensure the circuit is correctly connected to the supply and electronic loads before applying any power. See Figure 2 for proper setup.

Table 2. Operating Options

Jumper	Position	Function
24	EN-GND	Disable output
	EN Floating	Enable output

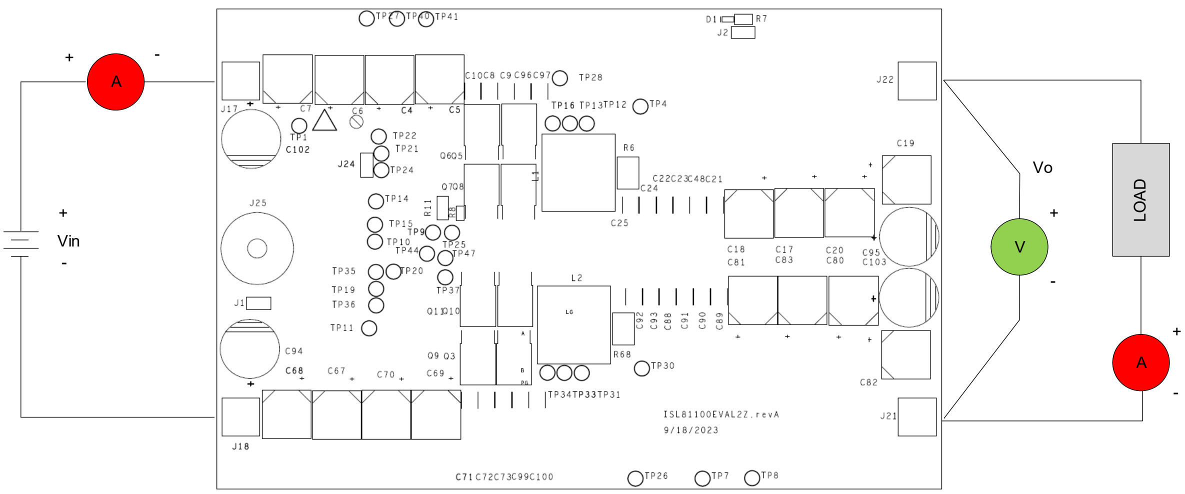

Figure 2. Proper Test Setup

2. Turn on the power supply.
3. Adjust the input voltage (V_{IN}) within the specified range and observe the output voltage. The output voltage variation should be within 3%.
4. Adjust the load current within the specified range and observe the output voltage. The output voltage variation should be within 3%.
5. Use an oscilloscope to observe output voltage ripple and phase node ringing. For accurate measurement, see Figure 3 for proper test setup.

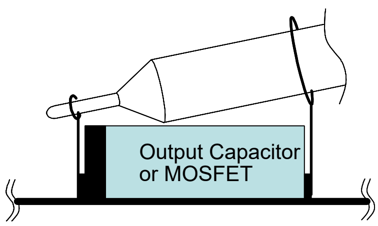

Figure 3. Proper Probe Setup to Measure Output Ripple and Phase Node Ringing

2. Board Design

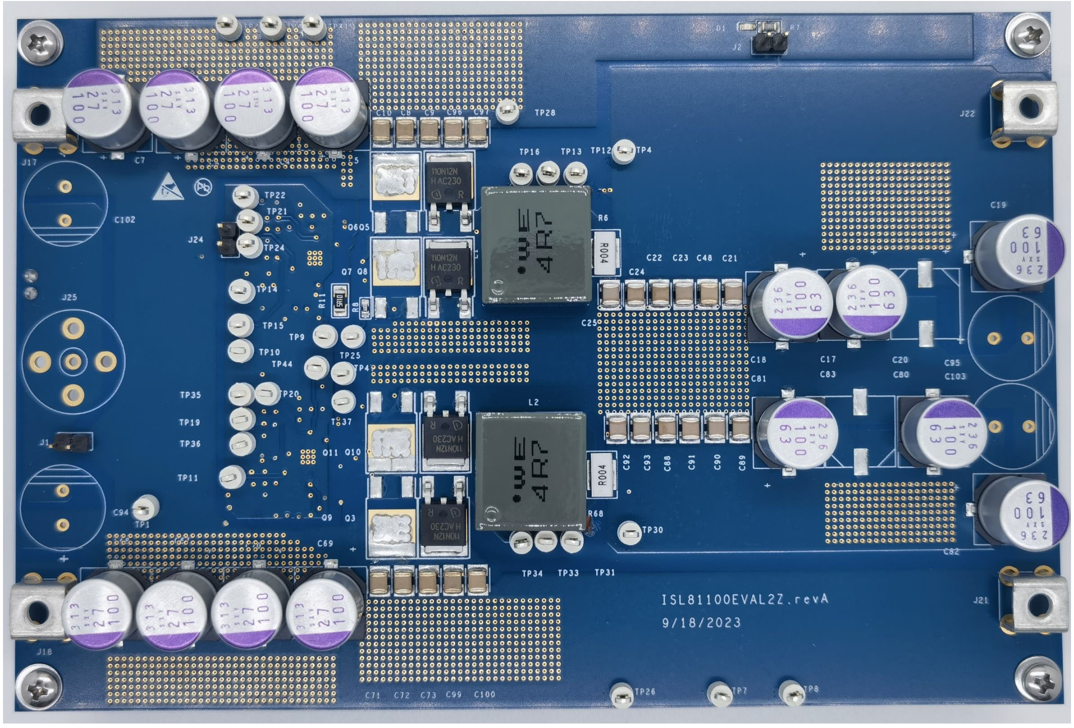

Figure 4. Evaluation Board, Top View

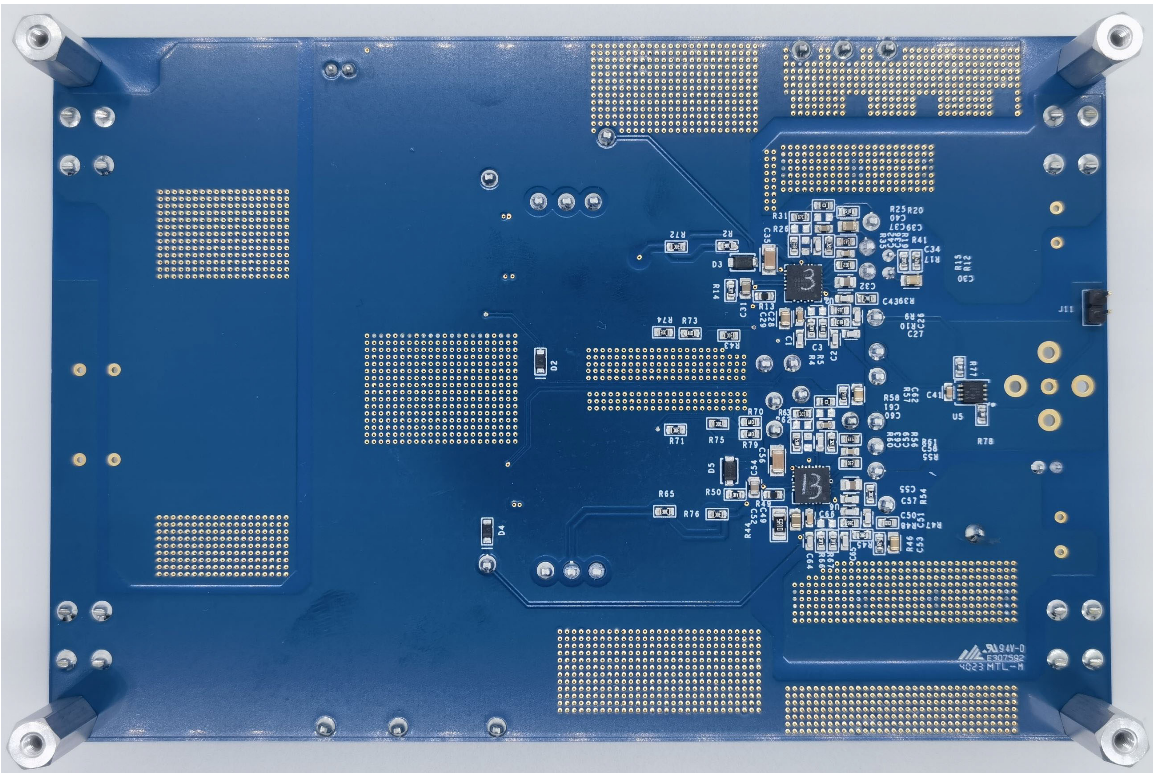

Figure 5. Evaluation Board, Bottom View

2.1 PCB Layout Guidelines

Attention to Printed Circuit Board (PCB) layout requirements is necessary to successfully implement an ISL81100-based DC/DC converter. The ISL81100 switches at a high frequency; therefore, the switching times are short. Even the shortest trace has significant impedance at these switching frequencies, and the peak gate drive current rises significantly in an extremely short time. The transition speed of the current from one device to another causes voltage spikes across the interconnecting impedances and parasitic circuit elements. These voltage spikes can degrade efficiency, generate EMI, and increase device voltage stress and ringing. Careful component selection and proper PCB layout minimize the magnitude of these voltage spikes.

The following are critical components when using the ISL81100 DC/DC converter:

- Controller
- Switching power components
- Small-signal components

The switching power components are the most critical to the layout because they switch a large amount of energy that tends to generate a large amount of noise. The critical small-signal components are those connected to sensitive nodes or those supplying critical bias currents. A multilayer PCB is recommended.

Complete the following steps to optimize the PCB layout.

1. Place the input capacitors, FETs, inductor, and output capacitor first. Isolate these power components on dedicated areas of the board with their ground terminals adjacent to one another. Place the input and output high-frequency decoupling ceramic capacitors close to the MOSFETs.
2. If signal components and the IC are placed separately from the power train, Renesas recommends using full ground planes in the internal layers with shared SGND and PGND to simplify the layout design. Otherwise, use separate ground planes for the power ground and the small signal ground. Connect the SGND and PGND together close to the IC. ***Warning***: DO NOT connect them together anywhere else.
3. Keep the loop formed by the input capacitor, the top FET, and the bottom FET as small as possible.
4. Ensure the current paths from the input capacitor to the FETs, the power inductor, and the output capacitor are as short as possible with maximum allowable trace widths.
5. Place the PWM controller IC close to the lower FETs. The low-side FET gate drive connections should be short and wide. Place the IC over a quiet ground area. Avoid switching ground loop currents in this area.
6. Place the VDD bypass capacitor close to the VDD pin of the IC and connect its ground end to the PGND pin. Connect the PGND pin to the ground plane by a via. ***Warning*****:** DO NOT connect the PGND pin directly to the SGND EPAD.
7. Place the gate drive components (BOOT diodes and BOOT capacitors) together near the controller IC.
8. Place the output capacitors as close to the load as possible. To avoid inductance and resistances, use short, wide copper regions to connect output capacitors to load.
9. Use copper-filled polygons or wide, short traces to connect the junction of the upper FET, lower FET, and output inductor. Keep the PHASE node connection to the IC short. ***Warning***: DO NOT unnecessarily oversize the copper islands for the PHASE node. Because the phase node is subjected to extreme dv/dt voltages, the stray capacitor formed between these islands and the surrounding circuitry tends to couple switching noise.
10. Route all high-speed switching nodes away from the control circuitry.
11. Create a separate small analog ground plane near the IC. Connect the SGND pin to this plane. Connect all small signal grounding paths, including feedback resistors, current monitoring resistors and capacitors, soft-starting capacitors, loop compensation capacitors and resistors, and EN pull-down resistors to this SGND plane.
12. Use a pair of traces with a minimum loop for the input or output current sensing connection.
13. Ensure the feedback connection to the output capacitor is short and direct.

2.2 ISL81100EVAL2Z Circuit Schematic

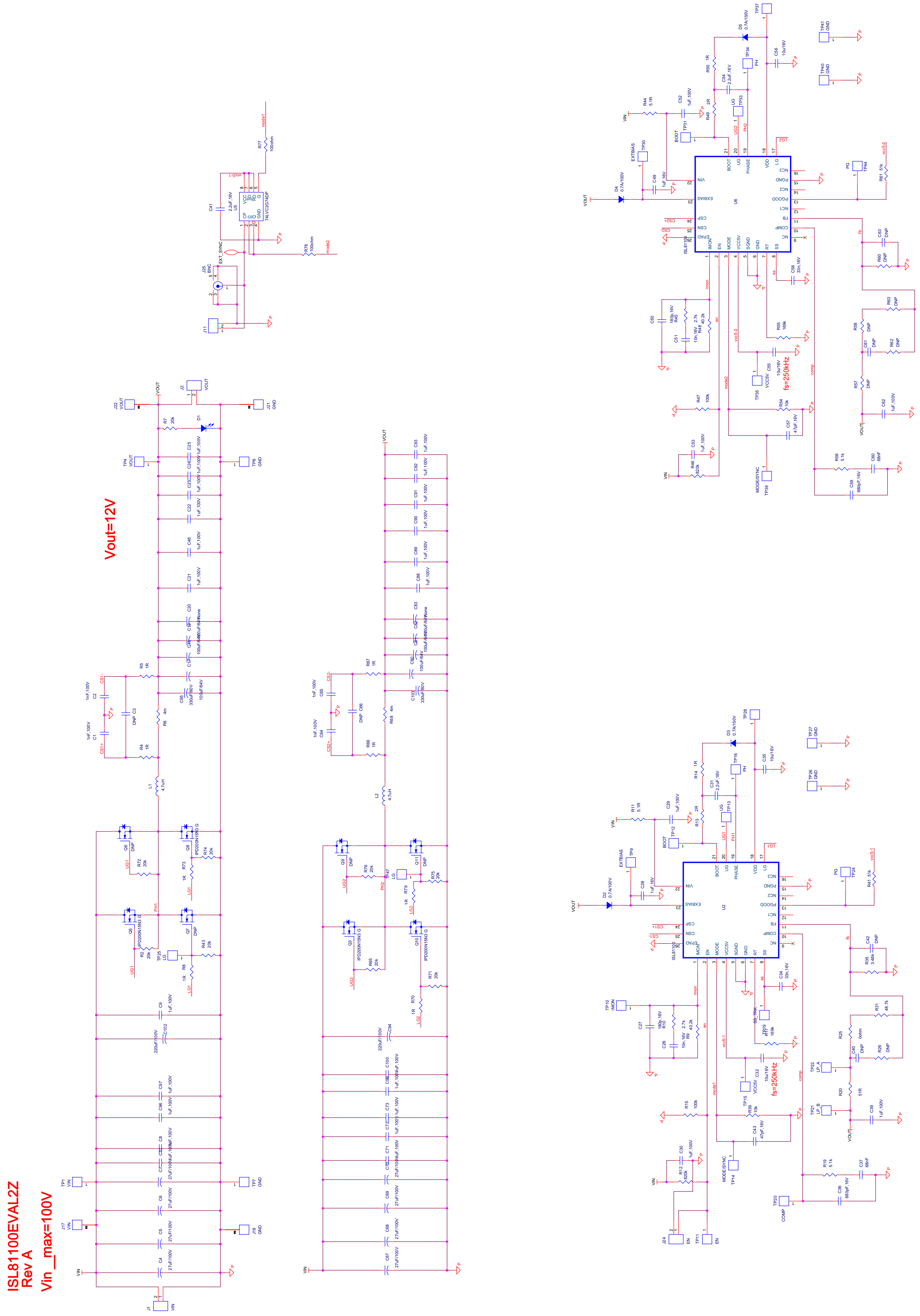

Figure 6. Schematic

2.3 Bill of Materials

Qty	Reference Designator	Description	Manufacturer	Manufacturer Part
1		PWB-PCB, ISL81100EVAL2Z, REVA, ROHS	Multilayer PCB Technology	ISL81100EVAL2ZREVAPCB
4	C1, C2, C64, C65	Multilayer Ceramic Capacitors MLCC - SMD/SMT 1000PF 100V 5% 0603	Murata	GRM1885C2A102JA01
			TDK	C1608C0G2A102J080AA
12	C3, C20, C40, C42, C61, C63, C66, C83, C94, C95, C102, C103	NONE, DNP	-	-
8	C4, C5, C6, C7, C67, C68, C69, C70	Aluminum Organic Polymer Capacitors 100VDC 27µF 20% 30mΩ SMD	Panasonic	100SXV27M
22	C8, C9, C10, C21, C22, C23, C24, C25, C48, C88, C89, C90, C91, C92, C93, C71, C72, C73, C96, C97, C99, C100	Multilayer Ceramic Capacitors MLCC - SMD/SMT 1.0µF 100V 10% 0805	Murata	GRM21BC72A105KE01
			TDK	C2012X7S2A105K125AB
6	C17, C18, C19, C81, C82, C83	Aluminum Organic Polymer Capacitors 63V 100µF ESR 12mΩ	Panasonic	63SXV100M
2	C26, C51	Multilayer Ceramic Capacitors MLCC - SMD/SMT 0.01µF 100V 10% 0603	Murata	GCM188R72A103KA37
			TDK	C1608C0G1H103J080AA
2	C27, C50	Multilayer Ceramic Capacitors MLCC - SMD/SMT 180PF 100V 5% 0603	Murata	GCM1885C2A181JA16
			TDK	CGA3E2C0G1H181J080AA
2	C28, C49	Multilayer Ceramic Capacitors MLCC - SMD/SMT 1.0µF 25V 10% 0805	Murata	GCJ188R71E105KA01D
			TDK	C1608X7R1C105K080AC
3	C31, C41, C54	Multilayer Ceramic Capacitors MLCC - SMD/SMT 0603 16V 2.2µF X5R 10% T: 0.8mm	Murata	GCM188C71C225ME11 or
			TDK	C1608X5R1C225K080AB
2	C32, C55	Multilayer Ceramic Capacitors MLCC - SMD/SMT 10µF 16V 10% 0603	Murata	GRM188R61C106KAALJ
			TDK	C2012X6S1C106K125AC
2	C34, C58	Multilayer Ceramic Capacitors MLCC - SMD/SMT 0.033µF 50V 10% 0603	Murata	GCM188L81H333MA55
			TDK	CGA3E2X7R1H333K080AA
2	C35, C56	Multilayer Ceramic Capacitors MLCC - SMD/SMT 1206 16V 10µF X5R 10% T: 1.6mm	Murata	GRM31CC81E106MA12
			TDK	C3216X5R1C106K160AA
2	C36, C59	Multilayer Ceramic Capacitors MLCC - SMD/SMT 680PF 100V 5% 0603	Murata	GCM1885C2A681JA16D
2	C37, C60	Multilayer Ceramic Capacitors MLCC - SMD/SMT 0.068µF 100V 10% 0603	Murata	GCM188R72A683KA37
			TDK	C1608C0G1V683J080AC
2	C43, C57	Multilayer Ceramic Capacitors MLCC - SMD/SMT 10PF 100V 5% 0603	Murata	GCM1885C2A100JA16D
1	D1	Standard LEDs - SMD Green Clear 571nm	Lite-On	LTST-C191KGKT
2	D2, D4	Schottky Diodes & Rectifiers SCHOTTKY DIODE 100V 0.7A	ROHM Semiconductor	RB578VAM100

Qty	Reference Designator	Description	Manufacturer	Manufacturer Part
2	D3, D5	Schottky Diodes & Rectifiers 150V 1A Schottky Barrier Rectifier	Onsemi	S115FP
4	J17, J18, J21, J22	HDWARE, TERMINAL, M4 METRIC SCREW, TH, 4P, SNAP-FIT, ROHS	Keystone	7795
4	J1, J2, J11, J24	CONN-HEADER, 1x2, BRKAWY 1×36, 2.54mm, ROHS	BERG/FCI	68000-236HLF
1	J25	RF CONNECTORS / COAXIAL CONNECTORS 75 OHM BNC JACK AND PLUG, CABLE CONNECTOR	Samtec	BNC7T-P-C-GN-ST-CA3
2	L1, L2	Power Inductors - SMD WE-XHMI SMD 1510 4.7uH 17A 3.5mΩ	Wurth	74439370047
2	U2, U6	100V Buck PWM Controller, 25P, TQFN, 5×5, ROHS	Renesas Electronics America	ISL81100FRTZ
1	U5	IC FF D-TYPE SNGL 1BIT 8TSSOP	Nexperia USA Inc.	74LVC2G74DP
4	Q3, Q5, Q8, Q10	MOSFET N-Ch 120V 75A TO252-3	Infineon	IPD110N12NS3G
4	Q6, Q7, Q9, Q11	NONE, DNP	-	-
6	R26, R57, R58, R60, R62, R63	NONE, DNP		
8	R2, R43, R65, R71, R72, R74, R75, R76,	RES SMD 20kΩ 1% 1/10W 0603	Yageo	RC0603FR-0720KL
8	R4, R5, R8, R14, R50, R70, R73, R79	RES SMD 1Ω 1% 1/10W 0603	Yageo	RC0603FR-071RL
2	R6, R68	RES SMD 0.004Ω 3W 2512 WIDE	Susumu	KRL6432E-M-R004-F-T1
1	R7	RES SMD 20kΩ 1% 1/10W 0805	Yageo	RC0805FR-0720KL
2	R9, R48	RES SMD 40.2Ω 1% 1/10W 0603	Yageo	RC0603FR-0740K2L
2	R10, R45	RES SMD 2.7kΩ 1% 1/10W 0603	Yageo	RC0603FR-072K7L
2	R11, R44	RES SMD 5.1Ω 1% 1/10W 1206	Yageo	RC1206FR-075R1L
2	R12, R46	RES SMD 820kΩ 1% 1/10W 0603	Yageo	RC0603FR-07820KL
2	R13, R49	RES SMD 2Ω 1% 1/10W 0603	Yageo	RC0603FR-072RL
2	R15, R47	RES SMD 100kΩ 1% 1/10W 0603	Yageo	RC0603FR-07100KL
2	R41, R61	RES SMD 51kΩ 1% 1/10W 0603	Yageo	RC0603FR-0751KL
2	R17, R55	RES SMD 169kΩ 1% 1/10W 0603	Yageo	RC0603FR-07169KL
2	R19, R56	RES SMD 5.1kΩ 1% 1/10W 0603	Yageo	RC0603FR-075K1L
1	R20	RES SMD 51Ω 1% 1/10W 0603	Yageo	RC0603FR-0751RL
1	R25	RES SMD 0Ω 1% 1/10W 0603	Yageo	RC0603FR-070RL
1	R31	RES SMD 48.7kΩ 1% 1/10W 0603	Yageo	RC0603FR-0748K7L
1	R35	RES SMD 3.48kΩ 1% 1/10W 0603	Yageo	RC0603FR-073K48L
2	R39, R54	RES SMD 10kΩ 1% 1/10W 0603	Yageo	RC0603FR-0710KL
2	R77, R78	RES SMD 100Ω 1% 1/10W 0603	Yageo	RC0603FR-07100RL

Qty	Reference Designator	Description	Manufacturer	Manufacturer Part
32	TP1, TP4, TP7-TP16, TP19-TP22, TP24-TP28, TP30, TP31, TP33-TP37, TP40, TP41, TP44, TP47	CONN-COMPACT TEST PT, VERTICAL, WHT, ROHS	Keystone	5007
4	Four corners	SCREW, 4-40×1/4in, PHILLIPS, PANHEAD, STAINLESS, ROHS	Keystone	2204

2.4 Board Layout

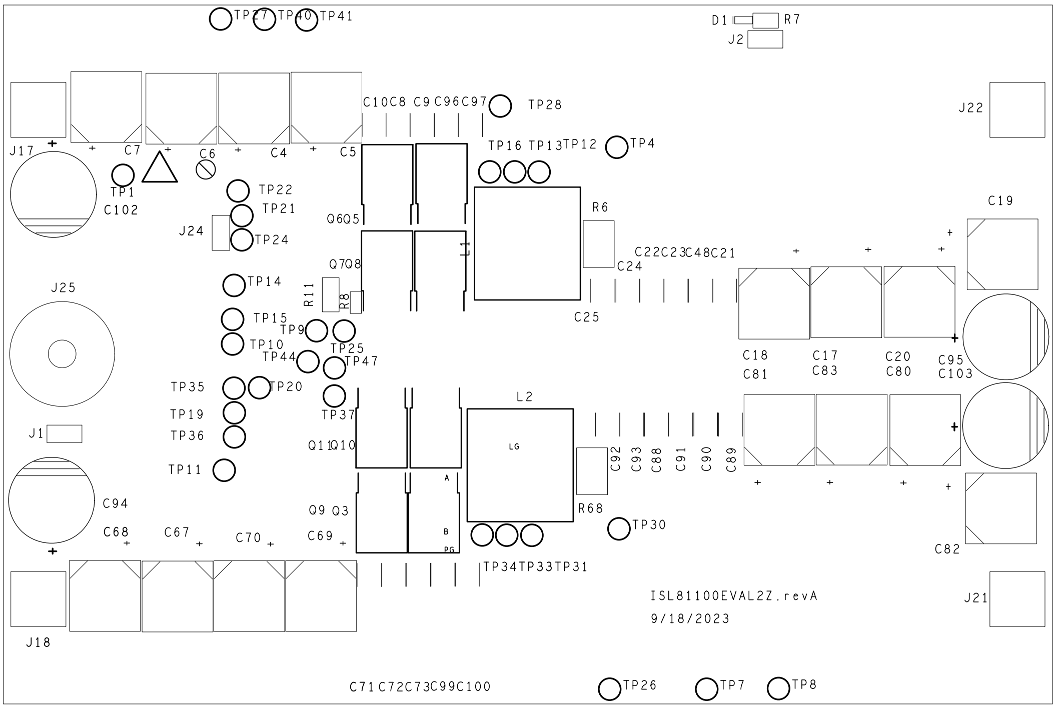

Figure 7. Silkscreen Top

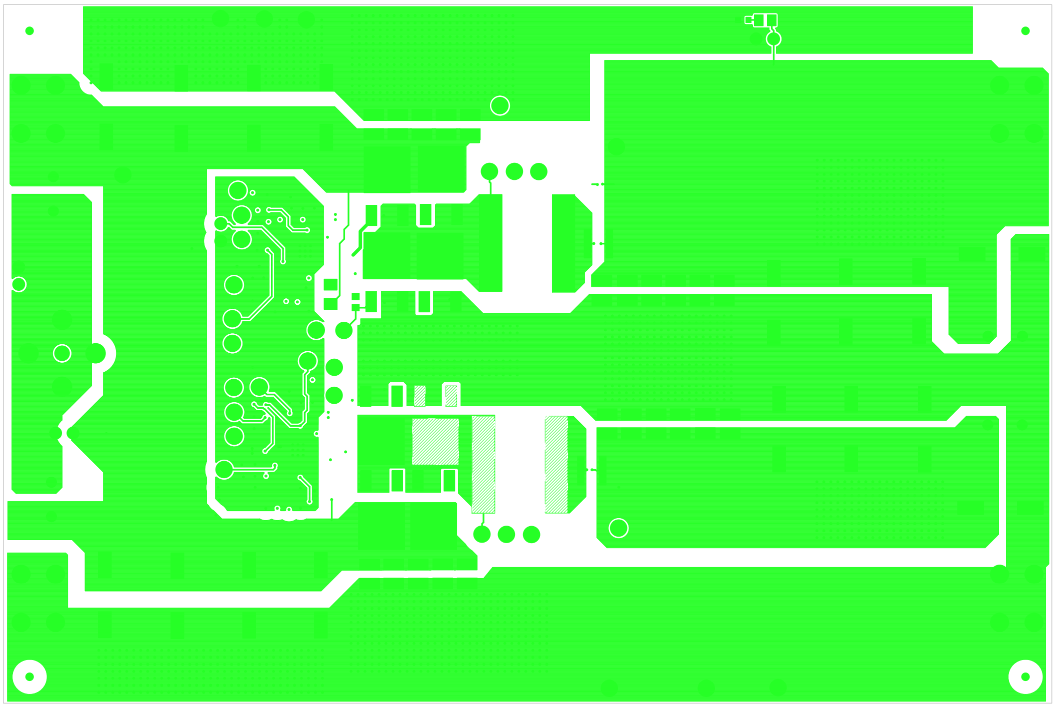

Figure 8. Top Layer

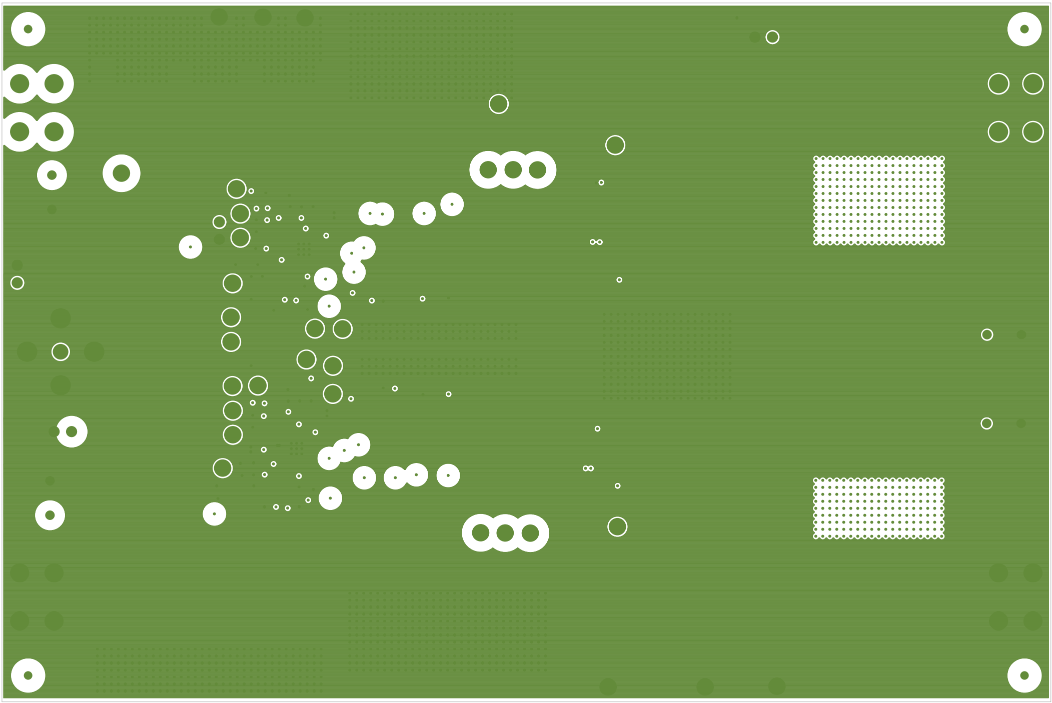

Figure 9. Second Layer (Solid Ground)

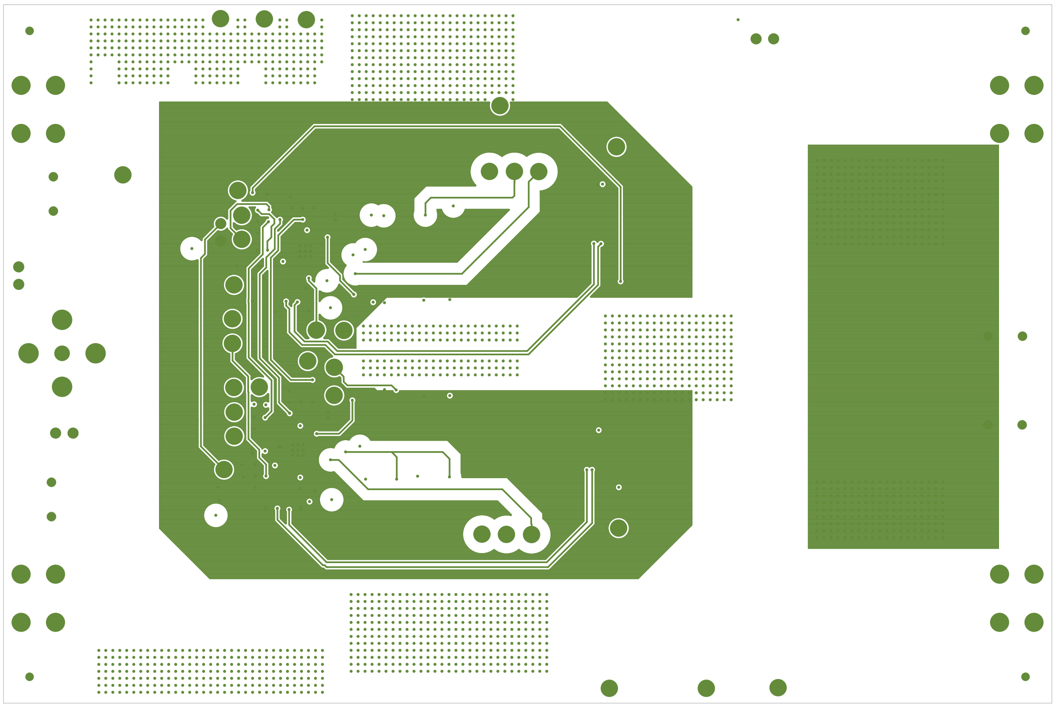

Figure 10. Third Layer

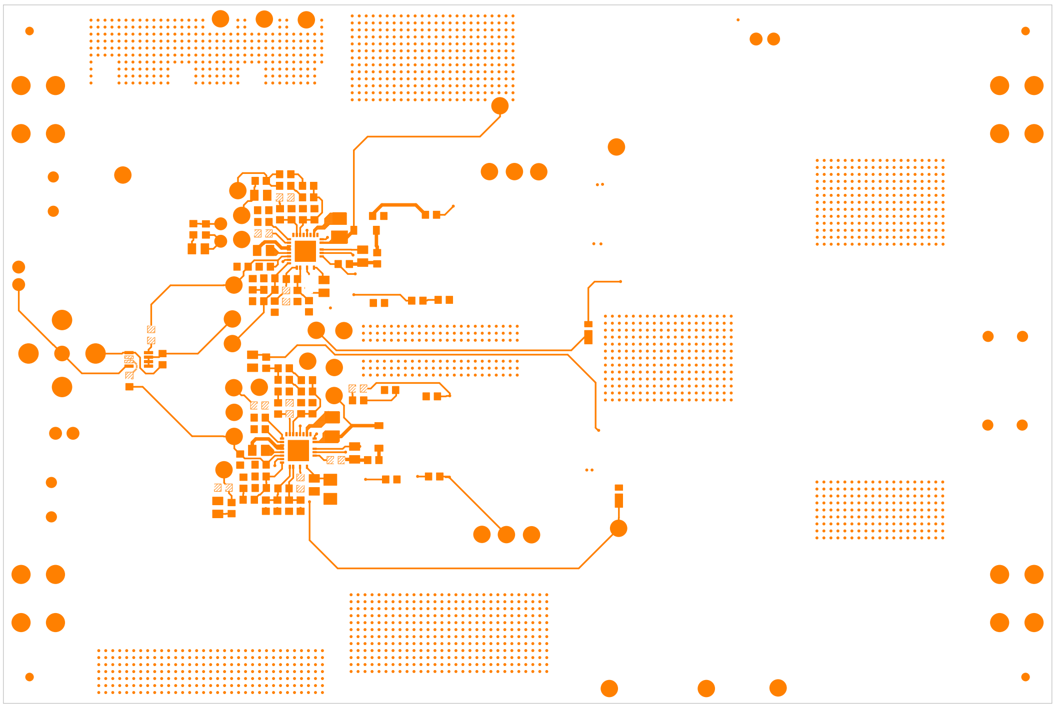

Figure 11. Bottom Layer

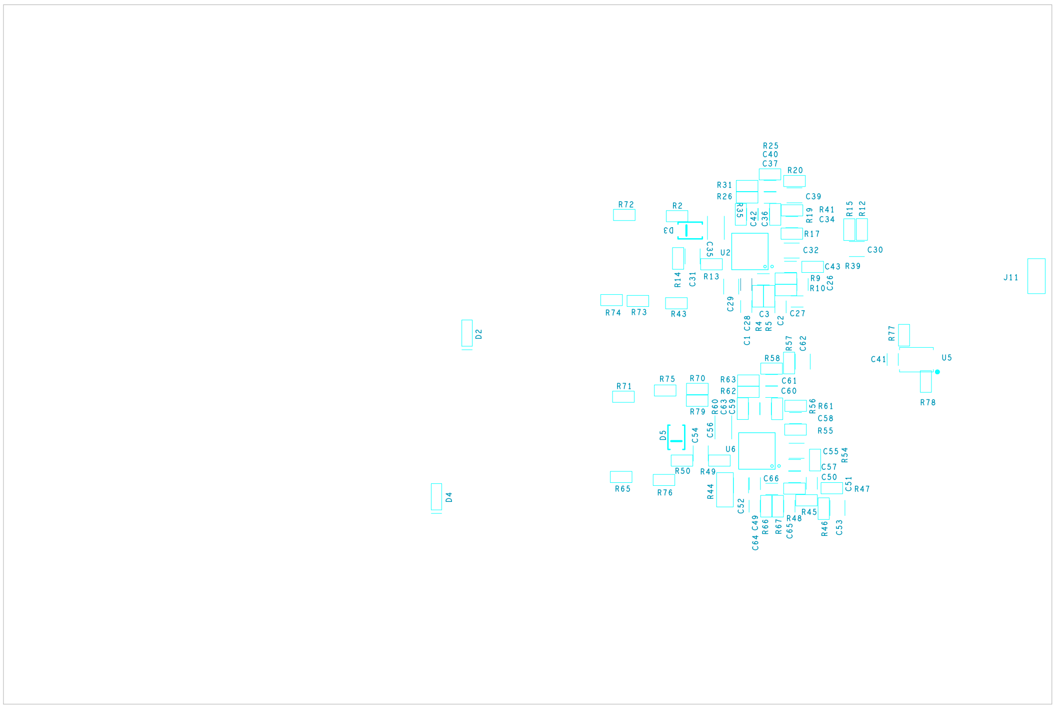

Figure 12. Silkscreen Bottom

3. Typical Performance Curves

V_{IN} = 48V, T_A = 25°C, unless otherwise noted.

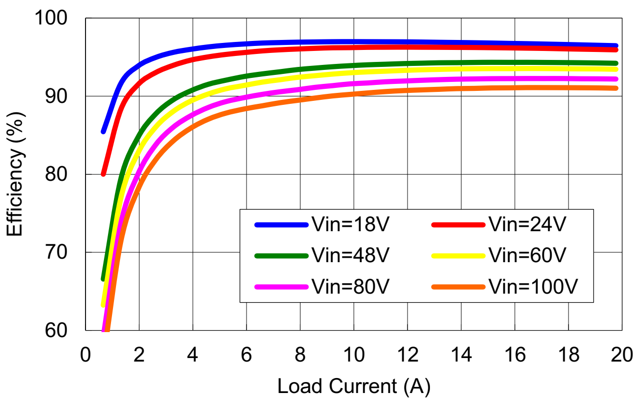

Figure 13. Efficiency

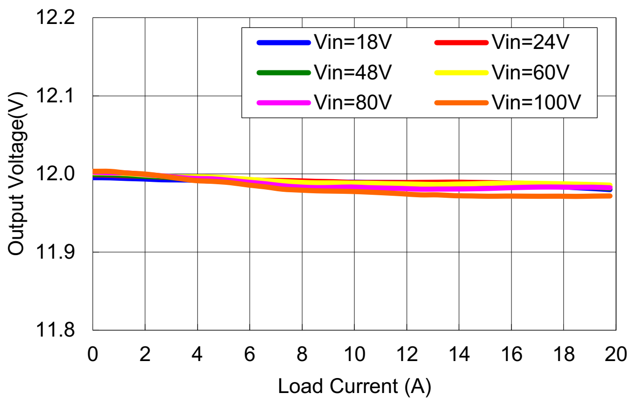

Figure 14. Load Regulation

V_{IN} = 48V, T_A = 25°C, unless otherwise noted. (Cont.)

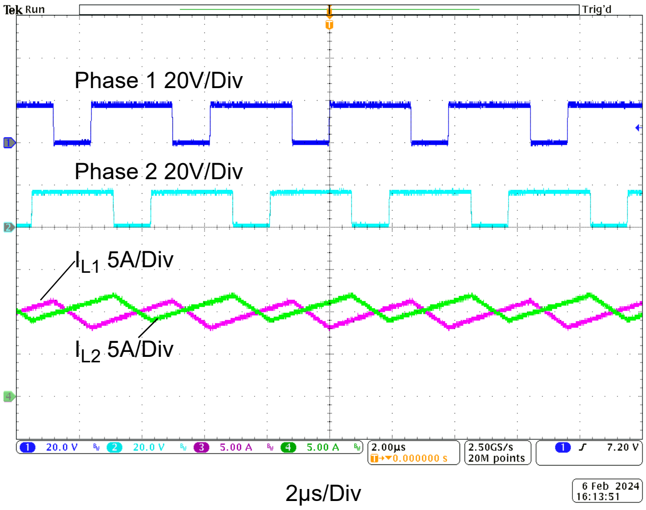

Figure 15. Steady State, V_{IN} = 18V, I_{OUT} = 20A

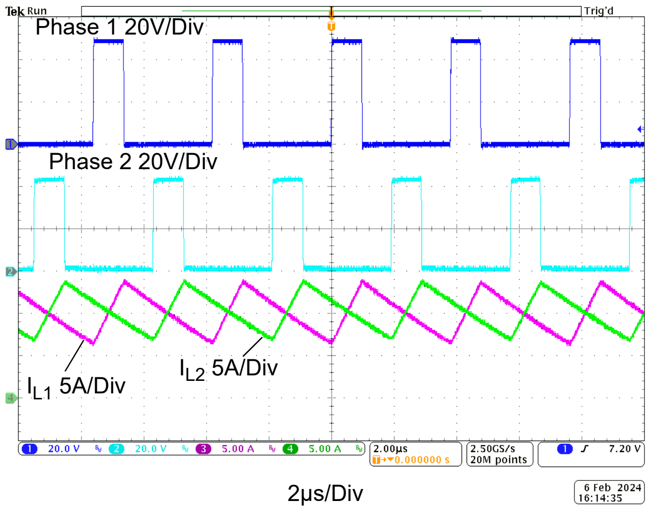

Figure 16. Steady State, V_{IN} = 48V, I_{OUT} = 20A

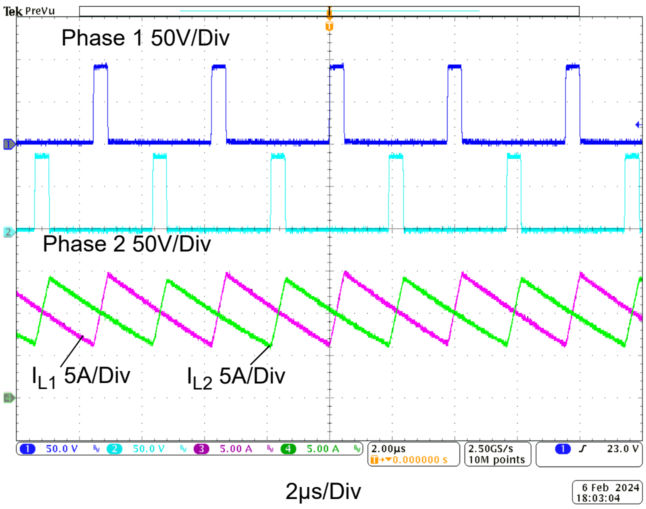

Figure 17. Steady State, V_{IN} = 100V, I_{OUT} = 20A

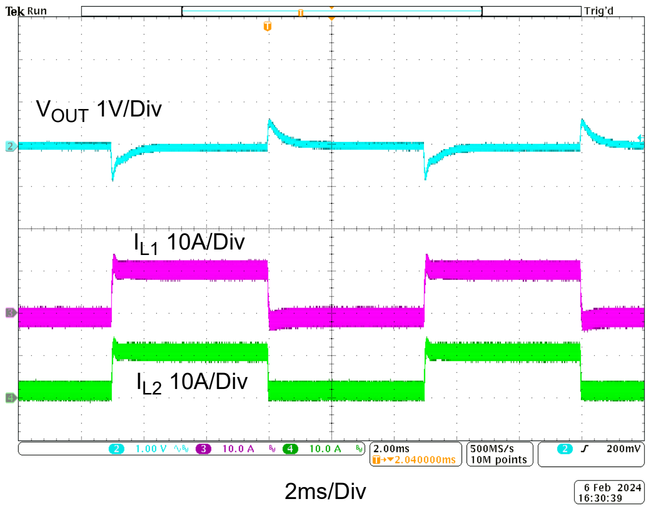

Figure 18. Load Transient, V_{IN} = 18V, I_{OUT} = 0A to 20A, 2.5A/µs

V_{IN} = 48V, T_A = 25°C, unless otherwise noted. (Cont.)

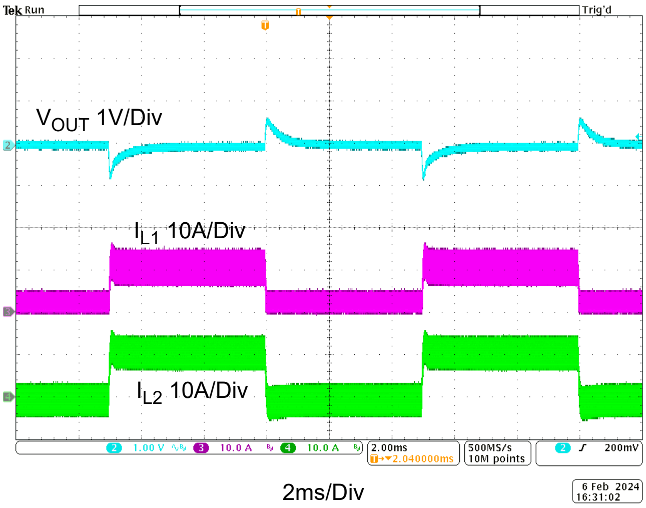

Figure 19. Load Transient, V_{IN} = 48V, I_{OUT} = 0A to 20A, 2.5A/µs

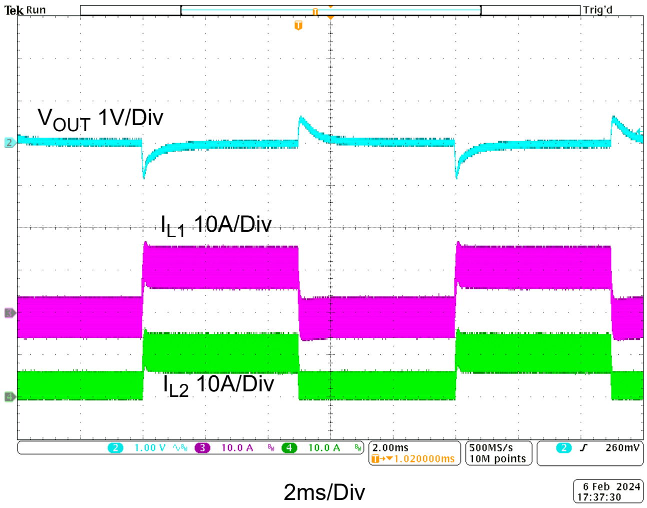

Figure 20. Load Transient, V_{IN} = 100V, I_{OUT} = 0A to 20A, 2.5A/µs

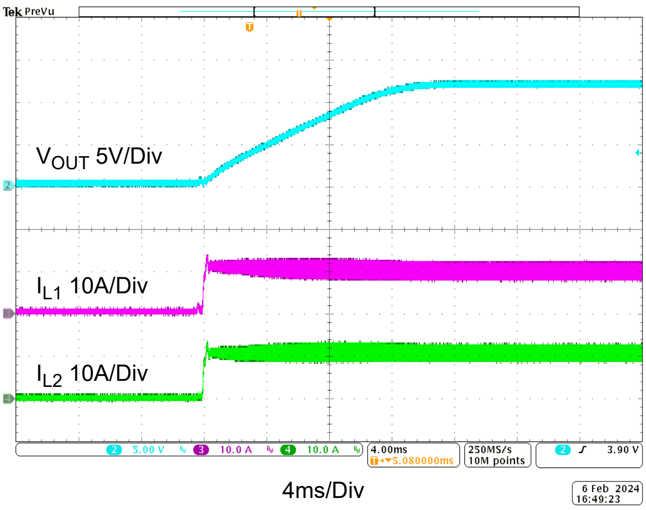

Figure 21. Start-Up Waveform, V_{IN} = 18V, I_{OUT} = 20A

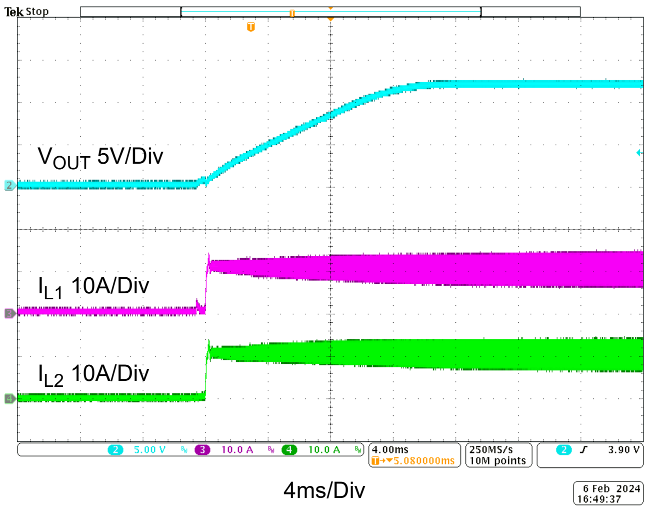

Figure 22. Start-Up Waveform, V_{IN} = 48V, I_{OUT} = 20A

V_{IN} = 48V, T_A = 25°C, unless otherwise noted. (Cont.)

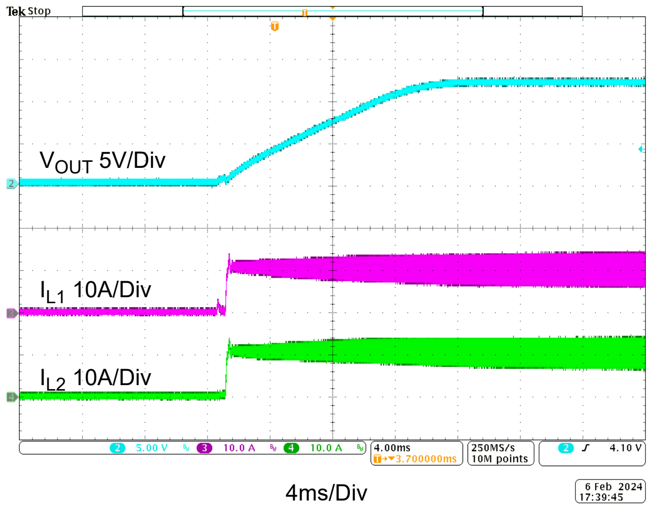

Figure 23. Start-Up Waveform, V_{IN} = 100V, I_{OUT} = 20A

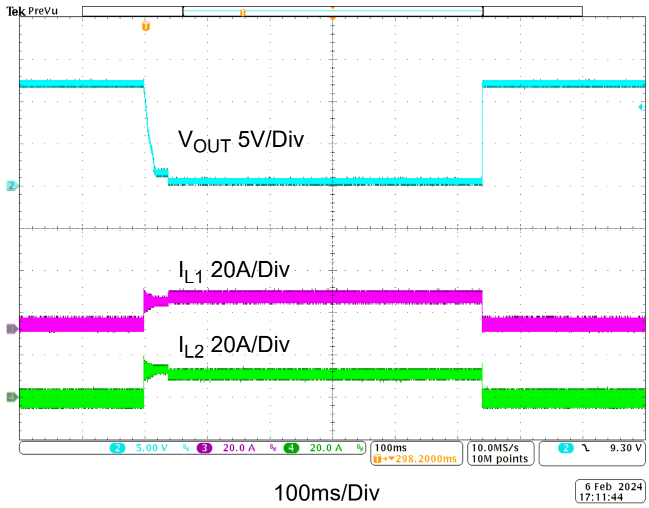

Figure 24. Short-Circuit Waveform

4. Ordering Information

Part Number	Description
ISL81100EVAL2Z	100V Buck Controller 2-Phase Evaluation Board

5. Revision History

Revision	Date	Description
1.00	Mar 11, 2024	Initial release

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