ISL81802EVAL3Z

Evaluation Board

The ISL81802EVAL3Z 4-phase evaluation board (shown in Figure 4) features the ISL81802, a 80V high-voltage dual 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 optimize inductor size while the strong gate driver delivers up to 40A for the buck output.

Key Features

- Wide input range: 18V to 80V
- High light-load efficiency in pulse skipping DEM operation
- Programmable soft-start
- Optional DEM/PWM operation
- Optional CC/HICCUP OCP protection
- Supports pre-bias output with soft-start
- PGOOD indicator
- OVP, OTP, and UVP protection
- Back biased from output to improve efficiency

The ISL81802EVAL3Z 4-phase evaluation board is designed for high current applications. The current rating of the ISL81802EVAL3Z is limited by the FETs and inductor selected. The ISL81802EVAL3Z electrical ratings are shown in Table 1.

Table 1. Electrical Rating

Parameter	Rating
Input Voltage	18V to 80V
Switching Frequency	200kHz
Output Voltage	12V
Output Current	40A
OCP Set Point	Minimum 44A at ambient room temperature

Ordering Information

Part Number	Description
ISL81802EVAL3Z	High Voltage Dual Buck Controller Evaluation Board

Related Literature

For a full list of related documents, visit our website:

- ISL81802 device page

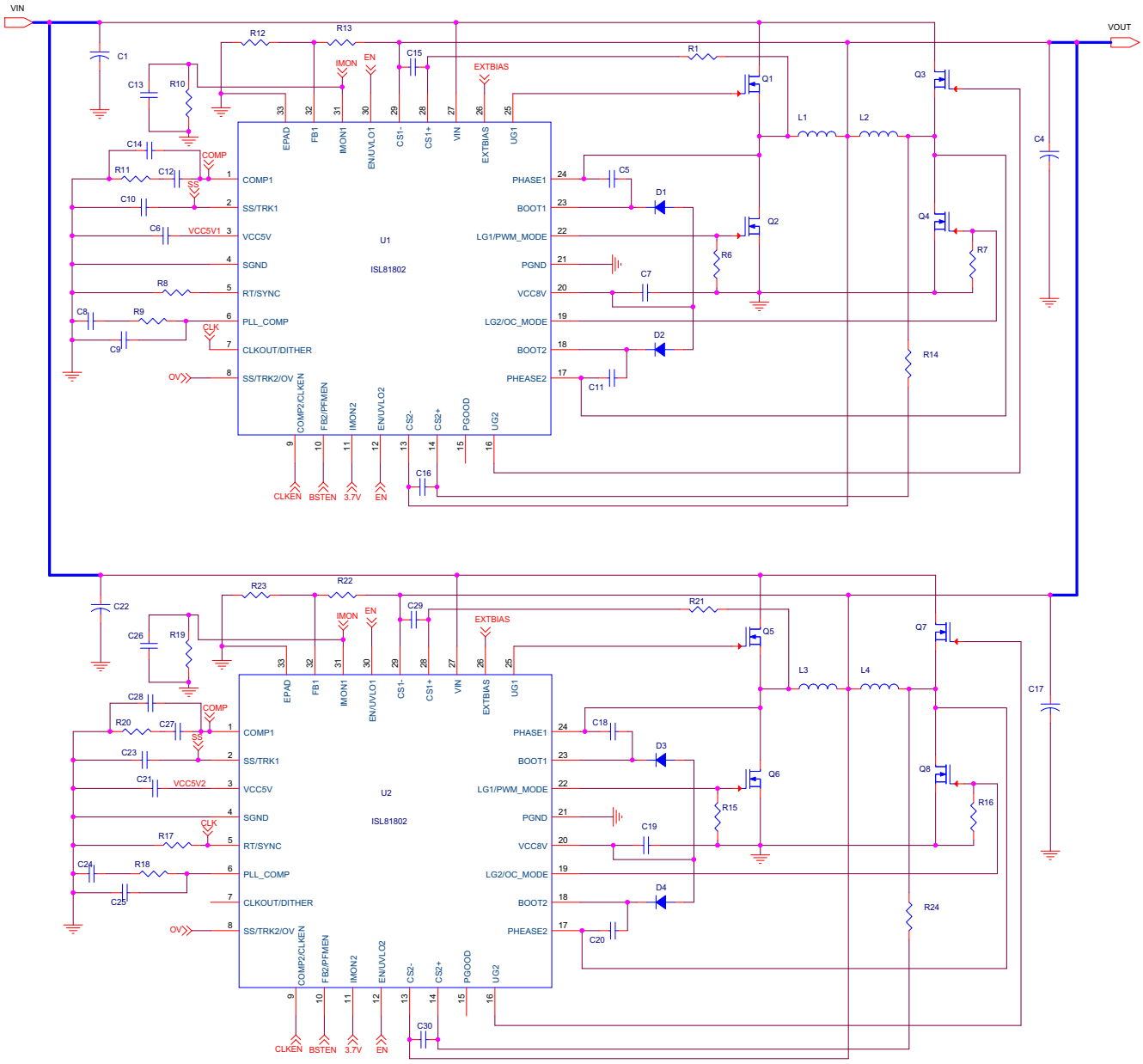


Figure 1. ISL81802EVAL3Z Block Diagram

1. Functional Description

The ISL81802EVAL3Z is the same test board used by Renesas application engineers and IC designers to evaluate the performance of the ISL81802 HTSSOP IC. The board provides an easy and complete evaluation of all the IC and board functions.

As shown in Figure 2, 18V to 80V VIN is supplied to J1/J13 (+) and J2/J14 (-). The regulated 12V output on J4/J10 (+) and J5/J11 (-) can supply up to 40A to the load. Because of the high power efficiency, the evaluation board can run at 40A continuously without airflow at room temperature ambient conditions.

Test points TP1 through TP36 provide easy access to the IC pin and external signal injection terminals.

As shown in Table 2, connectors J6 and J8 provide a selection of either Forced PWM mode (shorting Pin 1 and Pin 2) or DEM mode (shorting Pin 2 and Pin 3). Connectors J7 and J12 provide a selection of either constant current limit (shorting Pin 1 and Pin 2) or HICCUP OCP (shorting Pin 2 and Pin 3). Connectors J3 and J9 provide an option to disable the converter by shorting its Pin 1 and Pin 2.

1.1 Recommended Testing Equipment

The following materials are recommended for testing:

- 0V to 80V power supply with at least 40A source current capability
- Electronic loads capable of sinking current up to 50A
- Digital Multimeters (DMMs)
- 100MHz quad-trace oscilloscope

1.2 Operating Range

The input voltage range is from 18V to 80V for an output voltage of 12V. If the output voltage is set to a lower value, the minimum V_{IN} can be reset to a lower value by changing both the ratio of R_1 and R_5, and the ratio of R_{58} and R_{63}. The minimum EN threshold that V_{IN} can be set to is 4.5V.

The rated load current is 40A with the OCP point set at minimum 44A at ambient room temperature conditions. The operating temperature range of this board is -40°C to +85°C.

Note: Airflow is needed for higher temperature ambient conditions.

1.3 Quick Test Guide

1. Jumper J6 provides the option to select PWM or DEM. Jumper J7 provides the option to select constant current limit or HICCUP. See Table 2 for the operating options. Ensure that 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
3, 9	EN-GND	Disable output
	EN Floating	Enable output
6, 8	Pin 1-2	PWM
	Pin 2-3	DEM
7, 12	Pin 1-2	Constant current limit
	Pin 2-3	HICCUP

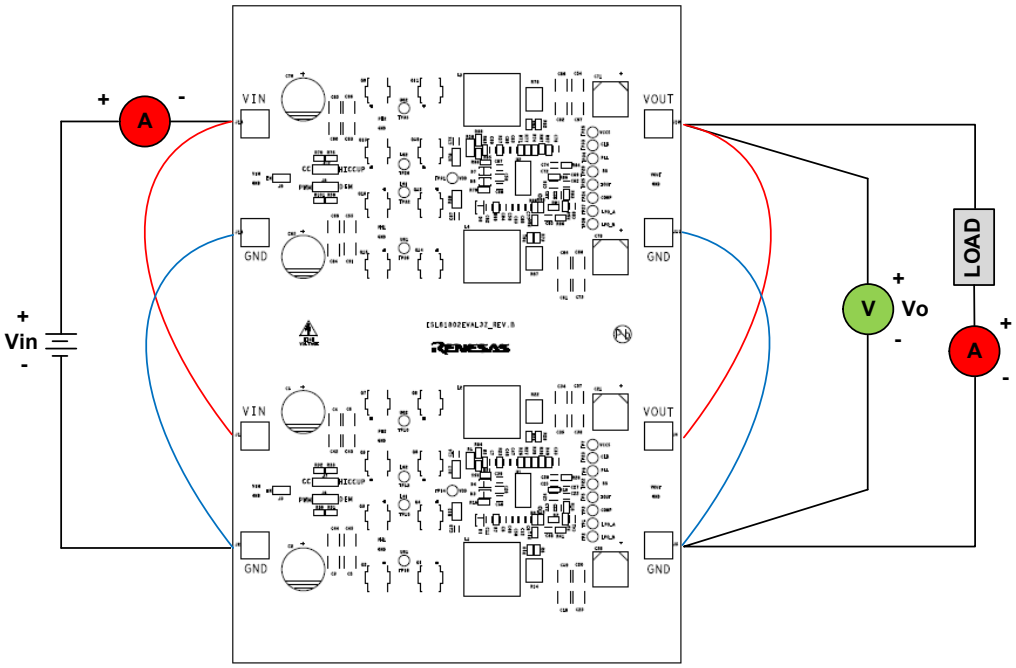


Figure 2. Proper Test Setup

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.

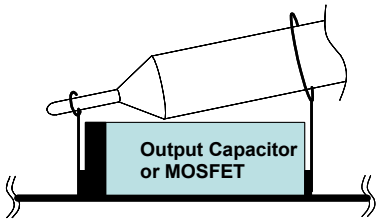


Figure 3. Proper Probe Setup to Measure Output Ripple and Phase Node Ringing

2. PCB Layout Guidelines

Careful attention to Printed Circuit Board (PCB) layout requirements is necessary for successful implementation of an ISL81802 based DC/DC converter. The ISL81802 switches at a high frequency; therefore, the switching times are short. At these switching frequencies, even the shortest trace has significant impedance 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 minimizes the magnitude of these voltage spikes.

The following are critical components

when using the ISL81802 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 tend 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. **Note: 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 FETs 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.
   Note: 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 nodes connection to the IC short. **Note: DO NOT** unnecessarily oversize the copper islands for the PHASE nodes. Because the phase nodes are 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 minimum loop for the input or output current sensing connection.
13. Ensure the feedback connection to the output capacitor is short and direct.

2.1 ISL81802EVAL3Z Evaluation Board

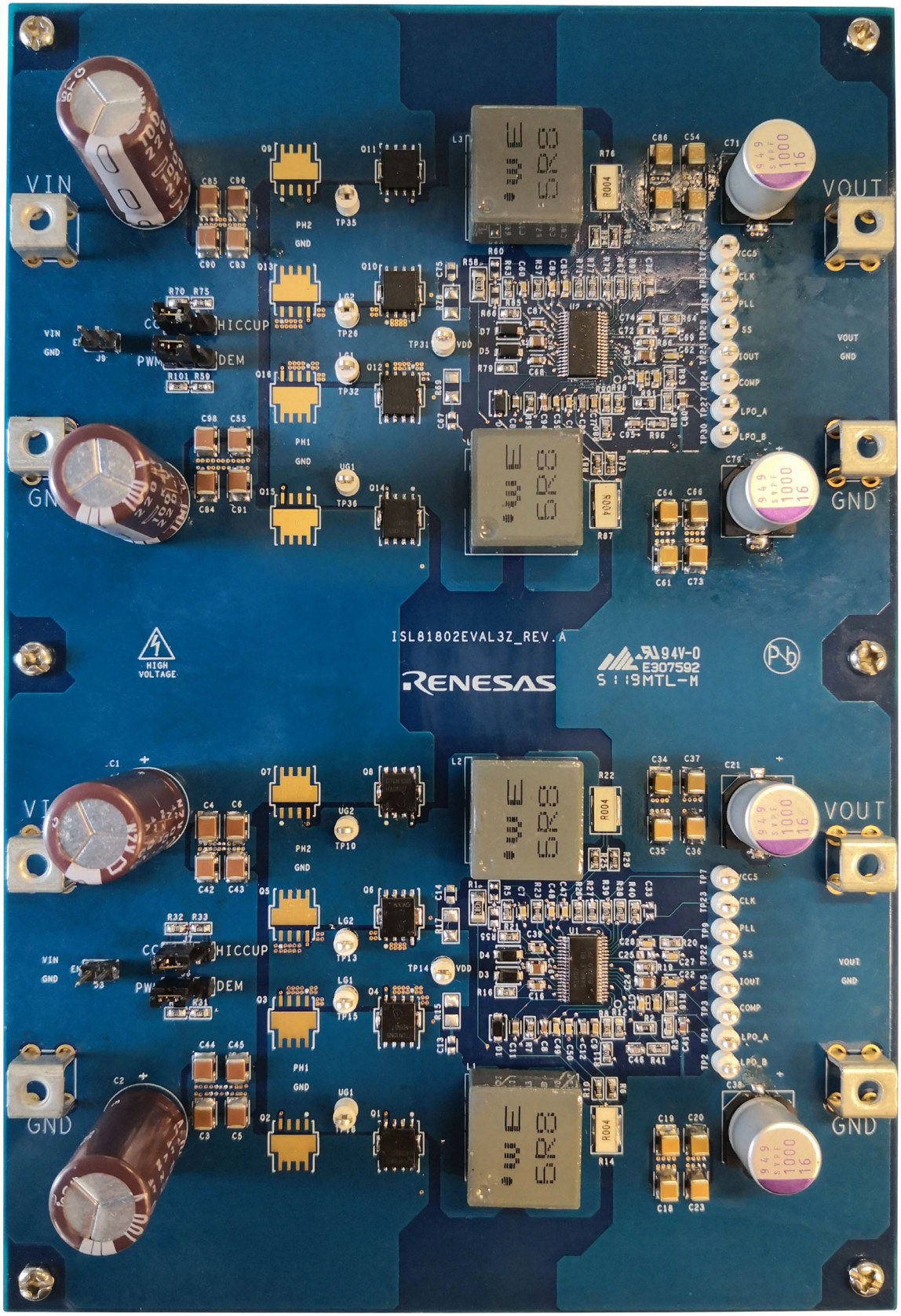


Figure 4. ISL81802EVAL3Z Evaluation Board, Top View

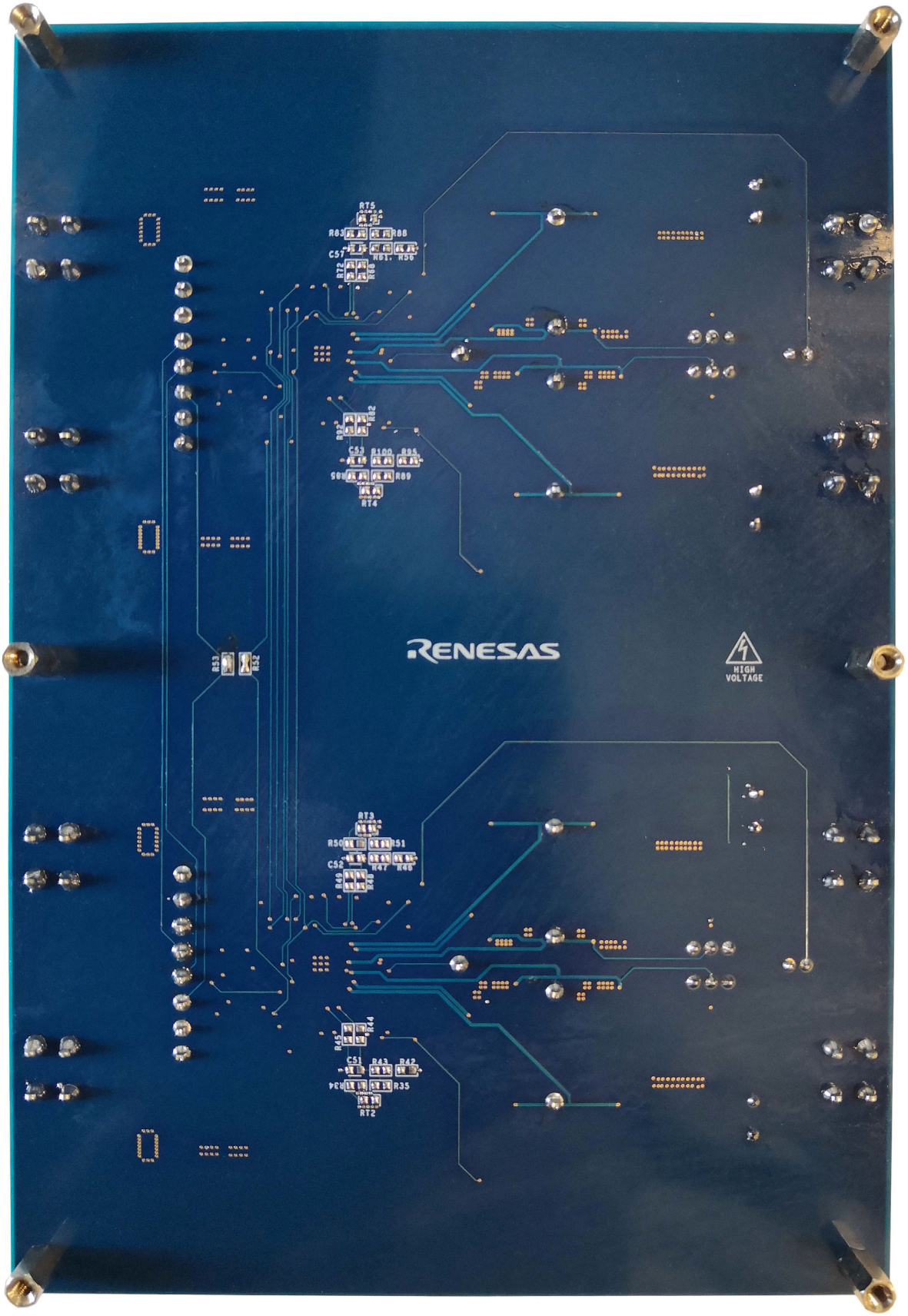


Figure 5. ISL81802EVAL3Z Evaluation Board, Bottom View

2.2 ISL81802EVAL3Z Circuit Schematics

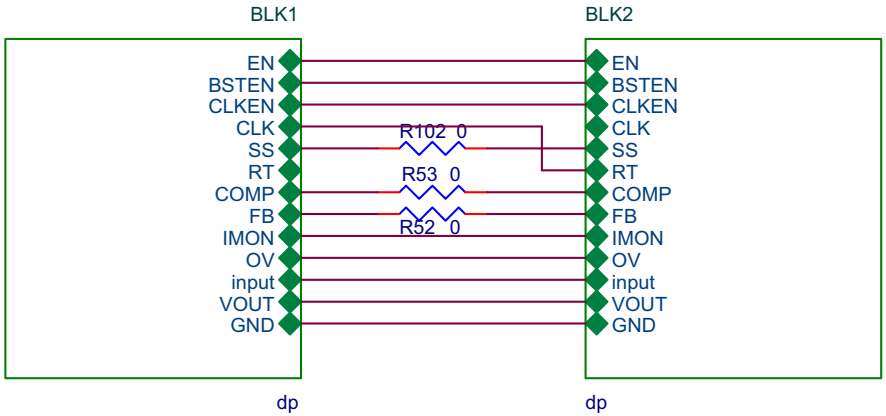


Figure 6. Schematic (1/3)

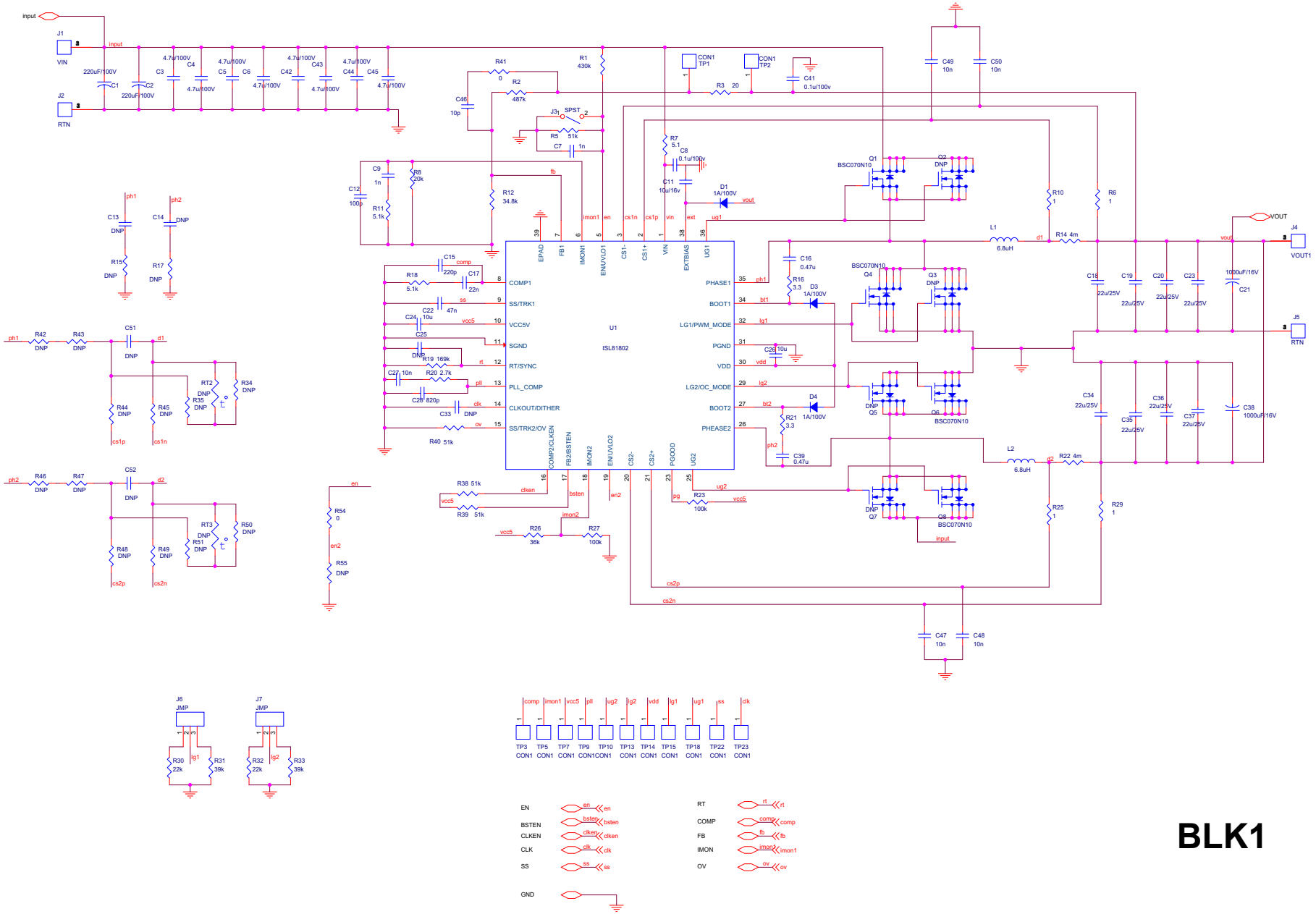


Figure 7. Schematic (2/3)

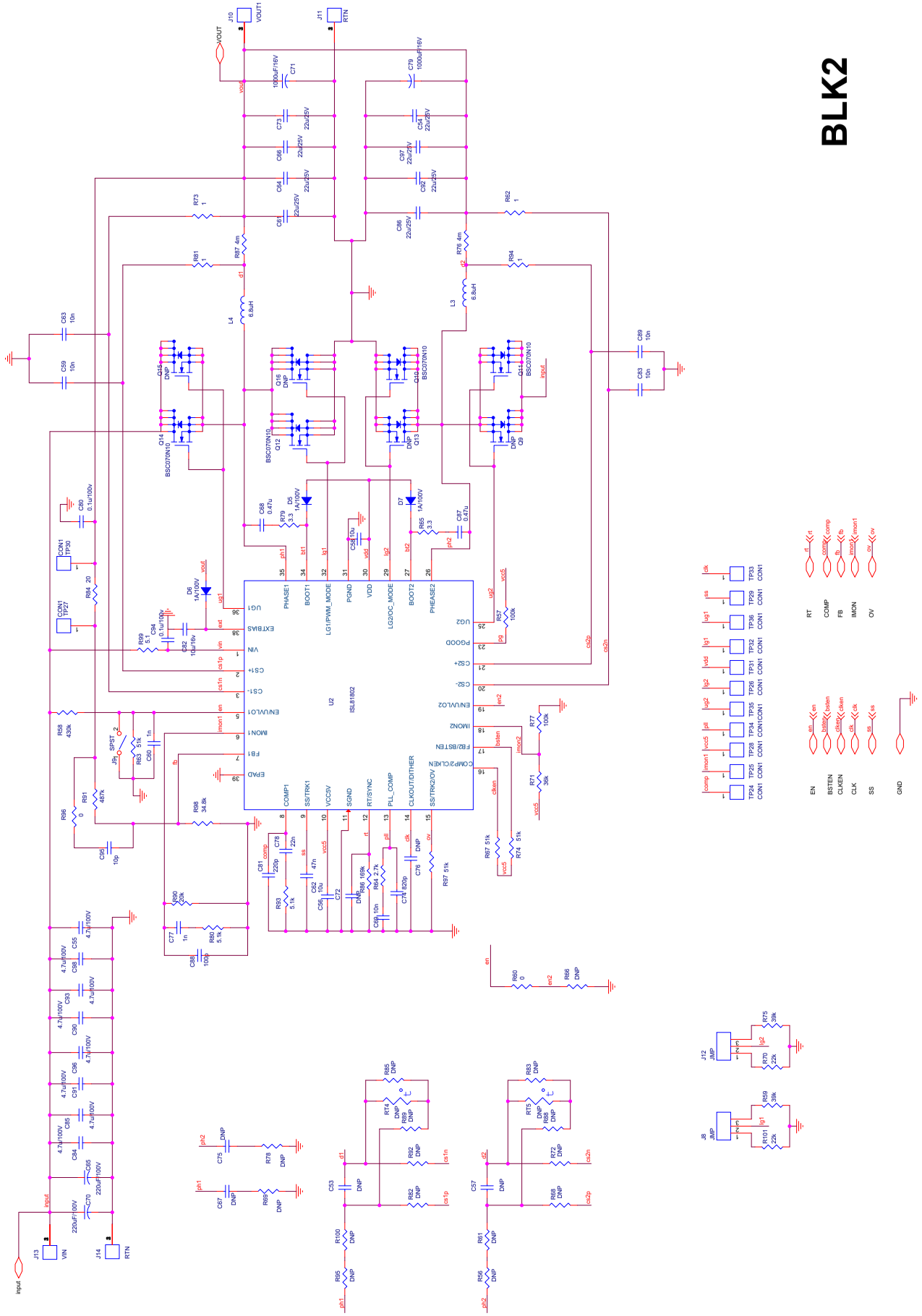


Figure 8. Schematic (3/3)

2.3 Bill of Materials

Qty	Reference Designator	Description	Manufacturer	Manufacturer Part
1		PWB-PCB, ISL81802EVAL3Z, REVB, ROHS	Multilayer PCB Technology	ISL81802EVAL3ZREVBPCB
4	C1, C2, C65, C70	CAP, RADIAL, 12.5x26.5, 220µF, 100V, 20%, ALUM.ELEC., 5mm, ROHS	United Chemi-Con	EKZN101ELL221MK25S
16	C3, C4, C5, C6, C42, C43, C44, C45, C55, C84, C85, C90, C91, C93, C96, C98	CAP-AEC-Q200, SMD, 1210, 4.7µF, 100V, 10%, X7S, ROHS	TDK	CGA6M3X7S2A475K200AB
4	C7, C60, C9, C77	CAP, SMD, 0603, 1000pF, 50V, 10%, X7R, ROHS	TDK	C1608X7R1H102K080AE
4	C8, C41, C80, C94	CAP, SMD, 0603, 0.1µF, 100V, 10%, X7R, ROHS	Vishay	GRJ188R72A104KE11D
2	C11, C82	CAP, SMD, 0603, 10µF, 16V, X5R, 10%, ROHS	Murata	GRM188R61C106KAALJ
2	C12, C88	CAP, SMD, 0603, 100pF, 50V, X7R, 10%, ROHS	Kemet	C0603C101K5RACTU
2	C15, C81	CAP, SMD, 0603, 220pF, 50V, 10%, X7R, ROHS	Murata	GRM188R71H221KA01D
4	C16, C39, C68, C87	CAP, SMD, 0603, 0.47µF, 25V, 10%, X7R, ROHS	Murata	GRM188R71E474KA12D
2	C17, C18	CAP, SMD, 0603, 0.022µF, 50V, X7R, ROHS	Tdk	CGJ3E2X7R1E223K080AA
16	C18, C19, C20, C23, C34, C35, C36, C37, C54, C61, C64, C66, C73, C86, C92, C97	CAP, SMD, 1210, 22µF, 25V, X7R, ROHS	Murata	GRM32ER71E226KE15L
4	C21, C38, C71, C79	CAP-OSCON, SMD, 10mm, 1000µF, 16V, 20%, 12mΩ, ROHS	Panasonic	16SVPF1000M
2	C22, C62	CAP, SMD, 0603, 0.047µF 25V X7R, ROHS	Kemet	C0603C473K3RACTU
4	C24, C26, C56, C58	CAP, SMD, 0805, 10µF, 16V, 10%, X7S, ROHS	Murata	GRM21BC71C106KE11L
2	C28, C74	CAP, SMD, 0603, 820pF, 50V, 10%, X7R, ROHS	Kemet	C0603C821K5RACTU
10	C47, C48, C49, C50, C59, C63, C83, C89, C27, C69	CAP, SMD, 0603, 0.01µF, 100V, 5%, X7R, ROHS	Kemet	C0603C103J1RACTU
2	C46, C95	CAP, SMD, 0603, 10pF, 50V, 10%, C0G, ROHS	Kemet	C0603C100K5GACTU
0	C13, C14, C25, C33, C51, C52, C53, C57, C67, C72, C75, C76	CAP, SMD, 0603, DNP-PLACE HOLDER, ROHS		
6	D1, D3, D4, D5, D6, D7	DIODE-RECTIFIER, SMD, 2P, S0D-123FL, 100V, 1A, ROHS	ON Semiconductor	MBR1H100SFT3G
8	J1, J2, J4, J5, J10, J11, J13, J14	HDWARE, TERMINAL, M4 METRIC SCREW, TH, 4P, SNAP-FIT, ROHS	Keystone	7795
2	J3, J9	CONN-HEADER, 1x2, BRKAWY 1x36, 2.54mm, ROHS	Berg/FCI	68000-236HLF
4	J6, J7, J8, J12	CONN-HEADER, 1x3, BREAKAWY 1x36, 2.54mm, ROHS	Berg/FCI	68000-236HLF
4	L1, L2, L3, L4	COIL-PWR INDUCTOR, SMD, 6.8µH, 20%, 15A, 4.1mΩ, ROHS	Wurth	74439370068
2	U1, U2	80V DUAL-BUCK PWM CONTROLLER, 38P, HTSSOP, ROHS	Renesas Electronics America	ISL81802FVEZ
8	Q1, Q4, Q6, Q8, Q10, Q11, Q12, Q14	TRANSISTOR-MOS, N-CHANNEL, SMD, 8P, PPK SO-8, 100V, 80A, ROHS	Infineon	BSC070N10NS5ATMA1

Qty	Reference Designator	Description	Manufacturer	Manufacturer Part
0	Q2, Q3, Q5, Q7, Q9, Q13, Q15, Q16	DO NOT POPULATE OR PURCHASE		
2	R1, R58	RES SMD 430kΩ 1% 1/4W 1206	Panasonic	ERJ-8ENF4303V
2	R2, R91	RES SMD 487kΩ 1% 1/10W 0603	Yageo	RC0603FR-07487KL
2	R3, R84	RES SMD 20Ω 1% 1/10W 0603	Yageo	RC0603FR-0720RL
8	R6, R73, R10, R25, R81, R94, R29, R62	RES SMD 1Ω 1% 1/10W 0603	Panasonic	ERJ-3RQF1R0V
2	R7, R99	RES SMD 5.1Ω 1% 1/10W 0603	Yageo	RC0603FR-075R1L
2	R8, R90	RES SMD 20kΩ 1% 1/10W 0603	Yageo	RC0603FR-0720KL
4	R11, R80, R18, R93	RES SMD 5.1kΩ 1% 1/10W 0603	Yageo	RC0603FR-075K1L
2	R12, R98	RES SMD 34.8kΩ 1% 1/10W 0603	Yageo	RC0603FR-0734K8L
4	R14, R22, R76, R87	RES SMD 0.004Ω 3W 2512 WIDE	Susumu	KRL6432E-M-R004-F-T1
4	R16, R21, R65, R79	RES SMD 3.3Ω 1% 1/10W 0603	Yageo	RC0603FR-073R3L
2	R19, R86	RES SMD 169kΩ 1% 1/10W 0603	Venkel	CR0603-10W-1693FT
2	R20, R64	RES SMD 2.7kΩ 1% 1/10W 0603	Yageo	RC0603FR-072K7L
4	R23, R27, R57, R77	RES SMD 100kΩ 1% 1/10W 0603	Yageo	RC0603FR-07100KL
2	R26, R71	RES SMD 22kΩ 1% 1/10W 0603	Yageo	RC0603FR-0722KL
4	R30, R32, R70, R101	RES SMD 39kΩ 1% 1/10W 0603	Yageo	RC0603FR-0739KL
4	R31, R33, R59, R75	RES SMD 39kΩ 1% 1/10W 0603	Yageo	RC0603FR-0739KL
8	R38, R39, R40, R67, R74, R97, R5, R63	RES SMD 51kΩ 1% 1/10W 0603	Yageo	RC0603FR-0751KL
7	R41, R96, R52, R53, R54, R60, R102	RES SMD 0Ω 1% 1/10W 0603	Yageo	RC0603FR-070RL
0	R42, R43, R46, R47, R56, R61, R95, R100, R15, R17, R69, R78, R34, R35, R44, R45, R48, R49, R50, R51, R55, R66, R68, R72, R82, R83, R85, R88, R89, R92, RT2, RT3, RT4, RT5	RES, SMD, 0603, DNP-PLACE HOLDER, ROHS		
26	TP1, TP2, TP3, TP5, TP7, TP9, TP10, TP13, TP14, TP15, TP18, TP22, TP23, TP24, TP25, TP26, TP27, TP28, TP29, TP30, TP31, TP32, TP33, TP34, TP35, TP36	CONN-COMPACT TEST PT, VERTICAL, WHT, ROHS	Keystone	5007
4	J6, J7, J8, J12	CONN-JUMPER, SHORTING, 2PIN, BLACK, GOLD, ROHS	Sullins	SPC02SYAN
6	Six corners	SCREW, 4-40x1/4in, PHILLIPS, PANHEAD, STAINLESS, ROHS	Keystone	2204
6	Six corners	STANDOFF, 4-40x3/4in, F/F, HEX, ALUMINUM, 0.25 OD, ROHS	Keystone	7795

2.4 Board Layout

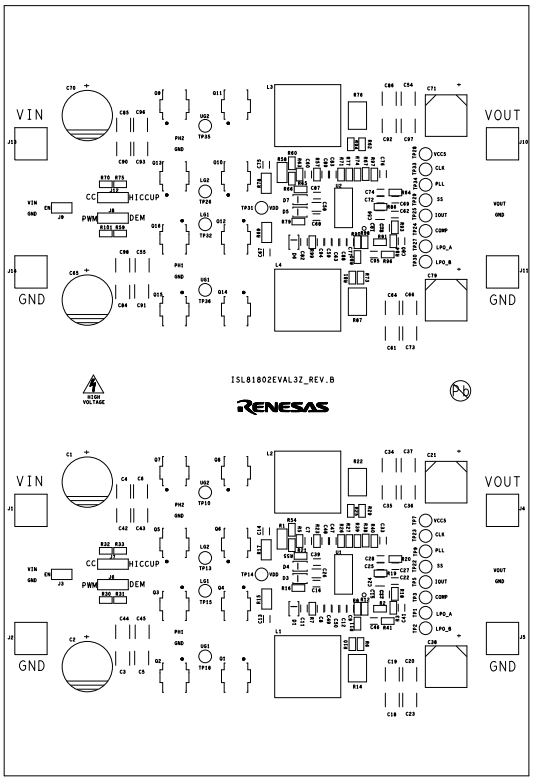


Figure 9. Silkscreen Top

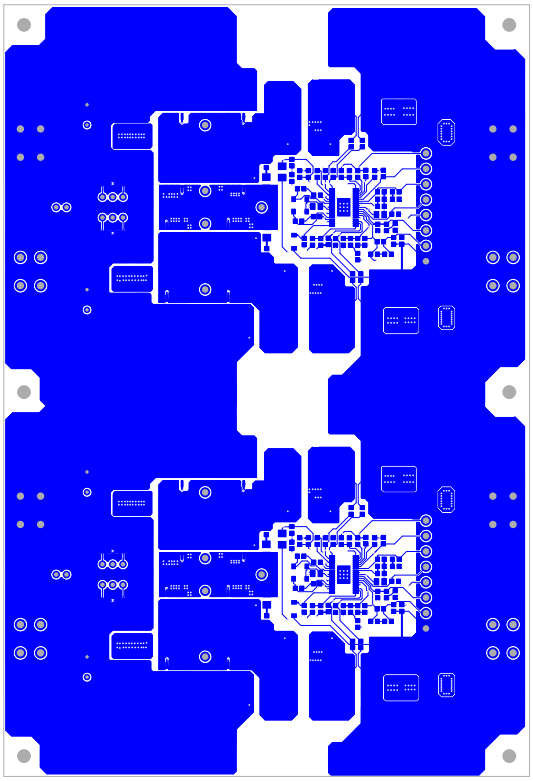


Figure 10. Top Layer

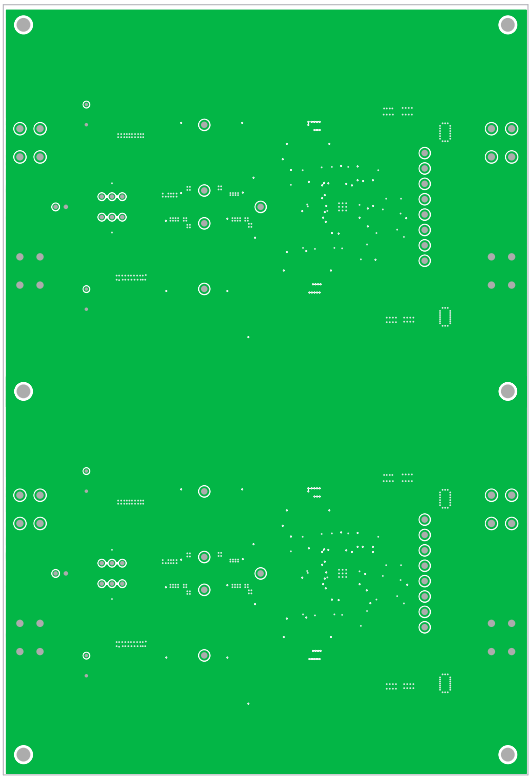


Figure 11. Second Layer (Solid Ground)

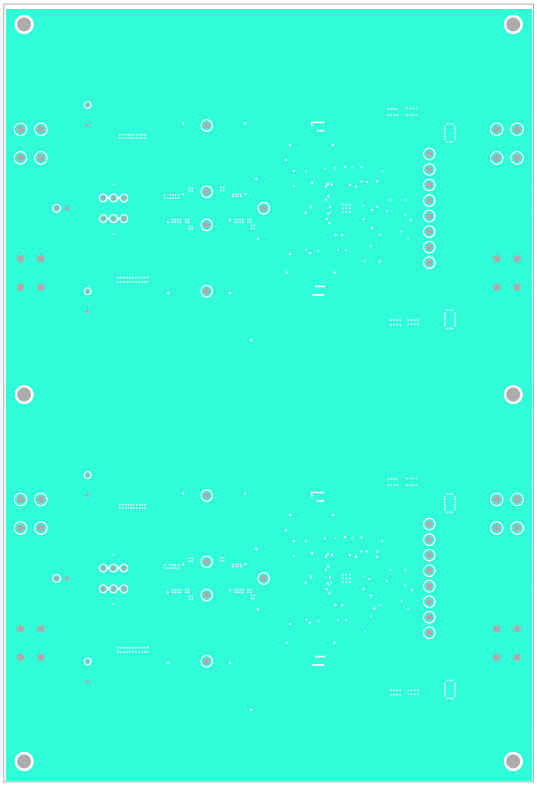


Figure 12. Third Layer

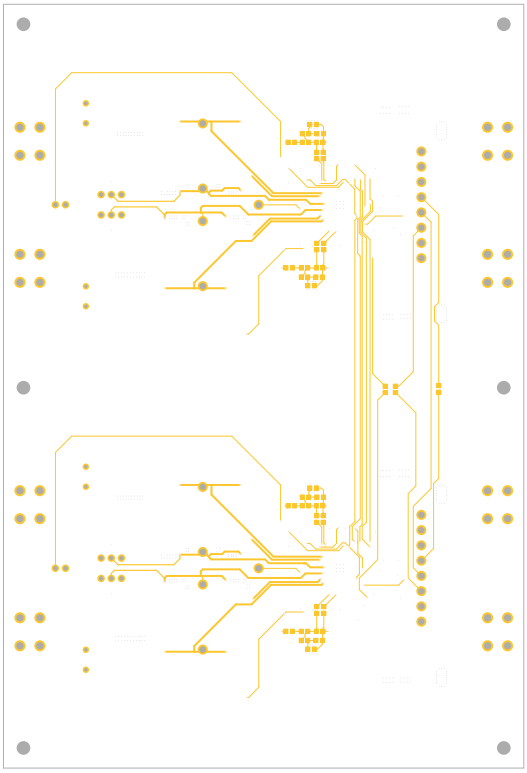


Figure 13. Bottom Layer

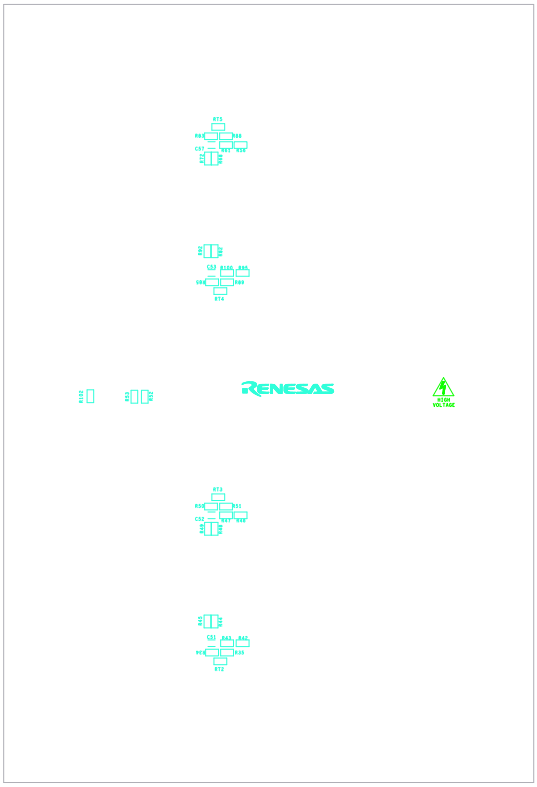


Figure 14. Silkscreen Bottom

3. Typical Performance Curves

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

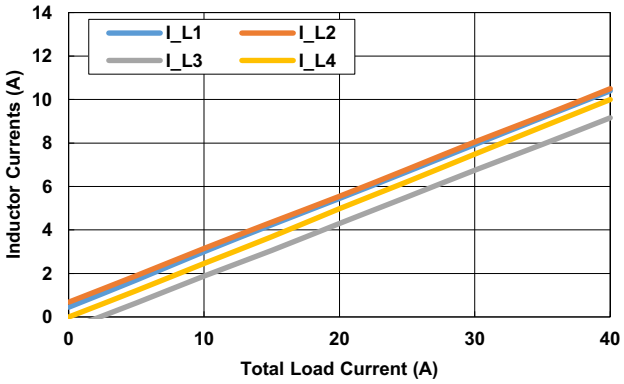


Figure 15. Load Current Sharing, V_{IN} = 48V, CCM

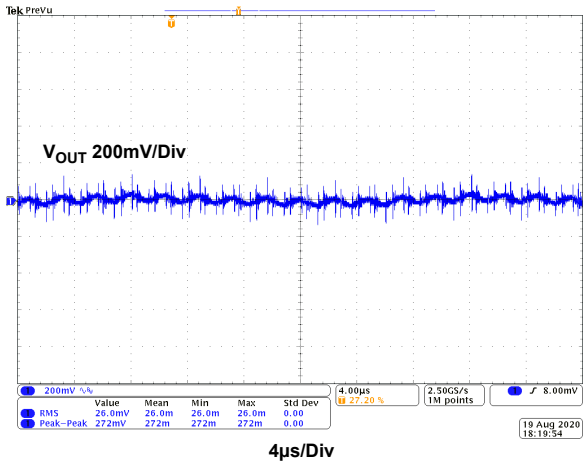


Figure 16. Output Voltage Ripple, V_{IN} = 48V, I_{OUT} = 40A, CCM

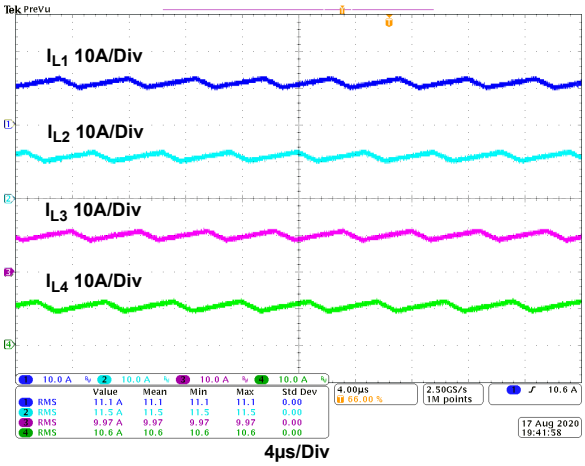


Figure 17. Inductor Current I_{L1}, I_{L2}, I_{L3}, I_{L4}, V_{IN} = 18V, I_{OUT} = 40A

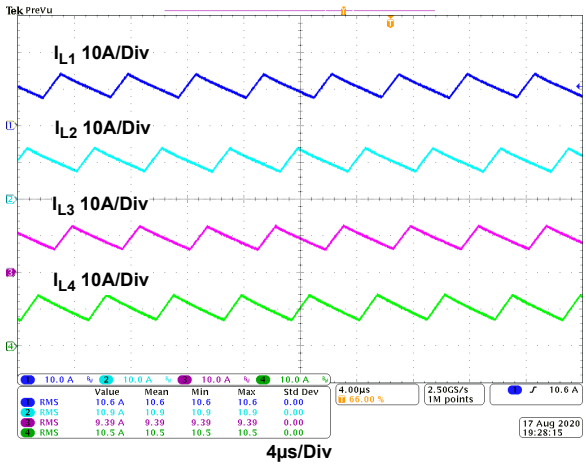


Figure 18. Inductor Current I_{L1}, I_{L2}, I_{L3}, I_{L4}, V_{IN} = 48V, I_{OUT} = 40A

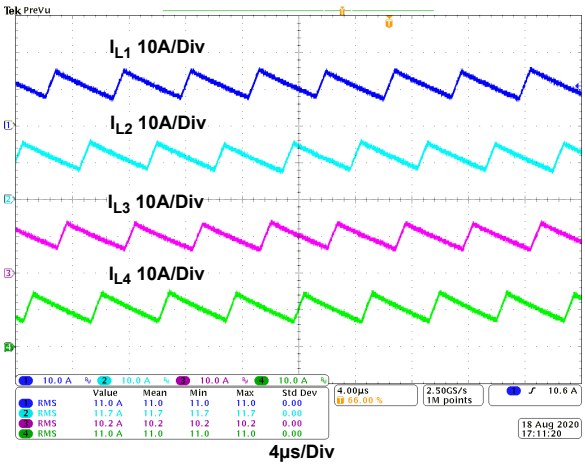


Figure 19. Inductor Current I_{L1}, I_{L2}, I_{L3}, I_{L4}, V_{IN} = 80V, I_{OUT} = 40A

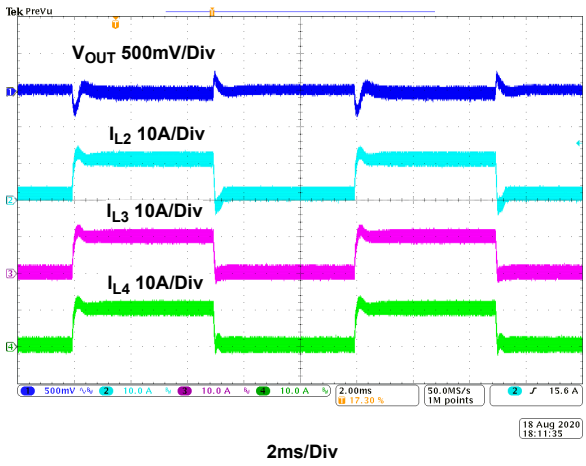
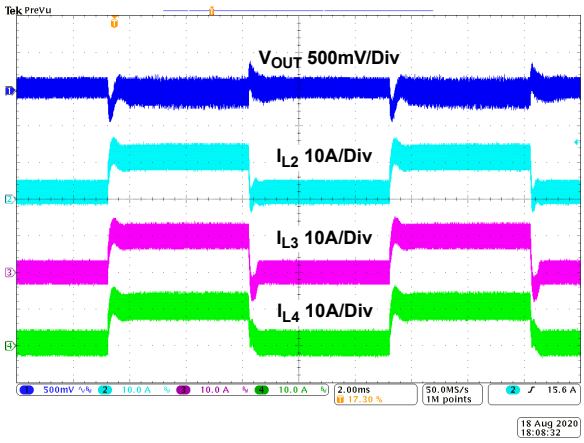


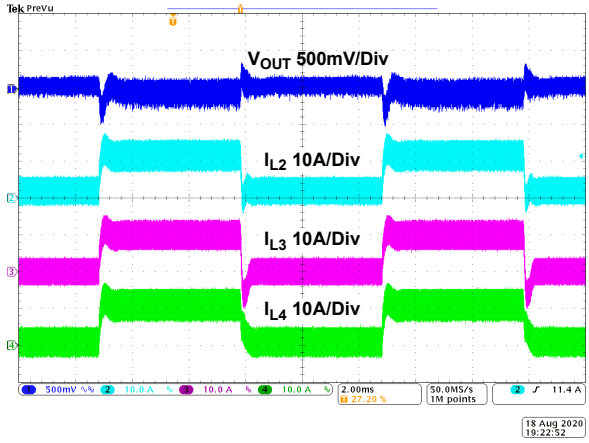
Figure 20. Load Transient, V_{IN} = 18V, I_{OUT} = 0A to 40A, 2.5A/µs, CCM

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



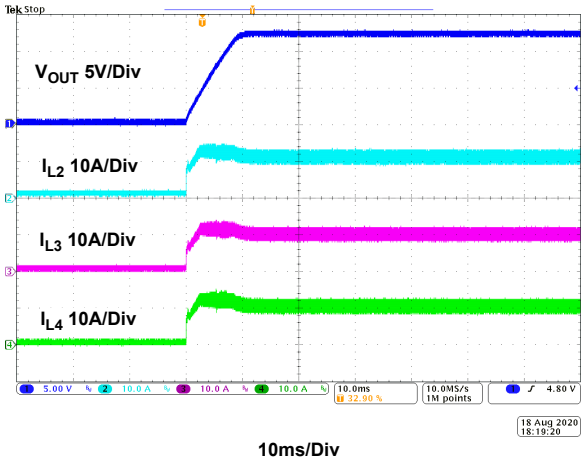
2ms/Div

Figure 21. Load Transient, V_{IN} = 48V, I_{OUT} = 0A to 40A, 2.5A/µs, CCM



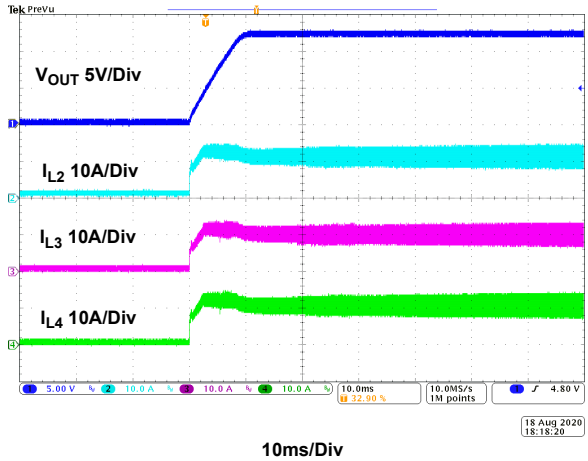
2ms/Div

Figure 22. Load Transient, V_{IN} = 80V, I_{OUT} = 0A to 40A, 2.5A/µs, CCM



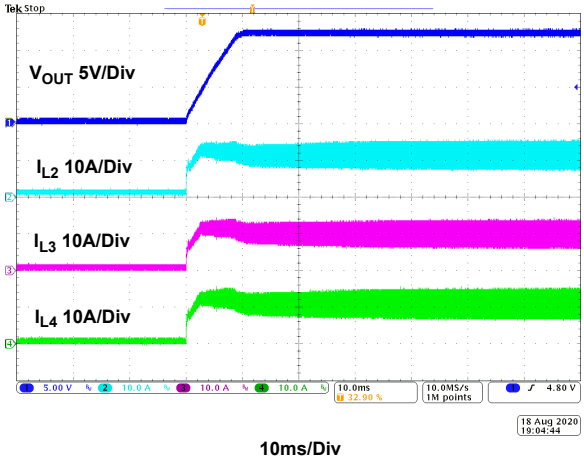
10ms/Div

Figure 23. Start-Up Waveform, V_{IN} = 18V, I_{OUT} = 40A, CCM



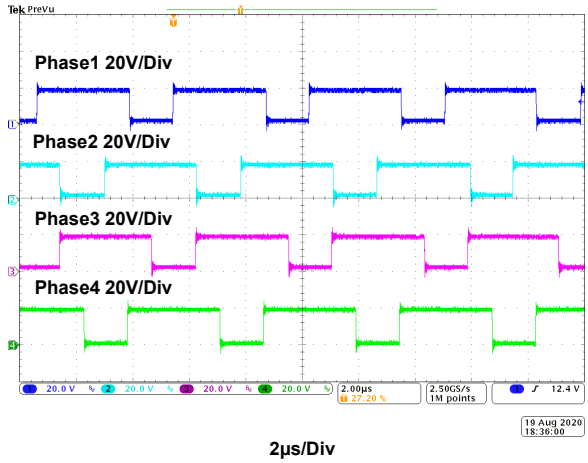
10ms/Div

Figure 24. Start-Up Waveform, V_{IN} = 48V, I_{OUT} = 40A, CCM



10ms/Div

Figure 25. Start-Up Waveform, V_{IN} = 80V, I_{OUT} = 40A, CCM



2µs/Div

Figure 26. Phase1, Phase2, Phase3, Phase4, V_{IN} = 18V, I_{OUT} = 40A, CCM

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

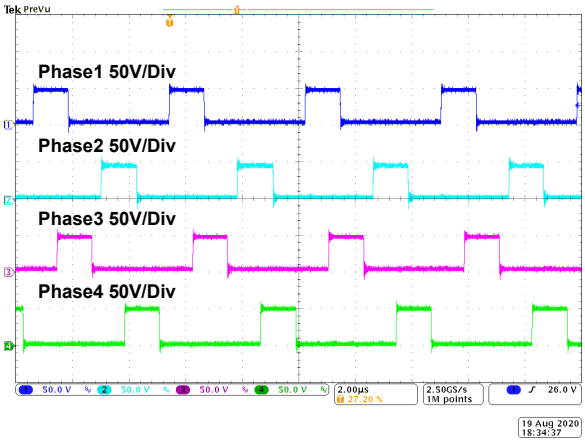


Figure 27. Phase1, Phase2, Phase3, Phase4, V_{IN} = 48V, I_{OUT} = 40A, CCM

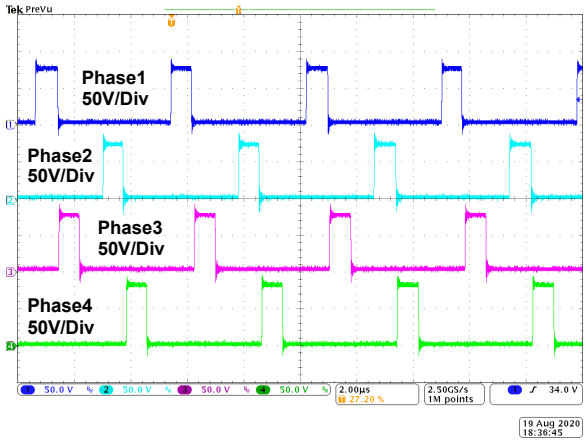


Figure 28. Phase1, Phase2, Phase3, Phase4, V_{IN} = 80V, I_{OUT} = 40A, CCM

4. Revision History

Rev.	Date	Description
1.00	Sep.15.20	Initial release