ISL70002SEHEVAL3Z

Differential Remote Sensing Evaluation Board

The ISL70002SEHEVAL3Z evaluation board is designed to demonstrate the features of the ISL70002SEH, a TID and SEE hardened 22A synchronous buck regulator IC with integrated MOSFETs intended for space applications. For more detailed information about the ISL70002SEH, refer to the *ISL70002SEH Datasheet*.

The ISL70002SEHEVAL3Z is similar to the ISL70002SEHEVAL1Z, but AGND is separated from PGND. This allows remote ground sensing to compensate for voltage loss in the ground path. Ground sensing is an important feature when providing a tightly regulated core voltage for a FPGA or microcontroller.

Features

- Separate VOUT and GND Force and Sense terminals
- Optional 2x2mΩ emulated trace resistance included on board
- 3V to 5.5V input
- Adjustable V_{OUT} from 0.6V to 0.85×V_{IN}

Recommended Equipment

- A 6V power supply capable of at least 10A
- An electronic load capable of sinking at least 12A
- Three Digital Multimeters (DMMs)
- A 500MHz four-channel oscilloscope
- Optional: One differential voltage probe to measure one signal with respect to a different ground.

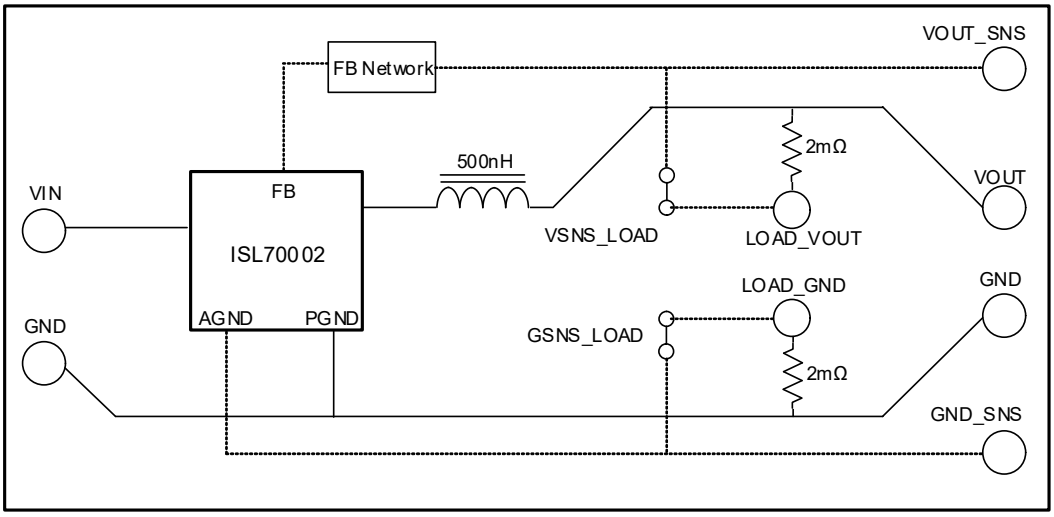

Figure 1. ISL70002SEHEVAL3Z Block Diagram

Contents

1. Functional Description

1.1 Quick Start Instructions

1. Toggle S1 to the down (OFF) position.
2. Study Figure 2 to see how to hook up the evaluation board.

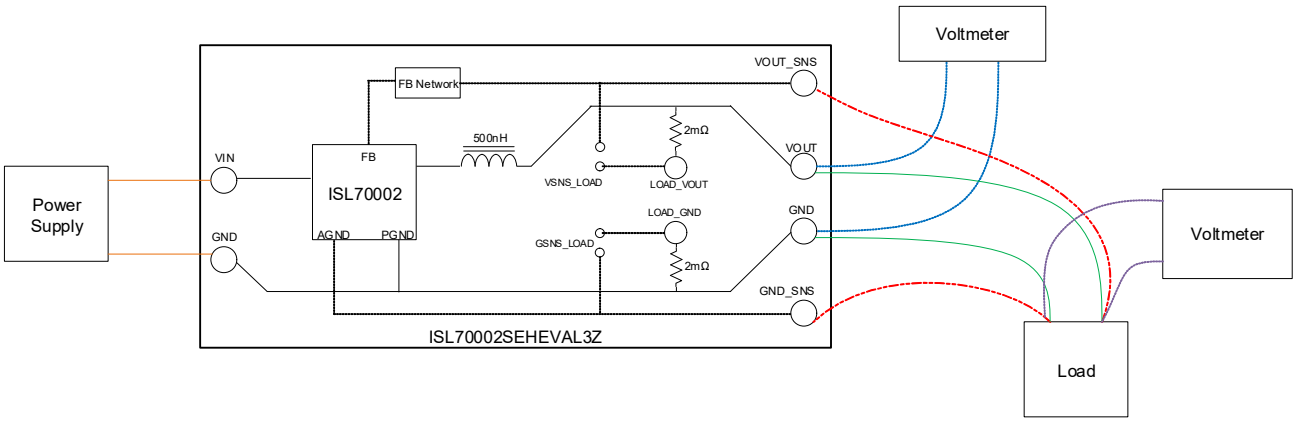

Figure 2. Quick Start Diagram

3. Turn on the power supply. Set the output voltage to 5V and set the output current limit to 10A. Turn off the power supply output.
4. Connect the positive lead of the power supply to J1 and the negative lead of the power supply to J2.
5. Turn on the electronic load and set the output current to 5A.
6. Connect the positive lead of the electronic load to VOUT (J39) and to VOUT_SNS with two separate wires.
7. Connect the negative lead of the electronic load to GND (J40) and to GND_SNS with two separate wires.
8. (Optional) Configure one DMM to monitor the input voltage from TP7 to TP11.
9. Configure another DMM to monitor the output voltage from TP13 to TP11 or the VOUT and GND terminals.
10. Configure a third DMM to monitor the voltage on the electronic load.
11. Connect Channel 1 of the oscilloscope to J6 (or from TP33 to TP28) to monitor the rectangular waveform on the LXx pins.
12. Connect Channel 2 of the oscilloscope to J14 (or from TP36 to TP37) to monitor the output voltage. Ripple voltage is customarily measured AC-coupled with 20MHz bandwidth limiting.
13. Toggle S1 to the up (ON) position.
14. Verify the output voltage is 1.0V ±3% and the frequency of the LXx waveform is 1MHz ±10%.
15. Vary the load and observe V_{OUT} at the load maintaining regulation. The voltage at the VOUT-GND terminals should boost under increasing load to account for the resistance of the wires to the load.
16. To see more pronounced compensation, insert some intentional resistance (1-10mΩ) between the VOUT and/or GND (force) terminals and the load. Follow the Onboard Resistor Instructions to use the onboard 2mΩ resistors.

1.2 Onboard Resistor Instructions

1. The configuration shown in Figure 3 uses onboard series resistors to emulate resistive loss in a PCB or IC package.

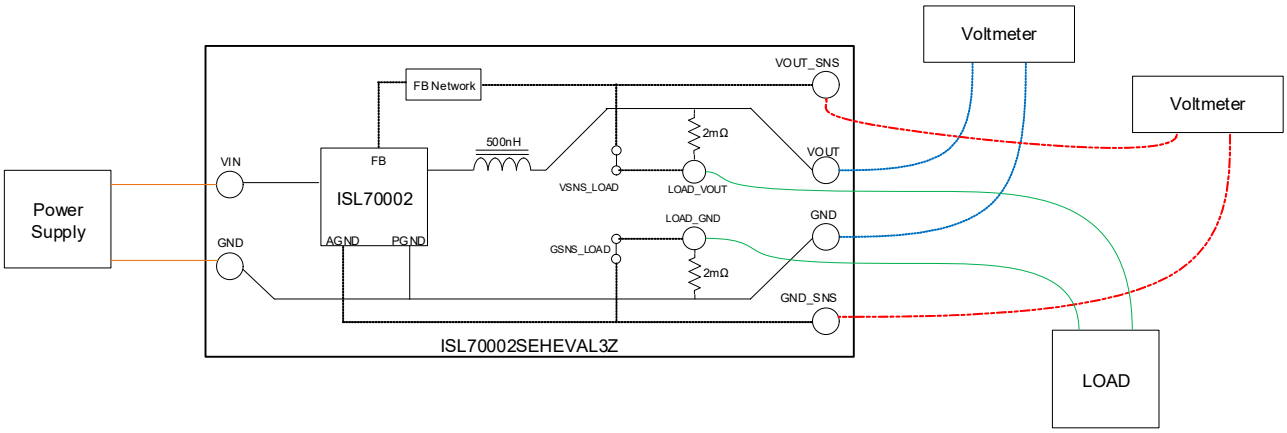

Figure 3. On-Board Series Resistor Diagram

2. Install VSNS_LOAD and GSNS_LOAD jumpers.
3. Connect the DC load to the LOAD_VOUT and LOAD_GND terminals. Solder, clip, or bolt wires to the terminals.
4. Connect one voltmeter to the VOUT and GND terminals. Connect another to the VOUT_SNS and GND_SNS terminals as shown in Figure 3.
5. Enable, disable, and modulate the DC load to observe the POL converter compensating for the trace impedance. This includes 4mΩ of onboard chip resistors and parasitic resistance of the evaluation PCB. Observations should be similar to Figure 19.

2. Board Design

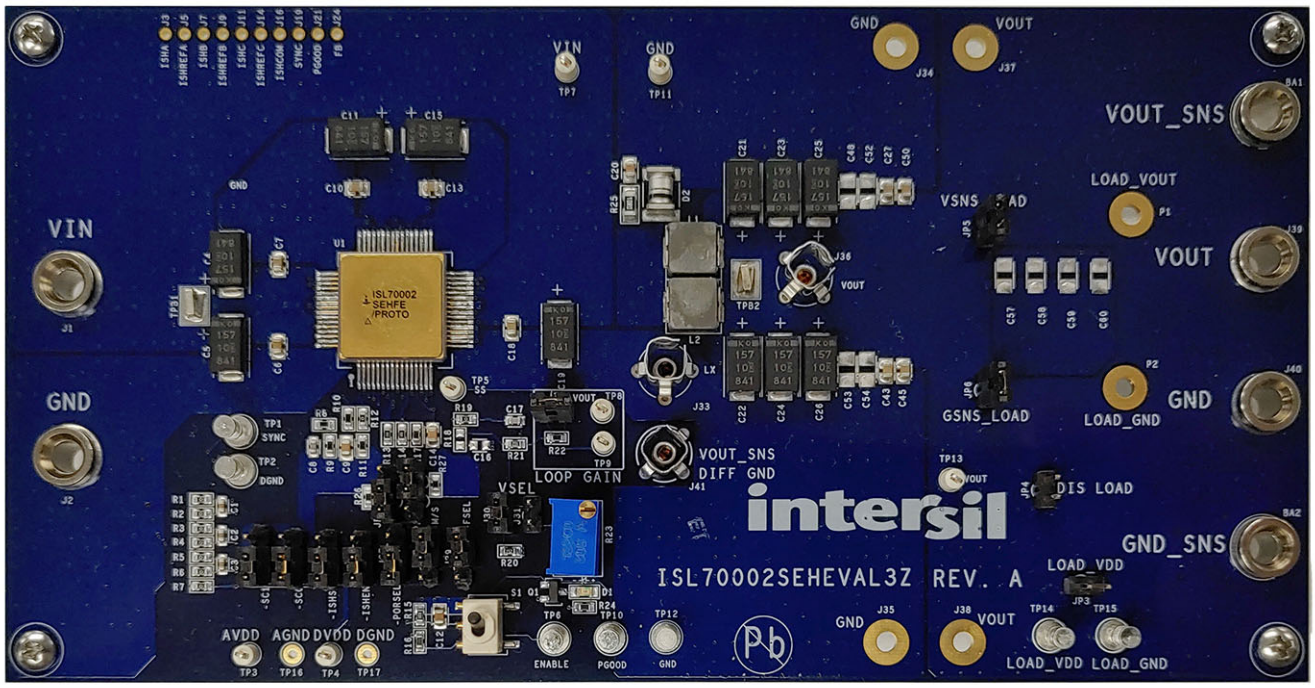

Figure 4. ISL70002SEHEVAL3Z Evaluation Board (Top)

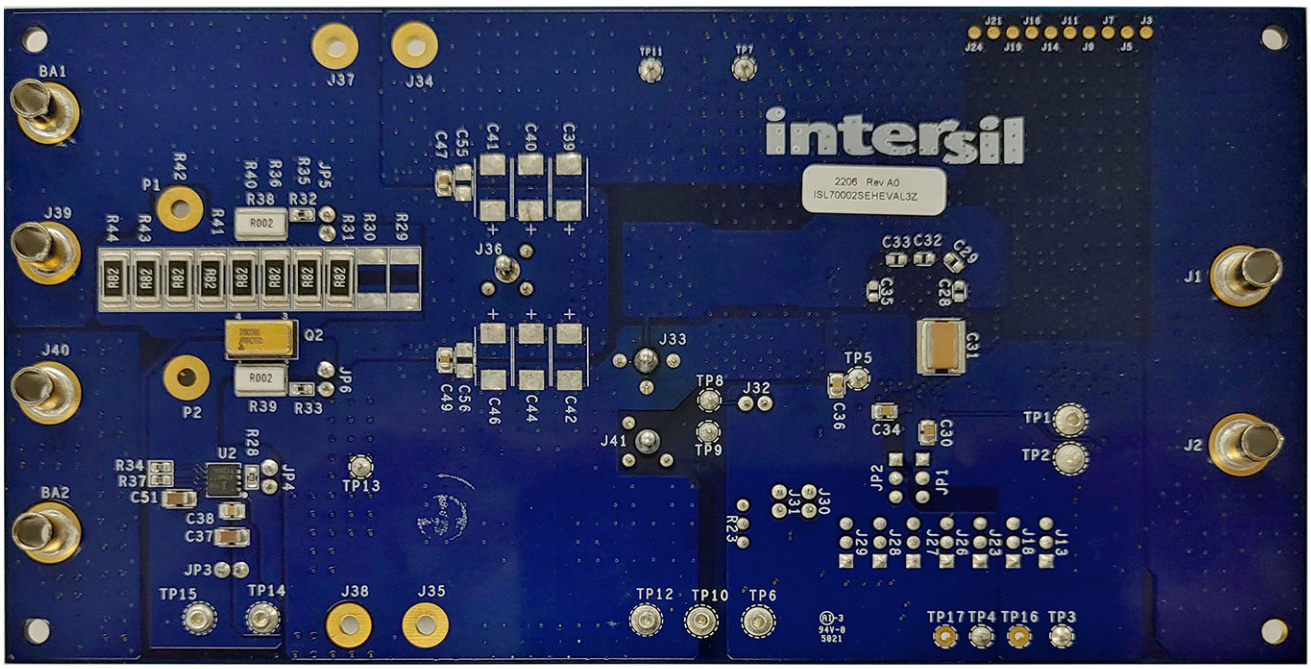

Figure 5. ISL70002SEHEVAL3Z Evaluation Board (Bottom)

2.1 Layout Guidelines

PCB design files are available on the ISL70002SEHEVAL3Z webpage for you to study or incorporate into your design.

1. Use a six-layer PCB with 2 ounce (70µm) copper outer layers or an equivalent in more layers.
2. Two interior layers should be dedicated for PGND planes. In addition, place a square island of PGND on the top layer directly underneath the body of the ISL70002SEH. Fill this area with vias to connect the top island to the PGND planes for optimal electrical and thermal performance. The ISL70002SEHVFE parts have an exposed metal bottom that can be soldered to the PCB. You may also use a thermal interface material such as a Sil-Pad to ensure good thermal contact between the PCB and the IC, with or without an exposed metal bottom.
3. Top and bottom layers should be used primarily for high-power traces ensuring the lowest impedance paths between the input capacitors, the IC, the inductor, and the output capacitors. Where convenient, use the top layer to connect the IC pins to the various small signal resistor and capacitors.
4. Connect all DGND and PGNDx pins to the PGND island under the part. Connect all PVINx pins to the input power supply using the lowest resistance PCB layers (typically the top and bottom) if possible.
5. Locate a PVIN ceramic bypass capacitor as close as possible to each pair of PGNDx and PVINx pins on the top of the PCB and connect them to the pins in the top layer.
6. Group the small signal components together near their pin(s) on U1. This should include the components that touch pins 1-16 and 59-63.
7. Locate the output voltage resistive divider as close as possible to the FB pin of the IC. Run a VOUT sense route from the top node of the divider directly to the positive terminal on the load. This route can be on any layer.
8. Enclose the small signal components in an AGND pour, and duplicate that pour on an interior layer. Connect these together with multiple vias. Connect the AGND pin and passive component leads of the IC to this pour.
9. Connect the GND side of the VOUT capacitors to the PGND planes with a low impedance path back to the IC.
10. Run an AGND route from the copper pour all the way to the negative terminal of the load. Run this parallel to the VOUT sense route that connects the FB divider to the load.
11. Use a small island of copper to connect the LXx pins of U1 to the inductor(s), L1 (and L2, if using two parallel inductors), to minimize the routing capacitance that degrades efficiency. Separate the island from ground and power planes as much as possible. This copper pattern may need to be replicated on multiple layers to reduce the resistance.
12. Keep all signal traces as short as possible.
13. A small series snubber (R25 and C20) connected from the LXx pins to the PGNDx pins can be used to dampen ringing on the LXx pins if desired.
14. For optimum thermal performance, place a pattern of vias on the top layer of the PCB directly underneath U1. Connect the vias to the ground planes, which serve as a heatsink.

2.2 Schematic Diagram

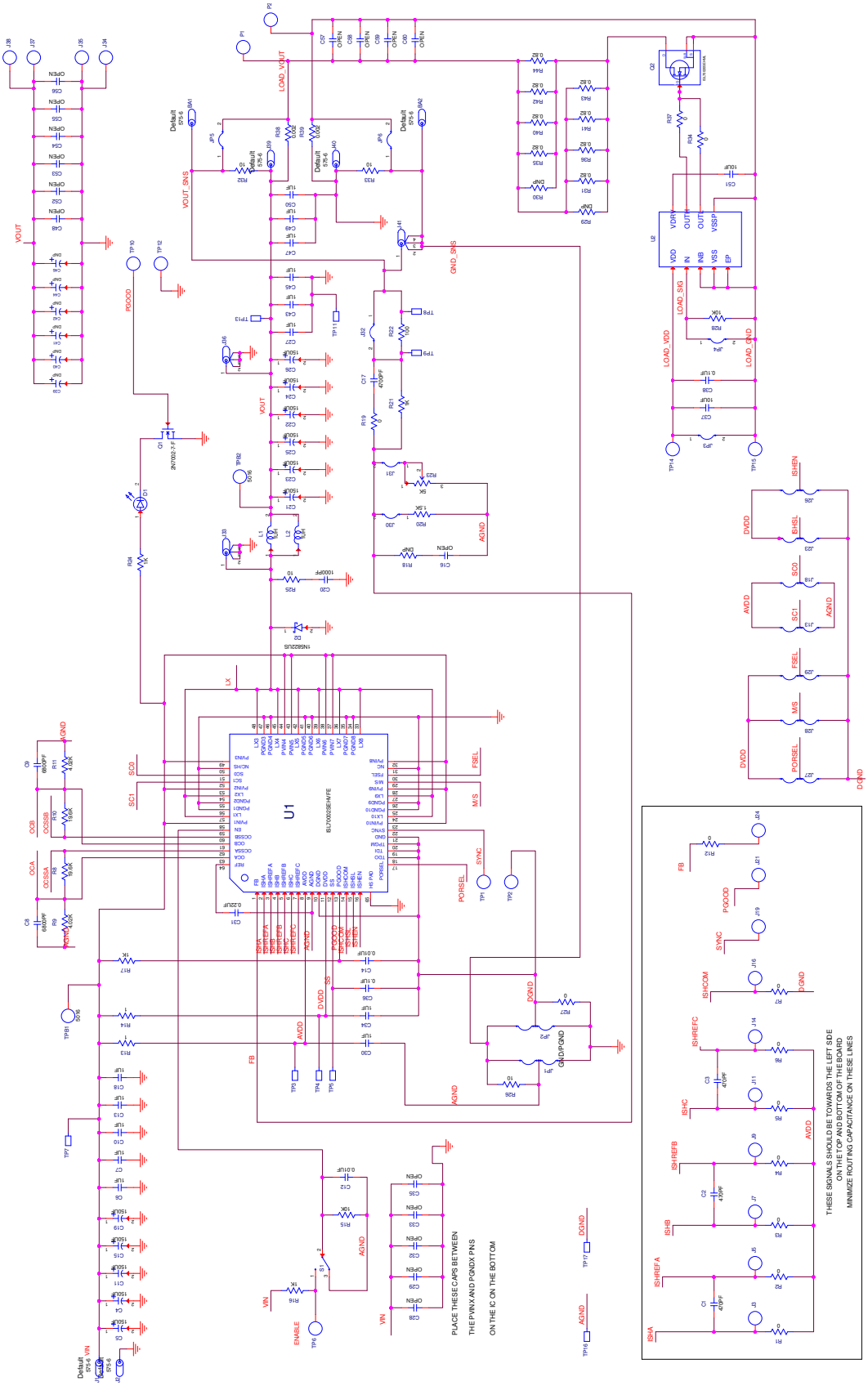

Figure 6. ISL70002SEHEVAL3Z Schematic

2.3 Bill of Materials

Qty	Reference Designator	Description	Manufacturer	Manufacturer Part Number
1	C20	CAP-AEC-Q200, SMD, 0805, 1000PF, 200V, 10%, X7R, ROHS	Kemet	C0805C102K2RACAUTO
2	C12, C14	CAP-AEC-Q200, SMD, 0805, 0.01µF, 200V, 10%, X7R, ROHS	Kemet	C0805C103K2RACAUTO
1	C9	CAP-AEC-Q200, SMD, 0805, 6800pF, 200V, 10%, X7R, ROHS	Kemet	C0805C682K2RACAUTO
1	C31	CAP, SMD, 1825, 0.22µF, 200V, 10%, X7R, ROHS	Kemet	C1825C224K2RAC7800
3	C1, C2, C3	CAP, SMD, 0603, 470pF, 25V, 10%, X7R, ROHS	Venkel	C0603X7R250-471KNE
1	C17	CAP, SMD, 0603, 4700pF, 50V, 5%, C0G/NP0, ROHS	Kemet	C0603C472J5GACTU
1	C8	CAP, SMD, 0603, 6800pf, 50V, 5%, X7R, ROHS	AVX	06035C682JAT2A
15	C6, C7, C10, C13, C18, C27, C30, C34, C43, C45, C47, C49, C50, C36, C38	CAP, SMD, 0805, 1µF, 10V, 10%, X7R, ROHS	Venkel	C0805X7R100-105KNE
2	C37, C51	CAP, SMD, 1206, 10UF, 16V, 10%, X5R, ROHS	Samsung	CL31A106KOHNNNE
11	C4, C5, C11, C15, C19, C21-C26	CAP TANT, LOW ESR, SMD, D, 150µF, 10V, 20%, 6mΩ, ROHS	Kemet	T530D157M010ATE006
2	L1, L2	COIL-PWR INDUCTOR, SMD, 6.9×6.5, 1.0µH, 20%, 11A, ROHS	Vishay	IHLP2525CZER1R0M01
3	J33, J36, J41	CONN-SCOPE PROBE TEST PT, COMPACT, PCB MNT, ROHS	Tektronix	131-4353-00
7	TP1, TP2, TP6, TP10, TP12, TP14, TP15	CONN-TURRET, TERMINAL POST, TH, ROHS	Keystone	1514-2
8	TP3, TP4, TP5, TP7, TP8, TP9, TP11, TP13	CONN-MINI TEST POINT, VERTICAL, WHITE, ROHS	Keystone	5002
2	TPB1, TPB2	CONN-COMPACT TEST POINT, SMD, ROHS	Keystone	5016
6	BA1, BA2, J1, J2, J39, J40	CONN-JACK, MINI BANANA, SDRLESS, NICKEL/BRASS, 0.175 PLUG, ROHS	Keystone	575-6
7	J13, J18, J23, J26, J27, J28, J29	CONN-HEADER, 1×3, BREAKAWY 1×36, 2.54mm, ROHS	BERG/FCI	68000-236HLF
7	J30, J31, J32, JP3, JP4, JP5, JP6	CONN-HEADER, 1×2, RETENTIVE, 2.54mm, 0.230×0.120, ROHS	BERG/FCI	69190-202HLF

Qty	Reference Designator	Description	Manufacturer	Manufacturer Part Number
9	Pins 1-2: J13, J18, J23, J26, J27, Pins 2-3: J28, J29, J30, J32	CONN-JUMPER, SHUNT, 2P, 2.54mmPITCH, BLK, 6mm, OPEN, ROHS	Sullins	SPC02SYAN
1	D2	DIODE-SCHOTTKY, LOW IR, SMD, 2P, 40V, 3A, ROHS	Microsemi	1N5822US
1	D1	LED-GaAs RED, SMD, 2×1.25mm, 100mW, 40mA, 10mcd, ROHS	Liteon/Vishay	LTST-C170CKT
1	U1	IC-12A SYNC BUCK REGULAT, 64P, CQFP, W/HEATSINK, ROHS	Renesas Electronics	ISL70002SEHFE/PROTO
1	Q2	IC-PROTO, RAD HARD, 40V GAN FET, 4P, CLCC, ROHS	Renesas Electronics	ISL70020SEHL/PROTO ALT: ISL73020SEHL/PROTO
1	U2	IC-GaN FET DRIVER, 8PTDFN, 4×4, ROHS	Renesas Electronics	ISL71040MRTZ
1	Q1	TRANSISTOR, N-CHANNEL, 3LD, SOT-23, 60V, 115mA, ROHS	Diodes, Inc.	2N7002-7-F
1	R23	POT-TRIM, TH, 5K, 0.5W, 10%, 3P, 3/8, ROHS	Bourns	3299W-1-502LF
1	R21	RES-AEC-Q200, SMD, 0603, 1k, 1/10W, 0.1%, THINFILM, ROHS	Panasonic	ERA-3AEB102V
2	R15, R28	RES-AEC-Q200, SMD, 0603, 10k, 1/10W, 0.1%, THINFILM, ROHS	Panasonic	ERA-3AEB103V
1	R20	RES-AEC-Q200, SMD, 0603, 1.5k, 1/10W, 0.1%, THINFILM, ROHS	Panasonic	ERA-3AEB152V
2	R8, R10	RES-AEC-Q200, SMD, 0603, 19.6k, 1/10W, 0.1%, THINFILM, ROHS	Panasonic	ERA-3AEB1962V
2	R9, R11	RES-AEC-Q200, SMD, 0603, 4.02k, 1/10W, 0.1%, THINFILM, ROHS	Panasonic	ERA-3AEB4021V
2	R13, R14	RES, SMD, 0603, 1Ω, 1/10W, 1%, TF, ROHS	Panasonic	ERJ-3RQF1R0V
3	R26, R32, R33	RES, SMD, 0603, 10Ω, 1/10W, 1%, TF, ROHS	KOA	RK73H1JT10R0F
12	R1, R2, R3, R4, R5, R6, R7, R12, R19, R34, R37, R27	RES, SMD, 0603, 0Ω, 1/10W, TF, ROHS	Venkel	CR0603-10W-000T
1	R22	RES, SMD, 0603, 100Ω, 1/10W, 1%, TF, ROHS	Venkel	CR0603-10W-1000FT
3	R16, R17, R24	RES, SMD, 0603, 1K, 1/10W, 1%, TF, ROHS	Panasonic	ERJ-3EKF1001V
1	R25	RES, SMD, 1206, 10Ω, 1/4W, 1%, TF, ROHS	Venkel	CR1206-4W-10R0FT
8	R31, R35, R36, R40, R41, R42, R43, R44	RES, SMD, 2512, 0.82Ω, 1W, 5%, TF, ROHS	Panasonic	ERJ-1TRQJR82U

Qty	Reference Designator	Description	Manufacturer	Manufacturer Part Number
2	R38, R39	RES-AEC-Q200, SMD, 2512W, 0.002Ω, 3W, 2%, MF, ROHS	Susumu CO., LTD	KRL6432E-M-R002-G-T1
1	S1	SWITCH-TOGGLE, SMD, 6PIN, SPDT, 2POS, ON-NONE-ON, ROHS	ITT Industries/C&K Division	GT11MSCBE
4	Four corners	SCREW, 4-40×1/4in, PHILLIPS, PANHEAD, STAINLESS, ROHS	Building Fasteners	PMSSS 440 0025 PH
4	Four corners	STANDOFF, 4-40×3/4in, F/F, HEX, ALUMINUM, 0.25 OD, ROHS	Keystone	2204
0	C16, C28, C29, C32, C33, C35	CAP, SMD, 0603, DNP- Do not populate		
0	C48, C52, C53, C54, C55, C56, C57, C58, C59, C60	CAP, SMD, 1206, DNP- Do not populate		
0	JP1, JP2	DO NOT POPULATE		
0	C39, C40, C41, C42, C44, C46	DO NOT POPULATE		T530D157M010ATE006
0	J3, J5, J7, J9, J11, J14, J16, J19, J21, J24,	DO NOT POPULATE		
0	P1, P2, J34, J35, J37, J38	DO NOT POPULATE		
0	R18	RESISTOR, SMD, 0603, DNP- Do not populate		
0	R29, R30	RES, SMD, 2512, DNP- Do not populate		

2.4 Board Layout

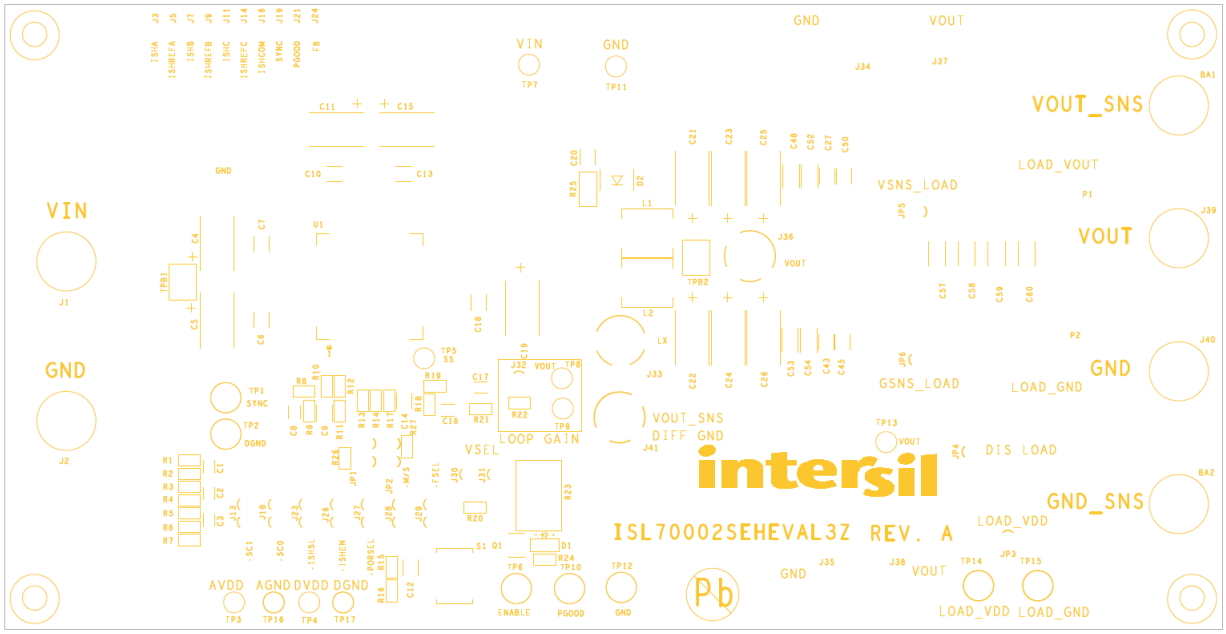

Figure 7. Top Silkscreen

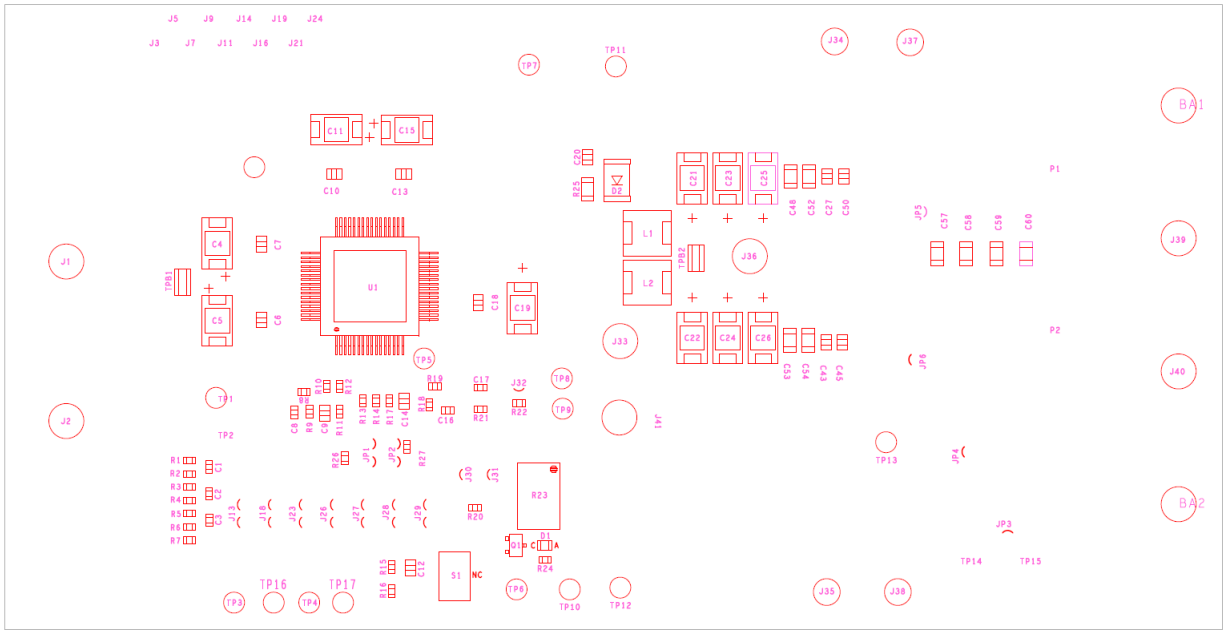

Figure 8. Top Layer Component Placement

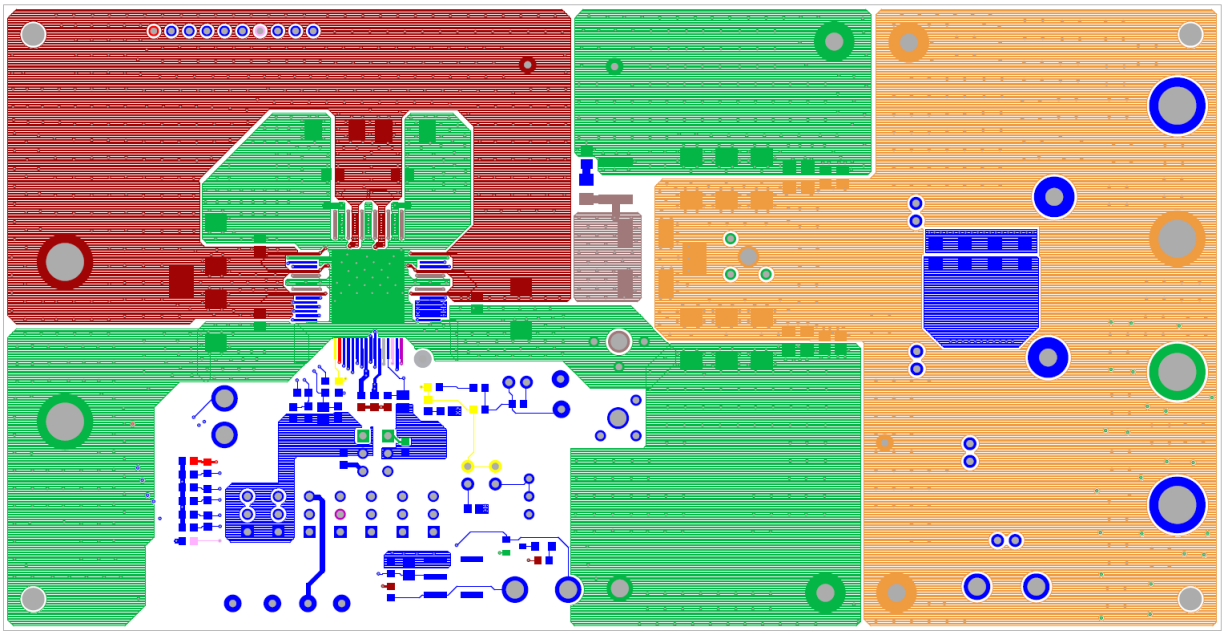

Figure 9. Layer 1 (Top Component Layer)

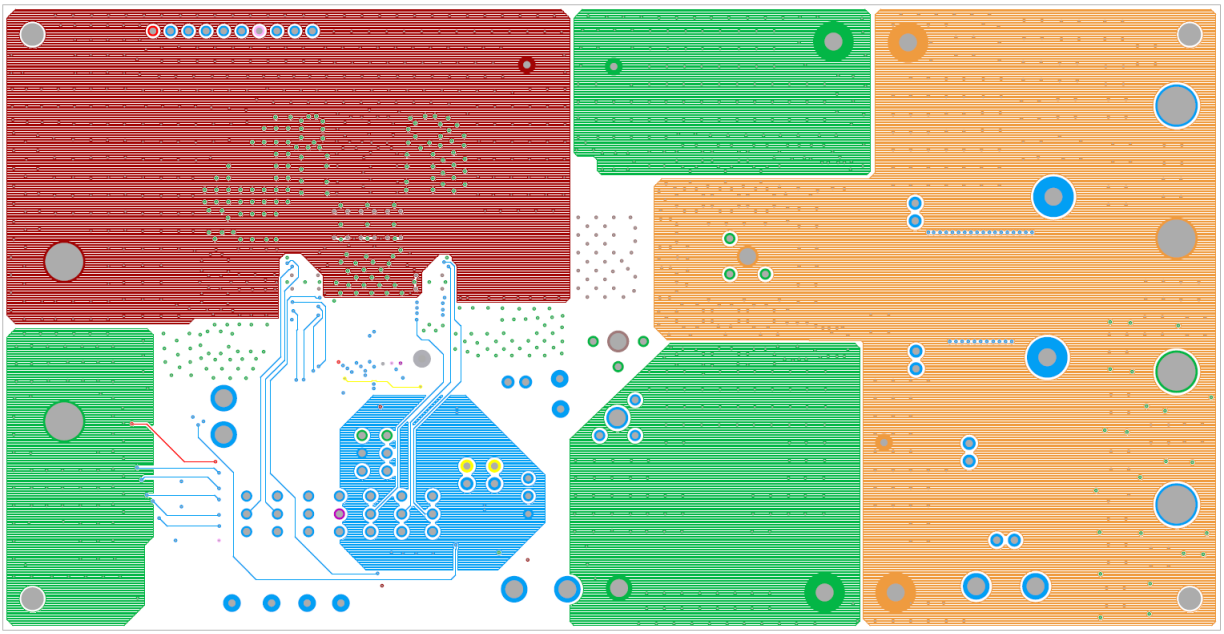

Figure 10. Layer 2

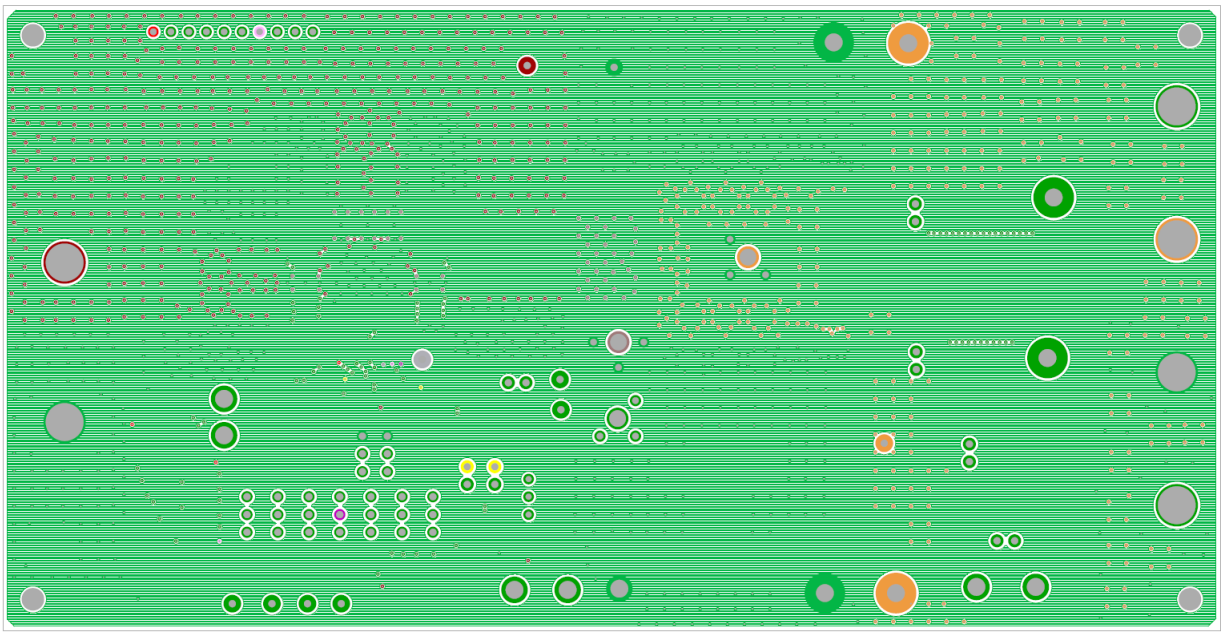

Figure 11. Layer 3

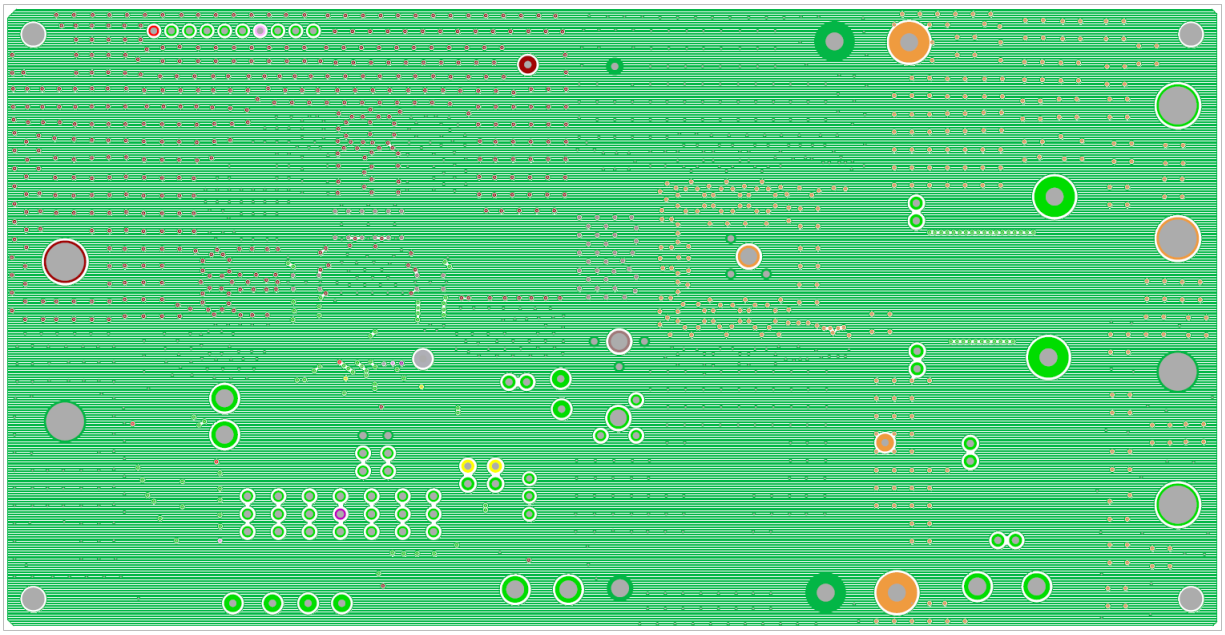

Figure 12. Layer 4

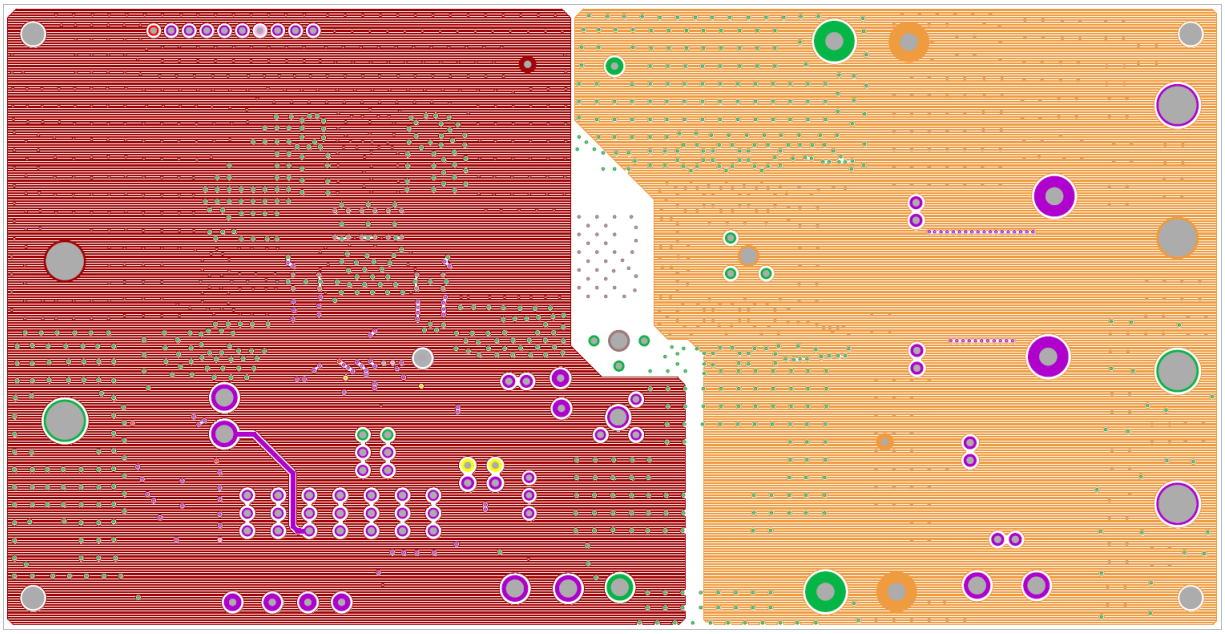

Figure 13. Layer 5

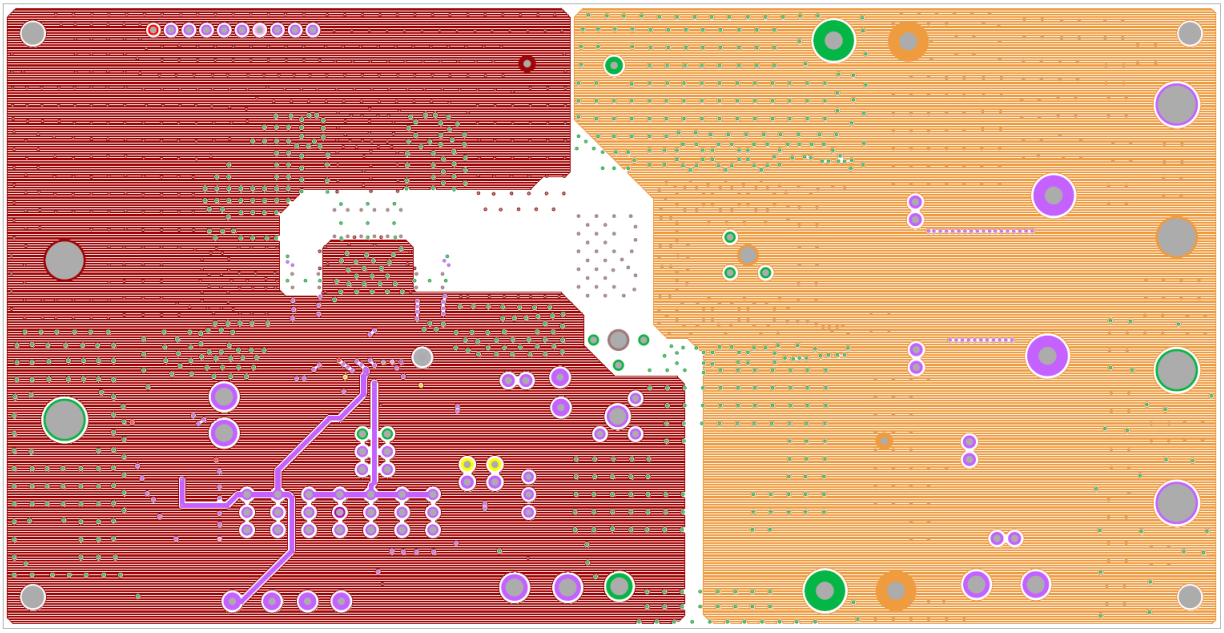

Figure 14. Layer 6

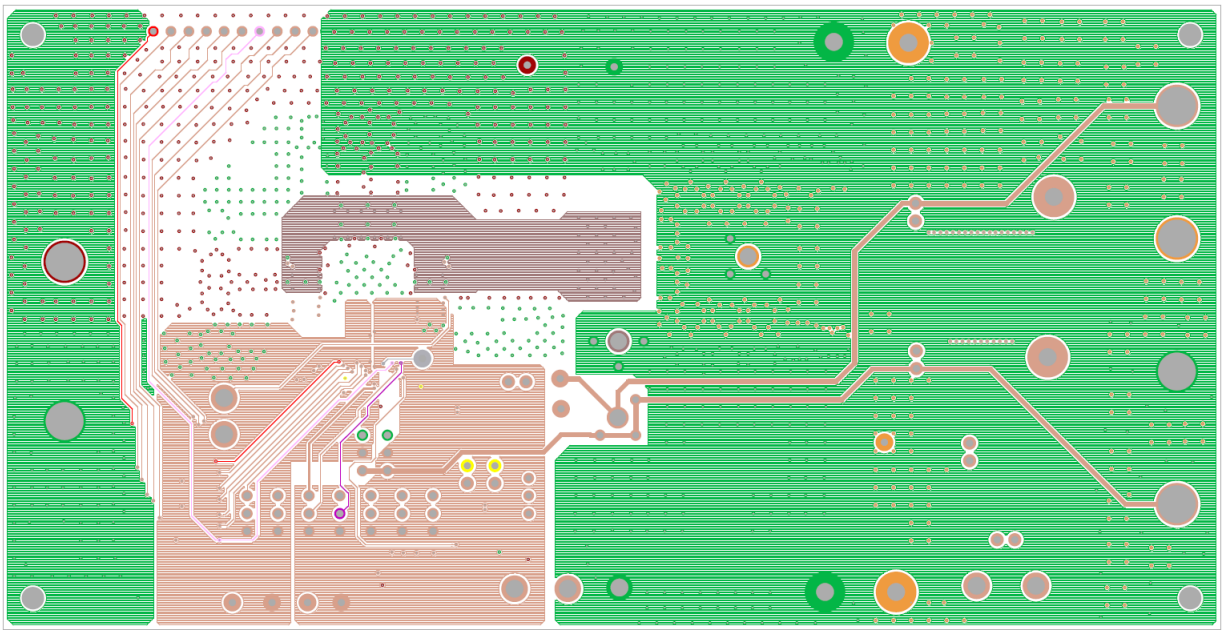

Figure 15. Layer 7

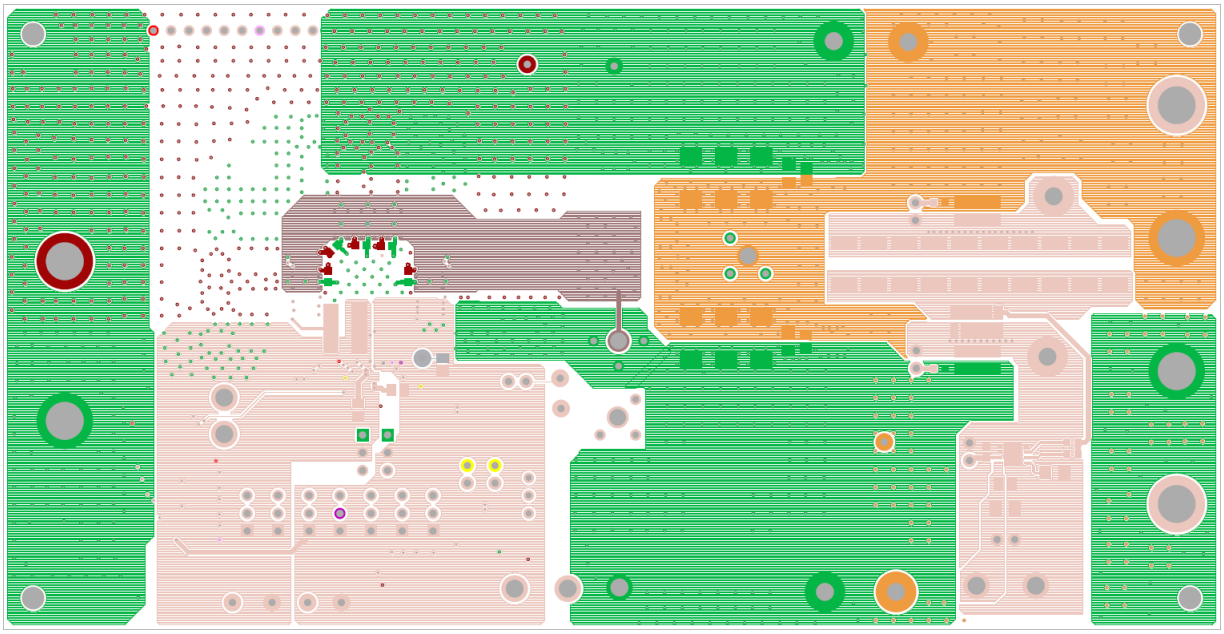

Figure 16. Layer 8 (Bottom Component Layer)

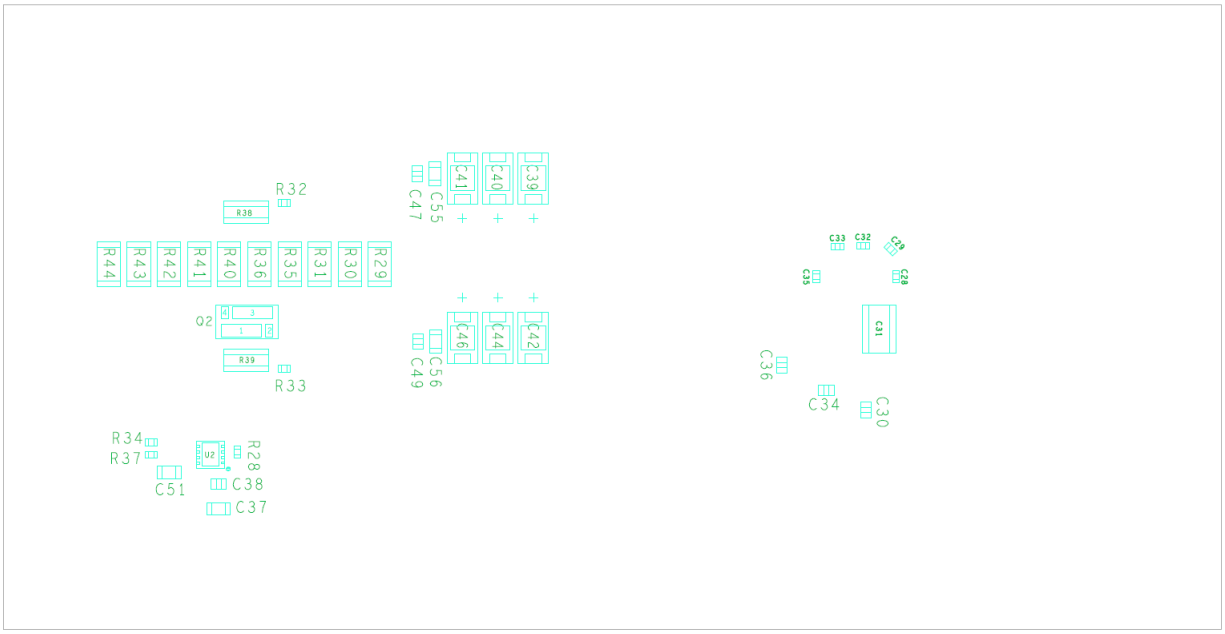

Figure 17. Bottom Layer Component Placement

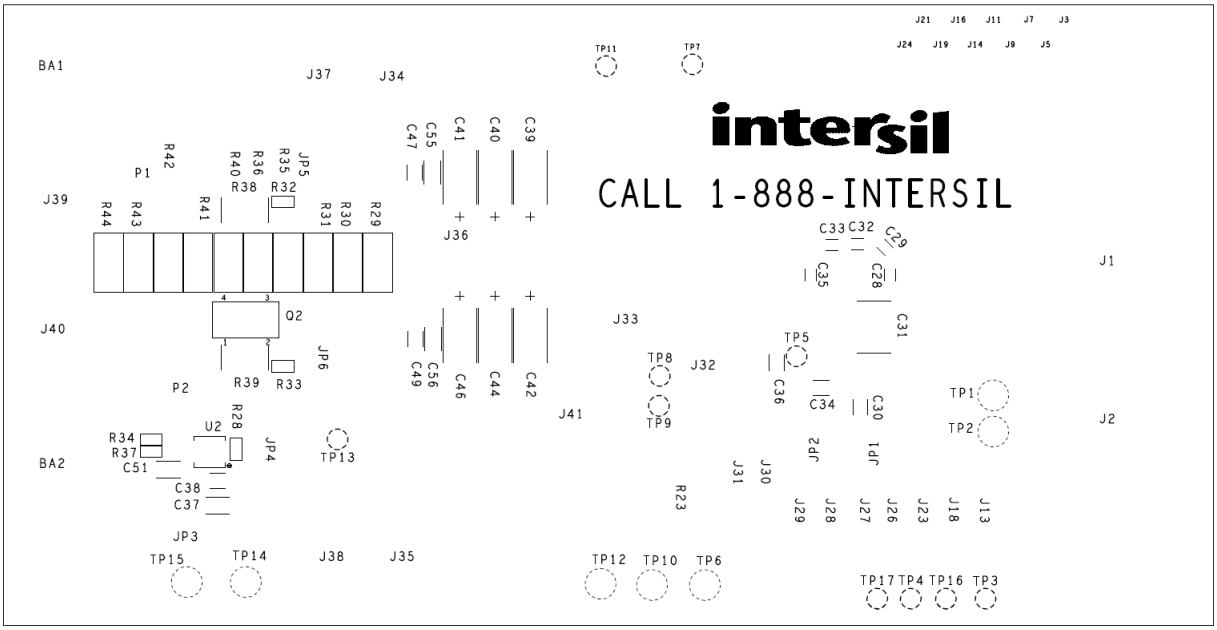

Figure 18. Bottom Silkscreen

3. Typical Performance Curves

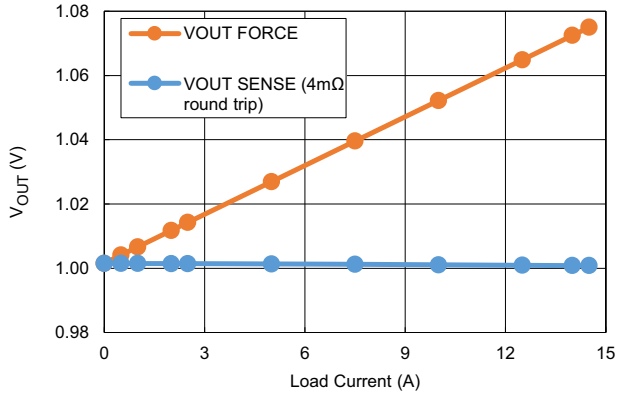

Figure 19. V_{OUT} Force and Sense using Integrated 2mΩ Resistors

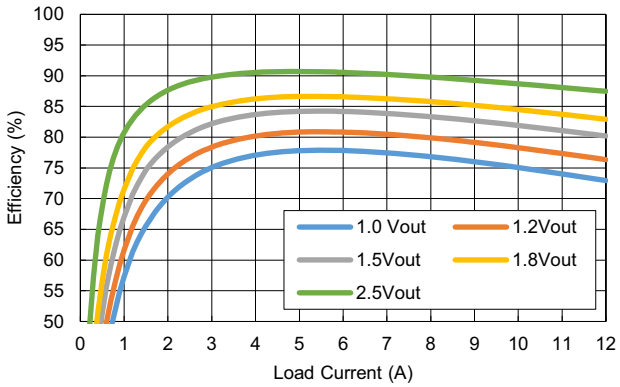

Figure 20. Efficiency vs Load vs Output Voltage V_{IN} = 3.3V, f_{SW} = 500kHz, -55°C Case Temperature

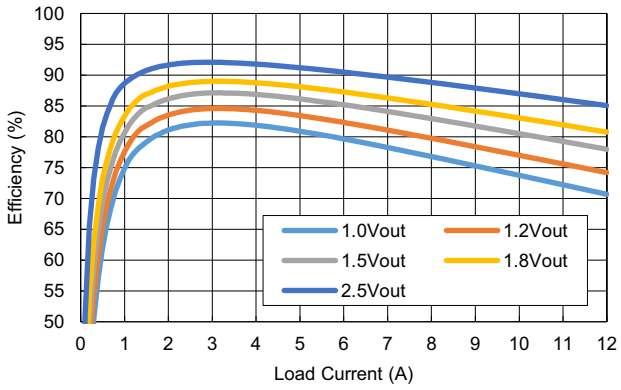

Figure 21. Efficiency vs Load vs Output Voltage V_{IN} = 3.3V, f_{SW} = 500kHz, +25°C Case Temperature

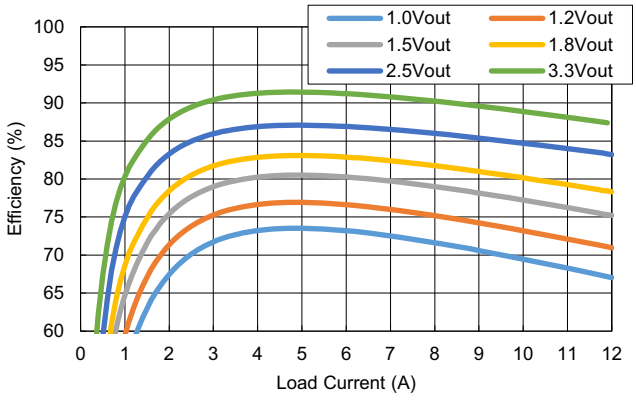

Figure 22. Efficiency vs Load vs Output Voltage V_{IN} = 5V, f_{SW} = 1MHz, +25°C Case Temperature

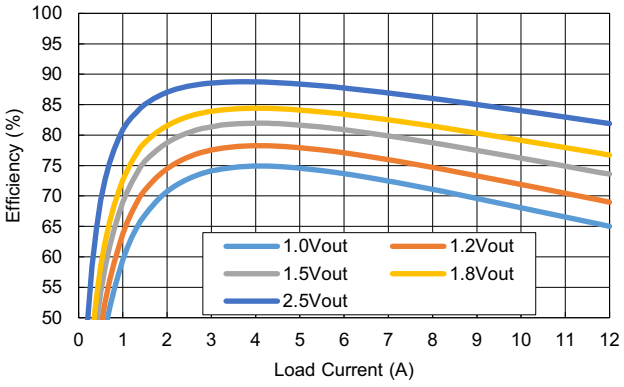

Figure 23. Efficiency vs Load vs Output Voltage V_{IN} = 3.3V, f_{SW} = 500kHz, +85°C Case Temperature

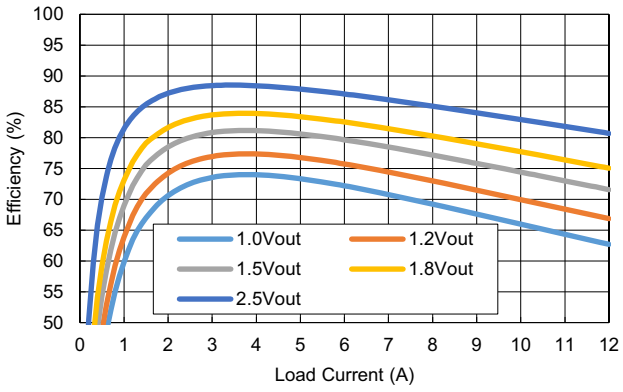

Figure 24. Efficiency vs Load vs Output Voltage, V_{IN} = 3.3V, f_{SW} = 500kHz, +125°C Case Temperature

4. Ordering Information

Part Number	Description
ISL70002SEHEVAL3Z	ISL70002SEH remote sensing evaluation board

5. Revision History

Revision	Date	Description
1.00	Aug 16, 2022	Initial release

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