ISL73847SEHEV2Z

Radiation Hardened Dual-Phase Current Mode PWM Controller Board

The ISL73847SEHEV2Z evaluation board benchmarks the performance of the ISL73847SEH dual-phase buck controller. The evaluation board is optimized for a 4.5V to 15V input operation to generate a 50A max, 1V output. Input and output connections, test points, and jumper settings on the board provide customers an easy-to-use evaluation platform for point-of-load power applications.

Features

- Power-Good LED indicator
- On-board transient load current generator
- Integrated LDO (VCC)
- External Clock Synchronization (SYNCI & SYNCO)
- Droop regulation set by a single resistor

Specifications

- Buck Power Supply input (PVIN): 4.5V to 15V
- Controller Analog Supply input (VDD): 4.5V to 19V
- Preset output voltage: 1V
- Preset Switching Frequency: 500kHz
- Maximum dual-phase output current: 50A
- Maximum single-phase output current: 25A
- Preset droop regulation

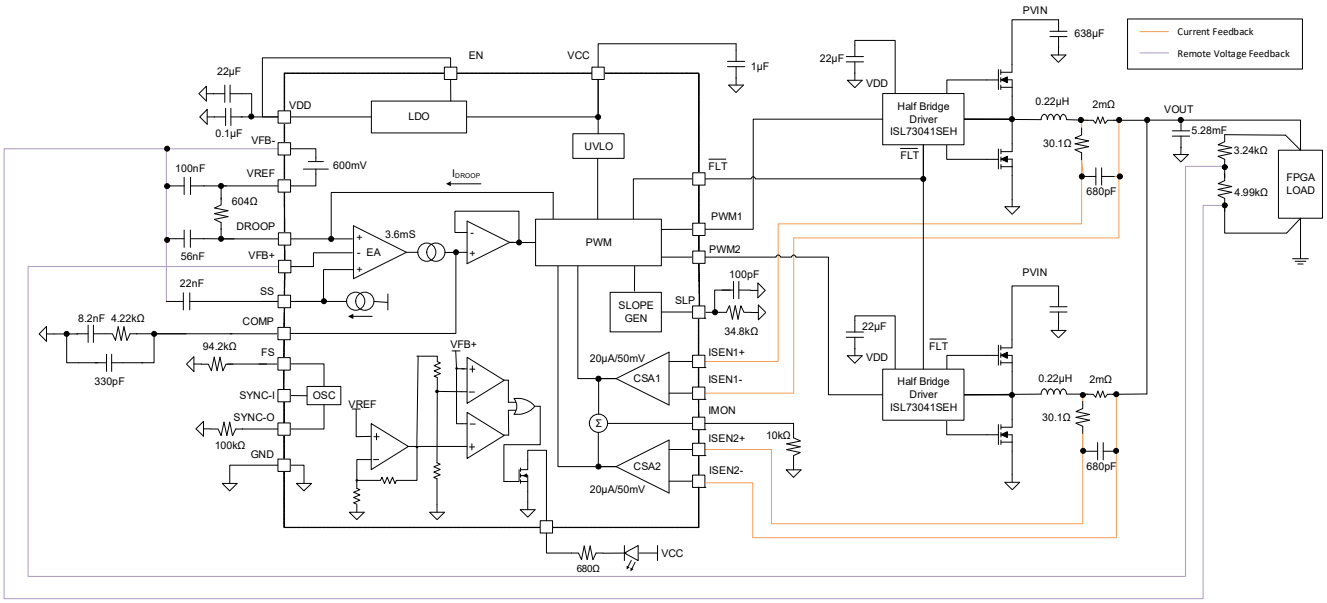

Figure 1. ISL73847SEHEV2Z Block Diagram

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1. Functional Description

1.1 Operating Range

The ISL73847SEHEV2Z evaluation board requires two supply rails to operate properly. One for the ISL73847SEH controller analog supply input (VDD) and one for the on-board buck power supply input (PVIN). The VDD rail accepts an input voltage range of 4.5V to 19V. The PVIN should be set from 4.5V to 15V. The buck regulator circuit is preset for a 1V output voltage and a switching frequency of 500kHz with a 0.22µH output inductor and 2.64mF output capacitance per phase with the option of being synchronized to an external clock using SYNCI.

1.2 Quick-Start Guide

See Table 1 to get an overview of all the default jumper settings and their different configurations.

1. Ensure JP1, JP4, and JP5 are connected to position 2-3.
2. Ensure JP2 is removed.
3. Ensure JP3 and JP6 are connected.
4. Apply a 4.5V to 15V voltage to PVIN metal banana plug connectors as shown in Figure 2.
5. Apply a 4.5V to 19V voltage to the VDD banana connectors as shown in Figure 2.
6. If required, a resistor or electronic load can be connected to the VOUT metal banana plug connectors as shown in Figure 2. If using an electronic load, you can add 4w sense lines on the TP29 test jumper.

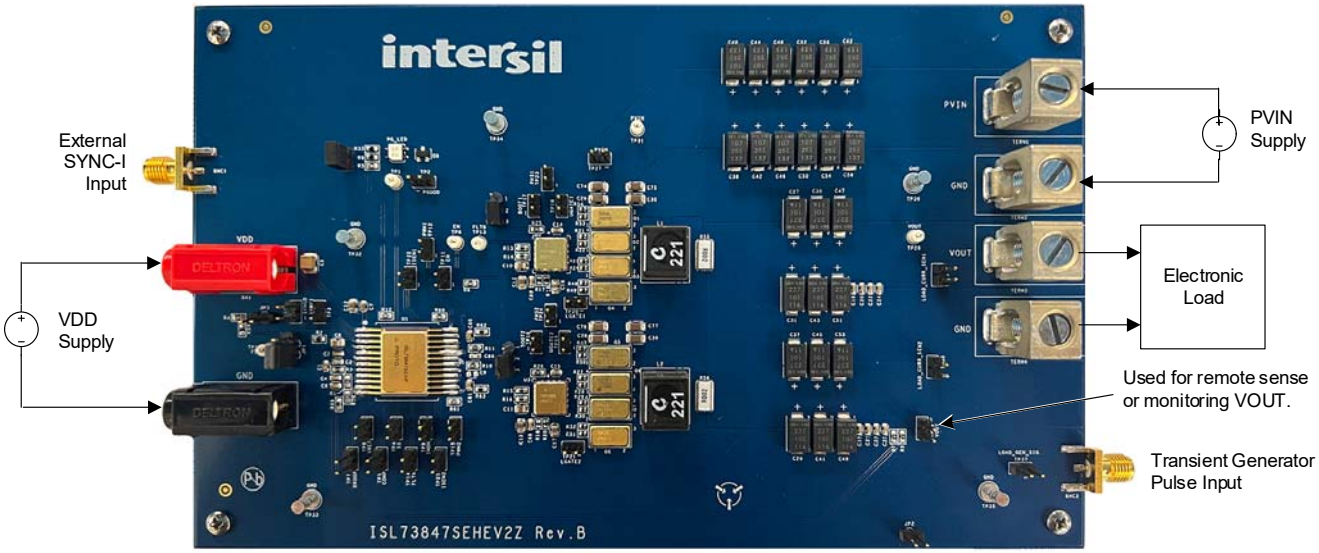


Figure 2. ISL73847SEHEV2Z Board Setup

Table 1. Default Jumper Settings and Alternate Configurations

Jumper	Function/Description	Default Configuration	Alternate Configuration
JP1	Sets the frequency of the ISL73847SEH Controller	Jumper in 2-3 position connects a 94.2kΩ pull-down from FS to GND, which sets the internal oscillator frequency to 1MHz (500kHZ switching frequency).	Jumper in 1-2 position ties FS to VCC, which sets the internal oscillator frequency to 1MHz (500kHZ switching frequency).
JP2	Powers the ISL70040SEH FET driver, which is part of the load transient generator circuit	Remove Jumper to disconnect VDD and disable the FET driver.	Populate Jumper to connect VDD to enable the FET driver.
JP3	Sets the output of the SYNCO pin	Populate Jumper and connect a 100kΩ pull-down from SYNC-O to GND (R_4), and remove the SYNC-O to VCC pull-up (R_{59}). This outputs the internal oscillator or SYNC-I external oscillator.	Populate Jumper and remove the 100kΩ pull-down from SYNC-O to GND (R_4), and populate the SYNC-O to VCC pull-up (R_{59}) with a 100kΩ. This outputs 1/2 of the frequency of the internal oscillator or SYNC-I external oscillator.
JP4	Disables the phase 1 output of the buck regulator	Jumper in 2-3 position ties PWM of the ISL73041SEH FET Driver (U2) to PWM1 of the ISL73847SEH controller, which enables phase 1 output of the buck regulator.	Jumper in 1-2 position ties PWM of the ISL73041SEH FET Driver (U2) to VCC, which disables phase 1 output of the buck regulator.
JP5	Disables the phase 2 output of the buck regulator	Jumper in 2-3 position ties PWM of the ISL73041SEH FET Driver (U3) to PWM2 of the ISL73847SEH controller, which enables phase 2 output of the buck regulator.	Jumper in 1-2 position ties PWM of the ISL73041SEH FET Driver (U3) to VCC, which disables phase 2 output of the buck regulator.
JP6	Disables or enables LED lights driven by PG	Populate jumper to enable LED PG indication.	Remove Jumper to disable LED PG indication.

1.3 Changing the Switching Frequency

The ISL73847SEHEV2Z is configured for a 500kHz switching frequency by a JP1 connecting a 94.2kΩ pull-down resistor (R_2) on the FS pin. The evaluation board includes a 0.22µH inductor and an array of output bypass capacitors for a 2.64mF output capacitance per phase, which makes up the LC filter. If you need to select a different switching frequency, see Figure 3 for selecting the appropriate R_2 value on FS. An alternate on-board configuration is to connect JP1 to position 1-2, which ties FS to VCC. This setting defaults the switching frequency to 500kHz. For more information on the FS pin, refer to the *ISL73847SEH datasheet*.

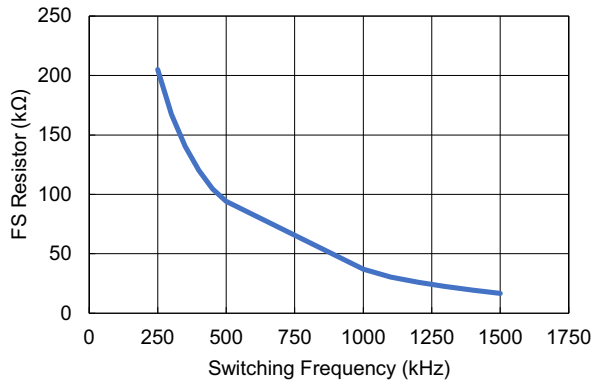


Figure 3. R_{FS} vs Frequency

1.4 External Clock Synchronization

If you need to synchronize the buck switching frequency to an external clock, a SMA female connector (BNC1) is available on the board. TP3 can be used to monitor the external clock signal on SYNC-I. For the external oscillator to be used in place of the internal oscillator, the external oscillator frequency needs to be 15% greater than the internal oscillator frequency. For more information on the external clock synchronization, refer to the *ISL73847SEH datasheet*.

1.5 Clock Output

The SYNC-O pin is configured to output the internal oscillator frequency (1MHz) through a jumper (JP3) connecting a 100kΩ pull-down (R_4) to GND. The SYNC-O pin can be monitored using the TP26 test jumper.

Note: If you are using an external clock signal on the SYNC-I pin, that external clock is output on SYNC-O in place of the internal clock if the external oscillator frequency is 15% greater than the internal oscillator frequency. If you need to output half of the internal or external oscillator frequency, move the 100kΩ resistor from R_4 to R_{59}. For more information on SYNC-O, refer to the *ISL73847SEH datasheet*.

1.6 Soft-Start Adjustment

The ISL73847SEHEV2Z is configured for a 2ms soft-start time by a 22nF bypass capacitor (C_2) connected to the SS pin. The SS time can be adjusted from 2ms to 200ms by changing the C_2 capacitor. If you need to select a different soft-start time use Equation 1 below which shows how to calculate the capacitance given the desired soft-start time. For more information on SS, refer to the *ISL73847SEH datasheet*.

(EQ. 1) $$C_{SS} = \frac{t_{SS} \times 1 \times 10^{-5}}{V_{REF}}$$

where:

- C_{SS} is the soft-start capacitance in Farads
- t_{SS} is the required soft-start time in seconds
- VREF is the reference voltage, which is nominally 0.6V

1.7 Droop Regulation

The ISL73847SEHEV2Z is configured to minimize peak-to-peak transient response excursions by using a 604Ω resistor (R_1) connected between VREF and DROOP pin. If droop regulation is not needed, replace the 604Ω with a 0Ω resistor to short VREF and DROOP pin together. For more information on the droop regulation, refer to the *ISL73847SEH datasheet*.

1.8 IMON

The ISL73847SEHEV2Z is configured to monitor the average current though the inductor as a voltage on the IMON pin. A 10kΩ pull-down resistor (R_{10}) is connected to this pin. TP9 test jumper is provided to monitor the IMON pin voltage. If required, a bypass capacitor (C_9) can be added in parallel to R_{10} to improve the averaging. For more information on the IMON pin, refer to the *ISL73847SEH datasheet*.

1.9 Enabling/Disabling

The ISL73847SEHEV2Z is configured to automatically enable when VDD reaches a certain voltage on power-up by 4.99kΩ resistor (R_6) connected between EN and VDD. To disable the part in this default configuration, apply 0V or ground to the TP8 test point. To disable automatic enabling on power-up and to control EN by an external supply, remove R_6 and connect another external supply to TP8. For more information on the enabling and disabling the controller, refer to the *ISL73847SEH datasheet*.

1.10 Using the On-Board Load Transient Generator

An on-board load transient generator is made available to evaluate the buck-regulator output. The circuit is shown in Figure 8. The circuit comprises an NMOS FET load switch driven by a Renesas ISL70040SEH Rad-Hard, GAN FET driver requiring 0-5V logic signals. Logic HIGH drives the load ON and logic LOW turns the load OFF. The load current is preset by six parallel 220mΩ resistors on each output phase (25A) for a total load current of 50A. Complete the following steps to properly set-up and operate the load transient generator.

1. Connect an external pulse generator to the on-board SMA connector (BNC2).
2. To monitor the pulse generator signal, use the TP37 test jumper.
3. Connect jumper to JP2 to connect VDD to power the FET driver.
4. Monitor the output voltage using TP29.

2. Board Design

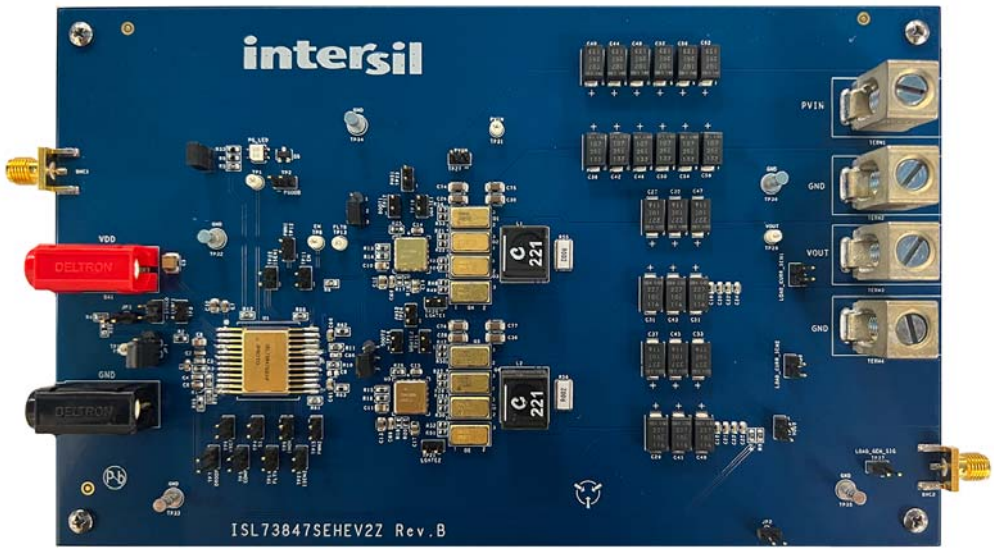


Figure 4. ISL73847SEHEV2Z Evaluation Board (Top)

Figure 5. ISL73847SEHEV2Z Evaluation Board (Bottom)

2.1 Schematic Diagrams

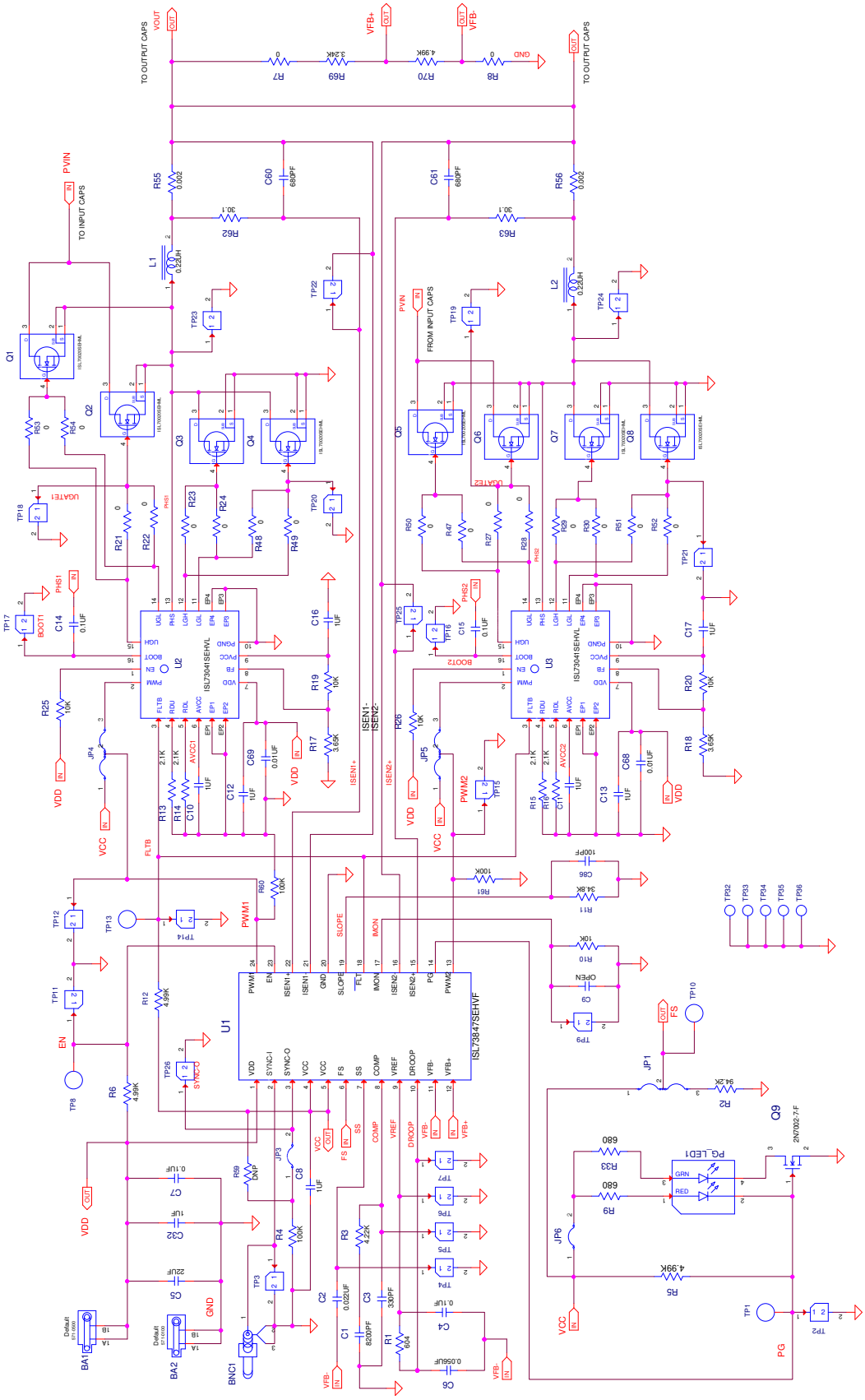


Figure 6. ISL73847SEHEV2Z Schematic (Page 1)

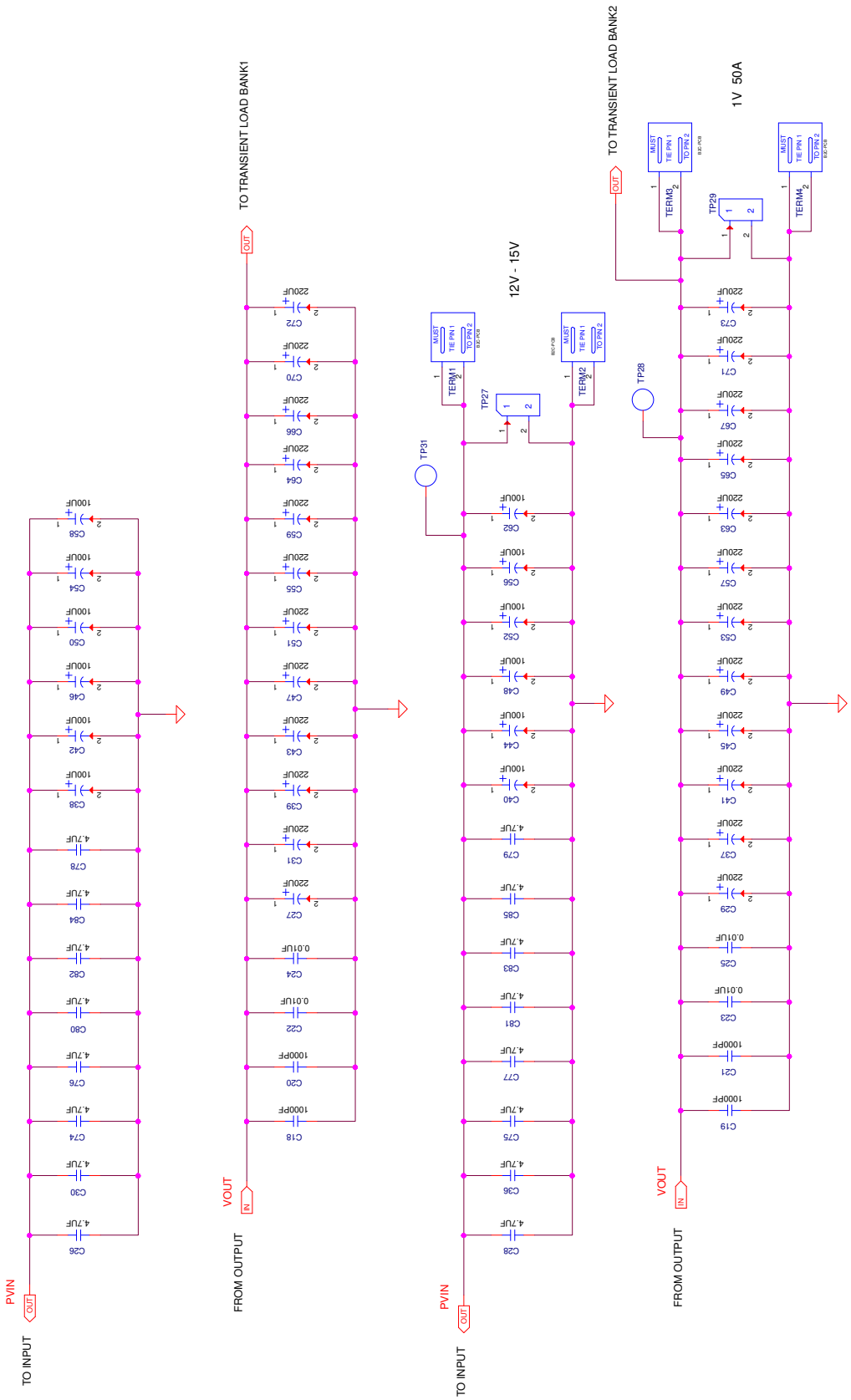


Figure 7. ISL73847SEHEV2Z Schematic (Page 2)

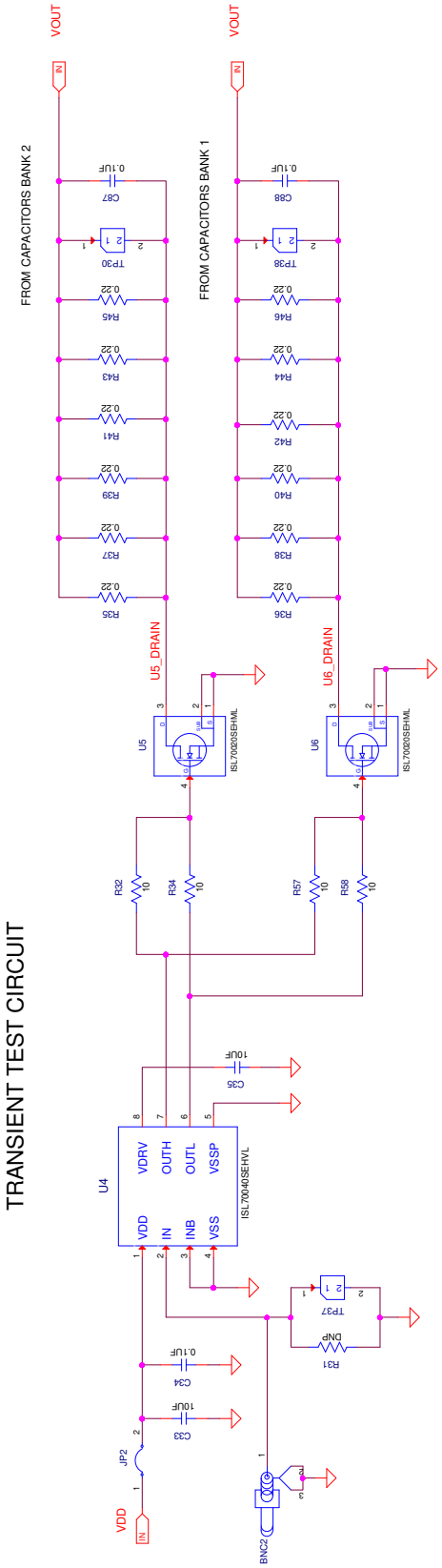


Figure 8. ISL73847SEHEV2Z Schematic (Page 3)

2.2 Bill of Materials

Qty	Reference Designator	Description	Manufacturer	Manufacturer Part
1		PWB-PCB, ISL73847SEHEV2Z, REVB, ROHS	Imagineering Inc	ISL73847SEHEV2ZREVBPCB
2	C87, C88	CAP-BOARDFLEX, SMD, 0603, 0.1µF, 25V, 10%, X7R, ROHS	Kemet	C0603X104K3RACTU
1	C6	CAP, SMD, 0603, 0.056µF, 50V, 10%, X7R, ROHS	Kemet	C0603X563K5RAC7867
3	C8, C10, C11	CAP, SMD, 0805, 1.0µF, 25V, 10%, X7R, ROHS	TDK	C2012X7R1E105K
16	C26, C28, C30, C36, C74, C75, C76, C77, C78, C79, C80, C81, C82, C83, C84, C85	CAP, SMD, 1206, 4.7µF, 25V, 10%, X7R, ROHS	TDK	C3216X7R1E475K
1	C5	CAP, SMD, 1210, 22µF, 25V, 10%, X7R, ROHS	Murata	GRM32ER71E226KE15L
1	C86	CAP, SMD, 0603, 100pF, 25V, 10%, X7R, ROHS	Kemet	C0603C101K3RAC7867
4	C18-C21	CAP, SMD, 0603, 1000pF, 16V, 10%, X7R, ROHS	Venkel	C0603X7R160102KNE
4	C22-C25	CAP, SMD, 0603, 0.01µF, 16V, 10%, X7R, ROHS	Venkel	C0603X7R160-103KNE
2	C68, C69	CAP, SMD, 0603, 0.01µF, 25V, 10%, X7R, ROHS	Venkel	C0603X7R250-103KNE
4	C4, C14, C15, C34	CAP, SMD, 0603, 0.1µF, 25V, 10%, X7R, ROHS	Yageo	CC0603KRX7R8BB104
1	C7	CAP, SMD, 0603, 0.1µF, 50V, 10%, X7R, ROHS	AVX	06035C104KAT2A
1	C2	CAP, SMD, 0603, 0.022µF, 16V, 10%, X7R, ROHS	Venkel	C0603X7R160-223K
1	C3	CAP, SMD, 0603, 330pF, 50V, 5%, NP0, ROHS	Panasonic	ECJ-1VC1H331J
2	C60, C61	CAP, SMD, 0603, 680pF, 50V, 10%, X7R, ROHS	Murata	GRM188R71H681KA01D
0	C9	CAP, SMD, 0603, DNP-PLACE HOLDER, ROHS		
5	C12, C13, C16, C17, C32	CAP, SMD, 0805, 1.0µF, 25V, 10%, X5R, ROHS	AVX	08053D105KAT4A
2	C33, C35	CAP, SMD, 1206, 10µF, 25V, 10%, X7R, ROHS	Venkel	C1206X7R250-106KNE
12	C38, C40, C42, C44, C46, C48, C50, C52, C54, C56, C58, C62	CAP-TANT, SMD, 7.3x4.3mm, 100µF, 25V, 20%, 30mΩ at 100MHz, ROHS	Kemet	T521X107M025ATE030

Qty	Reference Designator	Description	Manufacturer	Manufacturer Part
24	C27, C29, C31, C37, C39, C41, C43, C45, C47, C49, C51, C53, C55, C57, C59, C63, C64, C65, C66, C67, C70, C71, C72, C73	CAP-TANT, SMD, 7.3×4.3×2.8, 220µF, 10V, 20%, 6mΩ, ROHS	Kemet	T530D227M010ATE006
1	C1	CAP, SMD, 0603, 8200pF, 50V, 5%, X7R, ROHS	Vishay/Vitramon	VJ0603Y822JXACW1BC
2	L1, L2	COIL-PWR INDUCT, AEC-Q200, SMD, 11.3×10mm, 0.22µH, 20%, 98.8A, ROHS	Coilcraft	XAL1010-221MEB
2	BNC1, BNC2	CONN-RF, SMA JACK, 50Ω, 18GHz, TAB-END LAUNCH, ROHS	Amphenol	132357-11
5	TP32-TP36	CONN-TURRET, TERMINAL POST, TH, ROHS	Keystone	1514-2
6	TP1, TP8, TP10, TP13, TP28, TP31	CONN-MINI TEST POINT, VERTICAL, WHITE, ROHS	Keystone	5002
1	BA2	CONN-PLUG, BANA-INSUL-SDRLESS, BLACK, 4mm, RA	Deltron	571-0100
1	BA1	CONN-PLUG, BANA-INSUL-SDRLESS, RED, 4mm, RA	Deltron	571-0500
3	JP1, JP4, JP5	CONN-HEADER, 1×3, BREAKAWY 1×36, 2.54mm, ROHS	BERG/FCI	68000-236HLF
30	TP2, TP3, TP4, TP5, TP6, TP7, TP9, TP11, TP12, TP14-TP26, TP27, TP29, TP30, TP37, TP38, JP2, JP3, JP6	CONN-HEADER, 1×2, RETENTIVE, 2.54mm, 0.230×0.120, ROHS	BERG/FCI	69190-202HLF
4	JP6, JP1-Pins 2-3, JP4-Pins 2-3, JP5-Pins 2-3	CONN-JUMPER, SHUNT, 2P, 2.54mmPITCH, BLK, 6mm, OPEN, ROHS	Sullins	SPC02SYAN
1	PG_LED	LED, SMD, 3×2.5mm, 4P, RED/GREEN, 12/20MCD, 2V	Lumex	SSL-LXA3025IGC-TR
10	Q1-Q8, U5, U6	IC-PROTO, RAD HARD, 40V GAN FET, 4P, CLCC, ROHS	Renesas Electronics	ISL70020SEHL/PROTO
1	U4	IC-100V, RAD-HARD, GAN FET DRIVER, SMD, 8P, CLCC, ROHS	Renesas Electronics	ISL70040SEHL/PROTO
2	U2, U3	IC-RAD LIGHT GaN FET, HALF BRIDGE DRIVER, 14P, CLCC, ROHS	Renesas Electronics	ISL73041SEHL/PROTO
1	U1	IC-RAD LIGHT BUCK CONTROLLER, 24P, FP, ROHS	Renesas Electronics	ISL73847SEHF/PROTO

Qty	Reference Designator	Description	Manufacturer	Manufacturer Part
1	Q9	TRANSISTOR, N-CHANNEL, 3LD, SOT-23, 60V, 115mA, ROHS	Diodes, Inc.	2N7002-7-F
16	R21-R24, R27-R30, R47-R54	RES-AEC-Q200, SMD, 0402, 0Ω, 1/16W, TF, ROHS	Vishay/Dale	CRCW04020000Z0ED
2	R9, R33	RES-AEC-Q200, SMD, 0603, 680Ω, 1/10W, 1%, TF, ROHS	Vishay/Dale	CRCW0603680RFKEA
12	R35-R46	RES-CURR.SENSE, SMD, 2512, 0.22Ω, 2W, 1%, TF, ROHS	Bourns	CRM2512-FX-R220ELF
0	R31, R59	RESISTOR, SMD, 0603, 0.1%, MF, DNP-PLACE HOLDER		
2	R19, R20	RES, SMD, 0402, 10K, 1/16W, 1%, TF, ROHS	Panasonic	ERJ-2RKF1002X
2	R17, R18	RES, SMD, 0402, 3.65K, 1/16W, 1%, TF, ROHS	Panasonic	ERJ-2RKF3651
2	R7, R8	RES, SMD, 0603, 0Ω, 1/10W, TF, ROHS	Venkel	CR0603-10W-000T
3	R10, R25, R26	RES, SMD, 0603, 10K, 1/10W, 1%, TF, ROHS	Venkel	CR0603-10W-1002FT
4	R4, R60, R61	RES, SMD, 0603, 100K, 1/10W, 1%, TF, ROHS	Venkel	CR0603-10W-1003FT
4	R13-R16	RES, SMD, 0603, 2.1K, 1/10W, 1%, TF, ROHS	Panasonic	ERJ-3EKF2101V
2	R62, R63	RES, SMD, 0603, 30.1Ω, 1/10W, 1%, TF, ROHS	Yageo	RC0603FR-0730R1L
1	R69	RES, SMD, 0603, 3.24K, 1/10W, 1%, TF, ROHS	Panasonic	ERJ-3EKF3241V
1	R11	RES, SMD, 0603, 34.8K, 1/10W, 1%, TF, ROHS	Venkel	CR0603-10W-3482FT
1	R3	RES, SMD, 0603, 4.22K, 1/10W, 1%, TF, ROHS	Rohm	MCR03EZPFX4221
4	R5, R6, R12, R70	RES, SMD, 0603, 4.99K, 1/10W, 1%, TF, ROHS	Panasonic	ERJ-3EKF4991V
1	R1	RES, SMD, 0603, 604Ω, 1/10W, 1%, TF, ROHS	Panasonic	ERJ-3EKF6040V
2	R55, R56	RES-AEC-Q200, SMD, 2512W, 0.002Ω, 3W, 2%, MF, ROHS	Susumu Co., ltd	KRL6432E-M-R002-G-T1
4	R32, R34, R57, R58	RES-AEC-Q200, SMD, 0603, 10Ω, 1/10W, 1%, TF, ROHS	Rohm	KTR03EZPF10R0
1	R2	RES, SMD, 0603, 94.2K, 1/10W, 0.1%, THINFILM, ROHS	Yageo	RT0603BRD0794K2L

Qty	Reference Designator	Description	Manufacturer	Manufacturer Part
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
4	TERM1-TERM4	HDWARE-WIRE LUG, TH, 11.8×10.3mm, SLOTTED SCREW, 2-14AWG, ROHS	International Hydraulics Inc	B2C-PCB

2.3 Board Layout

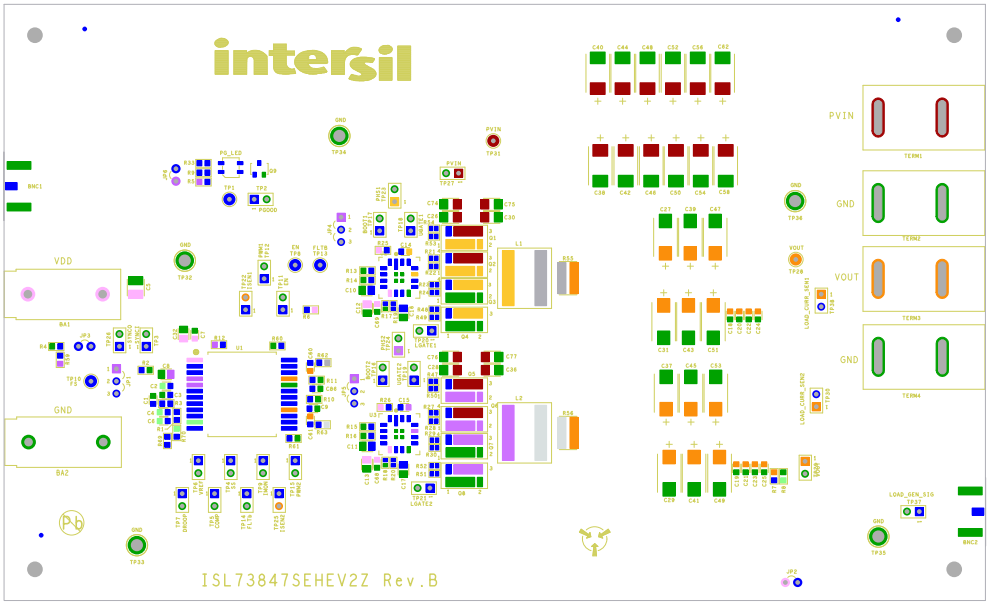


Figure 9. Silkscreen Top Layer

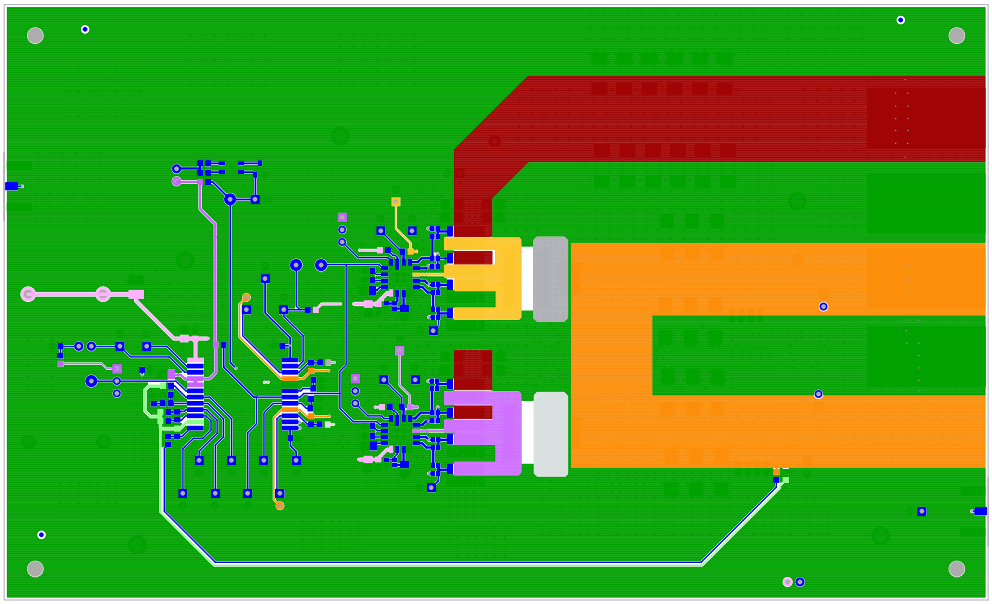


Figure 10. Top Layer

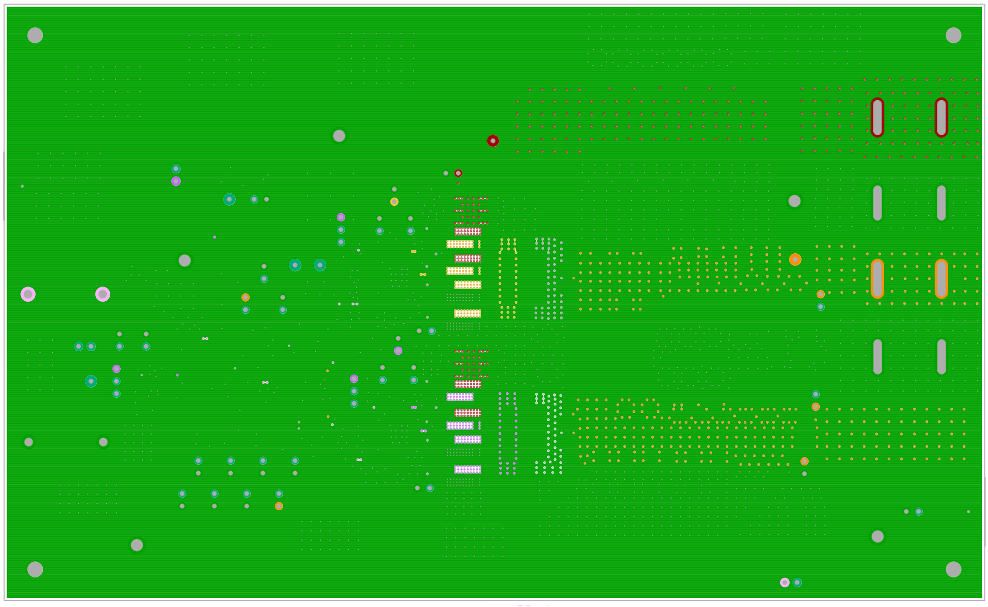


Figure 11. Layer 2

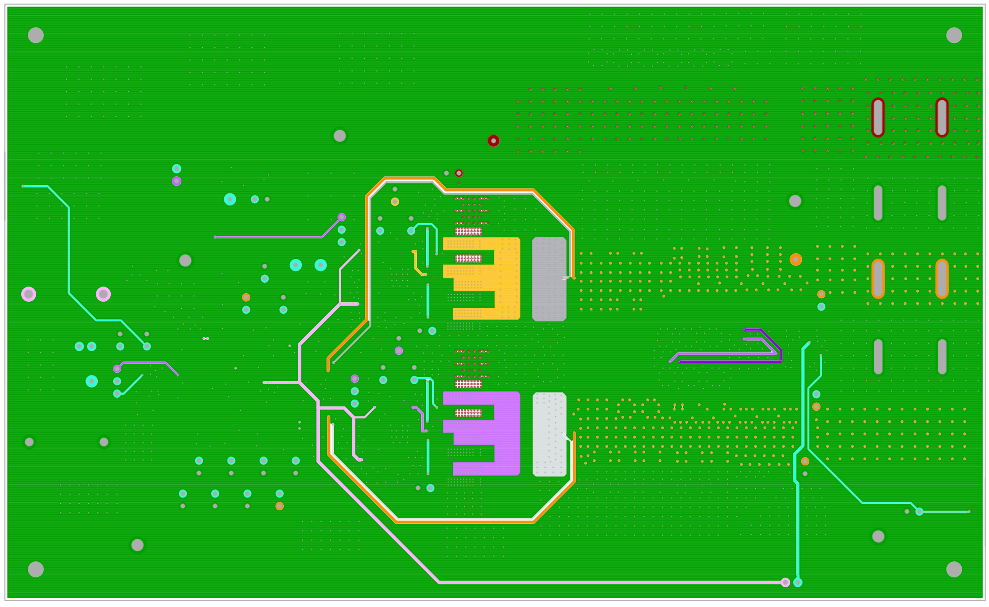


Figure 12. Layer 3

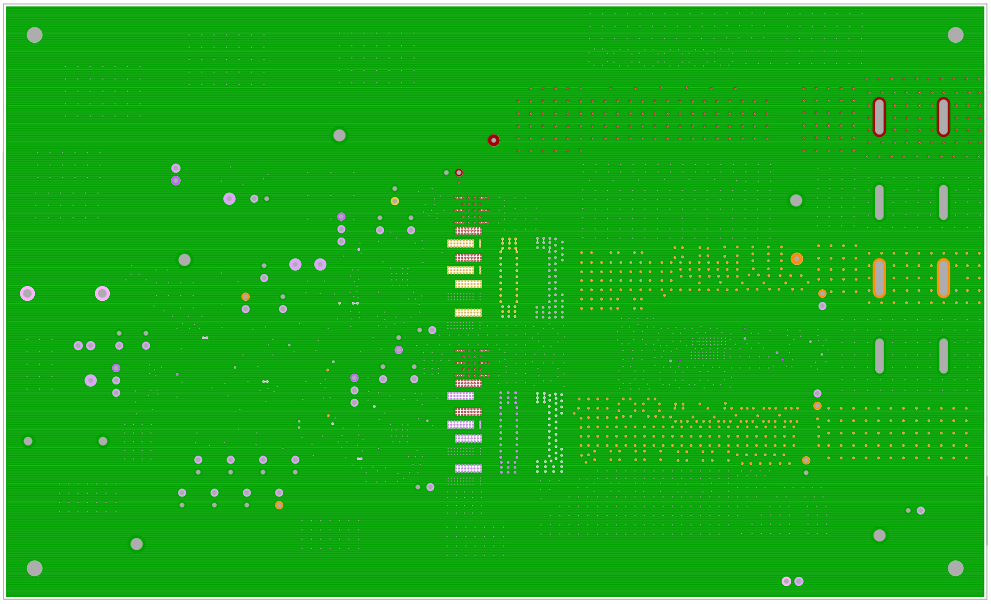
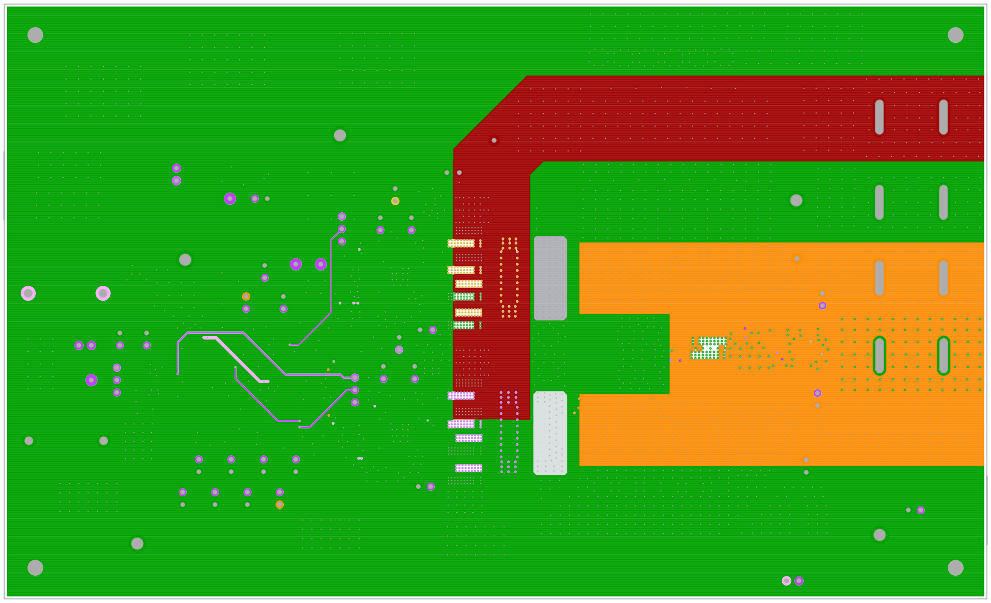


Figure 13. Layer 4



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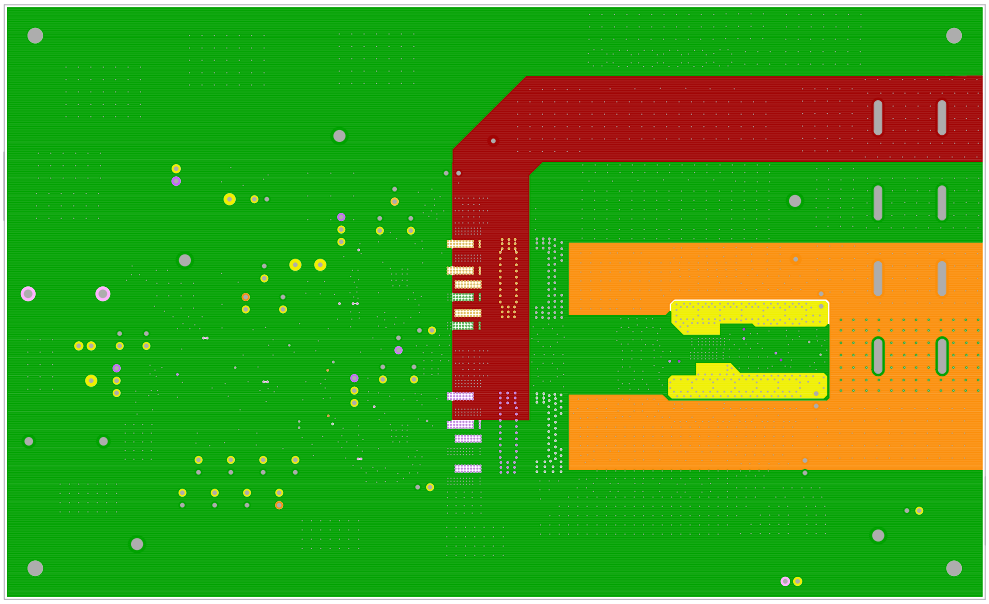

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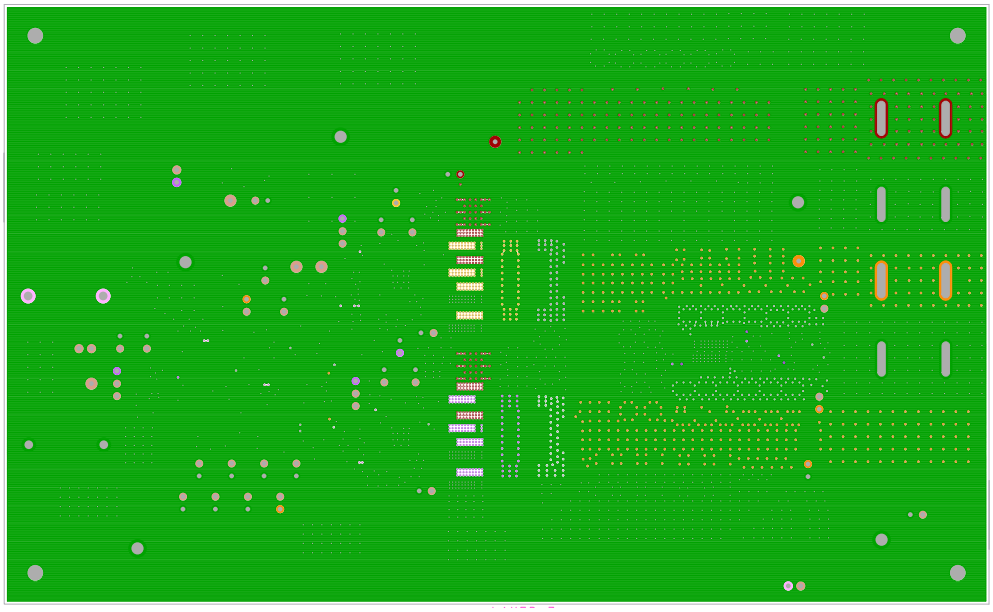

Figure 16. Layer 7

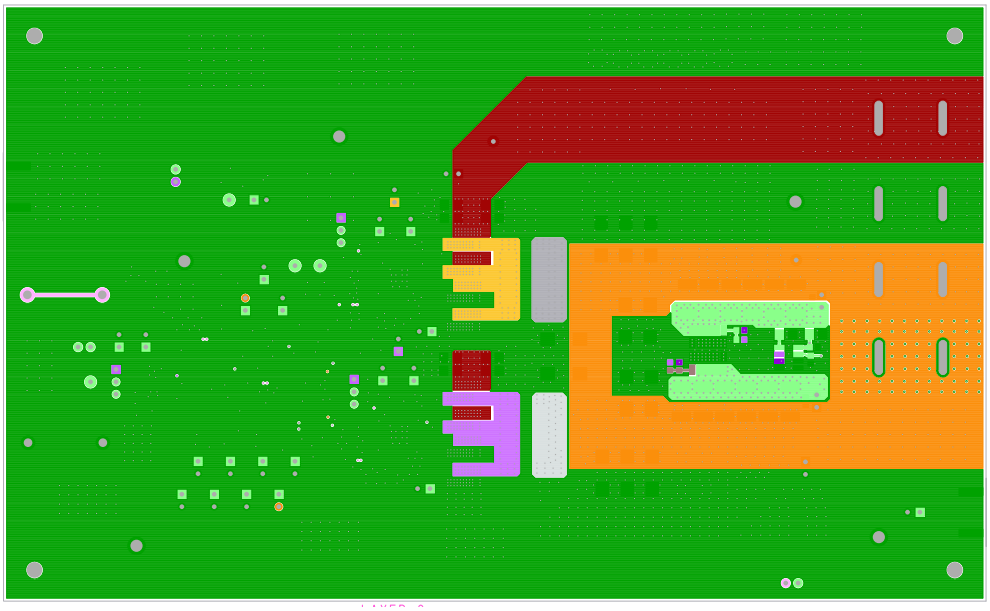

Figure 17. Bottom Layer

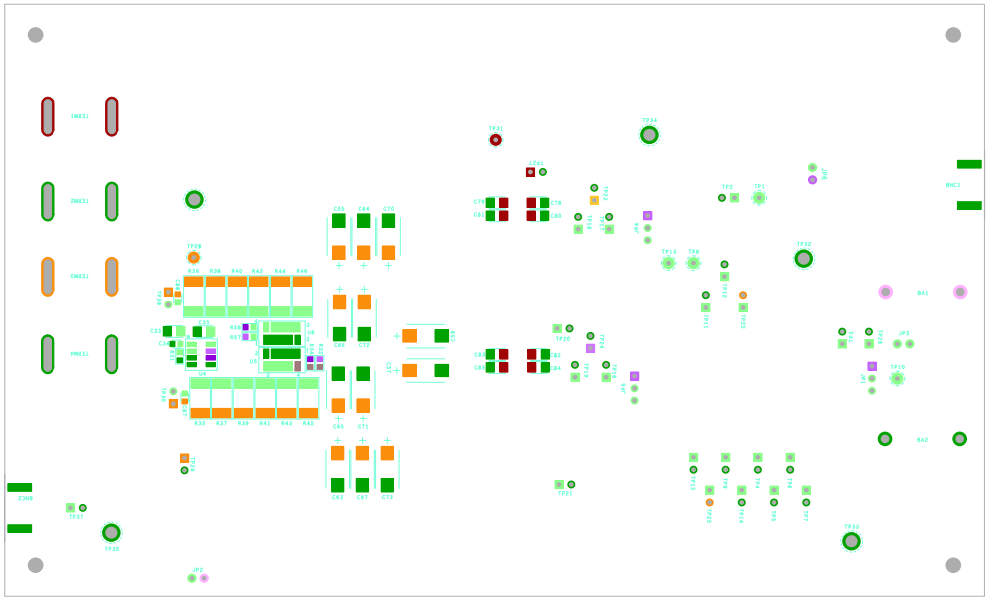

Figure 18. Silkscreen Bottom Layer

3. Typical Performance Graphs

Unless otherwise noted, V_{OUT} = 1V; L_{OUT} = 220nH per phase, C_{OUT} = 2.64mF per phase, C_{DROOP} = 56nF, C_{VREF} = 100nF, R_{DROOP} = 0Ω, R_{FS} = 94.2kΩ, C_{SS} = 22nF, C_{COMP} = 8.2nF, R_{COMP} = 4.22kΩ, C_{POLE} = 330pF, C_{VCC}= 1µF, R_{SLP} = 34.8kΩ, C_{SLP} = 100pF, T_A = +25°C

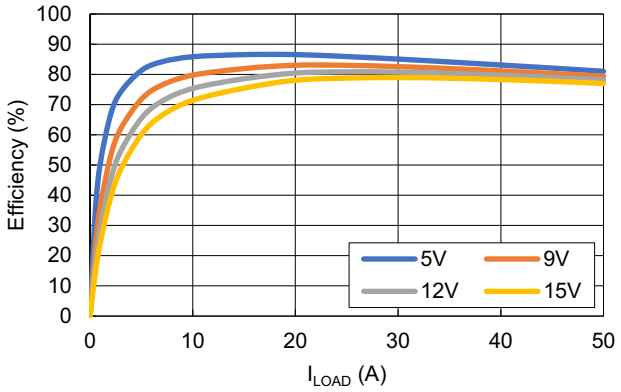

Figure 19. Conversion Efficiency for Various V_{IN} (f_{SW} = 500kHz, ISL70020SEHML, XAL1010-221ME)

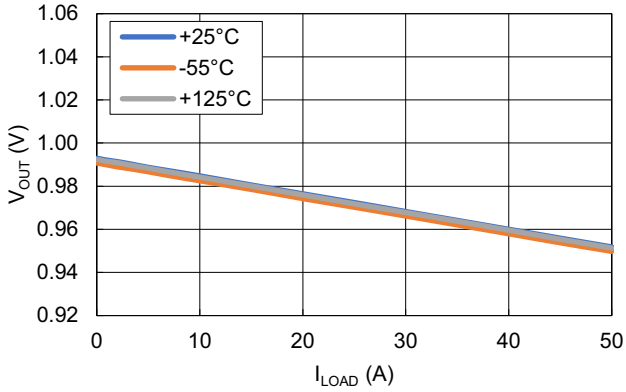

Figure 20. Droop Regulation for Various Temperatures (V_{IN} = 12V, R_{DROOP} = 604Ω)

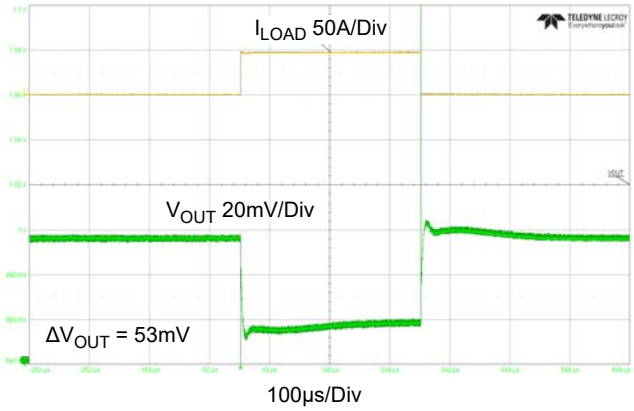

Figure 21. Load Transient Response (V_{IN} = V_{DD} = 12V, R_{DROOP} = 604Ω)

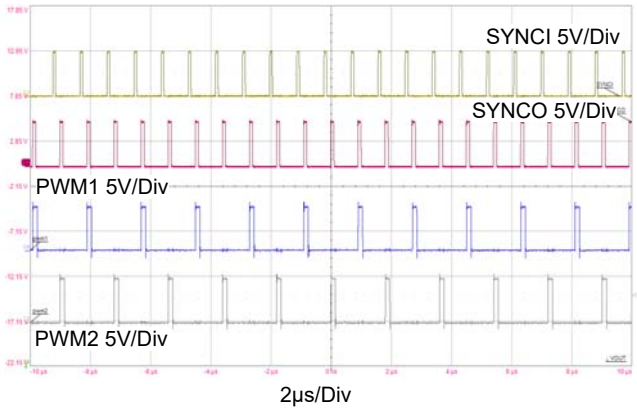

Figure 22. SYNC-O Frequency = SYNC-I Frequency (V_{DD} = 12V, V_{IN} = 12V, R_{SYNC-O} = 100kΩ to GND)

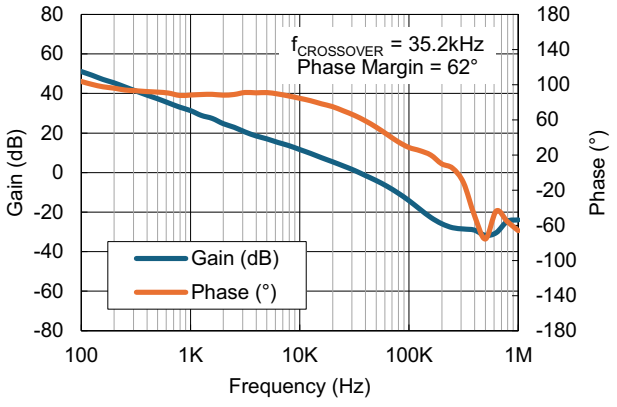

Figure 23. Gain and Phase vs Frequency (V_{IN} = 5V, I_{LOAD} = 0A, f_{SW} = 500kHz)

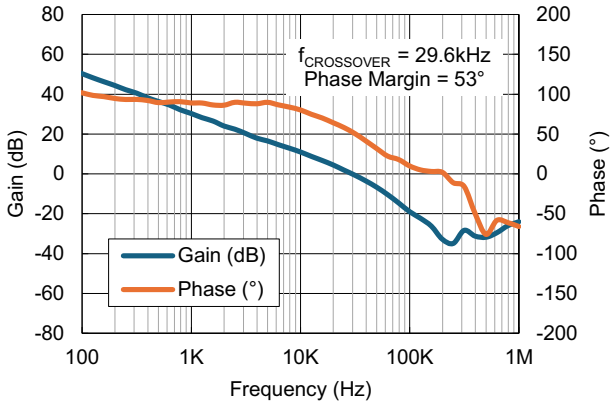

Figure 24. Gain and Phase vs Frequency (V_{IN} = 12V, I_{LOAD} = 0A, f_{SW} = 500kHz)

Unless otherwise noted, V_{OUT} = 1V; L_{OUT} = 220nH per phase, C_{OUT} = 2.64mF per phase, C_{DROOP} = 56nF, C_{VREF} = 100nF, R_{DROOP} = 0Ω, R_{FS} = 94.2kΩ, C_{SS} = 22nF, C_{COMP} = 8.2nF, R_{COMP} = 4.22kΩ, C_{POLE} = 330pF, C_{VCC}= 1µF, R_{SLP} = 34.8kΩ, C_{SLP} = 100pF, T_A = +25°C (Cont.)

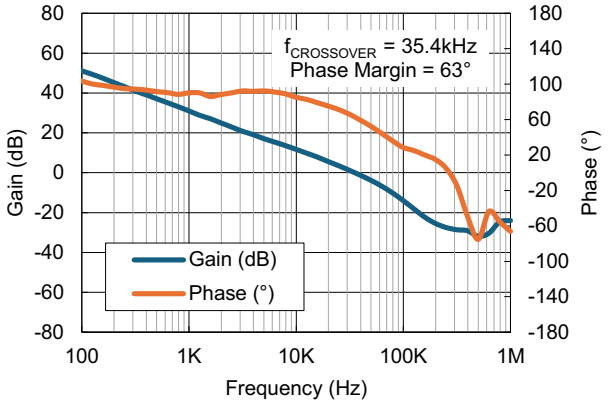

Figure 25. Gain and Phase vs Frequency (V_{IN} = 5V, I_{LOAD} = 25A, f_{SW} = 500kHz)

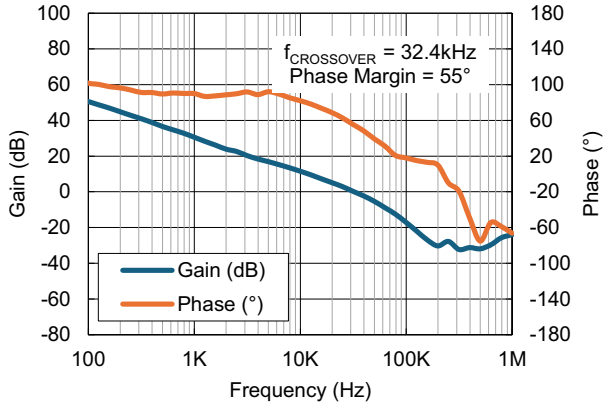

Figure 26. Gain and Phase vs Frequency (V_{IN} = 12V, I_{LOAD} = 25A, f_{SW} = 500kHz)

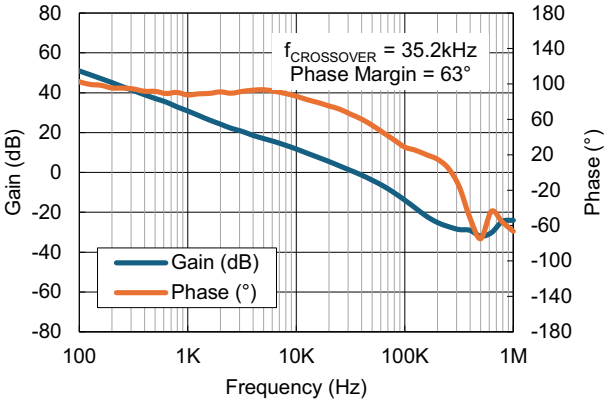

Figure 27. Gain and Phase vs Frequency (V_{IN} = 5V, I_{LOAD} = 50A, f_{SW} = 500kHz)

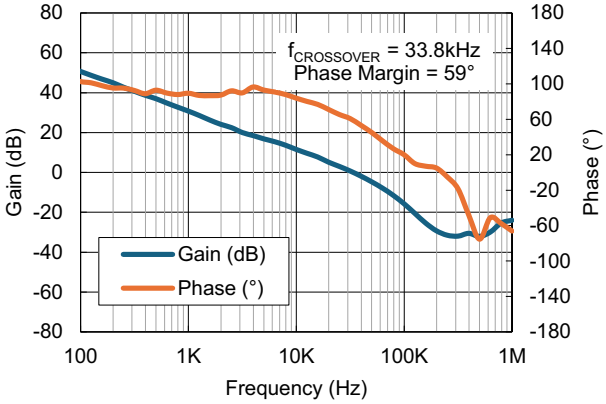

Figure 28. Gain and Phase vs Frequency (V_{IN} = 12V, I_{LOAD} = 50A, f_{SW} = 500kHz)

4. Ordering Information

Part Number	Description
ISL73847SEHEV2Z	Radiation Hardened Dual-Phase Current Mode PWM Controller Board

5. Revision History

Revision	Date	Description
1.02	Sep 23, 2026	Updated the Quick-Start Guide section. Updated Table 1. Updated Figure 3.
1.01	May 13, 2024	Added Figure 23 through Figure 28.
1.00	Nov 21, 2022	Initial release

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