ISL73849SLHEV3Z

4-Phase ISL73849SLH Board

The ISL73849SLHEV3Z evaluation board benchmarks the performance of two ISL73849SLH dual-phase buck controllers, four ISL73041SEH GaN half-bridge drivers, and sixteen ISL70020SEH 40V GaN FETs in a 4-phase, 100A configuration. It is designed for the VERSAL VC1902 VCCINT core rail. The evaluation board is designed to work with 5V PVIN power rail and an auxiliary VDD supply for the controller/driver VDD and external clock generator circuits.

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.

Contents

- ISLUSBISLUSBPMADAPT3Z
- USB 2.0, Type A Male to Type Mini-B Male

Features

- On-board 2MHz clock generator for synchronization
- On-board 50A transient load current generator
- Power-Good (PG) LED indicator
- Integrated LDO (VCC)
- Load-line DROOP regulation
- Differential remote sensing

Specifications

- Buck power supply input (PVIN): 5V, ±5%
- Analog Supply input (VDD)
  - 5V to 13.2V when clocks come from an off-board external clock
  - 9V to 13.2V when using the on-board clock generator circuit
- Output voltage (no-load): 0.809V
- Preset Switching Frequency: 1MHz
- Maximum output current: 100A (25A/phase)
- Preset 2.6% DROOP regulation
- Number of Board Layers: 8
- PCB Thickness: 2oz outer, 1oz inner

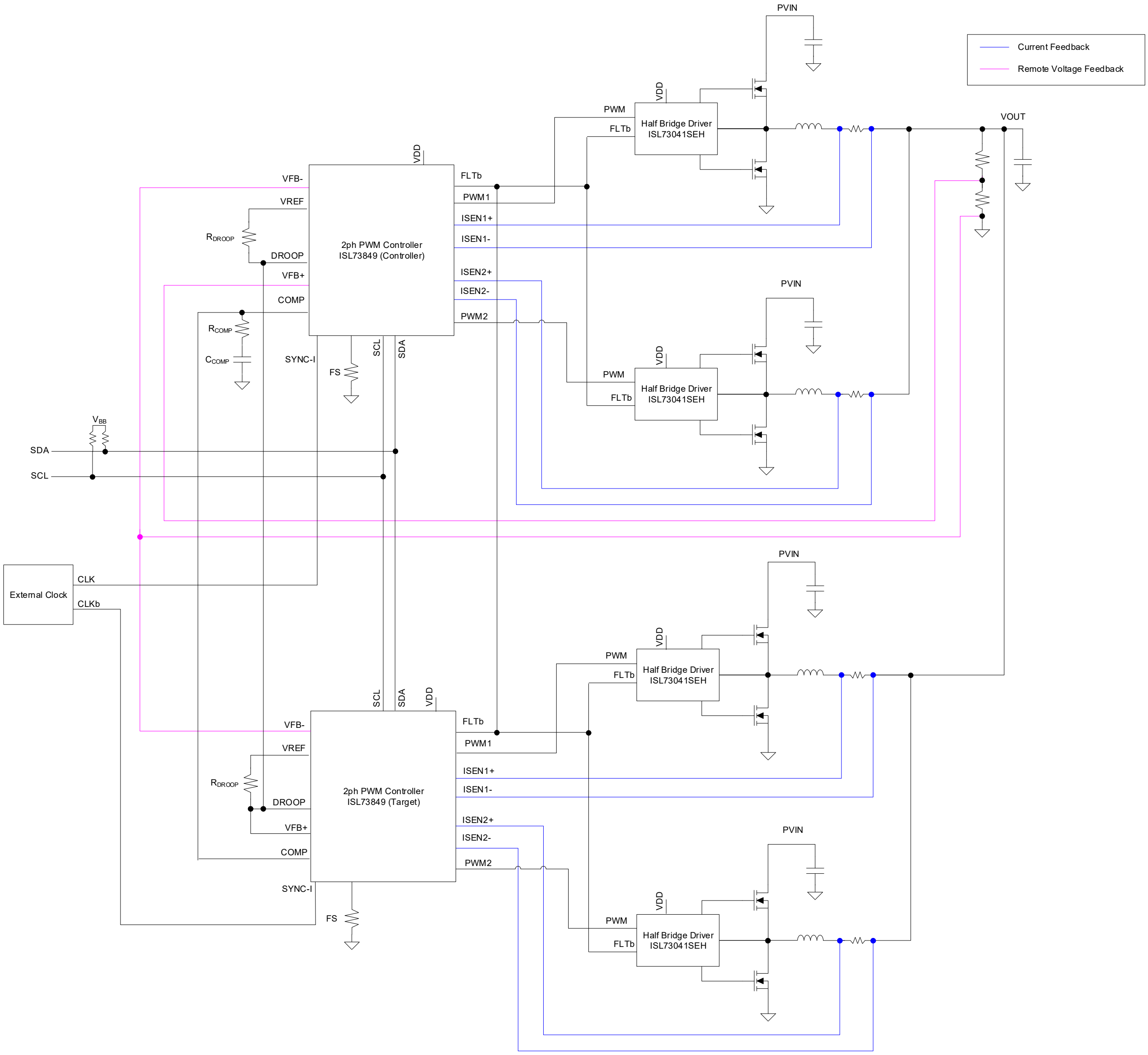


Figure 1. Block Diagram

Contents

1. Functional Description

The ISL73849SLH is a dual-phase PWM Controller that interfaces with the ISL73041SEH GaN half-bridge drivers to control the ISL70020SEH GaN FETs for point-of-load buck regulation in low-voltage, high-current applications such as FPGA core rails. Each PWM Controller is a dual-phase IC; therefore, the design is a 4-phase solution. Each ISL73849SLH controller operates its two phases at 180 degrees phase shift. Using an external clock with a 50% duty cycle and an inverted and non-inverted input to the SYNC-I pins of the ISL73849SLH provides the 90 degrees phase shift needed for 4-phase operation. Each phase delivers 25A RMS for a total 100A solution.

1.1 Operating Range

The ISL73849SLHEV3Z evaluation board requires two supply rails to operate properly. One for the two ISL73849SLH controller’s analog supply input, the four ISL73041SEH GaN half-bridge drivers, and the load transient and clock generator circuits (VDD). The other rail is for the on-board buck power supply input (PVIN).

The PVIN should be set to 5V. The VDD rail accepts an input range of 9V to 13.2V when using the on-board clock circuit because of the minimum VDD of the ISL78841A in that circuit. If using an off-board external clock circuit to supply the clocks to the SYNC-I pins of both controllers, the VDD rail can be 5V to 13.2V or simply tied to the PVIN rail to be powered by a single 5V supply. The VDD voltage is limited to a maximum of 13.2V because of the ISL73041SEH GaN drivers. The buck regulator circuit is preset for a 0.798V output voltage and a switching frequency of 1MHz. The output voltage can be brought up to 0.809V by programming both controller's reference voltage to 0.6V through PMBus. This converter is capable of providing 100A of output current.

1.2 Two Controller 4-Phase Configuration

The ISL73849SLH is a stand-alone PWM Controller, but with proper configuration it can be connected together to provide multiphase operation to deliver higher load current and reduce output ripple voltage. The configuration diagram of connecting two controllers together is shown in Figure 2.

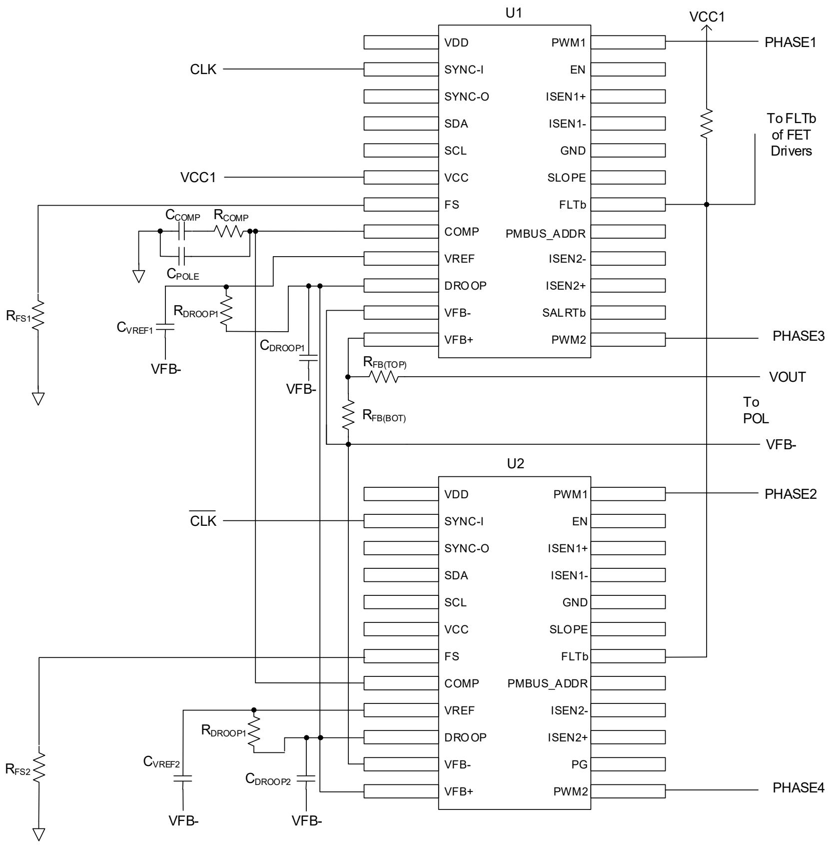


Figure 2. 4-Phase Configuration

To connect two ISL73849SLH controllers for a 4-phase configuration, use the following connections.

- For 90° phase shifted operation in a 4-phase Buck, an external Clock at twice the switching frequency with 50% duty cycle and its complimentary is necessary. See On-Board Clock Generator for Synchronization on generating the clock and complimentary signal for this demonstration board.
- The error amplifier of the second controller (U9) is disabled by tying its DROOP (EA+) and VFB+ (EA-) pins together so it outputs zero current. This allows the first controller's (U1) COMP signal to drive its own PWM comparator in addition to the U9 controller when the COMP pins of the two controllers are connected together.
- RCOMP, CCOMP, and CPOLE are connected to the first controller's (U1) COMP pin. Depopulate the RCOMP, CCOMP, and CPOLE of the second controller (U9) and tie its COMP pin to the first controller's COMP pin.
- When using droop regulation, determine the amount of droop resistance needed on each controller by using the *ISL73849SLH Datasheet* or by using the *ISL73849 Design Calculator*.
- Connect the DROOP pins of the two controllers together. The VREF of each controller supplies the droop current needed into the DROOP pins and the voltage on DROOP includes the average of the VREF voltage on the two controllers.
- Connect the VFB- pins of the two controllers together so they have a common differential reference voltage.
- Connect the FLTb pins of the two controllers and four ISL73041SEH drivers together to a single pull-up resistor. The resistor can connect to VCC of either controller.
- Because the ISL73849SLH controller has 180° phase shift between its own two phases and a 4-phase system has 90° phase shift, the phases are interleaved between the two controllers. For example, U1 controller is Phase 1/Phase 3 and U9 controller is Phase 2/Phase 4.
- When using PMBus for the ISL73849SLH to program non-default modes, program the controller and target to the same register values.

1.3 PMBus GUI Installation

1. Run the ISL73849_Cust_Installer_v0.0.13.
2. Accept the Agreement.
3. Click **Next** to default to the recommended destination location for the install.
4. Click **Next** to default to the recommended application shortcut install name and location.
5. Click **Install**.
6. Click **Finish** to launch the application.
7. The GUI opens.

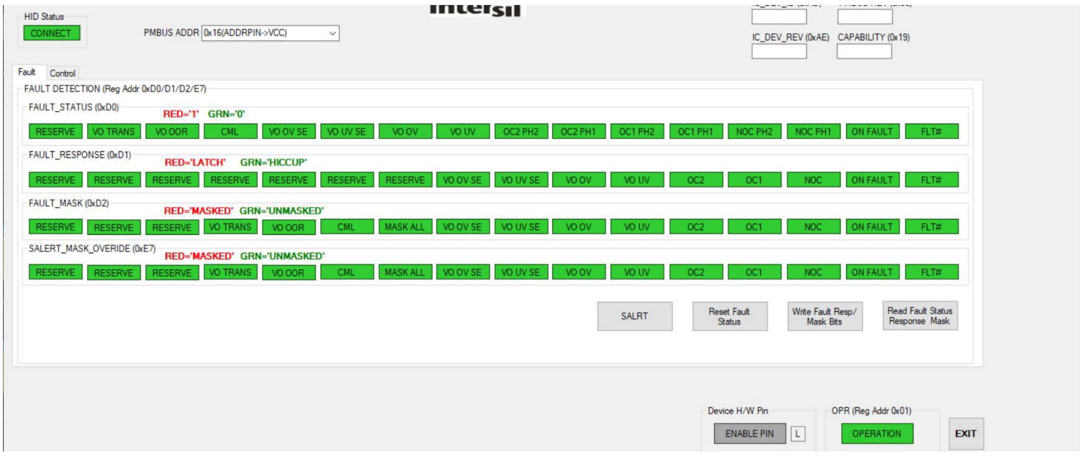


Figure 3. ISL73849 Evaluation Software Main Page

8. Close the GUI.

1.4 Quick-Start Guide

1. Ensure JP1 and JP3 is connected to position 1-2.
2. Ensure JP4, JP5, JP14, and JP15 is connected to position 2-3.
3. Ensure JP16 is connected to position 2-3.
4. Ensure JP2, JP10, JP11 and JP17 is removed.
5. Ensure JP6, JP7, JP8, JP9, JP12, JP13, and JP18 is connected. JP8 and JP18 connect the on-board clock generator.
6. Flip all the switches up on SW1.
7. Flip all the switches except switch 1 on SW2.
8. Connect the ISLUSBPMBADAPT3ZA as shown to the J2 connector as shown in Figure 4.

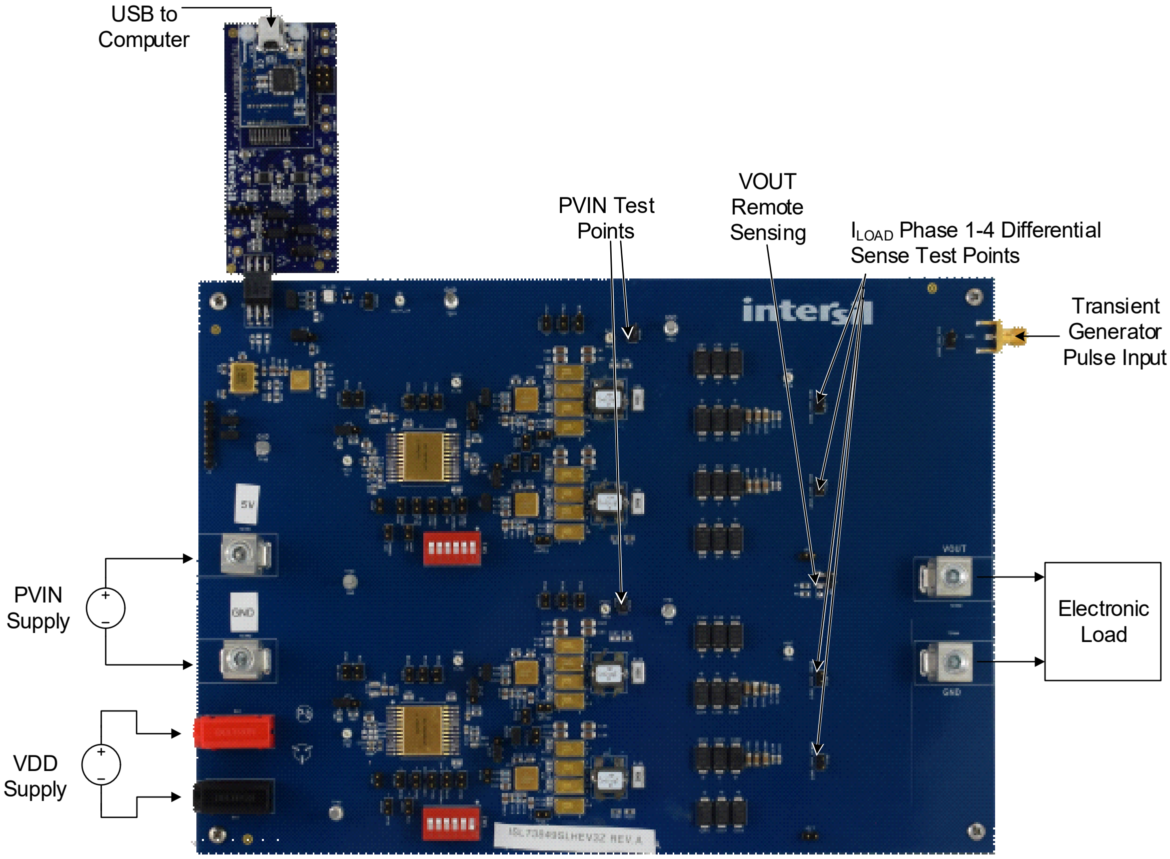


Figure 4. ISL73849SLHEV3Z Board Setup

9. Connect the provided USB to your computer and the ISLUSBPMBADAPT3ZA.
10. Apply a 5V voltage to the PVIN metal banana plug connectors as shown in Figure 4. To monitor PVIN on the board, use TP27 or TP65. TP27 is closer to Phase 1 and 3, TP65 is closer to Phase 2 and 4.
11. Apply a 9V to 13.2V voltage to the VDD banana connectors as shown in Figure 4 to use the on-board clock generator. If using an off-board external clock generator, VDD can be 5V to 13.2V.
12. If required, a resistor or electronic load can be connected to the VOUT metal banana plug connectors as shown in Figure 4. If using an electronic load, you can add 4W sense lines or a multimeter to on the TP29 test jumper.
13. Enable the ISL73849 with the Device H/W Pin (**ENABLE PIN** button) on the GUI as shown in Figure 5. The board is enabled and is immediately disabled with the PMBus OPERATION bit.

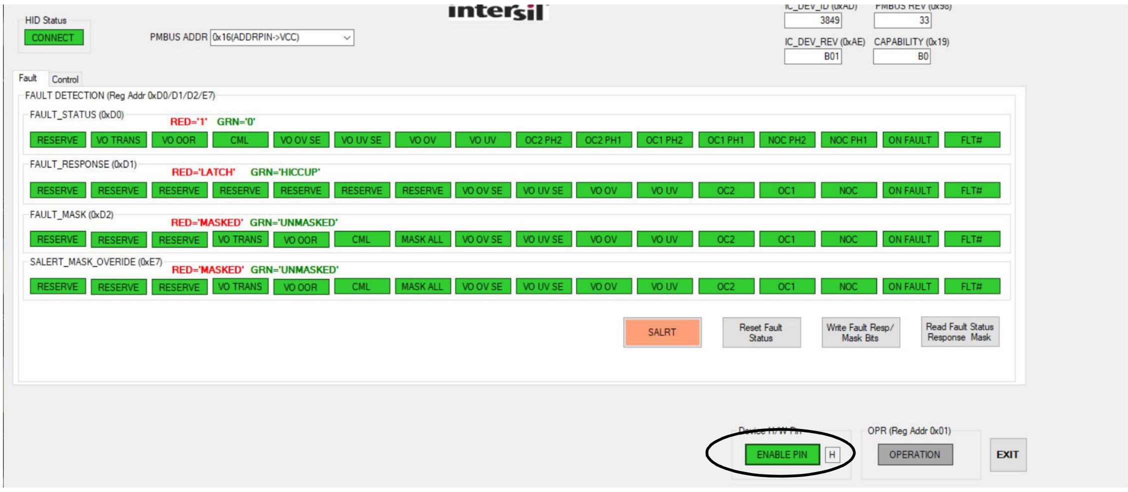


Figure 5. Click the ENBLE PIN Button

14. Program the VREF of the PWM Controller to 0.6V by clicking **Write VREF** as shown in Figure 6 below.

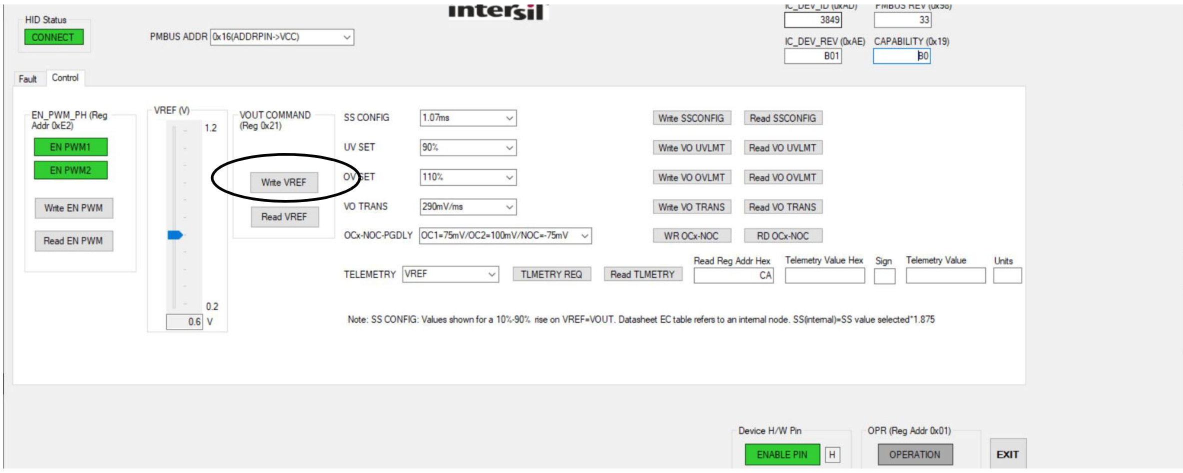


Figure 6. Change the VREF

15. Program the **SS_CONFIG** to 1.07ms on the U1 PWM Controller. The **READ SSCONFIG** button reads back the SS_CONFIG register and confirms the write was successful.

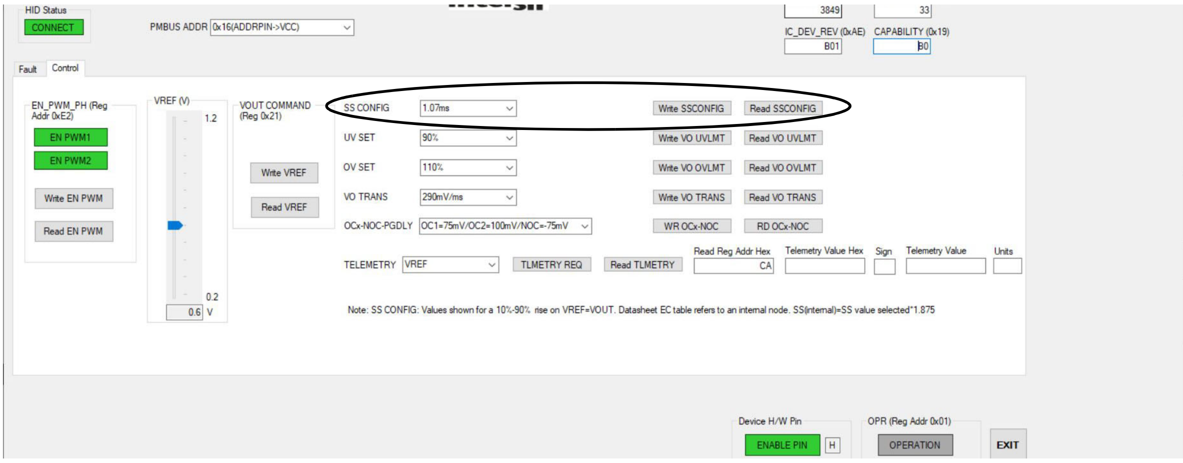


Figure 7. Program SS_CONFIG to 1.15ms on PWM Controller U1

16. Change the **PMBUS ADDR** to 0x11 and program the U9 PWM Target Controller VREF to 0.6V by clicking the **WRITE VREF** button and the **SS_CONFIG** to 1.07ms by clicking the **WRITE SSCONFIG** button.

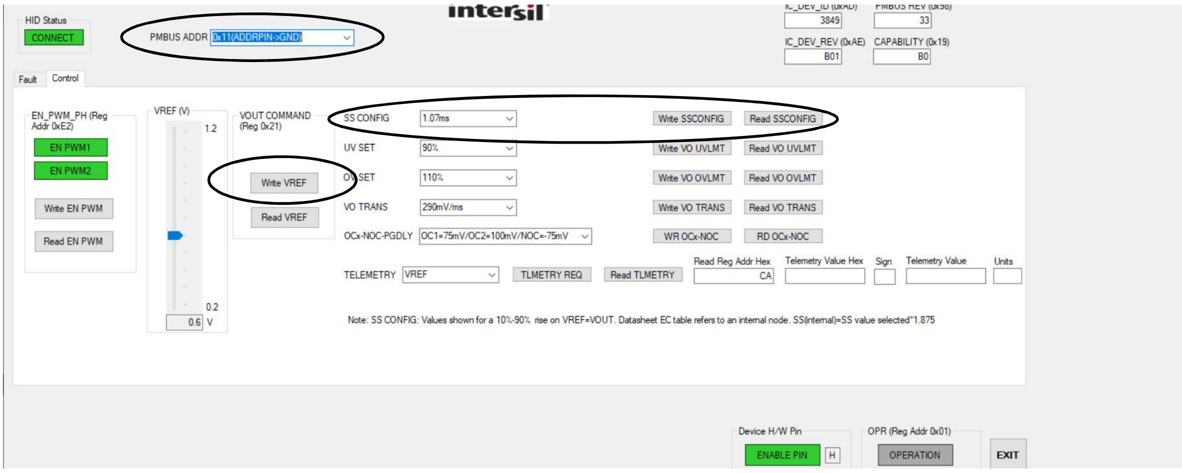


Figure 8. Program SS_CONFIG to 1.07ms on PWM Controller U9

17. Go back to **PMBUS ADDR** 0x16 on the GUI.

18. Enable power-up with the **OPERATION** button as shown in Figure 9.

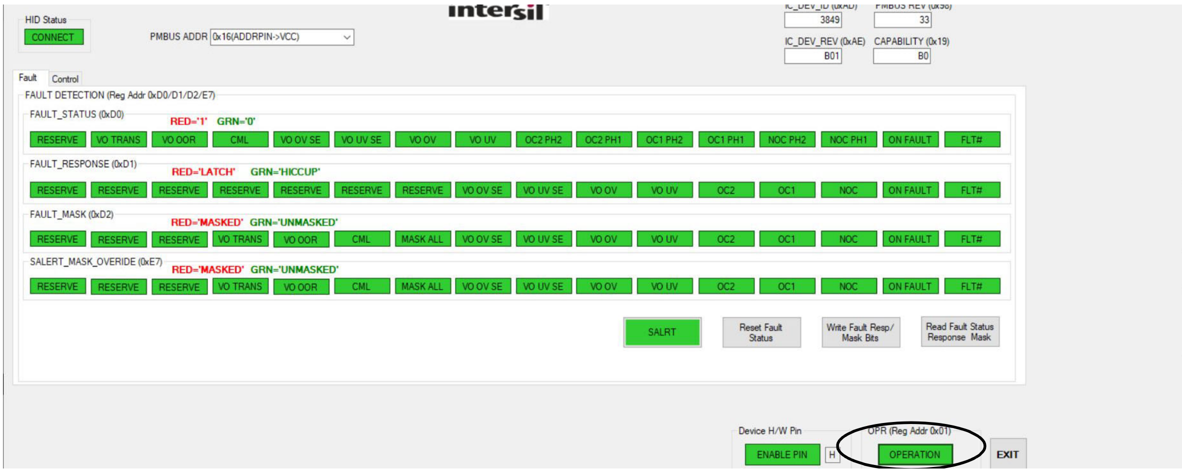


Figure 9. Click the OPERATION button

1.5 On-Board Load Transient Generator

The ISL73849SLHEV3Z includes an on-board transient load generator that uses two ISL70040SEH GaN FET drivers to control four ISL70020SEH N-Channel GaN FET load switches. The load is composed of 4x 200mΩ resistors on each phase.The transient load generator simulates a 50A load step on the 0.809V rail when the FETs are turned on. For smaller load steps, unpopulate some of the load resistors. For larger load steps, there is an additional 3x spots for 2512 chip resistors per phase.

To use the on-board transient generator, short JP2 and JP17 to power up the two ISL70040SEH with the VDD supply. Connect your pulse generator or function generator to the TRAN_IN BNC1 connector. Renesas recommends using the transient load generator in low duty cycle to prevent thermal failure of the resistors. Based on the bandwidth of the converter, a load transient of 500µs is sufficiently long enough to see the converter transient response. Keep the period of the transient load low (for example, for 1% duty cycle use 50ms). A 0V to 5V logic signal is sufficient to drive the ISL70040SEH. To monitor or trigger off of the pulse generator signal, use the TP37 test jumper.

1.6 On-Board Clock Generator for Synchronization

For proper 4-phase 90° phase shifted operation, the ISL73849SLHEV3Z uses an external clock synchronization circuit to output complimentary clocks on the SYNC-I pins of the ISL73849SLH controller.

The ISL73849SLHEV3Z is designed with 1MHz switching frequency, therefore a 2MHz clock is needed. The external clock solution is implemented with a ISL78841ASRH current mode PWM controller. Timing is made through the RTCT pin, which provides a square wave clock signal at the OUT pin. The inverted clock output is generated by putting the clock signal into the ISL70040 GaN FET driver, which offers an INB input that provides the inverted clock signal at OUTH/OUTL. While the 2MHz clock generated by the ISL78841ASRH works under a nominal case, it cannot be guaranteed over full operational range. Renesas recommends using a dedicated clock generator instead. The ISL70040 GaN FET driver can be used to generate the inverted clock signal.

To use the On-board clock synchronization circuit, ensure the JP8 and JP18 jumpers are shorted.

1.7 Droop Regulation

The ISL73849SLHEV3Z is configured to minimize peak-to-peak transient response excursions by using a 392Ω resistor connected between VREF and DROOP pin of each controller (R_1 and R_{86}). If droop regulation is not needed, short out the DROOP resistors with JP10 and JP11. For more information about the droop regulation, refer to the *ISL73849SLH Datasheet*.

1.8 Enabling/Disabling

The ISL73849SLHEV3Z is configured by default with JP16 in position 2-3 to enable the ISL73849SLH with the ISLUSBPMBADAPT3ZA, which has an MCU that controls the EN pin and PMBus OPERATION bit in conjunction with the ISL73849 GUI Software. This allows the user to change the PMBus registers to non-default values before powering up the converter.

2. Changing VIN, VOUT, IOUT, and Transient Parameters

The ISL73849SLHEV3Z showcases a multiphase converter design for the VERSAL VC1902 VCCINT core rail for V_{IN} = 5V, V_{OUT} = 0.8V, and I_{LOAD} = 140A. However, the design can be adjusted for different PVIN, VOUT, and I_{LOAD} parameters by changing various components throughout the board.

2.1 Increasing the Maximum Output Current

For higher output currents, the ISL73849SLHEV3Z can be modified by changing various components. For example to increase the per-phase current from 25A to 35A for a total 140A solution, make the following changes to the board. *Note*: The dissipative elements in the power stage (GaN FETs and inductor) see a higher temperature rise due to the increased load current.

1. To evaluate 140A continuous operation, the two high-side and two low-side GaN FETs can handle the current. For larger currents, a separate PCB design to accommodate more GaN FETs in parallel and increase the number of PCB layers to handle the extra current requirements to be designed.
2. Decrease the R_{SENSE} (R55, R56, R132, R133) resistor from 2mΩ down to 1.43mΩ so that a 50mV full-scale input to the ISENSE+/ISENSE- pins of the ISL73849SLH is developed with 35A RMS of load current. The Susumu resistors have a 3mΩ available, therefore, two in parallel can be used for 1.5mΩ.
3. Reduce the inductor value. The inductor Coilcraft SLR1070 120nH was used. There is no smaller inductance in this family. However, the Coilcraft SLC1049 offers a 75nH inductor with adequate saturation and RMS current ratings that can be substituted. The SLC1049 recommended PCB land pattern is slightly different but can be reasonably mounted onto the PCB board.
4. Use the additional DNP placeholders for tantalum capacitors on the 0.8V rail if required. A minimum of 6x220µF per phase is required for 140A operation.

5. Change the slope compensation, error amp compensation, and droop compensation per the loop design calculator. At minimum, change C_comp from 4.7nF to 3.9nF.
6. Adjust the timing circuit on ISL71041M U107 from ~1MHz to 875kHz to comply with the maximum inductor value recommended in the loop design calculator. Change C89 from 10pF to 22pF and R78 from 11kΩ to 30.9kΩ.

3. Board Design

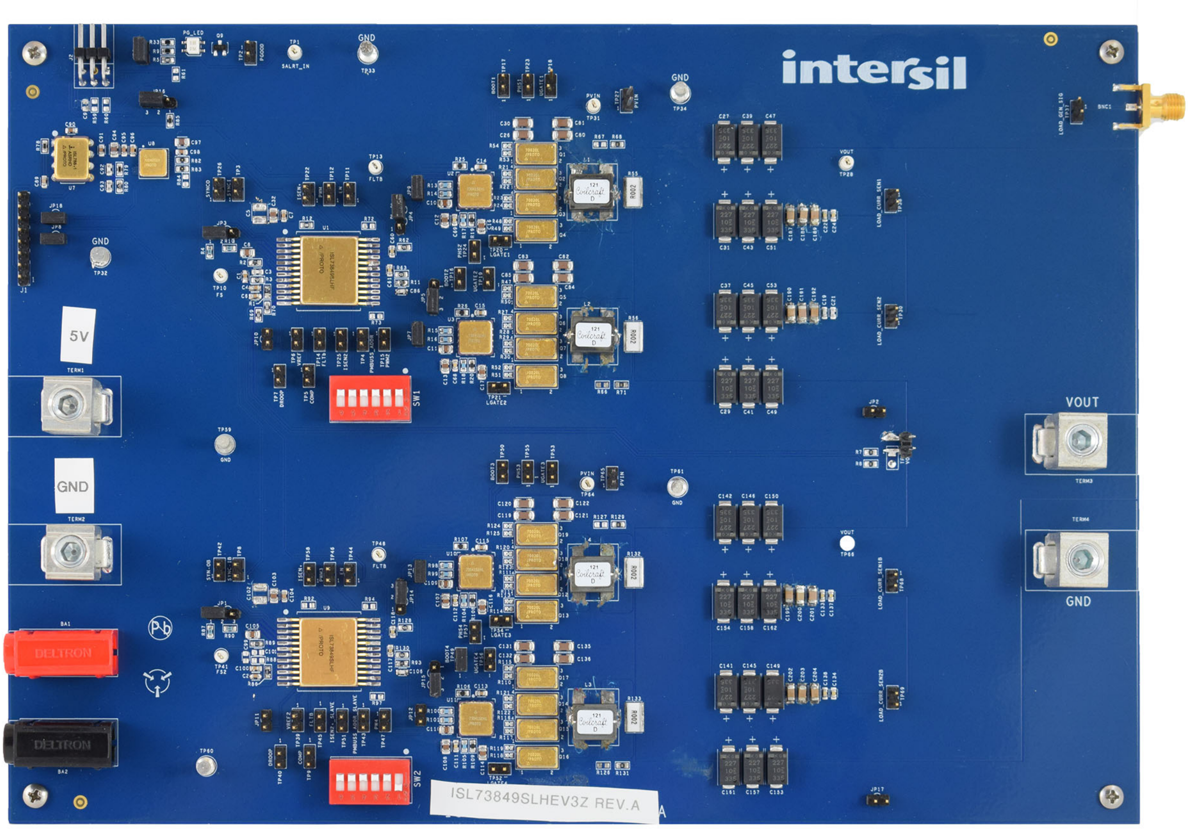


Figure 10. ISL73849SLHEV3Z Evaluation Board (Top)

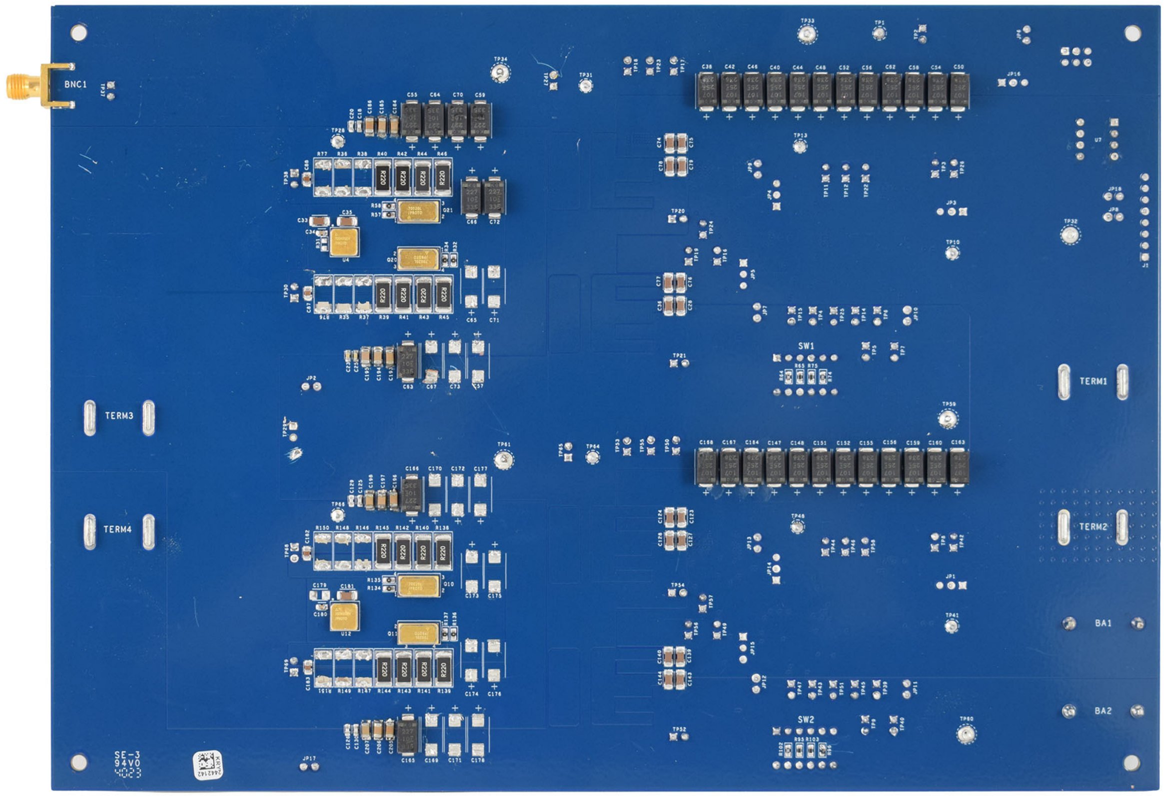


Figure 11. ISL73849SLHEV3Z Evaluation Board (Bottom)

3.1 Schematic Diagrams

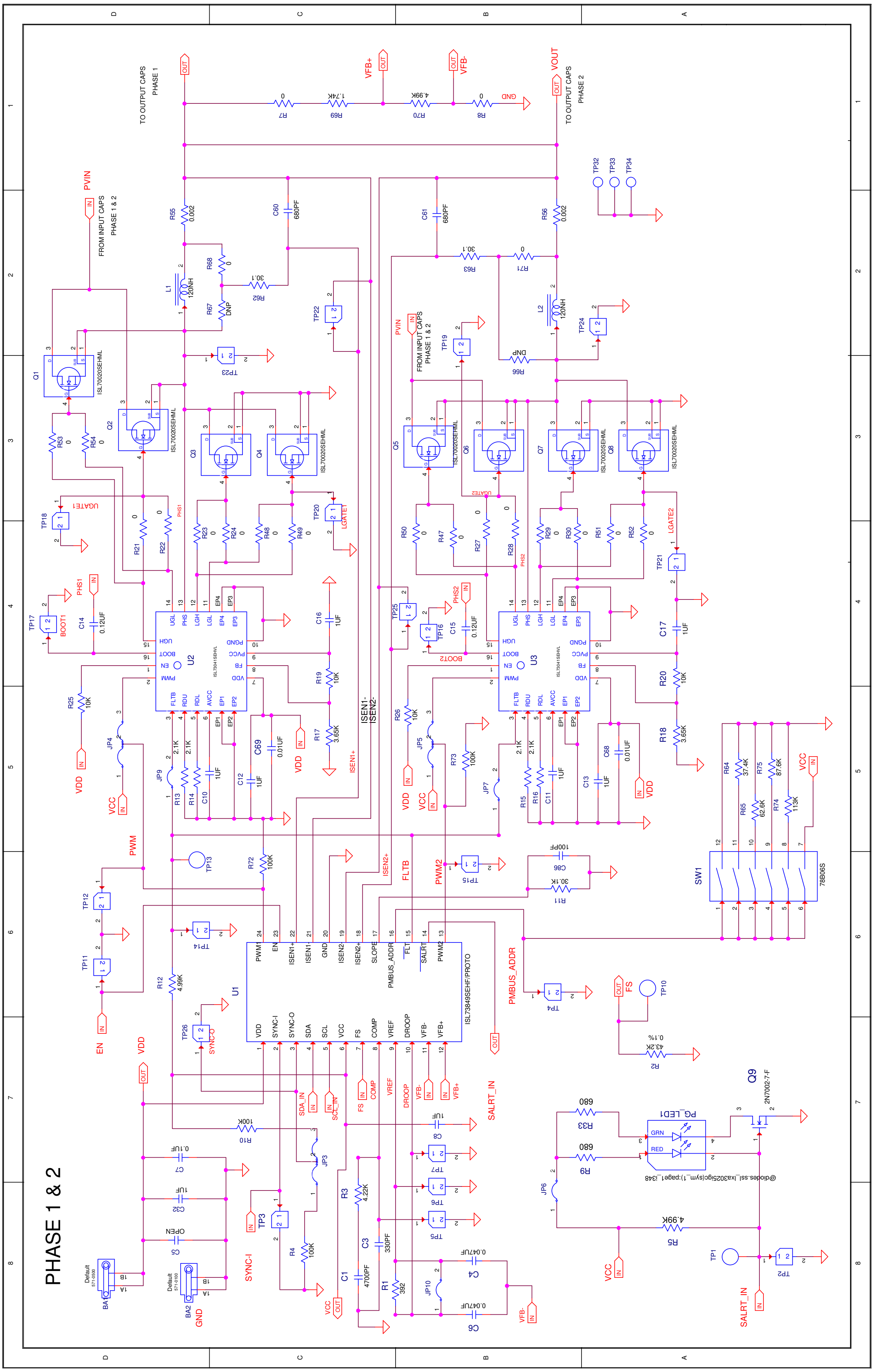


Figure 12. ISL73849SLHEV3Z Schematic (Phases 1 & 2)

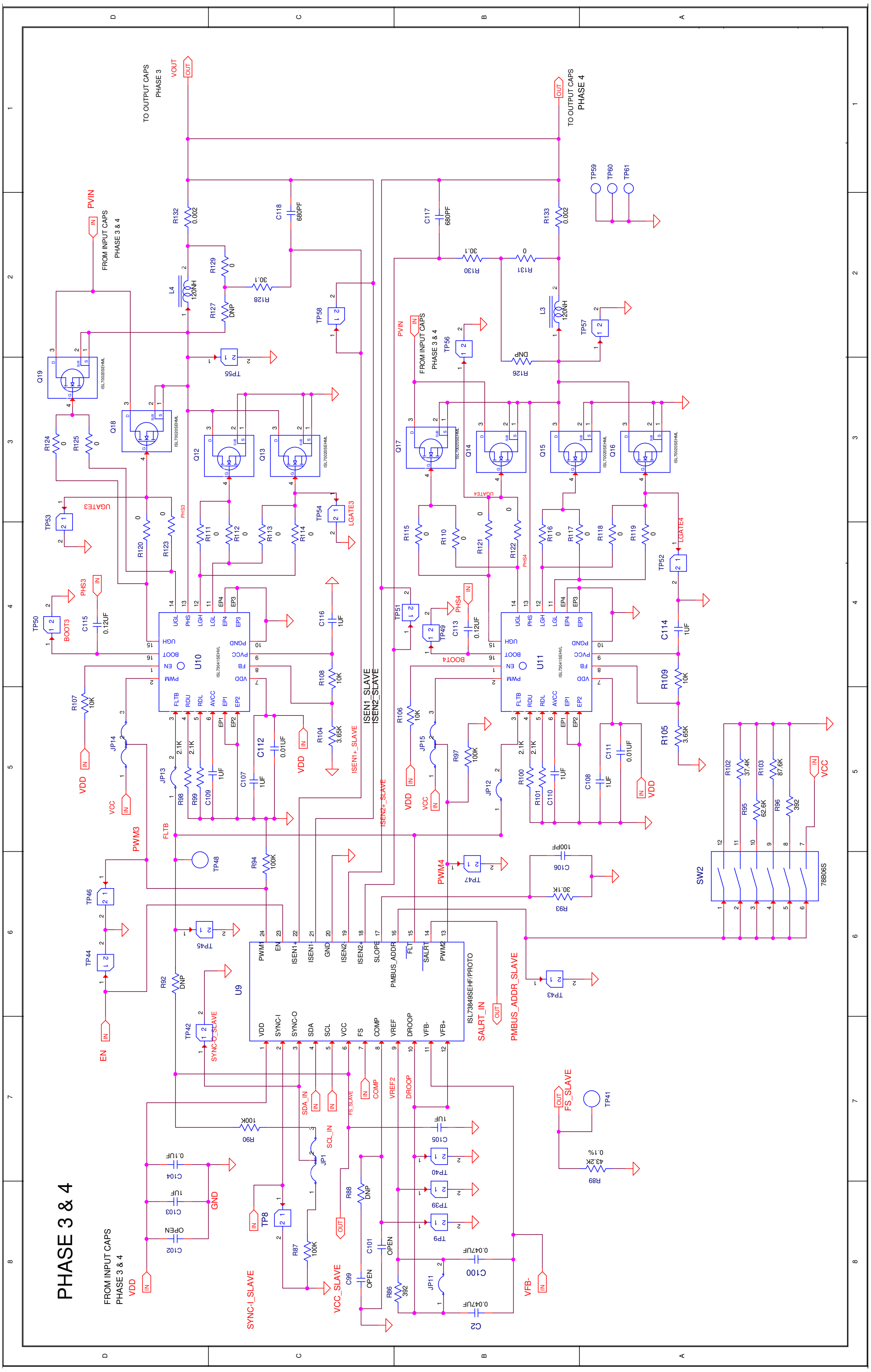


Figure 13. ISL73849SLHEV3Z Schematic (Phases 3 & 4)

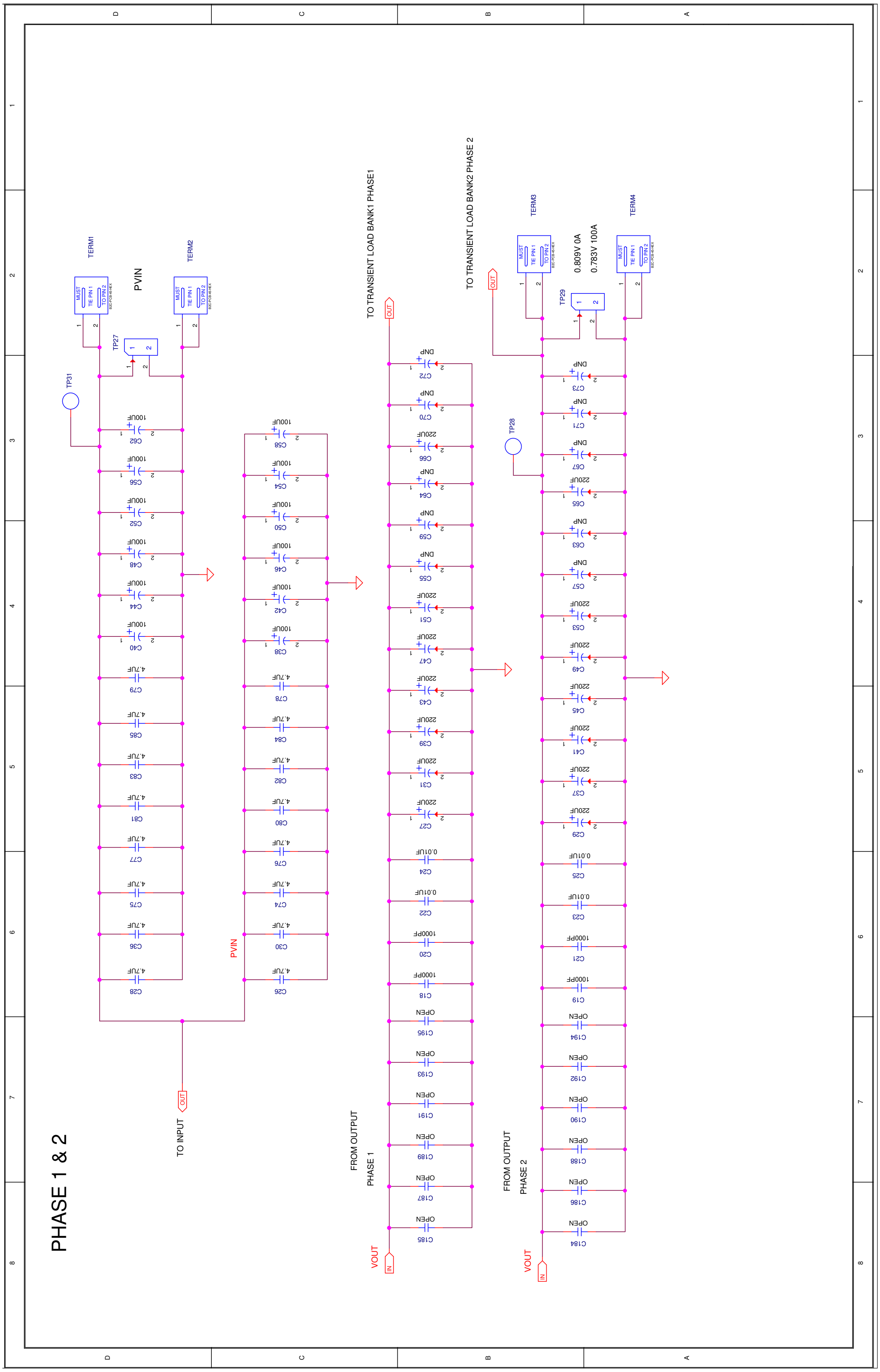


Figure 14. ISL73849SLHEV3Z Schematic (Phases 1 & 2 C_{IN} and C_{OUT})

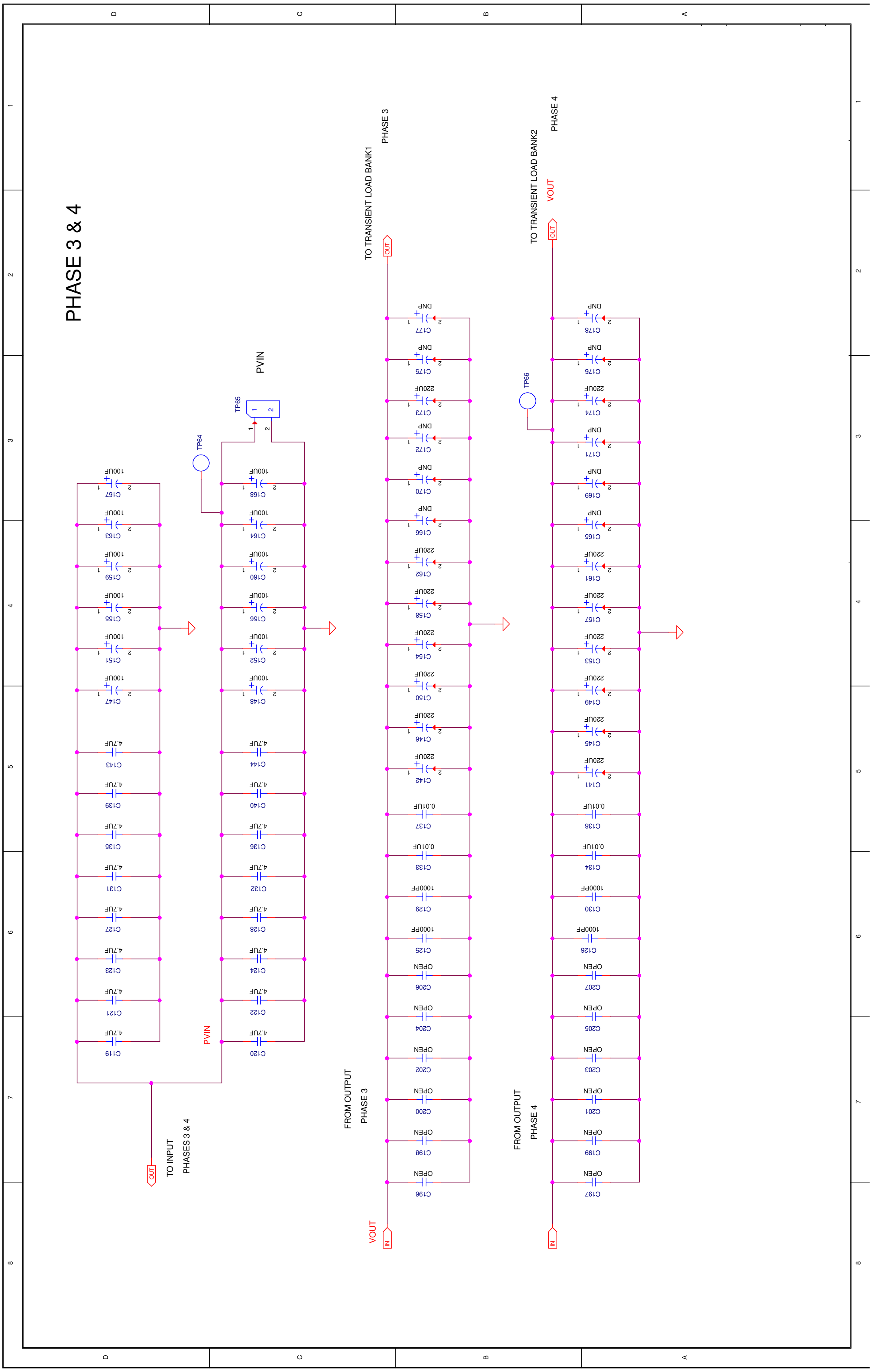


Figure 15. ISL73849SLHEV3Z Schematic (Phases 3 & 4 - C_{IN} and C_{OUT})

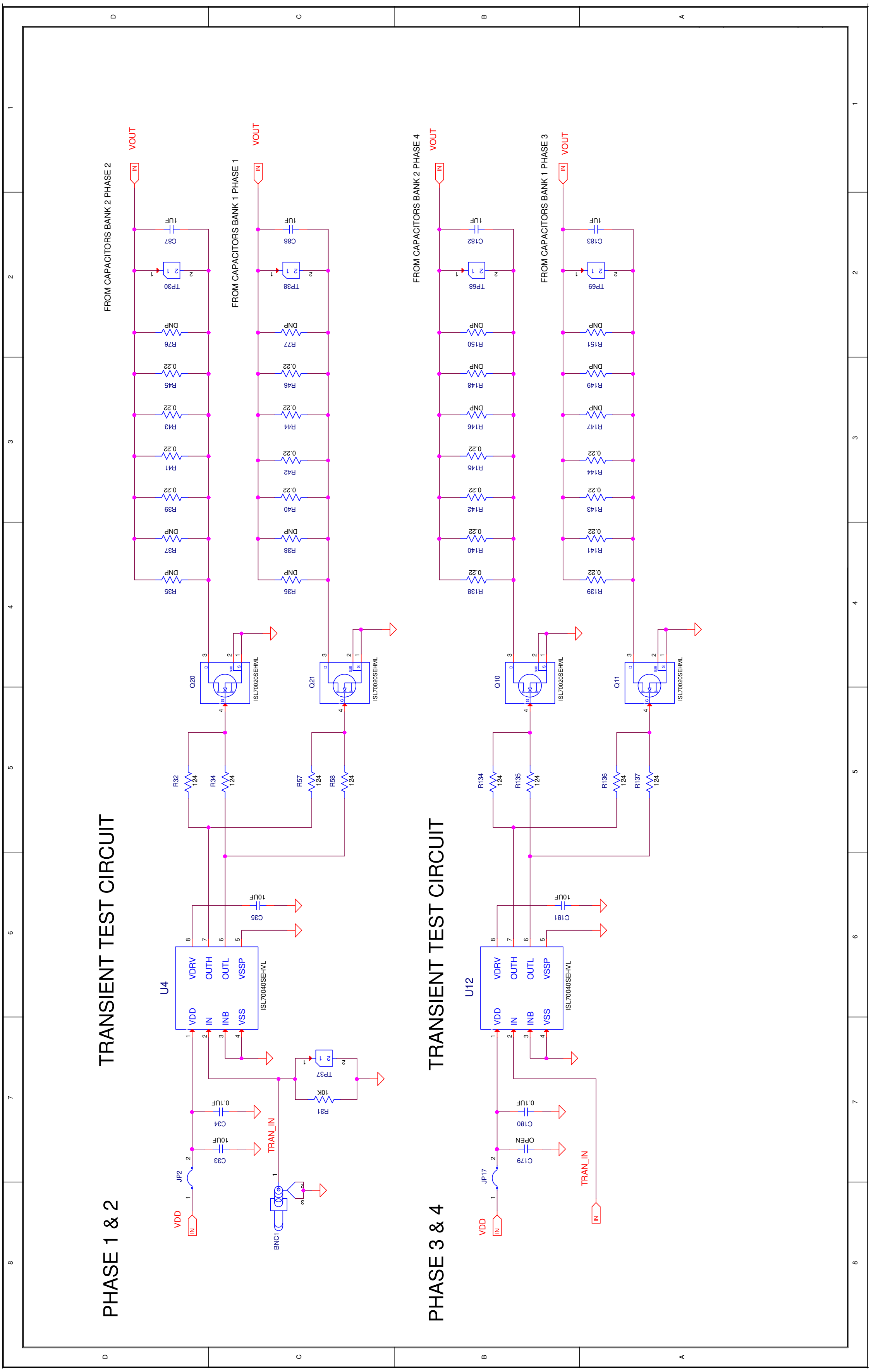


Figure 16. ISL73849SLHEV3Z Schematic (Transient Test Circuits)

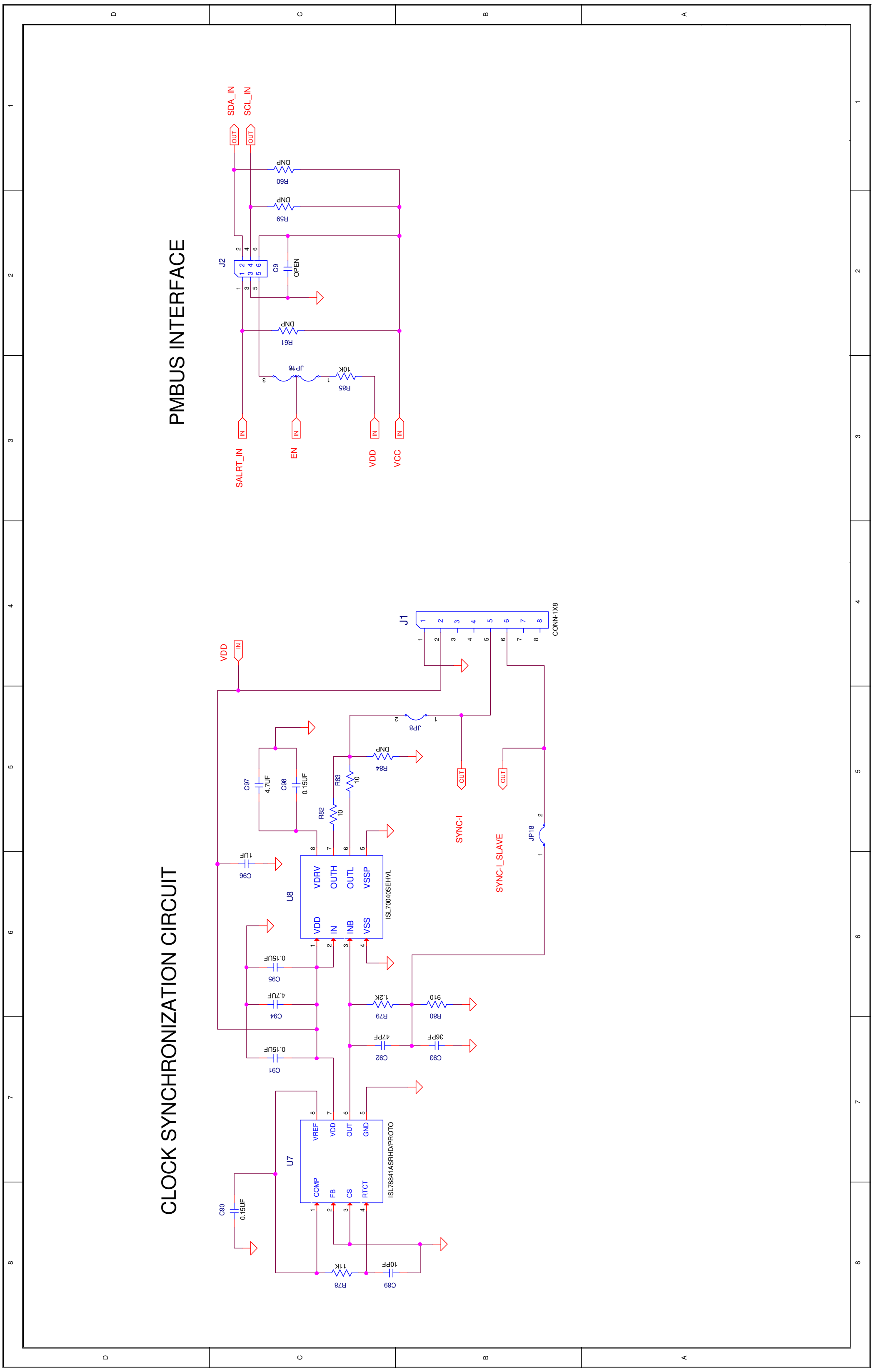


Figure 17. ISL73849SLHEV3Z Schematic (Clock Synchronization Circuit)

3.2 Bill of Materials

Qty	Ref Des	Description	Manufacturer	Part Number
1	PCB	Bare PCB Board	Imagineering	ISL73849SLHEV3ZREVAPCB
4	4 CORNERS PCB	SCREW, 4-40X1/4in, PHILLIPS, PANHEAD, SS, ROHS	Keystone Electronics	4-40X1/4-SCREW-SS
4	4 CORNERS PCB	STANDOFF, 4-40X3/4in, F/F, HEX, ALUMINUM, ROHS	Keystone Electronics	4-40X3/4-STANDOFF-METAL
1	BA1	CONN-PLUG, TH, 4mm INSUL.SOCKET, RED, R/A, ROHS	Deltron	571-0500
1	BA2	CONN-PLUG, TH, 4mm INSUL.SOCKET, BLK, R/A, ROHS	Deltron	571-0100
1	BNC1	CONN-RF, SMA JACK, 50Ω, 18GHz, TAB-END LAUNCH, ROHS	Amphenol RF	132357-11
1	C1	CAP, CER, 4700pF, 50V, C0G, 0603, ROHS	TDK Corporation	CGA3E2C0G1H472J080AA-T
4	C14, C15, C113, C115	CAP, SMD, 0603, 0.12µF, 50V, 10%, X7R, ROHS	Kemet	C0603C124K5RAC7867-T
0	C179	DO NOT POPULATE OR PURCHASE	N/A	DNP
24	C184-C207	CAP, SMD, 1206, 10µF, 6.3V, 10%, X7R, ROHS	Kemet	C1206C106K9RAC7800-T
8	C18-C21, C125, C126, C129, C130	CAP, SMD, 0603, 1000pF, 25V, 10%, C0G/NP0, ROHS	Kyocera AVX	KGM15ACG1E102KT-T
4	C2, C4, C6, C100	CAP, SMD, 0.047µF, 50V, X7R, ROHS	Walsin Technology Inc.	0603B473K500CT-T
12	C22-C25, C68, C69, C111, C112, C133, C134, C137, C138	CAP, SMD, 0603, 0.01µF, 25V, 10%, X7R, ROHS	Kemet	C0603C103K3RAC7411-T
32	C26, C28, C30, C36, C74-C85, C119-C124, C127, C128, C131, C132, C135, C136, C139, C140, C143, C144	CAP, SMD, 1206, 4.7µF, 25V, 10%, X7R, ROHS	TDK Corporation	C3216X7R1E475K160AE-T
28	C27, C29, C31, C37, C39, C41, C43, C45, C47, C49, C51, C53, C65, C66, C141, C142, C145, C146, C149, C150, C153, C154, C157, C158, C161, C162, C173, C174	CAP-TANT, SMD, 7.3×4.3×2.8, 220µF, 10V, 20%, ROHS	Kemet	T530D227M010ATE006-T
1	C3	CAP, SMD, 0603, 330pF, 25V, 5%, C0G/NP0, ROHS	Kemet	C0603C331J3GAC7867-T
3	C33, C35, C181	CAP, SMD, 1206, 10µF, 25V, 10%, X7R, ROHS	TDK Corporation	C3216X7R1E106K160AB-T
2	C34, C180	CAP, SMD, 0603, 0.1µF, 25V, 10%, X7R, ROHS	Kemet	C0603X104K3RACTU-T
24	C38, C40, C42, C44, C46, C48, C50, C52, C54, C56, C58, C62, C147, C148, C151, C152, C155, C156, C159, C160, C163, C164, C167, C168	CAP-TANT, SMD, 7.3x4.3mm, 100µF, 25V, 20%, ROHS	Kemet	T521X107M025ATE030-T

Qty	Ref Des	Description	Manufacturer	Part Number
0	C5, C102	DO NOT POPULATE OR PURCHASE	N/A	DNP
0	C55, C57, C59, C63, C64, C67, C70-C73, C165, C166, C169-C172, C175-C178	Ripple 6500ma ESR 6mΩ High Capacitance Low ESR Tantalum SMD Cap	NA	DNP
4	C60, C61, C117, C118	CAP, SMD, 0603, 680pF, 25V10%, X7R, ROHS	Kyocera AVX	KGM15AR71E681KT-T
2	C7, C104	CAP, SMD, 0603, 0.1µF, 50V, 10%, X7R, ROHS	TDK Corporation	C1608X7R1H104K080AA-T
20	C8, C10-C13, C16, C17, C32, C87, C88, C103, C105, C107-C110, C114, C116, C182, C183	CAP, SMD, 0805, 1.0µF, 25V, 10%, X7R, ROHS	TDK Corporation	C2012X7R1E105K125AB-T
2	C86, C106	CAP, SMD, 0603, 100pF, 50V, 10%, X7R, ROHS	Yageo	CC0603KPX7R9BB101-T
1	C89	CAP-AEC-Q200, SMD, 0603, 10pF, 100V, 10%, C0G, ROHS	Vishay Vitramon	VJ0603A100KXBAC31-T
0	C9, C99, C101	DO NOT POPULATE OR PURCHASE	N/A	DNP
4	C90, C91, C95, C98	CAP-AEC-Q200, SMD, 0603, 0.15µF, 50V, 10%, X7R, ROHS	TDK Corporation	CGA3E3X7R1H154K080AB-T
1	C92	CAP-AEC-Q200, SMD, 0603, 47pF, 100V, 10%, C0G, ROHS	Kemet	C0603C470K1GACAUTO-T
1	C93	CAP, SMD, 0603, 36pF, 50V, 10%, X8R, ROHS	Kemet	C0603C360K5HACAUTO-T
2	C94, C97	CAP-AEC-Q200, SMD, 0805, 4.7µF, 25V, 10%, X7R, ROHS	Kemet	C0805C475K3RACAUTO-T
1	C96	CAP, SMD, 0603, 1µF, 25V, 10%, X7R, ROHS	Murata Electronics	GRM188R71E105KA12-T
1	J1	CONN-HEADER, 1×8, BRKAWY 1×36, 2.54mm, ROHS	Amphenol ICC (FCI)	68000-236HLF-1X8
1	J2	CONN-HEADER, 2×3, BRKAWY, 2.54mm, TIN, R/A, ROHS	Samtec Inc.	TSW-103-08-T-D-RA
14	JP1 (PINS 1&2), JP3 (PINS 1-2), JP4 (PINS 2-3), JP5 (PINS 2-3), JP6, JP7, JP8, JP9, JP12, JP13, JP14 (PINS2-3), JP15 (PINS 2-3), JP16 (PINS 2-3), JP18	CONN-JUMPER, SHUNT, 2P, 2.54mmPITCH, BLK, 6mm, ROHS	Sullins Connector Solutions	SPC02SYAN
7	JP1, JP3-JP5, JP14-JP16	CONN-HEADER, 1×3, BREAKAWY 1×36, 2.54mm, ROHS	Amphenol ICC (FCI)	68000-236HLF-1X3
4	L1-L4	COIL-PWR INDUCTOR, SMD, 10.4x8mm, 120nH, 10%, ROHS	Coilcraft Inc.	SLR1070-121KEC-T
1	PG_LED	LED, 565nm, 2.2V GREEN, 2V RED, 20mA, ROHS	Lumex Opto/Components Inc.	SSL-LXA3025IGC-TR-T
1	PLACE ASSY IN BAG	BAG, STATIC, 10×12, ZIP LOC, ROHS	Uline	10X12-STATIC-BAG
20	Q1-Q8, Q10-Q21	TRANSISTOR, RAD HARD, 40V GAN FET, 4P, CLCC, ROHS	Renesas	ISL70020SEHML

Qty	Ref Des	Description	Manufacturer	Part Number
1	Q9	TRANSISTOR, N-CHANNEL, SOT-23, 60V, 115mA, ROHS	Diodes Incorporated	2N7002-7-F-T
3	R1, R86, R96	RES-AEC-Q200, SMD, 0603, 392Ω, 1/10W, 1%, TKF, ROHS	Panasonic Electronic Components	ERJ3EKF3920V-T
2	R11, R93	RES-AEC-Q200, SMD, 0603, 30.1K, 1/10W, 1%, TKF, ROHS	Yageo	AC0603FR-0730K1L-T
8	R13-R16, R98-R101	RES-AEC-Q200, SMD, 0603, 2.1K, 1/10W, 1%, TKF, ROHS	KOA Speer Electronics, Inc.	RK73H1JTTD2101F-T
4	R17, R18, R104, R105	RES-AEC-Q200, SMD, 0603, 3.65K, 1/10W, 1%, ROHS	KOA Speer Electronics, Inc.	RK73H1JTTD3651F-T
10	R19, R20, R25, R26, R31, R85, R106-R109	RES-AEC-Q200, SMD, 0603, 10K, 1/10W, 1%, TKF, ROHS	Vishay Dale	CRCW060310K0FKEB-T
2	R2, R89	RES-AEC-Q200, SMD, 0603, 43.2K, 1/10W, 0.1%, ROHS	Panasonic Electronic Components	ERA-3AEB4322V-T
32	R21-R24, R27-R30, R47-R54, R110-R125	RES, SMD, 0402, 0Ω, 1/16W, 1%, TNF, ROHS	Vishay Beyschlag/Draloric/BC Components	MCS04020Z0000ZE000-T
1	R3	RES-AEC-Q200, SMD, 0603, 4.22K, 1/10W, 1%, TKF, ROHS	Yageo	AC0603FR-074K22L-T
8	R32, R34, R57, R58, R134-R137	RES-AEC-Q200, SMD, 0603, 124Ω, 1/10W, 1%, TKF, ROHS	Stackpole Electronics Inc	RMCF0603FT124R-T
0	R35-R38, R76, R77, R146-R151	DO NOT POPULATE OR PURCHASE	N/A	DNP
16	R39-R46, R138-R145	RES-CURR.SENSE, SMD, 2512, 0.22Ω, 2W, 1%, TF, ROHS	Bourns Inc.	CRM2512-FX-R220ELF-T
8	R4, R10, R72, R73, R87, R90, R94, R97	RES-AEC-Q200, SMD, 0603, 100K, 1/10W, 1%, TKF, ROHS	Stackpole Electronics Inc	RMCF0603FT100K-T
3	R5, R12, R70	RES, SMD, 0603, 4.99K, 1/10W, 1%, TKF, ROHS	Yageo	RC0603FR-074K99L-T
4	R55, R56, R132, R133	RES-AEC-Q200, SMD, 2512W, 0.002Ω, 3W, 2%, MF, ROHS	Susumu	KRL6432E-M-R002-G-T1-T
0	R59-R61, R66, R67, R88, R92, R126, R127	DO NOT POPULATE OR PURCHASE	N/A	DNP
4	R62, R63, R128, R130	RES-AEC-Q200, SMD, 0603, 30.1Ω, 1/8W, 1%, TKF, ROHS	KOA Speer Electronics, Inc.	RK73H1JTTD30R1F-T
2	R64, R102	RES, SMD, 0603, 37.4K, 1/10W, 1%, TKF, ROHS	Yageo	RC0603FR-0737K4L-T
2	R65, R95	RES-AEC-Q200, SMD, 0603, 62.6K, 1/10W, 1%, TNF, ROHS	KOA Speer Electronics, Inc.	RN73R1JTTD6262F100-T
1	R69	RES-AEC-Q200, SMD, 0603, 1.64K, 1/10W, 1%, TKF, ROHS	KOA Speer Electronics, Inc.	RK73H1JTTD1741F-T

Qty	Ref Des	Description	Manufacturer	Part Number
6	R7, R8, R68, R71, R129, R131	RES-AEC-Q200, SMD, 0603, 0Ω, 1/10W, TKF, ROHS	Stackpole Electronics Inc	RMCF0603ZT0R00-T
1	R74	RES, SMD, 0603, 113K, 1/10W, 1%, TKF, ROHS	Yageo	RC0603FR-07113KL-T
2	R75, R103	RES-AEC-Q200, SMD, 0603, 87.6K, 1/10W, 1%, THINFILM, ROHS	KOA Speer Electronics, Inc.	RN73R1JTTD8762F100-T
1	R78	RES-AEC-Q200, SMD, 0603, 11K, 1/10W, 1%, TKF, ROHS	Stackpole Electronics Inc	RMCF0603FT11K0-T
1	R79	RES, SMD, 0603, 1.2K, 1/10W, 1%, TF, ROHS	Panasonic Electronic Components	ERJ-3EKF1201V-T
1	R80	RES-AEC-Q200, SMD, 0603, 910Ω, 1/10W, 1%, TKF, ROHS	Yageo	AC0603FR-07910RL-T
2	R82, R83	RES-AEC-Q200, SMD, 0603, 10Ω, 1/10W, 1%, TKF, ROHS	Rohm	KTR03EZPF10R0-T
0	R84	DO NOT POPULATE OR PURCHASE	N/A	DNP
2	R9, R33	RES-AEC-Q200, SMD, 0603, 680ohm, 1/10W, 1%, TKF, ROHS	Vishay Dale	CRCW0603680RFKEA-T
2	SW1, SW2	SWITCH, TH, DIP, 6P, SLIDE, SPST SEALED	Grayhill Inc.	78B06ST
4	TERM1-TERM4	HDWARE-SINGLE WIRE LUG, TH, 11.8×10.3mm, HEX SCREW, ROHS	International Hydraulics Inc.	B2C-PCB-HEX
9	TP1, TP10, TP13, TP28, TP31, TP41, TP48, TP64, TP66	CONN-MINI TEST POINT, VERTICAL, WHITE, ROHS	Keystone Electronics	5002
0	TP27, TP29, TP65	DO NOT POPULATE OR PURCHASE	N/A	DNP
60	TP2-TP9, TP11, TP12, TP14-TP26, TP27, TP29, TP30, TP37-TP40, TP42-TP47, TP49-TP58, TP65, TP68, TP69, JP2, JP6-JP13, JP17, JP18	TEST POINT 2 Pin Header 2.54mm (.100) Pitch	Amphenol ICC (FCI)	69190-202HLF
6	TP32-TP34, TP59-TP61	CONN-TURRET, TERMINAL POST, TH, ROHS	Keystone Electronics	1514-2
2	U1, U9	IC-RH BUCK CONTROLLER W/PMBUS, 24P, CFP, ROHS	Renesas	ISL73849SLHF/PROTO
4	U2, U3, U10, U11	IC-RL GaN FET, HALF BRIDGE DRIVER, 14P, CLCC, ROHS	Renesas	ISL73041SEHVL
3	U4, U8, U12	IC-100V, RAD-HARD, GAN FET DRIVER, SMD, 8P, CLCC	Renesas	ISL70040SEHVL
1	U7	IC-RAD HARD CURRENT MODE PWM, 8P, CFP, ROHS	Renesas	ISL78841ASRHD/PROTO
1	AFFIX TO BOTTOM OF PCB	LABEL-DATE CODE= LINE 1:YRWK-REV#, LINE 2;BOM NAME	N/A	LABEL-DATE CODE

Qty	Ref Des	Description	Manufacturer	Part Number
1	BAG AND SHIP	CABLE-USB 2.0, TYPE A MALE/TYPE MINI-B MALE, ROHS	Molex	88732-8800
1	BAG AND SHIP	PWB-FG, ISLUSBPMADAPT3Z, ROHS	Renesas	ISLUSBPMADAPT3ZFG

3.3 Board Layout

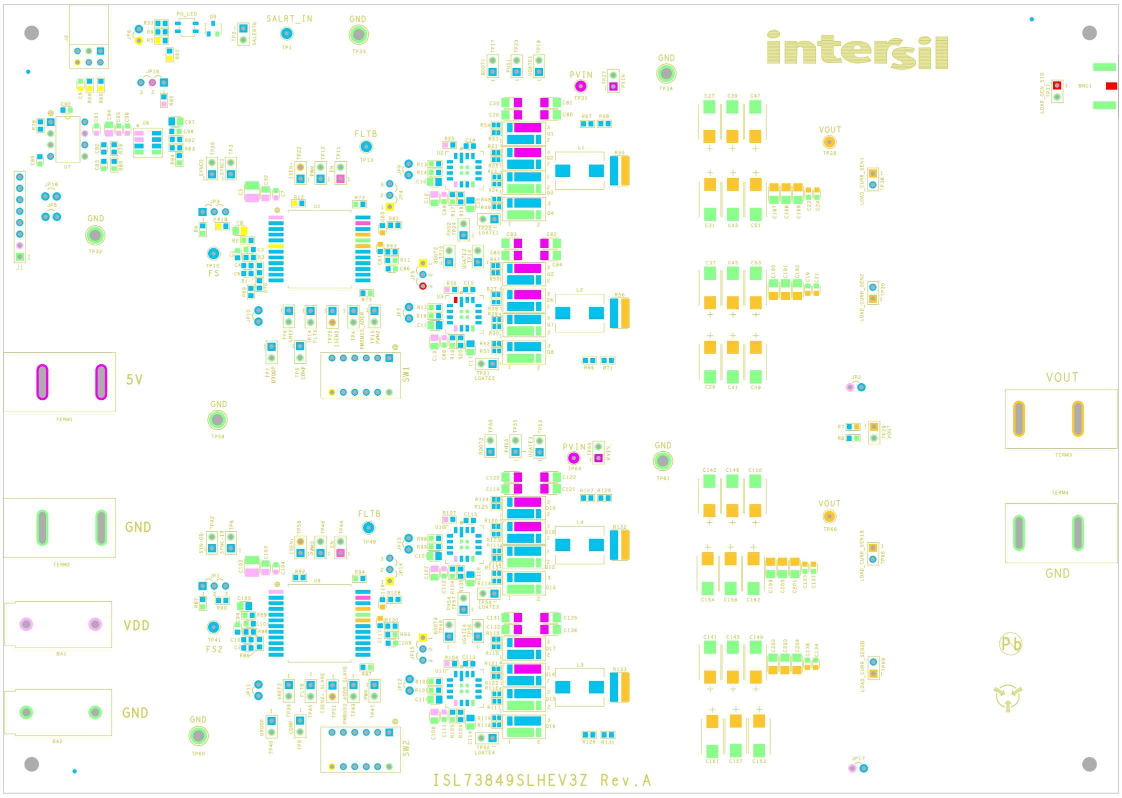


Figure 18. Silkscreen Top Layer

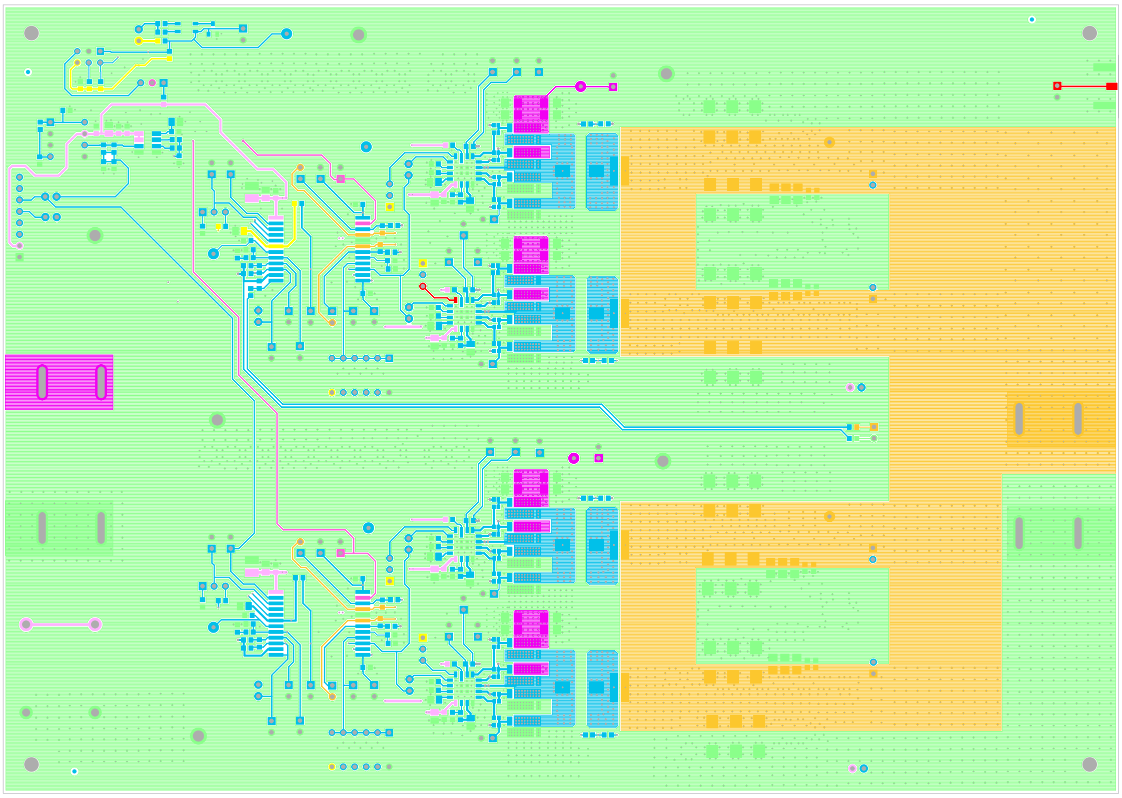


Figure 19. Top Layer

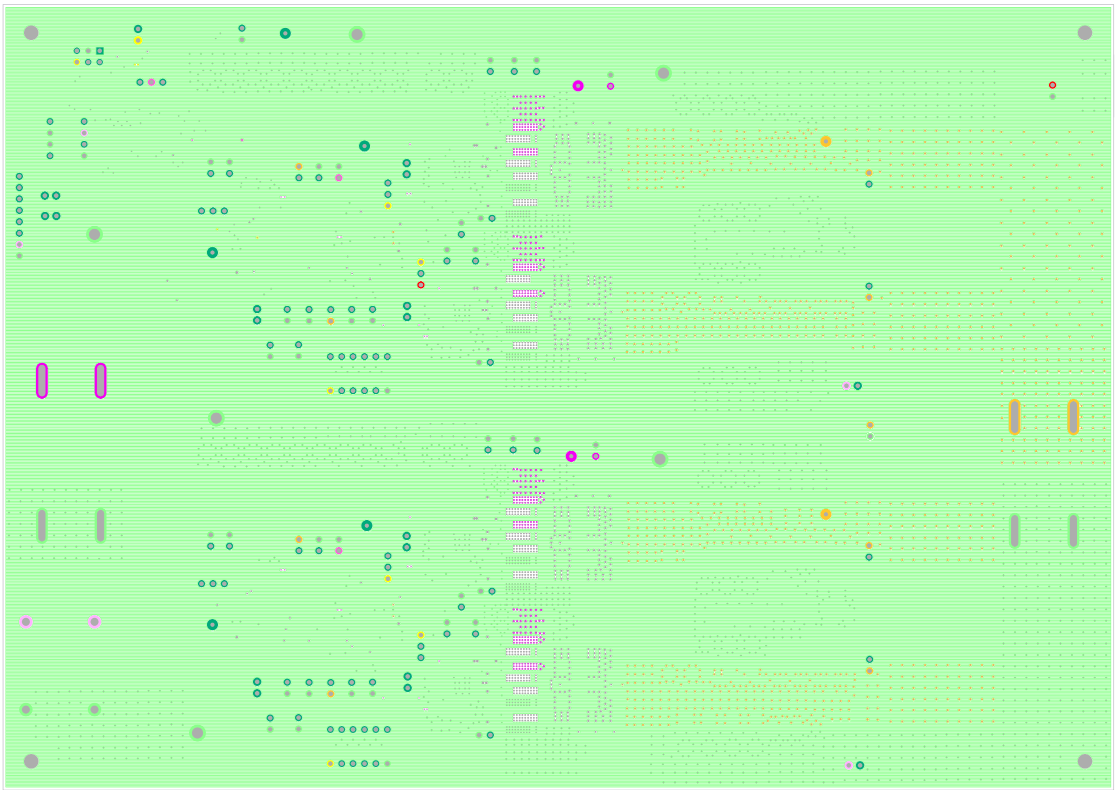


Figure 20. Layer 2

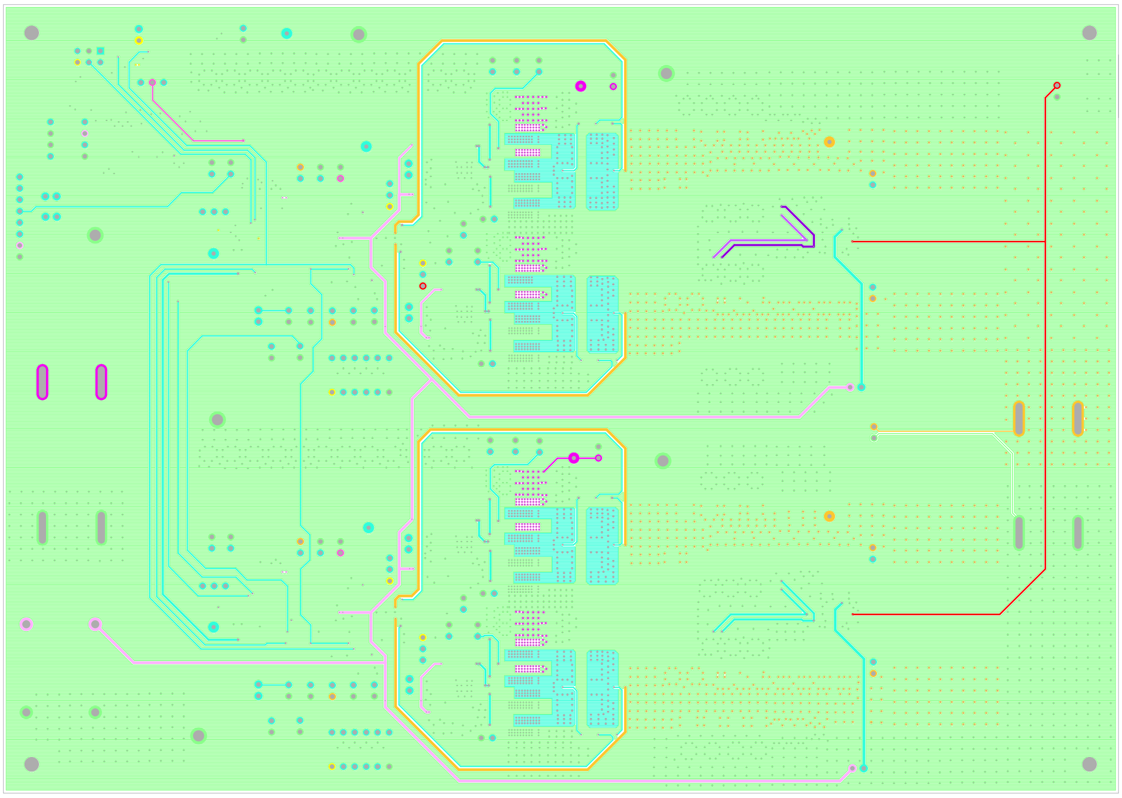


Figure 21. Layer 3

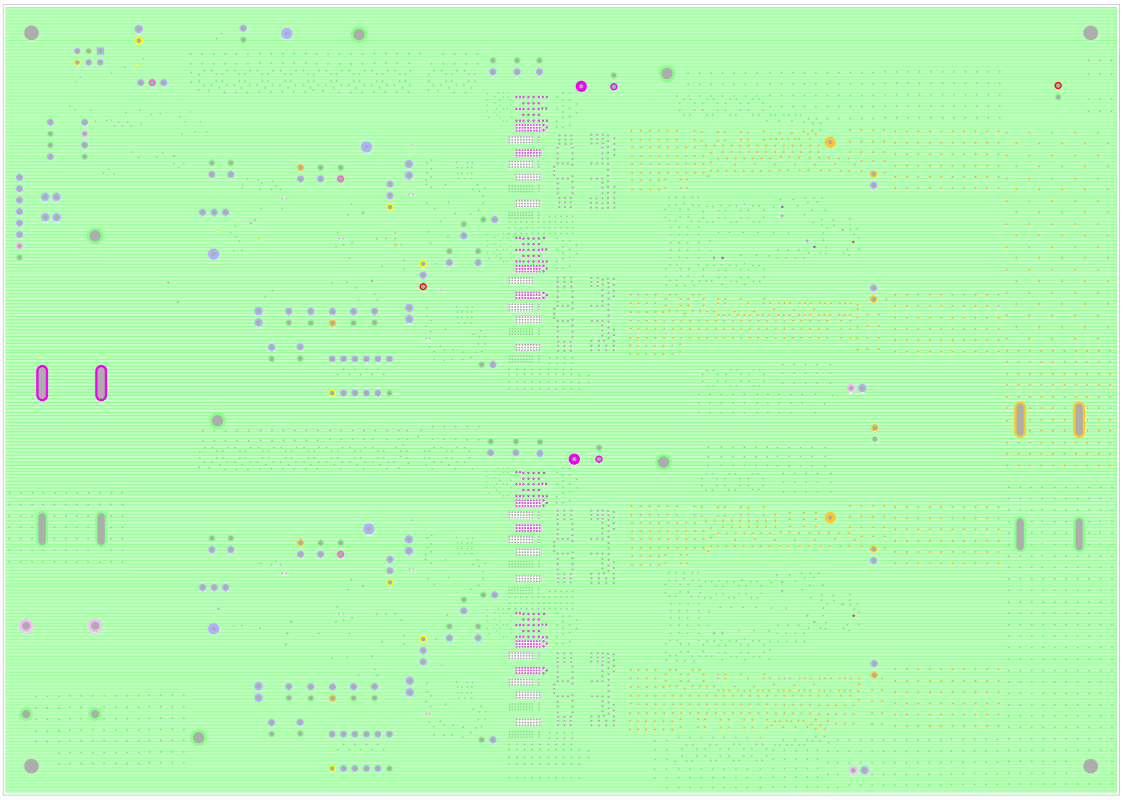


Figure 22. Layer 4

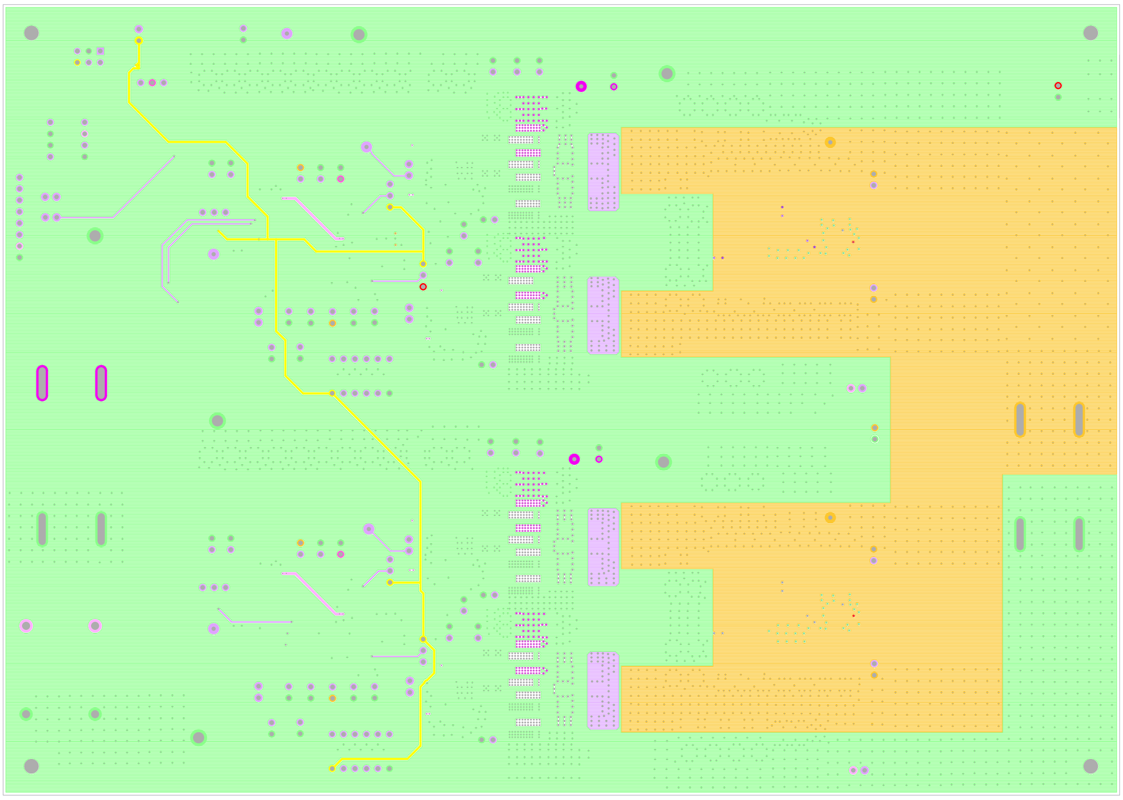


Figure 23. Layer 5

Figure 24. Layer 6

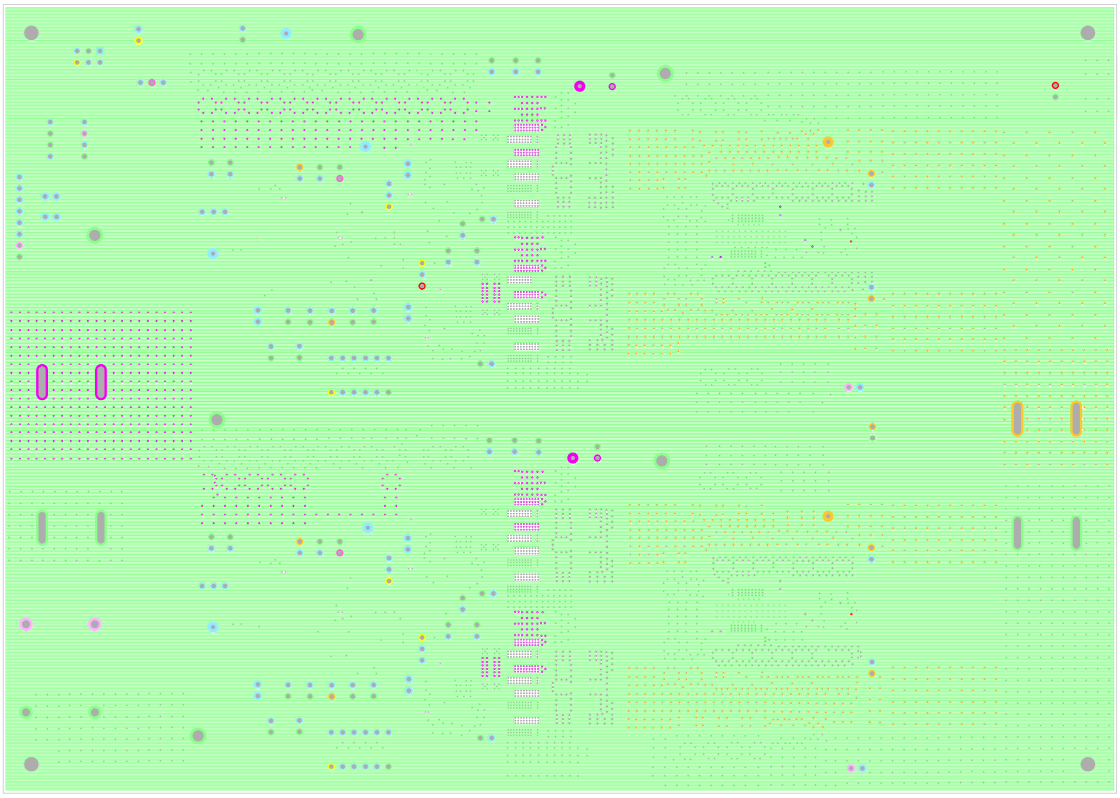


Figure 25. Layer 7

Figure 26. Bottom Layer

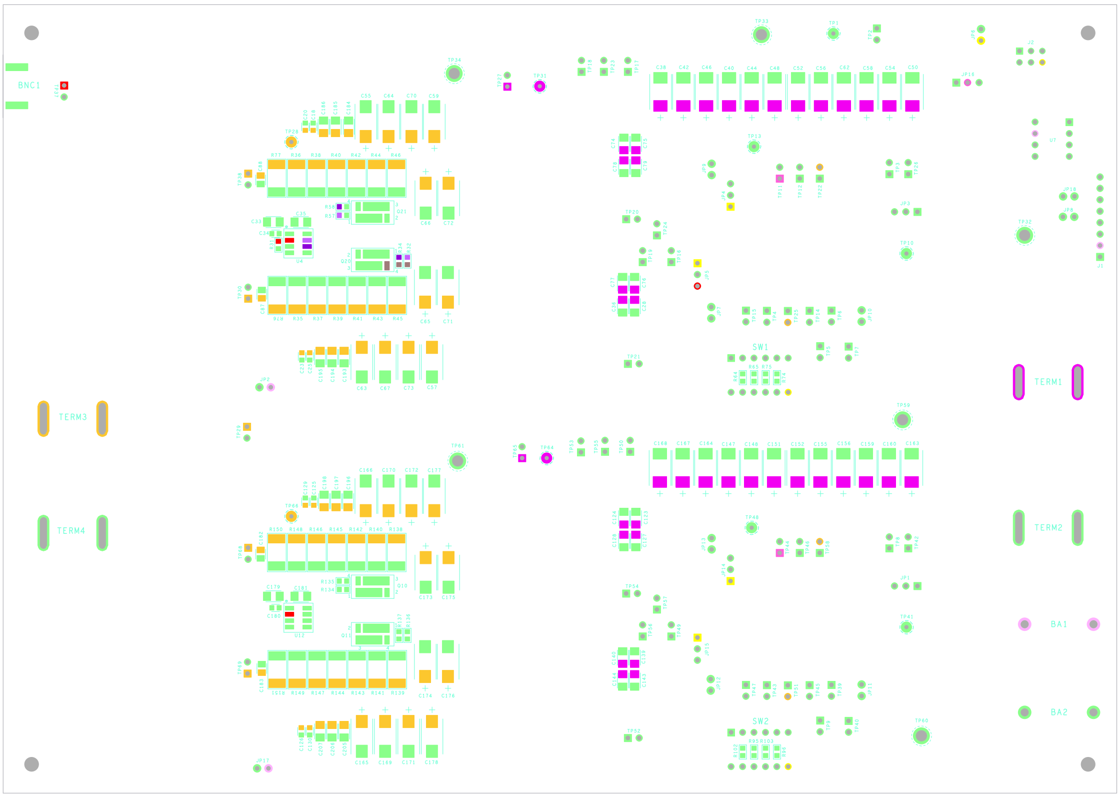
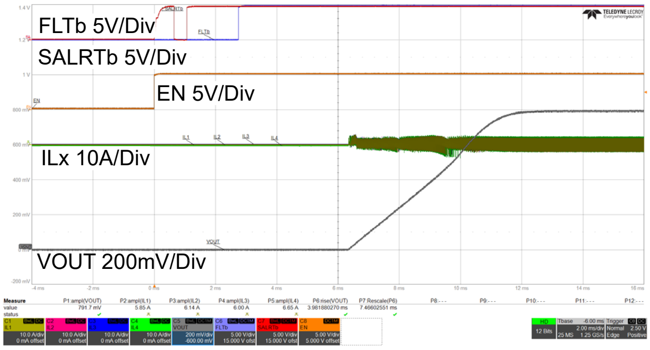


Figure 27. Silkscreen Bottom Layer

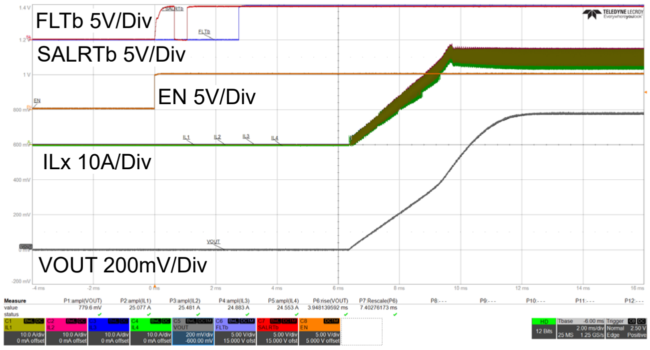
4. Typical Performance Graphs

Unless otherwise noted: V_{DD} = 12V, P_{VIN}= 5V, VREF=0.592V, f_{SW}=1MHz; L_{OUT} = 120nH per phase, C_{OUT} = 1.54mF per phase, C_{DROOP} = 47nF, C_{VREF} = 47nF, R_{DROOP} = 392Ω, R_{FS} = 43.2kΩ, C_{SS} = 22nF, C_{COMP} = 4.7nF, R_{COMP} = 4.22kΩ, C_{POLE} = 330pF, C_{VCC} = 1µF, R_{SLP} = 30.1kΩ, C_{SLP} = 100pF, T_A = +25°C



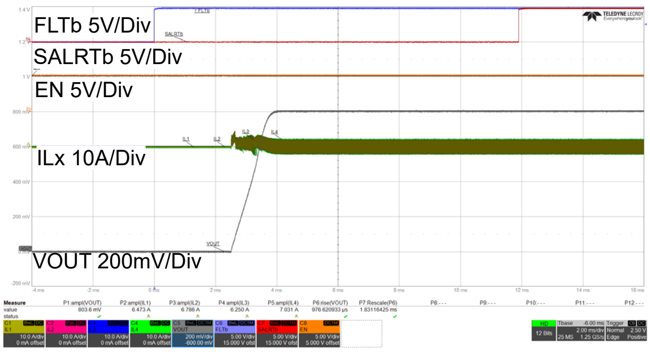
2ms/Div

Figure 28. Soft-Start Enable with the EN pin (I_{LOAD} = 0A)



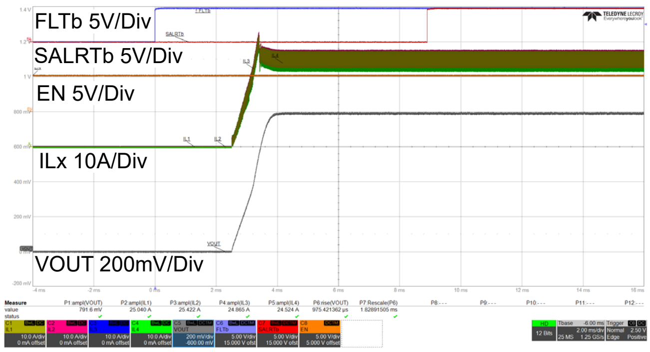
2ms/Div

Figure 29. Soft-Start Enable with the EN pin (I_{LOAD} = 100A)



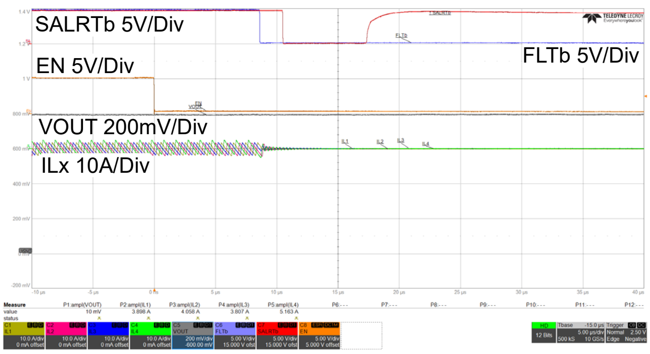
2ms/Div

Figure 30. Soft-Start Enable with the OPERATION Bit (I_{LOAD} = 0A, VREF = 0.6V with VOUT_COMMAND = 0x4Bh, SS = 2ms with SS_CONFIG = 0x01h)



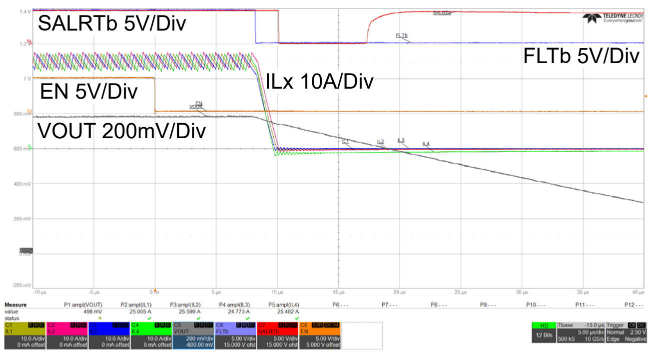
2ms/Div

Figure 31. Soft-Start Enable with the OPERATION Bit (I_{LOAD} = 100A, VREF = 0.6V with VOUT_COMMAND = 0x4Bh, SS = 2ms with SS_CONFIG = 0x01h)



5µs/Div

Figure 32. Shutdown with the EN pin (I_{LOAD} = 0A)



5µs/Div

Figure 33. Shutdown with the EN pin (I_{LOAD} = 100A)

Unless otherwise noted: V_{DD} = 12V, P_{VIN}= 5V, VREF=0.592V, f_{SW}=1MHz; L_{OUT} = 120nH per phase, C_{OUT} = 1.54mF per phase, C_{DROOP} = 47nF, C_{VREF} = 47nF, R_{DROOP} = 392Ω, R_{FS} = 43.2kΩ, C_{SS} = 22nF, C_{COMP} = 4.7nF, R_{COMP} = 4.22kΩ, C_{POLE} = 330pF, C_{VCC} = 1µF, R_{SLP} = 30.1kΩ, C_{SLP} = 100pF, T_A = +25°C (Cont.)

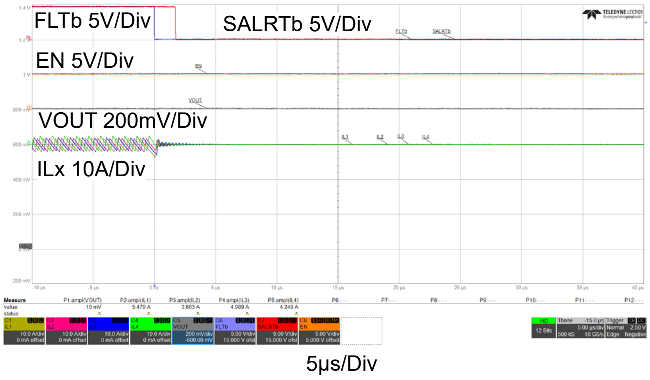


Figure 34. Shutdown with the OPERATION Bit (I_{LOAD} = 0A)

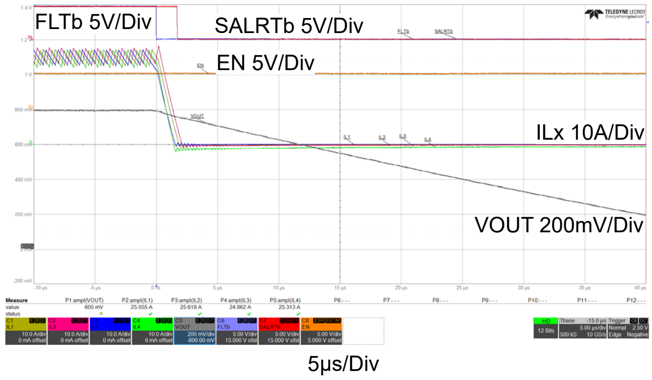


Figure 35. Shutdown with the OPERATION Bit (I_{LOAD} = 100A)

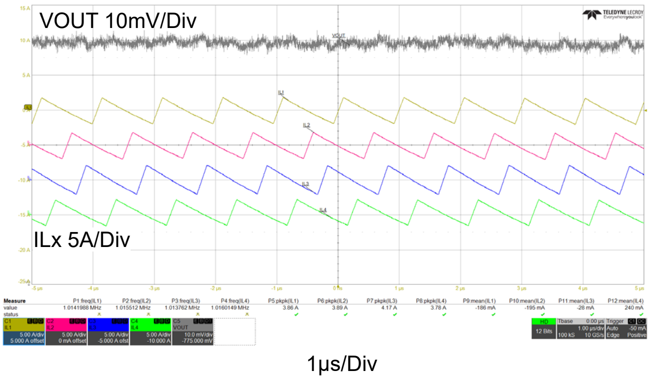


Figure 36. 4-Phase Current Sharing (I_{LOAD} = 0A)

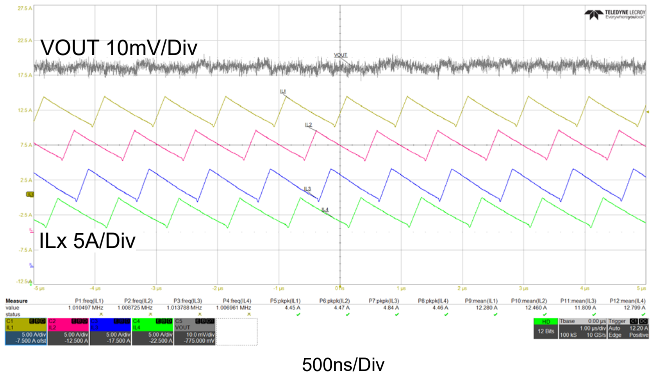


Figure 37. 4-Phase Current Sharing (I_{LOAD} = 50A)

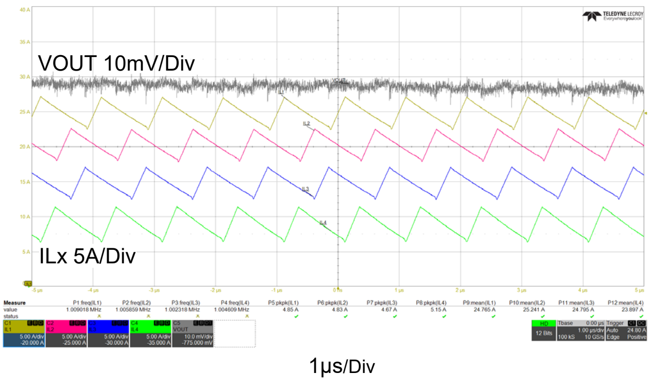


Figure 38. 4-Phase Current Sharing (I_{LOAD} = 100A)

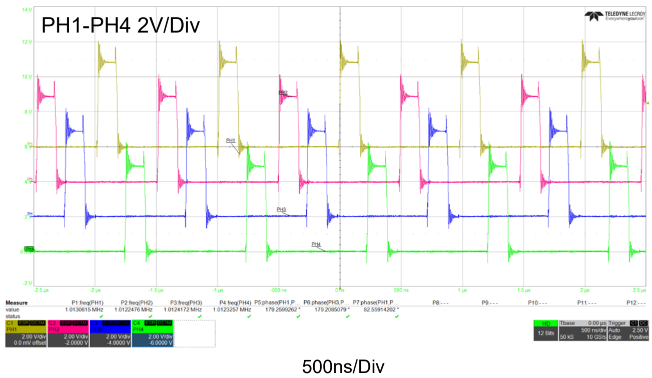


Figure 39. 4-Phase Clock Phase Shifting (I_{LOAD} = 0A)

Unless otherwise noted: V_{DD} = 12V, P_{VIN}= 5V, VREF=0.592V, f_{SW}=1MHz; L_{OUT} = 120nH per phase, C_{OUT} = 1.54mF per phase, C_{DROOP} = 47nF, C_{VREF} = 47nF, R_{DROOP} = 392Ω, R_{FS} = 43.2kΩ, C_{SS} = 22nF, C_{COMP} = 4.7nF, R_{COMP} = 4.22kΩ, C_{POLE} = 330pF, C_{VCC} = 1µF, R_{SLP} = 30.1kΩ, C_{SLP} = 100pF, T_A = +25°C (Cont.)

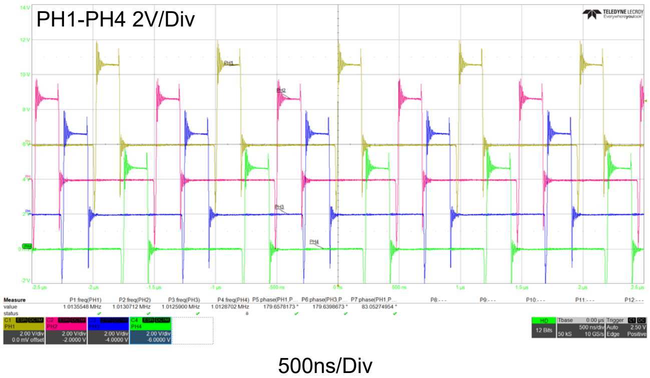


Figure 40. 4-Phase Clock Phase Shifting (I_{LOAD} = 50A)

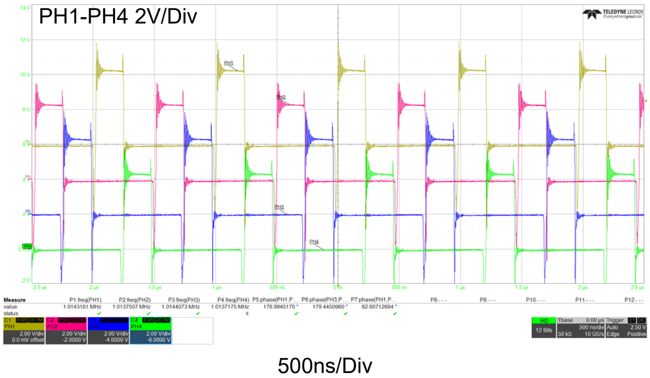


Figure 41. 4-Phase Clock Phase Shifting (I_{LOAD} = 100A)

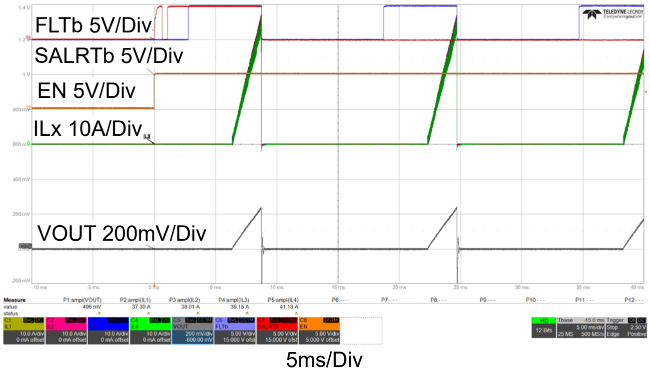


Figure 42. Over-current Protection Fault Response on Power-Up with EN

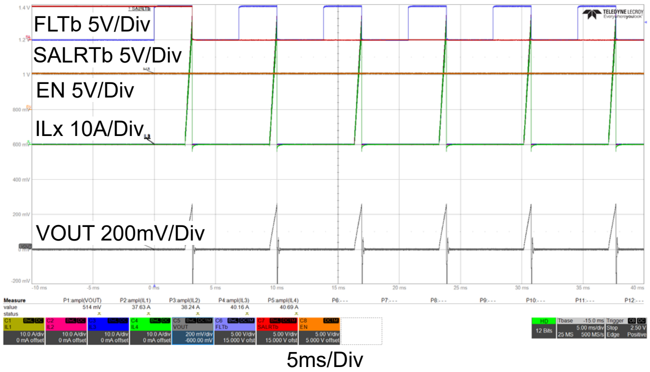


Figure 43. Over-current Protection Fault Response on Power-Up with OPERATION bit (VREF = 0.6V with VOUT_COMMAND = 0x4Bh, SS = 2ms with SS_CONFIG = 0x01h)

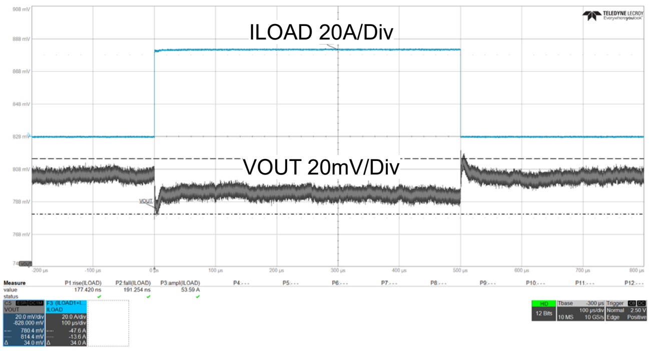


Figure 44. Load Transient with DROOP Regulation (ΔI_{LOAD} = 50A)

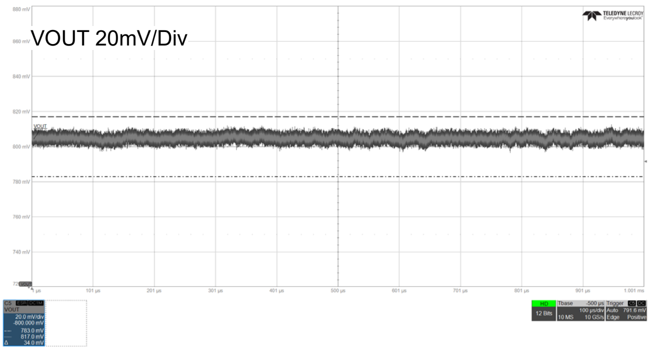


Figure 45. Steady State Output Ripple with ±17mV Compliance Window Shown (I_{LOAD} = 0A)

Unless otherwise noted: V_{DD} = 12V, P_{VIN}= 5V, VREF=0.592V, f_{SW}=1MHz; L_{OUT} = 120nH per phase, C_{OUT} = 1.54mF per phase, C_{DROOP} = 47nF, C_{VREF} = 47nF, R_{DROOP} = 392Ω, R_{FS} = 43.2kΩ, C_{SS} = 22nF, C_{COMP} = 4.7nF, R_{COMP} = 4.22kΩ, C_{POLE} = 330pF, C_{VCC} = 1µF, R_{SLP} = 30.1kΩ, C_{SLP} = 100pF, T_A = +25°C (Cont.)

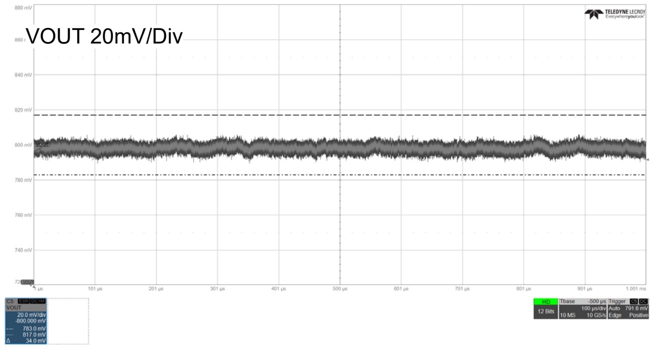


Figure 46. Steady State Output Ripple with ±17mV Compliance Window Shown (I_{LOAD} = 50A)

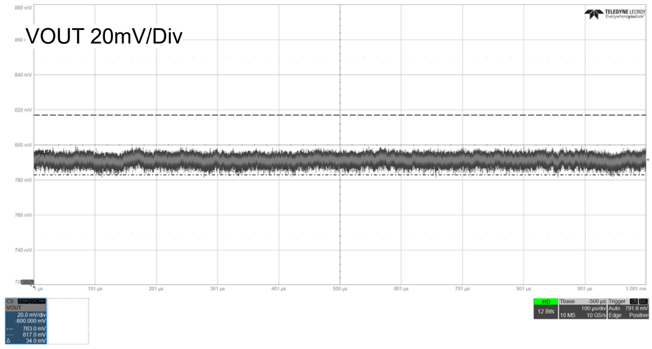


Figure 47. Steady State Output Ripple with ±17mV Compliance Window Shown (I_{LOAD} = 100A)

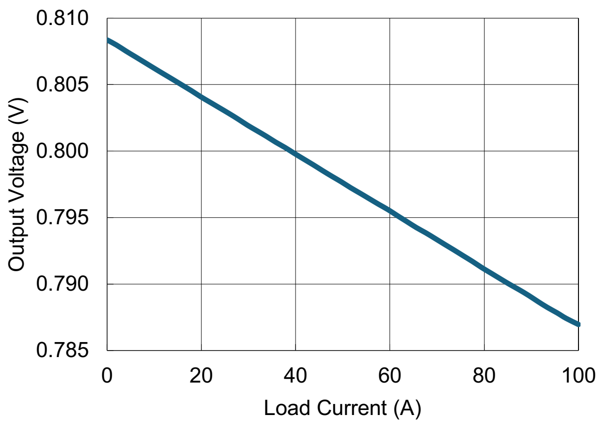


Figure 48. Load Regulation with DROOP

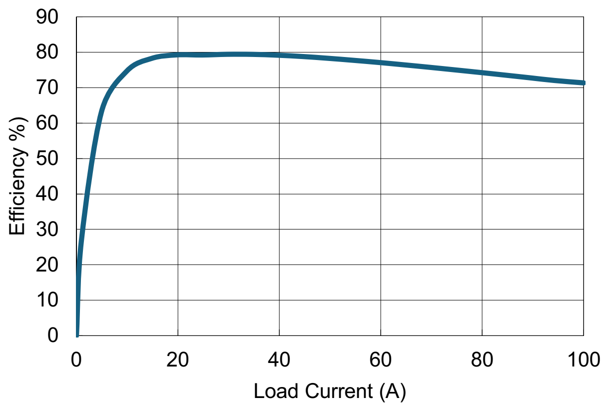


Figure 49. Conversion Efficiency vs Load Current

5. Ordering Information

Part Number	Description
ISL73849SLHEV3Z	4-Phase ISL73849SLH Board

6. Revision History

Revision	Date	Description
1.01	Dec 5, 2025	Updated page 1 content. Updated board photos.
1.00	Oct 17, 2024	Initial release

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www.renesas.com

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