™

# ISL9444EVAL1Z: Triple PWM Step-Down Synchronous Buck Controller

## ISL9444EVAL1Z Evaluation Board

The ISL9444EVAL1Z evaluation board (shown in Figure 1) features the ISL9444. The ISL9444 is a triple-output synchronous buck controller that integrates three PWM controllers. The ISL9444 offers external soft-start, independent enable functions and integrates UV/OV/OC/OT protection. Its current mode control architecture and internal compensation network keep peripheral component count minimal. Programmable switching frequency ranging from 200kHz to 1200kHz helps to optimize inductor size while the strong gate drivers deliver up to 25A for each PWM channel.

## Electrical Rating

The ISL9444EVAL1Z evaluation board is designed for low current application. The current rating of the ISL9444EVAL1Z is limited by the FETs and inductors selected. The ISL9444 gate drivers are capable of delivering up to 25A for each PWM channel as long as the proper FETs and inductors are provided. The electrical ratings of ISL9444EVAL1Z are shown in Table 1.

**TABLE 1. ELECTRICAL RATING**

| PARAMETER | RATING |
|---|---|
| Input Voltage | 6V-20V |
| Switching Frequency | 600kHz |
| PWM1 Output | 1.05V @ max 6A |
| PWM2 Output | 3.3V @ max 6A |
| PWM3 Output | 1.8V @ max 6A |
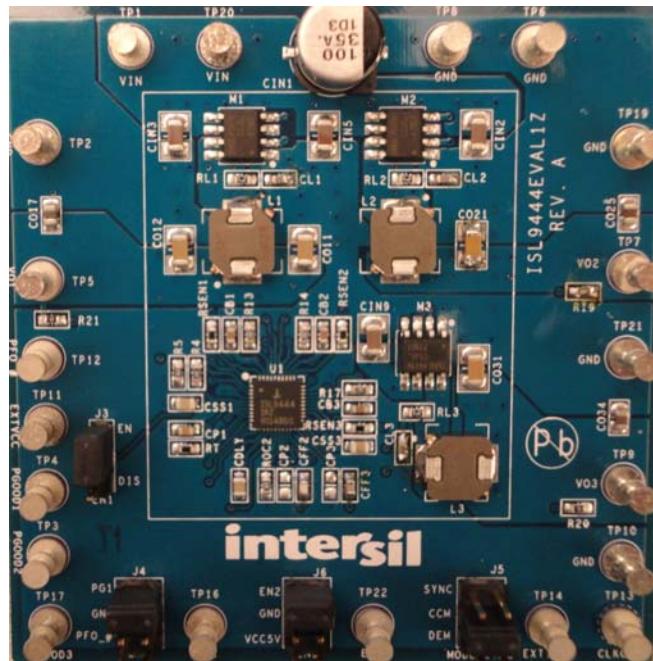


**FIGURE 1. ISL9444EVAL1Z EVALUATION BOARD**

## What's Inside

The Evaluation Board Kit contains the following materials:

- The ISL9444EVAL1Z
- The ISL9444 datasheet
- This EVAL KIT document

## Recommended Testing Equipment

The following materials are recommended to perform testing:

- 0V to 20V Power Supply with at least 10A Source Current Capability
- Three Electronic Loads Capable of Sinking Current up to 7A
- Digital Multimeters (DMMs)
- 100MHz Quad-Trace Oscilloscope

## Quick Test Guide

1. ISL9444 has a total of three PWM outputs. Jumpers J3, J4 and J6 provide rich options to control these three PWM outputs. Please refer to Table 2 for the desired operating option. The default option is to enable PWM1 when VCC5V is ready and then enable PWM2 and PWM3 simultaneously after PWM1 finishes start-up (i.e., PGOOD1 is high).

2. Ensure that the circuit is correctly connected to the supply and electronic loads prior to applying any power. Please refer to Figure 2 for proper set-up.

3. Turn on the power supply.

4. Adjust input voltage VIN within the specified range and observe output voltage. The output voltage variation should be within 3%.

5. Adjust load current within the specified range and observe output voltage. The output voltage variation should be within 3%.

6. Use an oscilloscope to observe output voltage ripple and Phase node ringing. For accurate measurement, please refer to Figure 3 for proper test set-up.

**TABLE 2.**

| JUMPER # | POSITION | FUNCTION |
|---|---|---|
| J3 | EN (Pin 1-2) | Enable PWM1 when VCC5V is ready. |
| | DIS (Pin 2-3) | Disable PWM1 |
| J4 | PG1 (Pin 1-2) | Enable PWM2 when PGOOD1 is high. If this option is chosen, PWM2 will be enabled after PWM1 finishes start-up. |
| | GND (Pin 3-4) | Disable PWM2 |
| | PFO_# (Pin 5-6) | Enable PWM2 when PFI is high. In the ISL9444EVAL1Z, PFI is connected to the input voltage through a resistor divider. If this option is chosen, PWM2 will be enabled when the input voltage is around 6.4V |
| J6 | EN2 (Pin 1-2) | Enable PWM3 when EN2 is high. In this option, PWM3 is tracking with PWM2. |
| | GND (Pin 3-4) | Disable PWM3 |
| | VCC5V (Pin 5-6) | Enable PWM3 when VCC5V is ready. |
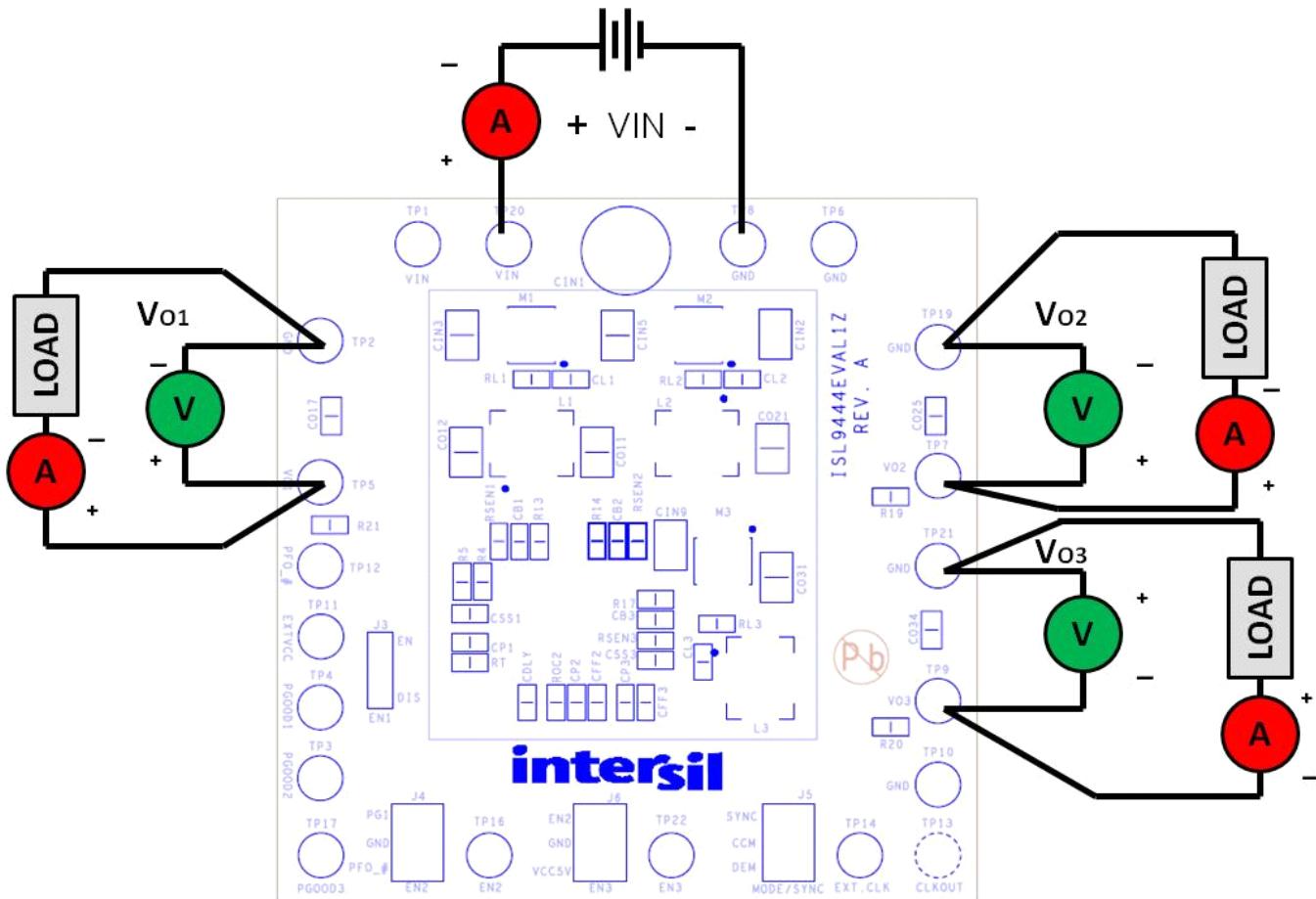
**FIGURE 2. PROPER TEST SET-UP**
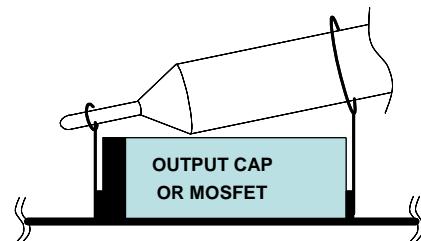


**FIGURE 3. PROPER PROBE SET-UP TO MEASURE OUTPUT RIPPLE AND PHASE NODE RINGING**

# Typical Evaluation Board Performance Curves $V_{IN}$ = 12V, unless otherwise noted.
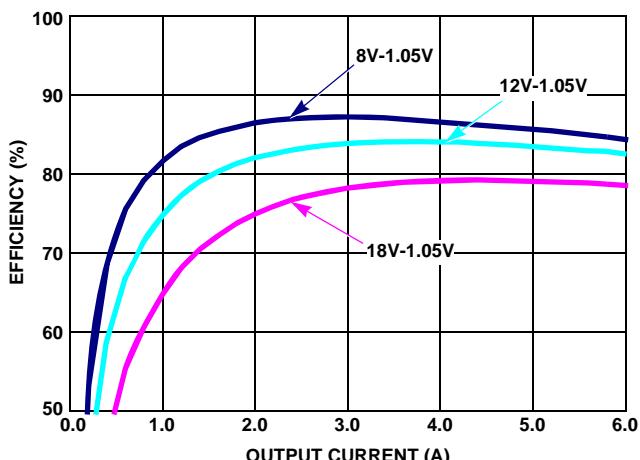


FIGURE 4. PWM1 EFFICIENCY vs LOAD ($V_O$ = 1.05V)
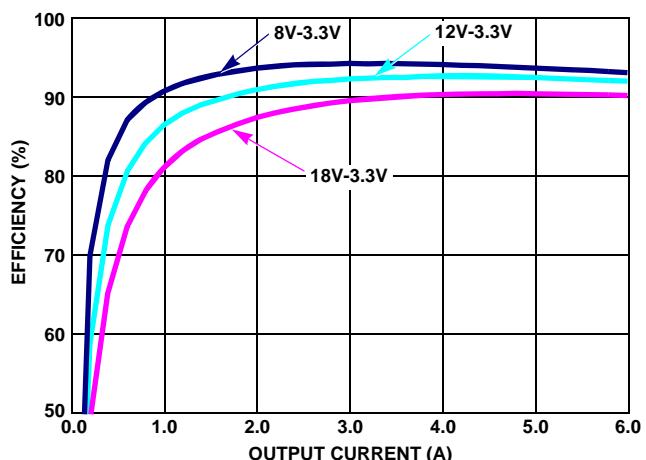


FIGURE 5. PWM2 EFFICIENCY vs LOAD ($V_O$ = 3.3V)
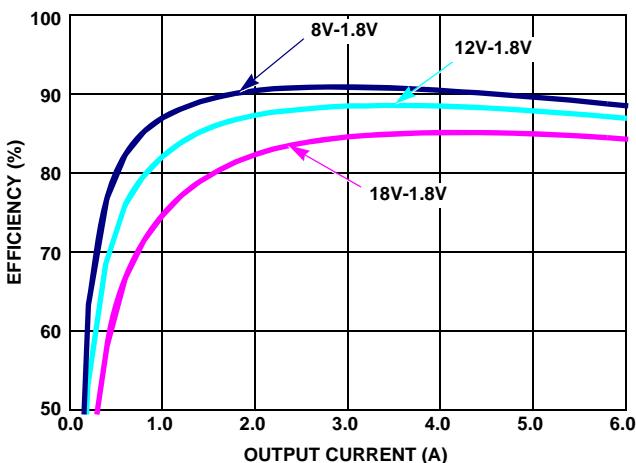


FIGURE 6. PWM3 EFFICIENCY vs LOAD ($V_O$ = 1.8V)
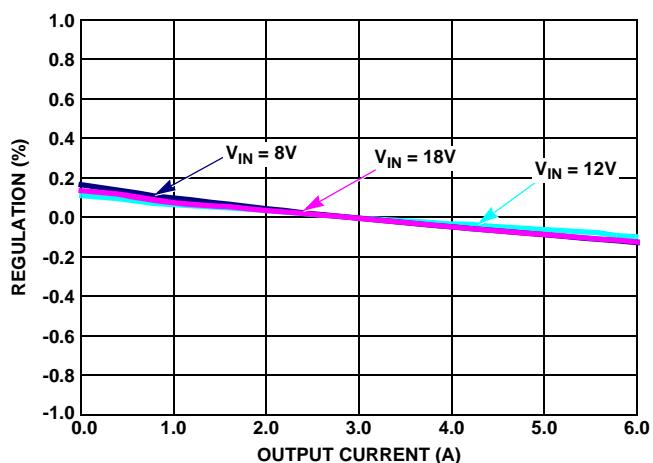


FIGURE 7. PWM1 LOAD REGULATION CURVES
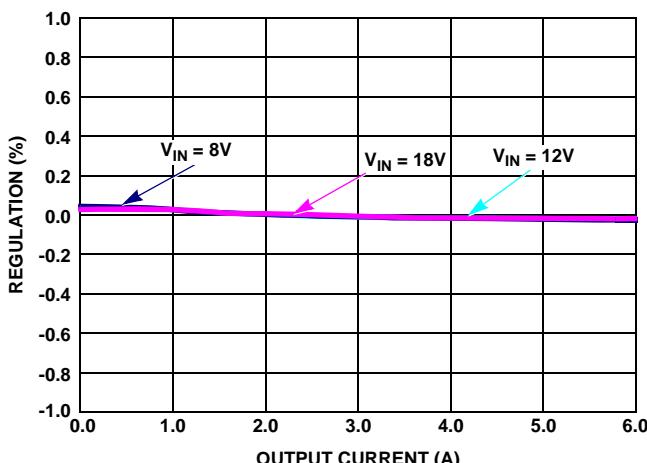


FIGURE 8. PWM2 LOAD REGULATION CURVES
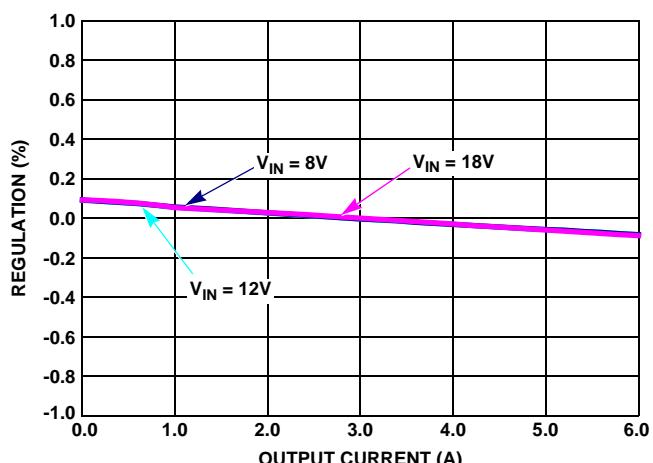


FIGURE 9. PWM3 LOAD REGULATION CURVES

# Typical Evaluation Board Performance Curves $V_{IN}$ = 12V, unless otherwise noted. (Continued)
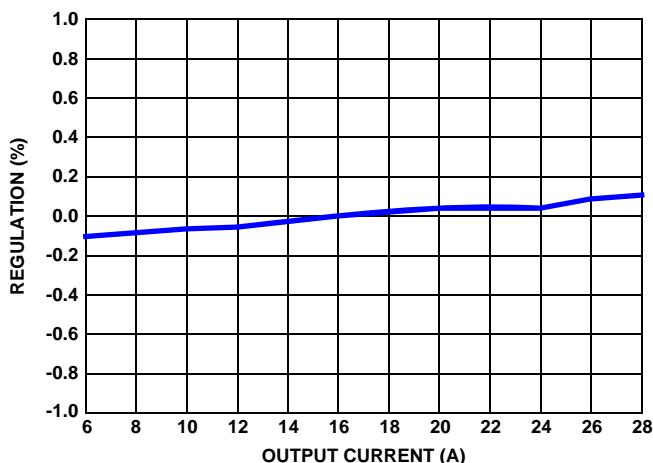


FIGURE 10.  PWM1 LINE REGULATION CURVE
($V_{IN}$ = 12V, $I_{01}$ = $I_{02}$ = $I_{03}$ = 6A)
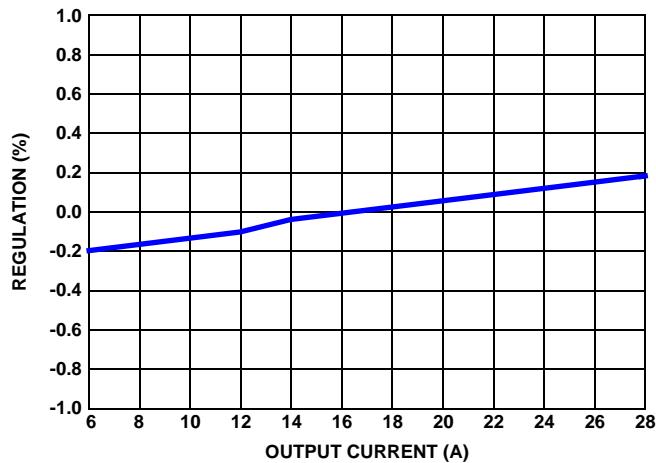


FIGURE 11.  PWM2 LINE REGULATION CURVE
($V_{IN}$ = 12V, $I_{01}$ = $I_{02}$ = $I_{03}$ = 6A)
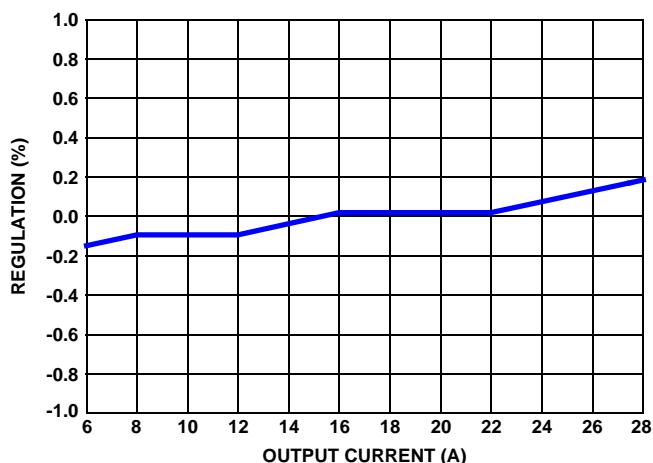


FIGURE 12.  PWM3 LINE REGULATION CURVE
($V_{IN}$ = 12V, $I_{01}$ = $I_{02}$ = $I_{03}$ = 6A)
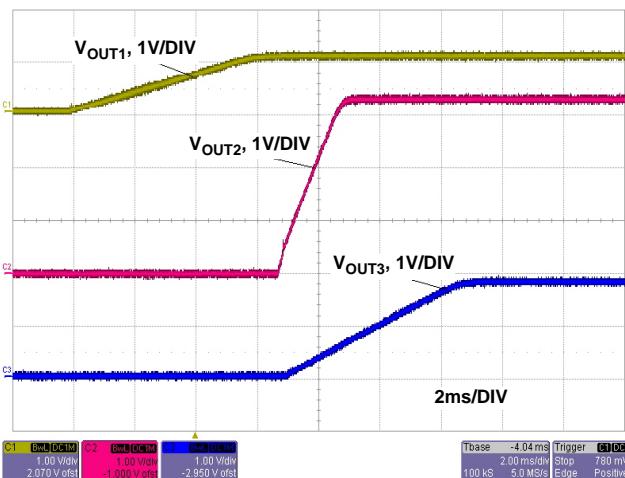


FIGURE 13.  SOFT-START CURVES
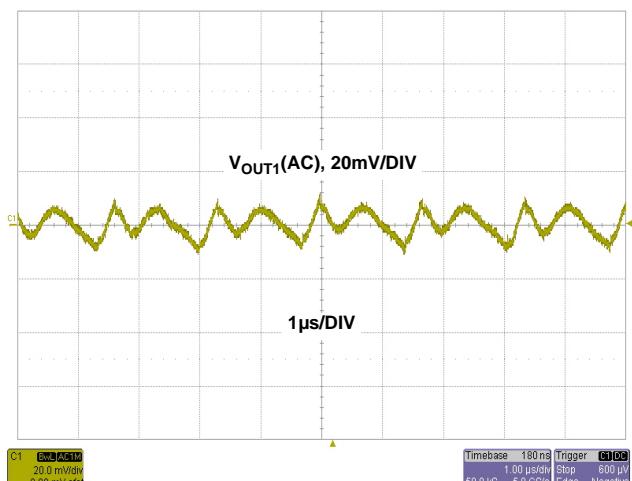


FIGURE 14.  PWM1 OUTPUT RIPPLE UNDER MAX LOAD
($V_{IN}$ = 12V, $I_{01}$ = $I_{02}$ = $I_{03}$ = 6A)



FIGURE 15.  PWM2 OUTPUT RIPPLE UNDER MAX LOAD
($V_{IN}$ = 12V, $I_{01}$ = $I_{02}$ = $I_{03}$ = 6A)

## Typical Evaluation Board Performance Curves $V_{IN}$ = 12V, unless otherwise noted. (Continued)



**FIGURE 16. PWM3 OUTPUT RIPPLE UNDER MAX LOAD ($V_{IN}$ = 12V, $I_{O1}$ = $I_{O2}$ = $I_{O3}$ = 6A)**

# Schematic

7V to 16V

1.05V @6A

3.3V @6A

1.8V @6A

U1 ISL9444

**Pin labels (left side):**
- 1 PFO_N
- 2 PFI
- 3 EXTBIAS
- 4 VCC_5V
- 5 VIN
- 6 EN/SS1
- 7 FB1
- 8 OCSET1
- 9 RT
- 10 PGOOD1

**Pin labels (right side):**
- 30 CLKOUT
- 29 PGND
- 28 LGATE3
- 27 UGATE3
- 26 BOOT3
- 25 PHASE3
- 24 ISEN3
- 23 MODE/SYNC
- 22 EN3
- 21 TK/SS3

**Pin labels (top):**
- 40 ISEN1
- 39 PHASE1
- 38 BOOT1
- 37 UGATE1
- 36 LGATE1
- 35 LGATE2
- 34 UGATE2
- 33 BOOT2
- 32 PHASE2
- 31 ISEN2

**Pin labels (bottom):**
- 41 PAD
- 11 PGOOD2
- 12 PGOOD3
- 13 PG3_DLY
- 14 EN2
- 15 SGND
- 16 OCSET2
- 17 FB2
- 18 TK/SS2
- 19 OCSET3
- 20 FB3

**Test points:** TP1 VIN, TP20 VIN, TP21 GND, TP2 VIN-, TP5 VO1, TP6 GND, TP7 VO2, TP8 GND, TP19 GND, TP9 VO3, TP10 GND, TP11 ExtVCC, TP12 PFO_N, TP13 CLKOUT, TP14 Ext. Clock, TP16 EN2, TP17 PGOOD3, TP3 PGOOD2, TP4 PGOOD1, TP22 EN3

**MOSFETs:** M1 IRF7907, M2 IRF7907, M3 IRF7907

**Inductors:** L1 1.0u (TDK, SPM6530T-1R0M120), L2 1.5u (SPM6530T-1R5M100), L3 1.5u (SPM6530T-1R5M100)

J3 EN1: ENABLE / EN/SS1 / DISABLE

J5 MODESYNC: SYNC / CCM / DEM — MODE/SYNC

J4: PFO_N, DISABLE, PGOOD1

J6: VCC5V, DISABLE, EN2 — EN3

R19, R20, R21 and R23 are for EVAL board testing only.
They are not necessary in end applications.

PWM3 is configured to track the VO2 by default.

**Selected component values:**
CIN1 100u 35V, CIN2 10uF 25V, CIN3 10uF 25V, CIN5 10u 25V, CIN4 DNP 25V, CIN6 DNP 25V, CIN7 DNP 25V, CIN8 DNP 25V, CIN9 DNP 25V, CIN10 DNP 25V
CO18 DNP 6.3V, CO13 DNP 6.3V, CO15 DNP 6.3V, CO12 47u 6.3V, CO19 DNP 6.3V, CO17 10u 6.3V, CO16 DNP 6.3V, CO14 DNP 6.3V, CO11 47u 6.3V
CO21 47u 6.3V, CO22 DNP 6.3V, CO23 DNP, CO24 DNP, CO25 10u
CO31 47u 6.3V, CO32 DNP 6.3V, CO33 DNP 6.3V, CO34 10uF 6.3V
CBIAS 1u 16V, CFIN 0.47u 35V, CVCC1 4.7u 16V, Css1 10n
CB1 0.1u 16V, CB2 0.1u 16V, CB3 0.1u 16V
CL1 820p, CL2 820p, CL3 820pF
RL1 1.2, RL2 1.2, RL3 1.2
R13 2.2, R14 2.2, R17 2.2
Rsen1 1.3K, Rsen2 1.3K, Rsen3 1.0K
R4 51.1K 1%, R5 12.1K 1%, R21 0, R1 15.8K 1%, R23 0, R22 DNP, R2 31.6K 1%
Cff1 470pF, Cff4 DNP, Cp1 820p, RT 49.9K
ROC1 80.6K, ROC2 80.6K, ROC3 80.6K
RPG1 100K, RPG2 100K, RPG3 100K
R3 16.5K 1%, Cff3 100p, R6 10.5K 1%, Cp3 DNP, R7 DNP 1%, R9 DNP 1%
CSS2 DNP, CSS3 10n, CDLY 10n
R20 0, R19 0, R8 115K 1%, Cff2 47p, Cp2 DNP, R11 30.9k 1%
RFIN 0, VCC5V, SVIN

VIN, VO1, VO2, VO3, PH1, PH2, PH3, PFO_N, PGOOD1, PGOOD2, PGOOD3, MODESYNC, EN2, EN3

# ISL9444EVAL1Z BOM

| PART NUMBER | QTY | UNITS | REFERENCE DESIGNATOR | DESCRIPTION | MANUFACTURER | MANUFACTURER PART |
|---|---|---|---|---|---|---|
| ISL9444EVAL1ZREVAPCB | 1 | ea | | PWB-PCB, ISL9444EVAL1Z, REVA, ROHS | IMAGINEERING INC | ISL9444EVAL1ZREVAPCB |
| H1045-00101-50V5-T | 1 | ea | CFF3 | CAP, SMD, 0603, 100pF, 50V, 5%, C0G, ROHS | PANASONIC | ECJ-1VC1H101J |
| H1045-00104-50V10-T | 3 | ea | CB1, CB2, CB3 | CAP, SMD, 0603, 0.1µF, 50V, 10%, X7R, ROHS | TDK | C1608X7R1H104K |
| H1045-00105-50V10-T | 1 | ea | CBIAS | CAP, SMD, 0603, 1µF, 50V, 10%, X5R, ROHS | TDK | C1608X5R1H105K |
| H1045-00470-50V5-T | 1 | ea | CFF2 | CAP, SMD, 0603, 47pF, 50V, 5%, C0G, NP0, ROHS | AVX | 06035A470JAT2A |
| H1045-00471-50V10-T | 1 | ea | CFF1 | CAP, SMD, 0603, 470pF, 50V, 10%, X7R, ROHS | VENKEL | C0603X7R500-471KNE |
| H1045-00474-50V10-T | 1 | ea | CFIN | CAP, SMD, 0603, 0.47µF, 50V, 10%, X7R, ROHS | TDK | C1608X7R1H474K |
| H1045-00821-50V10-T | 1 | ea | CP1 | CAP, SMD, 0603, 820pF, 50V, 10%, X7R, ROHS | KEMET | C0603C821K5RACTU |
| H1045-00821-50V5-T | 3 | ea | CL1, CL2, CL3 | CAP, SMD, 0603, 820pF, 50V, 5%, C0G, ROHS | KEMET | C0603C821J5GACTU |
| H1046-00103-16V10-T | 3 | ea | CSS1, CSS3, CDLY | CAP, SMD, 0805, 0.01µF, 16V, 10%, X7R, ROHS | KEMET | C0805C103K4RACTU |
| H1046-00106-6R3V10-T | 1 | ea | CO17, CO25, CO34 | CAP, SMD, 0805, 10µF, 6.3V, 10%, X5R, ROHS | VENKEL | C0805X5R6R3-106KNE |
| H1046-00475-16V10-T | 1 | ea | CVCC1 | CAP, SMD, 0805, 4.7µF, 16V, 10%, X5R, ROHS | PANASONIC | ECJ-2FB1C475K |
| H1065-00106-35V10-T | 4 | ea | CIN2, CIN3, CIN5, CIN9 | CAP, SMD, 1206, 10µF, 35V, 10%, X5R, ROHS | VENKEL | C1206X5R350-106KNE |
| H1065-00476-6R3V20-T | 4 | ea | CO11, CO12, CO21, CO31 | CAP, SMD, 1206, 47µF, 6.3V, 20%, X5R, ROHS | MURATA | GRM31CR60J476ME19L |
| EEE-1VA101UAP-T | 1 | ea | CIN1 | CAP, SMD, 8x10.2, 100µF, 35V, 20%, ALUM.ELEC., ROHS | PANASONIC | EEE-1VA101UAP |
| SPM6530T-1R0M120-T | 1 | ea | L1 | COIL-PWR INDUCTOR, SMD, 7.1x6.5, 1.0µH, 20%, 12A, ROHS | TDK | SPM6530T-1R0M120 |
| SPM6530T-1R5M100-T | 2 | ea | L2, L3 | COIL-PWR INDUCTOR, SMD, 7.1x6.5, 1.5µH, 20%, 11A, ROHS | TDK | SPM6530T-1R5M100 |
| 1514-2 | 20 | ea | TP1-TP14, TP17, TP16, TP19, TP20, TP21, TP22 | CONN-TURRET, TERMINAL POST, TH, ROHS | KEYSTONE | 1514-2 |
| 67996-272HLF-2X3 | 3 | ea | J4, J5, J6 | CONN-HEADER, 2x3, BREAKAWY 2x36, 2.54mm, VERTICAL, ROHS | BERG/FCI | 67996-272HLF |
| 68000-236HLF-1X3 | 1 | ea | J3 | CONN-HEADER, 1x3, BREAKAWY 1x36, 2.54mm, ROHS | BERG/FCI | 68000-236HLF |
| SPC02SYAN | 4 | ea | J3, J4, J5, J6 | CONN-JUMPER, SHORTING, 2PIN, BLACK, GOLD, ROHS | SULLINS | SPC02SYAN |
| ISL9444IRZ | 1 | ea | U1 | IC-STEP-DOWN CONTROLLER, 40P, QFN, 5x5, ROHS | INTERSIL | ISL9444IRZ |
| IRF7907PBF | 3 | ea | M1, M2, M3 | TRANSIST-DUALMOS, N-CHANNEL, 8P, SOIC, 30V, 9.1A, ROHS | INTERNATIONAL RECTIFIER | IRF7907PBF |
| H2511-001R2-1/10W1-T | 3 | ea | RL1, RL2, RL3 | RES, SMD, 0603, 1.2Ω, 1/10W, 1%, TF, ROHS | PANASONIC | ERJ-3RQF1R2V |

## ISL9444EVAL1Z BOM (Continued)

| PART NUMBER | QTY | UNITS | REFERENCE DESIGNATOR | DESCRIPTION | MANUFACTURER | MANUFACTURER PART |
|---|---|---|---|---|---|---|
| H2511-002R2-1/10W1-T | 3 | ea | R13, R14, R17 | RES, SMD, 0603, 2.2Ω, 1/10W, 1%, TF, ROHS | PANASONIC | ERJ-3RQF2R2V |
| H2511-00R00-1/10W-T | 5 | ea | RFIN, R21, R23, R19, R20 | RES, SMD, 0603, 0Ω, 1/10W, TF, ROHS | VENKEL | CR0603-10W-000T |
| H2511-01001-1/10W1-T | 1 | ea | RSEN3 | RES, SMD, 0603, 1k, 1/10W, 1%, TF, ROHS | PANASONIC | ERJ-3EKF1001V |
| H2511-01003-1/10W1-T | 3 | ea | RPG1, RPG2, RPG3 | RES, SMD, 0603, 100k, 1/10W, 1%, TF, ROHS | VENKEL | CR0603-10W-1003FT |
| H2511-01052-1/10W1-T | 1 | ea | R6 | RES, SMD, 0603, 10.5k, 1/10W, 1%, TF, ROHS | YAGEO | RC0603FR-0710K5L |
| H2511-01153-1/10W1-T | 1 | ea | R8 | RES, SMD, 0603, 115k, 1/10W, 1%, TF, ROHS | PANASONIC | ERJ-3EKF1153V |
| H2511-01212-1/10W1-T | 1 | ea | R5 | RES, SMD, 0603, 12.1k, 1/10W, 1%, TF, ROHS | VENKEL | CR0603-10W-1212FT |
| H2511-01301-1/10W1-T | 2 | ea | RSEN1, RSEN2 | RES, SMD, 0603, 1.3k, 1/10W, 1%, TF, ROHS | VISHAY/DALE | CRCW06031K30FKTA |
| H2511-01582-1/10W1-T | 1 | ea | R1 | RES, SMD, 0603, 15.8 k, 1/10W, 1%, TF, ROHS | VENKEL | CR0603-10W-1582FT |
| H2511-01652-1/10W1-T | 1 | ea | R3 | RES, SMD, 0603, 16.5k, 1/10W, 1%, TF, ROHS | PANASONIC | ERJ-3EKF1652V |
| H2511-03092-1/10W1-T | 1 | ea | R11 | RES, SMD, 0603, 30.9k, 1/10W, 1%, TF, ROHS | YAGEO | RC0603FR-0730K9L |
| H2511-03162-1/10W1-T | 1 | ea | R2 | RES, SMD, 0603, 31.6k, 1/10W, 1%, TF, ROHS | VISHAY | CRCW06033162F |
| H2511-04992-1/10W1-T | 1 | ea | RT | RES, SMD, 0603, 49.9k, 1/10W, 1%, TF, ROHS | VENKEL | CR0603-10W-4992FT |
| H2511-05112-1/10W1-T | 1 | ea | R4 | RES, SMD, 0603, 51.1k, 1/10W, 1%, TF, ROHS | VENKEL | CR0603-10W-5112FT |
| H2511-08062-1/10W1-T | 3 | ea | ROC1, ROC2, ROC3 | RES, SMD, 0603, 80.6k, 1/10W, 1%, TF, ROHS | PANASONIC | ERJ-3EKF8062V |
| 5X8-STATIC-BAG | 1 | ea | Place assy in bag | BAG, STATIC, 5x8, ZIPLOC, ROHS | INTERSIL | 212403-013 |
| DNP | 0 | ea | R7, R9, R22 | DO NOT POPULATE OR PURCHASE | | |
| DNP | 0 | ea | a) CFF4, CIN4, CIN6, CIN7, CIN8, CIN10 | DO NOT POPULATE OR PURCHASE | | |
| DNP | 0 | ea | b) CP2, CP3, CSS2, C013, -C016, C018 | DO NOT POPULATE OR PURCHASE | | |
| DNP | 0 | ea | c) C019, C022, C023, C024, C032, C033 | DO NOT POPULATE OR PURCHASE | | |
| LABEL-DATE CODE | 1 | ea | | LABEL-FOR DATE CODE AND BOM REV # | INTERSIL | LABEL-DATE CODE |

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# ISL9444EVAL1Z PCB Layout
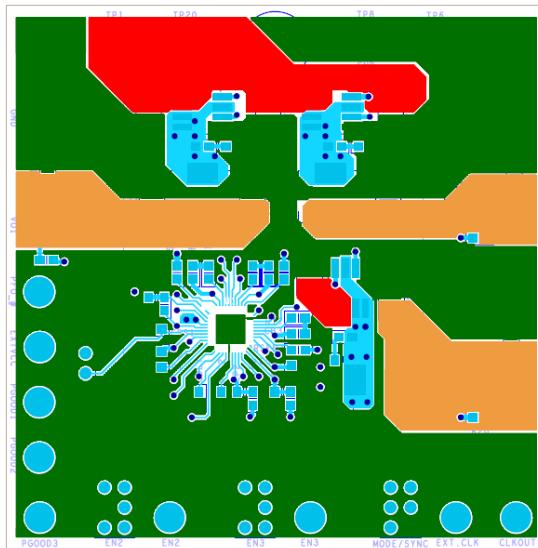
FIGURE 17.  TOP LAYER
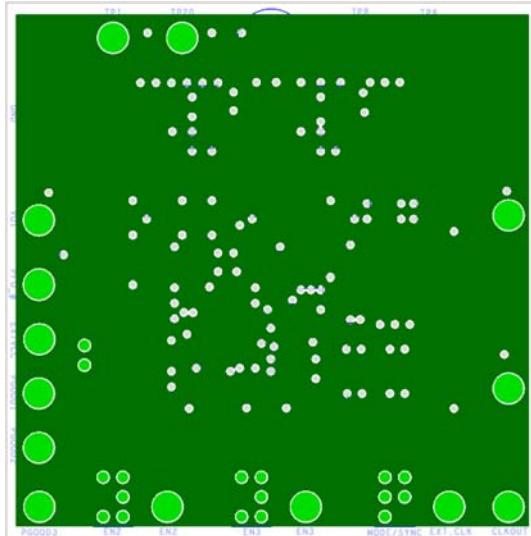


FIGURE 18.  SECOND LAYER (SOLID GROUND)
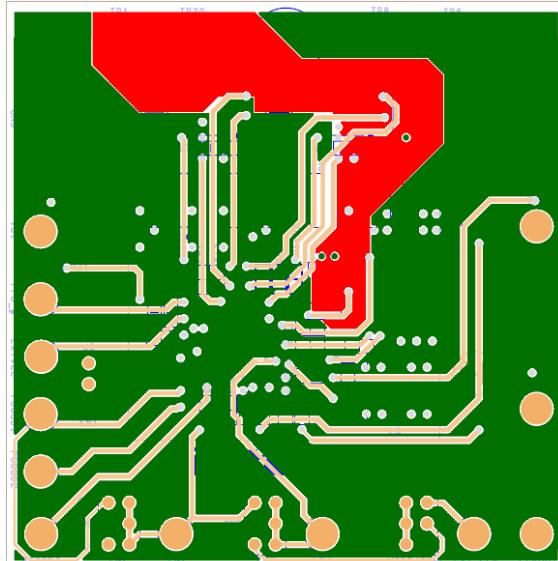


FIGURE 19.  THIRD LAYER



FIGURE 20.  BOTTOM LAYER