ISL8016CIR1EVAL1Z

6A Low Quiescent Current High Efficiency Synchronous Buck Regulator

AN1630
Rev 1.00
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Description

The ISL8016CIR1EVAL1Z kit is intended for use by individuals with requirements for Point-of-Load applications sourcing from 2.7V to 5.8V. The ISL8016CIR1EVAL1Z simple smallest factor evaluation board is used for a quick and easy demonstration of the performance of the ISL8016 low quiescent high efficiency synchronous buck regulator.

The ISL8016 is offered in a 3mmx4mm 20 Ld QFN package with 1mm maximum height. The complete converter occupies can be as small as 0.15in^2 area.

Key Features

- High Efficiency Synchronous Buck Regulator with up to 97% Efficiency
- 0.8% Reference Accuracy Over-Temperature/Load/Line
- Fixed Output Voltage Option
- ±10% Output Voltage Margining
- Adjustable Current Limit
- Current Sharing Capable
- Start-up with Pre-Biased Output
- Internal Soft-Start - 1ms or Adjustable
- Soft-Stop Output Discharge During Disabled
- Adjustable Frequency from 500kHz to 4MHz - Default at 1MHz
- External Synchronization up to 4MHz - Master to Slave Phase Shifting Capability

Recommended Equipment

The following materials are recommended to perform testing:

- 0V to 10V Power Supply with at least 10A source current capability or 5V battery
- Electronic Loads capable of sinking current up to 7A
- Digital Multimeters (DMMs)
- 100MHz quad-trace oscilloscope
- Signal generator

Quick Setup Guide

1. Ensure that the circuit is correctly connected to the supply and loads prior to applying any power.
2. Connect the bias supply to VIN, the plus terminal to VIN, J1, and the negative return to PGND, J2.
3. Connect the output load to VOUT, the plus terminal to VOUT1, J3 and the negative return to PGND, J4.
4. Verify that the position is PWM for S1.
5. Verify the position is OPEN for S2 and S3.
6. Verify that the position is ON for S4 and S5.
7. Turn on the power supply.
8. Verify the output voltage is 1.8V for VOUT1.

Evaluating the Other Output Voltage

The ISL8016CIR1EVAL1Z kit output is preset to 1.8V for VOUT1, however, output voltages can be adjusted from 0.6V to 5V. The output voltage programming resistor, R1, will depend on the desired output voltage of the regulator. The value for the feedback resistor is typically between 0Ω and 200kΩ, as shown in Equation 1.

$$R2 = R1\left(\frac{VFB}{VO - VFB}\right) \quad \text{(EQ. 1)}$$

If the output voltage desired is 0.6V, then R2 is left unpopulated and R1 is shorted. For faster response performance, add 10pF to 47pF in parallel to R1. Check bode plot to insure optimum performance.

Frequency Control

ISL8016 has an FS pin that controls the frequency of operation. Programmable frequency allows for optimization between efficiency and external component size. Default switching frequency is 1MHz when FS is tied to VIN (R6 = 0 and R5 is open). By connecting R5 to GND, the switching frequency could be changed from 500kHz (R5 = 390k) to 4MHz (R5 = 40k) according to Equation 2:

$$R_T[k\Omega] = \frac{200 \cdot 10^3}{f_{OSC}[kHz]} - 10 \quad \text{(EQ. 2)}$$

When using R5 to adjust the operational frequency, this also sets external compensation mode. Please refer to the ISL8016 datasheet (FN7616) for more details.

Soft-Start Control

Short CSS1 to SGND for internal soft-start (approximately 1ms). Populate CSS1 to adjust the soft-start time. This capacitor, along with an internal 1.6mA current source, sets the soft-start interval of the converter, t_{SS}.

$$CSS1[\mu F] = 3.33 \cdot t_{SS}[s] \quad \text{(EQ. 3)}$$

CSS must be less than 33nF to insure proper soft-start reset after fault condition.

Synchronization Control

The ISL8016 can be synchronized from 700kHz to 4MHz by an external signal applied to the SYNCIN pin. The rising edge on the SYNCIN triggers the rising edge of the PHASE pulse. Make sure that the minimum on-time of the PHASE node is greater than 140ns.

SYNCOUT is a 250µA current pulse signal output triggered by the rising edge of the clock or the SYNCIN signal (whichever is greater in frequency) to drive the other ISL8016 and avoid the system's beat frequencies effects. To implement time shifting between the master circuit to the slave, it is recommended to add a capacitor, C13 as shown in the schematic. The time delay from SYNCOUT_Master to SYNCIN_Slave is calculated in pF using the following:

$$C_6[pF] = 0.357 \cdot t[ns] \quad \text{(EQ. 4)}$$

Where, t is the desired time shift between the master and the slave circuits in ns. Care must be taken to include PCB parasitic capacitance of ~3pF to 10pF.

The maximum should be limited to 1/Fs-100ns to insure that SYNCOUT has enough time to discharge before the next cycle starts.

Swtiches Control

The ISL8016 evaluation board contains S1 thru S5 for various controls of the ISL8016 circuitries. Table 1 details this function.

TABLE 1. SWITCH SETTINGS

S1	MODE	FUNCTION
1	PWM	Fixed PWM frequency at light load
3	PFM	Force continuous mode
S2	ISET	PROGRAM OUTUT CURRENT
1	LOW	SET OUTPUT LOAD TO 2A.
-	OPEN	SET OUTPUT LOAD TO 6A.
3	HIGH	SET OUTPUT LOAD TO 4A.
S3	VSET	SET OUTPUT MARGIN
1	LOW	SET OUTPUT VOLTAGE -10%.
-	OPEN	NO OUTPUT VOLTAGE MARGIN
3	HIGH	SET OUTPUT VOLTAGE +10%.
S4	ENABLE	FUNCTION
1	OFF	DISABLE VOUT1
3	PFM	ENABLE VOUT1
S5	ENABLE	FUNCTION
1	OFF	DISABLE VOUT2
3	PFM	ENABLE VOUT2

ISL8016CIR1EVAL1Z Schematic

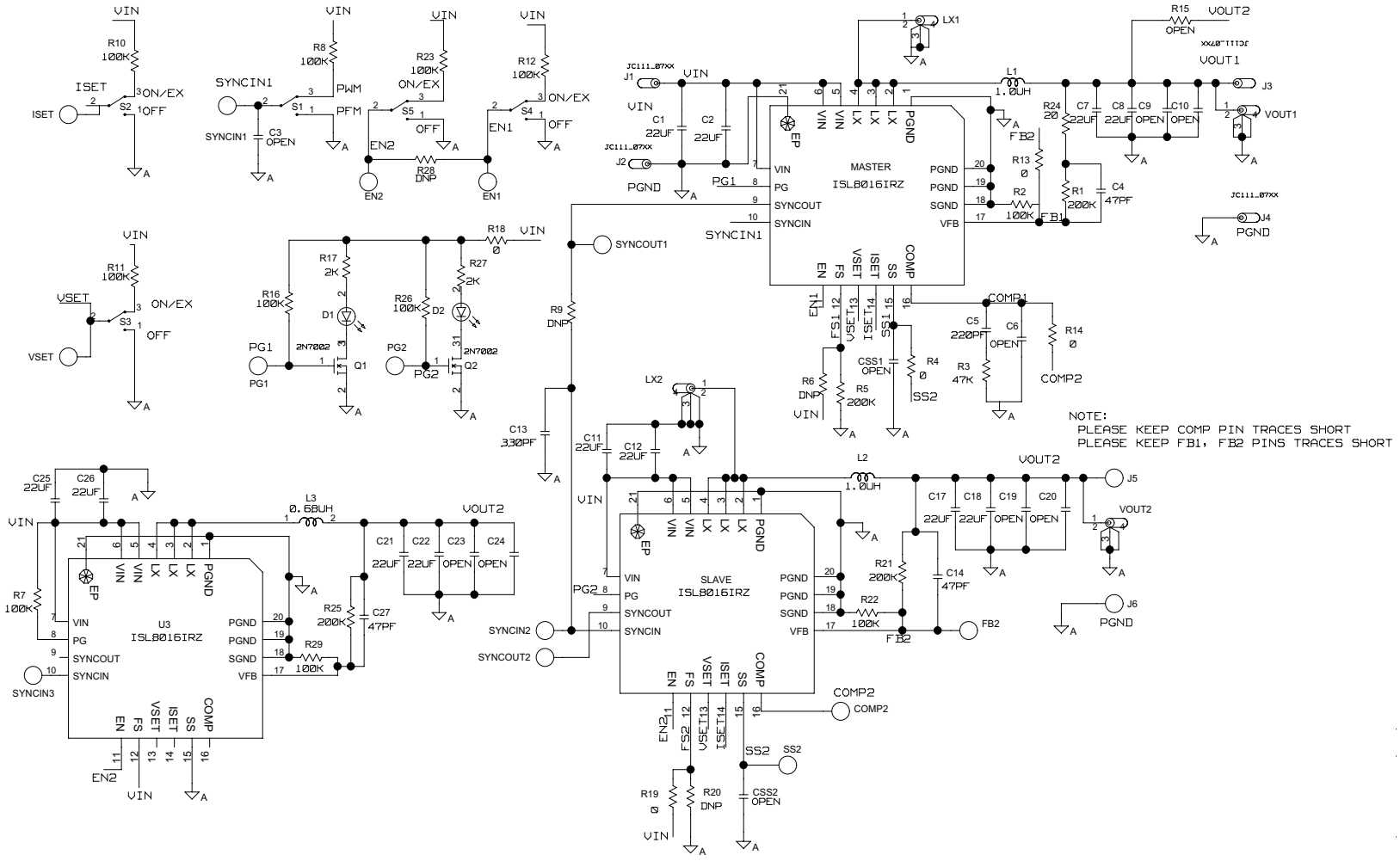

TABLE 2. BILL OF MATERIALS

PART NUMBER	QTY	UNITS	REFERENCE DESIGNATOR	DESCRIPTION	MANUFACTURER	MANUFACTURER PART #
ISL8016CIR1EVAL1ZREVAPCB	1	ea	SEE LABEL-RENAME BOARD	PWB-PCB, ISL8016CIR1EVAL1Z, REVA, ROHS	TBD	ISL8016CIR1EVAL1ZREVAPCB
H1045-00150-50V5-T	1	ea	C4	CAP, SMD, 0603, 15pF, 50V, 5%, NPO, ROHS	MURATA	GRM39C0G150J050AD
H1045-00221-50V5-T	1	ea	C5	CAP, SMD, 0603, 220pF, 50V, 5%, C0G, ROHS	VENKEL	C0603C0G500-221JNE
H1045-00333-50V5-T	1	ea	CSS1	CAP, SMD, 0603, 33000pF, 25V, 5%, X7R, ROHS	AVX	06035C333JAT2A
H1045-DNP	0	ea	C3, C6, CSS2	CAP, SMD, 0603, DNP-PLACE HOLDER, ROHS	MURATA	GRM36C0G680J050AQ
H1065-00226-6R3V20-T	5	ea	C1, C2, C7, C8, C10	CAP, SMD, 1206, 22µF, 6.3V, 20%, X5R, ROHS		
H1065-00476-6R3V20-T	1	ea	C9	CAP, SMD, 1206, 47µF, 6.3V, 20%, X5R, ROHS	MURATA	GRM31CR60J476ME19L
H1065-DNP	0	ea	C19, C20, C23, C24	CAP, SMD, 1206, DNP-PLACE HOLDER, ROHS		
IHLP-5050CE-01-1R0M	1	ea	L1	COIL-PWR INDUCTOR, SMD, 13mm, 1.0µH, 20%, 24A, ROHS	VISHAY	IHLP-5050CE-01-1R0M
111-0702-001	2	ea	J1, J3	CONN-GEN, BIND.POST, INSUL-RED, THMBNUT-GND	JOHNSON COMPONENTS	111-0702-001
111-0703-001	2	ea	J2, J4	CONN-GEN, BIND.POST, INSUL-BLK, THMBNUT-GND	JOHNSON COMPONENTS	111-0703-001
131-4353-00	2	ea	LX1, VOUT1	CONN-SCOPE PROBE TEST PT, COMPACT, PCB MNT, ROHS	TEKTRONIX	131-4353-00
1514-2	2	ea	J5, J6	CONN-TURRET, TERMINAL POST, TH, ROHS	KEYSTONE	1514-2
5000	14	ea	EN1, EN2, FB2, PG1, PG2, SS2, ISET, VSET, COMP2, SYNCIN1-SYNCIN3, SYNCOUT1, SYNCOUT2	CONN-MINI TEST PT, VERTICAL, RED, ROHS	KEYSTONE	5000
LTST-C170CKT	2	ea	D1, D2	LED-GaAs RED, SMD, 2X1.25mm, 100mW, 40mA, 10mcd, ROHS	LITEON/VISHAY	LTST-C170CKT
B340B-13-F-T	2	ea	D1, D2	DIODE-SCHOTTKY, SMD, SMB, 2P, 40V, 3A, ROHS	DIODES INC.	B340B-13-F
ISL8016IRZ	1	ea	MASTER	IC-ADJ. 6A BUCK REGULATOR, 20P, QFN, 3X4, ROHS	INTERSIL	ISL8016IRZ
2N7002-7-F-T	2	ea	Q1, Q2	TRANSISTOR, N-CHANNEL, 3 LD, SOT23, 60V, 115mA, ROHS	DIODES, INC.	2N7002-7-F
H2505-DNP	0	ea	R6, R9 ,R20, R28	RESISTOR,SMD,0603,0.1%, MF,DNP-PLACE HOLDER		
H2510-DNP	0	ea	R4, R7, R13, R14, R19, R21, R22, R25, R29	RES,SMD,0402, DNP, DNP, DNP,TF,ROHS		

TABLE 2. BILL OF MATERIALS (Continued)

PART NUMBER	QTY	UNITS	REFERENCE DESIGNATOR	DESCRIPTION	MANUFACTURER	MANUFACTURER PART #
H2511-00200-1/10W1-T	1	ea	R24	RES,SMD,0603,20ohm,1/10W,1%,TF,ROHS	PANASONIC	ERJ-3EKF20R0V
H2511-00R00-1/10W-T	1	ea	R18	RES, SMD, 0603, 0Ω, 1/10W, TF, ROHS	VENKEL	CR0603-10W-000T
H2511-01003-1/10W1-T	9	ea	R2, R3, R8, R10-R12, R16, R23, R26	RES, SMD, 0603, 100k, 1/10W, 1%, TF, ROHS	VENKEL	ERJ-3EKF1003V
					ROHM	CR0603-10W-1003FT
					YAGEO	MCR03EZPFX1003
					VISHAY/DALE	ERJ-3EKF1004V
H2511-02003-1/10W1-T	2	ea	R1, R5	RES, SMD, 0603, 200k, 1/10W, 1%, TF, ROHS	PANASONIC	ERJ-3EKF2003V
					VENKEL	CR0603-10W-2003FT
					ROHM	MCR03EZPFX2003
					KOA	RK73H1JTTD2003F
					VISHAY/DALE	CRCW06031M00FKEA
H2511-DNP	0	ea	R17, R27	RES, SMD, 0603, DNP-PLACE HOLDER, ROHS		
H2514-DNP	0	ea	R15	RES,SMD, 1210, DNP, DNP, DNP, TF, ROHS		
GT11MSCBE-T	3	ea	S1, S4, S5	SWITCH-TOGGLE, SMD, 6PIN, SPDT, 2POS, ON-ON, ROHS	ITT INDUSTRIES/C&K DIVISION	GT11MSCBE
GT13MSCBE	2	ea	S2, S3	SWITCH-TOGGLE, SMD, 6PIN, SPDT, 3POS, ON-OFF-ON, ROHS	ITT INDUSTRIES/C&K DIVISION	GT13MSCBE
DNP	0	ea	C11-C14, C17, C18, C21, C22, C25-C27	DO NOT POPULATE OR PURCHASE		
DNP	0	ea	L2, L3, LX2, VOUT2, U3, SLAVE	DO NOT POPULATE OR PURCHASE		

ISL8016CIR1EVAL1Z Board Layout

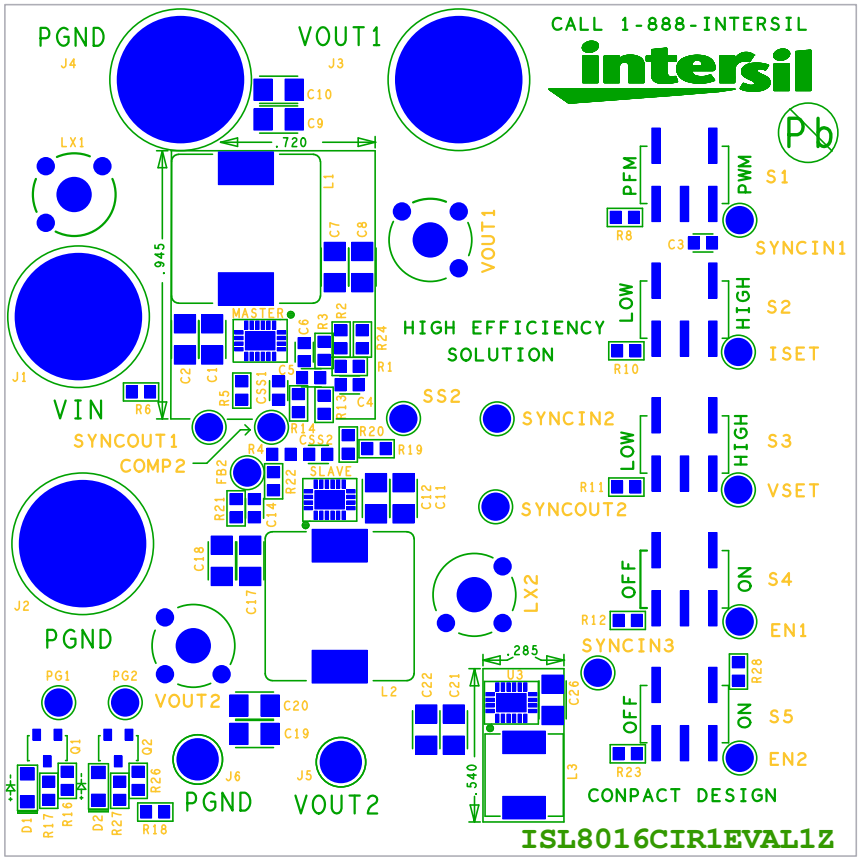

FIGURE 1. TOP LAYER COMPONENTS

ISL8016CIR1EVAL1Z Board Layout (Continued)

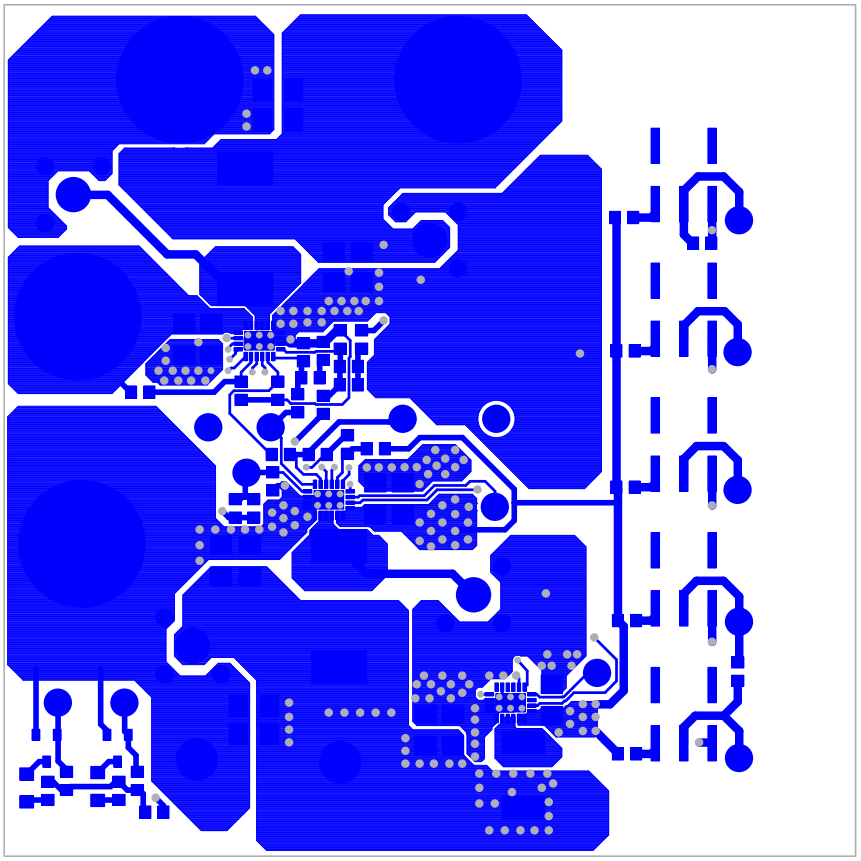

FIGURE 2. TOP LAYER ETCH

ISL8016CIR1EVAL1Z Board Layout (Continued)

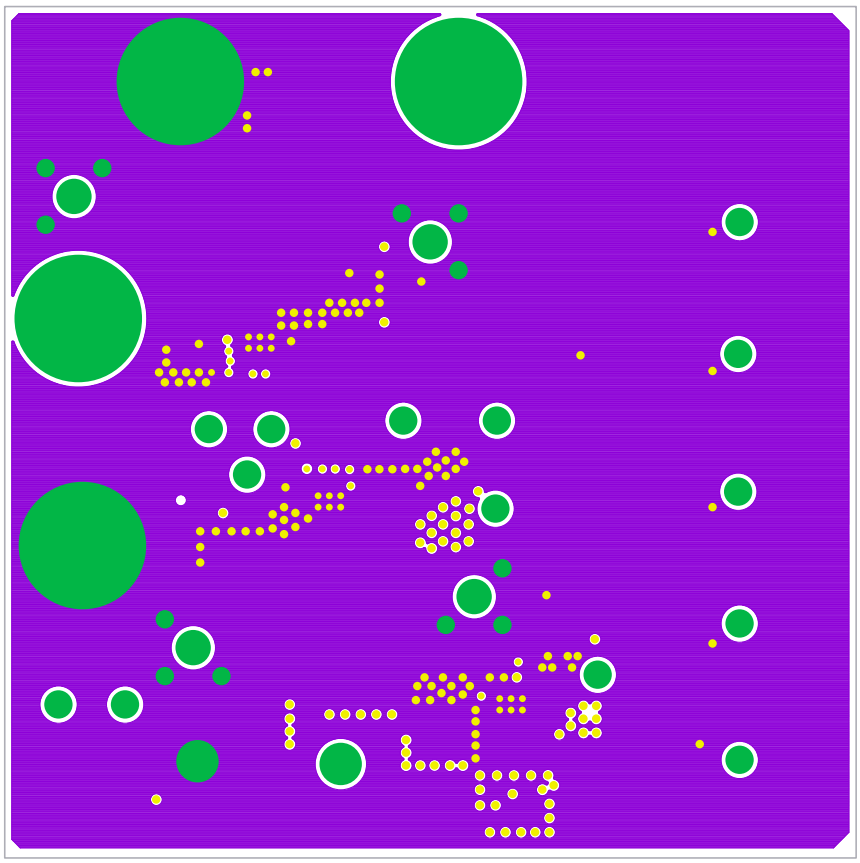

FIGURE 3. SECOND LAYER ETCH

ISL8016CIR1EVAL1Z Board Layout (Continued)

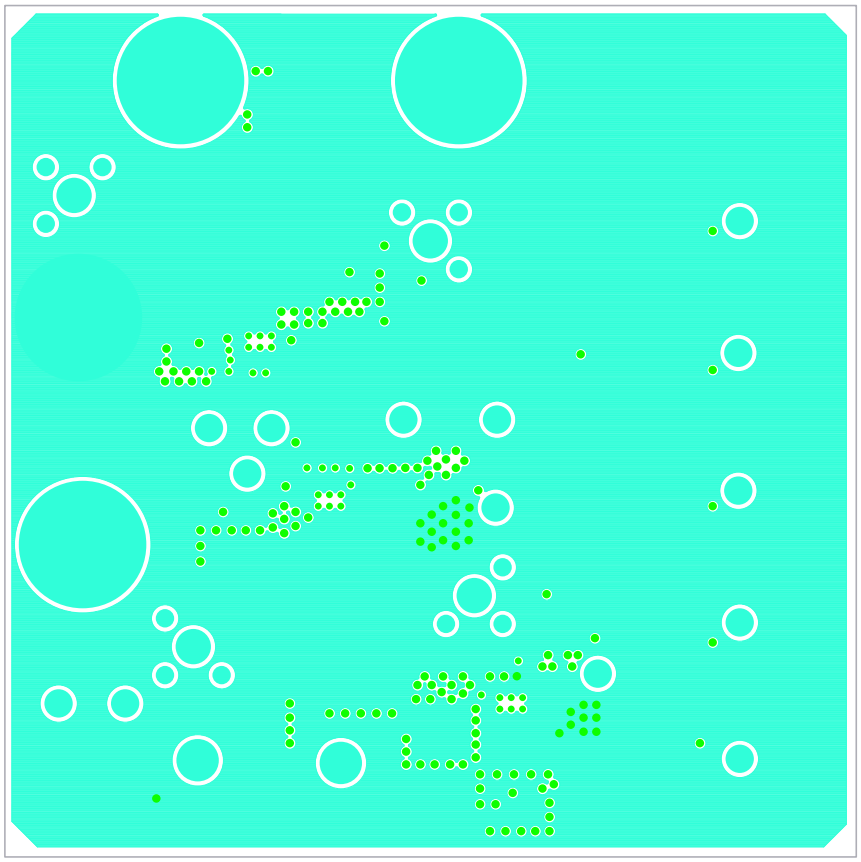

FIGURE 4. THIRD LAYER ETCH

ISL8016CIR1EVAL1Z Board Layout (Continued)

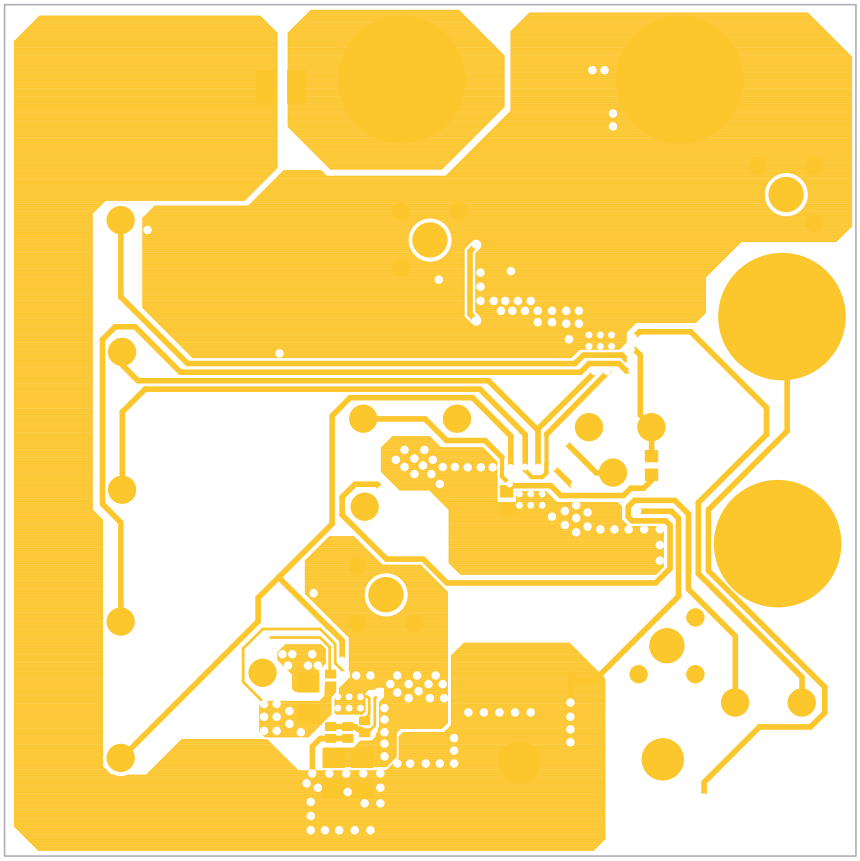

FIGURE 5. BOTTOM LAYER ETCH

ISL8016CIR1EVAL1Z Board Layout (Continued)

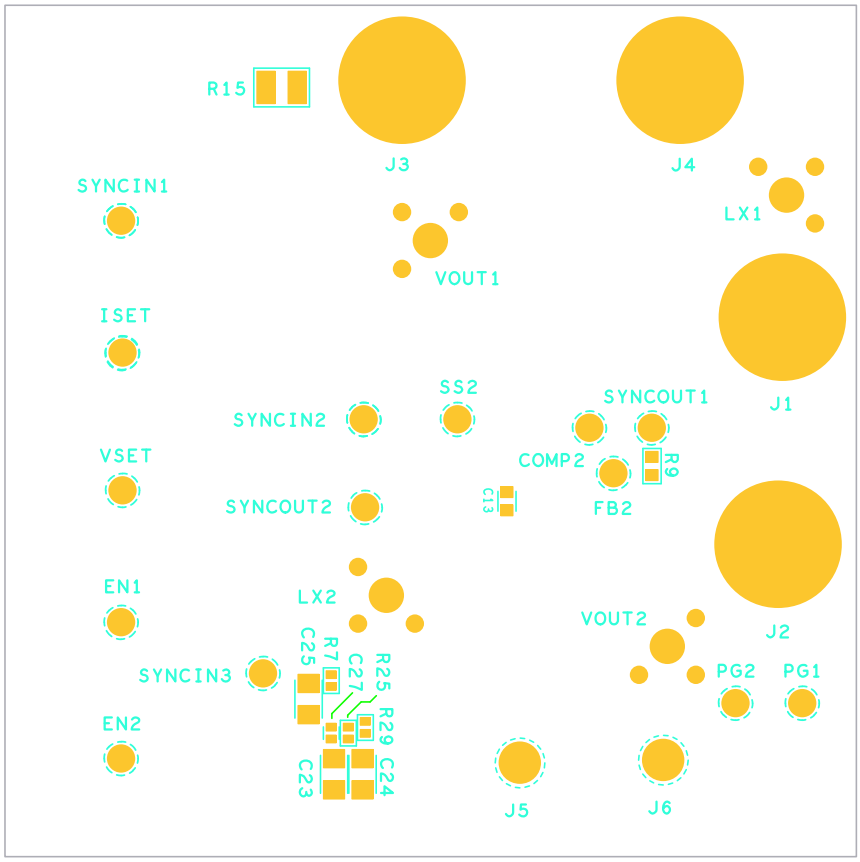

FIGURE 6. BOTTOM LAYER COMPONENTS

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