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3A/4A Low Quiescent Current High Efficiency Synchronous Buck Regulator

Description

The ISL8023_24EVAL3Z kit is intended for use by individuals with requirements for Point-of-Load applications sourcing from 2.7V to 5.5V. The ISL8023_24EVAL3Z simple smallest factor evaluation board is used for a quick and easy demonstration of the performance of the ISL8023, ISL8024 low quiescent high efficiency synchronous buck regulator.

The ISL8023 and ISL8024 are offered in a 3mmx3mm 16 Ld TQFN package with 1mm maximum height. The complete area that the converter occupies can be as small as $0.22in^2$.

Key Features

- High Efficiency Synchronous Buck Regulator with up to 95% Efficiency
- 0.8% Reference Accuracy Over-Temperature/Load/Line
- 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
- Negative OC protection

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 V_{IN}, the plus terminal to V_{IN}, P4 and the negative return to PGND, P5.
3. Connect the output load to VO, the plus terminal to VO, P7 and the negative return to PGND, P8.
4. Verify that the position is PWM for SW2.
5. Verify that the position is ON for SW1.
6. Turn on the power supply.
7. Verify the output voltage is 1.8V for VO.

Evaluating the Other Output Voltage

The ISL8023_24EVAL3Z kit output is preset to 1.8V for VO, however, output voltages can be adjusted from 0.6V to 5V. The output voltage programming resistor, R_1, 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 R_2 is left unpopulated and R_1 is shorted. For faster response performance, add 10pF to 47pF in parallel to R_1. Check bode plot to insure optimum performance.

Frequency Control

ISL8023, ISL8024 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 2MHz when FS is tied to V_{IN} (R_{11} = 0 and R_{12} is open). By connecting R_{12} to GND, the switching frequency could be changed from 1MHz (R_{12} = 206k) to 4MHz (R_{12} = 40k) according to Equation 2:

$$R_T[k\Omega] = \frac{220 \cdot 10^3}{f_{OSC}[kHz]} - 14 \quad \text{(EQ. 2)}$$

When using R_{12} to adjust the operational frequency, this also sets external compensation mode. Please refer to the ISL8023, ISL8024 datasheet (FN7812) for more details.

Soft-start Control

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

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

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

Switches Control

The ISL8023, ISL8024 evaluation board contains SW1 and SW2 for various controls of the ISL8023, ISL8024 circuitries. Table 1 details this function.

TABLE 1. SWITCH SETTINGS

SW1	ENABLE	FUNCTION
1	OFF	DISABLE VO
3	ON	ENABLE VO
SW2	**MODE**	**FUNCTION**
1	PWM	Fixed PWM frequency at light load
3	PFM	Force continuous mode

ISL8023_24EVAL3Z Schematic

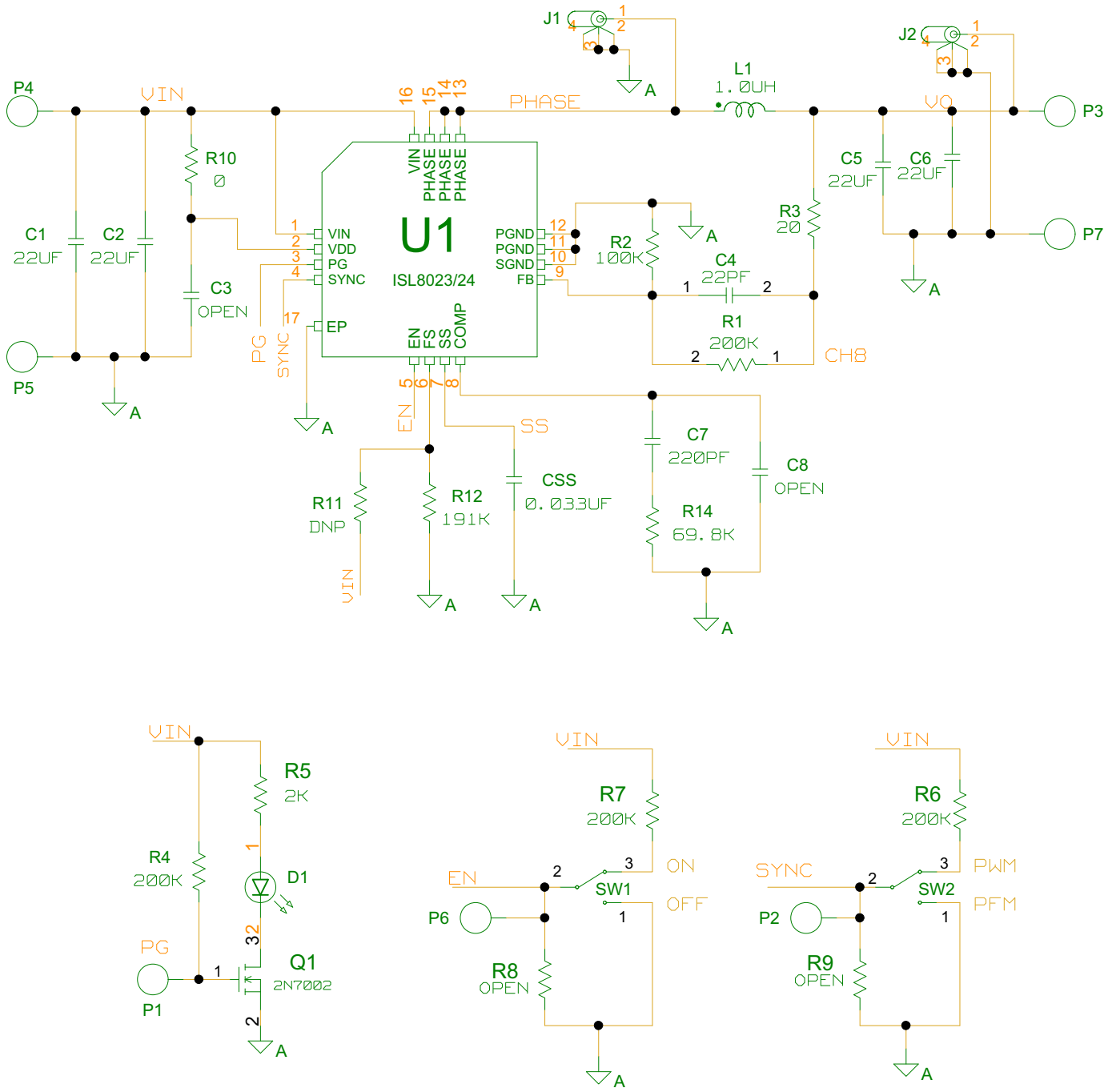

TABLE 2. BILL OF MATERIALS

PART NUMBER	QTY	UNITS	REFERENCE DESIGNATOR	DESCRIPTION	MANUFACTURER	MANUFACTURER PART
ISL8023_24EVAL3ZREVA PCB	1	ea		PWB-PCB, ISL8023_24EVAL3Z, REVA, ROHS	TBD	ISL8023_24EVAL3ZREVA PCB
H1045-00220-50V5-T	1	ea	C4	CAP, SMD, 0603, 22pF, 50V, 5%, C0G, ROHS	VENKEL	C0603C0G500-220JNE
H1045-00221-50V10-T	1	ea	C7	CAP, SMD, 0603, 220pF, 50V, 10%, X7R, ROHS	MURATA	GRM188R71H221KA01D
H1045-00333-16V10-T	1	ea	CSS	CAP, SMD, 0603, 33000pF, 16V, 10%, X7R, ROHS	VENKEL	C0603X7R160-333KNE
H1045-DNP	0	ea	C3, C8	CAP, SMD, 0603, DNP-PLACE HOLDER, ROHS		
H1065-00226-6R3V10-T	2	ea	C2, C5	CAP, SMD, 1206, 22µF, 6.3V, 10%, X5R, ROHS	MURATA	GRM31CR60J226KE19L
H1065-DNP	0	ea	C1, C6	CAP, SMD, 1206, DNP-PLACE HOLDER, ROHS		
DR73-1R0-R	1	ea	L1	COIL-PWR INDUCTOR, SMD, 7.6mm, 1.0µH, 20%, 5.28A, ROHS, SHIELDED	COOPER ELECTRONIC TECH.	DR73-1R0-R
131-4353-00	2	ea	J1, J2	CONN-SCOPE PROBE TEST PT, COMPACT, PCB MNT, ROHS	TEKTRONIX	131-4353-00
1514-2	4	ea	P4, P5, P7, P8	CONN-TURRET, TERMINAL POST, TH, ROHS	KEYSTONE	1514-2
5002	3	ea	P1, P2, P6	CONN-MINI TEST POINT, VERTICAL, WHITE, ROHS	KEYSTONE	5002
LTST-C170CKT	1	ea	D1	LED-GaAs RED, SMD, 2x1.25mm, 100mW, 40mA, 10mcd, ROHS	LITEON/VISHAY	LTST-C170CKT
ISL8023/24IRZ	1	ea	U1	IC-3A/4A BUCK REGULATOR, 16P, QFN, 3x3, ROHS	INTERSIL	ISL8023/24IRZ
2N7002-7-F-T	1	ea	Q1	TRANSISTOR, N-CHANNEL, 3 LD, SOT-23, 60V, 115mA, ROHS	DIODES, INC.	2N7002-7-F
H2505-DNP	0	ea	R11	RESISTOR, SMD, 0603, 0.1%, MF, DNP-PLACE HOLDER		
H2511-00200-1/10W1-T	1	ea	R3	RES, SMD, 0603, 20Ω, 1/10W, 1%, TF, ROHS	PANASONIC	ERJ-3EKF20R0V
H2511-00R00-1/10W-T	1	ea	R10	RES, SMD, 0603, 0Ω, 1/10W, TF, ROHS	VENKEL	CR0603-10W-000T
H2511-01003-1/10W1-T	2	ea	R2, R14	RES, SMD, 0603, 100k, 1/10W, 1%, TF, ROHS	VENKEL	CR0603-10W-1003FT
H2511-01913-1/10W1-T	1	ea	R12	RES, SMD, 0603, 191k, 1/10W, 1%, TF, ROHS	VENKEL	CR-0603-10W-1913FT
H2511-02003-1/10W1-T	4	ea	R1, R4, R6, R7	RES, SMD, 0603, 200k, 1/10W, 1%, TF, ROHS	VENKEL	CR0603-10W-2003FT
H2511-DNP	0	ea	R5, R8, R9	RES, SMD, 0603, DNP-PLACE HOLDER, ROHS		
GT11MSCBE-T	2	ea	SW1, SW2	SWITCH-TOGGLE, SMD, 6 PIN, SPDT, 2POS, ON-ON, ROHS	ITT INDUSTRIES/C&K DIVISION	GT11MSCBE
5X8-STATIC-BAG	1	ea	Place assy in bag	BAG, STATIC, 5x8, ZIPLOC, ROHS	INTERSIL	212403-013
DNP	0	ea	P3 (3VH30/1JN5)	DO NOT POPULATE OR PURCHASE		
LABEL-SERIAL NUMBER	1	ea		LABEL-FOR SERIAL NUMBER AND BOM REV #	INTERSIL	LABEL-SERIAL NUMBER

ISL8023_24EVAL3Z Board Layout

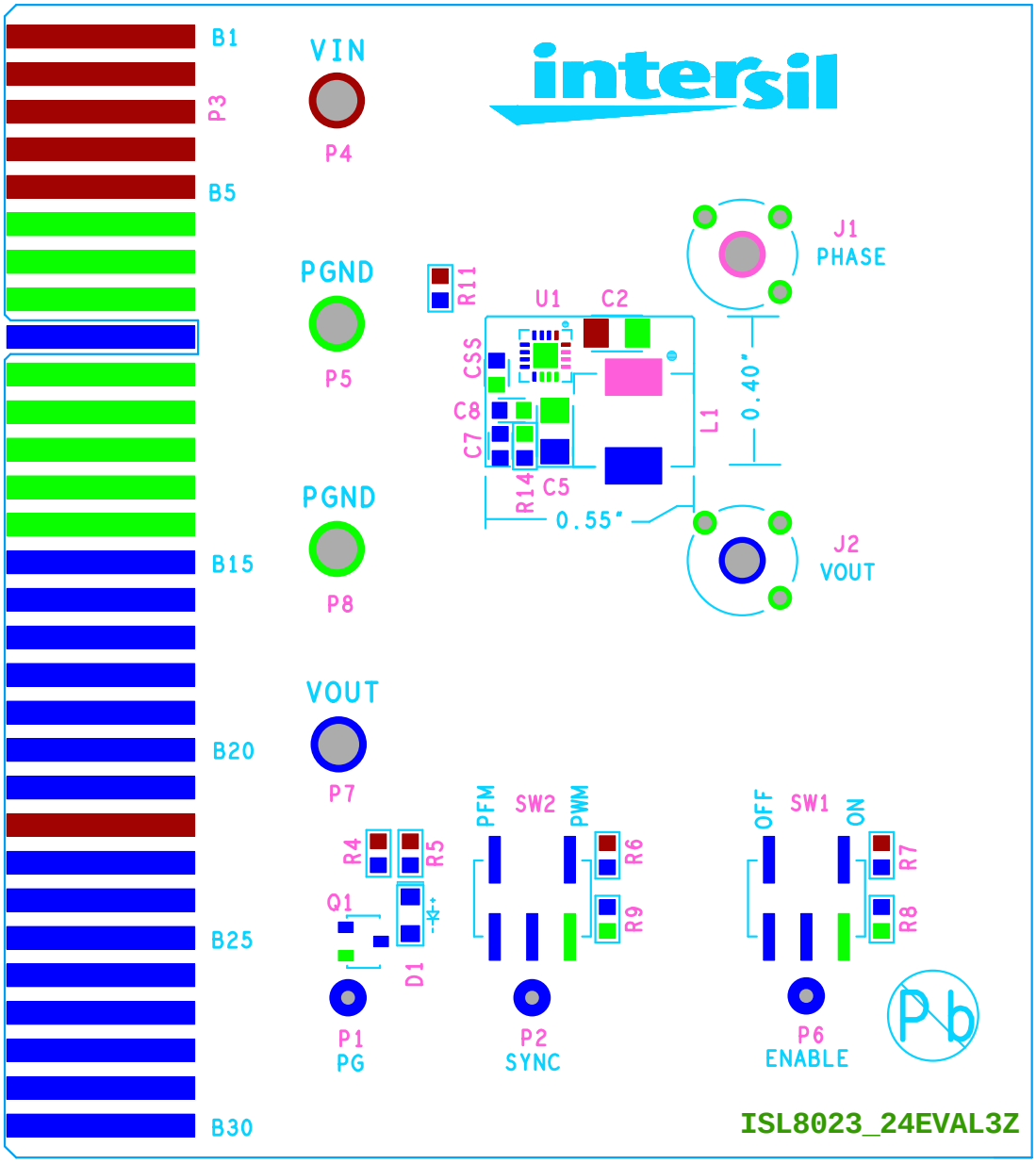

FIGURE 1. TOP LAYER COMPONENTS

ISL8023_24EVAL3Z Board Layout (Continued)

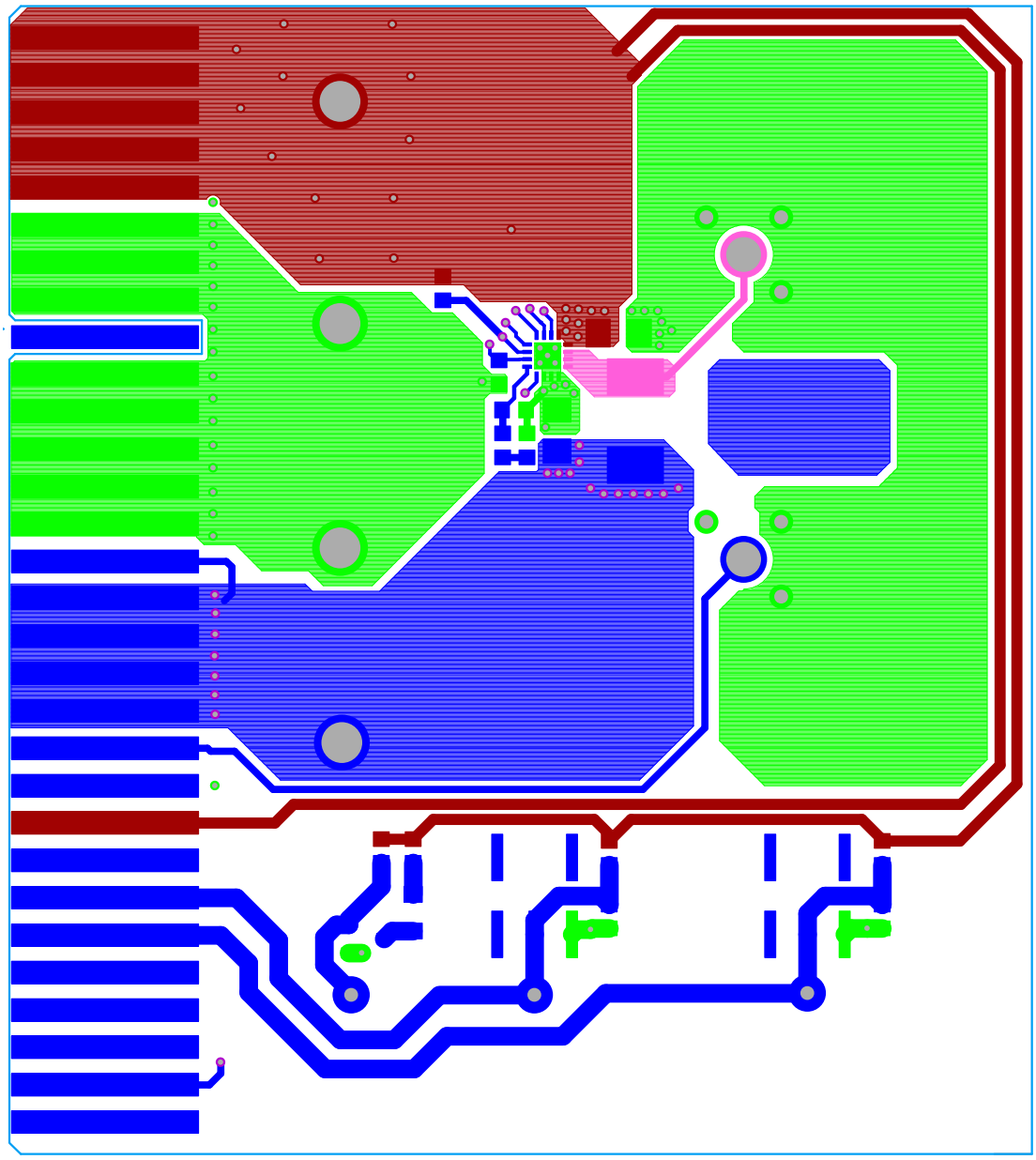

FIGURE 2. TOP LAYER ETCH

ISL8023_24EVAL3Z Board Layout (Continued)

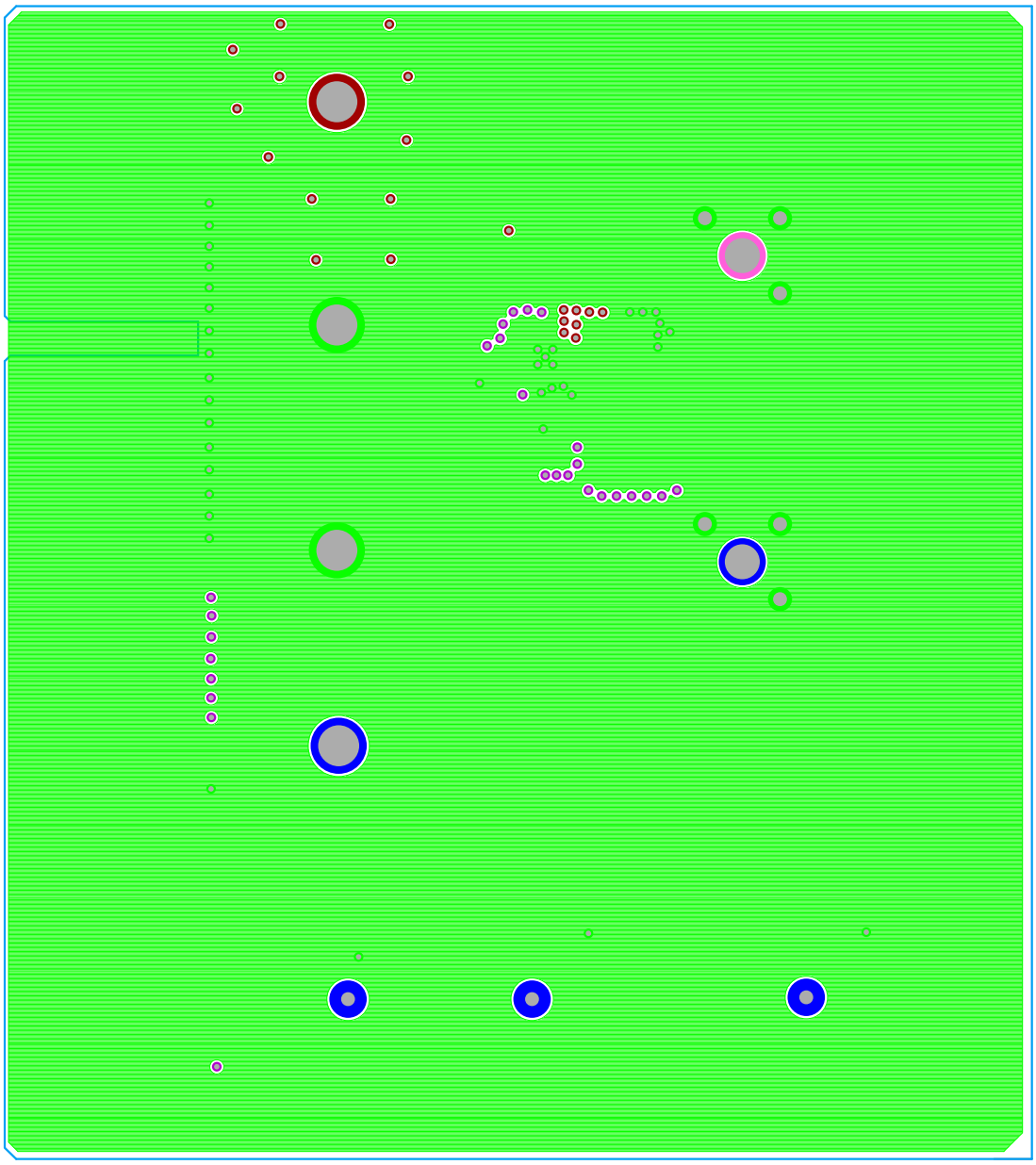

FIGURE 3. SECOND LAYER ETCH

ISL8023_24EVAL3Z Board Layout (Continued)

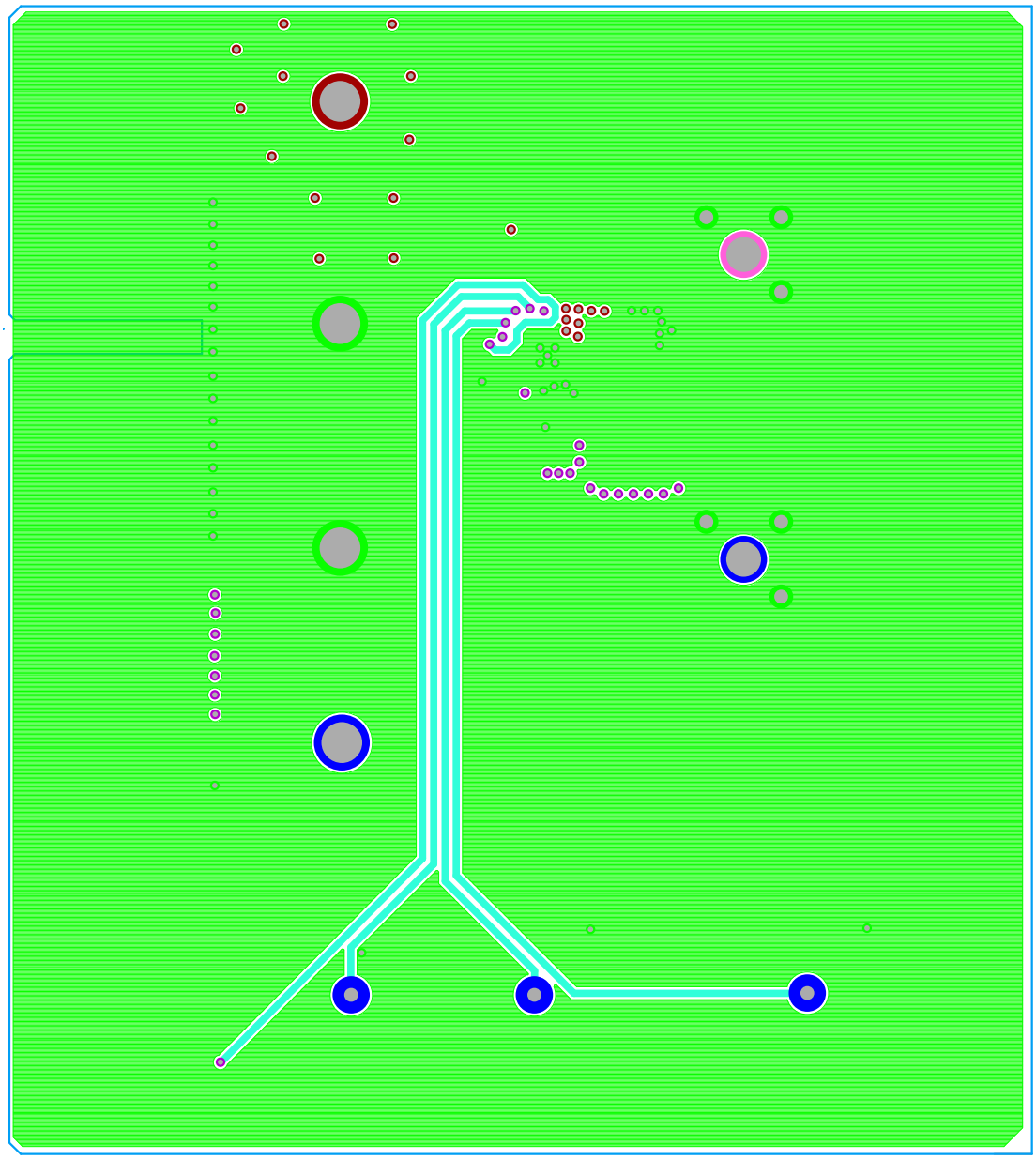

FIGURE 4. THIRD LAYER ETCH

ISL8023_24EVAL3Z Board Layout (Continued)

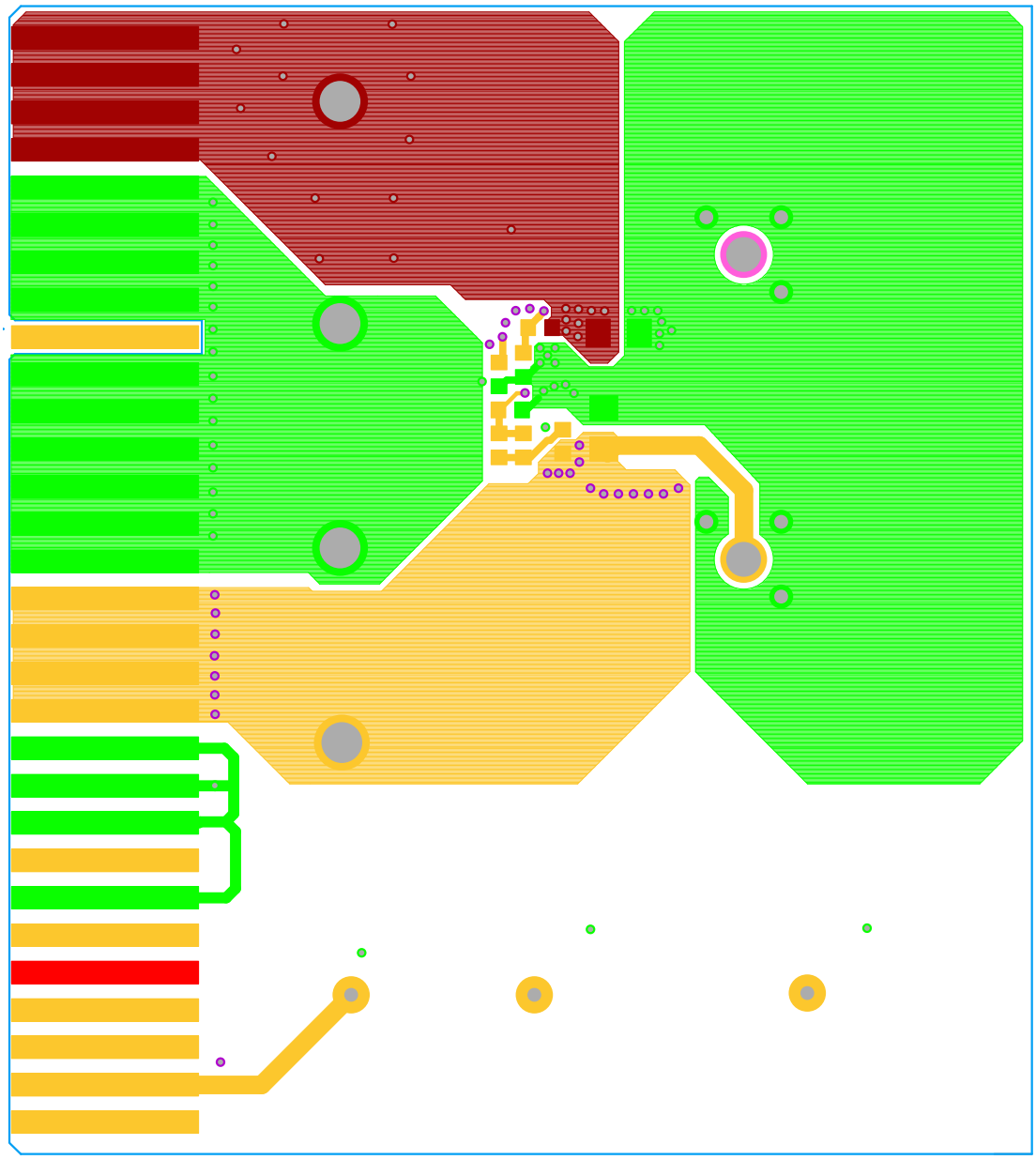

FIGURE 5. BOTTOM LAYER ETCH

ISL8023_24EVAL3Z Board Layout (Continued)

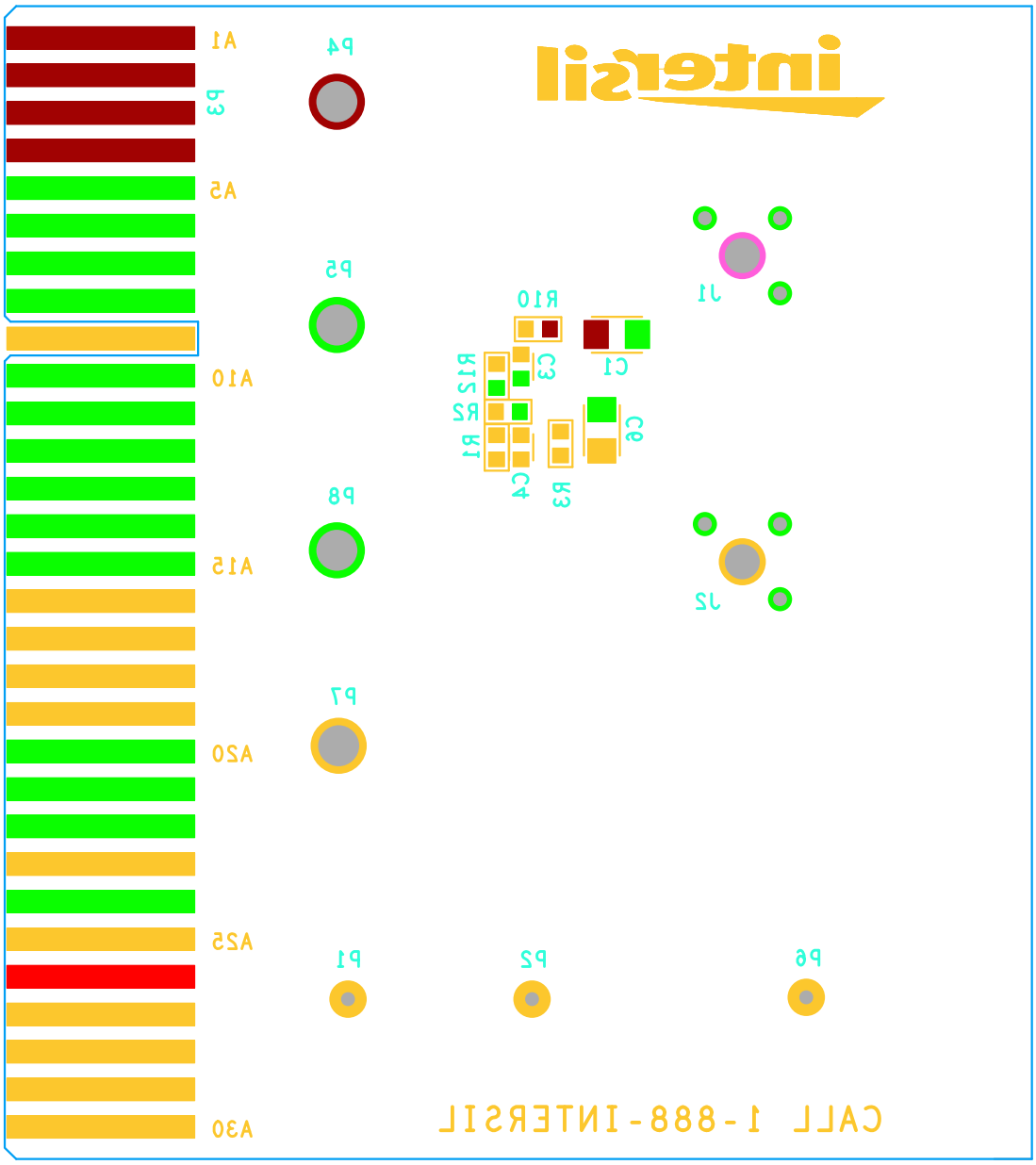

FIGURE 6. BOTTOM LAYER COMPONENTS