ISL6268EVAL1Z User Guide

Application Note | October 9, 2007 | AN1274.0

Introduction

The ISL6268EVAL1Z evaluation board demonstrates the performance of the ISL6268HZ single-phase synchronous-buck PWM controller featuring Intersil's Robust Ripple Regulator (R^3) technology. The evaluation DC/DC converter design criteria is located in Table 1. An on-board dynamic-load generator is included for evaluating the transient-load response. The dynamic-load applies a 2.5ms pulse of 250mΩ across VOUT and GND every 30ms. Contents of this document include:

- Recommended Test Equipment
- Interface Connections
- Switch Descriptions
- Jumper Descriptions
- Test Point Descriptions
- Typical Waveforms
  - Start-up
  - Shut-down
  - Diode-emulation
  - Load-transient response
  - Line-transient response
  - Overvoltage protection
  - Undervoltage protection
  - Overcurrent protection
- Evaluation Board Documentation
  - Schematic
  - Bill of materials
  - Silk-screen plots
  - Board layer plots

TABLE 1. DC/DC DESIGN CRITERIA

PARAMETER	VALUE	UNITS
VIN	7 to 25	VDC
VOUT	1.20	VDC
FULL-LOAD	5.0	ADC
PWM FREQUENCY	300	kHz

Recommended Equipment

- (QTY 1) Adjustable 25V, 3A Power Supply
- (QTY 1) Fixed 12V, 100mA Power Supply
- (QTY 1) Fixed 5V, 100mA Power Supply
- (QTY 1) Adjustable 10A Constant Current Electronic Load
- (QTY 1) DVM
- (QTY 1) Four Channel Oscilloscope

Interface Connections

- VIN: Input voltage to the power stage of the converter
  - J1: VIN positive power input
  - TP1: VIN positive voltage sense
  - J2: VIN return power input
  - TP2: VIN return voltage sense
- VOUT: Regulated output voltage from the converter
  - J3: VOUT positive power output
  - TP3: VOUT positive voltage sense
  - J4: VOUT return power output
  - TP4: VOUT return voltage sense
- VCC: +5V input voltage for VCC, PVCC, PGOOD-LED and pull-up voltage rail
  - J5: 5V positive input
  - J6: 5V return input
- +12V: Input voltage for the dynamic-load generator
  - J7: 12V positive input
  - J8: 12V return input

Switch Descriptions

- S1: ENABLE
  - OFF: Shorts the EN pin to GND (disable PWM)
  - ON: Allows the EN pin to pull-up to +5V (enable PWM)
- S2: DYNAMIC LOAD
  - OFF: Load disabled
  - ON: Load enabled

Jumper Descriptions

- JP1: Connects +5V supply to the PGOOD LED circuit. The shunt jumper is normally installed. Remove the shunt jumper when making low power efficiency measurements
- JP2: Isolates the EN pin from switch S1 so that it can be externally driven

Test-point Descriptions

- P1: Scope-probe socket for measuring the PHASE node
- P2: Scope-probe socket for measuring VOUT
- P3: Scope-probe socket for measuring voltage across the dynamic-load resistors (hence load current)
- TP5: Monitor the PGOOD pin
- TP6: Monitor or drive the EN pin
- TP7: Monitor the COMP pin (SENSITIVE!)
- TP8: Monitor the FB pin (SENSITIVE!)
- TP9: Monitor the FSET pin
- TP10: Monitor the PVCC pin
- TP11 to TP16: Signal Ground

Typical Waveforms

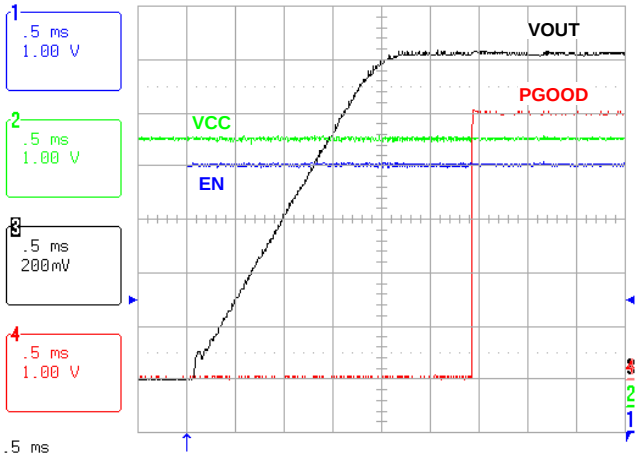

FIGURE 1. SOFT-START: NO LOAD

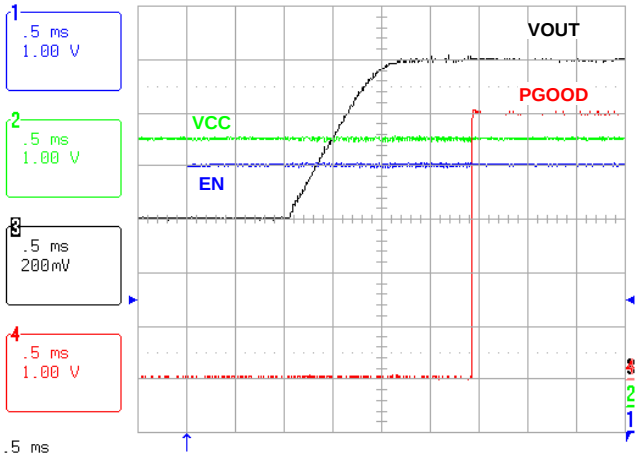

FIGURE 2. SOFT-START: NO LOAD, 50% VOUT-PREBIAS

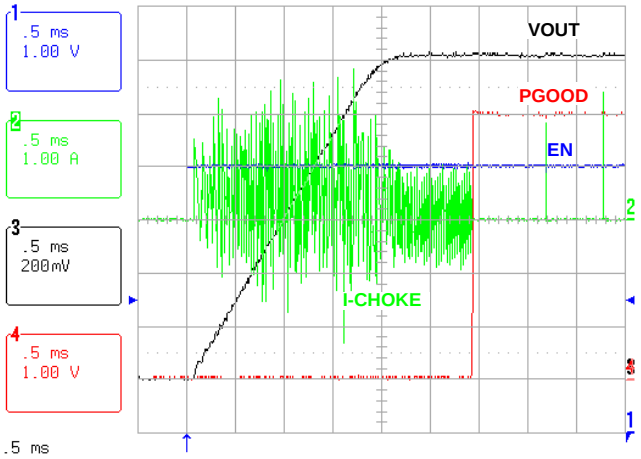

FIGURE 3. IN-RUSH CURRENT: NO LOAD

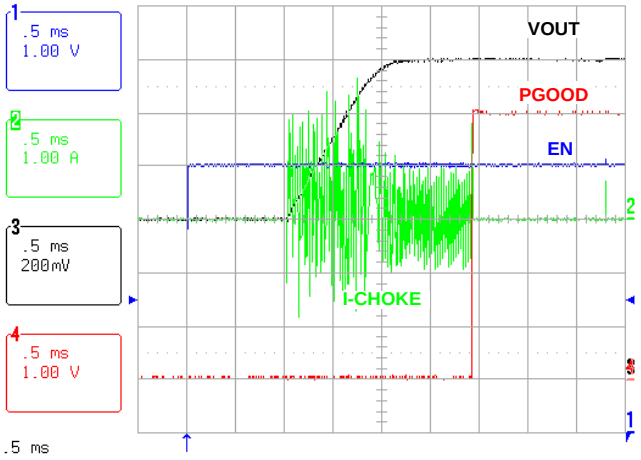

FIGURE 4. IN-RUSH CURRENT: NO LOAD, 50% VOUT-PREBIAS

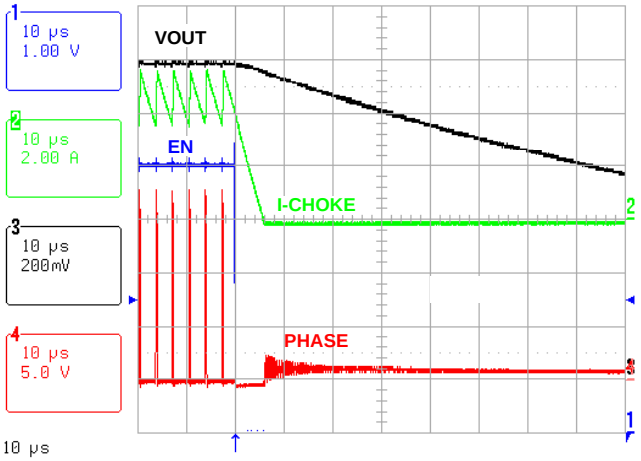

FIGURE 5. SHUTDOWN: EN FALLING, 250mΩ LOAD

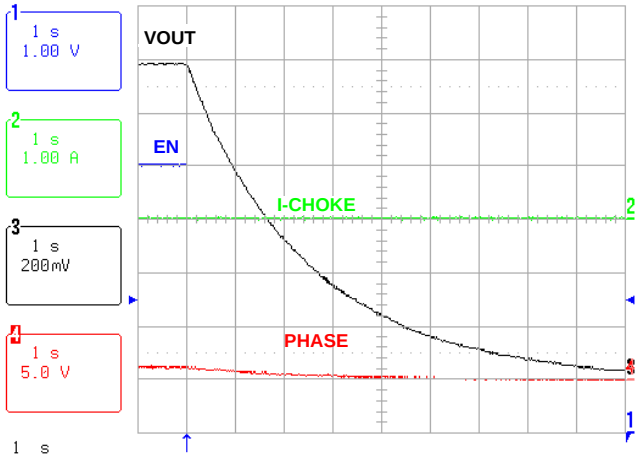

FIGURE 6. SHUTDOWN: EN FALLING, NO LOAD

Typical Waveforms (Continued)

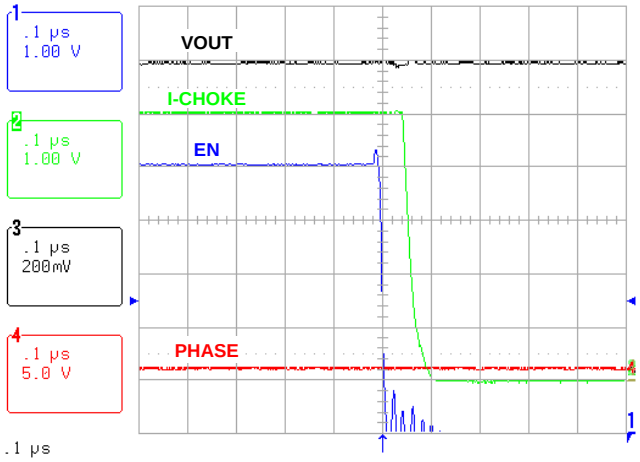

FIGURE 7. SHUTDOWN: EN-FALLING TO PGOOD-FALLING, NO LOAD

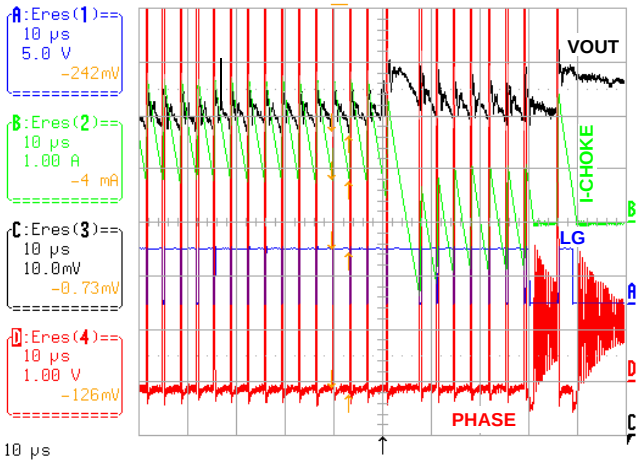

FIGURE 8. ENTERING DEM: 750mΩ LOAD DUMP, 100mA DC STATIC LOAD

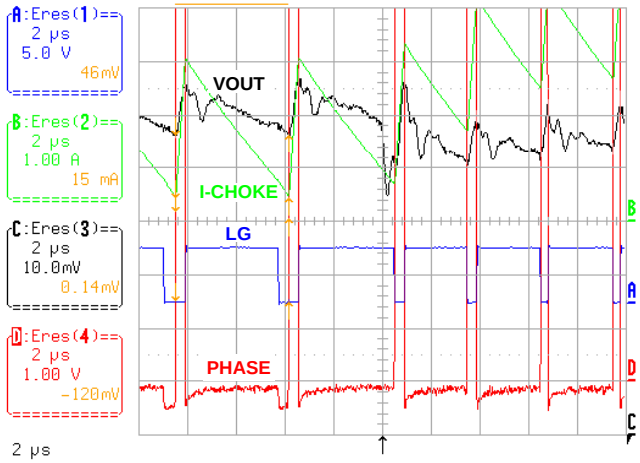

FIGURE 9. EXITING DEM: 750mΩ LOAD STEP, 1.75A DC STATIC LOAD

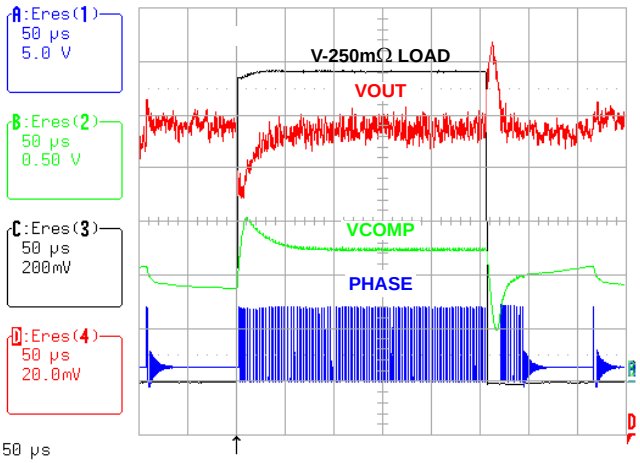

FIGURE 10. LOAD TRANSIENT: 250mΩ LOAD STEP, 10mA DC STATIC LOAD

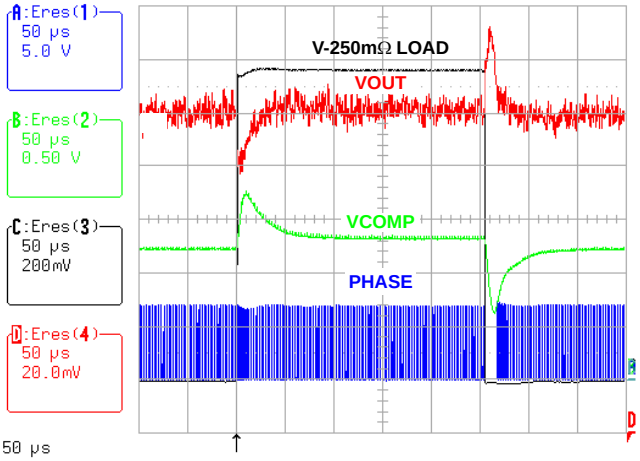

FIGURE 11. LOAD TRANSIENT: 250mΩ LOAD STEP, 5A DC STATIC LOAD

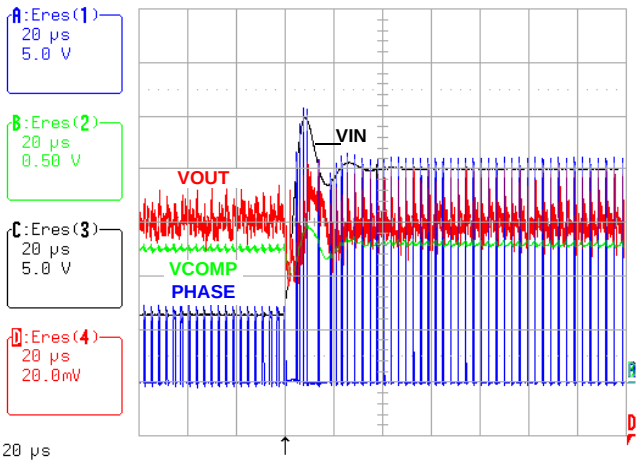

FIGURE 12. LINE TRANSIENT: 7V TO 20V STEP, 5A LOAD

Typical Waveforms (Continued)

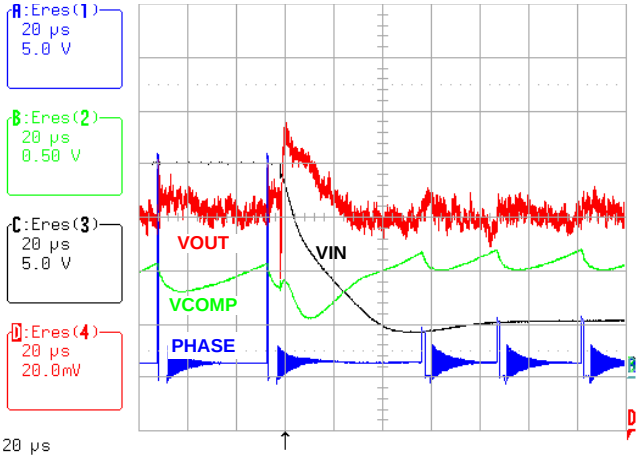

FIGURE 13. LINE TRANSIENT: 20V TO 7V STEP, 100mA LOAD

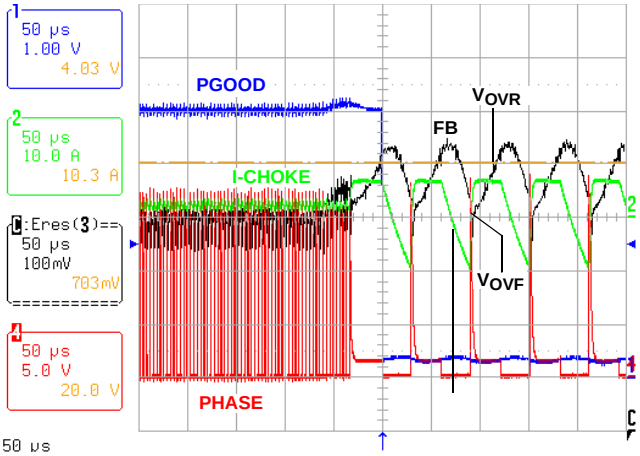

FIGURE 14. OVERVOLTAGE PROTECTION: SHORT ACROSS HIGH-SIDE MOSFET DRAIN-SOURCE, 2A DC STATIC LOAD

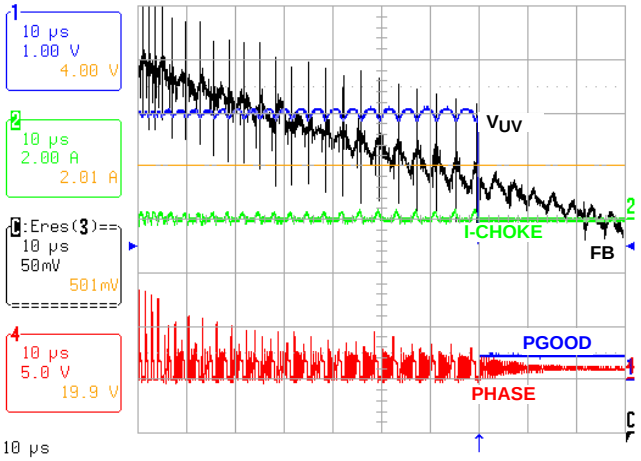

FIGURE 15. UNDERVOLTAGE PROTECTION: SHORT ACROSS HIGH-SIDE MOSFET GATE-SOURCE, 2A DC STATIC LOAD

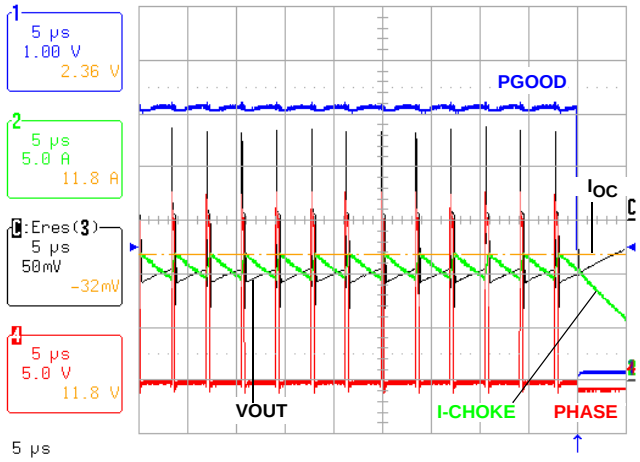

FIGURE 16. OVERCURRENT PROTECTION: 11.8A$_{PEAK}$ CHOKE CURRENT, 5.0mΩ $r_{DS(ON)}$, 2.1kΩ RSEN

The value of the OCP overcurrent programming resistor R_{SEN} is calculated using Equation 1:

$$R_{SEN} = \frac{\left(I_{FL} + \frac{I_{PP}}{2}\right) \cdot OC_{SP} \cdot r_{DS(ON)}}{I_{OC}} \quad \text{(EQ. 1)}$$

where:

- $r_{DS(ON)}$ is the on-state resistance of the low-side MOSFET
- I_{OC} is the I_{SEN} threshold current that trips the OCP circuit
- I_{FL} is the maximum continuous design load current
- I_{PP} is the inductor peak-to-peak ripple current
- OC_{SP} is the desired OCP setpoint multiplier relative to I_{FL}

The ISL6268EVAL1Z delivers 5A I_{FL} with approximately 30% inductor ripple current (1.5A$_{P-P}$) The low-side MOSFET has 5mΩ $r_{DS(ON)}$. The OCP setpoint should be chosen to avoid nuisance tripping due to component tolerances and temperature effects. The ISL6268EVAL1Z is programmed to 190% (OC_{SP} = 1.9). Using Equation 1 finds R_{SEN} = 2.1kΩ.

The value of the frequency programming resistor R_{FSET} is calculated using Equation 2:

$$R_{FSET} = \frac{1}{K \cdot f_{SW}} \quad \text{(EQ. 2)}$$

where:

- f_{SW} is the PWM switching frequency
- K = 66 x 10^{-12}

The ISL6268EVAL1Z is programmed for 300kHz. Using Equation 2 finds R_{FSET} = 49.9kΩ.

The regulation voltage setpoint programming resistors R_{TOP} and R_{BOTTOM} are calculated using Equation 3:

$$V_{REF} = V_{OUT} \cdot \frac{R_{BOTTOM}}{R_{TOP} + R_{BOTTOM}} \quad \text{(EQ. 3)}$$

where:

- V_{REF} = 600mV

The ISL6268EVAL1Z is programmed for 1.20V, therefore, R_{TOP} = R_{BOTTOM}. The loop compensation is usually responsible for selecting R_{TOP}, which in this case is 2.49kΩ.

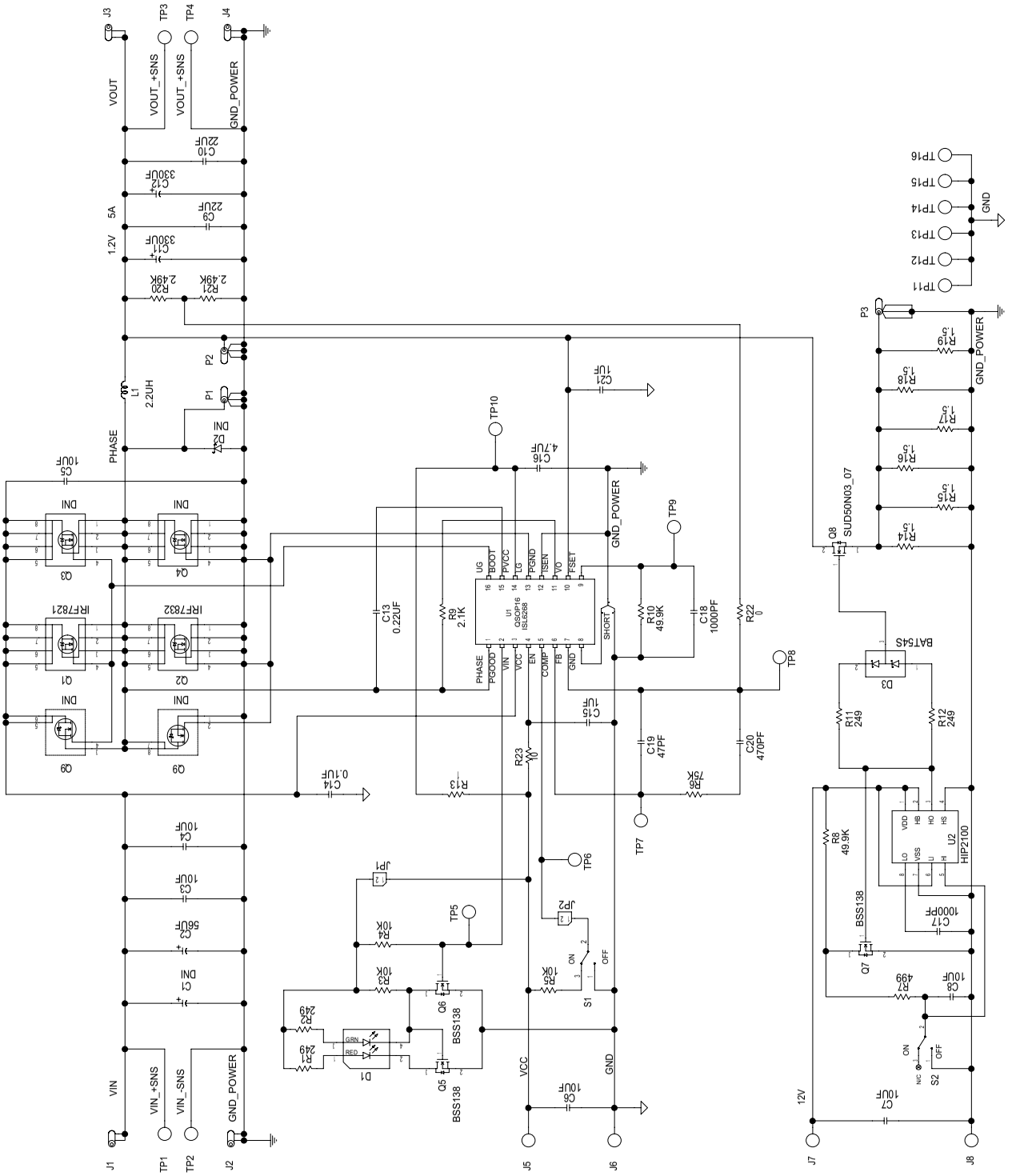

FIGURE 17. ISL6268EVAL1Z REV B CIRCUIT SCHEMATIC

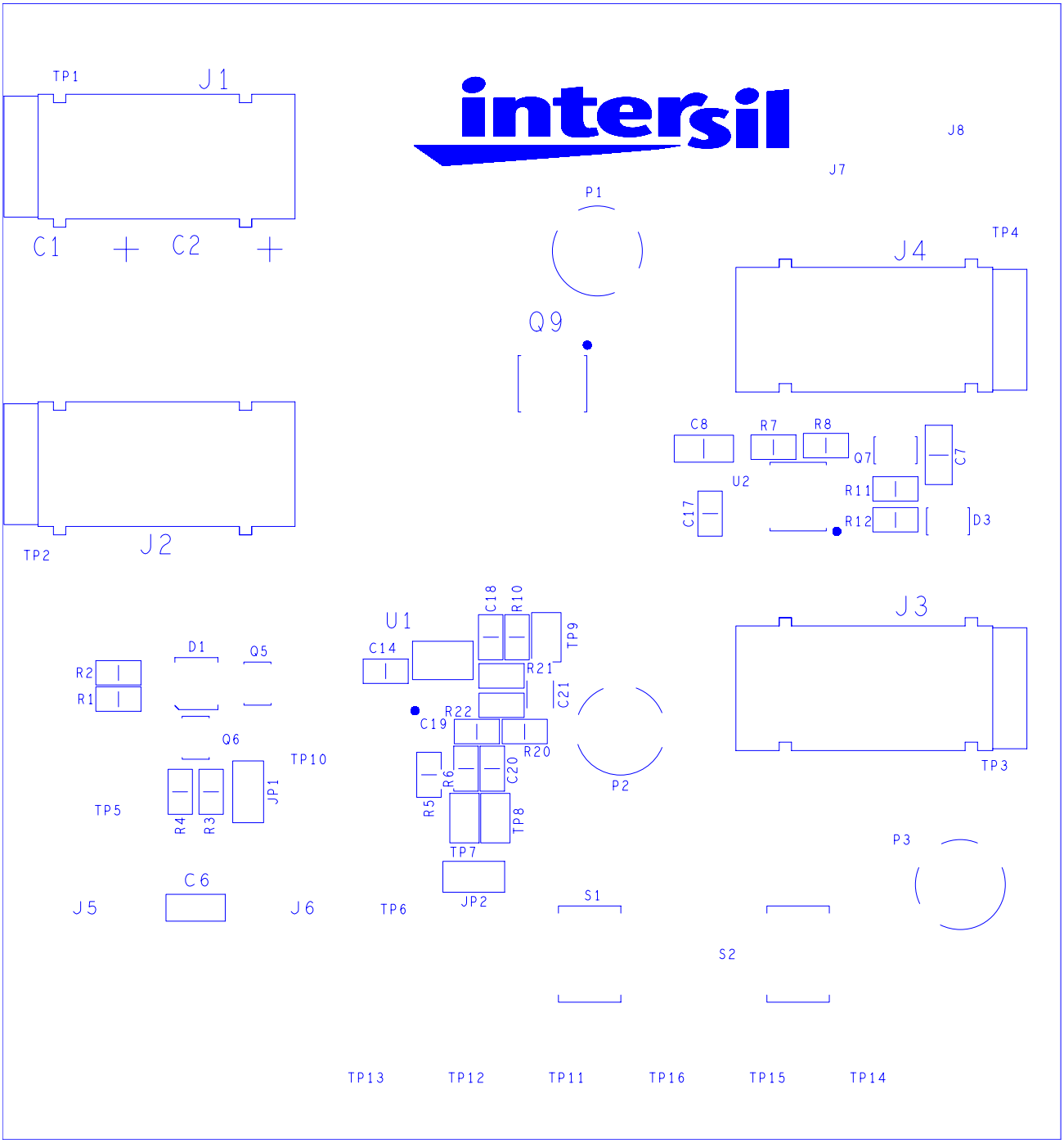

FIGURE 18. PCB TOP SILK SCREEN

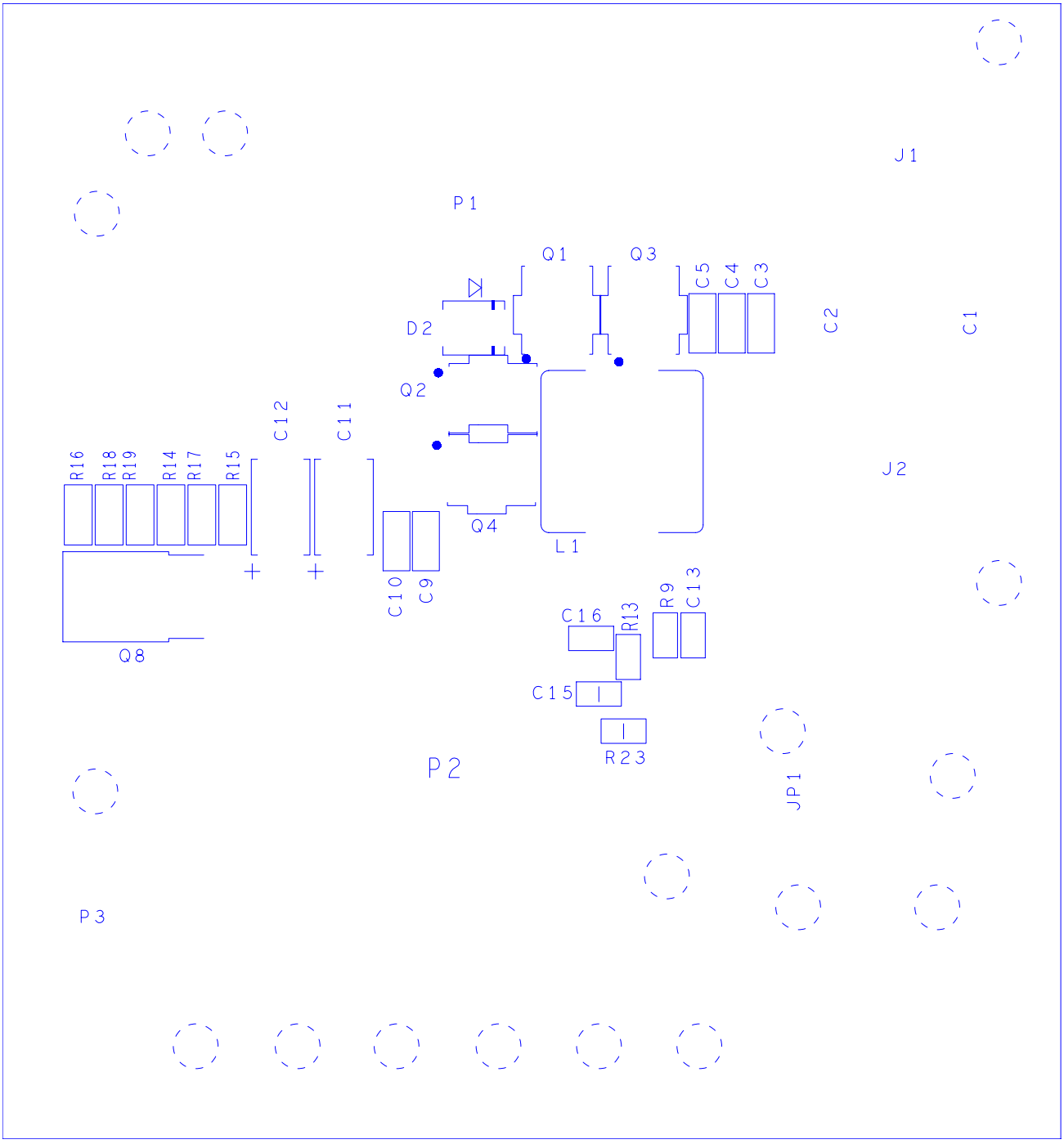

FIGURE 19. PCB BOTTOM SILK SCREEN (MIRRORED)

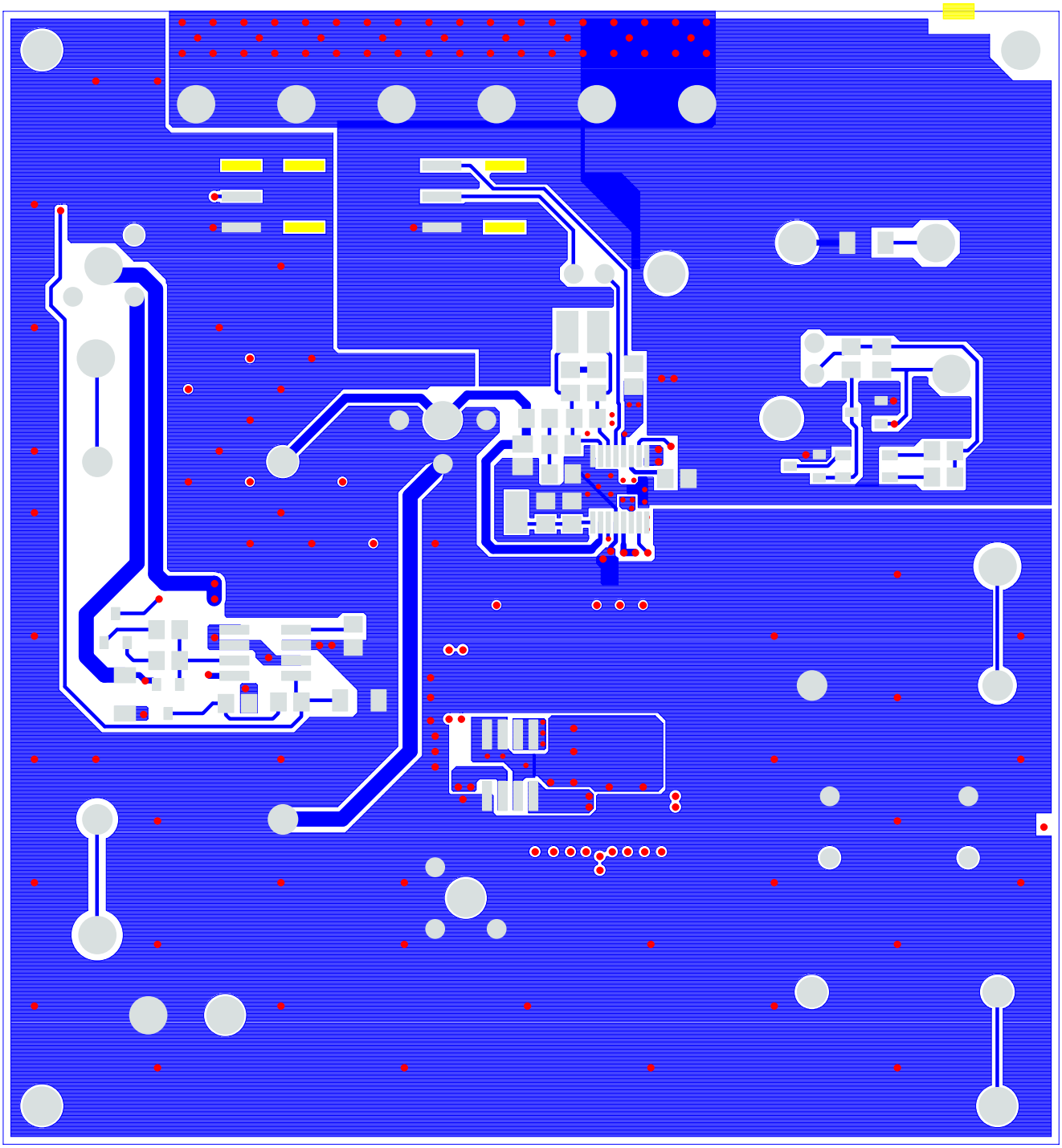

FIGURE 20. PCB TOP LAYER ETCH

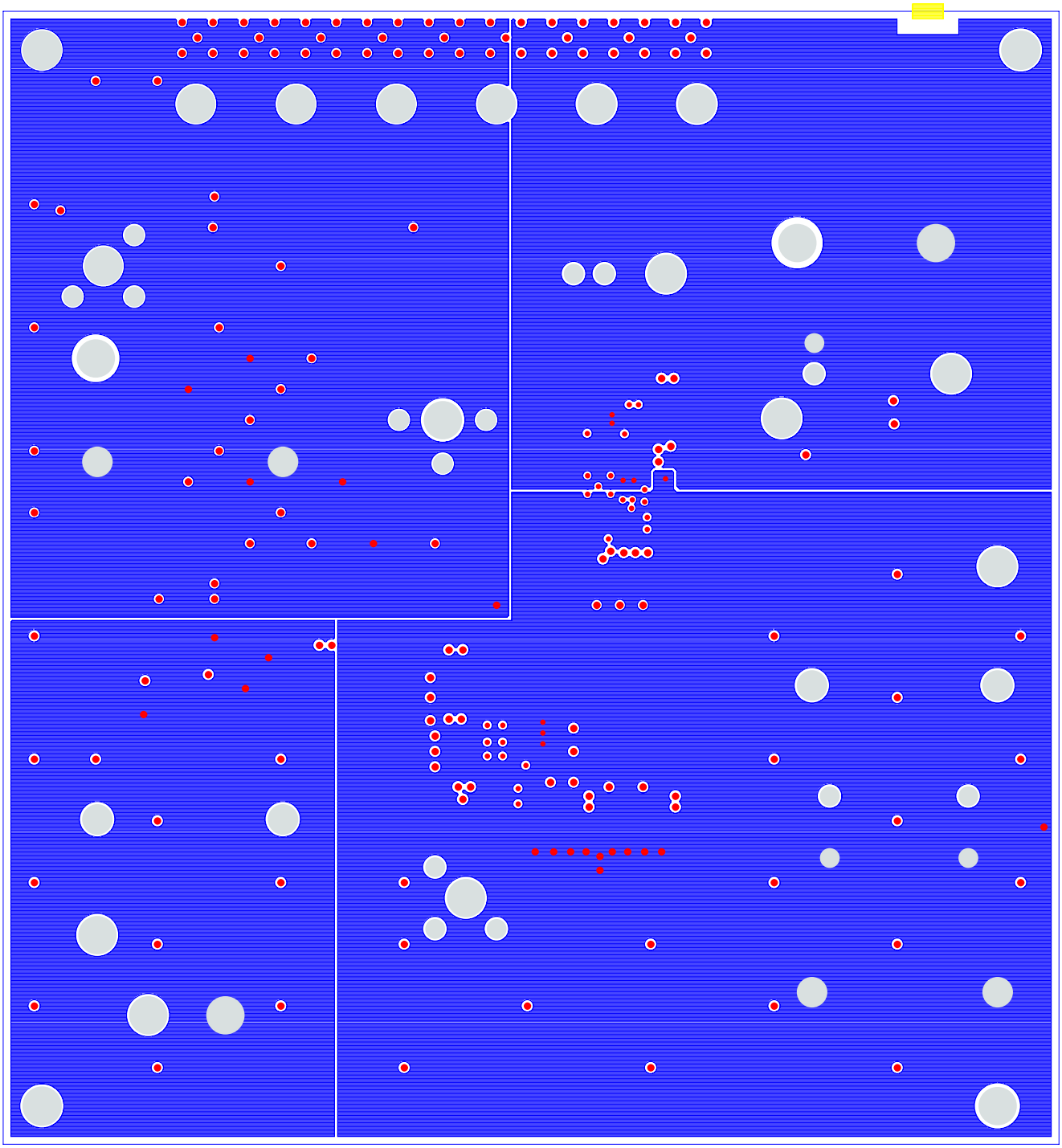

FIGURE 21. PCB LAYER 2 ETCH

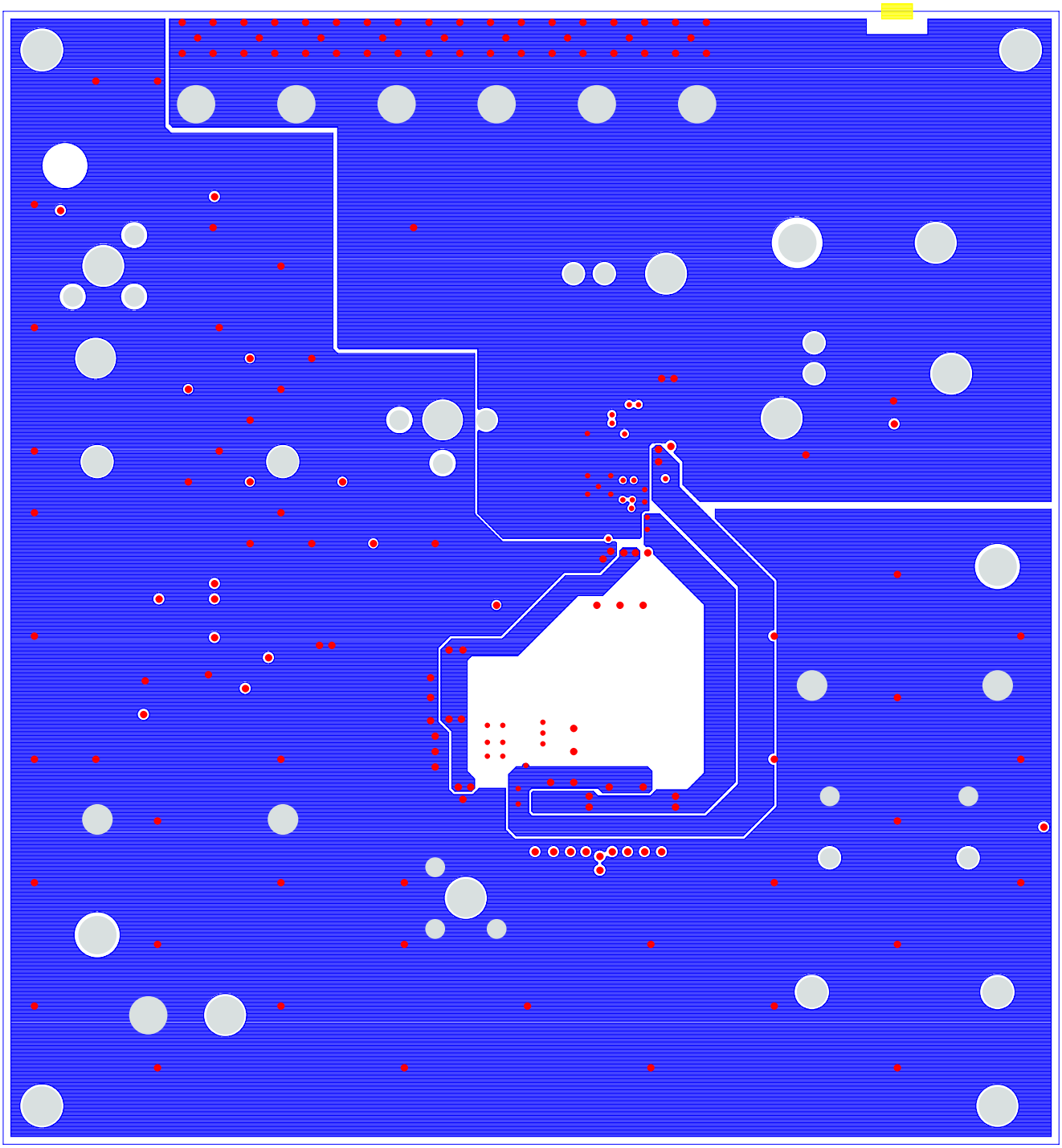

FIGURE 22. PCB LAYER 3 ETCH

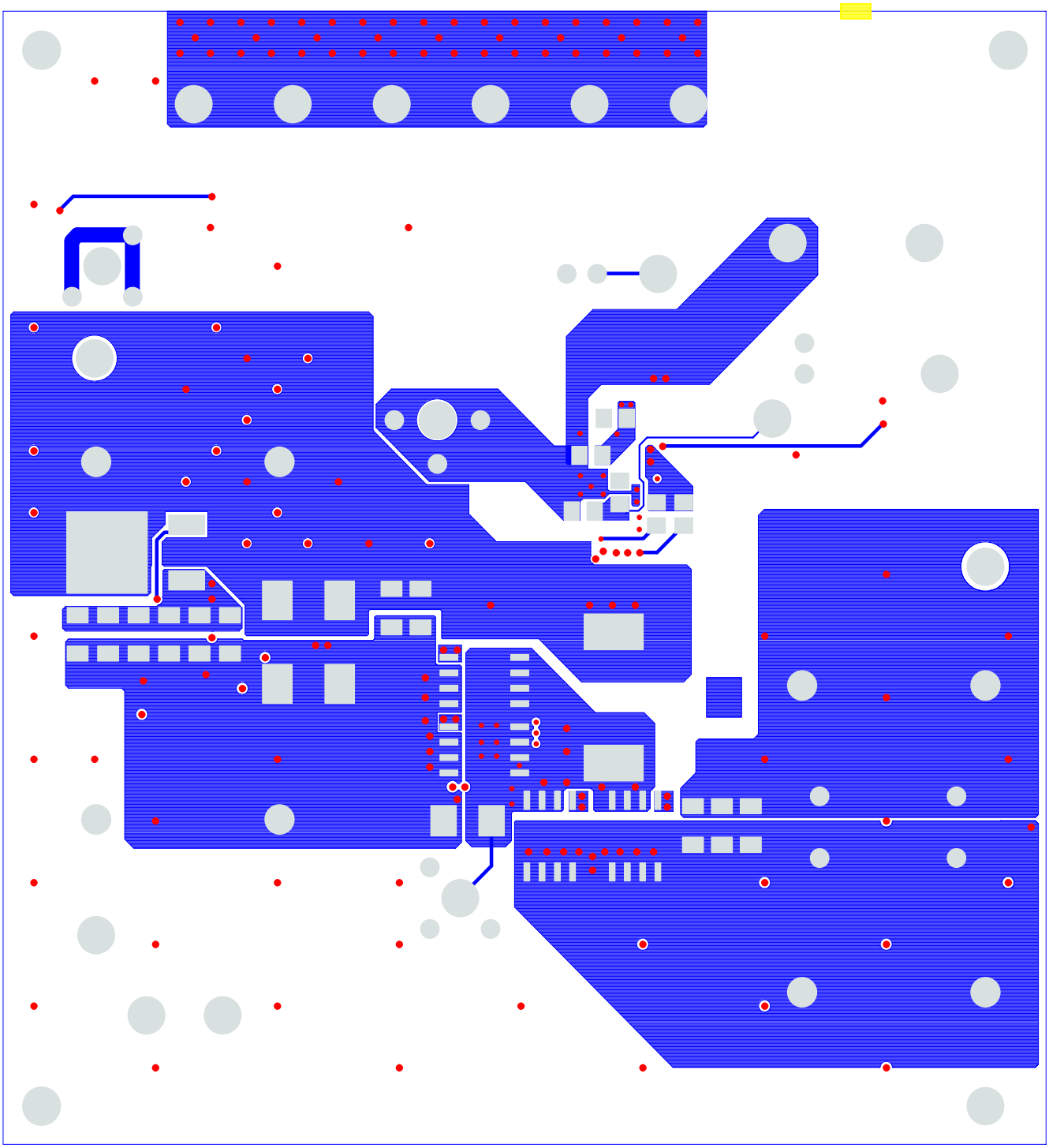

FIGURE 23. PCB BOTTOM LAYER ETCH

Bill of Materials

QTY	REFERENCE	DESCRIPTION/COMMENT	MFG NAME	MFG NUMBER
1	C2	CAP, RADIAL, 56µF, 25V, OSCON	SANYO	25SP56M
2	C11, C12	CAP, SMD, [7.3mmx4.3mm], 330µF, 2V, 7mΩ, 20%, SP-CAP	PANASONIC	EEF-SD0D331R
1	C13	CAPACITOR, 0805, 0.22µF, 16V, 20%, X7R	GENERIC	NA
1	C14	CAPACITOR, 0805, 0.1µF, 50V, 20%, X7R	GENERIC	NA
2	C15, C21	CAPACITOR, 0805, 1µF, 6.3V, 20%, X5R	GENERIC	NA
1	C16	CAPACITOR, 0805, 4.7µF, 6.3V, 20%, X5R	GENERIC	NA
2	C17, C18	CAPACITOR, 0805, 1000pF, 50V, 10%, X7R	GENERIC	NA
1	C19	CAPACITOR, 0805, 47pF, 50V, 5%, X7R	GENERIC	NA
1	C20	CAPACITOR, 0805, 470pF, 50V, 5%, X7R	GENERIC	NA
2	C9, C10	CAPACITOR, 1206, 22µF, 6.3V, 20%, X5R	GENERIC	NA
6	C3 to C8	CAPACITOR, 1206, 10µF, 25V, 20%, X5R	GENERIC	NA
1	D1	LED, SMD, 3mmx2.5mm, 4P, RED/GREEN,12/20MCD, 2V	LUMEX	SSL-LXA3025IGC-TR
1	D3	DIODE, SCHOTTKY, DUAL, SOT23, 30V, 200mA	ON-SEMI	BAT54S
3	TP7, TP8, TP9	TEST-POINT, SMD, 0.070x0.135 PAD	KEYSTONE	MTP5015SM
2	J1, J3	PLUG, BANANA, THRU-HOLE, RED, 4.23mm	MOUSER	164-6219
2	J2, J4	PLUG, BANANA, THRU-HOLE, BLK, 4.23mm	MOUSER	164-6218
4	J5, J7, TP1, TP3	TEST-POINT, VERTICAL, RED	KEYSTONE	CTP5005
10	J6, J8, TP2, TP4, TP11 to TP16	TEST-POINT, VERTICAL, BLACK	KEYSTONE	CTP5006
3	TP5, TP6, TP10	TEST-POINT, VERTICAL, WHITE	KEYSTONE	CTP5007
2	JP1, JP2	HEADER, 1x2, RETENTIVE, 2.54mm	FCI	68000-236
1	L1	INDUCTOR, SMD, 13mm, 2.2µH, 20%, 29A, SHIELDED	VISHAY	IHLP-5050CE-01-2R2M
1	Q1	MOSFET, N-CH, SMD, 8P, SO8, 30V, 9.5mΩ	IR	IRF7821
1	Q2	MOSFET, N-CH, SMD, 8P, SO8, 30V, 4mΩ	IR	IRF7832
3	Q5-Q7	MOSFET, N-CH, SMD, 3P, SOT23, 50V, 200mA	FAIRCHILD	BSS138LT1
1	Q8	MOSFET, N-CH, SMD, TO-252AA, 30V, 7mΩ	SILICONIX	SUD50N03-07
4	R1, R2, R11, R12	RESISTOR, 0805, 249Ω, 1%	GENERIC	NA
2	R8, R10	RESISTOR, 0805, 49.9kΩ, 1%	GENERIC	NA
1	R13	RESISTOR, 0805, 1Ω, 5%	GENERIC	NA
6	R14 to R19	RESISTOR, 1206, 1.5Ω, 1%	GENERIC	NA
1	R22	RESISTOR, 0805, 1kΩ, 1%	GENERIC	NA
3	R3 to R5	RESISTOR, 0805, 10kΩ, 1%	GENERIC	NA
1	R6	RESISTOR, 0805, 75kΩ, 1%	GENERIC	NA
1	R7	RESISTOR, 0805, 499Ω, 1%	GENERIC	NA
1	R9	RESISTOR, 0805, 2.1kΩ, 1%	GENERIC	NA
2	R20, R21	RESISTOR, 0805, 1.5kΩ, 1%	GENERIC	NA
2	S1, S2	TOGGLE-SWITCH, SPDT, On-None-On, SMT	C&K	GT13MSCKE
1	U1	IC, PWM-CONTROLLER, 1CH, 16P, SSOP	INTERSIL	ISL6268
1	U2	IC, DRIVER, BRIDGE, 8P, SOIC, 100V	INTERSIL	HIP2100B
	C1, D2, P1, P2, P3, Q3, Q4, Q9	NOT POPULATED		