

## Introduction

The ISL6269EVAL2Z evaluation board demonstrates the performance of the ISL6269 single-phase synchronous-buck PWM controller featuring Intersil's Robust Ripple Regulator ( $R^3$ ) technology. An on-board dynamic-load generator is included for evaluating the transient-load response, which applies a 2.5ms pulse of 120mΩ across  $V_{OUT}$  and GND every 30ms. Contents of this document include:

- Design Criteria
- Recommended Test Equipment
- Interface Connections
- Switch Descriptions
- Jumper Descriptions
- Test Point Descriptions
- Typical Waveforms
  - Start-up
  - Static continuous conduction mode
  - Static diode-emulation mode
  - Load-transient response
- Evaluation Board Documentation
  - Schematic
  - Silk-screen plots
  - Board layer plots
  - Bill of materials

**TABLE 1. DC/DC DESIGN CRITERIA**

PARAMETER	VALUE	UNITS
VIN	7 to 25	VDC
VOUT	1.10 or 1.20	VDC
FULL-LOAD	20.0	ADC
PWM FREQUENCY	300 or 600	kHz

## Design Criteria

The design criteria listed in Table 1 was, to a large extent, influenced by customer input. The PWM switching frequency can be programmed to any frequency between 200kHz and 600kHz. If only one PWM frequency setting is desired, this can be accomplished by simply not populating  $R_{17}$ . The output voltage can be programmed to any voltage between 0.6V and 3.3V. If only one output voltage setting is desired, this can be accomplished by simply not populating  $R_{16}$ .

The OCP setpoint resistor  $R_{SEN}$  ( $R_{13}$ ) is selected to protect the output load, without nuisance shutdowns due to component tolerances and temperature effects. Using Equation 1 finds  $R_{SEN}$  ( $R_{13}$ ) = 2.96kΩ. Using the next highest standard 1% value yields.  $R_{SEN}$  ( $R_{13}$ ) = 3.01kΩ where:

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

- $r_{DS(ON)}$  of Q8||Q10 low-side MOSFETs is 2mΩ
- $I_{OC}$  is 26μA
- $I_{FL}$  is 20A continuous
- $I_{PP}$  is 5.0A<sub>PP</sub> (25% of  $I_{FL}$  20A)
- $OC_{SP}$  is 1.8 (180% of  $I_{FL}$ )

The PWM switching frequency  $f_{SW}$  is programmed for 300kHz by resistance  $R_{FSET}$  ( $R_{12}$ ) when switch S2 is in the LOWER position. Setting switch S2 in the UPPER position will program  $f_{SW}$  for approximately 600kHz with the parallel resistance of  $R_{12}$  and  $R_{17}$ . Using Equation 2 finds the value for  $R_{FSET}$  ( $R_{12}$ ) = 57.6kΩ. The “K” constant in Equation 2 is ideally  $66.8 \times 10^{-12}$  however, this value can be affected by the ripple voltage on the COMP pin. The ripple voltage on the COMP pin increases with the bandwidth of the feedback loop compensation, effectively reducing the value of “K”. The ISL6269EVAL2Z evaluation board is aggressively compensated for approximately 100kHz bandwidth, making the value of “K” effectively  $58 \times 10^{-12}$ .

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

The output voltage is programmed for 1.10V using resistors  $R_{19}$  ( $R_{TOP}$ ) and  $R_{20}$  ( $R_{BOTTOM}$ ) when switch S3 is in the LOWER position. Setting switch S3 in the UPPER position will program the output voltage for 1.20V using resistor  $R_{19}$  ( $R_{TOP}$ ) and the parallel resistance of  $R_{20}$  and  $R_{16}$  ( $R_{BOTTOM}$ ). The loop compensation is usually responsible for selecting  $R_{TOP}$  ( $R_{19}$ ) which in this case is 3.01kΩ. The voltage setpoint programming resistance  $R_{BOTTOM}$  is calculated using Equation 3 where:

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

- $V_{REF}$  = 600mV
- $R_{TOP}$  = 3.01kΩ
- $V_{OUT}$  = 1.10V or 1.20V

Begin by finding the value of  $R_{20}$  for  $V_{OUT} = 1.10V$  from Equation 2:  $R_{20} = 3.57kΩ$ . Find the value of parallel resistance  $R_{20}$  and  $R_{16}$  for  $V_{OUT} = 1.20V$  from Equation 3:  $R_{20} || R_{16} = 3.01kΩ$ , therefore  $R_{16} = 19.1kΩ$ .

## Recommended Equipment

- (QTY 1) Adjustable 25V, 5A Power Supply
- (QTY 1) Fixed 12V, 100mA Power Supply
- (QTY 1) Fixed 5V, 100mA Power Supply
- (QTY 1) Adjustable 20A Constant Current Electronic Load
- (QTY 1) DVM
- (QTY 1) Four Channel Oscilloscope

## Interface Connections

- $V_{IN}$ : Input voltage to the power stage of the converter
  - J5:  $V_{IN}$  positive power input
  - J7:  $V_{IN}$  return power input
- $V_{OUT}$ : Regulated output voltage from the converter
  - J6:  $V_{OUT}$  positive power output
  - J8:  $V_{OUT}$  return power output
- +5VIN: +5V input voltage for PVCC, PGOOD-LED, and pull-up voltage rail
  - J2: 5V positive input
  - J1: 5V return input
- +12V: Input voltage for the dynamic-load generator
  - J4: 12V positive input
  - J3: 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 FPWM
  - LOWER: Selects the lower of two programmed  $f_{SW}$
  - UPPER: Selects the higher of two programmed  $f_{SW}$
- S3: DYNAMIC VOUT
  - LOWER: Selects the lower of two programmed output voltages
  - UPPER: Selects the higher of two programmed output voltages
- S4: FCCM
  - DEM: Enables diode-emulation-mode
  - CCM: Inhibits diode-emulation-mode
- S5: DYNAMIC LOAD
  - OFF: Load disabled
  - ON: Load enabled

## Jumper Descriptions

- JP1: Selects the +5V source for PVCC and auxiliary circuits. See Table 1 for list of configurations.
- JP2: Connects +5V supply to the PGOOD LED circuit and pull-up resistors. The shunt jumper is normally installed and should be removed when making low power efficiency measurements.

- JP3: Isolates the EN input pin from switch S1 so that an external signal can be used.
- JP4: Isolates the frequency range selection switch S2 so that an external signal can be used.
- JP5: Isolates the  $V_{OUT}$  selection switch S3 so that an external signal can be used.
- JP6: Isolates the FCCM input pin from switch S4 so that an external signal can be used.
- JP7: Isolates the PGOOD input pin from the LED circuit so that the pull-down resistance can be measured.
- JP8: Opens the circuit path to the VIN pin so that an ammeter can be inserted for measuring current into the VIN pin.

TABLE 2. JUMPER JP1 CONFIGURATIONS

JP1			SOURCE OF 5V		
PIN 1 TO 2	PIN 3 TO 4	PIN 5 TO 6	VCC	PVCC	AUX
OPEN	SHORT	SHORT	LDO	J2	J2
SHORT	OPEN	SHORT	LDO	LDO	J2

## Test-point Descriptions

- TP1 to TP5: Signal ground
- TP6: Scope-probe socket for measuring  $V_{IN}$
- TP7: Monitors the voltage at the PVCC pin
- TP8: Monitors the voltage of JP1 pins 2, 4 and 6
- TP9: Monitors the voltage at JP4 pin 1
- TP10: Monitors the voltage at JP5 pin 1
- TP11: Monitors the voltage at the PGOOD pin
- TP12: Monitors the voltage at the FSET pin
- TP13: Monitors the voltage at the upper feedback resistor
- TP14: Monitors the voltage at the FB pin (SENSITIVE)
- TP15: Monitors the voltage at the COMP pin (SENSITIVE)
- TP16: Monitors the voltage at the EN pin
- TP17: Monitors the voltage at the FCCM pin
- TP18: Monitors the voltage at the VCC pin
- TP19: Scope-probe socket for measuring  $V_{OUT}$
- TP20:  $V_{IN}$  positive voltage sense
- TP21:  $V_{IN}$  return voltage sense
- TP22: Monitors the voltage at the VIN pin
- TP23:  $V_{OUT}$  positive voltage sense
- TP24:  $V_{OUT}$  return voltage sense
- TP25: Scope-probe socket for measuring the voltage of the PHASE node
- TP26: Scope-probe socket for measuring voltage across the dynamic-load resistors (hence load current)
- TP27: Monitors the voltage at the gate terminal of the dynamic load MOSFET

Typical Waveforms

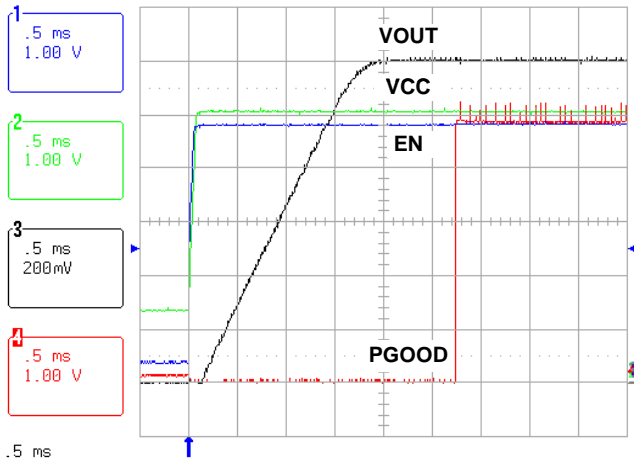


FIGURE 1. SOFT-START: 50Ω-LOAD, FCCM = HIGH

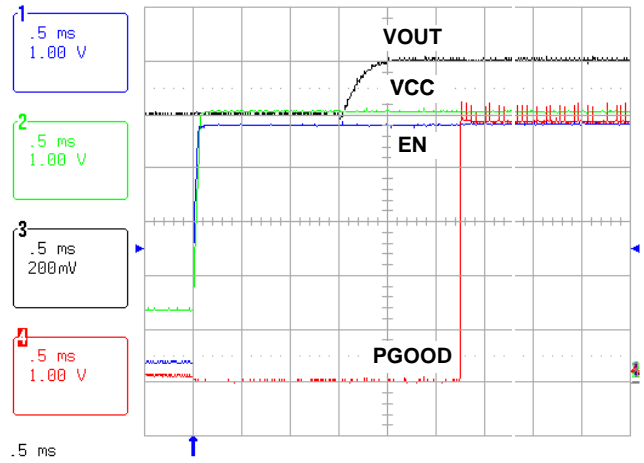


FIGURE 2. SOFT-START: 50Ω-LOAD, FCCM = HIGH, 1V VOUT-PREBIAS

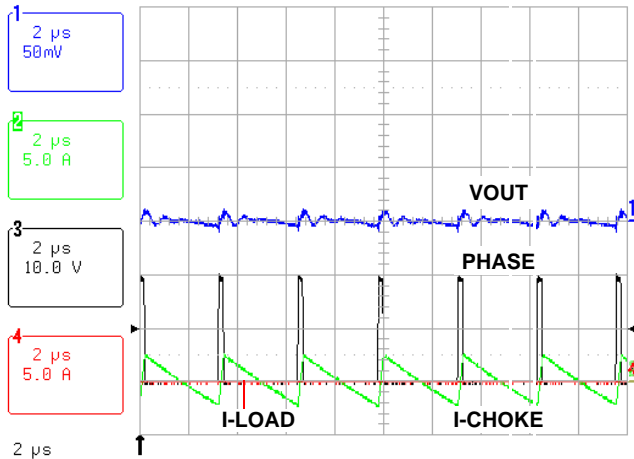


FIGURE 3. CCM INDUCTOR CURRENT: NO-LOAD

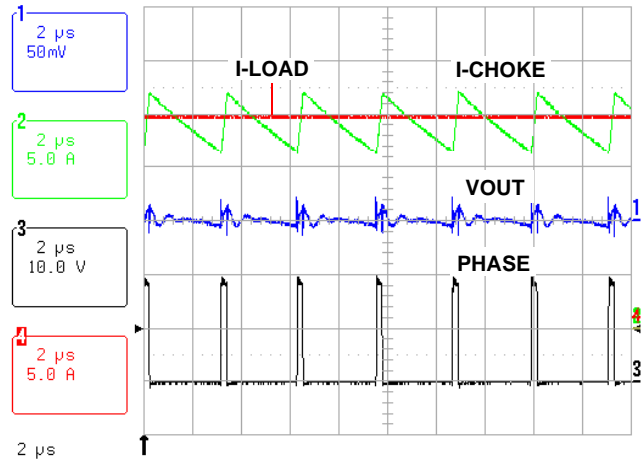


FIGURE 4. CCM INDUCTOR CURRENT: 20A LOAD

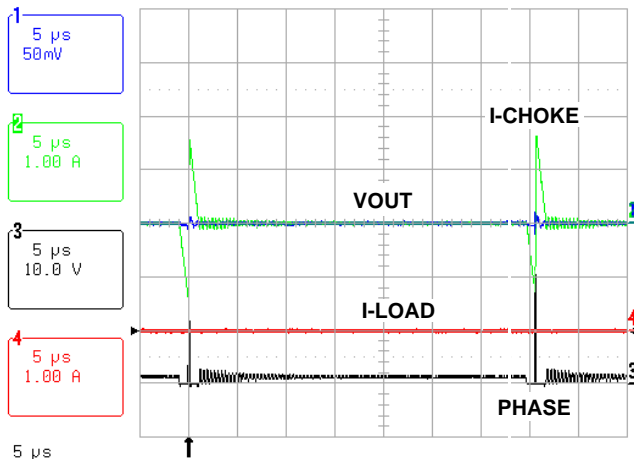


FIGURE 5. DCM INDUCTOR CURRENT: NO-LOAD

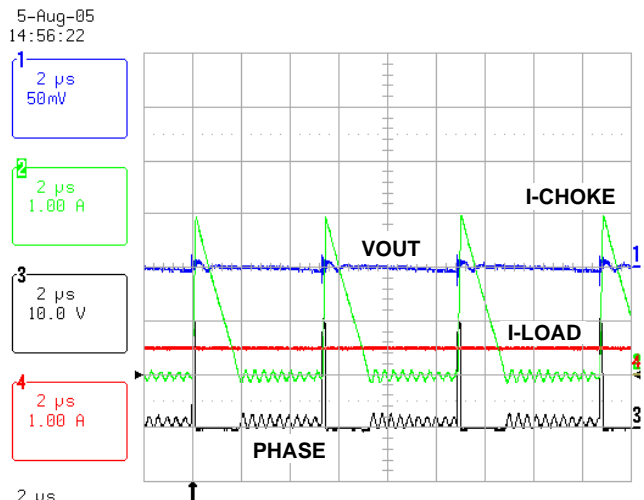


FIGURE 6. DCM INDUCTOR CURRENT: 500mA LOAD

Typical Waveforms (Continued)

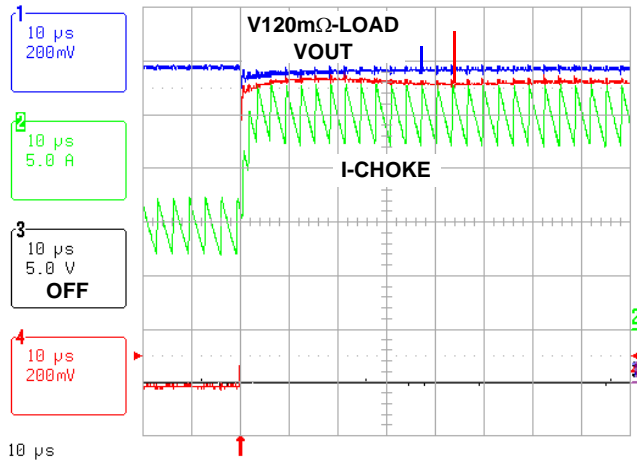


FIGURE 7. CCM TRANSIENT LOAD-STEP: 10A STATIC LOAD

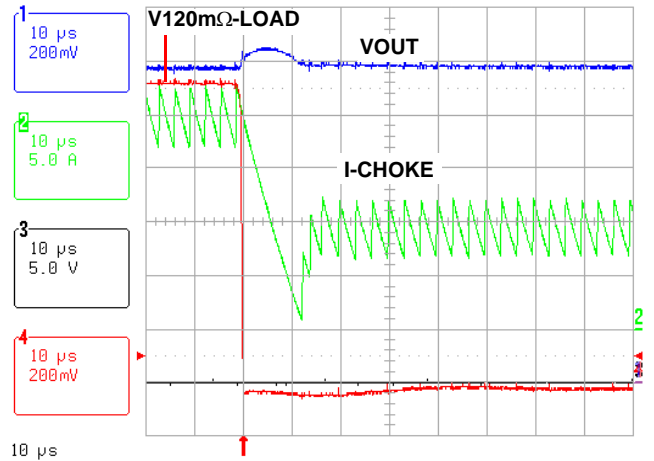


FIGURE 8. CCM TRANSIENT LOAD-DUMP: 10A STATIC LOAD

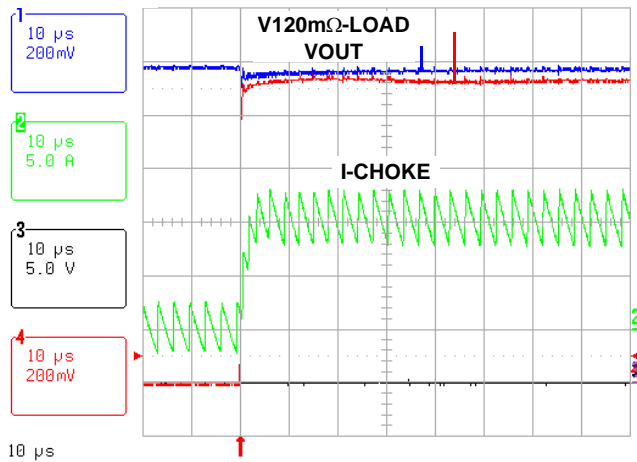


FIGURE 9. CCM TRANSIENT LOAD-STEP: NO STATIC LOAD

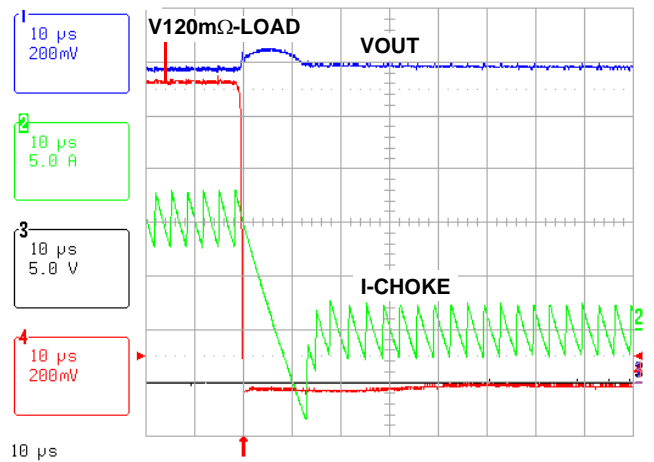


FIGURE 10. CCM TRANSIENT LOAD-DUMP: NO STATIC LOAD

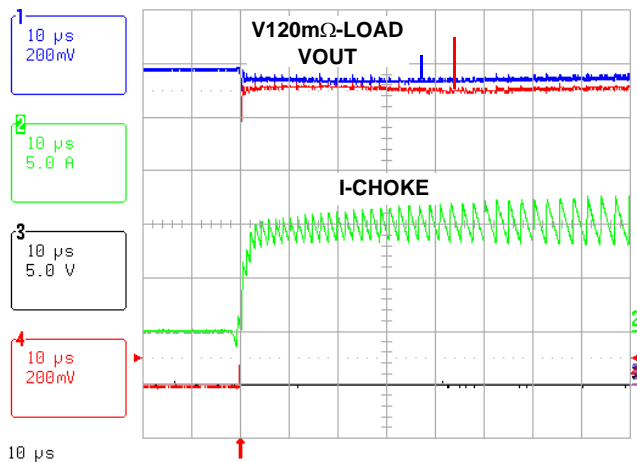


FIGURE 11. DCM TRANSIENT LOAD-STEP: NO STATIC LOAD

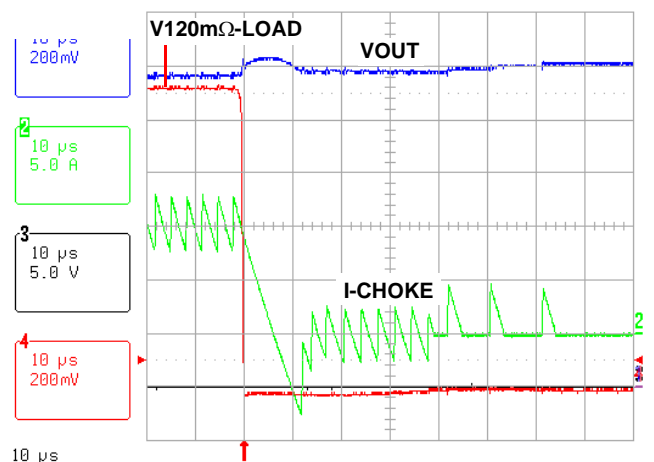


FIGURE 12. DCM TRANSIENT LOAD-DUMP: NO STATIC LOAD

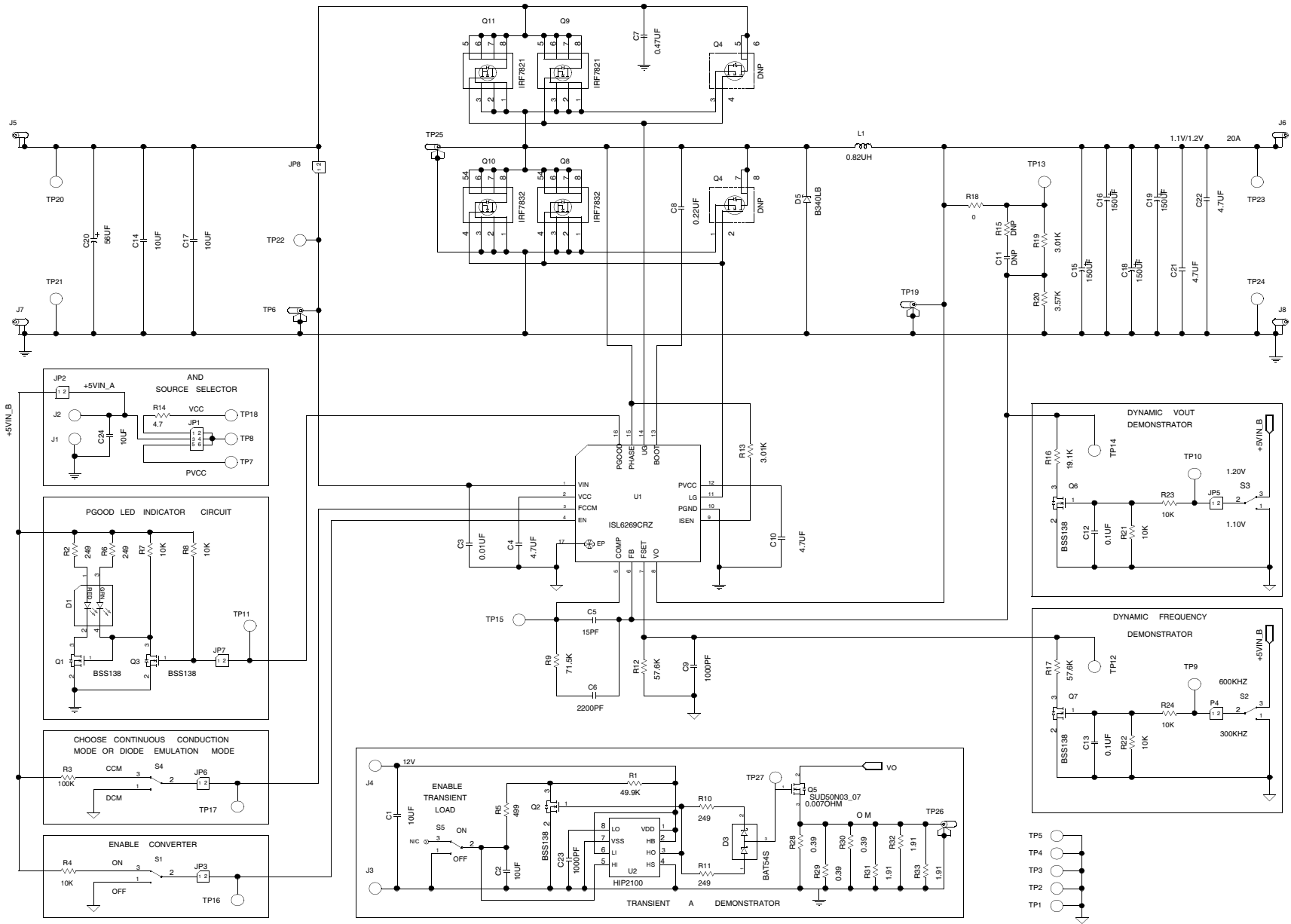


FIGURE 1. ISL6269EVAL2Z CIRCUIT SCHEMATIC

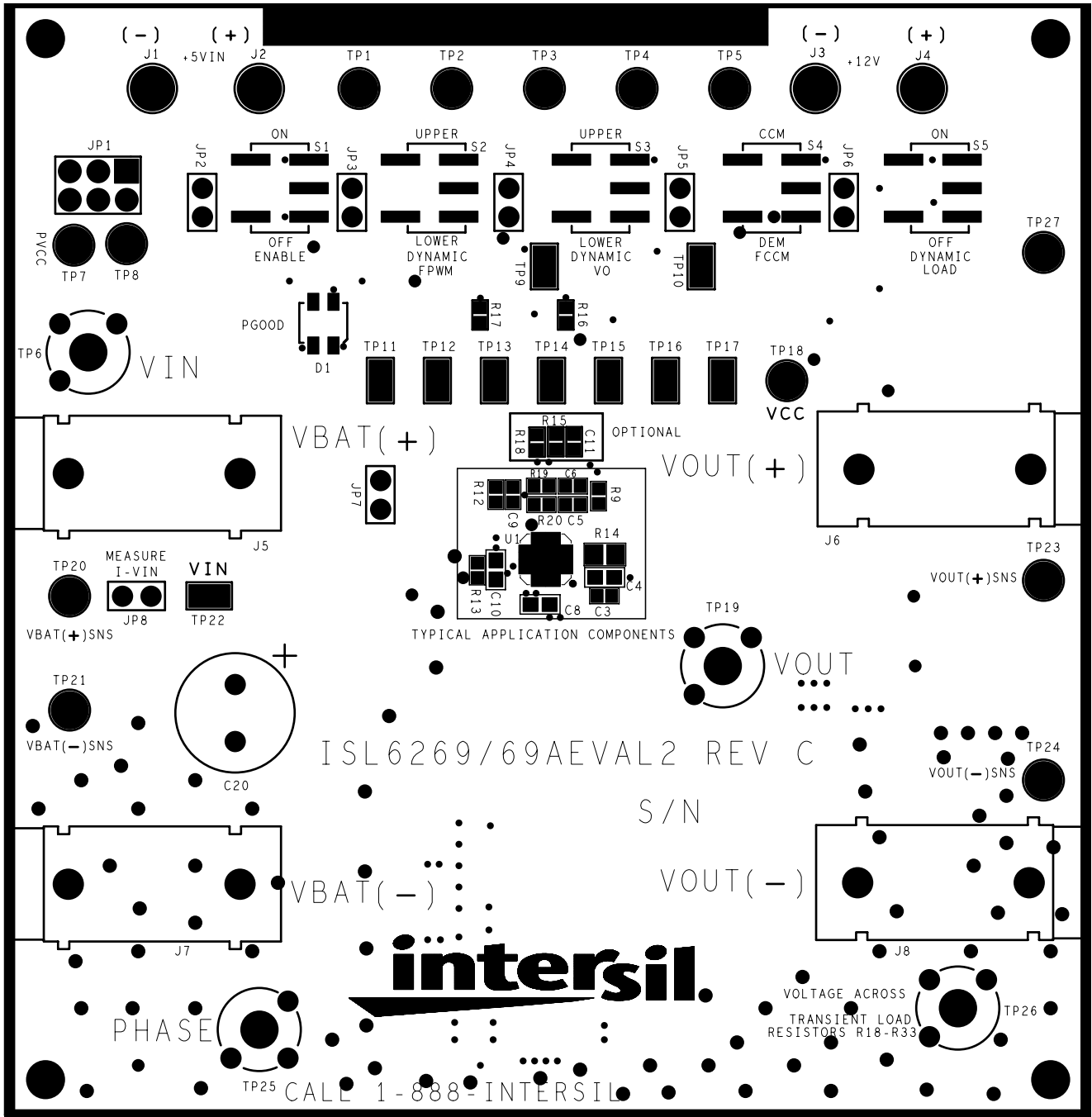


FIGURE 13. PCB TOP SILK SCREEN

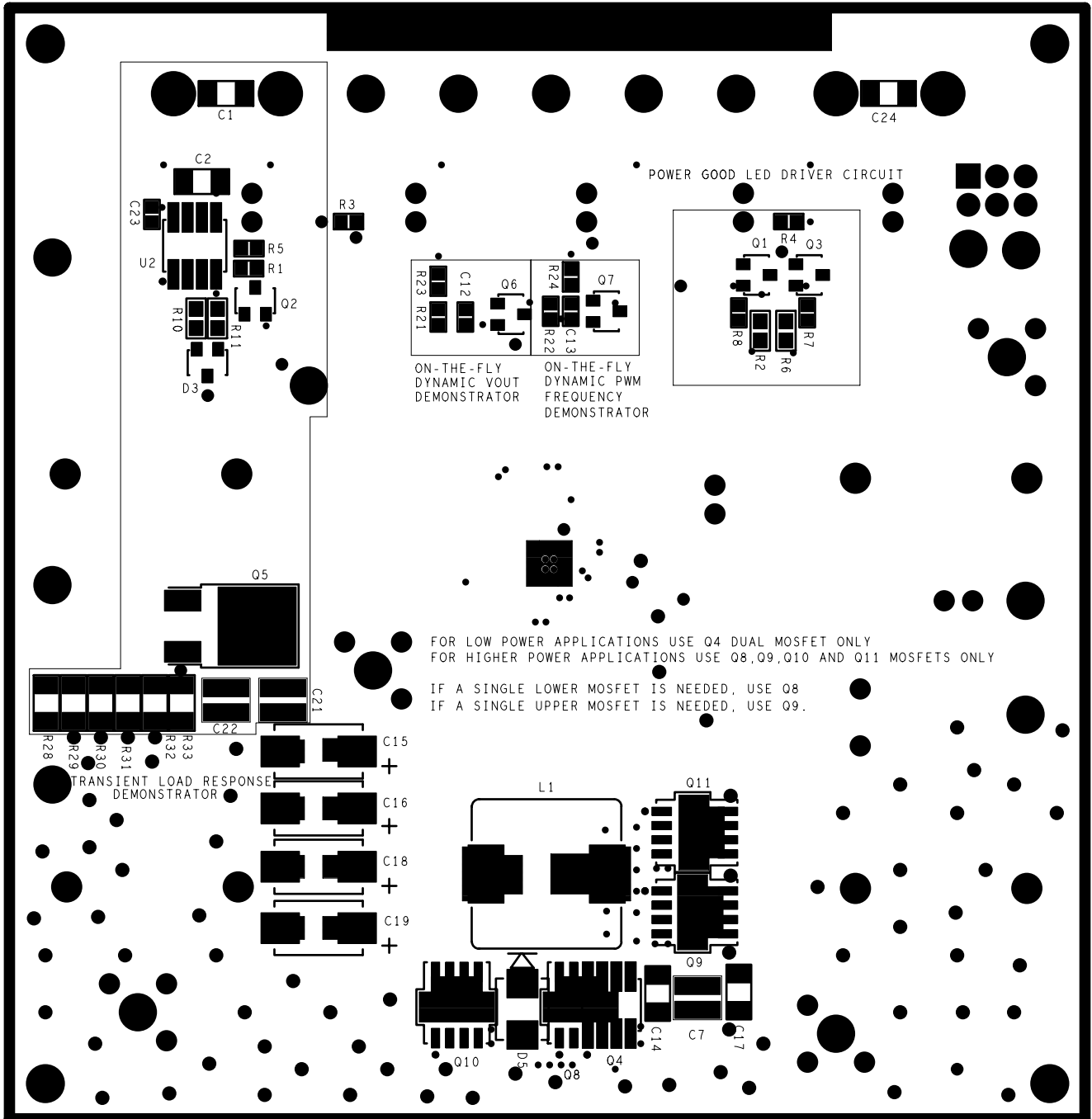


FIGURE 14. PCB BOTTOM SILK SCREEN (MIRRORED)

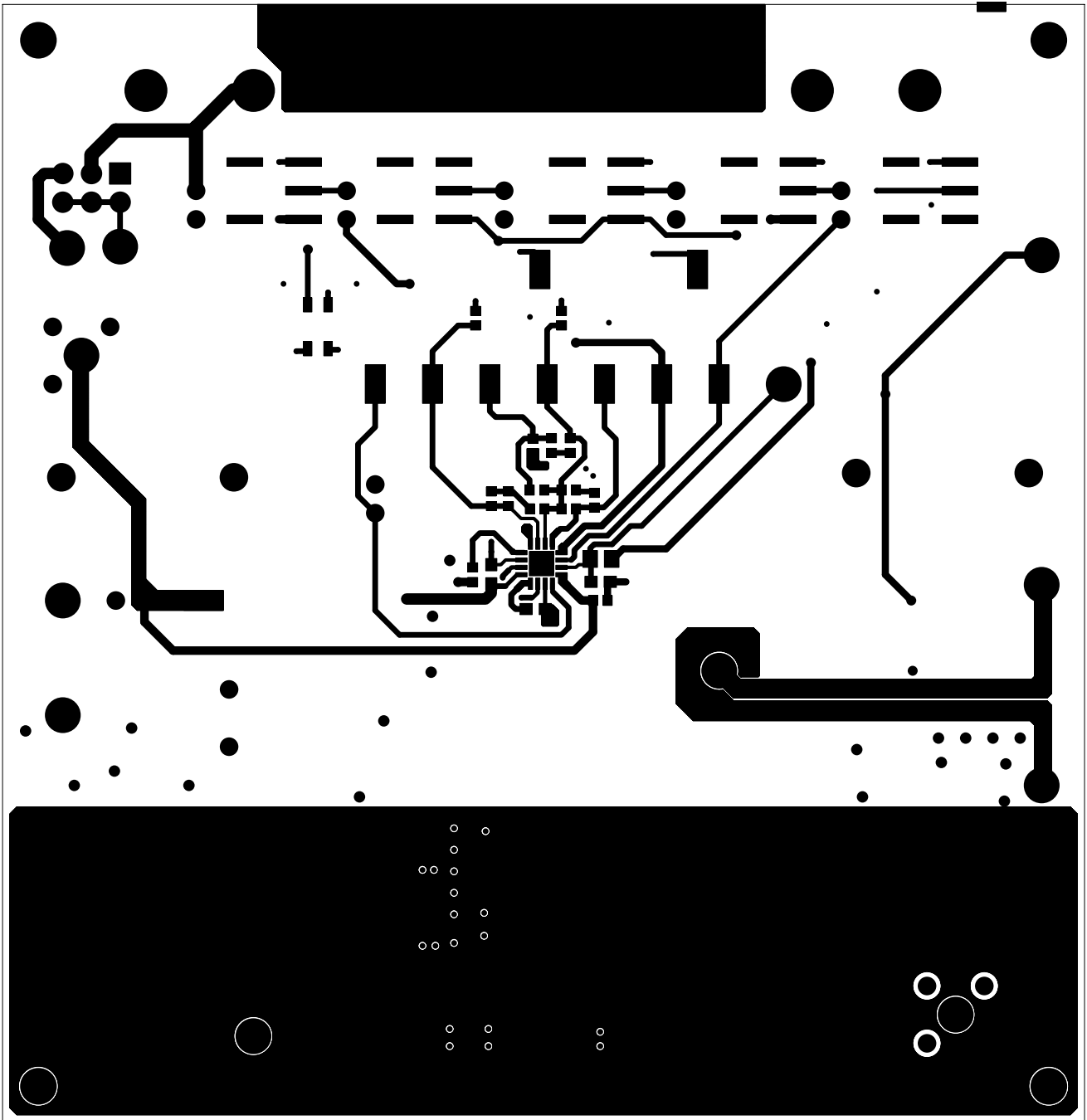


FIGURE 15. PCB TOP LAYER ETCH



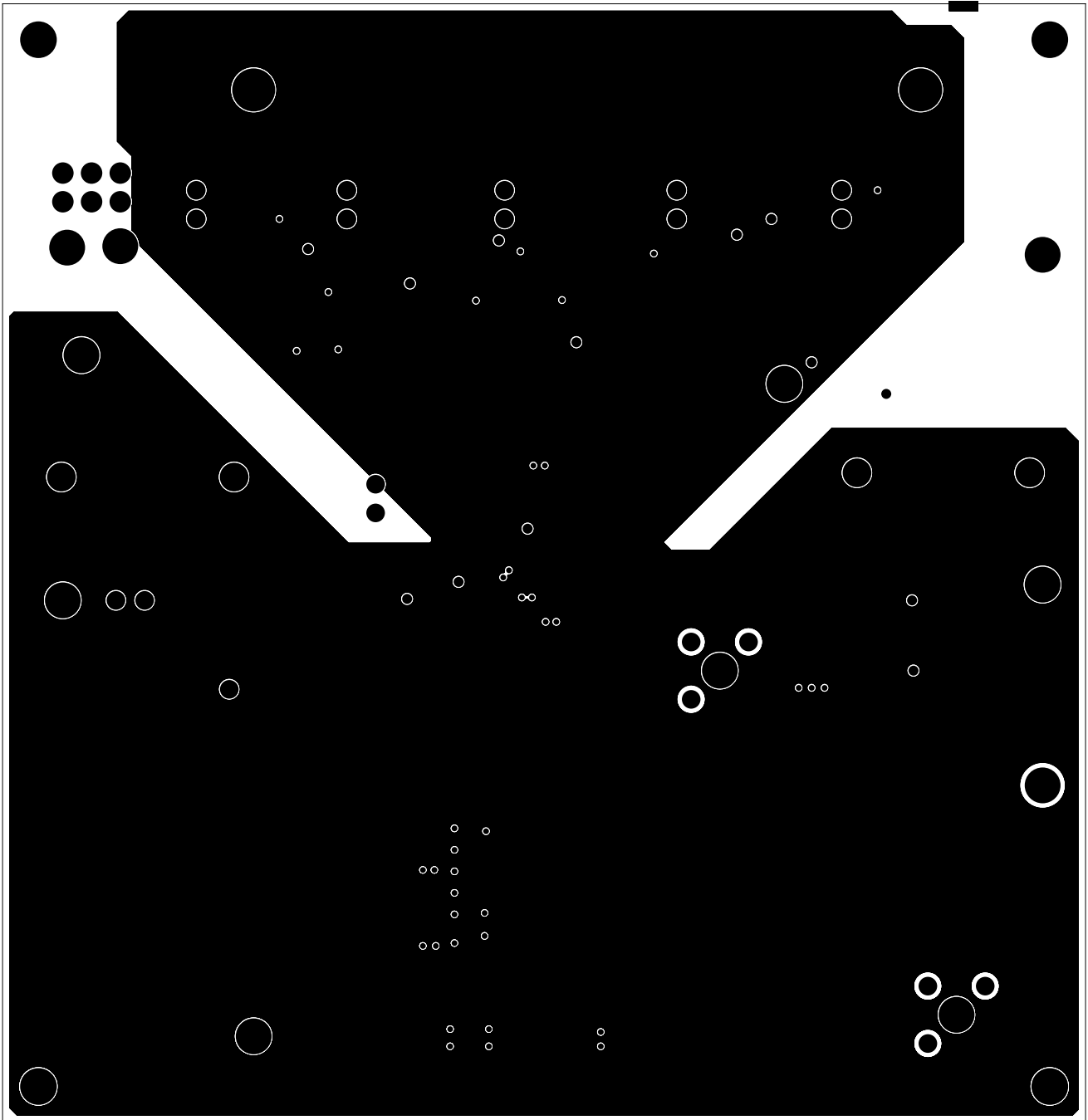


FIGURE 16. PCB LAYER 2 ETCH

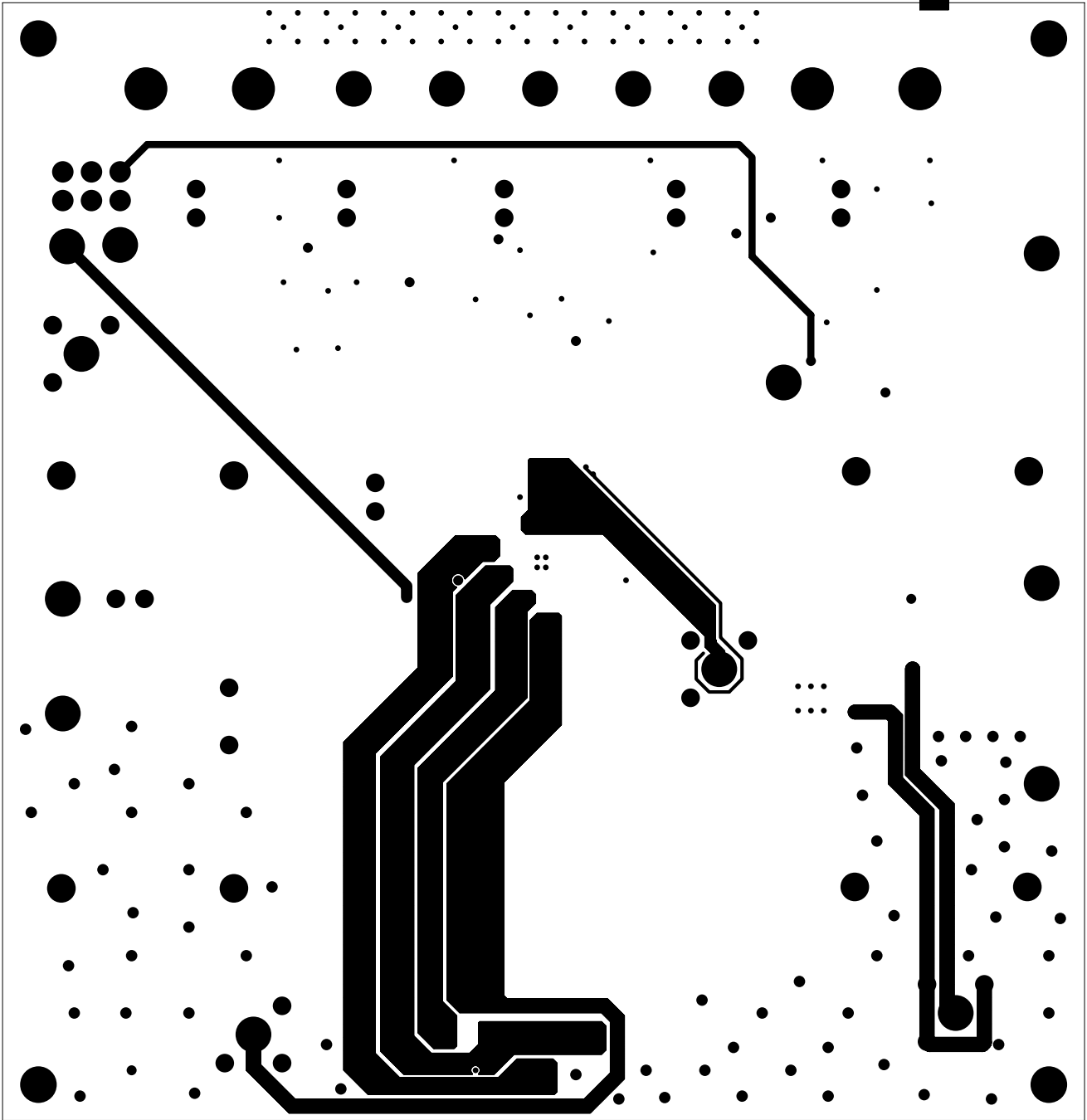


FIGURE 17. PCB LAYER 3 ETCH

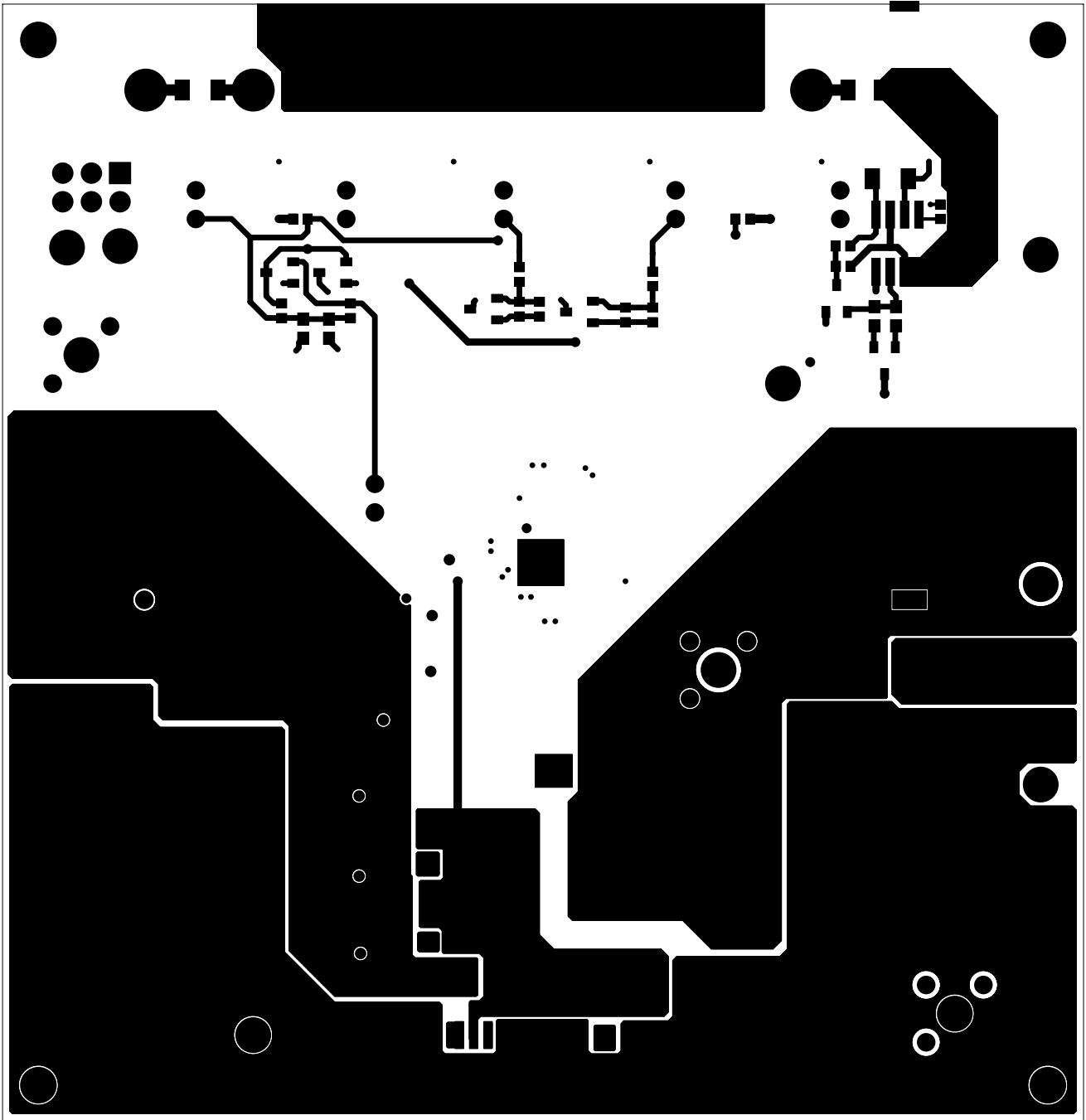


FIGURE 18. PCB BOTTOM LAYER ETCH

## Application Note 1194

### Bill of Materials

QTY	REFERENCE	DESCRIPTION/COMMENT	MFG NAME	MFG NUMBER
5	C1, C2, C14, C17, C24	CAP, SMD, 1206, 10µF, 25V, 20%, X5R, ROHS	PANASONIC	ECJ-3YB1E106M
2	C12, C13	CAP, SMD, 0402, 0.1µF, 25V, 10%, X5R, ROHS	TDK	C1005X5R1E104K
4	C15, C16, C18, C19	CAP, SMD, 7.3mmx4.3mm, 150µF, 4V, 20%, SP-CAP	PANASONIC	EEF-SD0G151R
1	C20	CAP, RADIAL, 56µF, 25V, OSCON	SANYO	25SP56M
2	C21, C22	CAPACITOR, SMD, 0612, 4.7µF, 6.3V, 10%, X5R	TDK	C1632X5R0J475K
1	C3	CAP, SMD, 0402, 0.01µF, 25V, 10%, X7R, ROHS	AVX	04023C103KAT
2	C4, C10	CAP, SMD, 0603, 4.7µF, 6.3V, 20%, X5R, ROHS	TDK	C1608X5R0J475M
1	C5	CAP, SMD, 0402, 15pF, 50V, 5%, NPO, ROHS	MURATA	GRM36COG150J050AQ
1	C6	CAP, SMD, 0402, 2200pF, 50V, 10%, X7R, ROHS	PANASONIC	ECJ-0EB1H222K
1	C7	CAPACITOR, SMD, 0612, 0.47µF, 25V, 10%, X7R	TDK	C1632X7R1E474K
1	C8	CAP, SMD, 0603, 0.22µF, 25V, 20%, X7R, ROHS	VISHAY	VJ0603X224MXXAT
2	C9, C23	CAP, SMD, 0402, 1000pF, 50V, 5%, C0G, ROHS	MURATA	GRM1555C1H102JA01D
1	D1	LED, SMD, 3mmx2.5mm, 4P, RED/GREEN, 12/20MCD, 2V	LUMEX	SSL-LXA3025IGC-TR
1	D3	DIODE, SCHOTTKY, DUAL, SOT23, 30V, 200mA	FAIRCHILD	BAT54S
1	D5	DIODE-SCHOTTKY, SMB, 40V, 3A, LOW-VF, ROHS	DIODES INC.	B340LB-13-F
4	J1 to J4	TERMINAL, TURRET-POST, TH, ROHS	KEYSTONE	1514-2
2	J5, J6	PLUG, BANANA, THRU-HOLE, RED, 4.23mm, ROHS	MOUSER	164-6219
2	J7, J8	PLUG, BANANA, THRU-HOLE, BLKD, 4.23mm, ROHS	MOUSER	164-6218
1	JP1	HEADER, 2x3, BRKAWY 2x36, 2.54mm, ST	BERG/FCI	67996-272
7	JP2 to JP8	HEADER, 1x2, RETENTIVE, 2.54mm, ST, ROHS	BERG/FCI	69190-202
10	JP1(1 to 2, 3 to 4, 5 to 6), JP2 to JP8	JUMPER, 2PIN, HIGHBDY, SHUNT	BERG/FCI	71363-102
1	L1	INDUCTOR, SMD, 13mm, 0.82µH, 20%, 44A, SHIELDED	VISHAY	IHLP5050CEERR82M01
5	Q1, Q2, Q3, Q6, Q7	MOSFET, N-CH, SMD, 3P, SOT23, 50V, 0.2A, Pb-free	DIODES INC.	BSS138-7-F
2	Q8, Q10	MOSFET, N-CH, 8P, SOIC, 30V, 4mΩ	IR	IRF7832PBF
2	Q8, Q9	MOSFET, N-CH, 8P, SOIC, 30V, 9.1mΩ	IR	IRF7821PBF
1	Q5	MOSFET, N-CH, SMD, TO-252AA, 30V, 7mΩ	VISHAY	SUD50N03-07
1	R1	RES, SMD, 0402, 49.9k, 1/16W, 1%, TF, ROHS	PANASONIC	ERJ-2RKF4992
2	R12, R17	RES, SMD, 0402, 57.6k, 1/16W, 1%, TF, ROHS	PANASONIC	ERJ-2RKF5762X
1	R14	RES, SMD, 0805, 4.7Ω, 1/8W, 5%, TF, ROHS	PANASONIC	ERJ-6GEYJ4R7V
1	R16	RES, SMD, 0402, 19.1k, 1/16W, 1%, TF, ROHS	PANASONIC	ERJ-2RKF1912
1	R18	RES, SMD, 0402, 0Ω, 1/16W, 5%, TF, ROHS	PANASONIC	ERJ-2GE0JR00
2	R13, R19	RES, SMD, 0402, 3.01k, 1/16W, 1%, TF, ROHS	PANASONIC	ERJ-2RKF3011
4	R2, R6, R10, R11	RES, SMD, 0603, 249Ω, 1/16W, 1%, TF, ROHS	PANASONIC	ERJ-3EKF2490
1	R20	RES, SMD, 0402, 3.57k, 1/16W, 1%, TF, ROHS	PANASONIC	ERJ-2RKF3571X
3	R28, R29, R30	RES, SMD, 1206, 0.39Ω, 1/4W, 1%, TF, ROHS	PANASONIC	ERJ-8RQFR39V
1	R3	RES, SMD, 0402, 100k, 1/16W, 1%, TF, ROHS	PANASONIC	ERJ2RKF1003
3	R31, R32, R33	RES, SMD, 1206, 1.91Ω, 1/4W, 1%, TF, ROHS	YAGEO	9C12063A1R91FGHFT
7	R4, R7, R8, R21 to R24	RES, SMD, 0402, 10k, 1/16W, 1%, TF, ROHS	PANASONIC	ERJ-2RKF1002
1	R5	RES, SMD, 0402, 499Ω, 1/16W, 1%, TF, ROHS	PANASONIC	ERJ-2RKF4990X

## Application Note 1194

### Bill of Materials (Continued)

QTY	REFERENCE	DESCRIPTION/COMMENT	MFG NAME	MFG NUMBER
1	R9	RES, SMD, 0402, 71.5k, 1/16W, 1%, TF, ROHS	PANASONIC	ERJ-2RKF7152X
5	S1 to S5	SWITCH-TOGGLE, SMD, ULTRAMINI, 1P, SPST, MINI	C&K	GT11MSCKE
7	TP1 to TP5, TP21, TP24	COMPACT TEST PT, VERTICAL, BLK, ROHS	KEYSTONE	5006
1	TP27	COMPACT TEST PT, VERTICAL, WHT, ROHS	KEYSTONE	5007
4	TP6, TP19, TP25, TP26	SCOPE PROBE TEST POINT, PCB MNT	TEKTRONIX	131-4353-00
5	TP7, TP8, TP18, TP20, TP23	COMPACT TEST PT, VERTICAL, RED, ROHS	KEYSTONE	5005
10	TP9 to TP17, TP22	MINI TEST POINT, SMD	KEYSTONE	5015
1	U1	IC-PWM CONTROLLER, 16P, QFN, 4x4, Pb-free	INTERSIL	ISL6269CRZ
1	U2	IC-HI FREQ BRIDGE DRIVER, 8P, SOIC, 100V	INTERSIL	HIP2100IB

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