

ISL6269AEVAL2Z

User Guide For ISL6269A and ISL6269B PWM Controllers

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Introduction

The ISL6269AEVAL2Z evaluation board demonstrates the performance of the ISL6269A or ISL6269B single-phase synchronous-buck PWM controller featuring Intersil's Robust Ripple Regulator (R³) technology. The ISL6269AEVAL2Z is shipped with the ISL6269A controller installed. The ISL6269B controller can be evaluated using the ISL6269AEVAL2Z with no further circuit modifications beyond changing the IC. An on-board dynamic-load generator is included for evaluating the transient-load response, that applies a 2.5ms pulse of 250mΩ 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
 - Shut-down
 - Diode-emulation
 - Load-transient response
 - Line-transient response
- Evaluation Board Documentation
 - Schematic
 - Bill of materials
 - Silk-screen plots
 - Board layer plots

TABLE 1. DC/DC DESIGN CRITERIA

| PARAMETER | VALUE | UNITS |
|---------------|--------------|-------|
| VIN | 5 to 25 | VDC |
| VOUT | 1.10 or 1.20 | VDC |
| FULL-LOAD | 5.0 | 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 R₁₇. 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 R₁₆.

The OCP setpoint resistor R_{SEN} (R₁₃) is selected to protect the output load, without nuisance shutdowns due to component tolerances and temperature effects. Using Equation 1 finds R_{SEN} (R₁₃) = 6.49kΩ 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 Q4 low-side MOSFETs is 15mΩ
- I_{OC} is 26μA
- I_{FL} is 5A continuous
- I_{PP} is 1.5A_{PP} (30% of I_{FL} 5A)
- OC_{SP} is 2.1 (210% of I_{FL})

The PWM switching frequency f_{SW} is programmed for 300kHz by resistance R_{FSET} (R₁₂) 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 R₁₂ and R₁₇. Using Equation 2 finds the value for R_{FSET} (R₁₂) = 57.6kΩ. The “K” constant in Equation 2 is ideally 66.8 x 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 ISL6269AEVAL2Z evaluation board is aggressively compensated for approximately 100kHz bandwidth, making the value of “K” effectively 58 x 10⁻¹².

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

The output voltage is programmed for 1.10V using resistors R₁₉ (R_{TOP}) and R₂₀ (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 R₁₉ (R_{TOP}) and the parallel resistance of R₂₀ and R₁₆ (R_{BOTTOM}). The loop compensation is usually responsible for selecting R_{TOP} (R₁₉), 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 R₂₀ for V_{OUT} = 1.10V from Equation 2: R₂₀ = 3.57kΩ. Find the value of parallel resistance R₂₀ and R₁₆ for V_{OUT} = 1.20V from Equation 3: R₂₀ || R₁₆ = 3.01kΩ, therefore R₁₆ = 19.1kΩ.

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 5A 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 VCC, 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. Remove the shunt jumper 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 |
| SHORT | SHORT | SHORT | J2 | J2 | J2 |
| SHORT | OPEN | SHORT | TP8 | TP8 | J2 |
| SHORT | SHORT | OPEN | J2 | TP7 | 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

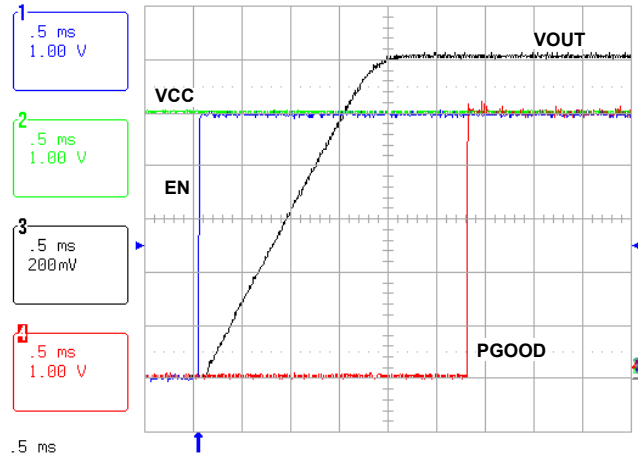


FIGURE 1. SOFT-START: 250mΩ LOAD, FCCM = HIGH

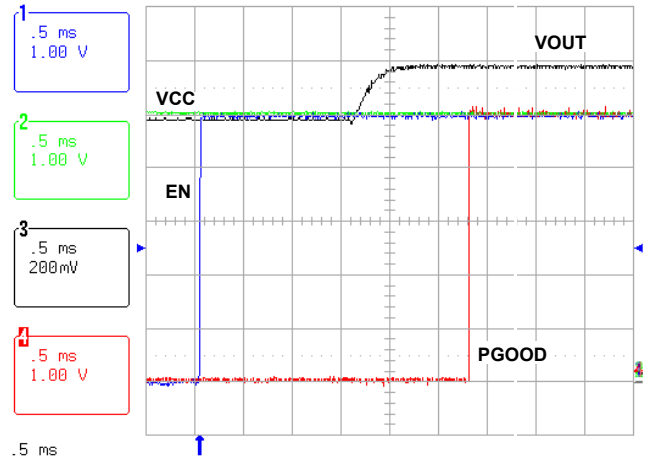


FIGURE 2. SOFT-START: NO-LOAD, FCCM = HIGH, 1V VOUT-PREBIAS

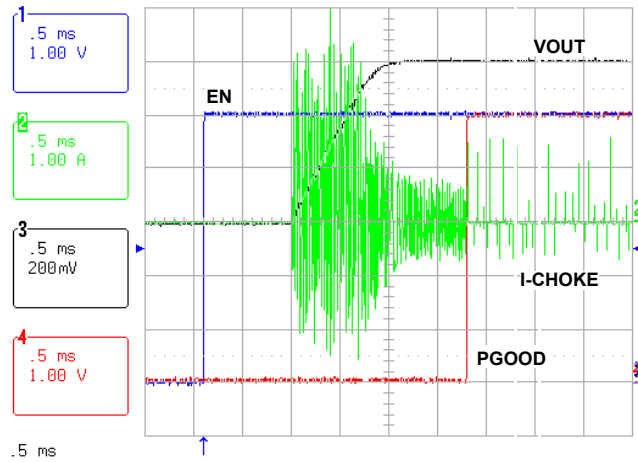


FIGURE 3. OUTPUT CAPACITOR IN-RUSH CURRENT: 50Ω LOAD, FCCM = LOW, 1V VOUT-PREBIAS

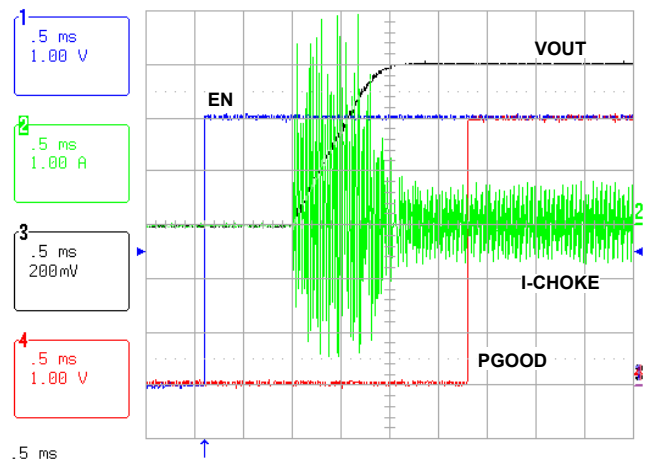


FIGURE 4. OUTPUT CAPACITOR IN-RUSH CURRENT: 50Ω LOAD, FCCM = HIGH, 1V VOUT-PREBIAS

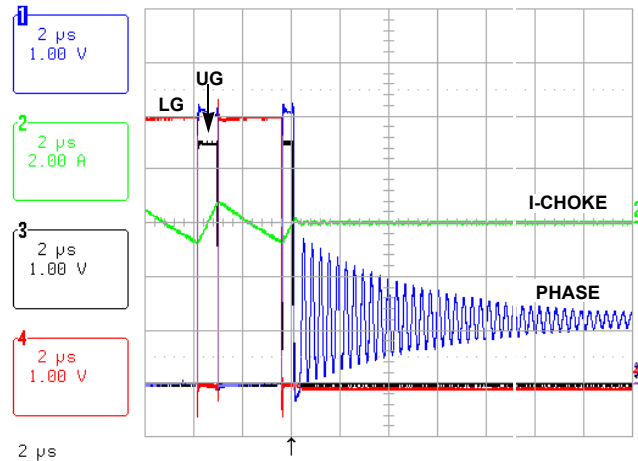


FIGURE 5. SHUTDOWN: EN PULLED LOW, NO-LOAD

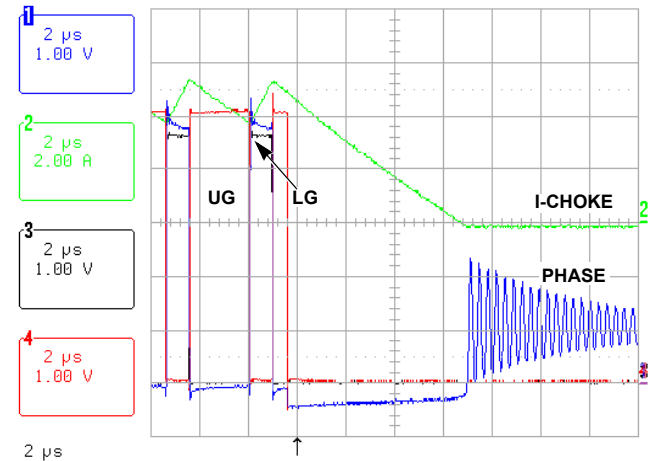


FIGURE 6. SHUTDOWN: EN FALLING, 250mΩ-LOAD

Typical Waveforms (Continued)

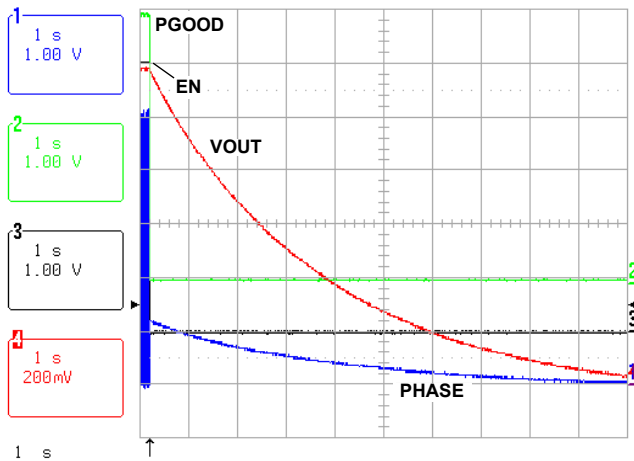


FIGURE 7. SHUTDOWN: VOUT DECAY, NO-LOAD

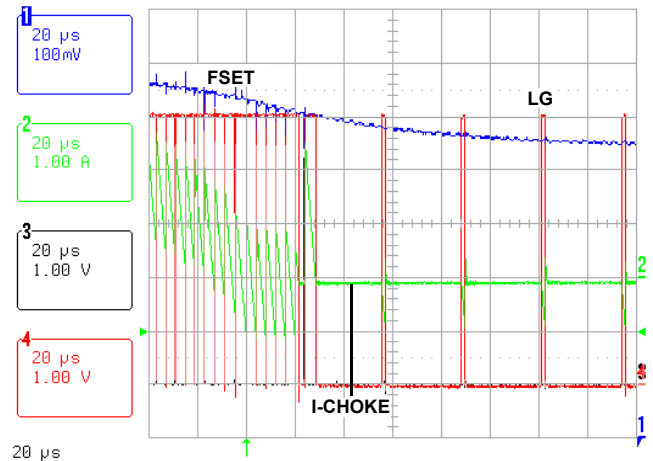


FIGURE 8. ENTERING DEM: 250mΩ LOAD-DUMP (UG TOO NARROW TO SEE)

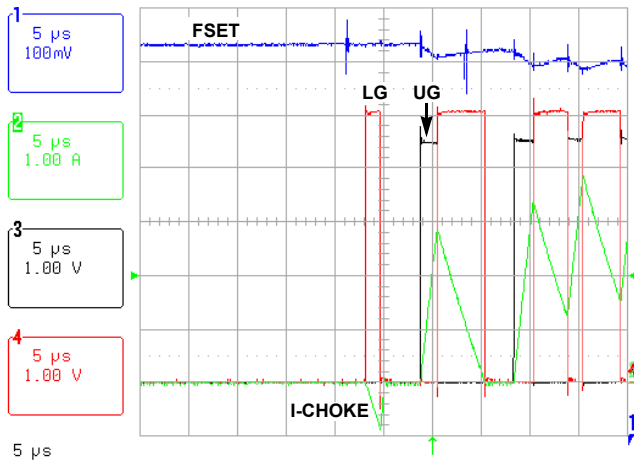


FIGURE 9. EXITING DEM: 250mΩ LOAD-STEP

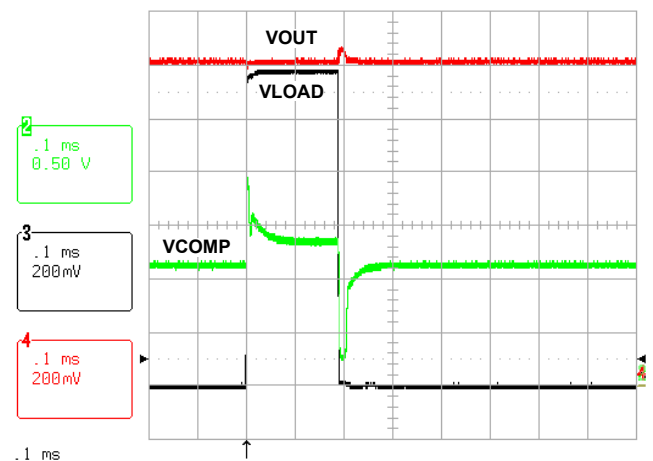


FIGURE 10. LOAD TRANSIENT: FCCM = HIGH, IN CCM BEFORE 250mΩ LOAD-STEP

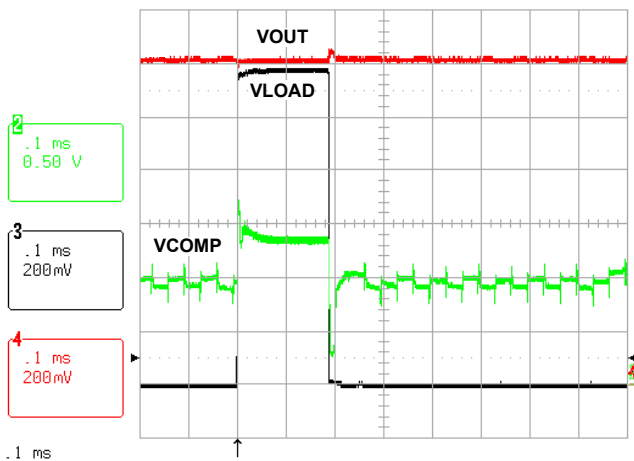


FIGURE 11. LOAD TRANSIENT: FCCM = LOW, IN DEM BEFORE 250mΩ LOAD-STEP

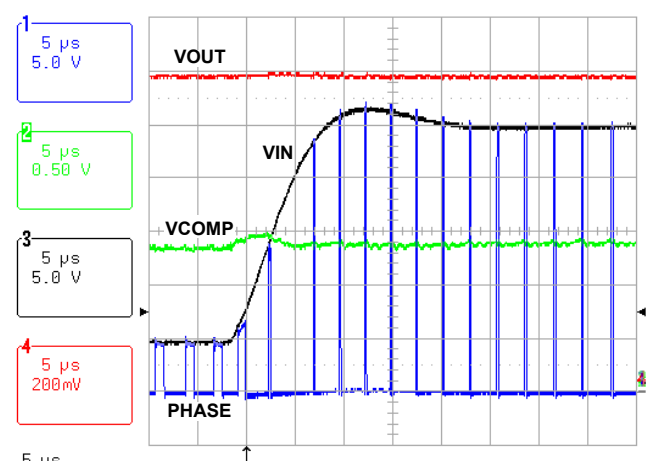


FIGURE 12. LINE TRANSIENT: 5V TO 25V STEP, 250mΩ LOAD

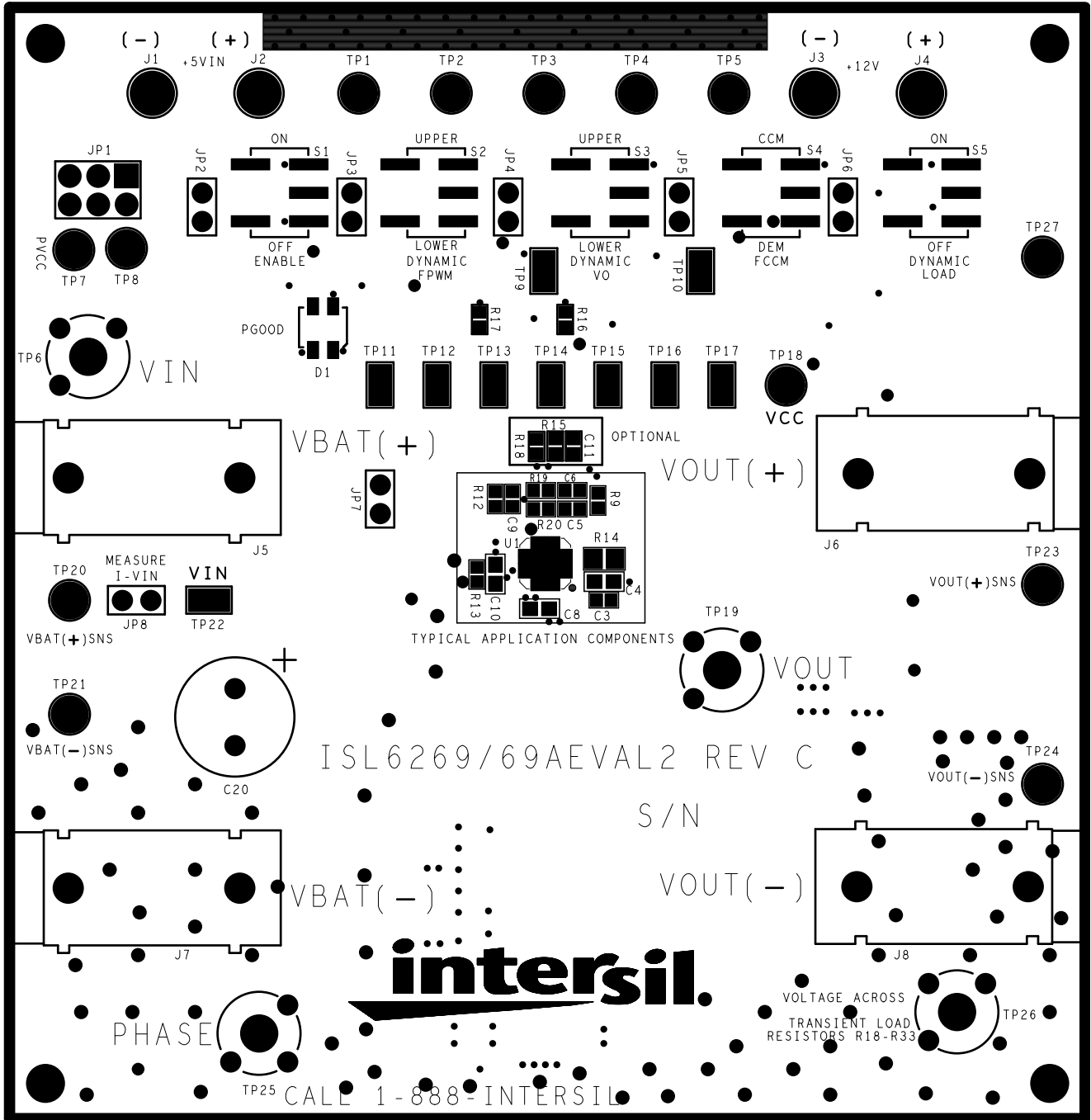


FIGURE 14. PCB TOP SILK SCREEN

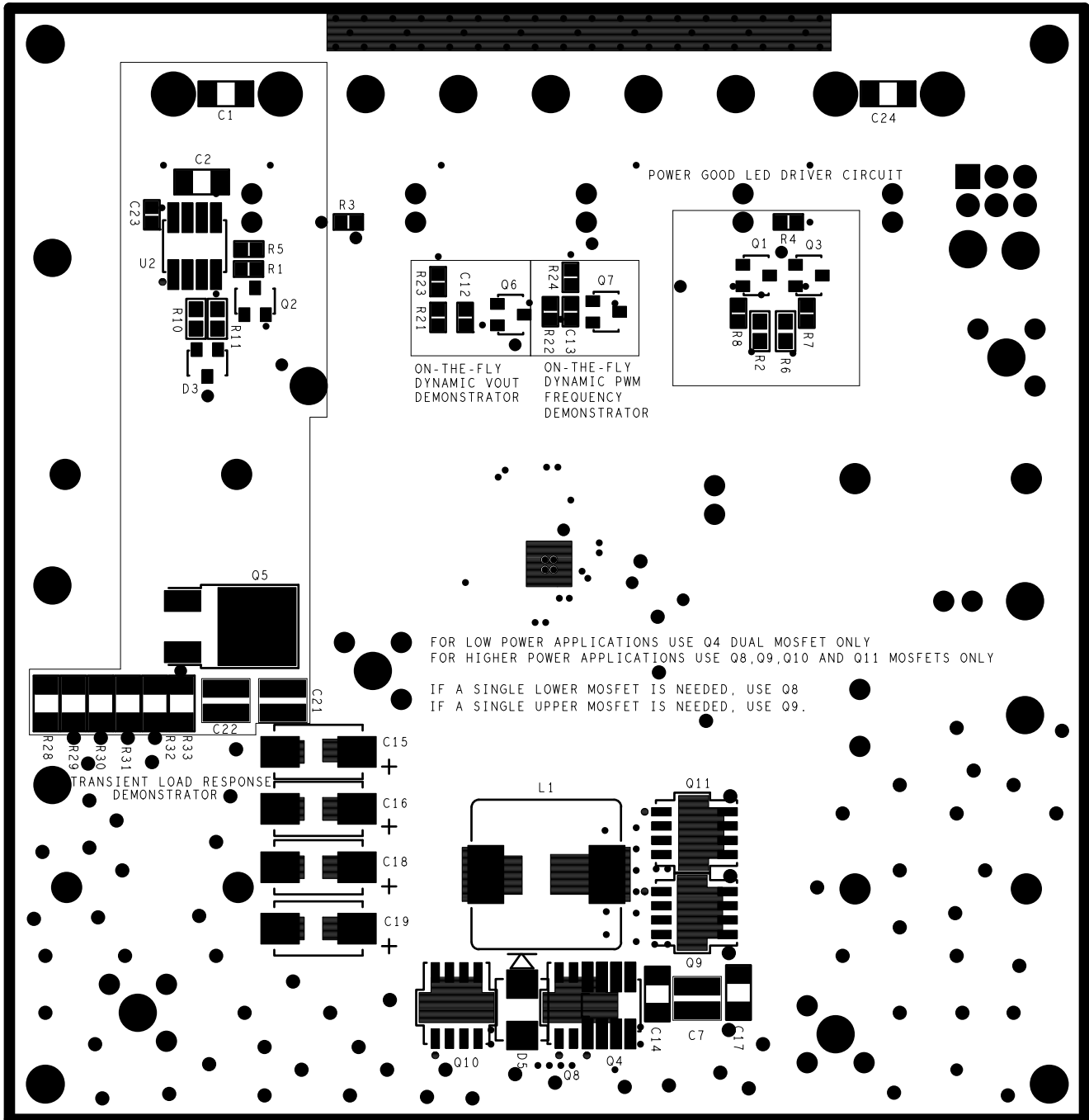


FIGURE 15. PCB BOTTOM SILK SCREEN (MIRRORED)

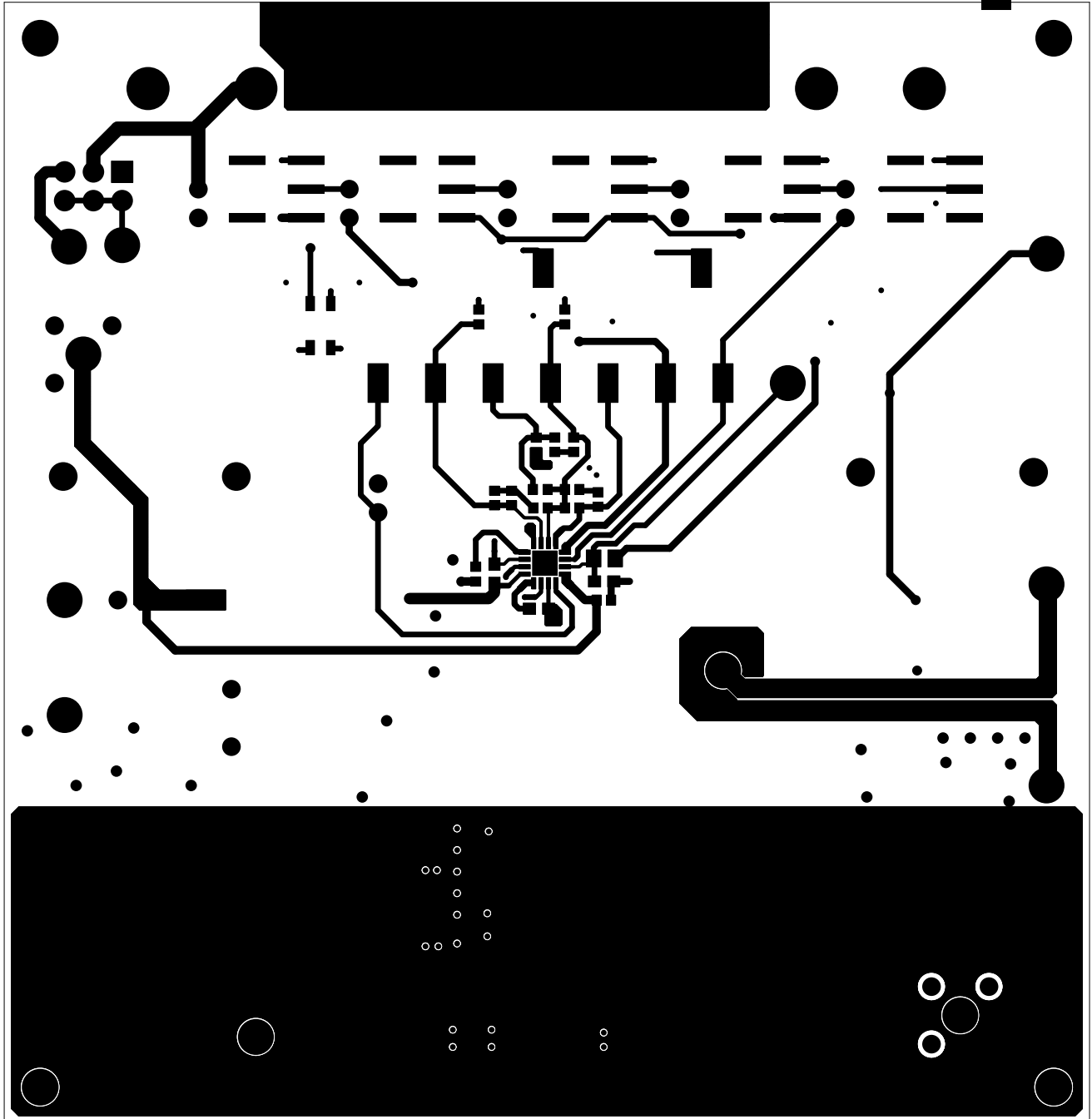


FIGURE 16. PCB TOP LAYER ETCH

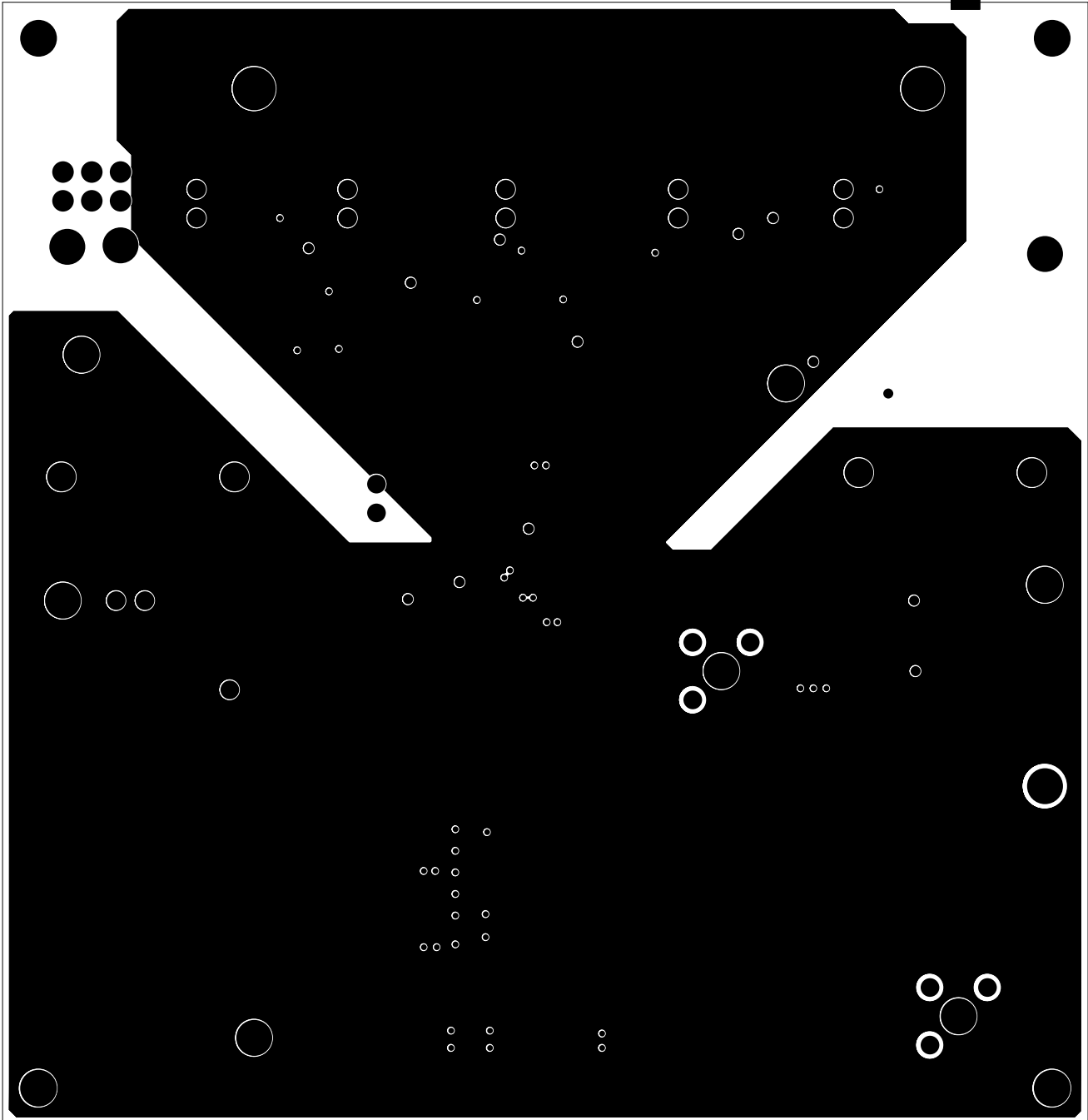


FIGURE 17. PCB LAYER 2 ETCH

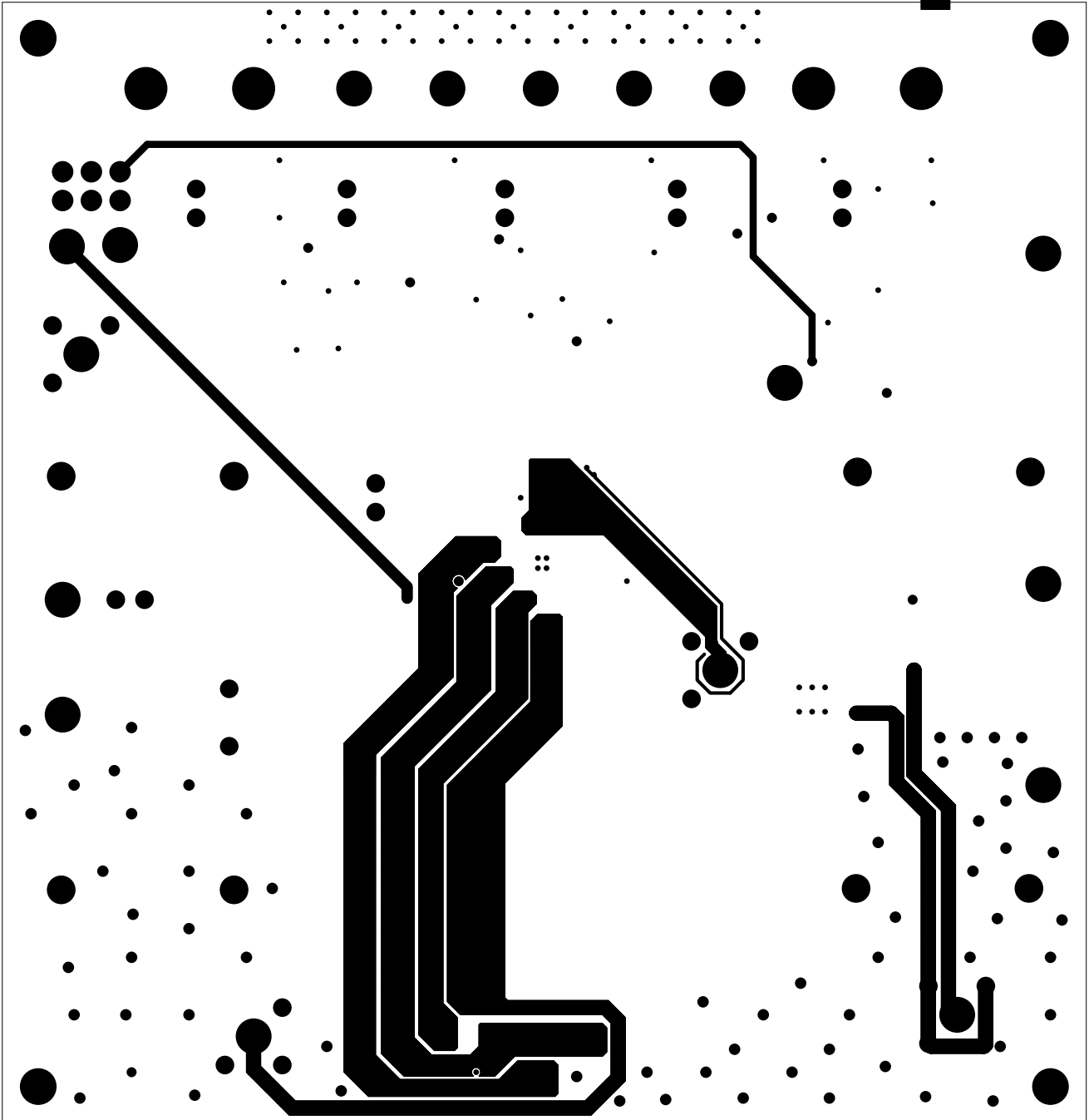


FIGURE 18. PCB LAYER 3 ETCH

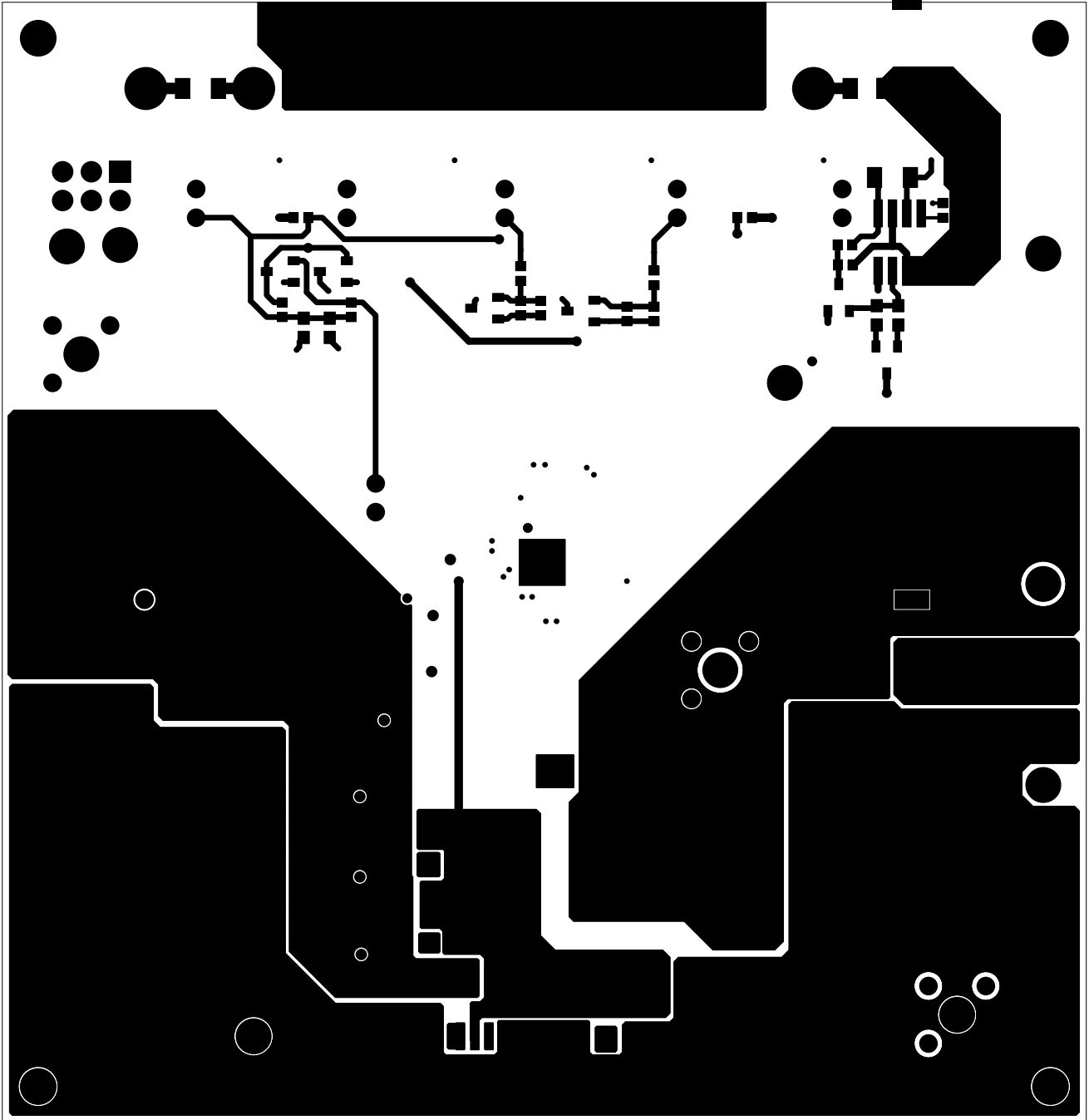


FIGURE 19. PCB BOTTOM LAYER ETCH

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, 16V, 10%, X7R, ROHS | MURATA | GRM36X7R104K016AD |
| 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, 4.7pF, 50V, 0.25pF, NPO, ROHS | MURATA | GRM36COG4R7C050AQ |
| 1 | C6 | CAP, SMD, 0402, 470pF, 50V, 10%, X7R, ROHS | PANASONIC | ECJ-0EB1H471K |
| 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%, COG, 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, 2 PIN, HIGHBDY, SHUNT | BERG/FCI | 71363-102 |
| 1 | L1 | INDUCTOR, SMD, 13mm, 2.2µH, 20%, 29A, SHIELDED | VISHAY | IHLP5050CEER2R2M01 |
| 5 | Q1, Q2, Q3, Q6, Q7 | MOSFET, N-CH, SMD, 3P, SOT23, 50V, 0.2A, Pb-free | DIODES INC. | BSS138-7-F |
| 1 | Q4 | MOSFET, N-CH, DUAL, 8P, SOIC, 30V, 17mΩ | FAIRCHILD | FDS6982AS |
| 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 | R13 | RES, SMD, 0402, 6.49k, 1/16W, 1%, TF, ROHS | YAGEO | RC0402FR-076K49L |
| 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 |
| 1 | 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 |
| 6 | R28 to R33 | RES, SMD, 1206, 1.43Ω, 1/4W, 1%, TF, ROHS | YAGEO | RC1206FR-071R43L |
| 1 | R3 | RES, SMD, 0402, 100k, 1/16W, 1%, TF, ROHS | PANASONIC | ERJ2RKF1003 |
| 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 |
| 1 | R9 | RES, SMD, 0402, 150k, 1/16W, 1%, TF, ROHS | YAGEO | RC0402FR-07150KL |

Bill of Materials (Continued)

| QTY | REFERENCE | DESCRIPTION/COMMENT | MFG NAME | MFG NUMBER |
|-----|----------------------------|---|-------------------|-------------|
| 5 | S1 to S5 | SWITCH-TOGGLE, SMD, ULTRAMINI, 1P, SPST, MINI | C&K COMPONENTS | 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-GPU CONTROLLER, 16P, QFN, 4x4, Pb-free | INTERSIL | ISL6269ACRZ |
| 1 | U2 | IC-HI FREQ BRIDGE DRIVER, 8P, SOIC, 100V | INTERSIL | HIP2100IB |

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