# EVQ4425B-QB-00A

**1.5A, 36V, 400kHz, High-Efficiency, Synchronous, Step-Down LED Driver Evaluation Board**

## DESCRIPTION

The EVQ4425B-QB-00A is an evaluation board for the MPQ4425B, a high-efficiency, synchronous, rectified, step-down, switch-mode LED driver with integrated internal power high-side and low-side MOSFETs (HS-FET and LS-FET, respectively).

The MPQ4425B offers a compact solution that achieves 1.5A of continuous output current, with excellent load and line regulation across a wide input supply range. Synchronous mode offers high efficiency during all operation.

The EVQ4425B-QB-00A is a fully assembled and tested evaluation board that generates load currents up to 1.5A across a 4V to 36V input voltage range.

## ELECTRICAL SPECIFICATIONS

| Parameter | Symbol | Value | Units |
|---|---|---|---|
| Input voltage | $V_{EMI}$ | 4 to 36 | V |
| Output current | $I_{OUT}$ | 1.5 | A |

## FEATURES

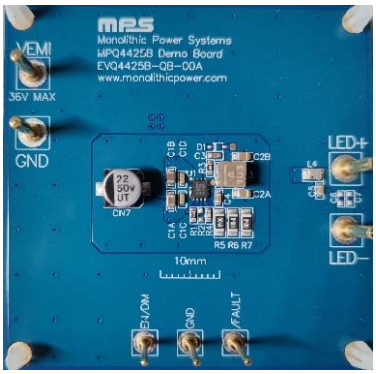
- Wide 4V to 36V Operating Input Range
- Internal 85mΩ HS-FET and 50mΩ LS-FET
- Synchronous Mode for High-Efficiency Operation
- 400kHz Default Switching Frequency
- PWM Dimming (100Hz Minimum Dimming Frequency)
- Forced Continuous Conduction Mode (FCCM)
- 0.2V Reference Voltage
- Internal Soft Start
- Fault Indication for LED Short/Open and Thermal Shutdown
- Over-Current Protection (OCP) with Valley Current Detection
- Thermal Shutdown
- Available in a QFN-13 (2.5mmx3mm) Package
- CISPR25 Class 5 Compliant
- Available in AEC-Q100 Grade 1

## APPLICATIONS

- Automotive LED Lighting



## EVQ4425B-QB-00A EVALUATION BOARD

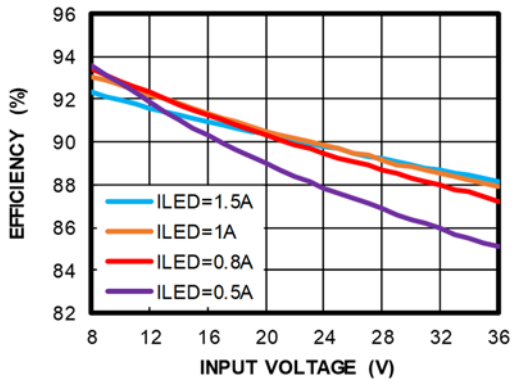



**LxWxH (6.35cmx6.35cmx1.3cm)**

| Board Number | MPS IC Number |
|---|---|
| EVQ4425B-QB-00A | MPQ4425BGQ-AEC1 |

**Efficiency vs. Input Voltage**

$V_{LED}$ = 6.4V



## QUICK START GUIDE

1. Preset the power supply between 4V and 36V, then turn off the power supply.
2. If longer cables (>0.5m total) are being used between the source and the evaluation board, install a damping capacitor at the input terminals. This is critical when $V_{IN}$ exceeds 24V.
3. Connect the power supply terminals to:
   a. Positive (+): VEMI
   b. Negative (-): GND
4. Connect the LED terminals to:
   a. Positive (+): LED+
   b. Negative (-): LED-
5. After making the connections, turn on the power supply. The MPQ4425B should automatically start up.
6. To use the enable (EN) function, apply a digital input to the EN pin. Drive EN above 1.45V to turn the regulator on; drive EN below 1V to turn it off.
7. To use the dimming function, apply a 100Hz to 2kHz external clock to the EN/DIM pin for pulse-width modulation (PWM) dimming.
8. The output current ($I_{OUT}$) is set by the external feedback resistor ($R_{FB}$). If the feedback reference voltage is 0.2V, $I_{LED}$ can be calculated with Equation (1):

$$I_{LED} = \frac{0.2V}{R_{FB}} \quad (1)$$

   Figure 1 shows the feedback resistor network.

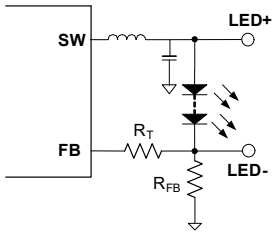



**Figure 1: Feedback Resistor Network**

9. A resistor ($R_T$) sets the loop bandwidth. A lower $R_T$ results in higher bandwidth. However, a high bandwidth may cause insufficient phase margin, which causes an unstable loop. Choose an $R_T$ value that achieves an appropriate tradeoff between bandwidth and phase margin.

   Table 1 shows the recommended minimum $R_{FB}$ and $R_T$ values for common outputs using 1-series or 2-series LEDs.

**Table 1: Recommended Resistor Values**

| $I_{LED}$ (A) | $R_{FB}$ (mΩ) | $R_T$ (kΩ) |
|---|---|---|
| 0.5 | 400 (1%) | 200 (1%) |
| 1 | 200 (1%) | 150 (1%) |
| 1.5 | 133 (1%) | 100 (1%) |

# EVALUATION BOARD SCHEMATIC

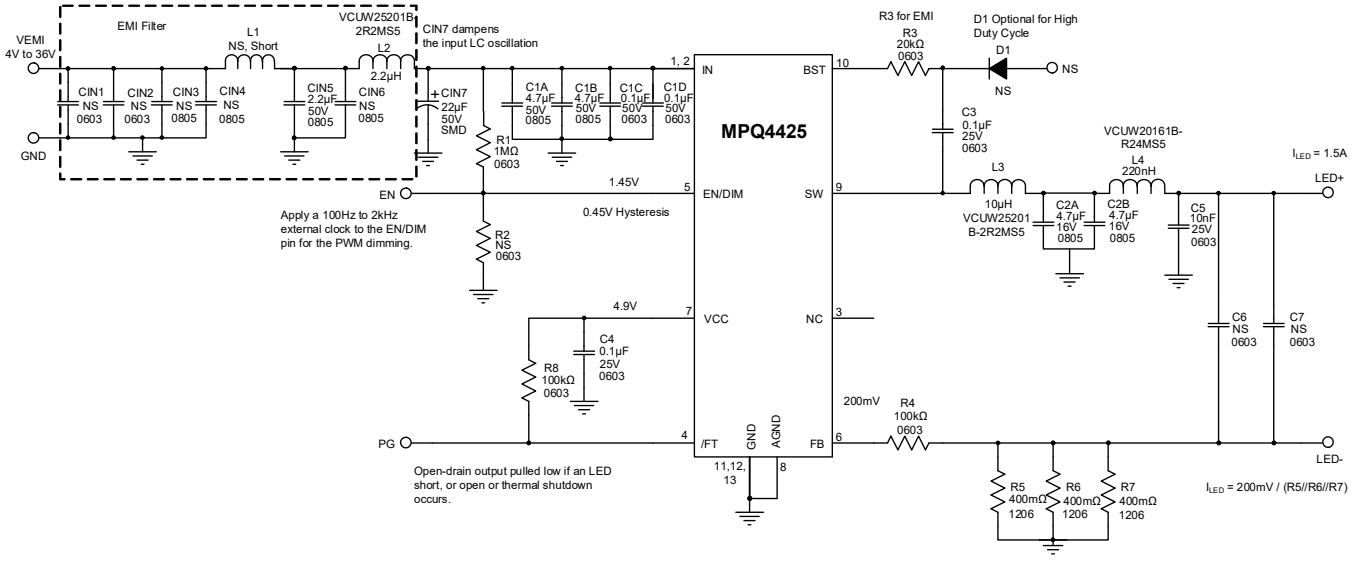
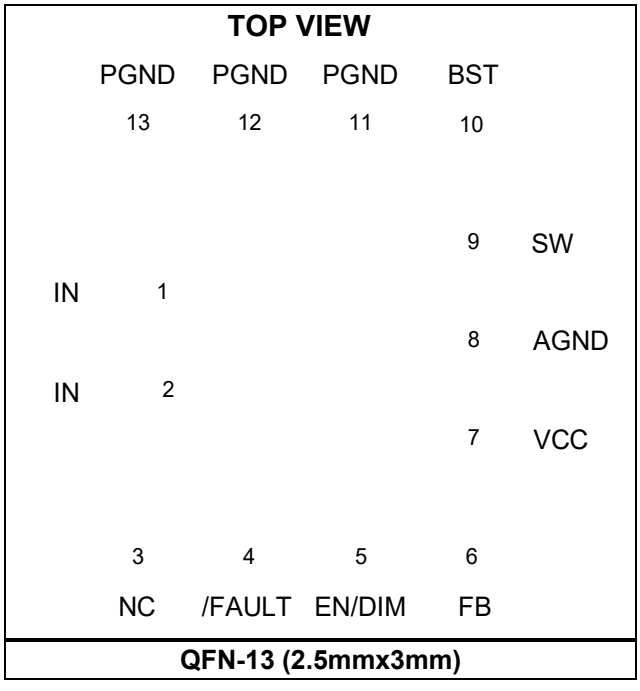



**Figure 2: Evaluation Board Schematic**

# PACKAGE REFERENCE

**TOP VIEW**




**QFN-13 (2.5mmx3mm)**

## EVQ4425B-QB-00A BILL OF MATERIALS

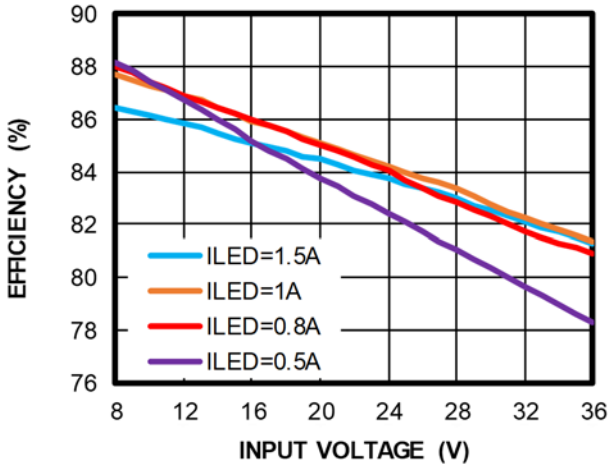
| Qty | Ref | Value | Description | Package | Manufacturer | Manufacturer P/N |
|---|---|---|---|---|---|---|
| 1 | CIN5 | 2.2µF | Ceramic capacitor, 50V, X7R | 0805 | TDK | C2012X7R1H225K |
| 1 | CIN7 | 22µF | Electrolytic capacitor, 50V | SMD | Cotronic | UT1H220M0605VG |
| 2 | C1A, C1B | 4.7µF | Ceramic capacitor, 50V, X7S | 0805 | Murata | GRM21BC71H475KE11L |
| 2 | C1C, C1D | 0.1µF | Ceramic capacitor, 50V, X7R | 0603 | Murata | GRM188R71H104KA93D |
| 2 | C2A, C2B | 4.7µF | Ceramic capacitor, 16V, X7R | 0805 | Murata | GCM21BR71C475KA73L |
| 2 | C3, C4 | 0.1µF | Ceramic capacitor, 25V, X7R | 0603 | Murata | GCJ188R71E104KA12D |
| 1 | C5 | 10nF | Ceramic capacitor, 25V, X7R | 0603 | Wurth | 885012206065 |
| 7 | CIN1, CIN2, CIN3, CIN4, CIN6, C6, C7 | NS | | | | |
| 1 | D1 | NS | | | | |
| 1 | L1 | Short | | | | |
| 1 | L2 | 2.2µH | Inductor, 70mΩ, DCR, 2.6A | SMD | Cyntec | VCUW25201B-2R2MS5 |
| 1 | L3 | 10µH | Inductor, 84mΩ, DCR, 3.1A | SMD | Coilcraft | XAL4040-103MEB |
| 1 | L4 | 240nH | Inductor, 27mΩ, DCR, 6.5A | SMD | Cyntec | VCUW20161B-R24MS5 |
| 1 | R1 | 1MΩ | Film resistor, 5% | 0603 | Yageo | RC0603JR-071ML |
| 1 | R3 | 20kΩ | Film resistor, 1% | 0603 | Yageo | RC0603FR-0720RL |
| 2 | R4, R8 | 100kΩ | Film resistor, 1% | 0603 | Yageo | RC0603FR-07100KL |
| 3 | R5, R6, R7 | 400mΩ | Film resistor, 1% | 1206 | Yageo | RL1206FR-070R4L |
| 1 | R2 | NS | | | | |
| 1 | U1 | MPQ4425 | Step-down regulator | QFN-13 (2mmx3mm) | MPS | MPQ4425BGQB-AEC1 |
| 4 | VEMI, GND, LED+, LED- | | 2 golden pins | | Custom | |
| 3 | EN/DIM, GND, /FAULT | | 1 golden pin | | Custom | |

## EVB TEST RESULTS

**Performance waveforms are tested on the evaluation board, $V_{IN}$ = 12V, 2 LEDs in series, L = 10µH, $f_{SW}$ = 400kHz, $T_A$ = 25°C, unless otherwise noted.**

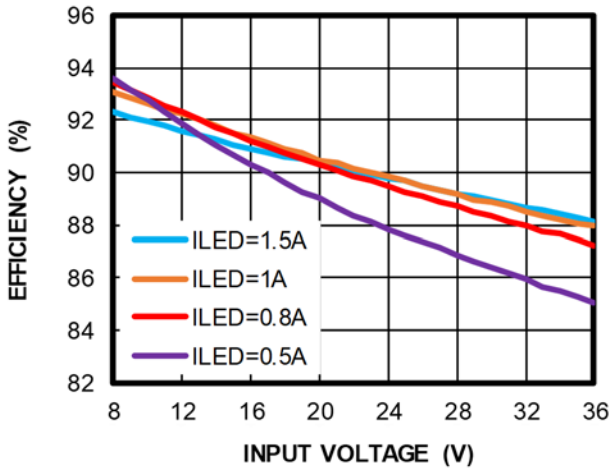
**Efficiency vs. Input Voltage**

1 LED ($V_{LED}$ = 3.2V)

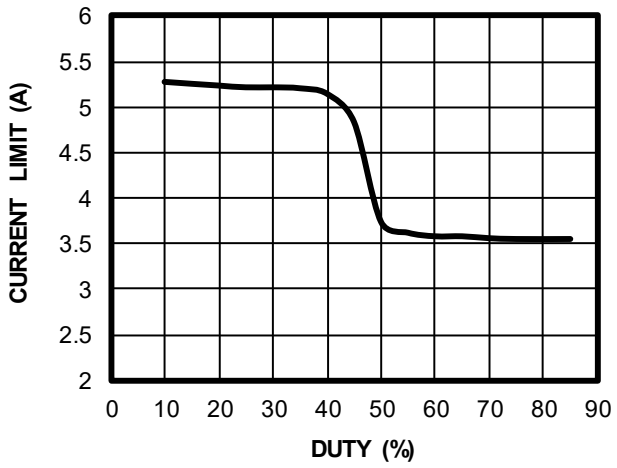



**Efficiency vs. Input Voltage**

2LEDs ($V_{LED}$ = 6.4V)




**Current Limit vs. Duty**

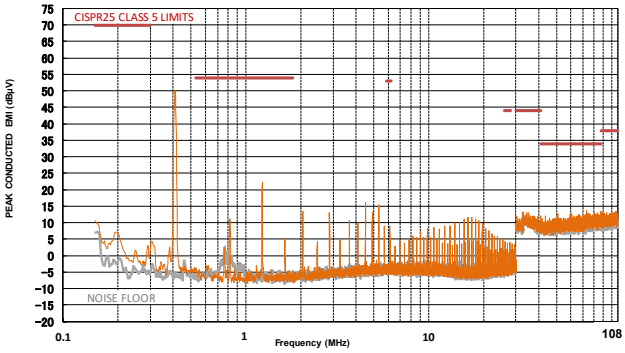


# EVB TEST RESULTS *(continued)*

**Performance waveforms are tested on the evaluation board, $V_{IN}$ = 12V, 2 LEDs in series, L = 10µH, $f_{SW}$ = 400kHz, $T_A$ = 25°C, unless otherwise noted.**

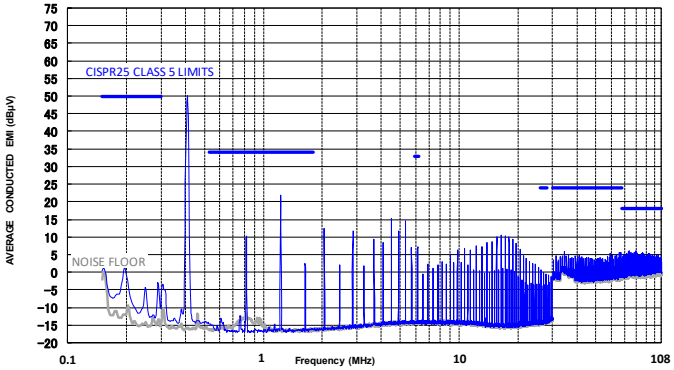
### CISPR25 Class 5 Peak Conducted Emissions

150kHz to 108MHz



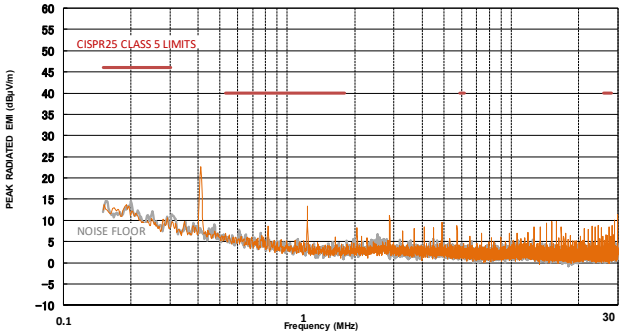

### CISPR25 Class 5 Average Conducted Emissions

150kHz to 108MHz



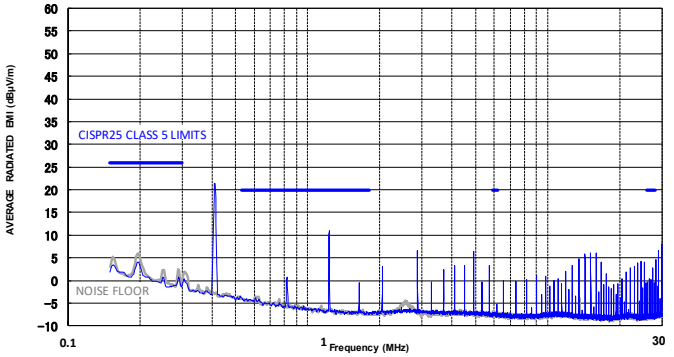

### CISPR25 Class 5 Peak Radiated Emissions

150kHz to 30MHz



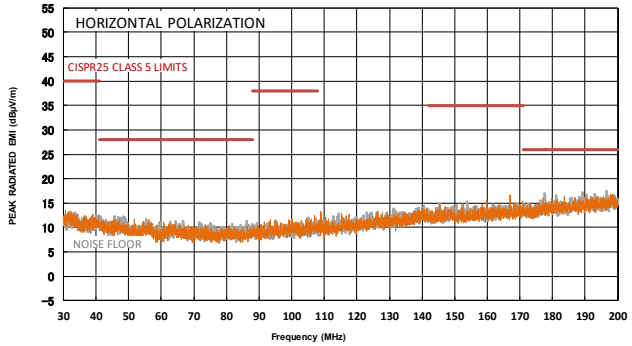

### CISPR25 Class 5 Average Radiated Emissions

150kHz to 30MHz



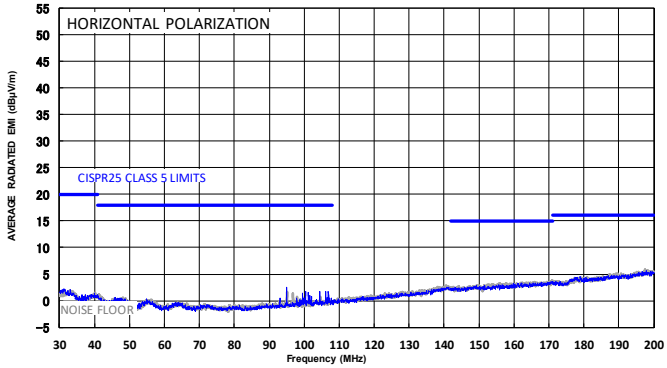

### CISPR25 Class 5 Peak Radiated Emissions

Horizontal, 30MHz to 200MHz




### CISPR25 Class 5 Average Radiated Emissions

Horizontal, 30MHz to 200MHz

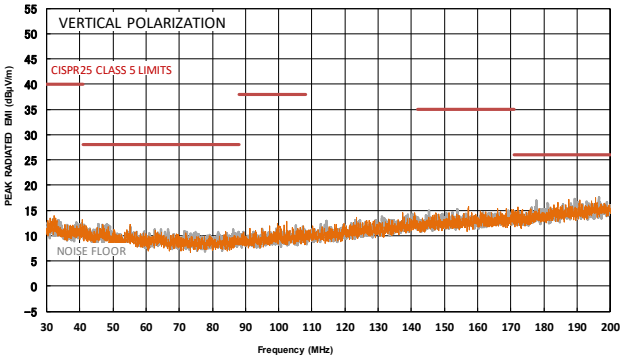


## EVB TEST RESULTS *(continued)*

**Performance waveforms are tested on the evaluation board, $V_{IN}$ = 12V, 2 LEDs in series, L = 10µH, $f_{SW}$ = 400kHz, $T_A$ = 25°C, unless otherwise noted.**

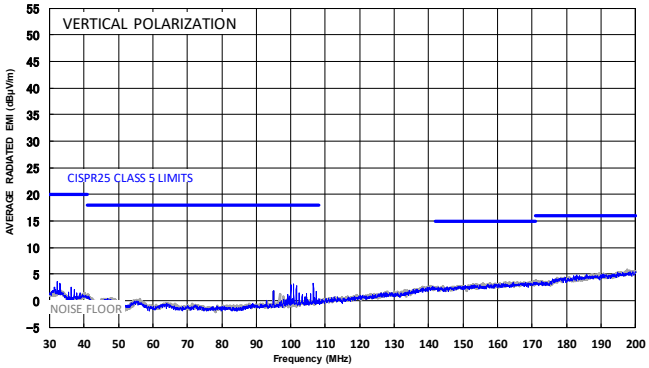
### CISPR25 Class 5 Peak Radiated Emissions

Vertical, 30MHz to 200MHz



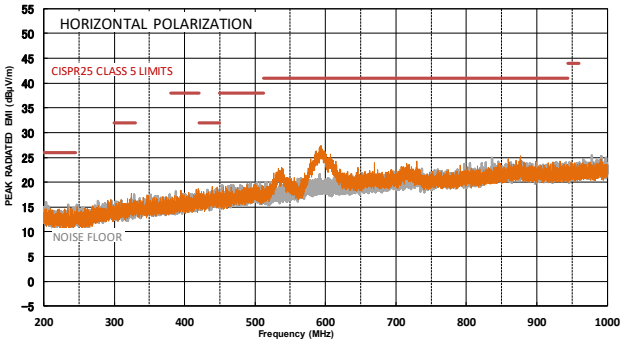

### CISPR25 Class 5 Average Radiated Emissions

Vertical, 30MHz to 200MHz



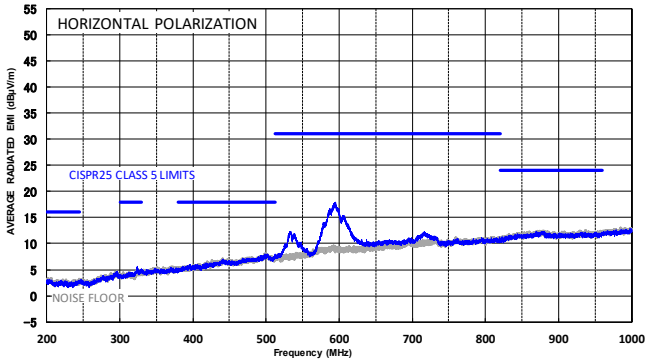

### CISPR25 Class 5 Peak Radiated Emissions

Horizontal, 200MHz to 1GHz



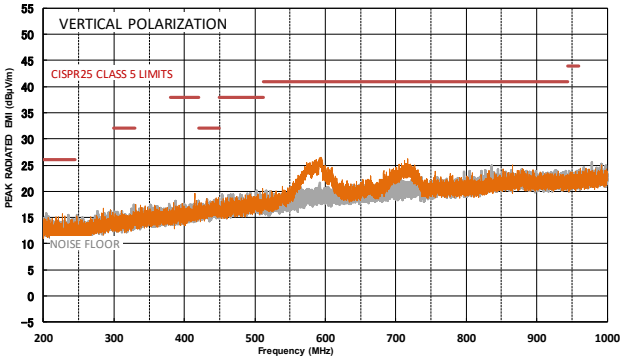

### CISPR25 Class 5 Average Radiated Emissions

Horizontal, 200MHz to 1GHz



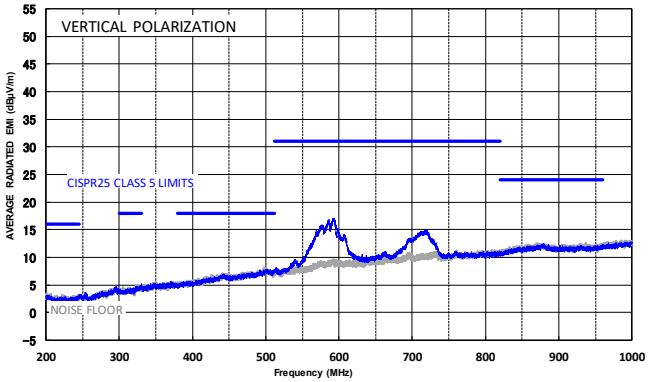

### CISPR25 Class 5 Peak Radiated Emissions

Vertical, 200MHz to 1GHz




### CISPR25 Class 5 Average Radiated Emissions

Vertical, 200MHz to 1GHz

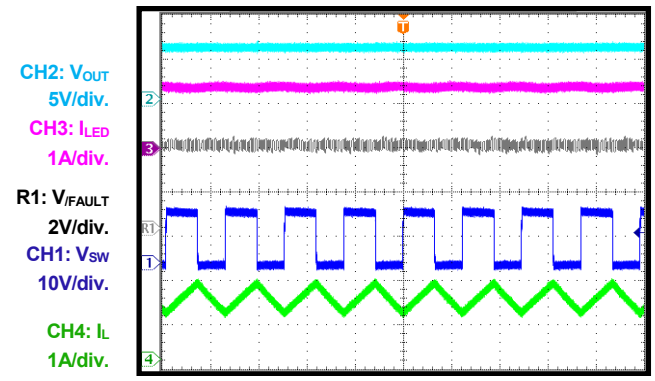


## EVB TEST RESULTS *(continued)*

**Performance waveforms are tested on the evaluation board, $V_{IN}$ = 12V, 2 LEDs in series, L = 10µH, $f_{SW}$ = 400kHz, $T_A$ = 25°C, unless otherwise noted.**

### Steady State

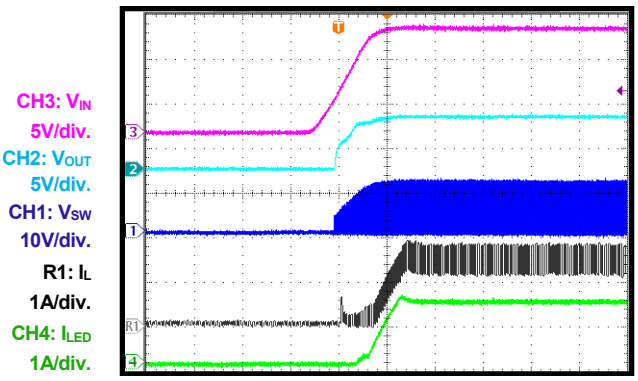
$I_{LED}$ = 1.5A




2µs/div.

### Start-Up through VIN

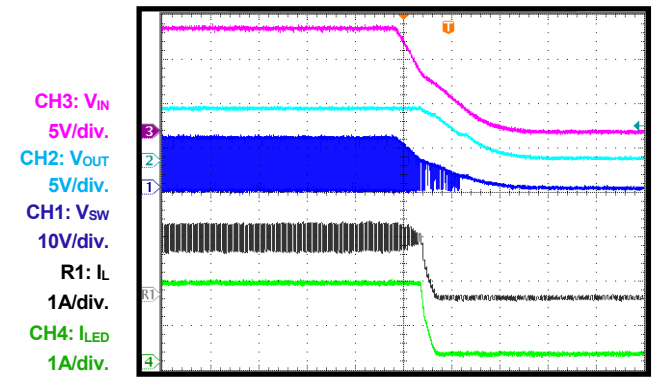
$I_{LED}$ = 1.5A




1ms/div.

### Shutdown through VIN

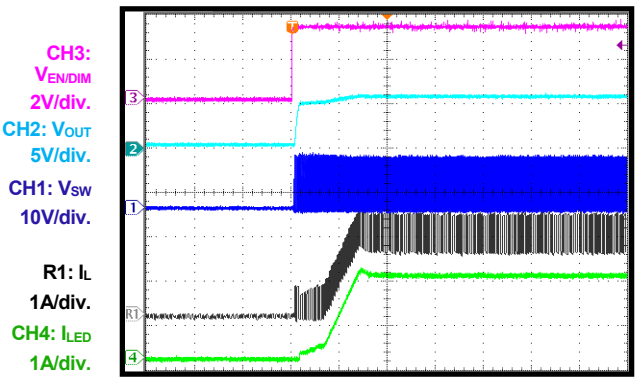
$I_{LED}$ = 1.5A




10ms/div.

### Start-Up through EN

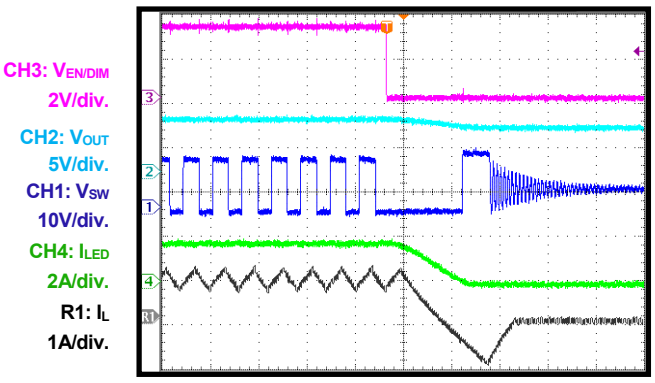
$I_{LED}$ = 1.5A




1ms/div.

### Shutdown through EN

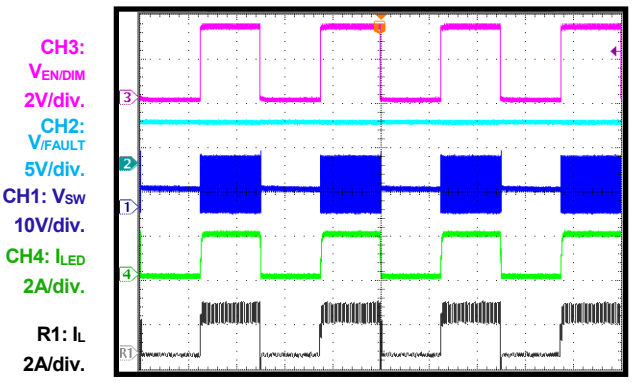
$I_{LED}$ = 1.5A




4µs/div.

### PWM Dimming

$f_{PWM}$ = 200Hz, Duty = 50%



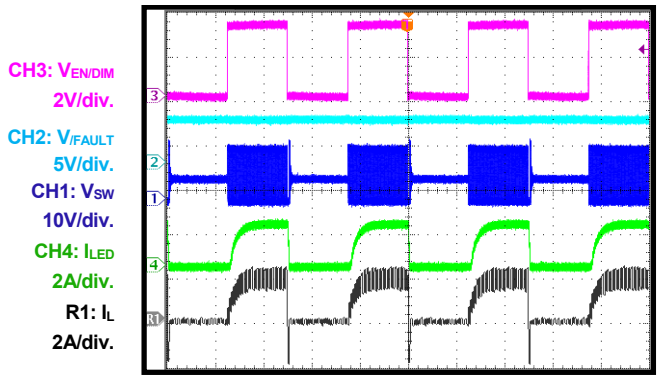

2ms/div.

## EVB TEST RESULTS *(continued)*

**Performance waveforms are tested on the evaluation board, $V_{IN}$ = 12V, 2 LEDs in series, L = 10µH, $f_{SW}$ = 400kHz, $T_A$ = 25°C, unless otherwise noted.**

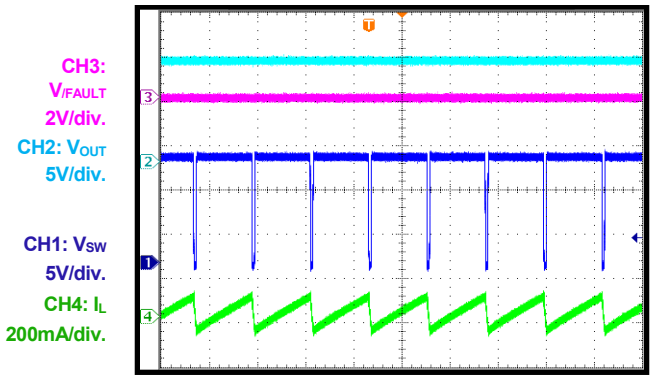
### PWM Dimming

$f_{PWM}$ = 2kHz, Duty = 50%



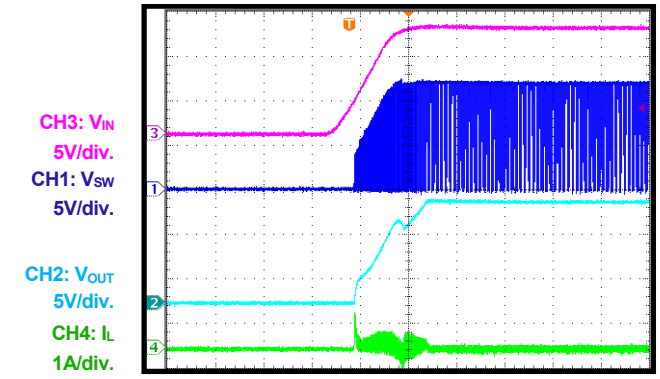

200µs/div.

### LED Open Steady State



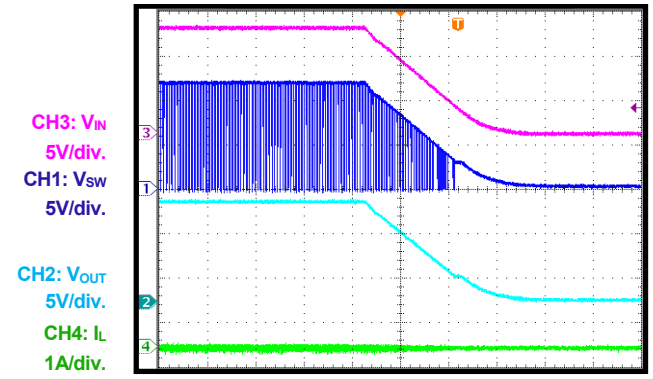

2µs/div.

### LED Open Input Start-Up



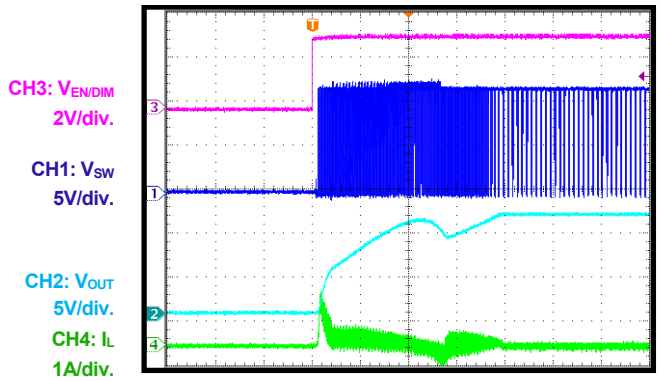

1ms/div.

### LED Open Input Shutdown



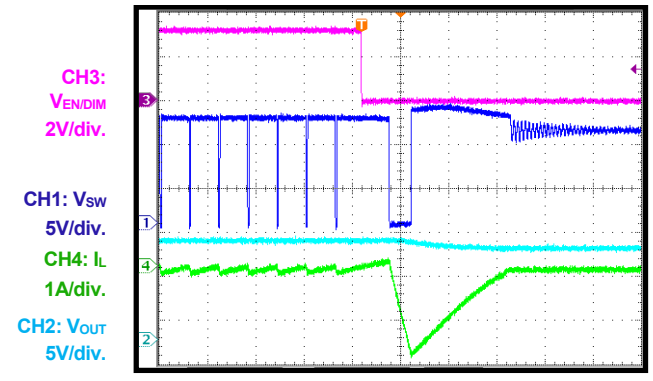

10ms/div.

### LED Open EN On




400µs/div.

### LED Open EN Off



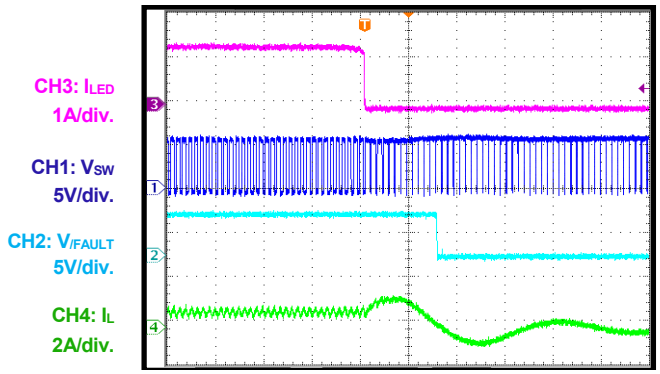

4µs/div.

## EVB TEST RESULTS *(continued)*

**Performance waveforms are tested on the evaluation board, $V_{IN}$ = 12V, 2 LEDs in series, L = 10µH, $f_{SW}$ = 400kHz, $T_A$ = 25°C, unless otherwise noted.**

### LED Open Entry

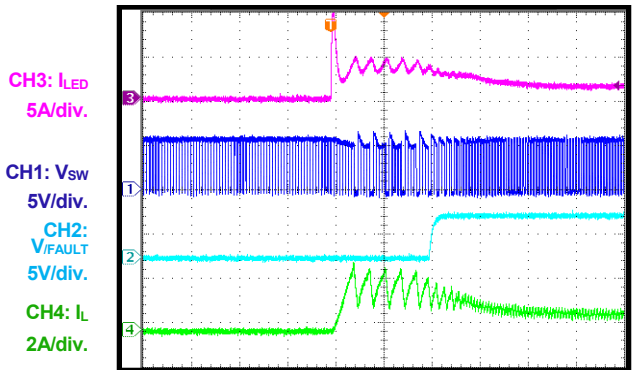
$I_{LED}$ = 1.5A




20µs/div.

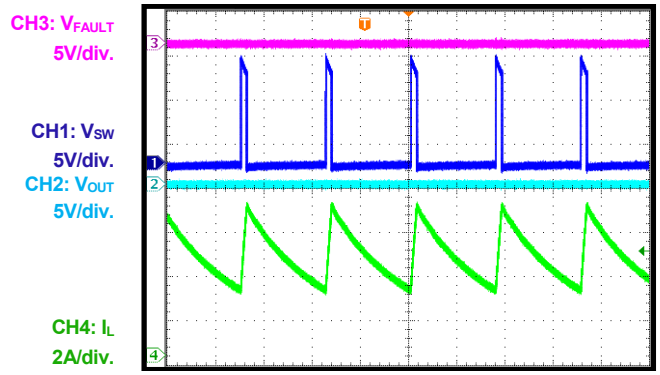
### LED Open Recovery

$I_{LED}$ = 1.5A



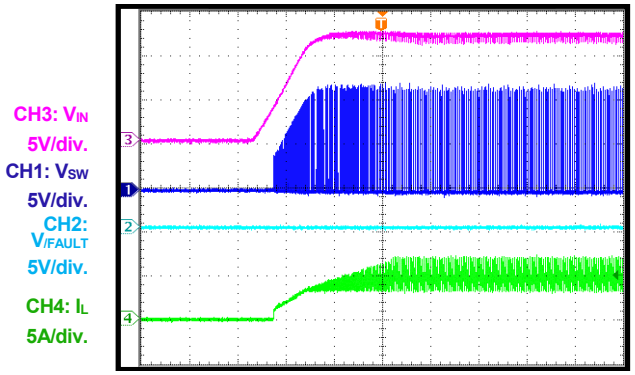

40µs/div.

### LED+ Short to GND Steady State



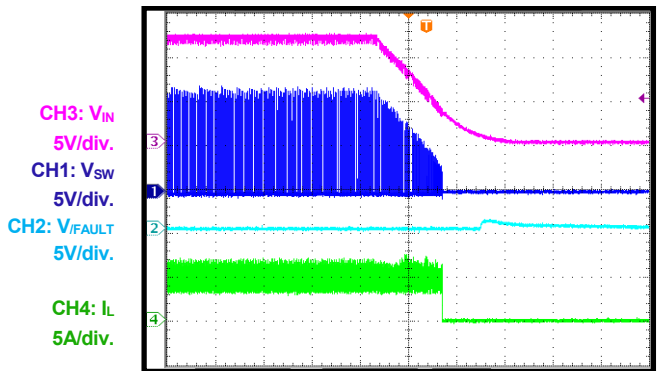

10µs/div.

### LED+ Short to GND Input Start-Up



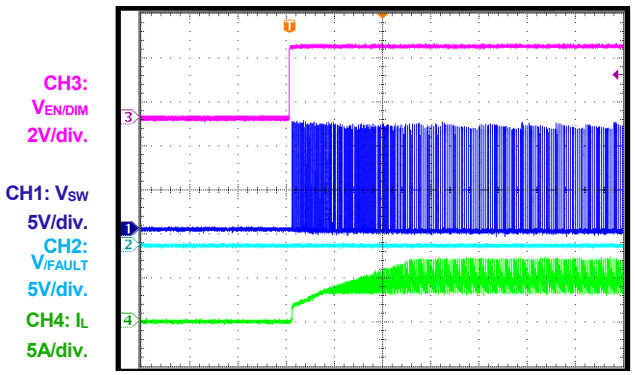

1ms/div.

### LED+ Short to GND Input Shutdown




10ms/div.

### LED+ Short to GND EN On

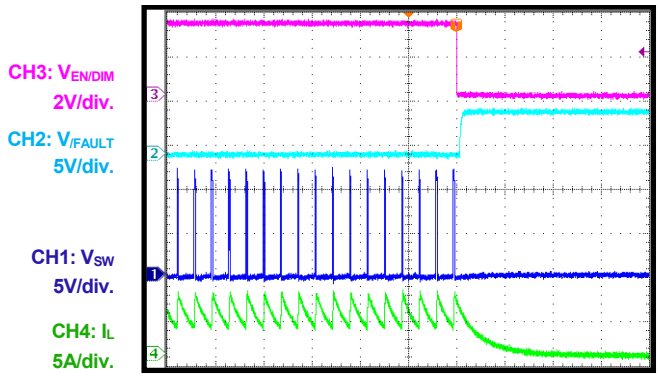



1ms/div.

## EVB TEST RESULTS *(continued)*

**Performance waveforms are tested on the evaluation board, $V_{IN}$ = 12V, 2 LEDs in series, L = 10µH, $f_{SW}$ = 400kHz, $T_A$ = 25°C, unless otherwise noted.**

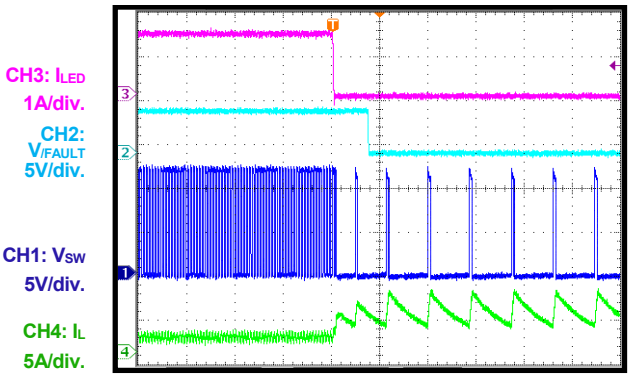
### LED+ Short to GND EN Off




100µs/div.

### LED+ Short to GND Entry

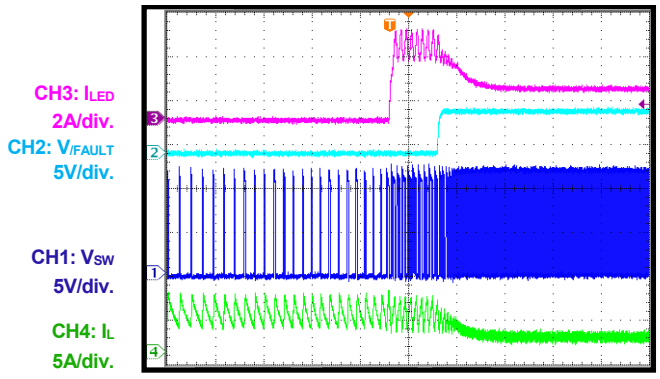
$I_{LED}$ = 1.5A




40µs/div.

### LED+ Short to GND Recovery

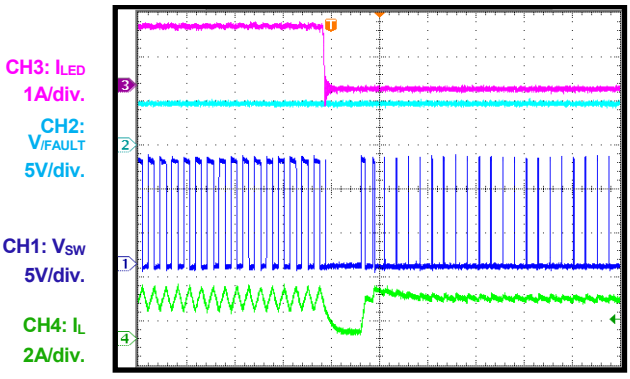
$I_{LED}$ = 1.5A




100µs/div.

### LED+ Short to LED- Entry

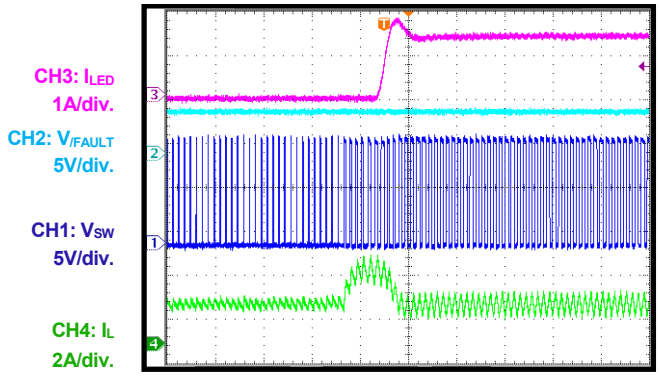
$I_{LED}$ = 1.5A




10µs/div.

### LED+ Short to LED- Recovery

$I_{LED}$ = 1.5A




20µs/div.

## PCB LAYOUT

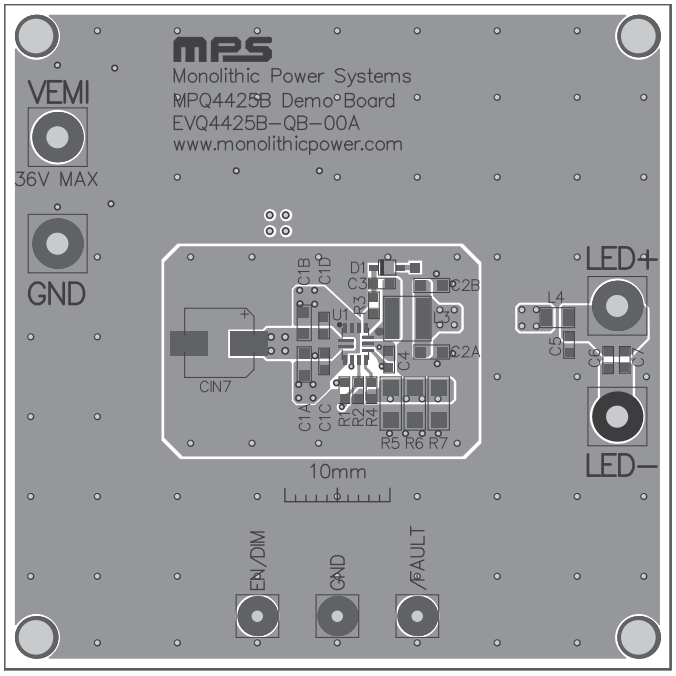



Figure 3: Top Silk and Top Layer

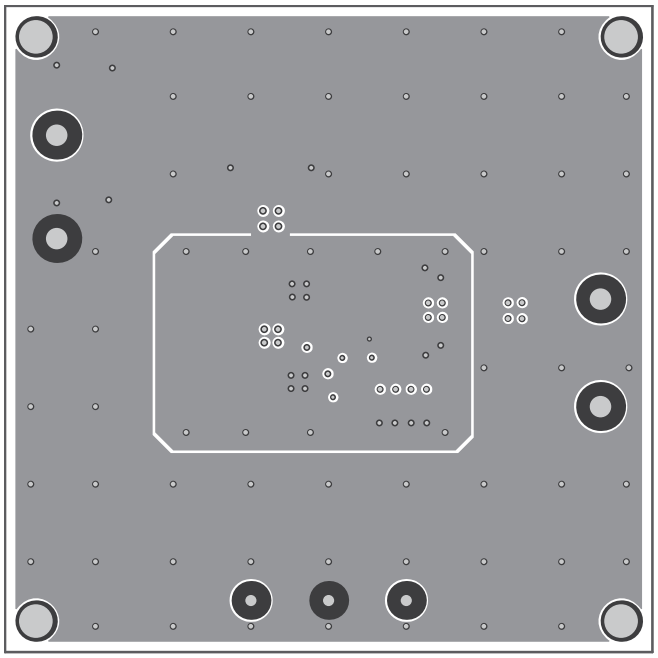


Figure 4: Mid-Layer 1

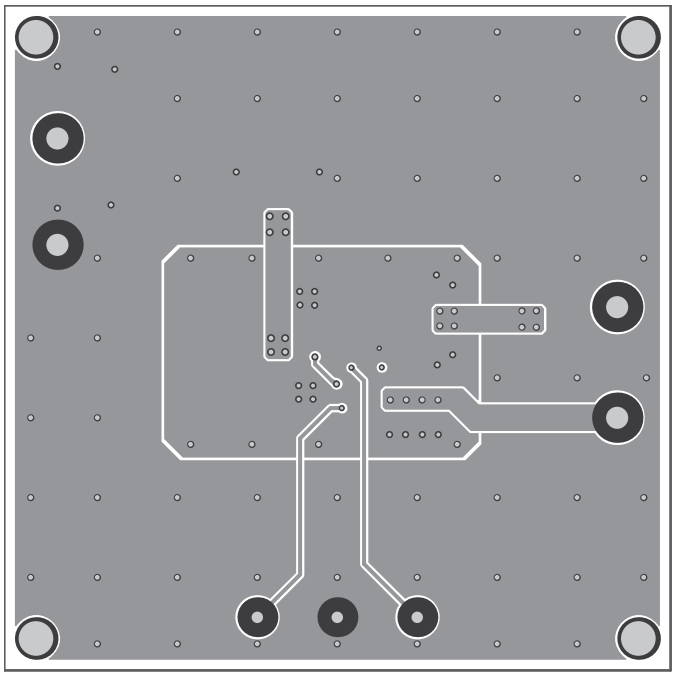


Figure 5: Mid-Layer 2

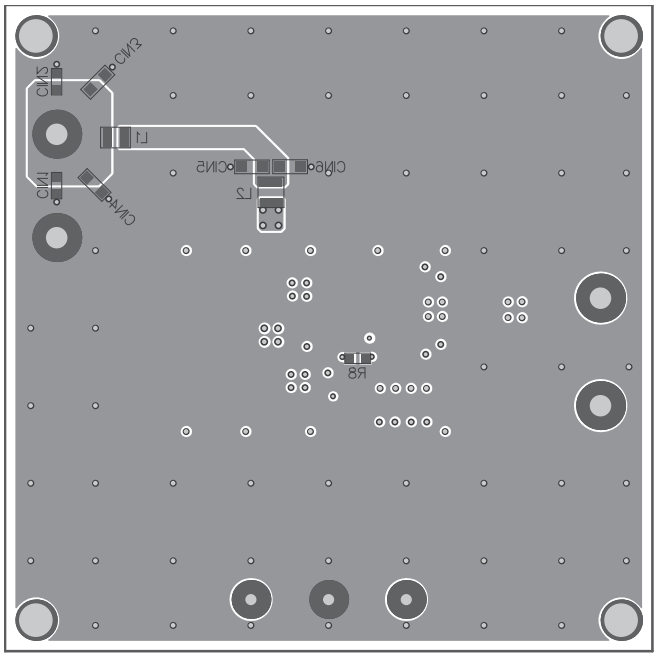


Figure 6: Bottom Layer and Bottom Silk