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

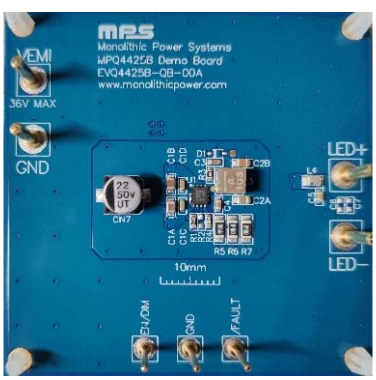
FEATURES

- 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

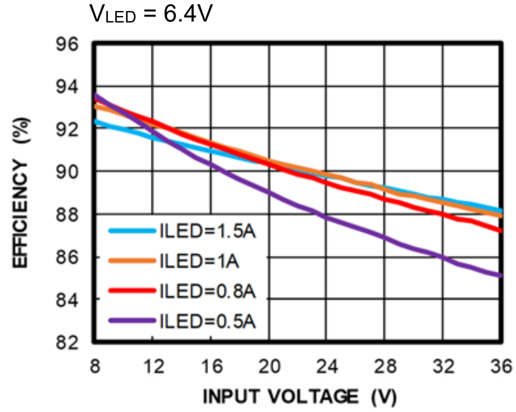
EVQ4425B-QB-00A EVALUATION BOARD



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):

$$I_{LED} = \frac{0.2V}{R_{FB}} \tag{1}$$

   Figure 1 shows the feedback resistor network.

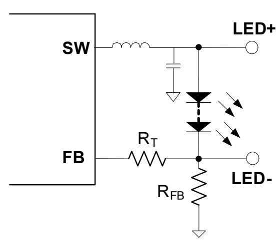


Figure 1: Feedback Resistor Network

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

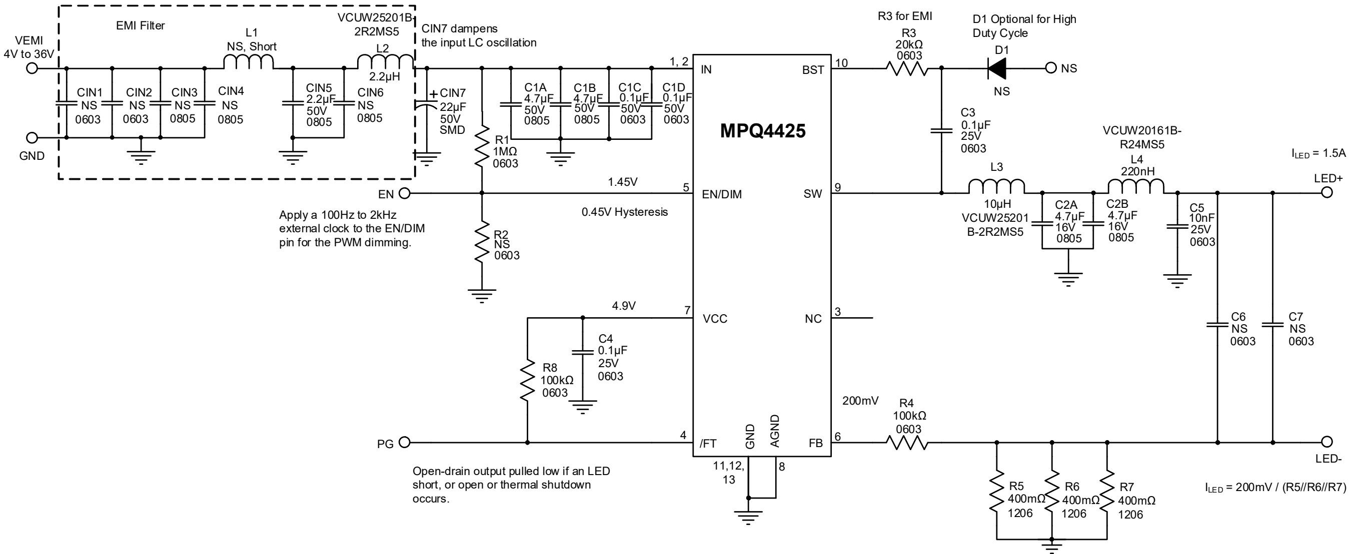
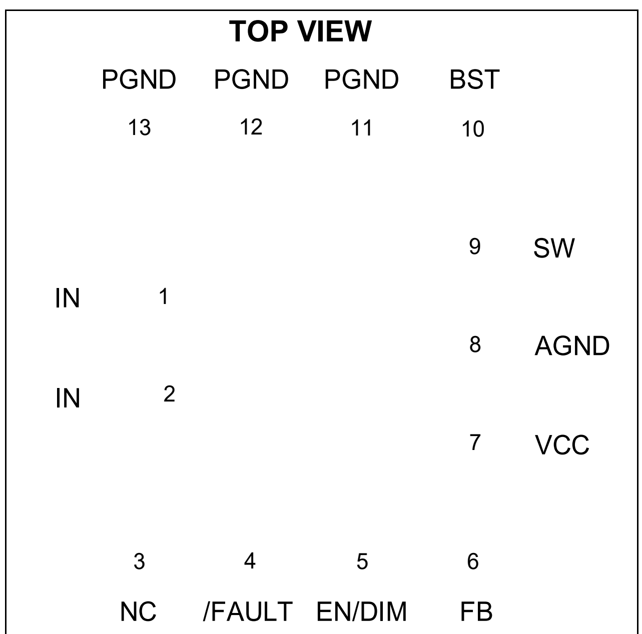


Figure 2: Evaluation Board Schematic

PACKAGE REFERENCE



QFN-13 (2.5mmx3mm)

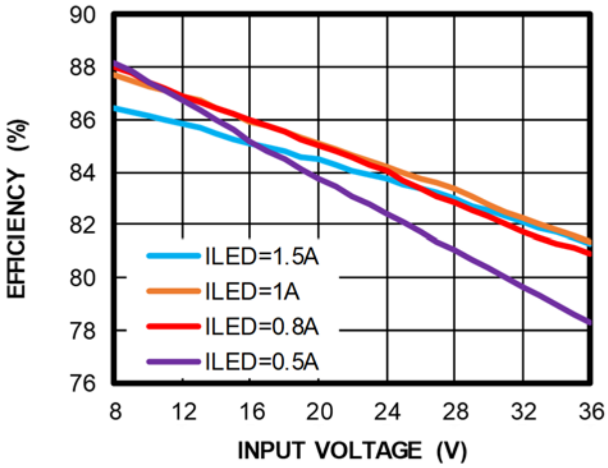
EVQ4425B-QB-00A BILL OF MATERIALS

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	

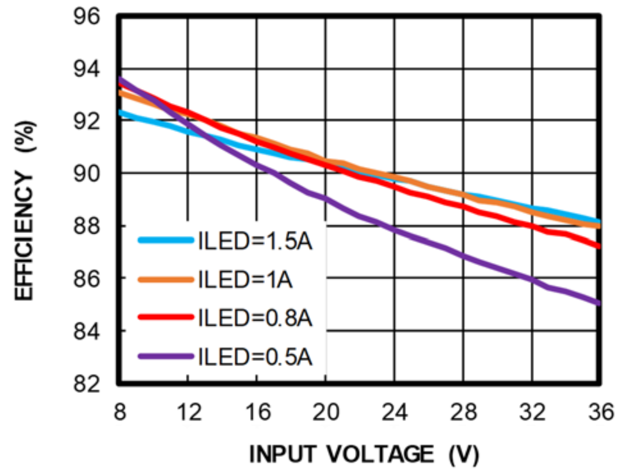
EVB TEST RESULTS

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.

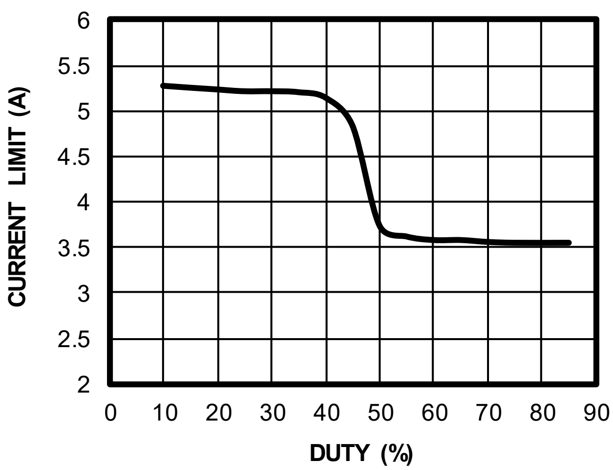
Efficiency vs. Input Voltage
1 LED (V_{LED} = 3.2V)



Efficiency vs. Input Voltage
2LEDs (V_{LED} = 6.4V)



Current Limit vs. Duty

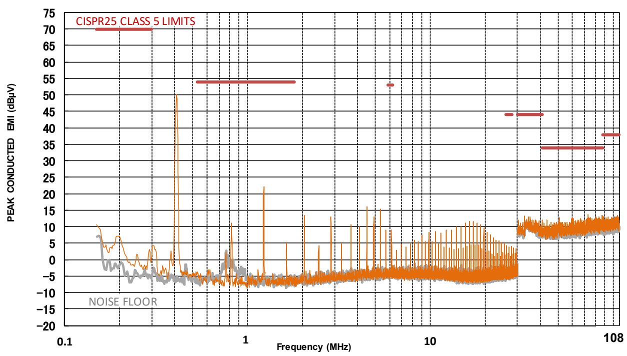


EVB TEST RESULTS *(continued)*

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.

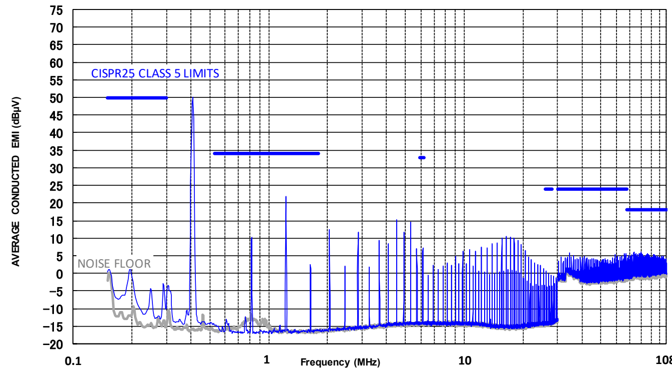
CISPR25 Class 5 Peak Conducted Emissions

150kHz to 108MHz



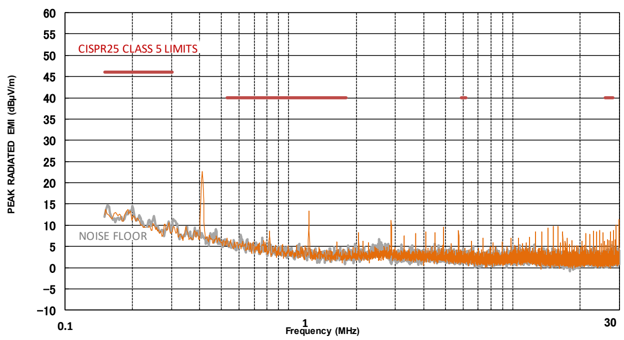
CISPR25 Class 5 Average Conducted Emissions

150kHz to 108MHz



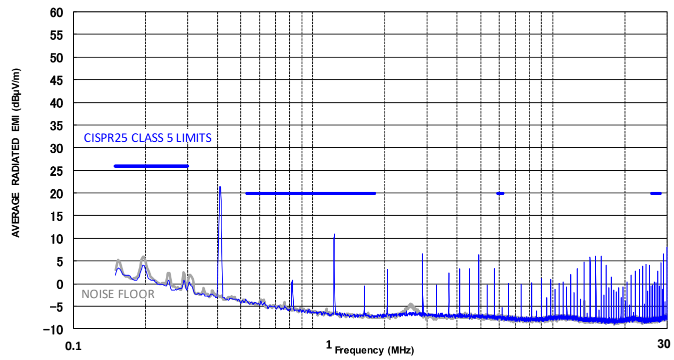
CISPR25 Class 5 Peak Radiated Emissions

150kHz to 30MHz



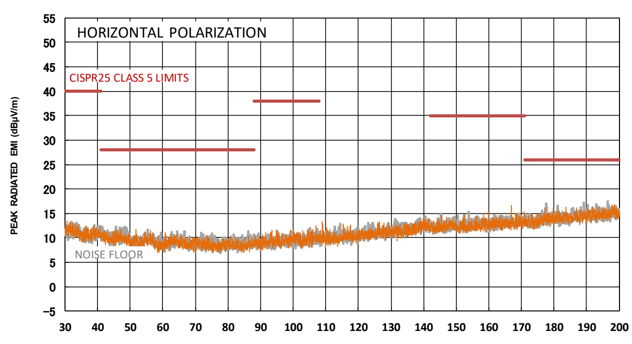
CISPR25 Class 5 Average Radiated Emissions

150kHz to 30MHz



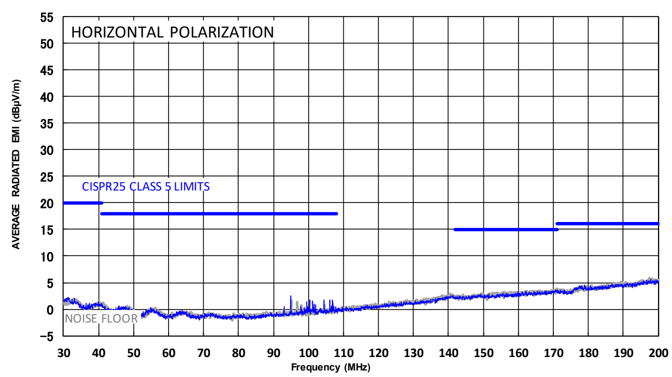
CISPR25 Class 5 Peak Radiated Emissions

Horizontal, 30MHz to 200MHz



CISPR25 Class 5 Average Radiated Emissions

Horizontal, 30MHz to 200MHz

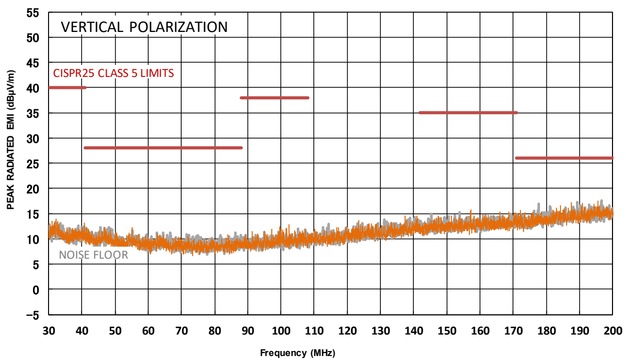


EVB TEST RESULTS *(continued)*

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.

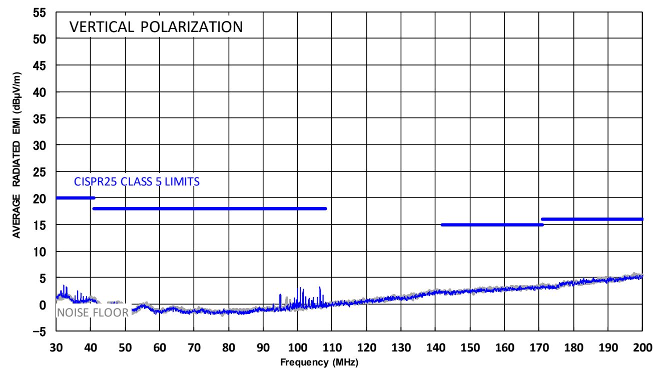
CISPR25 Class 5 Peak Radiated Emissions

Vertical, 30MHz to 200MHz



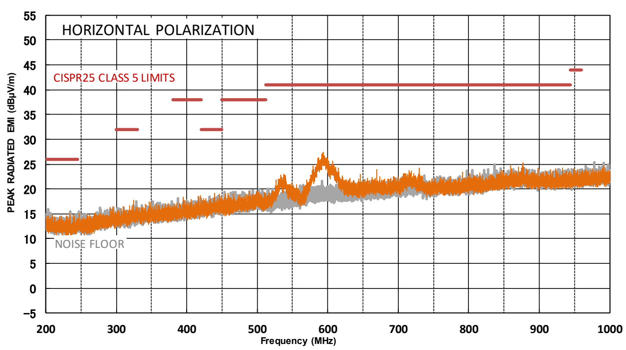
CISPR25 Class 5 Average Radiated Emissions

Vertical, 30MHz to 200MHz



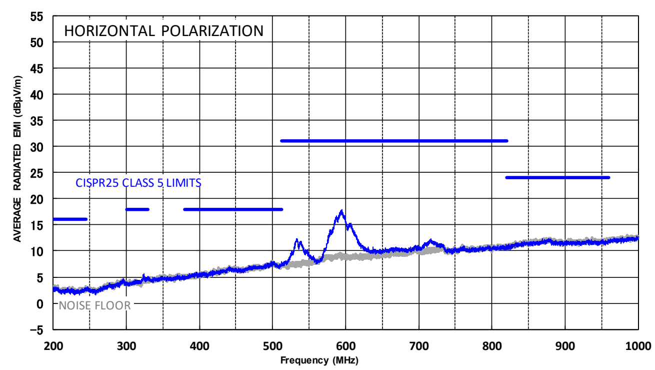
CISPR25 Class 5 Peak Radiated Emissions

Horizontal, 200MHz to 1GHz



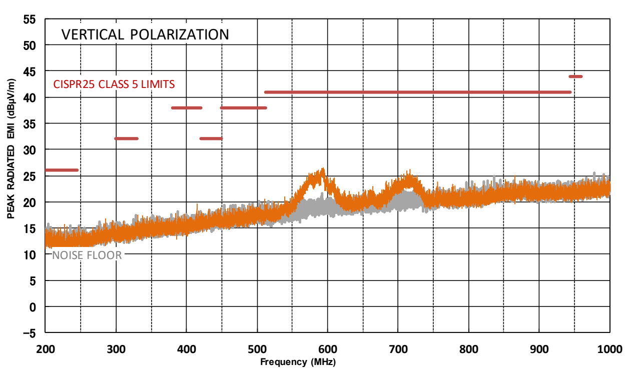
CISPR25 Class 5 Average Radiated Emissions

Horizontal, 200MHz to 1GHz



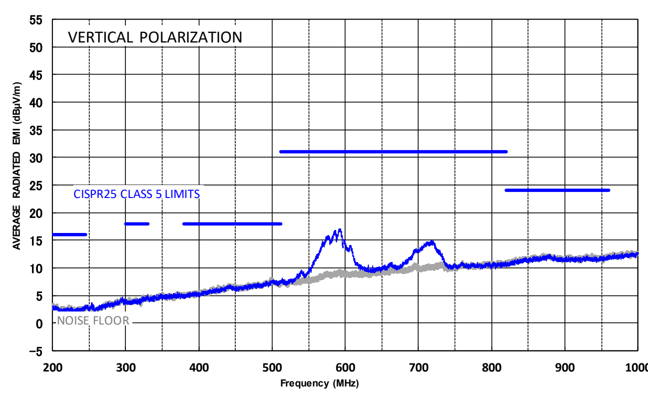
CISPR25 Class 5 Peak Radiated Emissions

Vertical, 200MHz to 1GHz



CISPR25 Class 5 Average Radiated Emissions

Vertical, 200MHz to 1GHz

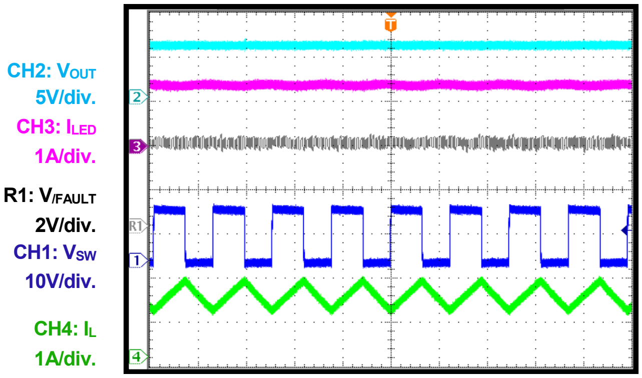


EVB TEST RESULTS *(continued)*

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

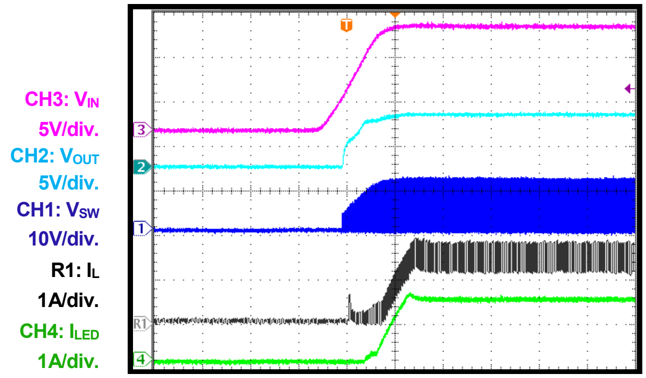
I_{LED} = 1.5A



2μs/div.

Start-Up through VIN

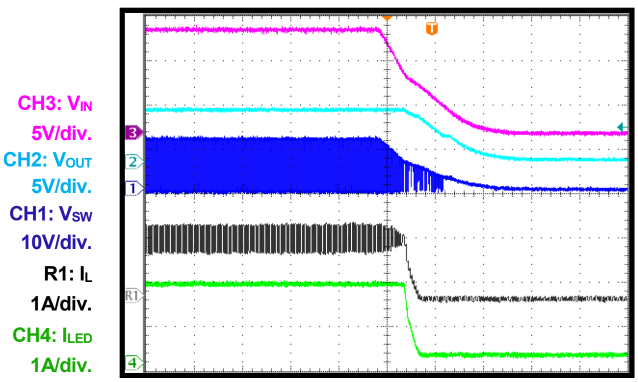
I_{LED} = 1.5A



1ms/div.

Shutdown through VIN

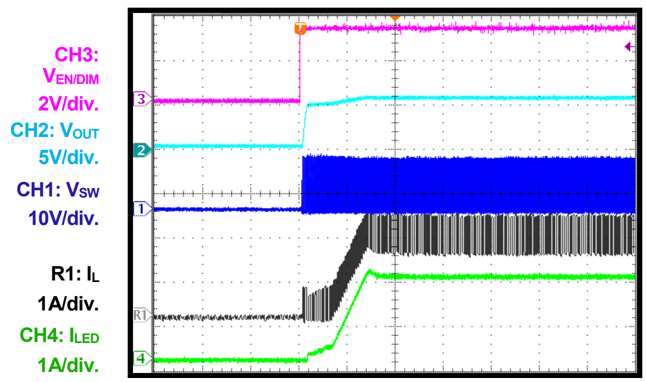
I_{LED} = 1.5A



10ms/div.

Start-Up through EN

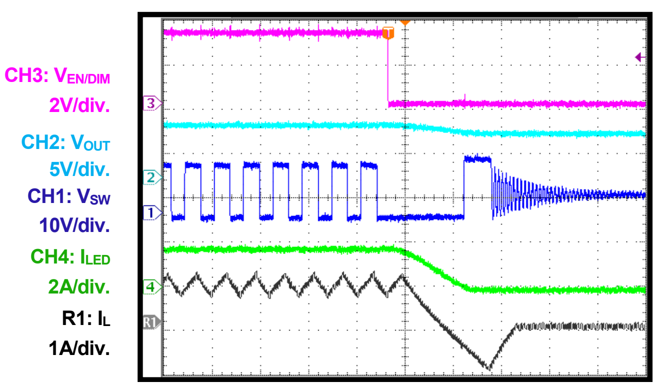
I_{LED} = 1.5A



1ms/div.

Shutdown through EN

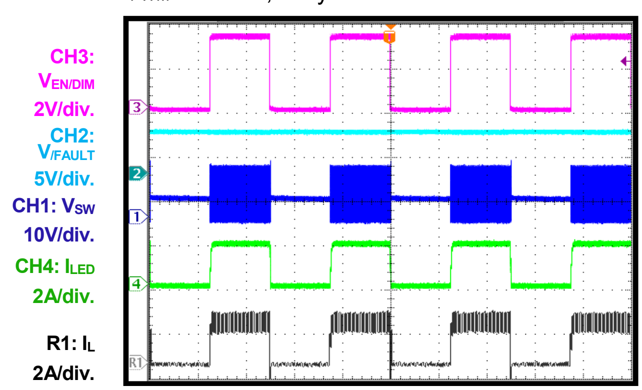
I_{LED} = 1.5A



4μs/div.

PWM Dimming

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



2ms/div.

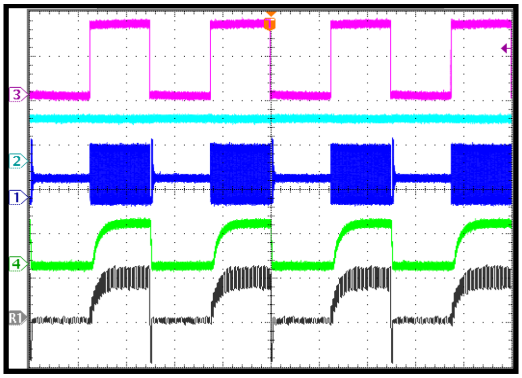
EVB TEST RESULTS *(continued)*

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%

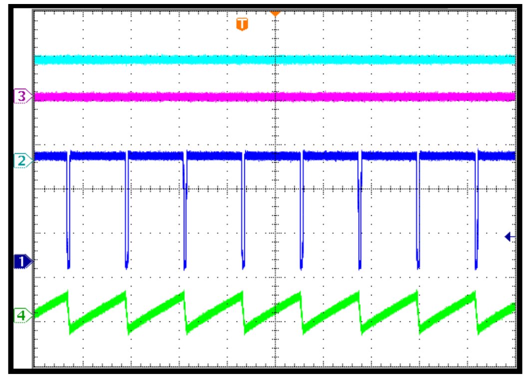
CH3: $V_{EN/DIM}$ 2V/div.
CH2: $V_{/FAULT}$ 5V/div.
CH1: V_{SW} 10V/div.
CH4: I_{LED} 2A/div.
R1: I_L 2A/div.



200μs/div.

LED Open Steady State

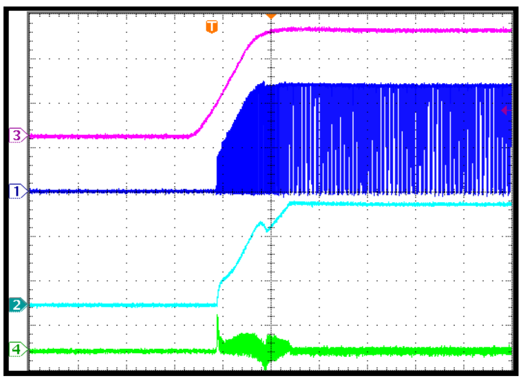
CH3: $V_{/FAULT}$ 2V/div.
CH2: V_{OUT} 5V/div.
CH1: V_{SW} 5V/div.
CH4: I_L 200mA/div.



2μs/div.

LED Open Input Start-Up

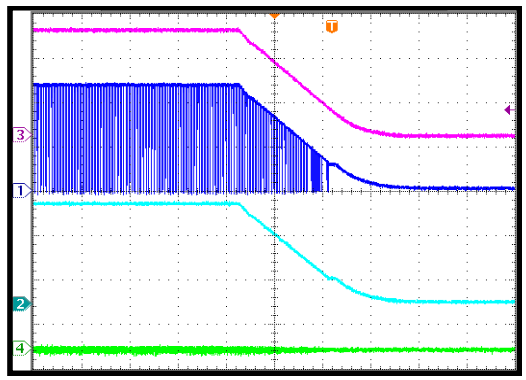
CH3: V_{IN} 5V/div.
CH1: V_{SW} 5V/div.
CH2: V_{OUT} 5V/div.
CH4: I_L 1A/div.



1ms/div.

LED Open Input Shutdown

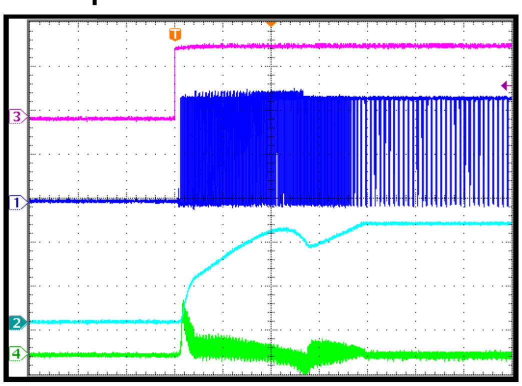
CH3: V_{IN} 5V/div.
CH1: V_{SW} 5V/div.
CH2: V_{OUT} 5V/div.
CH4: I_L 1A/div.



10ms/div.

LED Open EN On

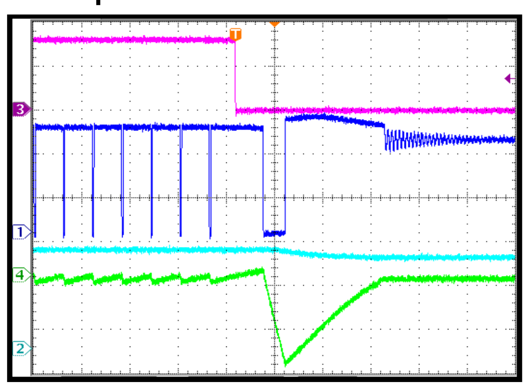
CH3: $V_{EN/DIM}$ 2V/div.
CH1: V_{SW} 5V/div.
CH2: V_{OUT} 5V/div.
CH4: I_L 1A/div.



400μs/div.

LED Open EN Off

CH3: $V_{EN/DIM}$ 2V/div.
CH1: V_{SW} 5V/div.
CH4: I_L 1A/div.
CH2: V_{OUT} 5V/div.



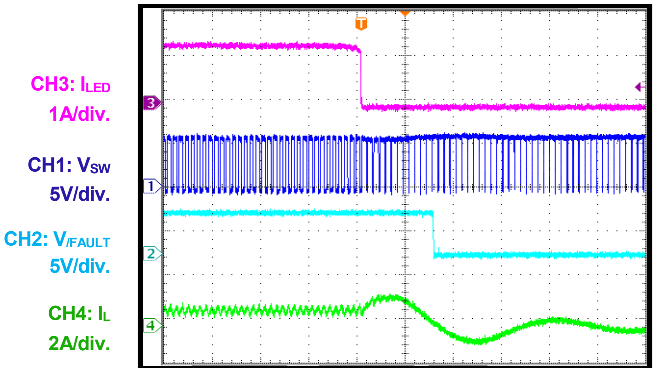
4μs/div.

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

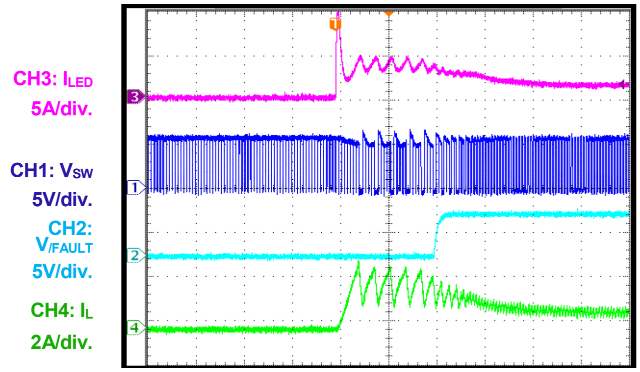
I_{LED} = 1.5A



20µs/div.

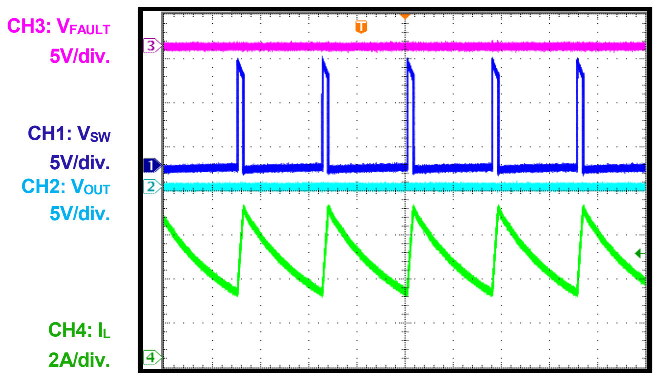
LED Open Recovery

I_{LED} = 1.5A



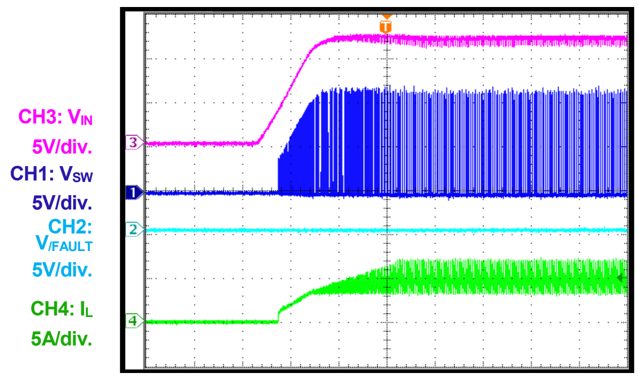
40µs/div.

LED+ Short to GND Steady State



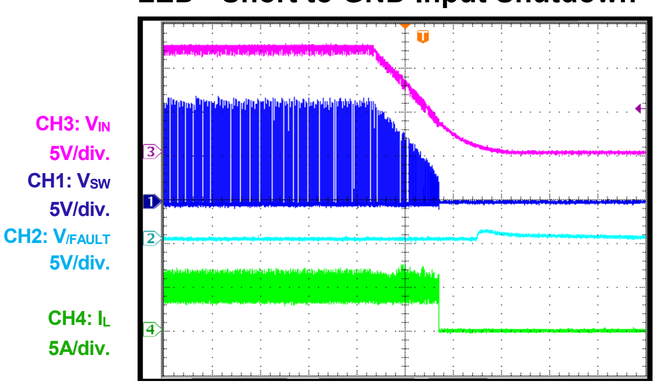
10µs/div.

LED+ Short to GND Input Start-Up



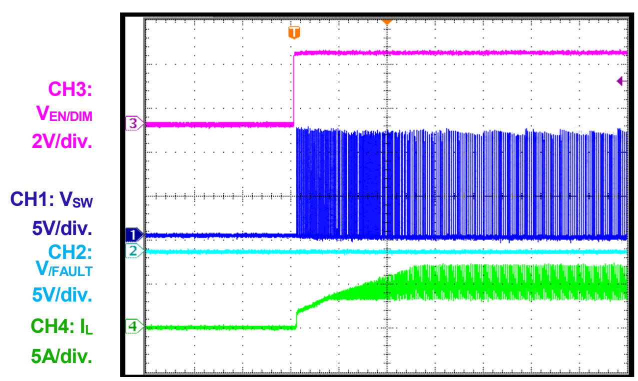
1ms/div.

LED+ Short to GND Input Shutdown



10ms/div.

LED+ Short to GND EN On

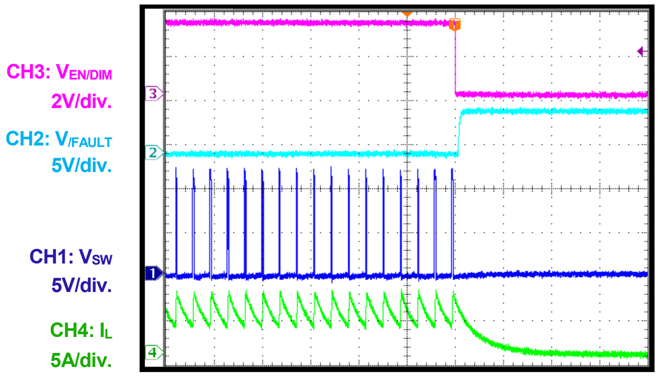


1ms/div.

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.

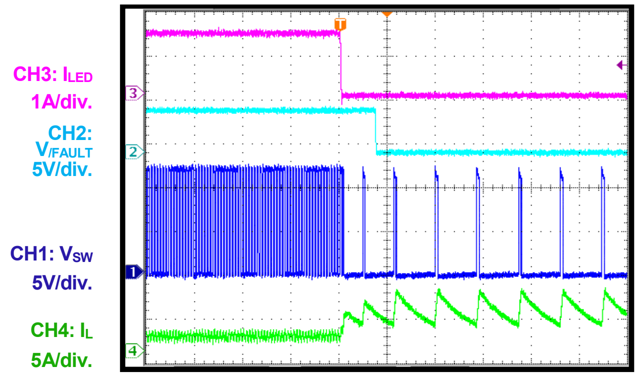
LED+ Short to GND EN Off



100μs/div.

LED+ Short to GND Entry

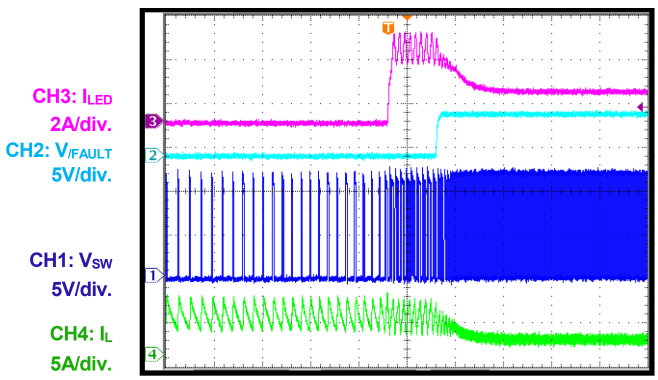
I_{LED} = 1.5A



40μs/div.

LED+ Short to GND Recovery

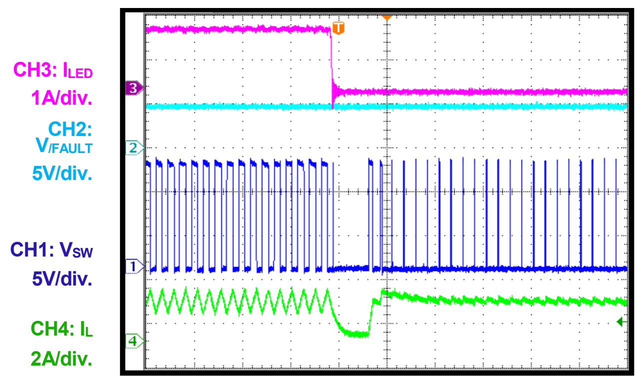
I_{LED} = 1.5A



100μs/div.

LED+ Short to LED- Entry

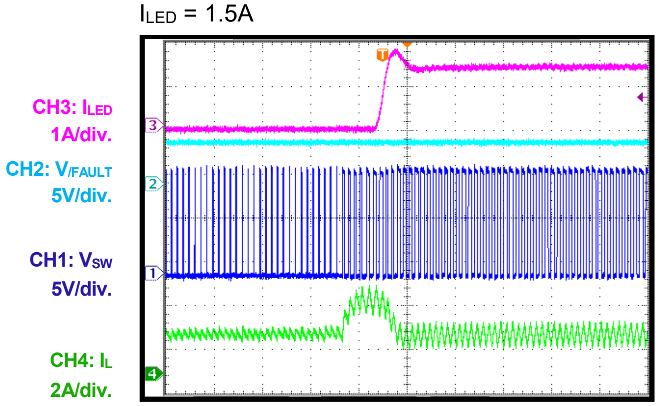
I_{LED} = 1.5A



10μs/div.

LED+ Short to LED- Recovery

I_{LED} = 1.5A



20μs/div.

PCB LAYOUT

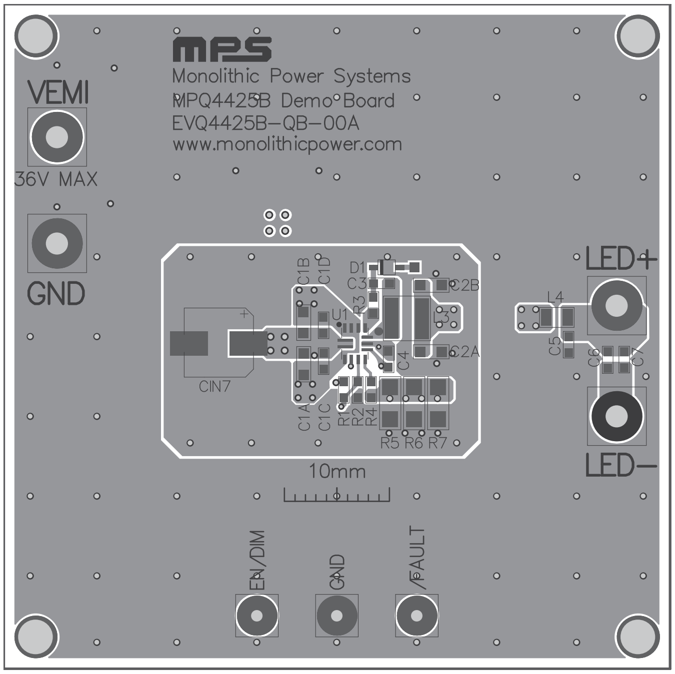


Figure 3: Top Silk and Top Layer

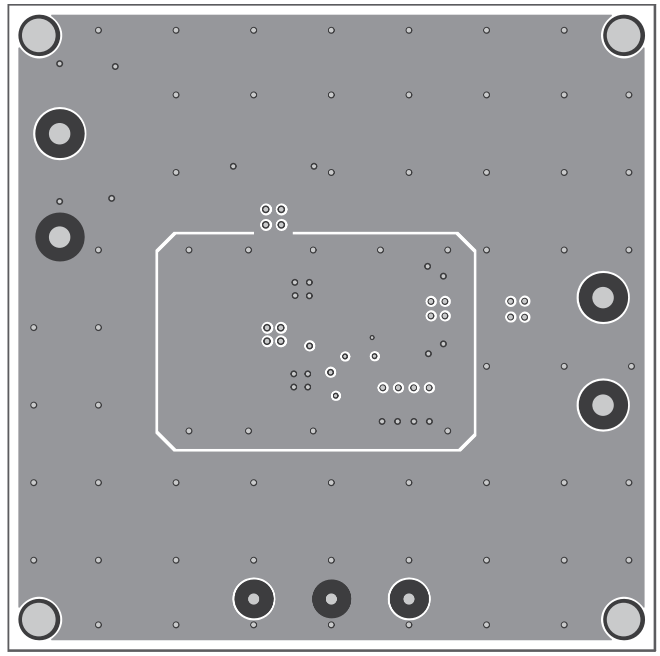


Figure 4: Mid-Layer 1

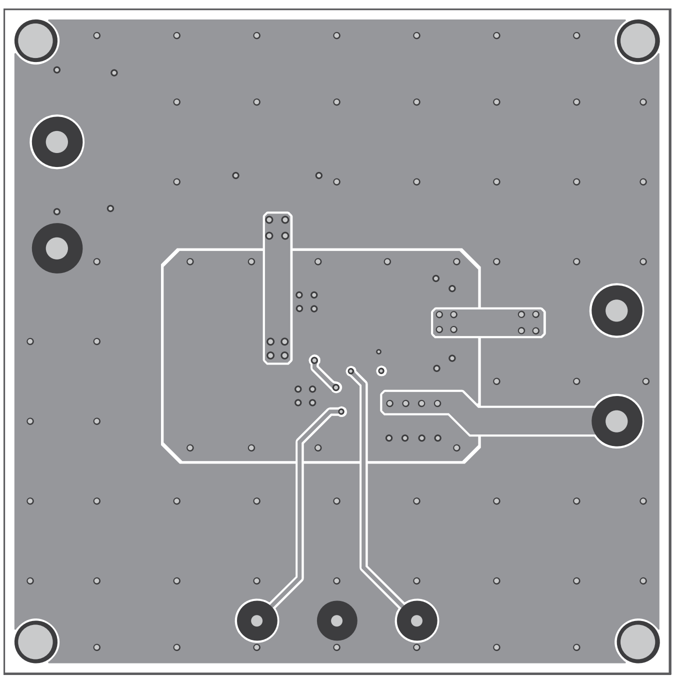


Figure 5: Mid-Layer 2

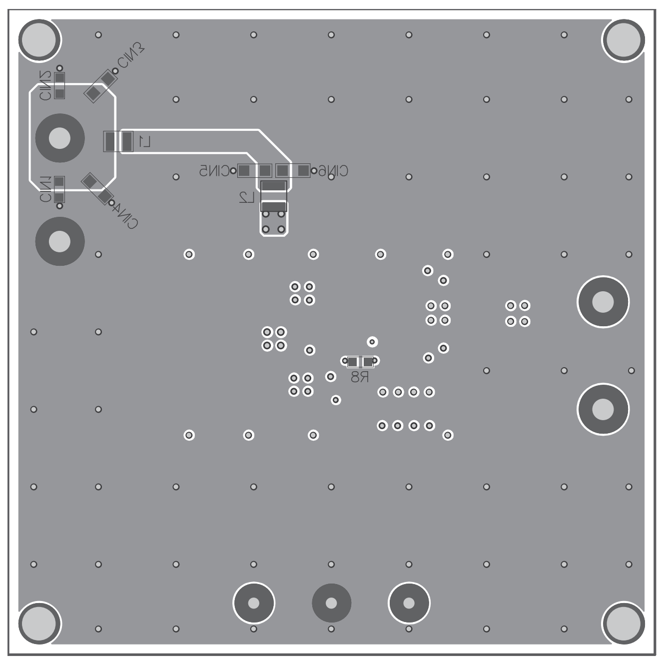


Figure 6: Bottom Layer and Bottom Silk

REVISION HISTORY

Revision #	Revision Date	Description	Pages Updated
1.0	1/4/2021	Initial Release	-