



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

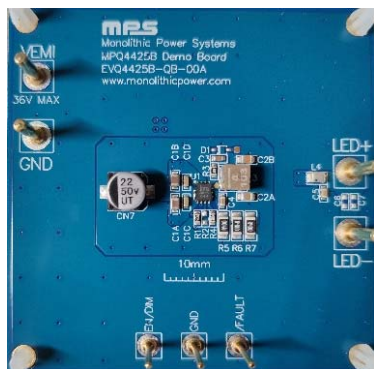
- Wide 4V to 36V Operating Input Range
- Internal 85mΩ HS-FET and 50mΩ LS-FET
- Synchronous Mode for High-Efficiency Operation
- 400kHz Default Switching Frequency
- PWM Dimming (100Hz Minimum Dimming Frequency)
- Forced Continuous Conduction Mode (FCCM)
- 0.2V Reference Voltage
- Internal Soft Start
- 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

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EVQ4425B-QB-00A EVALUATION BOARD

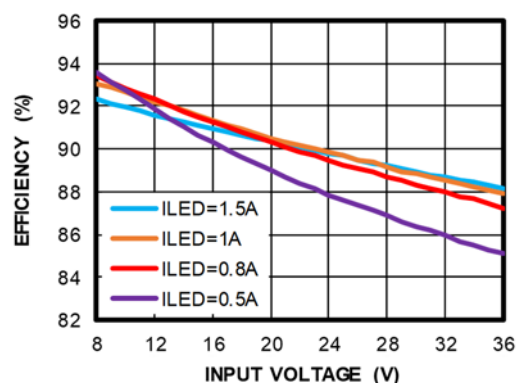


LxWxH (6.35cmx6.35cmx1.3cm)

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.

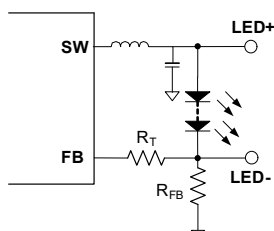


Figure 1: Feedback Resistor Network

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

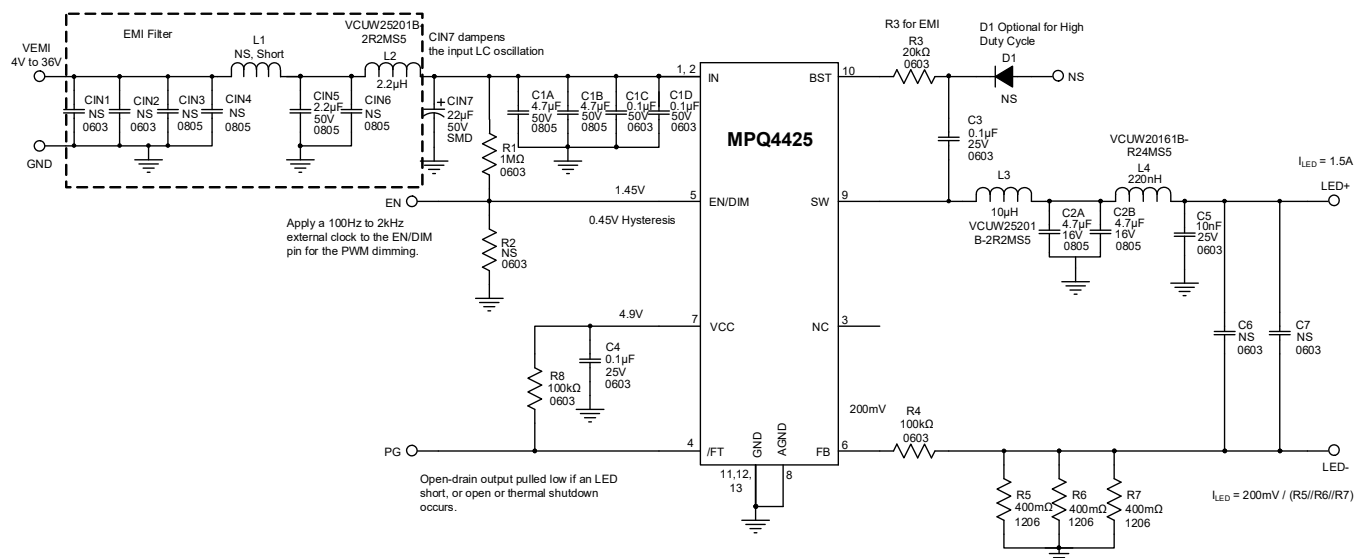


Figure 2: Evaluation Board Schematic

PACKAGE REFERENCE

TOP VIEW				
	PGND	PGND	PGND	BST
	13	12	11	10
				9 SW
IN	1			8 AGND
IN	2			7 VCC
	3	4	5	6
	NC	/FAULT	EN/DIM	FB
QFN-13 (2.5mmx3mm)				

EVQ4425B-QB-00A BILL OF MATERIALS

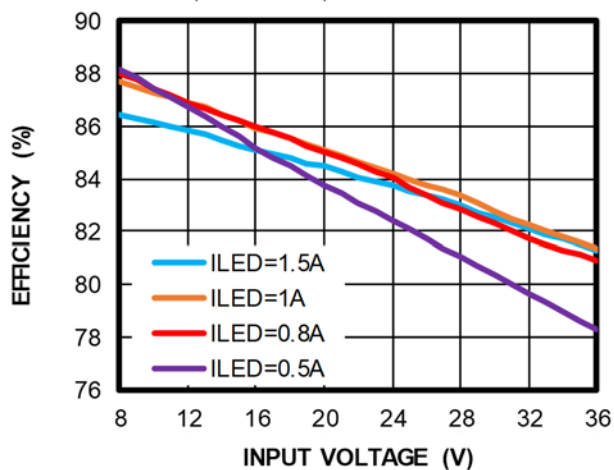
Qty	Ref	Value	Description	Package	Manufacturer	Manufacturer P/N
1	CIN5	2.2μF	Ceramic capacitor, 50V, X7R	0805	TDK	C2012X7R1H225K
1	CIN7	22μF	Electrolytic capacitor, 50V	SMD	Cotronic	UT1H220M0605VG
2	C1A, C1B	4.7μF	Ceramic capacitor, 50V, X7S	0805	Murata	GRM21BC71H475KE11L
2	C1C, C1D	0.1μF	Ceramic capacitor, 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, $L = 10\mu H$, $f_{SW} = 400kHz$, $T_A = 25^\circ C$, unless otherwise noted.

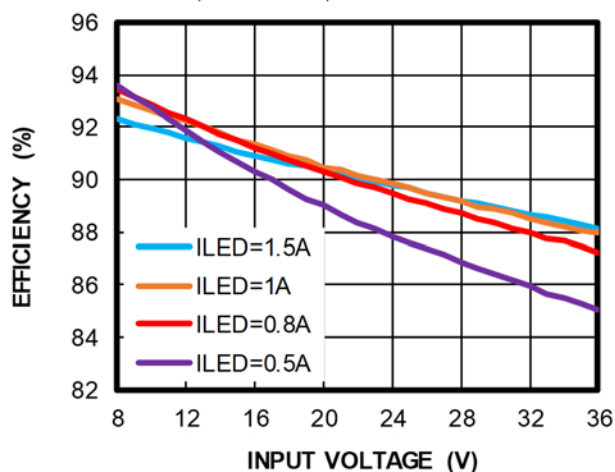
Efficiency vs. Input Voltage

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

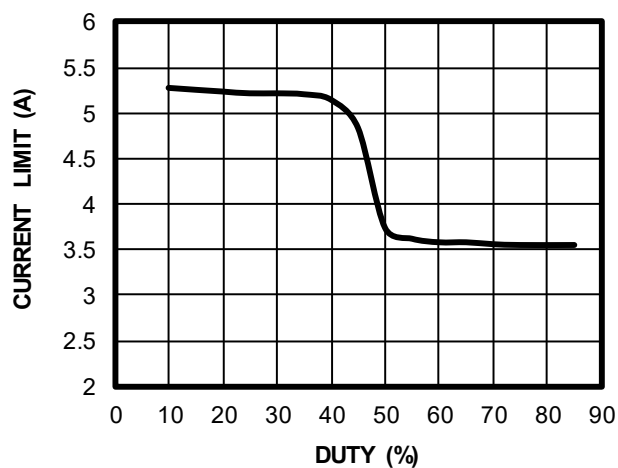


Efficiency vs. Input Voltage

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



Current Limit vs. Duty

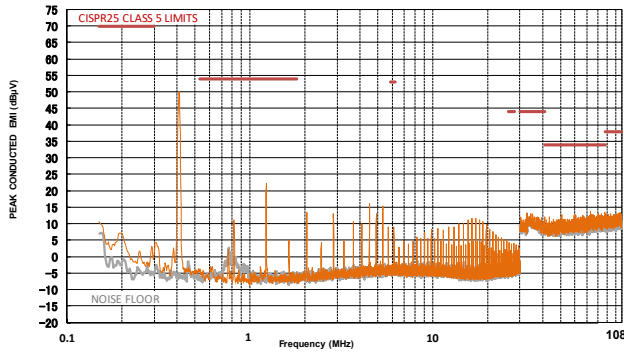


EVB TEST RESULTS (continued)

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

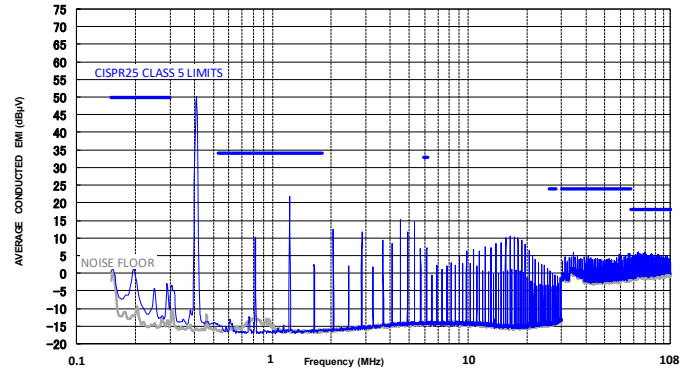
CISPR25 Class 5 Peak Conducted Emissions

150kHz to 108MHz



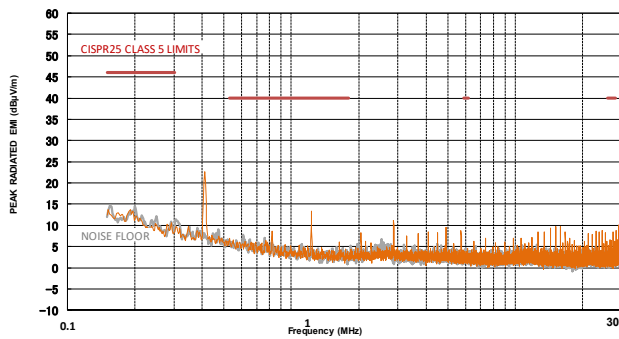
CISPR25 Class 5 Average Conducted Emissions

150kHz to 108MHz



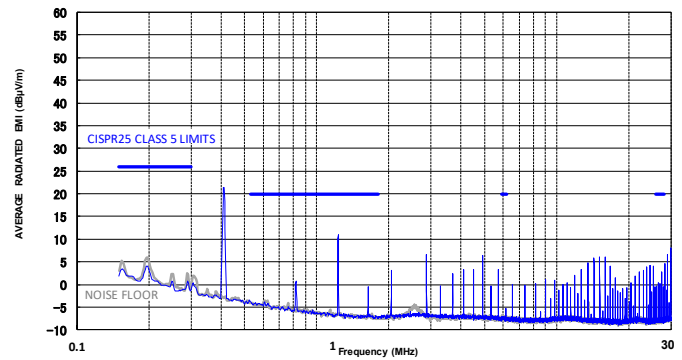
CISPR25 Class 5 Peak Radiated Emissions

150kHz to 30MHz



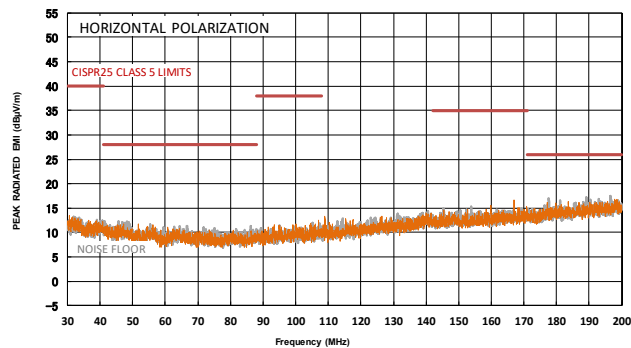
CISPR25 Class 5 Average Radiated Emissions

150kHz to 30MHz



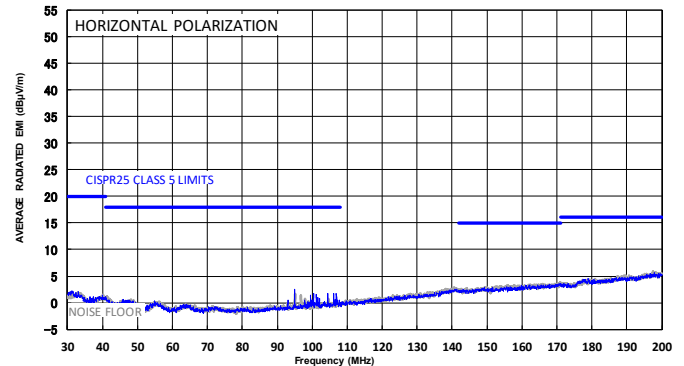
CISPR25 Class 5 Peak Radiated Emissions

Horizontal, 30MHz to 200MHz



CISPR25 Class 5 Average Radiated Emissions

Horizontal, 30MHz to 200MHz

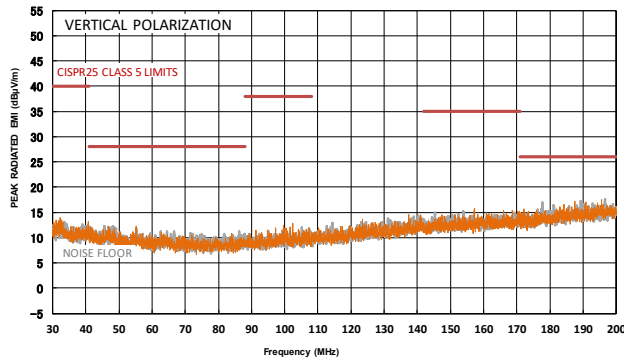


EVB TEST RESULTS (continued)

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

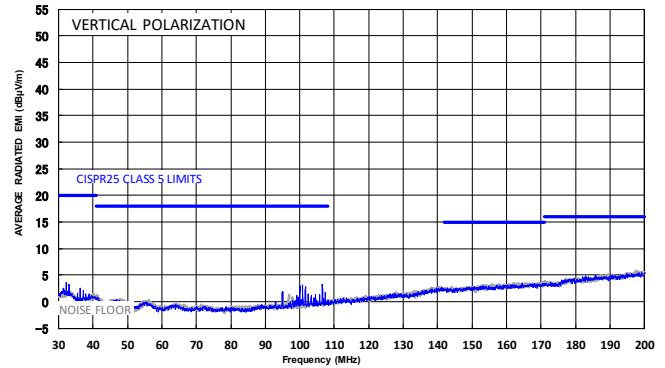
CISPR25 Class 5 Peak Radiated Emissions

Vertical, 30MHz to 200MHz



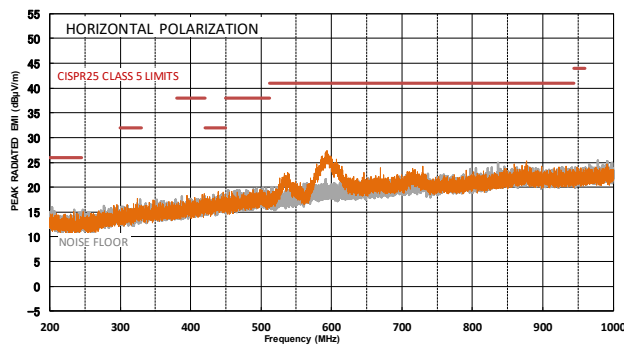
CISPR25 Class 5 Average Radiated Emissions

Vertical, 30MHz to 200MHz



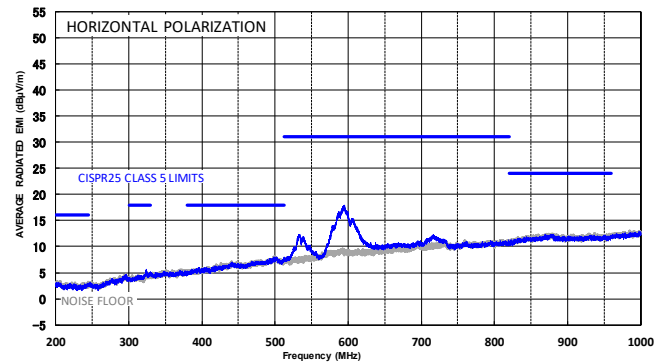
CISPR25 Class 5 Peak Radiated Emissions

Horizontal, 200MHz to 1GHz



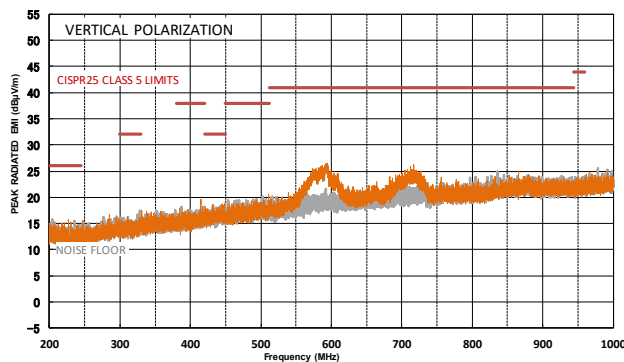
CISPR25 Class 5 Average Radiated Emissions

Horizontal, 200MHz to 1GHz



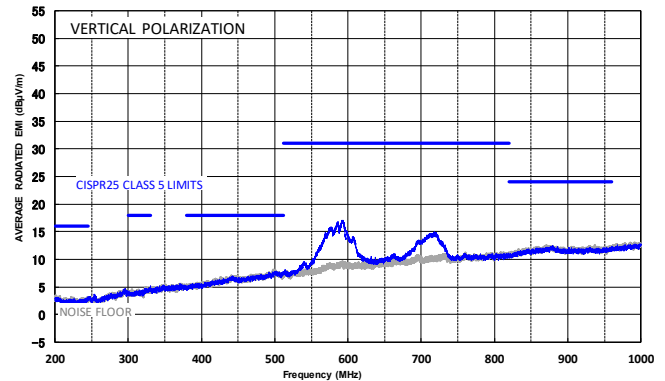
CISPR25 Class 5 Peak Radiated Emissions

Vertical, 200MHz to 1GHz



CISPR25 Class 5 Average Radiated Emissions

Vertical, 200MHz to 1GHz



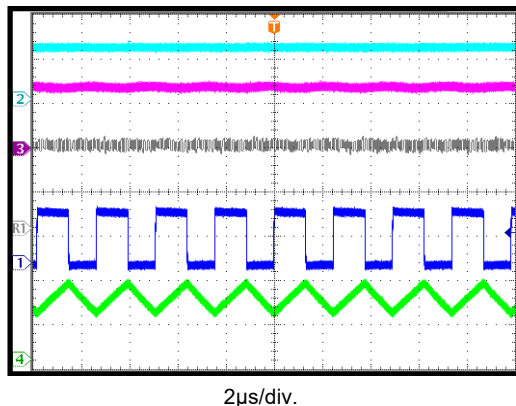
EVB TEST RESULTS (continued)

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

Steady State

 $I_{LED} = 1.5A$

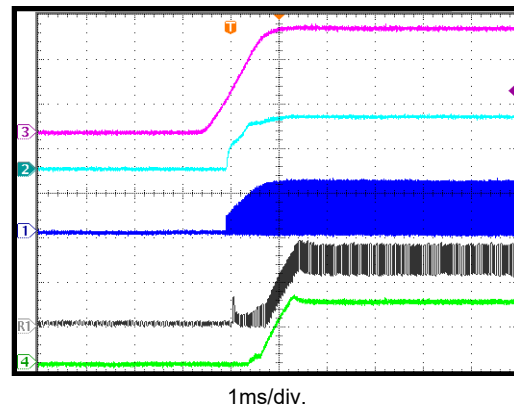
CH2: V_{OUT}
5V/div.
CH3: I_{LED}
1A/div.
R1: V_{FAULT}
2V/div.
CH1: V_{SW}
10V/div.
CH4: I_L
1A/div.



Start-Up through VIN

 $I_{LED} = 1.5A$

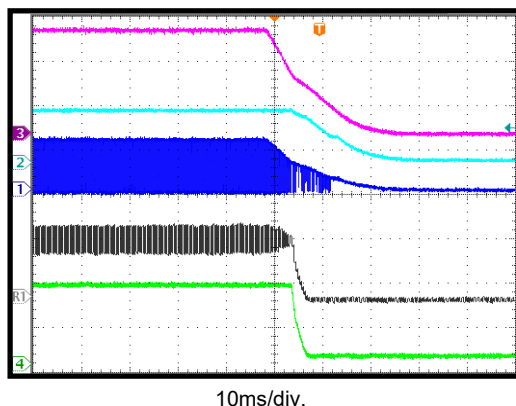
CH3: V_{IN}
5V/div.
CH2: V_{OUT}
5V/div.
CH1: V_{SW}
10V/div.
R1: I_L
1A/div.
CH4: I_{LED}
1A/div.



Shutdown through VIN

 $I_{LED} = 1.5A$

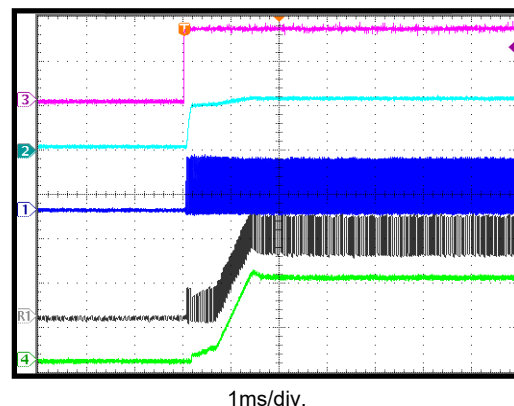
CH3: V_{IN}
5V/div.
CH2: V_{OUT}
5V/div.
CH1: V_{SW}
10V/div.
R1: I_L
1A/div.
CH4: I_{LED}
1A/div.



Start-Up through EN

 $I_{LED} = 1.5A$

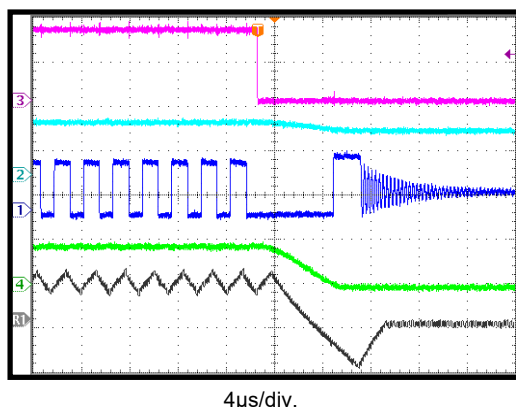
CH3: $V_{EN/DIM}$
2V/div.
CH2: V_{OUT}
5V/div.
CH1: V_{SW}
10V/div.
R1: I_L
1A/div.
CH4: I_{LED}
1A/div.



Shutdown through EN

 $I_{LED} = 1.5A$

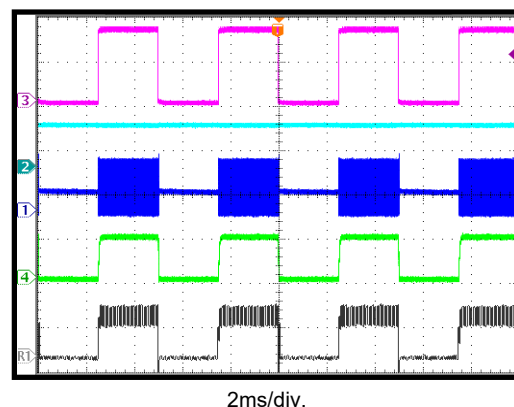
CH3: $V_{EN/DIM}$
2V/div.
CH2: V_{OUT}
5V/div.
CH1: V_{SW}
10V/div.
CH4: I_{LED}
2A/div.
R1: I_L
1A/div.



PWM Dimming

 $f_{PWM} = 200Hz$, 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.



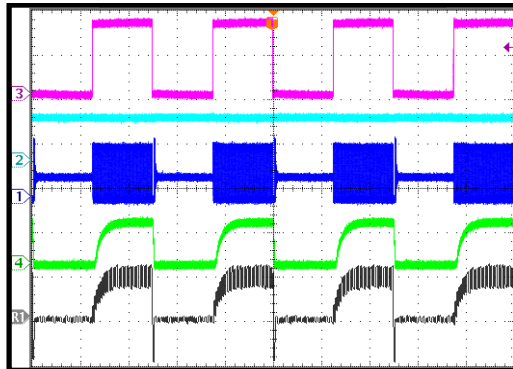
EVB TEST RESULTS (continued)

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

PWM Dimming

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

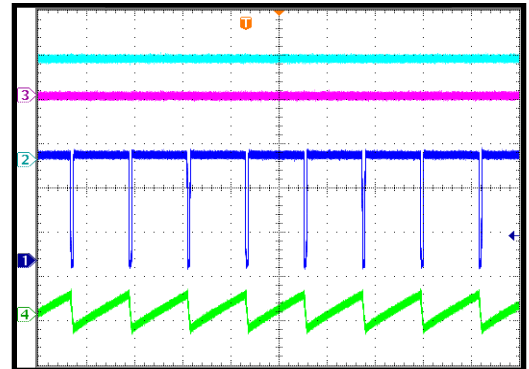
CH3: $V_{EN/DIM}$
2V/div.
CH2: V_{FAULT}
5V/div.
CH1: V_{SW}
10V/div.
CH4: I_{LED}
2A/div.
R1: I_L
2A/div.



200µs/div.

LED Open Steady State

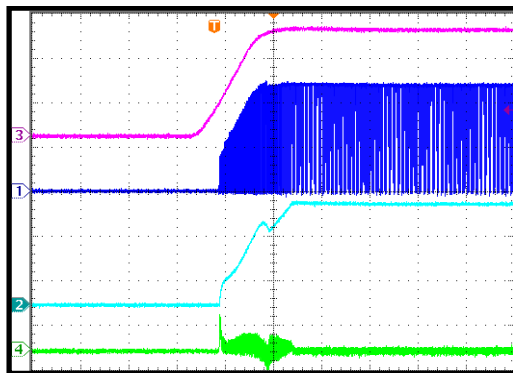
CH3: V_{FAULT}
2V/div.
CH2: V_{OUT}
5V/div.
CH1: V_{SW}
5V/div.
CH4: I_L
200mA/div.



2µs/div.

LED Open Input Start-Up

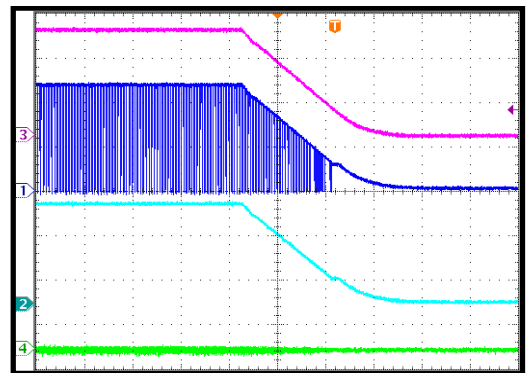
CH3: V_{IN}
5V/div.
CH1: V_{SW}
5V/div.
CH2: V_{OUT}
5V/div.
CH4: I_L
1A/div.



1ms/div.

LED Open Input Shutdown

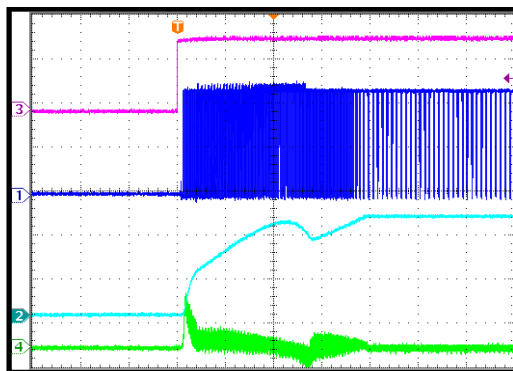
CH3: V_{IN}
5V/div.
CH1: V_{SW}
5V/div.
CH2: V_{OUT}
5V/div.
CH4: I_L
1A/div.



10ms/div.

LED Open EN On

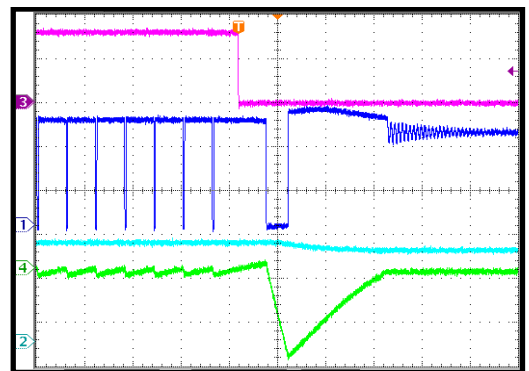
CH3: $V_{EN/DIM}$
2V/div.
CH1: V_{SW}
5V/div.
CH2: V_{OUT}
5V/div.
CH4: I_L
1A/div.



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.

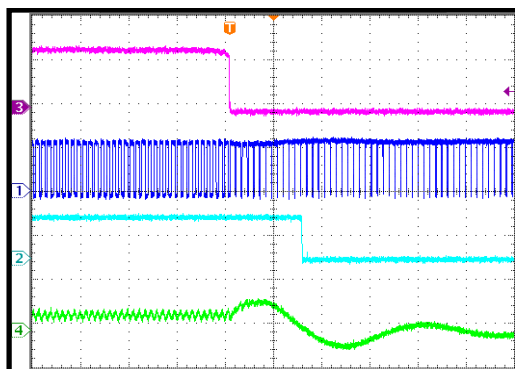
EVB TEST RESULTS (continued)

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

LED Open Entry

 $I_{LED} = 1.5A$

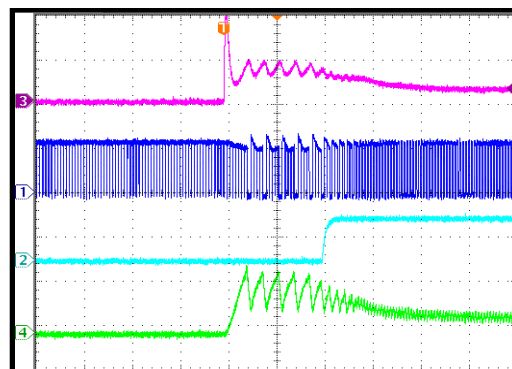
CH3: I_{LED}
1A/div.
CH1: V_{SW}
5V/div.
CH2: V_{FAULT}
5V/div.
CH4: I_L
2A/div.



LED Open Recovery

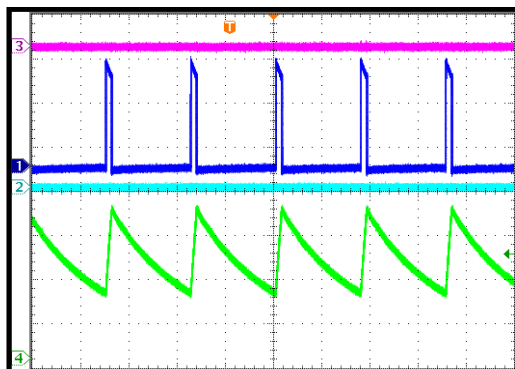
 $I_{LED} = 1.5A$

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



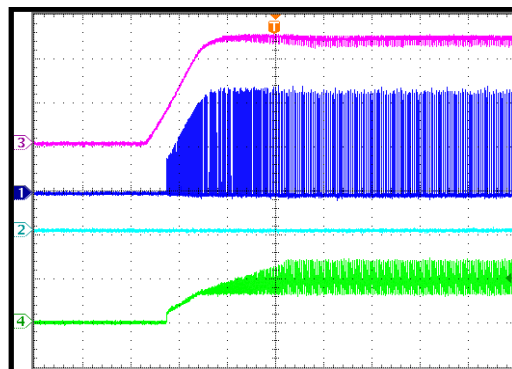
LED+ Short to GND Steady State

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



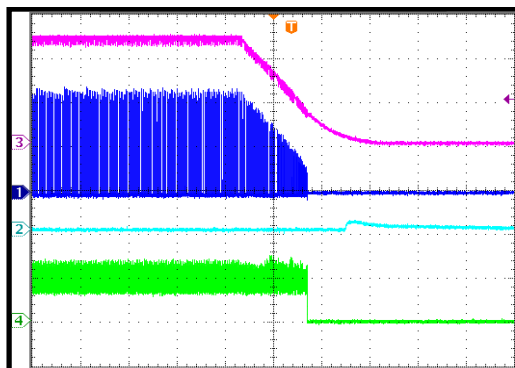
LED+ Short to GND Input Start-Up

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



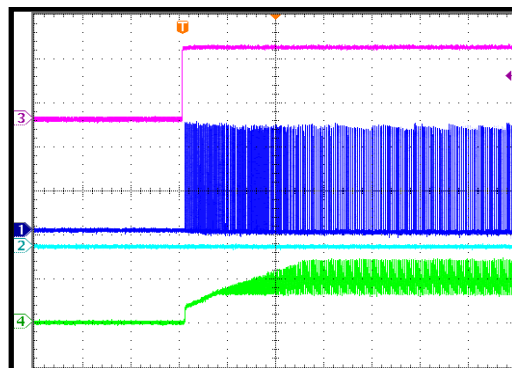
LED+ Short to GND Input Shutdown

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



LED+ Short to GND EN On

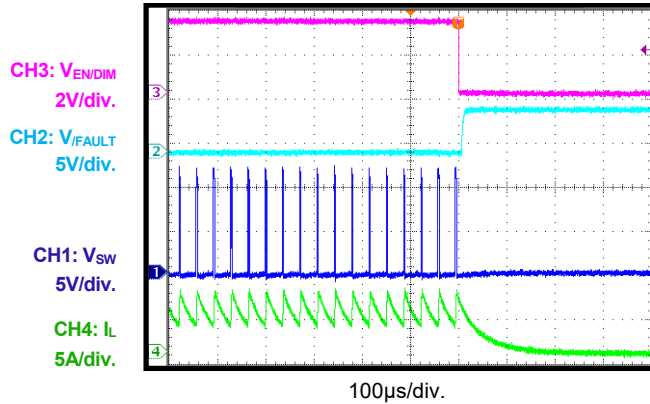
CH3: $V_{EN/DIM}$
2V/div.
CH1: V_{SW}
5V/div.
CH2: V_{FAULT}
5V/div.
CH4: I_L
5A/div.



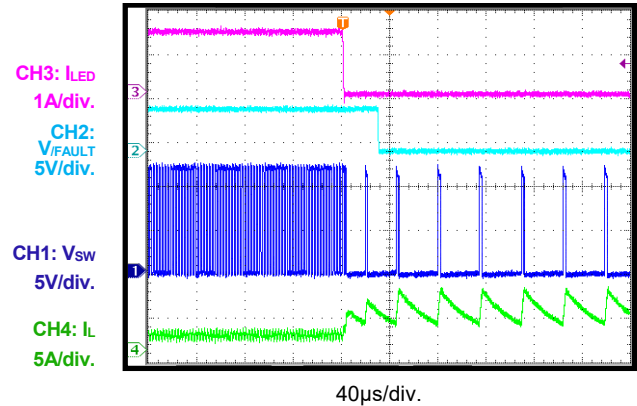
EVB TEST RESULTS (continued)

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

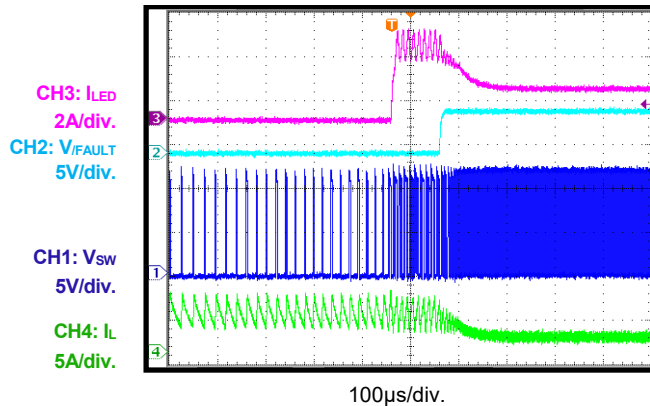
LED+ Short to GND EN Off



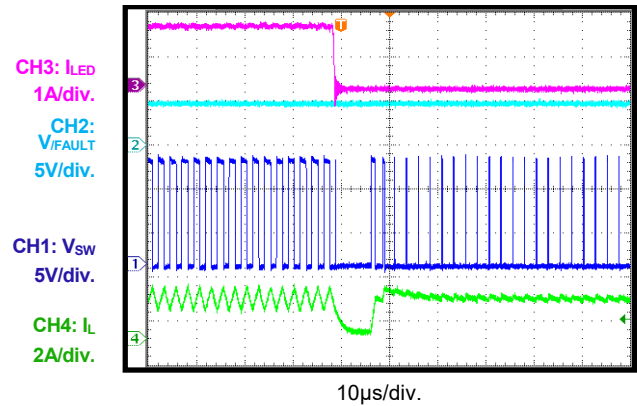
LED+ Short to GND Entry

 $I_{LED} = 1.5A$


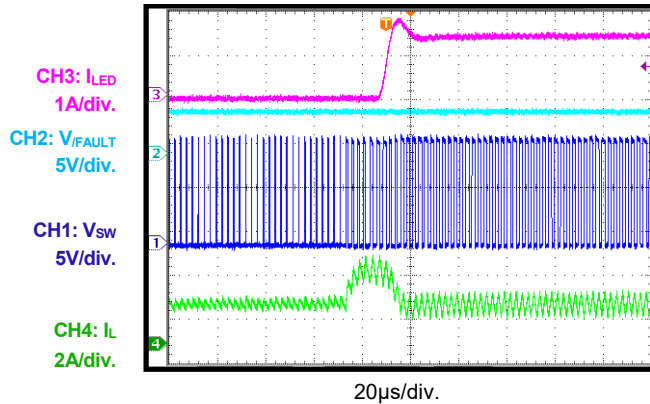
LED+ Short to GND Recovery

 $I_{LED} = 1.5A$


LED+ Short to LED- Entry

 $I_{LED} = 1.5A$


LED+ Short to LED- Recovery

 $I_{LED} = 1.5A$


PCB LAYOUT

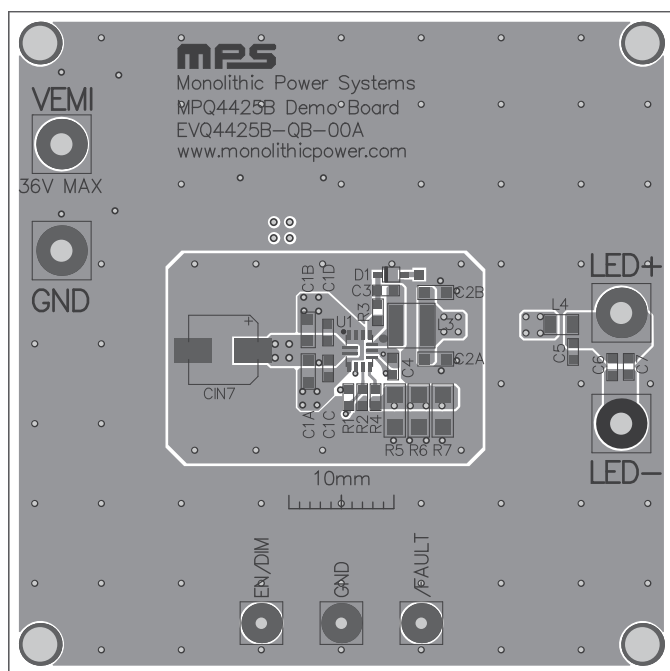


Figure 3: Top Silk and Top Layer

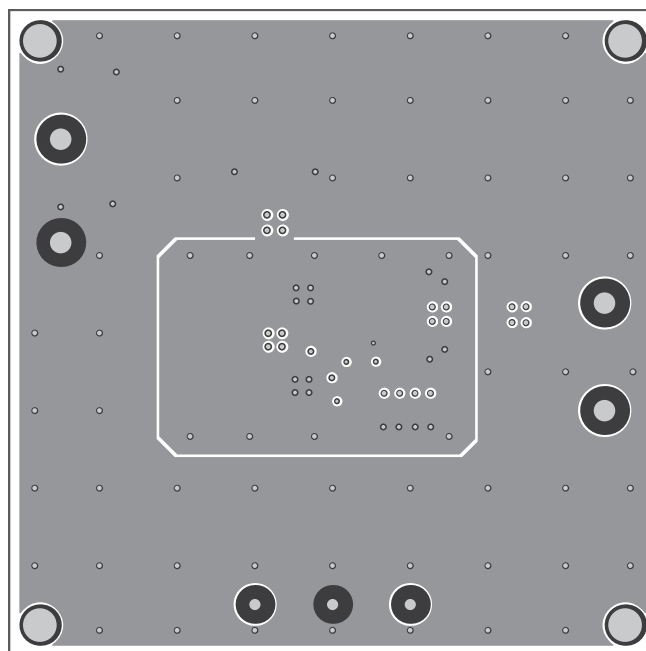


Figure 4: Mid-Layer 1

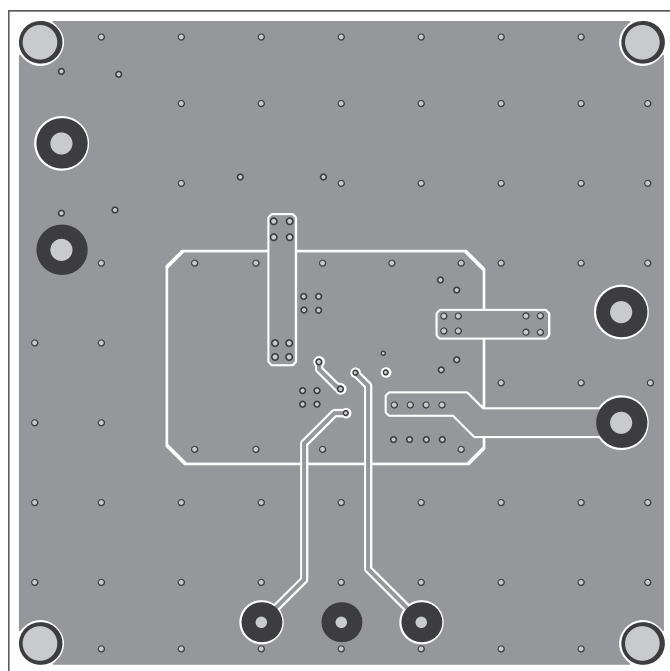


Figure 5: Mid-Layer 2

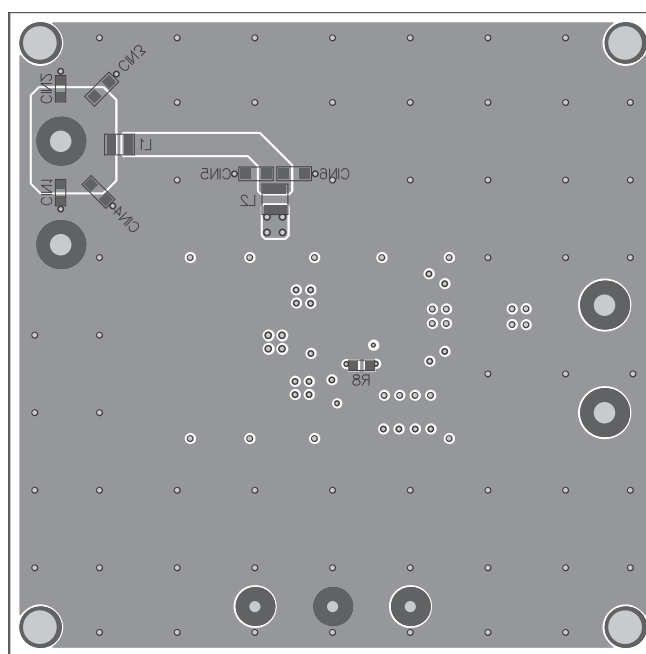


Figure 6: Bottom Layer and Bottom Silk

REVISION HISTORY

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

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