



EVQ4425B-J-00A

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

DESCRIPTION

The EVQ4425B-J-00A is an evaluation board for the MPQ4425B-AEC1.

The MPQ4425B-AEC1 is a high-efficiency, synchronous, rectified, step-down, switch-mode white LED driver with built-in power MOSFETs. It offers a very compact solution to achieve 1.5A of continuous output current with excellent load and line regulation across a wide input supply range. The MPQ4425B-AEC1 has synchronous mode operation for high efficiency.

The EVQ4425B-J-00A is a fully assembled and tested evaluation board, which generates load currents up to 1.5A from a 4V to 36V input range.

ELECTRICAL SPECIFICATIONS

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

FEATURES

- Wide 4V to 36V Operating Input Range
- 85mΩ High-Side and 50mΩ Low-Side Internal Power MOSFETs
- High-Efficiency Synchronous Mode Operation
- Default 400kHz Switching Frequency
- PWM Dimming (Minimum 100Hz Dimming Frequency)
- Forced CCM Mode
- 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 TSOT23-8 Package
- CISPR25 Class 5 Compliant
- Available in AEC-Q100 Grade 1

APPLICATIONS

- Automotive LED Lighting

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EVQ4425B-J-00A EVALUATION BOARD

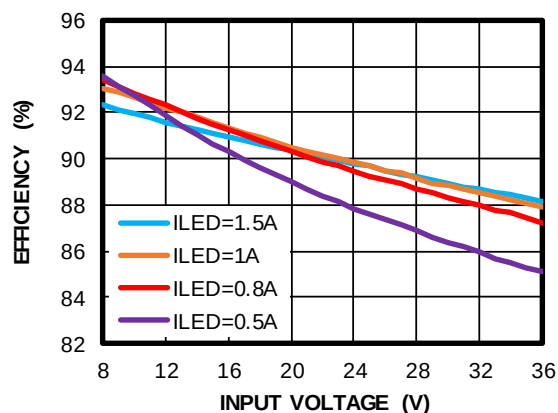


(LxWxH) 6.35cmx6.35cmx1.3cm

Board Number	MPS IC Number
EVQ4425B-J-00A	MPQ4425BGJ-AEC1

Efficiency vs. Input Voltage

$V_{LED} = 6.4V$



QUICK START GUIDE

- Connect the terminals of the LED to:
 - Positive (+): LED+
 - Negative (-): LED-
- Preset the power supply output between 4 and 36V, then turn the power supply off.
If longer cables (>0.5m) are used between the source and the EVB, install a damping capacitor at the input terminals. This is strongly recommended when $V_{IN} \geq 24V$.
- Connect the terminals of the power supply output to:
 - Positive (+): VIN
 - Negative (-): GND

To improve EMI performance, connect the input power between VEMI and GND.
- Turn the power supply on. The MPQ4425BGJ-AEC1 should automatically start up.
- To use the enable 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.
- To use the dimming function, apply a 100Hz to 2kHz external clock to the EN/DIM pin for PWM dimming.
- The output current is set by the external 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 recommended feedback network.

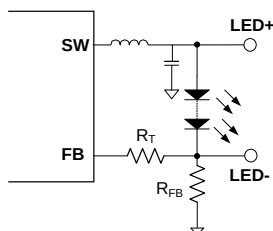


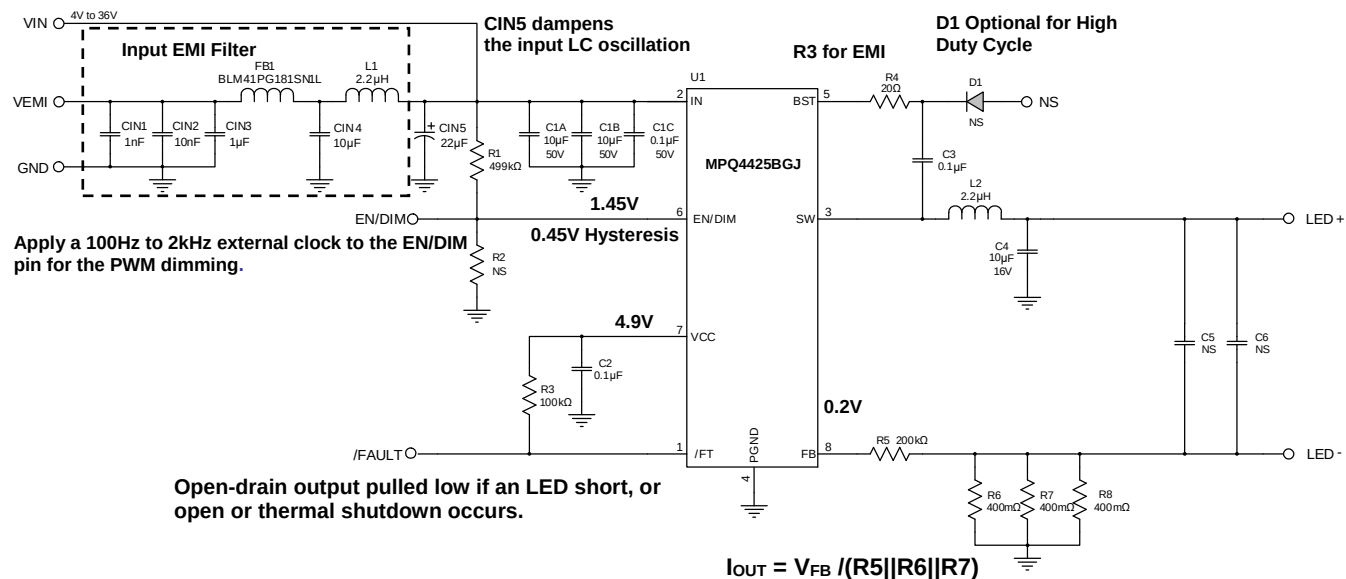
Figure 1: Feedback Network

- R_T sets the loop bandwidth. A lower R_T results in higher bandwidth. However, a high bandwidth may cause insufficient phase margin, which results in an unstable loop. Choose a proper value for R_T to make a tradeoff between bandwidth and phase margin. Table 1 lists the recommended feedback resistor and R_T values for common outputs with 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



Package Reference

TOP VIEW

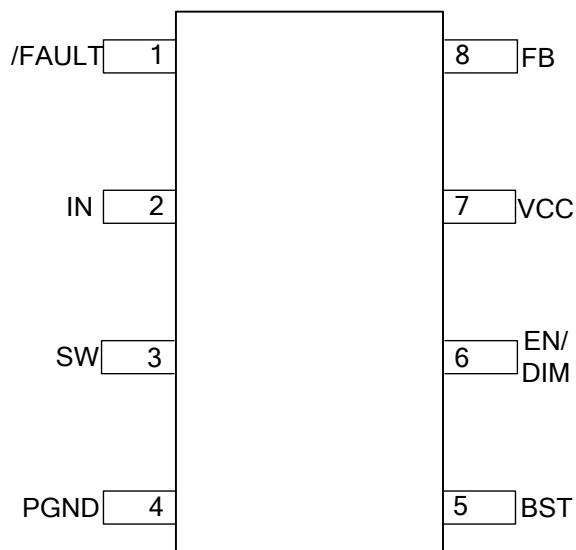


Figure 2: Evaluation Board Schematic

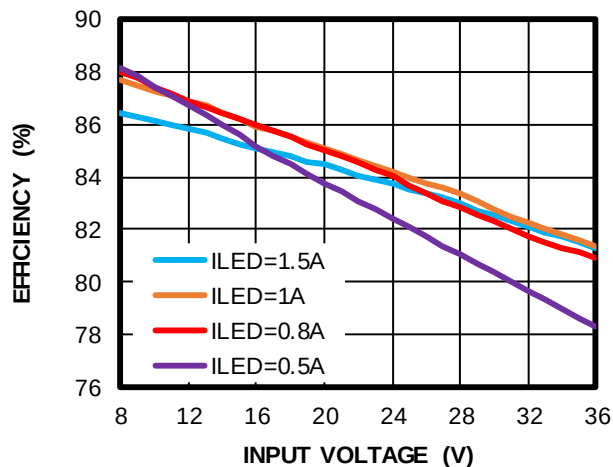
EVQ4425B-J-00A BILL OF MATERIALS

Qty	Ref	Value	Description	Package	Manufacturer	Manufacturer P/N
1	CIN1	1nF	Ceramic capacitor, 50V, X7R	0603	Murata	GRM188R71H102KA01D
1	CIN2	10nF	Ceramic capacitor, 50V, X7R	0603	Murata	GRM188R71H103KA01D
1	CIN3	1μF	Ceramic capacitor, 50V, X7R	1206	Murata	GRM31MR71H105KA88L
1	CIN4	10μF	Ceramic capacitor, 50V, X7R	1210	Murata	GRM32ER71H106KA12L
1	CIN5	22μF	Electrolytic capacitor, 63V	SMD	Jianghai	VTD-63V22
2	C1A, C1B	10μF	Ceramic capacitor, 50V, X5R	1206	Murata	GRM31CR61H106KA12L
1	C1C	0.1μF	Ceramic capacitor, 50V, X7R	0603	Murata	GRM188R71H104KA93D
2	C2, C3	0.1μF	Ceramic capacitor, 16V, X7R	0603	Murata	GRM188R71C104KA01D
1	C4	10μF	Ceramic capacitor, 16V, X7R	1210	Murata	GRM32DR71C106KA01L
2	C5, C6	NS				
1	D1	NS				
1	FB1		Bead, 180Ω at 100MHz, 3.5A	1812	Murata	BLM41PG181SN1L
1	L1	2.2μH	Inductor, 82mΩ DCR, 3.3A	SMD	Toko	DFE252012F-2R2MP2
1	L2	10μH	Inductor, 84mΩ DCR, 3.1A	SMD	Coilcraft	XAL4040-103MEB
1	R1	499kΩ	Film resistor, 1%	0603	Yageo	RC0603FR-07499KL
1	R3	100kΩ	Film resistor, 1%	0603	Yageo	RC0603FR-07100KL
1	R4	20	Film resistor, 1%	0603	Yageo	RC0603FR-0720RL
1	R5	200kΩ	Film resistor, 1%	0603	Yageo	RC0603FR-07200KL
3	R6, R7, R8	400mΩ	Film resistor, 1%	1206	Yageo	RL1206FR-070R4L
1	R2	NS				
1	U1	MPQ4425-AEC1	Step-down regulator	SOT23-8	MPS	MPQ4425BGJ-AEC1
5	VIN, VEMI, GND, GND, VOUT		2.0mm golden pin		Custom	
3	/FAULT, GND, EN/DIM		2.54mm test pin		Custom	

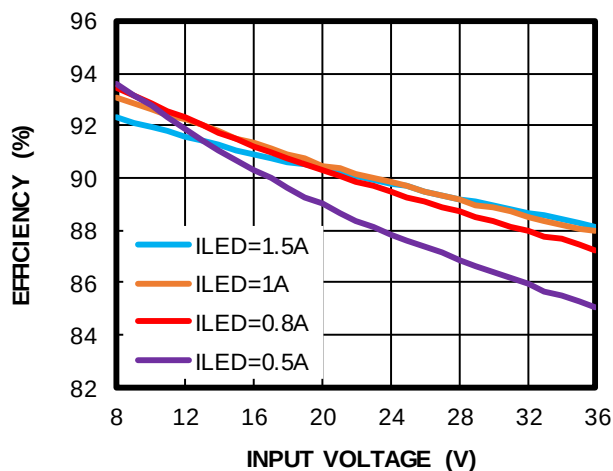
EVB TEST RESULTS

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

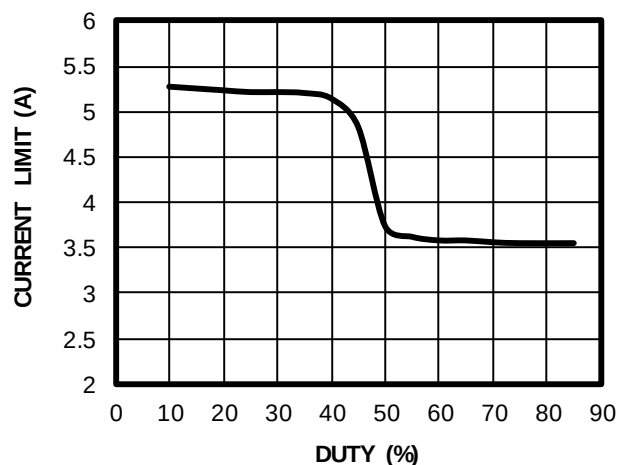
Efficiency vs. Input Voltage

 $V_{LED} = 3.2V$


Efficiency vs. Input Voltage

 $V_{LED} = 6.4V$


Current Limit vs. Duty

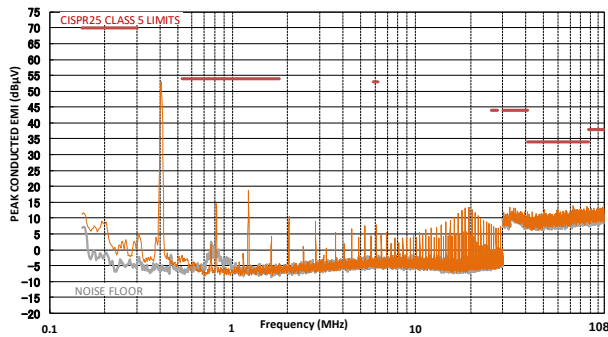


EVB TEST RESULTS (continued)

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

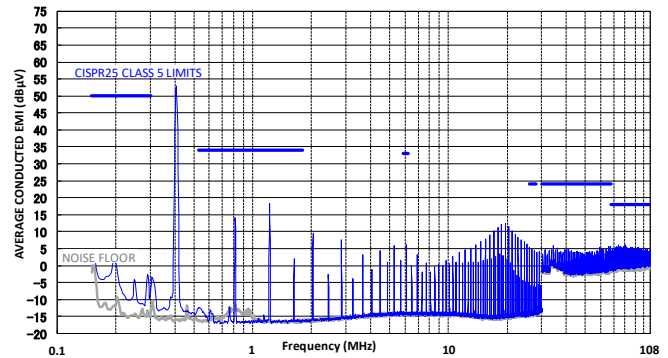
CISPR25 Class 5 Peak Conducted Emissions

150kHz to 108MHz



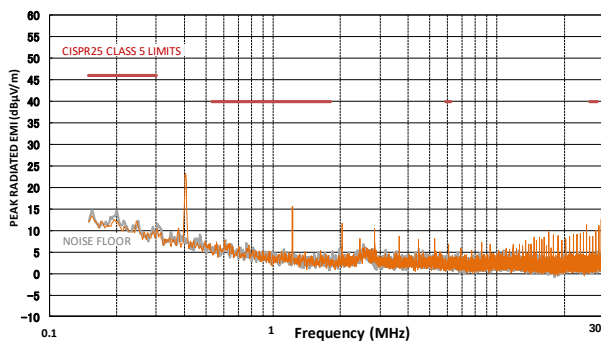
CISPR25 Class 5 Average Conducted Emissions

150kHz to 108MHz



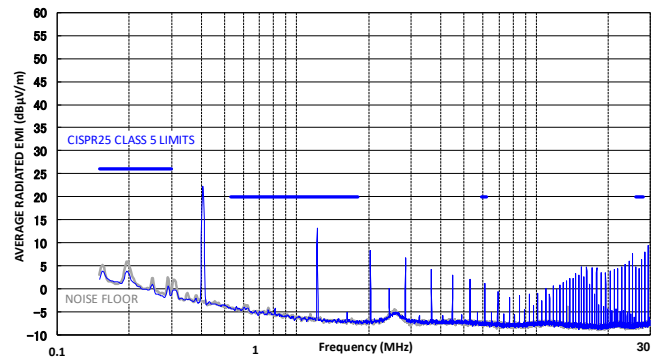
CISPR25 Class 5 Peak Radiated Emissions

150kHz to 30MHz



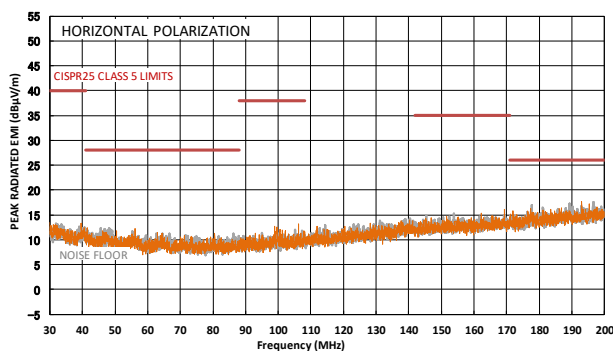
CISPR25 Class 5 Average Radiated Emissions

150kHz to 30MHz



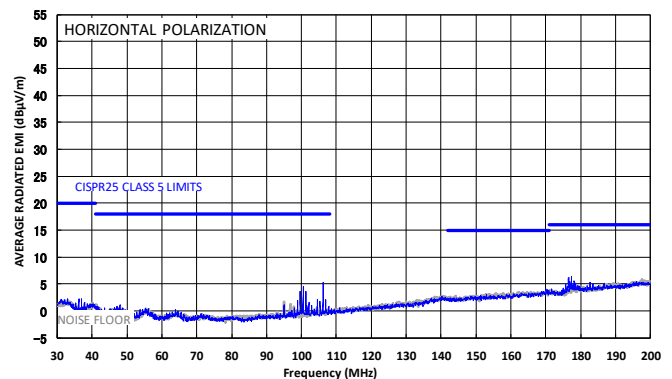
CISPR25 Class 5 Peak Radiated Emissions

Horizontal, 30MHz to 200MHz



CISPR25 Class 5 Average Radiated Emissions

Horizontal, 30MHz to 200MHz

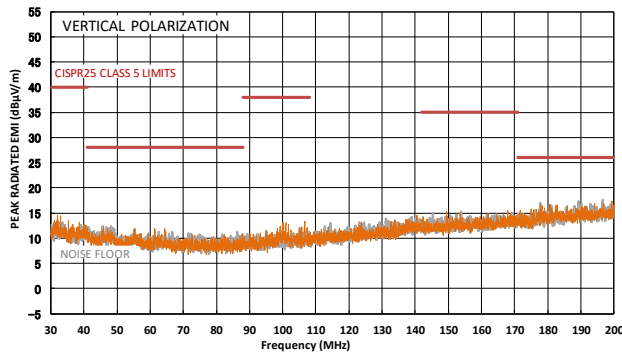


EVB TEST RESULTS (continued)

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

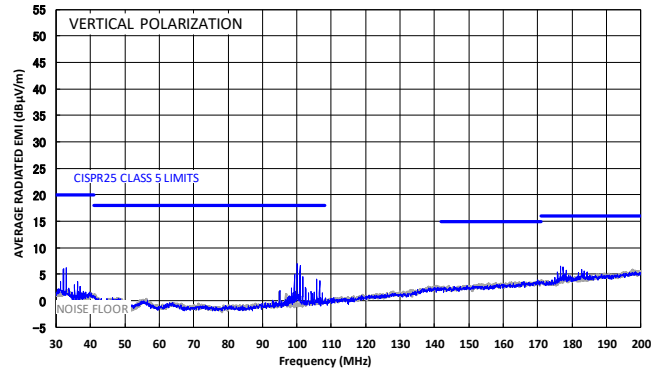
CISPR25 Class 5 Peak Radiated Emissions

Vertical, 30MHz to 200MHz



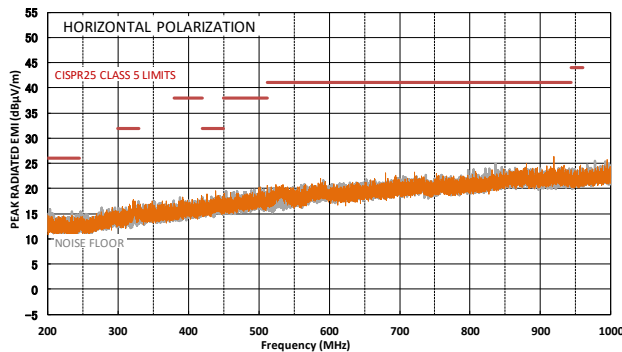
CISPR25 Class 5 Average Radiated Emissions

Vertical, 30MHz to 200MHz



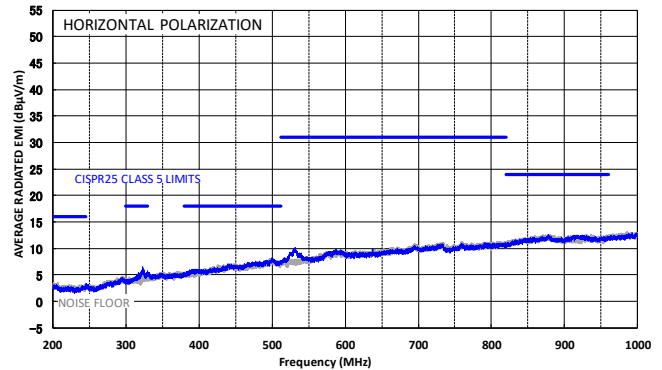
CISPR25 Class 5 Peak Radiated Emissions

Horizontal, 200MHz to 1GHz



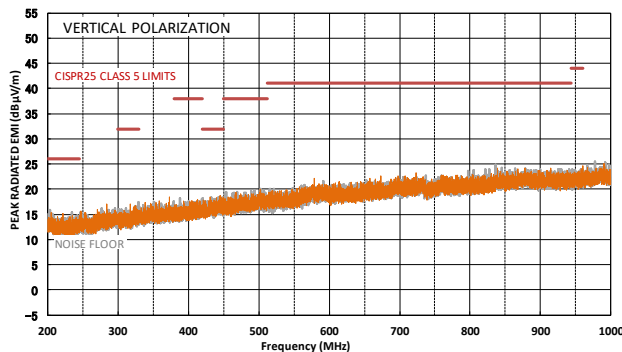
CISPR25 Class 5 Average Radiated Emissions

Horizontal, 200MHz to 1GHz



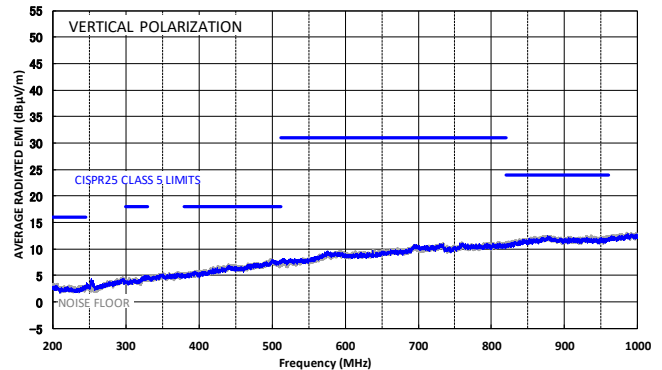
CISPR25 Class 5 Peak Radiated Emissions

Vertical, 200MHz to 1GHz



CISPR25 Class 5 Average Radiated Emissions

Vertical, 200MHz to 1GHz



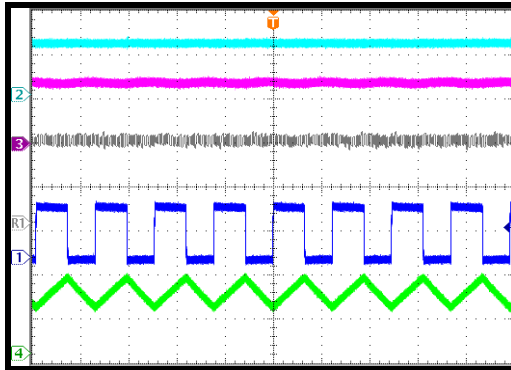
EVB TEST RESULTS (continued)

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

Steady State

 $I_{LED} = 1.5A$

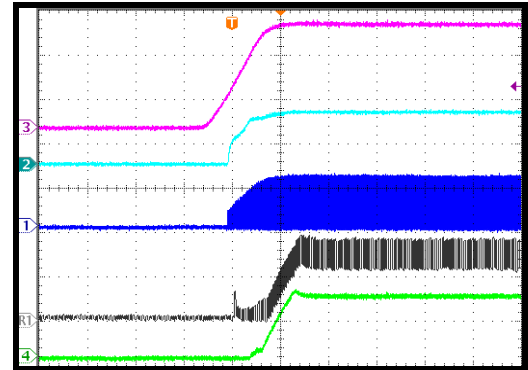
CH2: V_{OUT}
5V/div.
CH3: I_{LED}
1A/div.
R1: V_{FAULT}
2V/div.
CH1: V_{SW}
10V/div.
CH4: I_L
1A/div.



Start-Up through VIN

 $I_{LED} = 1.5A$

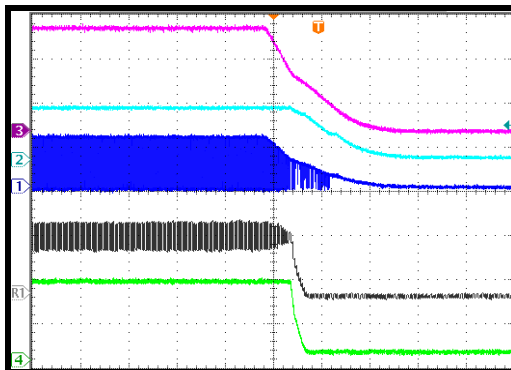
CH3: V_{IN}
5V/div.
CH2: V_{OUT}
5V/div.
CH1: V_{SW}
10V/div.
R1: I_L
1A/div.
CH4: I_{LED}
1A/div.



Shutdown through VIN

 $I_{LED} = 1.5A$

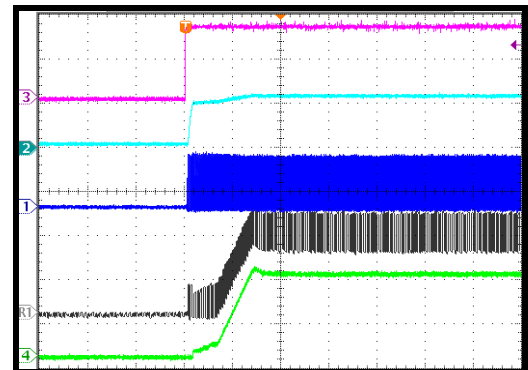
CH3: V_{IN}
5V/div.
CH2: V_{OUT}
5V/div.
CH1: V_{SW}
10V/div.
R1: I_L
1A/div.
CH4: I_{LED}
1A/div.



Start-Up through EN

 $I_{LED} = 1.5A$

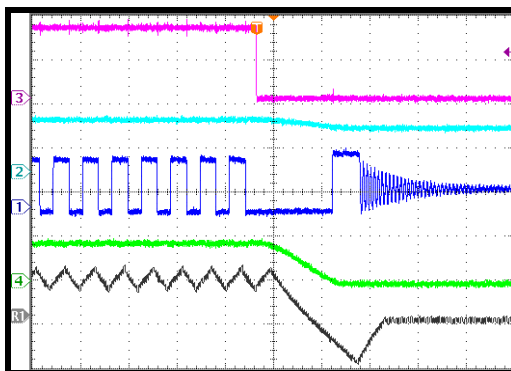
CH3: $V_{EN/DIM}$
2V/div.
CH2: V_{OUT}
5V/div.
CH1: V_{SW}
10V/div.
R1: I_L
1A/div.
CH4: I_{LED}
1A/div.



Shutdown through EN

 $I_{LED} = 1.5A$

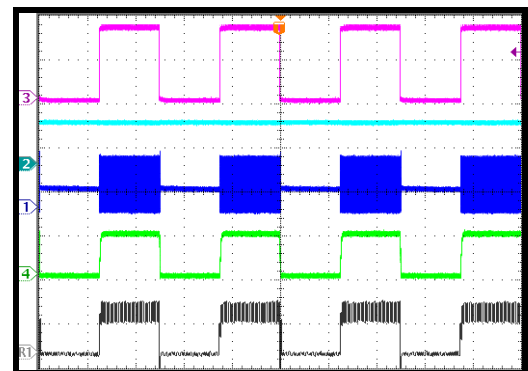
CH3: $V_{EN/DIM}$
2V/div.
CH2: V_{OUT}
5V/div.
CH1: V_{SW}
10V/div.
CH4: I_{LED}
2A/div.
R1: I_L
1A/div.



PWM Dimming

 $f_{PWM} = 200Hz$

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.



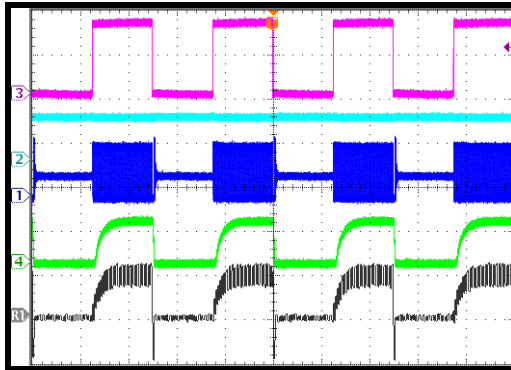
EVB TEST RESULTS (continued)

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

PWM Dimming

 $f_{PWM} = 2kHz$

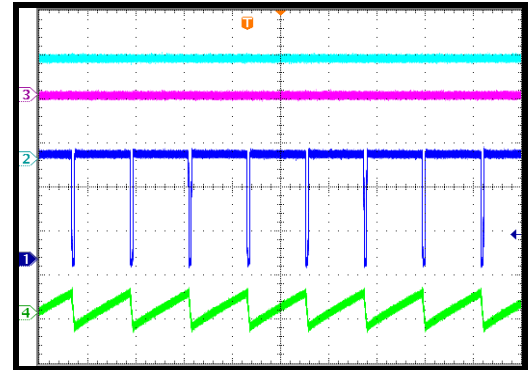
CH3: $V_{EN/DIM}$
2V/div.
CH2: V_{FAULT}
5V/div.
CH1: V_{SW}
10V/div.
CH4: I_{LED}
2A/div.
R1: I_L
2A/div.



200µs/div.

LED Open Steady State

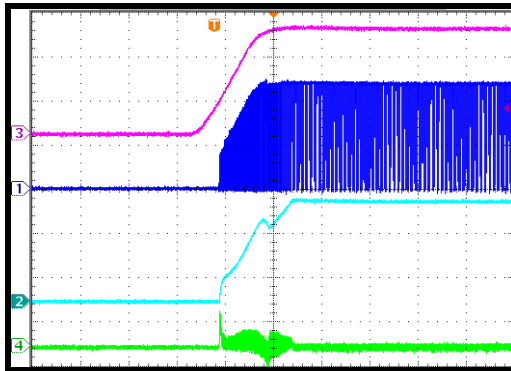
CH3: V_{FAULT}
2V/div.
CH2: V_{OUT}
5V/div.
CH1: V_{SW}
5V/div.
CH4: I_L
200mA/div.



2µs/div.

LED Open Input Start-Up

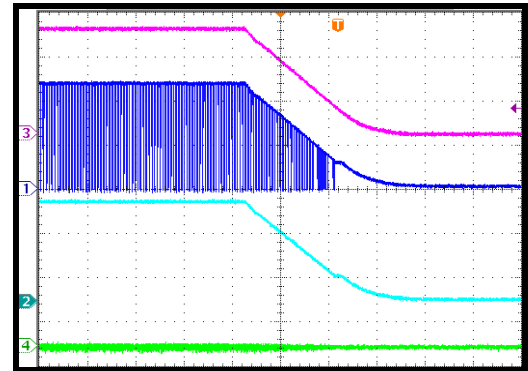
CH3: V_{IN}
5V/div.
CH1: V_{SW}
5V/div.
CH2: V_{OUT}
5V/div.
CH4: I_L
1A/div.



1ms/div.

LED Open Input Shutdown

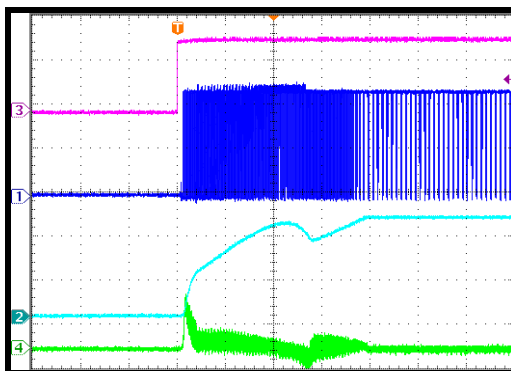
CH3: V_{IN}
5V/div.
CH1: V_{SW}
5V/div.
CH2: V_{OUT}
5V/div.
CH4: I_L
1A/div.



10ms/div.

LED Open EN On

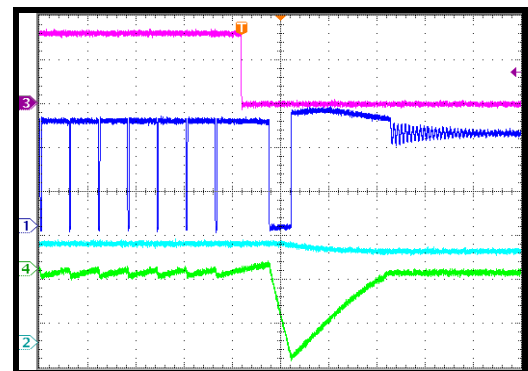
CH3: $V_{EN/DIM}$
2V/div.
CH1: V_{SW}
5V/div.
CH2: V_{OUT}
5V/div.
CH4: I_L
1A/div.



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.

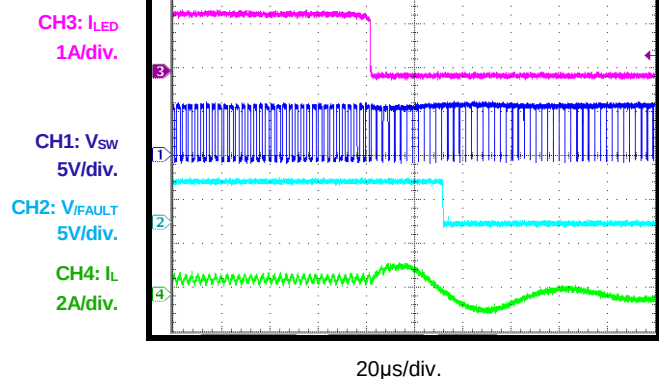


4µs/div.

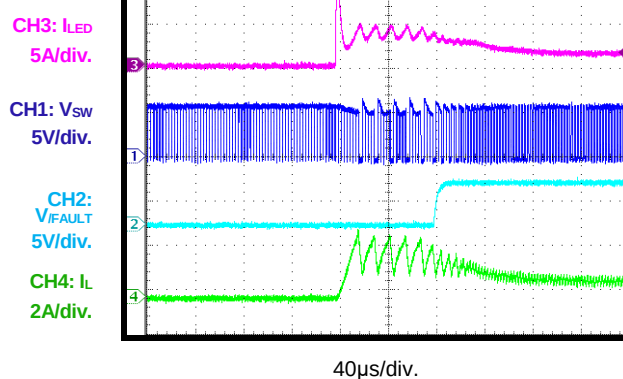
EVB TEST RESULTS (continued)

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

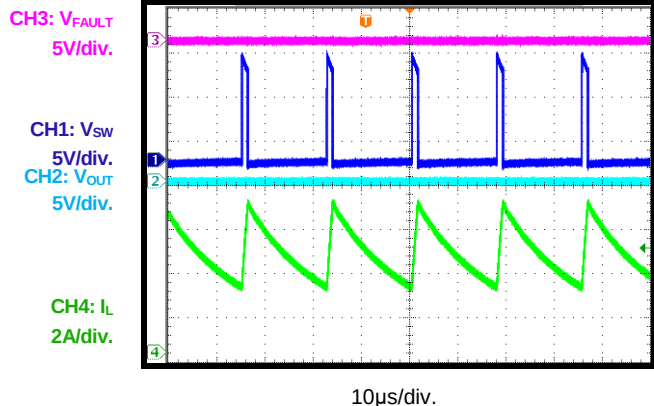
LED Open Entry

 $I_{LED} = 1.5A$


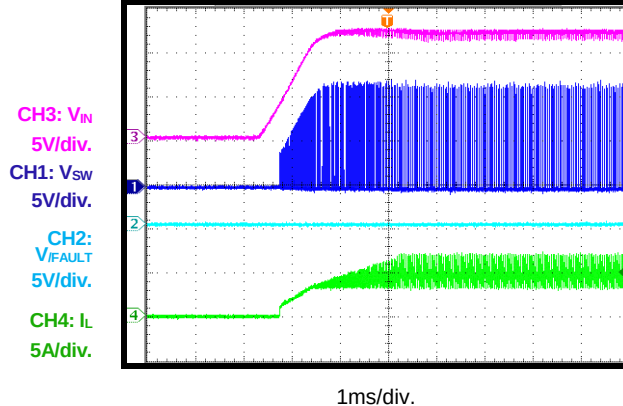
LED Open Recovery

 $I_{LED} = 1.5A$


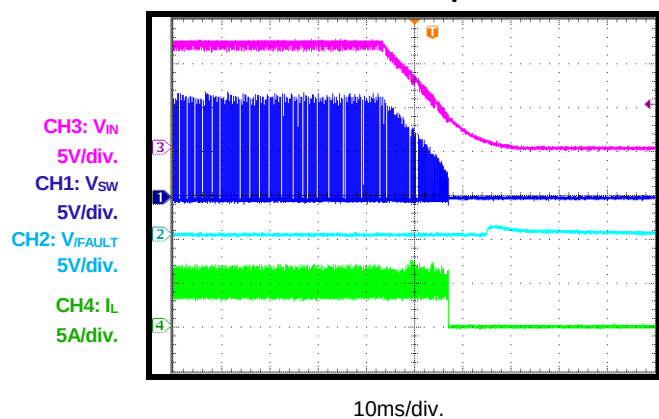
LED+ Short to GND Steady State



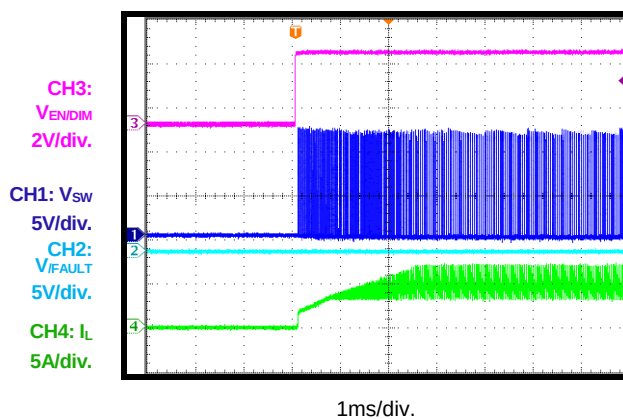
LED+ Short to GND Input Start-Up



LED+ Short to GND Input Shutdown



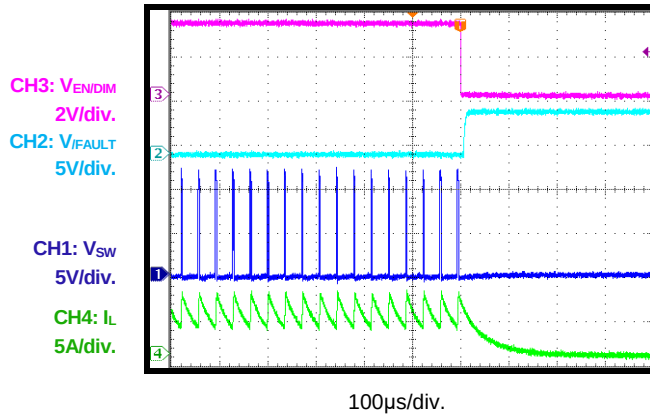
LED+ Short to GND En On



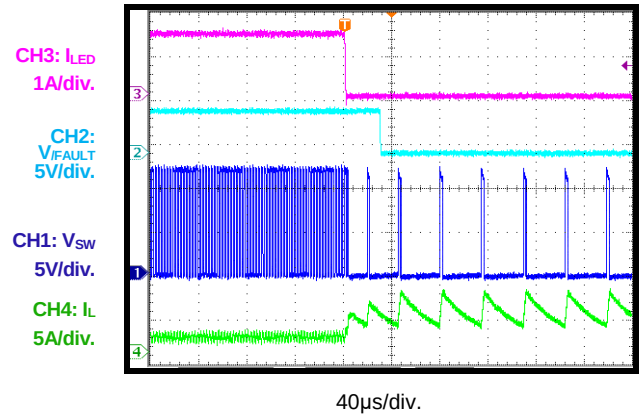
EVB TEST RESULTS (continued)

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

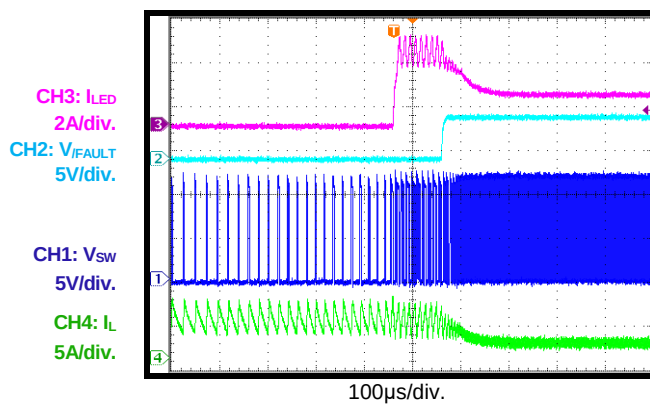
LED+ Short to GND En Off



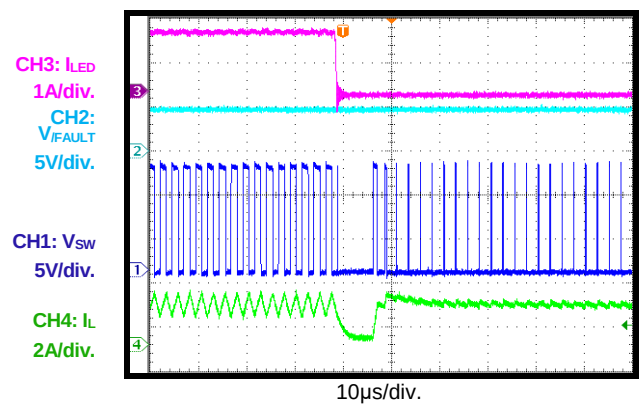
LED+ Short to GND Entry

 $I_{LED} = 1.5A$


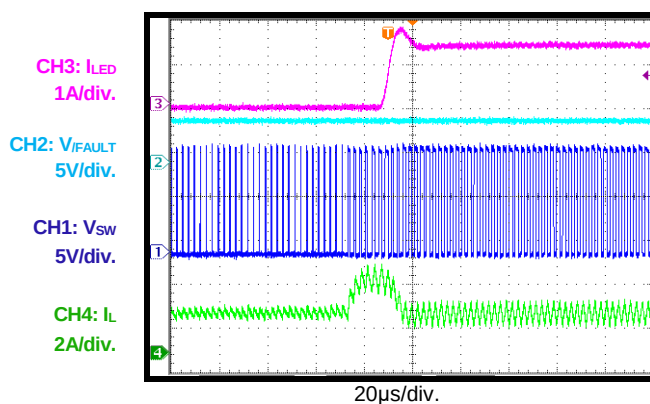
LED+ Short to GND Recovery

 $I_{LED} = 1.5A$


LED+ Short to LED- Entry

 $I_{LED} = 1.5A$


LED+ Short to LED- Recovery

 $I_{LED} = 1.5A$


PCB LAYOUT

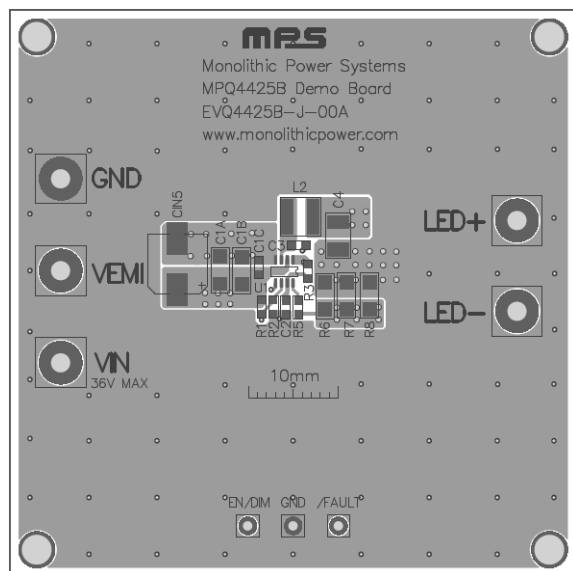


Figure 3: Top Silk and Top Layer

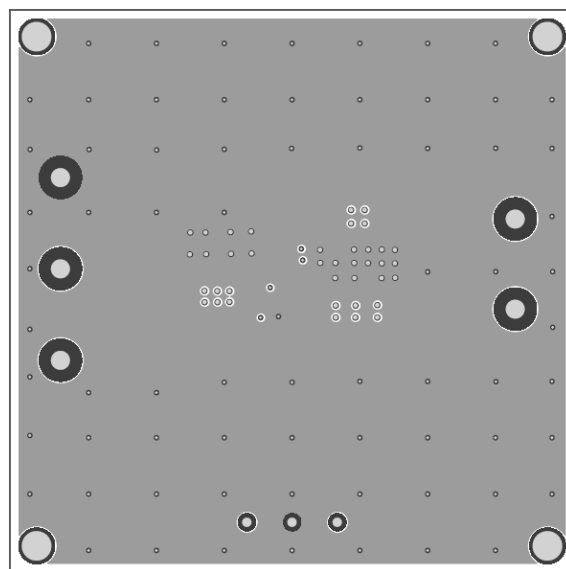


Figure 4: Inner Layer 1

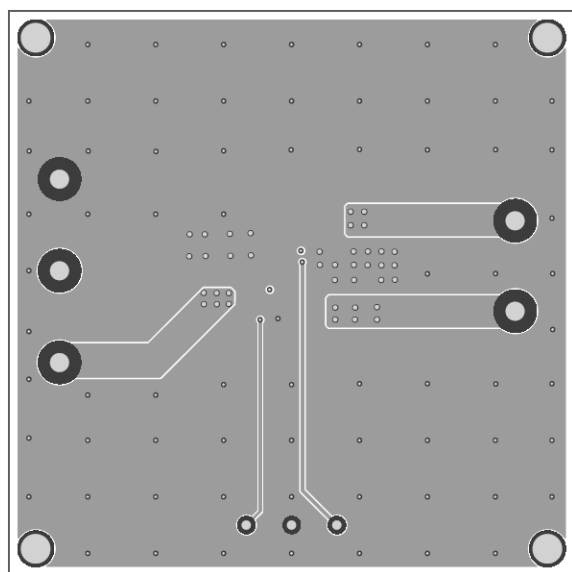


Figure 5: Inner Layer 2

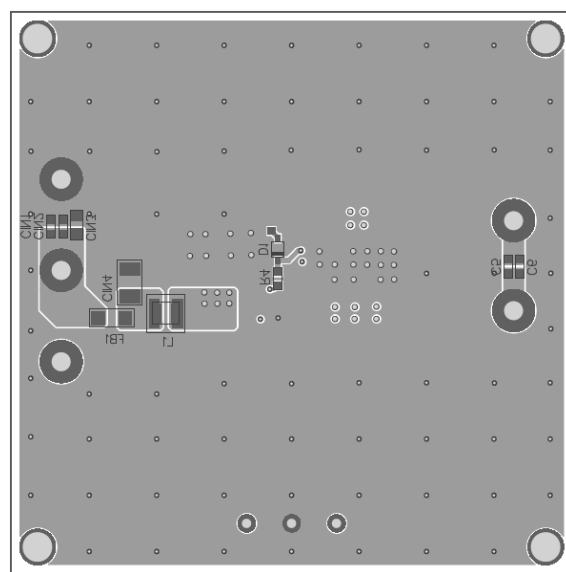


Figure 6: Bottom Silk and Bottom Layer

Revision History

Revision #	Revision Date	Description	Pages Updated
1.0	7/30/2020	Initial Release	-

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