EVQ7232-L-00A

36V, 6A, Synchronous, Step-Down, Infrared LED Driver Evaluation Board, AEC-Q100 Qualified

DESCRIPTION

The EVQ7232-L-00A is an evaluation board designed to demonstrate the capabilities of the MPQ7232, a synchronous, step-down, constant-current infrared (IR) LED driver. The MPQ7232 is rated for a 4.5V to 36V input voltage (V_{IN}) range. It is a compact solution that can provide up to 6A of peak LED current (I_{LED_PEAK}). An ideal configuration is to drive one or two IR LEDs. Peak current-mode control provides fast transient response and eases loop stabilization.

The MPQ7232 can support a 10Hz to 2kHz pulse-width modulation (PWM) dimming frequency range, making it compatible with IR LED applications that require 30FPS, 60FPS, or 120FPS dimming. The MPQ7232 can also support analog dimming by applying a DC voltage between 0.2V and 1.6V on the ADIM pin to linearly adjust the internal LED current (I_{LED}) reference voltage between 25mV and 200mV. Frequency spread spectrum (FSS) modulation improves EMC performance.

The MPQ7232 features a dedicated fault pin, as well as a full protection features, including LED short protection, LED open protection, and thermal shutdown.

The EVQ7232-L-00A is a fully assembled and tested synchronous, step-down IR LED driver evaluation board. It generates up to 6A of I_{LED_PEAK} across a 4.5V to 36V V_{IN} range.

The MPQ7232 is available in a QFN-15 (3mmx4mm) package with wettable flanks. The MPQ7232 is available in AEC-Q100 Grade 1.

PERFORMANCE SUMMARY

Specifications are at T_A = 25°C, unless otherwise noted.

Parameters	Conditions	Value
Input voltage (V_{IN}) range		4.5V to 36V
Peak LED current (I_{LED_PEAK})	V_{IN} = 4.5V to 36V	6A
Typical efficiency	V_{IN} = 12V, f_{SW} = 2.25MHz, 2 LEDs, I_{LED} = 4A	88.77%
Peak efficiency	V_{IN} = 8V, f_{SW} = 2.25MHz, 2 LEDs, I_{LED} = 2A	91.82%
Switching frequency (f_{SW})	V_{IN} = 4.5V to 16V	2.25MHz
	V_{IN} = 16V to 36V	1.13MHz

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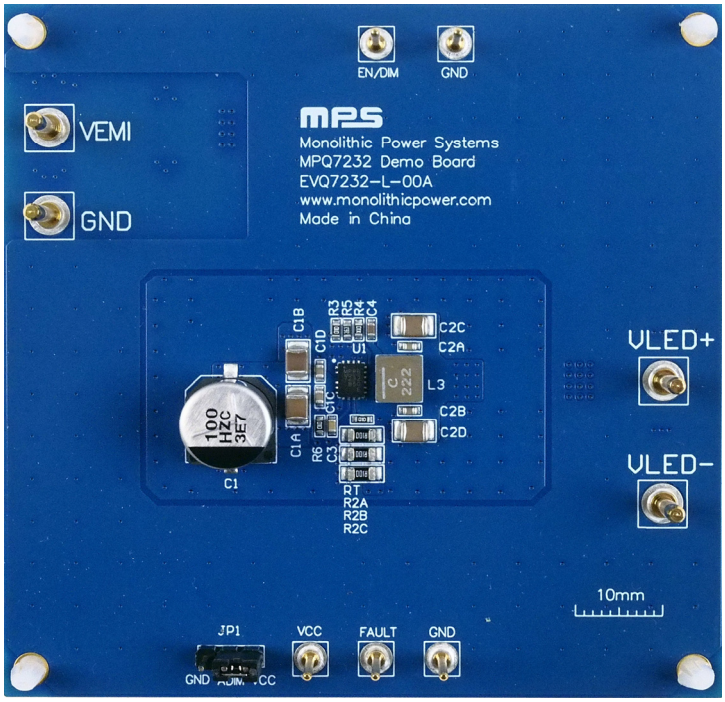
EVALUATION BOARD



LxWxH (8.3cmx8.3cmx1.3cm)

Board Number	MPS IC Number
EVQ7232-L-00A	MPQ7232GLE-AEC1

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QUICK START GUIDE

1. Preset the power supply between 4.5V 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 the VEMI voltage (V_{EMI}) exceeds 24V.
3. Connect the power supply terminals to:
   a. Positive (+): VEMI
   b. Negative (-): GND
4. Connect the load terminals to:
   a. Positive (+): VLED+
   b. Negative (-): VLED-
5. After making the connections, turn on the power supply.
6. To use the enable (EN) function, apply a digital input to the EN/DIM pin. Pull EN/DIM above 1.65V to turn the regulator on; pull EN/DIM below 1.05V for longer than 600ms to turn it off.

   Note that when using the EN pin to turn the IC on and off, the time between when EN is off and when EN is on (several seconds, depending on the output capacitance [C_{OUT}] and VLED+) should be long enough to ensure that the VLED+ voltage (V_{LED+}) drops below 2.7V; otherwise, an LED open fault is triggered the next time EN is on. To avoid unexpectedly triggering LED open protection, place a 1kΩ dummy load in parallel with C_{OUT} to discharge VLED+ to a low voltage. Using the typical pulse-width modulation (PWM) dimming frequency (10Hz to 2kHz) to turn on the IC does not have this limitation and the IC will be turned on in a short time. Unexpectedly triggering LED open protection only happens when the IC is on after shut down through long EN/DIM low.
7. To use the PWM dimming function, apply a 10Hz to 2kHz square wave signal to the EN/DIM pin to enable PWM dimming. Pull EN/DIM above 1.65V to turn PWM dimming on; pull EN/DIM below 1.05V to turn PWM dimming off.
8. To use the analog dimming function, apply a DC voltage between 0.2 and 1.6V to the ADIM pin to linearly adjust the internal LED current (I_{LED}) reference voltage between 25mV and 200mV.
9. I_{LED} is set by the external resistors (R2A, R2B, and R2C) (see Figure 2 on page 5). I_{LED} can be calculated with Equation (1):

$$I_{LED} = \frac{0.2V}{R2A//R2B//R2C} \quad (1)$$

10. A resistor (R_T) sets the loop bandwidth. A lower R_T results in a higher bandwidth; however, a high bandwidth may cause an insufficient phase margin and unstable loop. Choose an R_T that achieves an appropriate tradeoff between the bandwidth and phase margin.

    Table 1 shows the recommended R2A, R2B, R2C, and RT values for common I_{LED} using one or two IR LEDs.

Table 1: Resistor Selection for Common I_{LED}

I_{LED} (A)	R2A//R2B//R2C (mΩ)	R_T (kΩ)
1	200 (1%)	150 (1%)
2	100 (1%)	100 (1%)
4	50 (1%)	100 (1%)
6	33.3 (1%)	100 (1%)

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Figure 1 shows the measurement equipment set-up.

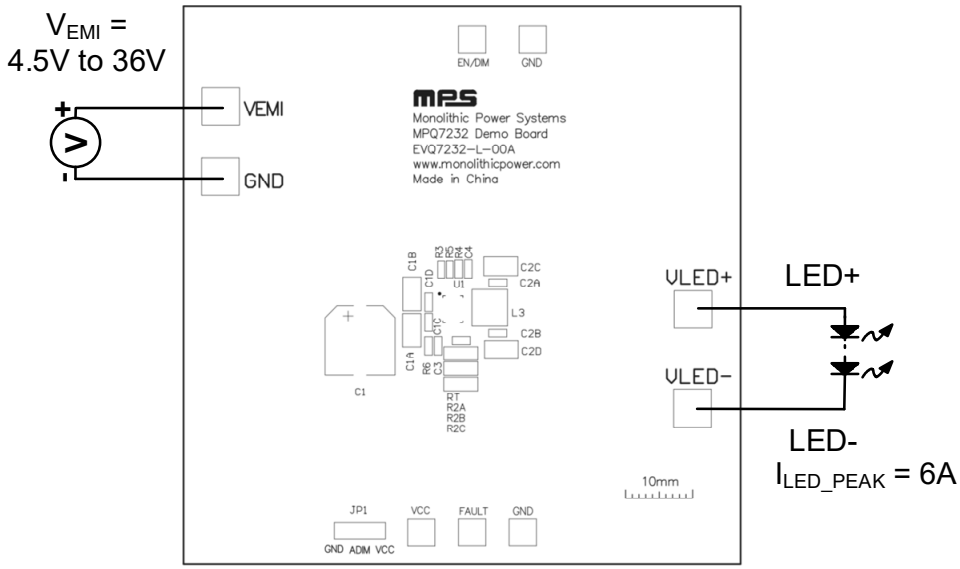

Figure 1: Measurement Equipment Set-Up

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EVALUATION BOARD SCHEMATIC

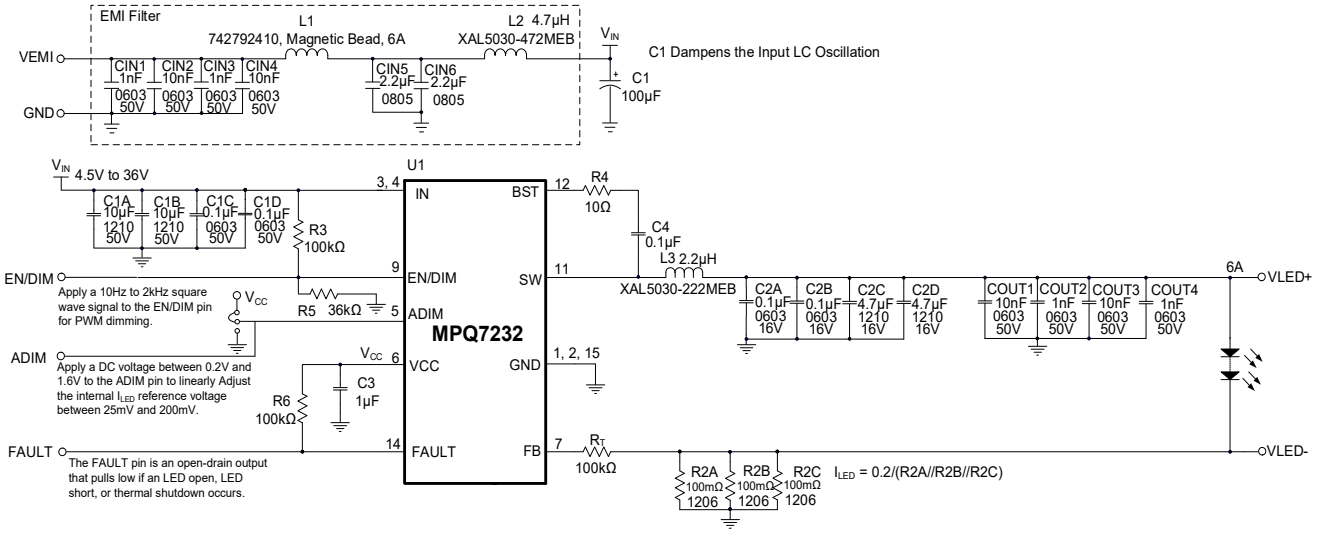

Figure 2: Evaluation Board Schematic

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EVQ7232-L-00A BILL OF MATERIALS

Qty	Ref	Value	Description	Package	Manufacturer	Manufacturer PN
1	C1	100µF	Electrolytic capacitor, 50V, X7R	SMD	Panasonic	EEHZC1H101P
2	C1A, C1B	10µF	Ceramic capacitor, 50V, X7R	1210	Murata	GRM32ER71H106KA12L
4	C1C, C1D, C2A, C2B	100nF	Ceramic capacitor, 50V, X7R	0603	Murata	GRM188R71H104KA93D
2	C2C, C2D	4.7µF	Ceramic capacitor, 25V, X7R	1210	TDK	C3225X7R1E475M
1	C3	1µF	Ceramic capacitor 6.3V, X5R	0603	Murata	GRM188R60J105KA01D
1	C4	100nF	Ceramic capacitor, 25V, X7R	0603	Murata	GCJ188R71E104KA12D
2	CIN1, CIN3	1nF	Ceramic capacitor, 50V, X7R	0603	Murata	GRM188R71H102KA01D
2	CIN2, CIN4	10nF	Ceramic capacitor, 50V, X7R	0603	Murata	GRM188R71H103KA01D
2	CIN5, CIN6	2.2µF	Ceramic capacitor, 50V, X7R	0805	TDK	C2012X7R1H225K
1	COUT1	10nF	Ceramic capacitor, 50V, C0G	0603	Murata	GRM1885C1H103JA01D
1	COUT2	1nF	Ceramic capacitor, 50V, C0G	0603	Murata	GRM1885C1H102JA01D
1	COUT3	10nF	Ceramic capacitor, 50V, C0G	0603	Murata	GRM1885C1H103JA01D
1	COUT4	1nF	Ceramic capacitor, 50V, C0G	0603	Murata	GRM1885C1H102JA01D
5	GND, VCC, EN, FAULT	1mm	1mm golden pin	DIP	Custom (1)	
4	GND, VEMI, VLED+, VLED-	2mm	2mm golden pin	DIP	Custom (1)	
1	JP1	2.54mm	2.54mm test pin	DIP	Custom (1)	
1	L1	6A	Magnetic bead, 6A	SMD	Wurth	742792410
1	L2	4.7µH	Inductor, 36mΩ DCR, 5.9A	SMD	Coilcraft	XAL5030-472MEB
1	L3	2.2µH	Inductor, 14.5mΩ DCR, 9.7A	SMD	Coilcraft	XAL5030-222MEB
3	R2A, R2B, R2C	100mΩ	Film resistor, 1%	1206	CYNTEC	VSRP1206S1-R100F
3	R3, R6, R_T	100kΩ	Film resistor, 5%	0603	Yageo	RC0603JR-07100KL
1	R4	10Ω	Film resistor, 1%	0603	Yageo	RC0603FR-0710RL
1	R5	36kΩ	Film resistor, 1%	0603	Yageo	RC0603FR-0736KL
1	U1	MPQ7232-AEC1	Step-down converter	QFN-15 (3mmx4mm)	MPS	MPQ7232GLE-AEC1

Note:

1) MPS custom-produces these pins. Visit the MPS website for more information.

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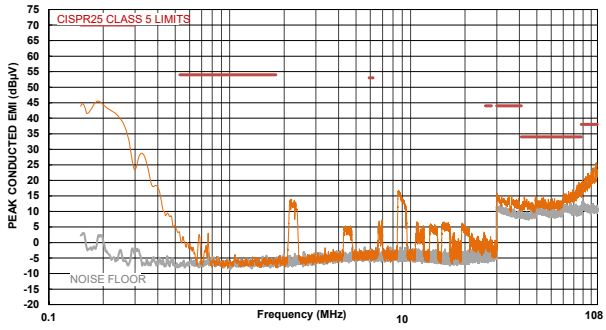
EVB TEST RESULTS

Performance curves and waveforms are tested on the evaluation board. V_{IN} = 12V, two LEDs in series (V_{LED} = 6.4V) at I_{LED_PEAK} = 6A, PWM dimming = 30Hz/5ms, f_{SW} = 2.25MHz, L = 2.2µH, T_A = 25°C, unless otherwise noted. (2)

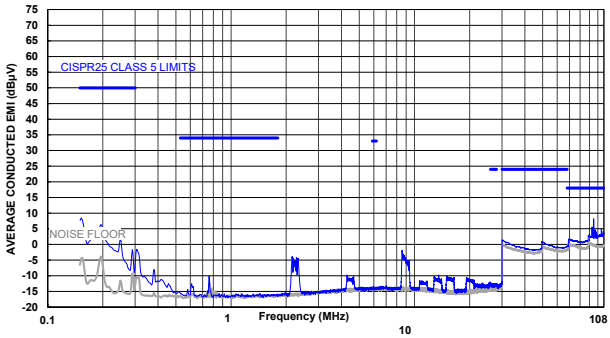
CISPR 25 Class 5 Peak Conducted Emissions

150kHz to 108MHz



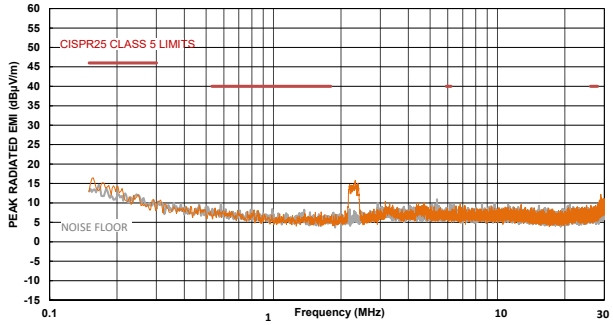
CISPR 25 Class 5 Average Conducted Emissions

150kHz to 108MHz



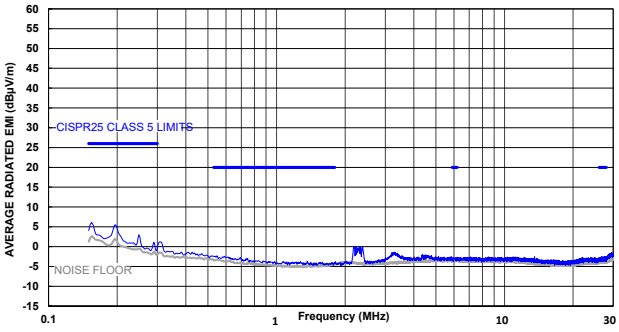
CISPR 25 Class 5 Peak Radiated Emissions

150kHz to 30MHz



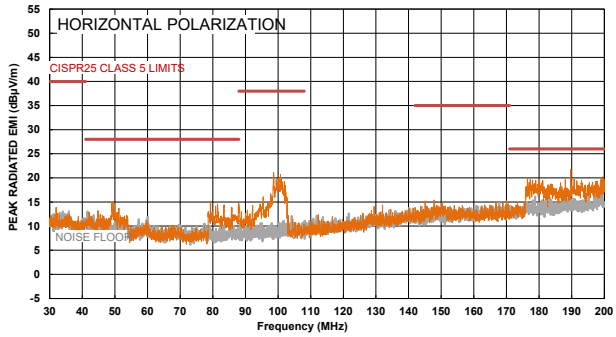
CISPR 25 Class 5 Average Radiated Emissions

150kHz to 30MHz



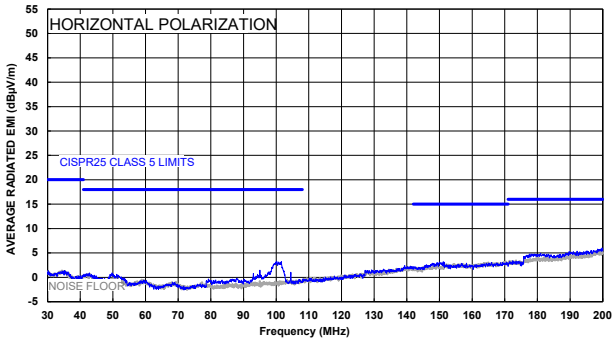
CISPR 25 Class 5 Peak Radiated Emissions

Horizontal, 30MHz to 200MHz



CISPR 25 Class 5 Average Radiated Emissions

Horizontal, 30MHz to 200MHz



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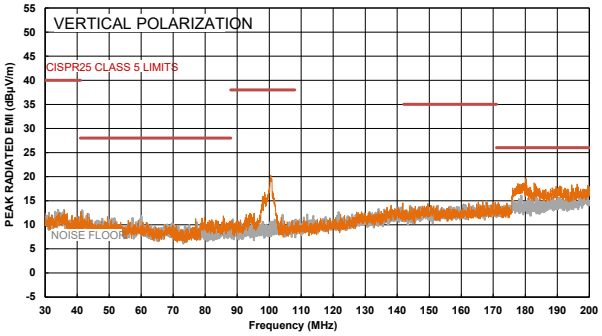
EVB TEST RESULTS *(continued)*

Performance curves and waveforms are tested on the evaluation board. V_{IN} = 12V, two LEDs in series (V_{LED} = 6.4V) at I_{LED_PEAK} = 6A, PWM dimming = 30Hz/5ms, f_{SW} = 2.25MHz, L = 2.2µH, T_A = 25°C, unless otherwise noted. (2)

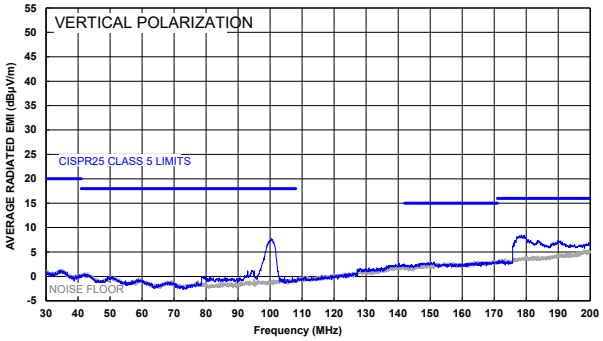
CISPR 25 Class 5 Peak Radiated Emissions

Vertical, 30MHz to 200MHz



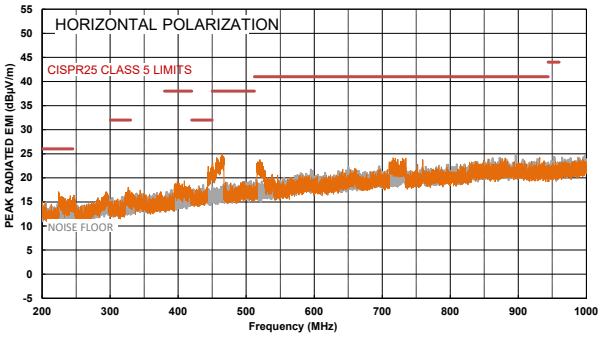
CISPR 25 Class 5 Average Radiated Emissions

Vertical, 30MHz to 200MHz



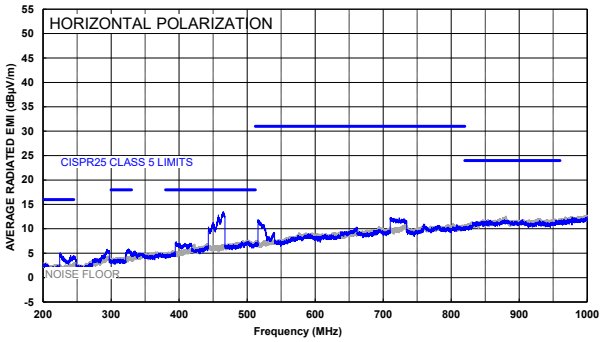
CISPR 25 Class 5 Peak Radiated Emissions

Horizontal, 200MHz to 1GHz



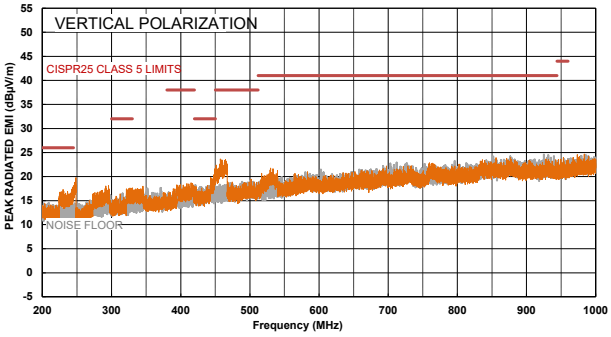
CISPR 25 Class 5 Average Radiated Emissions

Horizontal, 200MHz to 1GHz



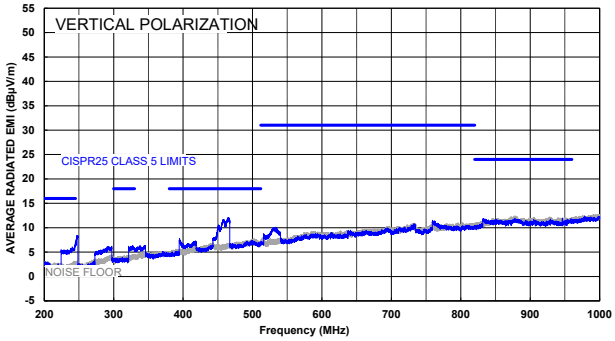
CISPR 25 Class 5 Peak Radiated Emissions

Vertical, 200MHz to 1GHz



CISPR 25 Class 5 Average Radiated Emissions

Vertical, 200MHz to 1GHz



Note:

2) The EMI test results are based on the typical application circuit with EMI filters (see Figure 2 on page 5).

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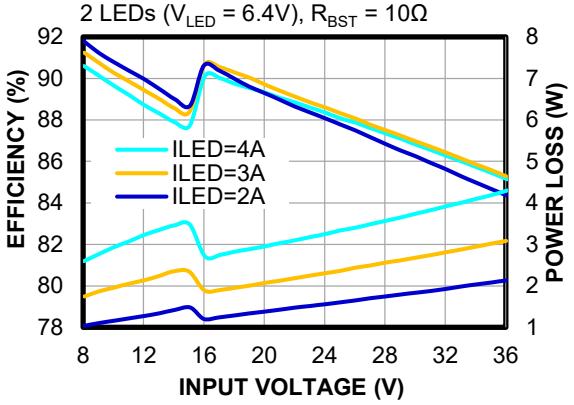
EVB TEST RESULTS *(continued)*

Performance curves and waveforms are tested on the evaluation board. V_{IN} = 12V, two LEDs in series (V_{LED} = 6.4V), f_{SW} = 2.25MHz, L = 2.2µH, T_A = 25°C, unless otherwise noted. (2)

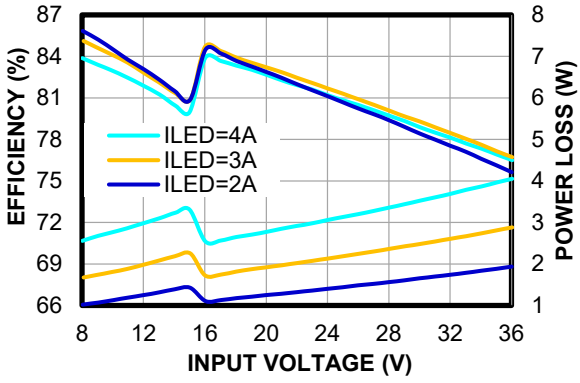
Efficiency with 2 LEDs

2 LEDs (V_{LED} = 6.4V), R_{BST} = 10Ω



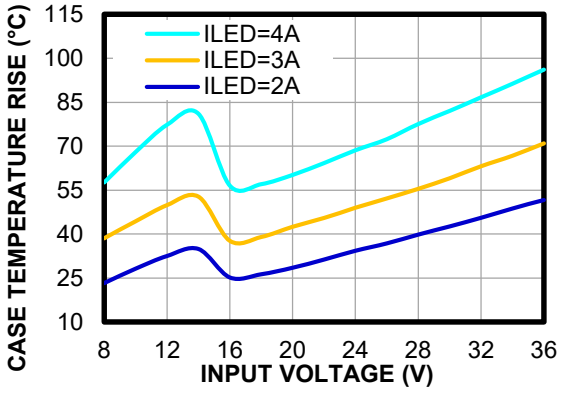
Efficiency with 1 LED

1 LED (V_{LED} = 3.2V), R_{BST} = 10Ω



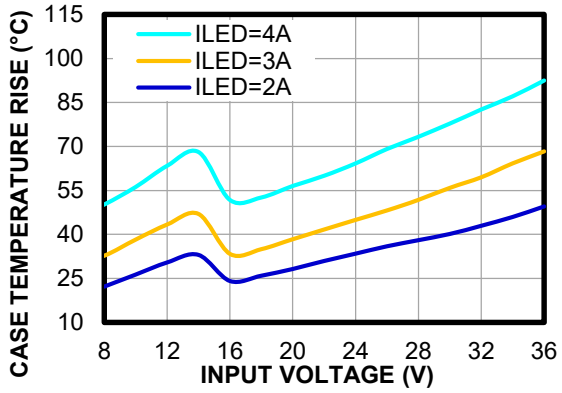
Case Temperature Rise with 2 LEDs

2 LEDs (V_{LED} = 6.4V), R_{BST} = 10Ω



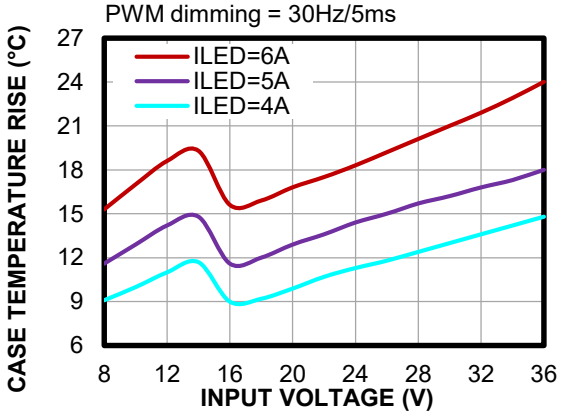
Case Temperature Rise with 1 LED

1 LED (V_{LED} = 3.2V), R_{BST} = 10Ω



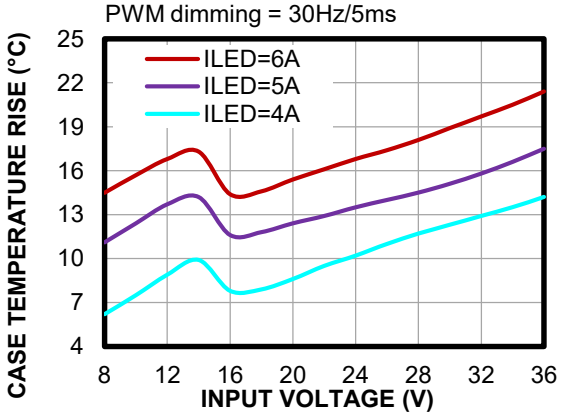
Case Temperature Rise with 2 LEDs

PWM dimming = 30Hz/5ms



Case Temperature Rise with 1 LED

PWM dimming = 30Hz/5ms



Note:

3) The inductor information for the efficiency and thermal curves is as follows: L = 2.2µH (XEL5030-222MEB), R_{BST} = 10Ω.

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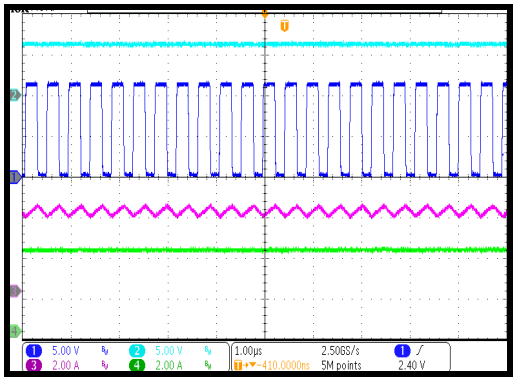
EVB TEST RESULTS *(continued)*

Performance curves and waveforms are tested on the evaluation board. V_{IN} = 12V, two LEDs in series (V_{LED} = 6.4V), f_{SW} = 2.25MHz, L = 2.2µH, T_A = 25°C, unless otherwise noted.

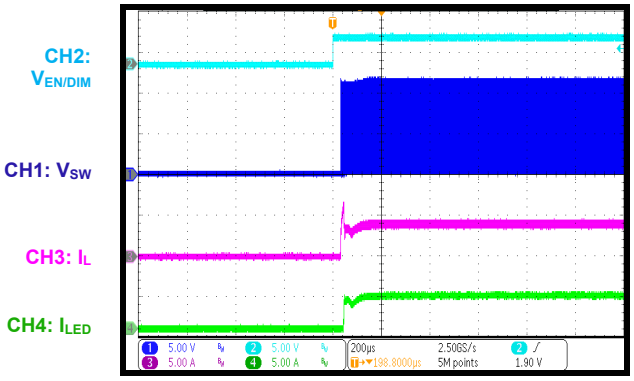
Steady State

I_{LED} = 4A



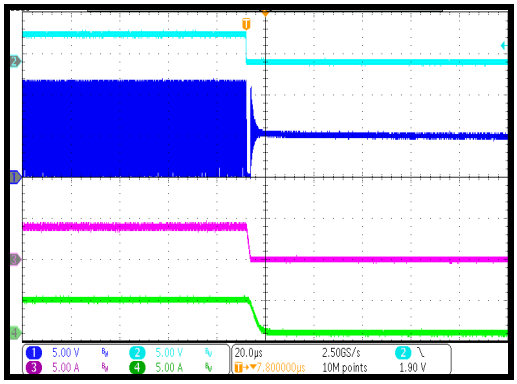
Start-Up through EN

I_{LED} = 4A



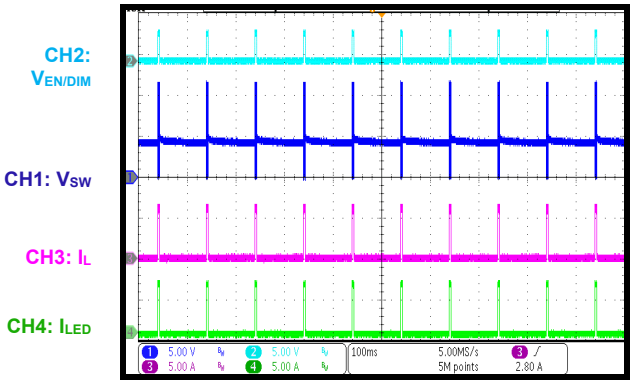
Shutdown through EN

I_{LED} = 4A



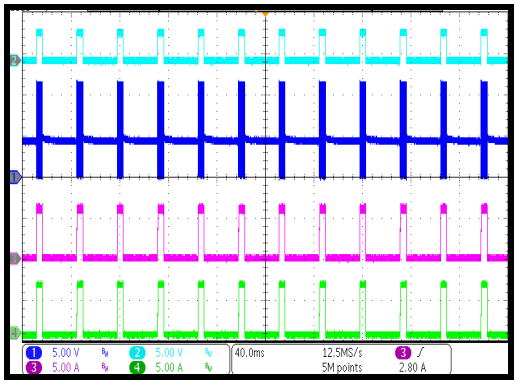
PWM Dimming Steady State

Dimming frequency/on time = 10Hz/5ms,
I_{LED_PEAK} = 6A



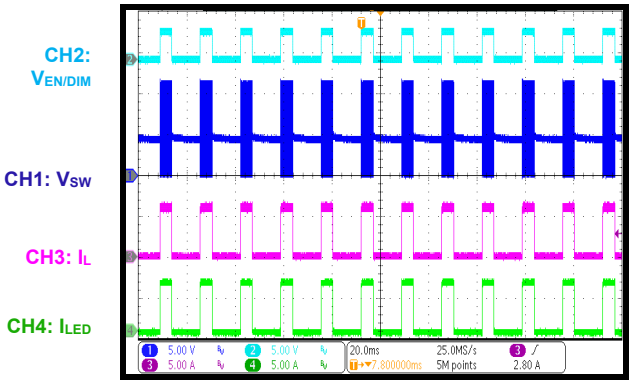
PWM Dimming Steady State

Dimming frequency/on time = 30Hz/5ms,
I_{LED_PEAK} = 6A



PWM Dimming Steady State

Dimming frequency/on time = 60Hz/5ms,
I_{LED_PEAK} = 6A



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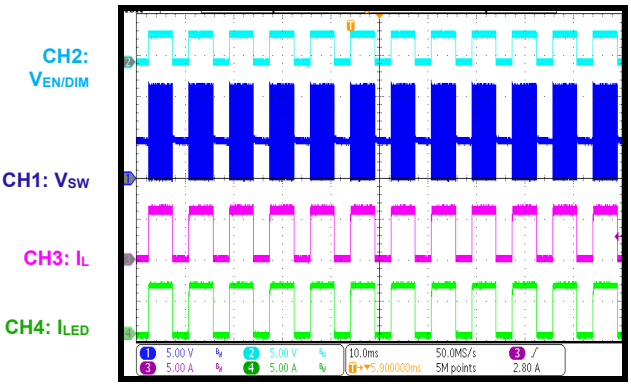
EVB TEST RESULTS *(continued)*

Performance curves and waveforms are tested on the evaluation board. V_{IN} = 12V, two LEDs in series (V_{LED} = 6.4V), f_{SW} = 2.25MHz, L = 2.2µH, T_A = 25°C, unless otherwise noted.

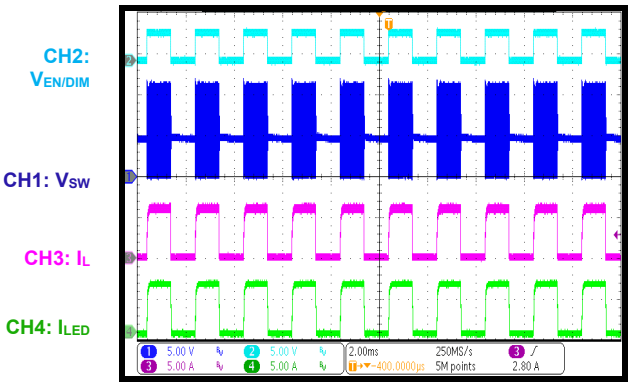
PWM Dimming Steady State

Dimming frequency/on time = 120Hz/5ms, I_{LED_PEAK} = 6A



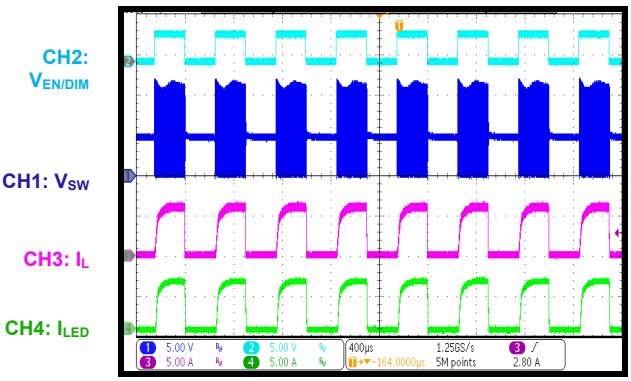
PWM Dimming Steady State

Dimming frequency = 500Hz, dimming duty = 50%, I_{LED_PEAK} = 6A



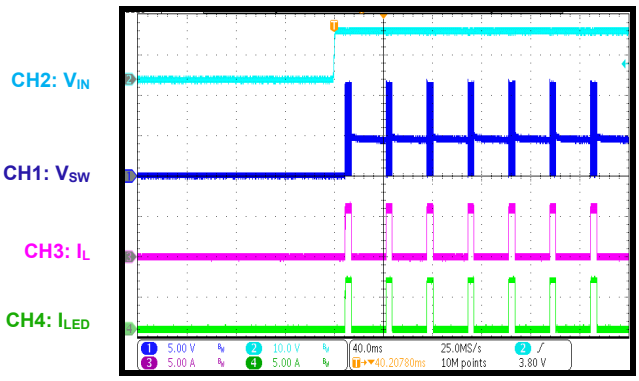
PWM Dimming Steady State

Dimming frequency = 2kHz, dimming duty = 50%, I_{LED_PEAK} = 6A



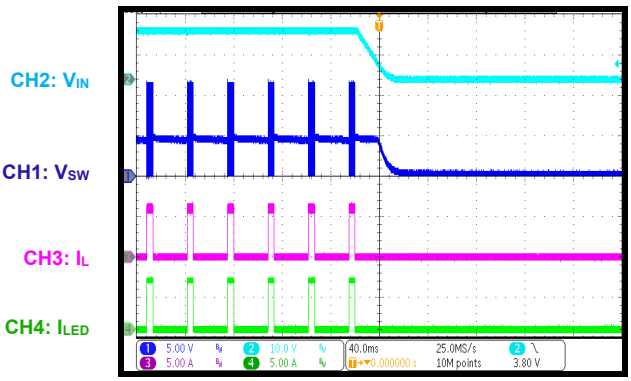
PWM Dimming

Start-up through VIN, I_{LED_PEAK} = 6A



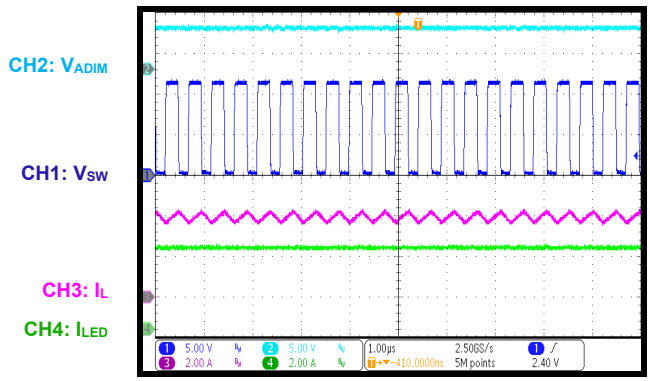
PWM Dimming

Shutdown through VIN, I_{LED_PEAK} = 6A



Analog Dimming Steady State

V_{ADIM} = 5V



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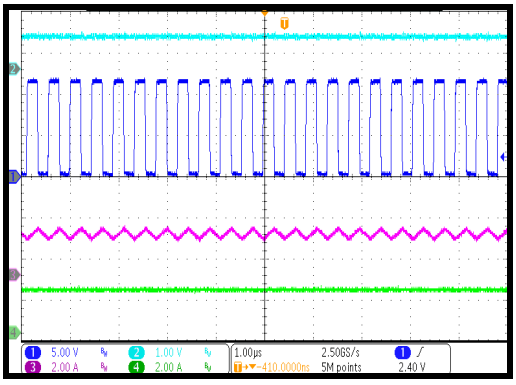
EVB TEST RESULTS *(continued)*

Performance curves and waveforms are tested on the evaluation board. V_{IN} = 12V, two LEDs in series (V_{LED} = 6.4V), f_{SW} = 2.25MHz, L = 2.2µH, T_A = 25°C, unless otherwise noted.

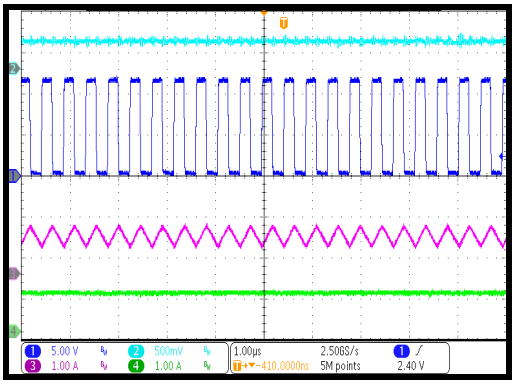
Analog Dimming Steady State

V_{ADIM} = 0.8V



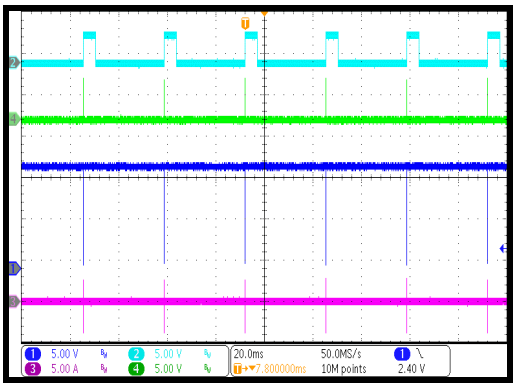
Analog Dimming Steady State

V_{ADIM} = 0.4V



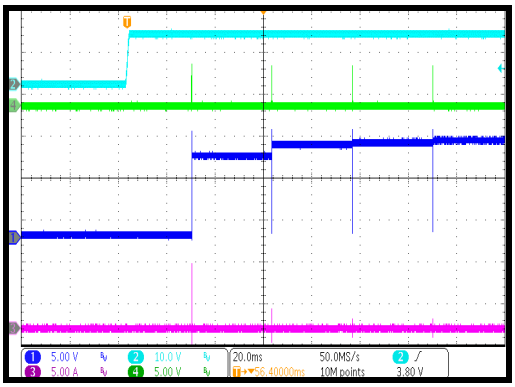
PWM Dimming

LED open steady state



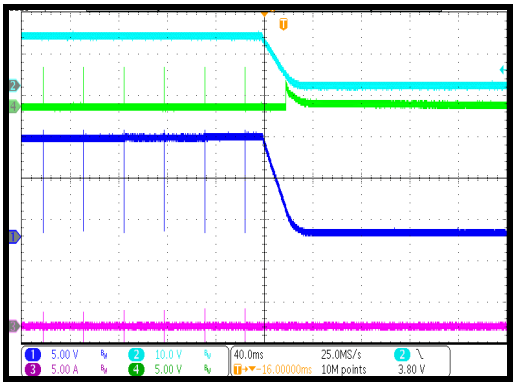
PWM Dimming

LED open input start-up



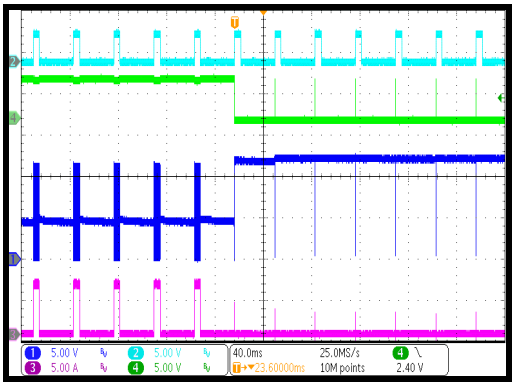
PWM Dimming

LED open input shutdown



PWM Dimming

LED open entry, I_{LED_PEAK} = 6A



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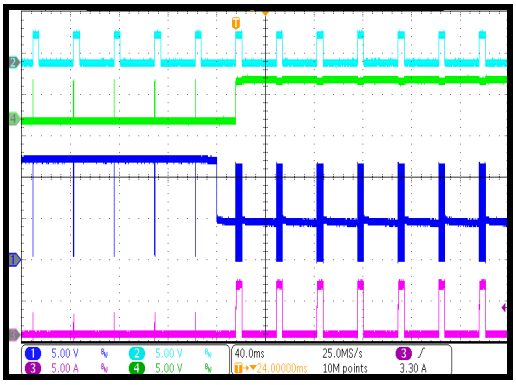
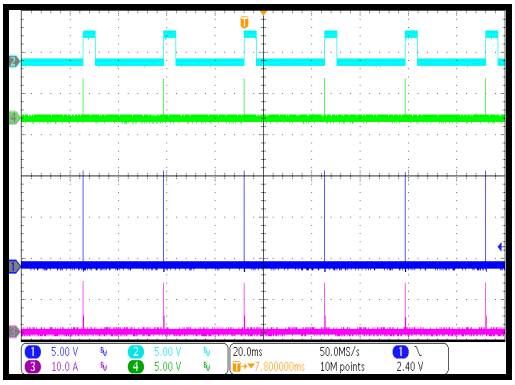
EVB TEST RESULTS *(continued)*

Performance curves and waveforms are tested on the evaluation board. V_{IN} = 12V, two LEDs in series (V_{LED} = 6.4V), f_{SW} = 2.25MHz, L = 2.2µH, T_A = 25°C, unless otherwise noted.

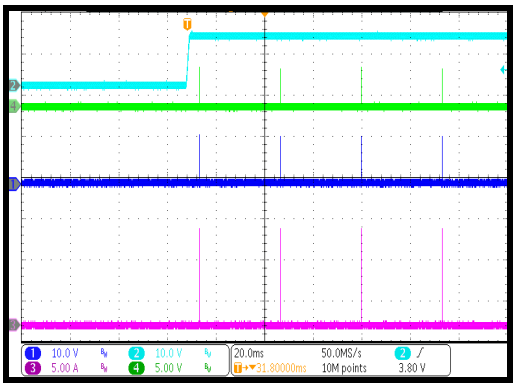
PWM Dimming
LED open recovery, I_{LED_PEAK} = 6A



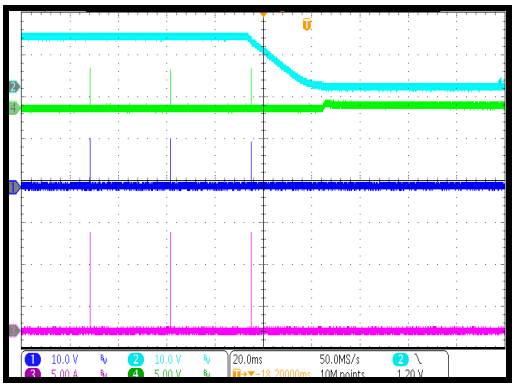
PWM Dimming
LED+ short to GND steady state, I_{LED_PEAK} = 6A



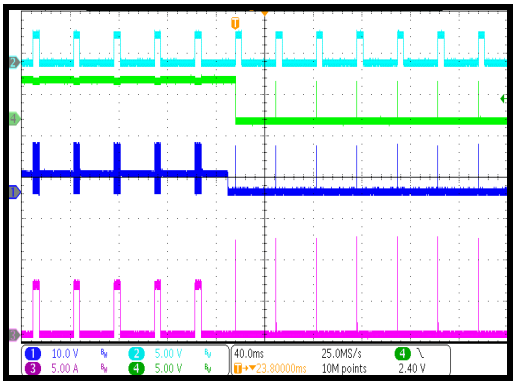
PWM Dimming
LED short to GND input start-up



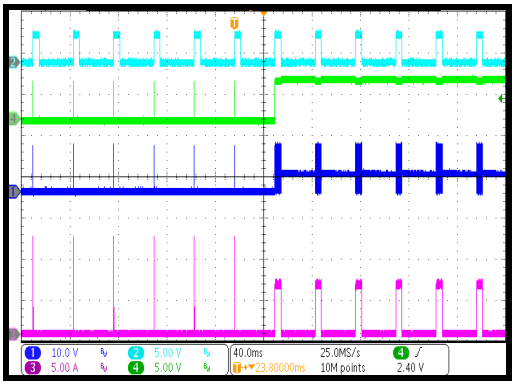
PWM Dimming
LED short to GND input shutdown



PWM Dimming
LED+ short to GND entry, I_{LED_PEAK} = 6A



PWM Dimming
LED+ short to GND recovery, I_{LED_PEAK} = 6A



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PCB LAYOUT

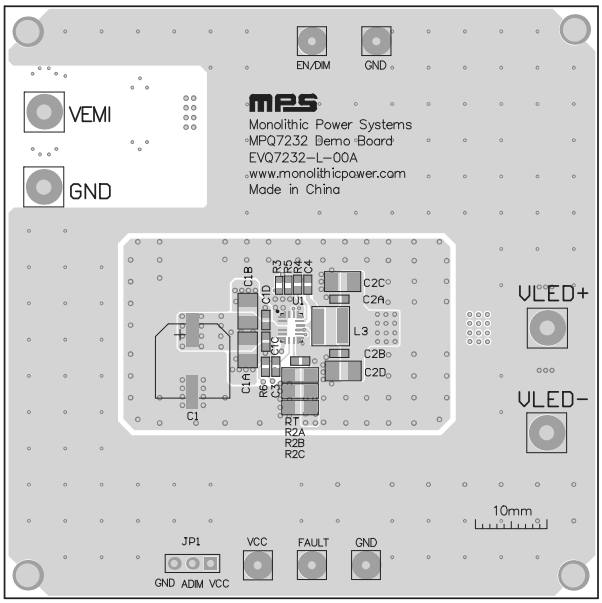

Figure 3: Top Silk and Top Layer

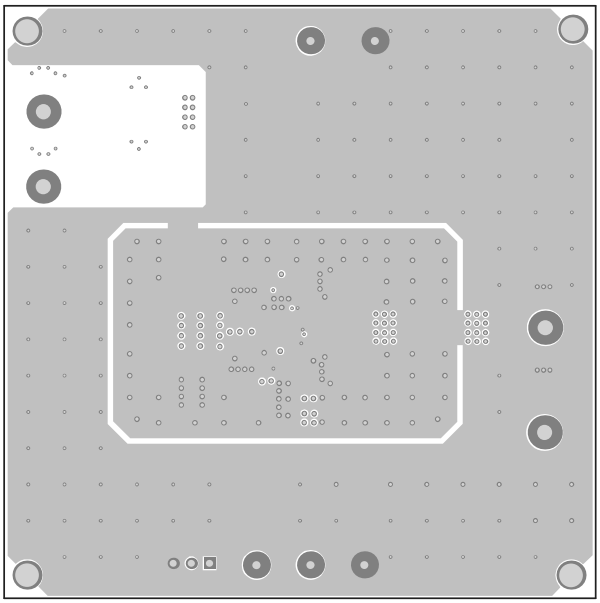

Figure 4: Mid-Layer 1

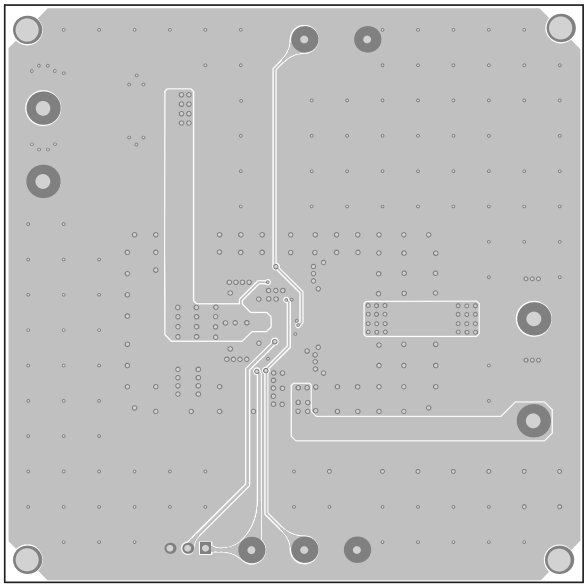

Figure 5: Mid-Layer 2

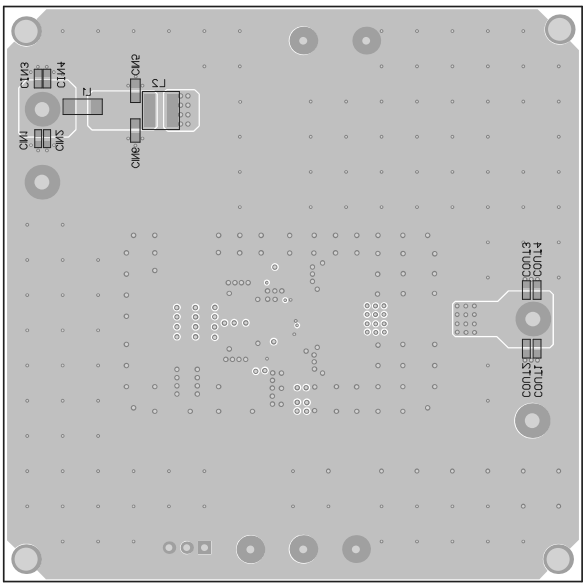

Figure 6: Bottom Layer and Bottom Silk

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REVISION HISTORY

Revision #	Revision Date	Description	Pages Updated
1.0	3/19/2024	Initial Release	-

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