EVQ7200-L-00B

42V, 1.2A, Synchronous LED Driver Buck-Boost Mode Evaluation Board

DESCRIPTION

The EVQ7200-L-00B evaluation board is designed to demonstrate the capabilities of the MPQ7200-AEC1. The MPQ7200-AEC1 is a high-frequency, constant-current LED driver with integrated power MOSFETs. It offers a very compact solution to achieve a 1.2A continuous output, with excellent load and line regulation across a wide input supply range.

Constant frequency hysteretic control mode provides extremely fast transient response without the loop compensation. The switching frequency is 1.15MHz in buck-boost mode for optimized efficiency and thermal performance.

The EVQ7200-L-00B is a fully assembled and tested buck-boost mode LED driver evaluation board. It generates an LED current up to 1.2A from a 6V to 20V input range.

ELECTRICAL SPECIFICATIONS

Parameter	Symbol	Value	Units
Input voltage	V_{EMI}	6 to 20	V
Output current	I_{LED}	1.2	A
Output voltage	V_{LED}	3 to 15	V

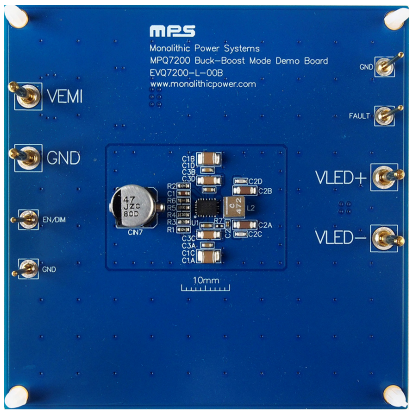
FEATURES

- Wide 6V to 42V Operating Input Range
- Buck-Boost Mode: Configurable 1.2A Max Continuous Output Current
- 44mΩ/40mΩ Internal Power MOSFETs
- Default 1.15MHz Switching Frequency for Buck-Boost Mode with Spread Spectrum
- PWM Dimming (100Hz to 2kHz Dimming Frequency)
- Internal 500Hz Two-Step Dimming with Programmable Duty Cycle
- Fault Indication for LED Short (to GND & Battery), Open, Output Over-voltage and Thermal Shutdown
- Over-Current Protection (OCP)
- Programmable Thermal Derating via NTC Remote Temperature Sensing
- EMI Reduction
- Available in a QFN-19 (3mmx4mm) Wettable Flank Package
- Available in AEC-Q100 Grade 1

APPLICATIONS

- Automotive LED Lighting

EVQ7200-L-00B EVALUATION BOARD

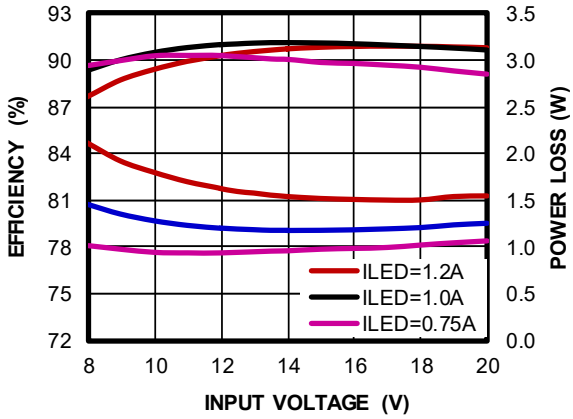


(LxWxH) 8.3cmx8.3cmx1.3cm

Board Number	MPS IC Number
EVQ7200-L-00B	MPQ7200GLE-AEC1

Efficiency vs. Input Voltage vs. Power Loss

4 LEDs (V_{LED} = 12V), buck-boost mode



QUICK START GUIDE

1. Preset the power supply between 6V and 20V. Note that the input voltage (V_{IN}) plus output voltage (V_{OUT}) should be less than 40V.
2. Turn off the power supply.
3. If longer cables (>0.5m total) are used between the source and the EVB, install a damping capacitor at the input terminals. This is especially critical when V_{EMI} exceeds 24V.
4. Connect the power supply terminals to:
   a. Positive (+): VEMI
   b. Negative (-): GND
5. Connect the load terminals to:
   a. Positive (+): LED+
   b. Negative (-): LED-
6. After making the connections, turn on the power supply.
7. To use the enable function:
   a. Apply a digital input to the EN/DIM pin.
   b. Drive EN above 2.5V to turn the regulator on; drive EN below 1V to turn it off.
8. When two-step dimming is inactivated (R_{DUTY} = 4.87kΩ), an external 100Hz to 2kHz PWM waveform can be applied to the EN/DIM pin.
9. Table 1 shows the proposed R3 in E96 series for different two-step dimming duty. When EN/DIM is high, the dimming duty cycle is 100%. When EN/DIM is low, the dimming duty cycle is X% shown in Table 1.

Table 1: Two-Step Dimming Duty vs. R_{DUTY}

Two-Step Dimming Duty (X%)	R_{DUTY} (Ω)
15%	61900
14%	41200
13%	27400
12%	18200
11%	12100
10%	7870
PWM dimming (two-step dimming inactivated)	4870
9%	3090
8%	2050
7%	1370
6%	887
5%	576

10. The external resistor (R5) connected to the ISET pin sets the LED current (I_{LED}). Generally, the value of R5 can be calculated with Equation (1):

$$R5 = \frac{16}{I_{LED}(A)}(k\Omega) \quad (1)$$

QUICK START GUIDE *(continued)*

To get better LED current precision, Table 2 shows the recommended LED setting resistor value in buck-boost mode when I_{LED} is below 0.7A (see Figure 1).

Table 2: Resistor Selection when I_{LED} ≤ 700mA in Buck-Boost Mode

I_{LED} (A)	R_{ISET} (kΩ)
0.7	22.6
0.65	24.2
0.6	26.1
0.55	28.2
0.5	30.9
0.45	34.0
0.4	37.4

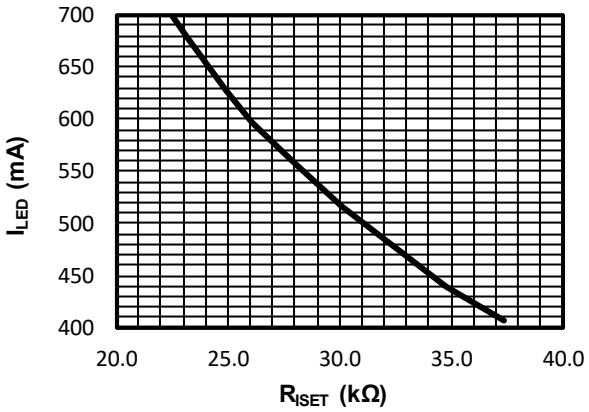
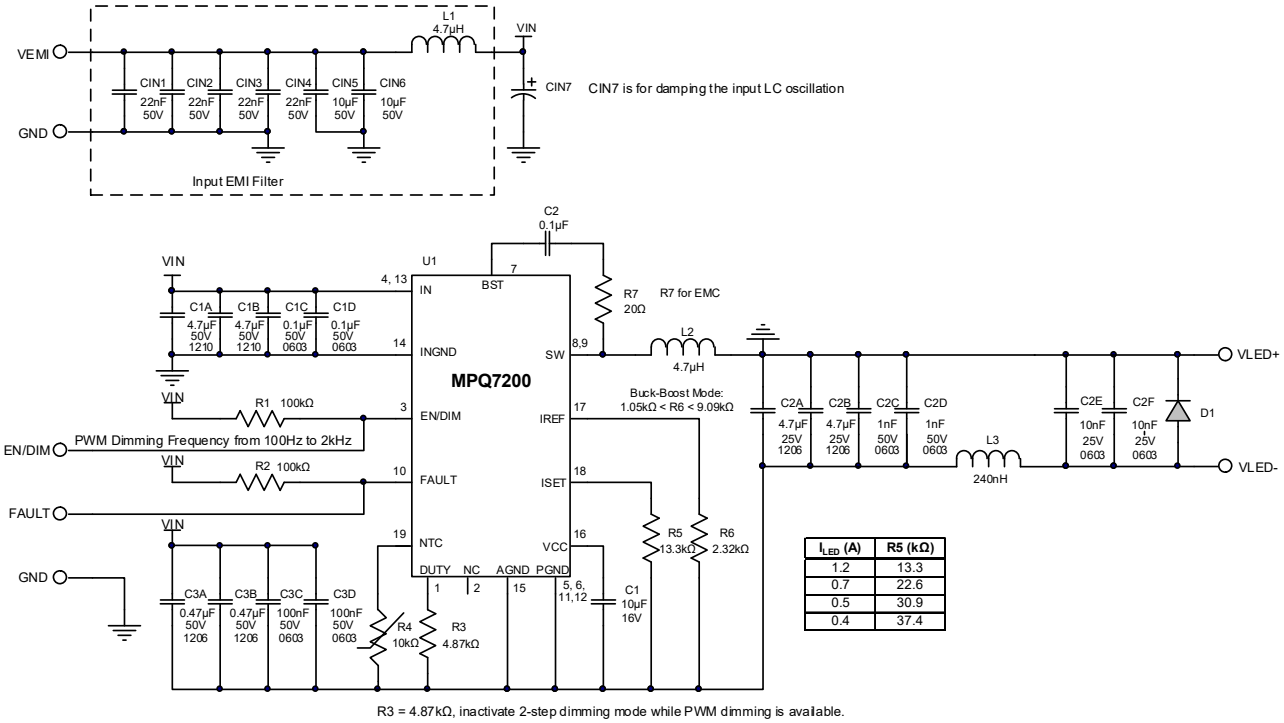


Figure 1: I_{LED} vs. R_{ISET} when I_{LED} ≤ 700mA in Buck-Boost Mode

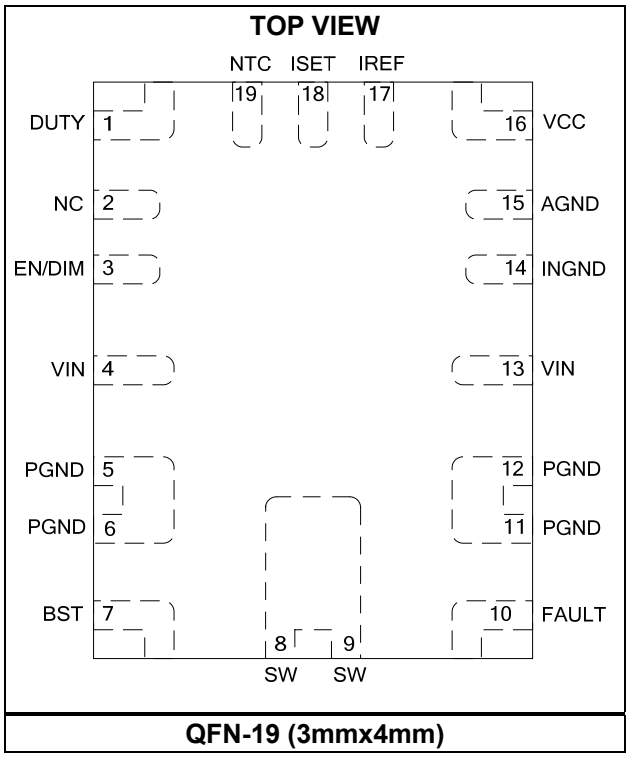
EVALUATION BOARD SCHEMATIC



I_{LED} (A)	R5 (kΩ)
1.2	13.3
0.7	22.6
0.5	30.9
0.4	37.4

Figure 1: Evaluation Board Schematic

PACKAGE REFERENCE



QFN-19 (3mmx4mm)

EVQ7200-L-00B BILL OF MATERIALS

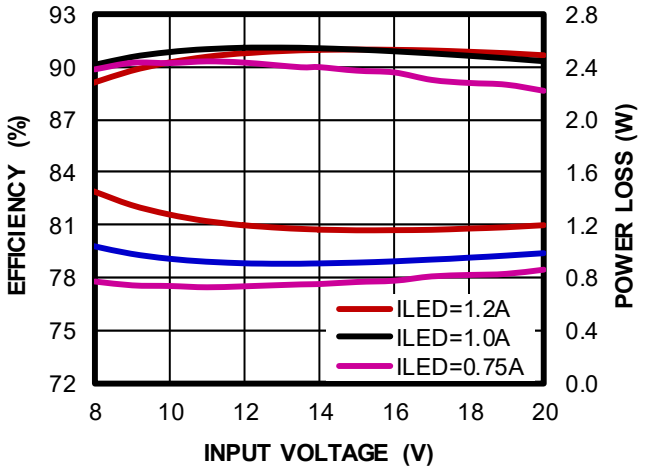
Qty	Designator	Value	Description	Package	Manufacturer	Manufacturer PN
4	CIN1, CIN2, CIN3, CIN4	22nF	Ceramic capacitor, 50V, X7R	0603	Murata	GRM188R71H223KA01D
2	CIN5, CIN6	10µF	Ceramic capacitor, 50V, X7R	1210	Murata	GRM32ER71H106KA8
1	CIN7	47µF	Electrolytic capacitor, 63V	SMD	Panasonic	EEHZC1J470P
2	C1A, C1B	4.7µF	Ceramic capacitor, 50V, X7R	1210	Murata	GRM32ER71H475KA8
4	C1C, C1D, C3C, C3D	0.1µF	Ceramic capacitor, 50V, X7R	0603	Murata	GRM188R71H104KA93D
2	C2A, C2B	4.7µF	Ceramic capacitor, 25V, X7R	1206	TDK	C3216X7R1E475M
2	C3A, C3B	0.47µF	Ceramic capacitor, 50V, X7R	1206	TDK	C3216X7R1H474K
2	C2C, C2D	1nF	Ceramic capacitor, 50V, C0G	0603	Murata	GRM1885C1H02JAC
2	C2E, C2F	10nF	Ceramic capacitor, 25V, X7R	0603	Wurth	885012206065
1	C1	10µF	Ceramic capacitor, 10V, X7R	0603	Murata	GRM188Z71A106KA73D
1	C2	0.1µF	Ceramic capacitor, 16V, X7R	0402	Murata	GCM155R71C104KA55D
1	D1	B140	Schottky diode, 40V, 1A	SMA	Diodes, Inc.	B140
1	L1	4.7µH	Inductor, 44.1mΩ DCR, 4.6A	SMD	Coilcraft	XAL4030-472MEB
1	L2	4.7µH	Inductor, 44.1mΩ DCR, 4.6A	SMD	Coilcraft	XAL4030-472MEB
1	L3	240nH	Inductor, 27mΩ DCR, 6.5A	SMD	Cyntec	VCUW20161B-R24MS5
2	R1, R2	100kΩ	Film resistor, 5%	0603	Yageo	RC0603JR-07100KL
1	R3	4.87kΩ	Film resistor, 1%	0603	Yageo	RC0603FR-074K87L
1	R4	10kΩ	Film resistor, 1%	0603	Yageo	RC0603FR-0710kL
1	R7	20Ω	Film resistor, 1%	0402	Yageo	RC0402FR-0720RL
1	R5	13.3kΩ	Film resistor, 1%	0603	Yageo	RC0603FR-0713K3L
1	R6	2.32kΩ	Film resistor, 1%	0603	Yageo	RC0603FR-072K32L
1	U1	MPQ7200	Step-up/down regulator	QFN-19 (3mmx 4mm)	MPS	MPQ7200GL-AEC1
4	VEMI, GND, VLED+, VLED-		2.0mm golden pin		Custom	
4	EN, GND, FAULT, GND		1.0mm golden pin		Custom	

EVB TEST RESULTS

Performance curves and waveforms are tested on the evaluation board, V_{IN} = 13.5V, 4 LEDs (V_{LED} = 12V), L = 4.7µH, f_{SW} = 1.15MHz, T_A = 25°C, buck-boost mode, unless otherwise noted.

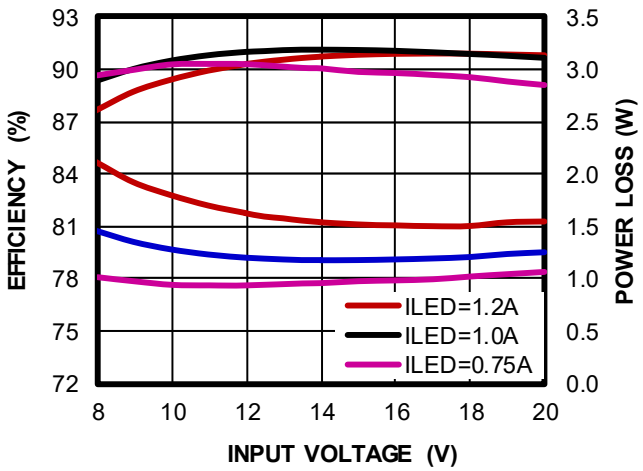
Efficiency vs. Input Voltage vs. Power Loss

3 LEDs (V_{LED} = 9V)



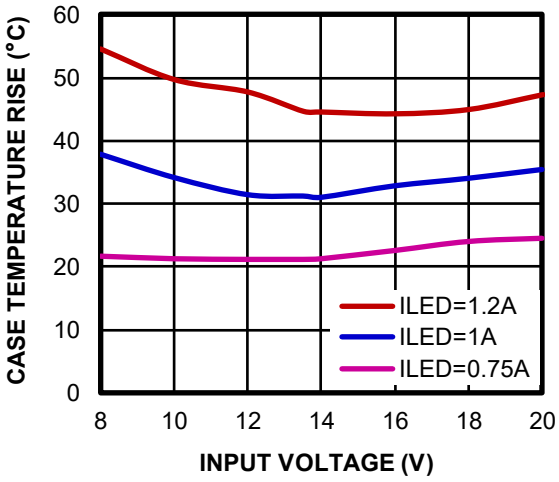
Efficiency vs. Input Voltage vs. Power Loss

4 LEDs (V_{LED} = 12V)



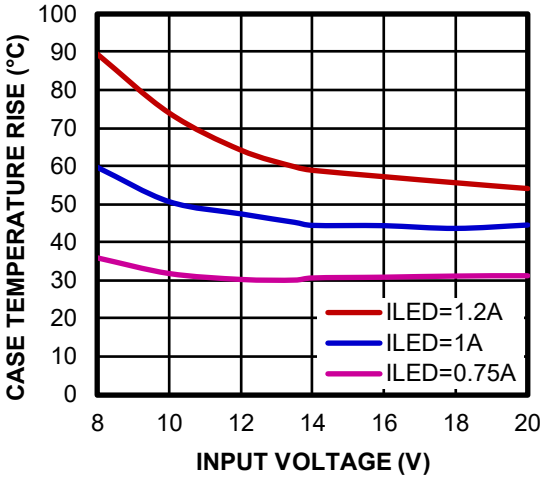
Case Temperature Rise vs. Input Voltage

3 LEDs (V_{LED} = 9V)



Case Temperature Rise vs. Input Voltage

4 LEDs (V_{LED} = 12V)

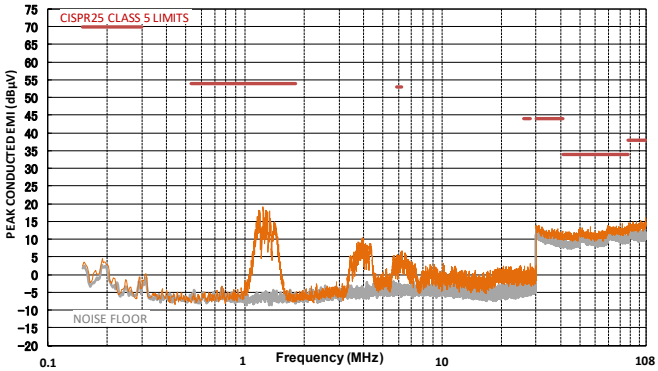


EVB TEST RESULTS *(continued)*

Performance curves and waveforms are tested on the evaluation board, V_{IN} = 13.5V, 4 LEDs (V_{LED} = 12V), L = 4.7µH, f_{SW} = 1.15MHz, T_A = 25°C, buck-boost mode, unless otherwise noted.

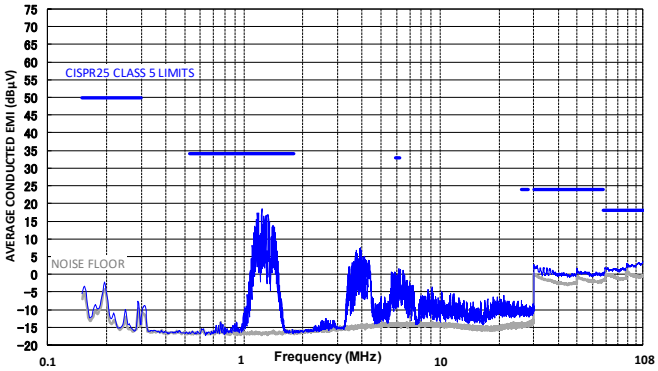
CISPR25 Class 5 Peak Conducted Emissions

150kHz to 108MHz



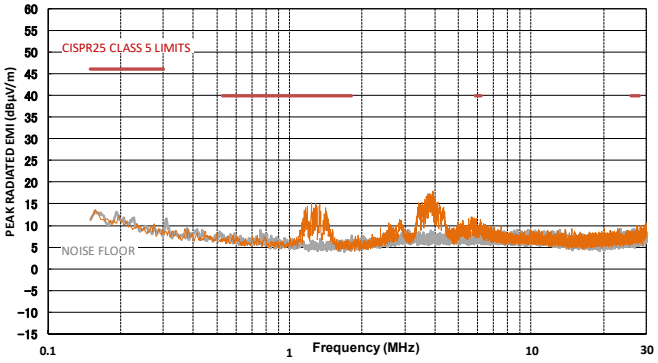
CISPR25 Class 5 Average Conducted Emissions

150kHz to 108MHz



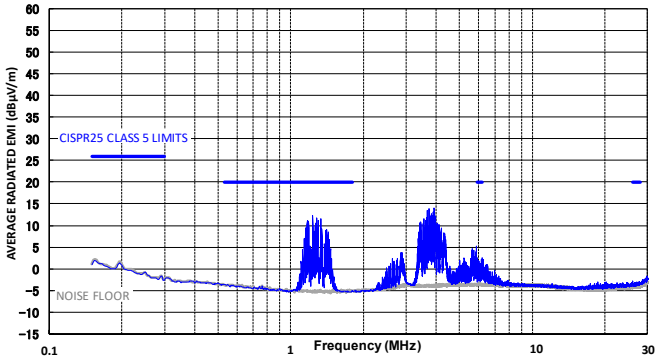
CISPR25 Class 5 Peak Radiated Emissions

150kHz to 30MHz



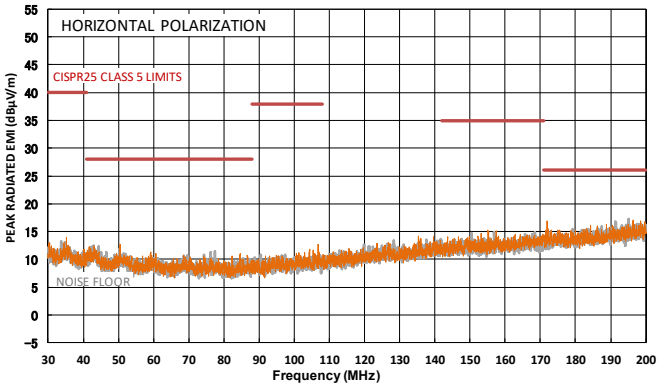
CISPR25 Class 5 Average Radiated Emissions

150kHz to 30MHz



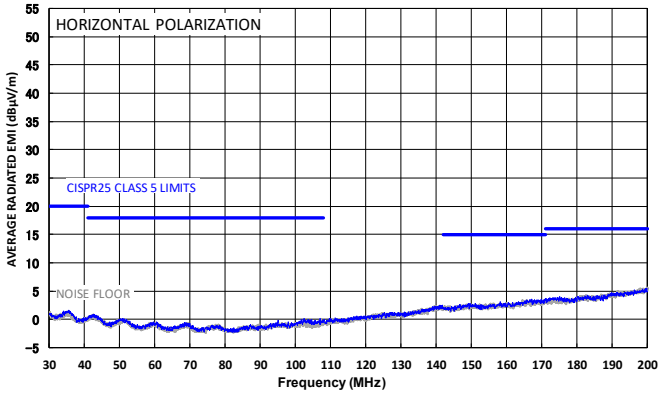
CISPR25 Class 5 Peak Radiated Emissions

Horizontal, 30MHz to 200MHz



CISPR25 Class 5 Average Radiated Emissions

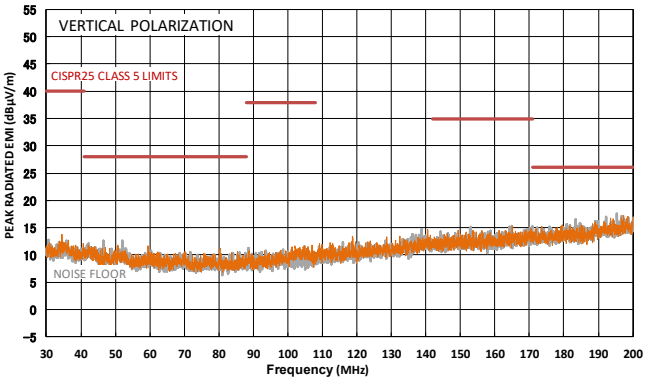
Horizontal, 30MHz to 200MHz



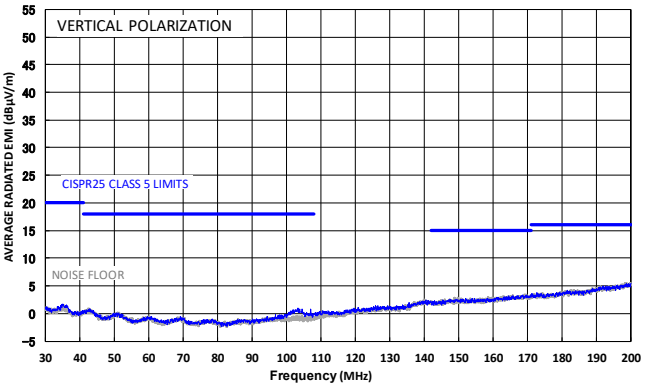
EVB TEST RESULTS *(continued)*

Performance curves and waveforms are tested on the evaluation board, V_{IN} = 13.5V, 4 LEDs (V_{LED} = 12V), L = 4.7µH, f_{SW} = 1.15MHz, T_A = 25°C, buck-boost mode, unless otherwise noted.

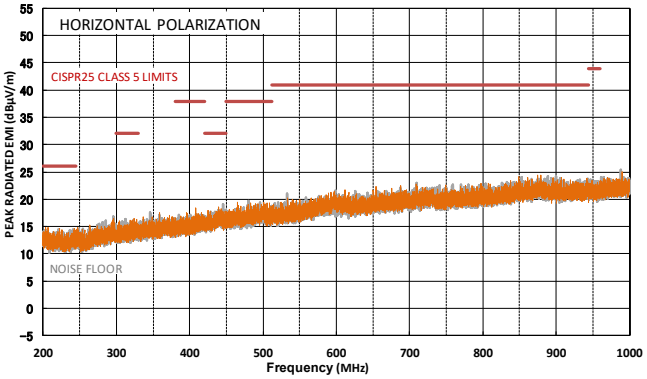
CISPR25 Class 5 Peak Radiated Emissions
Vertical, 30MHz to 200MHz



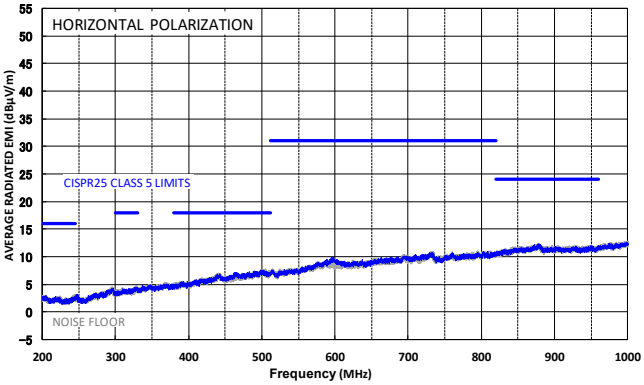
CISPR25 Class 5 Average Radiated Emissions
Vertical, 30MHz to 200MHz



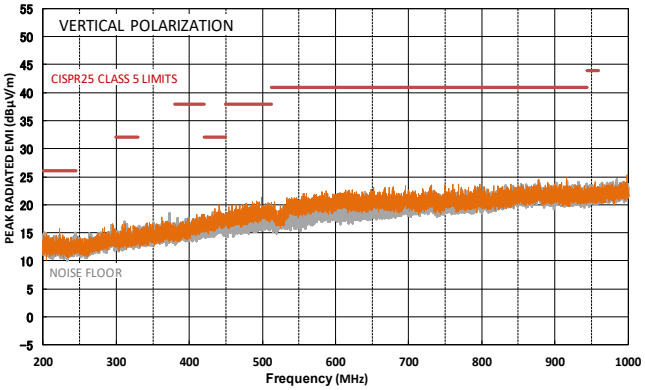
CISPR25 Class 5 Peak Radiated Emissions
Horizontal, 200MHz to 1GHz



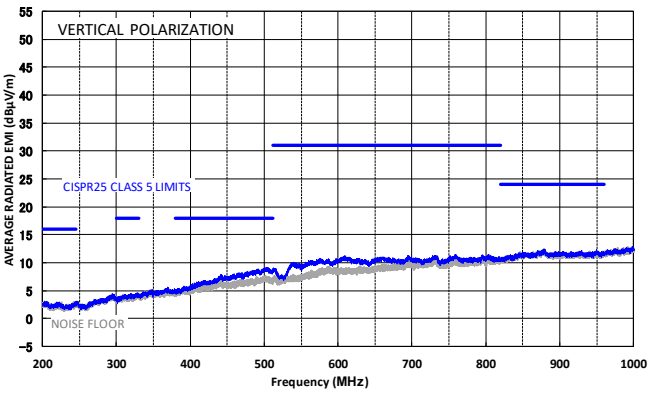
CISPR25 Class 5 Average Radiated Emissions
Horizontal, 200MHz to 1GHz



CISPR25 Class 5 Peak Radiated Emissions
Vertical, 200MHz to 1GHz



CISPR25 Class 5 Average Radiated Emissions
Vertical, 200MHz to 1GHz

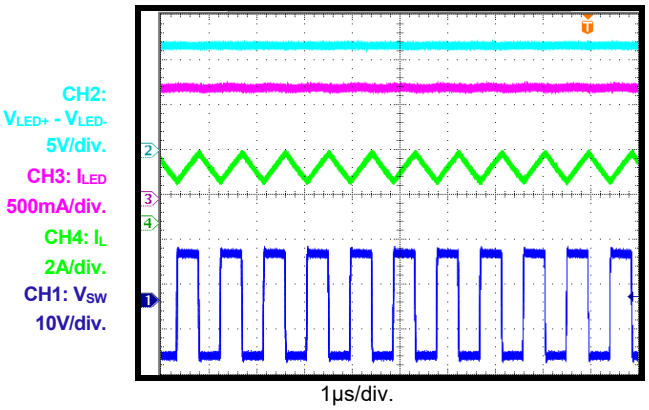


EVB TEST RESULTS *(continued)*

Performance curves and waveforms are tested on the evaluation board, V_{IN} = 13.5V, 4 LEDs (V_{LED} = 12V), L = 4.7µH, f_{SW} = 1.15MHz, T_A = 25°C, buck-boost mode, unless otherwise noted.

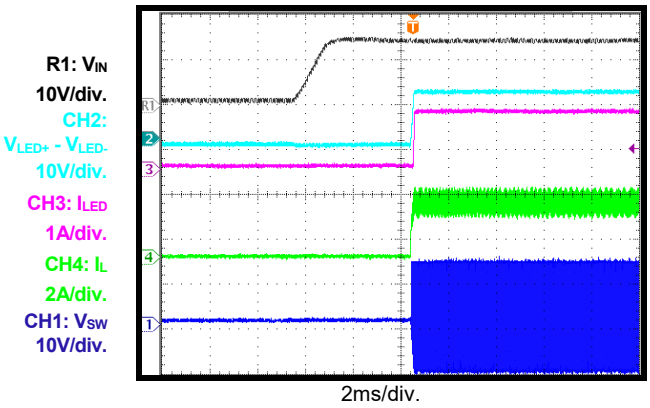
Steady State

I_{LED} = 1.2A



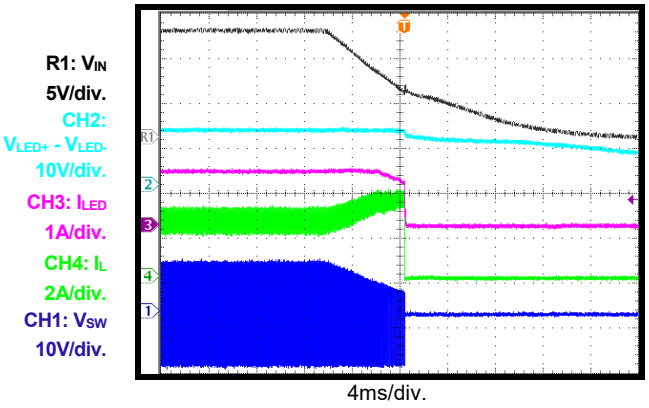
Start-Up through VIN

I_{LED} = 1.2A



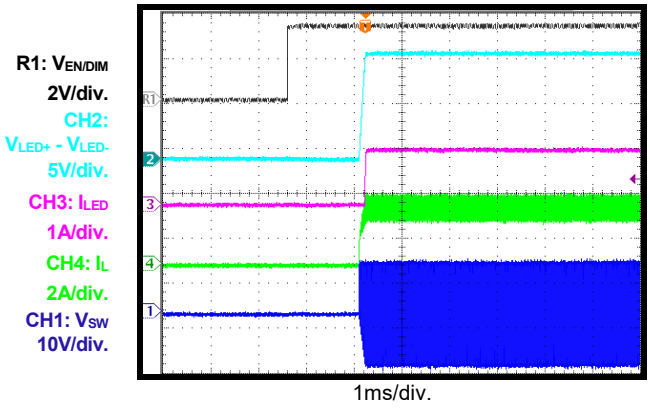
Shutdown through VIN

I_{LED} = 1.2A



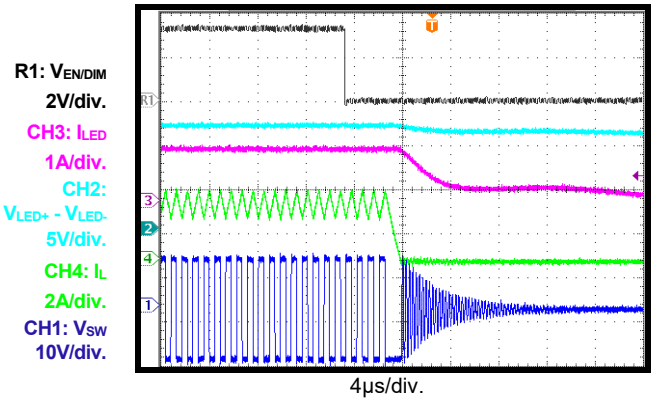
Start-Up through EN

I_{LED} = 1.2A



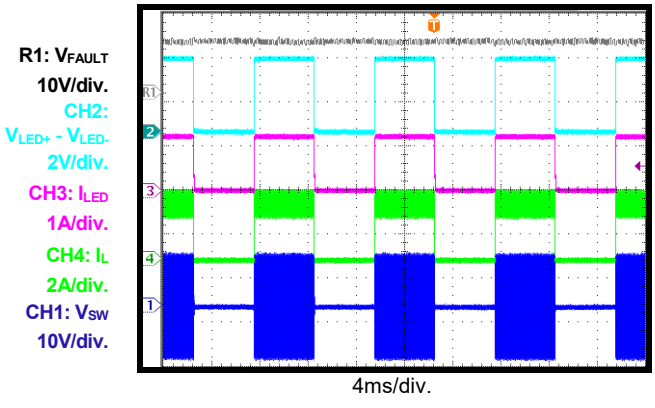
Shutdown through EN

I_{LED} = 1.2A



PWM Dimming Steady State

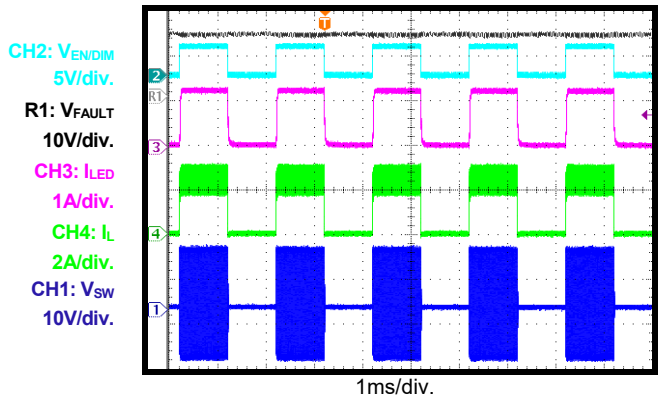
Dimming frequency = 100Hz



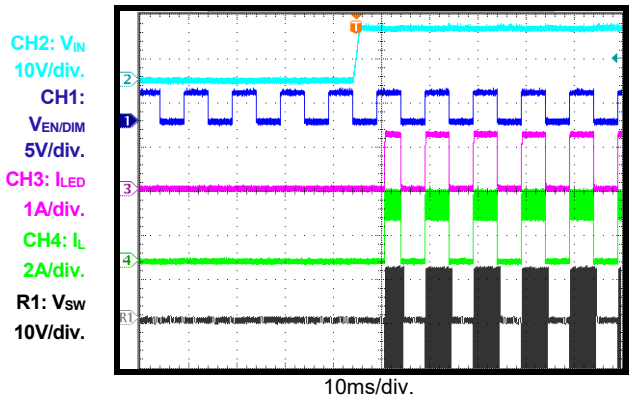
EVB TEST RESULTS *(continued)*

Performance curves and waveforms are tested on the evaluation board, V_{IN} = 13.5V, 4 LEDs (V_{LED} = 12V), L = 4.7µH, f_{SW} = 1.15MHz, T_A = 25°C, buck-boost mode, unless otherwise noted.

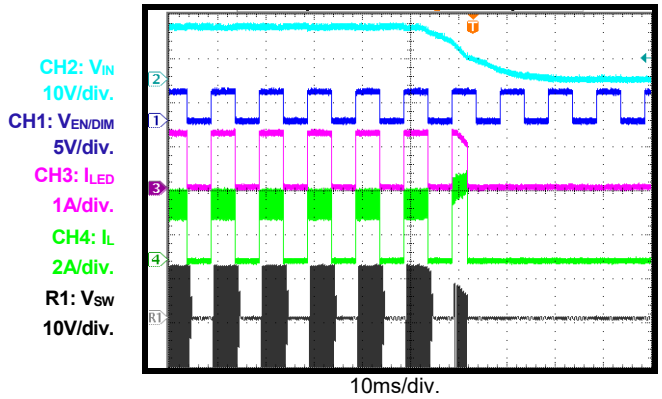
PWM Dimming Steady State
Dimming frequency = 500Hz



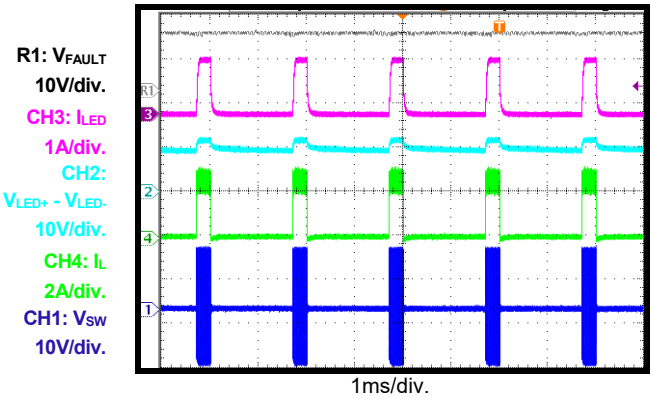
PWM Dimming
Start-Up through VIN



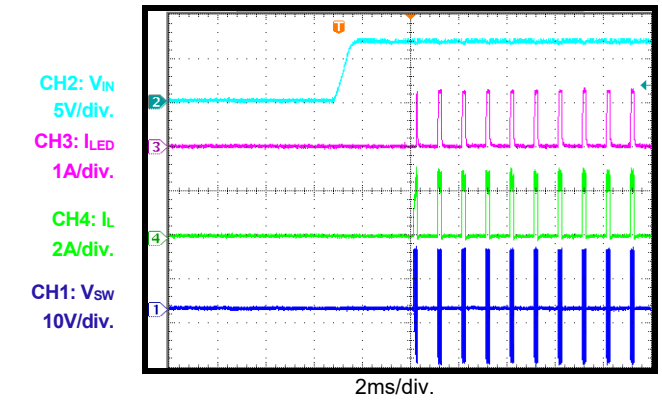
PWM Dimming
Shutdown through VIN



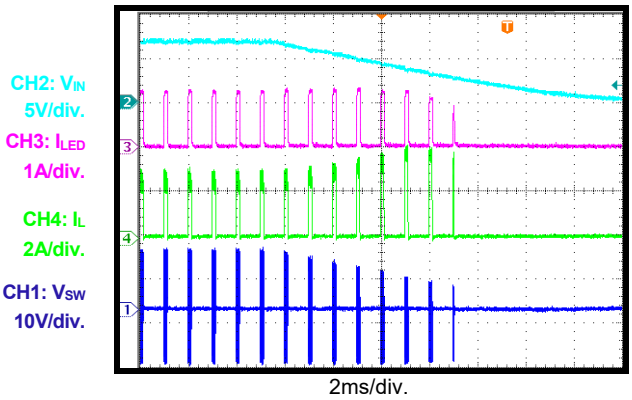
Two-Step Dimming
Steady state



Two-Step Dimming
Start-Up through VIN



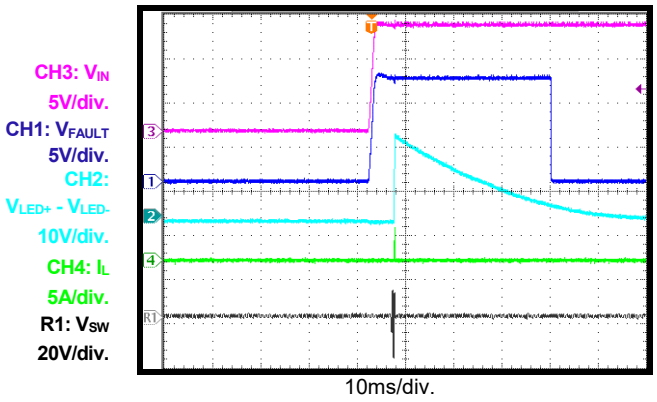
Two-Step Dimming
Shutdown through VIN



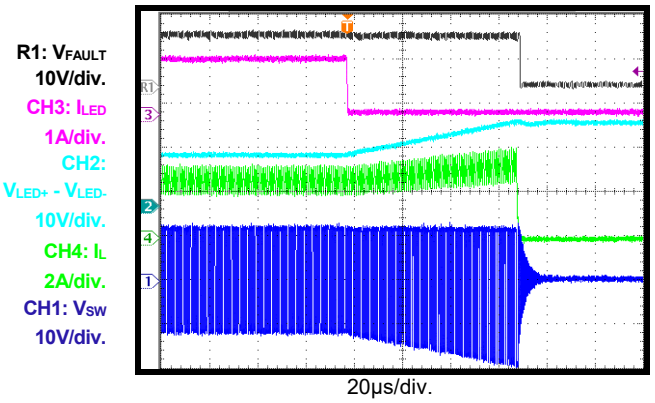
EVB TEST RESULTS *(continued)*

Performance curves and waveforms are tested on the evaluation board, V_{IN} = 13.5V, 4 LEDs (V_{LED} = 12V), L = 4.7µH, f_{SW} = 1.15MHz, T_A = 25°C, buck-boost mode, unless otherwise noted.

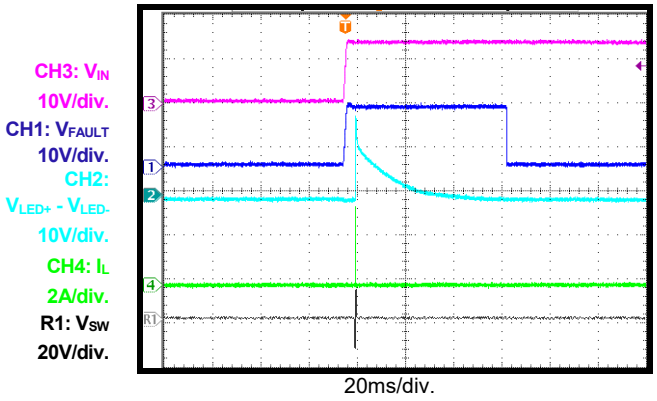
No Dimming
LED open, start-up through VIN



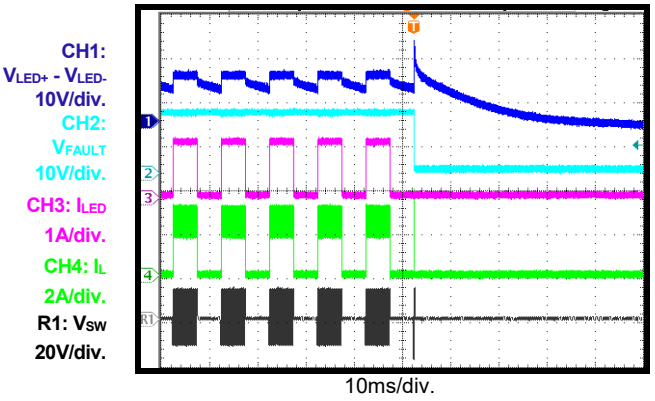
No Dimming
LED open entry



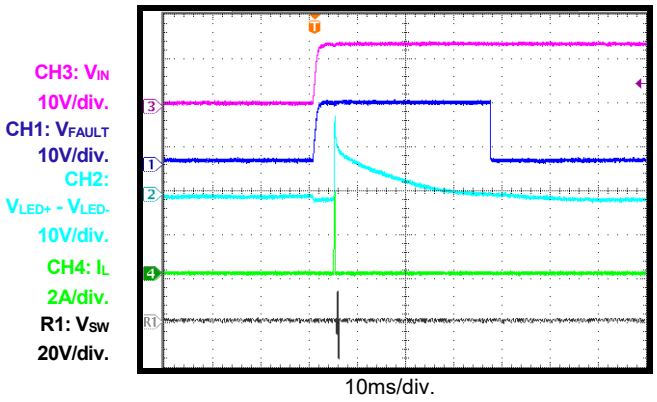
PWM Dimming
LED open, start-up through VIN



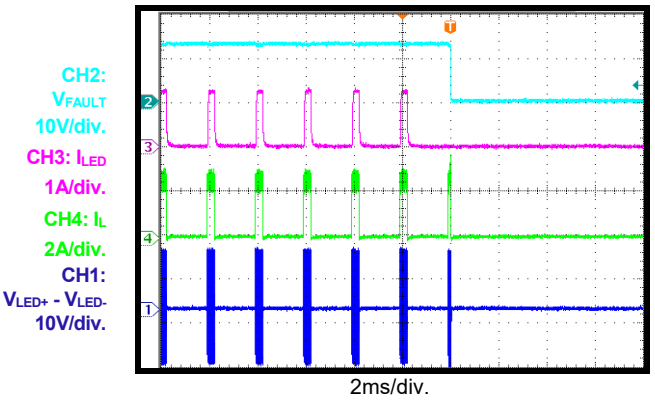
PWM Dimming
LED open entry



Two-Step Dimming
LED open, start-up through VIN



Two-Step Dimming
LED open entry

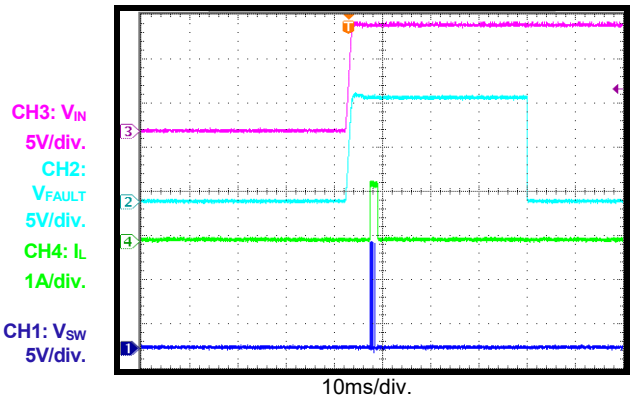


EVB TEST RESULTS *(continued)*

Performance curves and waveforms are tested on the evaluation board, V_{IN} = 13.5V, 4 LEDs (V_{LED} = 12V), L = 4.7µH, f_{SW} = 1.15MHz, T_A = 25°C, buck-boost mode, unless otherwise noted.

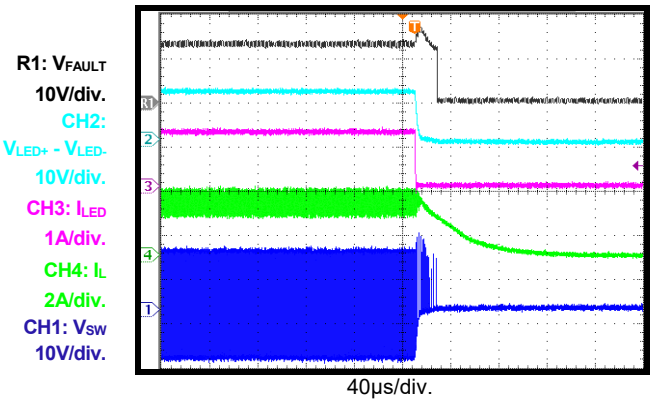
No Dimming

LED+ Short to LED-, start-up through VIN



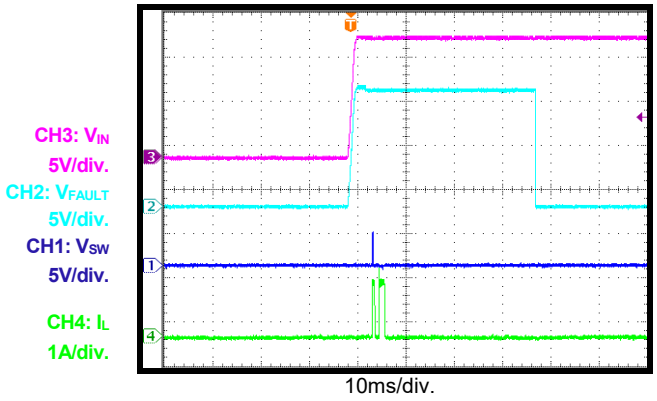
No Dimming

LED+ short to LED- entry



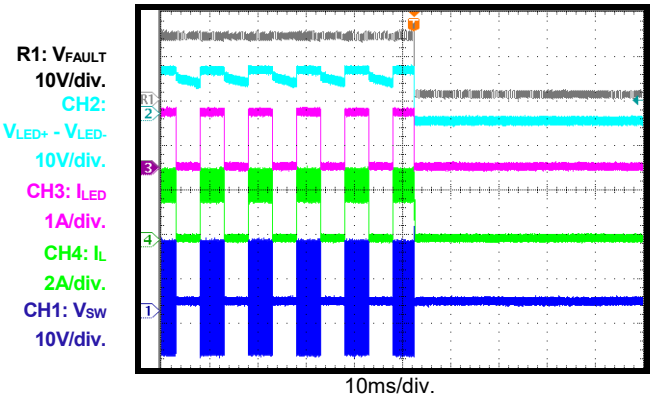
PWM Dimming

LED+ Short to LED-, start-up through VIN



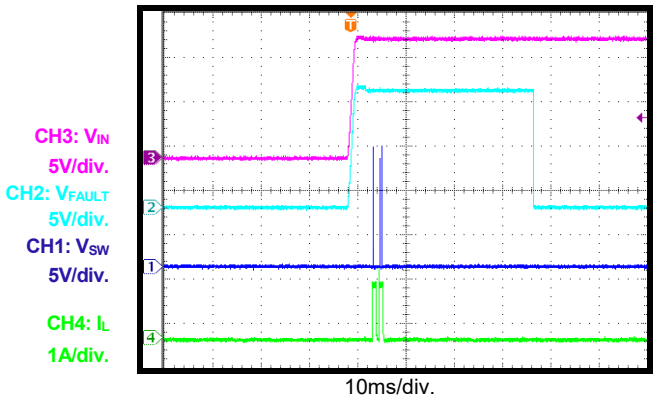
PWM Dimming

LED+ short to LED- entry



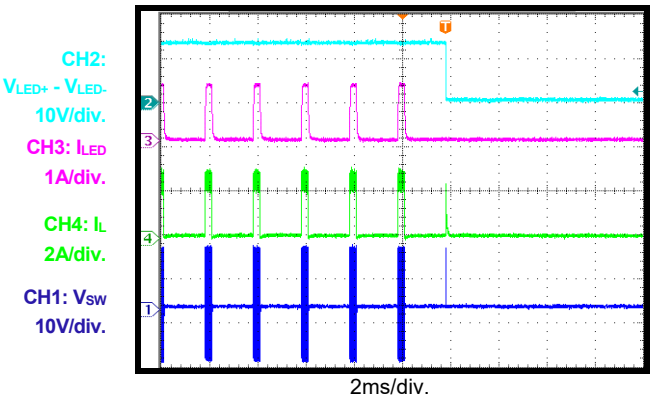
Two-Step Dimming

LED+ Short to LED-, start-up through VIN



Two-Step Dimming

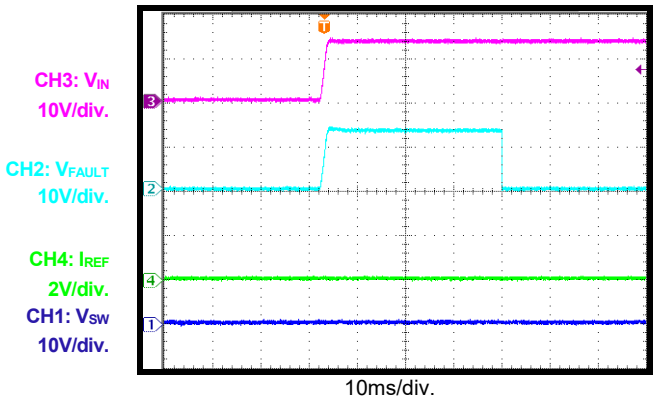
LED+ short to LED- entry



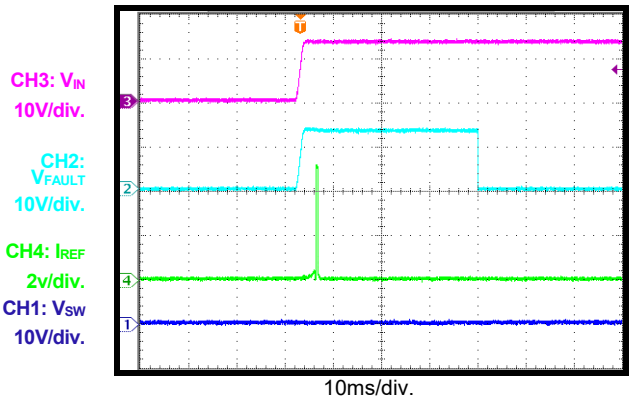
EVB TEST RESULTS *(continued)*

Performance curves and waveforms are tested on the evaluation board, V_{IN} = 13.5V, 4 LEDs (V_{LED} = 12V), L = 4.7µH, f_{SW} = 1.15MHz, T_A = 25°C, buck-boost mode, unless otherwise noted.

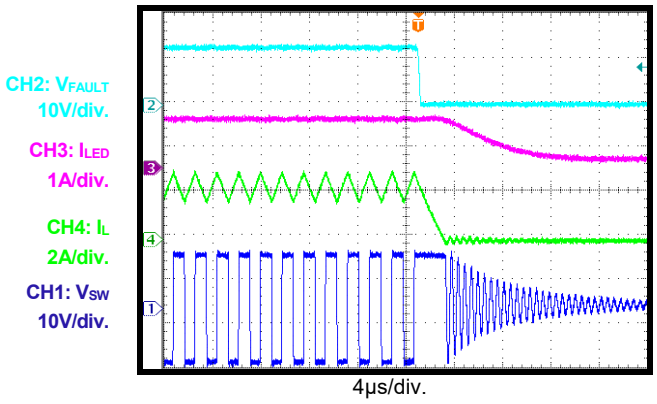
I_{REF} Short before VIN Start-Up



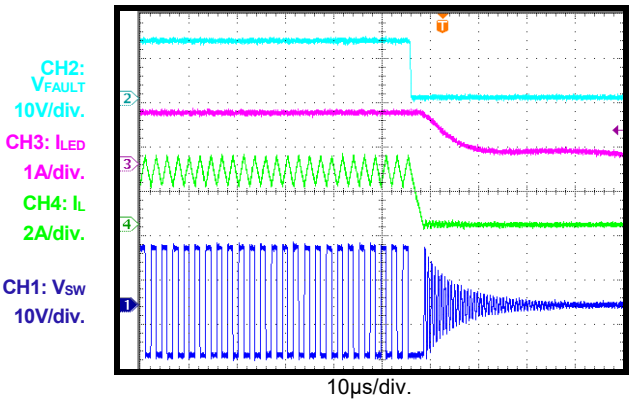
I_{REF} Open before VIN Start-Up



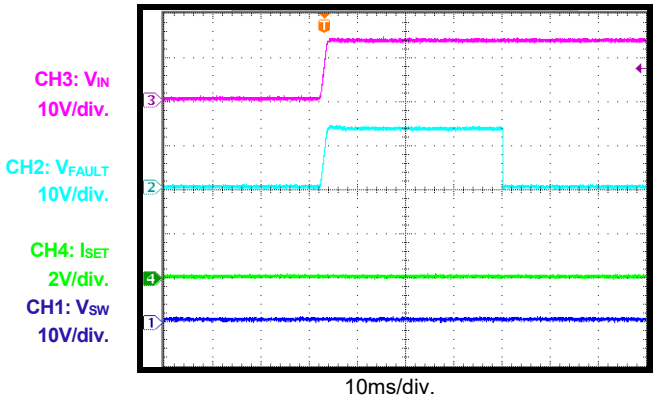
I_{REF} Short after VIN Start-Up



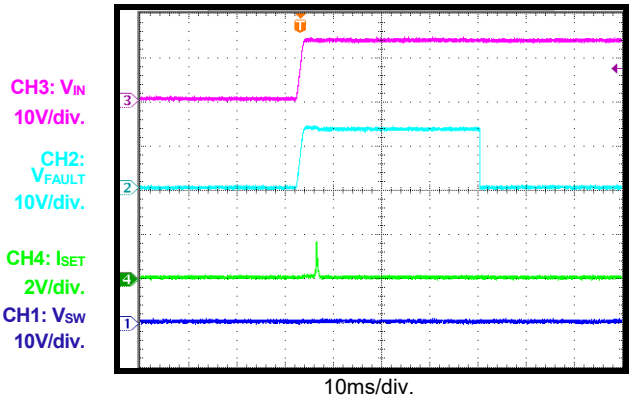
I_{REF} Open after VIN Start-Up



I_{SET} Short before VIN Start-Up



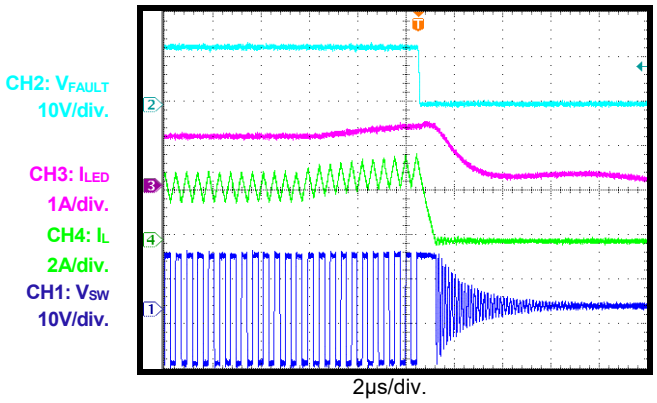
I_{SET} Open before VIN Start-Up



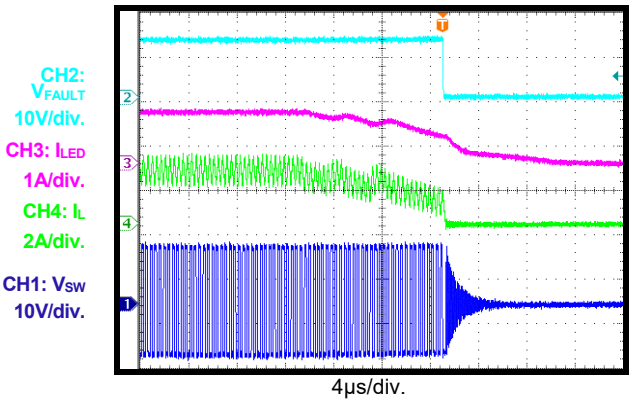
EVB TEST RESULTS *(continued)*

Performance curves and waveforms are tested on the evaluation board, V_{IN} = 13.5V, 4 LEDs (V_{LED} = 12V), L = 4.7µH, f_{SW} = 1.15MHz, T_A = 25°C, buck-boost mode, unless otherwise noted.

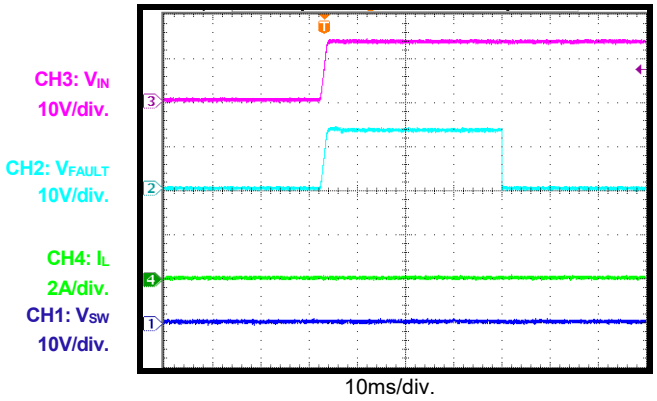
I_{SET} Short after VIN Start-Up



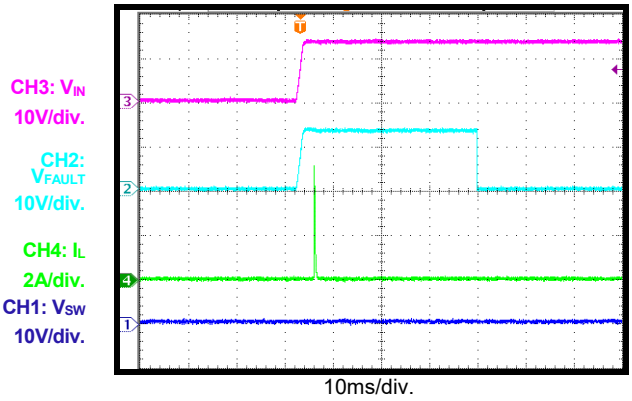
I_{SET} Open after VIN Start-Up



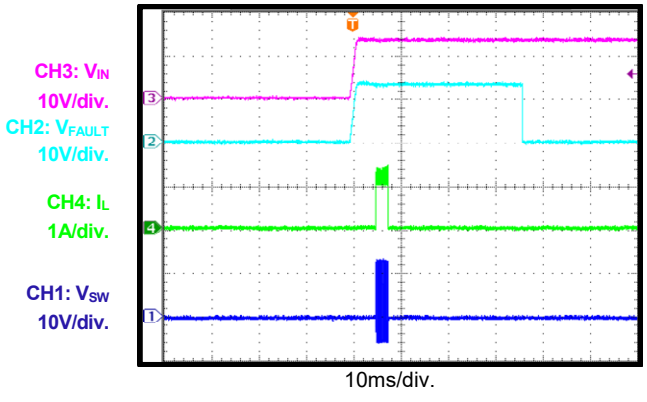
I_{DUTY} Short before VIN Start-Up



I_{DUTY} Open before VIN Start-Up



Mode Detect Wrong at VIN Start-Up



PCB LAYOUT

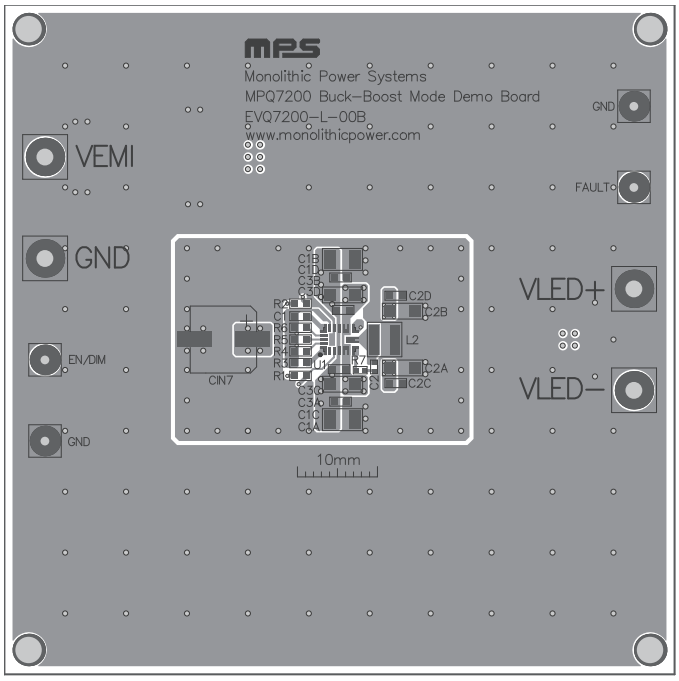


Figure 2: Top Silk and Top Layer

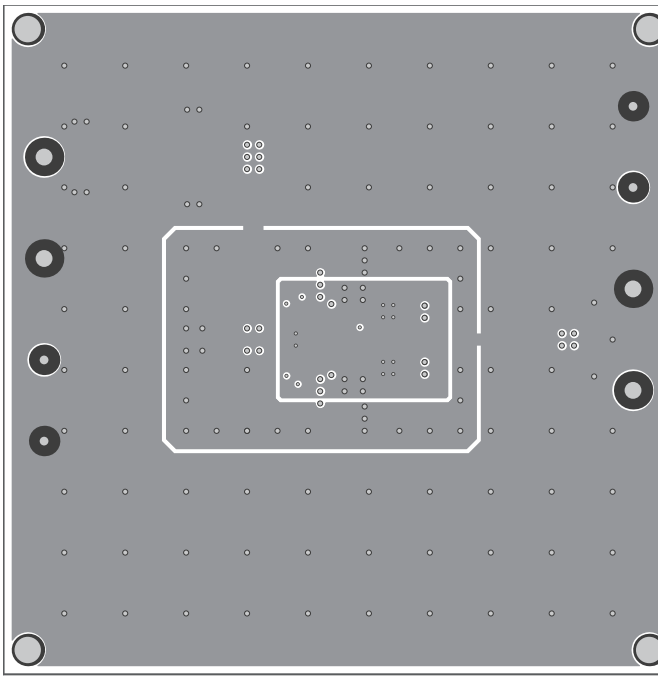


Figure 3: Mid-Layer 1

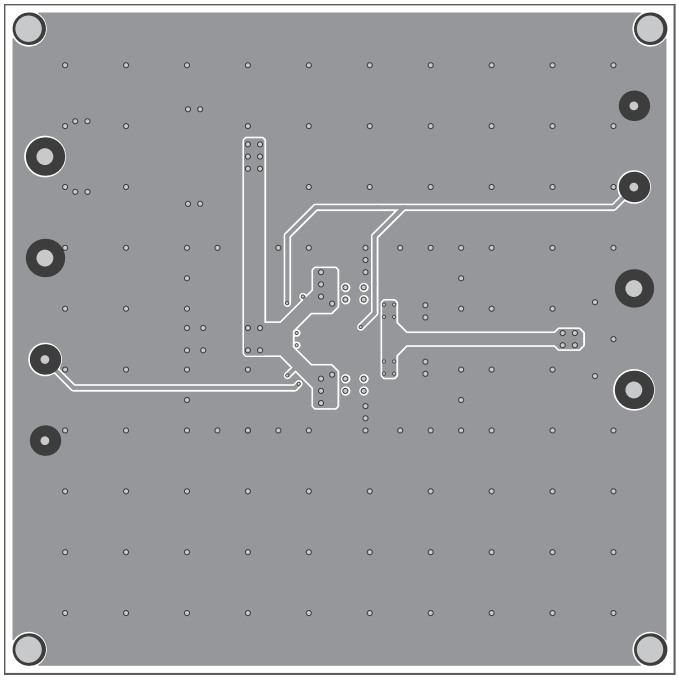


Figure 4: Mid-Layer 2

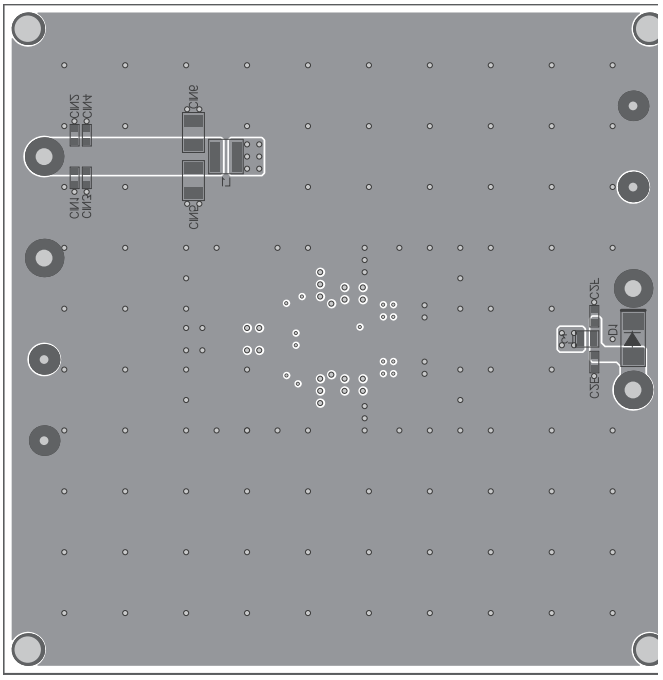


Figure 5: Bottom Layer and Bottom Silk

REVISION HISTORY

Revision #	Revision Date	Description	Pages Updated
1.0	2/23/2021	Initial Release	-

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