EVQ7200A-L-00B

42V, 1.2A, 410kHz, Synchronous LED Driver Buck-Boost Mode Evaluation Board, AEC-Q100 Qualified

DESCRIPTION

The EVQ7200A-L-00B is an evaluation board designed to demonstrate the capabilities of the MPQ7200A, a constant-current LED driver with integrated power MOSFETs. It offers a very compact solution to achieve 1.2A of continuous output current (I_{OUT}), with excellent load and line regulation across a wide input supply range.

Constant frequency hysteretic control mode provides extremely fast transient response without loop compensation. The switching frequency (f_{SW}) is 410kHz in buck-boost mode for optimized efficiency and thermal performance.

The MPQ7200A is available in a QFN-19 (3mmx4mm) package with wettable flanks, and is available in AEC-Q100 Grade 1.

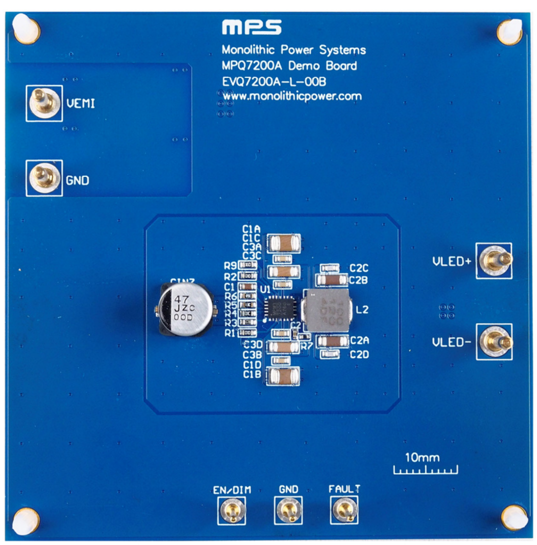
The EVQ7200A-L-00B is a fully assembled and tested buck-boost mode LED driver evaluation board. It generates an LED current up to 1.2A from a 6V to 20V input range.

PERFORMANCE SUMMARY

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

Parameters	Conditions	Value
Input voltage (V_{IN}) range		6V to 20V
Maximum output current (I_{OUT})	V_{IN} = 6V to 20V	1.2A
Typical efficiency	V_{IN} = 13.5V, 4 LEDs, I_{OUT} = 1.2A	89.95%
Peak efficiency	V_{IN} = 13.5V, 4 LEDs, I_{OUT} = 0.75A	91.06%
Switching frequency (f_{SW})		410kHz

EVALUATION BOARD



LxWxH (8.3cmx8.3cmx1.3cm)

Board Number	MPS IC Number
EVQ7200A-L-00B	MPQ7200AGLE-AEC1

QUICK START GUIDE

1. Preset the power supply between 6V and 20V, then turn off the power supply (see Figure 1). Note that the input voltage (V_{EMI}) plus output voltage (V_{OUT}) should be below 40V.

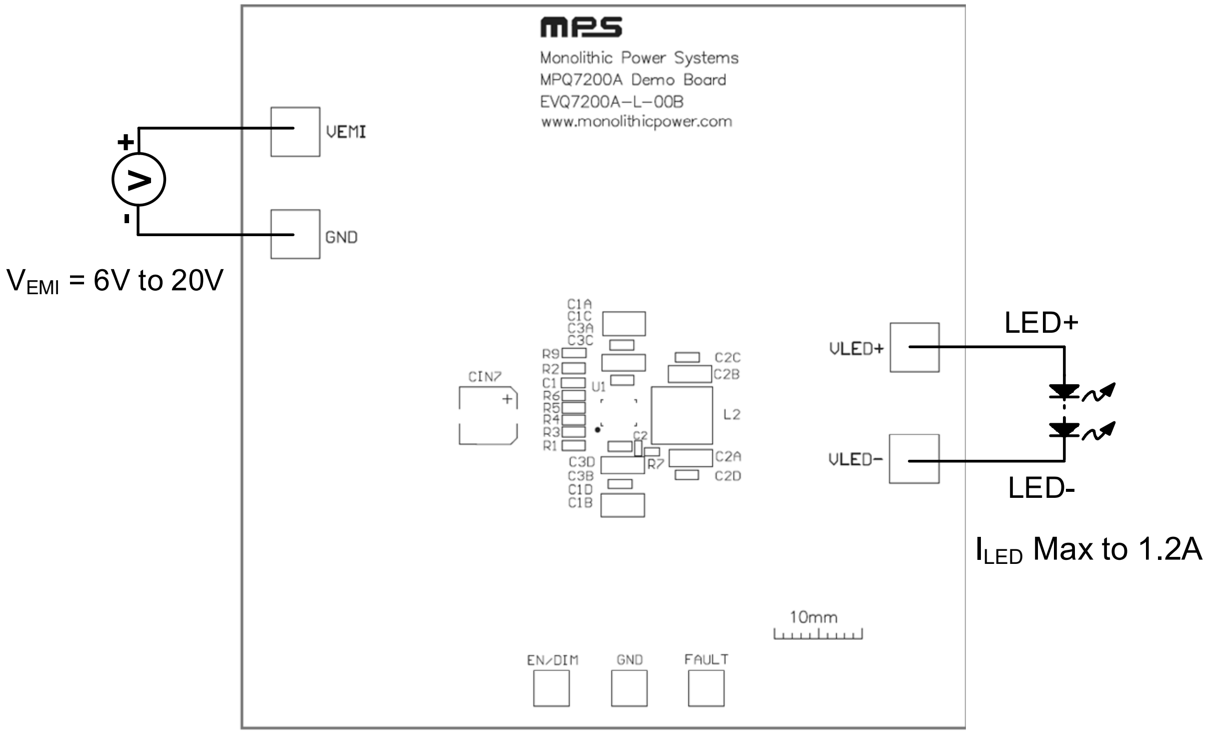


Figure 1: Measurement Equipment Set-Up

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 especially critical when 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. Drive EN above 2.5V to turn the regulator on; drive EN below 1V to turn it off.
7. When two-step dimming is inactive (R_{DUTY} = 4.87kΩ), an external 100Hz to 2kHz pulse-width modulation (PWM) waveform can be applied to the EN/DIM pin.
8. To initiate two-step dimming, use the EN/DIM pin. Table 1 on page 3 shows the proposed resistor (R3) in E96 series for different dimming duty cycles. When EN/DIM is high, the dimming duty cycle is 100%; when EN/DIM is low, the dimming duty cycle percentage varies.

QUICK START GUIDE *(continued)*

Table 1: Two-Step Dimming Duty vs. R3

Two-Step Dimming Duty	R3 (Ω)
15%	61900
14%	41200
13%	27400
12%	18200
11%	12100
10%	7870
Two-step dimming off	4870
9%	3090
8%	2050
7%	1370
6%	887
5%	576

9. The external resistor (R5) connected to the ISET pin sets the LED current (I_{LED}). R5 can be calculated using Equation (1):

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

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

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

I_{LED} (A)	R5 (kΩ)
0.7	22.6
0.65	24.4
0.6	26.3
0.55	28.6
0.5	31.5
0.45	34.9
0.4	39.1

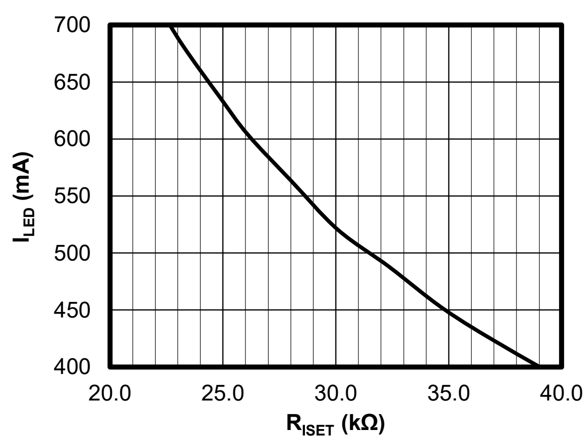
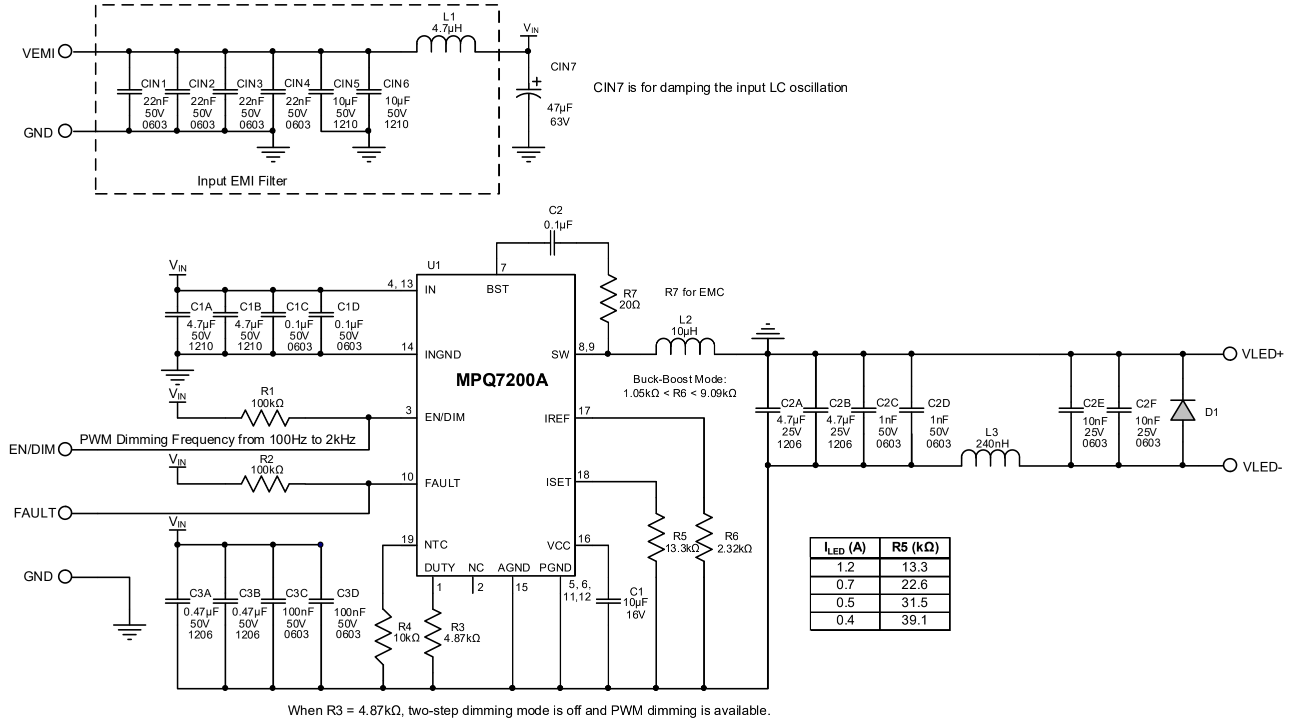


Figure 2: I_{LED} vs. R_{ISET} when I_{LED} ≤ 700mA in Buck-Boost Mode

EVALUATION BOARD SCHEMATIC



I_{LED} (A)	R5 (kΩ)
1.2	13.3
0.7	22.6
0.5	31.5
0.4	39.1

Figure 3: Evaluation Board Schematic

EVQ7200A-L-00B BILL OF MATERIALS

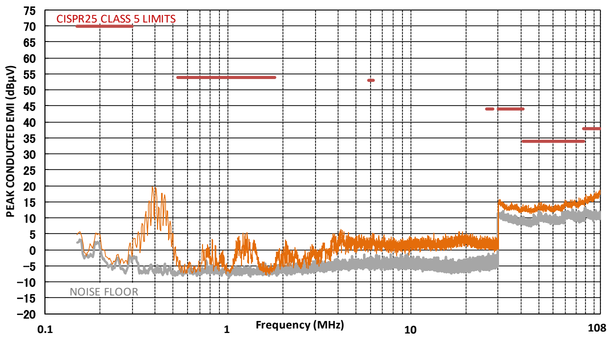
Qty	Ref	Value	Description	Package	Manufacturer	Manufacturer PN
1	L1	4.7µH	Inductor, 44.1mΩ DCR, 4.6A	SMD	Coilcraft	XAL4030-472MEB
1	L2	10µH	Inductor, 61mΩ DCR, 4A	SMD	Cyntec	VCMT063T-100MN5
1	L3	240nH	Inductor, 27mΩ DCR, 3.8A	SMD	Cyntec	VCUW20161B-R24MS5-89
4	CIN1, CIN2, CIN3, CIN4	22nF	Ceramic capacitor, 50V, X7R	0603	TDK	C1608X7R1H223K
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	0603	Murata	GRM188R71C104KA01D
2	R1, R2	100kΩ	Film resistor, 5%	0603	Yageo	RC0603JR-07100KL
1	R9	10Ω	Film resistor, 1%	0604	Yageo	RC0603FR-0710RL
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	R3	4.87kΩ	Film resistor, 1%	0603	Yageo	RC0603FR-074K87L
1	D1	40V	Schottky diode, 1A	SMA	Diodes, Inc.	B140
4	VEMI, GND, VLED+, VLED-	2mm	Golden pin	DIP	Custom	
4	EN, GND, DIM, FAULT	1mm	Golden pin	DIP	Custom	
1	U1	MPQ7200A	Buck-boost regulator, AEC-Q100	QFN-19 (3mmx4mm)	MPS	MPQ7200AGLE-AEC1

EVB TEST RESULTS

Performance curves and waveforms are tested on the evaluation board, V_{IN} = 13.5V, 4 LEDs in series (V_{LED} = 12V), f_{SW} = 410kHz, L = 10μH, T_A = 25°C, unless otherwise noted.

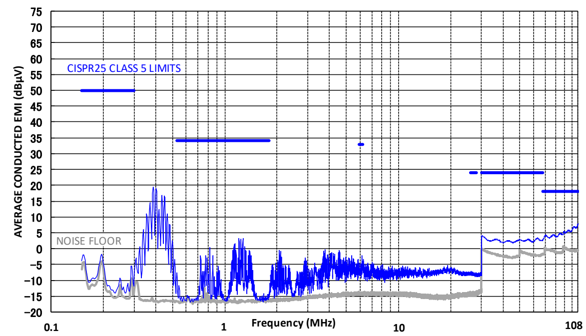
CISPR25 Class 5 Peak Conducted Emissions

150kHz to 108MHz



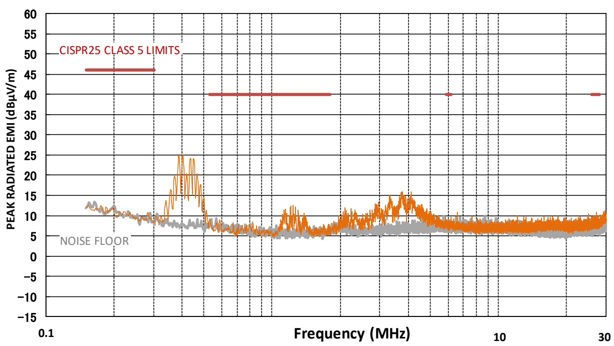
CISPR25 Class 5 Average Conducted Emissions

150kHz to 108MHz



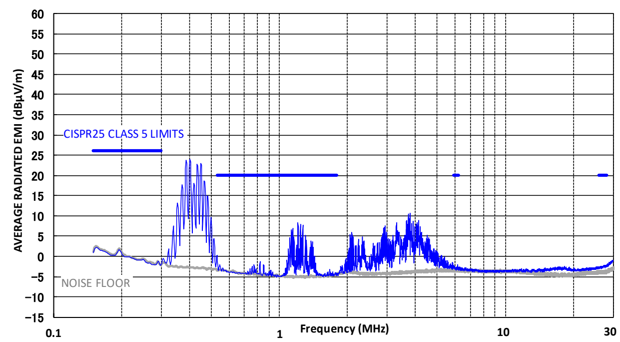
CISPR25 Class 5 Peak Radiated Emissions

150kHz to 30MHz



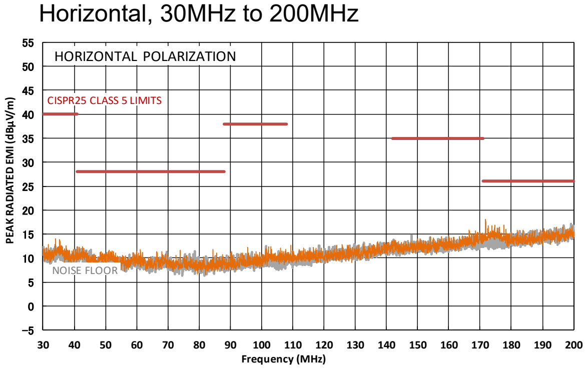
CISPR25 Class 5 Average Radiated Emissions

150kHz to 30MHz



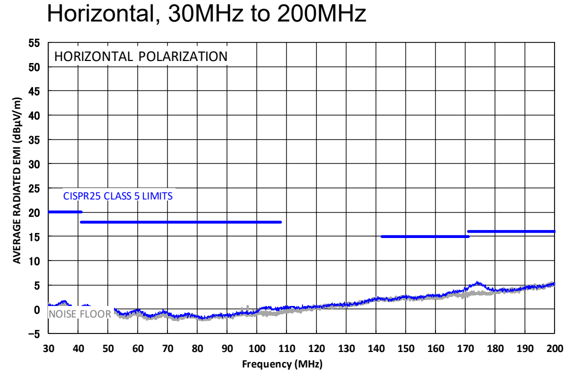
CISPR25 Class 5 Peak Radiated Emissions

Horizontal, 30MHz to 200MHz



CISPR25 Class 5 Average Radiated Emissions

Horizontal, 30MHz to 200MHz

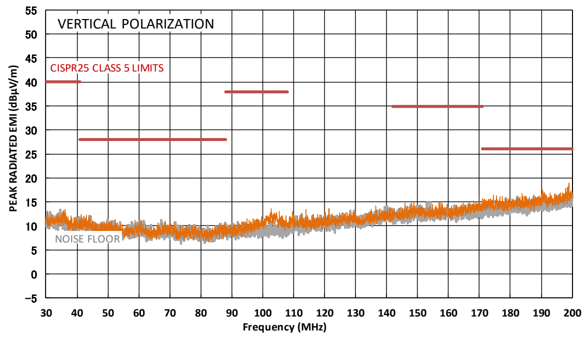


EVB TEST RESULTS *(continued)*

Performance curves and waveforms are tested on the evaluation board, V_{IN} = 13.5V, 4 LEDs in series (V_{LED} = 12V), f_{SW} = 410kHz, L = 10µH, T_A = 25°C, unless otherwise noted.

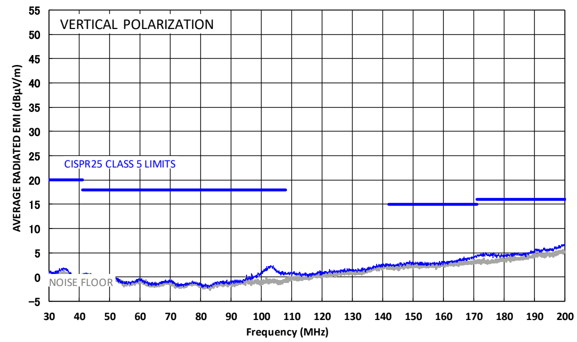
CISPR25 Class 5 Peak Radiated Emissions

Vertical, 30MHz to 200MHz



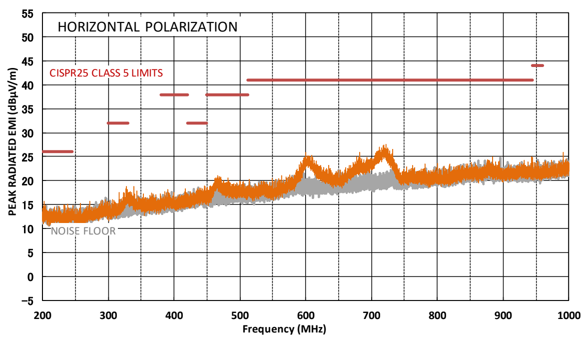
CISPR25 Class 5 Average Radiated Emissions

Vertical, 30MHz to 200MHz



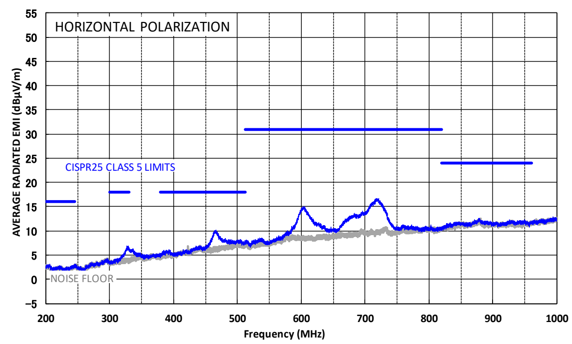
CISPR25 Class 5 Peak Radiated Emissions

Horizontal, 200MHz to 1GHz



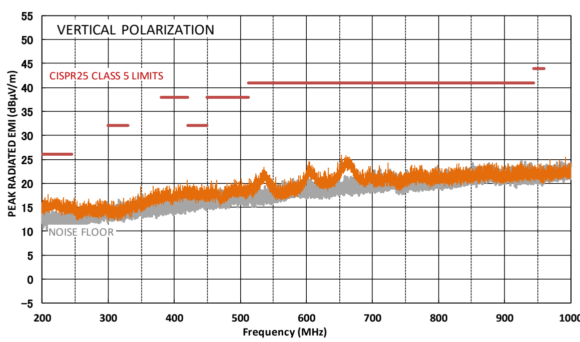
CISPR25 Class 5 Average Radiated Emissions

Horizontal, 200MHz to 1GHz



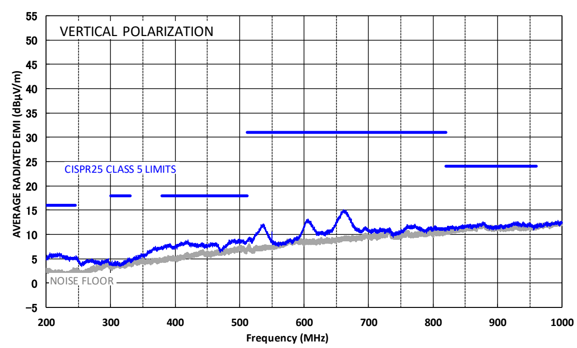
CISPR25 Class 5 Peak Radiated Emissions

Vertical, 200MHz to 1GHz



CISPR25 Class 5 Average Radiated Emissions

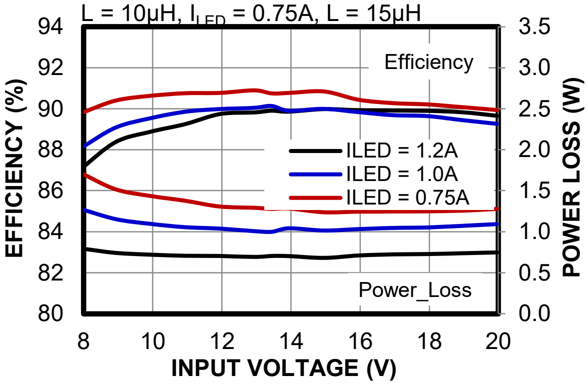
Vertical, 200MHz to 1GHz



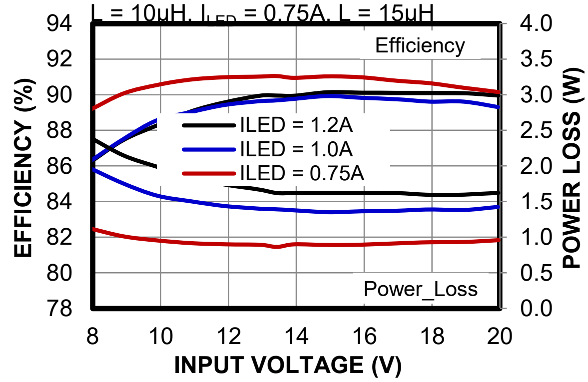
EVB TEST RESULTS *(continued)*

Performance curves and waveforms are tested on the evaluation board, V_{IN} = 13.5V, 4 LEDs in series (V_{LED} = 12V), f_{SW} = 410kHz, L = 10µH, T_A = 25°C, unless otherwise noted. (1)

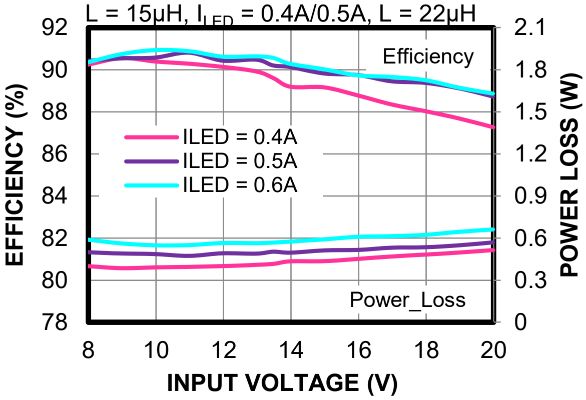
Efficiency vs. Input Voltage vs. Power Loss
3 LEDs (V_{LED} = 9V), I_{LED} = 1.2A/1A, L = 10µH, I_{LED} = 0.75A, L = 15µH



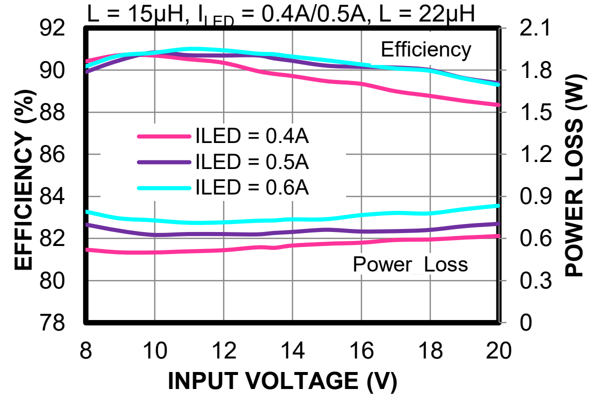
Efficiency vs. Input Voltage vs. Power Loss
4 LEDs (V_{LED} = 12V), I_{LED} = 1.2A/1A, L = 10µH, I_{LED} = 0.75A, L = 15µH



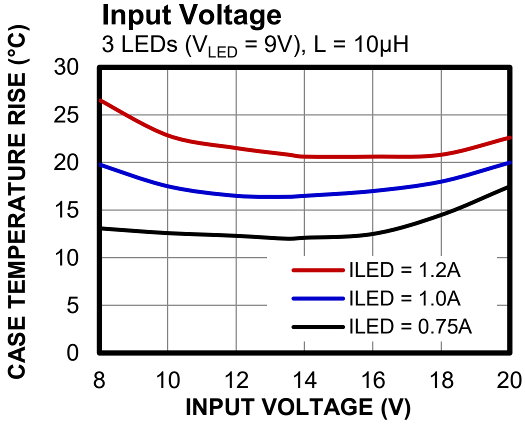
Efficiency vs. Input Voltage vs. Power Loss
3 LEDs (V_{LED} = 9V), I_{LED} = 0.6A, L = 15µH, I_{LED} = 0.4A/0.5A, L = 22µH



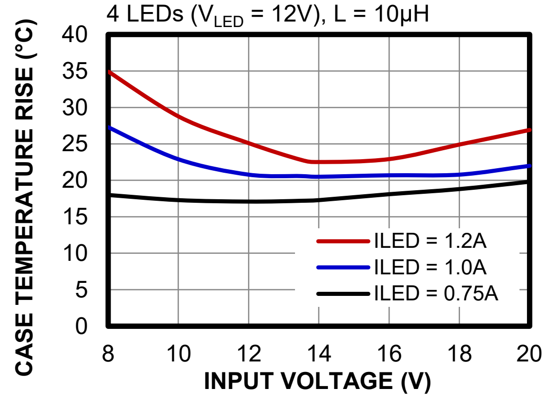
Efficiency vs. Input Voltage vs. Power Loss
4 LEDs (V_{LED} = 12V), I_{LED} = 0.6A, L = 15µH, I_{LED} = 0.4A/0.5A, L = 22µH



Case Temperature Rise vs. Input Voltage
3 LEDs (V_{LED} = 9V), L = 10µH



Case Temperature Rise vs. Input Voltage
4 LEDs (V_{LED} = 12V), L = 10µH



Note:

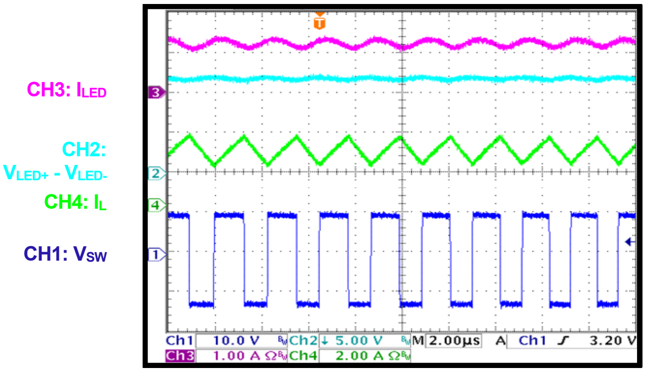
1) The inductor details about the efficiency curves follow: L = 15µH (XAL5050-153MEB), L = 22µH (XAL5050-223MEB).

EVB TEST RESULTS *(continued)*

Performance curves and waveforms are tested on the evaluation board, V_{IN} = 13.5V, 4 LEDs in series (V_{LED} = 12V), f_{SW} = 410kHz, L = 10µH, T_A = 25°C, unless otherwise noted.

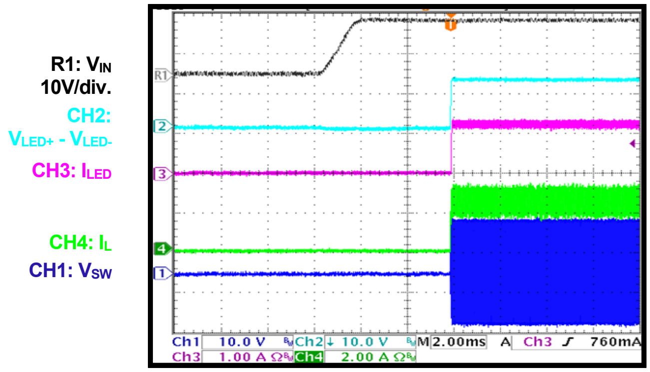
Steady State

I_{LED} = 1.2A



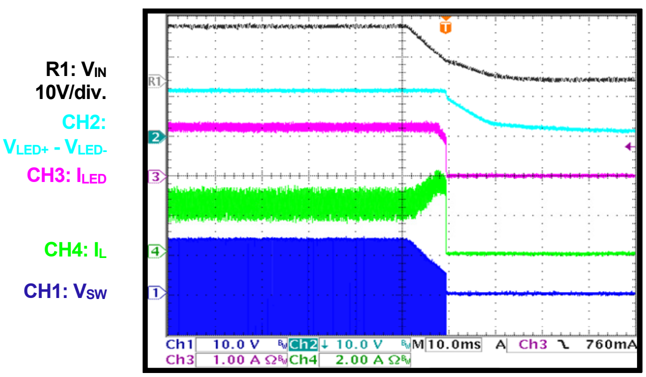
Start-Up through VIN

I_{LED} = 1.2A



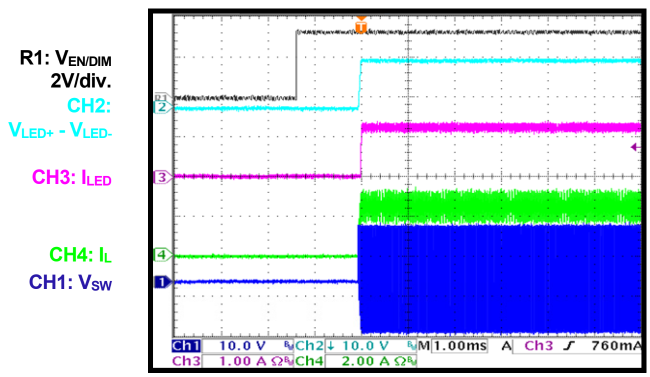
Shutdown through VIN

I_{LED} = 1.2A



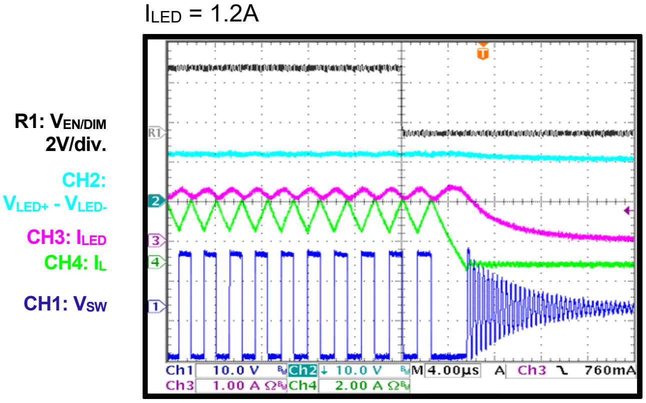
Start-Up through EN

I_{LED} = 1.2A



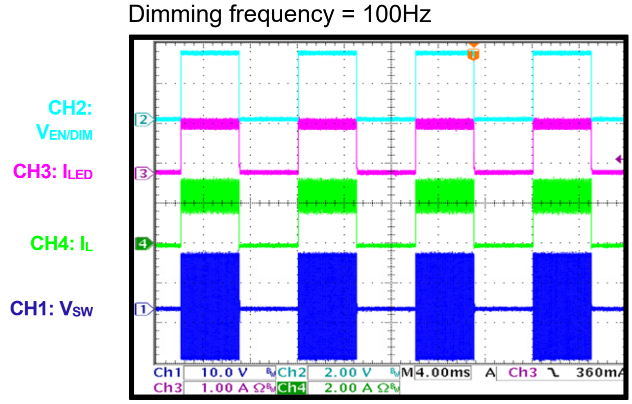
Shutdown through EN

I_{LED} = 1.2A



PWM Dimming Steady State

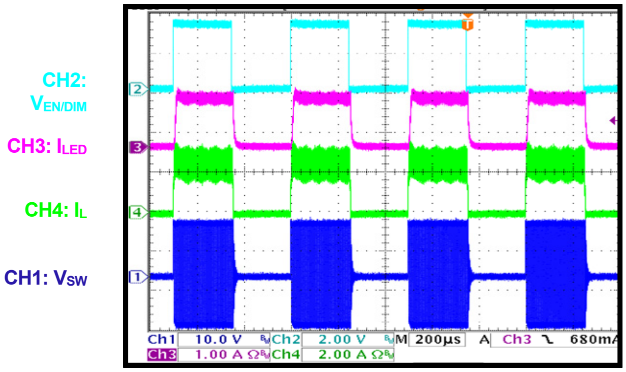
Dimming frequency = 100Hz



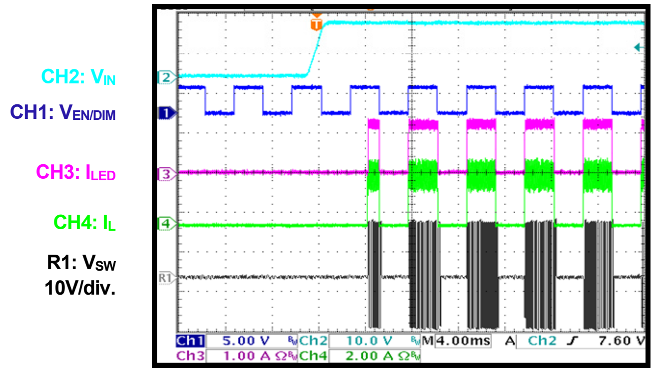
EVB TEST RESULTS *(continued)*

Performance curves and waveforms are tested on the evaluation board, V_{IN} = 13.5V, 4 LEDs in series (V_{LED} = 12V), f_{SW} = 410kHz, L = 10µH, T_A = 25°C, unless otherwise noted.

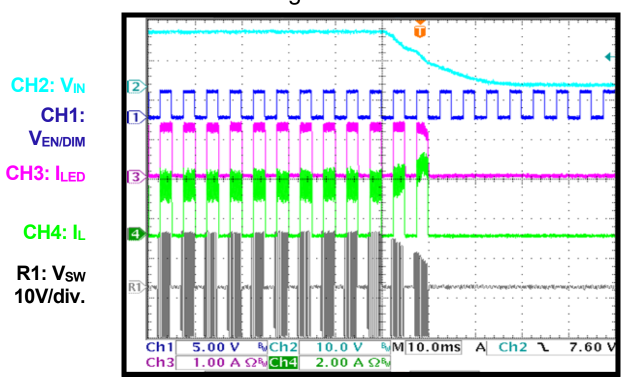
PWM Dimming Steady State
Dimming frequency = 2kHz



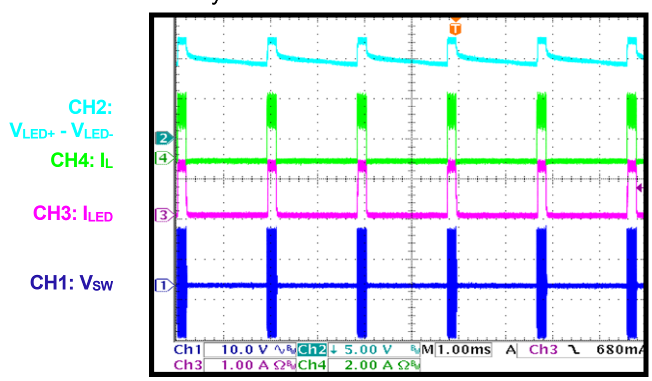
PWM Dimming
Start-up through VIN



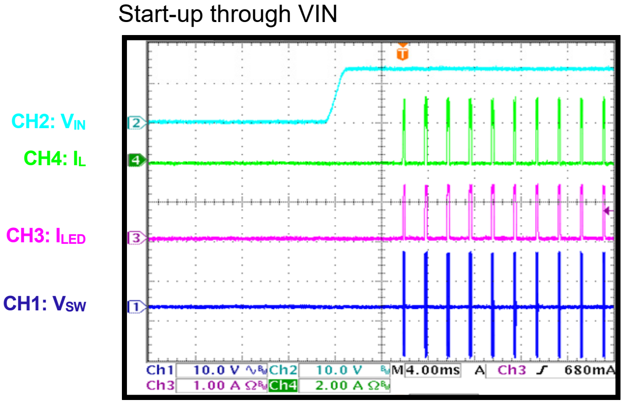
PWM Dimming
Shutdown through VIN



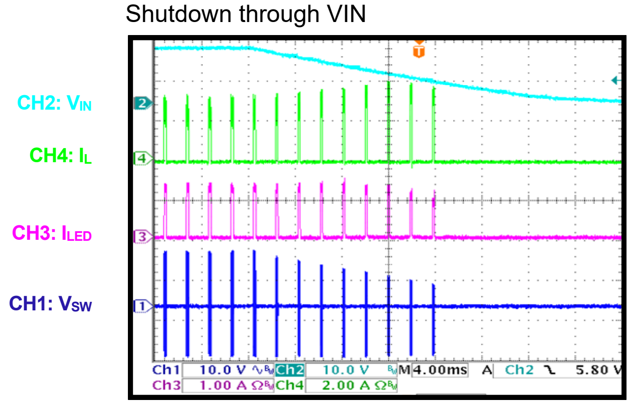
Two-Step Dimming
Steady state



Two-Step Dimming
Start-up through VIN



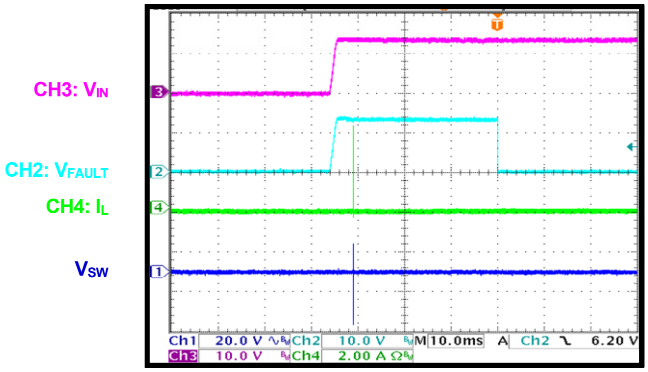
Two-Step Dimming
Shutdown through VIN



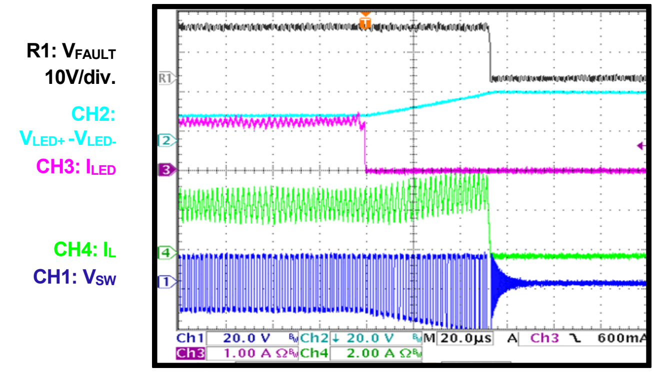
EVB TEST RESULTS *(continued)*

Performance curves and waveforms are tested on the evaluation board, V_{IN} = 13.5V, 4 LEDs in series (V_{LED} = 12V), f_{SW} = 410kHz, L = 10µH, T_A = 25°C, unless otherwise noted.

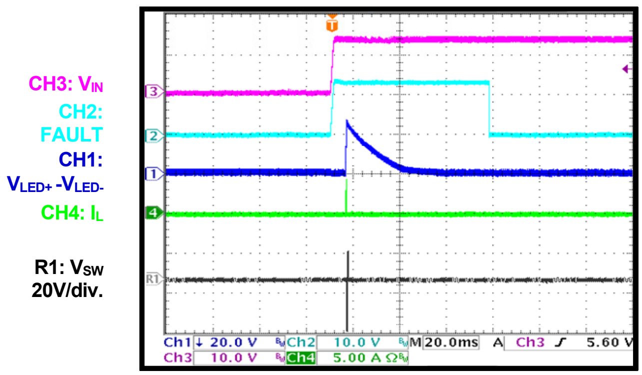
No Dimming
LED open during VIN start-up



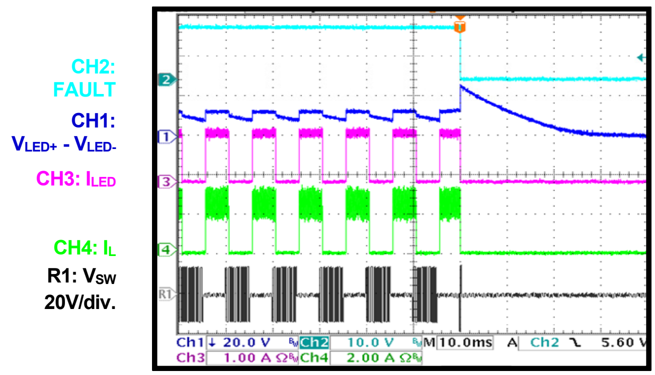
No Dimming
LED open entry



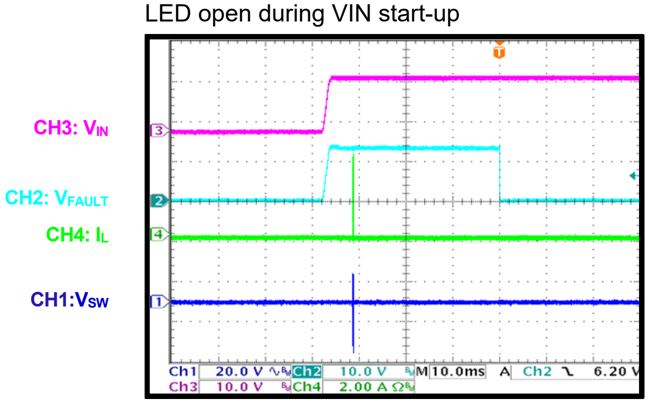
PWM Dimming
LED open during VIN start-up



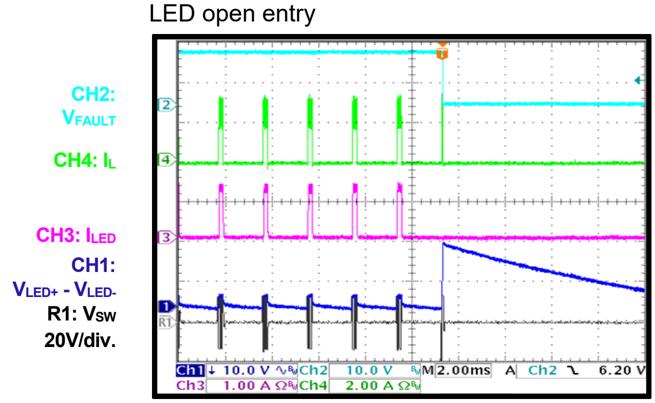
PWM Dimming
LED open entry



Two-Step Dimming
LED open during VIN start-up



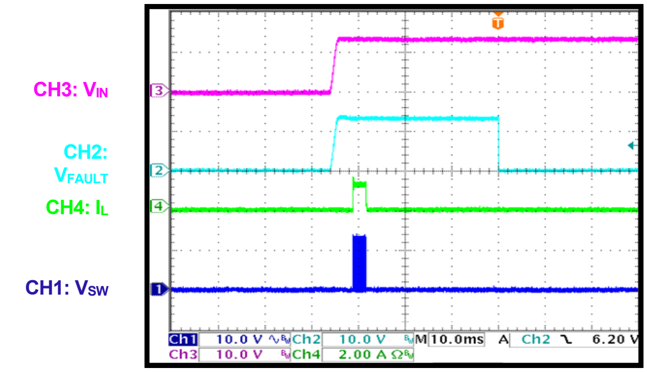
Two-Step Dimming
LED open entry



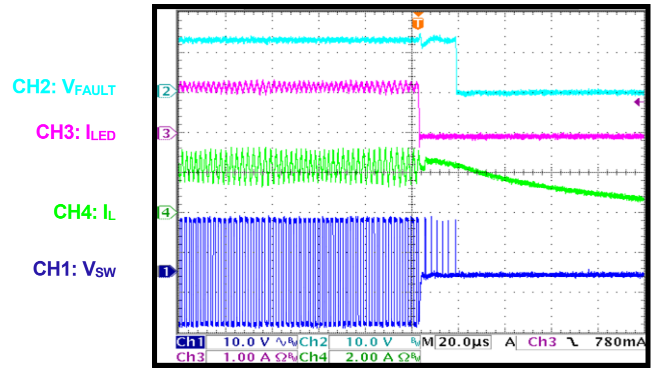
EVB TEST RESULTS *(continued)*

Performance curves and waveforms are tested on the evaluation board, V_{IN} = 13.5V, 4 LEDs in series (V_{LED} = 12V), f_{SW} = 410kHz, L = 10μH, T_A = 25°C, unless otherwise noted.

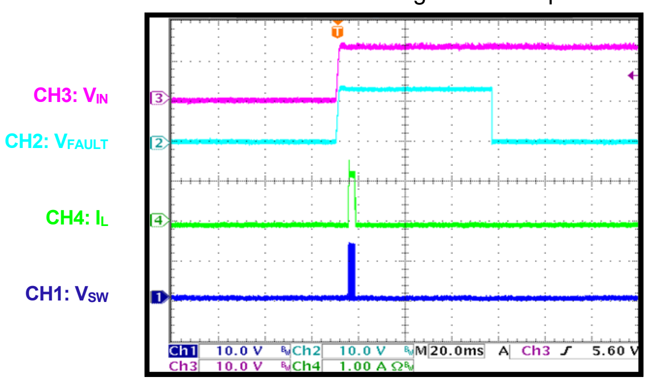
No Dimming
LED+ short to LED- during VIN start-up



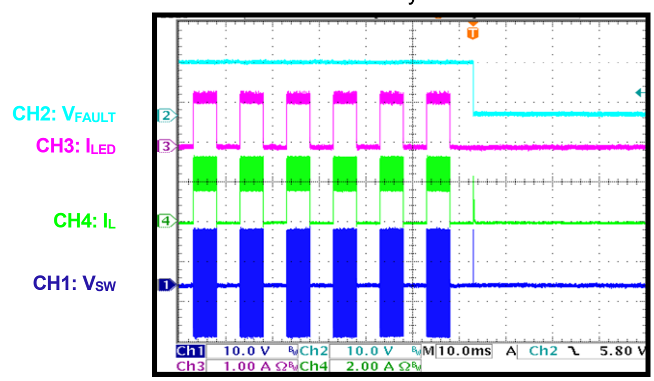
No Dimming
LED+ short to LED- entry



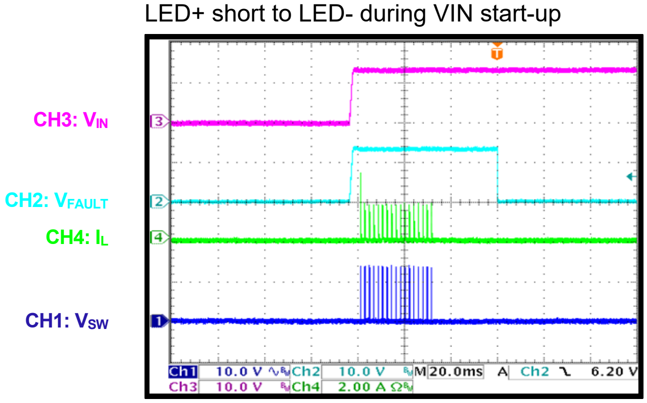
PWM Dimming
LED+ short to LED- during VIN start-up



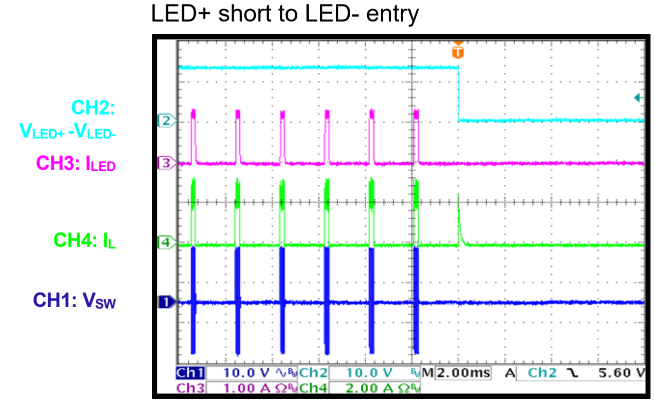
PWM Dimming
LED+ short to LED- entry



Two-Step Dimming
LED+ short to LED- during VIN start-up



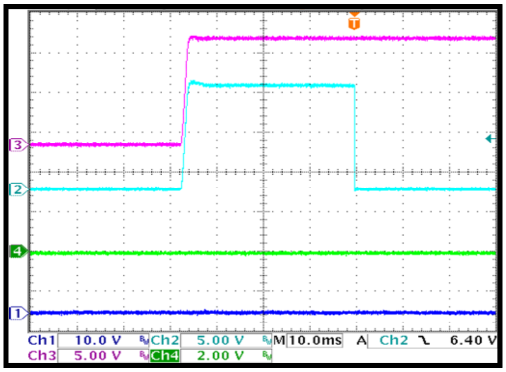
Two-Step Dimming
LED+ short to LED- entry



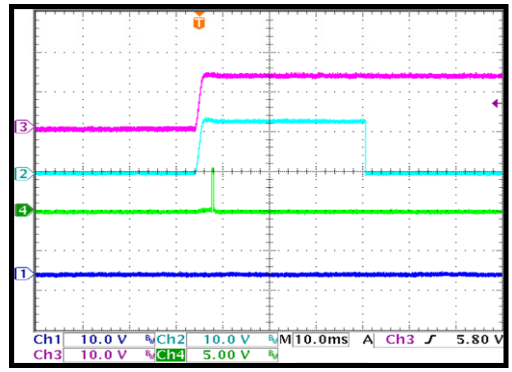
EVB TEST RESULTS *(continued)*

Performance curves and waveforms are tested on the evaluation board, V_{IN} = 13.5V, 4 LEDs in series (V_{LED} = 12V), f_{SW} = 410kHz, L = 10µH, T_A = 25°C, unless otherwise noted.

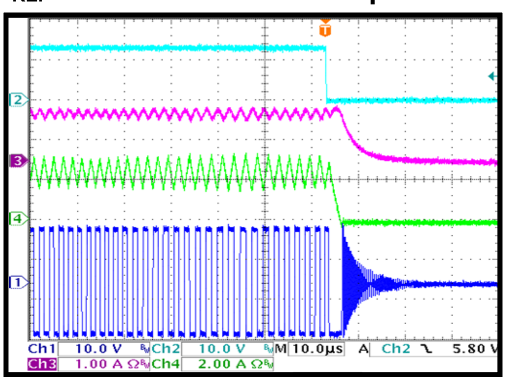
I_{REF} Short before VIN Start-Up



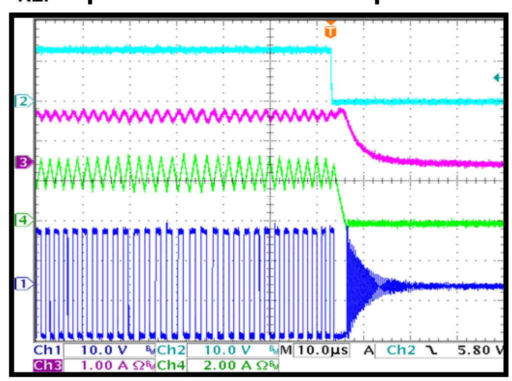
I_{REF} Open before VIN Start-Up



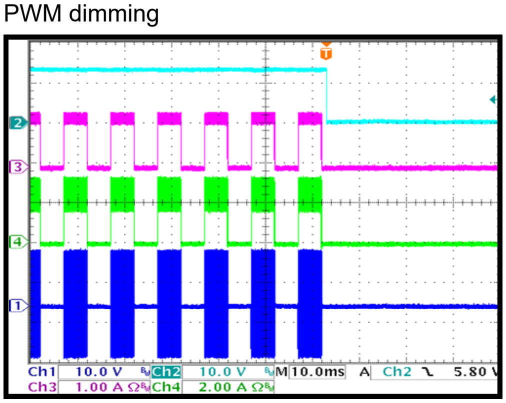
I_{REF} Short after VIN Start-Up



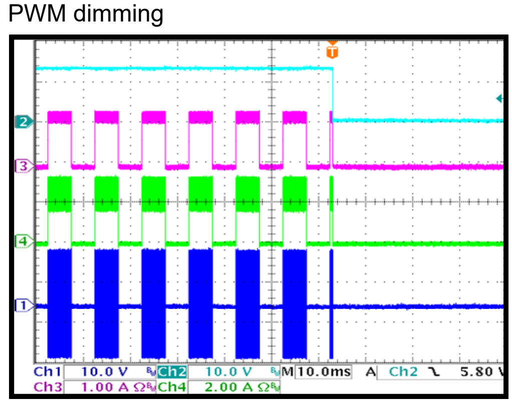
I_{REF} Open after VIN Start-Up



I_{REF} Short after VIN Start-Up
PWM dimming



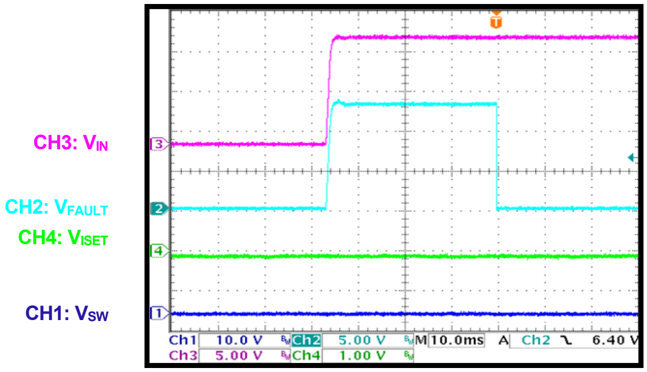
I_{REF} Open after VIN Start-Up
PWM dimming



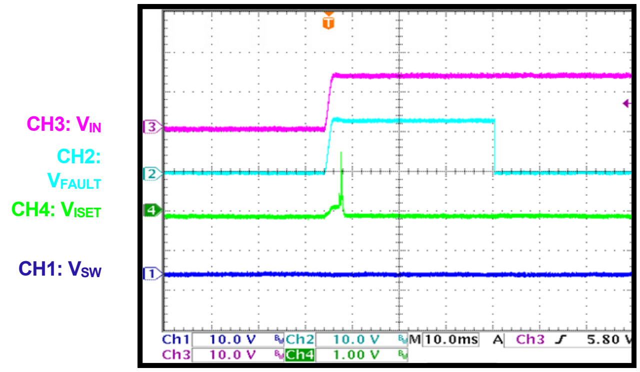
EVB TEST RESULTS *(continued)*

Performance curves and waveforms are tested on the evaluation board, V_{IN} = 13.5V, 4 LEDs in series (V_{LED} = 12V), f_{SW} = 410kHz, L = 10µH, T_A = 25°C, unless otherwise noted.

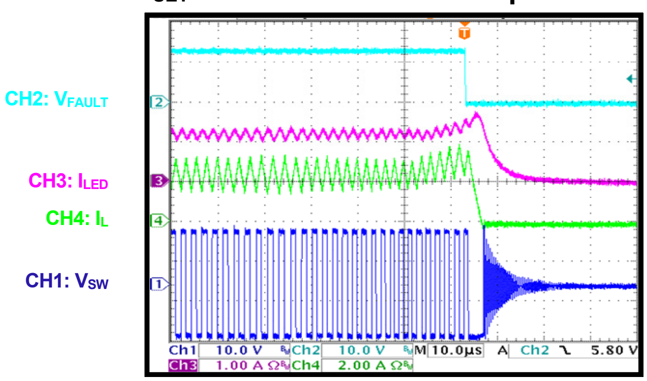
I_{SET} Short before VIN Start-Up



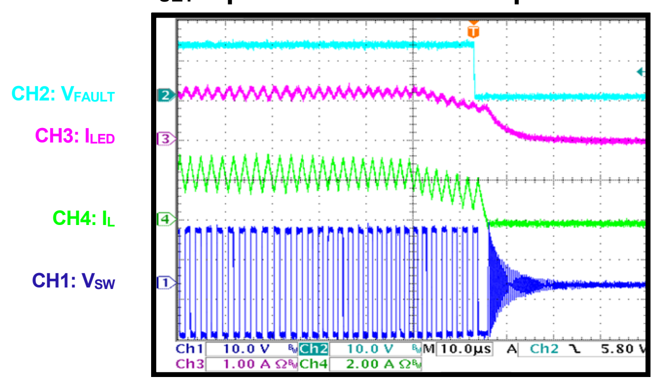
I_{SET} Open before VIN Start-Up



I_{SET} Short after VIN Start-Up

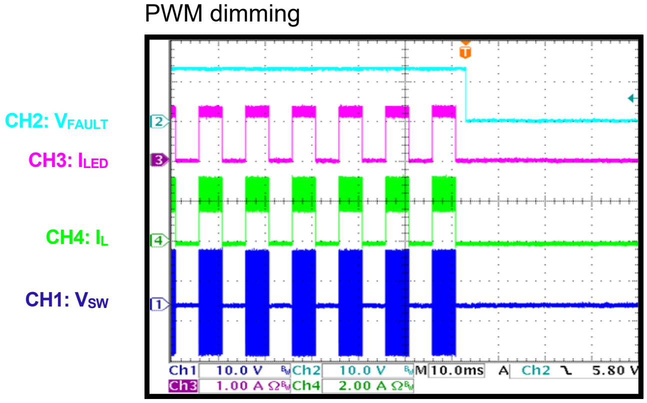


I_{SET} Open after VIN Start-Up



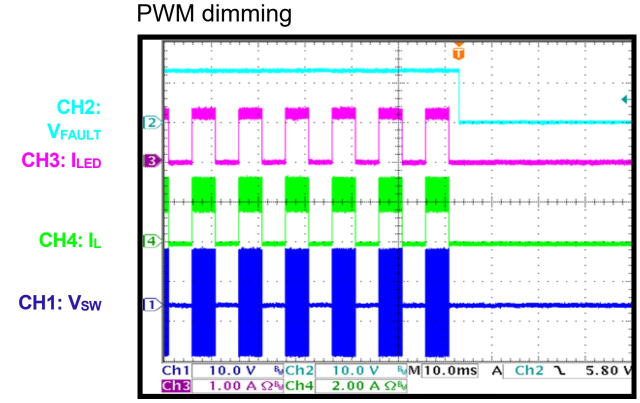
I_{SET} Short after VIN Start-Up

PWM dimming



I_{SET} Open after VIN Start-Up

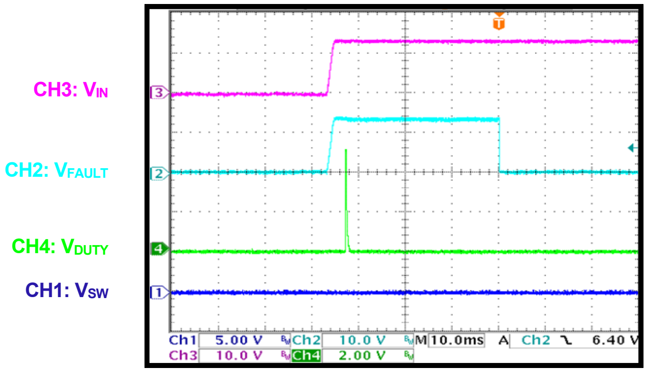
PWM dimming



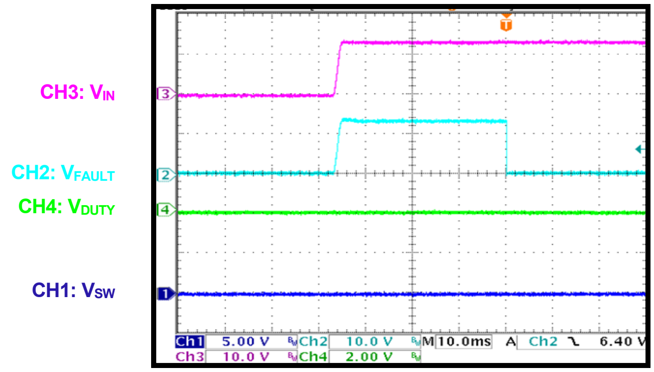
EVB TEST RESULTS *(continued)*

Performance curves and waveforms are tested on the evaluation board, V_{IN} = 13.5V, 4 LEDs in series (V_{LED} = 12V), f_{SW} = 410kHz, L = 10µH, T_A = 25°C, unless otherwise noted.

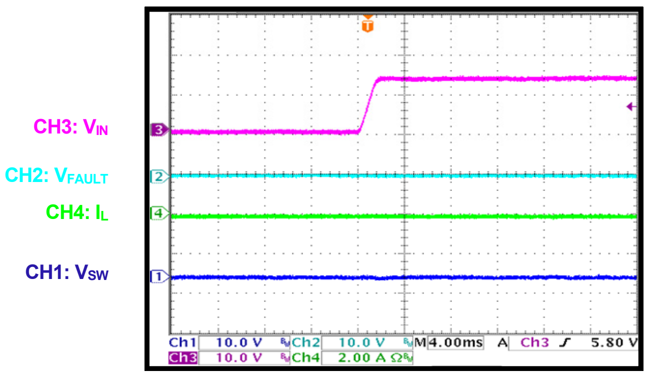
I_{DUTY} Short before VIN Start-Up



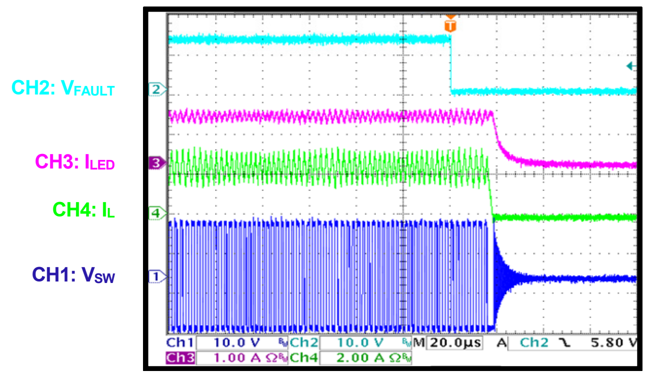
I_{DUTY} Open before VIN Start-Up



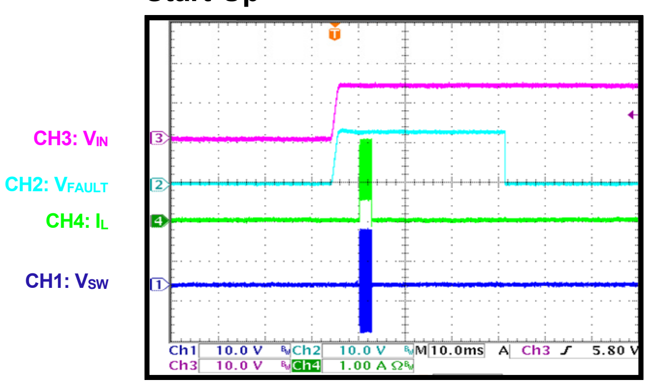
FAULT Short during VIN Start-Up



FAULT Short after VIN Start-Up



False Mode Detection during VIN Start-Up



PCB LAYOUT

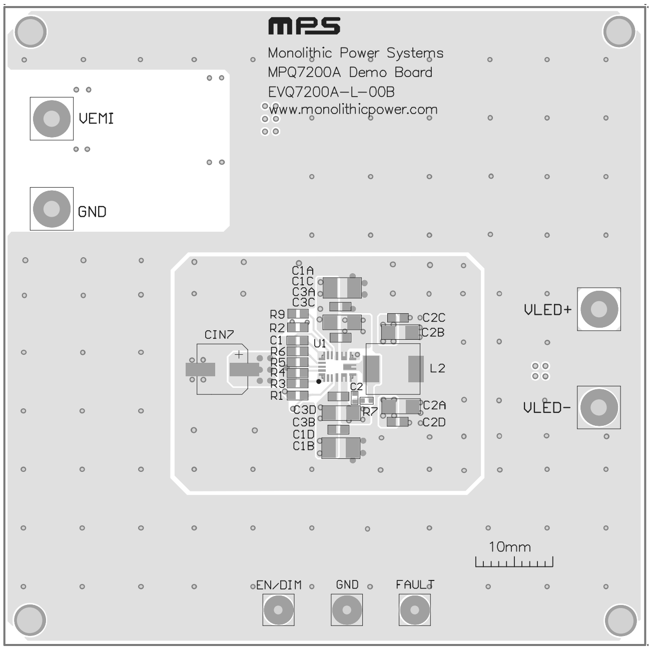


Figure 4: Top Silk and Top Layer

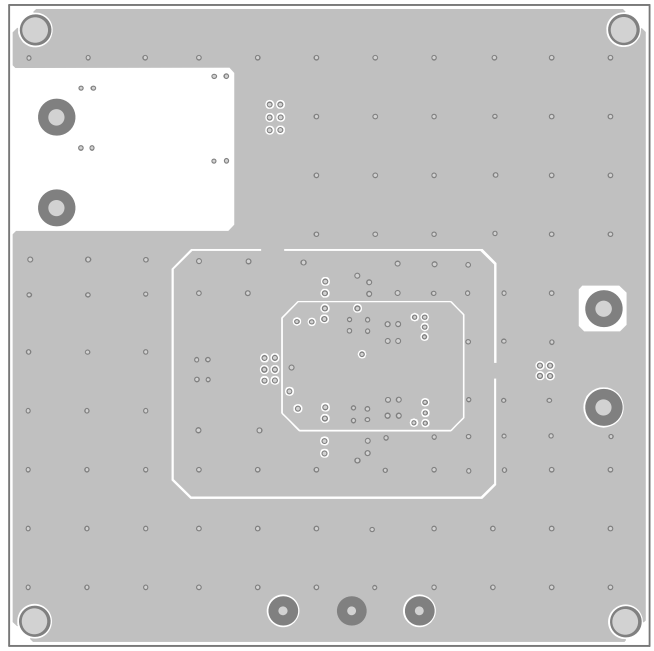


Figure 5: Mid-Layer 1

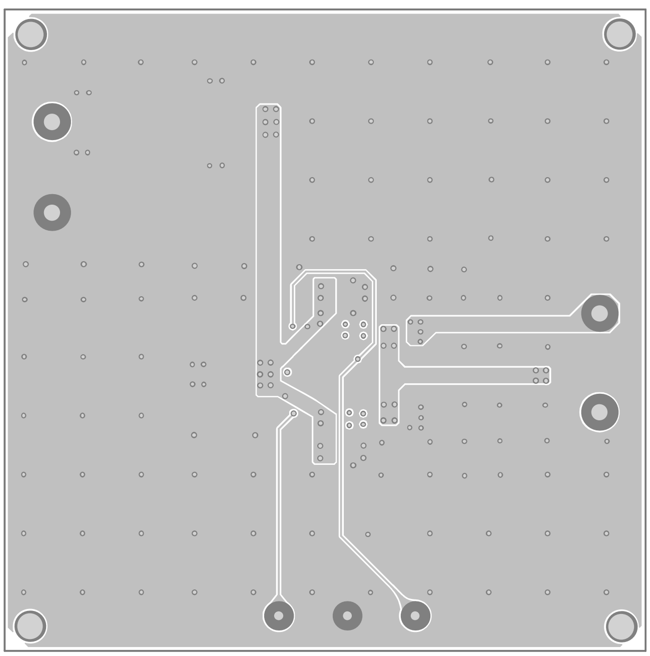


Figure 6: Mid-Layer 2

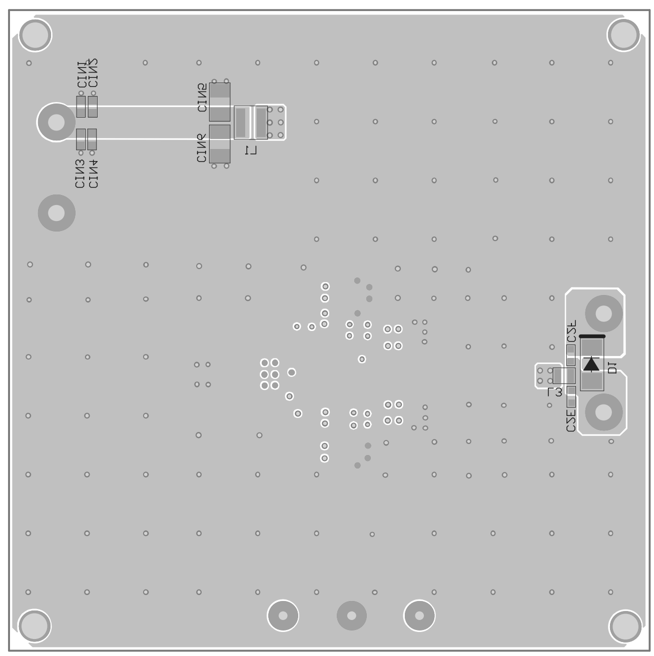


Figure 7: Bottom Layer and Bottom Silk