EVQ7200-L-00A

42V, 3A Synchronous, Buck Mode LED Driver Evaluation Board

DESCRIPTION

The EVQ7200-L-00A is an evaluation board for the MPQ7200-AEC1, a high-frequency, constant-current LED driver with integrated power MOSFETs. It offers a compact solution to achieve 3A of continuous output current, with excellent load and line regulation over a wide input supply range.

Constant frequency hysteretic control mode provides fast transient response without loop compensation. In buck mode, the MPQ7200-AEC1's switching frequency (up to 2.3MHz) reduces ripple current and electromagnetic interference (EMI).

The MPQ7200-AEC1 is available in a QFN-19 (3mmx4mm) wettable flank package and is AEC-Q100 Grade 1 qualified.

The EVQ7200-L-00A is a fully assembled and tested buck mode LED driver evaluation board. It generates an LED current up to 3A from a 6V to 42V input range.

ELECTRICAL SPECIFICATIONS

Parameter	Symbol	Value	Units
Input voltage	V_{EMI}	6 to 42	V
Output current	I_{OUT}	3	A

FEATURES

- Wide 6V to 42V Operating Input Range
- Configurable 3A Maximum Continuous Output Current in Buck Mode
- 44mΩ/40mΩ Internal Power MOSFETs
- Default 2.3MHz Switching Frequency for Buck Mode with Spread Spectrum
- 100Hz to 2kHz Dimming Frequency for Pulse-Width Modulation (PWM) Dimming
- 500Hz Internal 2-Step Dimming with Programmable Duty Cycle
- Fault Indication for LED Short, LED Open, Output Over-Voltage, and Thermal Shutdown
- Over-Current Protection (OCP) with Latch-Off
- Programmable Thermal Derating via Negative Temperature Coefficient (NTC) Remote Temperature Sensing
- EMI Reduction Technique
- Available in a QFN-19 (3mmx4mm) Wettable Flank Package
- Available in AEC-Q100 Grade 1

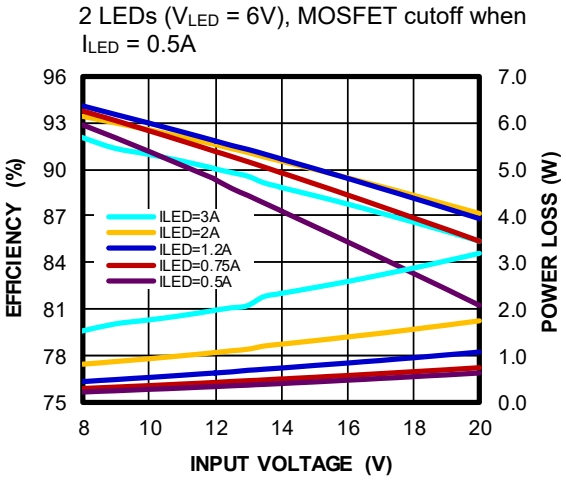
APPLICATIONS

- Automotive LED Lighting

EVQ7200-L-00A EVALUATION BOARD

LxWxH (9cmx9cmx1.3cm)

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



Efficiency vs input voltage

QUICK START GUIDE

1. Preset the power supply between 6V and 42V, then turn off the power supply.
2. If longer cables (>0.5m total) are being used between the source and the evaluation board, install a damping capacitor at the input terminals. This is critical when V_{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 on the regulator on; drive EN below 1V to turn it off.
7. When 2-step dimming is off (R_{DUTY} = 4.87kΩ), an external 100Hz to 2kHz pulse-width modulation (PWM) waveform can be applied to the EN/DIM pin.
8. Use the EN/DIM pin to start the 2-step dimming function. When EN/DIM is high, the dimming duty cycle is 100%. When EN/DIM is low, the dimming duty cycle percentage varies (see Table 1).

   Table 1 shows the proposed resistor (R3) in E96 series for different dimming duty cycles.

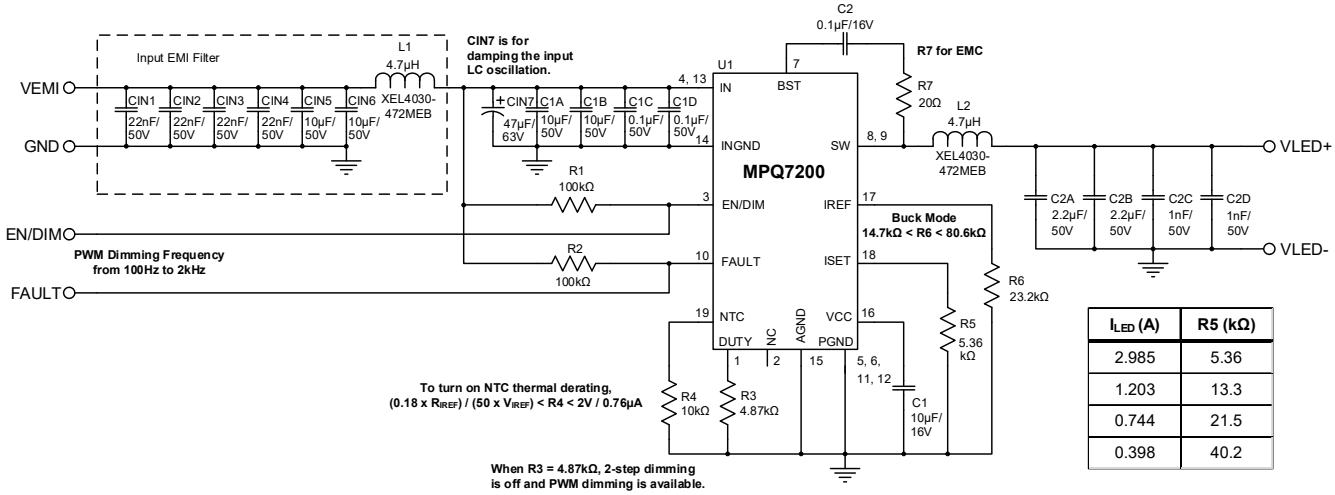
Table 1: 2-Step Dimming Duty vs. R3

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

9. Set the LED current with the external resistor connected to the ISET pin. The value of the external resistor can be calculated with Equation (1):

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

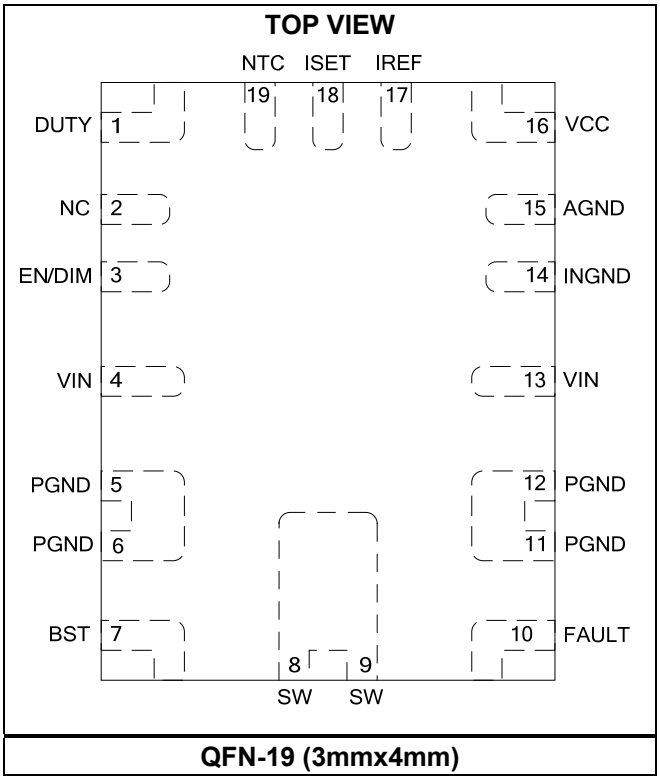
EVALUATION BOARD SCHEMATIC



I_{LED} (A)	R5 (kΩ)
2.985	5.36
1.203	13.3
0.744	21.5
0.398	40.2

Figure 1: Evaluation Board Schematic

PACKAGE REFERENCE



QFN-19 (3mmx4mm)

EVQ7200-L-00A BILL OF MATERIALS

Qty	Ref	Value	Description	Package	Manufacturer	Manufacturer PN
4	C1A, C1B, CIN5, CIN6	10µF	Ceramic capacitor, 50V, X7R	1210	Murata	GRM32ER71H106KA8
2	C1C, C1D	0.1µF	Ceramic capacitor, 50V, X7R	0603	Murata	GRM188R71H104KA93D
2	C2A, C2B	2.2µF	Ceramic capacitor, 50V, X7R	1210	TDK	C3225X7R1H225K
2	C2C, C2D	1nF	Ceramic capacitor, 50V, C0G	0603	Murata	GRM1885C1H02JAC
1	C1	10µF	Ceramic capacitor, 16V, X5R	0603	Murata	GRM188R61C106KAA
1	C2	0.1µF	Ceramic capacitor, 16V, X7R	0603	Murata	GRM188R71C104KA01D
1	CIN7	47µF	Electrolytic capacitor, 63V	SMD	Panasonic	EEHZC1J470P
4	CIN1, CIN2, CIN3, CIN4	22nF	Ceramic capacitor, 50V, X7R	0603	TDK	C1608X7R1H223K
1	L1, L2	4.7µH	Inductor, 44.1mΩ DCR, 5.1A	SMD	Coilcraft	XEL4030-472MEB
2	R1, R2	100kΩ	Film resistor, 5%	0603	Yageo	RC0603JR-07100KL
1	R3	4.87kΩ	Film resistor, 1%	0603	Yageo	RC0603FR-074K87L
2	R4	10kΩ	Film resistor, 1%	0603	Yageo	RC0603FR-0710KL
1	R5	5.36kΩ	Film resistor, 1%	0603	Yageo	RC0603FR-075K36L
1	R6	23.2kΩ	Film resistor, 1%	0603	Yageo	RC0603FR-0723K2L
1	R7	20Ω	Film resistor, 1%	0603	Yageo	RC0603FR-0720RL
1	U1		Step-up/down LED driver	QFN-19 (3mmx4mm)	MPS	MPQ7200GLE-AEC1
5	VEMI, GND, VLED+, VLED-		2 golden pin		Custom (1)	
3	EN/DIM, GND, FAULT		1 golden pin		Custom (1)	

Note:

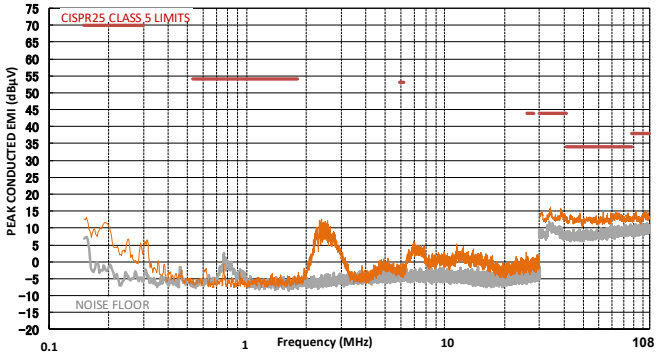
1) MPS custom-produces these pins. Visit the Contact page on our website for more information.

EVB TEST RESULTS

Performance curves and waveforms are tested on the evaluation board. V_{IN} = 13.5V, V_{LED} = 6V, L = 4.7µH, f_{SW} = 2.3MHz, T_A = 25°C, in buck mode, unless otherwise noted.

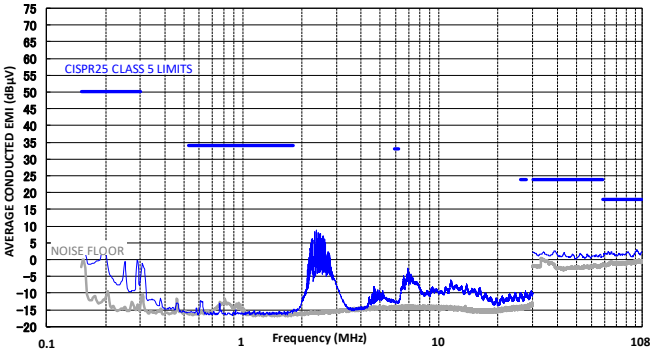
CISPR25 Class 5 Peak Conducted Emissions

150kHz to 108MHz



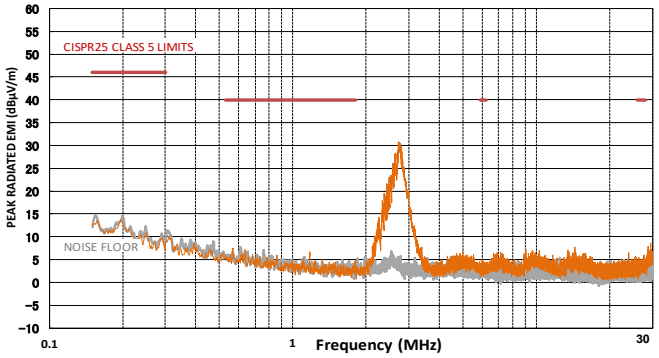
CISPR25 Class 5 Average Conducted Emissions

150kHz to 108MHz



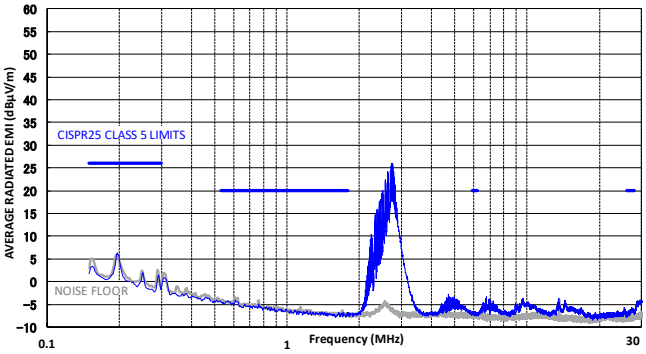
CISPR25 Class 5 Peak Radiated Emissions

150kHz to 30MHz



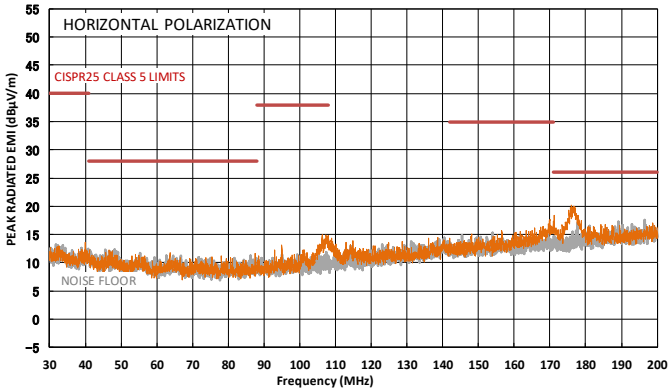
CISPR25 Class 5 Average Radiated Emissions

150kHz to 30MHz



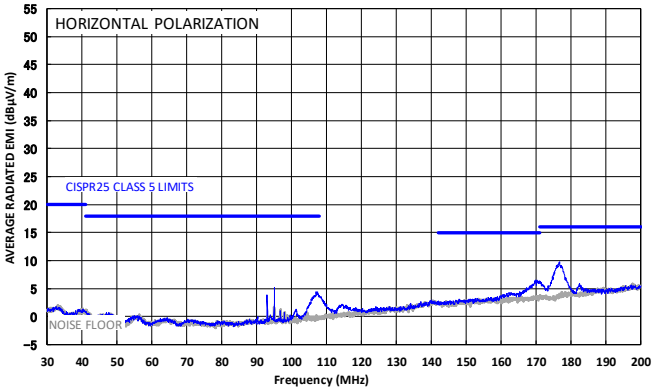
CISPR25 Class 5 Peak Radiated Emissions

Horizontal, 30MHz to 200MHz



CISPR25 Class 5 Average Radiated Emissions

Horizontal, 30MHz to 200MHz

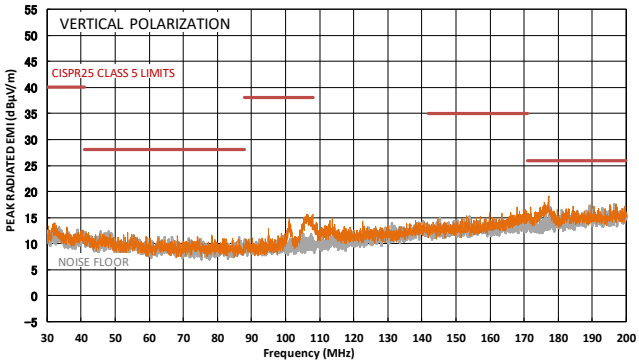


EVB TEST RESULTS *(continued)*

Performance curves and waveforms are tested on the evaluation board. V_{IN} = 13.5V, V_{LED} = 6V, L = 4.7µH, f_{SW} = 2.3MHz, T_A = 25°C, in buck mode, unless otherwise noted.

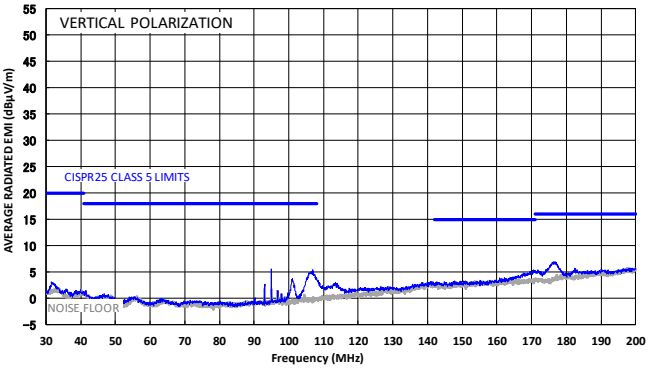
CISPR25 Class 5 Peak Radiated Emissions

Vertical, 30MHz to 200MHz



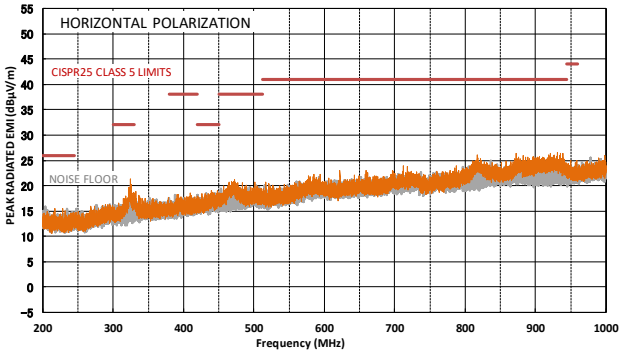
CISPR25 Class 5 Average Radiated Emissions

Vertical, 30MHz to 200MHz



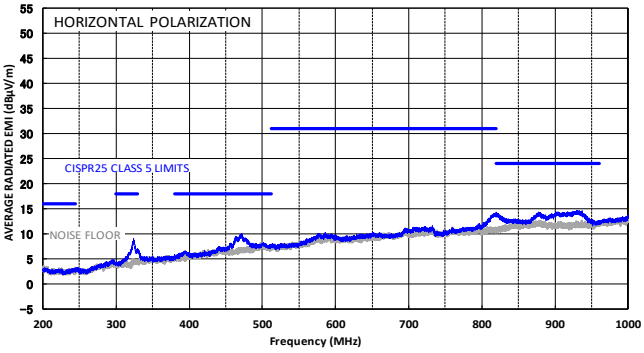
CISPR25 Class 5 Peak Radiated Emissions

Horizontal, 200MHz to 1GHz



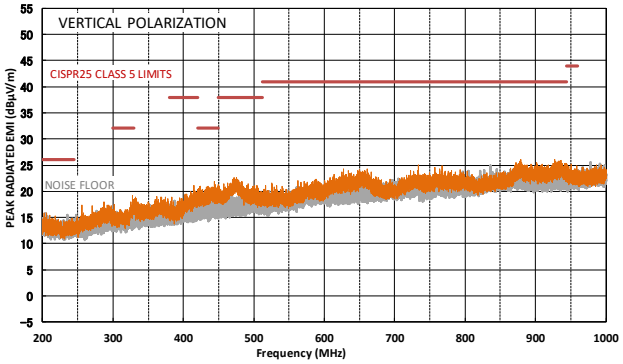
CISPR25 Class 5 Average Radiated Emissions

Horizontal, 200MHz to 1GHz



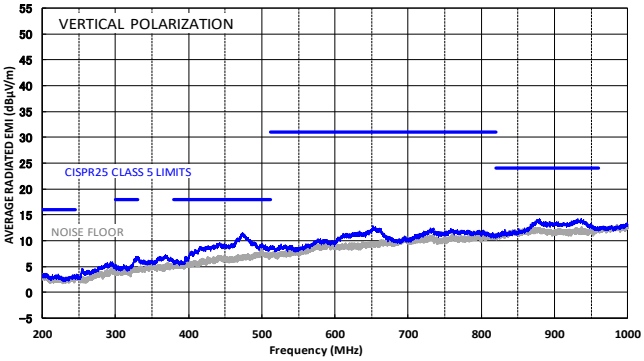
CISPR25 Class 5 Peak Radiated Emissions

Vertical, 200MHz to 1GHz



CISPR25 Class 5 Average Radiated Emissions

Vertical, 200MHz to 1GHz

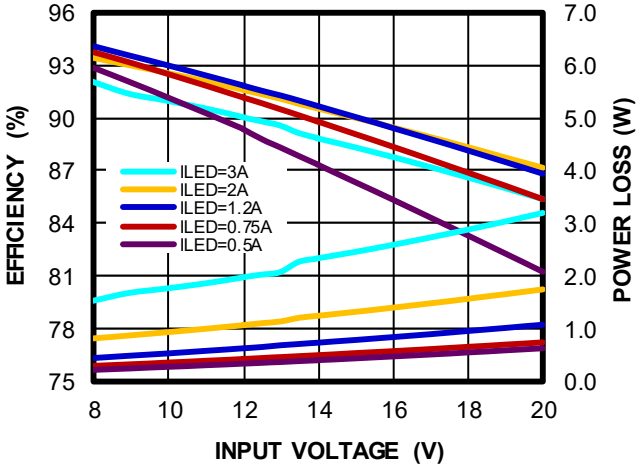


EVB TEST RESULTS *(continued)*

Performance curves and waveforms are tested on the evaluation board. V_{IN} = 13.5V, V_{LED} = 6V, L = 4.7µH, f_{SW} = 2.3MHz, T_A = 25°C, in buck mode, unless otherwise noted.

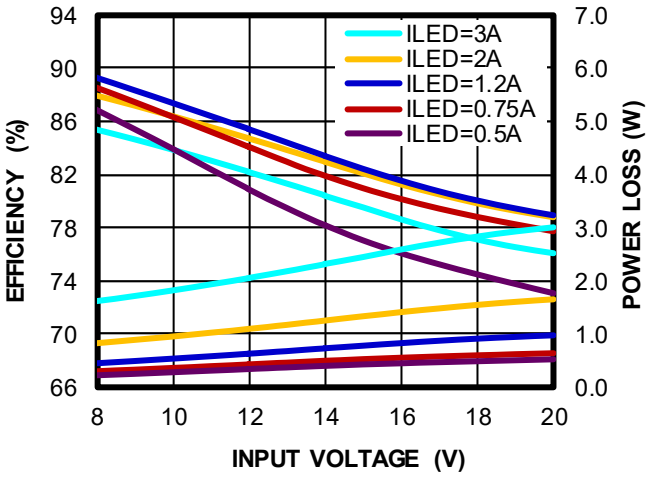
Efficiency vs. Input Voltage

2 LEDs (V_{LED} = 6V), MOSFET cutoff when I_{LED} = 0.5A



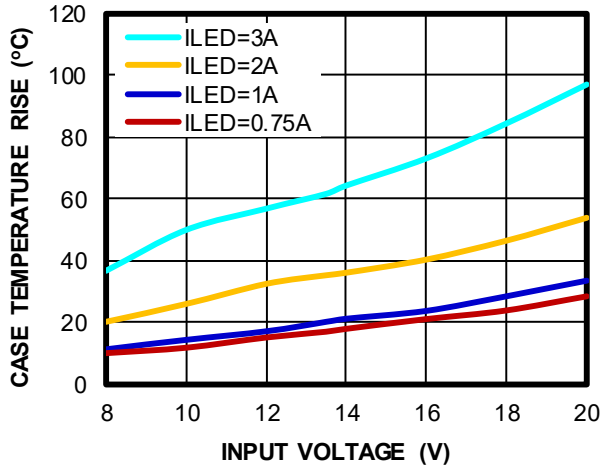
Efficiency vs. Input Voltage

1 LED (V_{LED} = 3V), MOSFET cutoff when I_{LED} = 0.5A



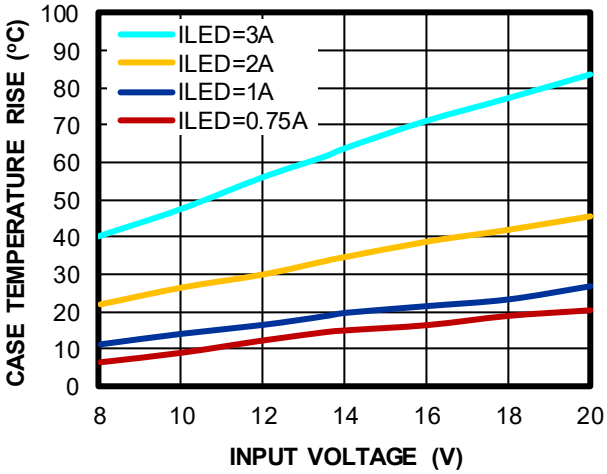
Case Temperature Rise vs. Input Voltage

2 LEDs (V_{LED} = 6V)



Case Temperature Rise vs. Input Voltage

1 LED (V_{LED} = 3V)

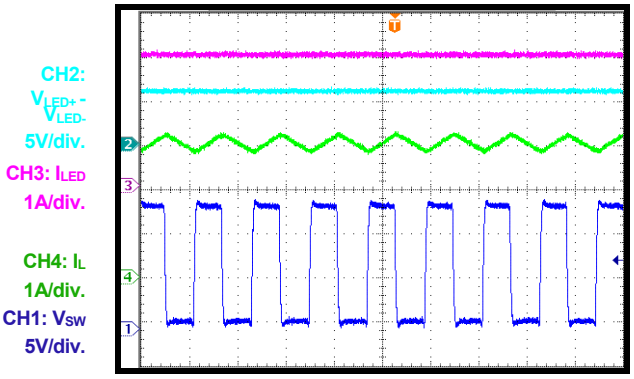


EVB TEST RESULTS *(continued)*

Performance curves and waveforms are tested on the evaluation board. V_{IN} = 13.5V, V_{LED} = 6V, L = 4.7µH, f_{SW} = 2.3MHz, T_A = 25°C, in buck mode, unless otherwise noted.

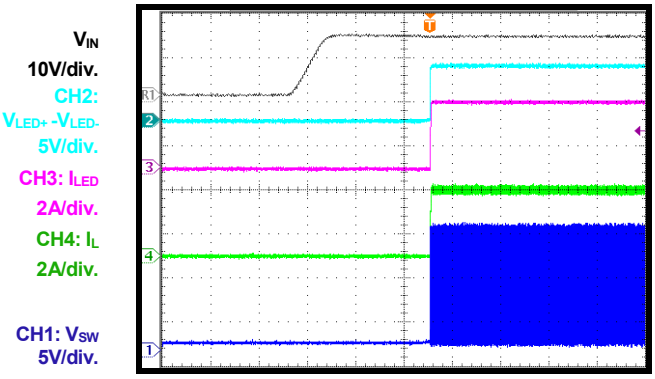
Steady State

I_{LED} = 3A



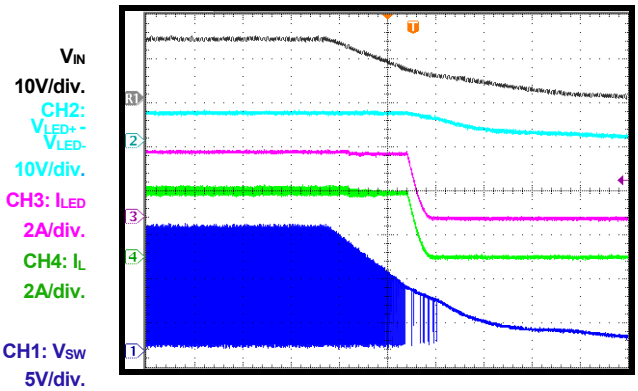
Start-Up through VIN

I_{LED} = 3A



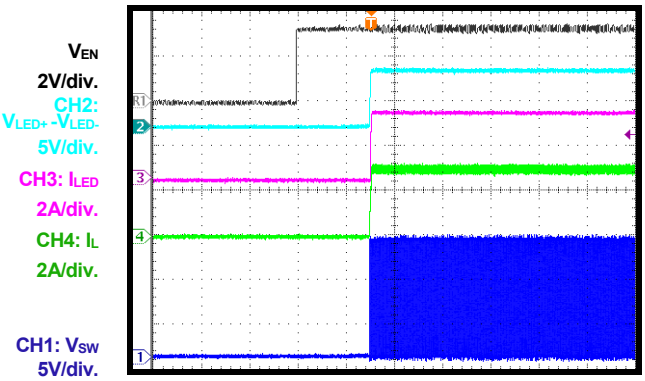
Shutdown through VIN

I_{LED} = 3A



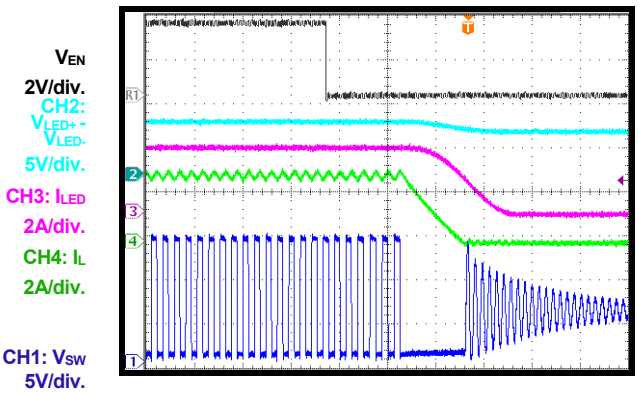
Start-Up through EN

I_{LED} = 3A



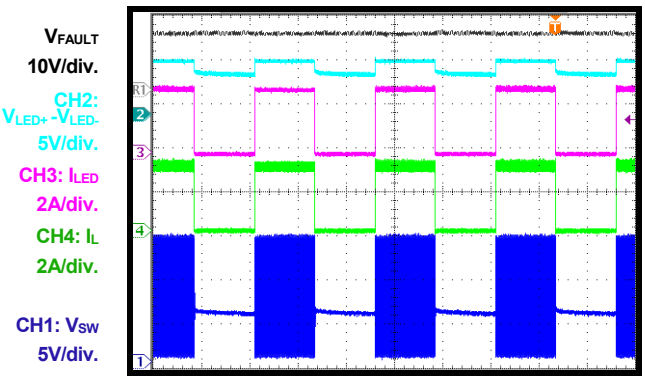
Shutdown through EN

I_{LED} = 3A



PWM Dimming Steady State

Dimming frequency = 100Hz

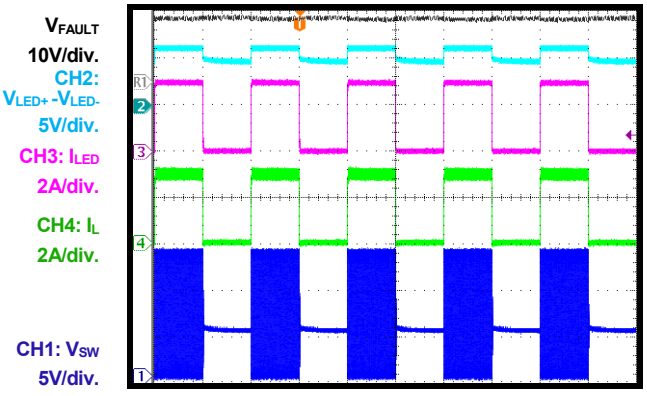


EVB TEST RESULTS *(continued)*

Performance curves and waveforms are tested on the evaluation board. V_{IN} = 13.5V, V_{LED} = 6V, L = 4.7µH, f_{SW} = 2.3MHz, T_A = 25°C, in buck mode, unless otherwise noted.

PWM Dimming Steady State

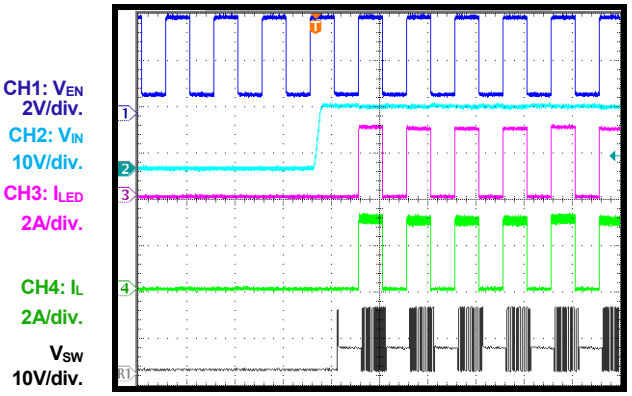
Dimming frequency = 500Hz



1ms/div.

PWM Dimming

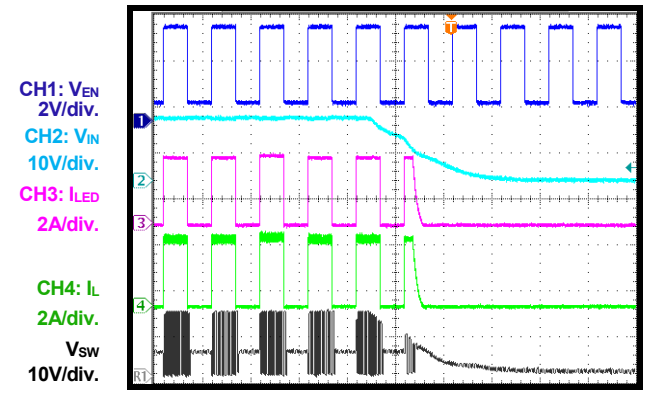
Start-up through VIN



10ms/div.

PWM Dimming

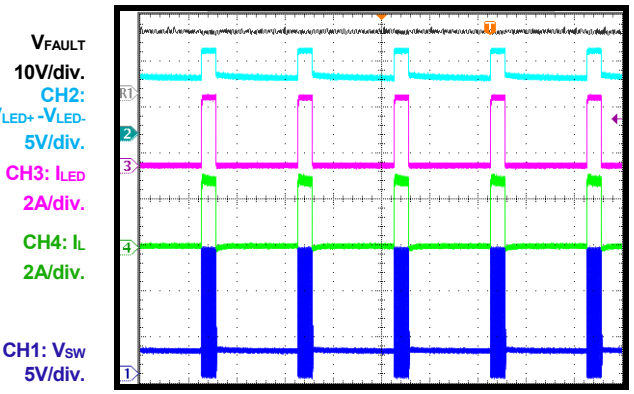
Shutdown through VIN



10ms/div.

2-Step Dimming

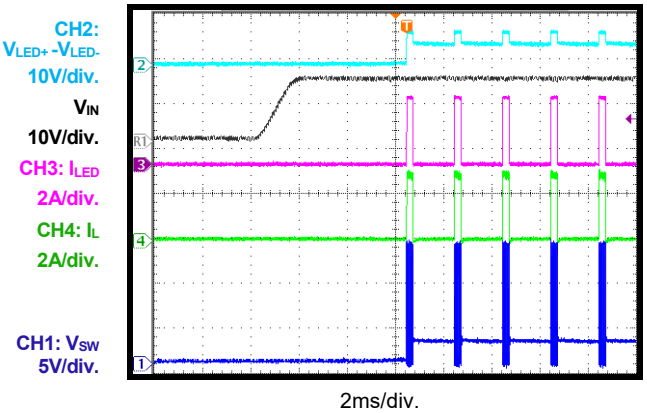
Steady state



1ms/div.

2-Step Dimming

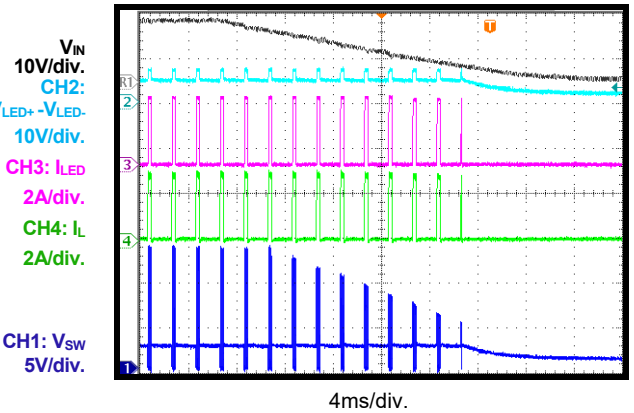
Start-up through VIN



2ms/div.

2-Step Dimming

Shutdown through VIN

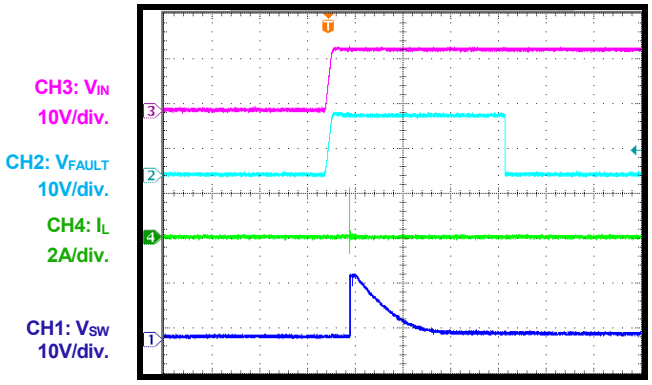


4ms/div.

EVB TEST RESULTS *(continued)*

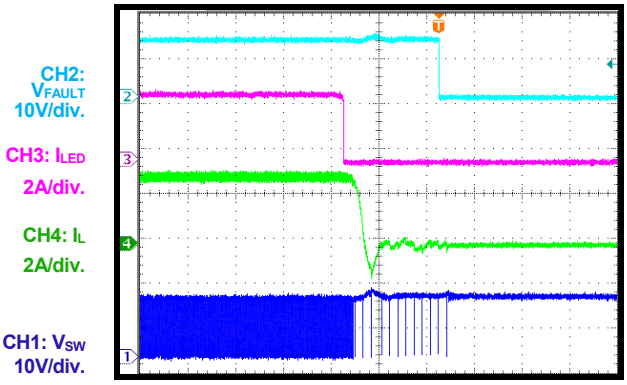
Performance curves and waveforms are tested on the evaluation board. V_{IN} = 13.5V, V_{LED} = 6V, L = 4.7µH, f_{SW} = 2.3MHz, T_A = 25°C, in buck mode, unless otherwise noted.

No Dimming
LED open power on



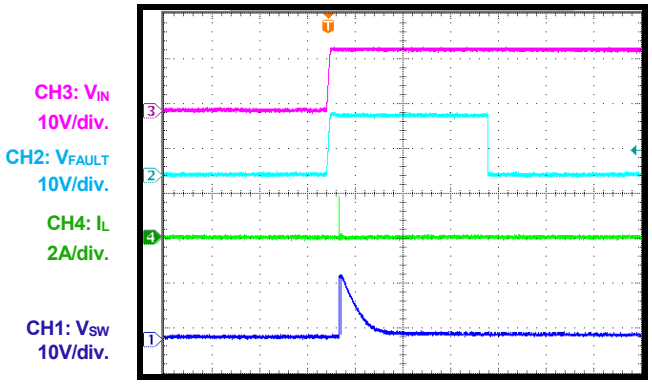
10ms/div.

No Dimming
LED open entry



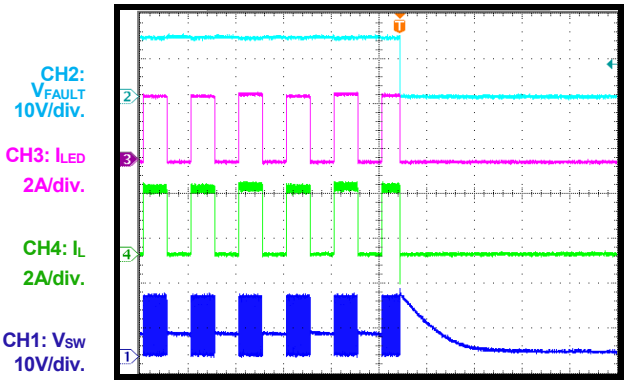
40µs/div.

PWM Dimming
LED open power on



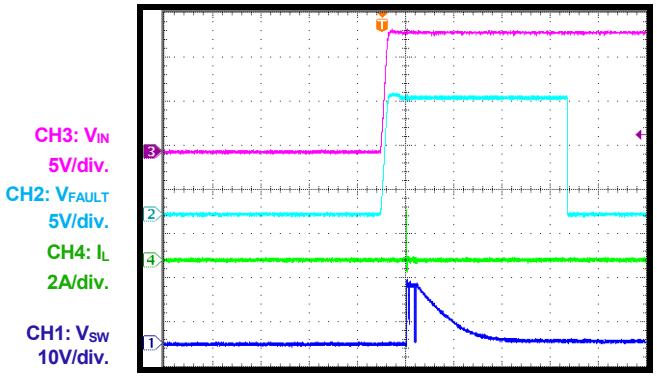
20ms/div.

PWM Dimming
LED open entry



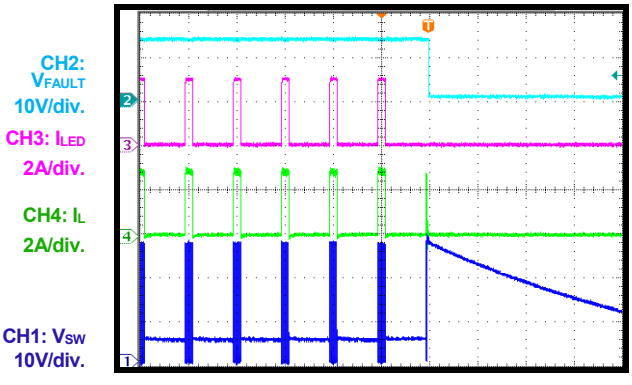
10ms/div.

2-Step Dimming
LED open power on



10ms/div.

2-Step Dimming
LED open entry

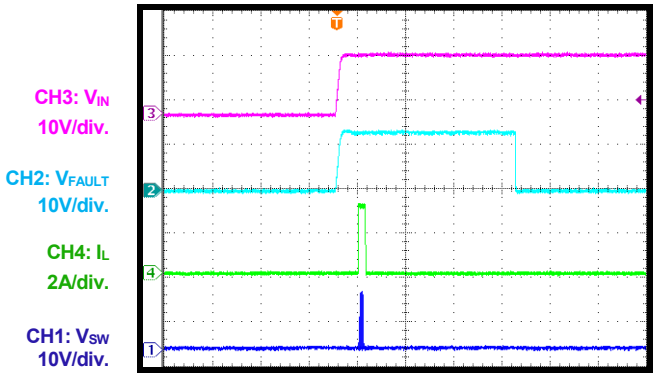


2ms/div.

EVB TEST RESULTS *(continued)*

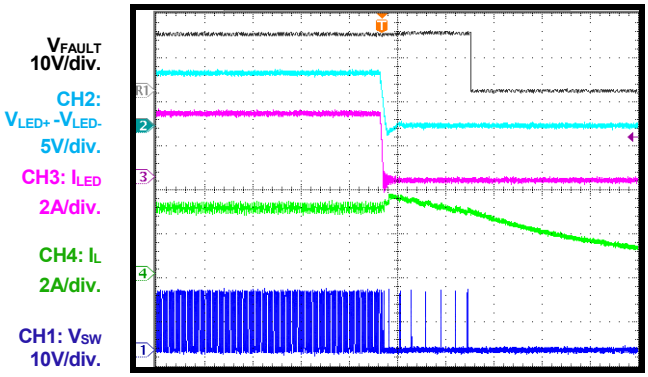
Performance curves and waveforms are tested on the evaluation board. V_{IN} = 13.5V, V_{LED} = 6V, L = 4.7µH, f_{SW} = 2.3MHz, T_A = 25°C, in buck mode, unless otherwise noted.

No Dimming
LED+ short to LED- power on



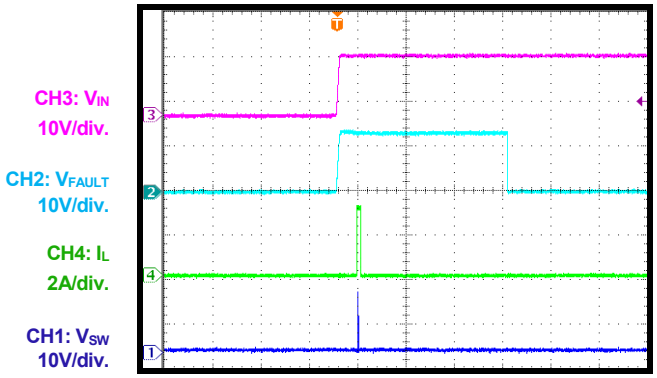
10ms/div.

No Dimming
LED+ short to LED- entry



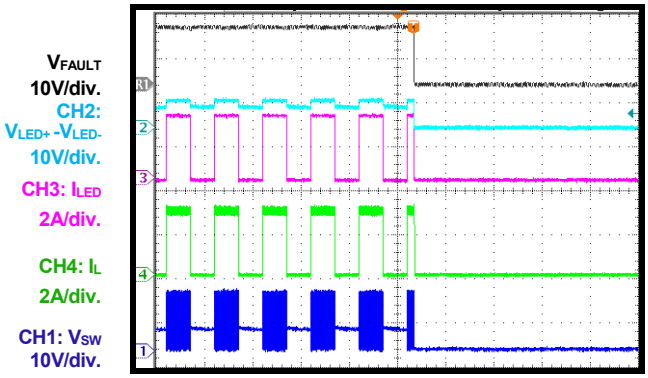
10µs/div.

PWM Dimming
LED+ short to LED- power on



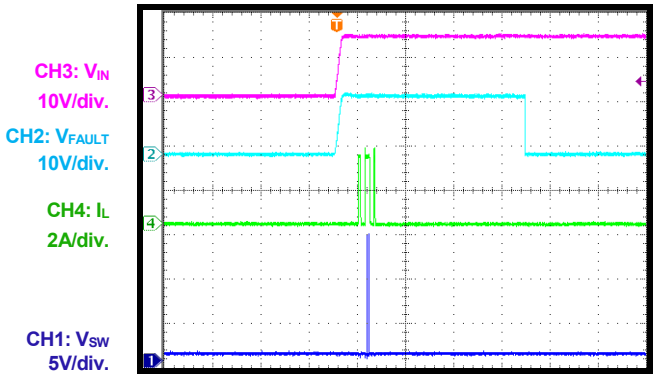
20ms/div.

PWM Dimming
LED+ short to LED- entry



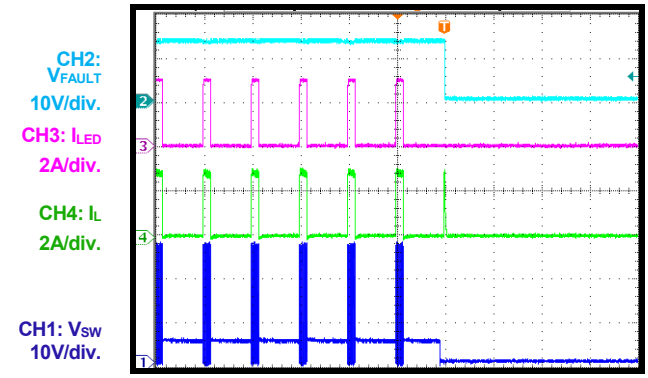
10ms/div.

2-Step Dimming
LED+ short to LED- power on



10ms/div.

2-Step Dimming
LED+ short to LED- entry

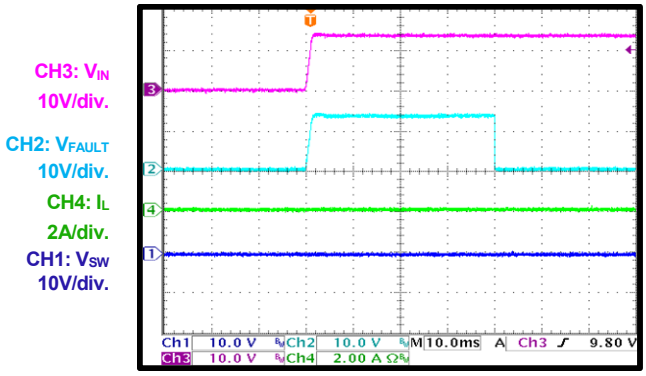


2ms/div.

EVB TEST RESULTS *(continued)*

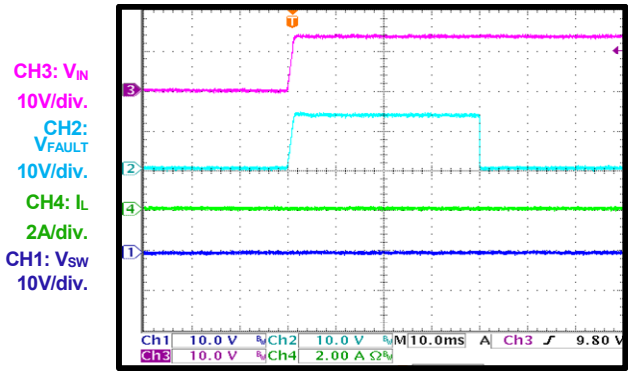
Performance curves and waveforms are tested on the evaluation board. V_{IN} = 13.5V, V_{LED} = 6V, L = 4.7µH, f_{SW} = 2.3MHz, T_A = 25°C, in buck mode, unless otherwise noted.

IREF Short before Start-Up



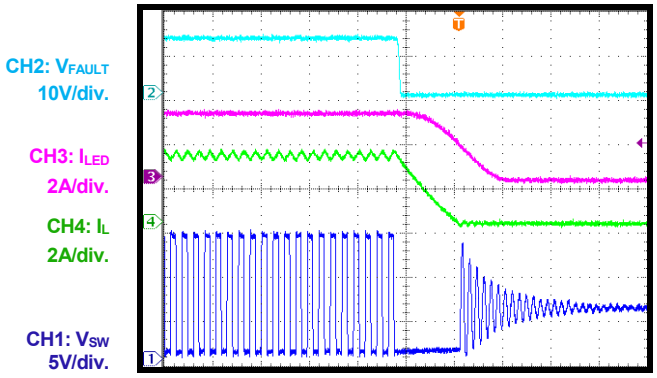
10ms/div.

IREF Open before Start-Up



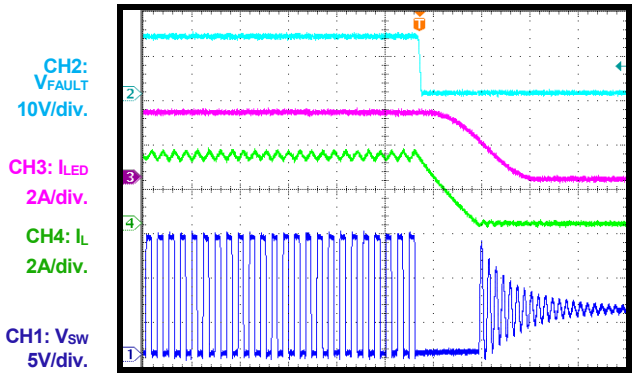
10ms/div.

IREF Short after Start-Up



2µs/div.

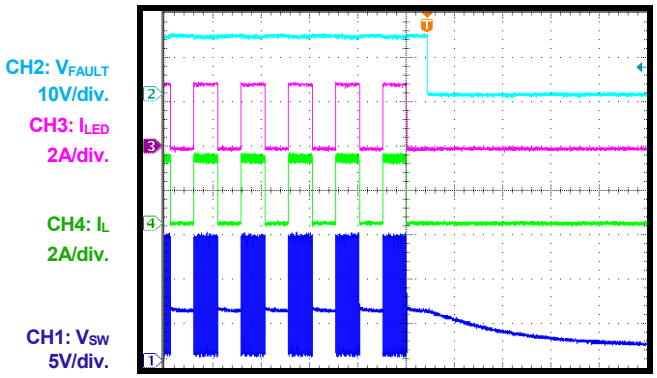
IREF Open after Start-Up



2µs/div.

IREF Short after Start-Up

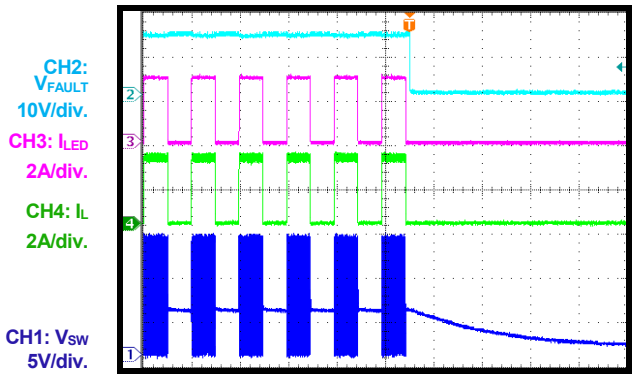
PWM dimming



2ms/div.

IREF Open after Start-Up

PWM dimming

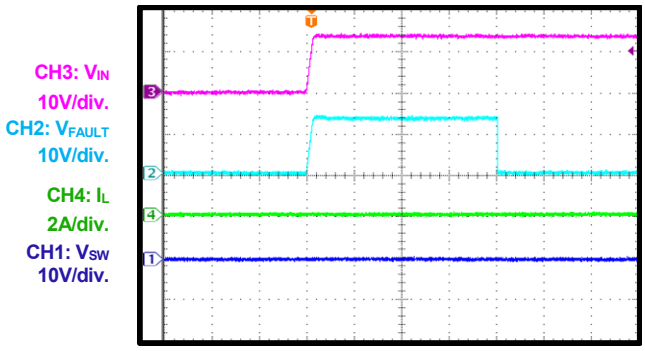


2ms/div.

EVB TEST RESULTS *(continued)*

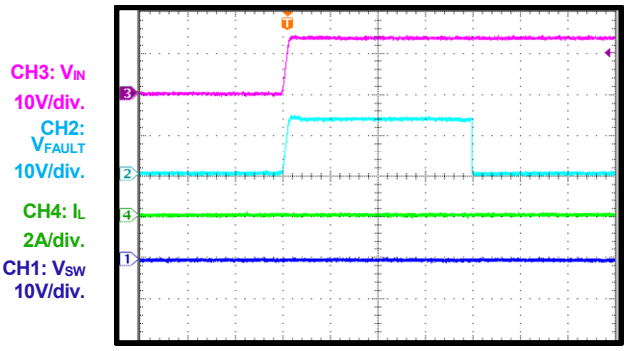
Performance curves and waveforms are tested on the evaluation board. V_{IN} = 13.5V, V_{LED} = 6V, L = 4.7µH, f_{SW} = 2.3MHz, T_A = 25°C, in buck mode, unless otherwise noted.

ISET Short before Start-Up
PWM dimming



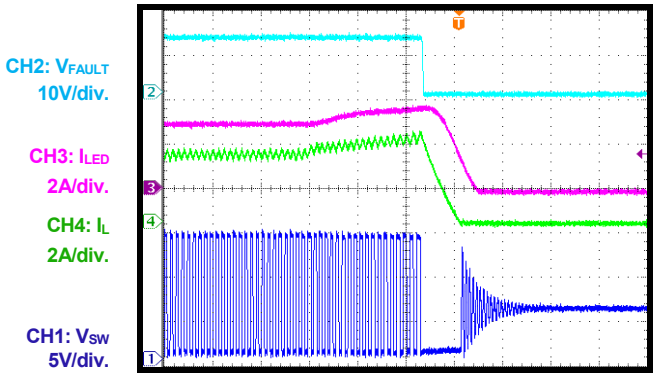
10ms/div.

ISET Open before Start-Up
PWM dimming



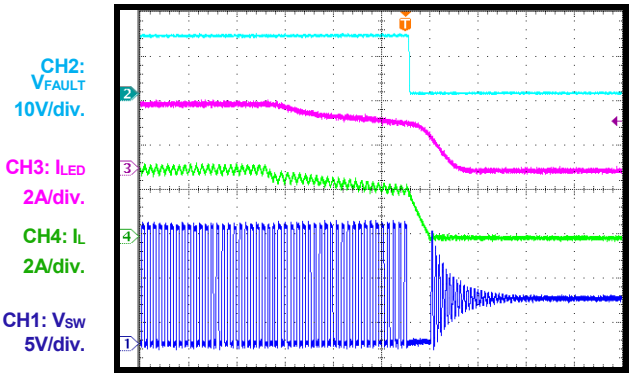
10ms/div.

ISET Short after Start-Up



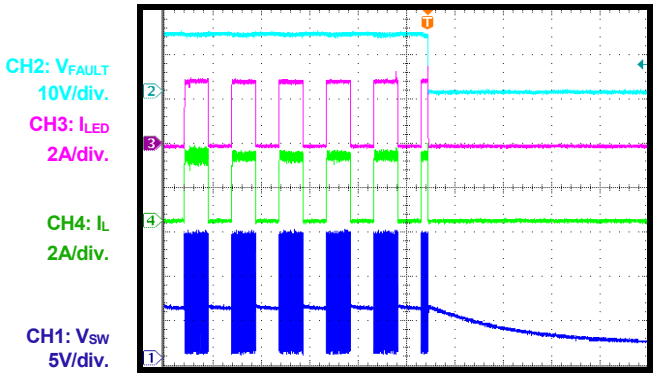
4µs/div.

ISET Open after Start-Up



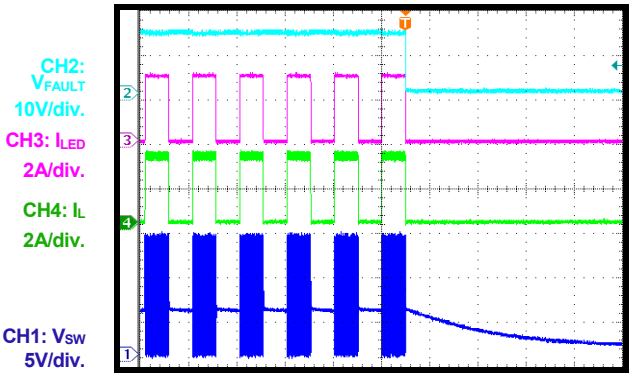
4µs/div.

ISET Short after Start-Up
PWM dimming



2ms/div.

ISET Open after Start-Up
PWM dimming

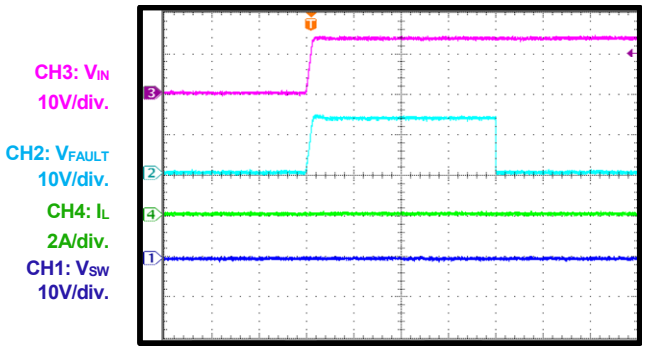


2ms/div.

EVB TEST RESULTS *(continued)*

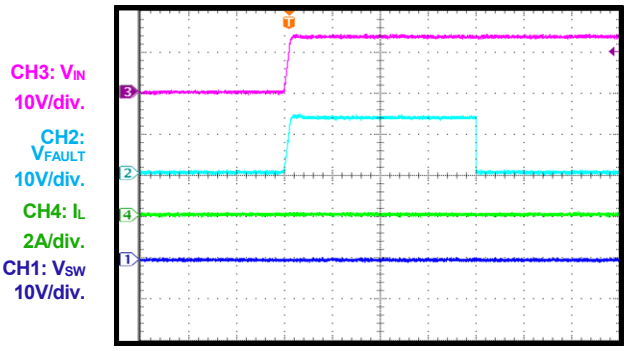
Performance curves and waveforms are tested on the evaluation board. V_{IN} = 13.5V, V_{LED} = 6V, L = 4.7µH, f_{SW} = 2.3MHz, T_A = 25°C, in buck mode, unless otherwise noted.

DUTY Short before Start-Up



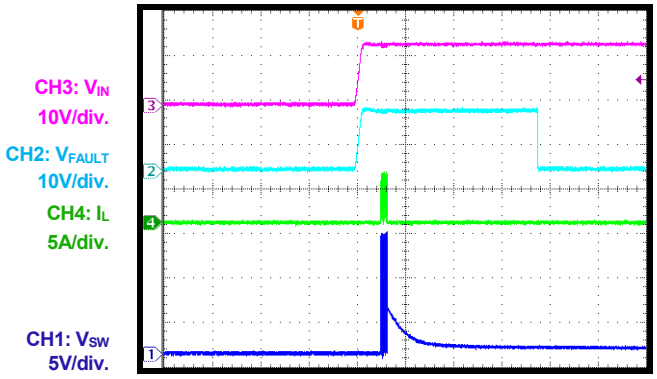
10ms/div.

DUTY Open before Start-Up



10ms/div.

Mode Detect with Incorrect Configuration at VIN Start-Up



10ms/div.

PCB LAYOUT

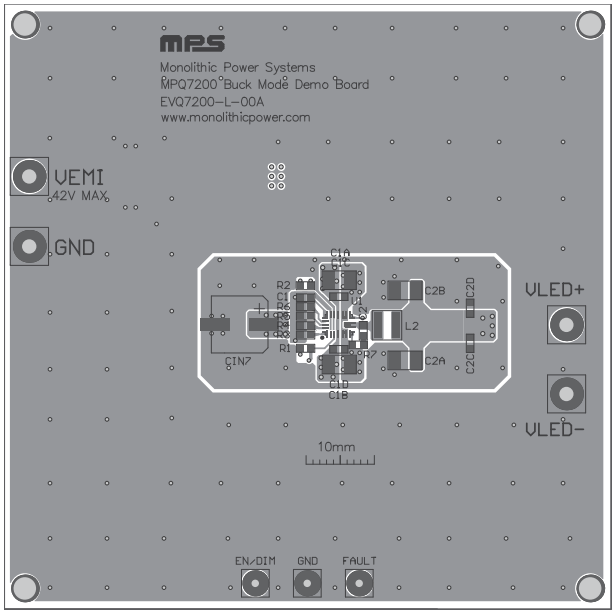


Figure 2: Top Silk and Top Layer

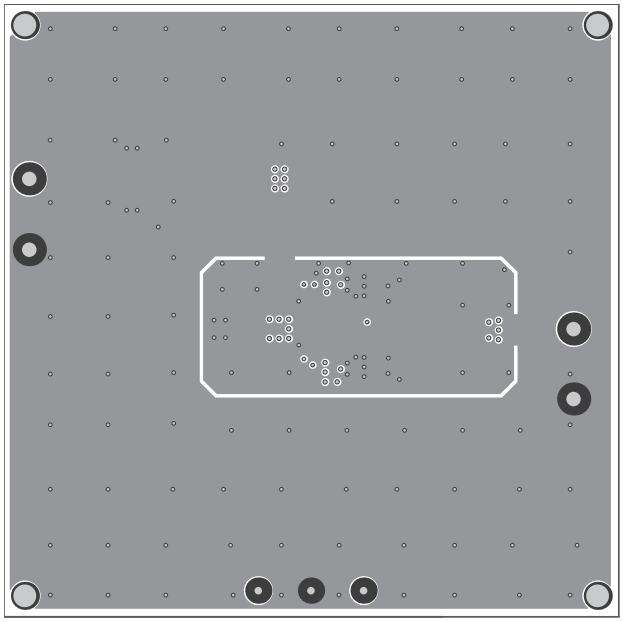


Figure 3: Mid-Layer 1

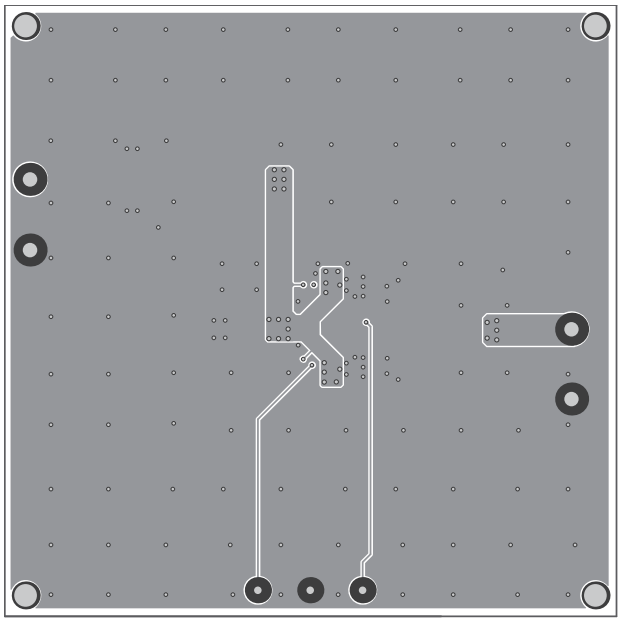


Figure 4: Mid-Layer 2

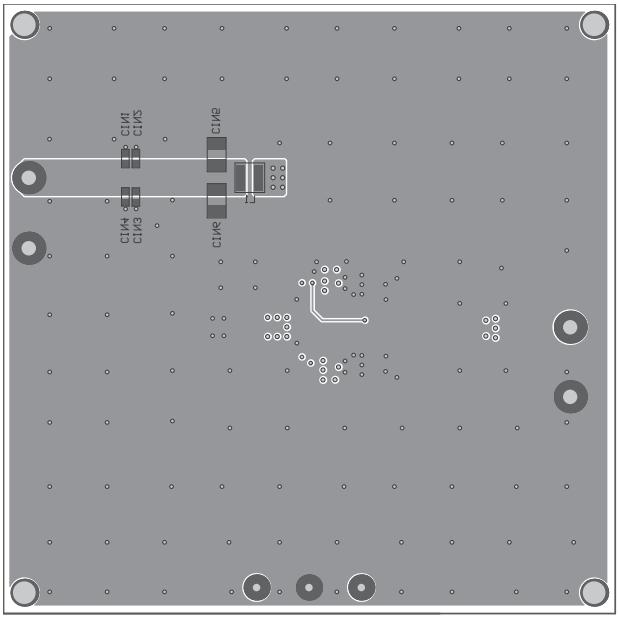


Figure 5: Bottom Layer and Bottom Silk

REVISION HISTORY

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

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