EVQ3359-LE-00A

Four-Channel, Max 150mA/Channel, Boost WLED Driver with High Dimming Ratio Evaluation Board, AEC-Q100 Qualified

DESCRIPTION

The EVQ3359-LE-00A is an evaluation board designed to demonstrate the capabilities of the MPQ3359, a four-channel, step-up converter that drives white LED (WLED) arrays as backlighting for small or mid-sized LCD panels.

Peak current control is used as the pulse-width modulation (PWM) control architecture for regulating the boost converter. Four channel current sources are applied to the LED cathode to adjust LED brightness. This regulates the current in each LED string to the value set by an external current-setting resistor, with a 2.5% current regulation accuracy between strings.

The MPQ3359's low on resistance ($R_{DS(ON)}$) MOSFET and headroom voltage improves efficiency. The switching frequency (f_{SW}) is configurable via a resistor or an external clock.

The MPQ3359 provides analog and PWM dimming via the EN/ADIM and PDIM pins. The device also has a fixed delay time between LED current channels to eliminate noise during PWM dimming.

Protection features include over-current protection (OCP), over-voltage protection (OVP), over-temperature protection (OTP), LED short protection, and LED open protection.

The EVQ3359-LE-00A is a fully assembled evaluation board. The MPQ3359 is available in a QFN-20 (3mmx4mm) package, and is AEC-Q100 Grade 1 qualified.

PERFORMANCE SUMMARY

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

Parameters	Conditions	Value
Input voltage (V_{IN})		12V typical
LED strings	The over-voltage protection (OVP) threshold is 40.2V, so it is recommended for the output voltage (V_{OUT}) to be below 36V	4 strings, 12 LEDs/string
LED current (I_{LED})	R_{ISET} = 10kΩ	120mA/string

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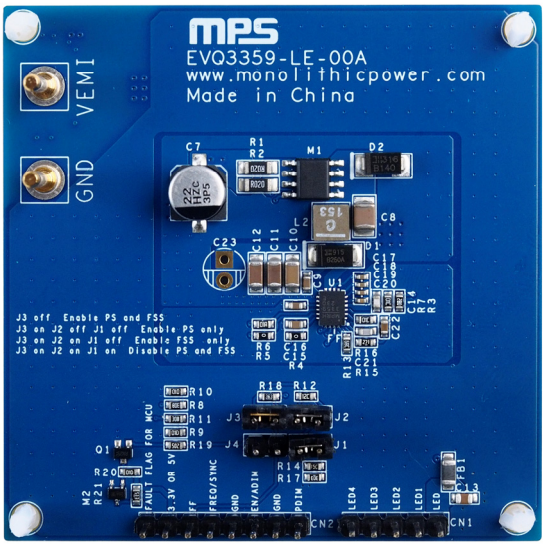
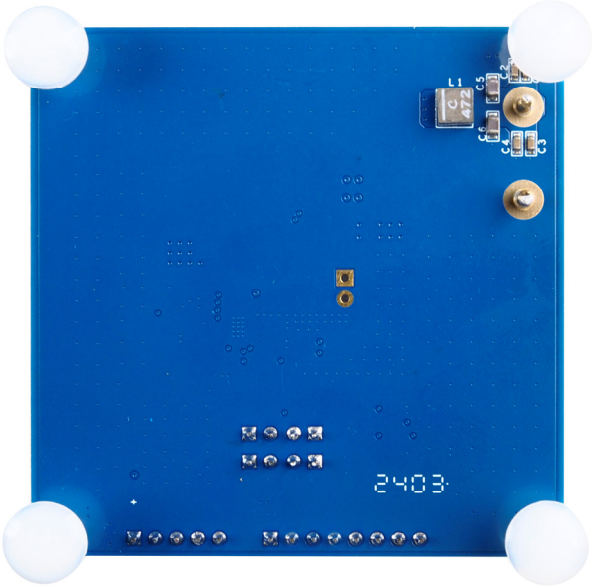
EVQ3359-LE-00A EVALUATION BOARD





LxWxH (6.35cmx6.35cmx2cm)

Board Number	MPS IC Number
EVQ3359-LE-00A	MPQ3359GLE-AEC1 or MP3359GLE

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QUICK START GUIDE

1. Connect the LED (4 strings) load terminals to:
   a. Positive (+): LED
   b. Negative (-): LED1, LED2, LED3, and LED4
2. Connect the DC power supply (typically preset to 12V) terminals to:
   a. Positive (+): VEMI
   b. Negative (-): GND
3. For pulse-width modulation (PWM) dimming, pull the EN/ADIM pin high to turn the MPQ3359 on, then apply a PWM signal with a minimum voltage below 0.5V and a maximum voltage above 1.4V via the PDIM pin. It is recommended for the PWM signal frequency to be between 100Hz and 30kHz.
4. For analog dimming, pull the PDIM pin high and apply a PWM signal with a minimum voltage below 0.5V and a maximum voltage above 1.4V via the EN/ADIM pin. It is recommended for the PWM signal frequency to be above 5kHz.

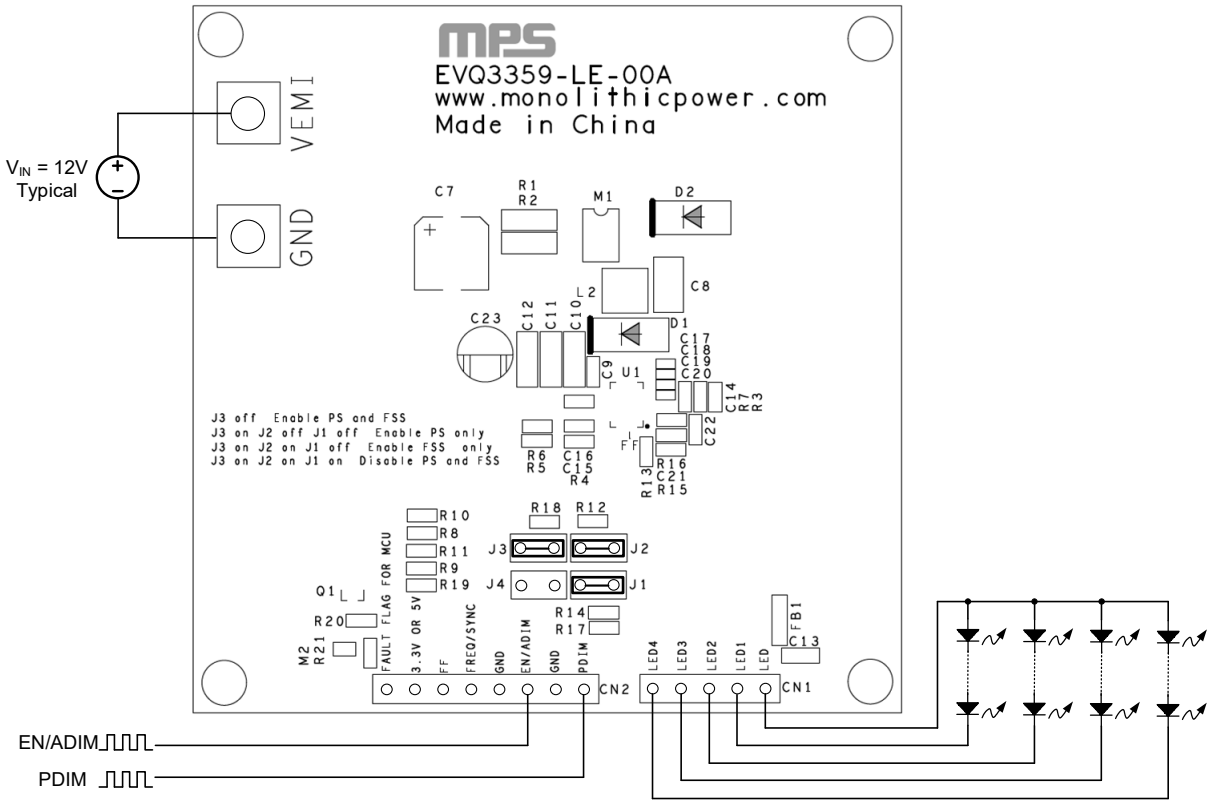

Figure 1: Measurement Equipment Set-Up (1) (2) (3) (4) (5)

Notes:

1) When J1~J3 are shorted, the delay function and frequency spread spectrum (FSS) function are disabled.
2) When J1 is open and J2~J3 are shorted, only the FSS function is enabled.
3) When J1~J2 are open and J3 is shorted, only the delay function is enabled.
4) When J1~J3 are open, the delay function and FSS function are enabled.
5) If the fault flag signal is used by the microcontroller (MCU), short J4 and provide a 3.3V or 5V DC voltage to the “3.3V OR 5V” pin. Then the “FAULT FLAG FOR MCU” pin level can be compatible with the user’s MCU.

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EVALUATION BOARD SCHEMATICS

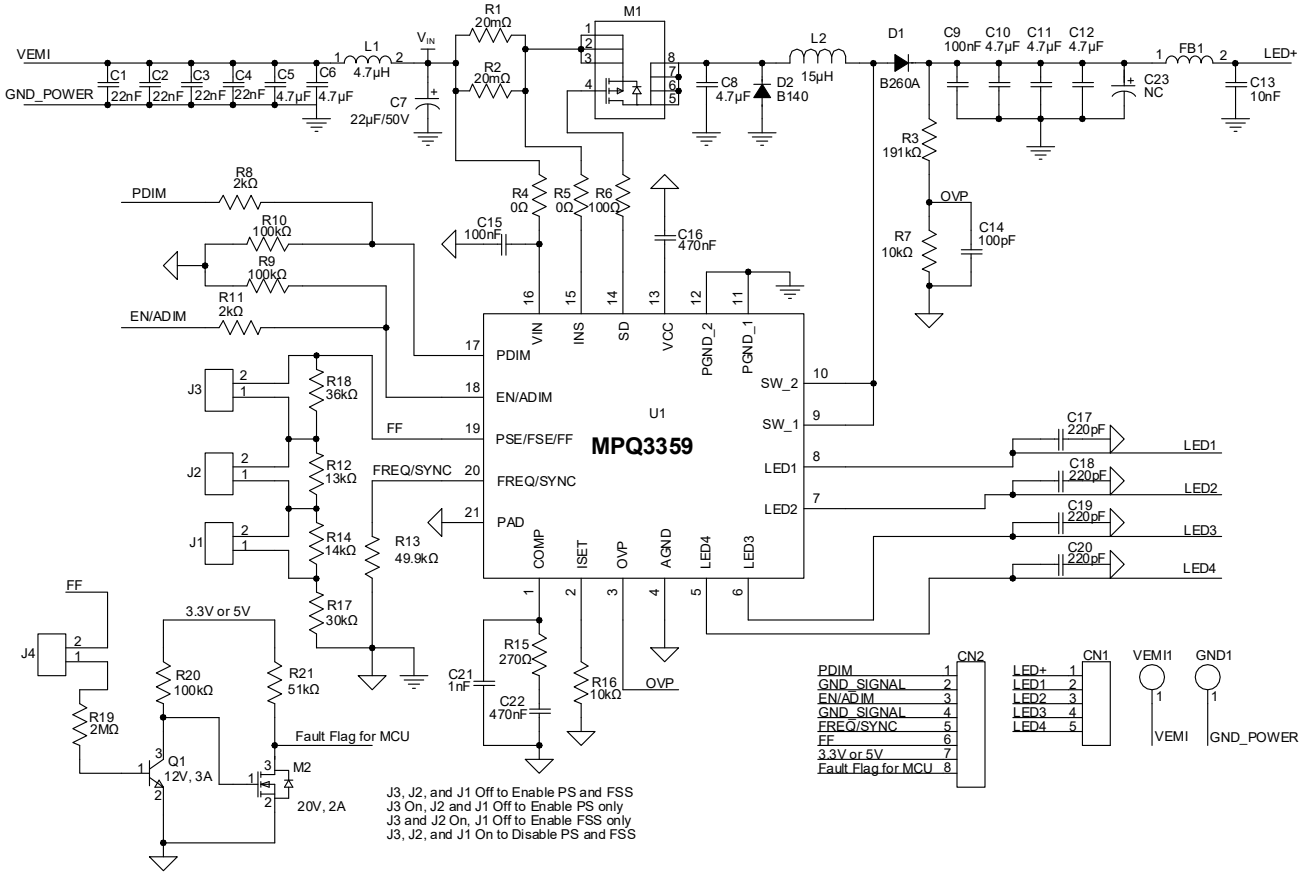

Figure 2: Evaluation Board Schematic

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EVQ3359-LE-00A BILL OF MATERIALS

Qty	Ref	Value	Description	Package	Manufacturer	Manufacturer PN
4	C1, C2, C3, C4	22nF	Ceramic capacitor, 50V, X7R	0603	Wurth	885012206091
2	C5, C6	4.7μF	Ceramic capacitor, 50V, X7S	0805	Murata	GRM21BC71H475KE11L
1	C7	22μF	Electrolytic capacitor, 50V	SMD	Panasonic	EEHZC1H220P
1	C8	4.7μF	Ceramic capacitor, 50V, X7R	1210	Murata	GRM32ER71H475KA88L
2	C9, C15	100nF	Ceramic capacitor, 50V, X7R	0603	Murata	GCM188R71H104KA57D
3	C10, C11, C12	4.7μF	Ceramic capacitor, 50V, X7S	1206	Murata	GCM31CC71H475KA03L
1	C13	10nF	Ceramic capacitor, 50V, X7R	0805	TDK	C2012X7R1H103K
1	C14	100pF	Ceramic capacitor, 50V, C0G	0603	Murata	GRM1885C1H101JA01D
2	C16, C22	470nF	Ceramic capacitor, 16V, X7R	0603	Murata	GRM188R71C474KA88D
4	C17, C18, C19, C20	220pF	Ceramic capacitor, 50V, X7R	0402	Murata	GRM155R71H221KA01D
1	C21	1nF	Ceramic capacitor, 50V, C0G	0603	Murata	GRM1885C1H102JA01D
1	C23	NC				
1	D1	60V	Schottky diode, 2A	SMA	Diodes, Inc.	B260A-13-F
1	D2	40V	Schottky diode, 1A	SMA	Fairchild	B140T
1	FB1	6A	Magnetic bead	1206	Murata	BLM31PG330SN1L
1	L1	4.7μH	Inductor, 44.1mΩ, 5.1A	SMD	Coilcraft	XEL4030-472MEB
1	L2	15μH	Inductor, 120mΩ, 2.8A	SMD	Coilcraft	XAL4040-153MEB
1	M1	-60V	P-channel MOSFET, 23mΩ, 9.3A	SO-8	Analog Power	AM4417P-T1-PF
1	M2	20V	N-channel MOSFET, 58mΩ, 2A	SC-703	Analog Power	AM1320N-T1-PF
1	Q1	12V	Transistor, 3A	SOT-323	Diodes, Inc.	2DD2652-7
2	R1, R2	20mΩ	Film resistor, 1%	1206	Yageo	RL1206FR-070R02L
1	R3	191kΩ	Film resistor, 1%	0603	Yageo	RC0603FR-07191KL
2	R4, R5	0Ω	Film resistor, 1%	0603	Yageo	RC0603FR-070RL
1	R6	100Ω	Film resistor, 1%	0603	Yageo	RC0603FR-07100RL
2	R7, R16	10kΩ	Film resistor, 1%	0603	Yageo	RC0603FR-0710KL
2	R8, R11	2kΩ	Film resistor, 1%	0603	Yageo	RC0603FR-072KL
3	R9, R10, R20	100kΩ	Film resistor, 1%	0603	Yageo	RC0603FR-07100KL
1	R12	13kΩ	Film resistor, 1%	0603	Yageo	RC0603FR-0713KL
1	R13	49.9kΩ	Film resistor, 1%	0603	Yageo	RC0603FR-0749K9L
1	R14	14kΩ	Film resistor, 1%	0603	Yageo	RC0603FR-0714KL

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EVQ3359-LE-00A BILL OF MATERIALS *(continued)*

Qty	Ref	Value	Description	Package	Manufacturer	Manufacturer PN
1	R15	270Ω	Film resistor, 1%	0603	Yageo	RC0603FR-07270RL
1	R17	30kΩ	Film resistor, 1%	0603	Yageo	RC0603FR-0730KL
1	R18	36kΩ	Film resistor, 1%	0603	Yageo	RC0603FR-0736KL
1	R19	2MΩ	Film resistor, 5%	0603	Yageo	RC0603JR-072ML
1	R21	51kΩ	Film resistor, 1%	0603	Yageo	RC0603FR-0751KL
6	CN1, CN2, J1, J2, J3, J4	2.54mm	Connector header, 180°	DIP	Any	
2	VEMI1, GND1	2mm	Golden pin	DIP	Any	
1	U1	MPQ3359 or MP3359	4-channel, step-up boost WLED driver	QFN-20 (3mmx 4mm)	MPS	MPQ3359GLE-AEC1 or MP3359GLE

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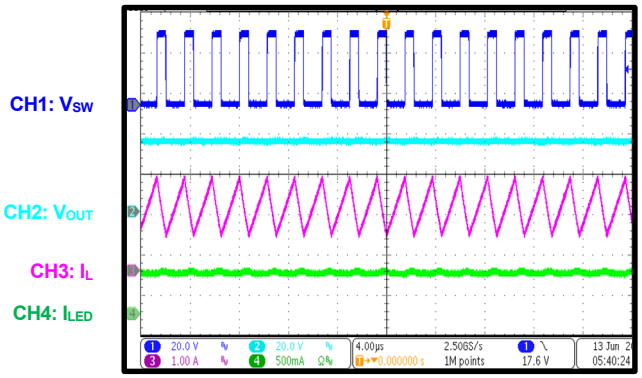
EVB TEST RESULTS

Performance waveforms are tested on the evaluation board. V_{IN} = 12V, 4 strings, 12 LEDs in series, 120mA/string, L = 15µH, f_{SW} = 440kHz, T_A = 25°C, unless otherwise noted.

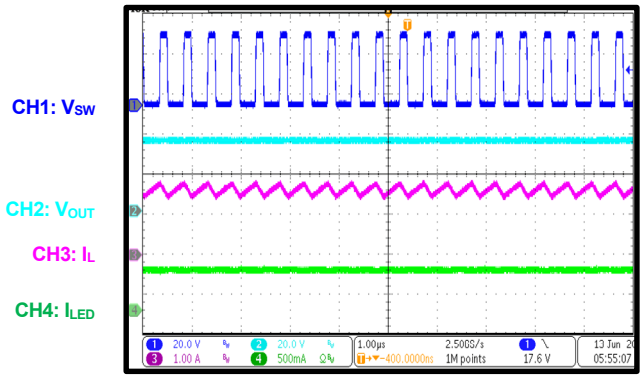
Steady State

f_{SW} = 440kHz

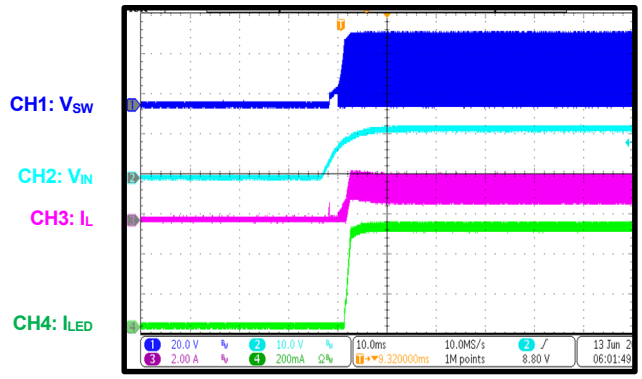


Steady State

f_{SW} = 2.2MHz

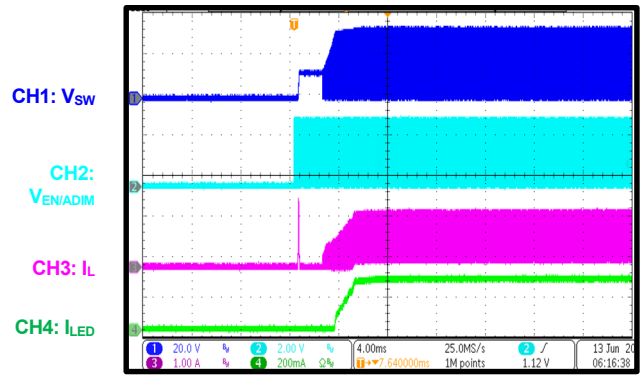


Start-Up through VIN



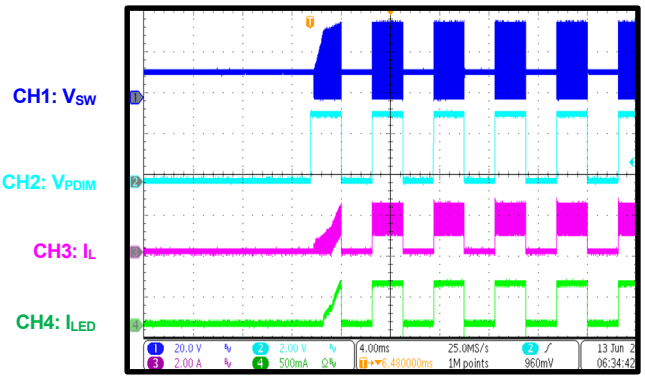
Start-Up through EN/ADIM

$f_{EN/ADIM}$ = 10kHz, $D_{EN/ADIM}$ = 50%



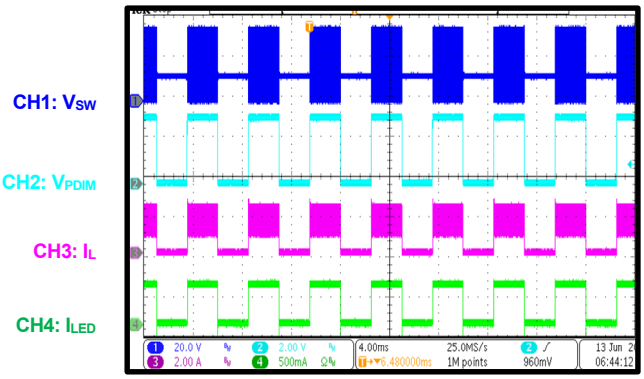
Start-Up through PDIM

f_{PDIM} = 200Hz, D_{PDIM} = 50%



PWM Dimming

f_{PDIM} = 200Hz, D_{PDIM} = 50%



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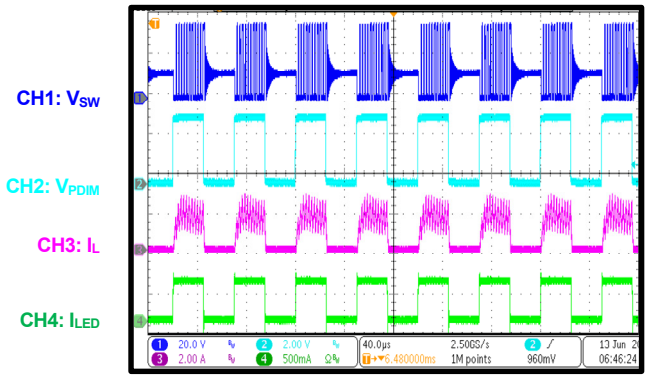
EVB TEST RESULTS *(continued)*

Performance waveforms are tested on the evaluation board. V_{IN} = 12V, 4 strings, 12 LEDs in series, 120mA/string, L = 15µH, f_{SW} = 440kHz, T_A = 25°C, unless otherwise noted.

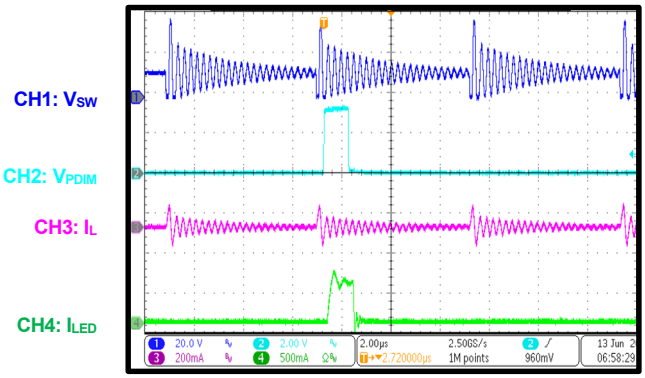
PWM Dimming

f_{PDIM} = 20kHz, D_{PDIM} = 50%



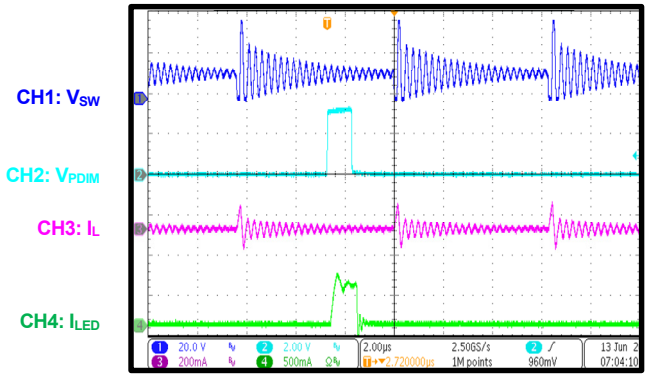
PWM Dimming

f_{PDIM} = 200Hz, D_{PDIM} = 0.02%



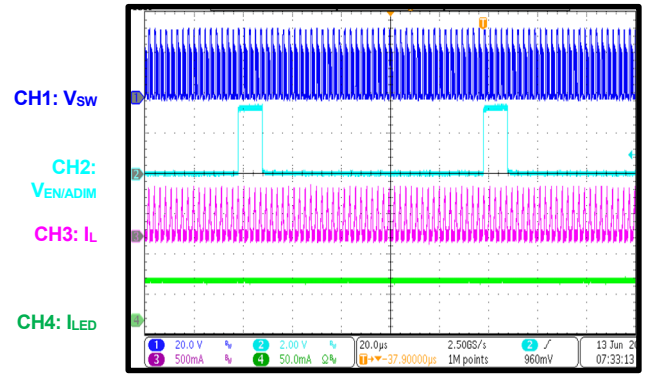
PWM Dimming

f_{PDIM} = 100Hz, D_{PDIM} = 0.01%



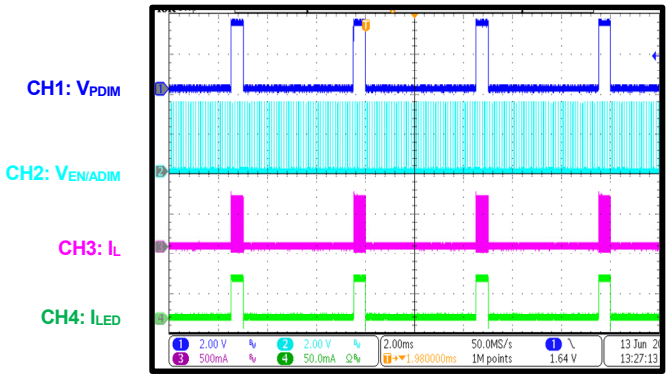
Analog Dimming

$f_{EN/ADIM}$ = 10kHz, $D_{EN/ADIM}$ = 10%



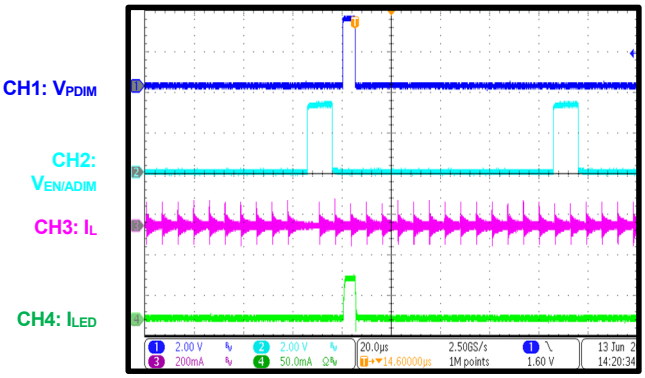
PWM Dimming and Analog Dimming

f_{PDIM} = 200Hz, D_{PDIM} = 10%, $f_{EN/ADIM}$ = 10kHz, $D_{EN/ADIM}$ = 10%



PWM Dimming and Analog Dimming

f_{PDIM} = 200Hz, D_{PDIM} = 0.1%, $f_{EN/ADIM}$ = 10kHz, $D_{EN/ADIM}$ = 10%



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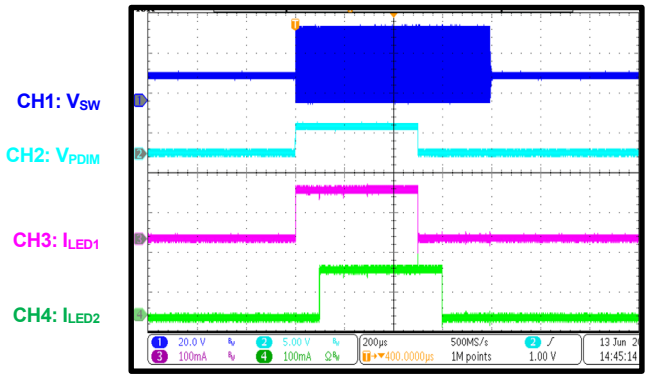
EVB TEST RESULTS *(continued)*

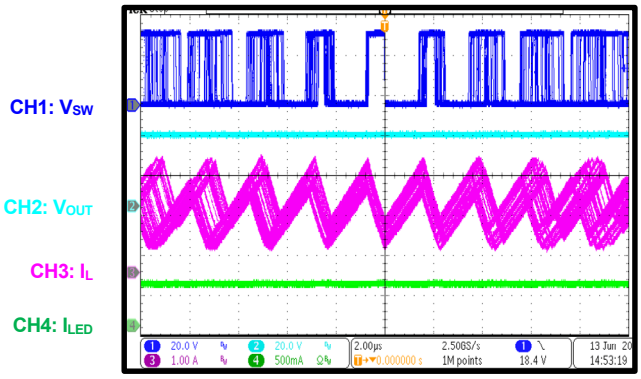
Performance waveforms are tested on the evaluation board. V_{IN} = 12V, 4 strings, 12 LEDs in series, 120mA/string, L = 15µH, f_{SW} = 440kHz, T_A = 25°C, unless otherwise noted.

PWM Dimming with 100µs Delay Function

f_{PDIM} = 200Hz, D_{PDIM} = 10%

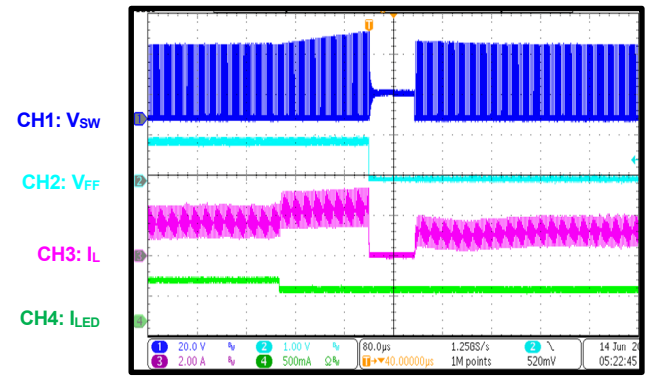


Frequency Spread Spectrum



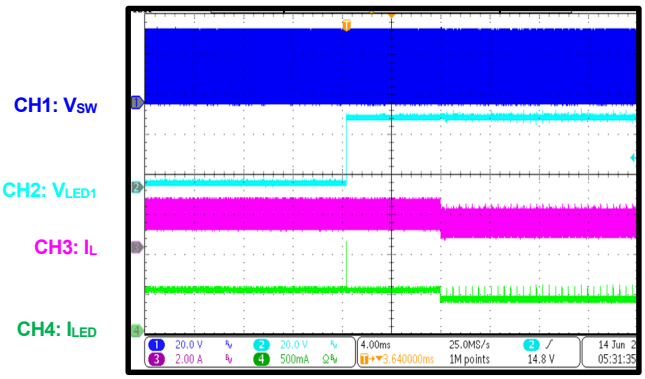
LED Open Protection

Open LED1 during normal operation



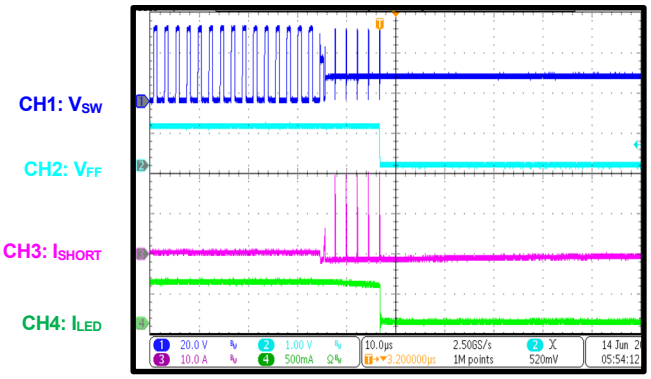
LED Short Protection

Short LED1 during normal operation



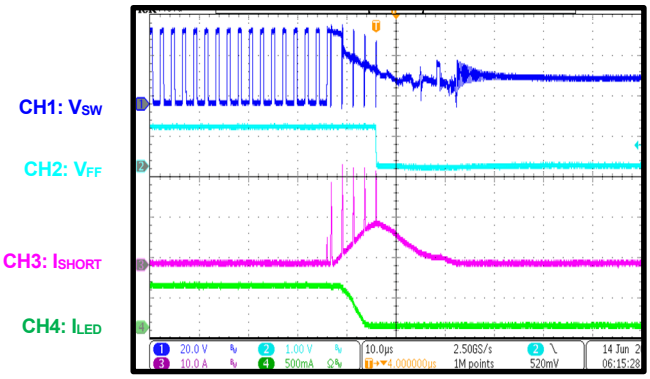
Short Inductor Protection

Short inductor during normal operation



Short Diode Protection

Short diode during normal operation



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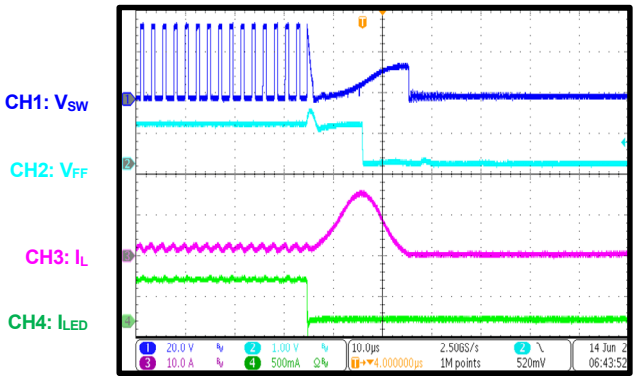
EVB TEST RESULTS *(continued)*

Performance waveforms are tested on the evaluation board. V_{IN} = 12V, 4 strings, 12 LEDs in series, 120mA/string, L = 15µH, f_{SW} = 440kHz, T_A = 25°C, unless otherwise noted.

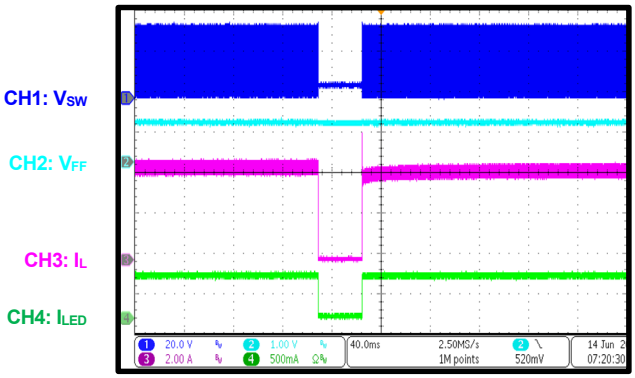
Short V_{OUT} to GND Protection

Input OCP threshold = 10A



Over-Temperature Protection

V_{IN} = 6V



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PCB LAYOUT

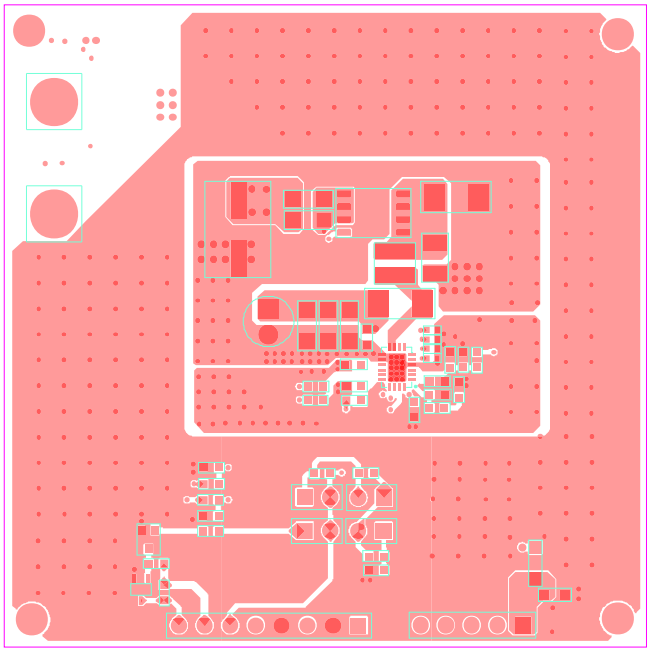

Figure 3: Top Layer

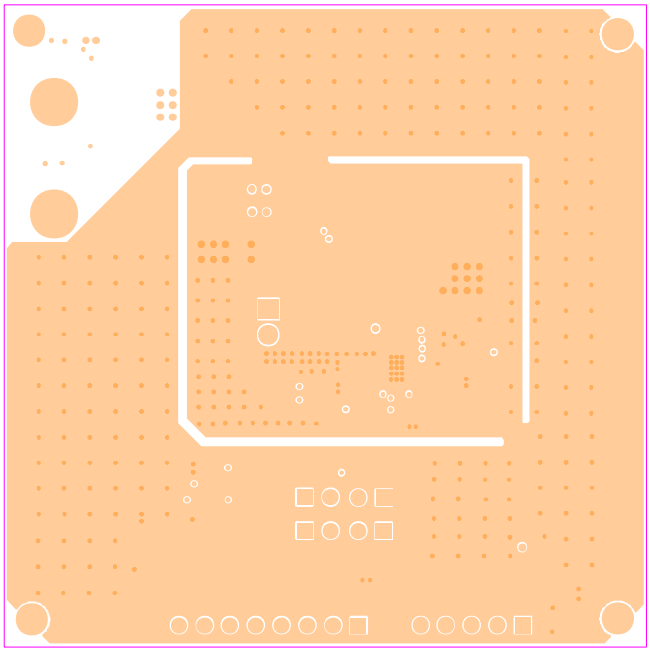

Figure 4: Mid-Layer 1

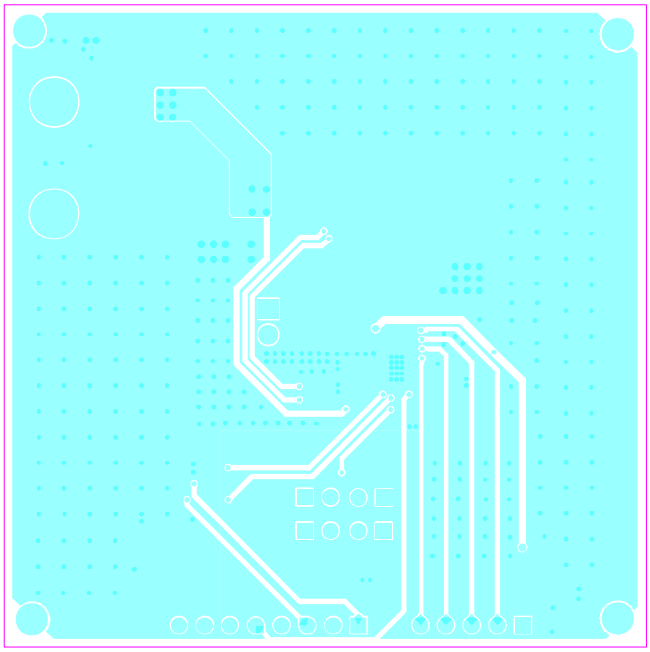

Figure 5: Mid-Layer 2

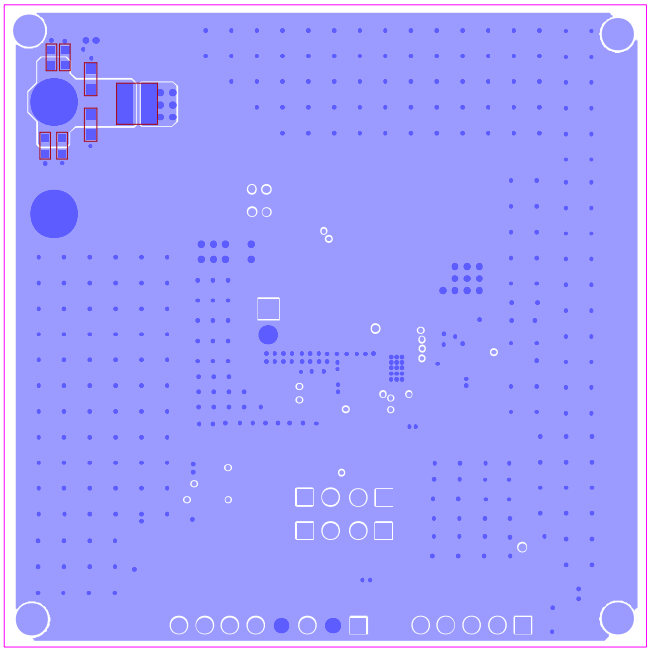

Figure 6: Bottom Layer

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REVISION HISTORY

Revision #	Revision Date	Description	Pages Updated
1.0	7/29/2024	Initial Release	-

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