# 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.

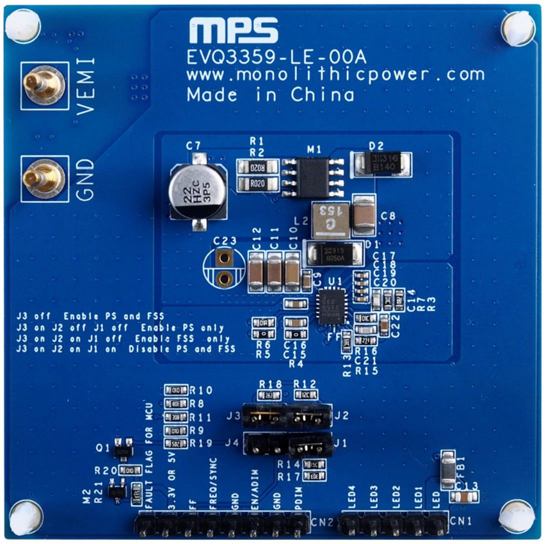
The EVQ3359-LE-00A is a fully assembled evaluation board. The MPQ3359 is available in a QFN-20 (3mmx4mm) package, and is AEC-Q100 Grade 1 qualified.

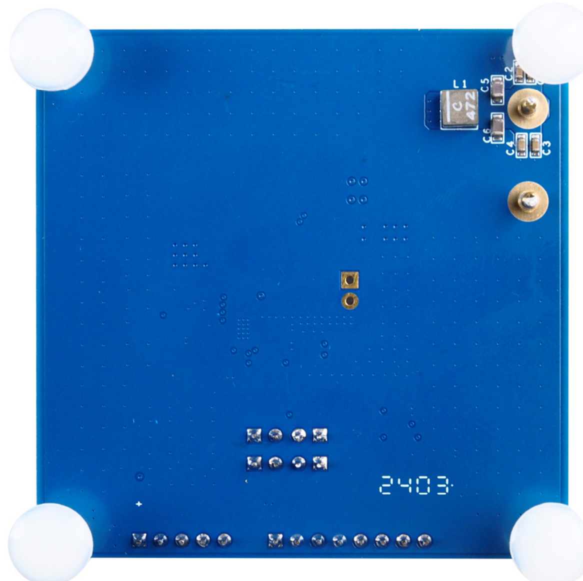
## PERFORMANCE SUMMARY

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,<br>12 LEDs/string |
| LED current ($I_{LED}$) | $R_{ISET}$ = 10kΩ | 120mA/string |

# EVQ3359-LE-00A EVALUATION BOARD




**LxWxH (6.35cmx6.35cmx2cm)**

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

## 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.

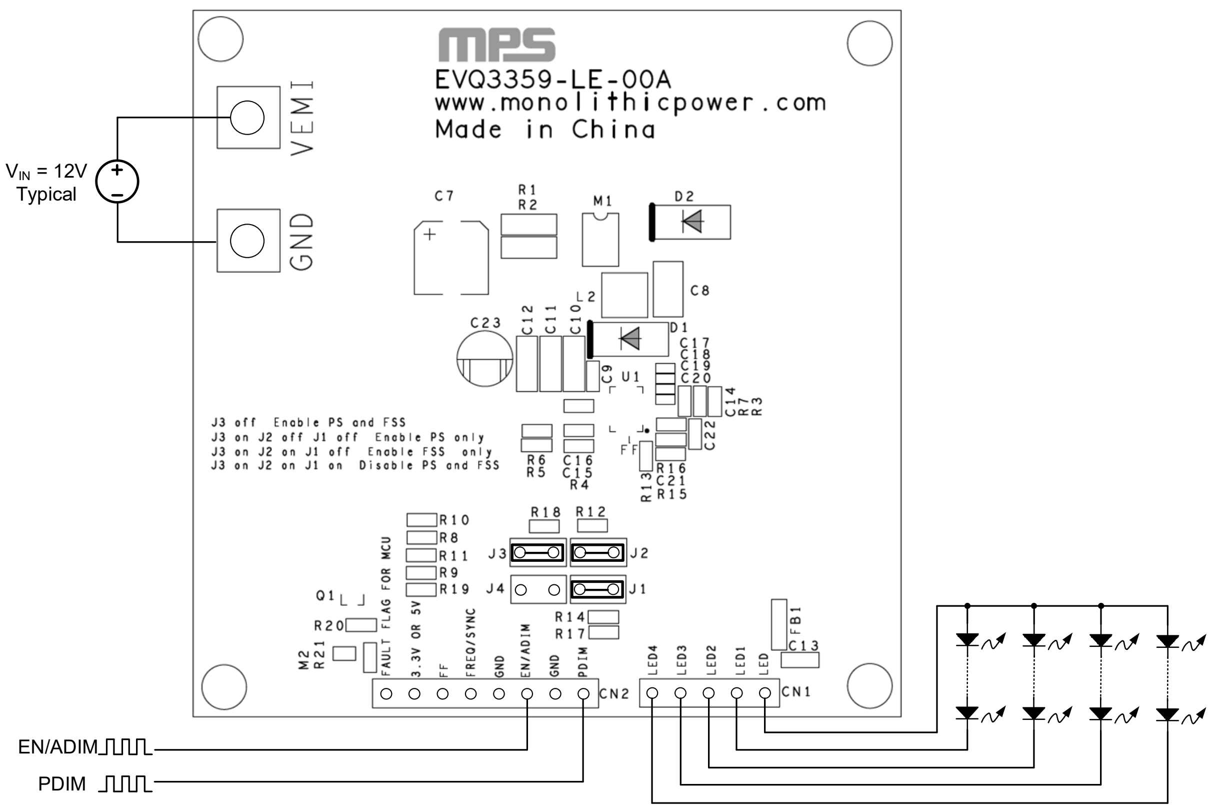



**Figure 1: Measurement Equipment Set-Up** (1) (2) (3) (4) (5)

**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.

# EVALUATION BOARD SCHEMATICS

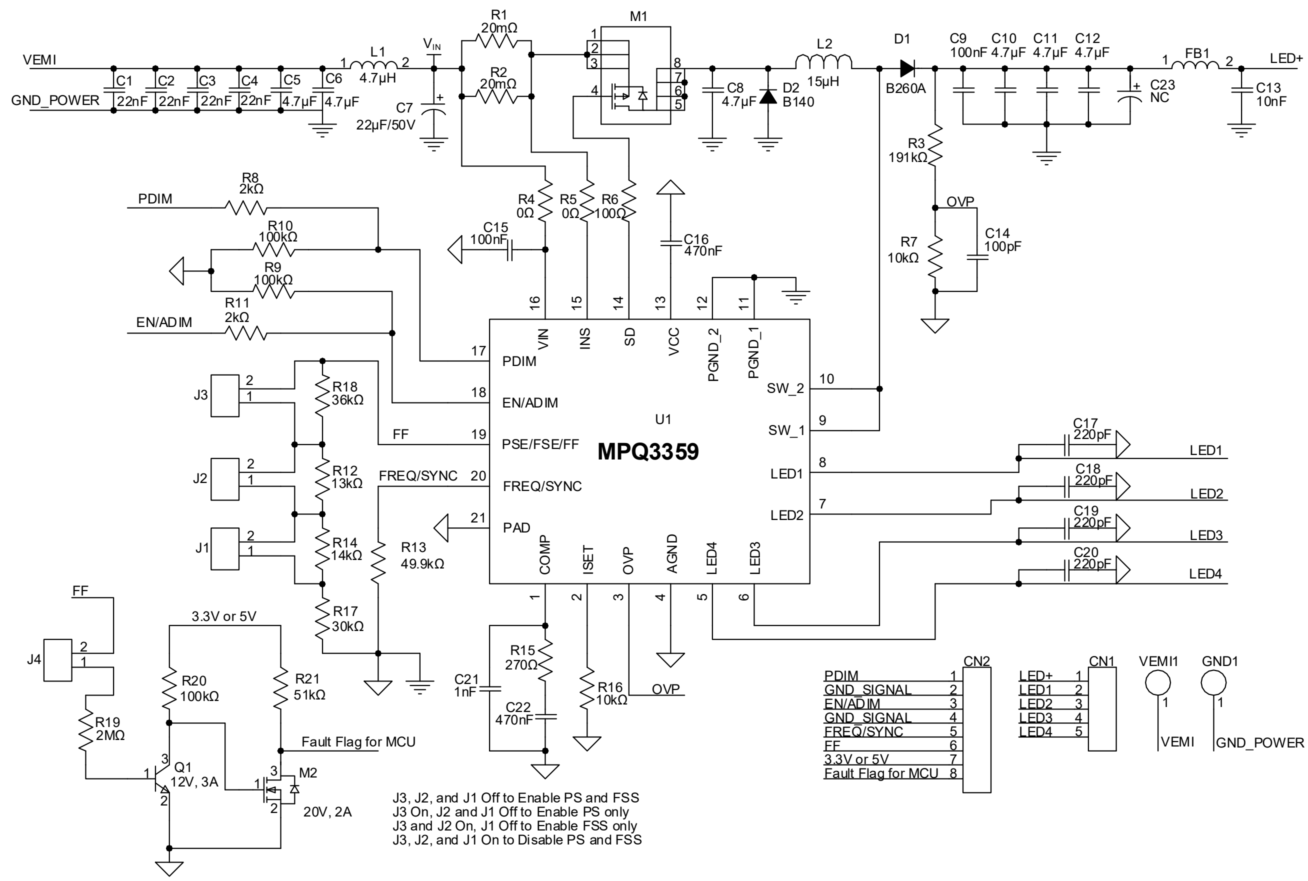



**Figure 2: Evaluation Board Schematic**

## 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 |

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

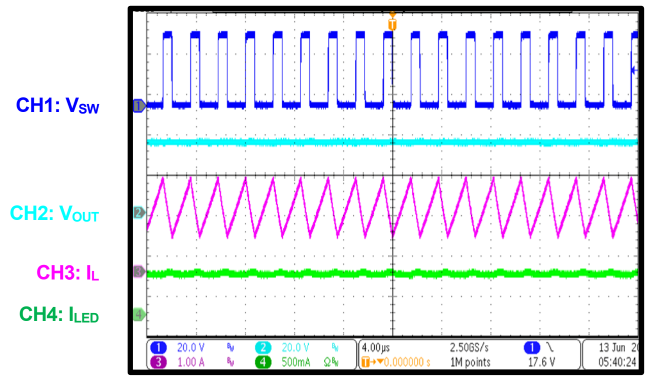
| Qty | Ref | Value | Description | Package | Manufacturer | Manufacturer PN |
|---|---|---|---|---|---|---|
| 1 | R15 | 270Ω | Film resistor, 1% | 0603 | Yageo | RC0603FR-07270RL |
| 1 | R17 | 30kΩ | Film resistor, 1% | 0603 | Yageo | RC0603FR-0730KL |
| 1 | R18 | 36kΩ | Film resistor, 1% | 0603 | Yageo | 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 |

# 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.**

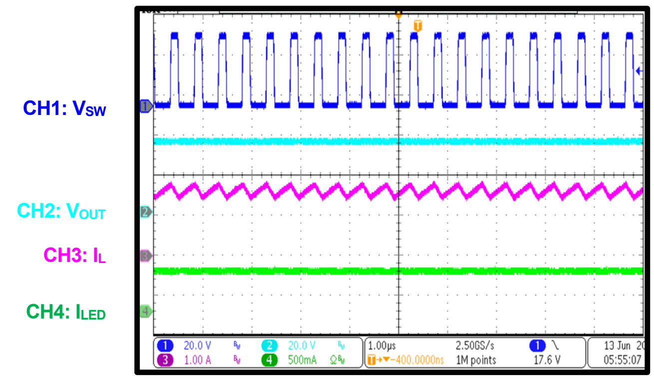
**Steady State**

$f_{SW}$ = 440kHz

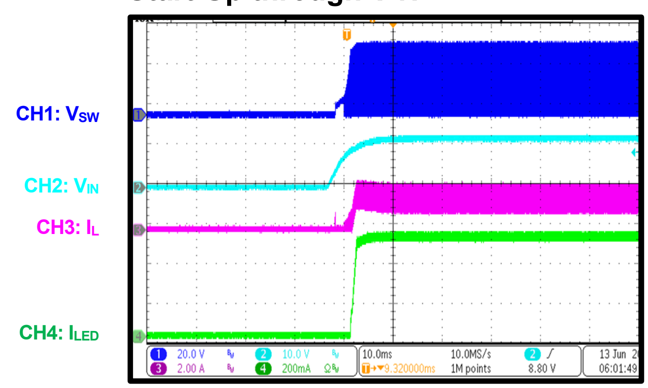



**Steady State**

$f_{SW}$ = 2.2MHz

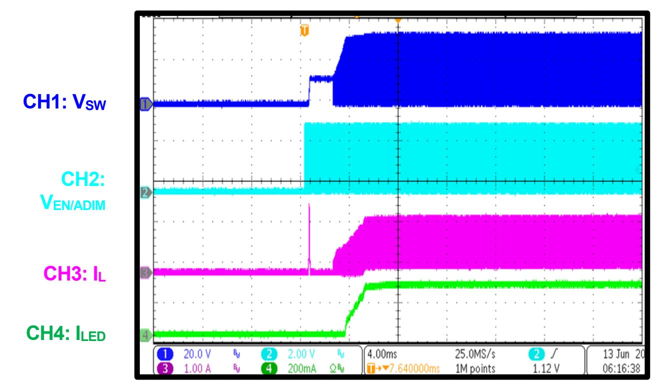



**Start-Up through VIN**



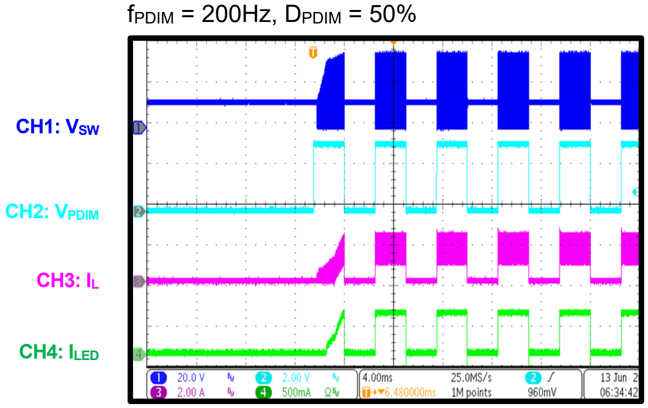

**Start-Up through EN/ADIM**

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



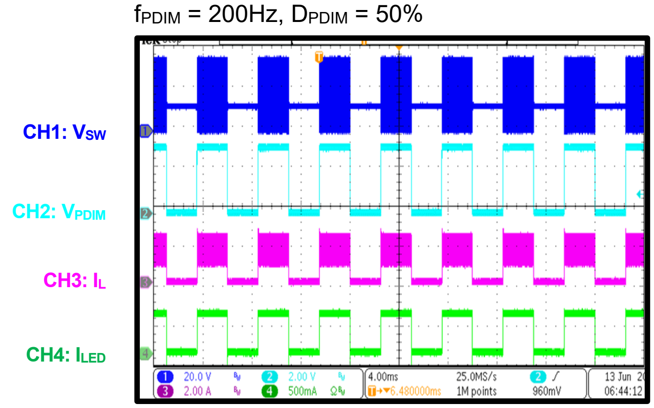

**Start-Up through PDIM**

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




**PWM Dimming**

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

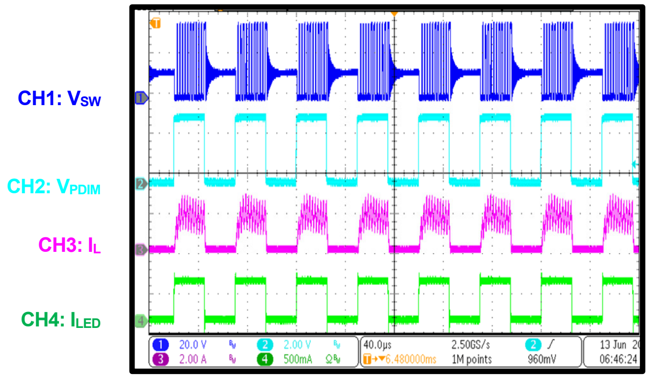


## EVB TEST RESULTS *(continued)*

**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.**

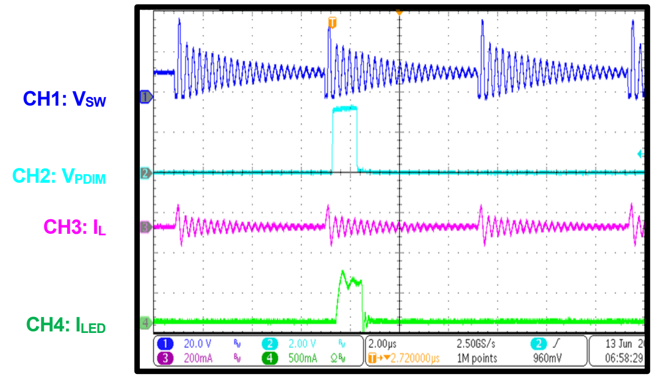
**PWM Dimming**

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



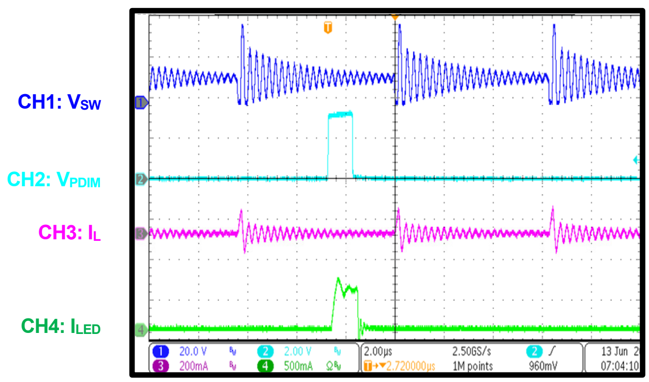

**PWM Dimming**

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



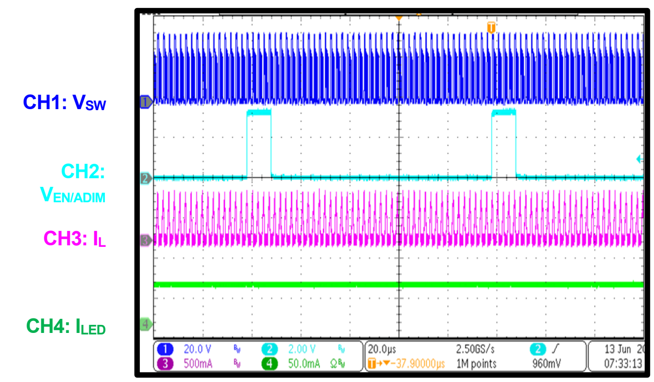

**PWM Dimming**

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



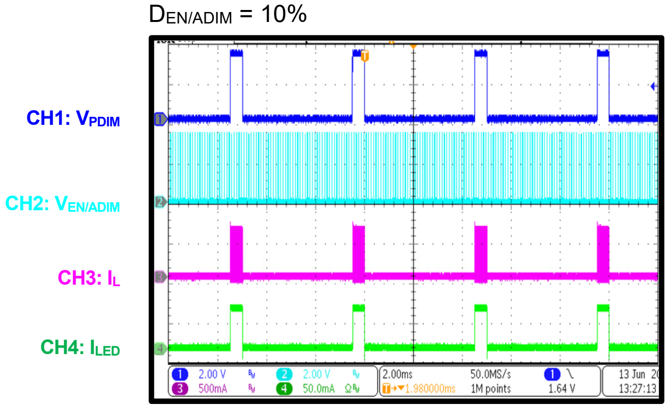

**Analog Dimming**

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



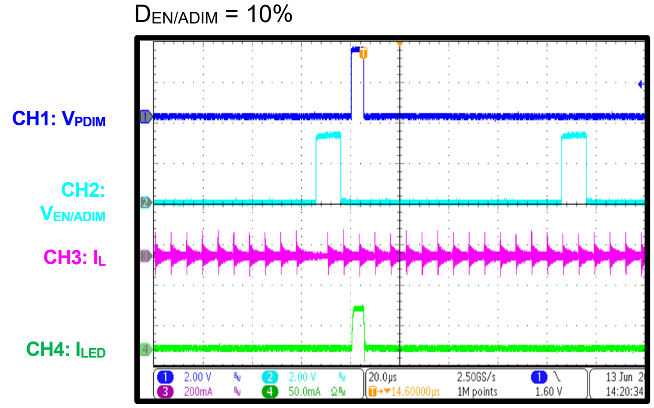

**PWM Dimming and Analog Dimming**

$f_{PDIM}$ = 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%

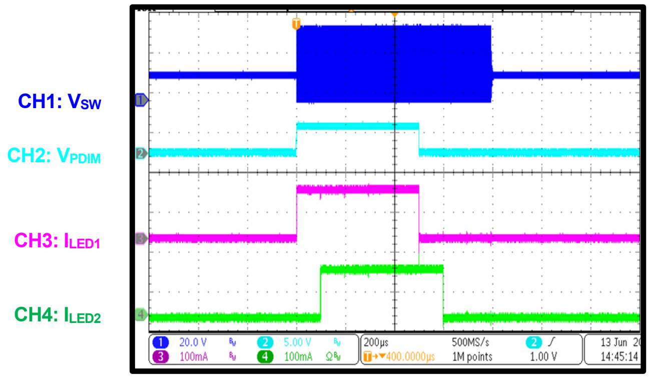


## EVB TEST RESULTS *(continued)*

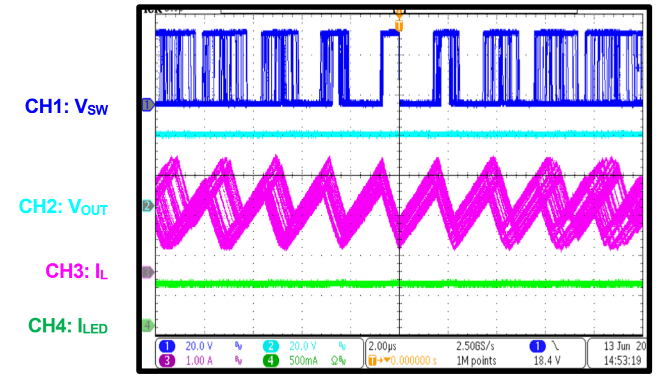
**Performance waveforms are tested on the evaluation board. $V_{IN}$ = 12V, 4 strings, 12 LEDs in series, 120mA/string, L = 15µH, $f_{SW}$ = 440kHz, $T_A$ = 25°C, unless otherwise noted.**

### PWM Dimming with 100µs Delay Function

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

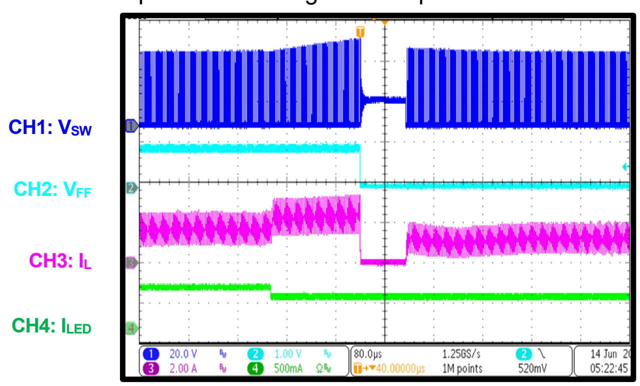



### Frequency Spread Spectrum



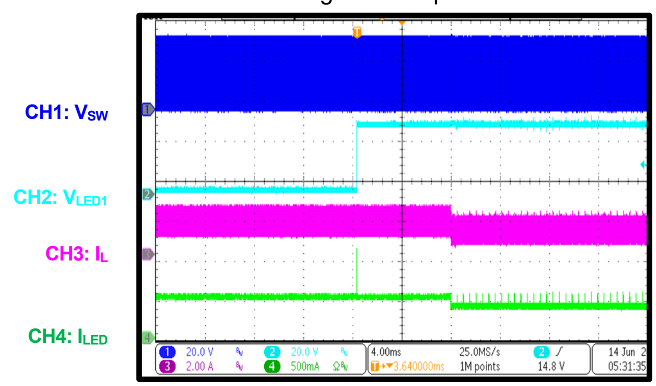

### LED Open Protection

Open LED1 during normal operation



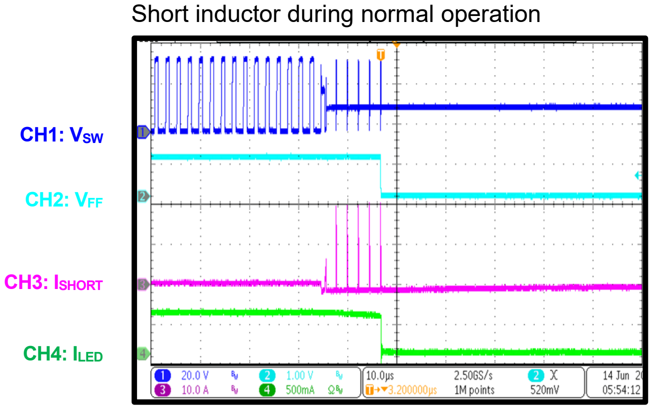

### LED Short Protection

Short LED1 during normal operation



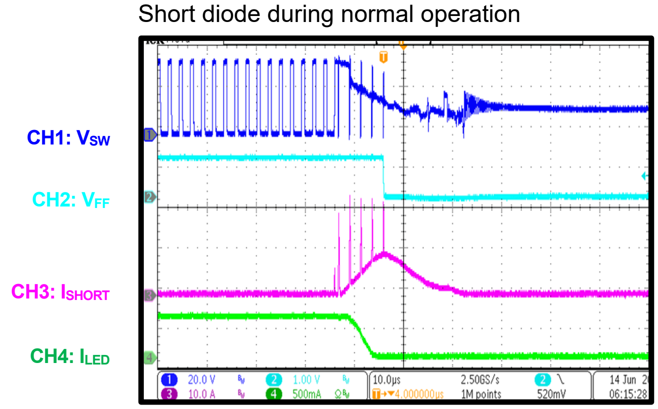

### Short Inductor Protection

Short inductor during normal operation




### Short Diode Protection

Short diode during normal operation

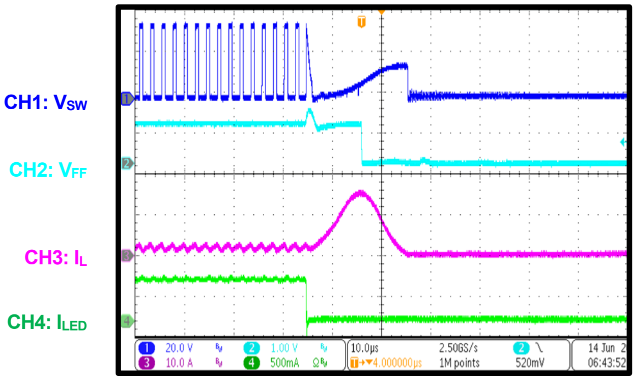


## EVB TEST RESULTS *(continued)*

**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.**

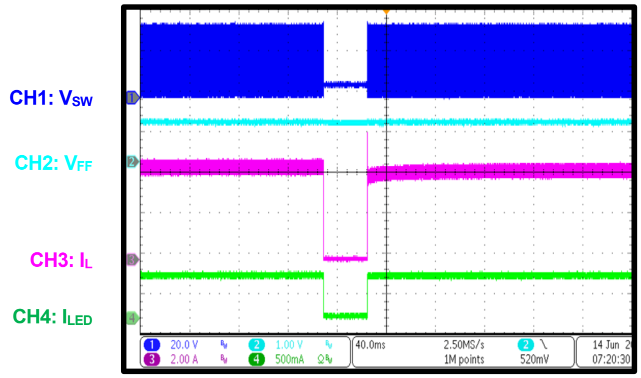
**Short $V_{OUT}$ to GND Protection**

Input OCP threshold = 10A




**Over-Temperature Protection**

$V_{IN}$ = 6V



## PCB LAYOUT

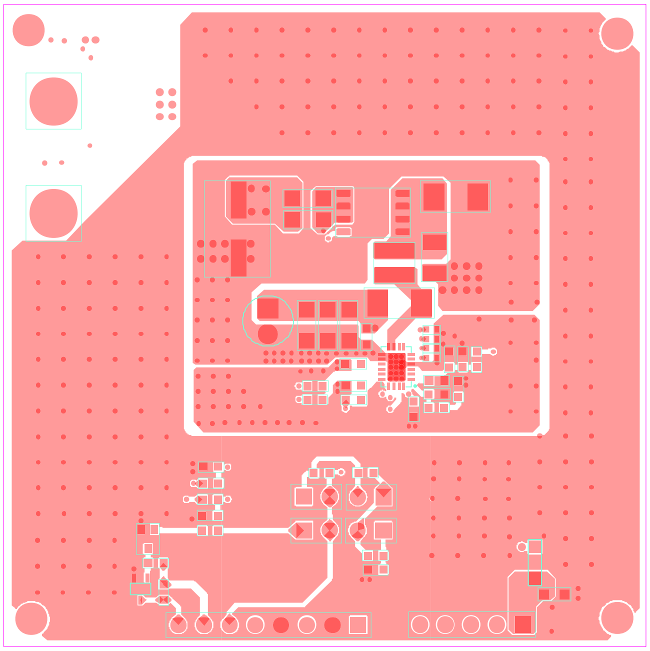


Figure 3: Top Layer

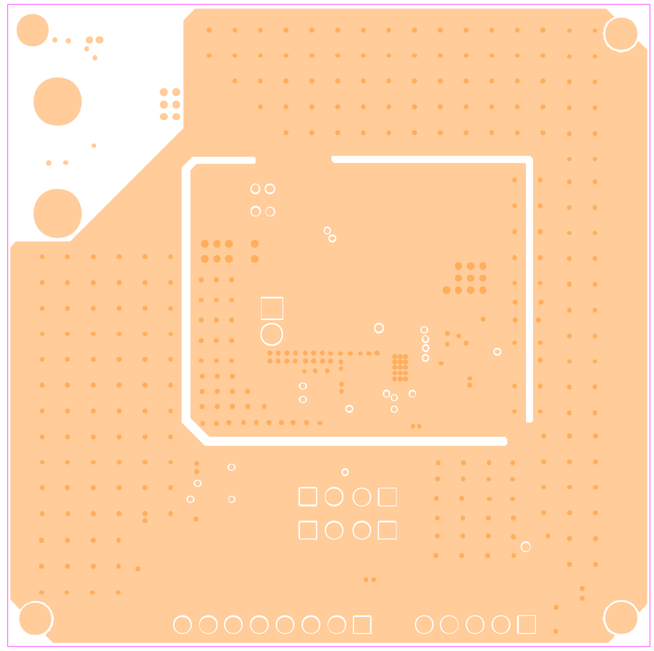


Figure 4: Mid-Layer 1

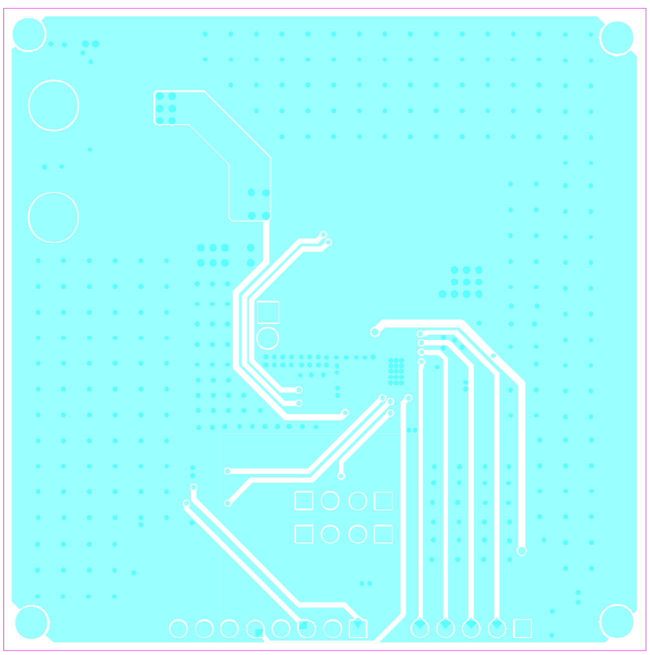


Figure 5: Mid-Layer 2

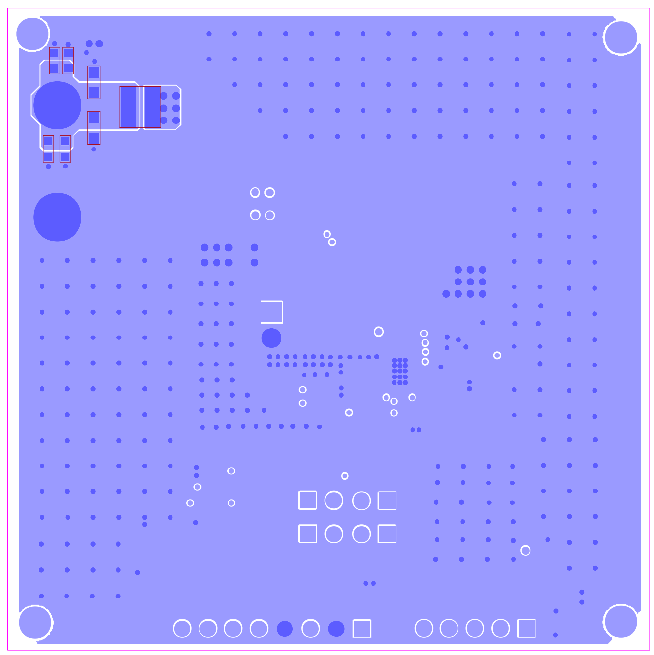


Figure 6: Bottom Layer

# REVISION HISTORY

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