EVQ3321-QQE-00A

48-Channel, Max 80mA/Ch, LED Driver with Independent Analog and PWM Dimming Evaluation Board, AEC-Q100

DESCRIPTION

The EVQ3321-QQE-00A evaluation board is designed to demonstrate the capabilities of the MPQ3321 and MPQ3321A, 48-channel LED drivers with a 22V voltage rating and maximum 80mA current sources. It is designed to drive the LED arrays as local dimming backlighting in automotive LCD panels.

The MPQ3321 and MPQ3321A employ low headroom to regulate the LED current (I_{LED}). The adaptive voltage feedback function optimizes the LED voltage, which achieves higher system efficiency.

The MPQ3321 and MPQ3321A support independent 16-bit pulse-width modulation (PWM) and 7-bit analog dimming for each channel via the serial interface.

The configurable internal registers provide reliable and flexible application. The 25MHz serial interface clock guarantees a high data transfer rate for multiple devices operating in a daisy chain application.

Robust protections are included to guarantee safe operation of the device. Protection modes include LED open protection, LED short protection, and over-temperature protection (OTP). All fault statuses can be read through the serial interface.

The MPQ3321 and MPQ3321A are available in a QFN-68 (8mmx8mm) packages. They are available in AEC-Q100 Grade 0.

PERFORMANCE SUMMARY

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

Parameters	Conditions	Value
Input voltage (V_{IN}) range		3.5V to 20V
LED channels	Each channel can be enabled/disabled via the SPI interface	48 channels
Maximum LED current (I_{LED})	IMAX[2:0] = 111b	80mA per channel
PCLK frequency (f_{PCLK})	CLKM pin floating, PCLK pin has clock input	≤30MHz
	PCLK pin floating, CLKM pin has a resistor	Selectable (5MHz, 10MHz, or 20MHz)
SPI clock frequency (f_{SCLK})		≤25MHz

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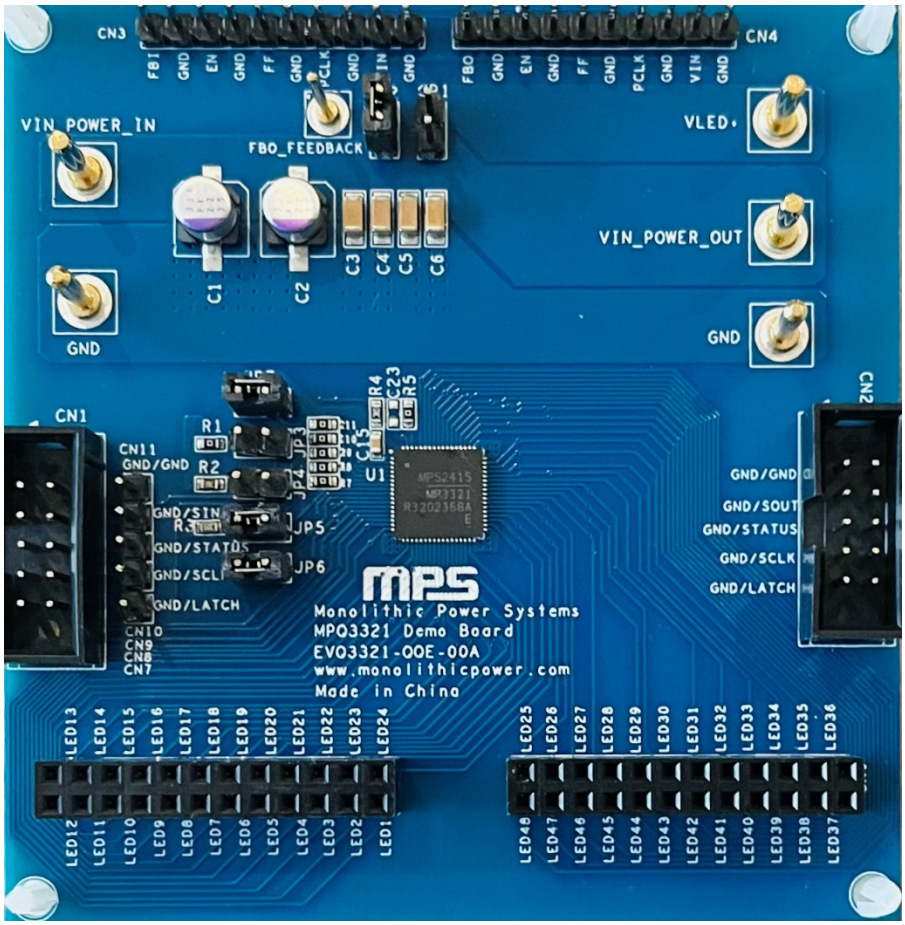
EVQ3321-QQE-00A EVALUATION BOARD



LxWxH (8.1cmx8.3cmx2cm)

Board Number	MPS IC Number
EVQ3321-QQE-00A	MPQ3321GQQE-AEC1, MPQ3321AGQQE-AEC1

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QUICK START GUIDE

The EVQ3321-QQE-00A evaluation board is easy to set up and use to evaluate the performance of the MPQ3321 and MPQ3321A. To use the evaluation board, following the steps below:

1. Short JP2 to connect VIN_POWER_IN to the IC's VIN pin.
2. Short one of the jumpers (JP3, JP4, or JP5) to use the internal PCLK. Short the jumper to enable the internal PCLK:
   a. JP3: 5MHz
   b. JP4: 10MHz
   c. JP5: 20MHz
3. Short JP6 to set the IC to the master mode if the adaptive feedback control (AFC) function is enabled.
4. Short JP7 to connect the IC's SOUT pin to the host's MISO pin.
5. Connect the LED load terminals (48 strings) to:
   a. Positive (+): VIN_POWER_OUT
   b. Negative (-): LED1~LED48
6. Preset the voltage source placed between the VIN_POWER_IN and GND terminals to be between 3V and 22V, according to the LED load condition.
7. Pull the EN pin high to enable the device.
8. Connect the SIN, SCLK, LATCH, SOUT, and GND pins of the evaluation board to the MOSI, SCK, CS, MISO, and GND pins of the serial peripheral interface (SPI) communication kit, respectively. (1)
9. Configure the registers by using the MPQ3321's GUI via the SPI interface. (2)

Notes:

1) Contact an MPS FAE to obtain the SPI communication kit.
2) Contact an MPS FAE to obtain the MPQ3321 GUI configuration tool for more details on configuring the registers during evaluation.

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EVALUATION BOARD SCHEMATIC

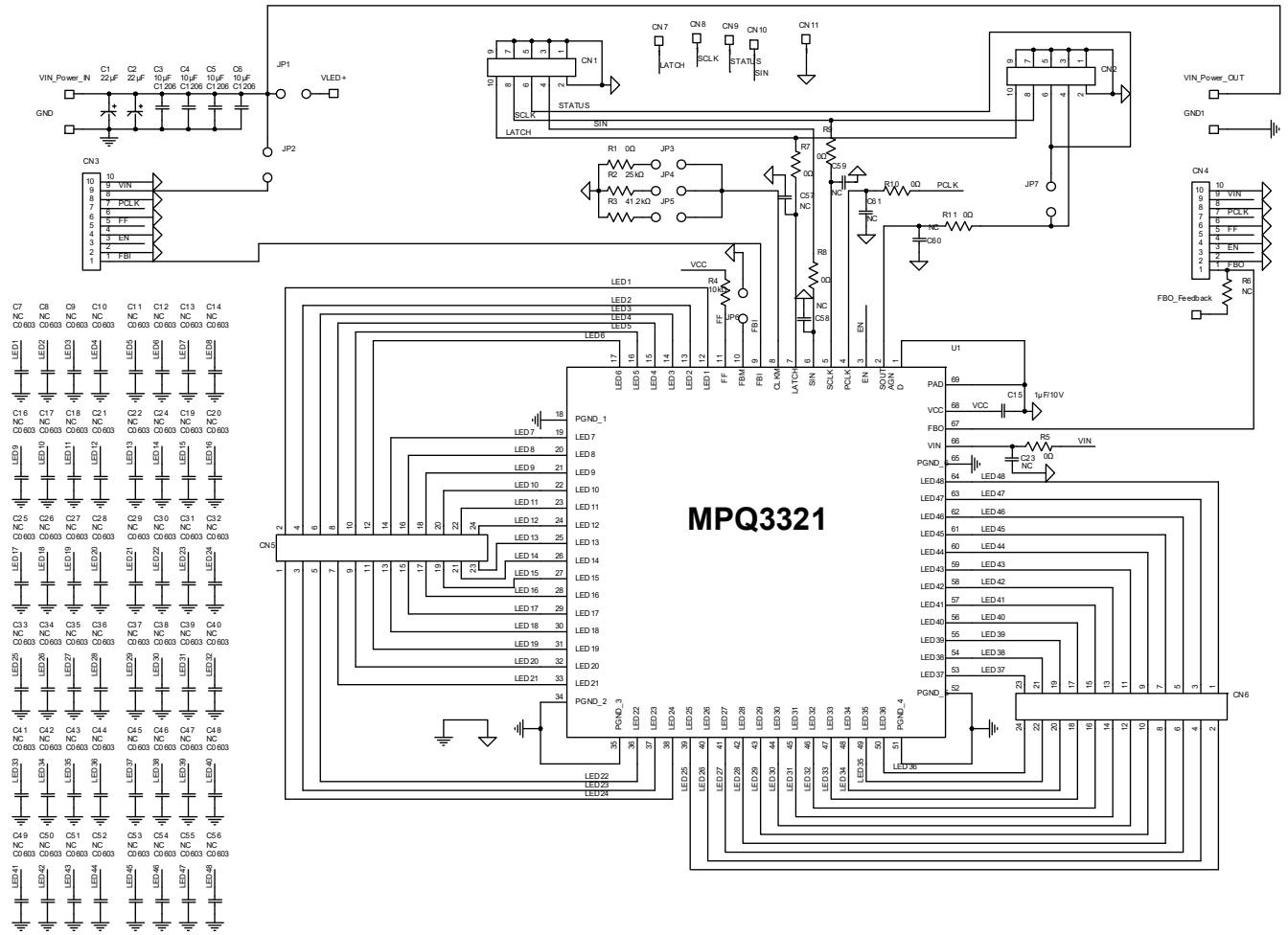

Figure 1: Evaluation Board Schematic

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EVQ3321-QQE-00A BILL OF MATERIALS

Qty	Ref	Value	Description	Package	Manufacturer	Manufacturer PN
24	CN1, CN2, CN3, CN4,CN5, CN6, CN7, CN8, CN9, CN10, CN11, FBO_Feedback, GND1, VLED+, VIN_Power_OUT, VIN_Power_IN, GND, JP1, JP2, JP3, JP4, JP5, JP6, JP7	2.54mm	Connector, 180°	CONN/TP	Custom (3)	
2	C1, C2	22µF	Capacitor, 50V, SMD	SMD	Panasonic	EEHZC1H220P
4	C3, C4, C5, C6	10µF	Capacitor, 25V, X7R, 1206	1206	Wurth	885012208069
54	C7, C8, C9, C10, C11, C12, C13, C14, C16, C17, C18, C19, C20, C21, C22, C23, C24, C25 ,C26, C27, C28, C29, C30, C31, C32, C33, C34, C35, C36, C37, C38, C39, C40, C41, C42, C43, C44, C45, C46, C47, C48, C49, C50, C51, C52, C53, C54, C55, C56, C57, C58, C59, C60, C61	NC				
1	C15	1µF	Capacitor, 10V, X7R, 0603	0603	Wurth	885012206026
7	R1, R5, R7, R8, R9, R10, R11	0Ω	Film resistor, 1%, 0603	0603	Yageo	RC0603FR-070RL
1	R2	24.9kΩ	Film resistor, 1%, 0603	0603	Yageo	RC0603FR-0724K9L
1	R3	41.2kΩ	Film resistor, 1%, 0603	0603	Yageo	RC0603FR-0741K2L
1	R4	10kΩ	Film resistor, 1%, 0603	0603	Yageo	RC0603FR-0710KL
1	R6	NC	Film resistor, 1%, 0603	0603		
1	U1	MPQ3321-AEC1 or MPQ3321A-AEC1	48-channel, 80mA/ch LED driver	QFN-68 (8mmx 8mm)	MPS	MPQ3321GQQE-AEC1 or MPQ3321AGQQE-AEC1

Note:

3) MPS custom-produces these pins. Contact an MPS FAE for details.

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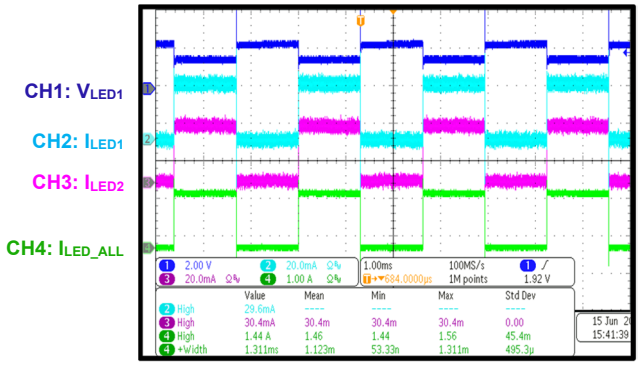
EVB TEST RESULTS

V_{IN} = 4V, f_{PCLK} = 25MHz, PDB = 16-bit, I_{MAX} = 30mA/ch, LED = 48P1S, T_A = 25°C, unless otherwise noted.

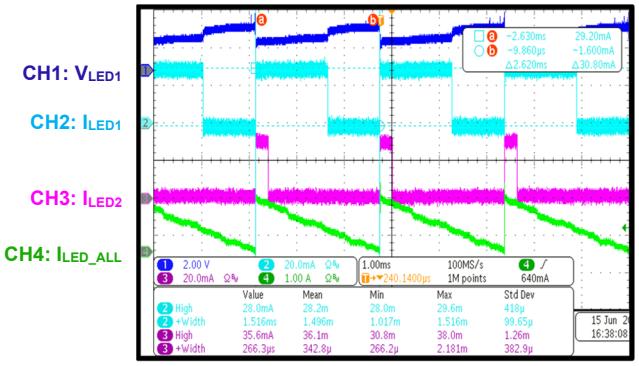
PWM Dimming

PWM duty cycle = 50% for each channel



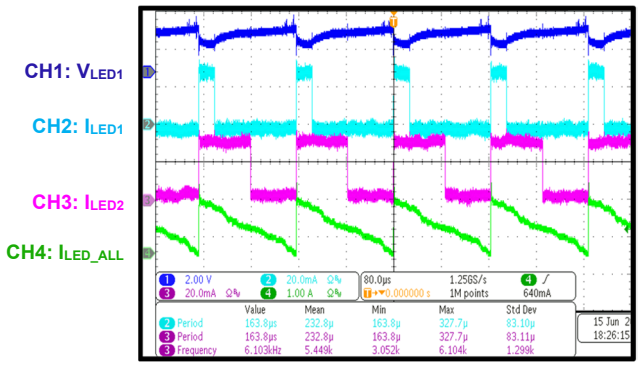
PWM Dimming

Random duty cycle for each channel



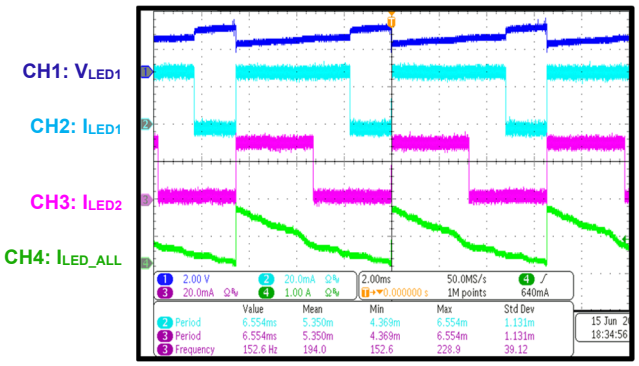
PWM Dimming

PDB = 12-bit, random duty cycle for each channel



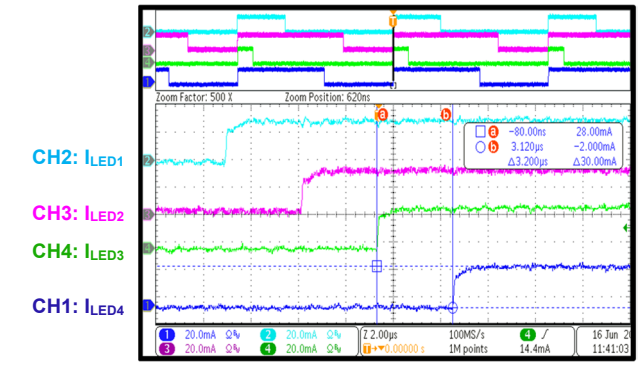
PWM Dimming

f_{PCLK} = 10MHz, random duty cycle for each channel



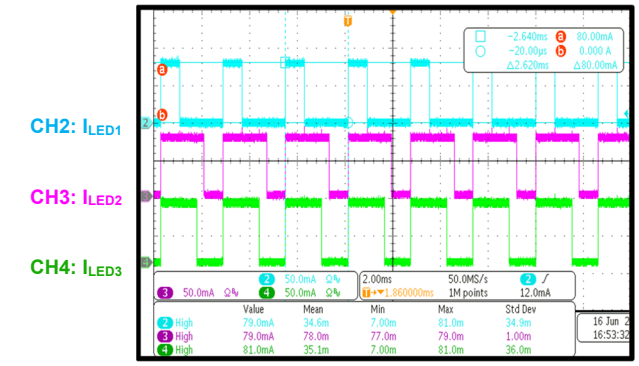
PWM Dimming

f_{PCLK} = 20MHz, phase shift = 64pclk, time delay = 3.2µs



Analog Dimming

I_{MAX} = 80mA/ch, I_{LED} = 100% for each channel



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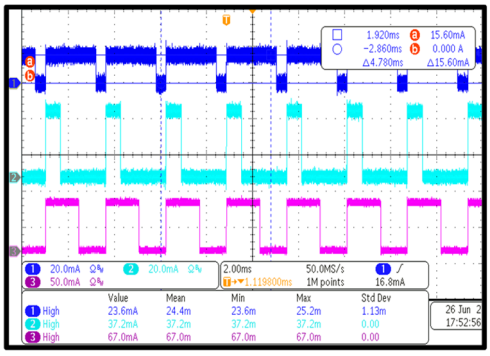
EVB TEST RESULTS *(continued)*

V_{IN} = 4V, f_{PCLK} = 25MHz, PDB = 16-bit, I_{MAX} = 30mA/ch, LED = 48P1S, T_A = 25°C, unless otherwise noted.

Analog Dimming

I_{MAX} = 80mA/ch, random I_{LED} for each channel

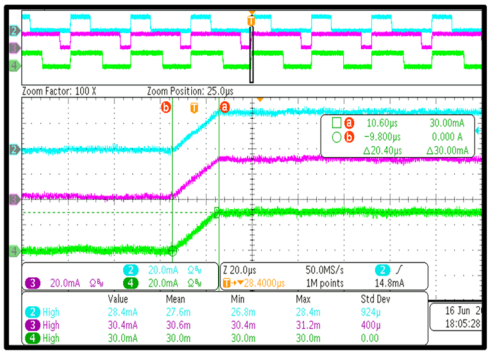
CH1: I_{LED1}
CH2: I_{LED2}
CH3: I_{LED3}



Analog Dimming

Slew rate = 4PCLK/step

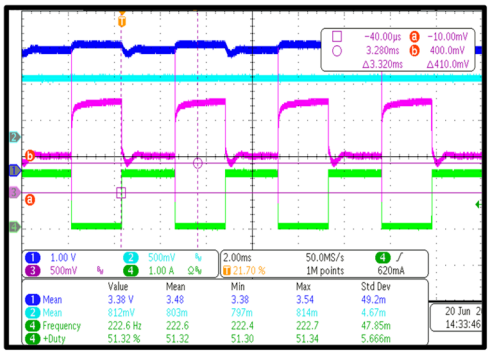
CH2: I_{LED1}
CH3: I_{LED2}
CH4: I_{LED3}



Adaptive Feedback Control (AFC)

Headroom = 300mV, hysteresis = 200mV, PWM duty cycle = 51.32%, slew rate = 1PCLK/step

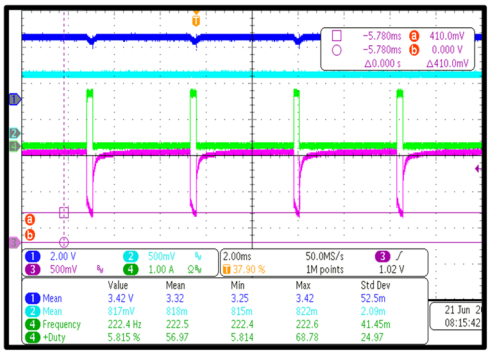
CH2: V_{FBO}
CH1: V_{LED}
CH3: V_{LED1}
CH4: I_{LED1}



Adaptive Feedback Control (AFC)

Headroom = 300mV, hysteresis = 200mV, PWM duty cycle = 5.82%, phase shift = 1PCLK

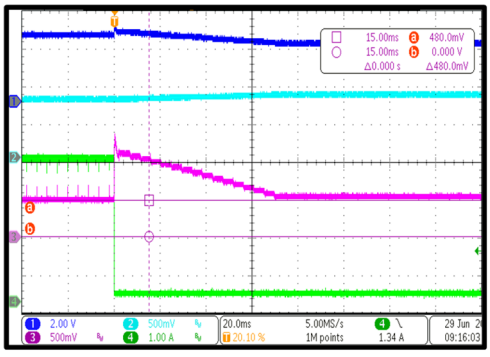
CH1: V_{LED}
CH2: V_{FBO}
CH4: I_{LED1}
CH3: V_{LED1}



Adaptive Feedback Control (AFC)

Headroom = 300mV, hysteresis = 200mV, I_{MAX} = 80mA/string, I_{LED} from 100% to 5%

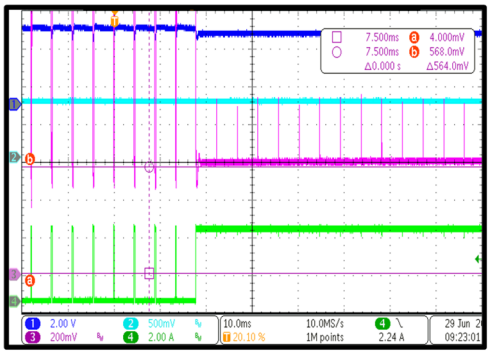
CH1: V_{LED}
CH2: V_{FBO}
CH3: V_{LED1}
CH4: I_{LED_TOTAL}



Adaptive Feedback Control (AFC)

I_{MAX} = 80mA/string, PWM duty cycle from 100% to 5%, I_{LED} = 100%

CH1: V_{LED}
CH2: V_{FBO}
CH3: V_{LED1}
CH4: I_{LED_TOTAL}



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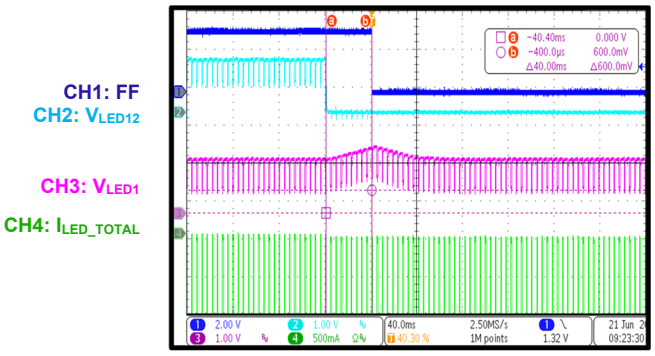
EVB TEST RESULTS *(continued)*

V_{IN} = 4V, f_{PCLK} = 25MHz, PDB = 16-bit, I_{MAX} = 30mA/ch, LED = 48P1S, T_A = 25°C, unless otherwise noted.

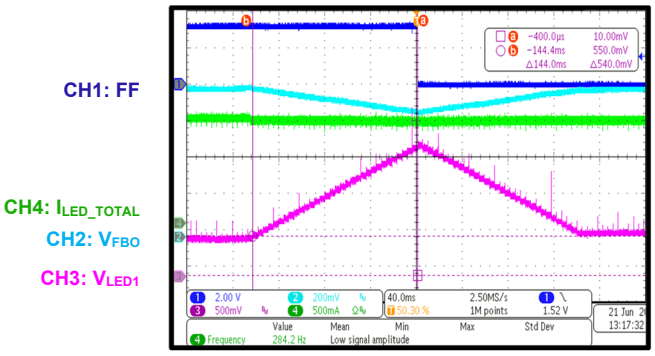
Open LED Protection

OPS = 8 steps, open channel 12



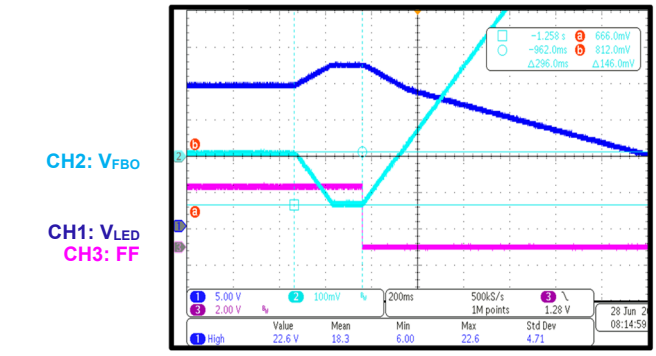
Open LED Protection

OPS = 32 steps, open channel 12



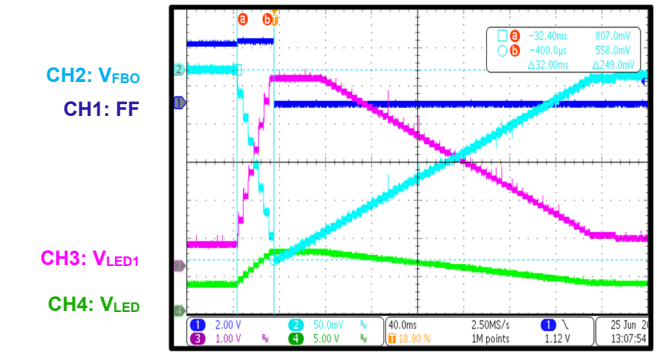
Open LED Protection

OVP = 22V, open channel 12



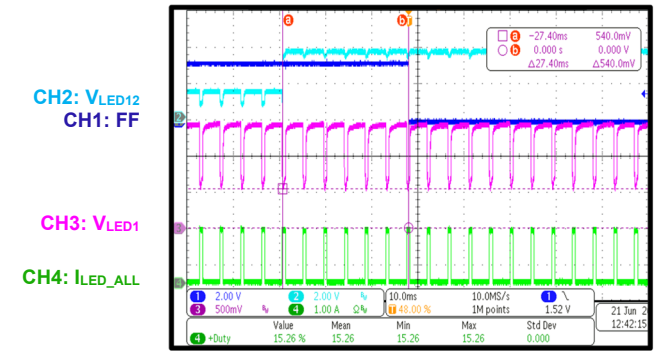
Open LED Protection

Step-up = 8 steps, open channel 12

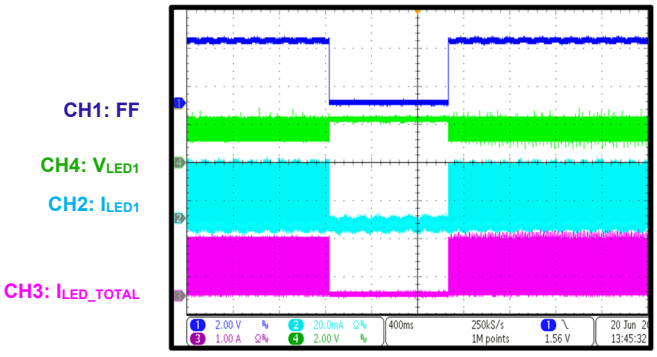


Short LED Protection

Short channel 12



Over-Temperature Protection



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PCB LAYOUT

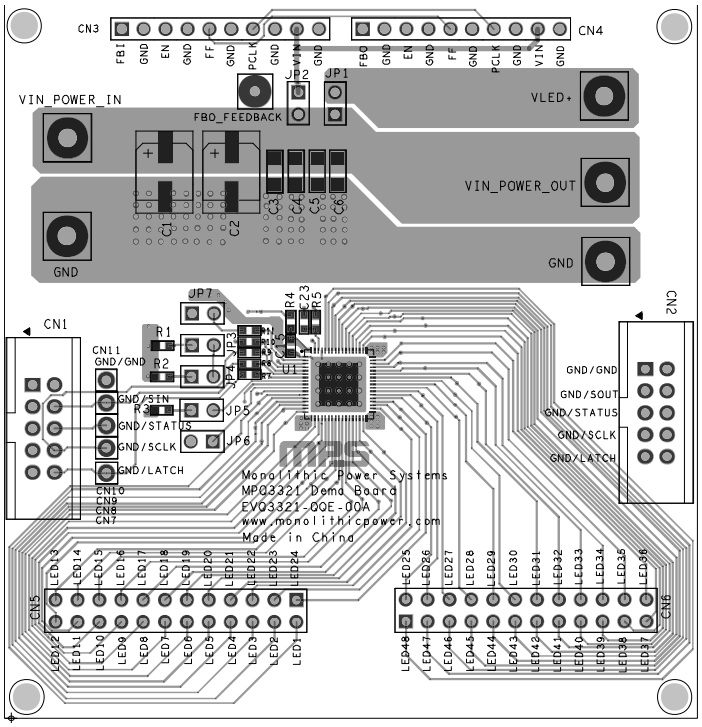

Figure 2: Top Layer

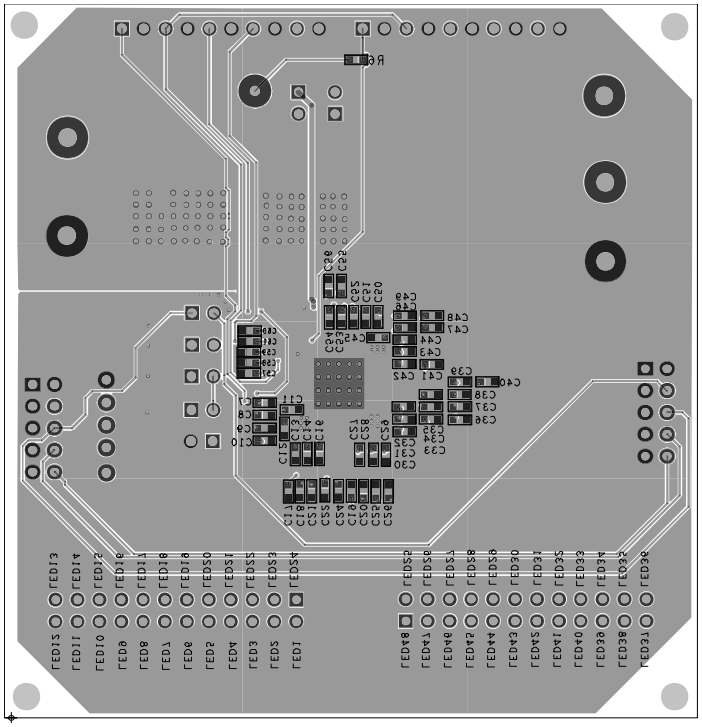

Figure 3: Bottom Layer

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REVISION HISTORY

Revision #	Revision Date	Description	Pages Updated
1.0	11/8/2024	Initial Release	-
1.1	12/4/2025	Added the MPQ3321A as a supported IC in the Description section.	1
		Added the MPQ3321A as a supported IC in the EVQ3321-QQE-00A Evaluation Board section.	2
		Added the MPQ3321A as a supported IC in the Quick Start Guide section.	3
		Added the MPQ3321A as a supported IC in the EVQ3321-QQE-00A Bill of Materials section.	5

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