EVQ7220-R-00A

6-Channel, Max 100mA/Ch Boost LED Driver Evaluation Board

DESCRIPTION

The EVQ7220-R-00A evaluation board is designed to demonstrate the capabilities of MPS's MPQ7220GR-AEC1.

The MPQ7220 is a boost converter with six channel current sources. It is designed for driving automotive tail lights.

The MPQ7220 uses peak current mode as its PWM control architecture. The switching frequency can be programmed by a resistor. It independently regulates the current in each LED string to the value set by an external current-setting resistor.

The EVQ7220-R-00A is a fully assembled and tested, boost LED driver evaluation board. It generates an LED current up to 100mA from a 3.5V to 36V input range with a 450kHz switching frequency.

ELECTRICAL SPECIFICATIONS

Parameter	Symbol	Value	Units
Input voltage	V_{EMI}	3.5 to 36	V
Output voltage	V_{LED}	<42	V
LED current/string	I_{LED}	100	mA
# LEDs	-	6 strings	-

FEATURES

- 3.5V to 36V Input Voltage Range
- Six Channels with Max 100mA per Channel
- Internal 100mΩ, 50V MOSFET
- Configurable f_{SW} Up to 2.2MHz
- External Sync SW Function
- PWM Dimming (100Hz to 20kHz Dimming Frequency)
- Excellent EMI Performance, Spread Spectrum
- Disconnect V_{OUT} from V_{IN}
- 2.5% Current Matching
- Cycle-by-Cycle Current Limiting
- Configurable LED Short and OVP Thresholds
- LED Current Auto-Decrement at High Temperatures
- Protections: LED Short/Open, OTP, OCP, Inductor Short, Fault Indicator Signal Output
- Available in a QFN-24 (4mmx4mm) Package
- Available in AEC-Q100 Grade 1

APPLICATIONS

- Automotive Tail Lights

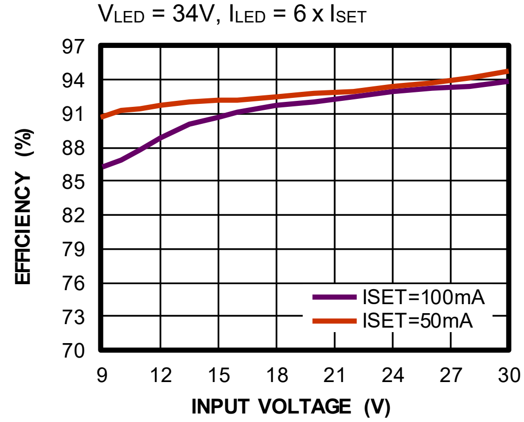
EVQ7220-R-00A EVALUATION BOARD

(LxWxH) 8.3cmx8.3cmx2cm

Board Number	MPS IC Number
EVQ7220-R-00A	MPQ7220GR-AEC1

Efficiency vs. Input Voltage

V_{LED} = 34V, I_{LED} = 6 x I_{SET}



QUICK START GUIDE

1. Provide a voltage source between 3.5V and 36V between the VEMI terminal and GND.
2. If longer cables (>0.5m total) are used between the source and the EVB, install a damping capacitor at the input terminals. This is critical when V_{EMI} exceeds 24V.
3. Connect the LED load terminals to:
   a. Positive (+): LED+
   b. Negative (-): LED1~6
4. Drive EN above 1.2V to turn on the driver; drive EN below 0.4V to turn it off.
5. Apply a 100Hz to 20kHz PWM signal on the DIM pin for brightness control. Drive the DIM pin above 1.2V if the dimming function not used.
6. Calculate the LED current amplitude setting (I_{LED}) with Equation (1):

$$I_{LED}(mA) = \frac{1245}{R_{ISET}(k\Omega)} \quad (1)$$

   For R_{ISET} = 12.4kΩ, I_{LED} is 100mA.

7. The voltage divider sets the over-voltage protection (OVP) point (see Figure 1 on page 3). Calculate the OVP voltage (V_{OVP}) with Equation (2):

$$V_{OVP}(V) = 2V \times \frac{R_{11} + R_{12}}{R_{12}} \quad (2)$$

   The OVP point is typically set about 10% to 30% above the LED voltage.

8. The frequency can be configured via an external resistor or an external clock on the FREQ/SYNC pin. Calculate the switching frequency (f_{SW}) using Equation (3):

$$f_{SW}(kHz) = \frac{22000}{R_{FRE}(k\Omega)} \quad (3)$$

   For R_{FREQ} = 48.7kΩ, f_{SW} is set to 450kHz.

EVALUATION BOARD SCHEMATIC

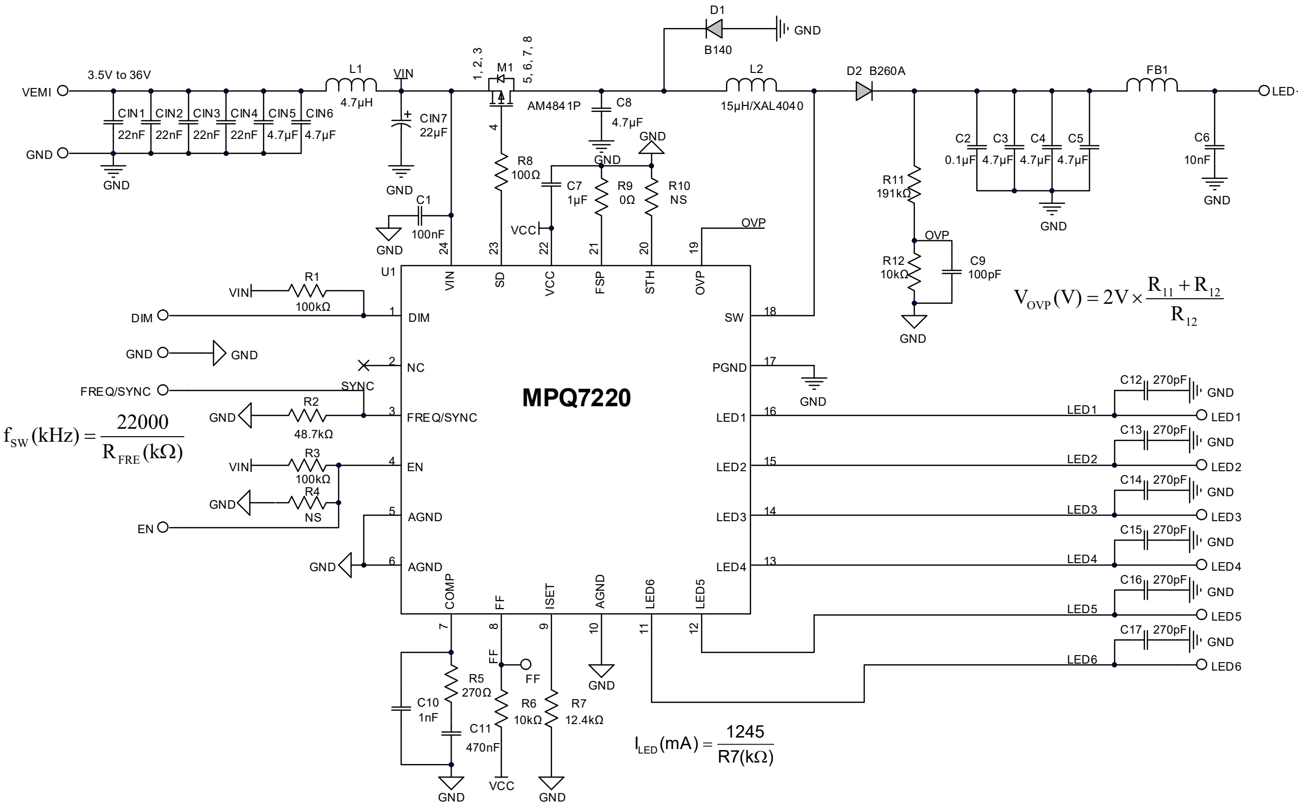
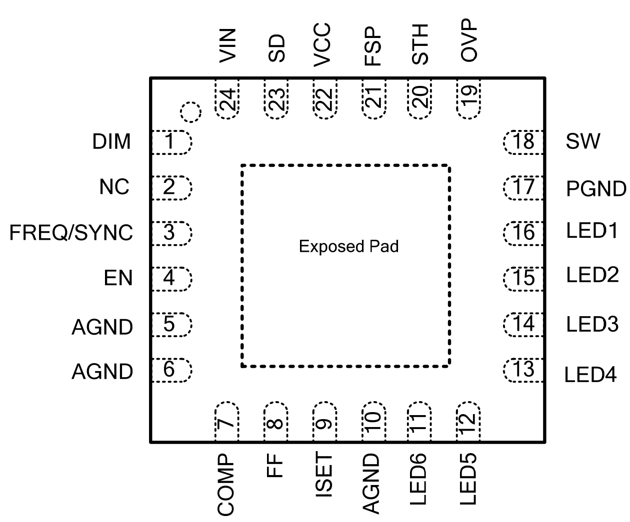


Figure 1: Evaluation Board Schematic

PACKAGE REFERENCE

TOP VIEW



QFN-24 (4mmx4mm)

EVQ7220-R-00A BILL OF MATERIALS

Qty	Ref	Value	Description	Package	Manufacturer	Manufacturer PN
4	CIN1, CIN2, CIN3, CIN4	22nF	Ceramic capacitor, 50V, X7R	0603	Murata	GRM188R71H223KA01D
5	CIN5, CIN6, C3, C4, C5	4.7μF	Ceramic capacitor, 50V, X7S	0805	Murata	GRM21BC71H475KE11L
1	CIN7	22μF	Electrolytic capacitor, 50V	SMD	Panasonic	EEHZC1H220P
2	C1, C2	100nF	Ceramic capacitor, 50V, X7R	0603	Murata	GCM188R71H104KA57D
1	C6	10nF	Ceramic capacitor, 50V, X7R	0805	TDK	C2012X7R1H103K
1	C7	1μF	Ceramic capacitor, 16V, X7R	0805	Murata	GRM21BR71C105KA01
1	C8	4.7μF	Ceramic capacitor, 50V, X7R	1210	Murata	GCM32ER71H475KA55L
1	C9	100pF	Ceramic capacitor, 50V, C0G	0603	Murata	GRM1885C1H101JA01D
1	C10	1nF	Ceramic capacitor, 50V, C0G	0603	Murata	GRM1885C1H102JA01D
1	C11	470nF	Ceramic capacitor, 16V, X7R	0603	Murata	GRM188R71C474KA88D
6	C12, C13, C14, C15, C16, C17	270pF	Ceramic capacitor, 50V, C0G	0603	Murata	GRM1885C1H271JA01D
1	D1	1A	Schottky diode, 40V	SMA	Diodes, Inc.	B140-13-F
1	D2	2A	Schottky diode, 60V	SMA	Diodes, Inc.	B260A-13-F
1	L1	4.7μH	Inductor, 150mΩ, 2.5A	SMD	Cyntec	VCTA32251B-4R7MS6-89
1	L2	15μH	Inductor, 120mΩ, 2.8A	SMD	Coilcraft	XAL4040-153MEB
1	FB1	1.1A	Magnetic Bead, 1000	0805	Murata	BLM21SP102SN1
1	M1	-40V	P-Channel MOSFET	SO-8	Analog Power	AM4841P
2	R1, R3	100kΩ	Film resistor, 1%	0603	Yageo	RC0603FR-07100KL
1	R2	48.7kΩ	Film resistor, 1%	0603	Yageo	RC0603FR-0748K7L
1	R4	NS				
1	R5	270 Ω	Film resistor, 1%	0603	Yageo	RC0603FR-07270RL
2	R6, R12	10kΩ	Film resistor, 1%	0603	Yageo	RC0603FR-0710KL
1	R7	12.4kΩ	Film resistor, 1%	0603	Yageo	RC0603FR-0712K4L
1	R8	100Ω	Film resistor, 1%	0603	Yageo	RC0603FR-07100RL
1	R9	0 Ω	Film resistor, 1%	0603	Yageo	RC0603FR-070RL
1	R10	NS				
1	R11	191kΩ	Film resistor, 1%	0603	Yageo	RC0603FR-07191KL

EVQ7220-R-00A BILL OF MATERIALS *(continued)*

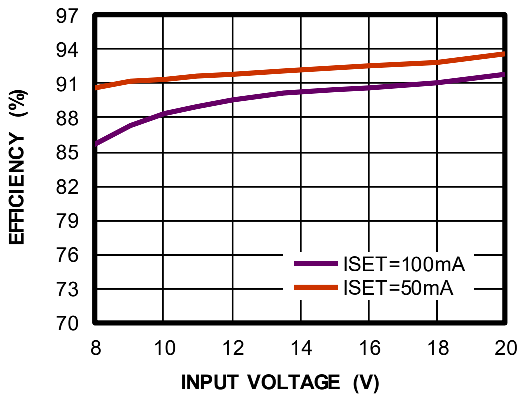
Qty	Ref	Value	Description	Package	Manufacturer	Manufacturer PN
1	U1	MPQ7220	6-channel boost LED driver	QFN-24 (4mmx4mm)	MPS	MPQ7220GR-AEC1
2	VEMI, GND	2mm	Golden pin	Terminal	Custom	
13	DIM, SYNC, EN, FF, GND, LED1-LED6, LED+	2.54mm	13-header test pin	Header	Custom	

EVB TEST RESULTS

Performance curves and waveforms are tested on the evaluation board. V_{IN} = 12V, L = 15µH, LED = 6P12S, f_{SW} = 450kHz, I_{SET} = 100mA, T_A = 25°C, unless otherwise noted.

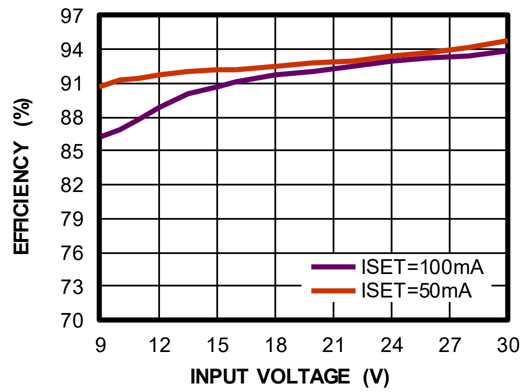
Efficiency with 6P8S LED

V_{LED} = 23V, I_{LED} = 6 x I_{SET}



Efficiency with 6P12S LED

V_{LED} = 34V, I_{LED} = 6 x I_{SET}

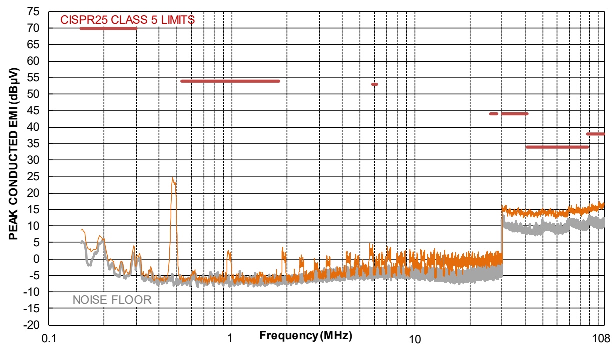


EVB TEST RESULTS *(continued)*

Performance curves and waveforms are tested on the evaluation board. V_{IN} = 12V, L = 15µH, LED = 6P12S, f_{SW} = 450kHz, I_{SET} = 100mA, with EMI filters, T_A = 25°C, unless otherwise noted.

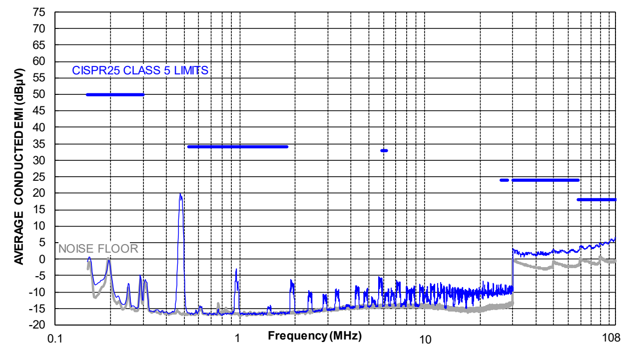
CISPR25 Class 5 Peak Conducted Emissions

150kHz to 108MHz



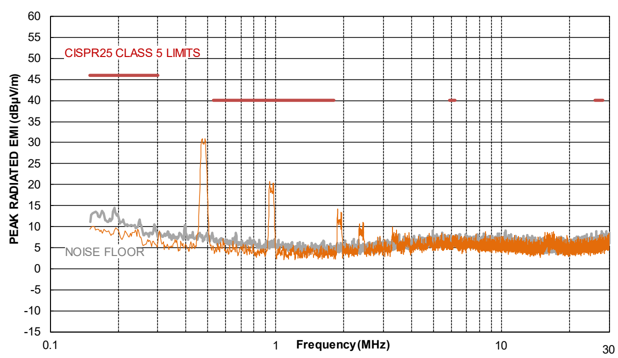
CISPR25 Class 5 Average Conducted Emissions

150kHz to 108MHz



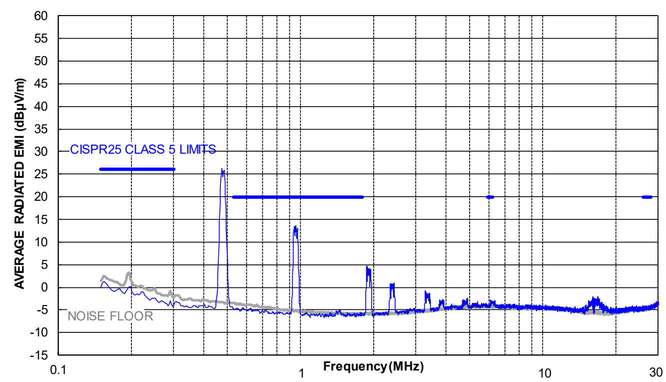
CISPR25 Class 5 Peak Radiated Emissions

150kHz to 30MHz



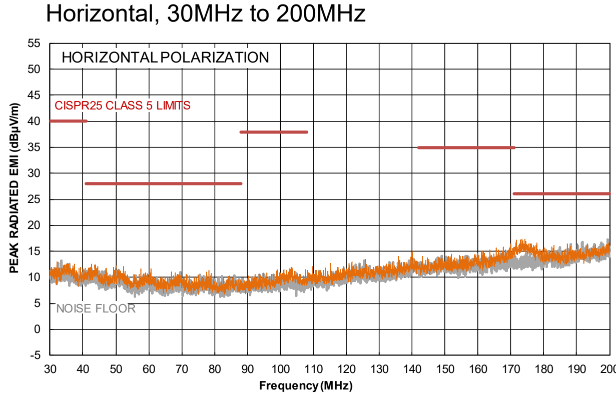
CISPR25 Class 5 Average Radiated Emissions

150kHz to 30MHz



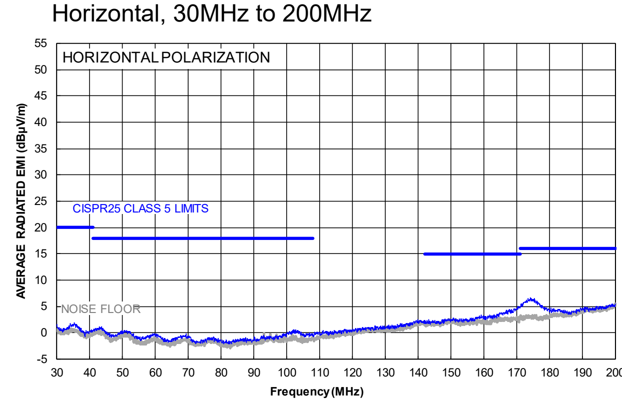
CISPR25 Class 5 Peak Radiated Emissions

Horizontal, 30MHz to 200MHz



CISPR25 Class 5 Average Radiated Emissions

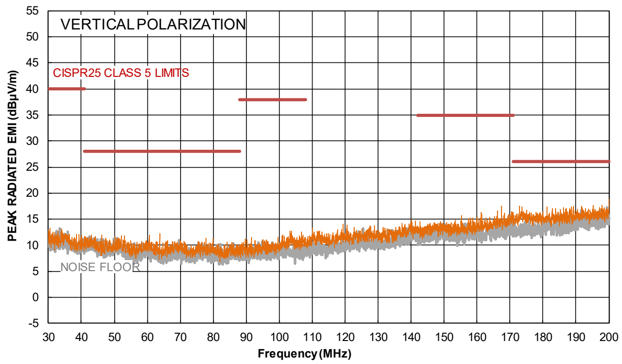
Horizontal, 30MHz to 200MHz



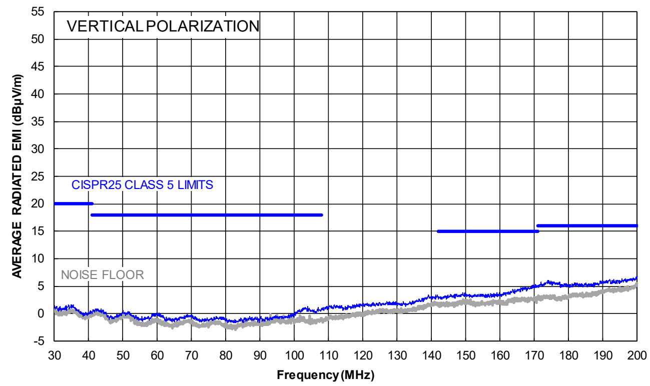
EVB TEST RESULTS *(continued)*

Performance curves and waveforms are tested on the evaluation board. V_{IN} = 12V, L = 15µH, LED = 6P12S, f_{SW} = 450kHz, I_{SET} = 100mA, with EMI filters, T_A = 25°C, unless otherwise noted.

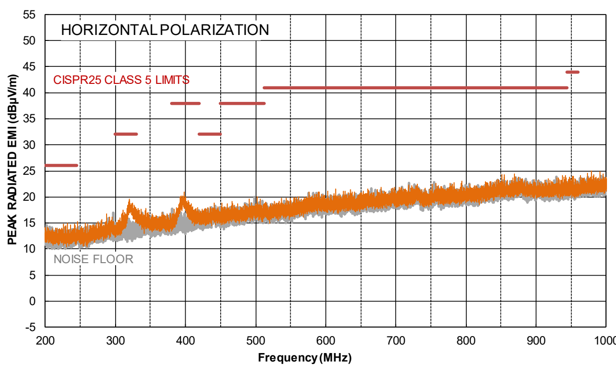
CISPR25 Class 5 Peak Radiated Emissions
Vertical, 30MHz to 200MHz



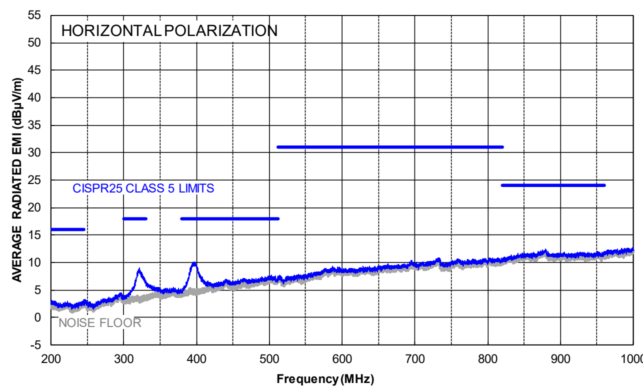
CISPR25 Class 5 Average Radiated Emissions
Vertical, 30MHz to 200MHz



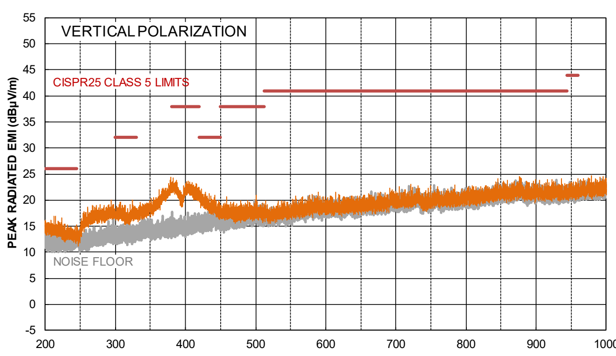
CISPR25 Class 5 Peak Radiated Emissions
Horizontal, 200MHz to 1GHz



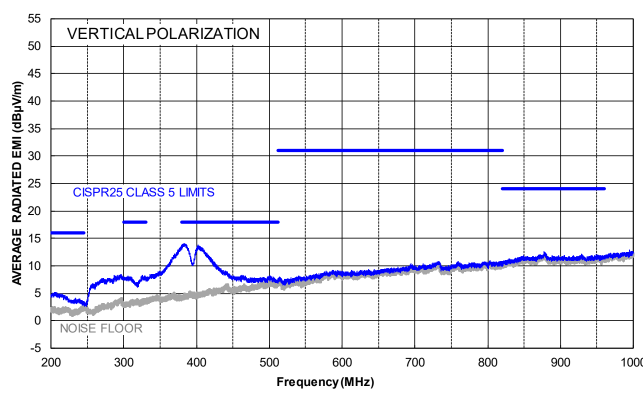
CISPR25 Class 5 Average Radiated Emissions
Horizontal, 200MHz to 1GHz



CISPR25 Class 5 Peak Radiated Emissions
Vertical, 200MHz to 1GHz



CISPR25 Class 5 Average Radiated Emissions
Vertical, 200MHz to 1GHz

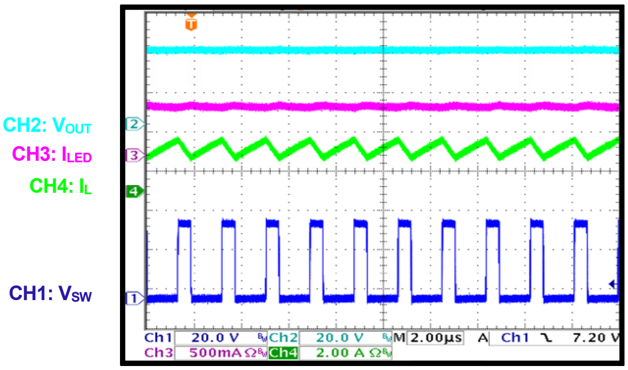


EVB TEST RESULTS *(continued)*

Performance curves and waveforms are tested on the evaluation board. V_{IN} = 12V, L = 15μH, LED = 6P12S, f_{SW} = 450kHz, I_{SET} = 100mA, T_A = 25°C, unless otherwise noted.

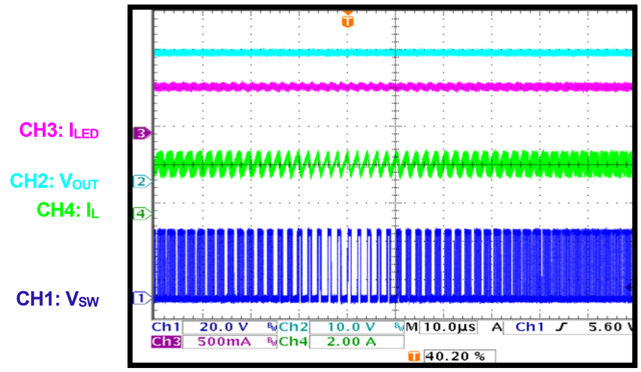
Steady State

I_{SET} = 100mA



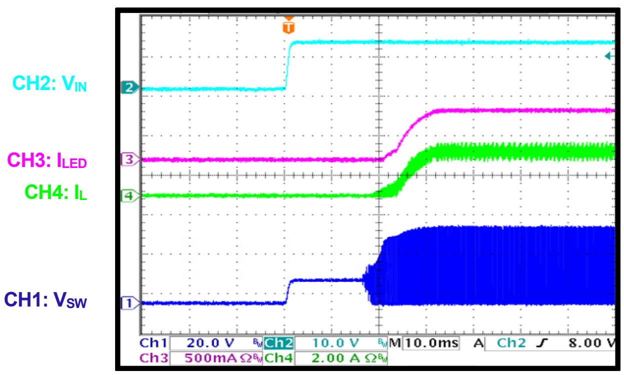
Frequency Spread Spectrum

1/20 of the center frequency



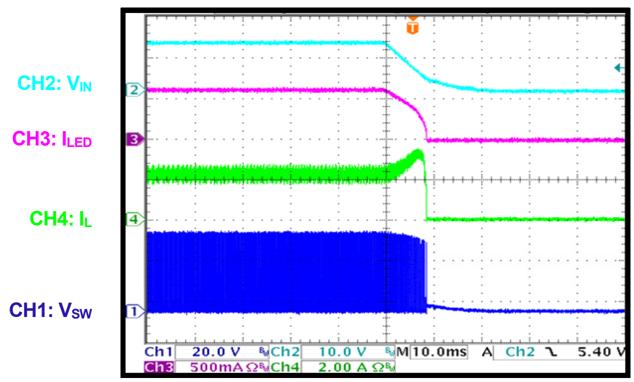
Start-Up through VIN

I_{SET} = 100mA



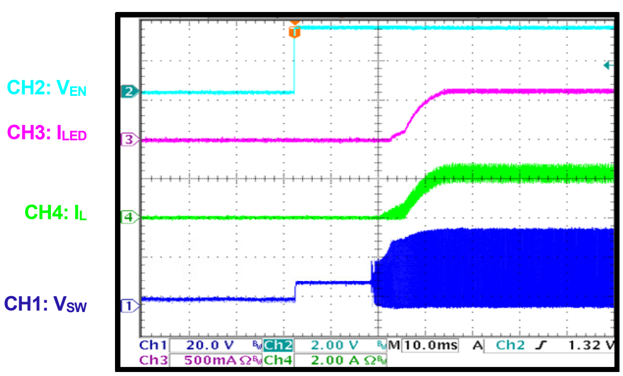
Shutdown through VIN

I_{SET} = 100mA



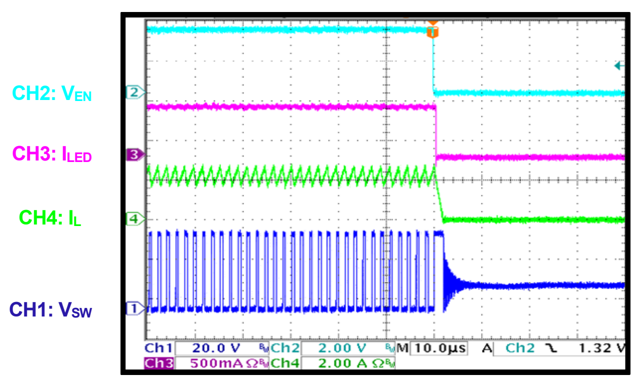
Start-Up through EN

I_{SET} = 100mA



Start-Up through EN

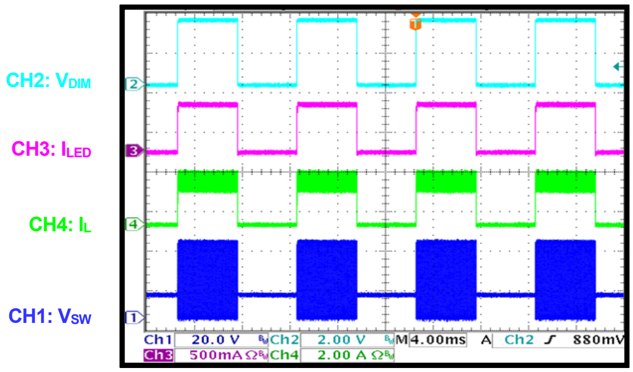
I_{SET} = 100mA



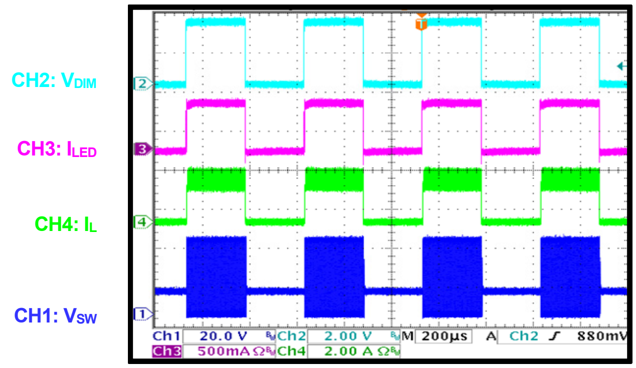
EVB TEST RESULTS *(continued)*

Performance curves and waveforms are tested on the evaluation board. V_{IN} = 12V, L = 15µH, LED = 6P12S, f_{SW} = 450kHz, I_{SET} = 100mA, T_A = 25°C, unless otherwise noted.

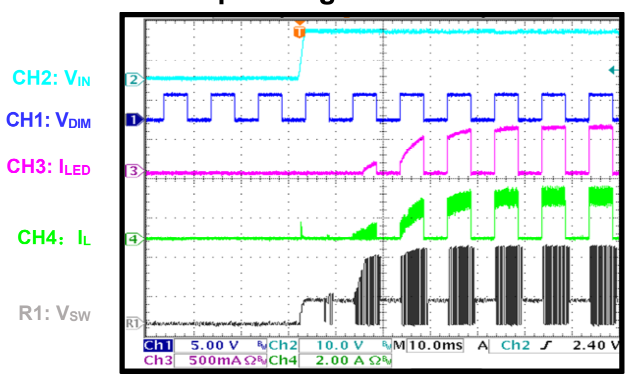
PWM Dimming Steady State
Dimming frequency = 100Hz



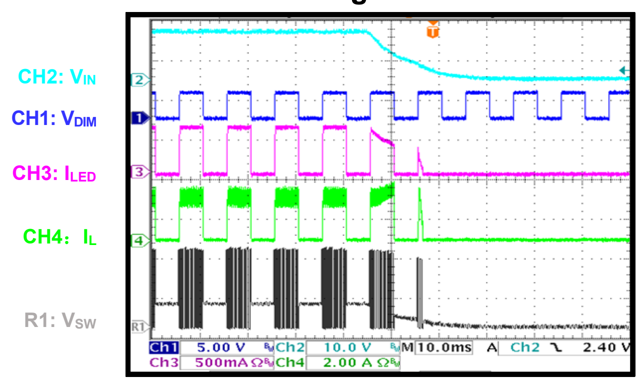
PWM Dimming Steady State
Dimming frequency = 2kHz



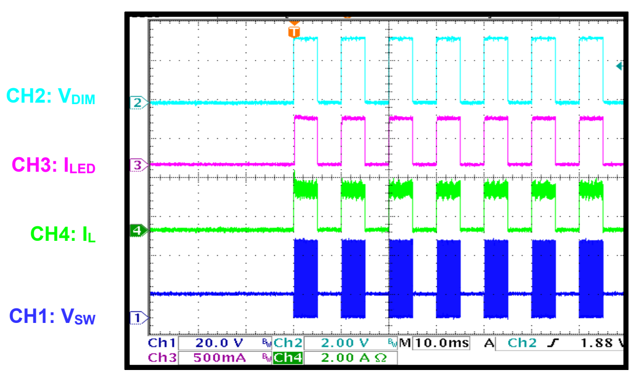
PWM Dimming
Start-Up through VIN



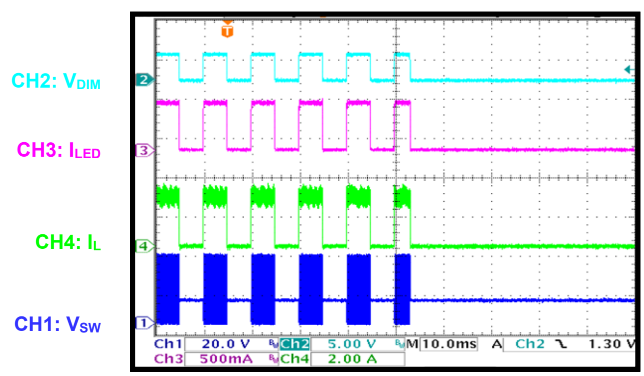
PWM Dimming
Shutdown through VIN



PWM Dimming On



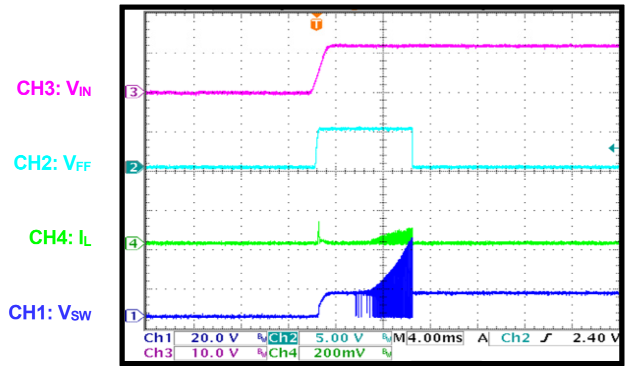
PWM Dimming Off



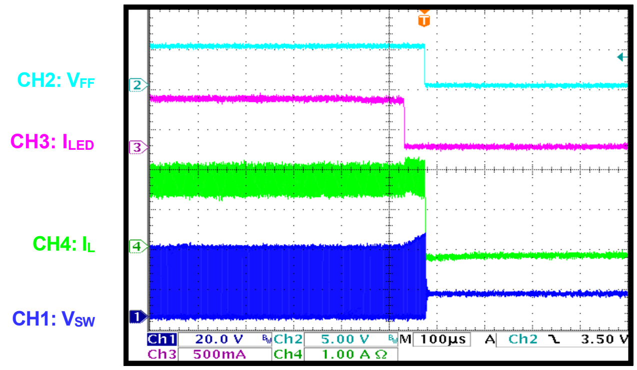
EVB TEST RESULTS *(continued)*

Performance curves and waveforms are tested on the evaluation board. V_{IN} = 12V, L = 15µH, LED = 6P12S, f_{SW} = 450kHz, I_{SET} = 100mA, T_A = 25°C, unless otherwise noted.

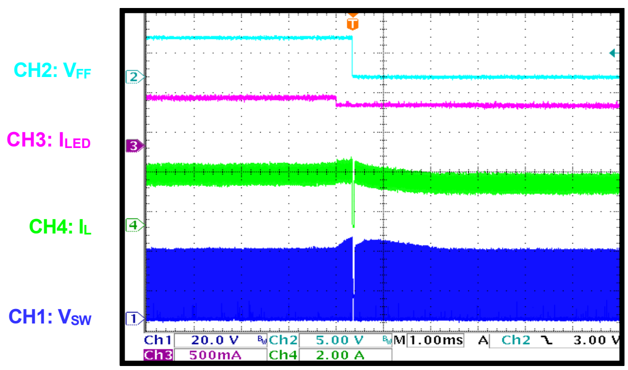
All 6 Strings LED Open Power On



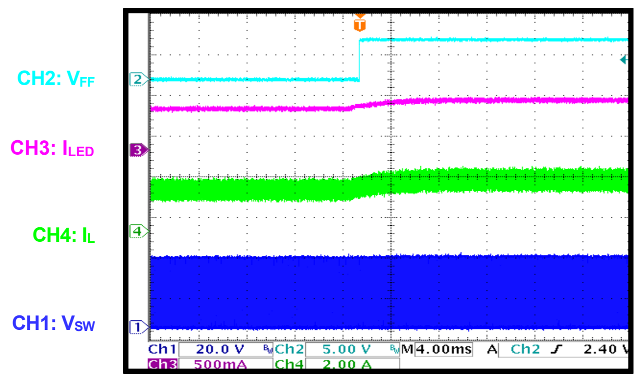
All 6 Strings LED Open Entry



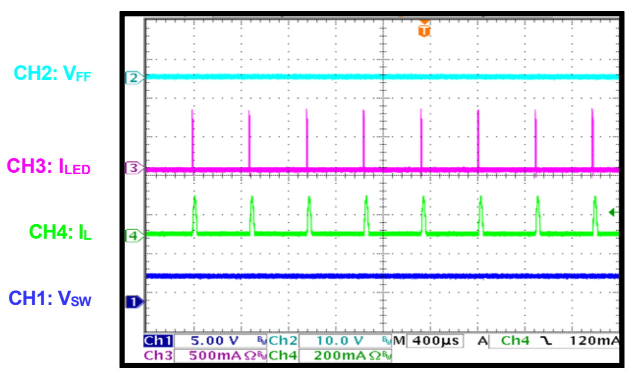
1 String LED Open Entry



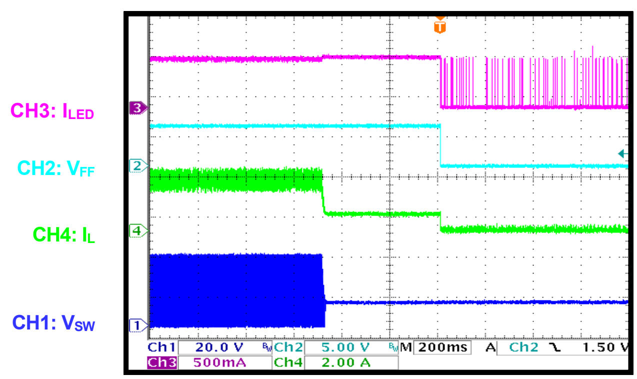
1 String LED Open Recovery



V_{OUT} Short to LEDx Steady State



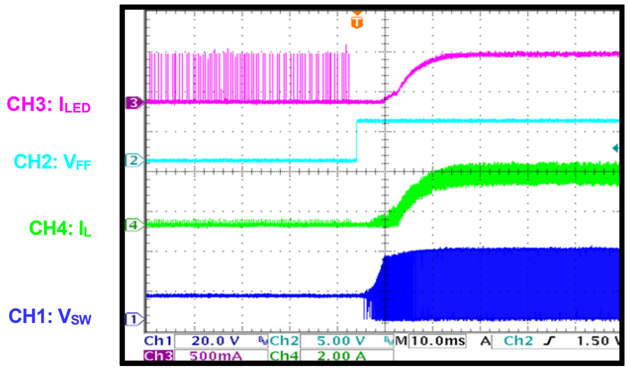
V_{OUT} Short to LEDx Entry



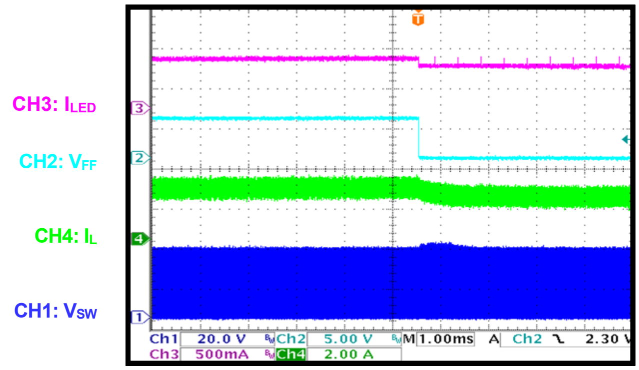
EVB TEST RESULTS *(continued)*

Performance curves and waveforms are tested on the evaluation board. V_{IN} = 12V, L = 15µH, LED = 6P12S, f_{SW} = 450kHz, I_{SET} = 100mA, T_A = 25°C, unless otherwise noted.

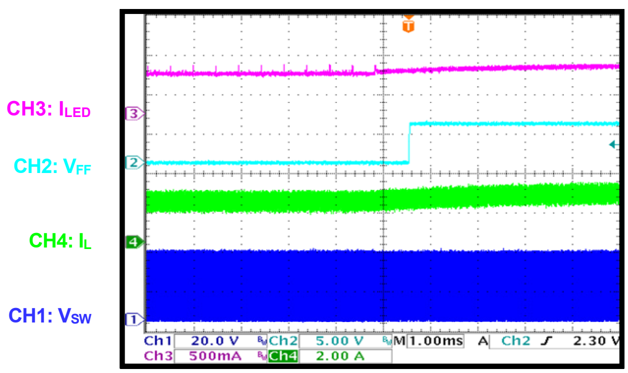
V_{OUT} Short to LEDx Recovery



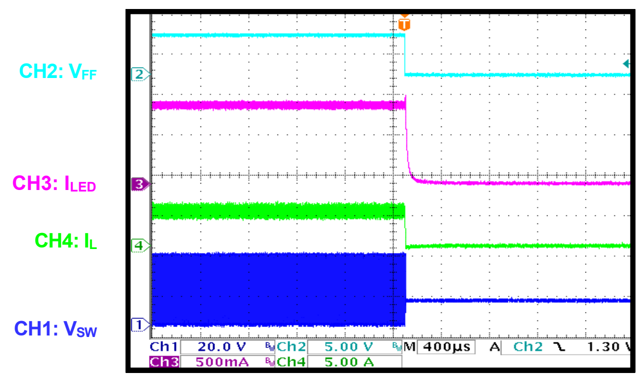
V_{OUT} Short to LED1 Entry



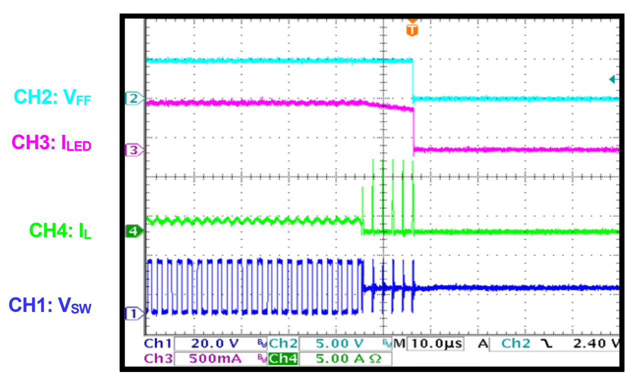
V_{OUT} Short to LED1 Recovery



LEDx Short to GND Entry



Inductor Short Entry



PCB LAYOUT

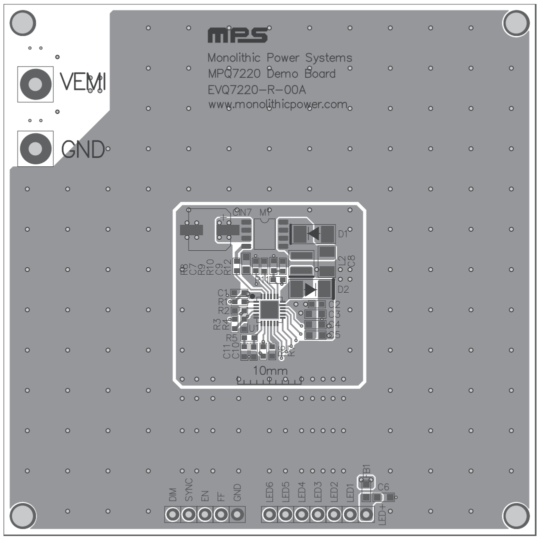


Figure 2: Top Silk Layer and Top Layer

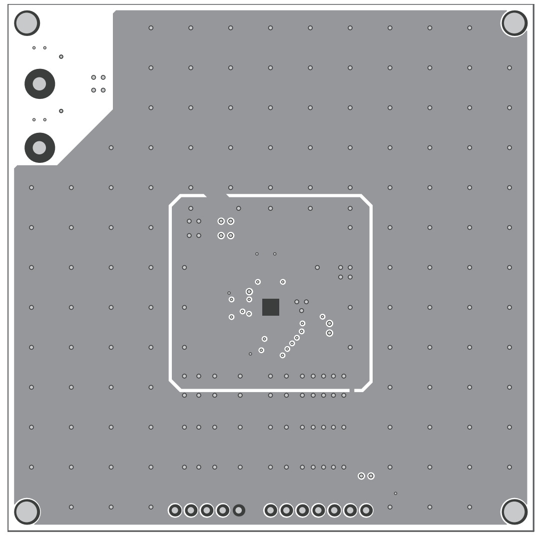


Figure 3: Mid-Layer 1

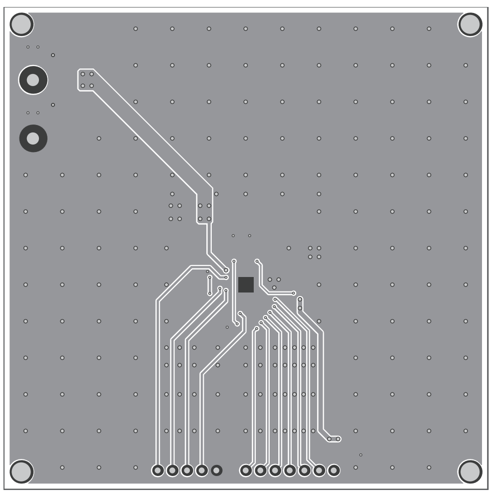


Figure 4: Mid-Layer 2

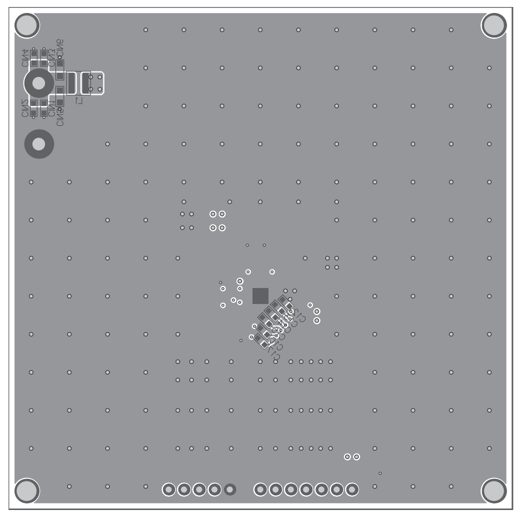


Figure 5: Bottom Layer and Bottom Silk

REVISION HISTORY

Revision #	Revision Date	Description	Pages Updated
1.0	4/13/2021	Initial Release	-