EV4425M-QB-00A

High Efficiency 1.5A, 36V, 2.2MHz Synchronous Step Down LED Driver Evaluation Board

DESCRIPTION

The EV4425M-QB-00A is an evaluation board for the MP/MPQ4425M.

MP/MPQ4425M is a high-efficiency, synchronous, rectified, step-down, switch-mode white LED driver with built-in power MOSFETs. It offers a very compact solution to achieve a 1.5A continuous output current with excellent load and line regulation over a wide input supply range. The MP/MPQ4425M has synchronous mode operation to get high efficiency.

The EV4425M-QB-00A is a fully assembled and tested evaluation board, which generates load current up to 1.5A from a 4V to 36V input range.

ELECTRICAL SPECIFICATIONS

Parameter	Symbol	Value	Units
Input Voltage	V_{IN}	4 – 36	V
Output Current	I_{OUT}	1.5	A

FEATURES

- EMI Reduction Technique
- Wide 4V-to-36V Operating Input Range
- 85mΩ High-Side, 50mΩ Low-Side Internal Power MOSFETs
- High-Efficiency Synchronous Mode Operation
- Default 2.2MHz Switching Frequency
- PWM Dimming (Min 100Hz Dimming Frequency)
- Force CCM Mode
- 0.2V Reference Mode
- Internal Soft-Start
- Fault Indication for LED Short, Open and Thermal Shutdown
- Over-Current Protection (OCP) with Valley-Current Detection
- Proprietary Switching-Loss-Reduction Technology
- Thermal Shutdown
- Available in a QFN-13 (2.5mmx3mm) Package
- CISPR25 Class5 Compliant
- AEC-Q100 Grade-1

APPLICATIONS

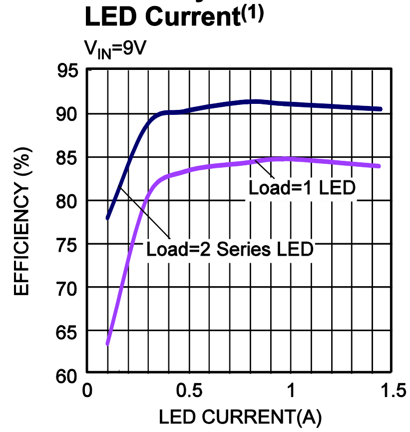
- Automotive LED Lighting

EVALUATION BOARD

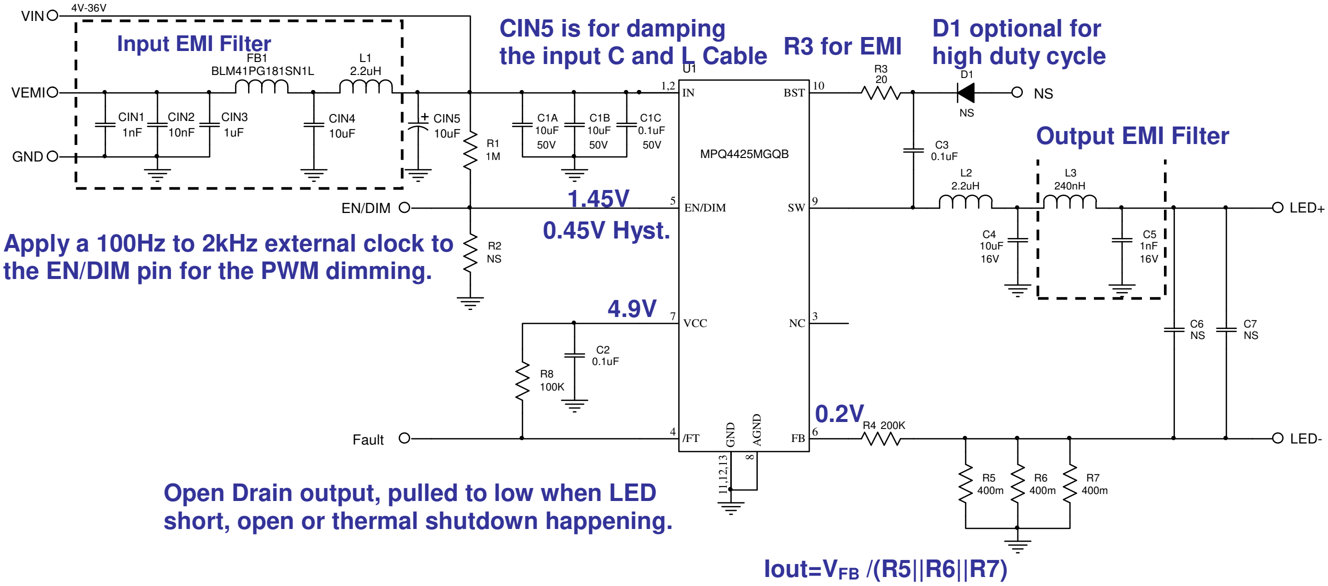
(L x W x H) 2.5" x 2.5" x 0.4"
(6.4cm x 6.4cm x 1.0cm)

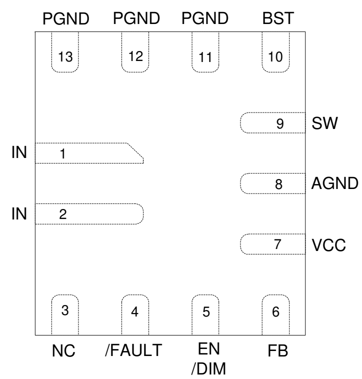
Board Number	MPS IC Number
EV4425M-QB-00A	MP/MPQ4425MGQB

Efficiency vs. LED Current(1)



EVALUATION BOARD SCHEMATIC



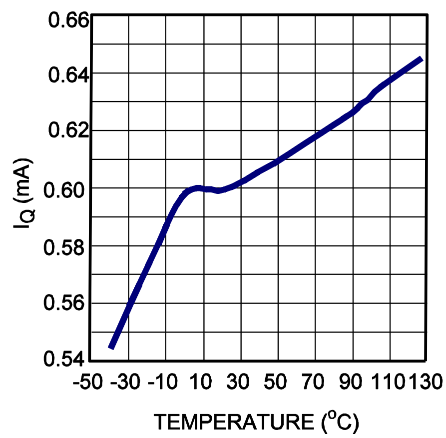


EV4425M-QB-00A BILL OF MATERIALS

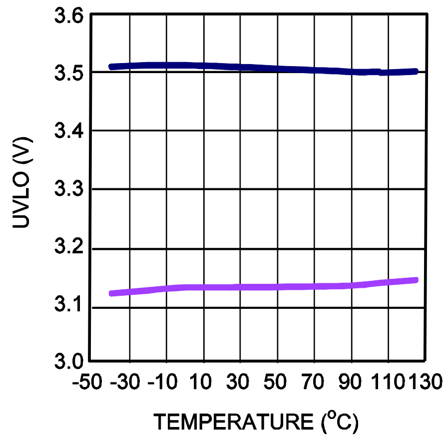
Qty	Ref	Value	Description	Package	Manufacturer	Part Number
1	CIN1	1nF	Ceramic Cap., 50V, X7R	0603	muRata	GRM188R71H102KA01D
1	CIN2	10nF	Ceramic Cap., 50V, X7R	0603	muRata	GRM188R71H103KA01D
1	CIN3	1μF	Ceramic Cap., 50V, X7R	1206	muRata	GRM31MR71H105KA88L
2	CIN4, CIN5	10μF	Ceramic Cap., 50V, X7R	1210	muRata	GRM32ER71H106KA12L
2	C1A, C1B	10μF	Ceramic Cap., 50V, X5R	1206	muRata	GRM31CR61H106KA12L
1	C1C	0.1μF	Ceramic Cap., 50V, X7R	0603	muRata	GRM188R71H104KA93D
2	C2, C3	0.1μF	Ceramic Cap., 16V, X7R	0603	muRata	GRM188R71C104KA01D
1	C4	10μF	Ceramic Cap., 16V, X7R	1210	muRata	GRM32DR71C106KA01L
1	C5	1nF	Ceramic Cap., 16V, X7R	0603	muRata	GRM188R71C102KA01D
2	C6, C7	NS				
1	D1	NS				
1	FB1		Bead, 180ohm at 100MHz, 3.5A	1812	muRata	BLM41PG181SN1L
2	L1, L2	2.2μH	Inductor, 82mOhm DCR, 3.3A	SMD	TOKO	DFE252012F-2R2MP2
1	L3	240nH	Inductor, 19mOhm DCR, 5A	SMD	TOKO	DFE201612E-R24MP2
1	R1	1M	Film Res., 5%	0603	Yageo	RC0603JR-071ML
1	R3	20	Film Res., 1%	0603	Yageo	RC0603FR-0720RL
1	R4	200k	Film Res., 1%	0603	Yageo	RC0603FR-07200KL
3	R5, R6, R7	400m	Film Res., 1%	1206	Yageo	RL1206FR-070R4L
1	R8	100k	Film Res., 1%	0603	Yageo	RC0603FR-07100KL
1	R2	NS				
1	U1		Step-Down Regulator	QFN13(2X3)	MPS	MPQ4425MGQB
5	VIN, VEMI, GND, GND, VOUT		2.0 Golden Pin		HZ	
4	PG, GND, EN/DIM, GND		2.54mm Test Pin		HZ	

TYPICAL CHARACTERISTICS

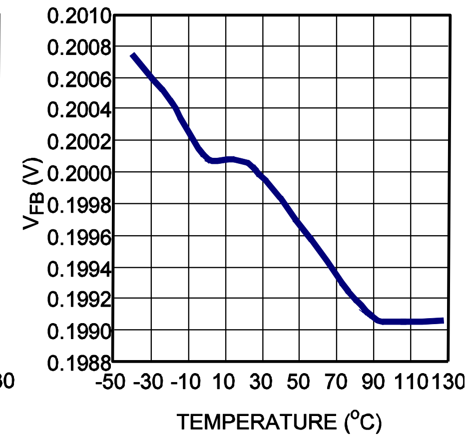
I_Q vs. Temperature



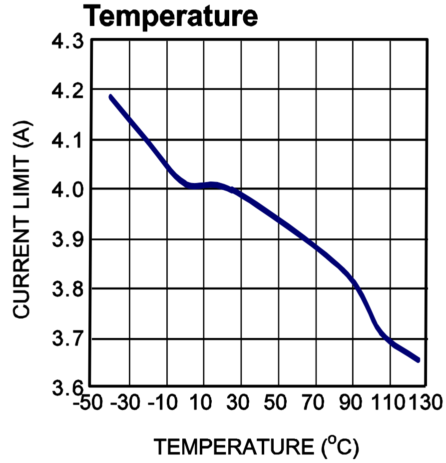
V_{IN} UVLO vs.Temperature



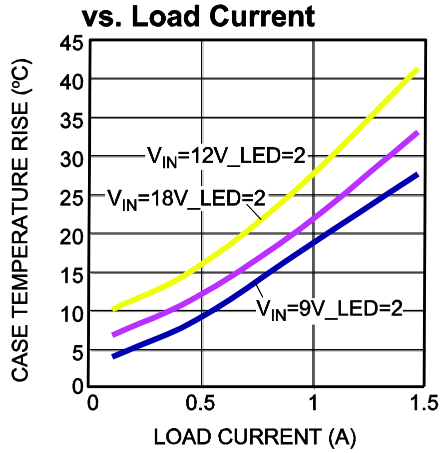
V_{FB} vs. Temperature



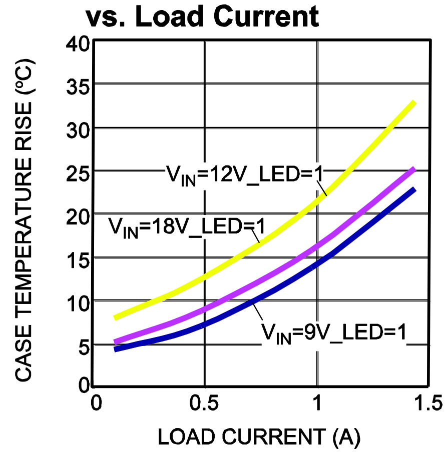
Current Limit vs. Temperature



Case Temperature Rise vs. Load Current



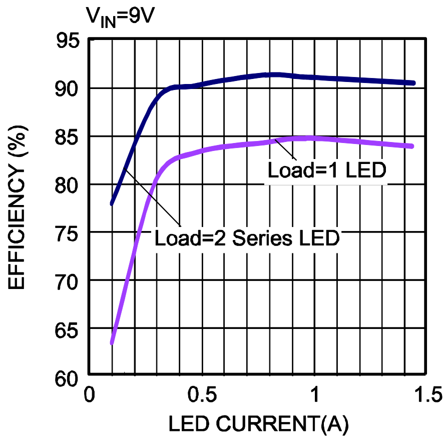
Case Temperature Rise vs. Load Current



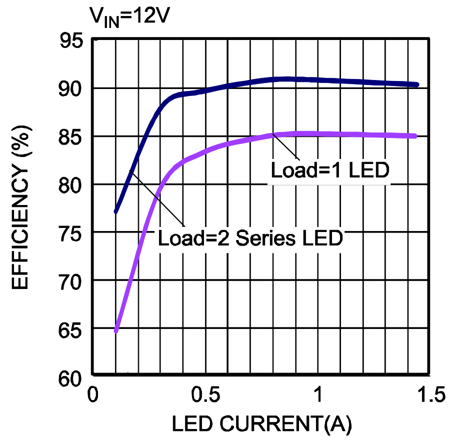
EVB TEST RESULTS

Performance waveforms are tested on the evaluation board.
V_{IN} = 12V, LOAD=2 series LED, L=2.2µH, F_{SW}=2.2MHz, T_A = +25°C, unless otherwise noted.[1]

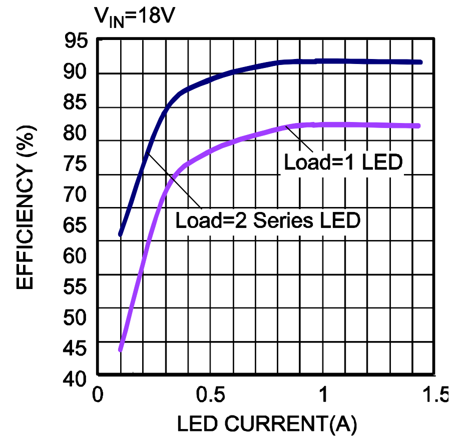
Efficiency vs. LED Current



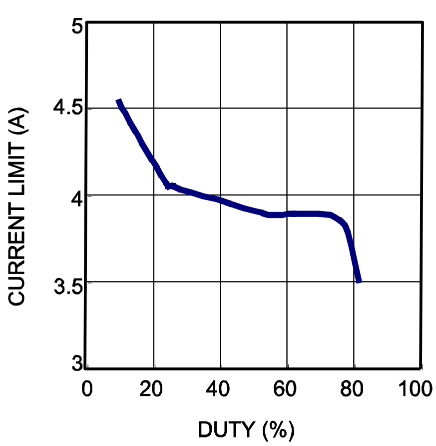
Efficiency vs. LED Current



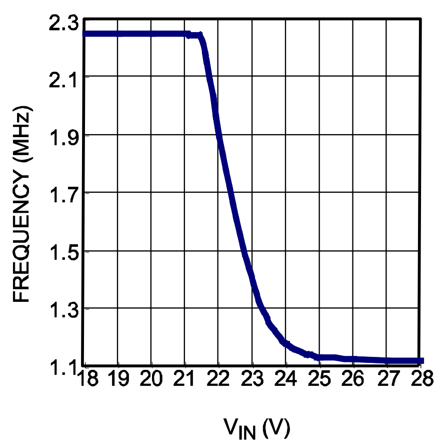
Efficiency vs. LED Current



Current Limit vs.Duty



Frequency vs. V_{IN}

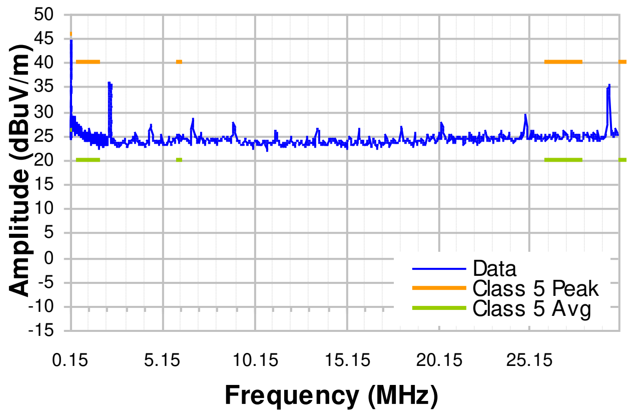


Note:
1). All the efficiency curves are tested on EVB without input and output filters.

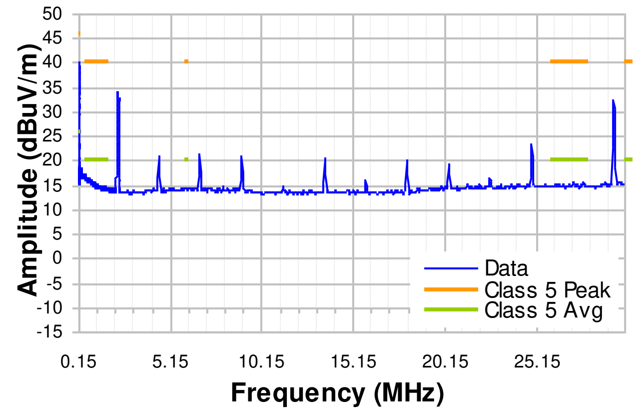
EVB TEST RESULTS *(continued)*

Performance waveforms are tested on the evaluation board.
V_{IN} = 12V, LOAD=2 series LED, I_{LED}=1.5A, L=2.2µH, F_{SW}=2.2MHz, with EMI filters, T_A = +25°C, unless otherwise noted. (2)

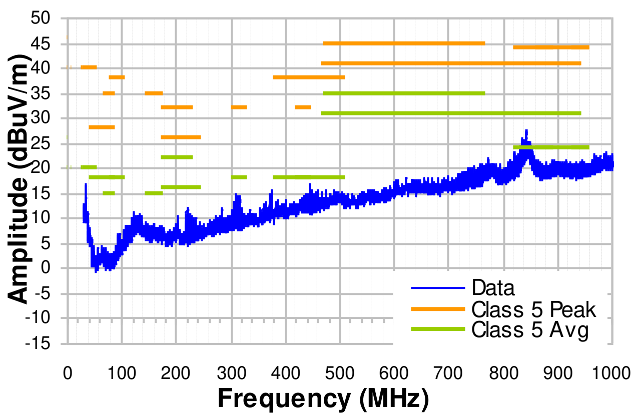
CISPR25 Class 5 Peak Radiated Emissions (150kHz-30MHz)



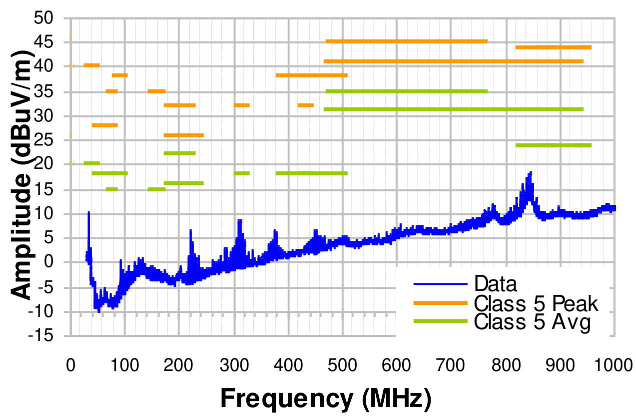
CISPR25 Class 5 Average Radiated Emissions (150kHz-30MHz)



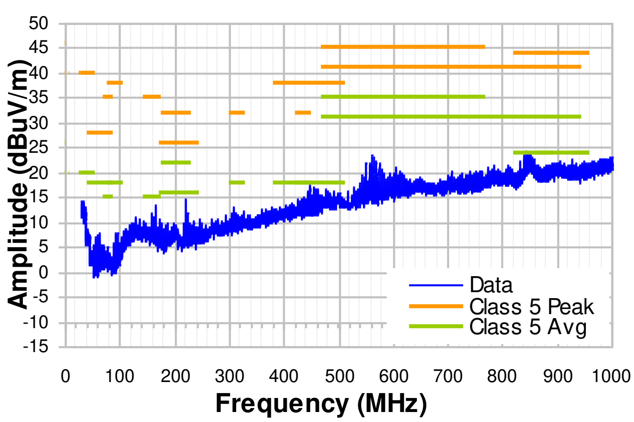
CISPR25 Class 5 Peak Radiated Emissions (Vertical, 30MHz-1GHz)



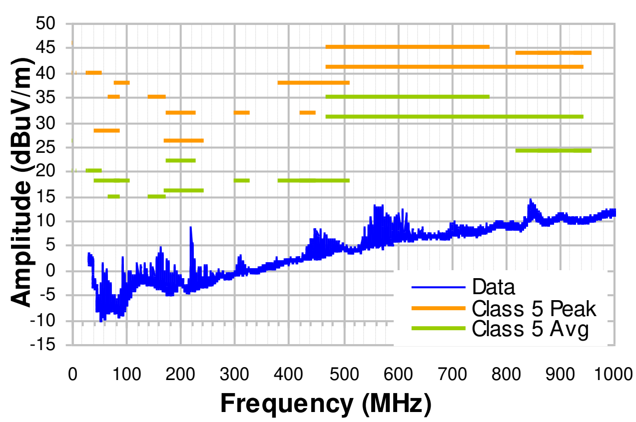
CISPR25 Class 5 Average Radiated Emissions (Vertical, 30MHz-1GHz)



CISPR25 Class 5 Peak Radiated Emissions (Horizontal, 30MHz-1GHz)



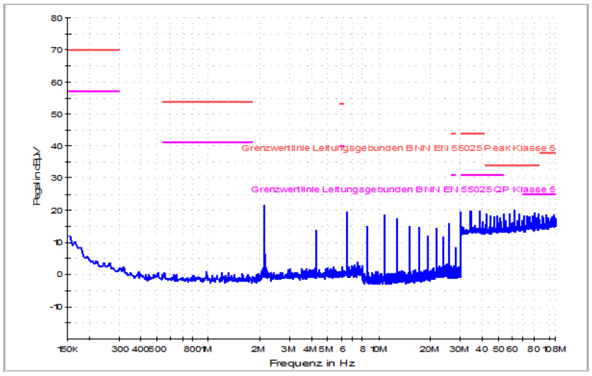
CISPR25 Class 5 Average Radiated Emissions (Horizontal, 30MHz-1GHz)



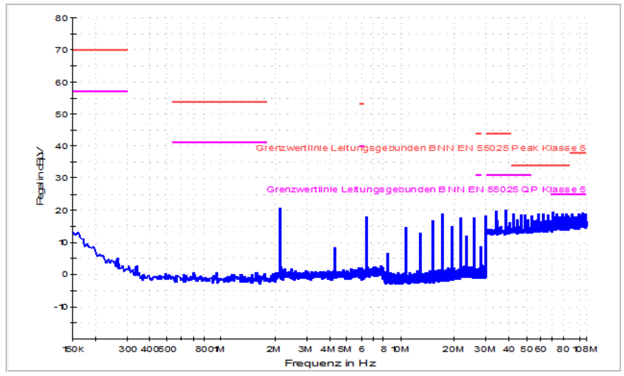
EVB TEST RESULTS *(continued)*

Performance waveforms are tested on the evaluation board.
V_{IN} = 12V, LOAD=2 series LED, I_{LED}=1.5A, L=2.2µH, F_{SW}=2.2MHz, with EMI filters, T_A = +25°C, unless otherwise noted. [2]

CISPR25 Class5 Peak Conducted Emissions (150kHz-108MHz)



CISPR25 Class5 Average Conducted Emissions (150kHz-108MHz)

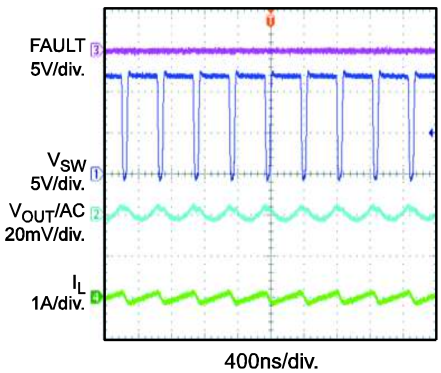


Note:
2). The EMI test results are based on application circuit with input and output EMI filters.

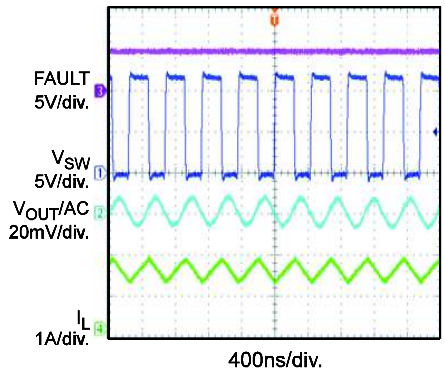
EVB TEST RESULTS *(continued)*

Performance waveforms are tested on the evaluation board.
V_{IN} = 12V, LOAD=2 series LED, L=2.2µH, F_{SW}=2.2MHz, T_A = +25°C, unless otherwise noted.

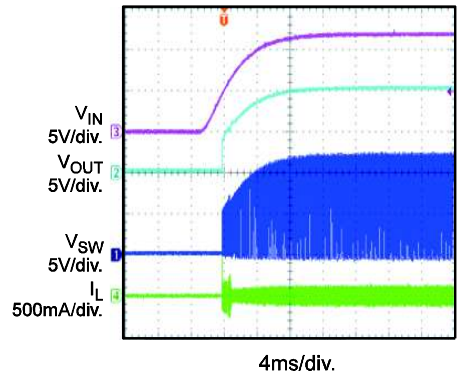
Steady State
I_{LED} = 0A



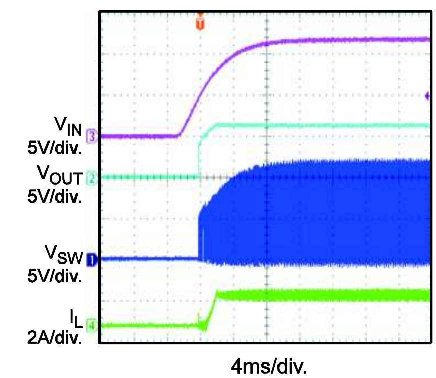
Steady State
I_{LED} = 1.5A



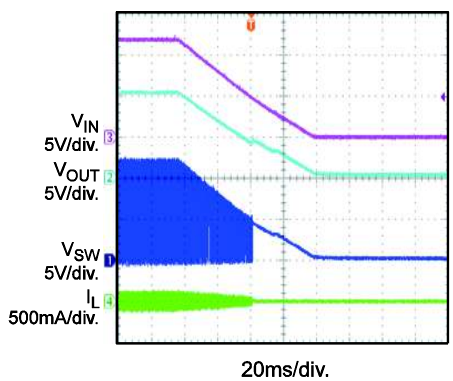
Start-Up through V_{IN}
I_{LED} = 0A



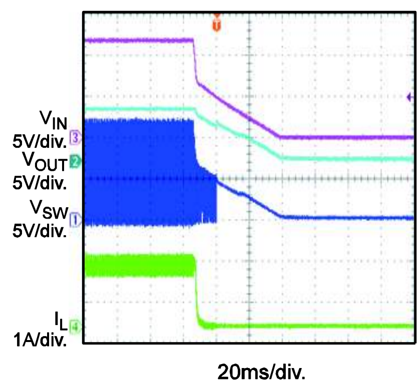
Start-Up through V_{IN}
I_{LED} = 1.5A



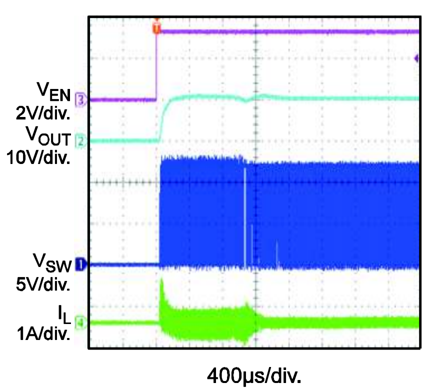
Shutdown through V_{IN}
I_{LED} = 0A



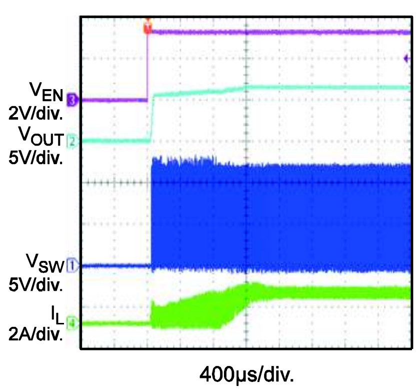
Shutdown through V_{IN}
I_{LED} = 1.5A



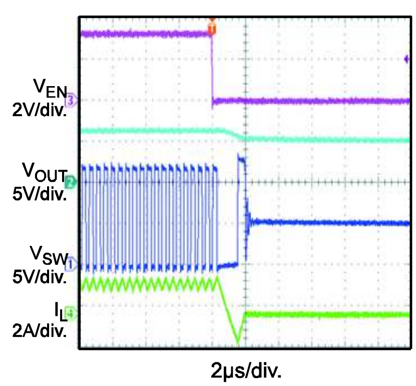
Start-Up through EN
I_{LED} = 0A



Start-Up through EN
I_{LED} = 1.5A



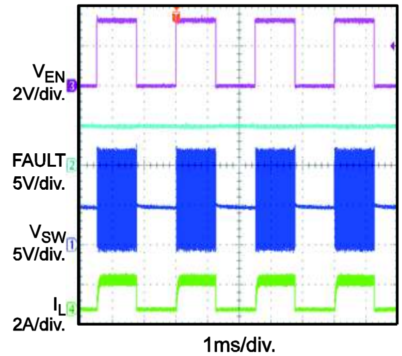
Shutdown through EN
I_{LED} = 1.5A



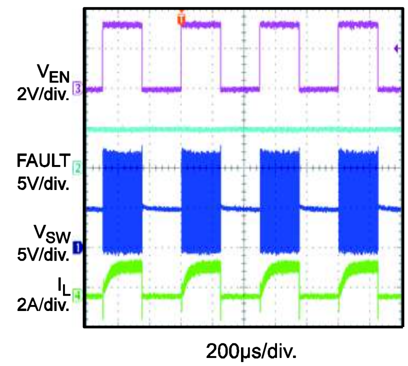
EVB TEST RESULTS *(continued)*

Performance waveforms are tested on the evaluation board.
V_{IN} = 12V, LOAD=2 series LED, L=2.2µH, F_{SW}=2.2MHz, T_A = +25°C, unless otherwise noted.

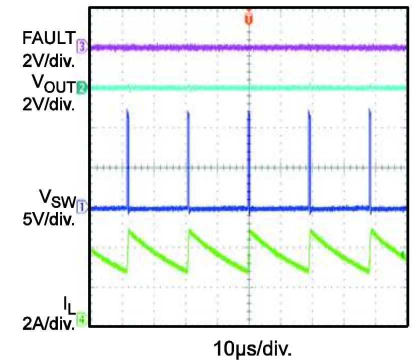
PWM Dimming
400Hz



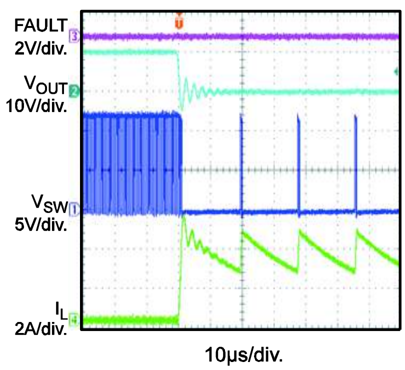
PWM Dimming
2kHz



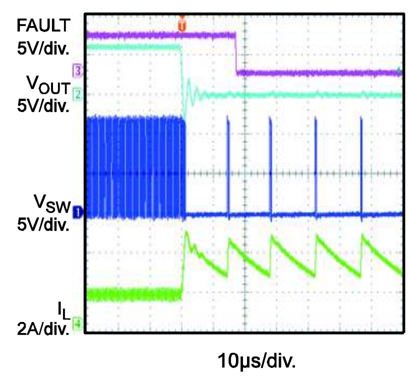
LED+ Short to GND
Steady State



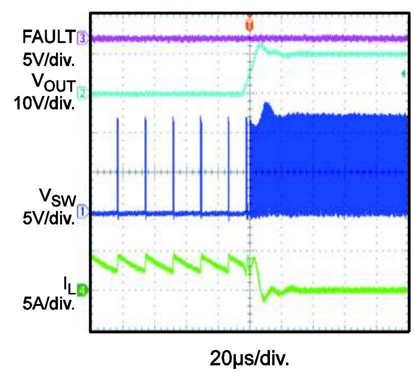
LED+ Short to GND Entry
I_{LED} = 0A



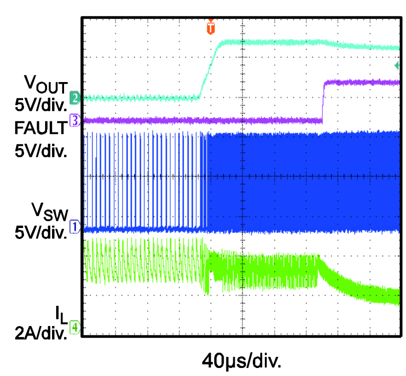
LED+ Short to GND Entry
I_{LED} = 1.5A



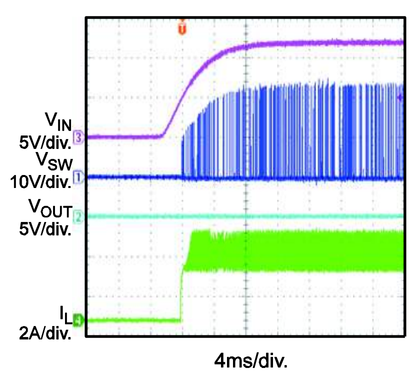
LED+ Short to GND Recovery
I_{LED} = 0A



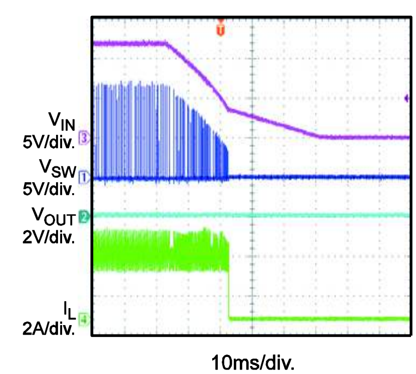
LED+ Short to GND Recovery
I_{LED} = 1.5A



LED+ Short to GND
Input Power On



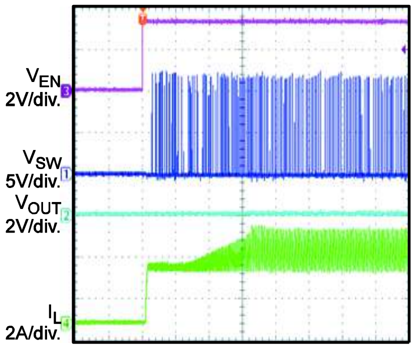
LED+ Short to GND
Input Power Off



EVB TEST RESULTS *(continued)*

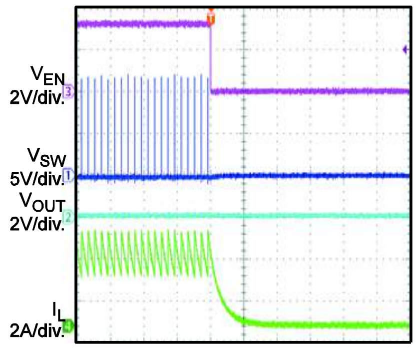
Performance waveforms are tested on the evaluation board.
V_{IN} = 12V, LOAD=2 series LED, L=2.2µH, F_{SW}=2.2MHz, T_A = +25°C, unless otherwise noted.

LED+ Short to GND EN On



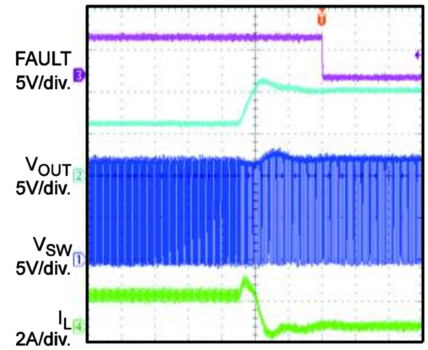
400µs/div.

LED+ Short to GND EN Off



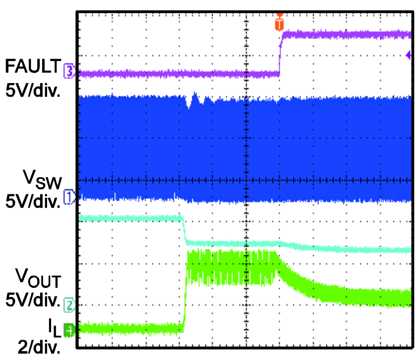
100µs/div.

LED Open Entry



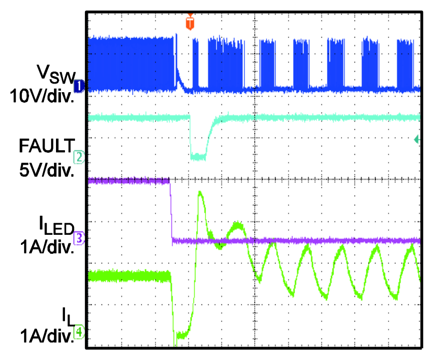
10µs/div.

LED Open Recovery



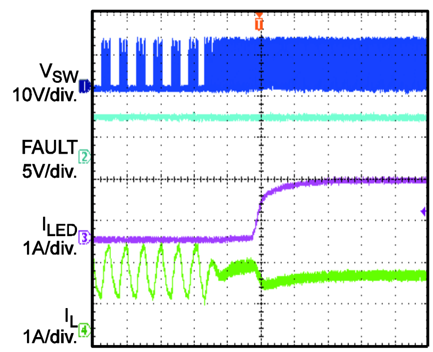
40µs/div.

LED+ and LED- Short Entry



20µs/div.

LED+ and LED- Short Recovery



40µs/div.

PRINTED CIRCUIT BOARD LAYOUT

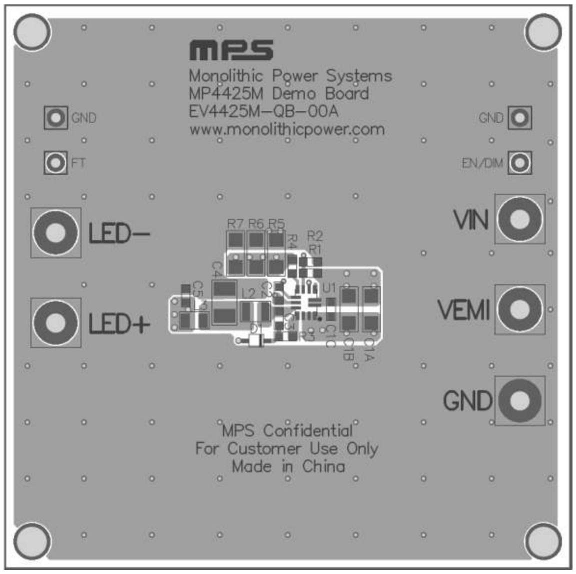


Figure 1—Top Silk Layer and Top Layer

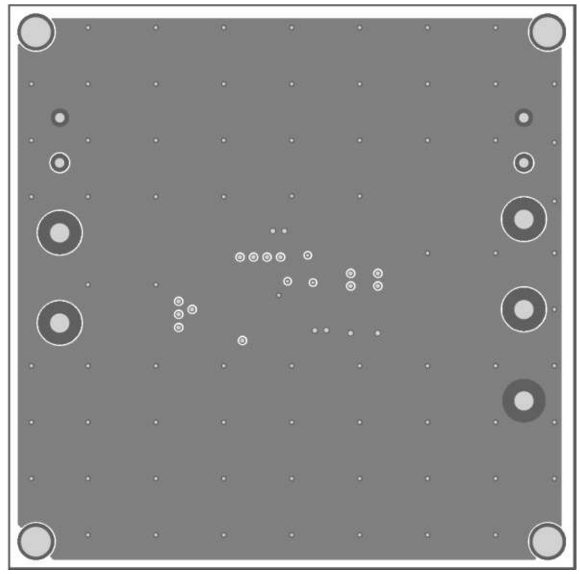


Figure 2—Inner1 Layer

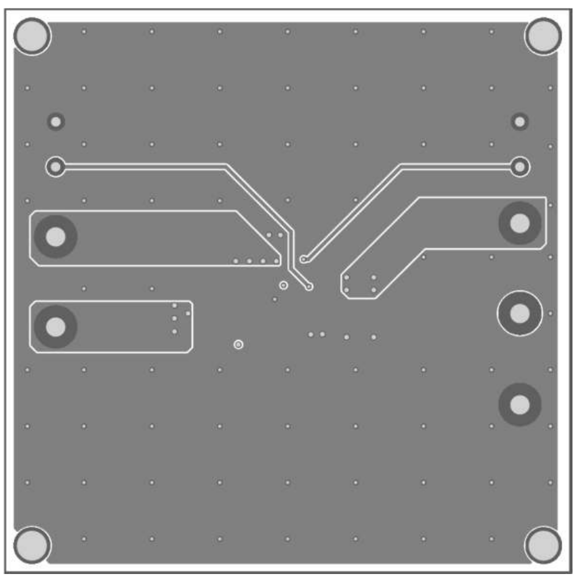


Figure 3—Inner2 Layer

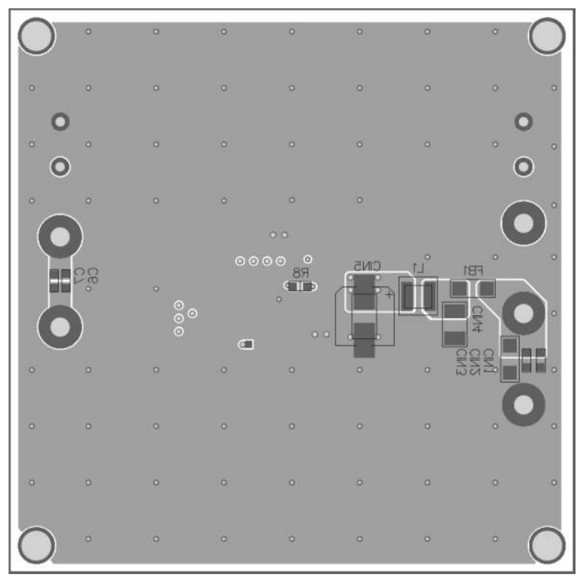


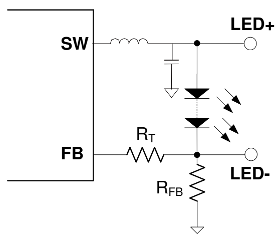
Figure 4—Bottom Silk Layer and Bottom Layer

QUICK START GUIDE

1. Connect the positive and negative terminals of the LED to the LED+ and LED- pins, respectively.
2. Preset the power supply output to between 4 and 36V, and then turn it off.

   If longer cables are used between the source and the EVB (>0.5m total), a damping capacitor should be installed at the input terminals. Especially when Vin is ≥ 24V.
3. Connect the positive and negative terminals of the power supply output to the VIN and GND pins, respectively. To get better EMI performance, connect the input power between VEMI and GND.
4. Turn the power supply on. The MP/MPQ4425MGQB will automatically startup.
5. To use the Enable function, apply a digital input to the EN pin. Drive EN higher than 1.45V to turn on the regulator, drive EN less than 1V to turn it off.
6. To use the Dimming function, apply a 100Hz to 2kHz external clock to the EN/DIM pin for the PWM dimming.
7. The output current is set by the external resistor R_{FB}, Feedback reference voltage is 0.2V, I_{LED} is then given by below equation:

$$I_{LED} = \frac{0.2V}{R_{FB}}$$



8. R_T is used to set the loop bandwidth. Basically, lower R_T, higher bandwidth. But high bandwidth may cause insufficient phase margin, resulting in loop unstable. So a proper value of R_T is needed to make a trade-off between bandwidth and phase margin. Below table lists the recommended feedback resistor and R_T values for common output with 1 or 2 series LED.

I_{LED} (A)	R_{FB} (mΩ)	R_T (kΩ)
0.5	400(1%)	200 (1%)
1	200(1%)	150 (1%)
1.5	133(1%)	100 (1%)