

## DESCRIPTION

The EV4415M-QB-00A is an evaluation board for the MP/MPQ4415MGQB.

MP/MPQ4415MGQB is a synchronous, rectified, step-down, switch-mode convertor with built-in power MOSFETs and one input bypass capacitor. It offers a very compact solution to achieve a 1.5A of continuous output current with excellent load and line regulation over a wide input supply range. The MP/MPQ4415M uses synchronous mode operation to achieve high efficiency over the output current load range.

The EV4415M-QB-00A is a fully assembled and tested evaluation board, it generates 3.3V output voltage at 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 Voltage	$V_{OUT}$	3.3	V
Output Current	$I_{OUT}$	1.5	A

## FEATURES

- Wide 4V to 36V Operating Input Range
- 1.5A Continuous Load Current
- 90mΩ High-Side, 50mΩ Low-Side Internal Power MOSFETs
- High-Efficiency Synchronous Mode Operation
- Default 2.2MHz Switching Frequency
- 450kHz to 2.2MHz Frequency Sync
- Forced Continuous Conduction Mode (CCM)
- Internal Soft Start (SS)
- Power Good (PG) Indicator
- Over-Current Protection (OCP) with Valley-Current Detection and Hiccup
- Thermal Shutdown
- Output Adjustable from 0.8V
- Available in a QFN-13 (2.5mmx3mm) Package
- CISPR25 Class 5 Compliant
- AEC-Q100 Grade-1

## APPLICATIONS

- Automotive
- Industrial Control Systems
- Medical and Imaging Equipment
- Telecom Applications
- Distributed Power Systems

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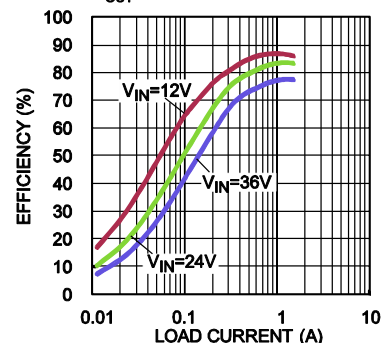
## EVALUATION BOARD



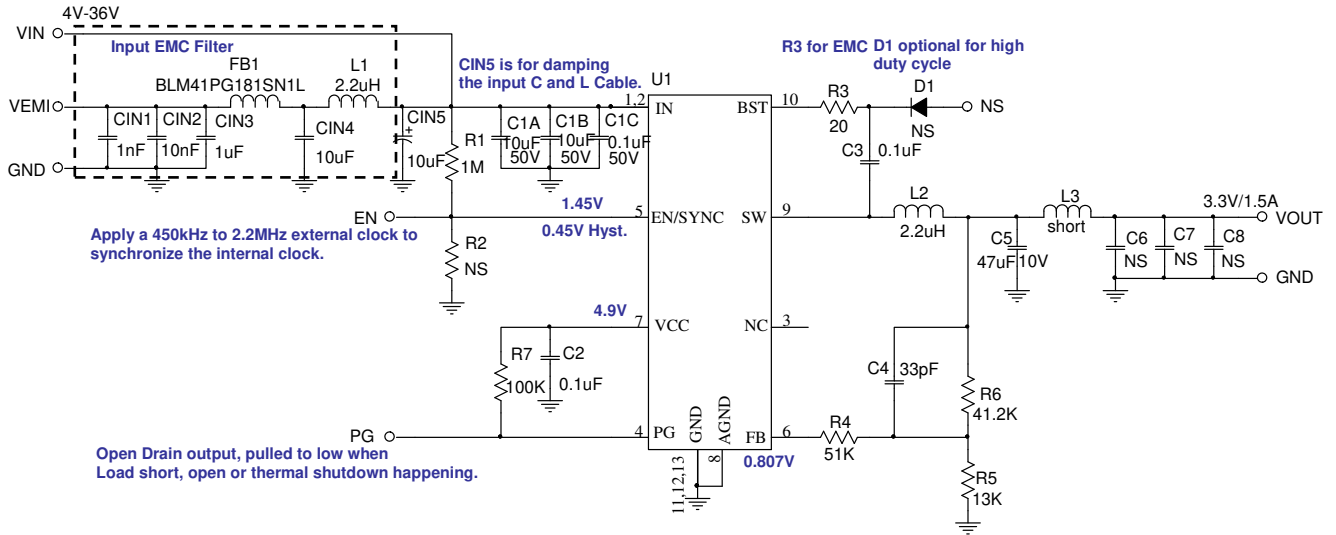
(L x W x H) 2.5" x 2.5" x 0.4"  
(6.4cm x 6.4cm x 1.0cm)

Board Number	MPS IC Number
EV4415M-QB-00A	MP/MPQ4415MGQB

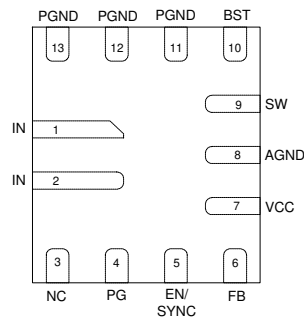
**Efficiency vs. Load Current**  
 $V_{OUT}=3.3V$



### EVALUATION BOARD SCHEMATIC



Package reference



Reference for FB divider selection

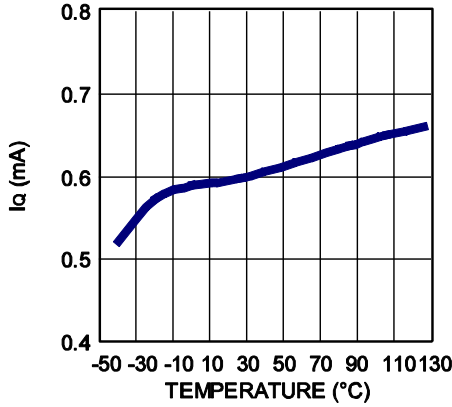
Vo(V)	R6(kΩ)	R5(kΩ)
5	41.2(1%)	7.68(1%)
2.5	41.2(1%)	19.6(1%)
1.8	41.2(1%)	33.5(1%)

**EV4415M-QB-00A BILL OF MATERIALS**

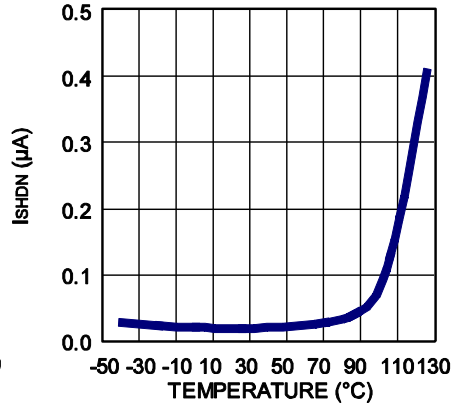
Qty	Ref	Value	Description	Package	Manufacturer	Part Number
5	CIN1,CIN5	NS				
2	C1A, C1B	10 $\mu$ F	Ceramic Cap., 50V, X5R	1206	muRata	GRM31CR61H106KA12L
1	C1C	0.1 $\mu$ F	Ceramic Cap., 50V, X7R	0603	muRata	GRM188R71H104KA93D
2	C2, C3	0.1 $\mu$ F	Ceramic Cap., 16V, X7R	0603	muRata	GRM188R71C104KA01D
1	C4	33pF	Ceramic Cap., 50V, C0G	0603	muRata	GRM1885C1H330JA01D
1	C5	47 $\mu$ F	Ceramic Cap., 10V, X5R	1210	muRata	GRM32ER61A476KE20L
3	C6, C7, C8	NS				
1	D1	NS				
1	FB1	NS				
1	L1	NS				
1	L2	2.2 $\mu$ H	Inductor, 82mOhm DCR, 3.3A	SMD	TOKO	DFE252012F-2R2MP2
1	L3	Short				
1	R1	1M	Film Res., 5%	0603	Yageo	RC0603JR-071ML
1	R3	20	Film Res., 1%	0603	Yageo	RC0603FR-0720RL
1	R4	51k	Film Res., 1%	0603	Yageo	RC0603FR-0751KL
1	R5	13k	Film Res., 1%	0603	Yageo	RC0603FR-0713KL
1	R6	41.2k	Film Res., 1%	0603	Yageo	RC0603FR-0741K2L
1	R7	100k	Film Res., 1%	0603	Yageo	RC0603FR-07100KL
1	R2	NS				
1	U1		Step-Down Regulator	QFN13(2X3)	MPS	MPQ4415MGQB
5	VIN, VEMI, GND, GND, VOUT		2.0 Golden Pin		HZ	
4	PG, GND, EN/ SYNC, GND		2.54mm Test Pin		HZ	

### TYPICAL CHARACTERISTICS

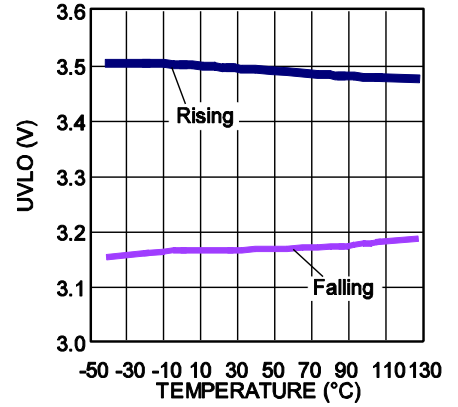
**Quiescent Current vs. Temperature**



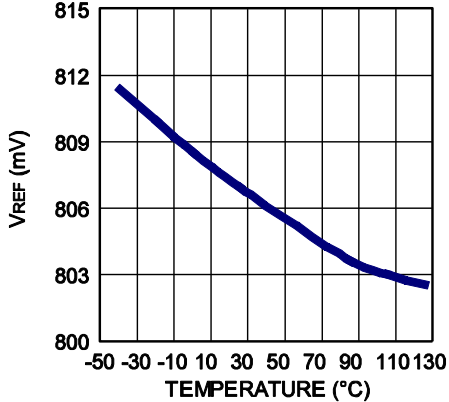
**Shutdown Current vs. Temperature**



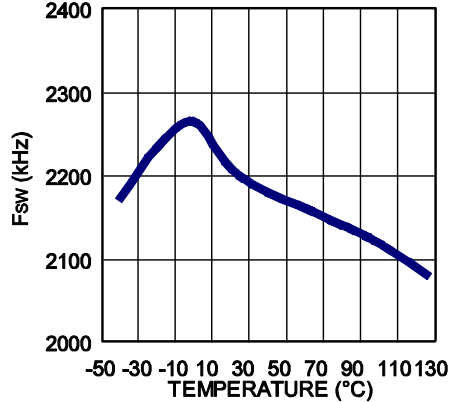
**V<sub>IN</sub> UVLO Threshold vs. Temperature**



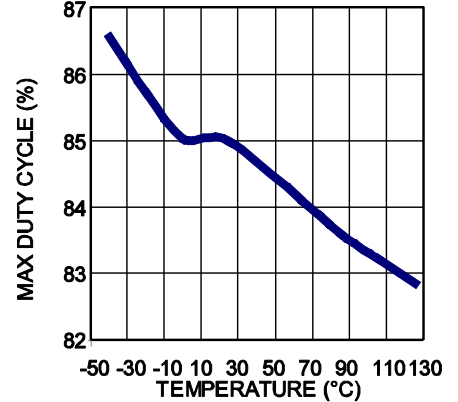
**Feedback Reference vs. Temperature**



**Switching Frequency vs. Temperature**



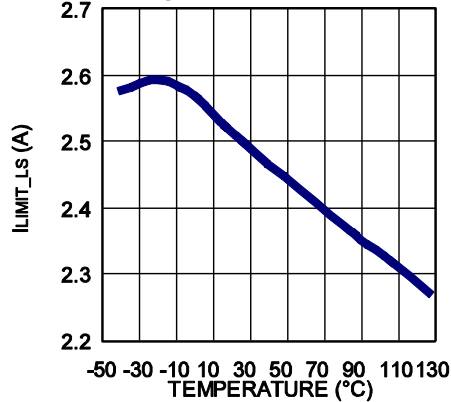
**Max Duty Cycle vs. Temperature**



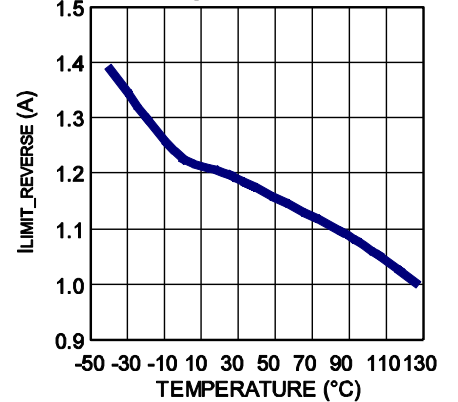
**Current Limit vs. Temperature**

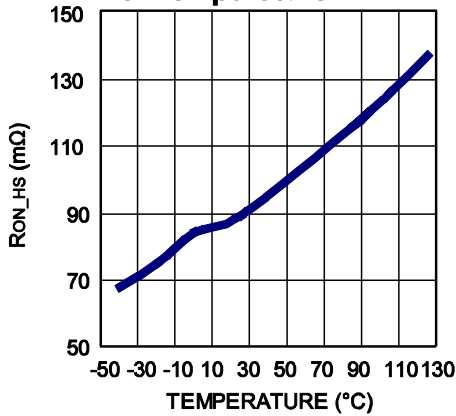
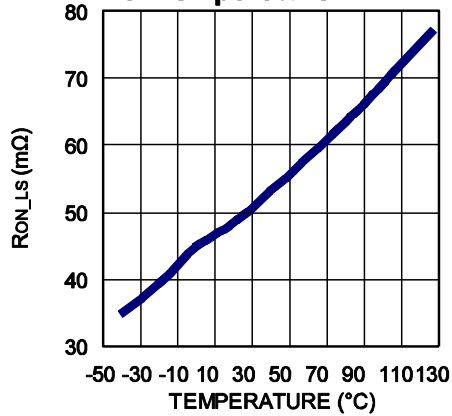
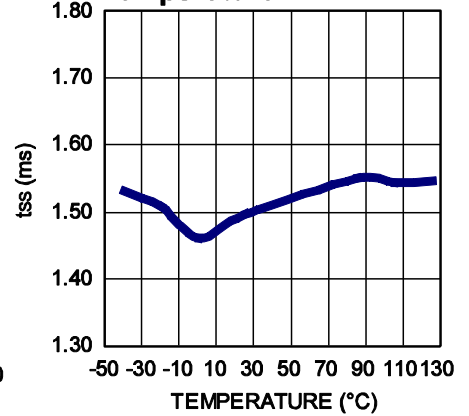
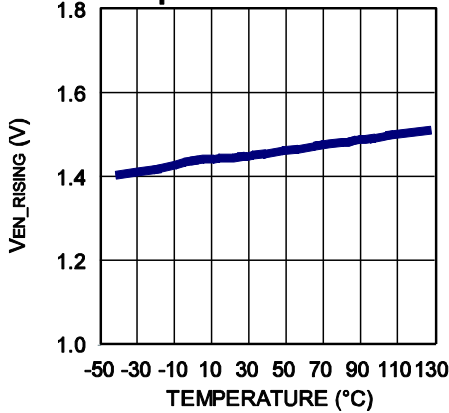
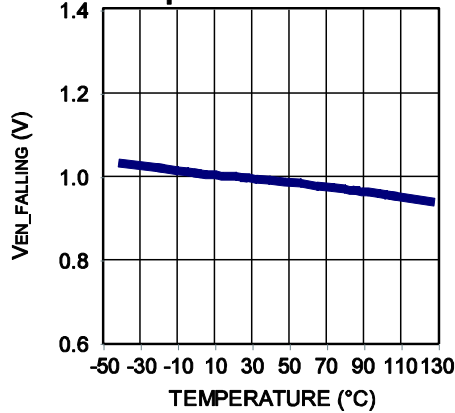
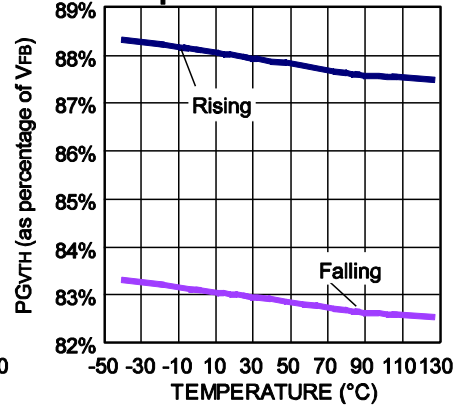
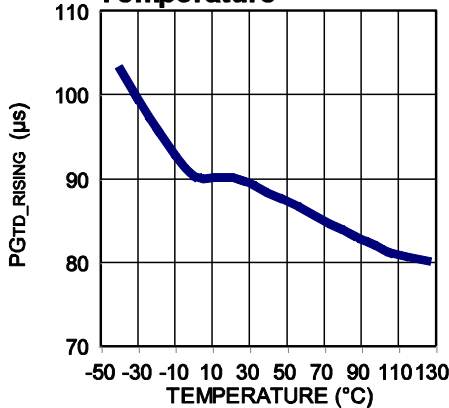
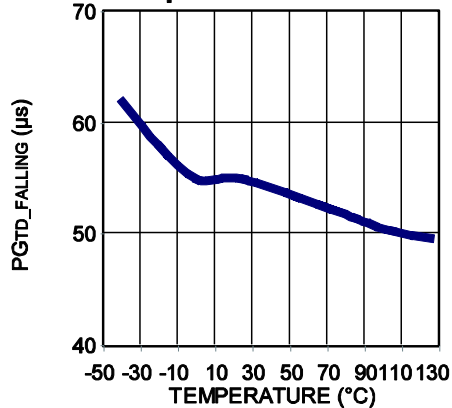


**Valley Current Limit vs. Temperature**



**Reverse Current Limit vs. Temperature**

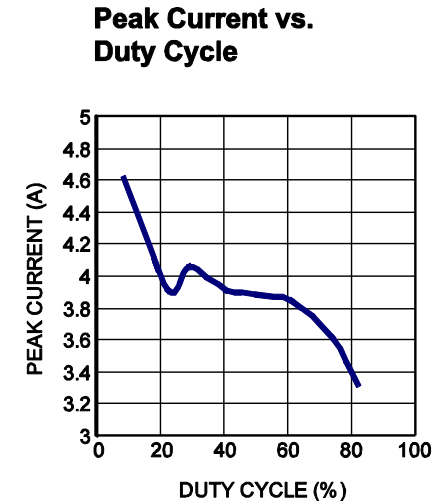
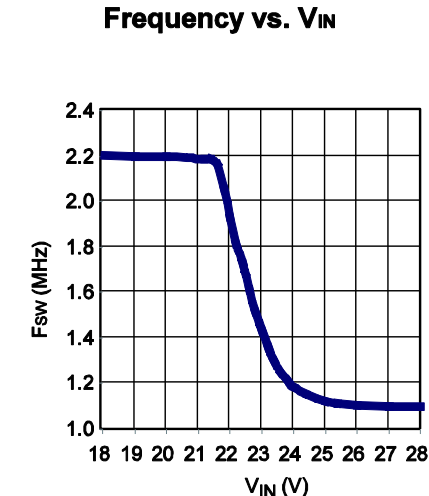
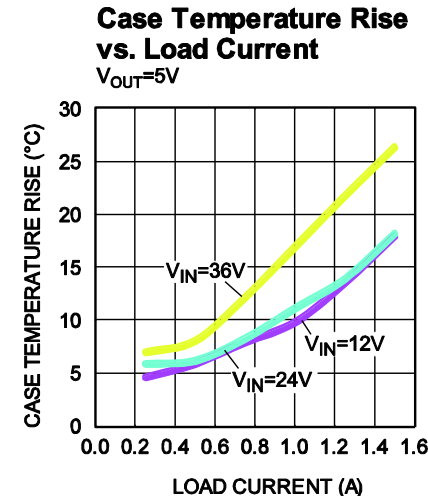
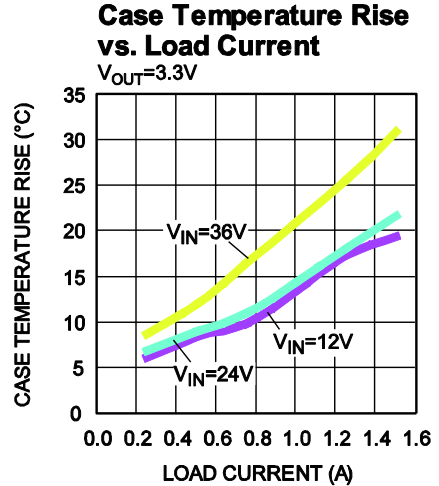
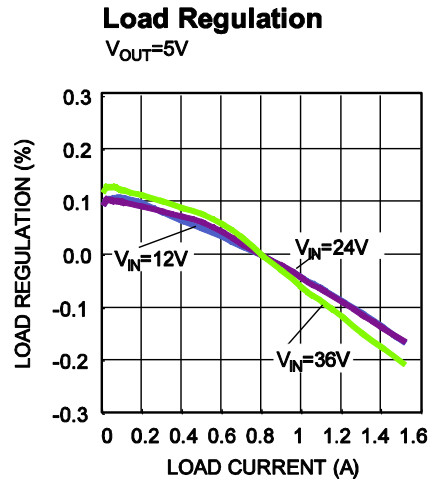
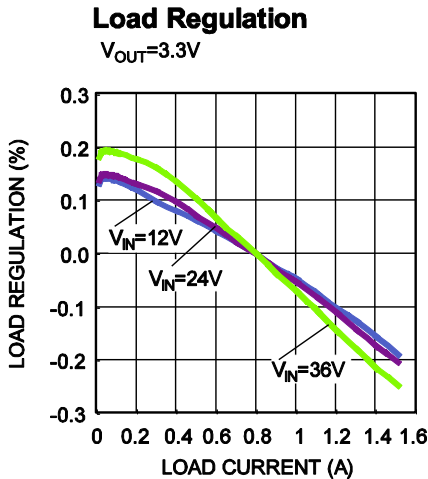
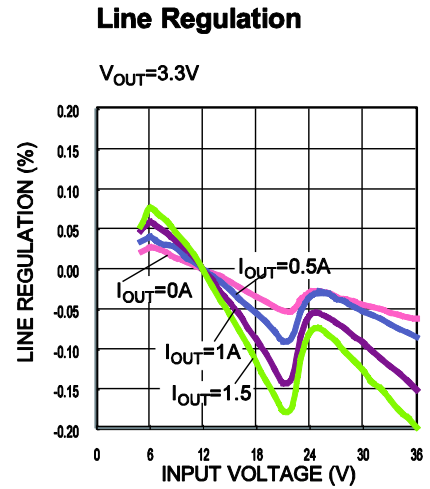
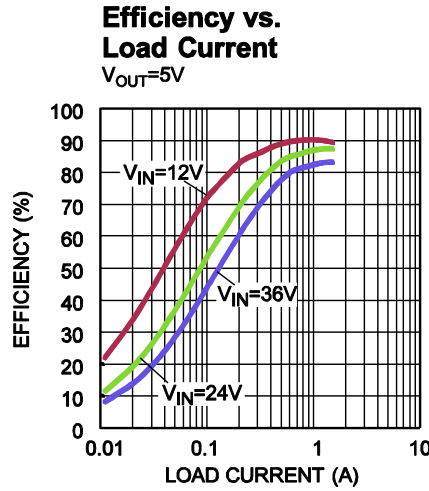
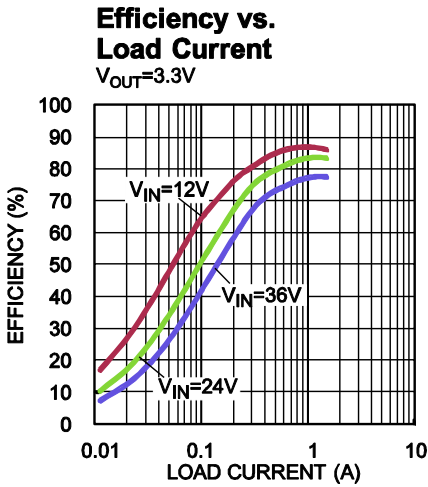


**TYPICAL CHARACTERISTICS** *(continued)*
**HS-FET On Resistance vs. Temperature**

**LS-FET On Resistance vs. Temperature**

**Soft-Start Time vs. Temperature**

**EN Rising Threshold vs. Temperature**

**EN Falling Threshold vs. Temperature**

**PG Threshold vs. Temperature**

**PG Rising Delay vs. Temperature**

**PG Falling Delay vs. Temperature**


## EVB TEST RESULTS

Performance waveforms are tested on the evaluation board.

$V_{IN} = 12V$ ,  $V_{OUT} = 3.3V$ ,  $L = 2.2\mu H$ ,  $F_{SW} = 2.2MHz$ ,  $T_A = +25^\circ C$ , unless otherwise noted.

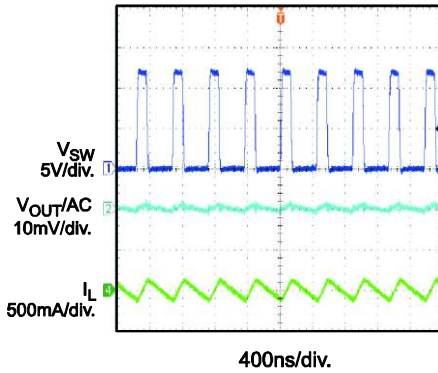


## EVB TEST RESULTS *(continued)*

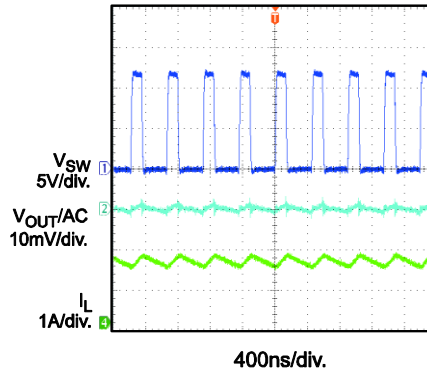
Performance waveforms are tested on the evaluation board.

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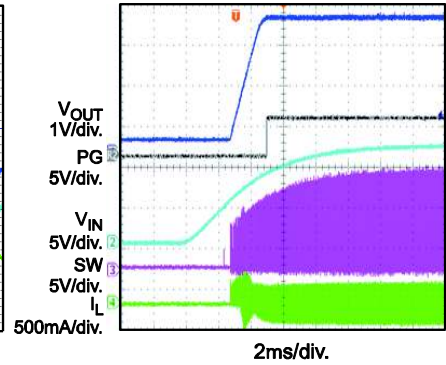
**Steady State**  
 $I_{OUT} = 0A$



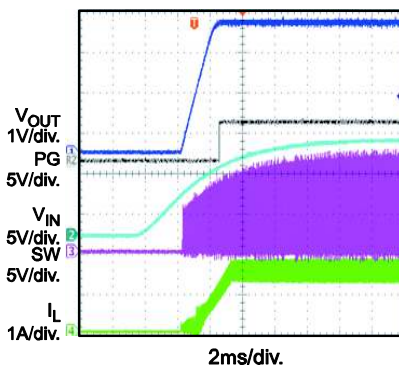
**Steady State**  
 $I_{OUT} = 1.5A$



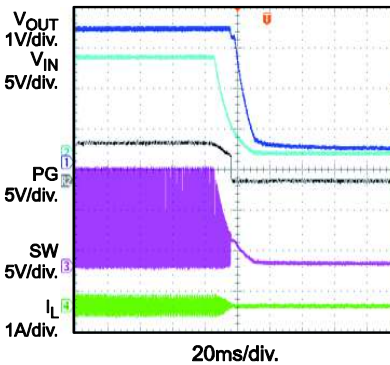
**Start-Up through Input Voltage**  
 $I_{OUT} = 0A$



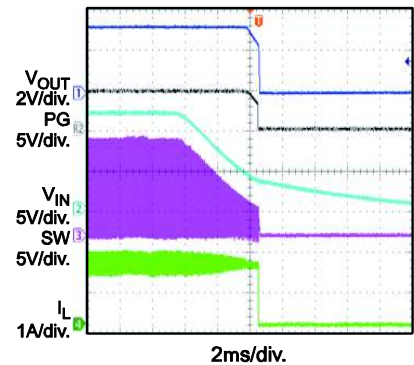
**Start-Up through Input Voltage**  
 $I_{OUT} = 1.5A$



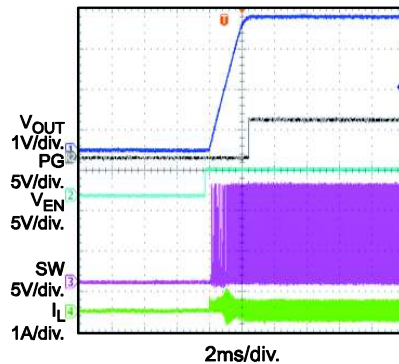
**Shutdown through Input Voltage**  
 $I_{OUT} = 0A$



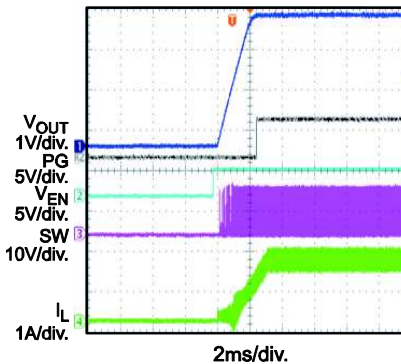
**Shutdown through Input Voltage**  
 $I_{OUT} = 1.5A$



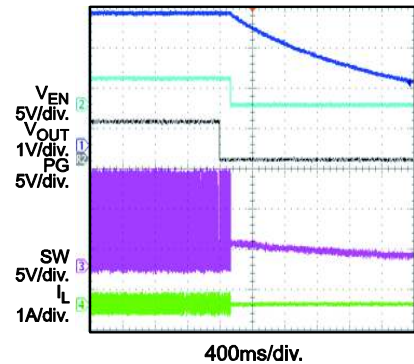
**Start-Up through Enable**  
 $I_{OUT} = 0A$



**Start-Up through Enable**  
 $I_{OUT} = 1.5A$



**Shutdown through Enable**  
 $I_{OUT} = 0A$

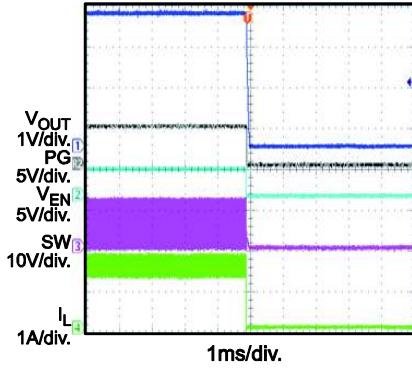


## EVB TEST RESULTS *(continued)*

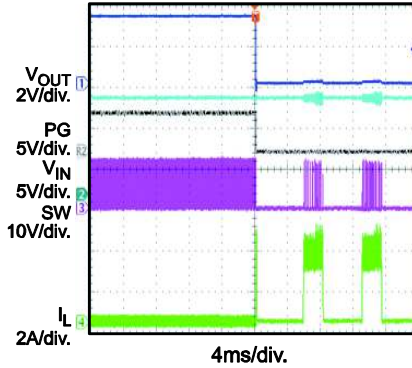
Performance waveforms are tested on the evaluation board.

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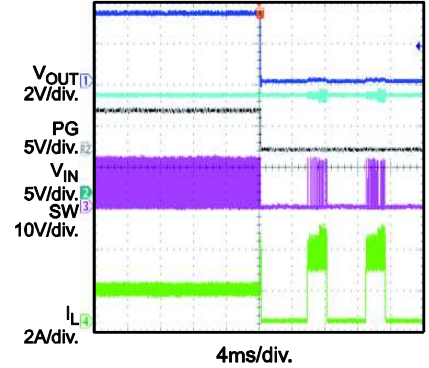
**Shutdown through Enable**  
 $I_{OUT} = 1.5A$



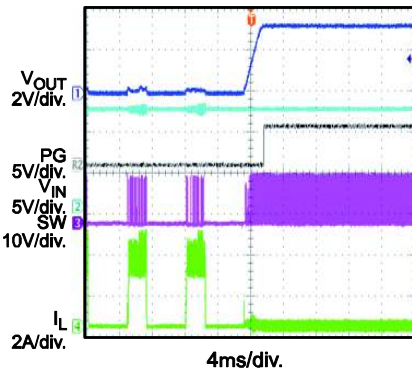
**SCP Entry**  
 $I_{OUT} = 0A$



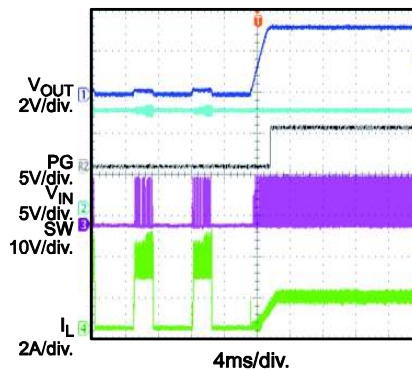
**SCP Entry**  
 $I_{OUT} = 1.5A$



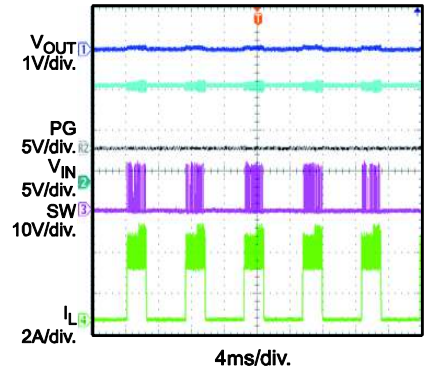
**SCP Recovery**  
 $I_{OUT} = 0A$



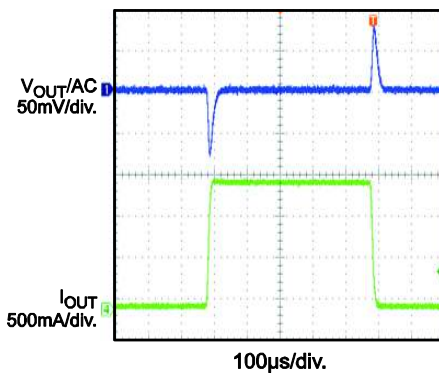
**SCP Recovery**  
 $I_{OUT} = 1.5A$



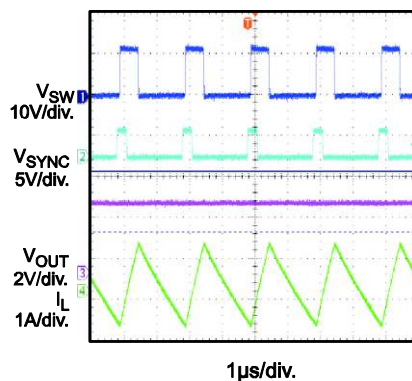
**SCP Steady State**



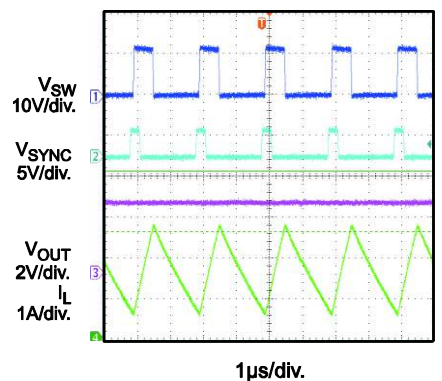
**Load Transient**  
 $I_{OUT} = 0A-1.5A$



**SYNC Operation**  
 $f_{SYNC} = 500kHz$ ,  $D = 15\%$ ,  $I_{OUT} = 0A$



**SYNC Operation**  
 $f_{SYNC} = 500kHz$ ,  $D = 15\%$ ,  $I_{OUT} = 1.5A$





### PRINTED CIRCUIT BOARD LAYOUT

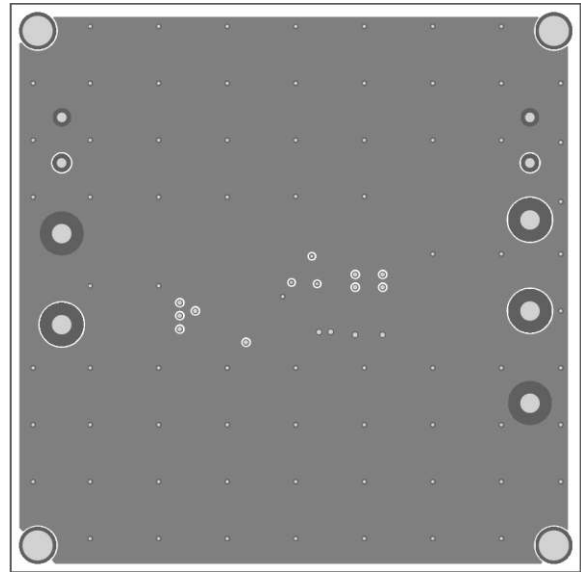
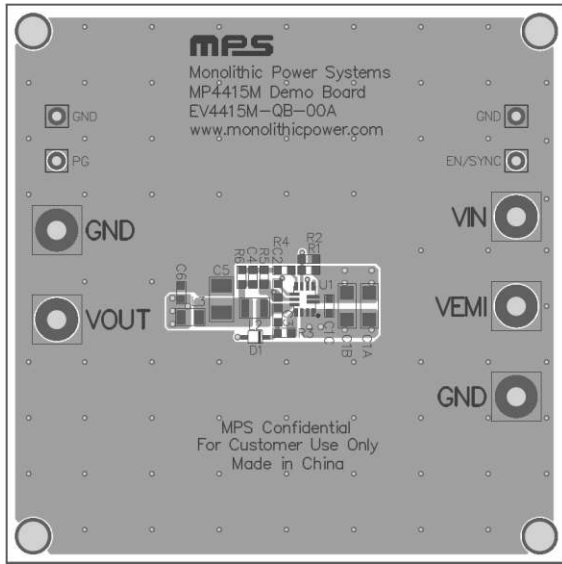


Figure 1—Top Silk Layer and Top Layer

Figure 2—Inner1 Layer

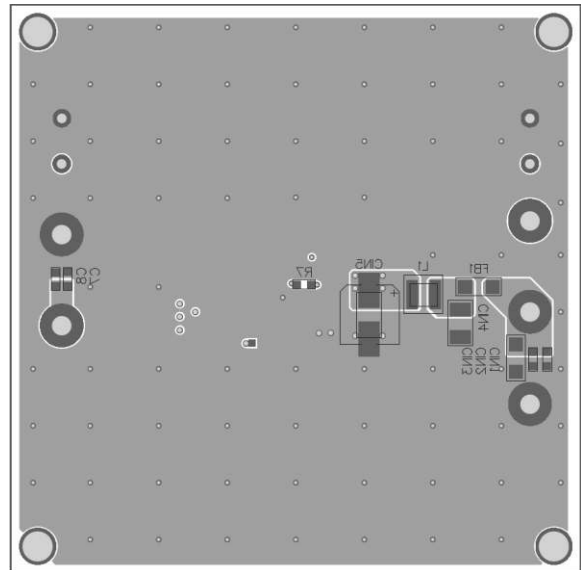
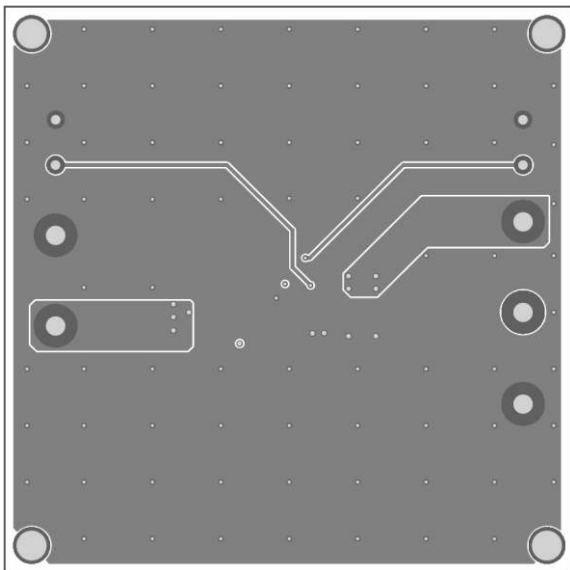


Figure 3—Inner2 Layer

Figure 4—Bottom Silk Layer and Bottom Layer

## QUICK START GUIDE

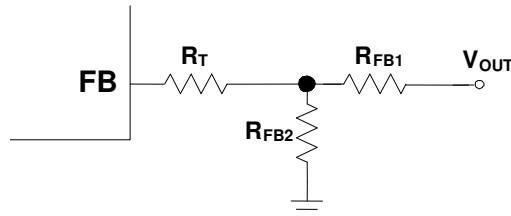
1. Connect the positive and negative terminals of the load to the VOUT and GND pins, respectively.

Be aware that electronic loads represent a negative impedance to the regulator and if set to a too high current will trigger Hiccup mode.

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.
4. Turn the power supply on. The MP/MPQ4415MGQB will automatically startup.
5. To use the Enable function, apply a digital input to the EN/Sync 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 Sync function, apply a 450kHz to 2.2MHz external clock to the EN/Sync pin to synchronize the internal clock rising edge.
7. The output voltage is set by the external resistor divider. The feedback resistor ( $R_{FB1}$ ) also sets the feedback loop bandwidth with the internal compensation capacitor. Choose  $R_{FB1}$  to be around 40kΩ when  $V_{OUT} \geq 1V$ .  $R_{FB2}$  can then be calculated with below equation:

$$R_{FB2} = \frac{R_{FB1}}{\frac{V_{OUT}}{0.807V} - 1}$$

8. The T-type network is highly recommended when  $V_{OUT}$  is low.



9.  $R_T + R_{FB1}$  is used to set the loop bandwidth. The lower  $R_T + R_{FB1}$  is, the higher the bandwidth. However, a high bandwidth may cause an insufficient phase margin, resulting in loop unstable. Therefore, a proper  $R_T$  value is required to make a trade-off between bandwidth and phase margin. Below table lists the recommended feedback resistor and  $R_T$  values for common output voltages.

$V_{OUT}$ (V)	$R_{FB1}$ (kΩ)	$R_{FB2}$ (kΩ)	$R_T$ (kΩ)
3.3	41.2 (1%)	13 (1%)	51 (1%)
5	41.2 (1%)	7.68 (1%)	51 (1%)

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