EV4432-L-00A

36V, 2.2A, Low Quiescent Current Synchronous Step-Down Convertor Evaluation Board

NOT RECOMMENDED FOR NEW DESIGNS, REFER TO EVQ4432-L-00A

DESCRIPTION

The EV4432-L-00A is an evaluation board for the MP/MPQ4432GL.

MP/MPQ4432GL is a frequency programmable (350kHz to 2.5MHz), synchronous, step-down, switching regulator with integrated internal high-side and low-side power MOSFETs. It provides up to 2.2A highly efficient output current with current mode control for fast loop response.

The MP/MPQ4432GL employs AAM (Advanced Asynchronous Modulation) mode which helps to achieve high efficiency at light load condition by scaling down the switching frequency to reduce the switching and gate driving losses.

The EV4432-L-00A is a fully assembled and tested evaluation board, it generates +3.3V output voltage at load current up to 2.2A from a 3.3V to 36V input range.

ELECTRICAL SPECIFICATIONS

Parameter	Symbol	Value	Units
Input Voltage	V_{IN}	3.3 – 36	V
Output Voltage	V_{OUT}	3.3	V
Output Current	I_{OUT}	2.2	A

FEATURES

- Wide 3.3V-to-36V Operating Input Range
- 2.2A Continuous Output Current
- 1μA Low Shutdown Mode Current
- 10μA Sleep Mode Quiescent Current
- Internal 90mΩ High-Side and 40mΩ Low-Side MOSFETs
- 350kHz to 2.5MHz Programmable Switching Frequency
- Synchronize to External Clock Selectable In-Phase or 180° Out-of-Phase
- Power Good Indicator
- Programmable Soft-Start Time
- 80ns Minimum On Time
- Selectable Forced CCM and AAM
- Low Dropout Mode
- Over-Current Protection with Valley-Current Detection and Hiccup
- Thermal Shutdown
- Available in Wettable Flank
- Available in AEC-Q100 Grade-1
- Fully Assembled and Tested

APPLICATIONS

- Automotive Systems
- Industrial Power Systems

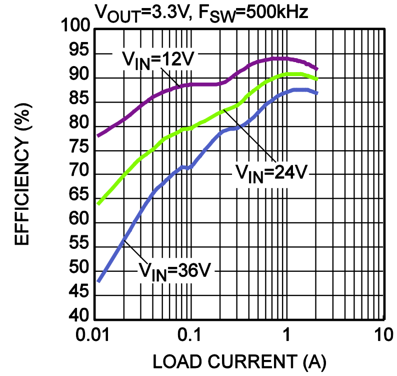
EVALUATION BOARD

(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
EV4432-L-00A	MP/MPQ4432GL

Efficiency vs. Load Current

V_{OUT}=3.3V, F_{SW}=500kHz



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 3.3V 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/MPQ4432GL will automatically startup.

5. To use the Enable function, apply a digital input to the EN pin. Drive EN higher than 1.05V to turn on the regulator, drive EN less than 0.93V to turn it off.

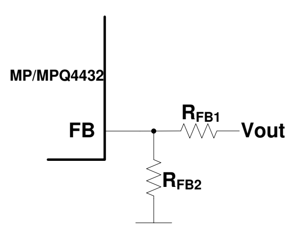
6. The oscillating frequency of MP/MPQ4432 can be programmed by an external frequency resistor R_{FREQ}. The value of R_{FREQ} can be estimated with below equation:

$$R_{FREQ}(k\Omega) = \frac{170000}{f_{SW}^{1.11}(kHz)}$$

7. To use the Sync function, apply a 350kHz to 2.5MHz clock to the Sync pin to synchronize the internal oscillator frequency to the external clock. The external clock should be at least 250kHz larger than R_{FREQ} set frequency. The SYNC pin can also be used to select forced CCM mode or AAM mode. Drive it high before the chip starts up to choose forced CCM mode, and drive it low or leave it float to choose AAM mode.

8. The output voltage is set by the external resistor divider. Choose R_{FB1} to be around 40kΩ. Then R_{FB2} can be calculated with below equation:

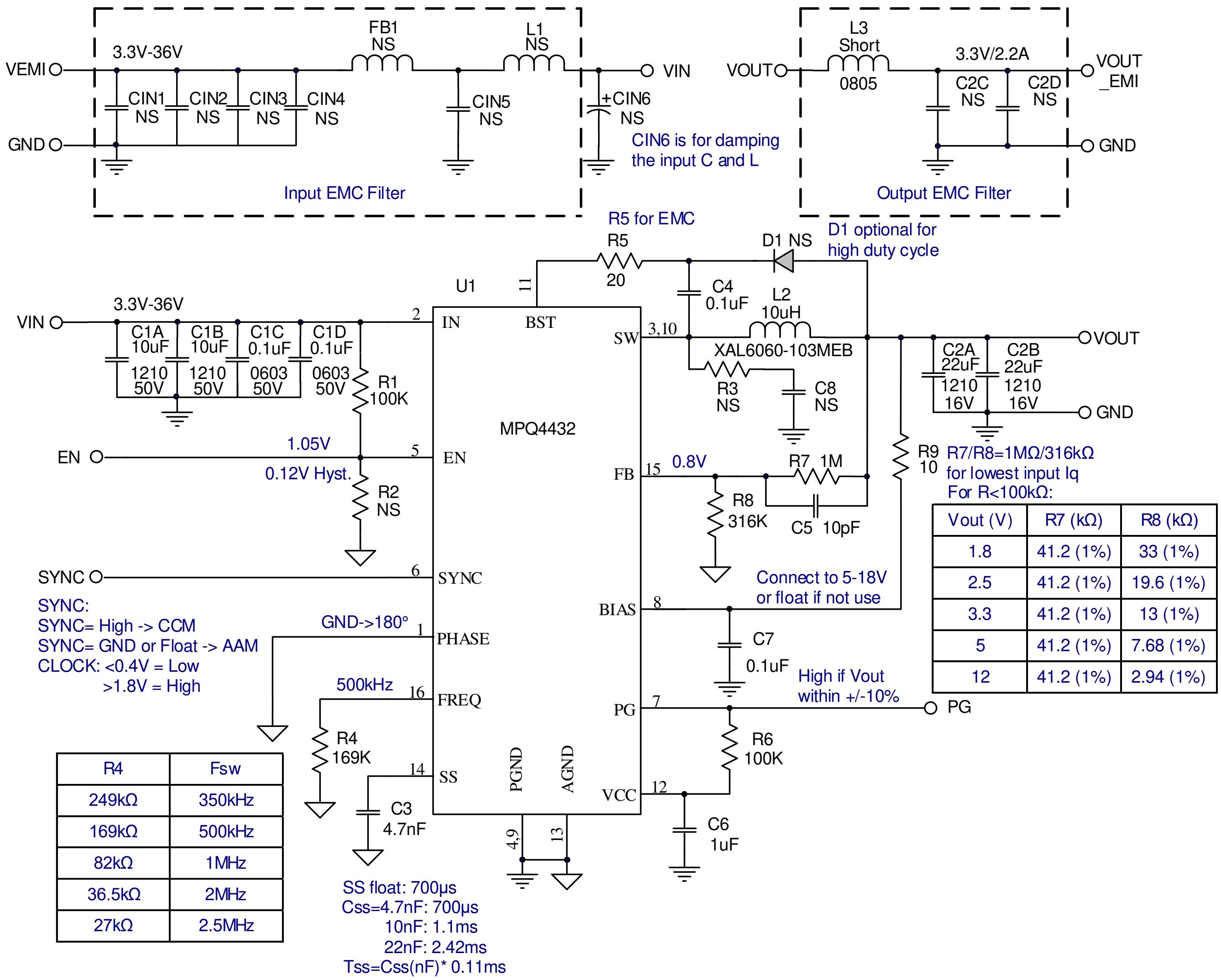
$$R_{FB2} = \frac{R_{FB1}}{\frac{V_{OUT}}{0.8V} - 1}$$



Below table lists the recommended feedback resistor values for common output voltages.

V_{OUT} (V)	R_{FB1} (kΩ)	R_{FB2} (kΩ)
1.8	41.2 (1%)	33 (1%)
2.5	41.2 (1%)	19.6 (1%)
3.3	41.2 (1%)	13 (1%)
5	41.2 (1%)	7.68 (1%)
12	41.2 (1%)	2.94 (1%)

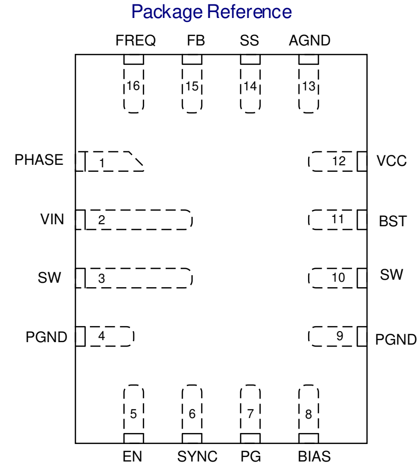
EVALUATION BOARD SCHEMATIC



R4	Fsw
249kΩ	350kHz
169kΩ	500kHz
82kΩ	1MHz
36.5kΩ	2MHz
27kΩ	2.5MHz

Vout (V)	R7 (kΩ)	R8 (kΩ)
1.8	41.2 (1%)	33 (1%)
2.5	41.2 (1%)	19.6 (1%)
3.3	41.2 (1%)	13 (1%)
5	41.2 (1%)	7.68 (1%)
12	41.2 (1%)	2.94 (1%)

Package Reference



NOT RECOMMENDED FOR NEW DESIGNS, REFER TO EVQ4432-L-00A

EV4432-L-00A BILL OF MATERIALS

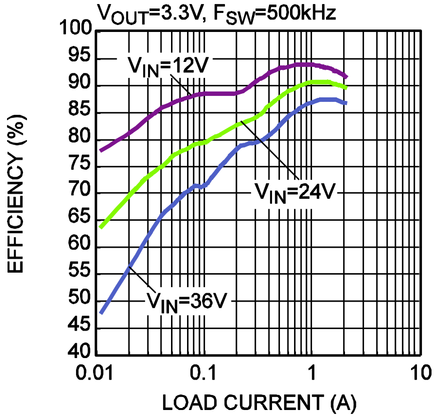
Qty	Ref	Value	Description	Package	Manufacturer	Part Number
2	C1A, C1B	10µF	Ceramic Cap; 50V;X7R;1210	1210	muRata	GRM32ER71H106KA12L
2	C1C, C1D	0.1µF	Ceramic Cap; 50V;X7R;0603	0603	muRata	GRM188R71H104KA93D
2	C2A, C2B	22µF	Ceramic Cap; 16V;X7R;1210	1210	muRata	GRM32ER71C226KEA8L
1	C3	4.7nF	Ceramic Cap; 50V;X7R;0603	0603	muRata	GRM188R71H472KA01D
2	C4, C7	0.1µF	Ceramic Cap; 16V;X7R;0603	0603	muRata	GRM188R71C104KA01D
1	C5	10pF	Ceramic Cap; 50V;C0G;0603	0603	muRata	GRM1885C1H100JA01
1	C6	1µF	Ceramic Cap; 16V;X7R;0603	0603	muRata	GRM188R71C105KA12D
9	CIN1-CIN6, C2C, C2D, C8	NS				
1	FB1	NS				
1	D1	NS				
1	L1	NS				
1	L2	10µH	Inductor, 27mOhm DCR, 7.6A	SMD	Coilcraft	XAL6060-103MEB
1	L3	Short				
2	R1, R6	100k	Film Res., 5%	0603	Yageo	RC0603JR-07100KL
1	R4	169k	Film Res., 1%	0603	Yageo	RC0603FR-07169KL
1	R5	20	Film Res., 1%	0603	Yageo	RC0603FR-0720RL
1	R7	1M	Film Res., 1%	0603	Yageo	RC0603FR-071ML
1	R8	316k	Film Res., 1%	0603	Yageo	RC0603FR-07316KL
1	R9	10	Film Res., 5%	0603	Yageo	RC0603JR-0710RL
2	R2, R3	NS				
1	U1		Step-Down Regulator	QFN-16 (3mmX4mm)	MPS	MPQ4432GL
5	VIN, VEMI, GND, VOUT, GND		2.0 Golden Pin		HZ	
5	EN, GND, SYNC, GND, PG		1.0 Golden Pin		HZ	

EVB TEST RESULTS

V_{IN} = 12V, V_{OUT} =3.3V, L=10µH, F_{SW}=500kHz, AAM mode, T_A = +25°C, unless otherwise noted.

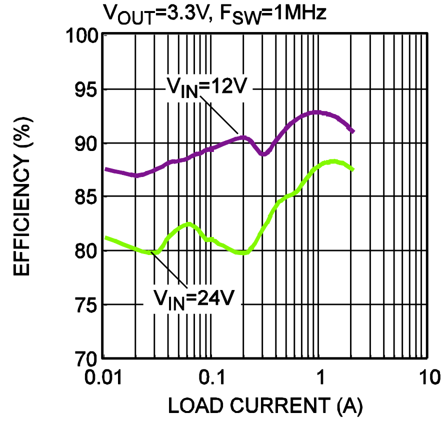
Efficiency vs. Load Current

V_{OUT}=3.3V, F_{SW}=500kHz



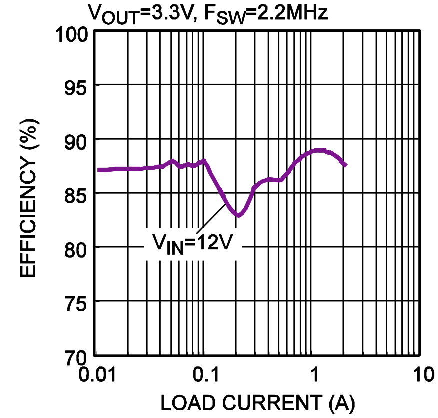
Efficiency vs. Load Current

V_{OUT}=3.3V, F_{SW}=1MHz



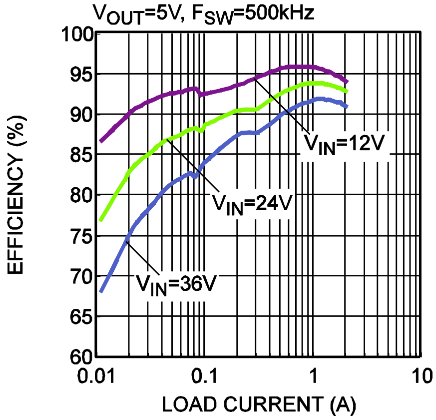
Efficiency vs. Load Current

V_{OUT}=3.3V, F_{SW}=2.2MHz



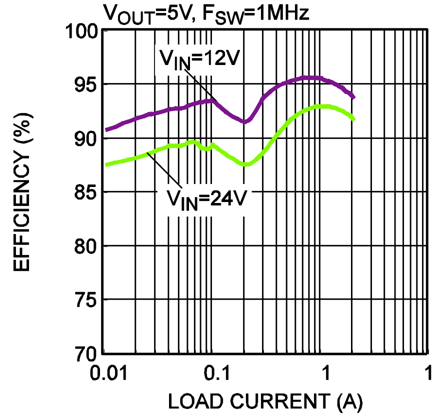
Efficiency vs. Load Current

V_{OUT}=5V, F_{SW}=500kHz



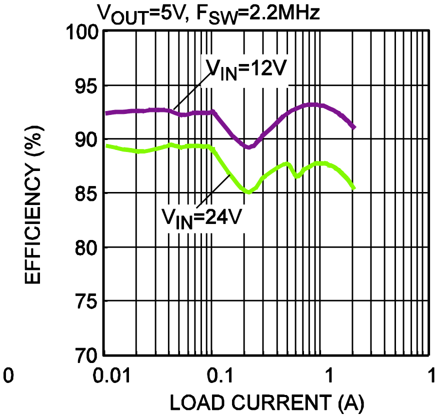
Efficiency vs. Load Current

V_{OUT}=5V, F_{SW}=1MHz



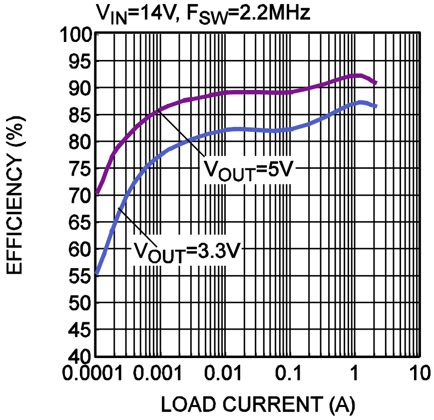
Efficiency vs. Load Current

V_{OUT}=5V, F_{SW}=2.2MHz



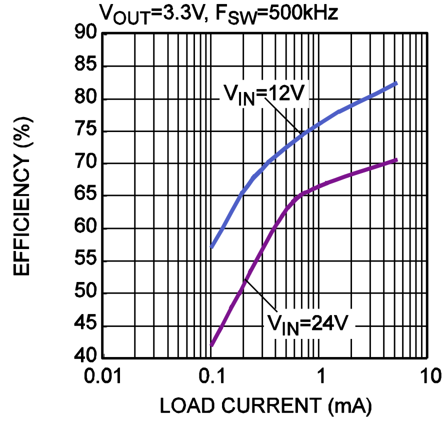
Efficiency vs. Load Current

V_{IN}=14V, F_{SW}=2.2MHz



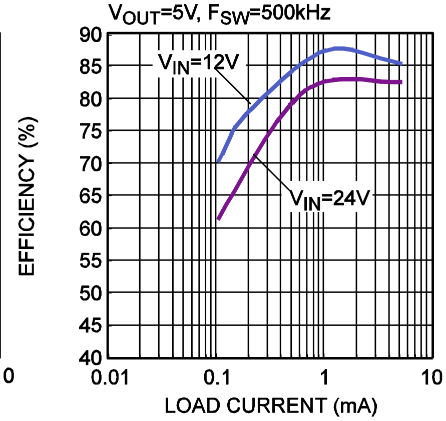
Efficiency vs. Load Current (Extreme Light Load)

V_{OUT}=3.3V, F_{SW}=500kHz



Efficiency vs. Load Current (Extreme Light Load)

V_{OUT}=5V, F_{SW}=500kHz

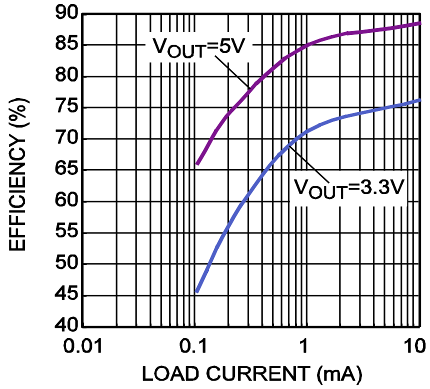


EVB TEST RESULTS *(continued)*

Performance waveforms are tested on the evaluation board.
V_{IN} = 12V, V_{OUT} =3.3V, L=10µH, F_{SW}=500kHz, AAM mode, T_A = +25°C, unless otherwise noted.

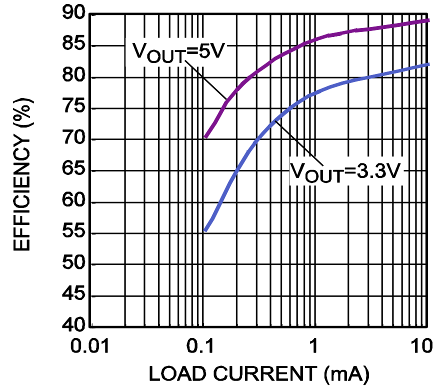
Efficiency vs. Load Current (Extreme Light Load)

V_{IN}=14V, F_{SW}=400kHz



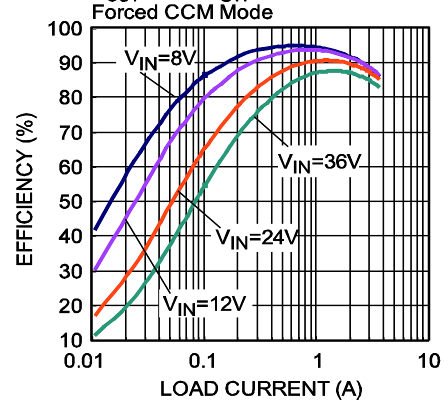
Efficiency vs. Load Current (Extreme Light Load)

V_{IN}=14V, F_{SW}=2.2MHz



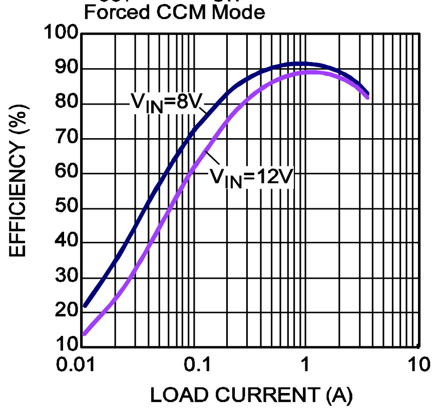
Efficiency vs. Load Current

V_{OUT}=3.3V, F_{SW}=500kHz, Forced CCM Mode



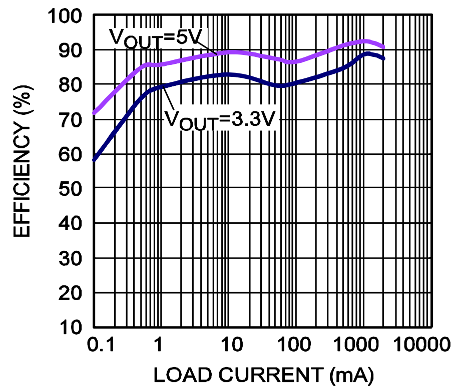
Efficiency vs. Load Current

V_{OUT}=3.3V, F_{SW}=2.2MHz, Forced CCM Mode



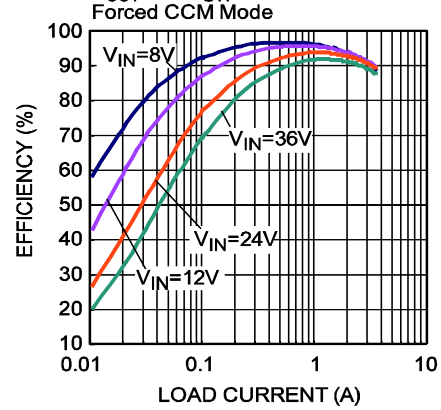
Efficiency vs. Load Current

V_{OUT}=12V, F_{SW}=2.2MHz, L=2.2µH



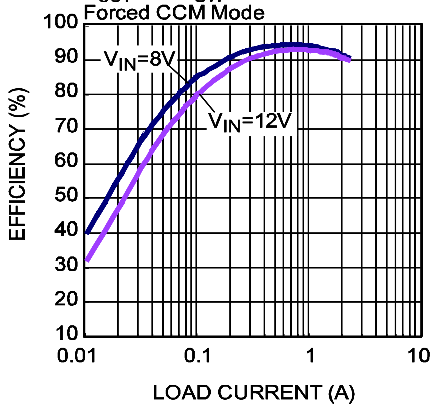
Efficiency vs. Load Current

V_{OUT}=5V, F_{SW}=500kHz, Forced CCM Mode



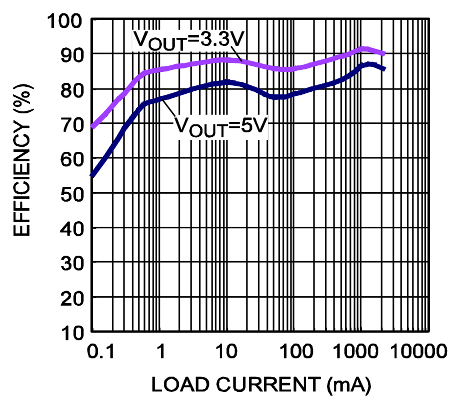
Efficiency vs. Load Current

V_{OUT}=5V, F_{SW}=2.2MHz, Forced CCM Mode



Efficiency vs. Load Current

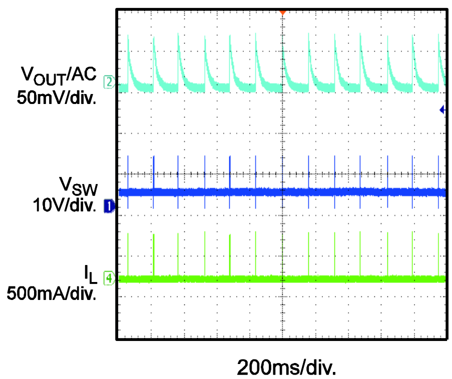
V_{IN}=14V, F_{SW}=2.2MHz, L=2.2µH



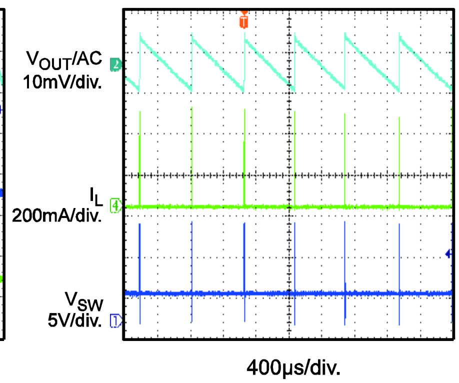
EVB TEST RESULTS *(continued)*

Performance waveforms are tested on the evaluation board.
V_{IN} = 12V, V_{OUT} =3.3V, L=10µH, F_{SW}=500kHz, AAM mode, T_A = +25°C, unless otherwise noted.

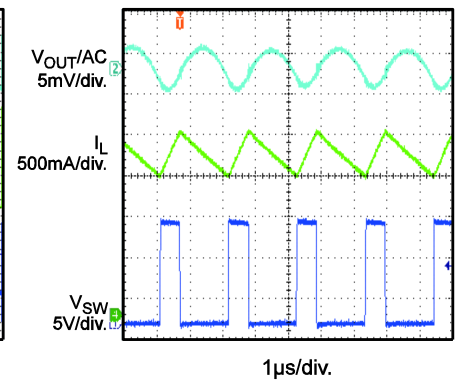
Steady State
I_{OUT}=0A, AAM mode



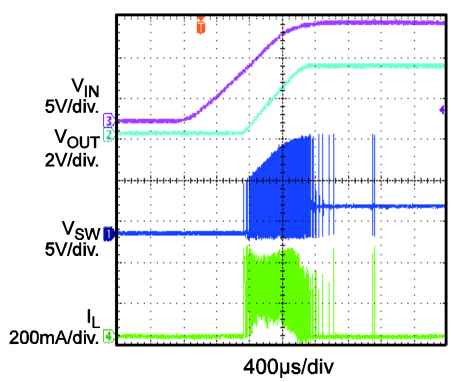
Steady State
I_{OUT}=1mA, AAM mode



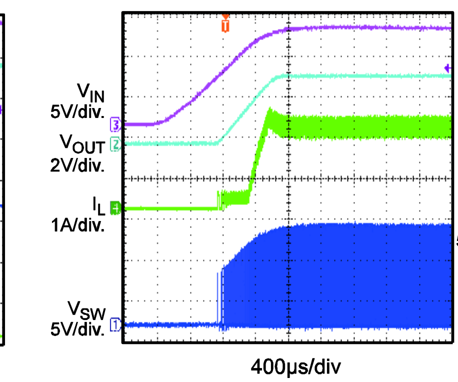
Steady State
I_{OUT}=2A



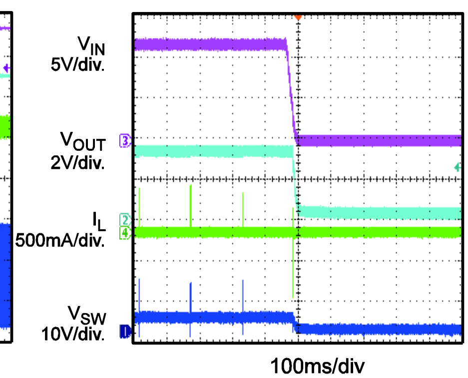
Start-Up through VIN
I_{OUT}=0A



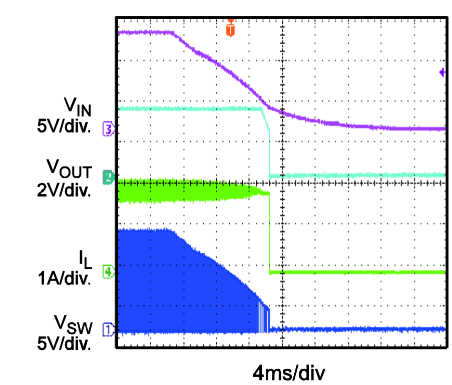
Start-Up through VIN
I_{OUT}=2A



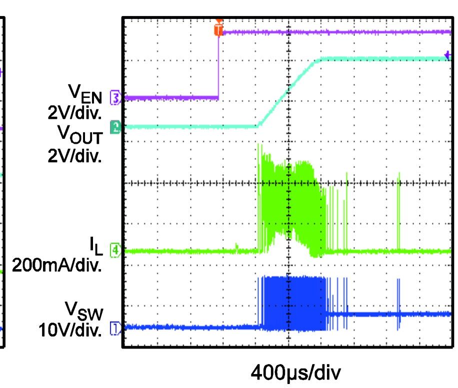
Shutdown through VIN
I_{OUT}=0A



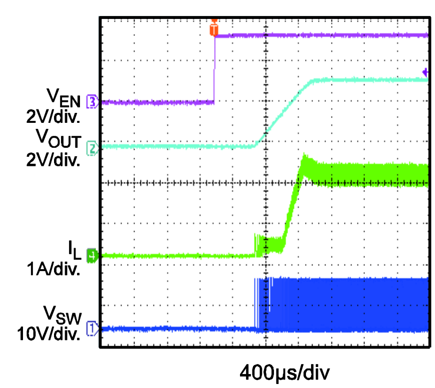
Shutdown through VIN
I_{OUT}=2A



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



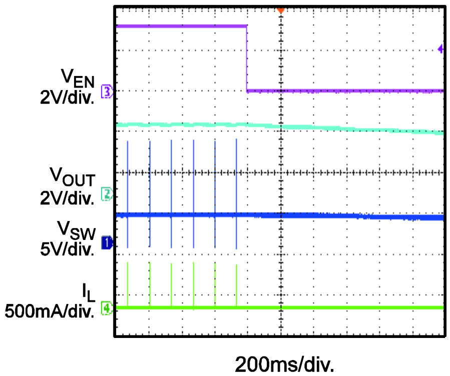
Start-Up through EN
I_{OUT}=2A



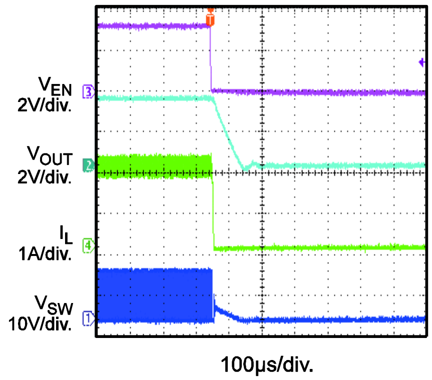
EVB TEST RESULTS *(continued)*

Performance waveforms are tested on the evaluation board.
V_{IN} = 12V, V_{OUT} =3.3V, L=10µH, F_{SW}=500kHz, AAM mode, T_A = +25°C, unless otherwise noted.

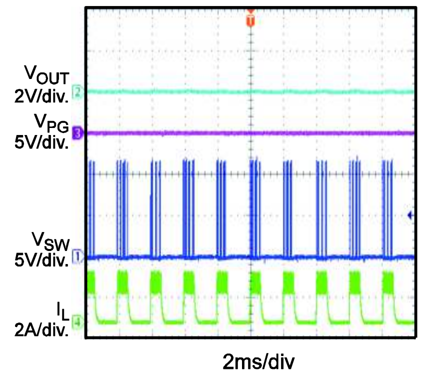
Shutdown through EN
I_{OUT}=0A



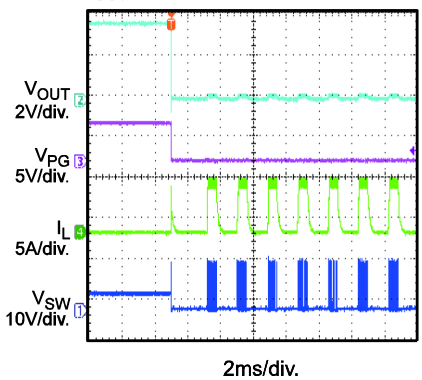
Shutdown through EN
I_{OUT}=2A



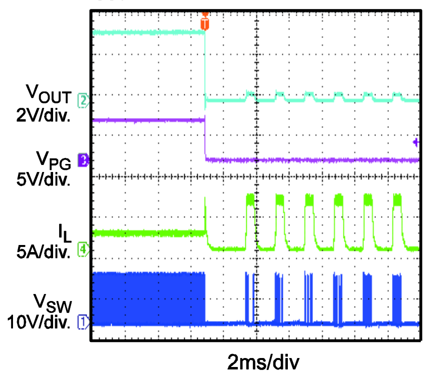
SCP Steady State



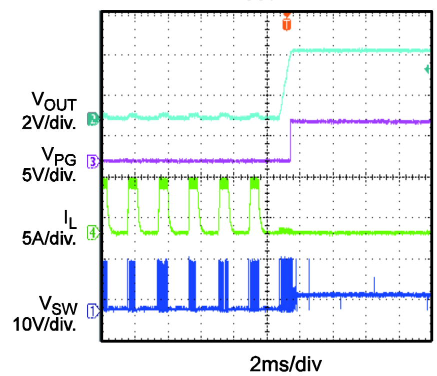
SCP Entry
I_{OUT}=0A to short circuit



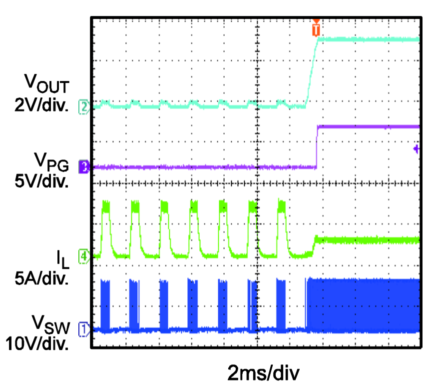
SCP Entry
I_{OUT}=2A to short circuit



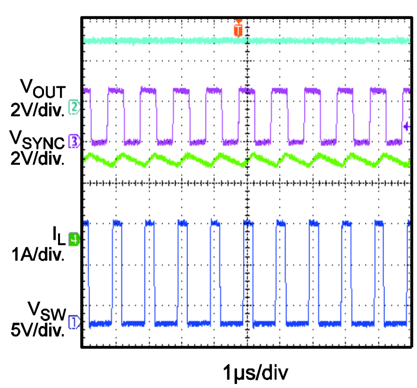
SCP Recovery
short circuit to I_{OUT}=0A



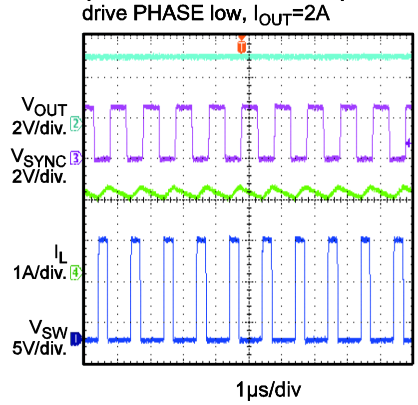
SCP Recovery
short circuit to I_{OUT}=2A



SYNC Operation (In-Phase)
drive PHASE high, I_{OUT}=2A



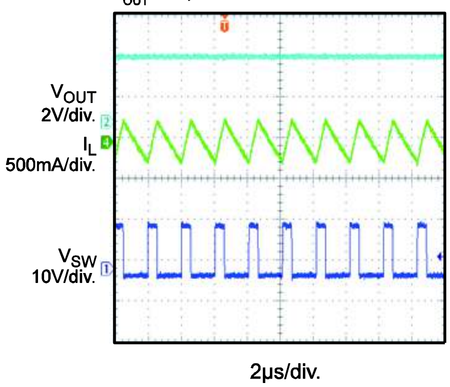
SYNC Operation (180° Out-of-Phase)
drive PHASE low, I_{OUT}=2A



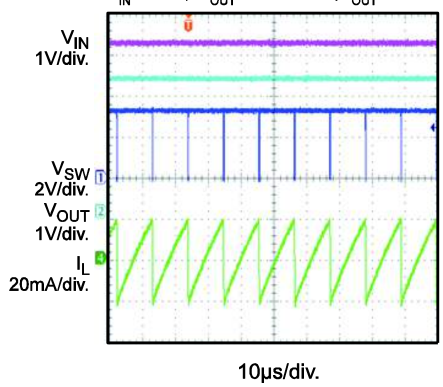
EVB TEST RESULTS *(continued)*

Performance waveforms are tested on the evaluation board.
V_{IN} = 12V, V_{OUT} =3.3V, L=10µH, F_{SW}=500kHz, AAM mode, T_A = +25°C, unless otherwise noted.

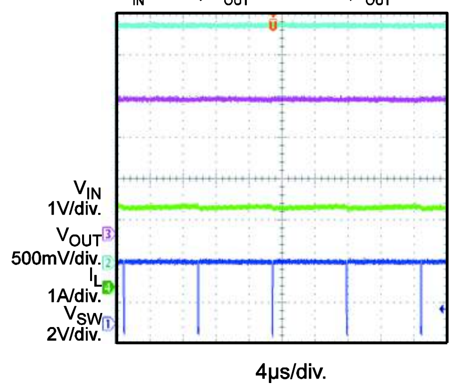
Forced CCM Operation
I_{OUT}=0A, forced CCM mode



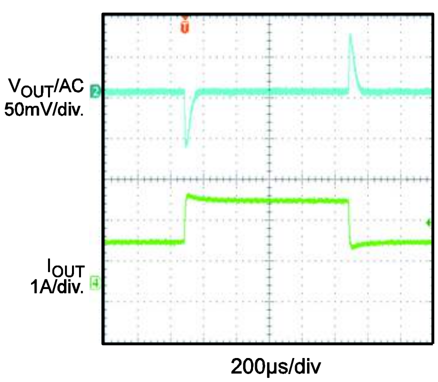
Dropout Operation
V_{IN}=3.3V, V_{OUT} set to3.3V, I_{OUT}=0A



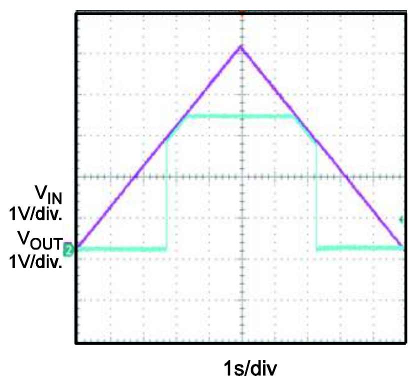
Dropout Operation
V_{IN}=3.3V, V_{OUT} set to3.3V, I_{OUT}=2A



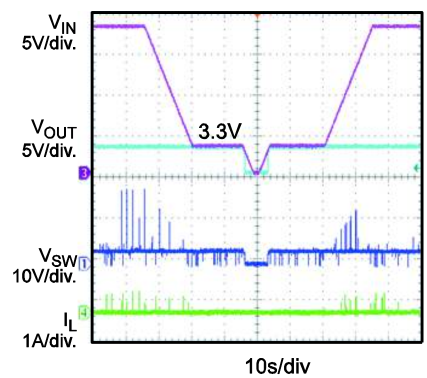
Load Transient
IOUT=1A<->2A, 1.6A/µs



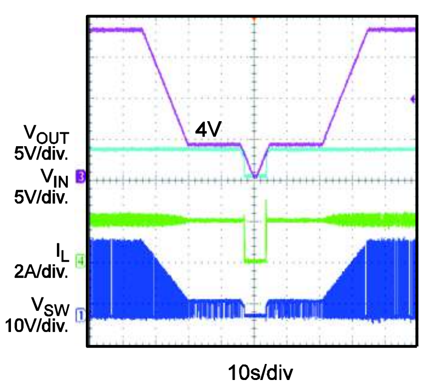
VIN Ramp Up and Down
I_{OUT}=0.1A



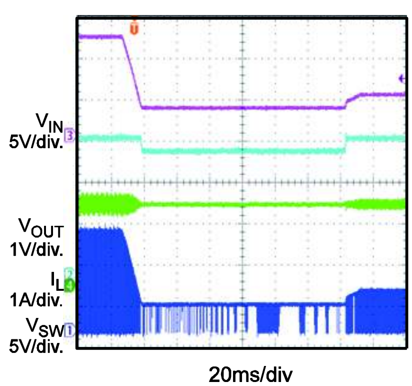
VIN Ramp Down and Up
I_{OUT}=1mA



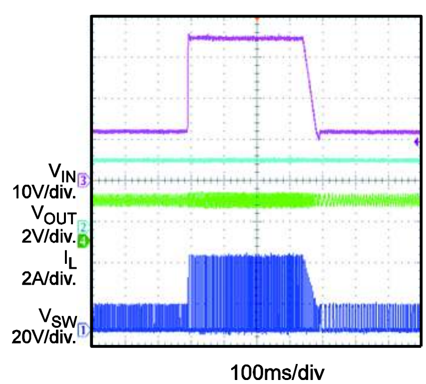
VIN Ramp Down and Up
I_{OUT}=2A



Cold-Crank
V_{IN}=12V->3.3V->5V, I_{OUT}=2A



Load Dump
V_{IN}=12V<->36V, I_{OUT}=2A



PRINTED CIRCUIT BOARD LAYOUT

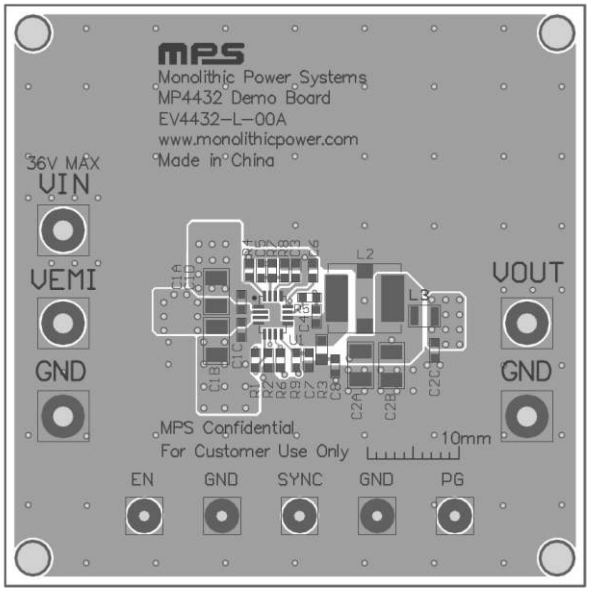


Figure 1—Top Silk Layer and Top Layer

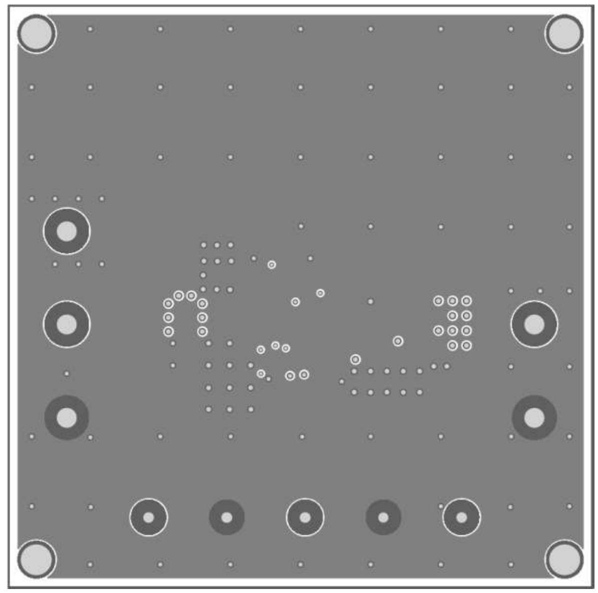


Figure 2—Inner1 Layer

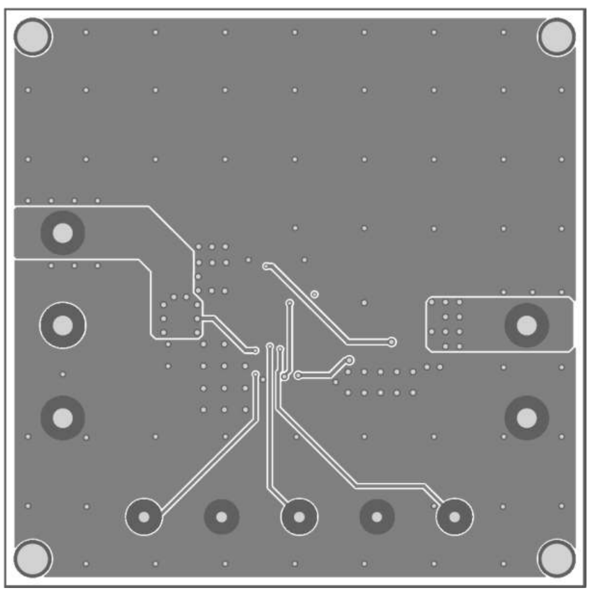


Figure 3—Inner2 Layer

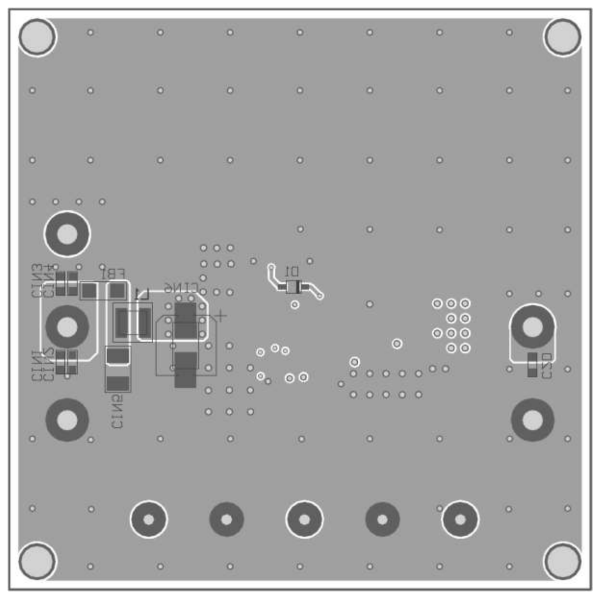


Figure 4—Bottom Silk Layer and Bottom Layer

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