EVQ9841-L-00A

36V, 1A, Low Quiescent Current Synchronous Step-Down Convertor Evaluation Board

DESCRIPTION

The EVQ9841-L-00A Evaluation Board is designed to demonstrate the capabilities of MPS' MP/MPQ9841.

MP/MPQ9841GL 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 1A highly efficient output current with current mode control for fast loop response.

The MP/MPQ9841GL 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 EVQ9841-L-00A is a fully assembled and tested evaluation board, it generates +3.3V output voltage at load current up to 1A from a 3.3V to 36V input range with 450kHz switching frequency.

ELECTRICAL SPECIFICATION

Parameter	Symbol	Value	Units
Input Voltage	V_{EMI}	3.3 - 36	V
Output Voltage	V_{OUT}	3.3	V
Output Current	I_{OUT}	1	A

FEATURES

- Wide 3.3V to 36V Operating Input Range
  1A Continuous Output Current
- 2μA Low Shutdown Mode Current
- 14μA Sleep Mode Quiescent Current
- Internal 125mΩ High-Side and 115mΩ 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 a QFN-16 (3mmx4mm) Package
- Available Wettable Flank
- AEC-Q100 Grade-1

APPLICATIONS

- Automotive Systems
- Industrial Power Systems

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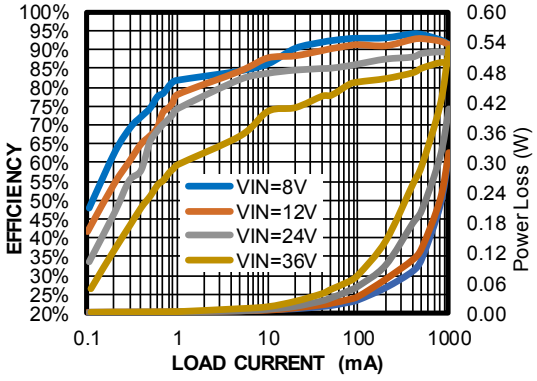
EVQ9841-L-00A EVALUATION BOARD

(L × W × H) 8.9cm x 8.9cm x 2cm

Board Number	MPS IC Number
EVQ9841-L-00A	MP/MPQ9841GL

Efficiency vs. Load Current

V_{OUT}=3.3V, AAM



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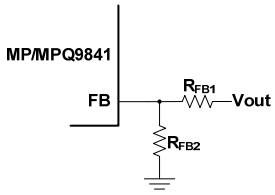
QUICK START GUIDE

1. Preset power supply to 3.3V ≤ V_{IN} ≤ 36V.
   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. Turn power supply 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 power supply terminals to:
   a. Positive (+): VEMI
   b. Negative (–): GND
4. Connect load to:
   a. Positive (+): VOUT
   b. Negative (–): GND
5. Turn power supply on after making connections.
6. 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.
7. The oscillating frequency of MP/MPQ9841 can be programmed by an external frequency resistor R_{FREQ}. The value of R_{FREQ} can be estimated with below equation:

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

8. 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.
9. 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. For different output voltage, R_{FB1} and R_{FB2} can be calculated by 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%)

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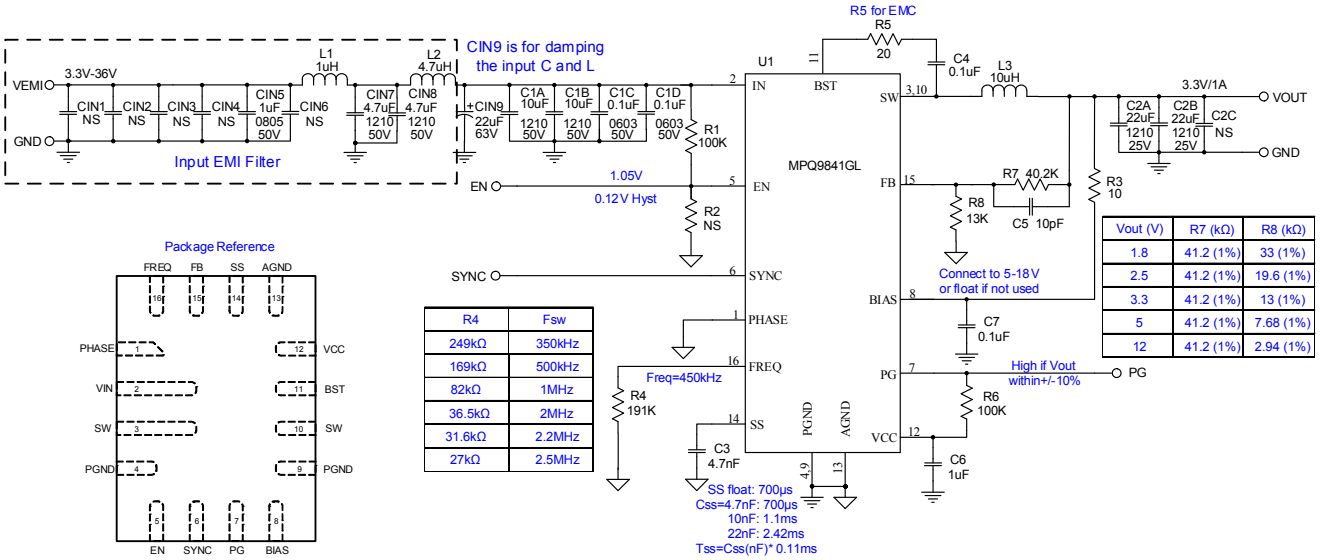
EVALUATION BOARD SCHEMATIC



R4	Fsw
249kΩ	350kHz
169kΩ	500kHz
82kΩ	1MHz
36.5kΩ	2MHz
31.6kΩ	2.2MHz
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%)

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EVQ9841-L-00A BILL OF MATERIALS

Qty	Ref	Value	Description	Package	Manufacture	Manufacture_PN
1	CIN5	1μF	Ceramic Cap., 50V, X7R	0805	muRata	GRM21BR71H105KA12L
4	CIN7, CIN8, C1A, C1B	4.7μF	Ceramic Cap., 50V, X7S	0805	muRata	GRM21BR71H475KE11L
1	CIN9	22μF	Electrolytic Capacitor., 63V	SMD	Jianghai	VTD-63V22
2	C1C, C1D	0.1μF	Ceramic Cap., 50V, X7R	0603	muRata	GRM188R71H104KA93D
2	C2A, C2B	22μF	Ceramic Cap., 16V, X7R	1210	muRata	GRM32ER71C226KEA8L
1	C3	4.7nF	Ceramic Cap., 50V, X7R	0603	muRata	GRM188R71H472KA01D
2	C4, C7	0.1μF	Ceramic Cap., 16V, X7R	0603	muRata	GRM188R71C104KA01D
1	C5	10pF	Ceramic Cap., 50V, C0G	0603	muRata	GRM1885C1H100JA01
1	C6	1μF	Ceramic Cap., 16V, X7R	0603	muRata	GRM188R71C105KA12D
6	CIN1, CIN2, CIN3, CIN4, CIN6, C2C	NS				
1	L1	1μH	Inductor, 41mOhm DCR, 3.1A	SMD	Cyntec	VCTA20161B-1R0MS6-89
1	L2	4.7μH	Inductor, 165mOhm DCR, 1.7A	SMD	Cyntec	VCTA25201B-4R7MS6-89
1	L3	10μH	Inductor, 48.6mOhm DCR, 3.7A	SMD	Cyntec	VCHA042A-100MS6-89
2	R1, R6	100k	Film Res., 1%	0603	Yageo	RC0603FR-07100KL
1	R3	10	Film Res., 1%	0603	Yageo	RC0603FR-0710RL
1	R4	191k	Film Res., 1%	0603	Yageo	RC0603FR-07191KL
1	R5	20	Film Res., 1%	0603	Yageo	RC0603FR-0720RL
1	R7	41.2k	Film Res., 1%	0603	Yageo	RC0603FR-0741K2L
1	R8	13k	Film Res., 1%	0603	Yageo	RC0603FR-0713KL
1	R10	1k	Film Res., 1%	0603	Yageo	RC0603FR-071KL
1	R12	11k	Film Res., 1%	0603	Yageo	RC0603FR-0711KL
1	R2	NS				
1	U1		Step-Down Regulator	QFN-16 (3mmX4mm)	MPS	MPQ9841GL
4	VEMI, GND, VOUT, GND		2.0 Golden Pin		HZ	
5	EN, GND, SYNC, GND, PG		1.0 Golden Pin		HZ	

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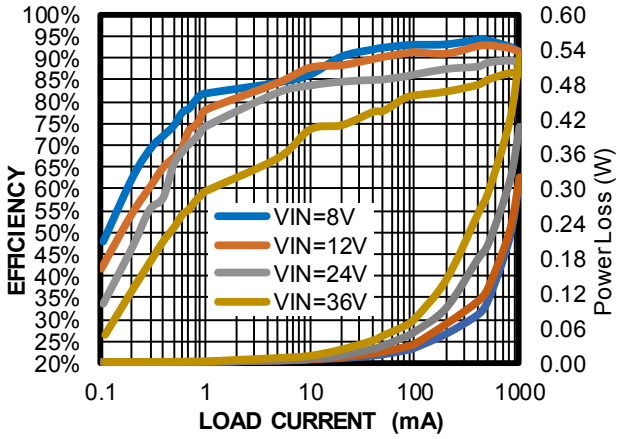
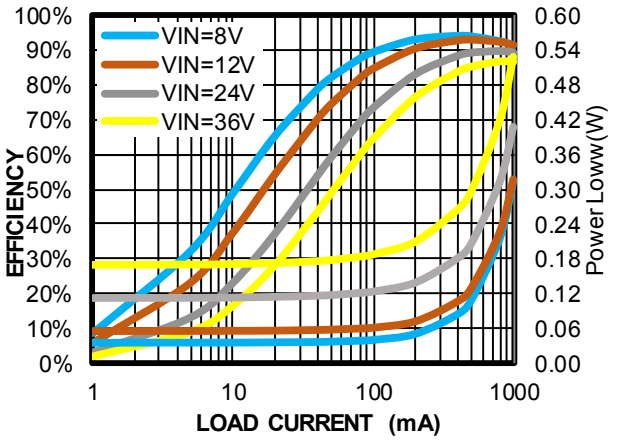
EVB TEST RESULTS

Performance curves and waveforms are tested on the evaluation board.
V_{IN} = 12V, V_{OUT} = 3.3V, L = 10μH, F_{SW} = 450kHz, T_A = 25°C, unless otherwise noted.

Efficiency vs. Load Current
V_{OUT}=3.3V, AAM



Efficiency vs. Load Current
V_{OUT}=3.3V, CCM



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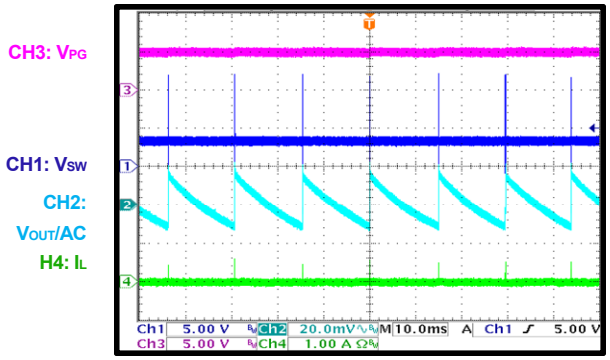
EVB TEST RESULTS *(continued)*

Performance curves and waveforms are tested on the evaluation board.
V_{IN} = 12V, V_{OUT} = 3.3V, L = 10µH, F_{SW} = 450kHz, T_A = 25°C, unless otherwise noted.

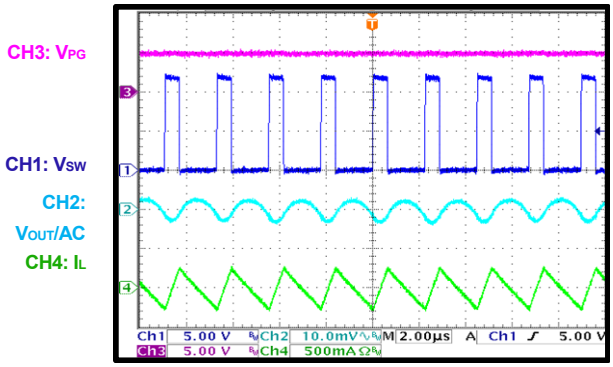
Steady State

V_{IN} = 12V, V_{OUT} = 3.3V, I_{OUT} = 0A, AAM



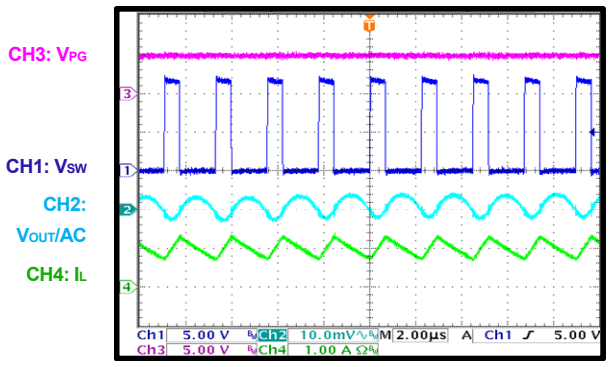
Steady State

V_{IN} = 12V, V_{OUT} = 3.3V, I_{OUT} = 0A, CCM



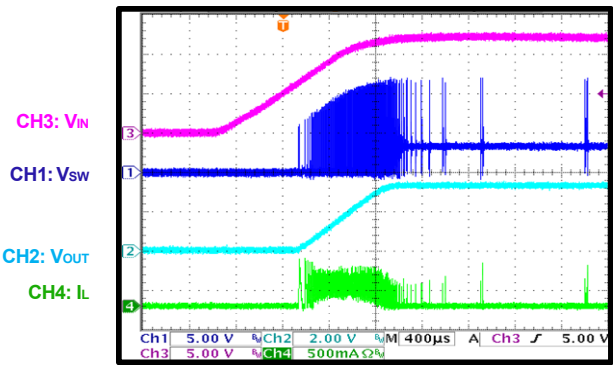
Steady State

V_{IN} = 12V, V_{OUT} = 3.3V, I_{OUT} = 1A



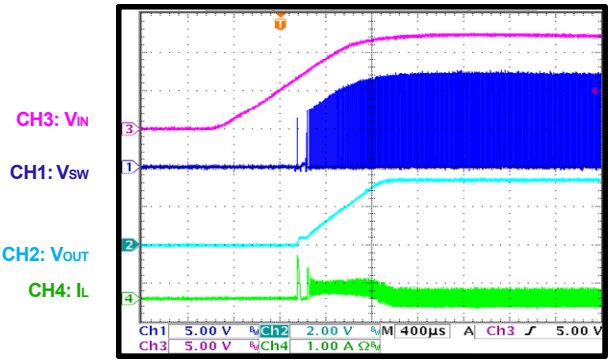
Power On

V_{IN} = 12V, V_{OUT} = 3.3V, I_{OUT} = 0A, AAM



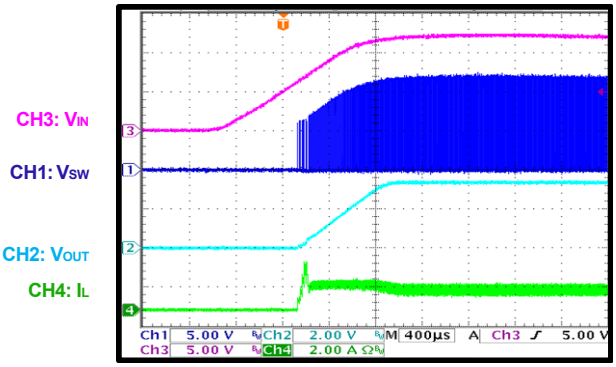
Power On

V_{IN} = 12V, V_{OUT} = 3.3V, I_{OUT} = 0A, CCM



Power On

V_{IN} = 12V, V_{OUT} = 3.3V, I_{OUT} = 1A



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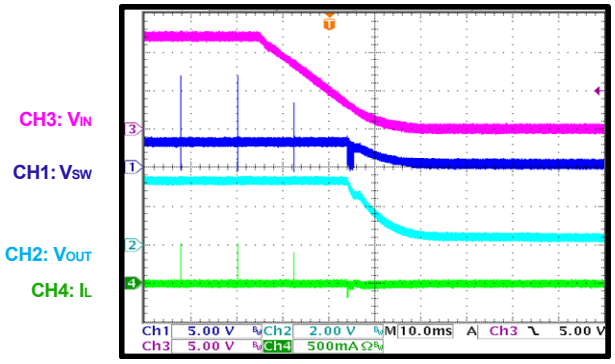
EVB TEST RESULTS *(continued)*

Performance curves and waveforms are tested on the evaluation board.
V_{IN} = 12V, V_{OUT} = 3.3V, L = 10µH, F_{SW} = 450kHz, T_A = 25°C, unless otherwise noted.

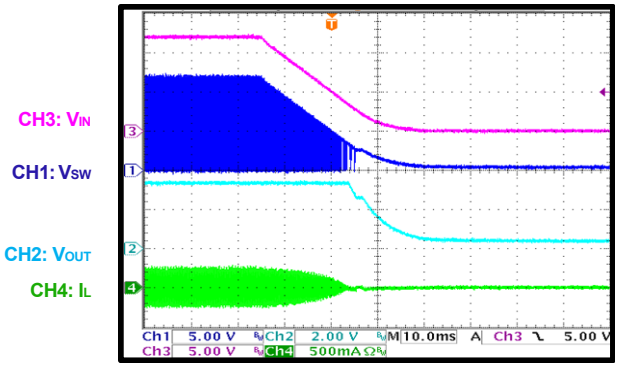
Power Off

V_{IN} = 12V, V_{OUT} = 3.3V, I_{OUT} = 0A, AAM



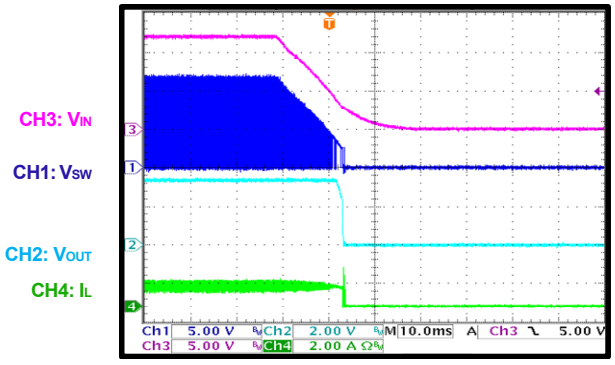
Power Off

V_{IN} = 12V, V_{OUT} = 3.3V, I_{OUT} = 0A, CCM



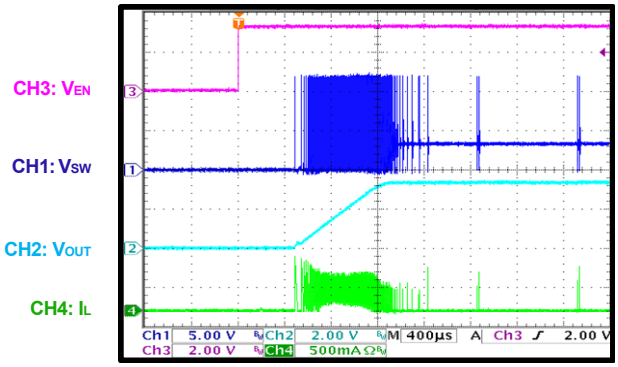
Power Off

V_{IN} = 12V, V_{OUT} = 3.3V, I_{OUT} = 1A



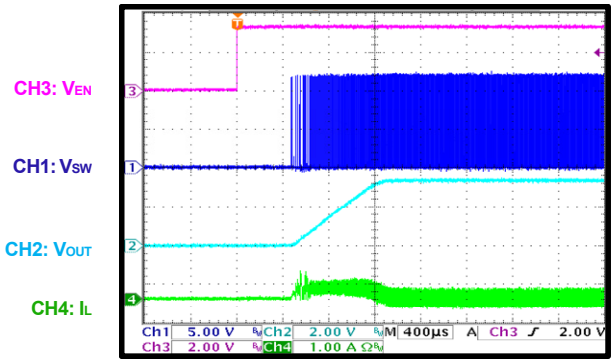
EN On

V_{IN} = 12V, V_{OUT} = 3.3V, I_{OUT} = 0A, AAM



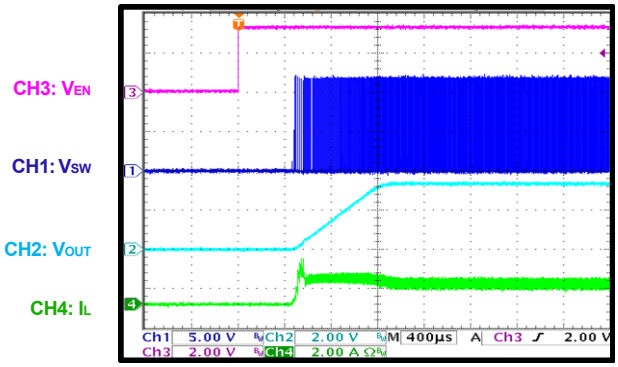
EN On

V_{IN} = 12V, V_{OUT} = 3.3V, I_{OUT} = 0A, CCM



EN On

V_{IN} = 12V, V_{OUT} = 5V, I_{OUT} = 1A



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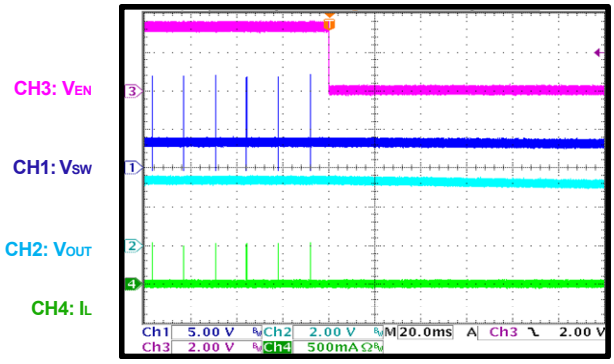
EVB TEST RESULTS *(continued)*

Performance curves and waveforms are tested on the evaluation board.
V_{IN} = 12V, V_{OUT} = 3.3V, L = 10µH, F_{SW} = 450kHz, T_A = 25°C, unless otherwise noted.

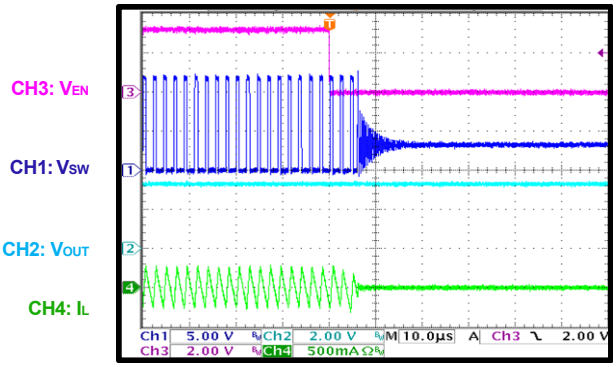
EN Off

V_{IN} = 12V, V_{OUT} = 3.3V, I_{OUT} = 0A, AAM



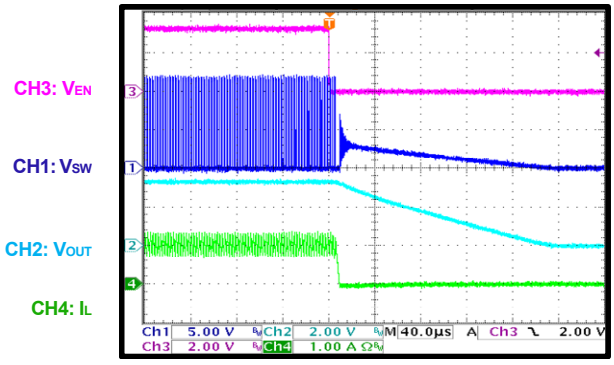
EN Off

V_{IN} = 12V, V_{OUT} = 3.3V, I_{OUT} = 0A, CCM



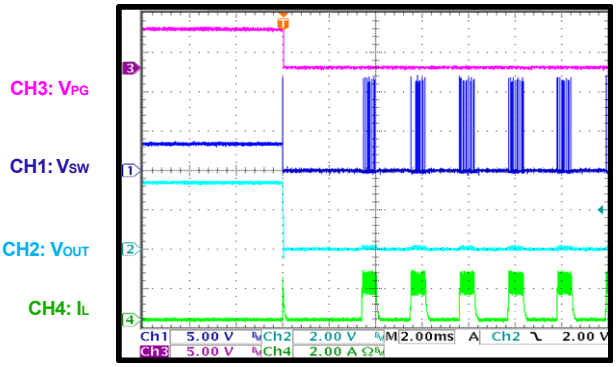
EN Off

V_{IN} = 12V, V_{OUT} = 3.3V, I_{OUT} = 1A



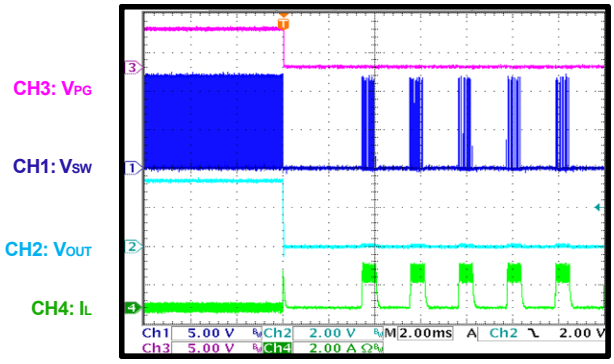
SCP Entry

V_{IN} = 12V, V_{OUT} = 3.3V, I_{OUT} = 0A, AAM



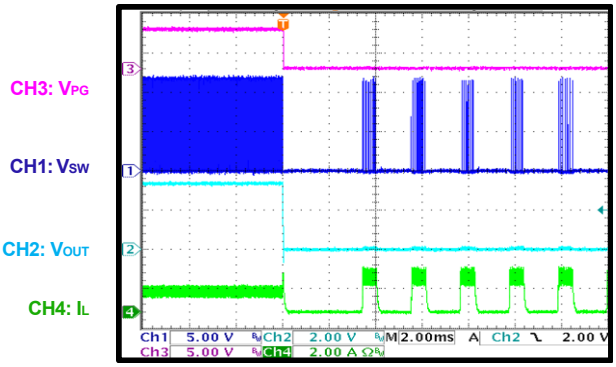
SCP Entry

V_{IN} = 12V, V_{OUT} = 3.3V, I_{OUT} = 0A, CCM



SCP Entry

V_{IN} = 12V, V_{OUT} = 3.3V, I_{OUT} = 1A



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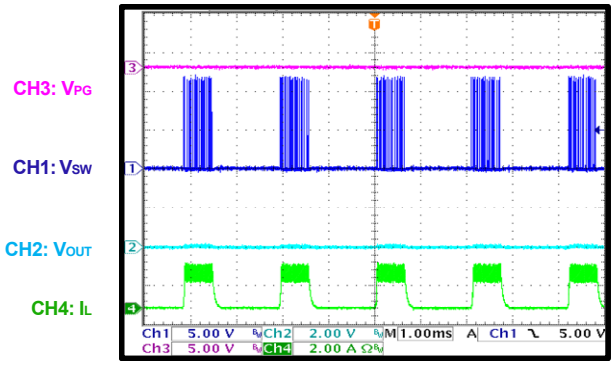
EVB TEST RESULTS *(continued)*

Performance curves and waveforms are tested on the evaluation board.
V_{IN} = 12V, V_{OUT} = 3.3V, L = 10µH, T_A = 25°C, unless otherwise noted.

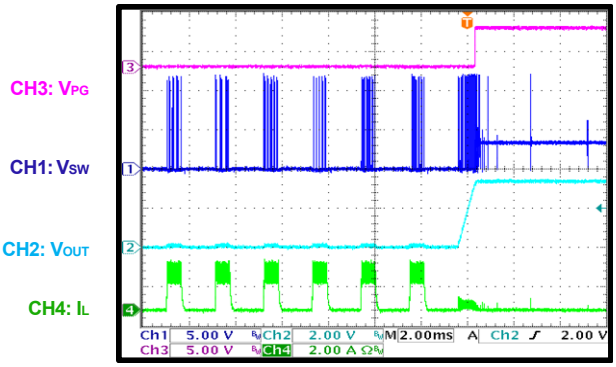
SCP Steady State

Vin=12V



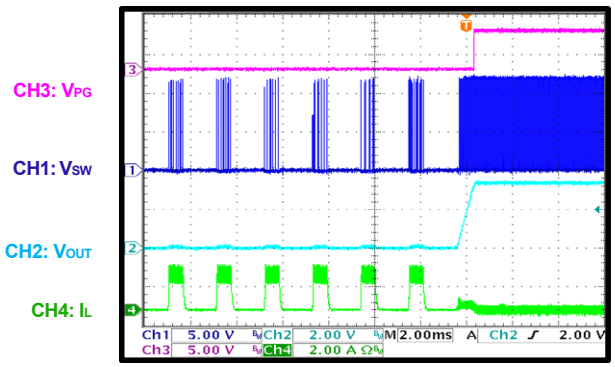
SCP Recovery

V_{IN} = 12V, V_{OUT} = 3.3V, I_{OUT} = 0A, AAM



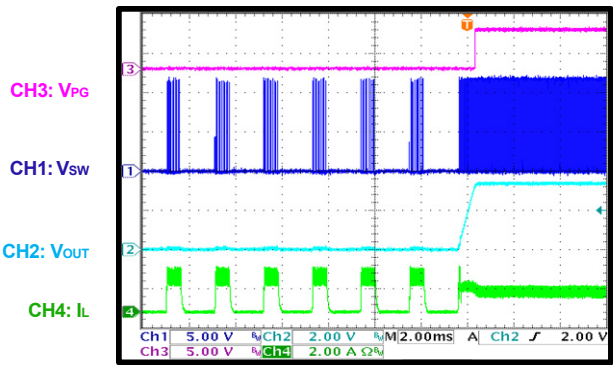
SCP Recovery

V_{IN} = 12V, V_{OUT} = 3.3V, I_{OUT} = 0A, CCM



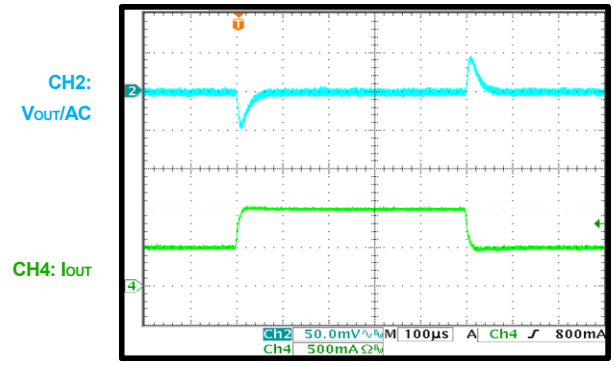
SCP Recovery

V_{IN} = 12V, V_{OUT} = 3.3V, I_{OUT} = 1A



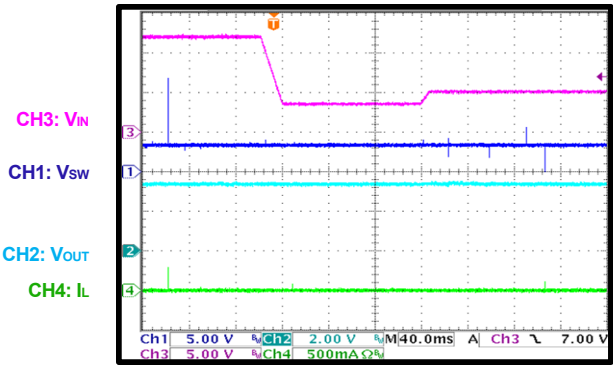
Load Transient

Vin = 12V, Vout = 3.3V, Iout = 0.5A-1A



Cold Crank

V_{IN} = 12V→3.3V→5V, I_{OUT} = 0A, AAM



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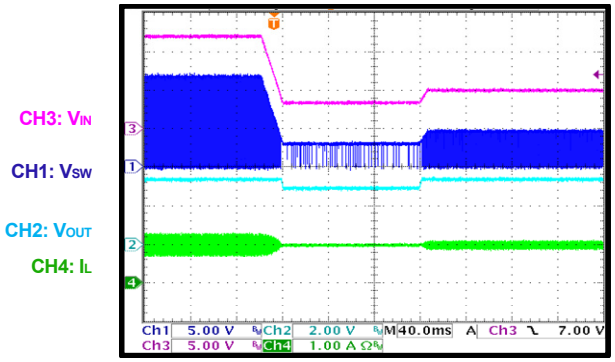
EVB TEST RESULTS *(continued)*

Performance curves and waveforms are tested on the evaluation board.
V_{IN} = 12V, V_{OUT} = 3.3V, L = 10µH, T_A = 25°C, unless otherwise noted.

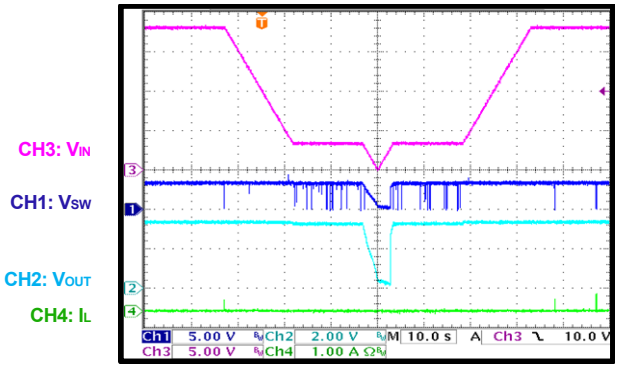
Cold Crank

V_{IN} = 12V→3.3V→5V, I_{OUT} = 1A



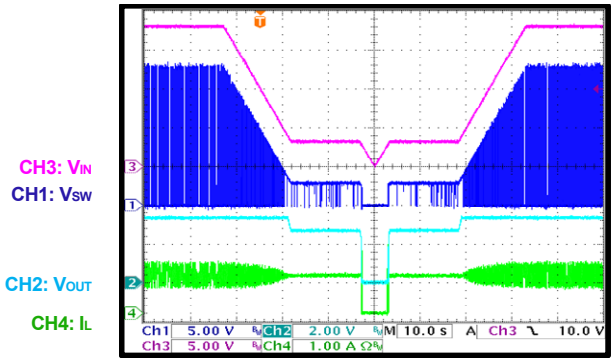
VIN Ramp Down and Up

V_{IN} = 18V→3.3V→0V→3.3V→18V, I_{OUT} = 0A, AAM



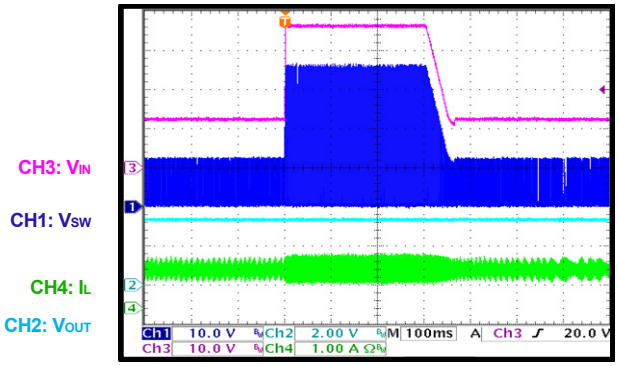
VIN Ramp Down and Up

V_{IN} = 18V→3.3V→0V→3.3V→18V, I_{OUT} = 1A



Load Dump

V_{IN} = 12V→36V→12V, I_{OUT} = 1A



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PRINTED CIRCUIT BOARD LAYOUT

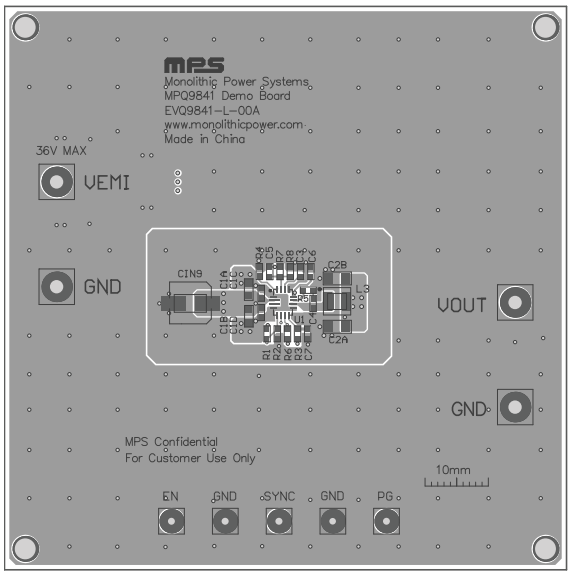

Figure 1: Top Silk Layer and Top Layer

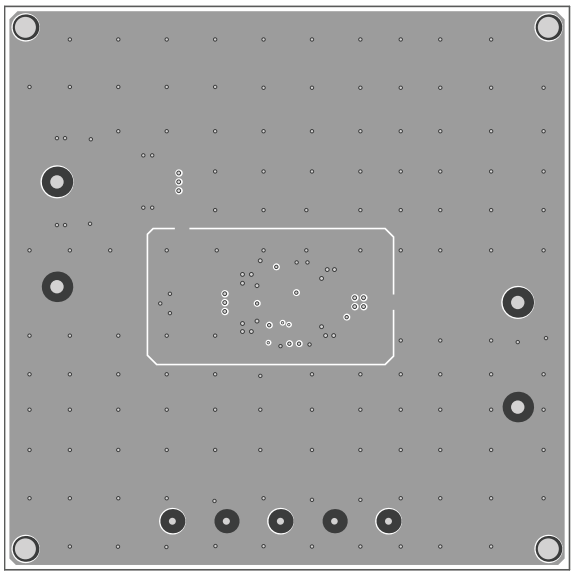

Figure 2: Inner 1 Layer

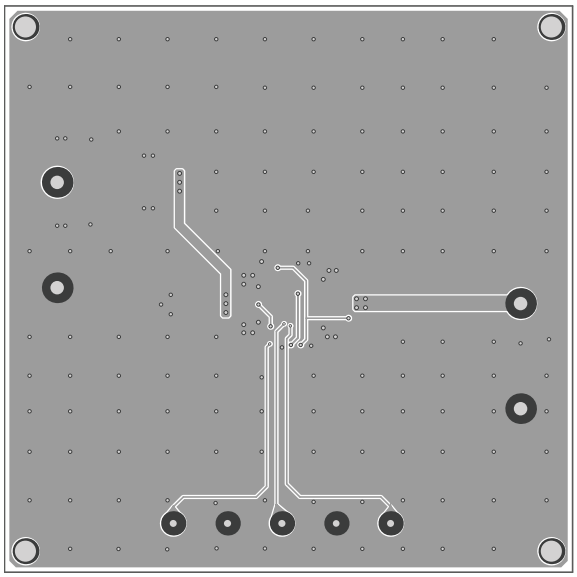

Figure 3: Inner 2 Layer

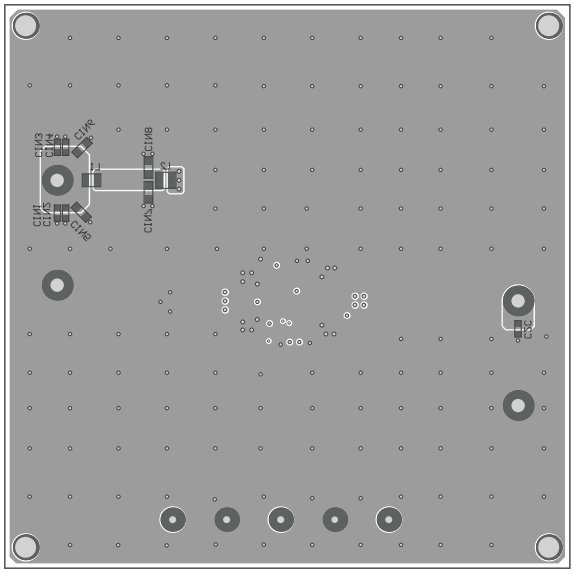

Figure 4: Bottom Silk Layer and Bottom Layer

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