EVQ4433-L-00A

36V, 3A, Low Quiescent Current Synchronous Step-Down Convertor Evaluation Board

DESCRIPTION

The EVQ4433-L-00A Evaluation Board is designed to demonstrate the capabilities of MPS' MP/MPQ4433.

MP/MPQ4433GL 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 3A highly efficient output current with current mode control for fast loop response.

The MP/MPQ4433GL 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 EVQ4433-L-00A is a fully assembled and tested evaluation board, it generates +5V output voltage at load current up to 3A from a 5V to 36V input range.

ELECTRICAL SPECIFICATION

Parameter	Symbol	Value	Units
Input Voltage	V_{IN}, V_{EMI}	5 - 36	V
Output Voltage	V_{OUT}	5	V
Output Current	I_{OUT}	3	A

FEATURES

- Wide 5V to 36V Operating Input Range
  3A 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 a QFN-16 (3mmx4mm) Package
- Available Wettable Flank
- AEC-Q100 Grade-1

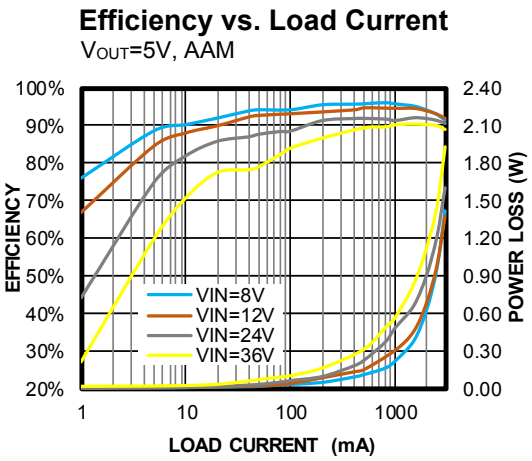
APPLICATIONS

- Automotive Systems
- Industrial Power Systems

EVQ4433-L-00A EVALUATION BOARD

(L × W × H) 8.3cm x 8.3cm x 1.3cm

Board Number	MPS IC Number
EVQ4433-L-00A	MP/MPQ4433GL

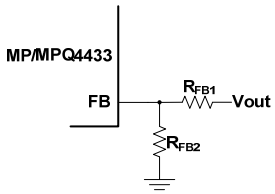


QUICK START GUIDE

1. Preset power supply to 5V ≤ 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/MPQ4433 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. Choose R_{FB1} to be around 40kΩ. Then R_{FB2} can be calculated with below equation:



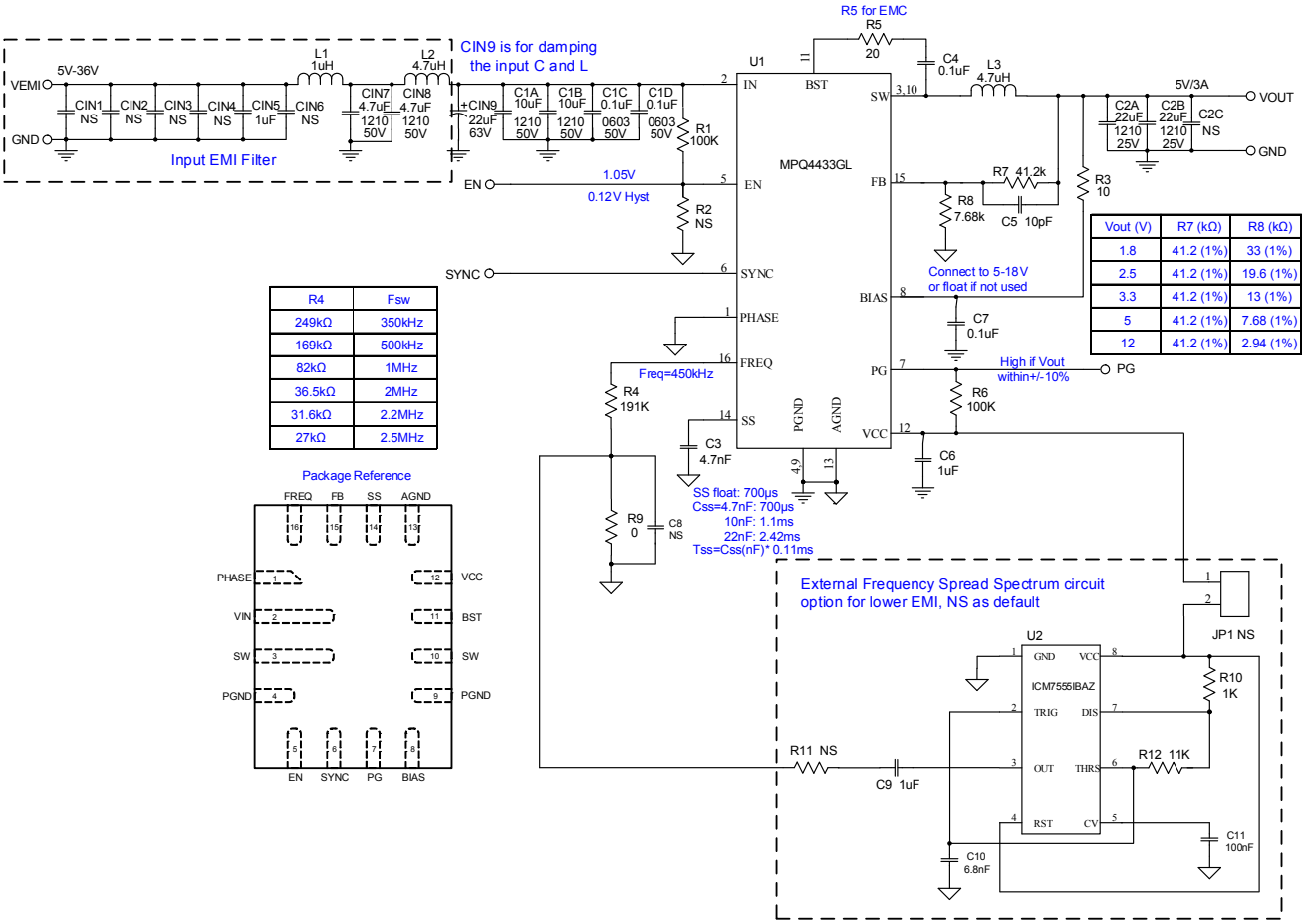
$$R_{FB2} = \frac{R_{FB1}}{\frac{V_{OUT}}{0.8V} - 1}$$

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%)

10. JP1 and JP2 can be used for adding an external shielding above inductor and IC, NS as default.

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%)

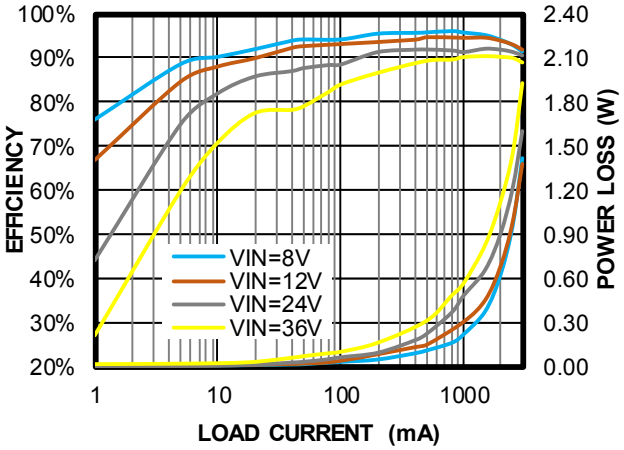
EVQ4433-L-00A BILL OF MATERIALS

Qty	Ref	Value	Description	Package	Manufacture	Manufacture_PN
1	CIN5	1μF	Ceramic Cap., 50V, X7R	0805	muRata	GRM21BR71H105KA12L
2	CIN7, CIN8	4.7μF	Ceramic Cap., 50V, X7R	1210	muRata	GRM32ER71H475KA88L
1	CIN9	22μF	Electrolytic Capacitor., 63V	SMD	Jianghai	VTD-63V22
2	C1A, C1B	10μF	Ceramic Cap., 50V, X7R	1210	muRata	GRM32ER71H106KA12L
2	C1C, C1D	0.1μF	Ceramic Cap., 50V, X7R	0603	muRata	GRM188R71H104KA93D
2	C2A, C2B	22μF	Ceramic Cap., 25V, X7R	1210	muRata	GRM32ER71H226KE15L
1	C3	4.7nF	Ceramic Cap., 50V, X7R	0603	TDK	C1608X7R1H472K
3	C4, C7, C11	0.1μF	Ceramic Cap., 16V, X7R	0603	muRata	GRM188R71C104KA01D
1	C5	10pF	Ceramic Cap., 50V, C0G	0603	muRata	GRM1885C1H100JA01
2	C6, C9	1μF	Ceramic Cap., 16V, X7R	0603	muRata	GRM188R71C105KA12D
1	C10	6.8nF	Ceramic Cap., 50V, X7R	0603	TDK	C1608X7R1H682K
7	CIN1, CIN2, CIN3, CIN4, CIN6, C2C,C8	NS				
2	JP1,JP2	NS				
1	L1	1μH	Inductor, 41mOhm DCR, 3.1A	SMD	Cyntec	VCTA20161B-1R0MS6-89
1	L2	4.7μH	Inductor, 48.6mOhm DCR, 3.7A	SMD	Cyntec	VCHA042A-4R7MS6-89
1	L3	4.7μH	Inductor, 31.5mOhm DCR, 6A	SMD	Cyntec	VCMT063T-4R7MN5-89
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	7.68k	Film Res., 1%	0603	Yageo	RC0603FR-0713KL
1	R10	1k	Film Res., 1%	0603	Yageo	RC0603FR-071KL
1	R9	0	Film Res., 1%	0603	Yageo	RC0603FR-070RL
1	R12	11k	Film Res., 1%	0603	Yageo	RC0603FR-0711KL
2	R2, R11	NS				
1	U2			SOP-8	Intersil	ICM7555IBAZ
4	VEMI, GND, VOUT, GND		2.0 Golden Pin		HZ	
5	EN, GND, SYNC, GND, PG		1.0 Golden Pin		HZ	
1	U1		Step-Down Regulator	QFN-16 (3mmX4mm)	MPS	MPQ4433GL

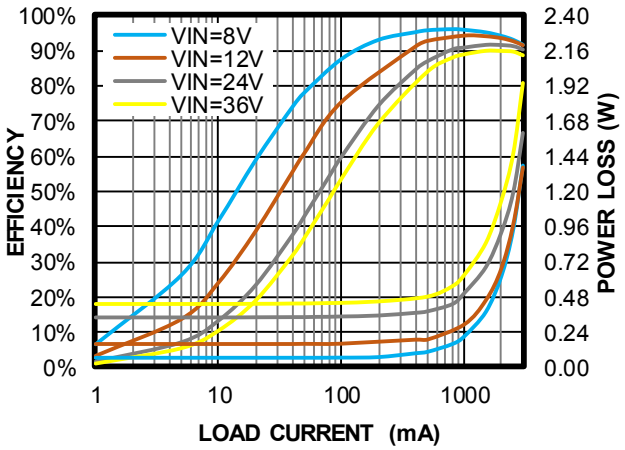
EVB TEST RESULTS

Performance curves and waveforms are tested on the evaluation board.
V_{IN} = 12V, V_{OUT} = 5V, L = 4.7µH, F_{SW}= 450kHz, T_A = 25°C, unless otherwise noted.

Efficiency vs. Load Current
V_{OUT}=5V, AAM



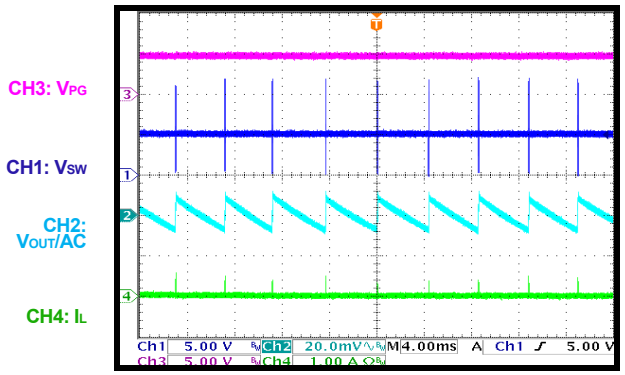
Efficiency vs. Load Current
V_{OUT}=5V, CCM



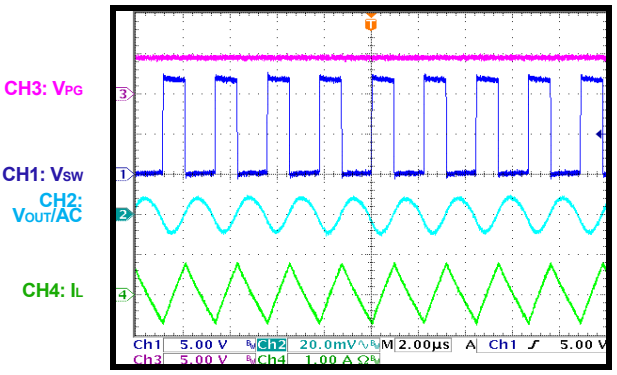
EVB TEST RESULTS *(continued)*

Performance curves and waveforms are tested on the evaluation board.
V_{IN} = 12V, V_{OUT} = 5V, L = 4.7µH, F_{SW}= 450kHz, T_A = 25°C, unless otherwise noted.

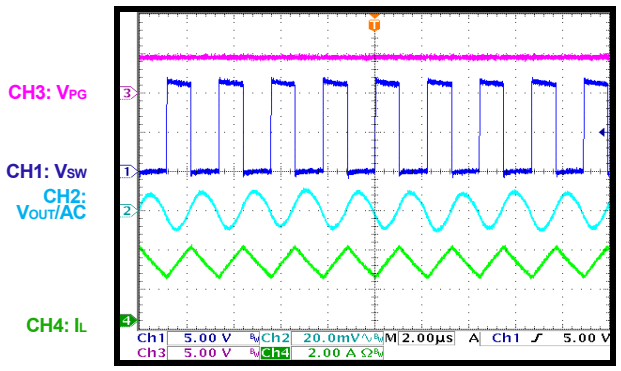
Steady State
I_{OUT} = 0A, AAM



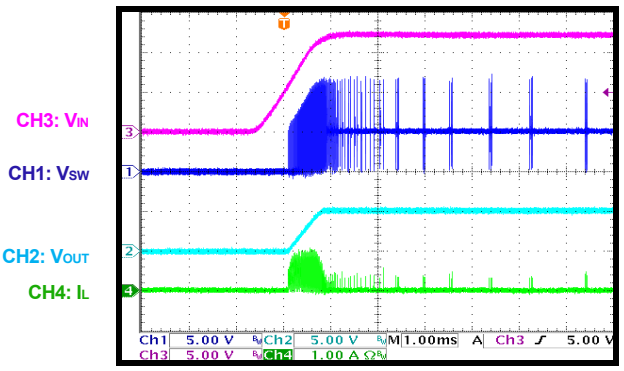
Steady State
I_{OUT} = 0A, CCM



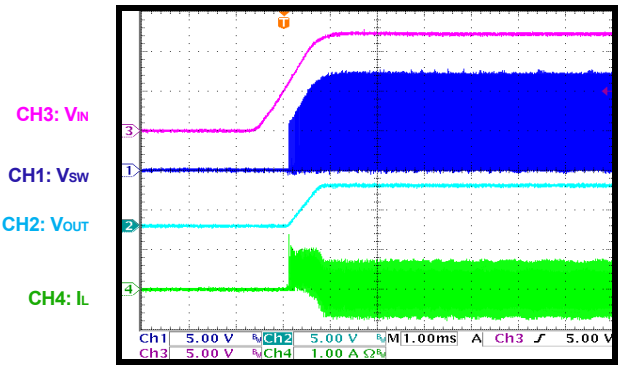
Steady State
I_{OUT} = 3A



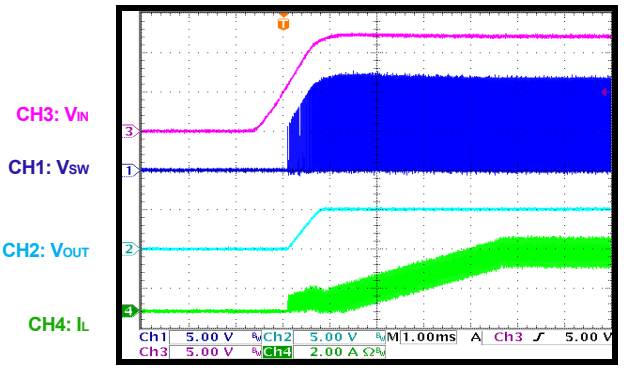
Power On
I_{OUT} = 0A, AAM



Power On
I_{OUT} = 0A, CCM



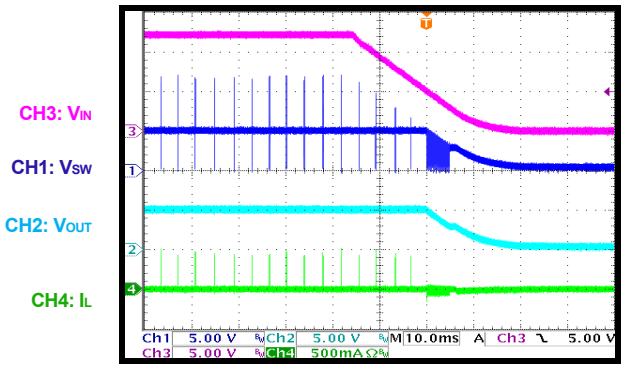
Power On
I_{OUT} = 3A



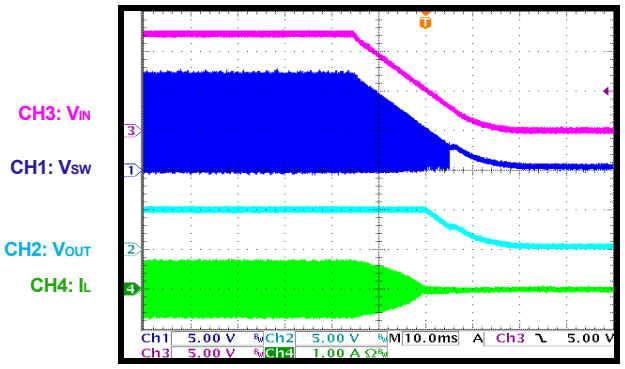
EVB TEST RESULTS *(continued)*

Performance curves and waveforms are tested on the evaluation board.
V_{IN} = 12V, V_{OUT} = 5V, L = 4.7µH, F_{SW}= 450kHz, T_A = 25°C, unless otherwise noted.

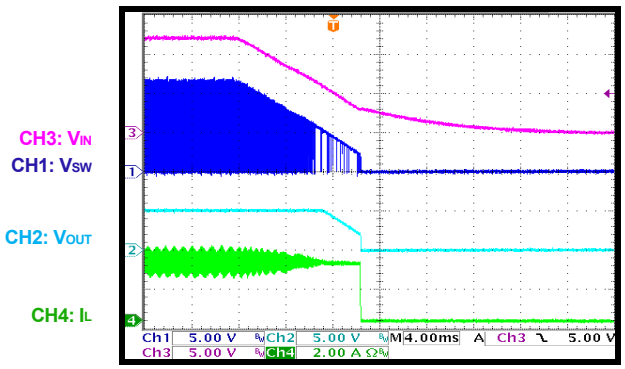
Power Off
I_{OUT} = 0A, AAM



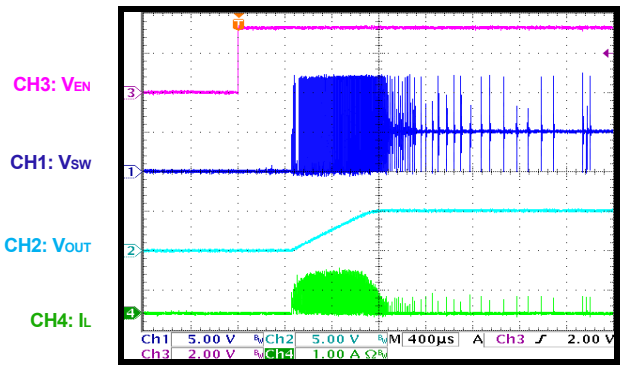
Power Off
I_{OUT} = 0A, CCM



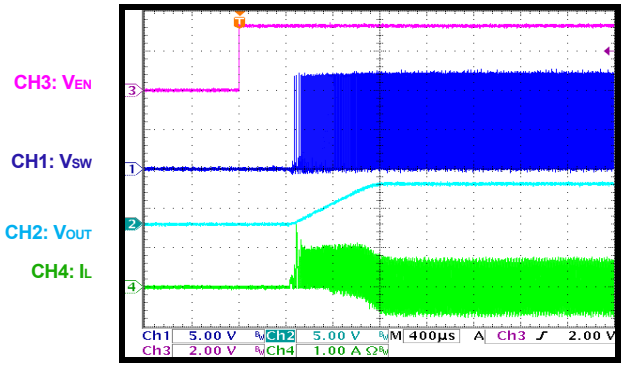
Power Off
I_{OUT} = 3A



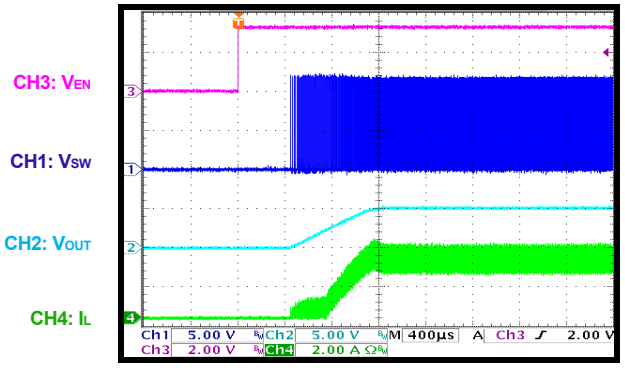
En On
I_{OUT} = 0A, AAM



En On
I_{OUT} = 0A, CCM



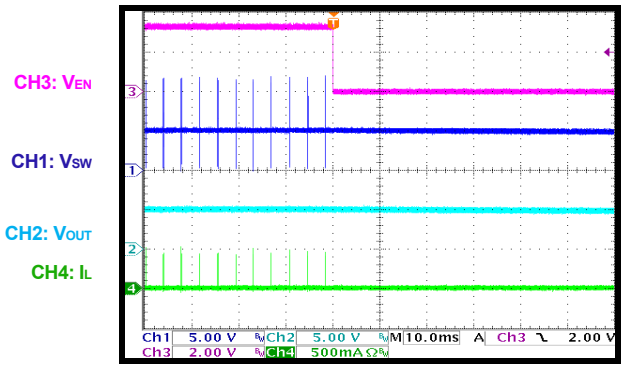
En On
I_{OUT} = 3A



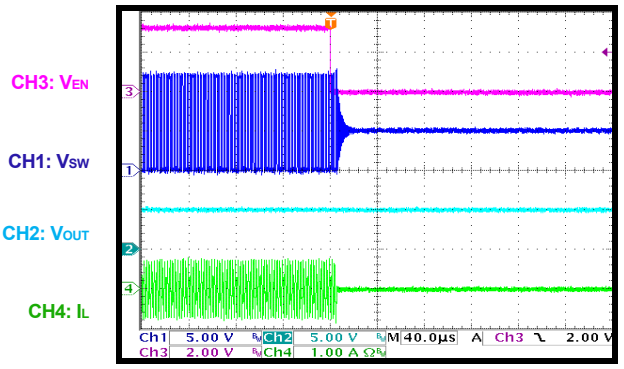
EVB TEST RESULTS *(continued)*

Performance curves and waveforms are tested on the evaluation board.
V_{IN} = 12V, V_{OUT} = 5V, L = 4.7µH, F_{SW}= 450kHz, T_A = 25°C, unless otherwise noted.

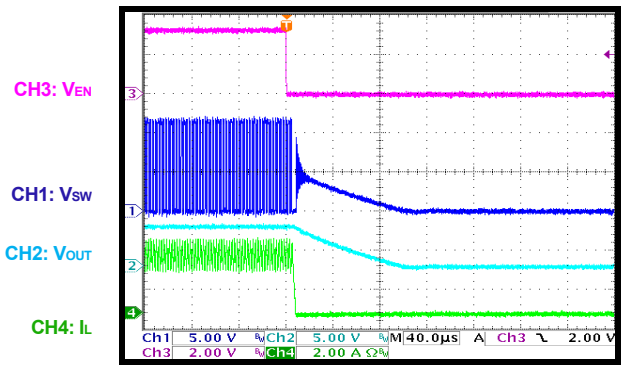
En Off
I_{OUT} = 0A, AAM



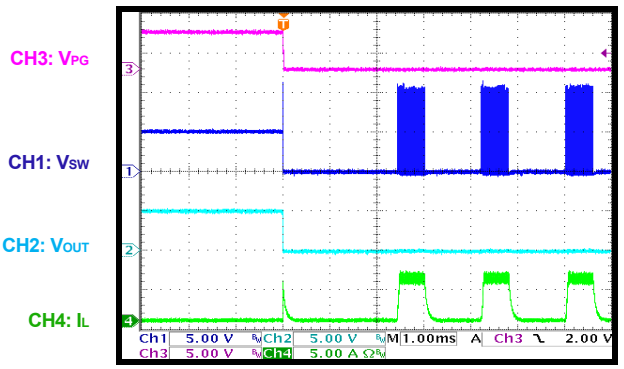
En Off
I_{OUT} = 0A, CCM



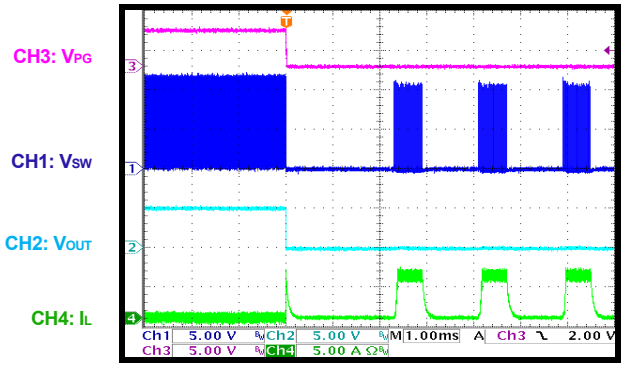
En Off
I_{OUT} = 3A



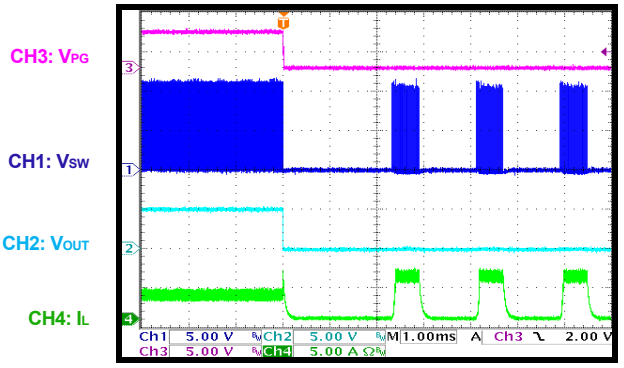
SCP Entry
I_{OUT} = 0A, AAM



SCP Entry
I_{OUT} = 0A, CCM



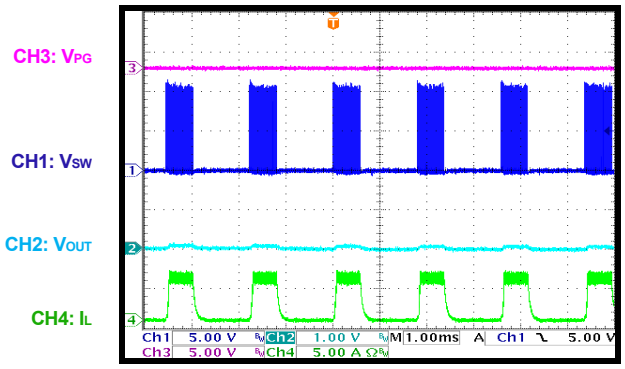
SCP Entry
I_{OUT} = 3A



EVB TEST RESULTS *(continued)*

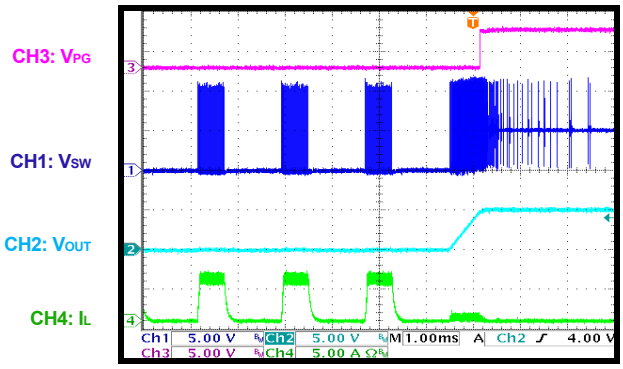
Performance curves and waveforms are tested on the evaluation board.
V_{IN} = 12V, V_{OUT} = 5V, L = 4.7µH, F_{SW}= 450kHz, T_A = 25°C, unless otherwise noted.

SCP Steady State



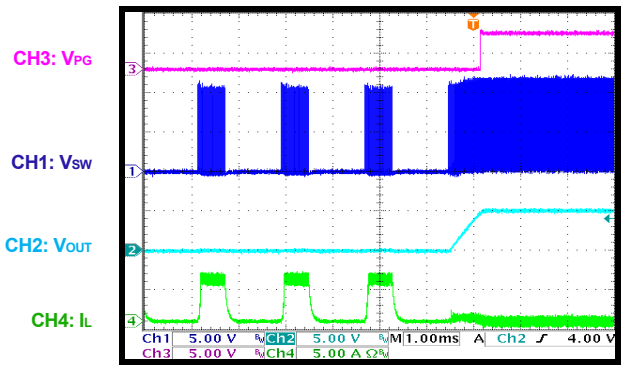
SCP Recovery

I_{OUT} = 0A, AAM



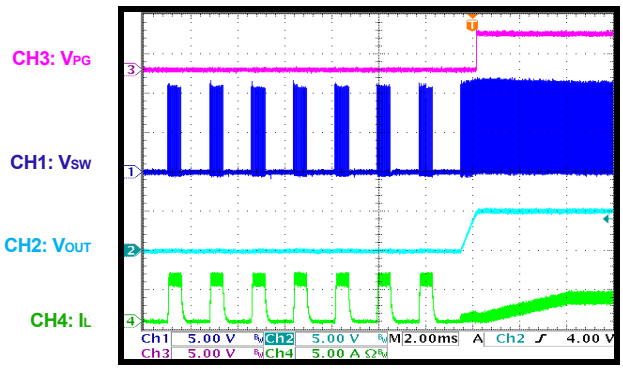
SCP Recovery

I_{OUT} = 0A, CCM



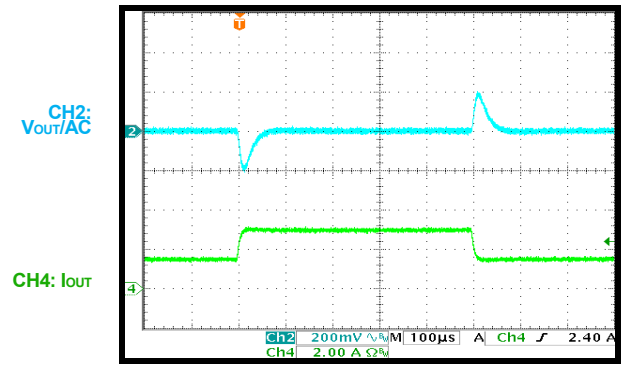
SCP Recovery

I_{OUT} = 3A



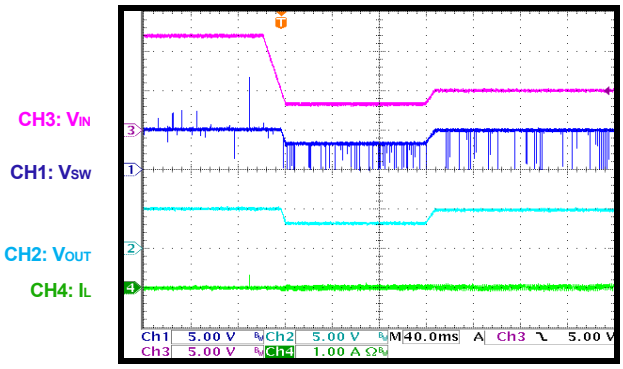
Load Transient

I_{OUT} = 1.5A -3A



Cold Crank

V_{IN} = 12V→3.3V→5V, I_{OUT} = 0A

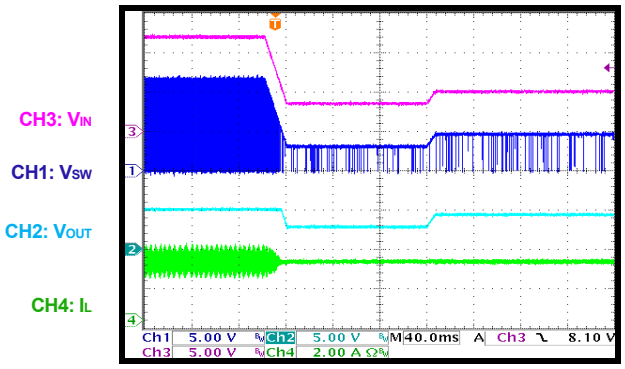


EVB TEST RESULTS *(continued)*

Performance curves and waveforms are tested on the evaluation board.
V_{IN} = 12V, V_{OUT} = 5V, L = 4.7µH, F_{SW}= 450kHz, T_A = 25°C, unless otherwise noted.

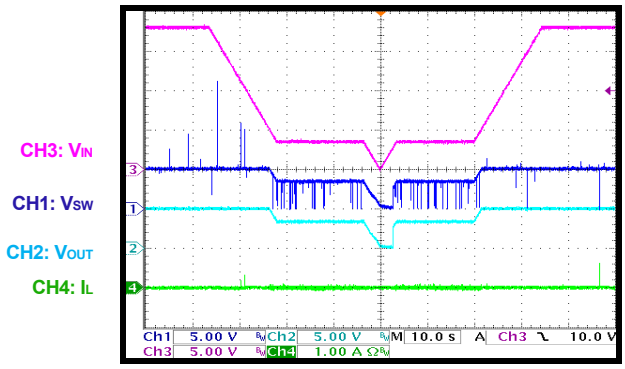
Cold Crank

V_{IN} = 12V→3.3V→5V, I_{OUT} = 3A



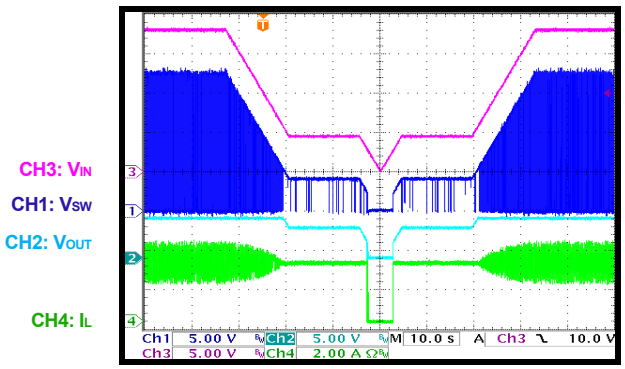
VIN Ramp Down and Up

V_{IN} = 18V→3.5V→0V→3.5V→18V, I_{OUT} = 0A



VIN Ramp Down and Up

V_{IN} = 18V→4.5V→0V→4.5V→18V, I_{OUT} = 3A



Load Dump

V_{IN} = 12V→36V→12V, I_{OUT} = 3A