



EVQ4324-L-4000-00A

36V, 4A Peak, Low Quiescent Current, Synchronous, Step-Down Converter Evaluation Board, AEC-Q100 Qualified

DESCRIPTION

The EVQ4324-L-4000-00A evaluation board is designed to demonstrate the capabilities of the MPQ4324GLE-4000-AEC1, a configurable 350kHz to 2.5MHz frequency, synchronous, step-down switching regulator with integrated, internal high-side and low-side MOSFETs (HS-FET and LS-FET, respectively).

The MPQ4324GLE-4000-AEC1 provides up to 4A peak of highly efficient output current (I_{OUT}) with peak current mode control. The wide 3.3V to 36V input voltage (V_{IN}) range and 42V load dump tolerance accommodate a variety of step-down applications in automotive input environments. A 1 μ A shutdown mode quiescent current (I_Q) allows the device to be used in battery-powered applications.

High power conversion efficiency across the entire load range is achieved by scaling down the switching frequency (f_{SW}) under light-load

conditions to reduce switching and gate driver losses.

An open-drain power good (PG) signal indicates whether the output is within 94.5% to 105.5% of its nominal voltage. Frequency foldback prevents inductor current (I_L) runaway during start-up. Thermal shutdown provides reliable, fault-tolerant operation.

A high duty cycle and low-dropout (LDO) mode provide support for automotive cold-crank conditions.

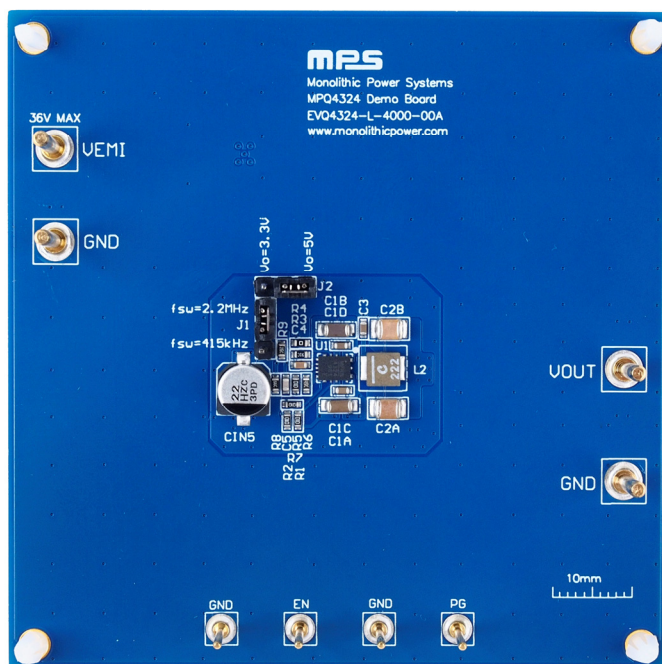
The EVQ4324-L-4000-00A is fully assembled and tested. The MPQ4324GLE-4000-AEC1 is available in a QFN-12 (3mmx4mm) package with wettable flanks. It is available in AEC-Q100 Grade 1.

PERFORMANCE SUMMARY

Specifications are at $T_A = 25^\circ\text{C}$, unless otherwise noted.

Parameters	Conditions	Value
Input voltage (V_{IN}) range		3.3V to 36V
Output voltage (V_{OUT})	$V_{IN} = 6\text{V to } 36\text{V}$, $I_{OUT} = 0\text{A to } 4\text{A}$	5V
Maximum output current (I_{OUT})	$V_{IN} = 3.3\text{V to } 36\text{V}$	4A
Typical efficiency	$V_{IN} = 12\text{V}$, $V_{OUT} = 5\text{V}$, $I_{OUT} = 4\text{A}$	92.2%
Peak efficiency	$V_{IN} = 8\text{V}$, $V_{OUT} = 5\text{V}$, $I_{OUT} = 1\text{A}$	96.9%
Switching frequency (f_{SW})		2.2MHz

EVQ4324-L-4000-00A EVALUATION BOARD



LxWxH (8.3cmx8.3cmx1cm)

Board Number	MPS IC Number
EVQ4324-L-4000-00A	MPQ4324GLE-4000-AEC1

QUICK START GUIDE

The EVQ4324-L-4000-00A evaluation board is easy to set up and use to evaluate the performance of the MPQ4324. For proper measurement equipment set-up, refer to Figure 2 on page 4 and follow the steps below:

1. Preset the power supply (V_{IN}) to be between 3.3V and 36V, then turn off the power supply.
2. Set the load current between 0A and 4A peak. Electronic loads represent a negative impedance to the regulator, and setting the current too high may trigger hiccup mode.
3. If longer cables (>0.5m total) are used between the source and the evaluation board, place a damping capacitor at the input terminals, especially when $V_{IN} \geq 24V$.
4. Connect the power supply terminals to:
 - a. Positive (+): VEMI
 - b. Negative (-): GND
5. Connect the load terminals to:
 - a. Positive (+): VOUT
 - b. Negative (-): GND
6. After making the connections, turn on the power supply. The board should start up automatically.
7. To use the enable (EN) function, apply a digital input to the EN pin. Pull EN above 1.02V to turn the regulator on; pull EN below 0.85V to turn it off. If the EN function is not used, EN can be connected directly to V_{IN} .
8. Connect a resistor between the FREQ and GND pins to set the internal switching frequency (f_{SW}).
9. Set the output voltage (V_{OUT}) using the external resistor divider (see Figure 1).

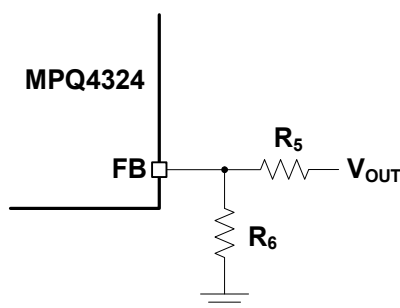


Figure 1: Feedback Divider Network with Adjustable Output

R_5 should be 100k Ω . Then R_6 can be calculated with Equation (1):

$$R_6 = \frac{R_5}{\frac{V_{OUT}}{0.8V} - 1} \quad (1)$$

Refer to the Application Information section in the MPQ4324 datasheet to calculate the inductance (L) and output capacitance (C_{OUT}) for different output voltages.

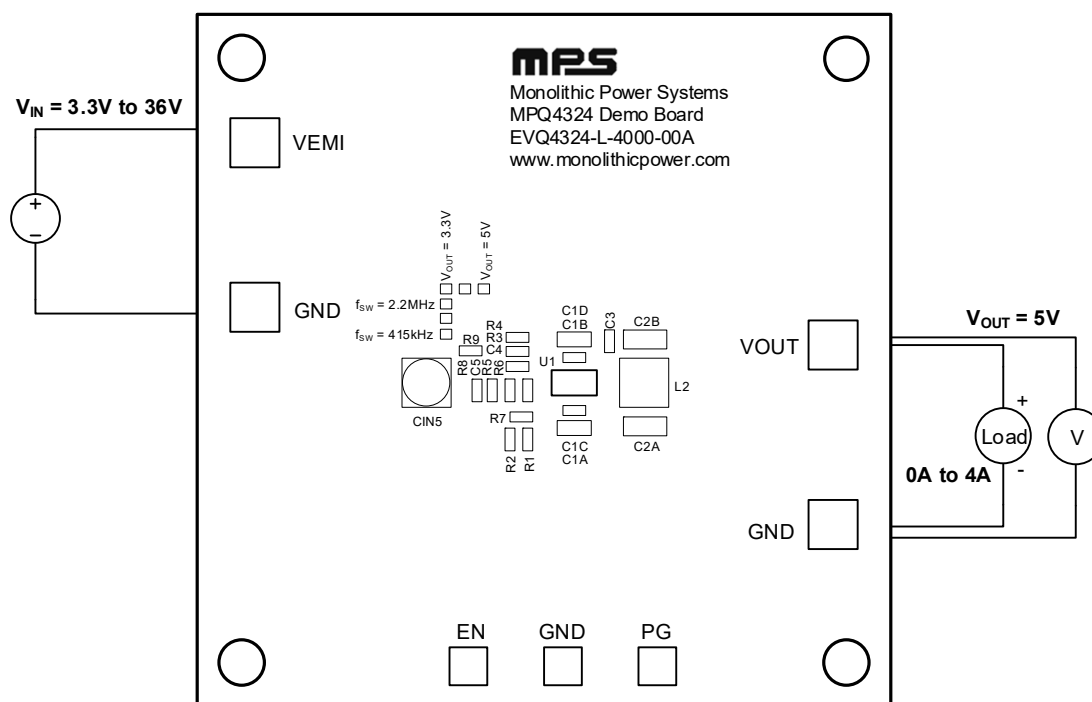


Figure 2: Measurement Equipment Set-Up

EVALUATION BOARD SCHEMATIC

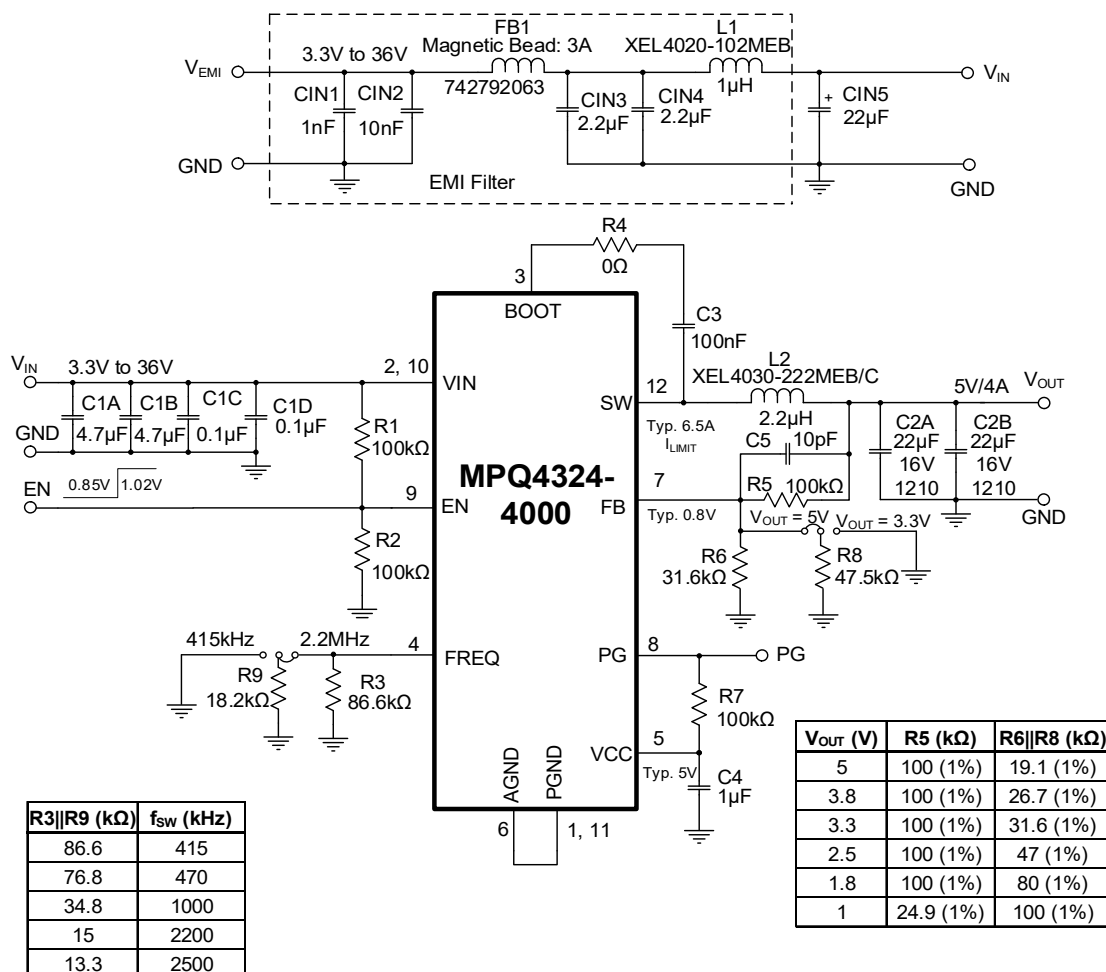
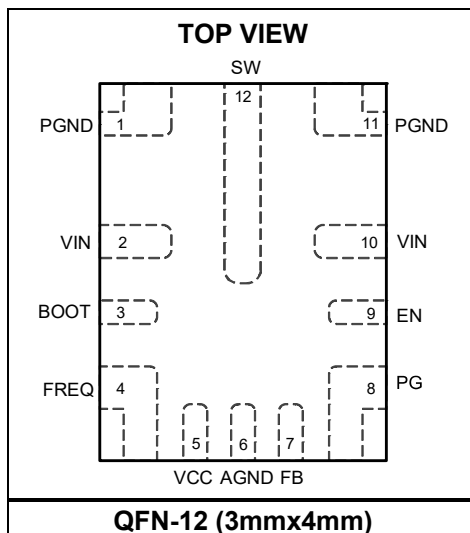


Figure 3: Evaluation Board Schematic

PACKAGE REFERENCE



EVQ4324-L-4000-00A BILL OF MATERIALS

Qty	Ref	Value	Description	Package	Manufacturer	Manufacturer PN
1	CIN1	1nF	Ceramic capacitor, 50V, X7R	0603	Murata	GRM216R71H102KA01
1	CIN2	10nF	Ceramic capacitor, 50V, X7R	0603	Murata	GRM188R71H103KA01D
2	CIN3, CIN4	4.7µF	Ceramic capacitor, 50V, X7R	0805	Murata	GRM21BR61H475KE51
1	CIN5	22µF	Aluminum polymer capacitor, 50V	SMD	Panasonic	EEHZC1H220P
2	C1A, C1B	4.7µF	Ceramic capacitor, 50V, X7S	1206	Murata	GRM31CR71H475KA12L
3	C1C, C1D, C3	100nF	Ceramic capacitor, 50V, X7R	0603	Murata	GRM188R71H104KA93D
2	C2A, C2B	22µF	Ceramic capacitor, 25V, X7R	1210	Murata	GRM32ER71C226KEA8L
1	C5	10pF	Ceramic capacitor, 50V, NP0	0603	Wurth	885012006051
1	C4	1µF	Ceramic capacitor, 25V, X7R	0603	Murata	GCM188R71E105KA64D
1	FB1	3A	Magnetic bead	0805	Wurth	742792063
1	L1	1µH	Inductor, 14.6mΩ, 9.6A	SMD	Coilcraft	XEL4020-102MEB
1	L2	2.2µH	Inductor, 22.1mΩ, 5.8A	SMD	Coilcraft	XEL4030-222MEB
4	R1, R5, R7, R2	100kΩ	Film resistor, 1%	0603	Yageo	RC0603FR-07100KL
1	R6	31.6kΩ	Film resistor, 1%	0603	Yageo	RC0603FR-0731K6L
1	R3	86.6kΩ	Film resistor, 1%	0603	Yageo	RC0603FR-0786K6L
1	R8	47.5kΩ	Film resistor, 1%	0603	Yageo	RC0603FR-0747K5L
1	R9	18.2kΩ	Film resistor, 1%	0603	Yageo	RC0603FR-0718K2L
1	R4	0Ω	Film resistor, 5%	0603	Yageo	RC0603JR-070RL
2	J1, J2	2.54mm	Test pin, 3-pin	DIP	Any	
4	VEMI, GND, VOUT, GND	2mm	Golden pin	DIP	Custom ⁽¹⁾	
3	PG, EN, GND	1mm	Golden pin	DIP	Custom ⁽¹⁾	
1	U1	MPQ4324	36V, 4A peak, configurable frequency, low-I _Q , synchronous step-down converter with integrated, internal MOSFETS	QFN-12 (3mmx4mm)	MPS	MPQ4324GLE-4000-AEC1

Note:

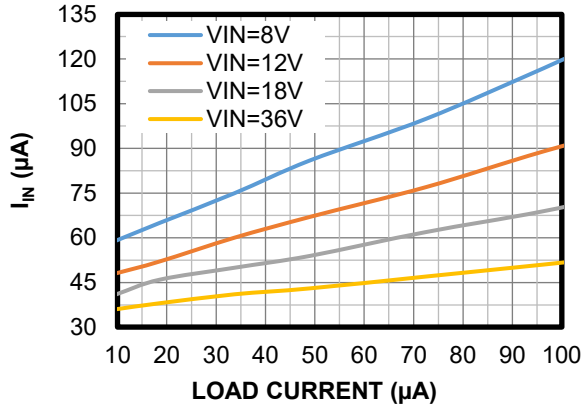
1) MPS custom-produces these pins. Contact an MPS FAE for more information.

EVB TEST RESULTS

Performance curves and waveforms are tested on the evaluation board. $V_{IN} = 12V$, $V_{OUT} = 5V$, $T_A = 25^{\circ}C$, unless otherwise noted.

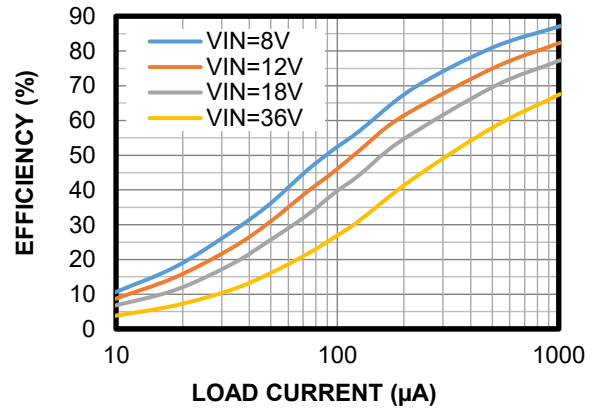
Input Current vs. Load Current

$R_{FB1} = 100k\Omega$, $R_{FB2} = 19.1k\Omega$,
DCR = 22.1m Ω



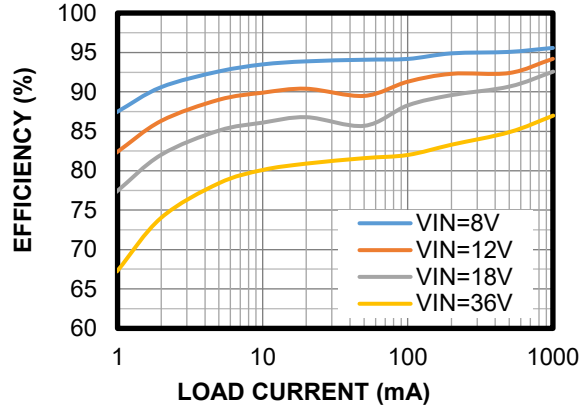
Efficiency vs. Load Current

$R_{FB1} = 100k\Omega$, $R_{FB2} = 19.1k\Omega$,
DCR = 22.1m Ω



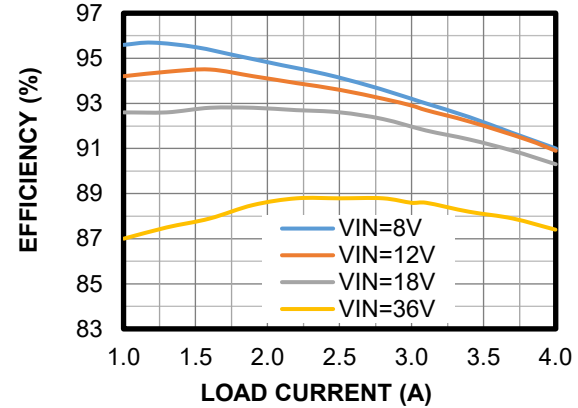
Efficiency vs. Load Current

DCR = 22.1m Ω



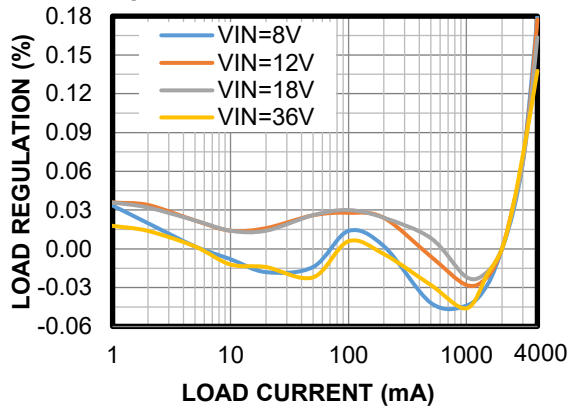
Efficiency vs. Load Current

DCR = 22.1m Ω



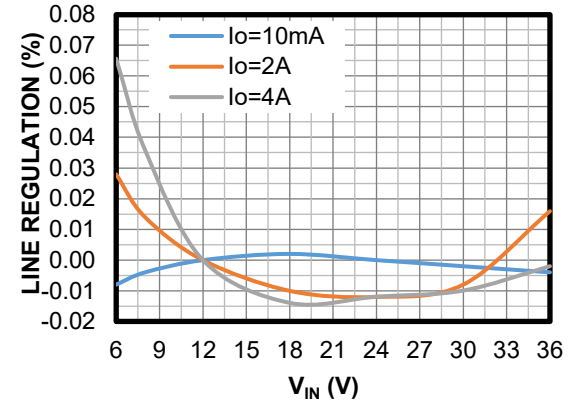
Load Regulation

DCR = 22.1m Ω



Line Regulation

DCR = 22.1m Ω

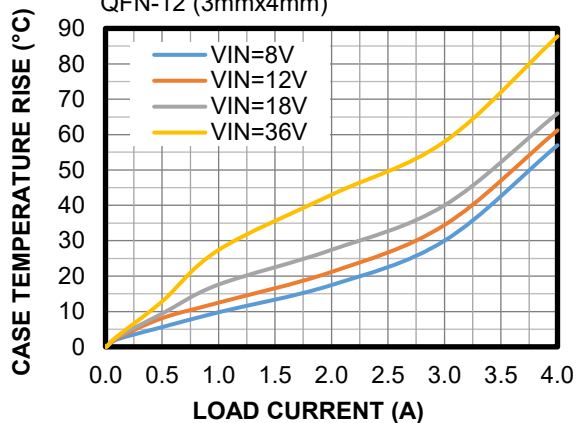


EVB TEST RESULTS *(continued)*

Performance curves and waveforms are tested on the evaluation board. $V_{IN} = 12V$, $V_{OUT} = 5V$, $T_A = 25^{\circ}C$, unless otherwise noted.

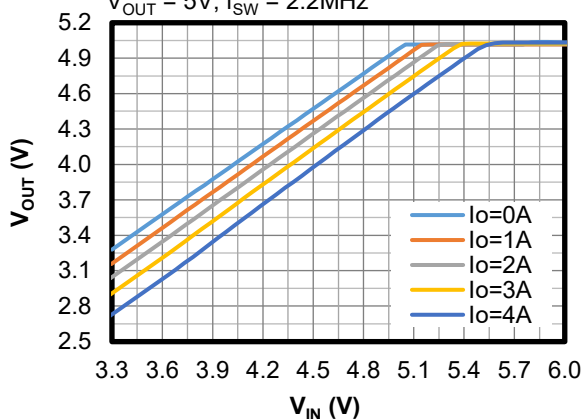
Case Temperature Rise

$V_{OUT} = 5V$, $f_{SW} = 2.2MHz$,
QFN-12 (3mmx4mm)



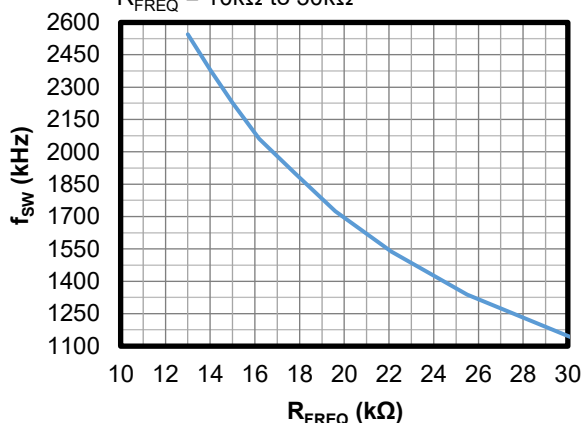
Low-Dropout Mode

$V_{OUT} = 5V$, $f_{SW} = 2.2MHz$



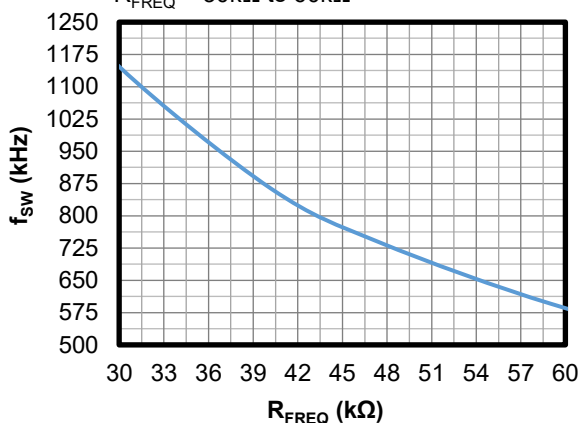
f_{SW} vs. R_{FREQ}

$R_{FREQ} = 10k\Omega$ to $30k\Omega$



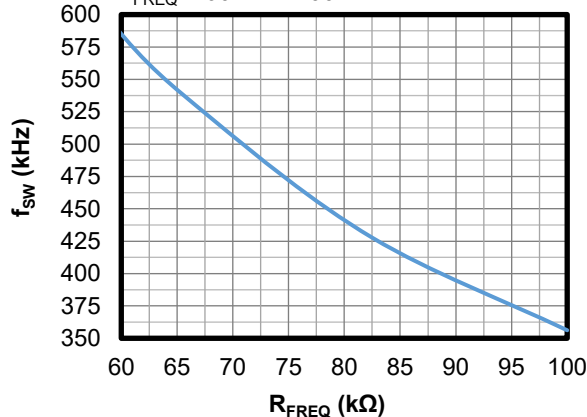
f_{SW} vs. R_{FREQ}

$R_{FREQ} = 30k\Omega$ to $60k\Omega$



f_{SW} vs. R_{FREQ}

$R_{FREQ} = 60k\Omega$ to $100k\Omega$

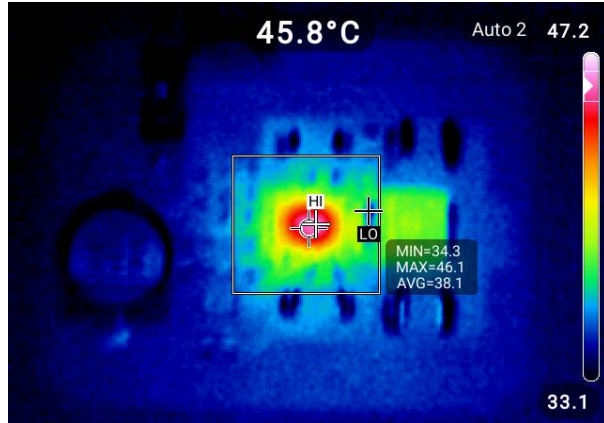


EVB TEST RESULTS *(continued)*

Performance curves and waveforms are tested on the evaluation board. $V_{IN} = 12V$, $V_{OUT} = 5V$, $T_A = 25^{\circ}C$, unless otherwise noted.

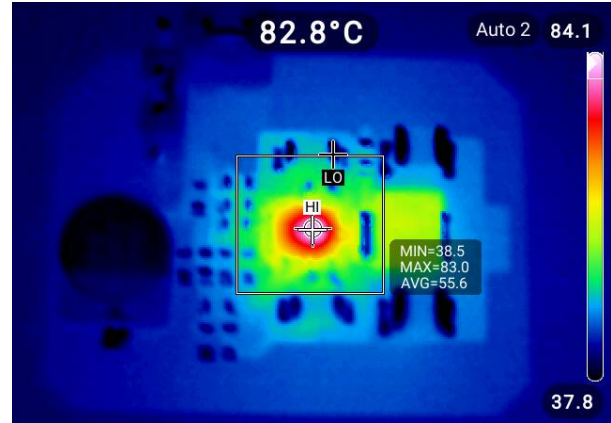
Thermal Performance

$I_{OUT} = 2A$, no forced airflow, $T_{CASE} = 46.1^{\circ}C$



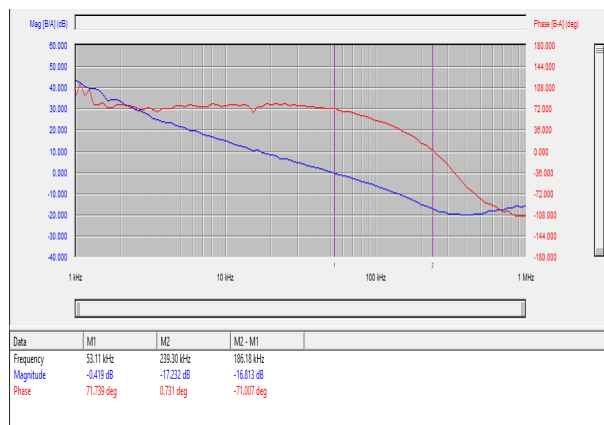
Thermal Performance

$I_{OUT} = 4A$, no forced airflow, $T_{CASE} = 83^{\circ}C$



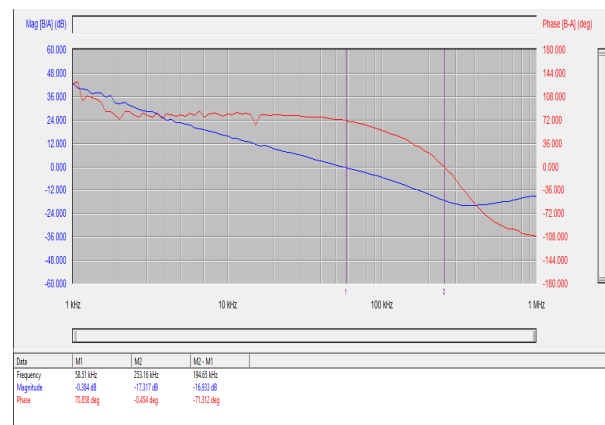
Bode Plot

$I_{OUT} = 1A$, $PM = 71.7^{\circ}$, $GM = 17.2dB$



Bode Plot

$I_{OUT} = 4A$, $PM = 70.8^{\circ}$, $GM = 17.3dB$

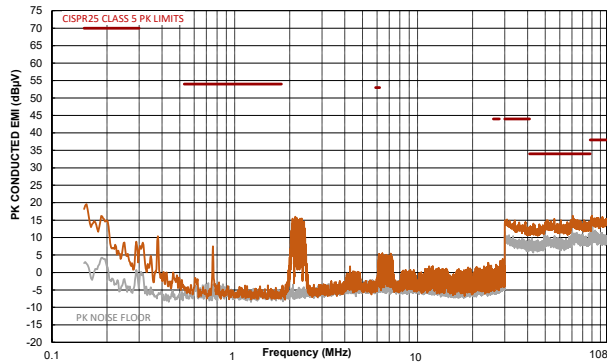


EVB TEST RESULTS *(continued)*

Performance curves and waveforms are tested on the evaluation board. $V_{IN} = 12V$, $V_{OUT} = 5V$, $T_A = 25^{\circ}C$, unless otherwise noted.

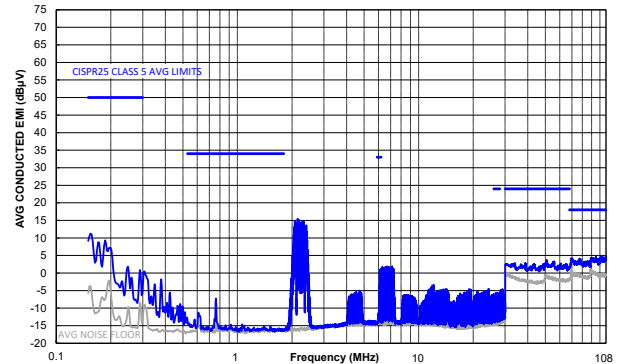
CISPR 25 Class 5 Peak Conducted Emissions

150kHz to 108MHz



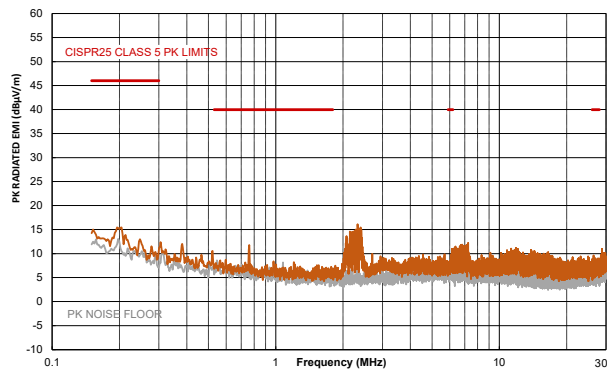
CISPR 25 Class 5 Average Conducted Emissions

150kHz to 108MHz



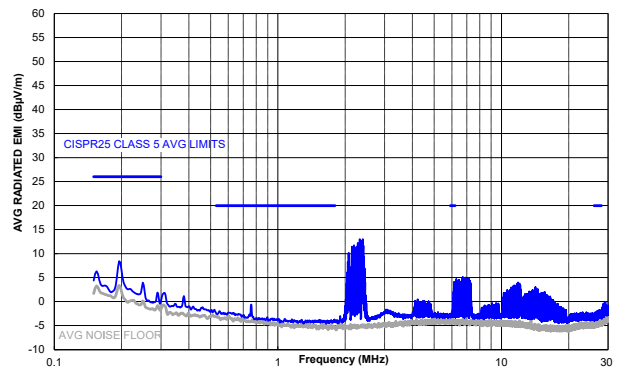
CISPR 25 Class 5 Peak Radiated Emissions

150kHz to 30MHz



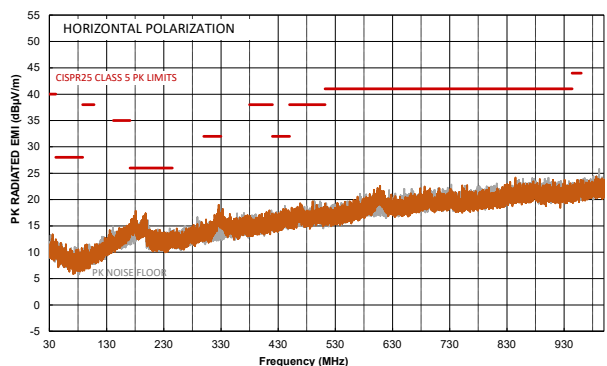
CISPR 25 Class 5 Average Radiated Emissions

150kHz to 30MHz



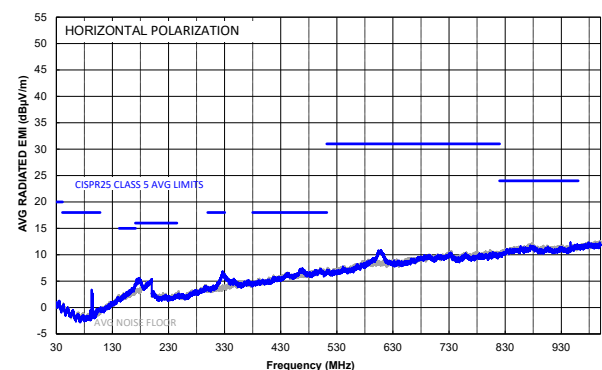
CISPR 25 Class 5 Peak Radiated Emissions

Horizontal, 30MHz to 1GHz



CISPR 25 Class 5 Average Radiated Emissions

Horizontal, 30MHz to 1GHz

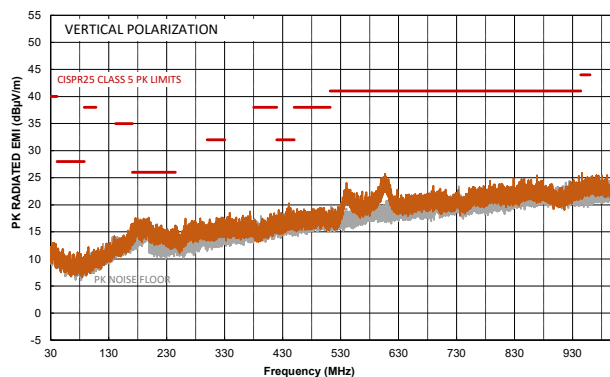


EVB TEST RESULTS *(continued)*

Performance curves and waveforms are tested on the evaluation board. $V_{IN} = 12V$, $V_{OUT} = 5V$, $T_A = 25^{\circ}C$, unless otherwise noted.

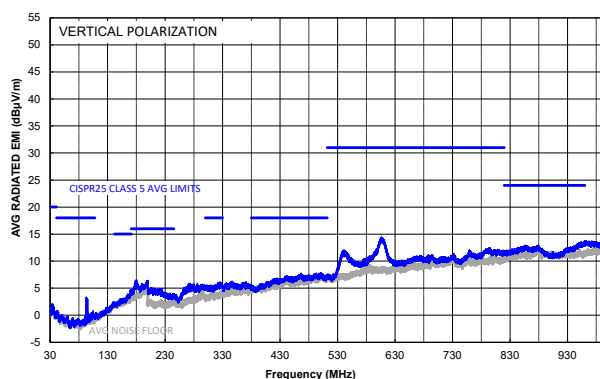
CISPR 25 Class 5 Peak Radiated Emissions

Vertical, 30MHz to 1GHz



CISPR 25 Class 5 Average Radiated Emissions

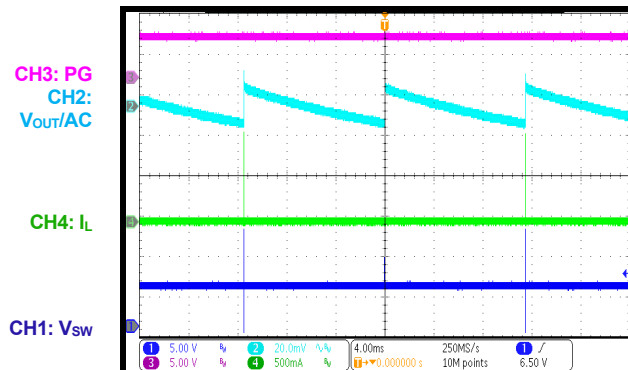
Vertical, 30MHz to 1GHz



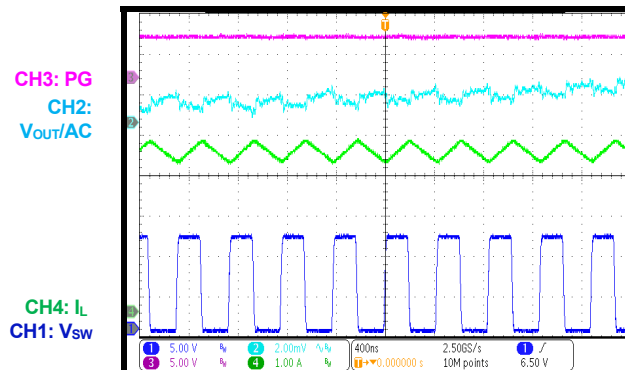
EVB TEST RESULTS *(continued)*

Performance curves and waveforms are tested on the evaluation board. $V_{IN} = 12V$, $V_{OUT} = 5V$, $T_A = 25^{\circ}C$, unless otherwise noted.

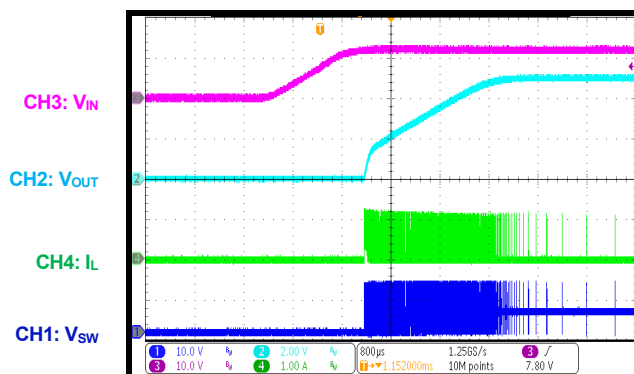
Steady State

 $I_{OUT} = 0A$


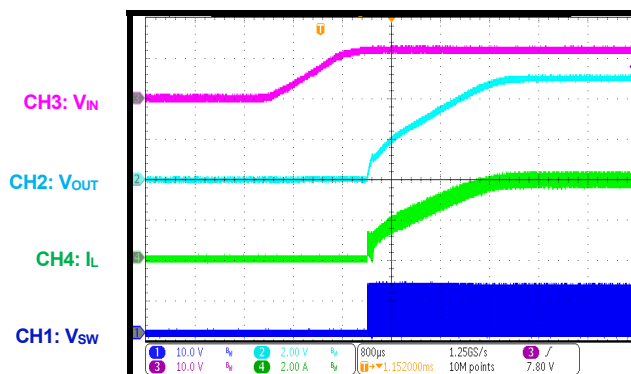
Steady State

 $I_{OUT} = 4A$


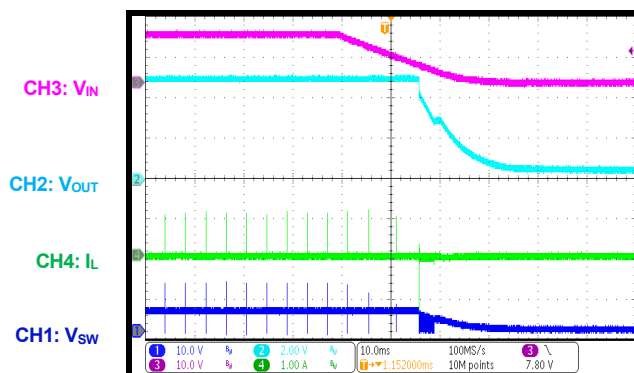
Start-Up through VIN

 $I_{OUT} = 0A$


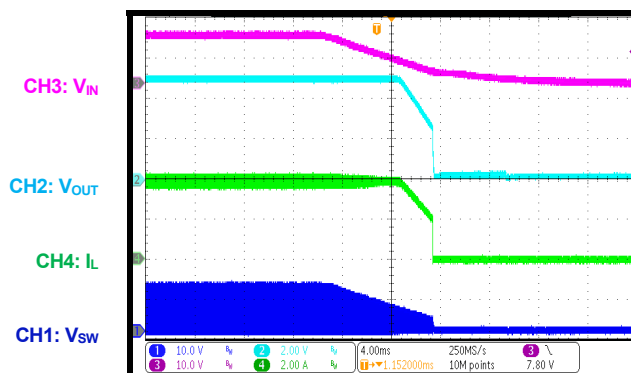
Start-Up through VIN

 $I_{OUT} = 4A$


Shutdown through VIN

 $I_{OUT} = 0A$


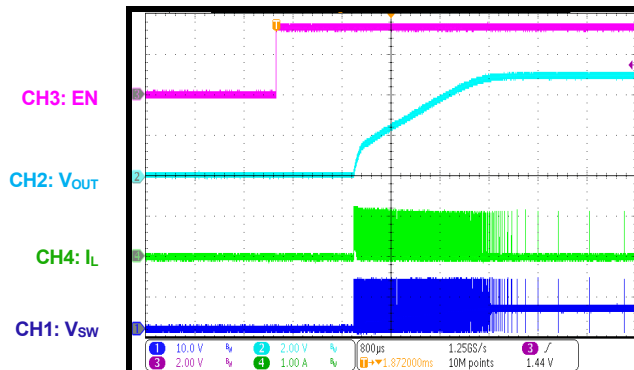
Shutdown through VIN

 $I_{OUT} = 4A$


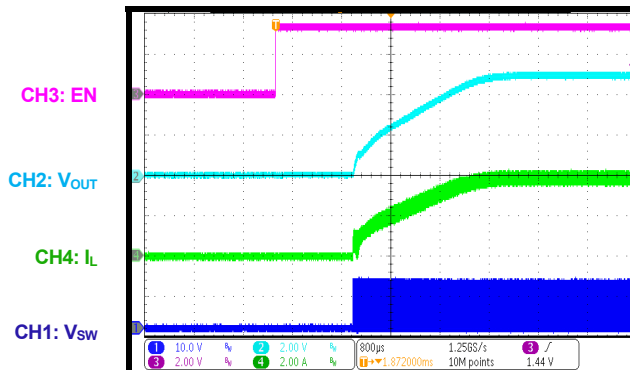
EVB TEST RESULTS (continued)

Performance curves and waveforms are tested on the evaluation board. $V_{IN} = 12V$, $V_{OUT} = 5V$, $T_A = 25^{\circ}C$, unless otherwise noted.

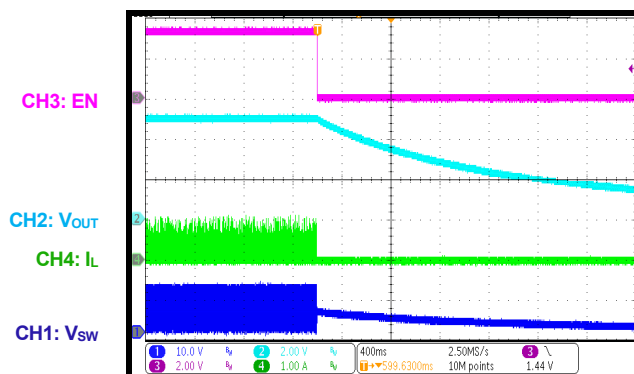
Start-Up through EN

 $I_{OUT} = 0A$


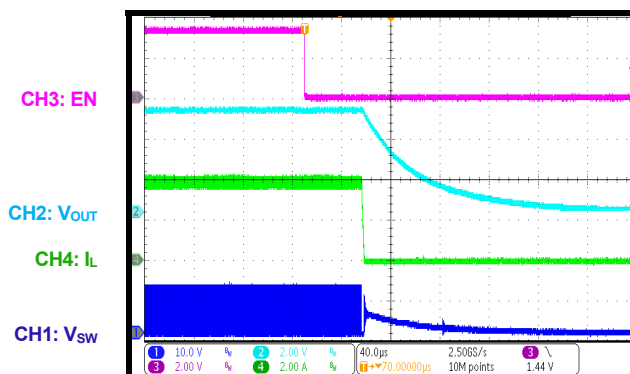
Start-Up through EN

 $I_{OUT} = 4A$


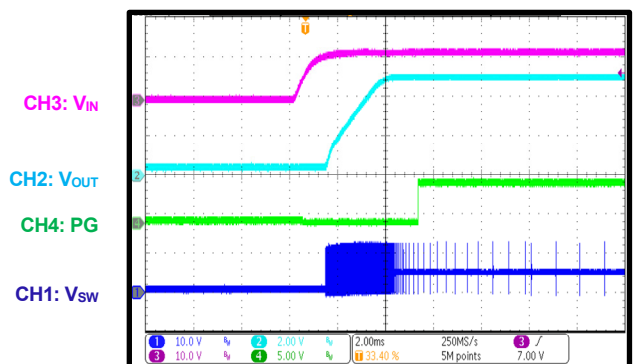
Shutdown through EN

 $I_{OUT} = 0A$


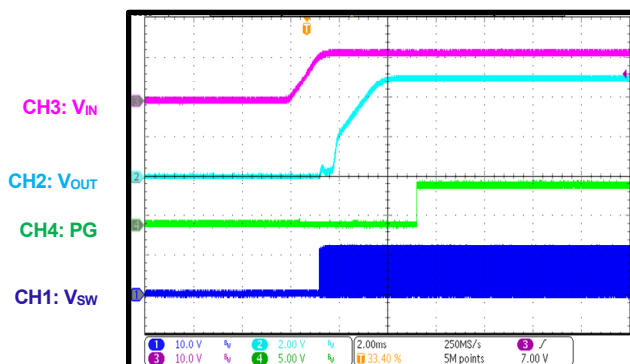
Shutdown through EN

 $I_{OUT} = 4A$


PG Start-Up through VIN

 $I_{OUT} = 0A$


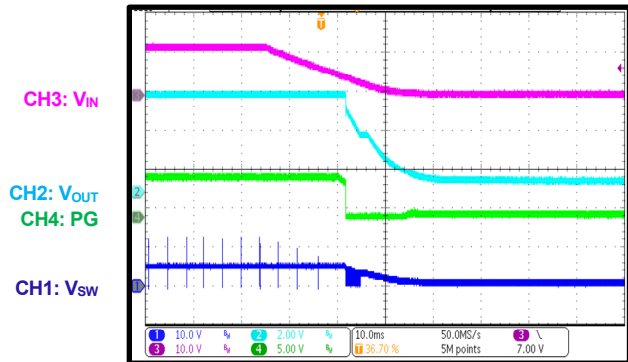
PG Start-Up through VIN

 $I_{OUT} = 4A$


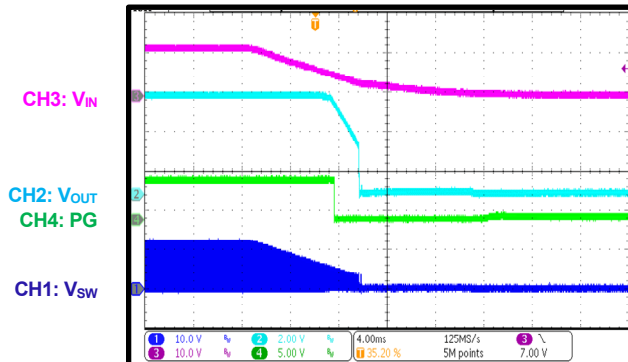
EVB TEST RESULTS *(continued)*

Performance curves and waveforms are tested on the evaluation board. $V_{IN} = 12V$, $V_{OUT} = 5V$, $T_A = 25^{\circ}C$, unless otherwise noted.

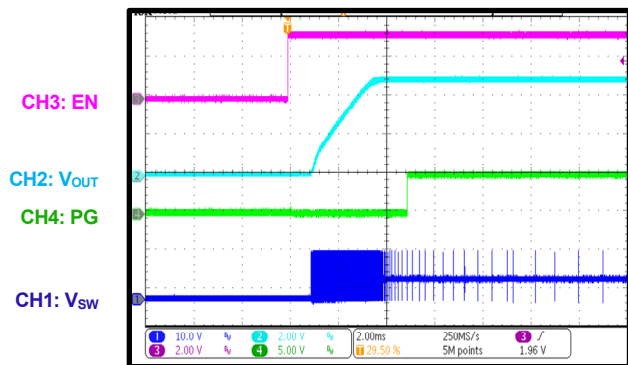
PG Shutdown through VIN

 $I_{OUT} = 0A$


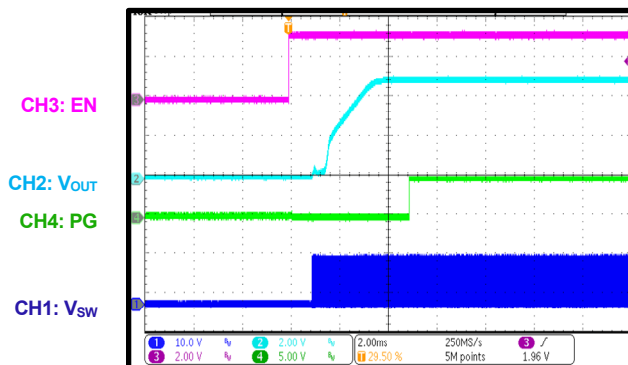
PG Shutdown through VIN

 $I_{OUT} = 4A$


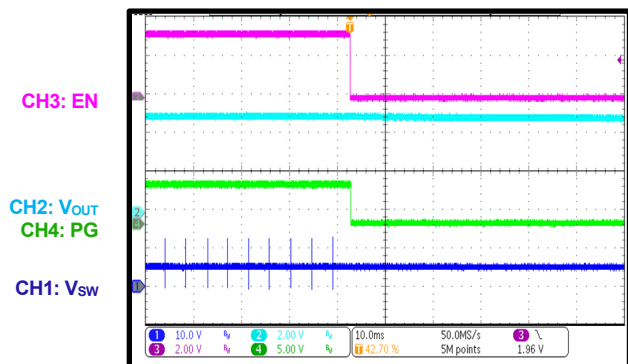
PG Start-Up through EN

 $I_{OUT} = 0A$


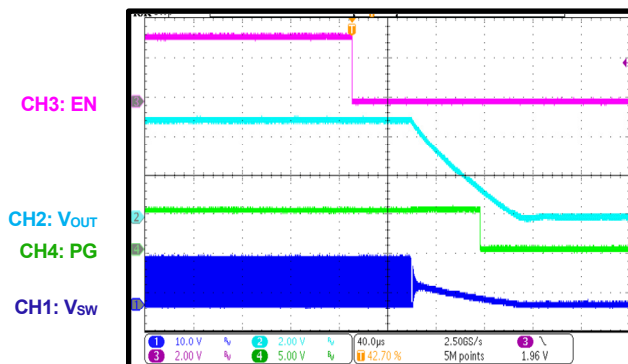
PG Start-Up through EN

 $I_{OUT} = 4A$


PG Shutdown through EN

 $I_{OUT} = 0A$


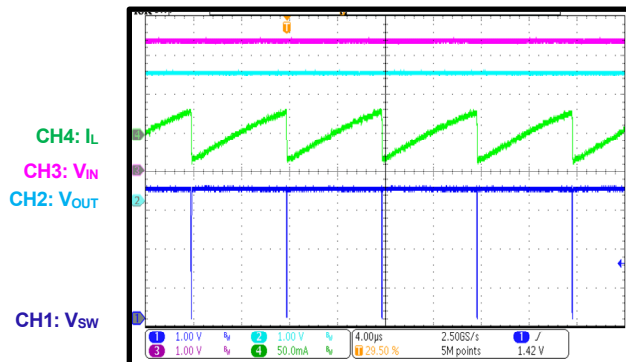
PG Shutdown through EN

 $I_{OUT} = 4A$


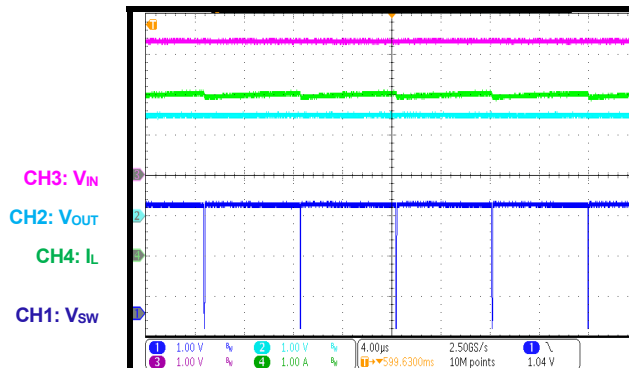
EVB TEST RESULTS *(continued)*

Performance curves and waveforms are tested on the evaluation board. $V_{IN} = 12V$, $V_{OUT} = 5V$, $T_A = 25^{\circ}C$, unless otherwise noted.

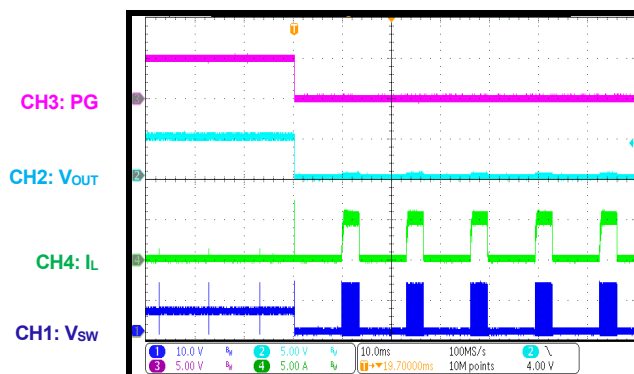
Low-Dropout Mode

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


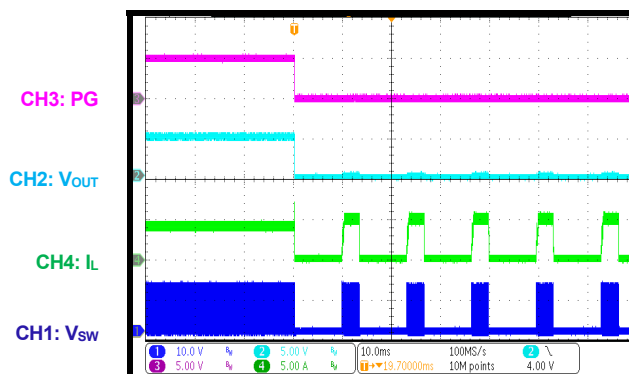
Low-Dropout Mode

 $I_{OUT} = 4A$, $V_{IN} = 3.3V$


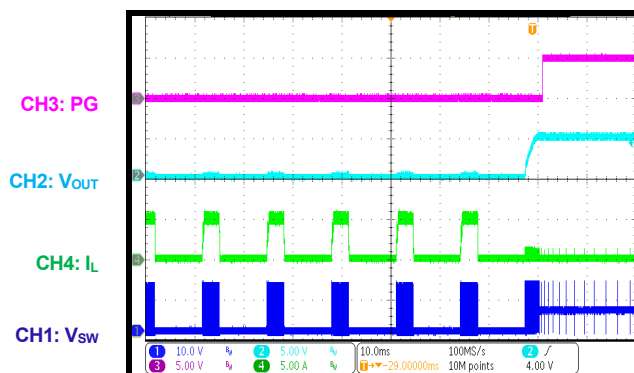
SCP Entry

 $I_{OUT} = 0A$


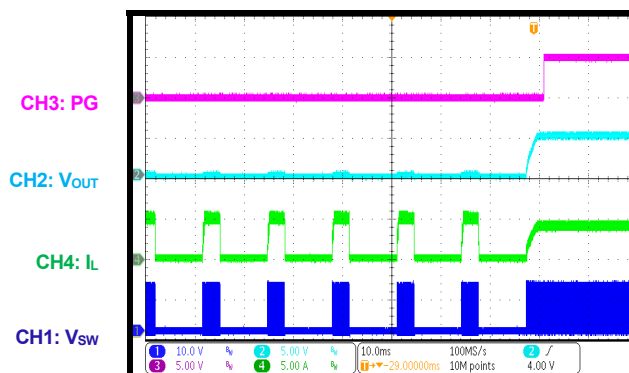
SCP Entry

 $I_{OUT} = 4A$


SCP Recovery

 $I_{OUT} = 0A$


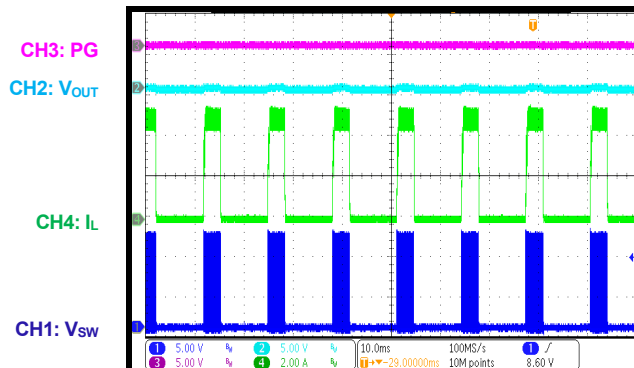
SCP Recovery

 $I_{OUT} = 4A$


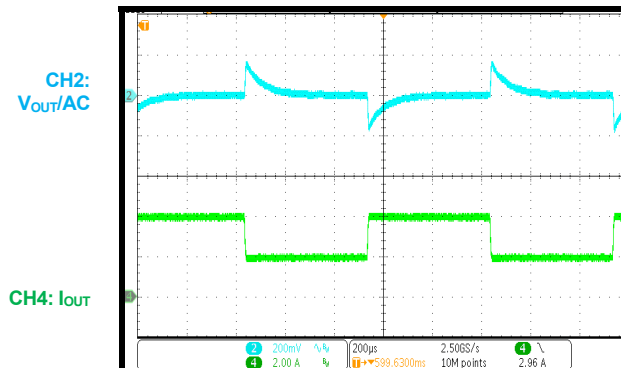
EVB TEST RESULTS *(continued)*

Performance curves and waveforms are tested on the evaluation board. $V_{IN} = 12V$, $V_{OUT} = 5V$, $T_A = 25^{\circ}C$, unless otherwise noted.

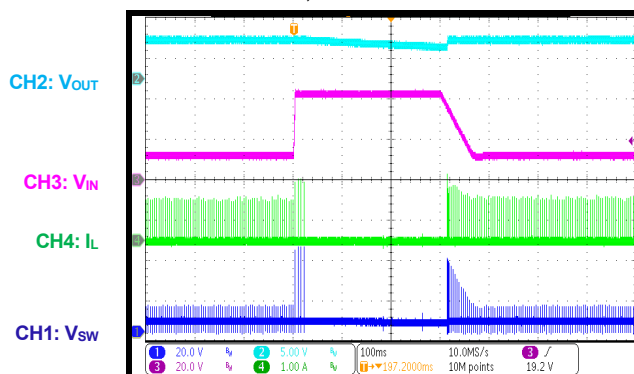
SCP Steady State

 $I_{OUT} = 0A$


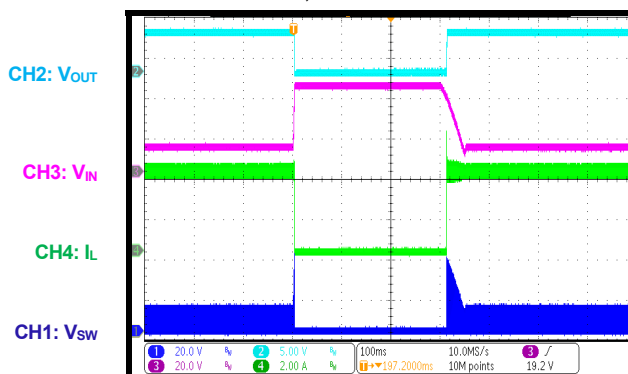
Load Transient Response

 $I_{OUT} = 2A$ to $4A$, $1.6A/\mu s$


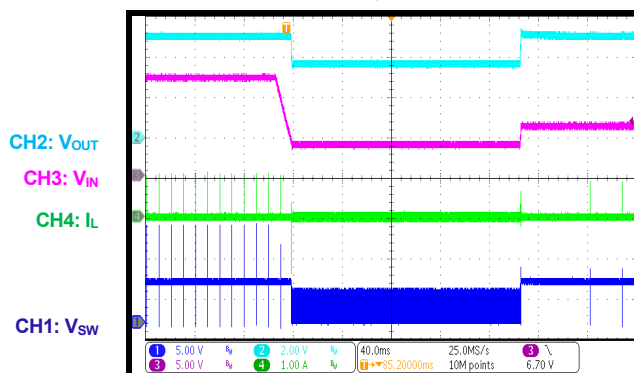
Load Dump

 $V_{IN} = 12V$ to $42V$, $I_{OUT} = 0A$


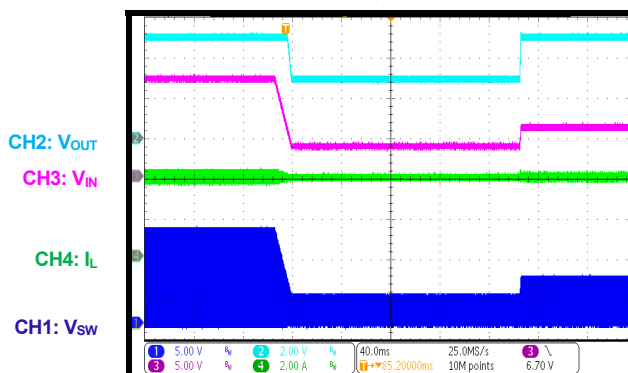
Load Dump

 $V_{IN} = 12V$ to $42V$, $I_{OUT} = 4A$


Cold Crank

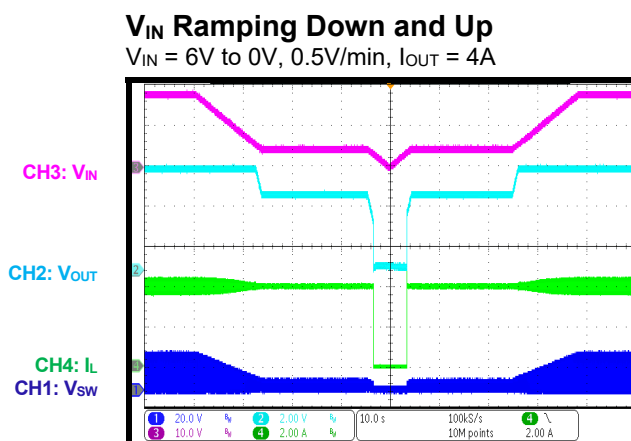
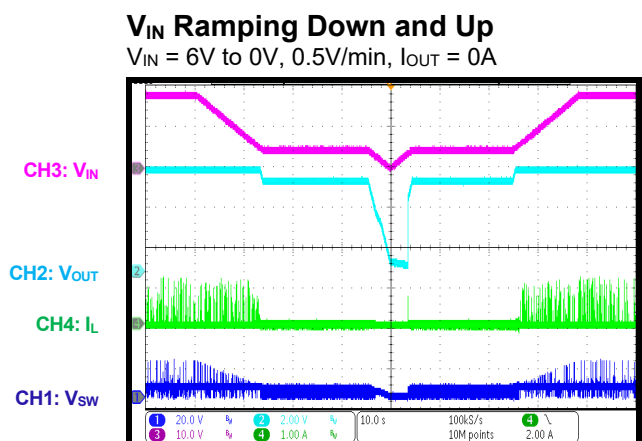
 $V_{IN} = 12V$ to $3.3V$ to $6V$, $I_{OUT} = 0A$


Cold Crank

 $V_{IN} = 12V$ to $3.3V$ to $6V$, $I_{OUT} = 4A$


EVB TEST RESULTS *(continued)*

Performance curves and waveforms are tested on the evaluation board. $V_{IN} = 12V$, $V_{OUT} = 5V$, $T_A = 25^{\circ}C$, unless otherwise noted.



PCB LAYOUT (2)

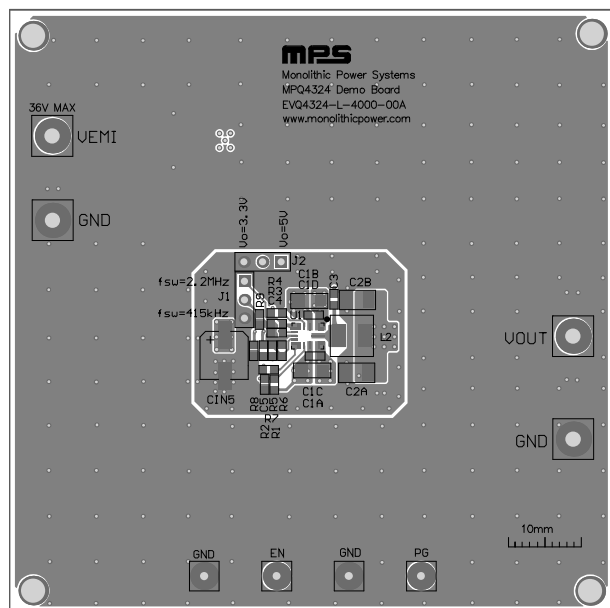


Figure 4: Top Silk and Top Layer

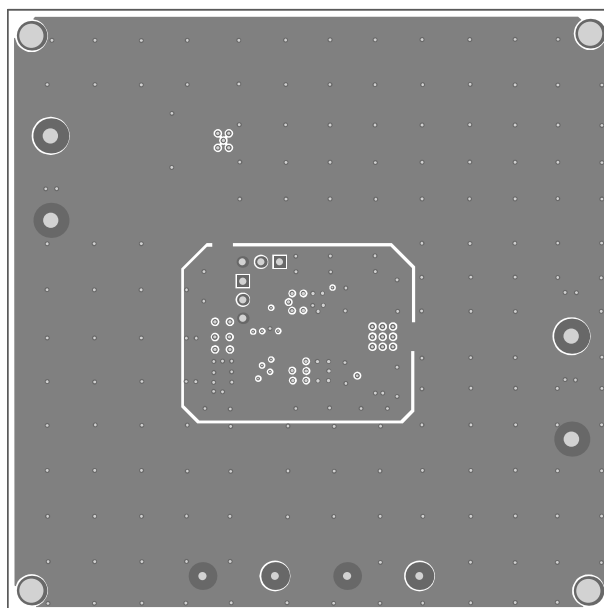


Figure 5: Mid-Layer 1

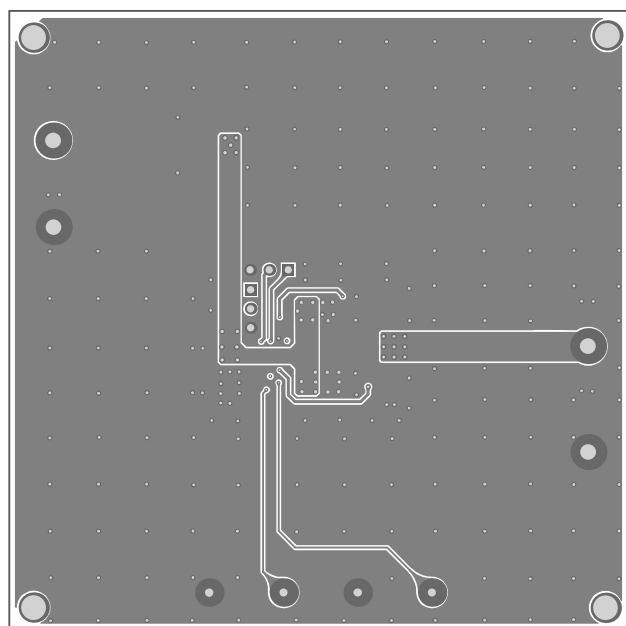


Figure 6: Mid-Layer 2

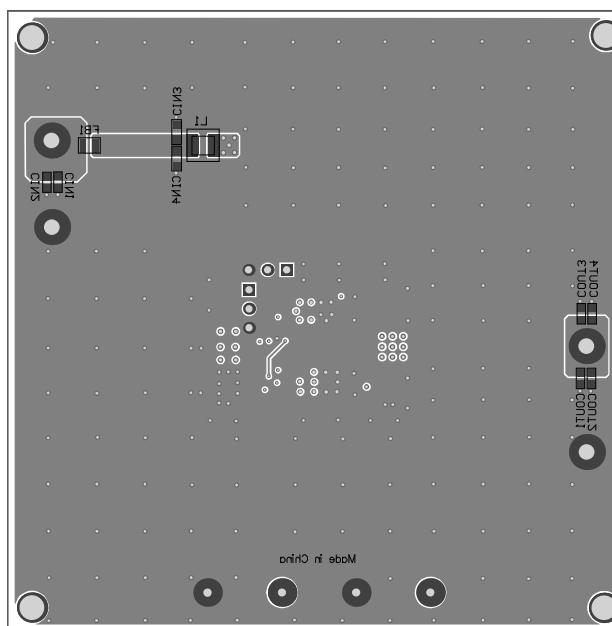


Figure 7: Bottom Layer and Bottom Silk

Note:

- 2) The copper thickness is 2oz.



REVISION HISTORY

Revision #	Revision Date	Description	Pages Updated
1.0	10/31/2024	Initial Release	-

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