



EVQ4321-D-01A

42V Load Dump Tolerant, 1A, Ultra-Compact,
Low- I_Q , Synchronous Step-Down Converter
Evaluation Board, AEC-Q100 Qualified

DESCRIPTION

The EVQ4321-D-01A is an evaluation board designed to demonstrate the capabilities of the MPQ4321, a configurable-frequency (350kHz to 2.5MHz), synchronous, step-down switching converter with integrated, internal high-side MOSFETs (HS-FETs) and low-side MOSFETs (LS-FETs).

The MPQ4321 provides up to 1A 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 accommodates 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 wide load range is achieved by scaling down

the switching frequency (f_{SW}) under light-load conditions to reduce the switching and gate driving 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 helps prevent inductor current (I_L) runaway during start-up. Thermal shutdown provides reliable, fault-tolerant operation.

A high duty cycle and low-dropout mode are provided for automotive cold-crank conditions.

The EVQ4321-D-01A is fully assembled and tested. The MPQ4321 is available in a QFN-12 (2mmx3mm) package with wettable flanks.

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})	$V_{IN} = 6\text{V to } 36\text{V}$, $I_{OUT} = 0\text{A to } 1\text{A}$	$V_{OUT} = 5\text{V}$
Maximum output current (I_{OUT})	$V_{IN} = 3.3\text{V to } 36\text{V}$	1A
Typical efficiency	$V_{IN} = 12\text{V}$, $V_{OUT} = 5\text{V}$, $I_{OUT} = 1\text{A}$	92.6%
Peak efficiency	$V_{IN} = 8\text{V}$, $V_{OUT} = 5\text{V}$, $I_{OUT} = 1\text{A}$	94.4%
Switching frequency (f_{SW})		2.2MHz

EVQ4321-D-01A – 42V LOAD DUMP, 1A, SYNC BUCK EVAL BOARD, AEC-Q100



LxWxH (8.3cmx8.3cmx1cm)

Board Number	MPS IC Number
EVQ4321-D-01A	MPQ4321GDE-AEC1

QUICK START GUIDE

The EVQ4321-D-01A evaluation board is easy to set up and use to evaluate the MPQ4321's performance. 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}) between 6V and 36V, then turn off the power supply.
2. Set the load current between 0A and 1A. Electronic loads represent a negative impedance to the regulator, and setting a current too high may trigger hiccup mode.
3. If longer cables are used between the source and the evaluation board (>0.5m total), 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.
7. To use the enable function, apply a digital input to the EN pin. Drive EN above 1.02V to turn the regulator on; drive EN below 0.85V to turn it off. If the enable 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. The external resistor divider sets the output voltage (V_{OUT}) (see Figure 1).

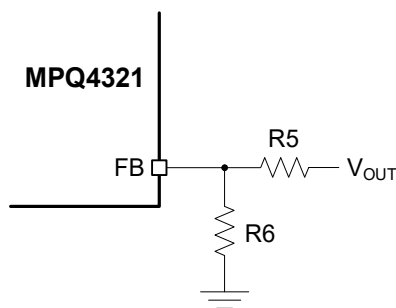
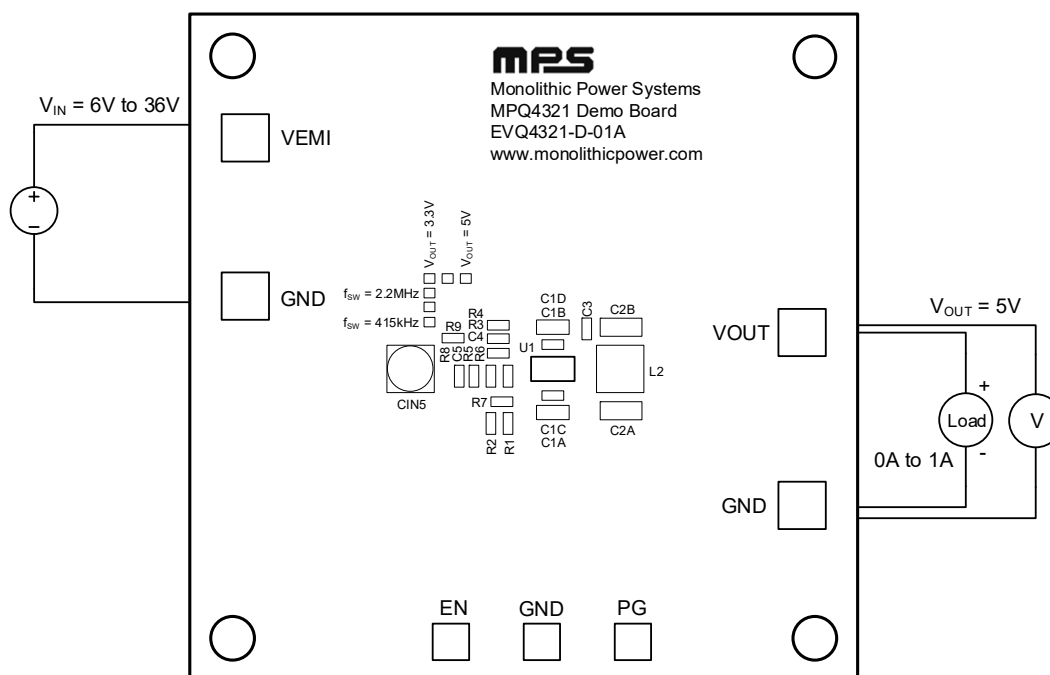


Figure 1: Feedback Divider Network with Adjustable Output

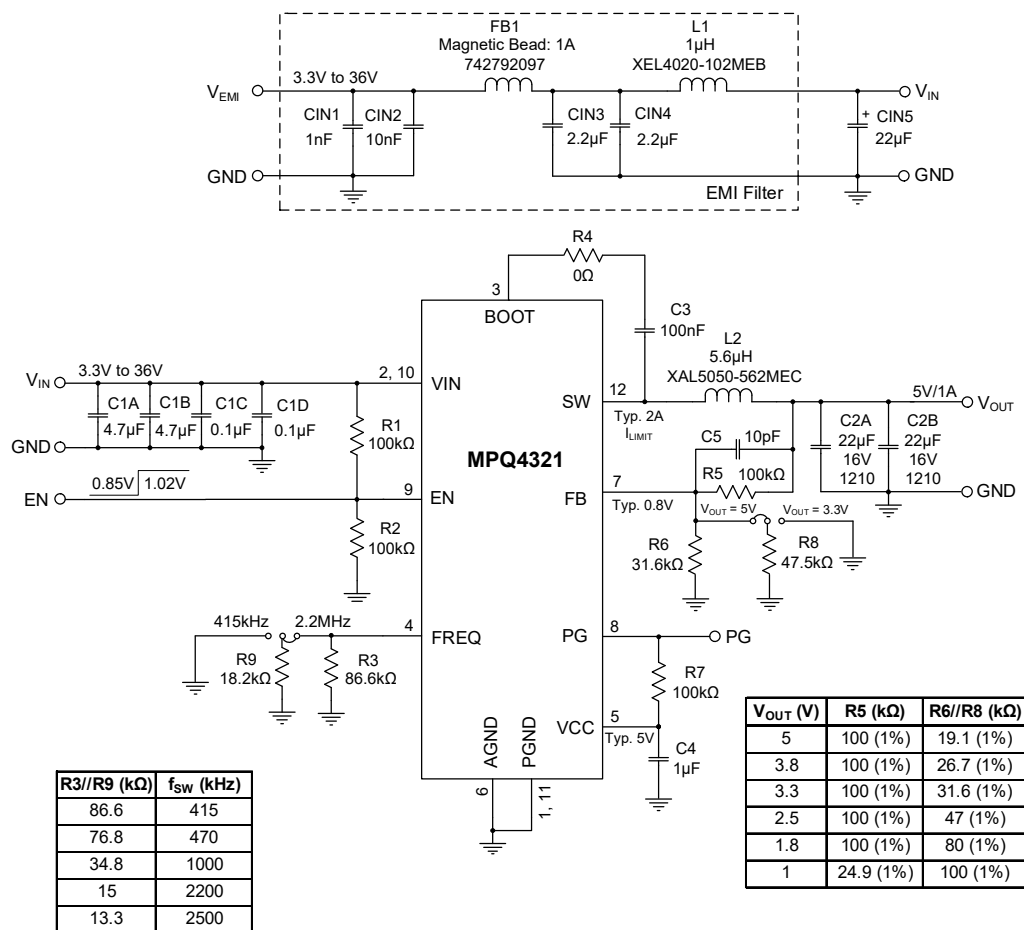
R5 is selected to be 100kΩ. R6 can then be calculated using Equation (1):

$$R6 = \frac{R5}{\frac{V_{OUT}}{0.8V} - 1} \quad (1)$$

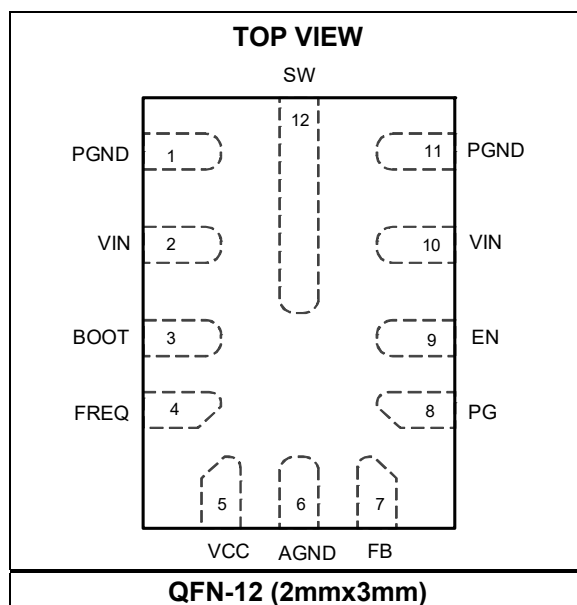
Refer to the Application Information section in the MPQ4321 datasheet to calculate the inductance and output capacitance for different V_{OUT} values.


Figure 2: Measurement Equipment Set-Up

EVALUATION BOARD SCHEMATIC


Figure 3: Evaluation Board Schematic

PACKAGE REFERENCE



EVQ4321-D-01A 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	1A	Magnetic bead	0805	Wurth	742792097
1	L1	1μH	Inductor, 14.6mΩ, 9.6A	SMD	Coilcraft	XEL4020-102MEB
1	L2	5.6μH	Inductor, 25.8mΩ, 5.3A	SMD	Coilcraft	XAL5050-562MEC
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	MPQ4321	42 load dump, 1A, low- <i>I</i> _Q , synchronous step-down converter, AEC-Q100 qualified	QFN-12 (2mmx3mm)	MPS	MPQ4321GDE-AEC1

Note:

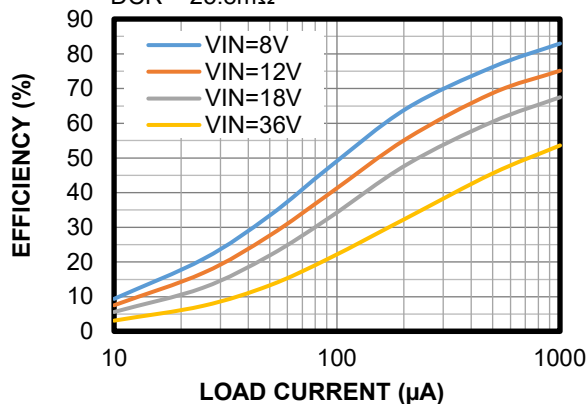
1) Contact an MPS FAE for more information on MPS custom pins.

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.

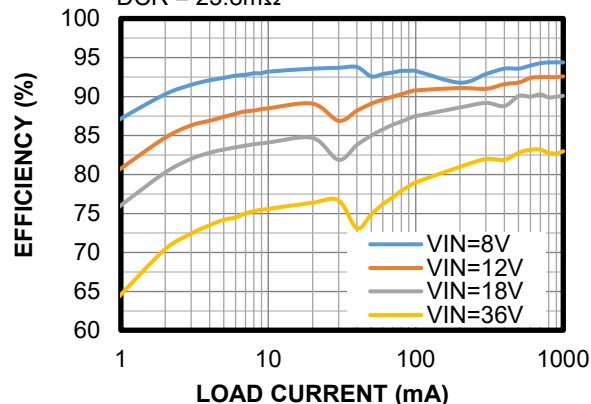
Efficiency vs. Load Current

$R_{FB1} = 100k\Omega$, $R_{FB2} = 19.1k\Omega$,
DCR = 25.8m Ω



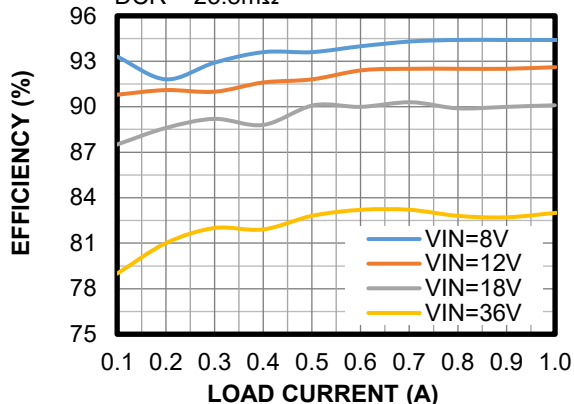
Efficiency vs. Load Current

DCR = 25.8m Ω



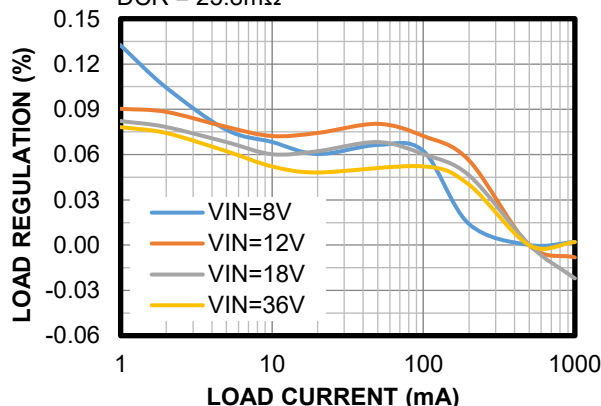
Efficiency vs. Load Current

DCR = 25.8m Ω



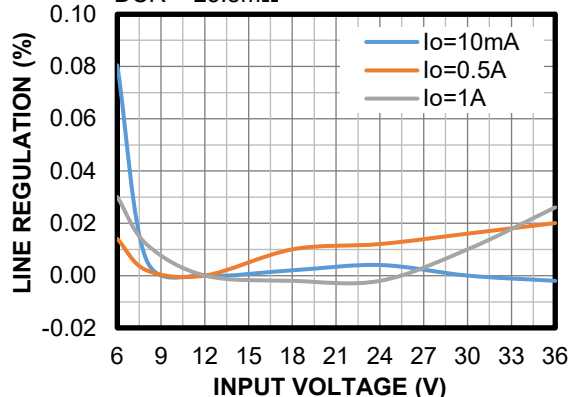
Load Regulation

DCR = 25.8m Ω



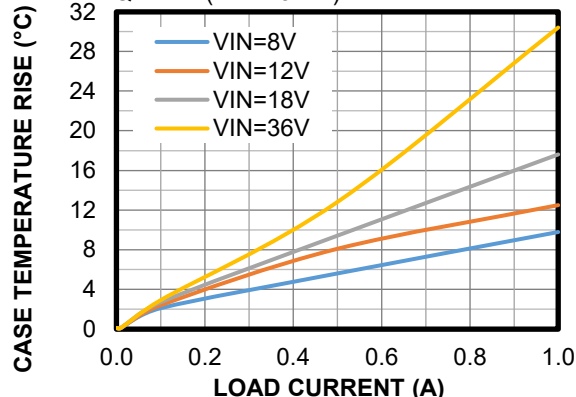
Line Regulation

DCR = 25.8m Ω



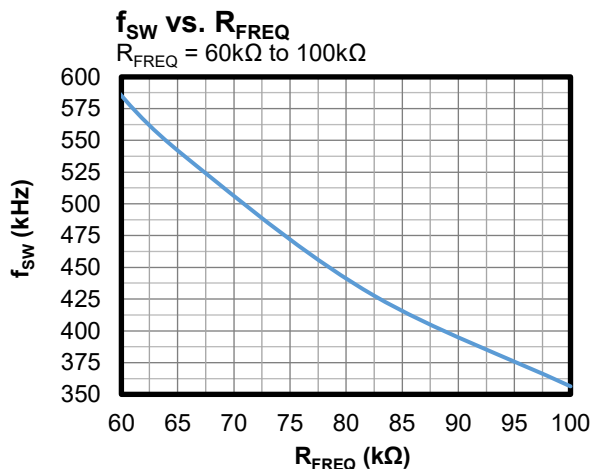
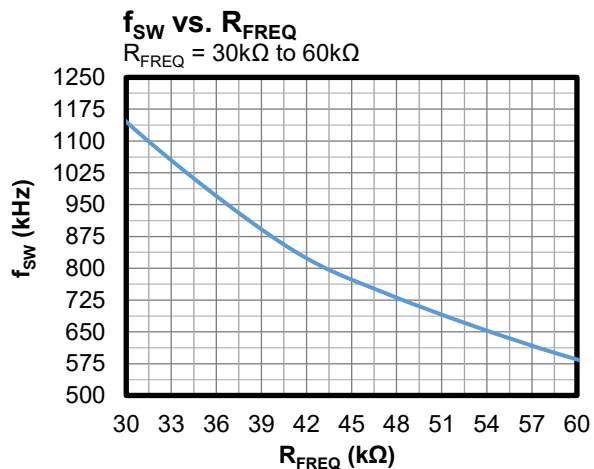
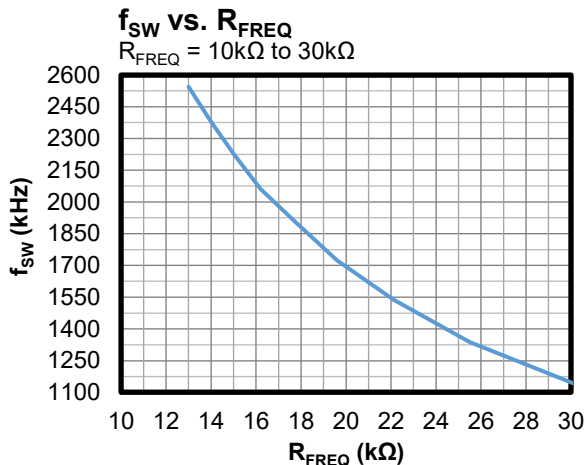
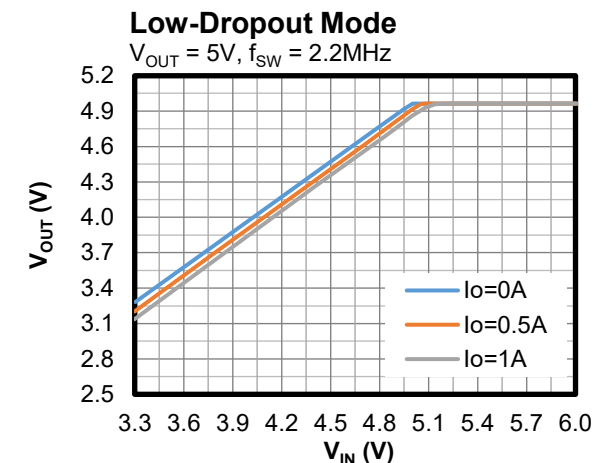
Case Temperature Rise

$V_{OUT} = 5V$, $f_{SW} = 2.2MHz$,
QFN-12 (2mmx3mm)



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.

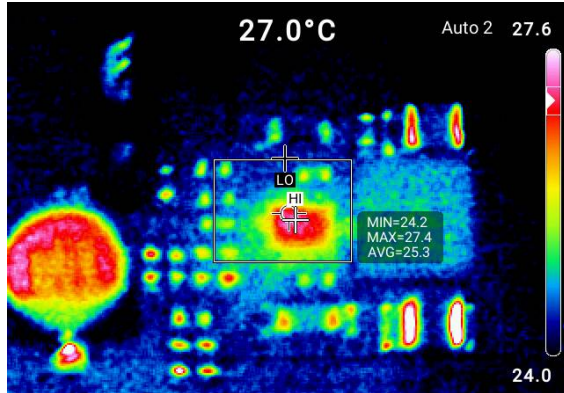


EVB TEST RESULTS *(continued)*

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

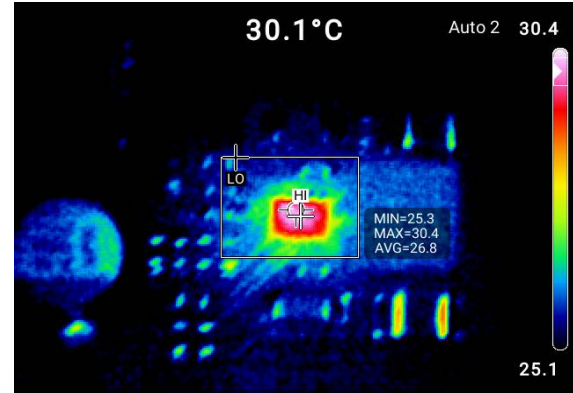
Thermal Performance

$I_{OUT} = 0.5A$, no forced airflow, $T_{CASE} = 27.4^\circ C$



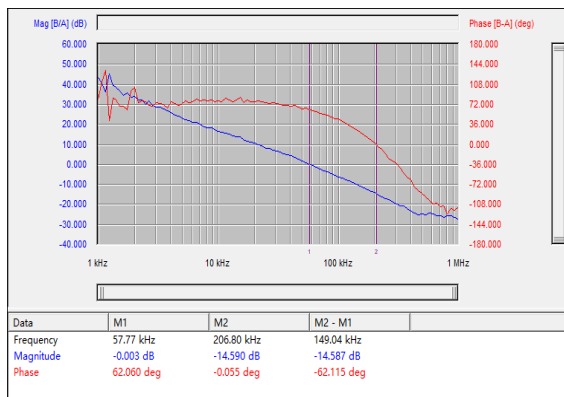
Thermal Performance

$I_{OUT} = 1A$, no forced airflow, $T_{CASE} = 30.4^\circ C$



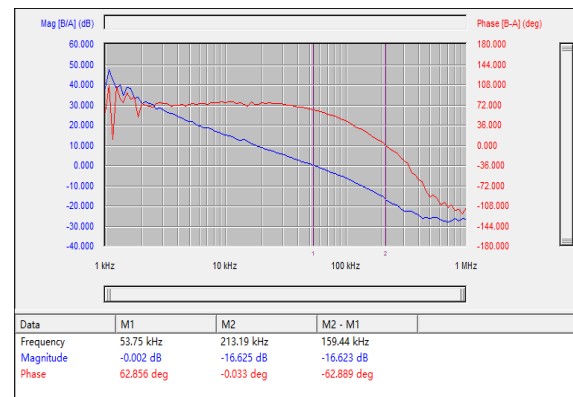
Bode Plot

$I_{OUT} = 0.5A$, $PM = 62.1^\circ$, $GM = 14.6dB$



Bode Plot

$I_{OUT} = 1A$, $PM = 62.8^\circ$, $GM = 16.6dB$

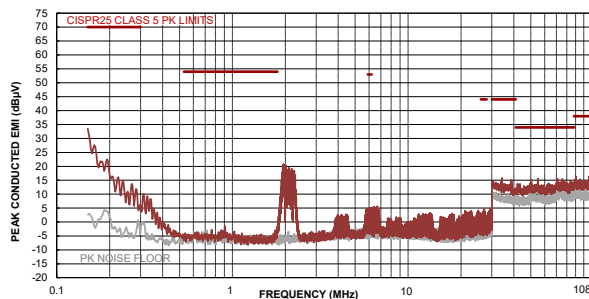


EVB TEST RESULTS *(continued)*

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

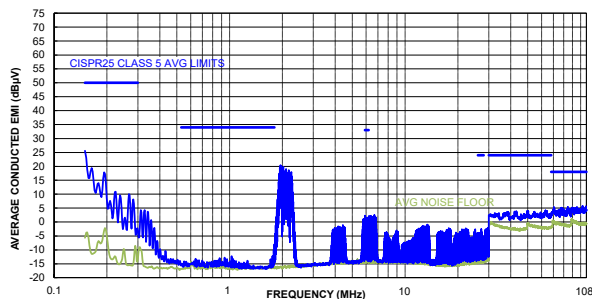
CISPR 25 Class 5 Peak Conducted Emissions

150kHz to 108MHz



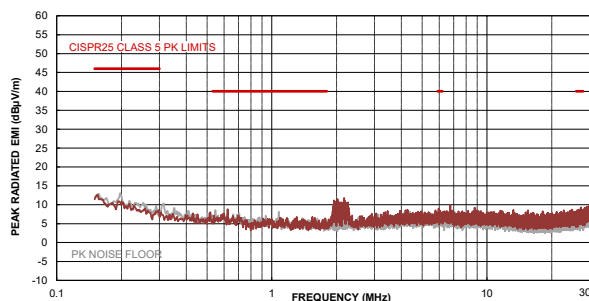
CISPR 25 Class 5 Average Conducted Emissions

150kHz to 108MHz



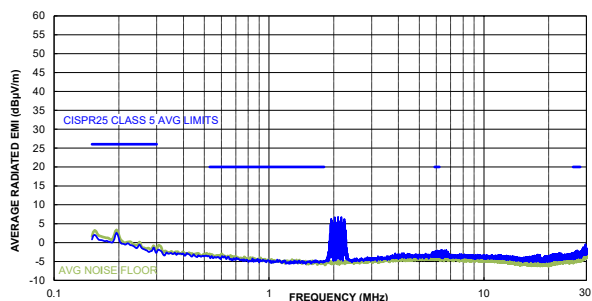
CISPR 25 Class 5 Peak Radiated Emissions

150kHz to 30MHz



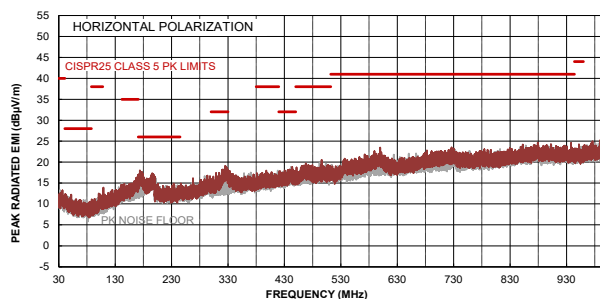
CISPR 25 Class 5 Average Radiated Emissions

150kHz to 30MHz



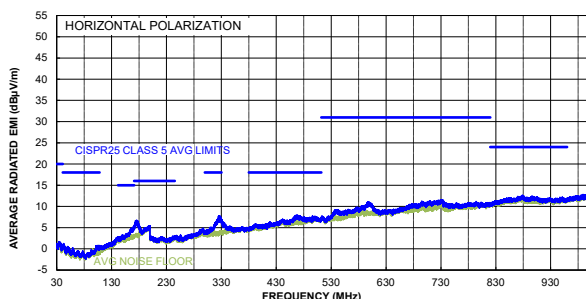
CISPR 25 Class 5 Peak Radiated Emissions

Horizontal, 30MHz to 1GHz



CISPR 25 Class 5 Average Radiated Emissions

Horizontal, 30MHz to 1GHz

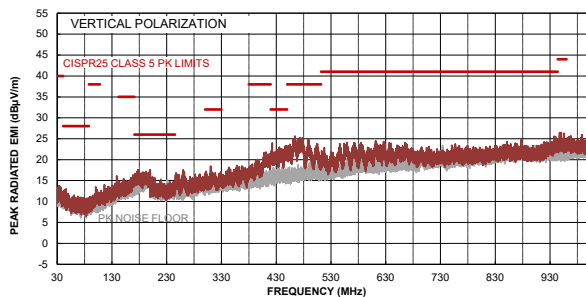


EVB TEST RESULTS *(continued)*

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

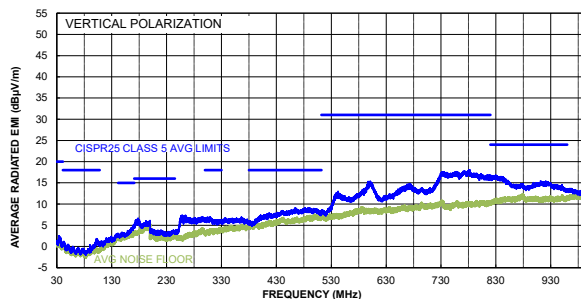
CISPR 25 Class 5 Peak Radiated Emissions

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.

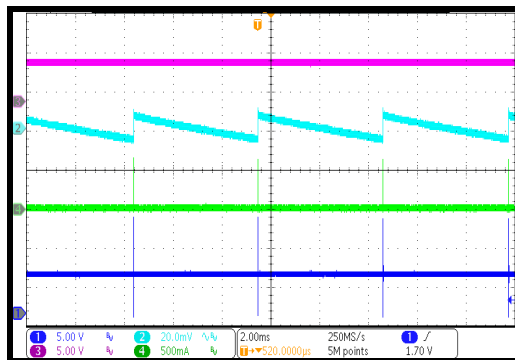
Steady State

 $I_{OUT} = 0A$

CH3: V_{PG}

CH2: V_{OUT}/AC

CH4: I_L

CH1: V_{SW}


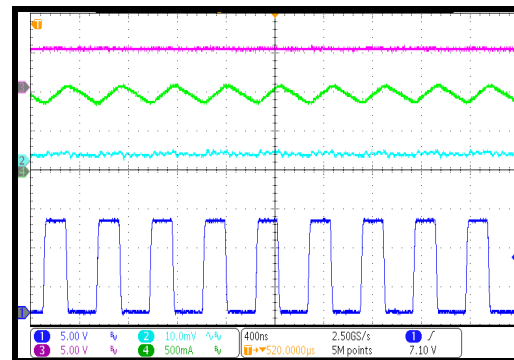
Steady State

 $I_{OUT} = 1A$

CH3: V_{PG}

CH2: V_{OUT}/AC

CH4: I_L

CH1: V_{SW}


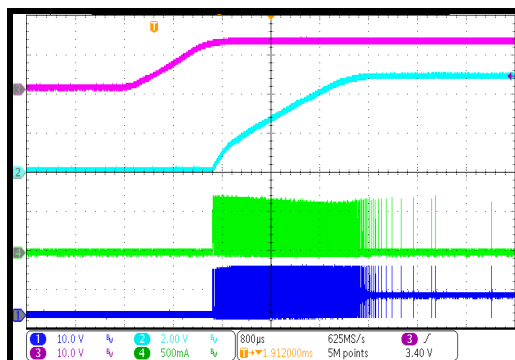
Start-Up through VIN

 $I_{OUT} = 0A$

CH3: V_{IN}

CH2: V_{OUT}

CH4: I_L

CH1: V_{SW}


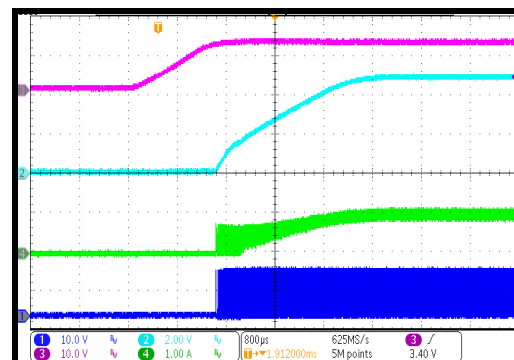
Start-Up through VIN

 $I_{OUT} = 1A$

CH3: V_{IN}

CH2: V_{OUT}

CH4: I_L

CH1: V_{SW}


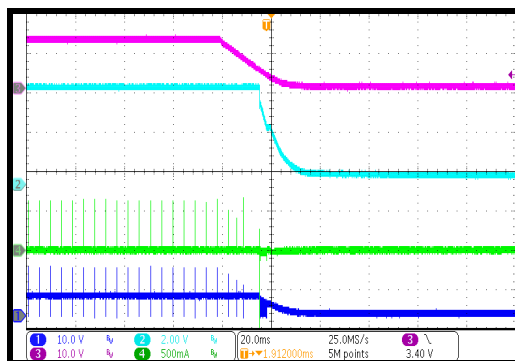
Shutdown through VIN

 $I_{OUT} = 0A$

CH3: V_{IN}

CH2: V_{OUT}

CH4: I_L

CH1: V_{SW}


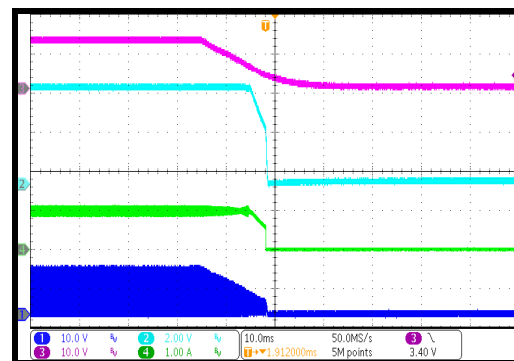
Shutdown through VIN

 $I_{OUT} = 1A$

CH3: V_{IN}

CH2: V_{OUT}

CH4: I_L

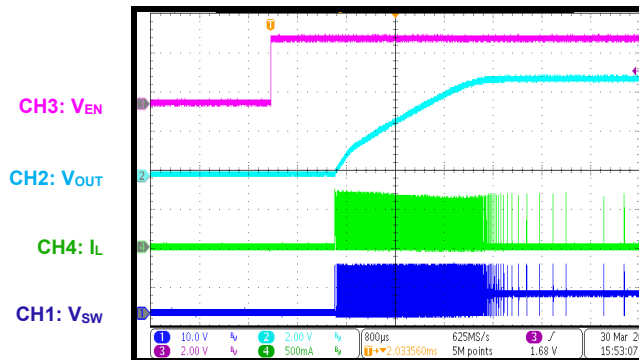
CH1: V_{SW}


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.

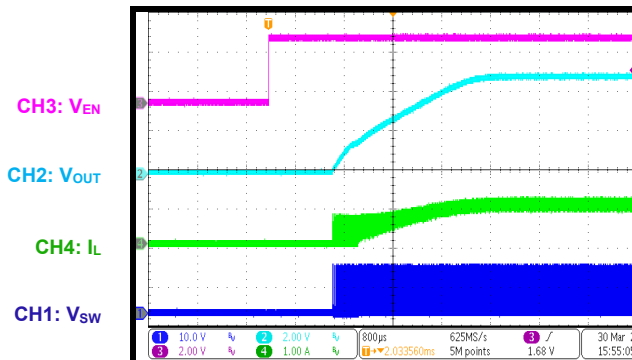
Start-Up through EN

$I_{OUT} = 0A$



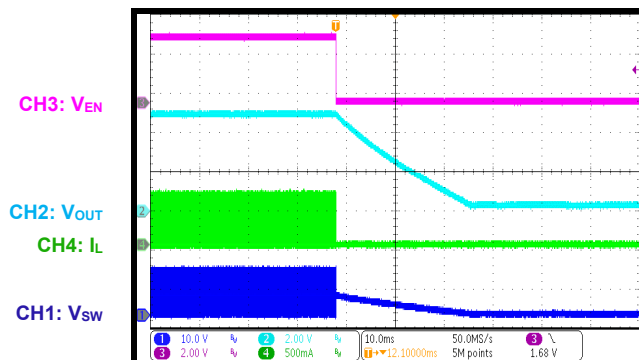
Start-Up through EN

$I_{OUT} = 1A$



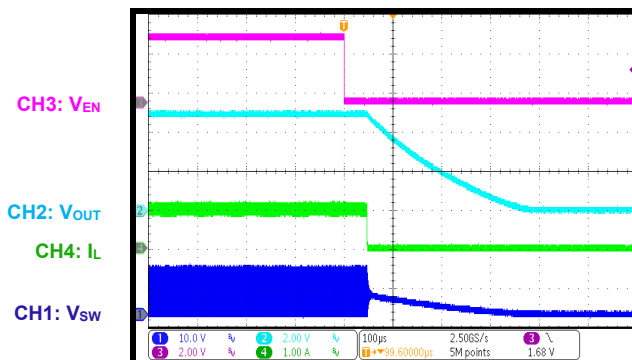
Shutdown through EN

$I_{OUT} = 0A$



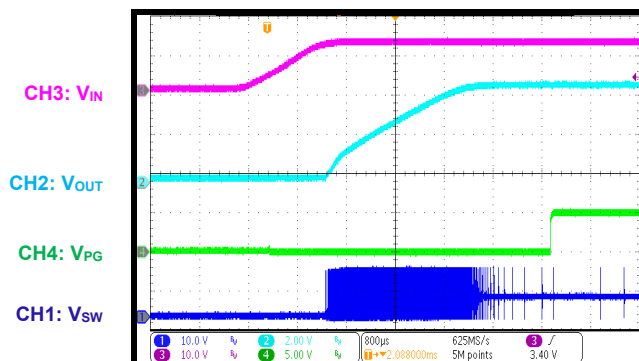
Shutdown through EN

$I_{OUT} = 1A$



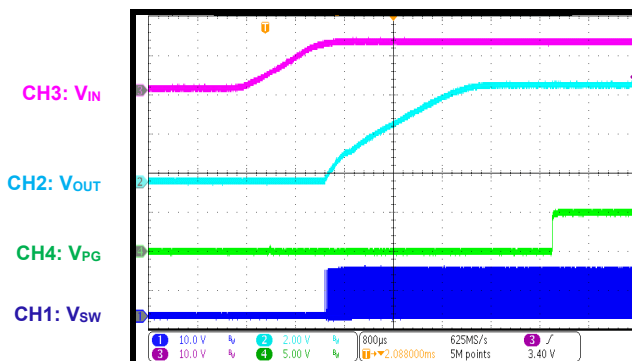
PG in Start-Up through VIN

$I_{OUT} = 0A$



PG in Start-Up through VIN

$I_{OUT} = 1A$

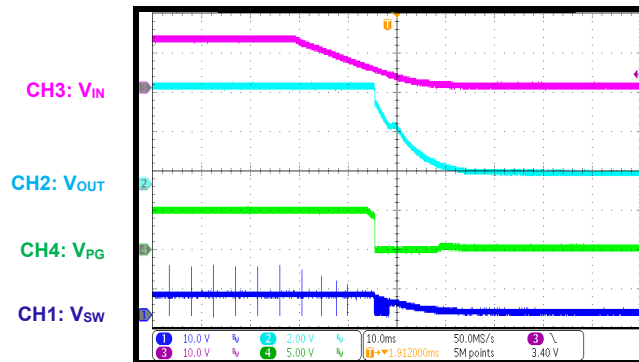


EVB TEST RESULTS *(continued)*

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

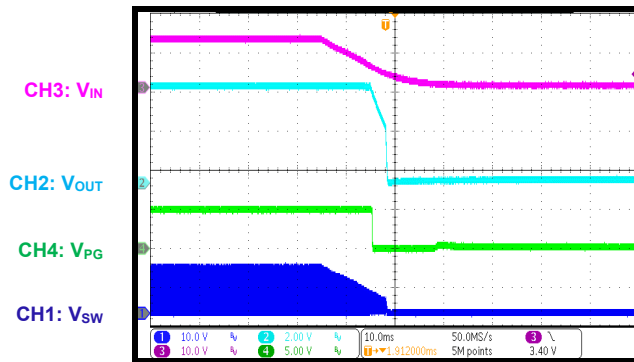
PG in Shutdown through VIN

$I_{OUT} = 0A$



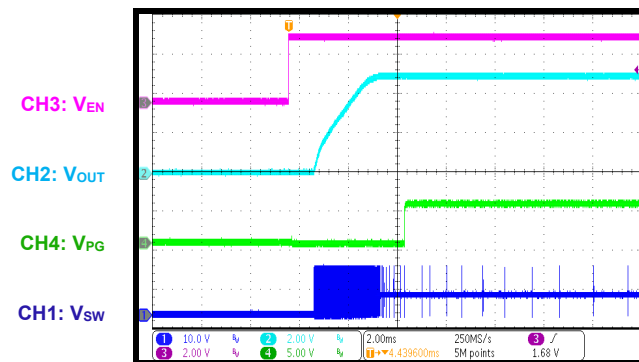
PG in Shutdown through VIN

$I_{OUT} = 1A$



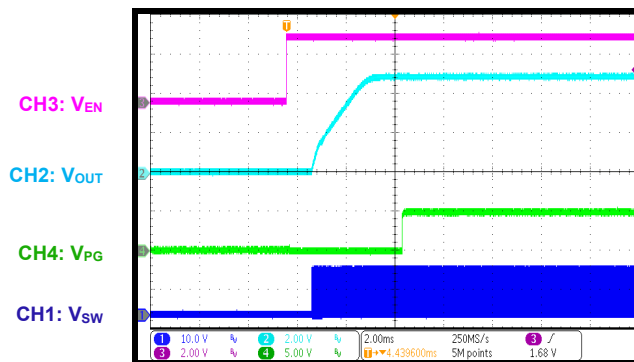
PG in Start-Up through EN

$I_{OUT} = 0A$



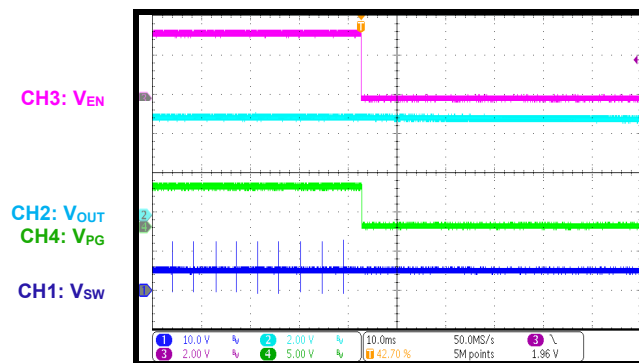
PG in Start-Up through EN

$I_{OUT} = 1A$



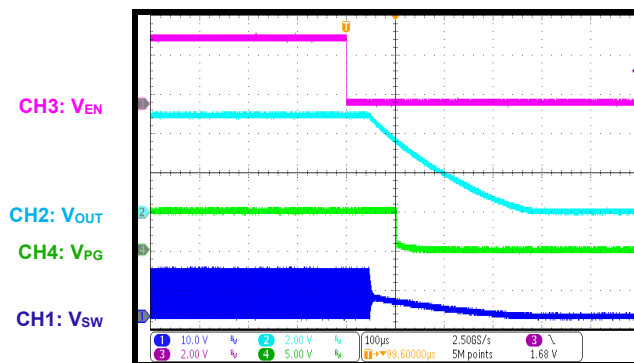
PG in Shutdown through EN

$I_{OUT} = 0A$



PG in Shutdown through EN

$I_{OUT} = 1A$

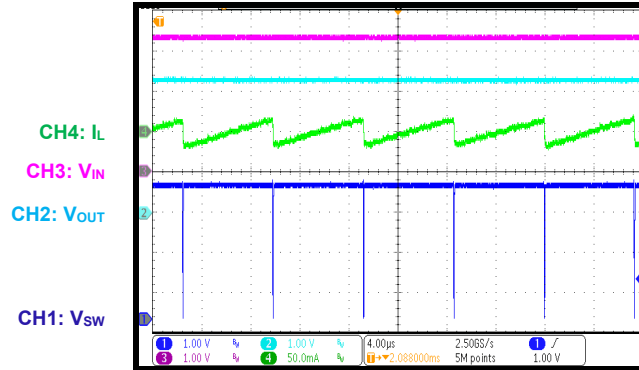


EVB TEST RESULTS *(continued)*

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

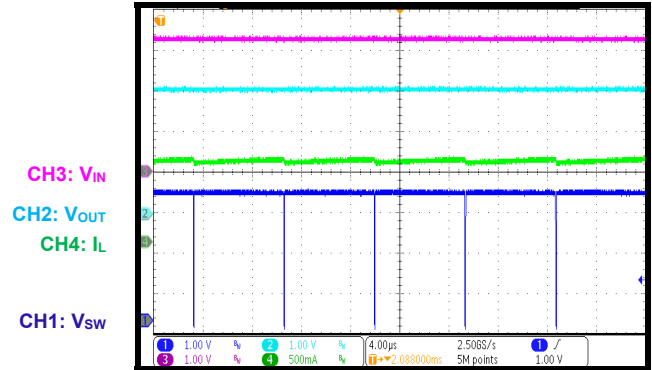
Low-Dropout Mode

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



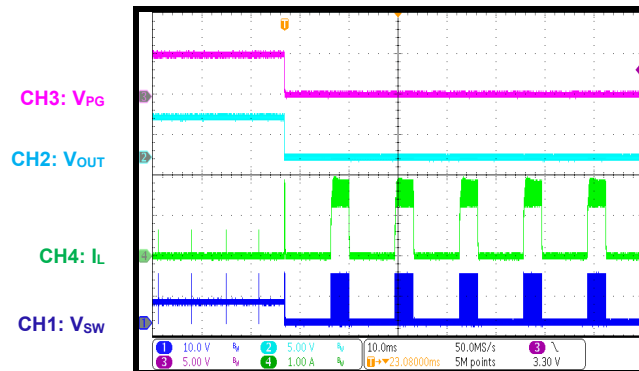
Low-Dropout Mode

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



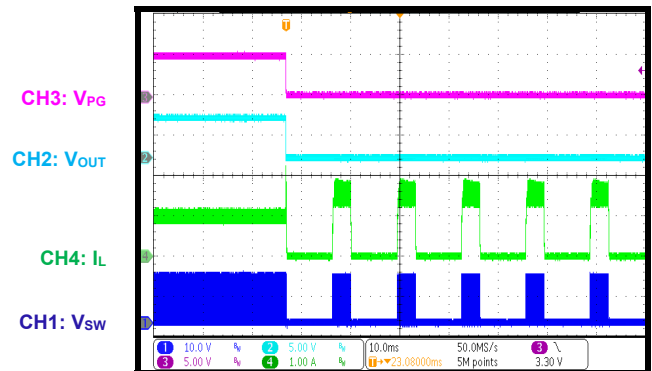
SCP Entry

$I_{OUT} = 0A$



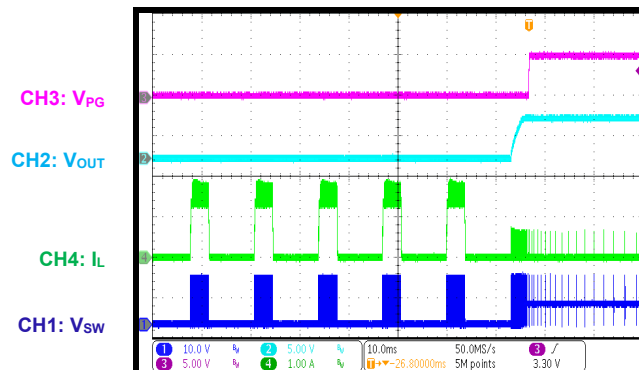
SCP Entry

$I_{OUT} = 1A$



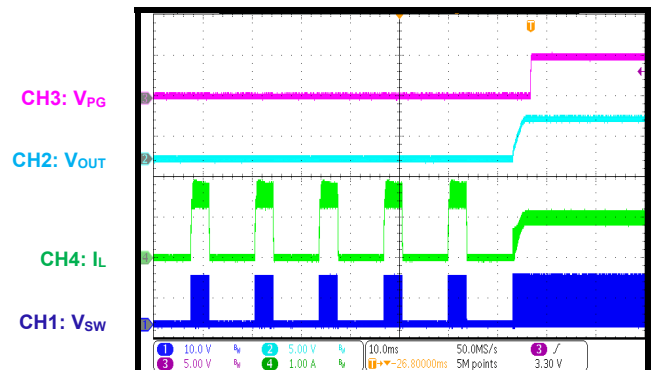
SCP Recovery

$I_{OUT} = 0A$



SCP Recovery

$I_{OUT} = 1A$

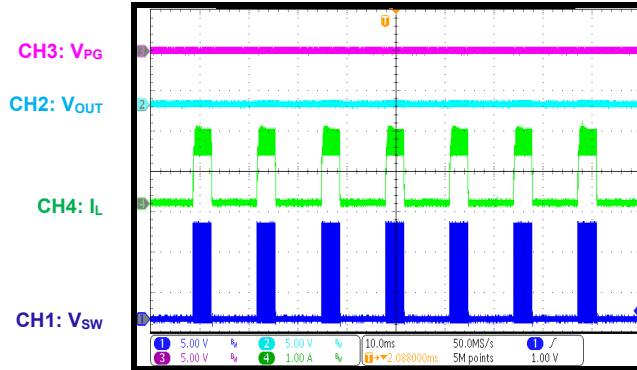


EVB TEST RESULTS *(continued)*

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

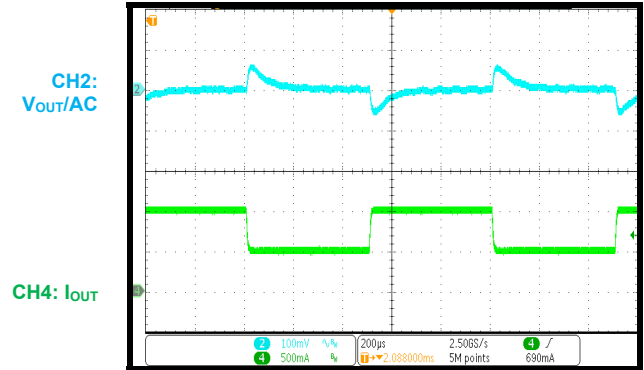
SCP Steady State

$I_{OUT} = 0A$



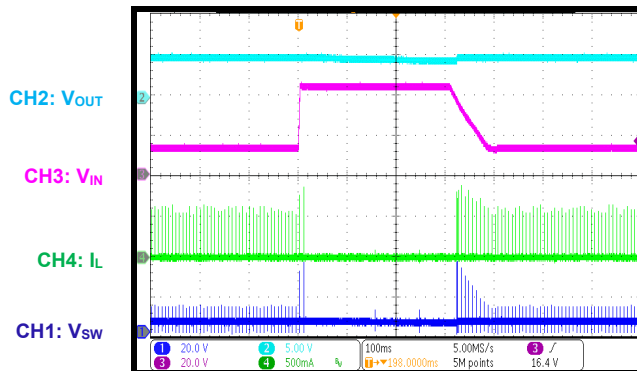
Load Transient

$I_{OUT} = 0.5A$ to $1A$, $1.6A/\mu s$



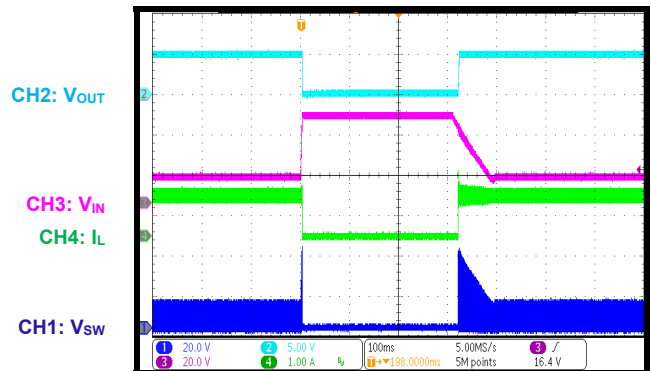
Load Dump

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



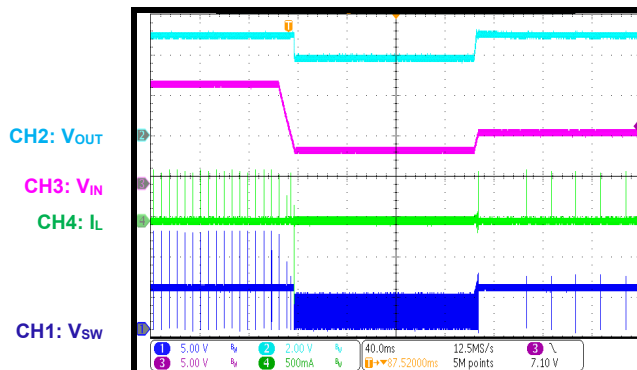
Load Dump

$V_{IN} = 12V$ to $42V$, $I_{OUT} = 1A$



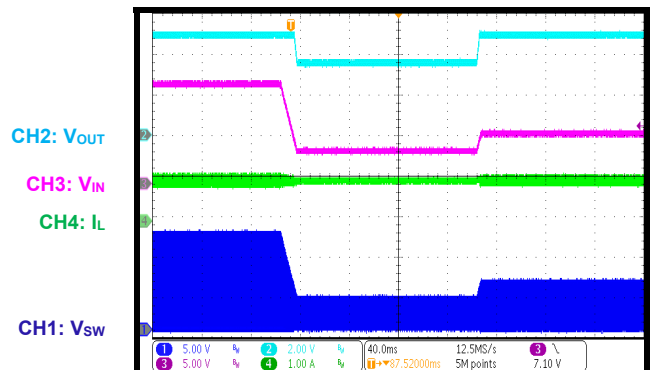
Cold Crank

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



Cold Crank

$V_{IN} = 12V$ to $3.3V$ to $6V$, $I_{OUT} = 1A$

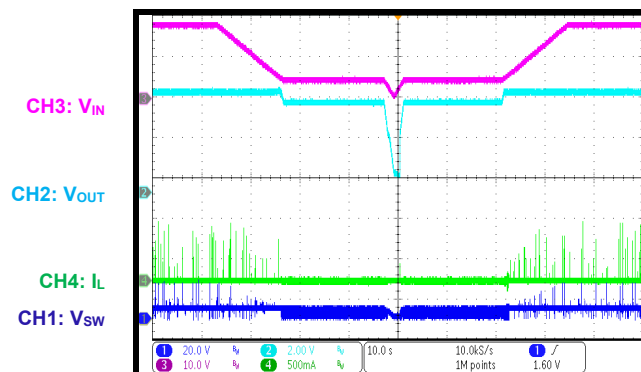


EVB TEST RESULTS *(continued)*

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

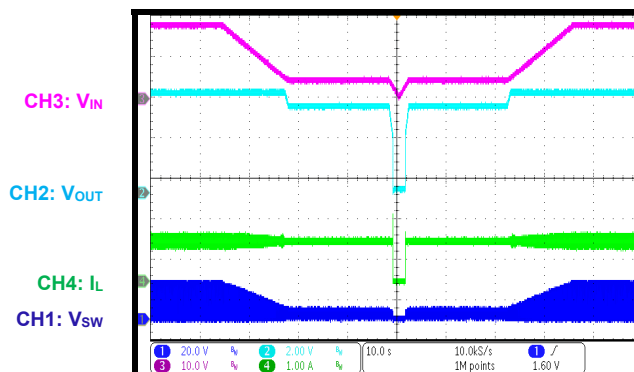
V_{IN} Ramping Down and Up

$V_{IN} = 18V$ to $4.5V$ to $0V$ to $4.5V$ to $18V$,
 $I_{OUT} = 0A$



V_{IN} Ramping Down and Up

$V_{IN} = 18V$ to $4.5V$ to $0V$ to $4.5V$ to $18V$,
 $I_{OUT} = 1A$



PCB LAYOUT (2)

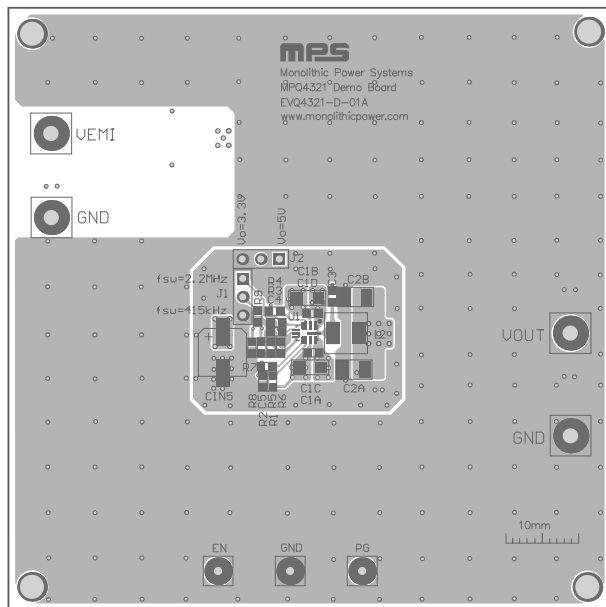


Figure 4: Top Silk and Top Layer

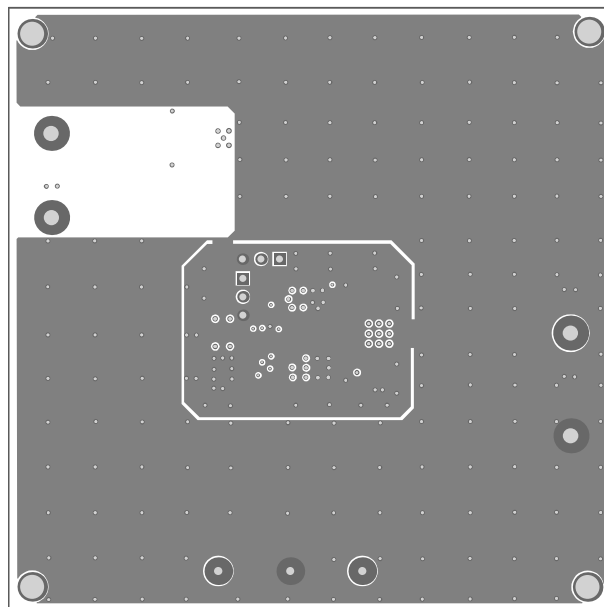


Figure 5: Mid-Layer 1

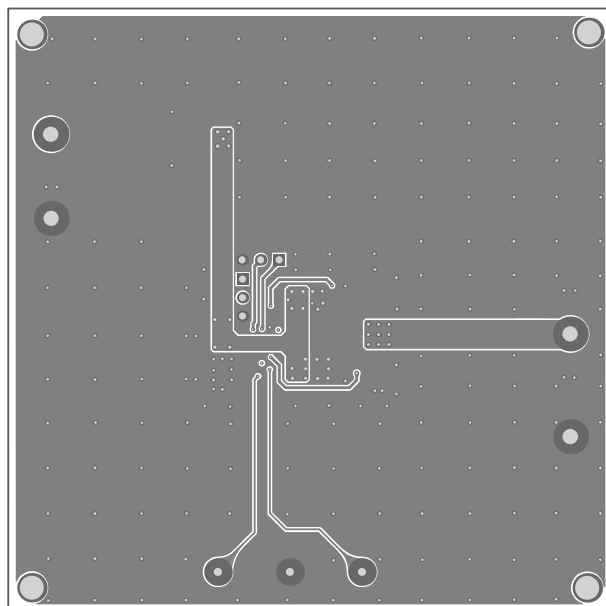


Figure 6: Mid-Layer 2

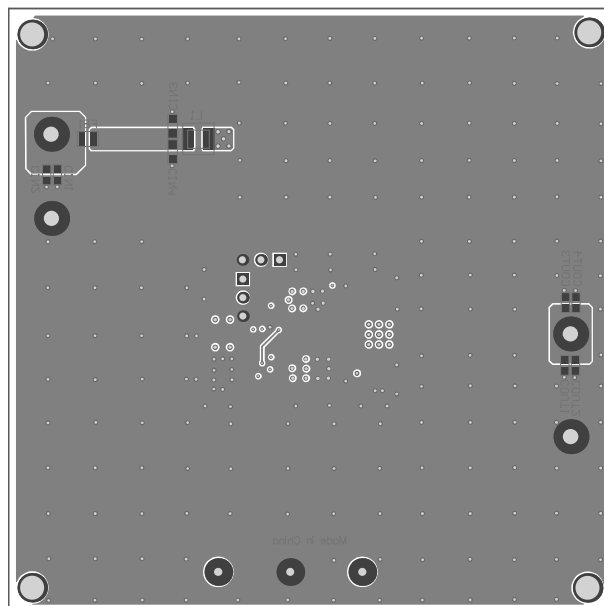


Figure 7: Bottom Layer and Bottom Silk

Note:

- 2) The copper thickness is 2oz.



REVISION HISTORY

Revision #	Revision Date	Description	Pages Updated
1.0	5/8/2024	Initial Release	-

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