



EVQ4314-R-01A

45V, 4A, Low- I_Q , Synchronous Step-Down Converter with Frequency Spread Spectrum Evaluation Board, AEC-Q100 Qualified

DESCRIPTION

The EVQ4314-R-01A evaluation board is designed to demonstrate the capabilities of the MPQ4314, a synchronous, step-down switching regulator with a configurable frequency and integrated, internal high-side MOSFET (HS-FET) and low-side MOSFET (LS-FET). It provides up to 4A of highly efficient output current (I_{OUT}), with current mode control for fast loop response.

The wide 3.3V to 45V input voltage (V_{IN}) range accommodates a variety of step-down applications in automotive input environments. A 1.7 μ A quiescent current (I_Q) in shutdown mode allows the device to be used in battery-powered applications. High power conversion

efficiency across a wide load range is achieved by scaling down the switching frequency (f_{SW}) under light-load conditions to reduce switching and gate driver losses.

Frequency foldback helps prevent inductor current runaway during start-up. Thermal shutdown provides reliable, fault-tolerant operation. High duty cycle and low-dropout (LDO) mode are provided for automotive cold crank conditions.

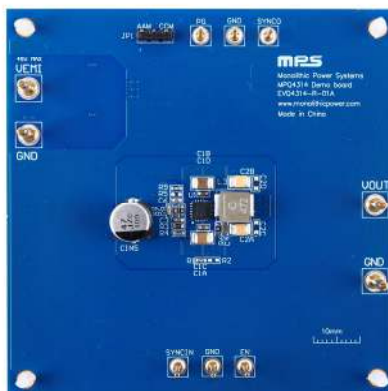
The EVQ4314-R-01A is fully assembled and tested. The MPQ4314-AEC1 is available in a QFN-20 (4mmx4mm) wettable flank package, and is AEC-Q100 Grade 1 qualified.

PERFORMANCE SUMMARY

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

Parameter	Conditions	Value
Input voltage (V_{IN}) range		3.3V to 45V
Output voltage (V_{OUT})	$V_{IN} = 3.3\text{V to } 45\text{V}$, $I_{OUT} = 0\text{A to } 4\text{A}$	$V_{OUT} = 3.3\text{V}$
Maximum output current (I_{OUT})	$V_{IN} = 3.3\text{V to } 45\text{V}$	4A
Typical efficiency	$V_{IN} = 12\text{V}$, $V_{OUT} = 3.3\text{V}$, $I_{OUT} = 4\text{A}$	93.1%
Switching frequency (f_{SW})		410kHz

EVQ4314-R-01A EVALUATION BOARD



LxWxH (8.3cmx8.3cmx1.3cm)

Board Number	MPS IC Number
EVQ4314-R-01A	MPQ4314GRE-AEC1

QUICK START GUIDE

1. Preset the power supply (V_{IN}) between 3.3V and 45V. Electronic loads represent a negative impedance to the regulator, and setting a current too high triggers hiccup mode.
2. Turn off V_{IN} . If longer cables are used between the source and the evaluation board (>0.5m total), then install a damping capacitor at the input terminals, especially if $V_{IN} \geq 24V$.
3. Connect the power supply terminals to (see Figure 2 on page 3):
 - a. Positive (+): VEMI
 - b. Negative (-): GND
4. Connect the load terminals to (see Figure 2 on page 3):
 - a. Positive (+): VOUT
 - b. Negative (-): GND
5. After making the connections, turn on the power supply. The board should automatically start up.
6. To use the enable function, apply a digital input to the EN pin. Drive EN above 1V to turn the regulator on; drive EN below 0.85V to turn the regulator off.
7. The MPQ4314's oscillating (switching) frequency can be configured by an external frequency resistor (R_3). R_3 can be estimated based on the switching frequency (f_{sw}) vs. frequency resistance (R_{FREQ}) curve (see Figure 1).

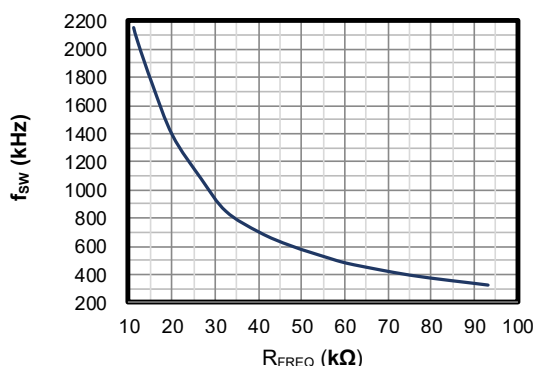


Figure 1: R3 Frequency Resistance

8. To use the sync function, apply a 350kHz to 1000kHz external clock to the SYNCIN pin to synchronize the internal clock's rising edge.
9. The output voltage (V_{OUT}) is set by the external resistor divider. If $R_7 = 100k\Omega$, then R_8 can be calculated using Equation (1):

$$R_8 = \frac{R_7}{\frac{V_{OUT}}{0.815V} - 1} \quad (1)$$

Table 1 shows the recommended R_7 and R_8 values for common output voltages.

Table 1: Resistor Selection for Output Voltages

V_{OUT} (V)	R_7 (k Ω)	R_8 (k Ω)
3.3	100 (1%)	32.4 (1%)
5	100 (1%)	19.1 (1%)

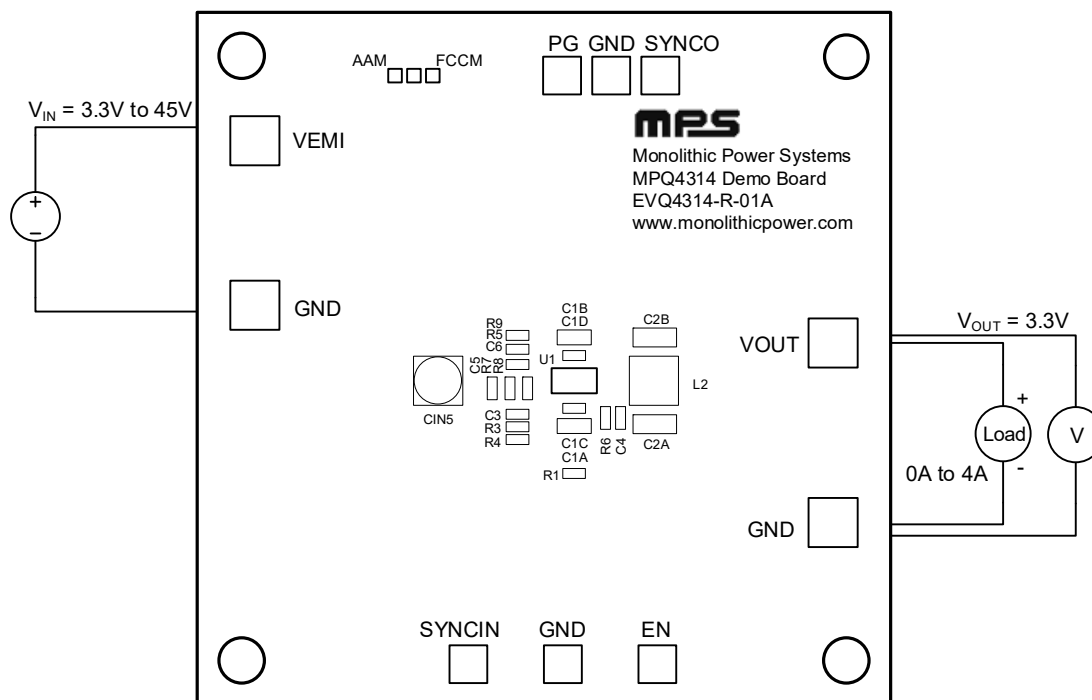


Figure 2: Measurement Equipment Set-Up

EVALUATION BOARD SCHEMATIC

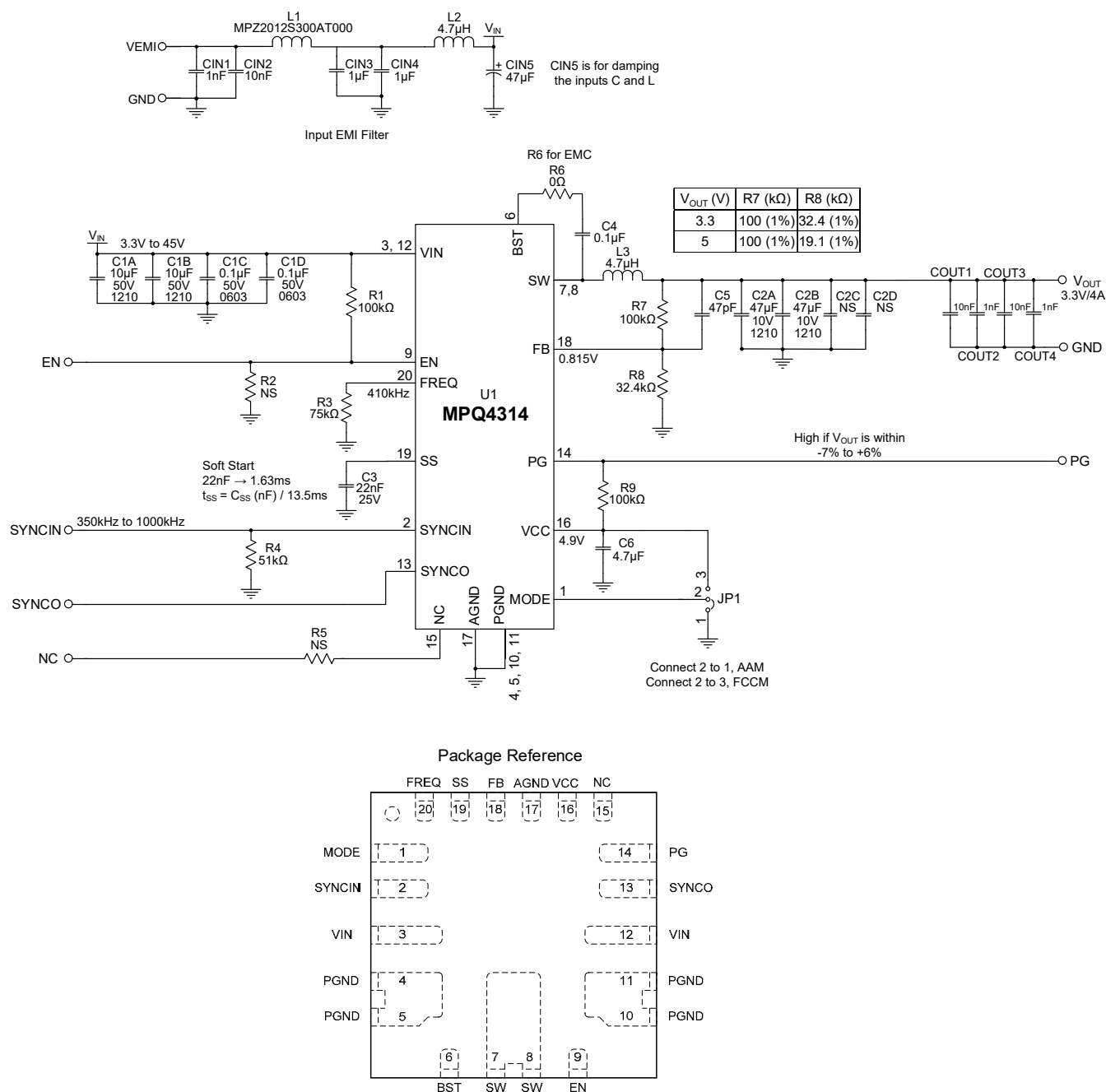


Figure 3: Evaluation Board Schematic and Package Reference

EVQ4314-R-01A BILL OF MATERIALS

Qty	Ref	Value	Description	Package	Manufacturer	Manufacturer PN
3	CIN1, COUT2, COUT4	1nF	Ceramic capacitor, 50V, X7R	0603	Murata	GRM216R71H102KA01
3	CIN2, COUT1, COUT3	10nF	Ceramic capacitor, 50V, X7R	0603	Murata	GRM188R71H103KA01D
2	CIN3, CIN4	1μF	Ceramic capacitor, 50V, X7R	1206	TDK	C3216X7R1H105K
1	CIN5	47μF	Aluminum capacitor, 63V	SMD	Panasonic	EEHZA1J470P
2	C1A, C1B	10μF	Ceramic capacitor, 50V, X7R	1210	Murata	GRM32ER71H106KA12L
2	C1C, C1D	0.1μF	Ceramic capacitor, 50V, X7R	0603	Murata	GCJ188R71H104KA12D
2	C2A, C2B	47μF	Ceramic capacitor, 10V, X5R	1210	Murata	GRM32ER61A476KE20L
1	C3	22nF	Ceramic capacitor, 25V, X7R	0603	Murata	GRM188R71E223JA01D
1	C4	0.1μF	Ceramic capacitor, 50V, X7R	0603	Murata	GRM188R71H104KA93D
1	C5	47pF	Ceramic capacitor, 50V, C0G	0603	TDK	C1608C0G1H470J
1	C6	4.7μF	Ceramic capacitor, 10V, X5R	0603	Murata	GRM188R61A475KE15D
1	L1	10mΩ	Magnetic bead, 6A	0805	TDK	MPZ2012S300AT000
1	L2	4.7μH	Inductor, 31.5mΩ, 6A	SMD	Cyntec	VCMT063T-4R7MN5T
1	L3	4.7μH	Inductor, 15.02mΩ, 12.1A	SMD	Coilcraft	XAL6060-472MEC
3	R1, R7, R9	100kΩ	Film resistor, 1%	0603	Yageo	RC0603FR-07100KL
1	R3	75kΩ	Film resistor, 1%	0603	Yageo	RC0603FR-0775KL
1	R4	51kΩ	Film resistor, 1%	0603	Yageo	RC0603FR-0751KL
1	R6	0Ω	Film resistor, 1%	0603	Yageo	RC0603FR-070RL
1	R8	32.4kΩ	Film resistor, 1%	0603	Yageo	RC0603FR-0732K4L
4	C2C, C2D, R2, R5	NS				
1	JP1	2.54mm	Test pin, 3-pin	DIP	Any	
4	VEMI, GND, VOUT, GND	2mm	Golden test pin	DIP	Custom ⁽¹⁾	
7	SYNCIN, ICS, PG, SYNCO, EN, GND, GND	1mm	Golden test pin	DIP	Custom ⁽¹⁾	
1	U1	MPQ4314	45V/4A, step-down converter, AEC-Q100	QFN-20 (4mmx4mm)	MPS	MPQ4314GRE-AEC1

Note:

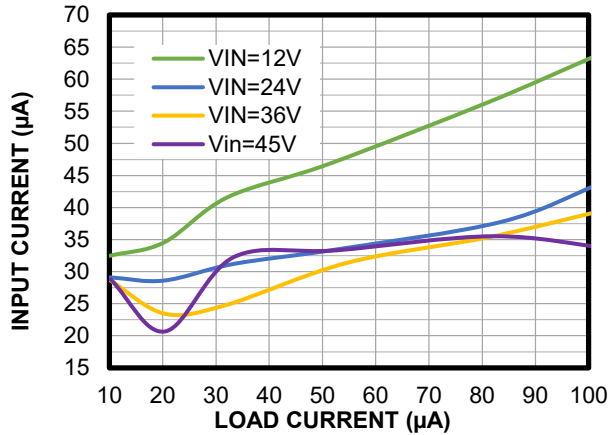
1) Contact an MPS FAE for more information regarding custom pins.

EVB TEST RESULTS

Performance curves and waveforms are tested on the evaluation board, $V_{IN} = 12V$, $V_{OUT} = 3.3V$, $C_{OUT} = 2 \times 47\mu F$, $L = 4.7\mu H$, $f_{SW} = 410kHz$, $T_A = 25^\circ C$, unless otherwise noted.

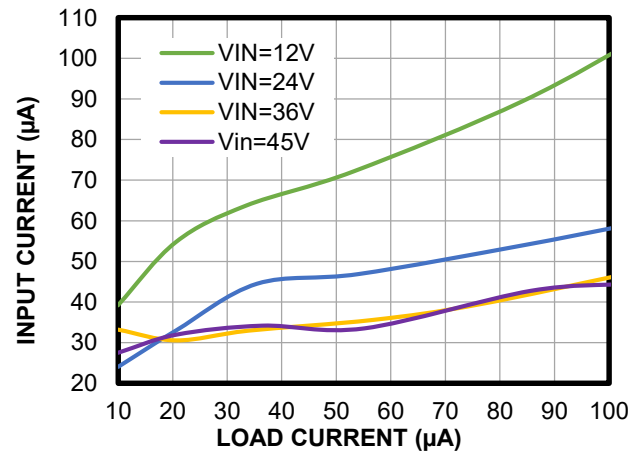
Input Current vs. Load Current

AAM mode, $V_{OUT} = 3.3V$



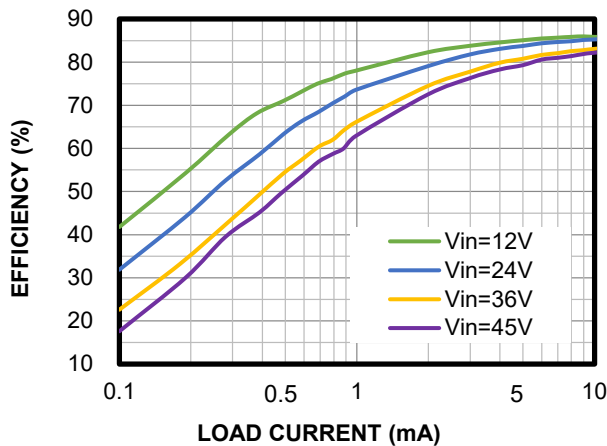
Input Current vs. Load Current

AAM mode, $V_{OUT} = 5V$



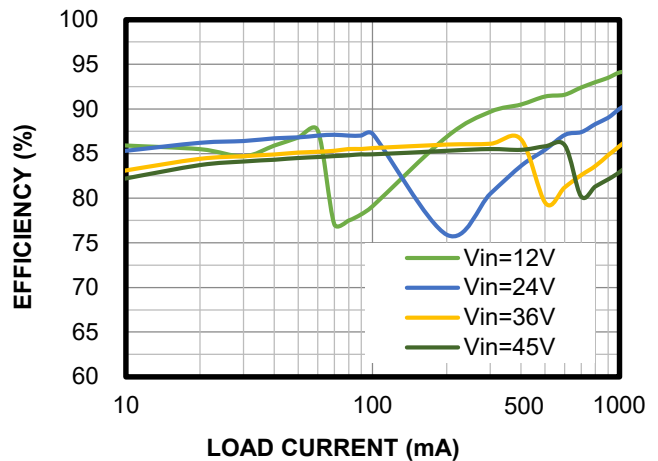
Efficiency vs. Load Current

AAM mode, $V_{OUT} = 3.3V$, 0.1mA to 10mA



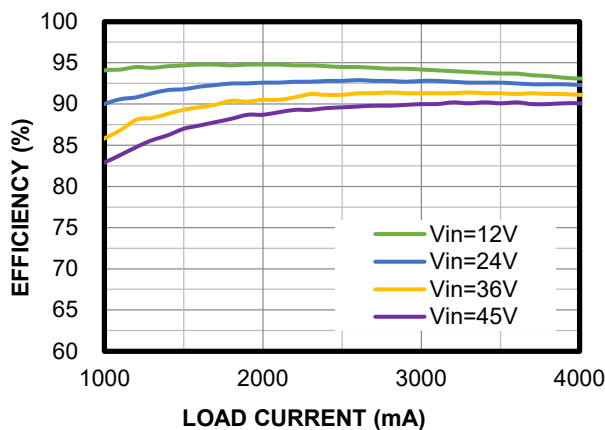
Efficiency vs. Load Current

AAM mode, $V_{OUT} = 3.3V$, 10mA to 1000mA



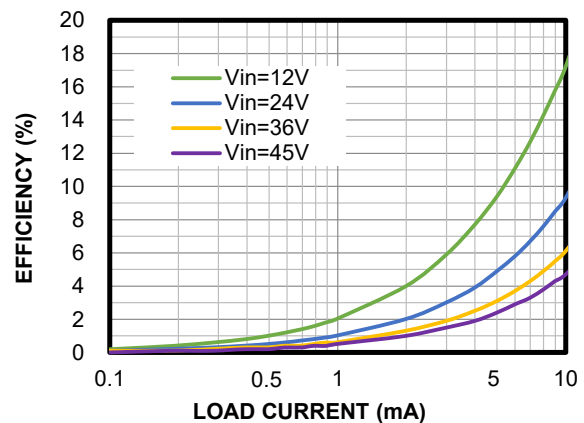
Efficiency vs. Load Current

AAM mode, $V_{OUT} = 3.3V$, 1A to 4A



Efficiency vs. Load Current

FCCM, $V_{OUT} = 3.3V$, 0.1mA to 10mA

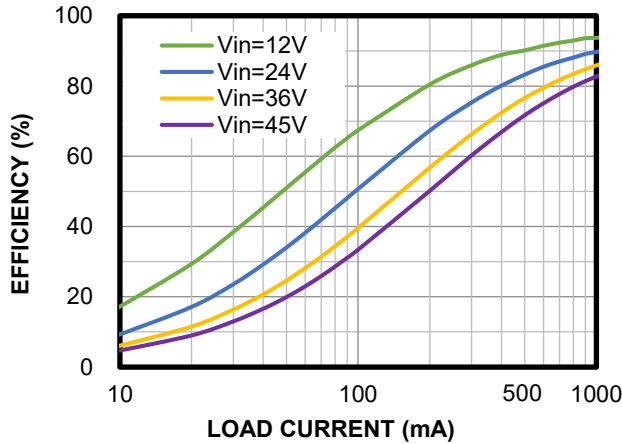


EVB TEST RESULTS *(continued)*

Performance curves and waveforms are tested on the evaluation board, $V_{IN} = 12V$, $V_{OUT} = 3.3V$, $C_{OUT} = 2 \times 47\mu F$, $L = 4.7\mu H$, $f_{SW} = 410kHz$, $T_A = 25^\circ C$, unless otherwise noted.

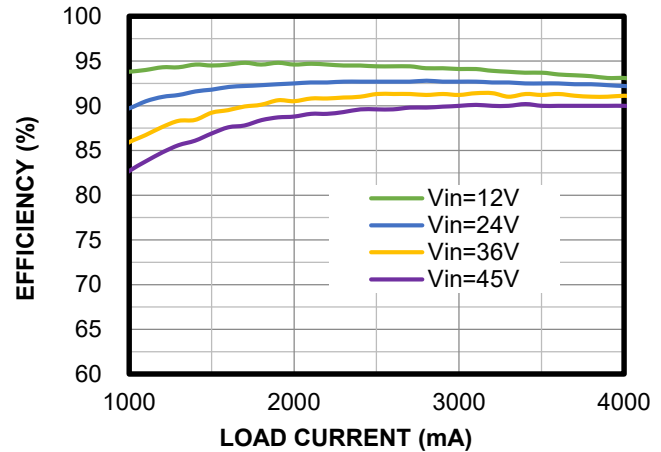
Efficiency vs. Load Current

FCCM, $V_{OUT} = 3.3V$, 10mA to 1000mA



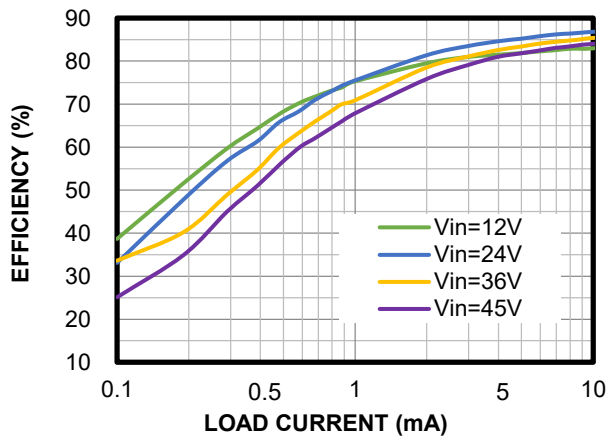
Efficiency vs. Load Current

FCCM, $V_{OUT} = 3.3V$, 1A to 4A



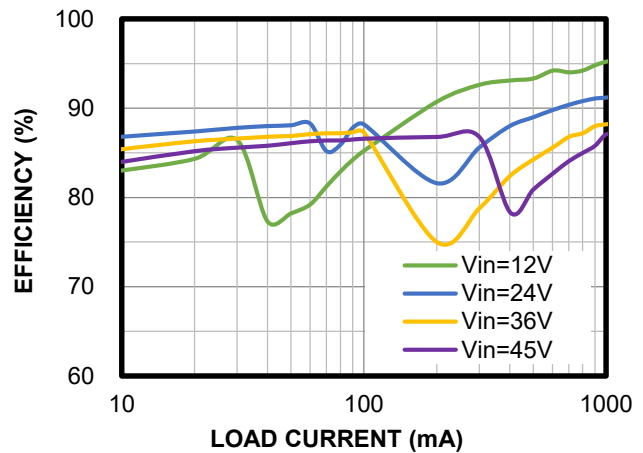
Efficiency vs. Load Current

AAM mode, $V_{OUT} = 5V$, 0.1mA to 10mA



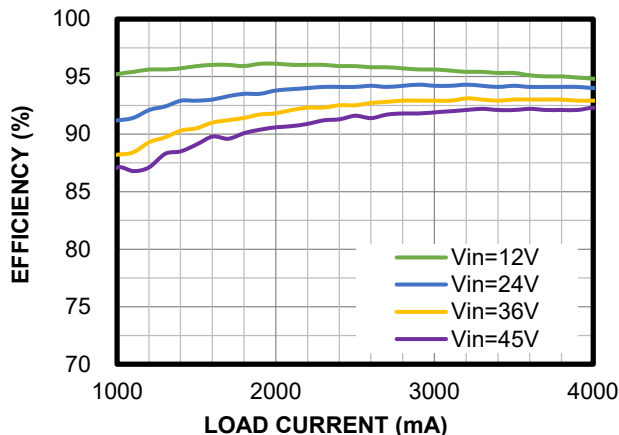
Efficiency vs. Load Current

AAM mode, $V_{OUT} = 5V$, 10mA to 1000mA



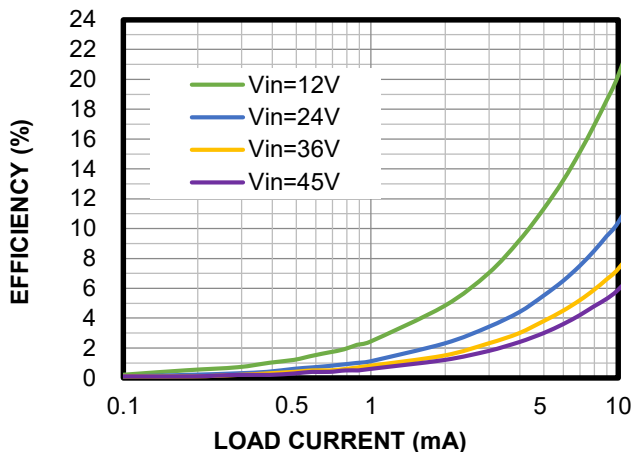
Efficiency vs. Load Current

AAM mode, $V_{OUT} = 5V$, 1A to 4A



Efficiency vs. Load Current

FCCM, $V_{OUT} = 5V$, 0.1mA to 10mA

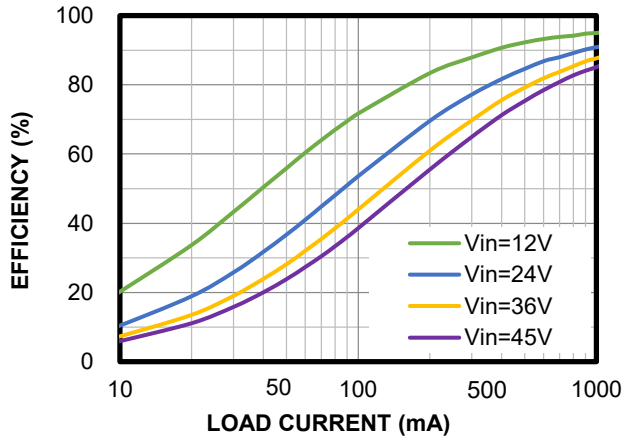


EVB TEST RESULTS *(continued)*

Performance curves and waveforms are tested on the evaluation board, $V_{IN} = 12V$, $V_{OUT} = 3.3V$, $C_{OUT} = 2 \times 47\mu F$, $L = 4.7\mu H$, $f_{SW} = 410kHz$, $T_A = 25^\circ C$, unless otherwise noted.

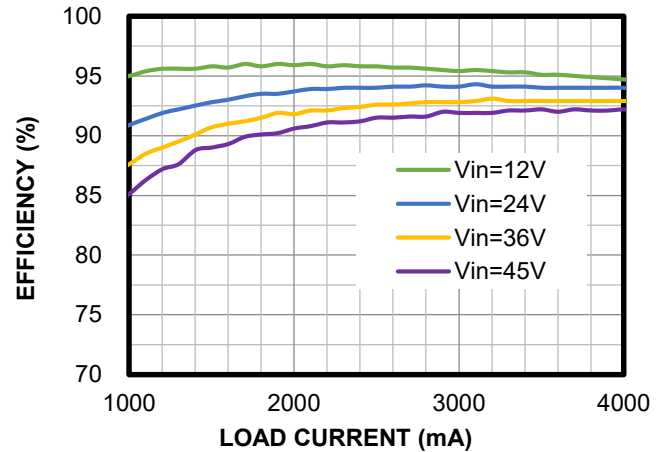
Efficiency vs. Load Current

FCCM, $V_{OUT} = 5V$, 10mA to 1000mA



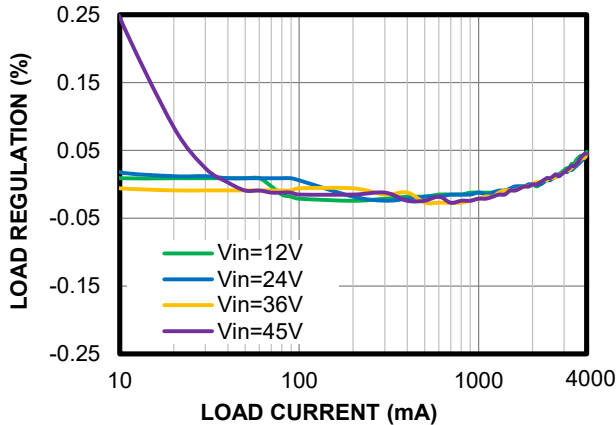
Efficiency vs. Load Current

FCCM, $V_{OUT} = 5V$, 1A to 4A



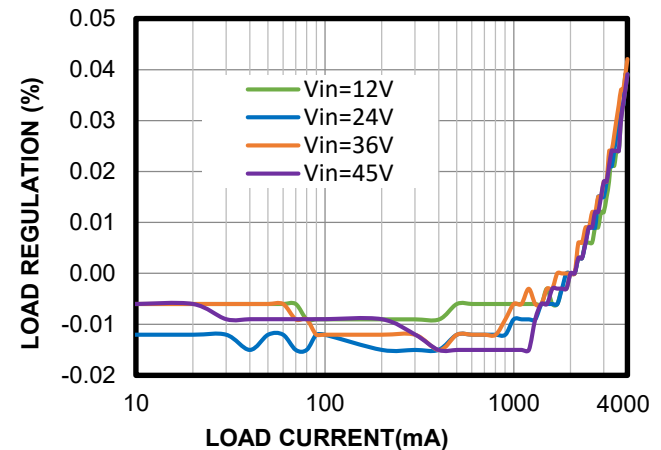
Load Regulation

$V_{OUT} = 3.3V$, AAM mode



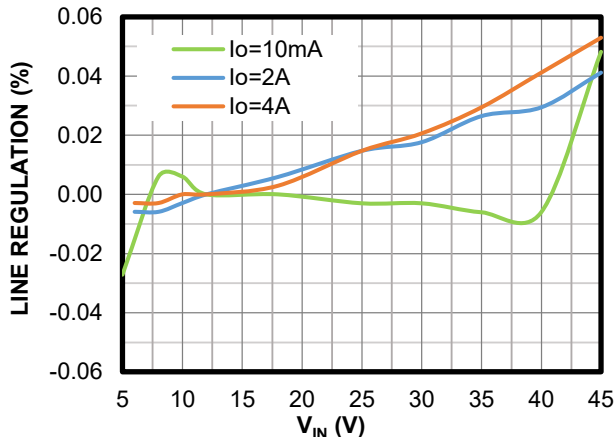
Load Regulation

$V_{OUT} = 3.3V$, FCCM



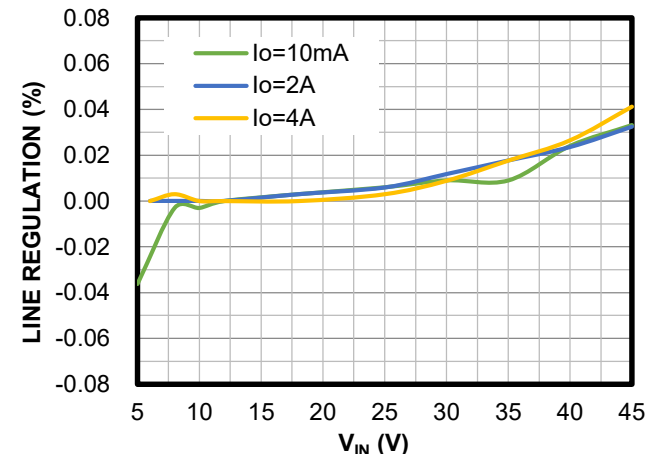
Line Regulation

$V_{OUT} = 3.3V$, AAM mode



Line Regulation

$V_{OUT} = 3.3V$, FCCM

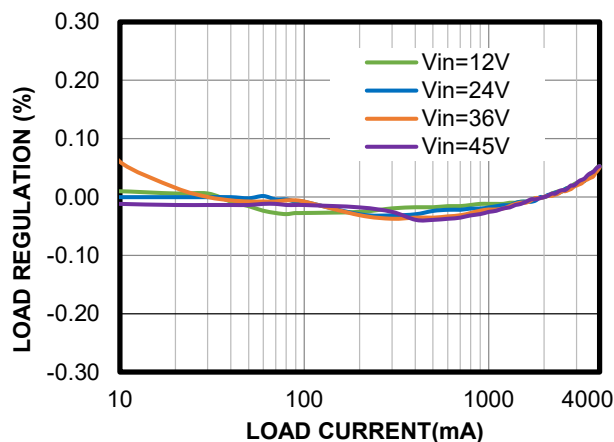


EVB TEST RESULTS (continued)

Performance curves and waveforms are tested on the evaluation board, $V_{IN} = 12V$, $V_{OUT} = 3.3V$, $C_{OUT} = 2 \times 47\mu F$, $L = 4.7\mu H$, $f_{SW} = 410kHz$, $T_A = 25^\circ C$, unless otherwise noted.

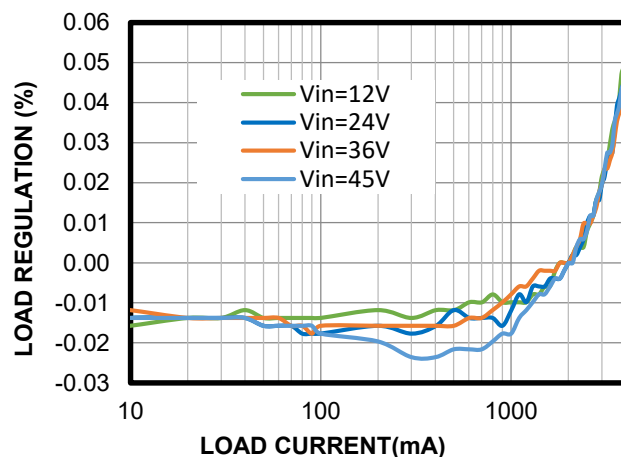
Load Regulation

$V_{OUT} = 5V$, AAM mode



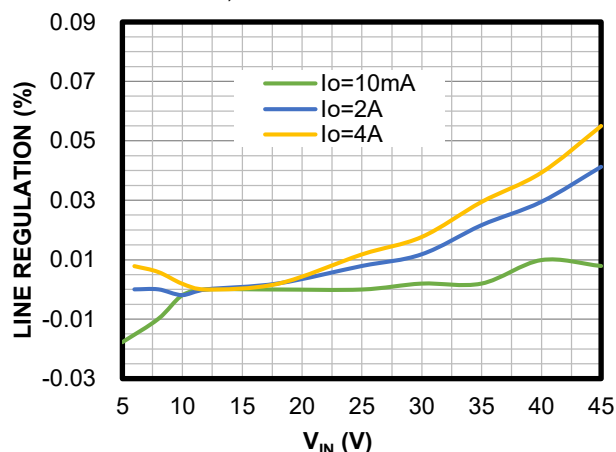
Load Regulation

$V_{OUT} = 5V$, FCCM



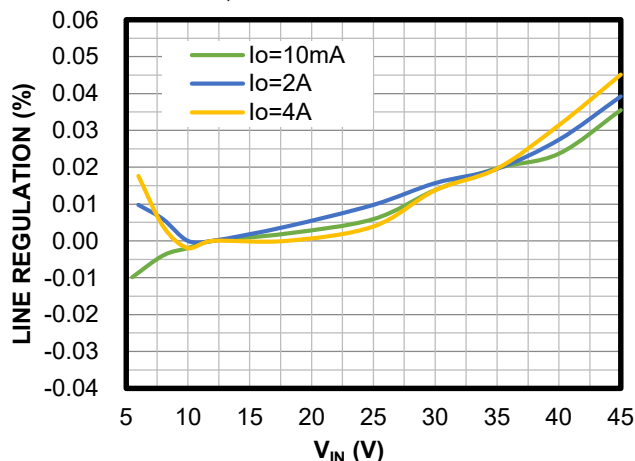
Line Regulation

$V_{OUT} = 5V$, AAM mode



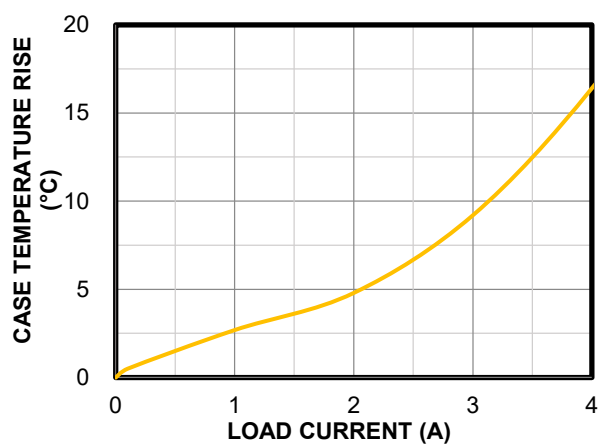
Line Regulation

$V_{OUT} = 5V$, FCCM



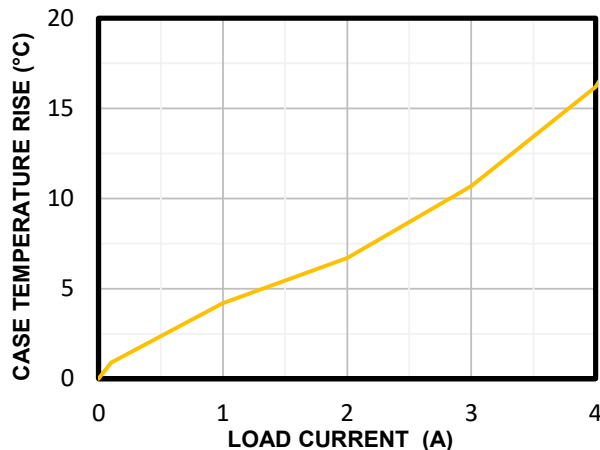
Case Temperature Rise

$V_{OUT} = 3.3V$



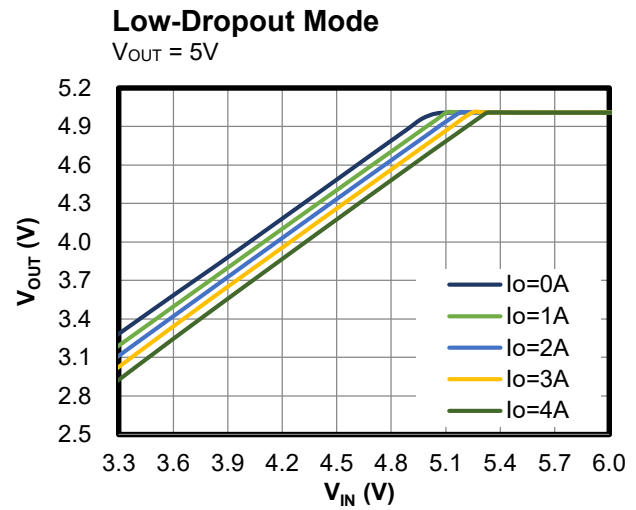
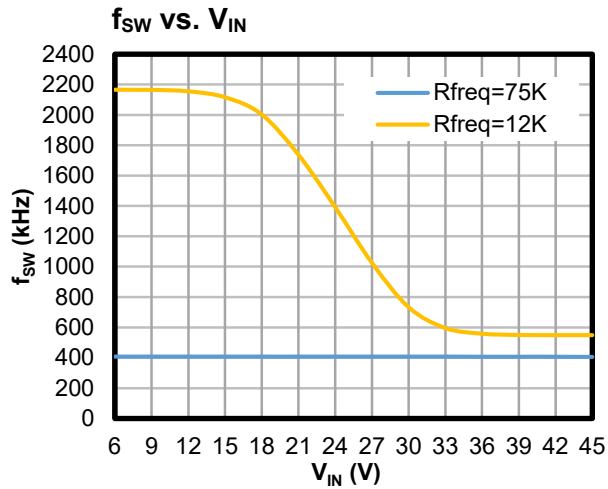
Case Temperature Rise

$V_{OUT} = 5V$



EVB TEST RESULTS *(continued)*

Performance curves and waveforms are tested on the evaluation board, $V_{IN} = 12V$, $V_{OUT} = 3.3V$, $C_{OUT} = 2 \times 47\mu F$, $L = 4.7\mu H$, $f_{SW} = 410kHz$, $T_A = 25^\circ C$, unless otherwise noted.

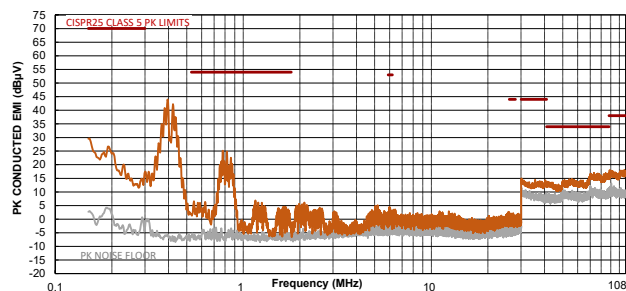


EVB TEST RESULTS (continued)

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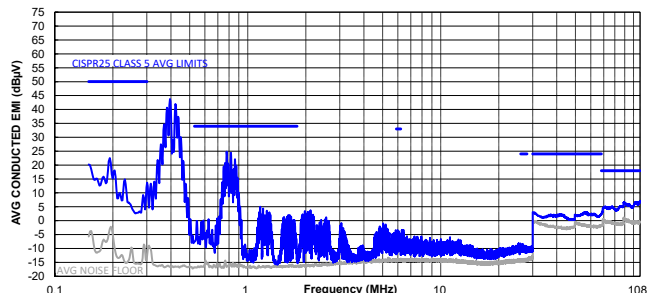
CISPR25 Class 5 Peak Conducted Emissions

150kHz to 108MHz



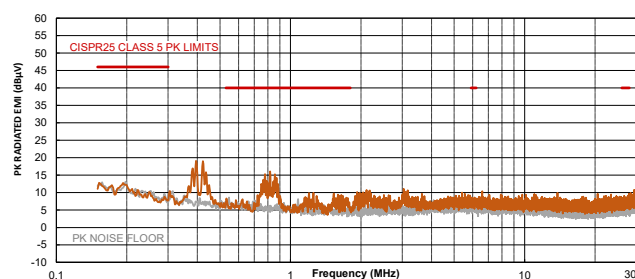
CISPR25 Class 5 Average Conducted Emissions

150kHz to 108MHz



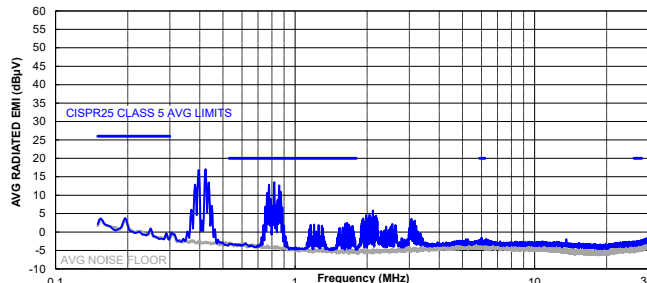
CISPR25 Class 5 Peak Radiated Emissions

150kHz to 30MHz



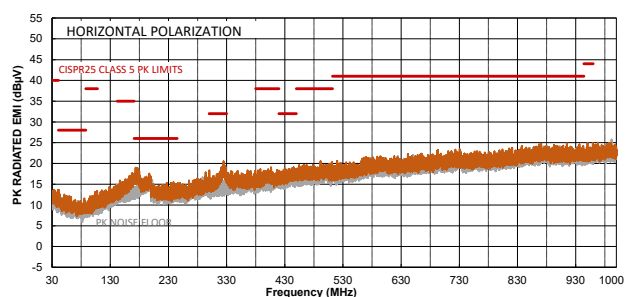
CISPR25 Class 5 Average Radiated Emissions

150kHz to 30MHz



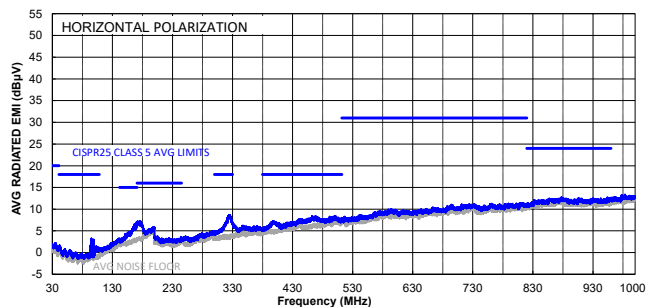
CISPR25 Class 5 Peak Radiated Emissions

Horizontal, 30MHz to 1GHz



CISPR25 Class 5 Average Radiated Emissions

Horizontal, 30MHz to 1GHz

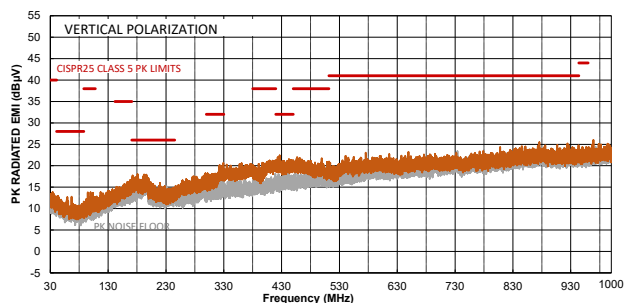


EVB TEST RESULTS *(continued)*

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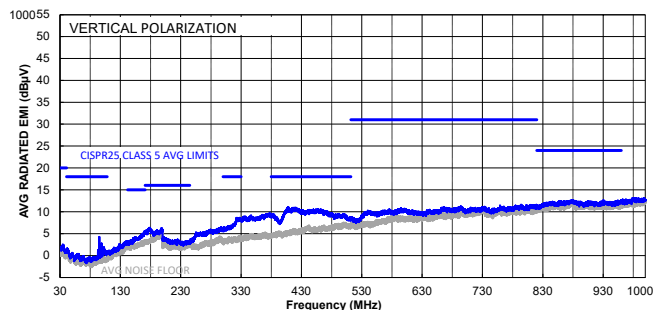
CISPR25 Class 5 Peak Radiated Emissions

Vertical, 30MHz to 1GHz



CISPR25 Class 5 Average Radiated Emissions

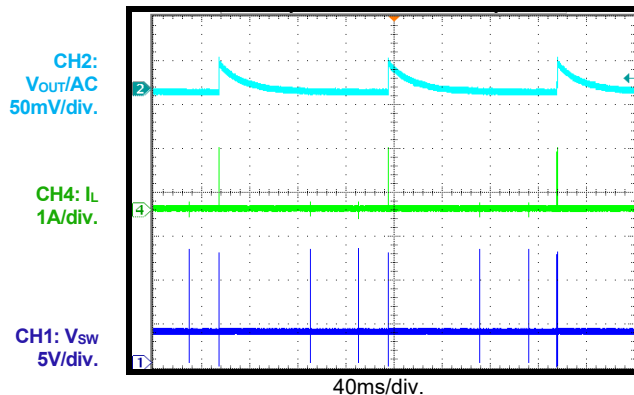
Vertical, 30MHz to 1GHz



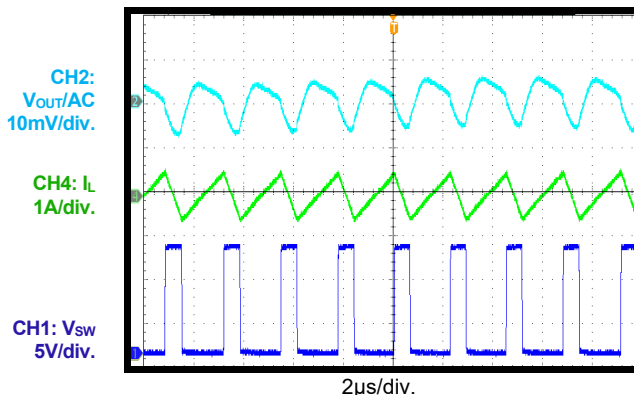
EVB TEST RESULTS (continued)

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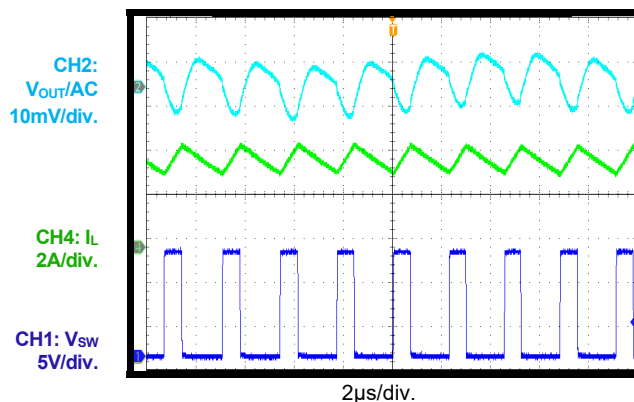
Steady State

 $I_{OUT} = 0A$, AAM mode


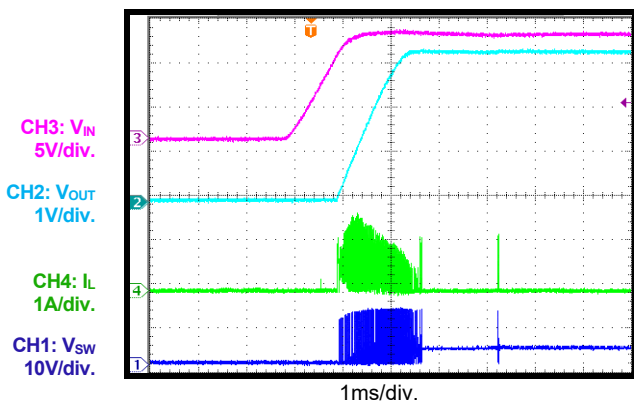
Steady State

 $I_{OUT} = 0A$, FCCM


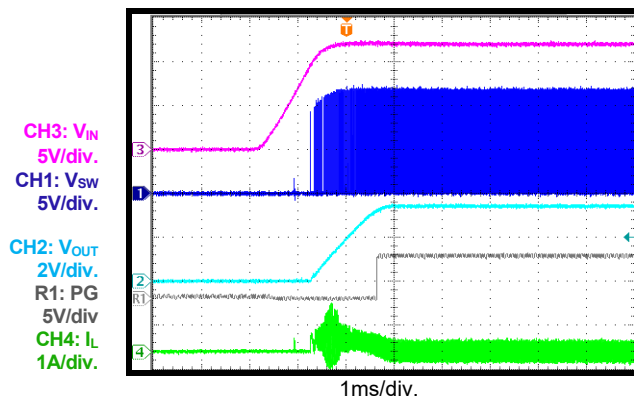
Steady State

 $I_{OUT} = 4A$


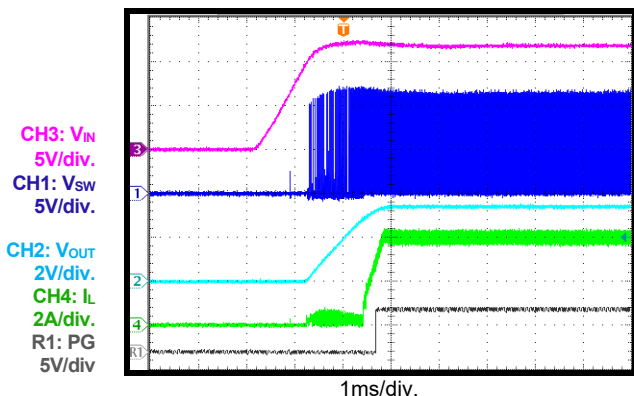
Start-Up through VIN

 $I_{OUT} = 0A$, AAM mode


Start-Up through VIN

 $I_{OUT} = 0A$, FCCM


Start-Up through VIN

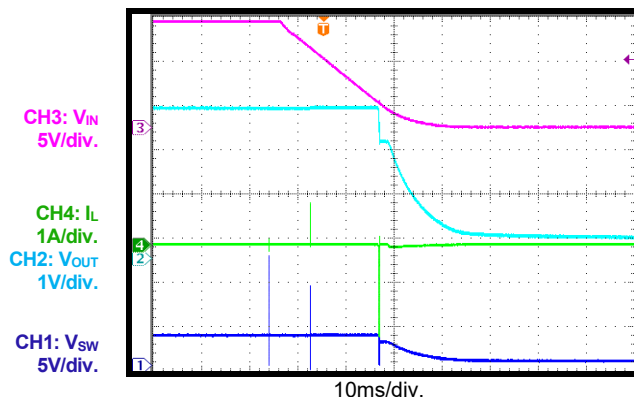
 $I_{OUT} = 4A$


EVB TEST RESULTS (continued)

Performance curves and waveforms are tested on the evaluation board, $V_{IN} = 12V$, $V_{OUT} = 3.3V$, $C_{OUT} = 2 \times 47\mu F$, $L = 4.7\mu H$, $f_{SW} = 410kHz$, $T_A = 25^\circ C$, unless otherwise noted.

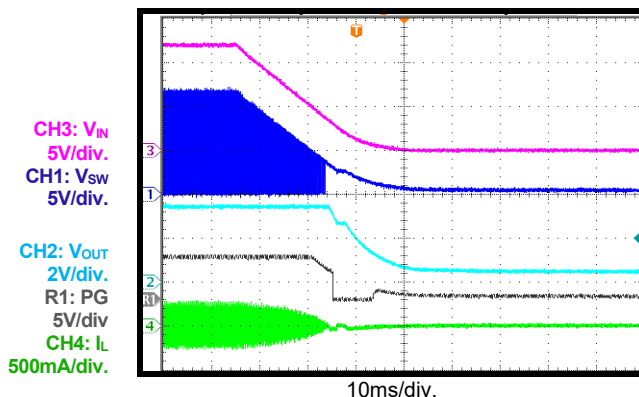
Shutdown through VIN

$I_{OUT} = 0A$, AAM mode



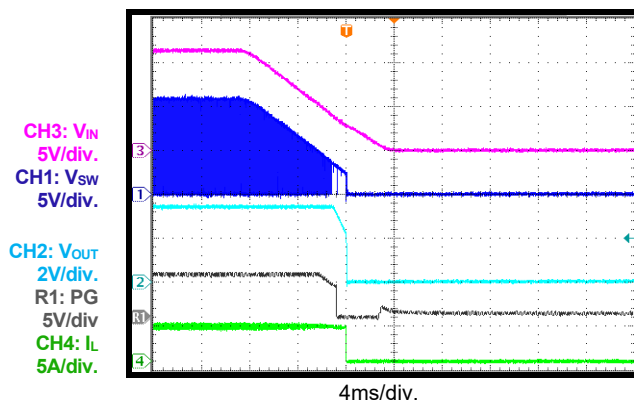
Shutdown through VIN

$I_{OUT} = 0A$, FCCM



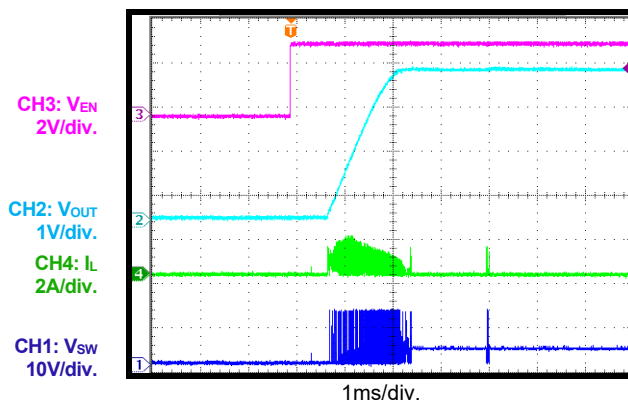
Shutdown through VIN

$I_{OUT} = 4A$



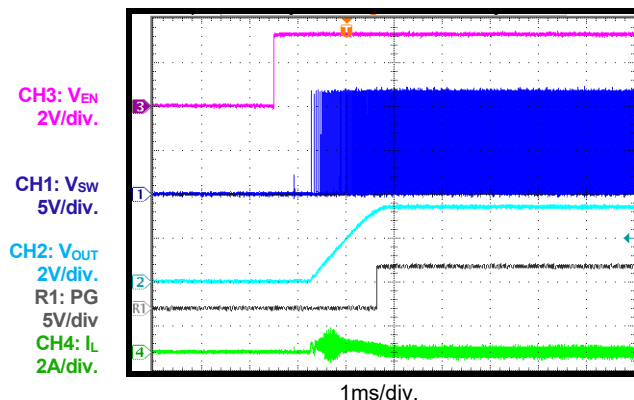
Start-Up through EN

$I_{OUT} = 0A$, AAM mode



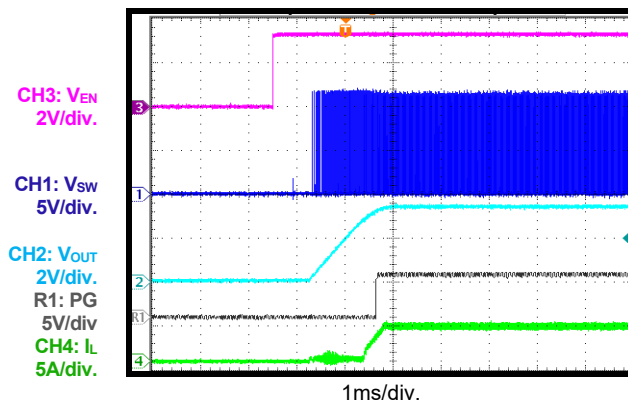
Start-Up through EN

$I_{OUT} = 0A$, FCCM



Start-Up through EN

$I_{OUT} = 4A$



EVB TEST RESULTS *(continued)*

Performance curves and waveforms are tested on the evaluation board, $V_{IN} = 12V$, $V_{OUT} = 3.3V$, $C_{OUT} = 2 \times 47\mu F$, $L = 4.7\mu H$, $f_{SW} = 410kHz$, $T_A = 25^\circ C$, unless otherwise noted.

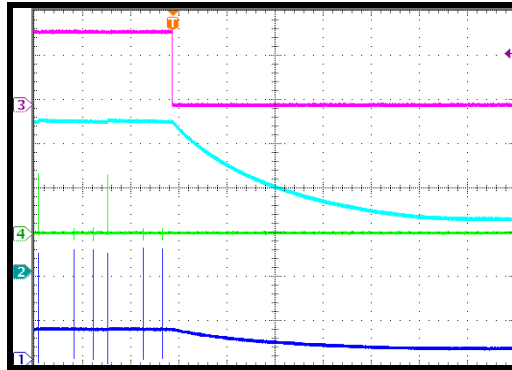
Shutdown through EN

 $I_{OUT} = 0A$, AAM mode

CH3: V_{EN}
2V/div.

CH4: I_L
1A/div.

CH2: V_{OUT}
1V/div.

CH1: V_{SW}
5V/div.


100ms/div.

Shutdown through EN

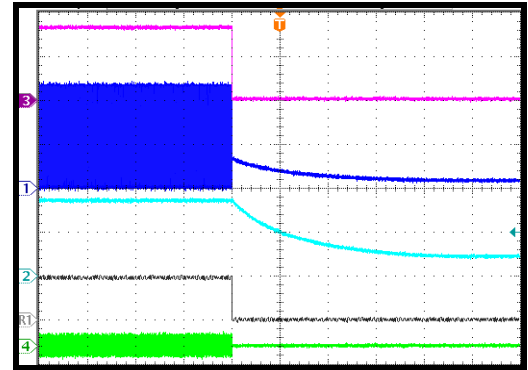
 $I_{OUT} = 0A$, FCCM

CH3: V_{EN}
2V/div.

CH1: V_{SW}
5V/div.

CH2: V_{OUT}
2V/div.

R1: PG
5V/div.

CH4: I_L
1A/div.


100ms/div.

Shutdown through EN

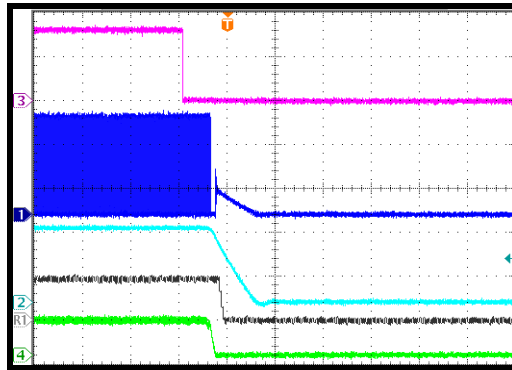
 $I_{OUT} = 4A$

CH3: V_{EN}
2V/div.

CH1: V_{SW}
5V/div.

CH2: V_{OUT}
2V/div.

R1: PG
5V/div.

CH4: I_L
5A/div.


100μs/div.

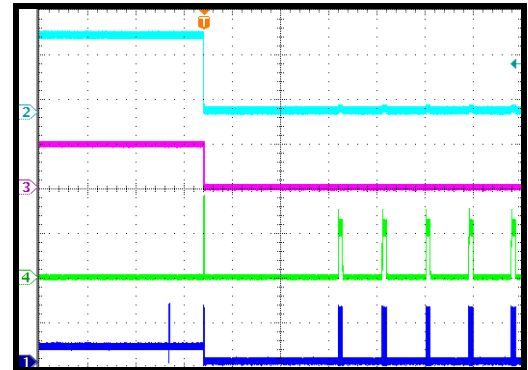
SCP Entry

 $I_{OUT} = 0A$, AAM mode

CH2: V_{OUT}
2V/div.

CH3: V_{PG}
5V/div.

CH4: I_L
10A/div.

CH1: V_{SW}
10V/div.


20ms/div.

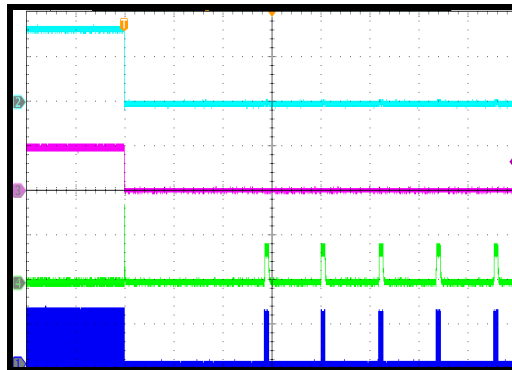
SCP Entry

 $I_{OUT} = 0A$, FCCM

CH2: V_{OUT}
2V/div.

CH3: V_{PG}
5V/div.

CH4: I_L
10A/div.

CH1: V_{SW}
10V/div.


20ms/div.

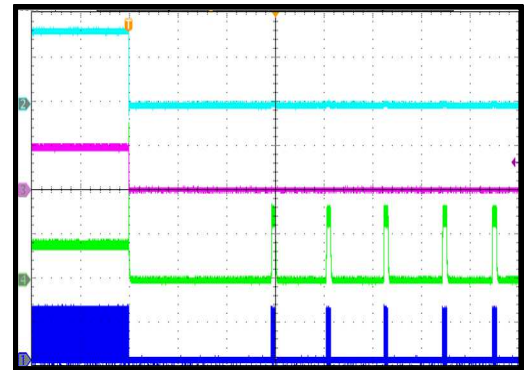
SCP Entry

 $I_{OUT} = 4A$

CH2: V_{OUT}
2V/div.

CH3: V_{PG}
5V/div.

CH4: I_L
5A/div.

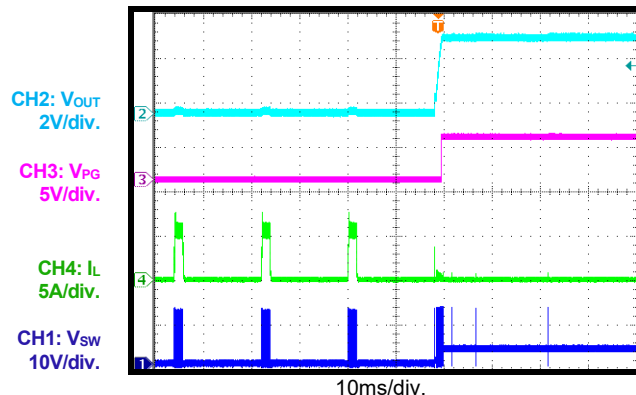
CH1: V_{SW}
10V/div.


20ms/div.

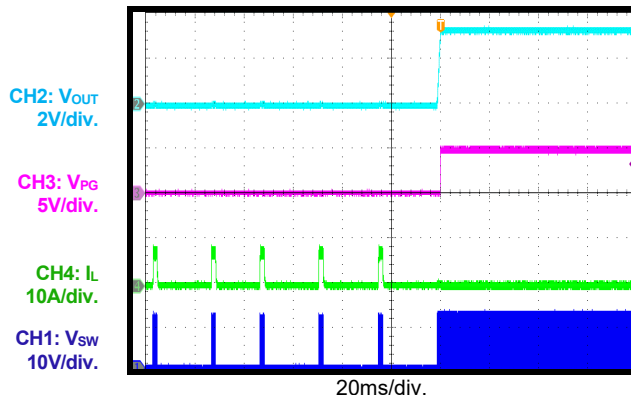
EVB TEST RESULTS (continued)

Performance curves and waveforms are tested on the evaluation board, $V_{IN} = 12V$, $V_{OUT} = 3.3V$, $C_{OUT} = 2 \times 47\mu F$, $L = 4.7\mu H$, $f_{SW} = 410kHz$, $T_A = 25^\circ C$, unless otherwise noted.

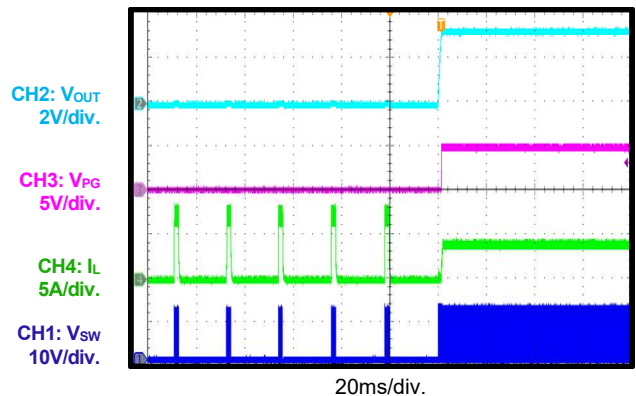
SCP Recovery

 $I_{OUT} = 0A$, AAM mode


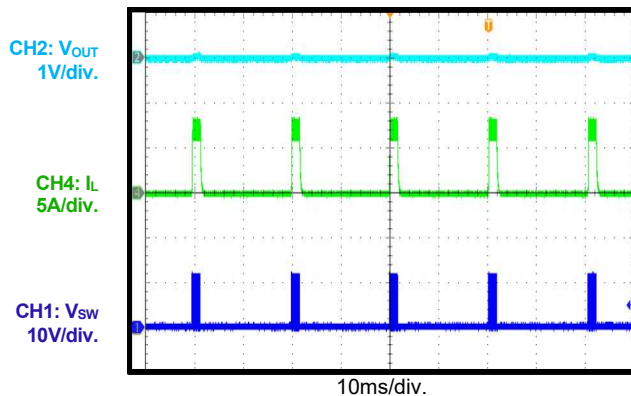
SCP Recovery

 $I_{OUT} = 0A$, FCCM


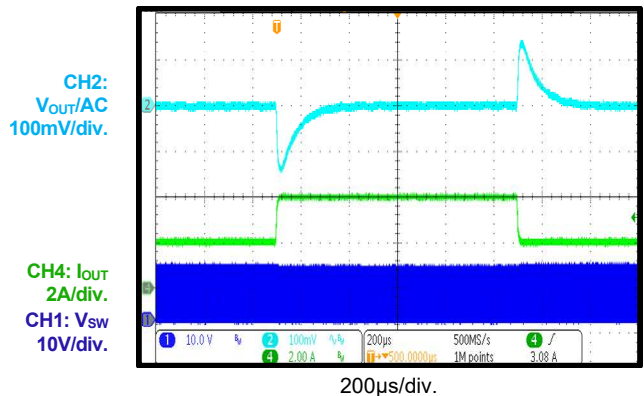
SCP Recovery

 $I_{OUT} = 4A$


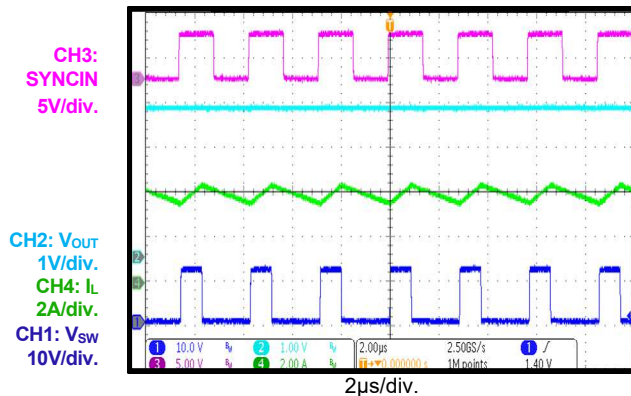
SCP Steady State



Load Transient

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


SYNC Operation

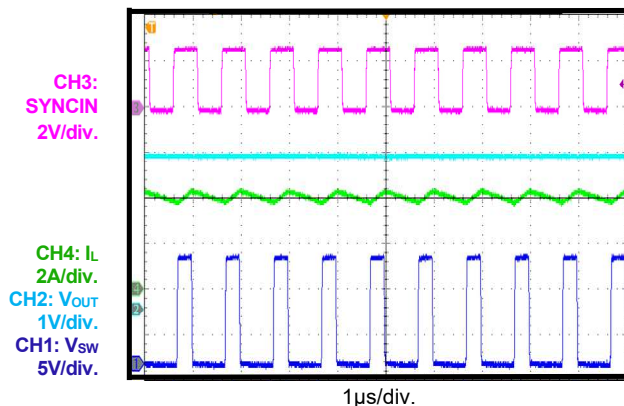
 $I_{OUT} = 4A$, SYNC frequency = 350kHz


EVB TEST RESULTS (continued)

Performance curves and waveforms are tested on the evaluation board, $V_{IN} = 12V$, $V_{OUT} = 3.3V$, $C_{OUT} = 2 \times 47\mu F$, $L = 4.7\mu H$, $f_{SW} = 410kHz$, $T_A = 25^\circ C$, unless otherwise noted.

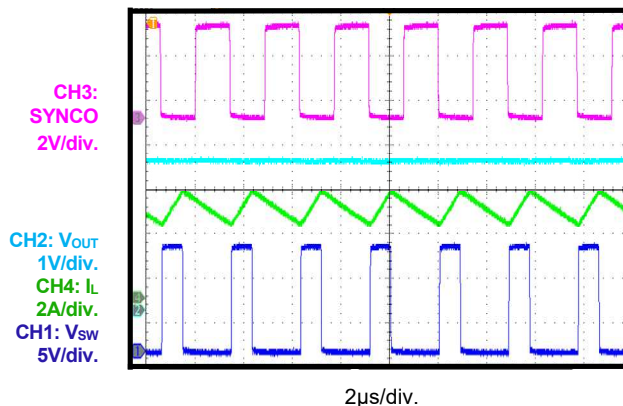
SYNC Operation

$I_{OUT} = 4A$, SYNC frequency = 1000kHz



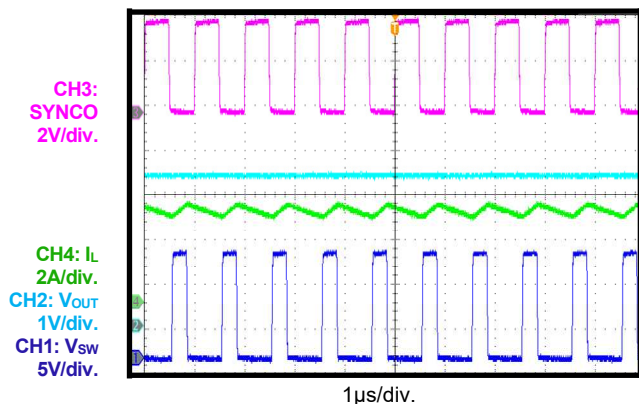
SYNCO Operation

$I_{OUT} = 4A$, SYNC frequency = 350kHz



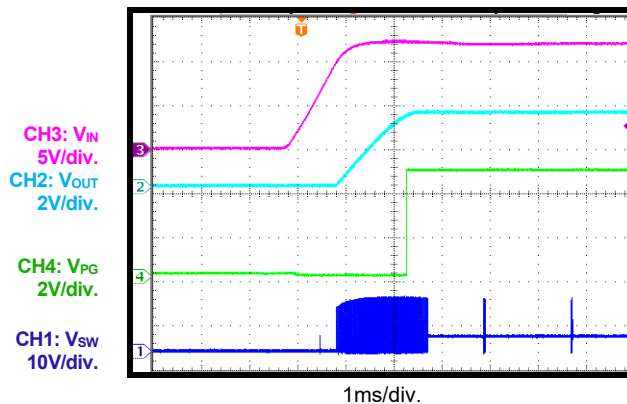
SYNCO Operation

$I_{OUT} = 4A$, SYNC frequency = 1000kHz



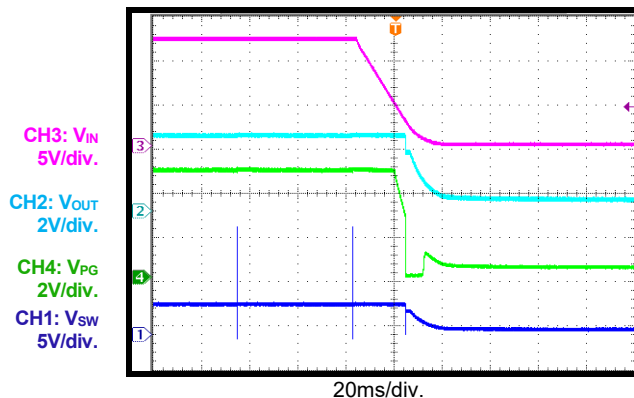
PG in Start-Up through VIN

$I_{OUT} = 0A$, AAM mode



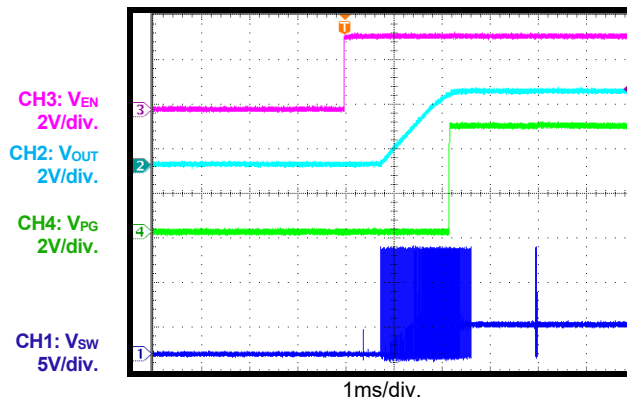
PG in Shutdown through VIN

$I_{OUT} = 0A$, AAM mode



PG in Start-Up through EN

$I_{OUT} = 0A$, AAM mode

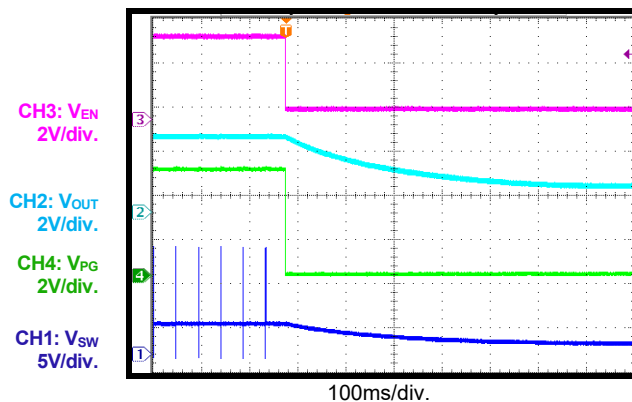


EVB TEST RESULTS (continued)

Performance curves and waveforms are tested on the evaluation board, $V_{IN} = 12V$, $V_{OUT} = 3.3V$, $C_{OUT} = 2 \times 47\mu F$, $L = 4.7\mu H$, $f_{SW} = 410kHz$, $T_A = 25^\circ C$, unless otherwise noted.

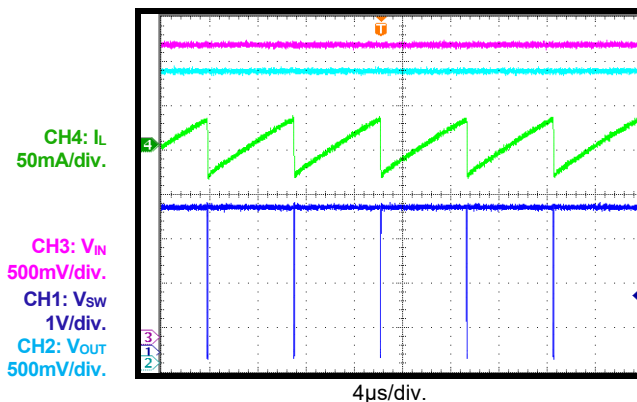
PG in Shutdown through EN

$I_{OUT} = 0A$, AAM mode



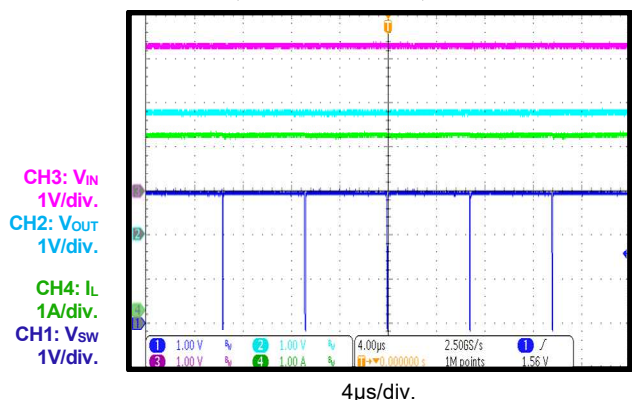
Low-Dropout Mode

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



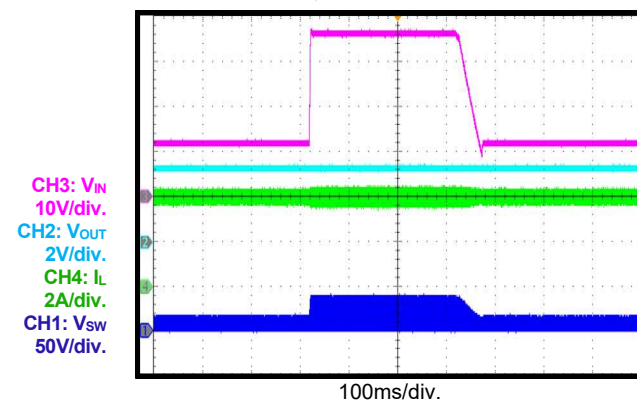
Low-Dropout Mode

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



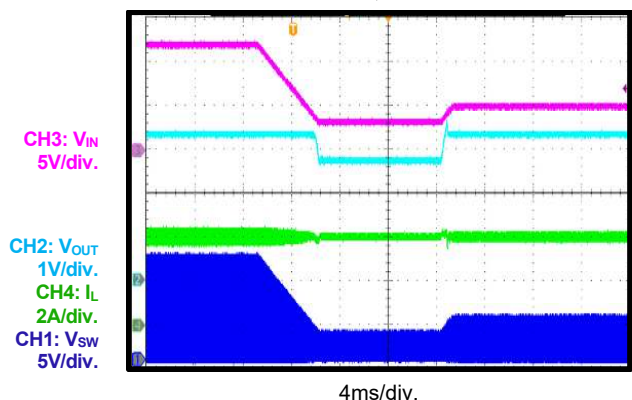
Load Dump

$V_{IN} = 12V$ to 36V, $I_{OUT} = 4A$



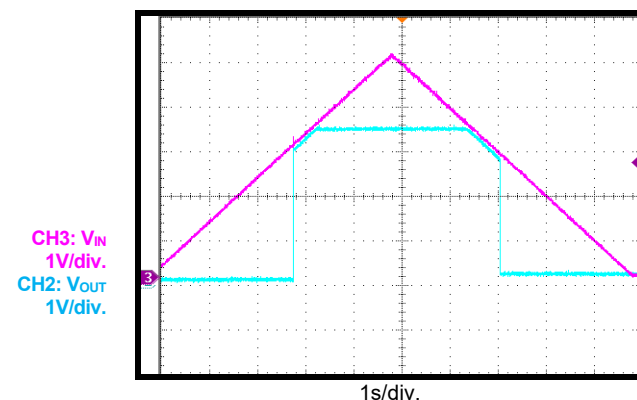
Cold Crank

$V_{IN} = 12V$ to 3.3V to 5V, $I_{OUT} = 4A$



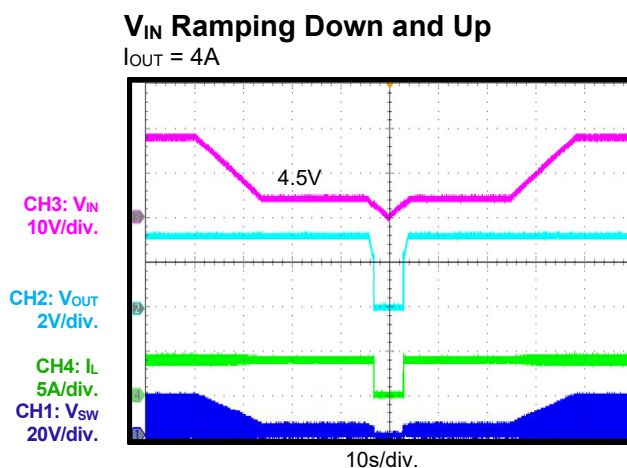
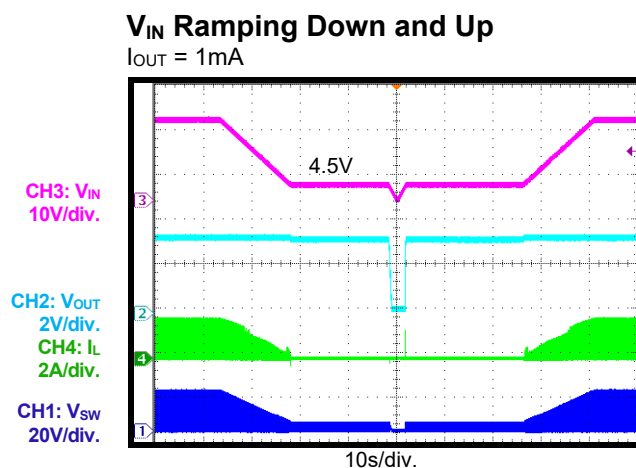
V_{IN} Ramping Up and Down

$I_{OUT} = 0.1A$



EVB TEST RESULTS *(continued)*

Performance curves and waveforms are tested on the evaluation board, $V_{IN} = 12V$, $V_{OUT} = 3.3V$, $C_{OUT} = 2 \times 47\mu F$, $L = 4.7\mu H$, $f_{SW} = 410kHz$, $T_A = 25^\circ C$, unless otherwise noted.



PCB LAYOUT (2)

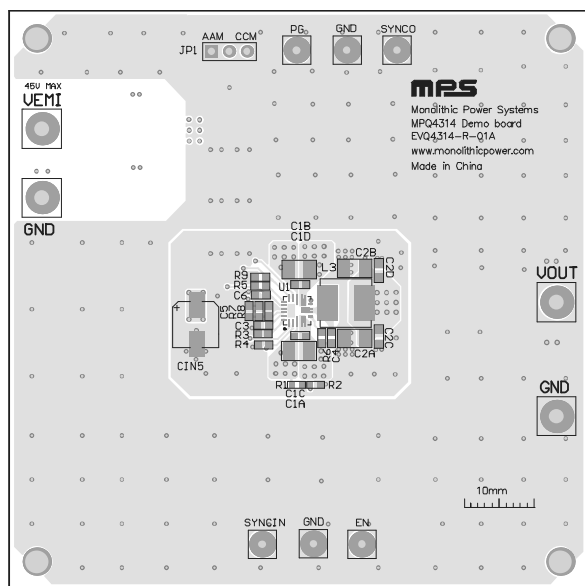


Figure 4: Top Silk and Top Layer

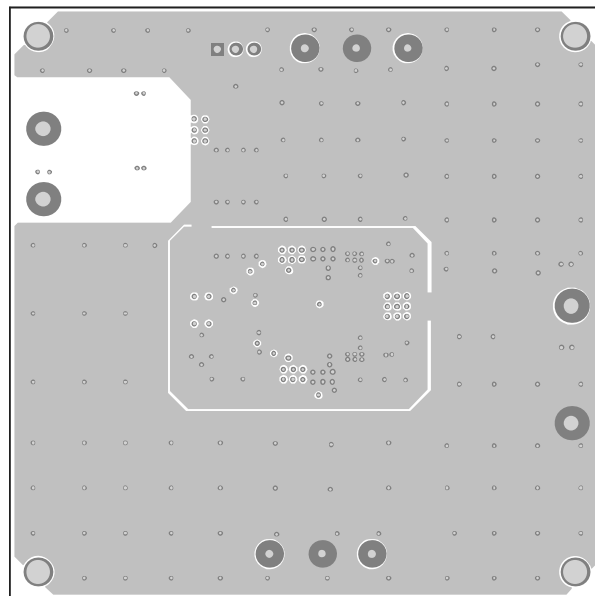


Figure 5: Mid-Layer 1

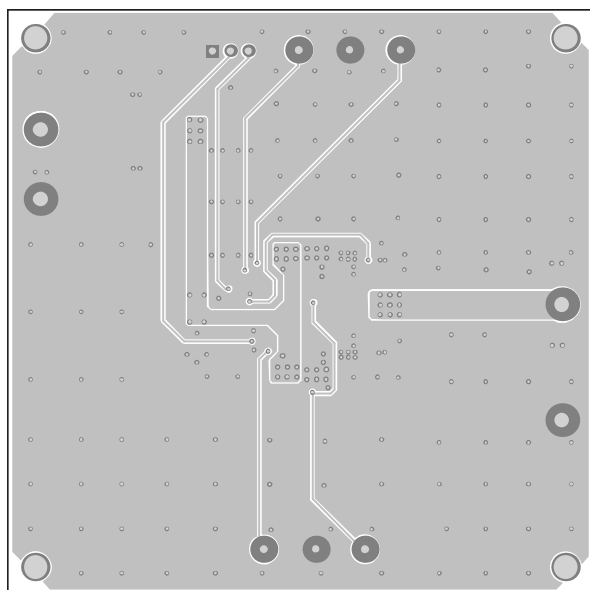


Figure 6: Mid-Layer 2

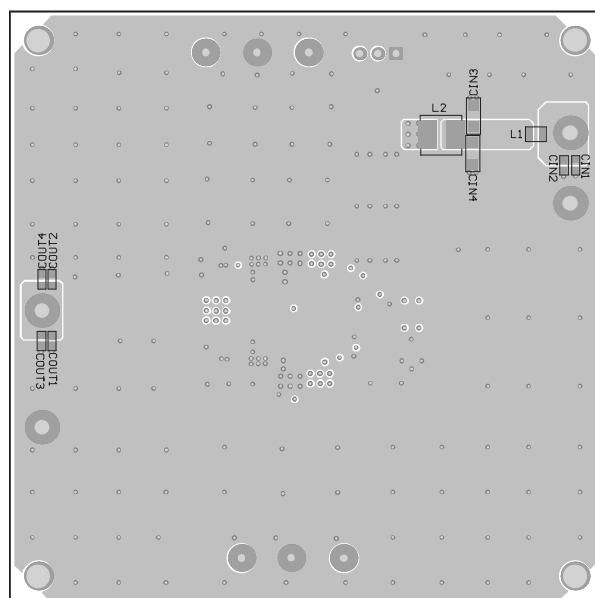


Figure 7: Bottom Layer and Bottom Silk

Note:

- 2) The copper thickness is 2oz.

REVISION HISTORY

Revision #	Revision Date	Description	Pages Updated
1.0	3/21/2022	Initial Release	-

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