



EVQ4313-R-01A

45V, 3A, Low- I_Q , Synchronous Step-Down Converter with Frequency Spread Spectrum Evaluation Board, AEC-Q100 Qualified

DESCRIPTION

The EVQ4313-R-01A evaluation board is designed to demonstrate the capabilities of the MPQ4313, a synchronous, step-down switching regulator with a configurable frequency and an integrated, internal high-side MOSFET (HS-FET) and low-side MOSFET (LS-FET). It provides up to 3A 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 (I_L) runaway during start-up. Thermal shutdown provides reliable, fault-tolerant operation. High-duty cycle and low-dropout mode are provided for automotive cold crank conditions.

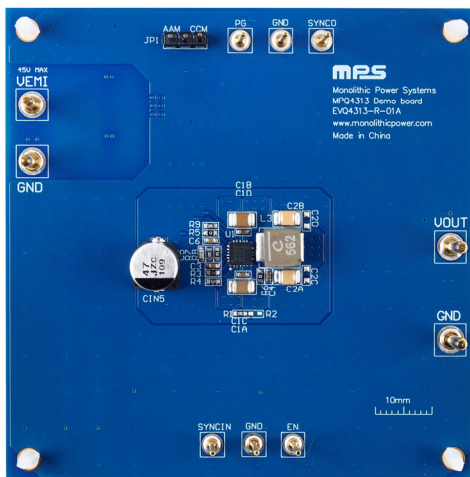
The EVQ4313-R-01A is fully assembled and tested. The MPQ4313 is available in a QFN-20 (4mmx4mm) package with wettable flank, and is AEC-Q100 Grade 1 qualified.

PERFORMANCE SUMMARY

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

Parameter	Condition	Value
Input voltage (V_{IN}) range		3.3V to 45V
Output voltage (V_{OUT})	$V_{IN} = 3.3\text{V to } 45\text{V}$, $I_{OUT} = 0\text{A to } 3\text{A}$	3.3V
Maximum output current (I_{OUT})	$V_{IN} = 3.3\text{V to } 45\text{V}$	3A
Typical efficiency	$V_{IN} = 12\text{V}$, $V_{OUT} = 3.3\text{V}$, $I_{OUT} = 3\text{A}$	94.2%
Switching frequency (f_{SW})		410kHz

EVQ4313-R-01A EVALUATION BOARD



LxWxH (8.3cmx8.3cmx1.3cm)

Board Number	MPS IC Number
EVQ4313-R-01A	MPQ4313GRE-AEC1

QUICK START GUIDE

1. Preset the power supply (V_{IN}) between 3.3V and 45V, then turn off the power supply. Electronic loads represent a negative impedance to the regulator, setting a current too high can trigger hiccup mode.
2. If longer cables (>0.5m total) are used between the source and the evaluation board, install a damping capacitor at the input terminals, especially when $V_{IN} \geq 24V$.
3. Connect the power supply terminals to:
 - a. Positive (+): VEMI
 - b. Negative (-): GND
4. Connect the load terminals to:
 - 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 on the regulator; drive EN below 0.85V to turn off the regulator.
7. The MPQ4313's switching frequency (f_{SW}) can be configured by R3, the FREQ pin's resistor (R_{FREQ}). R3 can be estimated based on the relationship between f_{SW} and R_{FREQ} (see Figure 1).

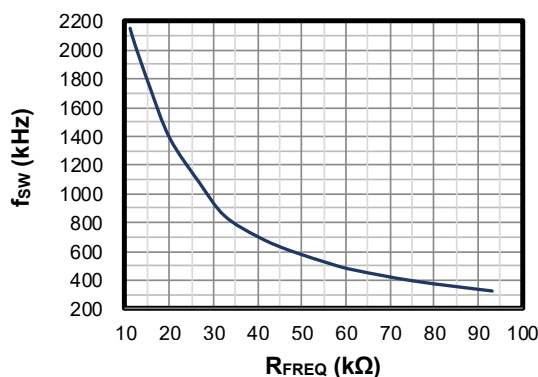


Figure 1: f_{SW} vs. R_{FREQ}

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 $R7 = 100k\Omega$, then $R8$ can be calculated using Equation (1):

$$R8 = \frac{R7}{\frac{V_{OUT}}{0.815V} - 1} \quad (1)$$

Table 1 shows the recommended R7 and R8 values for common output voltages.

Table 1: Resistor Selection for Output Voltages

V_{OUT} (V)	R7 (k Ω)	R8 (k Ω)
3.3	100 (1%)	32.4 (1%)
5	100 (1%)	19.1 (1%)

Figure 2 shows the measurement equipment set-up.

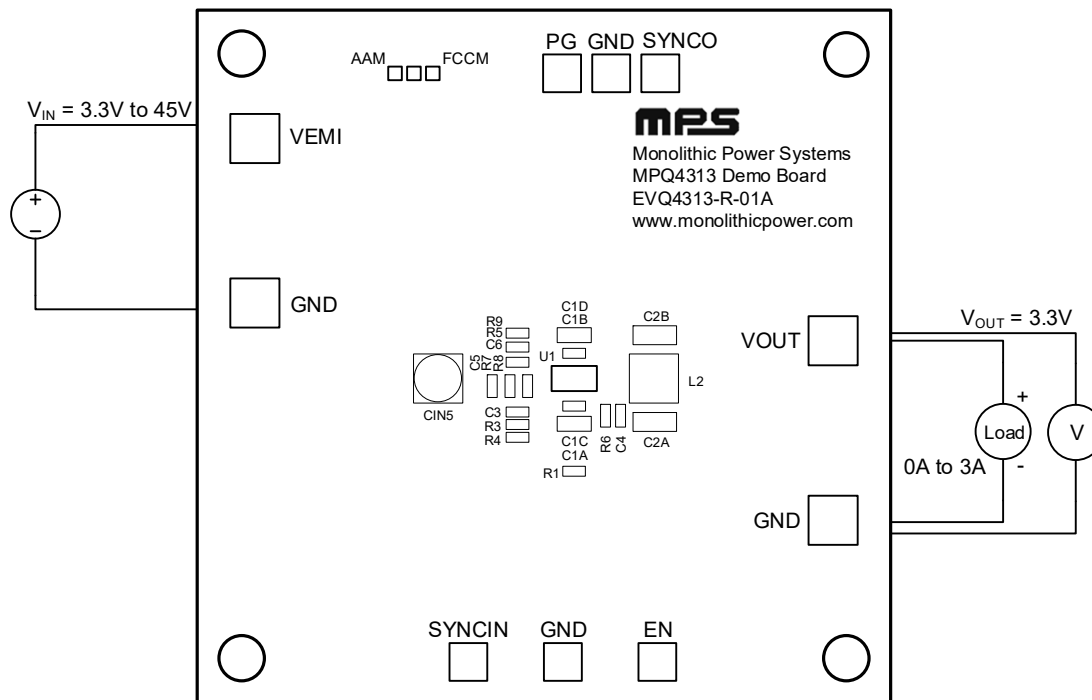


Figure 2: Measurement Equipment Set-Up

EVALUATION BOARD SCHEMATIC

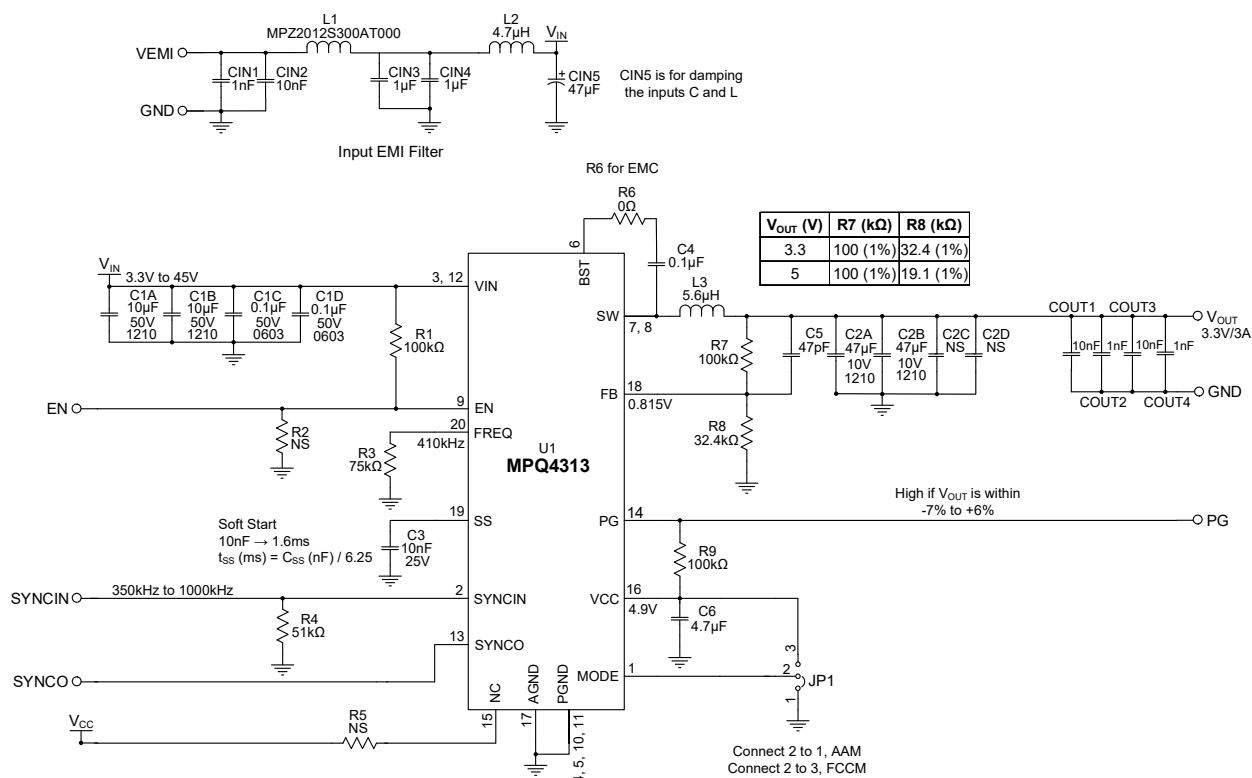
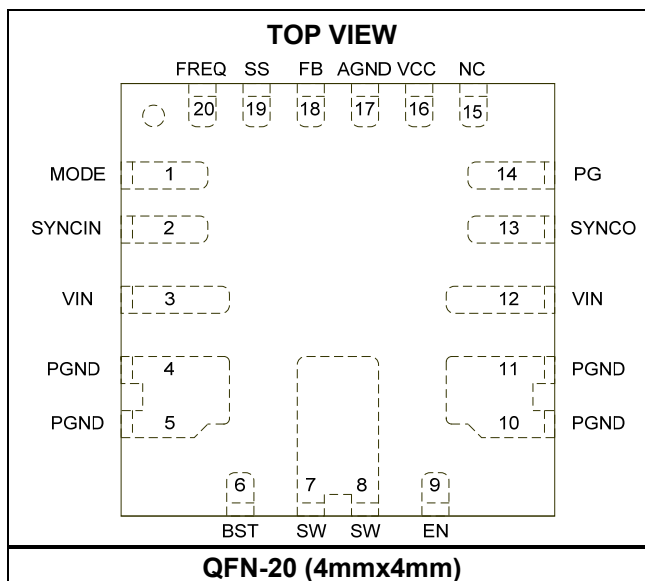


Figure 3: Evaluation Board Schematic

PACKAGE REFERENCE



EVQ4313-R-01A BILL OF MATERIALS

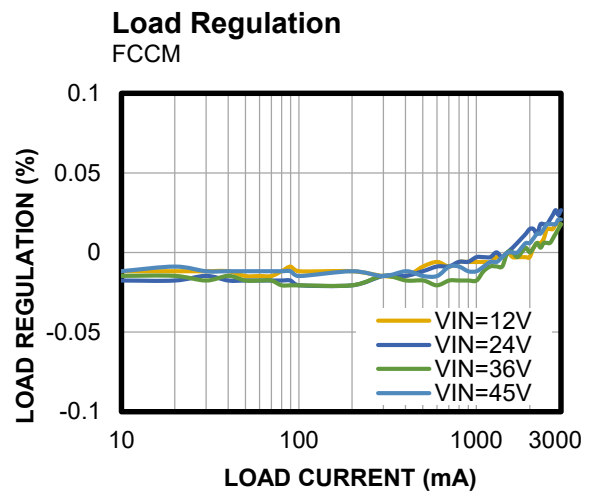
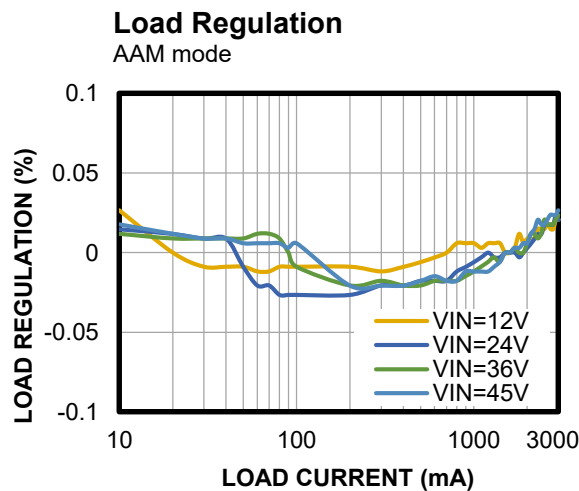
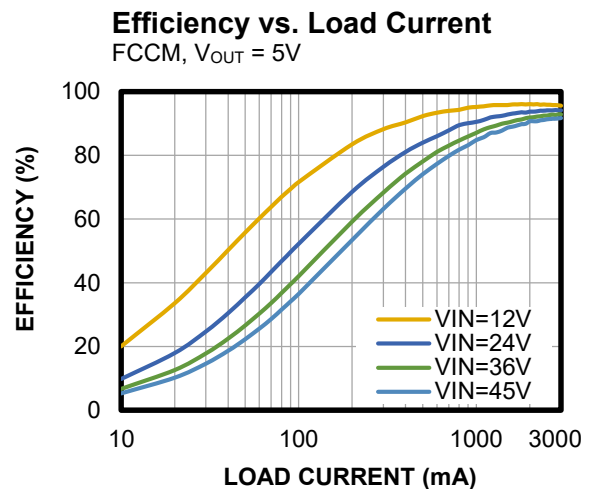
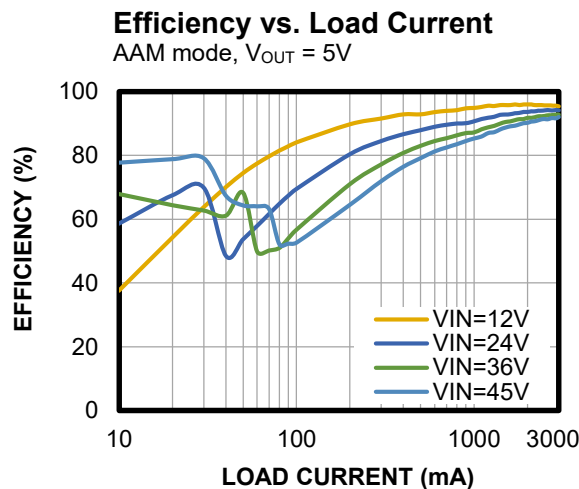
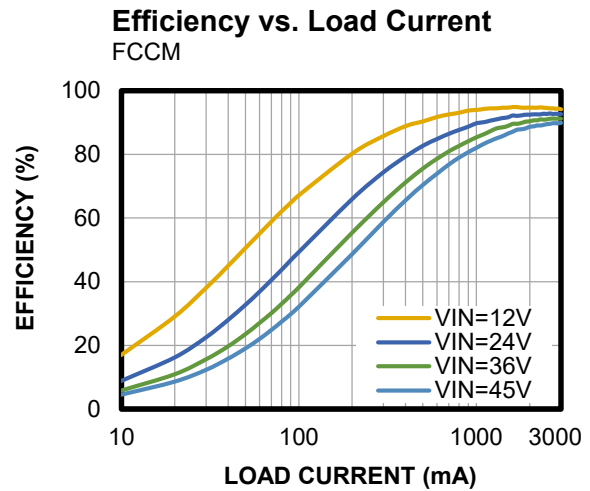
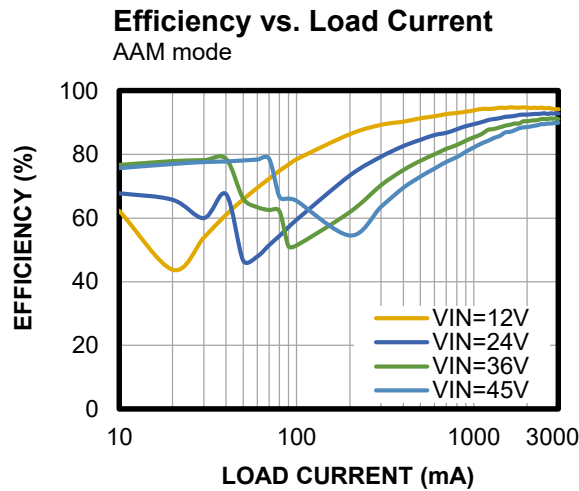
Qty	Ref	Value	Description	Package	Manufacturer	Manufacturer PN
3	CIN1, COUT2, COUT4	1nF	Ceramic capacitor, 50V, X7R	0603	Murata	GRM216R71H102KA01
3	CIN2, COUT1, COUT3	10nF	Ceramic capacitor, 50V, X7R	0603	Murata	GRM188R71H103KA01D
2	CIN3, CIN4	1μF	Ceramic capacitor, 50V, X7R	1206	TDK	C3216X7R1H105K
1	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	10nF	Ceramic capacitor, 25V, X7R	0603	Murata	GRM188R71E103KA01D
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	30mΩ	Magnetic bead, 6A	0805	TDK	MPZ2012S300AT000
1	L2	4.7μH	Inductor, 31.5mΩ, 6A	SMD	Cyntec	VCMT063T-4R7MN5T
1	L3	5.6μH	Inductor, 14.5mΩ, 9.9A	SMD	Coilcraft	XAL6060-562MEC
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 pin	DIP	Custom ⁽¹⁾	
7	SYNCIN, ICS, PG, SYNCO, EN, GND, GND	1mm	Golden pin	DIP	Custom ⁽¹⁾	
1	U1	MPQ4313	45V, 3A, step-down converter, AEC-Q100	QFN-20 (4mmx4mm)	MPS	MPQ4313GRE-AEC1

Note:

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

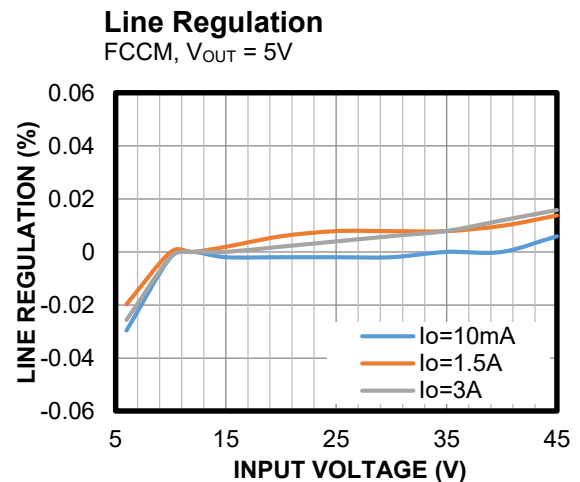
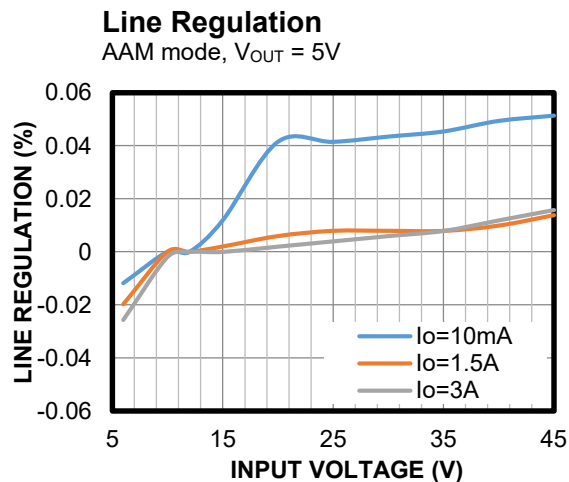
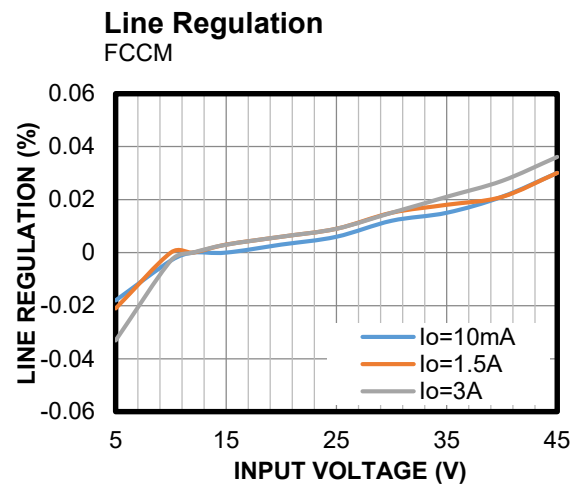
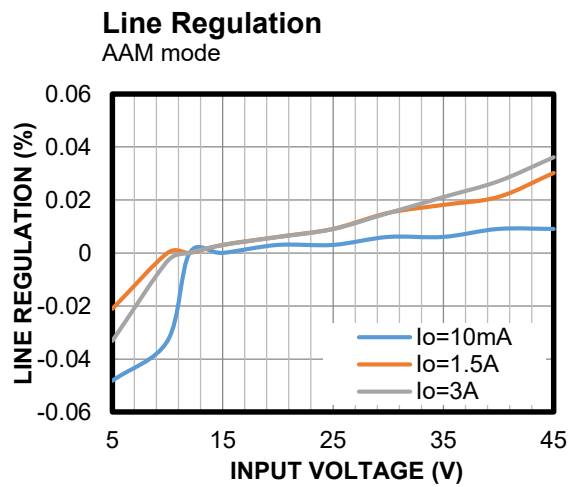
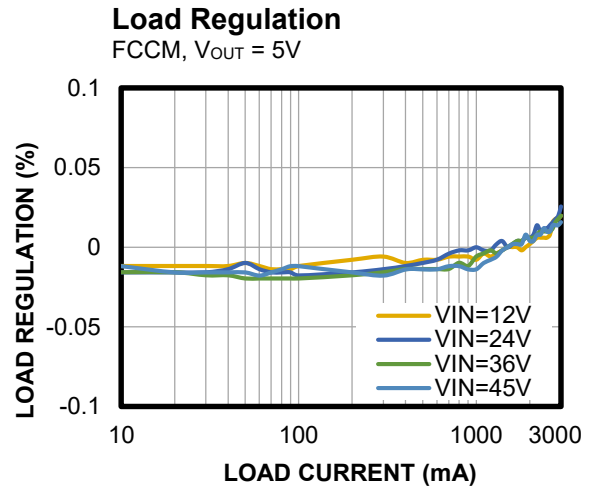
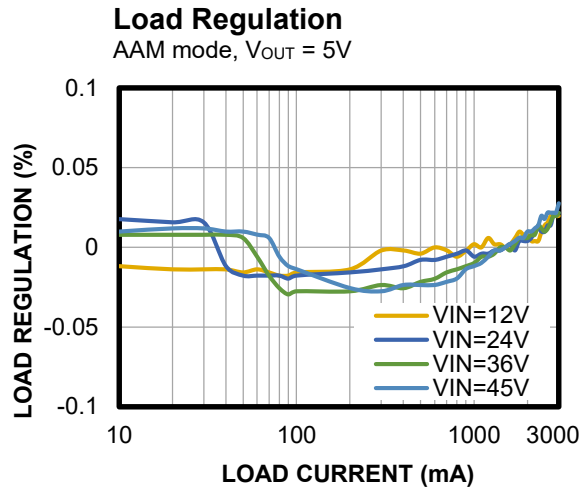
EVB TEST RESULTS

Performance curves and waveforms are tested on the evaluation board, $V_{IN} = 12V$, $V_{OUT} = 3.3V$, $C_{OUT} = 2 \times 47\mu F$, $L = 5.6\mu H$, $f_{SW} = 410kHz$, $T_A = 25^\circ C$, unless otherwise noted.



EVB TEST RESULTS *(continued)*

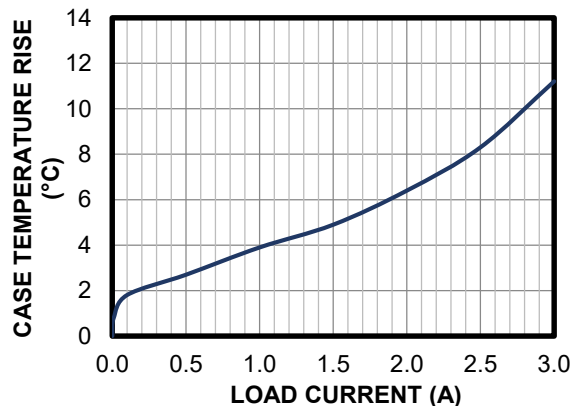
Performance curves and waveforms are tested on the evaluation board, $V_{IN} = 12V$, $V_{OUT} = 3.3V$, $C_{OUT} = 2 \times 47\mu F$, $L = 5.6\mu H$, $f_{SW} = 410kHz$, $T_A = 25^\circ C$, unless otherwise noted.



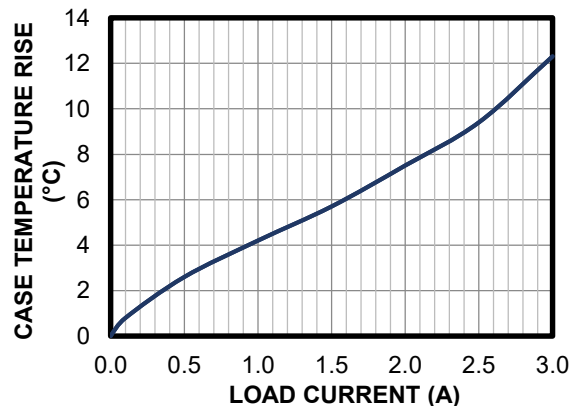
EVB TEST RESULTS *(continued)*

Performance curves and waveforms are tested on the evaluation board, $V_{IN} = 12V$, $V_{OUT} = 3.3V$, $C_{OUT} = 2 \times 47\mu F$, $L = 5.6\mu H$, $f_{SW} = 410kHz$, $T_A = 25^\circ C$, unless otherwise noted.

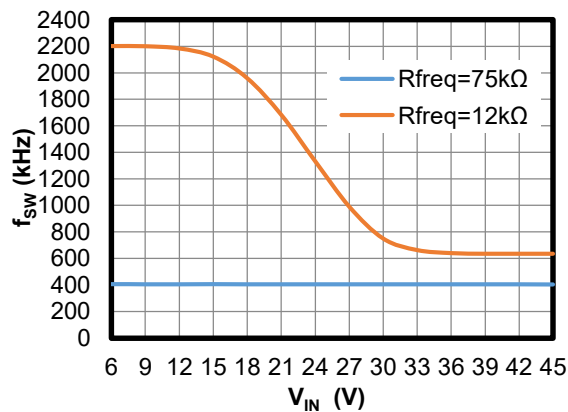
Case Temperature Rise

 $V_{OUT} = 3.3V$


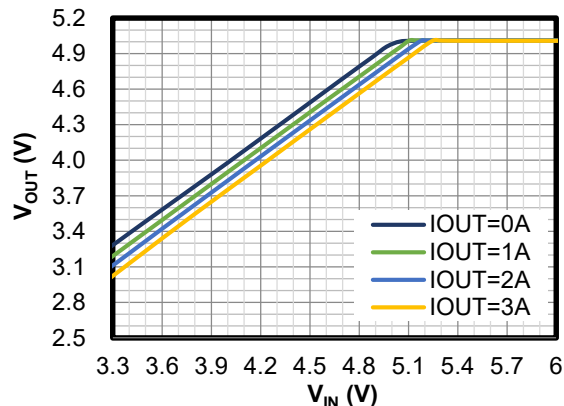
Case Temperature Rise

 $V_{OUT} = 5V$


f_{SW} vs. V_{IN}



Low-Dropout Mode

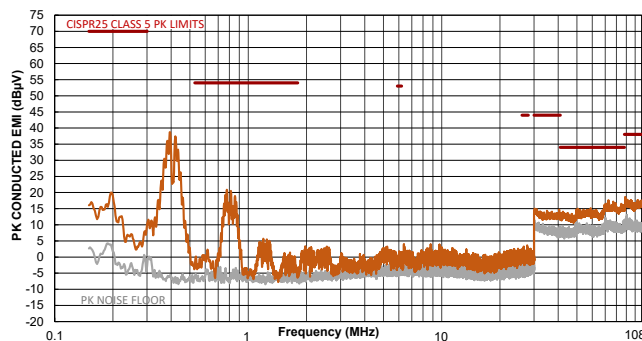
 $V_{OUT} = 5V$


EVB TEST RESULTS (continued)

Performance curves and waveforms are tested on the evaluation board, $V_{IN} = 12V$, $V_{OUT} = 3.3V$, $C_{OUT} = 2 \times 47\mu F$, $L = 5.6\mu H$, $f_{SW} = 410kHz$, $T_A = 25^\circ C$, unless otherwise noted.

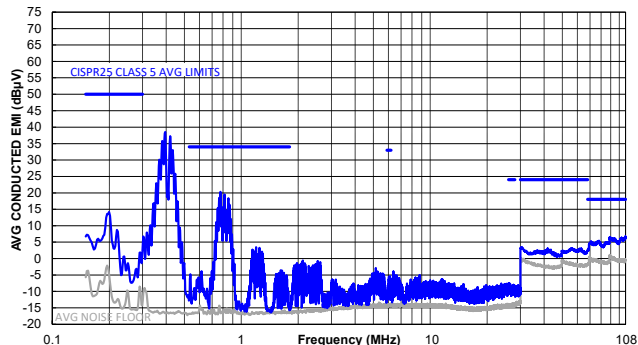
CISPR25 Class 5 Peak Conducted Emissions

150kHz to 108MHz



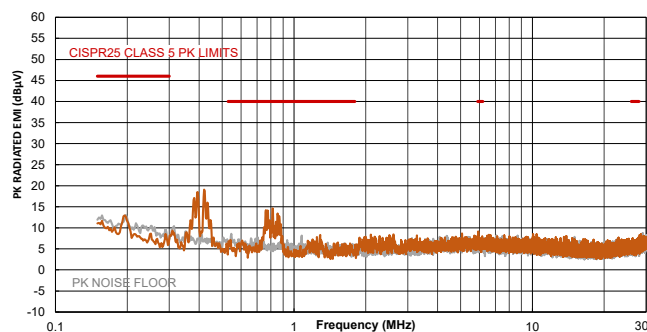
CISPR25 Class 5 Average Conducted Emissions

150kHz to 108MHz



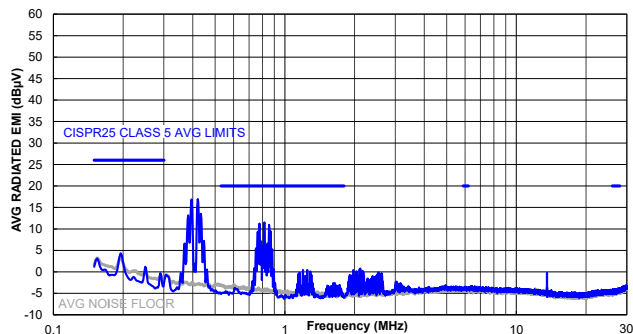
CISPR25 Class 5 Peak Radiated Emissions

150kHz to 30MHz



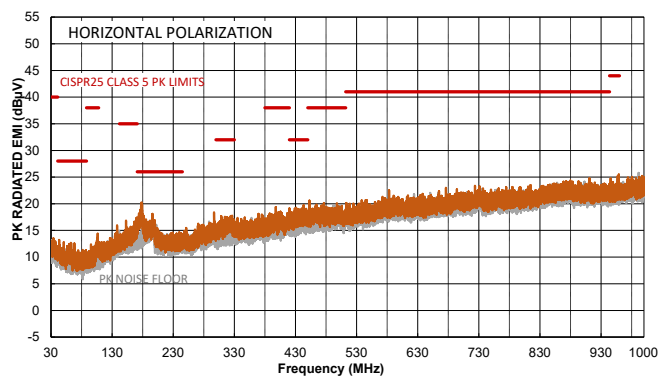
CISPR25 Class 5 Average Radiated Emissions

150kHz to 30MHz



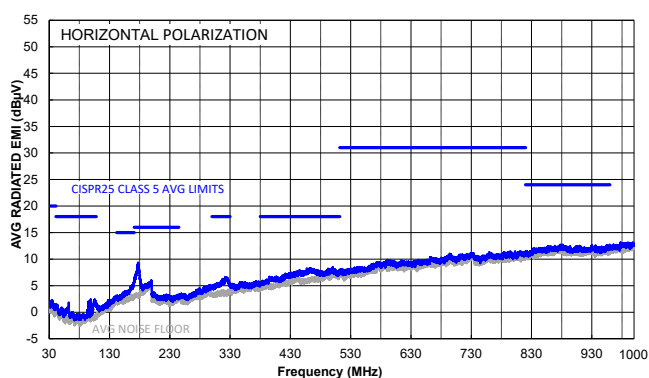
CISPR25 Class 5 Peak Radiated Emissions

Horizontal, 30MHz to 1GHz



CISPR25 Class 5 Average Radiated Emissions

Horizontal, 30MHz to 1GHz

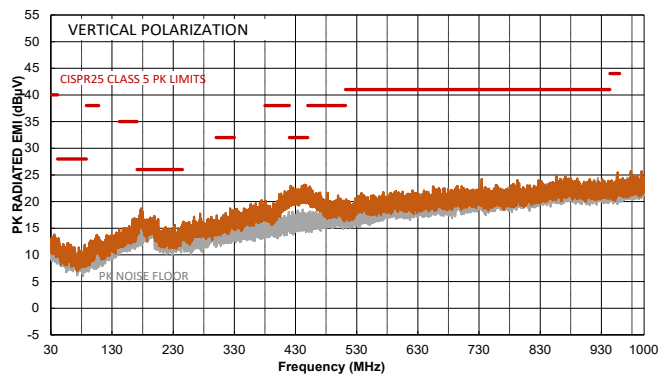


EVB TEST RESULTS *(continued)*

Performance curves and waveforms are tested on the evaluation board, $V_{IN} = 12V$, $V_{OUT} = 3.3V$, $C_{OUT} = 2 \times 47\mu F$, $L = 5.6\mu H$, $f_{SW} = 410kHz$, $T_A = 25^\circ C$, unless otherwise noted.

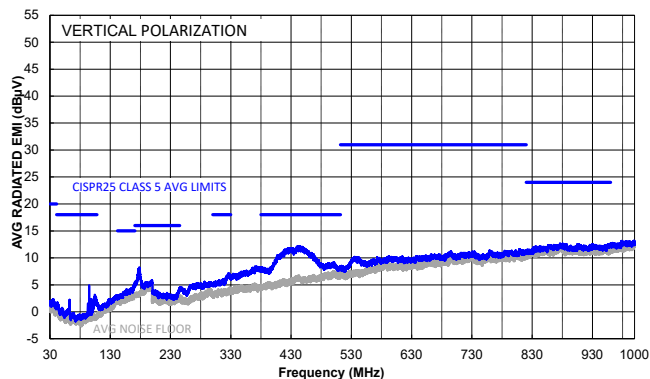
CISPR25 Class 5 Peak Radiated Emissions

Vertical, 30MHz to 1GHz



CISPR25 Class 5 Average Radiated Emissions

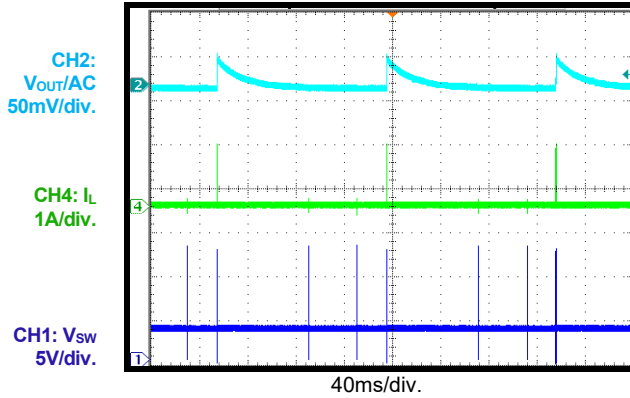
Vertical, 30MHz to 1GHz



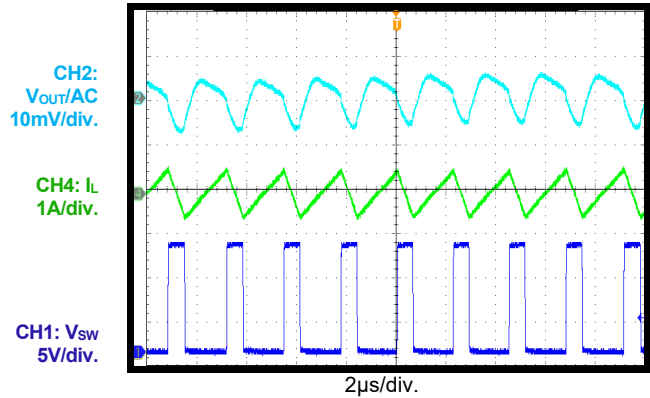
EVB TEST RESULTS *(continued)*

Performance curves and waveforms are tested on the evaluation board, $V_{IN} = 12V$, $V_{OUT} = 3.3V$, $C_{OUT} = 2 \times 47\mu F$, $L = 5.6\mu H$, $f_{SW} = 410kHz$, $T_A = 25^\circ C$, unless otherwise noted.

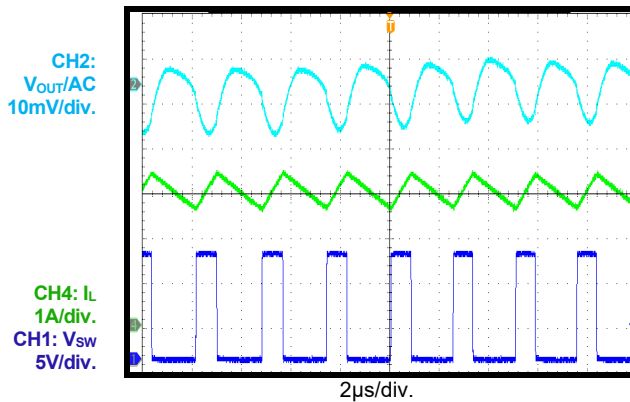
Steady State

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


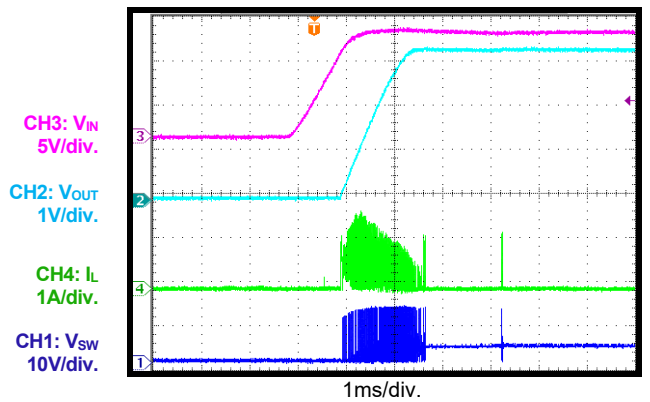
Steady State

 $I_{OUT} = 0A$, FCCM


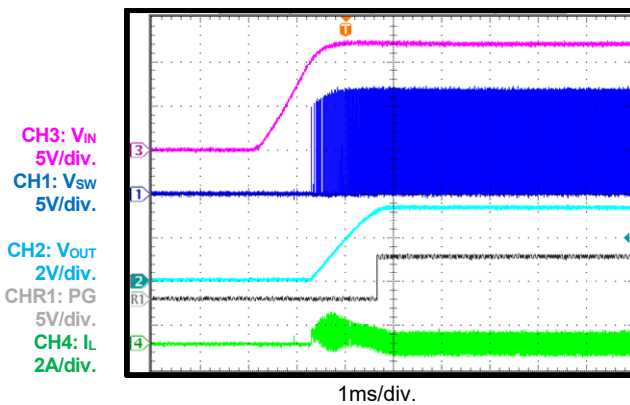
Steady State

 $I_{OUT} = 3A$


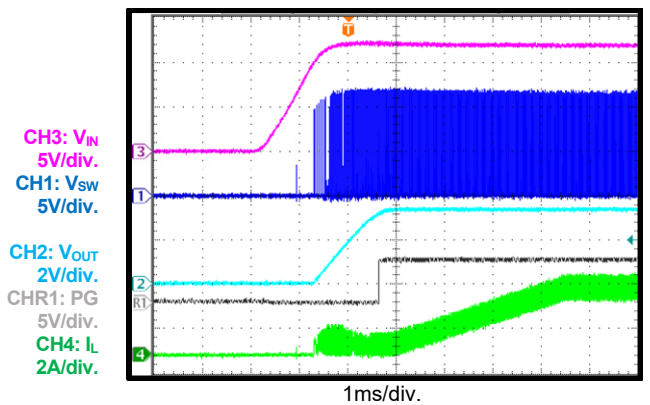
Start-Up through VIN

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


Start-Up through VIN

 $I_{OUT} = 0A$, FCCM


Start-Up through VIN

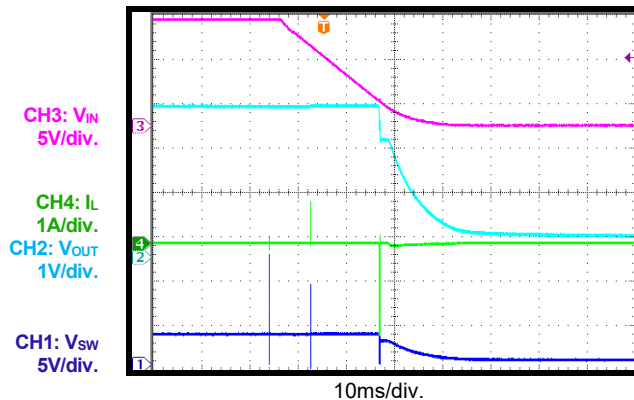
 $I_{OUT} = 3A$


EVB TEST RESULTS (continued)

Performance curves and waveforms are tested on the evaluation board, $V_{IN} = 12V$, $V_{OUT} = 3.3V$, $C_{OUT} = 2 \times 47\mu F$, $L = 5.6\mu H$, $f_{SW} = 410kHz$, $T_A = 25^\circ C$, unless otherwise noted.

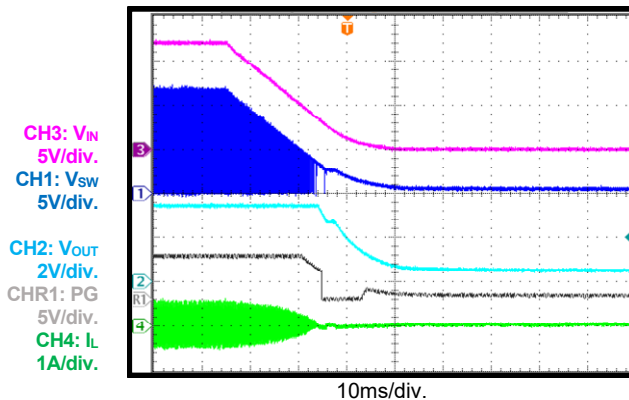
Shutdown through VIN

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



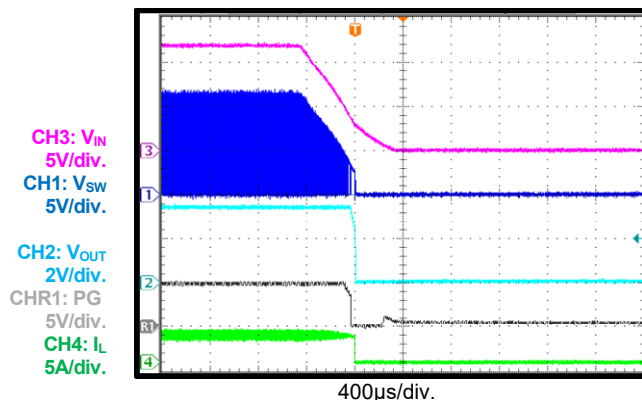
Shutdown through VIN

$I_{OUT} = 0A$, FCCM



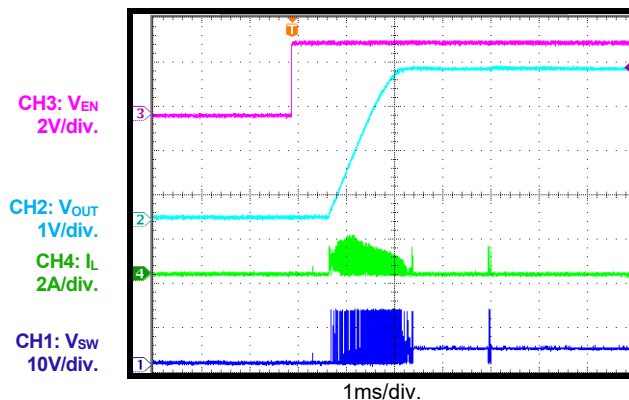
Shutdown through VIN

$I_{OUT} = 3A$



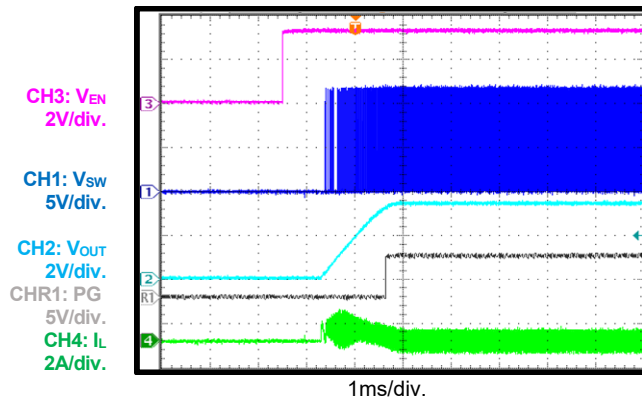
Start-Up through EN

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



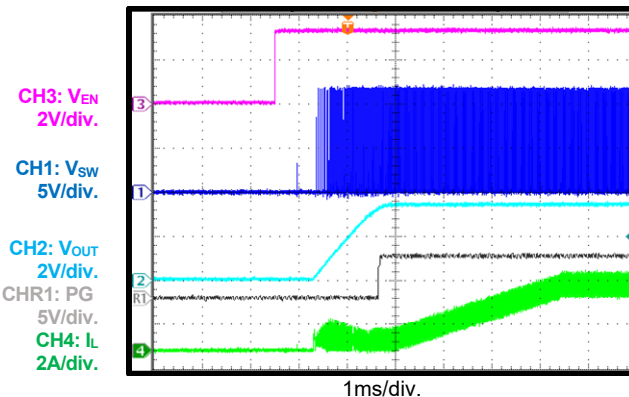
Start-Up through EN

$I_{OUT} = 0A$, FCCM



Start-Up through EN

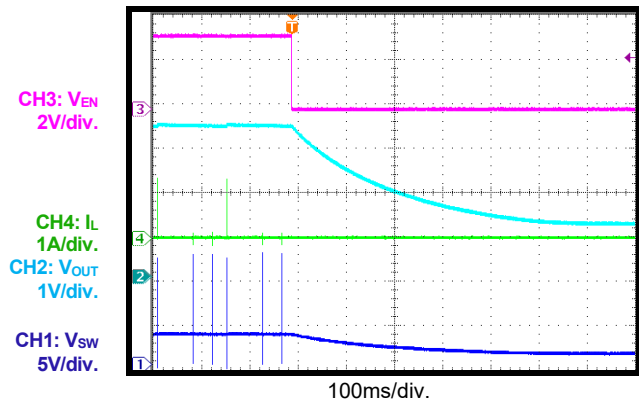
$I_{OUT} = 3A$



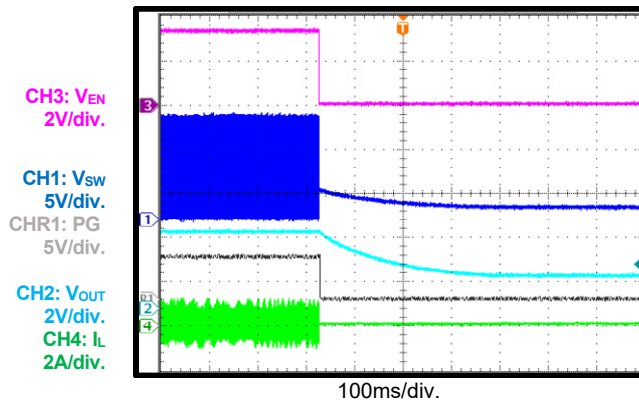
EVB TEST RESULTS (continued)

Performance curves and waveforms are tested on the evaluation board, $V_{IN} = 12V$, $V_{OUT} = 3.3V$, $C_{OUT} = 2 \times 47\mu F$, $L = 5.6\mu H$, $f_{SW} = 410kHz$, $T_A = 25^\circ C$, unless otherwise noted.

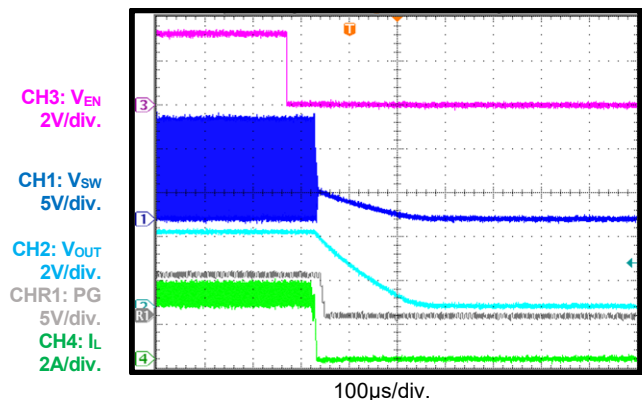
Shutdown through EN

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


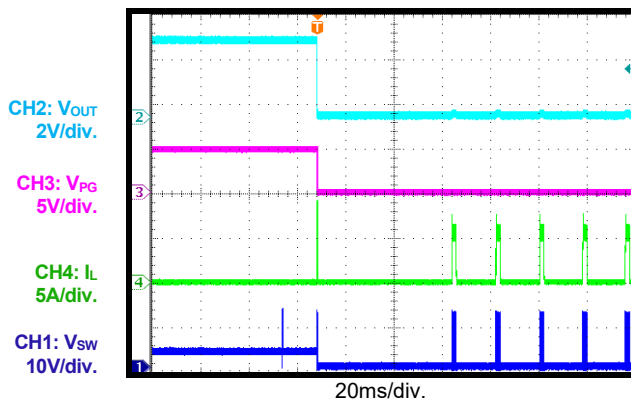
Shutdown through EN

 $I_{OUT} = 0A$, FCCM


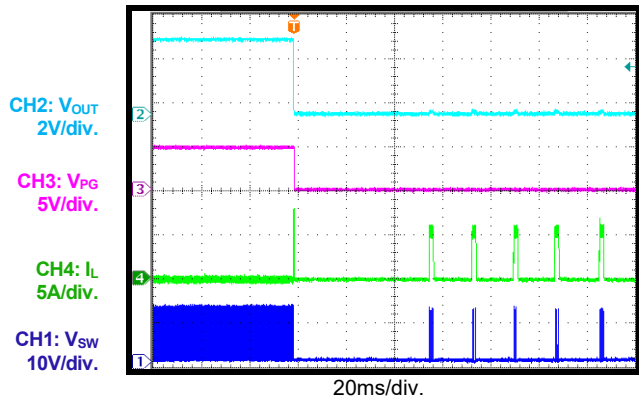
Shutdown through EN

 $I_{OUT} = 3A$


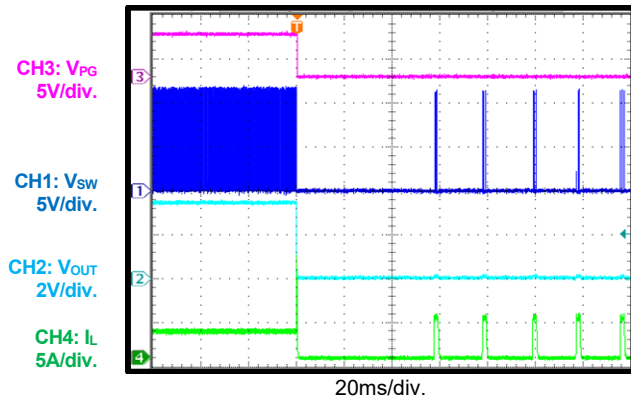
SCP Entry

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


SCP Entry

 $I_{OUT} = 0A$, FCCM


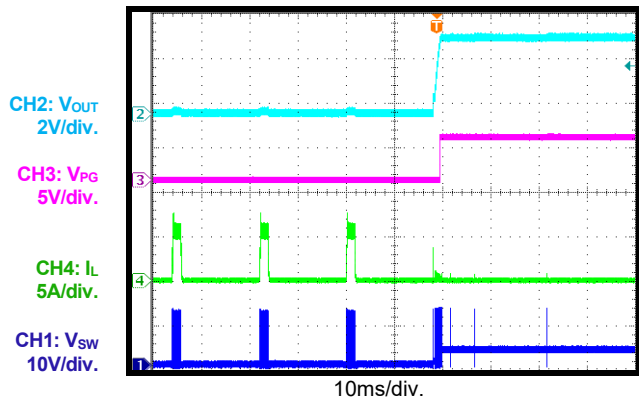
SCP Entry

 $I_{OUT} = 3A$


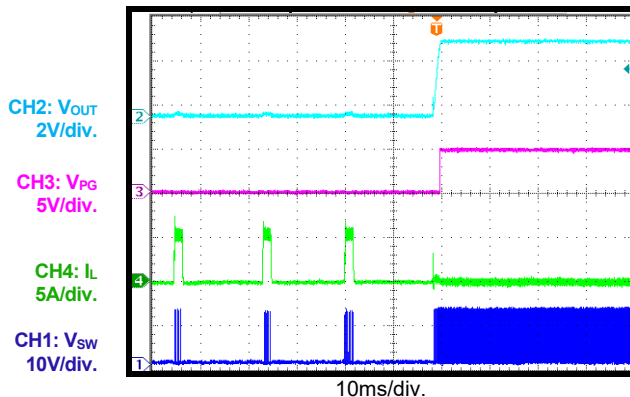
EVB TEST RESULTS *(continued)*

Performance curves and waveforms are tested on the evaluation board, $V_{IN} = 12V$, $V_{OUT} = 3.3V$, $C_{OUT} = 2 \times 47\mu F$, $L = 5.6\mu H$, $f_{SW} = 410kHz$, $T_A = 25^\circ C$, unless otherwise noted.

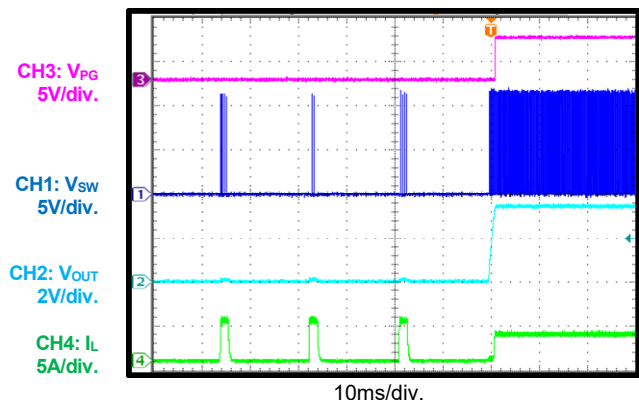
SCP Recovery

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


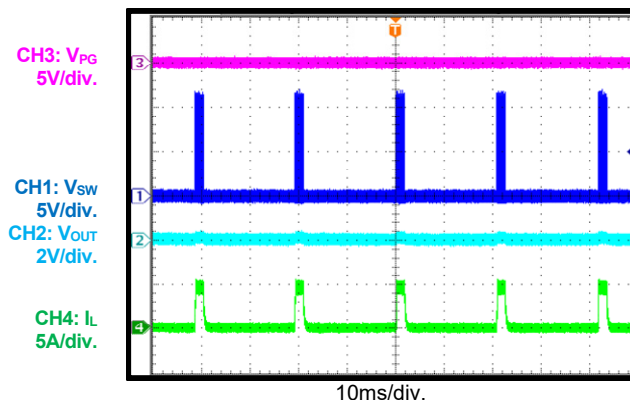
SCP Recovery

 $I_{OUT} = 0A$, FCCM


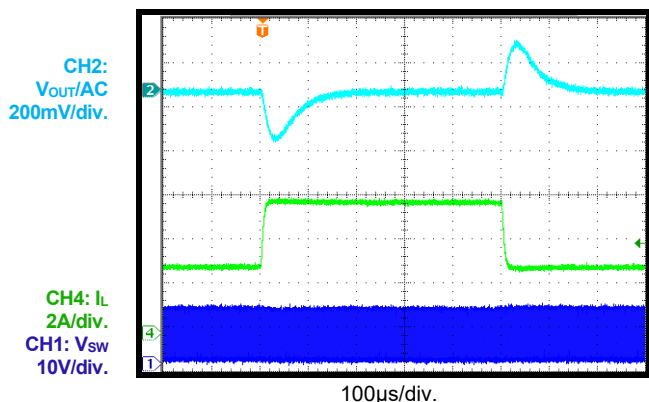
SCP Recovery

 $I_{OUT} = 3A$


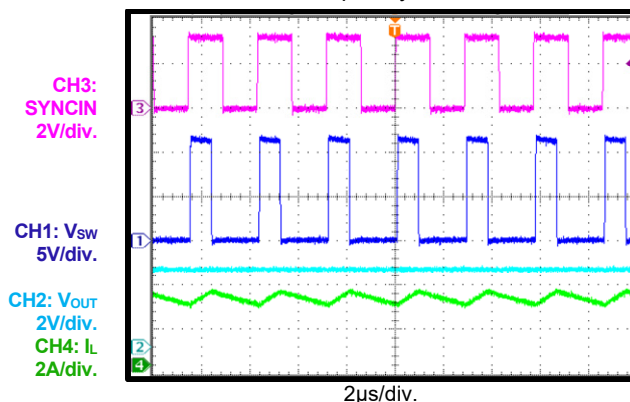
SCP Steady State



Load Transient

 $I_{OUT} = 1.5A$ to $3A$


SYNC Operation

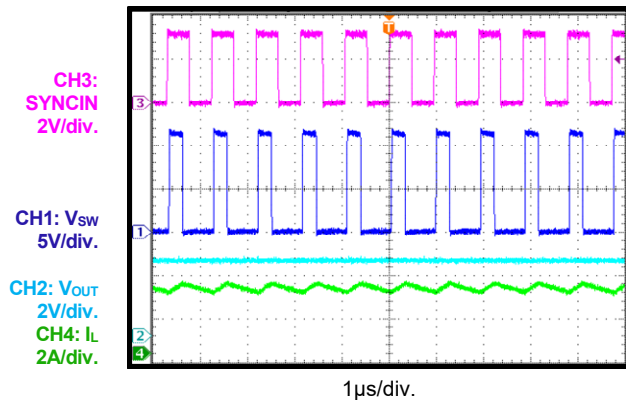
 $I_{OUT} = 3A$, SYNC frequency = 350kHz


EVB TEST RESULTS (continued)

Performance curves and waveforms are tested on the evaluation board, $V_{IN} = 12V$, $V_{OUT} = 3.3V$, $C_{OUT} = 2 \times 47\mu F$, $L = 5.6\mu H$, $f_{SW} = 410kHz$, $T_A = 25^\circ C$, unless otherwise noted.

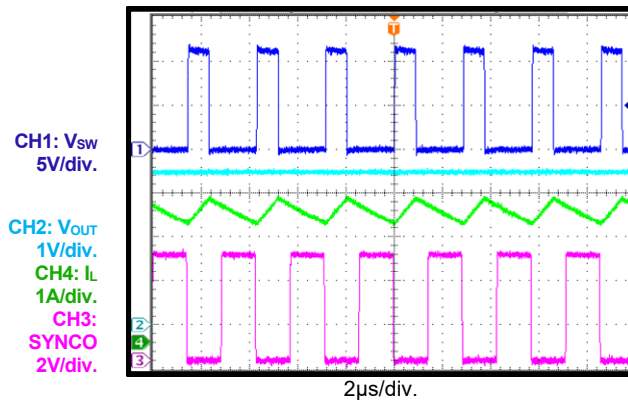
SYNC Operation

$I_{OUT} = 3A$, SYNC frequency = 1000kHz



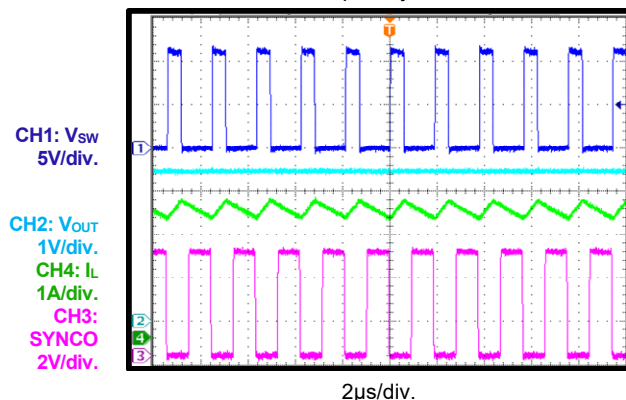
SYNCO Operation

$I_{OUT} = 3A$, SYNC frequency = 350kHz



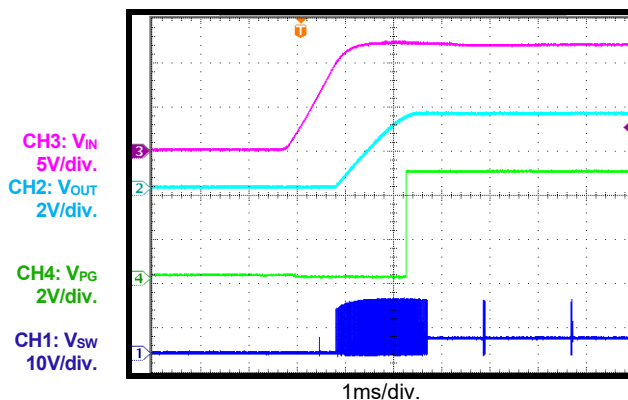
SYNCO Operation

$I_{OUT} = 3A$, SYNC frequency = 530kHz



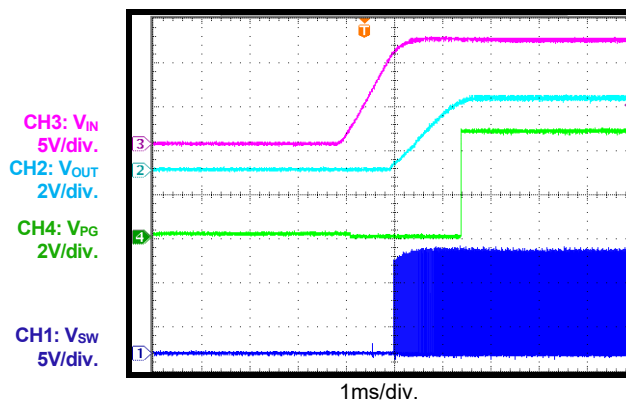
PG in Start-Up through VIN

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



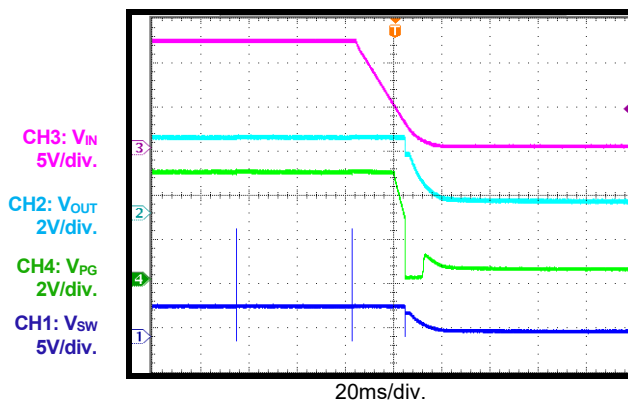
PG in Start-Up through VIN

$I_{OUT} = 3A$



PG in Shutdown through VIN

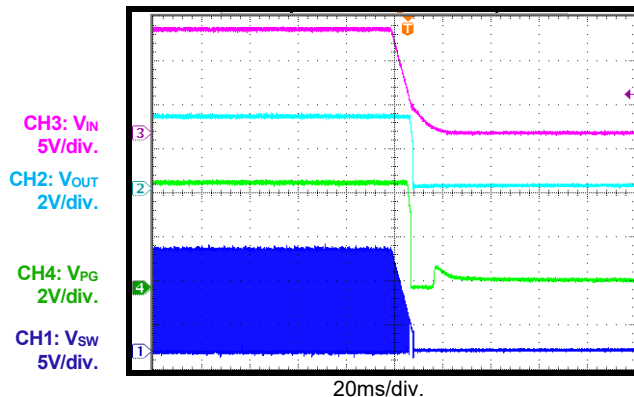
$I_{OUT} = 0A$, AAM mode



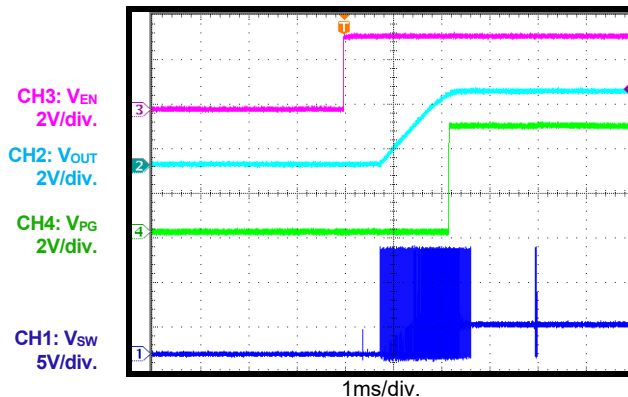
EVB TEST RESULTS (continued)

Performance curves and waveforms are tested on the evaluation board, $V_{IN} = 12V$, $V_{OUT} = 3.3V$, $C_{OUT} = 2 \times 47\mu F$, $L = 5.6\mu H$, $f_{SW} = 410kHz$, $T_A = 25^\circ C$, unless otherwise noted.

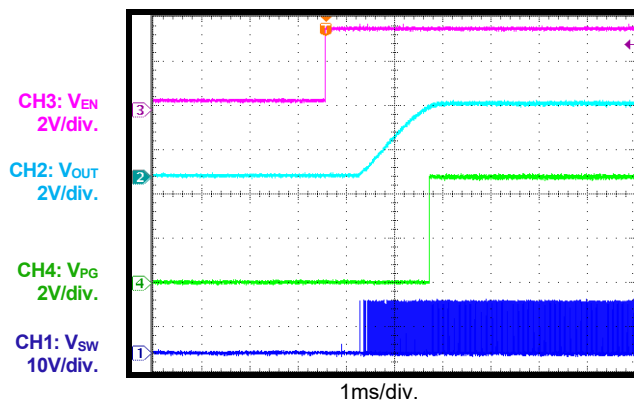
PG in Shutdown through VIN

 $I_{OUT} = 3A$


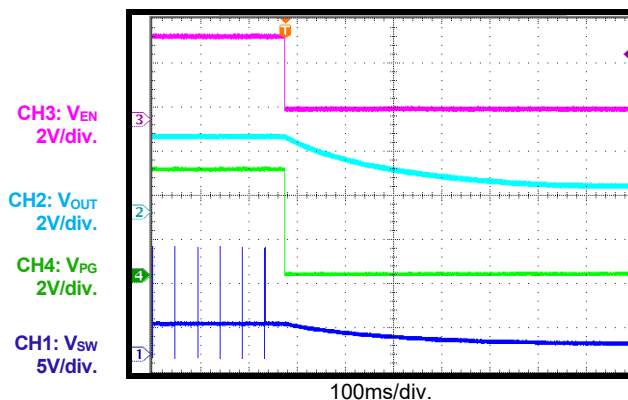
PG in Start-Up through EN

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


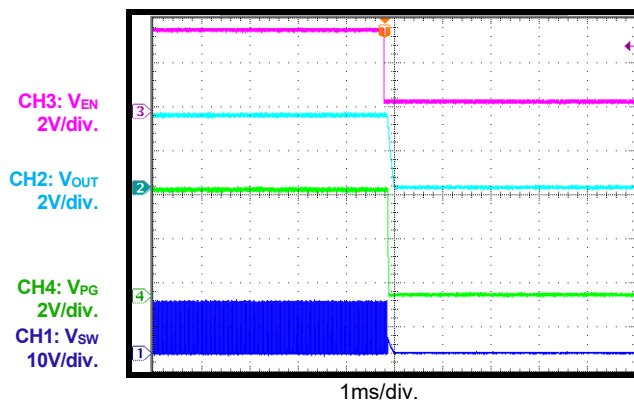
PG in Start-Up through EN

 $I_{OUT} = 3A$


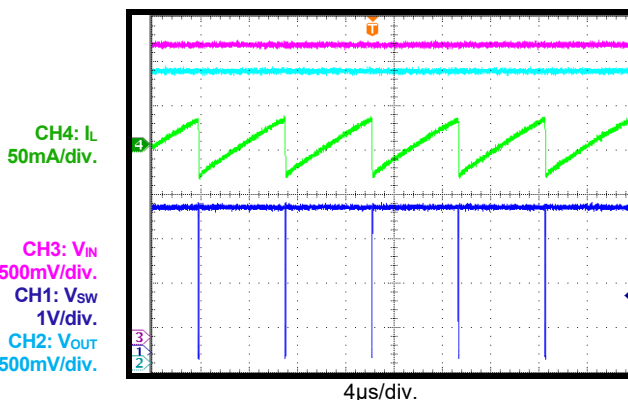
PG in Shutdown through EN

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


PG in Shutdown through EN

 $I_{OUT} = 3A$


Low-Dropout Mode

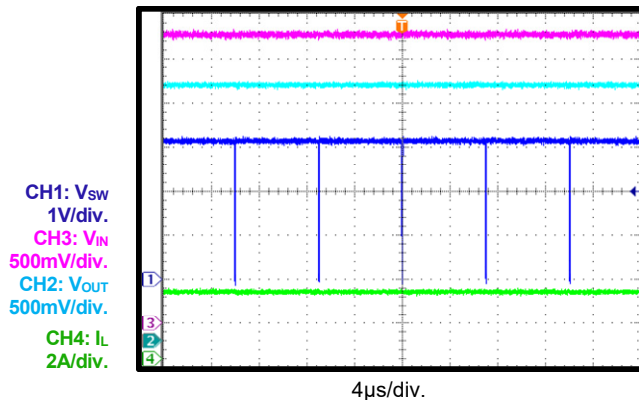
 $V_{IN} = 3.3V$, V_{OUT} set to 3.3V, $I_{OUT} = 0A$


EVB TEST RESULTS (continued)

Performance curves and waveforms are tested on the evaluation board, $V_{IN} = 12V$, $V_{OUT} = 3.3V$, $C_{OUT} = 2 \times 47\mu F$, $L = 5.6\mu H$, $f_{SW} = 410kHz$, $T_A = 25^\circ C$, unless otherwise noted.

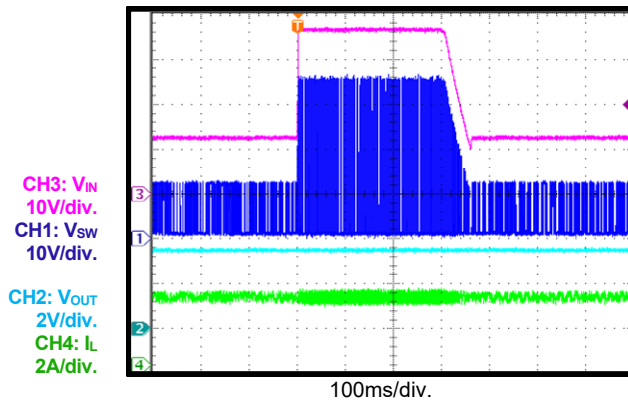
Low-Dropout Mode

$V_{IN} = 3.3V$, V_{OUT} set to 3.3V, $I_{OUT} = 3A$



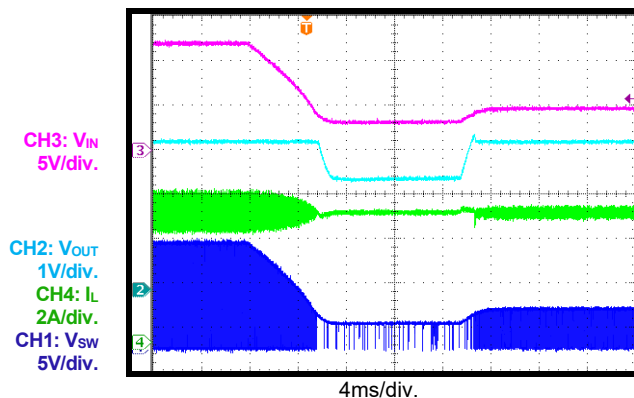
Load Dump

$V_{IN} = 12V$ to 36V, $I_{OUT} = 3A$



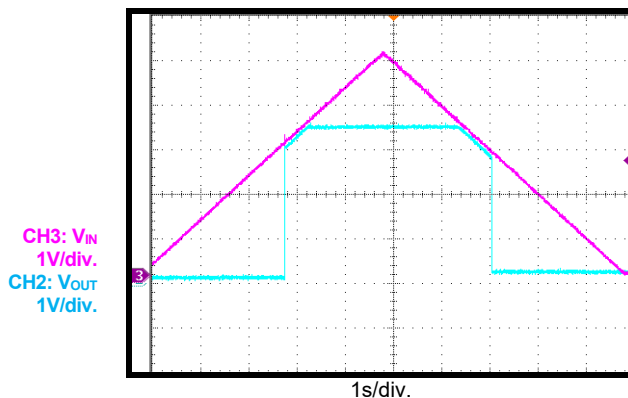
Cold Crank

$V_{IN} = 12V$ to 3.3V to 5V, $I_{OUT} = 3A$



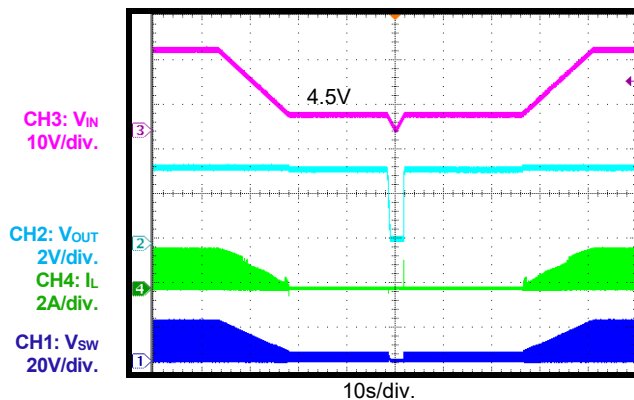
V_{IN} Ramping Up and Down

$I_{OUT} = 0.1A$



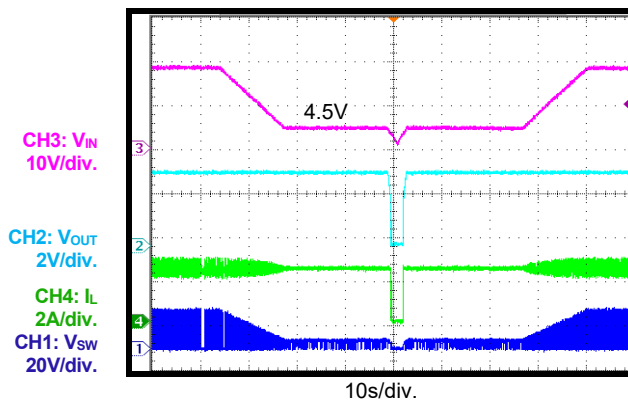
V_{IN} Ramping Down and Up

$I_{OUT} = 1mA$



V_{IN} Ramping Down and Up

$I_{OUT} = 3A$



PCB LAYOUT (2)

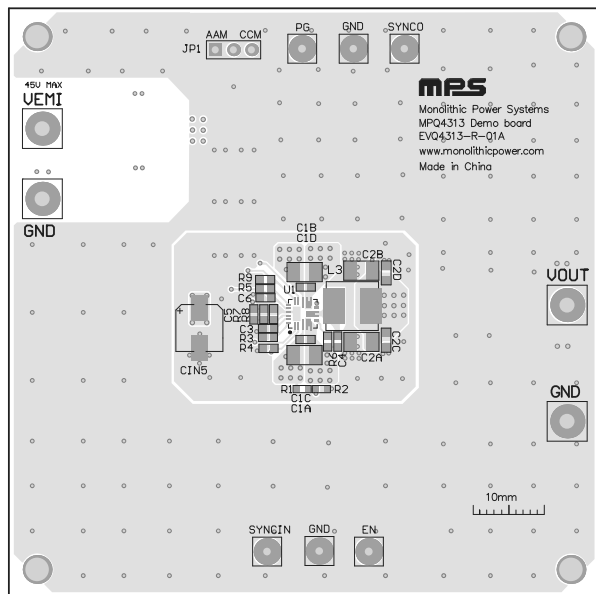


Figure 4: Top Silk and Top Layer

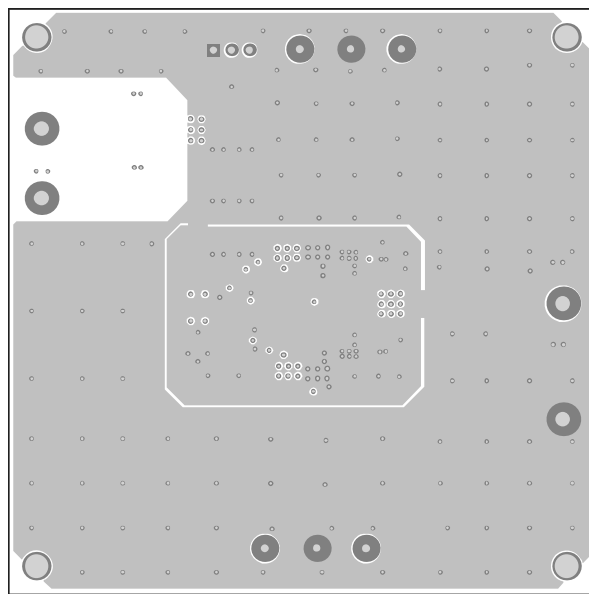


Figure 5: Mid-Layer 1

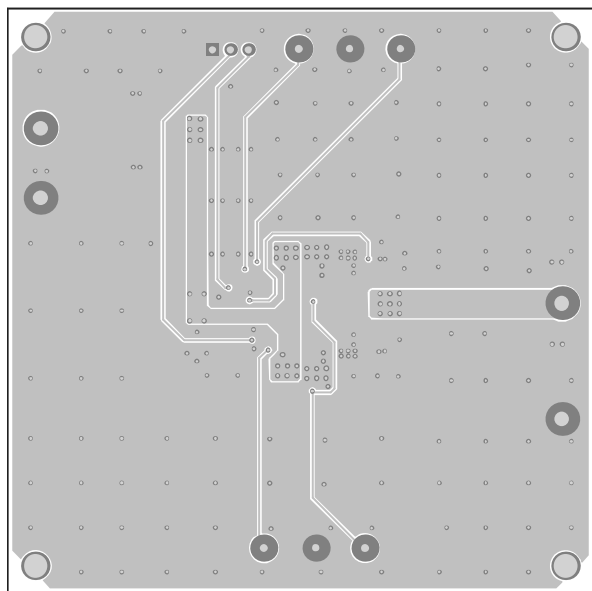


Figure 6: Mid-Layer 2

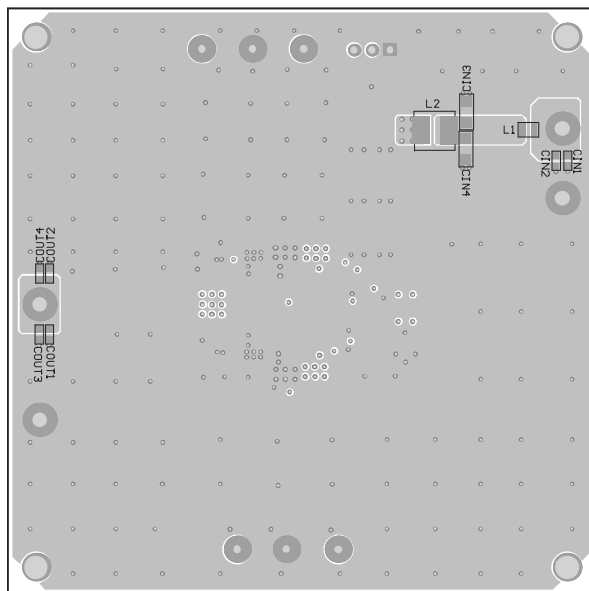


Figure 7: Bottom Layer and Bottom Silk

Note:

- 2) The copper thickness is 2oz.

REVISION HISTORY

Revision #	Revision Date	Description	Pages Updated
1.0	5/26/2022	Initial Release	-

Notice: The information in this document is subject to change without notice. Please contact MPS for current specifications. Users should warrant and guarantee that third-party Intellectual Property rights are not infringed upon when integrating MPS products into any application. MPS will not assume any legal responsibility for any said applications.

Mouser Electronics

Authorized Distributor

Click to View Pricing, Inventory, Delivery & Lifecycle Information:

[Monolithic Power Systems \(MPS\):](#)

[EVQ4313-R-01A](#)