EVQ4573-QB-00A

60V, 2.5A, High-Efficiency, Synchronous Buck Converter Evaluation Board, AEC-Q100

DESCRIPTION

The EVQ4573-QB-00A is an evaluation board designed to demonstrate the capabilities of the MPQ4573-AEC1, a fully integrated, fixed-frequency, synchronous step-down converter. It can achieve up to 2.5A of continuous output current (I_{OUT}) with peak current control for excellent transient response.

Advanced asynchronous modulation (AAM) mode achieves high efficiency under light-load conditions by scaling down the frequency to reduce switching and gate driver losses.

The EVQ4573-QB-00A is a fully assembled and tested evaluation board that generates up to 5V of output voltage (V_{OUT}) and up to 2.5A of load current across a wide 5V to 60V input voltage range.

The MPQ4573-AEC1 is available in a QFN-12 (2.5mmx3mm) package.

ELECTRICAL SPECIFICATIONS

Parameter	Symbol	Value	Units
Input voltage	V_{EMI}	5 to 60	V
Output voltage	V_{OUT}	5	V
Output current	I_{OUT}	2.5	A

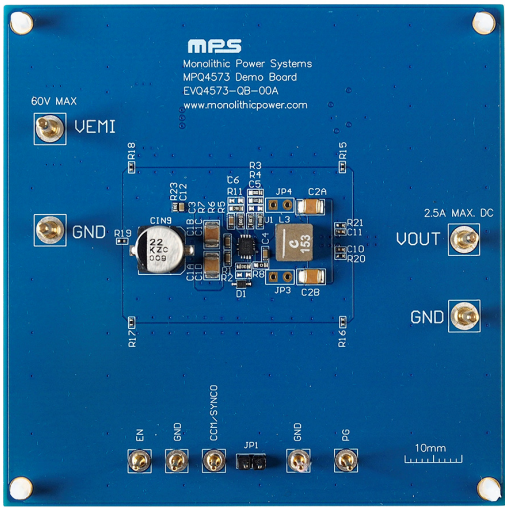
FEATURES

- Wide 5V to 60V Operating Input Range
  2.5A Continuous Output Current (I_{OUT})
- High-Efficiency, Synchronous Mode Control
- 250mΩ/45mΩ Internal Power MOSFETs
- Up to 2.2MHz Configurable Switching Frequency (f_{SW})
- 180° Out-of-Phase SYNCO Clock
- 40μA Quiescent Current (I_Q)
- Low 2μA Shutdown Current
- Selectable Advanced Asynchronous Modulation (AAM) Mode or Forced Continuous Conduction Mode (FCCM) during Light-Load Operation
- 0.45ms Internal Soft Start (SS)
- Remote Enable (EN) Control
- Power Good (PG) Indicator
- Low-Dropout (LDO) Mode
- Over-Current Protection (OCP)
- Thermal Shutdown
- Available in a QFN-12 (2.5mmx3mm) Package
- Available in AEC-Q100 Grade 1

APPLICATIONS

- Automotive Systems
- Industrial Power Systems

EVQ4573-QB-00A EVALUATION BOARD

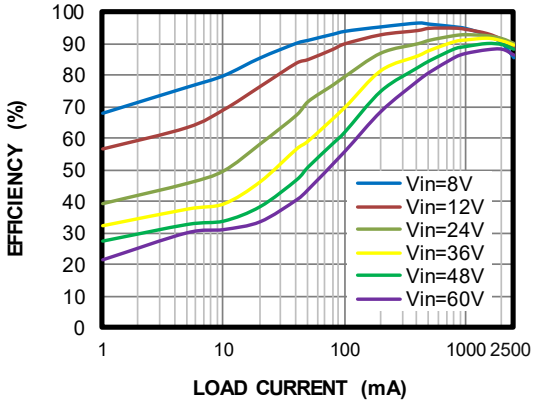


LxWxH (8.9cmx8.9cmx1.3cm)

Board Number	MPS IC Number
EVQ4573-QB-00A	MPQ4573GQBE-AEC1

Efficiency vs. Load Current

V_{OUT} = 5V, f_{SW} = 400kHz,
L = 15µH, AAM mode



QUICK START GUIDE

1. Preset the power supply between 5V and 60V. Be aware that electronic loads represent a negative impedance to the converter, which can trigger hiccup mode if the current exceeds 3.9A.
2. Turn off the power supply. If longer cables (>0.5m total) are being used between the source and the evaluation board, install a damping capacitor at the input terminals. This is critical when V_{IN} exceeds 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 start up automatically.
6. To use the enable (EN) function, apply a digital input to the EN pin. Drive EN above 1.45V to turn the converter on; drive EN below 1.12V to turn it off.
7. An external frequency resistor (R_{FREQ}) sets the switching frequency (f_{SW}). R_{FREQ} can be estimated with Equation (1):

$$R_{FREQ}(M\Omega) = \frac{30}{f_{SW}(kHz)} \quad (1)$$

   A bench test may be required to fine-tune the calculated resistance.
8. An external feedback resistor divider (R6 + R4) sets the output voltage (V_{OUT}). R6 + R4 also sets the loop bandwidth via an internal compensation capacitor. Choose R4 to be about 40kΩ. Then R5 can be calculated with Equation (2):

$$R5 = \frac{R4}{\frac{V_{OUT}}{0.8} - 1} \quad (2)$$

Figure 1 shows the feedback resistor network.

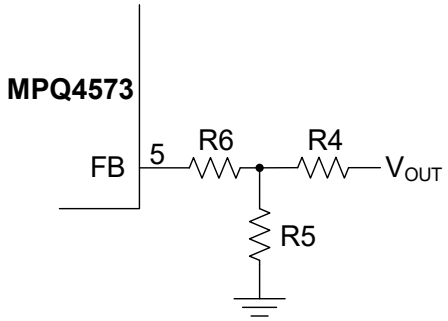


Figure 1: Feedback Resistor Network

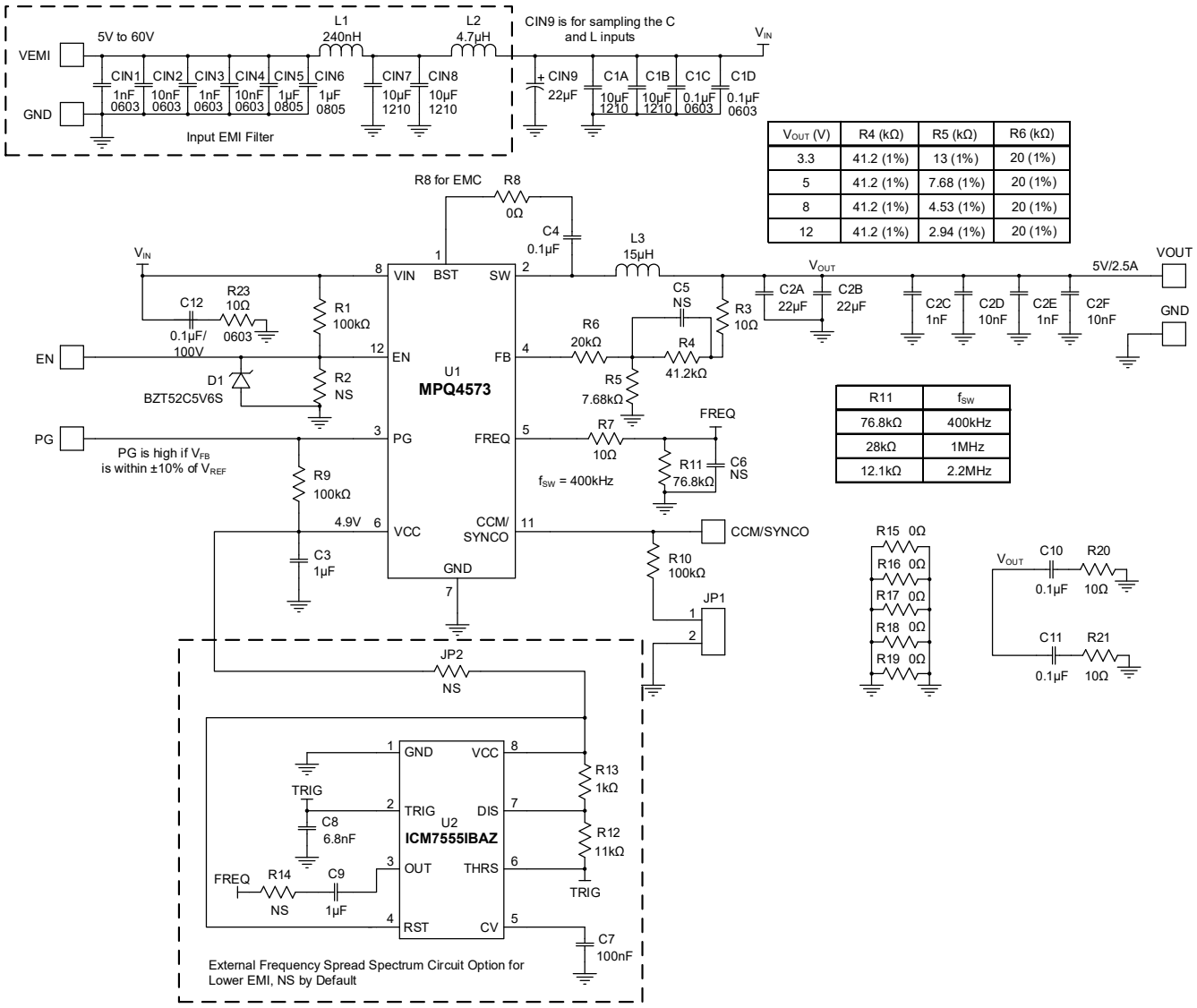
Table 1 lists the recommended feedback resistor values for common output voltages.

Table 1: Recommended Resistor Values

V_{OUT} (V)	R4 (kΩ)	R5 (kΩ)	R6 (kΩ)
3.3	41.2 (1%)	13 (1%)	20 (1%)
8	41.2 (1%)	4.53 (1%)	20 (1%)
5	41.2 (1%)	7.68 (1%)	20 (1%)
12	41.2 (1%)	2.94 (1%)	20 (1%)

9. Jumper points JP3 and JP4 can added for external shielding above the inductor and IC. JP3 and JP4 are not stuffed by default.

EVALUATION BOARD SCHEMATIC



VOUT (V)	R4 (kΩ)	R5 (kΩ)	R6 (kΩ)
3.3	41.2 (1%)	13 (1%)	20 (1%)
5	41.2 (1%)	7.68 (1%)	20 (1%)
8	41.2 (1%)	4.53 (1%)	20 (1%)
12	41.2 (1%)	2.94 (1%)	20 (1%)

R11	fSW
76.8kΩ	400kHz
28kΩ	1MHz
12.1kΩ	2.2MHz

Figure 2: Evaluation Board Schematic

EVQ4573-QB-00A BILL OF MATERIALS

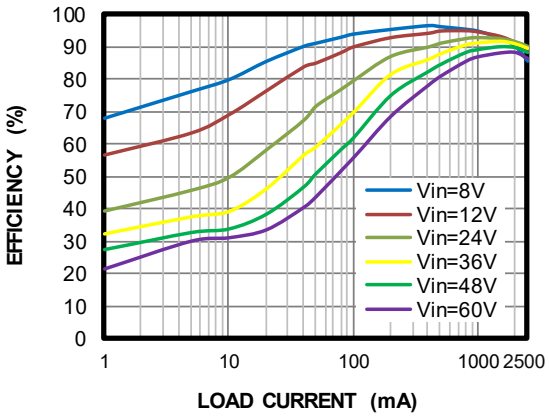
Qty	Designator	Value	Description	Package	Manufacturer	Manufacturer PN
4	CIN1, C1N3, C2C, C2E	1nF	Ceramic capacitor, 100V, X7R	0603	Murata	GRM188R72A102KA01D
4	CIN2, CIN4, C2D, C2F	10nF	Ceramic capacitor, 100V, X7R	0603	Murata	GRM188R72A103KA01D
2	CIN5, CIN6	1µF	Ceramic capacitor, 100V, X7S	0805	Murata	GRM21BC72A105KE01L
4	CIN7, CIN8, C1A, C1B	10µF	Ceramic capacitor, 100V, X7S	1210	Murata	GRM32EC72A106KE05L
1	CIN9	22µF	Electrical capacitor, 80V, SMD	SMD	Panasonic	EEHZC1K220P
3	C1C, C1D, C12	0.1µF	Ceramic capacitor, 100V, X7R	0603	Murata	GRM188R72A104KA35D
2	C2A, C2B	22µF	Ceramic capacitor, 25V, X7R	1210	Murata	GRM32ER71E226KE15L
2	C3, C9	1µF	Ceramic capacitor, 25V, X7R	0603	Murata	GRM188R71E105KA12D
2	C4, C7	0.1µF	Ceramic capacitor, 16V, X7R	0603	Murata	GRM188R71C104KA01D
1	C8	6.8nF	Ceramic capacitor, 50V, X7R	0603	TDK	C1608X7R1H682K
2	C10, C11	0.1µF	Ceramic capacitor, 16V, X7R	0402	Murata	GRM155R71C104KA88D
2	C5, C6	NS				
1	L1	240nH	Inductor, 19mΩ, 6.6A	SMD	Toko	DFE201612E-R24M
1	L2	4.7µH	Inductor, 83mΩ, 3.6A	SMD	Toko	FDSD0402-H-4R7M
1	L3	15µH	Inductor, 40mΩ, 5.8A	SMD	Coilcraft	XAL6060-153MEB
3	R1, R9, R10	100kΩ	Film resistor, 1%	0603	Yageo	RC0603FR-07100KL
3	R2, JP2, R14	NS				
3	R3, R7, R23	10Ω	Film resistor, 1%	0603	Yageo	RC0603FR-0710RL
1	R4	41.2kΩ	Film resistor, 1%	0603	Yageo	RC0603FR-0741K2L
1	R5	7.68kΩ	Film resistor, 1%	0603	Yageo	RC0603FR-077K68L
1	R6	20kΩ	Film resistor, 1%	0603	Yageo	RC0603FR-0720KL
1	R8	0Ω	Film resistor, 1%	0603	Yageo	RC0603FR-070RL
1	R11	76.8kΩ	Film resistor, 1%	0603	Yageo	RC0603FR-0776K8L
1	R12	11kΩ	Film resistor, 1%	0603	Yageo	RC0603FR-0711KL
1	R13	1kΩ	Film resistor, 1%	0603	Yageo	RC0603FR-071KL
5	R15, R16, R17, R18, R19	0Ω	Film resistor, 1%	0402	Yageo	RC0402FR-070RL
2	R20, R21	10Ω	Film resistor, 1%	0402	Yageo	RC0402FR-0710RL
1	D1	5.6V	Zener diode	SOD323	Diodes, Inc.	BZT52C5V6WS
1	U2	1MHz	Single timer/oscillator IC	SOIC-8	Intersil (Renesas)	ICM7555IBAZ
1	JP1	2.54mm	Test pin	DIP	Custom	
4	VEMI, GND, GND, VOUT	2mm	2 golden pins	DIP	Custom	
5	CCM/SYNCO, PG, GND, EN, GND	1mm	1 golden pin	DIP	Custom	
2	JP3, JP4	NS				
1	U1	MPQ4573-AEC1	Synchronous, step-down converter, 60V, 2.5A	QFN-12 (2.5mmx 3mm)	MPS	MPQ4573GQBE-AEC1

EVB TEST RESULTS

Performance curves and waveforms are tested on the evaluation board. V_{IN} = 24V, V_{OUT} = 5V, L = 15µH, f_{SW} = 400kHz, T_A = 25°C, unless otherwise noted.

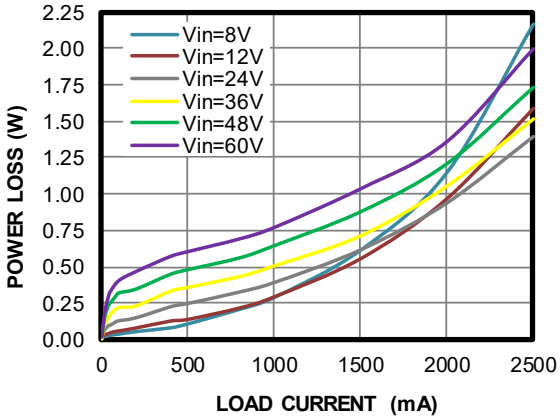
Efficiency vs. Load Current

f_{SW} = 400kHz, L = 15µH (1), AAM mode



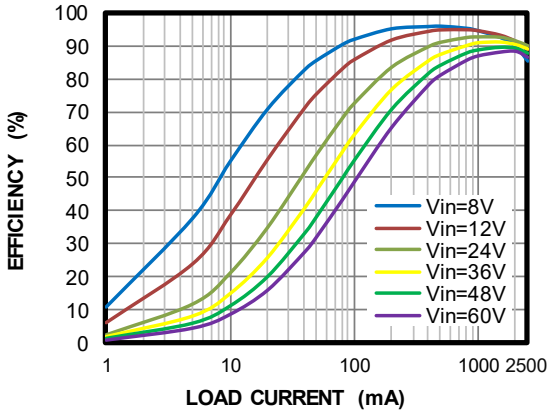
Power Loss vs. Load Current

f_{SW} = 400kHz, L = 15µH (1), AAM mode



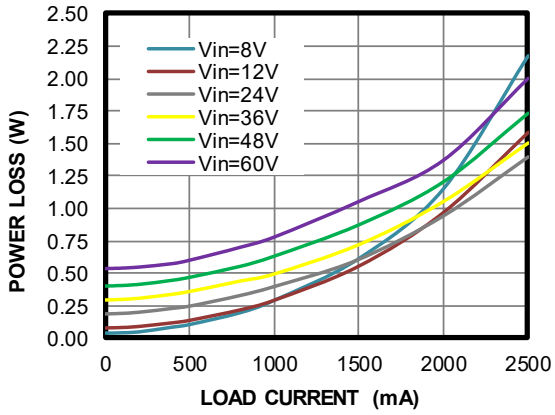
Efficiency vs. Load Current

f_{SW} = 400kHz, L = 15µH (1), FCCM



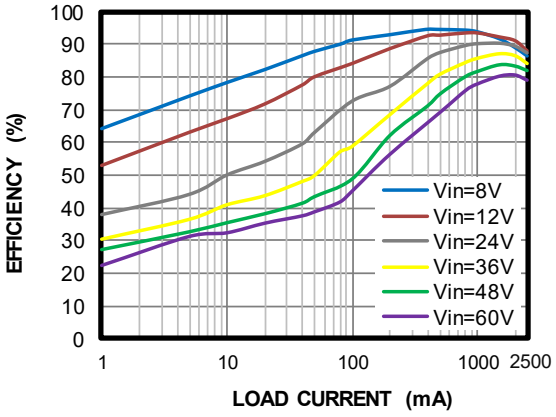
Power Loss vs. Load Current

f_{SW} = 400kHz, L = 15µH (1), FCCM



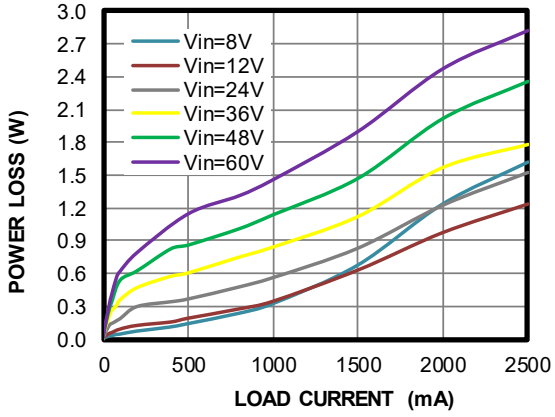
Efficiency vs. Load Current

f_{SW} = 1MHz, L = 10µH (2), AAM mode



Power Loss vs. Load Current

f_{SW} = 1MHz, L = 10µH (2), AAM mode

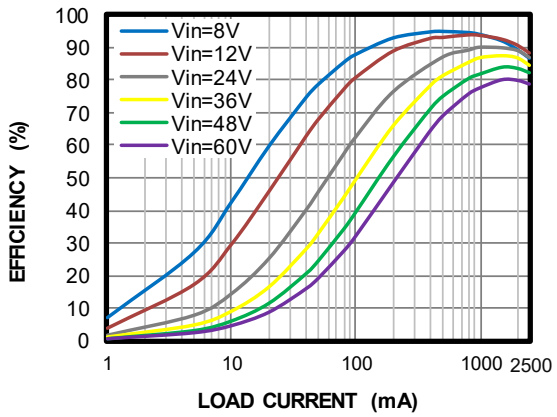


EVB TEST RESULTS *(continued)*

Performance curves and waveforms are tested on the evaluation board. V_{IN} = 24V, V_{OUT} = 5V, L = 15µH, f_{SW} = 400kHz, T_A = 25°C, unless otherwise noted.

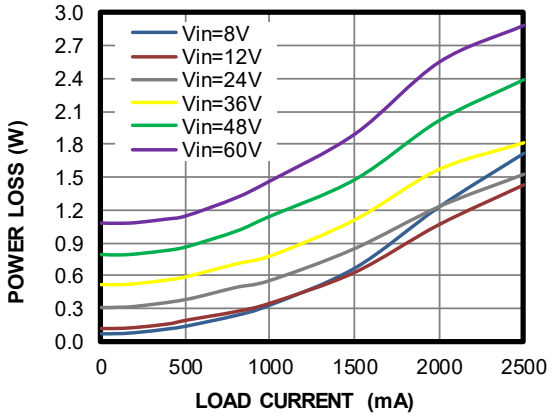
Efficiency vs. Load Current

f_{SW} = 1MHz, L = 10µH (2), FCCM



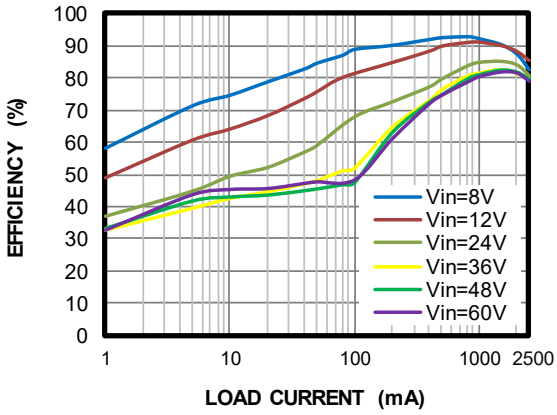
Power Loss vs. Load Current

f_{SW} = 1MHz, L = 10µH (2), FCCM



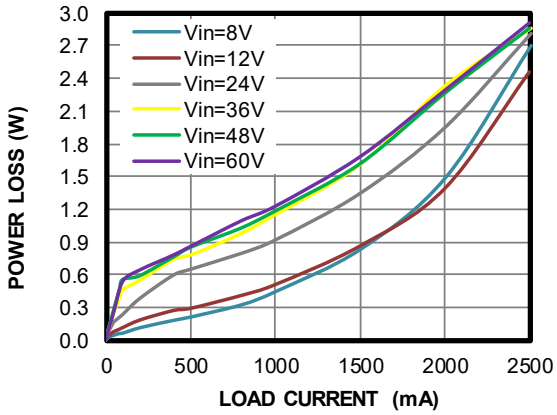
Efficiency vs. Load Current

f_{SW} = 2.2MHz, L = 4.7µH (3), AAM mode



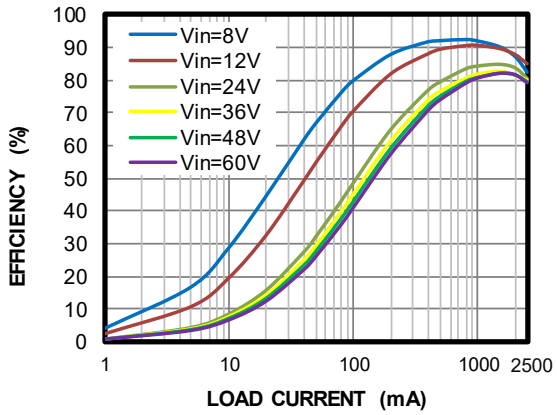
Power Loss vs. Load Current

f_{SW} = 2.2MHz, L = 4.7µH (3), AAM mode



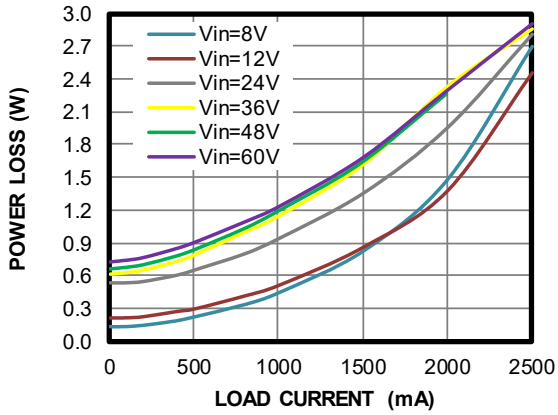
Efficiency vs. Load Current

f_{SW} = 2.2MHz, L = 4.7µH (3), FCCM



Power Loss vs. Load Current

f_{SW} = 2.2MHz, L = 4.7µH (3), FCCM



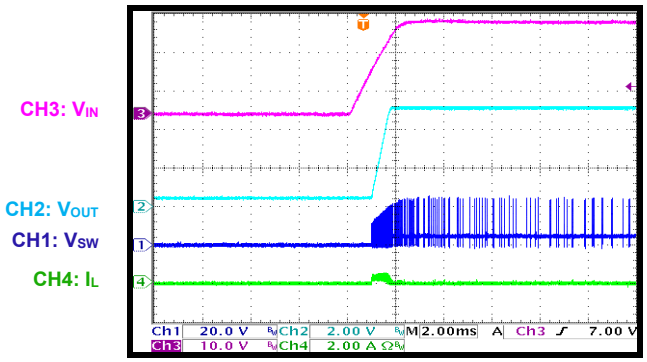
Notes:

1) Inductor part number: XAL6060-153MEB/C; DCR = 43.75mΩ.
2) Inductor part number: XAL6060-103MEB/C; DCR = 29.82mΩ.
3) Inductor part number: XAL5030-472MEB/C; DCR = 36mΩ.

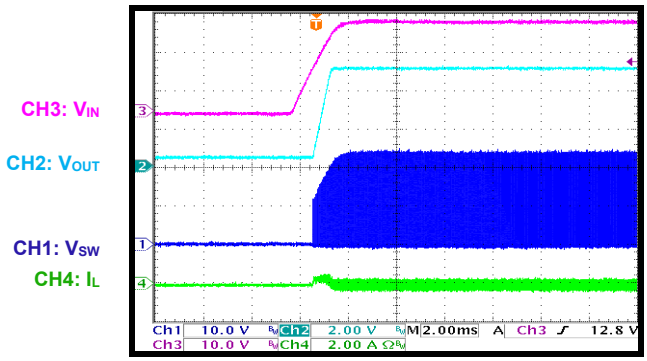
EVB TEST RESULTS *(continued)*

Performance curves and waveforms are tested on the evaluation board. V_{IN} = 24V, V_{OUT} = 5V, L = 15µH, f_{SW} = 400kHz, T_A = 25°C, unless otherwise noted.

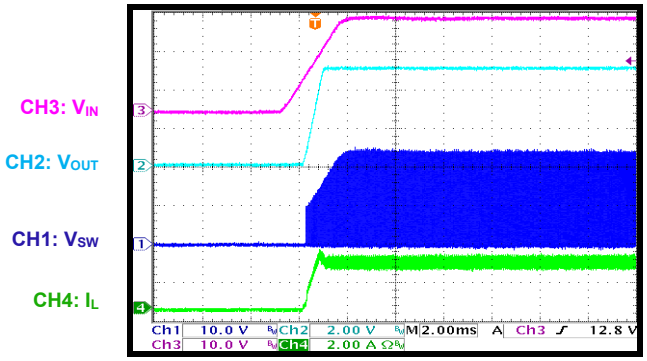
Start-Up through VIN
I_{OUT} = 0A, AAM mode



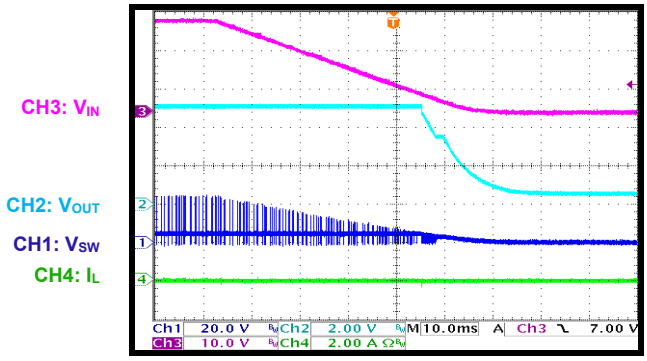
Start-Up through VIN
I_{OUT} = 0A, FCCM



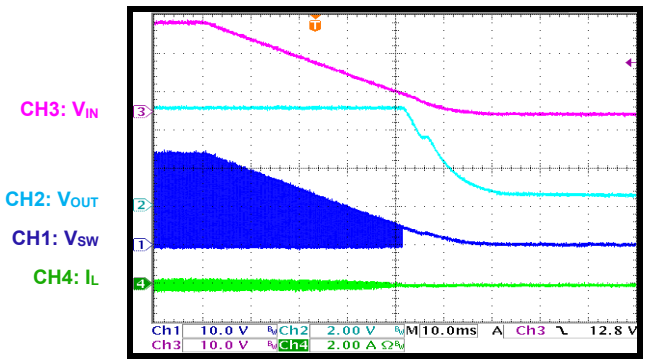
Start-Up through VIN
I_{OUT} = 2.5A



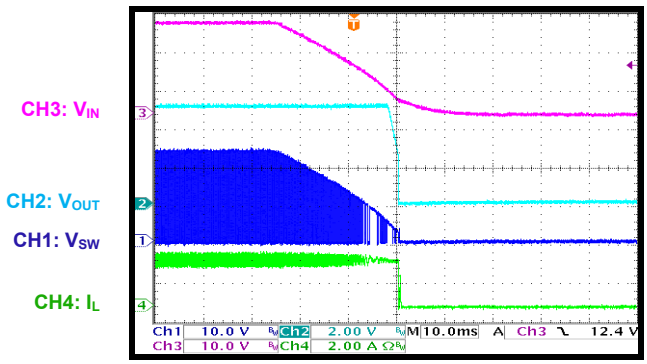
Shutdown through VIN
I_{OUT} = 0A, AAM mode



Shutdown through VIN
I_{OUT} = 0A, FCCM



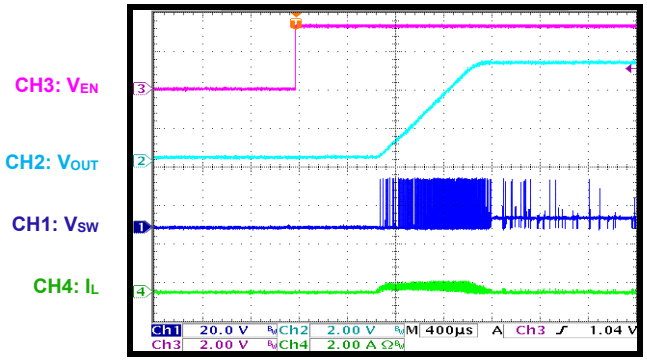
Shutdown through VIN
I_{OUT} = 2.5A



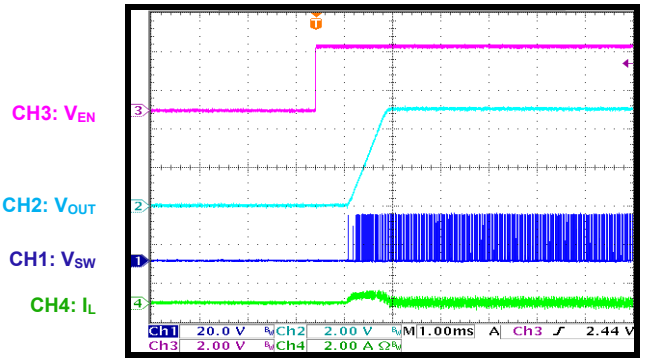
EVB TEST RESULTS *(continued)*

Performance curves and waveforms are tested on the evaluation board. V_{IN} = 24V, V_{OUT} = 5V, L = 15µH, f_{SW} = 400kHz, T_A = 25°C, unless otherwise noted.

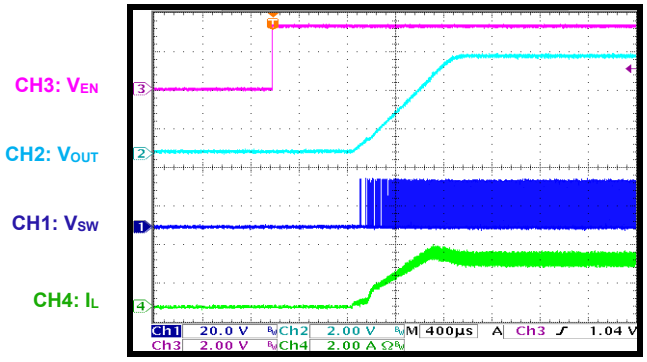
Start-Up through EN
I_{OUT} = 0A, AAM mode



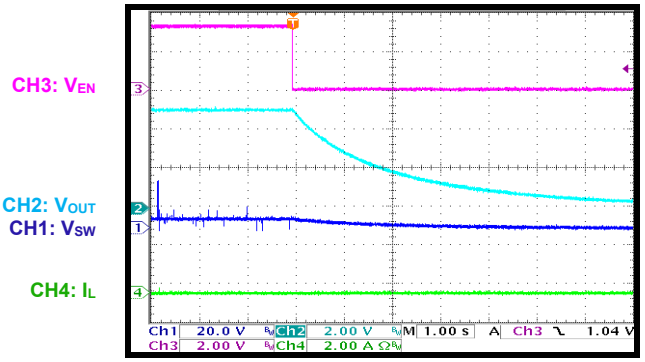
Start-Up through EN
I_{OUT} = 0A, FCCM



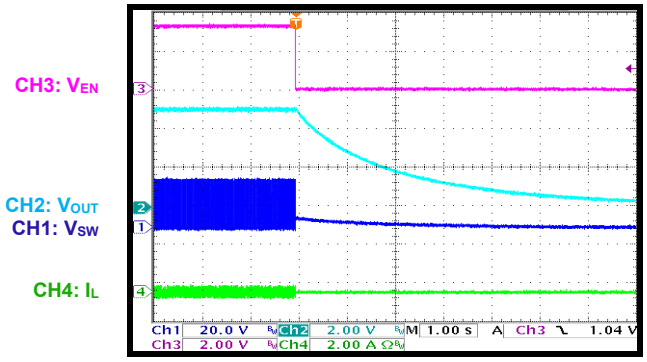
Start-Up through EN
I_{OUT} = 2.5A



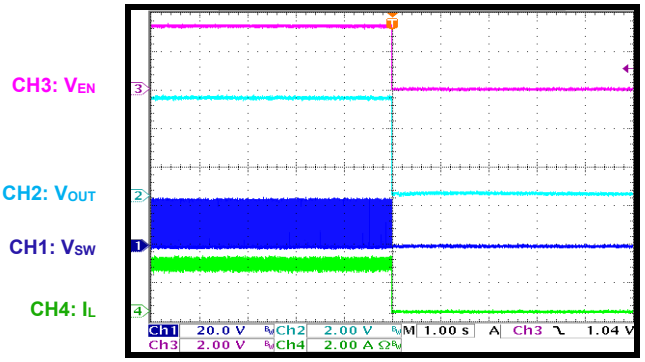
Shutdown through EN
I_{OUT} = 0A, AAM mode



Shutdown through EN
I_{OUT} = 0A, FCCM



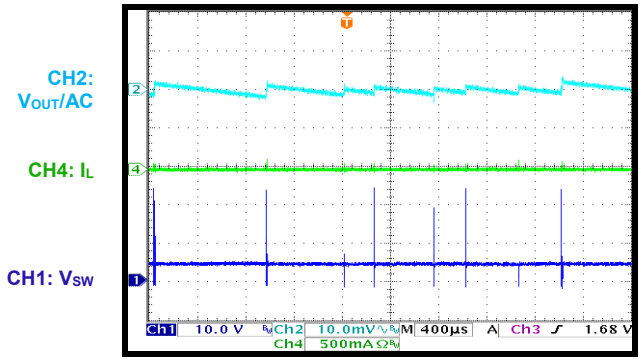
Shutdown through EN
I_{OUT} = 2.5A



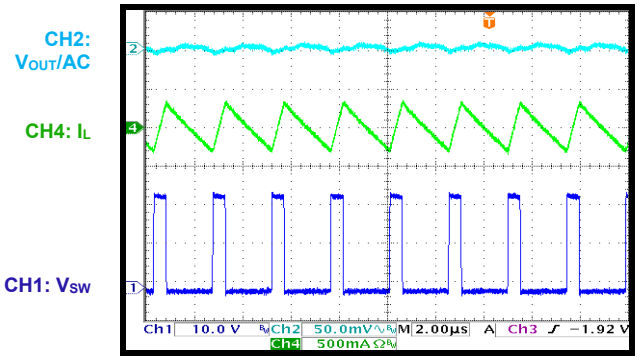
EVB TEST RESULTS *(continued)*

Performance curves and waveforms are tested on the evaluation board. V_{IN} = 24V, V_{OUT} = 5V, L = 15µH, f_{SW} = 400kHz, T_A = 25°C, unless otherwise noted.

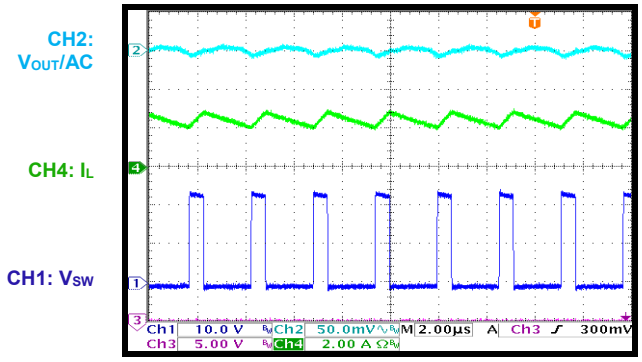
Output Ripple
I_{OUT} = 0A, AAM mode



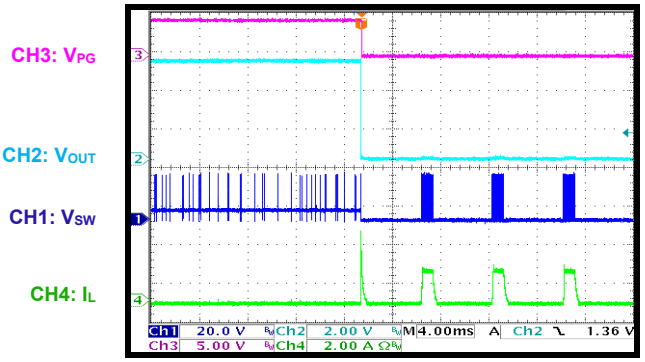
Output Ripple
I_{OUT} = 0A, FCCM



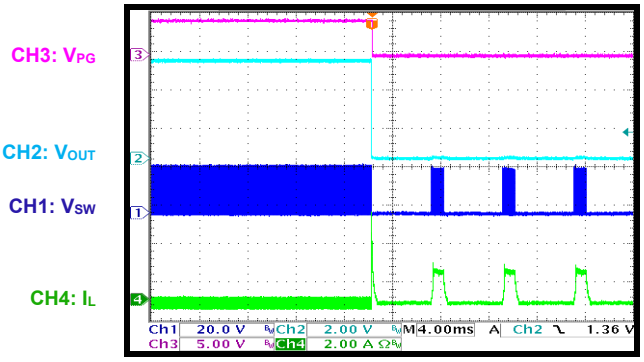
Output Ripple
I_{OUT} = 2.5A



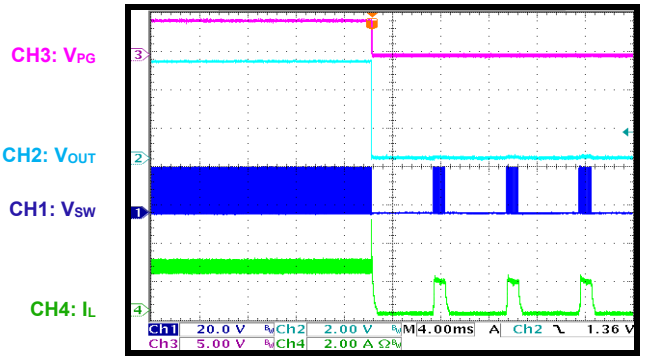
SCP Entry
I_{OUT} = 0A, AAM mode



SCP Entry
I_{OUT} = 0A, FCCM



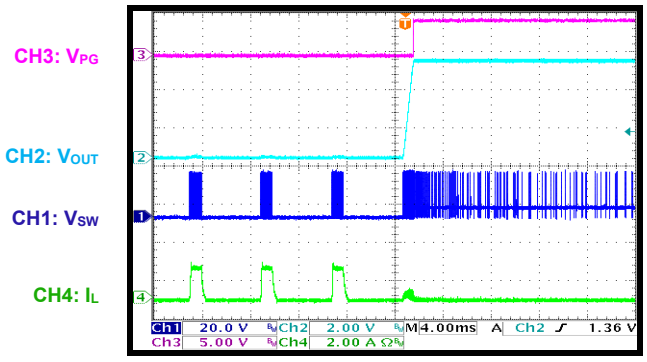
SCP Entry
I_{OUT} = 2.5A



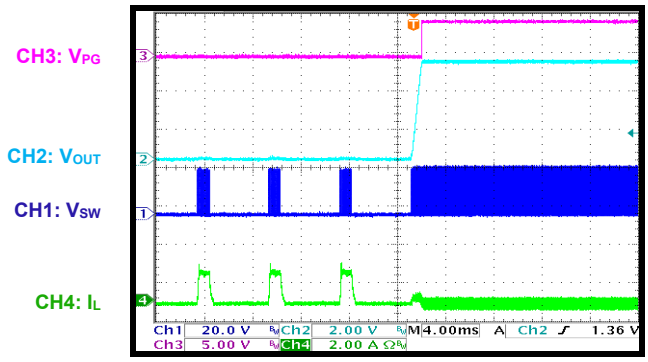
EVB TEST RESULTS *(continued)*

Performance curves and waveforms are tested on the evaluation board. V_{IN} = 24V, V_{OUT} = 5V, L = 15µH, f_{SW} = 400kHz, T_A = 25°C, unless otherwise noted.

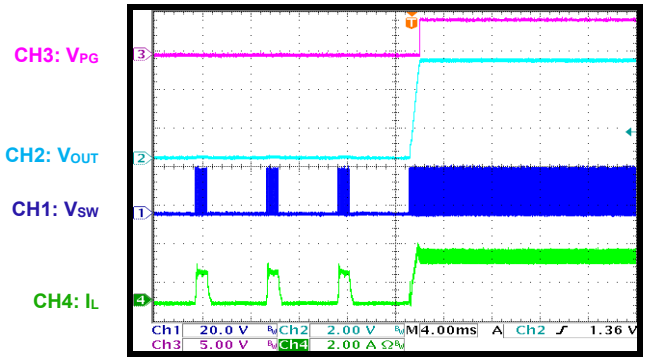
SCP Recovery
I_{OUT} = 0A, AAM mode



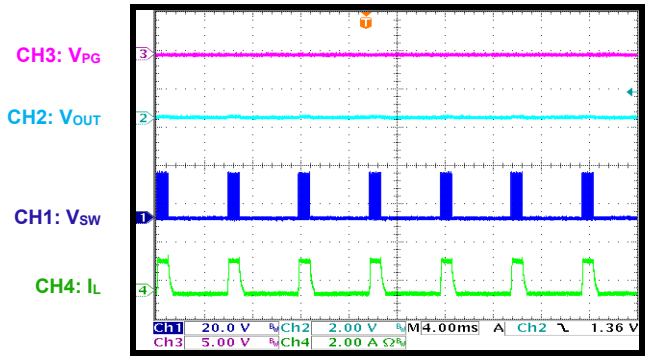
SCP Recovery
I_{OUT} = 0A, FCCM



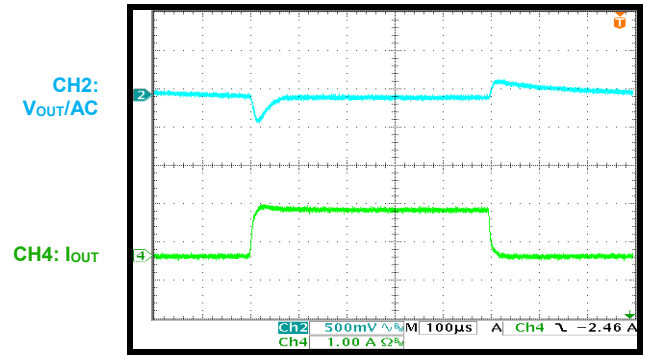
SCP Recovery
I_{OUT} = 2.5A



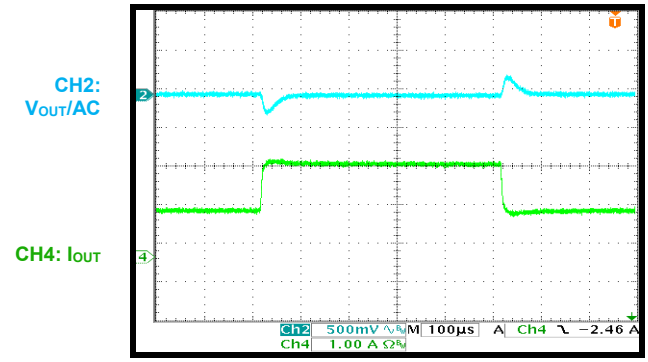
SCP Steady State



Load Transient
I_{OUT} = 0A to 1.5A, AAM mode



Load Transient
I_{OUT} = 1A to 2.5A, AAM mode

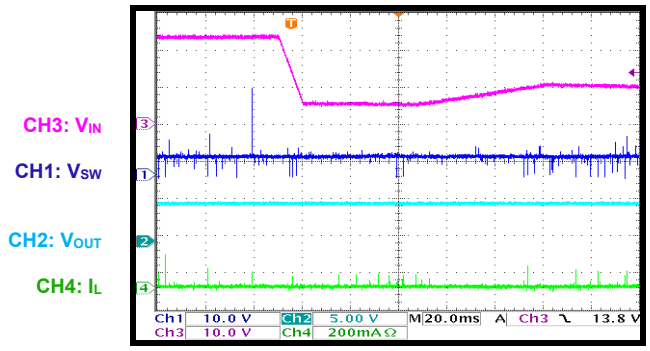


EVB TEST RESULTS *(continued)*

Performance curves and waveforms are tested on the evaluation board. V_{IN} = 24V, V_{OUT} = 5V, L = 15µH, f_{SW} = 400kHz, T_A = 25°C, unless otherwise noted.

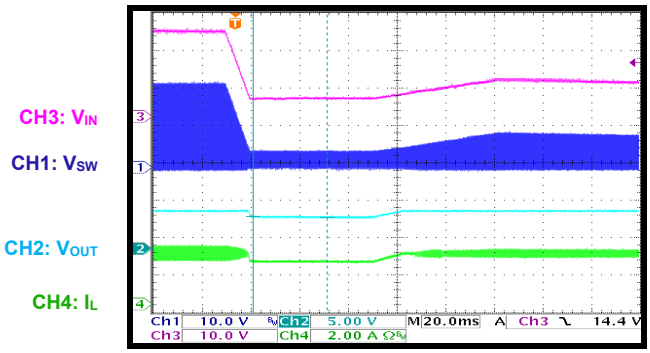
Cold Crank

V_{IN} = 24V to 6V to 10V, I_{OUT} = 0A



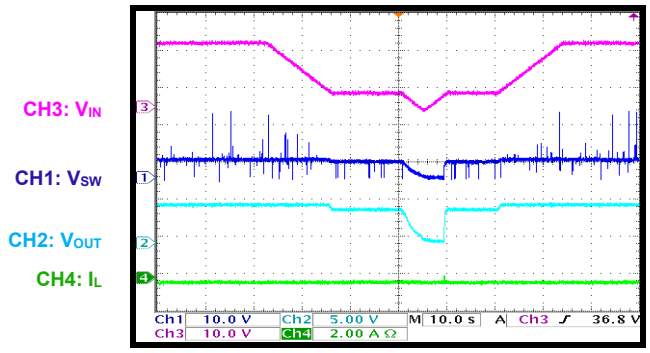
Cold Crank

V_{IN} = 24V to 6V to 10V, I_{OUT} = 2.5A



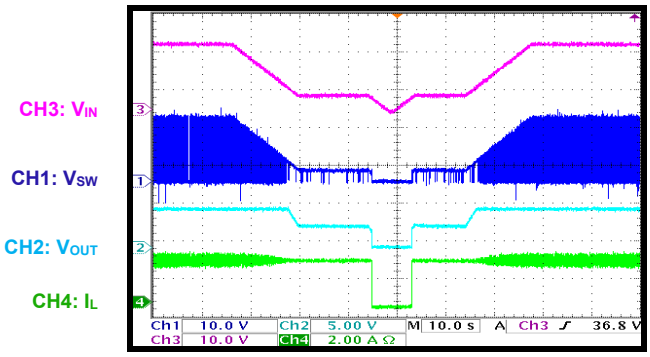
VIN Ramps Down and Up

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



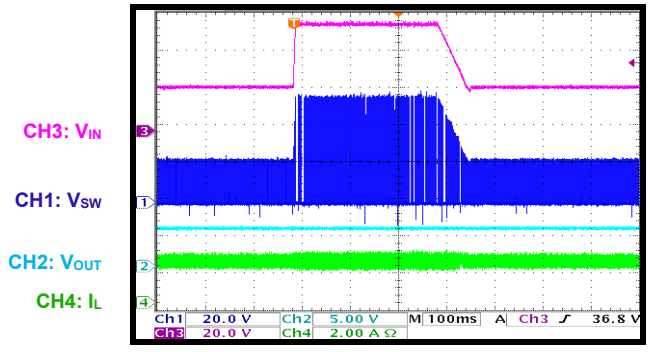
VIN Ramps Down and Up

V_{IN} = 18V to 4.5V to 0V to 4.5V to 18V,
I_{OUT} = 2.5A



Load Dump

V_{IN} = 24V to 58V to 24V, I_{OUT} = 2.5A



PCB LAYOUT

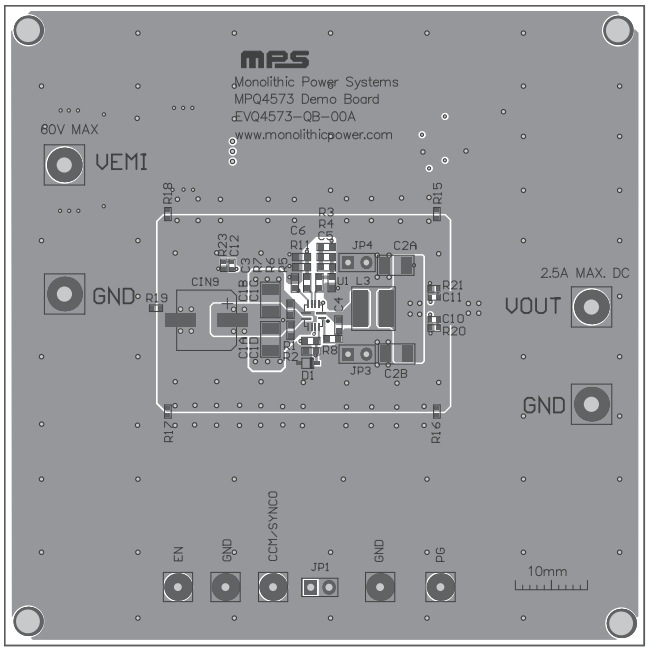


Figure 3: Top Silk and Top Layer

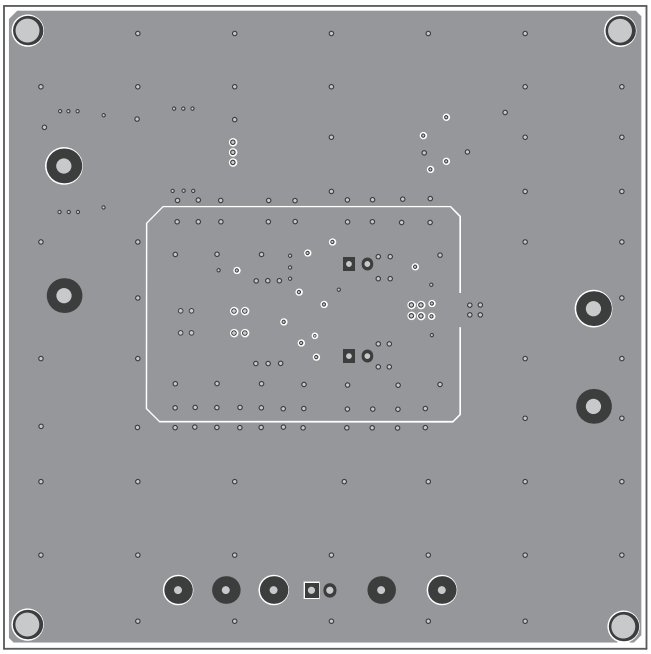


Figure 4: Mid-Layer 1

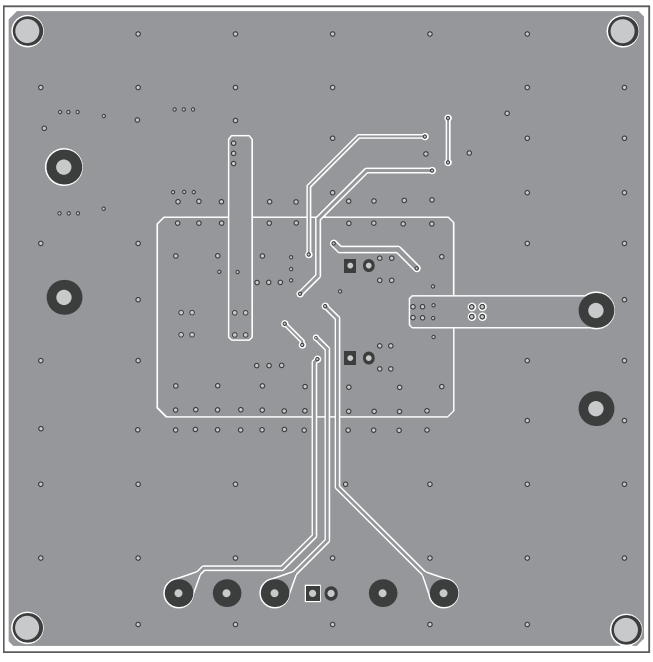


Figure 5: Mid-Layer 2

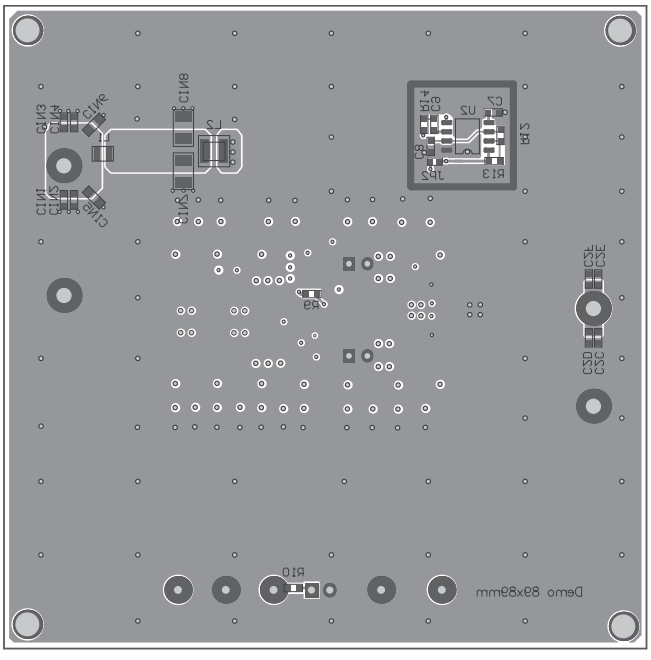


Figure 6: Bottom Layer and Bottom Silk

REVISION HISTORY

Revision #	Revision Date	Description	Pages Updated
1.0	5/25/2021	Initial Release	-