EVQ4571-QB-00A

60V, 1A, High-Efficiency, Synchronous Buck Converter Evaluation Board

DESCRIPTION

The EVQ4571-QB-00A evaluation board is designed to demonstrate the capabilities of MPS's MPQ4571/MPQ4571-AEC1.

The MPQ4571/MPQ4571-AEC1 is a fully-integrated, fixed-frequency, synchronous step-down converter. It can achieve up to 1A of continuous output current with peak current control for excellent transient response.

The MPQ4571/MPQ4571-AEC1 employs advanced asynchronous mode (AAM) to achieve high efficiency under light-load conditions by scaling down the switching frequency. This reduces switching and gate driving losses.

The EVQ4571-QB-00A is a fully assembled and tested evaluation board that can generate a 5V output voltage at load currents up to 1A from a 5V to 60V input range.

ELECTRICAL SPECIFICATIONS

Parameter	Symbol	Value	Units
Input voltage	V_{EMI}	5 to 60	V
Output voltage	V_{OUT}	5	V
Output current	I_{OUT}	1	A

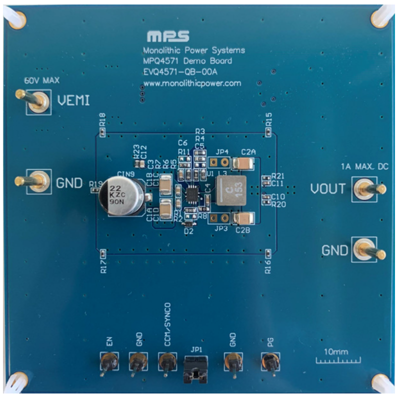
FEATURES

- Wide 5V to 60V Operating Input Range with 1A Continuous Output Current
- High-Efficiency Synchronous Mode Control
- 250mΩ/45mΩ Internal Power MOSFETs
- Configurable Frequency Up to 2.2MHz
- 180° Out-of-Phase SYNCO Clock
- 40μA Quiescent Current
- Low Shutdown Mode Current: 2μA
- Selectable AAM or Forced CCM Operation at Light-Load
- Internal 0.45ms Soft Start
- Remote EN Control
- Power Good Indicator
- Low-Dropout Mode
- Over-Current Protection
- Thermal Shutdown
- Available in a QFN-12 (2.5mmx3mm) Package
- AEC-Q100 Grade 1

APPLICATIONS

- Automotive Systems
- Industrial Power Systems

EVALUATION BOARD

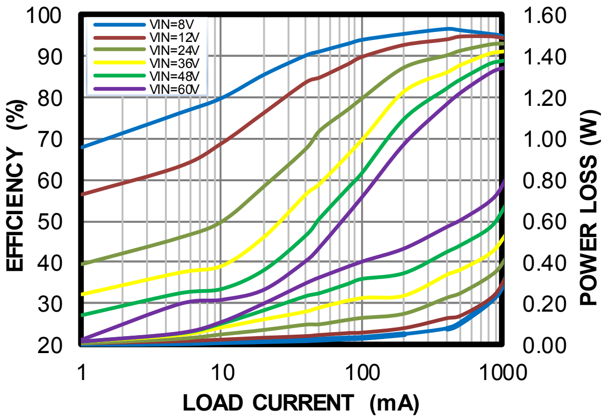


(LxWxH) 8.3cmx8.3cmx1.3cm

Board Number	MPS IC Number
EVQ4571-QB-00A	MPQ4571GQB-AEC1

Efficiency vs. Load Current vs. Power Loss

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



QUICK START GUIDE

1. Preset the power supply (V_{IN}) between 5V and 60V. Electronic loads represent a negative impedance to the regulator, and will trigger hiccup mode if set to a sufficiently high current.
2. Turn the power supply off. If longer cables are used between the source and the EVB (>0.5m total), install a damping capacitor at the input terminal, especially when V_{IN} exceeds 24V.
3. Connect the power supply terminals to:
    a. Positive (+): VEMI
    b. Negative (-): GND
4. Connect the load to:
    a. Positive (+): VOUT
    b. Negative (-): GND
5. Turn the power supply on after making the connections.
6. To use the enable function, apply a digital input to the EN pin. Drive EN above 1.45V to turn on the regulator; drive EN below 1.12V to turn it off.
7. The oscillating frequency of the MPQ4571/MPQ4571-AEC1 can be configured by an external frequency resistor (R_{FREQ}). R_{FREQ} can be estimated with Equation (1):

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

    The calculated resistance may need fine-tuning via bench test.
8. The output voltage is set by the below T-type feedback network figure (see Figure 1).

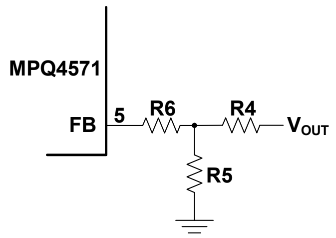


Figure 1: T-Type Feedback Network

The resistors (R6 + R4) also sets the loop bandwidth with the internal compensation capacitor. Choose R4 to be about 40kΩ. Then R5 can be calculated with Equation (2):

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

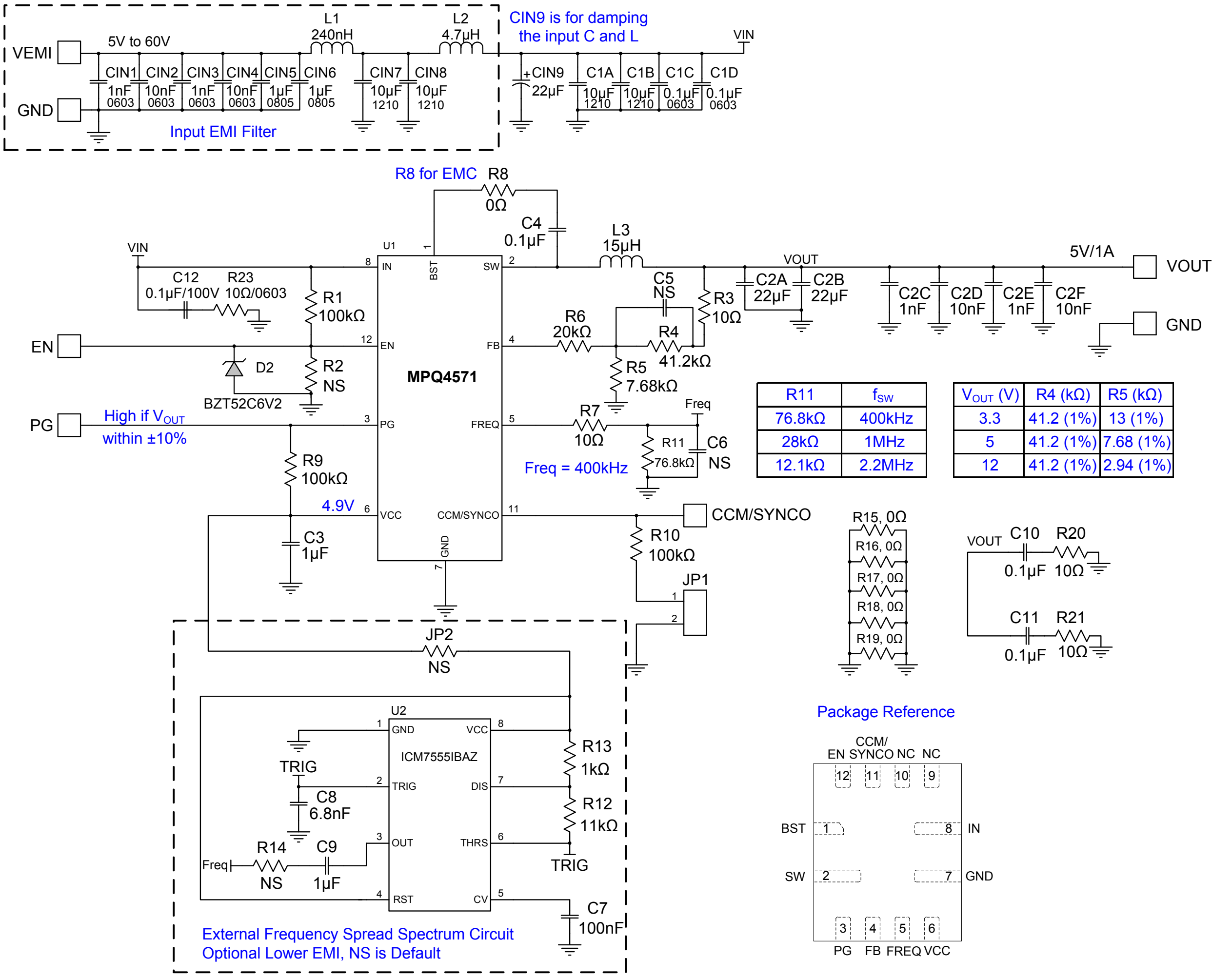
Table 1 lists the recommended feedback resistor values for common output voltages.

Table 1: Feedback Resistor for Output Voltages

V_{OUT} (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%)
12	41.2 (1%)	2.94 (1%)	20 (1%)

9. JP3 and JP4 can be used to install an external shielding above inductor and IC. JP3 and JP4 are not required components for the application.

EVALUATION BOARD SCHEMATIC



R11	f_{SW}
76.8kΩ	400kHz
28kΩ	1MHz
12.1kΩ	2.2MHz

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

BILL OF MATERIALS

Qty	Ref	Value	Description	Package	Manufacturer	Manufacturer P/N
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, 63V, SMD	SMD	Jianghai	VTD-63V22
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
4	C4, C7, C10, C11	0.1µF	Ceramic capacitor, 16V, X7R	0603	Murata	GRM188R71C104KA01D
1	C8	6.8nF	Ceramic capacitor, 50V, X7R	0603	TDK	C1608X7R1H682K
2	C5, C6	NS				
1	L1	240nH	Inductor, 240nH, 19mΩ, 6.6A	SMD	Toko	DFE201612E-R24M
1	L2	4.7uH	Inductor, 4.7µH, 83mΩ, 3.6A	SMD	Toko	FDSD0402-H-4R7M
1	L3	15µH	Inductor, 15µH, 40mΩ, 5.8A	SMD	Coilcraft	XAL6060-153MEB
3	R1, R9, R10	100kΩ	Film resistor, 1%	0603	Yageo	RC0603FR-07100KL
3	R2, JP2, R14	NS				

BILL OF MATERIALS *(continued)*

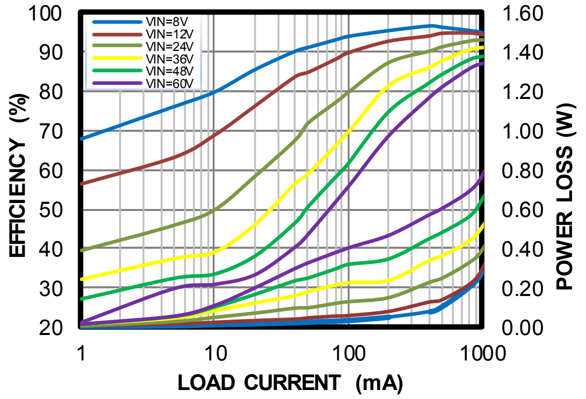
Qty	Ref	Value	Description	Package	Manufacturer	Manufacturer P/N
5	R3, R7, R20, R21, R23	10Ω	Film resistor, 1%	0603	Yageo	RC0603FR-0710RL
1	R4	41.2kΩ	Film resistor, 1%	0603	Yageo	RC0603FR-0741K2L
1	R5	7.68kΩ	Film resistor, 1%	0603	Yageo	RC0603FR-077K68L
1	R6	20kΩ	Film resistor, 1%	0603	Yageo	RC0603FR-0720KL
6	R8, R15, R16, R17, R18, R19	0	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
1	D2		Zener diode, 6.2V	SOD323	Diodes	BZT52C6V2
1	U1	MPQ4571	Step-down regulator	QFN12 (2.5mmx 3.0mm)	MPS	MPQ4571GQB-AEC1
1	U2		CMOS RC timer	SOP-8	Intersil	ICM7555IBAZ
1	JP1		2.54mm test pin		HZ	Any
4	VEMI, GND, GND, VOUT		2.0 golden pin		HZ	Any
2	JP3, JP4	NS				

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.

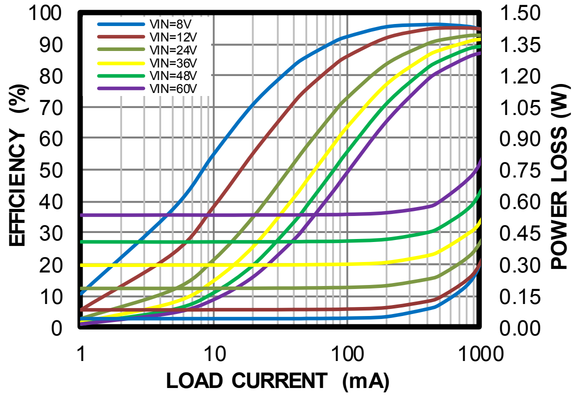
Efficiency vs. Load Current vs. Power Loss

f_{SW} = 400kHz, L = 15µH, AAM



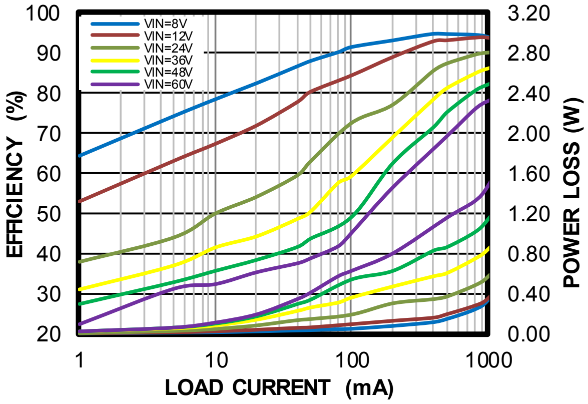
Efficiency vs. Load Current vs. Power Loss

f_{SW} = 400kHz, L = 15µH, CCM



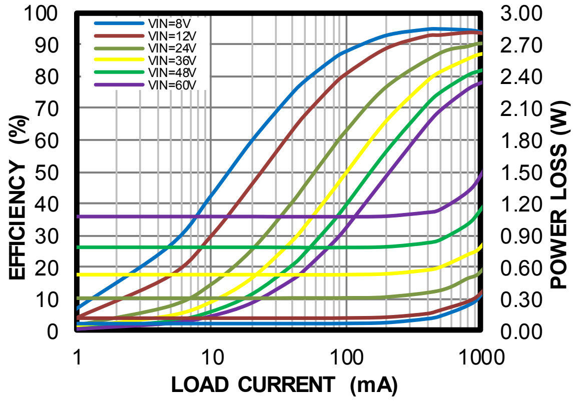
Efficiency vs. Load Current vs. Power Loss

f_{SW} = 1MHz, L = 10µH, AAM



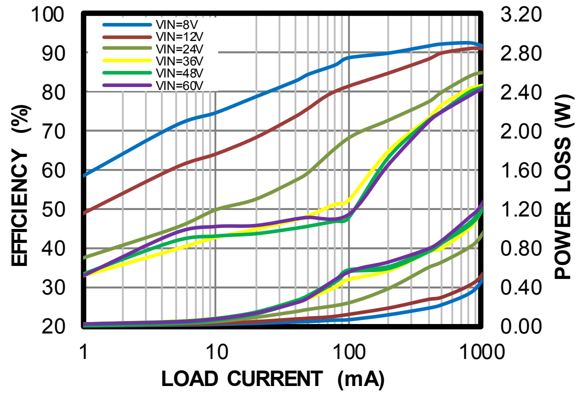
Efficiency vs. Load Current vs. Power Loss

f_{SW} = 1MHz, L = 10µH, CCM



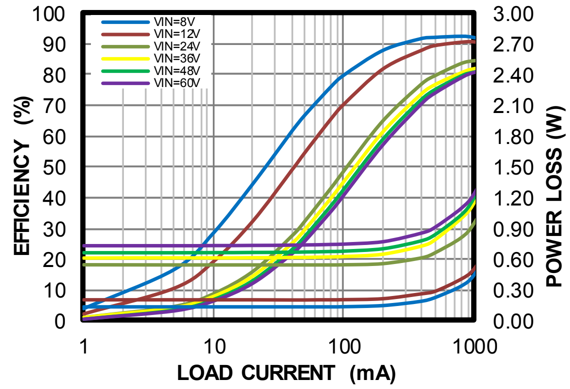
Efficiency vs. Load Current vs. Power Loss

f_{SW} = 2.2MHz, L = 4.7µH, AAM



Efficiency vs. Load Current vs. Power Loss

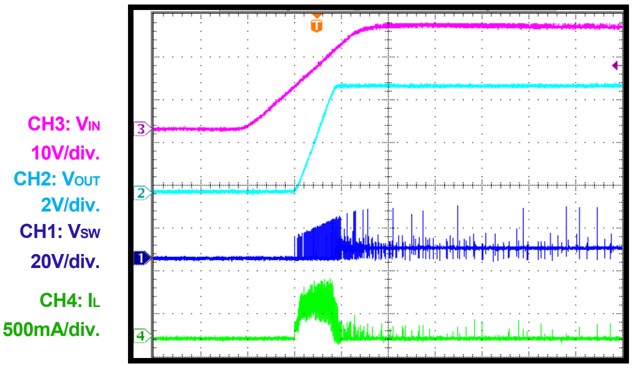
f_{SW} = 2.2MHz, L = 4.7µH, CCM



EVB TEST RESULTS *(continued)*

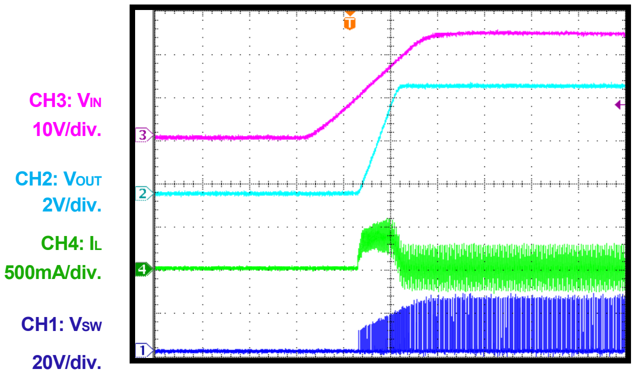
Performance curves and waveforms are tested on the evaluation board. V_{IN} = 24V, V_{OUT} = 5V, L = 15µH, f_{SW} = 400kHz, T_A = 25°C, unless otherwise noted.

Start-Up through Input Voltage
I_{OUT} = 0A, AAM



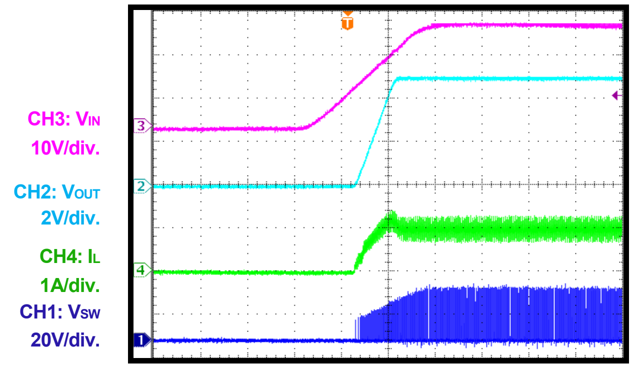
1ms/div.

Start-Up through Input Voltage
I_{OUT} = 0A, CCM



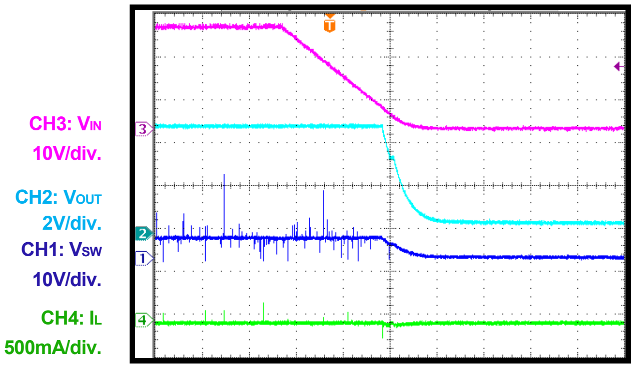
1ms/div.

Start-Up through Input Voltage
I_{OUT} = 1A



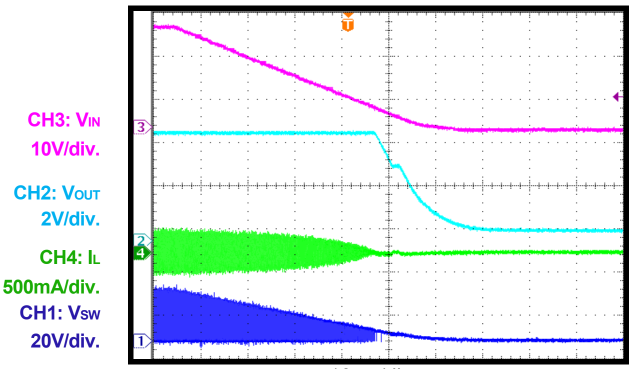
1ms/div.

Shutdown through Input Voltage
I_{OUT} = 0A, AAM



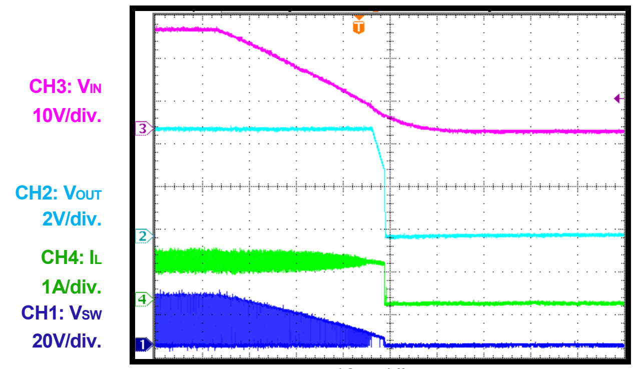
20ms/div.

Shutdown through Input Voltage
I_{OUT} = 0A, CCM



10ms/div.

Shutdown through Input Voltage
I_{OUT} = 1A

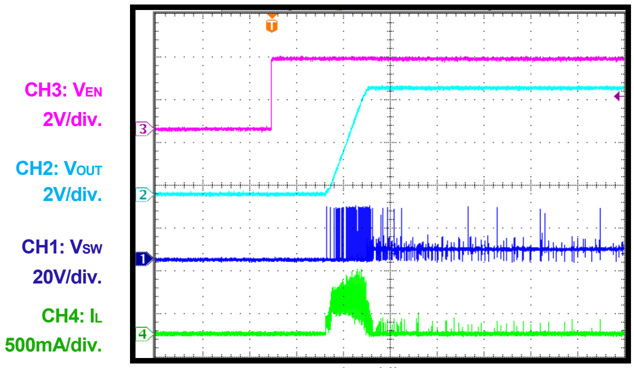


10ms/div.

EVB TEST RESULTS *(continued)*

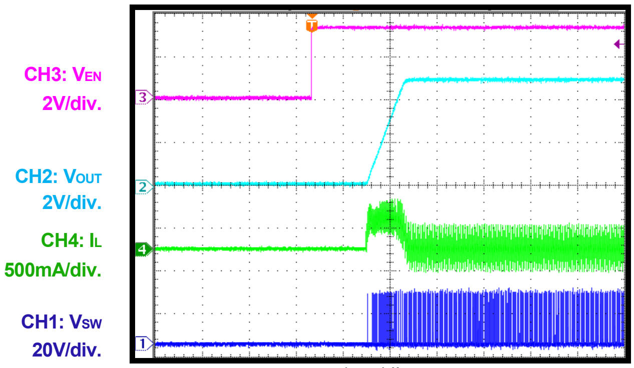
Performance curves and waveforms are tested on the evaluation board. V_{IN} = 24V, V_{OUT} = 5V, L = 15µH, f_{SW} = 400kHz, T_A = 25°C, unless otherwise noted.

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



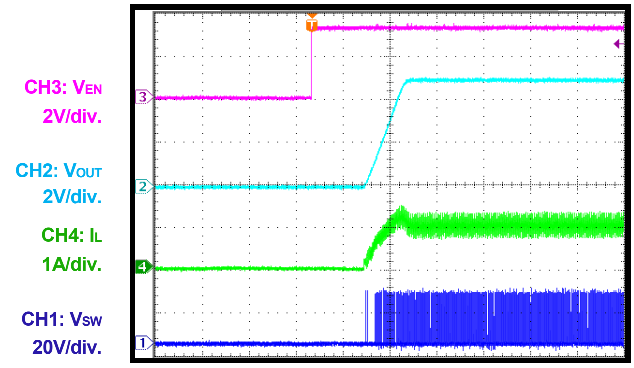
1ms/div.

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



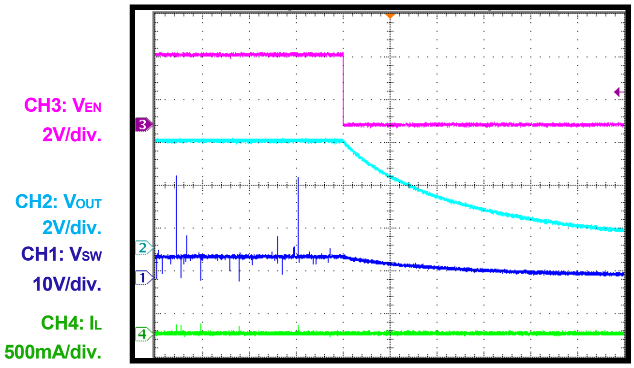
1ms/div.

Start-Up through EN
I_{OUT} = 1A



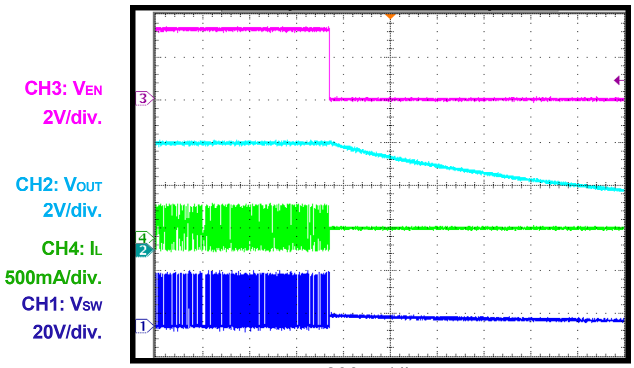
1ms/div.

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



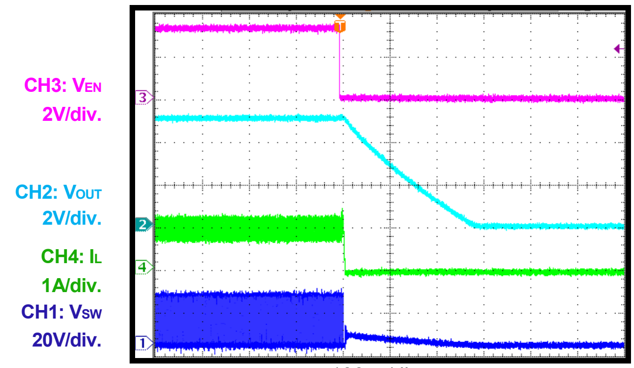
1s/div.

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



200ms/div.

Shutdown through EN
I_{OUT} = 1A



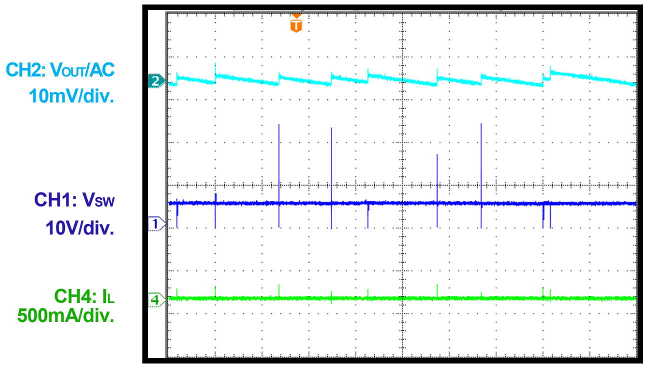
100µs/div.

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

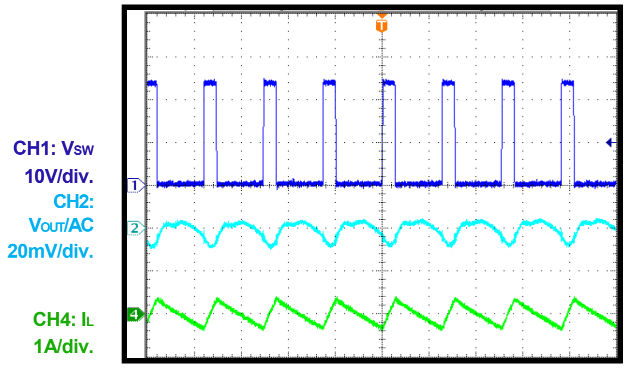
I_{OUT} = 0A, AAM



400µs/div.

Output Ripple

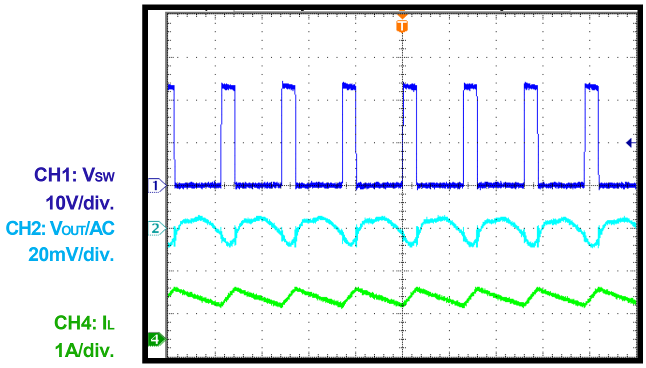
I_{OUT} = 0A, CCM



2µs/div.

Output Ripple

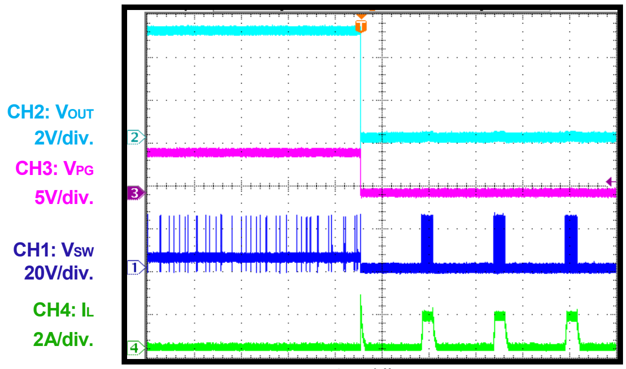
I_{OUT} = 1A



2µs/div.

SCP Entry

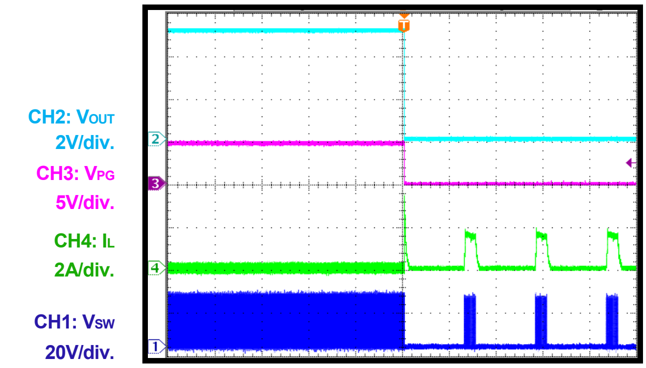
I_{OUT} = 0A, AAM



4ms/div.

SCP Entry

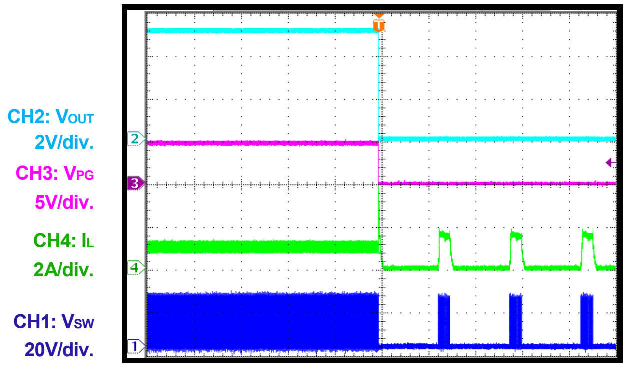
I_{OUT}= 0A, CCM



4ms/div.

SCP Entry

I_{OUT} = 1A

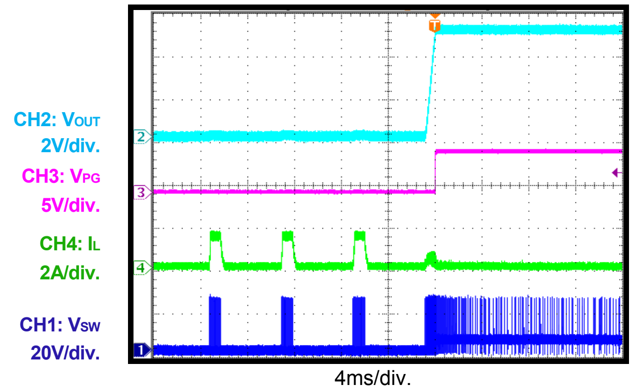


4ms/div.

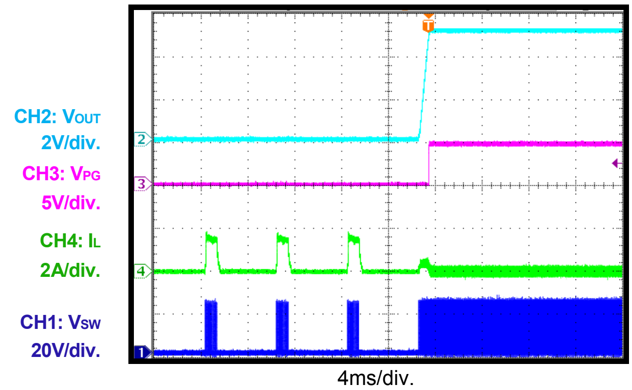
EVB TEST RESULTS *(continued)*

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.

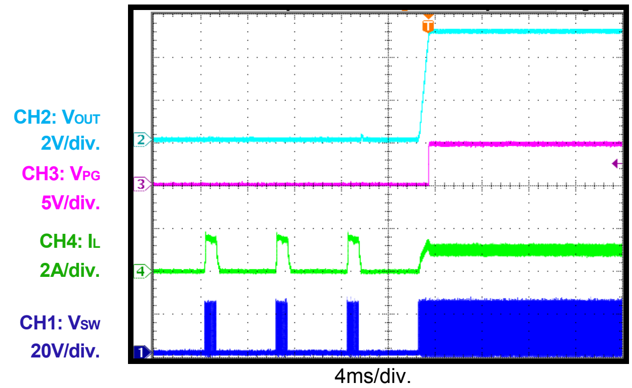
SCP Recovery
I_{OUT} = 0A, AAM



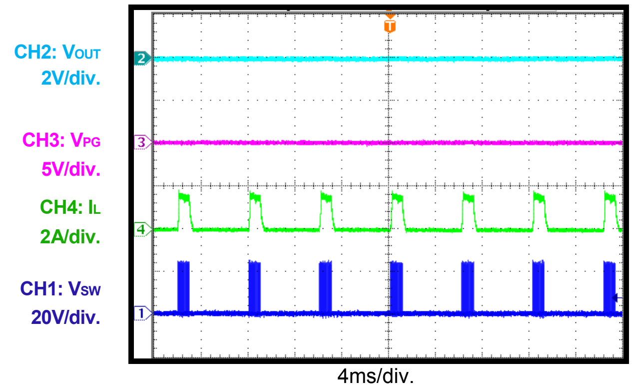
SCP Recovery
I_{OUT} = 0A, CCM



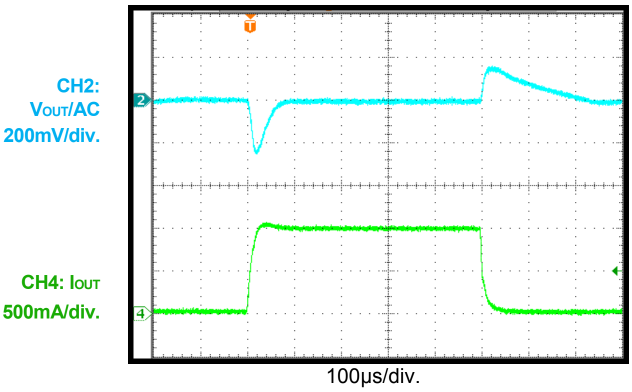
SCP Recovery
I_{OUT} = 1A



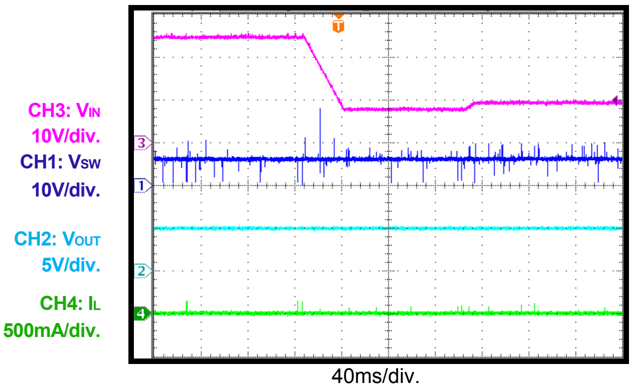
SCP Steady State



Load Transient
I_{OUT} = 0A to 1A, AAM



Cold Crank
V_{IN} = 24V to 4V to 5V, I_{OUT} = 0A

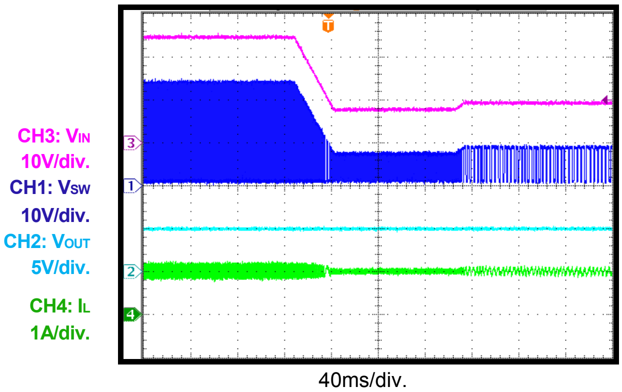


EVB TEST RESULTS *(continued)*

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.

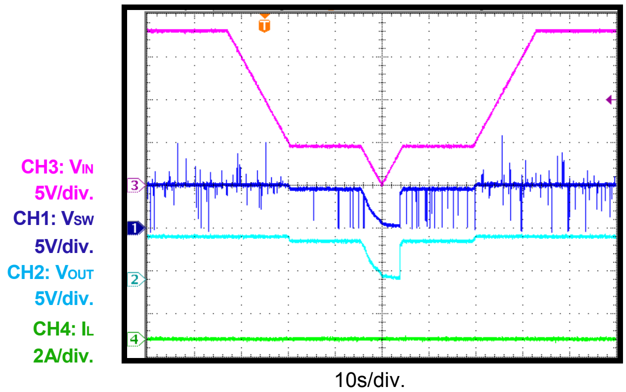
Cold Crank

V_{IN} = 24V to 4V to 5V, I_{OUT} = 1A



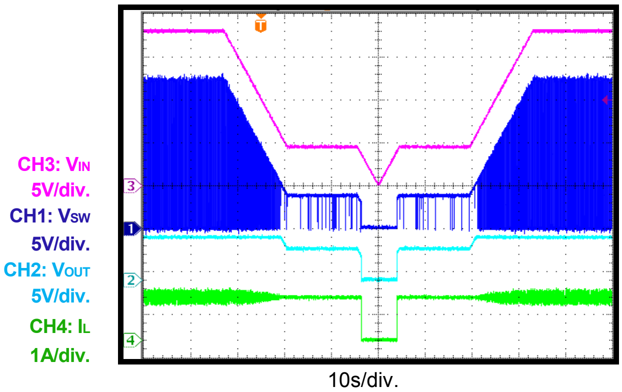
VIN Ramp Down and Up

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



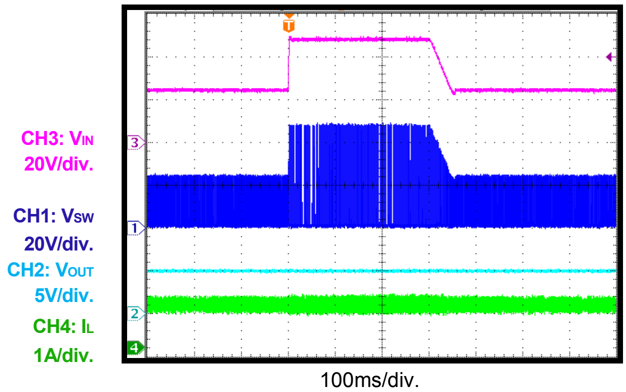
VIN Ramp Down and Up

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



Load Dump

V_{IN} = 24V to 48V to 24V, I_{OUT} = 1A



PCB LAYOUT

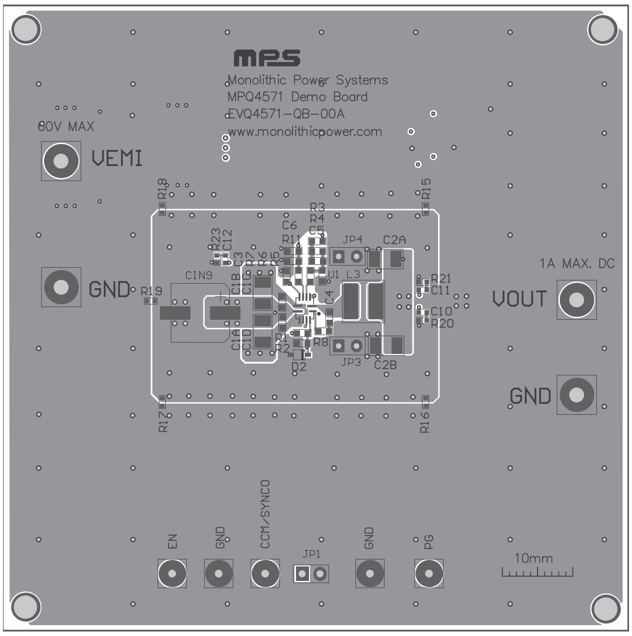


Figure 1: Top Silk and Top Layer

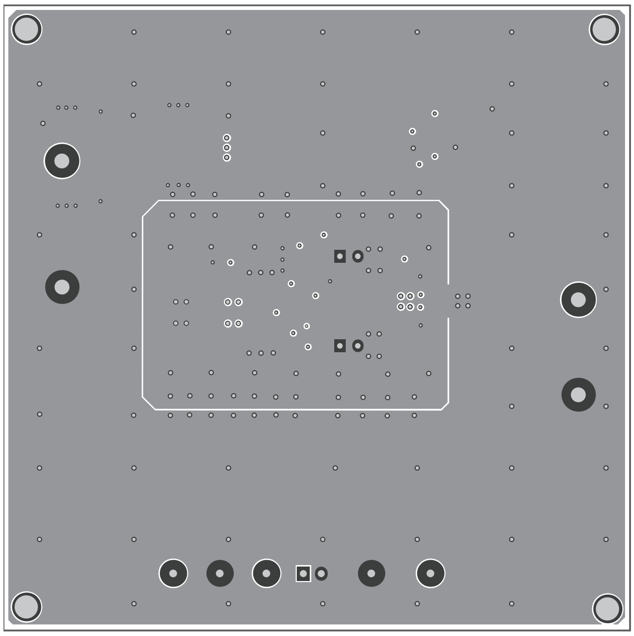


Figure 2: IN1 Layer

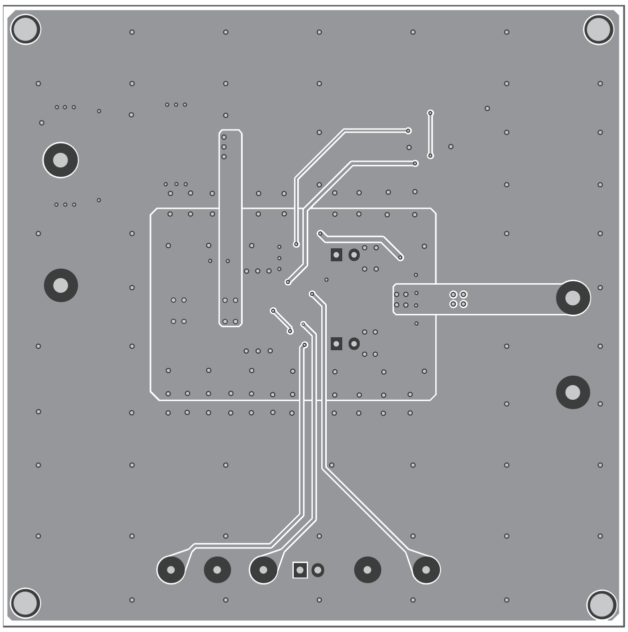


Figure 3: IN2 Layer

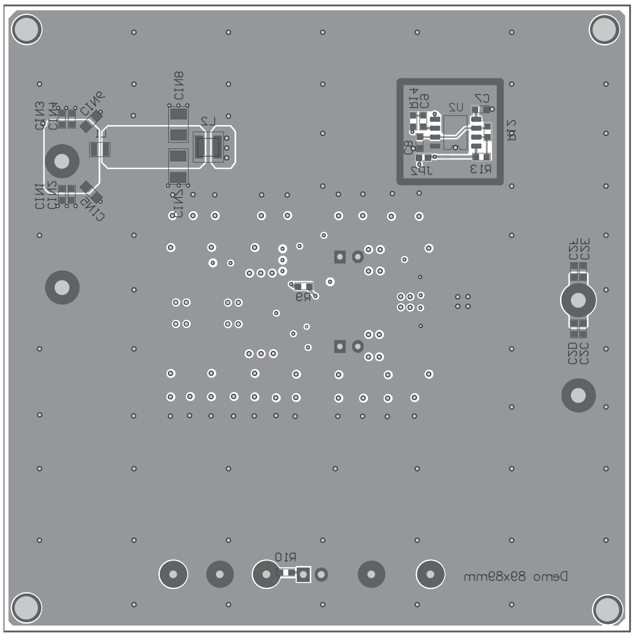


Figure 4: Bottom Silk and Bottom Layer