



# EVQ4431-L-00A

## 36V, 1A, Low Quiescent Current, Synchronous Step-Down Converter Evaluation Board

### DESCRIPTION

The EVQ4431-L-00A evaluation board is designed to demonstrate the capabilities of the MP4431 and the MPQ4431.

The MPQ4431 is a frequency-configurable (350kHz to 2.5MHz), synchronous, step-down switching regulator with integrated, internal high-side and low-side power MOSFETs. It provides up to 1A of highly efficient output current with current mode control for fast loop response.

The MPQ4431 employs advanced asynchronous mode (AAM) to achieve high efficiency under light-load conditions by scaling down the switching frequency. This reduces the switching and gate driving losses.

The EVQ4431-L-00A is a fully assembled and tested evaluation board, it generates 3.3V of output voltage at load currents up to 1A from a 3.3V to 36V input voltage range with 450kHz switching frequency.

The MPQ4431 is available in a QFN-16 (3mmx4mm) package.

### ELECTRICAL SPECIFICATIONS

Parameter	Symbol	Value	Units
Input voltage	$V_{EMI}$	3.3 to 36	V
Output voltage	$V_{OUT}$	3.3	V
Output current	$I_{OUT}$	1	A

### FEATURES

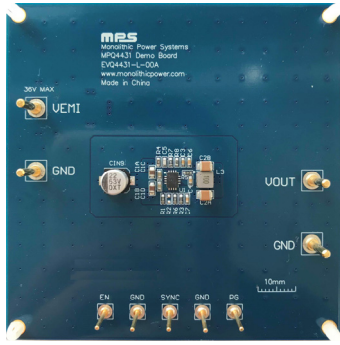
- Wide 3.3V to 36V Operating Input Voltage Range
- 1A of Continuous Output Current
- 1 $\mu$ A Low Shutdown Mode Current
- 10 $\mu$ A Sleep Mode Quiescent Current
- Internal 90m $\Omega$  High-Side and 80m $\Omega$  Low-Side MOSFETs
- 350kHz to 2.5MHz Configurable Switching Frequency
- Synchronize to External Clock, Selectable In-Phase or 180° Out-of-Phase
- Power Good Indicator
- Configurable Soft-Start Time
- 80ns Minimum On Time
- Selectable FCCM and AAM
- Low-Dropout Mode
- Over-Current Protection with Valley Current Detection and Hiccup Mode
- Thermal Shutdown
- Available in a QFN-16 (3mmx4mm) Package
- Available with Wettable Flanks
- AEC-Q100 Grade 1

### APPLICATIONS

- Automotive Systems
- Industrial Power Systems

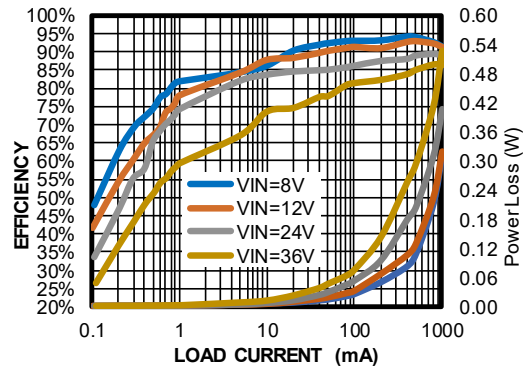
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## EVQ4431-L-00A EVALUATION BOARD



LxWxH (8.9cmx8.9cmx2cm)

**Efficiency vs. Load Current**  
 $V_{OUT} = 3.3V$ , AAM



Board Number	MPS IC Number
EVQ4431-L-00A	MP4431GL, MPQ4431GL

## QUICK START GUIDE

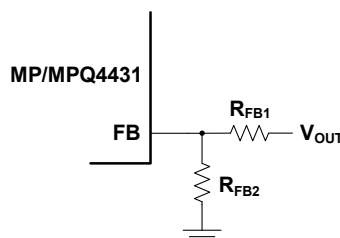
1. Preset the power supply ( $V_{IN}$ ) to be between 3.3V and 36V.  
Note that electronic loads represent a negative impedance to the regulator. If the current is set too high, hiccup mode may be triggered.
2. Turn the power supply off.  
If longer cables (>0.5m total) are used between the source and the evaluation board, a damping capacitor should be installed at the input terminals, especially if  $V_{IN} \geq 24V$ .
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. 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 1.05V to turn the device on; drive EN below 0.93V to turn it off.
7. The IC's oscillating frequency can be configured by an external frequency resistor ( $R_{FREQ}$ ).  $R_{FREQ}$  can be estimated with Equation (1):

$$R_{FREQ}(\text{k}\Omega) = \frac{170000}{f_{SW}^{1.11}(\text{kHz})} \quad (1)$$

8. To use the sync function, apply a 350kHz to 2.5MHz clock to the SYNC pin to synchronize the internal oscillator frequency to the external clock. The external clock should be at least 250kHz above the frequency set by  $R_{FREQ}$ . The SYNC pin can also select forced continuous conduction mode (FCCM) or advanced asynchronous mode (AAM). Drive SYNC high before the chip starts up to choose FCCM; drive SYNC low (or leave it floating) to select AAM.
9. The output voltage is set by the external resistor divider. The feedback resistor ( $R_{FB1}$ ) also sets the feedback loop bandwidth with the internal compensation capacitor. For different output voltages,  $R_{FB1}$  and  $R_{FB2}$  can be calculated with Equation (2):

$$R_{FB2} = \frac{R_{FB1}}{\frac{V_{OUT}}{0.8V} - 1} \quad (2)$$

Figure 1 shows the resistor divider set-up.



**Figure 1: Resistor Divider Set-Up**

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

**Table 1: Recommended Resistor Dividers**

<b>V<sub>OUT</sub> (V)</b>	<b>R<sub>FB1</sub> (kΩ)</b>	<b>R<sub>FB2</sub> (kΩ)</b>
1.8	41.2 (1%)	33 (1%)
2.5	41.2 (1%)	19.6 (1%)
3.3	41.2 (1%)	13 (1%)
5	41.2 (1%)	7.68 (1%)
12	41.2 (1%)	2.94 (1%)

# EVALUATION BOARD SCHEMATIC

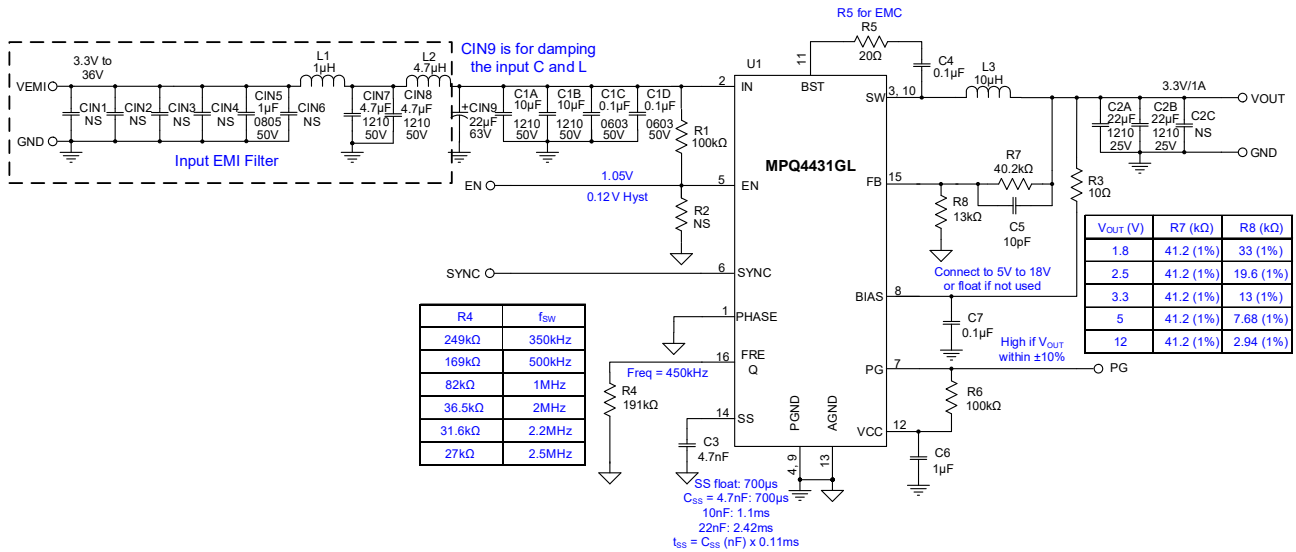
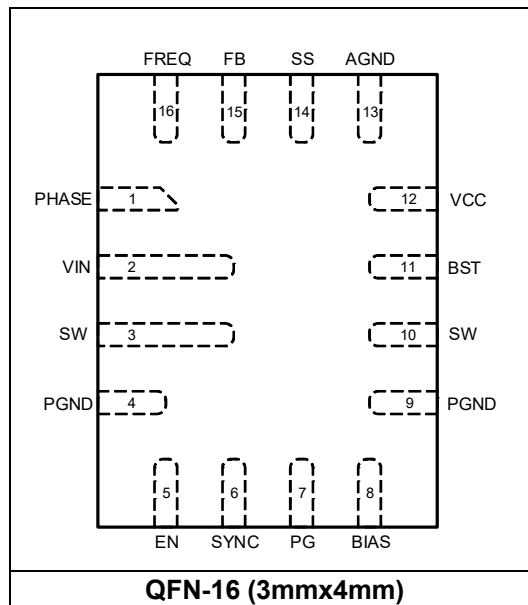


Figure 2: Evaluation Board Schematic

## PACKAGE REFERENCE



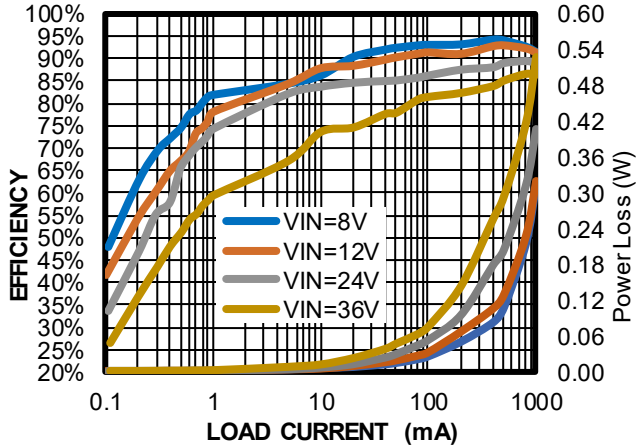
**EVQ4431-L-00A BILL OF MATERIALS**

Qty	Ref	Value	Description	Package	Manufacture	Manufacturer P/N
1	CIN5	1 $\mu$ F	Ceramic capacitor, 50V, X7R	0805	Murata	GRM21BR71H105KA12 L
4	CIN7, CIN8, C1A, C1B	4.7 $\mu$ F	Ceramic capacitor, 50V, X7S	0805	Murata	GRM21BR71H475KE11 L
1	CIN9	22 $\mu$ F	Electrolytic capacitor, 63V	SMD	Jianghai	VTD-63V22
2	C1C, C1D	0.1 $\mu$ F	Ceramic capacitor, 50V, X7R	0603	Murata	GRM188R71H104KA93 D
2	C2A, C2B	22 $\mu$ F	Ceramic capacitor, 16V, X7R	1210	Murata	GRM32ER71C226KEA8 L
1	C3	4.7nF	Ceramic capacitor, 50V, X7R	0603	Murata	GRM188R71H472KA01 D
2	C4, C7	0.1 $\mu$ F	Ceramic capacitor, 16V, X7R	0603	Murata	GRM188R71C104KA01 D
1	C5	10pF	Ceramic capacitor, 50V, C0G	0603	Murata	GRM1885C1H100JA01
1	C6	1 $\mu$ F	Ceramic capacitor, 16V, X7R	0603	Murata	GRM188R71C105KA12 D
6	CIN1, CIN2, CIN3, CIN4, CIN6, C2C	NS				
1	L1	1 $\mu$ H	Inductor, DCR = 41m $\Omega$ , 3.1A	SMD	Cyntec	VCTA20161B-1R0MS6-89
1	L2	4.7 $\mu$ H	Inductor, DCR = 165m $\Omega$ , 1.7A	SMD	Cyntec	VCTA25201B-4R7MS6-89
1	L3	10 $\mu$ H	Inductor, DCR = 48.6m $\Omega$ , 3.7A	SMD	Cyntec	VCHA042A-100MS6-89
2	R1, R6	100k $\Omega$	Film resistor, 1%	0603	Yageo	RC0603FR-07100KL
1	R3	10 $\Omega$	Film resistor, 1%	0603	Yageo	RC0603FR-0710RL
1	R4	191k $\Omega$	Film resistor, 1%	0603	Yageo	RC0603FR-07191KL
1	R5	20 $\Omega$	Film resistor, 1%	0603	Yageo	RC0603FR-0720RL
1	R7	41.2k $\Omega$	Film resistor, 1%	0603	Yageo	RC0603FR-0741K2L
1	R8	13k $\Omega$	Film resistor, 1%	0603	Yageo	RC0603FR-0713KL
1	R10	1k $\Omega$	Film resistor, 1%	0603	Yageo	RC0603FR-071KL
1	R12	11k $\Omega$	Film resistor, 1%	0603	Yageo	RC0603FR-0711KL
1	R2	NS				
1	U1	MPQ4431	Step-down converter	QFN-16 (3mmx4mm)	MPS	MPQ4431GL
4	VEMI, GND, VOUT, GND	Test point	2.0 golden pin	DIP	Any	
5	EN, GND, SYNC, GND, PG	Test point	1.0 golden pin	DIP	Any	

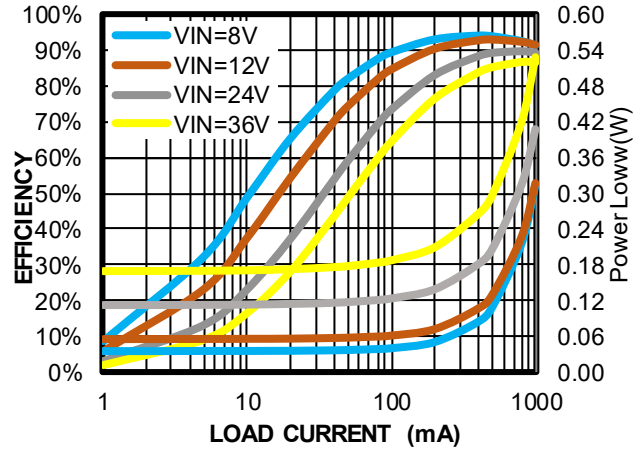
## EVB TEST RESULTS

Performance curves and waveforms are tested on the evaluation board.  $V_{IN} = 12V$ ,  $V_{OUT} = 3.3V$ ,  $L = 10\mu H$ ,  $f_{SW} = 450kHz$ ,  $T_A = 25^\circ C$ , unless otherwise noted.

**Efficiency vs. Load Current**  
 $V_{OUT} = 3.3V$ , AAM

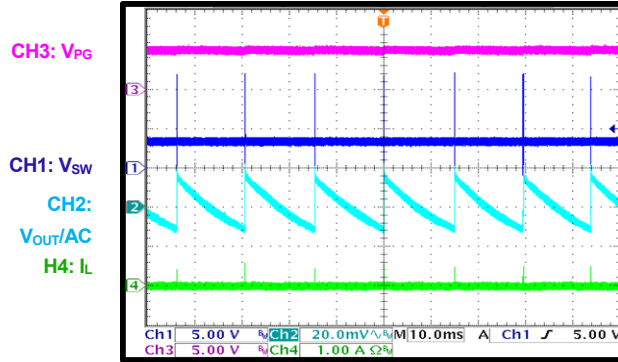
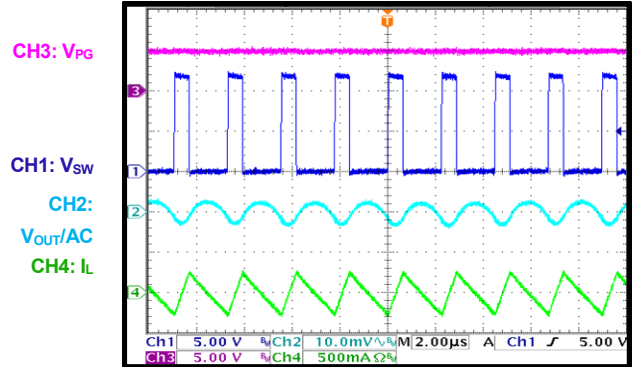
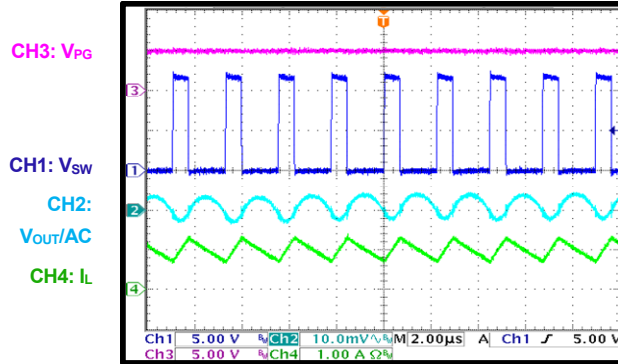
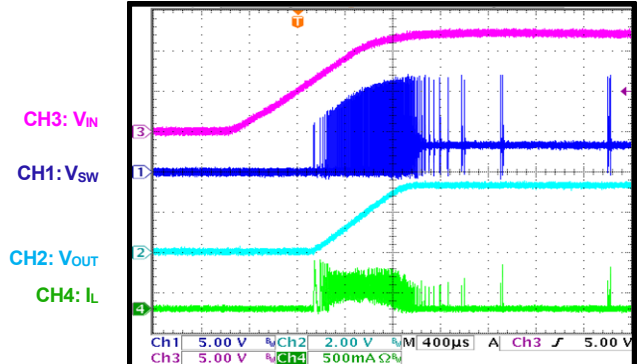
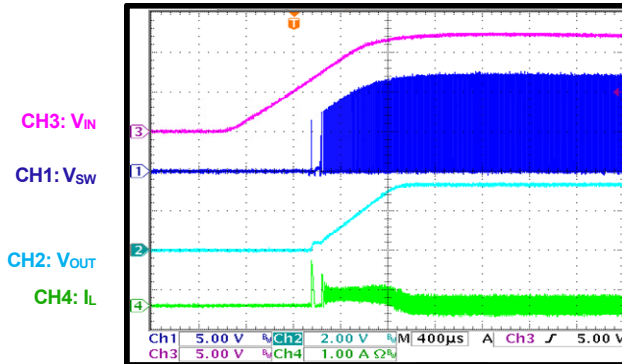
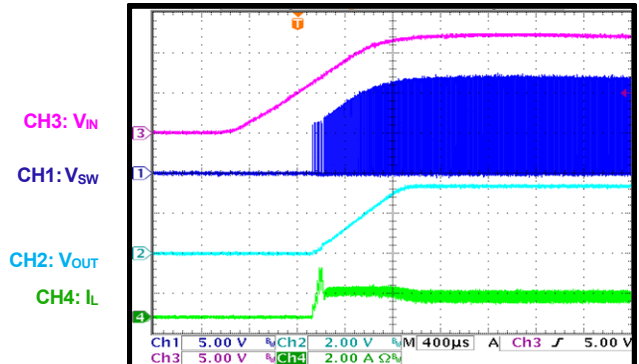


**Efficiency vs. Load Current**  
 $V_{OUT} = 3.3V$ , CCM



**EVB TEST RESULTS (continued)**

Performance curves and waveforms are tested on the evaluation board.  $V_{IN} = 12V$ ,  $V_{OUT} = 3.3V$ ,  $L = 10\mu H$ ,  $f_{SW} = 450kHz$ ,  $T_A = 25^\circ C$ , unless otherwise noted.

**Steady State**
 $V_{IN} = 12V$ ,  $V_{OUT} = 3.3V$ ,  $I_{OUT} = 0A$ , AAM

**Steady State**
 $V_{IN} = 12V$ ,  $V_{OUT} = 3.3V$ ,  $I_{OUT} = 0A$ , CCM

**Steady State**
 $V_{IN} = 12V$ ,  $V_{OUT} = 3.3V$ ,  $I_{OUT} = 1A$ 

**Start-Up**
 $V_{IN} = 12V$ ,  $V_{OUT} = 3.3V$ ,  $I_{OUT} = 0A$ , AAM

**Start-Up**
 $V_{IN} = 12V$ ,  $V_{OUT} = 3.3V$ ,  $I_{OUT} = 0A$ , CCM

**Start-Up**
 $V_{IN} = 12V$ ,  $V_{OUT} = 3.3V$ ,  $I_{OUT} = 1A$ 


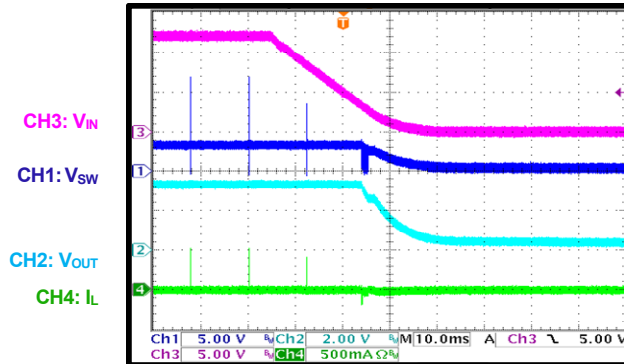


## EVB TEST RESULTS (continued)

Performance curves and waveforms are tested on the evaluation board.  $V_{IN} = 12V$ ,  $V_{OUT} = 3.3V$ ,  $L = 10\mu H$ ,  $f_{SW} = 450kHz$ ,  $T_A = 25^\circ C$ , unless otherwise noted.

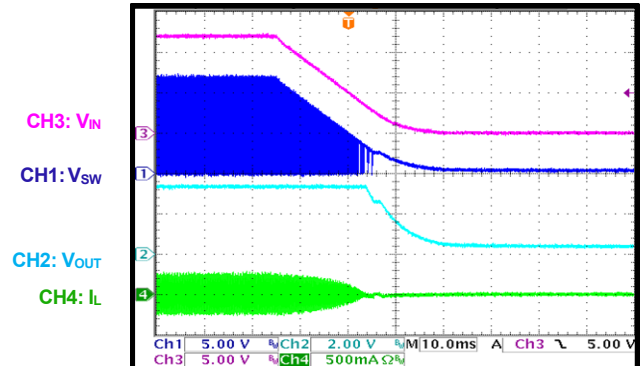
### Shutdown

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



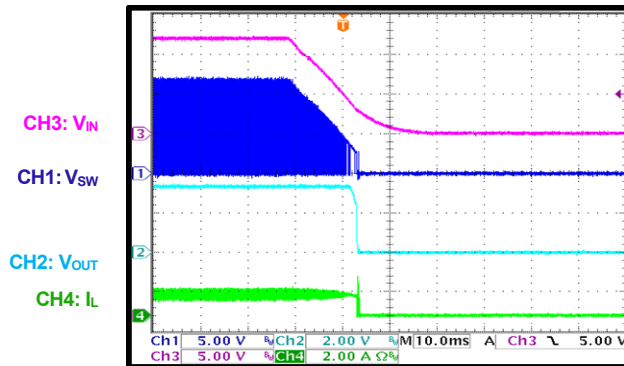
### Shutdown

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



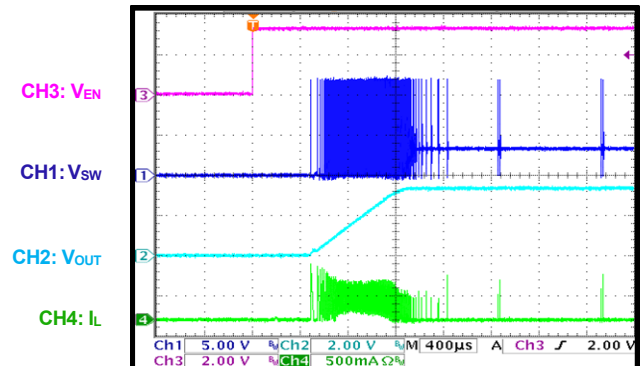
### Shutdown

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



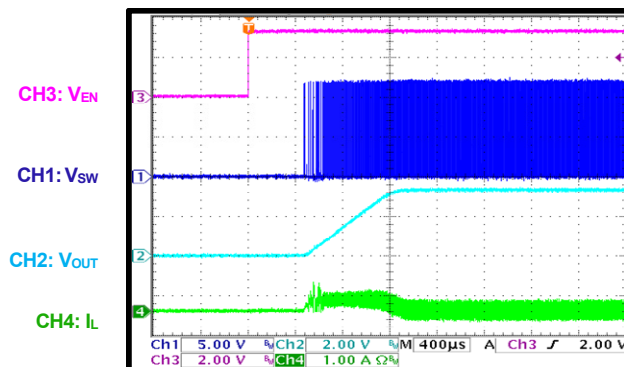
### EN On

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



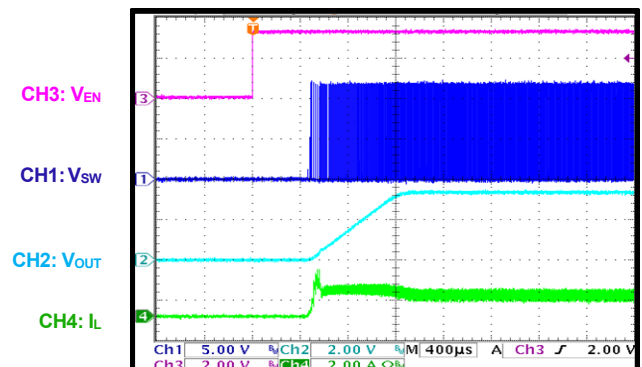
### EN On

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



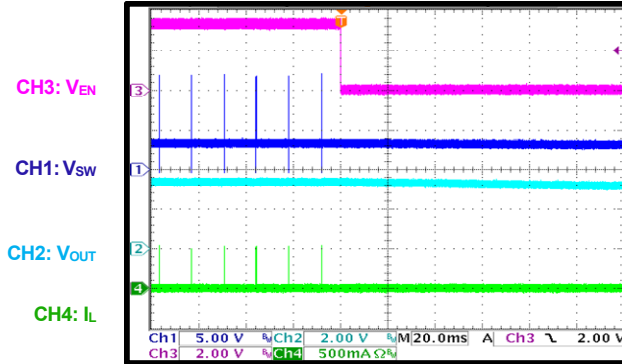
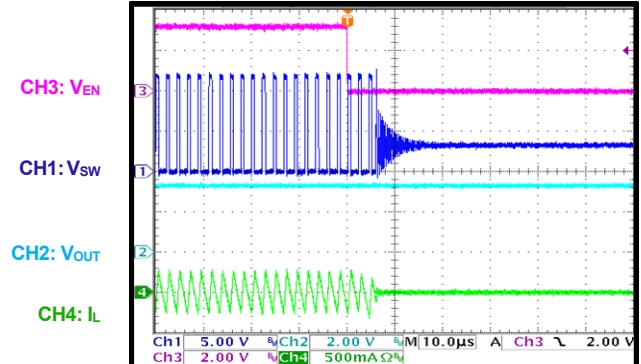
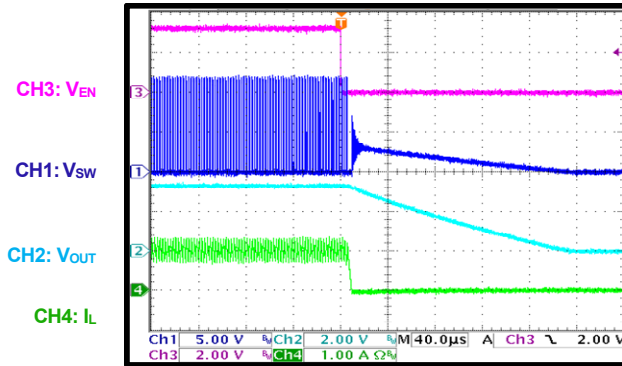
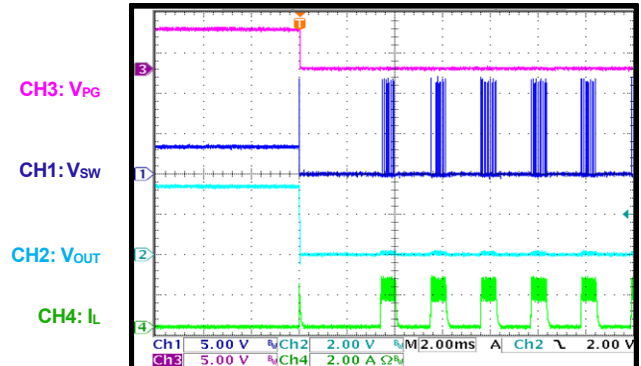
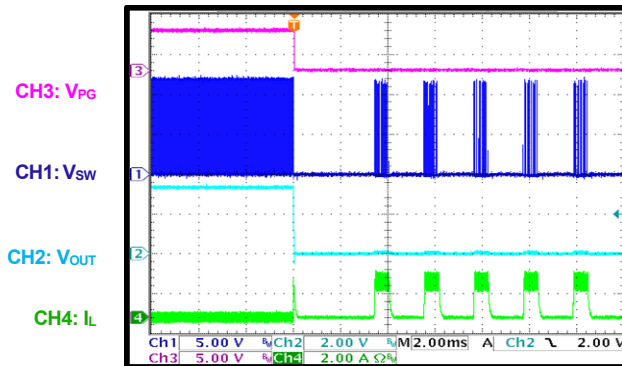
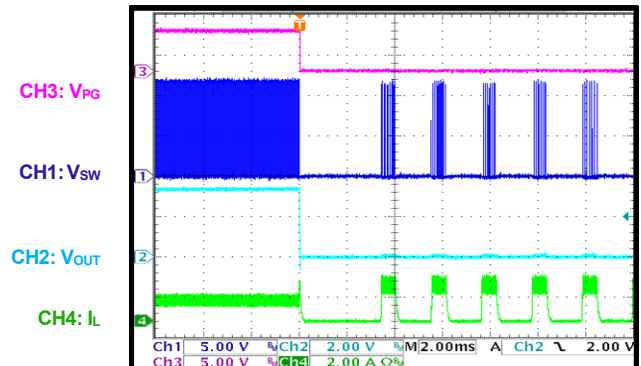
### EN On

$V_{IN} = 12V$ ,  $V_{OUT} = 5V$ ,  $I_{OUT} = 1A$



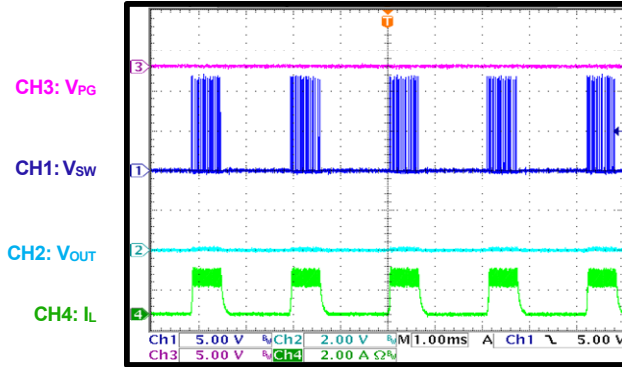
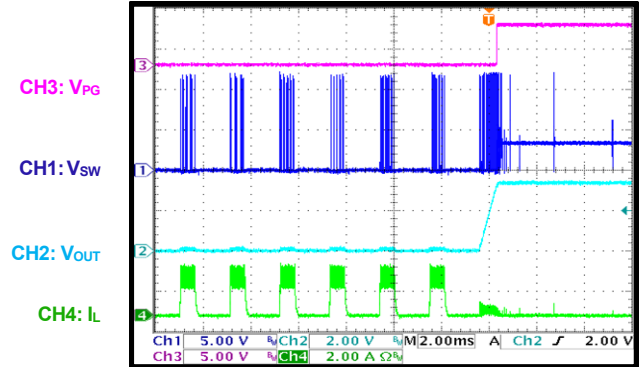
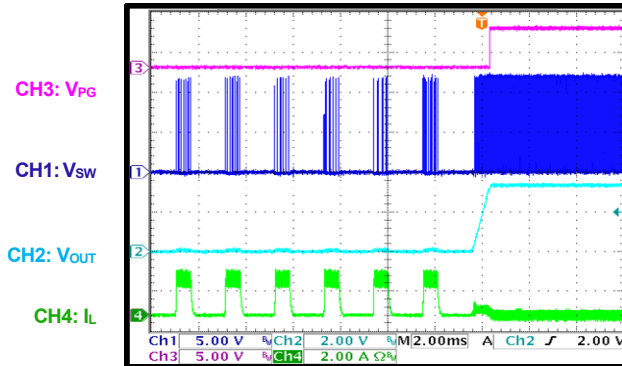
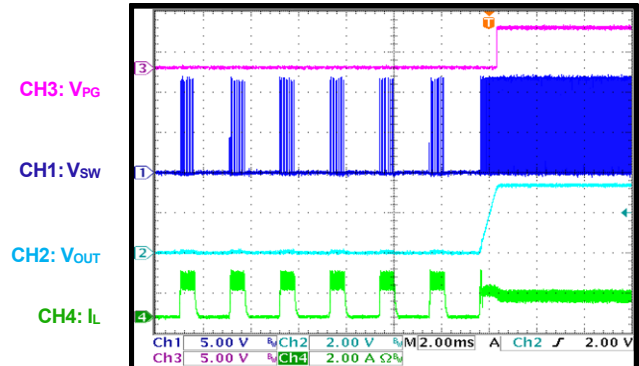
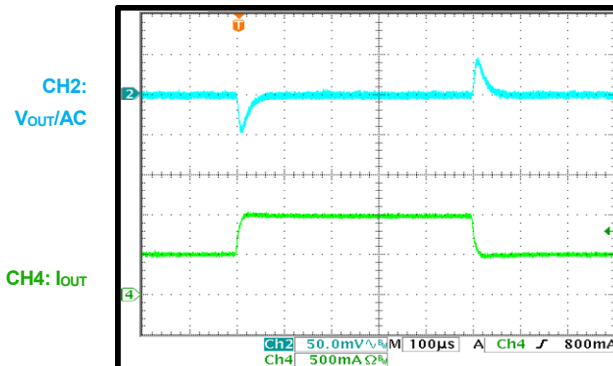
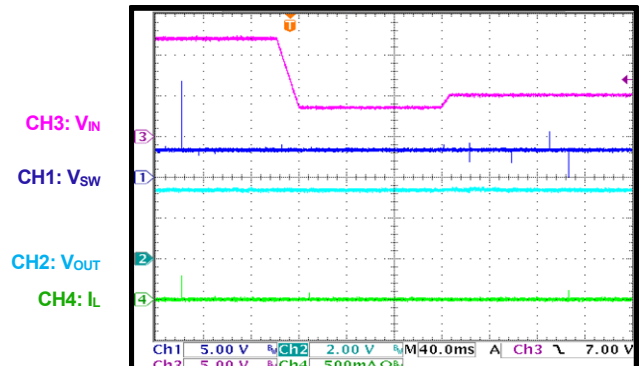
**EVB TEST RESULTS (continued)**

Performance curves and waveforms are tested on the evaluation board.  $V_{IN} = 12V$ ,  $V_{OUT} = 3.3V$ ,  $L = 10\mu H$ ,  $f_{SW} = 450kHz$ ,  $T_A = 25^\circ C$ , unless otherwise noted.

**EN Off**
 $V_{IN} = 12V$ ,  $V_{OUT} = 3.3V$ ,  $I_{OUT} = 0A$ , AAM

**EN Off**
 $V_{IN} = 12V$ ,  $V_{OUT} = 3.3V$ ,  $I_{OUT} = 0A$ , CCM

**EN Off**
 $V_{IN} = 12V$ ,  $V_{OUT} = 3.3V$ ,  $I_{OUT} = 1A$ 

**SCP Entry**
 $V_{IN} = 12V$ ,  $V_{OUT} = 3.3V$ ,  $I_{OUT} = 0A$ , AAM

**SCP Entry**
 $V_{IN} = 12V$ ,  $V_{OUT} = 3.3V$ ,  $I_{OUT} = 0A$ , CCM

**SCP Entry**
 $V_{IN} = 12V$ ,  $V_{OUT} = 3.3V$ ,  $I_{OUT} = 1A$ 


**EVB TEST RESULTS (continued)**

Performance curves and waveforms are tested on the evaluation board.  $V_{IN} = 12V$ ,  $V_{OUT} = 3.3V$ ,  $L = 10\mu H$ ,  $f_{SW} = 450kHz$ ,  $T_A = 25^\circ C$ , unless otherwise noted.

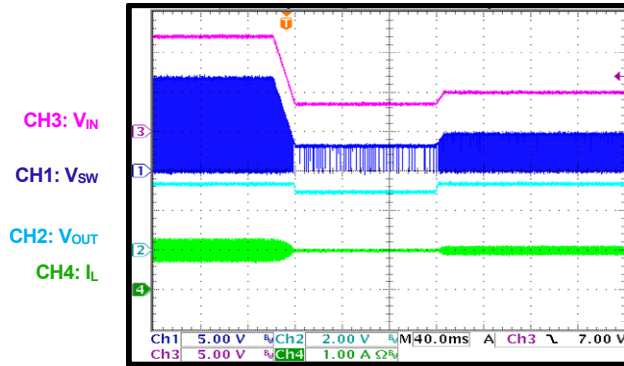
**SCP Steady State**
 $V_{IN} = 12V$ 

**SCP Recovery**
 $V_{IN} = 12V$ ,  $V_{OUT} = 3.3V$ ,  $I_{OUT} = 0A$ , AAM

**SCP Recovery**
 $V_{IN} = 12V$ ,  $V_{OUT} = 3.3V$ ,  $I_{OUT} = 0A$ , CCM

**SCP Recovery**
 $V_{IN} = 12V$ ,  $V_{OUT} = 3.3V$ ,  $I_{OUT} = 1A$ 

**Load Transient**
 $V_{IN} = 12V$ ,  $V_{OUT} = 3.3V$ ,  $I_{out} = 0.5A-1A$ 

**Cold-Crank Conditions**
 $V_{IN} = 12V$  to  $3.3V$  to  $5V$ ,  $I_{OUT} = 0A$ , AAM


## EVB TEST RESULTS (continued)

Performance curves and waveforms are tested on the evaluation board.  $V_{IN} = 12V$ ,  $V_{OUT} = 3.3V$ ,  $L = 10\mu H$ ,  $f_{SW} = 450kHz$ ,  $T_A = 25^\circ C$ , unless otherwise noted.

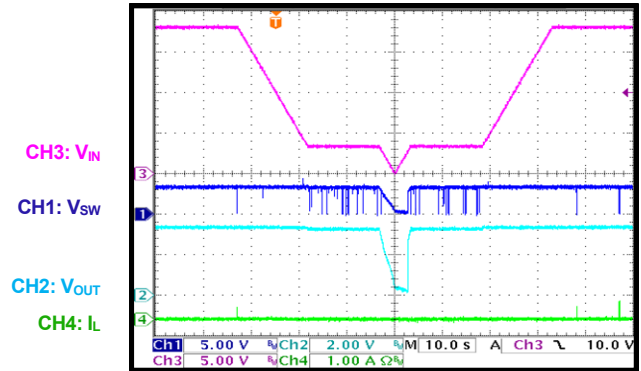
### Cold-Crank Conditions

$V_{IN} = 12V$  to  $3.3V$  to  $5V$ ,  $I_{OUT} = 1A$



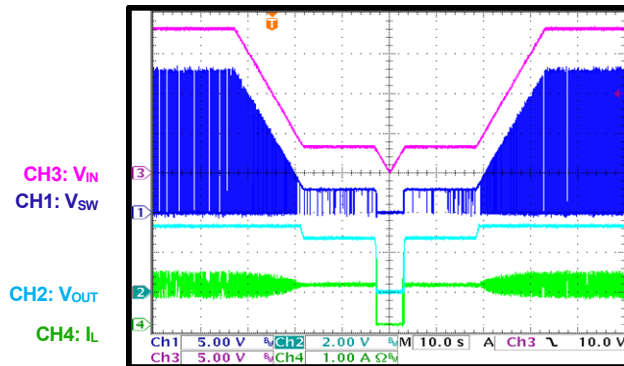
### VIN Ramp Down and Up

$V_{IN} = 18V$  to  $3.3V$  to  $0V$  to  $3.3V$  to  $18V$ ,  $I_{OUT} = 0A$ , AAM



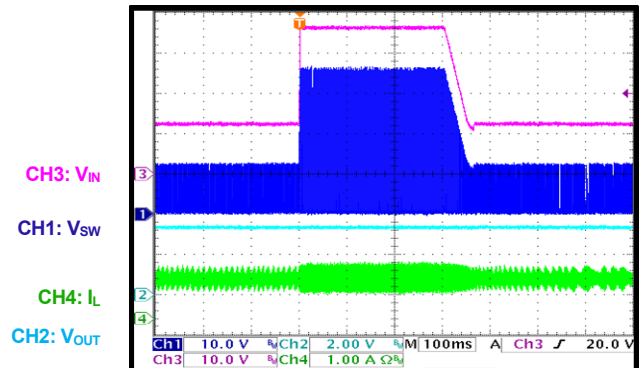
### VIN Ramp Down and Up

$V_{IN} = 18V$  to  $3.3V$  to  $0V$  to  $3.3V$  to  $18V$ ,  $I_{OUT} = 1A$



### Load Dump

$V_{IN} = 12V$  to  $36V$  to  $12V$ ,  $I_{OUT} = 1A$



### PCB LAYOUT

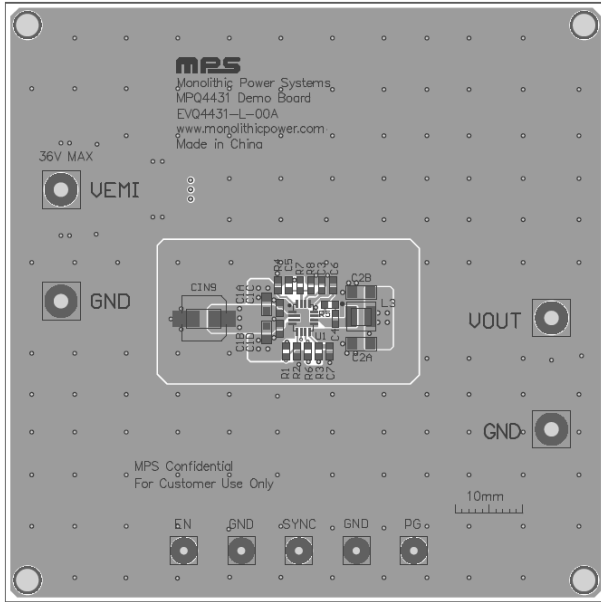


Figure 3: Top Silk Layer and Top Layer

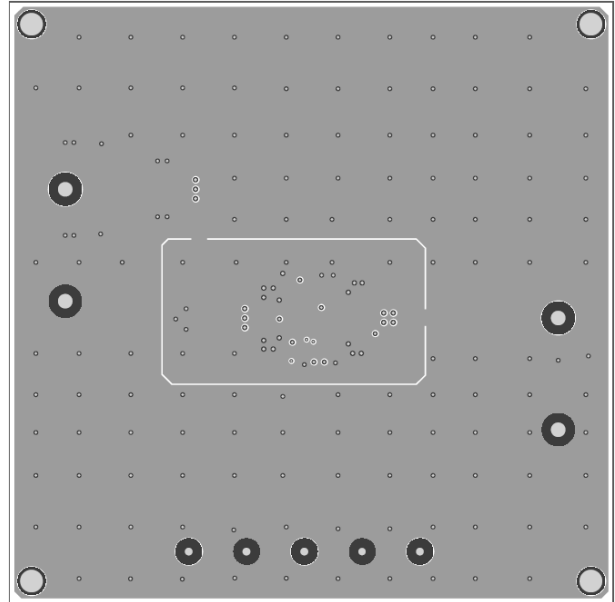


Figure 4: Inner Layer 1

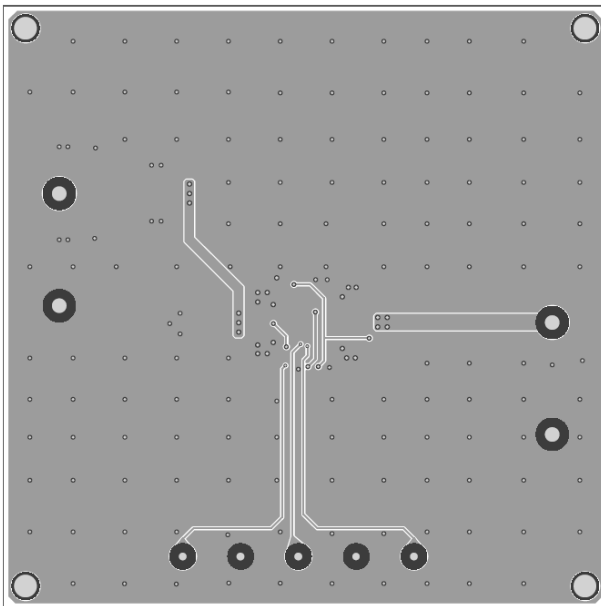


Figure 5: Inner Layer 2

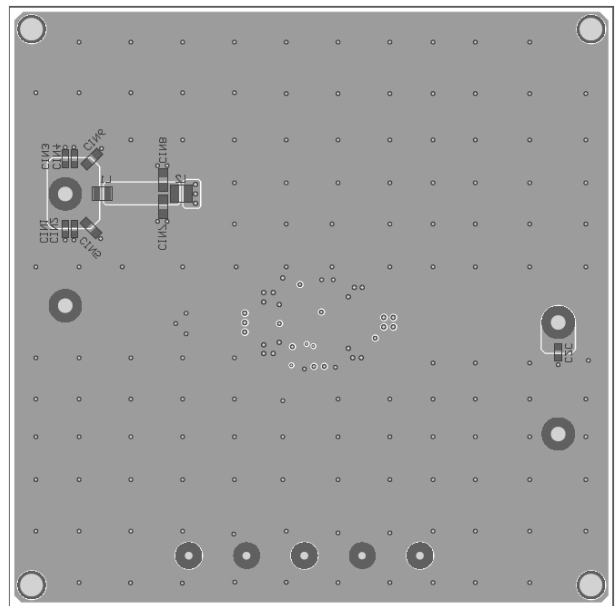


Figure 6: Bottom Silk Layer and Bottom Layer