



EVQ4432-L-00A

36V, 2.2A, Low Quiescent Current, Synchronous Step-Down Converter Evaluation Board

DESCRIPTION

The EVQ4432-L-00A evaluation board is designed to demonstrate the capabilities of the MPQ4432 and the MPQ4432-AEC1.

The MPQ4432 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 2.2A of highly efficient output current with current mode control for fast loop response.

The MPQ4432 employs advanced asynchronous modulation (AAM) mode to achieve high efficiency under light-load conditions by scaling down the switching frequency. This reduces the switching and gate driving losses.

The EVQ4432-L-00A is a fully assembled and tested evaluation board that generates 5V of output voltage at load currents up to 2.2A, from a 5V to 36V input voltage range.

The MPQ4432 is available in a QFN-16 (3mmx4mm) package.

ELECTRICAL SPECIFICATIONS

| Parameter | Symbol | Value | Units |
|----------------|------------------|---------|-------|
| Input voltage | V_{EMI} | 5 to 36 | V |
| Output voltage | V_{OUT} | 5 | V |
| Output current | I_{OUT} | 2.2 | A |

FEATURES

- Wide 5V to 36V Operating Input Range
- 2.2A of Continuous Output Current
- 1 μ A Low Shutdown Mode Current
- 10 μ A Sleep Mode Quiescent Current
- Internal 90m Ω High-Side and 40m Ω 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
- Available in AEC-Q100 Grade 1

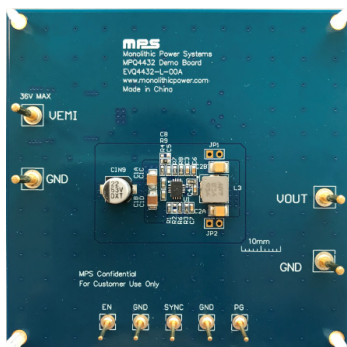
APPLICATIONS

- Automotive Systems
- Industrial Power Systems

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EVQ4432-L-00A EVALUATION BOARD

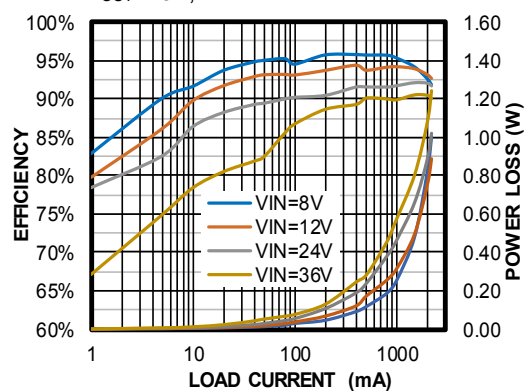


LxWxH (8.3cmx8.3cmx1.3cm)

| Board Number | MPS IC Number |
|---------------|------------------------------|
| EVQ4432-L-00A | MPQ4432GL, MPQ4432GL-AEC1 |

Efficiency vs. Load Current

V_{OUT} = 5V, AAM



QUICK START GUIDE

1. Preset the power supply (V_{IN}) to be between 5V 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):

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

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. Choose R_{FB1} to be about 40k Ω . 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.

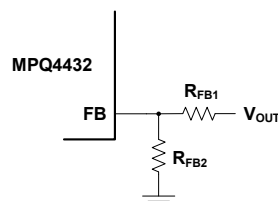


Figure 1: Resistor Divider Set-Up



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

Table 1: Recommended Resistor Dividers

| V_{OUT} (V) | R_{FB1} (kΩ) | R_{FB2} (kΩ) |
|----------------------------|-----------------------------|-----------------------------|
| 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

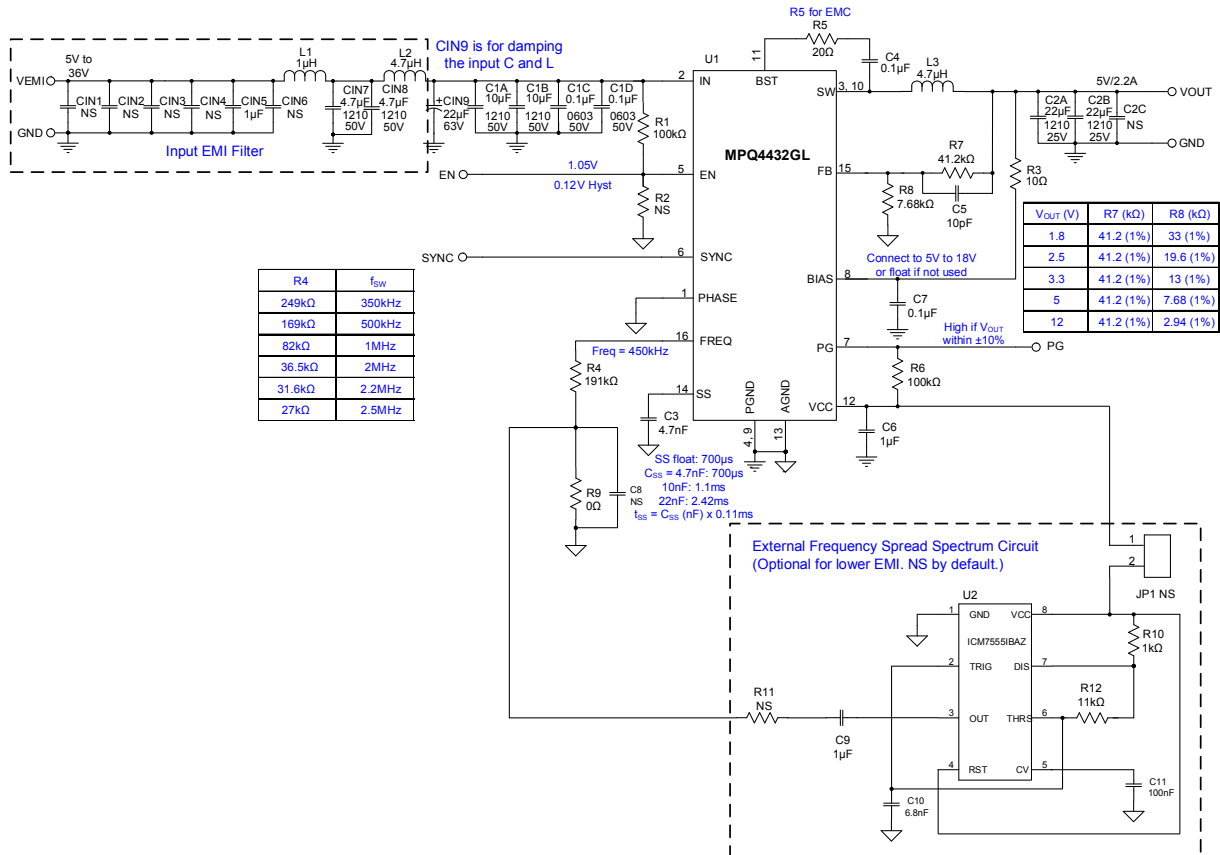
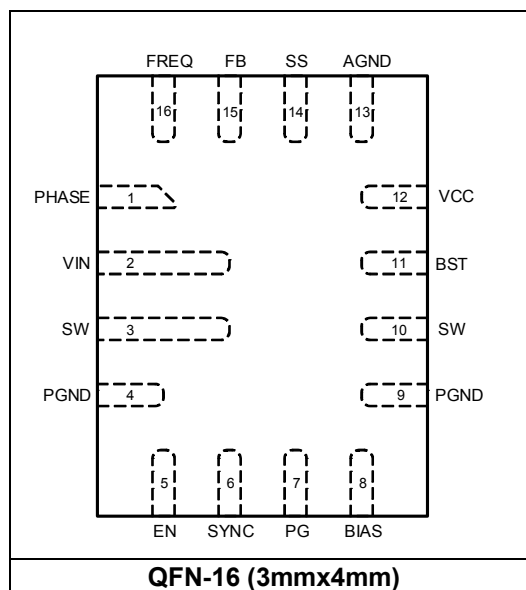


Figure 2: Evaluation Board Schematic

PACKAGE REFERENCE



EVQ4432-L-00A BILL OF MATERIALS

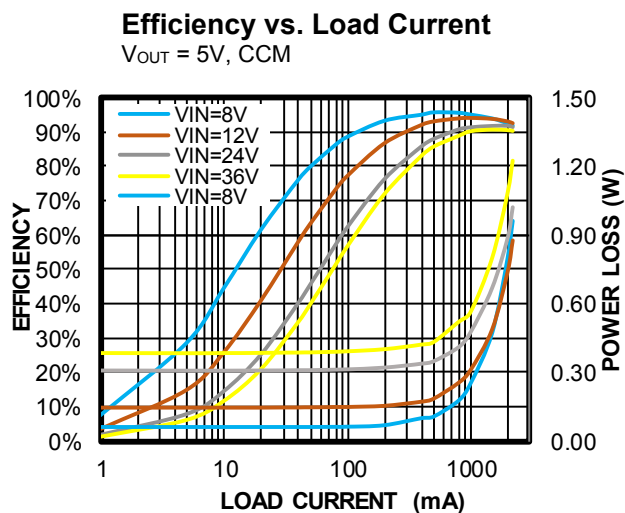
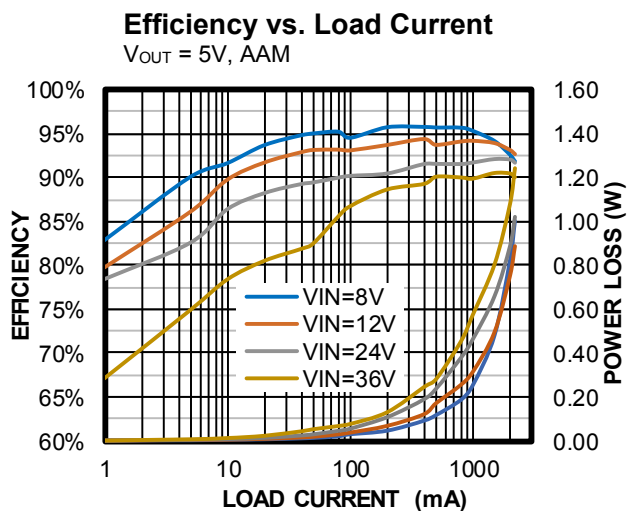
| Qty | Ref | Value | Description | Package | Manufacturer | Manufacturer PN |
|-----|---------------------------------------|----------------|---------------------------------------|---------|--------------|----------------------|
| 1 | CIN5 | 1 μ F | Ceramic capacitor, 50V, X7R | 0805 | Murata | GRM21BR71H105KA12L |
| 2 | CIN7, CIN8 | 4.7 μ F | Ceramic capacitor, 50V, X7R | 1210 | Murata | GRM32ER71H475KA88L |
| 1 | CIN9 | 22 μ F | Electrolytic capacitor, 63V | SMD | Jianghai | VTD-63V22 |
| 2 | C1A, C1B | 10 μ F | Ceramic capacitor, 50V, X7R | 1210 | Murata | GRM32ER71H106KA12L |
| 2 | C1C, C1D | 0.1 μ F | Ceramic capacitor, 50V, X7R | 0603 | Murata | GRM188R71H104KA93D |
| 2 | C2A, C2B | 22 μ F | Ceramic capacitor, 25V, X7R | 1210 | Murata | GRM32ER71H226KE15L |
| 1 | C3 | 4.7nF | Ceramic capacitor, 50V, X7R | 0603 | TDK | C1608X7R1H472K |
| 3 | C4, C7, C11 | 0.1 μ F | Ceramic capacitor, 16V, X7R | 0603 | Murata | GRM188R71C104KA01D |
| 1 | C5 | 10pF | Ceramic capacitor, 50V, C0G | 0603 | Murata | GRM1885C1H100JA01 |
| 2 | C6, C9 | 1 μ F | Ceramic capacitor, 16V, X7R | 0603 | Murata | GRM188R71C105KA12D |
| 1 | C10 | 6.8nF | Ceramic capacitor, 50V, X7R | 0603 | TDK | C1608X7R1H682K |
| 7 | CIN1, CIN2, CIN3, CIN4, CIN6, C2C, C8 | NS | | | | |
| 2 | JP1, JP2 | NS | | | | |
| 1 | L1 | 1 μ H | Inductor, DCR = 41m Ω , 3.1A | SMD | Cyntec | VCTA20161B-1R0MS6-89 |
| 1 | L2 | 4.7 μ H | Inductor, DCR = 48.6m Ω , 3.7A | SMD | Cyntec | VCHA042A-4R7MS6-89 |
| 1 | L3 | 4.7 μ H | Inductor, DCR = 31.5m Ω , 6A | SMD | Cyntec | VCMT063T-4R7MN5-89 |
| 2 | R1, R6 | 100k Ω | Film resistor, 1% | 0603 | Yageo | RC0603FR-07100KL |
| 1 | R3 | 10 Ω | Film resistor, 1% | 0603 | Yageo | RC0603FR-0710RL |
| 1 | R4 | 191k Ω | Film resistor, 1% | 0603 | Yageo | RC0603FR-07191KL |
| 1 | R5 | 20 Ω | Film resistor, 1% | 0603 | Yageo | RC0603FR-0720RL |
| 1 | R7 | 41.2k Ω | Film resistor, 1% | 0603 | Yageo | RC0603FR-0741K2L |
| 1 | R8 | 7.68k Ω | Film resistor, 1% | 0603 | Yageo | RC0603FR-0713KL |

**EVQ4432-L-00A BILL OF MATERIALS (continued)**

| Qty | Ref | Value | Description | Package | Manufacturer | Manufacturer PN |
|-----|------------------------------|--------------|---------------------|-------------------------|--------------|-----------------|
| 1 | R10 | 1k Ω | Film resistor, 1% | 0603 | Yageo | RC0603FR-071KL |
| 1 | R9 | 0 Ω | Film resistor, 1% | 0603 | Yageo | RC0603FR-070RL |
| 1 | R12 | 11k Ω | Film resistor, 1% | 0603 | Yageo | RC0603FR-0711KL |
| 2 | R2, R11 | NS | | | | |
| 1 | U2 | 18V | CMOS RC timer | SOP-8 | Intersil | ICM7555IBAZ |
| 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 | |
| 1 | U1 | MPQ4332 | Step-down converter | QFN-16 (3mmx 4mm) | MPS | MPQ4432GL |

EVB TEST RESULTS

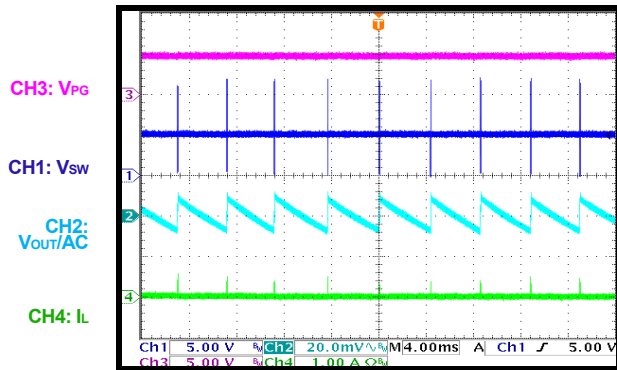
Performance curves and waveforms are tested on the evaluation board. $V_{IN} = 12V$, $V_{OUT} = 5V$, $L = 4.7\mu H$, $f_{sw} = 450kHz$, $T_A = 25^\circ C$, unless otherwise noted.



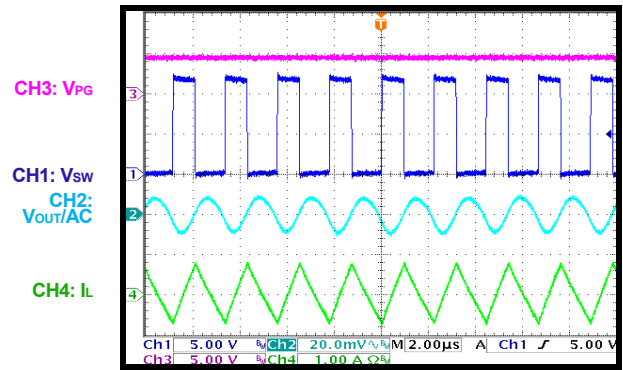
EVB TEST RESULTS *(continued)*

Performance curves and waveforms are tested on the evaluation board. $V_{IN} = 12V$, $V_{OUT} = 5V$, $L = 4.7\mu H$, $f_{sw} = 450kHz$, $T_A = 25^\circ C$, unless otherwise noted.

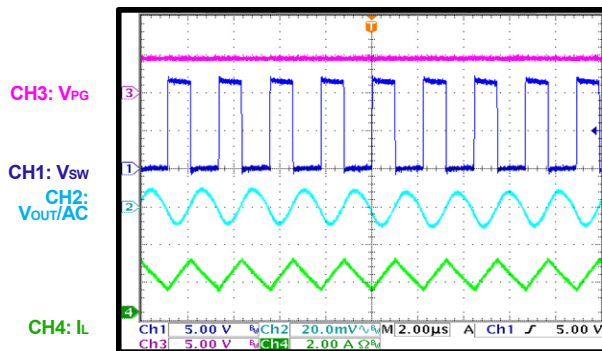
Steady State

 $I_{OUT} = 0A$, AAM


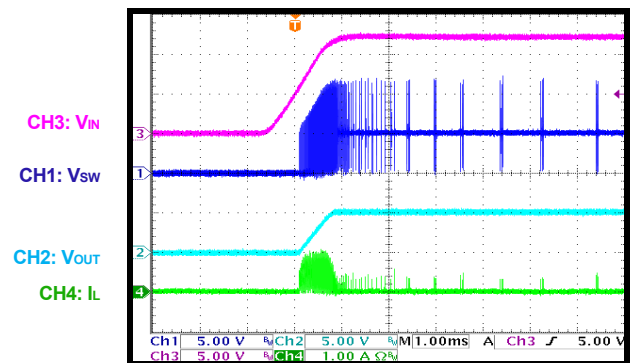
Steady State

 $I_{OUT} = 0A$, CCM


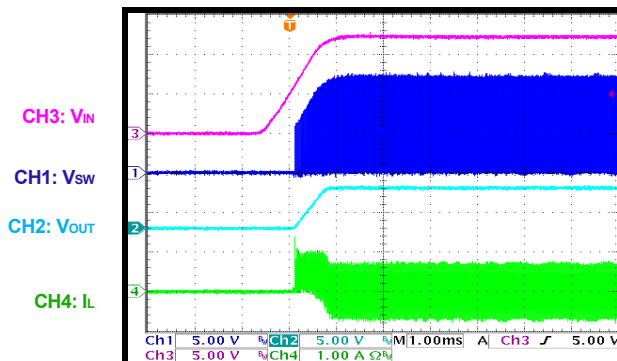
Steady State

 $I_{OUT} = 2A$


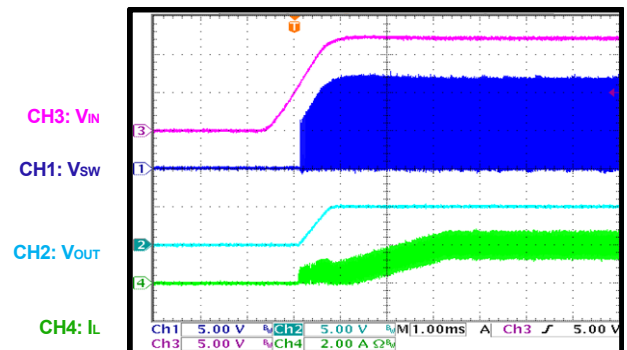
Start-Up

 $I_{OUT} = 0A$, AAM


Start-Up

 $I_{OUT} = 0A$, CCM


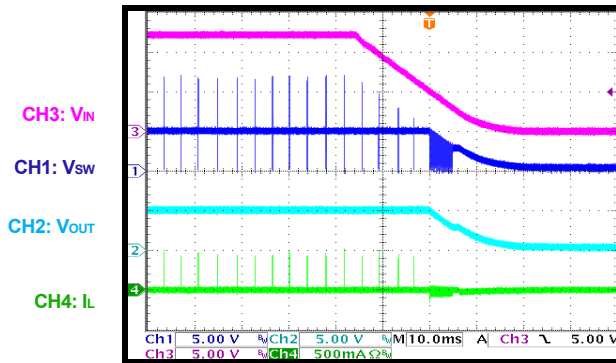
Start-Up

 $I_{OUT} = 2A$


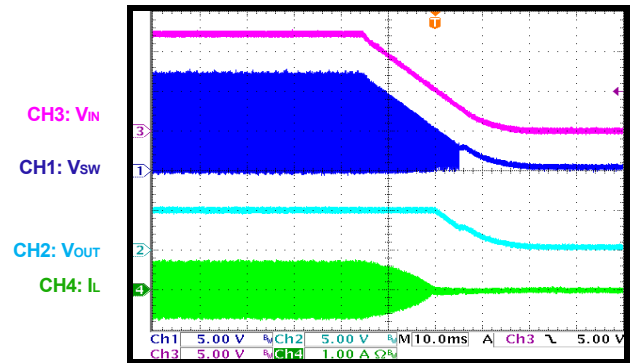
EVB TEST RESULTS *(continued)*

Performance curves and waveforms are tested on the evaluation board. $V_{IN} = 12V$, $V_{OUT} = 5V$, $L = 4.7\mu H$, $f_{sw} = 450kHz$, $T_A = 25^\circ C$, unless otherwise noted.

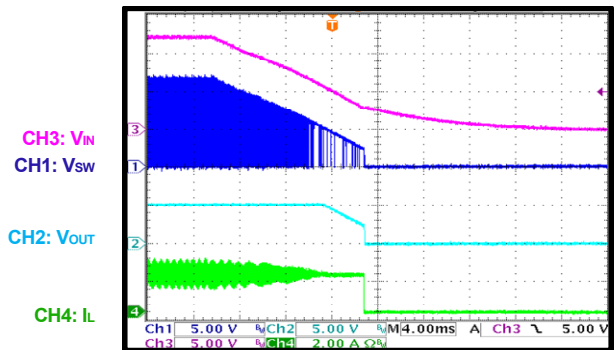
Shutdown

 $I_{OUT} = 0A$, AAM


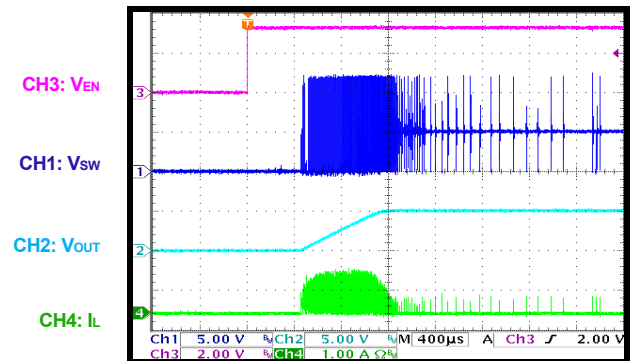
Shutdown

 $I_{OUT} = 0A$, CCM


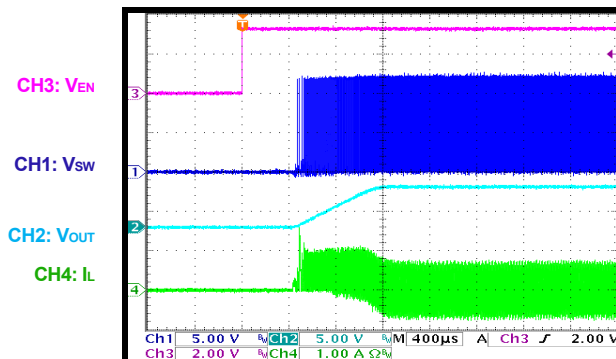
Shutdown

 $I_{OUT} = 2A$


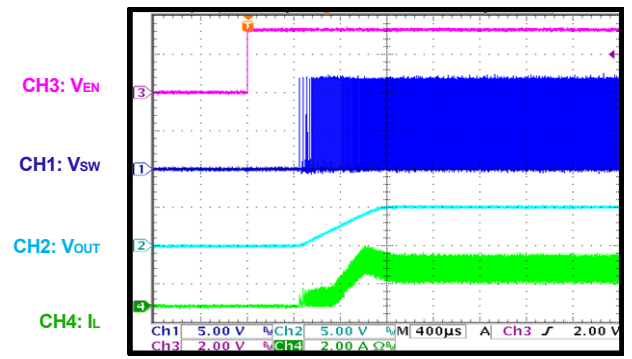
En On

 $I_{OUT} = 0A$, AAM


En On

 $I_{OUT} = 0A$, CCM


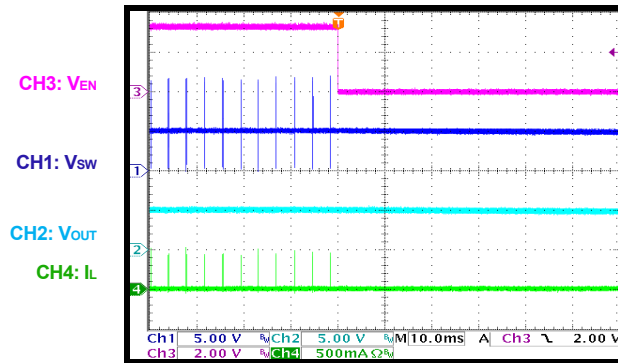
En On

 $I_{OUT} = 2A$


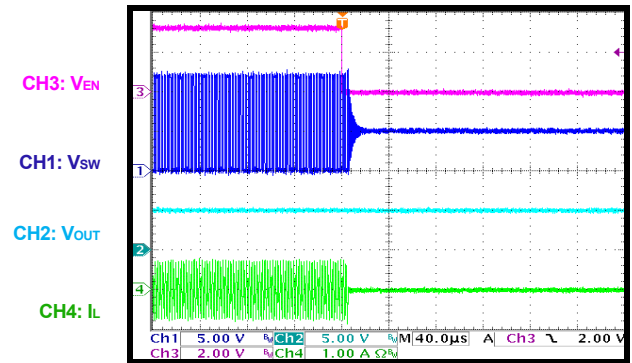
EVB TEST RESULTS (continued)

Performance curves and waveforms are tested on the evaluation board. $V_{IN} = 12V$, $V_{OUT} = 5V$, $L = 4.7\mu H$, $f_{sw} = 450kHz$, $T_A = 25^\circ C$, unless otherwise noted.

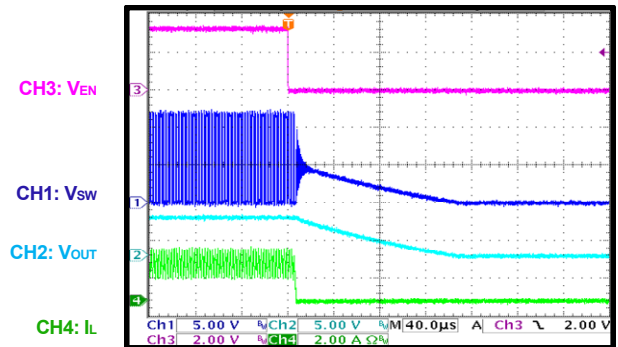
En Off

 $I_{OUT} = 0A$, AAM


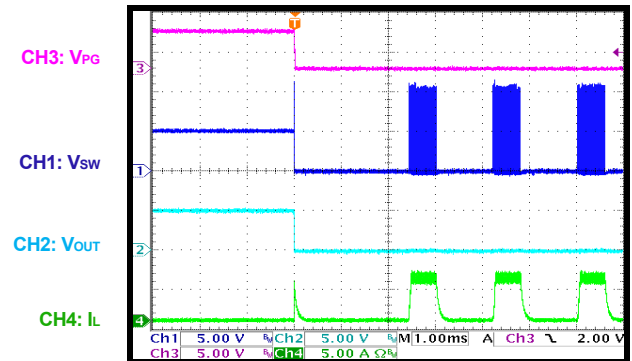
En Off

 $I_{OUT} = 0A$, CCM


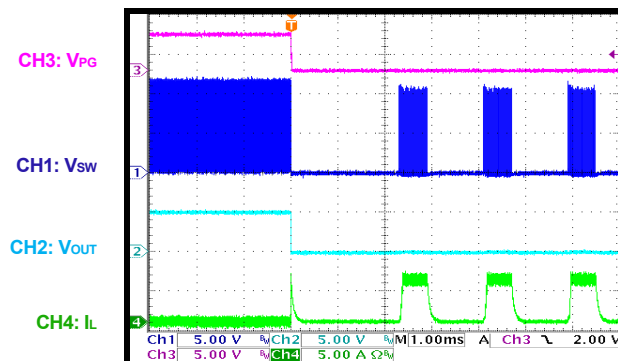
En Off

 $I_{OUT} = 2A$


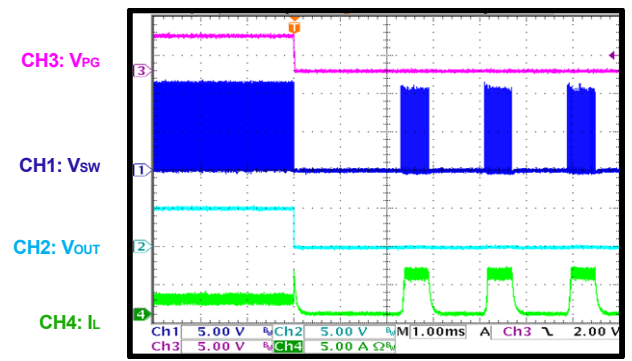
SCP Entry

 $I_{OUT} = 0A$, AAM


SCP Entry

 $I_{OUT} = 0A$, CCM


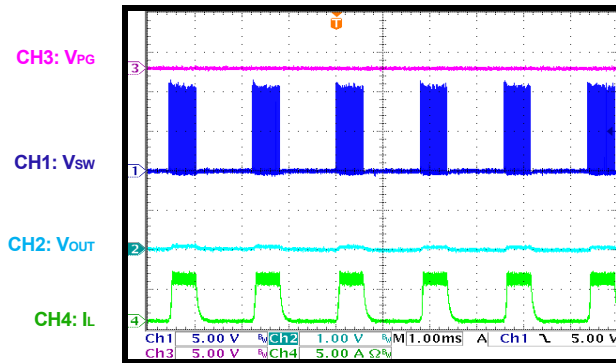
SCP Entry

 $I_{OUT} = 2A$


EVB TEST RESULTS (continued)

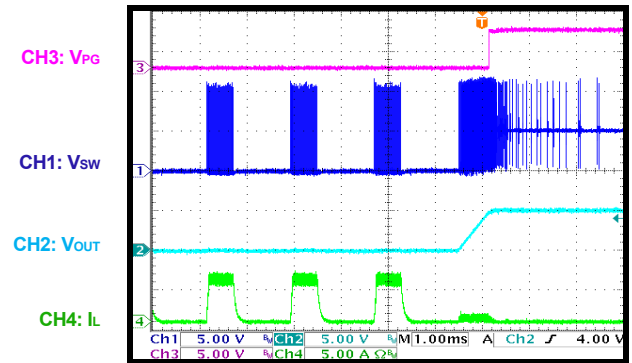
Performance curves and waveforms are tested on the evaluation board. $V_{IN} = 12V$, $V_{OUT} = 5V$, $L = 4.7\mu H$, $f_{sw} = 450kHz$, $T_A = 25^\circ C$, unless otherwise noted.

SCP Steady State



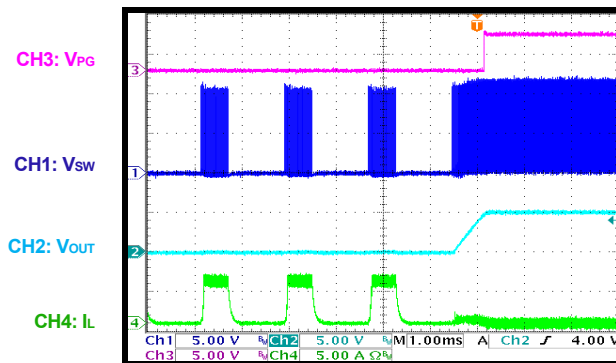
SCP Recovery

$I_{OUT} = 0A$, AAM



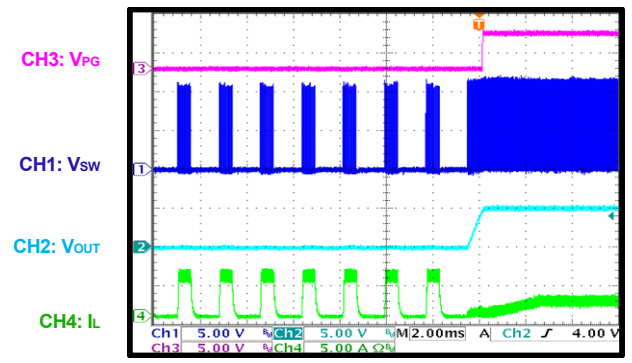
SCP Recovery

$I_{OUT} = 0A$, CCM



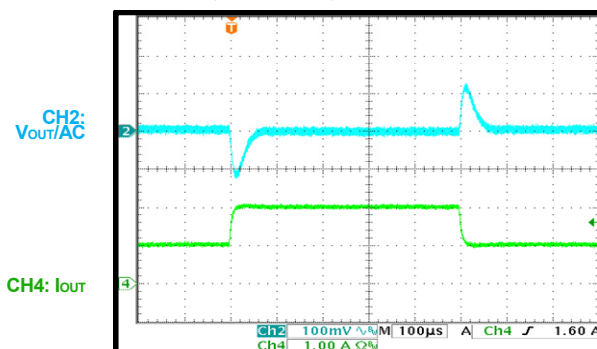
SCP Recovery

$I_{OUT} = 2A$



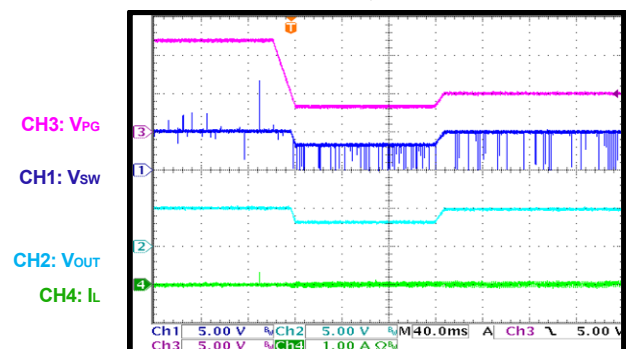
Load Transient

$V_{IN} = 12V$, $V_{OUT} = 5V$, $I_{OUT} = 1A$ to $2A$



Cold-Crank Conditions

$V_{IN} = 12V$ to $3.3V$ to $5V$, $I_{OUT} = 0A$

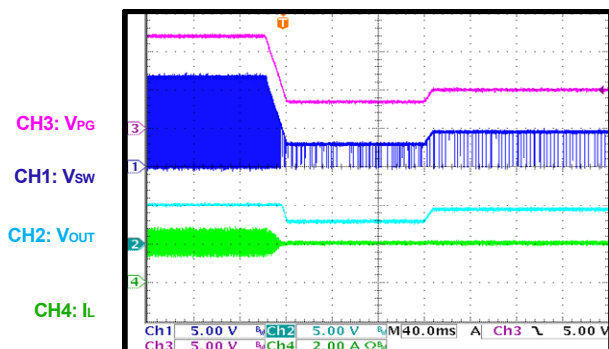


EVB TEST RESULTS *(continued)*

Performance curves and waveforms are tested on the evaluation board. $V_{IN} = 12V$, $V_{OUT} = 5V$, $L = 4.7\mu H$, $f_{sw} = 450kHz$, $T_A = 25^\circ C$, unless otherwise noted.

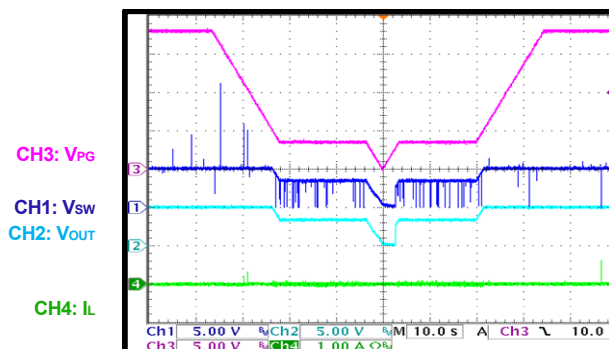
Cold-Crank Conditions

$V_{IN} = 12V$ to $3.3V$ to $5V$, $I_{OUT} = 2A$



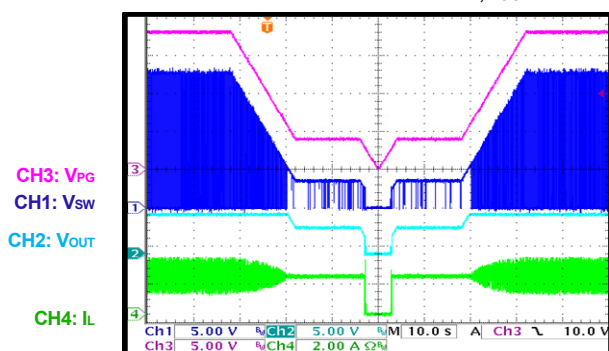
VIN Ramp Down and Up

$V_{IN} = 18V$ to $3.5V$ to $0V$ to $3.5V$ to $18V$, $I_{OUT} = 0A$



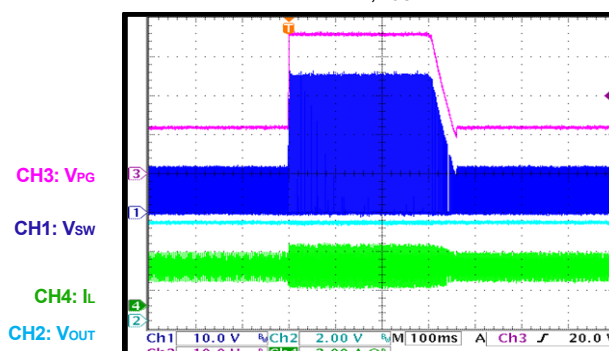
VIN Ramp Down and Up

$V_{IN} = 18V$ to $4V$ to $0V$ to $4V$ to $18V$, $I_{OUT} = 2A$



Load Dump

$V_{IN} = 12V$ to $36V$ to $12V$, $I_{OUT} = 2A$



PCB LAYOUT

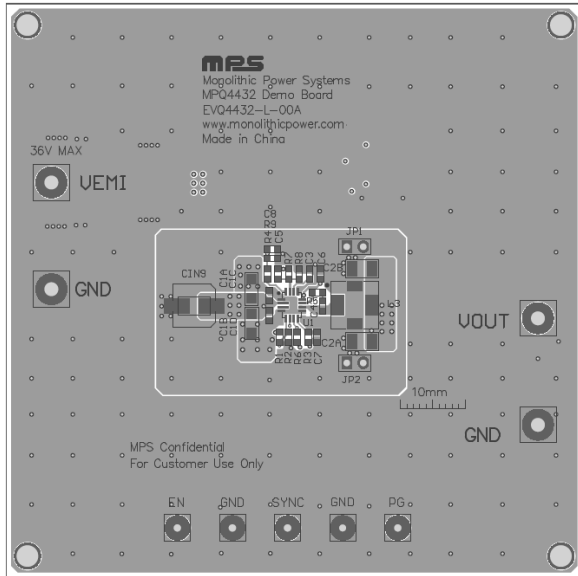


Figure 3: Top Silk and Top Layer

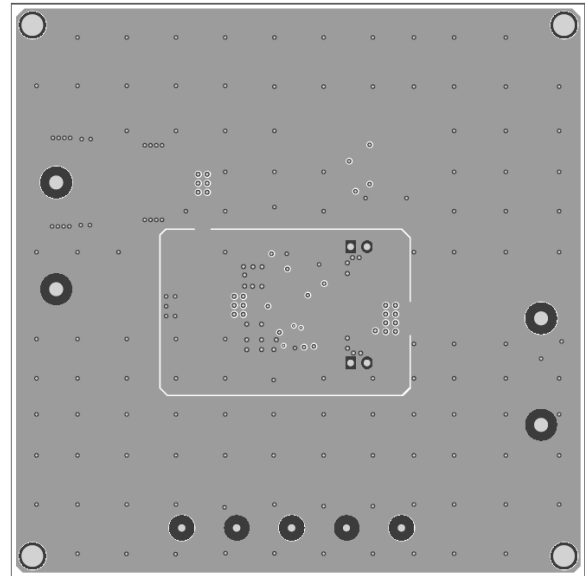


Figure 4: Inner Layer 1

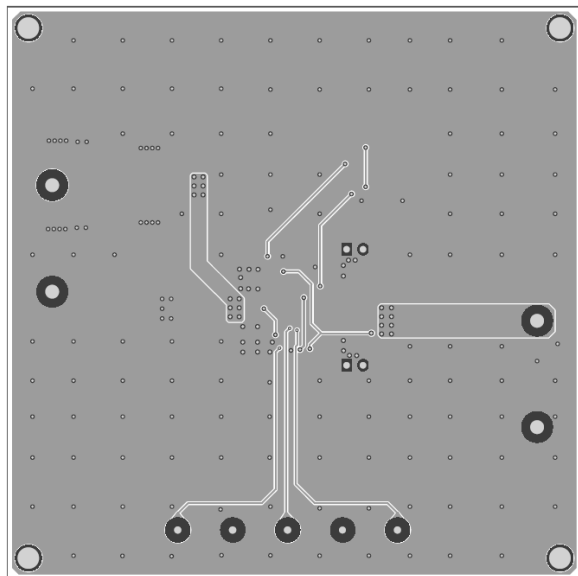


Figure 5: Inner Layer 2

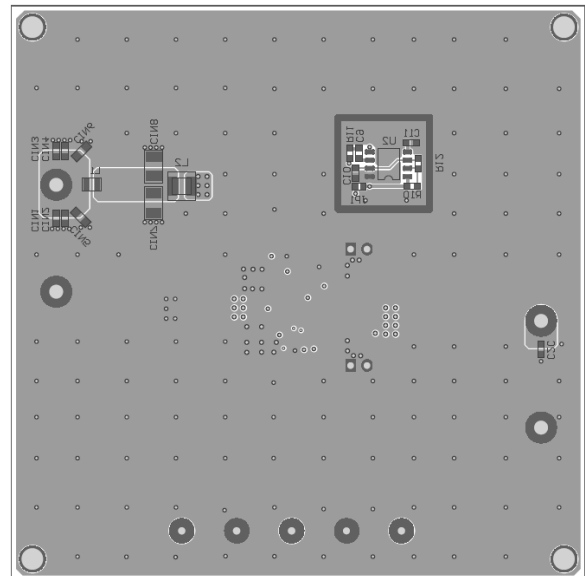


Figure 6: Bottom Silk and Bottom Layer

**REVISION HISTORY**

| Revision # | Revision Date | Description | Pages Updated |
|------------|---------------|----------------------------------|---------------|
| 1.0 | 10/30/219 | Initial Release | - |
| 1.1 | 10/08/2021 | Grammatical and clerical updates | All |

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