



EV2167A-Q-00A

6V, 6A, Configurable-Frequency, Synchronous Buck Converter Evaluation Board

DESCRIPTION

The EV2167A-Q-00A evaluation board is designed to demonstrate the capabilities of the MPQ2167A-AEC1.

MPQ2167A-AEC1 is a configurable- frequency (300kHz to 2.2MHz), synchronous, step-down switching regulator with integrated internal high-side and low-side power MOSFETs. It provides up to 6A of continuous output current with peak current control for excellent transient response.

The MPQ2167A-AEC1 can be configured for advanced asynchronous mode (AAM) or forced continuous conduction mode (FCCM) operation at light loads. AAM provides high efficiency by reducing switching losses under light-load conditions, while FCCM has controllable frequency and a lower output ripple.

The EV2167A-Q-00A is a fully assembled and tested evaluation board. It generates a 1.8V output voltage at load currents up to 6A from a 2.7V to 6V input range with a 2.1MHz switching frequency.

ELECTRICAL SPECIFICATIONS

| Parameter | Symbol | Value | Units |
|----------------|-----------|----------|-------|
| Input voltage | V_{EMI} | 2.7 to 6 | V |
| Output voltage | V_{OUT} | 1.8 | V |
| Output current | I_{OUT} | 6 | A |

FEATURES

- 2.7V to 6.0V Operating Input Range
- Adjustable Output from 0.606V
- Up to 6A Continuous Output Current
- High-Efficiency Synchronous Mode Control
- 35mΩ and 25mΩ Internal Power MOSFETs
- Configurable Frequency Up to 2.2MHz
- External SYNC Clock Up to 2.2MHz
- 42μA Quiescent Current
- Low Shutdown Mode Current
- 100% Duty Cycle Operation
- Internal Compensation Mode
- Selectable AAM or FCCM Operation
- External Soft Start
- Remote EN Control
- Power Good Indicator
- Cycle-by-Cycle OCP, SCP, V_{IN} ULVO, V_{OUT} OVP, and Thermal Shutdown
- Available in a Wettable Flank, QFN-14 (3mmx3mm) Package
- Available in AEC-Q100 Grade 1

APPLICATIONS

- Automotive Infotainment
- Automotive Clusters
- Automotive Telematics
- Industrial Supplies
- Battery-Powered Devices

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EV2167A-Q-00A EVALUATION BOARD

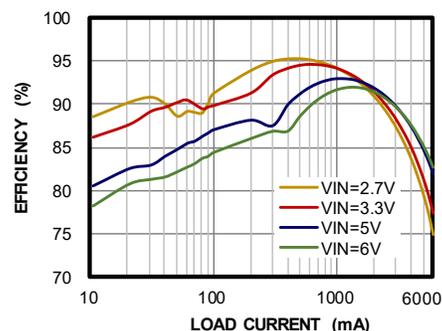


(LxWxH) 6.3cmx6.3cmx1cm

| Board Number | MPS IC Number |
|---------------|------------------|
| EV2167A-Q-00A | MPQ2167AGQE-AEC1 |

Efficiency vs. Load Current

$V_{OUT} = 1.8V$, $f_{sw} = 2.1MHz$, $L = 1\mu H$, AAM



QUICK START GUIDE

1. Preset the power supply to $2.7V \leq V_{IN} \leq 6.0V$. Be aware that electronic loads represent a negative impedance to the regulator, and if set to too high of a current, may trigger hiccup mode.
2. Turn the power supply off. If longer cables (>0.5m total) are used between the source and the EVB, C1D can be used to damp input spike when plugged in. For regular operation, it is not required to use C1D for damping.
3. Connect the power supply terminals to:
 - a. Positive (+): V_{IN}
 - b. Negative (-): GND
4. Connect the load terminals to:
 - a. Positive (+): V_{OUT}
 - b. Negative (-): GND
5. After making the connections, turn the power supply on. The board should automatically start up.
6. To use the enable function, apply a digital input to the EN pin. Drive EN above 1.2V to turn the regulator on; drive EN below 0.8V to turn it off.
7. Figure 1 shows the relationship between the external frequency resistor (R_{FREQ}) and the MPQ2167A's switching frequency.

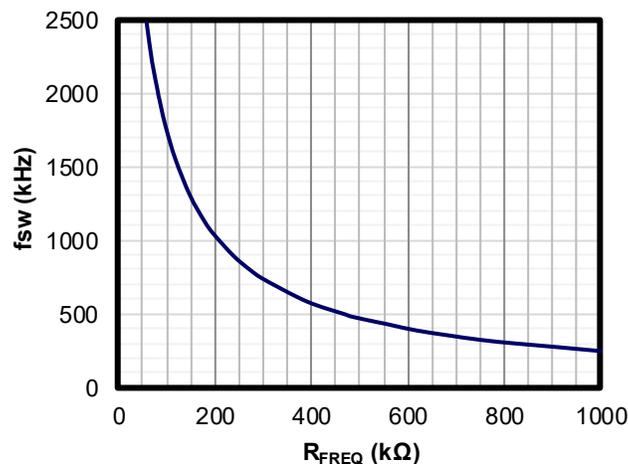


Figure 1: f_{sw} vs. R_{FREQ}

8. The FREQ/SYNC pin can be synchronized by the external clock. The sync frequency range 300kHz to 2.2MHz.
9. The MODE pin can be used to select advanced asynchronous mode (AAM) or forced continuous conduction mode (FCCM). Connect it to logic high or V_{IN} to choose FCCM. Connect it to logic low or GND to choose AAM. Do not float this pin.

10. The external resistor divider connected to FB sets the output voltage (V_{OUT}). The feedback resistor ($R1$) must account for both stability and dynamic response, so it should not be too large or too small. $R1$ is recommended to be 100k Ω . $R2$ can then be estimated with Equation (1):

$$R2 = \frac{R1}{\frac{V_{OUT}}{0.606} - 1} \quad (1)$$

A T-type feedback network is highly recommended (see Figure 2).

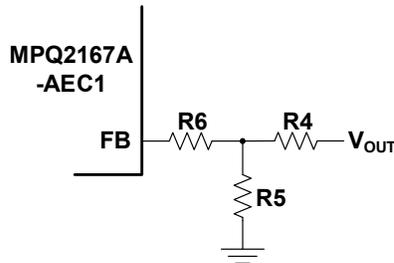


Figure 2: T-Type Feedback Network

The $R6$ and $R4$ resistors are used to set the loop bandwidth. A higher $R6 + R4$ value leads to lower bandwidth. Table 1 lists the recommended feedback resistor values for common output voltages.

Table 1: Recommended Resistor Values for Common Output Voltages

| V_{OUT} (V) | $R6$ (k Ω) | $R4$ (k Ω) | $R5$ (k Ω) |
|---------------|--------------------|--------------------|--------------------|
| 1.2 | 100 | 100 (1%) | 100 (1%) |
| 1.5 | 100 | 100 (1%) | 66.5 (1%) |
| 1.8 | 100 | 100 (1%) | 49.9 (1%) |
| 2.5 | 100 | 100 (1%) | 31.6 (1%) |
| 3.3 | 100 | 100 (1%) | 22.1 (1%) |

EVALUATION BOARD SCHEMATIC

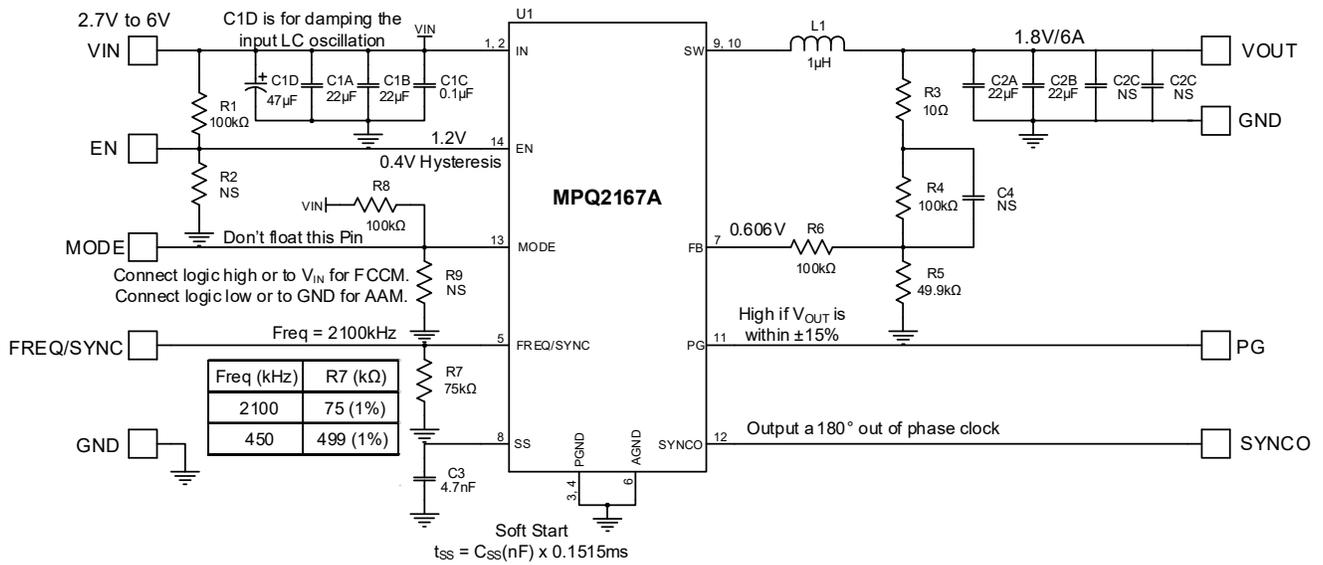


Figure 3: Evaluation Board Schematic

PACKAGE REFERENCE

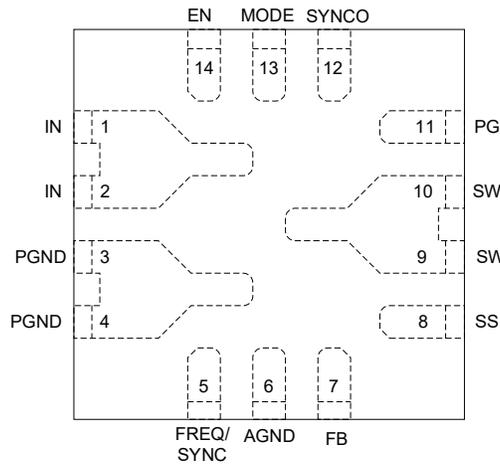


Figure 4: Package Reference

EV2167A-Q-00A BILL OF MATERIALS

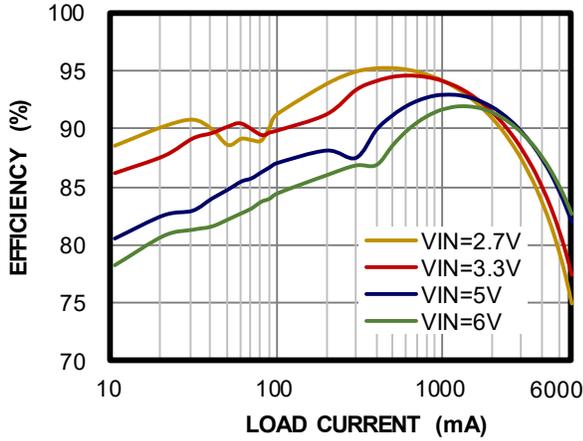
| Qty | Ref | Value | Description | Package | Manufacturer | Manufacturer P/N |
|-----|---|----------------|--------------------------------------|------------------|--------------|---------------------|
| 1 | C1A | 0.1 μ F | Ceramic capacitor, 16V, X7R | 0603 | Murata | GRM188R71C104K A01D |
| 2 | C1B, C1C | 10 μ F | Ceramic capacitor, 16V, X7R | 1206 | Murata | GRM31CR71A106K AC7L |
| 1 | C1D | 47 μ F | Electrolytic capacitor, 16V | SMD | Jianghai | VZ1-16V47 |
| 2 | C2A, C2B | 22 μ F | Ceramic capacitor, 10V, X7R | 1206 | Murata | GCJ31CR71A226ME 01L |
| 1 | C3 | 4.7nF | Ceramic capacitor, 50V, X7R | 0603 | Murata | GRM188R71H472K A01D |
| 1 | L1 | 1 μ H | Inductor, 9.4m Ω , DCR, 11.4A | SMD | Coilcraft | XEL5030-102MEC |
| 3 | R1, R4, R6 | 100k Ω | Film resistor, 1% | 0603 | Yageo | RC0603FR-07100KL |
| 1 | R2 | NS | | | | |
| 1 | R3 | 10 Ω | Film resistor, 1% | 0603 | Yageo | RC0603FR-0710RL |
| 1 | R5 | 49.9k Ω | Film resistor, 1% | 0603 | Yageo | RC0603FR-0749K9L |
| 1 | R7 | 75k Ω | Film resistor, 1% | 0603 | Yageo | RC0603FR-0775KL |
| 1 | U1 | MPQ2167A | Step-down converter | QFN-14 (3mmx3mm) | MPS | MPQ2167AGQE-AEC1 |
| 1 | JP1 | | 2.54mm test pin, 3 pins | | Any | |
| 4 | VIN, GND, GND, VOUT | Test point | 2.0mm golden pin | | Custom | |
| 7 | MODE, GND, EN, SYNCO, PG, GND, FREQ/ SYNC | Test point | 1.0mm golden pin | | Custom | |

EVB TEST RESULTS

Performance curves and waveforms are tested on the evaluation board. $V_{IN} = 5V$, $V_{OUT} = 1.8V$, $L = 1\mu H$, $C_{OUT} = 44\mu F$, $f_{SW} = 2.1MHz$, $T_A = 25^\circ C$, unless otherwise noted.

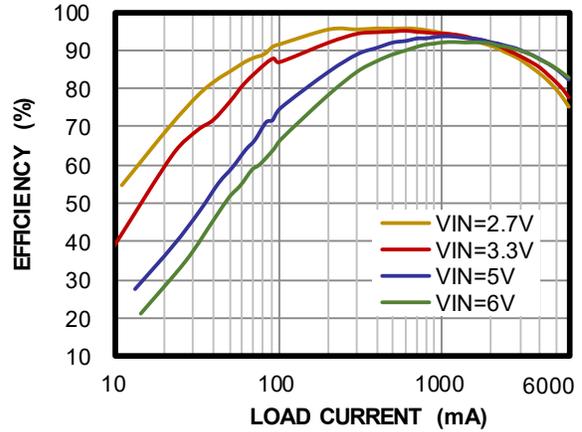
Efficiency vs. Load Current

$V_{OUT} = 1.8V$, AAM



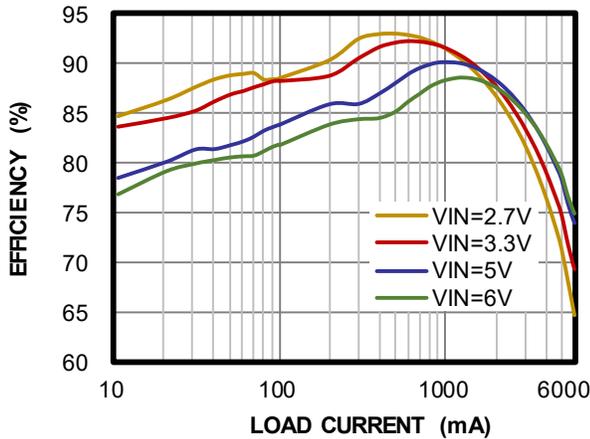
Efficiency vs. Load Current

$V_{OUT} = 1.8V$, FCCM



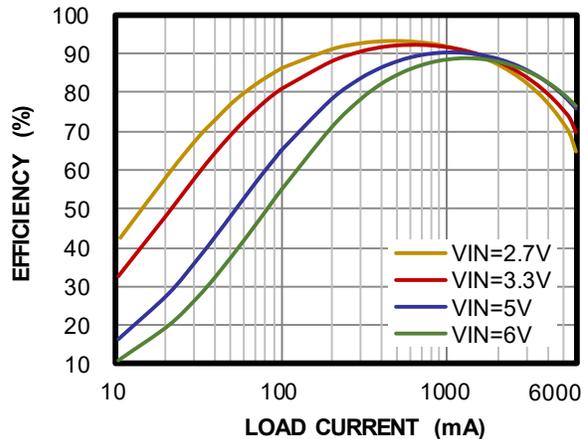
Efficiency vs. Load Current

$V_{OUT} = 1.2V$, AAM



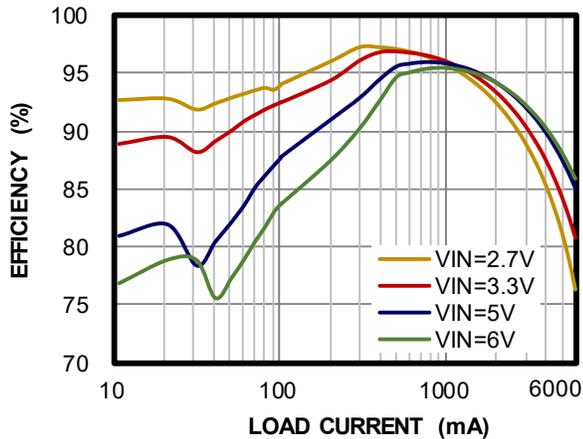
Efficiency vs. Load Current

$V_{OUT} = 1.2V$, FCCM



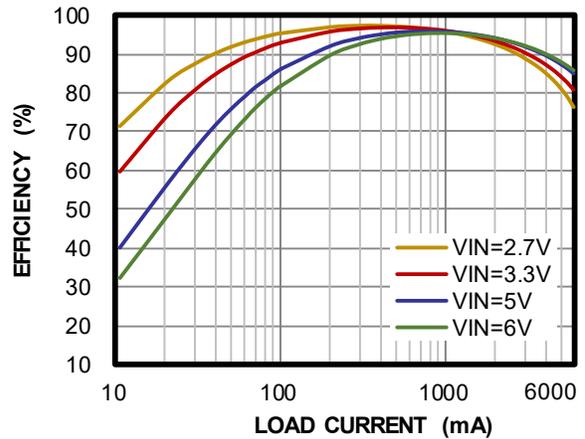
Efficiency vs. Load Current

$V_{OUT} = 1.8V$, $f_{SW} = 450kHz$, $L = 4.7\mu H$, AAM



Efficiency vs. Load Current

$V_{OUT} = 1.8V$, $f_{SW} = 450kHz$, $L = 4.7\mu H$, FCCM

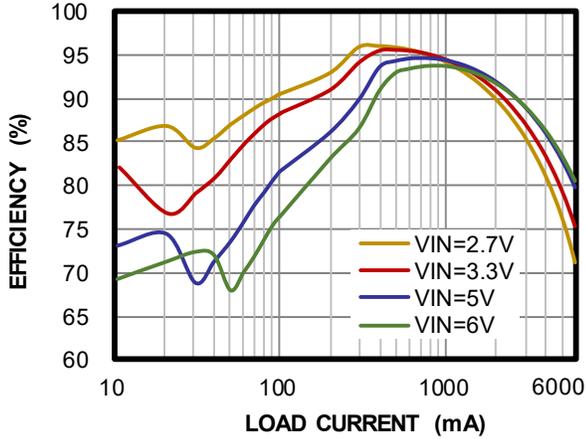


EVB TEST RESULTS (continued)

Performance curves and waveforms are tested on the evaluation board. $V_{IN} = 5V$, $V_{OUT} = 1.8V$, $L = 1\mu H$, $C_{OUT} = 44\mu F$, $f_{SW} = 2.1MHz$, $T_A = 25^\circ C$, unless otherwise noted.

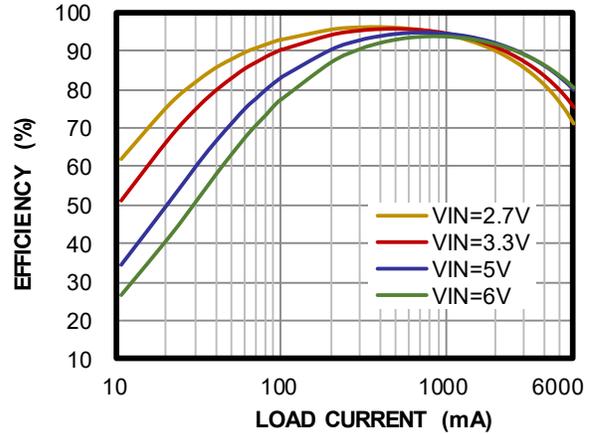
Efficiency vs. Load Current

$V_{OUT} = 1.2V$, $f_{SW} = 450kHz$, $L = 4.7\mu H$, AAM



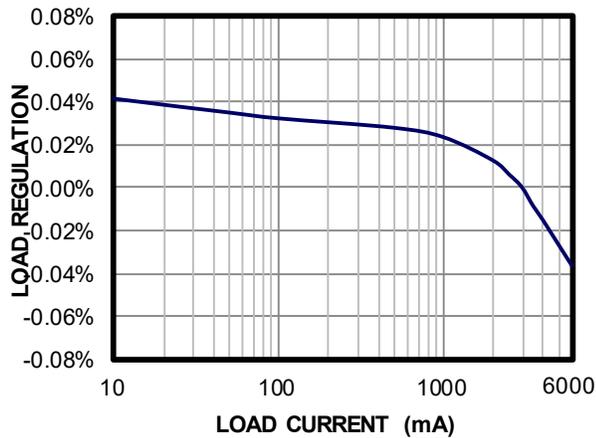
Efficiency vs. Load Current

$V_{OUT} = 1.2V$, $f_{SW} = 450kHz$, $L = 4.7\mu H$, FCCM



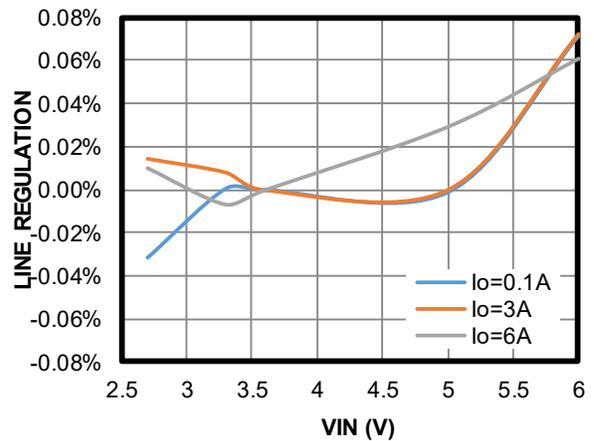
Load Regulation

$V_{OUT} = 1.8V$, AAM



Line Regulation

$V_{OUT} = 1.8V$, AAM

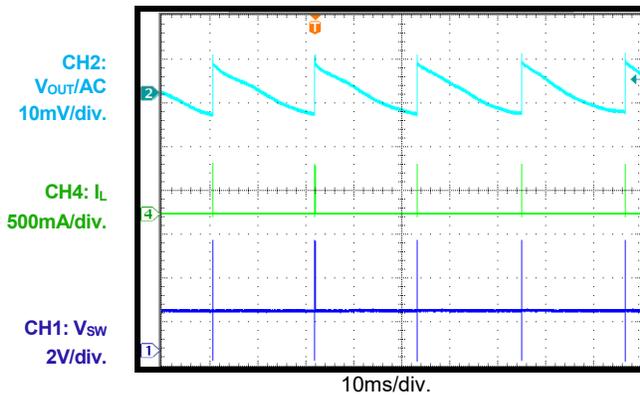


EVB TEST RESULTS (continued)

Performance curves and waveforms are tested on the evaluation board. $V_{IN} = 5V$, $V_{OUT} = 1.8V$, $L = 1\mu H$, $C_{OUT} = 44\mu F$, $f_{sw} = 2.1MHz$, $T_A = 25^\circ C$, unless otherwise noted.

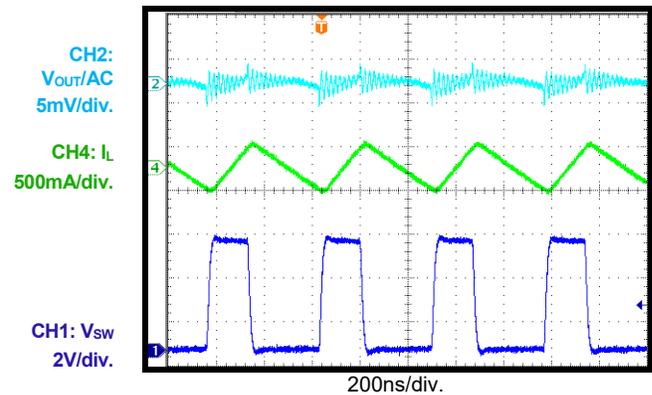
Steady State

$I_{OUT} = 0A$, AAM



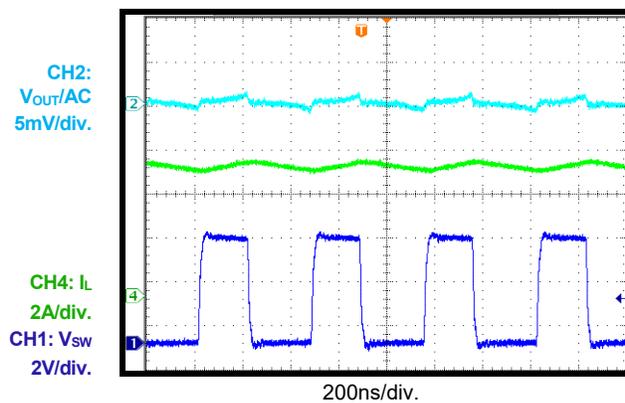
Steady State

$I_{OUT} = 0A$, CCM



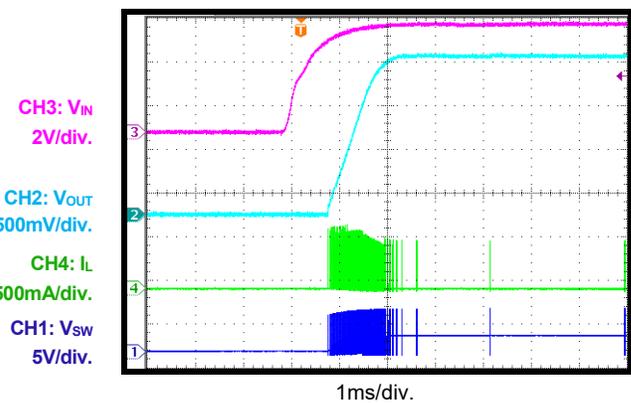
Steady State

$I_{OUT} = 6A$



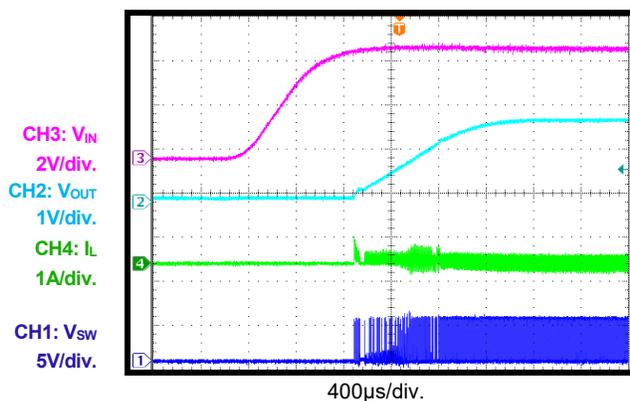
Start-Up through VIN

$I_{OUT} = 0A$, AAM



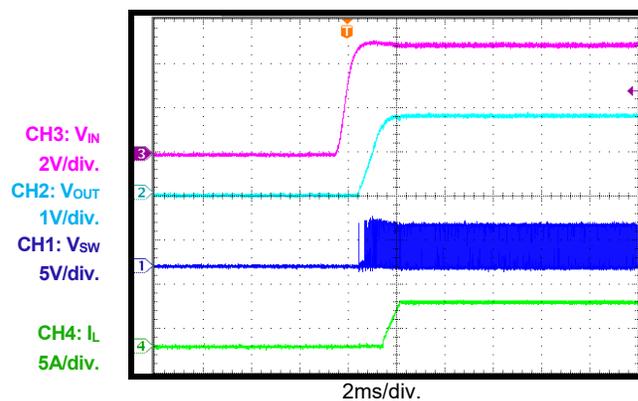
Start-Up through VIN

$I_{OUT} = 0A$, CCM



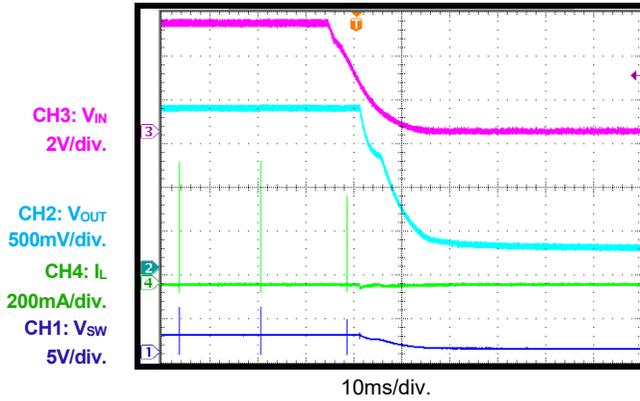
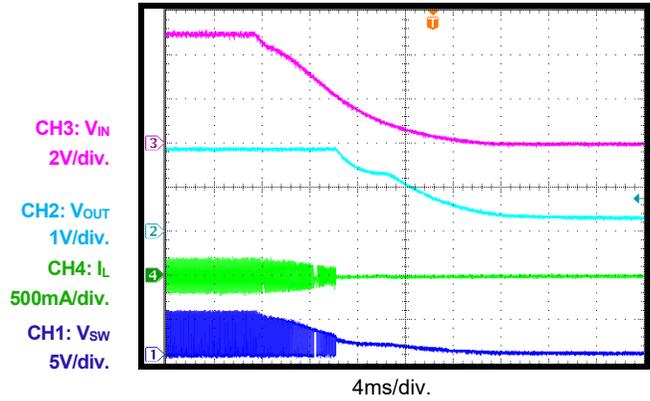
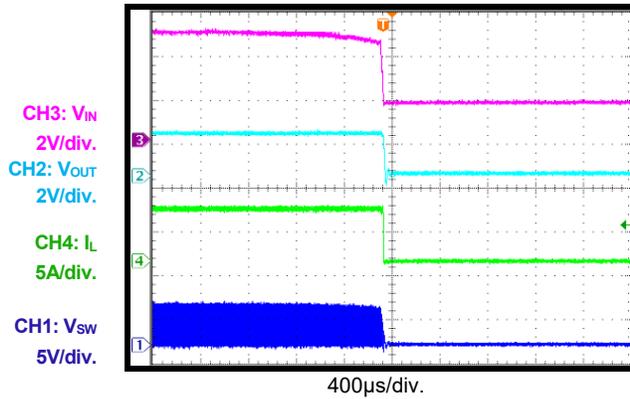
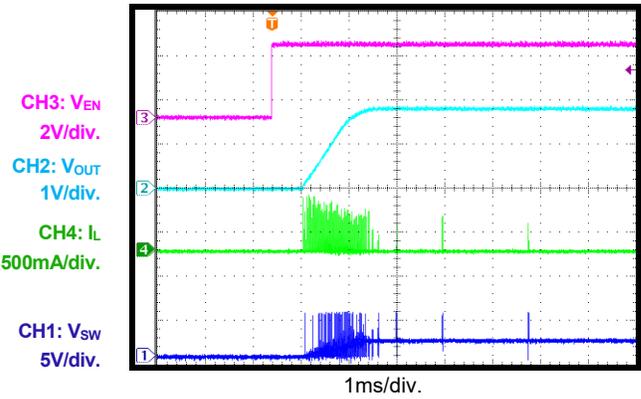
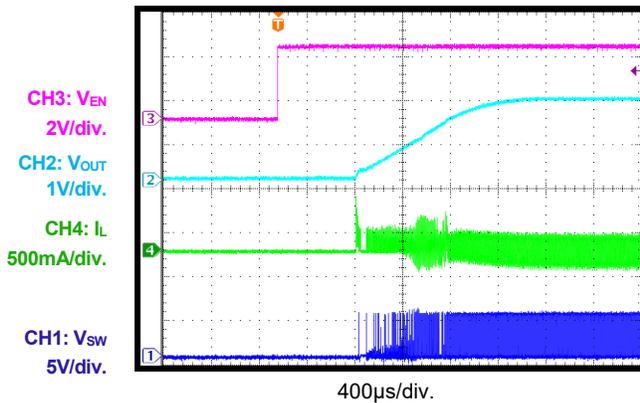
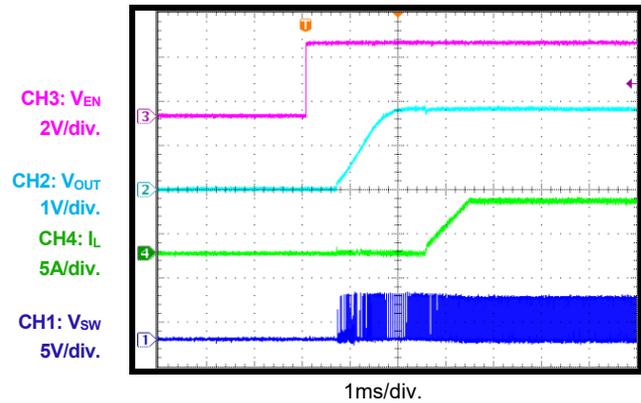
Start-Up through VIN

$I_{OUT} = 6A$



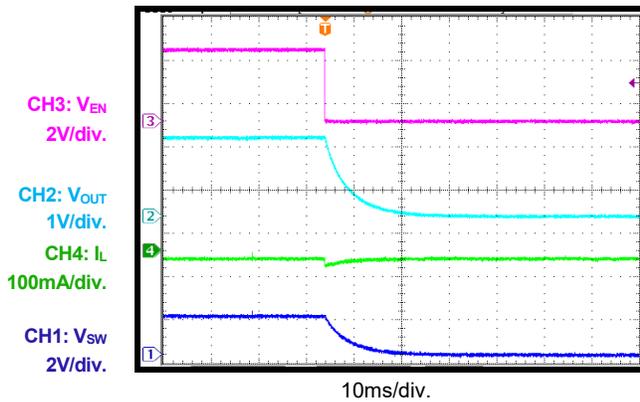
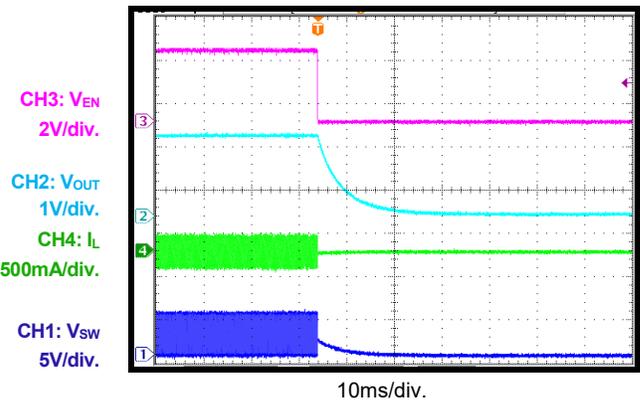
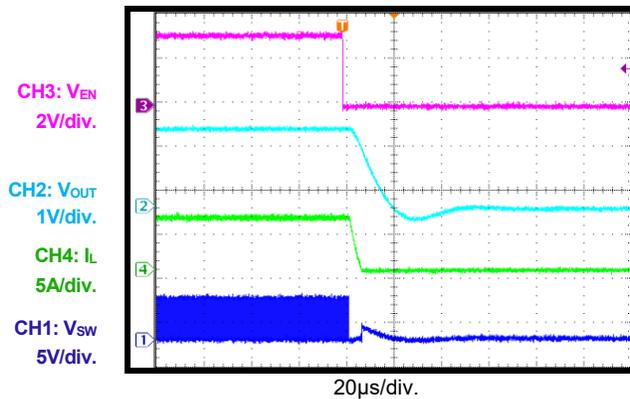
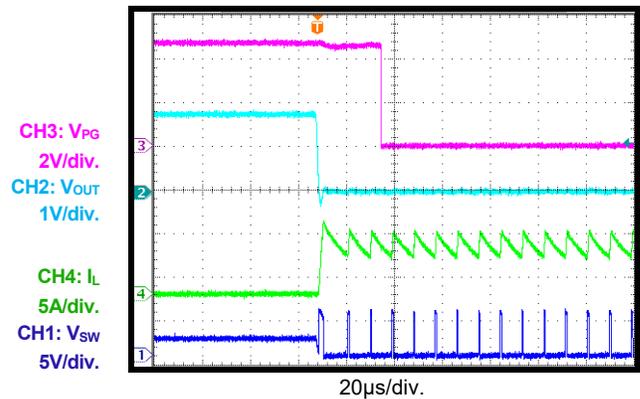
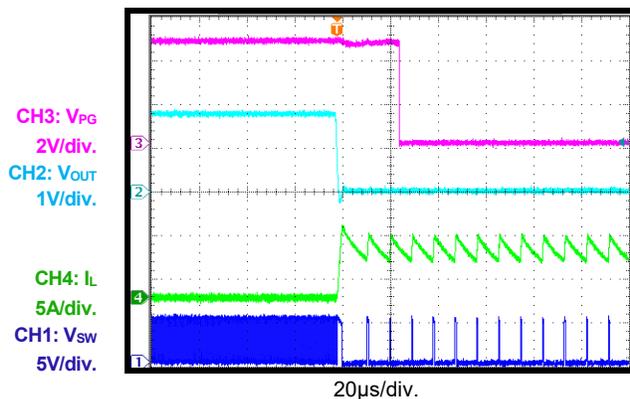
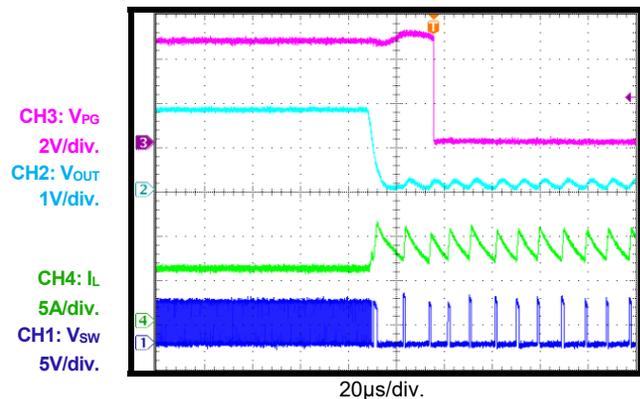
EVB TEST RESULTS (continued)

Performance curves and waveforms are tested on the evaluation board. $V_{IN} = 5V$, $V_{OUT} = 1.8V$, $L = 1\mu H$, $C_{OUT} = 44\mu F$, $f_{SW} = 2.1MHz$, $T_A = 25^\circ C$, unless otherwise noted.

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

Shutdown through VIN
 $I_{OUT} = 0A$, CCM

Shutdown through VIN
 $I_{OUT} = 6A$

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

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

Start-Up through EN
 $I_{OUT} = 6A$


EVB TEST RESULTS (continued)

 Performance curves and waveforms are tested on the evaluation board. $V_{IN} = 5V$, $V_{OUT} = 1.8V$, $L = 1\mu H$, $C_{OUT} = 44\mu F$, $f_{SW} = 2.1MHz$, $T_A = 25^\circ C$, unless otherwise noted.

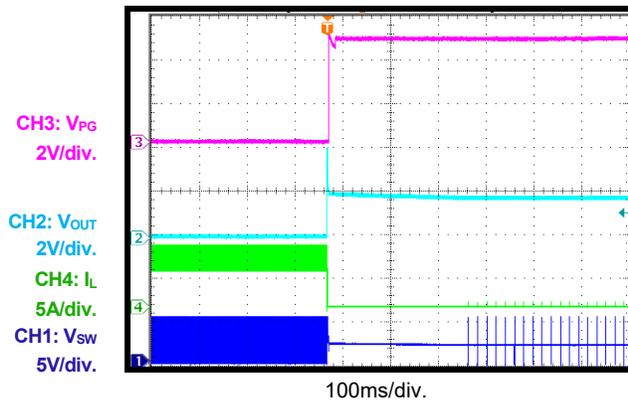
Shutdown through EN
 $I_{OUT} = 0A$, AAM

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

Shutdown through EN
 $I_{OUT} = 6A$

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

SCP Entry
 $I_{OUT} = 0A$, CCM

SCP Entry
 $I_{OUT} = 6A$


EVB TEST RESULTS (continued)

Performance curves and waveforms are tested on the evaluation board. $V_{IN} = 5V$, $V_{OUT} = 1.8V$, $L = 1\mu H$, $C_{OUT} = 44\mu F$, $f_{sw} = 2.1MHz$, $T_A = 25^\circ C$, unless otherwise noted.

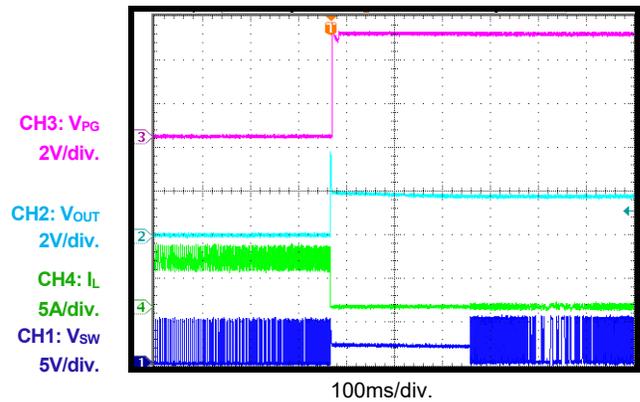
SCP Recovery

$I_{OUT} = 0A$, AAM



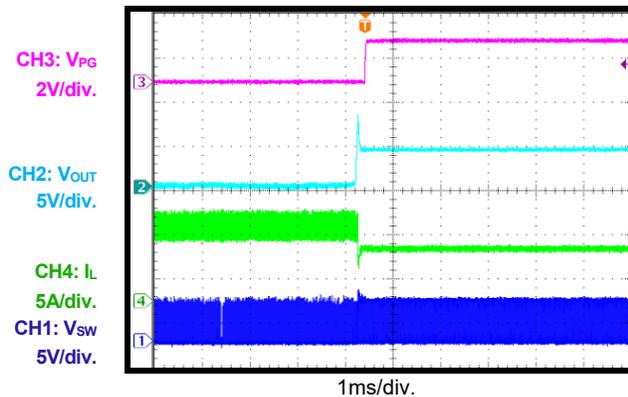
SCP Recovery

$I_{OUT} = 0A$, CCM



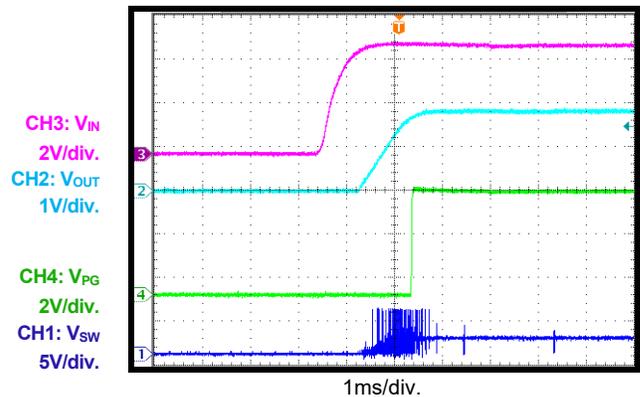
SCP Recovery

$I_{OUT} = 6A$



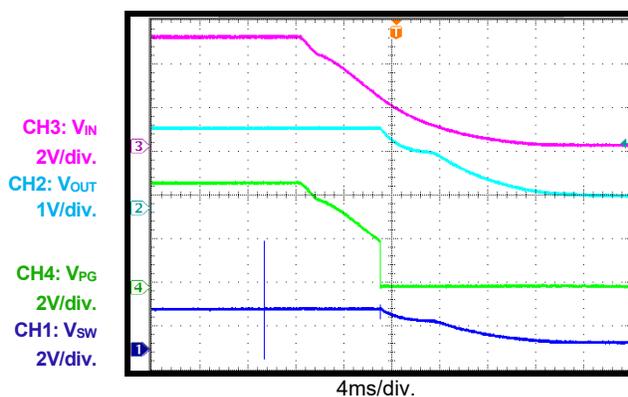
PG Start-Up through VIN

$I_{OUT} = 0A$, AAM



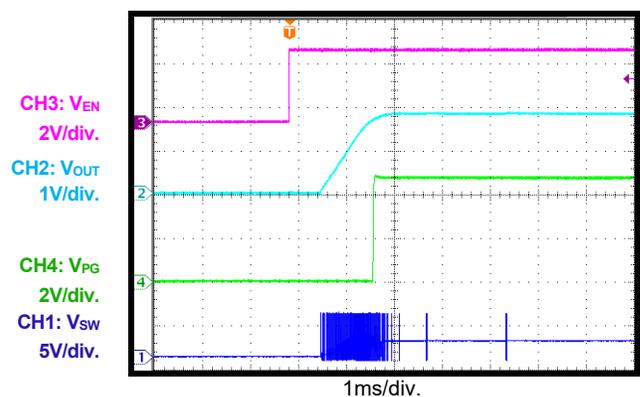
PG Shutdown through VIN

$I_{OUT} = 0A$, AAM



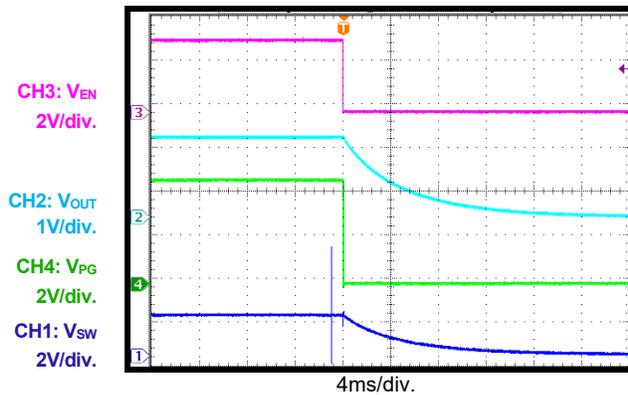
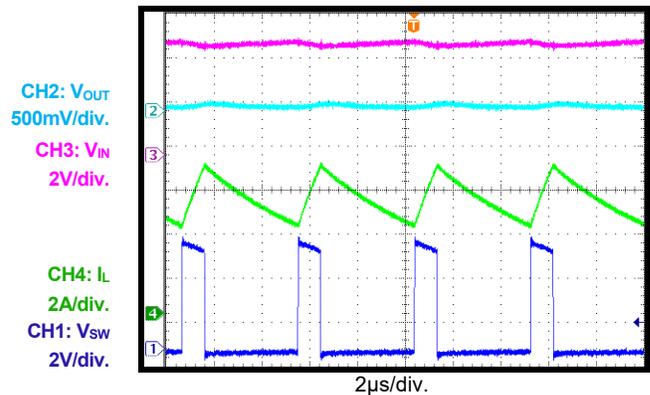
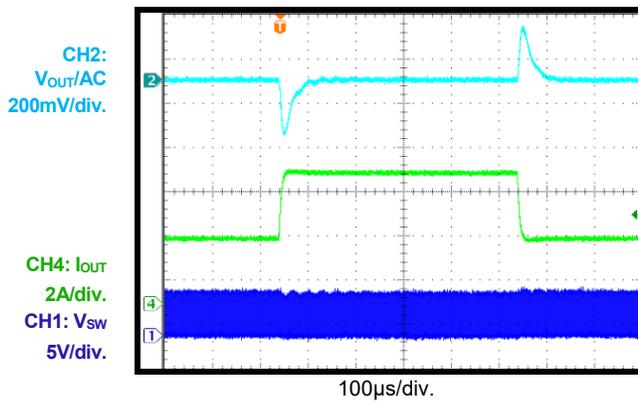
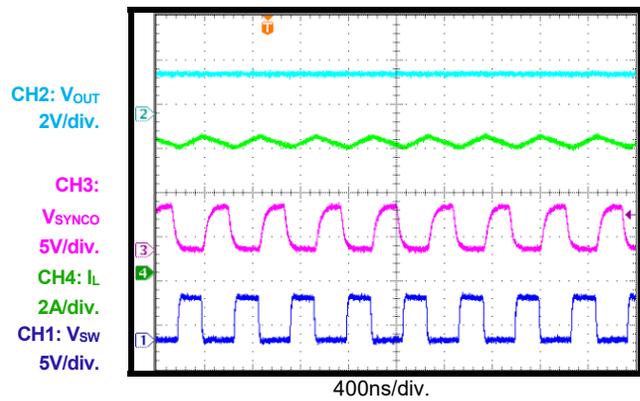
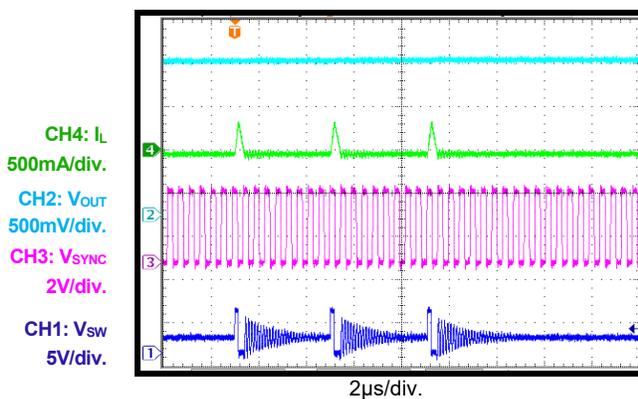
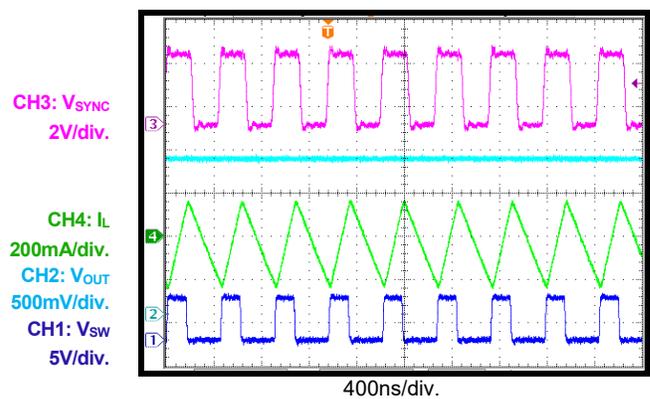
PG Start-Up through EN

$I_{OUT} = 0A$, AAM



EVB TEST RESULTS (continued)

 Performance curves and waveforms are tested on the evaluation board. $V_{IN} = 5V$, $V_{OUT} = 1.8V$, $L = 1\mu H$, $C_{OUT} = 44\mu F$, $f_{SW} = 2.1MHz$, $T_A = 25^\circ C$, unless otherwise noted.

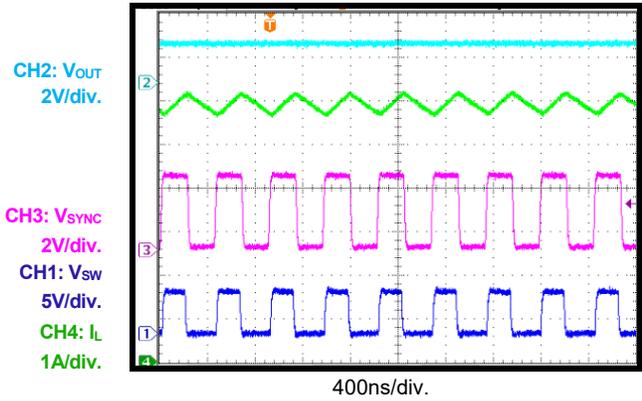
PG Shutdown through EN
 $I_{OUT} = 0A$, AAM

SCP Steady State

Load Transient
 $I_{OUT} = 3A$ to $6A$, $1.6A/\mu s$

SYNCO
 $I_{OUT} = 6A$

SYNCIN
 $I_{OUT} = 0A$, AAM, SYNC clock = 2.2MHz

SYNCIN
 $I_{OUT} = 0A$, FCCM, SYNC clock = 2.2MHz


EVB TEST RESULTS (continued)

Performance curves and waveforms are tested on the evaluation board. $V_{IN} = 5V$, $V_{OUT} = 1.8V$, $L = 1\mu H$, $C_{OUT} = 44\mu F$, $f_{SW} = 2.1MHz$, $T_A = 25^\circ C$, unless otherwise noted.

SYNCIN

$I_{OUT} = 6A$, SYNC clock = 2.2MHz



PCB LAYOUT

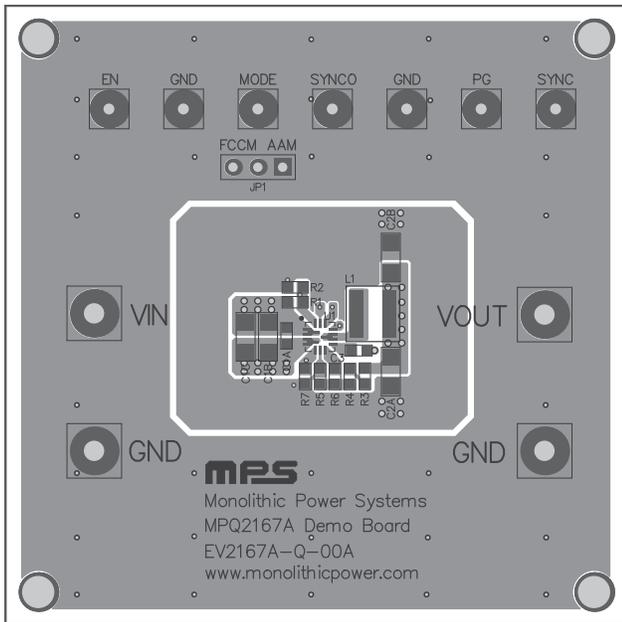


Figure 5: Top Silk and Top Layer

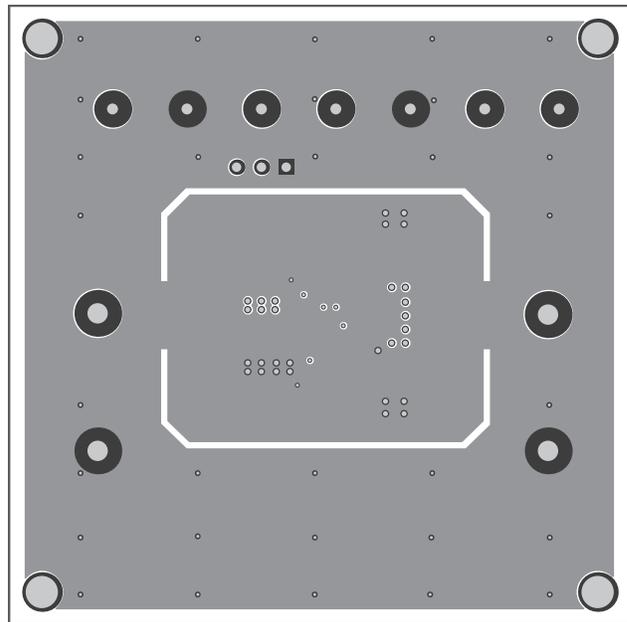


Figure 6: Mid-Layer 1

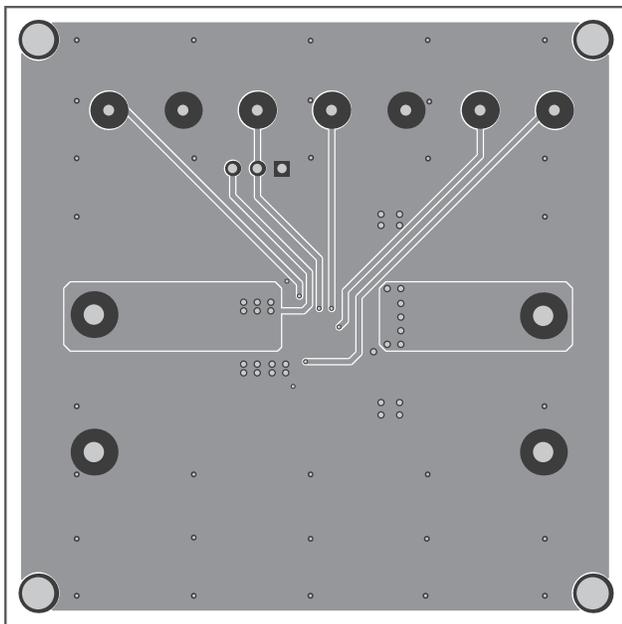


Figure 7: Mid-Layer 2

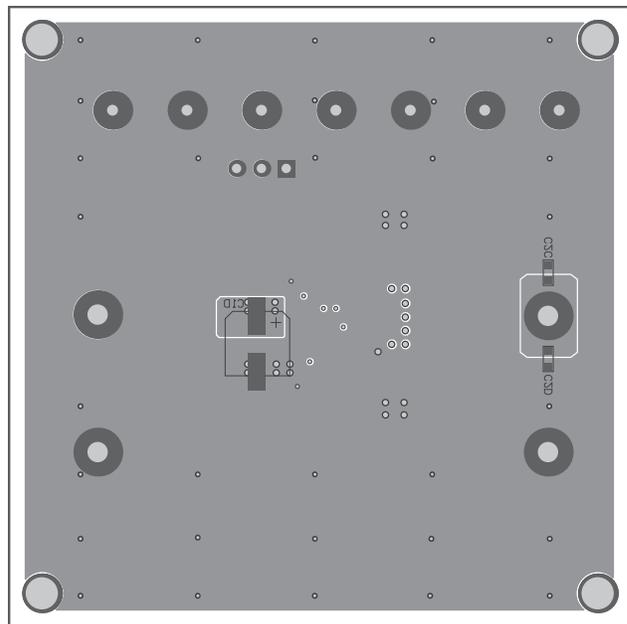


Figure 8: Bottom Layer and Bottom Silk



REVISION HISTORY

| Revision # | Revision Date | Description | Pages Updated |
|------------|---------------|-----------------|---------------|
| 1.0 | 1/4/2021 | Initial Release | - |

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