



EV2167B-D-00A

6V, 4A, Frequency Programmable Buck Converter Evaluation Board

DESCRIPTION

The EV2167B-D-00A Evaluation Board is designed to demonstrate the capabilities of MPQ2167B.

MPQ2167B is a frequency programmable (300kHz to 2.2MHz), synchronous, step-down, switching regulator with integrated internal high-side and low-side power MOSFETs. It provides up to 4A continuous output current with peak current control for excellent transient response.

The MPQ2167B can be configured for either advanced asynchronous mode (AAM) or forced continuous conduction mode (FCCM) operation at light load. AAM provides high efficiency by reducing switching losses at light load while FCCM has controllable frequency and a lower output ripple.

The EV2167B-D-00A is a fully assembled and tested evaluation board, it generates +1.8V output voltage at load current up to 4A from a 2.7V to 6V input range with 1.9MHz switching frequency.

ELECTRICAL SPECIFICATION

Parameter	Symbol	Value	Units
Input Voltage	V_{EMI}	2.7 - 6	V
Output Voltage	V_{OUT}	1.8	V
Output Current	I_{OUT}	4	A

FEATURES

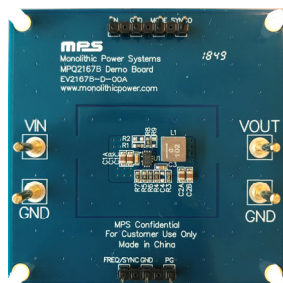
- 2.7V to 6.0V Operating Input Range
- Adjustable Output from 0.606V
- Up to 4A Continuous Output Current
- High Efficiency Synchronous Mode Control
- 35mΩ and 25mΩ Internal Power MOSFETs
- Programmable Frequency up to 2.2MHz
- 42μA Quiescent Current
- Low Shutdown Mode Current
- 100% Duty Cycle Operation
- Internal Compensation Mode
- Selectable AAM or FCCM Operation Option
- External Soft Start
- Remote EN Control
- Power Good Indicator
- Cycle-by-Cycle Over-Current Protection
- Short-Circuit Protection
- V_{IN} Under-Voltage Lockout
- V_{OUT} Over-Voltage Protection
- Thermal Shutdown
- Available in QFN-11 (2mmx3mm) Package
- Available in a Wettable Flank Package
- Available in AEC-Q100 Grade-1

APPLICATIONS

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

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EV2167B-D-00A EVALUATION BOARD

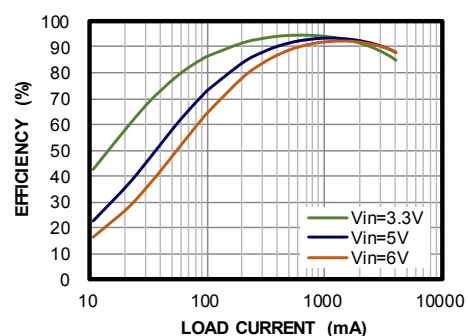


(L × W × H) 6.3cm x 6.3cm x 1cm

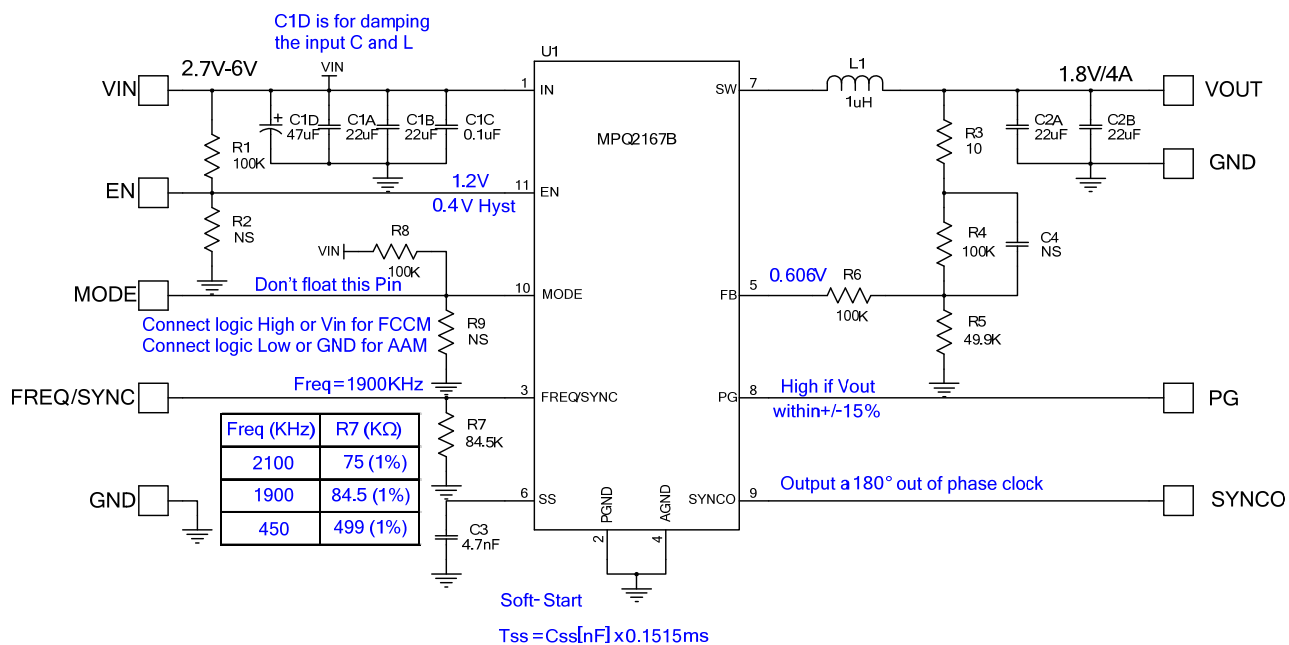
Board Number	MPS IC Number
EV2167B-D-00A	MPQ2167BGDE-AEC1

Efficiency vs. Load Current

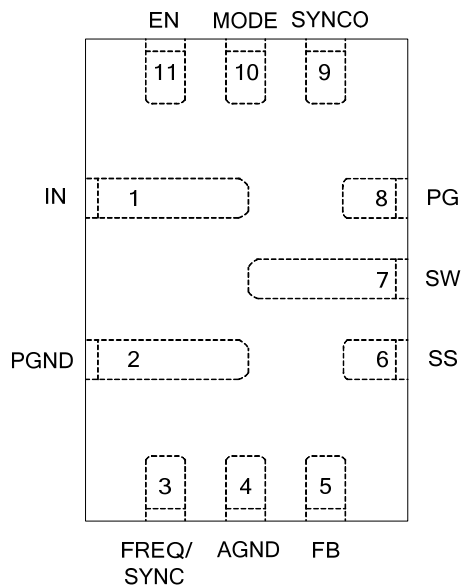
$V_{\text{OUT}}=1.8\text{V}$, CCM, $L=1\mu\text{H}$, $F_{\text{SW}}=2.1\text{MHz}$



EVALUATION BOARD SCHEMATIC



Package Reference



EV2167B-D-00A BILL OF MATERIALS

Qty	RefDes	Value	Description	Package	Manufacturer	Manufacturer_P/N
4	C1A, C1B, C2A, C2B	22 μ F	Ceramic Capacitor; 16V;X5R	0805	muRata	GRM21BR61C226ME44L
1	C1C	0.1 μ F	Ceramic Capacitor; 16V;X7R	0603	muRata	GRM188R71C104KA01D
1	C1D	47 μ F	Electrolytic Cap;16V	SMD	Jianghai	VZ1-16V47
1	C3	4.7nF	Ceramic Capacitor; 50V;X7R	0603	muRata	GRM188R71H472KA01D
1	C4	NS				
1	L1	1 μ H	Inductor; 7mohm DCR; 11.4A	SMD	Coilcraft	XEL5030-102MEC
1	L3	NS				
4	R1, R4, R6, R8	100K	Film Resistor;1%;	0603	Yageo	RC0603FR-07100KL
1	R3	10	Film Resistor;1%;	0603	Yageo	RC0603FR-0710RL
1	R5	49.9K	Film Resistor;1%;	0603	Yageo	RC0603FR-0749K9L
1	R7	84.5K	Film Resistor;1%;	0603	Yageo	RC0603FR-0784K5L
2	R2, R9	NS				
1	U1		Step-Down Converter	QFN	MPS	MPQ2167BGDE-AEC1
4	VIN, GND, GND, VOUT	Test Point	2.0 Golden Pin		HZ	
12	EN, MODE, FREQ/SYNC, GND, PG, SYNCO, GND	Test Point	2.54mm Test Pin		HZ	

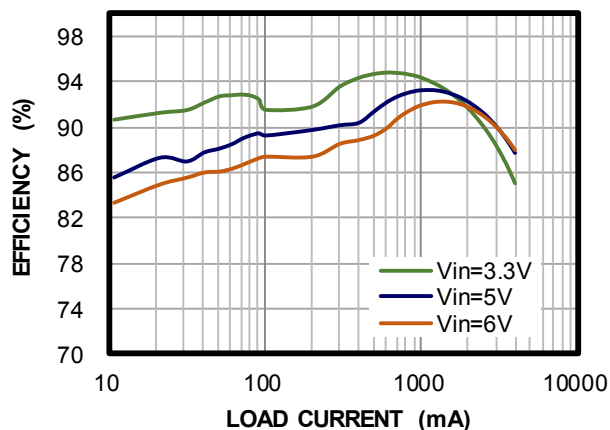
EVB TEST RESULTS

Performance curves and waveforms are tested on the evaluation board.

$V_{IN} = 5V$, $V_{OUT} = 1.8V$, $L = 1\mu H$, $F_{SW} = 2.1MHz$, $T_A = 25^\circ C$, unless otherwise noted.

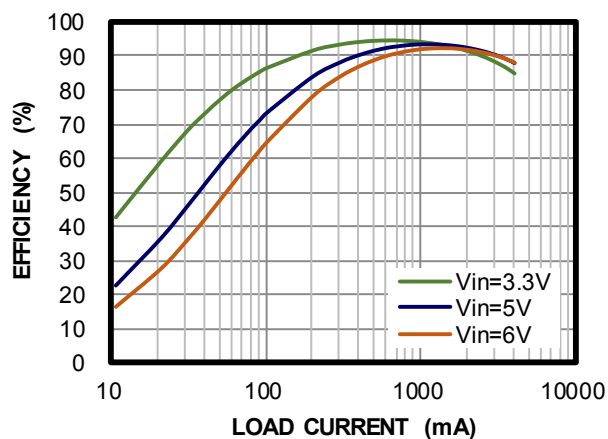
Efficiency vs. Load Current

$V_{OUT}=1.8V$, AAM



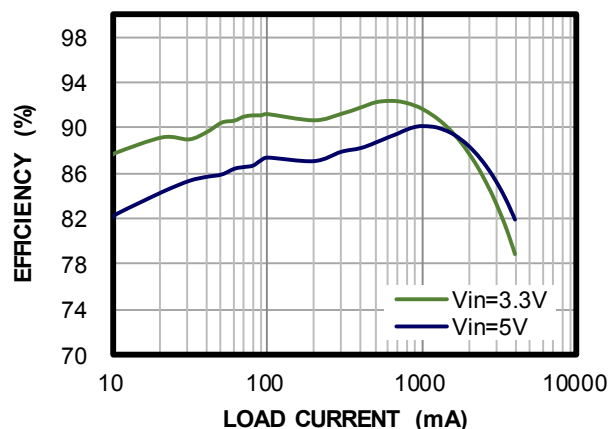
Efficiency vs. Load Current

$V_{OUT}=1.8V$, CCM



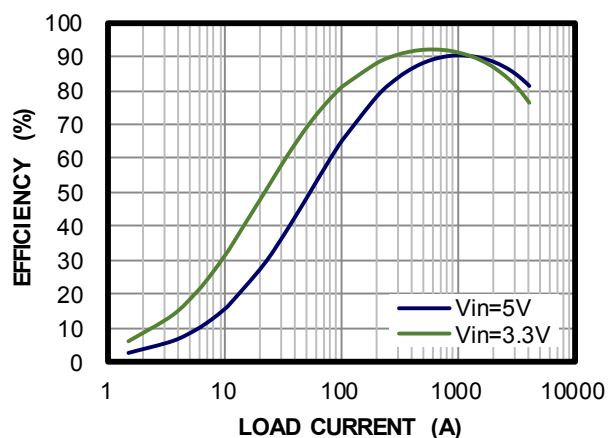
Efficiency vs. Load Current

$V_{OUT}=1.2V$, AAM



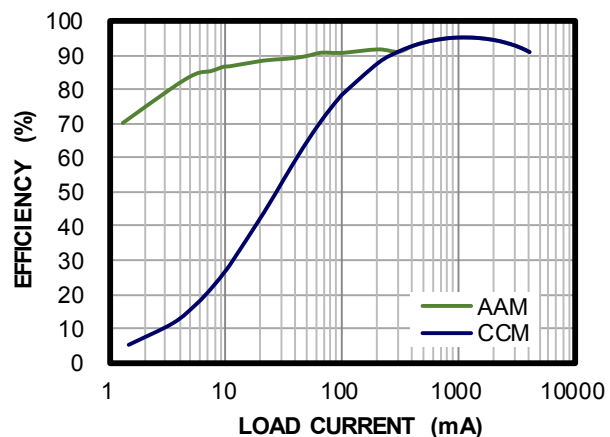
Efficiency vs. Load Current

$V_{OUT}=1.2V$, CCM



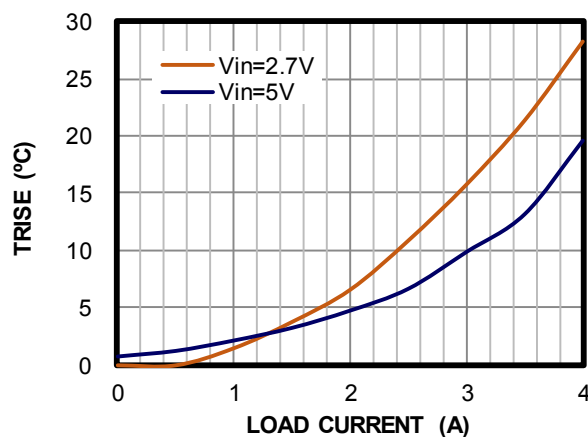
Efficiency vs. Load Current

$V_{IN}=5V$, $V_{OUT}=2.5V$



Case Thermal Rise

$V_{OUT}=1.8V$, AAM



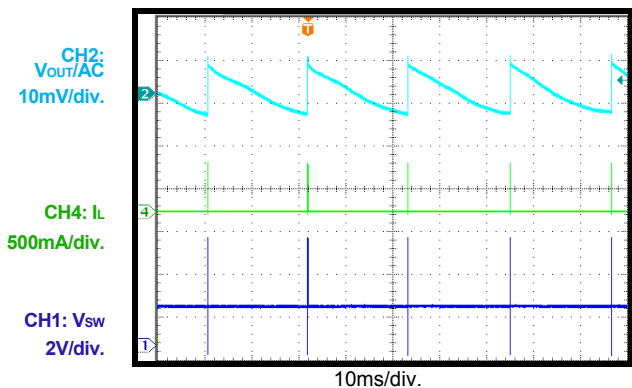
EVB TEST RESULTS (continued)

Performance curves and waveforms are tested on the evaluation board.

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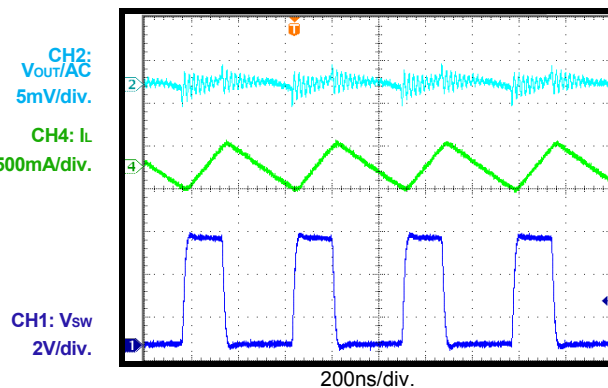
Steady State

$I_{OUT}=0A$, AAM



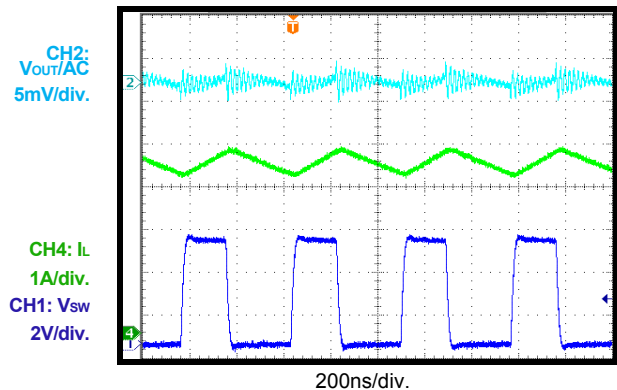
Steady State

$I_{OUT}=0A$, CCM



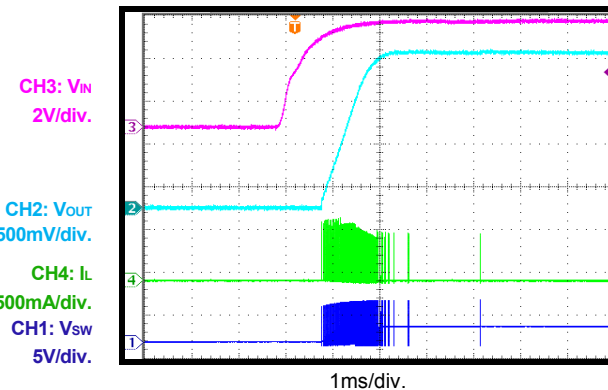
Steady State

$I_{OUT}=4A$



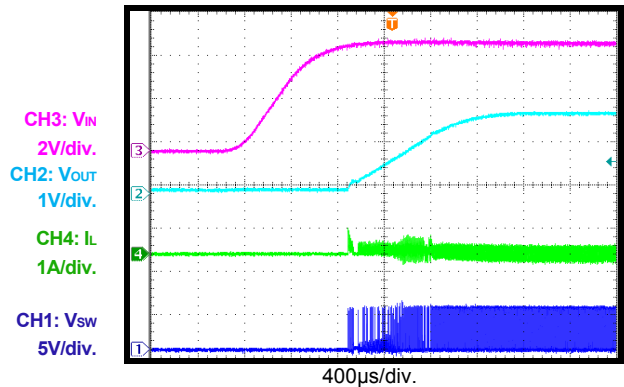
Start-Up through VIN

$I_{OUT}=0A$, AAM



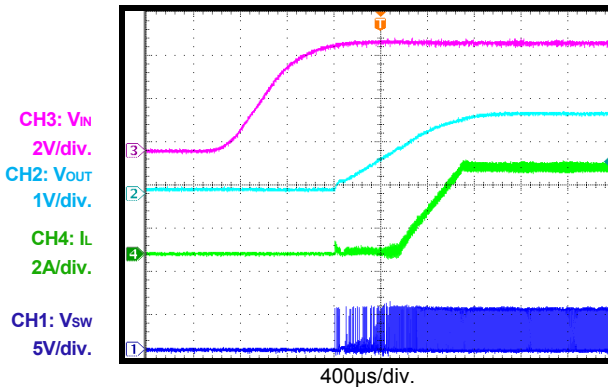
Start-Up through VIN

$I_{OUT}=0A$, CCM



Start-Up through VIN

$I_{OUT}=4A$



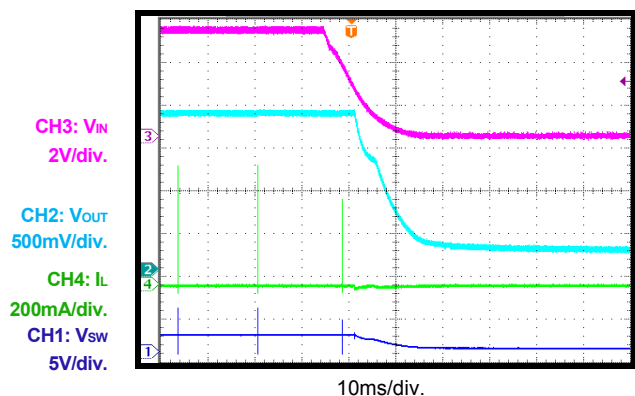
EVB TEST RESULTS (continued)

Performance curves and waveforms are tested on the evaluation board.

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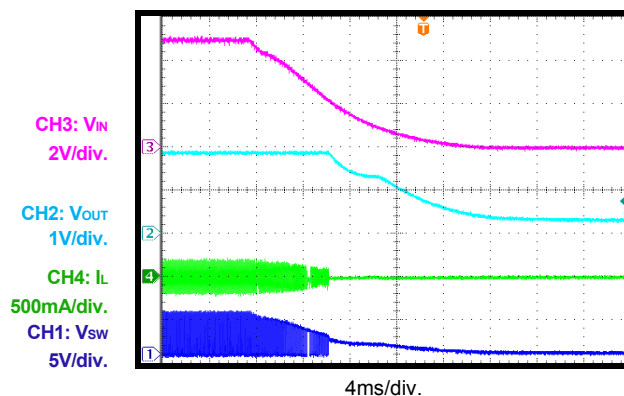
Shutdown through VIN

$I_{OUT}=0A$, AAM



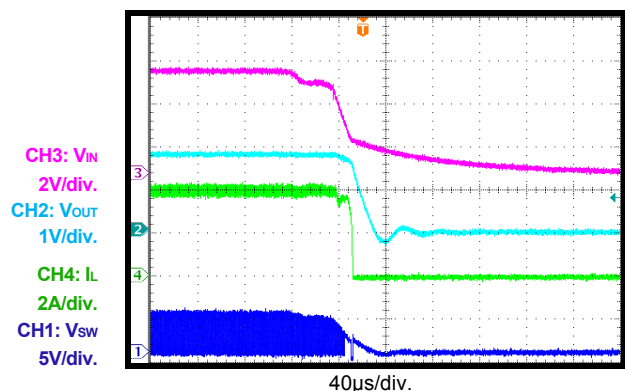
Shutdown through VIN

$I_{OUT}=0A$, CCM



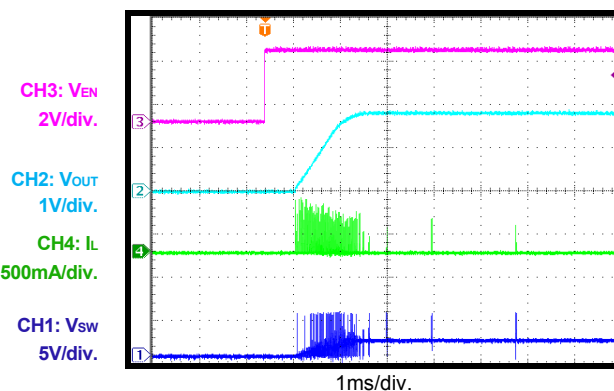
Shutdown through VIN

$I_{OUT}=4A$



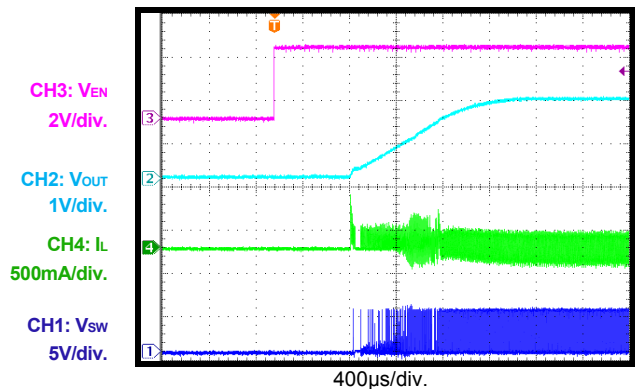
Start-Up through EN

$I_{OUT}=0A$, AAM



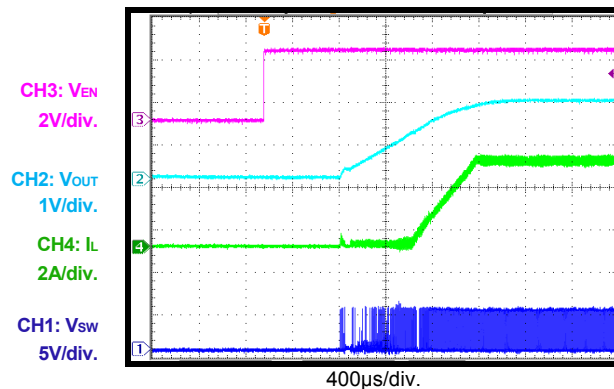
Start-Up through EN

$I_{OUT}=0A$, CCM



Start-Up through EN

$I_{OUT}=4A$



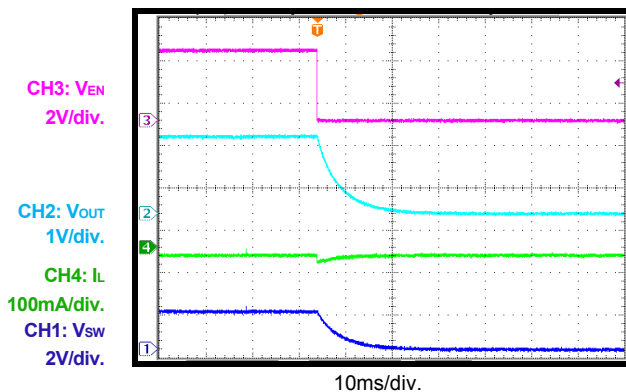
EVB TEST RESULTS (continued)

Performance curves and waveforms are tested on the evaluation board.

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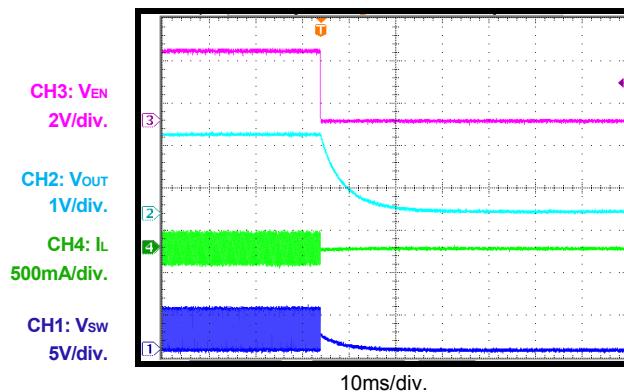
Shutdown through EN

$I_{OUT}=0A$, AAM



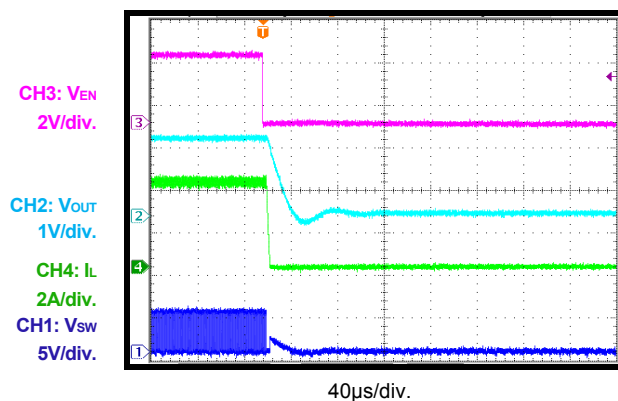
Shutdown through EN

$I_{OUT}=0A$, CCM



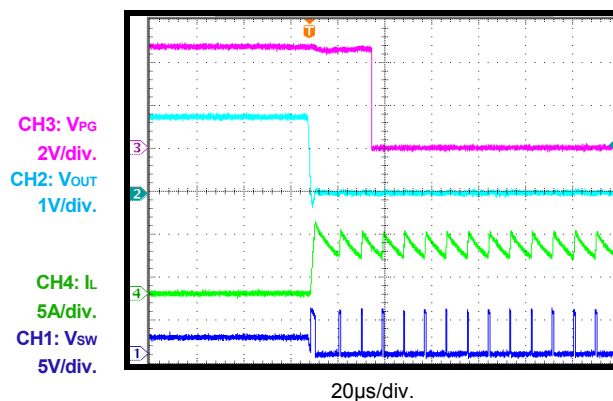
Shutdown through EN

$I_{OUT}=4A$



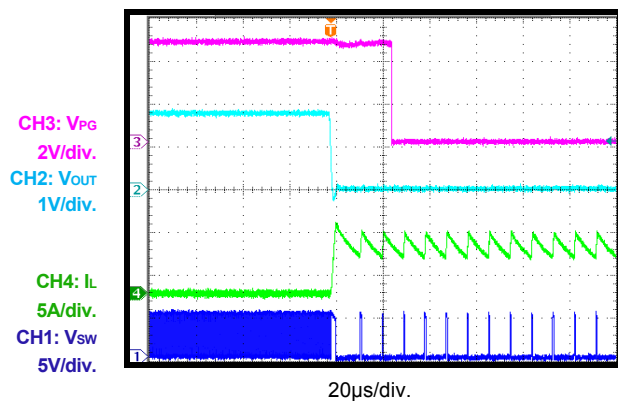
SCP Entry

$I_{OUT}=0A$, AAM



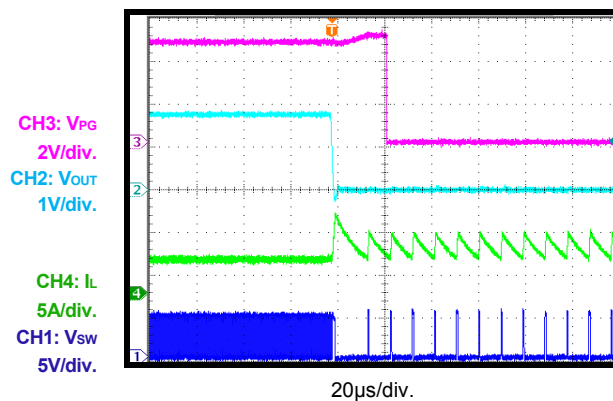
SCP Entry

$I_{OUT}=0A$, CCM



SCP Entry

$I_{OUT}=4A$



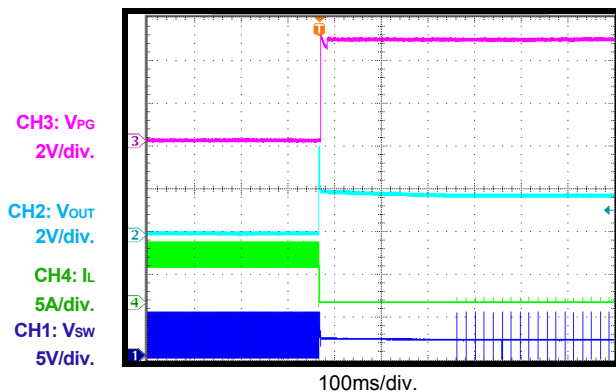
EVB TEST RESULTS (continued)

Performance curves and waveforms are tested on the evaluation board.

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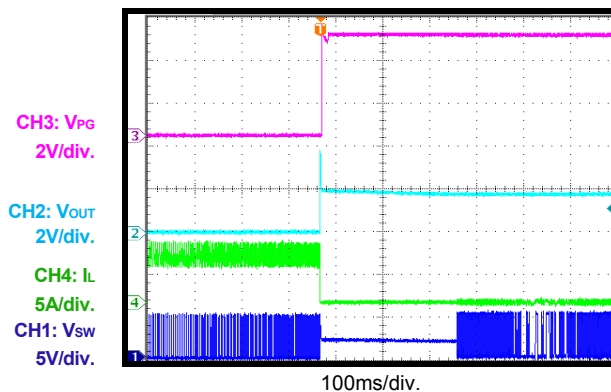
SCP Recovery

$I_{OUT}=0A$, AAM



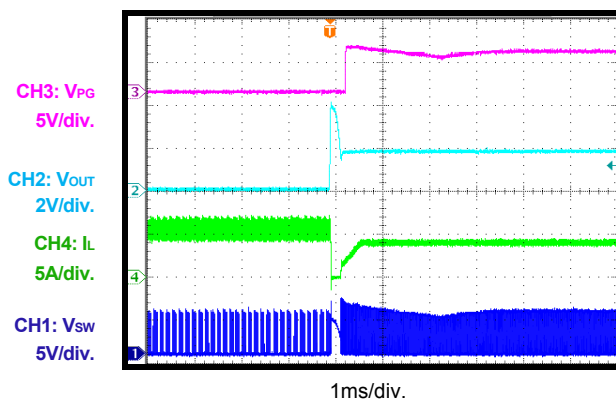
SCP Recovery

$I_{OUT}=0A$, CCM



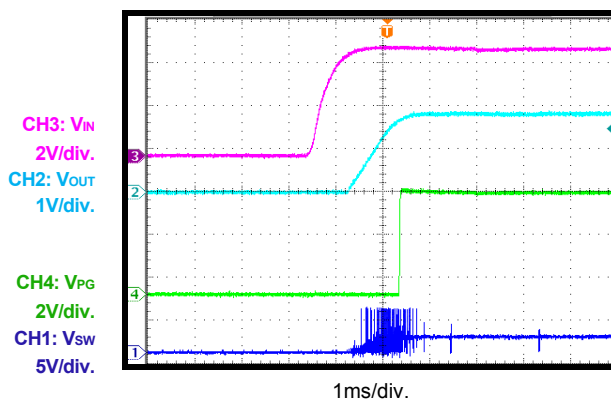
SCP Recovery

$I_{OUT}=4A$



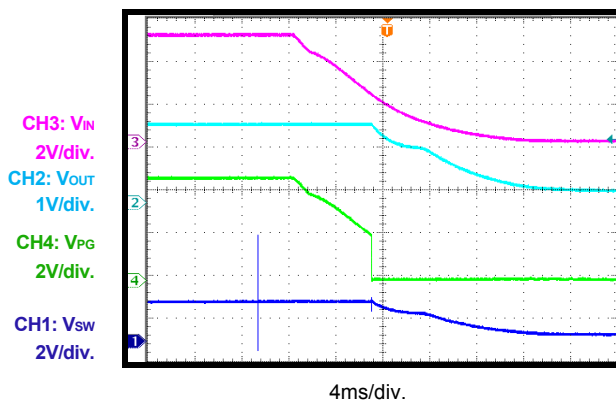
PG in Start-Up through VIN

$I_{OUT}=0A$, AAM



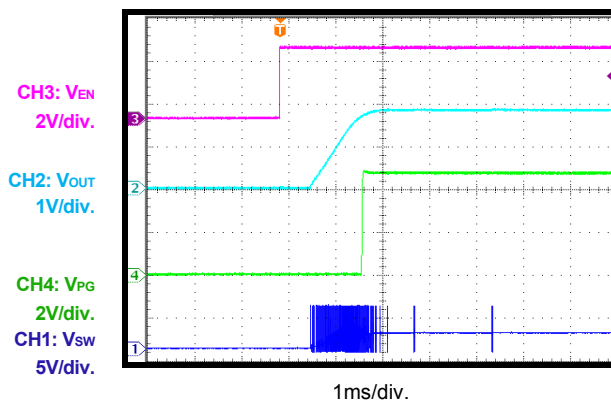
PG in Shutdown through VIN

$I_{OUT}=0A$, AAM



PG in Start-Up through EN

$I_{OUT}=0A$, AAM



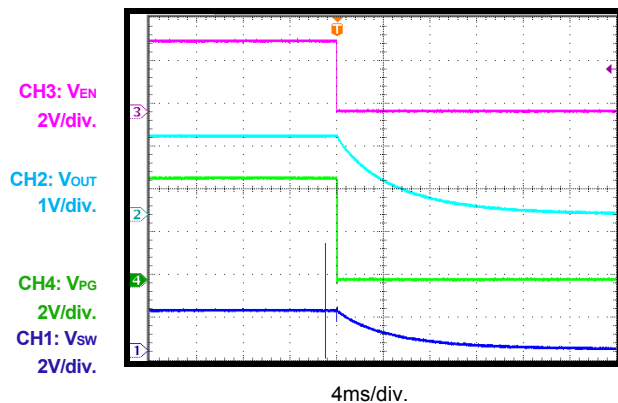
EVB TEST RESULTS *(continued)*

Performance curves and waveforms are tested on the evaluation board.

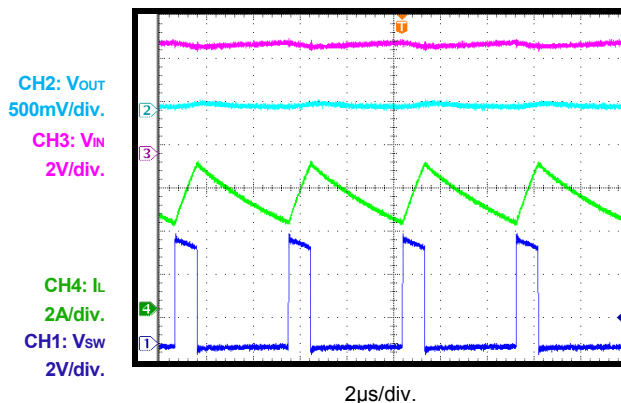
$V_{IN} = 5V$, $V_{OUT} = 1.8V$, $L = 1\mu H$, $F_{SW} = 2.1MHz$, $T_A = 25^\circ C$, unless otherwise noted.

PG in Shutdown through EN

$I_{OUT}=0A$, AAM

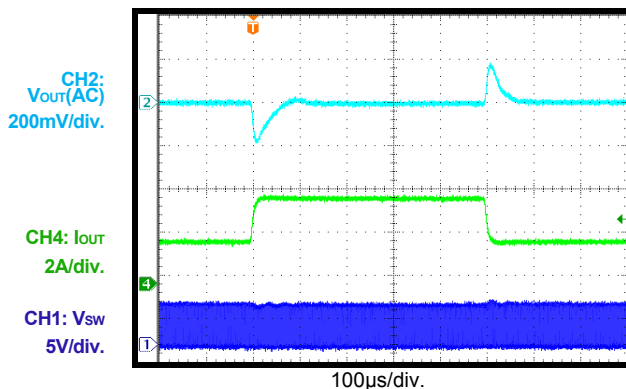


SCP Steady State



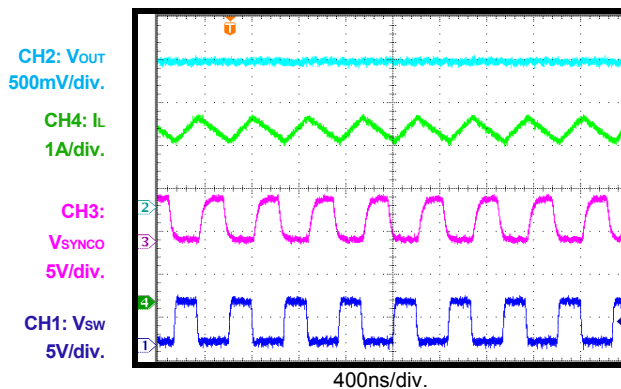
Load Transient

$I_{OUT}=2A \leftrightarrow 4A$, $1.6A/\mu s$



SYNCO

$I_{OUT}=4A$



PRINTED CIRCUIT BOARD LAYOUT

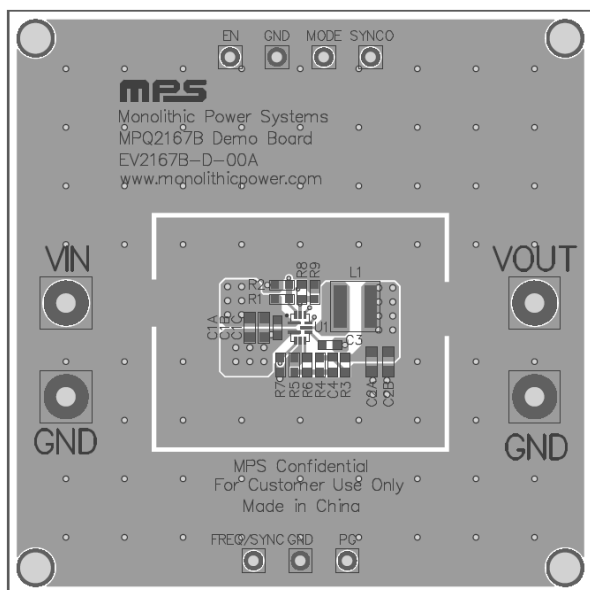


Figure 1: Top Silk Layer and Top Layer

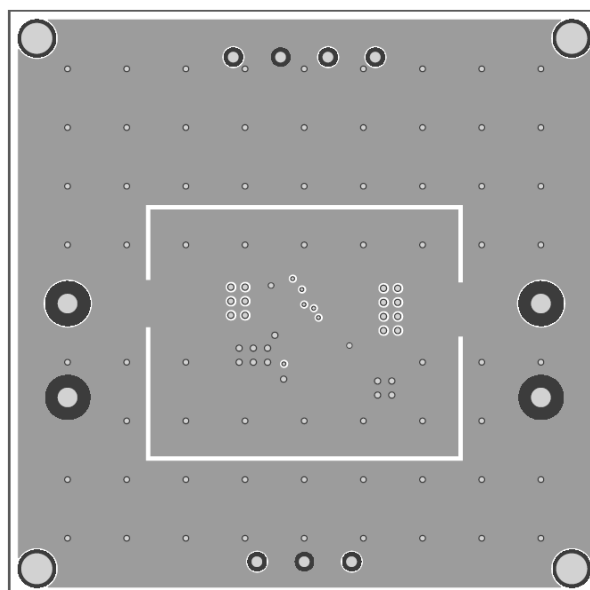


Figure 2: Inner 1 Layer

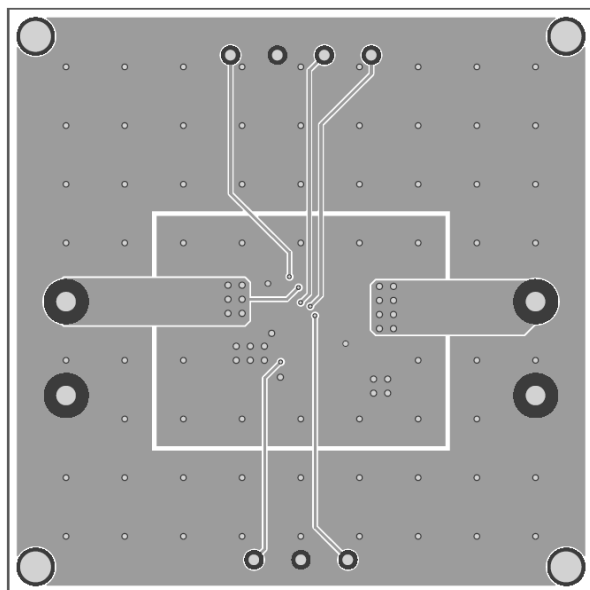


Figure 3: Inner 2 Layer

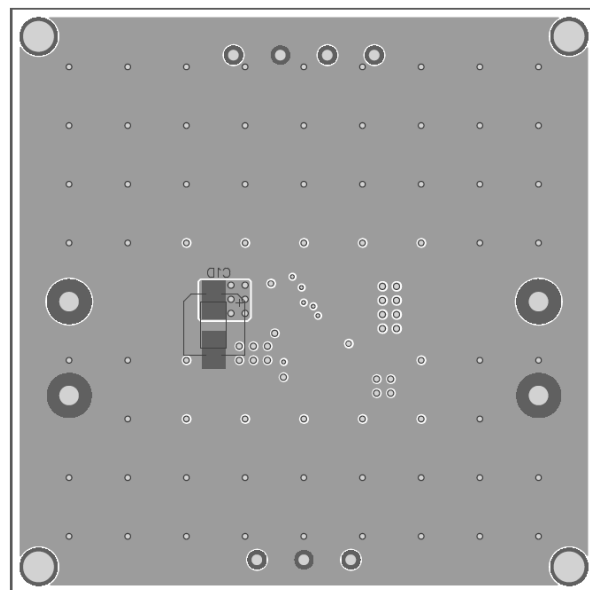
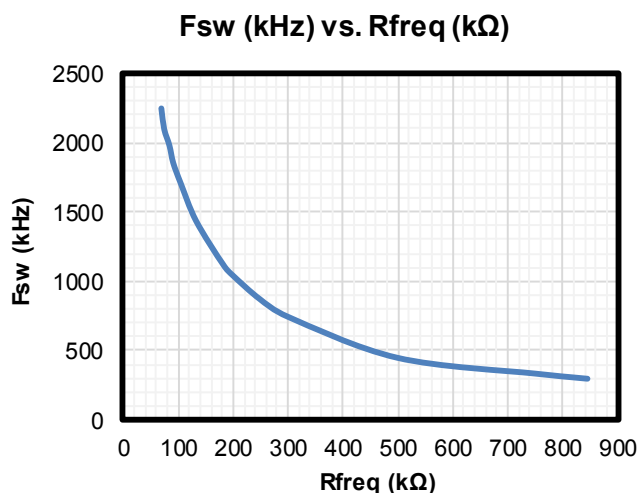


Figure 4: Bottom Silk Layer and Bottom Layer

QUICK START GUIDE

1. Preset 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 a too high current will trigger Hiccup mode.
2. Turn power supply off. If longer cables are used between the source and the EVB (>0.5m total), stuff C1D can damp input spike when plug in; for regular operation no need to stuff this capacitor.
3. Connect power supply terminals to:
 - a. Positive (+): V_{IN}
 - b. Negative (-): GND
4. Connect load to:
 - a. Positive (+): V_{OUT}
 - b. Negative (-): GND
5. Turn power supply on after making connections.
6. To use the Enable function, apply a digital input to the EN pin. Drive EN higher than 1.2V to turn on the regulator, drive EN less than 0.8V to turn it off.
7. The relationship between external frequency resistor R_{FREQ} and oscillating frequency of MPQ2167B can be estimated by below curve:

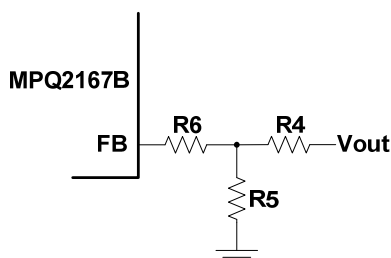


8. The FREQ/SYNC pin can also be used to synchronized by external clock. Sync frequency range is from 300kHz to 2.2MHz.
9. The Mode pin can also be used to select FCCM mode or AAM mode. Connect it to logic high or V_{IN} to choose forced FCCM mode, and connect it to logic low or GND to choose AAM mode, don't leave it floating.

10. The external resistor divider connected to FB sets the output voltage. The feedback resistor R1 must account for both stability and dynamic response, so it cannot be too large or too small. R1 is estimated to be 100kΩ. R2 is then given using equation:

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

The T-type feedback network is highly recommended:



R6+R4 is used to set the loop bandwidth. Basically, a higher R6+R4 brings lower bandwidth. To ensure loop stability, it is strongly recommended to limit the bandwidth around 0.1f_{SW}.

Below table lists the recommended feedback resistor values for common output voltages.

V _{OUT} (V)	R6 (kΩ)	R4 (kΩ)	R5 (kΩ)
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%)

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