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

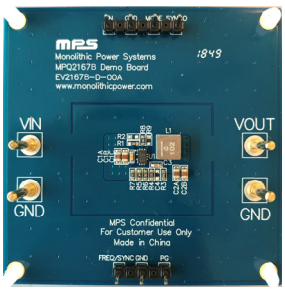
FEATURES

- 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

EV2167B-D-00A EVALUATION BOARD

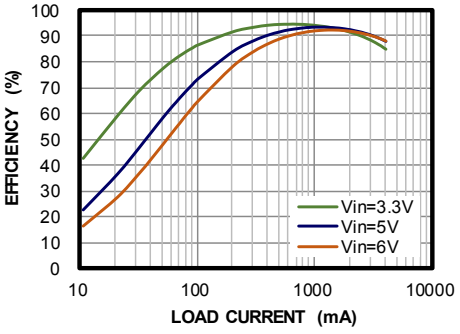


(L × W × H) 6.3cm x 6.3cm x 1cm

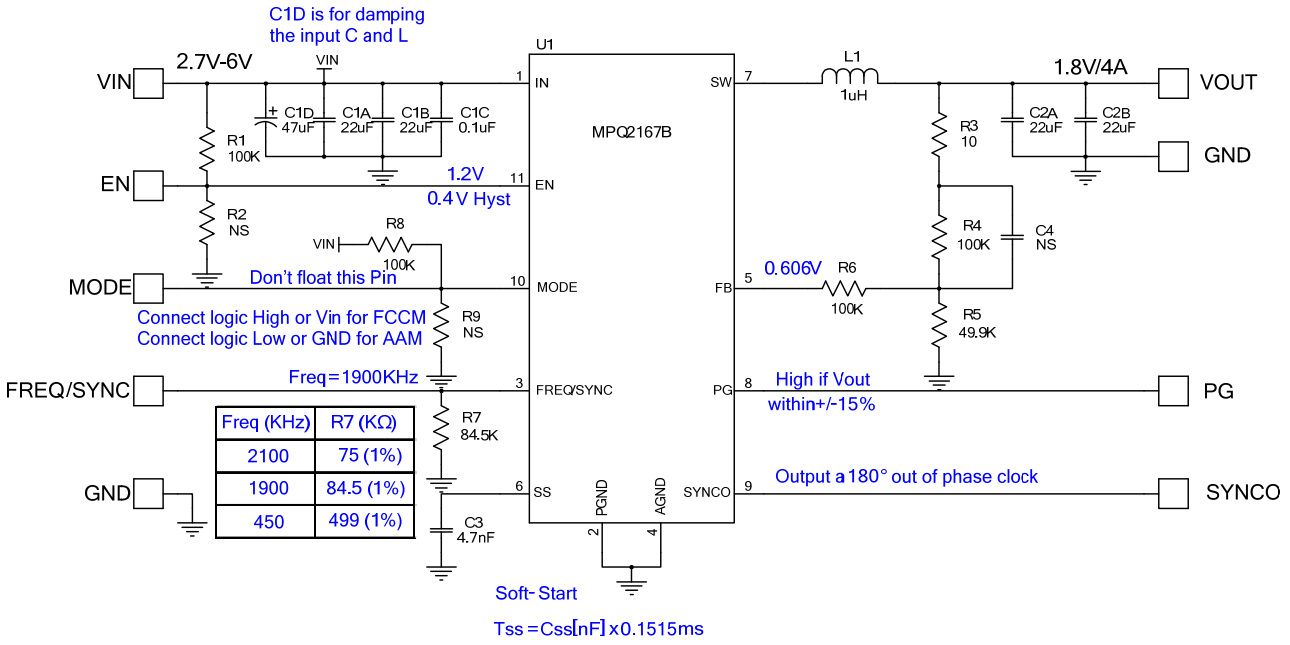
Board Number	MPS IC Number
EV2167B-D-00A	MPQ2167BGDE-AEC1

Efficiency vs. Load Current

V_{OUT}=1.8V, CCM, L=1μH, F_{SW}=2.1MHZ

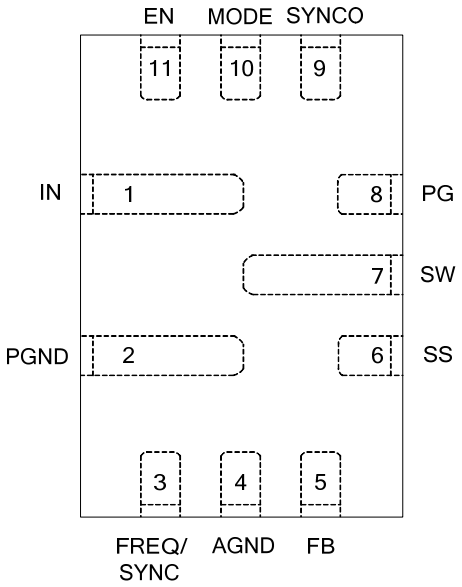


EVALUATION BOARD SCHEMATIC



Freq (KHz)	R7 (KΩ)
2100	75 (1%)
1900	84.5 (1%)
450	499 (1%)

Package Reference



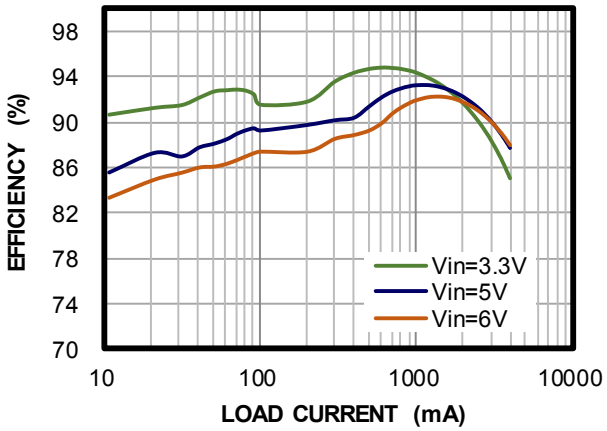
EV2167B-D-00A BILL OF MATERIALS

Qty	RefDes	Value	Description	Package	Manufacturer	Manufacturer_P/N
4	C1A, C1B, C2A, C2B	22µF	Ceramic Capacitor; 16V;X5R	0805	muRata	GRM21BR61C226ME44L
1	C1C	0.1µF	Ceramic Capacitor; 16V;X7R	0603	muRata	GRM188R71C104KA01D
1	C1D	47µF	Electrolytic Cap;16V	SMD	Jianghai	VZ1-16V47
1	C3	4.7nF	Ceramic Capacitor; 50V;X7R	0603	muRata	GRM188R71H472KA01D
1	C4	NS				
1	L1	1µH	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	

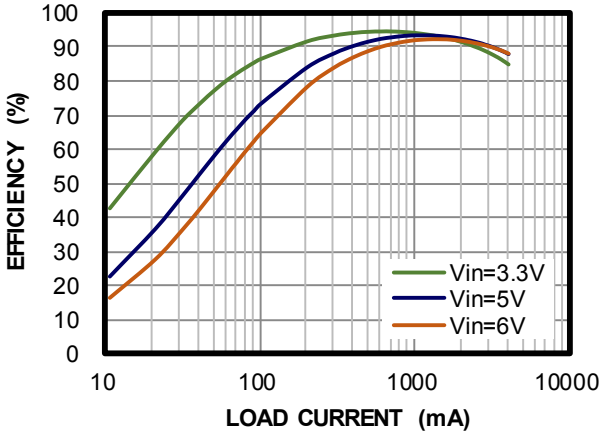
EVB TEST RESULTS

Performance curves and waveforms are tested on the evaluation board.
V_{IN} = 5V, V_{OUT} = 1.8V, L = 1µH, F_{SW} = 2.1MHz, T_A = 25°C, unless otherwise noted.

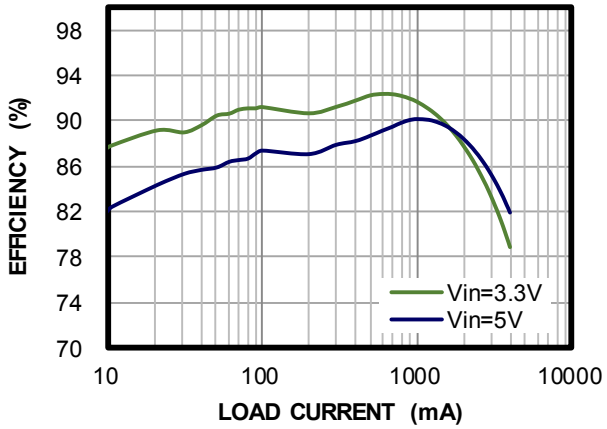
Efficiency vs. Load Current
V_{OUT}=1.8V, AAM



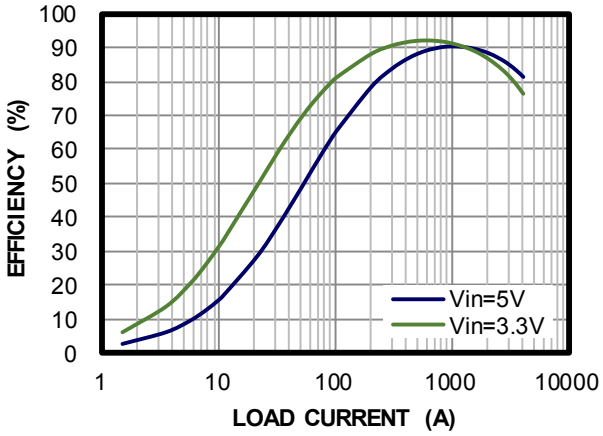
Efficiency vs. Load Current
V_{OUT}=1.8V, CCM



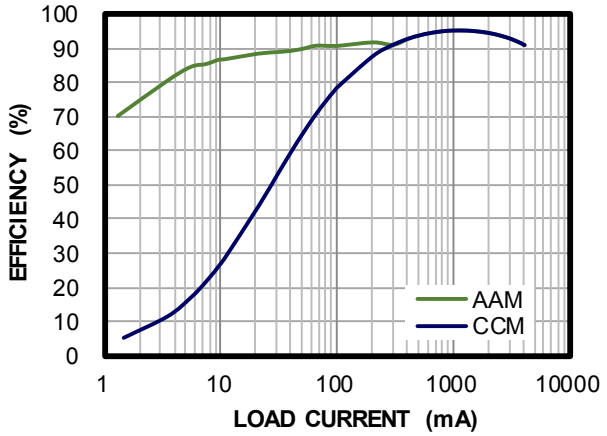
Efficiency vs. Load Current
V_{OUT}=1.2V, AAM



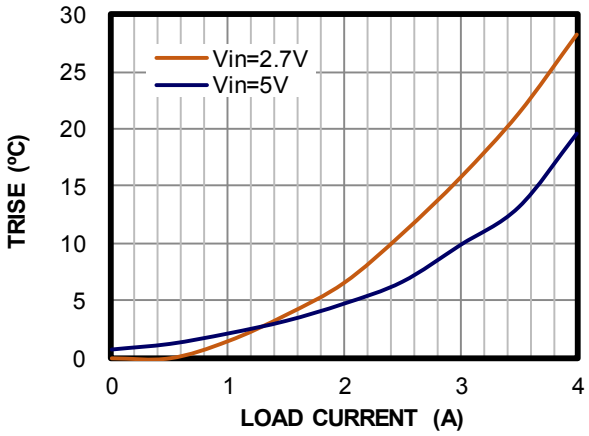
Efficiency vs. Load Current
V_{OUT}=1.2V, CCM



Efficiency vs. Load Current
V_{IN}=5V, V_{OUT}=2.5V



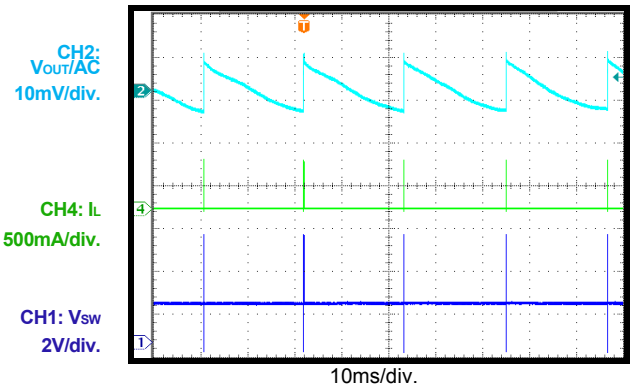
Case Thermal Rise
V_{OUT}=1.8V, AAM



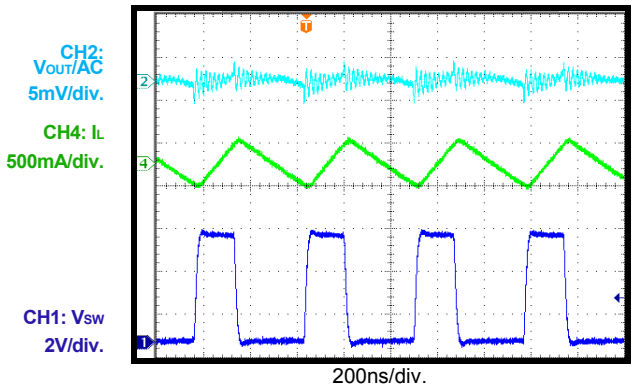
EVB TEST RESULTS *(continued)*

Performance curves and waveforms are tested on the evaluation board.
V_{IN} = 5V, V_{OUT} = 1.8V, L = 1µH, F_{SW} = 2.1MHz, T_A = 25°C, unless otherwise noted.

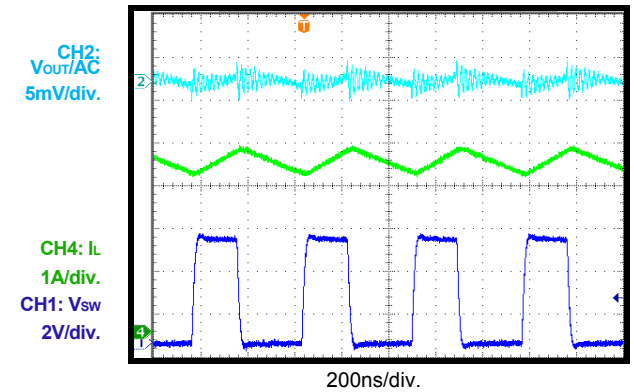
Steady State
I_{OUT}=0A, AAM



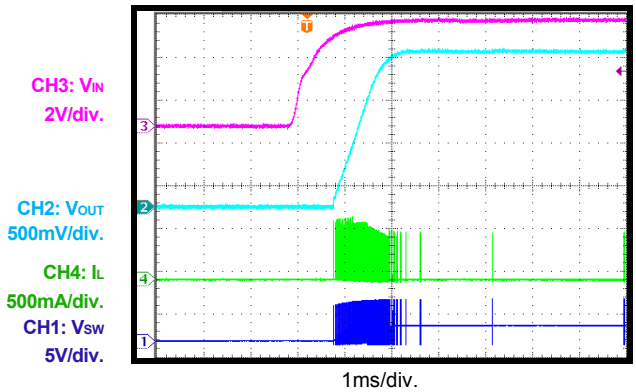
Steady State
I_{OUT}=0A, CCM



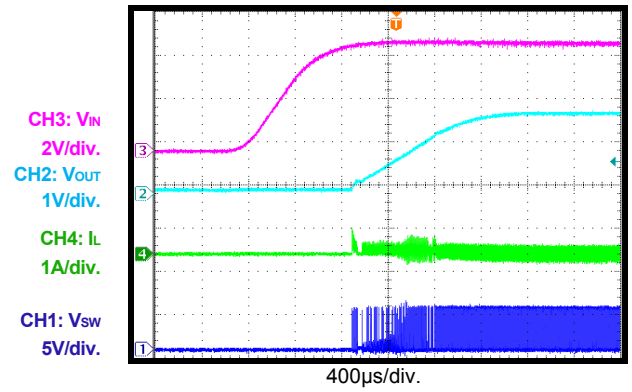
Steady State
I_{OUT}=4A



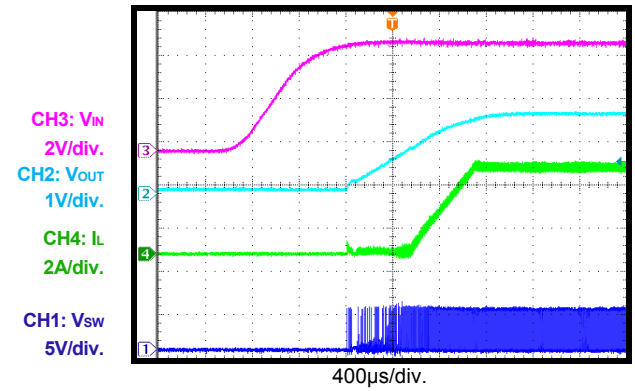
Start-Up through VIN
I_{OUT}=0A, AAM



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



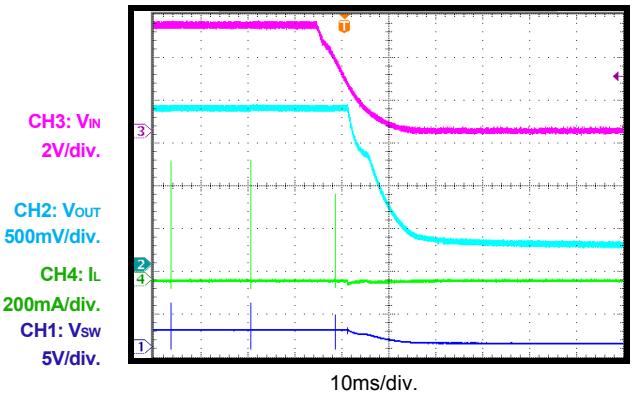
Start-Up through VIN
I_{OUT}=4A



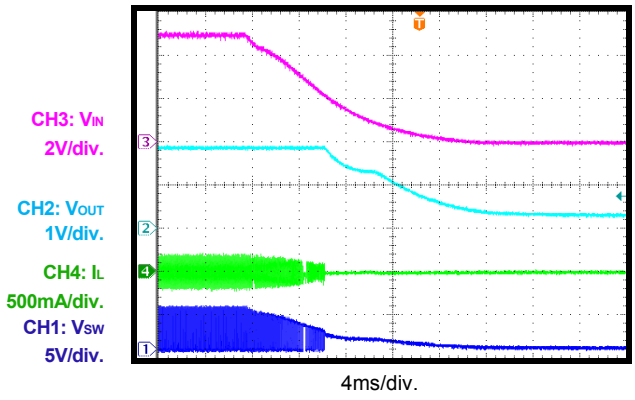
EVB TEST RESULTS *(continued)*

Performance curves and waveforms are tested on the evaluation board.
V_{IN} = 5V, V_{OUT} = 1.8V, L = 1µH, F_{SW} = 2.1MHz, T_A = 25°C, unless otherwise noted.

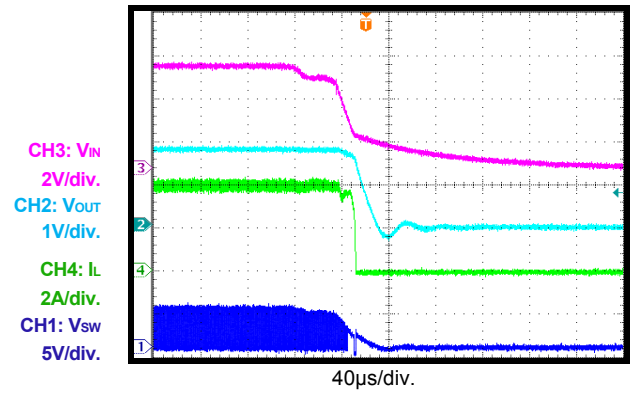
Shutdown through VIN
I_{OUT}=0A, AAM



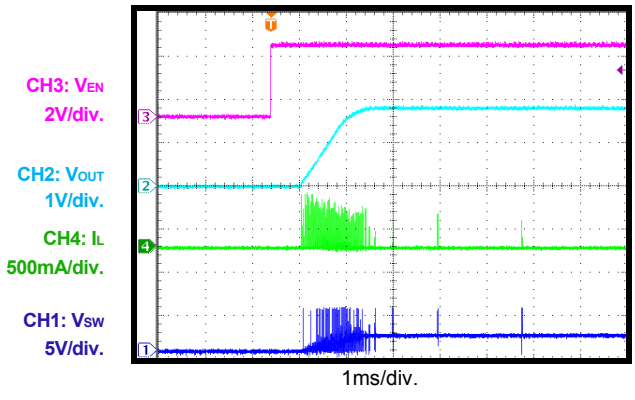
Shutdown through VIN
I_{OUT}=0A, CCM



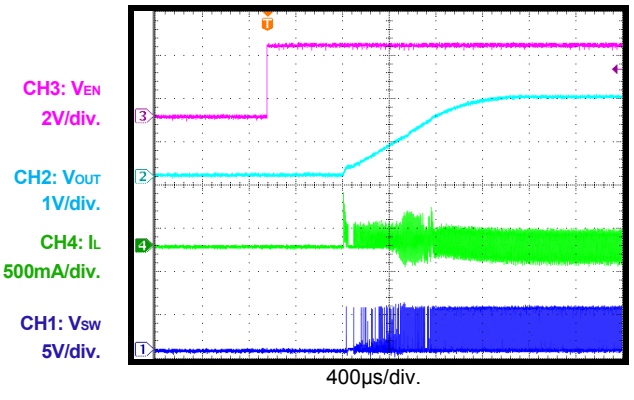
Shutdown through VIN
I_{OUT}=4A



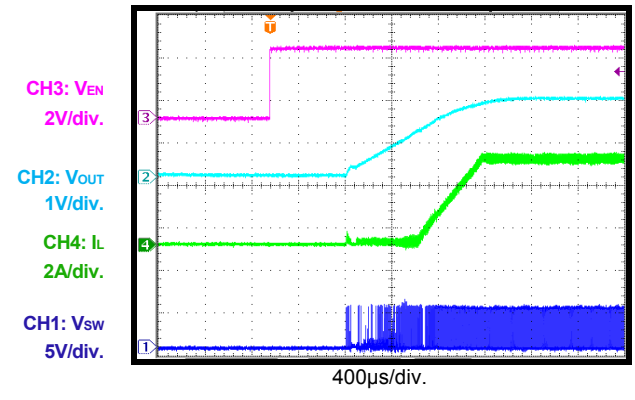
Start-Up through EN
I_{OUT}=0A, AAM



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



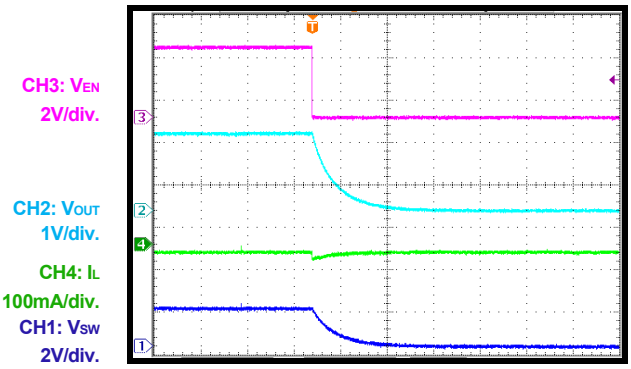
Start-Up through EN
I_{OUT}=4A



EVB TEST RESULTS *(continued)*

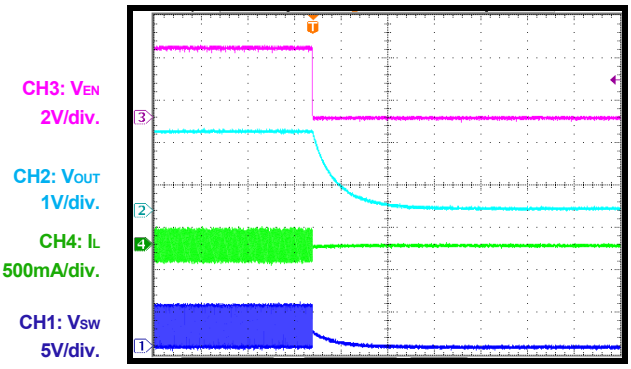
Performance curves and waveforms are tested on the evaluation board.
V_{IN} = 5V, V_{OUT} = 1.8V, L = 1µH, F_{SW} = 2.1MHz, T_A = 25°C, unless otherwise noted.

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



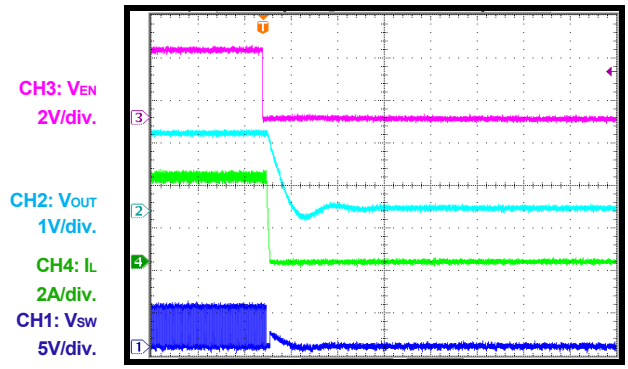
10ms/div.

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



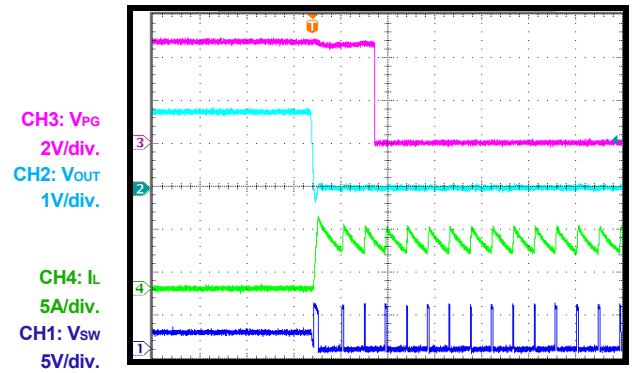
10ms/div.

Shutdown through EN
I_{OUT}=4A



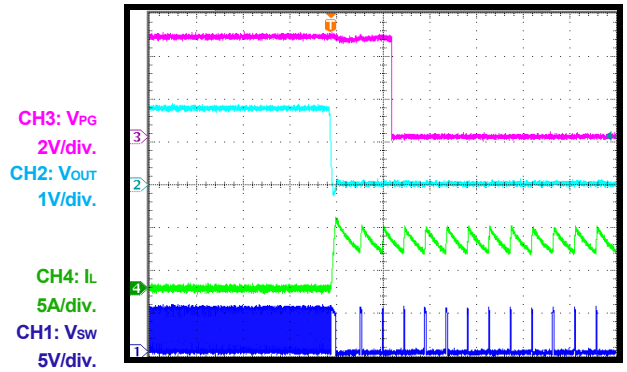
40µs/div.

SCP Entry
I_{OUT}=0A, AAM



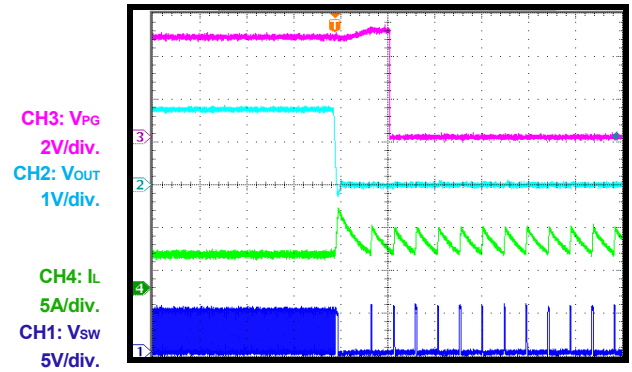
20µs/div.

SCP Entry
I_{OUT}=0A, CCM



20µs/div.

SCP Entry
I_{OUT}=4A

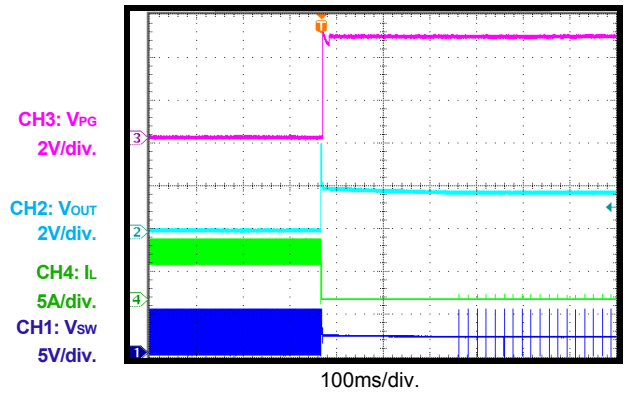


20µs/div.

EVB TEST RESULTS *(continued)*

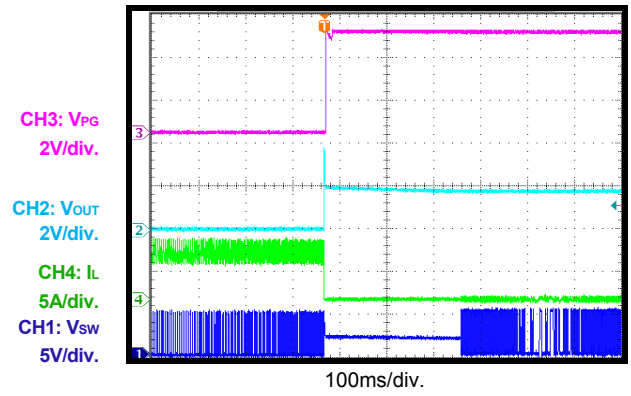
Performance curves and waveforms are tested on the evaluation board.
V_{IN} = 5V, V_{OUT} = 1.8V, L = 1µH, F_{SW} = 2.1MHz, T_A = 25°C, unless otherwise noted.

SCP Recovery
I_{OUT}=0A, AAM



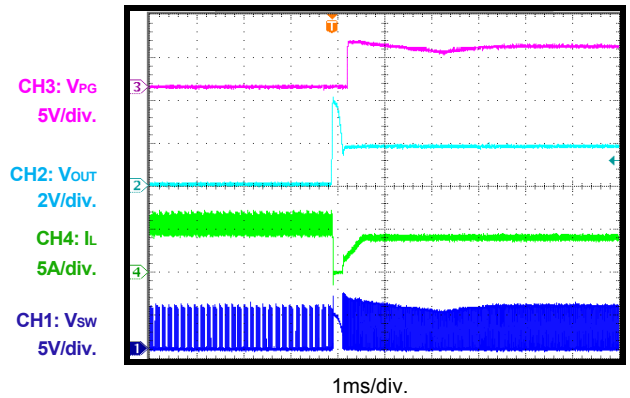
100ms/div.

SCP Recovery
I_{OUT}=0A, CCM



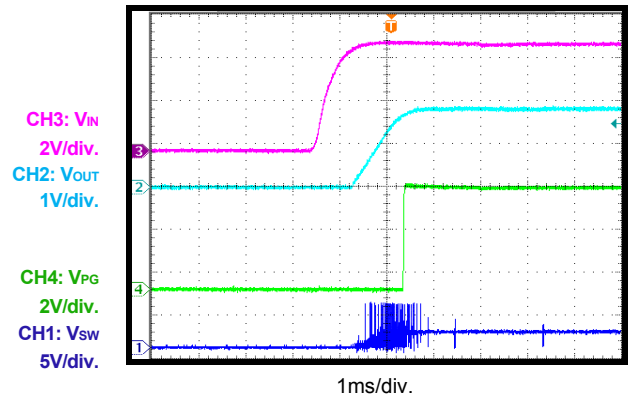
100ms/div.

SCP Recovery
I_{OUT}=4A



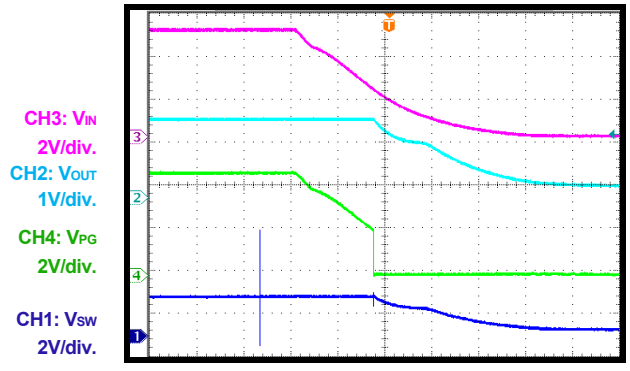
1ms/div.

PG in Start-Up through VIN
I_{OUT}=0A, AAM



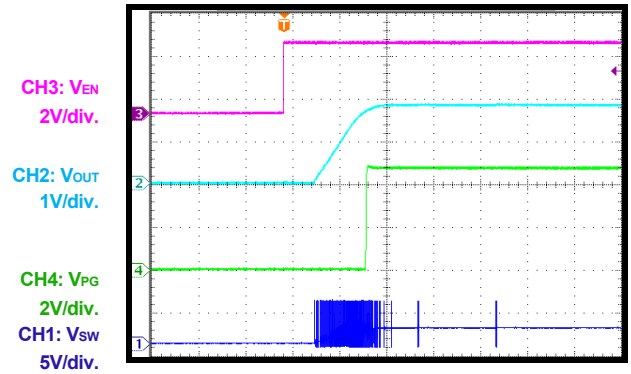
1ms/div.

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



4ms/div.

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



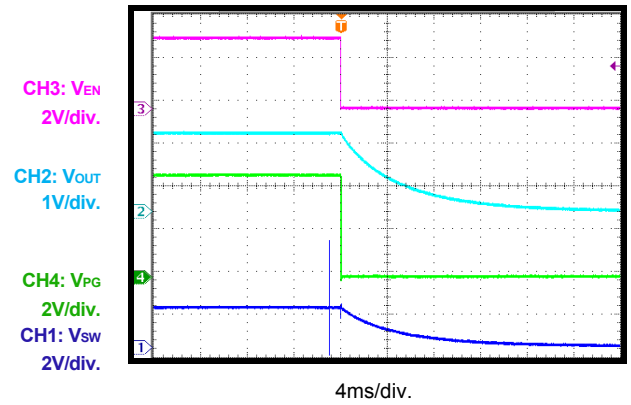
1ms/div.

EVB TEST RESULTS *(continued)*

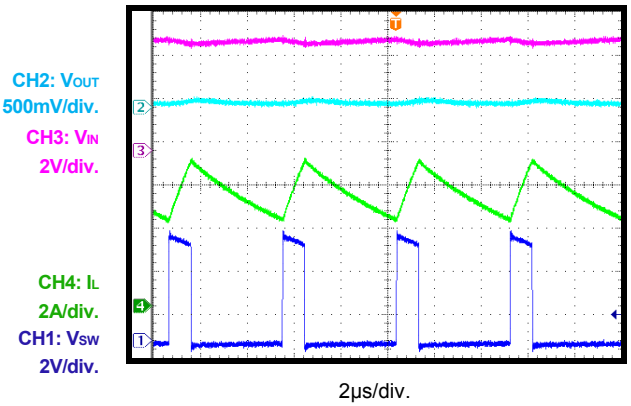
Performance curves and waveforms are tested on the evaluation board.
V_{IN} = 5V, V_{OUT} = 1.8V, L = 1µH, F_{SW} = 2.1MHz, T_A = 25°C, unless otherwise noted.

PG in Shutdown through EN

I_{OUT}=0A, AAM

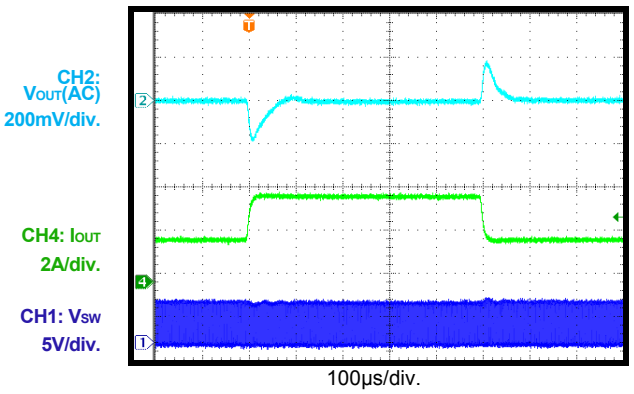


SCP Steady State



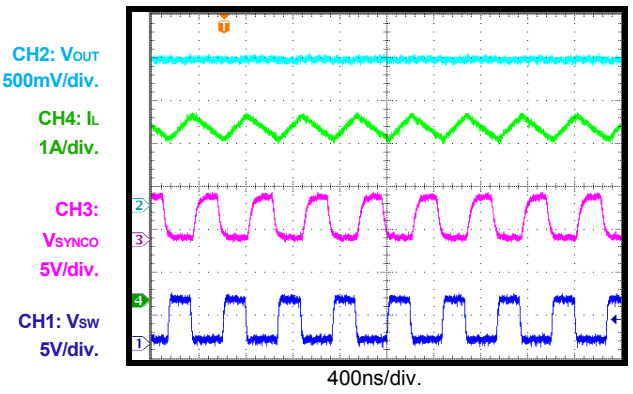
Load Transient

I_{OUT}=2A<->4A, 1.6A/µs



SYNCO

I_{OUT}=4A



PRINTED CIRCUIT BOARD LAYOUT

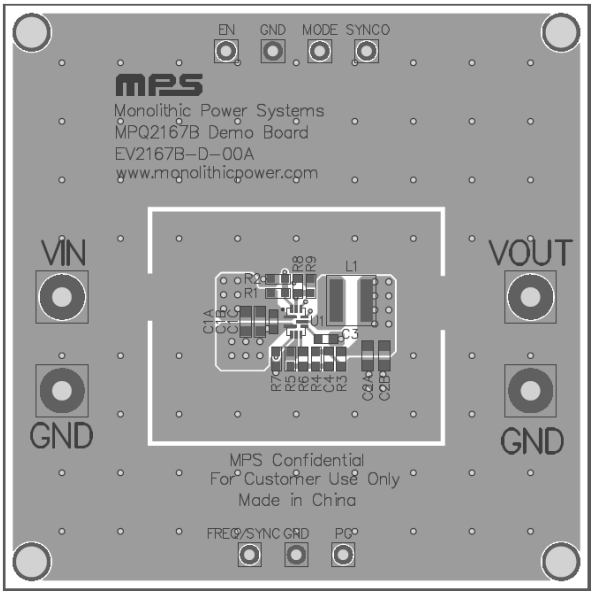


Figure 1: Top Silk Layer and Top Layer

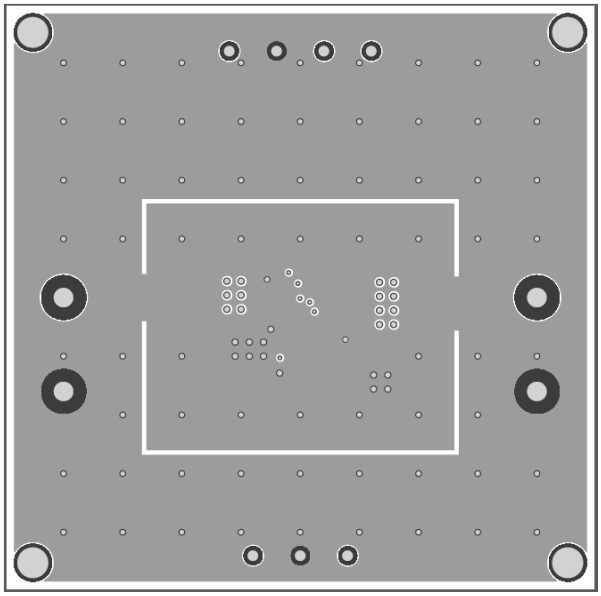


Figure 2: Inner 1 Layer

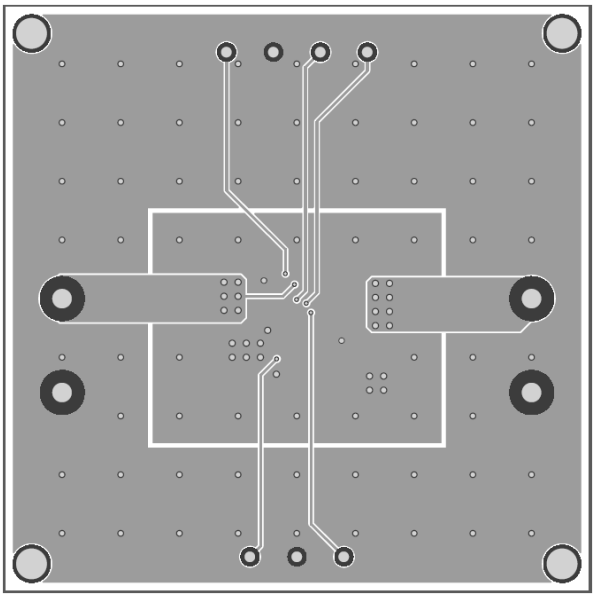


Figure 3: Inner 2 Layer

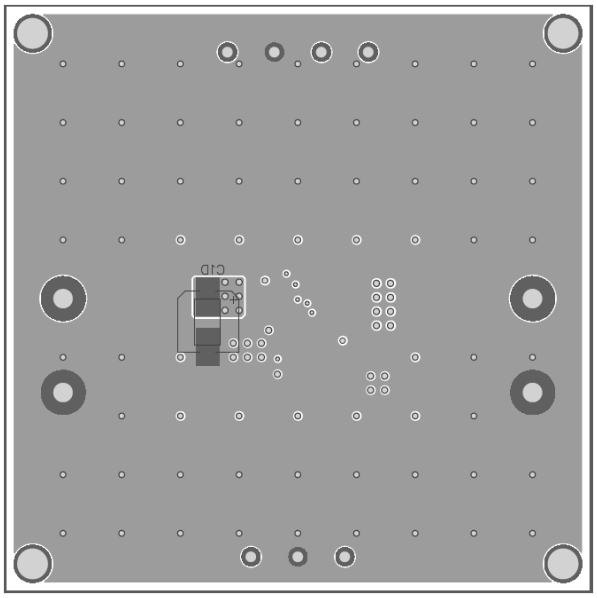
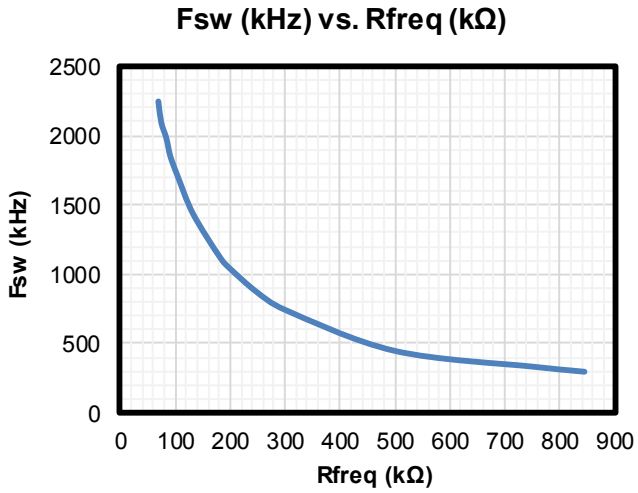


Figure 4: Bottom Silk Layer and Bottom Layer

QUICK START GUIDE

1. Preset power supply to 2.7V ≤ V_{IN} ≤ 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 (+): VIN
    b. Negative (–): GND
4. Connect load to:
    a. Positive (+): VOUT
    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:

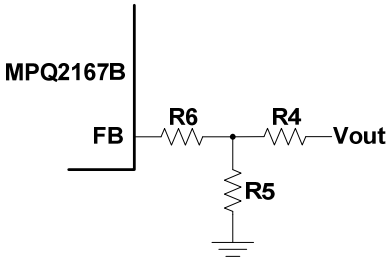


8. The FREQ/SYNC pin can also be used to synchronized by external clock. Sync frequency range is from 300kHz to 2.2MHz.
9. The Mode pin can also be used to select FCCM mode or AAM mode. Connect it to logic high or V_{IN} to choose forced FCCM mode, and connect it to logic low or GND to choose AAM mode, 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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