EVL28167-A-Q-00A

3A, 22V, Synchronous Buck-Boost Converter with I²C Interface for Power Delivery Evaluation Board

DESCRIPTION

The EVL28167-A-Q-00A is an evaluation board for the MP28167-A, a high-efficiency, synchronous buck-boost converter with four integrated power switches and an I²C interface. The device can regulate output voltages across a wide input voltage supply range (2.8V to 22V).

The MP28167-A's integrated output voltage scaling and configurable output current limit functions are ideal for USB power delivery (PD) applications.

In buck mode, the MP28167-A uses constant-on-time (COT) control. In boost mode, it uses constant-off-time control. This provides fast load transient response and a smooth buck-boost mode transient. The MP28167-A features automatic pulse-frequency modulation (PFM) and pulse-width modulation (PWM) modes, forced PWM mode, as well as configurable constant current (CC) limiting and soft start (SS). These features provide flexible design options for different applications.

The MP28167-A's fault protections include over-current protection (OCP), over-voltage protection (OVP), under-voltage protection (UVP), short-circuit protection (SCP), and thermal shutdown (TSD).

The MP28167-A requires a minimal number of readily available, standard external components, and is available in a QFN-16 (3mmx3mm) package.

ELECTRICAL SPECIFICATIONS

Parameter	Symbol	Value	Units
Operating input voltage	V_{IN}	12	V
Switching frequency	f_{SW}	500	kHz
Output voltage	V_{OUT}	5	V
Output current	I_{OUT}	3	A

FEATURES

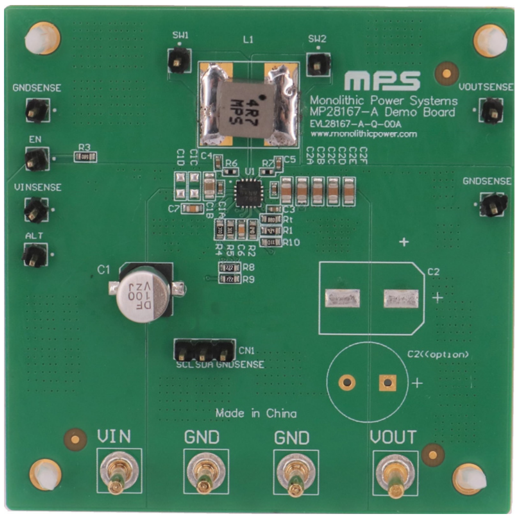
- Configurable Output Voltage via the FB Pin
- Wide 2.8V to 22V Operating Input Range
- 0.08V to 1.637V Reference Voltage (V_{REF}) Range with 0.8mV Resolution via the I²C (Default V_{REF} is 1V)
- 3A Output Current or 4A Input Current
- Four Internal, Low $R_{DS(ON)}$ Power MOSFETs
- Accurate Constant Current (CC) Output Current Limit with Internal Sensing
- 500kHz/750kHz Configurable Switching Frequency
- Line Drop Compensation
- Over-Voltage Protection (OVP) with Hiccup Mode
- Short-Circuit Protection (SCP) with Hiccup Mode
- Over-Temperature Protection
- I²C Interface and One-Time Programmable (OTP) Non-Volatile Memory:
  - Pulse-Frequency Modulation (PFM) Pulse-Width Modulation (PWM) Modes, Line Drop Compensation, Soft Start, OCP, OVP, etc.
- Configurable EN Shutdown Discharge
- Available in a QFN-16 (3mmx3mm) Package

MPL Optimized Performance with MPS Inductor MPL-AL6050 Series

APPLICATIONS

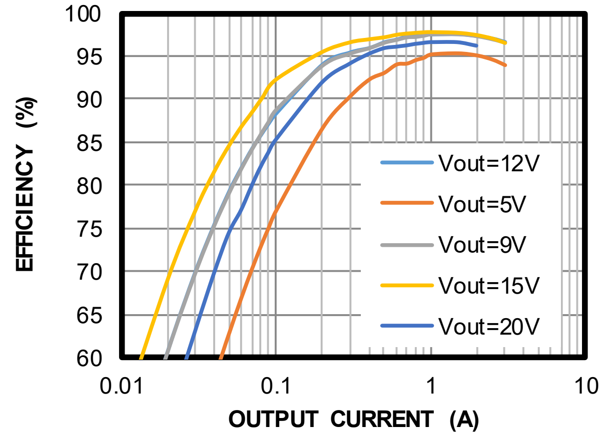
- USB Power Delivery (PD) for Sourcing Ports
- Buck-Boost Bus Voltage (V_{BUS}) Supplies

EVL28167-A-Q-00A EVALUATION BOARD



LxW (6.35cmx6.35cm)

Efficiency vs. Output Current
V_{IN} = 12V, V_{OUT} = 5V, f_{SW} = 500kHz,
L = 4.7μH, RDC = 16.5mΩ



Board Number	MPS IC Number	MPS Inductor
EVL28167-A-Q-00A	MP28167GQ-A	MPL-AL6050-4R7

QUICK START GUIDE

1. Connect the load terminals to:
   a. Positive (+): VOUT
   b. Negative (-): GND
2. Preset the power supply output to 12V.
3. Turn off the power supply.
4. Connect the power supply terminals to:
   a. Positive (+): VIN
   b. Negative (-): GND
5. After making the connections, turn on the power supply. The board automatically should start up with its default settings. The related parameters can be changed by the I^2C. (1)

Note:

1) Refer to the MP28167-A datasheet for how to change the parameters via the I^2C.

EVALUATION BOARD SCHEMATIC

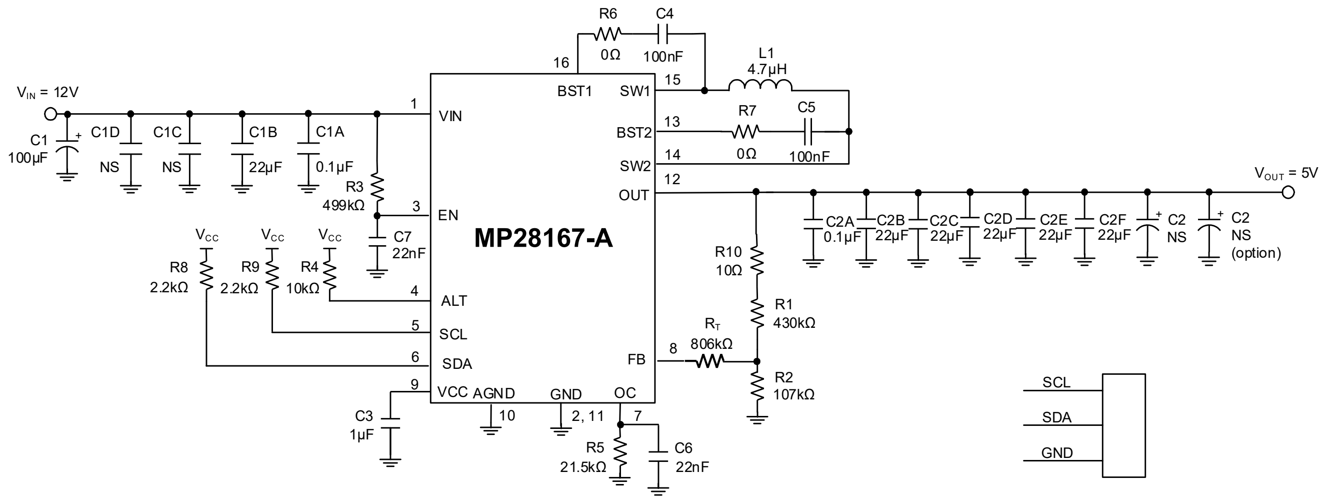


Figure 1: Evaluation Board Schematic

EVL28167-A-Q-00A BILL OF MATERIALS

Qty	Ref	Value	Description	Package	Manufacturer	Manufacturer PN
1	U1	MP28167-A	Synchronous buck-boost converter	QFN-16 (3mmx3mm)	MPS	MP28167GQ-A
1	L1	4.7µH	Inductor, RDC = 16.5mΩ, I_{SAT} = 11A	SMD	MPS	MPL-AL6050-4R7
1	C1	100µF	Electrolytic capacitor, 35V	SMD	Chemicon	EMZJ350ADA101MF80G
6	C1B, C2B, C2C, C2D, C2E, C2F	22µF	Ceramic capacitor 25V, X5R	0805	TDK	C2012X5R1E226M
1	C3	1µF	Ceramic capacitor, 16V, X6S	0402	Murata	GRM155C81C105KE11D
4	C1A, C2A, C4, C5	100nF	Ceramic capacitor, 50V, X7R	0402	Samsung	CL05B104KB5NNNC
2	C6, C7	22nF	Ceramic capacitor, 50V, X5R	0603	Murata	GRM188R71H223KA01D
0	C1C, C1D, C2, C2 (option)	NS	NA	NA	NA	NA
1	R1	430kΩ	Film resistor, 1%	0603	Yageo	RC0603FR-07430KL
1	R2	107kΩ	Film resistor, 1%	0603	Yageo	RC0603FR-07107KL
1	R3	499kΩ	Film resistor, 1%	0603	Yageo	RC0603FR-07499KL
1	R4	10kΩ	Film resistor, 1%	0603	Yageo	RC0603FR-0710KL
1	R5	21.5kΩ	Film resistor, 1%	0603	Yageo	RC0603FR-0721K5RL
2	R6, R7	0Ω	Film resistor, 1%	0402	Yageo	RC0402FR-070RL
2	R8, R9	2.2kΩ	Film resistor, 1%	0603	Yageo	RC0603FR-072K2L
1	R10	10Ω	Film resistor, 1%	0603	Yageo	RC0603FR-0710RL
1	R_T	806kΩ	Film resistor, 1%	0603	Yageo	RC0603FR-07806KL
1	CN1	2.54mm	Test pin	DIP	Wurth	61300311121

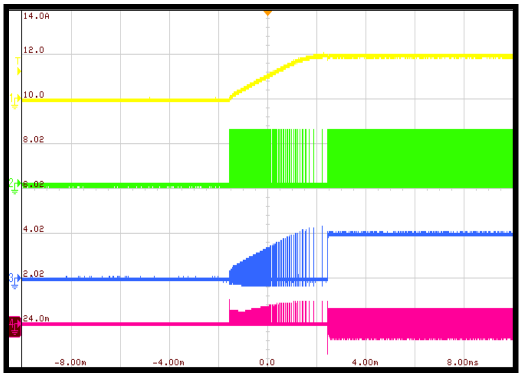
EVB TEST RESULTS

Performance waveforms are tested on the evaluation board. V_{IN} = 12V, V_{OUT} = 5V, L = 4.7µH, f_{SW} = 500kHz, T_A = 25°C, unless otherwise noted.

Start-Up through EN via I²C Command

Load = 0A

CH1: V_{OUT} 5V/div.
CH2: V_{SW1} 10V/div.
CH3: V_{SW2} 5V/div.
CH4: I_L 2A/div.

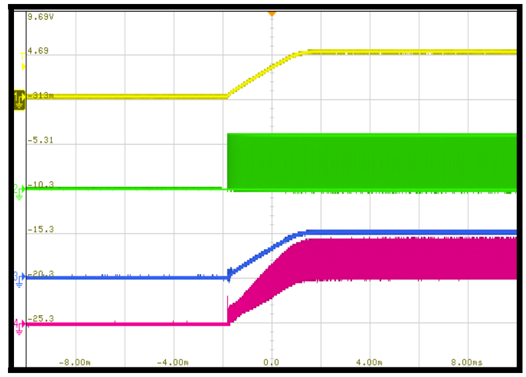


2ms/div.

Start-Up through EN via I²C Command

Load = 3A

CH1: V_{OUT} 5V/div.
CH2: V_{SW1} 10V/div.
CH3: V_{SW2} 5V/div.
CH4: I_L 2A/div.

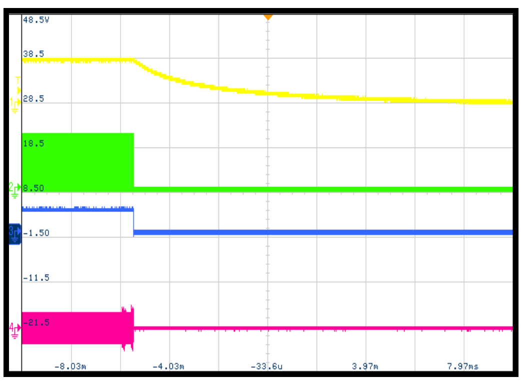


2ms/div.

Shutdown through EN via I²C Command

Load = 0A

CH1: V_{OUT} 5V/div.
CH2: V_{SW1} 10V/div.
CH3: V_{SW2} 10V/div.
CH4: I_L 2A/div.

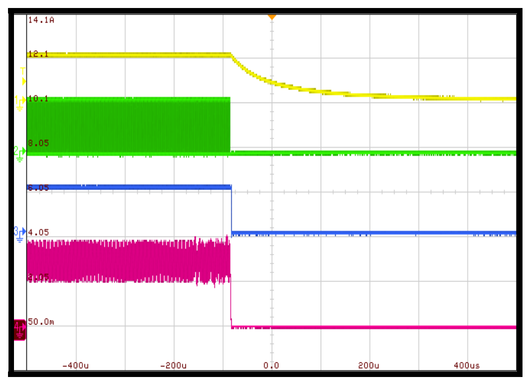


2ms/div.

Shutdown through EN via I²C Command

Load = 3A

CH1: V_{OUT} 5V/div.
CH2: V_{SW1} 10V/div.
CH3: V_{SW2} 5V/div.
CH4: I_L 2A/div.

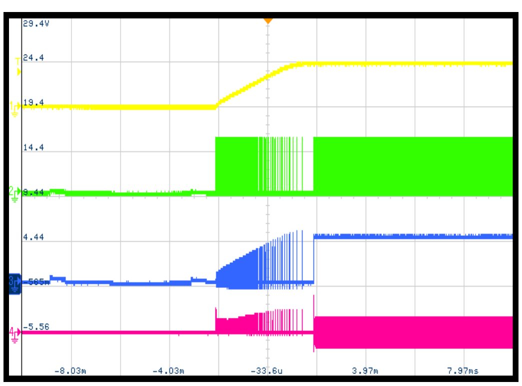


100µs/div.

Start-Up through EN

Load = 0A

CH1: V_{OUT} 5V/div.
CH2: V_{SW1} 10V/div.
CH3: V_{SW2} 5V/div.
CH4: I_L 2A/div.

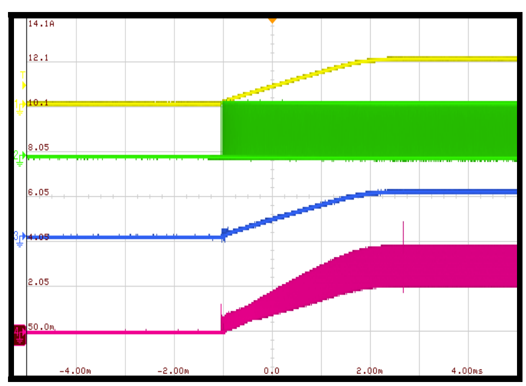


2ms/div.

Start-Up through EN

Load = 3A

CH1: V_{OUT} 5V/div.
CH2: V_{SW1} 10V/div.
CH3: V_{SW2} 5V/div.
CH4: I_L 2A/div.

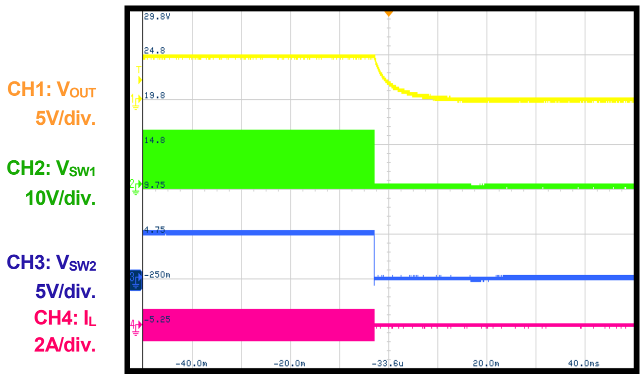


1ms/div.

EVB TEST RESULTS *(continued)*

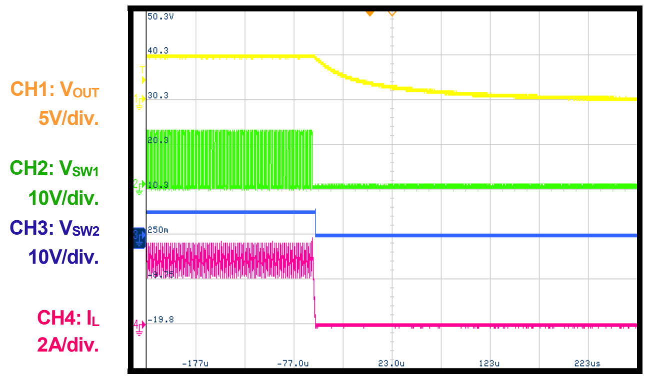
Performance waveforms are tested on the evaluation board. V_{IN} = 12V, V_{OUT} = 5V, L = 4.7µH, f_{SW} = 500kHz, T_A = 25°C, unless otherwise noted.

Shutdown through EN
Load = 0A



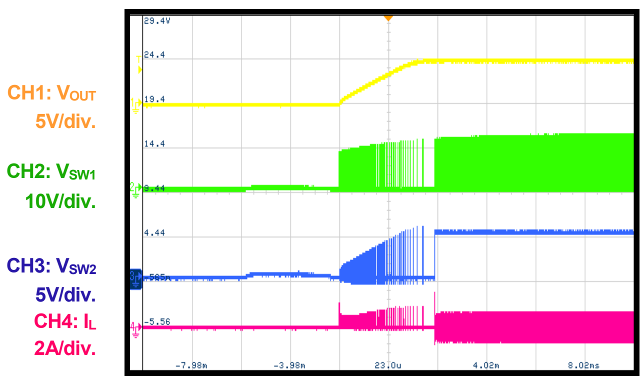
10ms/div.

Shutdown through EN
Load = 3A



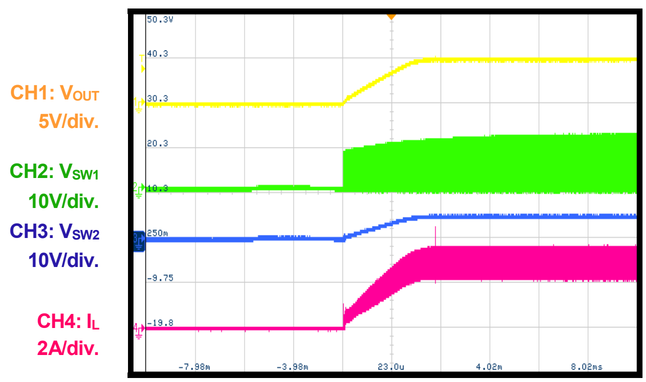
50µs/div.

Start-Up through VIN
Load = 0A



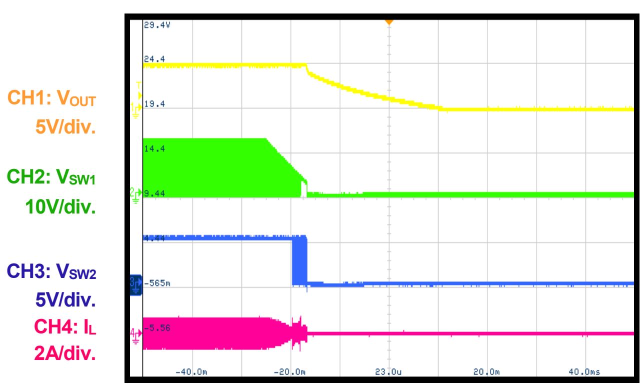
2ms/div.

Start-Up through VIN
Load = 3A



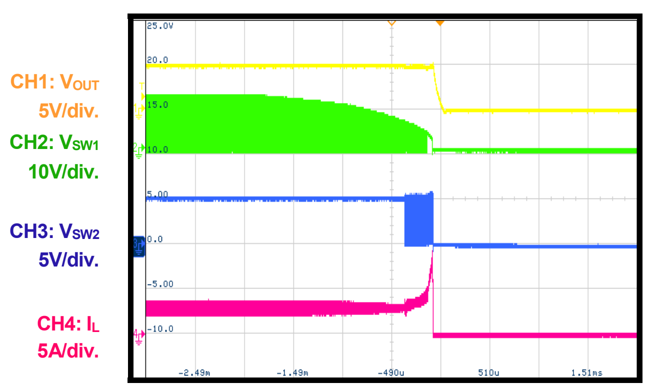
2ms/div.

Shutdown through VIN
Load = 0A



10ms/div.

Shutdown through VIN
Load = 3A



500µs/div.

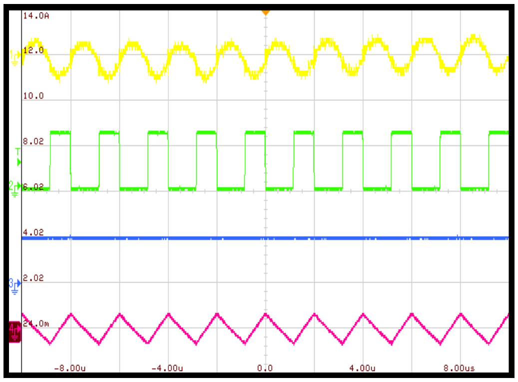
EVB TEST RESULTS *(continued)*

Performance waveforms are tested on the evaluation board. V_{IN} = 12V, V_{OUT} = 5V, L = 4.7µH, f_{SW} = 500kHz, T_A = 25°C, unless otherwise noted.

Steady State

V_{OUT} = 5V, load = 0A, f_{SW} = 500kHz

CH1: V_{OUT} 20mV/div.
CH2: V_{SW1} 10V/div.
CH3: V_{SW2} 5V/div.
CH4: I_L 2A/div.

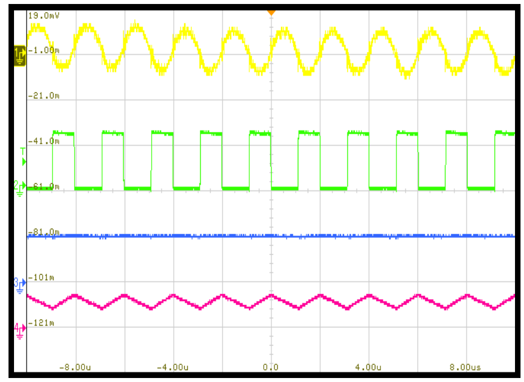


2µs/div.

Steady State

V_{OUT} = 5V, load = 3A, f_{SW} = 500kHz

CH1: V_{OUT} 20mV/div.
CH2: V_{SW1} 10V/div.
CH3: V_{SW2} 5V/div.
CH4: I_L 2A/div.

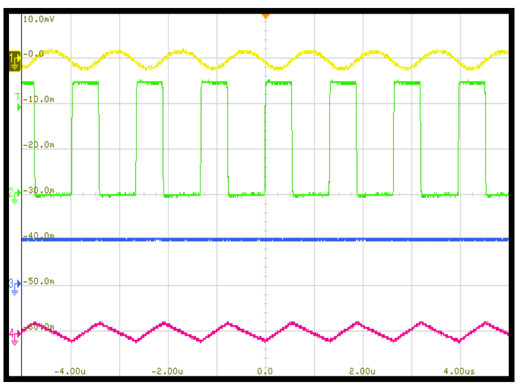


2µs/div.

Steady State

V_{OUT} = 5V, load = 0A, f_{SW} = 750kHz

CH1: V_{OUT}/AC 10mV/div.
CH2: V_{SW1} 5V/div.
CH3: V_{SW2} 5V/div.
CH4: I_L 2A/div.

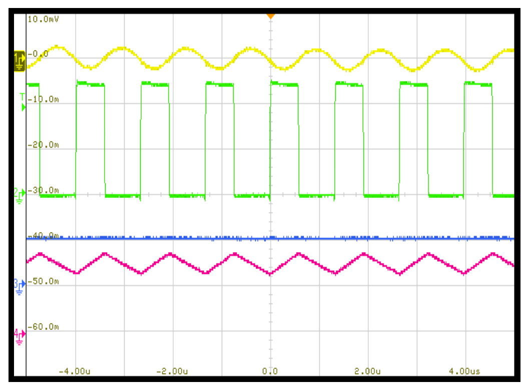


1µs/div.

Steady State

V_{OUT} = 5V, load = 3A, f_{SW} = 750kHz

CH1: V_{OUT}/AC 10mV/div.
CH2: V_{SW1} 5V/div.
CH3: V_{SW2} 5V/div.
CH4: I_L 2A/div.

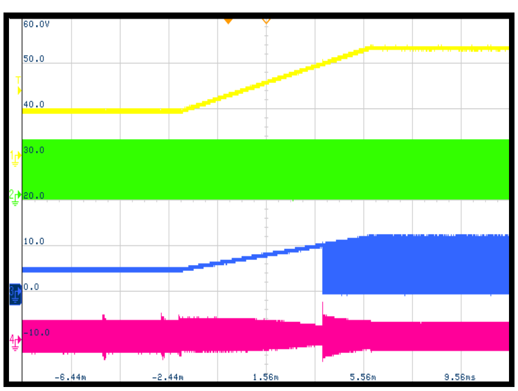


1µs/div.

I^2C VID

V_{OUT} = 5V to 12V, I_{OUT} = 0A, R1 = 430kΩ, R2 = 53.6kΩ

CH1: V_{OUT} 5V/div.
CH2: V_{SW1} 10V/div.
CH3: V_{SW2} 10V/div.
CH4: I_L 2A/div.

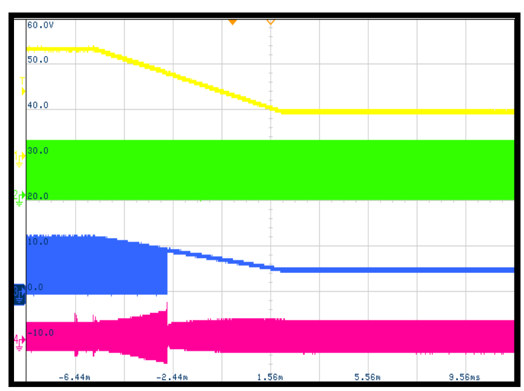


2ms/div.

I^2C VID

V_{OUT} = 5V to 12V, I_{OUT} = 0A, R1 = 430kΩ, R2 = 53.6kΩ

CH1: V_{OUT} 5V/div.
CH2: V_{SW1} 10V/div.
CH3: V_{SW2} 10V/div.
CH4: I_L 2A/div.



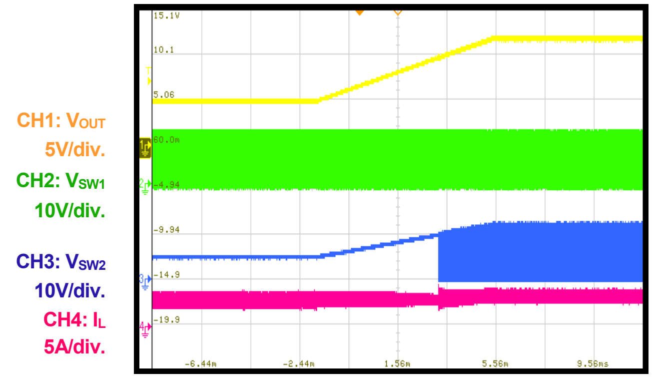
2ms/div.

EVB TEST RESULTS *(continued)*

Performance waveforms are tested on the evaluation board. V_{IN} = 12V, V_{OUT} = 5V, L = 4.7μH, f_{SW} = 500kHz, T_A = 25°C, unless otherwise noted.

I²C VID

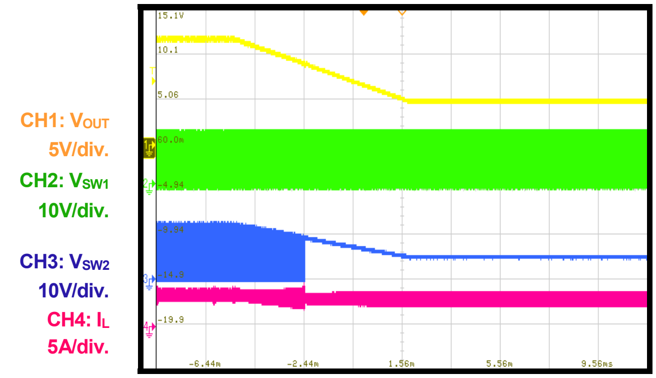
V_{OUT} = 5V to 12V, I_{OUT} = 3A, R1 = 430kΩ, R2 = 53.6kΩ



2ms/div.

I²C VID

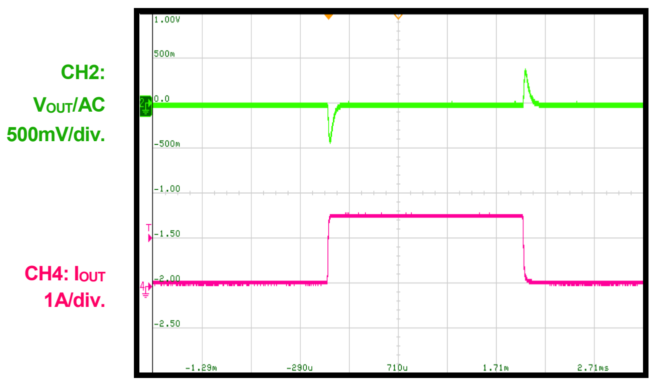
V_{OUT} = 5V to 12V, I_{OUT} = 3A, R1 = 430kΩ, R2 = 53.6kΩ



2ms/div.

Load Transient

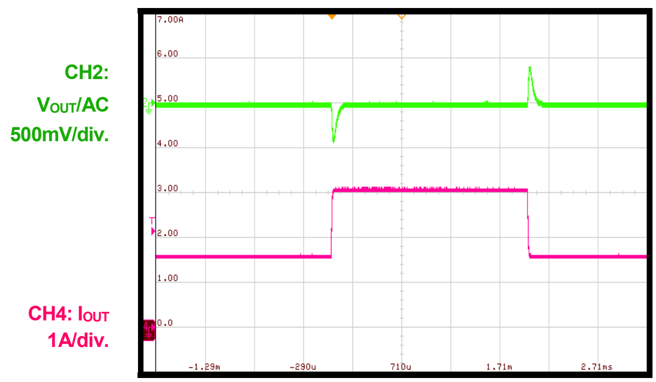
V_{IN} = 12V, V_{OUT} = 5V, no line drop compensation, 0A to 1.5A, 150mA/μs



500μs/div.

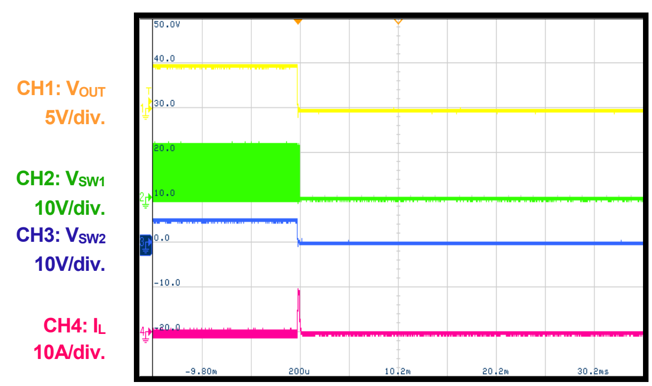
Load Transient

V_{IN} = 12V, V_{OUT} = 5V, no line drop compensation, 1.5A to 3A, 150mA/μs



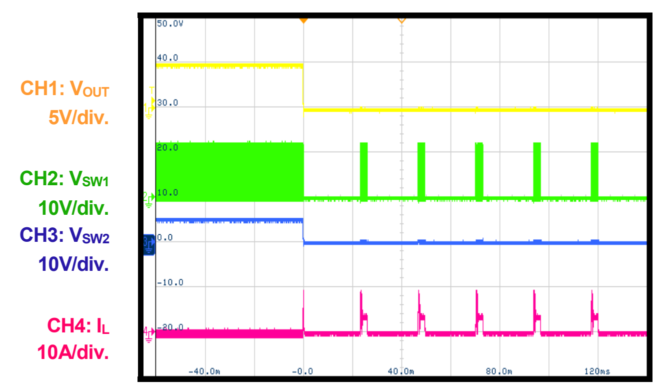
500μs/div.

SCP Entry in Latch-Off Mode



5ms/div.

SCP Entry in Hiccup Mode



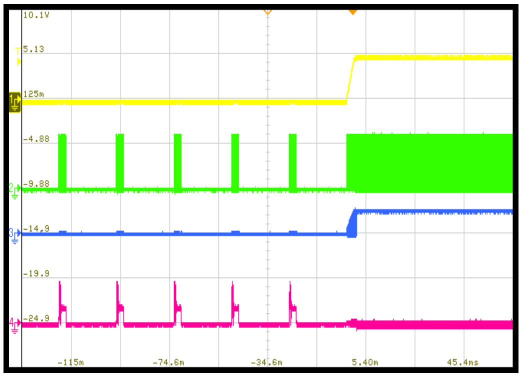
20ms/div.

EVB TEST RESULTS *(continued)*

Performance waveforms are tested on the evaluation board. V_{IN} = 12V, V_{OUT} = 5V, L = 4.7µH, f_{SW} = 500kHz, T_A = 25°C, unless otherwise noted.

SCP Recovery in Hiccup Mode

CH1: V_{OUT} 5V/div.
CH2: V_{SW1} 10V/div.
CH3: V_{SW2} 10V/div.
CH4: I_L 10A/div.

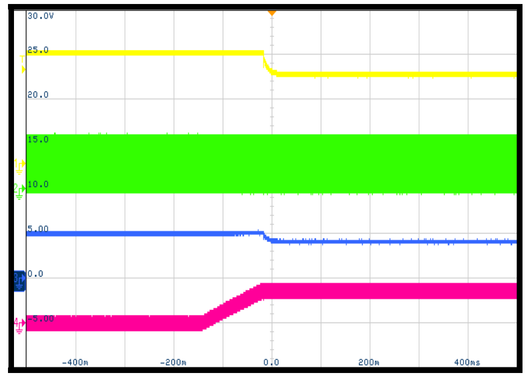


20ms/div.

CC Limit Entry

Tested in CV mode on an electronic load

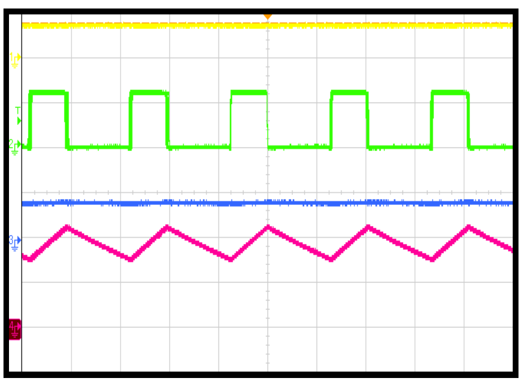
CH1: V_{OUT} 2V/div.
CH2: V_{SW1} 10V/div.
CH3: V_{SW2} 5V/div.
CH4: I_L 5A/div.



100ms/div.

CC Limit Steady State

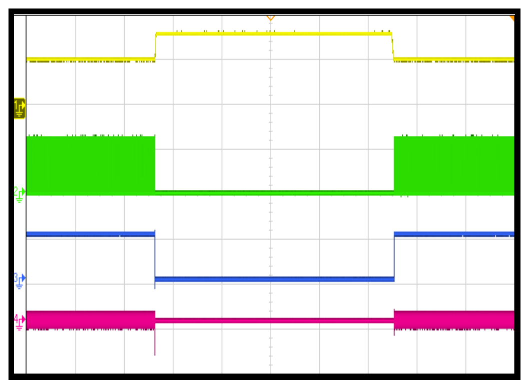
CH1: V_{OUT} 5V/div.
CH2: V_{SW1} 10V/div.
CH3: V_{SW2} 5V/div.
CH4: I_L 2A/div.



1µs/div.

V_{OUT} OVP in Hiccup Mode

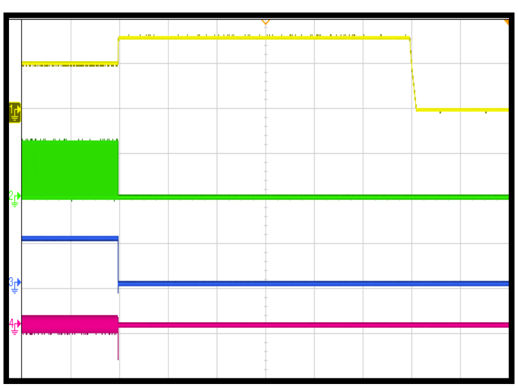
CH1: V_{OUT} 5V/div.
CH2: V_{SW1} 10V/div.
CH3: V_{SW2} 5V/div.
CH4: I_L 5A/div.



500ms/div.

V_{OUT} OVP in Latch-Off Mode

CH1: V_{OUT} 5V/div.
CH2: V_{SW1} 10V/div.
CH3: V_{SW2} 5V/div.
CH4: I_L 5A/div.



500ms/div.

PCB LAYOUT

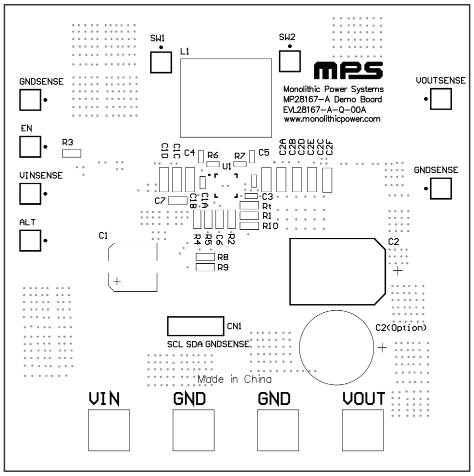


Figure 2: Top Silk

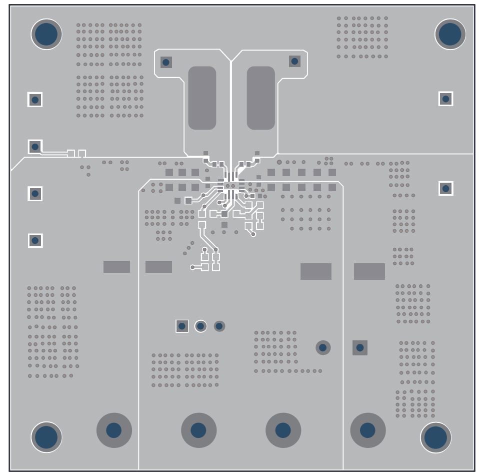


Figure 3: Top Layer

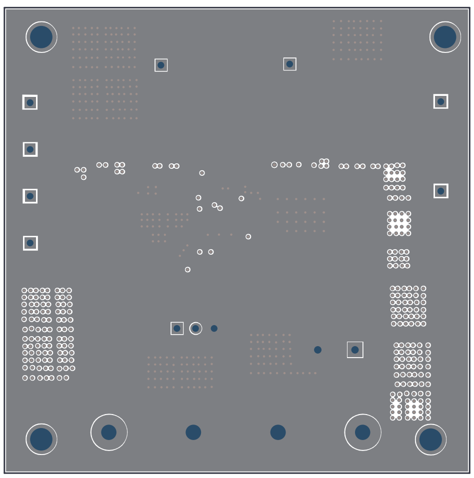


Figure 4: Mid-Layer 1

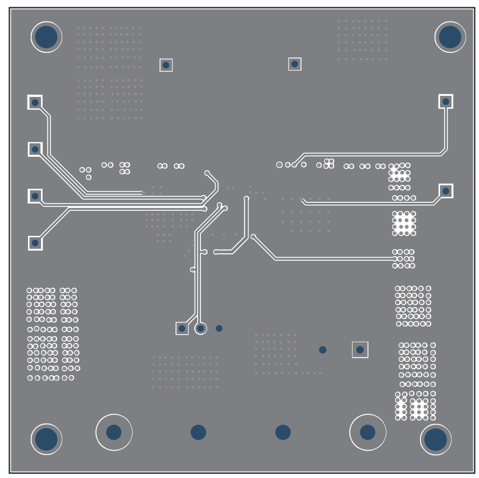


Figure 5: Mid-Layer 2

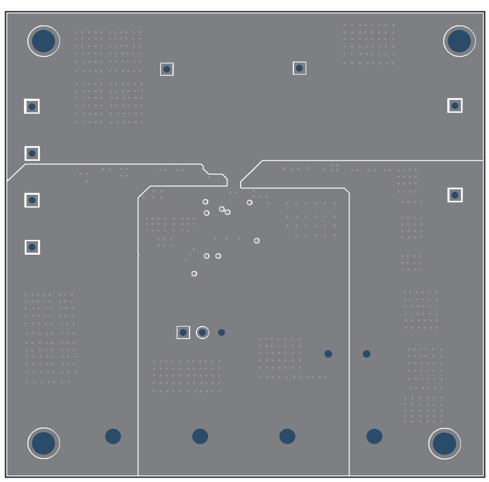


Figure 6: Bottom Layer

REVISION HISTORY

Revision #	Revision Date	Description	Pages Updated
1.0	2/25/2021	Initial Release	-