# 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

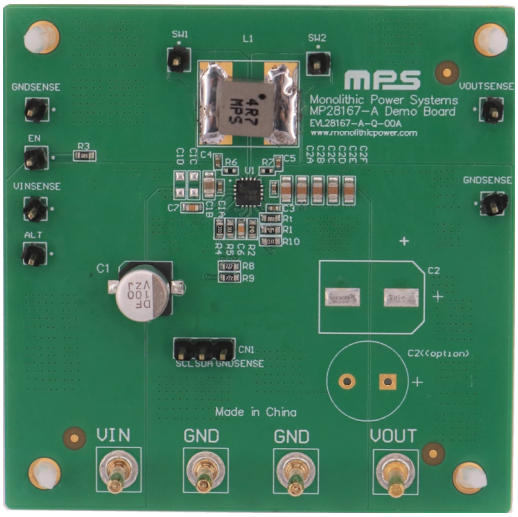
## APPLICATIONS

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

All MPS parts are lead-free, halogen-free, and adhere to the RoHS directive. For MPS green status, please visit the MPS website under Quality Assurance. "MPS", the MPS logo, and "Simple, Easy Solutions" are trademarks of Monolithic Power Systems, Inc. or its subsidiaries.


MPS Proprietary Information. Patent Protected. Unauthorized Photocopy and Duplication Prohibited.
© 2021 MPS. All Rights Reserved.

# EVL28167-A-Q-00A EVALUATION BOARD

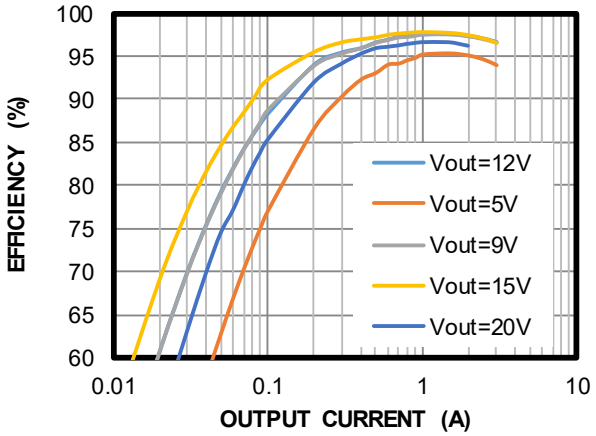



**LxW (6.35cmx6.35cm)**

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

**Efficiency vs. Output Current**

$V_{IN}$ = 12V, $V_{OUT}$ = 5V, $f_{SW}$ = 500kHz,
L = 4.7µH, RDC = 16.5mΩ





MPS Proprietary Information. Patent Protected. Unauthorized Photocopy and Duplication Prohibited.
© 2021 MPS. All Rights Reserved.

## 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 $I^2C$.


MPS Proprietary Information. Patent Protected. Unauthorized Photocopy and Duplication Prohibited.
© 2021 MPS. All Rights Reserved.

# EVALUATION BOARD SCHEMATIC

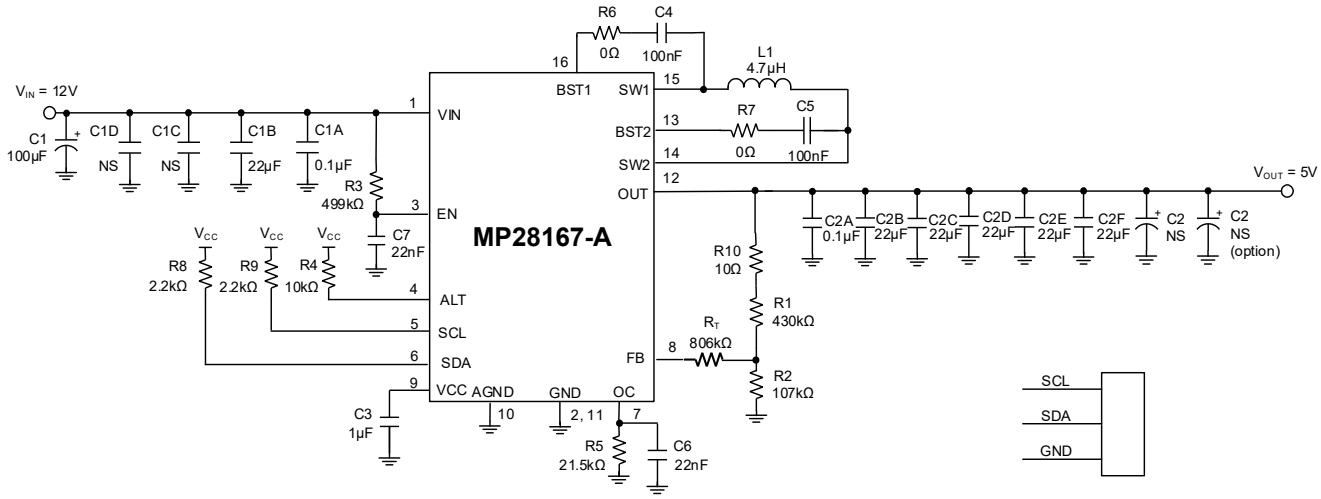



**Figure 1: Evaluation Board Schematic**


MPS Proprietary Information. Patent Protected. Unauthorized Photocopy and Duplication Prohibited.
© 2021 MPS. All Rights Reserved.

## 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 |

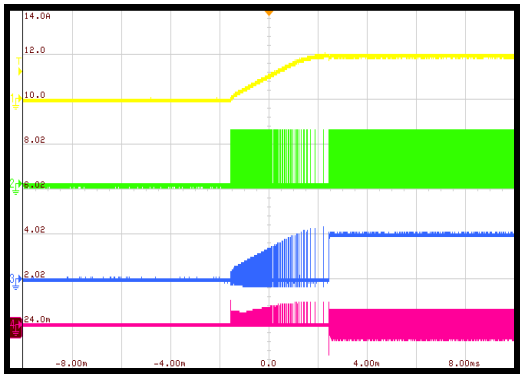

MPS Proprietary Information. Patent Protected. Unauthorized Photocopy and Duplication Prohibited.
© 2021 MPS. All Rights Reserved.

## 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.**

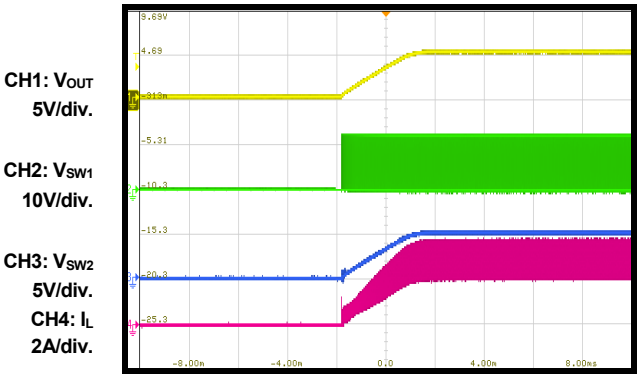
### Start-Up through EN via I²C Command

Load = 0A



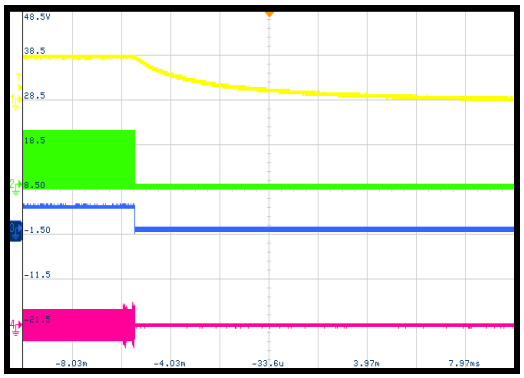

### Start-Up through EN via I²C Command

Load = 3A



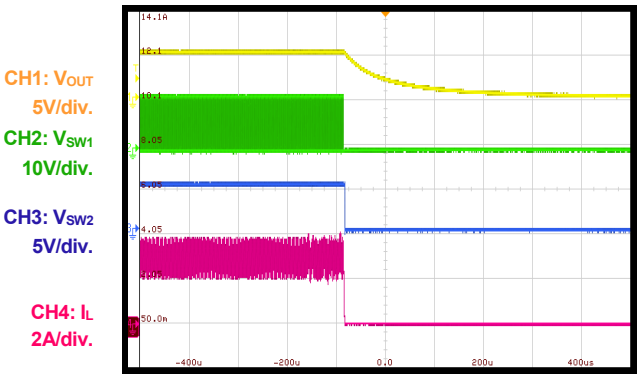

### Shutdown through EN via I²C Command

Load = 0A



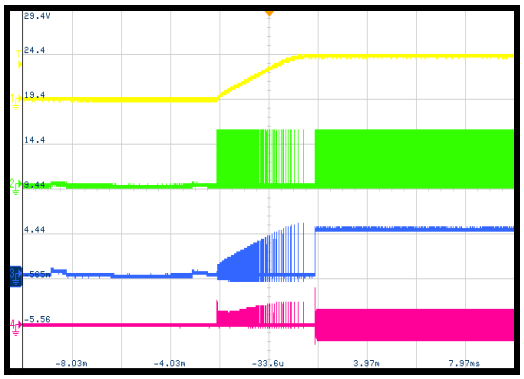

### Shutdown through EN via I²C Command

Load = 3A



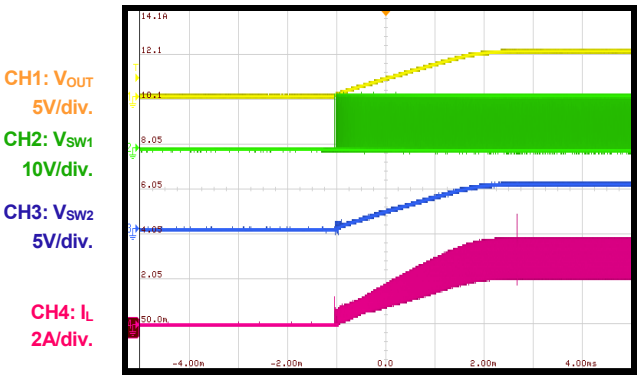

### Start-Up through EN

Load = 0A




### Start-Up through EN

Load = 3A



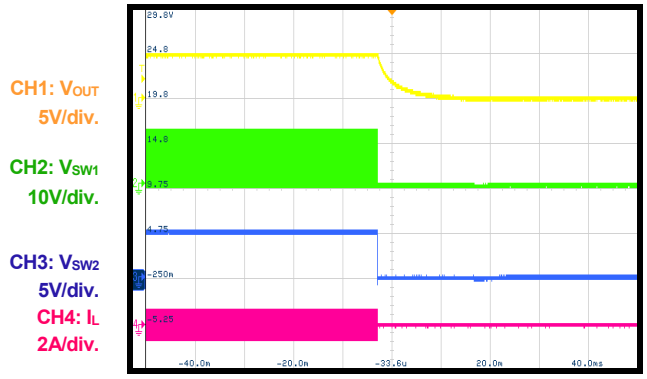


MPS Proprietary Information. Patent Protected. Unauthorized Photocopy and Duplication Prohibited.
© 2021 MPS. All Rights Reserved.

## EVB TEST RESULTS *(continued)*

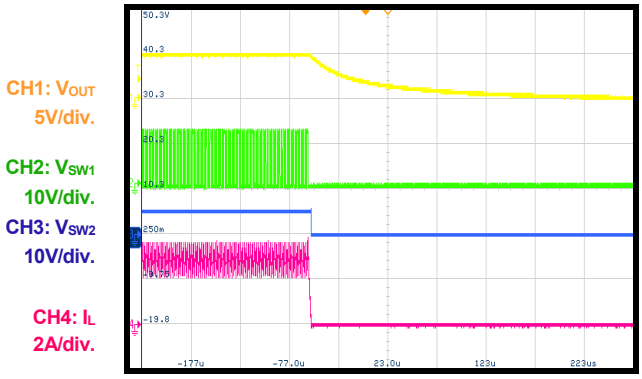
**Performance waveforms are tested on the evaluation board. $V_{IN}$ = 12V, $V_{OUT}$ = 5V, L = 4.7µH, $f_{SW}$ = 500kHz, $T_A$ = 25°C, unless otherwise noted.**

### Shutdown through EN
Load = 0A



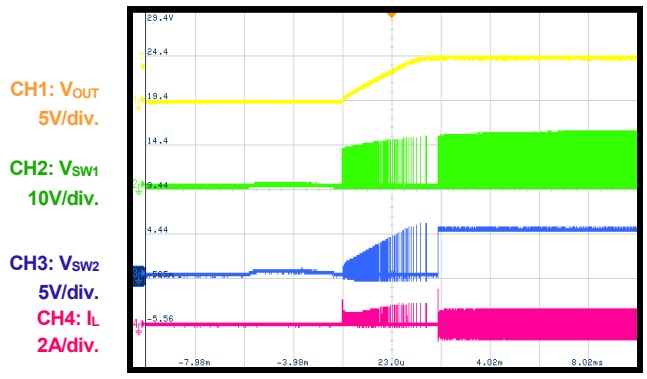

10ms/div.

### Shutdown through EN
Load = 3A



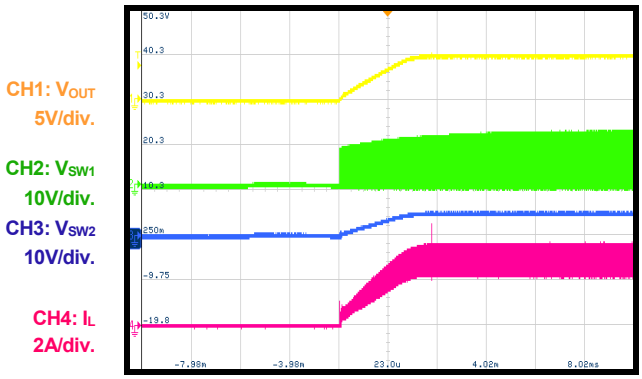

50µs/div.

### Start-Up through VIN
Load = 0A



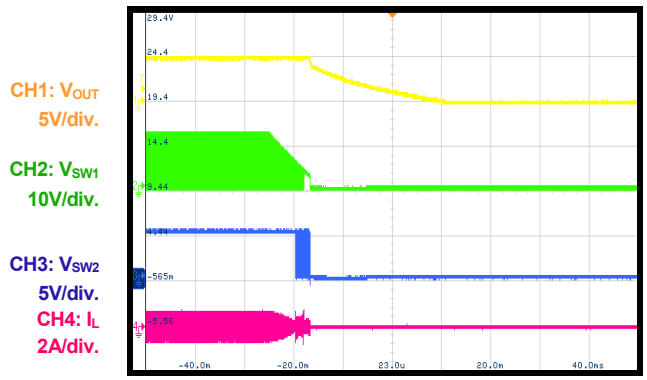

2ms/div.

### Start-Up through VIN
Load = 3A



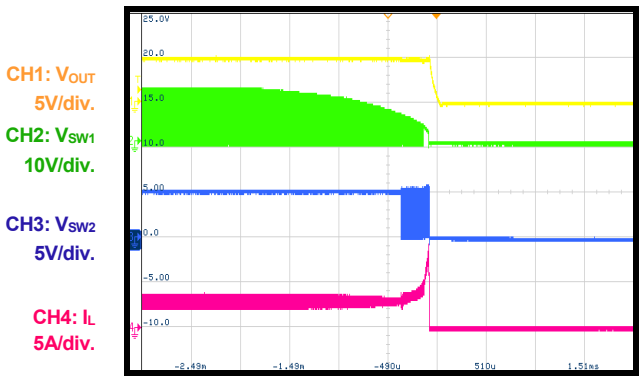

2ms/div.

### Shutdown through VIN
Load = 0A




10ms/div.

### Shutdown through VIN
Load = 3A




500µs/div.

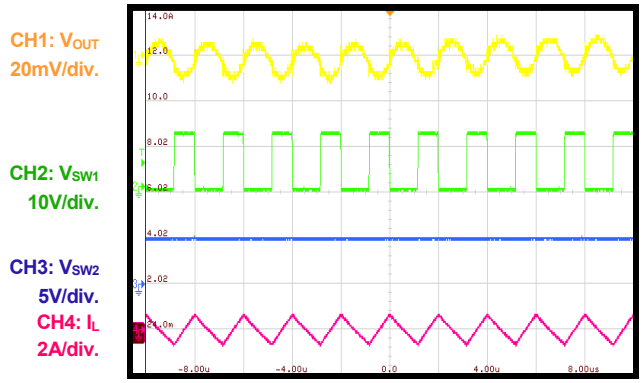

MPS Proprietary Information. Patent Protected. Unauthorized Photocopy and Duplication Prohibited.
© 2021 MPS. All Rights Reserved.

## 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

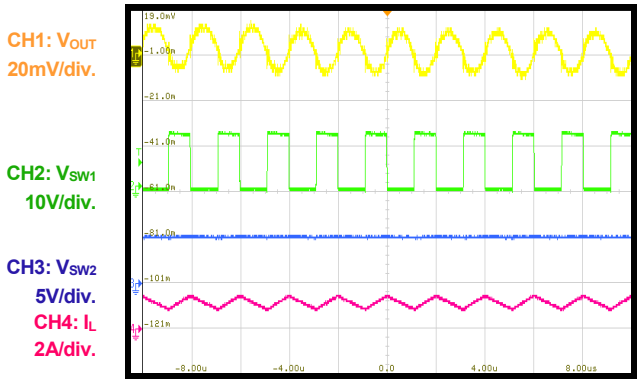
$V_{OUT}$ = 5V, load = 0A, $f_{SW}$ = 500kHz




2µs/div.

### Steady State

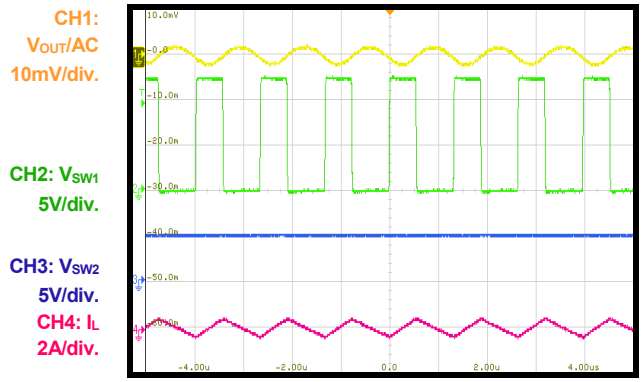
$V_{OUT}$ = 5V, load = 3A, $f_{SW}$ = 500kHz




2µs/div.

### Steady State

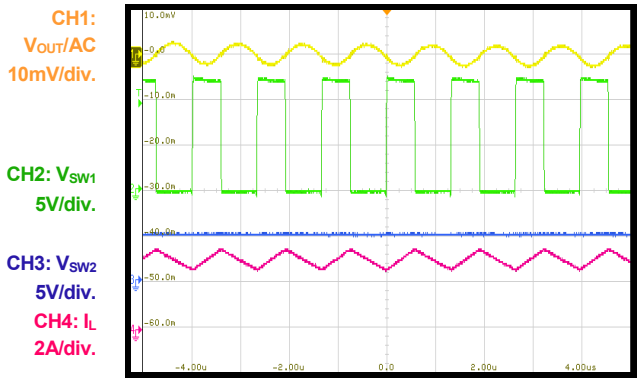
$V_{OUT}$ = 5V, load = 0A, $f_{SW}$ = 750kHz




1µs/div.

### Steady State

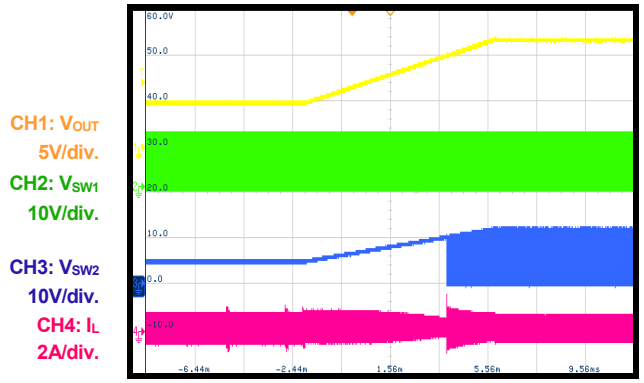
$V_{OUT}$ = 5V, load = 3A, $f_{SW}$ = 750kHz




1µs/div.

### I²C VID

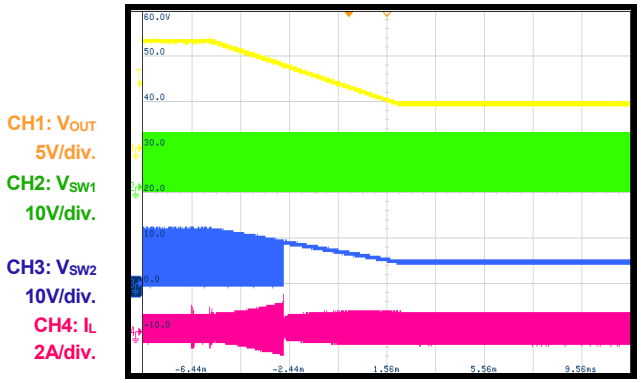
$V_{OUT}$ = 5V to 12V, $I_{OUT}$ = 0A, R1 = 430kΩ, R2 = 53.6kΩ




2ms/div.

### I²C VID

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




2ms/div.

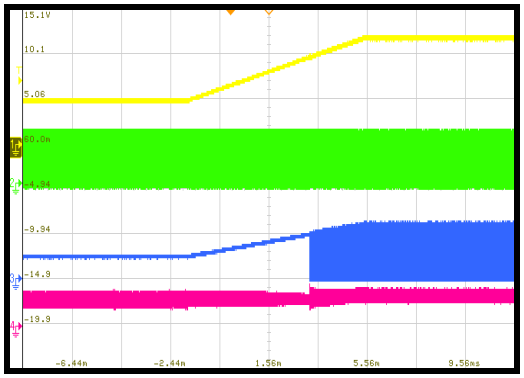

MPS Proprietary Information. Patent Protected. Unauthorized Photocopy and Duplication Prohibited.
© 2021 MPS. All Rights Reserved.

## 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

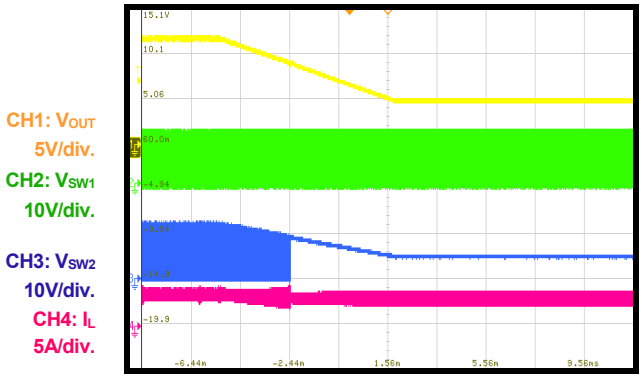
$V_{OUT}$ = 5V to 12V, $I_{OUT}$ = 3A, R1 = 430kΩ, R2 = 53.6kΩ




2ms/div.

### I²C VID

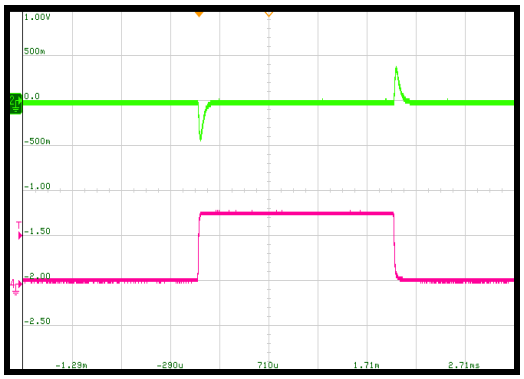
$V_{OUT}$ = 5V to 12V, $I_{OUT}$ = 3A, R1 = 430kΩ, R2 = 53.6kΩ




2ms/div.

### Load Transient

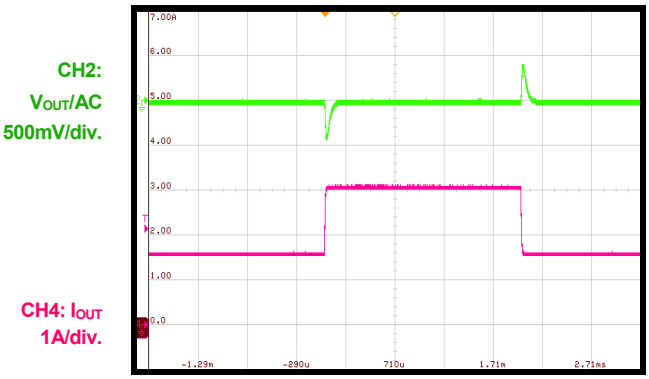
$V_{IN}$ = 12V, $V_{OUT}$ = 5V, no line drop compensation, 0A to 1.5A, 150mA/µs




500µs/div.

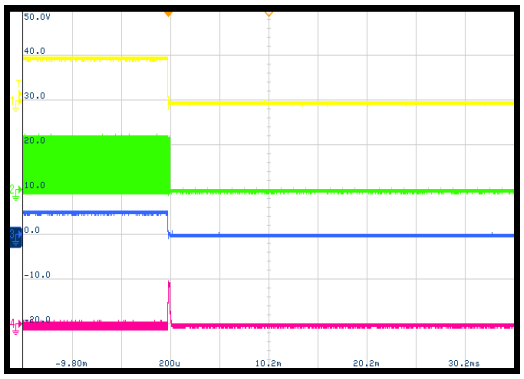
### Load Transient

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



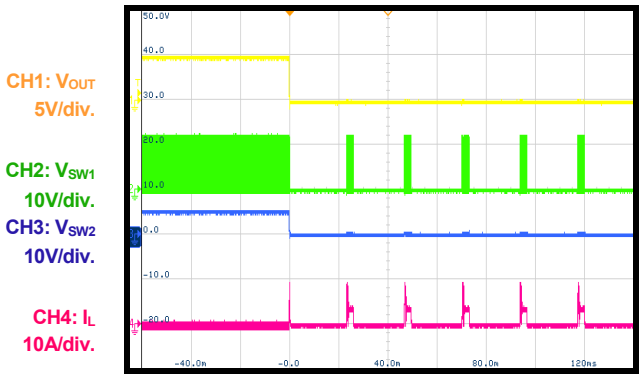

500µs/div.

### SCP Entry in Latch-Off Mode




5ms/div.

### SCP Entry in Hiccup Mode



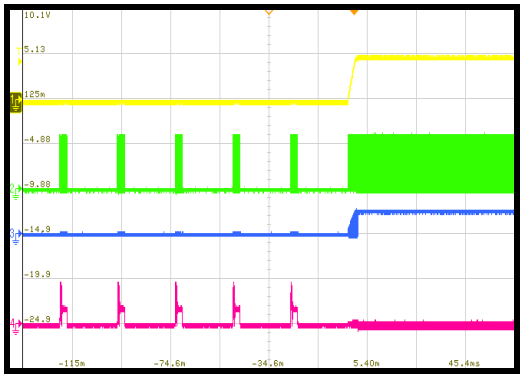

20ms/div.


MPS Proprietary Information. Patent Protected. Unauthorized Photocopy and Duplication Prohibited.
© 2021 MPS. All Rights Reserved.

## 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.**

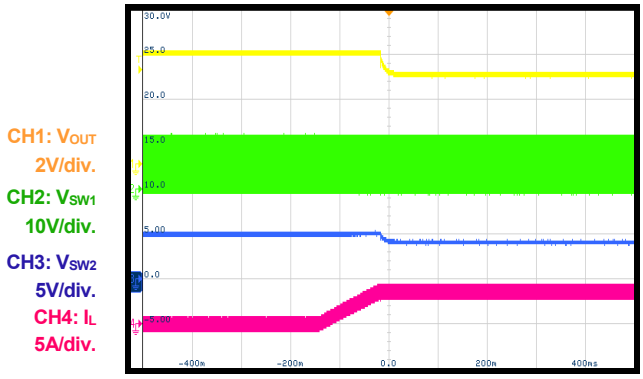
### SCP Recovery in Hiccup Mode




20ms/div.

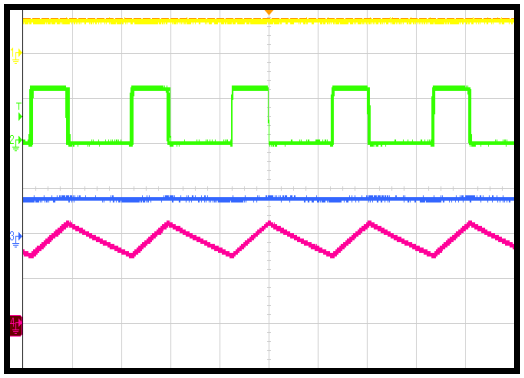
### CC Limit Entry

Tested in CV mode on an electronic load



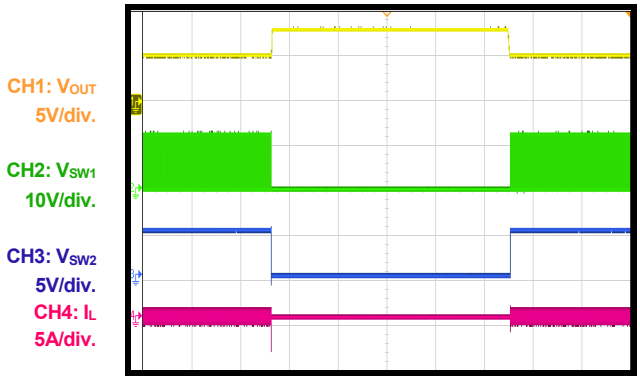

100ms/div.

### CC Limit Steady State



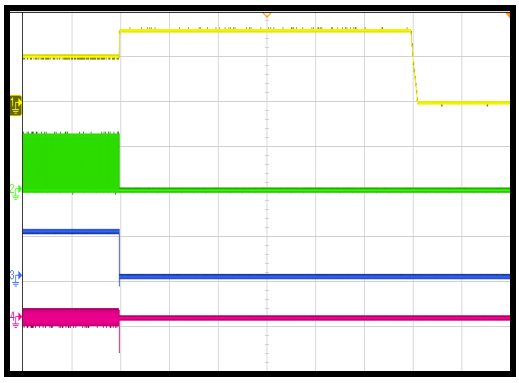

1µs/div.

### $V_{OUT}$ OVP in Hiccup Mode




500ms/div.

### $V_{OUT}$ OVP in Latch-Off Mode




500ms/div.


MPS Proprietary Information. Patent Protected. Unauthorized Photocopy and Duplication Prohibited.
© 2021 MPS. All Rights Reserved.

# PCB LAYOUT

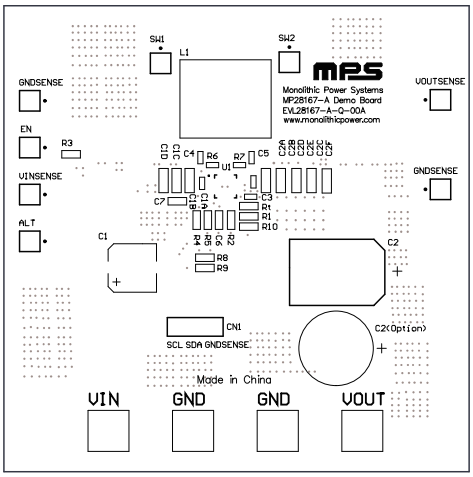



**Figure 2: Top Silk**

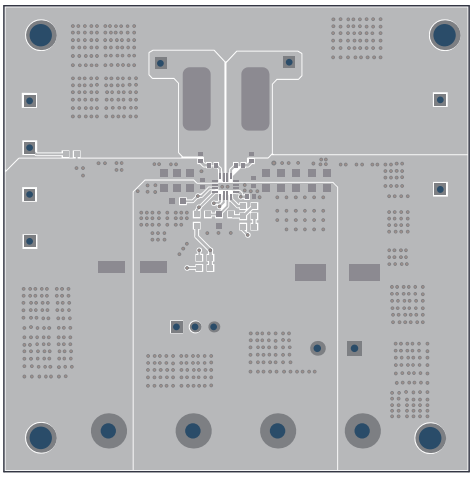


**Figure 3: Top Layer**

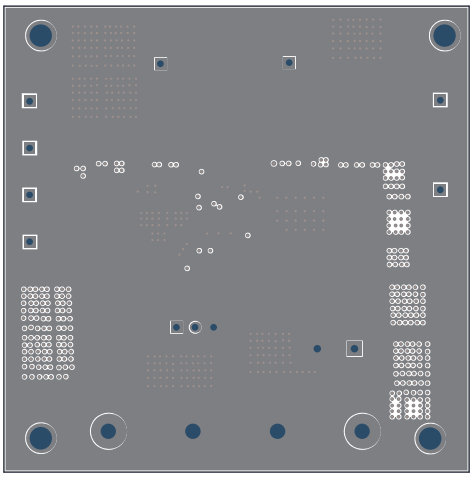


**Figure 4: Mid-Layer 1**

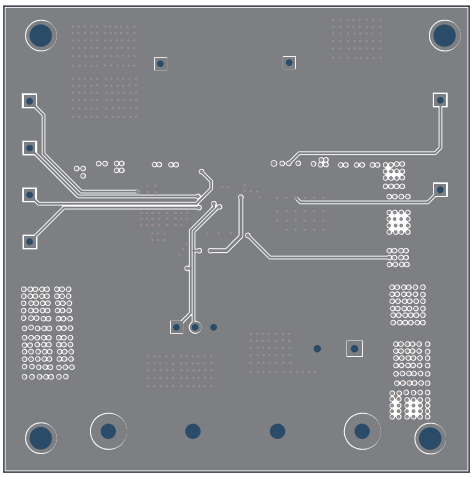


**Figure 5: Mid-Layer 2**

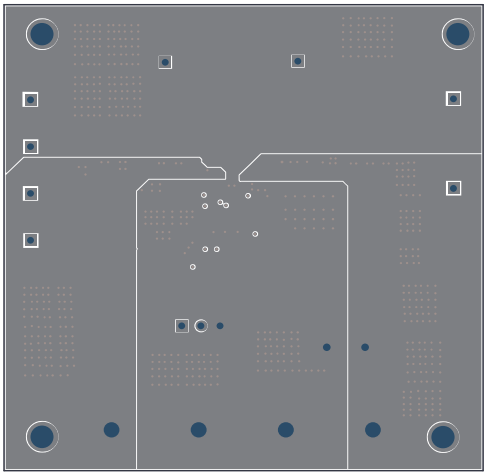


**Figure 6: Bottom Layer**


MPS Proprietary Information. Patent Protected. Unauthorized Photocopy and Duplication Prohibited.
© 2021 MPS. All Rights Reserved.

## REVISION HISTORY

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

**Notice:** The information in this document is subject to change without notice. Please contact MPS for current specifications. Users should warrant and guarantee that third-party Intellectual Property rights are not infringed upon when integrating MPS products into any application. MPS will not assume any legal responsibility for any said applications.


MPS Proprietary Information. Patent Protected. Unauthorized Photocopy and Duplication Prohibited.
© 2021 MPS. All Rights Reserved.