# EVQ4323M-G-00A

## 36V, 3A, Low-$I_Q$, Synchronous Step-Down Converter in a QFN-12L Package Evaluation Board, AEC-Q100 Qualified

## DESCRIPTION

The EVQ4323M-G-00A evaluation board is designed to demonstrate the capabilities of the MPQ4323M, a configurable-frequency (350kHz to 2.5MHz), synchronous, step-down switching regulator with integrated, internal high-side MOSFETs (HS-FETs) and low-side MOSFETs (LS-FETs).

The MPQ4323M provides 3A of highly efficient output current ($I_{OUT}$) with peak current control mode. The wide 3.3V to 36V input voltage ($V_{IN}$) range and 42V load dump tolerance accommodates a variety of step-down applications in automotive input environments. A 1µA quiescent current ($I_Q$) in shutdown mode allows the device to be used in battery-powered applications.

High power conversion efficiency across a wide load range is achieved by scaling down the switching frequency ($f_{SW}$) under light-load conditions to reduce the switching and gate driver losses.

An open-drain power good (PG) signal indicates whether the output is within 94.5% to 105.5% of its nominal voltage.

Frequency foldback helps prevent inductor current ($I_L$) runaway during start-up. Thermal shutdown provides reliable, fault-tolerant operation. A high duty cycle and low-dropout (LDO) mode are provided for automotive cold-crank conditions.

The EVQ4323M-G-00A is fully assembled and tested. The MPQ4323M is available in a QFN-12L (3.5mmx3.5mm) package with wettable flanks. It is available in AEC-Q100 Grade 1.

## PERFORMANCE SUMMARY

Specifications are at $T_A$ = 25°C, unless otherwise noted.

| Parameters | Conditions | Value |
|---|---|---|
| Input voltage ($V_{IN}$) range | | 3.3V to 36V |
| Output voltage ($V_{OUT}$) | $V_{IN}$ = 6V to 36V, $I_{OUT}$ = 0A to 3A | $V_{OUT}$ = 5V |
| Maximum output current ($I_{OUT}$) | $V_{IN}$ = 3.3V to 36V | 3A |
| Typical efficiency | $V_{IN}$ = 12V, $V_{OUT}$ = 5V, $I_{OUT}$ = 3A | 92.7% |
| Peak efficiency | $V_{IN}$ = 8V, $V_{OUT}$ = 5V, $I_{OUT}$ = 1A | 95.6% |
| Switching frequency ($f_{SW}$) | | 2.2MHz |

# EVQ4323M-G-00A EVALUATION BOARD


**LxWxH (8.3cmx8.3cmx1cm)**

| Board Number | MPS IC Number |
|---|---|
| EVQ4323M-G-00A | MPQ4323MGQCE-AEC1 |

## QUICK START GUIDE

The EVQ4323M-G-00A evaluation board is easy to set up and use to evaluate the MPQ4323M's performance. For proper measurement equipment set-up, refer to Figure 2 on page 4 and follow the steps below:

1. Preset the power supply between 6V and 36V, then turn off the power supply.
2. Set the load current between 0A and 3A. Electronic loads represent a negative impedance to the regulator, and setting a current too high may trigger hiccup mode.
3. If longer cables are used between the source and the evaluation board (>0.5m total), place a damping capacitor at the input terminals, especially when $V_{IN} \geq 24V$.
4. Connect the power supply terminals to:
   a. Positive (+): VEMI
   b. Negative (-): GND
5. Connect the load terminals to:
   a. Positive (+): VOUT
   b. Negative (-): GND
6. After making the connections, turn on the power supply.
7. To use the enable function, apply a digital input to the EN pin. Drive EN above 1.02V to turn the regulator on; drive EN below 0.85V to turn the regulator off. If the enable function is not used, EN can be connected directly to VIN.
8. Connect a resistor between the FREQ and GND pins to set the internal switching frequency ($f_{SW}$).
9. The external resistor divider sets the output voltage ($V_{OUT}$) (see Figure 1).

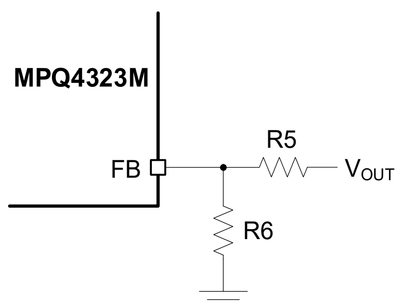



**Figure 1: Feedback Divider Network with Adjustable Output**

R5 is selected to be 100kΩ. R6 can then be calculated using Equation (1):

$$R6=\frac{R5}{\frac{V_{OUT}}{0.8V}-1} \quad (1)$$

Refer to the Application Information section in the MPQ4323M datasheet to calculate the inductance and output capacitance for different $V_{OUT}$ values.

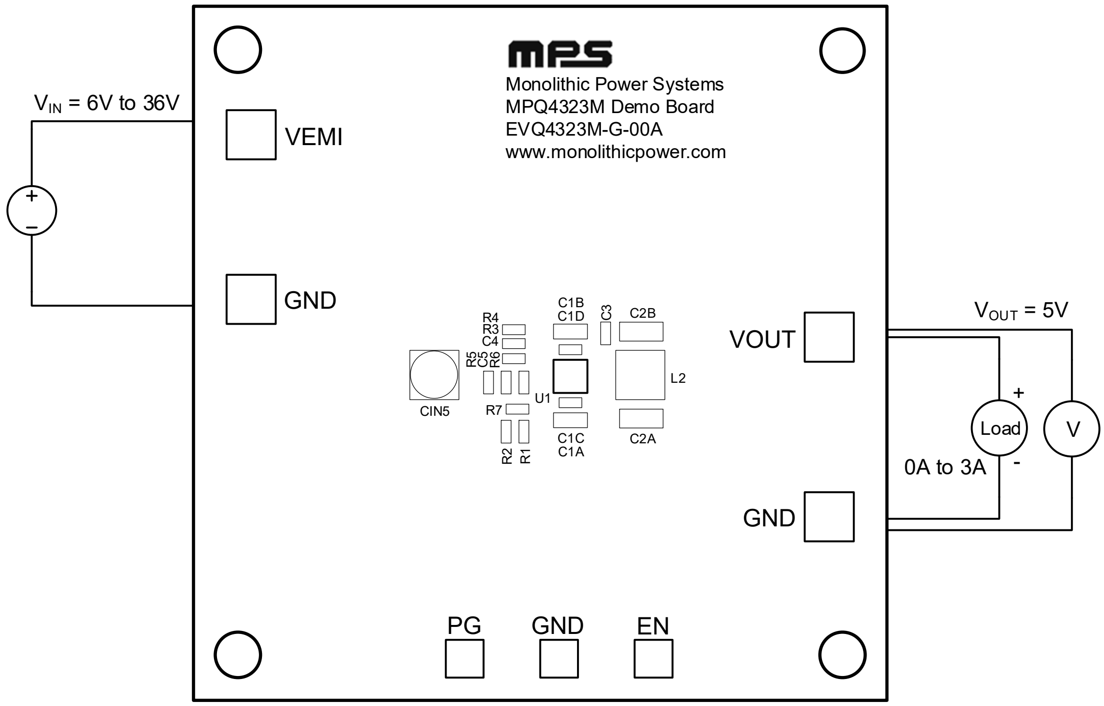
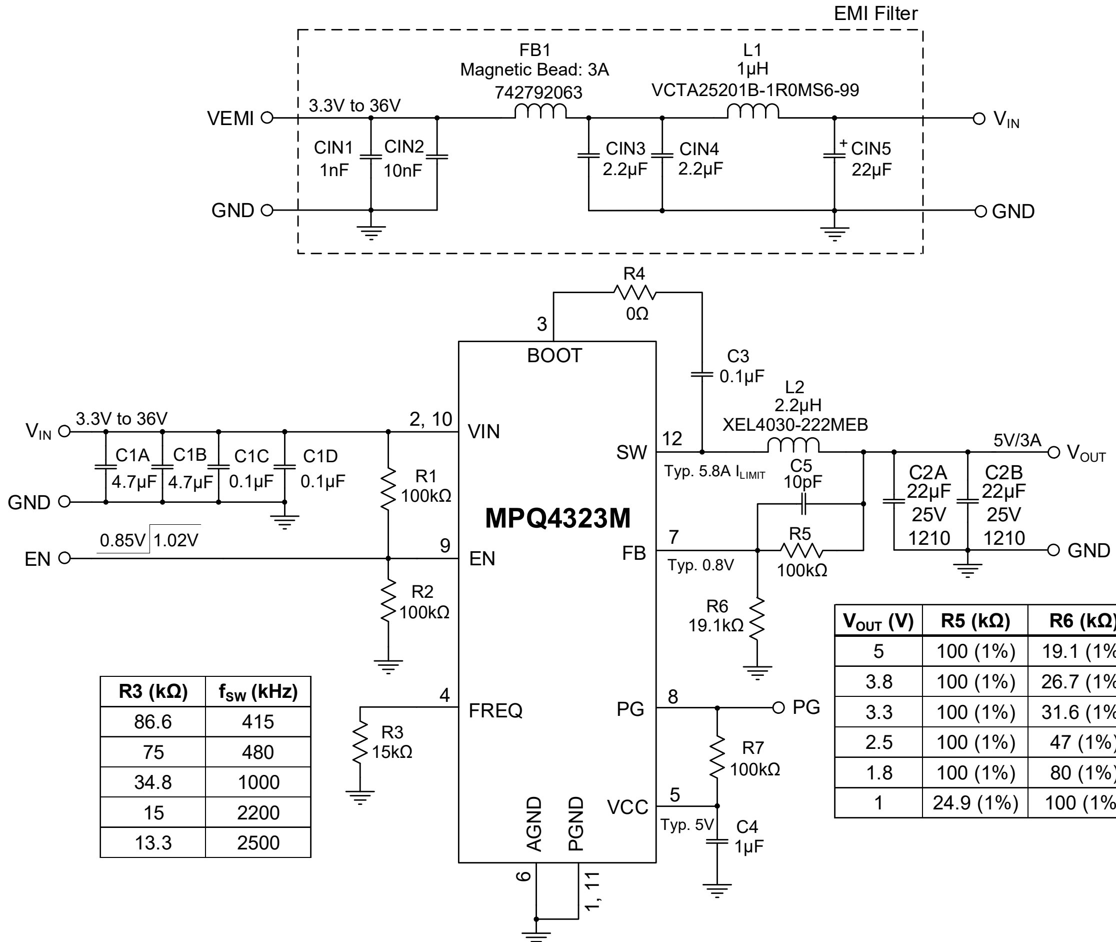



**Figure 2: Measurement Equipment Set-Up**

# EVALUATION BOARD SCHEMATIC

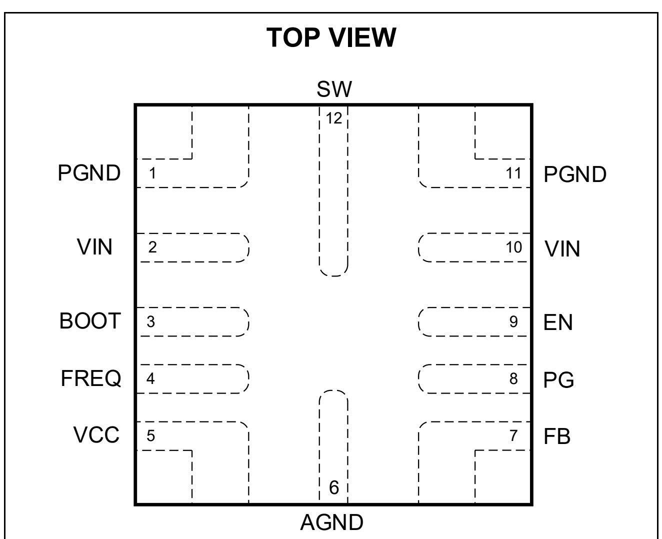



| R3 (kΩ) | $f_{SW}$ (kHz) |
|---|---|
| 86.6 | 415 |
| 75 | 480 |
| 34.8 | 1000 |
| 15 | 2200 |
| 13.3 | 2500 |

| $V_{OUT}$ (V) | R5 (kΩ) | R6 (kΩ) |
|---|---|---|
| 5 | 100 (1%) | 19.1 (1%) |
| 3.8 | 100 (1%) | 26.7 (1%) |
| 3.3 | 100 (1%) | 31.6 (1%) |
| 2.5 | 100 (1%) | 47 (1%) |
| 1.8 | 100 (1%) | 80 (1%) |
| 1 | 24.9 (1%) | 100 (1%) |

**Figure 3: Evaluation Board Schematic**

# PACKAGE REFERENCE




**QFN-12L (3.5mmx3.5mm)**

## EVQ4323M-G-00A BILL OF MATERIALS

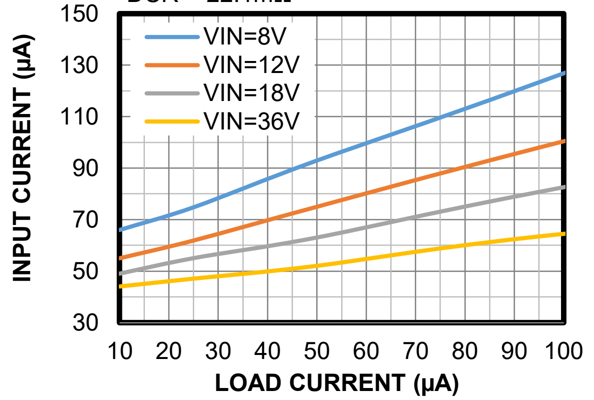
| Qty | Ref | Value | Description | Package | Manufacturer | Manufacturer PN |
|---|---|---|---|---|---|---|
| 1 | CIN1 | 1nF | Ceramic capacitor, 50V, X7R | 0603 | Murata | GRM216R71H102KA01 |
| 1 | CIN2 | 10nF | Ceramic capacitor, 50V, X7R | 0603 | Murata | GRM188R71H103KA01D |
| 2 | CIN3, CIN4 | 2.2μF | Ceramic capacitor, 50V, X7R | 0805 | TDK | CGA4J3X7R1H225KT000N |
| 1 | CIN5 | 22μF | Aluminum polymer capacitor, 50V | SMD | Panasonic | EEHZC1H220P |
| 2 | C1A, C1B | 4.7μF | Ceramic capacitor, 50V, X7S | 1206 | Murata | GRM31CR71H475KA12L |
| 3 | C1C, C1D, C3 | 100nF | Ceramic capacitor, 50V, X7R | 0603 | Murata | GRM188R71H104KA93D |
| 2 | C2A, C2B | 22μF | Ceramic capacitor, 25V, X7R | 1210 | Murata | GRM32ER71E226KE15L |
| 1 | C5 | 10pF | Ceramic capacitor, 50V, NP0 | 0603 | Wurth | 885012006051 |
| 1 | C4 | 1μF | Ceramic capacitor, 25V, X7R | 0603 | Murata | GCM188R71E105KA64D |
| 1 | FB1 | 3A | Magnetic bead | 0805 | Wurth | 742792063 |
| 1 | L1 | 1uH | Inductor, 35mΩ, 3.8A | SMD | Cyntec | VCTA25201B-1R0MS6-99 |
| 1 | L2 | 2.2μH | Inductor, 22.1mΩ, 5.8A | SMD | Coilcraft | XEL4030-222MEB |
| 4 | R1, R5, R7, R2 | 100kΩ | Film resistor, 1% | 0603 | Yageo | RC0603FR-07100KL |
| 1 | R6 | 19.1kΩ | Film resistor, 1% | 0603 | Yageo | RC0603FR-0719K1L |
| 1 | R3 | 15kΩ | Film resistor, 1% | 0603 | Yageo | RC0603FR-0715KL |
| 1 | R4 | 0Ω | Film resistor, 5% | 0603 | Yageo | RC0603JR-070RL |
| 1 | U1 | MPQ4323M | 3A, low-$I_Q$, sync step-down converter, AEC-Q100 | QFN-12L (3.5mmx 3.5mm) | MPS | MPQ4323MGQCE-AEC1 |

## EVB TEST RESULTS

**Performance curves and waveforms are tested on the evaluation board. $V_{IN}$ = 12V, $V_{OUT}$ = 5V, $T_A$ = 25°C, unless otherwise noted.**

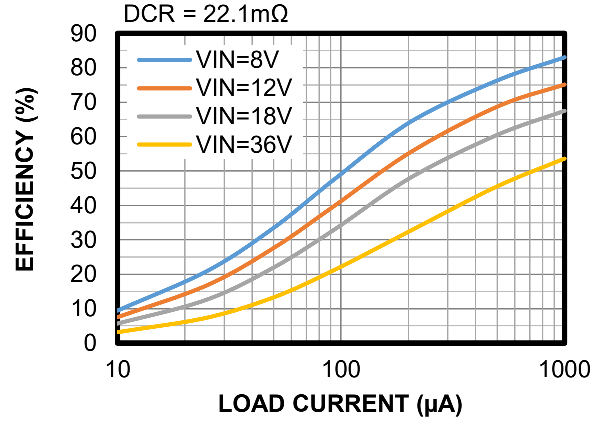
### Input Current vs. Load Current

$R_{FB1}$ = 100kΩ, $R_{FB2}$ = 19.1kΩ,
DCR = 22.1mΩ



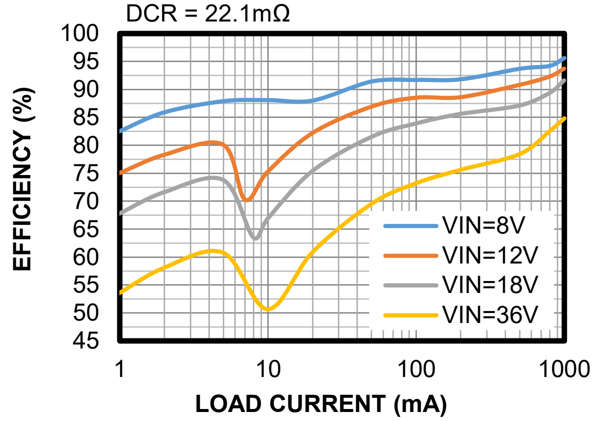

### Efficiency vs. Load Current

$R_{FB1}$ = 100kΩ, $R_{FB2}$ = 19.1kΩ,
DCR = 22.1mΩ



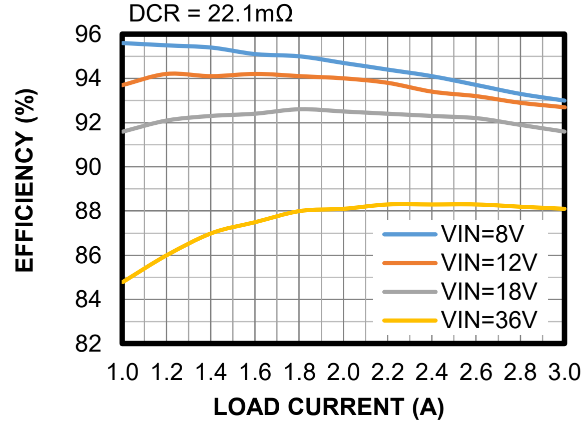

### Efficiency vs. Load Current

DCR = 22.1mΩ



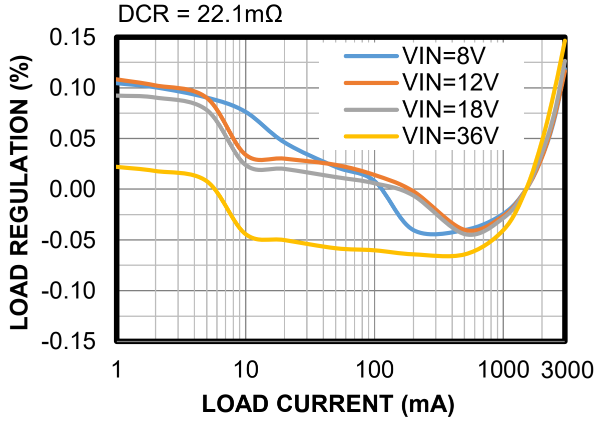

### Efficiency vs. Load Current

DCR = 22.1mΩ



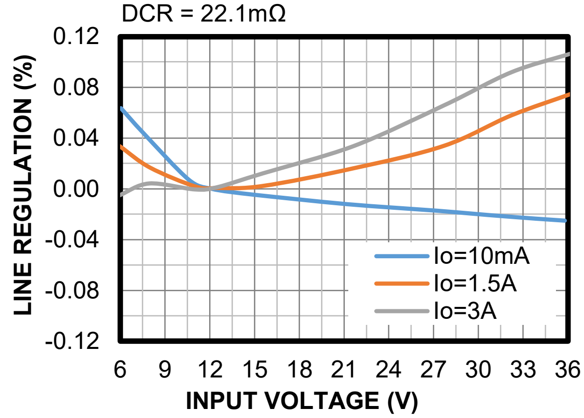

### Load Regulation

DCR = 22.1mΩ




### Line Regulation

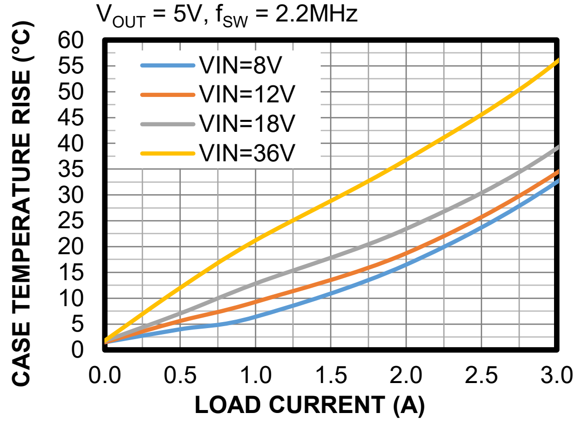
DCR = 22.1mΩ



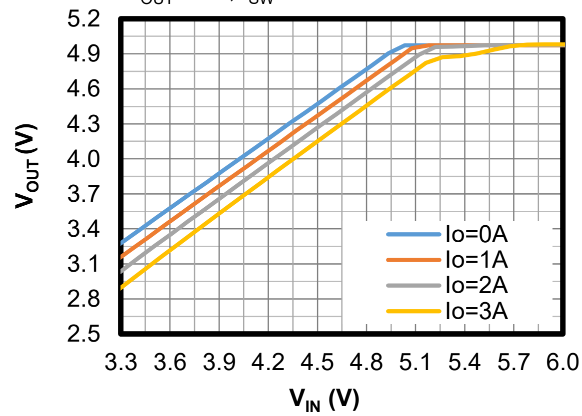
## EVB TEST RESULTS *(continued)*

**Performance curves and waveforms are tested on the evaluation board. $V_{IN}$ = 12V, $V_{OUT}$ = 5V, $T_A$ = 25°C, unless otherwise noted.**

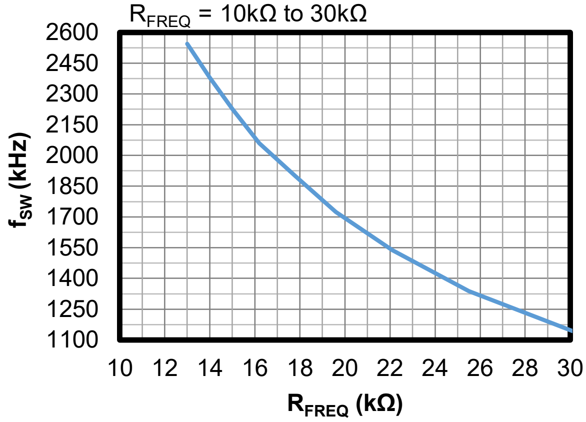
**Case Temperature Rise**
$V_{OUT}$ = 5V, $f_{SW}$ = 2.2MHz



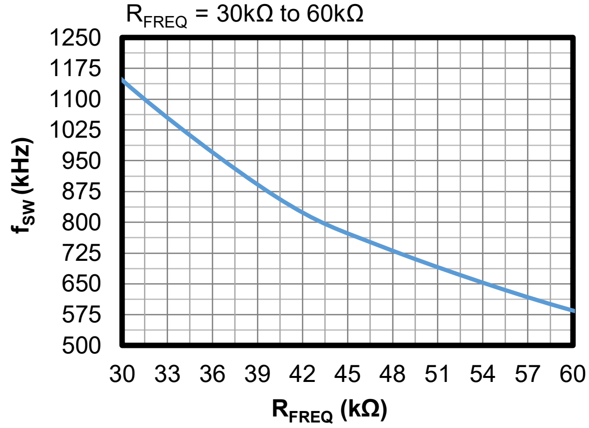

**Low-Dropout Mode**
$V_{OUT}$ = 5V, $f_{SW}$ = 2.2MHz



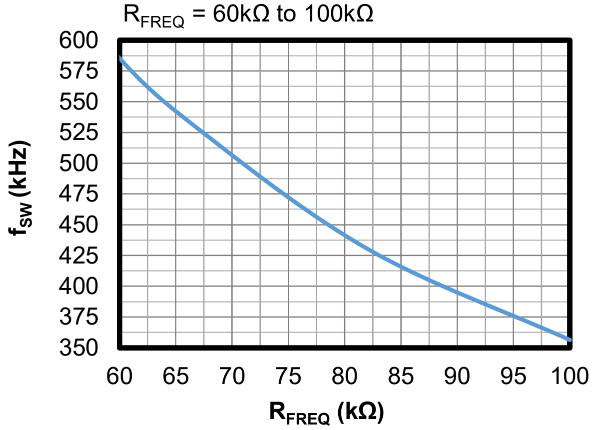

**$f_{SW}$ vs. $R_{FREQ}$**
$R_{FREQ}$ = 10kΩ to 30kΩ




**$f_{SW}$ vs. $R_{FREQ}$**
$R_{FREQ}$ = 30kΩ to 60kΩ




**$f_{SW}$ vs. $R_{FREQ}$**
$R_{FREQ}$ = 60kΩ to 100kΩ

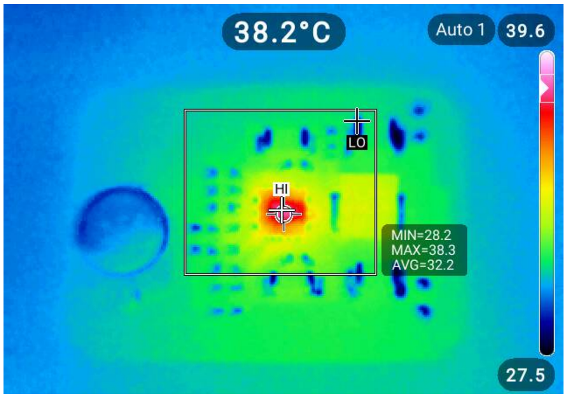


## EVB TEST RESULTS *(continued)*

**Performance curves and waveforms are tested on the evaluation board. $V_{IN}$ = 12V, $V_{OUT}$ = 5V, $T_A$ = 25°C, unless otherwise noted.**

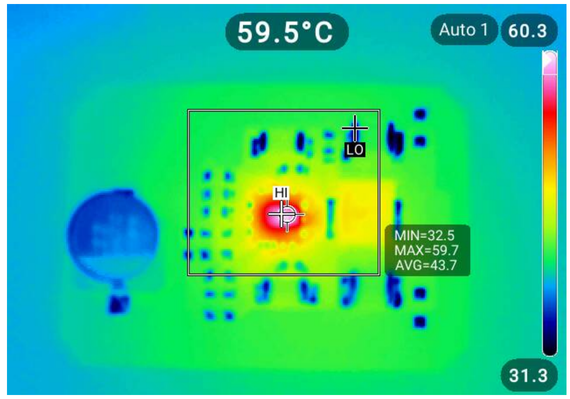
**Thermal Performance**

$I_{OUT}$ = 1.5A, no forced airflow, $T_{CASE}$ = 38.2°C




**Thermal Performance**

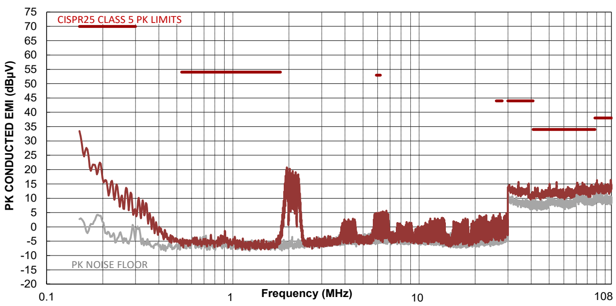
$I_{OUT}$ = 3A, no forced airflow, $T_{CASE}$ = 59.5°C



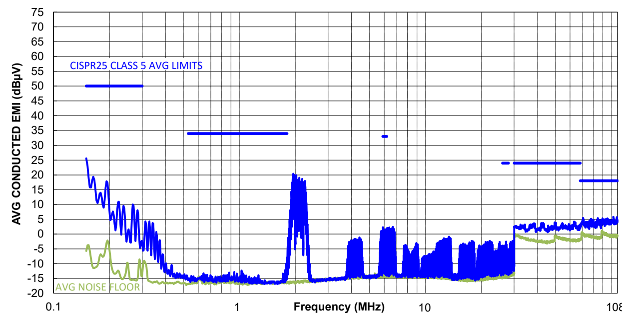
## EVB TEST RESULTS *(continued)*

**Performance curves and waveforms are tested on the evaluation board. $V_{IN}$ = 12V, $V_{OUT}$ = 5V, $T_A$ = 25°C, unless otherwise noted.**

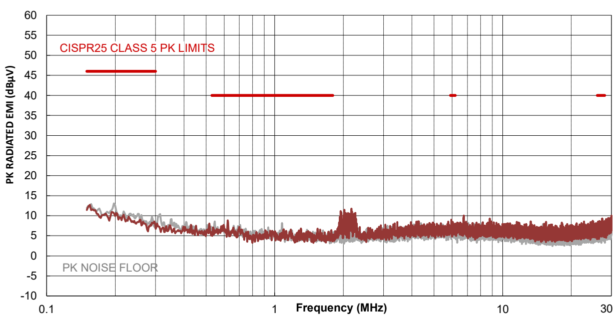
**CISPR25 Class 5 Peak Conducted Emissions**
150kHz to 108MHz



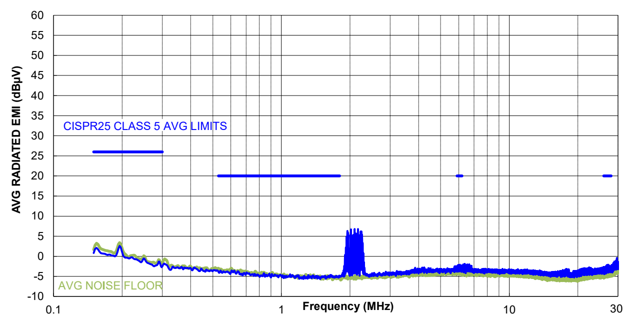

**CISPR25 Class 5 Average Conducted Emissions**
150kHz to 108MHz



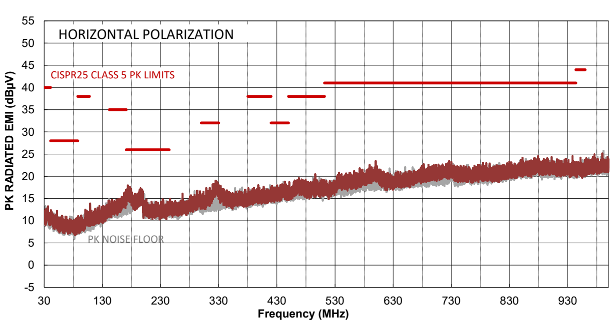

**CISPR25 Class 5 Peak Radiated Emissions**
150kHz to 30MHz



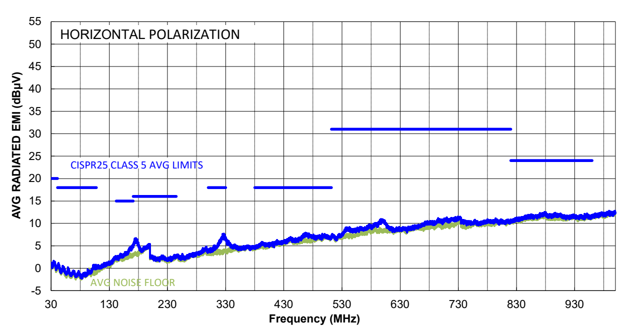

**CISPR25 Class 5 Average Radiated Emissions**
150kHz to 30MHz




**CISPR25 Class 5 Peak Radiated Emissions**
Horizontal, 30MHz to 1GHz



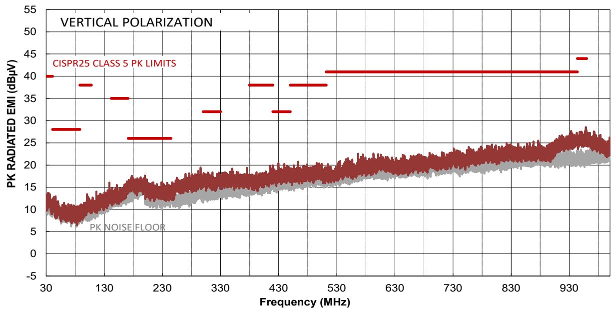

**CISPR25 Class 5 Average Radiated Emissions**
Horizontal, 30MHz to 1GHz



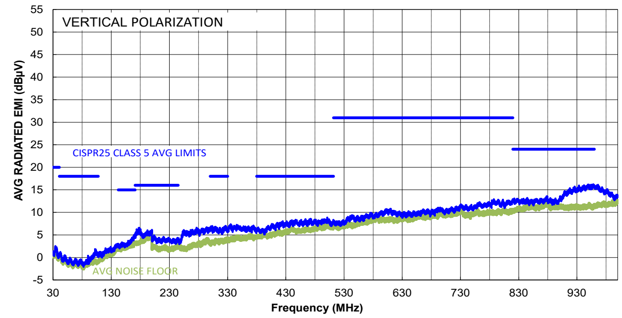
## EVB TEST RESULTS *(continued)*

**Performance curves and waveforms are tested on the evaluation board. $V_{IN}$ = 12V, $V_{OUT}$ = 5V, $T_A$ = 25°C, unless otherwise noted.**

**CISPR25 Class 5 Peak Radiated Emissions**
Vertical, 30MHz to 1GHz




**CISPR25 Class 5 Average Radiated Emissions**
Vertical, 30MHz to 1GHz

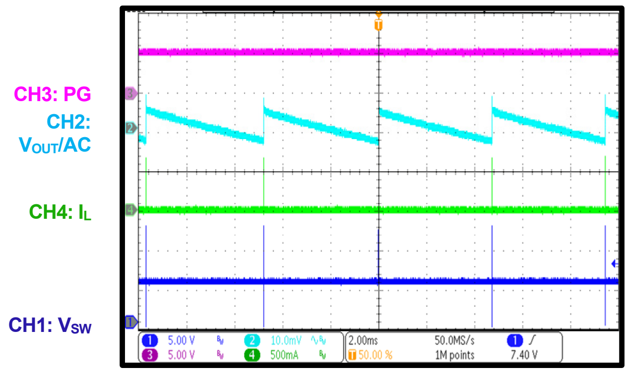


## EVB TEST RESULTS *(continued)*

**Performance curves and waveforms are tested on the evaluation board. $V_{IN}$ = 12V, $V_{OUT}$ = 5V, $T_A$ = 25°C, unless otherwise noted.**

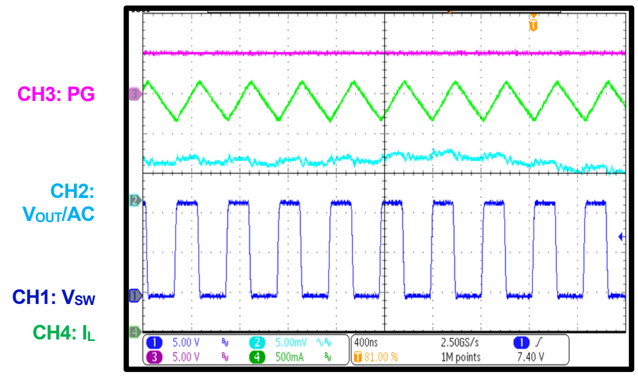
**Steady State**

$I_{OUT}$ = 0A



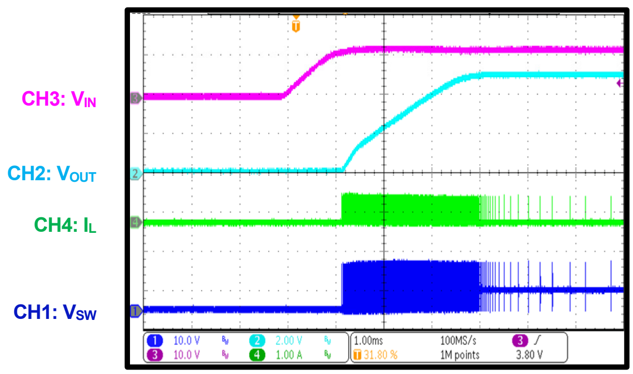

**Steady State**

$I_{OUT}$ = 3A



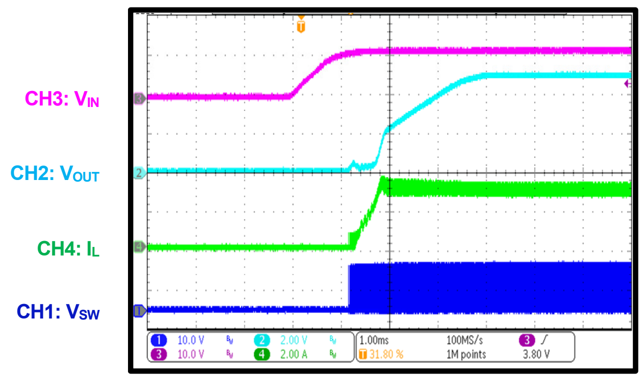

**Start-Up through VIN**

$I_{OUT}$ = 0A



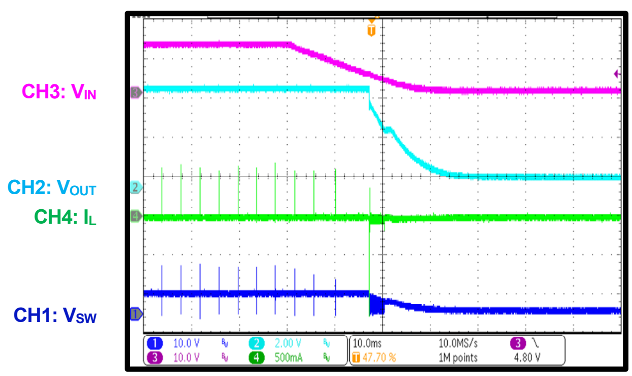

**Start-Up through VIN**

$I_{OUT}$ = 3A



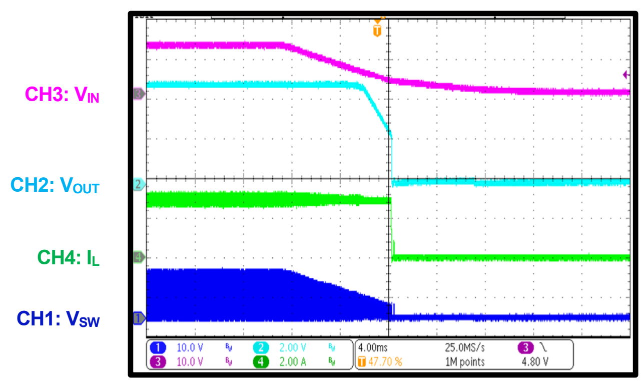

**Shutdown through VIN**

$I_{OUT}$ = 0A




**Shutdown through VIN**

$I_{OUT}$ = 3A

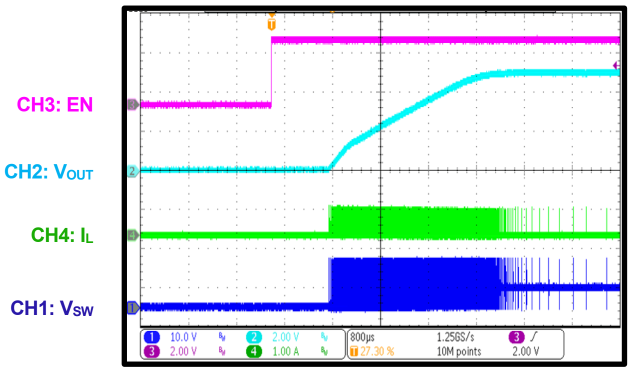


## EVB TEST RESULTS *(continued)*

**Performance curves and waveforms are tested on the evaluation board. $V_{IN}$ = 12V, $V_{OUT}$ = 5V, $T_A$ = 25°C, unless otherwise noted.**

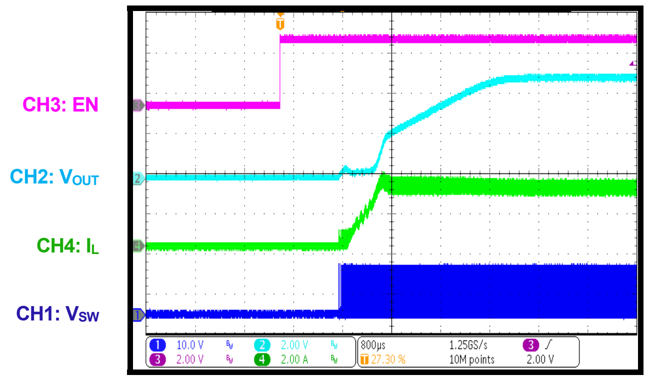
**Start-Up through EN**

$I_{OUT}$ = 0A



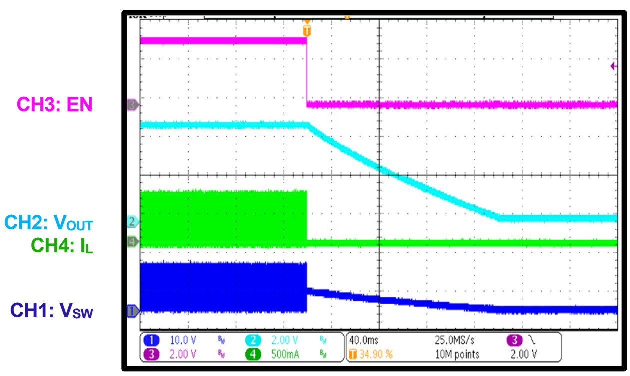

**Start-Up through EN**

$I_{OUT}$ = 3A



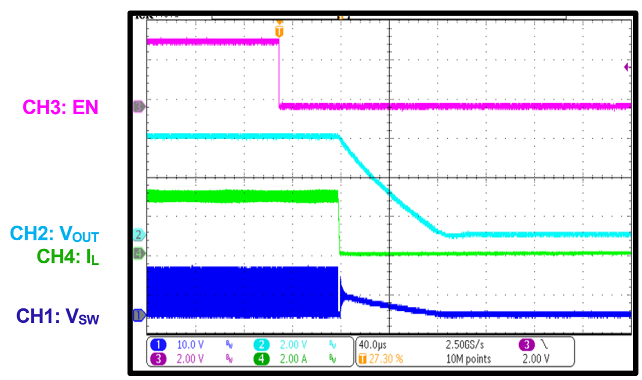

**Shutdown through EN**

$I_{OUT}$ = 0A



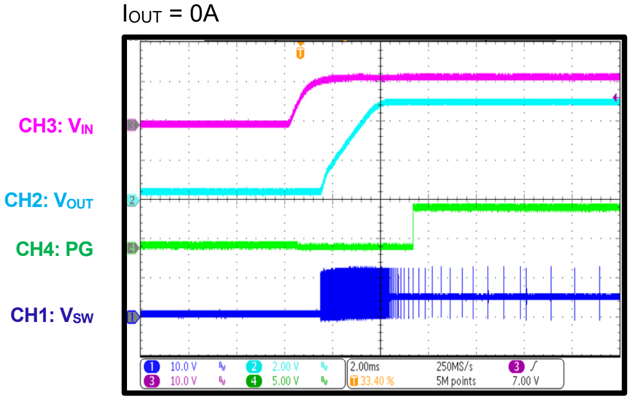

**Shutdown through EN**

$I_{OUT}$ = 3A



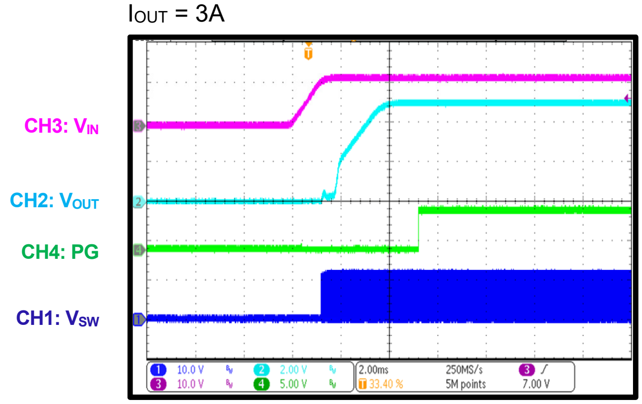

**PG in Start-Up through VIN**

$I_{OUT}$ = 0A




**PG in Start-Up through VIN**

$I_{OUT}$ = 3A

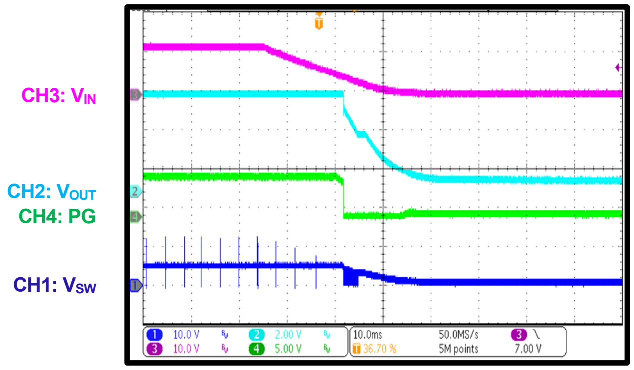


## EVB TEST RESULTS *(continued)*

**Performance curves and waveforms are tested on the evaluation board. $V_{IN}$ = 12V, $V_{OUT}$ = 5V, $T_A$ = 25°C, unless otherwise noted.**

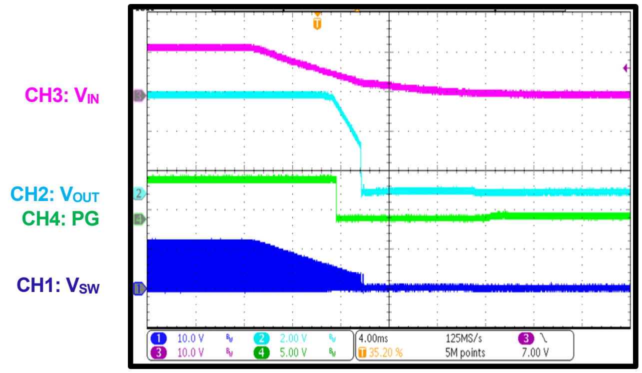
**PG in Shutdown through VIN**

$I_{OUT}$ = 0A



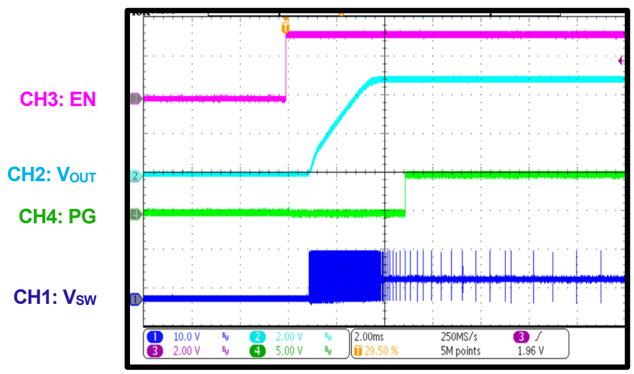

**PG in Shutdown through VIN**

$I_{OUT}$ = 3A



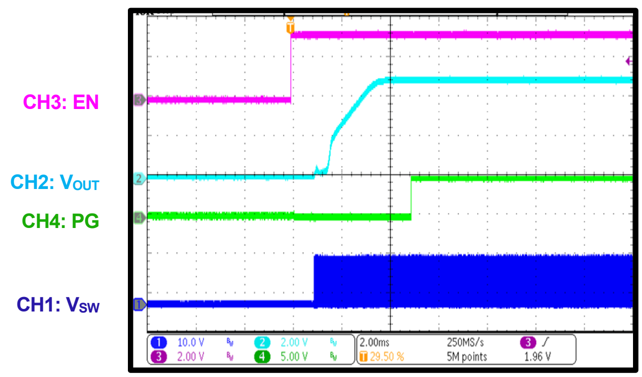

**PG in Start-Up through EN**

$I_{OUT}$ = 0A



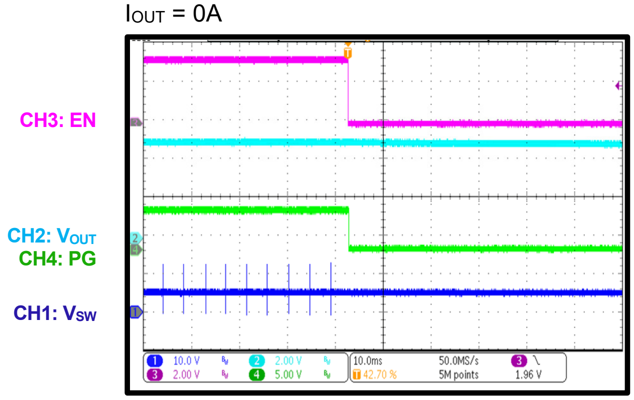

**PG in Start-Up through EN**

$I_{OUT}$ = 3A



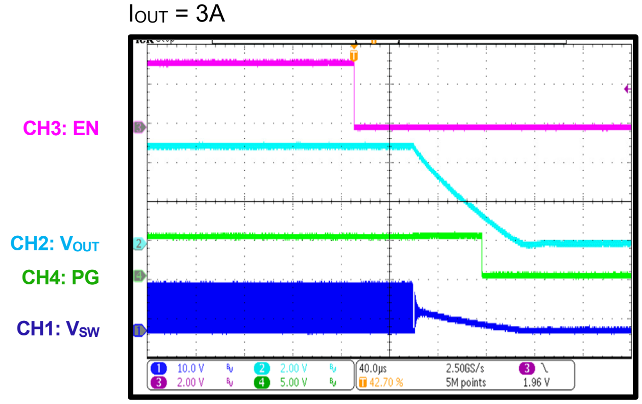

**PG in Shutdown through EN**

$I_{OUT}$ = 0A




**PG in Shutdown through EN**

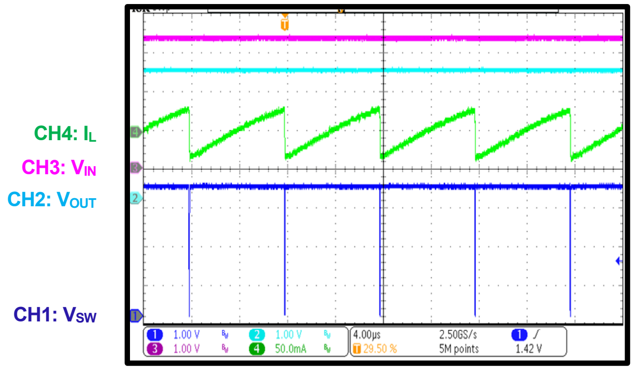
$I_{OUT}$ = 3A



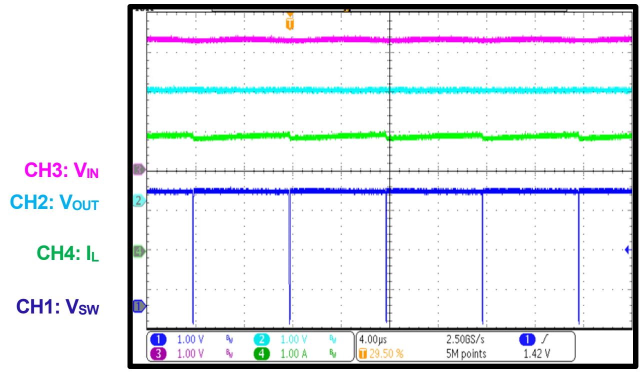
## EVB TEST RESULTS *(continued)*

**Performance curves and waveforms are tested on the evaluation board. $V_{IN}$ = 12V, $V_{OUT}$ = 5V, $T_A$ = 25°C, unless otherwise noted.**

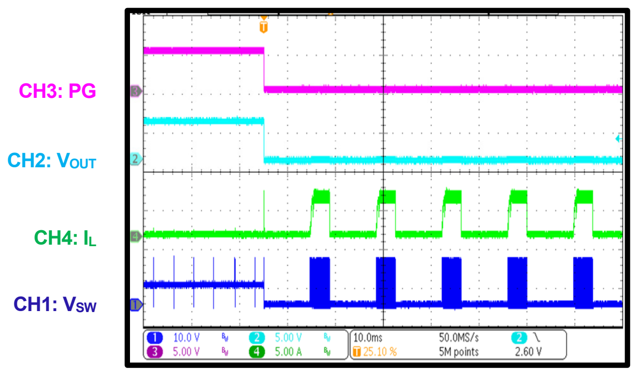
**Low-Dropout Mode**
$I_{OUT}$ = 0A, $V_{IN}$ = 3.3V



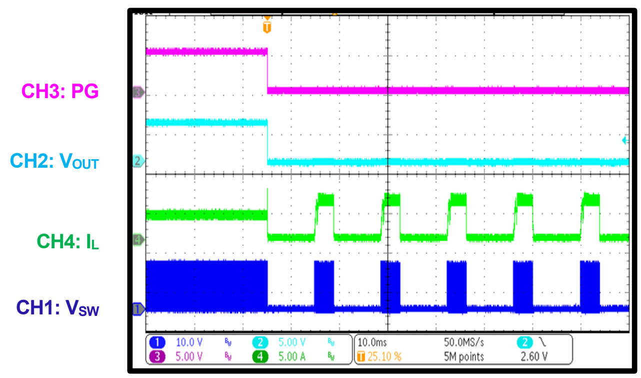

**Low-Dropout Mode**
$I_{OUT}$ = 3A, $V_{IN}$ = 3.3V



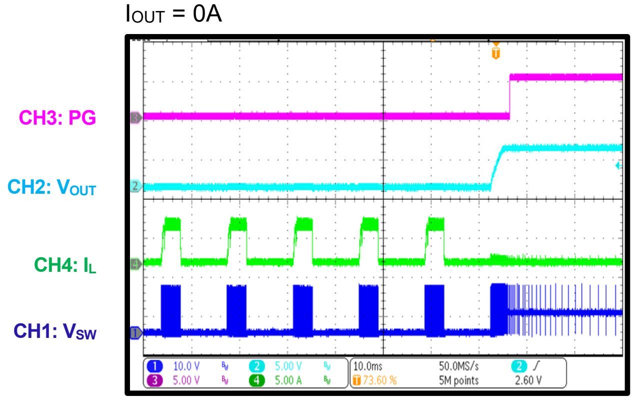

**SCP Entry**
$I_{OUT}$ = 0A



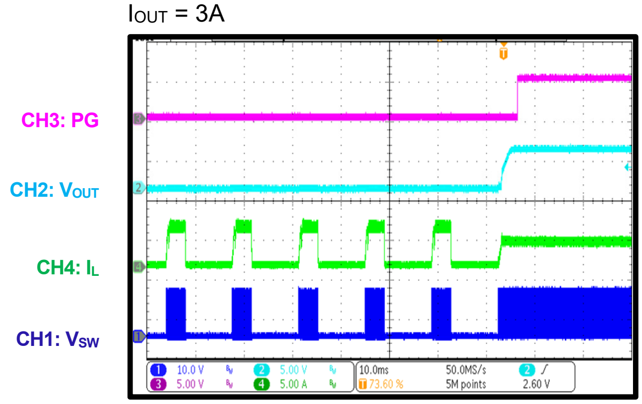

**SCP Entry**
$I_{OUT}$ = 3A




**SCP Recovery**
$I_{OUT}$ = 0A




**SCP Recovery**
$I_{OUT}$ = 3A

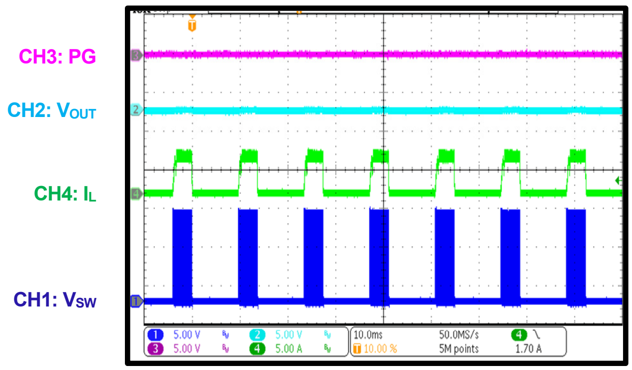


## EVB TEST RESULTS *(continued)*

**Performance curves and waveforms are tested on the evaluation board. $V_{IN}$ = 12V, $V_{OUT}$ = 5V, $T_A$ = 25°C, unless otherwise noted.**

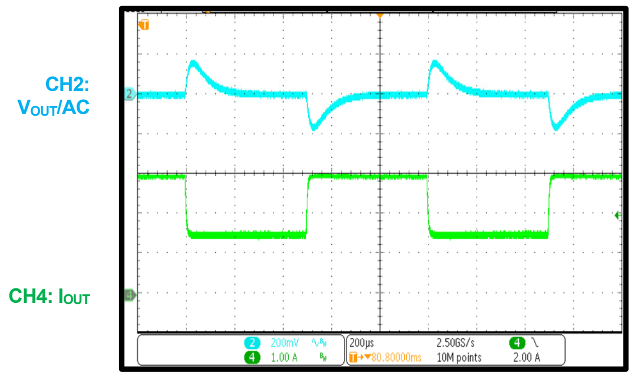
### SCP Steady State

$I_{OUT}$ = 0A



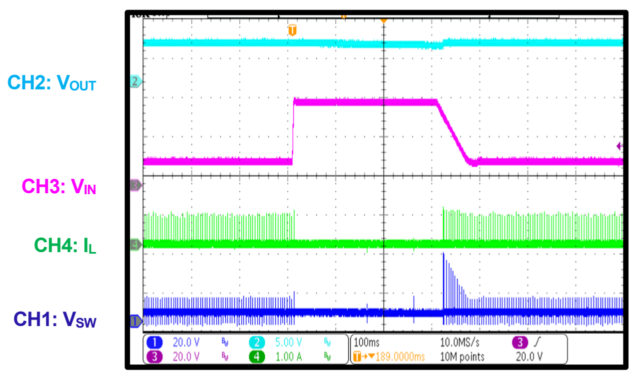

### Load Transient

$I_{OUT}$ = 1.5A to 3A, 1.6A/μs



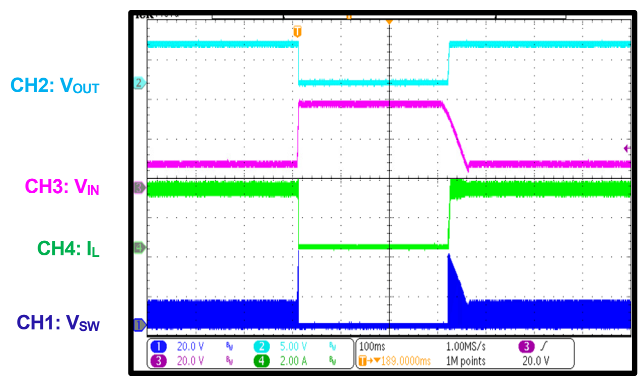

### Load Dump

$V_{IN}$= 12V to 42V, $I_{OUT}$ = 0A



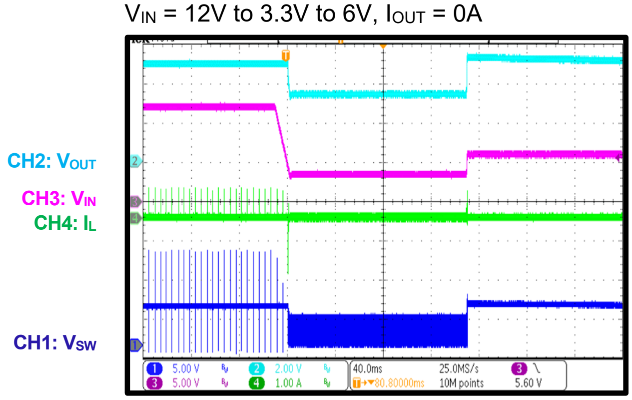

### Load Dump

$V_{IN}$ = 12V to 42V, $I_{OUT}$ = 3A



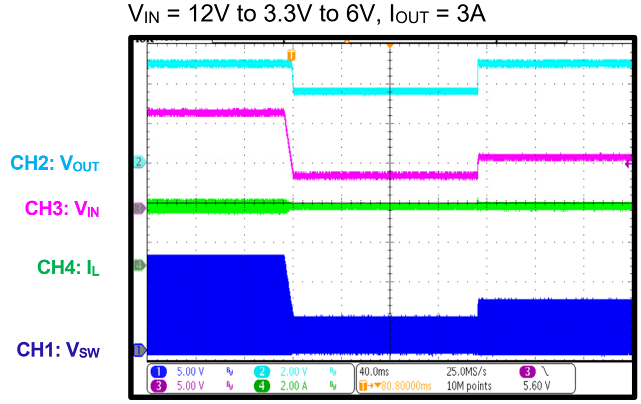

### Cold Crank

$V_{IN}$ = 12V to 3.3V to 6V, $I_{OUT}$ = 0A




### Cold Crank

$V_{IN}$ = 12V to 3.3V to 6V, $I_{OUT}$ = 3A

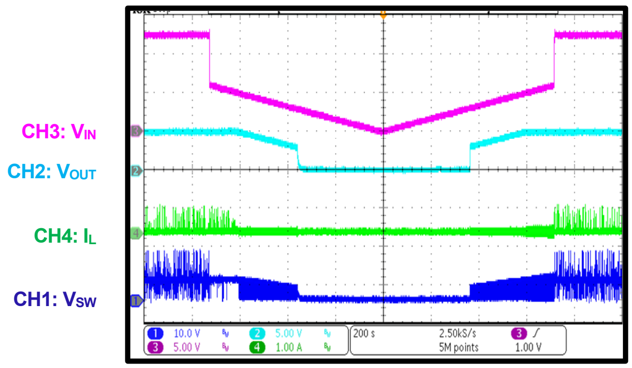


## EVB TEST RESULTS *(continued)*

**Performance curves and waveforms are tested on the evaluation board. $V_{IN}$ = 12V, $V_{OUT}$ = 5V, $T_A$ = 25°C, unless otherwise noted.**

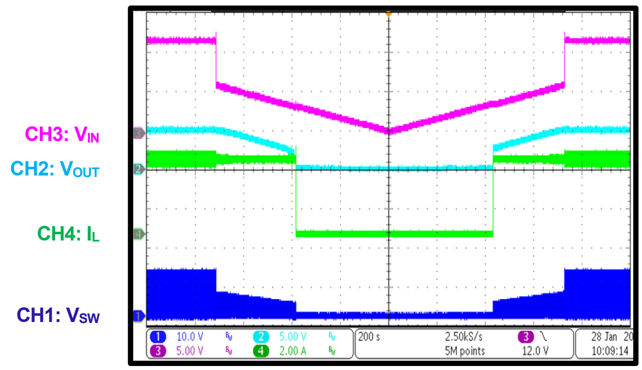
**$V_{IN}$ Ramping Down and Up**

$V_{IN}$ = 6V to 0V, 0.5V/min, $I_{OUT}$ = 0A




**$V_{IN}$ Ramping Down and Up**

$V_{IN}$ = 6V to 0V, 0.5V/min, $I_{OUT}$ = 3A



## PCB LAYOUT

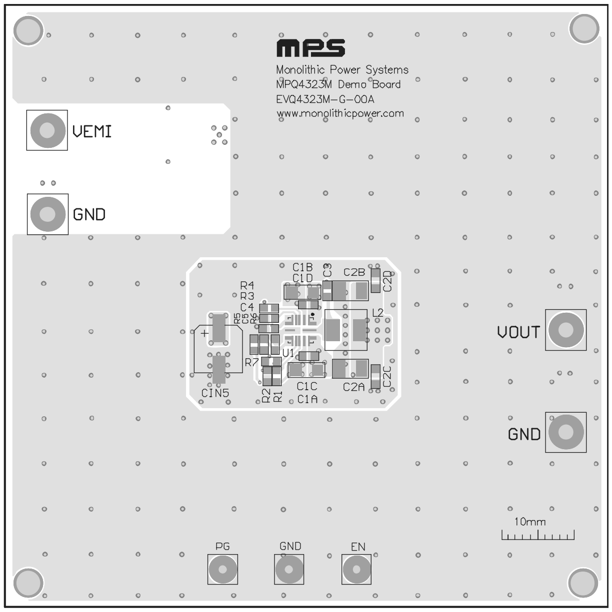



Figure 4: Top Silk and Top Layer

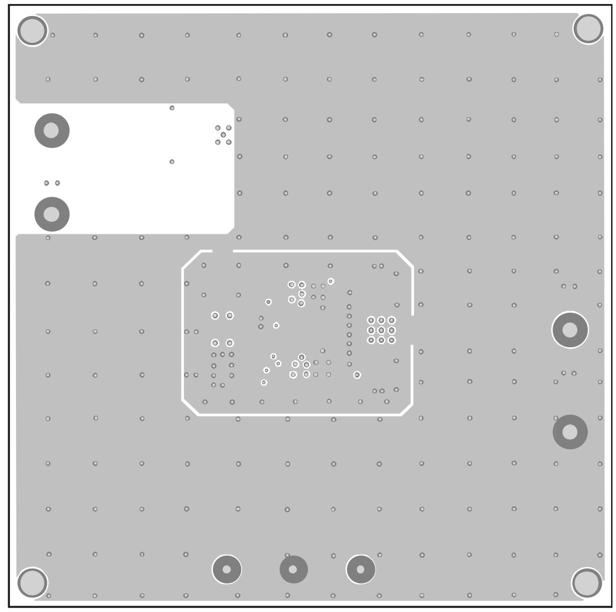


Figure 5: Mid-Layer 1

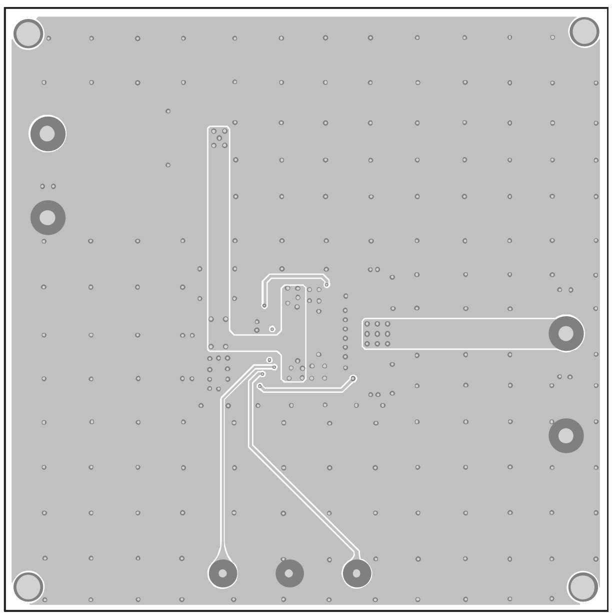


Figure 6: Mid-Layer 2

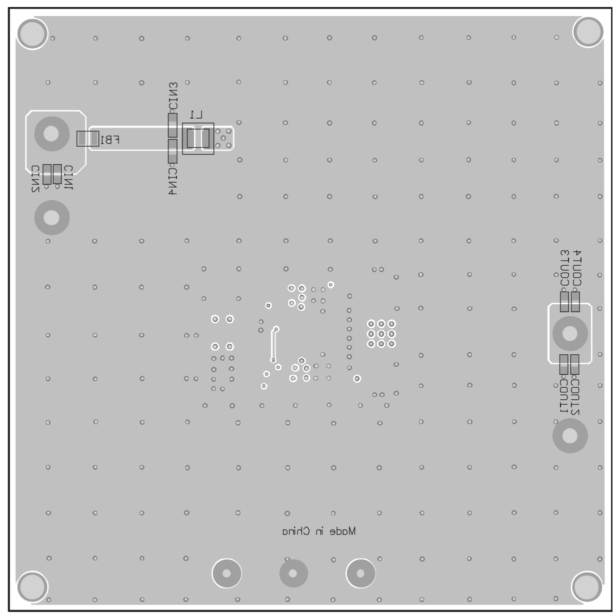


Figure 7: Bottom Layer and Bottom Silk

## REVISION HISTORY

| Revision # | Revision Date | Description | Pages Updated |
|---|---|---|---|
| 1.0 | 4/27/2022 | Initial Release | - |