EVQ2286-L-00A

6V, 12A, Configurable, High-Frequency, Synchronous Buck Converter, Evaluation Board, AEC-Q100 Qualified

DESCRIPTION

The EVQ2286-L-00A evaluation board is designed to demonstrate the capabilities of the MPQ2286, a configurable, high-frequency, synchronous buck converter with integrated internal high-side and low-side power MOSFETs (HS-FET and LS-FET, respectively).

The MPQ2286 operates from a 2.7V to 6V input voltage (V_{IN}) range, and provides up to 12A of highly efficient output current (I_{OUT}) with fixed-frequency, Zero-Delay PWM (ZDP™) control for optimal transient response.

The configurable 2MHz to 4MHz switching frequency (f_{SW}) during forced continuous conduction mode (FCCM) reduces the external inductance and capacitance. Internal feedback (FB) and compensation minimize the external component count and improve accuracy.

High power conversion efficiency across the wide load range is achieved by scaling down f_{SW} under light-load conditions to reduce f_{SW} and gate driver losses. Full protection features include short-circuit protection (SCP), over-current protection (OCP), input over-voltage protection (OVP), output OVP, and thermal shutdown. These protections provide reliable, fault-tolerant operation.

The digital interface features packet error checking (PEC), and the integrated multi-page one-time programmable (OTP) memory allows for a high degree of configurability.

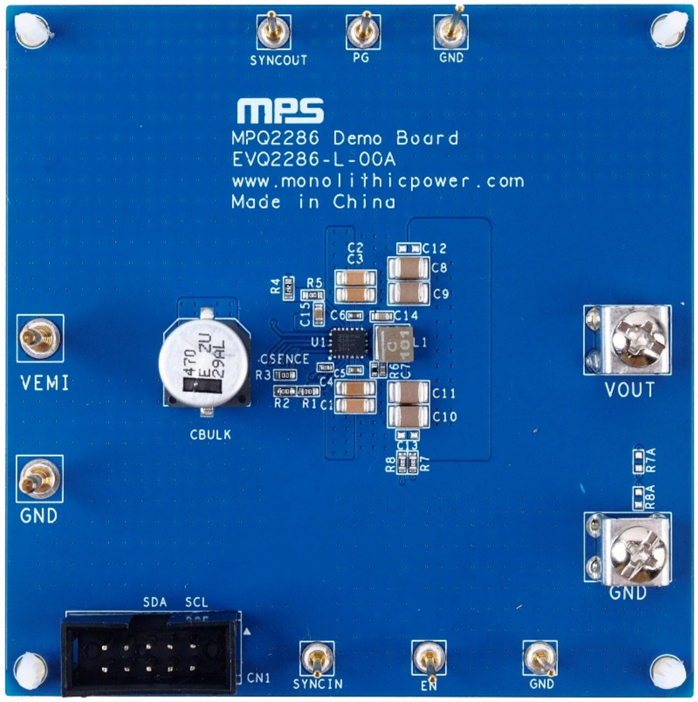
The EVQ2286-L-00A is a fully assembled and tested evaluation board. The MPQ2286 is available in a QFN-18 (3mmx4mm) package with wettable flanks, and is available in AEC-Q100 Grade 1.

PERFORMANCE SUMMARY

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

Parameters	Conditions	Value
Input voltage (V_{IN}) range		2.7 to 6V
Output voltage (V_{OUT})	V_{IN} = 2.7 to 6V, I_{OUT} = 0A to 12A	0.75V
Maximum output current (I_{OUT})	V_{IN} = 2.7V to 6V	12A
Typical efficiency	V_{IN} = 5V, V_{OUT} = 0.75V, I_{OUT} = 12A	82.7%
Peak efficiency	V_{IN} = 2.7V, V_{OUT} = 0.75V, I_{OUT} = 2.9A	90.4%
Switching frequency (f_{SW})		3MHz

EVQ2286-L-00A EVALUATION BOARD



LxWxH (8.3cmx8.3cmx1.3cm)

Board Number	MPS IC Number
EVQ2286-L-00A	MPQ2286GLE-0002-AEC1

QUICK START GUIDE

The EVQ2286-L-00A evaluation board is easy to set up and use to evaluate the MPQ2286'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 to be between 2.7V and 6V, then turn off the power supply.
2. Set the load current to be between 0A and 12A. Electronic loads represent a negative impedance to the regulator, and setting the current too high may trigger over-current protection (OCP).
3. If longer cables are used between the source and the evaluation board (>0.5m total), place a damping capacitor at the input terminals.
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. The board should start up automatically.
7. To use the enable (EN) function, apply a digital input to the EN pin. Drive EN above 1.2V to turn the regulator on; drive EN below 1.1V to turn it off. If the enable function is not used, EN can be connected to VIN through two resistor dividers. Ensure that the EN voltage (V_{EN}) does not exceed 4V.
8. Evaluate the MPQ2286 with the digital interface by following the steps below:
    a. Download and install the Virtual Bench Pro 4.0 (VBP 4.0) software from the MPS website. The MPQ2286's graphic user interface (GUI) is embedded in VBP 4.0.
    b. Connect the EVKT-USBI2C-02 communication kit to CN1 with the ribbon cable. [1]
    c. Connect the EVKT-USBI2C-02 to the computer with the USB cable. [1]
    d. Using the MPQ2286's GUI, scan for the evaluation board address, which is 03h by default.
    e. Evaluate the device with the MPQ2286's GUI, such as the power good (PG) delay time and switching frequency (f_{SW}).

    Figure 1 shows the digital interface evaluation kit set-up.

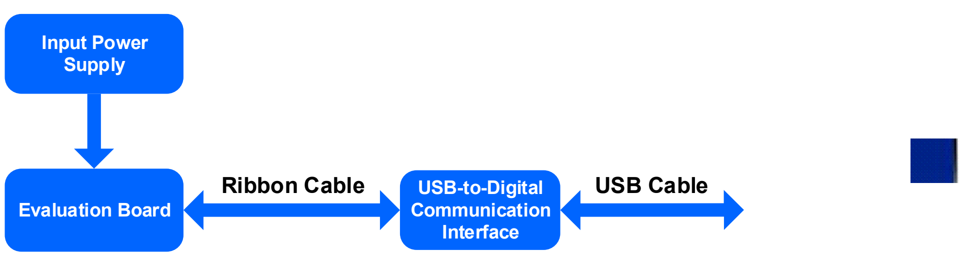


Figure 1: Digital Interface Evaluation Kit Set-Up

9. To use the SYNCIN function, the MPQ2286 operates in forced continuous conduction mode (FCCM) with a fixed frequency, regardless of the output current (I_{OUT}). f_{SW} can be synchronized to the rising edge of an external clock signal applied at SYNCIN. The high amplitude of the synchronous (SYNC) clock should be above 1.8V, and its low amplitude should be below 0.4V to drive the internal logic.

The recommended external SYNC frequency is ±15% of the set f_{SW} (between 2MHz and 4MHz). A pulse longer than 200ns is recommended.

Note:

1) The EVKT-USBI2C-02, which includes the ribbon and USB cables, can be purchased on the MPS website.

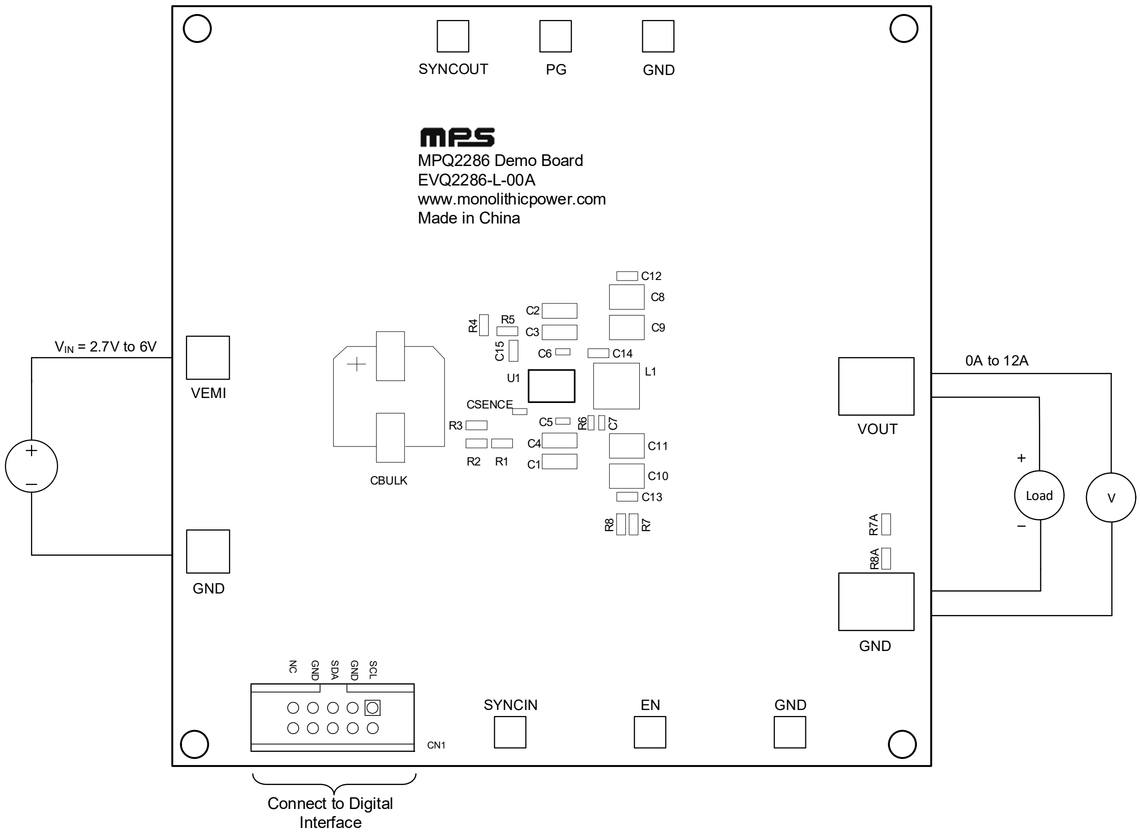


Figure 2: Measurement Equipment Set-Up

MPQ2286GLE-0002-AEC1 DEFAULT REGISTER VALUES

Command Code	Command Name	Type	Bytes	OTP	Value
01h	OPERATION	R/W	1	Yes	80
21h	VOUT_COMMAND	R/W	1	Yes	57
24h	VOUT_MAX	R/W	1	Yes	FF
29h	VOUT_SCALE	R/W	1	Yes	00
2Bh	VOUT_MIN	R/W	1	Yes	00
60h	TON_DELAY	R/W	1	Yes	00
64h	TOFF_DELAY	R/W	1	Yes	00
C5h	HICCUP_TIMER	R/W	1	Yes	01
C6h	VOUT_STARTUP_SLEW	R/W	1	Yes	00
C7h	VOUT_SHUTDOWN_SLEW	R/W	1	Yes	00
C8h	VOUT_SLEW	R/W	1	Yes	00
C9h	OUTPUT_DISCHARGE	R/W	1	Yes	01
CAh	FREQUENCY_DITHER	R/W	1	Yes	01
CBh	FREQUENCY_SET	R/W	1	Yes	06
CCh	COMPENSATION_CONFIG	R/W	2	Yes	0000
CDh	PG_MAPPING	R/W	1	Yes	00
CEh	PROTECTION_CONFIG	R/W	1	Yes	1C
CFh	PG_DELAY	R/W	1	Yes	00
D0h	PG_CONFIG	R/W	1	Yes	01
D1h	LIGHT_LOAD	R/W	1	Yes	01
D2h	ILIM_SCALE	R/W	1	Yes	02
D3h	ADDRESS	R/W	1	Yes	03
D4h	CONFIGURATION_CODE	R	1	Yes	00
D7h	MFR_OTP_MEM_CHK	R/W	1	Yes	00
D9h	SPARE_1	R/W	1	Yes	01
DAh	SPARE_2	R/W	1	Yes	00
DCh	SUMMING_BLOCK_CONFIG	R/W	1	Yes	31
DDh	MIN_ON_CONFIG	R/W	1	Yes	8B

EVALUATION BOARD SCHEMATIC

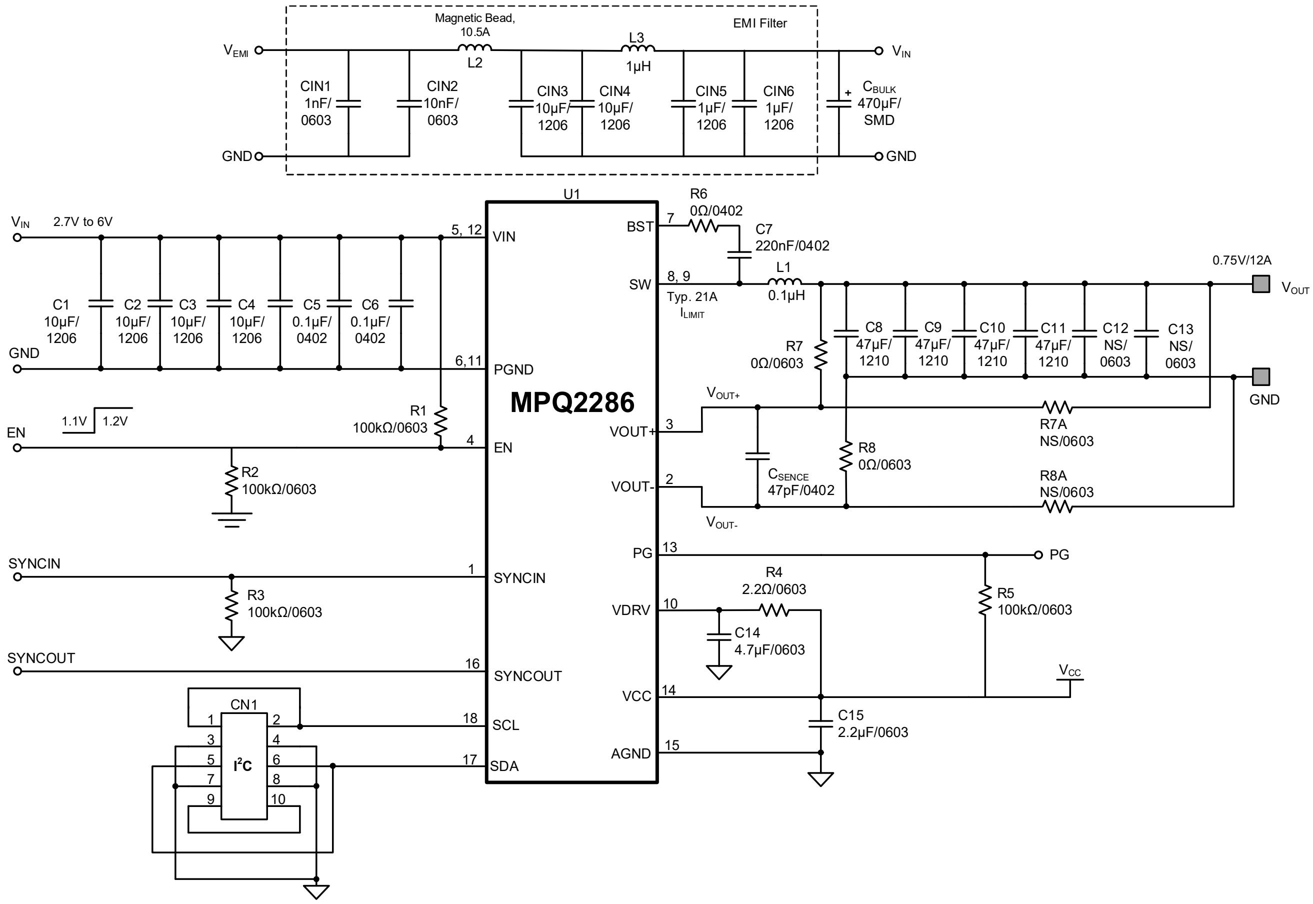
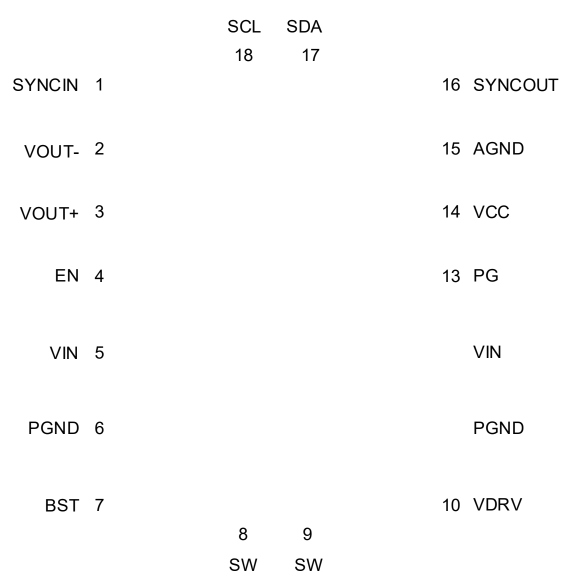


Figure 3: Evaluation Board Schematic

PACKAGE REFERENCE

TOP VIEW



QFN-18 (3mmx4mm)

EVQ2286-L-00A BILL OF MATERIALS

Qty	Ref	Value	Description	Package	Manufacturer	Manufacturer PN
1	CIN1	1nF	Capacitor, 50V, C0G	0603	Murata	GRM1885C1H102JA01D
1	CIN2	10nF	Capacitor, 50V, C0G	0603	Murata	GRM1885C1H103JA01D
6	C1, C2, C3, C4, CIN3, CIN4	10µF	Capacitor, 16V, X7R	1206	Murata	GRM31CR71C106KAC7L
2	CIN5, CIN6	1µF	Capacitor, 25V, X7R	1206	Murata	GRM31MR71E105KA01
2	C5, C6	100nF	Capacitor, 16V, X7R	0402	Murata	GCM155R71C104KA55D
1	C7	220nF	Capacitor, 16V, X7R	0402	Murata	GRM155R71C224KA12D
4	C8, C9, C10, C11	47µF	Capacitor, 6.3V, X7R	1210	Murata	GCM32ER70J476KE19L
2	C12, C13	NS				
1	C14	4.7µF	Capacitor, 10V, X5R	0603	Murata	GRM188R61A475KE15D
1	C15	2.2µF	Capacitor, 10V, X7R	0603	Murata	GRM188R71A225KE15D
1	C_{SENCE}	47pF	Capacitor, 50V, C0G	0402	Murata	GRM1555C1H470JA01D
1	C_{BULK}	470µF	Electrolytic capacitor, 25V	SMD	Panasonic	EEHZU1E471P
1	L1	100nH	Inductor, 1.5mΩ, 30A	SMD	Coilcraft	XEL4030-101MEB
1	L2	10.5A	Magnetic bead	1206	Wurth	74279221100
1	L3	1µH	Inductor, 13.25mΩ, 9A	SMD	Coilcraft	XEL4020-102MEB
4	R1, R2, R3, R5	100kΩ	Film resistor, 1%	0603	Yageo	RC0603FR-07100KL
1	R4	2.2Ω	Film resistor, 1%	0603	Yageo	RC0603FR-072R2L
1	R6	0Ω	Film resistor, 1%	0402	Yageo	RC0402FR-070RL
2	R7, R8	0Ω	Film resistor, 1%	0603	Royalohm	0603WAF0000T5E
2	R7A, R8A	NS				
6	SYNCOUT, SYNCIN, PG, EN, GND, GND	1mm	Golden pin	DIP	Custom (2)	
2	VOUT, GND	4-pin	Connector	DIP	Custom (2)	8191K-ND
2	VEMI, GND	2mm	Golden pin	DIP	Custom (2)	
1	CN1	2.54mm	Dual-row, 5-pin, digital interface connector	DIP	Custom (2)	
1	U1	MPQ2286-AEC1	6V, 12A, synchronous buck converter, AEC-Q100	QFN-18 (3mmx 4mm)	MPS	MPQ2286GLE-0002-AEC1

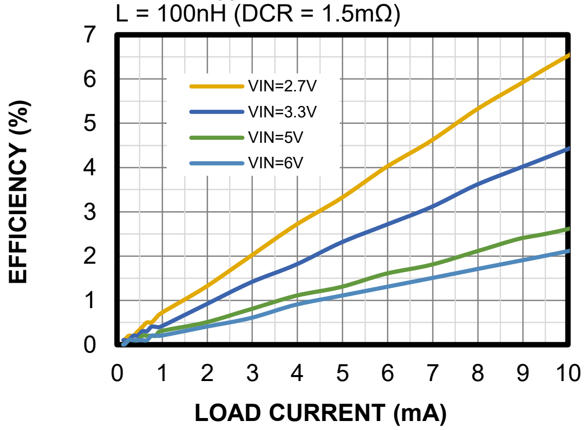
Note:

2) MPS custom-produces these pins. Contact an MPS FAE for more information.

EVB TEST RESULTS *(continued)*

Performance curves and waveforms are tested on the evaluation board. V_{IN} = 5V, V_{OUT} = 0.75V, C_{OUT} = 4 x 47µF, L = 100nH, T_A = 25°C, unless otherwise noted.

Efficiency vs. Load Current
FCCM, V_{OUT} = 0.75V, f_{SW} = 3MHz,
L = 100nH (DCR = 1.5mΩ)



Efficiency vs. Load Current
FCCM, V_{OUT} = 0.75V, f_{SW} = 3MHz,
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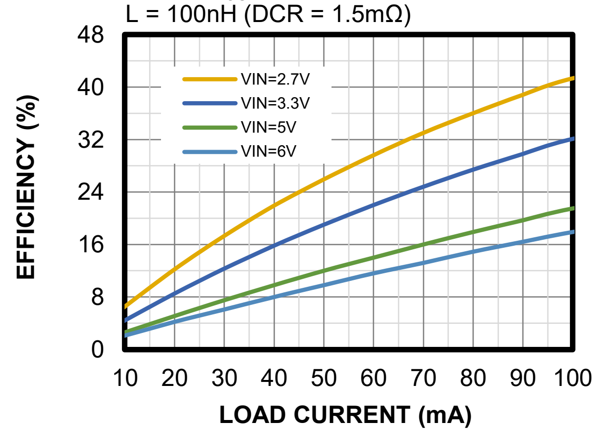
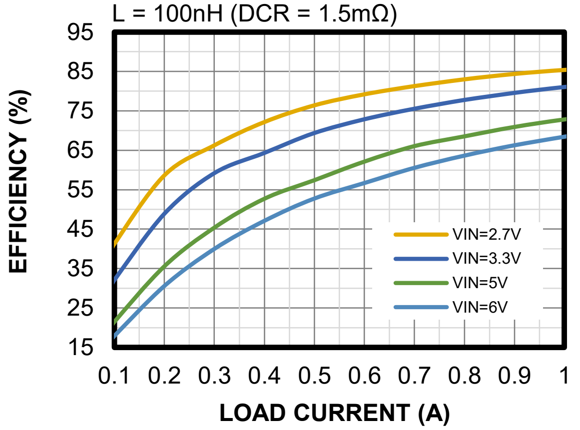
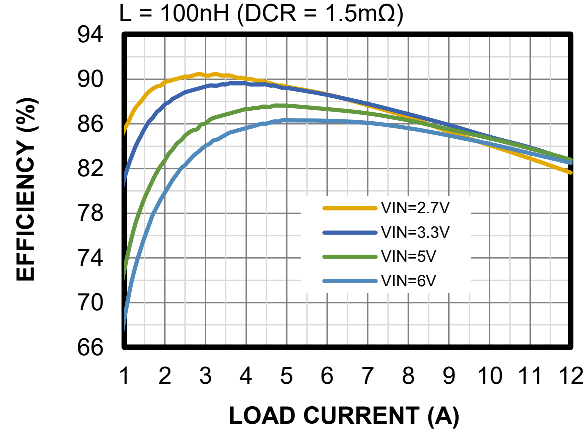


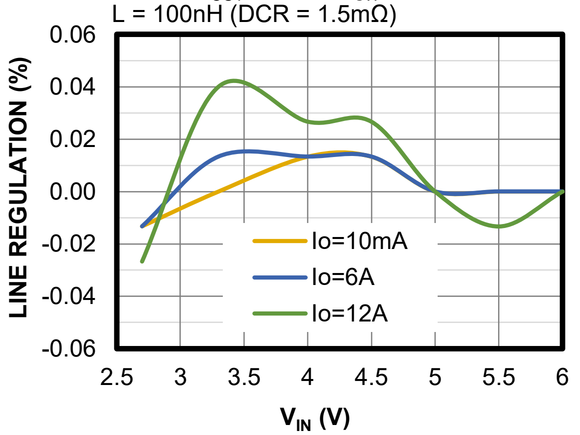
Efficiency vs. Load Current
FCCM, V_{OUT} = 0.75V, f_{SW} = 3MHz,
L = 100nH (DCR = 1.5mΩ)



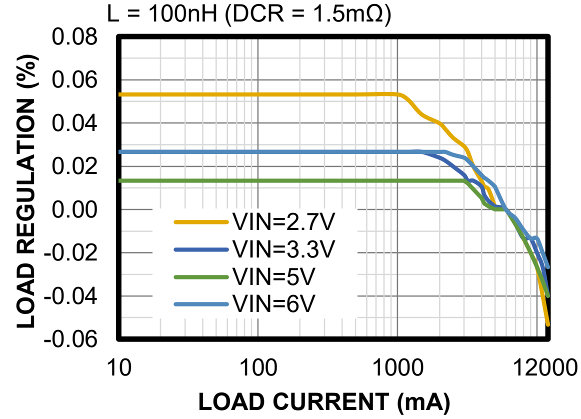
Efficiency vs. Load Current
FCCM, V_{OUT} = 0.75V, f_{SW} = 3MHz,
L = 100nH (DCR = 1.5mΩ)



Line Regulation
FCCM, V_{OUT} = 0.75V, f_{SW} = 3MHz,
L = 100nH (DCR = 1.5mΩ)

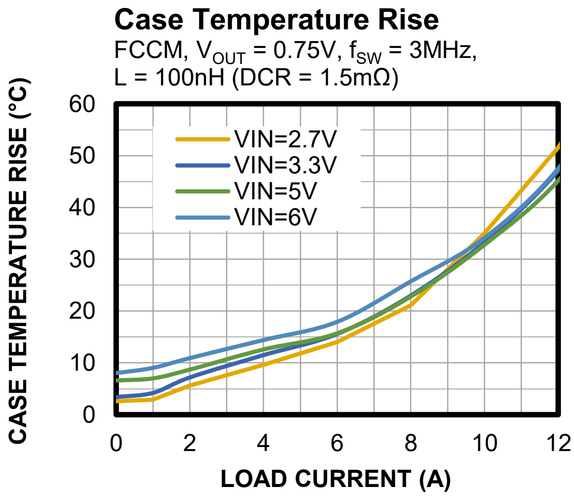


Load Regulation
FCCM, V_{OUT} = 0.75V, f_{SW} = 3MHz,
L = 100nH (DCR = 1.5mΩ)



EVB TEST RESULTS *(continued)*

Performance curves and waveforms are tested on the evaluation board. V_{IN} = 5V, V_{OUT} = 0.75V, C_{OUT} = 4 x 47µF, L = 100nH, T_A = 25°C, unless otherwise noted.

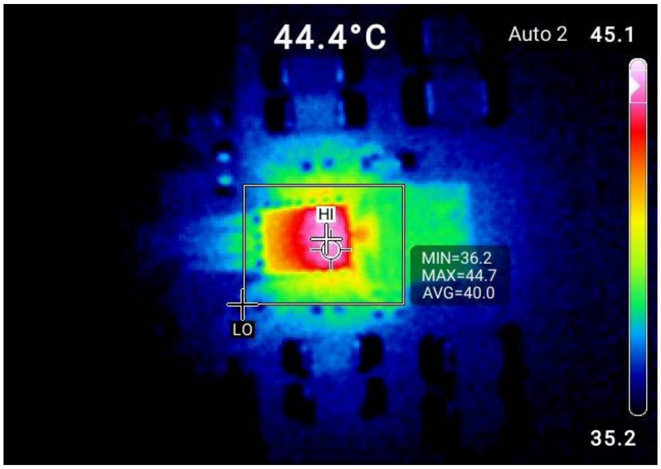


EVB TEST RESULTS *(continued)*

Performance curves and waveforms are tested on the evaluation board. V_{IN} = 5V, V_{OUT} = 0.75V, C_{OUT} = 4 x 47µF, L = 100nH, T_A = 25°C, unless otherwise noted.

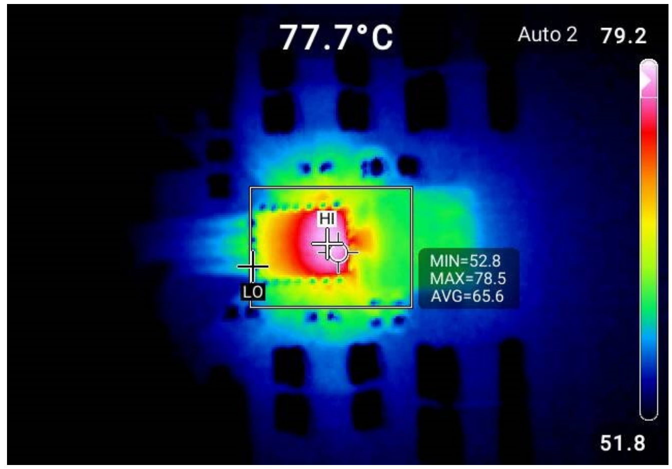
Thermal Performance

I_{OUT} = 6A, no forced airflow, T_{CASE} = 44.7°C



Thermal Performance

I_{OUT} = 12A, no forced airflow, T_{CASE} = 78.5°C

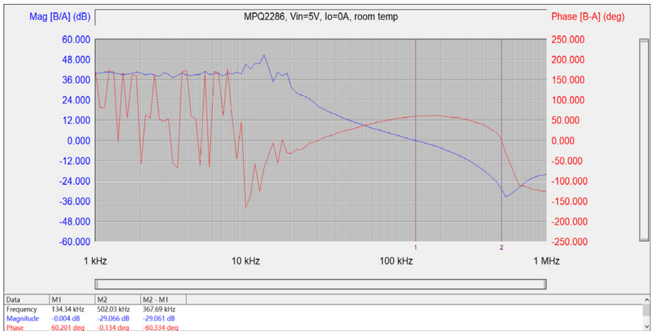


EVB TEST RESULTS *(continued)*

Performance curves and waveforms are tested on the evaluation board. V_{IN} = 5V, V_{OUT} = 0.75V, C_{OUT} = 4 x 47μF, L = 100nH, T_A = 25°C, unless otherwise noted.

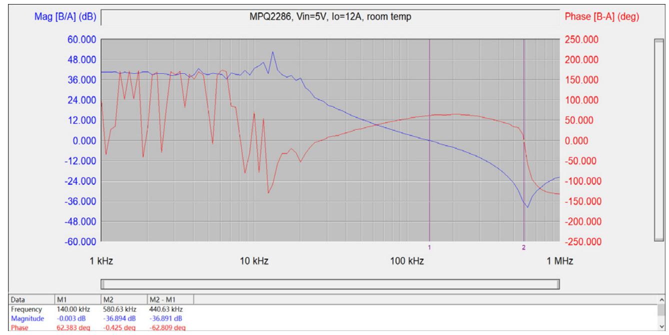
Bode Plot

I_{OUT} = 0A, PM = 60.2°, GM = 29dB



Bode Plot

I_{OUT} = 12A, PM = 62.3°, GM = 36.8dB

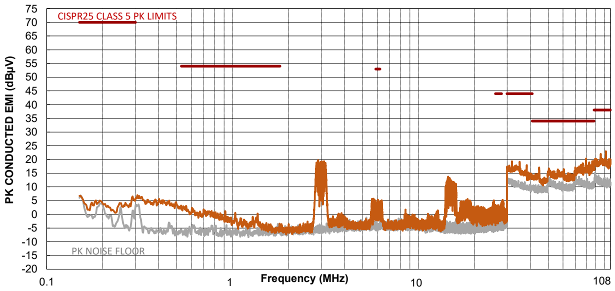


EVB TEST RESULTS *(continued)*

Performance curves and waveforms are tested on the evaluation board. V_{IN} = 6V, V_{OUT} = 0.75V, I_{OUT} = 12A, C_{OUT} = 4 x 47µF, L = 100nH, T_A = 25°C, unless otherwise noted.

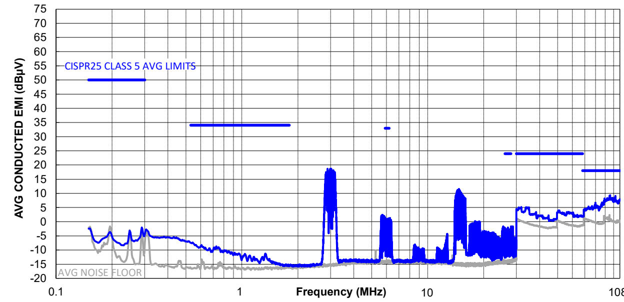
CISPR 25 Class 5 Peak Conducted Emissions

150kHz to 108MHz



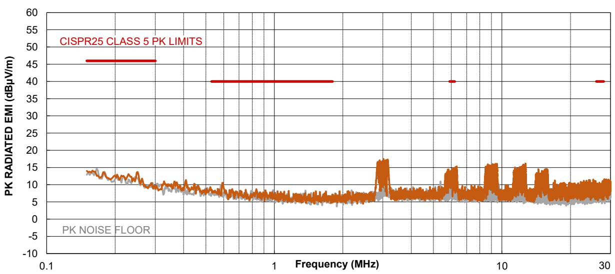
CISPR 25 Class 5 Average Conducted Emissions

150kHz to 108MHz



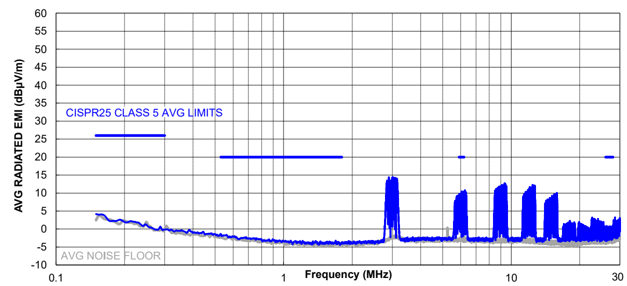
CISPR 25 Class 5 Peak Radiated Emissions

150kHz to 30MHz



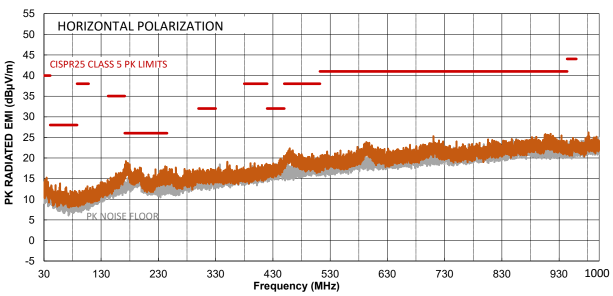
CISPR 25 Class 5 Average Radiated Emissions

150kHz to 30MHz



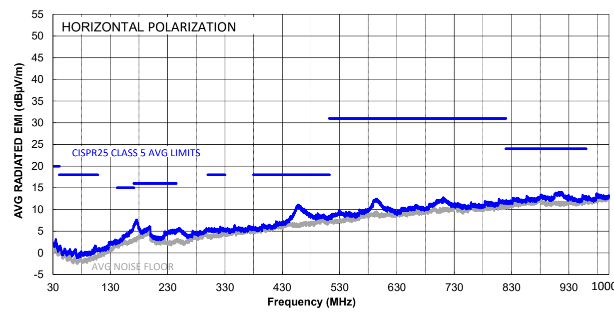
CISPR 25 Class 5 Peak Radiated Emissions

Horizontal, 30MHz to 1GHz



CISPR 25 Class 5 Average Radiated Emissions

Horizontal, 30MHz to 1GHz

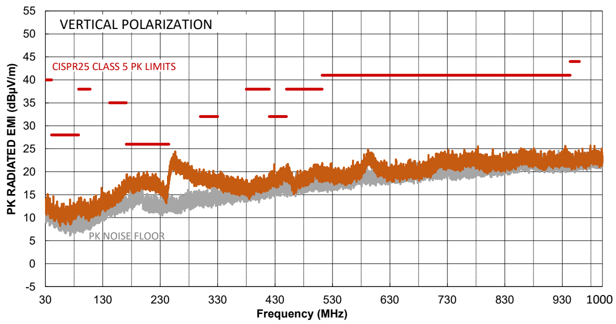


EVB TEST RESULTS *(continued)*

Performance curves and waveforms are tested on the evaluation board. V_{IN} = 6V, V_{OUT} = 0.75V, I_{OUT} = 12A, C_{OUT} = 4 x 47µF, L = 100nH, T_A = 25°C, unless otherwise noted.

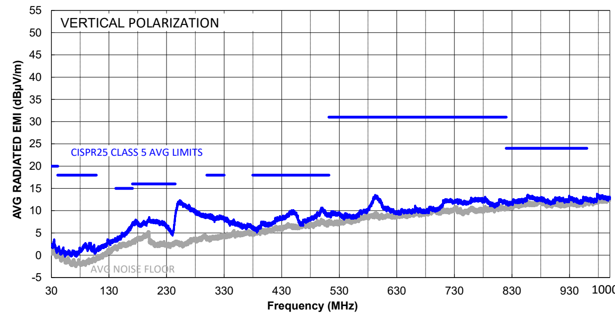
CISPR 25 Class 5 Peak Radiated Emissions

Vertical, 30MHz to 1GHz



CISPR 25 Class 5 Average Radiated Emissions

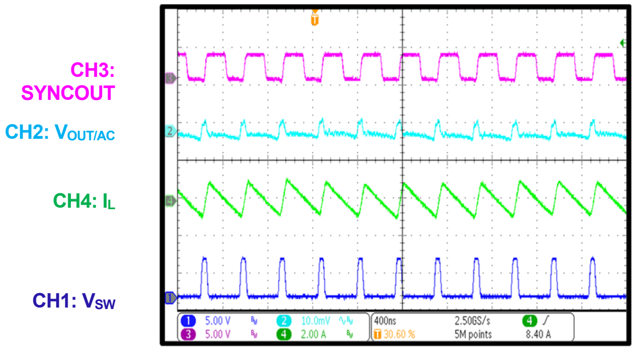
Vertical, 30MHz to 1GHz



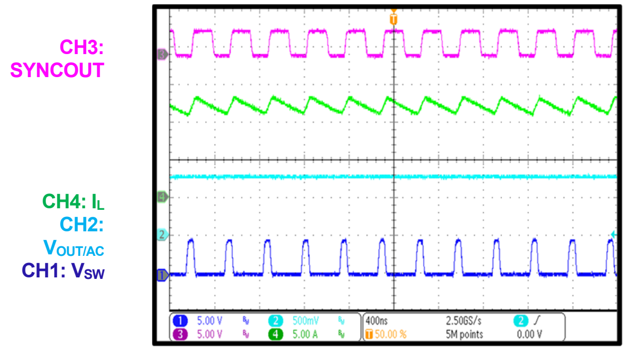
EVB TEST RESULTS *(continued)*

Performance curves and waveforms are tested on the evaluation board. V_{IN} = 5V, V_{OUT} = 0.75V, C_{OUT} = 4 x 47µF, L = 100nH, T_A = 25°C, unless otherwise noted.

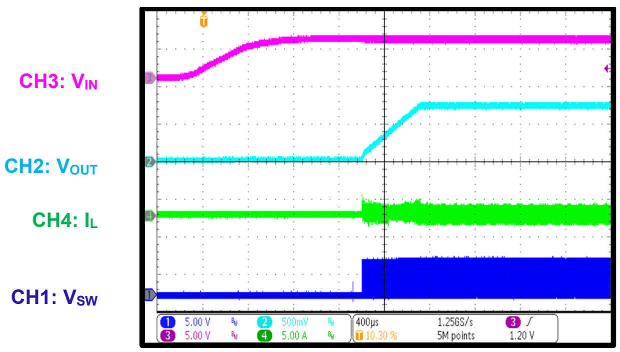
Steady State
I_{OUT} = 0A, FCCM



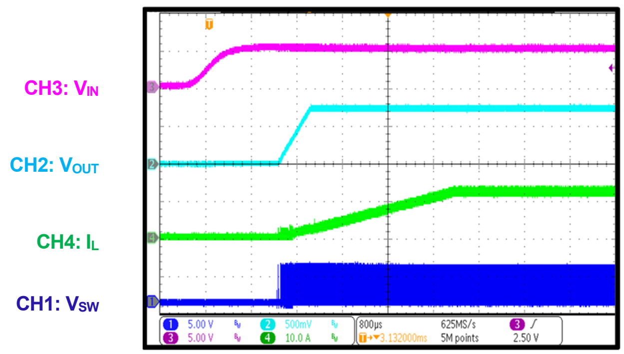
Steady State
I_{OUT} = 12A



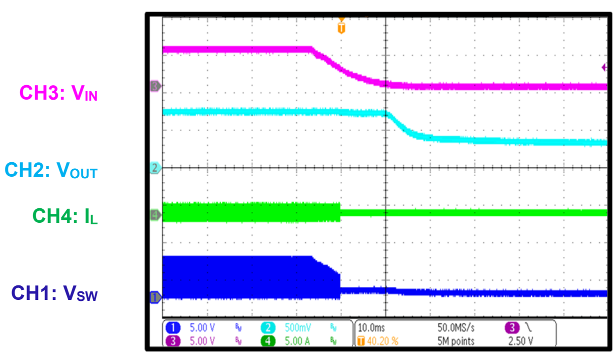
Start-Up through VIN
I_{OUT} = 0A, FCCM



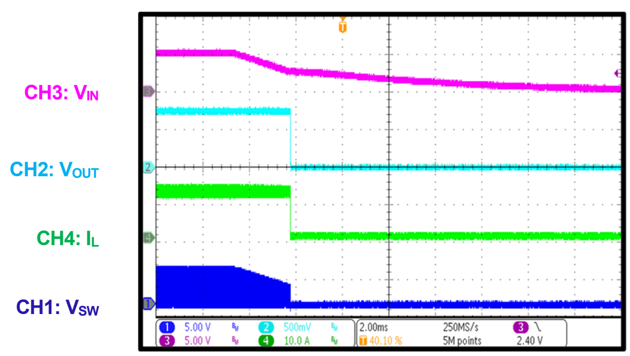
Start-Up through VIN
I_{OUT} = 12A



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



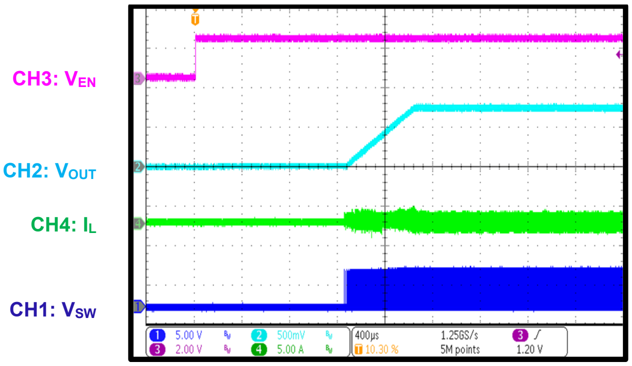
Shutdown through VIN
I_{OUT} = 12A



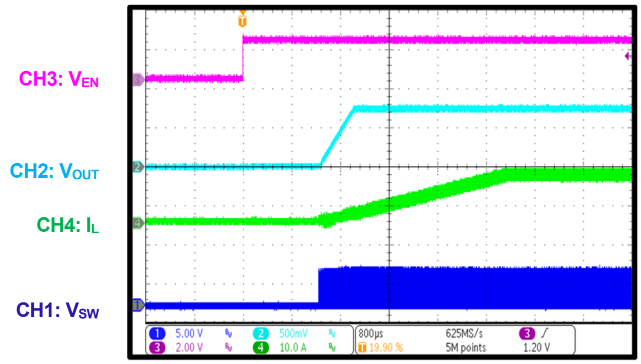
EVB TEST RESULTS *(continued)*

Performance curves and waveforms are tested on the evaluation board. V_{IN} = 5V, V_{OUT} = 0.75V, C_{OUT} = 4 x 47µF, L = 100nH, T_A = 25°C, unless otherwise noted.

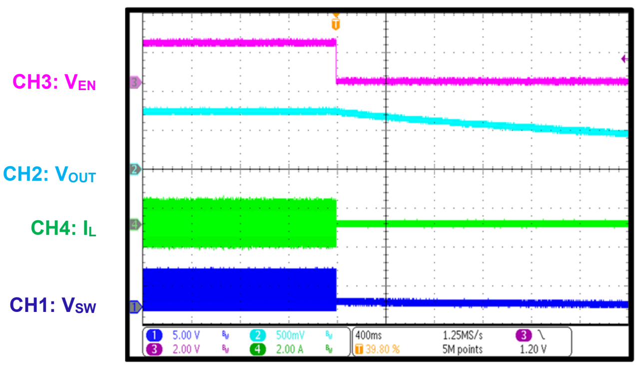
Start-Up through EN
I_{OUT} = 0A, FCCM



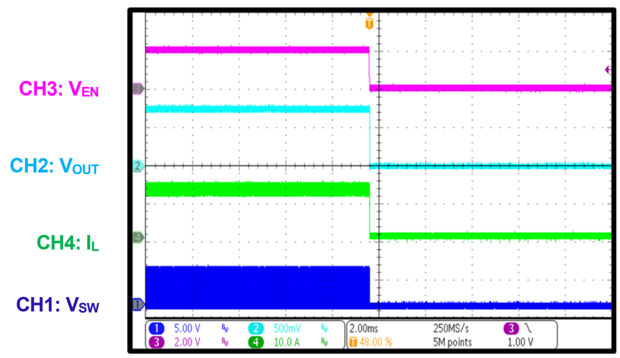
Start-Up through EN
I_{OUT} = 12A



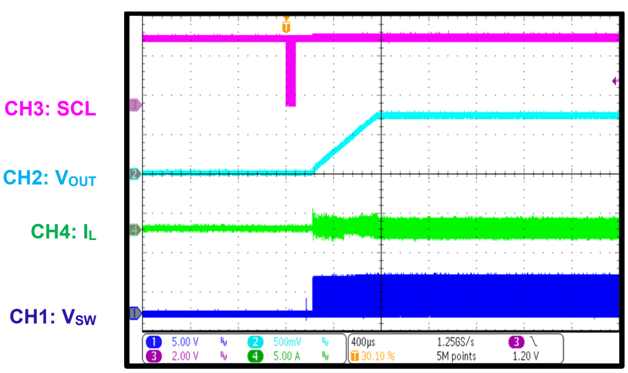
Shutdown through EN
I_{OUT} = 0A, FCCM



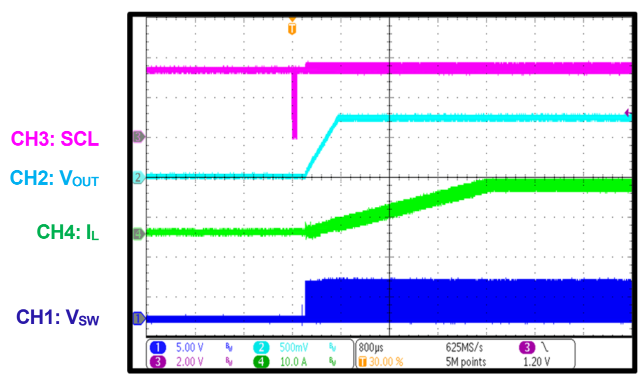
Shutdown through EN
I_{OUT} = 12A



Start-Up via the Digital Interface
I_{OUT} = 0A, FCCM



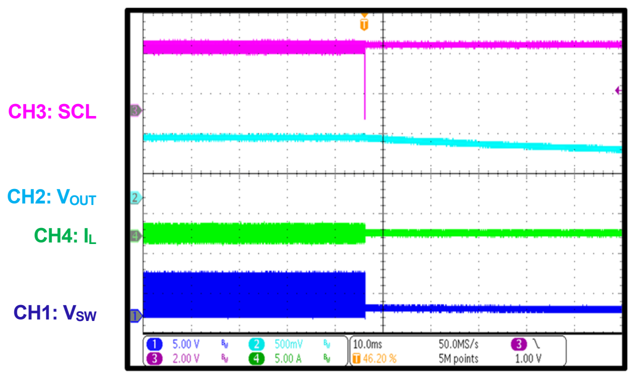
Start-Up via the Digital Interface
I_{OUT} = 12A



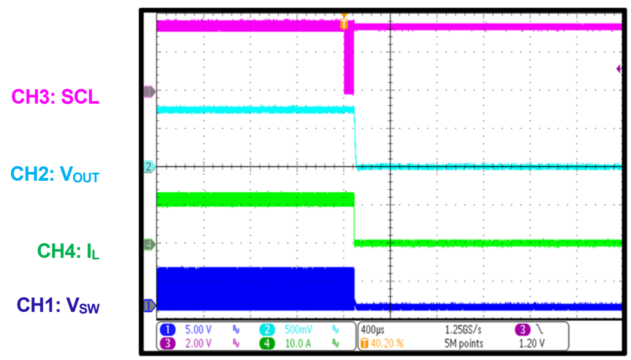
EVB TEST RESULTS *(continued)*

Performance curves and waveforms are tested on the evaluation board. V_{IN} = 5V, V_{OUT} = 0.75V, C_{OUT} = 4 x 47µF, L = 100nH, T_A = 25°C, unless otherwise noted.

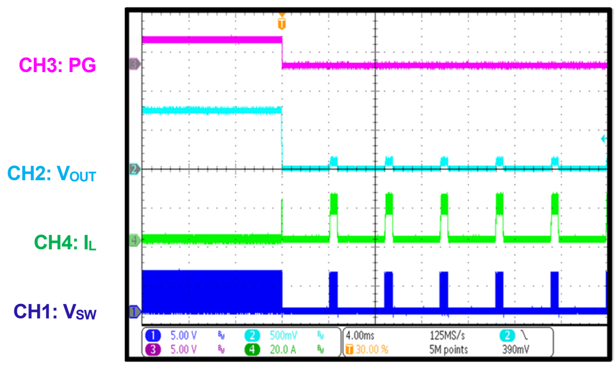
Shutdown via the Digital Interface
I_{OUT} = 0A, FCCM



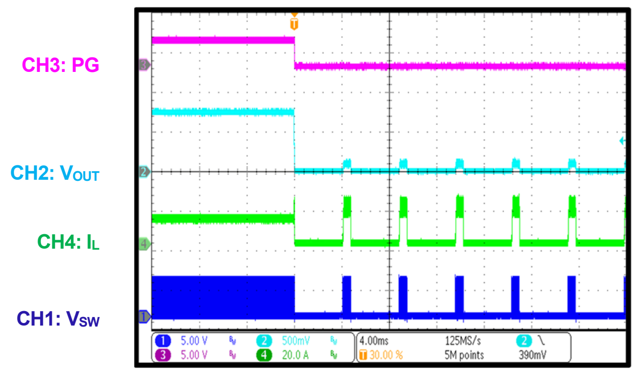
Shutdown via the Digital Interface
I_{OUT} = 12A



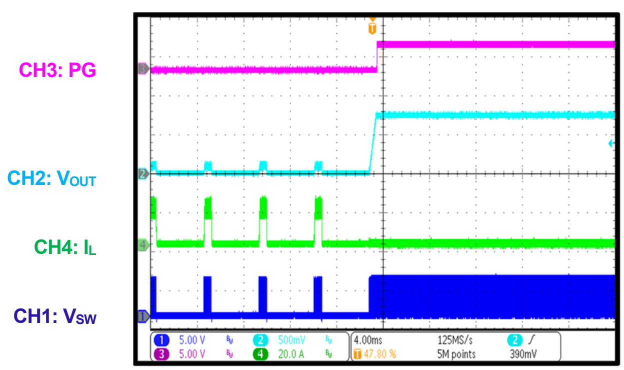
SCP Entry
I_{OUT} = 0A, FCCM



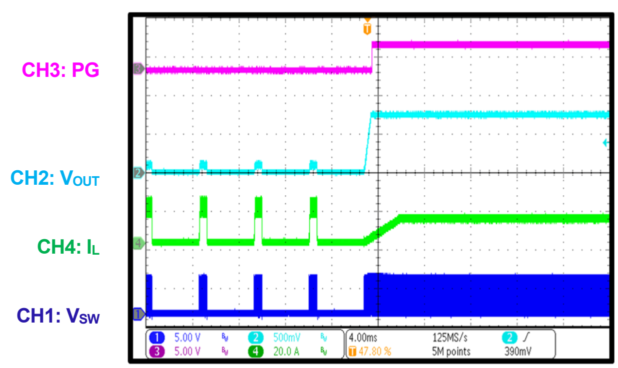
SCP Entry
I_{OUT} = 12A



SCP Recovery
I_{OUT} = 0A, FCCM



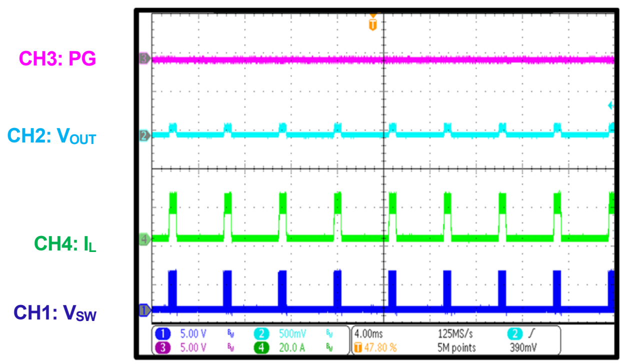
SCP Recovery
I_{OUT} = 12A



EVB TEST RESULTS *(continued)*

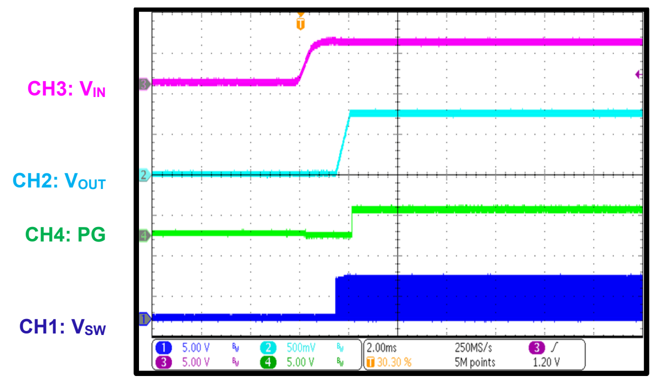
Performance curves and waveforms are tested on the evaluation board. V_{IN} = 5V, V_{OUT} = 0.75V, C_{OUT} = 4 x 47µF, L = 100nH, T_A = 25°C, unless otherwise noted.

SCP Steady State



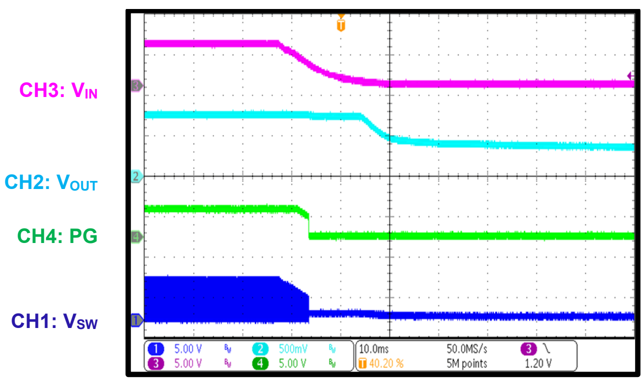
PG Start-Up through VIN

I_{OUT} = 0A, FCCM



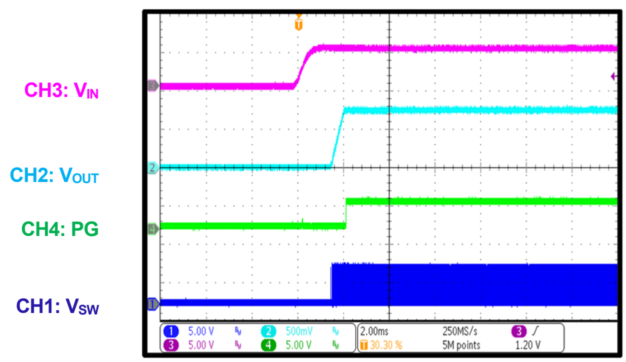
PG Shutdown through VIN

I_{OUT} = 0A, FCCM



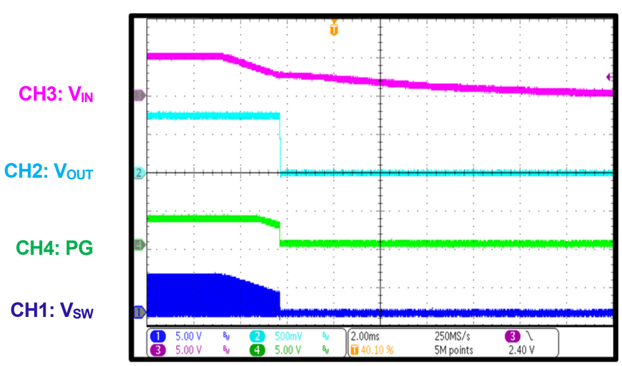
PG Start-Up through VIN

I_{OUT} = 12A



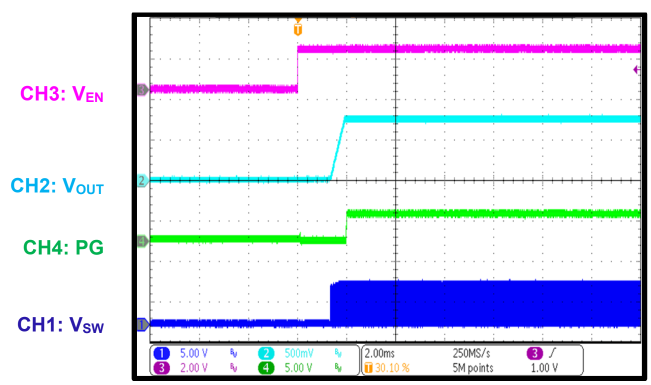
PG Shutdown through VIN

I_{OUT} = 12A



PG Start-Up through EN

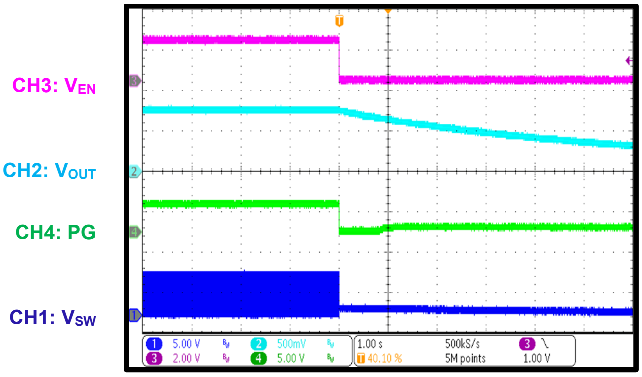
I_{OUT} = 0A, FCCM



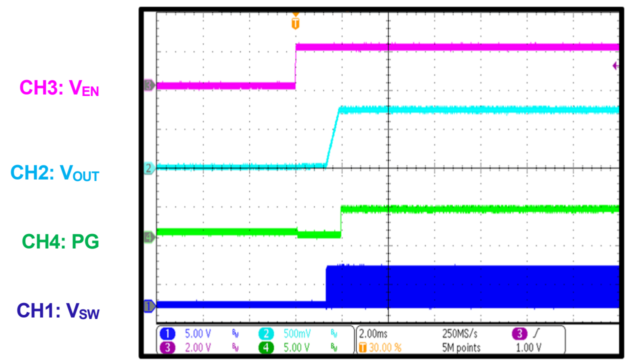
EVB TEST RESULTS *(continued)*

Performance curves and waveforms are tested on the evaluation board. V_{IN} = 5V, V_{OUT} = 0.75V, C_{OUT} = 4 x 47µF, L = 100nH, T_A = 25°C, unless otherwise noted.

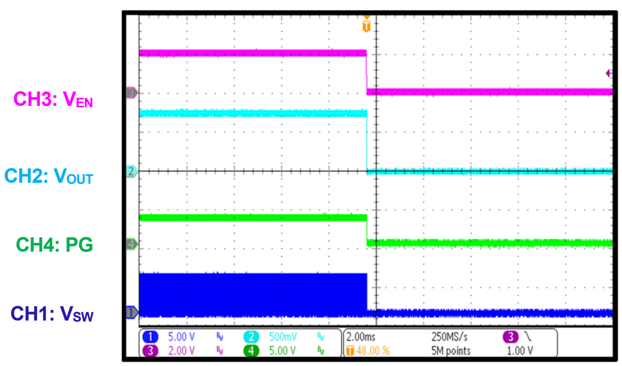
PG Shutdown through EN
I_{OUT} = 0A, FCCM



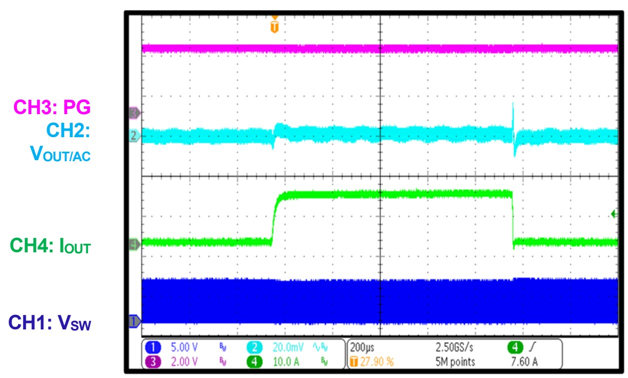
PG Start-Up through EN
I_{OUT} = 12A



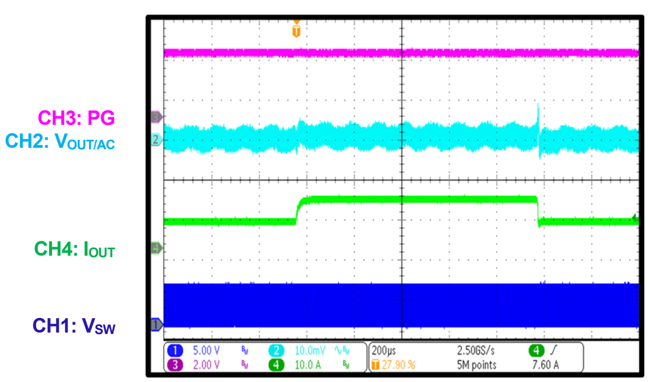
PG Shutdown through EN
I_{OUT} = 12A



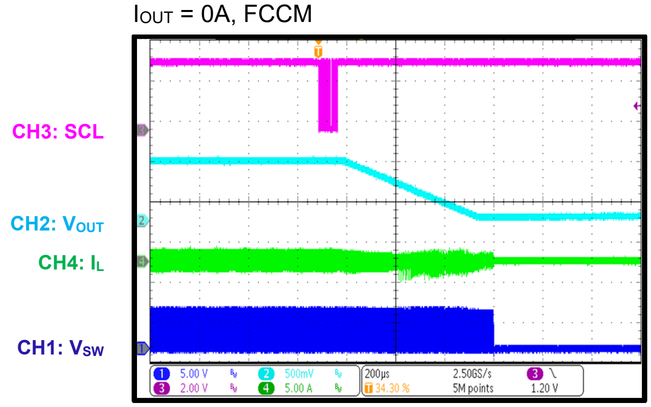
Load Transient Response
I_{OUT} = 0A to 12A,1.6A/µs, FCCM



Load Transient Response
I_{OUT} = 6A to 12A,1.6A/µs, FCCM



Soft Shutdown via the Digital Interface
I_{OUT} = 0A, FCCM

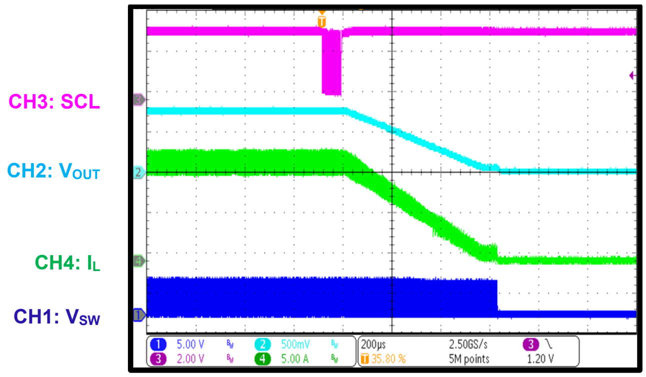


EVB TEST RESULTS *(continued)*

Performance curves and waveforms are tested on the evaluation board. V_{IN} = 5V, V_{OUT} = 0.75V, C_{OUT} = 4 x 47µF, L = 100nH, T_A = 25°C, unless otherwise noted.

Soft Shutdown via the Digital Interface

I_{OUT} = 12A



PCB LAYOUT (3)

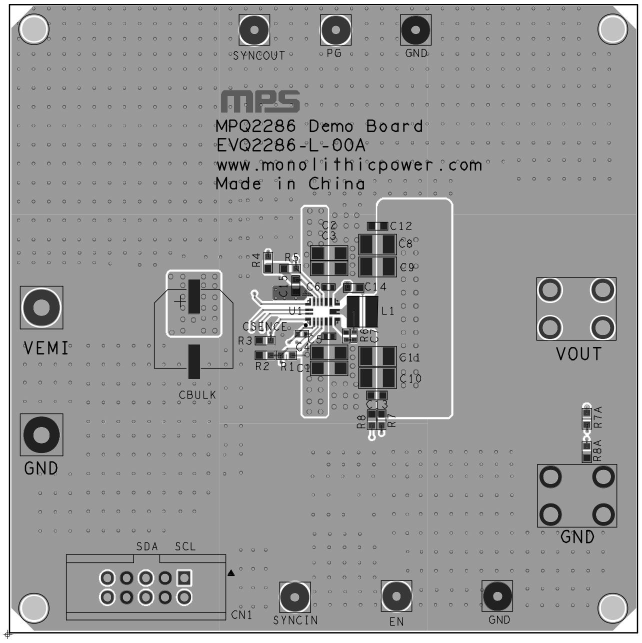


Figure 4: Top Silk and Top Layer

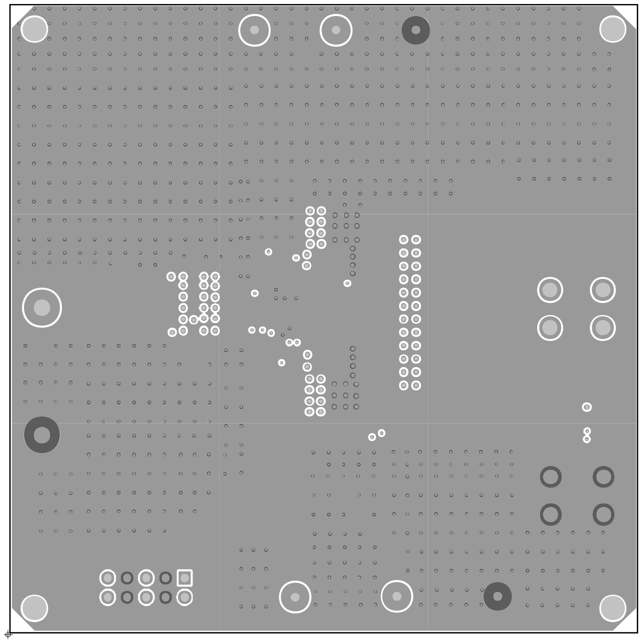


Figure 5: Mid-Layer 1

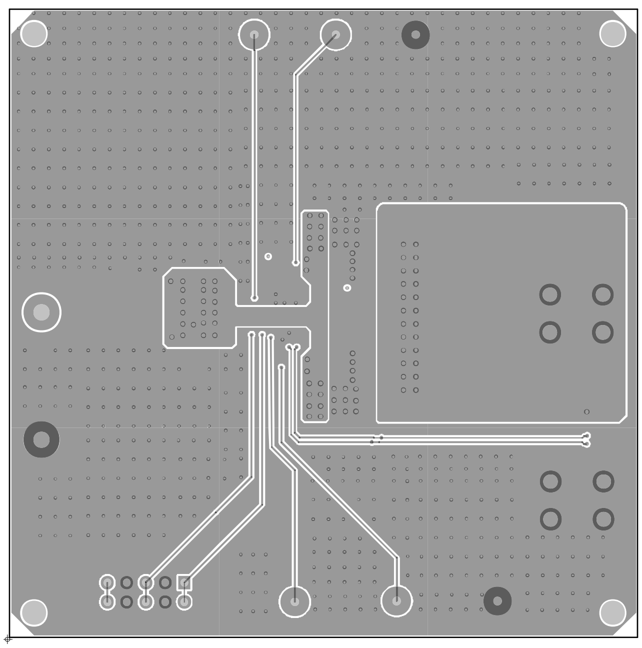


Figure 6: Mid-Layer 2

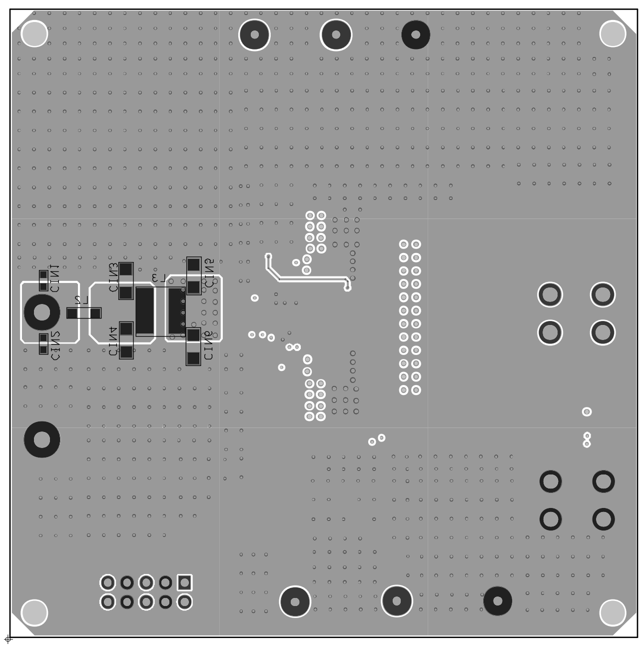


Figure 7: Bottom Layer and Bottom Silk

Note:

3) The copper thickness is 2oz.

REVISION HISTORY

Revision #	Revision Date	Description	Pages Updated
1.0	11/6/2024	Initial Release	-