



EVBL9840-L-00A

36V, 3.5A, Low I_Q , Synchronous, Step-Down Switch-Mode Convertor Evaluation Board

DESCRIPTION

The EVBL9840-L-00A is an evaluation board designed to demonstrate the capabilities of the MP9840 and the MPQ9840. The evaluation board features an integrated MPS power inductor.

The MP9840 is a configurable-frequency (350kHz to 2.5MHz), synchronous, step-down switch-mode converter with integrated, internal power MOSFETs. It can achieve up to 3.5A of highly efficient output current (I_{OUT}) across a wide 3.3V to 36V input voltage (V_{IN}) range, with current mode control for fast loop response.

Advanced asynchronous modulation (AAM) mode achieves high efficiency under light-load conditions by scaling down the switching frequency (f_{SW}) to reduce the switching and gate driver losses.

The EV9840-L-00A is a fully assembled and tested evaluation board that generates 3.3V of output voltage (V_{OUT}) and up to 3.5A of load current across the entire V_{IN} range.

ELECTRICAL SPECIFICATIONS

Parameter	Symbol	Value	Units
Input voltage	V_{IN}	3.3 to 36	V
Output voltage	V_{OUT}	3.3	V
Output current	I_{OUT}	3.5	A

FEATURES

- Wide 3.3V to 36V Operating Input Voltage (V_{IN}) Range
- Up to 3.5A Continuous Output Current (I_{OUT})
- 2 μ A Low Shutdown Current (I_{SD})
- 14 μ A Sleep Mode Quiescent Current (I_Q)
- 125m Ω and 55m Ω Internal Power MOSFETs
- Synchronous Mode for High Efficiency
- 350kHz to 2.5MHz Configurable Switching Frequency (f_{SW})
Selectable In-Phase or 180° Out-of-Phase
External SYNC Clock
- Power Good (PG) Indication
- Configurable Soft-Start Time (t_{SS})
- 80ns Minimum On Time
- Selectable Forced Continuous Conduction Mode (FCCM) and Advanced Asynchronous Modulation (AAM) Mode
- Low-Dropout (LDO) Mode
- Over-Current Protection (OCP) with Valley-Current Detection and Hiccup Mode
- Thermal Shutdown
- Available in Wettable Flank Package
- Fully Assembled and Tested

 **Optimized Performance with MPS Inductor MPL-AL6060 Series**

APPLICATIONS

- Automotive Systems
- Industrial Power Systems

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EVBL9840-L-00A EVALUATION BOARD

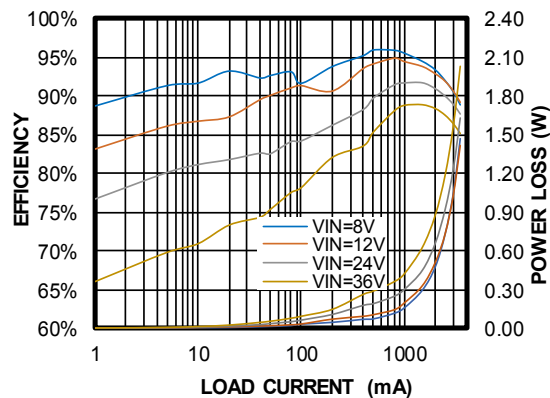


LxWxH (2.5cmx2.5cmx0.2cm)

Board Number	MPS IC Number	MPS Inductor
EVBL9840-L-00A	MP9840GL, MPQ9840GL	MPL-AL6060-100

Efficiency vs. Load Current vs. Power Loss

$V_{OUT} = 3.3V$, AAM mode



QUICK START GUIDE

- Connect load terminals to:
 - Positive (+): VOUT
 - Negative (-): GND
- Preset the power supply output to between 3.3V and 36V. Be aware that electronic loads represent a negative impedance to the converter, which can trigger hiccup mode if the current exceeds 5.6A.
- Turn off the power supply. If longer cables (>0.5m total) are being used between the source and the evaluation board, install a damping capacitor at the input terminals. This is critical when V_{IN} exceeds 24V.
- Connect power supply terminals to:
 - Positive (+): VIN
 - Negative (-): GND
- Turn on the power supply. The evaluation board should start up automatically.
- To use the enable (EN) function, apply a digital input to the EN pin. Drive EN above 1.05V to turn the converter on; drive EN below 0.93V to turn it off.
- The switching frequency (f_{SW}) can be configured via an external resistor (R_{FREQ}). R_{FREQ} can be estimated with Equation (1):

$$R_{FREQ}(k\Omega) = \frac{170000}{f_{SW}^{1.11}(kHz)} \quad (1)$$

- To use the synchronous (SYNC) function, apply a 350kHz to 2.5MHz clock to the SYNC pin to synchronize f_{SW} to the external clock. The external clock should be at least 250kHz above f_{SW}.
- The SYNC pin also selects either forced continuous conduction mode (FCCM) or advanced asynchronous modulation (AAM) mode. Drive SYNC high to make the device operate in FCCM; drive SYNC low or float SYNC to have it operate in AAM mode.
- The output voltage is set by the external resistor divider (R_{FB1} + R_{FB2}). Choose R_{FB1} to be about 40kΩ. Then R_{FB2} can be calculated with below Equation (2):

$$R_{FB2} = \frac{R_{FB1}}{\frac{V_{OUT}}{0.8V} - 1} \quad (2)$$

Figure 1 shows the feedback circuit.

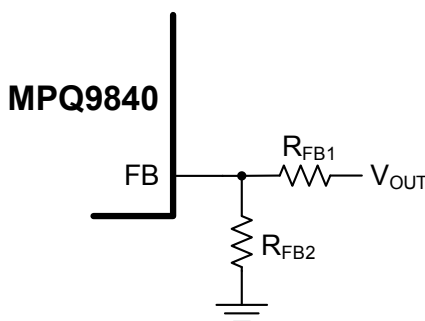


Figure 1: Feedback Circuit

Table 1 lists the recommended feedback resistor values for common output voltages.

Table 1: Recommended Resistor Values for Common Output Voltages

V_{OUT} (V)	R_{FB1} (kΩ)	R_{FB2} (kΩ)
1.8	41.2 (1%)	33 (1%)
2.5	41.2 (1%)	19.6 (1%)
3.3	41.2 (1%)	13 (1%)
5	41.2 (1%)	7.68 (1%)
12	41.2 (1%)	2.94 (1%)

EVALUATION BOARD SCHEMATIC

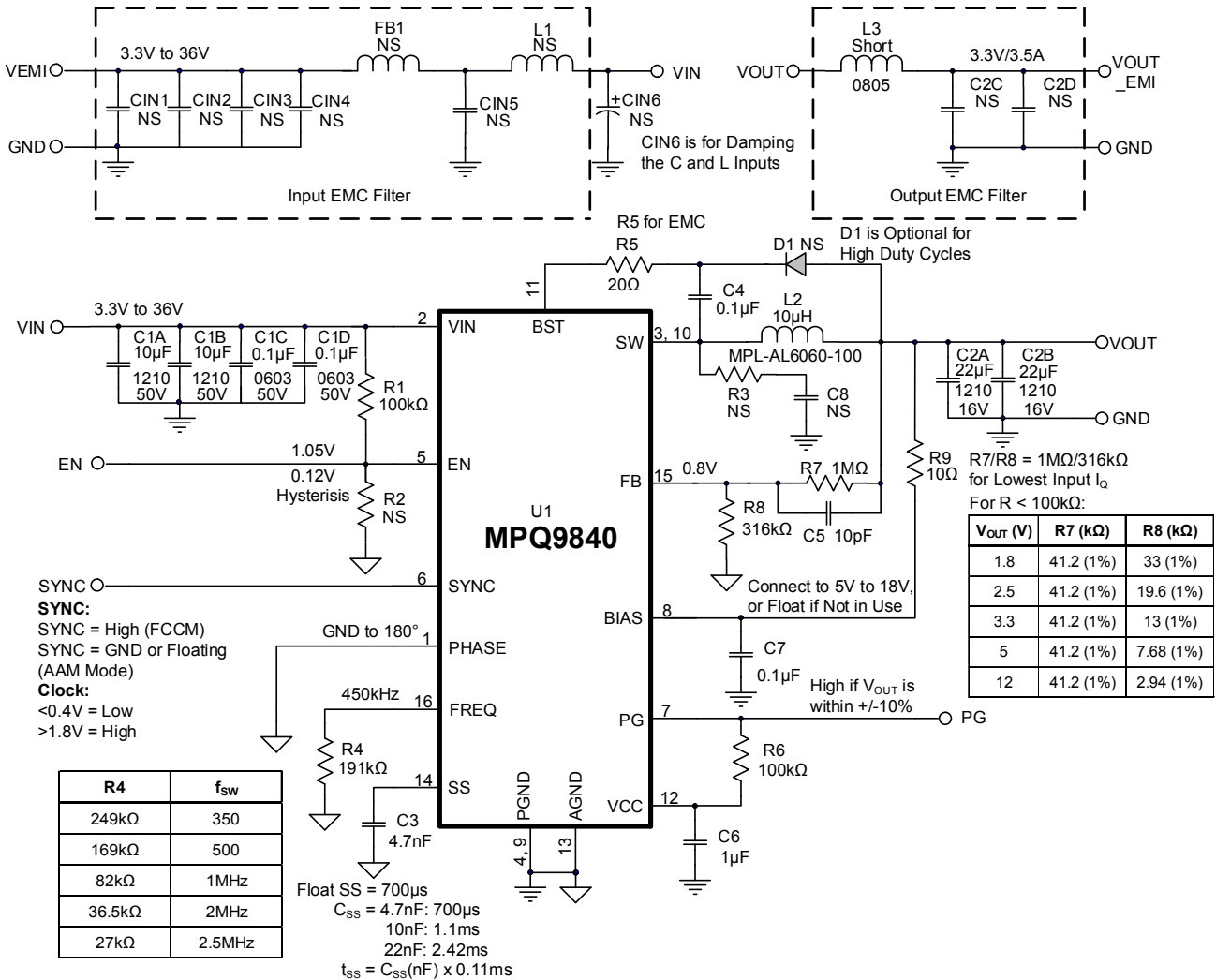
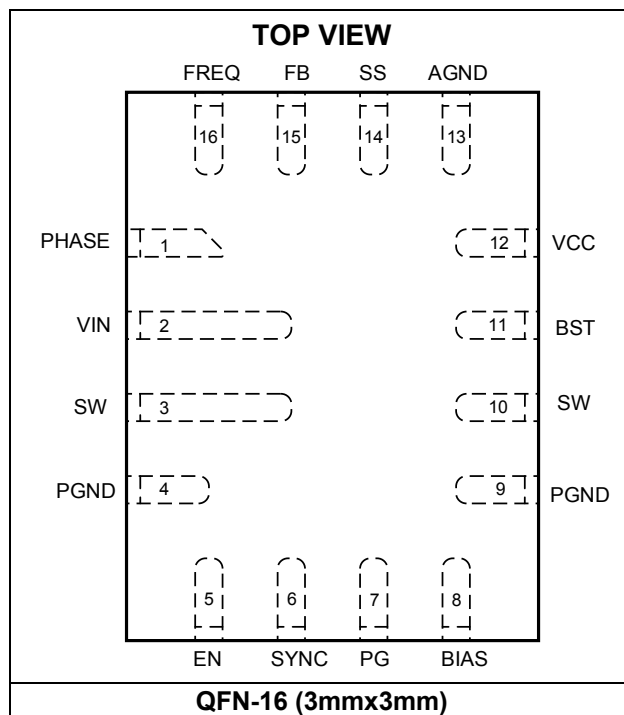


Figure 2: Evaluation Board Layout

PACKAGE REFERENCE



EVBL9840-L-00A BILL OF MATERIALS

Qty	Ref	Value	Description	Package	Manufacturer	Manufacturer PN
1	L2	MPL-AL6060-100	Inductor, 10μH, 27mΩ DCR, 7A	SMD	MPS	MPL-AL6060-100
2	C1A, C1B	10μF	Ceramic capacitor, 50V, X7R	1210	Murata	GRM32ER71H106KA12L
2	C1C, C1D	0.1μF	Ceramic capacitor, 50V, X7R	0603	Murata	GRM188R71H104KA93D
2	C2A, C2B	22μF	Ceramic capacitor, 25V, X7R	1210	Murata	GRM32ER71H226KE15L
1	C3	4.7nF	Ceramic capacitor, 50V, X7R	0603	TDK	C1608X7R1H472K
2	C4, C7	0.1μF	Ceramic capacitor, 16V, X7R	0603	Murata	GRM188R71C104KA01D
1	C5	10pF	Ceramic capacitor, 50V, C0G	0603	TDK	C1608C0G1H100D
1	C6	1μF	Ceramic capacitor, 16V, X7R	0603	TDK	C1608X7R1C105K
9	CIN1, CIN2, CIN3, CIN4, CIN5, CIN6, C2C, C2D, C8	NS				
1	D1	NS				
1	FB1	NS				
1	L1	NS				
1	L3	Short				
2	R1, R6	100kΩ	Film resolution, 5%	0603	Yageo	RC0603JR-07100KL
1	R4	191kΩ	Film resolution, 1%	0603	Yageo	RC0603FR-07191KL
1	R5	20Ω	Film resolution, 1%	0603	Yageo	RC0603FR-0720RL
1	R7	1MΩ	Film resolution, 1%	0603	Yageo	RC0603FR-071ML
1	R8	316kΩ	Film resolution, 1%	0603	Yageo	RC0603FR-07316KL
1	R9	10Ω	Film resolution, 5%	0603	Yageo	RC0603JR-0710RL
2	R2, R3	NS				
5	VIN, VEMI, GND, VOUT, GND	2mm	2mm golden pin, test point	DIP	Custom ⁽¹⁾	
5	EN, GND, SYNC, GND, PG	1mm	1mm golden pin, test point	DIP	Custom ⁽¹⁾	
1	U1	MP9840	Synchronous, step-down converter, 36V, 3.5A	QFN-16 (3mmx4mm)	MPS	MP9840GL

Note:

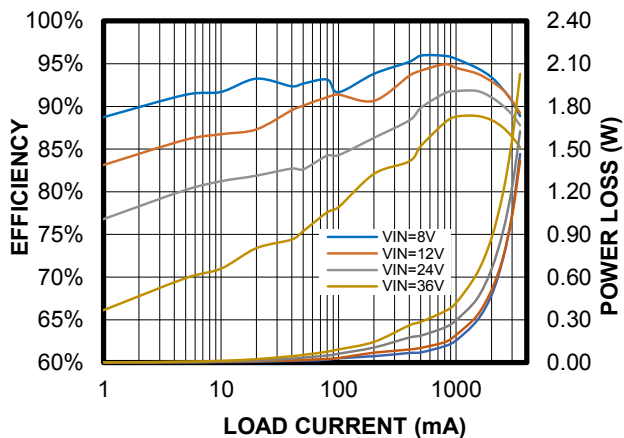
1) These pins are custom-made by MPS. For more information, contact an MPS FAE.

EVB TEST RESULTS

$V_{IN} = 12V$, $V_{OUT} = 3.3V$, $L = 10\mu H$, $f_{SW} = 450KHz$, $T_A = 25^\circ C$, unless otherwise noted.

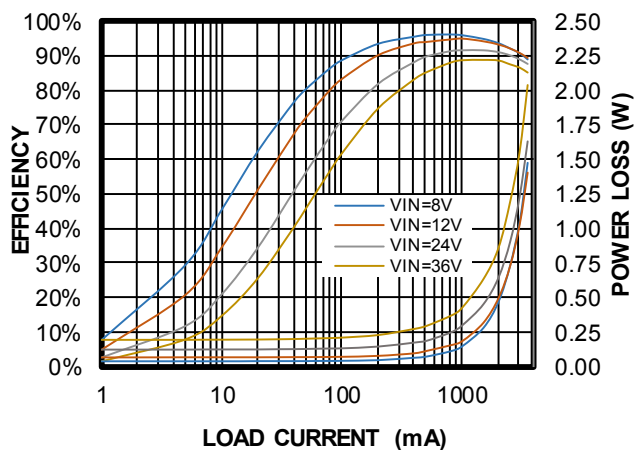
Efficiency vs. Load Current vs. Power Loss

$V_{OUT} = 3.3V$, AAM mode



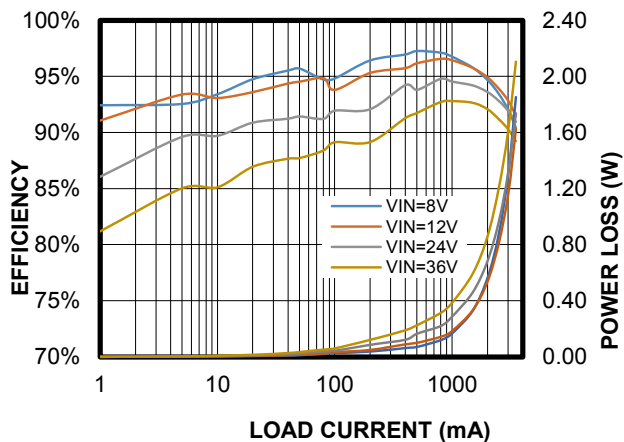
Efficiency vs. Load Current vs. Power Loss

$V_{OUT} = 3.3V$, FCCM



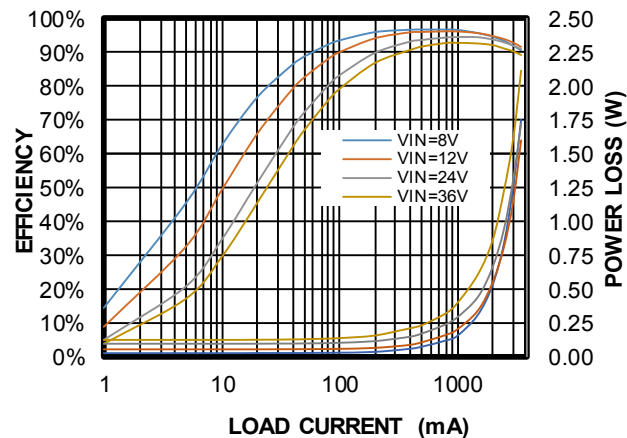
Efficiency vs. Load Current vs. Power Loss

$V_{OUT} = 5V$, AAM mode



Efficiency vs. Load Current vs. Power Loss

$V_{OUT} = 5V$, FCCM

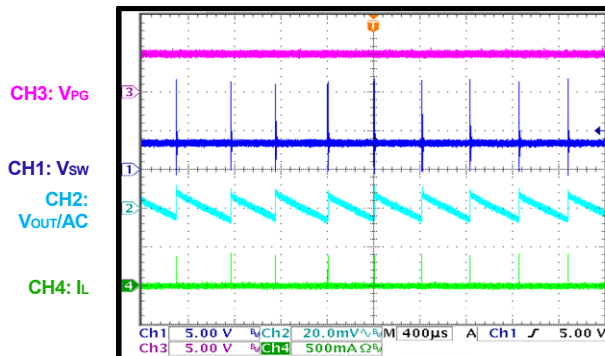


EVB TEST RESULTS *(continued)*

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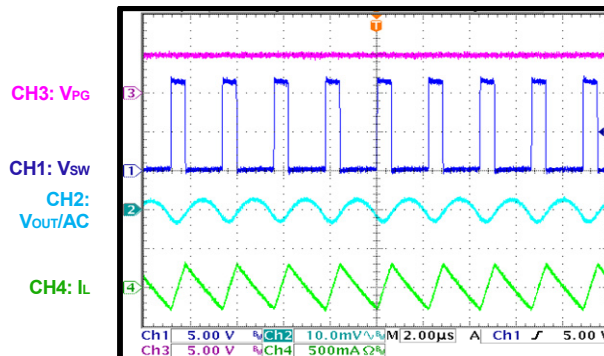
Steady State

$V_{IN} = 12V$, $V_{OUT} = 3.3V$, $I_{OUT} = 1mA$,
AAM mode



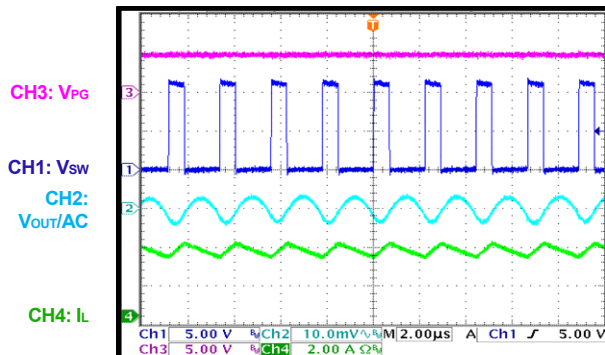
Steady State

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



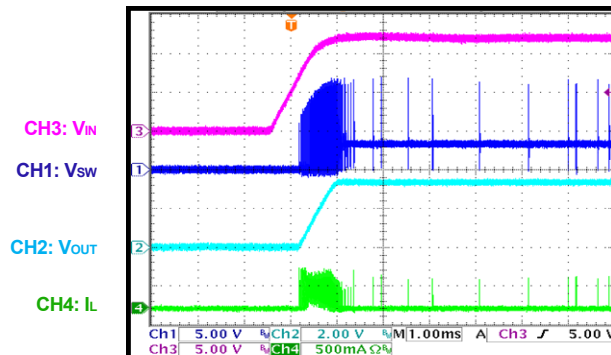
Steady State

$V_{IN} = 12V$, $V_{OUT} = 3.3V$, $I_{OUT} = 3.5A$



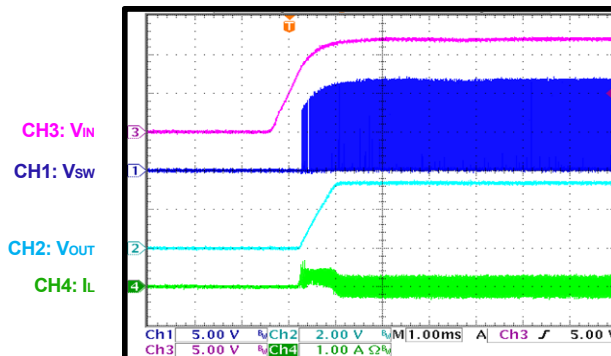
Start-Up

$V_{IN} = 12V$, $V_{OUT} = 3.3V$, $I_{OUT} = 0A$, AAM mode



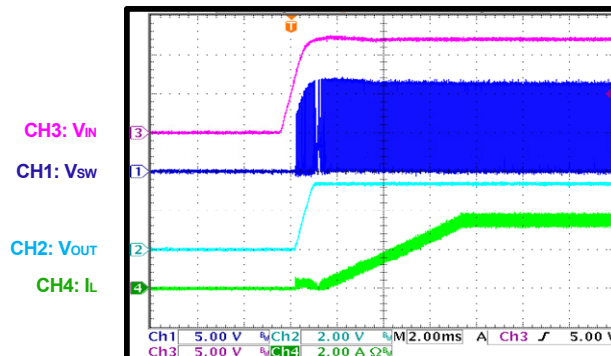
Start-Up

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



Start-Up

$V_{IN} = 12V$, $V_{OUT} = 3.3V$, $I_{OUT} = 3.5A$

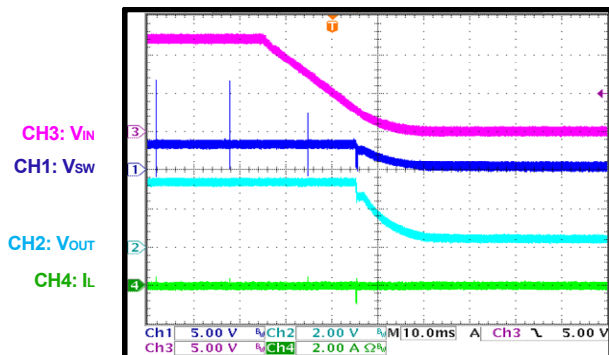


EVB TEST RESULTS (continued)

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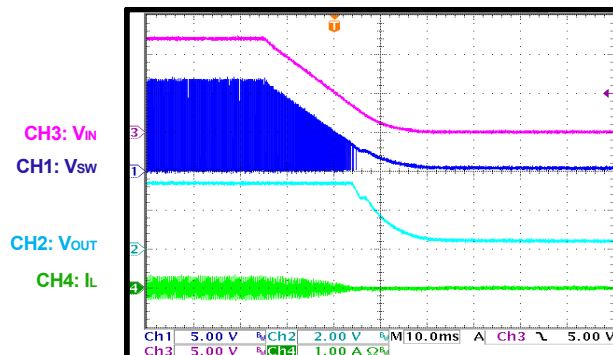
Shutdown

$V_{IN} = 12V$, $V_{OUT} = 3.3V$, $I_{OUT} = 0A$, AAM mode



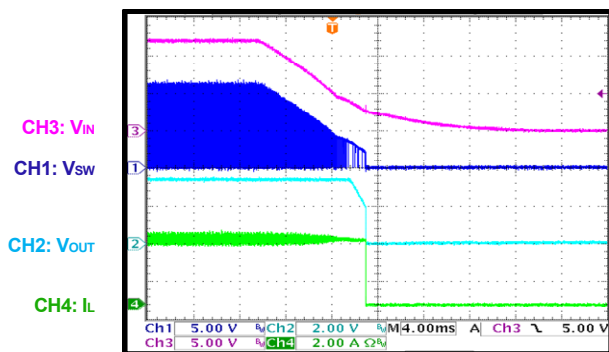
Shutdown

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



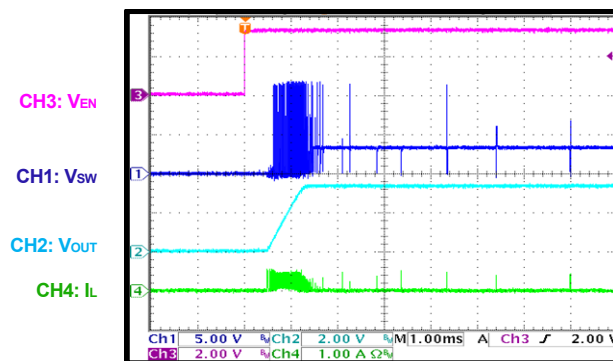
Shutdown

$V_{IN} = 12V$, $V_{OUT} = 3.3V$, $I_{OUT} = 3.5A$



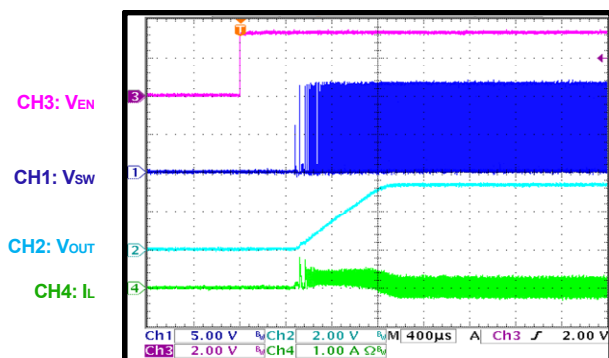
Start-Up through EN

$V_{IN} = 12V$, $V_{OUT} = 3.3V$, $I_{OUT} = 0A$, AAM mode



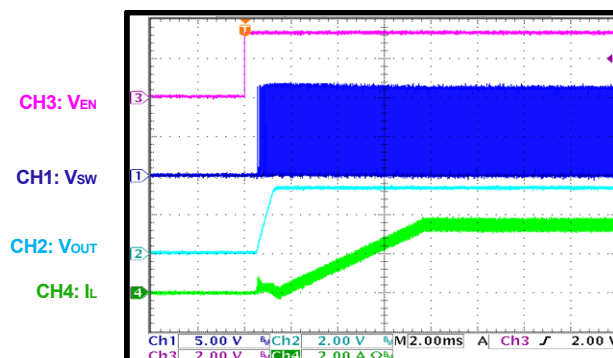
Start-Up through EN

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



Start-Up through EN

$V_{IN} = 12V$, $V_{OUT} = 3.3V$, $I_{OUT} = 3.5A$

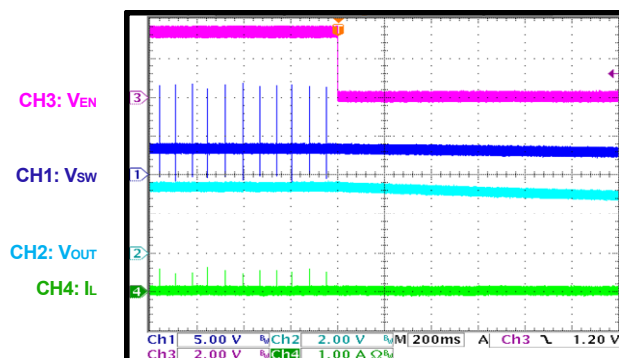


EVB TEST RESULTS (continued)

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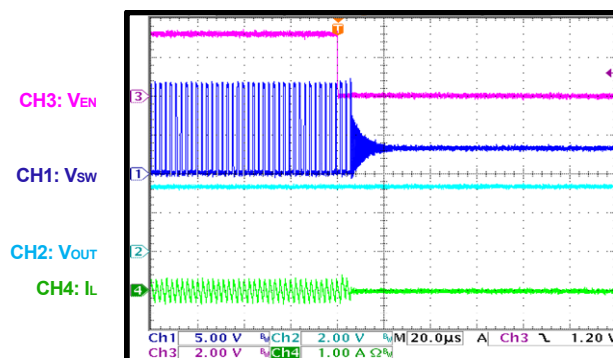
Shutdown through EN

$V_{IN} = 12V$, $V_{OUT} = 3.3V$, $I_{OUT} = 0A$, AAM mode



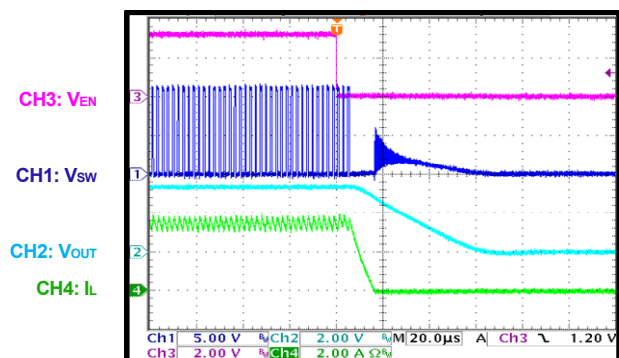
Shutdown through EN

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



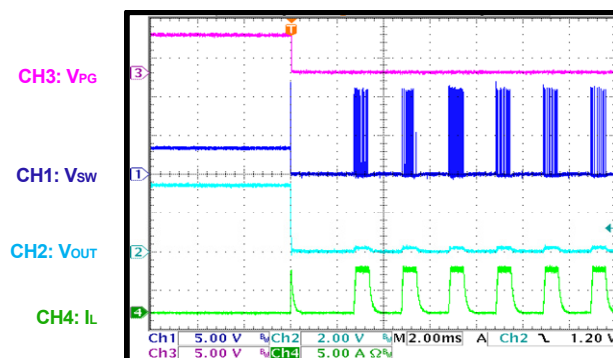
Shutdown through EN

$V_{IN} = 12V$, $V_{OUT} = 3.3V$, $I_{OUT} = 3.5A$



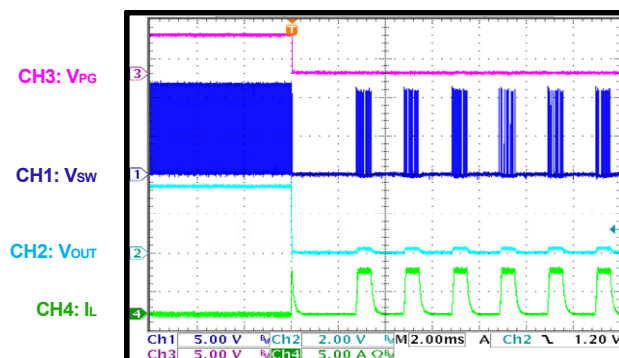
SCP Entry

$V_{IN} = 12V$, $V_{OUT} = 3.3V$, $I_{OUT} = 3.5A$, AAM mode



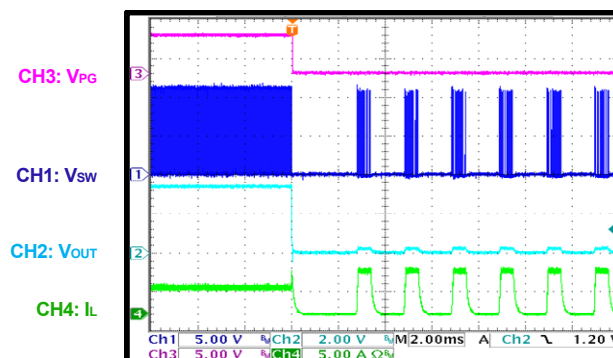
SCP Entry

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



SCP Entry

$V_{IN} = 12V$, $V_{OUT} = 3.3V$, $I_{OUT} = 3.5A$

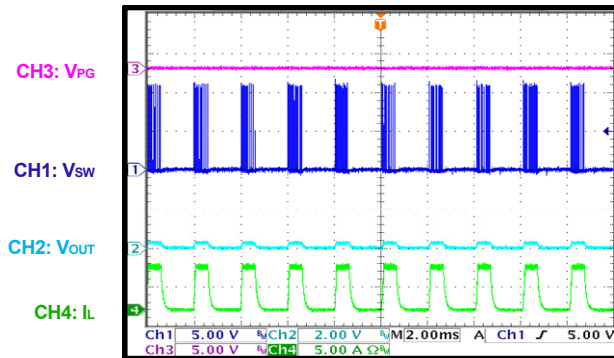


EVB TEST RESULTS (continued)

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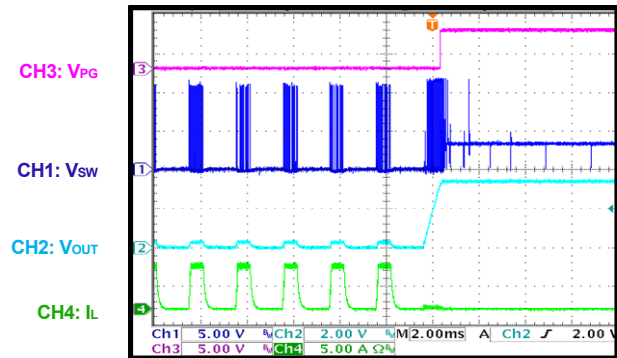
SCP Steady State

$V_{IN} = 12V$



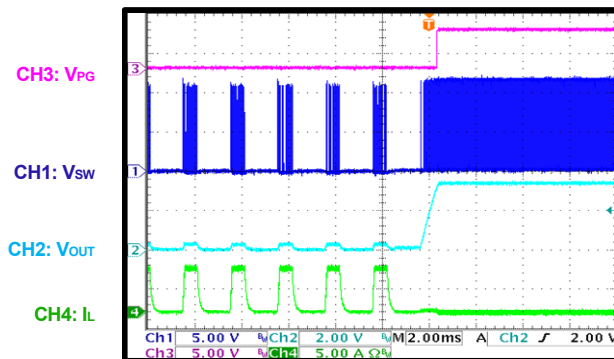
SCP Recovery

$V_{IN} = 12V$, $V_{OUT} = 3.3V$, $I_{OUT} = 0A$, AAM mode



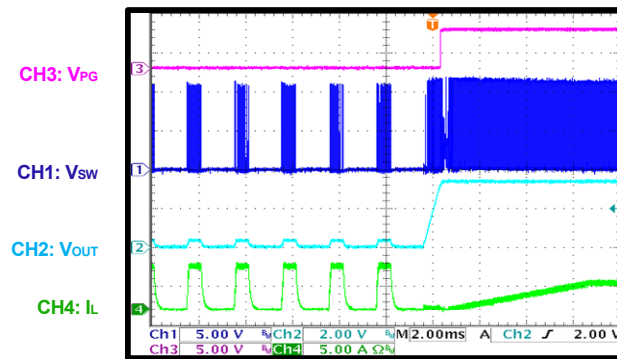
SCP Recovery

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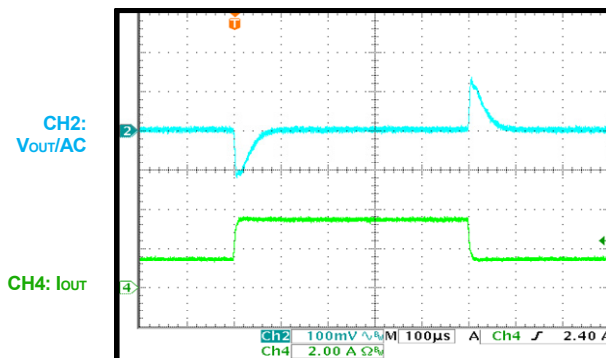
SCP Recovery

$V_{IN} = 12V$, $V_{OUT} = 3.3V$, $I_{OUT} = 3.5A$



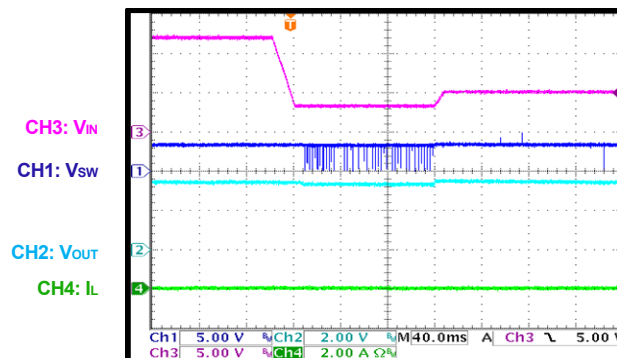
Load Transient

$V_{IN} = 12V$, $V_{OUT} = 3.3V$, $I_{OUT} = 1.5A$ to $3.5A$



Cold Crank

$V_{IN} = 12V$ to $3.3V$ to $5V$, $I_{OUT} = 0A$, AAM mode

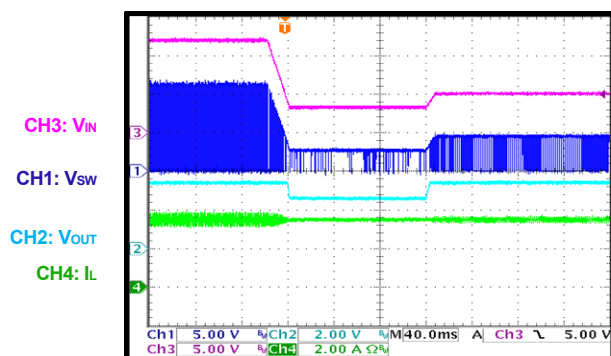


EVB TEST RESULTS (continued)

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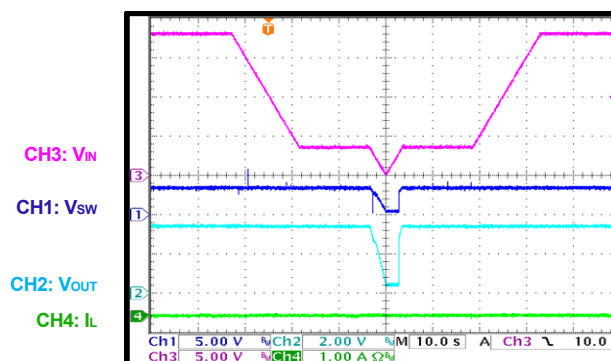
Cold Crank

$V_{IN} = 12V$ to $3.3V$ to $5V$, $I_{OUT} = 3.5A$



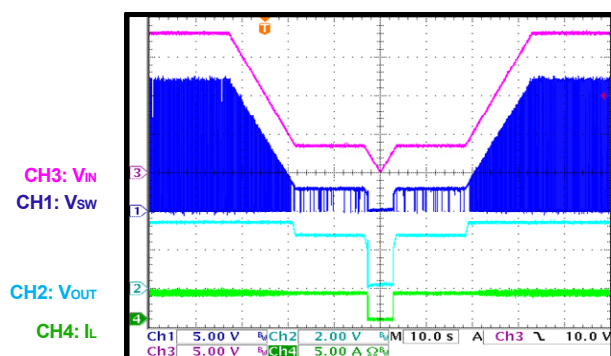
VIN Ramps Down and Up

$V_{IN} = 18V$ to $3.5V$ to $0V$ to $3.5V$ to $18V$, $I_{OUT} = 0A$



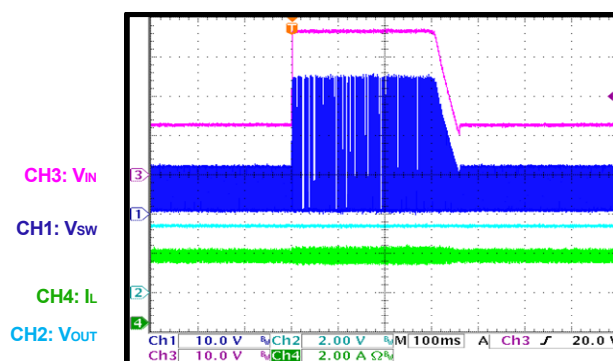
VIN Ramps Down and Up

$V_{IN} = 18V$ to $3.5V$ to $0V$ to $3.5V$ to $18V$, $I_{OUT} = 3.5A$



Load Dump

$V_{IN} = 12V$ to $36V$ to $12V$, $I_{OUT} = 3.5A$



PCB LAYOUT

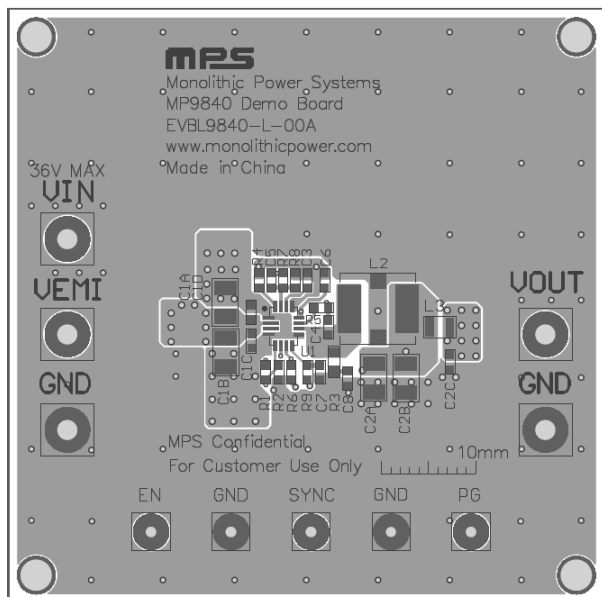


Figure 3: Top Silk and Top Layer

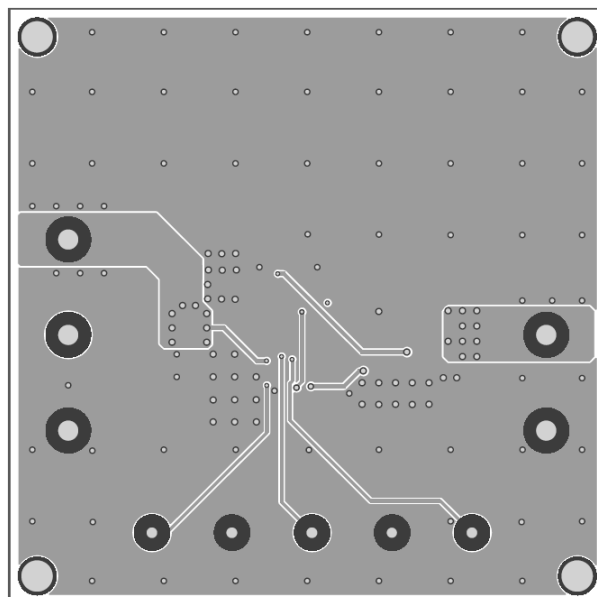


Figure 4: Mid-Layer 1

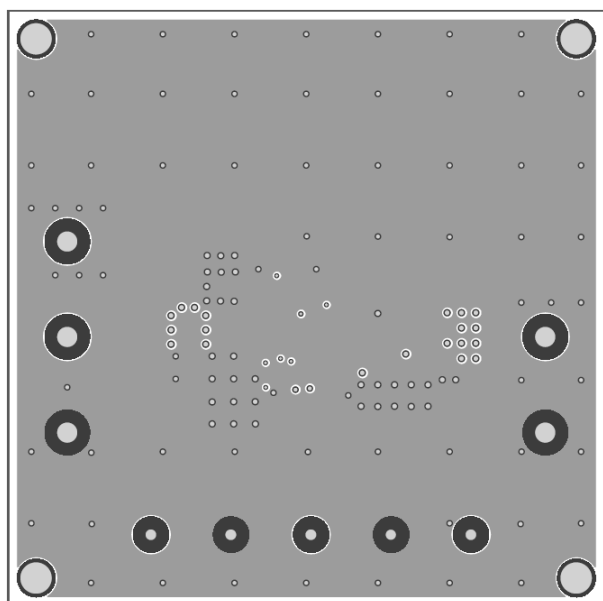


Figure 5: Mid-Layer 2

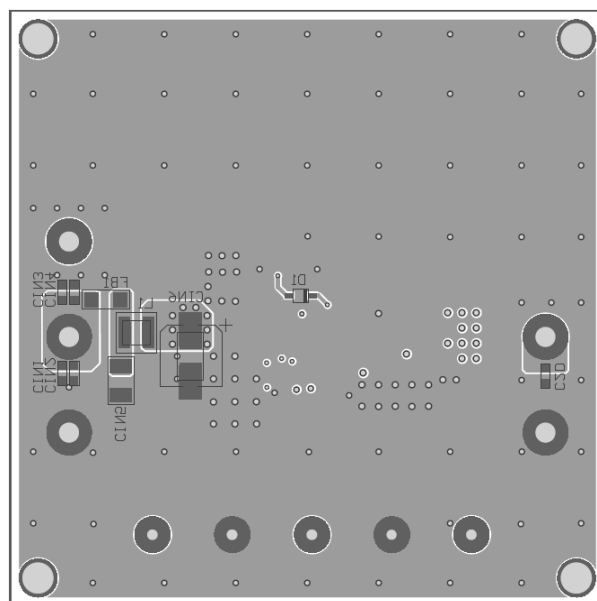


Figure 6: Bottom Layer and Bottom Silk



REVISION HISTORY

Revision #	Revision Date	Description	Pages Updated
1.0	10/18/2019	Initial Release	-
1.1	9/16/2021	Updated the Quick Start Guide section	3–4
		Updated the soft-start time (t_{ss}) formula in Figure 2 from “ $T_{ss}=C_{ss}(nF)*0.08ms$ ” to “ $T_{ss} = C_{ss}(nF) \times 0.11ms$ ”	5
		Updated the EVBL9840-L-00A Bill of Materials section	7
		Grammar and formatting updates; updated headers and footers; updated figure titles; updated pagination	All

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