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 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

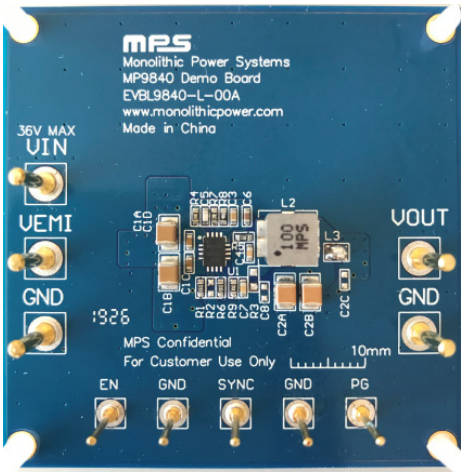
- Wide 3.3V to 36V Operating Input Voltage (V_{IN}) Range
- Up to 3.5A Continuous Output Current(I_{OUT})
- 2μA Low Shutdown Current (I_{SD})
- 14μA Sleep Mode Quiescent Current (I_Q)
- 125mΩ and 55mΩ Internal Power MOSFETs
- Synchronous Mode for High Efficiency
- 350kHz to 2.5MHz Configurable Switching 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

MPL Optimized Performance with MPS Inductor MPL-AL6060 Series

APPLICATIONS

- Automotive Systems
- Industrial Power Systems

EVBL9840-L-00A EVALUATION BOARD

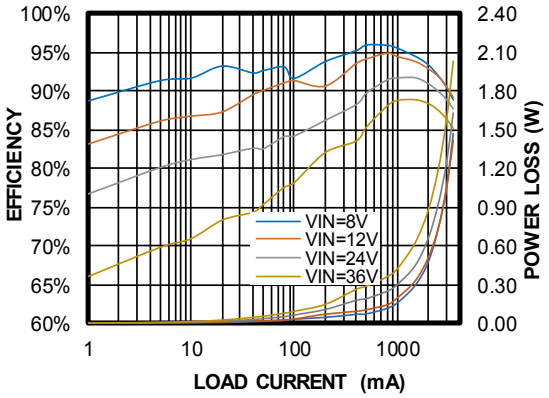


LxWxH (2.5cmx2.5cmx0.2cm)

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

1. Connect load terminals to:
   a. Positive (+): VOUT
   b. Negative (-): GND
2. 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.
3. 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.
4. Connect power supply terminals to:
   a. Positive (+): VIN
   b. Negative (-): GND
5. Turn on the power supply. The evaluation board should start up automatically.
6. 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.
7. The switching frequency (f_{SW}) can be configured via an external resistor (R_{FREQ}). R_{FREQ} can be estimated with Equation (1):

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

8. 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}.
9. 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.
10. 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.

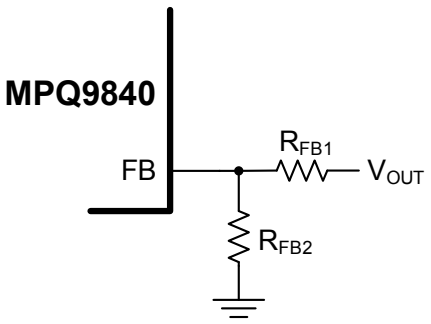


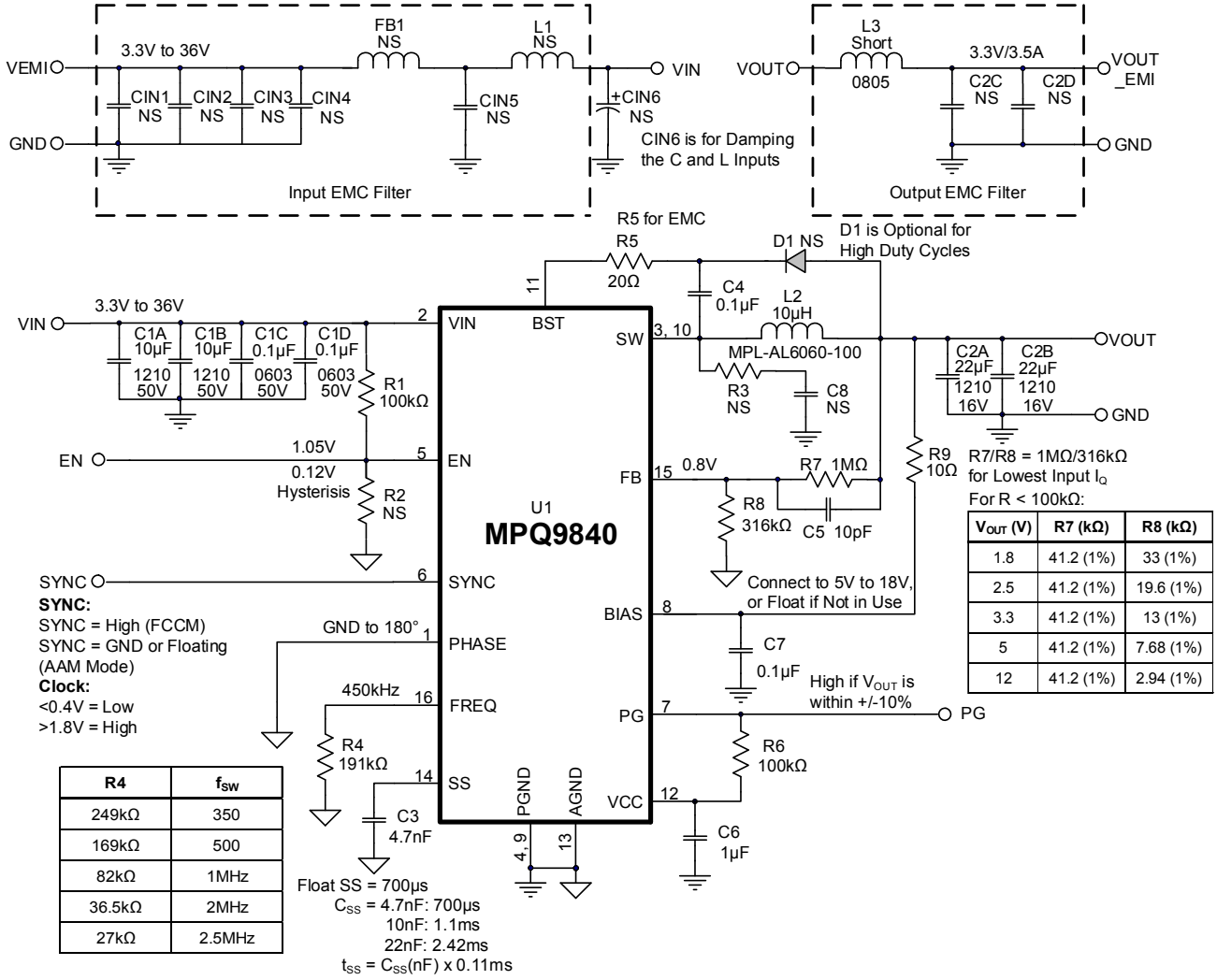
Figure 1: Feedback Circuit

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 SCHEMETIC

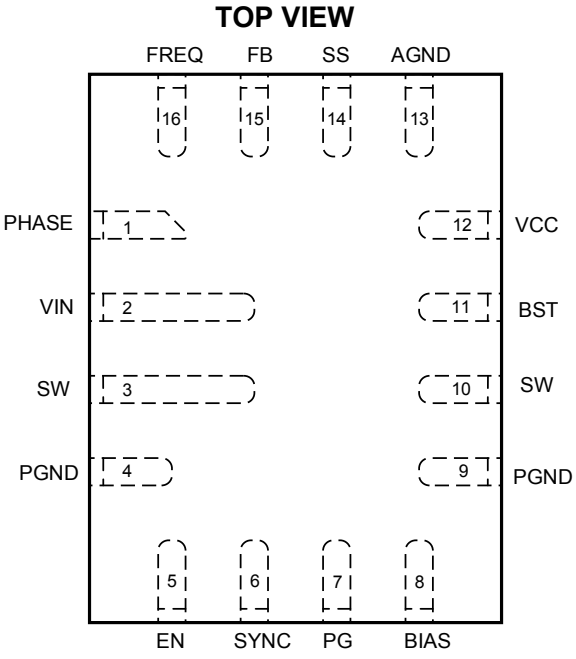


V_{OUT} (V)	R7 (kΩ)	R8 (kΩ)
1.8	41.2 (1%)	33 (1%)
2.5	41.2 (1%)	19.6 (1%)
3.3	41.2 (1%)	13 (1%)
5	41.2 (1%)	7.68 (1%)
12	41.2 (1%)	2.94 (1%)

R4	f_{SW}
249kΩ	350
169kΩ	500
82kΩ	1MHz
36.5kΩ	2MHz
27kΩ	2.5MHz

Figure 2: Evaluation Board Layout

PACKAGE REFERENCE



QFN-16 (3mmx3mm)

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 (3mmx 4mm)	MPS	MP9840GL

Note:

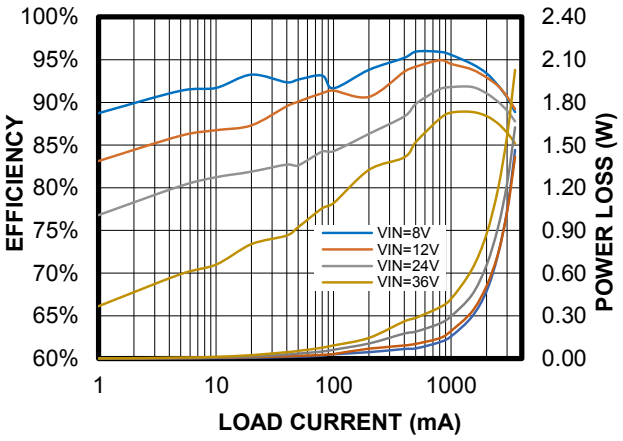
1) These pins are custom-made by MPS. For more information, contact an MPS FAE.

EVB TEST RESULTS

V_{IN} = 12V, V_{OUT} = 3.3V, L = 10µH, f_{SW} = 450KHz, T_A = 25°C, unless otherwise noted.

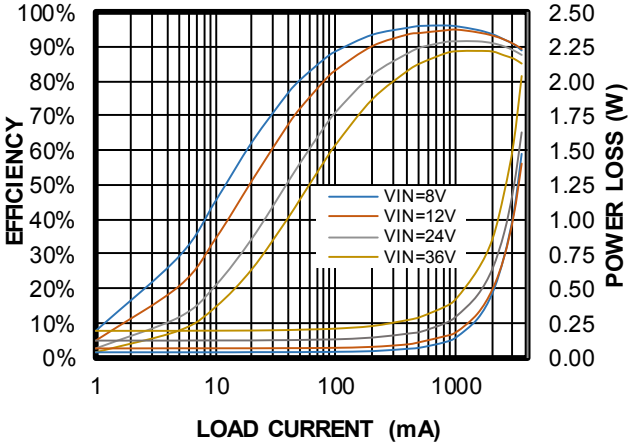
Efficiency vs. Load Current vs. Power Loss

V_{OUT} = 3.3V, AAM mode



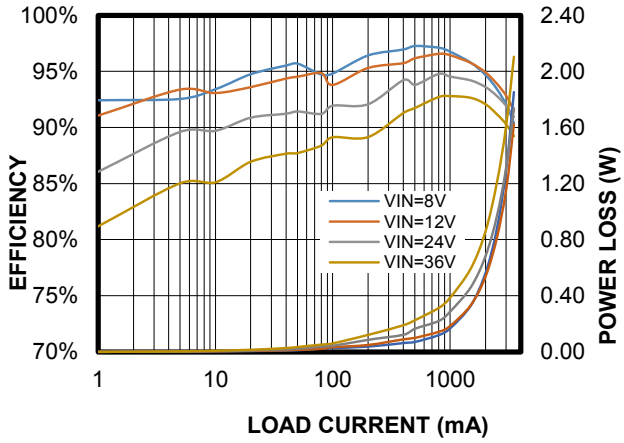
Efficiency vs. Load Current vs. Power Loss

V_{OUT} = 3.3V, FCCM



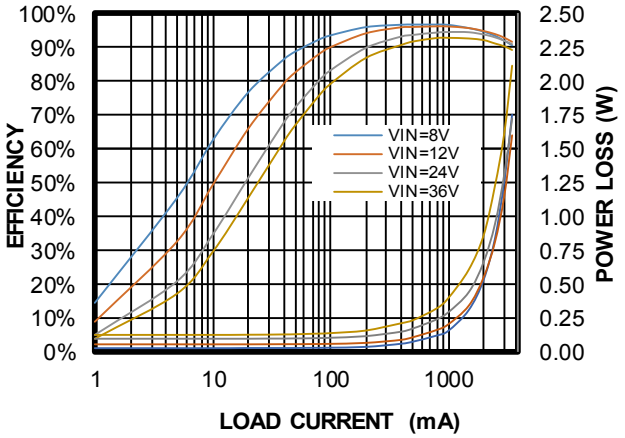
Efficiency vs. Load Current vs. Power Loss

V_{OUT} = 5V, AAM mode



Efficiency vs. Load Current vs. Power Loss

V_{OUT} = 5V, FCCM

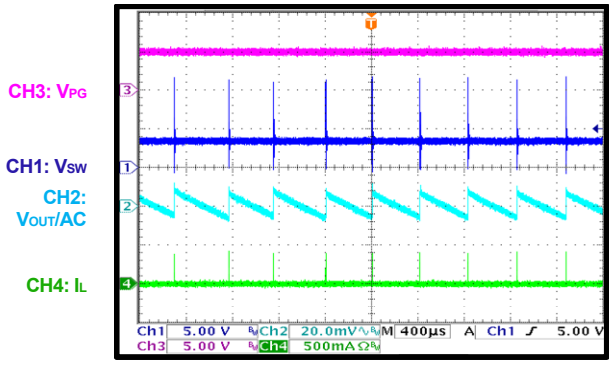


EVB TEST RESULTS *(continued)*

V_{IN} = 12V, V_{OUT} = 3.3V, L = 10µH, f_{SW} = 450KHz, T_A = 25°C, unless otherwise noted.

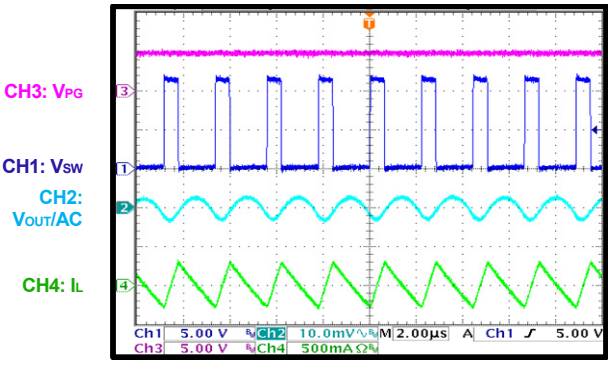
Steady State

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



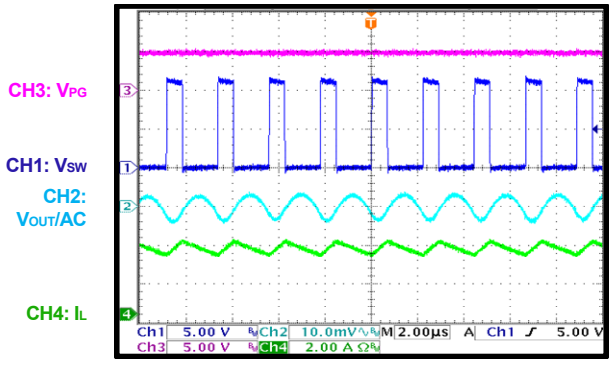
Steady State

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



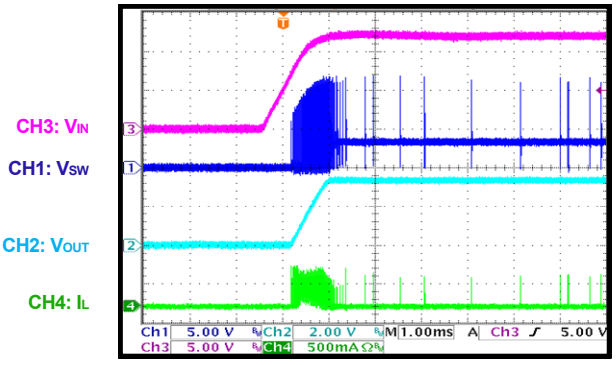
Steady State

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



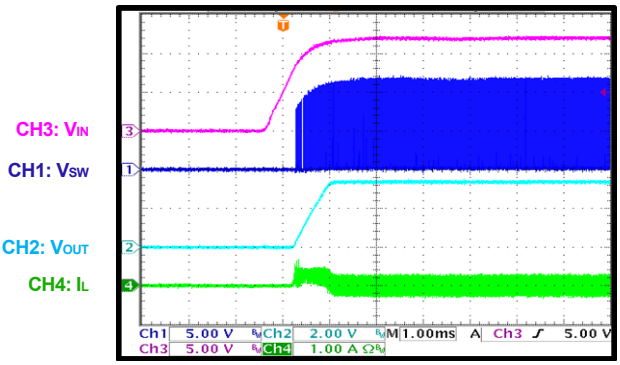
Start-Up

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



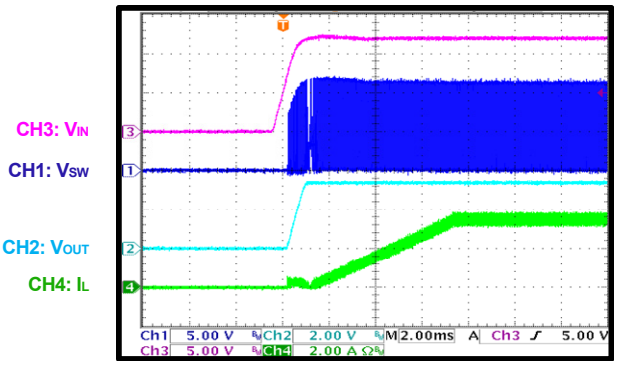
Start-Up

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



Start-Up

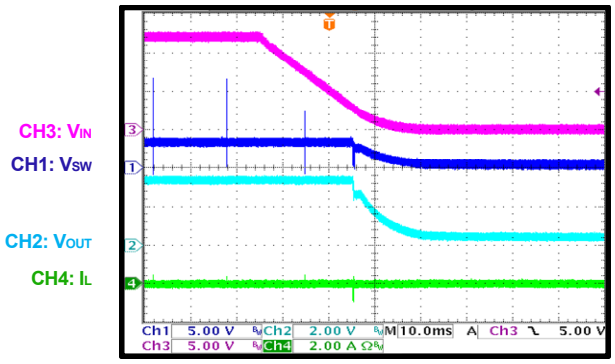
V_{IN} = 12V, V_{OUT} = 3.3V, I_{OUT} = 3.5A



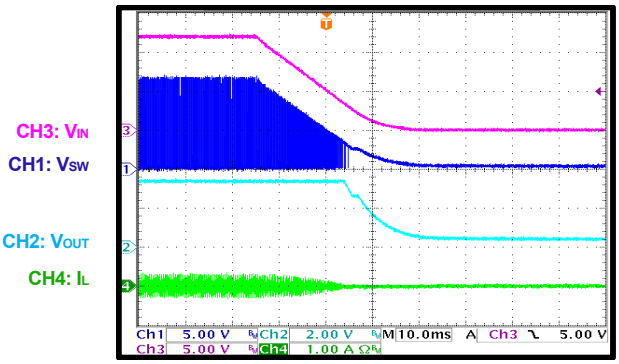
EVB TEST RESULTS *(continued)*

V_{IN} = 12V, V_{OUT} = 3.3V, L = 10µH, f_{SW} = 450KHz, T_A = 25°C, unless otherwise noted.

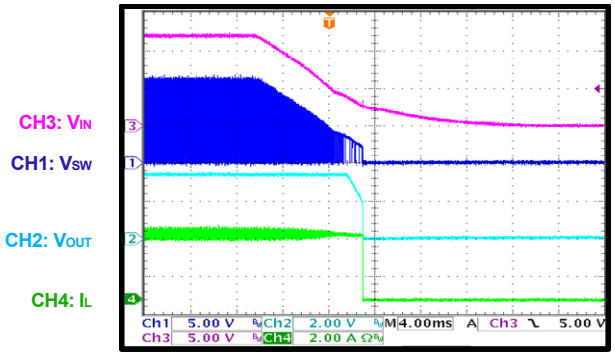
Shutdown
V_{IN} = 12V, V_{OUT} = 3.3V, I_{OUT} = 0A, AAM mode



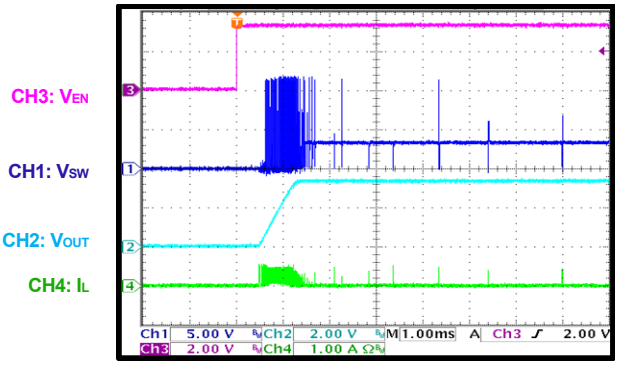
Shutdown
V_{IN} = 12V, V_{OUT} = 3.3V, I_{OUT} = 0A, FCCM



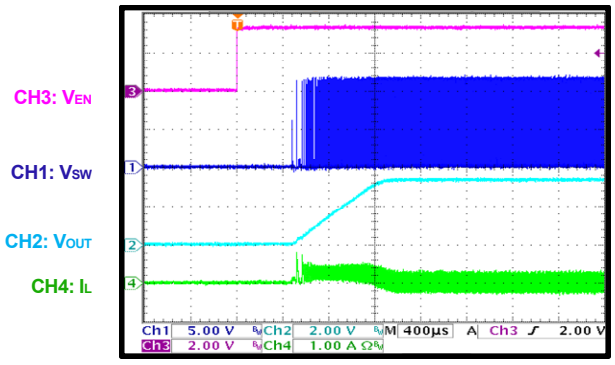
Shutdown
V_{IN} = 12V, V_{OUT} = 3.3V, I_{OUT} = 3.5A



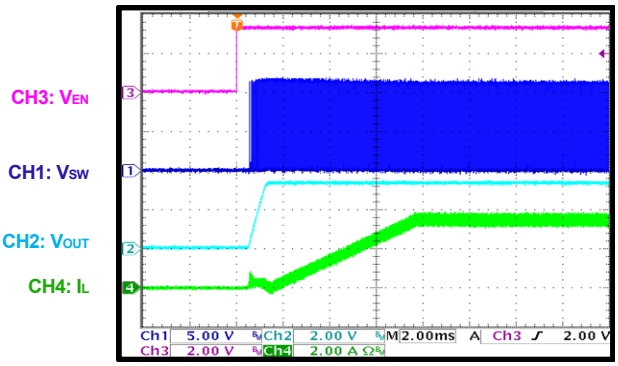
Start-Up through EN
V_{IN} = 12V, V_{OUT} = 3.3V, I_{OUT} = 0A, AAM mode



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

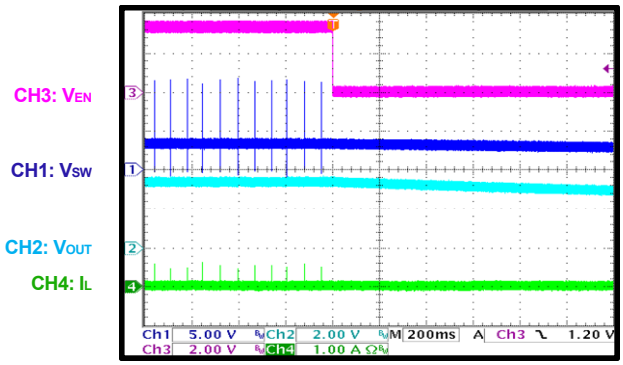


EVB TEST RESULTS *(continued)*

V_{IN} = 12V, V_{OUT} = 3.3V, L = 10µH, f_{SW} = 450KHz, T_A = 25°C, unless otherwise noted.

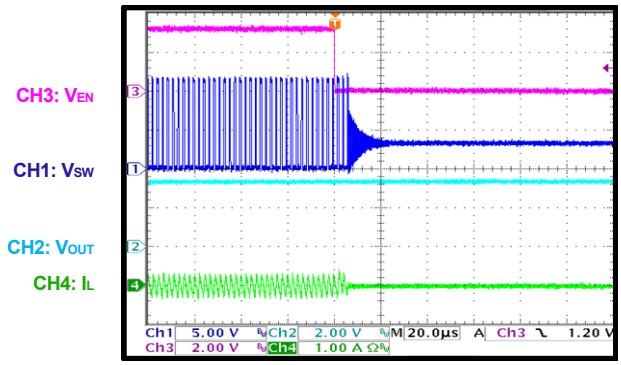
Shutdown through EN

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



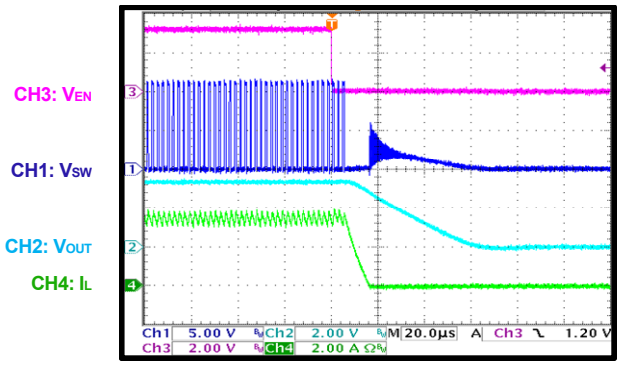
Shutdown through EN

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



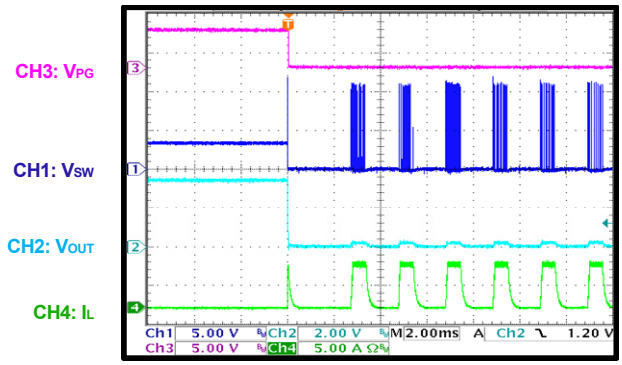
Shutdown through EN

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



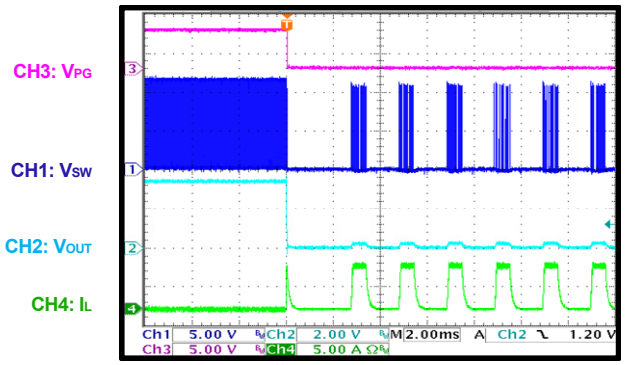
SCP Entry

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



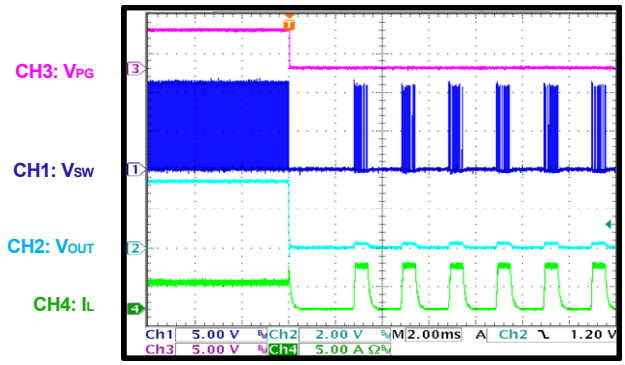
SCP Entry

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



SCP Entry

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

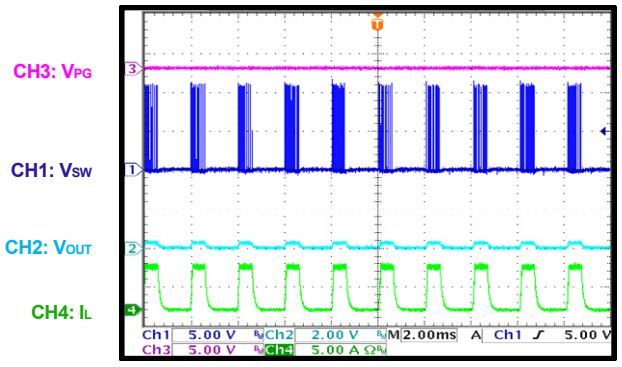


EVB TEST RESULTS *(continued)*

V_{IN} = 12V, V_{OUT} = 3.3V, L = 10µH, f_{SW} = 450KHz, T_A = 25°C, unless otherwise noted.

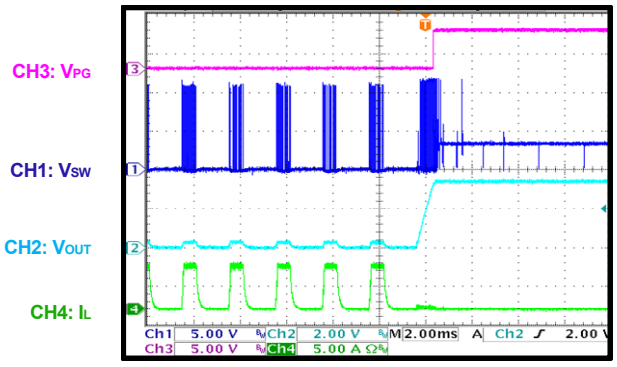
SCP Steady State

V_{IN} = 12V



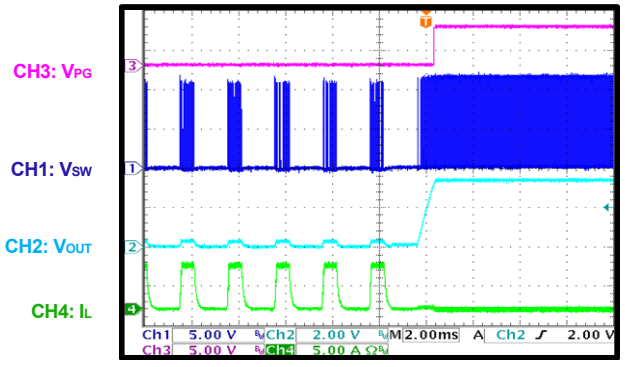
SCP Recovery

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



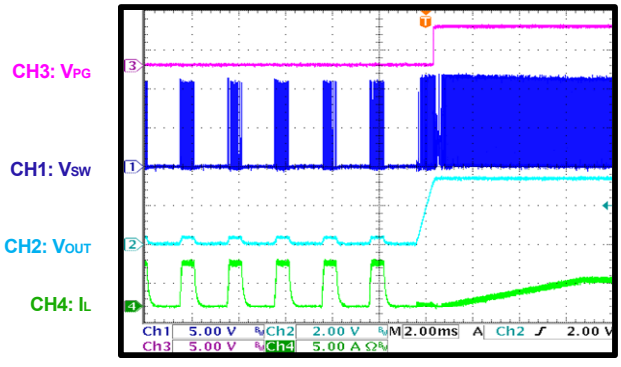
SCP Recovery

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



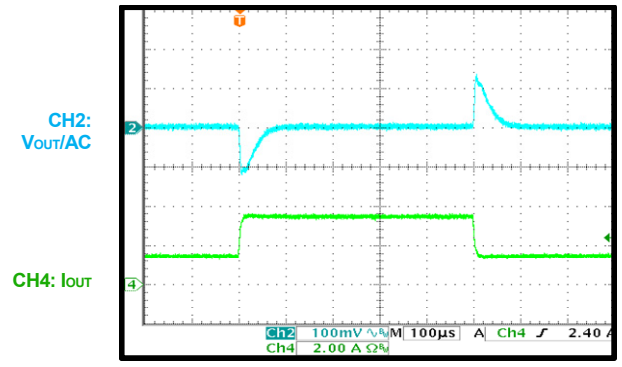
SCP Recovery

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



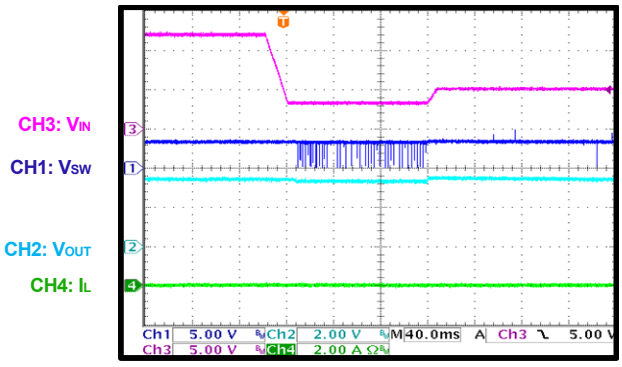
Load Transient

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

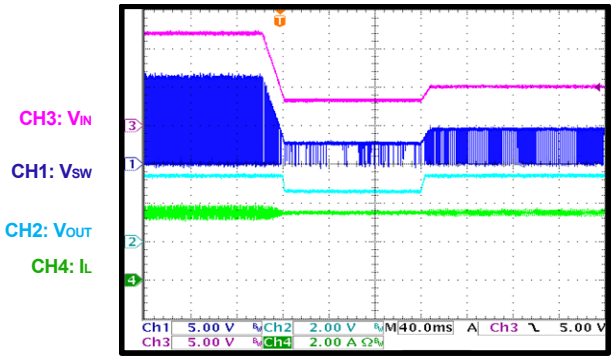


EVB TEST RESULTS *(continued)*

V_{IN} = 12V, V_{OUT} = 3.3V, L = 10µH, f_{SW} = 450KHz, T_A = 25°C, unless otherwise noted.

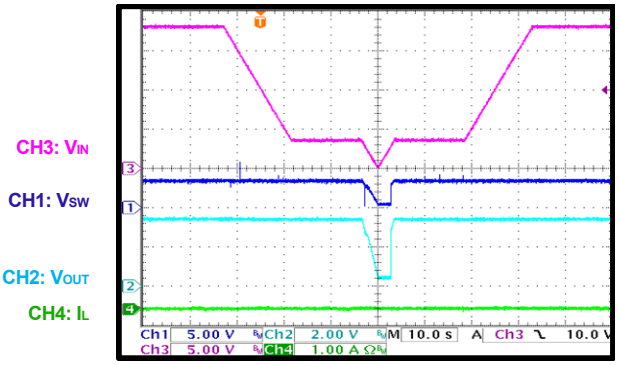
Cold Crank

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



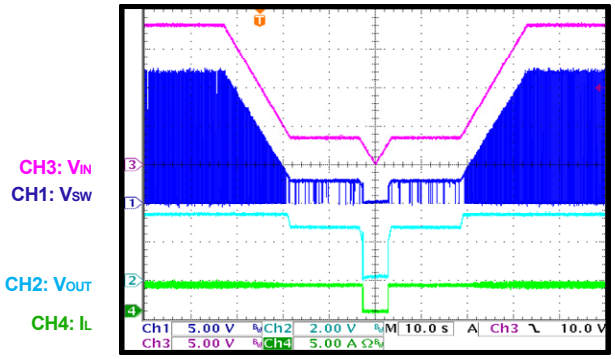
VIN Ramps Down and Up

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



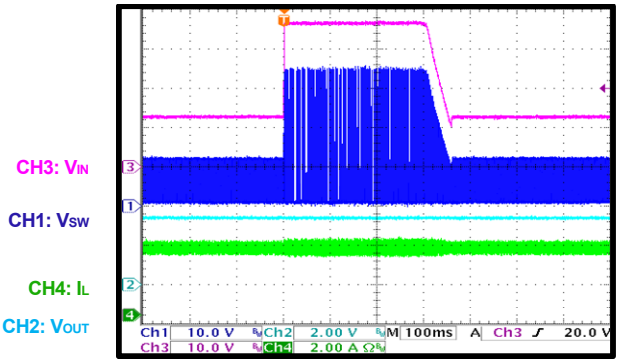
VIN Ramps Down and Up

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

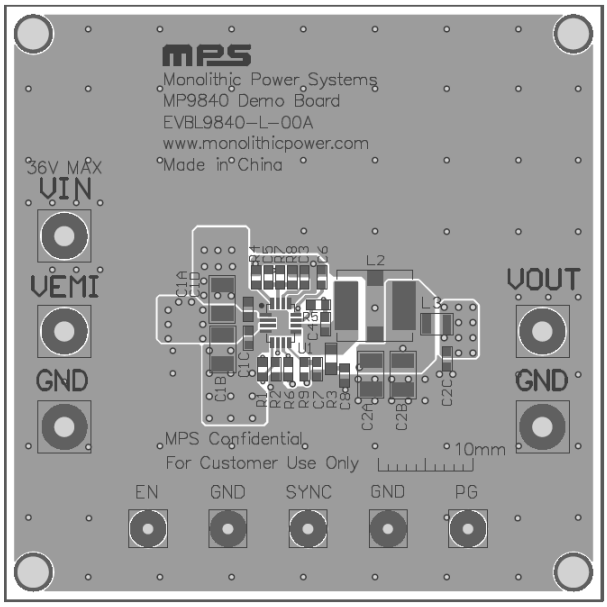


Figure 3: Top Silk and Top Layer

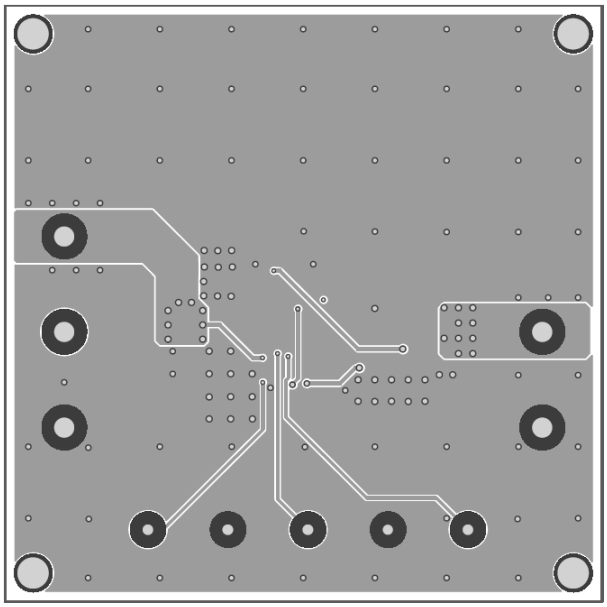


Figure 4: Mid-Layer 1

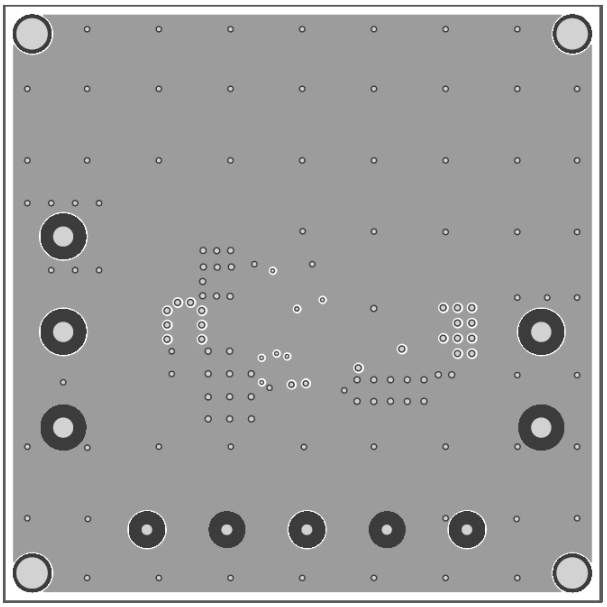


Figure 5: Mid-Layer 2

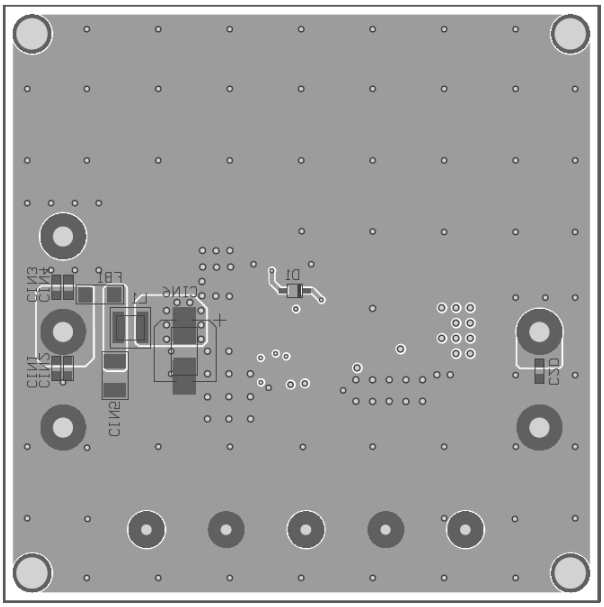


Figure 6: Bottom Layer and Bottom Silk

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) x 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