ISL8117DEMO3Z Demonstration Board User Guide

Description

The ISL8117DEMO3Z demonstration board (shown in Figure 4) features the ISL8117. The ISL8117 is a 60V high voltage synchronous buck controller that offers external soft-start, independent enable functions and integrates UV/OV/OC/OT protection. Its current mode control architecture and internal compensation network keep peripheral component count minimal. Programmable switching frequency ranging from 100kHz to 2MHz helps to optimize inductor size while the strong gate driver delivers up to 30A for the buck output.

Specifications

The ISL8117DEMO3Z demonstration board is designed for high current applications. The current rating of the ISL8117DEMO3Z is limited by the FETs and inductor selected. The electrical ratings of ISL8117DEMO3Z are shown in Table 1.

TABLE 1. ELECTRICAL RATINGS

PARAMETER	RATING
Input Voltage	4.5V to 60V
Switching Frequency	300kHz
Output Voltage	3.3V
Output Current	6A
OCP Set Point	Minimum 8A at ambient room temperature

Key Features

- Small, compact design
- Wide input range: 4.5V to 60V
- High light-load efficiency in pulse skipping DEM operation
- Programmable soft-start
- Optional DEM/CCM operation
- Supports prebias output with SR soft-start
- External frequency sync
- PGOOD indicator
- OCP, OVP, OTP, UVP protection

References

- ISL8117 datasheet

Ordering Information

PART NUMBER	DESCRIPTION
ISL8117DEMO3Z	High voltage PWM step-down synchronous buck controller

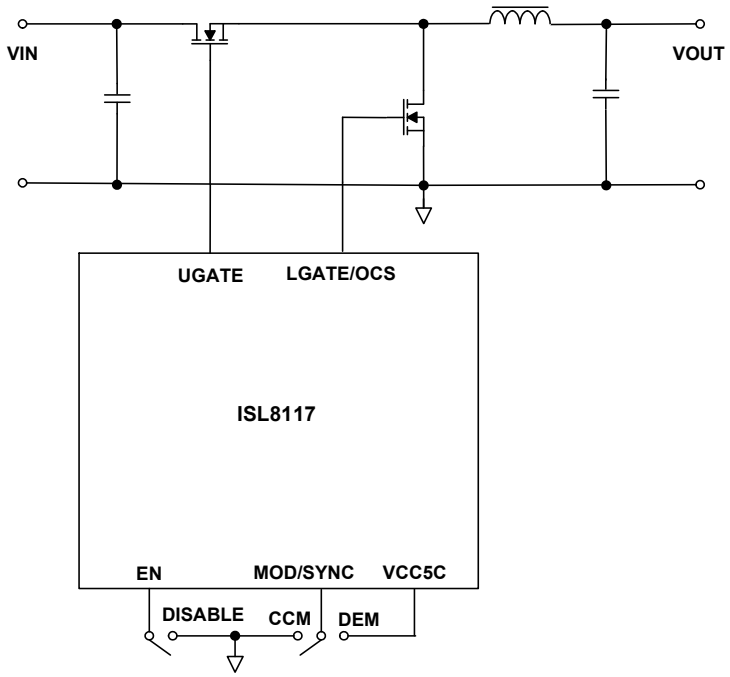

FIGURE 1. ISL8117DEMO3Z BLOCK DIAGRAM

Recommended Testing Equipment

The following materials are recommended to perform testing:

- 0V to 60V power supply with at least 10A source current capability
- Electronic loads capable of sinking current up to 10A
- Digital Multimeters (DMMs)
- 100MHz quad-trace oscilloscope

Quick Test Guide

1. Ensure that the circuit is correctly connected to the supply and electronic loads prior to applying any power. Please refer to Figure 3. on page 3 for proper setup.
2. Turn on the power supply.
3. Adjust input voltage V_{IN} within the specified range and observe output voltage. The output voltage variation should be within 3%.
4. Adjust load current within the specified range and observe output voltage. The output voltage variation should be within 3%.
5. Use an oscilloscope to observe output voltage ripple and phase node ringing. For accurate measurement, please refer to Figure 2 for proper test setup.

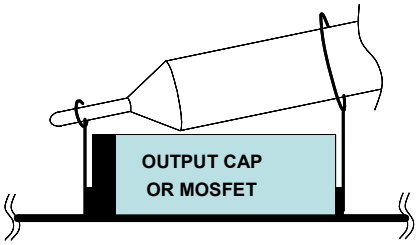

FIGURE 2. PROPER PROBE SETUP TO MEASURE OUTPUT RIPPLE AND PHASE NODE RINGING

Functional Description

The ISL8117DEMO3Z is a compact design with high efficiency and high power density.

As shown in Figure 3 on page 3, 4.5V to 60V V_{IN} is supplied to J1 (+) and J2 (-). The regulated 3.3V output on J3 (+) and J5 (-) can supply up to 6A to the load.

Operating Range

The input voltage range is from 4.5V to 60V for an output voltage of 3.3V. The rated load current is 6A with the OCP point set at a minimum 8A at room temperature ambient conditions.

The ISL8117 has an operating temperature range of -40°C to +125°C. Please note that airflow is needed.

Evaluating the Other Output Voltages

The ISL8117DEMO3Z output is preset to 3.3V, however, the output can be adjusted from 1.8V to 5V. The output voltage programming resistor, R_2, will depend on the desired output voltage of the regulator and the value of the feedback resistor R_1, as shown in Equation 1.

$$R_2 = R_1\left(\frac{0.6}{V_{OUT} - 0.6}\right) \quad \text{(EQ. 1)}$$

Table 2 shows the component selection that should be used for the respective V_{OUT} of 1.8V, 3.3V and 5V.

TABLE 2. EXTERNAL COMPONENT SELECTION

V_{OUT} (V)	R_2 (kΩ)
1.8	24.9
3.3	11
5	6.8

PCB Layout Guidelines

Careful attention to layout requirements is necessary for successful implementation of an ISL8117 based DC/DC converter. The ISL8117 switches at a very high frequency and therefore the switching times are very short. At these switching frequencies, even the shortest trace has significant impedance. Also, the peak gate drive current rises significantly in an extremely short time. Transition speed of the current from one device to another causes voltage spikes across the interconnecting impedances and parasitic circuit elements. These voltage spikes can degrade efficiency, generate EMI and increase device overvoltage stress and ringing. Careful component selection and proper PC board layout minimizes the magnitude of these voltage spikes.

There are three sets of critical components in a DC/DC converter using the ISL8117:

- The controller
- The switching power components
- The small signal components

The switching power components are the most critical from a layout point of view because they switch a large amount of energy, which tends to generate a large amount of noise. The critical small signal components are those connected to sensitive nodes or those supplying critical bias currents. A multilayer printed circuit board is recommended.

Layout Considerations

1. The input capacitors, upper FET, lower FET, inductor and output capacitor should be placed first. Isolate these power components on dedicated areas of the board with their ground terminals adjacent to one another. Place the input high frequency decoupling ceramic capacitors very close to the MOSFETs.
2. If signal components and the IC are placed in a separate area to the power train, it is recommended to use full ground planes in the internal layers with shared SGND and PGND to simplify the layout design. Otherwise, use separate ground planes for power ground and small signal ground. Connect the SGND and PGND together close to the IC. DO NOT connect them together anywhere else.
3. The loop formed by the input capacitor, the top FET and the bottom FET must be kept as small as possible.
4. Ensure the current paths from the input capacitor to the MOSFET, to the output inductor and the output capacitor are as short as possible with maximum allowable trace widths.
5. Place the PWM controller IC close to the lower FET. The LGATE connection should be short and wide. The IC can be best placed over a quiet ground area. Avoid switching ground loop currents in this area.
6. Place VCC5V bypass capacitor very close to the VCC5V pin of the IC and connect its ground to the PGND plane.
7. Place the gate drive components (optional BOOT diode and BOOT capacitors)- together near the controller IC.
8. The output capacitors should be placed as close to the load as possible. Use short wide copper regions to connect output capacitors to load to avoid inductance and resistances.
9. Use copper filled polygons or wide but short trace to connect the junction of the upper FET, lower FET and output inductor. Also keep the PHASE node connection to the IC short. DO NOT unnecessarily oversize the copper islands for the PHASE node. Since the phase nodes are subjected to very high dv/dt voltages, the stray capacitor formed between these islands and the surrounding circuitry will tend to couple switching noise.
10. Route all high speed switching nodes away from the control circuitry.
11. Create a separate small analog ground plane near the IC. Connect the SGND pin to this plane. All small signal grounding paths including feedback resistors, current limit setting resistor, soft-starting capacitor and EN pull-down resistor should be connected to this SGND plane.
12. Separate the current sensing trace from the PHASE node connection.
13. Ensure the feedback connection to the output capacitor is short and direct.

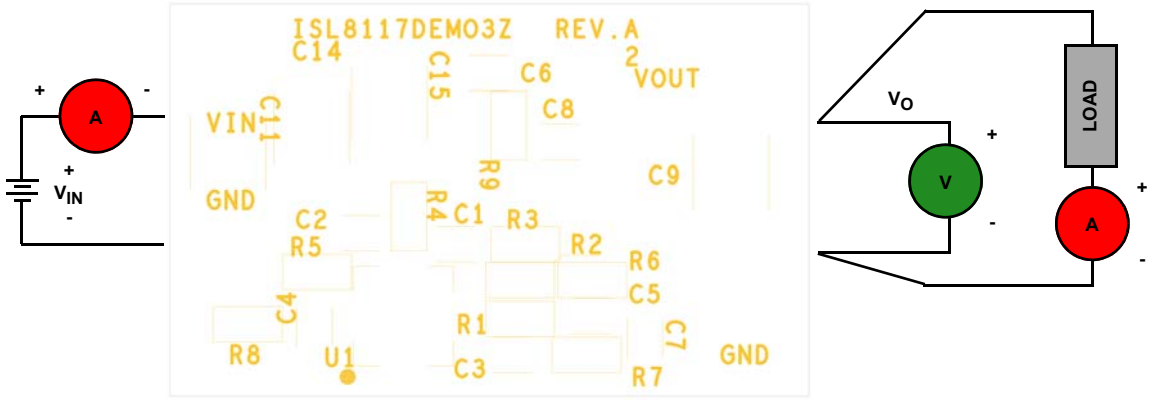

FIGURE 3. PROPER TEST SETUP

ISL8117DEMO3Z Demonstration Board

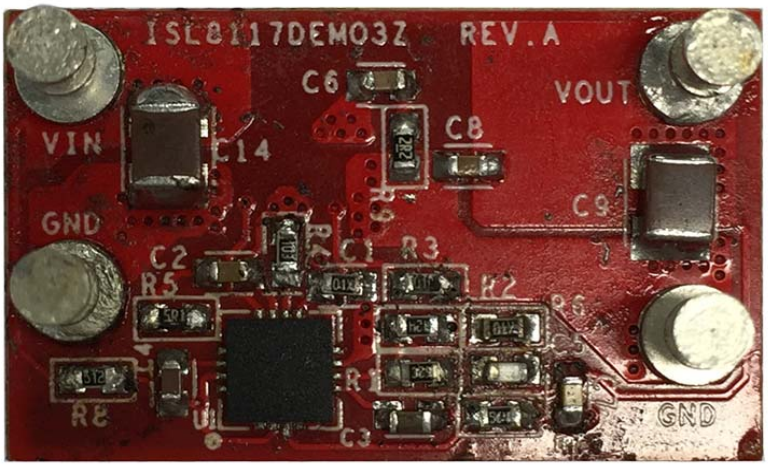

FIGURE 4. ISL8117DEMO3Z TOP SIDE

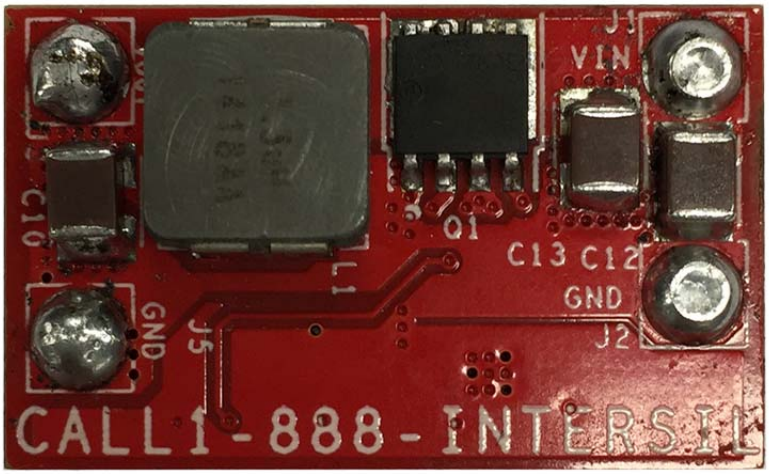

FIGURE 5. ISL8117DEMO3Z BOTTOM SIDE

Schematic

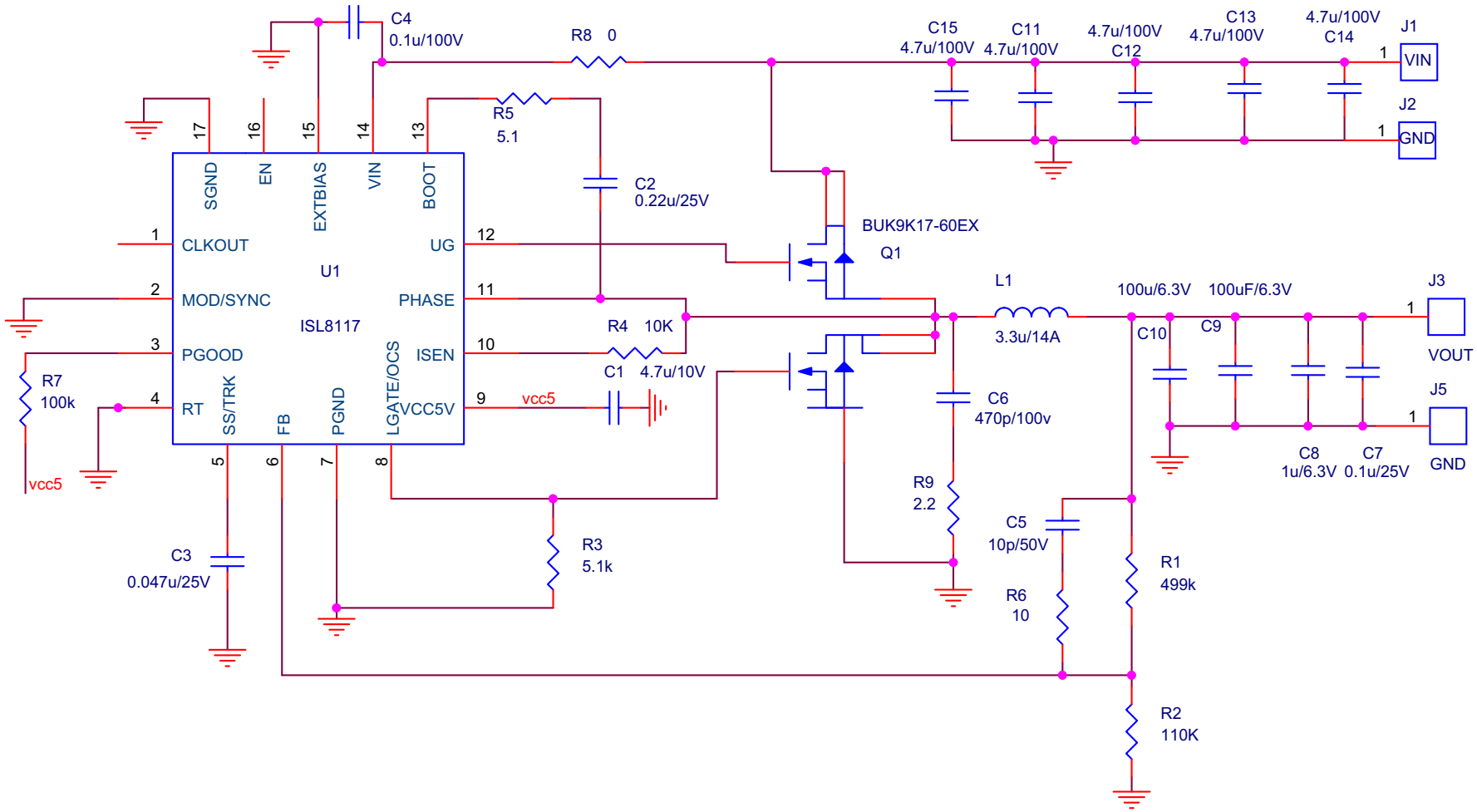

FIGURE 6. ISL8117DEM03Z SCHEMATIC

ISL8117DEMO3Z Bill of Materials

MANUFACTURER PART	QTY	UNITS	REFERENCE DESIGNATOR	DESCRIPTION	MANUFACTURER
ISL8117DEMO3ZREVAPCB	1	ea.		PWB-PCB, ISL8117DEMO3Z, REVA, ROHS	SHENZHEN MULTILAYER PCB TECHNOLOGY CO., LTD
GRM32EC70J107ME15L	2	ea	C9, C10	CAP, SMD, 1210, 100µF, 6.3V, 20%, X7S, ROHS	MURATA
C0603COG500-100KDE	1	ea	C5	CAP, SMD, 0603, 10pF, 50V, 10%, NP0, ROHS	VENKEL
C0603X7R101-104KNE	1	ea	C4	CAP, SMD, 0603, 0.1µF, 100V, 10%, X7R, ROHS	VENKEL
GRM188R71E104KA01D	1	ea	C7	CAP, SMD, 0603, 0.1µF, 25V, 10%, X7R, ROHS	MURATA
ECJ1VB0J105K	1	ea	C8	CAP, SMD, 0603, 1µF, 6.3V, 10%, X5R, ROHS	PANASONIC
C1608X7R1E224K	1	ea	C2	CAP, SMD, 0603, 0.22µF, 25V, 10%, X7R, ROHS	TDK
VJ0603Y471KXBA	1	ea	C6	CAP, SMD, 0603, 470pF, 100V, 10%, X7R, ROHS	VISHAY
GRM188R71E473KA01D	1	ea	C3	CAP, SMD, 0603, 0.047µF, 25V, 10%, X7R, ROHS	MURATA
C0603X5R100-475KNE	1	ea	C1	CAP, SMD, 0603, 4.7µF, 10V, 10%, X5R, ROHS	VENKEL
CGA6M3X7S2A475K200AB	5	ea	C11, C12, C13, C14, C15	CAP, SMD, 1210, 4.7µF, 100V, 10%, X7S, ROHS	TDK
IHLP3232DZER3R3M11	1	ea	L1	COIL-PWR INDUCTOR, SMD, 8.6X8, 3.3µH, 20%, 10.5A, 14.9mΩ, ROHS	VISHAY
1514-2	4	ea	J1, J2, J3, J5	CONN-TURRET, TERMINAL POST, TH, ROHS	KEYSTONE
ISL8117FRZ	1	ea	U1	IC-55V SWITCHING CONTROLLER, 16P, QFN, ROHS	INTERSIL
BUK9K17-60EX	1	ea	Q1	TRANSIST-MOS, DUAL N-CHANNEL, SMD, 8P, 56LFPAK, 60V, 26A, ROHS	NXP SEMICONDUCTOR
RK73H1JT10R0F	1	ea	R6	RES, SMD, 0603, 10Ω, 1/10W, 1%, TF, ROHS	KOA
ERJ-3RQF2R2V	1	ea	R9	RES, SMD, 0603, 2.2Ω, 1/10W, 1%, TF, ROHS	PANASONIC
CR0603-10W-05R1FT	1	ea	R5	RES, SMD, 0603, 5.1Ω, 1/10W, 1%, TF, ROHS	VENKEL
CR0603-10W-000T	1	ea	R8	RES, SMD, 0603, 0Ω, 1/10W, TF, ROHS	VENKEL
CR0603-10W-1002FT	1	ea	R4	RES, SMD, 0603, 10k, 1/10W, 1%, TF, ROHS	VENKEL
CR0603-10W-1003FT	1	ea	R7	RES, SMD, 0603, 100k, 1/10W, 1%, TF, ROHS	VENKEL
ERJ-3EkF1103V	1	ea	R2	RES, SMD, 0603, 110k, 1/10W, 1%, TF, ROHS	PANASONIC
ERJ-3EKF4993V	1	ea	R1	RES, SMD, 0603, 499k, 1/10W, 1%, TF, ROHS	PANASONIC
CR0603-10W-5101FT	1	ea	R3	RES, SMD, 0603, 5.1k, 1/10W, 1%, TF, ROHS	VENKEL

ISL8117DEMO3Z PCB Layout

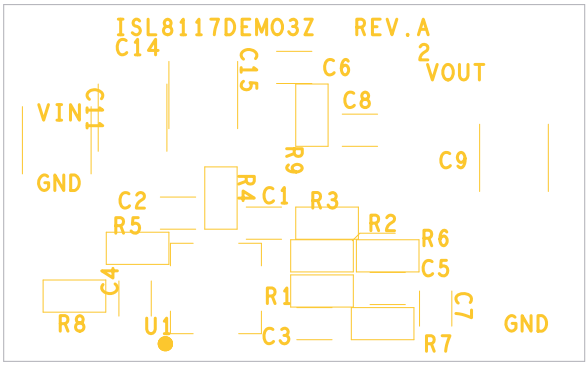

FIGURE 7. SILKSCREEN TOP

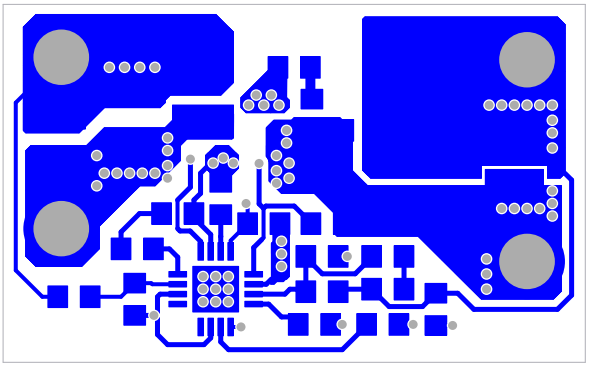

FIGURE 8. TOP LAYER

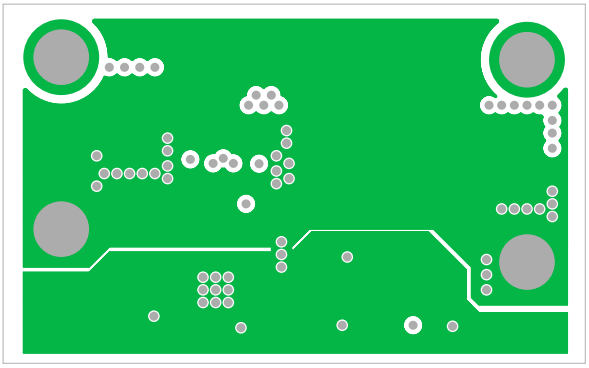

FIGURE 9. SECOND LAYER (SOLID GROUND)

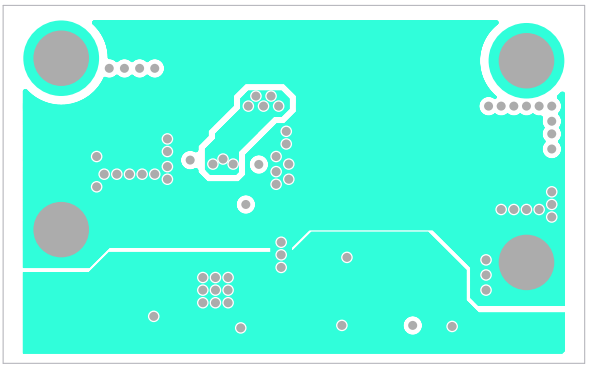

FIGURE 10. THIRD LAYER

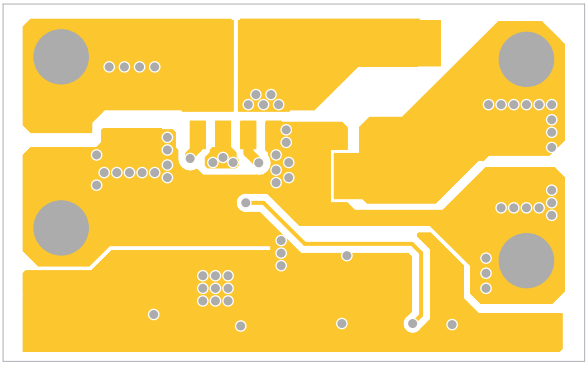

FIGURE 11. BOTTOM LAYER

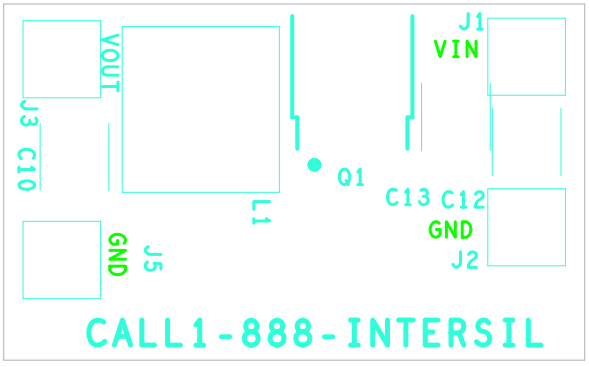

FIGURE 12. SILKSCREEN BOTTOM

Typical Demonstration Board Performance Curves

V_{IN} = 24V, V_{OUT} = 3.3V, unless otherwise noted.

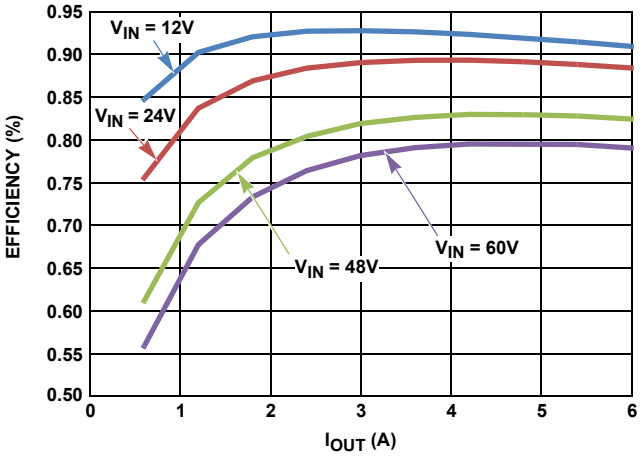

FIGURE 13. CCM EFFICIENCY

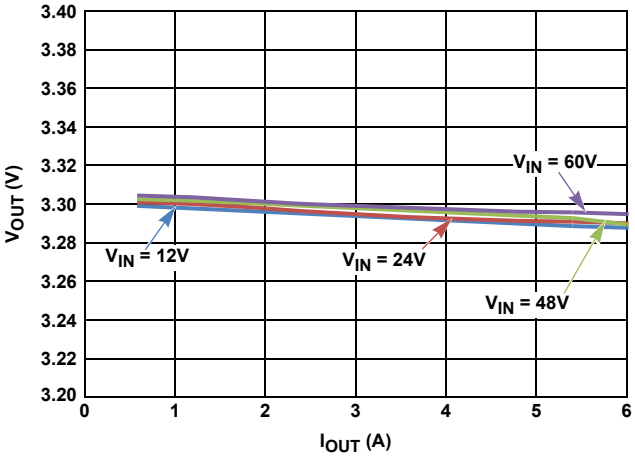

FIGURE 14. CCM LOAD REGULATION

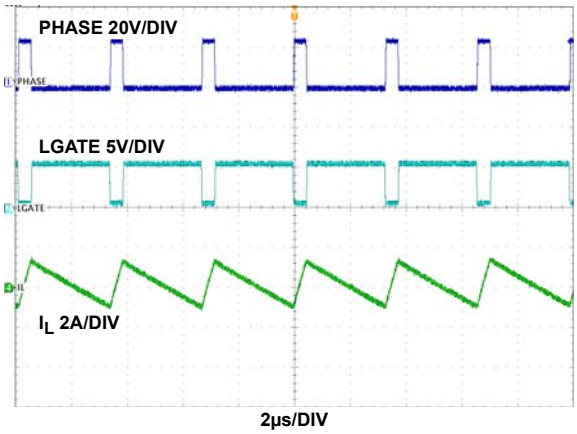

FIGURE 15. PHASE, LGATE AND INDUCTOR CURRENT WAVEFORMS, I_O = 0A

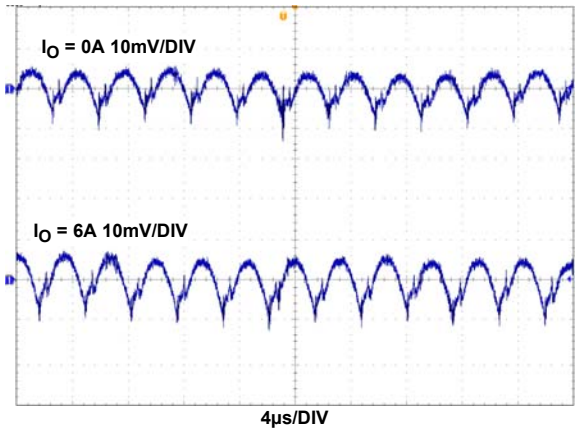

FIGURE 16. OUTPUT RIPPLE, MODE = CCM

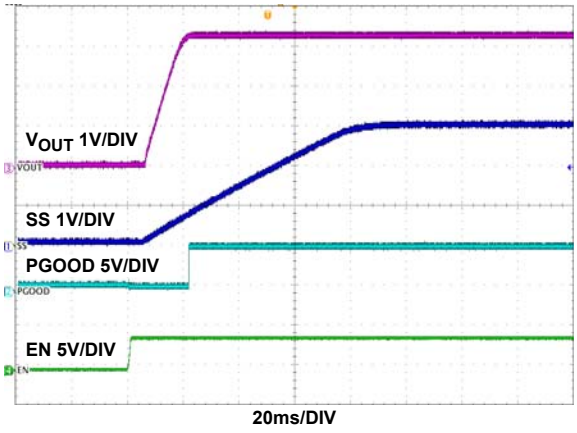

FIGURE 17. CCM START-UP WAVEFORMS: V_{OUT}, SS, PGOOD, EN, I_O = 0A

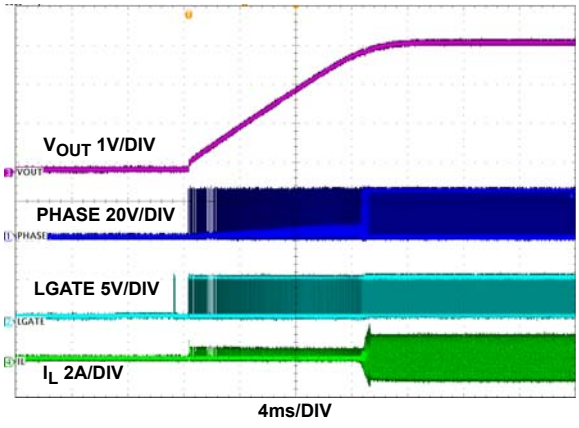

FIGURE 18. CCM START-UP WAVEFORMS: V_{OUT}, PHASE, LGATE, I_L, I_O = 0A

Typical Demonstration Board Performance Curves V_{IN} = 24V, V_{OUT} = 3.3V, unless otherwise noted. **(Continued)**

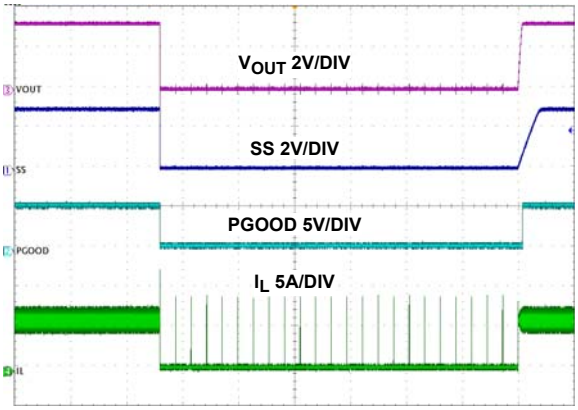

FIGURE 19. SHORT-CIRCUIT WAVEFORMS