

# ISL85415DEMO1Z

Wide VIN 500mA Synchronous Buck Regulator

AN1860  
Rev 2.00  
May 16, 2014

## Description

The ISL85415DEMO1Z kit is intended for use for point-of-load applications sourcing from 3V to 36V. The kit is used to demonstrate the performance of the ISL85415 Wide VIN Low Quiescent Current High Efficiency Sync Buck Regulator with 500mA output current.

The ISL85415 is offered in a 4mmx3mm 12 Ld DFN package with 1mm maximum height. The converter occupies 1.516 cm<sup>2</sup> area.

## Key Features

- Wide input voltage range 3V to 36V
- Synchronous operation for high efficiency
- No compensation required
- Integrated high-side and low-side NMOS devices
- Selectable PFM or forced PWM mode at light loads
- Internal fixed (500kHz) or adjustable switching frequency 300kHz to 2MHz
- Continuous output current up to 500mA
- Internal or external soft-start
- Minimal external components required
- Power-good and enable functions available

## Recommended Equipment

The following materials are recommended to perform testing:

- 0V to 50V power supply with at least 2A source current capability
- Electronic Loads capable of sinking current up to 1.5A
- Digital multimeters (DMMs)
- 100MHz quad-trace oscilloscope
- Signal generator

## Quick Setup Guide

1. Ensure that the circuit is correctly connected to the supply and loads prior to applying any power.
2. Connect the bias supply to VIN, the plus terminal to VIN (P4) and the negative return to GND (P5).
3. Turn on the power supply.
4. Verify the output voltage is 3.3V for V<sub>OUT</sub>.

## Evaluating the Other Output Voltage

The ISL85415DEMO1Z kit output is preset to 3.3V; however, output voltages can be adjusted from 0.6V to 15V. The output voltage programming resistor, R<sub>2</sub>, will depend on the desired output voltage of the regulator and the value of the feedback resistor R<sub>1</sub>, as shown in [Equation 1](#).

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

If the output voltage desired is 0.6V, then R<sub>1</sub> is shorted. Please note that if V<sub>OUT</sub> is less than 1.8V, the switching frequency and compensation must be changed for 300kHz operation due to minimum on-time limitation. Please refer to datasheet [ISL85415](#) for further information.

[Table 1](#) on [page 2](#) shows the component selection that should be used for the respective V<sub>OUT</sub>s.



FIGURE 1. FRONT OF EVALUATION BOARD ISL85415DEMO1Z



FIGURE 2. BACK OF EVALUATION BOARD ISL85415DEMO1Z

TABLE 1. EXTERNAL COMPONENT SELECTION

| V <sub>OUT</sub><br>(V) | L <sub>1</sub><br>(μH) | C <sub>OUT</sub><br>(μF) | R <sub>1</sub><br>(kΩ) | R <sub>2</sub><br>(kΩ) | C <sub>FB</sub><br>(pF) | R <sub>FS</sub><br>(kΩ) | R <sub>COMP</sub><br>(kΩ) | C <sub>COMP</sub><br>(pF) |
|-------------------------|------------------------|--------------------------|------------------------|------------------------|-------------------------|-------------------------|---------------------------|---------------------------|
| 12                      | 45                     | 10                       | 90.9                   | 4.75                   | 22                      | 115                     | 100                       | 470                       |
| 5                       | 22                     | 2x22                     | 90.9                   | 12.4                   | 100                     | 120                     | 100                       | 470                       |
| 3.3                     | 22                     | 2x22                     | 90.9                   | 20                     | 100                     | 120                     | 100                       | 470                       |
| 2.5                     | 22                     | 2x22                     | 90.9                   | 28.7                   | 100                     | 120                     | 100                       | 470                       |
| 1.8                     | 22                     | 22                       | 100                    | 50                     | 22                      | 120                     | 50                        | 470                       |

## Frequency Control

The ISL85415 has an FS pin that controls the frequency of operation. Programmable frequency allows for optimization between efficiency and external component size. It also allows low frequency operation for low V<sub>OUTS</sub> when minimum on time would limit the operation otherwise. Default switching frequency is 500kHz when FS is tied to V<sub>CC</sub> (R<sub>10</sub> = 0). By removing R<sub>10</sub> the switching frequency could be changed from 300kHz (R<sub>12</sub> = 340k) to 2MHz (R<sub>12</sub> = 32.4k). Please refer to datasheet [ISL85415](#) for calculating the value of R<sub>10</sub>. Do not leave this pin floating.

## Disabling/Enabling Function

ISL85415DEMO1Z board has EN pin tied to VCC via R7. This keeps the part enabled all the time. To disable the part, remove R7 and populate R8 with a 0Ω resistor.

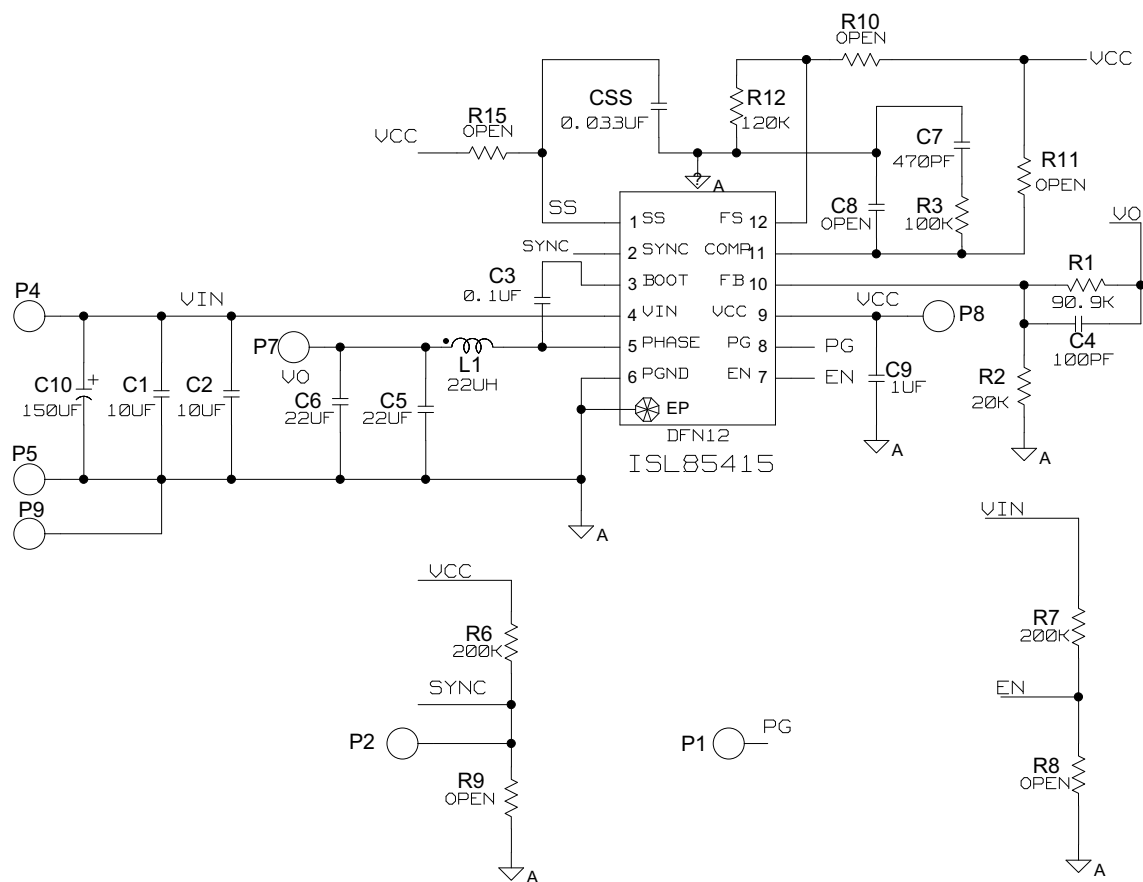
## SYNC Control

The ISL85415 evaluation board has a SYNC pin that allows external synchronization frequency to be applied. Default board configuration has R<sub>6</sub> = 200k to V<sub>CC</sub>, which defaults to PWM operation mode and also to the pre-selected switching frequency set by R<sub>12</sub> (see datasheet and previous section [“Frequency Control”](#) for details). If this pin is tied to GND the IC will operate in PFM mode. For PFM operation, remove R<sub>6</sub> and populate R<sub>9</sub> with 0Ω resistor.

## Soft-Start /COMP Control

R<sub>15</sub> selects between internal (R<sub>15</sub> = 0) and external soft-start. R<sub>11</sub> selects between internal (R<sub>11</sub> = 0) and external compensation. Please refer to Pin Description Table (Page 3) of the [ISL85415](#) datasheet.

# ISL85415DEMO1Z Schematic



**NOTE:** If the IC is used in an application where the input test leads have large parasitic inductance, the input electrolytic capacitor C10 may be added to prevent transient voltages on the input pin.

## ISL85415DEMO1Z Bill of Materials

| PART NUMBER           | QTY | UNIT | REFERENCE DESIGNATOR | DESCRIPTION                                                | MANUFACTURER      | MANUFACTURER PART     |
|-----------------------|-----|------|----------------------|------------------------------------------------------------|-------------------|-----------------------|
| ISL85400EVAL2ZREVAPCB | 1   | ea   | LABEL-RENAME BOARD   | PWB-PCB,<br>ISL85400EVAL2Z, REVA,<br>ROHS                  | INTERSIL          | ISL85400EVAL2ZREVAPCB |
| EEE-FK1H151P-T (DNP)  | 1   | ea   | C10 (OPTIONAL)       | CAP, SMD, 10.3mm,<br>150μF, 50V, 20%, ROHS,<br>ALUM.ELEC.  | PANASONIC         | EEE-FK1H151P          |
| H1044-00101-50V5-T    | 1   | ea   | C4                   | CAP, SMD, 0402, 100pF,<br>50V, 5%, COG, ROHS               | MURATA            | GRM1555C1H101JZ01D    |
| H1044-00333-16V10-T   | 1   | ea   | CSS                  | CAP, SMD, 0402,<br>33000pF, 16V, 10%,<br>X7R, ROHS         | MURATA            | GRM36X7R333K016AQ     |
| H1044-00471-50V10-T   | 1   | ea   | C7                   | CAP, SMD, 0402, 470pF,<br>50V, 10%, X7R, ROHS              | PANASONIC         | ECJ-0EB1H471K         |
| H1044-DNP             | 0   | ea   | C8                   | CAP, SMD, 0402,<br>DNP-PLACE HOLDER,<br>ROHS               |                   |                       |
| H1045-00104-50V10-T   | 1   | ea   | C3                   | CAP, SMD, 0603, 0.1μF,<br>50V, 10%, X7R, ROHS              | AVX               | 06035C104KAT2A        |
| H1045-00105-16V10-T   | 1   | ea   | C9                   | CAP, SMD, 0603, 1μF,<br>16V, 10%, X5R, ROHS                | MURATA            | GRM188R61C105KA12D    |
| H1065-00106-50V10-T   | 2   | ea   | C1, C2               | CAP, SMD, 1206, 10μF,<br>50V, 10%, X5R, ROHS               | TDK               | C3216X5R1H106K        |
| H1065-00226-6R3V10-T  | 2   | ea   | C5, C6               | CAP, SMD, 1206, 22μF,<br>6.3V, 10%, X5R, ROHS              | MURATA            | GRM31CR60J226KE19L    |
| 74408943220           | 1   | ea   | L1                   | COIL-PWR INDUCTOR,<br>SMD, 4.8mm, 22μH,<br>20%, 1.1A, ROHS | Würth Electronics | 74408943220           |
| 5000                  | 2   | ea   | P4, P7               | CONN-MINI TEST PT,<br>VERTICAL, RED, ROHS                  | KEYSTONE          | 5000                  |
| 5001                  | 2   | ea   | P5, P9               | CONN-MINI TEST PT,<br>VERTICAL, BLK, ROHS                  | KEYSTONE          | 5001                  |
| 5002                  | 2   | ea   | P1, P2               | CONN-MINI TEST POINT,<br>VERTICAL, WHITE, ROHS             | KEYSTONE          | 5002                  |
| ISL85415FRZ           | 1   | ea   | U1                   | IC-500mA BUCK<br>REGULATOR, 12P, DFN,<br>3x4, ROHS         | INTERSIL          | ISL85415FRZ           |
| H2510-01003-1/16W1-T  | 1   | ea   | R3                   | RES, SMD, 0402, 100k,<br>1/16W, 1%, TF, ROHS               | PANASONIC         | ERJ2RKF1003           |
| H2510-01203-1/16W1-T  | 1   | ea   | R12                  | RES, SMD, 0402, 120k,<br>1/16W, 1%, TF, ROHS               | ROHM              | MCR01MZPF1203         |
| H2510-02002-1/16W1-T  | 1   | ea   | R2                   | RES, SMD, 0402, 20k,<br>1/16W, 1%, TF, ROHS                | PANASONIC         | ERJ2RKF2001           |
| H2510-02003-1/16W1-T  | 2   | ea   | R6, R7               | RES, SMD, 0402, 200k,<br>1/16W, 1%, TF, ROHS               | ROHM              | MCR01MZPF2003         |
| H2510-09092-1/16W1-T  | 1   | ea   | R1                   | RES, SMD, 0402, 90.9k,<br>1/16W, 1%, TF, ROHS              | VISHAY/DALE       | CRCW040290K9FKED      |

## ISL85415DEMO1Z Bill of Materials (Continued)

| PART NUMBER        | QTY | UNIT | REFERENCE DESIGNATOR                 | DESCRIPTION                                                | MANUFACTURER | MANUFACTURER PART  |
|--------------------|-----|------|--------------------------------------|------------------------------------------------------------|--------------|--------------------|
| H2510-DNP          | 0   | ea   | R8-R11, R15                          | RES, SMD, 0402, DNP, DNP, DNP, TF, ROHS                    |              |                    |
| 2X3-STATIC-BAG     | 1   | ea   | PLACE ASSY IN BAG                    | BAG, STATIC, 2x3, ZIP LOC                                  | TBD          | S-6509             |
| LABEL-DATE CODE    | 1   | ea   | AFFIX TO BACK OF PCB                 | LABEL-DATE CODE_BOM<br>REV#_SERIAL# LABEL<br>ON ZIL & QUEL | INTERSIL     | LABEL-DATE CODE    |
| LABEL-RENAME BOARD | 1   | ea   | RENAME TOP PCB TO:<br>ISL85415DEMO1Z | LABEL, TO RENAME<br>BOARD                                  | INTERSIL     | LABEL-RENAME BOARD |

## ISL85415DEMO1Z Board Layout

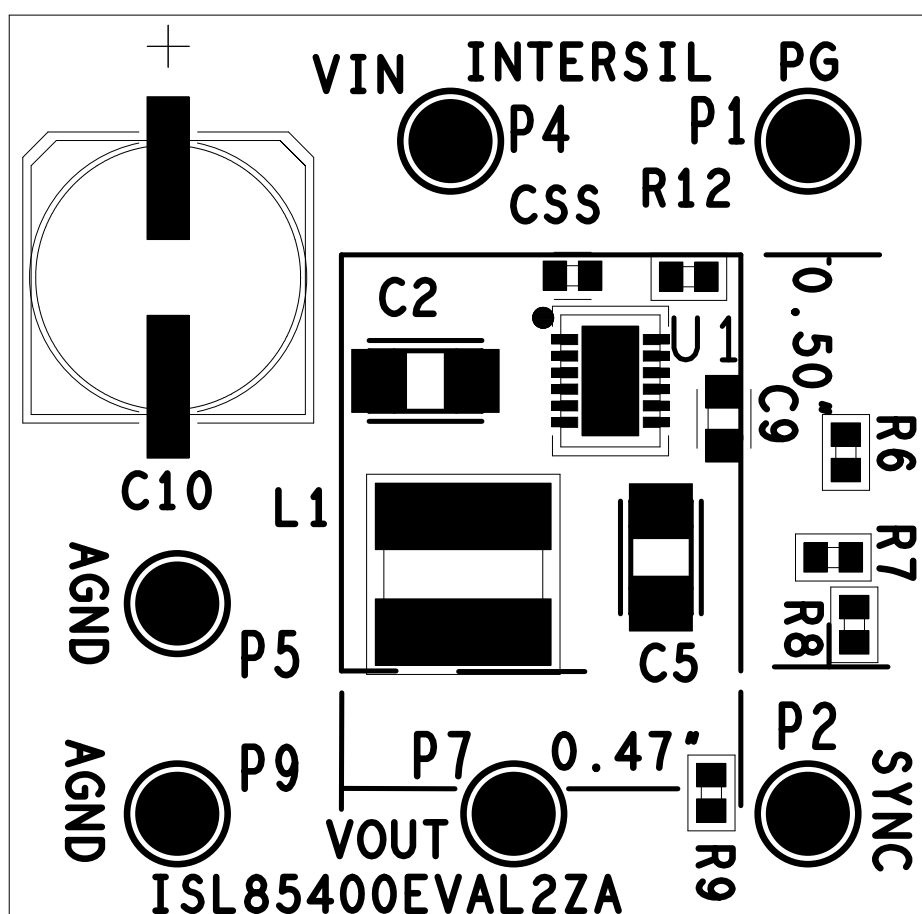


FIGURE 3. SILK SCREEN TOP

# ISL85415DEMO1Z Board Layout (Continued)

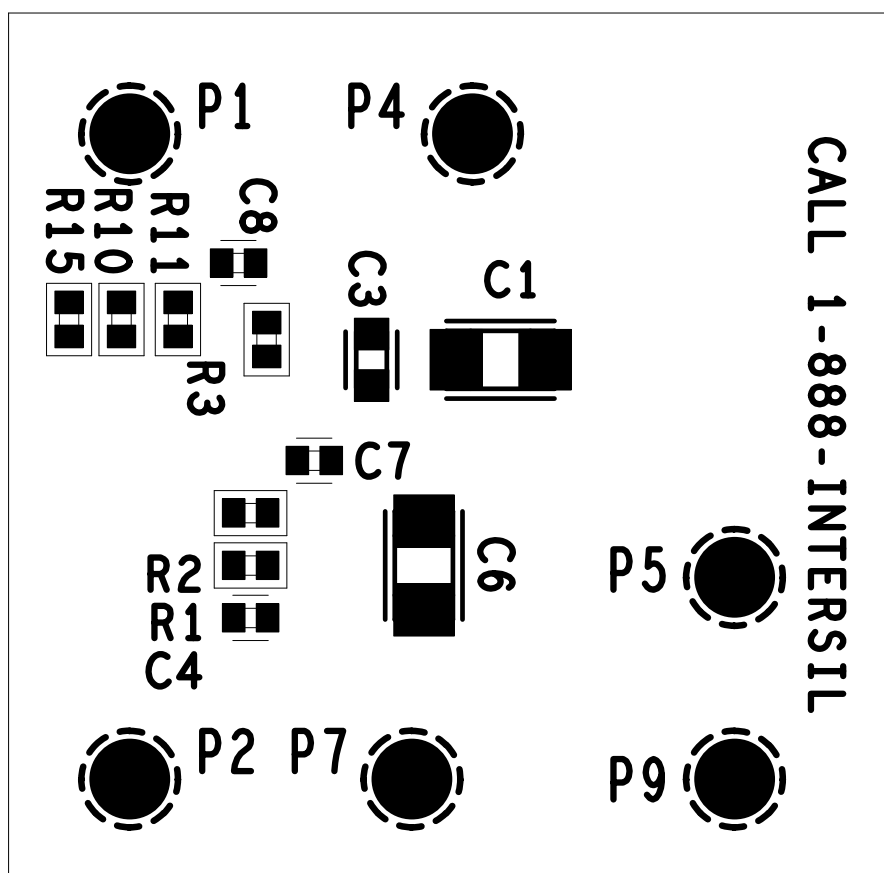
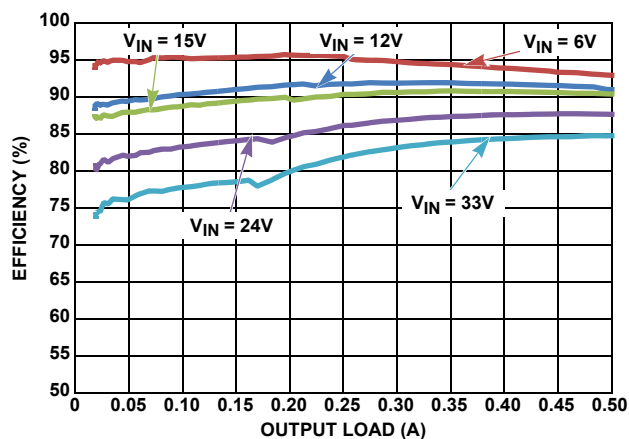
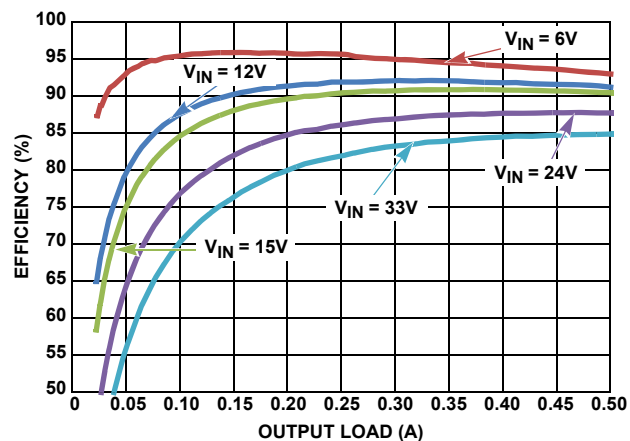
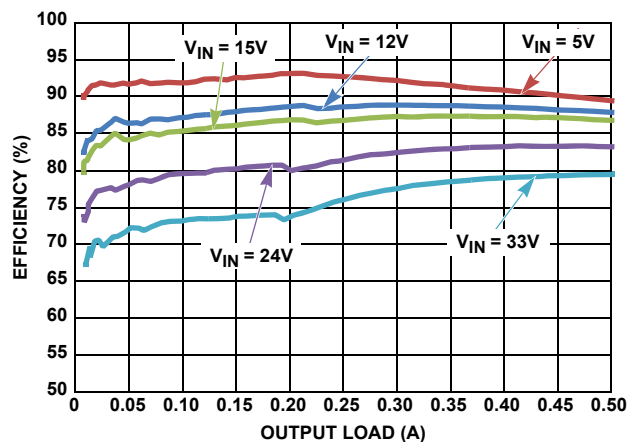
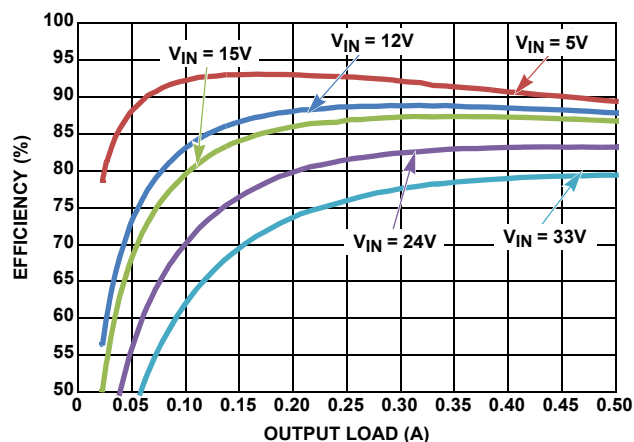
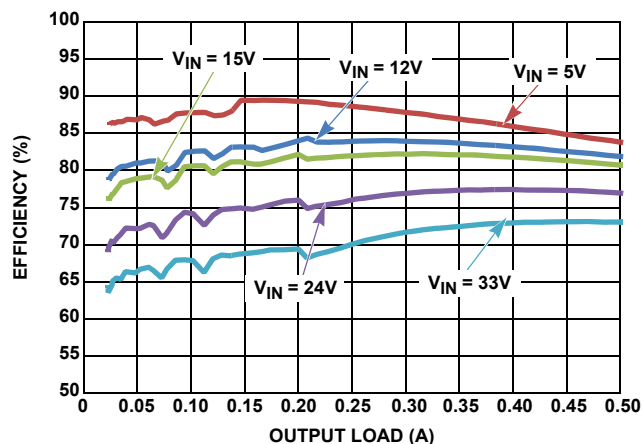
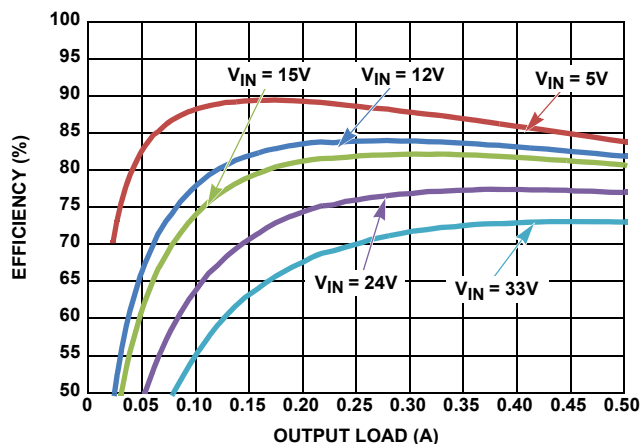
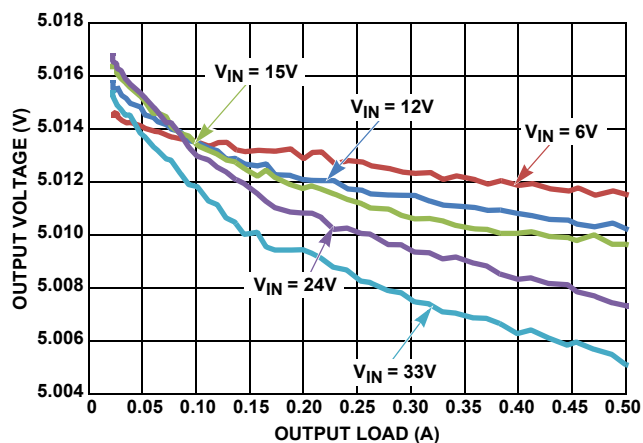
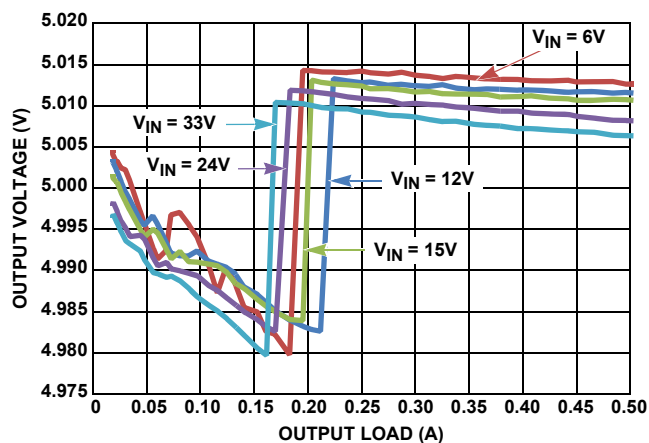


FIGURE 4. SILKSCREEN BOTTOM

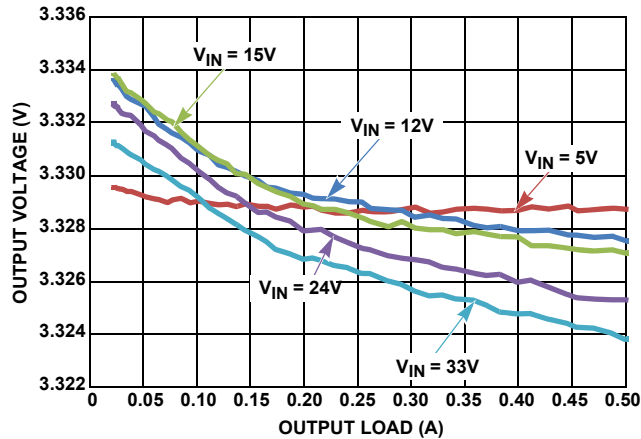
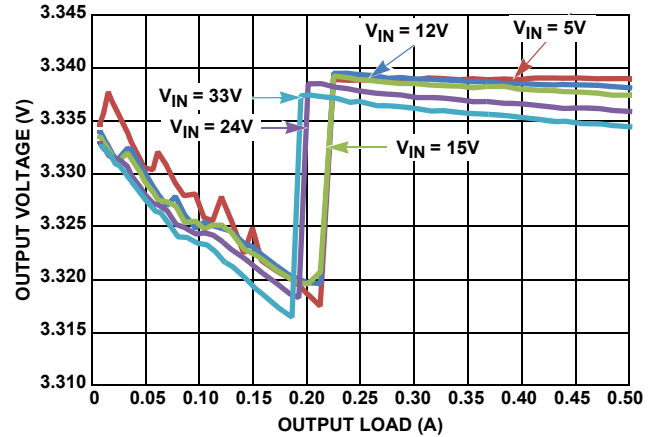
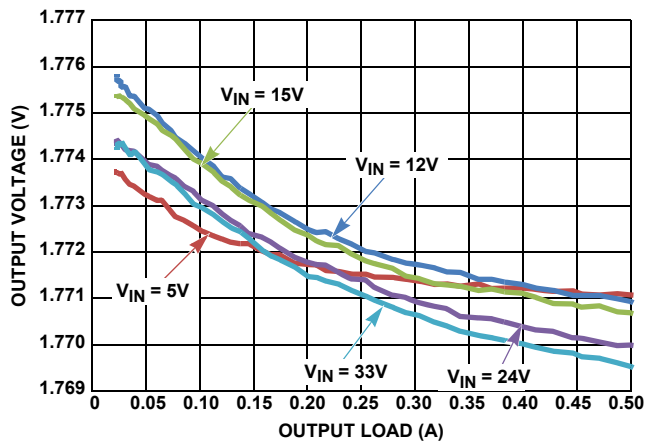
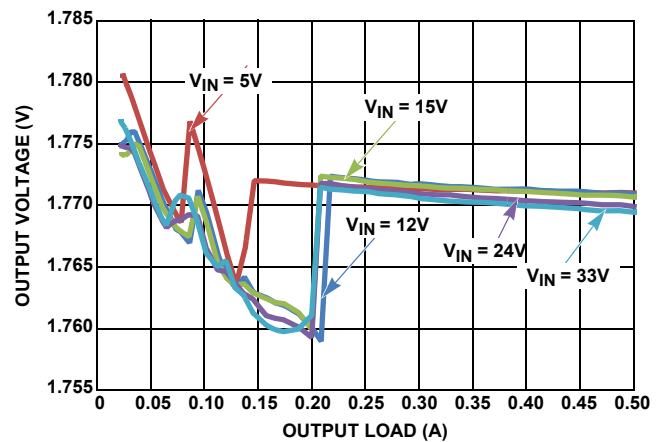
## Efficiency Curves $F_{SW} = 800\text{kHz}$ , $T_A = +25^\circ\text{C}$

FIGURE 5. EFFICIENCY vs LOAD, PFM,  $V_{OUT} = 5\text{V}$ FIGURE 6. EFFICIENCY vs LOAD, PWM,  $V_{OUT} = 5\text{V}$

# Efficiency Curves

 $F_{SW} = 800\text{kHz}$ ,  $T_A = +25^\circ\text{C}$  (Continued)
FIGURE 7. EFFICIENCY vs LOAD, PFM,  $V_{OUT} = 3.3\text{V}$ FIGURE 8. EFFICIENCY vs LOAD, PWM,  $V_{OUT} = 3.3\text{V}$ FIGURE 9. EFFICIENCY vs LOAD, PFM,  $V_{OUT} = 1.8\text{V}$ FIGURE 10. EFFICIENCY vs LOAD, PWM,  $V_{OUT} = 1.8\text{V}$ FIGURE 11.  $V_{OUT}$  REGULATION vs LOAD, PWM,  $V_{OUT} = 5\text{V}$ FIGURE 12.  $V_{OUT}$  REGULATION vs LOAD, PFM,  $V_{OUT} = 5\text{V}$

## Efficiency Curves $F_{SW} = 800\text{kHz}$ , $T_A = +25^\circ\text{C}$ (Continued)

FIGURE 13.  $V_{OUT}$  REGULATION vs LOAD, PWM,  $V_{OUT} = 3.3\text{V}$ FIGURE 14.  $V_{OUT}$  REGULATION vs LOAD, PFM,  $V_{OUT} = 3.3\text{V}$ FIGURE 15.  $V_{OUT}$  REGULATION vs LOAD, PWM,  $V_{OUT} = 1.8\text{V}$ FIGURE 16.  $V_{OUT}$  REGULATION vs LOAD, PFM,  $V_{OUT} = 1.8\text{V}$ 

## Typical Performance Curves $V_{IN} = 24\text{V}$ , $V_{OUT} = 3.3\text{V}$ , $F_{SW} = 800\text{kHz}$ , $T_A = +25^\circ\text{C}$ .

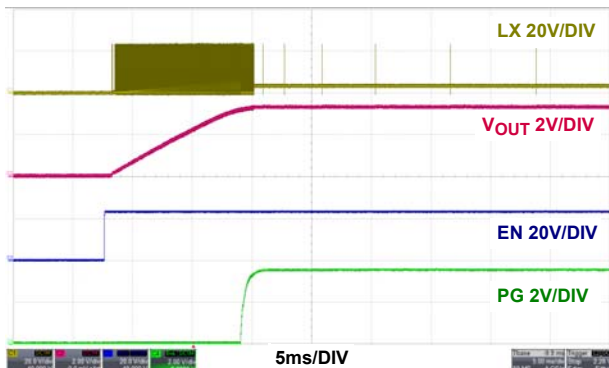


FIGURE 17. START-UP AT NO LOAD, PFM

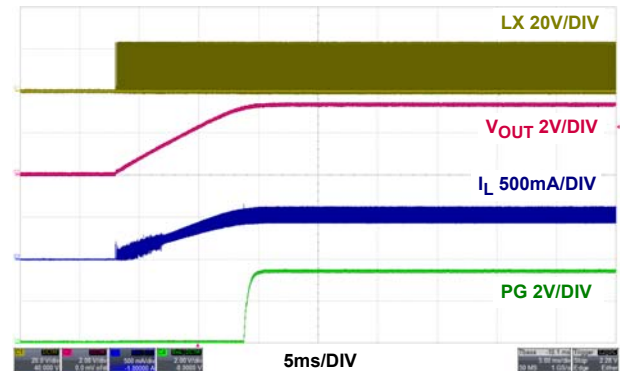


FIGURE 18. START-UP AT 500mA, PWM



## Typical Performance Curves $V_{IN} = 24V$ , $V_{OUT} = 3.3V$ , $F_{SW} = 800kHz$ , $T_A = +25^\circ C$ . (Continued)

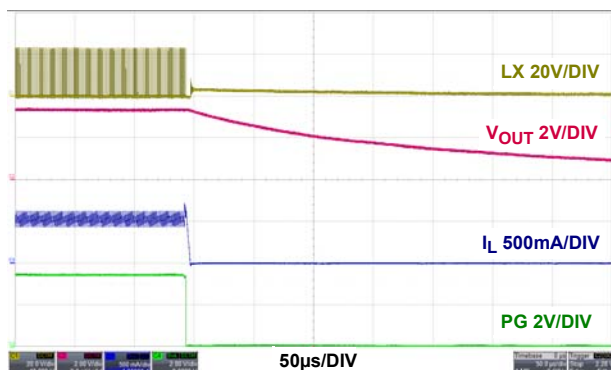


FIGURE 19. SHUTDOWN AT 500mA, PWM

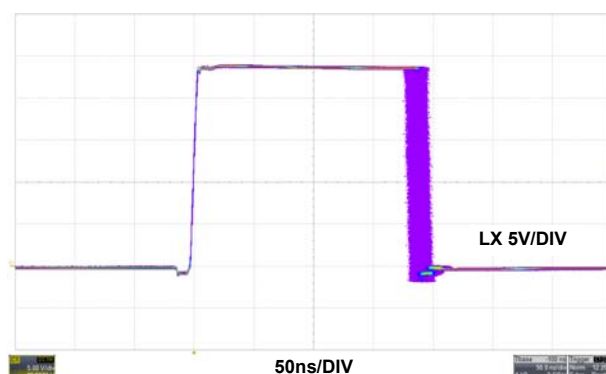


FIGURE 20. JITTER AT 500mA, PWM

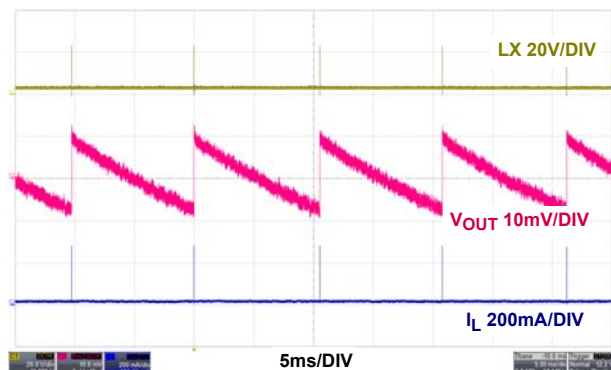


FIGURE 21. STEADY STATE AT NO LOAD, PFM

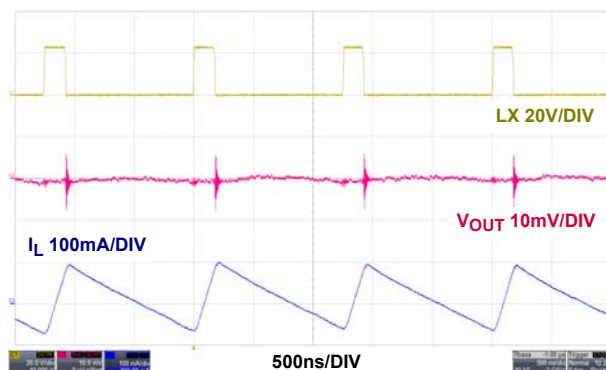


FIGURE 22. STEADY STATE AT NO LOAD, PWM

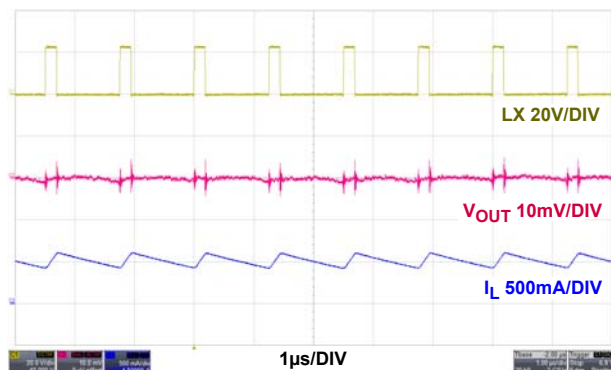


FIGURE 23. STEADY STATE AT 500mA LOAD, PWM

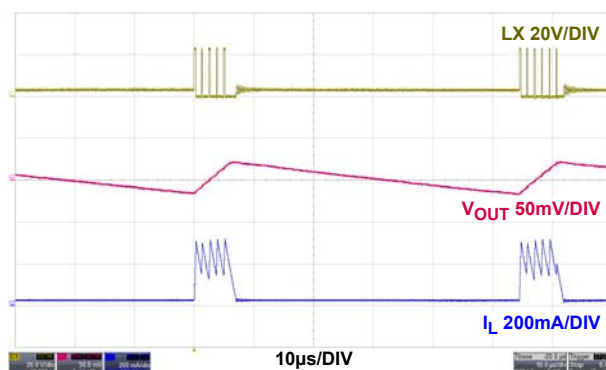


FIGURE 24. LIGHT LOAD OPERATION AT 20mA, PFM

## Typical Performance Curves $V_{IN} = 24V$ , $V_{OUT} = 3.3V$ , $F_{SW} = 800kHz$ , $T_A = +25^\circ C$ . (Continued)

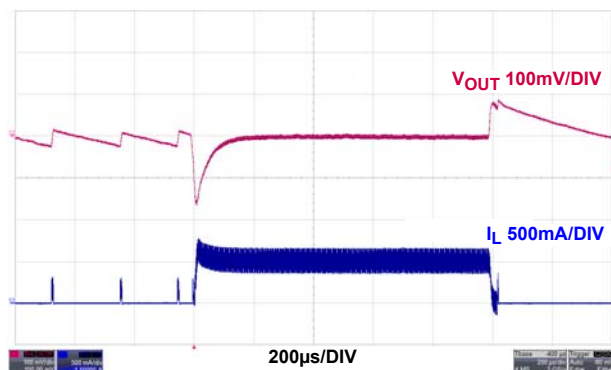


FIGURE 25. LOAD TRANSIENT, PFM

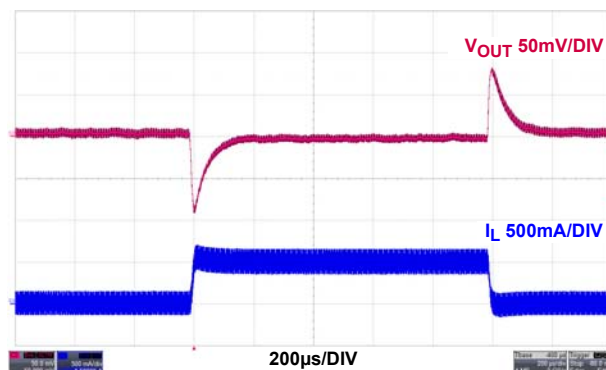


FIGURE 26. LOAD TRANSIENT, PWM

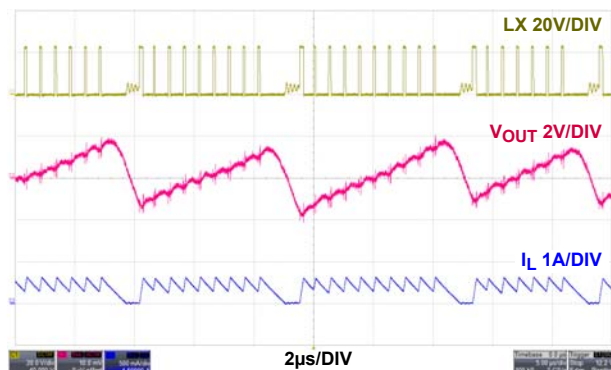


FIGURE 27. PFM TO PWM TRANSITION

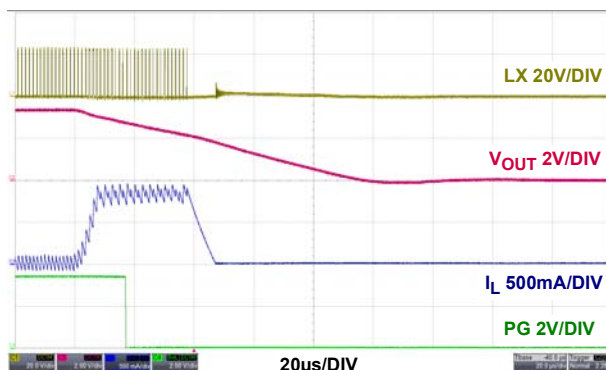


FIGURE 28. OVERCURRENT PROTECTION, PWM

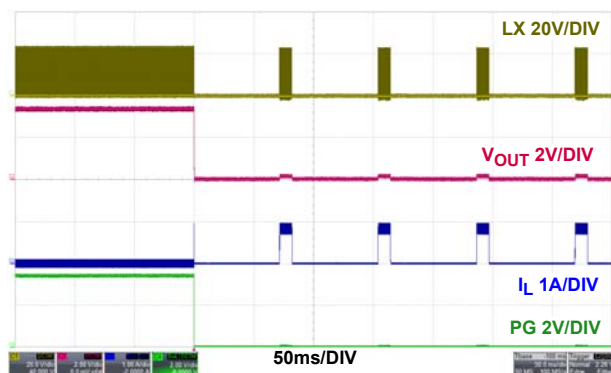


FIGURE 29. OVERCURRENT PROTECTION HICUP, PWM

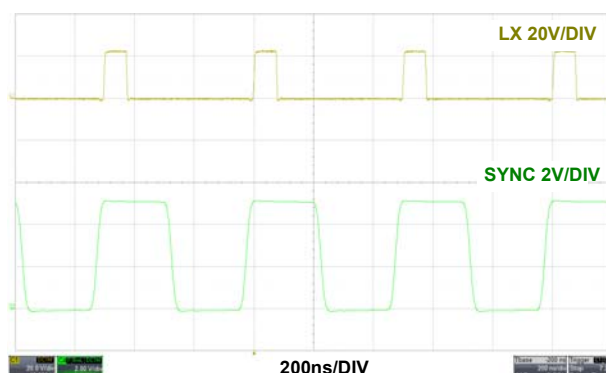


FIGURE 30. SYNC AT 500mA LOAD, PWM

## Typical Performance Curves $V_{IN} = 24V$ , $V_{OUT} = 3.3V$ , $F_{SW} = 800kHz$ , $T_A = +25^\circ C$ . (Continued)

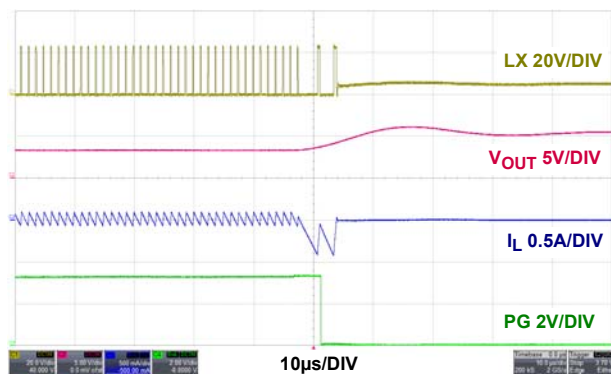


FIGURE 31. NEGATIVE CURRENT LIMIT, PWM

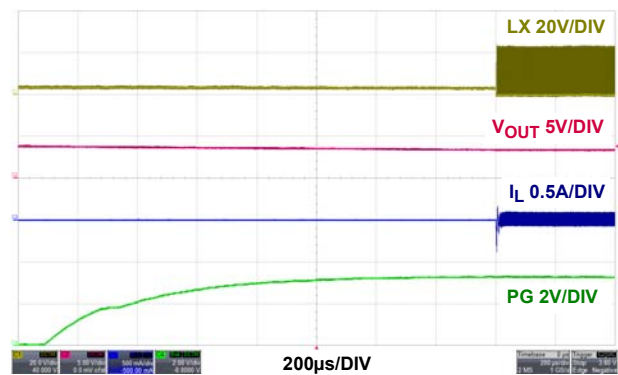


FIGURE 32. NEGATIVE CURRENT LIMIT RECOVERY, PWM

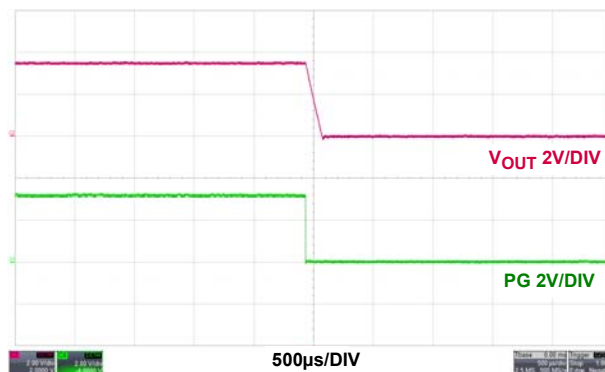


FIGURE 33. OVER-TEMPERATURE PROTECTION, PWM

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