*Author: Paul Orfanu*

# ISL85410EVAL1Z, ISL85410AEVAL1Z, ISL85418EVAL1Z Wide $V_{IN}$ 1A and 800mA Synchronous Buck Regulators

## Description

The ISL85410EVAL1Z, ISL85410AEVAL1Z, ISL85418EVAL1Z kits are intended for use for Point-of-Load applications sourcing from 3V to 36V. The kits are used to demonstrate the performance of the ISL85410, ISL85410A, ISL85418 Wide $V_{IN}$ Low Quiescent Current High Efficiency Sync Buck Regulators with 1A (ISL85410, ISL85410A) and 800mA (ISL85418EVAL1Z) output current.

The ISL85410, ISL85410A, ISL85418 are offered in a 4mmx3mm 12 Ld DFN package with 1mm maximum height. The converter occupies 1.516cm$^2$ 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 800mA
- 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 2A
- 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. Verify that the position is ON for S1.
4. Turn on the power supply.
5. Verify the output voltage is 3.3V for $V_{OUT}$.

### Evaluating the Other Output Voltage

The ISL85410EVAL1Z, ISL85410AEVAL1Z, ISL85418EVAL1Z kit outputs are preset to 3.3V; however, output voltages can be adjusted from 0.6V to 15V. The output voltage programming resistor, $R_3$, will depend on the desired output voltage of the regulator. The value for the feedback resistor is typically between 0Ω and 50kΩ as shown in Equation 1.

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

If the output voltage desired is 0.6V, then $R_1$ is shorted. Please note that if $V_{OUT}$ 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 datasheets ISL85410 and ISL85418 (FN8375/FN8369) for further information.

Table 1 on page 2 shows the component selection that should be used for the respective $V_{OUTs}$.

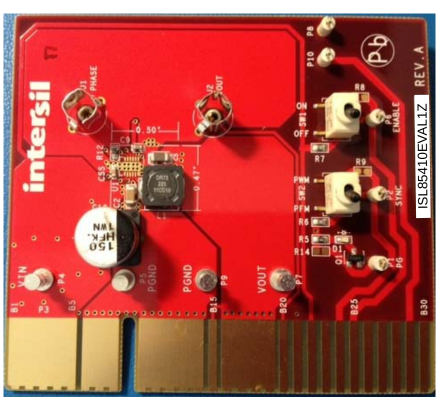



FIGURE 1. FRONT OF EVALUATION BOARD ISL85410EVAL1Z

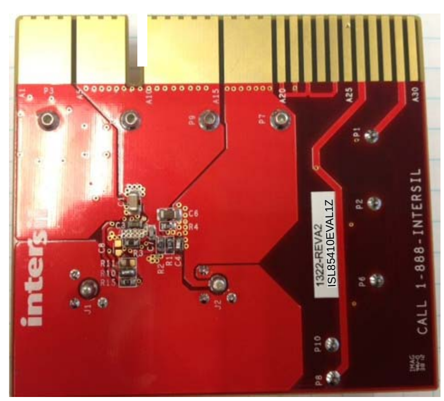



FIGURE 2. BACK OF EVALUATION BOARD ISL85410EVAL1Z

TABLE 1. EXTERNAL COMPONENT SELECTION

| $V_{OUT}$ (V) | $L_1$ (µH) | $C_{OUT}$ (µF) | $R_2$ (kΩ) | $R_3$ (kΩ) | $C_{FB}$ (pF) | $R_{FS}$ (kΩ) | $R_{COMP}$ (kΩ) | $C_{COMP}$ (pF) |
|---|---|---|---|---|---|---|---|---|
| 12 | 22 | 2x22 | 90.9 | 4.75 | 22 | 115 | 150 | 470 |
| 5 | 22 | 47µF+22µF | 90.9 | 12.4 | 27 | DNP (Note 1) | 100 | 470 |
| 3.3 | 22 | 47µF+22µF | 90.9 | 20 | 27 | DNP (Note 1) | 100 | 470 |
| 2.5 | 22 | 47µF+22µF | 90.9 | 28.7 | 27 | DNP (Note 1) | 100 | 470 |
| 1.8 | 12 | 47µF+22µF | 90.9 | 45.5 | 27 | DNP (Note 1) | 70 | 470 |

NOTE:

1. Connect FS to Vcc

## Frequency Control

The ISL85410, ISL85410A, ISL85418 have 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 $V_{OUTs}$ when minimum on time would limit the operation otherwise. Default switching frequency is 500kHz when FS is tied to $V_{CC}$ ($R_{10}$ = 0). By removing $R_{10}$ the switching frequency could be changed from 300kHz ($R_{12}$ = 340k) to 2MHz ($R_{12}$ = 32.4k). Please refer to datasheets ISL85410 and ISL85418 (FN8375/FN8369) for calculating the value of $R_{10}$. Do not leave this pin floating.

## Disabling/Enabling Function

The ISL85410, ISL85410A, ISL85418 evaluation boards contain an S1 switch that enables or disables the part, thus allowing low quiescent current state. Table 2 details this function.

TABLE 2. SWITCH SETTINGS

| S1 | ON/OFF CONTROL |
|---|---|
| ON | Enable $V_{OUT}$ |
| OFF | Disable $V_{OUT}$ |

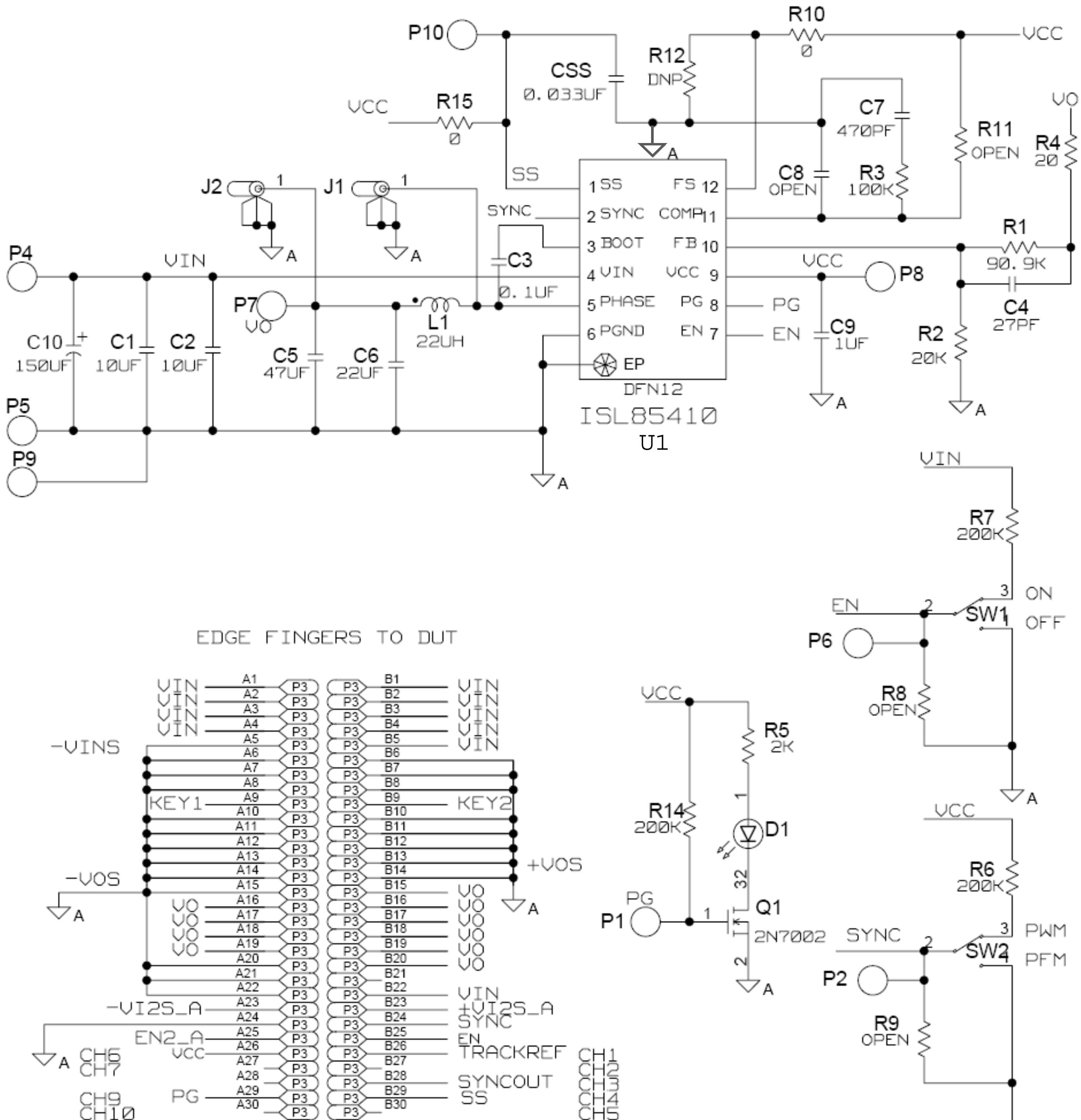
## SYNC Control

The ISL85410, ISL85410A, ISL85418 evaluation boards have a SYNC pin that allows external synchronization frequency to be applied. Default board configuration has $R_6$ = 200k to $V_{CC}$, which defaults to PWM operation mode and also to the pre-selected switching frequency set by $R_{12}$ (see datasheet and previous section “Frequency Control” for details). If this pin is tied to GND the IC will operate in PFM mode. The S2 switch allows forced PFM or PWM modes.

## Soft-Start/COMP Control

$R_{15}$ selects between internal ($R_{15}$ = 0) and external soft-start. $R_{11}$ selects between internal ($R_{11}$ = 0) and external compensation. For applications where repetitive restarts of the IC are required, it is recommended to add a 350kΩ resistor in parallel to CSS in order to allow its fast discharge. Please refer to Pin Description Table of the ISL85410 and ISL85418 (FN8375/FN8369) datasheets.

## ISL85410EVAL1Z Schematic




NOTE: The input electrolytic capacitor C10 is optional and it is used to prevent transient voltages when the input test leads have large parasitic inductance. It can be removed if the IC is used in a system application.

# Bill of Materials

| PART NUMBER | QTY | UNITS | REFERENCE DESIGNATOR | DESCRIPTION | MANUFACTURER | MANUFACTURER PART |
|---|---|---|---|---|---|---|
| ISL85400EVAL1ZREVAPCB | 1 | ea | SEE LABEL-RENAME BOARD | PWB-PCB, ISL85400EVAL1Z, REVA, ROHS | TBD | ISL85400EVAL1ZREVAPCB |
| EEE-FK1H151P-T | 1 | ea | C10 | CAP, SMD, 10.3mm, 150µF, 50V, 20%, ROHS, ALUM.ELEC. | PANASONIC | EEE-FK1H151P |
| H1045-00104-50V10-T | 1 | ea | C3 | CAP, SMD, 0603, 0.1µF, 50V, 10%, X7R, ROHS | AVX | 06035C104KAT2A |
| H1045-00105-16V10-T | 1 | ea | C9 | CAP, SMD, 0603, 1µF, 16V, 10%, X5R, ROHS | MURATA | GRM188R61C105KA12D |
| H1045-00270-50V5-T | 1 | ea | C4 | CAP, SMD, 0603, 27pF, 50V, 5%, NP0, ROHS | TDK | C1608C0G1H270J |
| H1045-00333-16V10-T | 1 | ea | CSS | CAP, SMD, 0603, 33000pF, 16V, 10%, X7R, ROHS | VENKEL | C0603X7R160-333KNE |
| H1045-00471-50V5-T | 1 | ea | C7 | CAP, SMD, 0603, 470pF, 50V, 5%, NP0, ROHS | PANASONIC | ECJ-1VC1H471J |
| H1045-DNP | 0 | ea | C8 | CAP, SMD, 0603, DNP-PLACE HOLDER, ROHS | | |
| H1065-00106-50V10-T | 2 | ea | C1, C2 | CAP, SMD, 1206, 10µF, 50V, 10%, X5R, ROHS | TDK | C3216X5R1H106K |
| H1065-00476-6R3V20-T | | | C5 | CAP, SMD, 1206, 47µF, 6.3V, 20%, X5R, ROHS | Murata | GRM31CR60J476ME19L |
| H1065-00226-6R3V20-T | 2 | ea | C6 | CAP, SMD, 1206, 22µF, 6.3V, 20%, X5R, ROHS | PANASONIC | ECJ-DV50J226M |
| DR73-220-R | 1 | ea | L1 | COIL-PWR INDUCTOR, SMD, 7.6mm, 22µH, 20%, 1.62A, ROHS | COOPER/COILTRONICS | DR73-220-R |
| 131-4353-00 | 2 | ea | J1, J2 | CONN-SCOPE PROBE TEST PT, COMPACT, PCB MNT, ROHS | TEKTRONIX | 131-4353-00 |
| 1514-2 | 4 | ea | P4, P5, P7, P9 | CONN-TURRET, TERMINAL POST, TH, ROHS | KEYSTONE | 1514-2 |
| 5002 | 5 | ea | P1, P2, P6, P8, P10 | CONN-MINI TEST POINT, VERTICAL, WHITE, ROHS | KEYSTONE | 5002 |
| LTST-C190KGKT-T | 1 | ea | D1 | LED, SMD, 0603, GREEN CLEAR, 2V, 20mA, 571nm, 35mcd, ROHS | LITEON/VISHAY | LTST-C190KGKT |
| ISL85410FRZ for ISL85410EVAL1Z, ISL85410AIRZ for ISL85410AEVAL1Z, ISL85418FRZ for ISL85418EVAL1Z, | 1 | ea | U1 | IC-800mA BUCK REGULATOR, 12P, DFN, 3X4, ROHS | INTERSIL | ISL85410FRZ ISL85410AIRZ ISL85418FRZ |
| 2N7002LT1G-T | 1 | ea | Q1 | TRANSISTOR-MOS, N-CHANNEL, SMD, SOT23, 60V, 115mA, ROHS | ON SEMICONDUCTOR | 2N7002LT1G |
| H2511-00200-1/10W1-T | 1 | ea | R4 | RES, SMD, 0603, 20Ω, 1/10W, 1%, TF, ROHS | PANASONIC | ERJ-3EKF20R0V |
| H2511-00R00-1/10W-T | 2 | ea | R10, R15 | RES, SMD, 0603, 0Ω, 1/10W, TF, ROHS | VENKEL | CR0603-10W-000T |
| H2511-01003-1/10W1-T | 1 | ea | R3 | RES, SMD, 0603, 100k, 1/10W, 1%, TF, ROHS | VENKEL | CR0603-10W-1003FT |

## Bill of Materials (Continued)

| PART NUMBER | QTY | UNITS | REFERENCE DESIGNATOR | DESCRIPTION | MANUFACTURER | MANUFACTURER PART |
|---|---|---|---|---|---|---|
| H2511-02001-1/10W1-T | 1 | ea | R5 | RES, SMD, 0603, 2k, 1/10W, 1%, TF, ROHS | KOA | RK73H1JTTD2001F |
| H2511-02002-1/10W1-T | 0 | ea | R2 | RES, SMD, 0603, 20k, 1/10W, 1%, TF, ROHS | VENKEL | CR0603-10W-2002FT |
| H2511-02003-1/10W1-T | 2 | ea | R6, R7 | RES, SMD, 0603, 200k, 1/10W, 1%, TF, ROHS | VENKEL | CR0603-10W-2003FT |
| H2511-09092-1/10W1-T | 1 | ea | R1 | RES, SMD, 0603, 90.9k, 1/10W, 1%, TF, ROHS | PANASONIC | ERJ-3EKF9092V |
| H2511-DNP | 0 | ea | R8, R9, R11, R12, R14 | RES, SMD, 0603, DNP-PLACE HOLDER, ROHS | | |
| GT11MSCBE-T | 2 | ea | SW1, SW2 | SWITCH-TOGGLE, SMD, 6PIN, SPDT, 2POS, ON-ON, ROHS | ITT INDUSTRIES/C&K DIVISION | GT11MSCBE |
| 5X8-STATIC-BAG | 1 | ea | Place assy in bag | BAG, STATIC, 5X8, ZIPLOC, ROHS | INTERSIL | 212403-013 |
| DNP | 0 | ea | P3 (3VH30/1JN5) | DO NOT POPULATE OR PURCHASE | | |
| LABEL-DATE CODE | 1 | ea | | LABEL-DATE CODE_BOM REV#_SERIAL# LABEL ON ZIL & QUEL | INTERSIL | LABEL-DATE CODE |
| LABEL-RENAME BOARD | 1 | ea | RENAME PCB TO: ISL85410EVAL1Z | LABEL, TO RENAME BOARD | INTERSIL | LABEL-RENAME BOARD |

# ISL85410EVAL1Z Board Layout

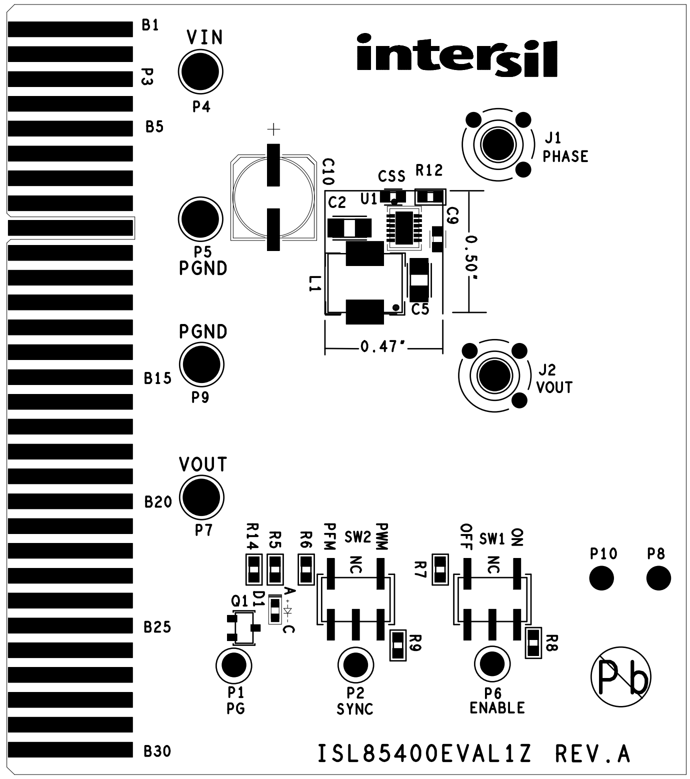



FIGURE 3. SILK SCREEN TOP

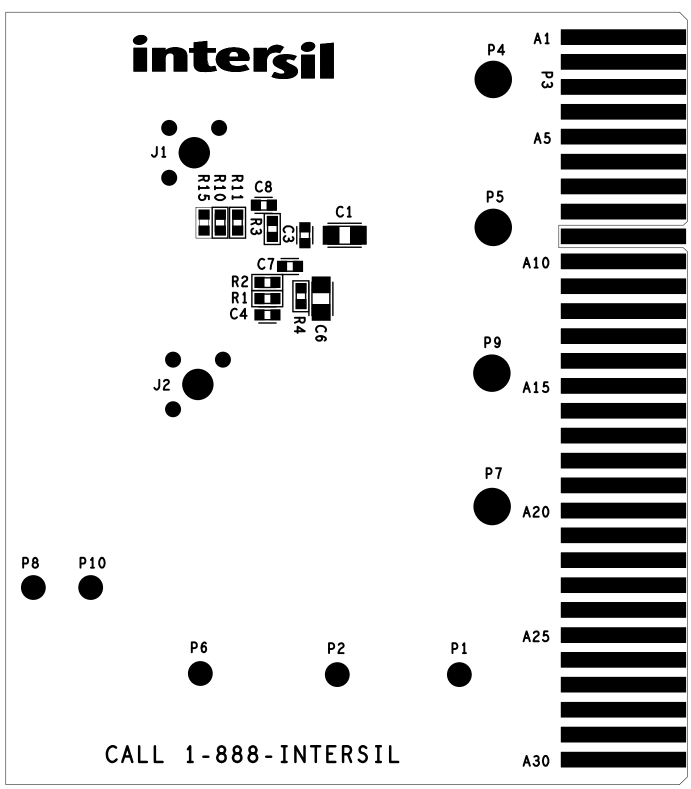



FIGURE 4. SILKSCREEN BOTTOM

## ISL85410 Efficiency Curves $F_{SW}$ = 500kHz, $T_A$ = +25°C

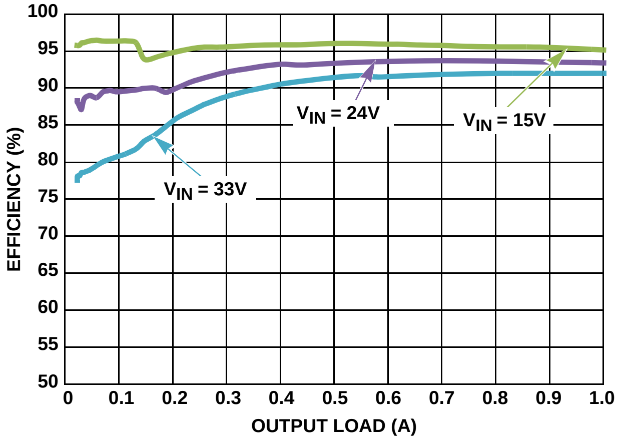



FIGURE 5. EFFICIENCY vs LOAD, PFM, $V_{OUT}$ = 12V

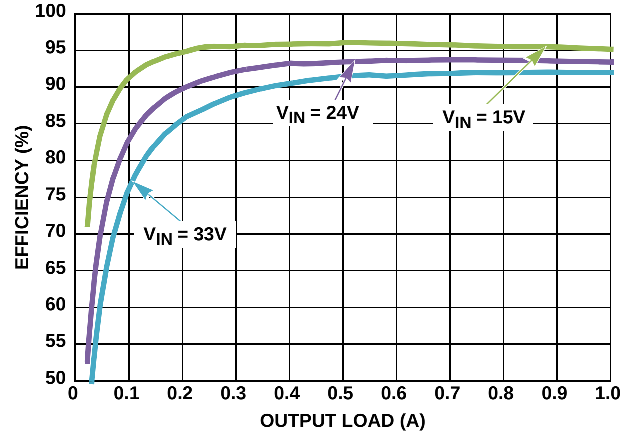



FIGURE 6. EFFICIENCY vs LOAD, PWM, $V_{OUT}$ = 12V

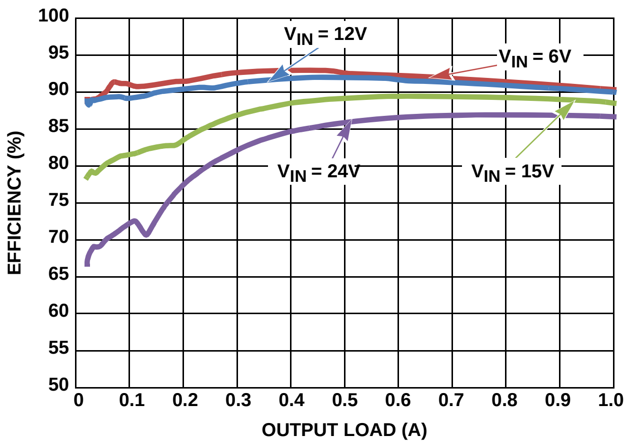



FIGURE 7. EFFICIENCY vs LOAD, PFM, $V_{OUT}$ = 5V, L1 = 30µH

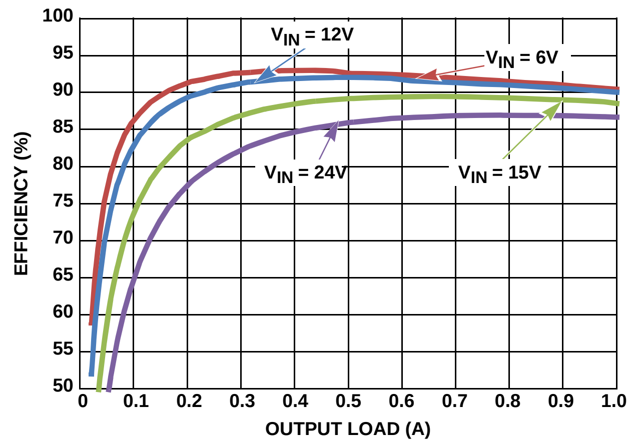



FIGURE 8. EFFICIENCY vs LOAD, PWM, $V_{OUT}$ = 5V, L1 = 30µH

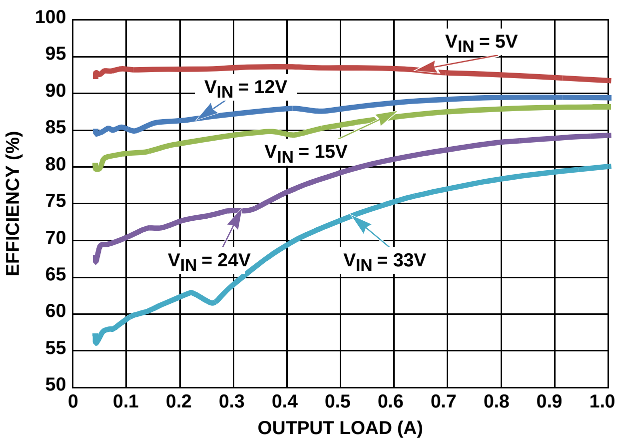



FIGURE 9. EFFICIENCY vs LOAD, PFM, $V_{OUT}$ = 3.3V

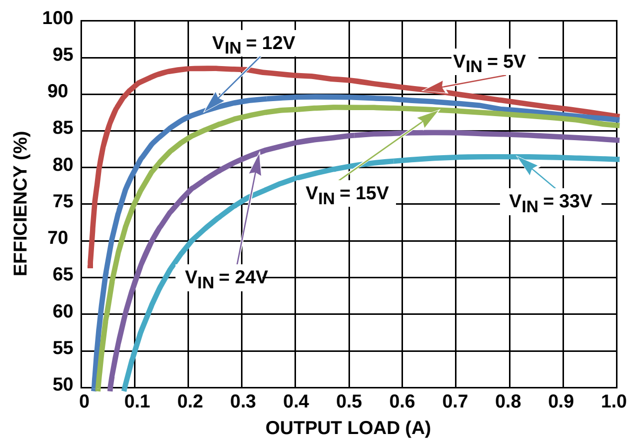



FIGURE 10. EFFICIENCY vs LOAD, PWM, $V_{OUT}$ = 3.3V

## ISL85410 Efficiency Curves $F_{SW}$ = 500kHz, $T_A$ = +25°C (Continued)

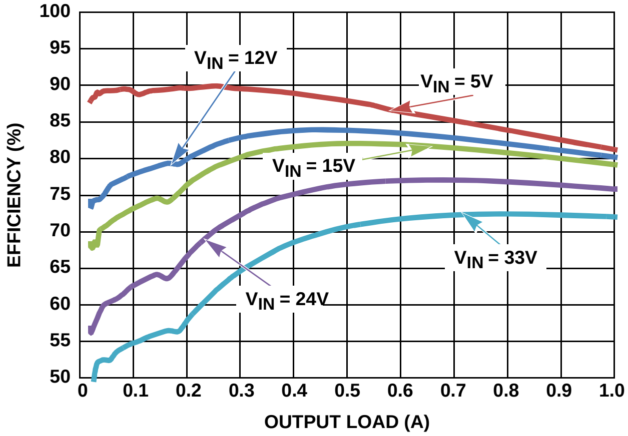



FIGURE 11. EFFICIENCY vs LOAD, PFM, $V_{OUT}$ = 1.8V

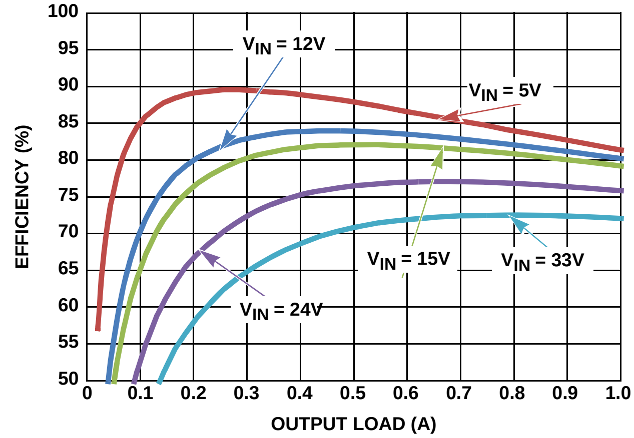



FIGURE 12. EFFICIENCY vs LOAD, PWM, $V_{OUT}$ = 1.8V

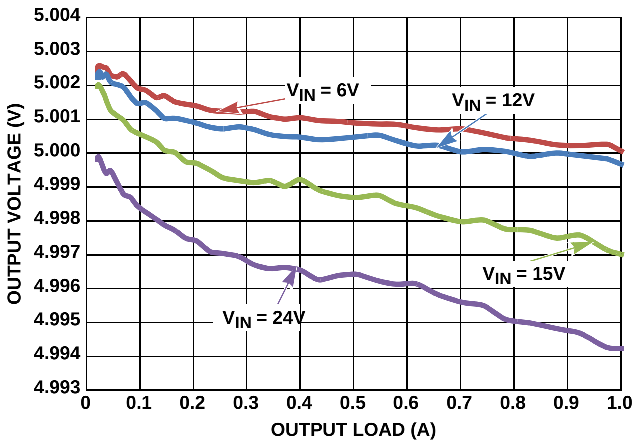



FIGURE 13. EFFICIENCY vs LOAD, PWM, $V_{OUT}$ = 5V, L1 = 30µH

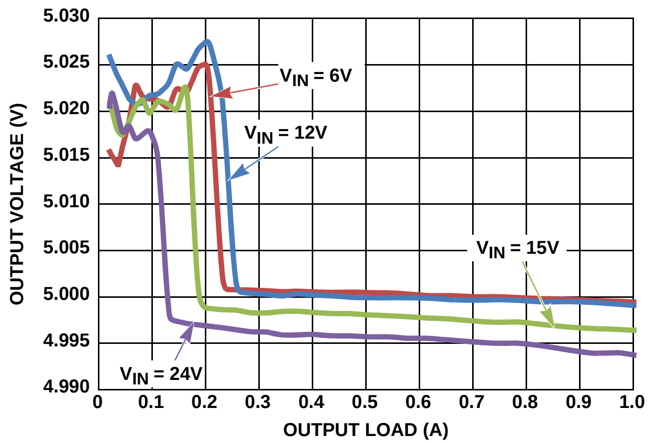



FIGURE 14. $V_{OUT}$ REGULATION vs LOAD, PFM, $V_{OUT}$ = 5V, L1 = 30µH

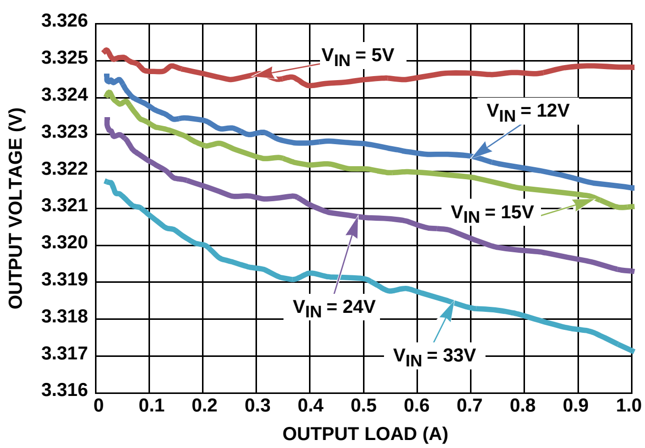



FIGURE 15. $V_{OUT}$ REGULATION vs LOAD, PWM, $V_{OUT}$ = 3.3V

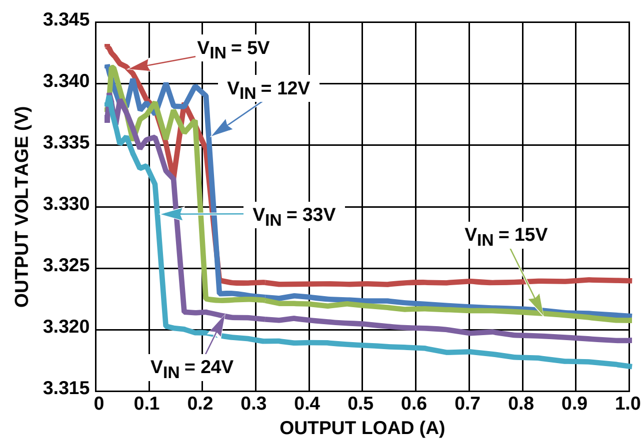



FIGURE 16. $V_{OUT}$ REGULATION vs LOAD, PFM, $V_{OUT}$ = 3.3V

## ISL85410 Efficiency Curves $F_{SW}$ = 500kHz, $T_A$ = +25°C (Continued)

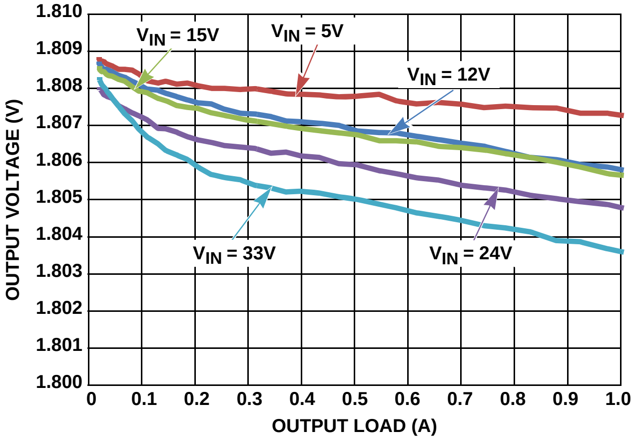



FIGURE 17. $V_{OUT}$ REGULATION vs LOAD, PWM, $V_{OUT}$ = 1.8V

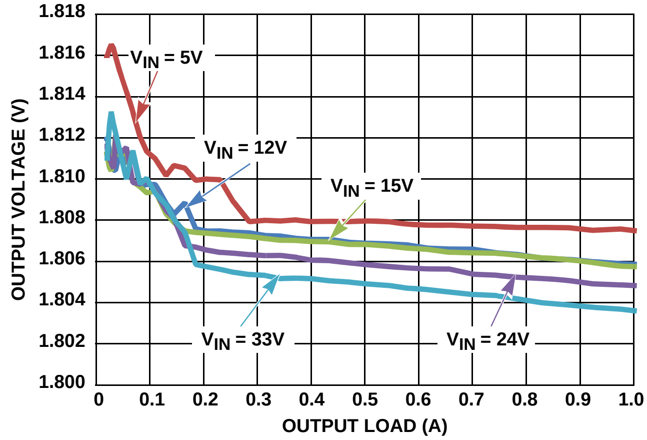



FIGURE 18. $V_{OUT}$ REGULATION vs LOAD, PFM, $V_{OUT}$ = 1.8V

## ISL85410 Typical Performance Curves $F_{SW}$ = 500kHz, $V_{IN}$ = 24V, $V_{OUT}$ = 3.3V, $T_A$ = +25°C

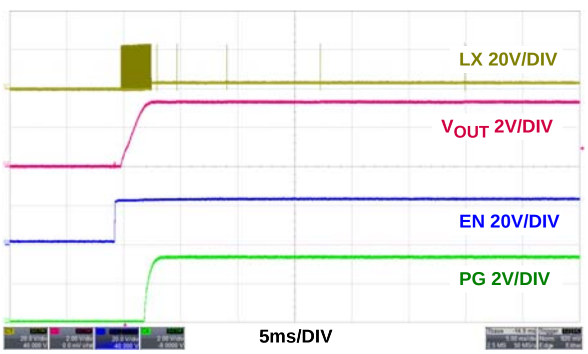



FIGURE 19. START-UP AT NO LOAD, PFM

FIGURE 21.

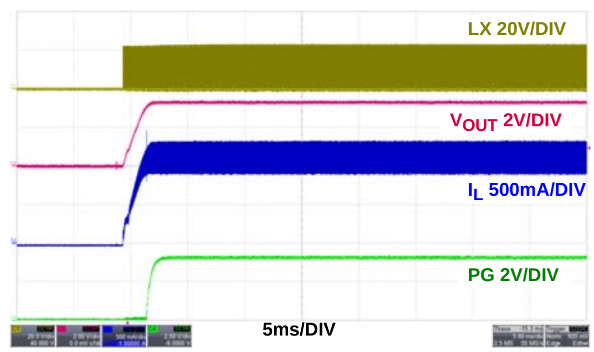



FIGURE 20. START-UP AT 1A, PWM

FIGURE 22.

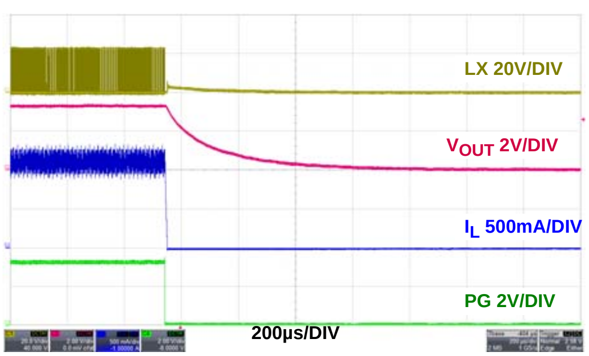



FIGURE 23. SHUTDOWN AT 1A, PWM

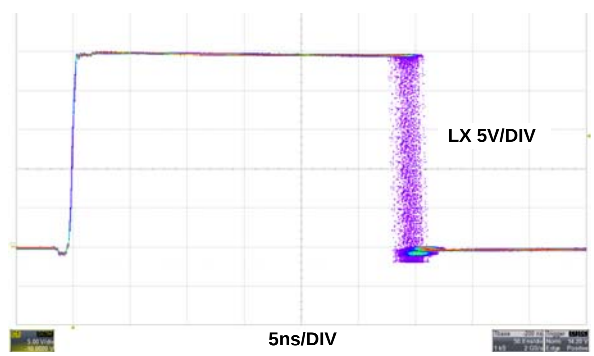



FIGURE 24. JITTER AT 1A LOAD, PWM

## ISL85410 Typical Performance Curves $F_{SW}$ = 500kHz, $V_{IN}$ = 24V, $V_{OUT}$ = 3.3V, $T_A$ = +25°C (Continued)

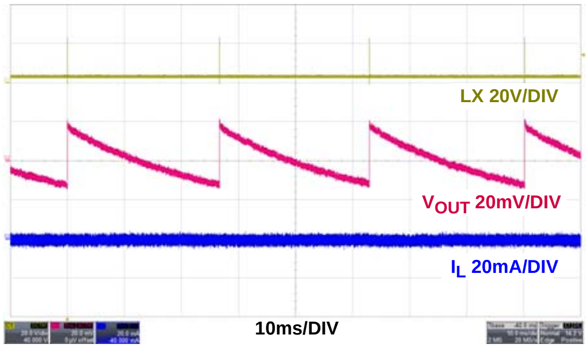



FIGURE 25. STEADY STATE AT NO LOAD, PFM

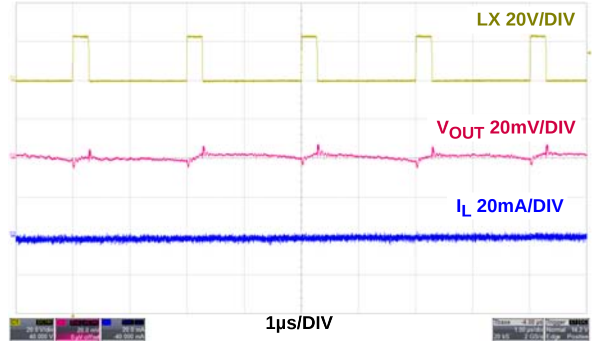



FIGURE 26. STEADY STATE AT NO LOAD, PWM

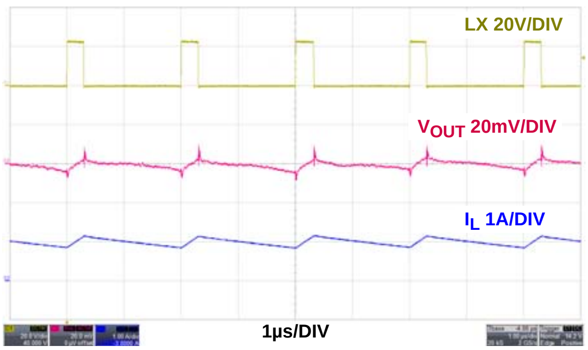



FIGURE 27. STEADY STATE AT 1A, PWM

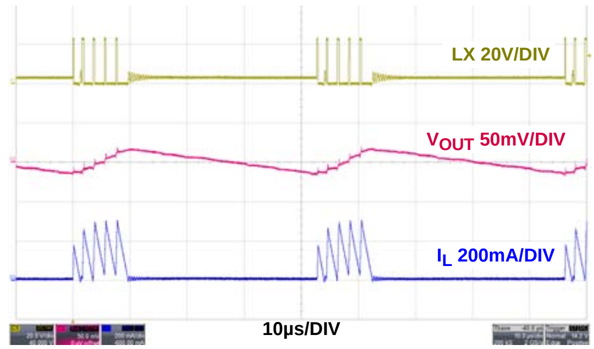



FIGURE 28. LIGHT LOAD OPERATION AT 20mA, PFM

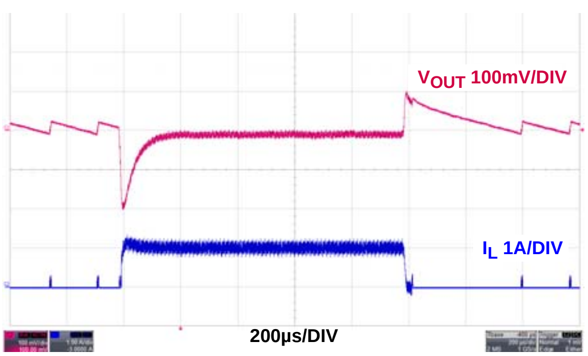



FIGURE 29. LOAD TRANSIENT, PFM

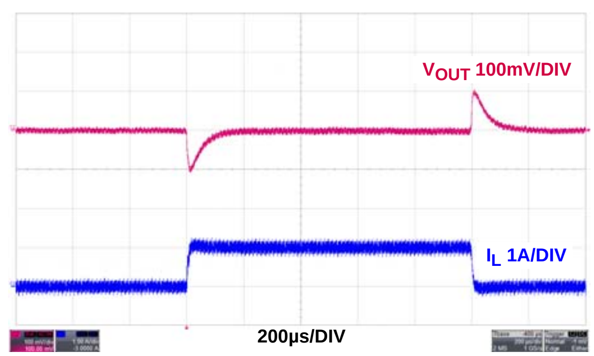



FIGURE 30. LOAD TRANSIENT, PWM

## ISL85410 Typical Performance Curves $F_{SW}$ = 500kHz, $V_{IN}$ = 24V, $V_{OUT}$ = 3.3V, $T_A$ = +25°C (Continued)

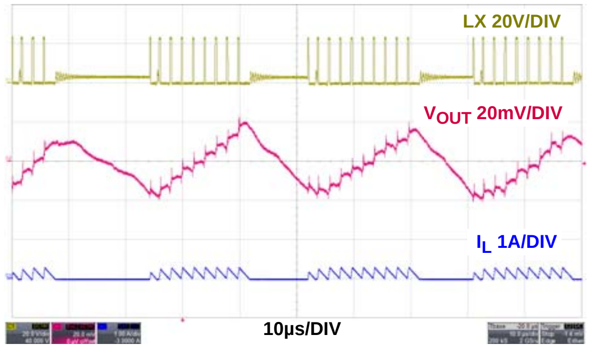


FIGURE 31. PFM TO PWM TRANSITION

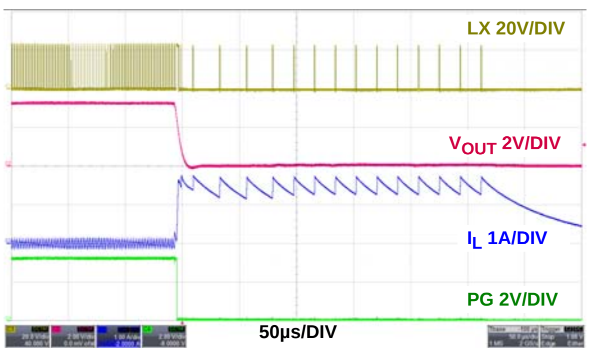


FIGURE 32. OVERCURRENT PROTECTION, PWM

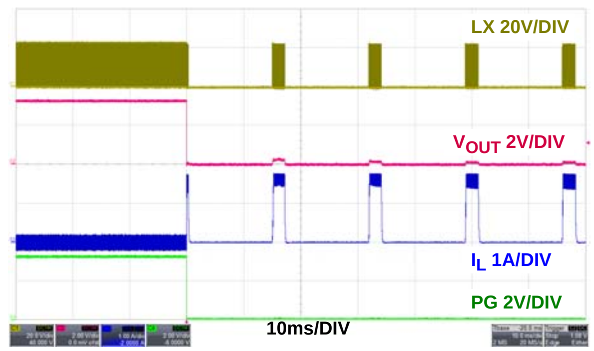


FIGURE 33. OVERCURRENT PROTECTION HICCUP, PWM

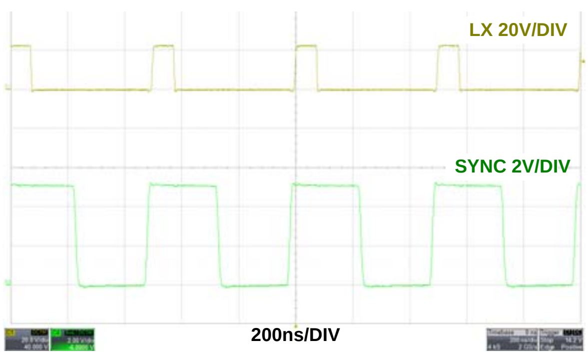


FIGURE 34. SYNC AT 1A LOAD, PWM

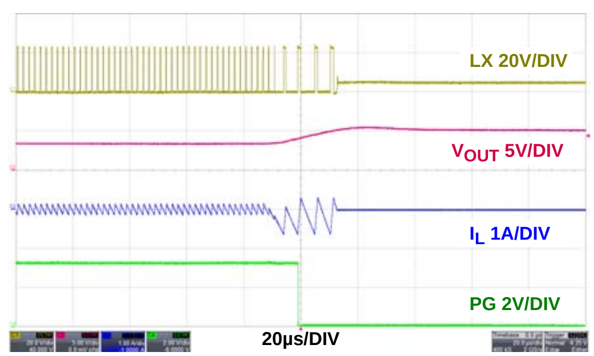


FIGURE 35. NEGATIVE CURRENT LIMIT, PWM

## ISL85410 Typical Performance Curves $F_{SW}$ = 500kHz, $V_{IN}$ = 24V, $V_{OUT}$ = 3.3V, $T_A$ = +25°C (Continued)

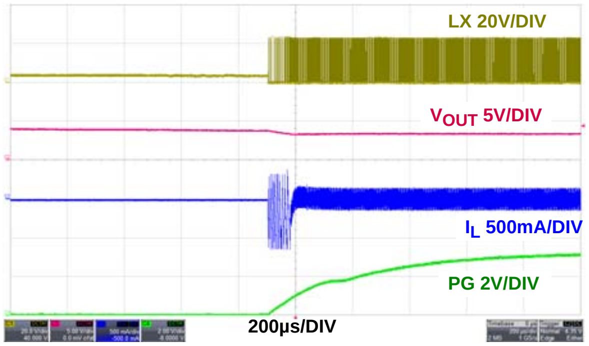



FIGURE 36. NEGATIVE CURRENT LIMIT RECOVERY, PWM

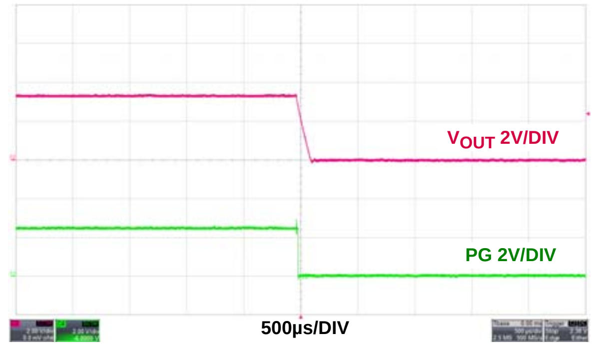



FIGURE 37. OVER-TEMPERATURE PROTECTION, PWM

## ISL85410A Only Typical Performance Curves $F_{SW}$ = 500kHz, $V_{IN}$ = 24V, $V_{OUT}$ = 3.3V, $T_A$ = +25°C

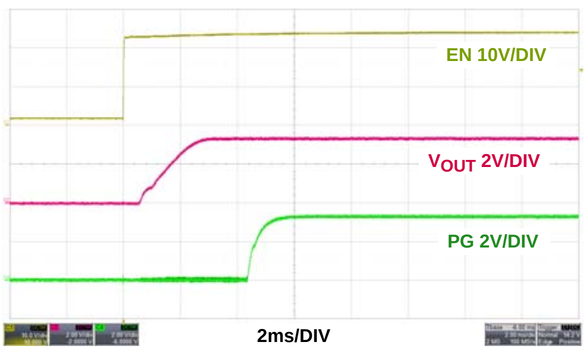



FIGURE 38. PGOOD DELAY, PWM, $I_{OUT}$ = 1A, SS = $V_{CC}$

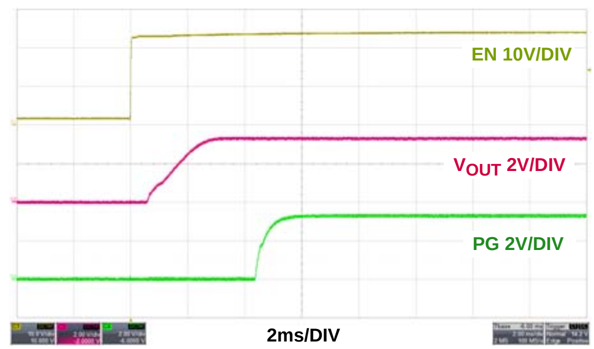



FIGURE 39. PGOOD DELAY, PWM, $I_{OUT}$ = 0A, SS = $V_{CC}$

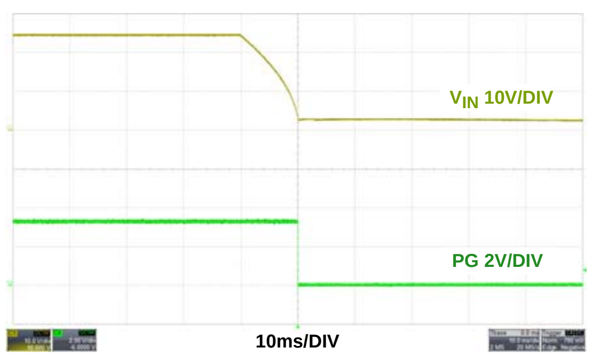



FIGURE 40. PGOOD LOW WITH $V_{IN}$ = 0V, PWM, $I_{\_SINK\_PG}$ = 1mA