

# ISL6446ADEMO1Z Dual Channel Step Down Regulator User Guide

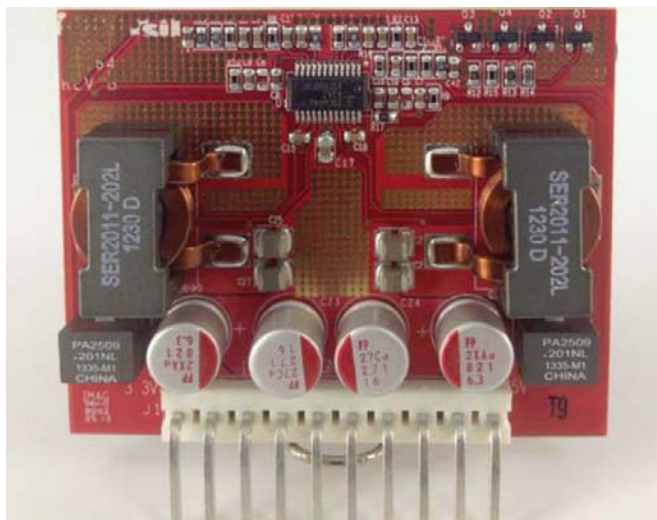


FIGURE 1. ISL6446ADEMO1Z REV B BOARD



FIGURE 2. ISL6446ADEMO1Z REV B BOARD BACKSIDE

## Introduction

The [ISL6446A](#) is a high performance Dual PWM + Single Linear Controller. This device integrates complete control, monitoring and protection functions for two synchronous buck PWM controllers and one low power linear controller. Each PWM channel is switched 180° out-of-phase for reduced input ripple current and lower EMI.

The PWM controller uses voltage mode control for simple output regulation. The output can be regulated from  $0.8 \cdot V_{IN}$  down to the 0.6V reference voltage. Switching frequency is programmable from 100kHz to 2.5MHz, providing either a cost optimized or compact power solution.

The ISL6446ADEMO1Z demo board is designed as an easy to use, dual output, non-isolated power module featuring synchronous buck function. It is well suited for any applications that require high performance, small space and low cost. The ISL6446ADEMO1Z output voltage is preset to 3.3V and 5V targeting ATX power supply applications. Each channel is designed for up to 20A of output current. Total power of the demo board is limited by thermal conditions.

## Evaluation Board Features

- 12V input voltage
- Preset +5V and +3.3V output
- 20A output current each channel
- Two-in-1 PWM controller with out-of-phase operation
- Voltage-mode PWM control
- Efficiency up to 94.9%
- Prebias start-up
- Undervoltage lockout
- Output overcurrent protection
- Over-temperature protection
- $f_{sw}$  set at 280kHz
- Simple dual layer board design

## Evaluation Board Specifications

SYMBOL	PARAMETER	TEST CONDITIONS	MIN	TYP	MAX	UNIT
$V_{IN}$	Input Range	Over $I_O$ range	10.8		13.2	V
$V_{OUT1}$	Output Range	Over $I_O$ range	4.8	5	5.2	V
$I_{OUT1}$	Output Current	From no load to full load	0		20	A
$V_{OUT2}$	Output Range	Over $I_O$ range	3.1	3.3	3.5	V
$I_{OUT2}$	Output Current	From no load to full load	0		20	A

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## Equipment Used for Validation

- 12V/200W input power source
- Dual channel electronic load

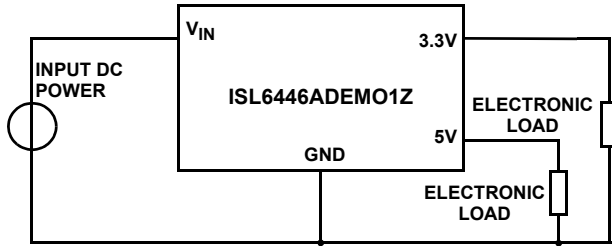


FIGURE 3. TYPICAL APPLICATION DIAGRAM

## Terminal Functions

TABLE 1. TERMINAL FUNCTIONS

TERMINAL NAME	DESCRIPTION
V <sub>IN</sub>	The positive input voltage node to the module, which is referenced to common GND.
GND	This is the common ground connection for the V <sub>IN</sub> and V <sub>OUT</sub> power connection.
5V	The regulated positive 5V power output with respect to the GND node.
3.3V	The regulated positive 3.3V power output with respect to the GND node.

## Getting Started

Using short twisted pair leads for any power connections and with all loads and power supplies off, refer to [Figure 4](#) for the proper measurement and equipment setup. The Power Supply (PS) should not be connected to the circuit until told to do so in the following procedure.

When measuring the input or output voltage ripple, care must be taken to avoid a long ground lead on the oscilloscope probe. Measure the input or output voltage ripple by touching the probe tip directly across V<sub>OUT</sub> and GND terminals.

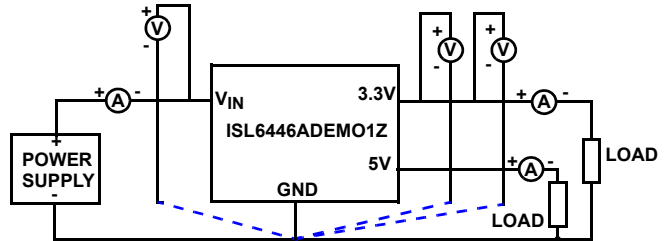


FIGURE 4. CONNECTION DIAGRAM

1. Keep the power supply and electronic load power off.
2. Connect the power supply; electronic load; voltage and current meters. [Figure 4](#) shows while keeping the power supply and load shut down.
3. Turn on the power supply and set the input voltage to 12V. Monitor input current. If input current exceeds 100mA, turn off power supply and look for shorts.
4. Confirm V<sub>OUT1</sub> = 3.3V, V<sub>OUT2</sub> = 5V
5. Slowly increase the load on V<sub>OUT</sub> to 15A. Verify V<sub>OUT1</sub> = 3.3V, V<sub>OUT2</sub> = 5V

The board is now ready for operation.

## Undervoltage Lockout Circuit

The ISL6446ADEMO1Z demo board includes as part of its circuitry a UVLO (Undervoltage Lockout) circuit that prevents it from starting up with V<sub>IN</sub> voltages less than about 7.8V. If you want to reduce the UVLO voltage, (resistor R<sub>12</sub> in the schematic of the board) it needs to be reduced in value.

## Application Note 1822

**Board Electrical Specifications**  $T_A = +25^\circ\text{C}$ ;  $V_{IN} = 12\text{V}$ ;  $V_{OUT1} = 3.3\text{V}$ ,  $V_{OUT2} = 5\text{V}$ , and  $I_{OUT1} = 15\text{A}$ ,  $I_{OUT2} = 15\text{A}$  (unless otherwise noted).

SYMBOL	PARAMETER	TEST CONDITIONS	MIN	TYP	MAX	UNIT
$V_{IN}$	Input Range	Over $I_O$ range	10.8		13.2	V
$V_{OUT1}$	Output Range	Over $I_O$ range	4.8	5	5.2	V
$I_{O1}$	Output Current	From no load to full load	0		20	A
$V_{OUT2}$	Output Range	Over $I_O$ range	3.1	3.3	3.5	V
$I_{O2}$	Output Current	From no load to full load	0		20	A
$\eta$	Efficiency for DC/DC	$V_{IN} = 12\text{V}$ ( <a href="#">Note 1</a> )	$I_{OUT1} = I_{OUT2} = 2\text{A}$	93.39		%
			$I_{OUT1} = I_{OUT2} = 4\text{A}$	95.18		%
			$I_{OUT1} = I_{OUT2} = 8\text{A}$	95.87		%
			$I_{OUT1} = I_{OUT2} = 12\text{A}$	95.53		%
			$I_{OUT1} = I_{OUT2} = 16\text{A}$	94.88		%
			$I_{OUT1} = I_{OUT2} = 20\text{A}$	93.99		%
$V_{r1}$	$V_{OUT1}$ Ripple (Peak-to-peak)	No load		30		mV <sub>p-p</sub>
		Full load		50		mV <sub>p-p</sub>
$V_{r2}$	$V_{OUT2}$ Ripple (Peak-to-peak)	No load		30		mV <sub>p-p</sub>
		Full Load		50		mV <sub>p-p</sub>
$V_{T1}$	Transient (Peak-to-peak)	Output peak-to-peak voltage variation when output current changing from 5A to 10A with 2.5A/ $\mu\text{s}$ slew rate		250		mV
$V_{T2}$	Transient (Peak-to-peak)	Output peak-to-peak voltage variation when output current changing from 5A to 10A with 2.5A/ $\mu\text{s}$ slew rate		250		mV
$F_s$	Switching Frequency	Over $V_{IN}$ and $I_O$ range		280		kHz

**NOTE:**

- For the efficiency test result please refer to [page 11](#).

# ISL6446ADEM01Z Schematic

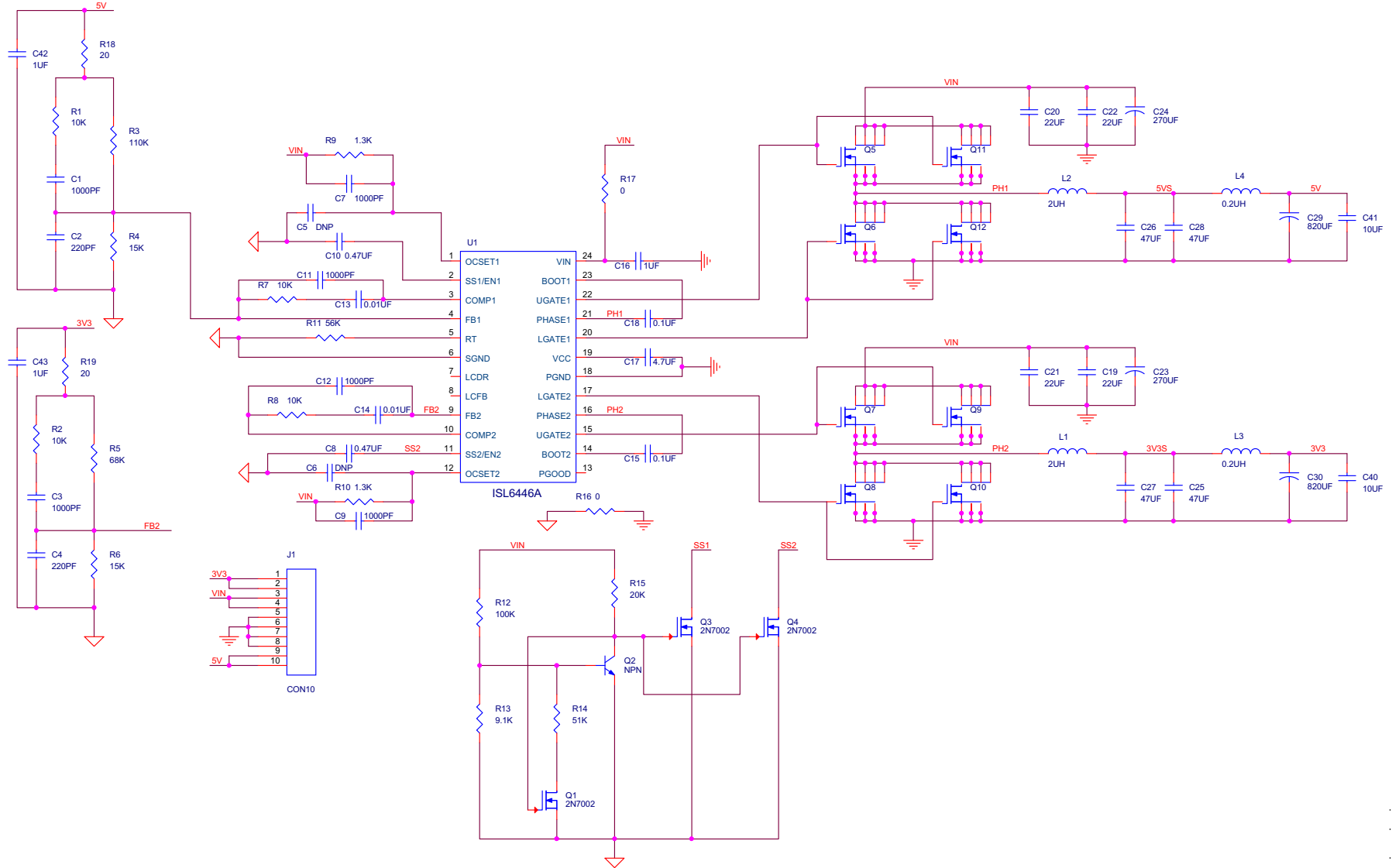


FIGURE 5. ISL6446ADEM01Z SCHEMATIC

## PCB Layout

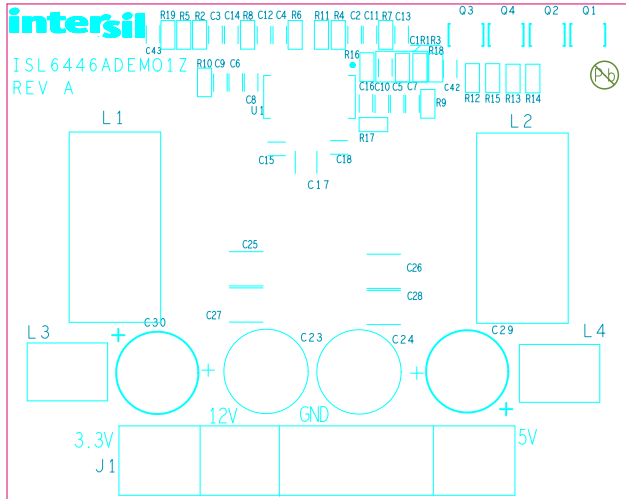


FIGURE 6. SILK SCREEN TOP

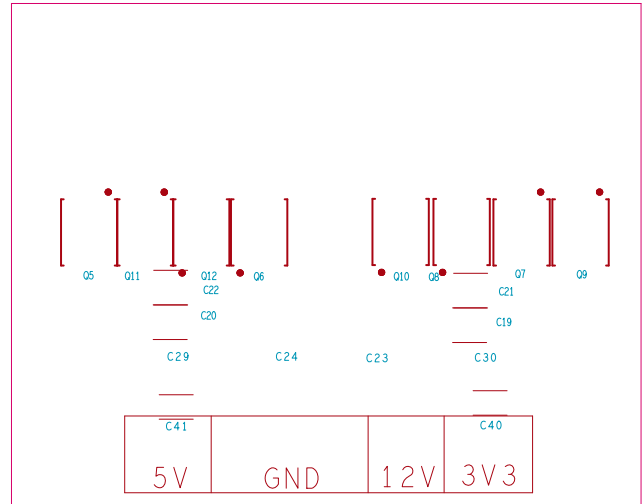


FIGURE 7. SILK SCREEN BOTTOM

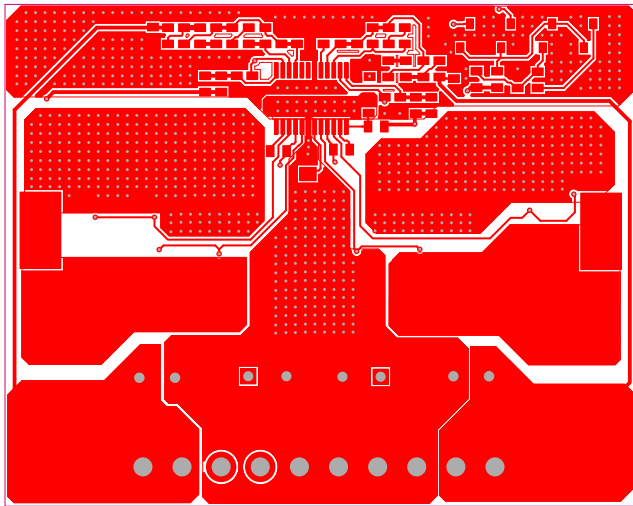


FIGURE 8. PCB TOP

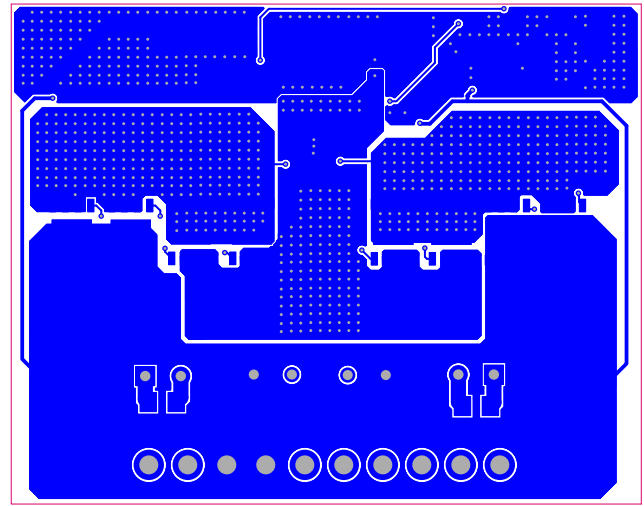


FIGURE 9. PCB BOTTOM

## Application Note 1822

### ISL6446ADEMO1Z Bill of Materials

MANUFACTURER PART	QTY	UNIT S	REFERENCE DESIGNATOR	DESCRIPTION	MANUFACTURER
ISL6446ADEMO1ZREVBPCB	1	ea.		PWB-PCB, ISL6446ADEMO1Z, REV B, ROHS	IMAGINEERING INC
06035C102KAT2A	6	ea.	C1, C3, C7, C9, C11, C12	CAP, SMD, 0603, 1000pF, 50V, 10%, X7R, ROHS	AVX
GRM39X7R103K050	2	ea.	C13, C14	CAP, SMD, 0603, 0.01µF, 50V, 10%, X7R, ROHS	MURATA
GRM39X7R104K025AD	2	ea.	C15, C18	CAP, SMD, 0603, 0.1µF, 25V, 10%, X7R, ROHS	MURATA
GRM188R61C105KA12D	3	ea.	C16, C42, C43	CAP, SMD, 0603, 1µF, 16V, 10%, X5R, ROHS	MURATA
GRM188R71H221KA01D	2	ea.	C2, C4	CAP, SMD, 0603, 220pF, 50V, 10%, X7R, ROHS	MURATA
C1608X7R1C474K	2	ea.	C8, C10	CAP, SMD, 0603, 0.47µF, 16V, 10%, X7R, ROHS	TDK
ECJ-2FB1C475K	1	ea.	C17	CAP, SMD, 0805, 4.7µF, 16V, 10%, X5R, ROHS	PANASONIC
C1206X7R100-106KNE	2	ea.	C40, C41	CAP, SMD, 1206, 10µF, 10V, 10%, X7R, ROHS	VENKEL
GRM32ER71C226KE18L	4	ea.	C19, C20, C21, C22	CAP, SMD, 1210, 22µF, 16V, 10%, X7R, ROHS	MURATA
ECJ-4YB0J476M	4	ea.	C25, C26, C27, C28	CAP, SMD, 1210, 47µF, 6.3V, 20%, X5R, ROHS	PANASONIC
PA2509.201NL	2	ea.	L3, L4	COIL-PWR INDUCTOR, SMD, 7X8.5, 0.2µH, 12%, 32A, 0.35mΩ, ROHS	PULSE
RL80J821MDN1KX	2	ea.	C29, C30	CAP, TH, RADIAL, 820µF, 6.3V, 20%, ALUM.POLYMER, 3.5mmLS, ROHS	NICHICON
RL81C271MDN1KX	2	ea.	C23, C24	CAP, TH, RADIAL, 270µF, 16V, 20%, ALUM.POLYMER, 3.5mmLS, ROHS	NICHICON
SER2011-202MLB	2	ea.	L1, L2	COIL-PWR INDUCTOR, SMD, 18.7X19.1, 2.0µH, 20%, 37A, 1.2mΩ, ROHS	COILCRAFT
1-640385-0	1	ea.	J1	CONN-HEADER, TH, 1X10, NYLON, R/A, 0.156mmPITCH, ROHS	TE CONNECTIVITY
ISL6446AIAZ	1	ea.	U1	IC-DUAL PWM/LINEAR CONTROLLER, 24P, QSOP, ROHS	INTERSIL
2N7002-7-F	3	ea.	Q1, Q3, Q4	TRANSISTOR, N-CHANNEL, 3LD, SOT-23, 60V, 115mA, ROHS	DIODES, INC.
BSC010NE2LS	4	ea.	Q7, Q8, Q11, Q12	TRANSIST-MOS, N-CHANNEL, 8P, PG-TDSON-8, 25V, 100A, ROHS	INFINEON TECHNOLOGY
MMBT3904	1	ea.	Q2	TRANSISTOR-NPN, SMD, SOT-23, 40V, 200mA, 350mW, ROHS	FAIRCHILD
ERJ-3EKF20R0V	2	ea.	R18, R19	RES, SMD, 0603, 20Ω, 1/10W, 1%, TF, ROHS	PANASONIC
CR0603-10W-000T	2	ea.	R16, R17	RES, SMD, 0603, 0Ω, 1/10W, TF, ROHS	VENKEL
RK73H1JT1002F	4	ea.	R1, R2, R7, R8	RES, SMD, 0603, 10k, 1/10W, 1%, TF, ROHS	KOA
CR0603-10W-1003FT	1	ea.	R12	RES, SMD, 0603, 100k, 1/10W, 1%, TF, ROHS	VENKEL
ERJ-3EKF1103V	1	ea.	R3	RES, SMD, 0603, 110k, 1/10W, 1%, TF, ROHS	PANASONIC
CRCW06031K30FKTA	2	ea.	R9, R10	RES, SMD, 0603, 1.3k, 1/10W, 1%, TF, ROHS	VISHAY/DALE
ERJ-3EKF1502V	2	ea.	R4, R6	RES, SMD, 0603, 15k, 1/10W, 1%, TF, ROHS	PANASONIC
CR0603-10W-2002FT	1	ea.	R15	RES, SMD, 0603, 20k, 1/10W, 1%, TF, ROHS	VENKEL
RC0603FR-0751KL	1	ea.	R14	RES, SMD, 0603, 51k, 1/10W, 1%, TF, ROHS	YAGEO
ERJ-3EKF5602V	1	ea.	R11	RES, SMD, 0603, 56k, 1/10W, 1%, TF, ROHS	PANASONIC
RC0603FR-0768KL	1	ea.	R5	RES, SMD, 0603, 68k, 1/10W, 1%, TF, ROHS	YAGEO
CR0603-10W-9101FT	1	ea.	R13	RES, SMD, 0603, 9.1k, 1/10W, 1%, TF, ROHS	VENKEL
SJ-5003SPBL	4	ea.	Bottom four corners	BUMPONS, 0.44inW x 0.20inH, DOMETOP, BLACK	3M

## ISL6446A DEMO1Z Test Report

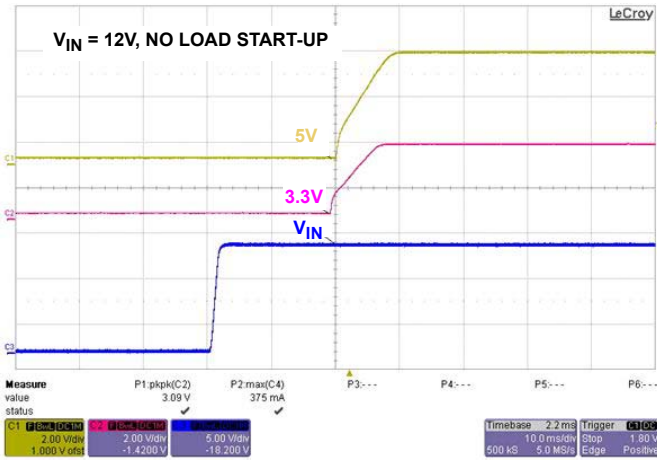


FIGURE 10. START-UP

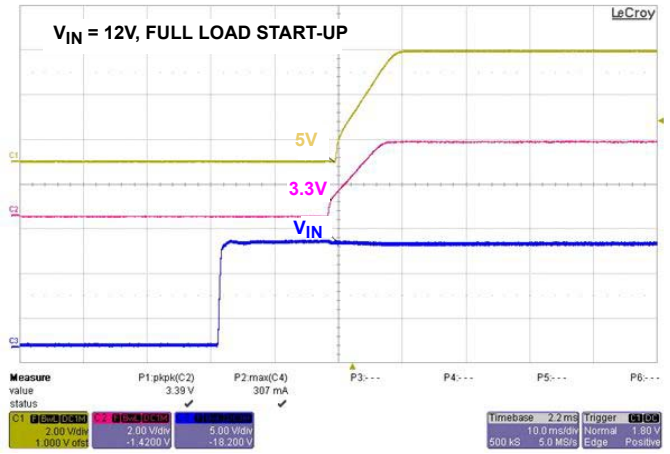


FIGURE 11. START-UP

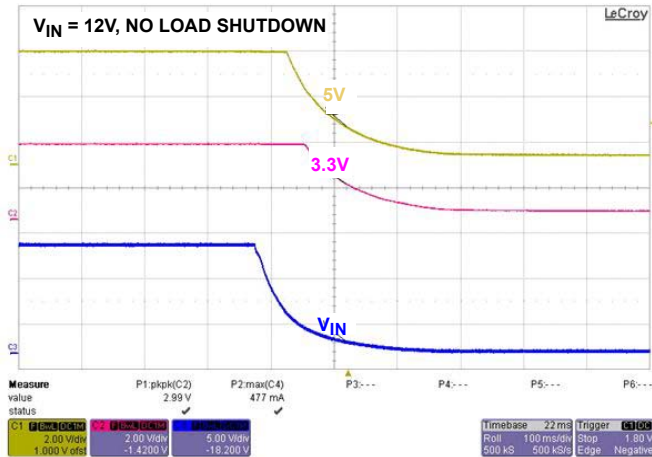


FIGURE 12. SHUTDOWN

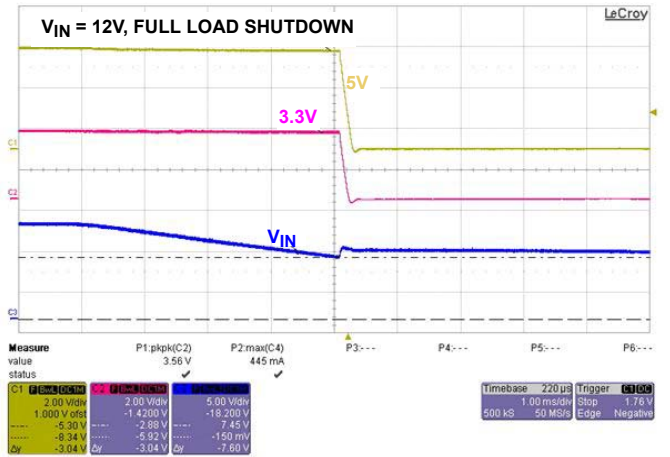


FIGURE 13. SHUTDOWN (UVLO VOLTAGE 7.4V)



## Efficiency Curves Input = 12VDC, Output = 5V/20A, 3.3V/20A.

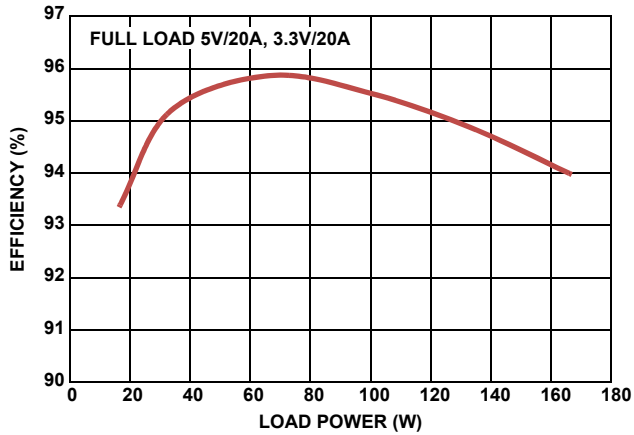


FIGURE 14. EFFICIENCY vs OUTPUT POWER

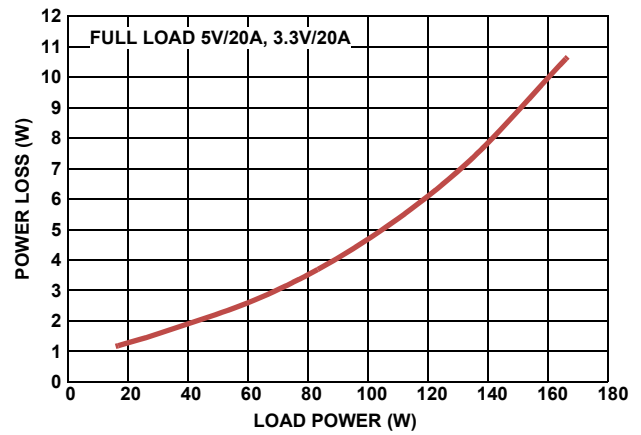


FIGURE 15. POWER LOSS vs OUTPUT POWER

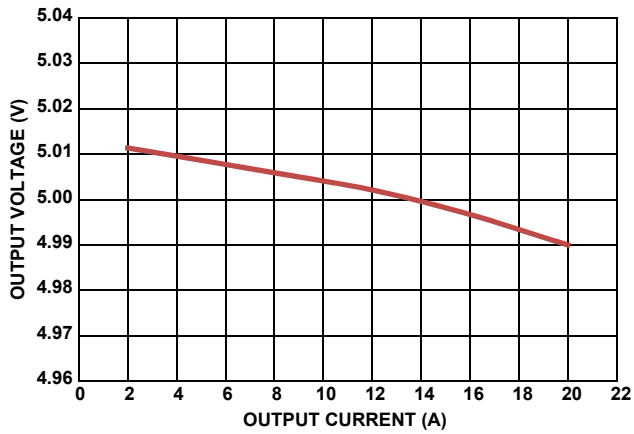


FIGURE 16. OUTPUT LOAD REGULATION 5V

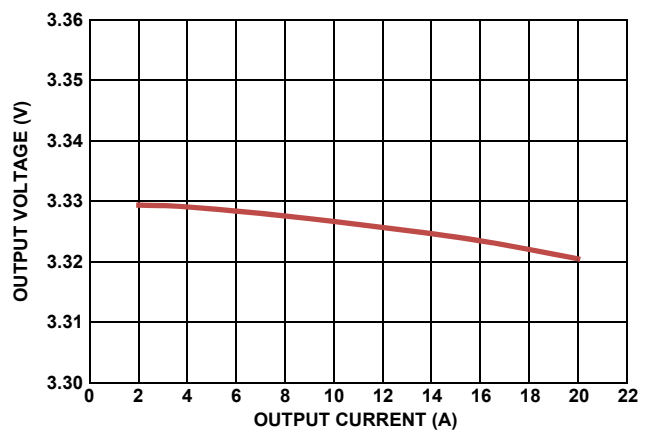


FIGURE 17. OUTPUT LOAD REGULATION 3.3V

## Steady State Operation 1st stage LC (2μH + 2\*47μF) + 2nd stage LC Output Filters (200nH + 820μF).

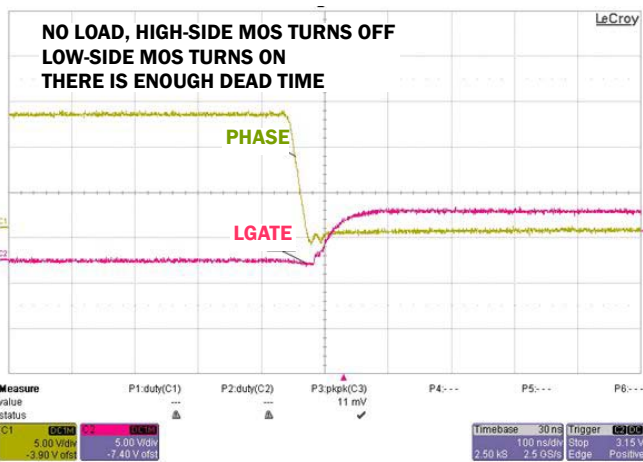


FIGURE 18. GATE DRIVER AND SWITCHING TRANSIENT

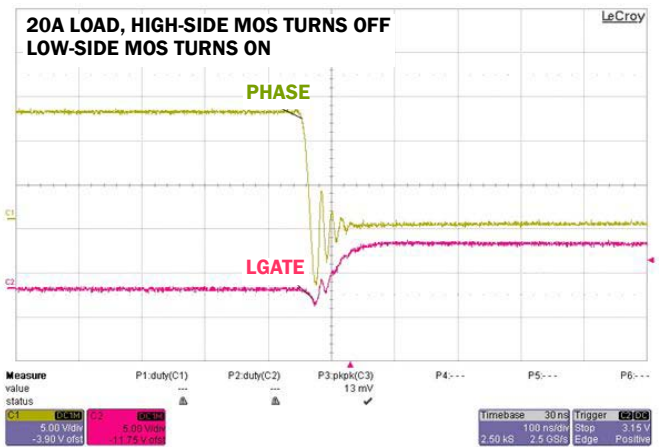


FIGURE 19. GATE DRIVER AND SWITCHING TRANSIENT

## Steady State Operation

1st stage LC ( $2\mu\text{H} + 2 \times 47\mu\text{F}$ ) + 2nd stage LC Output Filters ( $200\text{nH} + 820\mu\text{F}$ ). (Continued)

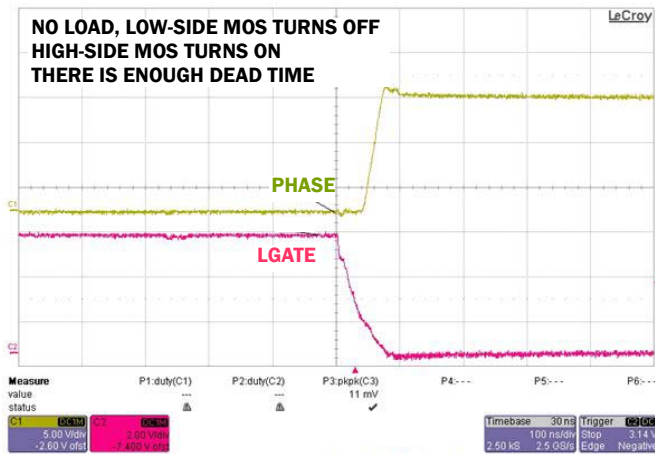


FIGURE 20. GATE DRIVER AND SWITCHING TRANSIENT

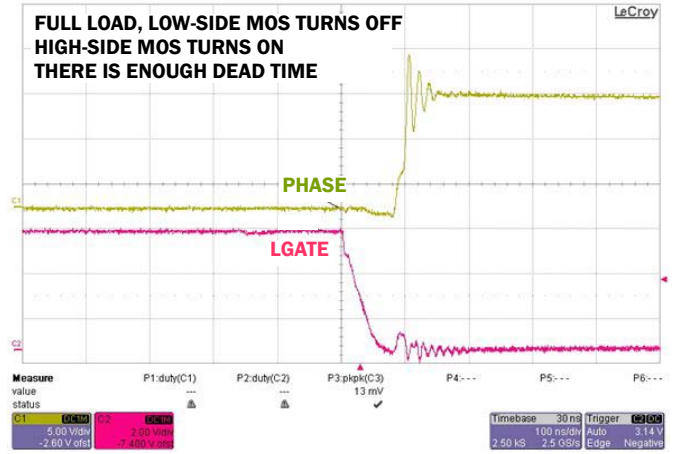


FIGURE 21. GATE DRIVER AND SWITCHING TRANSIENT

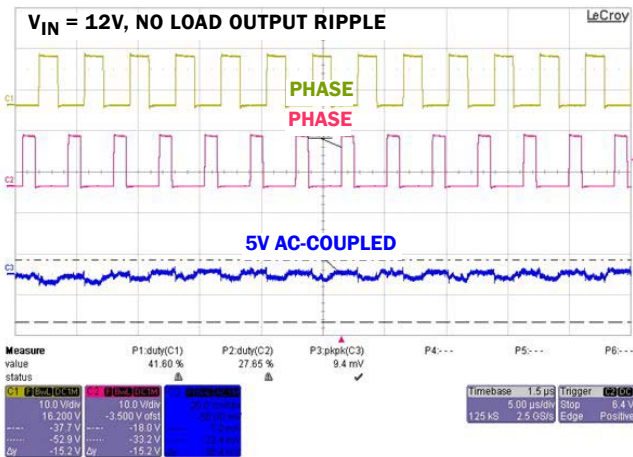


FIGURE 22. 5V NO LOAD OUTPUT RIPPLE 10mV

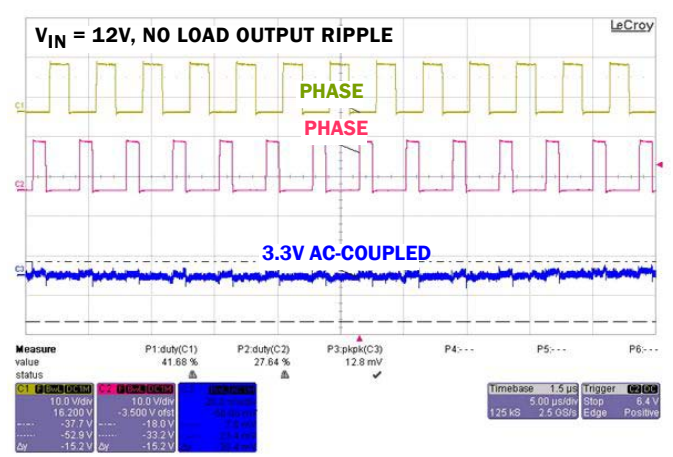


FIGURE 23. 3.3V NO LOAD OUTPUT RIPPLE 13mV

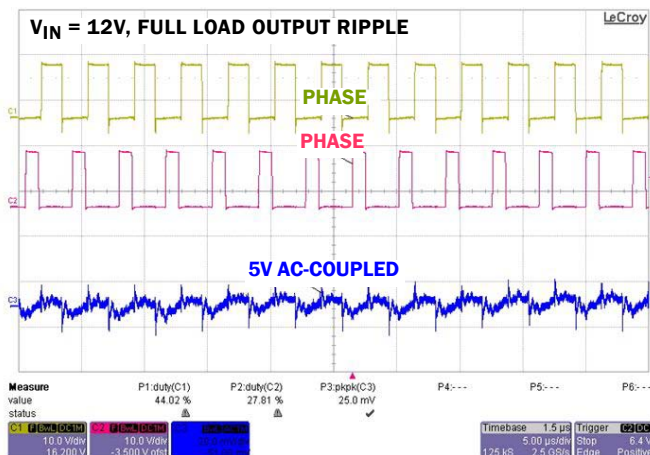


FIGURE 24. 5V FULL LOAD OUTPUT RIPPLE 25mV

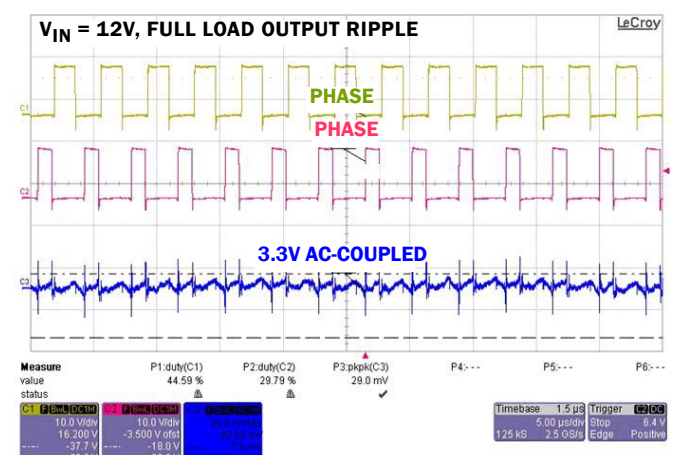


FIGURE 25. 3.3V FULL LOAD OUTPUT RIPPLE 29mV

## Output Transient Responses

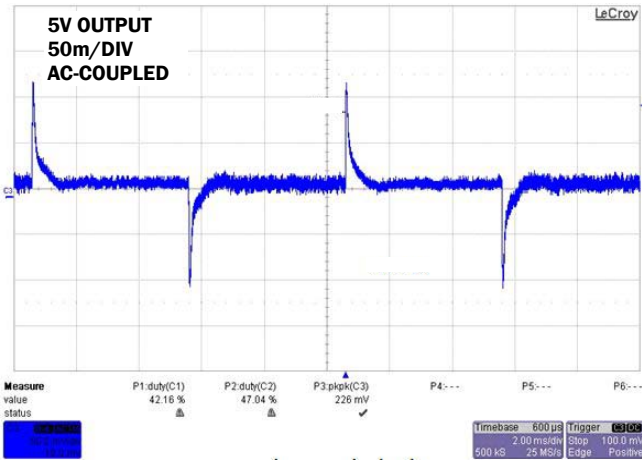


FIGURE 26. 5A~10A, 2.5A/µs, PEAK-TO-PEAK RIPPLE 226mV

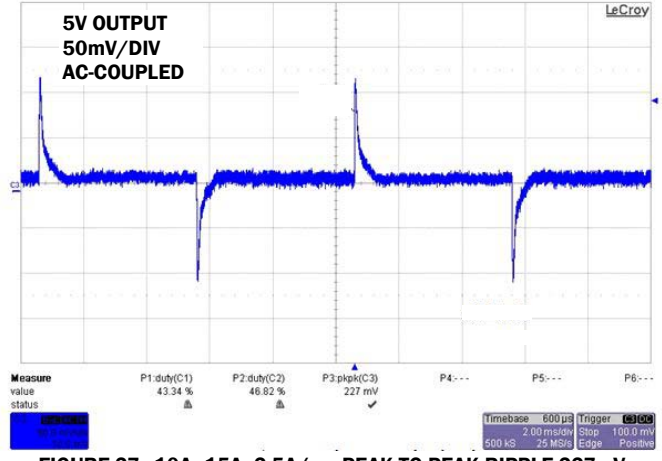


FIGURE 27. 10A~15A, 2.5A/µs, PEAK-TO-PEAK RIPPLE 227mV

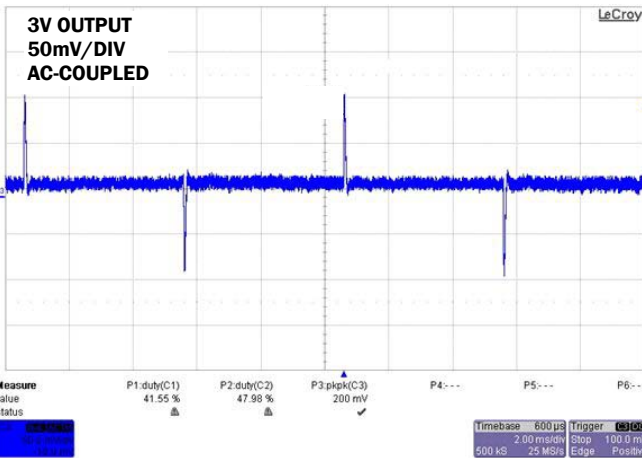


FIGURE 28. 5A~10A, 2.5A/µs, PEAK-TO-PEAK RIPPLE 200mV

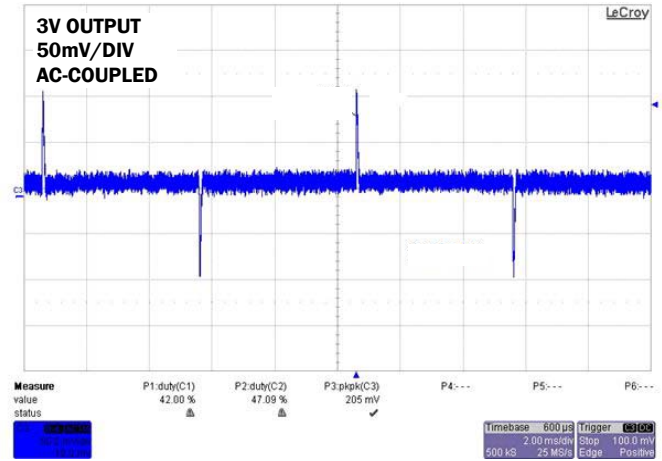


FIGURE 29. 10A~15A, 2.5A/µs, PEAK-TO-PEAK RIPPLE 205mV

## Protection

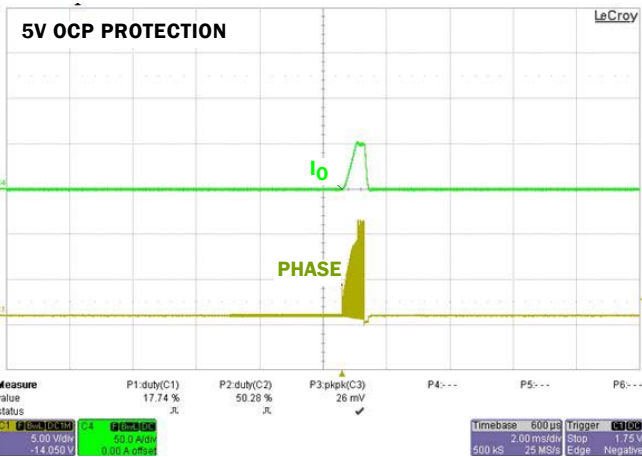


FIGURE 30. OVERCURRENT PROTECTION

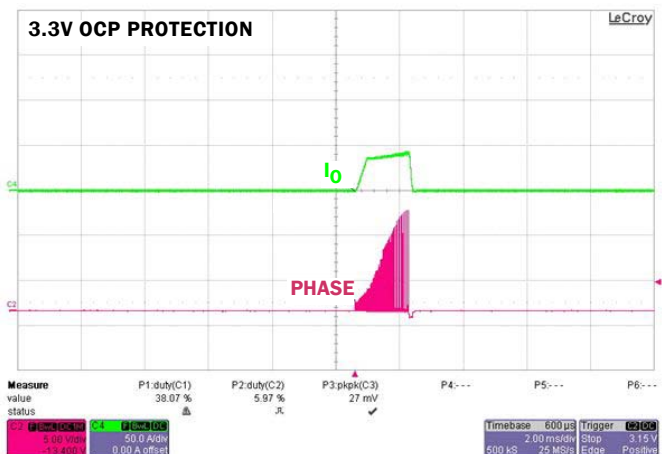


FIGURE 31. OVERCURRENT PROTECTION

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