ISL6446ADEMO1Z Dual Channel Step Down Regulator User Guide

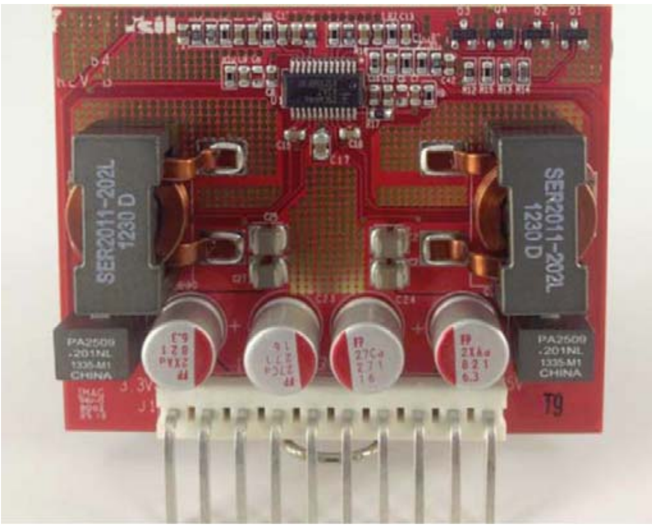


FIGURE 1. ISL6446ADEMO1Z REV B BOARD

FIGURE 2. ISL6446ADEMO1Z REV B BOARD BACKSIDE

Introduction

The ISL6446 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*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%
- Pre-Bias 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

Table of Contents

Equipment Used for Validation

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

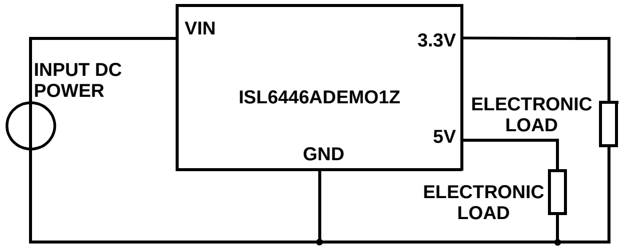


FIGURE 3. TYPICAL APPLICATION DIAGRAM

Terminal Functions

TABLE 1. TERMINAL FUNCTIONS

TERMINAL NAME	DESCRIPTION
VIN	The positive input voltage node to the module, which is referenced to common GND.
GND	This is the common ground connection for the VIN and VOUT 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_{OUT} and GND terminals.

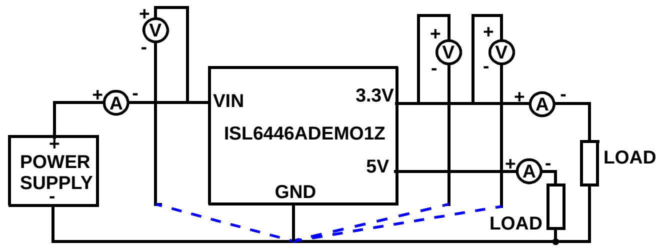


FIGURE 4. CONNECTION DIAGRAM

1. Keep the power supply and electronic load power off.
2. Connect the power supply; electronic load; voltage and current meters like 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_{OUT1} = 3.3V, V_{OUT2} = 5V
5. Slowly increase the load on V_{OUT} to 15A. Verify V_{OUT1} = 3.3V, V_{OUT2} = 5V

The board is now ready for operation.

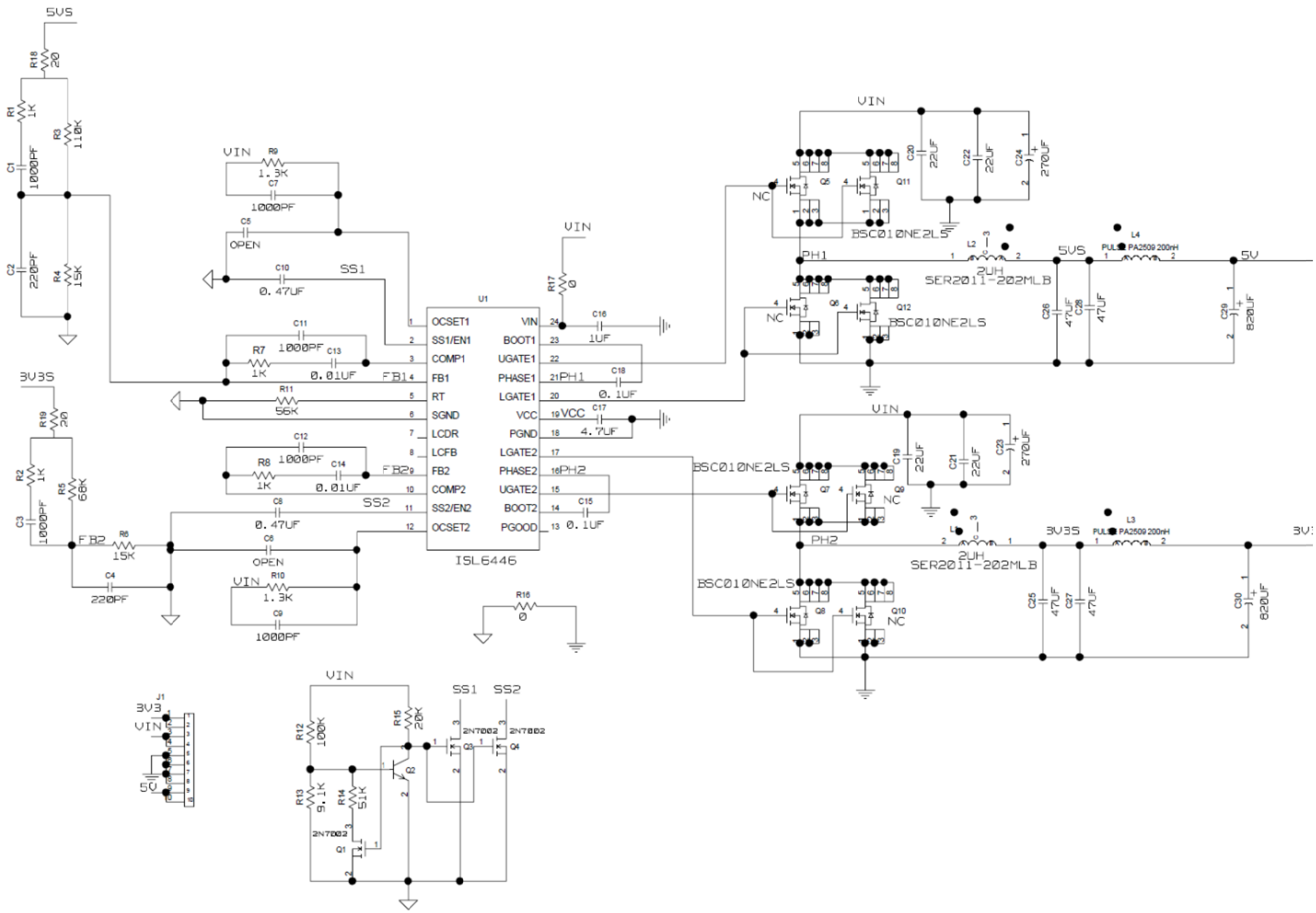
Electrical Specifications T_A = +25°C; V_{IN} = 12V; V_{OUT1} = 3.3V, V_{OUT2} = 5V, and I_{OUT1} = 15A, I_{OUT2} = 15A (unless otherwise noted).

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
η	Efficiency for DC/DC	V_{IN} = 12V (Note 1)	I_{OUT1} = I_{OUT2} = 2A		93.39		%
			I_{OUT1} = I_{OUT2} = 4A		95.18		%
			I_{OUT1} = I_{OUT2} = 8A		95.87		%
			I_{OUT1} = I_{OUT2} = 12A		95.53		%
			I_{OUT1} = I_{OUT2} = 16A		94.88		%
			I_{OUT1} = I_{OUT2} = 20A		93.99		%
V_{r1}	V_{OUT1} Ripple (Peak-to-Peak)	No load			30		mV_{P-P}
		Full load			50		mV_{P-P}
V_{r2}	V_{OUT2} Ripple (Peak-to-Peak)	No load			30		mV_{P-P}
		Full Load			50		mV_{P-P}
V_{T1}	Transient (Peak-to-Peak)	Output peak-to-peak voltage variation when output current changing from 5A to 10A with 2.5A/µs 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/µs slew rate			250		mV
Fs	Switching Frequency	Over V_{IN} and Io range			280		kHz

NOTE:

1. For the efficiency test result please refer to page 11.

ISL6446ADEMO1Z Schematic



PCB Layout

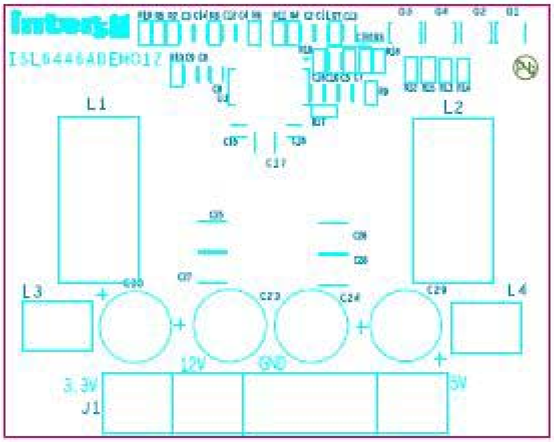


FIGURE 5. SILKSCREEN TOP

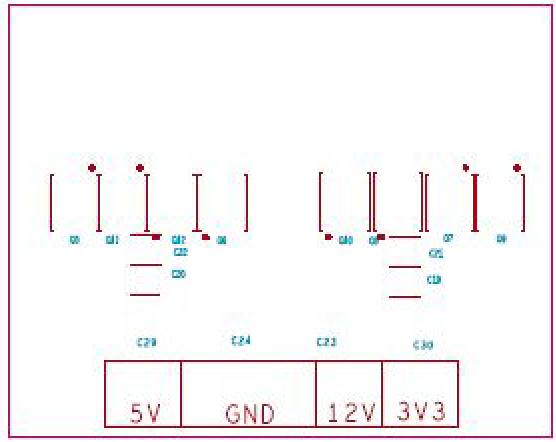


FIGURE 6. SILKSCREEN BOTTOM

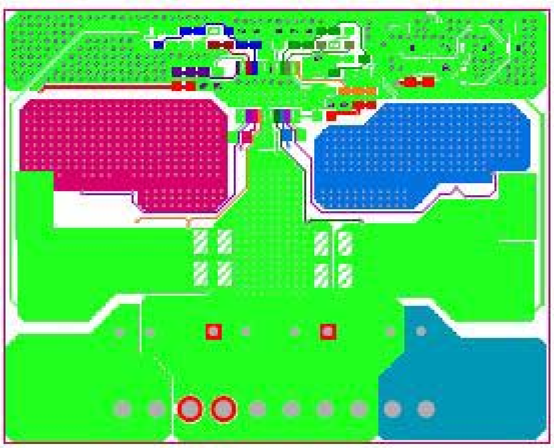


FIGURE 7. PCB TOP

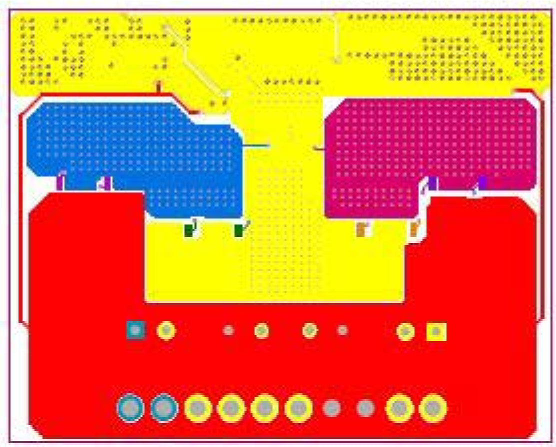


FIGURE 8. PCB BOTTOM

ISL6446ADEM01Z Bill of Materials

PART NUMBER	REF DESIGN	QTY	VALUE	TOL	VOLTAGE	POWER	PACKAGE TYPE	MANUFACTURER	DESCRIPTION
ISL6446AIAZ	U1	1					SSOP24	Intersil	Dual PWM and Linear Controller
2N7002	Q1, Q3, Q4	3					SOT23	Fairchild	N-Channel small signal MOSFET
MMBT3904	Q2	1					SOT23	Fairchild	NPN Transistor
BSC010NE2LS	Q7, Q8, Q11, Q12	4					PowerPAK SO-8	Infineon	25V, 100A, 1mΩ N-Channel MOSFET
SER2011-202MLB	L1, L2	2	2µH					Coilcraft	2µH, 37A, 1.2mΩ Inductor
PA2509.201NL	L3,L4	2	200nH					PULSE	200nH, 33A, 0.35mΩ Inductor
GENERIC	R1, R2	2	1kΩ	5%		1/16W	0603	GENERIC	Thick Film Chip Resistor
GENERIC	R3	1	110kΩ	1%		1/16W	0603	GENERIC	Thick Film Chip Resistor
GENERIC	R4, R6	2	15kΩ	1%		1/16W	0603	GENERIC	Thick Film Chip Resistor
GENERIC	R5	1	68kΩ	1%		1/16W	0603	GENERIC	Thick Film Chip Resistor
GENERIC	R7, R8	2	1kΩ	5%		1/16W	0603	GENERIC	Thick Film Chip Resistor
GENERIC	R9, R10	2	1.3kΩ	1%		1/16W	0603	GENERIC	Thick Film Chip Resistor
GENERIC	R11	1	56kΩ	1%		1/16W	0603	GENERIC	Thick Film Chip Resistor
GENERIC	R12	1	100kΩ	1%		1/16W	0603	GENERIC	Thick Film Chip Resistor
GENERIC	R13	1	9.1kΩ	1%		1/16W	0603	GENERIC	Thick Film Chip Resistor
GENERIC	R14	1	51kΩ	5%		1/16W	0603	GENERIC	Thick Film Chip Resistor
GENERIC	R15	1	20kΩ	5%		1/16W	0604	GENERIC	Thick Film Chip Resistor
GENERIC	R18, R19	2	20Ω	5%		1/16W	0603	GENERIC	Thick Film Chip Resistor
GENERIC	R16	1	0Ω	5%		1/16W	0603	GENERIC	Thick Film Chip Resistor
GENERIC	R17	1	0Ω	5%		1/16W	0603	GENERIC	Thick Film Chip Resistor
GENERIC	C1, C3, C7, C9, C11, C12	6	1nF	10%	50V		0603	GENERIC	Multilayer Capacitor
GENERIC	C2, C4	2	220pF	10%	50V		0603	GENERIC	Multilayer Capacitor
GENERIC	C8, C10	2	0.47µF	10%	16V		0603	GENERIC	Multilayer Capacitor
GENERIC	C13, C14	2	10nF	10%	50V		0603	GENERIC	Multilayer Capacitor
GENERIC	C15, C18	2	0.1µF	10%	25V		0603	GENERIC	Multilayer Capacitor
GENERIC	C16	1	1µF	20%	16V		0603	GENERIC	Multilayer Capacitor
GENERIC	C17	1	4.7µF	20%	16V		0805	GENERIC	Multilayer Capacitor

ISL6446ADEMO1Z Bill of Materials (Continued)

PART NUMBER	REF DESIGN	QTY	VALUE	TOL	VOLTAGE	POWER	PACKAGE TYPE	MANUFACTURER	DESCRIPTION
C3225X7R1C226M	C19 - C22	4	22µF	20%	16V		1210	GENERIC	Multilayer Capacitor
16SVPC270M	C23, C24	2	270µF		16V			SANYO	Electrolytic Capacitor
GRM32ER70J476ME20L	C25 - C28	4	47µF	20%	6.3V		1210	GENERIC	Multilayer Capacitor
6SVPC820M	C29, C30	2	820µF		6.3V			SANYO	Electrolytic Capacitor
1-640385-0	J1	1						TE Connectivity	10 Pin Connector

ISL6446ADEMO1Z Test Report

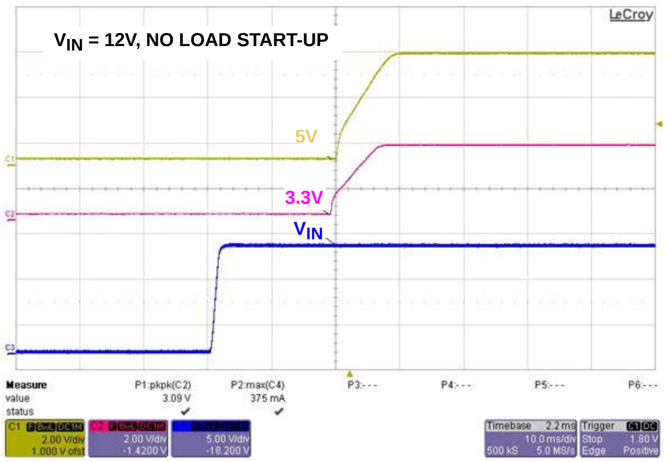


FIGURE 9. START-UP

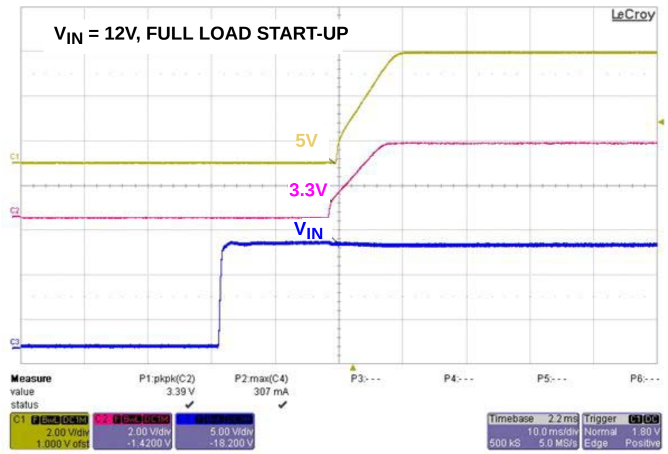


FIGURE 10. START-UP

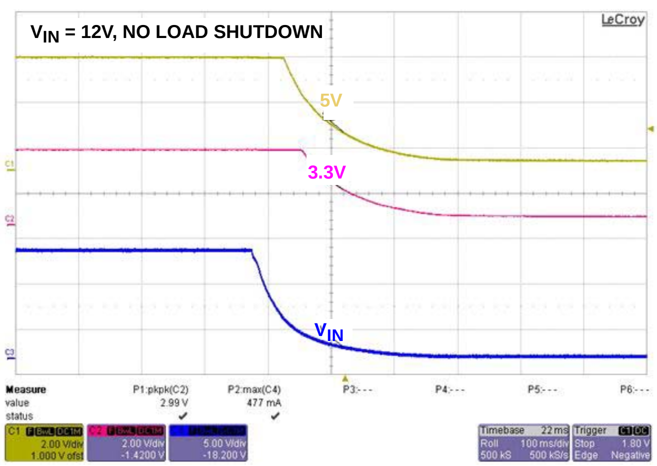


FIGURE 11. SHUTDOWN

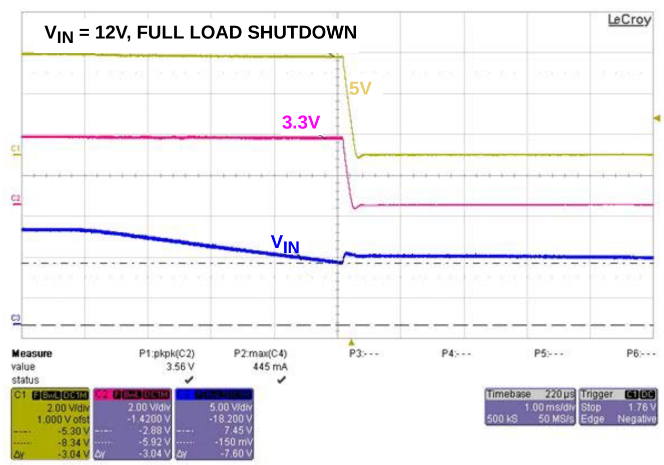


FIGURE 12. SHUTDOWN (UVLO VOLTAGE 7.4V)

Efficiency Curves

Input = 12VDC, Output = 5V/20A, 3.3V/20A

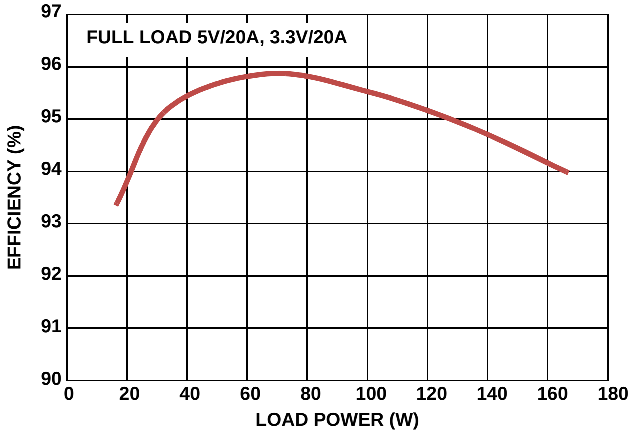


FIGURE 13. EFFICIENCY vs OUTPUT POWER

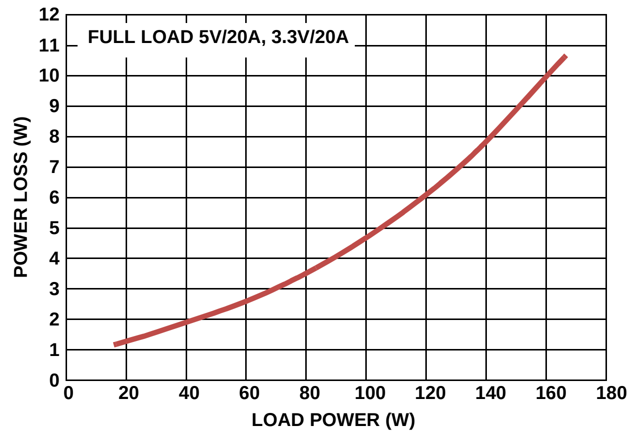


FIGURE 14. POWER LOSS vs OUTPUT POWER

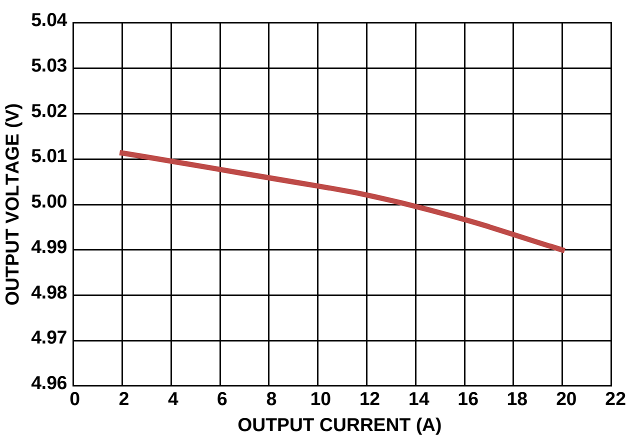


FIGURE 15. OUTPUT LOAD REGULATION 5V

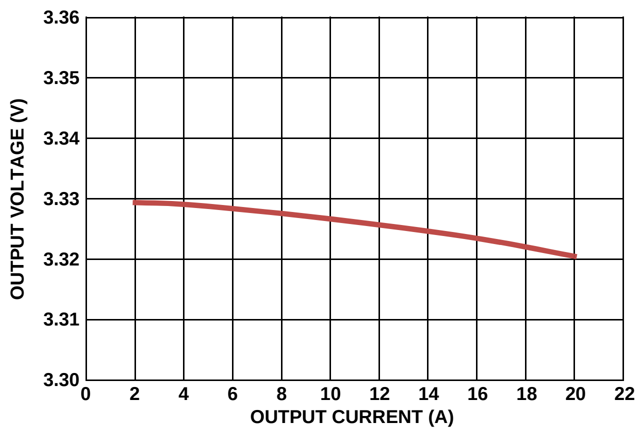


FIGURE 16. OUTPUT LOAD REGULATION 3.3V

Steady State Operation

1st stage LC (2µH + 2*47µF) + 2nd stage LC Output Filters (200nH + 820µF)

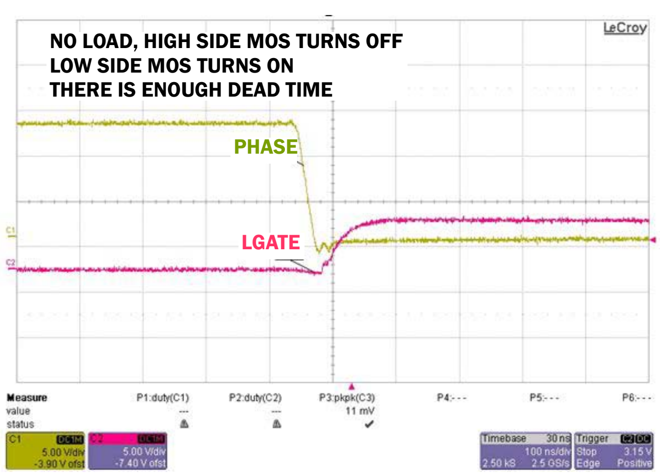


FIGURE 17. GATE DRIVER AND SWITCHING TRANSIENT

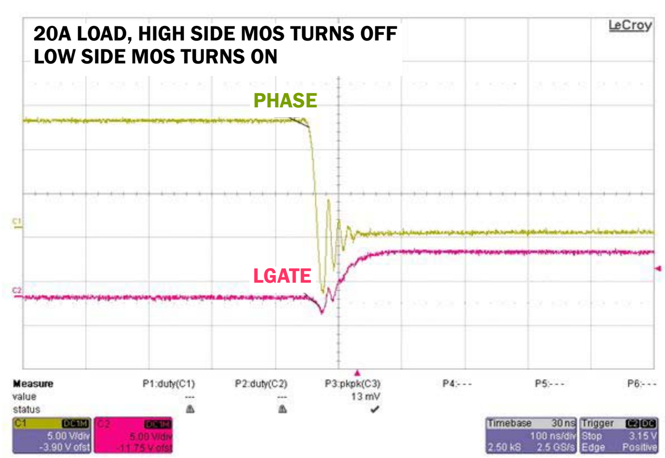


FIGURE 18. GATE DRIVER AND SWITCHING TRANSIENT

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

FIGURE 19. GATE DRIVER AND SWITCHING TRANSIENT

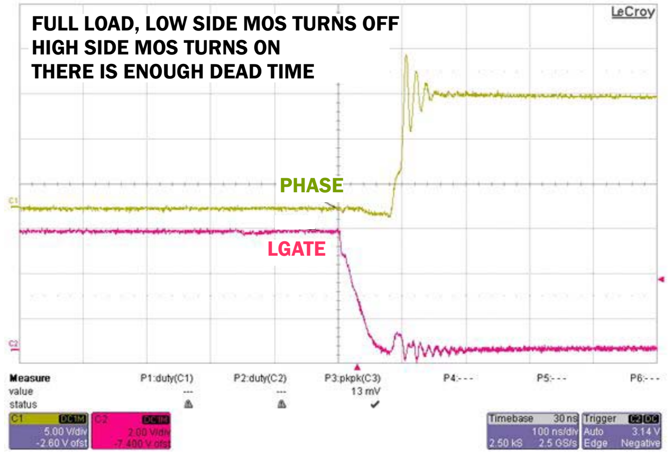


FIGURE 20. GATE DRIVER AND SWITCHING TRANSIENT

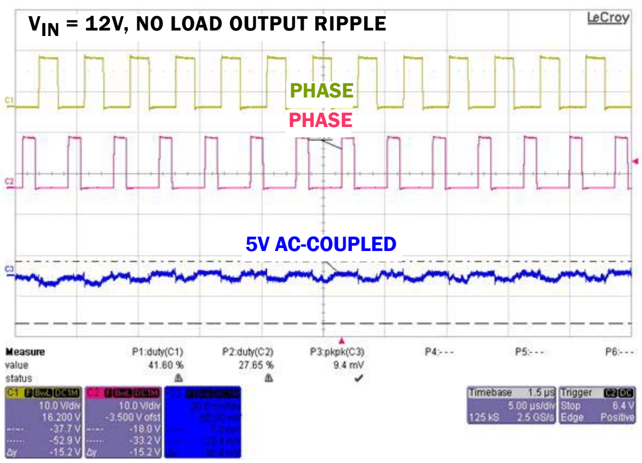


FIGURE 21. 5V NO LOAD OUTPUT RIPPLE 10mV

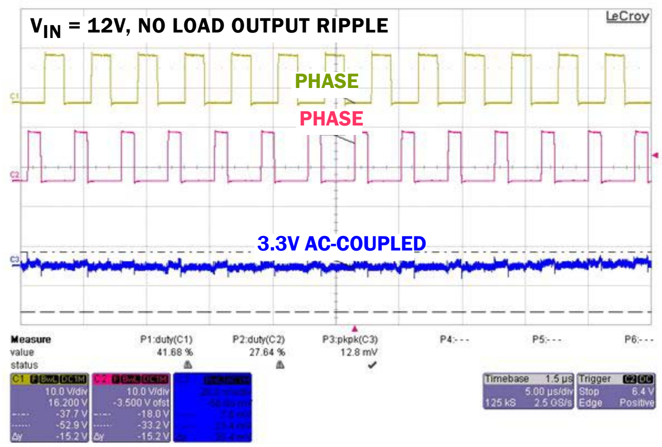


FIGURE 22. 3.3V NO LOAD OUTPUT RIPPLE 13mV

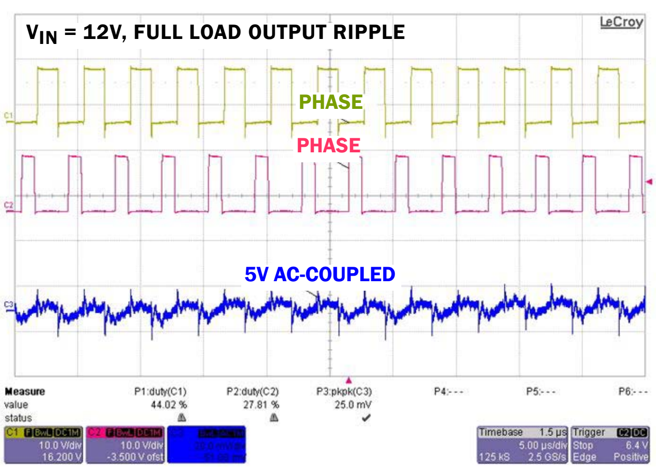


FIGURE 23. 5V FULL LOAD OUTPUT RIPPLE 25mV

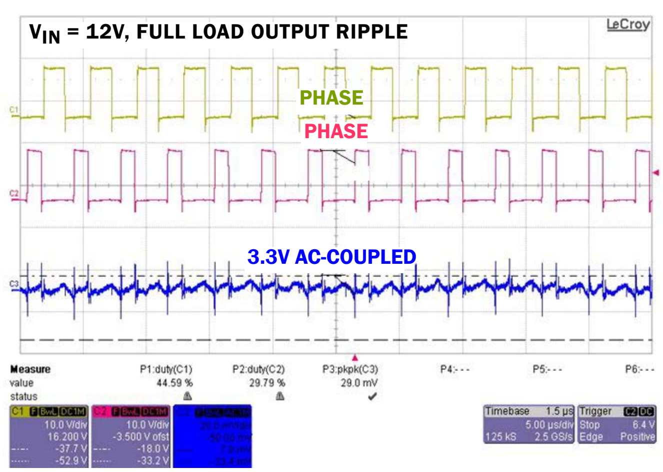


FIGURE 24. 3.3V FULL LOAD OUTPUT RIPPLE 29mV

Output Transient Responses

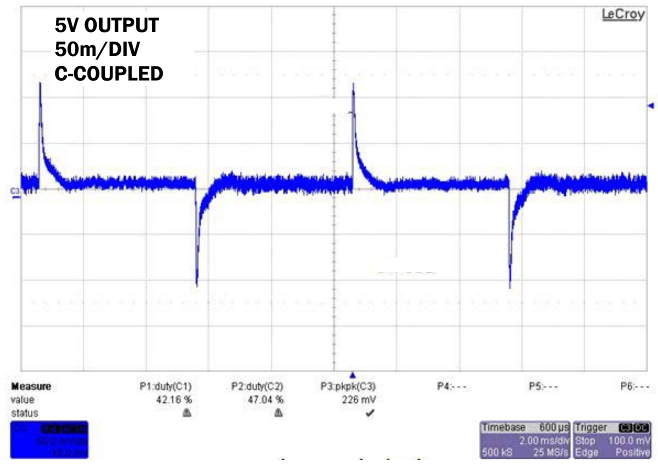


FIGURE 25. 5A~10A, 2.5A/µs, PEAK-TO-PEAK RIPPLE 226mV

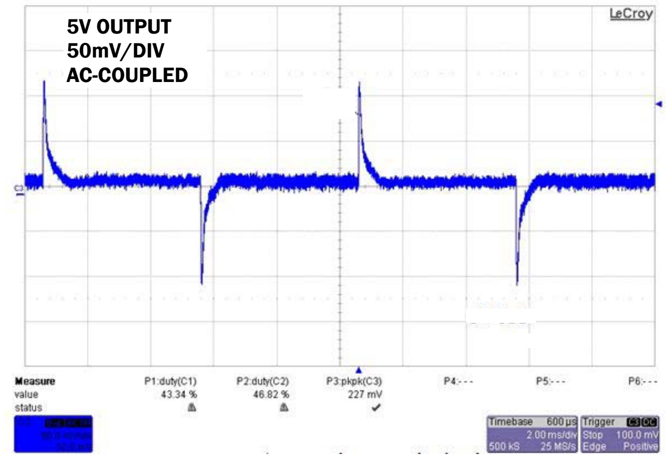


FIGURE 26. 10A~15A, 2.5A/µs, PEAK-TO-PEAK RIPPLE 227mV

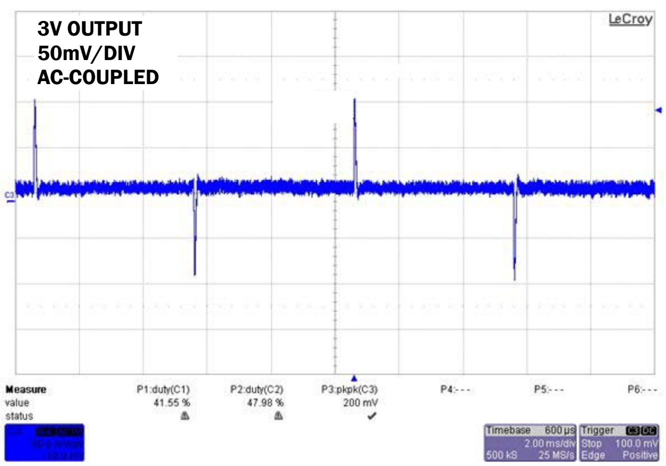


FIGURE 27. 5A~10A, 2.5A/µs, PEAK-TO-PEAK RIPPLE 200mV

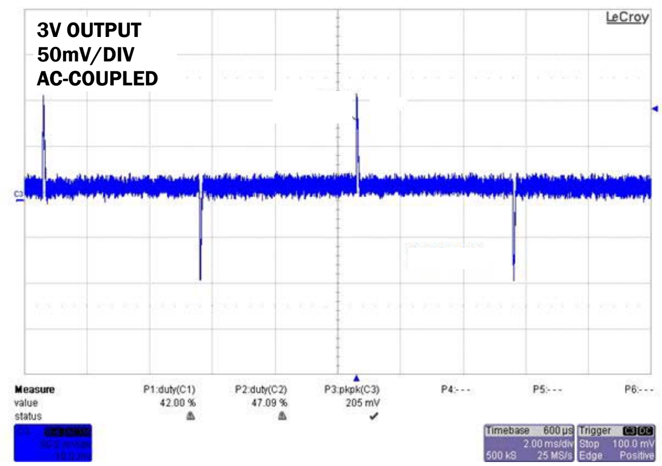


FIGURE 28. 10A~15A, 2.5A/µs, PEAK-TO-PEAK RIPPLE 205mV

Protection

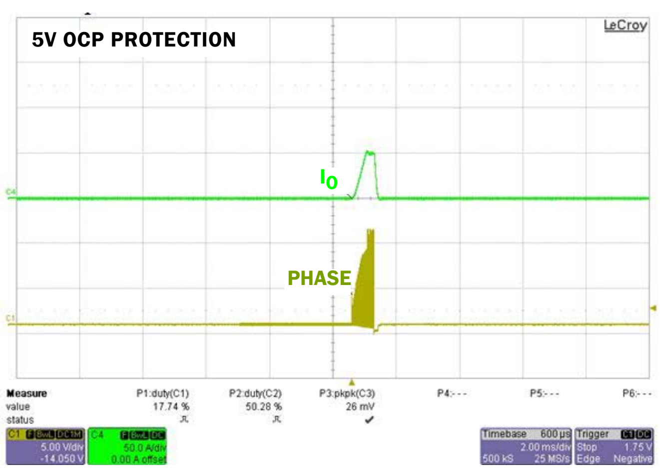


FIGURE 29. OVERCURRENT PROTECTION

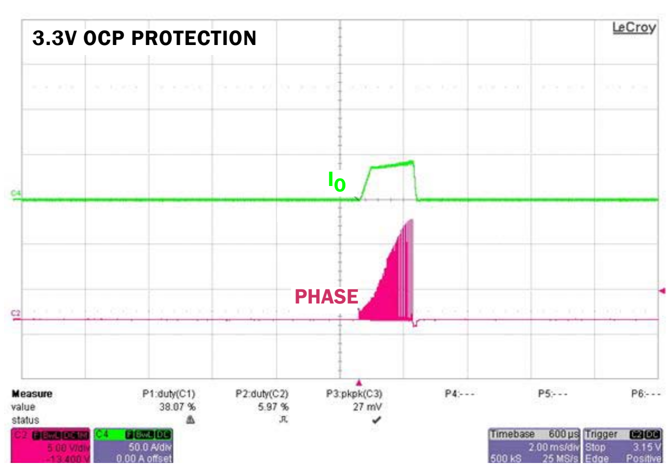


FIGURE 30. OVERCURRENT PROTECTION