Sup*IR*Buck™

USER GUIDE FOR IR3894 EVALUATION BOARD

1.2Vout

DESCRIPTION

The IR3894 is a synchronous buck converter, providing a compact, high performance and flexible solution in a small 5mm X 6 mm Power QFN package.

Key features offered by the IR3894 include internal Digital Soft Start/Soft Stop, precision 0.5Vreference voltage, Power Good, thermal protection, programmable switching frequency, Enable input, input under-voltage lockout for proper start-up, enhanced line/ load regulation with feed forward, external frequency synchronization with smooth clocking, smart internal LDO and pre-bias start-up.

Output over-current protection function is implemented by sensing the voltage developed across the on-resistance of the synchronous rectifier MOSFET for optimum cost and performance and the current limit is thermally compensated.

This user guide contains the schematic and bill of materials for the IR3894 evaluation board. The guide describes operation and use of the evaluation board itself. Detailed application information for IR3894 is available in the IR3894 data sheet.

BOARD FEATURES

- V_{in} = +12V (+ 13.2V Max)
- V_{out} = +1.2V @ 0- 12A
- F_s=600kHz
- L= 0.51uH
- C_{in}= 4x10uF (ceramic 1206) + 1X330uF (electrolytic)
- C_{out}=8x22uF (ceramic 0805)

CONNECTIONS AND OPERATING INSTRUCTIONS

A well regulated +12V input supply should be connected to VIN+ and VIN-. A maximum of 12A load should be connected to VOUT+ and VOUT-. The input and output connections of the board are listed in Table I.

IR3894 has only one input supply and internal LDO generates Vcc from Vin. If operation with external Vcc is required, then R15 can be removed and external Vcc can be applied between Vcc+ and Vcc- pins. Vin pin and Vcc/LDOout pins should be shorted together for external Vcc operation (use zero ohm resistor for R29).

The output can track voltage at the Vp pin. For this purpose, Vref pin is to be connected to ground (use zero ohm resistor for R21). The value of R14 and R28 can be selected to provide the desired tracking ratio between output voltage and the tracking input.

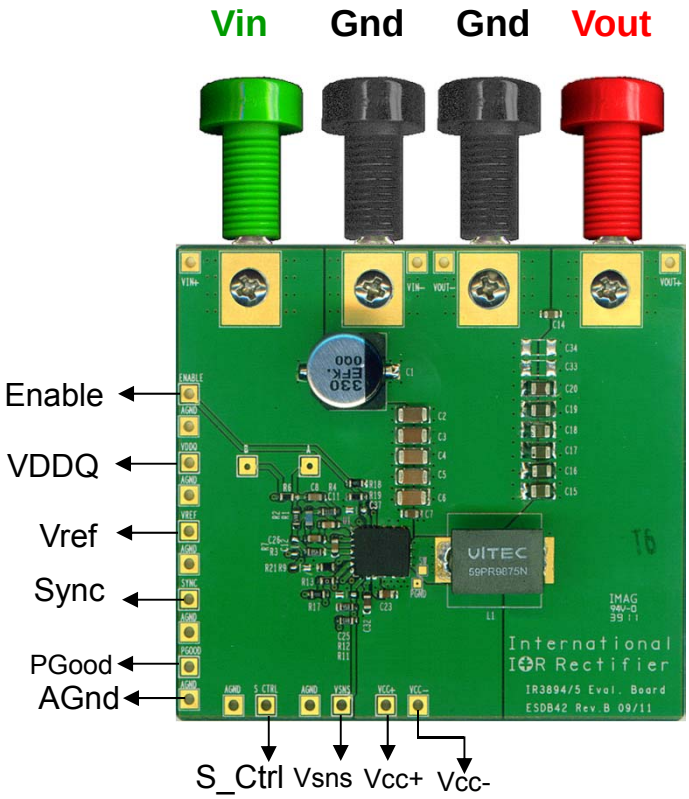
Table I. Connections

Connection	Signal Name
VIN+	Vin (+12V)
VIN-	Ground of Vin
Vout+	Vout(+1.2V)
Vout-	Ground for Vout
Vcc+	Vcc/ LDO_out Pin
Vcc-	Ground for Vcc input
Enable	Enable
PGood	Power Good Signal
Gnd	Analog ground

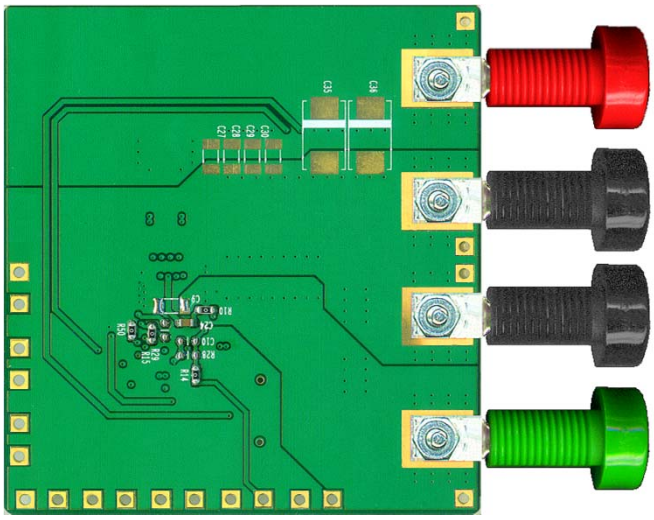
LAYOUT

The PCB is a 4-layer board (2.23”x2”) using FR4 material. All layers use 2 Oz. copper. The PCB thickness is 0.062”. The IR3894 and other major power components are mounted on the top side of the board.

Power supply decoupling capacitors, the bootstrap capacitor and feedback components are located close to IR3894. The feedback resistors are connected to the output at the point of regulation and are located close to the SupIRBuck IC. To improve efficiency, the circuit board is designed to minimize the length of the on-board power ground current path.



Top View



Bottom View

Fig. 1: Connection Diagram of IR3895/94 Evaluation Boards

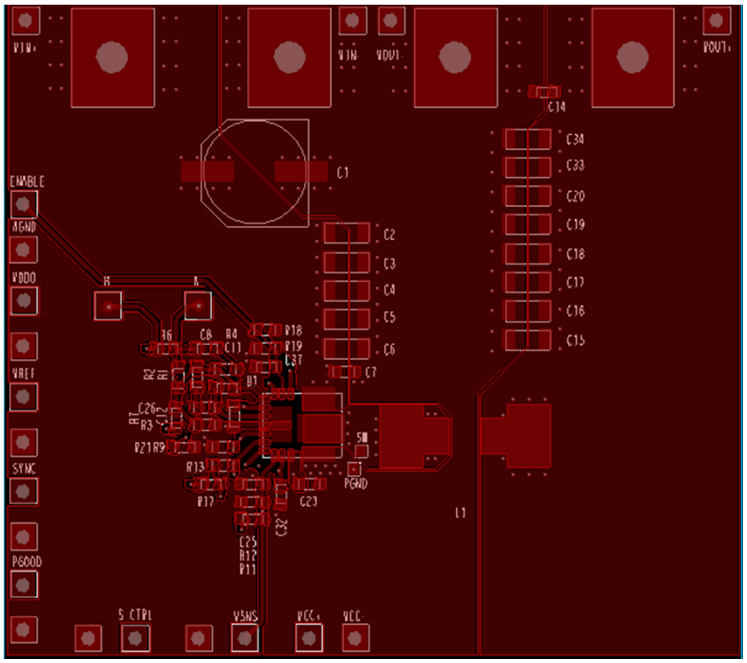
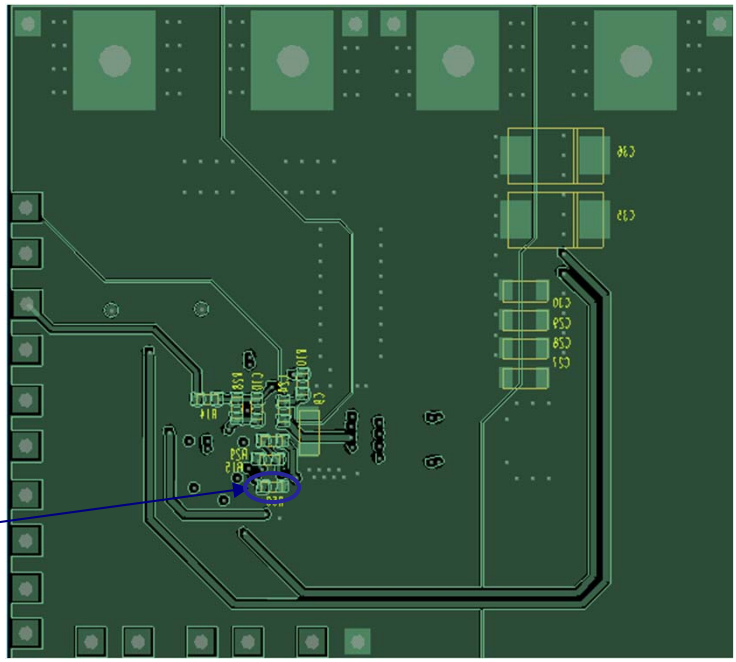


Fig. 2: Board Layout-Top Layer



Single point connection between Analog Gnd and PGnd

Fig. 3: Board Layout-Bottom Layer

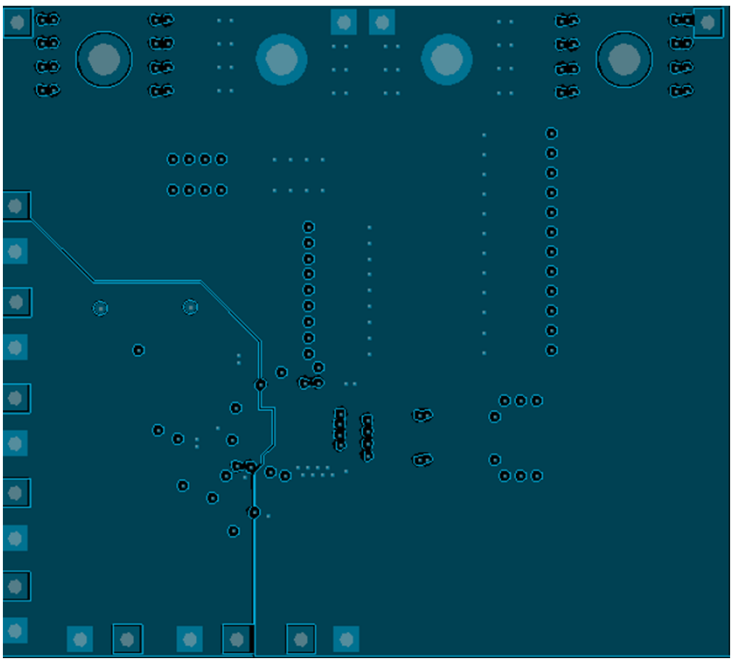


Fig. 4: Board Layout-Mid Layer 1

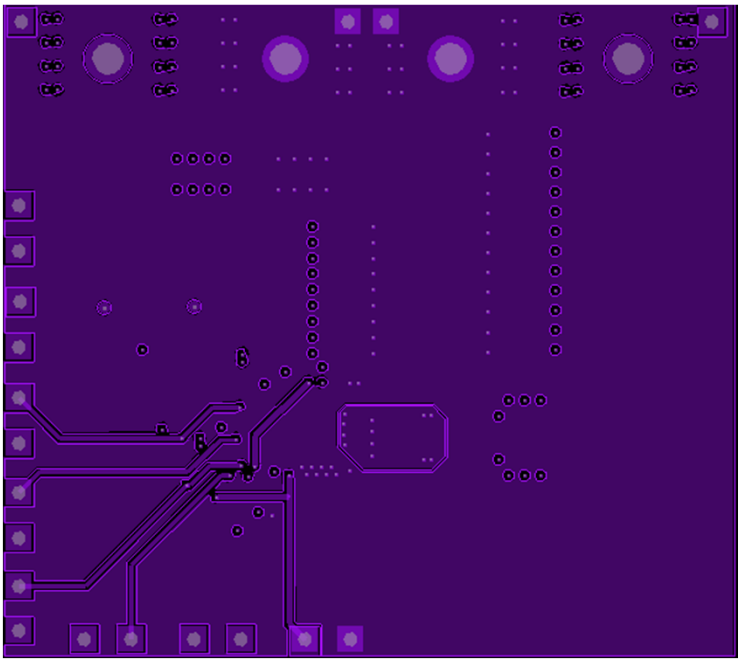


Fig. 5: Board Layout-Mid Layer 2

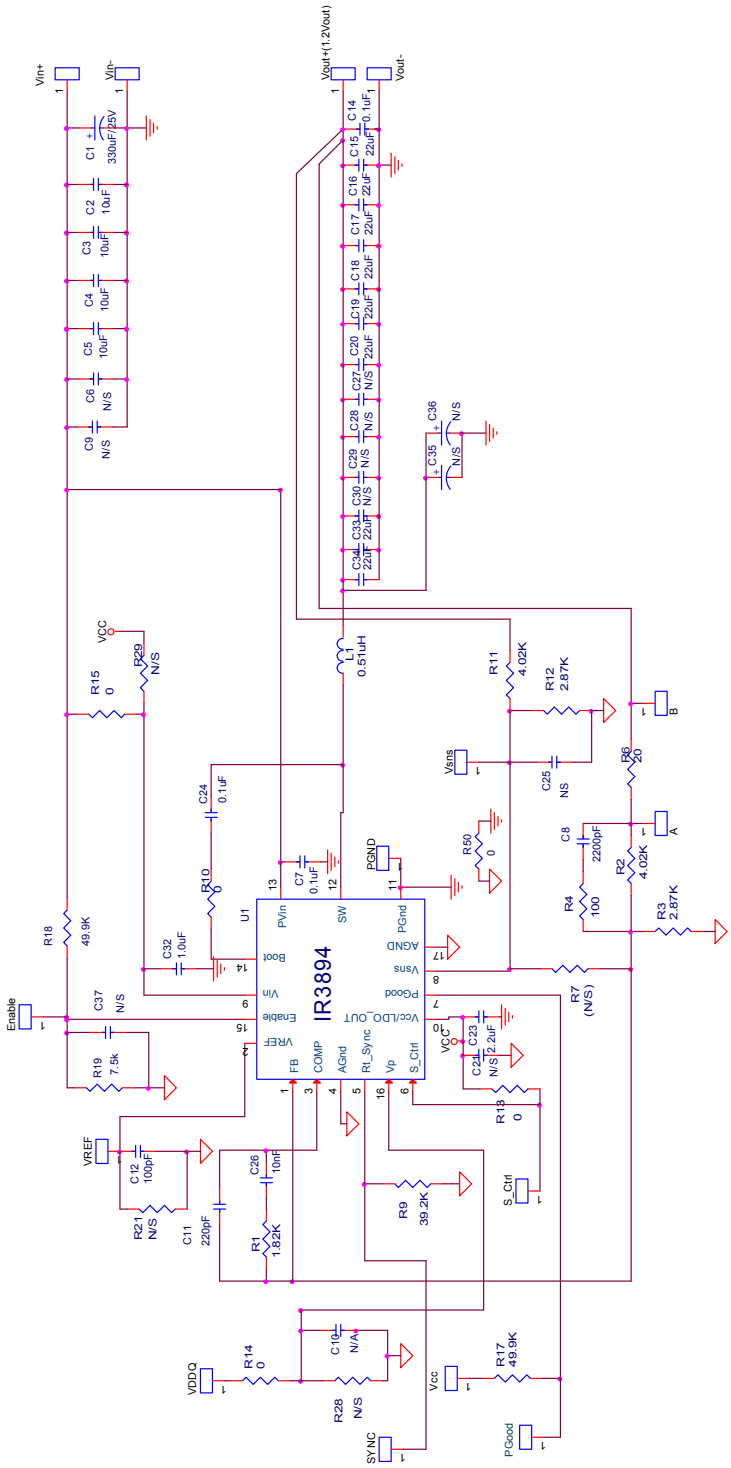


Fig. 6: Schematic of the IR3894 evaluation board

Bill of Materials

Item	Qty	Part Reference	Value	Description	Manufacturer	Part Number
1	1	C1	330uF	SMD Electrolytic F size 25V 20%	Panasonic	EEV-FK1E331P
2	4	C2 C3 C4 C5	10uF	1206, 25V, X5R, 20%	TDK	C3216X5R1E106M
3	3	C7 C14 C24	0.1uF	0603, 25V, X7R, 10%	Murata	GRM188R71E104KA01B
4	1	C12	100pF	0603,50V,NP0, 5%	Murata	GRM1885C1H101JA01D
5	1	C8	2200pF	0603,50V,X7R,10%	Murata	GRM188R71H222KA01B
6	1	C11	220pF	0603, 50V, COG, 5%	Murata	GRM1885C1H2201JA01D
7	8	C15 C16 C17 C18 C19 C20 C33 C34	22uF	0805, 6.3V, X5R, 20%	TDK	C2012X5R0J226M
8	1	C23	2.2uF	0603, 16V, X5R, 20%	TDK	C1608X5R1C225M
9	1	C26	10nF	0603, 25V, X7R, 10%	Murata	GRM188R71E103KA01J
10	1	C32	1.0uF	0603, 25V, X5R, 10%	Murata	GRM188R61E105KA12D
11	1	L1	0.51uH	SMD 11.0x7.2x7.5mm,0.29mΩ	Vitec	59PR9876N
12	1	R1	1.82k	Thick Film, 0603,1/10W,1%	Panasonic	ERJ-3EKF1821V
13	2	R2 R11	4.02k	Thick Film, 0603,1/10W,1%	Panasonic	ERJ-3EKF4021V
14	2	R3 R12	2.87k	Thick Film, 0603,1/10W,1%	Panasonic	ERJ-3EKF2871V
15	1	R4	100	Thick Film, 0603,1/10W,1%	Panasonic	ERJ-3EKF1000V
16	1	R6	20	Thick Film, 0603,1/10W,1%	Panasonic	ERJ-3EKF20R0V
17	1	R9	39.2k	Thick Film, 0603,1/10W,1%	Panasonic	ERJ-3EKF3922V
18	5	R10 R13 R14 R15 R50	0	Thick Film, 0603,1/10W	Panasonic	ERJ-3GEY0R00V
19	2	R17 R18	49.9k	Thick Film, 0603,1/10W,1%	Panasonic	ERJ-3EKF4992V
20	1	R19	7.5k	Thick Film, 0603,1/10W,1%	Panasonic	ERJ-3EKF7551V
21	1	U1	IR3894	PQFN 5x6mm	IR	IR3894MPBF

TYPICAL OPERATING WAVEFORMS
Vin=12.0V, Vo=1.2V, Io=0-12A, Room Temperature, no airflow

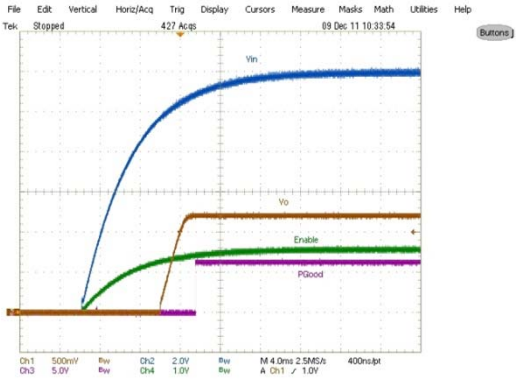


Fig. 7: Start up at 12A Load
Ch_1:V_{out}, Ch_2:V_{in}, Ch_3:PGood,Ch_4:Enable

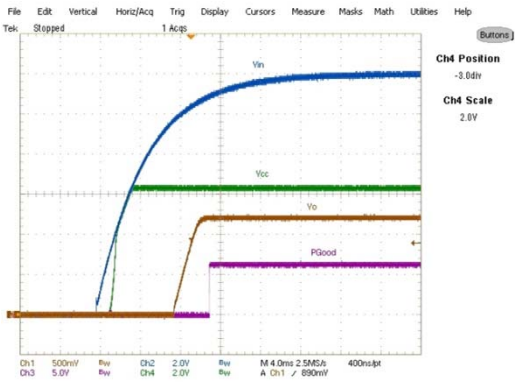


Fig. 8: Start up at 12A Load
Ch_1:V_{out}, Ch_2:V_{in}, Ch_3: PGood,Ch_4:Vcc

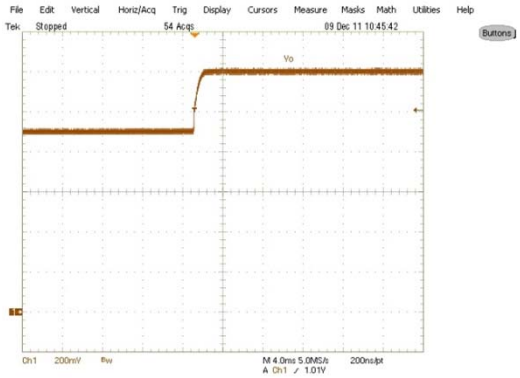


Fig. 9: Start up with Pre Bias , 0A Load,
Ch_1:V_o

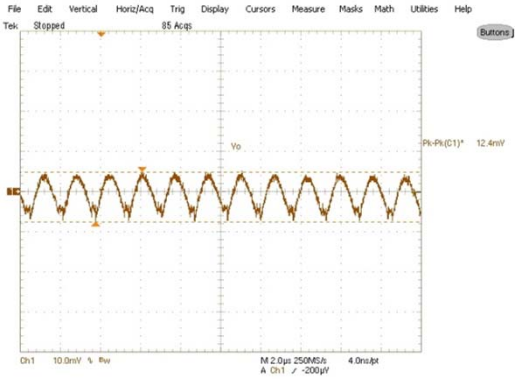


Fig. 10: Output Voltage Ripple, 12A load
Ch_1: V_{out} ,

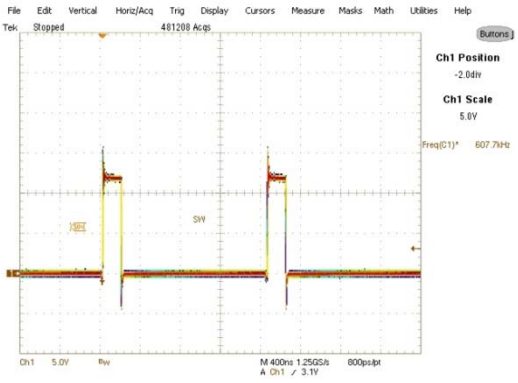


Fig. 11: Inductor node at 12A load
Ch_1:Switch Node

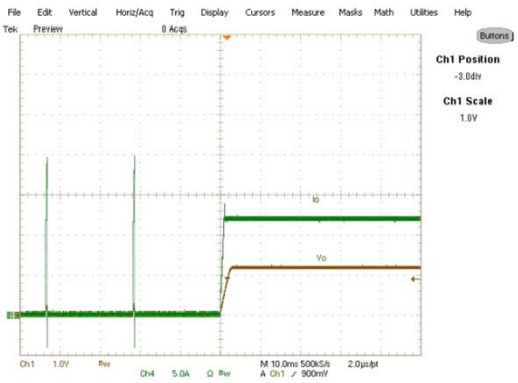
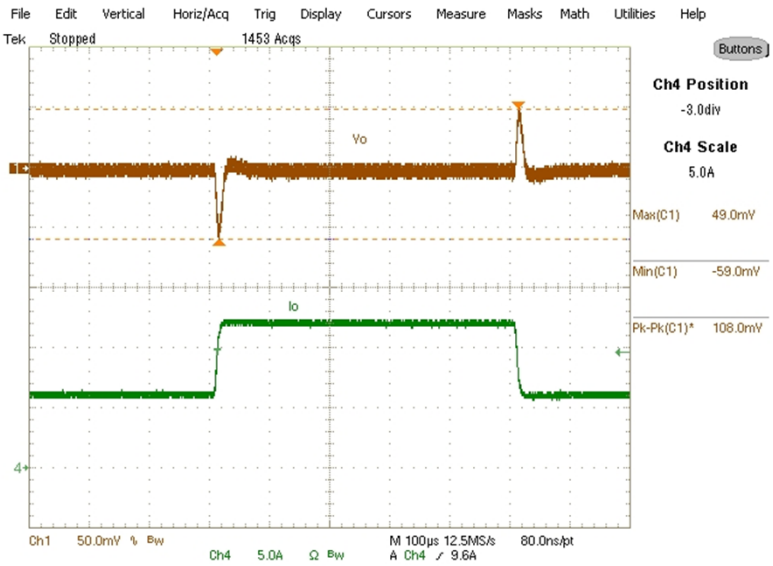
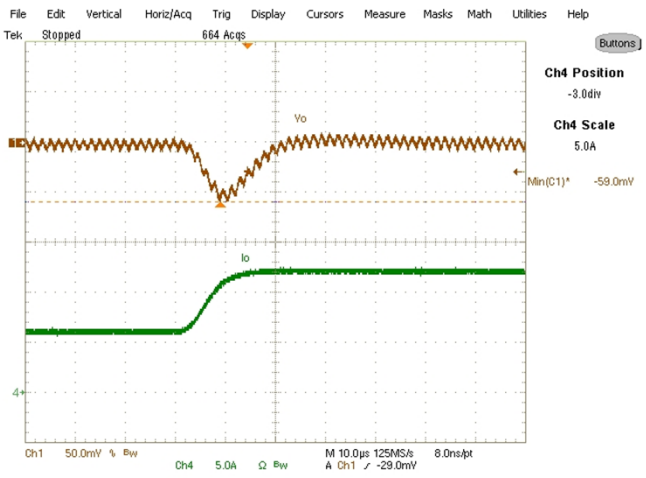


Fig. 12: Short circuit (Hiccup) Recovery
Ch_1:V_{out} , Ch4:Iout

TYPICAL OPERATING WAVEFORMS
Vin=12.0V, Vo=1.2V, Io=0-12A, Room Temperature, no air flow





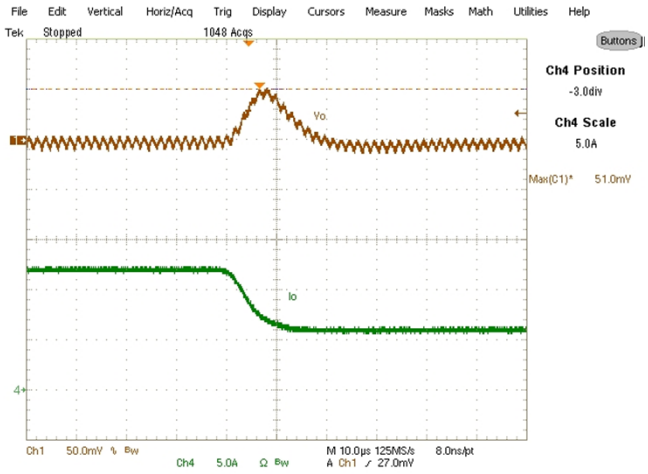


Fig. 13: Transient Response, 6A to 12A step @2.5A/usec slew rate
Ch_1:V_{out} Ch4-Iout

TYPICAL OPERATING WAVEFORMS
Vin=12.0V, Vo=1.2V, Io=0-12A, Room Temperature

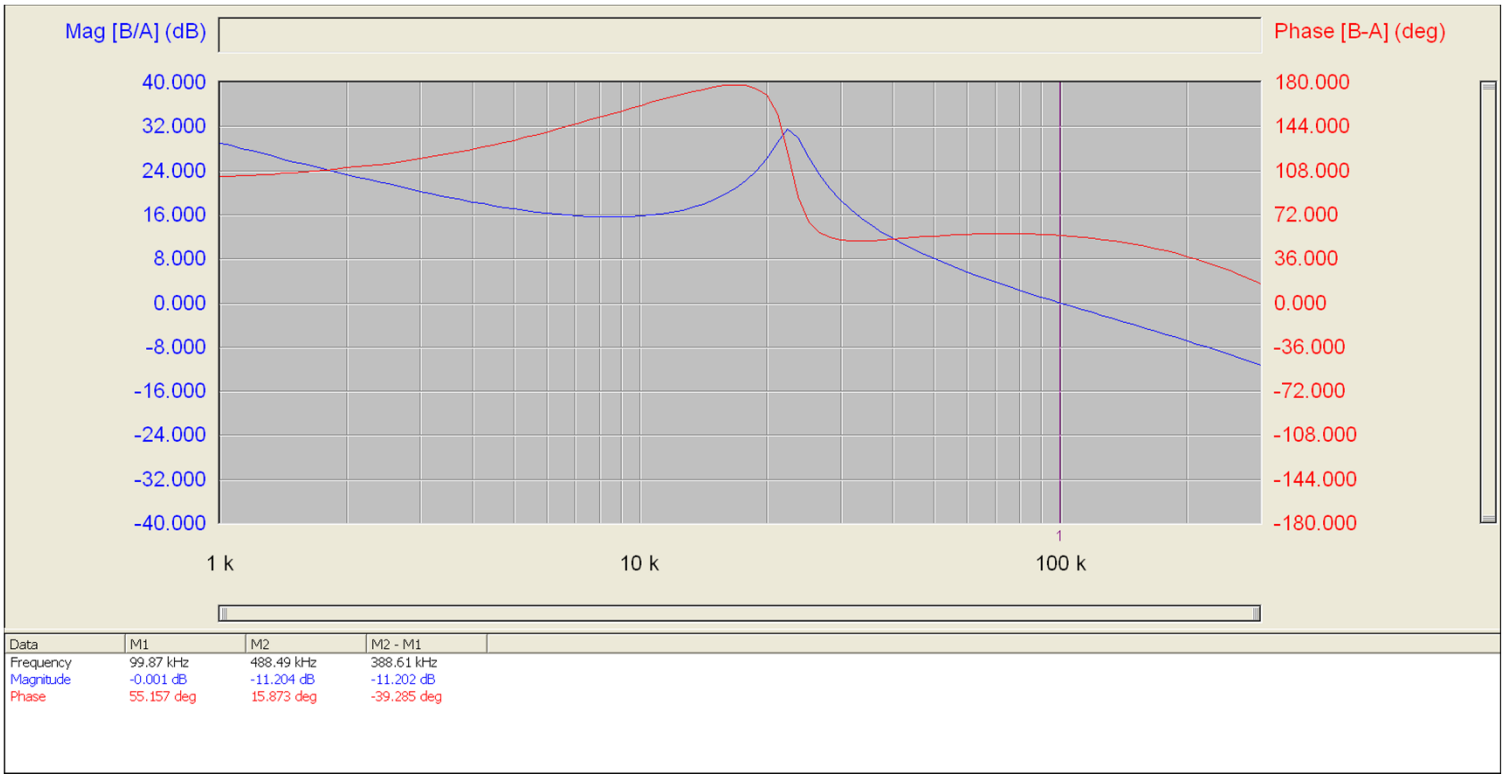


Fig. 14: Bode Plot at 12A load shows a bandwidth of 99.9kHz and phase margin of 55.2º

TYPICAL OPERATING WAVEFORMS
Vin=12.0V, Vo=1.2V, Io=0-12A, Room Temperature, no air flow

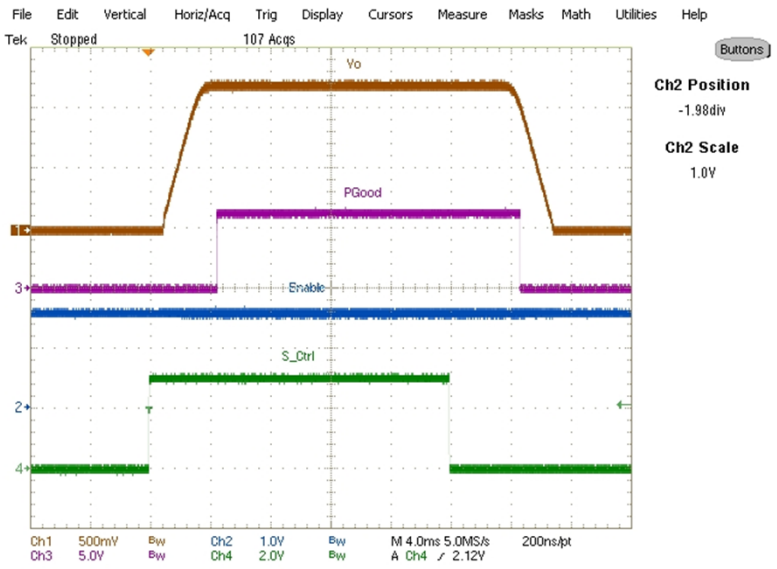


Fig (15) Soft start and soft stop using S_Ctrl pin

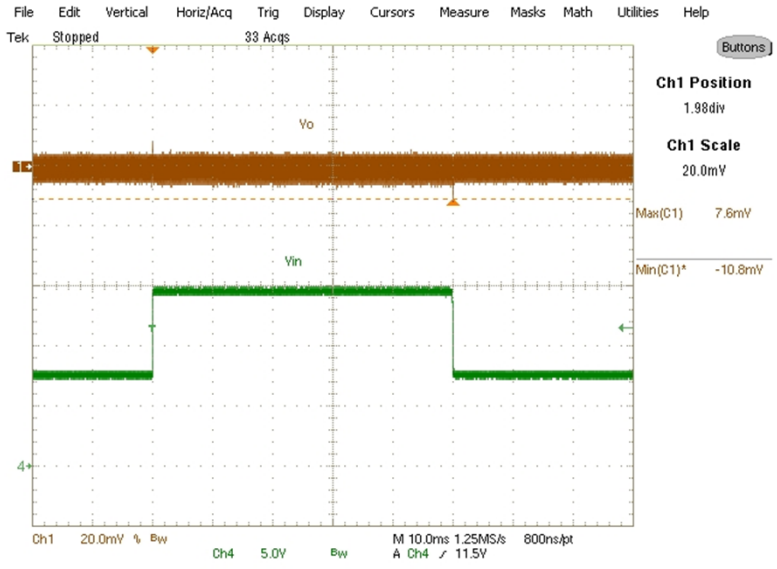


Fig (16) Feed Forward for Vin change from 6.8 to 16V and back to 6.8V
Ch_1-Vout Ch_4-Vin

TYPICAL OPERATING WAVEFORMS
Vin=12.0V, Vo=1.2V, Io=0-12A, Room Temperature, no air flow

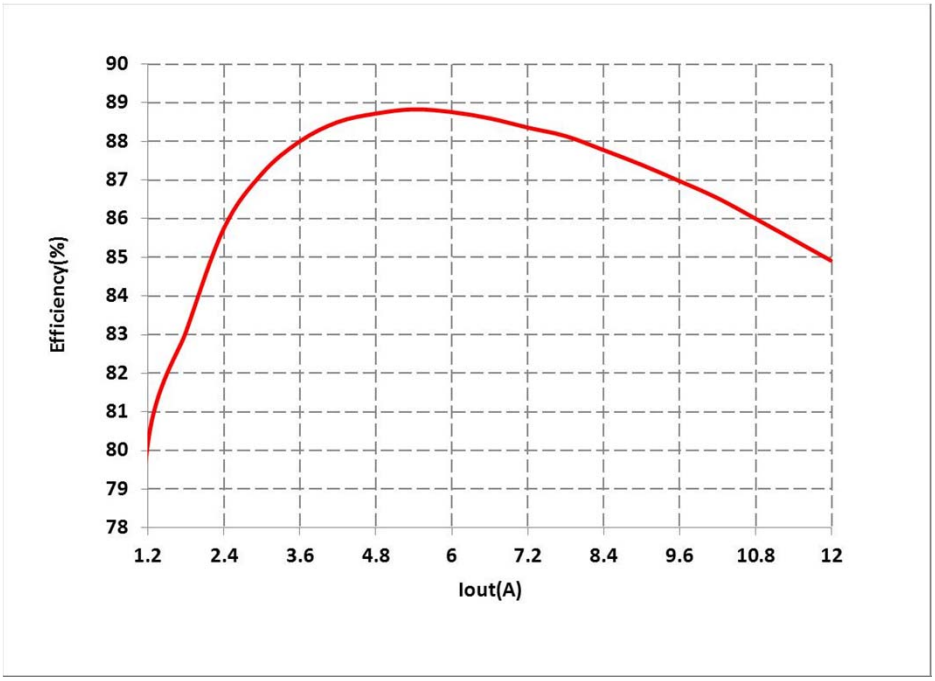


Fig.17: Efficiency versus load current

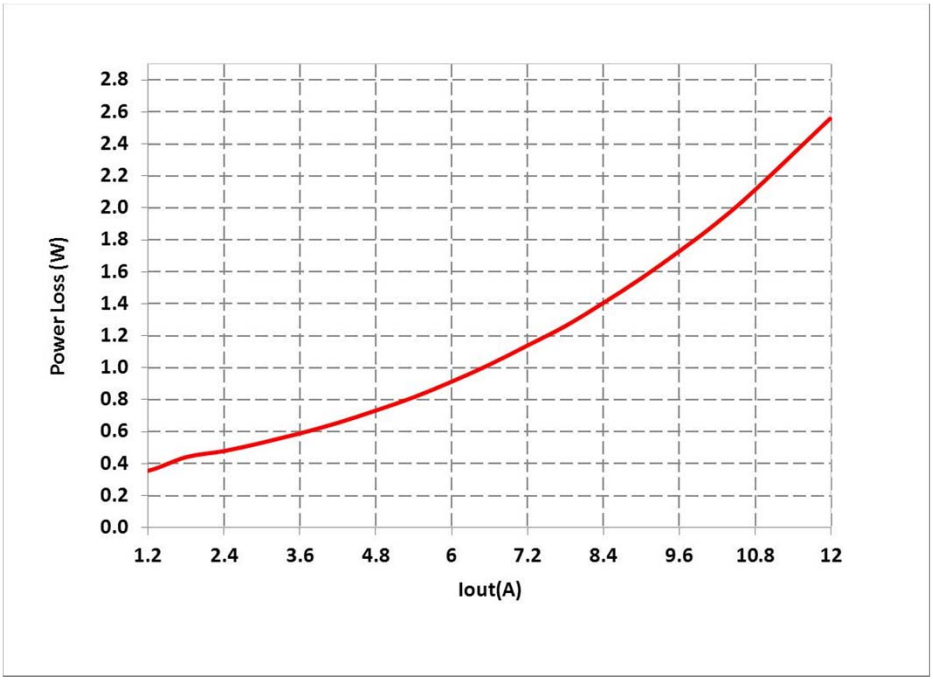


Fig.18: Power loss versus load current

THERMAL IMAGES
Vin=12.0V, Vo=1.2V, Io=0-12A, Room Temperature, No Air flow

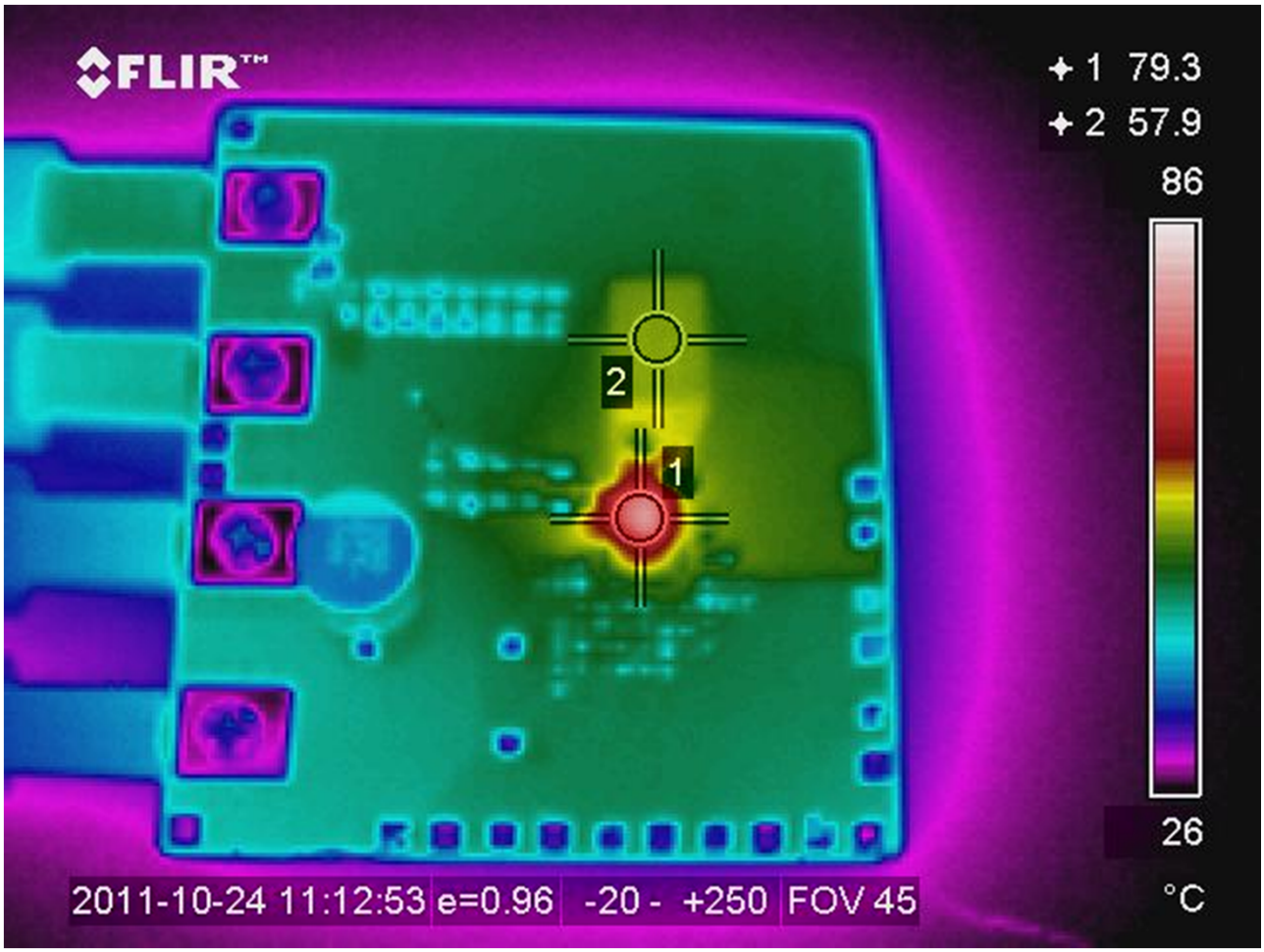


Fig. 19: Thermal Image of the board at 12A load
Test point 1 is IR3894
Test point 2 is inductor