Sup*IR*Buck™

USER GUIDE FOR IR3897 EVALUATION BOARD

0.609Vout-Tracking

DESCRIPTION

The IR3897 is a synchronous buck converter, providing a compact, high performance and flexible solution in a small 4mm X 5 mm Power QFN package.

Key features offered by the IR3897 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, 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 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 IR3897 evaluation board. The guide describes operation and use of the evaluation board itself. Detailed application information for IR3897 is available in the IR3897 data sheet.

BOARD FEATURES

- V_{in} = +12V (+ 13.2V Max)
- V_{out} = +0.609V @ 0- 3.6A (Source/Sink)
- F_s= 400kHz
- L= 0.82uH
- C_{in}= 2x10uF (ceramic 0805) + 1x330uF (electrolytic)*
- C_{out}= 4x47uF (ceramic 0805)

* The 330uF input capacitor is placed for damping the parasitic inductance of bench power supply wires. It is not required for the POL applications where input is delivered with power planes.

CONNECTIONS and OPERATING INSTRUCTIONS

A well regulated +12V input supply should be connected to VIN+ and VIN-. A maximum of 3.6A load should be connected to VOUT+ and VOUT-. The inputs and output connections of the board are listed in Table I.

IR3897 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/LDO_Out pins should be shorted together for external Vcc operation.

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

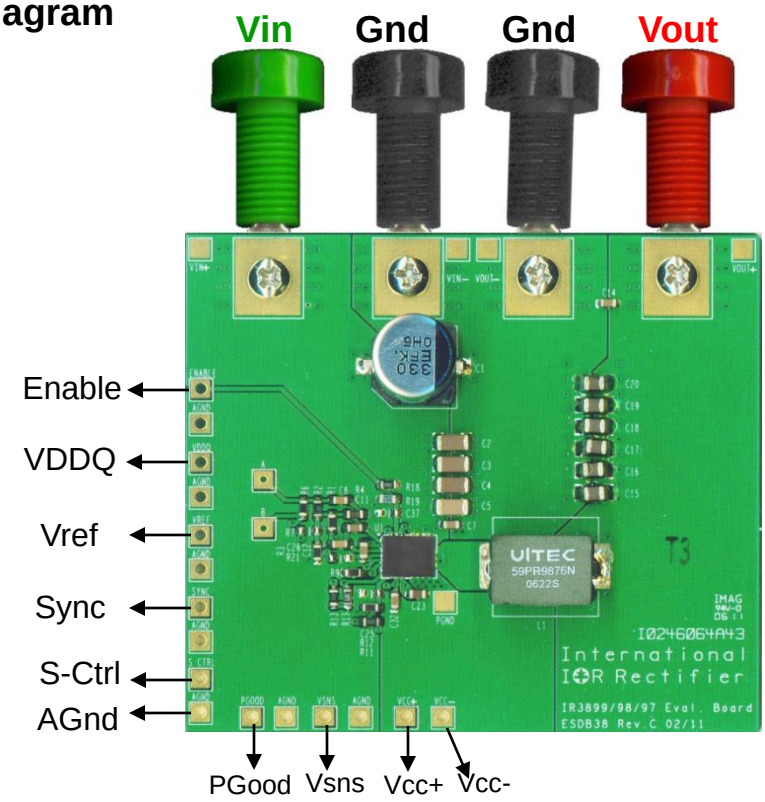
Connection	Signal Name
VIN+	Vin (+12V)
VIN-	Ground of Vin
Vout+	Vout(+0.609V)
Vout-	Ground for Vout
Vcc+	Vcc/ LDO_Out Pin
Vcc-	Ground for Vcc input
Enable	Enable
PGood	Power Good Signal
AGnd	Analog ground

LAYOUT

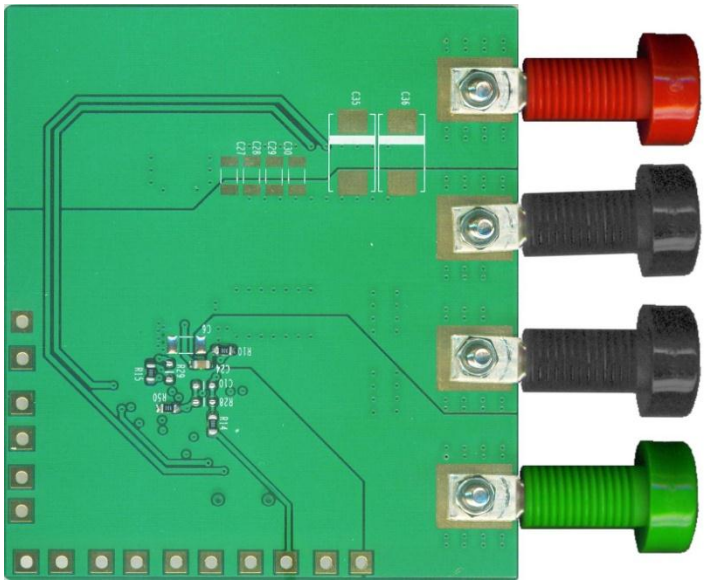
The PCB is a 4-layer board (2.23”x2”) using FR4 material. All layers use 2 Oz. copper. The PCB thickness is 0.062”. The IR3897 and other major power components are mounted on the top side of the board.

Power supply decoupling capacitors, the bootstrap capacitor and feedback components are located close to IR3897. 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.

Connection Diagram



Top View



Bottom View

Fig. 1: Connection Diagram of IR3899/98/97 Evaluation Boards

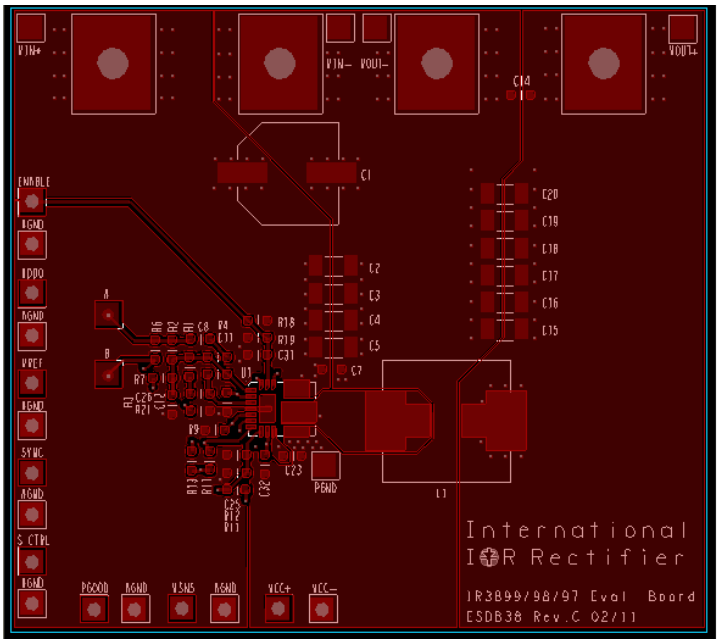
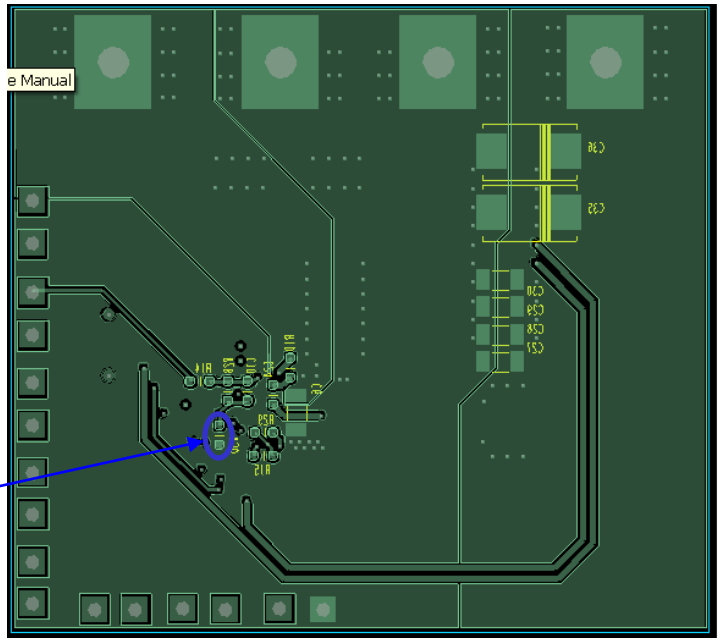


Fig. 2: Board Layout-Top Layer



Single point connection between AGnd and PGnd

Fig. 3: Board Layout-Bottom Layer

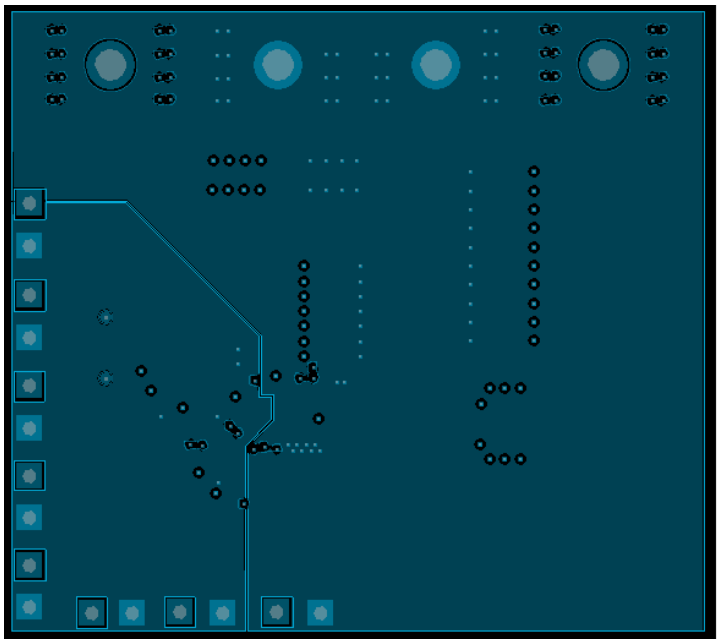


Fig. 4: Board Layout-Mid Layer 1

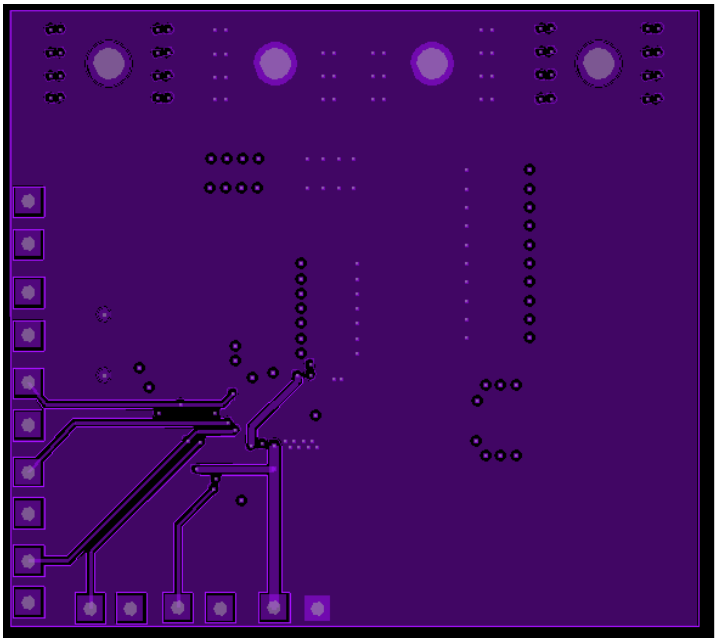


Fig. 5: Board Layout-Mid Layer 2

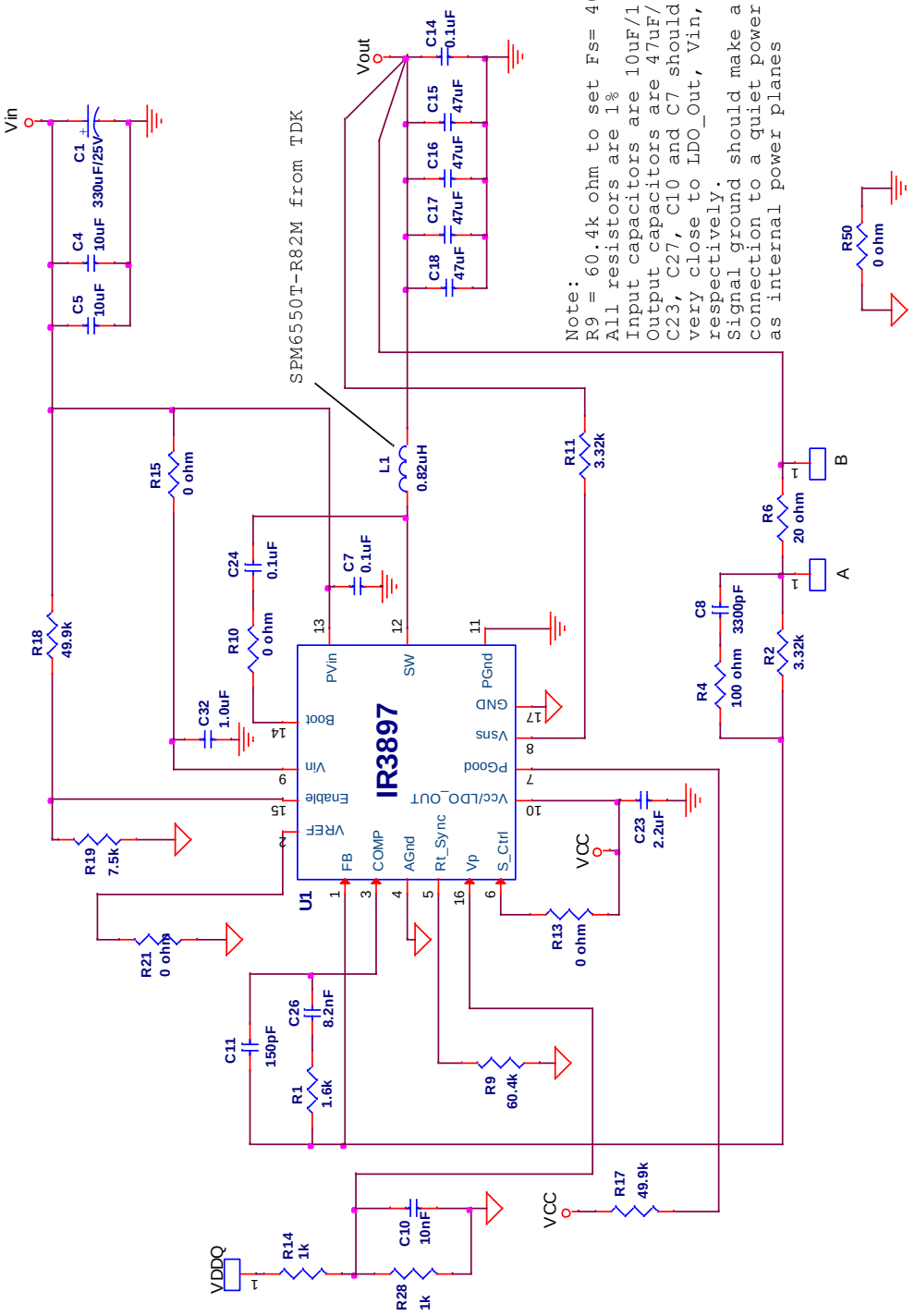


Fig. 6: Schematic of the IR3897 evaluation board

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	2	C4 C5	10uF	0805, 16V, X5R, 20%	TDK	C2012X5R1C106M085AC
3	3	C7 C14 C24	0.1uF	0603, 25V, X7R, 10%	Murata	GRM188R71E104KA01B
4	1	C8	3300pF	0603,50V, X7R, 10%	Murata	GRM188R71H332KA01B
5	1	C10	10nF	0603, 25V, X7R, 10%	Murata	GRM188R71E103KA01J
6	1	C11	150pF	0603, 50V, NP0, 5%	Murata	GRM1885C1H151JA01D
7	4	C15 C16 C17 C18	47uF	0805, 6.3V, X5R, 20%	TDK	C2012X5R0J476M125AC
8	1	C23	2.2uF	0603, 16V, X5R, 20%	TDK	C1608X5R1C225M
9	1	C26	8.2nF	0603, 25V, X7R, 10%	Murata	GRM188R71E822KA01J
10	1	C32	1.0uF	0603, 25V, X5R, 10%	Murata	GRM188R61E105KA12D
11	1	L1	0.82uH	SMD 6.86x6.47x5.0mm,4.2mΩ	TDK	SPM6550T-R82M
12	1	R1	1.60k	Thick Film, 0603,1/10W,1%	Panasonic	ERJ-3EKF1601V
13	2	R14 R28	1k	Thick Film, 0603,1/10W,1%	Panasonic	ERJ-3EKF1001V
14	2	R2 R11	3.32k	Thick Film, 0603,1/10W,1%	Panasonic	ERJ-3EKF3321V
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	60.4k	Thick Film, 0603,1/10W,1%	Panasonic	ERJ-3EKF6042V
18	5	R10 R13 R15 R21 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-3EKF7501V
21	1	U1	IR3897	PQFN 4x5mm	IR	IR3897MPBF

TYPICAL OPERATING WAVEFORMS
Vin=12.0V, Vo=0.609V, Io=0-3.6A, Room Temperature, no airflow



Fig. 7: Start up at 3.6A sourcing current
Ch_1:V_{in}, Ch_2:V_{out}, Ch_3:P_{Good} Ch_4:V_{ddq}



Fig. 8: Start up at 3.6A sourcing current
Ch_1:V_{cc}, Ch_2:V_{out}, Ch_3:Enable, Ch_4:V_{ddq}

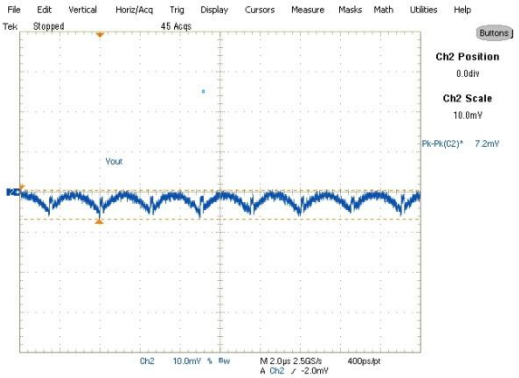


Fig. 9: Output voltage ripple, 3.6A sourcing current
Ch_2: V_{out}



Fig. 10: Output voltage ripple, 3.6A sinking current
Ch_2: V_{out}

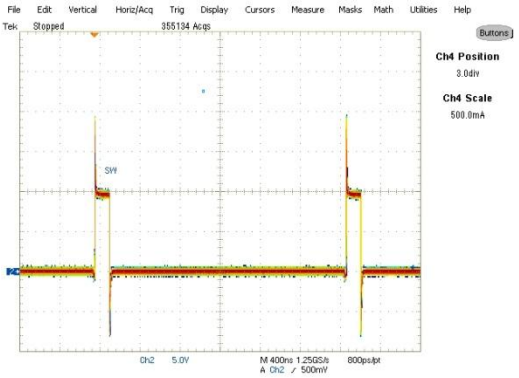


Fig. 11: Inductor node at 3.6A sourcing current
Ch_2:SW node

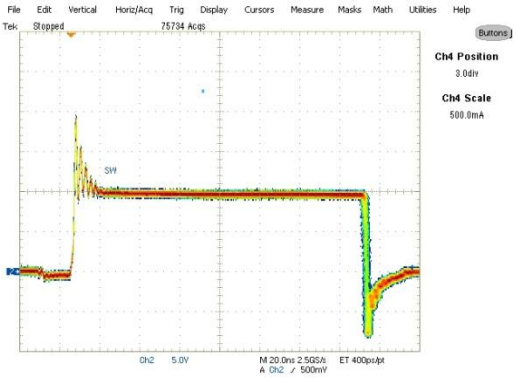


Fig. 12: Inductor node at 3.6A sourcing current (Expanded) Ch_2:SW node

TYPICAL OPERATING WAVEFORMS
Vin=12.0V, Vo=0.609V, Io=0-3.6A, Room Temperature, no airflow

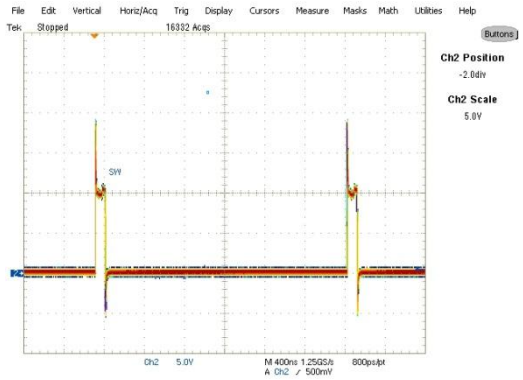


Fig. 13: Inductor node at 3.6A sinking current
Ch_2:SW node

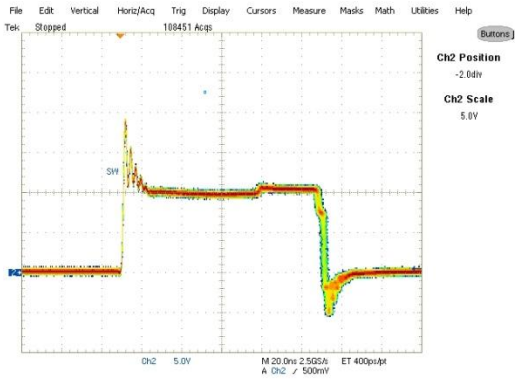


Fig. 14: Inductor node at 3.6A sinking current (Expanded) Ch_2:SW node

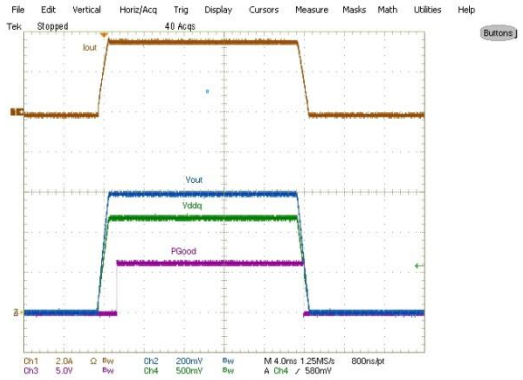


Fig. 15: Tracking mode, 3.6A sourcing current
Ch_1:I_{out}, Ch_2:V_{out}, Ch_3:P_{Good}, Ch_4:V_{ddq}



Fig. 16: Tracking mode, 3.6A sinking current
Ch_1:I_{out}, Ch_2:V_{out}, Ch_3:P_{Good}, Ch_4:V_{ddq}

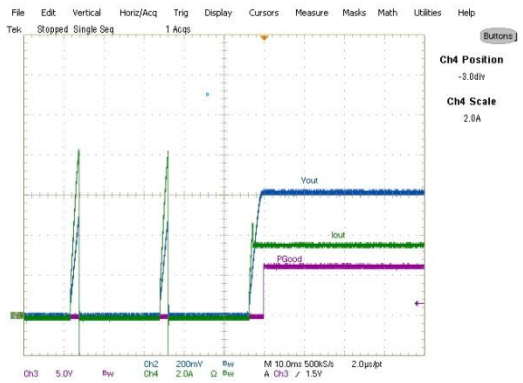
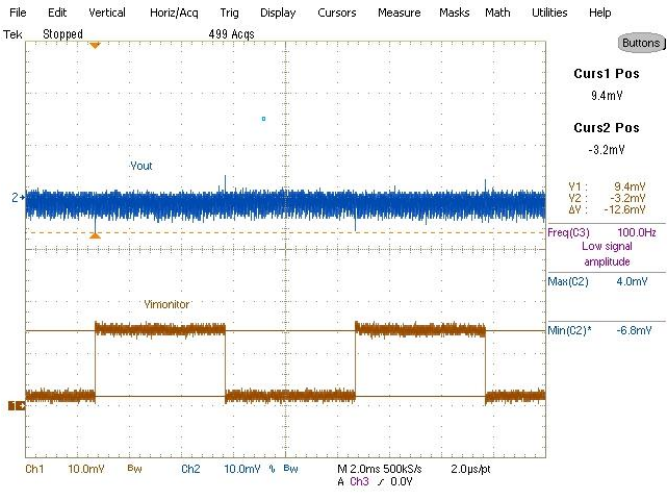
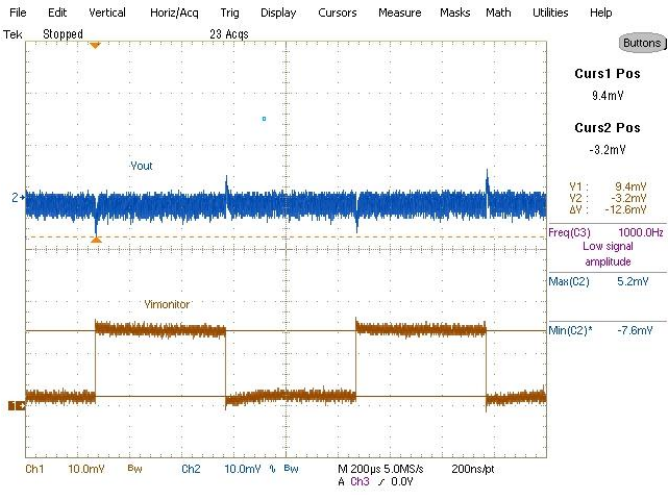


Fig. 17: Short circuit (Hiccup) recovery
Ch_2:V_{out}, Ch_3: P_{Good}, Ch_4:I_{out}

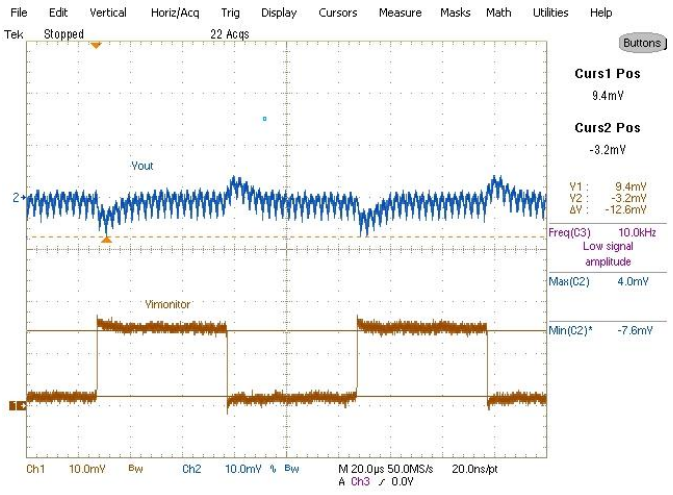
TYPICAL OPERATING WAVEFORMS
Vin=12.0V, Vo=0.609V, Io=0-3.6A, Room Temperature, no air flow



(a)



(b)

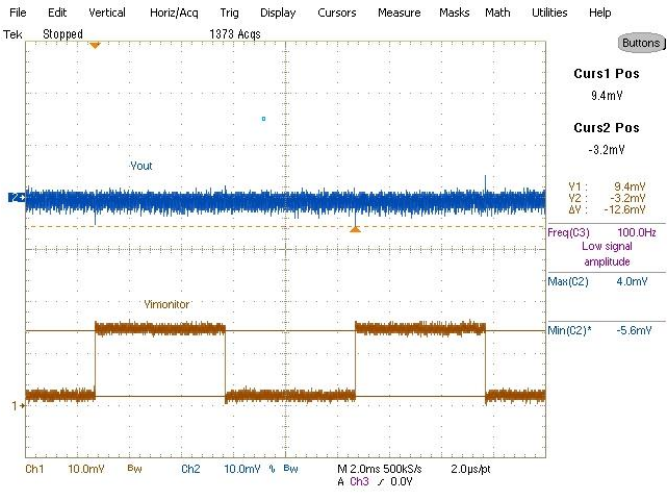


(c)

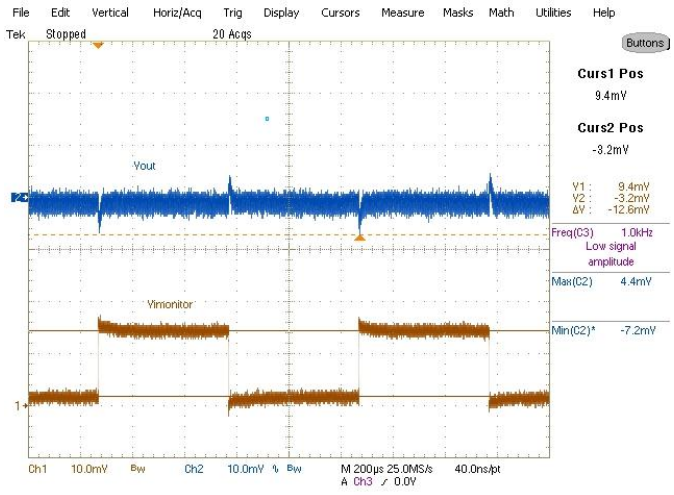
Fig. 18: Transient response, 3.35A to 3.6A steps at 3.24A/us raising/3.93A/us falling slew rates with different repetitive rates (Sourcing Current): (a) 100Hz, (b) 1kHz, and (c) 10kHz.
Ch_2:V_{out} Ch4:$V_{imonitor}$ (50.8mV/A)*

*Vimonitor is the voltage measured across a current sense resistor in series with the step load at a 50.8mV/A rate. Additional constant load of 3.35A is applied to the load.

TYPICAL OPERATING WAVEFORMS
Vin=12.0V, Vo=0.609V, Io=0-3.6A, Room Temperature, no air flow



(a)



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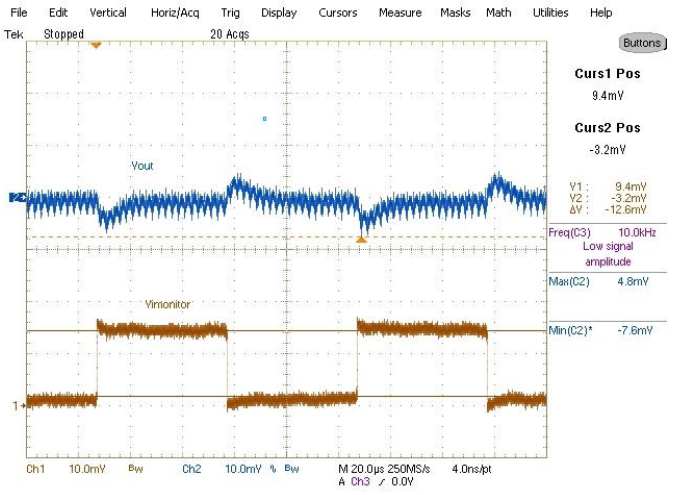


(c)

Fig. 18: Transient response, -3.6A to -3.35A steps at 3.24A/us raising/3.93A/us falling slew rates with different repetitive rates (Sinking Current): (a) 100Hz, (b) 1kHz, and (c) 10kHz.
Ch_2:V_{out} Ch4:$V_{imonitor}$ (50.8mV/A)*

*$V_{imonitor}$ is the voltage measured across a current sense resistor in series with the step load at a 50.8mV/A rate. Additional constant load of -3.6A is applied to the load.

TYPICAL OPERATING WAVEFORMS
Vin=12.0V, Vo=0.609V, Io=0-3.6A, Room Temperature, no air flow

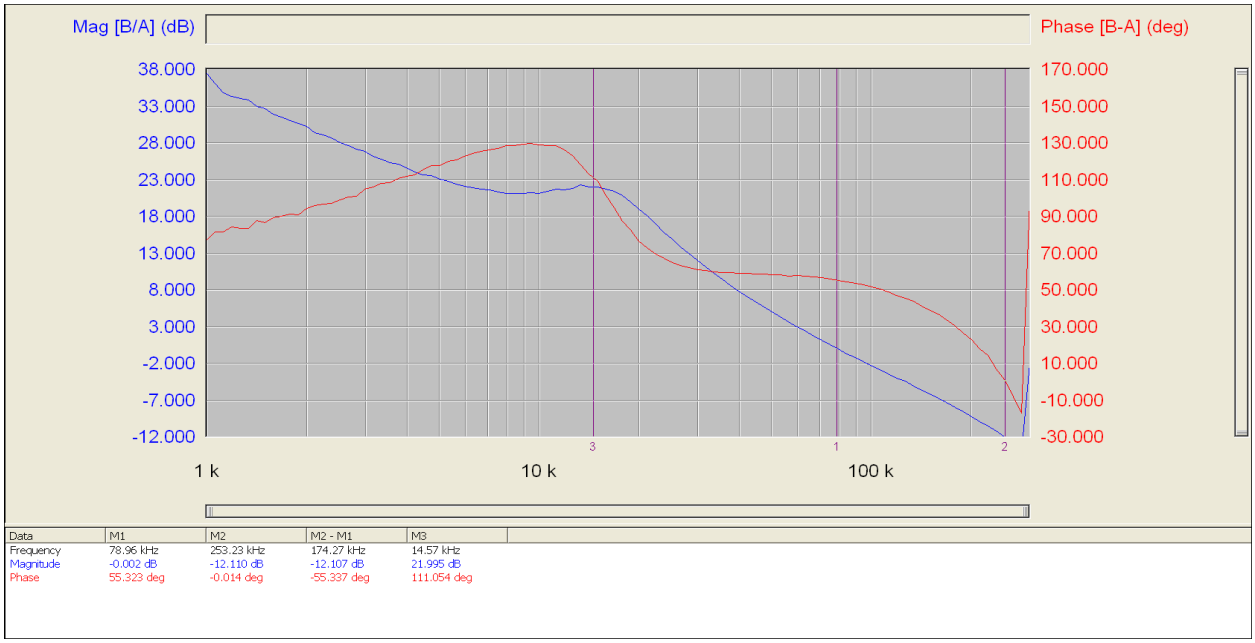


Fig. 20: Bode Plot at 3.6A sourcing current shows a bandwidth of 78.96kHz and phase margin of 55.323°

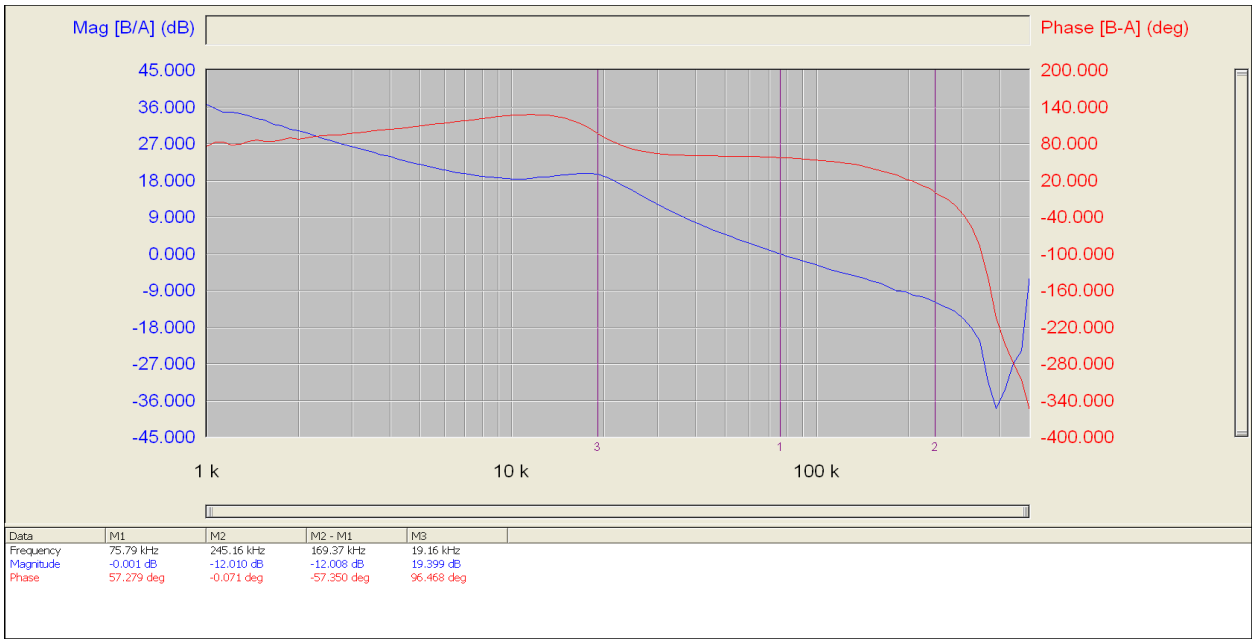


Fig. 21: Bode Plot at 3.6A sinking current shows a bandwidth of 75.79kHz and phase margin of 57.279°

TYPICAL OPERATING WAVEFORMS
Vin=12.0V, Vo=0.609V, Io=0-3.6A, Room Temperature, no air flow

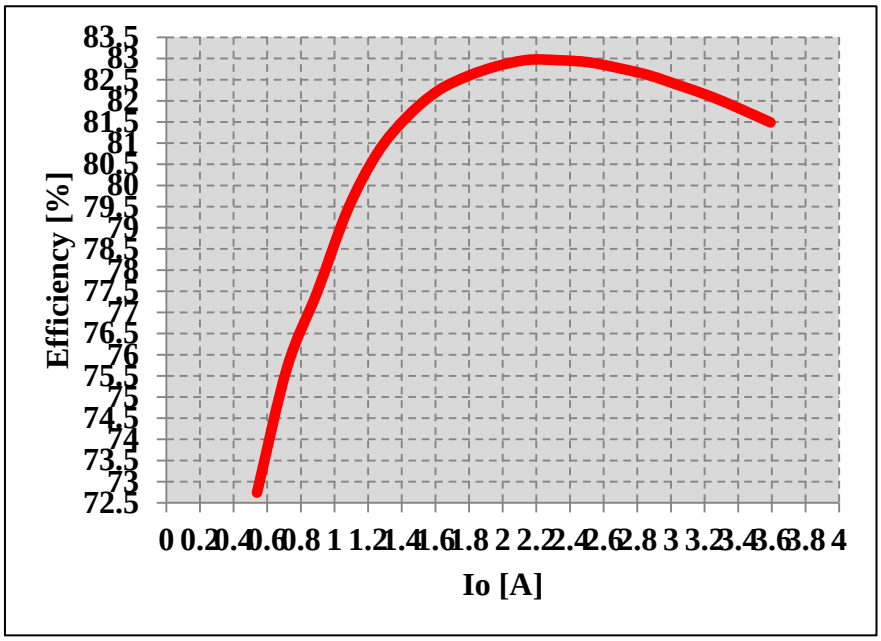


Fig.22: Efficiency versus load current (Sourcing Current)

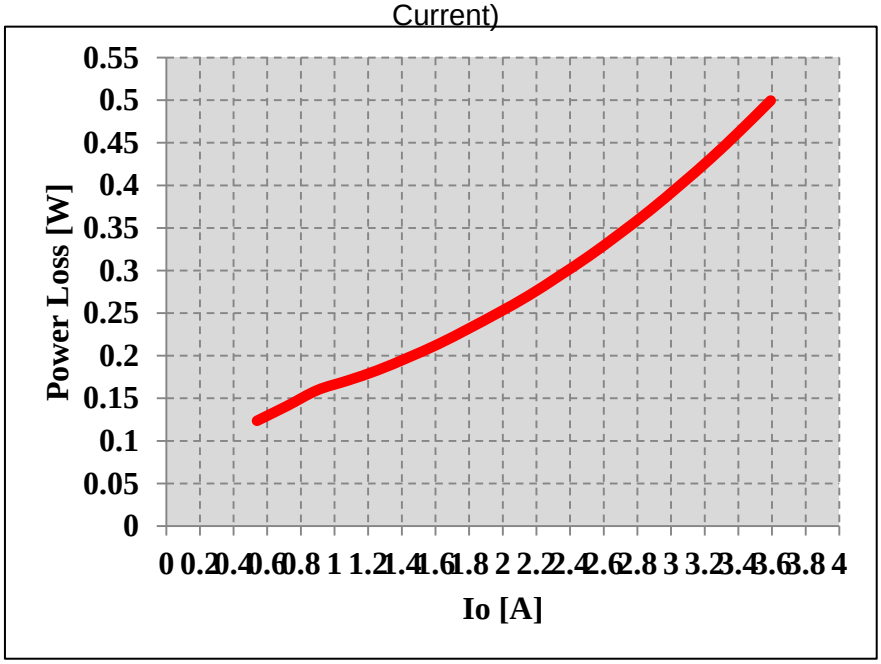


Fig.23: Power loss versus load current (Sourcing Current)

TYPICAL OPERATING WAVEFORMS
Vin=12.0V, Vo=0.609V, Io=0-3.6A, Room Temperature, no air flow

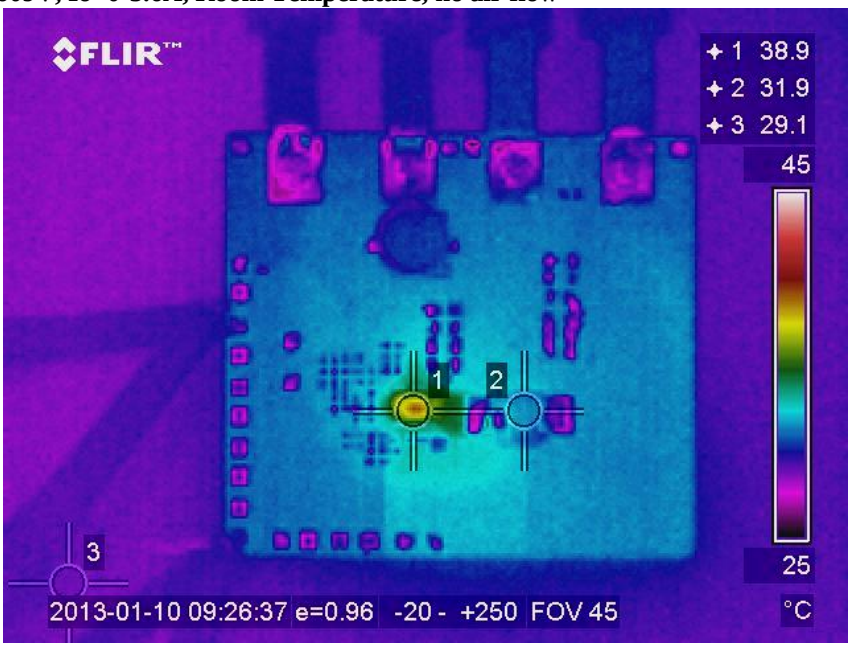


Fig. 24: Thermal Image of the board at 3.6A sourcing current
Test point 1 is IR3897
Test point 2 is inductor

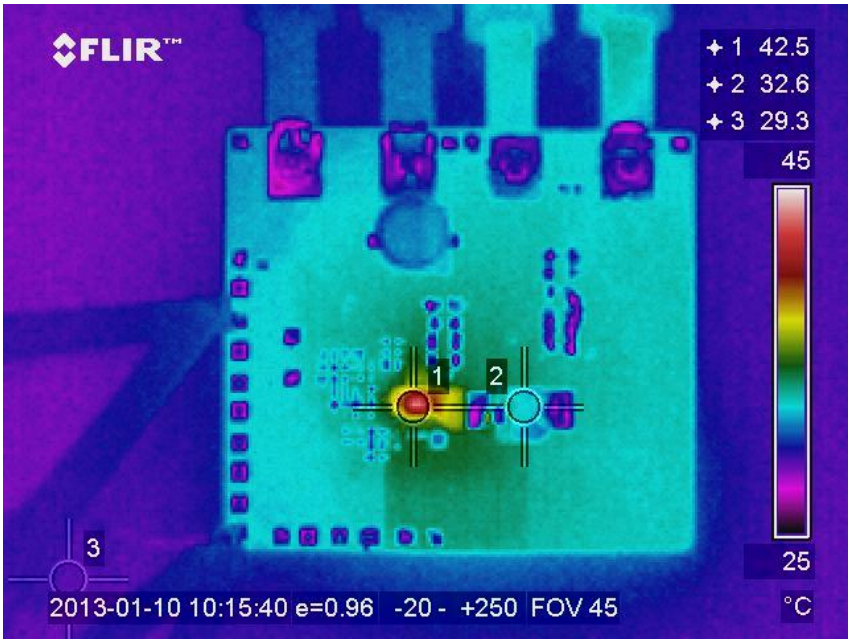


Fig. 25: Thermal Image of the board at 3.6A sinking current
Test point 1 is IR3897
Test point 2 is inductor

PCB METAL AND COMPONENT PLACEMENT

Evaluations have shown that the best overall performance is achieved using the substrate/PCB layout as shown in following figures. PQFN devices should be placed to an accuracy of 0.050mm on both X and Y axes. Self-centering behavior is highly dependent on solders and processes, and experiments should be run to confirm the limits of self-centering on specific processes. For further information, please refer to “SupIRBuck™ Multi-Chip Module (MCM) Power Quad Flat No-Lead (PQFN) Board Mounting Application Note**.” (AN1132)**

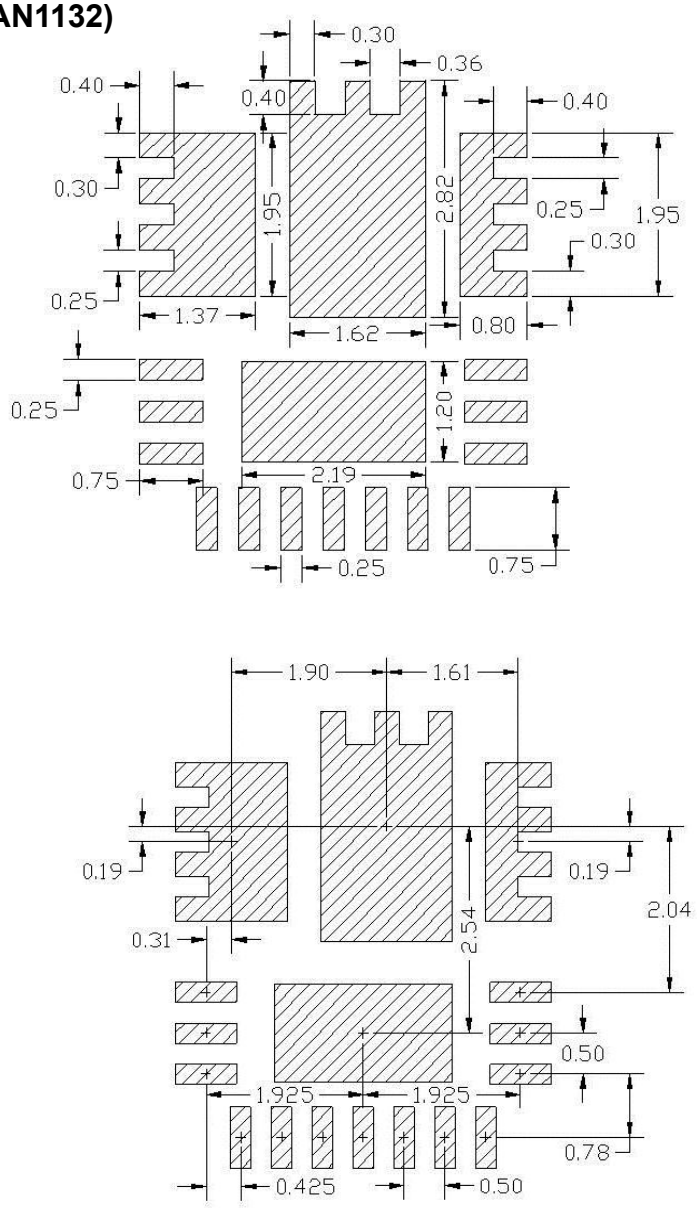


Figure 20: PCB Metal Pad Spacing (all dimensions in mm)

SOLDER RESIST

IR recommends that the larger Power or Land Area pads are Solder Mask Defined (SMD.)
This allows the underlying Copper traces to be as large as possible, which helps in terms of current carrying capability and device cooling capability. When using SMD pads, the underlying copper traces should be at least 0.05mm larger (on each edge) than the Solder Mask window, in order to accommodate any layer to layer misalignment. (i.e. 0.1mm in X & Y.)
However, for the smaller Signal type leads around the edge of the device, IR recommends that these are Non Solder Mask Defined or Copper Defined. When using NSMD pads, the Solder Resist Window should be larger than the Copper Pad by at least 0.025mm on each edge, (i.e. 0.05mm in X&Y,) in order to accommodate any layer to layer misalignment. Ensure that the solder resist in-between the smaller signal lead areas are at least 0.15mm wide, due to the high x/y aspect ratio of the solder mask strip.

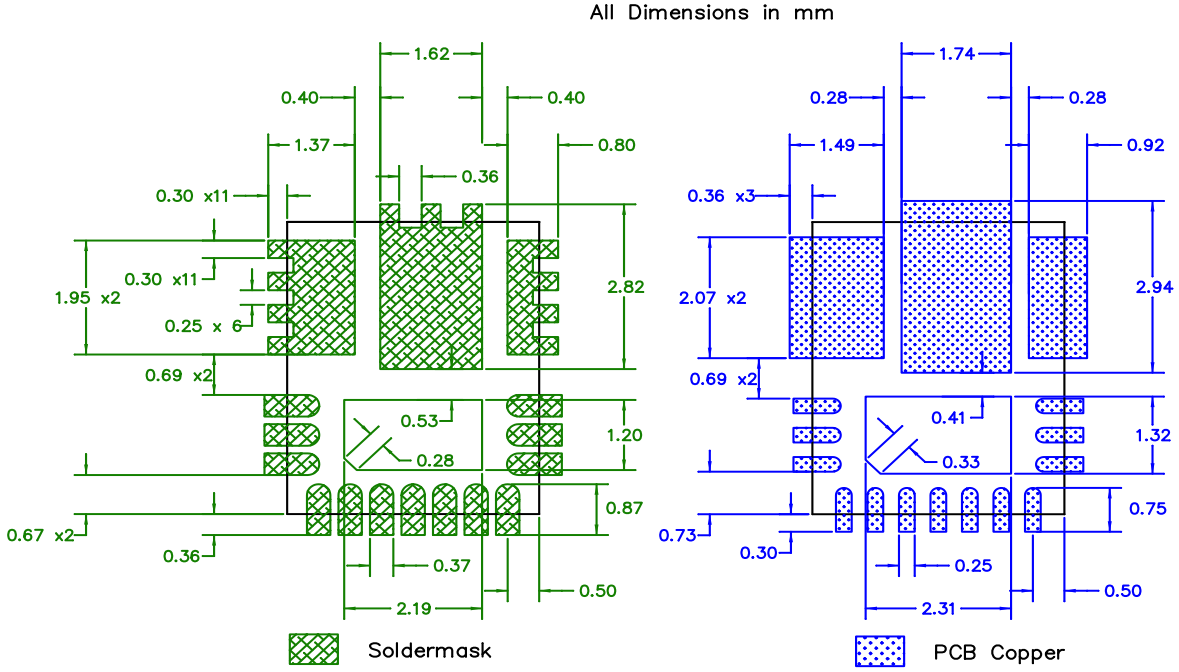


Figure 21: Solder resist

STENCIL DESIGN

Stencils for PQFN can be used with thicknesses of 0.100-0.250mm (0.004-0.010"). Stencils thinner than 0.100mm are unsuitable because they deposit insufficient solder paste to make good solder joints with the ground pad; high reductions sometimes create similar problems. Stencils in the range of 0.125mm-0.200mm (0.005-0.008"), with suitable reductions, give the best results. Evaluations have shown that the best overall performance is achieved using the stencil design shown in following figure. This design is for a stencil thickness of 0.127mm (0.005").The reduction should be adjusted for stencils of other thicknesses.

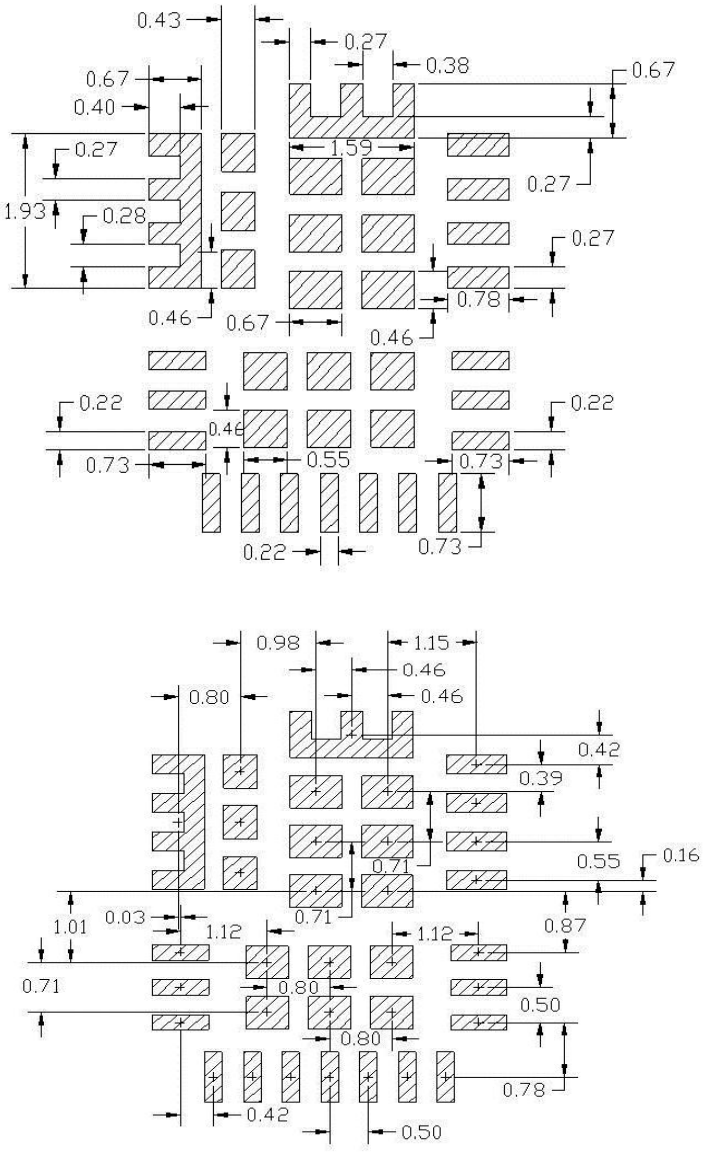
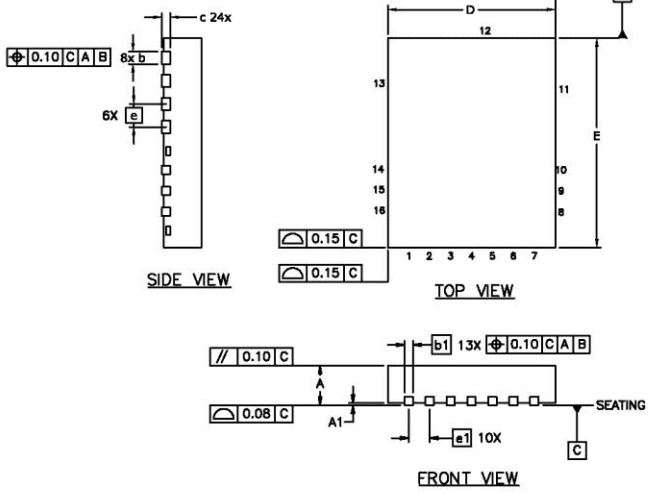


Figure 22: Stencil Pad Spacing (all dimensions in mm)

PACKAGE INFORMATION



DIM	MILLIMETERS		INCHES	
	MIN	MAX	MIN	MAX
A	0.800	1.000	.0315	.0394
A1	0.000	0.050	.0000	.0020
b	0.250	0.350	.0098	.0138
b1	0.150	0.250	.0059	.0098
c	0.203 REF.		.0080 REF.	
D	4.000 BASIC		.1575 BASIC	
E	5.000 BASIC		.1969 BASIC	
e	0.550 BASIC		.0217 BASIC	
e1	0.500 BASIC		.0197 BASIC	
e2	0.659 BASIC		.0259 BASIC	
L	0.350	0.450	.0138	.0177
M	1.900	2.000	.0748	.0787
N	0.453	0.553	.0178	.0218
O	1.567	1.667	.0617	.0656
P	2.470	2.570	.0972	.1012
Q	1.024	1.124	.0403	.0443
R	2.138	2.238	.0842	.0881
S	1.150	1.250	.0453	.0492
T	0.856	0.956	.0337	.0376
U	0.270	0.370	.0106	.0146
V	0.703	0.803	.0277	.0316
W	0.350	0.450	.0138	.0177
X	0.856	0.956	.0337	.0376
Y	0.703	0.803	.0277	.0316
Z	0.270	0.370	.0106	.0146

Figure 23: Package Dimensions

IR WORLD HEADQUARTERS: 233 Kansas St., El Segundo, California 90245, USA Tel: (310) 252-7105
TAC Fax: (310) 252-7903
This product has been designed and qualified for the Industrial market
Visit us at www.irf.com for sales contact information
Data and specifications subject to change without notice.01/13