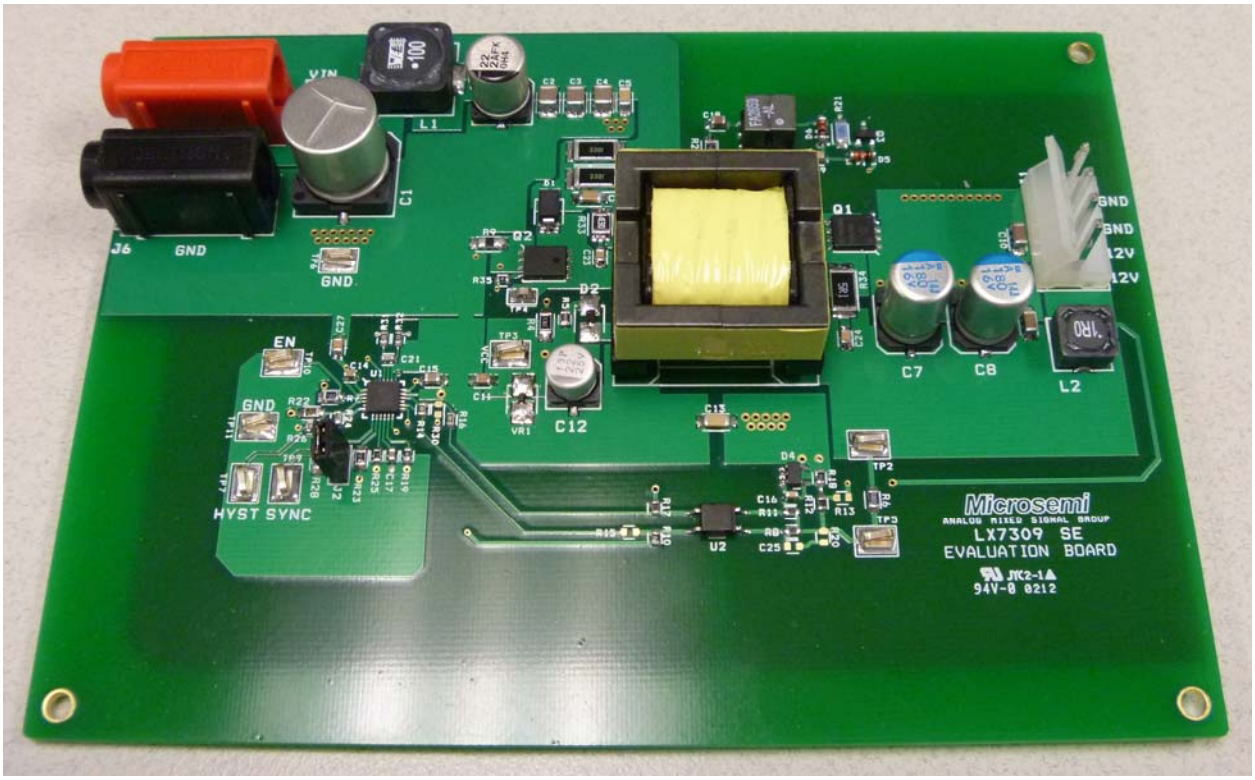
LX7309 EVALUATION BOARD USER'S GUIDE

LX7309 PWM Controller IC



Rev. 1.0 1/24/12

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OVERVIEW

The LX7309 is a peak current mode control synchronous flyback DC-DC controller. The controller has a number of features designed to improve efficiency and reliability, including:

- High Voltage Gate Drivers
- Soft Start Circuit
- Low Voltage Protection Warning
- Over Current Protection

The LX7309 device is housed in a 4mm x 4mm 24 pin plastic QFN package.

EVALUATION BOARD OPERATION

The LX7309 Evaluation Board contains a single LX7309 device and components necessary to provide a 12V 48W isolated output. Two standard Banana Jacks are provided for connecting to a 37V to 57V power source. A 4 pin connector provides the 12V output. Output current is 4A max. The input supply source should be voltage limited to 57V max.

The test point descriptions for the evaluation circuit are summarized in Table 1. Please refer to this table for evaluation board setup.

Table 1 – Evaluation Board I/O Connector and Test Point Reference

Reference	Description
J5	37V to 57V power source input (+) connection. Source should be capable of 1.6A continuous current
J6	37V to 57V power source input (-) connection. Source should be capable of 1.6A continuous current
J1	12V output connection. Maximum output power is 4 Amps.
J2	VIN_SEL selection. J2 installed configures the LX7309 to operate with VIN UVLO. With J2 not installed Power Fail Warning (PFW) is enabled. See LX7309 datasheet for details. It is recommended to operate this evaluation board with J2 installed.
TP1	VIN (+) monitor. Used as a monitor point for VIN+.
TP6	VIN (-) monitor. Used as a monitor point for VIN-.
TP3	VCC monitor. Used as a monitor point for VCC. Referenced to Primary Ground.
TP4	Primary Switch Node monitor. Used as a monitor point for the Primary Switch Drain connection. Referenced to Primary Ground.
TP2 & TP5	Optional Inputs for Network Analyzer. Used to generate Bode Plots. TP2 can be used to monitor the regulated output voltage before the post LC filter. This signal is referenced to Secondary Ground.
TP7	Power Fail Warning (PFW) monitor. Used when J2 is not installed. Referenced to Primary Ground.
TP8	SG output monitor. Used to monitor gate drive signal to synchronous FET drive isolation transformer. Referenced to Primary Ground
TP9	LX7309 SYNC input. A 5V peak signal with frequency set to 2 x the free-running frequency can be used to synchronize the LX7309's internal oscillator to an external clock. Pulse width should be 200ns max. Referenced to Primary Ground.
TP10	LX7309 ENABLE pin input. Pulled up to LX7309 VDD through a 100K resistor. Connect to Primary Ground to disable the LX7309.
TP11	Primary Ground. Used for scope probes and measurement terminations. Should not be used as a power ground connection.

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PCB LAYOUT GUIDELINES

When laying out the PCB, consideration of high current paths is required, in particular the primary-side high current paths from the input filter capacitors (C2 – C5, C20) to the transformer primary, the transformer primary to the primary switch transistor (Q2), the primary switch transistor's source current path to the current sense resistor (R9), and the sense resistor's current path back to the input filter capacitor's connection to ground. These critical current paths should be on a single layer only and not be established on multiple layers through vias. Establishing these traces along with their associated parts on the top layer is preferred, both electrically and thermally.

Equally, the secondary-side high current paths should be given the same consideration, with wide, heavy traces ran on a single layer only with no vias interrupting the current flow. These would include the current path from the transformer secondary to the output filter capacitors (C7 & C8), the transformer secondary to the synchronous rectifier (Q1), and the synchronous rectifier (Q1) ground current path back to the output filter capacitors (C7 & C8). The top layer is preferred for both the components and high current traces.

The high current ground should connect separately to the LX7309's pin 20, preferably on the top layer and unbroken by vias. Pin 20 is the return for the PG and SG gate drive circuits; a clean current path between this pin and the primary transistor return is essential.

The LX7309 and associated signal-level circuitry should utilize a separate signal ground common to pin 17. The VDD filter capacitor (C15), should be placed as close as practical to the LX7309, and connected directly (no vias) to VDD (pin 18) and pin 17.

The signal level ground, high current ground, and the return path from the VCC bootstrap supply filter capacitor (C12) should tie together at or near to the VDD filter capacitor's connection to pin 17.

Primary and Secondary traces should be separated by a minimum of 2mm (80mils).

It is recommended that the PCB utilize 2 Oz copper thickness for increased electrical and thermal performance.

A diagram indicating critical trace widths is shown in Figure 1. The EVB silkscreen, as well as top and bottom layers are shown in Figures 2 through 4. A complete schematic of the EVB is shown in Figure 5, followed by a Bill of Materials.

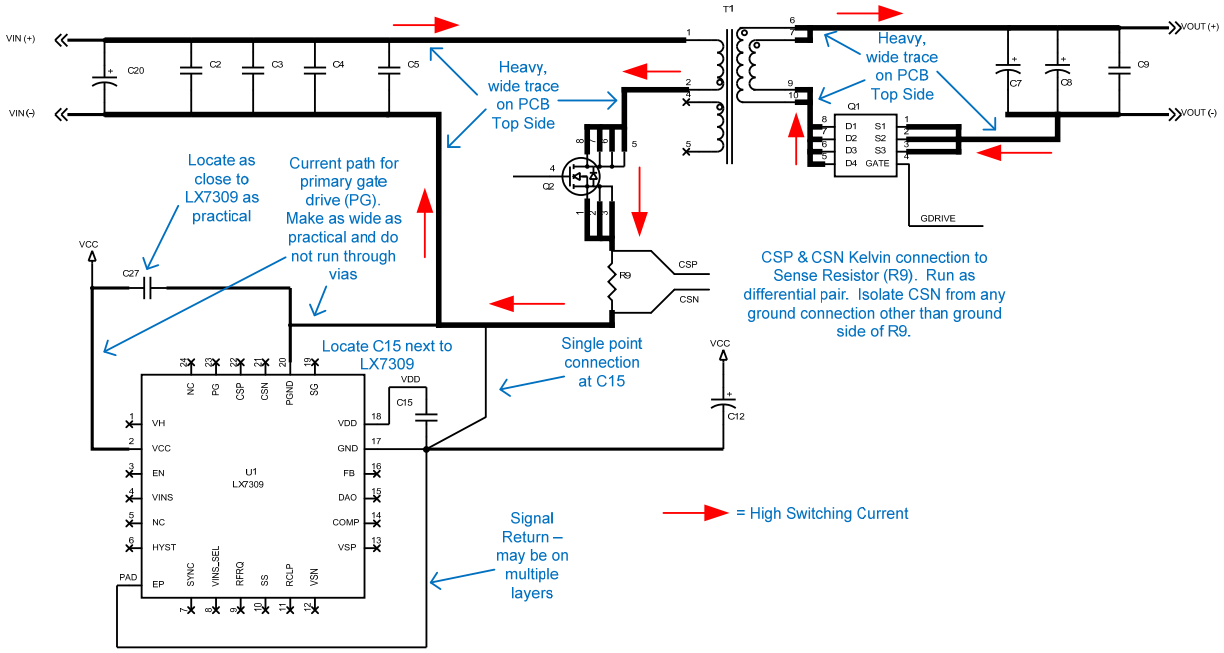

Figure 1. PCB Critical Traces

LX7309 EVALUATION BOARD LAYOUT

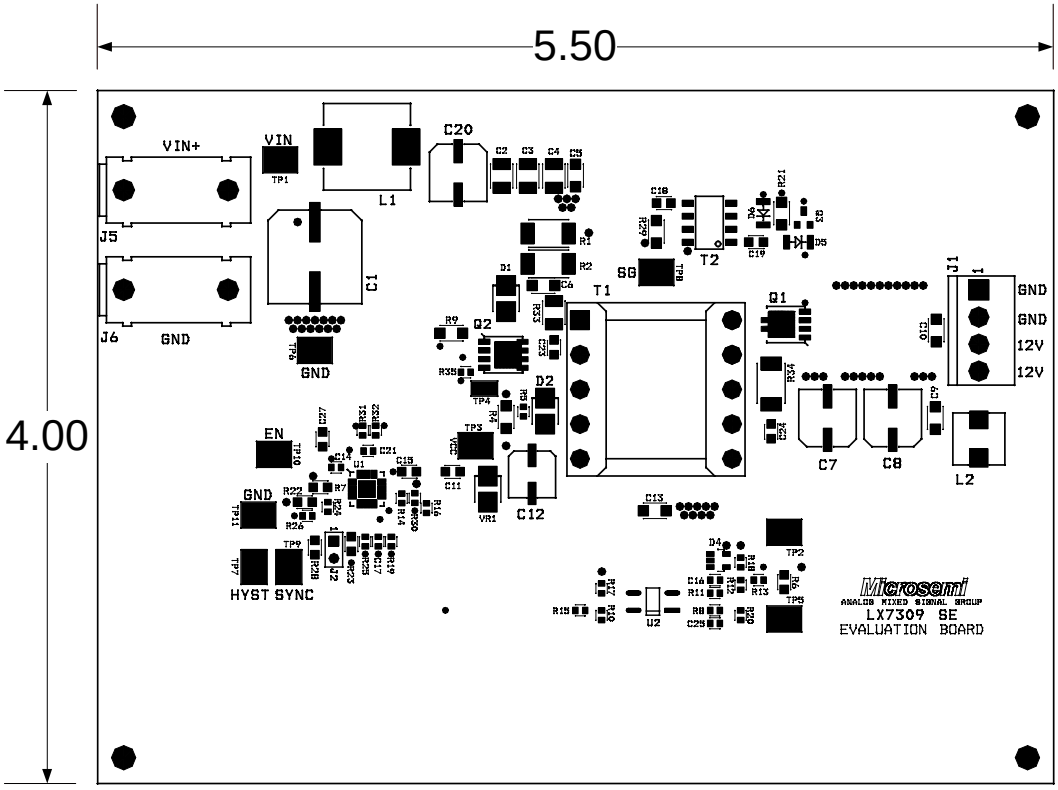

Figure 2 – Silkscreen Top

LX7309 EVALUATION BOARD LAYOUT

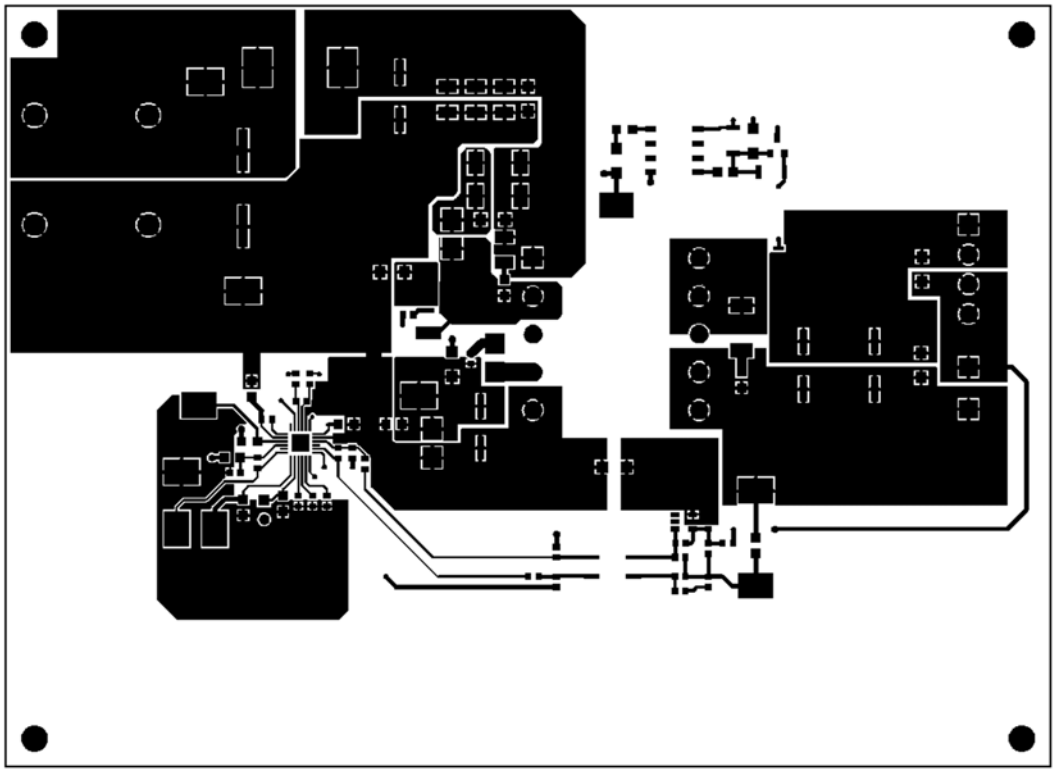

Figure 3 –Top Layer

LX7309 EVALUATION BOARD LAYOUT

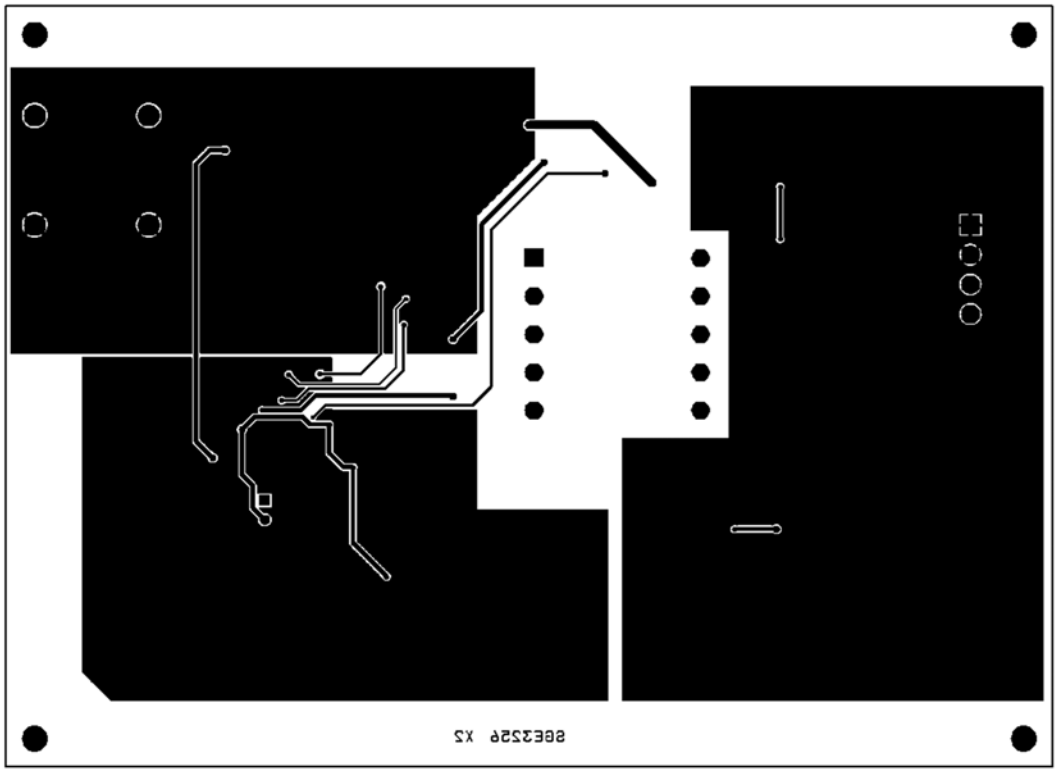

Figure 4 –Bottom Layer

TEST CONSIDERATIONS

The following is a guideline for testing the LX7309 IC:

- Output ground connections for the evaluation board output (J1 pins 1 and 2) are electrically isolated from the LX7309's primary ground connections (J6, TP6, and TP11). This should be taken into consideration when grounding test probes.
- The evaluation board will quickly become duty cycle limited at input voltages below 37V, and as such it is not recommended to operate below this voltage. It is recommended to operate with VIN UVLO function enabled (J2 installed), which will disable the controller at voltages at or below 36V. The VIN UVLO function is set to disable the controller at VIN falling voltages of 36V or less, and enable the controller at VIN rising voltages of 40V or more. To operate as PFW, remove jumper J2, and monitor signal at TP7. To change the rising and falling voltage thresholds of either the VIN UVLO or PFW functions, change the values of R22, R24, and R26. See the LX7309 Datasheet for further information.
- Resistor R27 is a 6.8 Ohm resistor in series with the bootstrap supply providing VCC. This resistor may be used to monitor LX7309's VCC current (after start-up) with a millivolt DMM.
- The PWM frequency can be synchronized to an external clock by connecting a 400kHz signal to TP9 (+) and TP11 (-). The signal should be a 0 to 5V peak signal with a maximum pulse width of 200ns. Care should be taken that the peak signal level input to TP9 does not exceed LX7309's VDD (pin 18) voltage.
- The sync signal should be 2 x the set free-running PWM frequency.
- The PWM frequency can be changed by changing resistor R25, however be aware that the transformer and several critical components are designed around 200kHz operation; any gross changes in PWM frequency cannot be tolerated without changing the transformer and other critical components.

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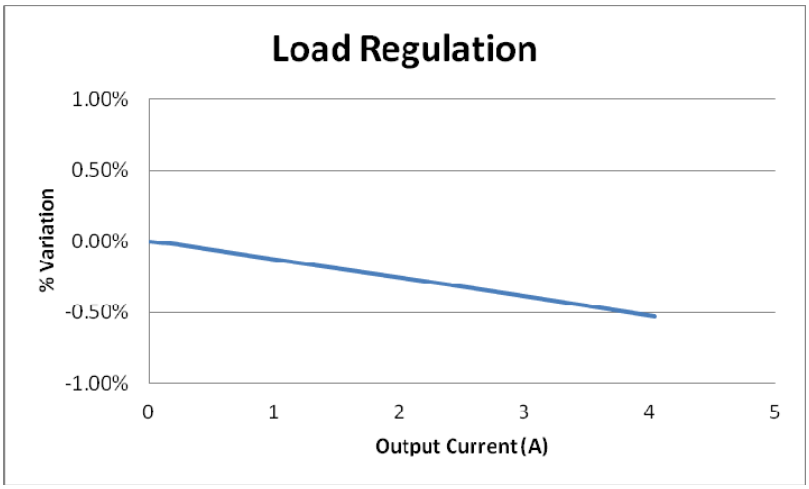
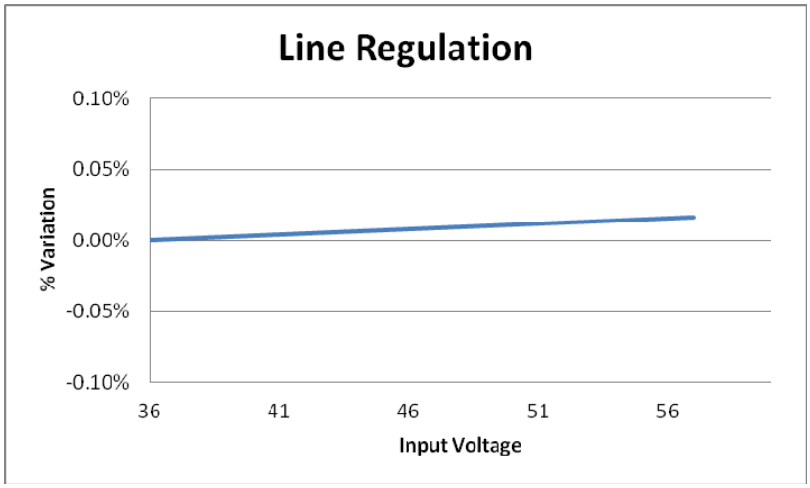
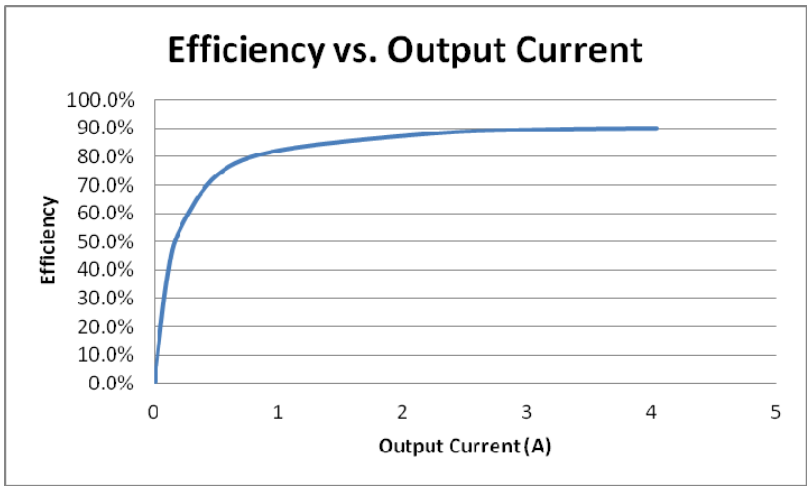
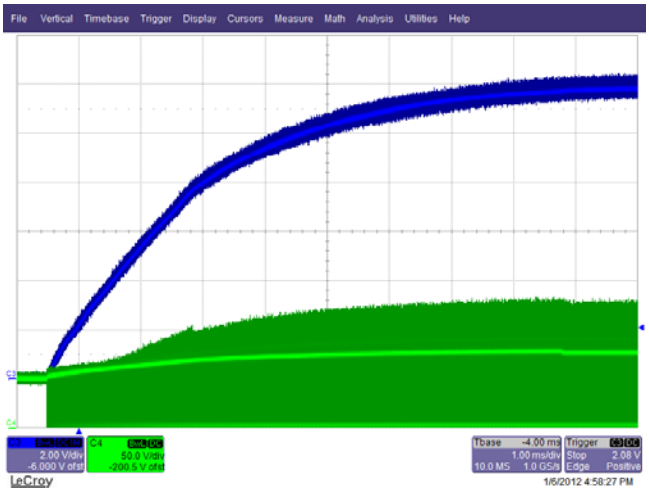
LX7309 EVALUATION BOARD TEST DATA



Note: the above is with post LC filter installed



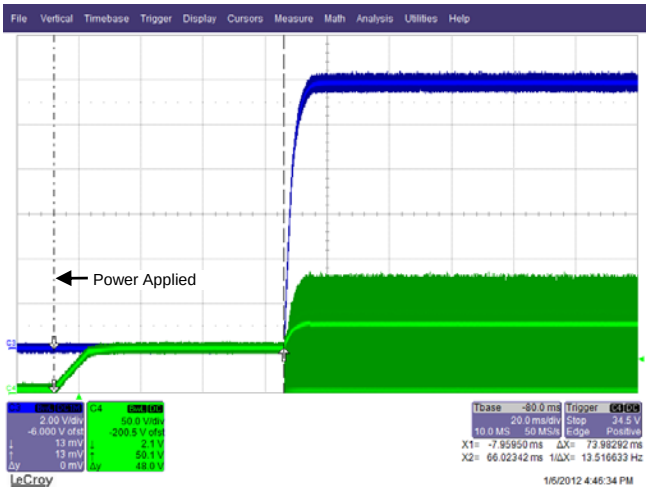




Full Load Start-up

CH3: VOUT

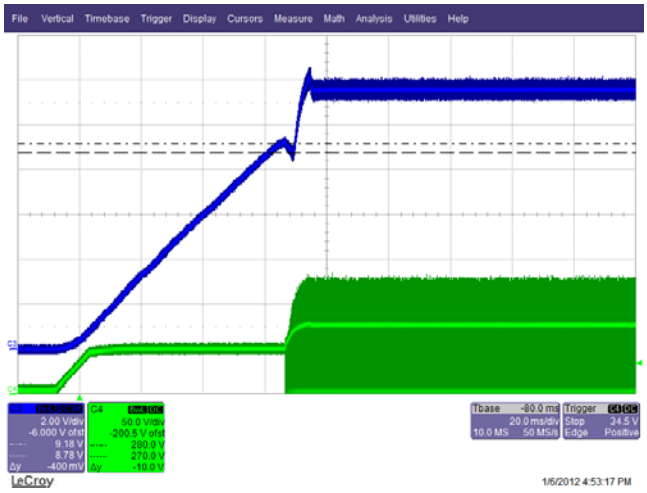
CH4: Primary Transistor (Q2) Drain



Start-up Delay

CH4: Primary Transistor (Q2) Drain

CH3: VOUT



VCC Start-up

CH3: VCC

CH4: Primary Transistor (Q2) Drain

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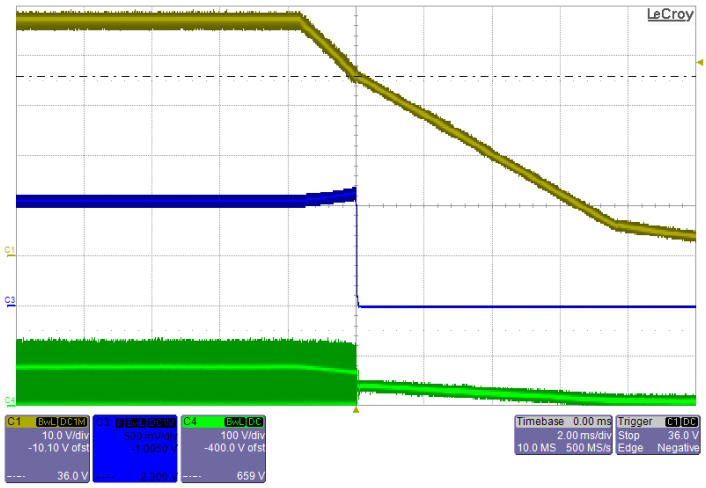
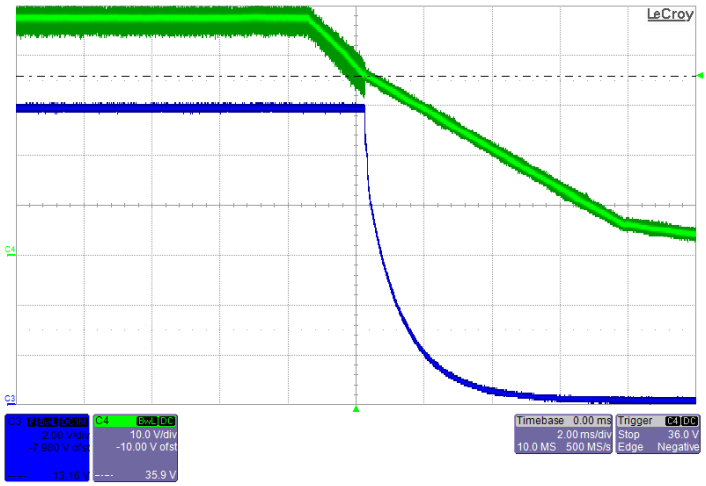


Full Load Shutdown with VIN UVLO Function

CH1: VIN

CH3: Comp pin (Pin 14)

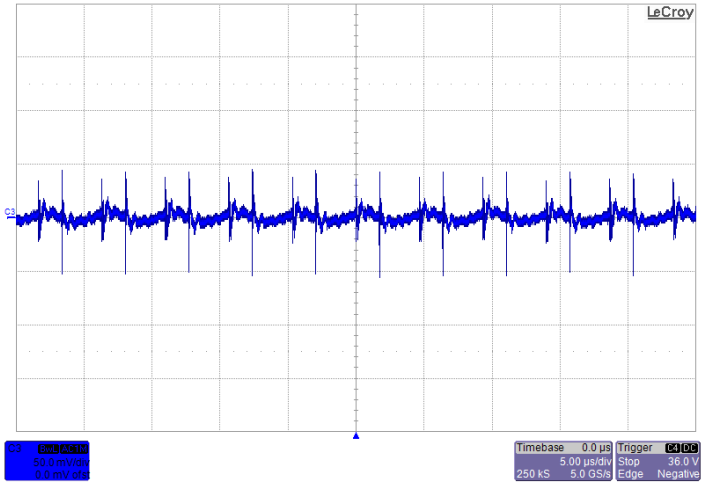
CH4: Primary Transistor (Q2) Drain



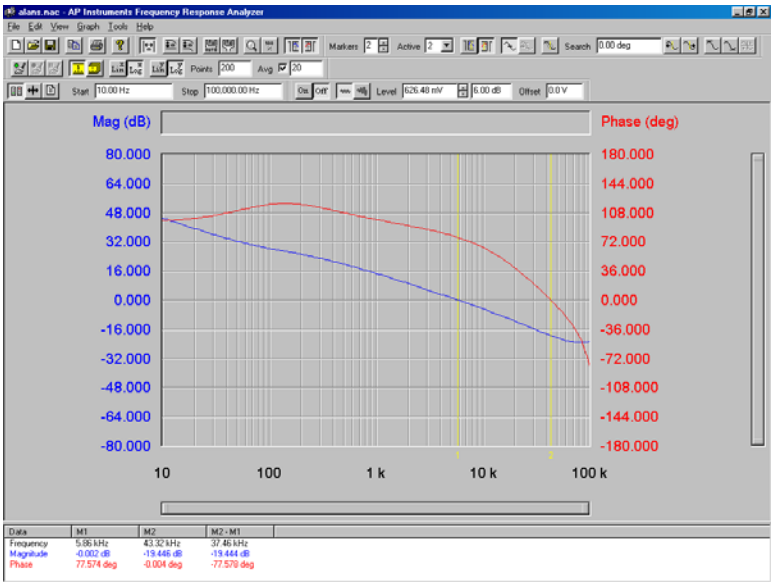
Full Load Shutdown with VIN UVLO Function

CH4: VIN

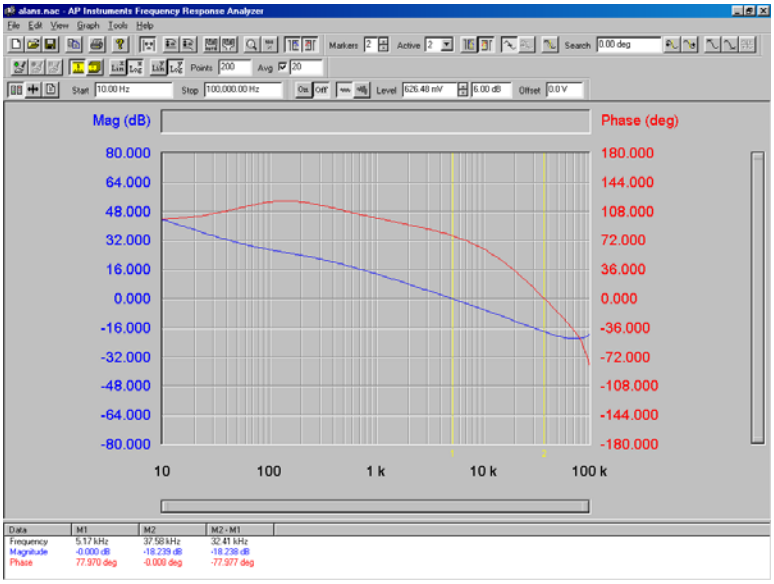
CH3: VOUT



Full Load Output Ripple



Bode Plot
VIN = 48V; 4A Load



Bode Plot
VIN = 37V; 4A Load

LX7309 EVALUATION BOARD SCHEMATIC

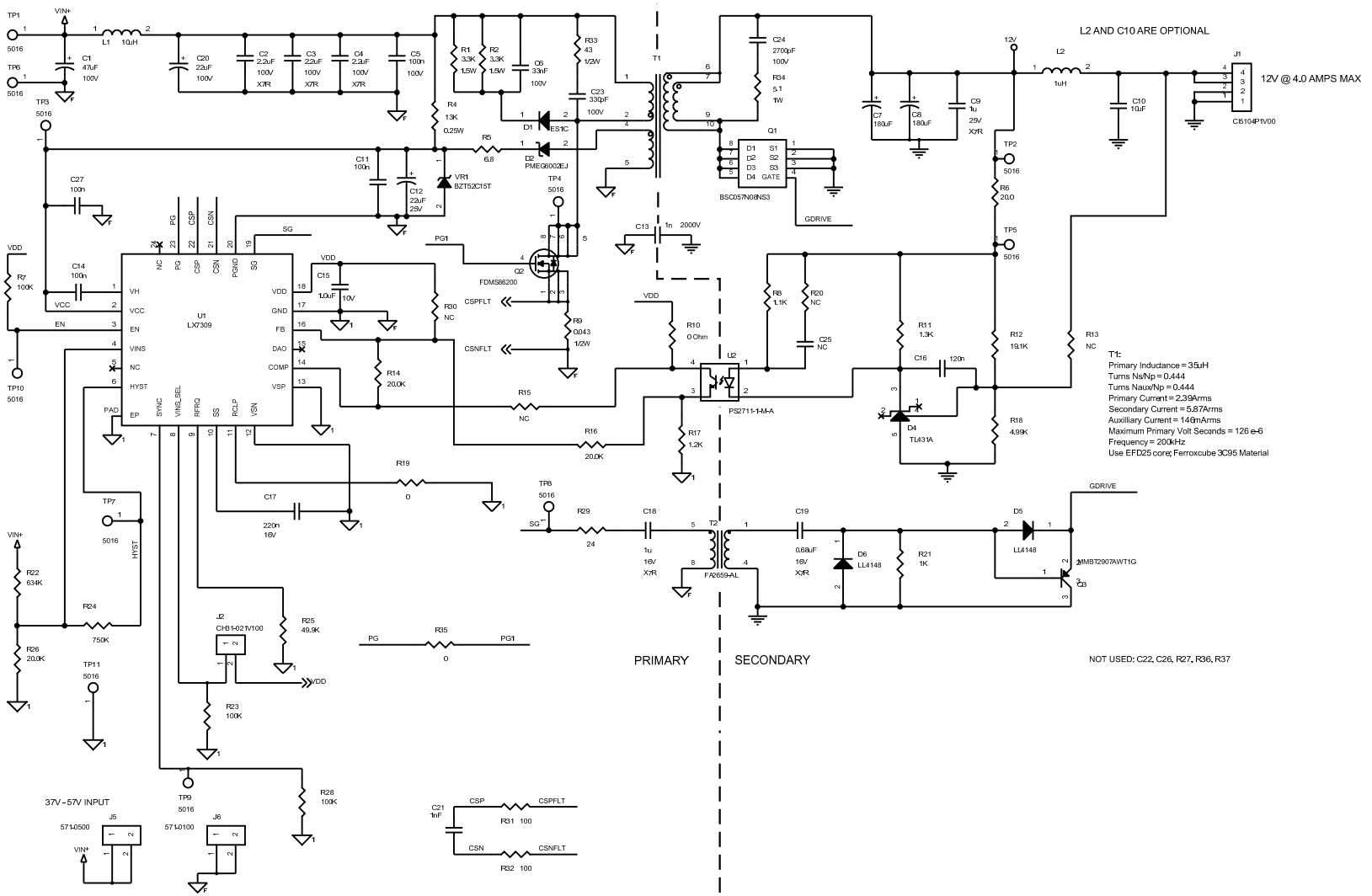


Figure 5 – LX7309 Evaluation Board Schematic

Bill of Materials - LX7309 Evaluation Board

Item Number	Quantity	Part Reference	Description	Manufacturer	Manufacturer Part Number
1	1	C1	CAP ALU 47uF 100V 20% 12.5mm x 13.5mm	Panasonic	EEVFK2A470Q
2	3	C2 C3 C4	CAP CER 2.2uF 100V 10% X7R ^1210 SMT	CAPAX	1210X225K101SNT
3	1	C5	CAP CRM 100nF 100V 10%^^X7R 1206 SMT	EPCOS	B37872K1104K62
4	1	C6	CAP CRM 33nF 100V 10%^^X7R 1206 SMT	AVX	12061C333KAT2A
5	2	C7 C8	CAP ALUM 180UF 16V 20% 4.36A 16m Ohm 8mm X 12mm SMD	United Chemicon	APXA160ARA181MHC0G
6	1	C9	CAP CRM 1uF 25V 10% X7R, 1206	TAIYOYUDEN	TMK316B7105ML-T
7	1	C10	CAP X7R 10uF 16V 10% 1206	TDK	C3216X7R1C106K
8	2	C11 C27	CAP CRM 100nF 25V 10%^^X7R 0805 SMT	Murata	GRM216R71E104KA01
9	1	C12	Capacitor, 22uF, 25V, Aluminum Electrolytic, 6.3mm x 5.4mm 105C SMD	Nichicon	UWT1E220M
10	1	C13	CAP CRM 1nF/2000V 10%++X7R 1206 SMT	AVX	1206GC102KAT1A
11	1	C14	Capacitor, X7R, 100nF, 16V, 10% 0603	TAIYOYUDEN	GRM216R71E104KA01
12	1	C17	Capacitor, X7R, 220nF, 16V, 10% 0603	TAIYOYUDEN	GRM216R71E224KA01
13	1	C15	Capacitor, Ceramic, 1.0uF, 10 Volt, 10%, 0805 Type SMD	Panasonic	ECJ2YB1A105K
14	1	C16	Capacitor, X7R, 120nF, 16V, 10% 0603	TAIYOYUDEN	EMK107B7124KA-T
15	1	C18	CAP CRM 1uF 16V 10%^^X7R 0805 SMT^^	Panasonic	ECJ2VB1C105K
16	1	C19	Capacitor, Ceramic, 0.68uF, 16 Volt, 10%, 0805 Type SMD	Panasonic	ECJ2VB1C684K
17	1	C20	CAP ALU 22uF 100V 20% 8mm X 10mm	Panasonic	EEEFK2A220P
18	1	C21	CAP CER 1000PF 10V X7R 0603	Kemet	C0603C102M8RACTU
19	1	C23	CAP CER 330PF 200V X7R 0805	AVX	08052C331KAT2A
20	1	C24	CAP CER 2700PF 100V X7R 0805	AVX	08051C272KAT2A
21	1	C25	No Stuff		
22	1	D1	DIO FAST SWI 150V, 1A	Fairchild	ES1C
23	1	D2	Diode, Schottky, 200mA, 60V, SOD-323	NXP	PMEG6002EJ,115
24	1	D4	IC Adj Prec Shunt Reg 2.5V ^^1% SOT-23-5 SMT	Texas Instruments	TL431ACDBVR
25	1	D5 D6	DIO FAST SWI 75V 300mA^^4nS SOD80C MiniMELF	Vishay	LL4148
26	1	J1	PIN HEADER 4 PIN 0.156"^^TIN, WITH LOCKING WALL	CviLux	CI5104P1V00
27	1	J2	PIN HEADER 2 PINs^^0.1" PIN SQUER+TIN	CviLux	CH31-021V100
28	1	J5	90o PCB Mounted Insulated Banana Socket 4mm Red	Deltron	571-0500
29	1	J6	90o PCB Mounted Insulated Banana Socket 4mm Black	Deltron	571-0100

Bill of Materials - LX7309 Evaluation Board

Item Number	Quantity	Part Reference	Description	Manufacturer	Manufacturer Part Number
30	1	L1	Inductor, 10uH SMD Inductor, 2.0A, 49m Ohm	Wurth	74477710
31	1	L2	Inductor, 1uH SMD Inductor, 5.3A, 11m Ohm	Wurth	7447779001
32	1	Q1	FET, N-Channel, 80V, 100A 5.7mΩ	Infineon	BSC057N08NS3
33	1	Q2	FET, N-Channel, 150V, 9A	Fairchild	FDMS86200
34	1	Q3	TRN PNP 60V 600mA SOT23 SMT 250mW MMBT2907AW^	ON Semiconductor	MMBT2907AWT1G
35	2	R1 R2	RES 3.3K OHM 1.5W 5% 2512 SMD	Vishay	CRCW25123K30JNEGHP
36	1	R4	Resistor, 13K Ohms, 1/4 Watt, 5% 1206 Type SMD	Panasonic	ERJ8GEYJ133V
37	1	R5	Resistor, 6.8 Ohm, 0603 Type SMD	Panasonic	ERJ3GEY6R80V
38	3	R10 R19 R35	Resistor, 0 Ohm jumper, 0603 Type SMD	Panasonic	ERJ3GEY0R00V
39	1	R6	Resistor, 20.0 Ohms, 1/8 Watt, 1% 0805 Type SMD	Rohm	MCR10EZHF20R0
40	3	R7 R23 R28	Resistor, 100K Ohms, 1/8 Watt, 5% 0805 Type SMD	Rohm	MCR10EZHJ104
41	1	R8	Resistor, 1.1K 1/10 Watt, 5% 0603 Type SMD	Panasonic	ERJ3GEYJ821V
42	1	R9	RES .043 OHM 1/2W 1% 1206 SMD	Panasonic	ERJ-8BWFR043V
43	1	R17	Resistor, 1.2K Ohms, 1/10 Watt, 5% 0603 Type SMD	Panasonic	ERJ3GEYJ122V
44	1	R11	Resistor, 1.5K Ohms, 1/10 Watt, 5% 0603 Type SMD	Rohm	MCR03EZPJ152
45	1	R26	Resistor, 20.0K Ohms, 1/16 Watt, 1% 0603 Type SMD	Panasonic	ERJ3EKF2002
46	1	R12	Resistor, 19.1K Ohms, 1/16 Watt, 1% 0603 Type SMD	Panasonic	ERJ3EKF1912
47	4	R13 R15 R20 R30	No Stuff		
48	2	R14 R16	Resistor,20.0K Ohms, 1/16 Watt, 1% 0603 Type SMD	Panasonic	ERJ3EKF2002
49	1	R18	Resistor, 4.99K Ohms, 1/16 Watt, 1% 0603 Type SMD	Panasonic	ERJ3EKF4991
50	2	R31, R32	Resistor, 100 Ohms, 1/10 Watt, 5% 0603 Type SMD	Panasonic	ERJ3GSYJ101
51	1	R21	Resistor, 1K Ohms, 1/4 Watt, 5% 1206 Type SMD	Panasonic	ERJ8GEYJ102V
52	1	R22	Resistor, 634K Ohms, 1/8 Watt, 1% 0805 Type SMD	Panasonic	ERJ6ENF6343
53	1	R24	Resistor, 750K Ohms, 1/16 Watt, 1% 0603 Type SMD	Panasonic	ERJ3EKF7503
54	1	R25	Resistor, 49.9K Ohms, 1/16 Watt, 1% 0603 Type SMD	Panasonic	ERJ3EKF4992
55	1	R29	Resistor, 24 Ohms, 1/4 Watt, 5% 1206 Type SMD	Panasonic	ERJ8GEYJ240V
56	1	R33	Resistor, 43 Ohms 1/2 Watt 5% 1210 Type SMD	Panasonic	ERJ-14YJ430U
57	1	R34	Resistor, 5.1 Ohms 1W 5% 2512 Type SMD	Panasonic	ERJ-1TYJ5R1U
58	1	T1	48W transformer;	TMP	SGE2944-1
59	1	T2	Transformer, Gate Drive, 1:1 turns ratio,	Coilcraft	FA2659-AL

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Bill of Materials - LX7309 Evaluation Board

Item Number	Quantity	Part Reference	Description	Manufacturer	Manufacturer Part Number
60	10	TP1 TP2 TP3 TP5 TP6 TP7 TP8 TP9 TP10 TP11	Terminal, Compact style test point, SMT PCB Mount	Keystone	5016
61	1	TP4	Terminal, Miniature style test point, SMT PCB Mount	Keystone	5015
62	1	U1	IC, POE PD PWM Controller, 24 pin 4mm x 4mm QFN	Microsemi	LX7309
63	1	U2	Optoisolator, CTR = 100 to 200, SMT mount	NEC	P2711-1-M-A
64	1	VR1	Diode, Zener, 15V, 100mW, SOD-523	Micro Commercial Co.	BZT52C15T
65	1	PCB	Printed Circuit Board	Microsemi	SGE3256 X2

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