LT3752/LT8311
Active Clamp Forward Converter with Synchronous Rectification

DESCRIPTION

Demonstration circuit 1994A is an active clamp forward converter with synchronous rectification featuring the LT®3752/LT8311 chipset.

This circuit was designed to demonstrate the high levels of performance, efficiency, and small solution size attainable using these parts. It operates at 240kHz and produces a regulated 12V, 12A output from an input voltage range of 18 to 72V: suitable for telecom, industrial, and other applications. It has an eighth-brick footprint area. Synchronous rectification helps to attain efficiency exceeding 94%.

The DC1994 circuit features soft-start which prevents output voltage overshoot on startup or when recovering from overload condition.

The DC1994 also has precise overcurrent protection circuit that allows for continuous operation under short circuit conditions. The low power dissipation under a short circuit condition ensures high reliability even during a prolonged output voltage short circuit.

The LT3752 includes an internal constant frequency flyback controller for creating a housekeeping voltage supply. The housekeeping supply is able to efficiently provide bias for both primary and secondary ICs, and eliminates the need to generate bias supplies from auxiliary windings in the main forward transformer. The housekeeping supply also allows bias to any secondary side IC before the main forward converter starts switching.

Please refer to LT3752 data sheet for design details and applications information.

Design files for this circuit board are available at http://www.linear.com/demo/DC1994A

PERFORMANCE SUMMARY

Specifications are at T_A = 25°C

SYMBOL	PARAMETER	CONDITIONS	MIN	TYP	MAX	UNITS
V_{IN}	Input Supply Range		18		72	V
V_{OUT}	Output Voltage		11.76	12.0	12.24	V
I_{OUT}	Maximum Output Current, Continuous	200LFM	12			A
FSW	Switching (Clock) Frequency			240		kHz
$V_{OUT\ P-P}$	Output Ripple	V_{IN} = 48V, I_{OUT} = 12A (20MHz BW)		100		mV_{P-P}
I_{REG}	Output Regulation	Line and Load (18V_{IN} to 72V_{IN}, 0A_{OUT} to 12A_{OUT})		±0.08		%
P_{OUT}/P_{IN}	Efficiency (see Figure 2)	V_{IN} = 48V, I_{OUT} = 12A		94		%

QUICK START PROCEDURE

Demonstration circuit 1994 is easy to set up to evaluate the performance of the LT3752/LT8311 chipset. Refer to Figure 1 for proper measurement equipment setup and follow the procedure below:

NOTE. When measuring the output voltage ripple, care must be taken to avoid a long ground lead on the oscilloscope probe. Measure the output voltage ripple by touching the probe tip and ground ring directly across the last output capacitor as shown in Figure 1.

1. Set an input power supply that is capable of 18V to 72V to 18V. Then turn off the supply.
2. Direct an airflow of 200LFM across the unit for sustained operation at full load.
3. With power off, connect the supply to the input terminals $+V_{IN}$ and $-V_{IN}$.
   a. Input voltages lower than 18V can keep the converter from turning on due to the undervoltage lockout feature of the LT3752/LT8311.
   b. If efficiency measurements are desired, an ammeter capable of measuring 10ADC can be put in series with the input supply in order to measure the DC1994A's input current.
   c. A voltmeter with a capability of measuring at least 72V can be placed across the input terminals in order to get an accurate input voltage measurement.
4. Turn on the power at the input.

NOTE. Make sure that the input voltage does not exceed 100V.

5. Check for the proper output voltage of 12V. Turn off the power at the input.
6. Once the proper output voltages are established, connect a variable load capable of sinking 12A at 12V to the output terminals $+V_{OUT}$ and $-V_{OUT}$. Set the current for 0A.
   a. If efficiency measurements are desired, an ammeter or a resistor shunt that is capable of handling 12ADC can be put in series with the output load in order to measure the DC1994A's output current.
   b. A voltmeter with a capability of measuring at least 12V can be placed across the output terminals in order to get an accurate output voltage measurement.
7. Turn on the power at the input.

NOTE. If there is no output, temporarily disconnect the load to make sure that the load is not set too high.

8. Once the proper output voltage is again established, adjust the load within the operating range and observe the output voltage regulation, ripple voltage, efficiency and other desired parameters.

QUICK START PROCEDURE

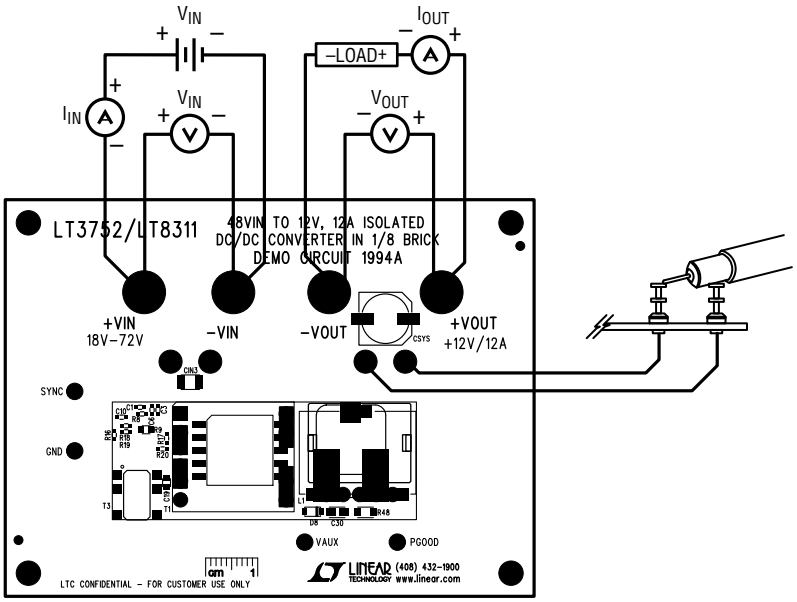


Figure 1. Proper Measurement Equipment Setup

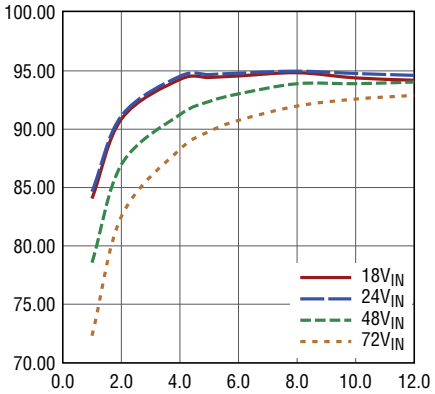


Figure 2. Efficiency

QUICK START PROCEDURE

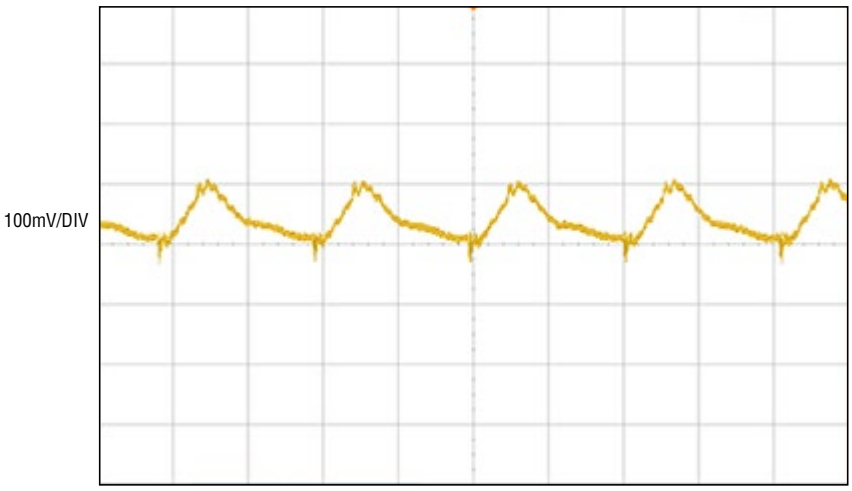


Figure 3. Output Ripple at $48V_{IN}$ and $12A_{OUT}$ (20MHz BW)

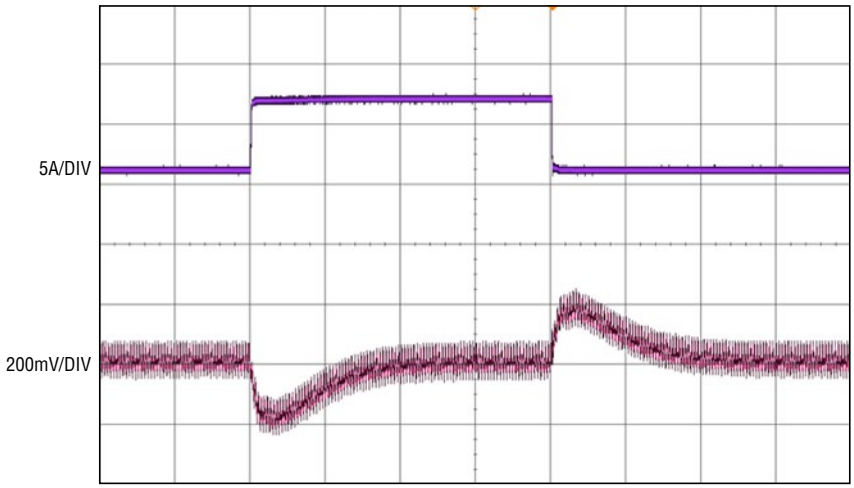


Figure 4. Transient Response Waveform at $48V_{IN}$ and $6A_{OUT}$ to $12A_{OUT}$

QUICK START PROCEDURE

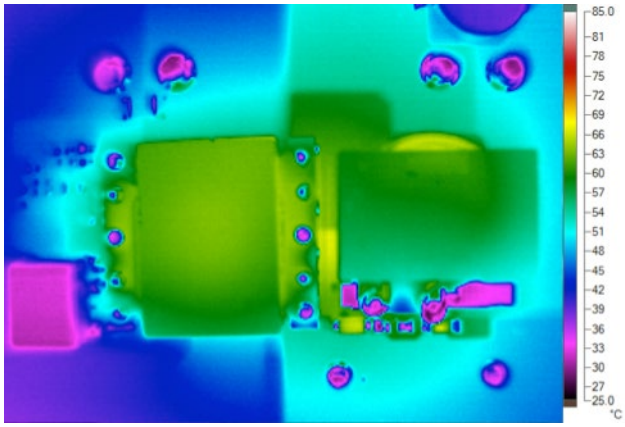


Figure 5. Thermal Map, Frontside at $48V_{IN}$ and $12A_{OUT}$ (T_A = 25°C, 200LFM)

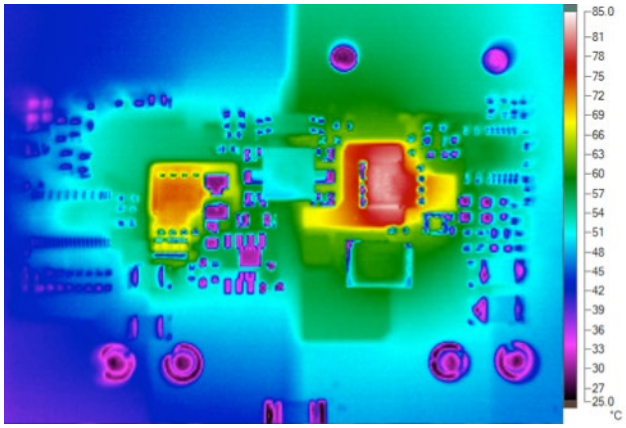


Figure 6. Thermal Map, Backside at $48V_{IN}$ and $12A_{OUT}$ (T_A = 25°C, 200LFM)

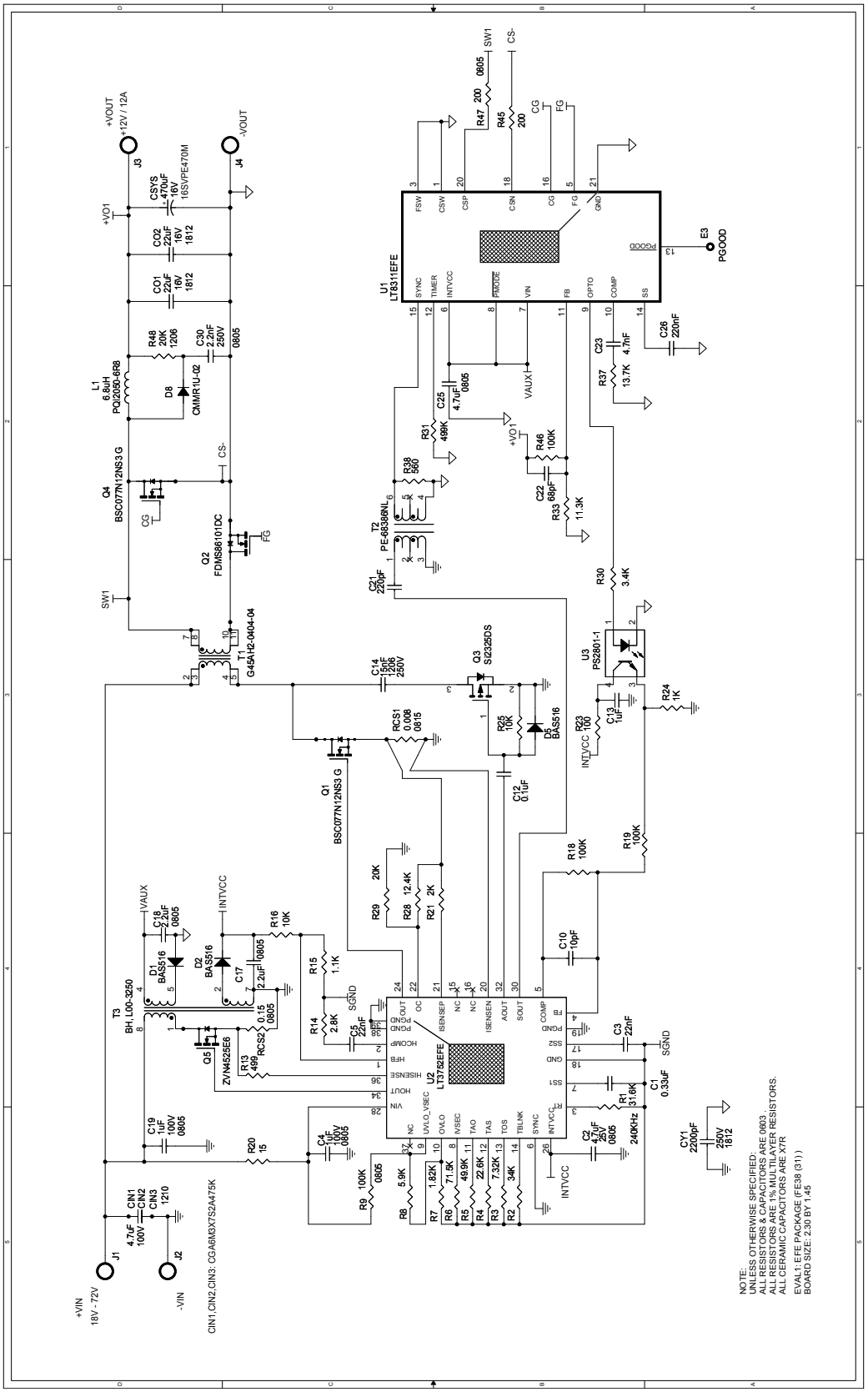
PARTS LIST

ITEM	QTY	REFERENCE	PART DESCRIPTION	MANUFACTURER/PART NUMBER
Required Circuit Components				
1	3	CIN1, CIN2, CIN3	CAP., X7S, 4.7µF, 100V, 10%, 1210	TDK, CGA6M3X7S2A475K
2	2	CO1, CO2	CAP., X7R, 33µF, 16V, 20%, 1812	TDK, C4532X7R1C336M
3	1	CSYS	CAP., ALUM., 470µF, 16V, SVPE Series	PANASONIC, 16SVPE470M
4	1	CY1	CAP., X7R, 2200pF, 250V, 10%, 1812	MURATA, GA343QR7GD222KW01L
5	1	C1	CAP., X7R, 0.33µF, 10V, 5%, 0603	KEMET C0603C334J4RACTU
6	2	C2, C25	CAP., X5R, 4.7µF, 25V, 10%, 0805	MURATA, GRM21BR61E475KA12L
7	2	C3, C5	CAP., X7R, 22nF, 25V, 10%, 0603	AVX, 06033C223KAT2A
8	2	C4, C19	CAP., X7S, 1µF, 100V, 10%, 0805	TDK, C2012X7S2A105K
9	1	C10	CAP., NP0, 10pF, 25V, 5%, 0603	AVX, 06033A100JAT2A
10	1	C12	CAP., X7R, 0.1µF, 25V, 10% 0603	AVX, 06033C104KAT2A
11	1	C13	CAP., X7R, 1µF, 16V, 10%, 0603	AVX, 0603YC105KAT2A
12	1	C14	CAP., X7R, 15nF, 250V, 10%, 1206	MURATA, GRM31BR72E153KW01L
13	2	C17, C18	CAP., X7R, 2.2µF, 25V, 20%, 0805	AVX, 08053C225MAT2A
14	1	C21	CAP., NPO, 220pF, 25V, 10%, 0603	AVX, 06033A221KAT2A
15	1	C22	CAP., NP0, 68pF, 25V, 10%, 0603	AVX, 06033A680KAT2A
16	1	C23	CAP., X7R, 4.7nF, 25V, 10%, 0603	AVX, 06033C472KAT2A
17	1	C26	CAP., X7R, 220nF, 16V, 5%, 0603	SAMSUNG, CL10B224JO8NNNC
18	1	C30	CAP., X7R, 2.2nF, 250V, 10%, 0805	MURATA, GRM21AR72E222KW01D
19	3	D1, D2, D5	DIODE, High-Speed Diode, SOD-523	NXP/PHILLIPS SEMI., BAS516
20	1	D8	DIODE, CMMR1U-02 SOD-123	CENTRAL SEMI., CMMR1U-02 TR
21	1	L1	INDUCTOR, 6.8µH	CHAMPS TECH., PQI2050-06R8
22	2	Q1, Q4	MOSFET, N-CH, 120V, PG-TDSON-8	INFINEON, BSC077N12NS3 G
23	1	Q2	MOSFET, N-CH, 100V, 60A, POWER 56	FAIRCHILD, FDMS86101DC
24	1	Q3	MOSFET, Si2325DS, SOT-23	VISHAY, Si2325DS-T1-E3
25	1	Q5	MOSFET, N-CH, 250V, SOT23-6	DIODES/ZETEX, ZVN4525E6TA
26	1	RCS1	RES., CHIP, 0.008Ω, 1W, 1%, RL3720W	SUSUMU, RL3720WT-R008-F
27	1	RCS2	RES., CHIP, 0.15Ω, 0.125W, 1%, 0805	VISHAY, WSL0805R1500FEA
28	1	R1	RES., Chip, 31.6k, 0.1W, 1%, 0603	VISHAY, CRCW060331K6FKEA
29	1	R2	RES., Chip, 34k, 0.1W, 1%, 0603	VISHAY, CRCW060334K0FKEA
30	1	R3	RES., Chip, 7.32k, 0.1W, 1%, 0603	VISHAY, CRCW06037K32FKEA
31	1	R4	RES., Chip, 22.6k, 0.1W, 1%, 0603	VISHAY, CRCW060322K6FKEA
32	1	R5	RES., Chip, 49.9k, 0.1W, 1%, 0603	VISHAY, CRCW060349K9FKEA
33	1	R6	RES., Chip, 71.5k, 0.1W, 1%, 0603	VISHAY, CRCW060371K5FKEA
34	1	R7	RES., Chip, 1.82k, 0.1W, 1%, 0603	VISHAY, CRCW06031K82FKEA
35	1	R8	RES., Chip, 5.9k, 0.1W, 1%, 0603	VISHAY, CRCW06035K90FKEA
36	1	R9	RES., Chip, 100k, 0.125W, 1%, 0805	VISHAY, CRCW0805100KFKEA
37	1	R13	RES., Chip, 499Ω, 0.1W, 1%, 0603	VISHAY, CRCW0603499RFKEA
38	1	R14	RES., Chip, 2.8k, 0.1W, 1%, 0603	VISHAY, CRCW06032K80FKEA
39	1	R15	RES., Chip, 1.10k, 0.1W, 1%, 0603	VISHAY, CRCW06031K10FKEA
40	2	R16, R25	RES., Chip, 10k, 0.1W, 5%, 0603	VISHAY, CRCW060310K0JNEA

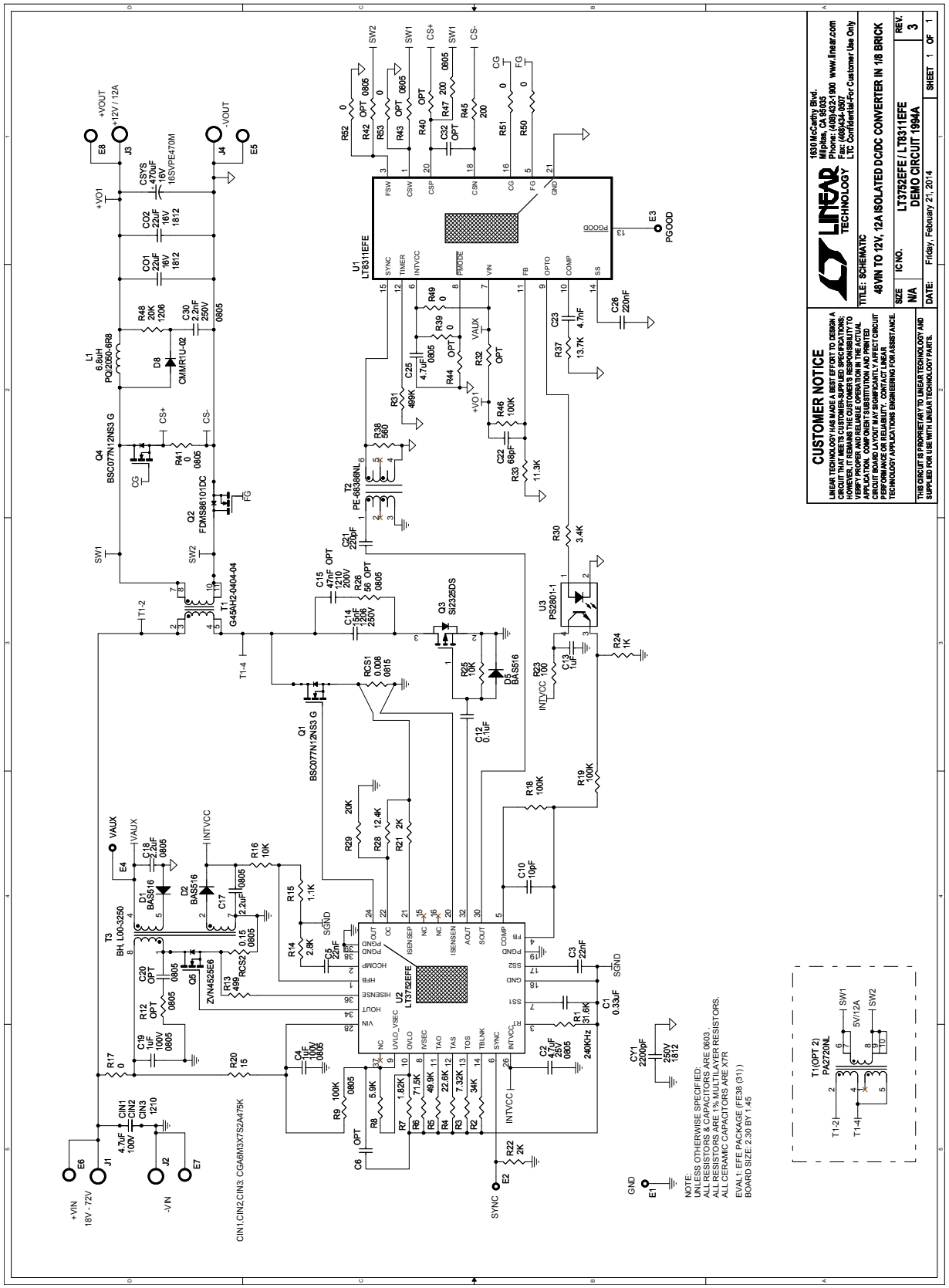
PARTS LIST

ITEM	QTY	REFERENCE	PART DESCRIPTION	MANUFACTURER/PART NUMBER
41	7	R17, R39, R49, R50-R53	RES., Chip, 0Ω, 0.1W, 0603	VISHAY, CRCW06030000Z0EA
42	3	R18, R19, R46	RES., Chip, 100k, 0.1W, 1%, 0603	VISHAY, CRCW0603100KFKEA
43	1	R20	RES., Chip, 15Ω, 0.1W, 1%, 0603	VISHAY, CRCW060315R0FKEA
44	2	R21, R22	RES., Chip, 2k, 0.1W, 1%, 0603	VISHAY, CRCW06032K00FKEA
45	1	R23	RES., Chip, 100Ω, 0.1W, 5%, 0603	VISHAY, CRCW0603100RJNEA
46	1	R24	RES., Chip, 1k, 0.1W, 1%, 0603	VISHAY, CRCW06031K00FKEA
47	1	R28	RES., Chip, 12.4k, 0.1W, 1%, 0603	VISHAY, CRCW060312K4FKEA
48	1	R29	RES., Chip, 20k, 0.1W, 1%, 0603	VISHAY, CRCW060320K0FKEA
49	1	R30	RES., Chip, 3.4k, 0.1W, 1%, 0603	VISHAY, CRCW06033K40FKEA
50	1	R31	RES., Chip, 499k, 0.1W, 1%, 0603	VISHAY, CRCW0603499KFKEA
51	1	R33	RES., Chip, 11.3k, 0.1W, 1%, 0603	VISHAY, CRCW060311K3FKEA
52	1	R37	RES., Chip, 13.7k, 0.1W, 1%, 0603	VISHAY, CRCW060313K7FKEA
53	1	R38	RES., Chip, 560Ω, 0.1W, 5%, 0603	VISHAY, CRCW0603560RJNEA
54	1	R41	RES., Chip, 0Ω, 0.125W, 1%, 0805	VISHAY, CRCW08050000Z0EA
55	1	R45	RES., Chip, 200Ω, 0.1W, 1%, 0603	VISHAY, CRCW0603200RFKEA
56	1	R47	RES., Chip, 200Ω, 0.125W, 1%, 0805	VISHAY, CRCW0805200RFKEA
57	1	R48	RES., Chip, 20k, 0.25W, 1%, 1206	VISHAY, CRCW120620K0FKEA
58	1	T1	TRANSFORMER, SMT	CHAMPS TECH., G45AH2-0404-04
59	1	T2	TRANSFORMER, SMT Gate Drive XFMR	PULSE, PE-68386NL
60	1	T3	TRANSFORMER, Flyback Converter XFMR	BH ELECT., L00-3250
61	1	U1	I.C., LT8311EFE#PBF TSSOP-20	LINEAR TECH., LT8311EFE#PBF
62	1	U2	I.C., LT3752EFE#PBF TSSOP-38	LINEAR TECH,. LT3752EFE#PBF
63	1	U3	I.C., PS2801C-1-P-A	NEC, PS2801C-1-P-A
Additional Demo Board Circuit Components				
1	0	C6, C32 (OPT)	CAP., 0603	
2	0	C15 (TBD)	CAP., 1210	
3	0	C20 (OPT)	CAP., 0805	
4	0	R12, R26 (OPT)	RES., 0805	
5	0	R32, R40, R44 (OPT)	RES., Chip, 0603	
6	0	R42, R43 (OPT)	RES., Chip, 0805	
Hardware: For Demo Board Only				
1	4	E1 to E4	TESTPOINT, TURRET, .061"	MILL-MAX, 2308-2-00-80-00-00-07-0
2	4	E5 to E8	TESTPOINT, TURRET, .094"	MILL-MAX, 2501-2-00-80-00-00-07-0
3	4	J1 to J4	BANANA JACK	KEYSTONE, 575-4
4	4	MH1 to MH4	STAND-OFF, NYLON 0.25"	KEYSTONE, 8831(SNAP ON)
5	1		FAB, PRINTED CIRCUIT BOARD	DEMO CIRCUIT 1994A
6	2		STENCIL (TOP & BOTTOM)	STENCIL DC1994A

SIMPLE SCHEMATIC DIAGRAM



FULL SCHEMATIC DIAGRAM



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