LTC3862-2
High Power, High Voltage Step-Up Converter

DESCRIPTION

Demonstration circuit 2006A-B is a multiphase high power, high voltage step-up DC/DC converter featuring two the LTC®3862-2 boost controllers. This demo board converts a 6V to 36V input voltage to a 120V output at up to 2.0A with two stages. The first stage converts the input voltage to 50V. The second stage converts the 50V to 120V and each stage uses one LTC3862-2.

The DC2006A-B supports three ways of biasing the LTC3862-2 controllers IC's by directly from the input voltage, or from a low power switching power supply or from an LDO regulator.

An onboard SEPIC power supply can provide a stable 10V bias voltage for both LTC3862-2 controllers over the wide varying input voltage. This allows the use of either logic level or standard level MOSFETs, even when the input voltage drops below the 10V set-point, which is useful in wide varying input applications.

An onboard LDO regulator can be selected for biasing the LTC3862-2 controllers which simplifies the design and is useful in applications where the input voltage is always higher than the required gate drive voltage.

The LTC3862-2 is a multiphase step-up (boost) DC/DC controller that delivers high output power in a compact footprint. Up to 12 power stages can be paralleled and clocked out-of-phase to minimize input and output filtering requirements. It has a 5.5V to 36V input voltage range and an output voltage range that is dependent on the choice of external components.

The LTC3862-2 utilizes peak current mode architecture for easy loop compensation and multiphase operation with very accurate phase-to-phase current matching. The fixed operating frequency can be set with a single resistor over a 75kHz to 500kHz range or can be synchronized to an external clock over a 50kHz to 600kHz frequency range. A current sense resistor is used in each phase to provide a precise cycle-by-cycle current limit. The powerful on-board gate drivers minimize switching losses and allow the use of multiple MOSFETs in parallel for very high current applications.

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

PERFORMANCE SUMMARY

PARAMETER	CONDITIONS	VALUE	UNITS
Minimum Input Supply Voltage		6	V
Maximum Input Supply Voltage		36	V
Output Voltage Range	V_{IN} = 6V to 36V, I_{OUT1} = 0A to 2.0A	120 ±2%	V
Typical switching frequency		200	kHz
Typical Output Ripple (V_{OUT}, 120V)	I_{LOAD} = 1.0A	150	mV
Efficiency Typical (V_{OUT}, 120V, V_{IN} 14V)	See Figure 3	93	%

QUICK START PROCEDURE

Demonstration circuit 2006 is easy to set up to evaluate the performance of the LTC3862-2 controllers. Refer to Figure 1 for proper measurement equipment setup and follow the procedure below:

NOTE. 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 the V_{IN} or V_{OUT} and GND terminals. See Figure 2 for proper scope probe technique.

1. Place jumper RUN1 (JP11) in the ON position. Place jumper RUN2 (JP10) in ON position also.
2. Place jumper BIAS (JP12) to the V_{IN} position.
3. With power off, connect the input power supply to V_{IN} and GND.

Turn the input power source on and slowly increase the input voltage. Be careful not to exceed 36V.

NOTE: Make sure that the input voltage V_{IN} does not exceed 36V. If higher operating voltage is required, power components with higher voltage ratings should be used.

4. Check for the proper output voltage of 120V. If there is no output, temporarily disconnect the load to make sure that the load is not set too high. Take all the precautions needed to work with high 120V output voltage.
5. Once the proper output voltages are established, adjust the load within the operating range and observe the output voltage regulation, ripple voltage, efficiency and other parameters.

LTC3862-2 BIAS CIRCUITS

The demo board DC2006A supports three ways of biasing LTC3862-2 controllers. Place jumper BIAS (JP12) to the V_{IN} position for input voltage above 10V, but below 36V. In this case bias pins of LTC3862-2 controllers will be connected directly to the input voltage.

Place jumper BIAS (JP12) to the AUX position for input voltage that can drop below 10V. The bias pins of LTC3862-2 controllers will be connected directly to the low power SEPIC converter, which provides regulated 10V.

The demo board DC2006A can be used for higher than 36V input voltages. In that case, the bias power for LTC3862-2 has to be limited under 36V. An external power source can be used to accomplish this or the optional bias regulator can be used. Remove R44 and R47 resistors and install 0Ω resistors R44 and R42.

Place jumper BIAS (JP12) to the AUX position. Since the power dissipation in linear regulator Q17 depends on the size of MOSFETs, switching frequency and voltage difference across Q17, all of the factors need to be considered when selecting the appropriate device for Q17. Please refer to LTC3862-2 data sheet.

CONVERTER EFFICIENCY

DC2006A-B efficiency reaches 92% at 12V input voltage generating 120V at 2.0A and 93% at 14V input voltage, see Figure 3. However, output current should be decreased at input voltages below 11V to reduce thermal stress on the converter. Figure 4 demonstrates maximum output current, as function of input voltage, assuming 120V output voltage.

All measurements were conducted at room temperature, natural convection cooling with no air flow.

QUICK START PROCEDURE

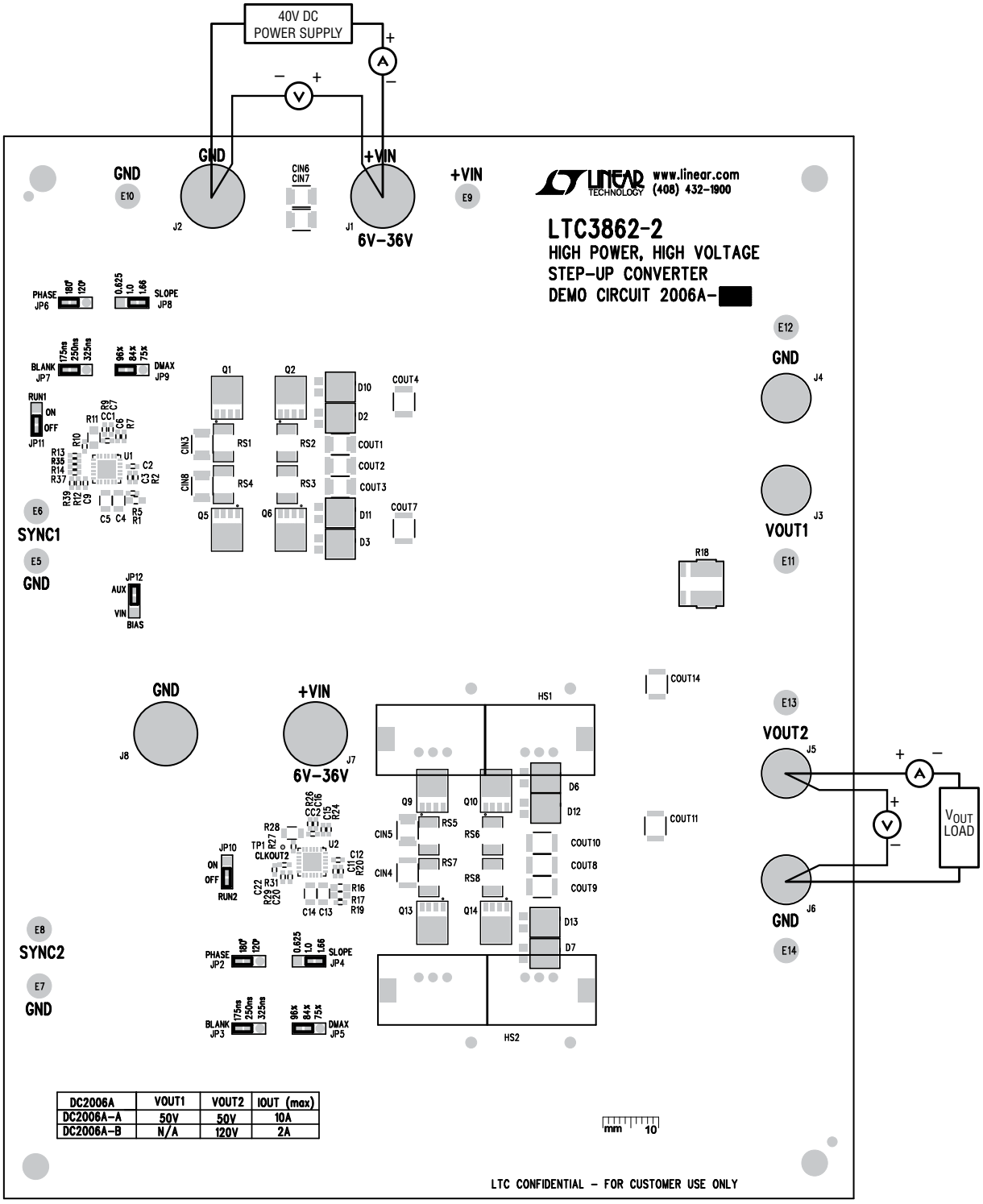

Figure 1. Proper Measurement Equipment Setup

QUICK START PROCEDURE

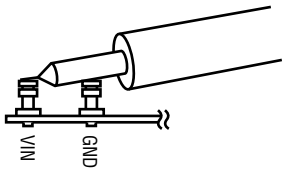

Figure 2. Measuring Input or Output Ripple

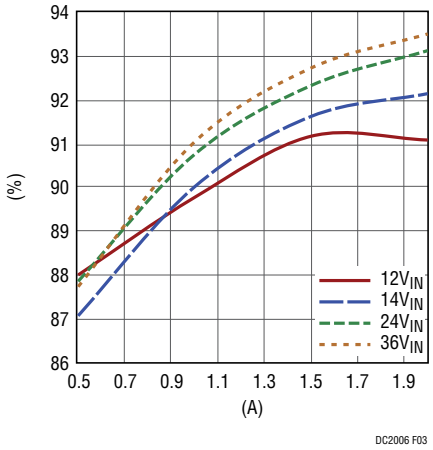

Figure 3. DC2006A-B, Efficiency vs Load

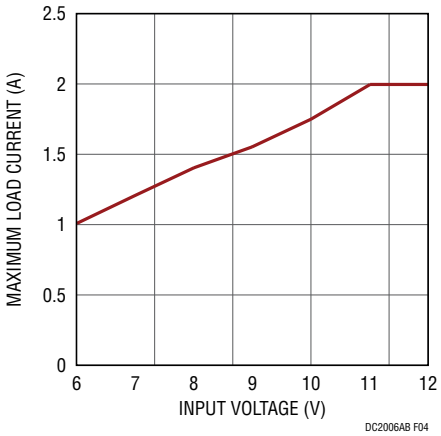

Figure 4. Load Current Derating at Low Input Voltages

QUICK START PROCEDURE

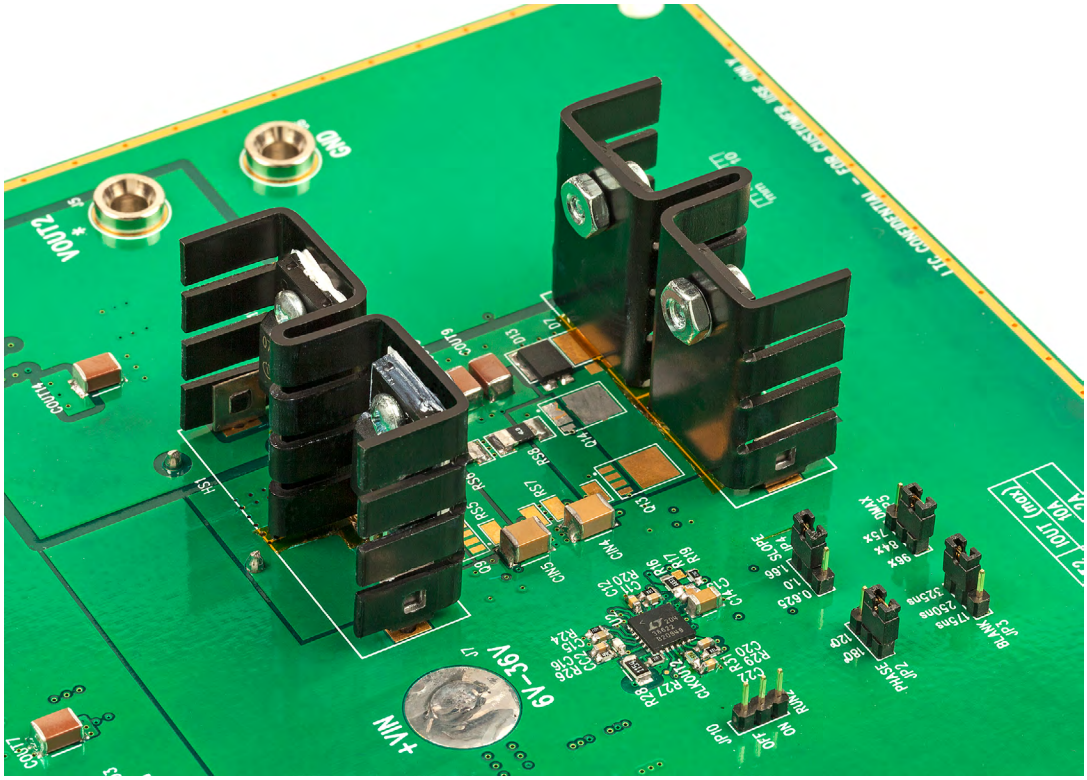

Figure 4. Installing Through-Hole MOSFETs and Heat Sink on Second Stage; AAVID TECH., 578622B03200G Heat Sink is Used

PARTS LIST

ITEM	QTY	REFERENCE	PART DESCRIPTION	MANUFACTURER/PART NUMBER
Required Circuit Components				
1	2	CC1, CC2	Cap., NPO 220pF, 25V, 5%, 0603	MURATA, CGM1885C1H221JA16D
2	1	CIN1	Cap., Alum 220µF, 50V 12.8 × 12.8	SUN ELECT., 50CE220KX
3	6	CIN3-CIN8	Cap., X5R 10uF, 50V, 20%, 1812	TDK, CKG45NX5R1H106M
3	7	COUT1-COUT4, COUT7, COUT15, COUT16	Cap., X7S 4.7µF, 100V, 10%, 1812	TDK, C4532X7S2A475K
4	5	COUT8-COUT11, COUT14	Cap., X7T 0.47µF, 450V, 1812	TDK C4532X7T2W474M
5	2	COUT5, COUT6	Cap., Alum. Elect. 100µF, 63V	SUN ELECT., 63CE100KX
6	2	COUT12, COUT13	Cap., Alum. 100µF, 160V, 20%	PANASONIC EEV-EB2C101M
6	5	C1, C8, C10, C17, C28	Cap., X7R 0.1µF, 25V, 10%, 0603	AVX, 06033C104KAT2A
7	2	C6, C15	Cap., X7R 0.47µF, 16V, 10%, 0603	AVX, 0603YC474KAT2A
8	2	C2, C12	Cap., NPO 1nF, 25V, 5%, 0603	AVX, 06033A102JAT2A
9	8	C3, C7, C9, C11, C16, C20, C22, C26	Cap., X7R 10nF, 25V, 5%, 0603	AVX, 06033C103JAT2A
10	3	C4, C13, C33	Cap., X5R 1µF, 50V, 10%, 1206	MURATA, GRM188R61H105KAAL
11	1	C18	Cap., X5R 1µF, 25V, 10%, 0603	AVX,06033D105KAT2A
12	1	C19	Cap., Polymer, 15uF, 25V	Panasonic,25TQC15MYFB
13	1	C21	Cap., X7S 2.2µF, 100V, 10%, 1206	TDK, C3216X7S2A225M
14	2	C24, C31	Cap., X7R 2.2µF, 25V, 20%, 0805	AVX, 08053C225MAT2A
15	2	C5, C14	Cap., X5R 4.7µF, 50V, 10%, 1206	TAIYO YUDEN, UMK316BJ475KL-T
16	4	D1, D4, D5, D8	Diode Schottky, SOD-323	DIODES/ZETEX, BAT760-7
17	2	D2, D11	Diode Schottky 8Amp 100V	VISHAY, V8P10-M3
18	2	D12, D13	Super Barrier Rectifier, 10A, 200V PWRD15	DIODES/ZETEX, SBR10U200P5-13
19	1	D16	Volt. Reg. Diode 12V SOD-323	NXP SEMI., PDZ12B
20	1	D15	Diode Schottky 1A, 60V	DIODES INC. PD3S160-7
21	1	D14	Diode Zener 7.5V	NXP/ PHILIPS PDZ7.5B
22	1	D17	Diode, 100V, SOD523	NXP/ PHILIPS BAS516
23	4	Q3, Q4, Q7, Q8	NPN/PNP Transistor	NXP SEMI., PBSS4140DPN
23	2	Q2, Q6	MOSFET 75V	INFINEON, BSC036NE7NS3G
24	2	Q10, Q14	MOSFET 150V	INFINEON, BSC190N15NS3G
25	1	Q16	MOSFET, 60V	FAIRCHILD, FDC5612
26	1	Q17	Transistor, SOT223	NXP SEMI., PZTA42
27	1	Q12	Transistor, SOT-23	DIODES, MMBTA42-7-F
28	2	L1, L2	INDUCTOR, 10µH	COILCRAFT, SER2918H-103KL
29	2	L6, L7	INDUCTOR, 100µH	COILCRAFT, PCV-2-104-05L
30	1	T2	Dual Winding Inductor, 100µH	COOPER BUSSMANN, DRQ73-101-R
31	7	R37, R14, R35, R47, R21, R22, R39	Res., Chip 0Ω, Jumper 0603	VISHAY, CRCW06030000Z0EA
32	4	RS2, RS3, RS6, RS8	Res., 0.004Ω, 1/2W, 1%, 2010	VISHAY, WSL20104L000FEA
33	1	R1	Res., Chip 84.5k, 1%, 0805	VISHAY, CRCW080584K5FKEA
34	4	R2, R12, R20, R29	Res., Chip 10Ω, 5%, 0603	VISHAY, CRCW060310R0JNEA
35	1	R45	Res., Chip 402Ω, 1%, 0603	VISHAY,CRCW0603402RFKEA
36	3	R5, R19, R9	Res., Chip 21k, 1%, 0603	VISHAY, CRCW060321K0FKEA

PARTS LIST

ITEM	QTY	REFERENCE	PART DESCRIPTION	MANUFACTURER/PART NUMBER
37	2	R7, R24	Res., Chip 66.5k, 1%, 0603	VISHAY, CRCW060366K5FKEA
38	2	R10, R27	Res., Chip 11.8k, 1%, 0603	VISHAY, CRCW060311K8FKEA
39	1	R11	Res., Chip 475k, 1%, 1206	VISHAY, CRCW1206475KFKEA
39	1	R16	Res., Chip 665k, 1%, 0805	VISHAY, CRCW0805665KFKEA
40	1	R26	Res., Chip 31.6k, 1%, 0603	VISHAY, CRCW06031K6FKEA
39	1	R28	Res., Chip 1.15M, 1%, 1206	VISHAY, CRCW12061M15FKEA
40	1	R34	Res., Chip 100k, 1%, 0603	VISHAY, CRCW0603100KFKEA
41	2	R46, R31	Res., Chip 10k, 1%, 0603	VISHAY, CRCW060310K0FKEA
42	1	R32	Res., Chip 0.1Ω, 1%, 0603	VISHAY, WSL0603R1000FEA
43	1	R50	Res., Chip 8.66k, 1%, 0603	VISHAY, CRCW06038K66FKEA
44	1	R23	Res., Chip 1M, 1%, 0603	VISHAY, CRCW06031M00FKEA
45	1	R44	Res., Chip 12.1k, 1%, 0603	VISHAY,,CRCW060312K1FKEA
46	1	R3	Res., Chip 3.32k, 1%, 1206	VISHAY,CRCW12063K32FKEA
47	1	R41	Res., Chip 10k, 1%, 1206	VISHAY,CRCW120610K0FKEA
48	1	R40	Res., Chip 115k, 1%, 0603	VISHAY, CRCW0603115K0FKEA
49	1	R38	Res., Chip 3.01k, 1%, 0603	VISHAY, CRCW06033K01FKEA
50	2	U1, U2	IC., LTC3862EUH-2#PBF, 5mm × 5mm, QFN	LINEAR TECH, LTC3862EUH-2#PBF
51	1	U3	IC., LTC3805-5	LINEAR TECH, LTC3805EMSE-5#TRMPBF
Additional Demo Board Circuit Components				
1		R4, R8, R15, R25, R26, R30, R42		OPT
2		C16, C29, C30		OPT
3		D3, D6, D7, D10		OPT
4		Q1, Q5, Q9, Q13		OPT
5		HS1, HS2	OPTIONAL Heat Sink	AAVID TECH., 578622B03200G
Hardware				
1	10	E1-E10	TESTPOINT, TURRET, .094"	MILL-MAX, 2501-2-00-80-00-00-07-0
2	4	J1, J2, J3, J4	CONN, BANANA JACK, KEYSTONE-575-4	KEYSTONE 575-4
3	1	JP1	JMP, 3 PIN, 1 ROW, 0.079"	SULLINS, NRPN031PAEN-RC
4	1	JP2	JMP, 3 PIN, 2 ROW, 0.079"	SULLINS, NRPN032PAEN-RC
6	4	MTGS at 4 corners	STANDOFF, NYLON .5 1/2"	KEYSTONE, 8833(SNAP-ON)
5	2	XJP1, XJP2	SHUNT, .079" CENTER	SAMTEC, 2SN-BK-G
6	2	J1, J2	Broaching Studs, .625 × 0.250	PennEngineering, KFH-032-10ET
7	2	J1, J2	Nut Brass, #10-32 M/S BR PL	ANY 10-32
8	2	J1, J2	Ring, Lug #10	KEYSTONE, 8205
9	2	J1, J2	Washer #10, Tin Plated Brass	ANY #10EXT BZ TN

SCHEMATIC DIAGRAM

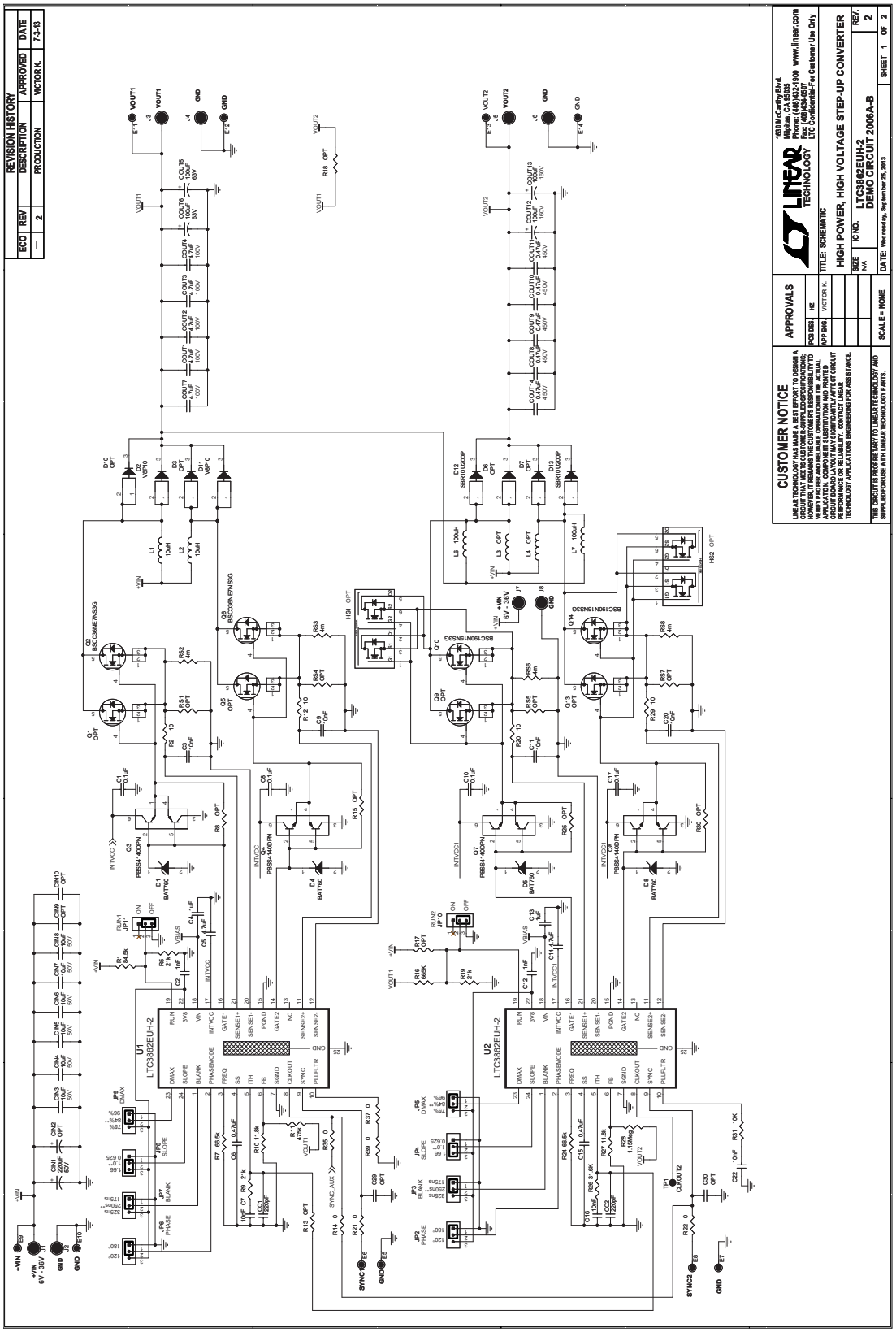

Figure 5. DC2006A-B Dual Stage Boost Converter

SCHEMATIC DIAGRAM

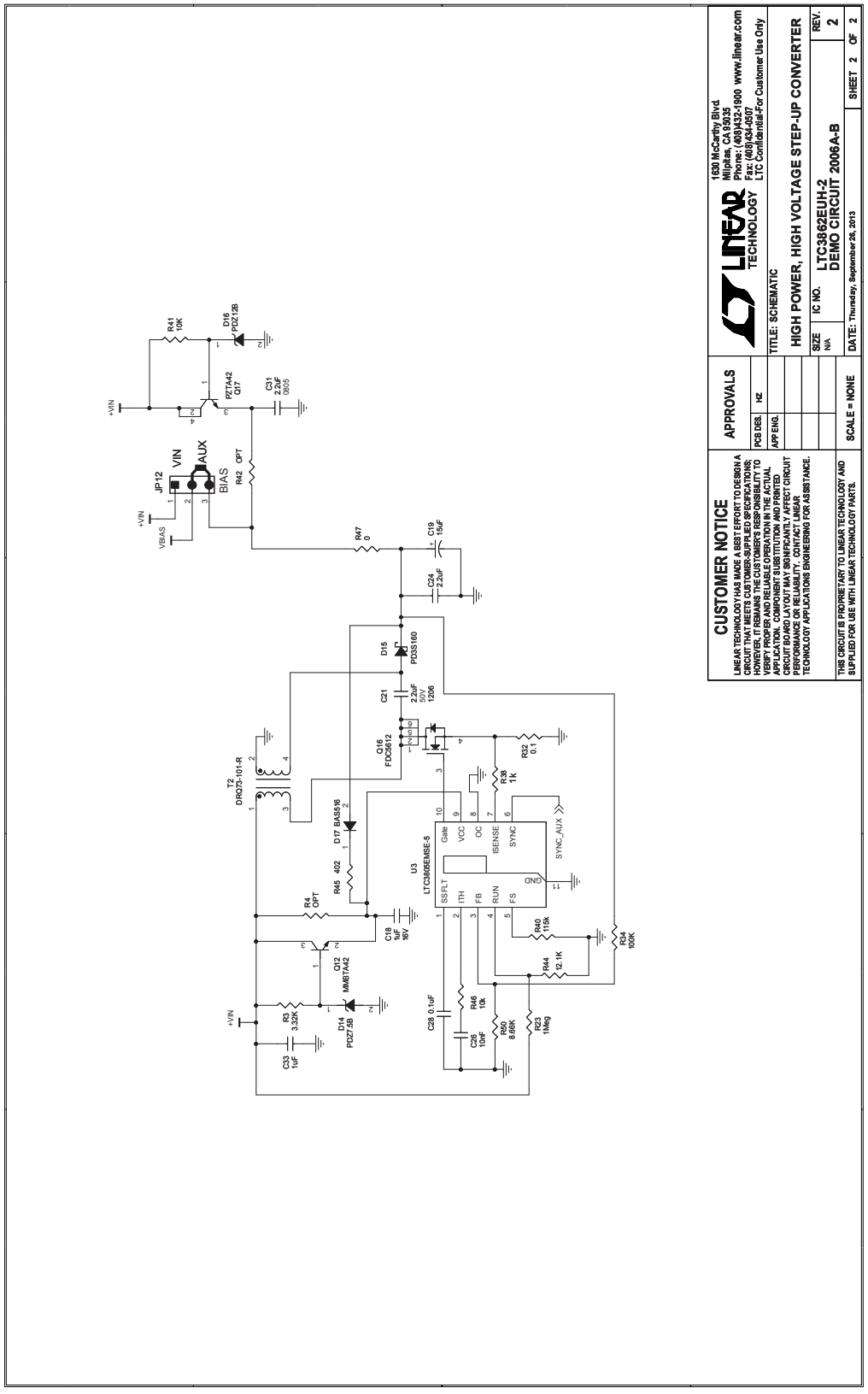

Figure 6. DC2006A-B Bias Circuitry

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