

LT3753

Active Clamp Forward Converter

DESCRIPTION

Demonstration circuit 2306A is an active clamp forward converter featuring the [LT[®]3753](#).

This circuit was designed to demonstrate the high level of performance and efficiency that can be attained with the LT3753. It operates at 100kHz and produces a regulated 54V, 1.5A output from a wide input voltage range of 10V to 54V, making it suitable for telecom, industrial, and other applications. The output voltage of this circuit is jumper selectable between 54V and 48V.

The DC2306 circuit features soft-start which prevents output voltage overshoot during startup or when recovering from overload condition.

The DC2306 also has precise overcurrent protection circuit that allows for continuous operation under short circuit conditions. The low power dissipation under short circuit conditions insures high reliability even during short circuits.

Please refer to LT3753 data sheet for design details and applications information.

Design files for this circuit board are available at <http://www.linear.com/demo/DC2306A>

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PERFORMANCE SUMMARY Specifications are at T_A = 25°C

| SYMBOL | PARAMETER | CONDITIONS | MIN | TYP | MAX | UNITS |
|-----------------------------------|------------------------------------|---|-----|------|-----|-------------------|
| V _{IN} | Input Supply Range | | 10 | | 54 | V |
| V _{OUT} | Output Voltage | | 53 | 54 | 55 | V |
| I _{OUT} | Maximum Output Current, Continuous | | 1.5 | | | A |
| f _{SW} | Switching (Clock) Frequency | | | 100 | | kHz |
| V _{OUT P-P} | Output Ripple | V _{IN} = 12V, I _{OUT} = 1.5A (20MHz BW) | | 40 | | mV _{P-P} |
| I _{REG} | Output Regulation | Line and Load (10V _{IN} to 54V _{IN} , 0A to 1.5A _{OUT}) | | ±0.1 | | % |
| P _{OUT} /P _{IN} | Efficiency (See Figure 2) | V _{IN} = 12V, I _{OUT} = 1.5A | | 93 | | % |

QUICK START PROCEDURE

Demonstration circuit 2306A is easy to set up to evaluate the performance of the LT3753. 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 10V to 54V to 10V. Then turn off the supply.
2. With power off, connect the supply to the input terminals $+V_{IN}$ and $-V_{IN}$.
 - a. Input voltages lower than 10V can keep the converter from turning on due to the undervoltage lockout feature of the LT3753.
 - b. If efficiency measurements are desired, an ammeter capable of measuring 9Adc can be put in series with the input supply in order to measure the DC2306A's input current.
 - c. A voltmeter with a capability of measuring at least 54V can be placed across the input terminals in order to get an accurate input voltage measurement.
3. Turn on the power at the input.

NOTE: Make sure that the input voltage does not exceed 100V.
4. Check for the proper output voltage of 54V. Turn off the power at the input.
5. Once the proper output voltages are established, connect a variable load capable of sinking 1.5A at 54V to the output terminals $+V_{OUT}$ and $-V_{OUT}$. Set the current for 0A.
 - a. If efficiency measurements are desired, an ammeter that is capable of handling 1.5Adc can be put in series with the output load in order to measure the DC2306A's output current.
 - b. A voltmeter can be placed across the output terminals in order to get an accurate output voltage measurement.
6. 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.
7. 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

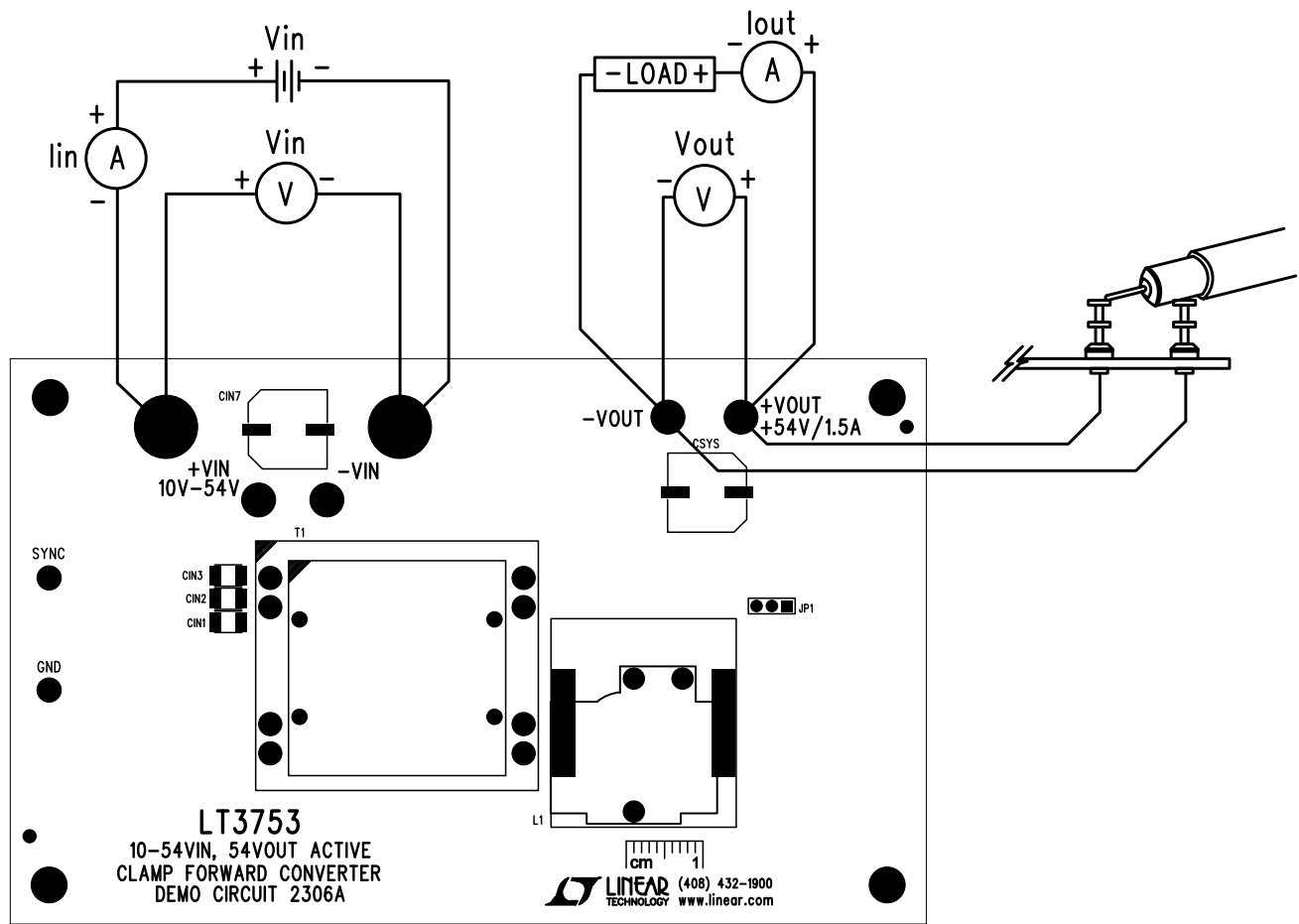


Figure 1. Proper Measurement Equipment Setup

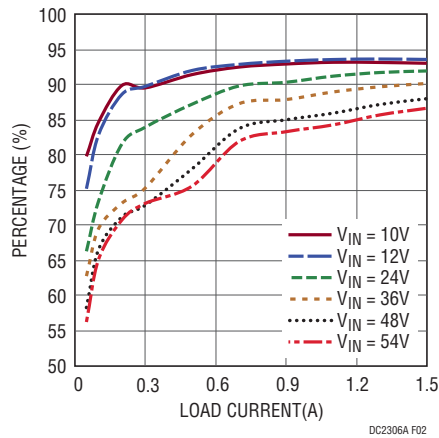


Figure 2. Efficiency vs Load Current

QUICK START PROCEDURE

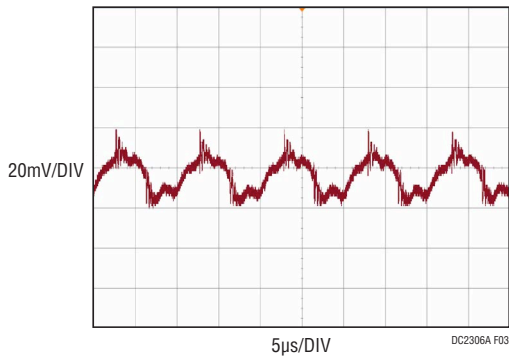


Figure 3. Output Ripple at 12V_{IN} and 1.5A_{OUT} (20MHz BW)

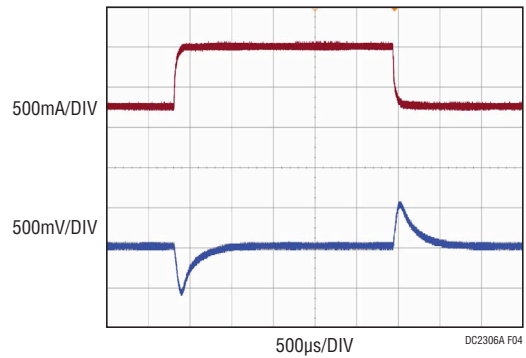


Figure 4. Transient Response Waveform at 12V_{IN} and 0.75A_{OUT} to 1.5A_{OUT}

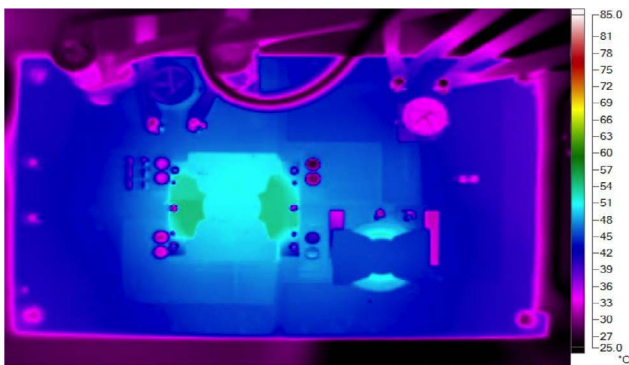


Figure 5. Thermal Map, Front Side at 12V_{IN} and 1.5A_{OUT} (T_A = 25°C)

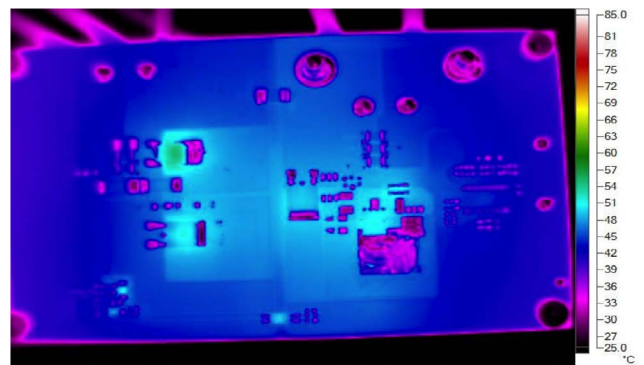


Figure 6. Thermal Map, Backside at 12V_{IN} and 1.5A_{OUT} (T_A = 25°C)

PARTS LIST

| ITEM | QTY | REFERENCE | PART DESCRIPTION | MANUFACTURER/PART NUMBER |
|------------------------------------|-----|---------------------|---|----------------------------|
| Required Circuit Components | | | | |
| 1 | 8 | CIN1-CIN6, CO1, CO2 | CAP., X7S, 4.7µF, 100V, 10%, 1210 | TDK, CGA6M3X7S2A475K |
| 2 | 1 | CIN7 | CAP., ALUM, 56µF, 63V | SUN ELEC., 63HVH56M |
| 3 | 1 | CSYS | CAP., ALUM, 47µF, 63V | SUN ELEC., 63HVH47M |
| 4 | 1 | CY1 | CAP., X7R, 2200pF, 250V, 10%, 1812 | MURATA, GA343QR7GD222KW01L |
| 5 | 1 | C1 | CAP., X7R, 1µF, 25V, 10%, 0603 | MURATA, GRM188R71E105KA12D |
| 6 | 1 | C2 | CAP., X7R, 4.7µF, 25V, 10%, 0805 | MURATA, GRM21BR61E475KA12L |
| 7 | 1 | C3 | CAP., X7R, 22nF, 25V, 10%, 0603 | MURATA, GRM188R71E223KA01D |
| 8 | 1 | C4 | CAP., X7S, 1µF, 100V, 10%, 0805 | TDK, C2012X7S2A105K |
| 9 | 1 | C5 | CAP., X7R, 100pF, 50V, 10%, 0603 | AVX, 06035C101KAT2A |
| 10 | 1 | C7 | CAP., X7R, 2200pF, 50V, 10%, 0603 | MURATA, GRM188R71H222KA01D |
| 11 | 1 | C8 | CAP., U2J, 2200pF, 630V, 10%, 1206 | MURATA, GRM31A7U2J222JW31D |
| 12 | 1 | C12 | CAP., X7R, 0.1µF, 50V, 10%, 0603 | MURATA, GRM188R71H104KA93D |
| 13 | 1 | C13 | CAP., X5R, 2.2µF, 25V, 10%, 0603 | TDK, C1608X5R1E225K080AB |
| 14 | 1 | C14 | CAP., X7R, 0.22µF, 100V, 10%, 1206 | TDK, C3216X7R2A224K115AA |
| 15 | 1 | C18 | CAP., COG, 4.7nF, 50V, 5%, 0603 | MURATA, GRM1885C1H472JA01D |
| 16 | 1 | C21 | CAP., NP0, 3900pF, 50V, 10%, 0603 | MURATA, GRM1885C1H392JA01D |
| 17 | 1 | C22 | CAP., X7R, 2.2pF, 50V, 10%, 0805 | MURATA, GRM21BR71E225KA73L |
| 18 | 1 | D1 | DIODE,SiC SCHOTTKY, DIODE, 600V, 4A, DPAK | INFINEON, IDD04SG60C |
| 19 | 1 | D2 | DIODE, 600V, 10A, TLM364 | CENTRAL SEMI., CTLHR10-06 |
| 20 | 1 | D3 | DIODE, 600V, 1A, SOD123F | CENTRAL SEMI., CMMR1U-06 |
| 21 | 1 | D4 | DIODE, ZENER, 10V, SOD-123 | CENTRAL SEMI., CMHZ4697 |
| 22 | 1 | D5 | DIODE, HIGH-SPEED DIODE, SOD-523 | NXP/PHILLIPS SEMI., BAS516 |
| 23 | 1 | L1 | INDUCTOR, 330µH | CHAMPS, PQA2050-330 |
| 24 | 1 | Q1 | MOSFET, N-CH, 100V, PG-TDSON-8 | INFINEON, BSC040N10NS5 |
| 25 | 1 | Q3 | MOSFET, P-CH, 100V, 4.2A, DPAK | INFINEON, SPD04P10PL G |
| 26 | 1 | RCS1 | RES., CHIP, 0.004Ω, 1W, 1%, 0815 | SUSUMU, RL3720WT-R004-F |
| 27 | 1 | R1 | RES., CHIP, 82.5k, 0.1W, 1%, 0603 | VISHAY, CRCW060382K5FKEA |
| 28 | 1 | R2 | RES., CHIP, 100k, 0.1W, 1%, 0603 | VISHAY, CRCW0603100KFKEA |
| 29 | 2 | R4, R17 | RES., CHIP, 0Ω, 0.1W, 1%, 0603 | VISHAY, CRCW06030000Z0EA |
| 30 | 1 | R5 | RES., CHIP, 44.2k, 0.1W, 1%, 0603 | VISHAY, CRCW060344K2FKEA |
| 31 | 1 | R6 | RES., CHIP, 187k, 0.1W, 1%, 0603 | VISHAY, CRCW0603187KFKEA |
| 32 | 1 | R7 | RES., CHIP, 2.55k, 0.1W, 1%, 0603 | VISHAY, CRCW06032K55FKEA |
| 33 | 1 | R8 | RES., CHIP, 12.7k, 0.1W, 1%, 0603 | VISHAY, CRCW060312K7FKEA |
| 34 | 1 | R9 | RES., CHIP, 100k, 1/8W, 1%, 0805 | VISHAY, CRCW0805100KFKEA |
| 35 | 3 | R10, R11, R23 | RES., CHIP, 100Ω, 0.1W, 1%, 0603 | VISHAY, CRCW0603100RFKEA |
| 36 | 2 | R12, R13 | RES., CHIP, 124k, 1W, 1%, 2512 | VISHAY, CRCW2512124KFKEG |
| 37 | 1 | R15 | RES., CHIP, 1.5k, 0.1W, 5%, 0603 | VISHAY, CRCW06031K50JNEA |
| 38 | 1 | R16 | RES., CHIP, 56.2k, 0.1W, 1%, 0603 | VISHAY, CRCW060356K2FKEA |
| 39 | 1 | R18 | RES., CHIP, 100k, 0.1W, 5%, 0603 | VISHAY, CRCW0603100KJNEA |
| 40 | 1 | R19 | RES., CHIP, 59k, 0.1W, 1%, 0603 | VISHAY, CRCW060359K0FKEA |
| 41 | 1 | R20 | RES., CHIP, 196k, 0.1W, 1%, 0603 | VISHAY, CRCW0603196KFKEA |

DEMO MANUAL DC2306A

PARTS LIST

| ITEM | QTY | REFERENCE | PART DESCRIPTION | MANUFACTURER/PART NUMBER |
|------|-----|-----------|-------------------------------------|-------------------------------|
| 42 | 1 | R21 | RES., CHIP, 3.01k, 0.1W, 1%, 0603 | VISHAY, CRCW06033K01FKEA |
| 43 | 1 | R22 | RES., CHIP, 2k, 0.1W, 1%, 0603 | VISHAY, CRCW06032K00FKEA |
| 44 | 1 | R24 | RES., CHIP, 340Ω, 0.1W, 1%, 0603 | VISHAY, CRCW0603340RFKEA |
| 45 | 1 | R25 | RES., CHIP, 10k, 0.1W, 1%, 0603 | VISHAY, CRCW060310K0FKEA |
| 46 | 1 | R27 | RES., CHIP, 1.5M, 0.1W, 1%, 0603 | VISHAY, CRCW06031M50FKEA |
| 47 | 1 | R28 | RES., CHIP, 9.53k, 0.1W, 1%, 0603 | VISHAY, CRCW06039K53FKEA |
| 48 | 1 | R29 | RES., CHIP, 10k, 0.25W, 1%, 1206 | VISHAY, CRCW120610K0FKEA |
| 49 | 1 | T1 | TRANSFORMER | CHAMPS, P26R2-0322-18R0 |
| 50 | 1 | U1 | I.C., LT3753EFE#TRPBF, TSSOP-38(31) | LINEAR TECH., LT3753EFE#TRPBF |
| 51 | 1 | U2 | I.C., PS2801C-1-P-A | NEC, PS2801C-1-P-A |
| 52 | 1 | U3 | I.C. LT1431CS8, SO8 | LINEAR TECH., LT1431CS8#TRPBF |

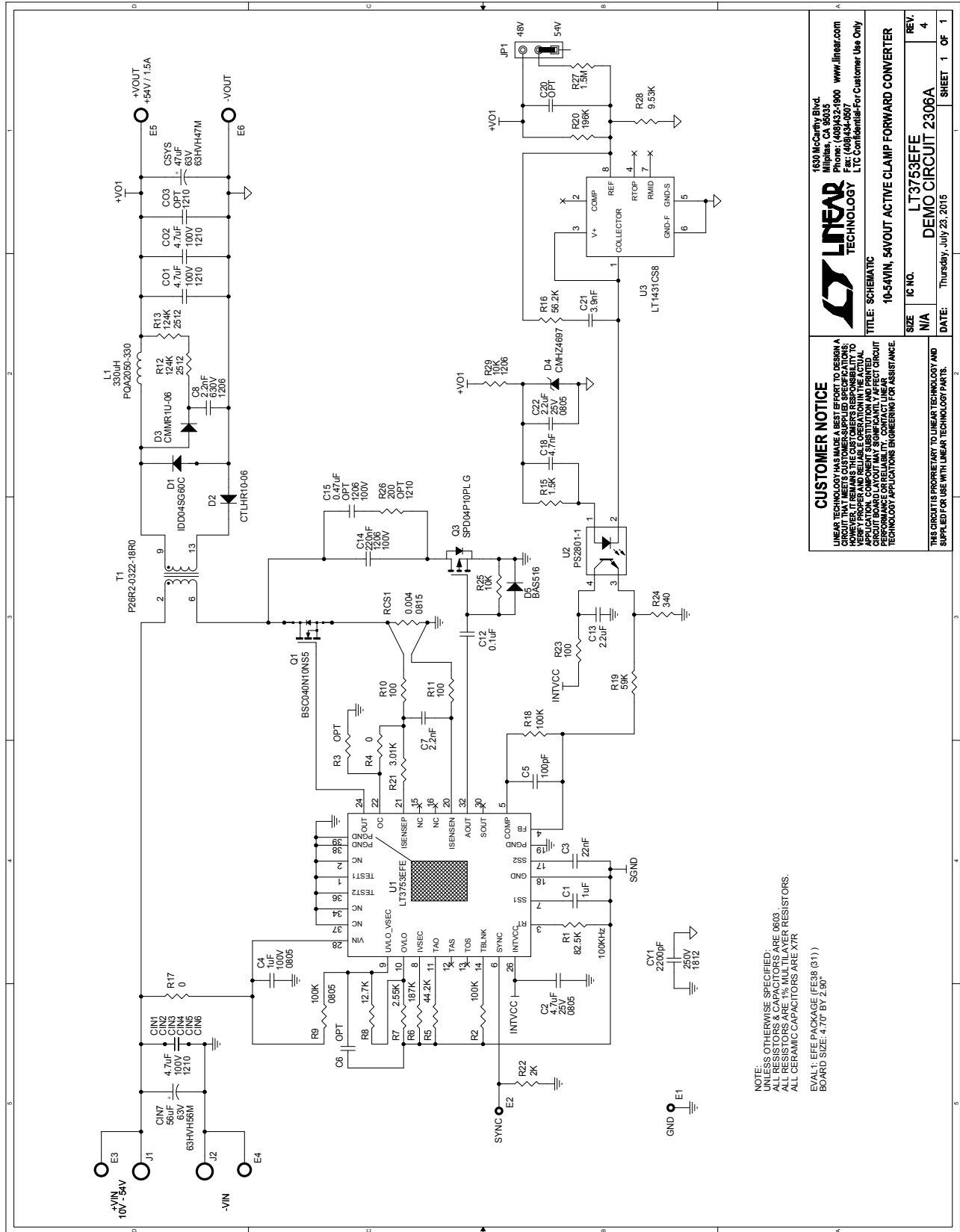
Additional Demo Board Circuit Components

| | | | | |
|---|---|-----------|------------------------------------|--|
| 1 | 0 | C03 (OPT) | CAP., 1210 | |
| 2 | 0 | C6 (OPT) | CAP., 0603 | |
| 3 | 0 | C15 (OPT) | CAP., X7R, 0.47μF, 100V, 10%, 1206 | |
| 4 | 0 | C20 (OPT) | CAP., 0603 | |
| 5 | 0 | R3 (OPT) | RES., 0603 | |
| 6 | 0 | R26 (OPT) | RES., CHIP, 200, 1/2W, 1%, 1210 | |

Hardware: For Demo Board Only

| | | | | |
|---|---|---------|------------------------------|-----------------------------------|
| 1 | 2 | E1, E2 | TESTPOINT, TURRET, .061" PBF | MILL-MAX, 2308-2-00-80-00-00-07-0 |
| 2 | 4 | E3-E6 | TESTPOINT, TURRET, .094" PBF | MILL-MAX, 2501-2-00-80-00-00-07-0 |
| 3 | 2 | J1, J2 | BANANA JACK | KEYSTONE, 575-4 |
| 4 | 1 | JP1 | CONN., HEADER, 1×3, 2mm | WURTH ELEKTRONIK, 620 003 111 21 |
| 5 | 1 | XJP1 | SHUNT, 2mm | WURTH ELEKTRONIK, 608 002 134 21 |
| 6 | 4 | MH1-MH4 | STAND-OFF, NYLON 0.25" | KEYSTONE, 8831(SNAP ON) |
| 7 | 1 | | FAB, PRINTED CIRCUIT BOARD | DEMO CIRCUIT 2306A |
| 8 | 2 | | STENCIL (TOP & BOTTOM) | STENCIL DC2306A |

SCHEMATIC DIAGRAM



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LT3753EFE
 DEMO CIRCUIT 2306A

10-54VIN, 54VOUT ACTIVE CLAMP FORWARD CONVERTER

| | | |
|-------------------------|--------------|------|
| SIZE | IC NO. | REV. |
| N/A | LT3753EFE | 4 |
| DATE: | SHEET 1 OF 1 | |
| Thursday, July 23, 2015 | | |

NOTE:
 UNLESS OTHERWISE SPECIFIED:
 ALL RESISTORS & CAPACITORS ARE 0603;
 ALL RESISTORS ARE 1% MULTILAYER RESISTORS.
 ALL CERAMIC CAPACITORS ARE X7R
 EVAL1: EPE PACKAGE (FE38 (31))
 BOARD SIZE: 4.70" BY 2.90"



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DEMO MANUAL DC2306A

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