

DESCRIPTION

Demonstration circuit 527 is a monolithic step-up / step-down DC/DC switching converter with Burst Mode™ featuring the LT3433. The board is optimized for 5V output at up to 400mA load current ($12V_{IN}$) and an input voltage range of 4V to 60V. With its wide input voltage range, 500mA internal power switches, 100 μ A quiescent current during Burst Mode, 200kHz switching frequency and thermally enhanced package, the LT3433 is a very versatile and powerful IC for DC/DC converters that require both step-up and step-down capability for $5V_{OUT}$ as well as compact space, high efficiency, low cost, and tolerance to high input voltage transients.

The LT3433 200kHz switching frequency allows all of the components to be small, surface mount devices. The current-mode control topology creates fast transient response and good loop stability with a minimum number of external components. The SHDN pin can be used

to program undervoltage lockout or place the part in micropower shutdown, reducing supply current to 10 μ A (25 μ A maximum) by driving the pin low. Burst Mode operation is jumper selectable for extremely low, light load quiescent current.

The LT3433 datasheet gives a complete description of the part, operation and applications information. The datasheet must be read in conjunction with this Quick Start Guide for demonstration circuit 527. The LT3433 is assembled in a small 16-pin thermally enhanced package with exposed pad. Proper board layout is essential for maximum thermal performance.

Design files for this circuit board are available. Call the LTC factory.

Burst Mode is a trademark of Linear Technology Corporation.

Table 1. Typical Performance Summary ($T_A = 25^\circ\text{C}$)

| PARAMETER | CONDITION | VALUE |
|----------------------------------|--|-----------------------|
| Input Voltage Range | | 4–60V |
| Zero Load Input Current | Burst Mode ON, $I_{OUT} = 0A$, $V_{IN} = 12V$ | 120 μ A |
| | Burst Mode OFF, $I_{OUT} = 0A$, $V_{IN} = 12V$ | 1.0mA |
| V_{OUT} | $V_{IN} = 4V$ to $60V$, $I_{SW(PK)} \leq 500mA$ | $5V \pm 3\%$ |
| Maximum Output Current | $V_{IN} = 4V$, $V_{OUT} = 5V$ | 125mA |
| | $V_{IN} = 12V$, $V_{OUT} = 5V$ | 400mA |
| | $V_{IN} = 48V$, $V_{OUT} = 5V$ | 340mA |
| Output Voltage Ripple | $V_{IN} = 4V$, $V_{OUT} = 5V$, $I_{OUT} = 125mA$ | 75mV _{PK-PK} |
| | $V_{IN} = 12V$, $V_{OUT} = 5V$, $I_{OUT} = 400mA$ | 25mV _{PK-PK} |
| | $V_{IN} = 48V$, $V_{OUT} = 5V$, $I_{OUT} = 340mA$ | 35mV _{PK-PK} |
| Light Load Output Voltage Ripple | $V_{IN} = 12V$, $V_{OUT} = 5V$, $I_{OUT} = 5mA$, Burst Mode ON | 18mV _{PK-PK} |
| | $V_{IN} = 12V$, $V_{OUT} = 5V$, $I_{OUT} = 5mA$, Burst Mode OFF | 7mV _{PK-PK} |
| Switching Frequency | $V_{IN} = 4V$ to $60V$, $V_{OUT} = 5V$ | 200kHz |
| Efficiency | $V_{IN} = 4V$, $I_{OUT} = 100mA$, $V_{OUT} = 5V$ | 58% |
| | $V_{IN} = 12V$, $I_{OUT} = 400mA$, $V_{OUT} = 5V$ | 80% |
| | $V_{IN} = 48V$, $I_{OUT} = 300mA$, $V_{OUT} = 5V$ | 71% |

QUICK START PROCEDURE

Demonstration circuit 527 is easy to set up to evaluate the performance of the LT3433. Refer to Figure 1 for proper measurement equipment setup and follow the procedure below:

NOTE: Make sure that the input voltage does not exceed 60V.

NOTE: The shutdown function is optional and its pin can be left floating (disconnected) if not being used.

NOTE: Do not hot-plug the input voltage terminal V_{IN} . The absolute maximum voltage on V_{IN} is 60V and hot-plugging a power supply through wire leads to the demonstration card can cause the voltage on the extremely low-ESR ceramic input capacitor to ring to twice its DC value. This is due to high currents instantaneously generated in the inductive supply leads from an input voltage step on the low-ESR ceramic input capacitor. A bulky higher-ESR capacitor, and an additional inductive filter can be added to the circuit to dampen hot-plug transient ringing. See *Application Note 88* for more details. A transient voltage suppressor diode may also be used to absorb transient overvoltage.

1. Connect the power supply (with power off), load, and meters as shown in Figure 1.
2. After all connections are made, turn on input power and verify that the output voltage is 5V.

NOTE: If the output voltage is too low, temporarily disconnect the load to make sure that the load is not set too high.

3. Once the proper output voltages are established, adjust the loads within the operating range and observe the output voltage regulation, ripple voltage, efficiency and other parameters.

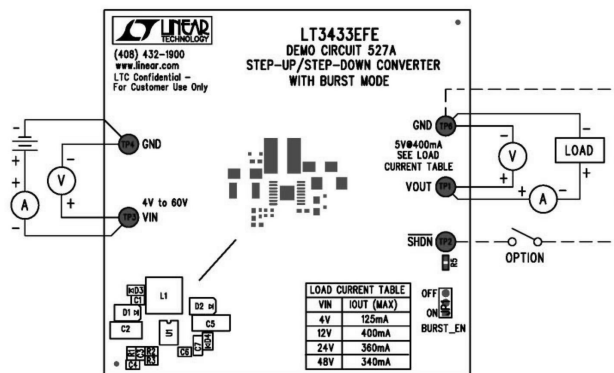


Figure 1. Proper Measurement Equipment Setup

CUSTOM OPTIONS

OUTPUT VOLTAGE

The components assembled on the board are optimized for a wide input voltage range and a 5V output. The feedback resistors (R2, R3) can be changed to adjust the output voltage according to the following equation:

$$V_{OUT} = 1.23 (1 + R2/R3)$$

COMPENSATION

Demonstration Circuit 527 has a frequency compensation network that is optimized for the tantalum output capacitor C5, the wide input voltage range 4V to 60V, and 5V output. Improved loop bandwidth can be achieved for various output voltages, output capacitors, and input voltage ranges by adjusting R1, C4, and C3. For more information, see the 'Frequency Compensation' section in the Application Note 19 or Application Note 76.

QUICK START GUIDE FOR DEMONSTRATION CIRCUIT 527

STEP-UP / STEP-DOWN CONVERTER WITH BURST MODE

SOFT START

The soft start capacitor C6 controls the peak switch current during startup by holding down the output of the error amplifier as it charges up. The soft start capacitor forces the peak switch current to start at zero. Output voltage overshoot can be reduced or eliminated using this capacitor. The time that it takes for the converter to reach maximum available current is

$$T_{SS} = 2.7 \cdot 10^5 \cdot C_{SS}$$

BURST MODE OPERATION

Jumper selectable Burst Mode operation provides the tradeoff of low quiescent current at light loads or low ripple voltage at light loads. Figure 2 demonstrates the increased efficiency using Burst Mode at light loads. As the load gets lighter and lighter the effect is increased. At zero load, the quiescent current of the IC is reduced to only 100µA with Burst Mode enabled. The effect of Burst Mode ripple current at light loads is shown in Figure 7. Extremely low, light load ripple voltage can be achieved by disabling Burst Mode.

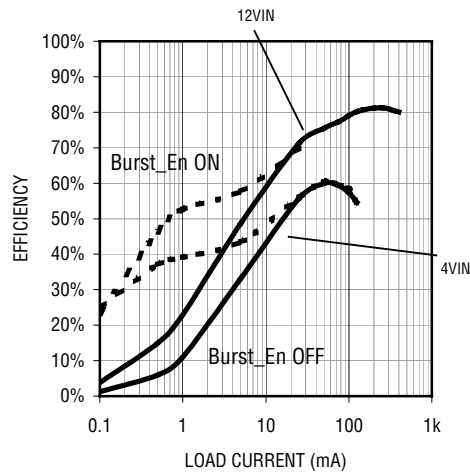


Figure 2. DC527 Typical Efficiency ($T_A = 25^\circ\text{C}$)

QUICK START GUIDE FOR DEMONSTRATION CIRCUIT 527

STEP-UP / STEP-DOWN CONVERTER WITH BURST MODE

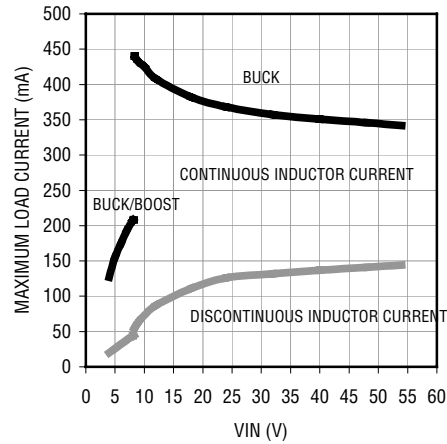


Figure 3. DC527 Maximum Load Current is Typically 400mA to 300mA in Buck Mode and 125mA to 200mA in Bridged Mode (Buck and Boost).

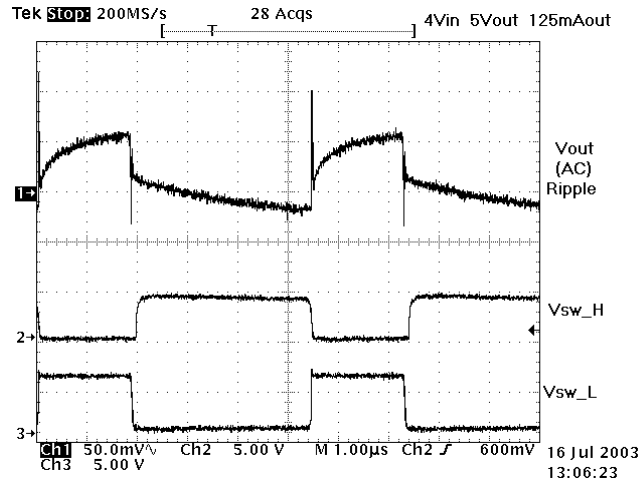


Figure 4. DC527 Output Voltage Ripple in Bridged Mode ($I_{OUT} = 125\text{mA}$, $V_{IN} = 4\text{V}$, $V_{OUT} = 5\text{V}$, $T_A = 25^\circ\text{C}$) CH1 is V_{OUT} ripple, CH2 is V_{SW_H} , CH3 is V_{SW_L}

QUICK START GUIDE FOR DEMONSTRATION CIRCUIT 527

STEP-UP / STEP-DOWN CONVERTER WITH BURST MODE

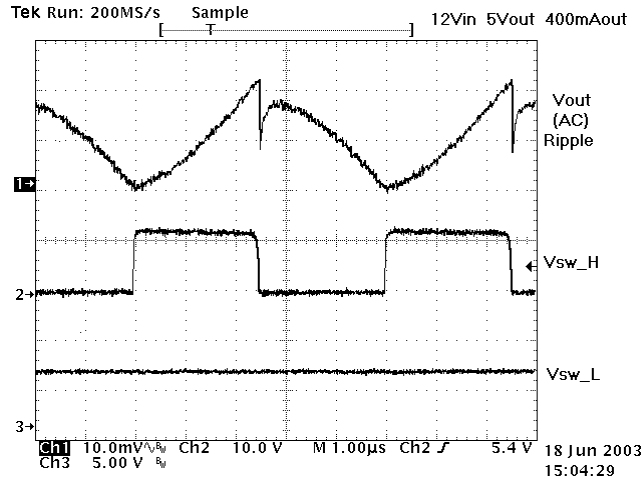


Figure 5. DC527 Output Voltage Ripple in Buck Mode ($I_{OUT} = 400\text{mA}$, $V_{IN} = 12\text{V}$, $V_{OUT} = 5\text{V}$, $T_A = 25^\circ\text{C}$) CH1 is V_{OUT} ripple, CH2 is V_{SW_H} , CH3 is V_{SW_L}

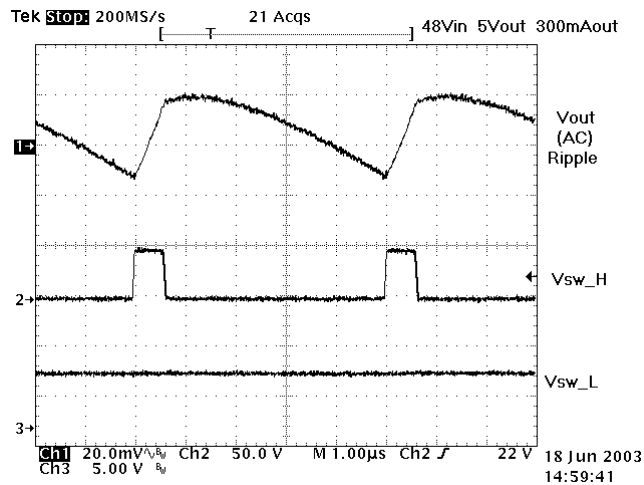


Figure 6. DC527 Output Voltage Ripple Buck Mode ($I_{OUT} = 300\text{mA}$, $V_{IN} = 48\text{V}$, $V_{OUT} = 5\text{V}$, $T_A = 25^\circ\text{C}$) CH1 is V_{OUT} ripple, CH2 is V_{SW_H} , CH3 is V_{SW_L}

QUICK START GUIDE FOR DEMONSTRATION CIRCUIT 527

STEP-UP / STEP-DOWN CONVERTER WITH BURST MODE

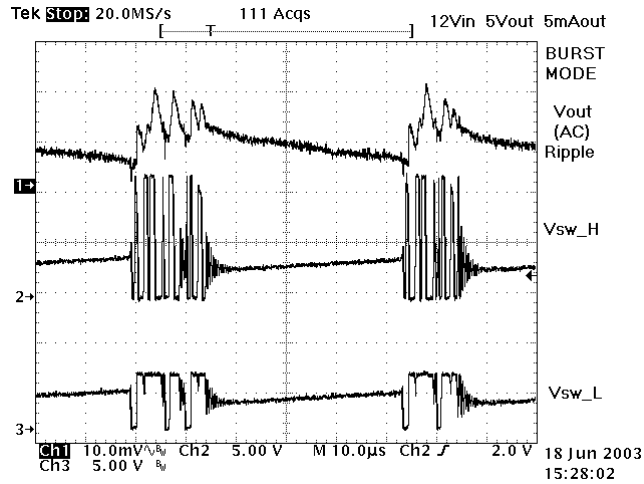


Figure 7. DC527 Output Voltage Ripple Burst Mode at Light Load with Burst Mode ($I_{OUT} = 5\text{mA}$, $V_{IN} = 12\text{V}$, $V_{OUT} = 5\text{V}$, $T_A = 25^\circ\text{C}$) CH1 is V_{OUT} ripple, CH2 is V_{SW_H} , CH3 is V_{SW_L}

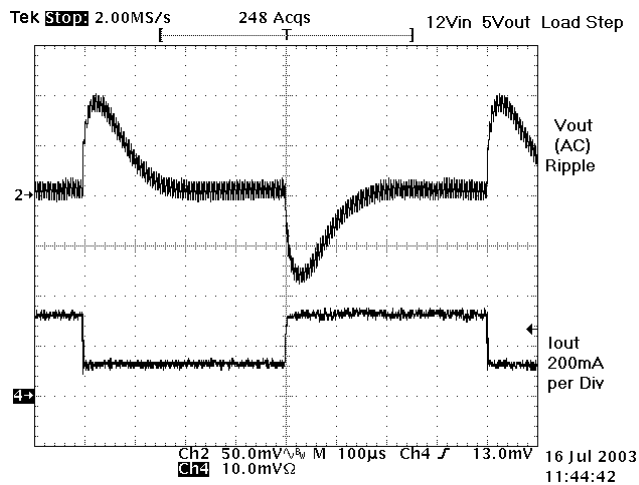


Figure 8. DC527 Step Load Response ($I_{OUT} = 100\text{mA}$ to 300mA , $V_{IN} = 12\text{V}$, $T_A = 25^\circ\text{C}$, $V_{OUT} = 5\text{V}$) CH2 is V_{OUT} ripple, CH4 is I_{OUT}

QUICK START GUIDE FOR DEMONSTRATION CIRCUIT 527

STEP-UP / STEP-DOWN CONVERTER WITH BURST MODE

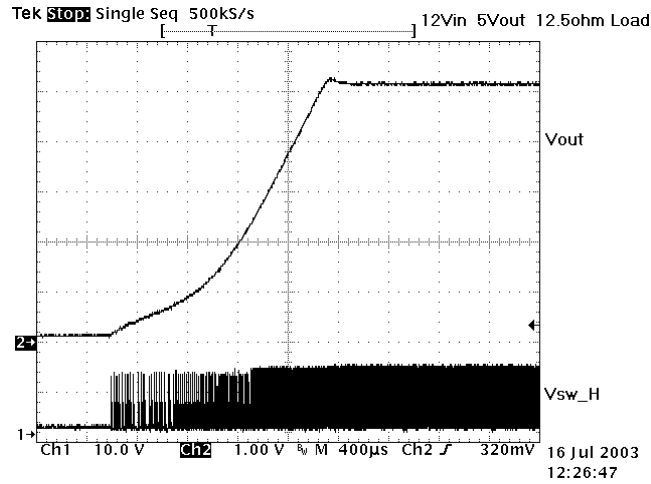
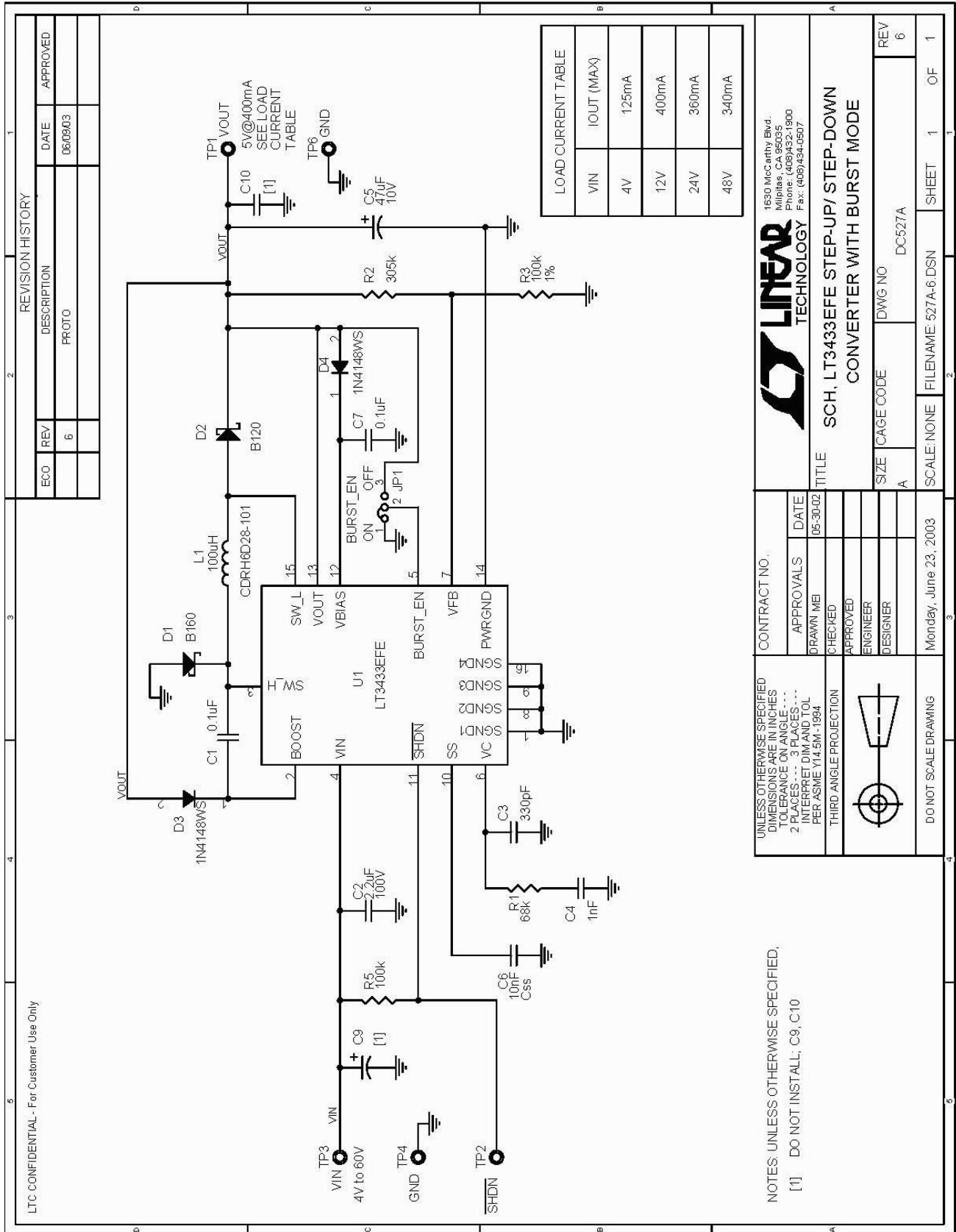


Figure 9. DC527 V_{OUT} Soft Start-Up with 10nF C_{SS} ($R_{LOAD} = 12.5\Omega$, $V_{IN} = 12V$, $T_A = 25^\circ C$) CH2 is V_{OUT} , CH1 is V_{SW_H}

QUICK START GUIDE FOR DEMONSTRATION CIRCUIT 527

STEP-UP / STEP-DOWN CONVERTER WITH BURST MODE



LINEAR TECHNOLOGY
 1630 McCarthy Blvd.
 Milpitas, CA 95035
 Phone: (408)432-1900
 Fax: (408)434-0507

SCH, LT3433EFE STEP-UP/STEP-DOWN CONVERTER WITH BURST MODE

CONTRACT NO. _____
 APPROVALS _____ DATE _____
 DRAWN MEI 05-30-02
 CHECKED _____
 APPROVED _____
 ENGINEER _____
 DESIGNER _____

UNLESS OTHERWISE SPECIFIED, DIMENSIONS ARE IN INCHES
 2 PLACES, 3 PLACES, ... INTERPRET DIM AND TOL PER ASME Y14.5M-1994

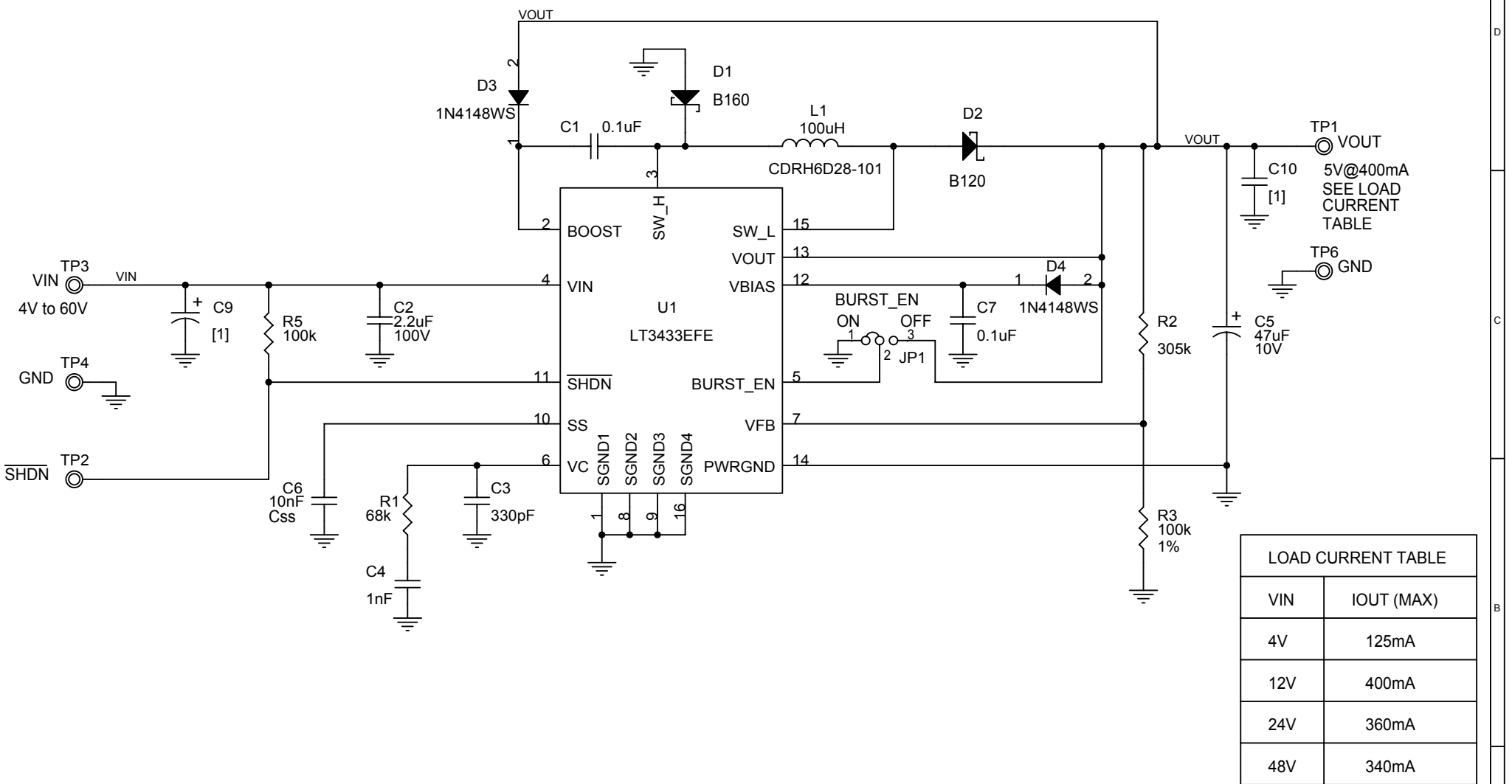
THIRD ANGLE PROJECTION

DO NOT SCALE DRAWING

SIZE (CAGE CODE) _____ DWG NO DC527A
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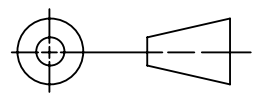
REV 6

| REVISION HISTORY | | | | |
|------------------|-----|-------------|----------|----------|
| ECO | REV | DESCRIPTION | DATE | APPROVED |
| | 6 | PROTO | 06/09/03 | |



NOTES: UNLESS OTHERWISE SPECIFIED,
 [1] DO NOT INSTALL; C9, C10

UNLESS OTHERWISE SPECIFIED
 DIMENSIONS ARE IN INCHES
 TOLERANCE ON ANGLE ---
 2 PLACES --- 3 PLACES ---
 INTERPRET DIM AND TOL
 PER ASME Y14.5M -1994



THIRD ANGLE PROJECTION

DO NOT SCALE DRAWING

| | |
|-----------------------|----------|
| CONTRACT NO. | |
| APPROVALS | DATE |
| DRAWN MEI | 05-30-02 |
| CHECKED | |
| APPROVED | |
| ENGINEER | |
| DESIGNER | |
| Monday, June 23, 2003 | |



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TITLE
**SCH, LT3433EFE STEP-UP/ STEP-DOWN
 CONVERTER WITH BURST MODE**

| | | | |
|-----------|-----------|------------------|----------|
| SIZE A | CAGE CODE | DWG NO DC527A | REV 6 |
|-----------|-----------|------------------|----------|

SCALE:NONE FILENAME:527A-6.DSN SHEET 1 OF 1

| <i>Item</i> | <i>Qty</i> | <i>Ref</i> | <i>Desc</i> | <i>Manufacturer / Part #</i> |
|-------------|------------|---------------------|--------------------------------|------------------------------|
| 1 | 1 | C1 | CAP, X7R 0.1uF 16V 10% 0603 | AVX 0603YC104KAT |
| 2 | 1 | C2 | CAP, X7R 2.2uF 100V 10% 1812 | TDK C4332X7R2A225K |
| 3 | 1 | C3 | CAP, NPO 330pF 50V 5% 0402 | AVX 04025C331JAT |
| 4 | 1 | C4 | CAP, X7R 1000pFuF 50V 10% 0603 | AVX 06035C102KAT |
| 5 | 1 | C5 | CAP, TANT 47uF 10V 20% 6032 | AVX TPSC476M010R0350 |
| 6 | 1 | C6 | CAP, X7R 0.01uF 100V 10% 0603 | AVX 06031C103KAT |
| 7 | 1 | C7 | CAP, X7R 0.1uF 16V 10% 0805 | AVX 0805YC104KAT1A |
| 8 | 0 | C9,C10 | DO NOT STUFF | OPTION |
| 9 | 1 | D1 | DIODE, B160 | DIODES INC. B160 |
| 10 | 1 | D2 | DIODE, B120 | DIODES INC. B120 |
| 11 | 2 | D4,D3 | DIODE, SWITCHING | DIODES INC. 1N4148WS |
| 12 | 1 | JP1 | HEADER, 3PIN, 2mm | COMM CON 2802S-03G2 |
| 13 | 1 | L1 | IND, 100uH | SUMIDA CDRH6D28-101 |
| 14 | 1 | R1 | RES, 68k OHMS 5% 1/16W 0603 | AAC CR16-683JM |
| 15 | 1 | R2 | RES, 305k OHMS 1% 1/16W 0402 | AAC CR05-3053FM |
| 16 | 1 | R3 | RES, 100k OHMS 1% 1/16W 0402 | AAC CR05-1003FM |
| 17 | 1 | R5 | RES, 100k OHMS 1% 1/16W 0603 | AAC CR16-1003FM |
| 18 | 0 | R6 | DO NOT STUFF | NONE |
| 19 | 5 | TP1,TP2,TP3,TP4,TP6 | TURRET | MILL-MAX-2501-2 |
| 20 | 1 | U1 | IC, LT3433EFE | LINEAR TECH LT3433EFE |
| 21 | 1 | JP1 | SHUNT, 2PIN, 2mm | COMM CON CCIJ2MM-138G |