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, 100µA 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 10µA (25µA 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.

Table 1. Typical Performance Summary (T_A = 25°C)

PARAMETER	CONDITION	VALUE
Input Voltage Range		4–60V
Zero Load Input Current	Burst Mode ON, I_{OUT} = 0A, V_{IN} = 12V	120µA
	Burst Mode OFF, I_{OUT} = 0A, V_{IN} = 12V	1.0mA
V_{OUT}	V_{IN} = 4V to 60V, $I_{SW(PK)} \le 500mA$	5V ± 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.

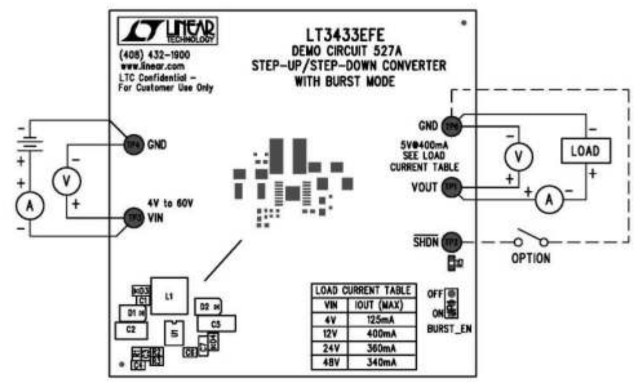


Figure 1. Proper Measurement Equipment Setup

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.

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

$T_{SS} = 2.7 * 10^5 * C_{SS}$

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.

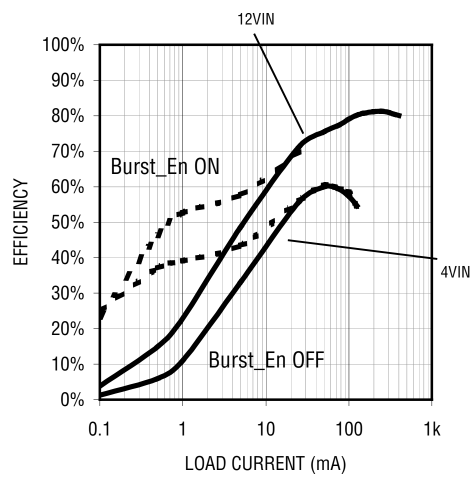


Figure 2. DC527 Typical Efficiency (T_A = 25°C)

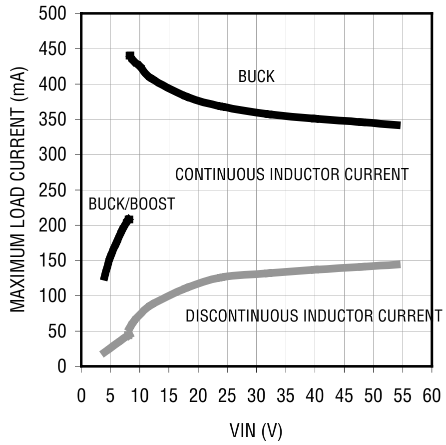


Figure 3. DC527 Maximum Load Current is Typically 400mA to 300mA in Buck Mode and 125mA to 200mA in Bridged Mode (Buck and Boost).

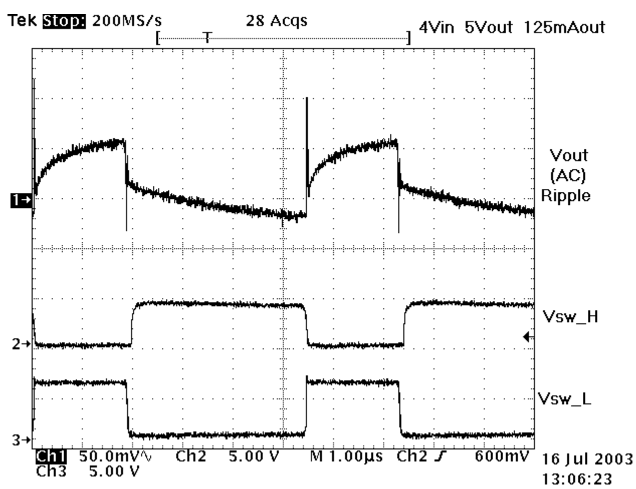


Figure 4. DC527 Output Voltage Ripple in Bridged Mode (I_{OUT} = 125mA, V_{IN} = 4V, V_{OUT} = 5V, T_A = 25°C) CH1 is V_{OUT} ripple, CH2 is V_{SW}_H, CH3 is V_{SW}_L

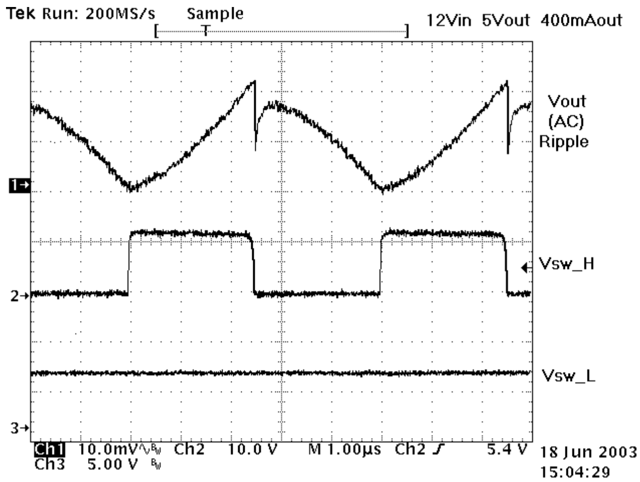


Figure 5. DC527 Output Voltage Ripple in Buck Mode (I_{OUT} = 400mA, V_{IN} = 12V, V_{OUT} = 5V, T_A = 25°C) CH1 is V_{OUT} ripple, CH2 is V_{SW}_H, CH3 is V_{SW}_L

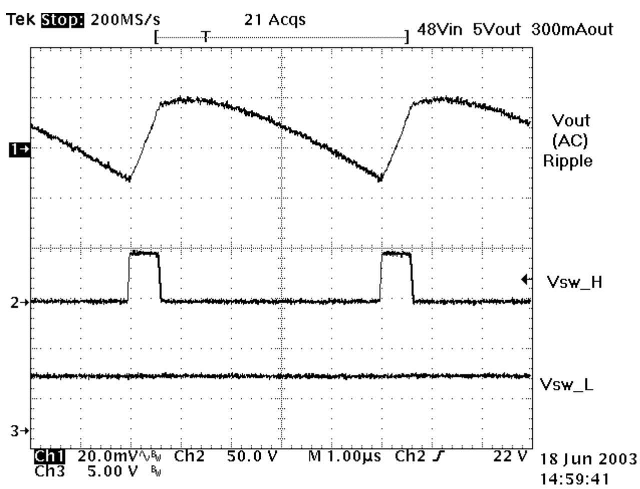


Figure 6. DC527 Output Voltage Ripple Buck Mode (I_{OUT} = 300mA, V_{IN} = 48V, V_{OUT} = 5V, T_A = 25°C) CH1 is V_{OUT} ripple, CH2 is V_{SW}_H, CH3 is V_{SW}_L

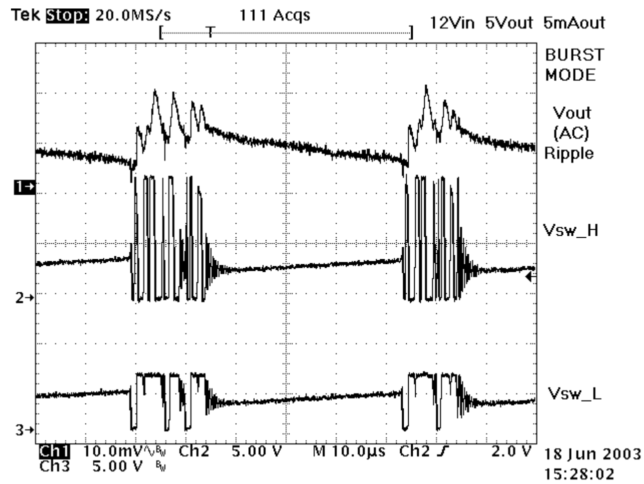


Figure 7. DC527 Output Voltage Ripple Burst Mode at Light Load with Burst Mode (I_{OUT} = 5mA, V_{IN} = 12V, V_{OUT} = 5V, T_A = 25°C) CH1 is V_{OUT} ripple, CH2 is V_{SW}_H, CH3 is V_{SW}_L

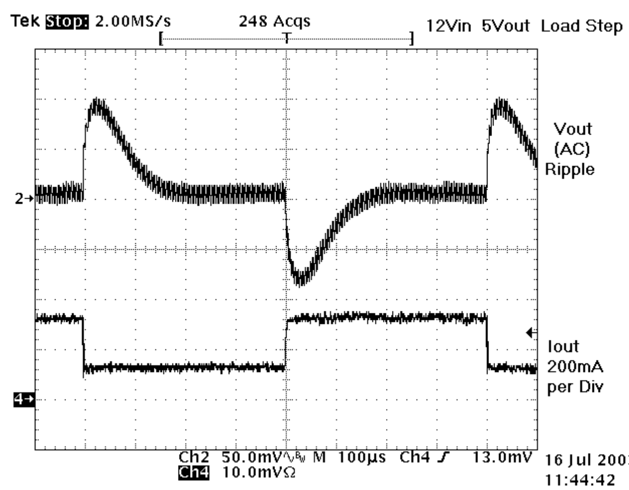


Figure 8. DC527 Step Load Response (I_{OUT} = 100mA to 300mA, V_{IN} = 12V, T_A = 25°C, V_{OUT} = 5V) CH2 is V_{OUT} ripple, CH4 is I_{OUT}

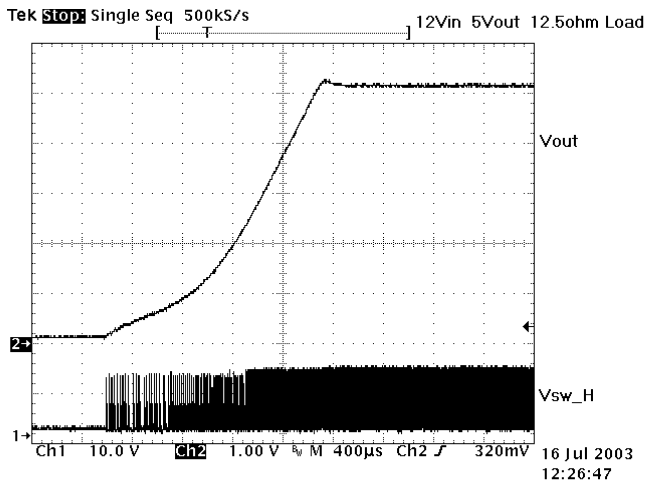
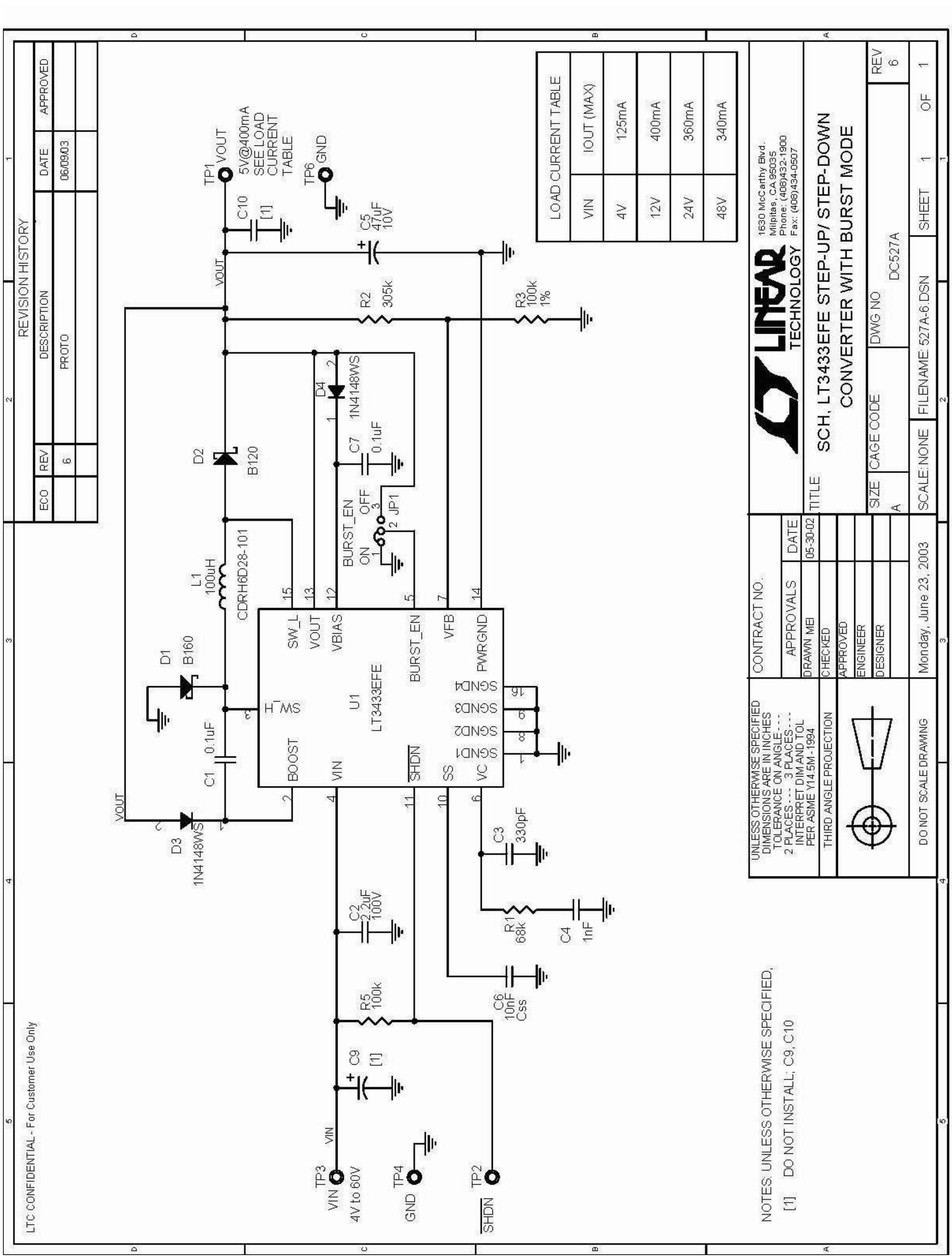


Figure 9. DC527 V_{OUT} Soft Start-Up with 10nF C_{SS} (R_{LOAD} = 12.5Ω, V_{IN} = 12V, T_A = 25°C) CH2 is V_{OUT}, CH1 is V_{SW}_H



REVISION HISTORY
ECO
REV
DESCRIPTION
DATE
APPROVED
6
PROTO
06/09/03
LOAD CURRENT TABLE
VIN
IOUT (MAX)
4V
125mA
12V
400mA
24V
360mA
48V
340mA
TP1
VOUT
5V@400mA
SEE LOAD
CURRENT
TABLE
TP6
GND
C10
[1]
C5
47uF
10V
R2
305k
R3
100k
1%
D4
1N4148WS
C7
0.1uF
D2
B120
BURST_EN
ON
OFF
JP1
L1
100uH
CDRH6D28-101
D1
B160
C1
0.1uF
D3
1N4148WS
U1
LT3433EFE
SW_L
VOUT
VBIAS
BURST_EN
VFB
PWRGND
SW_H
BOOST
VIN
SHDN
SS
VC
SGND1
SGND2
SGND3
SGND4
C3
330pF
R1
68k
C4
1nF
C2
2.2uF
100V
R5
100k
C6
10nF
Css
C9
[1]
TP3
VIN
4V to 60V
TP4
GND
TP2
SHDN
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NOTES: UNLESS OTHERWISE SPECIFIED,
[1] DO NOT INSTALL; C9, C10
1630 McCarthy Blvd.
Milpitas, CA 95035
Phone: (408)432-1900
Fax: (408)434-0507
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
CONTRACT NO.
APPROVALS
DATE
DRAWN MEI
05-30-02
CHECKED
APPROVED
ENGINEER
DESIGNER
UNLESS OTHERWISE SPECIFIED
DIMENSIONS ARE IN INCHES
THIRD ANGLE PROJECTION
DO NOT SCALE DRAWING
Monday, June 23, 2003

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REVISION HISTORY

ECO	REV	DESCRIPTION	DATE	APPROVED
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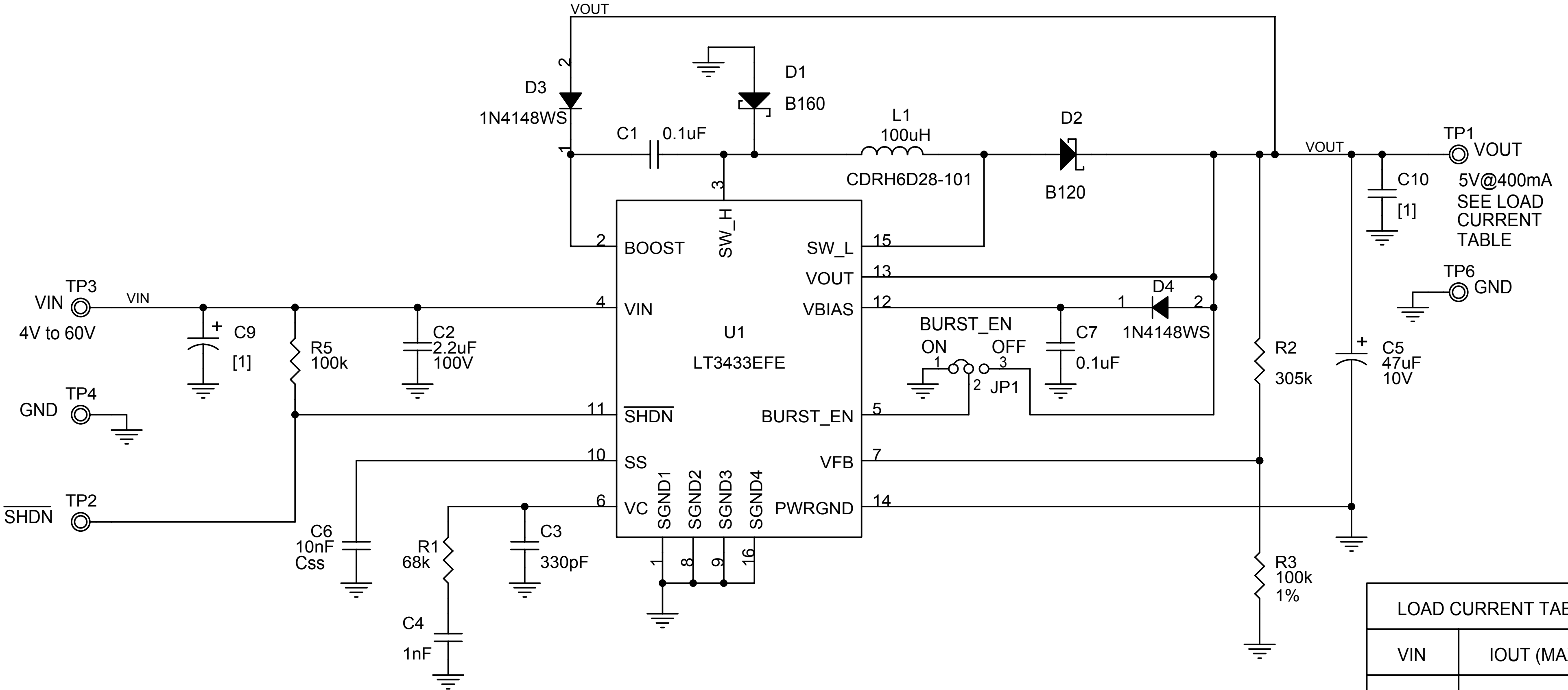

LOAD CURRENT TABLE	
VIN	IOUT (MAX)
4V	125mA
12V	400mA
24V	360mA
48V	340mA

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

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

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

SIZE	CAGE CODE	DWG NO	REV
A		DC527A	6

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

Item	Qty	Ref	Desc	Manufacturer / Part #
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