LTC1502-3.3
Single Cell to 3.3V Regulated Charge Pump DC/DC Converter

DESCRIPTION

Demonstration Circuit DC239 is a quadrupler charge pump DC/DC converter that produces a regulated 3.3V output from a single alkaline cell input. The circuit requires only five small external capacitors and no inductors. Low supply current (40µA typ) and minimal external component area make this power supply ideal for space and power conscious single-cell applications. The maximum output load is 10mA for input voltages greater than or equal to 1V. A jumper is available to put the circuit into shutdown mode, which reduces input quiescent current to 5µA (typ) and disconnects V_{OUT} from V_{IN}. **Gerber files for this circuit are available. Call the LTC factory.**

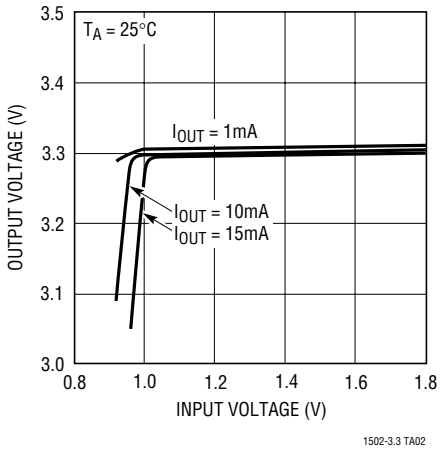
PERFORMANCE SUMMARY

Operating Temperature Range 0°C to 70°C

PARAMETER	CONDITIONS	MIN	TYP	MAX	UNITS
V_{IN} Operating Voltage		0.9		1.8	V
Minimum V_{IN} Start-Up Voltage	100kΩ V_{OUT} Load		0.75	0.9	V
V_{OUT}	$I_{OUT} \leq 10mA$, $1V \leq V_{IN} \leq 1.8V$	3.17	3.3	3.43	V
V_{IN} Operating Current	$I_{OUT} = 0mA$, $0.9V \leq V_{IN} \leq 1.8V$		40	90	µA
V_{IN} Shutdown Current	$C1^-/\overline{SHDN} = 0V$, $0.9V \leq V_{IN} \leq 1.8V$		5	15	µA
Output Ripple	$I_{OUT} = 10mA$, $V_{IN} = 1.25V$		50		mV_{P-P}
Efficiency	$V_{IN} = 1V$, $I_{OUT} = 10mA$		77		%

TYPICAL PERFORMANCE CHARACTERISTICS AND BOARD PHOTO

Output Voltage vs Input Voltage

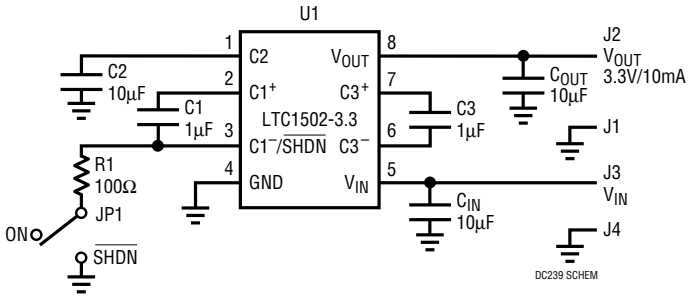


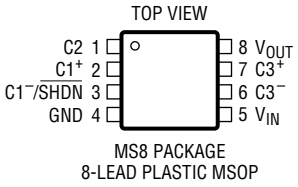
1502-3.3 TA02

Component Side

SCHEMATIC AND PACKAGE DIAGRAMS

Demo Board Schematic





MS8 PACKAGE
8-LEAD PLASTIC MSOP

LTC1502CMS8-3.3

PARTS LIST

REFERENCE DESIGNATOR	QUANTITY	PART NUMBER	DESCRIPTION	VENDOR	TELEPHONE
C1, C3	2	0603ZG105ZAT1A	1µF 10V Y5V Capacitor	AVX	(843) 946-0362
C2, C_{OUT}, C_{IN}	3	1206ZG106ZAT1A	10µF 10V Y5V Capacitor	AVX	(843) 946-0362
JP1	1	2802S-03G2	3-Pin, 2mm Jumper	Comm Con	(626) 301-4200
J1, J2, J3, J4	4	2501-2	0.090 Turret Testpoint	Mill-Max	(516) 922-6000
R1	1	CR16-101JM	100Ω 1/16W 5% Chip Resistor	TAD	(800) 508-1521
U1	1	LTC1502CMS8-3.3	MSOP Step-Up DC/DC IC	LTC	(408) 432-1900
	1	CCIJ2mm-138-G	2-Pin 2mm Shunt	Comm Con	(626) 301-4200

OPERATION

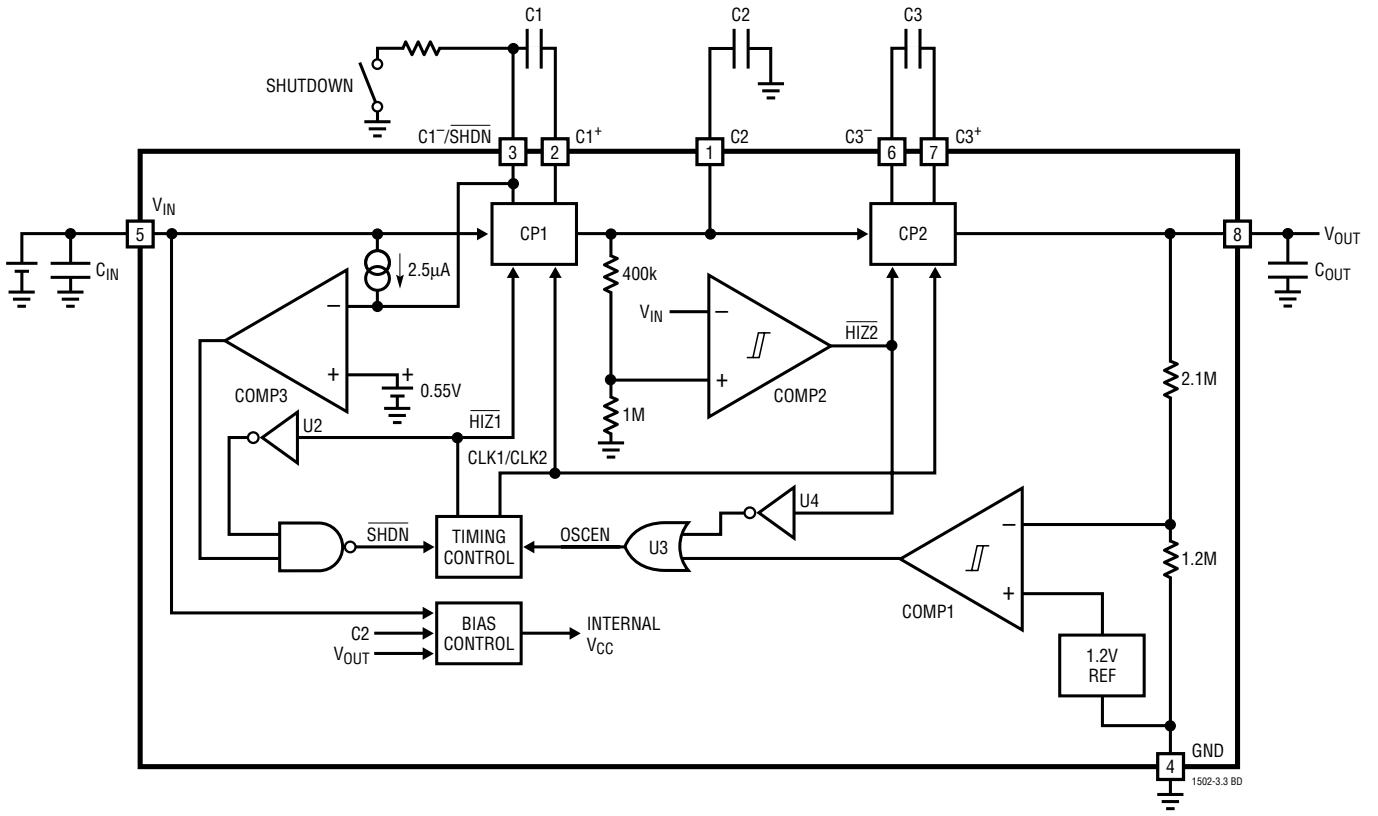
The LTC1502-3.3 uses a switched capacitor quadrupler charge pump to produce a boosted output voltage. The quadrupler charge pump consists of two voltage doubler charge pumps (CP1 and CP2 on the Block Diagram) cascaded in series. CP1 doubles the input voltage V_{IN}, and the CP1 output voltage is stored on external capacitor C2. The C2 pin also serves as the input for doubler CP2, whose output is stored on the output capacitor C_{OUT}. Each doubler is controlled by a 2-phase clock that is generated in the timing-control circuit. On phase one of the clock, the flying capacitors C1 and C3 are charged to their respective input voltages. On phase two, each charged flying capacitor is stacked on top of the input voltage and discharged through an internal switch onto its respective output. This sequence of charging and discharging the flying capacitors (CP1 and CP2) continues at the free running oscillator frequency (500kHz typ) until the output is in regulation. Regulation is achieved by comparing the divided output voltage to a fixed voltage reference. The charge pump clocks are disabled when the output voltage is above the desired regulation point set by COMP1. When the output has dropped below the lower trip point of COMP1, the charge pump clocks are turned back on until V_{OUT} is boosted back into regulation.

Enhanced Start-Up

Enhanced start-up capability is provided by the COMP2 circuitry. COMP2 compares the divided C2 voltage to the input voltage, V_{IN}. The COMP2 output disables the output charge pump, CP2, whenever the divided C2 voltage is lower than V_{IN}. The CP2 output is thereby forced into a high impedance state until the voltage on C2 has been raised above V_{IN} (the C2 pin should not be loaded for proper start-up). This allows a higher internal gate drive voltage to be generated (from the C2 pin) before the part's output (V_{OUT}) is connected to a load. Hysteresis in COMP2 forces CP2 to be turned ON and OFF while C_{OUT} is charged

OPERATION

LTC1502-3.3 Block Diagram



to prevent a lock-up condition if C2 droops too low during start-up. By the time the output nears the regulation point, the C2 voltage is well above the lower trip point of COMP2 and CP2 will remain enabled. This method of disabling the output charge pump while an internal boosted gate drive supply is developed allows the part to start up at low voltages with a larger output current load than would otherwise be possible.

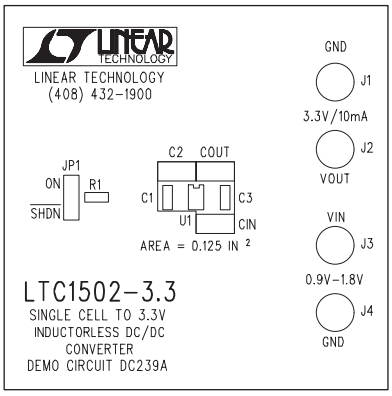
Shutdown

Shutdown is implemented using an external pull-down device on the C1⁻/$\overline{\text{SHDN}}$ pin. The demo circuit provides a jumper that selects either the ON or $\overline{\text{SHDN}}$ state. In the ON state, the 100Ω external pull-down resistor is left floating. In the $\overline{\text{SHDN}}$ state, the resistor is shorted to ground through the jumper. The center pin of the jumper can be driven with an external, open-drain device to test the AC start-up and shutdown characteristics. The shutdown feature can be used to prevent charge pump switching during noise sensitive intervals. The LTC1502-3.3 takes between 20µs and 50µs to switch from shutdown to active mode once the pull-down device has been turned off. During shutdown, V_{OUT} is disconnected from V_{IN}.

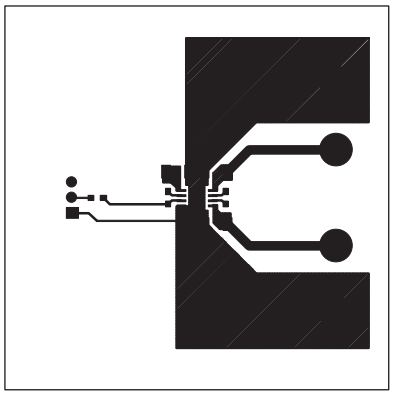
Short-Circuit Protection

When the output pin is shorted to ground, the LTC1502-3.3 will continuously charge the C2 capacitor to approximately 1.4 times V_{IN} and then discharge C2 into the shorted output. Since the discharging of C2 into V_{OUT} will bring the C2 voltage below the COMP2 start-up trip voltage, the output charge pump will be forced Hi-Z while C2 charges again. Hence, the internal charge pump gate drive voltage is limited to 1.4 • $V_{IN(MAX)}$ (on the C2 pin), and no continuous current is supplied to V_{OUT}. The resulting output short-circuit current is limited to under 30mA (typ), thereby allowing the LTC1502-3.3 to endure an indefinite output short circuit without damage. When the short is removed, the part will start up and operate normally.

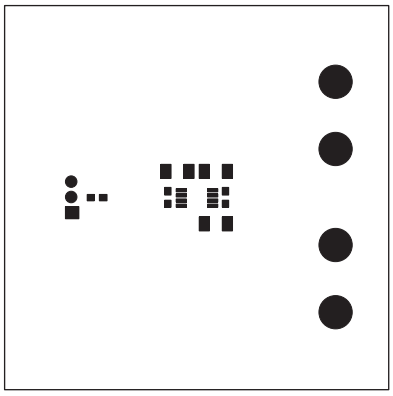
PCB LAYOUT AND FILM



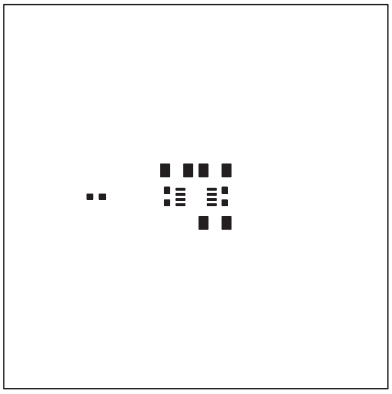
Component Side Silkscreen



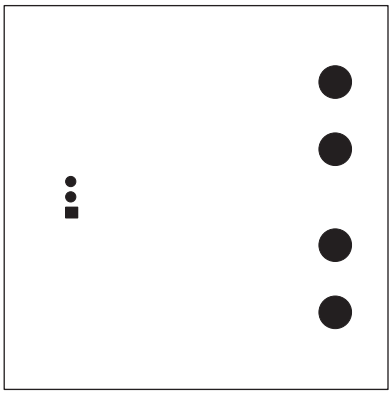
Copper Layer 1 (Top)



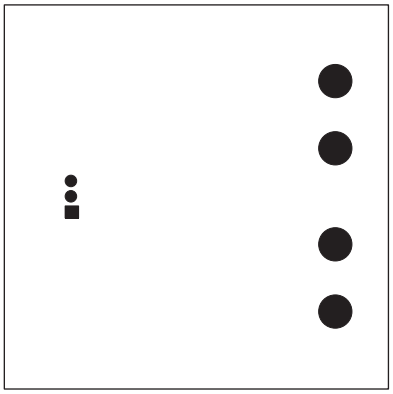
Component Side Solder Mask



Component Side Paste Mask

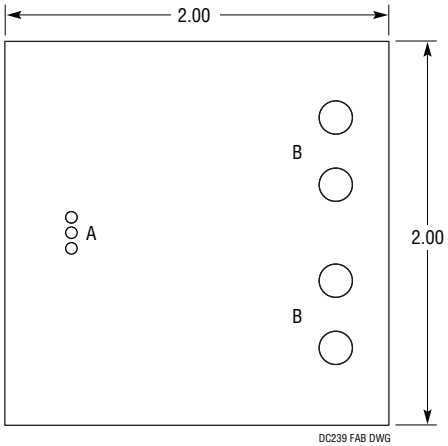


Copper Layer 2



Solder Side Solder Mask

PC FAB DRAWING



NOTES: UNLESS OTHERWISE SPECIFIED
1. ALL DIMENSIONS ARE IN INCHES
2. FINISHED MATERIAL IS FR4, 0.062 THICK 2 OZ COPPER, 2 LAYERS. PLATED HOLE WALL THICKNESS 0.001 MIN
3. PROCESS: SMOBC

SYMBOL	DIAMETER	NUMBER OF HOLES	PLTD
A	0.030	3	PLTD
B	0.094	4	PLTD
	TOTAL HOLES	7	

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