Demo Board DC323 Quick Start Guide

LTC1751-3.3/5/Adjustable 3.3V, 5V and Adjustable Micropower Charge Pump

DESCRIPTION

The DC323A demonstrates the small size, low power, ease of use and appropriate layout techniques for the LTC1751-X regulated charge pump. The LTC1751-X can be used wherever step-up voltage conversion is needed in a relatively tight space. The LTC1751-3.3 converts input voltages of 2.0V to 4.4V to a regulated voltage of 3.3V ±4% at up to 80mA. The LTC1751-5 converts input voltages of 2.7V to 5.5V to a regulated voltage of 5.0V ±4% at up to 100mA. The adjustable LTC1751 can be programmed to deliver voltages up to twice the available input voltage.

OPERATION

LTC1751-X Operation

The LTC1751-X is a family of regulated micropower voltage doubling charge pump DC/DC converters. The charge pump requires one flying capacitor for the doubling operation, a charge storage capacitor on the output and an input bypass capacitor. The LTC1751-5 can develop up to 100mA (500mW) from an input supply as low as 3V and the LTC1751-3.3 can develop 80mA from a 2.5V input. Extremely low operating current (20µA typical) and a low external parts count (one flying capacitor and two small bypass capacitors) make it ideally suited for small, battery-powered applications. The LTC1751-5 operates as a Burst Mode™ switched capacitor voltage doubler to ensure that the power supply current is extremely low when there is no load present. Burst Mode operation optimizes efficiency by disabling the charge pump whenever the output voltage is in regulation. All LTC1751-X devices have thermal shutdown capability and can survive a continuous short circuit from V_{OUT} to GND. The LTC1751-3.3 and LTC1751-5 have a PGOOD pin that indicates when the output voltage has reached its final value. This pin is useful for signaling to a microcontroller that a peripheral device has been fully powered and is available for use. PGOOD also indicates if the output has an undervoltage fault condition. The adjustable LTC1751 has an FB pin rather than a PGOOD pin and can be programmed to deliver an arbitrary output voltage (up to $2 \times V_{IN}$) or current. An optional soft-start capacitor may be used at the SS pin to prevent excessive current during start-up. Finally, the /SHDN pin can be used to disable the output or provide PWM level control of the average output voltage. In shutdown, the supply current drops to below 1µA. The LTC1751 family is available in an 8-pin MSOP package.

PARTS LIST

Reference Designator	Quantity	Description	Part Number	Vendor	Phone Number
C4	1	1000pF, 50V, NPO Chip Capacitor	06035A102JAT (0603)	AVX	(843) 946-0362
C3	1	1µF, 10V, X7R Chip Capacitor	LMK212BJ105MG (0805)	Taiyo Yuden	(408) 573-4150
C1, C2	2	10uF, 6.3V, X5R Chip Capacitor	JMK316BJ106ML (1206)	Taiyo Yuden	(408) 573-4150
E1–E7	7	Testpoint Turret	2501-2	Mill-Max	(516) 922-6000
JP1	1	0.079" Single-Row Header	2802S-03-G1	Comm Con	
JP1	1	0.079" Center Shunt	CCIJ2MM-138G	Comm Con	
R3 (Assy. A)	1	100k, 1/16W, 1% Chip Resistor	CR16-1003FM (0603)	AAC	(800) 528-1521
(Assy. B)	1	100k, 1/16W, 1% Chip Resistor	CR16-1003FM (0603)	AAC	(800) 528-1521
(Assy. C)	1	232k, 1/16W, 1% Chip Resistor	CR16-2323FM (0603)	AAC	(800) 528-1521
R1	0	Optional			
R2 (Assy. A)	0	(Open)			
(Assy. B)	0	(Open)			

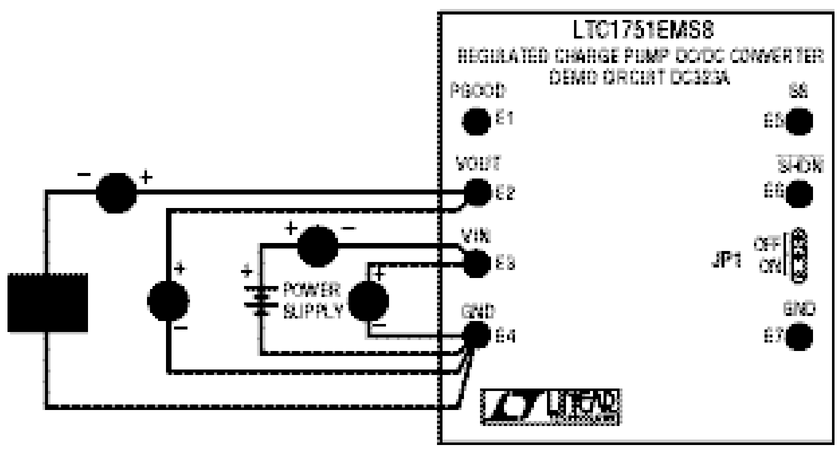
(Assy. C)	1	100k, 1/16W, 1% Chip Resistor	CR16-1003FM (0603)		AAC	(800) 528-1521
				Top Mark		
U1 (Assy. A)	1	5V Charge Pump Doubler IC	LTC1751EMS8-5	LTKP	Linear Technology	(408) 432-1900
(Assy. B)	1	3.3V Charge Pump Doubler IC	LTC1751EMS8-3.3	LTKN	Linear Technology	(408) 432-1900
(Assy. C)	1	Adjustable Charge Pump Doubler IC	LTC1751EMS8	LTKL	Linear Technology	(408) 432-1900

Hook-Up

Solid turret terminals are provided for easy connection to power supplies and test equipment. All necessary components and bypassing are included on-board. See Figure 1 for correct test and measurement equipment hook-up.

To begin evaluation of the LTC1751-X, connect an input supply from V_{IN} to GND (2V–4.4V for the LTC1751-3.3, 2.7V–5.5V for the LTC1751-5). Connect a load (resistor, test circuit or nothing) from V_{OUT} to GND. Set jumper JP1 to the RUN position. For best load-regulation performance, be sure to connect the measurement instrument directly to the DC323A demonstration board V_{OUT} and GND terminals. Series resistance between the V_{OUT} and GND terminals and the measurement device will add directly to the output resistance measurement.

For output ripple measurements an oscilloscope "tip-let" can be soldered directly between the V_{OUT} and GND terminals (they are adjacent). Due to fast switching edges in the LTC1751-X, an oscilloscope probe with a separate ground lead is not recommended since it may display ringing due to the probe's ground lead-inductance.



Shutdown

The LTC1751-X provides a shutdown feature for applications where operation is not required at all times. When the $\overline{SHDN}$ input is at or above V_{IH} (see data sheet), the LTC1751-X will be enabled and will provide power to the V_{OUT} pin. When $\overline{SHDN}$ is below V_{IL} (see data sheet) the LTC1751-X will be in shutdown and will disconnect V_{IN}

Figure 1. DC323 Test and Measurement Setup

from the load. Jumper JP1 connects the SHDN pin to V_{IN} or GND to quickly enable or disable the LTC1751-X. To evaluate the turn-on/turn-off characteristics of the LTC1751-X, a separate turret pin is provided for the $\overline{\text{SHDN}}$ pin. To use this input, first remove jumper JP1 completely from the board. When JP1 is removed, the $\overline{\text{SHDN}}$ connection becomes a high impedance and may be connected to any suitable signal source or function generator.

PGOOD (LTC1751-3.3 and LTC1751-5 only)

The PGOOD pin can be used to determine when the output has reached its final value and also indicates when a fault has occurred. The PGOOD pin is an open drain output that can be pulled up to any appropriate reference level (within the specified absolute maximum value). DC323-A and DC323-B come with a 100kΩ resistor that will pull PGOOD up to the output voltage installed in location R3. If desired, R3 can be removed and a pull-up resistor can placed in location R1 to pull PGOOD up to V_{IN}.

FB (Adjustable LTC1751)

On the adjustable LTC1751, pin 1 is used as the feedback pin rather than the PGOOD pin. The output voltage of the LTC1751 can be programmed by installing resistors in locations R2 and R3. The output voltage is programmed by the expression:

$$\frac{R3}{R2} = \frac{V_{OUT}}{1.205V} - 1$$

Alternatively, the LTC1751 can be programmed for a given current by replacing R3 with the desired load. The output current is then determined by the expression:

$$I_{OUT} = \frac{1.205V}{R2}$$

Soft-Start

The SS pin is used to control the ramp rate of the output voltage. By controlling the ramp rate of the output voltage at start-up, the inrush current can be minimized, thereby preventing significant loading and droop of the input voltage. The amount of input current that will be pulled at start-up is dependent upon the output capacitor and SS capacitor, as shown in the expression:

$$I_{IN} \approx \frac{C_{OUT}}{C_{SS}} \bullet \frac{V_{OUT}}{375K\Omega}$$

where V_{OUT} is the final regulation voltage of the LTC1751-3.3, LTC1751-5 or LTC1751.

PC Board Layout

Due to the switching nature of the charge pump inside the LTC1751, careful board layout is necessary. The DC323A demonstrates tight capacitor placement near the LTC1751 and a ground plane under the active part of the circuit.

COMPONENTS

Input and Output Capacitors

The capacitors on the V_{IN} and V_{OUT} nodes are 10µF, X5R style ceramic capacitors. Ceramic capacitors are generally recommended for charge pump applications because of their very low equivalent series resistance (ESR). When the charge pump is operating, the flying capacitor is connected by the internal switches from the input supply to ground ($Ø_1$) or stretched between the input pin and the output pin ($Ø_2$). In either mode large currents can flow due to the low impedances in the circuit. If either the input or output capacitor has considerable ESR, IR steps or "spikes" may result that can interfere with the regulation loop properties. Furthermore, some heating of the dielectric can occur in higher ESR capacitors such as aluminum or tantalum. In those cases the ripple current of the capacitor should be carefully considered.

Note that Y5V style capacitors typically lose considerable capacitance at temperatures much above or below room temperature. To maintain optimal regulation performance X5R or X7R style capacitor are recommended on the V_{OUT} node.

Flying Capacitor

The flying capacitor is a 1µF X7R style ceramic capacitor. X7R material was chosen for the flying capacitor because it maintains much of its capacitance over voltage and temperature variations. Thus the total available strength of the charge pump will not be affected by the flying capacitor.

For applications requiring lighter load current than specified, a smaller flying capacitor may be employed.

Warning: *The flying capacitor should never be a polarized type such as tantalum or aluminum since its voltage can reverse at start-up.*