QUICK START GUIDE FOR DEMONSTRATION CIRCUIT 735
LITHIUM-ION LINEAR BATTERY CHARGER WITH LDO REGULATOR
LTC4063EDD

DESCRIPTION

Demonstration circuit 735 is a complete constant-current, constant-voltage battery charger for one Lithium-Ion cell and includes a 3 Volt low dropout linear regulator. The LTC®4063EDD used on this demo circuit features an internal P-channel power MOSFET with a unique thermal feedback loop that reduces the output current under high ambient temperature and/or high power dissipation conditions. This feature allows the charger to provide higher charge currents under normal conditions and still provide safe charging under abnormal conditions such as high ambient temperature, high input voltage or low battery voltage.

Jumpers on the board allow charge currents from 250mA to 1A to be programmed and several charge termination methods to be used. Terminals are provided for shutting down the charger and/or the linear regulator, monitoring charge current and programming the minimum charge current level for termination (I_{DETECT}). An LED indicates when the charge current has dropped below the minimum charge current termination level.

The IC is available in a 10-pin (3X3) DFN thermally enhanced package featuring an exposed bottom-side metal pad for soldering to the pc board.

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

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

Input Voltage Range V_{IN}	4.3 to 8V (upper range limited by PC board dissipation)
Input Undervoltage Lockout	3.8V
Output Float Voltage V_{BAT} (constant voltage mode)	4.2V ±0.5%
Output Current I_{BAT} (constant current mode)	1 A, 0.5A, 0.25A ± 8% •••••••(selected by jumpers)
Current Monitor Output	1V ±5% @ Full Current
Charge Termination Timer	3 Hours ±10%
Charge Termination Threshold Current (I_{DETECT})	50mA, 25mA ± 10%
Low Dropout Regulator Output Voltage	3.00V ±5%
Low Dropout Regulator Rated Output Current	100mA
Input Voltage Range VIN	4.3 to 8V (upper range limited by PC board dissipation)
Input Undervoltage Lockout	3.8V

OPERATION

DC735 allows three methods of charge termination which are selected using jumper JP2. In the upper "Timer" position, the charge cycle terminates at the end of the timer period as set by capacitor C2. The 3 hour timer is sufficient time to fully charge a depleted battery when charging at a current level of C/2 to 1C.

The lower "Iterm" position selects minimum charge current termination (I_{DETECT}). This method terminates the charge cycle when the charge current drops to a programmed threshold level after the battery has reached the constant voltage portion of the charge cycle. Placing the jumper (JP3) in the middle position defeats the on board termination thus allowing external user termination.

The charge current and the termination current are selected using a combination of jumpers JP4 and JP5. (See table 2)

Table 2. Jumper Positions for Charge Current and Termination Current.

ICHG Select (JP5)	Charge Current / Termination Current	
	Iterm Select (JP4)	
	C/10	Fixed 50mA
HIGH	500mA / 50mA	1A / 50mA
LOW	250mA / 25mA	500mA / 50mA

The 3 Volt LDO Regulator is powered from the battery and requires approximately 2.6V to become active, although the output will not be regulated until the battery exceeds 3V.

The CHRG LED always indicates the presence of charge current that is greater than the I_{DETECT} current level that is selected by the Iterm jumper (JP4). The LED is on for charge current greater than Iterm, regardless of the termination method used as set by jumper JP2.

When minimum charge current termination (I_{DETECT}) is used, the charge cycle ends when the Charge current drops below the I_{DETECT} level. The CHRG LED also goes off.

NOTE: The current monitor terminal can be used to indicate charge current level at all times during the charge cycle with 1 Volt indicating 100% of the programmed current level. This terminal can also be used to program other charge currents by removing jumper JP5 and connecting an external programming resistor from the current monitor pin to ground. See data sheet for details.

The charger can be evaluated using an actual Lithium Ion battery or a battery simulator. The battery simulator is faster because all battery state-of-charge conditions can be quickly simulated.

QUICK START PROCEDURE

A battery simulator consists of an adjustable power supply with a load resistor across the power supply output. The resistor value is selected that will provide approximately 1A when the power supply is set for 2.5V and the power supply must provide at least 1.7A when adjusted for 4.2V. For this battery simulator, a 2.5 Ohm, 10 Watt power resistor connected to the output of a 5V, 2A bench supply will work fine. The power supply can now sink and source current, similar to a battery, and by changing the power supply output voltage, any battery state-of-charge condition can be quickly simulated.

Begin circuit evaluation by moving the jumpers to the appropriate positions. JP1 and JP3 should be in the ON position. Move the Termination Method jumper (JP2) to the Iterm (lower) position to select minimum charge current termination. Move jumper JP4 to the 50mA (lower) position and JP5 to the HIGH (upper) position. The charger is now set to charge at 1A and use minimum charge current (Iterm = 50mA) for charge termination.

With the input power supply and battery simulator power supply adjusted to 0V, connect the input power supply output to the Vin and GND, and the battery simulator power supply output to the BAT and GND terminals as shown in Figure 1. An ammeter or 100mΩ current sense resistor can be placed between the BAT terminal and the positive terminal of the battery simulator to measure charge current. Connect a 4½ digit DVM to the BAT and GND terminals to measure battery voltage and another DVM to the LDOout and GND terminals to measure the regulator output voltage.

Begin increasing the input supply voltage, up to 5V. At approximately 3.8V (the undervoltage lockout threshold), the CHRG LED will turn on and the preconditioning trickle charge of 100mA will begin flowing. Adjust the battery simulator power supply to 3V. At approximately 2.9V, the charge current will abruptly increase to the programmed constant current of 1A. Also, when the battery simulator supply exceeds approximately 2.5V, the LDO regulator output becomes active.

Continue slowly increasing the battery simulator power supply, thus simulating the Li-Ion battery accepting charge. As the battery simulator approaches the float voltage of 4.200V, the charge current will begin to drop as the charger begins the constant voltage portion of the charge cycle. It is important to keep the DC resistance between the charger output and the battery to a minimum, otherwise the charge current will begin dropping much sooner. When the charger is in the constant voltage portion of the charge cycle, small changes in the simulator power supply voltage will result in relatively large changes in charge current. When the charge current drops below the Iterm threshold of 50mA, the charge current will drop to 0, the CHRG LED will go OFF and the charge cycle will end. When timer termination is selected (using JP2), the CHRG LED will go off when the charge current drops below the threshold, but the charge cycle will continue until the 3 hour timer ends.

After the charge cycle has ended, if the battery voltage drops approximately 100mV, a recharge cycle will begin. A recharge cycle is 50% (1.5 hours) of the programmed time (provided timer termination is selected).

ADDITIONAL COMMENTS

Both the charger and the LDO regulator can be put into a low quiescent current shutdown mode using the CHGEN and LDOEN pins.

The Low Dropout Regulator is programmed (R4 and R5) for 3V out and can provide 100mA to a load.

Jumpers JP4 and JP5 interact with each other when programming charge current.

Other charge currents can be programmed by removing Jumper JP5 and adding a suitable external resistor from the Current Monitor pin to ground. (Note that JP4 will also determine charge current).

Likewise, other minimum charge current termination levels can be selected by removing jumper JP4 and adding a suitable resistor from the IDET pin to ground.

The internal termination can be defeated by moving jumper JP2 to the center position. Charge termination is then left to the user through the CHGEN terminal.

When the minimum charge current termination method is used and no battery is present, a sawtooth waveform of several hundred mV p-p will appear at the charger output. This is a function of the output capacitor and the charger output cycling between the recharge threshold voltage and the float voltage. The sawtooth frequency is dependant on the value of the output capacitor. With a 2.2µF output capacitor, the frequency is approximately 40Hz, which will cause the CHRG LED to appear dim. With a larger output capacitor, the LED will flash briefly.

To speed up the 3 hour timer when evaluating the charger circuit, replace the timing capacitor with a much smaller value. Several hundred picoFarads will reduce the total time to approx 30 seconds.

The one Ohm resistor in series with the ceramic input capacitor is used to minimize transient voltages

caused by the capacitor when the input voltage is quickly applied.

See LTC4063 Data Sheet For Additional Information.

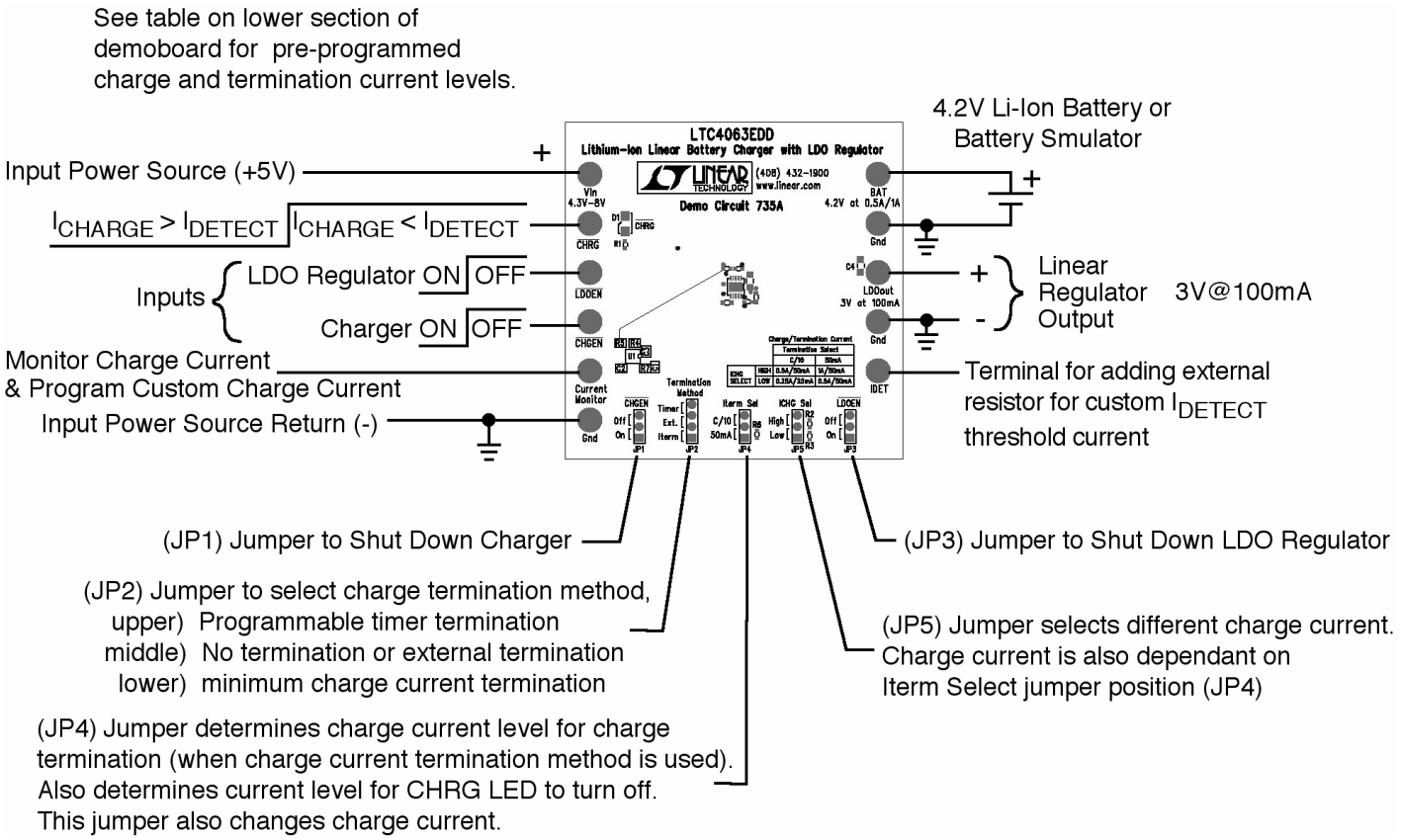
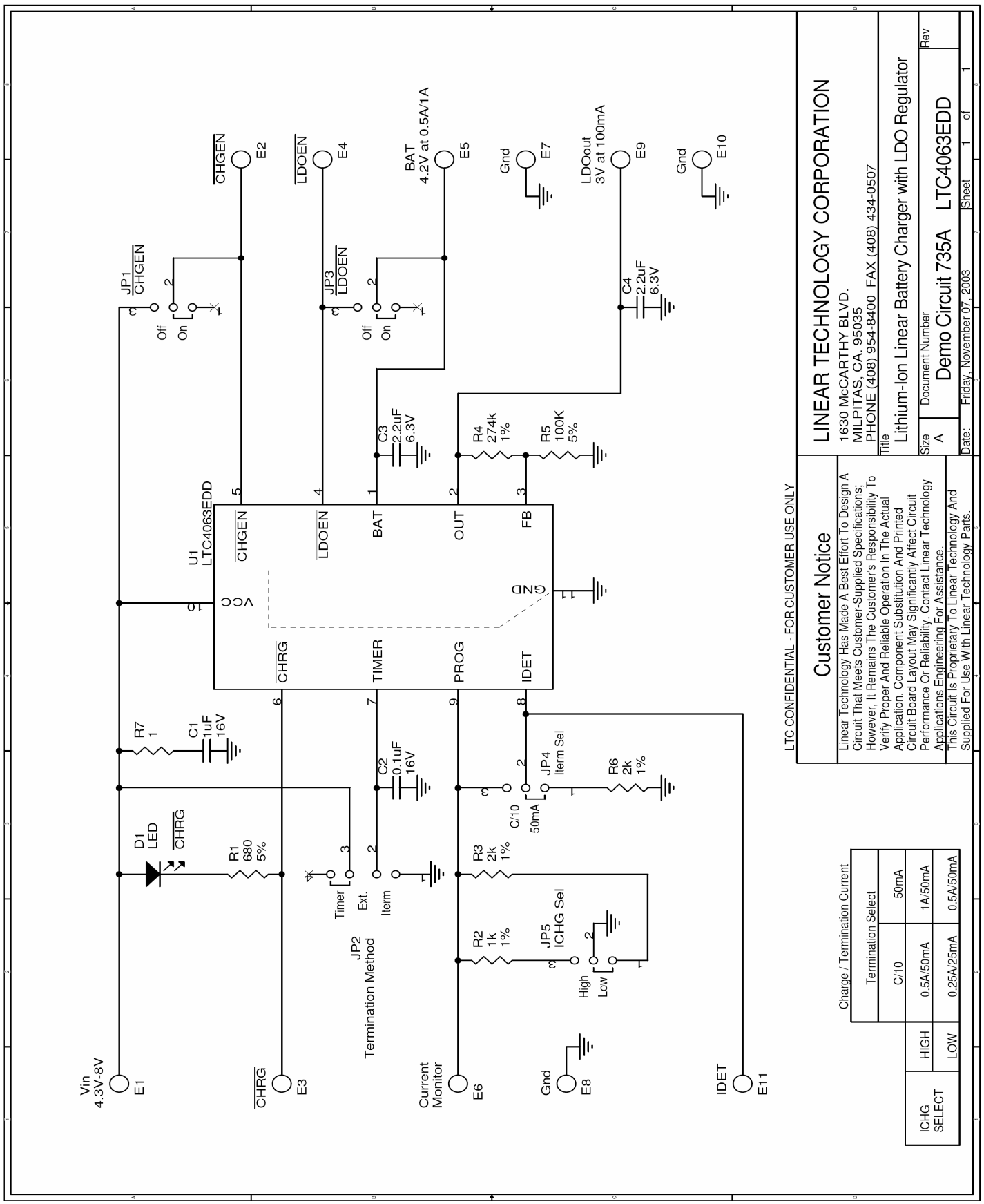


Figure 1. Proper Measurement Equipment Setup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Sheet 1 of 1
U1 LTC4063EDD
VCC
CHGEN
LDOEN
BAT
OUT
FB
GND
CHRG
TIMER
PROG
IDET
Vin 4.3V-8V
CHRG
Current Monitor
Gnd
IDET
BAT 4.2V at 0.5A/1A
Gnd
LDOut 3V at 100mA
Gnd
JP1 CHGEN
JP2 Termination Method
Timer
Ext.
Iterm
JP3 LDOEN
JP4 Iterm Sel
C/10
50mA
JP5 ICHG Sel
High
Low
Off
On
R1 680 5%
R2 1k 1%
R3 2k 1%
R4 274k 1%
R5 100K 5%
R6 2k 1%
R7 1
C1 1uF 16V
C2 0.1uF 16V
C3 2.2uF 6.3V
C4 2.2uF 6.3V
D1 LED
Charge / Termination Current
Termination Select
C/10
50mA
ICHG SELECT
HIGH
0.5A/50mA
1A/50mA
LOW
0.25A/25mA
0.5A/50mA

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