LT3650EDD-4.2/LT3650EDD-4.1 2A Monolithic Li-Ion Battery Chargers

DESCRIPTION

DC1229B is a 2A monolithic Li-Ion battery charger featuring the LT®3650EDD-4.2/LT3650EDD-4.1. The LT3650 is a complete mid-power Li-Ion battery charger that can operate over a wide input voltage range. The circuit provides CC/CV charging with a maximum charge current externally programmable up to 2A. A precondition feature trickle charges a low-voltage battery and bad battery detection provides a signal if the battery doesn't respond to preconditioning. The LT3650EDD is available in a 12-lead (3mm × 3mm) DFN surface mount package with an exposed pad.

Design files for this circuit board are available at http://www.linear.com/demo

PERFORMANCE SUMMARY (T_A = 25°C)

PARAMETER	CONDITIONS	VALUE
Input Voltage Range		7.5V to 32V
V_{OUT}		3.7V to 4.24V
Output Float Voltage	Constant Voltage Mode	4.2V/4.1V
Output Current Limit I_{LIM}	R_{RNG} = 20kΩ	2A

OPERATING PRINCIPLES

LT3650 is a complete monolithic mid-power Li-Ion battery charger, addressing high input voltage applications with solutions that require a minimum of external components. The IC uses a 1MHz constant frequency, average-current mode step-down architecture. Internal reverse voltage protection allows direct connection to the input supply without a blocking diode for single-cell applications (LT3650-4.2/LT3650-4.1).

NOTE: A blocking diode on the input supply connection is recommended to prevent the input from ringing below ground with a battery on the output.

The LT3650 incorporates a 2A switch that is driven by a bootstrapped supply to maximize efficiency during charging cycles. Wide input range allows operation to full charge from 5V ±5% (single cell) to 36V. A precision-threshold shutdown pin allows incorporation of UVLO functionality using a simple resistor-divider. The IC can also be put into a low-current shutdown mode, in which the input supply bias is reduced to only 15µA.

The LT3650 incorporates several degrees of charge current control freedom. The overall maximum charge current is set using an external inductor current sense resistor. A maximum charge current programming pin allows dynamic manipulation of the battery charge current. The LT3650 also incorporates a system input-supply current limit control feature that servos the battery charge current to accommodate overall system load requirements.

The LT3650 automatically enters a battery precondition mode if the sensed battery voltage is very low. In this mode, the charging current is reduced to 15% of the programmed maximum, as set by the inductor sense resistor, R_{SENSE}. Once the battery voltage climbs above an internally set threshold of 2.9V/cell, the IC automatically increases maximum charging current to the full programmed value.

OPERATING PRINCIPLES

The LT3650 can use a charge-current based 'C/10' termination scheme, which ends a charge cycle when the battery charge current falls to 1/10th the programmed maximum charge current. The LT3650 also contains an internal charge cycle control timer, for timer-based termination. When using the internal timer, the IC combines C/10 detection with a programmable time constraint, during which the charging cycle can continue beyond the C/10 level to "top-off" a battery. The charge cycle terminates when a specific time elapses, typically 3 hours. When the timer-based scheme is used, the IC also supports 'bad-battery' detection, which triggers a system fault if a battery stays in precondition mode for more than 1/8th of the total charge cycle time.

Once charging is terminated and the LT3650 is not actively charging, the IC automatically enters a low-current standby mode where supply bias currents are reduced to < 100µA. If the battery voltage drops 2.5% from the full-charge float voltage, the LT3650 engages an automatic charge cycle restart. The IC also automatically restarts a new charge cycle after a bad battery fault once the failed battery is removed and replaced with another battery.

The LT3650 contains provisions for a battery temperature monitoring circuit. This feature monitors battery temperature during the charging cycle using a thermistor, and suspends charging and signals a fault condition if the battery temperature moves outside a safe charging range of 0°C to 50°C.

The LT3650 contains two digital open-collector outputs, which provide charger status and signal fault conditions. These binary-coded pins signal battery charging, standby or shutdown modes, battery temperature faults, and bad battery faults.

QUICK START PROCEDURE

DC1229 is easy to set up to evaluate the performance of the LT3650EDD-4.2/LT3650EDD-4.1.

Use a blocking diode on the input supply connection, and short twisted pair leads for the power connections. With all loads and power supplies off, refer to Figure 1 for the proper measurement and equipment setup.

Follow the procedure below:

1. Jumper and Power Supply Setting:

   JP1 = 1 **PS1 = OFF**
   JP2 = 1 **PS2 = OFF**
   JP3 = C/10

2. Turn on PS2 and slowly increase the voltage until V_{BAT} is 2.7V while monitoring the current into the BAT pin. If the current is less than 5mA, turn on PS1. Increase PS1 until V_{IN} is 5V while monitoring the input current. If the current is less than 5mA, increase PS1 until V_{IN} is 12V.

3. Verify that the battery charging current, I_{BAT}, is between 200mA and 300mA. The CHRG LED should be on and the FAULT LED should be off.

4. Increase PS2 until V_{BAT} is 3.6V. Verify the input current, IIN, is between 700mA and 850mA, the battery current, I_{BAT}, is between 1.875A and 2.225A and that the CHRG LED is on.

5. Increase PS2 until V_{BAT} is 4.25V. Verify the battery charging current, I_{BAT}, is less than 5mA and that the CHRG LED is off.

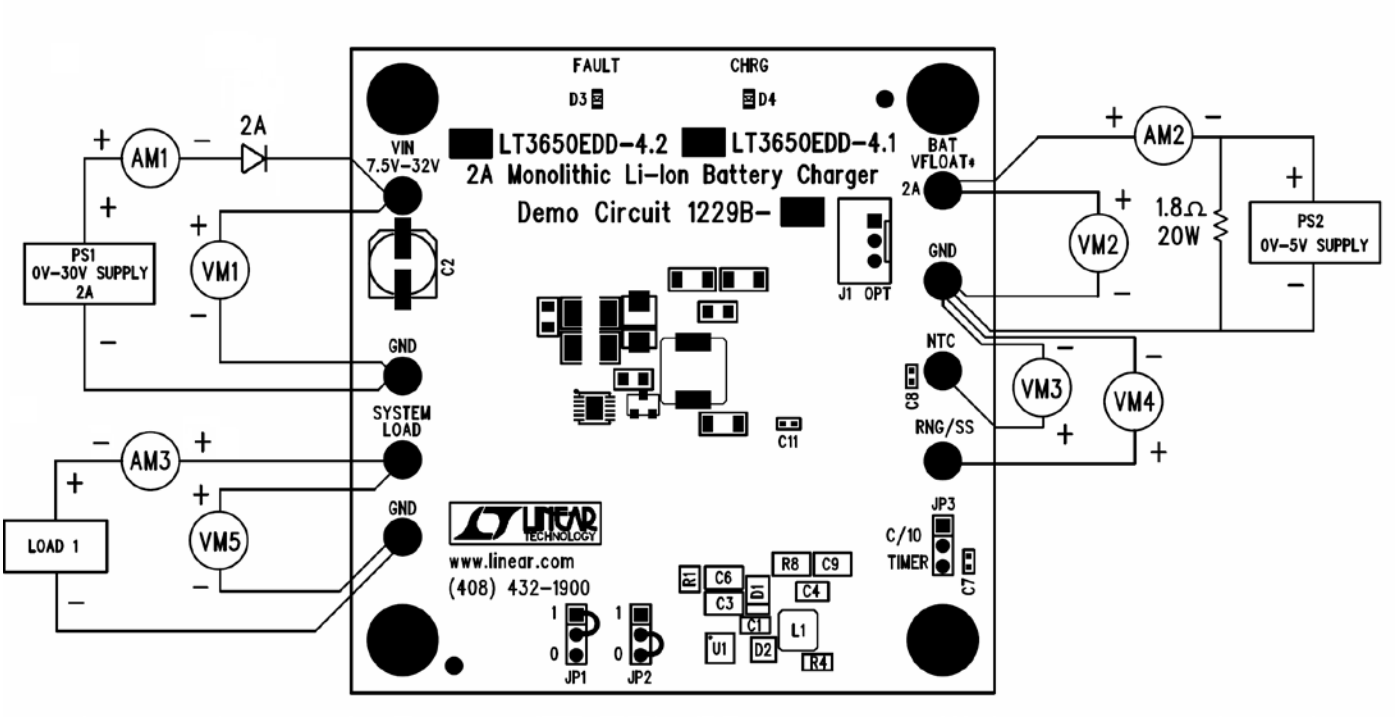
6. Decrease PS2 until V_{BAT} is 3.9V. Verify the battery current, I_{BAT}, is between 1.875A and 2.225A and that the CHRG LED is on.

7. Decrease PS2 until V_{BAT} is 3.6V. Connect a 10k resistor from the RNG/SS pin to ground. Verify the charging current, I_{BAT}, is between 850mA and 1.0A. Verify the voltage, V_{RNG}, on the RNG/SS turret is between 450mV and 550mV and the voltage V_{NTC} on the NTC turret is between 1.8V and 1.9V. Remove the 10k resistor from the RNG/SS pin to ground.

8. Set JP1 to SHDN. Verify the charging current, I_{BAT}, is less than 5mA and that the FAULT LED and the CHRG LED are off.

QUICK START PROCEDURE

9. Set JP1 to RUN. Connect a jumper from the NTC pin to ground. Verify the charging current, I_{BAT}, is less than 5mA and that the FAULT LED and the CHRG LED are on.
10. Remove the jumper from NTC to ground. Verify the charging current, I_{BAT}, is between 1.875A and 2.225A and that the FAULT LED is off and the CHRG LED is on.
11. Turn on LOAD1 and set to 1A. Verify the voltage, V_{SYSTEM}, on the system load turret is approximately equal to V_{IN}.
12. Turn off PS1, PS2 and LOAD1.



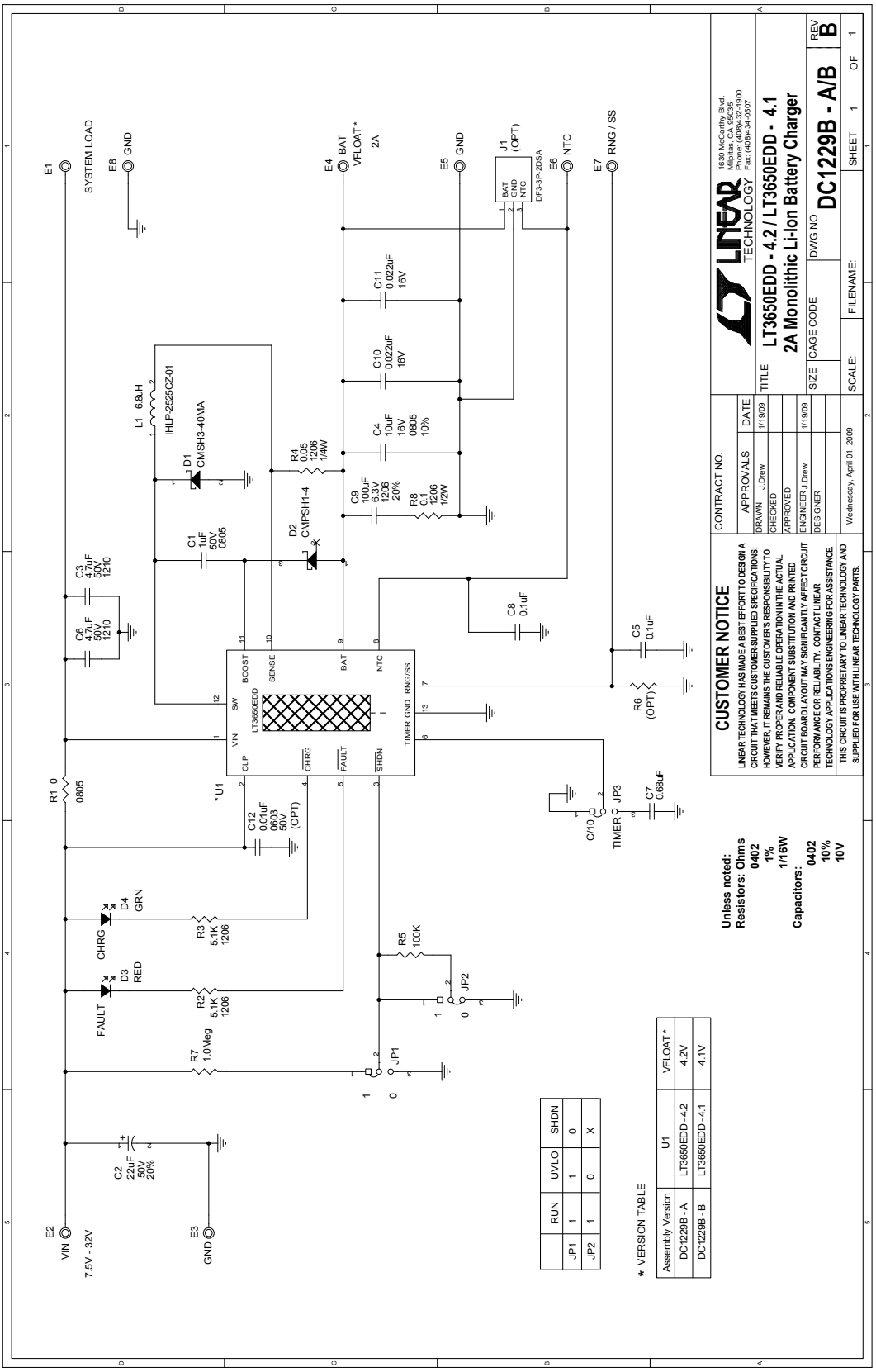
Note: Put a blocking diode between the input supply and the V_{IN} terminal. Kelvin connect the voltage meters directly to the board terminals as shown on the diagram. Use twisted pair input and output leads.

Figure 1. Proper Measurement Equipment Setup

PARTS LIST

ITEM	QTY	REFERENCE	PART DESCRIPTION	MANUFACTURER/PART NUMBER
Required Circuit Components				
1	1	C1	Capacitor, X7R, 1µF, 50V, 10%, 0805	Murata, GRM21BR71H105KA12B
2	2	C3, C6	Capacitor, X7R, 4.7µF, 50V, 10%, 1210	Murata, GRM32R71H475KA091B
3	1	C4	Capacitor, X7R, 10µF, 10V, 10%, 0805	Murata, GRM21BR71A106KE19B
4	2	C5, C8	Capacitor, Chip, X5R, 0.1µF, ±10%, 10V, 0402	AVX, 0402ZD104KAT2A
5	1	C7	Capacitor, X5R, 0.68µF, 10V, 10%, 0402	Murata, GRM155R61A684KE15D
6	1	C9	Capacitor, X5R, 100µF, 6.3V, 20%, 1206	Murata, GRM31CR60J107ME19L
7	1	D1	SMD, Schottky Barrier Rectifier	Central Semi, CMSH3-40MA
8	1	D2	SMD, Schottky Diode, SOT-23F	Central Semi, CMPSH1-4
9	1	L1	Power Inductor 6.8µH 20% 4.5A	Vishay, IHLP2525CZER6R8M011
10	1	R4	Resistor, Chip, 0.05Ω, 1/2W, 1%, 1206	IRC, LRC-LR1206-01-R050-F
11	1	R5	Resistor, Chip, 100k, 1/16W, 1%, 0402	Vishay, CRCW0402100KFKED
12	1	R7	Resistor, Chip, 1M, 1/16W, 1%, 0402	Vishay, CRCW04021M00FKED
13	1	R8	Resistor, Chip, 0.1Ω, 1/2W, 1%, 1206	IRC, LRC-LR1206-01-R100-F
14	1	U1 (Option A) U1 (Option B)	2A Monolithic Li-Ion Battery Charger	Linear Technology, LT3650EDD-4.2 Linear Technology, LT3650EDD-4.1
Optional Demo Circuit Components				
1	1	C2	Capacitor, SMT, 22µF, 50V, 20%	Sanyo, 50CE22BS
2	2	C10, C11	Capacitor, Chip, X7R, 0.022µF, ±10%, 16V, 0402	AVX, 0402YC223KAT2A
3	0	R6 (Opt)	Resistor, Chip, 0402	User Defined
4	1	D3	LED, Red	Panasonic, LNJ208R8ARA
5	1	D4	LED, Green	Lite-On, LTST-C190KGKT
6	1	R1	Resistor, Chip, 0 ,1/16W, 0805	Vishay, CRCW08050000Z0EA
7	2	R2, R3	Resistor, Chip, 5.1K,1/4W, 1%, 1206	Vishay, CRCW12065K10FKEA
8	0	C12 (Opt)	Capacitor, Chip, X7R, 0.01µF, ±10%, 50V, 0603	AVX, 06035C103KAT2A
Hardware				
1	8	E1-E8	Testpoint, Turret, .095"	Mill-Max, 2501-2-00-80-00-00-07-0
2	1	J1	Header, 3 Pins	Hirose Electric, DF3A-3P-2DSA
3	3	JP1, JP2, JP3	2MM Single Row Header, 3 Pin	Samtec, TMM-103-02-L-S
4	3	JP1, JP2, JP3	Shunt	Samtec, 2SN-BK-G
5	4		Stand-Off, Nylon 0.375" Tall (Snap-On)	Keystone, 8832 (Snap On)

SCHEMATIC DIAGRAM



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