QUICK START GUIDE FOR DEMONSTRATION CIRCUIT 1088A-A & B

DUAL INPUT STANDALONE LI-ION BATTERY CHARGERS

LTC4096/LTC4096X

DESCRIPTION

Demonstration circuits DC1088A-A and -B are complete standalone linear chargers that are capable of charging single cell Li-Ion or Li-Polymer batteries. The LTC4096/LTC4096X will detect and automatically select the appropriate input; a USB port or a 5V wall adapter input. The Input Power Present (PWR) pin indicates when sufficient input power is available and can drive up to 120mA. The charge current is automatically set to 500mA with the USB input and 1A with the wall adapter input. The charge cycle terminates when the charge current decreases to 50mA.

The LTC4096 operates in trickle charge mode (10% charge current) when the battery is below 2.9V. The LTC4096X does not have trickle charge mode and charges at full charge current when the battery is below 2.9V.

The charger may be disabled by setting the SUSP jumper, JP1, to the HI position. The CHRG LED indicates when the charger is in charge mode.

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

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

PARAMETER	CONDITION	VALUE
Adapter Input Voltage Range DCIN		4.25V – 5.5V
USB Input Voltage Range USBIN		4.25V – 5.5V
Output Float Voltage V_{BAT}	Constant Voltage Mode	4.200V (± 0.6%)
Charge Current I_{BAT} Adapter Input Power	Constant Current Mode	1A
Charge Current I_{BAT} Adapter Input Power	Trickle Charge Mode (LTC4096 Only)	100mA
Charge Current I_{BAT} USB Input Power	Constant Current Mode	500mA
Charge Current I_{BAT} USB Input Power	Trickle Charge Mode (LTC4096 Only)	50mA
V_{IDC}	Full Charge Current	1V
V_{IUSB}	Full Charge Current	1V

QUICK START PROCEDURE

The charger may be evaluated using an actual Li-Ion battery, a bi-polar supply, or a battery simulator.

A battery simulator consists of an adjustable supply with a load resistor across the supply output. A 2.5Ω 10W resistor value will provide a 1A load at 2.5V. This will allow the power supply to sink and source current similar to a battery, but allows the battery voltage to be changed quickly or remain at the same value indefinitely.

Refer to Figure 1 for proper measurement equipment setup and follow the procedure below.

1. Set the SUSP jumper, JP1, to the HI position.
2. With the power supplies adjusted to 0V, connect the USB Input, Adapter Input, and Battery Simulator with series ammeters as illustrated in Figure 1. An ammeter or a 100mΩ current sense resistor may be used to measure the battery charge current.

3. Connect voltmeters as shown in Figure 1 across USB Input and Ground, across the Adapter Input, and Ground, and across the Battery Output and Ground. These voltmeters may also be used to measure the voltage on the IDC, IUSB, ITERM, and PWR terminals.
4. Turn on the Battery Simulator supply to 2.5V and set the SUSP jumper to the LO position.
5. Increase the Adapter Input until the CHRG LED illuminates and observe the Adapter Input voltage and charge current. The Adapter Input voltage is at the rising DCIN Under Voltage Lockout threshold. The PWR voltage is approximately equal to the Adaptor Input voltage. The LTC4096 will be in trickle charge mode with a trickle charge current of 100mA. The LTC4096X will be in full charge mode with a charge current of 1A.
6. Increase the battery simulator supply to 3V and observe that the LTC4096 charge current will jump to full charge with a charge current of 1A. The LTC4096X charge current will remain at 1A.
7. Set the USB Input supply to 5V and slowly decrease the Adapter Input until the charge current suddenly drops to 500mA. The Adapter Input voltage is at the falling DCIN Under Voltage Lockout threshold and the PWR voltage is approximately equal to the USB Input voltage.
8. Increase the Adapter Input voltage until the charge current jumps back to 1A. The part is now utilizing the Adapter Input power and the PWR voltage is approximately equal to the Adapter Input voltage.
9. Set the Adapter Input voltage to 5V and slowly increase the Battery Simulator voltage until the charge current starts to decrease. The charger is now in constant voltage mode.
10. Continue slowly increasing the Battery simulator voltage while observing the charge current. Observe when the charge current decreases below the 50mA termination current, the charge cycle terminates.
11. Slowly decrease the Battery Simulator voltage until the CHRG LED illuminates. This indicates that the BAT voltage reached the recharge voltage threshold.
12. Set the Adapter Input to 0V and slowly decrease the USB Input until the CHRG LED turns off. The USB Input voltage is at the falling USB Under Voltage Lockout threshold and the PWR pin is equal to 0V.
13. Set the Battery Simulator voltage to 2.5V. Slowly increase the USB Input voltage until the CHRG LED illuminates. The USB input is at the rising USB Under Voltage Lockout and the PWR voltage is approximately equal to the USB Input voltage. The LTC4096 is in trickle charge mode with a trickle charge current of 50mA. The LTC4096X is in full charge mode with a charge current of 500mA.
14. Increase the USB Input voltage to 5V and slowly increase the Battery Simulator voltage to 3V. The LTC4096 jumps to full charge mode with a 500mA charge current. The LTC4096X charge current remains at 500mA.
15. Slowly increase the Battery Simulator until the charge current starts to decrease. The charger is now in constant voltage mode.
16. Slowly increase the Battery Simulator voltage while observing the charge current. Observe that when the charge current decreases below the 50mA termination current, the charge cycle terminates.
17. Slowly decrease the Battery Simulator voltage until the CHRG LED illuminates. This indicates that the BAT voltage reached the recharge voltage threshold.
18. Set the SUSP jumper the HI position. This disables the charger and puts the part into shutdown.
19. Set the Adapter Input supply to 5V and observe the Adapter Input current and the current to the Battery Simulator. The part remains in shutdown with the SUSP jumper in the HI position.

A 4.7uF output capacitor and a series 1Ω resistor are provided on the demo board to reduce the output ripple current when the battery is disconnected. Disconnecting the battery or battery simulator from the charge will result in a sawtooth waveform approximately 10mV p-p on the BAT output. This is a function of the charger and the output capacitor cycling between the recharge threshold voltage and the charge termination.

When finished, turn off the circuit by setting the SUSP jumper, JP1, to the HI position, turn off the input supplies and disconnect and/or turn off the battery or battery simulator.

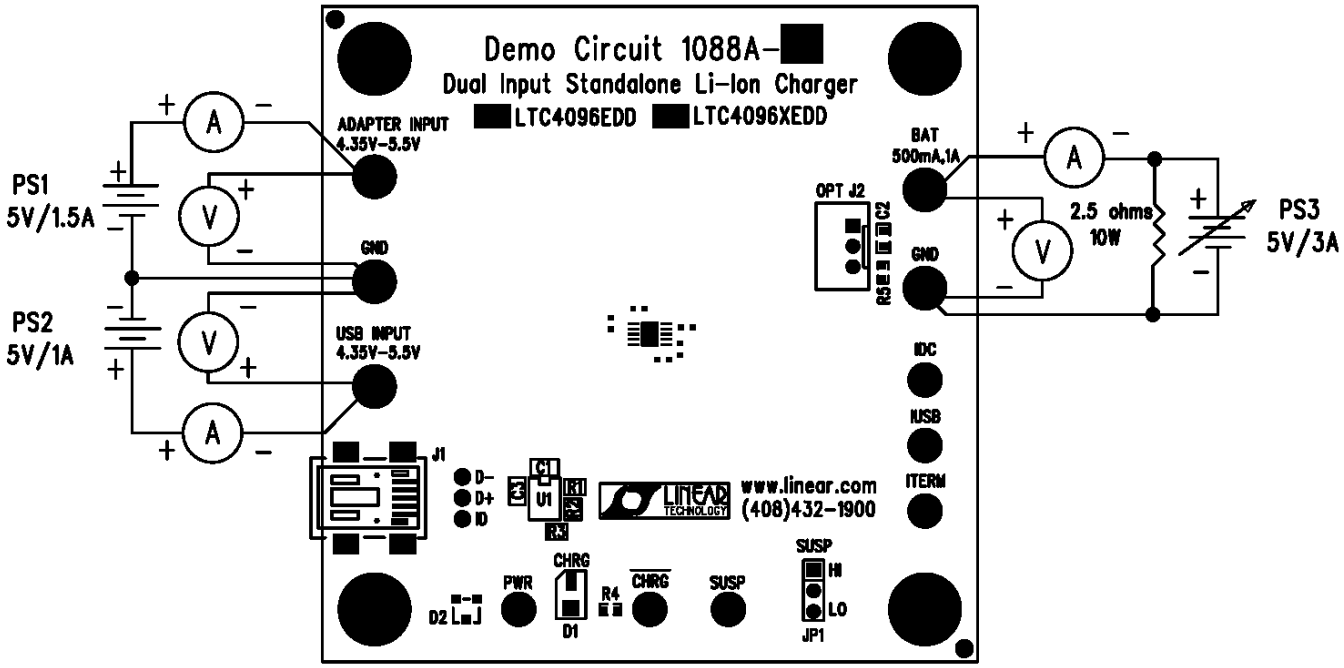
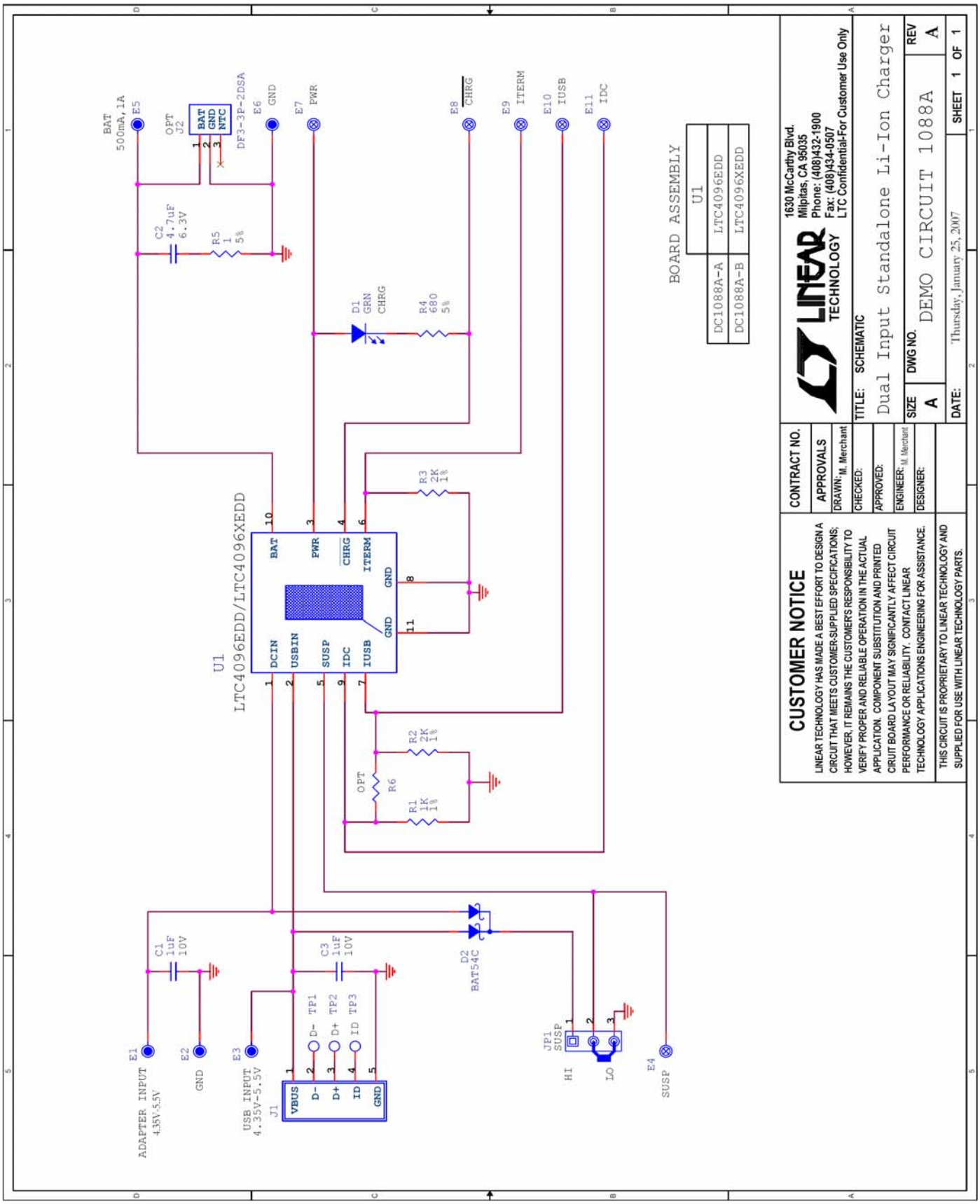


Figure 1. Proper Measurement Equipment Setup


U1
LTC4096EDD/LTC4096XEDD
BAT
PWR
CHRG
ITERM
GND
DCIN
USBIN
SUSP
IDC
IUSB
GND
BAT 500mA,1A
OPT J2
BAT
GND
NTC
DF3-3P-2DSA
C2 4.7uF 6.3V
R5 1 5%
D1 GRN CHRG
R4 680 5%
R3 2K 1%
R2 2K 1%
R1 1K 1%
OPT R6
C1 1uF 10V
C3 1uF 10V
D2 BAT54C
E1 ADAPTER INPUT 4.35V-5.5V
E2 GND
E3 USB INPUT 4.35V-5.5V
E4 SUSP
E5 BAT
E6 GND
E7 PWR
E8 CHRG
E9 ITERM
E10 IUSB
E11 IDC
J1
VBUS
D-
D+
ID
GND
TP1
TP2
TP3
JP1 SUSP
HI
LO
BOARD ASSEMBLY
U1
DC1088A-A LTC4096EDD
DC1088A-B LTC4096XEDD
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CONTRACT NO.
APPROVALS
DRAWN: M. Merchant
CHECKED:
APPROVED:
ENGINEER: M. Merchant
DESIGNER:
LINEAR TECHNOLOGY
1630 McCarthy Blvd.
Milpitas, CA 95035
Phone: (408)432-1900
Fax: (408)434-0507
LTC Confidential-For Customer Use Only
TITLE: SCHEMATIC
Dual Input Standalone Li-Ion Charger
SIZE A
DWG NO. DEMO CIRCUIT 1088A
REV A
DATE: Thursday, January 25, 2007
SHEET 1 OF 1

Linear Technology Corporation
LTC4096EDD

Parts List

DC1088A-A Rev 1
1/9/2007

Item	Qty	Ref - Des	Desc	Manufacturer's Part Number
		REQUIRED CIRCUIT COMPONENTS:		
1	2	C1,C3	CAP., X5R 1uF 10V 10% 0402	MURATA, GRM155R61A105K
2	2	R2,R3	Res., Chip 2K 1/16W 1%	AAC CR05-2001FM
3	1	R1	Res., Chip 1K 1/16W 1%	AAC CR05-1001FM
4	1	U1	I.C., Batt. Charger Controller	Linear Tech. Corp. LTC4096EDD
		ADDITIONAL DEMO BOARD CIRCUIT COMPONENTS:		
1	1	D2	SCHOTTKY BAT54C (Comm-Cath)	Zetex BAT54C
2	1	C2	CAP., X5R 4.7uF 6.3V 10% 0603	TDK, C1608X5R0J475K
3	1	R5	Res., Chip 1 Ohm 0.06W 5%	AAC CR05-1R0JM
4	1	J1	Connector, USB Mini-B	Tyco Electronics 440247-2
5	1	D1	LED, GRN	Panasonic LN1351-C-TR
6	1	R4	Res., Chip 680 0.06W 5%	AAC CR05-681JM
7	0	R6(OPT)	Res., 0402	
8	0	J2(OPT)	Connector, 2MM THRU HOLE	HRS, DF3-3P-2DSA
		HARDWARE FOR DEMO BOARD ONLY:		
1	1	J1	SOCKET, 2X7 2MM STRAIGHT	MOLEX/WALDOM 87831-1420
2	6	E4, E7-E11	Turret, Testpoint	Mill Max 2308-2
3	5	E1-E3,E5,E6	Turret, Testpoint	Mill Max 2501-2
4	1	JP1	Headers, 3 Pins 2mm Ctrs.	CommConn Con Inc. 2802S-03G2
5	1	JP1	Shunt, 2mm Ctrs.	SAMTEC 2SN-BK-G
6	4		STAND-OFF, NYLON 0.25" TALL	KEYSTONE, 8831

Linear Technology Corporation
LTC4096XEDD

Parts List

DC1088A-B Rev 1
1/9/2007

Item	Qty	Ref - Des	Desc	Manufacturer's Part Number
		REQUIRED CIRCUIT COMPONENTS:		
1	2	C1,C3	CAP., X5R 1uF 10V 10% 0402	MURATA, GRM155R61A105K
2	2	R2,R3	Res., Chip 2K 1/16W 1%	AAC CR05-2001FM
3	1	R1	Res., Chip 1K 1/16W 1%	AAC CR05-1001FM
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7	0	R6(OPT)	Res., 0402	
8	0	J2(OPT)	Connector, 2MM THRU HOLE	HRS, DF3-3P-2DSA
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3	5	E1-E3,E5,E6	Turret, Testpoint	Mill Max 2501-2
4	1	JP1	Headers, 3 Pins 2mm Ctrs.	CommConn Con Inc. 2802S-03G2
5	1	JP1	Shunt, 2mm Ctrs.	SAMTEC 2SN-BK-G
6	4		STAND-OFF, NYLON 0.25" TALL	KEYSTONE, 8831

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