DEMO CIRCUIT 1101
QUICK START GUIDE

LTC4097
USB/Wall Adapter Standalone Li-Ion/Polymer Battery Charger

DESCRIPTION

Demonstration circuit 1101 is a USB/Wall Adapter Standalone Li-Ion/Polymer Battery Charger featuring the LTC4097.

The LTC4097 is capable of charging a single cell Li-Ion or Li-Polymer battery from a wall adapter input or a USB input. The LTC4097 will detect and automatically select the appropriate input and charging current when an adequate input is available. The Voltage for NTC (VNTC) pin indicates when sufficient input power is available from either input and can drive up to 120mA to bias the NTC circuit and a charge LED.

When the adapter input (DCIN) is available, the charge current is programmed to provide 1A of constant charge current by the 1KΩ resistor, R2. The charge current is programmed to provide 475mA of constant charge by the 2.1KΩ resistor, R1, when the USB input (USBIN) is providing the input power and the High Power (HPWR) jumper is set to the 100% position. The HPWR jumper allows the user to select a constant charge current of 475mA in the 100% position, or 95mA in the 20% position when the USBIN input is providing the power. The charge cycle is programmed to terminate when the charge current drops below 50mA in constant voltage mode. This is set by the 2KΩ resistor, R3.

The LTC4097 also features a trickle charge mode, automatic recharge, undervoltage lockout and more. Please refer to the LTC4097 data sheet for more information.

PERFORMANCE SUMMARY

Specifications are at T_A = 25°C

PARAMETER	CONDITIONS	MIN	TYP	MAX	UNITS
DCIN Voltage Range DCIN		4.35		5.5	V
USBIN Voltage Range USBIN		4.35		5.5	V
Output Float Voltage V_{BAT}	Constant Voltage Mode, I_{BAT} = 1mA	4.179	4.2	4.221	V
Charge Current I_{BAT} DCIN Power	Constant Current Mode	0.937	1.0	1.063	A
Charge Current I_{BAT} DCIN Power	Trickle Charge Mode	85	100	115	mA
Charge Current I_{BAT} USBIN Power	Constant Current Mode HPWR jumper, JP2, = 100%	450	475	500	mA
Charge Current I_{BAT} USBIN Power	Constant Current Mode HPWR jumper, JP2, = 20%	90	95	100	mA
Charge Current I_{BAT} USBIN Power	Trickle Charge Mode	39.5	47.5	55.5	mA
V_{IDC}	Full Charge Current		1.0		V
V_{IUSB}	Full Charge Current		1.0		V
$I_{TERMINATE}$	R_{ITERM} = 2K	42	50	58	mA

OPERATING PRINCIPLES

A 4.7uF output capacitor and a series 1Ω resistor are provided on the demo board to reduce the output ripple voltage when the battery is not present. 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 threshold.

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.

Demonstration circuit 1101 is easy to set up to evaluate the performance of the LTC4097. Refer to Figure 1 for proper measurement equipment setup and follow the procedure below:

NOTE. When measuring the input or output voltage ripple, care must be taken to avoid a long ground lead on the oscilloscope probe. Measure the input or output voltage ripple by touching the probe tip directly across the V_{DCIN}, V_{USBIN} or V_{BAT} and GND terminals. See Figure 2 for proper scope probe technique.

1. Place jumpers in the following positions:

   JP1. SUSP to HI position.

   JP2. HPWR to 100% position.

   JP3. NTC to INT position.

2. With the power supplies adjusted to 0V, connect the USBIN, DCIN, and battery simulator with series ammeters as illustrated in Figure 1. An ammeter or a 50mΩ current sense resistor may be used to measure the battery charge current.

NOTE. Make sure the ammeters are set for currents of 1 amp or greater. If the impedance of the ammeters are too high on the inputs, the voltage drop across the ammeters may cause the part to oscillate in and out of UVLO.

3. Connect voltmeters, as shown in Figure 1, across USBIN and GND, across DCIN and GND, and across BAT and GND. These voltmeters may also be used to measure the voltage on the IDC, IUSB, ITERM, and VNTC terminals.

4. Turn on the battery simulator supply to 2.7V and set the SUSP jumper to the LO position.

   NOTE. Make sure that the BAT voltage does not exceed 6V.

5. Increase the DCIN voltage until the CHRG LED illuminates and observe the DCIN voltage and charge current. The DCIN voltage is approximately at the rising DCIN Under Voltage Lockout (UVLO) threshold. The VNTC voltage is approximately equal to the DCIN voltage. The LTC4097 will be in trickle charge mode with a trickle charge current of 100mA.

   NOTE. Make sure that the DCIN voltage does not exceed 7V.

6. Increase the battery simulator supply to 3V and observe that the charge current jumps to 1A. This is the DCIN full charge current.

7. Set the USBIN supply to 5V and slowly decrease DCIN until the charge current suddenly drops to 475mA. The DCIN voltage is at the falling DCIN UVLO threshold and the VNTC voltage is approximately equal to the USBIN voltage.

   NOTE. Make sure that the USBIN voltage does not exceed 7V.

8. Increase the DCIN voltage until the charge current jumps back to 1A. The part is now utilizing the DCIN power and the VNTC voltage is approximately equal to the DCIN voltage.

9. Set the DCIN voltage to 5V.

10. Slowly increase the battery simulator voltage until the charge current starts to decrease. The charger is now in constant voltage mode.

11. Continue to slowly increase the battery simulator voltage while observing the charge current. Observe that when the charge current decreases below the 50mA termination threshold, the charge cycle terminates.

12. Slowly decrease the battery simulator voltage until the CHRG LED illuminates. This indicates that the BAT voltage reached the recharge voltage threshold.

13. Set DCIN to 0V and slowly decrease USBIN until the CHRG LED turns off. The USBIN voltage is approximately at the falling USB UVLO threshold and the VNTC pin is equal to 0V.

14. Set the battery simulator voltage to 2.7V. Slowly increase the USBIN voltage until the CHRG LED illuminates. USBIN is at the rising USB UVLO and the VNTC voltage is approximately equal to the USBIN voltage. The LTC4097 is in trickle charge mode with a trickle charge current of 47.5mA.

15. Increase the USBIN voltage to 5V and slowly increase the battery simulator voltage to 3V and observe that the charge current jumps to 475mA. This is the USBIN full charge current.

16. Slowly increase the battery simulator until the charge current starts to decrease. The charger is now in constant voltage mode.

17. Slowly increase the battery simulator voltage while observing the charge current. Observe that when the charge current decreases below the 50mA termination threshold, the charge cycle terminates.

18. Slowly decrease the battery simulator voltage until the CHRG LED illuminates. This indicates that the BAT voltage reached the recharge voltage threshold.

19. Set the SUSP jumper to the HI position. This disables the charger and puts the part into shutdown.

20. Set the HPWR jumper to the 20% position and set the battery simulator voltage to 3.6V.

21. Set the SUSP jumper to the LO position. The charge current is now about 95mA.

22. Set the SUSP jumper to the HI position. This disables the charger and puts the part into shutdown.

23. Set the DCIN supply to 5V and observe the DCIN current and the current to the battery simulator. The part remains in shutdown with the SUSP jumper in the HI position.

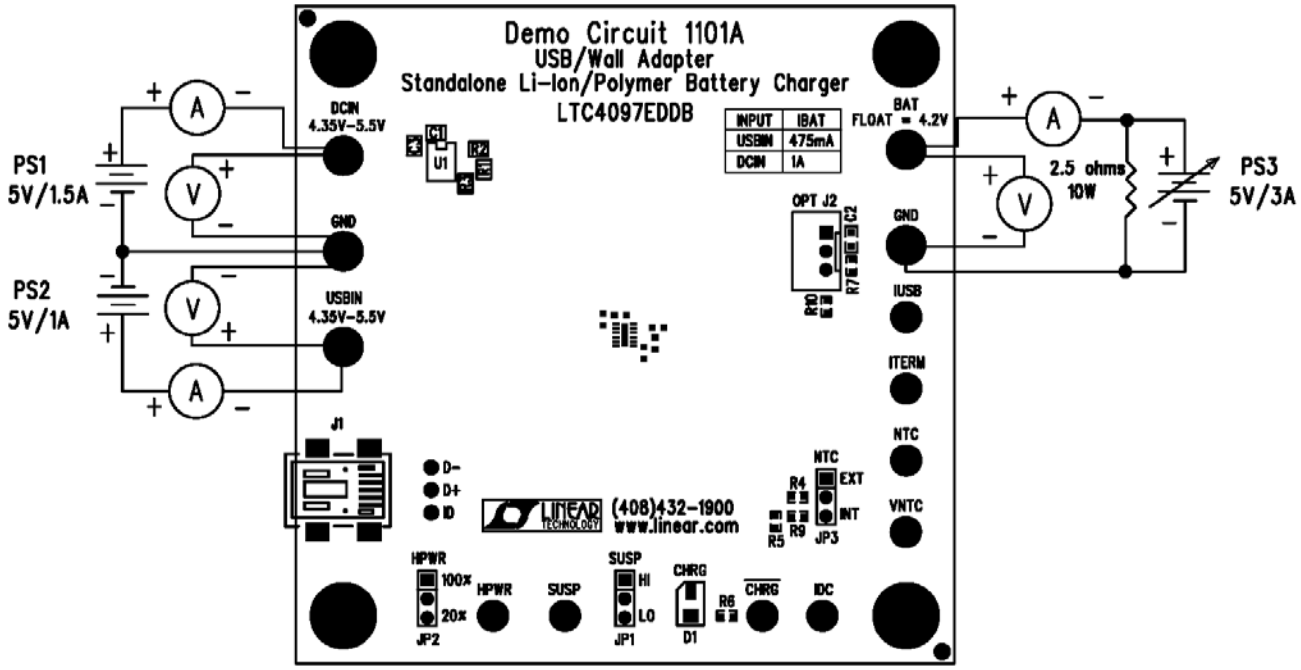


Figure 1. Proper Measurement Equipment Setup

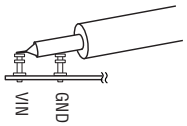
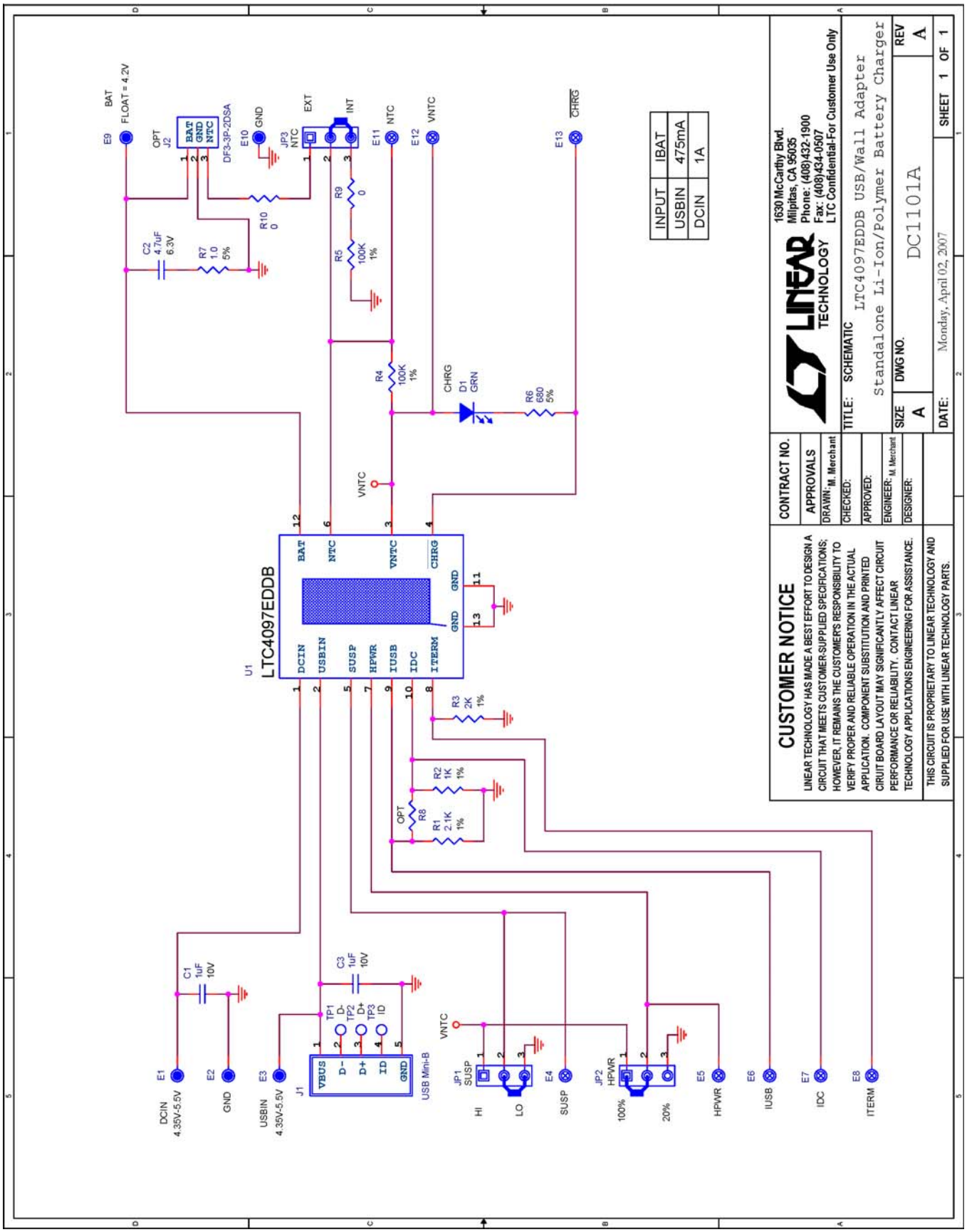


Figure 2. Measuring Input or Output Ripple


LTC4097EDDB
U1
DCIN
USBIN
SUSP
HPWR
IUSB
IDC
ITERM
BAT
NTC
VNTC
CHRG
GND
R1 2.1K 1%
R2 1K 1%
R3 2K 1%
R4 100K 1%
R5 100K 1%
R6 680 5%
R7 1.0 5%
R8 OPT
R9 0
R10 0
C1 1uF 10V
C2 4.7uF 6.3V
C3 1uF 10V
D1 GRN
CHRG
J1 USB Mini-B
J2 OPT
DF3-3P-2DSA
JP1 SUSP
JP2 HPWR
JP3 NTC
EXT
INT
E1 DCIN 4.35V-5.5V
E2 GND
E3 USBIN 4.35V-5.5V
E4 SUSP
E5 HPVR
E6 IUSB
E7 IDC
E8 ITERM
E9 BAT FLOAT = 4.2V
E10 GND
E11 NTC
E12 VNTC
E13 CHRG
INPUT IBAT
USBIN 475mA
DCIN 1A
CUSTOMER NOTICE
LINEAR TECHNOLOGY HAS MADE A BEST EFFORT TO DESIGN A CIRCUIT THAT MEETS CUSTOMER-SUPPLIED SPECIFICATIONS; HOWEVER, IT REMAINS THE CUSTOMER'S RESPONSIBILITY TO VERIFY PROPER AND RELIABLE OPERATION IN THE ACTUAL APPLICATION. COMPONENT SUBSTITUTION AND PRINTED CIRUIT BOARD LAYOUT MAY SIGNIFICANTLY AFFECT CIRCUIT PERFORMANCE OR RELIABILITY. CONTACT LINEAR TECHNOLOGY APPLICATIONS ENGINEERING FOR ASSISTANCE.
THIS CIRCUIT IS PROPRIETARY TO LINEAR TECHNOLOGY AND SUPPLIED FOR USE WITH LINEAR TECHNOLOGY PARTS.
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
LTC4097EDDB USB/Wall Adapter
Standalone Li-Ion/Polymer Battery Charger
SIZE A
DWG NO. DC1101A
REV A
DATE: Monday, April 02, 2007
SHEET 1 OF 1

Linear Technology Corporation
LTC4097EDDB

Parts List

Demo Circuit 1101A Rev 1
4/5/2007

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	1	R2	RES, CHIP 1K 1/16W 1% 0402	VISHAY, CRCW04021K00FKED
3	1	R3	RES, CHIP 2K 1/16W 1% 0402	VISHAY, CRCW04022K00FKED
4	1	R1	RES, CHIP 2.1K 1/16W 1% 0402	VISHAY, CRCW04022K10FKED
5	1	U1	IC, Batt. Charger Controller	Linear Tech. Corp., LTC4097EDDB
		ADDITIONAL DEMO BOARD CIRCUIT COMPONENTS:		
1	1	C2	CAP, X5R 4.7uF 6.3V 10% 0603	TDK, C1608X5R0J475K
2	2	R4,R5	RES, CHIP 100K, 1/16W 1% 0402	VISHAY, CRCW0402100KFKED
3	1	R6	RES, CHIP 680 0.06W 5% 0402	VISHAY, CRCW0402680RJNED
4	1	R7	RES, CHIP 1 Ohm 0.06W 5% 0402	VISHAY, CRCW04021R00JNED
5	0	R8(OPT)	RES, 0402	
6	2	R9,R10	RES, CHIP 0 OHM 0402	VISHAY, CRCW04020000Z0ED
7	1	D1	LED, GRN	Panasonic, LN1351-C-TR
8	1	J1	CONN, USB Mini-B	Tyco Electronics, 1734035-2
9	0	J2(OPT)	CONN, 2MM THRU HOLE	HRS, DF3-3P-2DSA
		HARDWARE FOR DEMO BOARD ONLY:		
1	8	E4-E8, E11-E13	TURRET, Testpoint	Mill Max, 2308-2
2	5	E1-E3,E9,E10	TURRET, Testpoint	Mill Max, 2501-2
3	3	JP1,JP2,JP3	HEADER, 3 Pins 2mm Ctrs.	SAMTEC, TMM-103-02-L-S
4	3	JP1,JP2,JP3	SHUNT, 2mm Ctrs.	SAMTEC, 2SN-BK-G
5	4		STAND-OFF, NYLON 0.25" TALL	KEYSTONE, 8831