DEMO CIRCUIT 1448
QUICK START GUIDE

LTC3455EUF-1
Dual DC/DC Converter with USB Power Manager and Li-Ion Battery

DESCRIPTION

Demonstration circuit 1448 is a Dual DC/DC Converter with USB Power Manager and Li-Ion Battery Charger featuring the LTC3455EUF-1. Power may be received from the USB input, a Wall Adapter, or a battery. DC1448 provides the following functions; 700mA CC/CV timer terminated charger suitable for Li-ion cells, USB power manager that ensures compliance with the USB power specification, two 1.5MHz synchronous step down converters and reset and power button status outputs for interface with a microprocessor.

The LTC3455EUF-1 is available in a 4mm x 4mm 24-pin exposed-pad QFN package.

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

PERFORMANCE SUMMARY

Specifications are at T_A = 25°C

PARAMETER	CONDITIONS	MIN	TYP	MAX	UNITS
Wall Adapter Input Voltage Range		4.75		5.5	V
USB Input Voltage Range		4.20		5.5	V
Battery Charger					
Iout	Vin = 5V, VBat = 3.6V	585	690	795	mA
Float Voltage	Vin = 5V	4.058		4.142	V
Trickle Charge Threshold	Vin = 5V (Battery voltage rising)		2.85		V
Recharge Threshold	$V_{BAT(REGULATED)}$ - $V_{RECHARGE}$		150		mV
USB Current					
Input Current 500mA Mode	Vin = 5V; USB Active 500mA Mode	440		500	mA
Input Current 100mA Mode	Vin = 5V; USB Active 100mA Mode	60		100	mA
Input Current Suspend Mode	Vin = 5V; USB Suspend		4	20	uA
Buck Converters					
Switcher 1		1.72		1.86	V
Switcher 2		3.02		3.27	V
Hot Swap Output	VBat 3.6V	3.02		3.27	V

OPERATING PRINCIPLES

Demo Circuit 1448 manages the power supplies that would be typical for a USB powered device. Power is input from either the USB cable or an adapter to an intermediate voltage bus. This intermediate voltage is then used to charge a Li-ion battery and to generate two low voltage outputs via high efficiency step down converters. The intermediate voltage bus is preferentially powered from the Wall Adapter, then from the USB input, and finally from the battery via an ideal diode. The battery charger is a CC/CV timer terminated type capable of

charge currents of up to 800mA. The two step down converters are high efficiency synchronous Bucks with outputs set at 1.8V and 3.15V. Other output settings are possible by altering the feedback resistor ratios. The chip is normally ON if either USB or Wall Adapter is present. If the battery is the only source of power then the circuit must be turned on by pressing the ON button and can be turned off by depressing the OFF button. The OFF button will only function when in battery power mode. The LTC3455-1 provides a reset signal for 200msec after power up. The $\overline{ON}$ pin is designed to interface to a push button while the PBSTAT reports the button status to allow the host microprocessor to shut down. Additionally there is an uncommitted op-amp which is used on the demo board as a low battery detector. Another possible use for the uncommitted op-amp would be as an LDO controller to generate an additional output or to augment the peak current capability of one of the existing outputs.

QUICK START PROCEDURE

Demonstration circuit 1448 is easy to set up to evaluate the performance of the LTC3455EUF-1. 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 VIN or VOUT and GND terminals. See Figure 2 for proper scope probe technique.

1. With power off, connect input power supplies, meters, battery simulator, and output loads as shown in Figure 1.
2. Set the Jumpers on Demo Circuit 1448 as shown below:

   JP1. MODE jumper to CONTINUOUS MODE position.

   JP3. HOT SWAP OUTPUT jumper to ON position.

   JP4. USB CURRENT jumper to 500mA position.

   JP5. USB SUSPEND jumper to USB ACTIVE position.

   JP6. 3.15V ON/OFF jumper to ON position.

USB Charging

3. Set the battery simulator voltage to zero; slowly raise the USB input voltage. When the supply voltage exceeds 4.1V the charger should activate and the charge LED will illuminate. Continue increasing the USB input voltage to 5.0V. The battery will be in trickle charge mode. Slowly increase the battery voltage. At voltages above 2.85V the battery charge current will increase to approximately 400mA. Continue increasing the battery voltage to 3.6V. Note that the input current from the USB does not exceed the USB spec of 500mA.
4. Increase the loads on the outputs. Note that as the output load is increased the charging current is decreased and the USB current remains within the 500mA limit.
5. Place the USB Current jumper, JP4, in the 100mA position and note that USB input current falls to maintain compliance with the USB input current specification. Also note that as the external load is increased the battery will start to discharge to power the VMAX intermediate voltage bus, illustrating the ideal diode function of the LTC3455EUF-1
6. Place the USB Suspend jumper, JP5, in the SUSPEND position and note that the USB current falls to under 100uA to comply with the suspend mode current.

Adapter Charging

7. Ramp up the wall adapter voltage. When the wall adapter exceeds 4.7V the LTC3455EUF-1 will cease drawing current from the USB and switch over to the wall adapter.
8. Note that the charge current to the battery has increased to approximately 690mA.
9. Increase the battery voltage to 4.1V and note that the charge current falls to 0. This illustrates the constant voltage portion of the charging characteristic.

Battery Powered Operation

10. Set Both USB input voltage and the adapter input voltage to zero. The battery will now support the operation of the demo board.

11. In battery mode operation the OFF pushbutton is now active. Push the OFF button and note battery current draw falls to less than 10uA.

12. Now restart the converter using the ON pushbutton. Note that the Reset LED goes on for 200ms. This simulates the Reset signal that the LTC3455EUF-1 provides to the processor upon initial power up.

13. Set the MODE jumper, JP1, to the BURST MODE position. Observe with an oscilloscope that the buck converter outputs will operate in Burst Mode while in light loads.

Other

14. Set the HOT SWAP OUTPUT jumper, JP3, to the OFF position. Observe that the hot swap output shuts off.

15. Set the 3.15V ON/OFF jumper, JP6, to the OFF position. Observe that the 3.15V output shuts off.

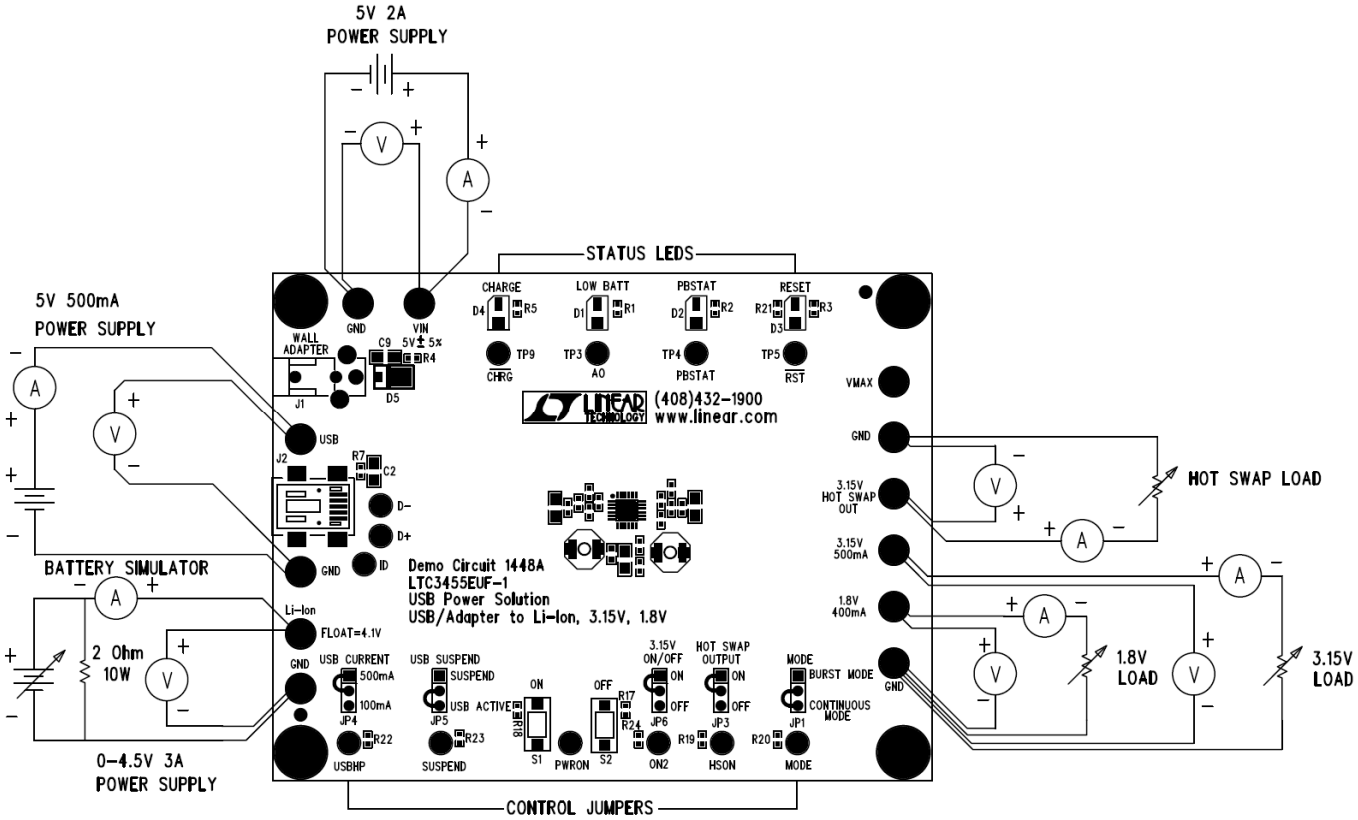


Figure 1. Proper Measurement Equipment Setup

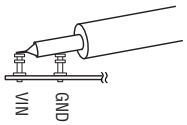
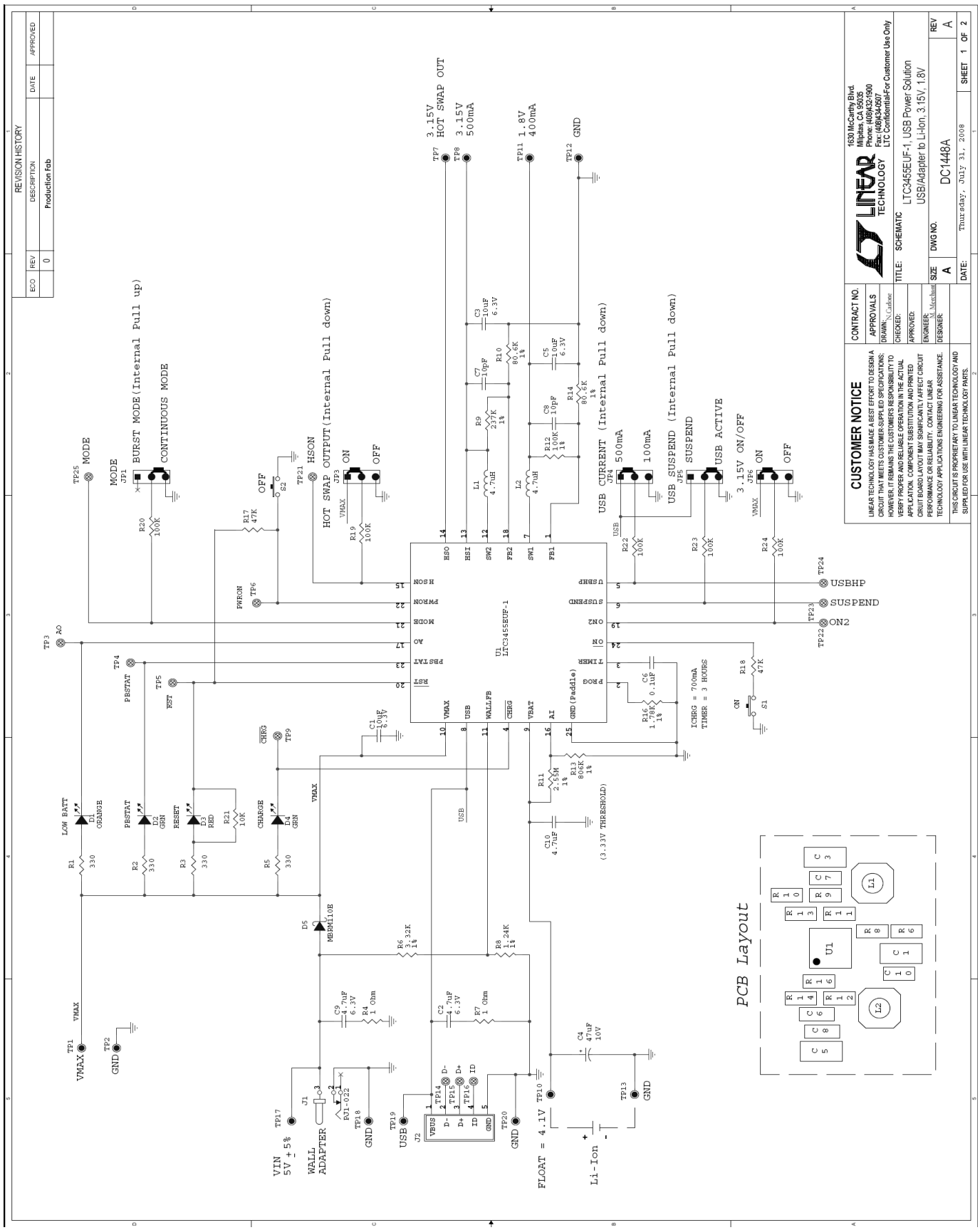


Figure 2. Measuring Input or Output Ripple


REVISION HISTORY
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DESCRIPTION
DATE
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CUSTOMER NOTICE
LINEAR TECHNOLOGY HAS MADE A BEST EFFORT TO DESIGN A CIRCUIT THAT MEETS CUSTOMER-SUPPLIED SPECIFICATIONS; HOWEVER, IT REMAINS THE CUSTOMERS 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.
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LTC Confidential-For Customer Use Only
TITLE: SCHEMATIC
LTC3455EUF-1, USB Power Solution
USB/Adapter to Li-Ion, 3.15V, 1.8V
SIZE A
DWG NO. DC1448A
REV A
DATE: Thursday, July 31, 2008
SHEET 1 OF 2
U1 LTC3455EUF-1
PCB Layout
MODE
BURST MODE(Internal Pull up)
CONTINUOUS MODE
HOT SWAP OUTPUT(Internal Pull down)
USB CURRENT (Internal Pull down)
500mA
100mA
USB SUSPEND (Internal Pull down)
SUSPEND
USB ACTIVE
3.15V ON/OFF
ON
OFF
3.15V HOT SWAP OUT
3.15V 500mA
1.8V 400mA
GND
USBHP
SUSPEND
ON2
LOW BATT
PBSTAT
RESET
CHARGE
VMAX
VIN 5V ± 5%
WALL ADAPTER
Li-Ion
FLOAT = 4.1V
ICHRG = 700mA
TIMER = 3 HOURS
(3.33V THRESHOLD)
MBRM110E