

# LTC4098EUFD-3.6: USB Compatible Switching Power Manager/Li-Ion Charger with Overvoltage Protection

## DESCRIPTION

Demonstration Circuit 1701A is a high efficiency USB Power/Li-Ion battery manager plus a HV regulator battery tracking controller. The LTC4098EUFD-3.6 is available in a 20-pin (3mm × 4mm × 0.75mm) QFN surface mount package.

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## PERFORMANCE SUMMARY

Specifications are at  $T_A = 25^\circ\text{C}$

| SYMBOL    | PARAMETER               | CONDITIONS                       | MIN  | TYP  | MAX | UNITS |
|-----------|-------------------------|----------------------------------|------|------|-----|-------|
| $V_{BUS}$ | Bus Input Voltage Range | Input disabled from 6V–30V       | 4.35 |      | 5.5 | V     |
| $V_{OUT}$ | Output Voltage Range    | Range is mode and load dependant | 3.5  |      | 5.5 | V     |
| $V_{BAT}$ | Output Float Voltage    | Constant voltage mode            |      | 3.6  |     | V     |
| $I_{BAT}$ | Output Charge Current   | Constant current mode            |      | 1.25 | 1.5 | A     |

## QUICK START PROCEDURE

Using short twisted pair leads for any power connections, with all loads and power supplies off, refer to Figures 1 & 2 for the proper measurement and equipment setup.

A companion HV Buck demo board is required for this check out procedure. The DC1394 (LT3480) board is recommended, and will be used for the following procedure. Please refer to the DC1394 Quick Start Guide for further information.

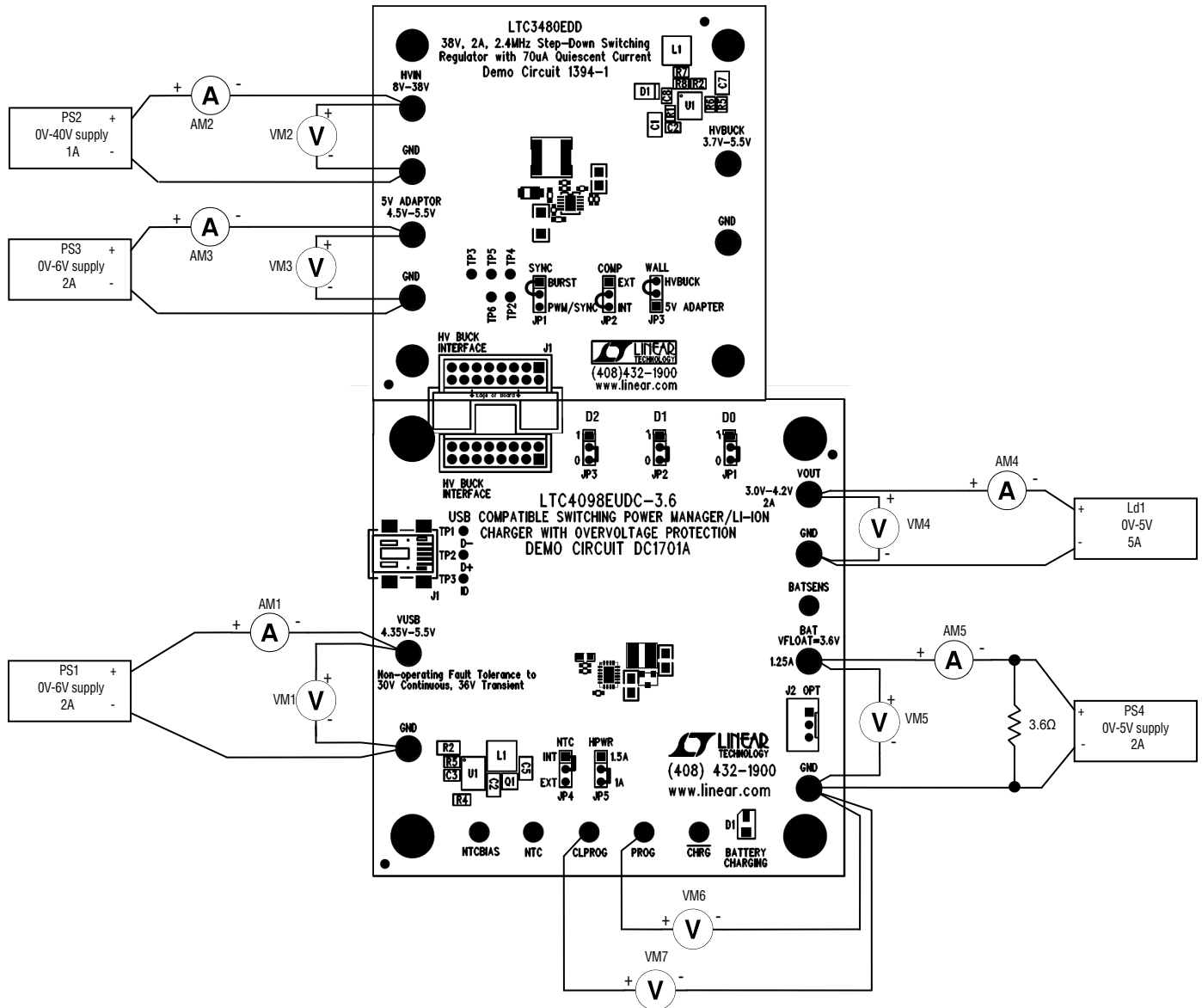
Follow the procedure below:

1. Select input from VUSB: Set WALL jumper (DC1394, JP3) to "5V ADAPTOR". Ensure that PS3 is off.
2. Set PS1 to 5V, and PS4 to 3.4V. Observe  $V_{OUT}$  (VM4),  $I(V_{USB})$  (AM1),  $V(CLPROG)$  (VM7) and  $V(PROG)$  (VM6). The LTC4098EUFD-3.6 is being powered from the USB input. The only load is the battery charger at 1.2A, but  $D[2..0] = 0$ , so

the input current limit is 100mA. Thus  $V_{OUT} \approx 3.4V$ ,  $I(V_{USB}) \approx 100mA$ ,  $V(CLPROG) \approx 1.2V$ , and  $V(PROG) \approx 0.08V$ .

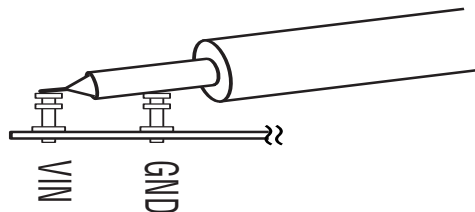
3. Set D1 (JP2) to "1". Observe  $V_{OUT}$  (VM4),  $I(V_{USB})$  (AM1),  $V(CLPROG)$  (VM7) and  $V(PROG)$  (VM6).  $D[2..0]$  now equals 2, the input current limit is 500mA, but the battery charge current is 1.2A, which exceeds the input current limit. Thus  $V_{OUT} \approx 3.5V$ ,  $I(V_{USB}) \approx 500mA$ ,  $V(CLPROG) \approx 1.2V$ , and  $V(PROG) \approx 0.4V$ .
4. Set D1 (JP2) to "0" and D0 (JP1) to "1". Observe  $V_{OUT}$  (VM4),  $I(V_{USB})$  (AM1),  $V(CLPROG)$  (VM7) and  $V(PROG)$  (VM6).  $D[2..0]$  now equals 1, the input current limit is 1A. The charge current is till 1.2A, but the  $V_{OUT}$  regulator is a switching regulator so  $P_{out} = P_{in} \cdot \eta$ , and so  $I_{out}$  is  $> 1.2A$  for  $I_{in} = 1A$ .  $V_{OUT} \approx 3.9V$ ,  $I(V_{USB}) \approx 1A$ ,  $V(CLPROG) \approx 1.2V$ , and  $V(PROG) \approx 1V$ .
5. Set PS1 to 0V, and  $Ld1$  to 0A. Observe  $V_{OUT}$  (VM4) and  $V(V_{OUT}, BAT)$ . There is

- no voltage at VUSB so VOUT is powered from V(BAT) via the ideal diode. Since the load on VOUT is 0,  $V_{OUT} = V(BAT)$  and  $V(V_{OUT}, BAT)$  is 0.
6. Set Ld1 to 1A. Observe VOUT (VM4) and  $V(V_{OUT}, BAT)$ . Set Ld1 to 0A. VOUT is still powered by V(BAT) via the ideal diode, but the load on VOUT is 1A. So,  $V(V_{OUT}, BAT) = 1A \times R_{ds(on)}$  of the ideal diode.  $V(V_{OUT}, BAT) \approx 200mV$ .
  7. Set PS1 to 5V. Set NTC (JP4) to "EXT". Does the "Battery Charging" LED blink? Set NTC (JP4) to "INT". The NTC voltage goes to 5V indicating a battery pack that is too cold. The charger indicates a fault by blinking the "Battery Charging" LED.
  8. Set WALL (DC1394, JP3) to "HVBUCK". Increase PS2 from 0V to 8V. Observe VOUT (VM4) and  $V(PROG)$  (VM6). The LT3480 is now supplying power to VOUT. Even though VUSB is available, the presence of voltage on the WALL pin of the LTC4098-3.6 has shut off the VOUT regulator. The Vc pin of the LTC4098-3.6 is setting the output voltage of the LT3480.  $V_{OUT} \approx 3.9V$ , and  $V(PROG) \approx 1V$ .
  9. Set Ld1 to 1A. Observe VOUT (VM4) and  $V(PROG)$  (VM6). In this case the LT3480 is supplying both the battery charger and the external load on VOUT.  $V_{OUT} \approx 3.9V$ , and  $V(PROG) \approx 1V$ .
  10. Set PS2 to 38V. Observe VOUT (VM4) and  $V(PROG)$  (VM6).
  11. Set Ld1 to 0A. Observe VOUT (VM4) and  $V(PROG)$  (VM6).
  12. Set WALL (DC1394, JP3) to "5V ADAPTOR" and PS3 to 5V. Observe VOUT (VM4) and  $V(PROG)$  (VM6). VOUT is being powered by a wall adaptor at 5V. The WALL still shuts the VOUT regulator off, but the Vc pin cannot control the VOUT voltage.  $V_{OUT} \approx 5V$ ,  $V(PROG) \approx 1V$ .
  13. Set Ld1 to 1A. Observe VOUT (VM4) and  $V(PROG)$  (VM6). Set Ld1 to 0A.
  14. Set D2 (JP3) to "1". Does "BATTERY CHARGING" LED go out? Setting D2 = 1 shuts off the Battery charger.

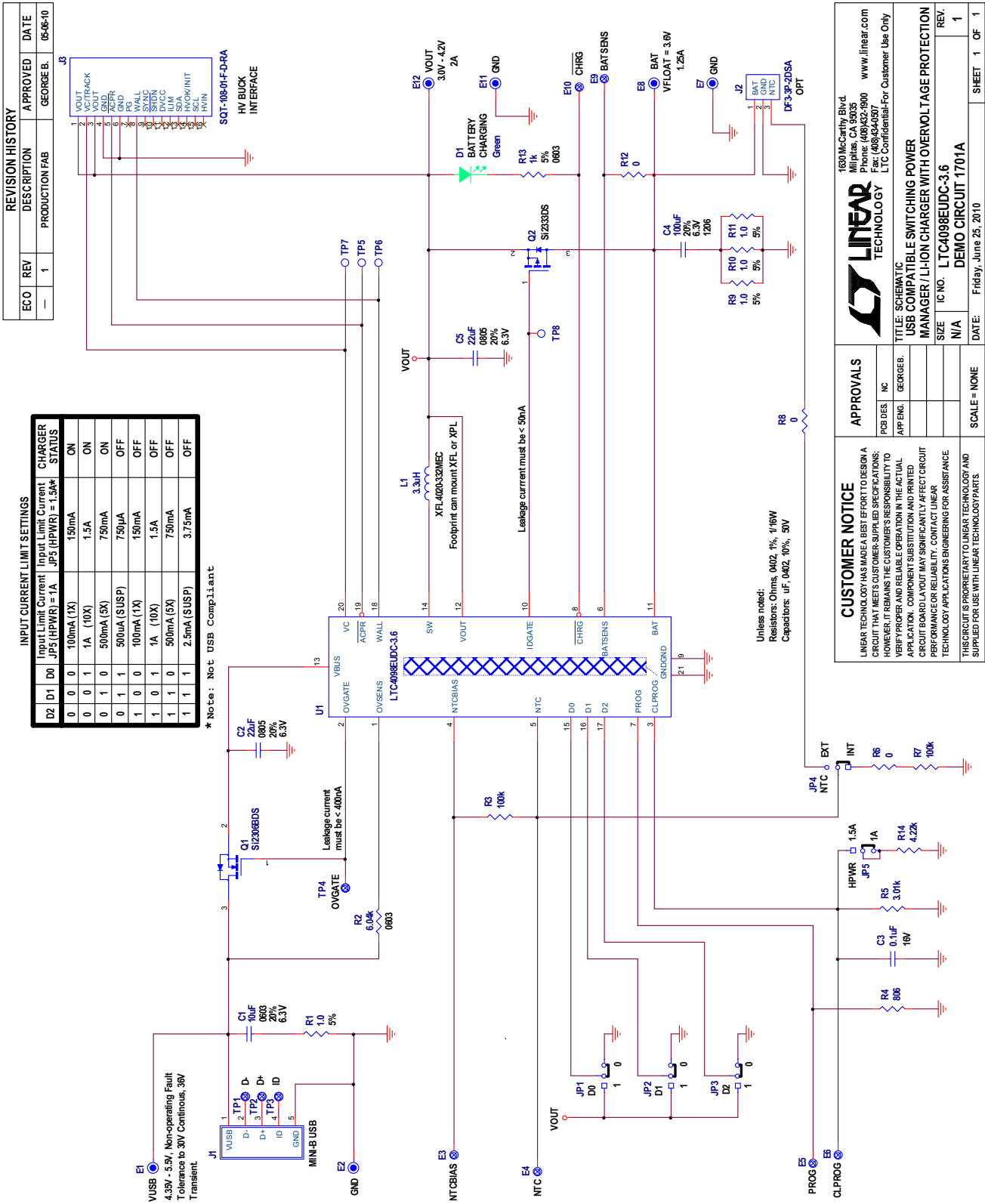


Note: All connections from equipment should be Kelvin connected directly to the Board PINS which they are connected to on this diagram and any input, or output, leads should be twisted pair

**Figure 1. Proper Measurement Equipment Setup for DC1701A**



**Figure 2. Measuring Input or Output Ripple**



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**APPROVALS**

| PCB DES. | NC        |
|----------|-----------|
| AP/ENG.  | GEORGE B. |

**USB COMPATIBLE SWITCHING POWER  
MANAGER / LI-ION CHARGER WITH OVERVOLTAGE PROTECTION**

SIZE: N/A IC NO: LTC4098EUDC-3.6  
DATE: Friday, June 25, 2010

**DEMO CIRCUIT 1701A**

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Milpitas, CA 95035  
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LTC Confidential-For Customer Use Only

|                                                  | Qty | Reference           | Part Description                                                                        | Manufacture / Part #          |
|--------------------------------------------------|-----|---------------------|-----------------------------------------------------------------------------------------|-------------------------------|
| <b>REQUIRED CIRCUIT COMPONENTS:</b>              |     |                     |                                                                                         |                               |
| 1                                                | 2   | C2,C5               | CAP, CHIP, X5R, 22 $\mu$ F, $\pm$ 20%, 6.3V, 0805                                       | TAIYO-YUDEN, JMK212BJ226MG    |
| 2                                                | 1   | C3                  | CAP, CHIP, X7R, 0.1 $\mu$ F, $\pm$ 10%, 16V, 0402                                       | TDK, C1005X7R1C104K           |
| 3                                                | 1   | L1                  | IND, SMT, 3.3 $\mu$ H, 80m $\Omega$ , $\pm$ 20%, 2.2A, 4mmX4mm                          | COILCRAFT, XFL4020-332MEC     |
| 4                                                | 1   | Q1                  | MOSFET, 30V, 65m $\Omega$ , 3.5A, SOT-23                                                | VISHAY, Si2306BDS-T1-E3       |
| 5                                                | 1   | R2                  | RES, CHIP, 6.04k $\Omega$ , $\pm$ 1%, 1/10W, 0603                                       | NIC, NRC06F6041TRF            |
| 6                                                | 1   | R4                  | RES, CHIP, 806 $\Omega$ , $\pm$ 1%, 1/16W, 0402                                         | VISHAY, CRCW0402806RFKED      |
| 7                                                | 1   | R5                  | RES, CHIP, 3.01k $\Omega$ , $\pm$ 1%, 1/16W, 0402                                       | VISHAY, CRCW04023K01FKED      |
| 8                                                | 1   | R12                 | RES, CHIP, 0 $\Omega$ jumper, 1/16W, 0402                                               | VISHAY, CRCW04020000Z0ED      |
| 9                                                | 1   | U1                  | USB COMPATIBLE SWITCHING<br>POWER MANAGER/LI-ION CHARGER WITH<br>OVERVOLTAGE PROTECTION | LINEAR TECH., LTC4098EUDC-3.6 |
| <b>ADDITIONAL DEMO BOARD CIRCUIT COMPONENTS:</b> |     |                     |                                                                                         |                               |
| 1                                                | 1   | C1                  | CAP, CHIP, X5R, 10 $\mu$ F, $\pm$ 20%, 6.3V, 0603                                       | TDK, C1608X5R0J106M           |
| 2                                                | 1   | C4                  | CAP, CHIP, X5R, 100 $\mu$ F, $\pm$ 20%, 6.3V, 1206                                      | MURATA, GRM31CR60J107ME39L    |
| 3                                                | 1   | D1                  | LED, GREEN, SMT, 1206                                                                   | PANASONIC, LN1351-C-TR        |
| 4                                                | 1   | Q2                  | MOSFET, -12V, 35m $\Omega$ , -5.3A, SOT-23                                              | VISHAY, Si2333DS-T1-E3        |
| 5                                                | 4   | R1,R9,R10,R11       | RES, CHIP, 1.0 $\Omega$ , $\pm$ 5%, 1/16W, 0402                                         | VISHAY, CRCW04021R00JNED      |
| 6                                                | 2   | R3,R7               | RES, CHIP, 100k $\Omega$ , $\pm$ 1%, 1/16W, 0402                                        | VISHAY, CRCW0402100KFKED      |
| 7                                                | 2   | R6,R8               | RES, CHIP, 0 $\Omega$ jumper, 1/16W, 0402                                               | VISHAY, CRCW04020000Z0ED      |
| 8                                                | 1   | R13                 | RES, CHIP, 1k $\Omega$ , $\pm$ 5%, 1/10W, 0603                                          | NIC, NRC06J102TRF             |
| 9                                                | 1   | R14                 | RES, CHIP, 4.22k $\Omega$ , $\pm$ 1%, 1/16W, 0402                                       | VISHAY, CRCW04024K22FKED      |
| <b>HARDWARE FOR DEMO BOARD ONLY:</b>             |     |                     |                                                                                         |                               |
| 1                                                | 6   | E1,E2,E7,E8,E11,E12 | Turret, 0.09"                                                                           | MILL-MAX, 2501-2              |
| 2                                                | 6   | E3,E4,E5,E6,E9,E10  | Turret, 0.061"                                                                          | MILL-MAX, 2308-2              |
| 3                                                | 1   | J1                  | CONN, USB MINI-B                                                                        | TYCO, 1734035-2               |
| 4                                                | 0   | J2-OPT              | CONN, Battery                                                                           | HIROSE, DF3-3P-2DSA           |
| 5                                                | 1   | J3                  | SOCKET, HV interface                                                                    | SAMTEC, SQT-108-01-F-D-RA     |
| 6                                                | 5   | JP1,JP2,JP3,JP4,JP5 | HEADER, 3 Pin Jumper, 2mm                                                               | SAMTEC, TMM-103-02-L-S        |
| 7                                                | 5   | JP1,JP2,JP3,JP4,JP5 | SHUNT, 2mm                                                                              | SAMTEC, 2SN-BK-G              |
| 8                                                | 4   |                     | STAND-OFF, NYLON 0.375" tall (SNAP ON)                                                  | KEYSTONE, 8832 (SNAP ON)      |
| 9                                                | 1   |                     | FAB, PRINTED CIRCUIT BOARD                                                              | DEMO CIRCUIT # DC1701A        |

Figure 4. DC1701A BOM