

# LTC4020EUHF

## High Power Buck-Boost Multi-Chemistry Battery Charger

### DESCRIPTION

Demonstration circuit 2134A is a high power buck-boost multichemistry battery charger featuring the [LTC®4020](#). The board will accept an input voltage between 15V and 55V. The float voltage of the battery output (BAT) is 25.2V, with 6.3A maximum charge current. The converter output ( $V_{OUT}$ ) has a voltage range of 21V to 28V, with 8A maximum load current. The LTC4020 contains a high efficiency synchronous buck-boost DC/DC controller, and uses a proprietary average current mode architecture.

The LTC4020 battery charger can provide a constant-current/constant-voltage charge algorithm (JP1: CC/CV,

with mode pin grounded), constant-current charging (JP1: CC, with mode pin floated), or charging with an optimized 4-step, 3-stage lead-acid battery charge profile (JP1: lead-acid, with mode pin connected to INTV<sub>CC</sub>).

The LTC4020 data sheet gives a complete description of the IC operation and application information. The data sheet must be read in conjunction with this quick start guide.

**Design files for this circuit board are available at <http://www.linear.com/demo/DC2134A>**

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### PERFORMANCE SUMMARY

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

PARAMETER	CONDITION	VALUE
Input Voltage Range		15V to 55V
Battery Float Voltage (BAT) (Nominal)	$I_{BAT} = 0A$	25.2V
Converter Output Voltage ( $V_{OUT}$ )	$I_{OUT} = 0A$ to 8A	21V to 28V
Maximum Battery Charge Current, $I_{BAT}$	$I_{OUT} = 0A$	6.3A
Maximum Converter Output Current, $I_{OUT}$	$I_{BAT} = 0A$	8A
Typical Efficiency	$V_{IN} = 24V, V_{OUT} = 25.2V, I_{OUT} = 8A$	98.1%
Typical Converter Output Ripple	$V_{IN} = 55V, V_{OUT} = 25.2V, I_{OUT} = 8A$ (20MHz Bandwidth)	109mV <sub>P-P</sub>

## QUICK START PROCEDURE

Demonstration circuit 2134A is easy to set up to evaluate the performance of the LTC4020. Refer to Figure 1 for the proper measurement equipment setup and follow the procedure below:

1. With power off, connect the input power supply (set for 0V) to  $V_{IN}$  and GND (input return).
2. Connect the converter output load between  $V_{out}$  and GND (Initial load: no load).
3. Connect the DVMs to the input and outputs.
4. Turn on the input power supply and slowly increase to 24V. Check for the proper output voltages,  $V_{OUT}$  of 25.2V and BAT of 25.2V.
5. Once the proper output voltages are established, adjust the converter output load within the operating range (8A maximum) and/or adjust input voltage (15V to 55V), and observe the output voltage regulation, ripple voltage, efficiency and other parameters.

Note: When measuring the output or input voltage ripple, do not use the long ground lead on the oscilloscope probe. See Figure 2 for the proper scope probe technique. Short, stiff leads need to be soldered to the (+) and (-) terminals of an output capacitor. The probe's ground ring needs to touch the (-) lead and the probe tip needs to touch the (+) lead.

### Additional Notes:

1. **CAUTION: Be careful when testing with high voltage. High voltage can result in an electric shock if care is not taken.**
2. **CAUTION: Batteries are potentially dangerous high energy sources. Improper connection, overcharge, or rapid discharge could result in explosion and/or fire. Please read the specification/manual of the battery before test.**
3. **The combined converter output load current and battery charging current should not exceed 8A.**
4. Without a proper battery, BAT output can be open or connected with other suitable loads for test purposes. It may be a good practice to add low ESR electrolytic capacitors to the BAT output ( $\geq 1000\mu\text{F}$  at  $\geq 35\text{V}$ , for 25.2V float voltage).  
  
Note: These capacitors help simulate the low impedance of a battery and maintain stability of the charge current loop. It's only needed for test purposes with electronic or resistive loads, and not needed in the actual battery application/test (where the BAT load is a battery).
5. BAT float voltage can be easily adjusted with the resistor divider R8/R10. Converter output voltage  $V_{OUT}$  can be adjusted with the resistor divider R9/R11. Adjust/optimize the loop compensations if necessary.

**QUICK START PROCEDURE**

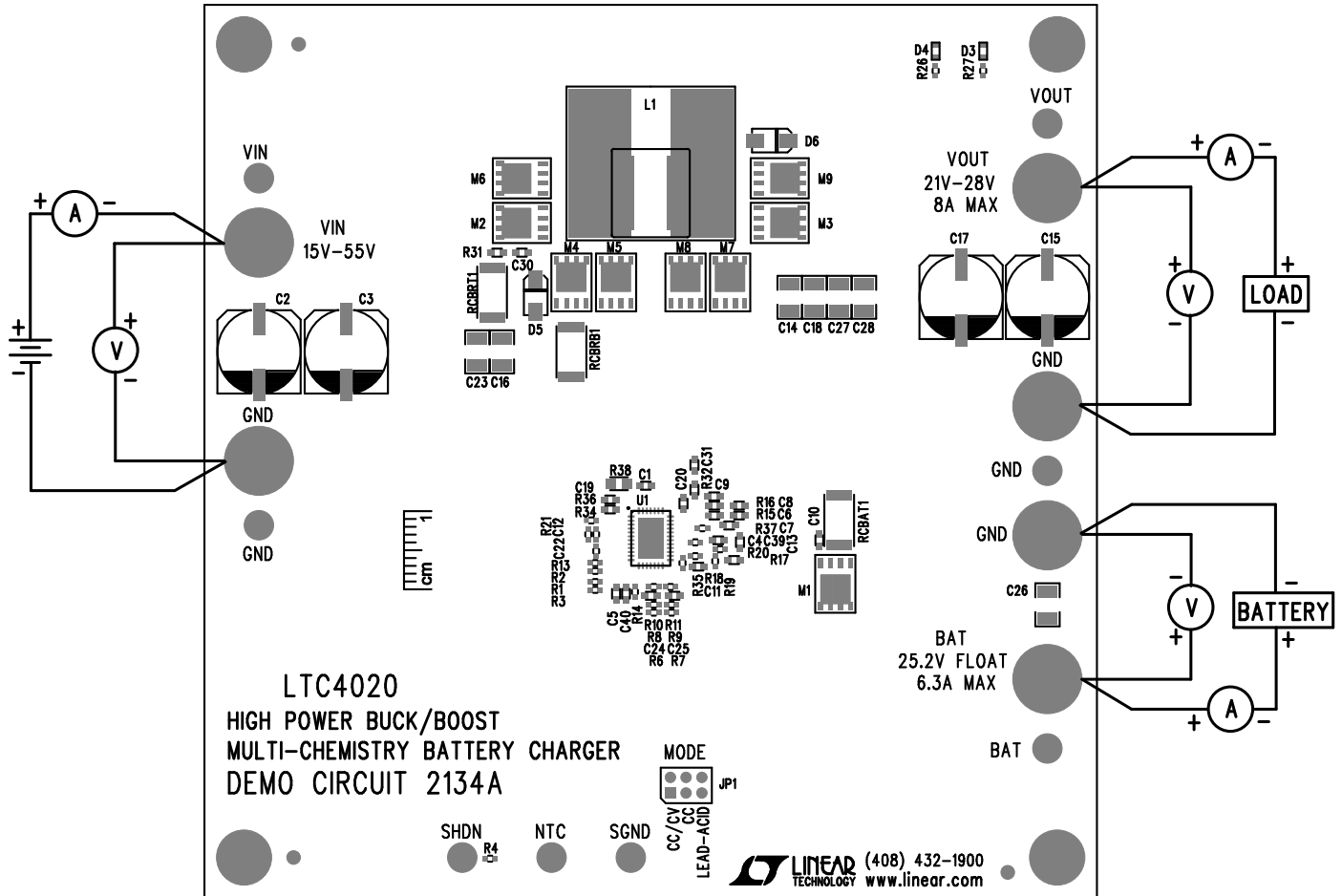


Figure 1. Proper Measurement Equipment Setup

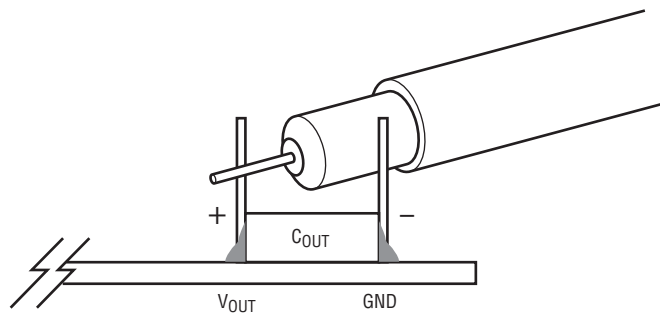


Figure 2. Measuring Output Voltage Ripple

## QUICK START PROCEDURE

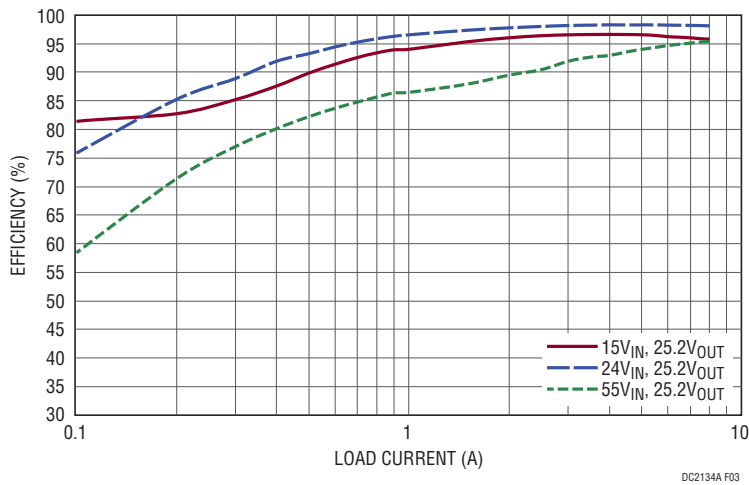


Figure 3. Efficiency vs Load Current ( $V_{OUT} = 25.2V$ )

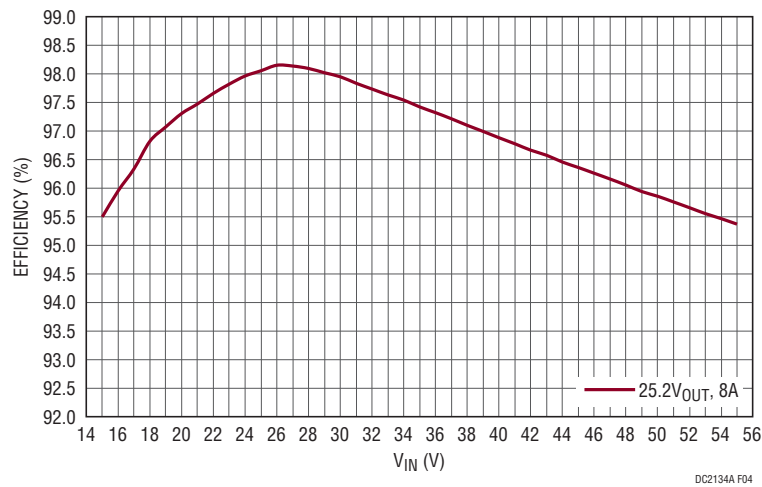


Figure 4. Efficiency vs Input Voltage ( $V_{OUT} = 25.2V$ ,  $I_{OUT} = 8A$ )

## PARTS LIST

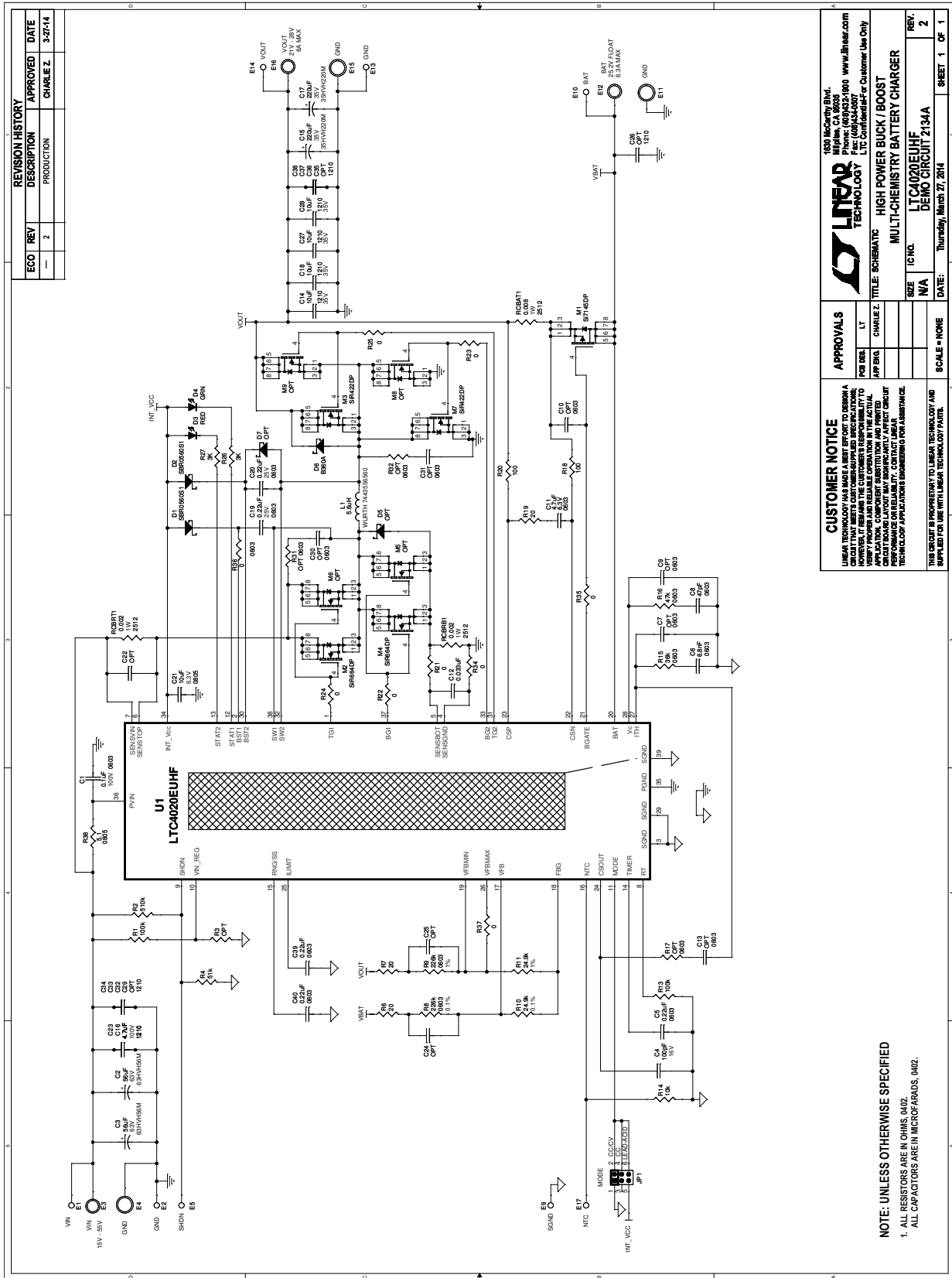
ITEM	QTY	REFERENCE	PART DESCRIPTION	MANUFACTURER/PART NUMBER
<b>Required Circuit Components</b>				
1	1	C1	CAP, CHIP, X7S, 0.1 $\mu$ F, 10%, 100V, 0603	TDK, C1608X7S2A104K
2	2	C2,C3	CAP, ELEC., 56 $\mu$ F, 20%, 63V, 10X12.5	SUNCON, 63HVH56M
3	1	C4	CAP, CHIP, C0G, 100pF, 10%, 16V, 0402	AVX, 0402YA101KAT9A
4	1	C6	CAP., MLCC, 6800pF, 50V,10%, 0603	AVX,ESD35C682K4T2A-18
5	1	C8	CAP, CHIP, C0G, 47pF, 10%, 50V, 0603	AVX., 06035A470KAT2A
6	1	C11	CAP, CHIP, X5R, 4.7 $\mu$ F, 10%, 6.3V, 0603	AVX, 06036D475KAT2A
7	1	C12	CAP, CHIP, X7R, 0.033 $\mu$ F, 10%, 25V, 0402	TDK, C1005X7R1E333K
8	4	C14, C18, C27, C28	CAP, CHIP, X5R, 10 $\mu$ F, 20%, 35V, 1210	AVX, 1210DD106MAT2A
9	2	C15, C17	CAP, ELEC., 220 $\mu$ F, 20%, 35V 10X12.5	SUNCON, 35HVH220M
10	2	C16, C23	CAP, CHIP, X7S, 4.7 $\mu$ F, 20%, 100V, 1210	TDK,C3225X7S2A475M
11	3	C5, C19, C20	CAP, CHIP, X5R,0.22 $\mu$ F, 10%, 25V, 0603	AVX, 06033D224KAT2A
12	1	C21	CAP, CHIP, X5R, 10 $\mu$ F, 20%, 6.3V, 0805	AVX., 08056D106KAT2A
13	2	C39, C40	CAP, CHIP, X7R,0.22 $\mu$ F, 20%, 10V, 0603	AVX, 0603ZC224MAT2A
14	2	D1, D2	DIODE, SMT, SUPERBARRIER, 60V, 0.5A, SOD123	DIODES INC., SBR0560S1-7
15	1	D3	DIODE, LED, RED, SMT, 0603	WÜRTH, 150060SS75000
16	1	D4	DIODE, LED, GREEN, 0603	WÜRTH, 150060VS75000
17	1	D6	DIODE., SMT SCHOTTKY BARRIER RECTIFIER, SMA	VISHAY, B360A-E3
18	1	L1	IND, SMT, 5.6 $\mu$ H	WÜRTH, 7443556560
19	1	M1	P-CHANNEL MOSFET, -30V PowerPAKS08	VISHAY, Si7145DP-T1-GE3
20	2	M2, M4	N-CHANNEL MOSFET, 60V, PowerPAKS08	VISHAY, SiR664DP-T1-GE3
21	2	M3, M7	N-CHANNEL MOSFET, 40V, PowerPAKS08	VISHAY, SiR422DP-T1-E3
22	1	RCBAT1	RES, CHIP, 0.008 $\Omega$ , 1%, 1W, 2512	VISHAY, WSL25128L000FEA
23	2	RCBRB1, RCBRT1	RES, CHIP, 0.002 $\Omega$ , 1%, 1W, 2512	VISHAY, WSL25122L000FEA
24	2	R1, R13	RES, CHIP, 100k $\Omega$ , 5%, 0402	VISHAY, CRCW0402100KJNED
25	1	R2	RES, CHIP, 510k $\Omega$ , 5%, 0402	VISHAY, CRCW0402510KJNED
26	1	R4	RES, CHIP, 51k $\Omega$ , 1%, 0402	VISHAY, CRCW040251K0FKED
27	3	R6, R7, R19	RES, CHIP, 20 $\Omega$ , 5%, 0402	VISHAY, CRCW040220R0JNED
28	1	R8	RES, CHIP, 226k $\Omega$ , 0.1%, 0603	VISHAY, TNPW06030F226BEEA
29	1	R9	RES, CHIP, 226k $\Omega$ , 1%, 0603	VISHAY, CRCW0603226KFKEA
30	1	R10	RES, CHIP, 24.9k $\Omega$ , 0.1%, 0402	VISHAY, TNPW04020F24K9BEED
31	1	R11	RES, CHIP, 24.9k $\Omega$ , 1%, 0402	VISHAY, CRCW040224K9FKED
32	1	R14	RES, CHIP, 10k $\Omega$ , 1%, 0402	VISHAY, CRCW040210K0FKED
33	1	R15	RES, CHIP, 36k $\Omega$ , 1%, 0603	VISHAY, CRCW060336K0FKEA
34	1	R16	RES, CHIP, 47k $\Omega$ , 1%, 0603	VISHAY, CRCW060347K0FKEA
35	2	R18, R20	RES, CHIP, 100 $\Omega$ , 5%, 0402	VISHAY, CRCW0402100RJNED
36	2	R26, R27	RES, CHIP, 3k $\Omega$ , 5%, 0402	VISHAY, CRCW04023K00JNED
37	1	U1	IC, LTC4020EUHF, 5mm x 7mm QFN-38	LINEAR TECH., LTC4020EUHF

# DEMO MANUAL DC2134A

## PARTS LIST

ITEM	QTY	REFERENCE	PART DESCRIPTION	MANUFACTURER/PART NUMBER
<b>Additional Demo Board Circuit Components</b>				
1	0	C13, C7, C9, C10, C30, C31 (OPT)	CAP, CHIP, OPT 0603	OPT
2	0	C22, C24, C25 (OPT)	CAP, CHIP, OPT 0402	OPT
3	0	C26, C29, C32-C38 (OPT)	CAP, CHIP, OPT 1210	OPT
4	0	D5 (OPT)	DIODE, OPT SMA	OPT
5	0	D7 (OPT)	DIODE, OPT SOD123	OPT
6	0	M5, M6, M8, M9 (OPT)	N-CHANNEL MOSFET, OPT PowerPAKS08	OPT
7	0	R3 (OPT)	RES, OPT 0402	OPT
8	8	R21-25, R34, R35, R37	RES, CHIP, 0 $\Omega$ JUMPER, 0402	VISHAY, CRCW04020000Z0ED
9	0	R17, R31, R32 (OPT)	RES, OPT 0603	OPT
10	1	R36	RES, CHIP, 0 $\Omega$ JUMPER, 0603	VISHAY, CRCW06030000Z0EA
11	1	R38	RES, CHIP, 5.1, 5%, 0805	VISHAY, CRCW08055R10JNEA
<b>Hardware: For Demo Board Only</b>				
1	8	E1, E2, E5, E9, E10, E13, E14, E17	TURRET, 0.09" DIA	MILL-MAX, 2501-2-00-80-00-00-07-0
2	6	E3, E4, E11, E12, E15, E16	VERTICAL BANANA JACK, 575-4	KEYSTONE, 575-4
3	1	JP1	HEADER, HD2X3-079	WÜRTH, 62000311121
4	1	XJP1	SHUNT, .079" CENTER	WÜRTH, 60800213421
5	4		STAND-OFF, NYLON (SNAP ON), 0.375" TALL	KEYSTONE, 8832 (SNAP ON)

SCHEMATIC DIAGRAM



REVISION HISTORY				
ECO	REV	DESCRIPTION	APPROVED	DATE
—	2	PRODUCTION	CHARLEZ	3-27-14

100 Lincoln Blvd.  
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**APPROVALS**  
 FOR DES: LT  
 APP'ING: CHARLEZ

**TITLE: SCHEMATIC**  
**PROJECT: MULTI-CHEMISTRY BATTERY CHARGER**

SCALE = NONE

DATE: Thursday, March 27, 2014

SHEET 1 OF 1

NOTE: UNLESS OTHERWISE SPECIFIED  
 1. ALL RESISTORS ARE IN OHMS, Ω.  
 ALL CAPACITORS ARE IN MICROFARADS, μMFD.



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# DEMO MANUAL DC2134A

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This notice contains important safety information about temperatures and voltages. For further safety concerns, please contact a LTC application engineer.

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LT 0414 • PRINTED IN USA

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