LTC4020EUHF
High Voltage Buck-Boost Multi-Chemistry Battery Charger

DESCRIPTION

Demonstration circuit 2044A is a 55V buck-boost multi-chemistry battery charger featuring the LTC4020. The board will accept an input voltage between 15V and 55V. The float voltage of the battery output (BAT) is 25.2V, with 3.3A maximum charge current. The converter output (VOUT) has a voltage range of 21V to 28V, with 3A 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 (CC/CV, with MODE pin grounded), constant-current charging (CC, with MODE pin floated), or charging with an optimized 4-step, 3-stage lead-acid battery charge profile (connect MODE pin to $INTV_{CC}$, with a 0Ω jumper at the optional R29 position).

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/DC2044A

PERFORMANCE SUMMARY

Specifications are at T_A = 25°C

SYMBOL	CONDITIONS	VALUE
Input Voltage Range		15V to 55V
Battery Float Voltage (BAT) (Nominal)	I_{BAT} = 0A to 3.3A	25.2V
Converter Output Voltage (VOUT)	I_{OUT} = 0A to 3A	21V to 28V
Maximum Battery Charge Current, I_{BAT}	I_{OUT} = 0A	3.3A
Maximum Converter Output Current, I_{OUT}	I_{BAT} = 0A	3A
Typical Efficiency	V_{IN} = 24V, V_{OUT} = 25.2V, I_{OUT} = 3A	97%
Typical Converter Output Ripple	V_{IN} = 55V, V_{OUT} = 25.2V, I_{OUT} = 3A (20MHz BW)	56mV_{P-P}

QUICK START PROCEDURE

Demonstration circuit 2044A 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 (3A 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 file. Please read the specification/manual of the battery before test.**
3. **The combined converter output load current and battery charging current should not exceed 3.3A.**
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 (≥1000µF at ≥35V, 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

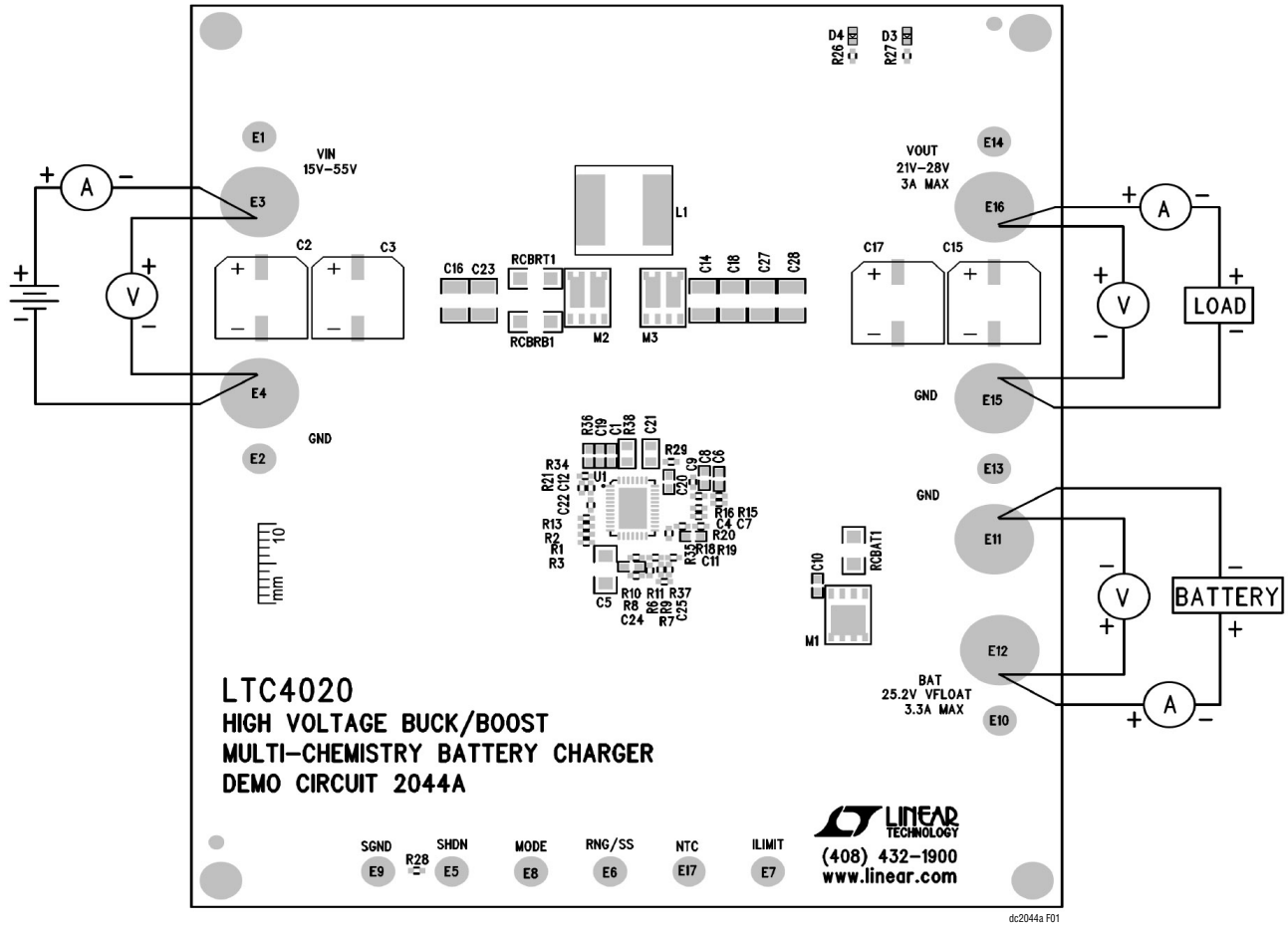


Figure 1. Proper Measurement Equipment Setup

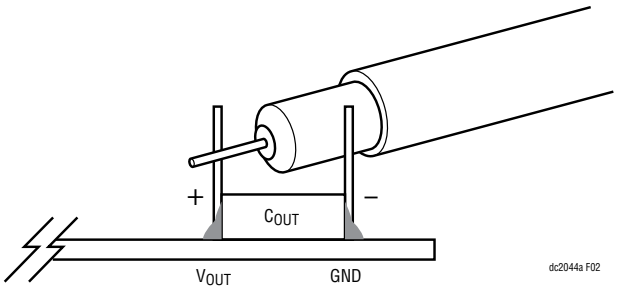


Figure 2. Measuring Output Voltage Ripple

QUICK START PROCEDURE

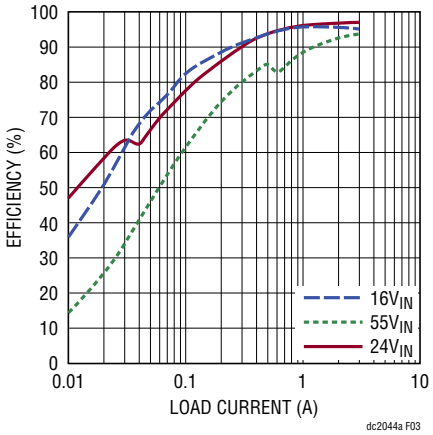


Figure 3. Efficiency vs Load Current (V_{OUT} = 25.2V)

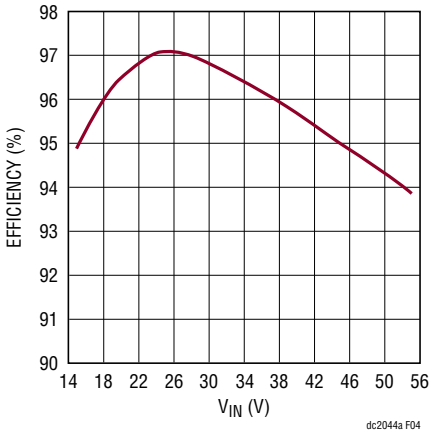


Figure 4. Efficiency vs Input Voltage (V_{OUT} = 25.2V, I_{OUT} = 3A)

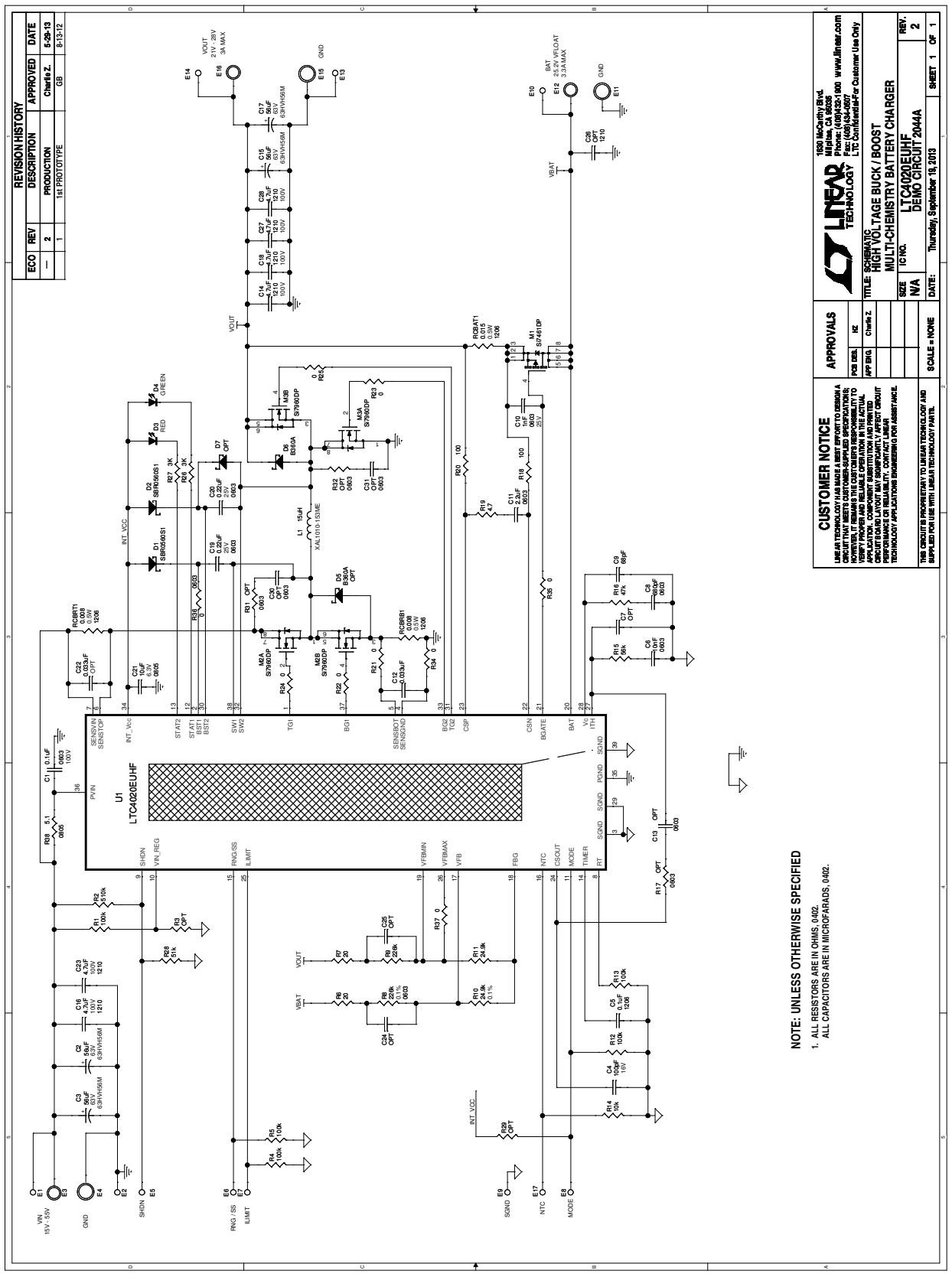
PARTS LIST

ITEM	QTY	REFERENCE	PART DESCRIPTION	MANUFACTURER/PART NUMBER
Required Circuit Components				
1	1	C1	CAP, CHIP, X7S, 0.1µF, 10%, 100V, 0603	TDK, C1608X7S2A104K
2	4	C2, C3, C15, C17	CAP, ELEC, 56µF, 20%, 63V, 10.3mm × 10.3mm	SUNCON, 63HVH56M
3	1	C4	CAP, CHIP, C0G, 100pF, 10%, 16V, 0402	AVX, 0402YA101KAT9A
4	1	C5	CAP, CHIP, C0G, 0.1µF, 10%, 16V, 1206	KEMET, C1206H104J3GACTU
5	1	C6	CAP, CHIP, X7R 10nF, 10%, 50V, 0603	AVX, 06035C103KAT
6	1	C8	CAP, CHIP, C0G, 680pF, 10%, 50V, 0603	AVX, 06035A681KAT2A
7	1	C9	CAP, CHIP, C0G, 68pF, 5%, 16V, 0402	AVX, 0402YA680JAT4A
8	2	C19, C20	CAP, CHIP, X5R, 0.22µF, 10%, 25V, 0603	AVX, 06033D224KAT2A
9	1	C10	CAP, CHIP, X7R, 0.001µF, 10%, 25V, 0603	AVZ, 06033C102KAT2A
10	1	C11	CAP, CHIP, X5R, 2.2µF, 10%, 16V, 0603	TDK, C1608X5R1C225K
11	1	C12	CAP, CHIP, X7R, 0.033µF, 10%, 25V, 0402	TDK, C1005X7R1E333K
12	6	C14, C16, C18, C23, C27, C28	CAP, CHIP, X7S, 4.7µF,20%, 100V, 1210	TDK, C3225X7S2A475M
13	1	C21	CAP, CHIP, X5R, 10µF, 20%, 6.3V, 0805	AVX, 08056D106KAT2A
14	2	D1, D2	DIODE, SMT, SUPERBARRIER, 60V, 0.5A, SOD123	DIODES INC, SBR0560S1
15	1	D3	DIODE, LED, RED, SMT, 0603	PANASONIC, LNJ208R8ARA
16	1	D4	DIODE, LED, GREEN, 0603	LITE-ON, LTST-C190KGKT
17	1	D6	DIODE, SMT SCHOTTKY BARRIER RECTIFIER, SMA	VISHAY, B360A-E3
18	1	L1	IND, SMT, 15µH, 10A, 20%, 10mm × 11.3mm	COILCRAFT, XAL1010-153MEB
19	1	M1	P-CHANNEL MOSFET, –60V, –14.4A, PowerPAKSO8	VISHAY, Si7461DP-T1-E3
20	2	M2, M3	DUAL N-CHANNEL MOSFET, 60V, 9.7A, PowerPAKSO8	VISHAY, Si7960DP-T1-E3
21	1	R2	RES, CHIP, 510kΩ, 5%, 0402	VISHAY, CRCW0402510KFKED
22	5	R1, R4, R5, R12, R13	RES, CHIP, 100kΩ, 5%, 0402	VISHAY, CRCW0402100KJNED
23	2	R6, R7	RES, CHIP, 20Ω, 5%, 0402	VISHAY, CRCW040220R0JNED
24	1	R8	RES, CHIP, 226kΩ, 0.1%, 0603	VISHAY, TNPW06030F226BEEA
25	1	R9	RES, CHIP, 226kΩ, 1%, 0402	VISHAY, CRCW0402226KFKED
26	1	R10	RES, CHIP, 24.9kΩ, 0.1%, 0402	VISHAY, TNPW04020F24K9BEED
27	1	R11	RES, CHIP, 24.9kΩ, 1%, 0402	VISHAY, CRCW040224K9FKED
28	1	R14	RES, CHIP, 10kΩ, 1%, 0402	VISHAY, CRCW040210K0FKED
29	1	R15	RES, CHIP, 56kΩ, 1%, 0402	VISHAY, CRCW040256K0FKED
30	1	R16	RES, CHIP, 47kΩ, 1%, 0402	VISHAY, CRCW040247K0FKED
31	8	R21 TO 25, R34, R35, R37	RES, CHIP, 0Ω JUMPER, 0402	VISHAY, CRCW04020000Z0ED
32	1	R36	RES, CHIP, 0Ω JUMPER, 0603	VISHAY, CRCW06030000Z0EA
33	2	R18, R20	RES, CHIP, 100Ω, 5%, 0402	VISHAY, CRCW0402100RJNED
34	1	R19	RES, CHIP, 4.7Ω, 5%, 0402	VISHAY, CRCW04024R70JNED
35	2	R26, R27	RES, CHIP, 3kΩ, 5%, 0402	VISHAY, CRCW04023K00JNED

PARTS LIST

ITEM	QTY	REFERENCE	PART DESCRIPTION	MANUFACTURER/PART NUMBER
36	1	R28	RES, CHIP, 51kΩ, 5%, 0402	VISHAY, CRCW040251K00JNED
37	1	R38	RES, CHIP, 5.1, 5%, 0805	VISHAY, CRCW08055R10JNEA
38	2	RCBRB1, RCBRT1	RES, CHIP, 0.008Ω, 1%, 0.5W, 1206	VISHAY, WSL12068L000FEA18
39	1	RCBAT1	RES, CHIP, 0.015Ω, 1%, 0.5W, 1206	TT ELEC LRC-LRF1206F-01-F
40	1	U1	IC, LTC4020EUHF, 5mm × 7mm QFN38	LINEAR TECHNOLOGY, LTC4020EUHF
Additional Demo Board Circuit Components				
1	0	C7, C13, C22, C24 ,C25 , C26, C30, C31 (OPT)	CAP, CHIP, OPTIONAL	
2	0	D7 (OPT)	DIODE, SMT SOD123	
3	0	D5(OPT)	DIODE, SMT SCHOTTKY BARRIER RECTIFIER, SMA	
4	0	R3, R17, R29, R31, R32 OPT	RES, OPTIONAL	
Hardware: For Demo Board Only				
1	11	E1, E2, E5 TO 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	4		STAND-OFF, NYLON (SNAP ON), 0.375" TALL	KEYSTONE, 8832 (SNAP ON)
4	1		FAB, PRINTED CIRCUIT BOARD	DEMO CIRCUIT 2044A

SCHEMATIC DIAGRAM



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