

LTC4020EUHF

High Power Buck-Boost Multi-Chemistry Battery Charger

DESCRIPTION

Demonstration circuit 2134B is a high power buck-boost multi-chemistry 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 (CC/CV); a four-step, three-stage lead-acid battery-charge profile or constant-current charging (CC). Battery-chemistry type is selected using onboard jumper JP1.

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.](#)

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

PARAMETER	CONDITIONS	MIN	TYP	MAX	UNITS
Input Voltage Range		15		55	V
Battery Float Voltage (BAT) (Nominal)	$I_{BAT} = 0\text{A to }6.3\text{A}$		25.2		V
Converter Output Voltage (V_{OUT})	$I_{OUT} = 0\text{A to }8\text{A}$	21		28	V
Maximum Battery Charge Current, I_{BAT}	$I_{OUT} = 0\text{A}$		6.3		A
Maximum Converter Output Current, I_{OUT}	$I_{BAT} = 0\text{A}$		8		A
Typical Efficiency	$V_{IN} = 24\text{V}, V_{OUT} = 25.2\text{V}, I_{OUT} = 8\text{A}$		98		%
Typical Converter Output Ripple	$V_{IN} = 55\text{V}, V_{OUT} = 27.7\text{V}, I_{OUT} = 8\text{A} (20\text{MHz BW})$		127		mV _{p-p}

QUICK START PROCEDURE

Demonstration circuit 2134B 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.

NOTE: Make sure that the voltage applied to VIN does not exceed 55V. The combined converter output load current and battery charging current should not exceed 8A.

1. With power off, connect the input power supply (set for 0V) to VIN and GND (input return).
2. Connect the converter output load between VOUT 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.

WARNING:

BE CAREFUL WHEN TESTING WITH HIGH VOLTAGE. HIGH VOLTAGE CAN RESULT IN AN ELECTRIC SHOCK IF CARE IS NOT TAKEN.

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.

Additional Notes

1. 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 that these capacitors help simulate the low impedance of a battery and maintain stability of the charge current loop. They are 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).
2. The 0 Ω , 2512 jumper (R41) in series with the inductor can be removed and a wire loop can be added in its place to facilitate the use of a current probe.
3. BAT float voltage can be easily adjusted with the resistor divider R44/R45. Converter output voltage V_{OUT} can be adjusted with the resistor divider R9/R11. Adjust/optimize the loop compensations if necessary.

QUICK START PROCEDURE

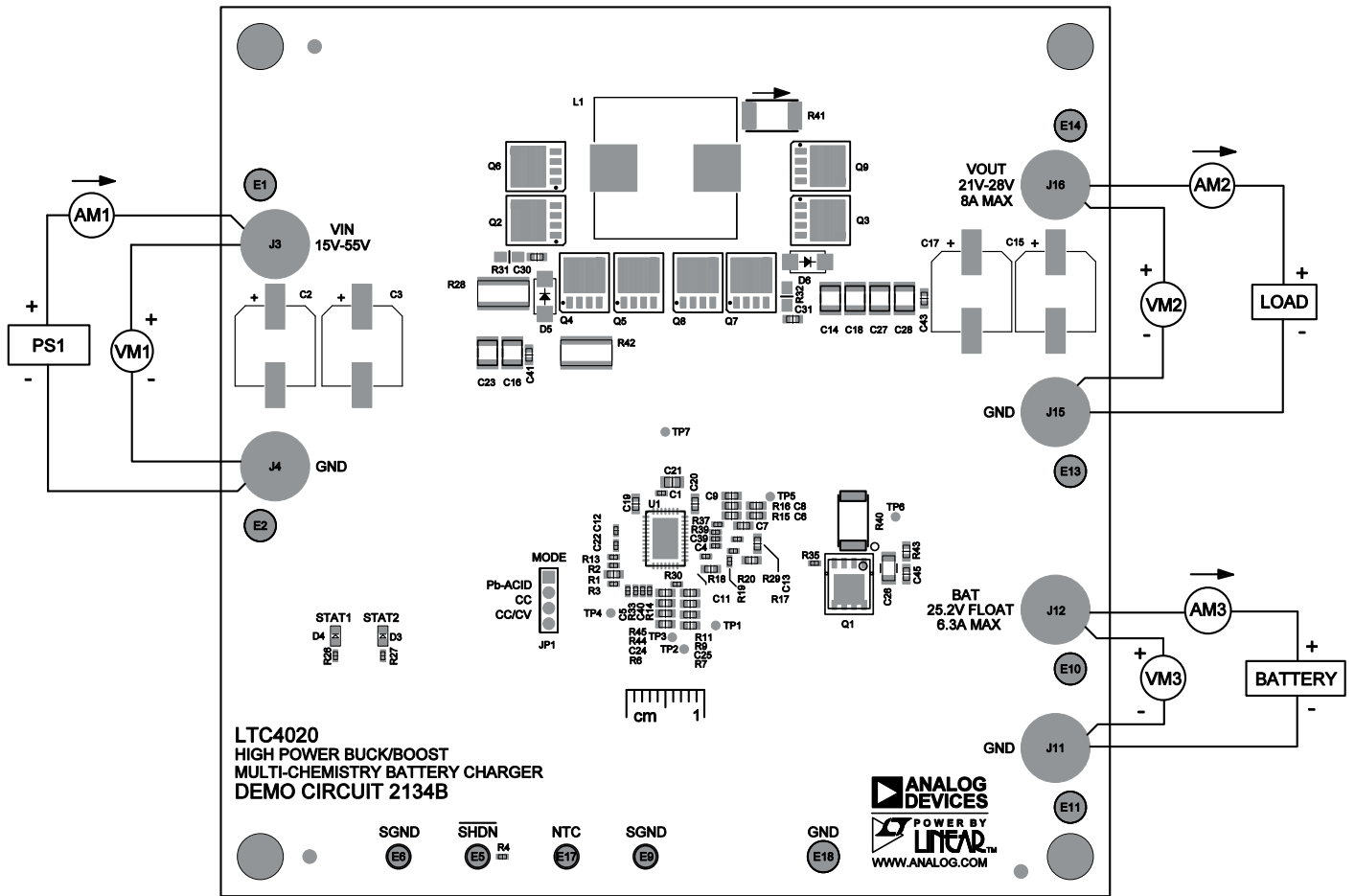


Figure 1. Proper Measurement Equipment Setup

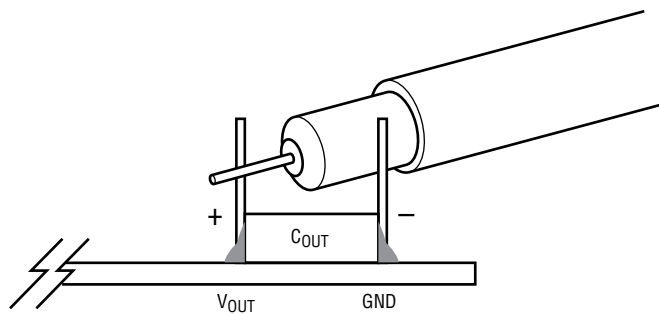


Figure 2. Measuring Output Voltage Ripple

TEST RESULTS

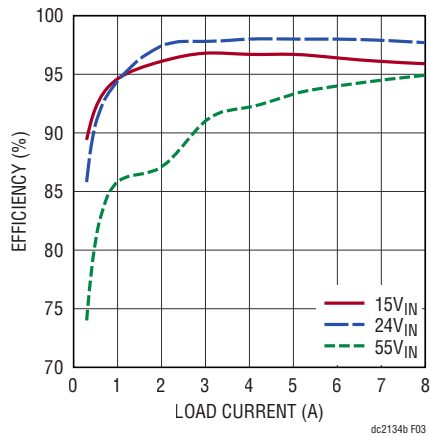


Figure 3. Efficiency vs Load Current ($V_{OUT} = 25.2V$)

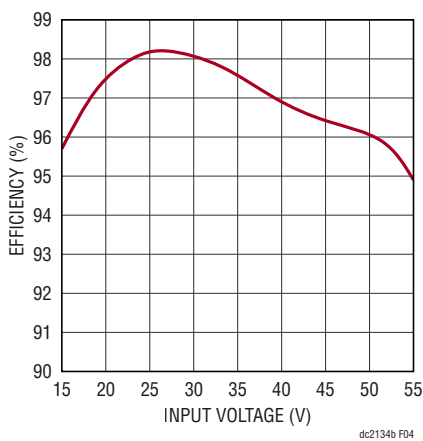


Figure 4. Efficiency vs Input Voltage ($V_{OUT} = 25.2V$, $I_{OUT} = 8A$)

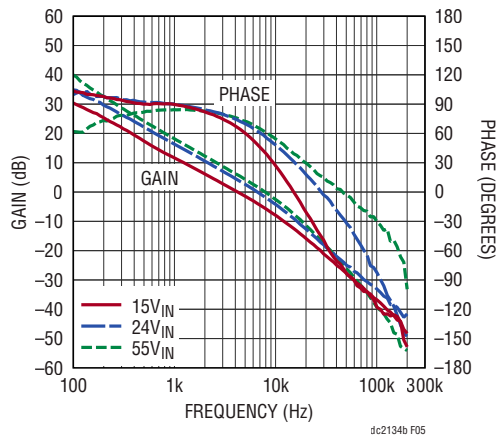


Figure 5. Bode Plots for V_{OUT} Voltage Control Loop ($V_{OUT} = 27.7V$, $I_{OUT} = 8A$, NTC = SGND)

PARTS LIST

ITEM	QTY	REFERENCE	PART DESCRIPTION	MANUFACTURER/PART NUMBER
Required Electrical Components				
1	2	C1, C5	CAP, 0.22 μ F, X7R, 16V, 10%, 0402, AEC-Q200	MURATA, GCM155R71C224KE02D
2	1	C11	CAP, 4.7 μ F, X7R, 10V, 10%, 0603	MURATA, GRM188Z71A475KE15D
3	1	C12	CAP, 0.1 μ F, X7R, 10V, 10%, 0402	MURATA, GRM155R71A104KA01D
4	1	C13	CAP, 0.022 μ F, X7R, 25V, 10%, 0603, AEC-Q200	KEMET, C0603C223K3RACAUTO
5	4	C14, C18, C27, C28	CAP, 10 μ F, X7R, 35V, 10%, 1210	AVX, 1210DD106KAT2A
6	2	C15, C17	CAP, 220 μ F, ALUM POLY HYB, 35V, 20%, 10mm \times 12.5mm, SMD, AEC-Q200	SUN ELECTRONIC INDUSTRIES CORP, 35HVH220M
7	2	C16, C23	CAP, 4.7 μ F, X7S, 100V, 10%, 1210, AEC-Q200	MURATA, GCM32DC72A475KE02L
8	2	C19, C20	CAP, 1 μ F, X7R, 16V, 10%, 0603	KEMET, C0603C105K4RAC7867
9	2	C2, C3	CAP, 56 μ F, ALUM POLY HYB, 63V, 20%, 10mm \times 112.5mm SMD, AEC-Q200	SUN ELECTRONIC INDUSTRIES CORP, 63HVH56M
10	2	C21, C42	CAP, 10 μ F, X7R, 16V, 10%, 0805	TAIYO YUDEN, EMK212BB7106MG-T
11	2	C39, C40	CAP, 0.22 μ F, X7R, 10V, 10%, 0402	MURATA, GRM155R71A224KE01D
12	1	C4	CAP, 100pF, C0G, 50V, 5%, 0402	AVX, 04025A101JAT2A
13	2	C41, C43	CAP, 0.01 μ F, X7R, 100V, 10%, 0603, AEC-Q200	MURATA, GCJ188R72A103KA01D
14	1	C44	CAP, 0.01 μ F, X7R, 50V, 10%, 1206	KEMET, C1206C103K5RAC7025
15	1	C45	CAP, 1 μ F, X7R, 50V, 10%, 0603	AVX, 06035C105KAT2A
16	1	C8	CAP, 270pF, C0G, 50V, 5%, 0603	AVX, 06035A271JAT2A
17	3	D1, D2, D7	DIODE, SBR, 60V, 500mA, SOD123	DIODES INC., SBR0560S1Q-7
18	1	D3	LED, RED, WATER-CLEAR, 0603	LITE-ON, LTST-C193KRKT-5A
19	1	D4	LED, GREEN, WATER-CLEAR, 0603	LITE-ON, LTST-C190KGKT
20	2	D5, D6	DIODE, SCHOTTKY RECTIFIER, 60V, 3A, 4.6mm \times 2.92mm	DIODES INC., B360A-13-F
21	1	D8	DIODE, ZENER, 12V, 500mW, SOD123, AEC-Q101	DIODES INC., BZT52C12-13-F
22	1	L1	IND., 5.6 μ H, SHIELDED WIREWOUND, 20%, 19A, 18.30mm \times 18.20mm SMT	WURTH ELEKTRONIK, 7443556560
23	1	Q1	XSTR., MOSFET, P-CH, 60V, 8.6A, PowerPAK SO-8	VISHAY, Si7461DP-T1-GE3
24	4	Q2, Q3, Q4, Q7	XSTR., MOSFET, N-CH, 60V, 93A, DFN5 (SO-8FL), AEC-Q101	ONSEMI, NTMFS5C646NLT1G
25	2	R1, R17	RES., 0 Ω , JUMPER, 0603, AEC-Q200	KOA SPEER, RK73Z1JTTDD
26	1	R11	RES., 24.9k, 1%, 1/10W, 0603, AEC-Q200	NIC, NRC06F2492TRF
27	1	R12	RES., 226k, 1%, 1/16W, 0402, AEC-Q200	NIC, NRC04F2263TRF
28	1	R14	RES., 10k, 1%, 1/10W, 0402, AEC-Q200	KOA SPEER, RK73H1ETTP1002F
29	1	R16	RES., 82.5k, 1%, 1/10W, 0603, AEC-Q200	PANASONIC, ERJ3EKF8252V
30	2	R18, R20	RES., 100 Ω , 1%, 1/16W, 0402, AEC-Q200	KOA SPEER, RK73H1ETTP1000F
31	1	R19	RES., 20 Ω , 1%, 1/16W, 0402, AEC-Q200	NIC, NRC04F20R0TRF
32	1	R2	RES., 511k, 1%, 1/16W, 0402, AEC-Q200	NIC, NRC04F5113TRF
33	4	R22-R25	RES., 10 Ω , 1%, 1/16W, 0402	YAGEO, RC0402FR-0710RL
34	2	R26, R27	RES., 2k, 1%, 1/16W, 0402, AEC-Q200	VISHAY, CRCW04022K00FKED
35	2	R28, R42	RES., 0.002 Ω , 2%, 3W, 2512, LONG-SIDE TERM., METAL, AEC-Q200	SUSUMU, KRL6432E-M-R002-G-T1
36	2	R3, R13	RES., 100k, 1%, 1/16W, 0402, AEC-Q200	NIC, NRC04F1003TRF

DEMO MANUAL DC2134B

PARTS LIST

ITEM	QTY	REFERENCE	PART DESCRIPTION	MANUFACTURER/PART NUMBER
37	2	R35, R37	RES., 0Ω, 5%, 1/16W, 0402	ROHM, MCR01MZPJ000
38	1	R4	RES., 51.1k, 1%, 1/16W, 0402, AEC-Q200	STACKPOLE ELECTRONICS, INC., RMCFO402FT51K1
39	1	R40	RES., 0.008Ω, 1%, 1W, 2512	VISHAY, WSL25128L000FEA
40	1	R41	RES., 0Ω, 200A, 2512, COPPER, SENSE	VISHAY, WSL251200000ZEA9
41	1	R43	RES., 1Ω, 1%, 1/10W, 0603	YAGEO, RC0603FR-071RL
42	1	R44	RES., 226k, 0.1%, 1/10W, 0603, HIGH STABILITY	VISHAY, TNPW0603226KBEEA
43	1	R45	RES., 24.9k, 0.1%, 1/8W, 0603, AEC-Q00	VISHAY, TNPW060324K9BEEA
44	1	R5	RES., 825k, 1%, 1/16W, 0402, AEC-Q200	VISHAY, CRCW0402825KFKED
45	2	R6, R7	RES., 20Ω, 1%, 1/10W, 0603	YAGEO, RC0603FR-0720RL
46	1	R9	RES., 226k, 1%, 1/10W, 0603	NIC, NRC06F2263TRF
47	1	U1	IC, 55V BUCK-BOOST BATTERY CHARGER, 38-PIN QFN	ANALOG DEVICES, LTC4020EUHF#PBF
48	1	U2	IC, 250mA, 4V TO 80V LDO LINEAR REG, DFN-12	ANALOG DEVICES, LT3012EDE#PBF

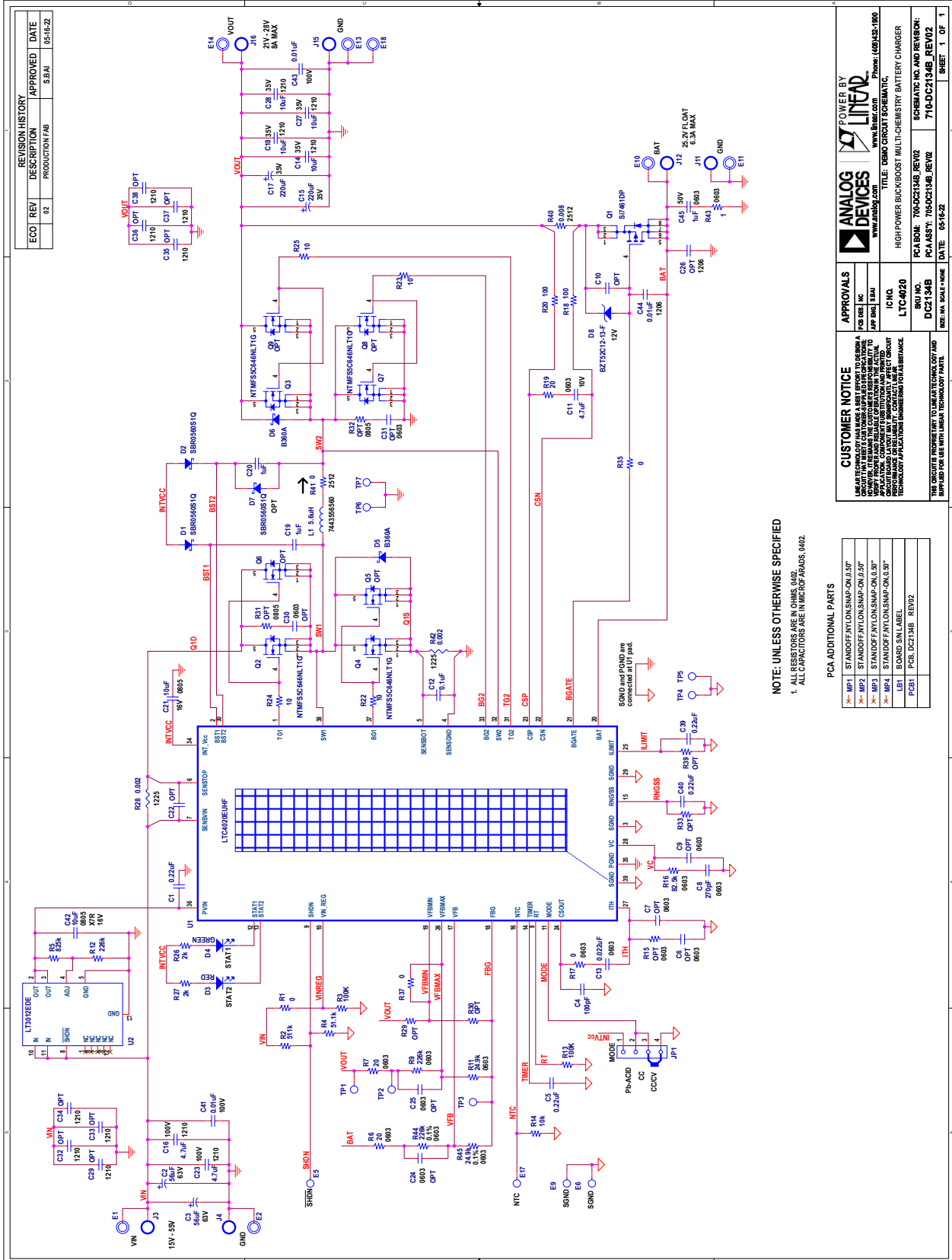
Optional Electrical Components

1	0	C6, C7, C9, C24, C25, C30, C31	CAP, OPTION, 0603	
2	0	C10, C22	CAP, OPTION, 0402	
3	0	C26, C44	CAP, OPTION, 1206	
4	0	C29, C32-C38	CAP, OPTION, 1210	
5	0	Q5, Q6, Q8, Q9	XSTR., OPTION, MOSFET, N-CH, DFN5 (SO-8FL)	
6	0	R15	RES., OPTION, 0603	
7	0	R29, R30, R33, R39	RES., OPTION, 0402	
8	0	R31, R32	RES., OPTION, 0805	

Hardware: For Demo Board Only

1	7	E1, E2, E10, E11, E13, E14, E18	TEST POINT, TURRET, 0.094" MTG. HOLE, PCB 0.062 THK	MILL-MAX, 2501-2-00-80-00-00-07-0
2	4	E5, E6, E9, E17	TEST POINT, TURRET, 0.064" MTG. HOLE, PCB 0.062" THK	MILL-MAX, 2308-2-00-80-00-00-07-0
3	6	J3, J4, J11, J12, J15, J16	CONN., BANANA JACK, FEMALE, THT, NON-INSULATED, SWAGE, 0.218"	KEYSTONE, 575-4
4	1	JP1	CONN., HDR, MALE, 1x4, 2mm, VERT, ST, THT	SULLINS CONNECTOR SOLUTIONS, NRPNO41PAEN-RC
5	4	MP1-MP4	STANDOFF, NYLON, SNAP-ON, 0.50"	WURTH ELEKTRONIK, 702935000
6	1	XJP1	CONN., SHUNT, FEMALE, 2-POS, 2mm	SAMTEC, 2SN-BK-G

SCHEMATIC DIAGRAM



ECO	REV	DESCRIPTION	APPROVED	DATE
	02	PRODUCTION FAB	S.BAI	05-16-22

REVISION HISTORY		APPROVALS	
ECO	REV	FOR DESI	INC
	02	APP INH	SDM
DESCRIPTION		IC NO.	LTC4020
PRODUCTION FAB		SKU NO.	DC2134B
		SCHEMATIC NO. AND REVISION	710-DC2134B_REV02
		PCA ASSY	706DC2134B_REV02
		DATE	05-16-22
		SHEET	1 OF 1

CUSTOMER NOTICE
 USE AS THE TARGET CUSTOMER SPECIFIED IN THE ACTUAL PART NUMBER AND RELEASE DATE. THE ACTUAL PART NUMBER AND RELEASE DATE MAY DIFFER FROM THE TARGET NUMBER AND DATE DUE TO TECHNOLOGY IMPROVEMENTS FOR THE PART.
 THIS CIRCUIT IS PROPRIETARY TO LINEAR TECHNOLOGY AND SHOULD NOT BE REPRODUCED OR TRANSMITTED IN ANY FORM OR BY ANY MEANS, ELECTRONIC OR MECHANICAL, INCLUDING PHOTOCOPYING, RECORDING, OR BY ANY INFORMATION STORAGE AND RETRIEVAL SYSTEM.

PCA-ADDITIONAL PARTS

MP1	STANDOFF-FYTONL5MNP-ON-0.50"
MP2	STANDOFF-FYTONL5MNP-ON-0.50"
MP3	STANDOFF-FYTONL5MNP-ON-0.50"
MP4	STANDOFF-FYTONL5MNP-ON-0.50"
LB1	BOARD S/N LABEL
PCB1	PCB DC2134B_REV02

NOTE: UNLESS OTHERWISE SPECIFIED
 1. ALL RESISTORS ARE IN OHMS, 0402.
 ALL CAPACITORS ARE IN MICROFARADS, 0402.



ESD Caution

ESD (electrostatic discharge) sensitive device. Charged devices and circuit boards can discharge without detection. Although this product features patented or proprietary protection circuitry, damage may occur on devices subjected to high energy ESD. Therefore, proper ESD precautions should be taken to avoid performance degradation or loss of functionality.

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