LTC4040
Battery Charger and Backup Power Manager

DESCRIPTION

Demonstration circuit 2118B is a combination step-down battery charger and step-up battery backup regulator using the LTC®4040 monolithic system power manager. The DC2118B has an input voltage range from 4.8V to 5.5V with overvoltage protection (OVP) to 40V, as limited by the external MOSFET. The input current is monitored to prioritize the load up to the 2.5A threshold before charge current is reduced.

Battery Charging

As initially configured, DC2118B is programmed for 2A charge current limit when in charge mode. The charge voltage is jumper-selectable in 8 discrete steps from 3.45V to 3.6V for $LiFePO_4$ chemistry or 3.95V to 4.1V for Li-ion chemistry, according to the F2/F1/F0 programming input settings.

The charge current limit is adjustable via the PROG pin resistor. End-of-charge status is triggered by current falling below C/8 and indicated by the $\overline{CHRG}$ LED. The optional NTC input provides temperature fault detection and status indicated by the $\overline{FAULT}$ LED. Charging can be enabled/disabled with the ENCHG jumper.

Battery Backup

Following an input power failure, the circuit automatically shifts to battery backup boost mode to regulate the VSYS output rail. The backup mode system output voltage is initially programmed for 5V. The input power failure status is indicated by the $\overline{PFO}$ LED.

If VSYS ever falls below the programmed reset threshold voltage, the $\overline{RST}$ LED will change states to indicate the need to reset the system and recharge the battery. Backup regulation can be enabled/disabled with the ENBST jumper.

For convenience, all LEDs can be disabled with the LED jumper to reduce the quiescent current of the system.

Design files for this circuit board are available.

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PERFORMANCE SUMMARY

Specifications are at T_A = 25°C

PARAMETER	CONDITIONS	VALUE
Charge Mode		
Input Voltage Range		4.8V to 5.5V
Overvoltage Protection Range	Limited by Q1 BV_{DSS}	5.5V to 40V
Input Current Limit	R7 = 10mΩ	2.5A
Default Charging Voltage	F2 = 1 (Li-Ion), F1 = 1, F0 = 1	4.10V
Charging Current	RPROG = 1.00k	2.0A
Safety Timer Period	F2 = 1 (Li-Ion)	4Hr
	F2 = 0 ($LiFePO_4$)	2Hr
Backup Mode		
DCIN Input Power Fail Threshold	R2 = 357k, R27 = 121k, DCIN Falling	4.8V
System Output Voltage	R4 = 1.69M, R5 = 324k	5.0V
Backup Battery Voltage Range		2.7V to 5.0V
System Reset Threshold	R4 = 1.69M, R5 = 324k, VSYS Falling	4.6V
Backup Boost Efficiency	VBAT = 3.6V, ISYS = 2A, VOUT = 5V	89%

PERFORMANCE SUMMARY

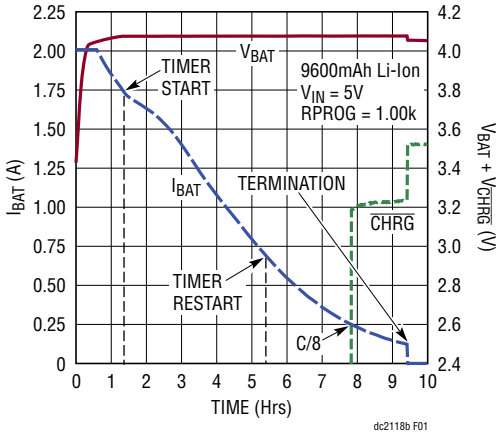


Figure 1. Typical Battery Charge Cycle

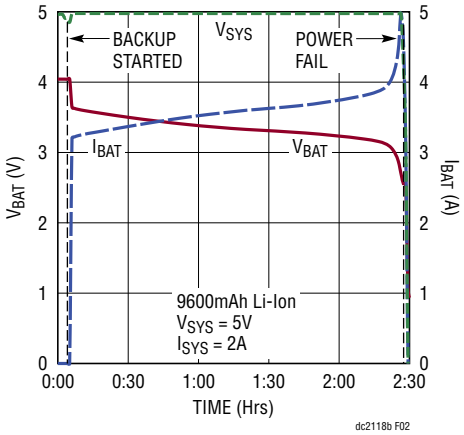


Figure 2. Typical Battery Discharge Cycle

QUICK START PROCEDURE

Demonstration circuit 2118B is easy to set up to evaluate the performance of LTC4040. Refer to Figure 2 for proper measurement equipment setup and follow the procedure below.

1. The jumpers are set as below for a typical 4.1V charging application:

JP1	NTC	INT
JP2	ENCHG	ON
JP3	ENBST	ON
JP4	F1	1
JP5	F0	1
JP6	LEDS	ON
JP7	F2	1

2. With all power off, connect the input supply, system load, and meters as shown in Figure 3.

Charge Mode

3. Connect the battery as shown in Figure 3 to charge at 4.1V, 2A. For alternate charge voltage settings, refer to Table 1.
4. Turn on the input power supply to evaluate charge mode. Adjust the input voltage and current limit to the desired value.

   NOTE: While DC2118B is robust to overvoltage conditions up to 40V on DCIN, DO NOT exceed this limit or damage may occur to MOSFET Q1 and IC U1.
5. Turn on and adjust the system load as necessary. Charging current will be limited when input current exceeds 2.5A.
6. The $\overline{CHRG}$ LED will toggle off when the charge current has dropped below 250mA. The timer will continue to run and charging will continue until the timer period ends. Multiple timer periods may be necessary to fully charge a large capacity battery, such as the one used to obtain Figure 1.
7. If the battery voltage does not increase above the low battery threshold during the precondition time or the thermistor value exceeds the normal range, $\overline{CHRG}$ will toggle off and $\overline{FAULT}$ will toggle on indicating a bad battery.

Backup Mode

8. Turn off the input power supply to evaluate backup mode.
9. The $\overline{PFO}$ LED will toggle on indicating input power failure.
10. Adjust the system load as necessary.

QUICK START PROCEDURE

11. Total backup runtime is based on battery capacity, circuit efficiency, and system load. Figure 2 shows an example discharge curve with constant current system load.
12. When VSYS falls below 7.5% of the programmed value, or 4.6V, then $\overline{RST}$ will toggle on.

Optional

1. Use an external thermistor connected between EXTNTC and GND as shown in Figure 3, with the NTC jumper, JP1, set to EXT.
2. Change the setting of the ENCHG, JP2, or ENBST, JP3, jumpers to enable/disable charging and backup boost respectively.
3. Monitor the PROG pin voltage for a scaled representation of the instantaneous charge current according to the relationship:

$$I_{BAT} = \frac{2000 \bullet V_{PROG}}{R_{PROG}}$$

Where R_{PROG} = R6 = 1kΩ.

4. Monitor the CLPROG pin voltage for a scaled representation of the instantaneous total input current according to the relationship:

$$I_{VIN} = \frac{V_{CLPROG}}{32 \bullet R_S}$$

Where R_S = R7 = 10mΩ.

5. All status LEDs can be disconnected to reduce the quiescent current by setting the LEDS jumper, JP6 to OFF.
6. External VDD can be used by connecting to EXTVDD and installing 0Ω for R16.

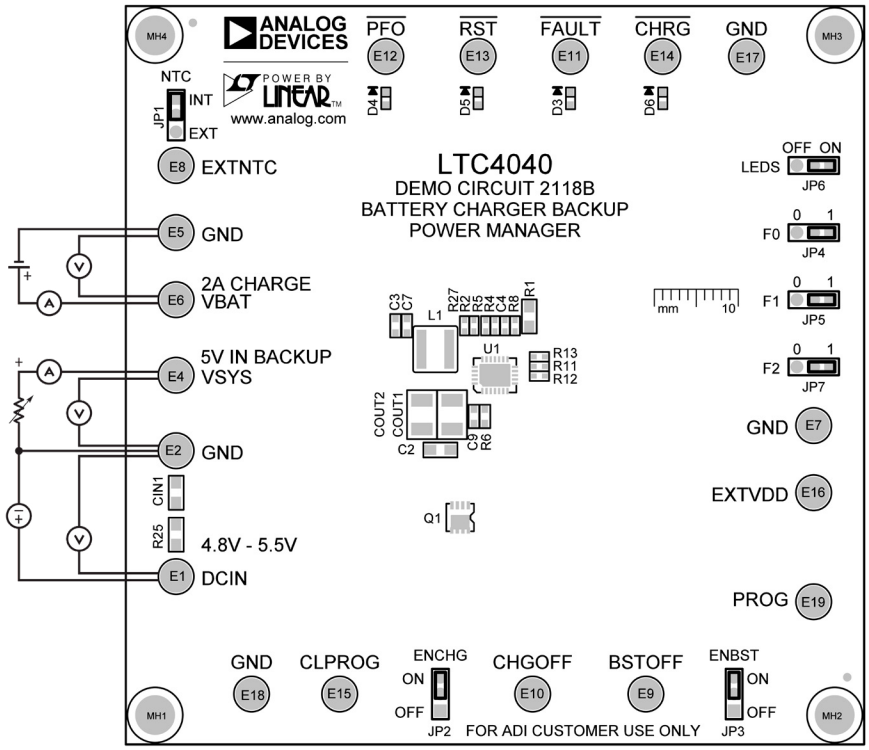


Figure 3. Proper Measurement Equipment Setup

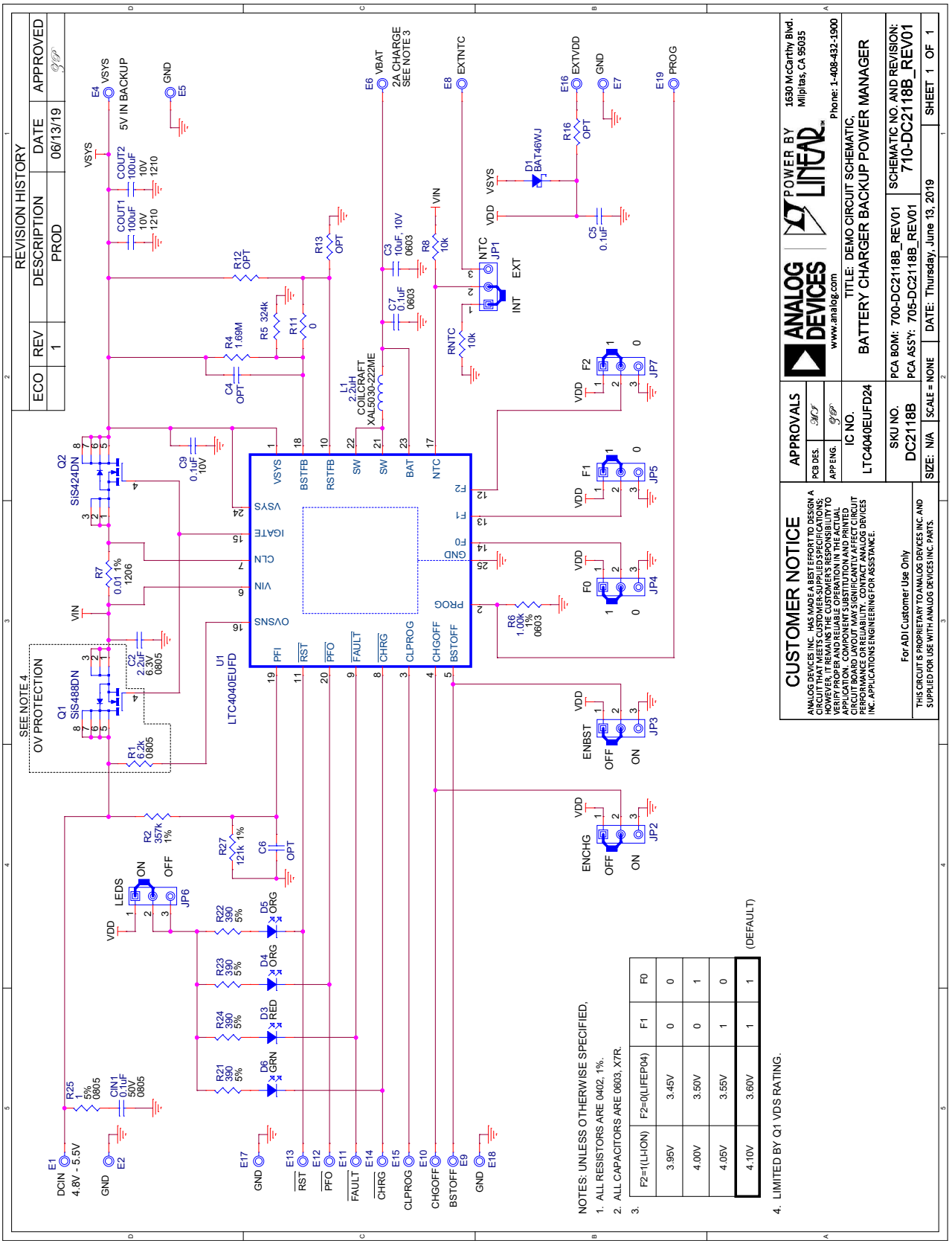
Table 1. Battery Charge Voltage Jumper Settings

JP7		JP5	JP4
F2 = 1 (Li-Ion)	F2 = 0 ($LiFePO_4$)	F1	F0
3.95	3.45	0	0
4.00	3.50	0	1
4.05	3.55	1	0
4.10	3.60	1	1

PARTS LIST

ITEM	QTY	REFERENCE	PART DESCRIPTION	MANUFACTURER/PART NUMBER
Required Circuit Components				
1	1	CIN1	CAP., X7R, 0.1µF, 10%, 50V, 0805	AVX, 08055C104KAT4A
2	2	COUT1, COUT2	CAP., X5R, 100µF, 20%, 10V, 1210	MURATA, GRM32ER61A107ME20L
3	1	C2	CAP., X7R, 2.2µF, 10%, 6.3V, 0805	MURATA, GRM21BR70J225MA01L
4	1	C3	CAP., X5R, 10µF, 20%, 10V, 0603	AVX, 0603ZD106MAT2A
5	2	C7, C9	CAP., X7R, 0.1µF, 10%, 10V, 0603	AVX, 0603ZC104KA72
6	1	L1	INDUCTOR, 2.2µH	COILCRAFT, XAL5030-222ME
7	1	Q2	XSTR, MOSFET N-CHANNEL, 20-V	VISHAY, SiS424DN-T1-GE3
8	1	R2	RES., 357k, 1/16W, 1%, 0402	VISHAY, CRCW0402357KFKED
9	1	R4	RES., 1.69MΩ, 1/16W, 1%, 0402	VISHAY, CRCW04021M69FKED
10	1	R5	RES., 324k, 1/16W, 1%, 0402	VISHAY, CRCW0402324KFKED
11	1	R6	RES., 1.00k, 1/10W, 1%, 0603	VISHAY, CRCW06031K00FKED
12	1	R7	RES., 0.01Ω, 1/4W, 1%, 1206	VISHAY, WSL1206R0100FEB
13	1	R8	RES., 10k, 1/16W, 1%, 0402	VISHAY, CRCW040210K0FKED
14	1	R11	RES., 0Ω JUMPER, 0402	VISHAY, CRCW04020000Z0ED
15	1	R25	RES., 1Ω, 1/8W, 5%, 0805	VISHAY, CRCW0805100RJNEA
16	1	R27	RES., 121k, 1/16W, 1%, 0402	VISHAY, CRCW0402121KFKED
17	1	U1	I.C., LTC4040EUFD	ANALOG DEVICES, LTC4040EUFD#PBF
Additional Demo Board Circuit Components				
1	0	C4, C6	CAP., 0402	OPT
2	1	C5	CAP., X5R, 0.1µF, 10%, 10V, 0402	MURATA, GRM155R71A104KA01J
3	1	D1	DIODE, SCHOTTKY	NXP, BAT46WJ
4	1	D3	DIODE, LED, SMT, RED, 0603	LITE-ON, LTST-C193KRKT-5A
5	2	D4, D5	DIODE, LED, SMT, ORANGE, 0603	LTIE-ON, LTST-C193KFKT-5A
6	1	D6	DIODE, LED, SMT, GREEN, 0603	LITE-ON, LTST-C193KGKT-5A
7	1	Q1	XSTR, MOSFET N-CHANNEL, 40-V	VISHAY, SiS488DN-T1-GE3
8	1	RNTC	RES., 10k, 1/16W, 1%, 0402	VISHAY, CRCW040210K0FKED
9	1	R1	RES., 6.2k, 1/8W, 5%, 0805	VISHAY, CRCW08056K20JNEA
10	0	R12, R13, R16	RES., 0402	OPT
11	4	R21-R24	RES., 390Ω, 1/16W, 5%, 0402	VISHAY, CRCW0402390RJNED
Hardware: For Demo Board Only				
1	18	E1, E2, E4-E19	TEST POINT, TURRET, 0.094"	MILL-MAX, 2501-2-00-80-00-00-07-0
2	7	JP1-JP7	3 PIN JUMPER, 2mm	SAMTEC TMM-103-02-L-S
3	7	XJP1-XJP7	SHUNT, 2mm	SAMTEC 2SN-BK-G
4	4	STAND-OFF	STAND-OFF, NYLON	KEYSTONE, 8834(SNAP ON)

SCHEMATIC DIAGRAM



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