ON Semiconductor

Design Note – DN05132/D

LiB Charge/Discharge Controller for Charging Cradle Systems

Device	Application	Input Voltage	Output Power	Topology	I/O Isolation
LC709301F	Charging Cradle	4.5 - 5.5	2.5 W	Charge/Discharge Controller	N/A

	Charge	Discharge
Output Voltage	4.2 V	5 V
Nominal Current	100 mA	100 mA
Max Current	500 mA	500 mA
Min Current	25 mA	25 mA

Device Efficiency	80 - 85 %
Operating Temp. Range	-40 to 85 °C
Overcharge/Discharge Protection	Yes
Pre-charge Control	Yes
Lib Protection	Yes
Low Battery Indication	Yes

Circuit Description

The LC709301F is a one-chip charge/discharge control system for charging cradles. It supports linear charging systems for 1-cell lithium-ion/polymer (li+) batteries within a range of 25 mA to 500 mA. Battery power while discharging is reversed, and the LC709301F operates as a boost converter while charging devices. It provides one-chip solution with charging/discharging and system control for cradle charging. This note is intended for users designing charge/discharge systems for end products such as ear-buds, smartwatch, portable speaker etc. The boost efficiency and standby current for LC709301F is plotted below.

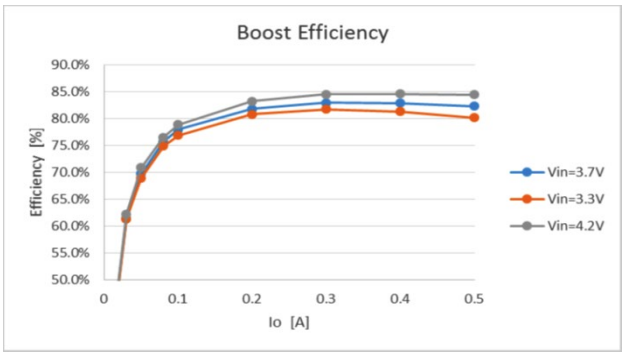


Figure 1: LC709301F boost efficiency based on battery capacity

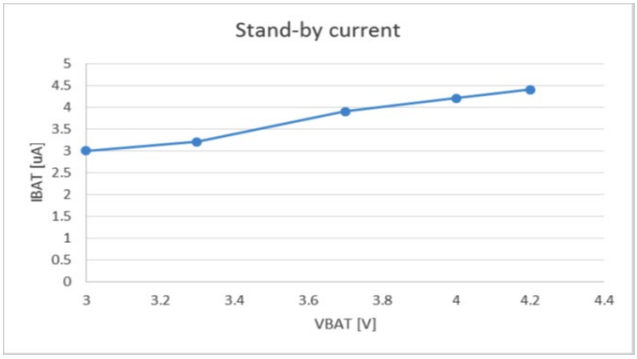


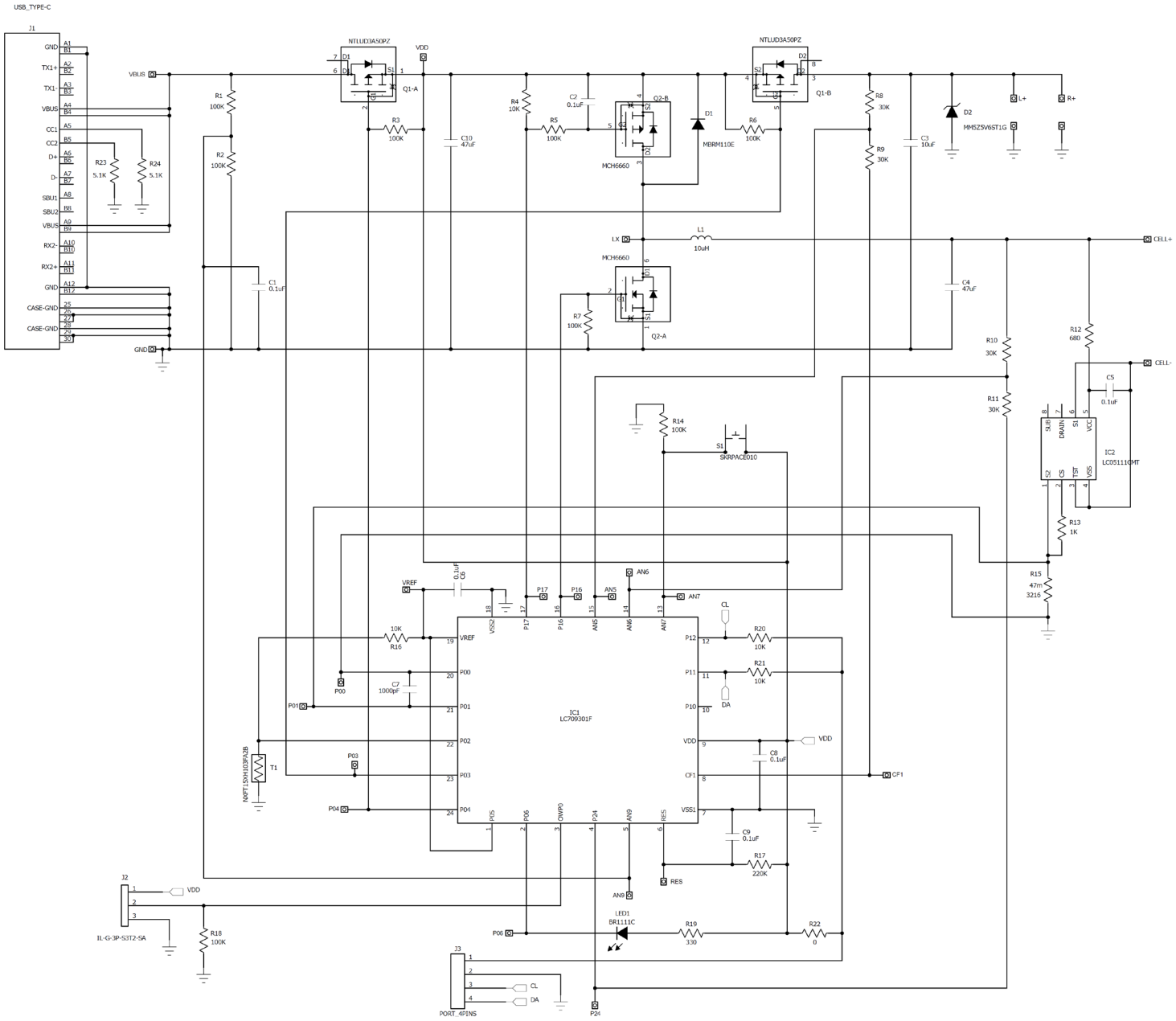
Figure 2: LC709301F standby current including Lib-protection IC

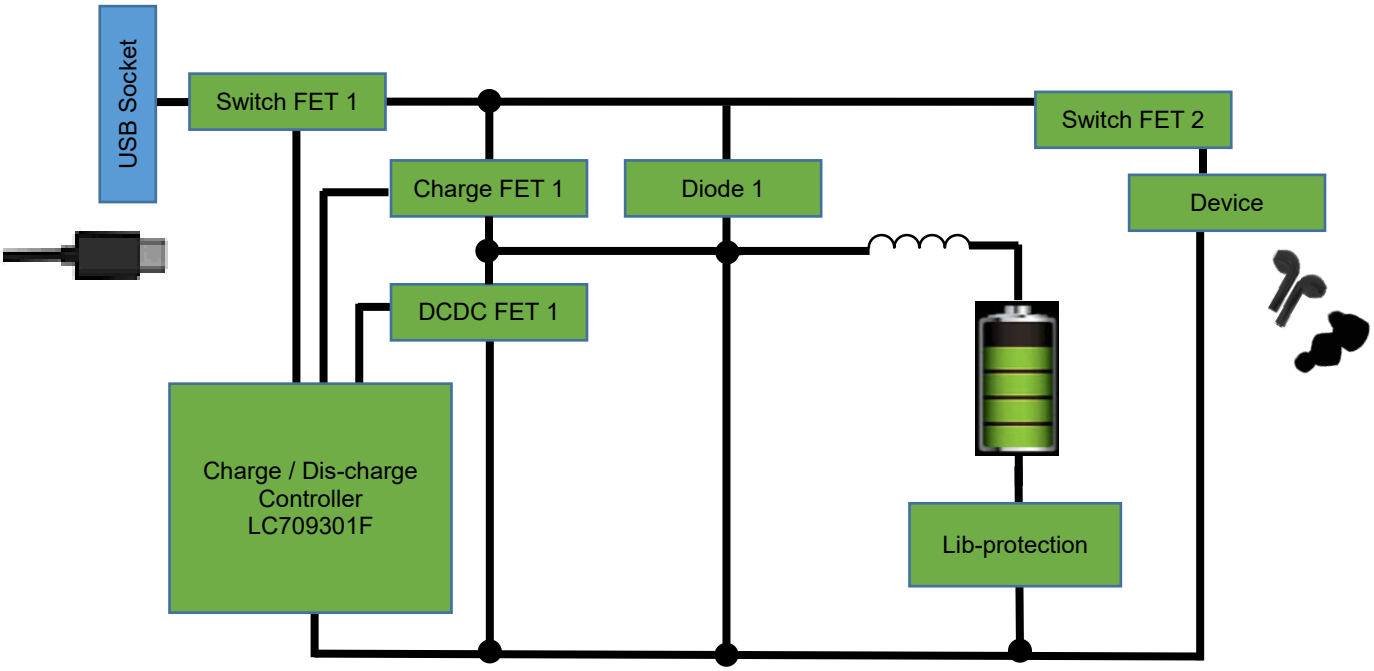
Key Features

- Supports linear charge control DC5V(USB) up to 500 mA
- Supports pass-through charge topology, DC5V output is directly powered via USB when wall power is connected
- Ultra-low stand-by current consumption
- Programmable MCU with I2C support
- MCU with on-chip thermistor for providing safety to load and device
- Supports external thermistor for measuring battery temperature.

Schematic

(CRADLE1GEVB with LC709301F)





Switch MOSFETs

Function	Device	Configuration	Polarity	VDDS Max (V)	VGSS Max (V)	ID Max (A)	RDS(ON) VGS = 4.5 V Typ/Max (mΩ)	Package
Switch FET 1 Switch FET 2	NTLUD3A50PZ	Dual	P-Channel	-20	/±8	5.6	37/50	UDFN6
Charge FET 1 DCDC FET 2	MCH6660	Dual	N-Channel P-Channel	20 -20	/±10 /±10	2 1.5	105/136 205/266	MCPH6

Schottky Diodes

Family	VR (V)	IO (A)	Example Device	Packages
Schottky	10	1.0	MBRM110E	POWERMITE (CASE 457-04)

Lib-protection

	Adjustable Range			VSSS Max /VGSS Max (V)	RSS(ON) VGS = 4.5 V Min/Typ/Max (mΩ)	RSS(ON) VGS = 3.1 V Min/Typ/Max (mΩ)	Features	Package(s)
	VOV Range (V)	VUV Range (V)	IOC/IOCH Range (A)					
LC05111CMT*	4.0 to 4.5	2.2 to 2.7	2 to 8	24/±12	8.8/11.2/14.0	10.4/13.0/18.2	Auto Wake-up, 0 V Charge	WDFN-6

Bill of Materials

(CRADLE1GEVB with LC709301F)

11/18/2019

Designator	Quantity	Description	Value	Tolerance	Footprint	Manufacturer	Manufacturer Part Number	Substitution Allowed	Lead Free
IC1	1	Charge/Discharge controller	–	–	VCT24	ON Semiconductor	LC709301FRF-AUMH	No	Yes
IC2	1	Lib-Protection	–	–	WDFN6	ON Semiconductor	LC05111CMTC20	No	Yes
Q1	1	Pch MOSFET	–	–	UDFN6	ON Semiconductor	NTLUD3A50PZ	No	Yes
Q2	1	Pch Nch MOSFET	–	–	MCPH6	ON Semiconductor	MCH6660	No	Yes
D1	1	Schottky diode	–	–	CASE457	ON Semiconductor	MBRM110ET1G	No	Yes
D2	1	Zener diode	–	–	SOD-523	ON Semiconductor	MM5Z5V6ST1G	No	Yes
L1	1	Inductor	10u	–	–	WE	74404042100	Yes	Yes
LED1	1	LED	Red	–	1608	Stanley	BR1111C	Yes	Yes
C1, C2, C5, C6, C8, C9	6	Chip Capacitor	0.1u	25V, ±10%	CAP_1608	Murata	GRM188B11E104KA01D	Yes	Yes
C7	1	Chip Capacitor	1000p	50V, ±10%	CAP_1608	Murata	GRM188B11H102KA01D	Yes	Yes
C3	1	Chip Capacitor	10u	25V, ±10%	CAP_3216	Murata	GRM31CB31E106KA75L	Yes	Yes
C4, C10	2	Chip Capacitor	47u	16V, ±10%	CAP_3225	Murata	GRM32ER61C476KE15L	Yes	Yes
R1-R3, R5-R7, R14, R18	8	Chip Resistor	100k	0.1W, ±1%	RES_1608	Rohm	MCR03EZPFX1003	Yes	Yes
R8-R11	4	Chip Resistor	30k	0.1W, ±1%	RES_1608	KOA	RK73H1JTTD3002F	Yes	Yes
R15	1	Chip Resistor	47m	1W, ±1%	RES_3216	Panasonic	ERJ8BWFR047V	Yes	Yes
R4, R16, R20, R21	4	Chip Resistor	10k	0.1W, ±1%	RES_1608	Rohm	MCR03EZPFX1002	Yes	Yes
R17	1	Chip Resistor	220k	0.1W, ±1%	RES_1608	KOA	RK73H1JTTD2203F	Yes	Yes
R12	1	Chip Resistor	680	0.125W, ±5%	RES_1608	KOA	RK73B1JTTD681J	Yes	Yes
R13	1	Chip Resistor	1k	0.1W, ±5%	RES_1608	Rohm	MCR03EZPJ102	Yes	Yes
R19	1	Chip Resistor	330	0.1W, ±5%	RES_1608	Rohm	MCR03EZPFX3300	Yes	Yes
R22	1	Chip Resistor	0	–	RES_1608	KOA	RK73Z1JTTD	Yes	Yes
S1	1	TACT SWITCH	–	–	–	ALPS	SKRPACE010	Yes	Yes
T1	1	Thermistor	10k	–	–	Murata	NXFT15XH103FA2B050	Yes	Yes
J1	1	Connector	–	–	–	JAE	USB Type-C	Yes	Yes
J2	1	Connector	–	–	–	JAE	IL-G-3P-S3T2-SA	Yes	Yes
J3	1	Connector	–	–	–	–	–	Yes	Yes
R23-24	1	Chip Resistor	5.1k	–	RES_1608	–	–	Yes	Yes

© 2019, SCILLC.

Disclaimer: Semiconductor Components Industries, LLC (SCILL) dba ON Semiconductor is providing this design note “AS IS” and does not assume any liability arising from its use; nor does SCILLC convey any license to its or any third party’s intellectual property rights. This document is provided only to assist customers in evaluation of the referenced circuit implementation and the recipient assumes all liability and risk associated with its use, including, but not limited to, compliance with all regulatory standards. SCILLC reserves the right to make changes without further notice to any products herein. SCILLC makes no warranty, representation or guarantee regarding the suitability of its products for any particular purpose, nor does SCILLC assume any liability arising out of the application or use of any product or circuit, and specifically disclaims any and all liability, including without limitation special, consequential or incidental damages.