# ON Semiconductor

# Is Now

**To learn more about onsemi™, please visit our website at**
**www.onsemi.com**

ON Semiconductor

## Design Note – DN05133/D

# LiB Charge/Discharge Controller for Bicycle LED Light Systems

| Device | Application | Input Voltage | Output Power | Topology | I/O Isolation |
|---|---|---|---|---|---|
| LC709301F | Bicycle LED Light | 4.5 - 5.5 | 10 W | Charge/Discharge Controller | N/A |

| | Charge | Discharge |
|---|---|---|
| **Output Voltage** | 4.2 V | 4.2-5.0 V |
| **Nominal Current** | 1000 mA | 1000 mA |
| **Max Current** | 2000 mA | 2000 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 solution LSI with charging/discharging and overall control functions for bicycle LED lights. Included is a DC/DC charging system to charge high power lithium-ion batteries quickly and efficiently. Supported are 1-cell lithium-ion/polymer (li+) batteries with charging ranges from 25 mA to 2000 mA. The LC709301F is highly efficient for LED lighting operations with ultra-low stand-by current consumption. It includes various safety features for battery and LED such as over current/voltage protection, thermal shutdown. It supports high, medium, low and flashing modes of operation for LED design. Boost efficiency and standby current for the LC709301F is plotted below.

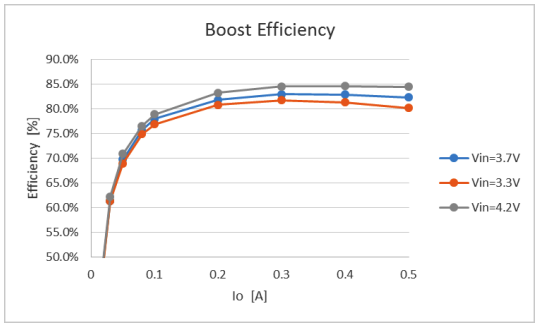



Figure 1: LC709301F boost efficiency based on battery capacity

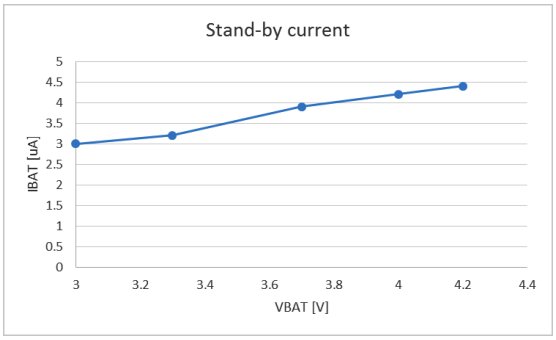


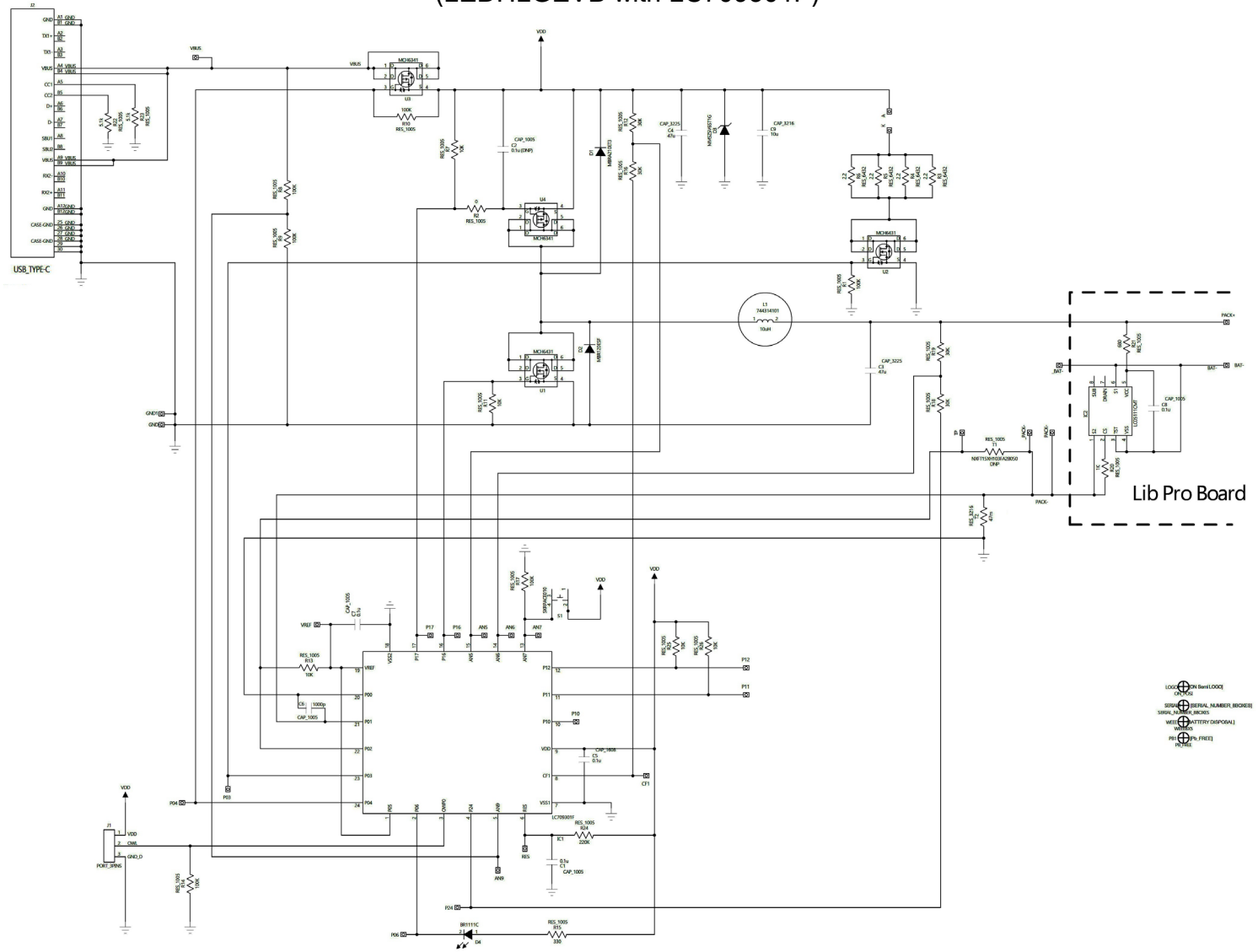

Figure 2: LC709301F standby current including Lib-protection IC

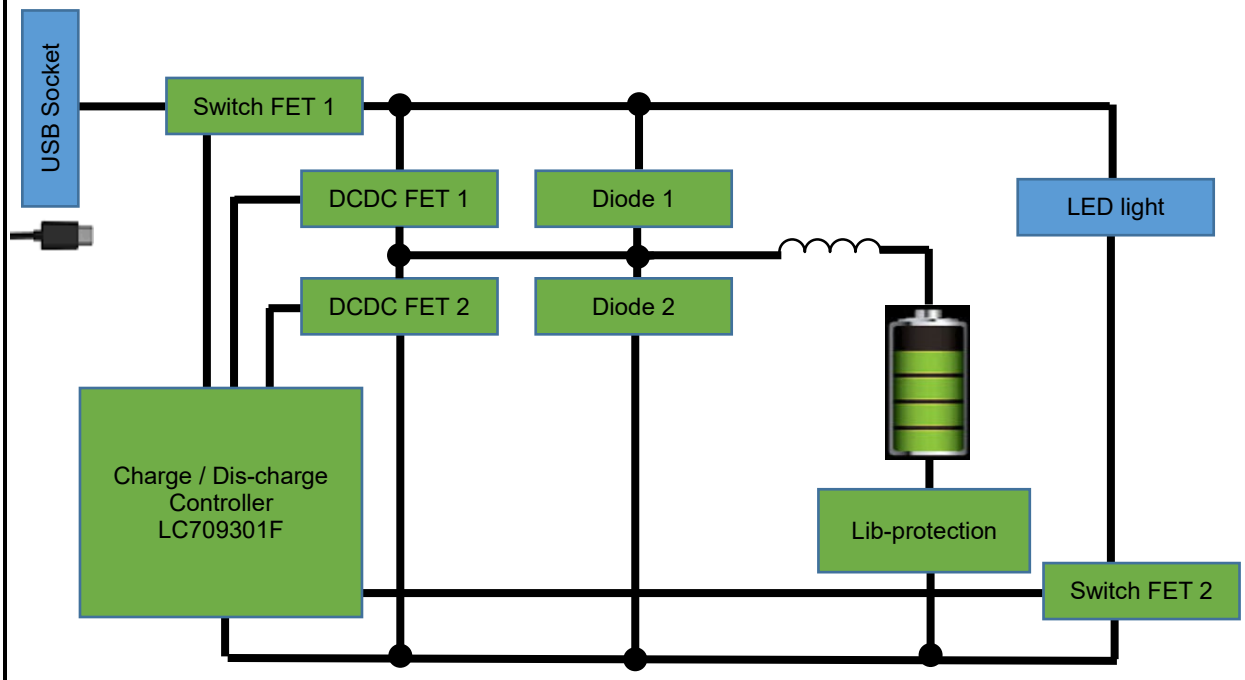
## Key Features

- DC-DC USB charging support up to 2000 mA range
- LED brightness remains constant even if battery voltage continuously degrades with long use
- Ultra-low standby current consumption
- Supports pass-through charge topology, DC5V output is directly powered via USB when wall power is connected
- Programmable MCU with I2C support
- MCU with on-chip thermistor for providing safety to LED and device

# Schematic

(LEDHLGEVB 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) | RDS(ON) VGS = 10 V Typ/Max (mΩ) | Package |
|---|---|---|---|---|---|---|---|---|---|
| Switch FET 1 DCDC FET 1 | MCH6341 | Single | P-Channel | -30 | /±20 | 5 | 71/100 | 45/59 | MCPH6 |
| Switch FET 2 DCDC FET 2 | MCH6431 | Single | N-Channel | 30 | /±20 | 5 | 65/91 | 42/55 | MCPH6 |

Schottky Diodes

| Family | VR (V) | IO (A) | Example Device | Packages |
|---|---|---|---|---|
| Schottky | 10 | 2.0 | MBRA210ET3 | SMA |
| Schottky | 20 | 1.0 | MBR120ESF | SOD−123FL |

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

(LEDHLGEVB 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-AUNH | No | Yes |
| IC2 | 1 | Lib-Protection | – | – | WDFN6 | ON Semiconductor | LC05111CMTC20 | No | Yes |
| U3, U4 | 2 | Pch MOSFET | – | – | MCPH6 | ON Semiconductor | MCH6341 | No | Yes |
| U1, U2 | 2 | Nch MOSFET | – | – | MCPH6 | ON Semiconductor | MCH6431 | No | Yes |
| D1 | 1 | Schottky Diode | – | – | | ON Semiconductor | MBRA210ET3 | No | Yes |
| D2 | 1 | Schottky Diode | – | – | | ON Semiconductor | MBR120ESFT1G | No | Yes |
| D3 | 1 | Zenner Diode | – | – | | ON Semiconductor | MM5Z5V6ST1G | No | Yes |
| D4 | 1 | LED | Red | – | 1608 | Stanley | BR1111C | Yes | Yes |
| L1 | 1 | Coil | 10uH | – | | WE | 744314101 | Yes | Yes |
| C1 C7, C8 | 3 | Chip Capacitor | 0.1u | 50V, ±10% | CAP_1005 | Murata | GRM155R71H104KE14D | Yes | Yes |
| C5 | 1 | Chip Capacitor | 0.1u | 50V, ±10% | CAP_1608 | Murata | GRM188F11H104ZA01D | Yes | Yes |
| C2 | 1 | Chip Capacitor | DNP | | CAP_1005 | Murata | | Yes | Yes |
| C6 | 1 | Chip Capacitor | 1000p | 50V, ±10% | CAP_1005 | Murata | GRM1552C1H102 | Yes | Yes |
| C3, C4 | 2 | Chip Capacitor | 47u | 16V, ±10% | CAP_3225 | Murata | GRM32ER61C476KE15L | Yes | Yes |
| C9 | 1 | Chip Capacitor | 10u | 25V, ±10% | CAP_3216 | Murata | GRM31CB31E106KA75L | Yes | Yes |
| R1, R8-R10, R14, R17 | 6 | Chip Resistor | 100k | 0.1W, ±1% | RES_1005 | Rohm | MCR01MZPJ104 | Yes | Yes |
| R12, R16, R18, R19 | 4 | Chip Resistor | 30k | 0.1W, ±1% | RES_1005 | KOA | RK73H1ETTP3002F | Yes | Yes |
| T2 | 1 | Chip Resistor | 47m | 1W, ±1% | RES_3216 | Panasonic | ERJ8BWFR047V | Yes | Yes |
| R3-R6 | 4 | Chip Resistor | 2.2 | 1W, ±1% | RES_6432 | Panasonic | ERJ1TRQF2R2U | Yes | Yes |
| R7, R11, R13, R25, R26 | 5 | Chip Resistor | 10k | 0.1W, ±1% | RES_1005 | Rohm | MCR01MRTJ103 | Yes | Yes |
| R24 | 1 | Chip Resistor | 220k | 0.1W, ±1% | RES_1005 | KOA | ERJ2RKD2203X | Yes | Yes |
| R21 | 1 | Chip Resistor | 680 | 0.125W, ±5% | RES_1005 | KOA | RK73B1ETTP681J | Yes | Yes |
| R20 | 1 | Chip Resistor | 1k | 0.1W, ±5% | RES_1005 | Murata | MCR01MZPJ102 | Yes | Yes |
| R22, R23 | 2 | Chip Resistor | 5.1k | 0.1W, ±5% | RES_1005 | Rohm | RK73B1ETTP512J | Yes | Yes |
| R15 | 1 | Chip Resistor | 330 | 0.1W, ±5% | RES_1005 | Rohm | MCR01MRTF3300 | Yes | Yes |
| R2 | 1 | Chip Resistor | 0 | – | RES_1005 | Rohm | MCR01MRTJ000 | Yes | Yes |
| S1 | 1 | TACT SWITCH | – | – | – | ALPS | SKRPACE010 | Yes | Yes |
| T1 | 1 | Thermistor | 10k | – | – | Murata | NXFT15XH103FA2B050 | Yes | Yes |
| J1 | 1 | 3pin Connector | – | – | – | JAE | IL-G-3P-S3T2-SA | Yes | Yes |
| J2 | 1 | USB_TYPE-C | – | – | – | RoHs | DX07S024JJ2 | Yes | Yes |
| TEST PADS | 27 | Testpads | | | PIN_1.5X1.5MM | N/A | N/A | | |
| | | | | | | | IL-G-3P-S3T2-SA | | |