LifePO4 MkIII pure battery power supply user's guide

By Ian Jin, May 15, 2020 Ver. 1.02b (Draft)

A. Safety warnings (please read first)

LifePO4 battery cells are high density energy storage devices. They could have risk of leaking, overheating, smoke, fire, explosion or damaging the circuit board if don't use properly.

1. Never short circuit at any time during storage, assembling and operation.

2. All battery cells are internally connected together in parallel on the PCB. You must never reverse the positive and negative terminals when assemble/solder them into PCB. Reversing battery terminals could be very dangerous.

3. Have to wearing protection glasses, gloves and other safety equipment when assemble/disassemble batteries.

4. Never expose battery and the battery power supply board under high temperature, sunshine or water.

5. In case of any issue happens, please put batteries or battery power supply board in a fire proof container. Also has to make sure the power adapter is disconnected.

6. Please follow other common battery safety instructions.

7. Have to use **80W or higher power iron** to solder battery holders, batteries or connectors to the board.

8. It is your responsibility to ensure the safety of DIY activities.

B. Introduction

Battery is a kind of passive power supply without any feedback. Comparing with active power supply such as a voltage regulator, it has much better load transient response and less noise. This LifePO4 pure battery power supply is a completed solution to provide battery based clean power voltage rails to DAC and other sensitive audio applications.

C. Highlighted Features and Specifications

- Five independent voltage rails

  Two 3.3V LifePO4 battery direct isolated voltage rails for clock and DAC section.

  Two 3.3V-13.2V battery direct isolated voltage rails for analog section and other sensitive circuits. Each of the rails can be configured as 3.3V, 6.6V, 9.9V or 13.2V separately.

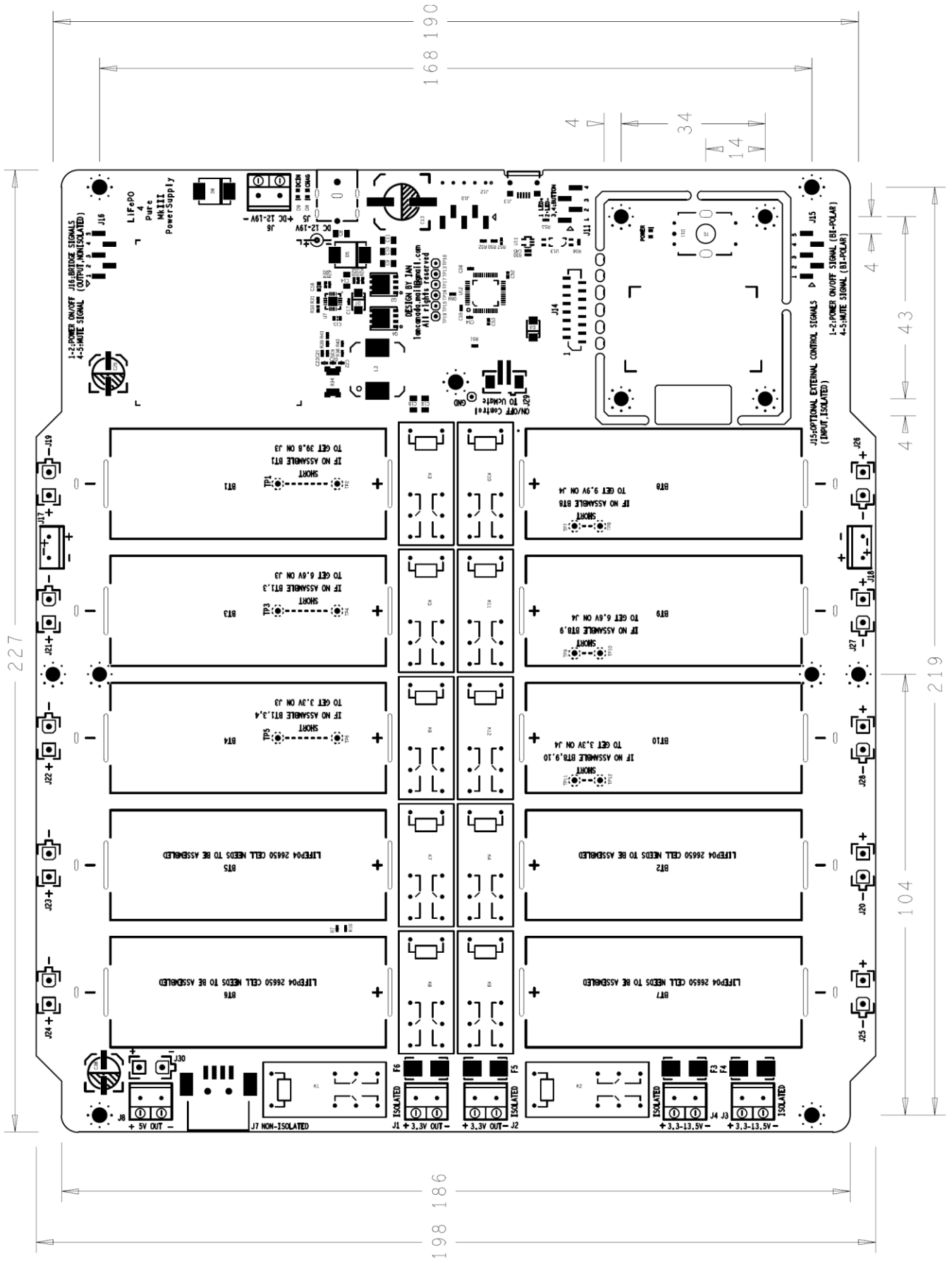
  Additional 5V 2A linear LT3042 regulated DC output for digital section (non-isolated, can be enabled/disabled).

- Smart battery management.
- End charge voltage can be programmed from the OLED GUI
- Battery run time can also be programmed from the OLED GUI.
- Equipped with protections, such as over current, over charge and over discharge protection as well as relay protection.
- Charging voltage, current and status can be monitored and displayed at real-time.
- Multiple LifePO4 power supplies can be bridged together to get more voltage rails.
- OLED control board can be beaked from main PCB in order to move to front panel.
- Programmable screensaver function to protect OLED from screen burn-in.
- Can use either 26650 battery cells with tabs or standard 26650 battery holders.

D. LifePO4 MkIII new improvements

- Ready for upgrading to ultra capacitor power supply by integrating with UcMateConditioner and UcHybrid through UcAdapter PCB (optional).
- New continuous DC 5V mode.
- Protection resistors were replaced by PTC fuses to reduce the risk of possible damaging.
- Optimized PCB layout with double thickness copper layers to lower power supply ESR even more.
- Accuracy of voltage measurements and monitoring were increased.
- Can have up to six 3.3V LifePO4 voltage output rails in total.
- All mounting holes are still compatible with MKII.

E. Layout and Dimensions (in mm)

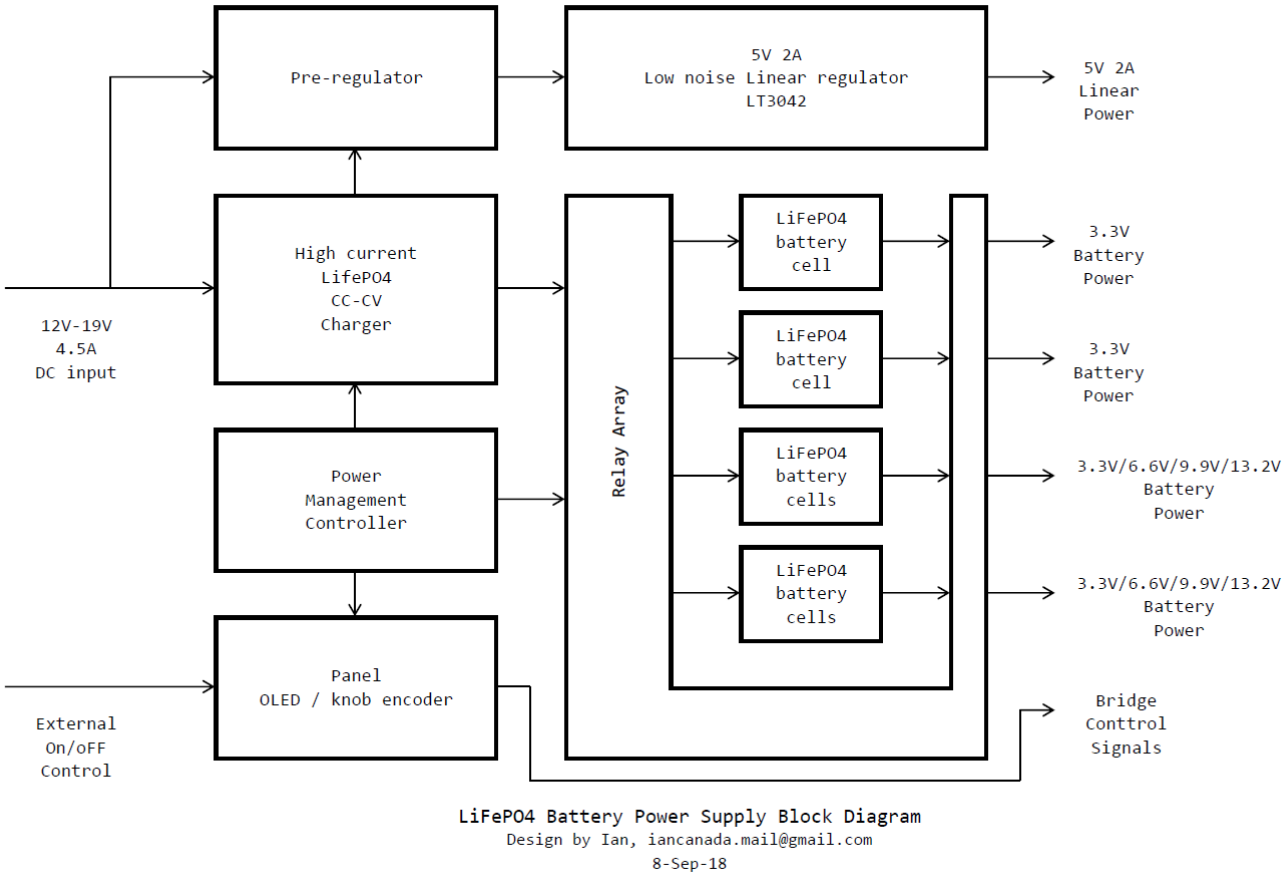

190
168
4
34
14
227
219
43
104
186
198
LiFePO
4
Pure
MkIII
PowerSupply
DC 12-19V
+DC 12-19V
DESIGN BY JAN
iancanada.mail@gmail.com
All rights reserved
ON/OFF Control
TO Uchkte
J15:OPTIONAL EXTERNAL CONTROL SIGNALS
(INPUT,ISOLATED)
1-2:POWER ON/OFF SIGNAL (BI-POLAR)
4-5:MUTE SIGNAL (BI-POLAR)
1-2:POWER ON/OFF SIGNAL (BI-POLAR)
4-5:MUTE SIGNAL (OUTPUT,NONISOLATED)
BT1
BT2
BT3
BT4
BT5
BT6
BT7
BT8
BT9
BT10
LIFEPO4 26650 CELL NEEDS TO BE ASSEMBLED
SHORT
TO GET 39.8 ON J3
TO GET 6.6V ON J3
TO GET 3.3V ON J3
TO GET 9.9V ON J4
TO GET 6.6V ON J4
TO GET 3.3V ON J4
+ 5V OUT –
NON-ISOLATED
+ 3,3V OUT –
ISOLATED
+ 3,3-13,5V –
POWER ON

F. Getting start

Caution: Never revise the polarity of the batteries. Never make battery tabs touching to any pad other than those need to be connected to.

1. Solder the knob encoder to the S1 position.
2. Make sure all battery cells are at same voltage level (within 5%) or being fully charged before installation.
3. Solder two 26650 LifePO4 battery cells (with tabs) or battery holders to BT6 and BT17 position.
4. Solder 26650 LifePO4 battery cells or battery holders to BT1,BT2,BT3,BT4,BT5,BT8,BT9 and BT10, or configure battery cells accord to the required voltages. Jumper wires may also be required. Please refer to battery configuration section for details.
5. Connect a 12-19V standard AC-DC adapter (with rated current higher than 3.5A) to J5 or J6. OLED screen will be turned on. DC-IN LED will be lit. CHARGE LED will be also lit or flashing according to the charging status.
6. Press and hold the knob button for more than 2 seconds, power supply will be turned on. Voltage rails will be applied to J1, J2, J3, J4, J7 and J8.
7. Press and hold the knob button for more than 2 seconds again, power supply will be turned off.

G. Block diagram



LiFePO4 Battery Power Supply Block Diagram

Design by Ian, iancanada.mail@gmail.com

8-Sep-18

H. Connectors

J5: DC power input connector

A 12V to 19V DC power supply with rated current higher than 3.5A must be connected to this 5.5mm/2.5mm power connector to operate. Any standard laptop AC-DC adapter (not included) can be used. High current linear power supply would be nice to have but not a necessary. Inside is positive terminal.

J6: DC power input connector alternative to J5

A 12V to 19V DC power supply with rated current higher than 3.5A can also be connected to this 2-pin 5.0mm terminal to operate. It's internally connected to J5.

J1: 3.3V pure battery output voltage rail in 2-pin 5.0mm terminal

This output is galvanic isolated from all other output and input. It comes with over current and over discharge protections. As well as relay protection. A 5A fuse F6 is connected to the output for additional current protection. It is also possible to connect this output in serial with other isolated output rails to extend the output voltage range. Highly recommended for DAC board and clock board.

J2: 3.3V pure battery output voltage rail in 2-pin 5.0mm terminal

This output is galvanic isolated from all other output and input. It comes with over current and over discharge protections. As well as relay protection. A 5A fuse F5 is connected to the output for additional current protection. It is

also possible to connect this output in serial with other isolated output rails to extend the output voltage range. Highly recommended for DAC board and clock board.

J3: 13.2V/9.9V/6.6V/3.3V pure battery output voltage rail in 2-pin 5.0mm terminal

This output can be configured to either13.2V or 9.9V or 6.6V or 3.3V.

This output is galvanic isolated from all other output and input. A 5A fuse F4 is connected to the output for current protection. It comes with relay protection too. It is also possible to connect this output in serial with other isolated output rails to extend the output voltage range. Highly recommended for I/V stage or other sensitive analog section.

J4: 13.2V/9.9V/6.6V/3.3V pure battery output voltage rail in 2-pin 5.0mm terminal

This output can be configured to either13.2V or 9.9V or 6.6V or 3.3V.

This output is galvanic isolated from all other output and input. A 5A fuse F3 is connected to the output for current protection. It comes with relay protection too. It is also possible to connect this output in serial with other isolated output rails to extend the output voltage range. Highly recommended for I/V stage or other sensitive analog section.

J8: 5V 2A linear low noise regulated output voltage rail in 2-pin 5.0mm terminal

LT3042 based linear regulator output. Can be used to power Raspberry Pi or other normal digital sections before isolator. It's not recommended for sensitive audio circuits like DAC, clock and I/V stage.

This output is not galvanic isolated from DC input. This output can be disabled from OLED GUI settings if not in need. Please don't connect any load to J8 if UcMateConditioner is installed.

J7: 5V 2A linear low noise regulated output voltage rail in USB-A socket

It's internally connected to J8.

J15: External control signal input

1, 2: ON/OFF control signal, bi-polar, isolated. Changing from 0V to 3.3V-6V turns power on. Changing from high level to 0V turns power off.

4, 5: Reserved for integrating with ultra capacitor power supply

3: No connected.

This connector can also be used as slave to connect to master power supply with bridge cable when multiple LifePO4 or ultra capacitor power supplies are working together for more voltage rails.

J16: Control signal output

1, 2: ON/OFF control signal output. 3.3V LVTTL logic level. Logic high when power is on. Logic low when power is off.

4, 5: Output signal reserved for integrating with ultra capacitor power supply

3: No connected.

This connector can also be used as master to connect to slave power supply with bridge cable when multiple LifePO4 or ultra capacitor power supplies are working together for more voltage rails.

J9, J14: 16pin FFC/FPC cable connectors

These two FFC/FPC connectors can connect the OLED board with main PCB of this power supply with supplied 16pin 1mm FFC cable when OLED board is moved to the front panel. Please keep them un-connected when the OLED board is linked to the main PCB as default.

J11: Optional external ON/OFF control button and LED indicator

1, 2: To external LED indicator. 1 : Anode(+), 2 : Cathode(-).

3, 4: To optional external push button for ON/OFF control, internally connected to knob encoder.

J10: UART reserved for communication or FW upgrade

3: Rxd.

4: Txd.

5: GND

All other pins: reserved please keep un-connected

9600, N, 8 ,1

J13: Micro USB socket, reserved for future applications or FW upgrade

J30: 5V output to UcMateConditioner

Internally connected to J8.

J29: ON/OFF control signal to UcMateConditioner

J25, J24, J20, J23, J28, J22, J27, J21, J26, J19

Bridge connectors to connect to UcHybrid ultra capacitor upgrade boards corresponding to battery cells BT7, BT6, BT2, BT5, BT10, BT4, BT9, BT3, BT8, BT1.

J25 and J24 were assembled by default.

J18, J17: Optional 5th and 6th 3.3V battery rail output.

I. Battery configurations

BT6: A 26650 LifePO4 battery cell must be assembled for 3.3V voltage rail at J1.

BT7: A 26650 LifePO4 battery cell must be assembled for 3.3V voltage rail at J2.

BT2, BT10, BT9, BT8: 26650 LifePO4 battery cells can be configured for voltage rail at J4.

Output voltage	Battery cells need to be assembled	Jumper wire
13.2V	BT2, BT10, BT9, BT8	None
9.9V	BT2, BT10, BT9	TP7-TP8: short
6.6V	BT2, BT10	TP9-TP10: short
3.3V	BT2	TP11-TP12: short
0V	Non	Non

BT5, BT4, BT3, BT1: 26650 LifePO4 battery cells can be configured for voltage rail at J3.

Output voltage	Battery cells need to be assembled	Jumper wire
13.2V	BT5, BT4, BT3, BT1	None
9.9V	BT5, BT4, BT3	TP1-TP2: short
6.6V	BT5, BT4	TP3-TP4: short
3.3V	BT5	TP5-TP6: short
0V	Non	Non

J. LED indicators

LED	Descriptions	Notes
D9	DCIN	Lit when DC input is connected
D8	Charge status	Lit when battery cells are in charging Flash when charger is stopped in standby mode
D11	POWER status	Lit when power is on Flash when power button is press hold

K. OLED GUI manual settings

Turn the knob encoder, you can access OLED GUI manual items. Press the knob key at the highlighted item you want to change, it will enter editing mode with item in flashing. Turn the knob encoder, you can go through all possible settings. Press the knob key at setting you want to change to, new setting will be applied and saved. Or it will exit editing mode if no activity for more than 3 seconds.

Item	Manual	Description	Settings	
1	“Hour”	Total run time in hours. After this time, LifePO4 power supply will turn off automatically to protect battery form possible over discharge	1 to 12 hours, *Default 5 hours Note: Setting run time will re-start the countdown timer at power on state	
2	“Volt”	End charge voltage. Charger will be automatically disabled into standby mode when this voltage is reached	3.25V to 3.75V *Default 3.35V	
3	“5V”	To enable/continuous/disable the 5V linear voltage rail	EN(enabled) or CON(continuous) or DIS(disabled) *Default is EN(enabled)	
4	“Reset”	To reset all settings back to factory default	YES or NO	
5	“OnSS”	Power on screen saver time in minutes Screen will be turned off if screen save time is up to prevent the OLED from burn-in.	DIS, or 1 to 20 minutes *Default is DIS(disabled)	
6	“OffSS”	Power off screen saver time in minutes Screen will be turned off if screen save time is up to prevent the OLED from burn-in.	DIS, or 1 to 20 minutes *Default is 1 minute	
7	“SCP1”	Enable or disable start up current protection at output terminal J1. Please keep it enabled unless need to output very high current.	EN(enabled) or DIS(disabled) *Default is EN(enabled)	
8	“SCP2”	Enable or disable start up current protection at output terminal J2. Please keep it enabled unless need to output very high current.	EN(enabled) or DIS(disabled) *Default is EN(enabled)	

L. OLED screen display

Some information will be displayed on the OLED screen

1. On/off status.
2. DC input voltage.
3. Countdown timer of run time.
4. Charger status.
5. Charging voltage.
6. Charging current.
7. Messages of operating and protection.

Note: The charge current calculation was calibrated to 10 LifePO4 battery cells. The displayed charging current could be higher than the actual if less battery cells are installed.

M. Application notes and tips

1. How to turn on the power supply

There are 3 ways to turn on the power supply:

(1). Press and hold the knob key for more than 2 seconds.

(2). If external on/off button is connected to J11, Press and hold this button for more than 2 seconds.

(3). Extern on/off control signal changing from 0V to 3.3V-6V will turn on the power

2. How to turn off the power supply

There are 3 ways to turn on the power supply:

(1). Press and hold the knob key for more than 2 seconds.

(2). If external on/off button is connected to J11, Press and hold this button for more than 2 seconds.

(3). Extern on/off control signal changing from 3.3V-6V to 0V will turn the power off.

3. In which conditions the power supply will turn off automatically

(1). If run time is up, the power supply will turn off automatically to prevent battery form possible over discharge.

(2). If any output voltage at J1 or J2 is lower than 3.3V, the power supply will turn off automatically to prevent battery form over discharge.

(3). If there is short circuit to J1 or J2 output, or the output current is too high, the power supply will go back to power off shortly after it was turned on.

4. Why need to manage the end charge voltage

Disabling the charge current when it's closed to the fully charge voltage can prevent the battery cells from over charge thus would be good for battery life time. The second reason is that some audio applications have sweet voltage, program the end charge voltage can make it falling into the sweet spot each time when it's turned on. Please keep in mind that when the charger goes to standby mode, the displayed battery voltage (discharge voltage at standby) could be lower than the end charge voltage. The difference could be around 0.1V up to how much the charging current it was or how many battery cells were installed. So, if you want the battery to be charged to 3.30V, normally you will need to the end charge voltage to 3.39V or 3.40V.

5. How to solder battery holders or battery to the LifePO4 board

The LifePO4 MkIII PCB has double thickness copper layer (2oz) to get low ESR performance. However it will be difficult to solder components to it than the normal PCBs. Have to use solder iron with 80W power or higher. Poor soldering will cause malfunction or degrade the performance.

6. How to move the OLED board to front panel

(1). Break the OLED board from the power supply main PCB.

(2). Mound the OLED board to the front panel.

(3). Connect the OLED board with the main PCB through the supplied 10 pin FFC cable from J9 to J14.

Please see the picture "Connection between main PCB and external OLED board" for the orientation of cable.

Reversing the FFC/FPC cable and turn knob can damage the processor chip, so must be very careful.

Please make sure the DC power (J5 or J6) are fully **disconnected** before you move the OLED board.

Please don't turn the knob at the first you re-connect the DC power until you confirm there is correct display on the OLED screen.

You can also use a back up OLED board (sold separately) without break the on-board OLED panel.

7. How to have on/off button and power LED at front panel without removing OLED board

Connect the front panel on/off button and the power LED indicator to connector J11 by a jumper wire cable.

8. How to use multiple power supplies to get more voltage rails or extend the voltage range

(1). Link the power supplies together through the supplied bridge cable. The cable will be connected from J16 of the master power supply to the J15 of the slave power supply, and so on.

(2). It is recommended to use separate DC input for each power supply. However, you can also share one DC input with all power supplies through input terminal J6, but have to make sure the DC adapter can deliver enough current.

(3). Since all pure battery outputs are galvanic isolated, you can connect different voltage rails in serial to extend the voltage range.

(4). Can also work with later on ultra capacitor power supply in the same way.

9. How to replace fuse

Voltage rail J1, J2, J3 and J4 equipped with fuses for over current protection. You need to confirm whether they are blown if there is no output. To replace a fuse, you will need:

(1). Lift one of the fuse terminals up by a needle. And then pick up it by a tweezers.

(3). Plug a new fuse into the socket. The P/N of the fuse: 0451005. Manufacturer: Littelfuse.

10. How to configure six isolated/independent 3.3V rails

It is possible to have six isolated/independent 3.3V rails under the following configurations.

(1). Install battery cells or battery holders to BT7, BT2, BT9, BT6, BT5 and BT3 positions.

(2). Short TP11 and TP12, and then short TP5 and TP6 at back side of PCB

Under this configuration, six pure 3.3V battery rails can be used, which are

J1, J2, J3, J4 and

Additional 3.3V rail: J17

The other additional 3.3V rail: J18

There is no fuse for the two additional 3.3V output. If it is possible, please include fuses in the power path.

11. Eliminate possible audible noise

When lower voltage switching mode DC power is used, for example a 12V/4A switching mode DC power adapter, sometimes there could be audible noise generated when charging the battery cells. The reason is that with lower voltage, the charger will draw much higher current from the switching power supply. This can cause higher ripple to the circuit and sometimes may fall into audible frequency range though it still fully functional.

To fix this issue, you can just simply replace it with a higher voltage power supply, say, a standard 18.5V laptop adapter, or high current linear power supply.

12. Notice of connecting OLED display board with FFC/FPC cable

If you want to move the OLED display board externally to the LifePO4 power supply board, you will need to connect it with the LifePO4 power supply through the supplied FFC/FPC cable. Please make sure the DC power (J5 or J6) are fully disconnected before you doing this kind of jobs.

13. How to upgrade 5V DC output to ultra capacitor power supply

a. Install a UcMateConditioner through UcAdpater PCB(optional).
b. Connect J30 to UcMateCoditioner 5V input
c. Connect J29 to UcMateConditioner ON/OFF control input
d. Connect device to the 5V output of UcMateConditioner (rather than J8)
e. Ready to go

Please see UcMateConditioner user’s manual for more details.

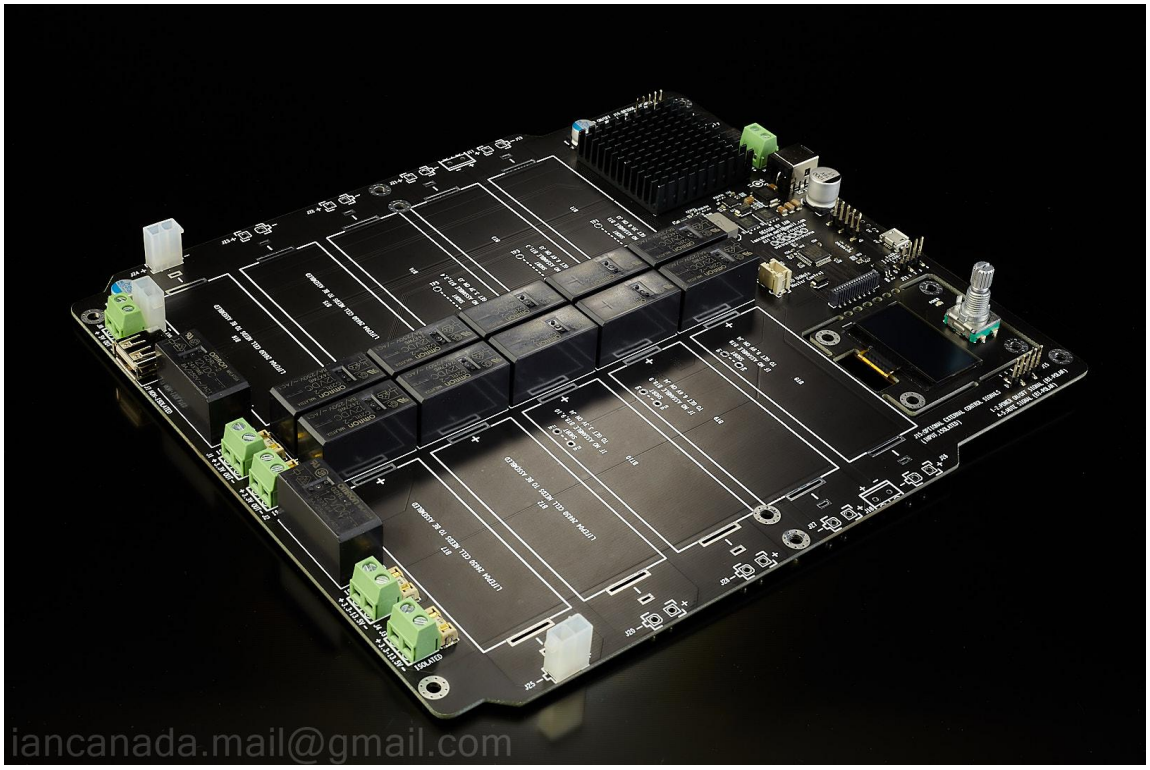
14. How to upgrade battery cells into ultra capacitor hybrid power cells

a. Install UcHybrid boards through UcAdpater PCB(optional) right above the cells that need to be upgraded.
b. Connect to each installed UcHybrid boards through the bridge cable.
c. Ready to go.

Please see UcHybrid user’s manual for more details.

N. LifePO4 power supply pictures

1. LifePO4 MkIII power supply.



2. LifePO4 MkIII power supply with battery holders and batteries

3. Upgrade to ultra capacitor power supply by UcMateConditioer, UcHybrid and UcAdpater

4. LifePO4 power supply integrates with DAC system

5. The connection between main PCB and OLED board when move OLED board externally