

LifePO4 Mini 3.3V

The Pure Battery Power Supply

By Ian Jin Oct 12, 2021 Ver. 0.95b

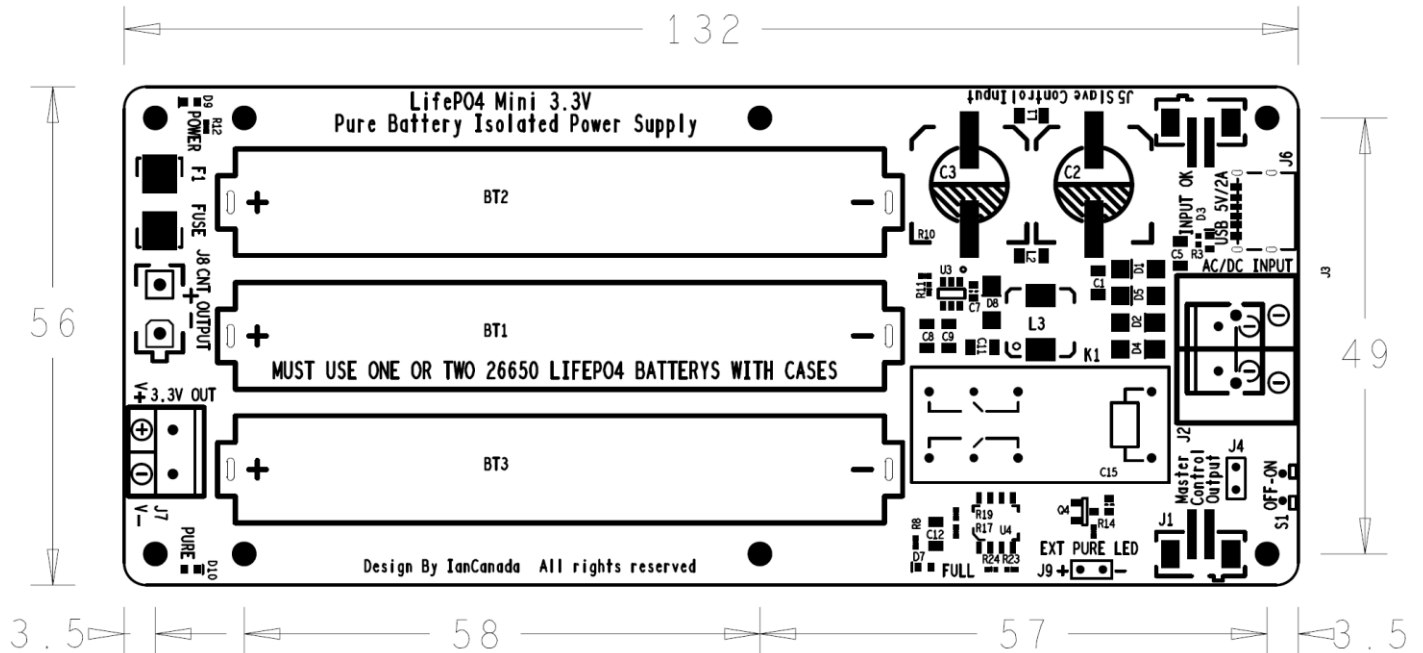
A. Introduction

LifePO4 Mini 3.3V is a low cost high performance pure battery power supply. It makes use of the 26650 LifePO4 battery cells to achieve a great power supply performance. Because it is a pure passive power supply, there will be no feedback and no active components involved when it's turned on. At the pure output mode, only the fully charged battery cells will be applied to the load. It's also capable of delivering up to 240A dynamic current with less than 3mOhm internal ESR (continuous output mode, two battery cells in parallel). It could be so far the one of the best low noise and ultra high dynamic power supplies in the world. Sound quality of sensitive audio applications such as low jitter clock oscillators, DACs, FIFOs and many other circuits will be benefited from this LifePO4 Mini power supply.

B. Specifications and Highlighted Features

- Pure LifePO4 power supply
- Low cost but no compromise on performance
- Pure output works in class A mode with battery current goes only in one direction
- Fixed 3.3V output
- Has both switched and continuous (great for clock oscillators) outputs
- Outputs are 100% isolated from charger, input and the rest of circuits when it is turned on at pure mode
- Has built-in on/off control switch (on-board or external)
- Has an isolated on/off control management chain that can be set up in a power supply group.
- Optical isolators are used for all internal operating logics.
- Can use standard 5V USB-C power adapter as input. AC input is also possible.
- Built-in protection scheme to prevent battery cells from exhausted or low output voltage
- Dynamic output current: up to 240A (A123 ANR26650M1-B)
- Output ESR: Less than 3 mOhm (Two A123 ANR26650M1-B battery cells in parallel)
- Ultra low output noise: Only decided by the battery cells
- Heavy duty design for 24/7 operation

C. Layout and Dimensions (in mm)



D. Getting started

1. Solder one (to BT1 or BT2 or BT3) or two (to BT2 and BT3 for parallel configuration) 26650 battery holders to the LifePO4 Mini 3.3V PCB. Please make sure the orientation is correct.
 2. Install one or two LifePO4 26650 battery cells into the holders. Please be very careful not to reverse the batteries.
 3. Connect the load to J7
 4. Make sure the on-off control switch S1 is at the off position and then connect a standard 5V USB-C power adapter with 2A or higher rated current to the DC input J6. The input LED D3 will be lit and the pre-charge mode will start. It may take up to hours or so at the first time of charging the battery cells. The full LED D7 will be lit once the battery cells are fully charged.
 5. Turn the on-off switch to the on position. Both output LED D9 and pure LED D10 will be lit.
- Now you can enjoy the great performance of the LifePO4 Mini battery power supply.

E. Principle of operating

LifePo4 Mini has three operation modes

1. Pre-charge mode

LifePO4 Mini will work in pre-charge mode when it is off while the input power supply is connected. In this mode, the battery cells will be connected to the dedicated onboard CC-CW battery charger. The full LED D7 will be lit after the battery pack is fully charged.

2. Pure output mode

LifePO4 Mini will go to the pure output mode if it is turned on while the full LED D7 is lit. In this mode, only the battery pack will be connected to the outputs. The charger and all other circuits will be disabled and disconnected from the output. All the monitoring and controlling jobs will be performed through the optical isolators. So the outputs will be 100% isolated from the rest of the circuits. Both pure LED D10 and output LED D9 will be lit to indicate the LifePO4 Mini is running in the pure output mode.

3. Protection mode

Because only the battery pack will be connected to the load, after running for a very long time at pure mode, the battery cells will be exhausted. In this case, to protect the batteries from damage, LifePO4 Mini protection mode will be triggered. The CC-CV charging circuit will be connected again to re-charge the battery cells. The output doesn't stop in this protection mode but the low noise performance will be degraded slightly (active circuits involved). After battery cells get fully charged again, the LifePO4 Mini will be automatically switched back to the pure output mode.

Note:

The battery pack will be disconnected from the LifePO4 Mini by the relay when the input power is absent. The switched output J7 will be also off in this case. However, the continuous output J8 will still be connected to the battery cells without stop.

F. Connectors

J6: DC power input connector in USB-C

A standard 5V USB-C power adapter must be connected to this connector to function. The USB-C power adapter has to be independent and cannot be shared with other devices.

J2: Optional AC/DC input barrier terminal block alternative to J6 (not installed by default)

An AC 9V-12V or DC 5V-12V (non-polarized) power supply can also be connected to J2 to replace J6. J6 must be kept unconnected if J2 is used. Both AC and DC inputs have to be independent and cannot be shared with other devices.

J7: Switched output (barrier terminal block)

This is the switched output of LifePO4 Mini. This output will be turned on and off when LifePO4 Mini is turned on or off. Normally the load will be connecting to this output.

A fuse F1 is installed to this output to protect from over current or short circuit.

The Littlefuse P/N of this fuse is 0451005.MRL or 0451008.MRL

J8: Continuous output (2 PIN Molex Mini-Fit connector)

This continuous output is specially designed for clock oscillators, sine to square converters and many other analog applications that need continuous power for a long time break-in. The continuous output is non-switched, so no matter LifePO4 Mini is turned on or off, the output will be always connected to the LifePO4 battery cells. Unplugging the cable is the only way to disconnect this output from the load.

The related Molex P/Ns of the cable are

Housing: 39012020

Terminal: 39000038

Same F1 fuse is also applied to this output to protect from over current or short circuit.

J4: Optional external on/off control switch connector, in 2-pin, 2.54mm (not installed by default)

External on/off control switch is functionally equivalent to the on-board switch S1.

To use the external on/off control switch, On-board switch S1 must be at off position.

External on/off switch is not supplied in the package.

J5: Slave on/off control input in 2-pin PH2.0, isolated and non-polarity

LifePO4 Mini can be controlled remotely from this slave control input. LifePO4 Mini will be turned on when a 3V-12V control voltage is applied to this input. The control signal is non-polarity and will be optically isolated from LifePO4 Mini.

To use the remote on/off control, On-board switch S1 must be kept at off position.

J1: Master on/off control output in 2-pin PH2.0

1: Control signal –

2: Control signal +

To set up a control chain of a power supply group, we can connect J1 to the slave input of the following LifePO4 Mini or other power supplies through the supplied control cable.

J9: Optional external pure LED connector (not installed by default)

External pure LED indicator can be connected to this connector to indicate pure status.

G. LED indicators

D3: Power input indicator. Indicating that the power input voltage is applied when lit.

D9: Power on indicator. Indicating that the LifePO4 Mini is turned on and output voltage is applied to J7 when lit.

Note: D9 has no business with the continuous output

D10: Pure output indicator. Indicating LifePO4 Mini is in pure output mode when lit.

D7: Full indicator. Indicating battery cells are fully charged when lit.

H. Application notes

1. Battery cells

One or two (parallel configuration) 26650 LifePO4 battery cells are needed for LifePO4 Mini to operate. A123 ANR26650M1B is recommended but not limited. 3.3V 26650 LifePO4 battery cells from other manufacturers or other P/N are all good for LifePO4 Mini. For safety reason, battery cells cannot be included. Users have to buy the battery cells by themselves.

2. ESR of LifePO4 Mini

ESR of the switched output = battery ESR + Fuse resistance + MOSFET ESR

ESR of the continuous output = battery ESR + Fuse resistance

Take an example, two ANR26650M1-B cells in parallel configuration

ESR (switched) = 3mOhm (batterys) + 12.5mOhm (fuse) + 0.8mOhm (MOS FETs) = **16.3mOhm**

To reach better ESR performance, we can also bypass the fuse F1 by shorting S3 with solder. In this case, ESR of switched output will be reduced to **3.8mOhm** and ESR of continuous output will become **3mOhm**.

Please be aware of the risk of damaging in case of short circuit if bypass the fuse.

If really want to, I would suggest only doing this upgrade after the whole system is settled.

The resistance of wires has also to be taken into account for an ultra low ESR power supply such as this LifePO4 Mini. So 16 AWG or bigger wires will be highly recommended for outputs.

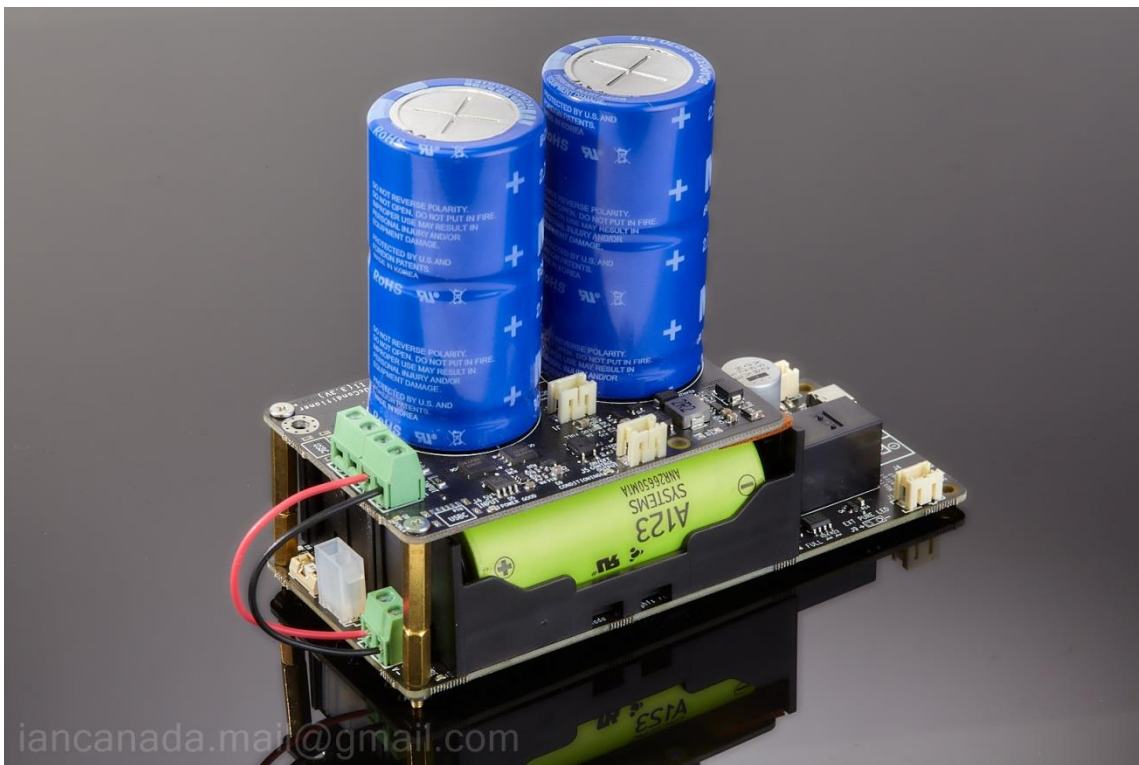
3. How to integrate LifePO4 Minis into a power supply group?

For a power supply group, please connect the Master control output of the first power supply (3V to 12V) to the Slave control input J5 of LifePO4 Mini, and then the master control output J1 of this LifePO4 Mini 3.3V to the next power supply or another LifePO4 Mini to make a control chain. LifePO4 Mini slave control input is optical isolated and non-polarity.

4. Is it possible to upgrade the performance of this LifePO4 Mini 3.3V with ultracapacitors?

The performance of this LifePO4 Mini 3.3V is still possible to be upgraded by integrating with an UcConditioner 3.3V, or an UcHybrid for lower cost.

To work with an UcConditioner 3.3, you can connect it to either J8 or J7. But the output should be connected to the output of UcConditioner in this case.



Or, to work with an UcHybrid, you can have to connect it to the continuous output J8 and then use J7 as output.

5. Suitable applications

LifePO4 Mini will work great for all kinds of ultra low noise applications such as low jitter oscillators, sine to square convertors, FifoPi clean side, DAC/ADCs, I/V stages, MM/MC phone amplifiers, pre-amplifiers and many other circuits. LifePO4 Mini could be one of the best possible performance power supplies for those applications.

6. Does the quality of DC input have business with the LifePO4 Mini output quality?

LifePO4 Mini outputs are 100% isolated from the input when it's turned on. And the on-board CC-CV charger is also disabled in pure output mode. So theoretically the quality of LifePO4 Mini outputs will have no business with the quality of the input DC power supply.

However, a good DC power supply can still have lower EMI noise to the environment. So, in any case, a good DC power supply will be always positive to the system.

I. Pictures of LifePO4 Mini 3.3V

1. LifePO4 Mini 3.3V as shipped



2. LifePO4 Mini 3.3V with two battery holders and battery cells



J. History of revising

Oct. 23, 2021 V0.9b released

Oct. 29,2021 V0.95b released

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