

PurePi
5V + 3.3V ultracapacitor/LifePO4 battery power supply combo for Raspberry Pi
User's manual

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A. Introduction

PurePi is a compact size audiophile grade dual power supply combo that is specially designed for Raspberry Pi audio applications to improve sound quality. PurePi integrates a 5V ultracapacitor power supply and a 3.3V isolated pure LifePO4 battery power supply together in one PCB. With the spring contacts, it is very easy to install a Raspberry Pi and other audio HATs on top of the PurePi without needing any additional power connectors. PurePi can also be used as a seat base of the whole audio project with anti-vibration spike feet and the possible rubber ring suspensions. PurePi would be very much suitable to build FifoPi or FifoPiMa based Raspberry Pi stream transports, DACs and other audiophile projects.

PurePi is functionally equivalent to a ConditionerPi 5V plus a LifePO4Mini 3.3V.

B. Features and Specifications

- 5V ultracapacitor power supply with two 100F/2.7V ultracapacitors pre-installed. ESR less than 10mOhm
- 3.3V isolated pure LifePO4 battery power supply with battery holders pre-installed for two 18650 battery cells. ESR less than 6 mOhm. The ultra low output noise would be only decided by the battery cells.
- Very well designed gold plated spring contacts to power a Raspberry Pi directly to GPIO from the bottom side of PCB without needing any connectors
- Works as a seat base of the whole project. Anti-vibration spike feet can be installed. And the rubber ring suspensions are also possible to be installed..
- Only one standard 5V 2.5A or higher current power supply in USB-C is needed as power input.
- On-board power ON/OFF control switch. This switch can also be extended as an external ON/OFF switch.
- Remote ON/OFF control output signals make it possible to integrate with multi-power supply systems as a group to perform a master on/off control.
- Built-in protection scheme to prevent battery cells from exhausted or low output voltage
- Passive power supply with ultra-low noise and high dynamic current
- Ultra-low ESR MOSFETs controlled by optical isolators to eliminate any possible leakage current

- Built-in active balancers for ultracapacitor protection.
- Low cost but no compromise on performance
- DIY friendly

C. PurePi pictures



PurePi as shipped

Kit includes:

PurePi (fully finished with ultracapacitors and battery holders pre-installed)

4 of M2.5*7 mm standoffs

4 of M2.5 screws

D. Layout and Dimensions (in mm)

E. Getting started

1. Install the 4 supplied 7mm standoffs to the PurePi.



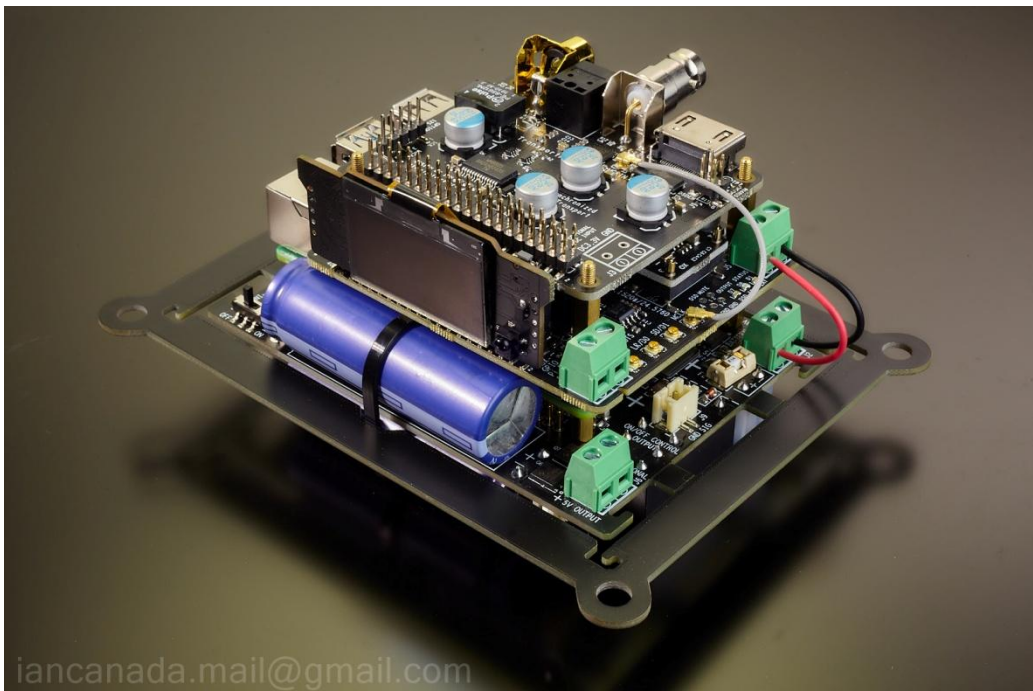
2. Install Raspberry Pi on top of the PurePi through the 7mm standoffs and then 4 11mm standoffs to fix it at the position. Make sure the five spring contacts are connected to the GPIO pins properly at the bottom side of the Raspberry Pi.



3. Install a FifoPiMa (or a FifoPiQ7, or other audio HATs) on top of the Raspberry Pi properly. Use two good quality wires connect the pure 3.3V battery power output from J2 of PurePi to J5 of FifoPiMa. Please be very careful not to reverse the positive and negative terminals.



4. Install a TransportPi MkII (or HdmiPi, HdmiPi Pro, TransportPi AES) on top of the FifoPiMa using 4 13mm standoffs. Connect the supplied U.FL cable from FifoPiMa MCLK output socket to J4 MCLKIN of TransportPi. Install a MonitorPi into the AUX GPIO of FifoPiMa if you need a OLED display (optional).



5. Install two 18650 3.2V LifePO4 battery cells into the battery holders at the bottom side of the PurePi. Please be very careful not to reverse the battery cells.



6. Make sure S1 is at OFF position. Connect a standard 5V USB-C power adapter with 2.5A or higher rated current to DC input J8 of the PurePi. The DC input indication LED D11 will light up shortly, or flash for a while before light up.
7. If it is the first time using the PurePi from empty, please wait for a couple of hours until UC FULL LED D10 and BATTERY FULL LED D4 are both lit up. Then turn the power switch S1 to the ON position. POWER ON LED D1 and UC enable LED D13 and PURE battery LED D8 will be all lit up.
8. Make sure everything is configured properly as required.
9. Enjoy the music.
10. Turn S1 to the OFF position when finish.

Tips:

1. It's strongly advised to leave the DC input always connected to J8, so that the ultracapacitors and batteries can be kept in fully charged before next time turned on.
2. If D11 doesn't light up when USB power input is plugged, it means either the USB power cable is too long or the USB power adapter doesn't deliver enough output current. You can fix the issue by replacing with a good USB power cable or a good power adapter.
3. Only 3.2V LifePO4 battery cells can be used. Don't use any other lithium batteries.
4. Both ultracapacitors and batteries can deliver huge current. Short circuit or reverse can result in serious damage to the PCB and other circuits.

F. Connectors and switches

J8: DC power input connector in USB-C

A standard 5V USB-C power adapter with higher than rated 2.5A current must be connected to this connector to function.

J4: 5V ultracapacitor power output in spring contacts

1, 3: 5V
5, 10, 13: GND

This is the main output of PurePi. This output will be turned on and off when ON/OFF switch is turned on or off. It is designed to connect to the GPIO of a Raspberry Pi directly from the bottom side.

J6: Optional 5V ultracapacitor output in 5mm terminal block

J6 works as an optional backup output. It is internally connected to the same 5V output of J4. This output can be used if the application requires.

J2: Pure 3.3V battery output in 5mm terminal block

This is the pure 3.3V LifePO4 power output. This output will be turned on and off when PurePi is turned on or off. FifoPi clean side or other high quality audio devices can be connected to this connector. This output will be 100% isolated in pure output mode when D8 is lit.

A fuse F2 is installed to this output to protect from over current or short circuit.

The Littelfuse P/N of this fuse is 0451005.MRL

J3: Continuous 3.3V battery output in 2 PIN Molex Mini-Fit connector

This continuous output is specially designed for clock oscillators 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

F2 fuse is also applied to this output to protect from over current or short circuit.

S2: ON/OFF switch

J2: External on/off control switch connector, in 2-pin PH2.0 connector

External on/off control switch is functionally equivalent to the on-board switch S2.

To use the external on/off control switch, On-board switch S2 must be at off position.

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

J9: 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 J9 to the slave input of the following power supplies through a control cable.

S4: Battery disable switch

OFF: Battery power function enabled (default)

ON: Disable battery power function

S4 must be kept at OFF position in normal operating (default)

However if you don't have batteries installed on PurePi, you have to switch it to ON position.

J7: External ultracapacitor connector in 2-pin PH2.0

1: Ultracapacitor –

2: Ultracapacitor +

Though it is not recommended but if you really want to increase the ultracapacitor capacity of a PurePi, you can install an external ultracapacitor pack to this connected. But it has to be very very careful:

1. The external ultracapacitors must have 5.4V or higher rated voltage
2. **Both internal and the external capacitors have to be discharged (by a 5-20 ohm power resistor) completely before connect to J4.**
3. The pre-charge time of PurePi will be much longer.

G. LED indicators

D11: Power INPUT GOOD indicator. When lit, it indicates that the power input voltage is applied well and the voltage is higher than 4.9V.

D1: Power ON indicator. Indicating that the PurePi is turned on and output voltages are applied when lit.

D13: Ultracapacitor enabled indicator. When lit, it indicates that the ultracapacitors are fully charge and applied to the output. If this LED is off when power on, it means that the voltages over ultracapacitors are not enough to be enabled for output. They still need to be charged more.

D8: Pure battery output indicator. Indicating the battery section is in pure output mode when lit.

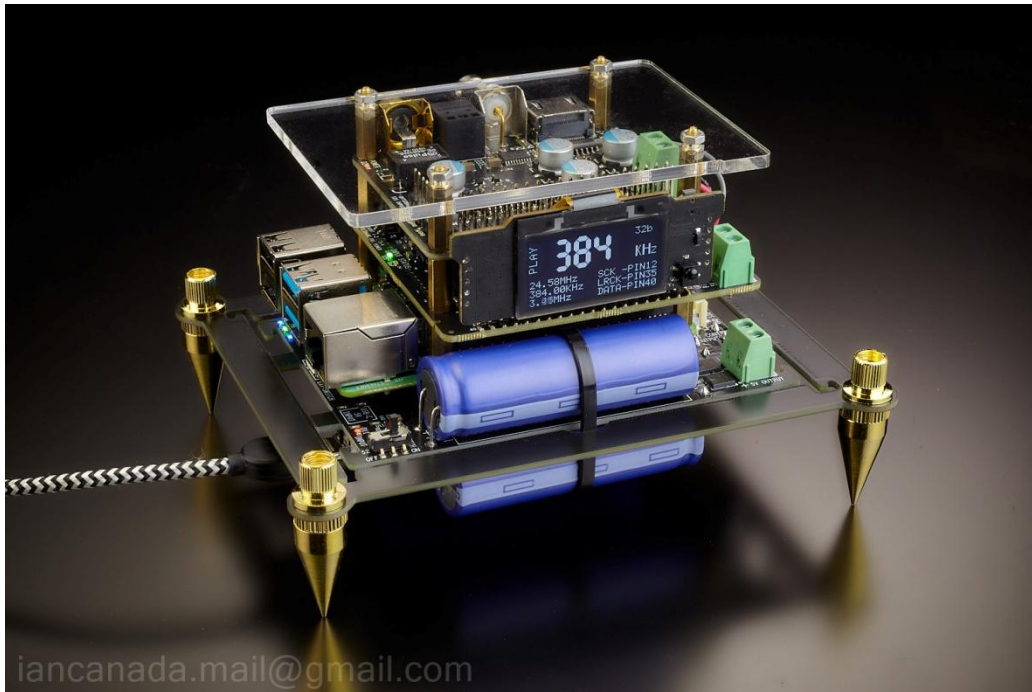
D10: UC FULL indicator. Indicating that the ultracapacitors are fully charged when lit.

D4: Battery full indicator. Indicating battery cells are fully charged when lit.

D9, D12: Ultracapacitor unbalancing warning LEDs.

H. PurePi example projects

1. Advanced compact size ultra-low jitter SYNC mode Raspberry Pi streamer transport



Project components:

- (1). PurePi 5V + 3.3V ultracapacitor/LifePO4 battery power supply combo
- (2). Raspberry Pi
- (3). FifoPiMa (or FifoPiQ7)
- (4). TransportPi mKII (or HdmiPi, or the coming TransportAES and the HdmiPiPro)
- (4). MonitorPi (optional)

Configurations:

Keep everything as default no change

Connections:

- (1). Connect the MCLK from J6 of FifoPiMa to J4 of TransportPi MKII.
- (2). Connect the 3.3V battery power supply from J2 of PurePi to J5 of FifoPiMa with two high quality wires.
- (3). Install the MonitorPi into the AUX GPIO of the FifoPiMa (optional)

Note: The spike feet kit can be found at Amazon.

2. Low cost high performance audiophile master mode RaspberryPi streamer transport



Project components:

- (1). PurePi 5V + 3.3V ultracapacitor/LifePO4 battery power supply combo
- (2). Raspberry Pi
- (3). TransportPiDigi all-in-one master mode RaspberryPi transport HAT

Configurations:

Remove jumpers from J2 of TransportPiDigi to use PurePi's 3.3V battery power supply.

Connections:

Connect the 3.3V battery power supply from J2 of PurePi to J3 of TransportPiDigi with two high quality wires.

Note:

MonitorPi can also be installed into the GPIO of the TransportPiDigi as an option if you need an OLED display for this project.

3. ESS DAC in SYNC clock mode with balanced/SE transformer I/V



Project components:

- (1). PurePi 5V + 3.3V ultracapacitor/LiFePO4 battery power supply combo
- (2). Raspberry Pi
- (3). FifoPiMa (or FifoPiQ7)
- (4). ESS9028Q2M DAC HAT
- (5). Transformer I/V board with two LL1544A audio line transformers
- (6). ESS controller

Configurations:

Configure ESS9028Q2M DAC to SYNC mode to use FifoPi's low jitter MCLK at SYNC mode

Keep everything else as factory default with on change

Connections:

- (1). Connect the MCLK from J6 of FifoPiMa to EXT MCK input of the ES9028Q2M DAC.
- (2). Connect the 3.3V battery power supply from J2 of PurePi to J5 of FifoPiMa with two high quality wires.
- (4). Connect the 3.3V battery power supply from J2 of PurePi to J3 of ES9028Q2M with another two high quality wires (share 3.3V battery power supply).
- (5). Install the ESS controller into the AUX GPIO of the FifoPiMa.

Note: Can also use ES9038Q2M Dual Mono DAC HAT.

I. Application notes

1. Safety notes

Once charged, the ultracapacitors will store energy even PurePi is switched at the OFF position. Please be very careful during installation not to short the circuit, especially when using the metal tools.

2. Where can I buy the spike feet?

Spike feet kit can be found at Amazon. You can just search “Spike feet kit”. For example:

3. How to install the anti-vibration rubber ring suspensions?

Rubber ring suspensions help the XO oscillators to improve phase noise performance by reducing mechanical vibration. It is possible to implement this solution on an PurePi. To do so, you will need:

- a. Break the PurePi PCB from the frame.
- b. Hook up 4 rubber o-rings (5x2 or similar) between the frame and the PurePi. (O-rings can also be found at Amazon)

Note: Please don't break the PurePi PCB unless you really decide to.

4. Is it possible to upgrade the performance of this PurePi ?

The performance of this PurePi is still possible to be upgraded by integrating with an UcConditioner 3.3V`.

You can connect J2 to UcConditioner 3.3 input. In this case, output have to be connected to the output of UcConditioner 3.3V.

5. Does the quality of DC input have business with the PurePi output quality?

The pure LifePO4 battery output is 100% isolated from the input at the pure mode. And the on-board battery charger will also be disabled in pure output mode. So theoretically the quality of battery outputs will have no business with the quality of the input DC power supply.

However, the 5V ultracapacitor output may still have something to do with the DC input because it's not in isolation mode. A higher grade DC power supply can still have lower EMI noise to the environment. So, there will be still some improvements if upgrade the 5V DC input with a lower noise linear power supply.

6. Working principle of LifePO4 power supply section

LifePO4 power supply section has three operation modes

(1). Pre-charge mode

LifePO4 power supply will work in pre-charge mode when PurePi is off and the input 5V DC input is still connected. In this mode, the battery cells will be connected to the onboard battery charger. The full LED D4 will be lit if the batteries are fully charged.

(2). Pure output mode

LifePO4 output will go to the pure output mode if PurePi is turned on while the full LED D4 is lit. In this mode, only the batteries 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. Pure LED D8 will be lit to indicate the LifePO4 section is running in the pure output mode.

(3). Protection mode

Because only the batteries will be connected to the load, after running for a very long time at pure mode, the battery cells can be exhausted. In this case, to protect the batteries from damage, a 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 output will be automatically switched back to the pure output mode.

Note:

The batteries will be disconnected from the PurePi by the relay when the input power is absent. The switched output J2 will be also off in this case. However, the continuous output J3 will still be connected to the battery cells without stop.

J. History of revising

Jul. 12, 2022 V0.9b released

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