

ConditionerPi

Raspberry Pi Ultra Capacitor Conditioner Board

By Ian Jin, June 6, 2020 Ver. 0.9b

A. Introduction

ConditionerPi is a HAT compatible ultra capacitor conditioner board that works for RaspberryPi. ConditionerPi can be installed directly into the local GPIO connector on top of a RaspberryPi between the rests of HATs. ConditionerPi will significantly improve the Raspberry Pi power supply quality by reducing internal ESR, the noise levels and the stability.

For audiophiles, upgrading Raspberry Pi based audio application with ConditionerPi could be a one of the most efficient solution to achieve better sound quality right away.

B. Highlighted Features and Specifications

- Seamlessly integrate with Raspberry Pi as local 5V power supply conditioner to upgrade all kinds of audio or other applications.
- Built-in ultra capacitor per-charge/charge circuits with current limitation.
- On-board RPi power ON/OFF control switch. This switch can also be extended as external ON/OFF switch.
- Remote ON/OFF control input (isolated) and output signals make it possible to integrate with multi-power supply system or perform remote on/off control.
- Power supply can be connected to ConditionerPi through either USB-C connector or the 5.5mm DC input connector.
- Conditioned 5V output feeds Raspberry Pi through local GPIO directly (preferred) or a USB-C cable.
- On-board active balancers for ultra capacitor protection.
- Full set of LED indications for power, power on, conditioning, power good and ultra capacitor full.
- Double thickness 2oz PCB copper layers especially designed for high current and ultra low ESR applications to achieve lowest possible ground noise.
- Fully ultra low resistance MOS FET architecture.
- MOS FETs are controlled by optical isolators to eliminate any possible leakage current.
- Can have additional low noise 3.3V output by installing an ultra-low noise 3.3V LDO board (supplied separately or from third party) to the reserved position on the ConditionerPi PCB.
- With external ultra capacitor connector makes it flexible for evaluation and possible upgrading.
- DIY friendly, plug and play, no software is required.

Top view of the Pi-Cond 1.0 PCB. The board is populated with various components including capacitors (C9-C17), resistors, and integrated circuits. Key labels include "Conditioner Pi", "ULTRA CAPACITORS P/N: BCAP0010 P270 X01 BCAP0010 P300 X11", and "Pi-Cond 1.0". Dimensions are indicated: 58mm width, 56.5mm height, and 49mm distance between mounting holes. A 5-pin header J5 is located at the bottom right.



D. Getting start to upgrade with ConditionerPi

1. Solder ultra capacitors (not included by default) to the positions of C9, C10, C11, C12, C14, C15, C16, C17.

Or just begin with only C9 and C14

Ultra capacitor P/N can be:

BCAP0010 P300 X11, or BCAP0010 P270 X01.

Lower ESR capacitors are preferred. Other ultra capacitors with same size are also good to go.

Please make sure using solder iron with **60W or higher** power for durable connections of this high current conditioner board. Pins are closed to each other so have to be very careful **not to short circuit**.

2. Plug ConditionerPi into GPIO connector on top of a RaspberryPi. Please use 12mm standoffs and make sure no component is touched in between. Install the rest of the RPi HATs.
3. Connect a 5V Raspberry Pi power supply to either DC input connector J7 or USB-C power input J10. Make sure the power supply is switched on. Both INPUT LED and POWER GOOD LED will light up right away. Shortly after, FULL LED will also light up (however if ultra capacitors are fully empty, it may take a couple of minutes to charge).
4. Turn the on-board ON/OFF control switch S1 to ON position. Both ON LED and power CONDITION LED will be lit up. Your RPi system will power up as usual with conditioned power supply.
5. Enjoy the music with the improvement by ConditionerPi.

Note: It is recommended keeping the external power supply always on with using the ConditionerPi on-board ON/OFF switch only.

Note: RaspberryPi will be powered directly from GPIO by ConditionerPi. No any other power supply is needed for Raspberry Pi when ConditionerPi is installed.

E. Connectors

J7: 5V DC power input connector

A 5V DC power supply with rated current 2A or higher must be connected to this 5.5mm/2.5mm power connector to operate. The voltage range must be within 4.9V to 5.3V. Center pin is positive.

J10: 5V USB type-C input power connector alternative to J7

If you want to use a USB power adapter, you can connect it to J10 and leave J7 unconnected at the same time. Rated current 2A or higher would be recommended. J7 and J10 are internally connected together.

J9: Optional 5V DC power input in 2-pin 5.0mm terminal (not assembled by default)

This connector is internally connected to J7 and J10. If it is required you can also connect/solder the 5V DC power input to this connector with leaving J7 and J10 unconnected. Please be very careful not to short the circuit or reverse the connections.

J2: ConditionerPi 5V output in USB type-C connector

This output is alternative to GPIO if you need to connect to a RaspberryPi externally through a USB cable. J2 is internally connected to ConditionerPi output.

J1: Optional ConditionerPi 5V output in 2-pin 5.0mm terminal (not assembled by default)

This connector is internally connected to ConditionerPi output and J2. If it is necessary you can also connect/solder the DC power output to this connector. Please be very careful not to reverse the connections or short the circuit.

J8: Ultra capacitor pack testing/monitoring connector in 2-pin PH2.0

- 1: V- of ultra capacitor pack
- 2: V+ of ultra capacitor pack

J5: External power on/off switch (un-installed by default)

If you want to use an external power on/off switch rather than the on-board switch, you need to connect it between the two pins of J5. And the on-board on/off switch S1 has to be turned in off position.

J6: Remote control signals in 4-pin PH2.0 connector

1-2: Isolated bi-polar remote on/off control input signal. Voltage range: 3V to 12V. To use external on/off control, the on-board on/off switch S1 has to be stayed in off position.

3-4: Non-isolated on/off control output signal. Range between 4.5V to 5V. If it is required, this signal can be connected to the isolated control signal input of other power supply that needs to be controlled.

Option 3.3V low noise output (un-installed by default)

If you need a low noise 3.3V regulated output at same time, you can install an ultra-low noise LDO board to the bottom side of ConditionerPi PCB by soldering IN, GND and OUT terminals to the corresponding pins of the LDO board. After that, you will have a high quality 3.3V voltage rail output. You can solder wires to 3.3V and GND pins and then feed them the device that needs to be powered.

J3 and J4: 40 pin GPIO connectors

Pin numbers	J3 40 PIN GPIO socket to connect to a RaspberryPi	J4 40 PIN GPIO connector to HAT on top of the Raspberry Pi	
1,17	3.3V from RPi	3.3V filtered	Pass-through
2,4	5V to RPi	5V conditioned voltage rail	Pass-through
6,9,14,20, 25,30,34, 39	GND	GND	Pass-through
3	I2C DA	I2C DA	Pass-through
4	I2C CL	I2C CL	Pass-through
27	ID DA	ID DA	Pass-through
28	ID CL	ID CL	Pass-through
12	SCK	SCK	Pass-through
35	LRCK/D1	LRCK/D	Pass-through
40	SD/D2	SD/D2	Pass-through
All other pins	same pin from preceding board	same pin from preceding board	Pass-through

F. LED indicators

D6: INPUT indicator: Indicating that the DC voltage is applied to input connectors when lit. The output of ConditionerPi will be valid at same time if S1 is switched on.

D3: POWER GOOD indicator: Indicating that the DC input voltage is higher than 4.9V when lit.

D2: Ultra capacitor FULL indicator: Indicating that the ultra capacitor pack is full when lit.

D5: Conditioning indicator: Indicating that the ConditionerPi output is in conditioning state when lit.

D1, D4: Ultra capacitor over voltage alarm indicator: Indicating the voltage of ultra capacitors is higher than 2.7V, active balancing is taking action.

G. Application notes

1. Ultra capacitors are in pair. If you don't want to assemble all of the at a time, you can install:
2 of them: C9 and C14
4 of them: C9, C14, C10 and C15
6 of them: C9, C14, C10, C15, C11 and C16
Internal ESR could be higher if ultra capacitors are not fully installed.
2. ConditionerPi doesn't regulate the voltage. So the output voltage will be up to the input voltage. The input voltage must be within the range of 4.9V to 5.3V. If it is lower, the ConditionerPi will not go to conditioning state. If it is higher, the ultra capacitors can get damaged or reduced the life time.
3. As long as the on/off switch is turned on, the Raspberry will always be powered up. However the ConditionerPi may not enter conditioning state until the ultra capacitors are fully charged.
4. It is recommended using the on-board S1 as power on/off control. However if you really want, you can still control the on/off from external power supply. You need to leave the S1 at on position if so. In this case, RPi will be powered up immediately when the external power supply is turned on. However, when the external power supply is turned off, there could be a bit delay to the RPi power off.

H. Pictures of the ConditionerPi

1. ConditionerPi as shipped (bottom side)



2. ConditionerPi as shipped (top side)



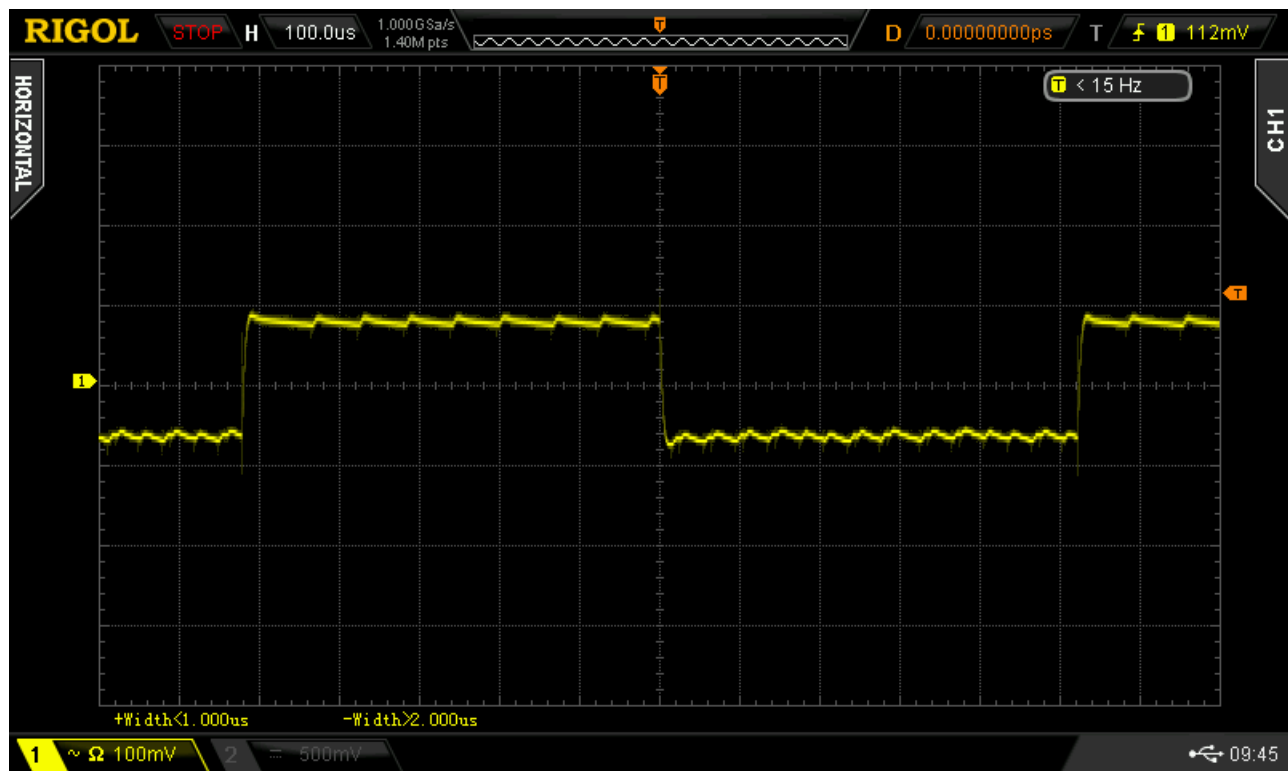
3. ConditionerPi with ultra capacitors installed



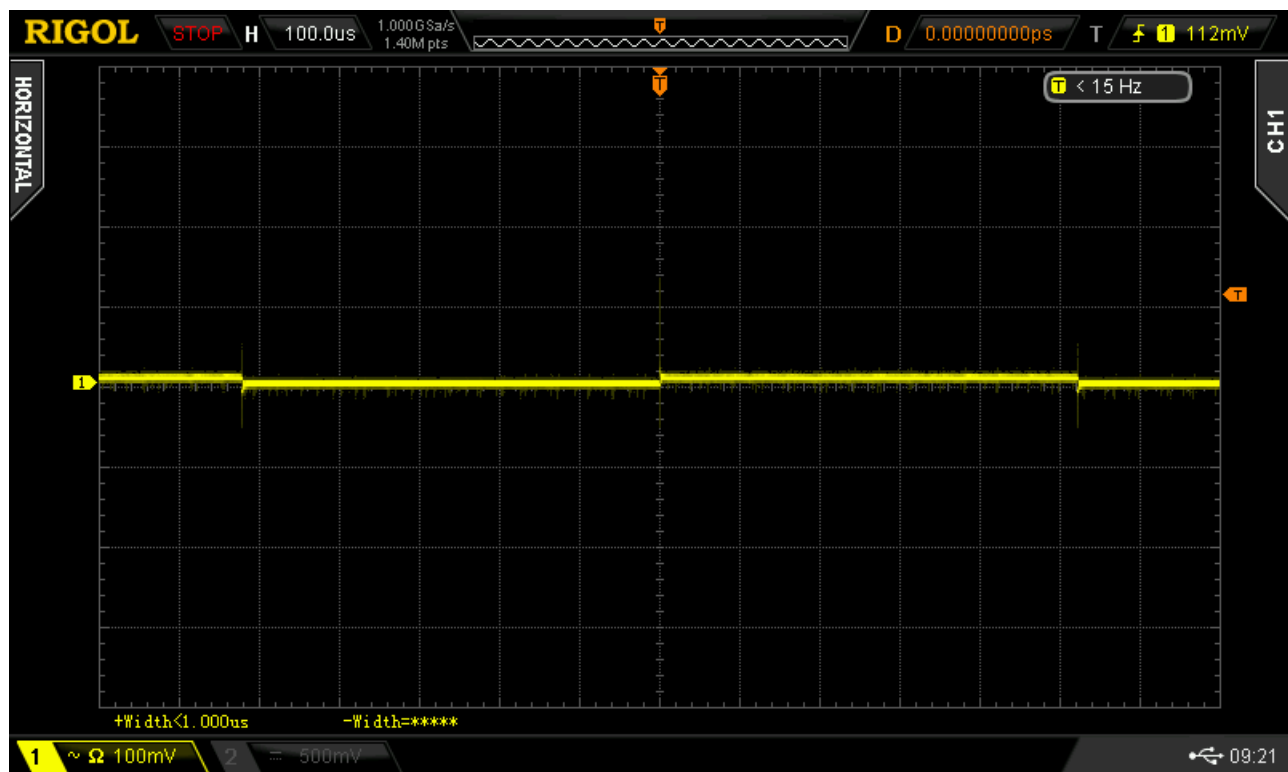
4. ConditionPi is working with a Raspberry Pi 4 and a DAC HAT, powered by a USB power adapter



5. Dynamic 500mA load transient response of a typical 5V/2A USB power supply



6. Dynamic 500mA load transient response of the same USB power supply with ConditionerPi installed



I. History of revising

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