# UcPure

## The Pure Ultra-capacitor Power Supply

By Ian Jin Dec 24, 2021 Ver. 1.0

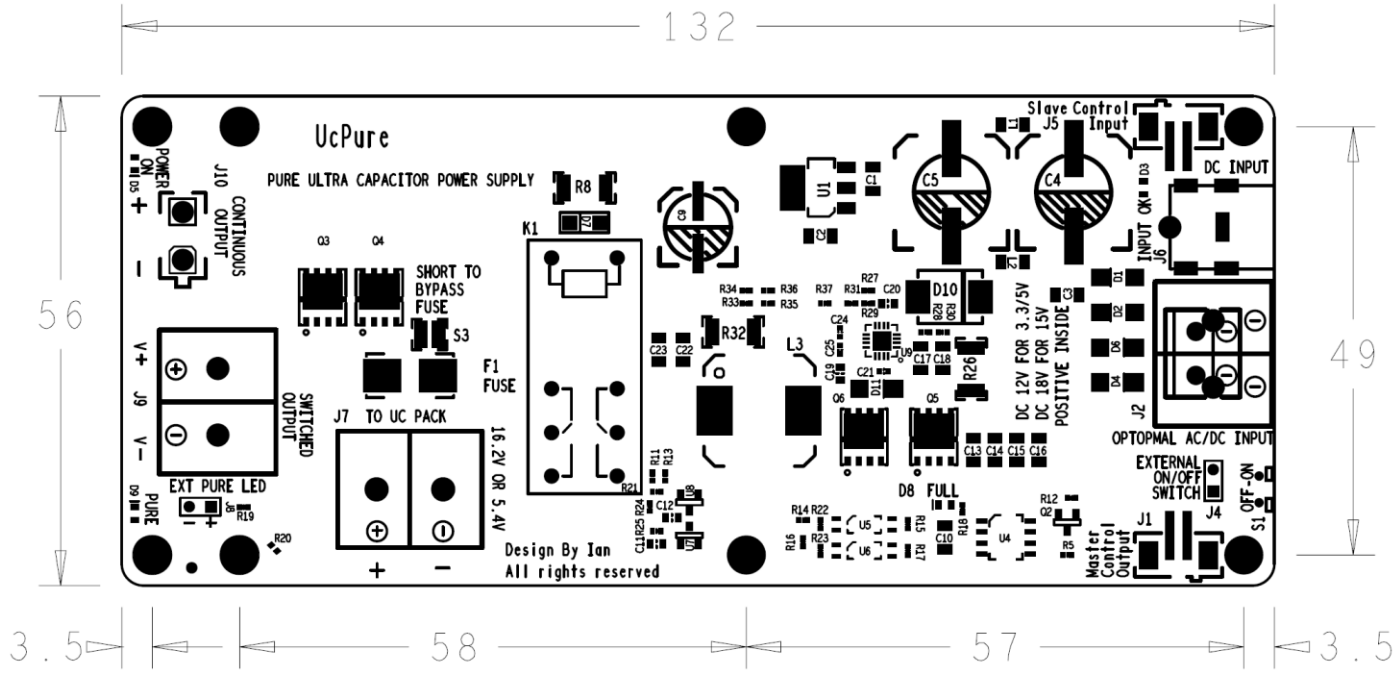
## A. Introduction

UcPure is a pure ultracapacitor power supply. It makes use of the 3000F or higher capacitance ultracapacitor pack to achieve an ultimate 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 pre-charged ultracapacitor pack will be applied to the load. It's also capable of delivering up to 1000A dynamic current with less than 0.58mOhm internal ESR (continuous output mode, decided by the 3000F ultracapacitors pack). It could be so far the best low noise and ultra high dynamic power supply in the real world. Sound quality of sensitive audio applications such as low jitter clock oscillators, DACs, FIFOs and many other circuits will be benefited from this UcPure power supply.

## B. Specifications and Highlighted Features

- Pure ultracapacitor power supply.
- Ultracapacitors work in class A mode which current going only in one direction.
- Output can be configured to 3.3V(default), 15V and 5V
- Has both switched and continuous (great for clock oscillators) outputs
- Outputs are 100% isolated from charger, input and other circuit 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 group of power supplies.
- Optical isolators are used for all internal operating logics.
- Can use 9V to 20V DC input for 3.3V/5V configuration and 18V-20V DC input for 15V configuration. AC input is also possible.
- Pre-Charging current has 3A (default) and 1.5A two settings to be suitable for different input power supplies.
- Built-in protection scheme to prevent ultracapacitor from exhausted and low output voltage
- Dynamic output current: up to 1000A (decided by the ultracapacitors )
- Output ESR: Less than 0.58 mOhm (3.3V or 5V configuration, decided by the ultracapacitors)
- Output noise: Decided only by the ultracapacitors
- Heavy duty design for 24/7 operation

## C. Layout and Dimensions (in mm)




## D. Getting started

1. Make sure the jumper settings are settled correctly for 3.3V(default), or 15V or 5V configurations.
2. Connect a fully empty ultracapacitor pack to J7. Make sure the polarity is correct. 3.3V and 5V configurations need a pack with two 3000F ultracapacitors. The 15V configuration needs a pack with six 3000F ultracapacitors. Ultracapacitor pack has to have built in balancer/protection boards.
3. Connect the load to J9
4. Make sure the on-off control switch S1 is at the off position and then connect a 18V-20V standard laptop power adapter with 3.5A or higher rated current to DC input J6 (inside is positive). The input LED D3 will be lit and the pre-charge mode will start. It may take up to an hour or so at the first time of charging the ultracapacitor pack. The full LED D8 will be lit once the ultracapacitor pack is fully charged.
5. Turn the on-off switch to the on position. Both output LED D5 and pure LED D9 will be lit.

   Now you can enjoy the performance of the ultimate UcPure ultracapacitor power supply.

## E. Principle of operating

UcPure has three operation modes

1. Pre-charge mode

   UcPure will work in pre-charge mode when it is off while the input power supply is connected. In this mode, the ultracapacitor pack will be connected to the dedicated onboard CC-CW ultracapacitor charger. The constant charging current can be programmed to 3A (default) or 1.5A according to the jumper settings. The full LED D8 will be lit after the ultracapacitor pack is fully charged.

2. Pure output mode

   UcPure will go to the pure output mode if it is turned on while the full LED D8 is lit. In this mode, only the ultracapacitor 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 circuit. Both pure LED D9 and output LED D5 will be lit to indicate the UcPure is running in the pure output mode.

3. Protection mode

   Because only ultracapacitor pack is connected to power the load, after running for a long time at pure mode (normally hours), the output voltage will be dropped below a threshold voltage. To protect the output from going low voltage, UcPure protection mode will be triggered in this case. The CC-CV charging circuit will be connected again to re-charge the ultracapacitor pack. The output doesn't stop in this protection mode but the low noise performance will be degraded slightly meanwhile (active circuits involved). After a couple of minutes, the UcPure will be automatically switched back to the pure output mode once the ultracapacitor pack is fully charged again.

Note:

The ultracapacitor pack will be disconnected by the relay from the UcPure when the input power is absent. The switched output J9 will be also off in this case. However, the continuous output J10 will still be connected to the ultracapacitor pack without stop.

## F. Jumper settings

| Configurations | S2 | S4 | S6 | Ultracapacitor Pack |
|---|---|---|---|---|
| 3.3V (default) | 0 (short) | 0 (short) | 0 (short) | 2 *3000F |
| 15V | Open | Open | Open | 6 * 3000F |
| 5V | 21K 0603 1% | 0 (short) | 11K 0603 1% | 2 * 3000F |

| Charging current | S5 | Charging time | DC/AC Input current |
|---|---|---|---|
| 1.5A | 0 (short) | Slower | Lower |
| 3A (default) | Open | Faster | Higher |

## G. Connectors

**J6: DC power input connector (5.5/2.5mm, positive terminal inside)**

A good quality 18V to 20V standard laptop power supply with 3.5A or higher rated current is recommended for all the configurations. Or for 3.3V/5V configurations, the input range can be DC9V to 20V. This DC input 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)**

| Configurations | AC input | Or DC input (bi-directional) | Rated current |
|---|---|---|---|
| 3.3V/5V | AC 12V | DC 9-20 V | Higher than 1.5A/3A according to the jumper settings |
| 15V | AC 15V | DC 18-20 V | Higher than 1.5A/3A according to the jumper settings |

Note: J6 has to be kept unconnected if J2 is used

Note: AC coil has to be independent and cannot be shared with other devices.

**J7: Ultracapacitor pack connector (barrier terminal block)**

Ultracapacitor pack must be connected to this connector to operate.

Please make sure the screws are tighten up and never reverse the positive and negative terminals.

**J9: Switched output (barrier terminal block)**

This is the switched output of UcPure. This output will be turned on and off when UcPure is on or off.

Normally the load is 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

**J10: Continuous output (2 PIN Molex Mini-Fit connector)**

This continues output is specially designed for clock oscillators, sine to square convertors and many other analog applications that need continuous power for long time break-in. The continuous output is non-switched, so the output will be always there no matter UcPure is on or off. The only way to turn off this output is to disconnect the connector by unplugging the cable

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**

UcPure can be controlled remotely from this slave control input. UcPure 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 UcPure.

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 UcPure or other power supplies through the supplied control cable.

**J8: Optional external pure LED connector**

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

This connector was no installed by default.

## H. LED indicators

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

D5: Power on indicator. Indicating that the UcPure is turned on and output voltage is applied to J9 when lit.

Note: D5 has no business with the continuous output

D9: Pure output indicator. Indicating UcPure is in pure output mode when lit.

D8: Full indicator. Indicating ultracapacitor pack is fully charged when lit.

## I. Application notes

**1. Ultracapacitors**

External ultracapacitor pack is needed for UcPure to operate. The capacitance of ultracapacitors have to be 3000F or higher.

Maxwell BCAP3000 P270 and BCAP3000 P300 are recommended but not limited. Other 3000F/2.7V or higher capacitance/voltage ultracapacitors are also good for UcPure.

It could be a good idea buying an ultracapacitor pack directly. It will have built-in balancer/protection boards and other accessories. Ultracapacitors and the balancer/protection boards can be sourced from eBay, Mouser, Digikey, Amazon, Aliexpress and other on-line stores.

## 2. ESR of UcPure

ESR of the switched output J9 = Ultracapacitor pack ESR + Fuse resistance + MOSFET ESR
ESR of the continuous output J10 = Ultracapacitor pack ESR + Fuse resistance

Take an example, at 3.3V/5V configuration with BCAP3000 P270 ultracapacitors
ESR (J9, switched) = 0.58mOhm (ultracapacitors) + 12.5mOhm (fuse) + 0.8mOhm (MOS FETs) =**13.88mOhm**

The resistance of wires has also to be taken into account for the ultra low ESR power supply such as the UcPure. 16 AWG or bigger wires are highly recommended for both supercapacitor pack and outputs.

To reach better ESR performance, we can also bypass the fuse F1 by shorting S3 with solder. In this case, ESR (J9, switched) will be reduced to **1.38mOhm** and J10 (continuous) will be only **0.58mOhm.**
**But have to be aware of the risk of damaging in case of short circuit.**
If really want to, I would suggest only doing this upgrade after the whole system is settled.

## 3. How to push the performance of the UcPure to the limit

The best performance of UcPure comes from a special continuous output mode that the wires of the output are connected directly to the positive and negative terminals of the ultracapacitor pack.
In this case, the ESR of UcPure will be exactly the ESR of ultracapacitors, say **0.58mOhm** for 3.3V/5V configuration.
Both fuse and wires to the ultracapacitor pack will be bypassed. So, shorting S3 is no longer a necessary.
I suggest using a connector to make it possible to disconnect the load from the ultracapacitor pack.

4. **How to integrate UcPures 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 UcPure, and then the master control output J1 of UcPuer to the next power supply or another UcPure to make a control chain. UcPure slave control input is optical isolated and non-polarity.

5. **How long the pure time will last before triggering the protection mode**

   The pure time can be calculated.

   Take for instance. If the output voltage drops from 3.4V to 3.0V (UcPure 3.3V configuration), the charge released will be Q = 1500 * 0.4 = 600 (Coulombs).

   If the load (FifoPi clean side together with SinePi) consumes 50mA current, the pure time will be:

   T = 600 /0.05 = 12000 seconds = 3.33 hours

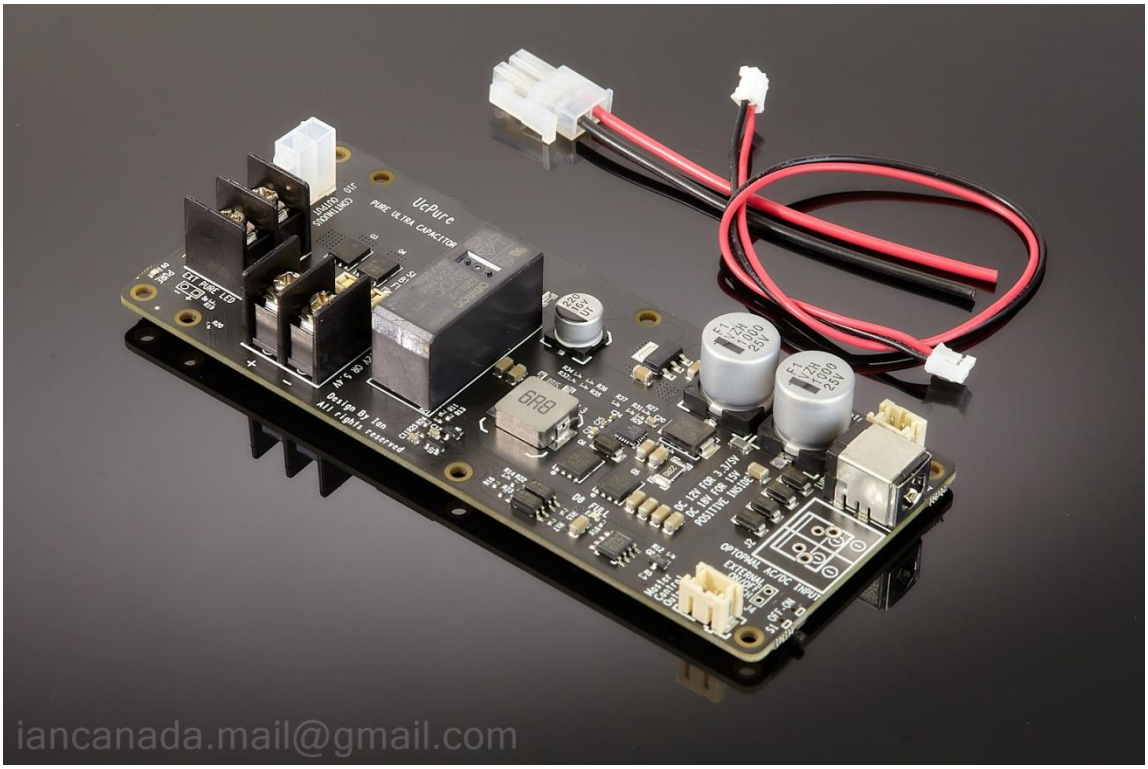
   After that time, the protection mode will be trigged to re-charge the ultracapacitor pack. However the protection mode will take only 3.33 minutes to fully charge the ultracapacitor pack again. UcPure will go back to the pure output mode after that time. So, this scheme doesn't really affect the listening experience much.

6. **Suitable applications**

   UcPure 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. UcPure could be the best possible performance power supply for those applications. However, high current applications may not suitable very well for UcPure though it can deliver up to 1000A dynamic current, for it could trigger the protection mode often.

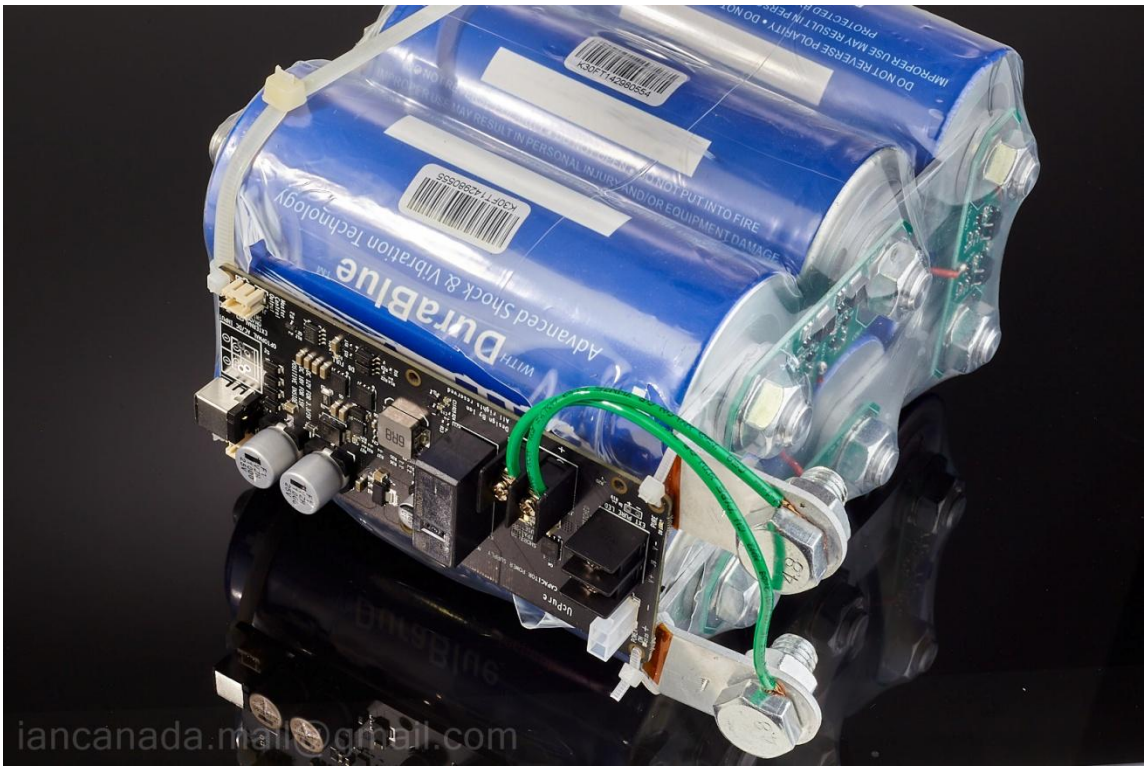
## J. Pictures of UcPure

1. UcPure as shipped



2. UcPure in 3.3V configuration


3. UcPure in 15V configuration



## K. History of revising

Sep 23, 2021 V0.9b released

Dec 24,2021 V1.0 released, Change max AC input voltage to 15V

disassemble the software provided. 