UcPure Pro 5V

UcPure Pro 3.3V

The Third-Generation Pure Ultra-capacitor Power Supply

By IanCanada

A. Introduction

UcPure Pro is the third-generation ultracapacitor power supply. It makes use of the huge 3000F or higher capacitance ultracapacitor pack to achieve an ultimate power supply performance. Because it is a pure passive power supply, there will be neither feedback nor active components involved when it's turned on. In the pure mode, the output is 100% isolated from input, only the pre-charged ultracapacitor pack will be connected to the load.

UcPure Pro revolutionary employs triple PCB architecture to separate the management PCB from the ultracapacitor pack PCBs. The output will be connected directly from the ultracapacitor pack without any other circuits involved. Bolt-down automotive fuses are first time being used by UcPure Pro for higher reliability and lower ESR. The output ESR will be just ultracapacitor ESR plus fuse ESR. The internal PCB ESR would be much lower than any previous generations.

UcPure Pro could be the best low noise, low ESR pure power supply in world so far. Sound quality of sensitive audio applications such as low jitter clock oscillators, DACs, FIFOs, I/V stages and many other circuits will be benefited greatly from this UcPure Pro power supply.

B. UcPure Pro 5V/3.3V new Features

- **Triple PCB** architecture makes it has the lowest ESR and noise levels among all UcPure generations.

- Plate PCBs were developed to connect the **output directly** from the ultracapacitor pack over much bigger double thickness multi-layers copper areas.

- Ultracapacitor plate PCBs are **separate from management PCB** for a much purer working condition.

- Only one **control cable** is needed between management PCB and plate PCB

- **5V or 3.3V** configurations

- Has both **precision** and normal **output** voltage range control mode

- **Precision balancers** have been integrated on PCB, so no longer need external balancer/protection boards.

- Much reliable **bolt-down automotive fuses** are first time being used to improve the performance more

- Configurable **input current limitation** to protect the AC/DC input without affecting the peak charging current.

- **Low profile** design, easier to integrate with different projects and cases.

- **10A** high peak charging current, charge and re-charge ultracapacitors very fast

- Ultra-high current/low ESR **output terminal connector,** ideal for thick or groups of power wires

- Optimized to **AC input** 12V to 15V, can also work with 15V to 19V DC input.

- Can use smaller transformer for input to save cost and space by taking the lower input current setting

- **Manual charging** triggering push-button option

- Possible to have a **control panel**

- Additional safety features

## C. Other Highlighted Features

- **Pure** ultracapacitor power supply

- Ultracapacitors work in **class A** mode which current going only in one direction.

- Outputs are 100% **isolated** from charger and power input at pure mode

- Can be controlled by the built-in /external **ON/OFF switch** or **control chain** (optical isolated) of the whole power supply group

- **Optical isolators** are used for all internal operating logics

- Built-in **protection scheme** to prevent ultracapacitor from exhausted and low output voltage

- With a powerful **SYNC UC charging** function. Can re-charge the UCs during music stops. This feature can avoid the output voltage drop or trigger the protection mode even if you listen to music for a very long time. SYNC input control signal can be connected to the MUTE signal of a MonitorPi pro or a FifoPiQ7. More UcPures can work together with a SYNC control chain. This signal is optical isolated from UcPure so it doesn't affect the power supply performance at all

- **Heavy duty** design for 24/7 operation

- **DIY friendly**, easy to install

D. UcPurePro 5V and 3.3V difference

- UcPurePro 5V and 3.3V manage boards are the same. But they have different settings and will be pre-configured and tested under desire voltage before delivery. It's possible to change the settings but that is not recommended.

- UcPurePro 5V and 3.3V share the front plate and back plate PCBs, so they are the same for both 5V and 3.3V configurations.

E. Layout and Dimensions

UcPure Pro 5V and 3.3V Management PCBs (J9, J10, J12, J15 jumper settings are different)
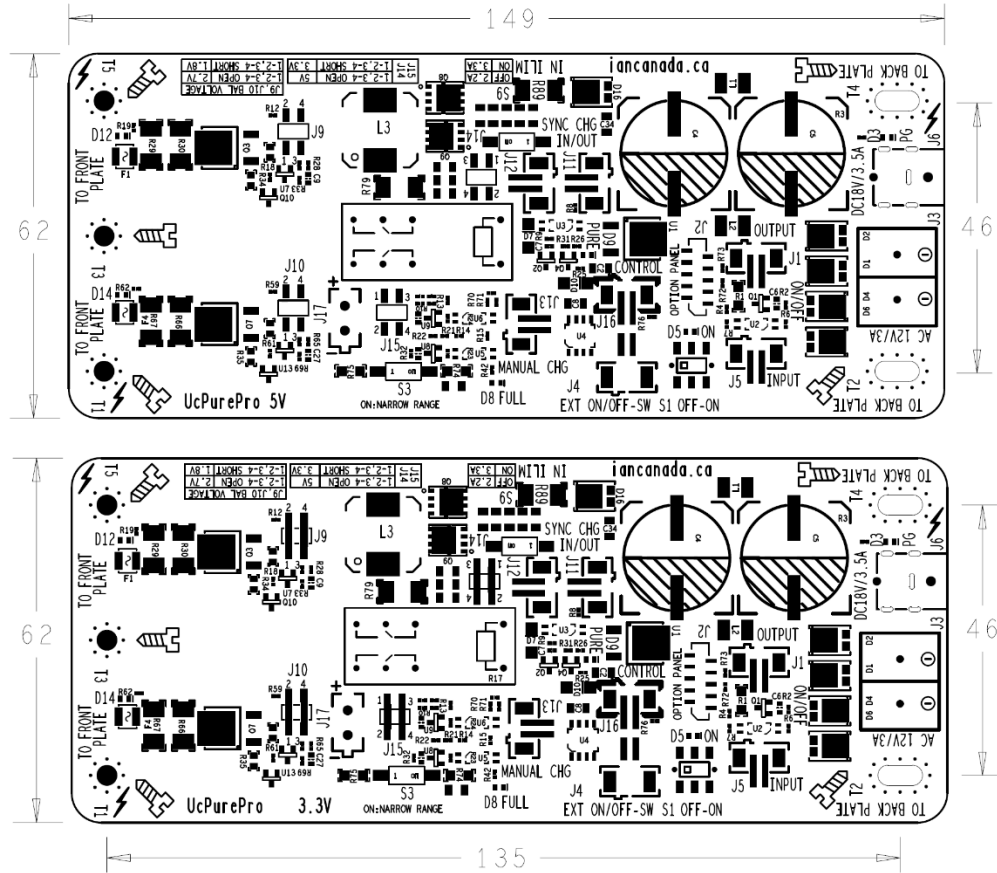
UcPure Pro 5V/3.3V Front Plate and Back Plate PCBs
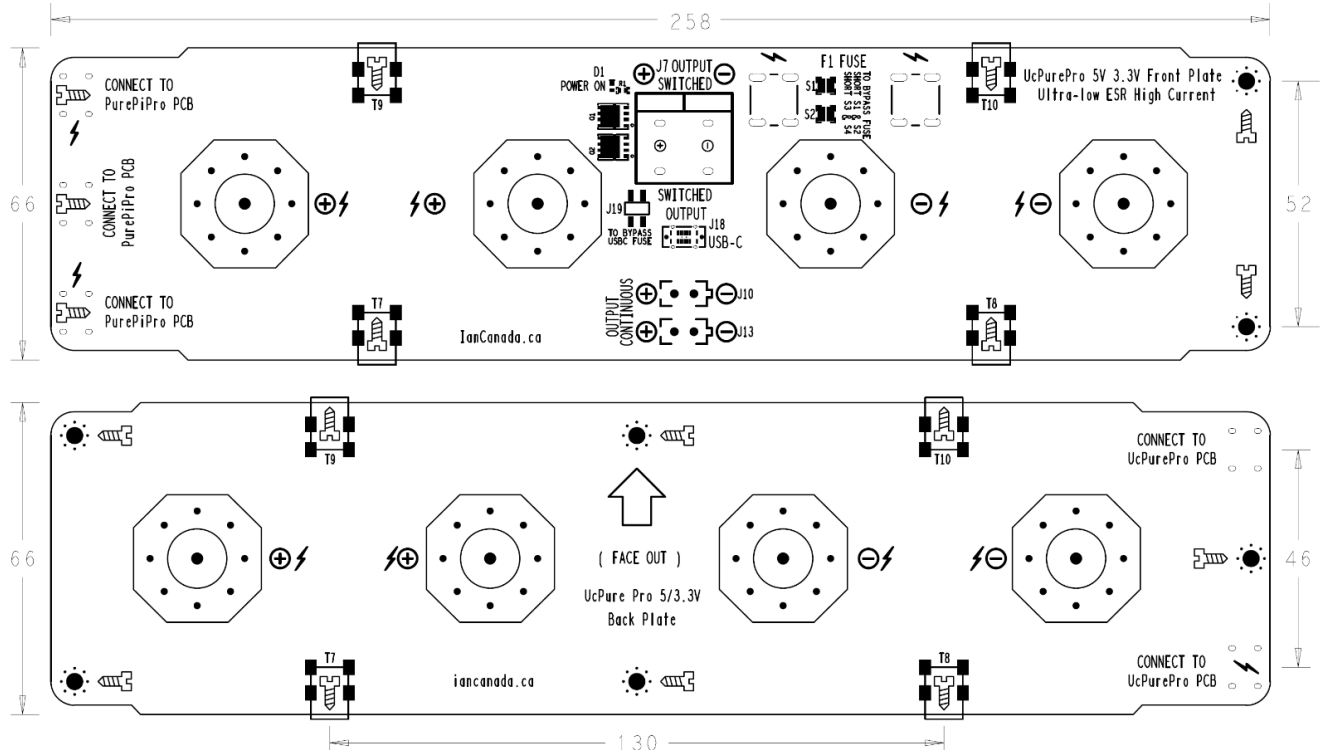
F. Installation steps

1. Install a 3mm thickness washer (or two 1.5mm washers) between each ultracapacitor terminal and PCB plate (8 terminals in total). Recommended UC P/Ns:
    XL60-2R7308T-R or
    TPLH-2R7/3000SL60138
    3V ultracapacitors are also good to use, such as
    XL60-3R0308T-R or
    TPLH-3R0/3000SL60138

2. Make sure all ultracapacitors are fully discharged first. Then Install all the four ultracapacitors into the UcPurePro back plate PCB in right **orientations as the same as the marks on the PCB**. Then screw the four 12mm nuts to the terminals (not tighten). Metal self-locking nuts are highly recommended to ensure best connection and lowest ESR under high current. **Never use plastic nuts** because of the possible poor connections!

3. Do the same as Step2 on the other side of the ultracapacitors to assemble the UcPurePro front plate PCB to the UC pack. Ensure no pins touch to the ultracapacitors at the both back side of the plate PCBs.

4. Put the ultracapacitor pack assembly on a flat surface, ensure the five connection terminals to the UcPurePro main board are at the same side. Tighten all eight self-locking nuts using nut socket tool KIT. Cover all the nuts with matched isolation caps to prevent from possible short circuits.

5. Install the UcPurePro 5V or 3.3V management board to the ultracapacitor pack terminals using the five 3mm spring washer screws. Ensure the screws are tightening. The last thing before finishing the assembling job is to Install a PH2.0 control cable from J1 of the front plate to the J16 of the UcPure Pro management board.
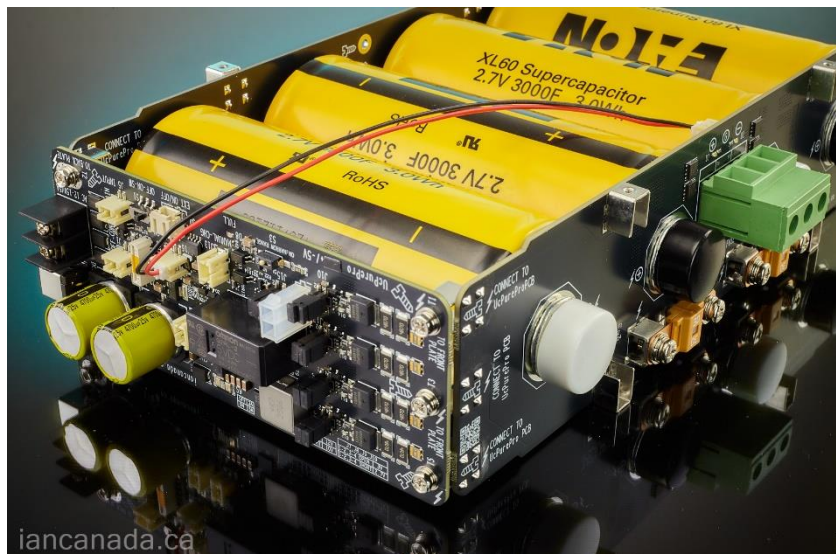
6. Ensure the UcPurePro output is not connected. Then connect an AC transformer coil to the J3. **1182M12** would be good for all configurations. D3 will light up after the transformer is powered up. If it is the first time of use, please wait for less than an hour until the Full LED D8 is on. Then turn on the UcPurePro power supply by the on-board or external ON-OFF switch (or by the control chain later), the blue pure LED, and D1 on the front plate will light up.

An additional safety feature may apply to this stage or when the ultracapacitors are fully empty. That is, if the ultracapacitor voltage doesn't reach to 75% full after 30 minutes of power up, the controller will cut off the charging current to prevent form any possible short circuit. If that's the case, you will find the ultracapacitor voltage stop increasing and the green LED D18 (at the back side of the management board PCB) turns off. To recover from this protection mode, please shut down (no turn off the on/off switch) the AC or DC power input, ensure there is no any actual short circuit, wait for at least 3 seconds, power up the UcPurePro again. The green LED D18 will light up shortly after and the UcPurePro will be back to work. This safety feature will not be triggered during normal operating.

Now, the world best power supply is working and will be ready for powering your project.

In pure mode, the output will be 100% isolated from the input so the common mode noise transmission path will be eliminated.   No ground loop can be built.

Note: Please follow the directions on the front plate and back plate PCBs for the ultracapacitor orientations, the orientations in the pictures could be different.

G. Jumper settings

Configurations	J14	J15	J9, J10
3.3 V	1-2: short 3-4: short	1-2: short 3-4: short	1-2: short 3-4: short
5 V	All open	All open	All open

Input Current Limitation	S9
2.2 A	OFF
3.3 A	ON

Precision output control	S3	Configuration	Re-charge threshold	Back to Pure Voltage
Normal voltage range	OFF	5V	4.64V	5.29V
		3.3V	3.03V	3.45V
Precision voltage range	ON	5V	4.82V	5.23V
		3.3V	3.12V	3.39V

Note: All jumpers are pre-set well according to the configuration before delivery

H. Connectors

J3: AC input barrier terminal block (Recommended)

An independent AC winding from transformer needs to be connected to J3 as the UcPure Pro power input. This AC coil cannot be shared with any other power supplies or devices to avoid possible short circuit and damage (Two independent coils from the same transformer can be fed into two different UcPurePro each, windings can also be in parallel to increase current, but one coil can not be shared by two UcPurePro). Please also don't exceed the AC input voltage higher than the recommendations.

Transformer P/Ns	2.2A Input (S9 OFF default)	3.3A Input (S9 ON)
UcPure Pro 5V/3.3V	1182L12 (single winding)	1182M12 (single winding)
	1182K15 (single winding)	1182M15 (single winding)
	1182J15 (parallel two winding)	1182K15 (parallel two winding)

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

A standard 18.5V laptop power adapter with 3.5A or higher rated current can be connected to J6 as power input. Have to make sure AC input J3 is unconnected. But this DC input is not recommended for actual applications because of the potential grounding issues and higher EMI noise to the environment. But you have no problem using this DC input for UcPure Pro function test before connecting to project.

J16: UcPurePro Control output connector, (2-pin PH2.0)

Must be connected to J1 of the UcPure Pro Front Plate PCB using the supplied control cable to function

J4: Optional external ON/OFF switch connector, (2-pin PH2.0)

This 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.
#61C External ON/OFF switch can be used which is not supplied by default.

J5: Slave ON/OFF control chain input (2-pin PH2.0, isolated and non-polarity)

UcPure Pro 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 Pro.
To use the ON/OFF/ control chain, On-board switch S1 or external ON/OFF switch must be kept at OFF position.

J1: Master ON/OFF control chain output (2-pin PH2.0)

1: Control signal –

2: Control signal + (5V)

To create a control chain of a power supply group, we can connect J1 to the slave input of the following UcPure Pro or other power supplies through the control cable, and so on.

J11, J12: SYNC control signal input/output (2-pin PH2.0)

1: SYNC control signal –

2: SYNC control signal +

To enable the SYNC mode, SYNC control signal + needs to be connected from the MonitorPi Pro or the FifoPiQ7's MUTE output.

With a built-in isolator, this control signal is non-polarity and will be optically isolated from UcPure Pro.

J11 an J12 are equivalent.

J13: Optional manual charge button connector, (2-pin PH2.0)

An optional external push-button can be connected to this connector to trigger a manual charging cycle in pure mode.

J17: Ultracapacitors pack discharge connector (Molex MINIFIT)

Before disassemble a UcPure Pro, the first thing needs to do is to discharge the ultracapacitors. You can use a #63A UcDumper to discharge them safely by just plugging the cable into J17.

T1, T4, T5:

High current screw connection terminals between UcPurePro management board and ultracapacitor pack PCBs through 3mm spring washer screws. Because of they are connected to ultracapacitor cells, please be very careful not to short circuit to the screws.

J2: Panel connector (Optional, 10pin 1mm FFC)

J2 can be connected to a possible control panel of the UcPure Pro.

T7, T8, T9, T10 and other mounting holes without lighting symbols:

Mounting brackets or mounting holes. Not connected to any circuit.

Note: All metal parts with lighting symbols are connected with ultracapacitors or internal circuits. Please be very careful not to short circuit. **Plastic or nylon screw drivers** are highly recommended to work with those screws because the ultracapacitors can always have energy even at power off or input is not connected.

I.   Resources On the Front Plate PCB

J7: Switched output (ultra-low ESR high current)

Switched main output of UcPure Pro. This is 52A huge current rated connector with very big terminal size. 6-20 AWG thick wires or groups or wires can bet fit perfectly into this connector. This output will be turned ON and OFF when UcPure Pro is ON or OFF.

J1: Control input connector, (2-pin PH2.0)

Must be connected to J16 of the UcPure Pro management PCB using the supplied control cable to function.

J10, J13: Continuous output (Molex MINIFIT)

The continuous output is non-switched, so this output will be always powered with ultracapacitor voltage no matter UcPure Pro is ON or OFF. The only way to turn off this output is to disconnect the connector by unplugging the cable.

J10 and J13 are equivalent. Fuse is also applied to these outputs, but have to be very careful to avoid any over current or short circuit.

F1, F2: High Reliable Bolt-down Automotive Fuses

Littelfuse MIDI M5 Automotive Fuses, some typical P/Ns:

Fuse P/Ns	Current Rating (A)	Cold Resistance (mOhm)
142.5631.5302	30	2.7
142.5631.5402	40	1.56
142.5631.5502	50	1.03
142.5631.5602	60	0.75
142.5631.6102	100	0.44
142.5631.6202	200	0.24

J. LED indicators

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

D5: Power on indicator. Indicating that the UcPure Pro is turned on.

Note: The continuous output has no business with D5

D1: Output indicator. Indicating UcPure Pro output voltage are applying to J7.

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

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

D11, D12, D13, D14: Precision balancer Action LEDs. It means the balancer is enabled and starting to dump the current of corresponding ultracapacitor. The maxima dump current will be up to 1.1A. It normally takes minutes to an hour to balance the voltages.

K. Application notes

1. **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 5.35V to 4.64V (UcPure Pro 5V configuration), the charge released Q = 3000 * 0.71 = 2130 (Coulombs).
   If the load current consumes 500mA current, the pure time will be:
   T = 2130 /0.5 = 4260 seconds = 1.2 hours
   After that time, the protection mode will be trigged to re-charge the ultracapacitor pack. The re-charge time would be very fast. It will take around 2 minutes to fully charge the ultracapacitor pack again. UcPure Pro will go back to the pure mode immediately after. So, this scheme doesn't really affect much to the listening experience. However, if the SYNC charge function is enabled, the re-charge process will be performed automatically even without being noticed.

2. **How to integrate UcPure Pro into a power supply group**
   To setup a ON/OFF control chain for a power supply group, please connect the Master control output (3V to 12V control voltage) of the first power supply (master) to the Slave control input J5 of the UcPure Pro, and then connect the master control output J1 of UcPuer Pro to the next power supply or another UcPure Pro and so on. UcPure Pro slave control input is optical isolated and non-polarity.

3. **What are the suitable applications using a PurePi Pro**
   UcPure Pro will work greatly for all kinds of ultra-low noise applications such as DAC/ADCs, I/V stages, MM/MC phone amplifiers, pre-amplifiers and many other circuits. UcPure Pro could be the best possible performance power supply in the real world so far. However, high current applications may not suitable very well for UcPure Pro though it can deliver up to thousands of amperes dynamic current, because high output current will consume the energy of ultracapacitors faster and trigger the protection mode often.

4. **How to enable the SYNC mode**
   SYNC mode is disabled by default. To enable this feature, you just need simply connect the two-pin connector cable to either J11 or J12 from a MonitorPi Pro or FifoPi Mute connector.
   If you want more UcPure Pro run SYNC mode as a group, you can connect the rest of SYNC connector (J11 or J12) to J11 or J12 of the next UcPure Pro by a PH2.0 cable and so on as a SYNC control chain.

5. **Upgrading Fuses for even lower ESR**
   UcPure Por power supply reaches to a level that the resistance of fuses cannot be ignored. In this case, Bolt-down Automotive Fuses are used for much lower resistance than the standard glass fuses. But it is still possible to lower the ESR even more.
   After your project runs stable, you can upgrade the on-board fuses to higher current rating ones for lower resistance. (Please make sure the UcPure Pro is turned off when you replacing the fuses.)
   You can also bypass the fuses by bridge short the S1, S2, S3, S4 by soldering balls. But it is not recommended.

L. Principle of operating

UcPure Pro has four operation modes

1. Pre-charge mode

UcPure Pro will work in pre-charge mode when power input is connected and the S1 switch is at OFF position. In this mode, the ultracapacitor pack will be connected to the advanced high current high efficiency CC-CW ultracapacitor charger. The charger will enter an initial charging stage first if the ultracapacitors are empty. In this stage, the charging current will be kept at around 6A for safety reason. To prevent from possible ultracapacitor short circuit, an additional safety feature will also be applied to this stage to cut off the current if the ultracapacitor voltage is not enough when time out. After the ultracapacitor voltage reaches to the 75% of the target voltage, it will be switched to the fast-charging stage. In this stage, the charger will keep 10A high constant current until the ultracapacitors are fully charged.

The full LED D8 will be lit after the ultracapacitor pack is fully charged.

2. Pure output mode

UcPure Pro will go to the pure output mode when S1(or control chain from J5) 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. Both pure LED D9 and output LEDs on the front plate PCB will be lit to indicate the UcPure Pro is running in the pure output mode. Ground loop will be cut off so no common mode EMI noise or other noise will be introduced.

3. Protection/re-charge mode

Because only passive ultracapacitor pack is connected to power the load, after running for a long time (normally hours) in pure mode, the output voltage will be dropped below a threshold voltage. In this case, to prevent the output from going into low voltage, the UcPure Pro protection mode will be triggered. The CC-CV charging circuit will be connected again and run in 10A fast-charging stage. The output doesn't stop in this protection mode but the low noise performance will be degraded slightly meanwhile (active charger involved).　After a couple of minutes, the ultracapacitor pack will be fully charged again and the UcPure Pro will be switched back to the pure output mode automatically.

4. SYNC mode

SYNC mode is a powerful feature of UcPure Pro. You can enable this feature by connect a SYNC control signal to J11 or J12 from a MonitorPi Pro or a FifoPi Q7. In this case, the Ultracapacitors can be charged when music is paused or stopped even if it's already in pure mode. SYNC mode can be used to avoid the output voltage drop or trigger the protection mode even if listening to music for a very long time. UcPure will be back to the pure mode again when music is playing.

M. #43A UcPure Pro 5V KIT

1. UcPure Pro 5V management PCB
2. UcPure Pro 5V/3.3V Front plate PCB
3. UcPure Pro 5V/3.3V back plate PCB
4. M12 Metal self-locking nut X 8
5. M12 3mm washer X 8
6. M12 nut protection/isolation cap/cover X 8 (#41J white and #41K black)
7. M3 spring washer screw X 5
8. 15cm control cable
9. 40cm control cable (#61B)

N. #43B UcPure Pro 3.3V KIT

1. UcPure Pro 3.3V management PCB
2. UcPure Pro 5V/3.3V Front plate PCB
3. UcPure Pro 5V/3.3V back plate PCB
4. M12 Metal self-locking nut X 8
5. M12 3mm washer X 8
6. M12 nut protection/isolation cap/cover X 8 (#41J white and #41K black)
7. M3 spring washer screw X 5
8. 15cm control cable
9. 40cm control cable (#61B)