

UcPure Mini 15V/12V

(+/-15V or +/-12V)

The Third-Generation High-voltage Low-cost Pure Ultra-capacitor Power Supply

By IanCanada



A. Introduction

15V, 12V, or +/-15V or +/-12V, are very useful power supplies for analog audio applications. People usually use low noise regulators for these circuits, but the active components and feedback limit the sound quality to reach a higher level.

Ultracapacitor power supply could be the best solution so far because it is very closed to the ideal voltage source. And it has much better 1/f noise or the flicker noise over the whole noise density plot range than any other regulators. However, a higher voltage ultracapacitor power supply could be very expensive if using the 3000F huge ultracapacitors. Fortunately, many sensitive analog applications demand pretty low current (lower than 100mA). That makes it possible to build a high voltage pure ultracapacitor power supply using the low-cost standard 16V UC packs.

UcPure Mini is the third-generation high voltage ultracapacitor power supply that was specially designed for analog applications to achieve a best performance. Because it is a pure passive power supply, there will be neither feedback nor active components being involved when it's turned on. In the pure mode, the output will be 100% isolated from input, only the pre-charged ultracapacitor pack will be connected to the load or the analog circuit.

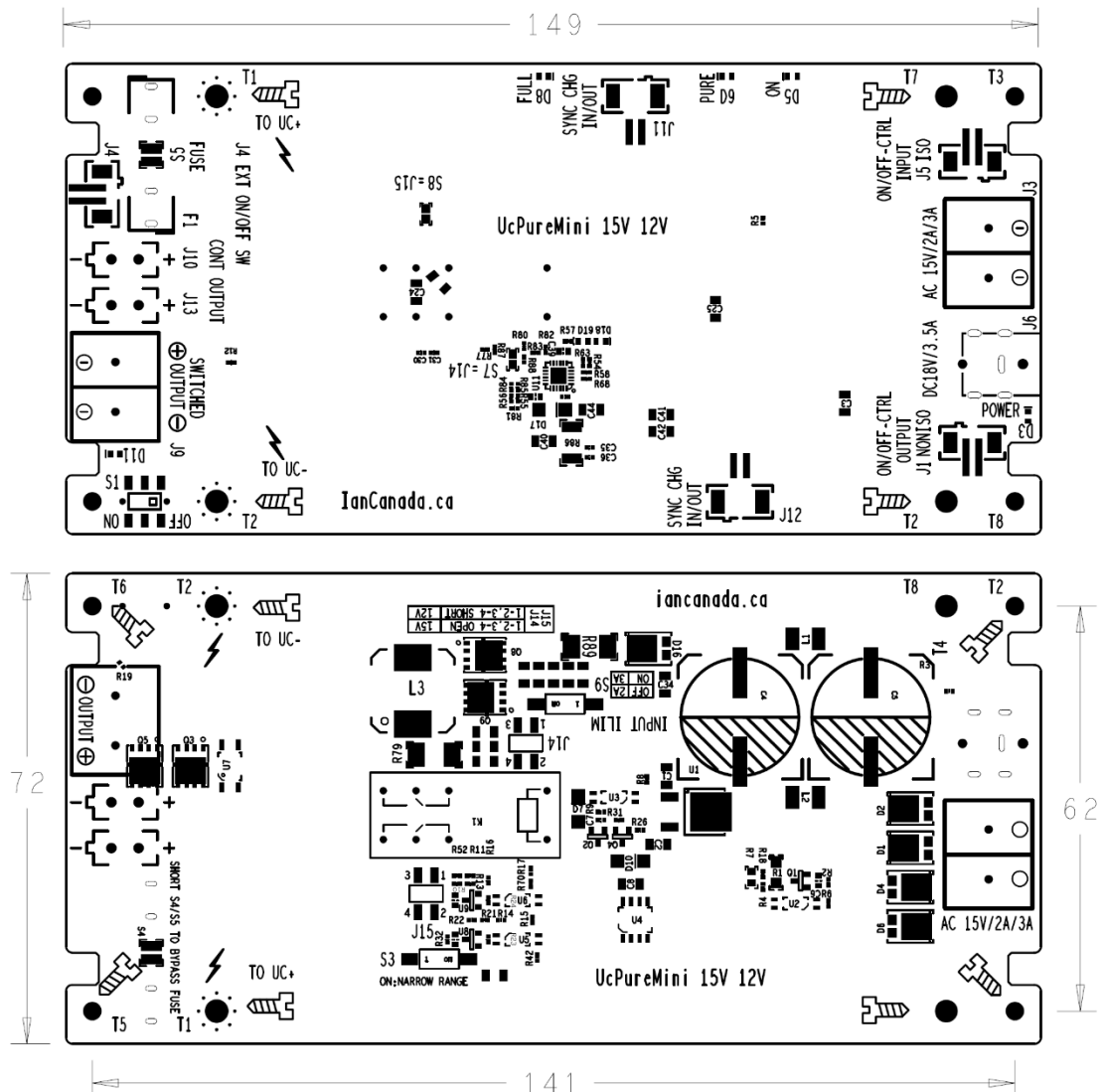
UcPure Mini could be the best low noise, low ESR, high voltage pure power supply in world so far. Sound quality of sensitive audio applications such as DACs, I/V stages, pre-amplifiers and many other analog circuits will be benefited greatly from this UcPure Mini power supply.

B. UcPure Mini Features and Specifications

- Ultra-low noise, high dynamic, compact size pure ultracapacitor analogy power supply with low cost and high flexibility.
- Ultracapacitors work in **class A** mode which current going in only one direction.
- Outputs are **isolated** from charger and power input at pure mode to eliminate 100% common mode EMI noise
- Standard 16V UC pack can be installed right on top of the UcPure Mini PCB using the copper standoffs for high current connection and it will be totally cable free to UC pack.
- UC pack is **separate from UcPureMini PCB** for a much purer working condition.
- **15V and 12V** configurations, can easily be setup for +/-15V and +/-12V
- Has both **precision** and normal **output** voltage range control mode
- **5A** high peak charging current, charge and re-charge ultracapacitors very fast
- Configurable **input current limitation** makes it possible to lower the overall cost by using small transformers. The feature can protect the transformer as well without affecting the peak charging current.
- Optimized to **AC 15V input**, can also work with 19V to 21V DC input.

- 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 Mini or a FifoPiQ7. More UcPures Mini 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 build

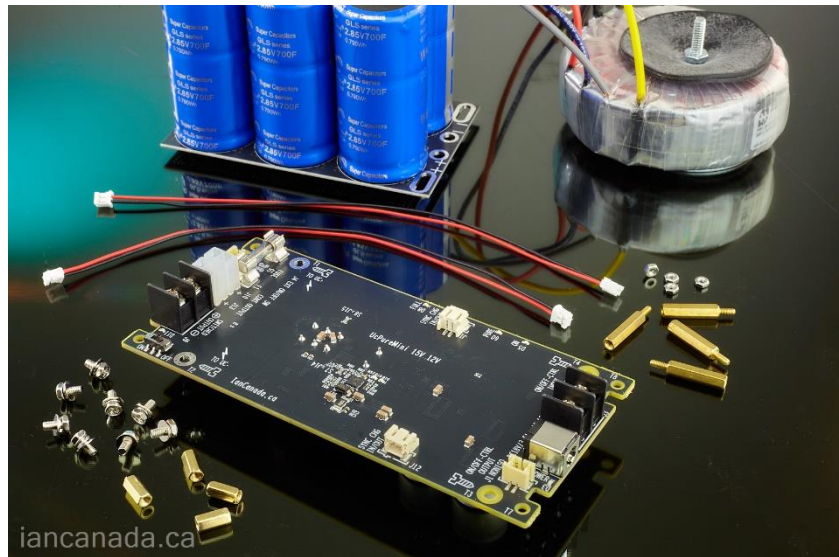
C. Layout and Dimensions



D. Installation steps

1. Prepare

- a. UcPureMini, set the jumpers to the desired voltage configuration and other settings.
- b. Standard 16V UC pack, make sure they are fully discharged
- c. AC 15V transformer (such as a 1182M15)



2. Assemble the four 10mm M3 copper female standoffs to the T1-T4 on the top side using the 3mm spring washer screws. Tighten the screws. Then install four 20mm M2.5 standoffs to the T5-T7 on the backside of UcPureMini as mounting feet.

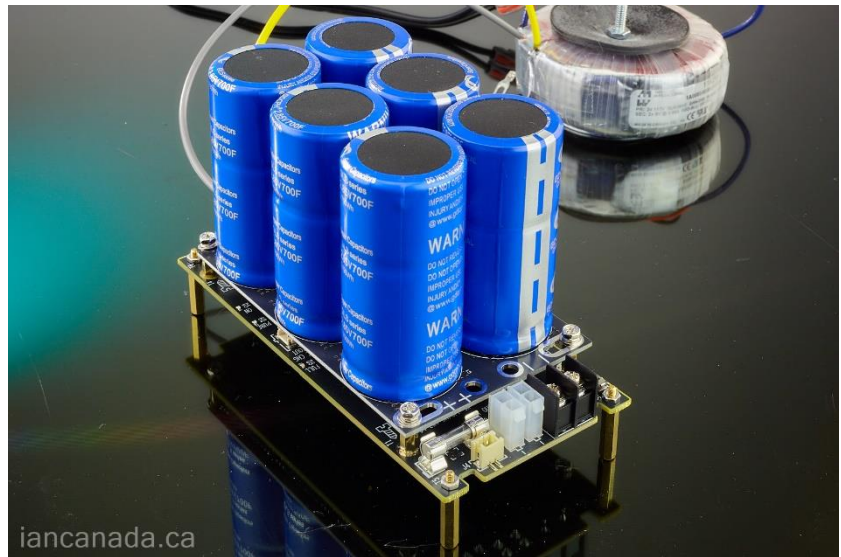


3. Install the 16V UC pack to the UcPureMini standoffs on top using 4 M3 spring washer screws. T1 to the positive terminal, T2 to the negative terminal. And T3, T4 just to hold the edge of the UC pack PCB. Please tighten the screws in the T1 and T2, but doesn't have to be very tighten for T3 and T4.



4. Connect the transformer 15V AC output to J3. Smaller transformers 1182K15, or 1182J15(parallel secondary windings) can also be used when enabling lower current limitation. Power up the transformer, Power LED D3 will light up.

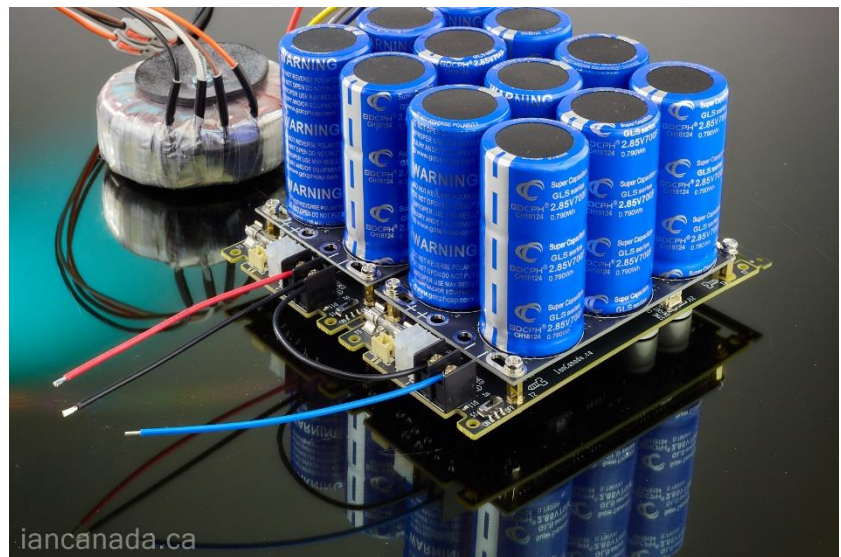
UcPureMine is capable of 5A high current charging up to 15V. So it will take less than 10 minutes to get a fully charge even for the first time of use. Full LED D8 will turn on after that. The UC self-leakage current could be higher than normal if it is first time being charged. Please keep it charging overnight before you use it (The ultracapacitors need 72 hours to get fully stable).



5. Turn the power switch S1 to the ON position. Both pure LED D9 and output LED D11 will light. J9 will have the pure 15V output.

The 15V UcPureMini power supply is ready for your project now.

If you want, you can also do the same using a UcPureMini Dual to build a compact size +/-15V pure ultracapacitor power supply.



Please note: T1, T2 and corresponding standoffs/screws will be connected to the UC pack terminals, please be very careful not to short circuit, because the voltage will be always there even at power down status. The other standoffs/screws are not connected to any circuit so they are safe.

E. Jumper settings

Configurations	J14	J15
12 V	1-2: short 3-4: short	1-2: short 3-4: short
15 V (default)	All open	All open

Input Current Limitation	S9
2.2 A (default)	OFF
3.3 A	ON

Precision output control	S3	Fully Charged Voltages	Re-charge threshold	Back to Pure Voltage
Normal voltage range	OFF	15.69V	15.55V	14.14V
		12.54V	12.46V	11.32V
Precision voltage range	ON	15.69V	15.49	14.69V
		12.54V	12.40V	11.76V

F. Connectors

J3: AC input barrier terminal block (Recommended)

An independent AC winding from transformer needs to be connected to J3 as the UcPure Mini 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 UcPureMini each, windings can also be in parallel to increase current, but one coil can not be shared by two UcPureMini). 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 Mini 15V/12V	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 when J6 is used. But the 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 function test before connecting to project.

J9: Switched output (ultra-low ESR high current)

The main output terminal connector of the UcPureMini. This output will be turned ON and OFF when UcPure Mini switch or control chain is ON or OFF.

J10, J13: Continuous output (Molex MINIFIT)

These continuous outputs are non-switched, so the output voltage will be always there no matter UcPure Mini is ON or OFF. The only way to turn off those outputs is to unplugging the cable from the connector. J10 and J13 are equivalent. Fuse is also applied to these outputs, so have to be very careful to avoid any over current or short circuit.

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 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 UcPure Mini. To use the ON/OFF/ control chain, On-board switch S1 or external ON/OFF switch must be at the 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 a slave ON/OFF control input of the following power supply 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 Mini or the FifoPiQ7's MUTE output.

With a built-in isolator, this control signal is non-polarity and will be optically isolated from UcPure Mini. J11 and J12 are equivalent.

T1, T2: (with the lighting symbols)

High current screw connection terminals between UcPureMini and UC pack.

T1: Positive terminal

T2: Negative terminal

T3, T4, T5, T6, T7: Mounting holes without lighting symbols

Just for mounting screws, not connected to any circuit.

F1: Fuse 5.2x20mm

10A 0217010.MXP. To lower the ESR, you can use higher rated current fuses after your project runs stable.

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.

G. LED indicators

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

D5: Power on indicator. Indicating that the UcPure Mini ON/OFF switch or the control chain is turned on.

Note: The continuous output J10 and J13 has no business with D5

D11: Output indicator. Indicating UcPure Mini output voltage are applying to J7.

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

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

D18, D19: Charger status indicators

H. UC pack

The standard 16V UC pack can be sourced easily from many online stores, such as Amazon, AliExpress and so on. Have to use the ones with UCs in two rows for the lower ESR performance. 600F is the minimal capacitance for each UC. Higher capacitance would be preferred.

I. Application notes

1. How long the pure time will last before triggering the Minitaction mode

The pure time can be calculated.

Take for instance. If the output voltage drops from 15.69V to 14.14V (UcPure Mini 15V configuration), the charge released $Q = 117 * 1.55 = 180.8$ (Coulombs).

If the load current consumes 50mA current, the pure time will be:

$$T = 180.8 / 0.05 = 3617 \text{ seconds} = 60.3 \text{ minutes}$$

After that time, the Minitaction mode will be triggered 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 Mini 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 set up an ON/OFF control chain as a power supply group

Setting up a ON/OFF control chain as a power supply group would be highly recommended and very easy. Please specify one unit as master power supply. Then connect the Master control output J1 to the control input J5 of the following slave UcPure Mini using the supplied control cable, and so on to the rest slave units. Install an external ON/OFF switch (#61C) to the J4 of the master unit or use its on-board switch S1 as the main control switch. Please also make sure all on-board switches are at the OFF position. UcPureMini slave control input will be optical isolated and non-polarity.



3. What are the suitable applications using a PurePi Mini

UcPure Mini 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 Mini could be the best possible performance power supply in the real world so far. However, high current applications may not be suitable for UcPure Mini 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 Minitection 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 Mini or FifoPi Mute connector.

If you want more UcPure Mini 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 Mini by a PH2.0 cable and so on as a SYNC control chain.

5. Upgrading Fuses for even lower ESR

UcPure Mini power supply reaches to a level that the resistance of fuses cannot be ignored. After your Project runs stable, you can upgrade the on-board fuses to higher current rating one for lower resistance. (Please make sure the UcPure Mini is turned off when you replacing the fuses.)

You can also bypass the fuses by bridge short the S4 and S5 by soldering balls though it is not recommended.

J. Principle of operating

UcPure Mini has four operation modes

1. Pre-charge mode

UcPure Mini 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 Mini 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 Mini 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. Minitection/re-charge mode

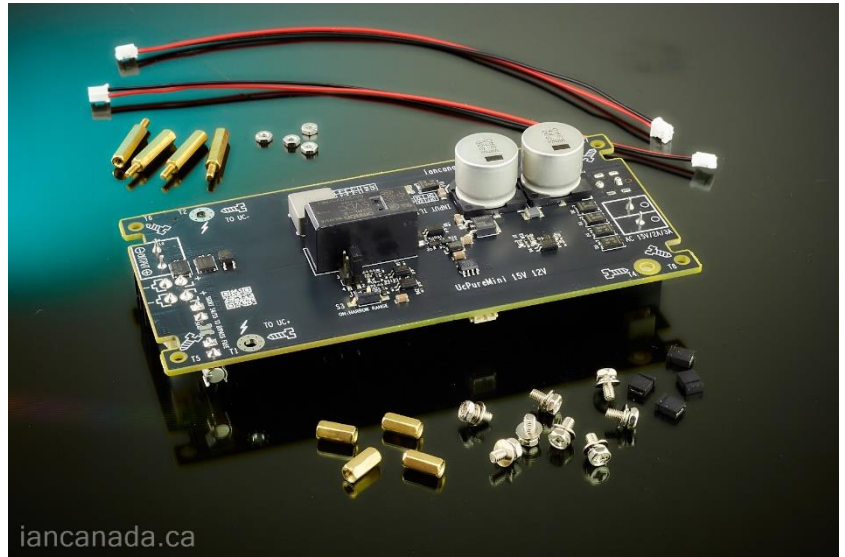
Because only passive ultracapacitor pack is connected to power the load, after running for a long time (normally hours) in pure mode, the output voltage will be dropped below a threshold voltage. In this case, to prevent the output from going into low voltage, the UcPure Mini Minitection mode will be triggered. The CC-CV charging circuit will be connected again and run in 10A fast-charging stage. The output doesn't stop in this Minitection 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 Mini will be switched back to the pure output mode automatically.

4. SYNC mode

SYNC mode is a powerful feature of UcPure Mini. You can enable this feature by connect a SYNC control signal to J11 or J12 from a MonitorPi Mini 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 Minitection mode even if listening to music for a very long time. UcPure will be back to the pure mode again when music is playing.

K. #53A UcPure Mini 15V/12V KIT

1. UcPure Mini 15V/12V PCB
2. 10mm M3 female copper standoffs X4
3. M3 spring washer screw X 8
4. M2.5 long standoffs X4
5. M2.5 nuts X 4
6. 15cm control cable X 2
7. Jumper caps X4



L. #53B UcPure Mini 15V/12V KIT

1. UcPure Mini Dual 15V/12V PCB
2. 10mm M3 female copper standoffs X8
3. M3 spring washer screw X 16
4. M2.5 long standoffs X 8
5. M2.5 nuts X 8
6. 15cm control cable X 4
7. Jumper caps X 8



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