WARNING

You are dealing with very high energy levels when using this system, which may result in personal injury or fire when handled improperly. Take appropriate safety measures and use this system with great caution. Never leave it unattended while being powered.

This product contains small parts; keep out of reach of children!

This system produces significant magnetic fields, do not use it when you have a cardiac pacemaker!

Always apply appropriate safety precautions when following this guide – they will not be explicitly mentioned in the following. If you are unsure how a specific step is properly and safely executed, don't do it!

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kSupply User Guide

The *kSupply* module is a versatile and fully adjustable high current voltage regulator with output current limiting. It is meant to be mounted directly on a specific 12V server power supply unit (PSU). The unit is designed to work with different models:

- DPS-800GB (Hewlett-Packard, very loud)
- HSTNS-PR01 (Hewlett-Packard, less fan noise)

Other models may also be suitable. The *kSupply* product page (https://www.keenlab.de/index.php/product/ksupply/) includes a compatibility list that will be extended over time.

The sections *"Usage with DPS-800GB"*, *"Usage with HSTNS-PR01", and "Usage with other similar server power supplies"* provide a detailed description of supported pinouts. Usage with any other 12V power supply is described in section "*Usage with other 12V power supplies*".

The module has been designed to rapidly charge the *kCap* ultracapacitor module for high speed welding, but it can also be used for many other applications that require a stabilized voltage at high amperage. For example, build a high current laboratory power supply from it by attaching external potentiometers for voltage and current, like described in section *"Bench supply conversion"*.

The ability of the module to operate either in constant-voltage or in constant-current mode allows using it as a charger for high-capacity lithium batteries. Please note that in such a case additional protection circuitry is mandatory to safely operate these batteries, e.g. a BMS.

With a small hardware change, the module can also operate in two quadrants and is able to transfer negative output current back to its input terminals. The necessary modification is described in section *"Two-quadrant* operation*"*.

This guide refers to kSupply revisions 5 and 6. Revision 6 adds an input overvoltage protector (D6, an SMCJ15A TVS); otherwise the two revisions are the same for setup and use. The revision number of your module is printed on the circuit board:



As you are dealing with electronic components when building the kit, this advice is a must as well:



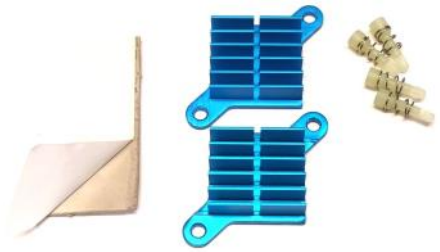
ESD damage is caused by a build-up of static electricity that is released into the circuitry when you accidentally touch a conductor on the circuit board. The build-up can come from either the board, or from you, or both. I package all the kits in an ESD-safe environment and ship all units in metallic ESD safe bags, eliminating static during production. During assembly and open-frame use, please take precautions to reduce ESD:

- Avoid conditions that result in high static electricity. For example, don't unpack or handle the unit while standing on carpet. Cool and dry air is very conducive to ESD. If you're in an area or season with a lot of lightning storms, you're probably more susceptible to ESD and require more caution.
- Ground yourself immediately prior to handling by touching a metal object that is connected to mains earth. Examples of these are desktop computers, all electric devices that have a metal housing, your professional soldering station, and of course the exposed ground contact of your electrical outlet.
- Notice that your body will only sense electrostatic discharge at voltages greater than approximately 1000 volts, but electronic components will already break at voltages well below that. This means that, if you don’t recognize ESD, this doesn’t mean that it does not happen. The mentioned precautions are even more important now!

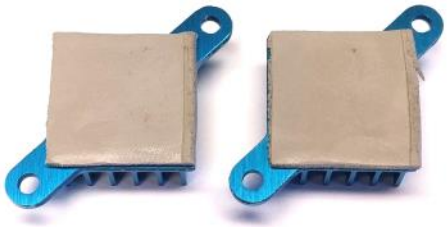
ASSEMBLY GUIDE – HEAT SINK KIT

The heat sink kit is an optional accessory and sold separately. It improves the power dissipation capacity of the module and allows using it at a higher continuous output current.

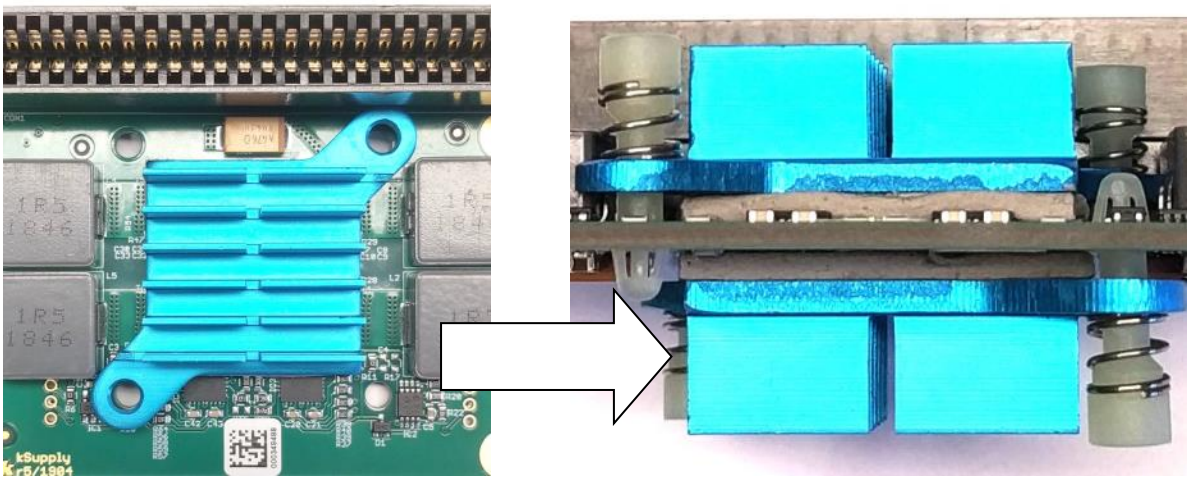
REQUIRED PARTS



2	heat sink, blue anodized
2	thermal pad, 25x25x2mm
4	mounting pin



Apply thermal pads to heat sinks.



Place one heat sink on the board. Make sure that the holes are aligned well and move it into place if necessary. Push down gently to fix it in position, and also to allow the thermal pad material to fill the gaps between the components. Then push in the mounting pins while continuing to push down the heat sink. Make sure that the pins are fully locked into place like shown on the right. Repeat with the other side.

IMPORTANT: depending on the air flow direction in your system, you can choose to orient the cooling fins horizontally as shown in the picture, or vertically. For use with one of the server PSUs, the horizontal arrangement is preferable.

ASSEMBLY GUIDE – CABLE KIT

The cable kit is an optional accessory and sold separately. It is provided to simplify integration with the *kCap* ultracapacitor module.

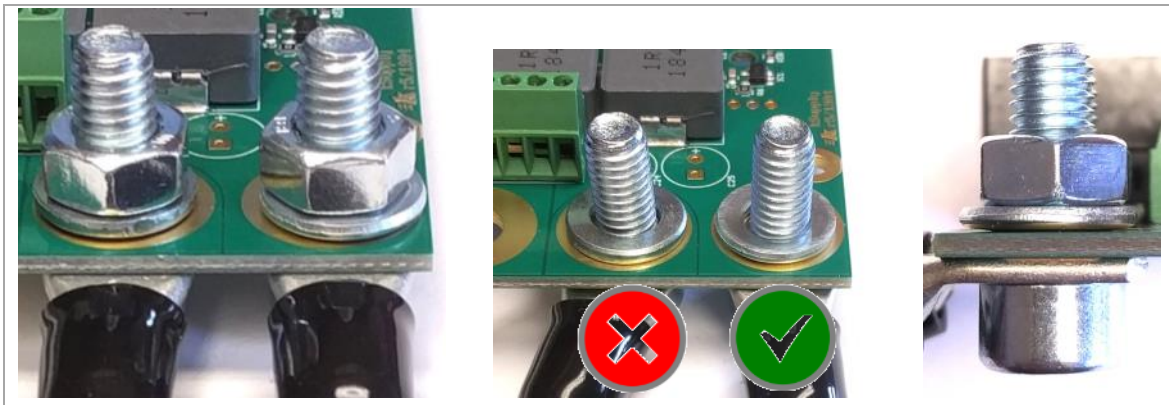
REQUIRED EQUIPMENT

Allen key 5mm	
Wrench 10mm	

REQUIRED PARTS



2	Cable assembly
4	Screw DIN912, M6 x 16mm, steel galvanic
4	Nut DIN934, M6, steel galvanic
4	Washer DIN125, M6 x 12mm x 1.6mm, steel galvanic



Use the M6 screws, washers and nuts to attach the cable assemblies to the module like shown. Tighten the nuts securely. Observe correct orientation of the washers, you may damage the circuit board otherwise. Use the stacking scheme as shown on the right.



Connect the cables to the input terminals of the *kCap* module as shown.

IMPORTANT: carefully observe the correct polarity - any mistake at this point will cause damage to both the *kCap* and *kWeld* modules!

IMPORTANT: adjust the output voltage of the kSupply module to the correct charge voltage before connecting kCap the first time (see the kCap manual for the voltage of your kCap revision), in order to ensure that the ultracapacitors will not be overcharged. Also adjust output current to maximum. See section *"Setting output voltage and current"* for instructions.

OPERATION GUIDE

SPECIFICATIONS

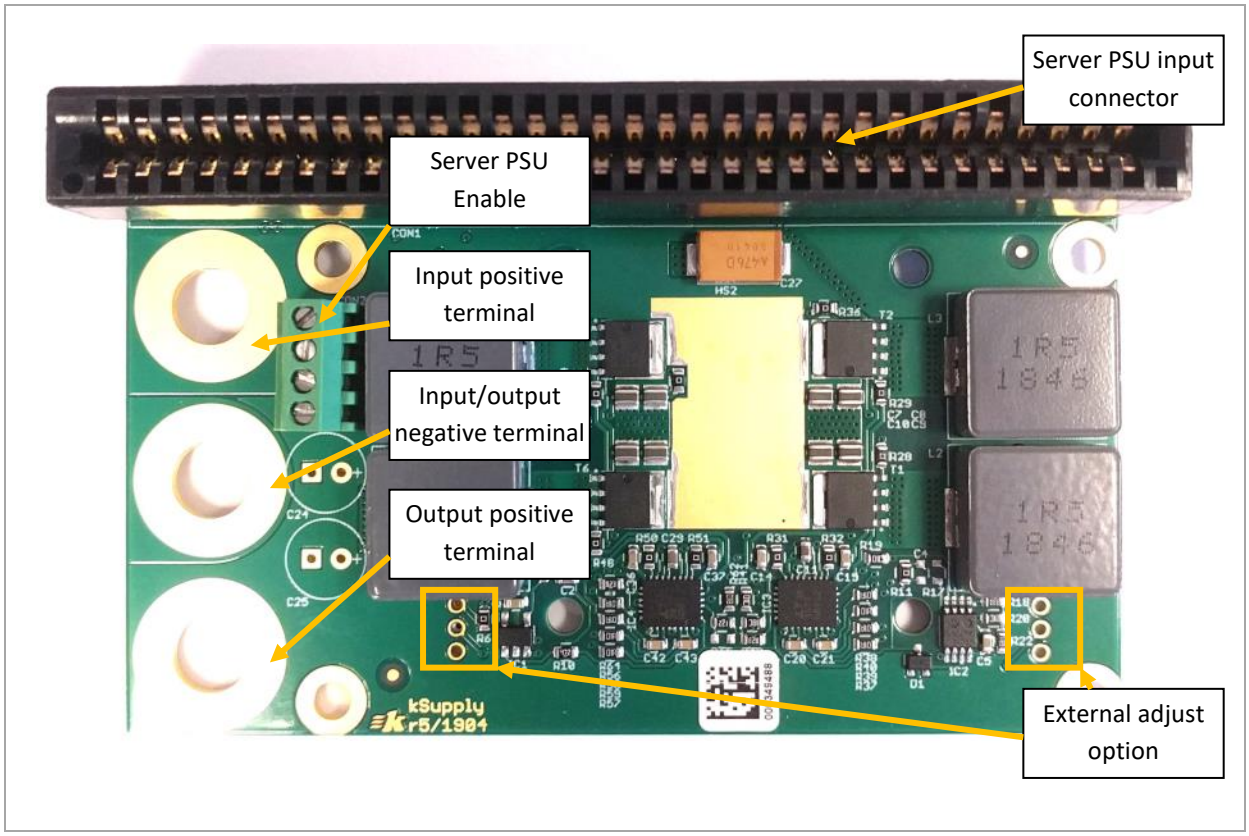
Electrical characteristics (typical values):

- output voltage: adjustable from 0V to 12V
- output current: adjustable from 0A to about 80A (the exact maximum varies slightly from unit to unit)
- maximum power delivery: about 960W (12V x 80A)
- can drive current into a short circuit like an ultracapacitor
- automatic transition between constant voltage (CV) and constant current (CC) modes
- overtemperature protection through current reduction (the current folds back above about 95°C at the board sensor)
- continuous output current
    - DPS-800GB, without heat sinks: 70A
    - HSTNS-PR01, without heat sinks: 50A
    - HSTNS-PR01, with heat sinks: 70A
    - free air, without heat sinks: 40A
    - free air, with heat sinks: 50A
- output enable from server power supply routed out to a screw terminal
- minimum voltage drop from input to output: 1.4V at 70A (measured; the electrical current limit is about 80A)
- input voltage range: 7V to 16V
- fast response to load changes: 80µs
- low output capacitance: 240µF
- dimensions without heat sinks: 86 x 53 x 18mm

Performance in combination with *kCap* / *kWeld:*

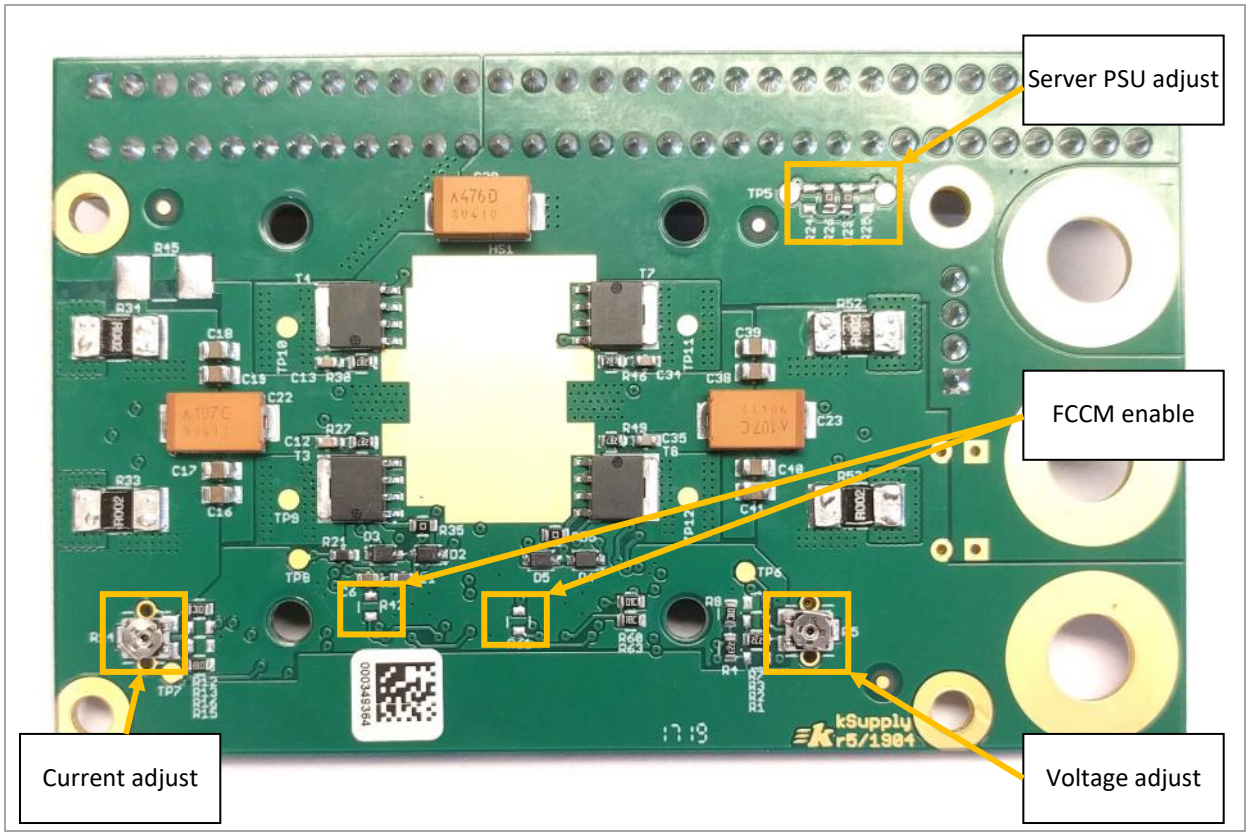
- recharge time less than 1 second after a 50J pulse

OVERVIEW – TOP SIDE



Element	Description
Server PSU input connector	Plug in your compatible server power supply here, if available.
Server PSU enable	Wire up a switch or jumper wire to enable the output of the server PSU and power up *kSupply*. Different connection schemes apply depending on the available PSU model, see sections *"Usage with DPS-800GB"* and "*Usage with HSTNS-PR01"* for details.
Input positive terminal	Usage with server PSU: leave empty. Usage with external PSU: connect the **positive** connection of your **power supply**.
Input/output negative terminal	Usage with server PSU: connect the **negative** connection of your **load**. Usage with external PSU: connect both the **negative** connection of your **power supply and** the **negative** connection of your **load**.
Output positive terminal	Connect the **positive** connection of your **load**.
External adjust option	Optionally wire up external potentiometers here when converting the module into a bench power supply; see section *"Bench supply conversion"* for more details.

OVERVIEW – BOTTOM SIDE



Element	Description
Server PSU adjust	Optionally tweak the output voltage of the server PSU to a higher level to enable kSupply output full 12V at maximum current. Different modification schemes apply depending on the available PSU model, see sections *"Usage with DPS-800GB"* and "*Usage with HSTNS-PR01"* for details.
FCCM enable	Optionally enable FCCM (Forced Continuous Conduction Mode) to allow current flow from output to input in two-quadrant operation mode. See section *"Two-quadrant operation"* for details. IMPORTANT: this feature requires the use of a power supply for *kSupply* with capability of reversed current flow (e.g. a battery). Otherwise, the module will dump the harvested energy into its input capacitors, and destroy itself from overvoltage.
Voltage adjust	Turn this trimmer to adjust the output voltage – see next section for details.
Current adjust	Turn this trimmer to adjust the current limit – see next section for details.

SETTING OUTPUT VOLTAGE AND CURRENT

Both output voltage and current limit can be adjusted through two small trimmers on the module.

IMPORTANT: It is highly recommended to use a small plastic screwdriver like shown below to turn the trimmers, as an accidentally slipping metal tool can cause a short circuit. The trimmers are delicate and can be damaged by too much torque, so turn them very gently.



When using *kSupply* to power a *kCap* ultracapacitor module, the following procedure is recommended:

1. Connect a multimeter to the output terminals using alligator clips.
2. Do **not** yet connect the *kCap* module to *kSupply*.
3. Turn on power to the *kSupply* module.
4. Turn the current adjust trimmer clockwise to its end stop, in order to set the current limit to its maximum. The directly supported server PSUs can deliver the full output current. With a weaker power supply, reduce the current limit instead, so that its overcurrent protection does not trip; the current is highest while the kCap is empty.
5. Turn the voltage adjust trimmer until the multimeter reads the correct charge voltage precisely: see the kCap manual for the voltage of your kCap revision. Turning clockwise increases the voltage.

You can then connect the *kCap* module the first time and power up the entire system.

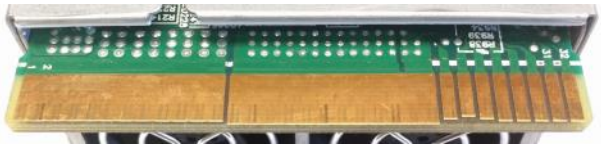
IMPORTANT when used with a large capacitance at the output:

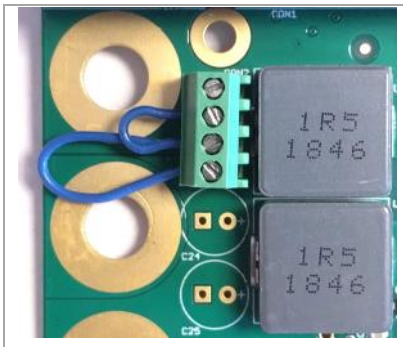
- Never adjust the current limit to zero by turning the corresponding trimmer fully counterclockwise. Due to the switch mode topology (synchronous buck), a certain amount of reversed power flow from the output to the input would occur in this condition, causing the input voltage to rise uncontrollably. This can destroy the connected power supply and/or the kSupply module due to overvoltage. With a kCap of revision 4 or later this cannot happen: its input is an ideal diode, so the kSupply output is at 0 V as soon as the server PSU is off. With a kCap of revision 3 or earlier, or any other capacitive load, the warning applies in full.
- With a kCap of revision 3 or earlier, or another capacitive load, use the system with caution: the kSupply output terminals carry the capacitor voltage even after the server PSU has been turned off. An accidental short circuit will result in a very large current flow.
- With such a load, the kSupply module feeds voltage back from the connected capacitors to its input. The recommended server PSUs are able to handle this situation even without AC input, as they are designed for load sharing and hot plugging. You will notice that the PSU fans will continue to spin in this situation, which helps discharging the capacitors. However, when using the system with a different power supply, make sure that it is either capable of back feeding, or add a switch to its output and adhere to a safe shutdown sequence: open switch first, then turn off the PSU.

USAGE WITH DPS-800GB

This supported PSU model has the following card-edge connector layout. Please make sure that your model has exactly the same layout, otherwise you might damage the PSU and/or kSupply module. Note that the model name does not always match the layout, so compare your unit visually with the pictures below. If your PSU has one of the two supported layouts but the enable jumper is wired incorrectly, it simply will not turn on; this causes no damage. Never connect a PSU whose blade layout differs from the two supported ones: this can damage the PSU and the kSupply.





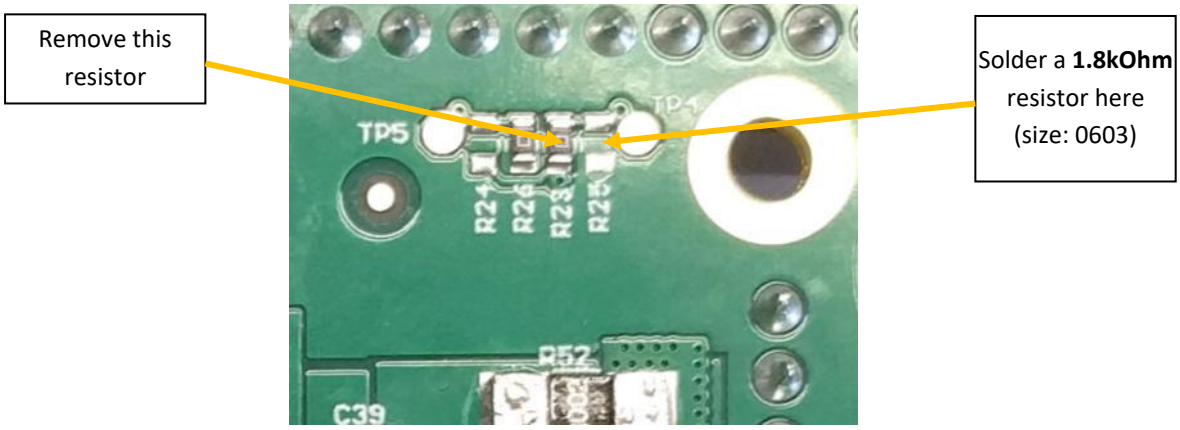


To enable the PSU, connect two jumper wires as shown above. If you want to add a switch, then insert it in the longer of the two loops shown.

This PSU model supports remote voltage sensing, which can be used to raise its output voltage. The achievable extra voltage is limited though, as the unit will interpret too much voltage demand as a fault and consequently shut down. There is no risk of damage though, and the unit can be put back in service by briefly removing AC power.

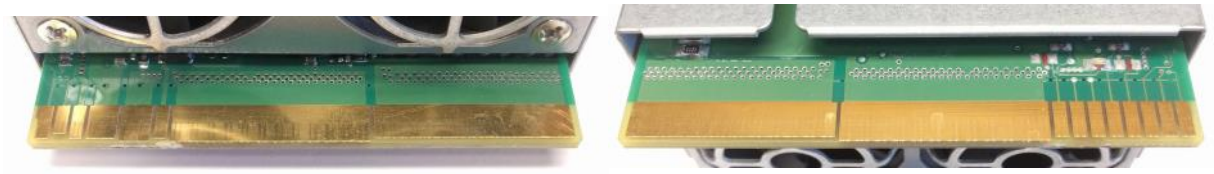
The unit tested here in the lab allowed to reliably raise its output voltage to 13.1V. This is accomplished by a modification of two SMD components on the *kSupply* module as shown below. If your unit shuts down, then you may try higher resistor values.

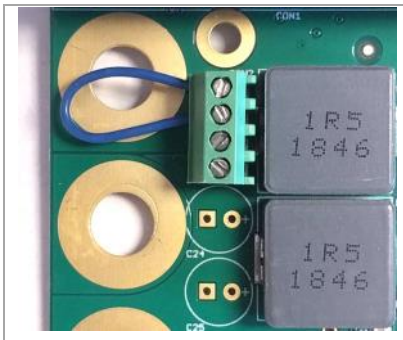
Remove R23 and fit R25 = 1.8 kOhm (0603) for 13.1V.



USAGE WITH HSTNS-PR01

This supported PSU model has the following card-edge connector layout. Please make sure that your model has exactly the same layout, otherwise you might damage the PSU and/or kSupply module. Note that the model name does not always match the layout, so compare your unit visually with the pictures below. If your PSU has one of the two supported layouts but the enable jumper is wired incorrectly, it simply will not turn on; this causes no damage. Never connect a PSU whose blade layout differs from the two supported ones: this can damage the PSU and the kSupply.



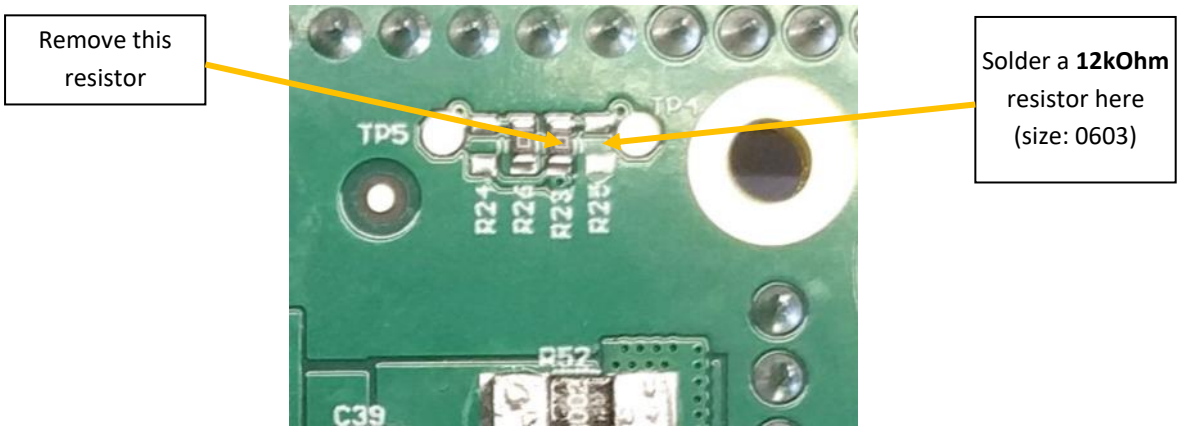


To enable the PSU, connect a jumper wire (or a switch) as shown above.

This PSU model supports remote voltage sensing, which can be used to raise its output voltage. The achievable extra voltage is limited though, as the unit will interpret too much voltage demand as a fault and consequently shut down. There is no risk of damage though, and the unit can be put back in service by briefly removing AC power.

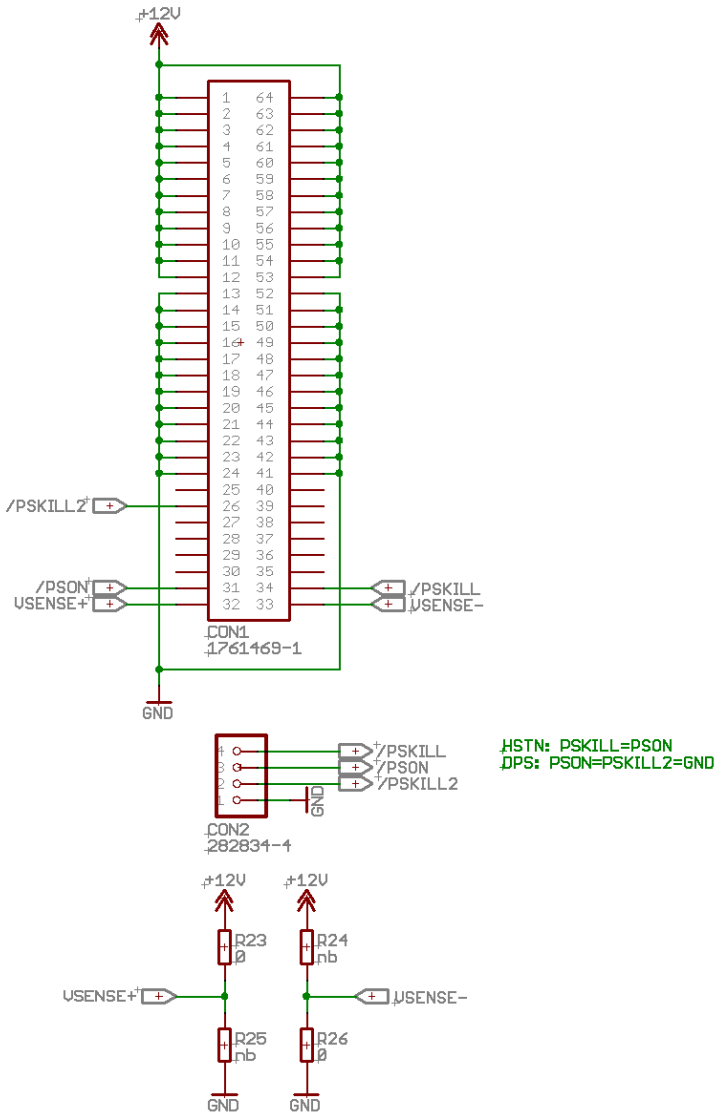
The unit tested here in the lab allowed to reliably raise its output voltage to 13.5V. This is accomplished by a modification of two SMD components on the *kSupply* module as shown below. If your unit shuts down, then you may try higher resistor values.

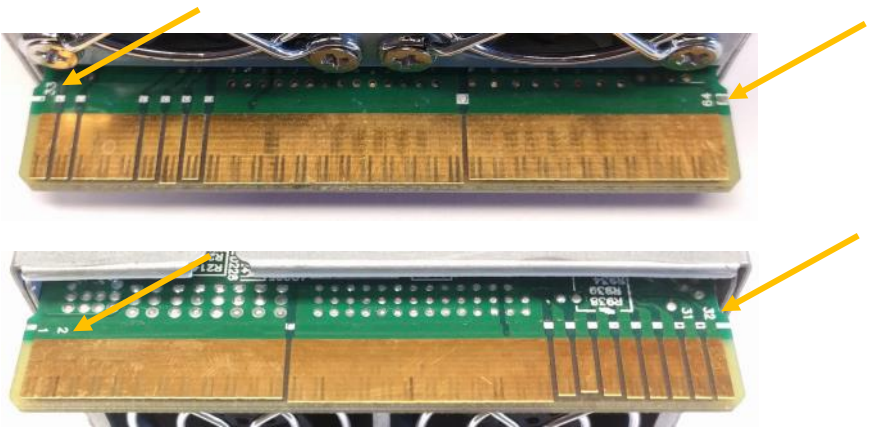
Remove R23 and fit R25 = 12 kOhm (0603) for 13.5V.



USAGE WITH OTHER SIMILAR SERVER POWER SUPPLIES

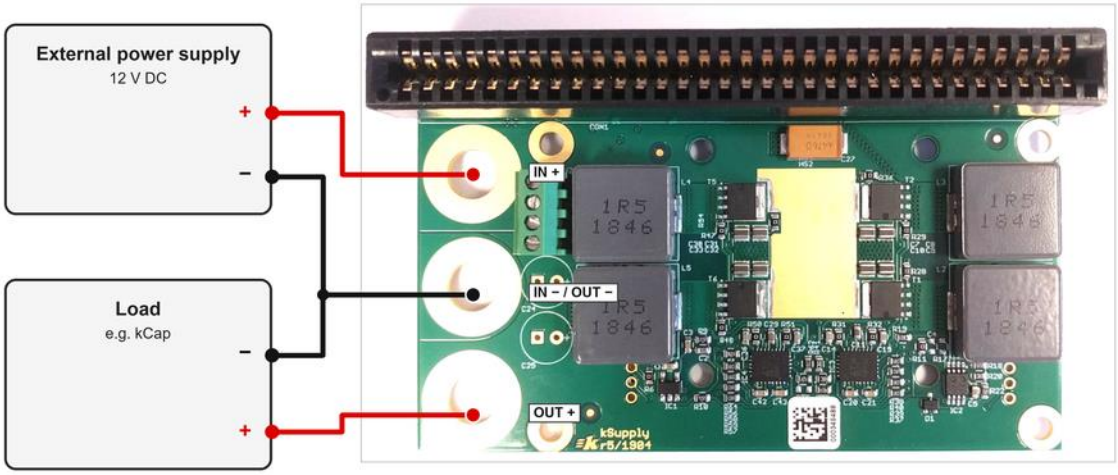
Other server PSU models might also work, but it may not be possible to power them up without doing further modifications. The following drawing shows the wiring scheme of *kSupply's* card-edge connector for your reference. The pin numbering follows the scheme that is printed on the DPS-800GB unit – see the pictures below.





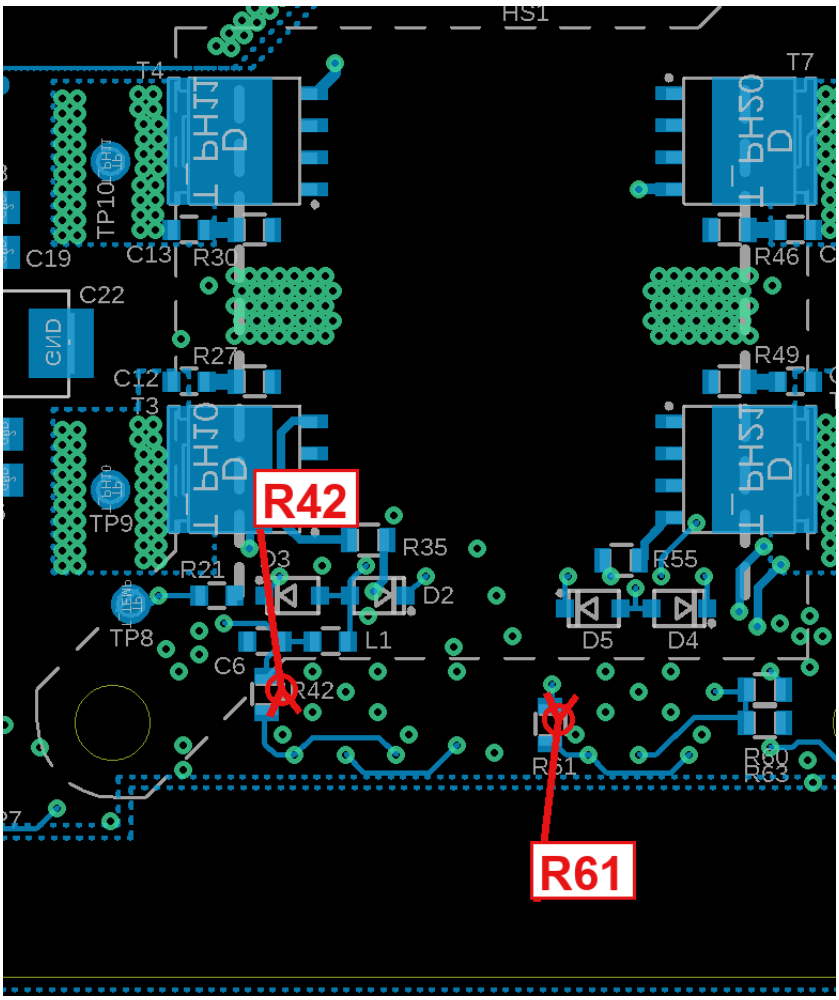
USAGE WITH OTHER 12V POWER SUPPLIES

The module can also be connected to any 12V power supply (like for example a desktop computer's ATX power supply) by attaching cables to its screw terminals. Keep these input cables no longer than 20 cm, otherwise the kSupply may become unstable.



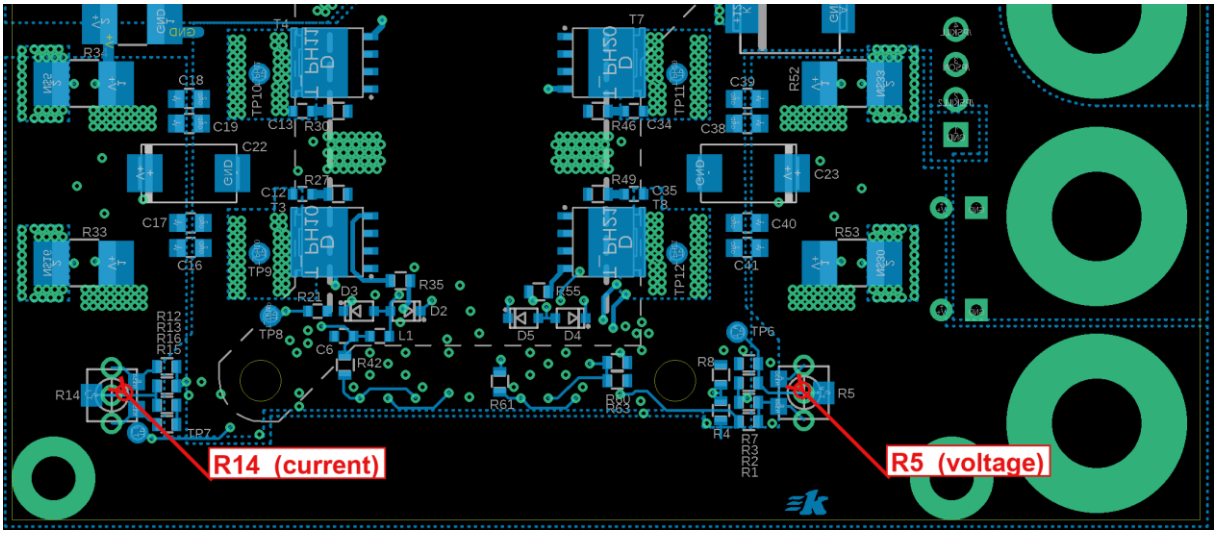
TWO-QUADRANT OPERATION

Fit the two solder jumpers R42 and R61 (marked FCCM enable on the bottom side). They tie the MODE pins of both LTC3870 controllers to forced continuous conduction, so the regulator can also sink current from its output back into the input (two-quadrant operation). The input source must be able to absorb that current, as a battery does; the input TVS (SMCJ15A on revision 6) only clamps a brief voltage spike if the source cannot absorb it, and is not a substitute for a source that can. Use this mode only with the recommended server PSUs or a source that is designed for reverse current.



BENCH SUPPLY CONVERSION

The kSupply can be turned into an adjustable bench supply by replacing the two trimmers with panel potentiometers: remove the voltage trimmer R5 and the current trimmer R14 (Bourns TC33X-2-103E, 10 kOhm) and connect a 10 kOhm linear potentiometer to each trimmer's three pads with short, twisted wires, in the same order (the wiper to the middle pad). Caveat: the current regulation is coarse and depends on the output voltage, because the LTC3870 limits the peak inductor current rather than the average output current; a bench supply built this way is a voltage source with an approximate current limit, not a precision current source.



REVISION HISTORY

1.0	2019-06-22	First published (incomplete) version
1.1	2019-06-25	Update (incomplete) version
2.0	2026-10-27	Revision 6; current limit about 80A; kCap charge voltage by revision; server PSU presets; two-quadrant and bench supply sections; wording corrections