Modular USB Power Supply (MUPS)

Version 1.00 Instructions, Revision 0 (May 2009)

Synopsis: The Modular Universal Serial Bus (USB) Power Supply (*MUPS*) is a small (26x37mm, +/- 1mm) electronic design intended to serve as an electrically-isolated power converter for low-power (1-2W) electronic devices, such as Ti Kan's Mini³ headphone amplifier. Typically comprising no more than nine components and requiring no adjustments or complicated measurements once assembled, it is intended to be as flexible and easy-to-use as possible. It is also highly efficient (70-80% efficiency, depending on IC and load) and relatively inexpensive; the parts for a single MUPS, sourced domestically, are less than $25 USD, including shipping. All parts can be sourced from a number of suppliers, and small-volume bulk overseas purchases (i.e. "group buys") should be able to source parts from North American distributors for $20 USD per MUPS, possibly less.

Background: The MUPS is essentially an implementation of a Texas Instruments reference design for the DCP01/DCP02 family of DC-DC converters. The heart of the design is an isolated converter in a DIP-14 through-hole IC package; this together with two low-value capacitors – one on the input, and one on the output – is essentially the "heart" of the MUPS, with most of the remaining components principally contributing user-friendliness and/or ease-of-use. The board accommodates both single- and dual-output chips, and in some circumstances could serve as a higher-power TLE2462 replacement.

Parts List:

IC1: a Texas Instruments DCP01 or DCP02 DC-DC converter. Recommended part: *DCP0515DP* (single 15VDC output) or *DCP0512DP* (single 12VDC output). *Required*.

C1: a reasonably low-ESR ceramic capacitor in 1206 SMD package, rated 2.2uf and 5V or greater. Tested and confirmed working: Taiyo Yuden TMK316B7225KL-T, Digi-Key part 587-1329-1-ND. *Required*.

C2: As per C3; *only* used with dual-output IC1 components. Required for a dual-output MUPS; useless on a single-output one.

C3: a reasonably low-ESR ceramic capacitor in 1206 SMD package, rated 1uf and higher voltage than the output of IC1. Tested and confirmed working: Taiyo Tuden GMK316B7105KL-T, Digi-Key part 587-1326-1-ND, a 35V part. *Required*.

Fuse: A resettable polyfuse or thermistor, 5V or greater, in 1206 SMD package. Rating depends on individual application; 250ma is probably a safe and sane choice for most 1W applications. Tested and confirmed working: Littelfuse 1206L025YR, Digi-Key part F2110CT-ND. *Recommended*; if omitted, jumper the pads.

USB connector: Standard PCB-mount "B" connector. Tested and confirmed working: Mill-Max 897-43-004-90-000000, Digi-Key part ED90064-ND. *Required* for USB use; not necessary for other applications.

LEDs: 3mm or 5mm, through-hole LEDs. The LED nearest the fuse is powered from the "input" (i.e. USB 5V, et cetera) voltage; the one between C3 and R2 is powered from the positive output of IC1. Pretty much *any* LED will work here. The longer (positive) leg of the "input" LED should be the "inner" one; the longer leg of the "output" LED should be the one facing away from IC1. Both are *optional*, and there's little point to populating both, unless you *really* like LEDs.

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R1: 0805-sized resistor, limits the current through the “input” LED. Standard calculations will give you an appropriate value for this resistor; if you're lazy, 180 ohms should work fine. *Required* if you want to use the corresponding LED.

R2: 0805-sized resistor, limits the current through the “output” LED. Standard calculations will give you an appropriate value for this resistor; if you're lazy, and use a 12V or 15V chip for IC1, 1K ohms should work acceptably here. *Required* if you want to use the corresponding LED.

Assembly suggestions:

Begin by soldering C1 and C3, and C2, if you're building a dual-output MUPS. Add the fuse, or jumper across it if you're feeling daring. None of these components are polarized. If you're adding an LED, solder the appropriate resistor in place.

At this point, you can check for solder bridges with an ohm meter, by measuring both sides of any given component. Less than 1 (one) ohm, and you've probably got a solder bridge.

Next, add IC1. Particularly if you're planning to use this in a Mini³, it may be advantageous to bend the leads, once they're through the board, “outward”, flat against the bottom of the PCB, before soldering. This will allow you to get the most stable connection between the MUPS and whatever you intend to mount it in.

Next, add the USB connector, assuming you're using one. It may help to make sure the pins protrude through the PCB as little as possible; this will help ensure that the MUPS mounts securely and evenly onto a Mini³, et cetera. Likewise, the large tabs on the shield/shroud of the connector should be bent so as to protrude as little as possible, for similar reasons.

Add the LED(s), if you're using it (them).

Inspect for solder bridges, dodgy solder joints, and the like; clean up any stray flux, and you're almost through.

The silkscreen on the output connectors denotes the correct pin(s) to take power from; “+” is the positive, isolated output; “-” is the negative, isolated output (when a dual-output chip is used), and the “g” pins are the isolated output ground.

At this point, everything *should* work. Connect your amplifier or other electronic device, plug in the USB cable (*at both ends*...), and you should be off and running.

The mounting hole furthest from the USB connector is correctly situated to mount with the “ribbon” hole in the battery area of a Mini^3 amplifier; the recommended mounting hardware is a 3-32 nylon bolt with matching nylon washer(s) and nut. For other applications, both mounting holes should be employed to provide adequate mechanical rigidity; the holes are on 0.75” centers.

Please note: The DCP01/DCP02 family of DC-DC converters require a *minimum* load current to operate. Note, that's not “operate properly”, that's just “operate”. This load is really low – 1 or 2 milliamperes, maybe even less – but it *must* be present for the chip to operate. If you have the lower, “output” LED installed, it *will* be enough to ensure the chip is always on and functioning. Otherwise, if you have no LED, nothing connected to the output, and measure the output with a multimeter, you're going to read either *zero* volts, or possibly under some circumstances something like thirty volts. DON'T PANIC. That's apparently how it's *supposed* to work.

That is all.