Power supply blues

Adding a power supply to your pet project is far from exciting, but it can mean the difference between good operation and no operation at all. Here's the why and how of power supply design.

by Don Taylor

The real enjoyment in an experimental project comes from designing, building, and, believe it or not, *debugging* a circuit. But when it comes time to design and build a dedicated dc supply to power the project, enthusiasm has usually reached an all-time low.

If these symptoms sound more than just a little bit familiar to you, you may be suffering from power supply design deficiency anemia, also known as the "Power Supply Blues". The common home remedy for this ailment is to take a couple of zeners and put the circuit to bed. Before you do, however, read this article carefully and you might avoid common irregularities in your future designs.

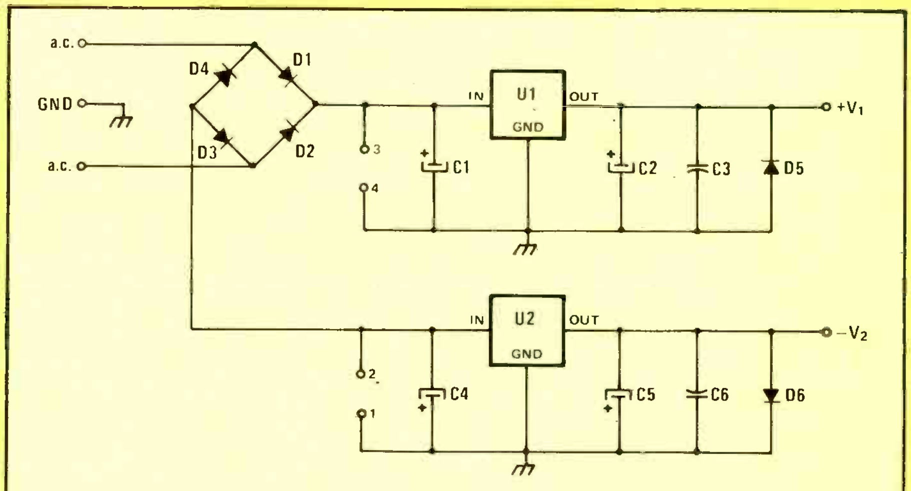
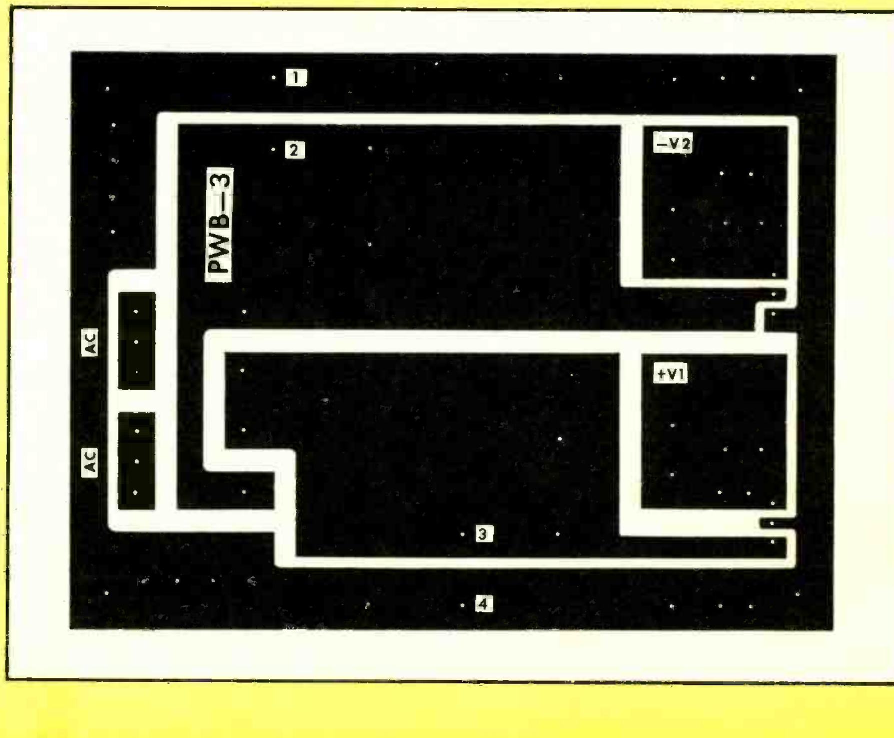


Figure 1 Schematic of dual polarity, standard power supply.



The power supply syndrome

The unfortunate thing about a ho-hum attitude toward power supply design is that it can create more problems than you might at first believe. Have you ever built an audio circuit that worked beautifully on the breadboard, only to have it drive you up the wall whenever a fluorescent light was switched off in the next room? Did your circuit sound a little cleaner in the workshop than it does now, with that inexpensive zener supply you installed? It might be that your circuit's performance is, to some degree, dependent on its power supply!

During debugging, most of us use a bench supply of reputable quality. These supplies usually have excellent line and load regulation and low ripple characteristics. In addition, they usually have other desirable features like adjustable current limiting or overvoltage protection. What happens, though, when that shiny new experimental circuit is connected to a supply with lesser credentials? Will the circuit perform as before, or will it have a new set of problems to debug, caused by such things as higher

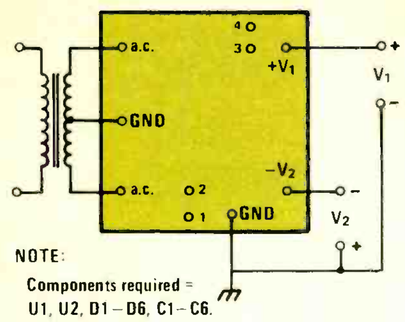


Figure 4 Dual polarity version.

power supply source impedance?

One way to minimize such problems is to connect a variety of power supply circuits to your project, and then select the most inexpensive supply that allows your circuit to perform within its specifications. There is, indeed, an optimum power supply for every project you might want to build. All you need is the time, energy and money necessary to find it.

Some large manufacturing firms that intend to produce a great number of units do find optimum design worth the effort. However, if you view the whole idea of power supply design with the same regard as taking out the garbage there is an easier way. Use the same supply in your equipment that you use on the bench. If you standardize on a single, inexpensive circuit, circuit problems related to power supply sensitivity virtually disappear. And, power supply design will become a much more fruitful, and bearable, task.

A standard design

Figure 1 is the schematic of a general-purpose power supply that provides both a positive and a negative fixed output voltage. The circuit is based on the 7800/7900 and LM320/LM340 series three-terminal voltage regulators available from many sources. These regulators are supplied in TO-220 packages and come in a variety of fixed voltages.

Output voltage is regulated to within ±5 percent of the nominal voltage. With proper heat sinking, these regulators can source more than an ampere of current—with built-in current limiting and thermal shutdown!

The supply of Figure 1 is both reliable and inexpensive to build. If you etch the board, the total cost of the dual-voltage version, less transformer, should be under $8. It is relatively compact, and can be configured as a dual polarity supply or a single positive or negative supply. When used as a dual supply, non-symmetrical voltages (e.g. +5V, -12V) can be

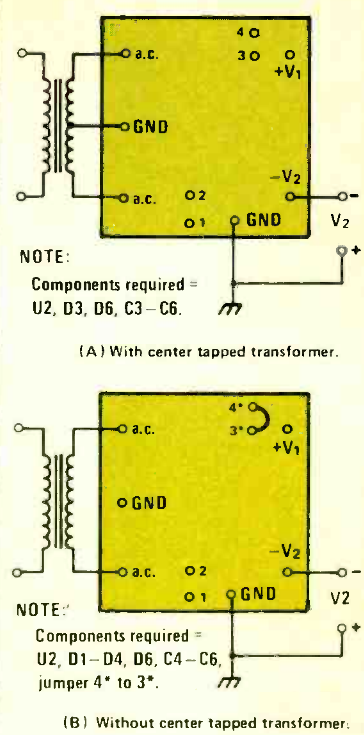
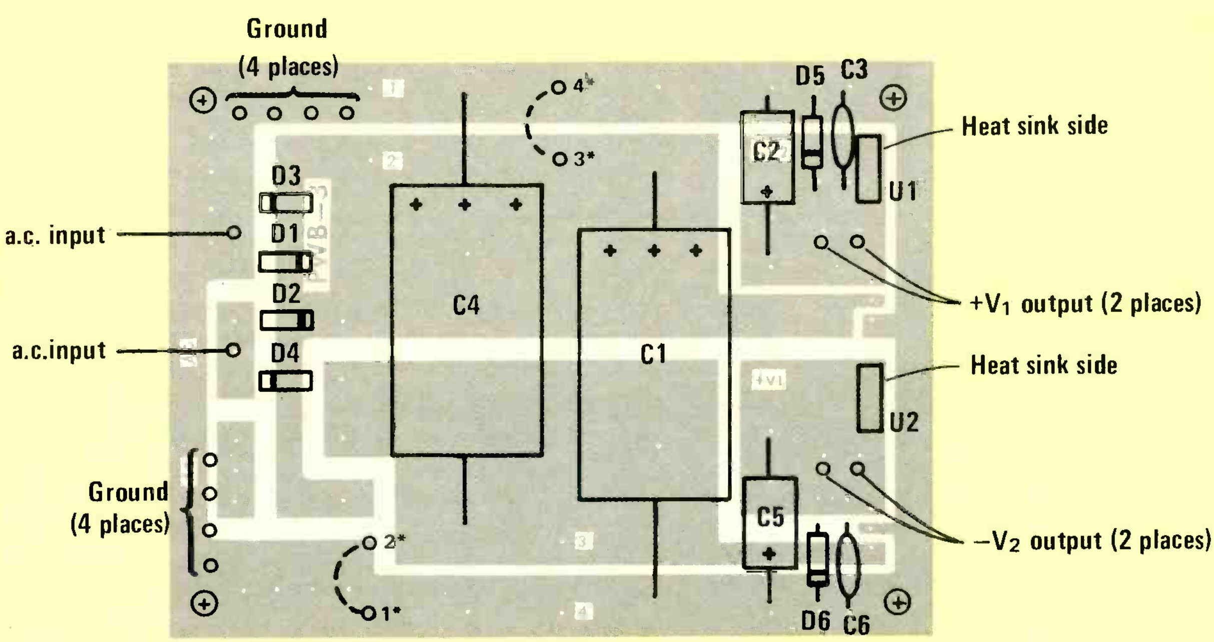


Figure 6 Negative output version.



NOTES:

1. Material: 1/16" G-10 glass epoxy.
2 1 oz., single sided copper clad.
2. Finished size: 4" x 3".
3. Revision A (May 1978)
4. *Jumpers (see text and Figures 5(B), 6(B).

Figure 3 Component placement diagram.

Table I
Parts list for dual-polarity version

Designation	Description
U1	7800/LM340 series positive voltage regulator IC
U2	7900/LM320 series negative voltage regulatur IC
D1-D6	1N4001 (or equivalent)
C1,C4	1000 mfd, 35V electrolytic
C2,C5	2.2–4.7 mfd, 35V electrolytic
C3,C6	.01 mfd, 50V ceramic

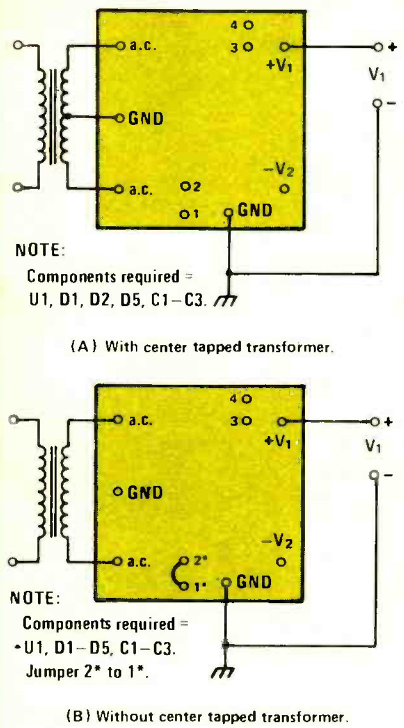


Figure 5 Positive output version.

obtained by selecting the proper regulators.

Figure 2 is the full-size printed wiring board layout, and Figure 3 shows the component locations for a fully-populated board. Holes have been provided in the board for capacitors of different lengths, and for components recommended by different manufacturers for their version of the regulators. A list of parts for a fully-populated board is contained in Table 2.

Wiring connections and the specific parts required for each of the three configurations are shown in Figures 4, 5 and 6. Note the jumpers necessary for single-polarity versions without a center-tapped transformer. Assembly of the board is straightforward,. Observe the polarity of all components, and make certain that working voltages on electrolytic capacitors are high enough to accommodate the regulator output voltage selected.

The regulators may be physically mounted to the board in a number of ways, but you must keep three things in mind: (1) These regulators *must* have adequate heatsinking, (2) the pin arrangements on the positive and negative regulators are different, and (3) the heat-conducting portion of the *negative* regulator *must* be isolated from your chassis ground.

There are two suitable methods of mounting the regulators to the board. For applications where only small amounts of current are needed and the filtered input voltage is somewhat close to the regulator output voltage, the technique shown in Figure 7 should do the job nicely. For larger currents, a larger heatsink should be used. Figure 8 shows how to use the equipment's metal chassis as a heatsink for the regulators. Note that both regulators are electrically insulated from the chassis.

When used as a bench supply, it is possible to install sockets, such as the 4038 series by Molex, on the board so that individually heatsunk regulators can be removed and plugged in to quickly change supply voltages for different projects. Remember to turn off the supply, though, to let the filter capacitors discharge before removing or inserting regulators—if you intend to use them more than once!

This article has presented an alternative for the design of power supplies for experimental projects. Although it's not intended as a panacea for all power supply related problems, it is the treatment indicated for the Power Supply Blues. Prescribe it for *your* next design!

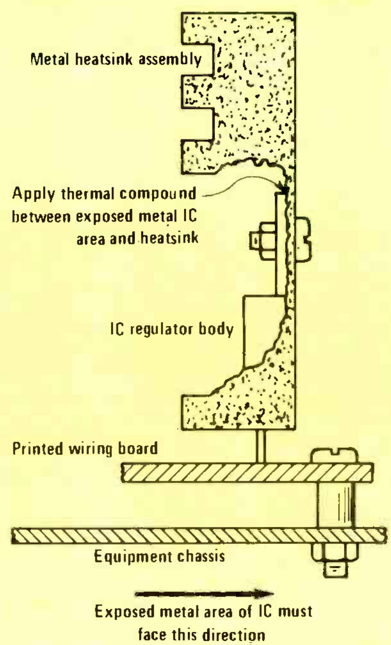


Figure 7 Construction with individual heatsink.

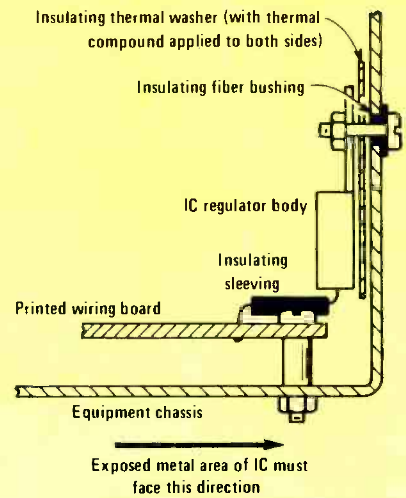


Figure 8 Construction using metal chassis as heatsink.