Variable Power Supply 0-50V / 0-2A (Refresh)

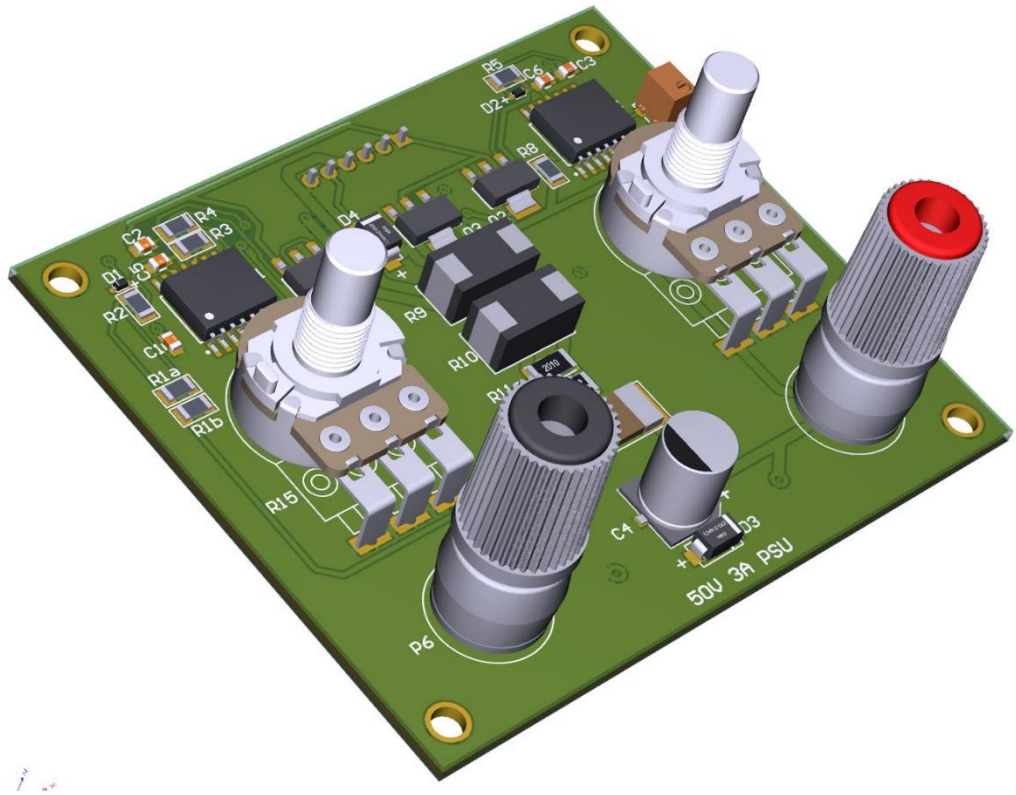
In the Elektor Summer Circuits of 1980, I came across just what I had been looking for; a decent power supply for my electronics work bench. It was to be my first major project (i.e., one with a box around it). After a few weeks of PCB manufacture, MCM switching design, wiring and box fabrication, it was finished. It worked like a dream and then continued to do so for more than forty years. Unfortunately, all the panel labelling was done with rub-down transfers which became less legible as the years went by.

Fast-forward to the present day and I decided that the appearance of the old box needed a bit of a tidy-up, so I took the front panel off to work on a new smart CAD-designed layout for it. When I looked inside, I was horrified by what I saw. “Did I really wire it up like that and with all those brittle wires and soldered directly into the PCB?” I decided that it couldn’t go back together like that again. This led to the idea of a complete rebuild and, if I was going to do that, I should use modern components which meant SMDs and good wiring with modern wire-to-board connectors.

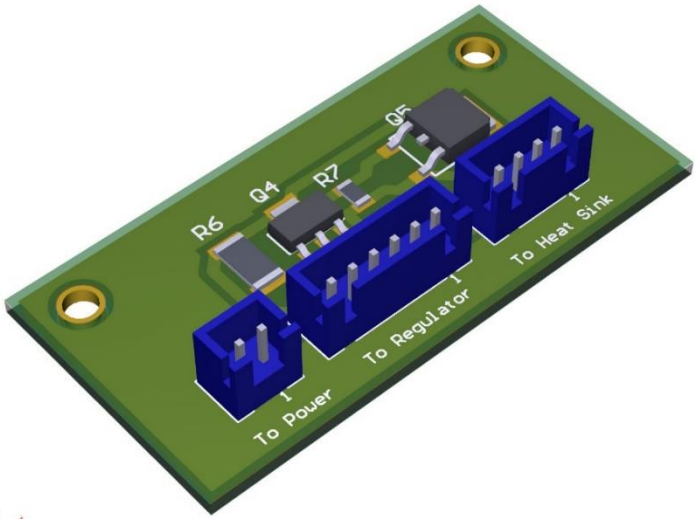
The new 0-50V PSU

The main consideration for the new design was always to tidy up the wiring. This led to a design of three parts: the main board, the power transistors on the heatsink and the linking driver board. All connected together using neat wiring with multiway connectors fitted. Now, at this point, many will be thinking that a nice reliable PSU can be purchased for a reasonable sum so why bother? The answer is easy, Electronics is a life-long hobby of mine and creating useful electronic devices using my own hands is what it’s all about.

The main board



The Driver Board



The Power Transistors on the Heatsink

This image shows the power transistors mounted on the common heatsink using insulation kits.

Design

The new design faithfully follows the original of 1980 right down to the numbering of components. Except that I used modern component designations e.g., Q was used to designate transistors. The other obvious difference was the wholesale use of surface mount components. This caused a problem as most of the semiconductors of yesteryear were not reproduced in SMD form, therefore requiring a search for their equivalents. The only components from the original build to survive the modernisation axe were the transformer, reservoir capacitor, the trusty 2N3055 power transistors and the enclosure of course.

Reading the original article and the National Semiconductor Application notes on the LM10 op amp will provide a lot of supporting background information regarding this project and both should be read. Because the literature is quite detailed, there is little point in my repeating any of it here.

At this point, I need to state that this design employs the use of a mains-powered transformer and people inexperienced with mains voltages should not attempt this project or should ask someone with experience who can help with this part of the assembly. *

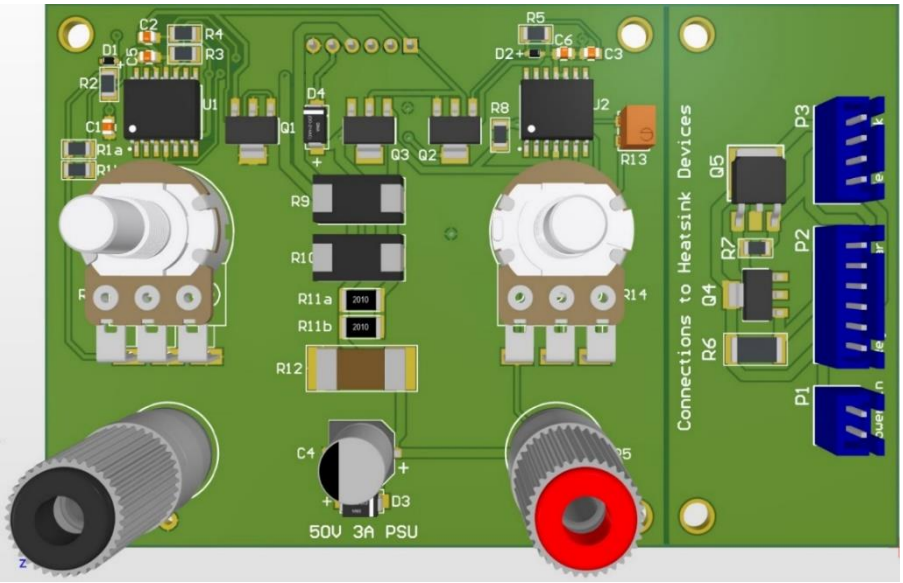
The Variations

The main power input components are all chassis mounted. The mains transformer I used has two x 20 Volt outputs which I wired in series to provide 40 Volts RMS which will output 56 Volts dc when rectified. The original design required an 80 to 100 VA rating but I chose a 120 VA version which provides 3 Amps. It's worth noting that chassis-mounted transformers are an expensive item so first decide on the current output that suits your needs before purchasing one. This then feeds to BR1 which is a 4 Amp bridge rectifier with a 1 Volt forward volt drop. This will then provide 55 Volts onload to C1 which is 4700uF / 63V type. This component is costly too and requires careful consideration. Firstly, the 63 Volt rating will be fine provided the RMS output from the transformer does not markedly exceed 40 Volts. Secondly, not all capacitors are created equal. In simple terms, ensure that the quoted ripple current for your capacitor is at least 120% of your intended maximum load current and the ESR value is below about 1 Ohm. Testing my original capacitor gave an ESR of 1.1 Ohms, a capacitance of 5,250 UF and a V-Loss of 2.3%: all seems good then.

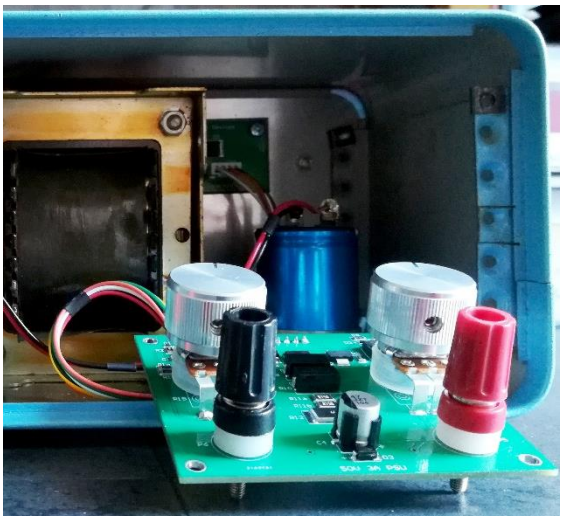
As stated earlier, the original circuit has not been changed except for the use of SMD components and the inclusion of decoupling capacitors for U1 and U2. Another variation is the splitting of R11 into two to dissipate the heat better and to give more options when setting up the Q3 current limit circuit. Another change is the mounting of the Potentiometers on the board. This removes five fly leads and gives alternative support options for the PCB. The major difference is the placing of the driver transistors on a separate board. Conversely to what you may think, this actually reduces the number of wires in the enclosure. This is because the drivers and power transistors are assembled as a unit on the back panel with P4 being the only wiring connection to the regulator board.

One design feature worthy of mention is related to the PCB manufacture. Both PCBs have been designed to be manufactured as one to save on costs. I have included two sets of Gerber files of this, the original version and the X2 version. I have my PCBs manufactured in Asia and there is an MOQ of five pieces, so reducing the number of parts simplifies the process and saves on costs too. A point of interest is that the postage always costs more than the PCBs do and the total cost is a half of that charged in Europe for one PCB (regrettably) and you still have four boards to share with friends too.

The Combined Boards – (request a 'V'-cut separation method of the boards)



Assembly Image



This photo was taken from the front before the new front panel was completed to illustrate how things will fit into place. The image shows the main board which will be attached directly to the front panel. Behind that is the chassis mounted reservoir capacitor and behind that, the driver board is just visible mounted on the back panel and the transformer needs no introduction of course.

Steve Griffin 2022