

MODIFYING A MOTHERBOARD'S VOLTAGE REGULATOR CIRCUIT

BACKGROUND INFORMATION

This guide demonstrates how to modify a CPU's voltage regulator circuit on a socket 3, 486-class motherboard. Although this document illustrates how to modify the regulator circuit on a Biostar MB8433-UUD v3.0 motherboard, the approach would be similar for most motherboards which allow for varying a CPU's core voltage via jumpers or DIP switches. Most motherboards employ an adjustable voltage regulator integrated circuit, whereby the output voltage is controlled by two set resistors. The designers of the MB8433-UUD adopted a Sharp PQ30RV21 voltage regulator. The specification sheet for this is still widely available for download on the internet. It contains much useful information such as pin-outs (4 pins), typical connection diagrams, and some basic equations. A voltage regulator is used to drop, or down regulate, either a 5 V or 12 V signal from the computer's power supply down to voltages which CPUs typically run at.

For the above mentioned voltage regulator, the output voltage (the voltage that powers the CPU) can be approximated as,

$$V_{out} = V_{ref} \times \left(1 + \frac{R2}{R1}\right), \text{ where } V_{ref} \cong 1.25V.$$

Resistors $R1$ and $R2$ are located on the motherboard and are known as surface mount (SMD) resistors. The MB8433-UUD has jumpers for 3 discrete voltages, 3.45 V, 4.0 V, and 5.0 V, which are controlled by jumpers JP37, JP39, and JP36. These jumpers simply act as path switches to different resistors to control the output voltage in the above equation. The 5 V jumper setting, however, probably does not transition through the Sharp voltage regulator, but comes directly from the computer's power supply [and direct to the CPU]. 3.45 V and 5.0 V settings are commonly found on socket 3 CPUs so we probably don't want to adjust those, but 4.0 V is rarely used so this is the voltage jumper setting we will tamper with.

There are a few CPUs which will benefit from running in the 3.45 V – 4.0 V range, namely the Cyrix 5x86 series of CPUs which are very thermally sensitive to voltages greater than or equal to 4 V. Cyrix/IBM 5x86 processors operating in the 120 - 133 MHz range usually require operating voltages of 3.6 - 3.9 V.

The motivation for this document was due, in part, to having achieved great success in overclocking an IBM 5x86C-100HF to 133 MHz on motherboards with a UMC 8881/8886 chipset and running at 2 x 66 MHz. This configuration was deemed stable at a specific CPU voltage of 3.85 V. Further details on this project can be found at,

<http://vogons.zetafleet.com/viewtopic.php?t=28848>
<http://vogons.zetafleet.com/viewtopic.php?p=247791>

MOTHERBOARD SURGERY

The remainder of this document will guide you through the surgical process pictorially.

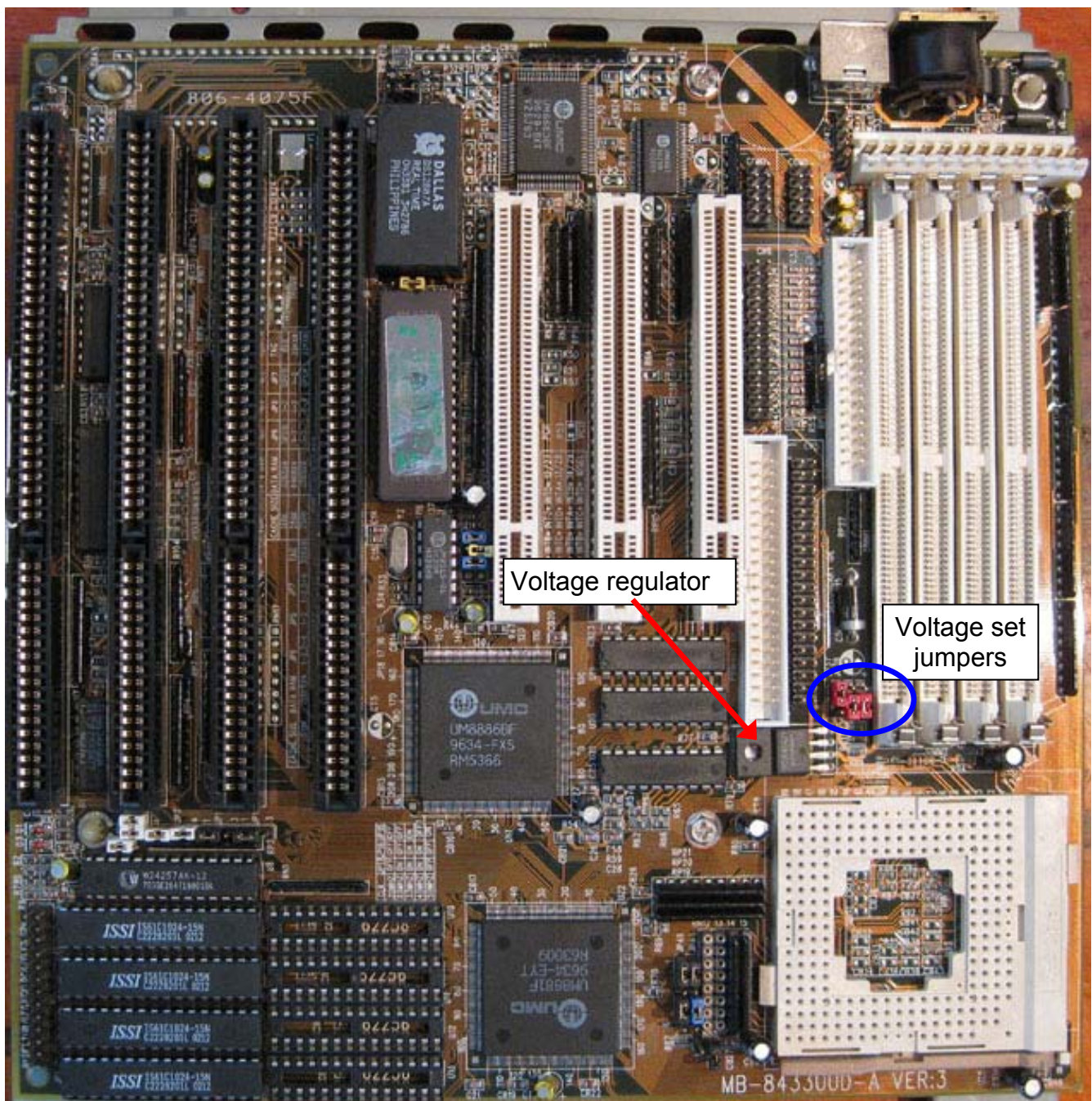


Figure 1: Above is an image of a standard MB-8433UUD v3.0 showing the location of the voltage regulator and voltage set jumpers.

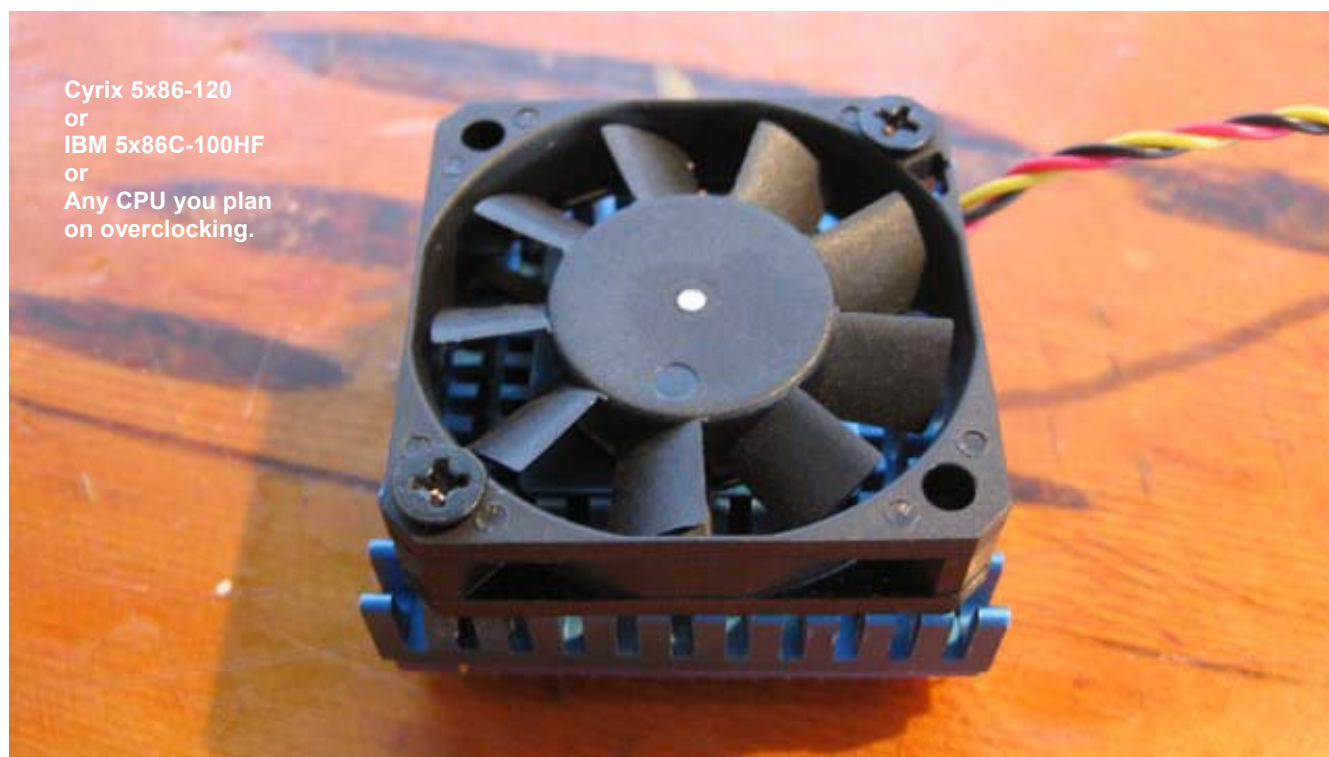


Figure 2: This image (top) shows a list of tools which may be required during the modification process. The 5 K Ω variable resistor used in this operation was a ½ watt trimmer, part number PV36W502C01B00. A 5 K Ω trimmer was selected since the resistor to be removed (1.8 K Ω) is half-way between the trimmer's upper and lower limit. (Bottom) You will definitely want to add a fan to any overclocked CPU.



Figure 3: A longer than normal Weller ETS tip is recommended to get into the tight confines of the motherboard.

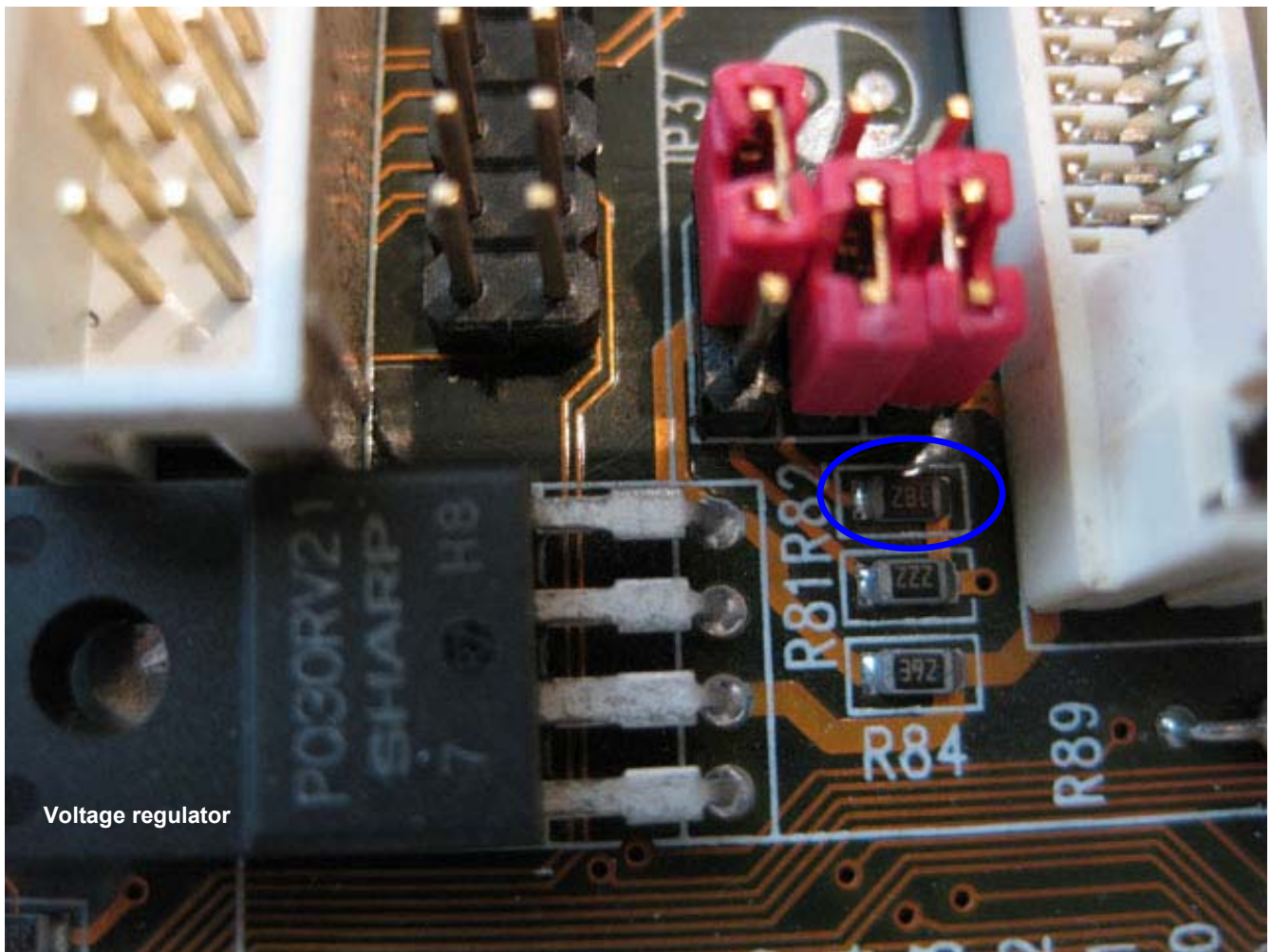


Figure 4: You will need to desolder the SMD resistor that has 182 printed on its face. Use a solder pump to suck out the old solder. This resistor is circled and has a resistance of 1.8 K Ω . The resistor below it with 222 (2.2 K Ω) controls the 3.45 V jumper setting. The resistor with 392 (3.9 K Ω) is R_1 in the above noted equation, while 182 and 222 make up two jumperable possibilities for R_2 .

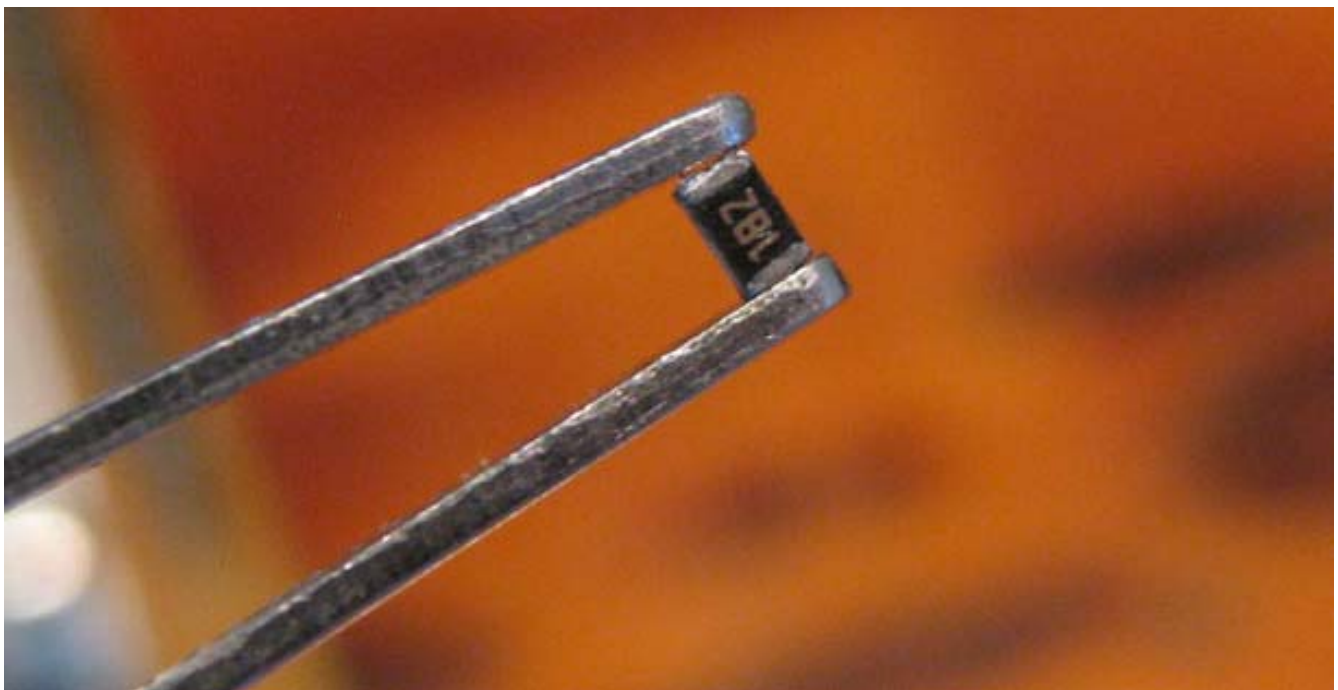
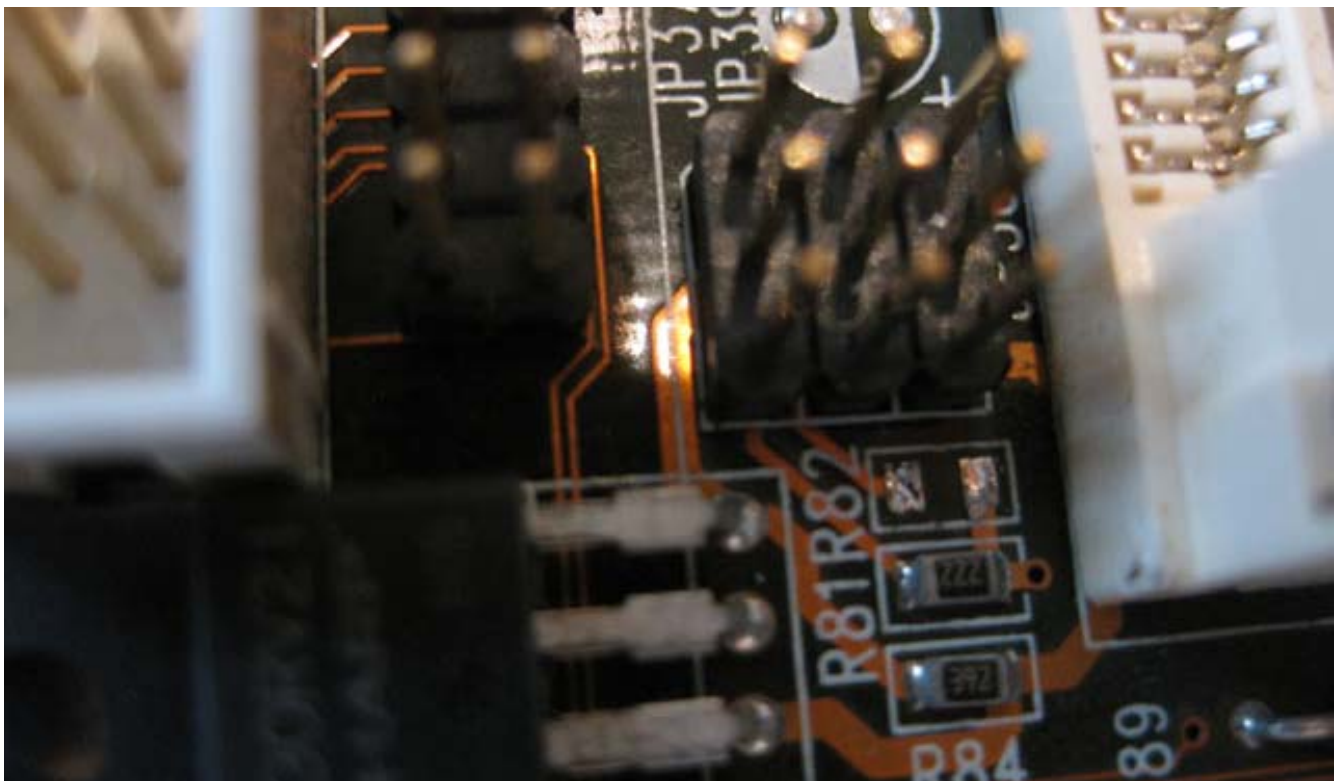


Figure 5: The removed SMD resistor and empty solder pads. These empty pads will be used to solder in the 5 K Ω trimmer.



Figure 6: This image shows how the pins of the trimmer were bent to facilitate easy soldering onto the solder pads. If possible, use lead-free solder to solder pins 1 and 2 together. Lead-free solder (tin and silver) will melt at a slightly higher temperature than leaded solder. Using *lead-free* solder here will ensure that this solder joint does not melt when you later solder the two exposed pins onto the motherboard using *leaded* solder. Be sure to set your soldering iron to about 530 °F when later using the *leaded* solder. This will ensure the lead-free solder does not later melt.

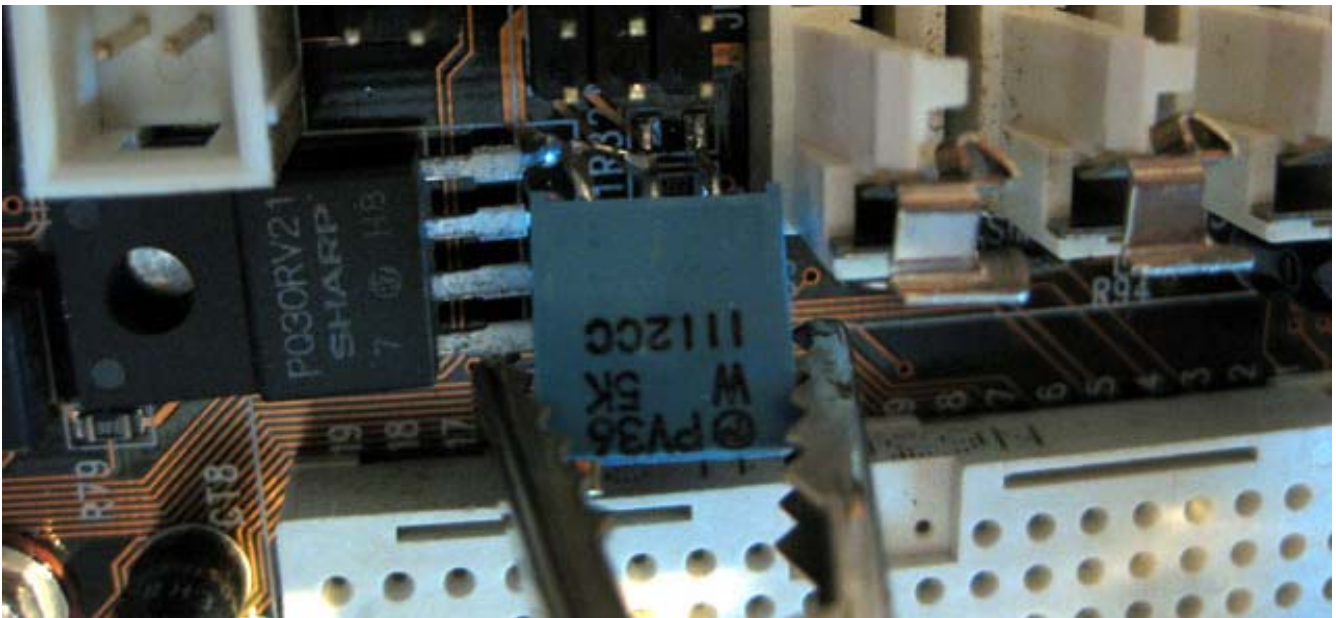
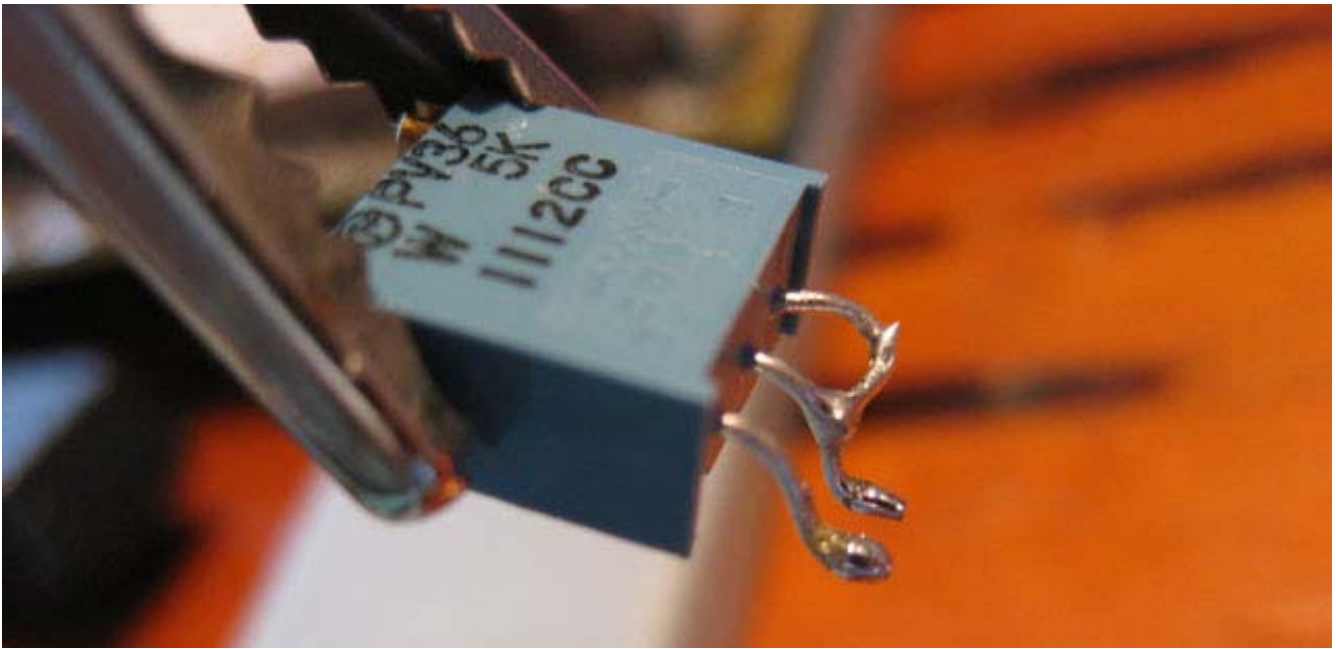


Figure 7: (Top) Be sure to first pre-soak the exposed pins in some leaded solder before moving it into position. It is actually quite difficult to get more solder in there once in position (bottom). Before you solder in the trimmer, use a multi-meter to measure the resistance across the two exposed pins. Set it to 2.0 K Ω using the adjustment screw. You won't be able to measure the resistance once it is soldered in place as the trimmer's resistance will be in parallel with the voltage regulator's resistance. 2.0 K Ω is a good starting value and will have the CPU running at about 3.7 V. You'll also want to remove the 3 red voltage-set jumpers as they tend to get in the way.

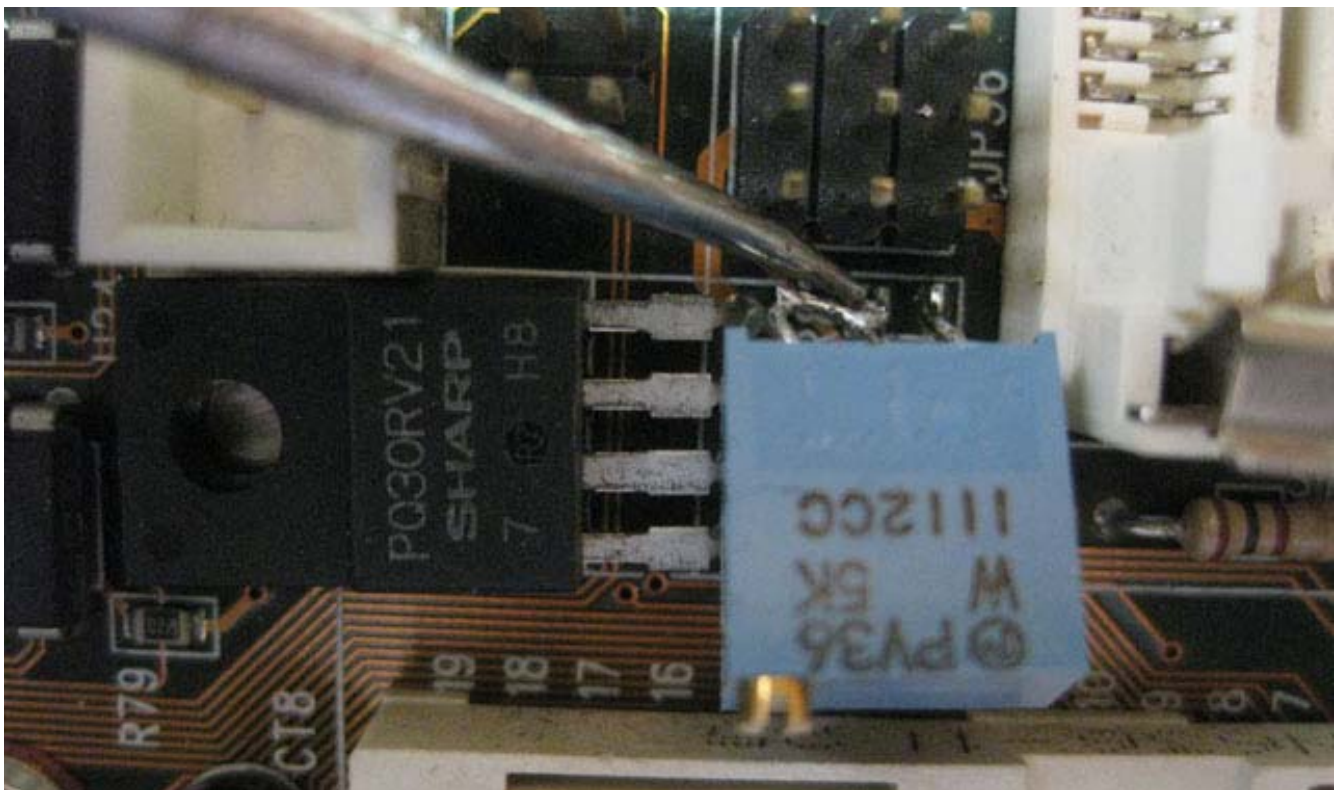
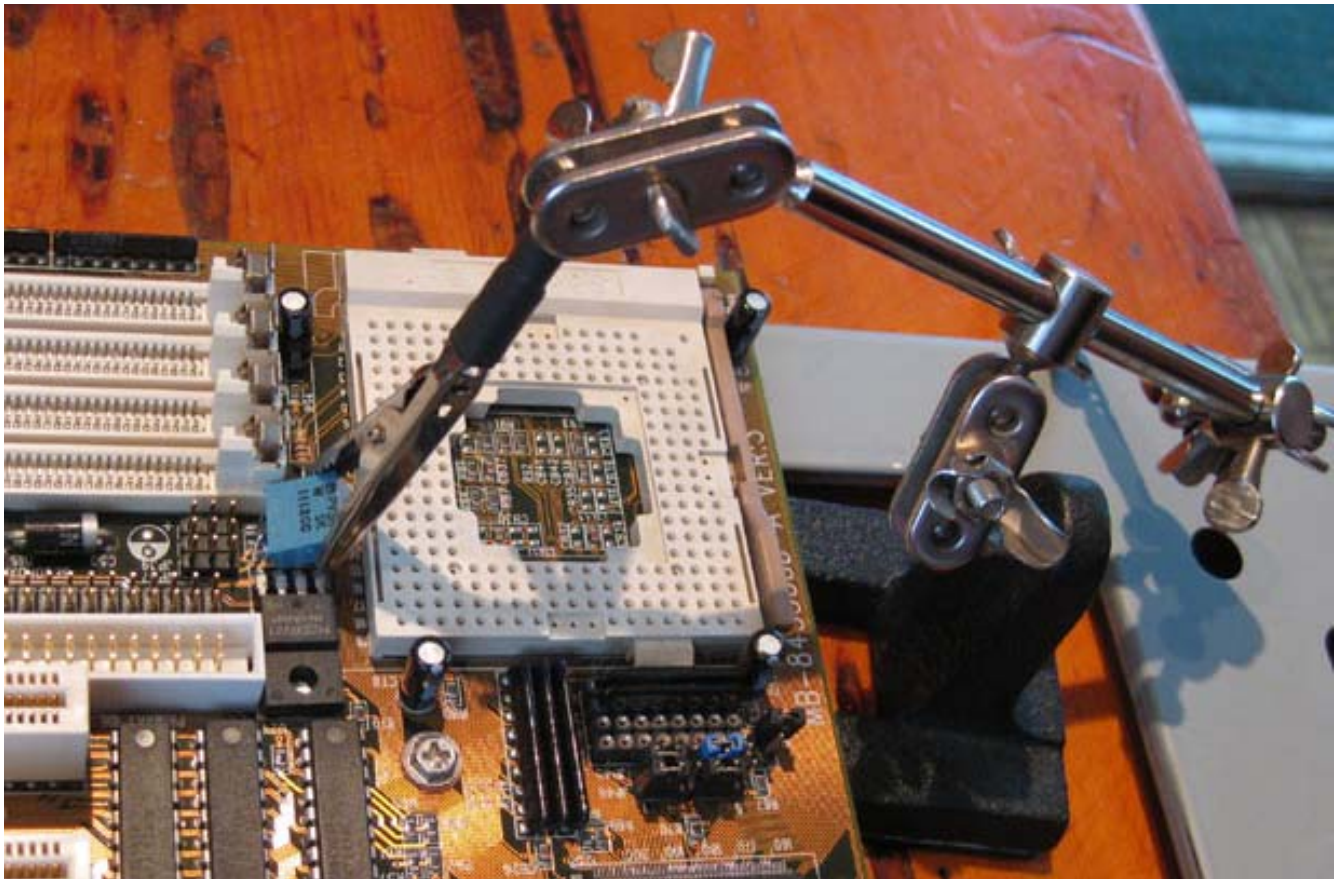


Figure 8: A 3rd hand is essential to hold the trimmer in place. If you don't have one, get one. Once soldered (bottom), use a poker to confirm that both pins made solid contact to the solder pads.

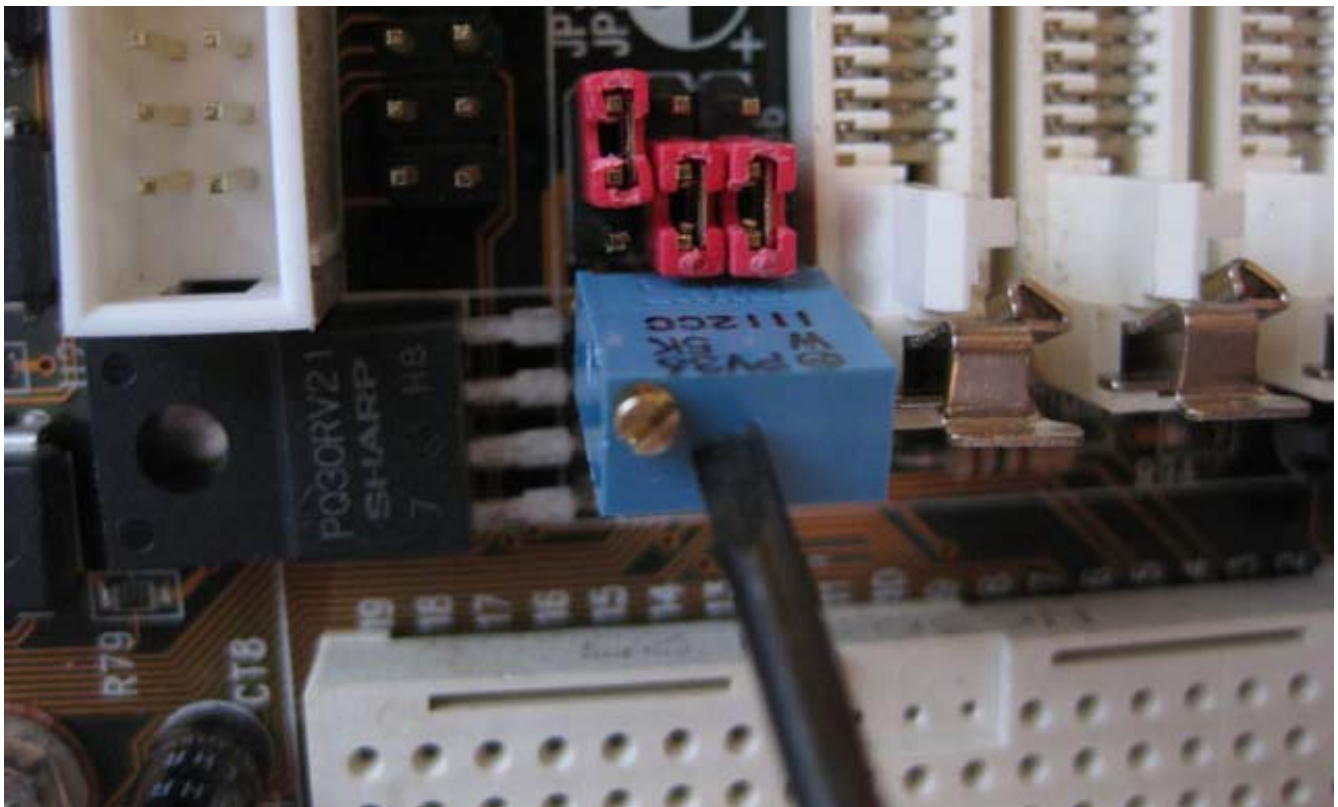
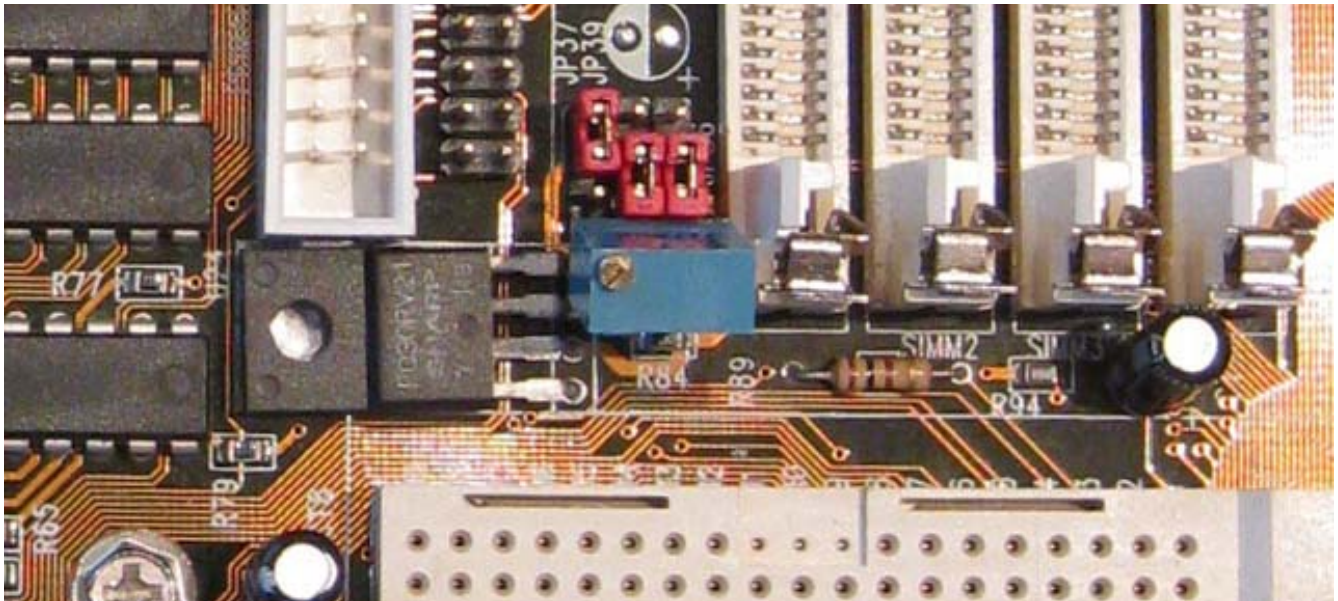


Figure 9: Once soldered in (top), you can gently straighten out the trimmer to a more vertical position. Be very careful not to force it too much as you will rip off the solder pad and the motherboard's copper trace. You can use a flat-headed screw driver (bottom) to adjust the trimmer's resistance, thereby adjusting the voltage regulator's output voltage to the CPU. Be sure to reconnect the 3 red voltage-set jumpers. I've tested this in the 3.0-4.1 V range. It didn't output more than 4.12 V, probably because the input to the voltage regulator is only 5 V instead of 12 V (the regulator itself drops some voltage). This seems to imply that the 5 V CPU jumper setting comes straight from the computer's power supply. If it is desired to have 4.1 – 5.0 V flexibility, it would be necessary to replace all 3 SMD resistors shown in Figure 4 and wire the regulator to the power supply's 12 V line.

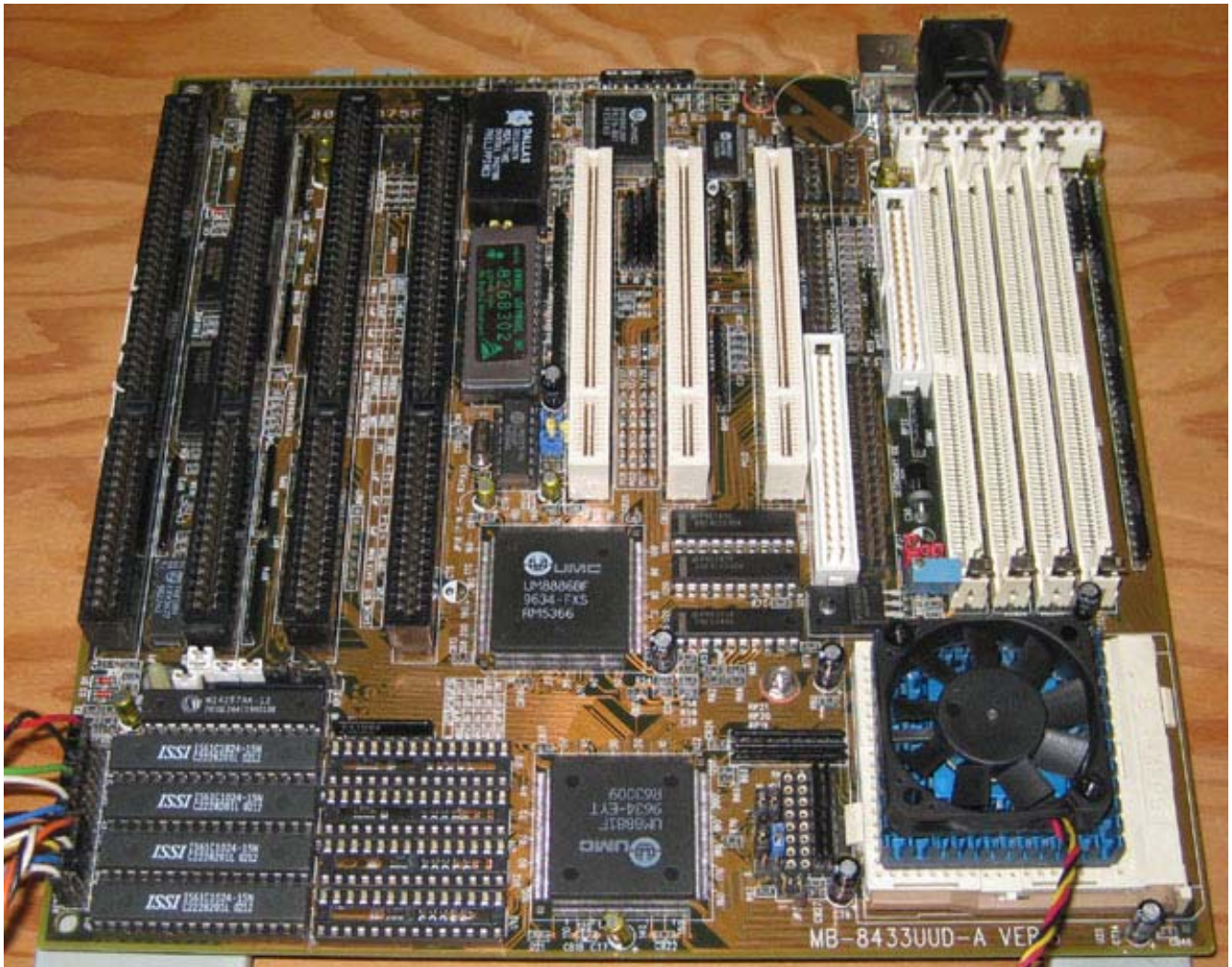


Figure 10: Sit back and admire your handiwork. That little blue 5 K Ω trimmer doesn't even look out of place!



Figure 11: Place the motherboard back into the case and hook everything back up.

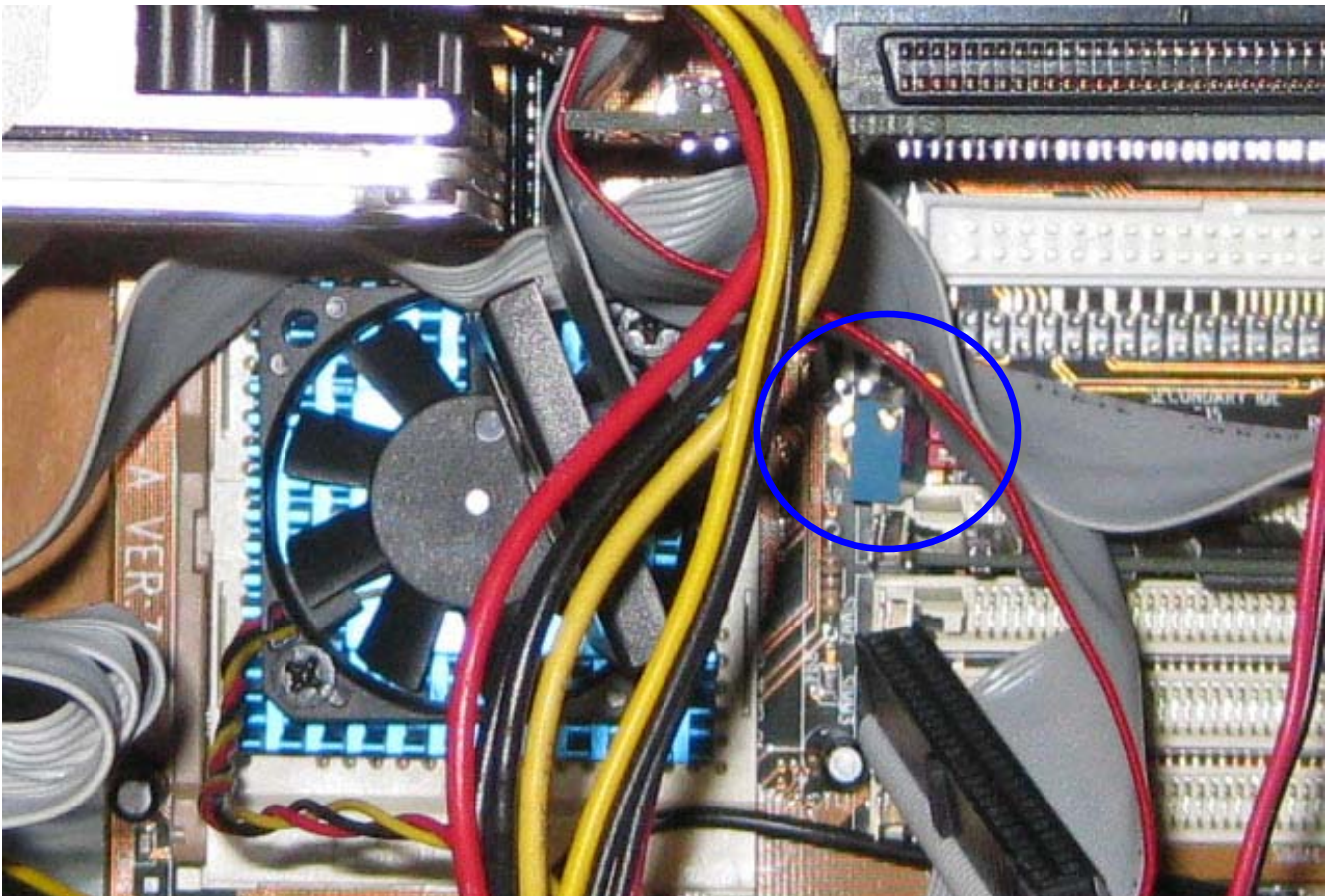
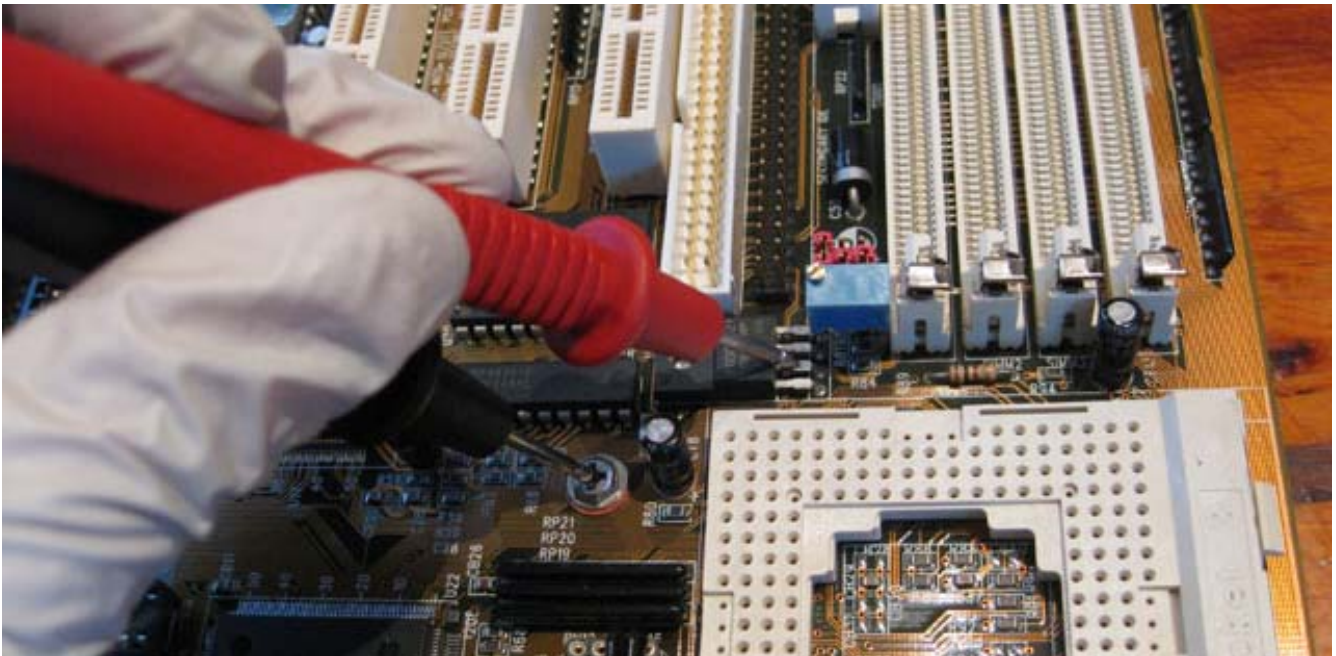


Figure 12: (Top) Demonstrating which pins on the voltage regulator to probe with a multi-meter to read the voltage delivered to the CPU. You'll want to use gripping IC test leads to fix your multi-meter's probe to the second pin of the voltage regulator. For ground, you can pick any ground (black lead) which is convenient. (Bottom) Displaying ease of access to the trimmer. Be gentle when jamming your screw driver down there to adjust the voltage.

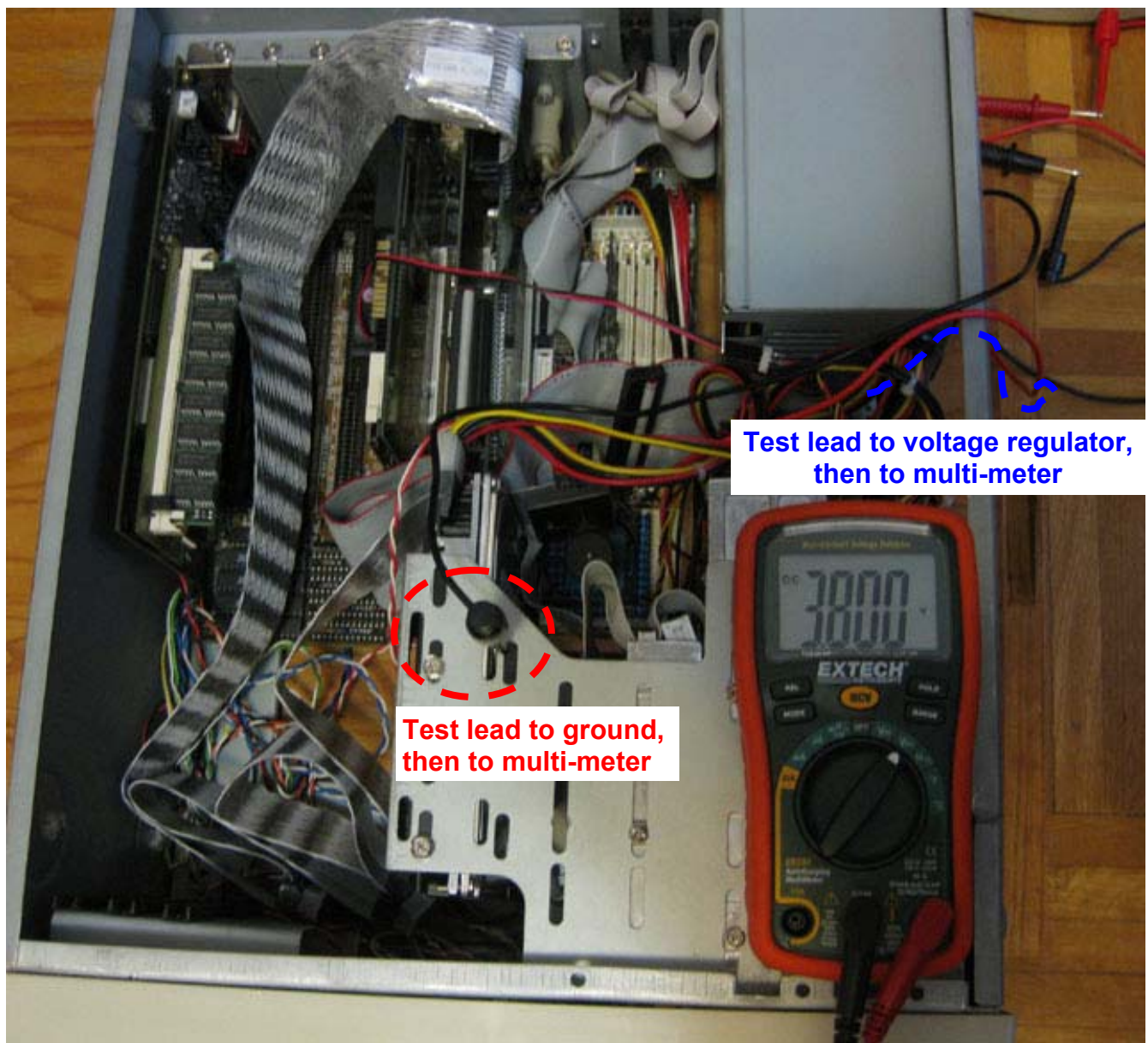


Figure 13: As is evident on the multi-meter's display, very fine control over the CPU's voltage can be achieved, 3.800 V in this case.



Figure 14: Once you have determined exactly what voltage you want to run your CPU at, that is, after it has been well established that your overclocked CPU is stable at this voltage, you may wish to solder in fixed value SMD resistors as shown. The ones selected above were for the 3.65 - 3.75 V range and were used to dial-in the 3.70 V needed to run an official Cyrix 5x86-133.