Buggy HP49G Serial Port

While working on a serial to IR converter, I discovered an error in the current hardware design of the HP49G. The schematic of the serial buffer, made up of 4 transistors, a few resistors and 2 diodes, differs from the original HP48 design. The driver should function as a current limiter in case to much current flows into or out of the output (HP_TX).
When you take a look at the original schematic (page 3), you can see that a current over 4mA ($I = U_{be} / R? = 0.6V / 150R = 4mA$) causes Q6 or Q7 to conduct and these will 'pinch' off Q5 or Q8 to limit the current that will flow to a few milliamps.
Now take a look at the new schematic drawing of the 49. Here you can see that R1 is not connected between the base-emitter juntions of Q1 and Q4, and can therefore never protect the port when to much current flows in or out of the port. And Q2 and Q4 look like they are upside down!

Another error is made with the diodes. In the 48 design two separate schottky diodes were used (glass melf). They have been replace by a dual schottky (L44 device marking, BAT54S or equivalent) in a SOT23 package. One diode passes a high voltage (spacing) to the output and the other one a low voltage (marking bits). When you take a look at Q2 and D1 you can see that the two PN junctions are 'head to head'! The buffer schematic is definitely not doing what it is supposed to do!

I did some measurements to prove these statements. (page 2) All measurements were made with fresh batteries in both the 48 and 49. Although the fact that the serial port is working (I've flashed my 49 two times before I discovered this), the signal coming from the 49 is weaker (-3.5V to 4V) than the one from the 48. This may the problem some people are having with the serial connection when they want to flash the 49 (but I am not sure!) I did already blow up one of the transistors. Probably my own fault, but it shows how vulnerable the port is. The first picture shows the waveform when sending a 'Z' on the 48. It swings nicely from -4.3V to +4.3V. The next one shows the waveform the 49. Here I had already blown up one of the transistors. The last picture shows the waveform after I changed all transistors. The signal is weaker and the negative edge is still a bit rounded. Probably because the signal cannot be pulled down. Most PCs will still accept this as a valid signal though.
I notified HP about it and they had discovered the error as well. New versions of the HP49G will be corrected. For those who bought their 49 early after its release (I bought mine in october) can try to patch their serial port buffer as I did. Tom Karlsson edited the layout and made a nice image on how to do so (page 5). A picture of my patched calc can be seen on page 6. Although it is a minor surgery, you will lose your warrenty when you open your HP49.

Good luck to those who have the guts to patch it themselves. I'd be gratefull with a picture of the 'new' buffer layout or any measurements on the serial port with ‘original’ transistors. The revision number on my PCB is 07 G 9924, written underneath the 1000uF capacitor. I guess the number F1633-80400 D below the left LCD controller is probably a production code.

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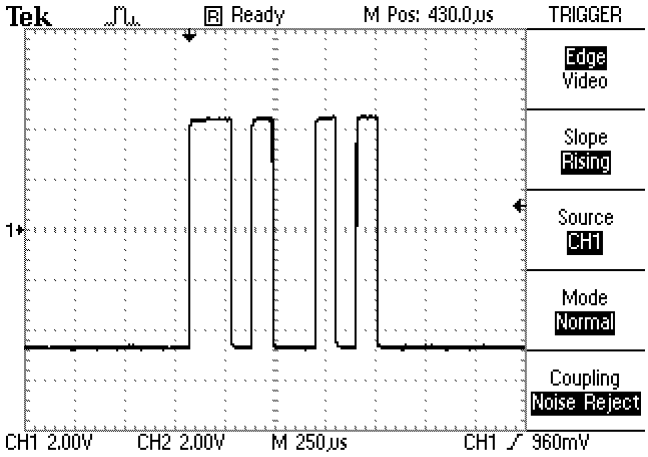
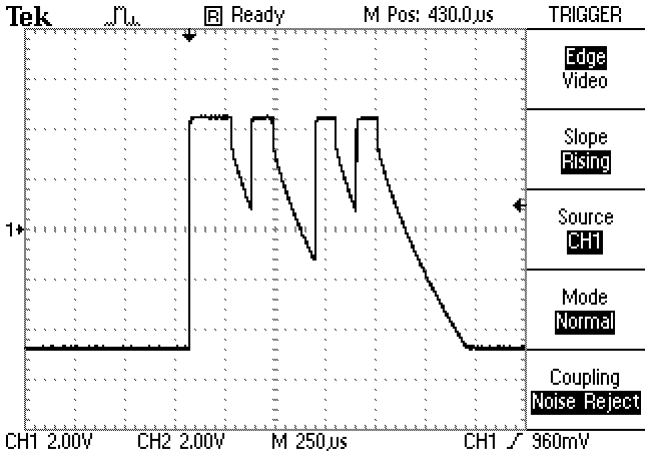
p2: waveforms
p3: schematics
p4: current pcb layout
p5: schematics of the patch
p6: patched pcb layout (by Tom Karlsson)
p7: picture of the patched board

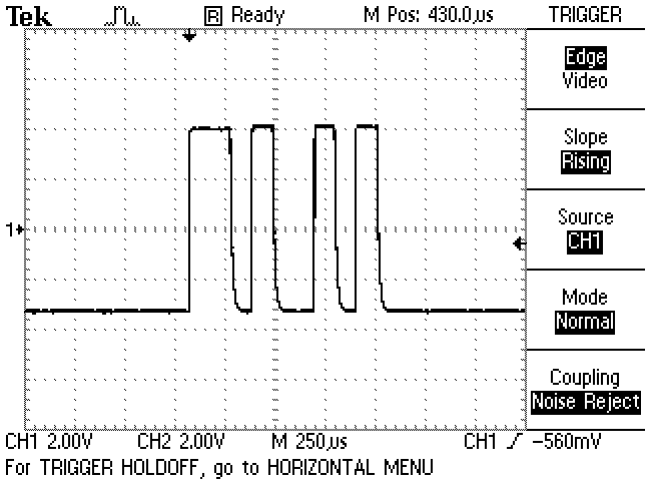
All following measurements were done with fresh batteries.



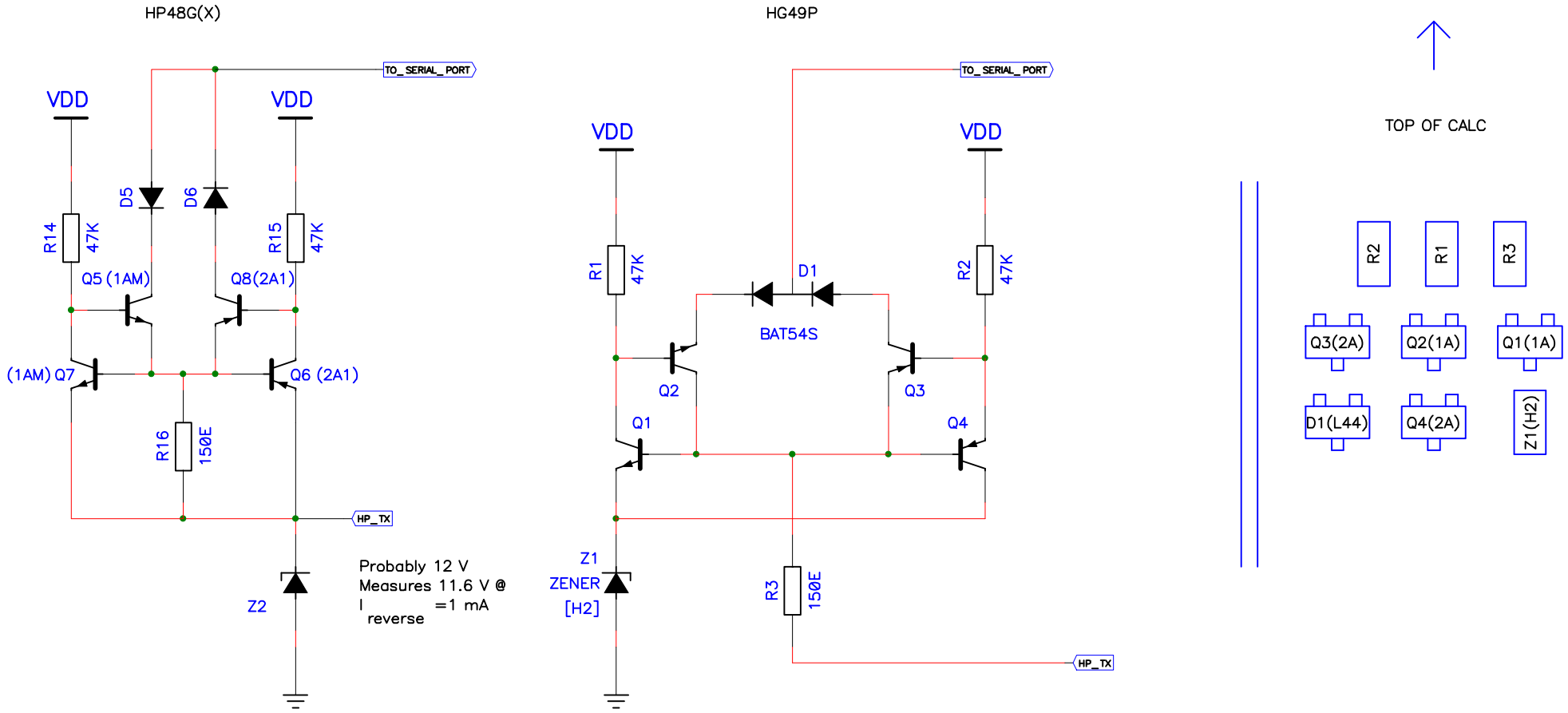
Waveform when transmitting a “Z” on a HP48



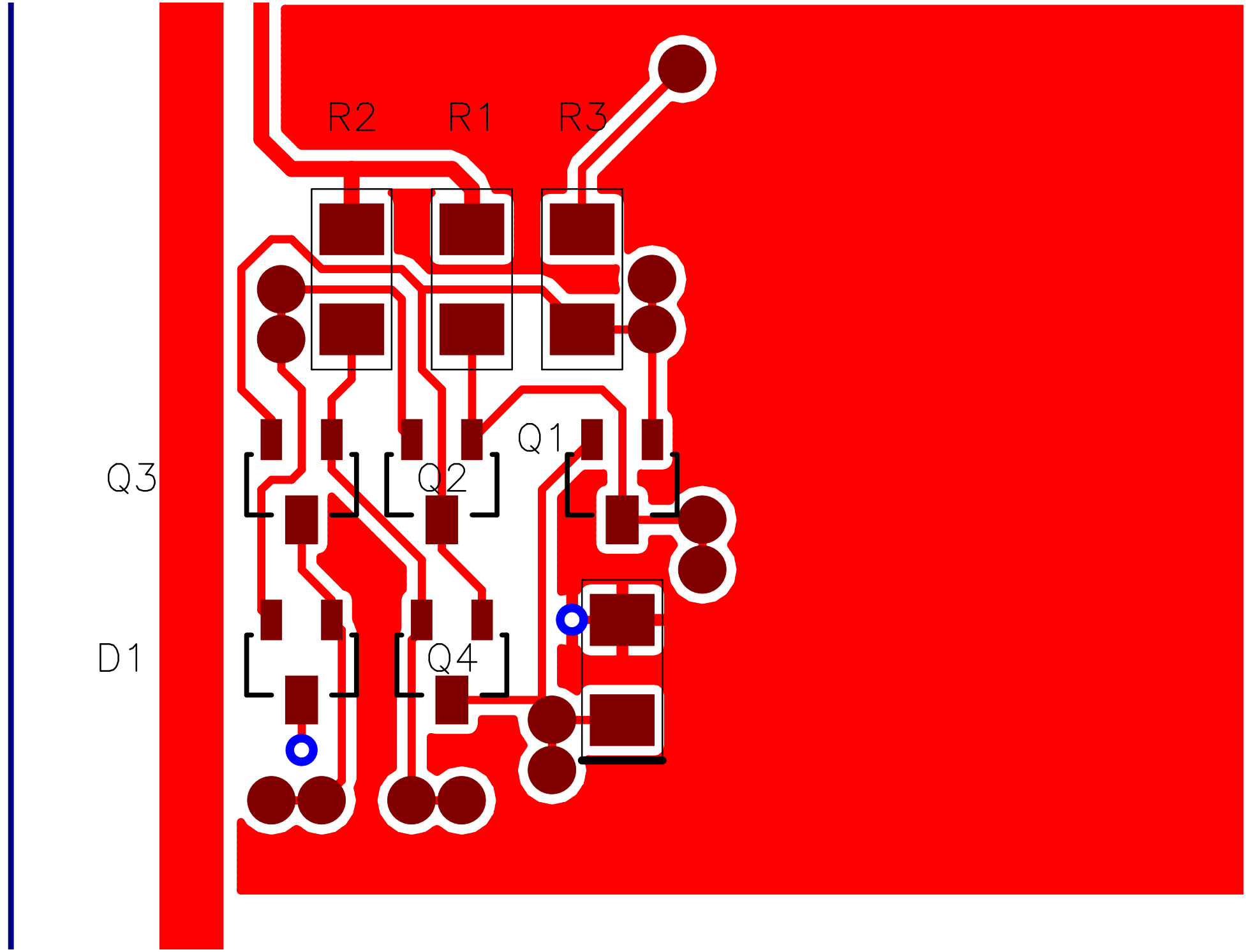
Waveform on a HP49G when I had blown up one of the transistors (easily)



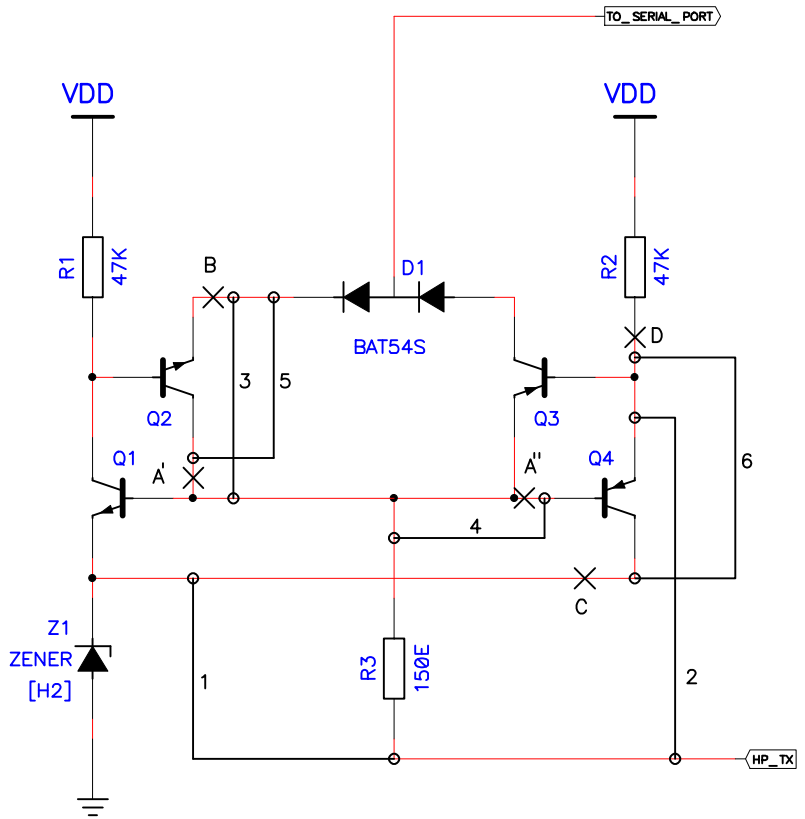
Waveform of a HP49G after I changed all transistors. A bit better, but still rounded on the falling edge, and the voltage swing is less than on a HP48



Title	HP48/49 serial driver	
Size	Number ---(Hobby)---	Rev 1.0
Date Sun Oct 10, 1999		Drawn by M. Flipse
Filename HP49serial.SCH		Sheet 1 of 1


R2
R1
R3
Q3
Q2
Q1
D1
Q4

HG49P



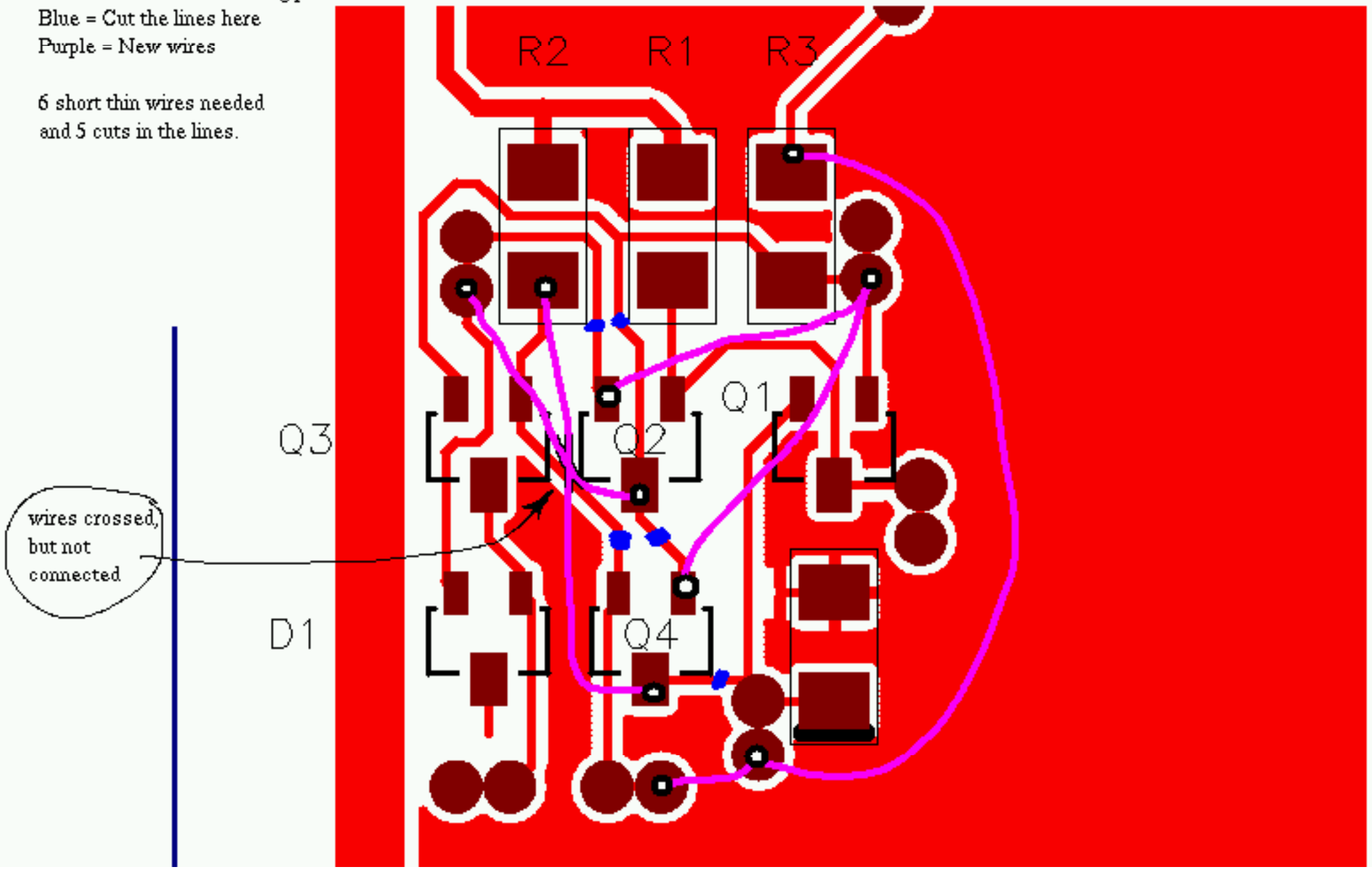
A' AND A" ARE A SINGLE CUT ON THE PCB

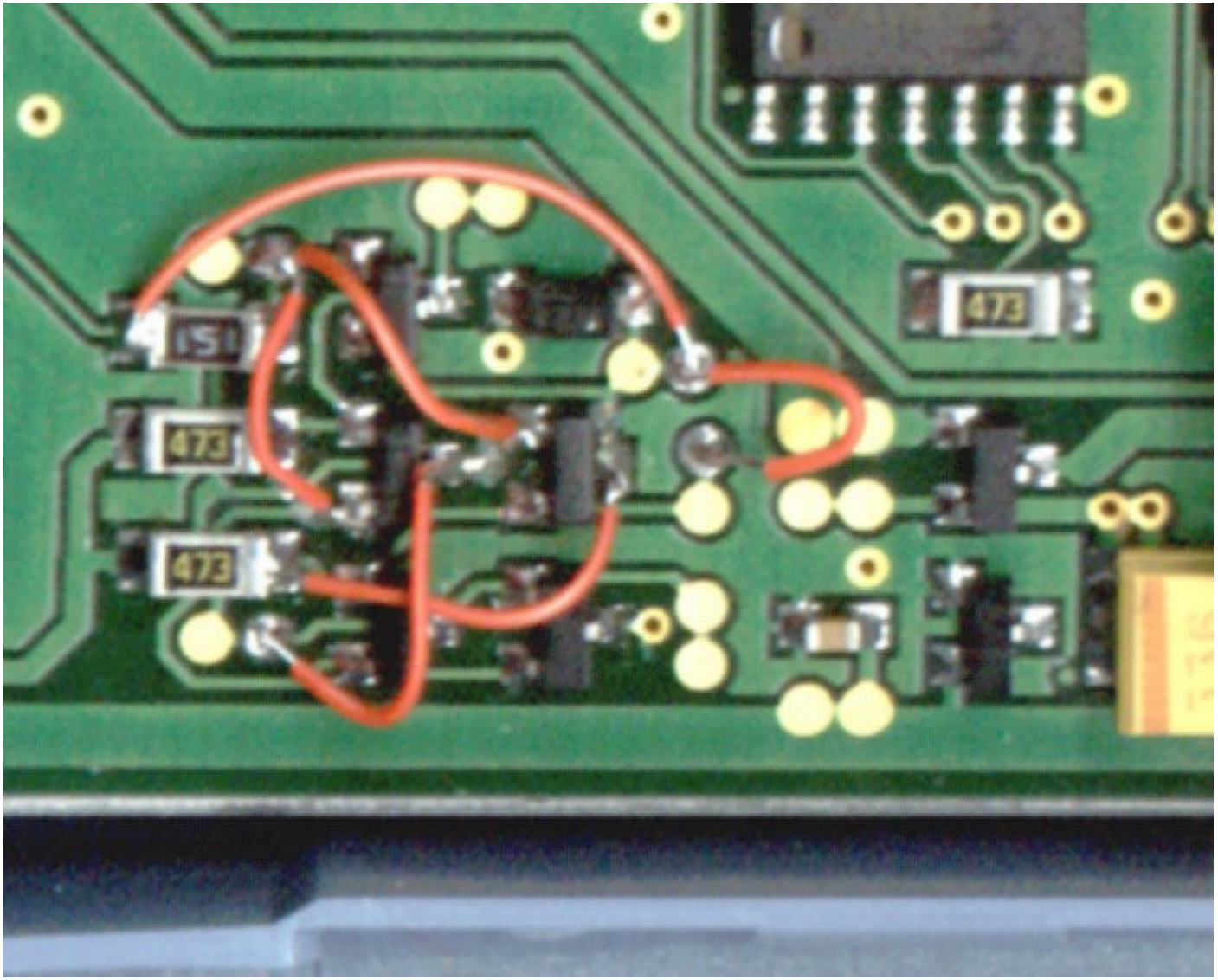
Title	HP49G serial port patch	
Size	Number ---(Hobby)---	Rev 1.0
Date Thu Dec 30, 1999		Drawn by M. Flipse
Filename HP49serialPatch.SCH		Sheet 1 of 1

Patching the serial interface on an HP49G

Black/White dot = soldering point
Blue = Cut the lines here
Purple = New wires

6 short thin wires needed
and 5 cuts in the lines.

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