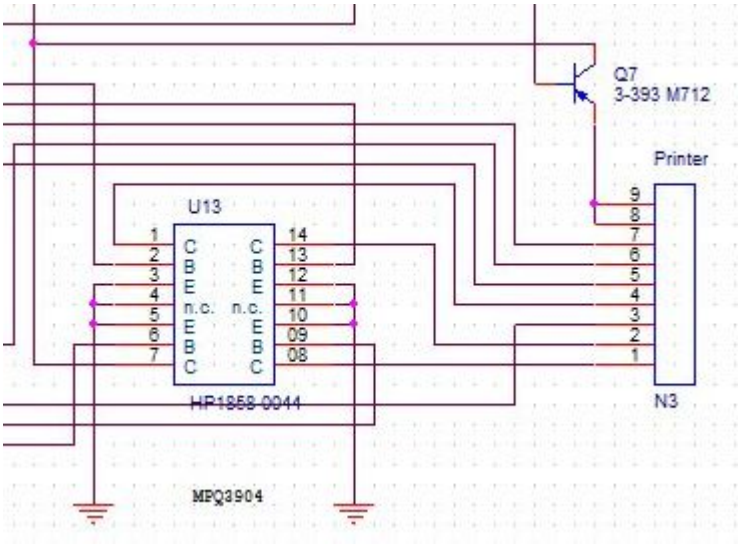
HP-19C Repair Birthday Workshop, an Odyssee

In January 2021, in fact it was the day of my 62nd birthday, when the strict corona lockdown in Germany was in effect, allowing only one person from another household as guest, I had the idea to invite Jef to an HP-19C repair birthday workshop. He brought his HP-19C to me, which he already had mainly restored from a very bad initial condition. It wouldn't light up at all at the beginning, the printer motor was spinning all the time and the printhead was moving endlessly from left to right and back. He cleaned the interior thourougly and by replacing all transistors and ICs and potentiometers of the „Power supply/Printer PCB“, finally the calculator started up and showed „**0.00**“ in the display, he could do calculations, even the printer motor stopped when it reached the home position.

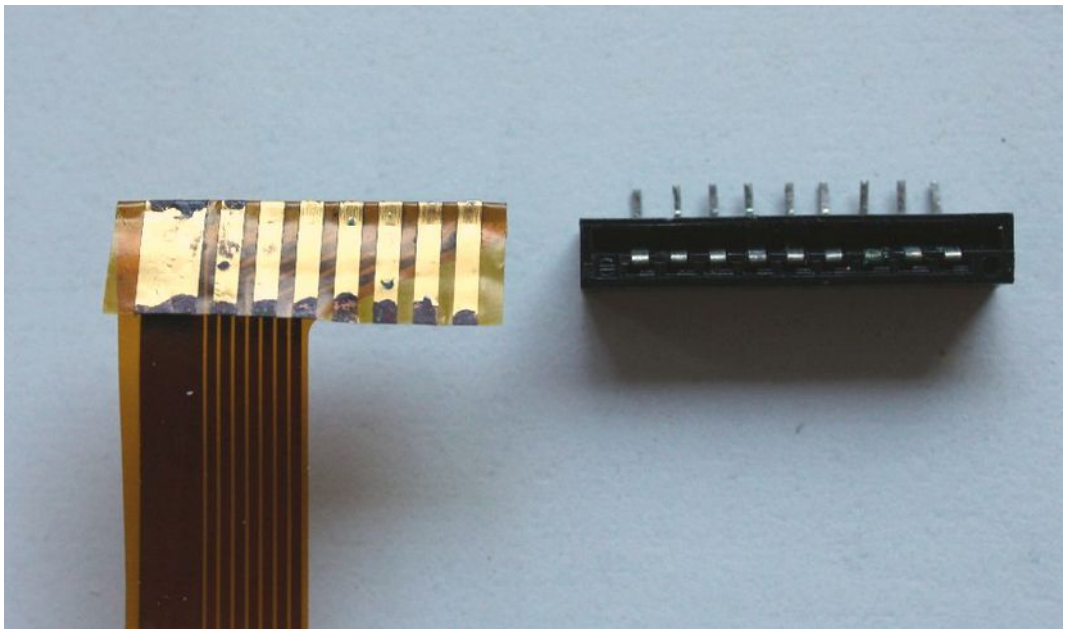
But the printer didn't print anything on paper, just the motor moved from left to right and back. What I thought would be a simple task of repair/replace of one transistor turned out to be a magnificent discovery journey into details of the calculator and to overcome one obstacle after the other, and Sherlock Holmes would have had its joy looking at us.

My first assumption, that transistor Q7 3-393 M712, which enables the printing, was not working, turned out to be true. My friend had already replaced it, but unfortunately had soldered it the wrong way in, emitter and collector was inverted. But when we inserted a new transistor, this time the right way, it still didn't work. We knit our brows, but anyway, we had to go on. Now we inserted a „known good“ printer PCB with „known good“ printer module into the calculator. And it worked flawlessly. This proved, that the rest of the calculator was in good condition and the PIK chip (Printer Interface Keyboard) , which was located on the processor board, was working.



Next step was to check the copper traces to the printhead. Will they have contact?

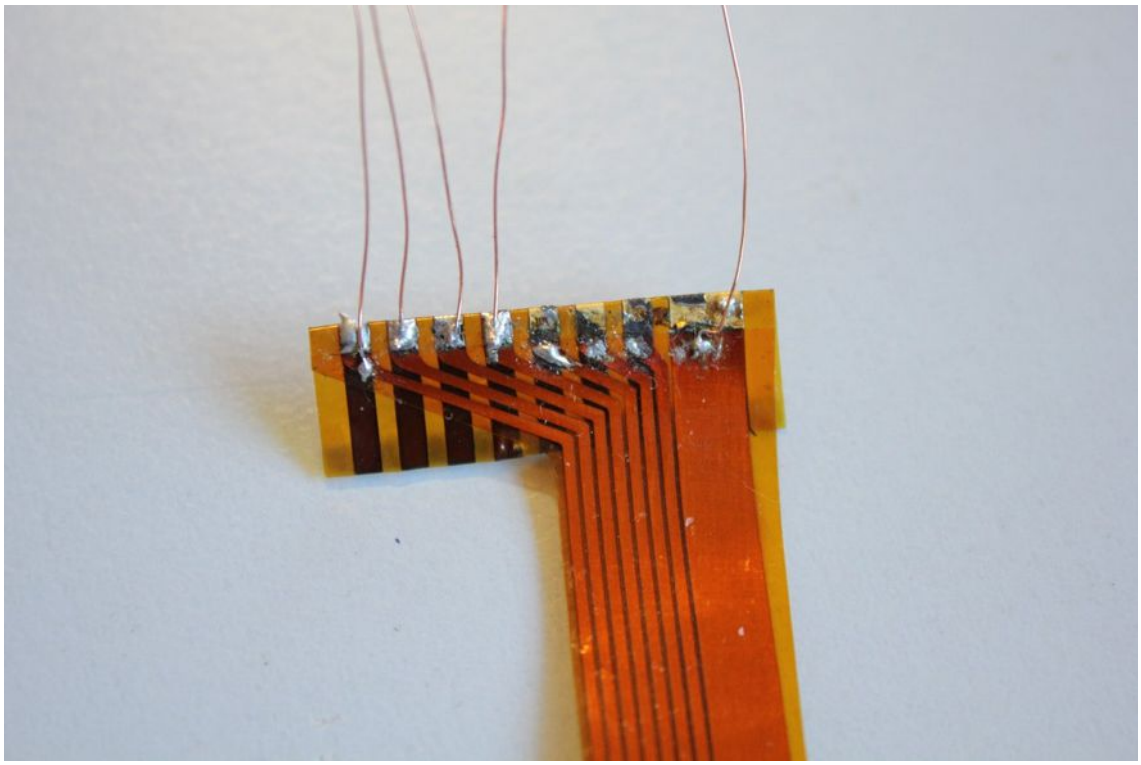
We unsoldered the connector. Here we discovered another flaw, as they are so many, in the HP-19C design. The flex cable is bent sharply and it is very difficult to remove it from the connector. You have to use a lot of force to get it out, and we assume, that the sharp edge also is prone to corrosion.The 9-pin printhead flex cable had 5!(five) bad contacts. Also the common line, the broad one in the image below, did not make contact, which explained why nothing was printed.



HP-19C printer flex cable connector

We couldn't use the connector any more, We decided to solder wires to the flex cable and to connect them directly to the PCB and give it a try. We saw each other already at the destination, only a small step before all would be done. First we got only two lines out of seven printed on paper.

What could be the reason for this failure? No idea! Therefore we decided to check the printhead pixel resistance, which we should have done before; we expected values between 10-14 Ohm.



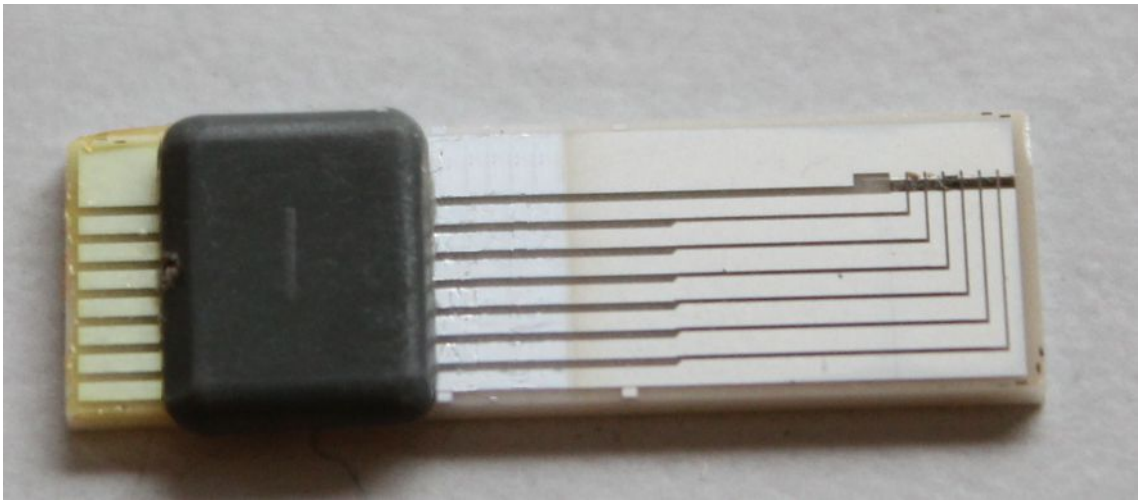
Here we got a big disappointment: three of the printheads had higher resistance than expected, or no contact at all. This was a knockout. The printhead cannot be repaired, except getting a printhead from another HP-19C, we thought. Although I had a bunch of (well, only three) HP-19C calculators in my collection, I would not tear the working printhead from one of it.

But why give up so soon? I had also some HP-97 in my collection, one of them was already cannibalized, but had a working printer module.

We didn't waste our time, and immediately started to disassemble the printer of my HP-97 and checked its printhead. Would it be OK and have the right resistance of the pixels measured? Yes! Would it fit into the HP-19C? No, not at all! Another disappointment. Although the white ceramic printhead itself seemed to be identical, it had a different flex cable and different vertical position of the pixels. Nevertheless we tried to insert it into the housing of the HP-19C. But there was another obstacle, a tiny grey plastic cover at the end of the flex cable, which connected the white ceramic printhead with the flex cable, was much too thick and was in the way. At least we could insert it half the way in. We made a print and saw again only two lines and tried to match them with the number 3.141592654, which we thought to see. There was no match! Two heads were smoking! Not printheads, but our heads. Until we discovered, that the HP-97 flex cable was oriented the wrong way, and we had inserted it pin 9-1 instead 1-9. Ah!! Oh No! Does this meant it was burned up? But electrically the printhead could not have been damaged - there were only resistors in the printhead, relieve! A quick check (which was done in 30 minutes, by removing everything, unsoldering the connector, checking of the resistance of the 7 pixels) confirmed, that it was still not destroyed.

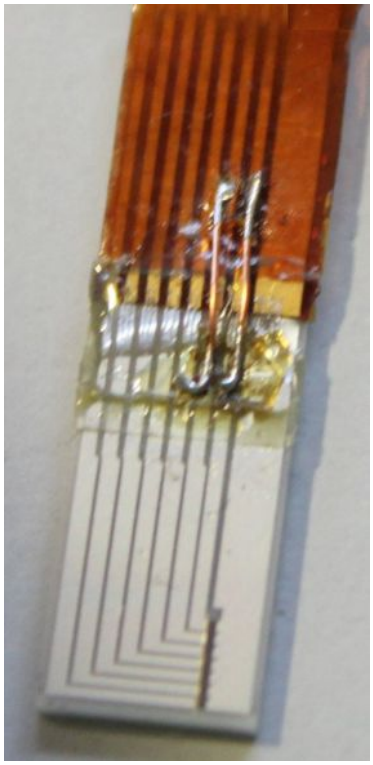
With the now reversed cable inserted, the first attempt to print looked promising, We still had only two pixel lines, but they seemed to match the number 3.141592654 in the display.

How to get the other pixels? What to do with the tiny grey plastic cover? Don't think too long! Remove it! OK, but be careful! After some time and checking proper tools we removed this protection shield and saw some very, very tiny bond wires, connecting the flex cable with the printhead. This was scary. Don't touch it! I forgot to take a picture of these tiny wires.



The rest of the day we were discussing how to proceed next. It was already late and Jef had to leave and drive back to Belgium, but not before we had some late night birthday dinner in my house and being very proud of what we had accomplished already.

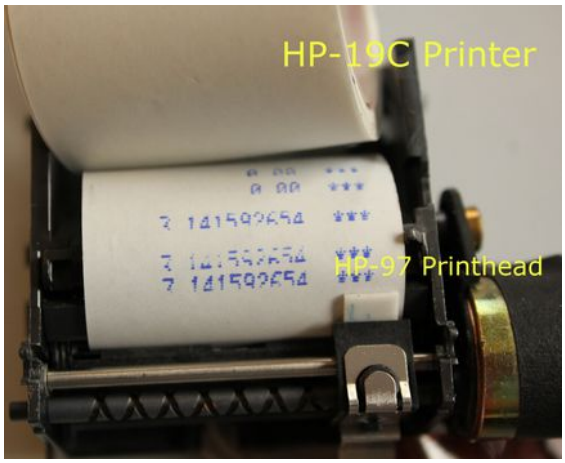
The next day I added some epoxy (two component glue) to protect the wires of the precious HP-97 printhead, the goal was: to protect the bond wires, but consume less space than the previous grey plastic cover, to fit into the small HP-19C printhead housing.

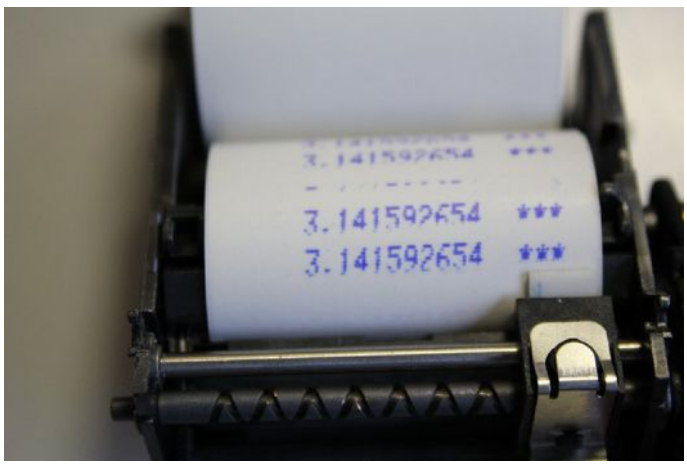


Unfortunately after the epoxy had solidified, two of the connections were gone, although I didn't touch the whole thing, I couldn't explain it. Perhaps it had occurred already, when we had removed the plastic cover.

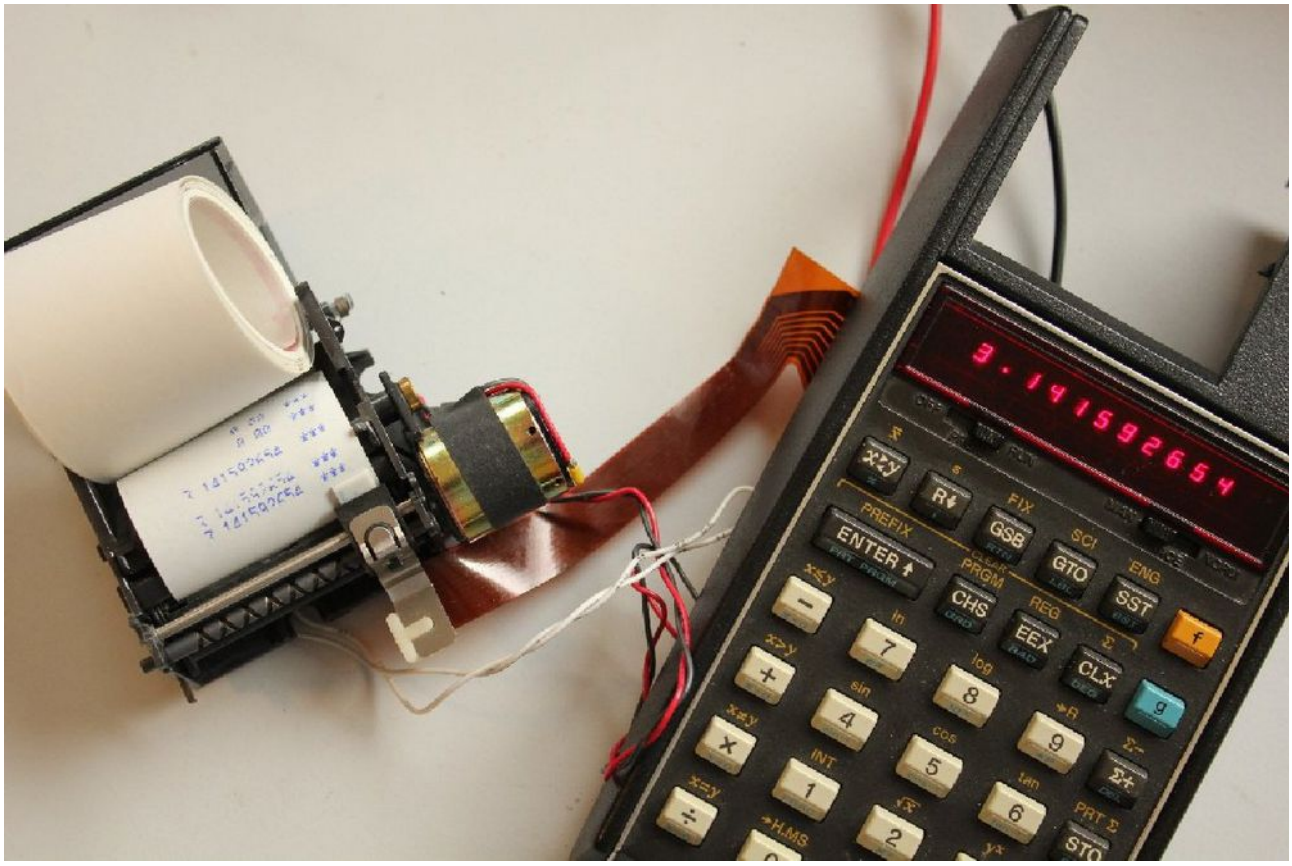
But why give up? I soldered two BIG! wires (see image at the left) instead of the broken bond wires, now covered with epoxy, and could re-establish the contacts.

I could now push the printhead into the HP-19C printer module and connect the HP-97 flexcable provisionally to the HP-19C printer board. And when I shifted the printhead more upwards, it printed the complete number, although the lowest line was a little weak.



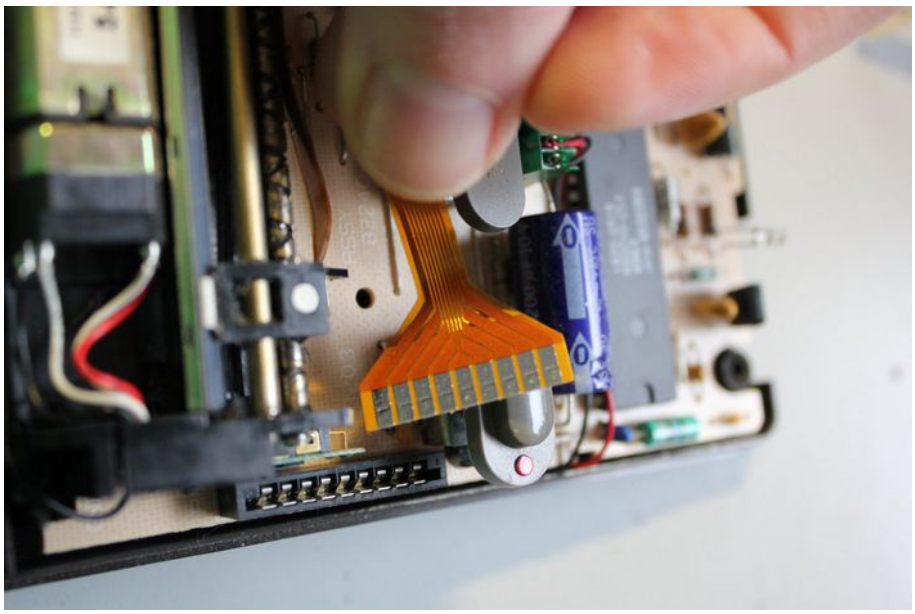


Probably the first time ever an HP-97 printhead was working in an HP-19C.



But still a long way to go! There was no way that the flex cable of the HP-97, which was oriented the wrong way, and much bigger than the original cable, would fit into the HP-19C, and closing the housing was impossible. It also had to move from left to right while printing without hitting anything inside. I thought about a solution.

The next steps needed some weeks. We wanted to check whether an HP-82240 thermo printer (which was more cheap than a HP-97) would have a more appropriate printhead and would fit better that the HP-97 design. Therefore Jef auctioned an HP-82240B printer for 50,- Euro. When it arrived, I opened it and found, that the flex cable was yet from another type, and I also found that removing the printhead from this printer module by disassembling it completely, seemed not easy, if possible at all. But at least I found, that the HP engineers had learned something:

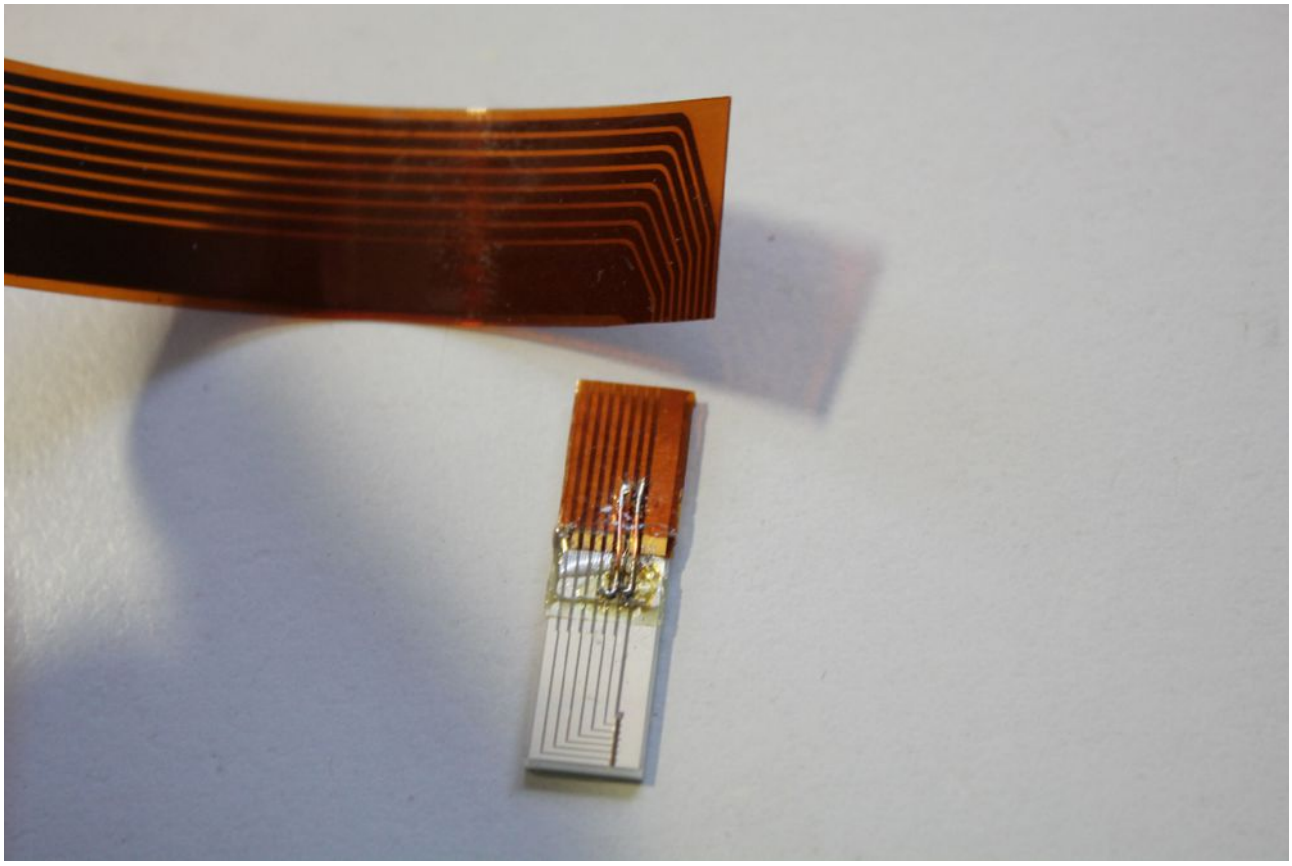


HP-82240B printer flex cable

The flex cable was not longer bent sharply, it was not bent at all, it was plugged straight into the connector and was easy to remove.

Thus the aquired HP-82240B was saved from cannibalization, it was assembled again carefully, and became the second thermo printer in my collection. The new one printed much faster than the other. Perhaps just better batteries, but this does not belong to this story.

Now the only left solution for the HP-19C repair was, to combine the original HP-19C flex cable with the HP-97 printhead. Therefore I made the two cuts in both cables.



HP-97 printhead with HP-19C flex cable

Unfortunately the time had come now, when things went wrong. I decided to remove the small rest of the flex cable from the printhead carrier to solder the wires directly to the silver colored traces. Although in the above image you can see that I could successfully solder two wires to the printhead, my next task was to solder all of them. It was not possible! The traces were presumably of very thin aluminium, and the oxide layer acted as the best solder resist I ever encountered in my life. I tried to remove the oxide layer with sand paper, I tried to scratch it with a scalpel, I tried different kind of solder, high temperature lead free, and low temperature lead tin alloy. I tried different sort of solder flux, I removed the flux with solvent hundred times and tried again, I changed the solder iron tip with a new one. I thought about etching the saphire type of aluminium oxide with hot concentrated NaOH solution, but rejected the idea as crazy, it would remove everything on the printhead and the printhead itself. Meanwhile after having heated up the small part a lot of times, I measured the resistance of the printhead pixels. And they got worse and worse. It seemed that by removing part of the thickness of the traces, the resistance was increased. I got nearly a nervous breakdown. I wanted to throw all things, that were laying on my table to the wall, including the calculator, and never come back in the room again.

Then I decided to give up.

Some years ago I bought an HP-19C with totally corroded electronics, but with a fully functional printer module. And also some years ago I gave this module to Bob Properi. This module is now inserted into an HP-19C near New York, because Bob, who is well known in the HP Museum forum, sent me his HP-19C for repair: his printer head had a missing pixel line. I had no better idea than to give him my printer module and the promise, whenever I would repair my totally corroded HP-19C, I would ask him to send the printer module back to me. As this is still not the case, I had no right to get the printer back from him. But I thought that his defective printer would be much better than nothing and why not insert it into Jefs HP-19C?

That was my solution, and that's what I did. I don't tell you about the many times some screws fell into the bottom of the case, and how I needed to open the case and try to close it again. Everybody who has even opened the HP-19C knows what I'm telling about. It is so difficult to get the golden springs into the holes of the upper PCB, and its gets even more difficult because you get angry. Then you need the fine fingers of a new born to put the display into its place. Then carefully try to get the two parts together. Then, when finished, you discover, that a keyboard row is not working, because one of the wires had become loose. And you have to open it again, not without grunting in pain. The HP-19C is the worst calculator HP ever made, they had no AutoCad, and still tried to build this machine without it. It is really terrible to assemble this machine. How the hell could they mass-produce it? It is time consuming to get all screws in its place, so many parts to put together. I needed two hours until it was done. Some annoying details I can't describe, my english language is not good enough or I don't want to remember. Nevertheless, if the housing is closed and everything is working, the HP-19C is a marvel of ingenuity. Sigh....

This is the final result, one pixel line is missing, but the number can still be read clearly.

If I will ever repair my totally corroded HP-19C then I will ask Bob Prosperi to send me my printer module. Then I will open Jef's HP-19C and give him the missing extra pixel line. But before that will happen, perhaps far in the future, I never will open an HP-19C again.

Bernhard Emese, Jef Ongena, February 2021