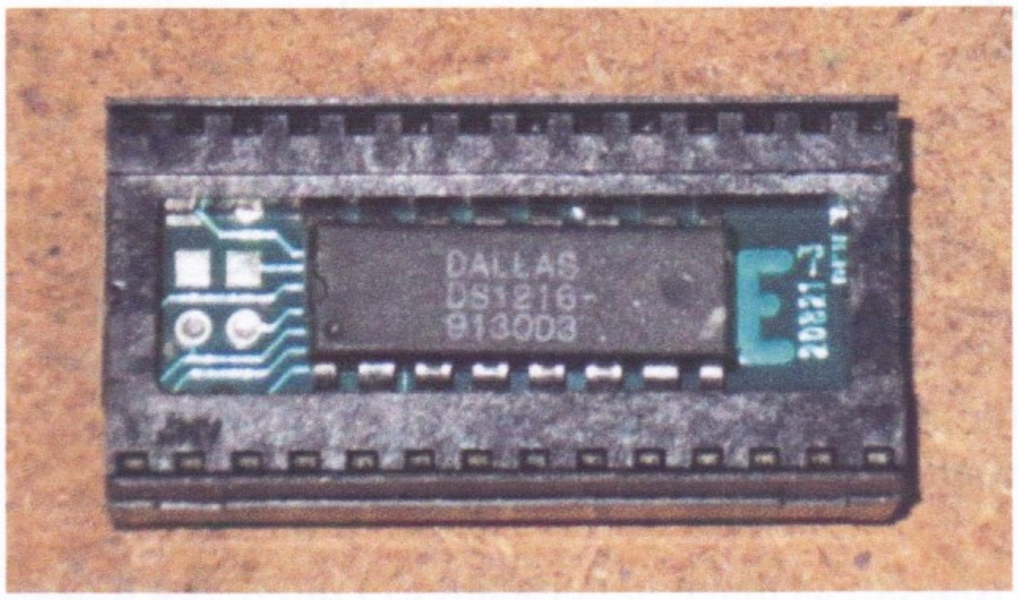
Substitute Backup Battery for Dallas Semiconductor DS1216E Smartwatch

Description by Charles Hett Lenexa, KS February 19, 2013

I have noticed that the Smartwatch function implemented with a DS1216 part in one of my Zenith Z100 computers has stopped working. It does not save the clock/calendar data any longer. This is not surprising as the part is probably at least twenty-five years old although I don't know for sure. So I set out to see what I could do about it as new ones are pretty expensive if they can be found at all and then, they may have very old batteries in them.

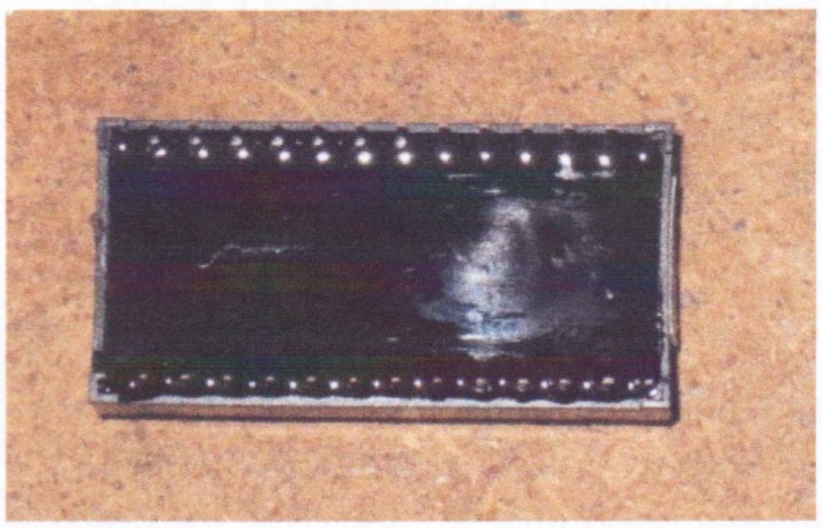
Warning: This modification requires soldering skills and the use of a small rotary tool. Use CAUTION when working around the lithium batteries because puncturing through the case or excessive heat can cause a fire or small explosion. Use eye protection when working directly with the battery.



The DS1216E consists of a twenty-eight pin IC socket with a printed circuit board on the bottom that contains a round 3v battery possibly similar to the CR927 which is 0.37" in diameter and a clock controller integrated circuit probably like the DS1315 chip although the chip on the board is marked with the overall assembly part number. The top side of this chip is readily accessible. The bottom where the battery is located is potted with epoxy.

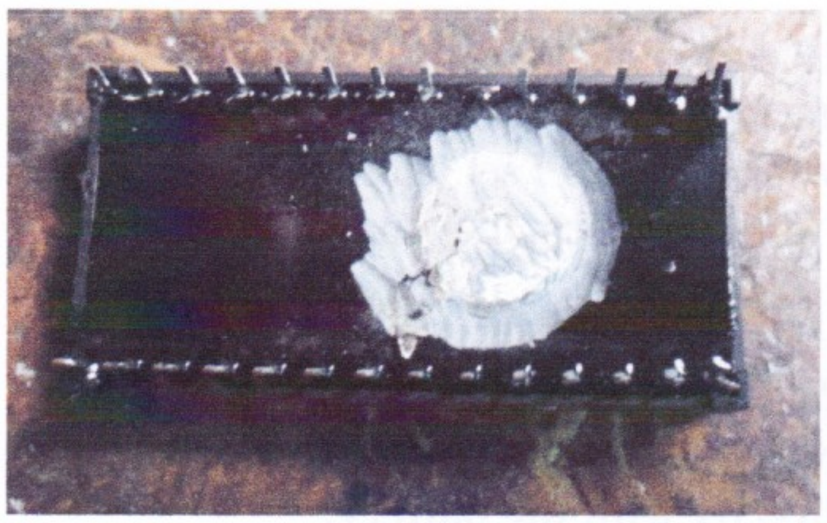
The positive terminal of the battery is connected to pin 4 of the controller via the pc board. The negative terminal is connected to pin 8 or ground. I measured the voltage at pin 4 and it was 0.47 vdc. No wonder it didn't work.

There appeared to be a couple of ways to approach this problem. One, I could rout away the potting and remove the battery and replace it on the bottom. Two, I could cut the BAT1 pin 4 and solder in wires leading to an external battery. I decided I would try option one but ended up with a slightly different version of option two. Note: It is OK to leave one terminal of the battery connected but at least one terminal **must** be disconnected before attempting to connect another battery in the circuit.

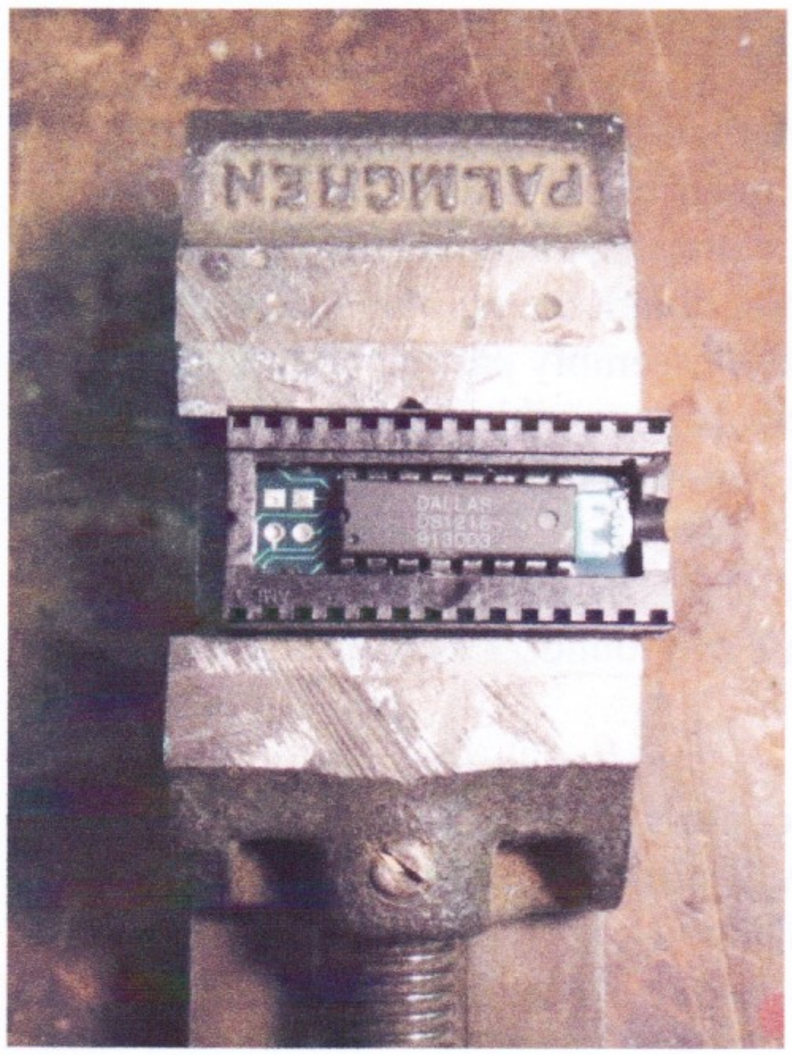


A close examination of the bottom of the DS1216E showed a ghost of the battery and one of its leads. It is difficult to see in this picture but it is there approximately between pins 5 and 23. (Pin 1 is lower right.) I had thought that the battery would be near the other end of the chip but this was not the case.

I began routing with a Rotary Tool and found the battery to be where indicated. What turned out to be the negative lead extends to the seven o'clock position in the photo. A smaller rotary tool router bit would have been better but I didn't have one.



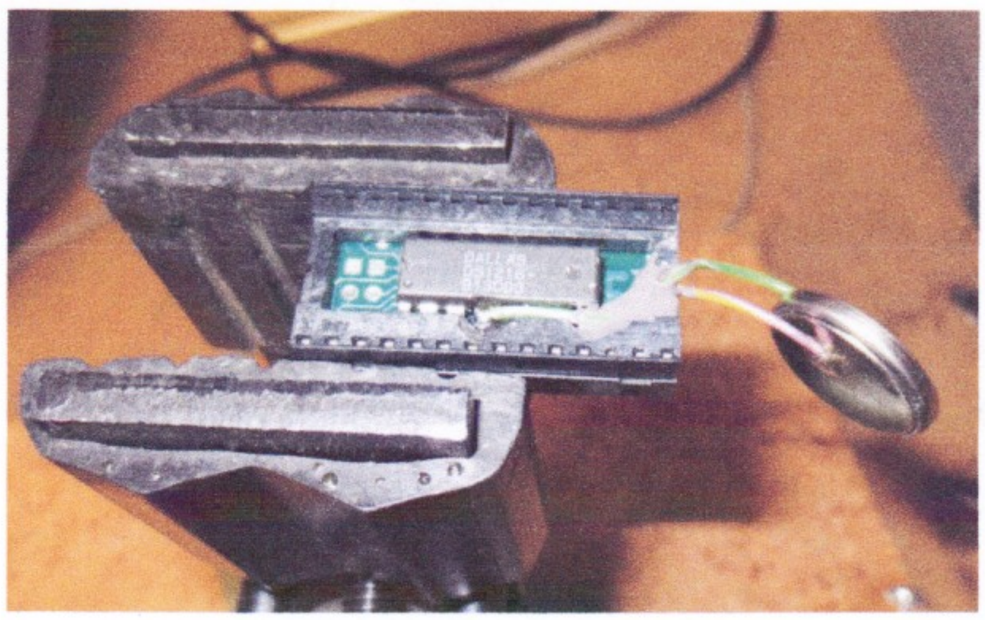
During this process I accidentally cut through the battery negative lead. (I was very careful to not cut through the battery case as I did not want the battery contents to escape.) Be aware it is possible that all DS1216E's are not the same and that the positive lead is the first one you encounter. Cut whichever one you see and proceed. The rest of the description assumes you have cut the negative lead. After thinking about this for a bit I thought why not just leave the battery in place and instead add a couple of wires topside to the clock controller chip BAT1 and GND terminals and keep the battery outboard?



That is what I decided to do. I started by routing beside controller pin 4 (BAT1) and the end of the socket for wire exit under the EPROM when it is plugged into the socket. After I took the photo I also routed beside controller pin 8 (GND). It would have been better to have routed the end of the socket inline with the controller pins 1-8 row but I didn't think of it in time. I routed beside the controller chip in order to gain access to the top of the controller IC pins with a soldering iron. Again, a smaller router bit would have been helpful. Use care to not nick the IC with the router.

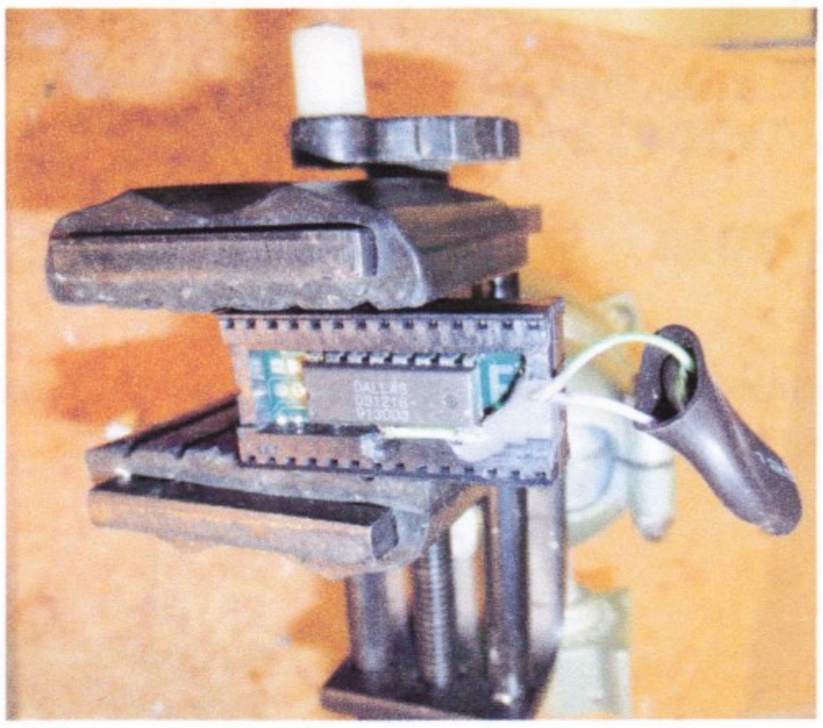
It is not necessary to rout out as much underneath as I did if you don't intend to remove the battery. Just rout enough to cut through the negative battery lead. Verify that it is cut by measuring no continuity from the battery side of the terminal to controller pin 8 (GND). Then measure continuity from the cutoff side of the battery terminal to pin 8.

After routing I soldered wires to the two pins. I used 26GA stranded Teflon covered wire. A smaller gauge would have been better but I couldn't find any. I wanted to use stranded wire to reduce the possibility of fatigue failure. <u>Be careful to get the + side of the battery connected to controller pin 4.</u> I installed the GND wire first, then the + wire as it lays on top of the other one. Then I soldered the wires to a CR2032 3.3v battery. These batteries are easy to find but any 3.0 to 3.3v battery should work fine. It is generally not a good practice to solder directly to any battery but I have done it before. I roughed up the surfaces and then smeared a little rosin flux on before soldering. Try to keep battery heating to a minimum. If you can get a battery with solder tabs spot welded on it would be safer and easier. A local battery supply store may be able to provide this.



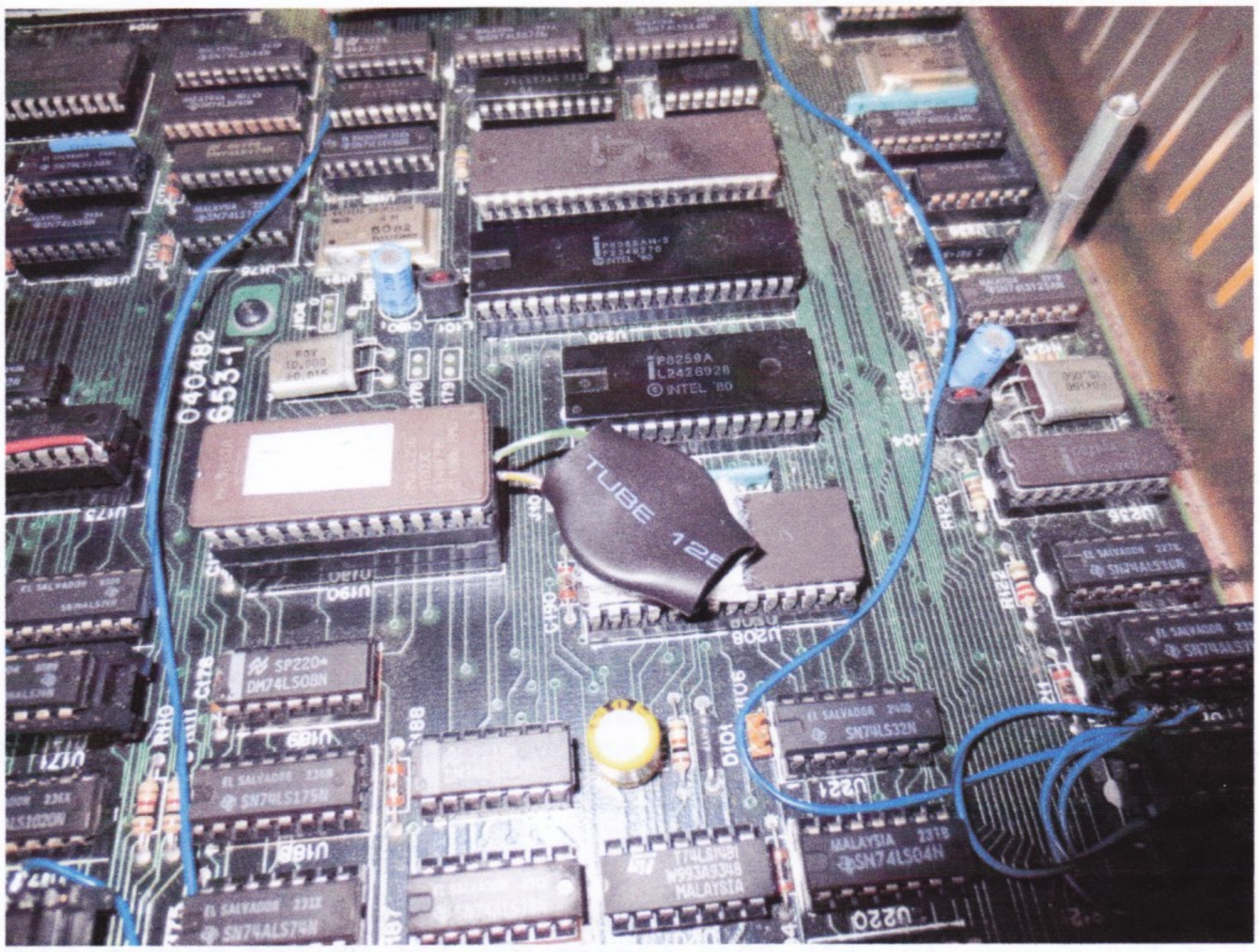
After having everything soldered, I potted the wires in place with JB Weld two part epoxy. Avoid getting epoxy in the socket holes. It might be a good idea to tape over the holes during the potting. Don't ask why I suggest this.

After the epoxy dried about four hours I slipped a short length of 3/4" heat shrink tubing over the battery and shrank it around the battery.



I checked the voltage at controller pin 4 with respect to controller pin 8 and it was +3.2vdc. Pay attention to the polarity here. It could be easy to get it backward. When all was ready, I installed the socket in the Z100 and plugged in the EPROM. Then I accepted a great suggestion from my wife and fastened the battery to the top of an adjacent IC with a couple of small strips of Velcro. For now it seems secure. I don't know what will happen to the self-adhesive of the Velcro over time.

This is how it looks installed in the Z100.



The other wires in the photo are for previous modifications to the Z100 motherboard and are not related to this subject.

I temporarily reinstalled enough hardware to boot to DOS and check the clock function. After resetting the clock with the DSCLOCK software, everything should be running fine. It is assumed the reader has DSCLOCK or similar software and understands how to use it. Reassemble the Z100 and enjoy.

This particular Z100 did not have a NVSRAM with clock on the IDEHD card so another clock solution was required.

Caution: I have since found that there may be 2 batteries in the DS1216E! Please see the Smartwatch update in issue #128. (SW Vagts)