IMMORTALIZING THE DALLAS DS1225 - ANOTHER APPROACH TO THE PROBLEM for 2465B SCOPES.

Dr. H. Holden. Oct. 2024.

Previously, in articles on the Tek 2465B scope I had explained how the DS1225 could be rehabilitated by having an external battery attached. A non-ideal solution due to the extra space it used up and the fact that the internal battery discharged the new battery over a short time.

I also investigated Shadow RAM as an option, however this had power cycling issues, despite having a capacitor to hold charge and allow time for the shadow RAM to operate.

After this I moved to replace the DS1225 with the FM16w08 FRAM. Over the last decade many Tek scope users followed this idea and for the most part, it worked very well. I received a number of emails from Universities and Technical Institutions thanking me for the paper. And it appeared that it saved many 2465B scopes from oblivion.

This is a link to the original article I wrote on the topic 10 years ago:

https://www.worldphaco.com/uploads/TEKTRONIX_2465b_OSCILLOSCOPE_CALIBRATION___REPOWERING_THE_DS1225.pdf

I recently decided to revisit the DS1225 to look at another repair option.

My initial solution using the FRAM as a substitute was more of a solution in Electronics Engineering. Much of the time though, solutions can reside in Mechanical Engineering, though some Electronic Technicians are not as well tooled up to solve problems mechanically.

Which is "better" the DS1225 battery backed up non-volatile SRAM or FM16w08 FRAM ?

The FRAM does have some features that are not as ideal as the BBNVSRAM (that is if the battery wasn't a problem in the Dallas part). However the FRAM is devoid of the battery issues, so it wins on that score.

The FRAM has the potential for memory cell fatigue, as there are a finite number of read-write cycles it can support. And with enough time it will become corrupt. Although the endurance of the part was specified as two orders of magnitude better for the FM16w08 versus the earlier FM1608 product from Ramtron.

Also, in other projects, I have found the read-write timing more difficult for the FM16w08, than standard SRAM.

As a check on my advice to use FMw08 FRAM in the 2465B, I constantly checked the integrity of the calibration file in my daily use Tek 2465B scope over the last 11 years after I fitted the FRAM. Comparing the calibration data in the aging FRAM IC with what was put in the part that I fitted, back in 2013. The calibration data remained intact.

The calibration data can be viewed directly in the scope with the Exerciser 02 option. Or it can be viewed in the actual RAM in the GQ-4x programmer, starting at address 1E00h. Don't be alarmed if you do this and find the first 11 words, or 22 bytes, have changed over time. These bytes alter after a DC Balance is performed from the front panel buttons, so they do not count in checking the integrity of the general calibration data in the rest of the 342 byte (171 word) calibration file.

However, the manual specifies the words in the calibration address zone as being from an address 00 to AAh using the Exerciser (171 words or 342 bytes).

On testing and comparing the Bytes over a decade in the FRAM, the bytes from 1E00h to 1F55h, 342 bytes (excluding the first 11 bytes), remain invariant in the RAM over a decade of use in the scope. Also the bytes from 1F56 to 1FFF remained unchanged too, possibly suggesting that some of the bytes immediately after after the 342 byte boundary are also used as constants, but not alluded to in the manual.

The DS1225, as a non-volatile memory device, appears incredibly resistant to any form of extreme power cycling. I have found it impossible to corrupt its data file even with severe power cycling events. This is due to the separate control IC in the module which negotiates between the +5v power pin and the internal backup battery and prevents writes occurring when the external 5V supply falls below a threshold. However, this is not exactly the case with the FM16w08 FRAM where I have been able, with practical experiments, to corrupt its contents with extreme power cycling.

In practice with the Tek 2465B scope and the FM16w08, a subtle power cycling issue does crop up, despite the calibration constants remaining intact over a decade. Many people who have put the FM16w08 into their 2465B scopes may not have noticed it. However, over the last decade of using my scope, I have.

When the scope is powered down the current scopes button settings and control settings are supposed to remain in RAM. On re-powering on occasions the process has failed in that the scope can come up with different settings, for example a lower or higher CRT beam brightness and the control requires re-adjusting. It is not a severe problem at all, however it speaks for the ability of the original DS1225 to not have an issue around the time of power ups and downs, and specifically at power down, data is reliably saved in RAM.

I ultimately came to the conclusion that the Dallas DS1225 would be the superior part to use in my Tek scopes…. if there was a way to solve their battery problem completely and immortalize them.

In the case of the DS1225 with a discharged internal battery, that battery essentially behaves as a resistor and draws current from any added external battery.

In the cases where I had applied external batteries, for example a 20mm diameter Lithium coin cell attached to the top of the DS1225, I found that larger capacity battery was discharged by the excessive leakage currents from the spent internal battery, within a year or two.

Although the DS1225 is not a rare part at all and there are many on eBay, the problem is that the user/buyer of them has really no idea of the condition of the internal battery. No significant current is drawn from the internal Lithium battery in the application. The battery effectively has its shelf life. Therefore one way to judge is from the IC’s date codes.

Currently all DS1225’s with 90’s date codes have expired batteries, or very close. The battery was guaranteed for 10 years, many still are working at 20 years, very few if any at 30 years of age.

DS1225's with later codes which suggest they are "probably ok" if they are 10 years old or less, are "likely ok" but the question is for how long? However, there are no guarantees and in addition to that, there are a lot of refurbished pulls on the market throwing in more variability.

It would nice to be able to easily and quickly replace the battery in the DS1225 with a known good new one, and that could be done every 10 years to prevent any problems.

Or before the battery has discharged to an unsafe level, to read the DS1225's contents in the GQ-4x (or similar) and re-write them after the battery change. Or simply keep the RAM file as I do for each of my scopes.

One of the things I initially discovered, in dealing with the original DS1225's in Tek scopes, was that at the point the internal battery was discharged to a level where the control IC deactivated the chip, the data in the SRAM chip inside was still actually intact. If a temporary support battery was then added, the DS1225's data content (which includes the scope's calibration data) could be retrieved in a reader such as the GQ-4x.

However, if the battery had deteriorated to a point where the DS1225 was still just working, attempts to read it in the GQ-4x resulted in progressive corruption of the file with each read. The point being that it is better to retrieve the contents of the DS1225, long before the internal battery is in a badly discharged condition.

A very safe time frame is 10 years after manufacture of the part, or not longer than 10 years after a new battery was fitted to an immortalized DS1225.

Of course the CAL file can be recorded manually before the DS1225 fails using the Exerciser 02 function of the scope itself and it can be manually programmed with the aid of a Hex Editor, into a good chip starting at 1E00h in the RAM's file.

Physical Variations of the DS1225:

The 90's date code versions of the DS1225 with expired internal batteries (as every one I have recently tested possesses) have now become my "favourite part" because their internal anatomy lends itself well to immortalizing them.

The reason is that Dallas over the years changed the internal construction of the original DS1225. There are at least three variations.

Initially the part had the control IC mounted on the lower surface, along with the battery, with the battery's negative terminal facing outwards toward the resin surface on the bottom of the IC. The round shape of the battery could just be detected in some cases looking at the black resin. These IC's contained the DIL version of the internal SRAM.

Later when Dallas moved to the SOIC version of the SRAM, the battery was moved to just below the top surface of the IC with the positive terminal facing outwards. In this variation, the top surface of the control IC is not visible on the bottom resin side. And there is another variation with the control IC in a different position on the bottom, unlike the ones shown in this article.

The method outlined in this article is designed for the original early type of the part, with the battery under the lower surface and the control IC in the relative position shown. The method will not work with other variants.

Idea to Immortalize the original DS1225:

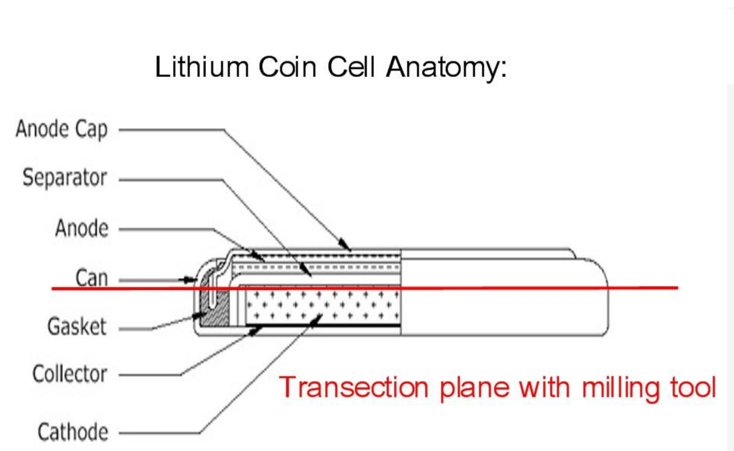
Recently, the thought occurred to me of a better solution for the DS1225.

The idea came about because in the past I had put a “battery inside a battery” to replace a zinc-carbon bias battery in a vintage tube radio. The idea being; have the battery appear original on the outside, but have a new battery on the inside. I decided to investigate doing a similar sort of thing to the DS1225.

Many methods and materials were tried to gain the successful result described in this article. For anyone attempting this, I would advise not to deviate from any of the processes or materials. This modification has been arrived at after a number of experiments and variations on the theme. In this case, things will likely go wrong if the methods and materials are deviated from.

I have arranged it so that no very special tools are required, except for a drill press and some easy to get milling tools and a hand made clamp system. And readily available materials were selected for the task.

Lithium Coin Cell Anatomy:



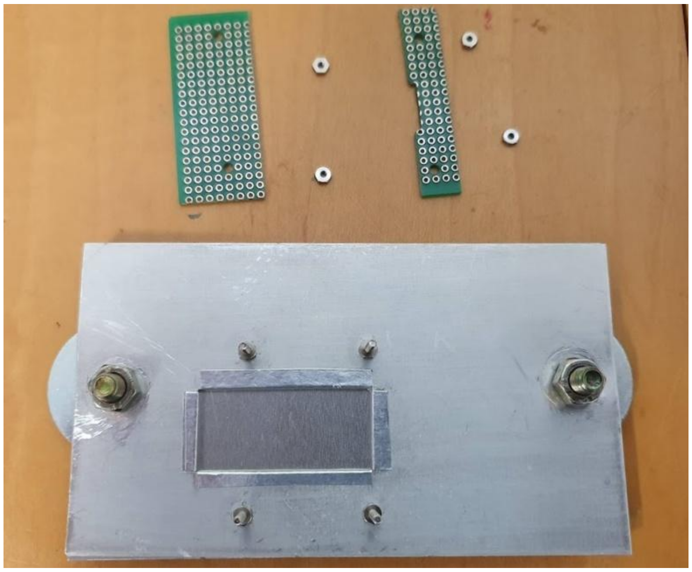
If the battery is transected in the plane shown above this allows cleaning out of the battery contents leaving the battery's lower casing (the positive terminal) intact to act as a carrier for a replacement battery. The remaining part of the anode cap's ring and its insulation also needs to be removed.

This is done by initially marking out the central axis for a milling tool to plane the top (negative terminal) off the battery. This does not need a milling machine and is easily done in a drill press, provided the DS1225 is clamped into an anti-rotation plate.

It is required that a plate is made with a rectangular hole that perfectly fits the DS1225 with little clearance. This can be bolted to the stage on a standard drill press. This is so the body of the DS1225 cannot rotate with application of the milling tool. I found it best to hold the DS1225 down with some strips of pcb material, rather than attempting to hold it down by hand.

The anti-rotation plate is composed of two sheets of aluminium, the bottom one is a plain plate. The only important dimension is the rectangular hole to just fit the DS1225 so that there is little movement. I used 2mm x 15mm CS head type screws, but any size within reason, 4-40 UNC or 3mm would be fine, provide they align with the holes in the pcb material and the holes in the pcb material enlarged to accommodate them.

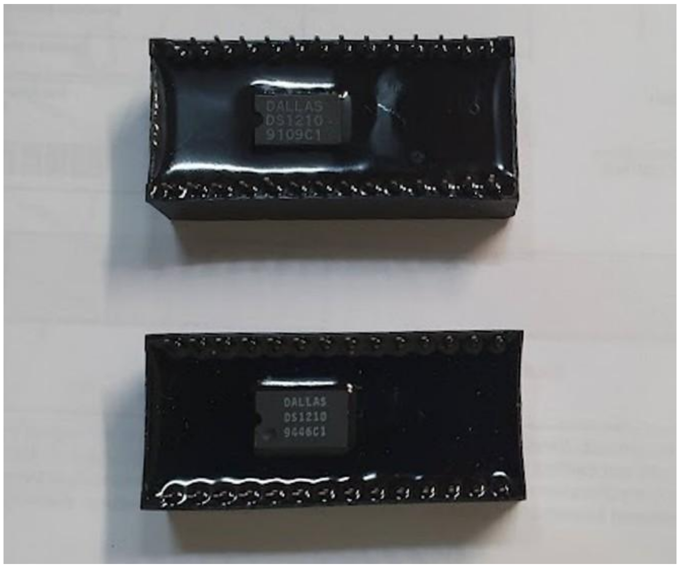
In my first plate I filed out the hole a little too large, but I simply shimmed it with some aluminium tape:

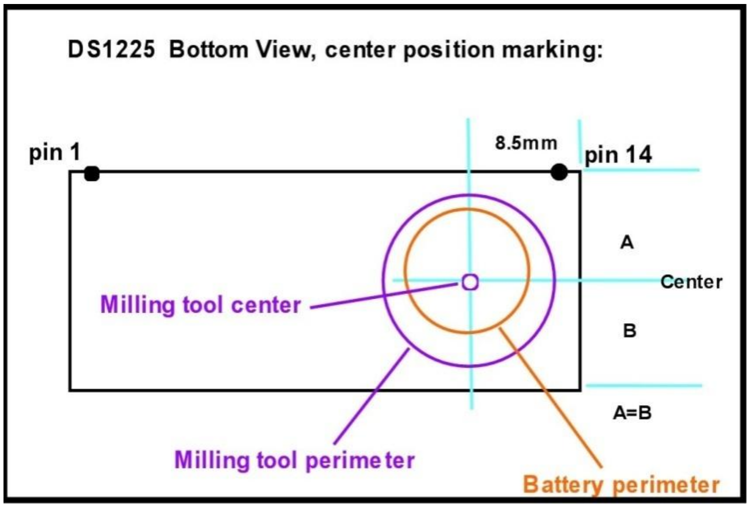


The DS1225 specimen is held down by some pcb material as shown, the nuts are simply tightened up enough to see the pcb material bend a little. The Milling tools provide insignificant upward force (unlike a drill) the main point being that the DS1225 is prevented from rotating and vibrating.

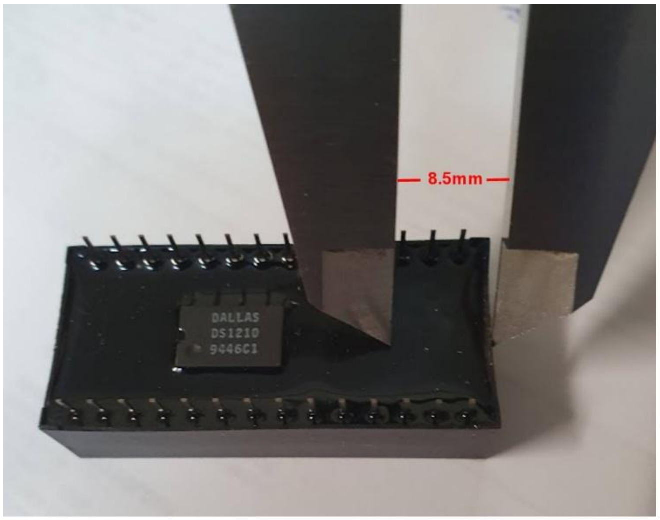
The centre is initially marked on the base of the DS1225, in the resin above the battery. Then a small countersink made with a 1.5mm drill. The position is aligned with the countersink and a small drill in the chuck of the drill press. After the position is set, the aluminium anti-rotation plate is bolted down very tightly to make sure that the plate cannot rotate. It pays to position the shafts of the bolts so they are up against the sides of the cut-outs in the stage (platform) of the drill press, to assist in the prevention of clockwise rotation of the plate.

The picture below shows the correct version of the RAM to be modified:





Firstly the positions of the milling tool centres are marked.



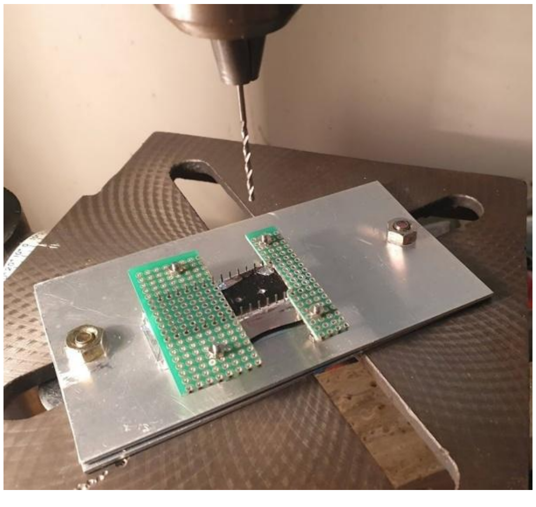
There is variability in the width, so it is measured and then the callipers reset to half the value found

To complete the task the required milling tools are a 2mm diameter, a 3/8” and a 12 mm diameter tool, all readily available on ebay. Don’t be temped to substitute any other sizes. For example, due to the variability of the exact battery position, and the internal anatomy of the battery, going from a 3/8 to 10mm size causes trouble.

Even though the battery is not exactly on centre, the 12mm milling tool must be, so as to avoid the pins on either side.

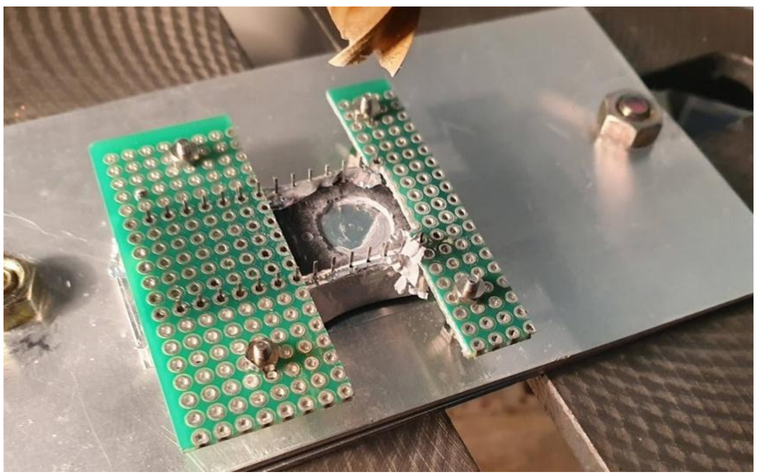
The holes are then marked so that the centre can be checked on the drill press before the anti-rotation plate is tightened and the milling tool is fitted to the Chuck.

The DS1225 undergoing the process has some aluminium foil attached over its pins, because it is being handled a lot and electrostatic discharge is a risk to the SRAM IC in it.

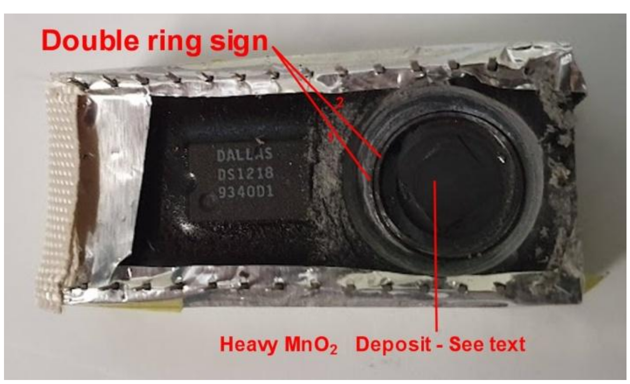


The plate and the drill stage on it are moved around until the drill in the chuck matches the position of the small countersinks in the resin. No drilling is done with this drill, it is for alignment only.

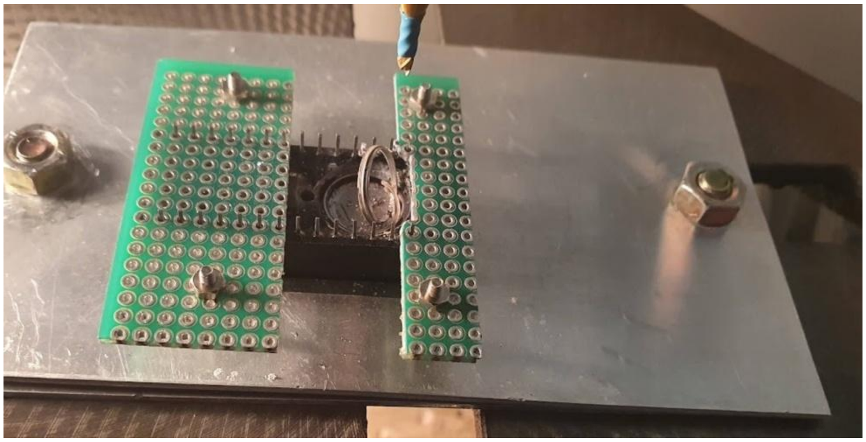
The 3/8 milling tool is then used to start milling into the battery. The resin over is removed first then it is a matter of taking it very slowly to mill through the battery's negative terminal. If it is done very fast it can heat up and the battery contents combust with a violet flame.



Once the top is milled through, there is a terrible stink. It pays then to remove the battery contents. Then change to the 12mm diameter tool and mill down until a double ring is seen. This represents the remains of the negative terminal inside the outer shell of the positive terminal.

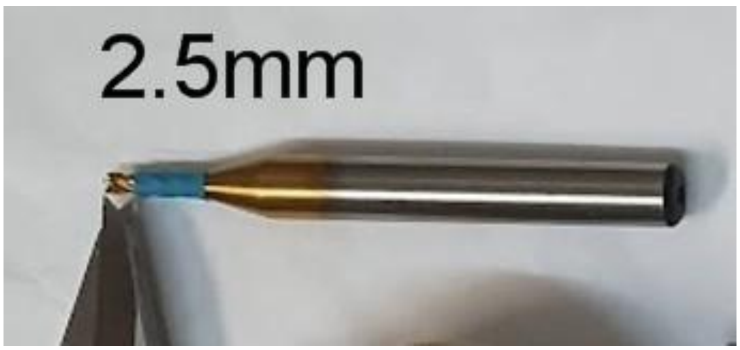


The inner ring needs to be removed because the internal diameter is either the same size or in some cases smaller than the donor battery at 10mm. Note: the inner metal ring cannot be removed by prizing it out, it must be split first. To do this the side of the 2mm tool is used to split the ring and just not quite tough the battery's positive outer shell. As soon as the metal ring is cut, it usually just jumps straight out of the shell:



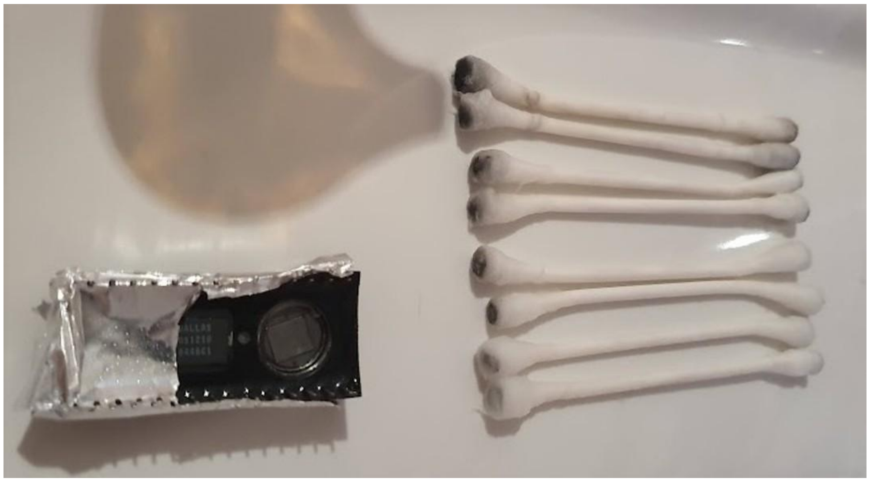
The Hole for a 2mm brass bush can then be made again aligning the centre with a small drill and using the 2mm milling tool.

Of note, the particular drill press might not be very accurate in advancing a tool or a drill to some specific depth. And it is important that the hole for the 2mm diameter Brass bush is not inserted more than 2.5mm below the resin's surface (which in the location the surface is close to 0.5mm below that of the control IC's top surface) it is better to apply coloured Heat shrink sleeve to the 2mm tool, so it is easy to see the depth, especially with a close up view with magnifying glasses and bright light while the tool is being advanced into the resin.



A very dark deposit will be found in the base of the battery's casing over the Collector Electrode. This electrode is spot welded with two welds to the battery casing (positive terminal) It is important therefore that the 3/8 tool, when it is used, is not advanced too far into the battery body or it can engage the electrode and tear it off. It is better left there, due to the thickness of the replacement battery.

The deposits on the Collector electrode, resembles Carbon physically, but it is Manganese Dioxide. It is completely insoluble in IPA and contact cleaners of any type. The way to remove it is with a stream of running water and a combination of tooth picks for the edges of the rectangular collector electrode and cue tips. It must be cleaned until no more black material appears on the cue tip. After that it can be sprayed with contact cleaner to displace the water.



When the DS1225 is prepared with the battery cleaned out and the 2mm diameter 2.5mm depth hole made, the brass insert can then be glued in.

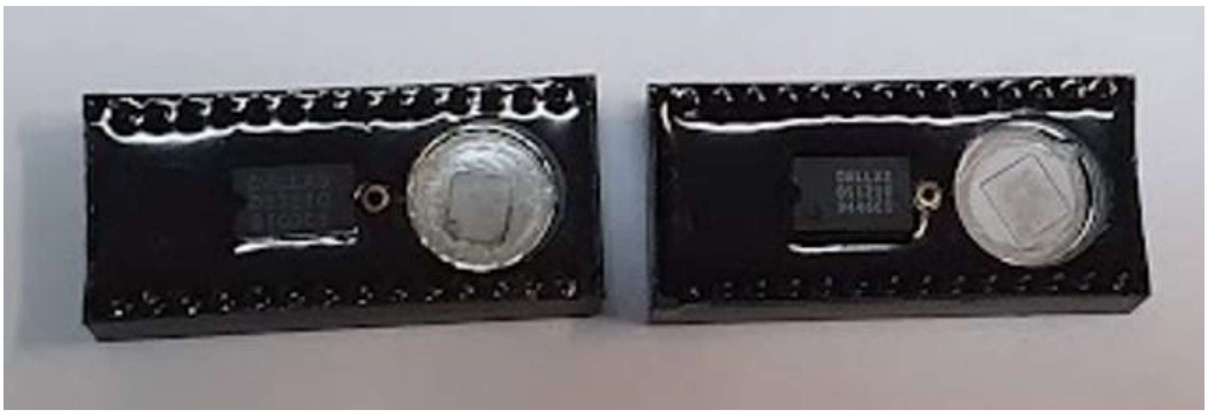
The only suitable glue for this application is 24Hr setting two part epoxy resin. Don’t use 5 minute resin, it is too soft. In Australia the product we used is clear and called Araldite, made by Sellys. In the USA the choices are more limited. The closest product is JB Weld of the 24 Hr variety.

To perform the gluing it is required that the inside of the hole is coated with glue and that glue is applied to the outside of the brass insert too. Prior to this the lubricated screw must be put into the insert to prevent glue entering the screw threads. However, the screw must be surface lubricated, or it is not possible to remove it after the glue cures.

The screws are sprayed with Inox’s MX-3 then placed on a tissue to remove the bulk of the lubricant:

The screws are then fitted to the brass insert and the insert & screw placed in the hole after coating the Brass insert's external surface with more glue. After it is fitted, the residual glue is wiped off with cue tips.

This must be left for 24 Hrs then the screw can be removed, leaving the brass insert in place. Don't be temped to think you can get away without the brass inserts. The resin is not suited to support threads.



New battery sitting in the cleaned out shell of original battery:

Required Battery Contacts:

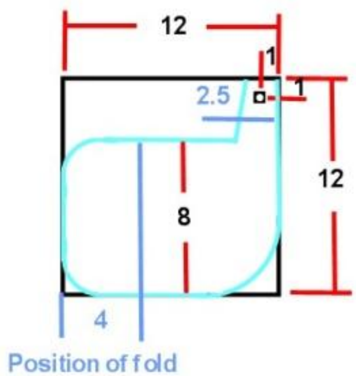
The Brass material to make the battery contacts is readily available. It is made by K & S metals and stocked in many hobby stores and is on Aliexpress & eBay.

The two thicknesses required are 0.005” and 0.016”. One major advantage of the 0.005 shim Brass is that it is easily cut with scissors, but still possible to drill well, which becomes more difficult with thinner shim brass.

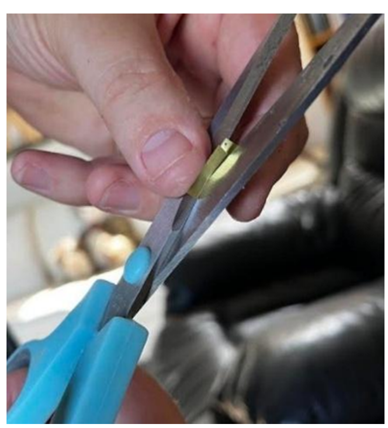
I made a batch of battery contacts to make five immortalized DS1225’s. To make the thin spring contact, start with 12 x 12mm squares and make the corner (0.5mm diameter) hole first:

K & S Metals 0.005” Shim Brass

0.5mm diameter corner hole



Shape cut out with Scissors.



The second required piece is merely a strip of 0.016” thick Brass with a hole for the screw:

Some small low angle bends are placed in the battery’s terminals as shown in the photo.

One issue with brass, it tends to be fairly reactive and tarnishes over time. One solution would be Gold or Nickel plating at the electroplater. I elected to use a product popular with the British for Tea Post restoration. The solution is rubbed on with cue tips and Silver plates the Brass without the requirement of an electric field. It is available on ebay.

The metal parts after silver plating:

The Brass Insert & Retaining Screw:

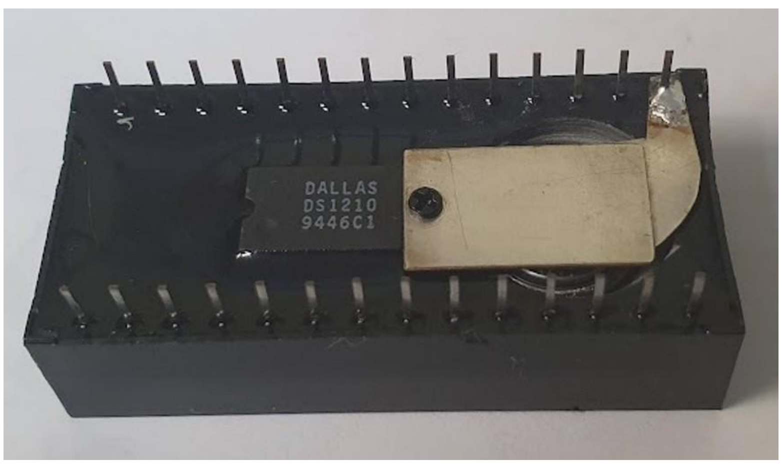
A closer view of the brass insert:

It is important that the hole depth, below the resin surface does not exceed 3mm under any circumstance, because the pcb inside the unit sits at about 4mm below the top surface of the control IC, which sits proud of the resin surface by about 0.5mm.

Therefore a hole depth, below the resin surface of 2.5mm has its base about 1mm away from the pcb surface inside the module. This is satisfactory clearance. If the pcb surface is drilled into, there are tracks there and it destroys the module.

Soldering the negative battery clip:

The battery clip is placed over the pin and the plate screwed down with the battery in the “carrier”

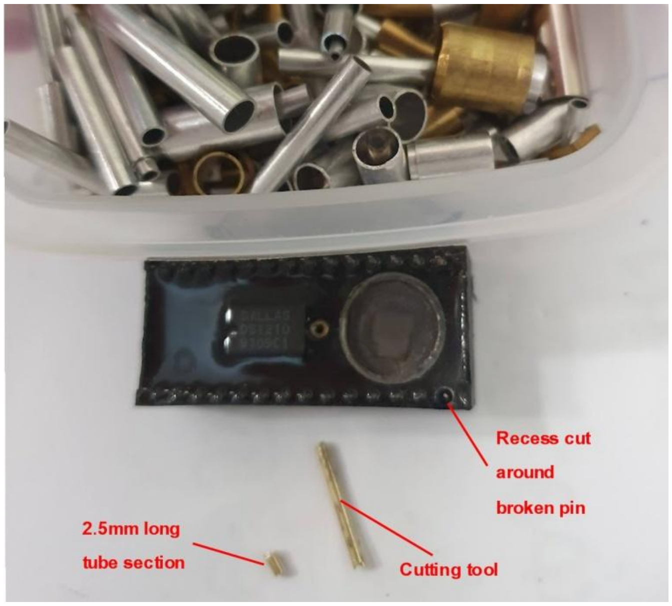


****

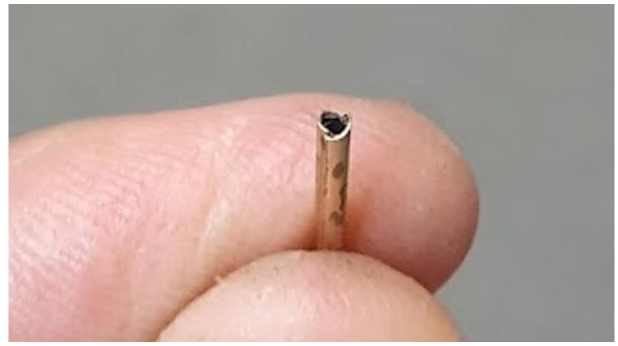
Repairing broken DS1225 pins:

One of the DS1225's I was sent by an ebay seller had a defective pin. It had obviously been bent over in the past and straightened out, perhaps more than once. With the lightest touch it broke off parallel with the resin surface.

Rather than throwing it away, I used a method I have used in the past. A small section of Brass tubing about 1.5mm diameter with a 1mm central hole, was modified. I have a box of various Aluminium & Brass tube scrap off-cuts that come in handy for various repairs, making brass Ferrules for example.

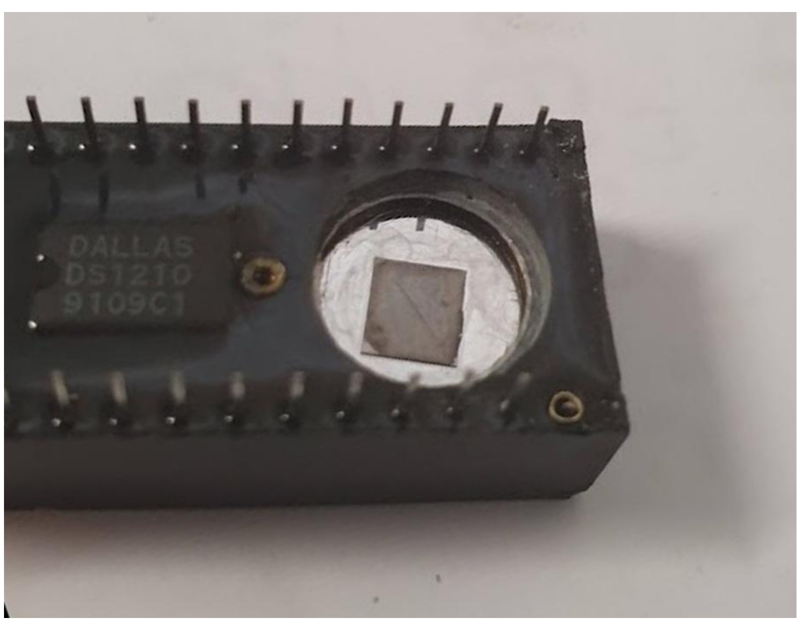


Simple hand made tool:



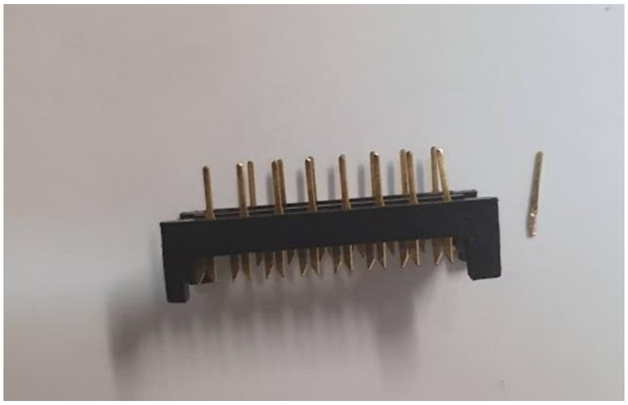
I hand flied some tapers on the end of the tube to make it sharp using a diamond file. Then in the drill press ran it over the broken pin to create a cylindrical recess in the resin around the pin of close to 2.5mm depth. This sort of tool removes the resin from around the pin, leaving the pin alone.

Then another piece of the same material as cut to a length of 2.5 mm, then dropped over the pin into the hole (no glue is used).



Once the short section of tube is placed around the broken pin, a donor pin can be added. It is important that the donor pin has the same geometry as the one you are replacing. In this case close to 0.26 x 0.48mm. I found some pins on a plug assembly extracted one and cut it down to make a donor pin.

:



The pin is then slipped into the hole inside the section of Brass tube, adjacent to the broken pin, and soldered. This is the better way to repair a broken pin on a DS1225:

****