

HP48 Repairs

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Introduction

There are several problems which typically occur in the late years of an HP48. The two most common problems are missing pixels (not just one or two but rows and/or columns of pixels) and non-responsive keys. This guide will attempt to explain how one might go about repairing an HP48 with these problems. It will also explain how to replace an LCD screen.

If you intend to do any repairs yourself, please understand that you can possibly render your HP48 useless or break components that are crucial to the internal structural integrity of the calculator. You can have your HP48 repaired by Randy at <http://www.fixthatcalc.com>. I have never had any repairs done by fixthatcalc.com nor do I have any affiliation with the site. However, I have heard only great feedback from people who sent their calculators in for repair and posted their experiences at <http://www.hpmuseum.org>.

On the other hand, if you prefer to do things yourself, please bear in mind that I take no responsibility for any damage you cause to the HP48 or to yourself. In order to do any repairs, you will have to open up the HP48. These units were never designed to be opened up. However it is still possible to open them with little to no cosmetic and structural damage. You learn how to do so by visiting:

URL to Opening the HP48: <http://users.ju.edu/hduong/open>

As an example, below is a photo of an HP48SX with a faulty screen. This unit has serial number 3039A02014. A few columns of pixels do not light up properly, and all the annunciators appear to be one. Upon further inspection, it turns out that when any of the annunciators are supposed to be on, then all annunciators appear to darken. When no annunciator should be on, all appear to be less dark, but still on. The screen also appears to have a darker upper half; however this is due to the slow refresh rate relative to the speed of the camera. This is a normal effect, similar to that of computer monitors when shown on T.V.



Faulty LCD

Diagnosis

Below are some symptoms, what they may mean, and how one might possibly fix the problems.

- **Problem:** Missing rows and/or columns of pixels, a pronounced black spot on the upper left hand corner of the display, or some/all of the annunciators always being on

Cause: If you press on the bezel just below the LCD or just above the LCD and the missing rows and/or columns of pixels seem to reappear (even if very faintly), then the likely cause is dust or a small gap in between the LCD connectors and the printed circuit board (PCB). If light pressure on the bezel does nothing, and your unit is an HP48SX whose serial number ranges from 3013AXXXXX through 3044AXXXXX, then there is a chance that you simply have a defective LCD screen. Symptoms of the problem are a pronounced black spot in the upper left hand corner of the display and/or dark/missing columns 3,5,7 and/or 9. HP used to replace these units even when out of warranty.

Fix: If it is a connector problem, the fix may be as simple as cleaning the contact areas and tightening the PCB to the connectors. If the problem is a defective LCD, the LCD screen will need replacement. In the HP48S/SX calculators, if there is presence of battery corrosion, there is a small chance the problems are beyond repair unless you have it fixed professionally (more on that later).

- **Problem:** Rows and/or columns of keys do not appear to be working.

Cause: If you press on the bezel just below the LCD and the keys which did not respond before start to work again, then the cause is likely a gap between the keyboard connector and the PCB.

Fix: If it is a connector problem, the fix may be as simple as cleaning the contact areas and tightening the PCB to the connectors. In the HP48S/SX calculators, if there is presence of battery corrosion, there is a small chance the problems are beyond repair unless you have it fixed professionally. If the nonworking key is isolated (i.e. all other keys within its row or column work fine), then that key may not be repairable (more on that later).

LCD and Keyboard Basics

The photos below show an HP48G and an HP48SX (serial number 3039A02014) opened and the PCB removed from the keyboard half. There are six twist-tabs which hold the PCB in place. Three are just above the LCD screen; three are just below the screen.



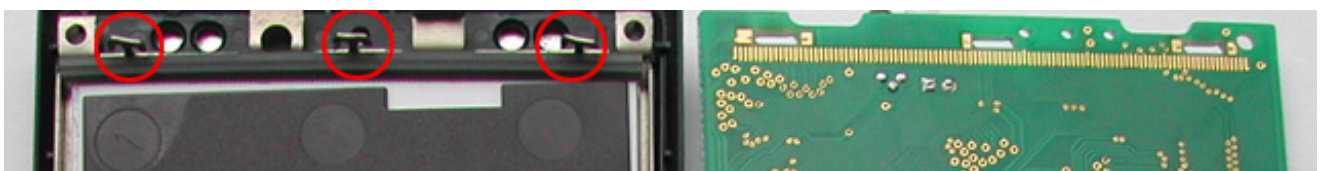
HP48SX (1)

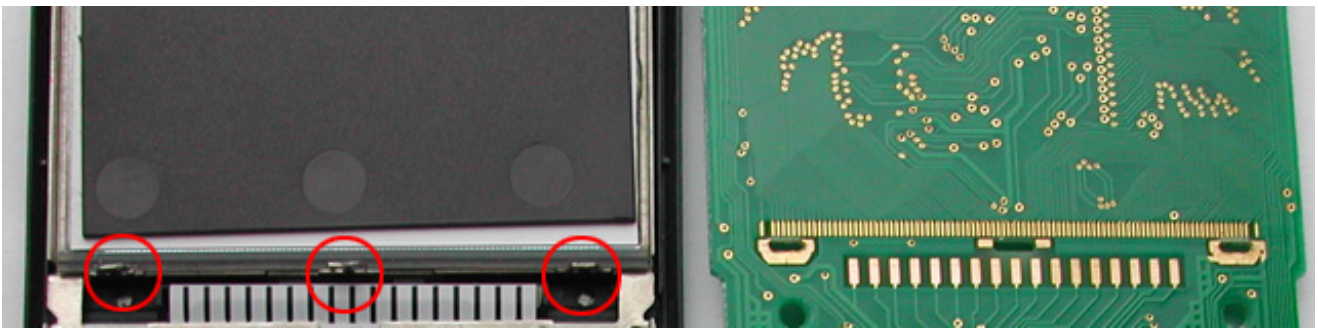


HP48SX (2)

The Six Twist Tabs

To remove the PCB from the keyboard layer, you will need a pair of needlenose pliers. If possible, use a pair with no teeth so that you do not warp the tabs. The tabs resemble a "T" and are not all twisted in the same direction. The top three are twisted in the same direction. The bottom three should be twisted in the opposite direction. Simply use the pliers to return the tabs to the untwisted position. While doing so, you may want to also move the pliers closer to the PCB so as to simultaneously straighten the tips. **Be careful!** The HP48S/SX PCBs are NOT silkscreened. So if your pliers happen to scrape against a trace on the PCB, you could disconnect some circuitry! The HP48G/G+/GX calculators have a silkscreened PCB. However you should still use care when undoing the tabs. Once all six tabs are lined up so that the PCB can come right off, press down on the tabs while pulling up on the PCB near the tab to slowly remove the PCB. Again, be careful that you do not scrape the traces when working with the HP48S/SX PCB! After removing the PCB, use the pliers to straighten out the tabs so that when you put the PCB back later on, they will not scrape the insertion points and cause PCB dust to fall onto the LCD or keyboard connectors.



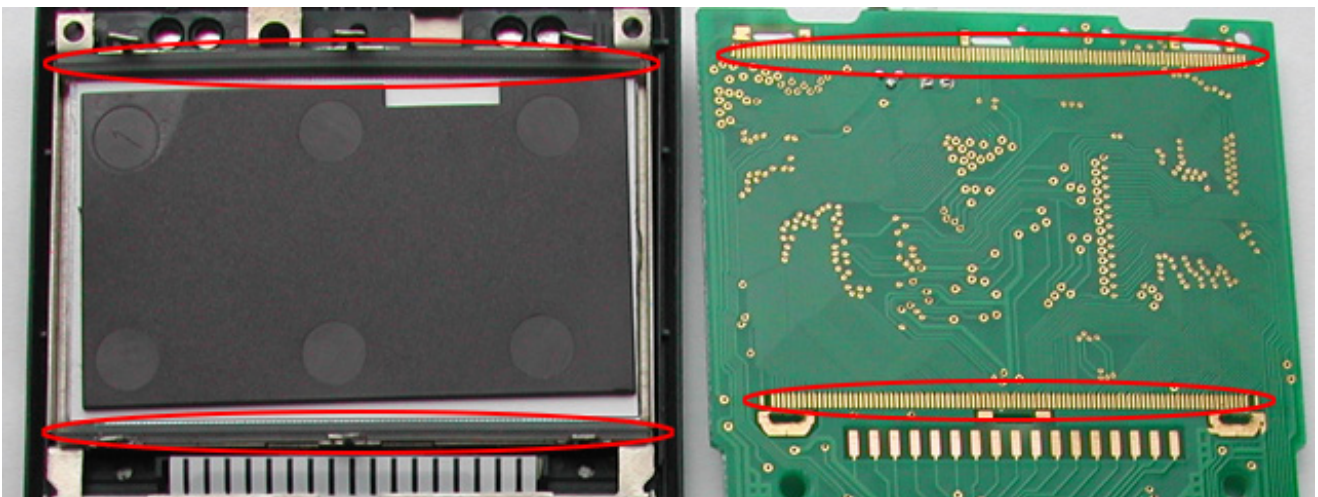


Six Twist Tabs

WARNING: You should keep to a minimum the number of times you twist and untwist the six tabs that hold the PCB to the keyboard layer as these will eventually break. Once even a single tab breaks, you will NOT be able to fix it. And the pixel/keyboard problems could possibly be worse than before. So make sure you know what you are doing.

The Connectors

Notice in the picture below how the LCD connectors (circled in red) near the top are very close to the IR and serial ports. It is not too hard to imagine how dust can get in via the serial port opening and lodge in between the rubber-like material that attaches to the LCD and the connector pads on the PCB.



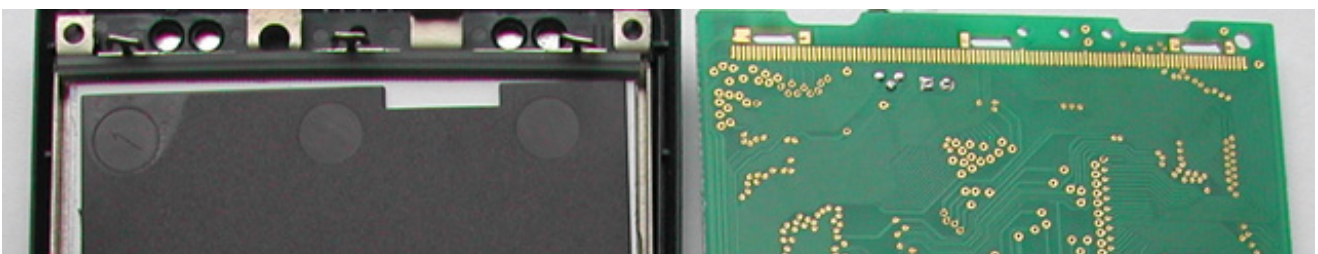
HP48G LCD Connectors

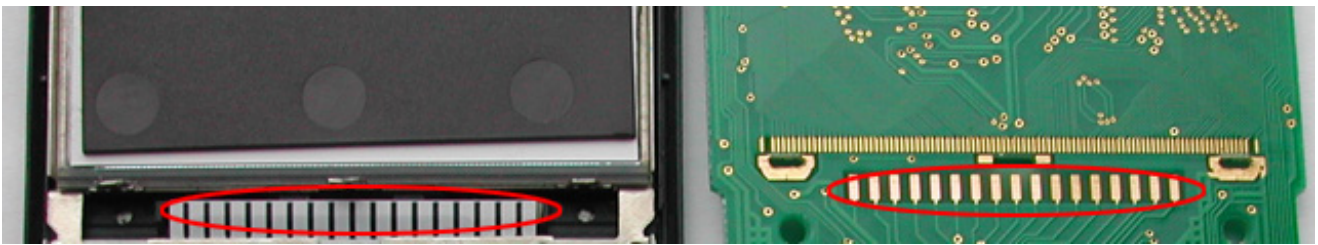
Not all LCD problems are the result of dirty contacts. In fact, there were a batch of LCDs in the SX units which had defective LCDs. Over time, several columns on the left hand side would no longer function, among other issues. According to a post from comp.sys.hp48

There was a specific problem that may or may not occur in a limited production of units. The problem has been isolated to the LCD and has been resolved with the vendor. The potentially defective LCD's were installed in HP 48's with serial numbers ranging 3013AXXXXX thru 3044AXXXXX. Symptoms of the problem are a pronounced black spot in the upper left hand corner of the display and/or dark/missing columns 3,5,7 and/or 9.

If a unit is failing for the above reasons, subject to verification by the Corvallis Service Center, it will be covered as part of the standard warranty, even if the standard warranty period has expired.

[Click here](http://comp.sys.hp48) to read the entire post on comp.sys.hp48.





HP48G Keyboard Connectors

In the photo above, the keyboard connectors are circled in red. On the left you can see the contact points. Underneath is a small piece of rubber-like material which is supposed to push the contact points against the PCB connectors. This piece (shown below) can decay over the years, or become overcompressed. The result is a gap between the PCB and the keyboard contacts. It is also possible that in the expandable modules, overuse of the card slots could lead to LCD or keyboard problems. RAM and ROM cards connect to the PCB via the card connector. When you pull the card out of the slot, you are lifting up (ever-so-slightly) on the card connector. The three tabs below the CPU eventually loosen up and then either dust or an air gap forms in between the PCB and the contacts from the keyboard layer. This is why the keyboard problems occur more often in the expandable series (at least in my experience, I have noticed far more expandable models with nonresponsive keys).

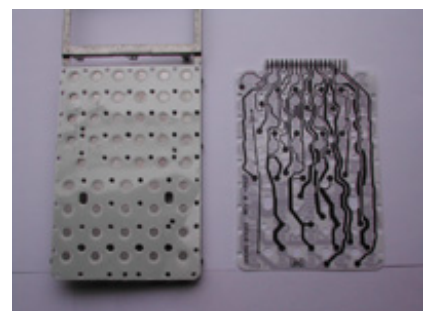
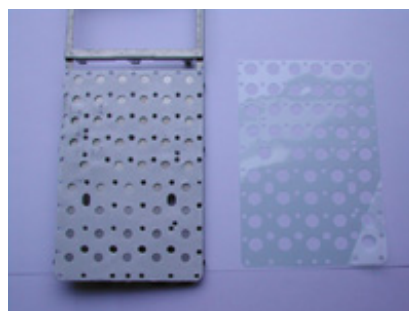


Rubber Under Keyboard Contacts

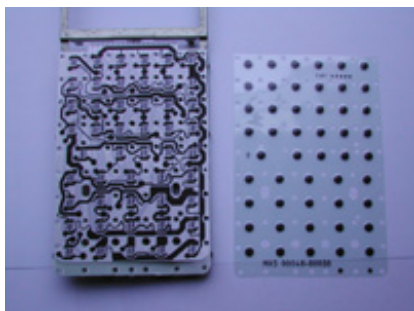
Note how there are 17 contacts for the keyboard. One is for the Vbat signal. One is specifically for the ON key. The remaining fifteen are dedicated to the row and columns (not exactly the typical definition of a column) of the keyboard. Thus, if a single contact does not function, you are likely to lose an entire row or column of keys. On the other hand, if a single key does not function properly, then it is unlikely a problem with the connectors. Instead, you may have problems within the keyboard. When you press on the bezel below the LCD, you are essentially pressing the keyboard contacts onto the PCB connectors. This is why nonresponsive rows and/or columns of keys may become active again.

HP48 Keyboard Anatomy

If the nonresponsive keys cannot be fixed by cleaning the contact points or tightening the PCB to the keyboard layer, then it is unlikely the keys can be fixed at all (unless the entire keyboard layer is replaced). The keys are all attached to a layer of plastic, on top of which the metal overlay is placed. On the opposite side is a metal plate, to which the PCB is attached. And sandwiched in between the plastic layer and the metal plate is the circuitry for each key. The metal plate is then heat-staked onto the plastic layer via a large collection of rivets. So in order to get to a single key, one would essentially have to destroy the rivets holding everything together. Below are photos of the various layers within the keyboard. This setup is essentially the same for the entire HP48 family. There may have been a few modifications over time, but the general design remains the same. In fact, the keyboards are interchangeable; you can use an HP48S/SX keyboard with an HP48G/G+/GX motherboard!



Layer 1: Paper



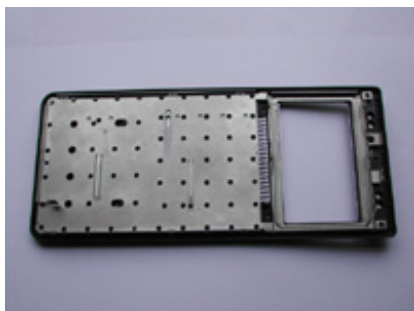
Layer 2: Plastic



Layer 3: Circuit



Layer 4: Key Domes



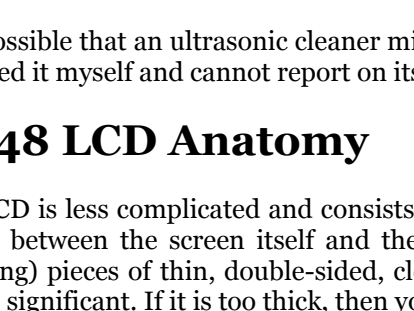
Assembled Layers



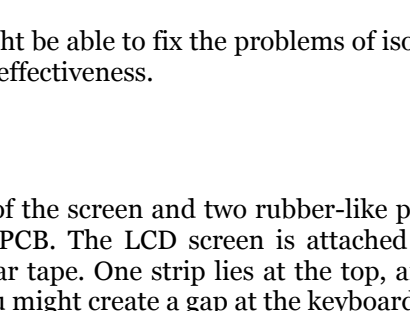
Back Side of Keyboard



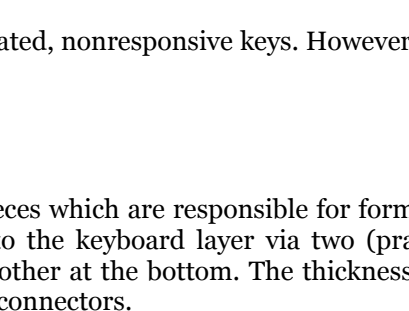
Keyboard Assembled



LCD Attached



LCD Connectors



It is possible that an ultrasonic cleaner might be able to fix the problems of isolated, nonresponsive keys. However, I have not tried it myself and cannot report on its effectiveness.

HP48 LCD Anatomy

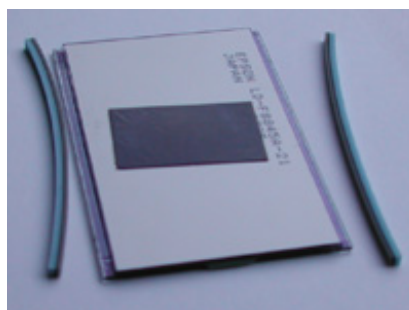
The LCD is less complicated and consists of the screen and two rubber-like pieces which are responsible for forming the circuit between the screen itself and the PCB. The LCD screen is attached to the keyboard layer via two (practically speaking) pieces of thin, double-sided, clear tape. One strip lies at the top, another at the bottom. The thickness of this tape is significant. If it is too thick, then you might create a gap at the keyboard connectors.



LCD: Front



LCD: Side



LCD: Back & Connectors

To remove the LCD screen, first hold the keyboard layer so that front of the LCD is facing down. **Take note of the orientation of the strips. Some have two different colors whereas others are more difficult to discern how they are oriented.** Nevertheless, a magnifying glass will reveal the spots where the three metal tabs come into contact with these strips. Use this to help you correctly orient the strips during a repair. Use both hands and place your thumbs up

underneath the front of the LCD near the edges. Your index fingers should be on the metal plate that houses the LCD. Now, simply use **VERY LIGHT** pressure near the edge of the LCD to press the LCD up and out of the metal plate while using your index fingers to press down on the metal plate. Go slowly and work with the top of the LCD (near the IR and serial ports) first. Then move along to the two sides. Have patience and eventually the screen will come out. **If you use too much pressure, you will bruise the screen. The effect will be spots on the screen where pixels appear darker than surrounding pixels.** Make sure that you keep the two rubber-like pieces together with the LCD screen. If you carefully examine the screen, you will notice that where the connectors are is a step-like indentation for these two rubber pieces. Since not all LCD screens are the same, the depth of the steps can vary. This is why it is important to keep the two rubber pieces together with the screen.

Making the Repairs

Before I describe the repairs, let me remind you of the possibility of completely ruining your HP48 if you are not familiar

with the internals. There are folks who can do the repairs for you, and they even have custom hardware for such repairs (www.fixthatcalc.com). So please do not attempt to make the repairs if you are not sure you can do it correctly.

Keyboard Repair

There are several things you can try. If it is clear that the connectors are dirty, try cleaning them. Use a lint-free cloth and alcohol to clean the contacts. If it is clear that the rubber piece underneath the contacts has been overcompressed, or has decayed, you can try to use a business card and cut a thin strip to place underneath the contacts. This should help press the contacts against the PCB once you put the PCB back into place. Of course, a piece of rubber of equivalent thickness would work as well. You may even want to try cutting up a thick piece of rubber band and see how it goes. The last step is to make sure that the PCB is tightly put back into place (more on that below).

As mentioned earlier, the HP48S/SX calculators do not have a silkscreened PCB. Hence, if there is corrosion in the battery compartment, there is also a good chance the corrosion has spread to the PCB. This is very likely especially if the calculator was left face-down during the corrosion process as the corrosive elements may have leaked also onto the keyboard curcuitry beneath the metal plate. Sometimes it is still possible to make the repairs. If corrosion has eroded away any of the traces on the PCB, you may be able to rewire the traces and connect them. Of course, a fine-tip 15 Watt solder iron will be needed. I will not get into the details of how to do such repairs. You can alternatively have the repairs done professionally (<http://www.circuittechctr.com/>).

LCD Repair

If the LCD does not need replacing, the only thing you should have to do is to make sure the contact points are clean. Again, a lint-free cloth and alcohol should do. I personally use a product called "klear screen" (for the purpose of cleaning laptop LCDs). It is highly unlikely that you should have to remove the two LCD strips and clean underneath them. However, if all else fails, this may just be the solution. The last step is to make sure that the PCB is tightly put back into place (more on that below).

If you need to replace the LCD screen, you will need a replacement screen along with the two LCD strips (again, it may be the case that these strips are NOT interchangeable). Make sure that you are working in a dust-free environment! First, clean the connector strips on the LCD screen as well as the two rubber strips. Then clean the surface within the LCD housing area and replace the double-sided tape if necessary. Place the LCD screen face down. If examine the sides of the LCD screen, one side should have a slight bump to indicate the correction orientation of the screen. If you are looking at the back of the screen, the bump should be to the right side. Alternatively, you can hold up the screen at an angle and see where the annunciators are supposed to be and use that to correctly orient the screen. Once the LCD screen is in place, place in the two rubber strips and make sure that they are in the correct orientation (see further above). I am not sure if this makes a difference, but it is better to be safe than sorry. I personally have always placed them the way they appear prior to removal.

Tightening the PCB Back into Place

This requires a skilled and steady hand. But before we get to this, now would be a good time to check whether or not some extra electrical tape is needed. Just underneath the positive battery terminal (on the metal plate of the more recent HP48 calculators) should be a piece of thin cushion that prevents the metal clip (bottom side of the PCB) from coming into contact with the metal plate. The HP48 keyboard was designed to have a few plastic columns that held the PCB away from the metal plate, but one cannot be too sure that this is sufficient (why else would they add the cushion in later units). So place some electrical tape on the metal plate where this metal clip would be to prevent any shorts from occurring. Just make sure you do not block a rivet hole that is very nearby!

And now onto the PCB itself. First, we need to place the PCB back into position. However, do NOT just plop the PCB over the six tabs. The tabs, even when straightened, could possibly scrape the inside of the insertion holes. The resulting PCB dust could then fall back onto the LCD strips and leave rows/columns of missing pixels. So the idea is to essentially hold the PCB just above the six tabs, then hold the entire keyboard and PCB assembly above your head (so that the PCB is closest to the ground and the LCD screen is facing the sky) and *then* press the PCB onto the keyboard layer. Any dust from the tabs scraping the PCB's insertion holes should fall to the ground. Then put everything back on a flat surface and twist the six tabs back to their original positions. The key here is to hold your needlenose pliers as close to the PCB as possible. Press the PCB down while twisting the tabs so that you do not have air gaps in between the LCD and/or keyboard connectors.

For your viewing pleasure, here is the final result of the HP48SX mentioned earlier.





Repaired HP48SX
(with black LCD)

Final Comments

Hopefully all went well. I can do this in one shot, but only because I have had a lot of practice. I had an HP48SX that had battery corrosion. Parts of the CPU (!?) had corroded to the point where professional repairs would have cost more than buying another unit. So I was free to make as many mistakes as I pleased. I also had an HP48G and HP48GX that I obtained in extremely poor condition (one had glue squeezed underneath the keys and the other had a damaged LCD and broken serial pins) which I also completely disassembled.

Han Duong