HM-133 & HM-151 Microphone Modifications

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08/29/2019

There are several web sites that describe changes to the HM-133. In addition to those, I have a couple of modifications that are pertinent to my HM-133 DTMF Adapter project. This document details the changes I feel are warranted, and a couple of links that cover other changes that one might wish to consider. In addition, the changes regarding the function (AKA status) LED and ballast modifications can also apply to the HM-151.

For the DTMF Adapter, there are two modifications that I feel should be made. One is to add a blue LED to the keypad area for the status LED function of the adapter. The other modification is to connect the PTT button directly to the PTT connector pin and bypass the connection to the microphone processor (the PTT modification is not needed for the HM-151).

The Disclaimer

These modifications require fine-pitch SMD soldering skills. If you don't have any experience with 0603 or smaller soldering, don't attempt to perform any of these modifications. They will void your microphone warranty as well, so you don't want a broken microphone on top of that.

A Short Anatomy Lesson

The HM-133 is reasonably easy to dismantle. Removing the two screws shown in Photo 1 allows the case of the microphone to be separated into halves. Once inside, there are three (3) screws which hold the PCB in place over the main keypad switch membrane. The PTT button actuator is actually two parts: The larger plastic piece seen in Photo 2, and a smaller flexible membrane contact adapter. The contact adapter is a bouncy little thing, so use care. It likes to bounce far away from your workspace. Photo 3 illustrates the PTT button actuator and contact adapter.

Photo 1. HM-133 back-side view

After removing the three (3) screws shown in Photo 2, remove the PCB by pivoting it along the edge with the PTT switch. Once it is rotated up 20 or so degrees, it should be possible to pull it away from the PTT button actuator. Avoid touching the key contacts on either the membrane or the PCB. The PTT actuator requires a bit of contortion to remove, but it doesn't require any force, so don't use any. It wants to rotate out of its cradle slightly.

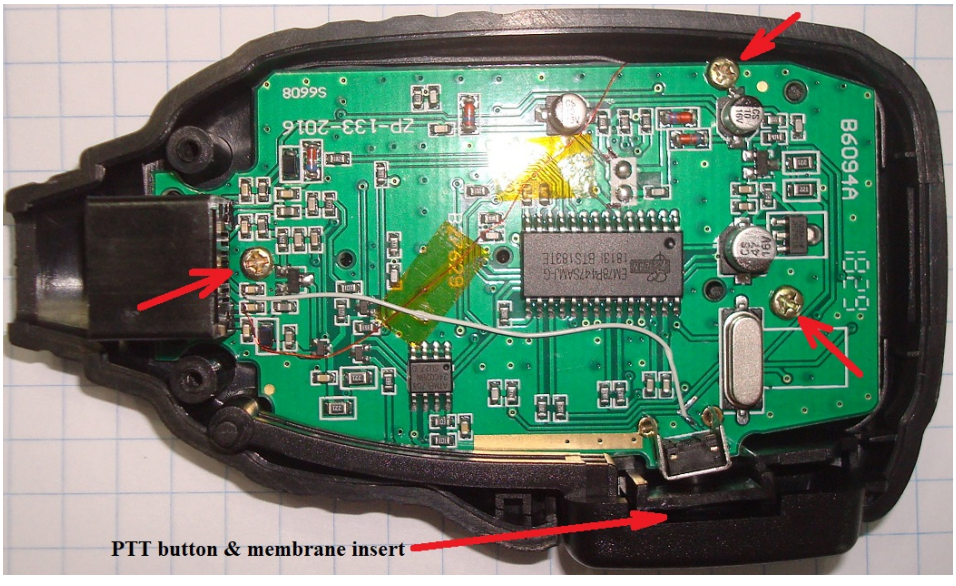


Photo 2. Main PCBA for the HM-133. Three (3) screws hold the circuit board in place.

Photo 3. PTT button and contact adapter

To reverse the process, after completing whatever changes are desired, first use a cotton swab and some 100% acetone (don't over-wet the cotton swab) to wipe the button contacts on the PCB. Then, install the PCB (don't over-tighten the screws), PTT button, and PTT contact adapter. Lastly, re-attach the back-shell and install two (2) screws.

The LED

Photo 4 shows the placement of the LED. Blue is preferred since it contrasts nicely with the green and red LEDs already placed on the board. Other colors can be used, but you run the risk of having uncertainty with the state of the added LED (this is of greatest concern in daylight applications). Most any blue, 0603 diode similar to the Lumex SML-LXIL0603USBCTR should be suitable.

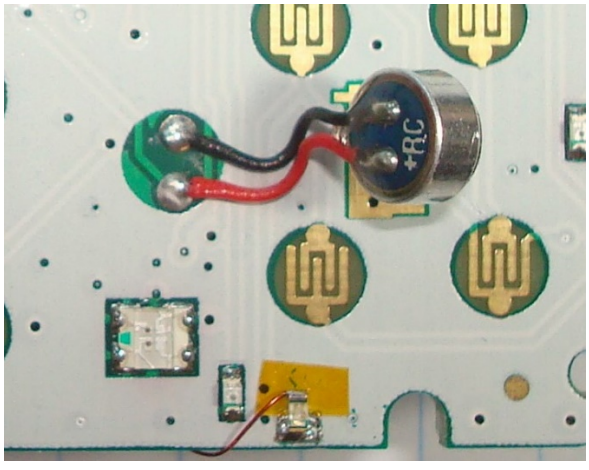


Photo 4. LED location. The mic element is also shown.

First, scrape away the soldermask in a 0.1" x 0.06" area at the edge of the PCB (see Photo 4). Make sure that the edge of the soldermask that will be under the LED is straight and that there are no jagged marks. I place a piece of Kapton tape under the anode, but this is not really necessary since the HM-133 has both a layer of soldermask and a layer of silkscreen in this area (as long as the area that will be under the anode of the LED is undisturbed). Tin the exposed copper (this is ground plane) and solder the cathode of the LED to the tinned copper. Tin the other side of the LED and attach one end of a piece of 34 AWG magnet wire to the LED anode. 30 AWG wire-wrap wire can be used instead, but the fine gauge magnet wire is easier to route around the edge of the PCB.

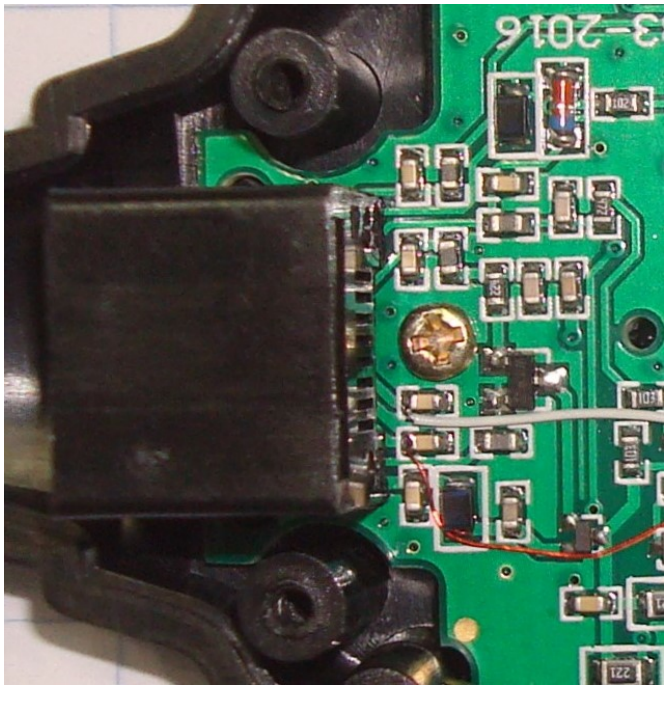


Photo 5. Closeup of the RJ45 connections. The white ww-wire connects to pin-4, while the magnet wire connects to pin-2.

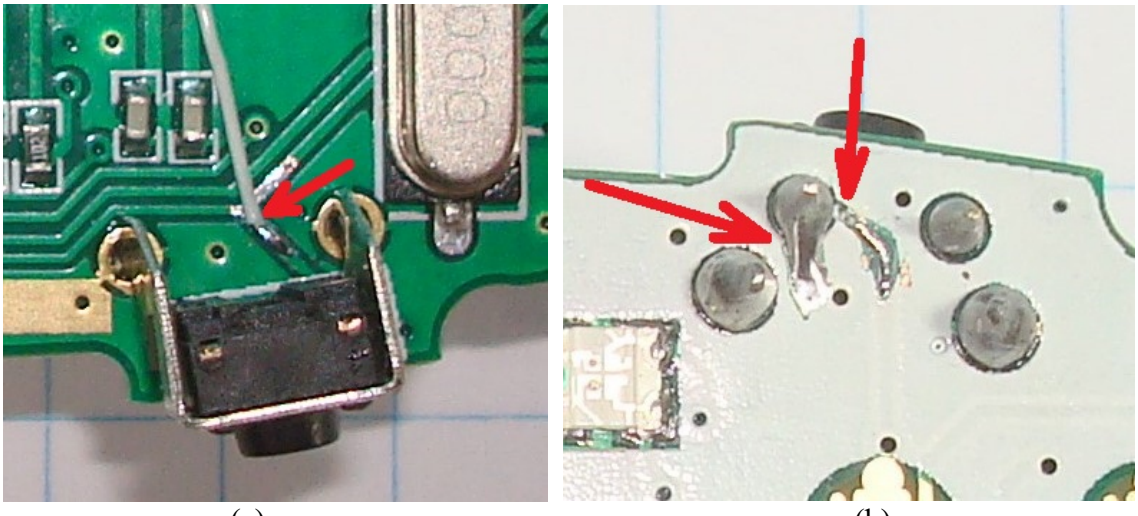
The other end of this wire connects to pin 2 of the RJ-45. Photo 5 illustrates the connection point (be sure to verify the connection to the RJ-45 as there are many different versions of the HM-133 out there). The wire-wrap wire in the photo is for the PTT modification. Kapton tape is a good choice to secure the wire. Tak-Pak™ (this is a Loctite gelled CA adhesive for tacking wires to PCBs) is another. If the wire is just long enough, it may not be necessary to secure it at all.

Photo 6. HM-151 LED shown illuminating the "F-2" button on an HM-151.

The PTT (HM-133 only)

Note: This modification renders the microphone incompatible with many (if not all) of the radio models that support the HM-133. If you intend to use your HM-133 interchangeably with these radios, this modification should be avoided.

In order to route the PTT to the dedicated connector pin, one must first disconnect the switch from the microphone processor. This requires cutting two traces. One is generally on the top side, and the other is generally on the bottom (button) side. Photo 7a illustrates modifications to the top, and Photo 7b to the bottom. The switch connection belonging to the bottom side trace is jumpered to GND. Simply scrape soldermask away from the ground plane adjacent to the pad, then bridge the gap with solder.



(a) (b)

Photo 7. PTT switch detail. (a) shows the top side trace cut (the trace is cut under the wire where the arrow points). (b) shows the bottom trace cut & GND solder bridge.

On the top side, the lead of the switch is generally difficult to reach, so it is important to leave plenty of trace to which the jumper-wire can be soldered. Carefully scrape the soldermask from the trace, and tin with solder. Apply a jumper (magnet or wire-wrap wire) from the trace to pin-4 of the RJ45 (see Photo 5).

The Microphone

There is a great source of variability between microphones of different radios, but I have even found great variability amongst HM-133 microphones (others have noted this as well). If you only have one HM-133, then you likely only need to consider increasing the coupling capacitor value (1uF is a good choice). If you have several HM-133s, and you notice a difference in their relative levels, then your best bet is to replace all of the mic elements with one that is purchased from a supplier where you have some expectation of consistency.

I have used CUI, Inc., PN: CMEJ-0629-36-L050 for my HM-133s. They are not expensive, so several can be purchased without much pain. I have experimented with adding some wire and foam to isolate the element from the microphone case. It did not help enough to notice. This "handsy" behavior is a little concerning, but I don't have a solution for it at the moment.

It is important to match the polarity of the element to the circuit. You can use an ohm meter to identify the MICE lead, which is likely the best bet (it is pin 5 of the RJ45 connector). You won't get DC continuity to the MIC connection, so it is difficult to confuse the connections. Install the new element as you see fit.

Locating the coupling capacitor can be a bit of a challenge given the number of different versions that are out there (neither of my HM-133s match the one service manual I've been able to locate). The best approach is to start at the connector (pin 6) and trace back to the first series capacitor encountered. This can be done by a combination of visual and ohm meter continuity checks. This capacitor will only have continuity to the connector pin on one side (there is likely a ferrite bead in series with the MIC line also, and these can occasionally look like capacitors, but ferrite beads will have continuity on both ends). Photo 8 illustrates one of the HM-133 microphones I modified.

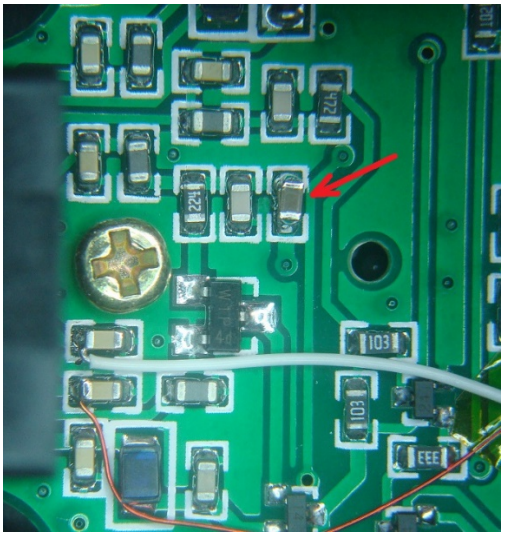


Photo 8. Location of 0.1uF coupling capacitor for MIC signal (additional cap has already been soldered on top).

Once located, simply "piggy-back" a 1.0uF, 0603 capacitor across the existing coupling cap. "Piggy-back" is the best approach unless you have tools and experience for removing SMD parts. The parallel capacitors will form a 1.1uF coupling capacitor, which is even more effective in this application.

Ballast!

I have had reasonable luck using lead sinker-weights and epoxy to add ballast to my microphones. Adding about 100 g of mass greatly improves the feel of the HM-133/151. However, each person has their preference, so it is worth some research to see how much mass you prefer. With the sinker weights, this is easy to do. 3/0 weights (about 0.2" in diameter) are about the right size – 100g of these weights is about 120 sinkers). "Pancaking" them (squeezing them with a pair of needle-nose pliers) helps increase the packing density somewhat but can take a while if you go with 100g of ballast.

First, I pack weights into the bottom of the center channel of the backshell (I add ballast to the backshell only). Photo 9 shows the first layer. Subsequent layers are added perpendicular to the first layer. I cover each layer with epoxy (JB Weld was used here) to make sure there are no annoying rattles that might develop (sooner or later).

Be sure to use a long work-life epoxy. 5-minute epoxies will set much too quickly. At least 30 minutes of working life is recommended (JB Weld has a much longer working life). I generally bake my epoxies at about 70C (about 150F). Some can become less viscous before fully setting, so it is best let the epoxy begin to set (this takes about 60 to 90 minutes for JB Weld).

The finished ballast modification is shown in Photo 10.

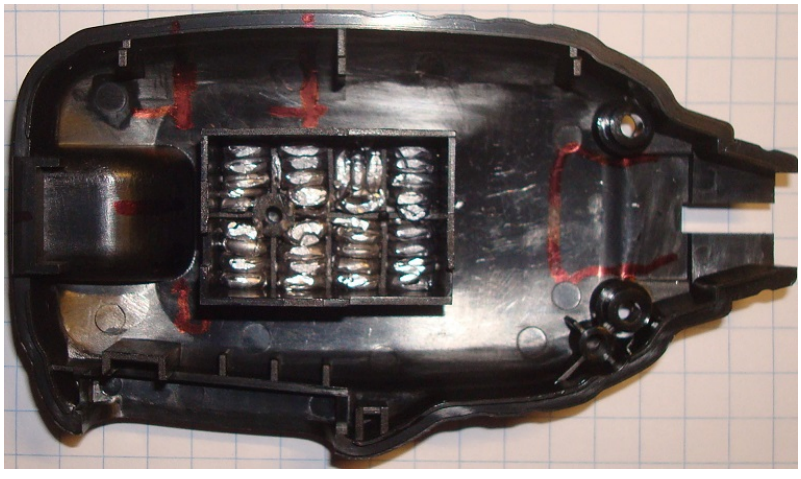


Photo 9. First layer of "squished" sinker weights. Note the sharpie marks for the connector and electrolytic capacitors to be used as guides when packing the weights.

Photo 10. Final ballast configuration.

Testing

Once the modifications are complete, carefully re-assemble the microphone and plug it into the DTMF adapter. The microphone can be tested with the back-shell removed but use care so as to not lose the PTT button adapter pieces. Turn the radio on. The blue status LED should light, and the PTT and keypad should operate. The blue function LED should flash whenever a button is pressed on the microphone keypad. Make sure the microphone audio is clear and of a reasonable deviation (this will also test the PTT modification if performed).

Conclusion

I am reasonably happy with my HM-133 and HM-151 microphones. However, this is perhaps more a measure of "the devil I know" than anything. The modifications (the ballast, in particular) can be a bit tedious, but having a plan is helpful to that end. Hopefully, this modification guide is helpful as well.

Bibliography

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(2) http://www.rollanet.org/~joeh/projects/hm133/ – by Joe Haas, KE0FF, site current as of the publish date of this article
(3) https://zl2vh.org.nz/assets/pdf/other/hm-133-mic-mods.pdf (observed 8/24/19)