

**MSX  
FM-SYNTHESIZER UNIT**

**HX-MU900**

**TOSHIBA**

## UPGRADE GUIDE

Revision 1.1

# 1. Introduction

Toshiba HX-MU900 was a FM Sound Synthesizer cartridge for the MSX System, based on the Y8950 chip but not intended to be used as a standard MSX-Audio. The product goal was to transform your MSX computer in a Music station, working together with its companion product, the HX-MU901 Musical Keyboard. While at first sight it seems that no efforts were made to make this cartridge to be anything more than what it was sold for (certainly because of some nearsighted marketing guy's decision), after you open the cartridge and investigate it with more details you get a totally different picture: someone in the engineering department left a lot of space for improvements and a crumble bread trail of what was his original project before being mutilated by the marketing department.

Aesthetically speaking, the cartridge itself is the most appealing of the three Y8950-based available for the MSX system, having the size of a ASCII Memory Mapper. As a comparison, the **Panasonic FS-CA1 MSX-Audio** is a cumbersome monster that only fit well on his original FS-A1 MSX2. Slots of many MSXs were not able to get it fit in. Then came the **Philips NMS-1205 Music Module**. Don't get me wrong, I also love it and it's a very good product, but lets face it: it's also a excessively big cartridge for day-to-day use.

Cartridge	Size (*1)	SampleRAM	BIOS	Sound Quality	Extras	Price
FS-CA1	999x	32KB	MSX-Audio: 24KB ROM, 4KB work-area SRAM)	Very Good	<ul style="list-style-type: none"><li>External Music Keyboard connector</li><li>Internal 32KB Music Editor</li><li>64KB Demo samples in ROM</li></ul>	Expensive
NMS-1205	4x	32KB (*2)	None (*3)	Good	<ul style="list-style-type: none"><li>Proprietary MIDI interface</li><li>Proprietary External Music Keyboard connector</li><li>Internal 32KB Music Editor</li></ul>	Expensive
HX-MU900	2x	None	None	Excellent	<ul style="list-style-type: none"><li>External Music Keyboard connector</li><li>Internal 32KB Music Editor</li></ul>	Accessible
SW-M004 (aka FM-PAC)	1.5x	None	Butchered for the YM2413	Very Good	<ul style="list-style-type: none"><li>4KB proprietary SRAM for savegames</li><li>Internal Music Demo</li></ul>	Accessible

\*1: Area relative to a standard MSX cartridge

\*2: Go to Hans Otten page for documents on how to upgrade it to 256KB

\*3: This can be changed with an easy upgrade. Have a look at [http://www.msxpro.com/mm\\_upgrade.html](http://www.msxpro.com/mm_upgrade.html)

Comparing the MSX sound expansions available in Japan at that time, one can quickly understand why consumers preferred the non-standard Panasonic FM-PAC as their choice. It's also easy to see that Toshiba HX-MU900 was the only cartridge that could have any chances against the Panasonic SW-M004 (FM-PAC), but only if it had the MSX-Audio BIOS.

## 1.1. Original Specifications

MSX-Audio standard compliant	No: lacks BIOS and SampleRAM
Sound chip	Y8950, aka MSX-Audio chip (YM3526+ADPCM)
Sample RAM	None
ROM	Synthe Music System, 32KB
SRAM	None
Audio Connections	Dual mono output
Keyboard connector	Standard, as described in the Y8950 datasheet

## 1.2. Upgrades available on this document

- 256KB SampleRAM
- MSX-Audio BIOS
- Audio input connector (\*see status on its respective page)

## 1.3. Specifications after all upgrades

MSX-Audio standard compliant	Yes
Sound chip	Y8950, aka MSX-Audio (YM3526+ADPCM)
Sample RAM	256KB
ROM	MSX-Audio BIOS, 24KB
SRAM	4KB (MSX-Audio BIOS work-area)
Audio Connections	Mono output, mono input
Keyboard connector	Standard, as described in the Y8950 datasheet

## 2. General Notes

#####  
DISCLAIMER

Try these upgrades at your own risk. Be warned that these modifications are unofficial and can damage your cartridge and all your equipment, including your MSX and your TV set.

#####

When opening the HX-MU900, be careful with it's excellent internal metal shielding. Do not touch this shielding with your bare hands, otherwise it can get rust by your sweat. If you use wisely the plastic covers you will not need to touch it at all. But, if you really need to, manipulate the shielding using some cloth, toilet paper or a tool, like pliers.

Do not use your original EPROM. Save it and buy another 27C256, just for the improbable possibility that you dislike the BIOS and opt for undoing everything.

### 3. First upgrade: 256KB of SampleRAM

Status: Complete, works as expected.

Difficulty: Easy (\*1)

Amount of work: Medium

Soldering skills required: basic+

\*1: As easy as the manual upgrade of the Philips NMS-8205 Music Module SampleRAM to 256KB.

Parts needed:

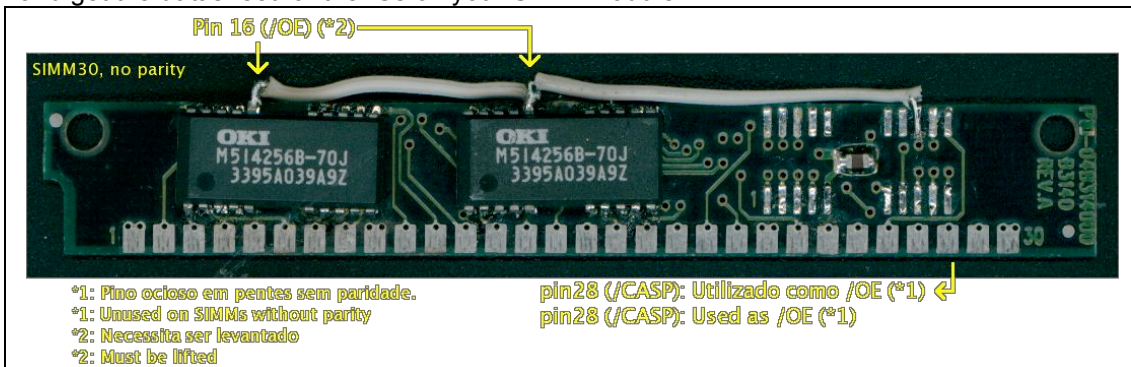
- One 30-pin SIMM Module containing 2 or 3 ICs, with 256KB up to 4MB RAM. Only 256KB will be used by the Y8950 anyway. You can use modules with 8 to 9 ICs on it, but I do not recommend it at all and you will understand why ahead;
- One Low-profile socket for the 30-pin SIMM Module. You can get one of those from many PC motherboards and some wave-table based soundcards. I got mine from a dead Turtlebeach Maui. It can also be found on SoundBlaster-32 sound cards;
- Wire-ups for making the necessary connections.

#### 3.1. Prepare the SIMM30 Module

All SIMM modules have the /OE pins off its ICs grounded. But the Y8950 requires this signal to work with the RAM. So we must do a little modification on the SIMM Module to re-enable this needed signal and allow the Y8950 to access it. Basically, all you have to do is lift the /OE pins of both the left and center ICs, and connect them with the /CAS pin of the 3<sup>rd</sup> IC (which itself may not be present, as in mine).

This is why I do not recommend the use of 8-9 ICs SIMMs: it will consume a lot of work to lift all EIGHT /OEs and its pins are very hard to be accessed.

A 256KB SIMM30 with 3 ICs probably has two 44256, 514256 or similar. Those are very easy to deal with and the pin-out is the same of those 44256 used on many MSX computers main RAM, only with a smaller SMD package. Many 1MB SIMM30 with 3 ICs use the 71C4400, which also has this same pin-out. Anyway be wise, go to the <http://www.alldatasheet.com> site and get the datasheet for the ICs on your SIMM module.

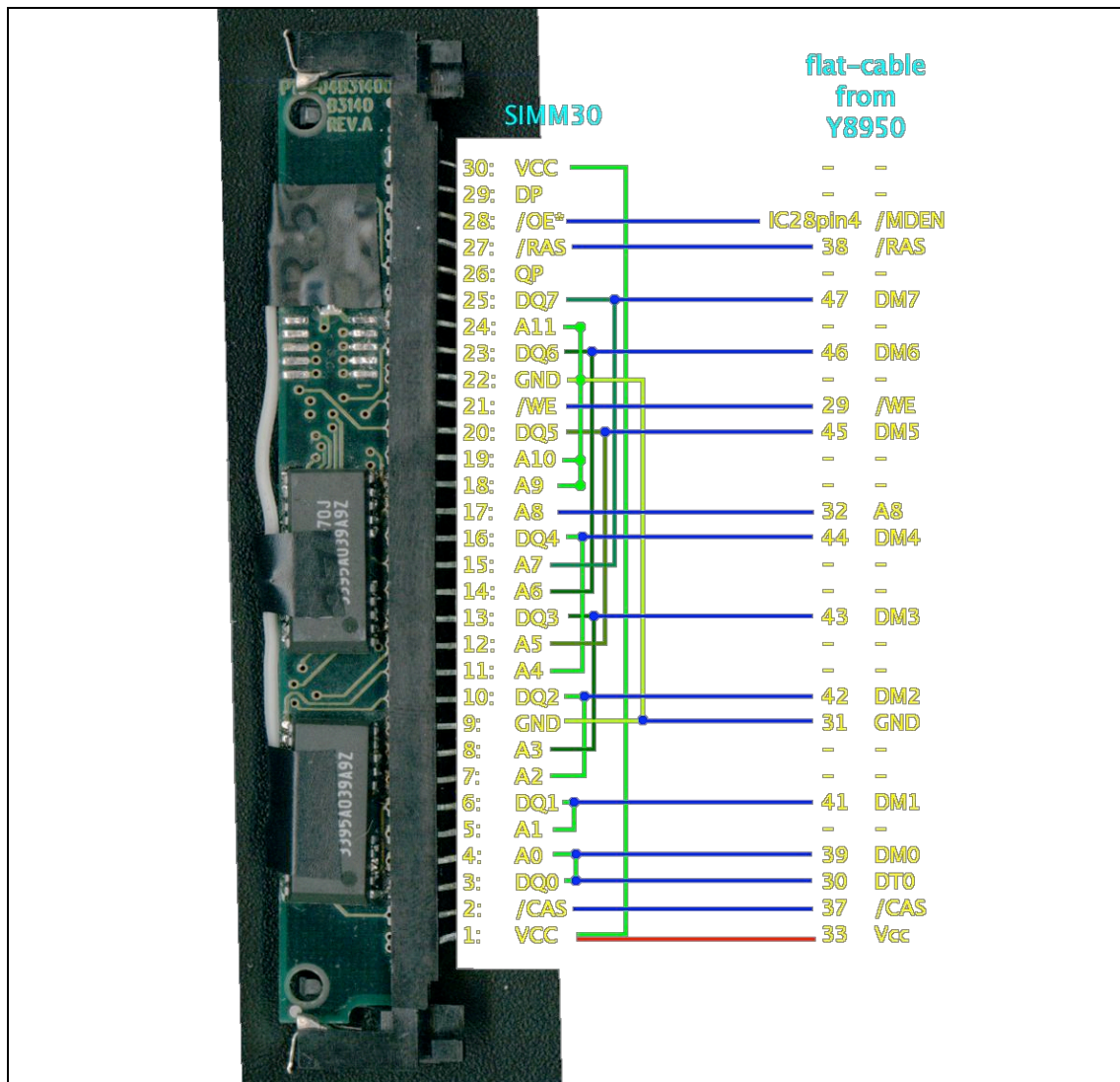


Use the picture above as a guide and proceed the steps listed below. Remember that your SIMM may have different ICs/layout than mine, so use this picture only to visualize how things will get.

1. Cut free the /OE of the left and center ICs. This can be easily done by passing the thin blade of a small box-cutter-knife between the board and the pin, which is shaped as a "U". Once the pin gets free, you can pull it out using a strong needle. Its up to you to decide if you want to remove the 3<sup>rd</sup> IC of the SIMM to reduce the power consumption a bit as I did, because it's only there for parity and the Y8950 will not use it at all.
2. Solder a wire to connect both /OE pins together and then a wire to connect them to the /CAS of the 3<sup>rd</sup> IC. If you could not find the datasheet of the 3<sup>rd</sup> IC, its easy to discover which pin it is: put your multimeter the continuity test mode (it's the mode it beeps when you touch things interconnected), put one tester on the pin-28 of the SIMM module and try each one of the pins of the 3<sup>rd</sup> IC until your multimeter beeps. If your module do not have the 3<sup>rd</sup> IC and there are no pads there for you to connect the /OE wire, just solder

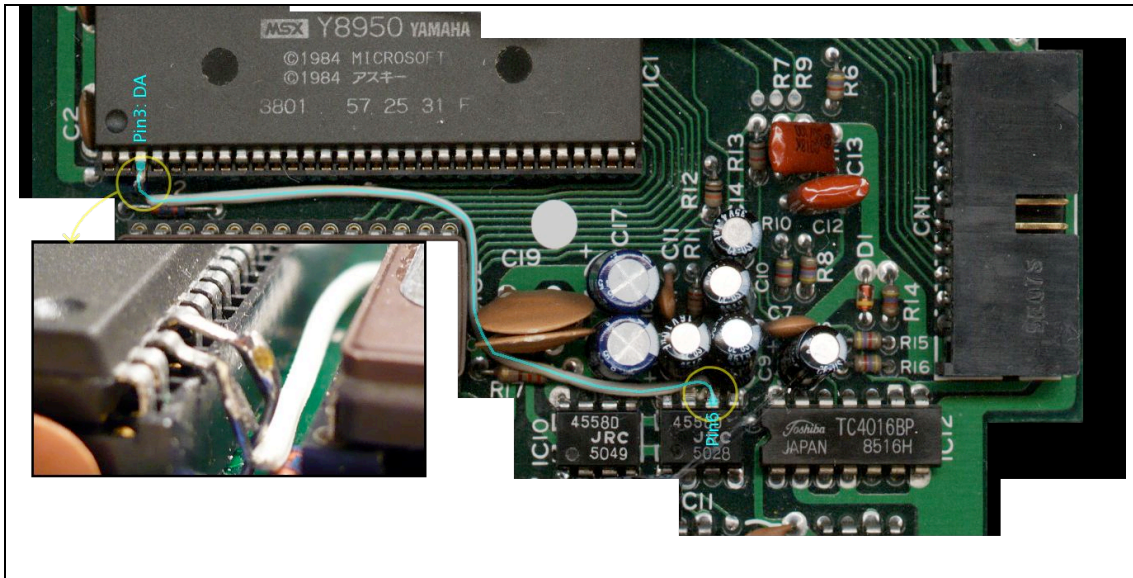


green lines and only after that connect it to the Y8950's flatcable as show on the blue/red lines.



### 3.4. The Reference Input

Unfortunately, Toshiba grounded on the socket the Y8950's Pin-3 (DA), which is used for the reference input, in a way it's not possible to easily cut the tracks to get it free. The only way to cut the tracks is by unsoldering the entire socket, cutting the tracks and re-solder it again. This is troublesome and would put a lot of unnecessary stress on your board. But on other hand, the fact that Toshiba opted to install the rare SPDIP socket means there's an easy way to free the Pin-3 for use. Just remove the Y8950 of its socket and carefully bend the Pin-3 out as shown on the picture below. There's a close-up of how it looks on the lower-left part of the picture. Note that I lifted both pins 3 and 4. You may want lift both pins too if you plan to install the 3<sup>rd</sup> upgrade of this document.



Now there's just one connection to be done:

1. Solder a wire (highlighted in cyan) connecting the lifted Pin-3 (DA) to the Pin-6 of the IC11.

After finishing this connection, re-check all the connections, put the SIMM module on its socket and fire the Unknown Reality demo to test your new 256KB SampleRAM.

## 4. Second upgrade: The MSX-Audio BIOS

Status: Complete, works as expected.

Difficulty: Very Easy (\*1)

Amount of work: Little

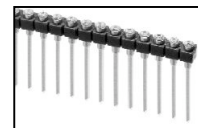
Soldering skills required: Basic

\*1: A lot easier than the MSX-Audio upgrade for the Philips NMS-8205 Music Module.

This upgrade was my most grateful surprise with this impressive little cartridge. Toshiba left space for a dual-ROM setup, but did it in a so flexible and well-designed way that doing this upgrade was little more than a matter of changing some jumpers and adding the missing ICs. And the final result, as you will notice, is of such high quality that an unadvised observer probably will believe it's all original.

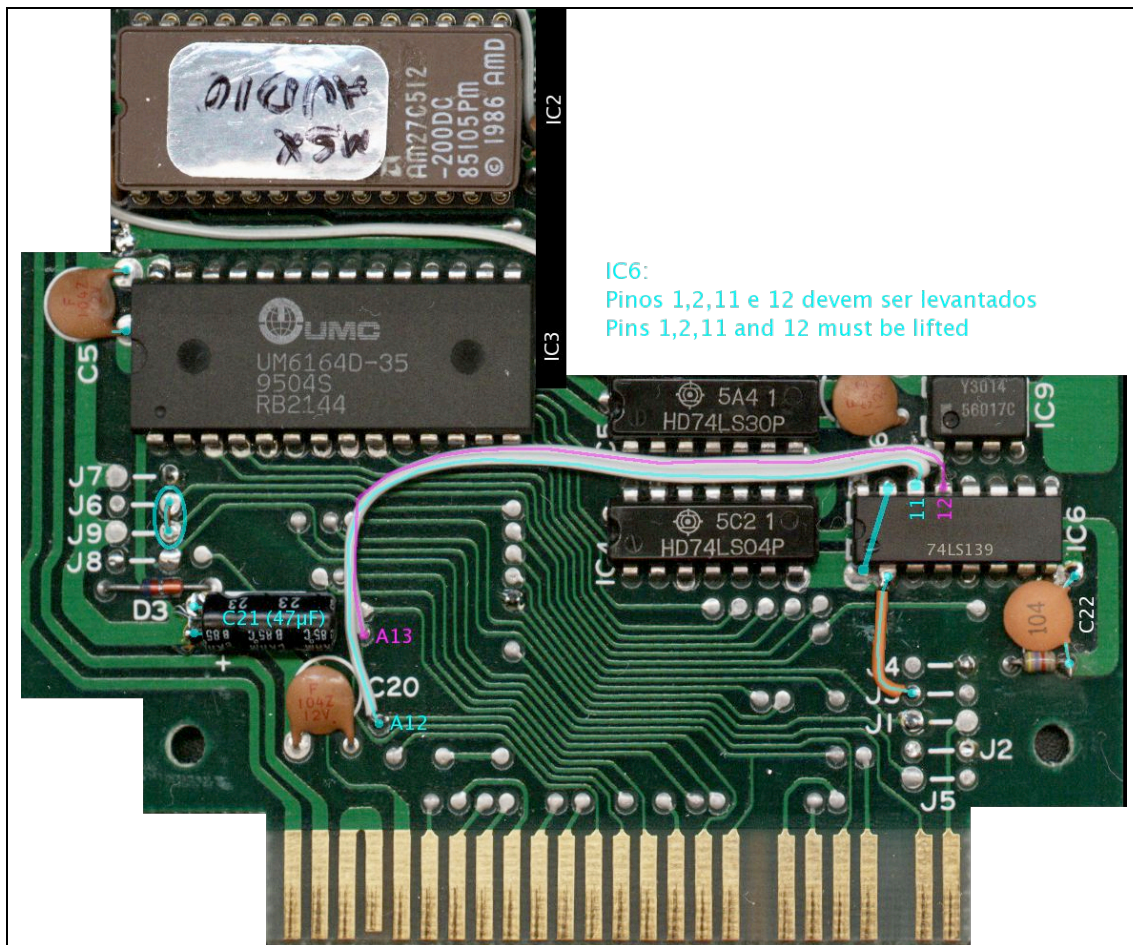
Parts needed:

- One 6164 (8KB SRAM), 7164 or similar. I got mine from a ISA network card. PC 386/486 caches can also be used, but you will need to find yourself some way to fit it in the larger pin out space reserved for the IC3. Maybe you can lift the pins 1-16 of the cache and connect it to one SIP socket like this pictured on the right, with its pins bended by 90 degree. **Be sure the pin-out order of your cache IC is compatible with the 6164 by checking both datasheets.** You'll notice the pin-26 is the CS<sub>2</sub> signal on <=8KB SRAMs and the A13 on others, but for the MSX-Audio BIOS requirements both are compatible. To make things easy for you, I already checked some of the most common PC caches:
  - The MT5C6408 is the same IC as 6164 (8KB SRAM) but with a narrower package, so it can be used.
  - 61256, 62256 and 7C256 can be used. They're 32KB SRAMs and are pin-compatible.
  - MT5C6401, MT5C6404 and MT5C6405 are not pin-compatible and cannot be used!
- One 27C256 EPROM. You will use it to save the new MSX-Audio BIOS. Keep the original 27256 EPROM in a safe place just in case you want to undo this upgrade (I wonder why, since having to press ESC on every boot to avoid the Music Editor is so annoying).
- One 74LS139 IC
- One or two 0.1µF ceramic capacitor



- One 47 $\mu$ F electrolytic capacitor
- Wire-ups for making the necessary connections

#### 4.1. Over the board



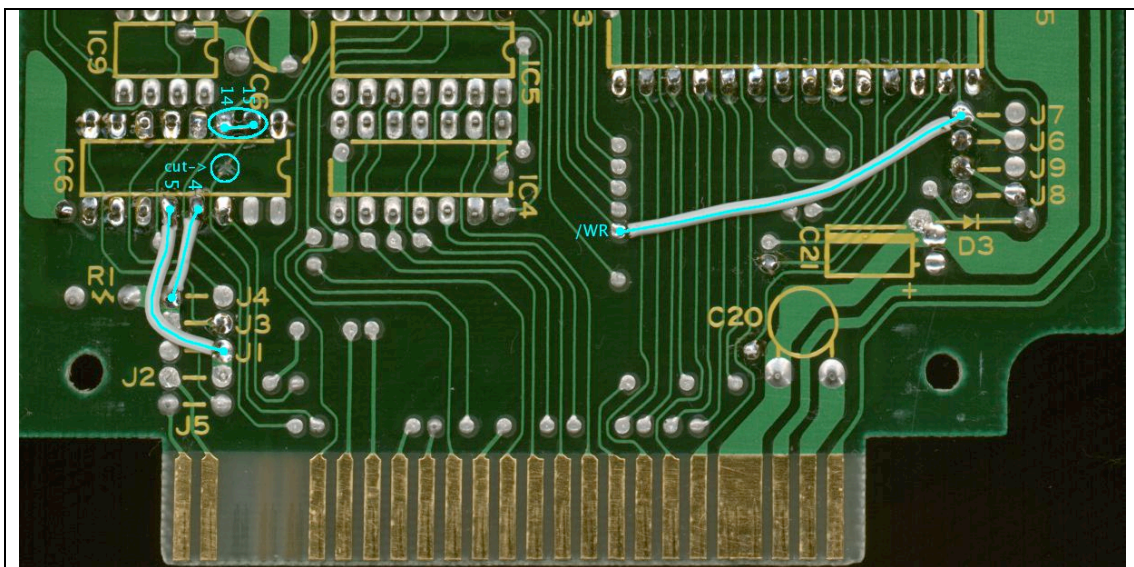
Follow the picture above for the following steps. You must resist the temptation to use sockets for the IC6 and IC3, otherwise this ICs will be placed too high and the plastic cover of your cartridge will not close anymore.

1. Program your new 27C256 EPROM with the MSX-Audio BIOS, which can be found at this link: [http://www.msxpro.com/hardware/mm\\_upgrade/msxaudio.zip](http://www.msxpro.com/hardware/mm_upgrade/msxaudio.zip) ;
2. Remove the solder to open all the holes listed below to prepare them to receive the new parts and wirings (left-right references taken with the board positioned as seen in the picture):
  - Holes for the IC3;
  - Holes for the IC6, including the little one just by the side of the pin-8 of the IC6, used by the new C22 on the picture;
  - Holes for the C21;
  - Right holes for the J4, J6, J7, and J9;
  - Left holes for J1 and J3;
  - The thru-holes labeled A12 and A13 in the picture;
  - If your board does not have the C5 capacitor, open the holes reserved for it;
3. Prepare your 74LS139 buy lifting the pins 2, 11 and 12;
4. If you are skilled enough you may bend the pins 1 and 10 under the 74LS139 making them touch each other, keeping both close to the IC's body, in a way they do not touch the board afterwards. If you don't think you will be able to do this, just lift the pins 1 and 10 as the others already lifted;
5. If you opted to bend the pins 1 and 10 under the 74LS139, solder them together. Do not use too much solder to avoid this connection to touch the board after the IC is inserted;



6. Put the 74LS139 on the space reserved for the IC6. I'll refer to this 74LS139 as IC6 from now on. If you soldered pins 1 and 10 under the IC6, double-check if the couple is not touching the board. You may want to put a patch of insulating tape on the board, under the IC6 if you prefer to be cautious.
7. Cut the bent-up pins you notice that are too close of the other components to get them a bit shorter. Probably you will only need to cut a piece of the pin-12 to avoid it to touch the IC9. For the other pins there are room enough;
8. Solder the unbent pins of the IC6 normally. This will get it fixed and ready for the next steps;
9. If you choose to bend up the pins 1 and 10, solder them together now;
10. Solder a wire from the left hole of the J3 to the pin-2 of the IC6;
11. Solder a wire (highlighted in purple on the picture) from the thru-hole labeled A13 on the picture to the pin-12 of the IC6;
12. Solder a wire (highlighted in cyan on the picture) from the thru-hole labeled A12 on the picture to the pin-11 of the IC6;
13. Put a 0.1 $\mu$ F ceramic capacitor on the space labeled as C22 on the picture. Note that this label is mine - you will not find it on the board. There's a small hole for one of its wires very close to the pin-8 of the IC6. The other wire of the C22 must be soldered on the right wire of the R1 resistor.
14. Solder a wire to connect the right hole of the J6 to the right hole of the J9;
15. Solder a 47 $\mu$ F electrolytic capacitor to the space labeled C21;
16. If your board do not already have it, solder a 0.1 $\mu$ F ceramic capacitor to the space labeled C5;
17. Put the 6164 SRAM on the space reserved for the IC3, soldering it on its place.
18. Remove the original 27256 EPROM and replace it with your new 27C256 containing the MSX-Audio BIOS. My HX-MU900 had it socketed, so it was very easy to replace. If your HX-MU900 has the 27256 EPROM soldered directly on the board, don't try to save it this IC, it's too risky for nothing and there are dumps on the Net. Just cut out all it's pins, get the IC out and carefully remove the pins one by one using your iron solder and pliers. Then solder a good turned socket in this place.

## 4.2. Under the board



19. Cut the track pointed by the label "Cut->" on the picture above;
20. Solder a jumper connecting the pins 14 and 15 of the IC6;
21. Solder a wire connecting the left pin of the J4 to the pin-4 of the IC6;
22. Solder a wire connecting the right pin of the J1 to the pin-5 of the IC6;
23. Solder a wire connecting the thru-hole labeled /WR to the left hole of the J7;

Recheck all the connections you did. If they're all ok, connect the cartridge to your MSX, connect a cable to its audio output and proceed the following test:

```
_AUDIO  
PLAY#2, "@33ABCDEF"
```

If you hear the MSX-Audio playing the notes, your upgrade was successful. You can test it further by running some games that use MSX-Audio, like Xevious, any Disk-Station, Golvellius-2, Super Cookies, any Rune Master, etc. Be aware that there are some bad game dumps around the Net where the MSX-Audio capabilities were ripped out. Probably this was made to free some space to convert the game to memory-mapper, another megarom type or any other clumsy elaborated patch.

You can also use your new fully compatible MSX-Audio with BASIC music made for the MSX-Music. All you need to do is change the CALL MUSIC command to CALL AUDIO. Both receive the same parameters. There's a neat tool by BiFi on the net that does this for you on-the-fly. It's called `_MUS2AUD` and can be found here:  
[http://www.msx.org/\\_MUS2AUD.newspost2978.html](http://www.msx.org/_MUS2AUD.newspost2978.html)

## 5. Third upgrade: Audio input connector

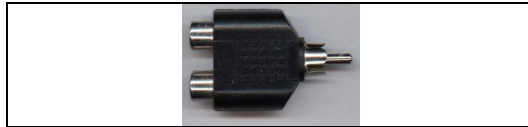
Status: **Incomplete**. Records audio, but with a weird background noise.

Difficulty: Hard

Amount of work: Quite some

Soldering skills required: Very good

The HX-MU900 doesn't have any input. There are two audio connectors on the cartridge and both are mono outputs. Please note that this is not stereo, it's only dual-mono, which is quite not the same. The same effect can be achieved by using one splitter like this bellow on any of the mono outputs:



My intention with this upgrade was to convert the red connector into an input, which makes sense. The upgrade seems almost complete, but there's some noise on the recordings and I just don't know how to get rid of it, since it requires analog electronics skills I don't have. I only know how to deal with digital circuits. If somebody with good analog electronics skills could please have a look and try to help to fix this, I would be very grateful.

If you're curious to know how the samples recorded sounds, I'll put online the files below, recorded using the FM-SAMPLER v2.2 from the Clubguide3 Magazine. This software saves raw 8bit signed files up to 26.7KHz, so I just imported them to a wav file using the Audacity audio editor. This means this files contain exactly what the Y8950 have read, without any distorting conversion beyond the 8bit->16bit (import raw) / 16bit->8bit (export to wav) done by Audacity.

- Jornal da Globo.wav: 26.7KHz sample, containing the ending greeting of a night news program;
- JOSOARES.wav: 15.5KHz Sample recorded from a talk show presented by Brazilian TV on late Saturdays. Nothing in particular, it's just what was showing on TV on the time of the record. My TV is the easiest thing around with audio-outs for these tests;
- INPUT-TVOut-Nocables.wav: This file has three 15.5KHz blocks of 16KB concatenated. The first part was recorded with the HX-MU900 input connected to the input of my stereo. It may sound weird, but this was done to be sure no sound signal could come in. The second part, the HX-MU900 was connected to my TV's audio out while the TV was on mute. You can notice by the change in the noise pattern. On the third part there are no connections at all to the HX-MU900, neither on the output or input jacks. You can clearly notice the noise recording level is far higher in this block. It must be said that the audio output still be crystal-clear, not affected by any of the situations shown on those files.

If even reading all of this above you decided to go ahead and install this upgrade, the steps needed will be described below. **But be warned to not even think to try this upgrade if you don't have very good skills and experience for this difficult modification.**

Parts needed:

- One 56K Ohm resistor
- One 330K Ohm resistor
- Two 10K Ohm resistors
- Two 1N4148 diodes
- One 0.47 $\mu$ F electrolytic capacitor
- One 1 $\mu$ F electrolytic capacitor
- One 10nF polystyrene capacitor. But those are not being produced anymore and so became very rare. It's said that the best replacement for it in this kind of application (sample-and-hold) is a 10nF polypropylene capacitor. At least here in Brazil those are very hard to find, so if that is your case, you may try a 10nF polyester as I did;
- Wire-ups for making the necessary connections

1. The pin-4 of the Y8950 must be lifted as you did with the pin3 on the SampleRAM upgrade;
2. Carefully unsolder and remove the IC10 from the board;
3. Now, on the solder side of the board, cut the track that connects the two RCA female plugs. This connection is pointed by the "1.Cut" label on the picture and is zoomed in the center-top of the picture for better comprehension. Notice that there will be an electrolytic capacitor (shown transparent) over this cut later;
4. Do, with extreme care, an L shaped cut as pointed by the label "2.Cut". This will free the pad of the pin-2 of the IC10 from being grounded; This cut is also zoomed on the upper center of the picture;
5. Solder the IC10 back on it's place;
6. Solder an electrolytic capacitor to the red female RCA connector as can be seen on the picture. Pay attention to its polarity also.
7. Solder a 56K Ohm resistor to the (-) pin of this capacitor.
8. Solder a wire-up connecting this resistor to the pin-2 of the IC10 as highlighted in purple on the picture.
9. Solder a 330K Ohm resistor between the pins 1 and 2 of the IC10.
10. Solder the 10nF polystyrene capacitor on the pins 2 and 5 of the IC1 (Y8950).









## 7. Thanks to:

- Adriano Camargo Rodrigues da Cunha, for its incredible contributions to the MSX community;
- Luciano Sturaro, of MSXPro, for his late night ICQ support and ideas, his excellent website with plenty of useful files/information and for publishing my MSX upgrade guides online.
- Paulo Maluf, for supplying good MSX hardware at decent prices and for producing the new keyboard film used to fix my old A1ST MSX;
- Ikeda, for selling me a new A1ST in perfect condition;
- Hans Otten, for putting online many of the documents where I got information to build the upgrades;
- BiFi, for it's nifty \_MUS2AUD tool;

And a very special thanks to **Manuel Bilderbeek**: he donated the Toshiba HX-MU900 you saw on this document. Without this help, these upgrades would never exist.