Convert Your AM-SW Radio to an AM-FM Radio

January 2026 Gord Rabjohn

The FM Converter described in rabjohn.ca/FM (please learn about the standard FM converter first, otherwise this document will not make much sense) was designed to convert an AM tube radio to FM. Once it is installed, the radio is no longer capable of receiving AM, and this is intentional; you don't want an AM and FM station being received at once. In the case of AM-Shortwave radios, both AM and SW are disabled when the converter is installed. It would be "cool", though, if AM operation could be maintained, and FM operates only when the radio is switched to SW. It is possible to make this happen, and I describe what must be done herein, but I recommend it only for someone with fairly advanced electronic skills because:
-There are many different SW bands and each would require specific components.
-There are many radios of different qualities and designs (some of which do not seem to have adequate LO swing to drive the converter) which may require some specific design tweaks.
-It is generally a more complex solution.
-The converter boards must be modified to facilitate this design.

There are four modifications that must be made to the basic design:

1. The operating frequency of the PLL must be increased to match the host radio's LO used during SW operation. The 9046 PLL operates well (with the need for increased drive from the LO) up to about 20MHz, so radios with the common 6ish to 18ish MHz SW bands can be accommodated. The level shift circuitry must be modified.
2. A circuit is needed to sense (by measuring the LO frequency, therefore the PLL output) whether the radio is operating in AM mode or SW (FM) mode.
3. The audio must be injected into the host radio in FM mode without loading the detector when in AM mode.
4. A negative voltage must be applied to disable the detector in FM mode, but this voltage must be removed during AM operation.

Modifying the PLL

The PLL modification is straight-forward. Reducing the 220pF timing capacitor (C2) to 33pF - 42pF works well for a radio with 5.6-20MHz SW band. If your shortwave radio has a lower frequency shortwave band, that would be preferable, as the PLL will be more sensitive. The value of C2 will need to be changed; about 100pF for a 2-6MHz shortwave band would be a good place to start.

The PLL phase detector is much less sensitive at high frequency, especially at the high frequency end of the band. This means that using the "gimic" capacitor to "sniff" the LO is likely not going to deliver adequate drive (for a SW band that goes to 18MHz). In the radio that I tried, I coupled the LO grid of the 6SA7 tube directly to the LO input with a 5pF capacitor (I mounted the board close to the 6SA7 to minimize additional capacitance). I played with a couple of radios, and I observed considerable variation in LO swing. One AC-DC set that I considered had inadequate LO level at the low end of the band.
The LO in an AM radio covers a range of about 2:1 (from about 1MHz to 2MHz) Shortwave bands tend to be wider, my particular radio is closer to 4:1. The PLL can accommodate a 4:1 range (just barely: the

datasheet claims the VCO operates from 1.1V to 3.9V worst case, but my measurements indicate that 0.8 to 4.0V works with some margin), but the level shift circuit around U2A is designed for about a 2:1 range. (The resistors are selected to approximately center the VCO tuning range) Of course, you could just use a subset of the shortwave band, but a better solution would be to decrease the value of the feedback resistor R8 to about 140k. This will allow the entire width of the dial to be used. (Note that the values of R8 and R9 are not critical, but their ratio is important) The output voltage of the PLL (pin 10 of U1) at the bottom end of tuning determines what ratio is required.

R8	R9	Ratio R9:R8	VCO voltage (band bottom)	Comment
220k	560k	2.55	1.41V	Default: appropriate for 2:1 (up to 2.8:1) LO range
220k	910k	4.14	0.97V	Appropriate for up to 4:1 LO range
140k	560k	4.03	1.0V	Appropriate for up to 4:1 LO range

Some shortwave radios have “Bandspread” bands that cover a very narrow frequency range, like 9-9.5MHz or 11-11.5MHz. I have never tried converting a radio like this, and I worry that the radio’s LO may not be stable enough (Consider this: you are tuning one of 100 FM channels (odd frequencies in North America) over the a 6-18MHz band so channels would be spaced at 120kHz intervals. A 10kHz LO drift is a negligible error. Over the 11-11.5MHz band, however, channels would be spaced at 5kHz intervals, so 10kHz LO drift is about 2 channel widths!). If you want to try, the level shift circuit needs to be modified, because the voltage generated by the PLL will swing only about 0.1V across the 11-11.5MHz band. A resistor from U2A pin 2 to ground will need to be added. This new resistor should approximately match R9. 100k is suggested for both. This will hold pin 2 at approximately 2.5V (the PLL will be adjusted with RV2 to match this voltage). R8 will need to be increased to about 500k – 1M to provide more gain.

Band Sense Circuit

A circuit is required to determine whether the radio should be in AM or FM operation. This is done by looking at the output of the PLL. When the host radio is in AM mode, the LO frequency will be low, and therefore the PLL output will be low. When the LO signal frequency is low, the op-amp U2A will be “railed” with its output low. This makes it quite easy to implement an AM-FM sensor with the unused op-amp. It can be connected to the existing op-amp inputs with a small offset created by the 33k and 330k resistor. By the way, when placed in parallel with the 220k resistor, these resistors reduce the total resistance to about 140k which is good for maximizing the tuning width.

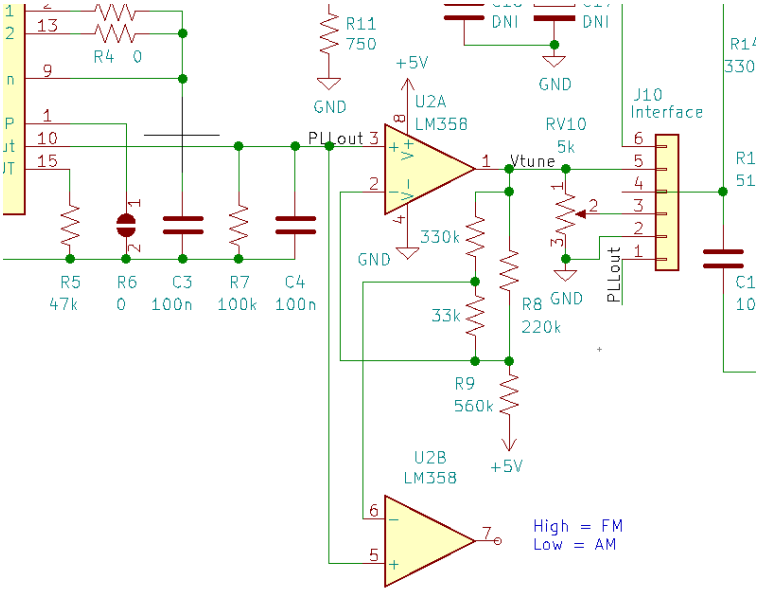


Figure 1 AM-FM Mode Sensing Circuit

Audio Injection

My first audio injection design drove the radio (at the detector) with an open collector transistor. When in AM mode, the output of U2A is low, Q51 is off and Q50 is off. The collector of Q50 in off state has a very low capacitance and should not (famous last words) interfere with AM reception. In FM mode, Q51 turned on, which biases up Q50. RV53 is adjusted so that the collector voltage of Q50 is -12V or so (the

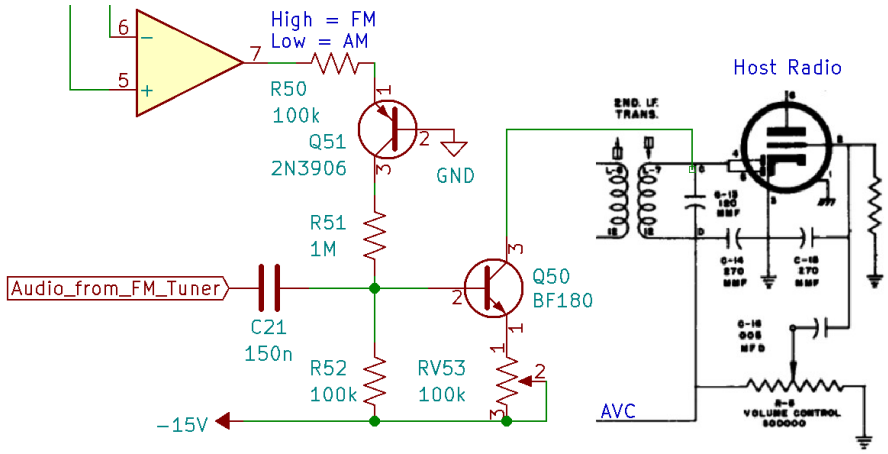


Figure 2 Audio Injection Circuit with an Issue!

collector's load is in the host radio (in this case the volume control)), and Q50 injects the audio into the radio. This works quite well in FM mode; -12V lowers the gain of the IF amplifier in the host radio and ensures that the detector diode is turned off. Q50 is mounted at the socket adaptor to minimize extra capacitance, and indeed it does not significantly detune the IF transformer. However, there is a catch: In AM mode, when tuned to a strong station, the AVC voltage generated in the radio can reach -10VDC (I've seen even more in other radios). This sounds innocent enough, but this is the average audio level, peak

audio levels can be twice that, and the RF peaks are even more. I was seeing over -30V at the peaks of the RF swing on the detector diode, which forward-biased Q50's B-C junction, and caused significant audio distortion on strong stations in AM mode. This could be solved by increasing the negative supply to at least -30V (I had already employed a doubler to get ~-15V so a quadrupler would be required). It could also be solved by injecting the audio directly into the volume control, but this cannot be done without modifying the radio. So, I abandoned this approach entirely.

Instead, the better and simpler solution (one that I should have tried first) is to use a small 6V (SPST-NO) reed relay to inject audio into the AM detector. By placing it right in the socket adaptor, it adds negligible capacitance to the AM detector. The relay needs to be tiny to fit in the socket adaptor. The relay is driven from a single transistor driver from the output of the AM-FM select op-amp. See figure 3. If I was doing this properly, I would also drive the "Reset" pin (pin 9) of the FM radio thru U11 from the AM-FM select op-amp (with appropriate logic sense), so that the FM radio is disabled when in AM mode.

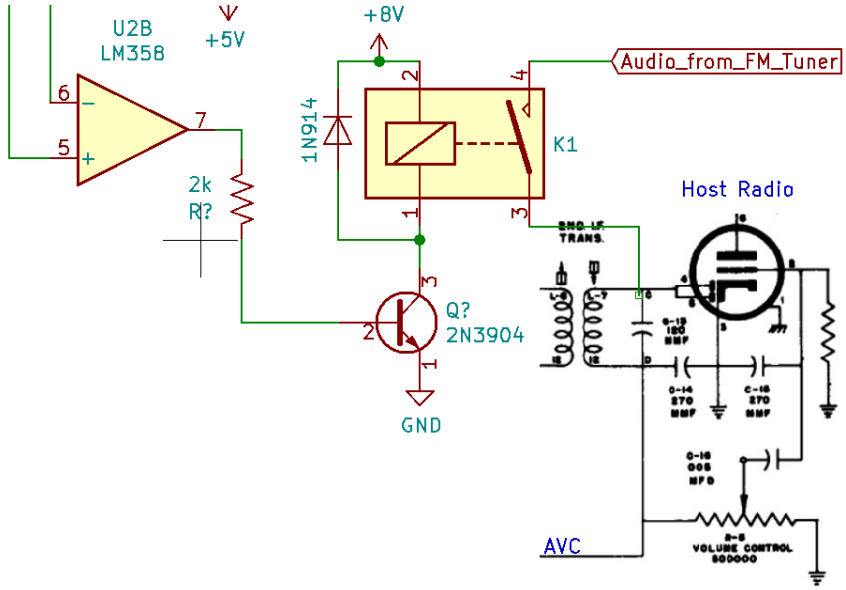


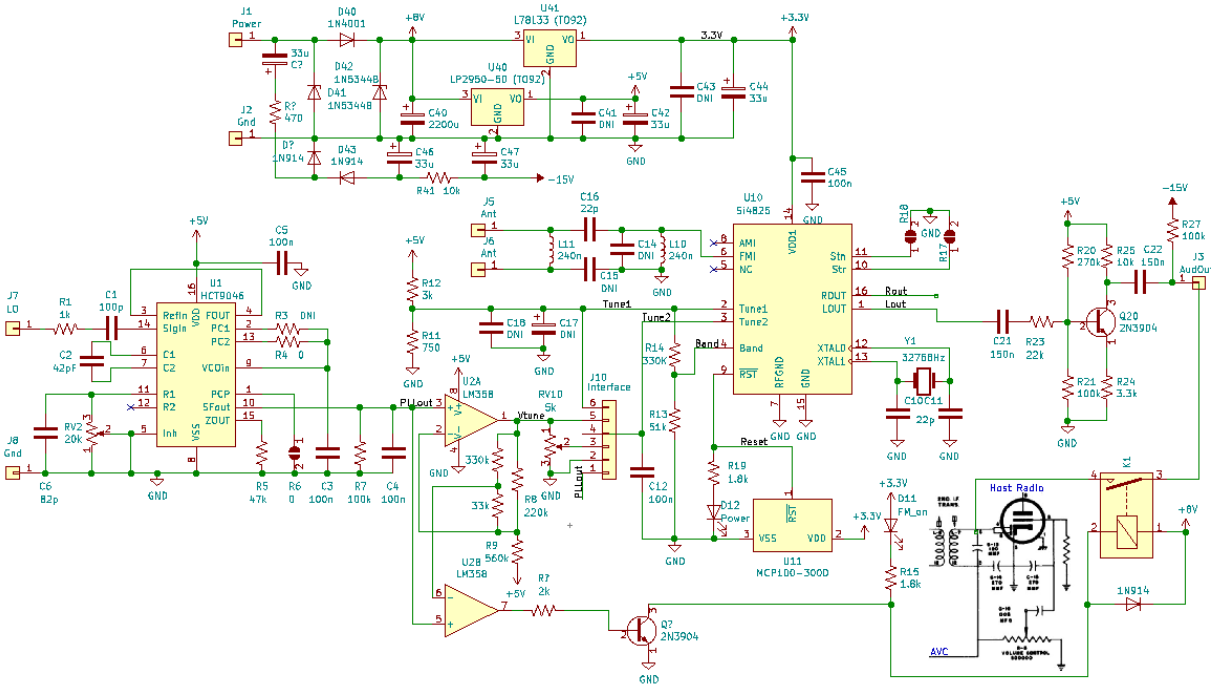
Figure 3 Better audio driver.

Example

I've tried this on a 5 tube GE model H53 AM-SW AC radio with a 5.5-20MHz SW band.

Figure 4 The CGE model H53 AM-SW radio (now AM-FM)

In this implementation, the board has a voltage doubler for the negative supply (maybe not necessary). The second op-amp for the AM/FM sensor is connected neatly with the 33K and 330K resistors. It drives the relay driver transistor (which also drives a LED). The relay is mounted on the socket adaptor for the 6SQ7 so minimal capacitance is added to the detector. This configuration works beautifully.



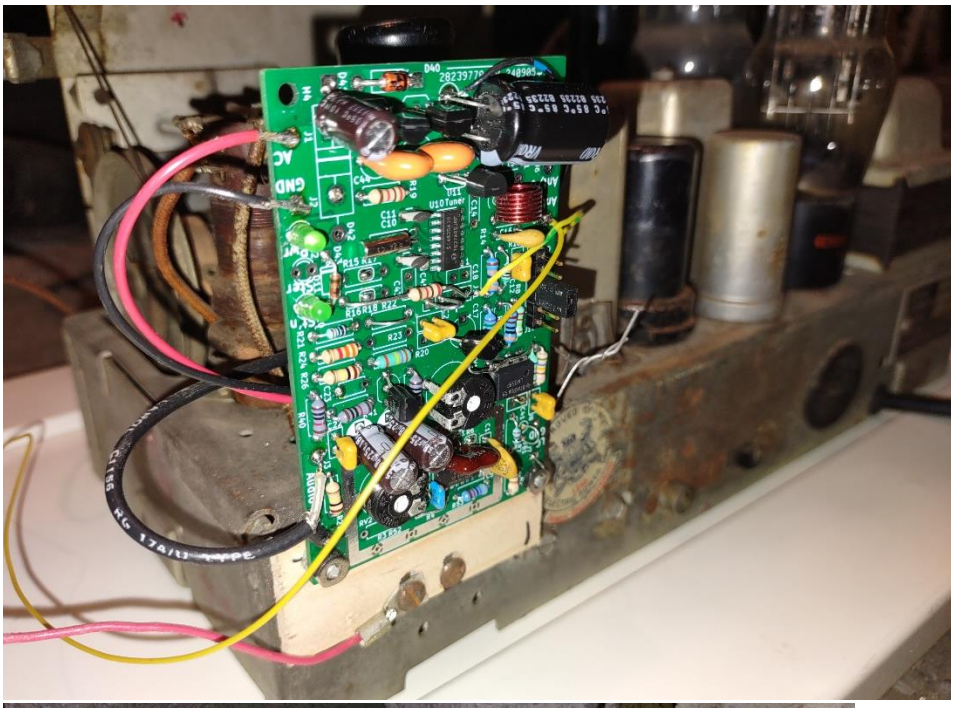


Figure 5 The board on the back of the radio. Held on with the antenna terminals.

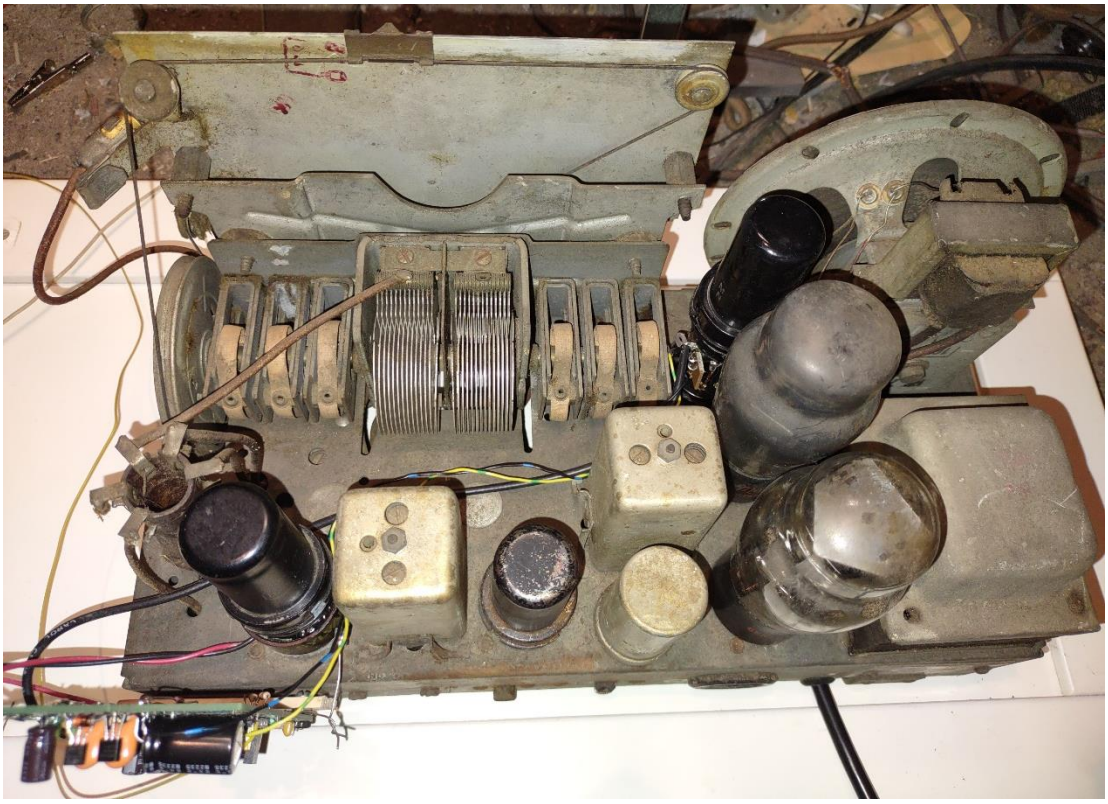


Figure 6 Top view of the radio with the FMC

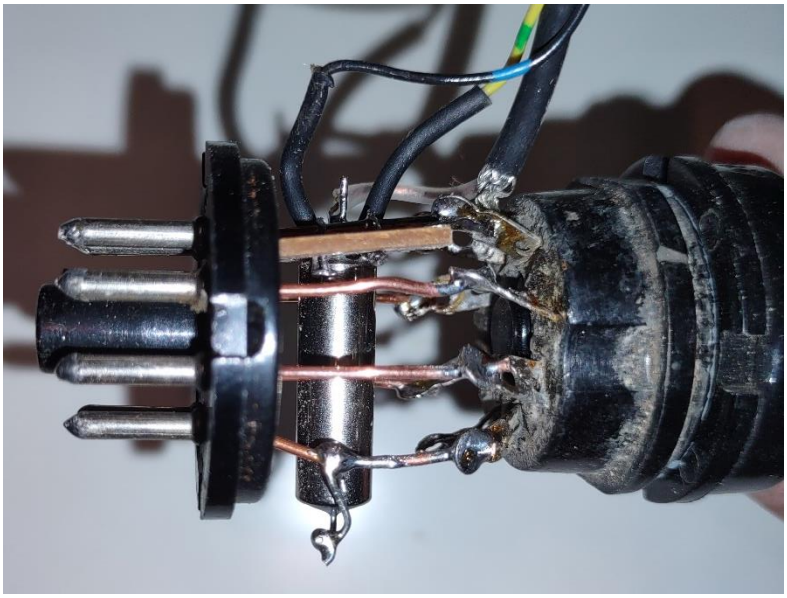


Figure 7 The 6SQ7 socket adaptor. The relay is the silver cylinder.

In conclusion, it works beautifully, but you will need to select the host radio carefully (6-18MHz SW band works, but a lower frequency band would be easier. It needs to be wide: at least 2:1. It must have good LO swing, not all radios do), and you will need to experiment with parts values to get it to work right.