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This document describes the steps necessary to interface a SoftRock (or similar Quadrature Sampling Detector) to the 10.695 MHz IF of a Kenwood TS-2000 transceiver.

NOTE: This procedure requires you to modify your TS-2000 at the circuit board level. As of this writing I have performed the modification on two different TS-2000 transceivers with absolutely no problems. The modifications are fairly simple (no traces to cut) and are reversible, but I will not be responsible for any damage to your radio as a result of these modifications. A mistake could render your radio inoperable and could result in expensive repairs. If you are not comfortable reading a schematic and working at the circuit board level (or if you just can't take responsibility for your own actions) then don't do these modifications. There are no kits available.

## Overview

There is currently a lot of interest in Software Defined Radio technology, especially with the availability of the inexpensive SoftRock SDR kits. (See <http://www.softrockradio.org> for more info.) A simple board using a Quadrature Sampling Detector (QSD) can be used with PC software and a good sound card to create a very capable radio receiver. If such a receiver is coupled to the IF circuitry of an existing general coverage receiver then one gets the best of both worlds - all band coverage with a panoramic view of the frequencies around the currently tuned frequency, and the ability to receive multiple signals simultaneously, ie. dual-receive.

Unfortunately most commercial radios do not make the IF signal available externally to the user. In my case I wanted to use my Kenwood TS-2000 HF/VHF/UHF transceiver with a SoftRock board to provide a panoramic display and dual receive capability. The TS-2000 has a quadruple conversion receiver with IF frequencies of 69 MHz, 10.695 MHz, 455 kHz, and 12 kHz. Examination of the schematic revealed that the best place to tap into the IF chain would be in the 10.695 MHz IF section. In searching for a tap point I had several requirements:

1. Avoid loading the existing IF signal
2. Avoid injecting noise or other signals back into the IF chain
3. Provide an output that was compatible with a SoftRock module
4. Have no impact on regular TS-2000 performance

I achieved these goals by tapping onto the output of Q22, an amplifier on the receiver board which buffers and amplifies the IF signal and feeds it to the noise blanker circuitry. I then built a simple two stage FET buffer amplifier which takes this signal and feeds it to the rear panel of the TS-2000. The FET buffer provides additional isolation and also includes an attenuator which lowers the IF output signal to a level suitable for feeding directly to the SoftRock.

## Assumptions

This writeup assumes the following things:

1. You are not using the HF RX antenna jack on the TS-2000. If you are then you'll have to figure out another way to bring out the IF signal from the TS-2000.
2. You do not have the DRU-3A digital voice recorder or VS-3 voice synthesis units installed. If you do then you'll have to find another place inside the radio to mount the interface circuit described below.
3. You have a SoftRock (or similar) that operates at or near 10.695 MHz. 10.7 MHz works but is not ideal. I'll go into more detail about that later.

## Implementation

The first thing you need is a circuit to buffer the 10.695 MHz IF signal and to provide isolation from the local oscillator (LO) on your SoftRock. The SoftRocks exhibit a fair amount of leakage of their LO out through the antenna port. Since you're going to be hooking the IF output of the Kenwood to the SoftRock's antenna input you want as much reverse isolation as possible. Putting a 10.695 MHz signal back into the 10.695 MHz IF circuitry would not be a Good Thing. Figure 1 shows the schematic for a simple FET buffer using a couple of J310 FETs.

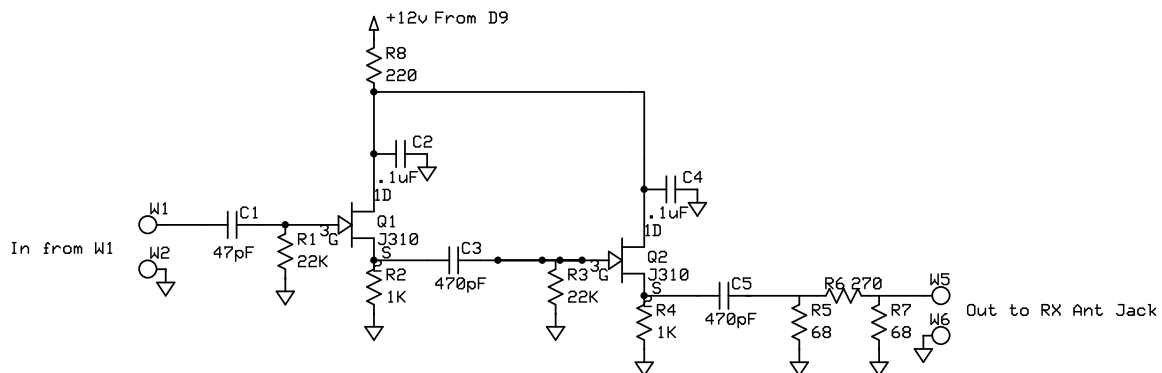


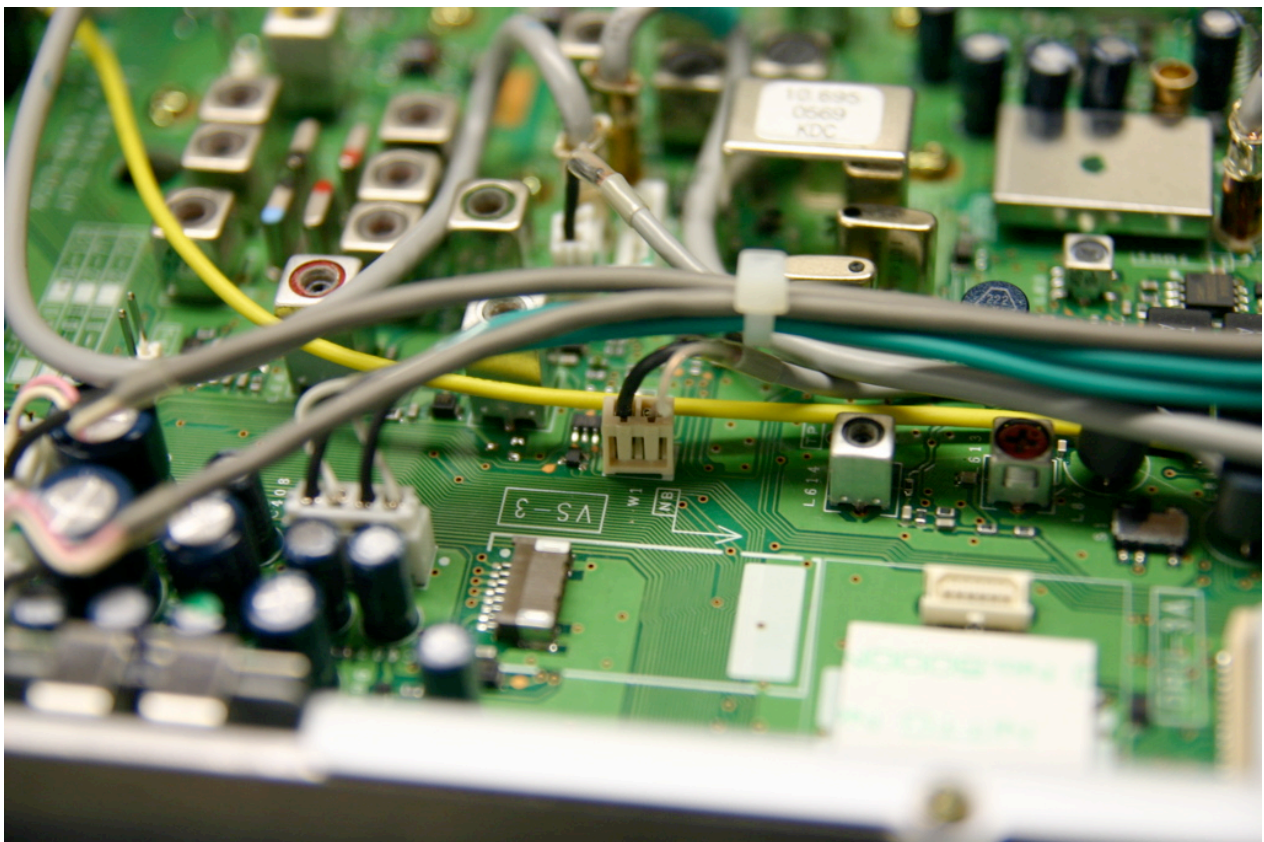
Figure 1 - FET Buffer Schematic

I experimented with bipolar transistors as well as FETs and got better performance from the FETs. If you are skilled in analog design (it's not one of my strengths) you can probably come up with something smaller/better/simpler. This circuit works for me. I used the J310 FETs because I had a bunch of them on hand. Others would probably work as well or better. I designed a simple PCB that would fit into the area designated

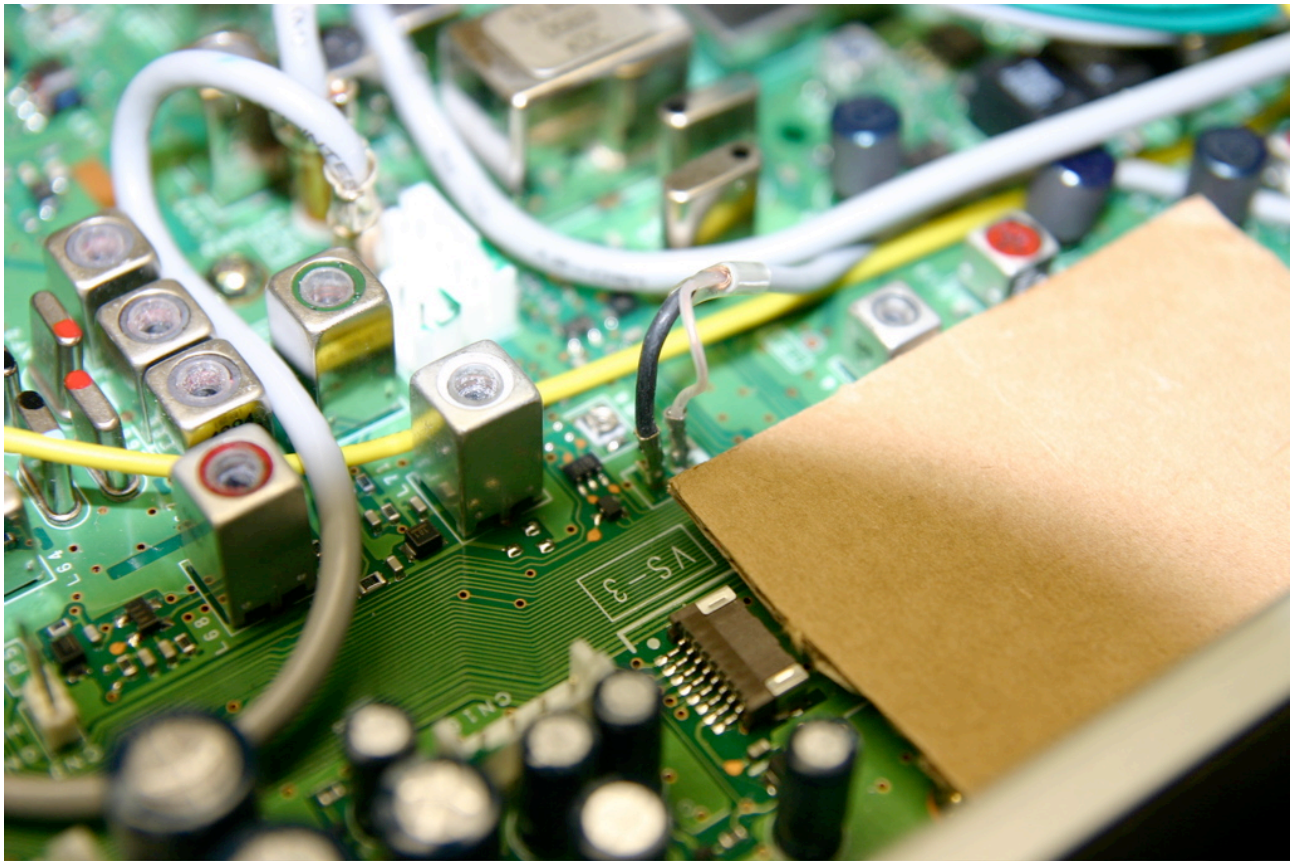
for the DRU-3A voice recorder module. I don't have this module and have no plans to buy it, so if you do you'll have to find a different mounting location for your buffer circuit.

Once you have built and tested the FET buffer it's time to open up the TS-2000 and mount the board and wire the cables. Here's what you do:

1. Remove the bottom cover of the TS-2000
2. Locate W1, a white plastic connector shell that has a shielded cable jumper going into it. This jumper carries the IF signal (amplified by Q22) to the TS-2000 noise blanker circuitry. There are two connectors marked "W1" - you want the one shown in the photograph below. (All photos are viewed from the "handle" side of the radio)



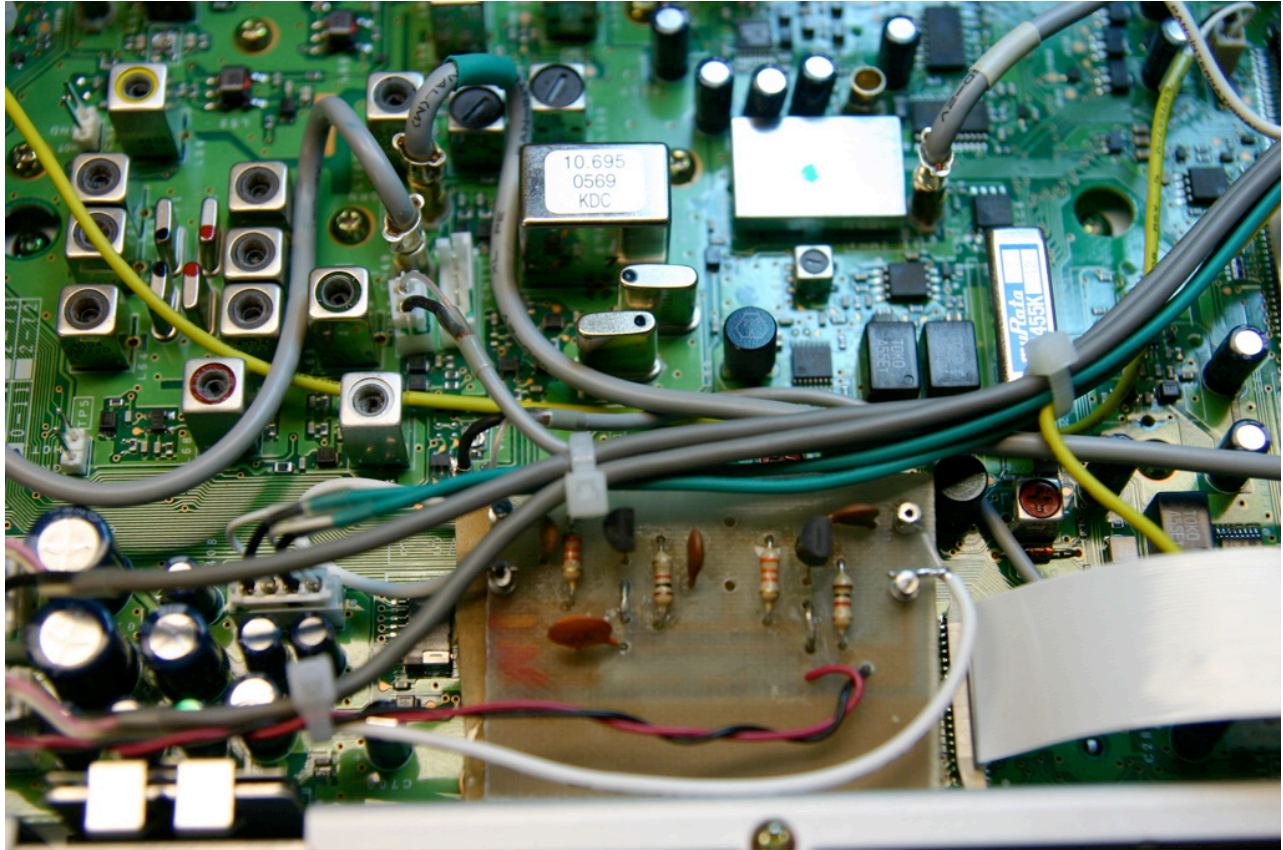
3. Using a small pair of diagonal cutters or wire snippers carefully (*very carefully*) cut away the white plastic shell surrounding the wires going into W1. The wires go to pins that are soldered into the PC board. Take your time and don't get over-zealous. You don't want to cut the wires or the pins, and you don't want to damage the PC board. The result will look like this:



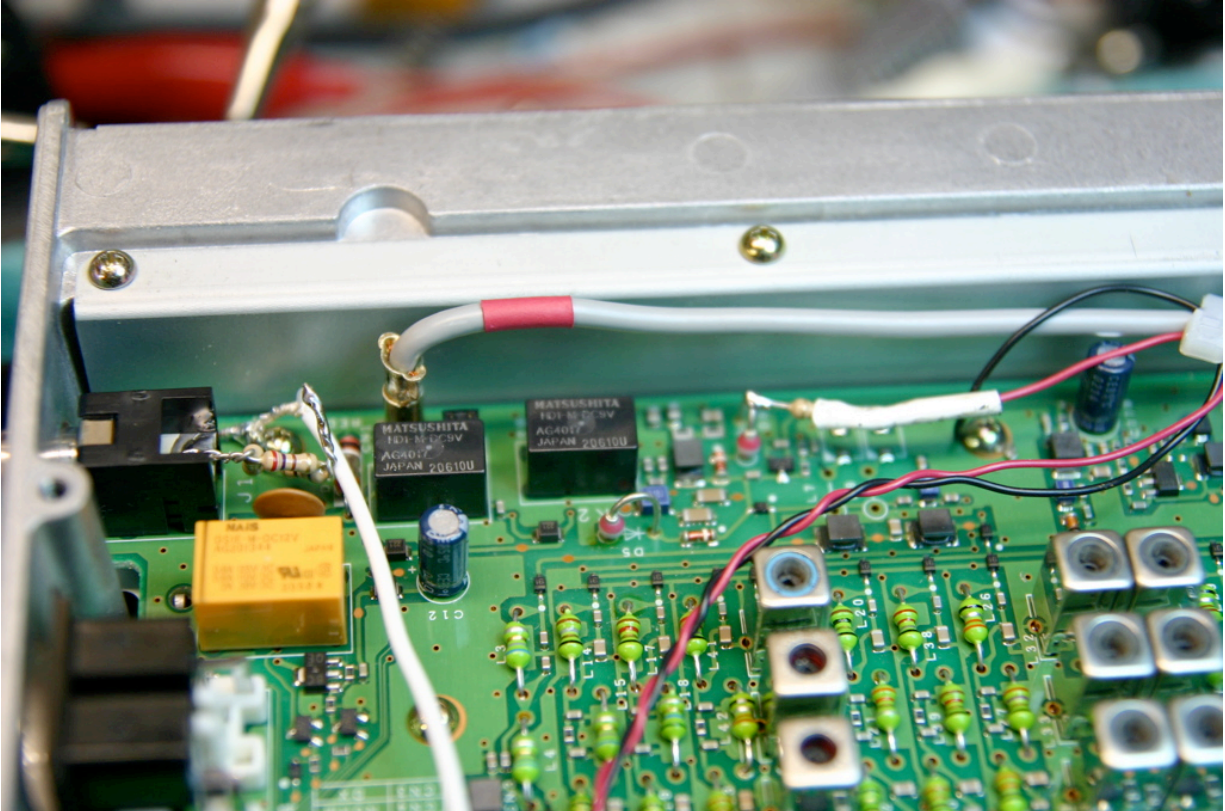
4. The pins you have exposed by cutting away the shell will be our W1 connection point for the 10.695 MHz IF signal. The white wire (on the right in the above photo) is the IF signal, and the black wire is ground. *Do NOT cut these wires.* We're simply going to solder the wires going to the input of the FET buffer to the pins going into the PC board. Use shielded cable (I used miniature coax) to go from the W1 connection point to the input of your FET buffer, and keep the cable short.
5. Now you'll need to mount the board. I put a piece of cardboard in the area normally designated for the VS-3 or DRU-3A options (I don't ever plan to get either of these, so the space was perfect for my FET buffer board) and held the cardboard down with double sticky tape. I used the same stuff to attach the FET buffer board to the cardboard.
6. Now route the output of the FET buffer board (again, use shielded cable) around the side and back of the radio over to the RCA phono connector used for the HF RX Antenna jack. Note: when the RX antenna is not used (not enabled in the TS-2000 menu) it is also disconnected physically by a relay. So it makes a good place to bring out the IF signal. If you actually use the HF RX antenna jack then you're going to have to find another way to get the signal out of the radio. You might consider the place where the 1.2 GHz pigtail comes out. I haven't tried that but it should be possible. Route your +12V power and ground wires from the board along the same route as the output cable. In the following photo the input to the FET buffer is on the

## SoftRock Interface to Kenwood TS-2000 10.695 MHZ IF

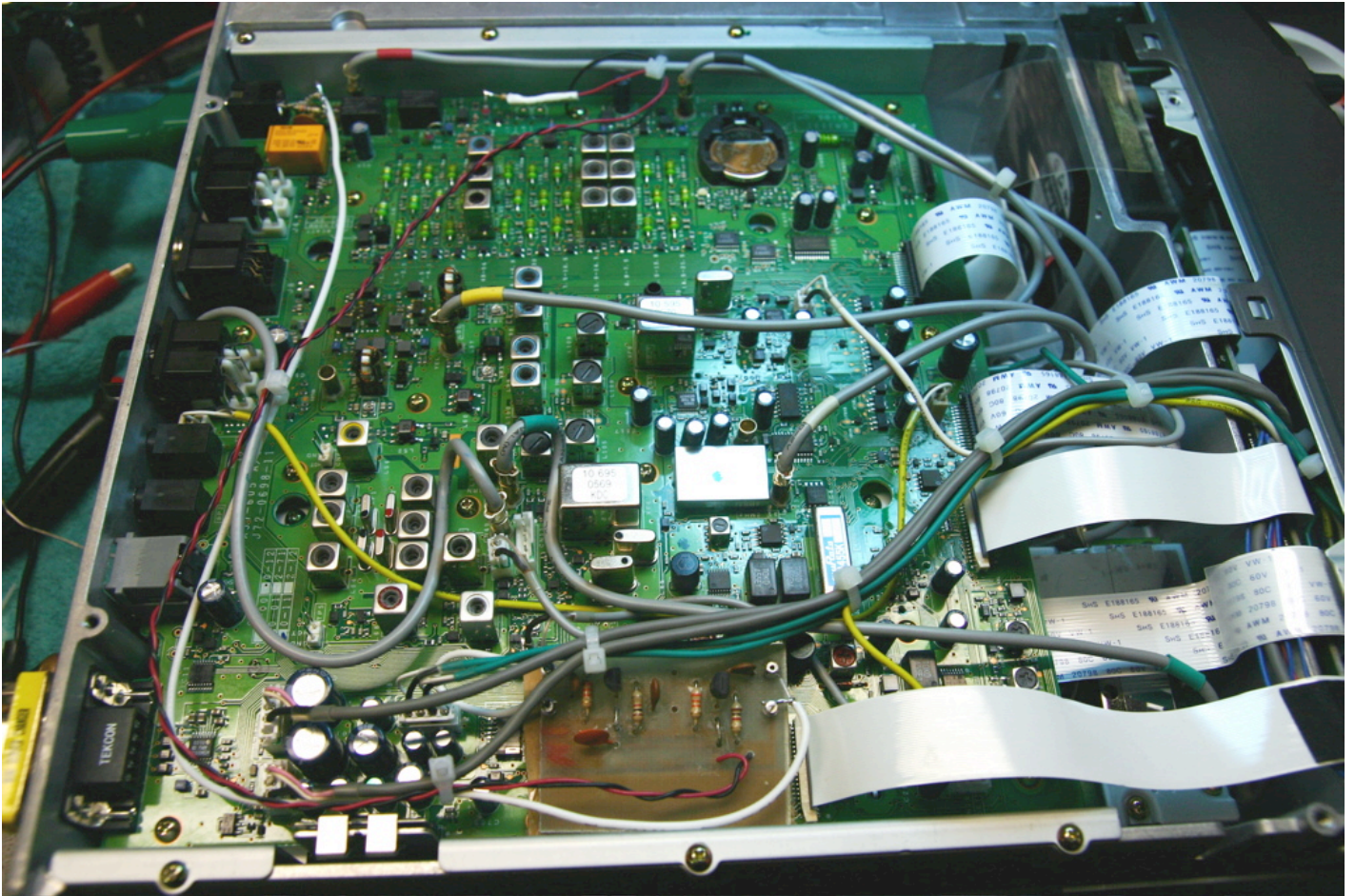
left side of the board and the output is on the right side of the board. The result should look something like this:



8. Now solder the output cable to the HF RX Antenna RCA phono jack. The metal exposed at the rear of the connector is the center conductor. You can attach the ground side of your output cable to the PC board screw near the RCA connector. In my case I added the 20 dB attenuator (Resistors R5, R6, and R7) after I did the FET buffer board, so I just soldered them onto the RCA connector. You can save yourself that hassle if you put them on your FET buffer board. The connection to the RCA connector looks like this:



9. Attach the +12V feed wire for your FET buffer to the top (cathode) of diode D9 as shown in the above photo. I soldered a 220 ohm resistor to the top of the diode and then attached the +12V wire to the other end of the resistor, covering it with heat shrink tubing. That's R8 on the FET buffer schematic. The reason I didn't put it on the FET board is that it serves as a kind of current limiter/fuse in case there is a short on the FET buffer board or in the power wire going to the FET buffer. Mistakes happen - wires get pinched, probes slip, etc. and it's cheaper to replace a resistor than to repair your radio. The current drawn by the FET buffer is so small that the drop across R8 is negligible.
10. The finished product is shown below. Now it's time to move on to the SoftRock.



### Connecting to a SoftRock

You're going to need a SoftRock board that can receive in the 10.695 MHz range. It is (or used to be) possible to buy SoftRocks with crystals that would work with a 10.7 MHz IF. You can use one of these, but 10.7 MHz is not ideal for the following reason. The center frequency of your SoftRock is the zero frequency point when it is down converted and sampled by your sound card. As a result there will be a "DC hump" at that point. In the case of the TS-2000, with its 10.695 MHz IF, the DC hump will end up being only about 5 kHz away from your rig's dial frequency. If all you have is a 10.7 MHz SoftRock then by all means use it - it'll work and you'll be able to see and hear signals up and down the band, but ideally you'd like to have your SoftRock center frequency at 10.680 MHz. That puts the "DC hump" up out of your way and gives you about 30 kHz (+/- 15 kHz around your center frequency) on the spectrum display. In my case I used a Silicon Labs Si570 programmable oscillator to place the center frequency of the SoftRock at 10.680 MHz, and it works quite well. You just need some way to clock the SoftRock at  $42.72 \text{ MHz}$  ( $10.680 \text{ MHz} * 4$ )

Connect a short piece of 50 ohm coax between the HF RX Antenna jack on the TS-2000 and the antenna input on your SoftRock. Apply power to your SoftRock and fire up your favorite SDR application.

### **Operation with SDR Software**

So far I've used this setup with Rocky and PowerSDR, but it should work with any software that works with a SoftRock. In PowerSDR I set the configuration for a SoftRock with a center frequency of 0.015 MHz (15 kHz) since my SoftRock center frequency (10.680 MHz) is offset 15 kHz from the TS-2000 IF frequency of 10.695 MHz. This put the signal I'm currently tuned to on the TS-2000 dial at approximately 0 on the spectrum display, and allows me to see signals 15 kHz above and below this point.

### **Quirks, Observations, and Things To Be Aware Of**

1. The TS-2000 apparently shifts its LO upstream from the 10.695 MHz IF whenever you adjust the filter bandwidth or center frequency on the radio. I have not investigated this, but I presume that it is done to simplify the radio's DSP code in the 12 kHz DSP IF. This behavior is manifested by a corresponding shift in frequency if you are listening to the signal coming from the SDR software.
2. There is a filter upstream from the 10.695 MHz IF that limits the response to around 30 kHz. You can actually see signals outside this range, but they are attenuated quite rapidly as you move beyond 15 kHz either side of center frequency.
3. If your spectrum looks "flipped" or tunes backward, reverse your I and Q connections to the sound card.
4. At least in my setup the S-meter on my TS-2000 matches the S-meter on PowerSDR almost exactly. I think that's just a happy accident - I didn't do anything to make it that way.
5. I have not done any serious receiver performance measurements using the SoftRock with the TS-2000 IF. I don't know what kind of dynamic range it has, or how well it handles close-by strong signals. I do know that the SoftRock provides a nice panadaptor function, and I can click on any signal I see and listen to it via the SDR software while also listening to another signal on the TS-2000. That's basically why I did this mod, so I have achieved my goal.

Your experimentation and input is encouraged.

73,

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