By Jan Skirrow

A SSB Detector for the R390 or R390A[1]

The R-390A, designed by Collins and built by a number of manufacturers, is one of the finest receivers of the golden age of tube technology. In some respects, it is superior to most modern receivers. But it reflects the missions of the 1950s, and is thus lacking in some significant ways. One of the most obvious is the lack of a single sideband (SSB) detector.

I wanted to construct a detector that could be used with the radio without making any modifications to the radio itself. Normally this could be difficult, but the stock R-390A brings out the necessary signals and connections to the rear panel. Thus, it is only necessary to provide the detection function externally, while matching the various signal levels required by the R-390A.

Several years ago I built an SSB detector from a schematic obtained through the R390A internet reflector list. It didn't work at all initially, due to errors in the schematic. Once these were located and corrected, the performance was still unsatisfactory.

The design used an LC oscillator that at best produced a quasi-sine wave that reduced audio quality. It was also not as stable as I wanted, with the usual mechanical problems associated with mounting and shielding a variable capacitor. It proved difficult to find a variable capacitor of the correct value, and the inductors used in the original design were junk box items that I didn't have. Despite sorting through a lot of different parts, I was never able to duplicate the performance claimed by the original author.

There were other oddities about the circuit that led me to the conclusion that a much better unit could be built from scratch. Also, at this point I knew more about the circuit than I had ever intended!

The result was a new design based on a very stable phase-locked oscillator. It is shown in the picture to the left.

Circuit Description

Schematic 1 (attached) is a schematic of the complete detector. A crystal controlled oscillator provides a 452kHz or 458kHz reference signal through shaping circuitry to an MC1496 detector. The R-390A IF output is amplified and applied to the signal input on the MC1496. The output of the MC1496 is filtered, amplified and applied to the R390A audio circuitry.

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The PLL Oscillator

U9 is a voltage controlled oscillator and phase detector in a single DIP package. The output of this oscillator needs to be either 452kHz or 458kHz. The output is fed to a scalar made up of U3 to U5. U7 and U6 provide gating to reset the scalars on the 452 or 458 count. This will produce a 1kHz pulse that is applied to the signal input on U9. A 1MHz crystal TTL oscillator, U1, is scaled by 1000 to provide a 1kHz reference signal that is applied to the reference input of U9.

If U9's output deviates from either 452kHz or 458kHz (depending on S3), the scaled signal from U5 will not be 1000Hz. The phase detector in U9 recognises this offset and generates an error signal that changes the VCO frequency to pull it back to the exact output frequency needed to give zero error.

A more complete description of this circuit is found in Tech Talk 9.

The CD4046B, U9, provides two pinouts that can be used to run a lock detect circuit, which I haven't included. The CD4046B will achieve lock within a few cycles at the 1kHz comparison frequency. Thus, there is no perceptible lock delay. If the lock isn't achieved, for some reason, the detector won't work and the user will know!

The Detector

The heart of the unit is a Motorola MC1496 detector. Out of production for some time, it has recently become available again.

The external 455kHz intermediate frequency signal from the R-390A rear panel socket is amplified and applied to the MC1496 signal input. R21 is used to set the level at the MC1496 to an optimal 1 volt peak to peak.

The MC1496 needs a sinusoidal signal on both signal and reference inputs. Thus, the square wave 452kHz or 458kHz signal from the PLL circuit is applied to an active filter composed of U14 and U15. R11 sets the optimal reference signal level of 60mV RMS to the MC1496 reference input.

The audio output from the MC1496 is filtered to remove any residual carrier or reference signals. It is then applied to a simple audio amplifier, with R30 used to set the output level so that when this is connected to the R390A, there is no significant change in audio level when S2 selects AM (where the internal R390A detector is connected to the audio circuit) or SSB (where the output of this unit is applied to the R390A audio circuitry.

Construction

The picture below shows the finished pcb mounted in a small plastic utility case with aluminum front and rear panels.

Front panel controls are S1 (power) S2 (AM/SSB) S3 (USB/LSB) and an LED power indicator.

The rear panel has a 12 volt regulator chip (for use with a wall transformer (see below), a bnc connector for the IF input, and a grommeted hole for the cable that connects to the R390 or R390A rear terminal strip.

The front and rear panels are part of the specified case. In this prototype, the panels

have been sprayed with yellow aluminum undercoating. Then plastic film with the legends printed on it has been prepared. These do not need to be glued, as they stay flat so long as they are carefully inserted under the lip on the plastic case as it is closed up. Holes have been cut to accommodate switches and other parts with an Xacto knife. The carefully tightened nuts on the controls are hold the plastic overlay in place.

Setup, Connection and Operation

This detector was designed for the R390 and R390A radios. It can be used with any radio that has a 455kHz IF output of appropriate level. However, it may not provide the kind of performance typical of detectors designed specifically for modern high performance radios. Also, the detector as designed assumes the use of the R390 or R390A internal audio amplifier.

To setup the detector, connect a well regulated 12VDC supply. A 12VDC wall power supply (wall wart) may result in audio hum due to a lack of adequate filtering and regulation. If a wall wart is used, a 12 volt regulator chip will likely be needed. In the finished unit shown in Figure 1, this extra chip is mounted on the rear aluminum plate. Although not shown in this photo, the chip should be bypassed with a 0.22ufd capacitor to ground on the input side, and a 0.1ufd capacitor on the output side.

While most 12V wall warts in fact give a high enough voltage under light load to allow a 12 volt regulator to work, it would be more reliable to use a 15 volt unit.

Connect the IF output from the rear of the R390 or R390A to the IF input. An AC voltmeter (or oscilloscope) capable of measuring accurately at 455kHz is needed for the setup. R21 is adjusted to provide the optimal signal level to the MC1496 under typical operating conditions. R11 is adjusted to provide the optimal carrier level at the MC1496.

The Diode Load jumper on the rear of the R390 or R390A is removed. A two wire plus shield cable is used to connect the radio to the detector. The connections are as shown on Schematic 1.

R30 is adjusted so that the audio level from the R390 or R390A remains more or less constant when selecting AM or SSB.

This detector does not alter the original AGC circuits in the R390 or R390A. Thus, optimal performance will be achieved by switching the receiver's AGC off, turning the receiver's Audio Gain to high or maximum, and using the RF Gain to set the output level.

The detector requires a steady hand on the receiver's tuning control, as the original mechanical tuning is barely adequate for tuning SSB stations. Excess slack in the radio's gear train can make tuning an SSB signal difficult.

More detailed assembly and setup instructions are provided with the kits listed below.

Available Kits

The detector is available as a kit in three different forms. Construction is fairly straightforward as no surface mount components are used. It does require careful soldering on closely spaced pads with a suitable fine tip iron. The board can be damaged easily from excess heat.

The Basic Kit includes the printed circuit board, the schematic, setup and operating instructions and a parts list including DigiKey part numbers. The pcb is two sided, professionally made, with plated-through holes, silk screened parts locators on the top side, and solder screens on both sides. All parts are conventional wire lead or solder tab type. The pcb is pre-drilled to mount on the existing bosses on the box shown in the pictures. This box is not included with the basic kit. The part number is.

The Board and Parts Kit includes all of the items in the Basic Kit, plus assembly suggestions for the PCB, and all the board mounted parts. Not included are the front panel switches and power indicator LED, rear panel connectors, wire, case or plastic overlays. Just those parts that are part of the printed circuit board.

The Complete Kit includes all of the above, plus the case, instructions for assembling the complete detector, front panel items (switches and LED power indicator), rear panel items

(12V regulator chip, power and RF connector, and grommet), plus a length of cable and some hook-up wire. In addition, printed plastic overlays for the front and rear panel lettering are included, as well as templates for drilling these panels. Pre-drilled panels are NOT available.

Finally, a **Power Supply** (a wall power transformer) is available.

Limited Time Offer

I plan to offer these kits until my stock is exhausted. Unless demand is spectacular, I don't intend to restock. Please email to confirm availability.

My interest is in sharing something into which I've invested a great deal of time and effort. I'm not in the Kit business!

Price List

1. Basic Kit: Email me.

2. Board and Parts Kit: $89.00

3. Complete Kit: $173.00

For US locations, air mail is included in the above prices. Shipping by surface mail is included for other locations world-wide. Other shipping methods may add cost. Shipping is normally within a week of receiving payment. Payment by PayPal is preferred. All prices are in US dollars. Orders for more than one kit receive a 5% discount.

To order, or to obtain further information on availability, please email me at:

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