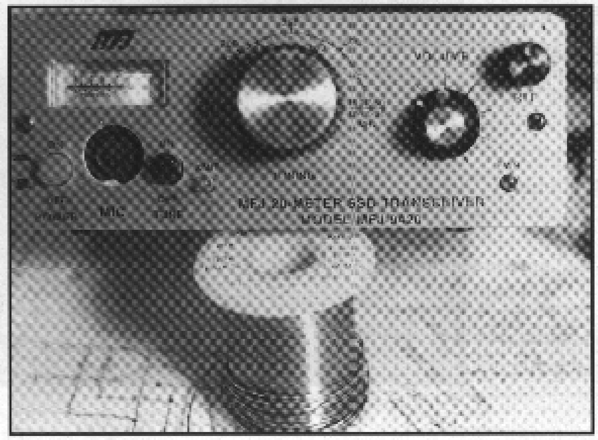
By Phil Salas, AD5X

The MFJ 9420D (D = Deluxe)

MFJ's adapter makes their small SSB transceiver into a bare-bones CW rig. A few simple upgrades (phone jack, CW filter, RIT) move it into the CW mainstream.



The MFJ series of single-band transceivers has become very popular in the amateur community. Of all the radios, I believe that the MFJ 9420 is the most versatile. With its extremely effective speech processor, the MFJ 9420 is a potent, lightweight and compact portable, mobile and fixed-station rig.

Although the MFJ 9420 is primarily a SSB radio, it can also work CW with the addition of an adapter board. The MFJ-415 CW Adapter lowers the frequency of the MFJ 9420 to the CW portion of the band with the push of a switch. It also provides side-tone monitoring and semi-break-in keying.

Several excellent reviews have already been written about this radio.[1] The purpose of this article is to show you how to significantly enhance the '9420, especially for CW operation.

[1]Notes appear on page 47.

Headphone Jack

This is the only enhancement that applies to SSB *and* CW operation. The MFJ 9420 does not have a headphone jack. This can be a *real problem* for late-night, quiet listening. I also wear 'phones much of the time when operating CW. A headphone jack is also handy for mobile operation. You can use it to connect the MFJ 9420 audio output to a CD-to-tape player adap-ter (such as a RadioShack #12-1951) to give you plenty of audio. The 1-W audio output of the MFJ 9420 is inadequate in a noisy mobile environment. (This audio level is fine for 16 or 32-Ω headphones, but you might want to include a 10 or 20-Ω series resistor if you use 4 or 8-Ω phones.—*Ed.*)

I wanted to add a 1/8-inch stereo jack to match most modern headphones and CD-to-tape adapters. Because the MFJ 9420 output audio amplifier has a balanced speaker output, the headphone jack must be isolated from ground. I accomplished this by using an enclosed PC-board mount jack mounted in an enlarged hole on the back panel. Figure 1 shows the wiring diagram. This DPDT jack is perfect for this application. The jack requires a 1/4-inch hole, so I drilled a 3/8-inch hole and insulated the nut from the chassis with a 1/4-inch fibershoulder washer. (See Figure 2.) This washer is a little too thick for the shaft length of the jack, but a few swipes of the fiber washer over a flat file fixed that. While I was at it, I made the speaker removable by adding a plug and jack to the speaker wires. (See Figures 1 and 3.)

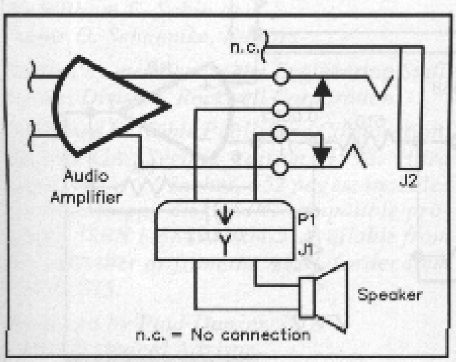


Figure 1—Schematic of the new headphone jack and speaker connections. Equivalent parts may be substituted. See Note 2 for suppliers' addresses.
P1,J1—Two-pin polarized, interlocking connectors (RS 274-222)
P2—1/8-inch stereo jack, enclosed, closed circuit (RS 274-246) mounted with a 1/4-inch fiber shoulder washer (Mouser #534-4711). See Figure 2.

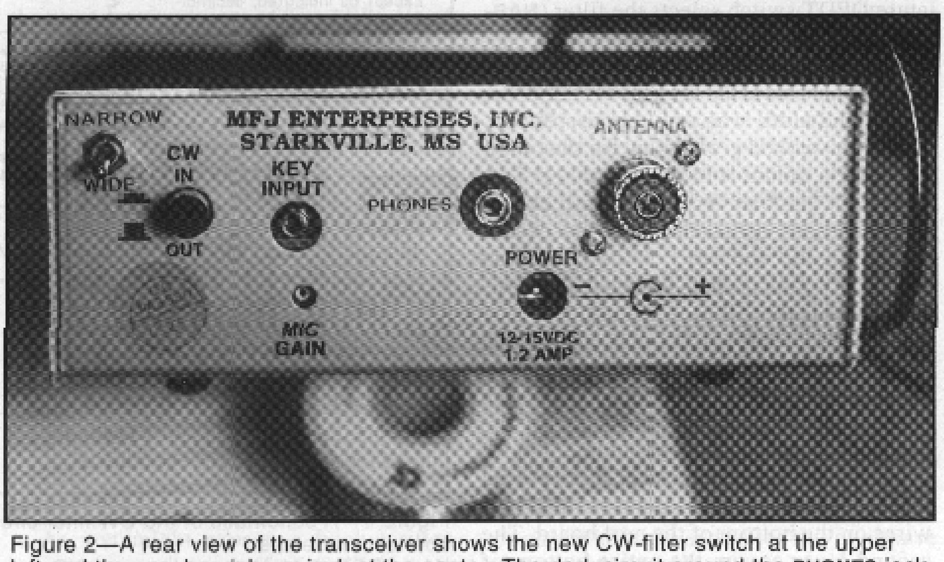


Figure 2—A rear view of the transceiver shows the new CW-filter switch at the upper left and the new headphone jack at the center. The dark circuit around the **PHONES** jack is a fiber shoulder washer to insulate the jack from the cabinet.

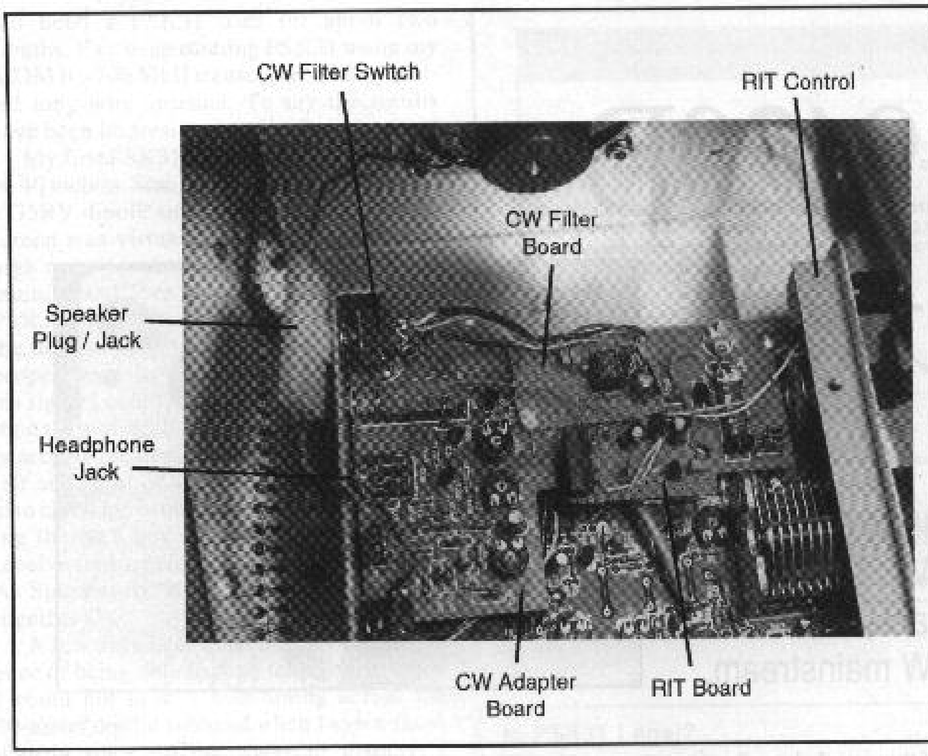


Figure 3—An interior view of the modified transceiver with modifications labeled.

CW Audio Filter

The MFJ 9420 is optimized for SSB. Therefore, no narrow-bandwidth CW filter is available. Because I operate CW most of the time, I wanted a filter.

I built an audio CW filter (see Figure 4) that consists of two band-pass filters, each with a Q of five and unity gain centered on 700 Hz. Pretty much any dual op amp can be used. I had several LM358s in my junk box, so I used one of these. When you build this filter, it's important to closely match the 0.0022 µF capacitors, 510 kΩ, 1 MΩ and 11 kΩ resistors used in both stages. That is, it doesn't matter if the values vary 5% from those shown, but the actual values of same-value parts used should match within a few percent of each other. A miniature DPDT switch selects the filter (**NARROW**) or bypasses it (**WIDE**).

When I built this unit, I found it centered almost exactly on 700 Hz, and the 3-dB bandwidth was only about 100 Hz. The filter worked great! Now for the tough part—let's mount it in the radio!

It isn't that bad. You can install everything without disassembling any of the boards inside the MFJ 9420 (that was one of my goals when I started this project). I built the filter on a small piece of RadioShack perf board material, with leads for +10 V dc, ground, audio in and out. I used two layers of double-sided tape (RS 64-2343) to mount the filter in the large blank area on the CW-adapter board. The first tape layer consists of small pieces placed around solder connections and wires on the bottom of the perf board. The second layer covers the entire bottom of the perf board. The **WIDE/NARROW** switch is mounted on the back panel near the upper-left corner. Figure 3 shows this all well.

I needed a way to break the audio path without removing any boards. To do this, I located C54 on the main board and rocked it back and forth until the leads broke. I tack-soldered a 1.0-µF electrolytic capacitor's negative lead to the negative lead broken from the original C54. The positive lead of this new capacitor connects to a common contact on the filter switch through a piece of RG-174 coax with the shield soldered to ground near the new C54 and near the switch.

Refer to Figure 4. You can pick up the audio input for the filter at pin 4 of the CW Adapter board. The side-tone audio is conveniently bridged onto the main audio line at this point. Solder a wire from pin 4 on the CW Adapter board to the other common contact on the new filter switch. Now, wire the switch so that one position shorts the audio across the switch: the **WIDE** mode. Wire the remaining switch contacts to route the audio through the filter. (The filter switch input, S1B, connects to pin 4 on the CW Adapter board. The filter output switch, S1A, connects to the new 1.0 µF capacitor.) Solder the new audio filter board's ground to any convenient ground on the CW Adapter board. Solder the +10 V filter wire to a pin on the CW Adapter's **ON/OFF** switch that can provide +10 V. Because the narrow filter is only used for CW reception, I picked the pin that provides +10 V only when the CW Adapter is on.

That's it. Now you can switch a narrow filter in and out when operating CW. This provides a tremendous selectivity advantage. In addition, when you center the received signal in this filter, your transmit offset is exactly 700 Hz (if the transmit offset is properly set).

Receiver Incremental Tuning (RIT)

The MFJ 9420 has no RIT. RIT is not needed for SSB operation, but it's very important for CW, especially when using a narrow filter.

Figure 5 shows my RIT circuit. A 78L06 voltage regulator ensures that the frequency-control voltage stays rock solid. I used a back-biased 1N4004 diode as a varactor. I got this idea from the NorCal 38

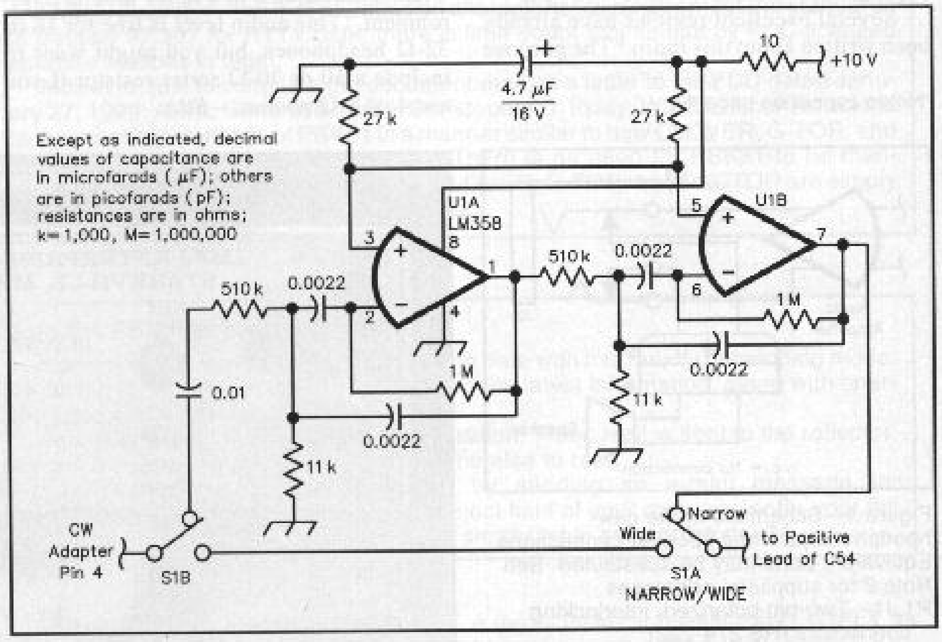


Figure 4—A schematic of the CW filter circuit and its switching. See text for connection details.

K1—SPST 12 V dc normally open SIP reed relay (1.6 kΩ coil, Hosfelt #45-191)

S1—DPDT toggle switch (Hosfelt #51-270)

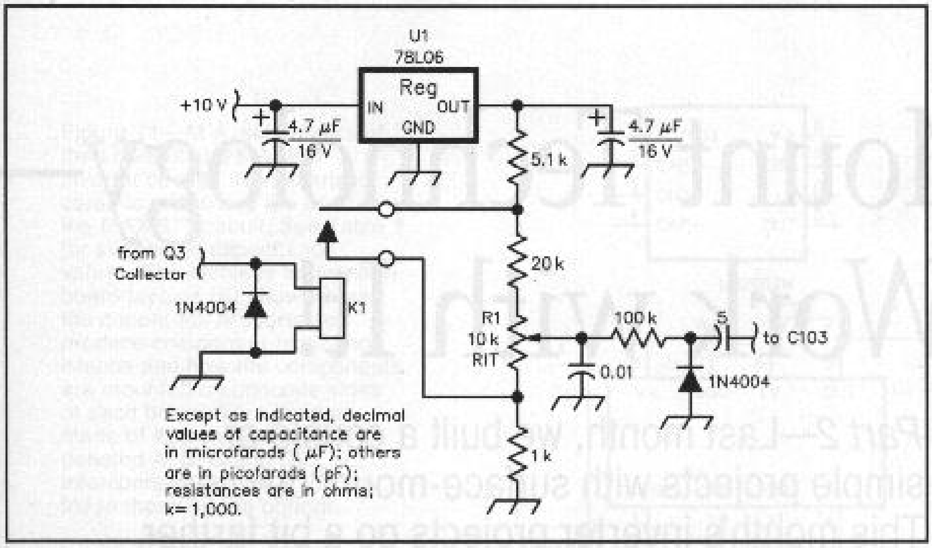


Figure 5—A schematic of the RIT circuit. See text for connection details.

R1—10 kΩ pot with center detent (Mouser #313-2000-10K)

K1—SPST SIP reed relay (Hosfelt #45-191)

Special, which uses a 1N4004 as a varactor to pull a crystal. The 1N4004 seems to work much like a MV2104. Like all varactors, you get the most capacitance variation at low voltages. Therefore, I set the center voltage at 1 V. With the circuit shown, the voltage varies from about 200 mV to about 1.8 V. Using the 5 pF series capacitor, I get a tuning range of about ±500 Hz. When transmitting, the relay fixes the voltage at 1 V by shorting out the potentiometer and 20-kΩ resistor. The relay is a normally open SPST SIP reed relay. This relay is small and has a relatively high coil resistance (about 1.6 kΩ). A second 1N4004 across the relay coil suppresses voltage spikes when the relay is deenergized, but any small-signal diode could be used here. Incidentally, I found no voltage-suppressor diode across the existing relay on the CW Adapter board, so I added one just to be safe. The RIT control is a 10 kΩ pot with a center detent. I mounted it in the upper-right corner of the front panel (see Figure 3). Any linear-taper pot could be used, but the center detent is nice for RIT. It makes the "no RIT" position easy to find and eliminates the need for an RIT on/off switch.

I built the RIT circuit on another small piece of perf board and attached it to the CW Adapter board with two layers of double-sided tape as I did with the audio filter. I built the RIT circuit much later than the audio filter. Now, I'd build both circuits on the same piece of perf board. A piece of small-diameter shielded microphone cable connects the RIT output to C103. (RG-174 will work well here, also.) Like the audio filter, the RIT circuitry can be connected without removing any boards or controls from the radio. After everything is connected, you will need to readjust C103 for correct frequency alignment in the CW part of the band. While you're at it, check and adjust (if necessary) the transmit CW offset. Make this 700 Hz, to match the narrow filter. Out of the box, my CW Adapter had about 1 kHz of transmit offset.

Summary

I've described modifications for the MFJ 9420 transceiver that turn this rig into a no-compromise SSB *and CW* radio. My parts cost for everything was less than $10, and the time required is only a few hours. The results are worth it!

Notes

[1]Steve Ford, WB8IMY, "MFJ 9420 20-Meter SSB-Travel Radio," *QST*, Feb 1996, pp 76-78.

[2]Parts Suppliers: Hosfelt Electronics, 2700 Sunset Blvd, Steubenville, OH 43952; tel 800-524-6464, fax 614-264-5414. Mouser Electronics, 2401 Hwy 287 N, Mansfield, TX 76063; tel 800-346-6873; e-mail **sales@mouser.com**; URL **http://www.mouser.com**.

Phil Salas, AD5X, is the Director of Radio Technology at Alcatel USA in Richardson, Texas. He was first licensed in 1964 and is active primarily in the HF CW bands. He shares his station with his wife Debbie, N5UPT, and daughter Stephanie, AC5NF.

New Books

HF Radio Systems & Circuits

By William E. Sabin and Edgar O. Schoenike, Editors

Written by members of the Engineering Staff, Collins Division, Rockwell Corporation

Published by Noble Publishing Corporation, Atlanta GA. Second edition, 1998. Hard cover, 9¹/₈ × 6¹/₄ inches, 652 pages; includes 3¹/₂-inch floppy disk of PC-compatible programs. ISBN 1-884932-04-5. Available from the publisher or from the ARRL (order Item 7253): $75.

Reviewed by Paul Danzer, N1II ARRL Technical Advisor

I gotta get this one! Every once in a while a book comes my way that gives me that reaction, and this one certainly did. This is a makeover of the classic engineering book, *Single Sideband Systems and Circuits* (see "New Books," *QST*, Jan 1996, p 94), but it's written in a manner that's accessible to professionals and hams alike. Before you say, "Oh yeah, here comes the calculus and vector analysis," think again. Math is sparsely used, and most often you neither need the math to understand the text nor to use the final design equation.

One of the editors, Bill Sabin, WØIYH, is a frequent contributor to ARRL publications and is the author of Chapter 17, Receivers, Transmitters, Transceivers and Projects of the most recent editions of *The ARRL Handbook for Radio Amateurs*. That chapter itself is a good recommendation for this book.

What did I like about the book? Well, to start with, it uses a *systems approach* to look at HF communication.

This book contains chapters and discussions of all aspects of HF radio. As an example, suppose you wanted to be able to work Western Europe at any time of the day or night from your QTH. This book, and several others, covers antenna requirements, transmitters, receivers and propagation—unique here is the total view of what it takes to establish a *link* from your QTH to the area of the world you want to work. Chapter 3, High Frequency (HF) Link Establishment, covers just this topic and demonstrates how commercial and military communication services would go about setting up this capability.

As you might expect, a book written by members of the staff of Collins (now Rockwell Collins) covers the basic elements of HF design. The chapter on system design includes information you might find valuable for your field day set-up—how to operate with more than one receiver. Chapter 4 starts the "conventional design" section. A minimum of mathematics is used, and generally just a basic knowledge of algebra will be enough. The idea of modular radio communication systems is brought out in the Exciter and Transceiver Design chapter—you have noticed how similar some of the ham radio hand-held transceivers are to commercial marine and public service units.

The book concludes with the description and application information for the 10 programs —actually 10 sets of programs—supplied on the accompanying disk. It is refreshing to actually get instructions on the use of software included with a book. Many publishers (and books) somehow don't manage to supply this information.

If you are interested in HF communications, want to improve your station to work more DX, or are considering building a major piece of hardware, this is a good reference to use before you spend any money or heat up that soldering iron. Collins quality was known in the ham world for many years, and the guys who wrote and edited this book have continued that tradition.