

Add Remote Control to Your ICOM Transceiver

Here's a fun project that finally marries the ubiquitous remote to the most important appliance in the home.

One of the wonderful things about modern ham transceivers is that they are also wideband receivers. I use my IC-756 extensively for shortwave reception, and even listen to AM on the broadcast band from time to time. Many radios, such as the popular IC-706, also support reception of the FM broadcast band and TV audio. In addition, I often casually browse the ham bands—simply to tune around the band to see what's on or to eavesdrop on interesting amateur conversations. I often engage in these activities while I'm doing something else...reading e-mail, building a homebrew project, or reviewing a recent issue of *QST*. When I'm casually listening to my radio, I don't want to be "glued" to it. It dawned on me that what my receiver really needed was a remote control. The TV receiver has a remote control, as does the CD player. Why not the amateur HF transceiver, as well?

Design Criteria

The remote control I envisioned would allow me to tune up and down the band, to change the receiver's volume and to directly access any memory, at any time. In addition, the remote should also work as a direct frequency entry keypad, allowing me to jump to any frequency in the receiver. Finally, it would be nice if the remote also contained a band plan so that it would know what mode to put the radio in for any given frequency. It should know, for example, that when I enter 14250, I want USB, but when I enter 7225, I mean LSB. It should also set the proper mode for shortwave broadcasts, FM frequencies, etc. The simple project presented here meets all of these criteria.

An infrared (IR) remote control system consists of two parts: the hand-held remote



and a device that receives and interprets the IR signal, and then uses this information to interface with the radio. Since it is now possible to buy a "Universal" remote control for as little as \$10 at stores like RadioShack or Wal-Mart, it made no sense for me to redesign this part of the system. This project is therefore a remote control interface, which contains an IR sensor and the circuitry necessary to control the radio. Universal remote control units can be programmed to command virtually any brand of TV or VCR. All I had to do was to make my transceiver "impersonate" one of these units. I decided to make it appear to the remote control as a Sony TV receiver.

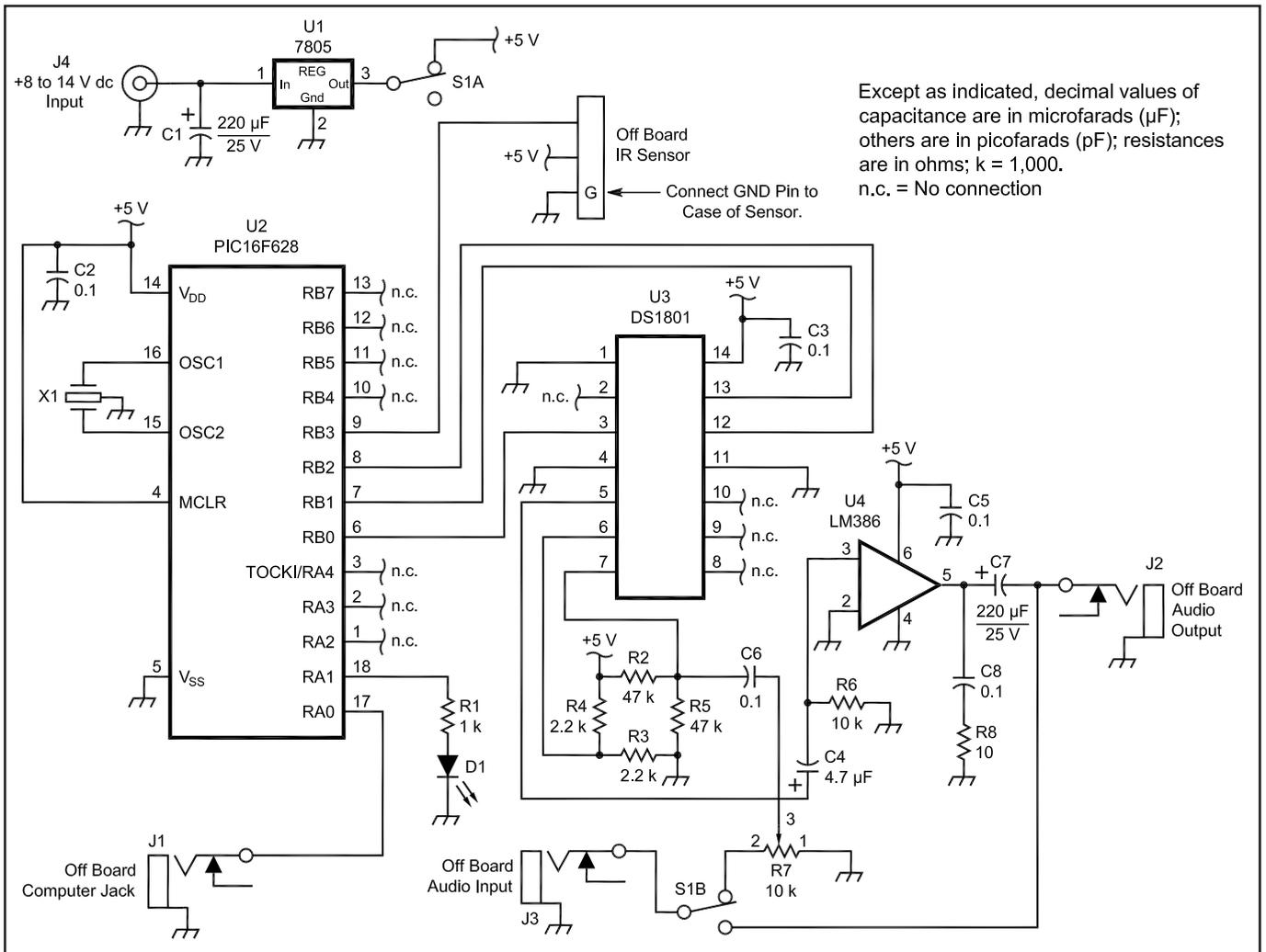
Circuit Description and Construction

There are four major components to the project: an IR sensor, a programmed PIC microcontroller, a digital potentiometer and an audio amplifier (see Figure 1). The IR sensor connects directly to the PIC, which interprets the codes sent from the hand-held remote. It connects to the

computer port on the transceiver to execute the user's commands. The interface is designed to work with any late model ICOM radio (more recent than the IC-735). The computer port allows the frequency and operating mode to be set and allows any programmed memory in the radio to be directly accessed. However, it is not possible to adjust the transceiver's volume via the computer port. The ability to adjust the volume was fairly important to me, since my goal was to avoid going near the radio when I was doing casual listening. Audio adjustments are implemented by using a patch cable to connect the external speaker output of the radio to the audio input on the remote control interface. An external speaker is then plugged into the audio output on the interface. A digital potentiometer allows the PIC microcontroller to adjust the volume and an audio amplifier IC boosts the audio to speaker drive level.

This was my first experience using a digital potentiometer, and I found there was quite a bit to learn in order to use these devices effectively. The Dallas Semicon-

¹Notes appear on page 43.



Except as indicated, decimal values of capacitance are in microfarads (μF); others are in picofarads (pF); resistances are in ohms; $k = 1,000$.
n.c. = No connection

Figure 1—The IR remote control receiver schematic. All resistors are $\frac{1}{4}$ W, 5% tolerance. Parenthetical part numbers are RadioShack, www.radioshack.com; all other parts as indicated. Digi-Key Corp, 701 Brooks Ave South, Thief River Falls, MN 56701; tel 800 344-4539; www.digikey.com. Be sure to solder the ground pin to the IR sensor case, if not already done.

C1, C7—220 μF capacitor, electrolytic, 25 V dc (272-1029).
C2, C3, C5, C6, C8—0.1 μF capacitor (272-1069).
C4—4.7 μF capacitor (272-1024).
D1—LED (276-026).
IR—IR detector module (276-0137).
J1-J3—Mono phone jack (274-251).
J4—Coaxial power jack, Digi-Key SC1153-ND.

R1—1 k Ω .
R2, R5—47 k Ω .
R3, R4—2.2 k Ω .
R6—10 k Ω .
R7—10 k Ω , trimmer potentiometer (271-282).
R8—10 Ω .
S1—DPDT toggle switch (275-626).
U1—7805T, 5 V regulator (276-1770).

U2—PIC16F628, programmed microcontroller, Digi-Key PIC16F628-20/P-ND.
U3—DS1801, digital potentiometer, Dallas Semiconductor; www.maxim-ic.com.
U4—LM386, audio amplifier (276-1731).
X1—10 MHz ceramic resonator, Digi-Key X906-ND.

ductor DS1801 used in this project actually contains two potentiometers—only one of which is used here. At first glance, three of the pins on the IC (high, low and wiper) seem to correspond to the three pins on a standard potentiometer but the IC can't be used as a simple drop-in replacement for an analog audio control. Audio signals contain both positive and negative voltages. The DS1801, on the other hand, is designed to control signals with only positive voltages. If you simply drop the device in to replace a standard potentiometer, you will obtain a very distorted signal at the output since the negative voltage components will have been eliminated.

The solution is to add dc bias to the

audio signal so the waveform is preserved but the voltage at every point is raised and never falls below zero volts. Resistors R2 through R5 constitute a Wheatstone bridge, performing this function.

A further problem occurs because the digital potentiometer is designed to work with relatively low voltage (line level) signals. The trimmer potentiometer, R7, allows you to adjust the input level to the device without changing the setting of the volume control on the transceiver. To bring the volume back up to a level that will drive a speaker, some amplification is required. I used an LM386 audio amplifier IC for this purpose. This was adequate to provide room-filling volume

in my shack. If you need more audio, you could use a powered speaker of the type typically used with PC audio systems. If you decide you do not wish to control the volume of the radio remotely, you can delete U3, U4, J2, J3 and all associated circuitry, making this into a very simple project indeed.

The unit requires a power supply voltage from 8 V to 14 V dc. U2 is a PIC16F628 microcontroller, which must be programmed before it can be used.¹ Kits as well as wired and tested units are available from the author.²

Setup and Operation

Two cables are required to connect the

remote control receiver to the radio. J1 should be connected to the radio's CI-V port. A patch cable with mono 1/8" plugs on both ends will work for this purpose, but use a high quality shielded cable. Another mono patch cable will be needed to connect the transceiver's external speaker jack to J3. An external speaker is connected to J2 and power is applied to J4. The completed remote control receiver is shown in Figure 2. Switch S1 turns the power on and bypasses audio to the IR receiver when it is off.

I used a very inexpensive hand-held remote control from RadioShack (Part Number 15-1989), purchased for under \$10. Any universal remote control should work as long as you can configure it for a Sony brand TV receiver. Look for one that has POWER, ENTER, and LAST or PREVIOUS keys. To configure the unit, begin with the transceiver off and the remote control interface on. Follow the instructions in your remote control manual to configure the remote to communicate with a Sony TV receiver. After configuring the remote control, try pressing the ENTER key while pointing it at the remote control interface. The LED on the interface should flash. Now turn on the transceiver and set its computer port baud rate to 9600. Also make a note of the radio's "CI-V address." This can be found in the transceiver's manual or, on newer radios, it can be found by looking at the relevant menu item on the radio. For example, the IC-706MKIIG is address 58h. Ignore the "h"; it merely indicates that the number is being expressed in hexadecimal rather than decimal. Press the POWER button twice, then enter the two-digit CI-V address. For the '706MKIIG, for example, you would press POWER POWER 5 8.

If the CI-V address has a letter in it (a hexadecimal number may contain the digits 0-9 and the letters A-F) the procedure is slightly different. Instead of the letter key, press the MUTE button then press the number of the key that corresponds to the letter of the alphabet you wish to use. For example, the default address of the IC-706MKII was 4Eh. To enter this address press POWER POWER 4 MUTE 5 (E is the fifth letter of the alphabet).

After you have set the CI-V address, try the channel up and down buttons. They should cause the radio's frequency to tune up and down. In sideband and CW modes, the radio will change in 100 Hz steps. In AM and FM modes, it will change in 1 kHz and 5 kHz steps, respectively.

Adjusting the audio is a little trickier. Leave the radio on and turn the remote control receiver off. Adjust the volume on the radio to a normal level. Now turn

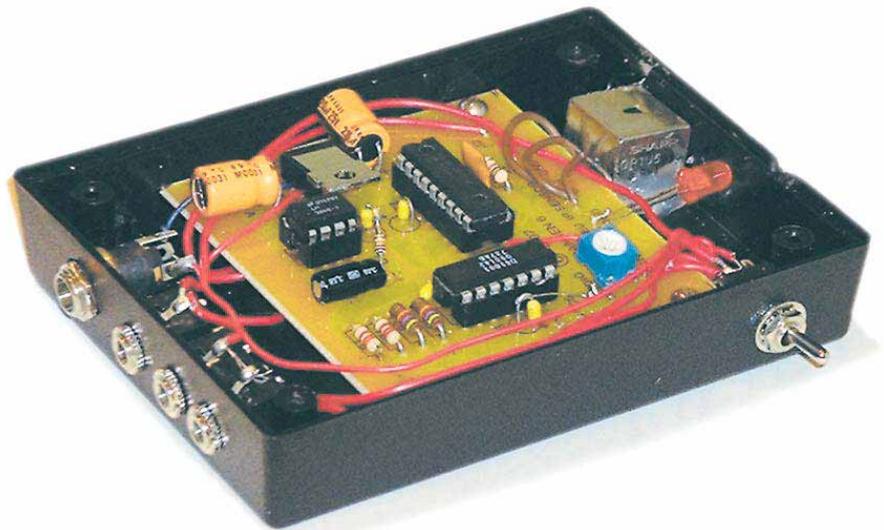


Figure 2—The prototype IR remote control receiver.

the remote control receiver on. Hold down the volume up button until the volume no longer increases. Now adjust R7 so that the volume you hear is about the same regardless of whether the unit is on or off. This method will cause you to be listening most of the time at or near the maximum volume level of the digital pot. I have found this produces the best results. Lower digital pot volume levels tend to introduce a "click" sound when the radio is tuned and make the mute function less effective.

Using the Remote

The remote control receiver is now ready for operation. The channel up/down, volume up/down and mute functions are self-explanatory. Direct frequency entry and memory selection may require some additional description. To enter a frequency, simply enter the digits using the POWER key as a decimal, if needed. Finish by pushing the ENTER key. When the ENTER key is pressed, you should see the LED on the remote control interface blink and the radio should respond to your command. You may enter the frequency either in kHz or MHz; the interface is smart enough to figure out which you mean. Here are some examples:

3 7 2 5 ENTER	3725 kHz
3 POWER 7 2 5 ENTER	3.725 MHz
1 4 2 5 0 POWER 5 ENTER	14250.5 kHz
1 4 6 POWER 6 4 ENTER	146.64 MHz
0 POWER 7 3 0 ENTER	730 kHz
1 4 ENTER	14 MHz

Note that you cannot enter a decimal as the first character. If you wish to enter a frequency starting with a decimal point, enter a zero first, then the decimal (POWER).

To go to any memory in the radio, simply press the PREVIOUS or LAST key, then the two-digit number of the memory

that you wish to use. For example, to go to memory number 1, press LAST 0 1.

You can use the channel up/down keys or direct frequency entry keys while in memory mode to tune the memory frequency. Pressing the ENTER key without first entering a frequency will cause the radio to switch from memory to VFO mode. Pressing the LAST key three times in a row will cause the radio to shift from VFO mode to memory mode, coming up on the last used memory.

Conclusion

After I installed the remote control on my IC-756, I found that I use the radio somewhat differently than I had previously. I almost never used direct frequency entry on the transceiver because the built-in interface is clumsy, but I make use of it constantly on the remote control. It's easy to operate the radio now while doing other things and I find that I spend more time listening to my transceiver than ever before.

Notes

¹The .HEX object file is available at www.arrl.org/files/qst-binaries/hansen0203.zip.

²A PC board for this project is available from FAR circuits 18N640 Field Ct, Dundee, IL 60118-9269; tel 847-836-9148. Price: \$4.50. A complete kit is available for \$45 from John Hansen, 49 Maple Ave, Fredonia, NY 14063. A pre-drilled enclosure can also be purchased for \$10. Wired and tested units are also available: see john.hansen.net.

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