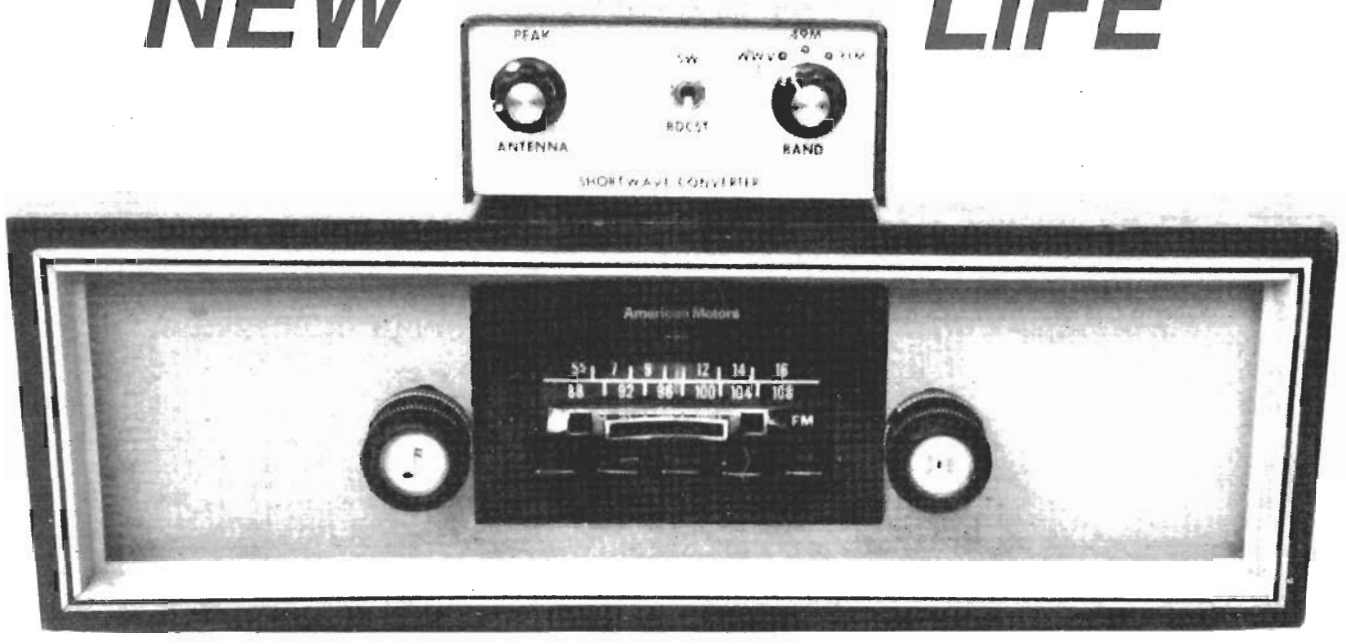
NEW LIFE FOR OLD CAR RADIOS



Hear the world with this deluxe shortwave converter!

GARY McCLELLAN

Part 2 LAST MONTH, WE showed you how to turn a car radio into a fine home receiver. But perhaps you're tired of hearing the same old music, news, and sports from your local stations. If so, take heart! This month we're going to show you how to build a shortwave converter that will let you hear the latest news from the places where it happens, while it happens. With it, you'll also hear the kinds of music and cultural events that are popular in many faraway places.

Our converter adapts any analog (dial type) AM car radio to receive international shortwave stations. It covers the two most popular bands, namely 49 (6 MHz) and 31 (9 MHz) meters, plus WWV (5 MHz); WWV is a frequency measurement service that also broadcasts time signals, making it great for setting your household clocks very accurately, among other things.

But why is using a converted car radio so important to this project? First, as outlined last time, those radios feature sensitivity and selectivity that is superior to what is offered by conventional home radios; a car radio modified for home use and outfitted with our shortwave converter will provide performance that is far superior to that of the low-cost multiband radios often seen at discount stores. Also, car radios are well shielded, so noise pickup is reduced resulting in quieter reception.

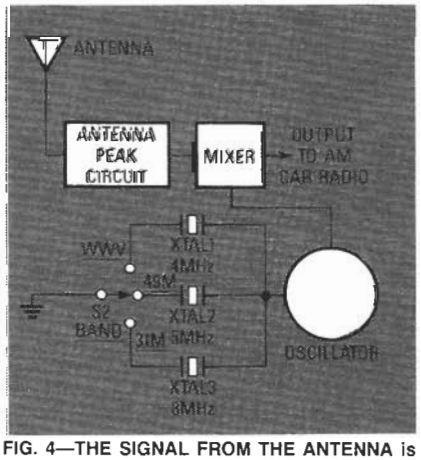


FIG. 4—THE SIGNAL FROM THE ANTENNA is mixed with a locally generated signal and the difference mixer-output frequency is output to the radio.

Considering those advantages, and the ease and low cost of converting a car radio to home use (as demonstrated last time), using a modified car radio for this project makes perfect sense.

Exploring the bands

If you've never listened to shortwave radio, you are probably wondering about the stations that you might discover and their programs. Of course, what you hear will vary due to broadcast conditions and what time of day you tune in; but here is a typical sample of what to expect: Radio HCJB (Ecuador), the BBC (UK) and Radio Deutsche Welle (Germany) offer music and news programs with a perspective not heard on U.S.-broadcast news reports. Other stations that you may find interesting include the Voice of Free China (Taiwan), Radio Havana Cuba (Cuba) and the Voice of America (U.S.). Those stations also offer music and cultural-affairs programs that are very entertaining. Surprisingly, those stations, and many more, were heard using only the equipment described here, plus a 4-foot antenna!

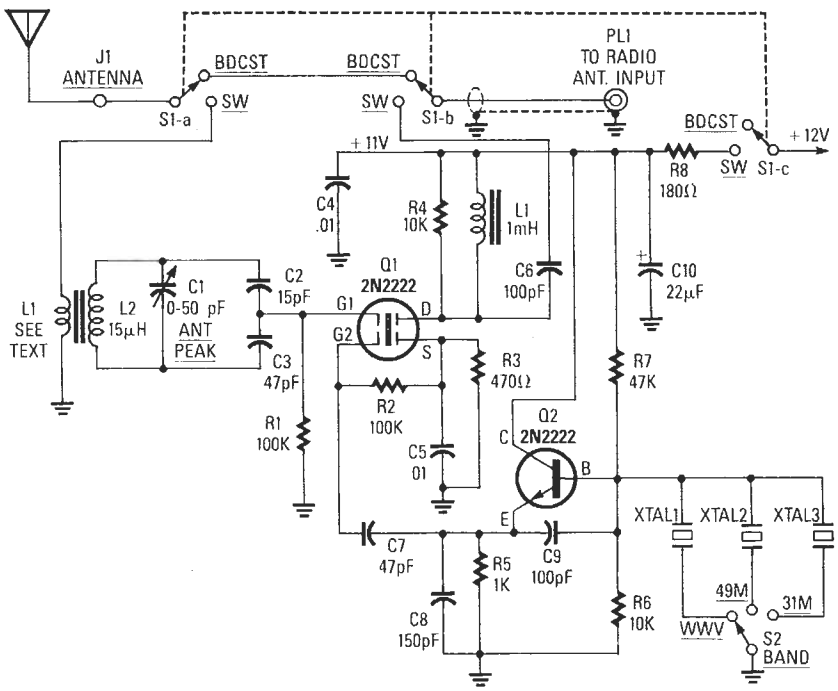


FIG. 5—COMPLETE SCHEMATIC for the shortwave converter. Few of the parts are critical, so feel free to make appropriate substitutions.

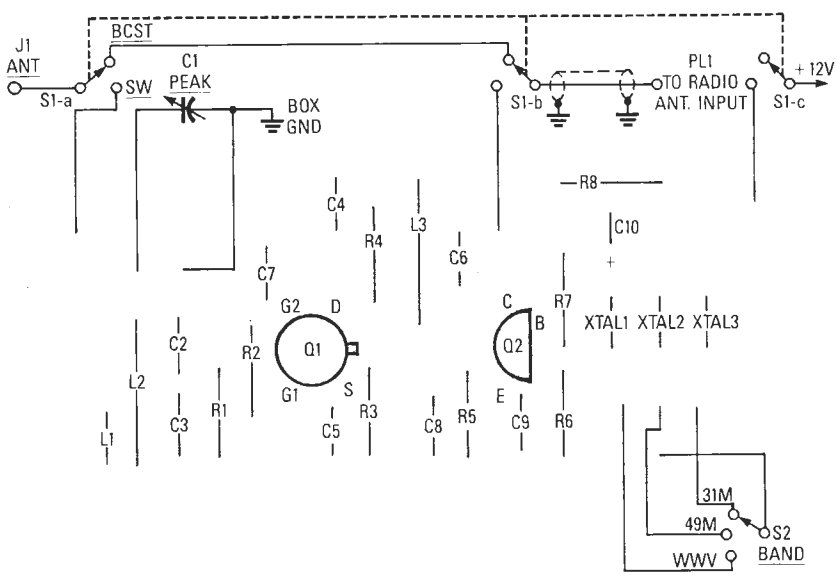


FIG. 6—USE THIS GUIDE when mounting the components; we recommend following it even if you are using perforated construction board.

How it works

The circuit downconverts signals from WWV, 49 meters, and 31 meters to frequencies in the AM-broadcast band. With it, it is possible to tune in worldwide shortwave stations just like the conventional AM broadcasts you normally hear on your radio. A block diagram in Fig. 4 shows the basic details of the converter circuitry.

The shortwave converter consists of mixer and crystal oscillator circuits. The mixer combines signals picked up by the antenna with a locally generated signal. The result is output signals in the 540–1600 kHz range; those are the frequencies that are normally received by the car radio.

The local signal is generated by the oscillator. Three crystals, 4 MHz, 5 MHz, and 8 MHz are used to provide coverage of the bands previously mentioned. Selection of the appropriate crystal, and hence the band to be received, is done using a three-position switch, S2.

Now that we know how the converter works, let's examine the circuitry in a little more detail; a complete schematic is shown in Fig. 5.

Signals from an antenna are input to the circuit via J1, a five-way binding post. A three-pole switch, S1, is used to select or bypass the converter. When that switch is in the broadcast position, your radio will operate as normal; in the shortwave position, power is fed to the converter (via S1-c) and shortwave frequencies are then easily received.

Assuming that shortwave reception has been selected, signals are first fed to a tuned circuit made up of L1, L2, and capacitors C1–C3. That circuit is set to pass only the frequency of interest and reject all others. The circuit is included to pre-

PARTS LIST

All resistors ¼-watt, 5%
R1, R2—100,000 ohms
R3—470 ohms
R4, R6—10,000 ohms
R5—1000 ohms
R7—47,000 ohms
R8—180 ohms
Capacitors
C1—50 pF, variable, see text
C2—15 pF, ceramic disc
C3, C7—47 pF, ceramic disc
C4, C5—0.01 μF, ceramic disc
C6, C9—100 pF, ceramic disc
C8—150 pF, ceramic disc
C10—22 μF, 16 volts, electrolytic
Semiconductors
Q1—40673 dual-gate MOSFET (RCA)
Q2—2N2222 NPN transistor
Other components
L1—4 turns, 28-gauge wire over L2, see text
L2—15-μH RF choke, JW Miller 9310-40 or equivalent
L3—1-mH RF choke, JW Miller 70F103AI or equivalent
J1—5-way binding post
PL1—Motorola-type auto-radio plug
S1—3PDT toggle switch, see text
S2—three-position rotary switch
XTAL1—4-MHz crystal, 32-pF parallel mode, HC-18 case
XTAL2—5 MHz crystal, 32 pF parallel mode, HC-18 case
XTAL3—8 MHz crystal, 32 pF parallel mode, HC-18 case
Miscelaneous—PC board or perforated construction board, knobs, 2- × 4- × 4- inch aluminum project box (LMB CR-442 or equivalent), RG-59 coax cable, hardware, hookup wire, solder, etc.

vent AM-broadcast signals from reaching the radio and causing interference. Capacitor C1 should be peaked for best reception once the circuit is fully assembled and tested.

The output across C3 is fed to the mixer circuit, which is built around Q1, a dual-gate MOSFET that functions as an RF amplifier and mixer, thereby reducing the number of parts required.

The local oscillator signal from Q2 is also fed to the mixer, via capacitor C7. The mixer output appears across L3 and R4 and is coupled to the output via C6. Resistor R4 limits the output level; it is needed because strong signals could otherwise cause distortion in the radio.

The local oscillator circuitry is simple and straightforward. It uses a standard Colpitts oscillator circuit built around Q2, with C8 and C9 providing feedback for oscillation. Crystals XTAL1–XTAL3 provide the proper operating frequencies as described earlier.

That about does it for the theory. Let's get started with construction.

Building the converter

The circuitry is simple, and easy to build, too. As we've shown, only two transistors and a few other assorted parts are used. While we've provided a PC pattern (see PC Service) and a placement guide (see Fig. 6), they are not strictly required. If you wish, you could wire up the circuit on a small piece of perforated construction board with good results. And best of all, no alignment of any kind is needed. That is great news for those of us who lack an RF test generator.

Probably the only hard-to-find part in the project will be variable capacitor C1. Those units are becoming scarce, because many of the original manufacturers are out of business. Try surplus stores for C1, or else substitute a higher-value unit. A 100-pF capacitor should work fine.

The semiconductors aren't too critical. Other MOSFET's, such as members of the 3N200 series, can be used if the RCA 40673 isn't available; the RCA component is preferred, however, since it is overload-resistant. For Q2, most garden-variety silicon NPN transistors such as the 2N3904, 2N4124, and others, should work just as well.

The coils may be almost any type available, providing that the inductances are the same. The miniature units specified were used simply because they were handy.

As for the crystals, low-cost computer types were used here; there is no need to order them custom made and wait for delivery. You can use surplus units of slightly different frequencies, if desired; all that will do is to change dial calibration on the car radio. However, with the values specified, 5 MHz (WWV), 6.0 MHz (49M), and 9.0 MHz (31M) tune in at exactly 1000 kHz on the radio. That is desirable, because it makes finding specific frequencies easier.

Moving on, the rest of the parts aren't especially critical. But you should assemble the project in a metal project box to avoid pickup of local AM-broadcast signals. The switches may be any combination of rotary or toggle types available.

Once you have all of the parts it's time to start construction. Here are some suggestions to help you do the job:

At this point there are two possible routes: First, you can turn to PC Service and fabricate the board for this project shown there. Otherwise you can mount the components on a 1.5- × 3.5-inch piece of perforated construction board and use point-to-point wiring.

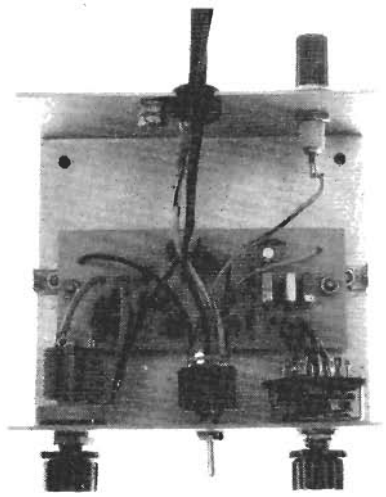
If you choose to go the PC-board route, a parts-placement diagram is shown in Fig. 6. Those using point-to-point wiring will find that diagram useful, too; for best results we recommend following roughly the same layout on the perforated construction board.

Start construction by winding coil L1. That is an easy task. Simply wind four turns of 28-gauge magnet wire over one end of L2. Then twist the wire ends together to hold the coil in place, secure the coil with nail polish, and let dry. Finish up by untwisting the wires and then tinning the ends.

Continue by installing the major components, such as the coils and crystals, on the board as shown. Then follow with the resistors and capacitors; be sure to keep all leads as short as possible. When done, install the semiconductors. Note carefully the tab positioning on Q1 and the flat side of Q2. Finish up by checking your work and correcting any errors.

Set the assembled board aside for a moment and prepare the aluminum box. Refer to Fig. 7 for a suggested panel layout, then drill your box accordingly. No dimensions are given for the layout because it will vary with the sizes of the parts you are using. Although not shown, you'll also have to drill a mounting hole for J1, as well as a hole for the output cable and the power lead; those holes should be located on the rear panel. When all holes are drilled, mark the functions with press-on labels and coat the box's exterior with clear plastic spray.

FIG. 7—THE COMPLETED CONVERTER. If you wish, follow the design shown here when laying out your front panel.



MOUNT THE BOARD inside the enclosure using ¼-inch spacers and 4-40 hardware.

When the cabinet preparation is complete, mount C1, S1, and S2 on the front panel, and J1 on the rear panel. After that, install the board in the enclosure. Use ¼-inch spacers and 4-40 hardware to secure the board in place. Be sure to install the knobs, too. Note that on C1, the pointer should be in the 9-o'clock position when the capacitor plates are fully closed.

Wire the board to the cabinet-mounted components using using stranded hookup wire; be sure to cut each wire as short as possible. Don't forget to install the bypass wire between S1-a and S1-b, and install a 3-foot length of hookup wire at S1-c for power. Feed that wire and a length of RG-59 coax through the rear-panel hole intended for that purpose. Solder the coax's center conductor to S1-b and the braid to ground. Attach plug PL1 to the other end of the cable and you are finished!

Using the converter

The unit is easy to hook up. Simply plug PL1 into the antenna jack of your car radio. Then connect the power lead to the power supply (as described last month). After that, connect a short antenna to binding post J1. A simple antenna such as a 4 foot piece of hookup wire should be sufficient.

Set switch S1 to the broadcast position and turn on the radio; you should hear regular AM-broadcast stations as before. Then set the band switch, S2, to the WWV position and turn S1 to the short-wave position. Tune your radio carefully around 1000 kHz and you should hear the WWV time clicks at least weakly. Adjust C1 for maximum volume and then you are all set!

Reception on 49 and 31 meters works the same way. Set the band switch to the band of interest, then tune in stations from 1000 to 1600 KHz on your radio. Adjust C1 for maximum volume on each station. That's all there is to it, so enjoy! **R-E**