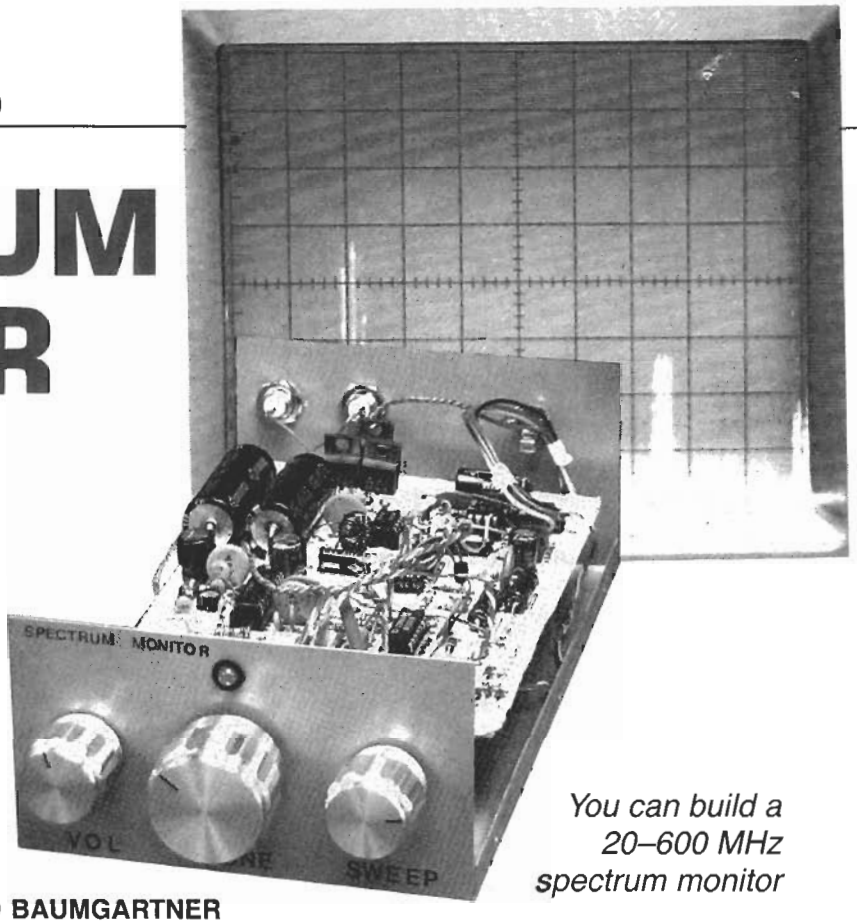
BUILD THIS

SPECTRUM MONITOR



You can build a 20–600 MHz spectrum monitor

FRED BAUMGARTNER

LAST MONTH WE WENT THROUGH ALL OF the details concerning the spectrum monitor's circuitry. We will continue with the construction procedures, as well as some troubleshooting.

Construction

The Parts-Placement diagram is shown in Fig. 1. This project is sufficiently easy to build and align that even those who shy away from RF construction shouldn't have any trouble. Reasonable care, especially in grounding, will allow successful construction on perfboard, protoboard, or the PC board.

If you're using a PC board (a foil pattern is provided in PC Service), use sockets for the IC's and Q1. Install R2 before C1 and C2 so that you'll have room to work, followd by IC1–IC3, IC5, D4, D5, L3, R15–R17, C30–C33, D2 and S1. Plug in IC5; you should now have +5 volts out of IC2, +10 volts out of IC1 and IC3, and +25 volts across D5. Use either pieces of clipped component leads or other stiff wire to make the pins of J8, the jack used to attach the tuner wires to the PC board. You can replace the tuner wiring-plug PL6 with any other compatible six-pin SIP versions, as long as you can find a matching socket that'll fit on the PC board.

The coils are hand-wound from No. 26 enameled wire. Inductors L1 and L2 are 12 and 8 turns on a ⅛-inch drill bit as the form. Transformer T2 is a 3:1 auto-transformer using a Mouser 542-T68-2 ferrite toroid-core with 3/16 -inch inside diameter. Tie a small knot in the wire and wind 8 evenly spaced primary turns, twist in a 1.5-inch center tap, and do the 24 secondary turns. A toroid prevents the cabinet from being flooded with 10-kHz magnetic noise.

The metal cabinet is a 8- × 4.5- × 2.5-inch steel box. All wires between the PC board and the controls and jacks should be twisted in related groups, and made sufficiently long to route them to the side of the PC board with J8 and PL6 so the PC board can be easily removed from its 1-inch standoffs. Use plastic and styrofoam between the PC board and tuner to stabilize both and insulate one from the other, and install the rest of the parts.

Figure 2 shows a photograph of the

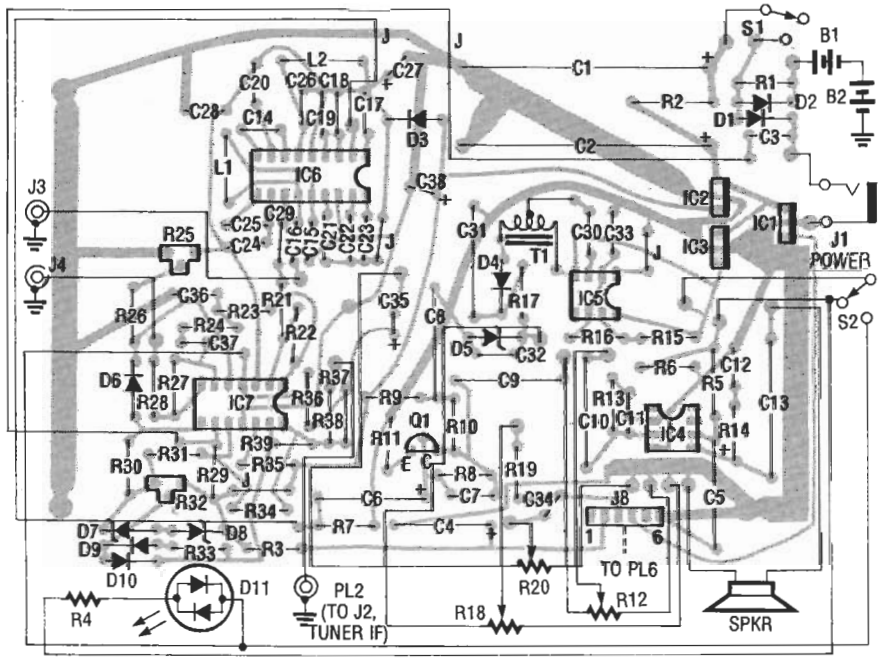


FIG. 1—PARTS-PLACEMENT DIAGRAM for the spectrum monitor. Use sockets for the IC's and Q1. Use plastic or styrofoam between the PC board and tuner to stabilize and insulate both.

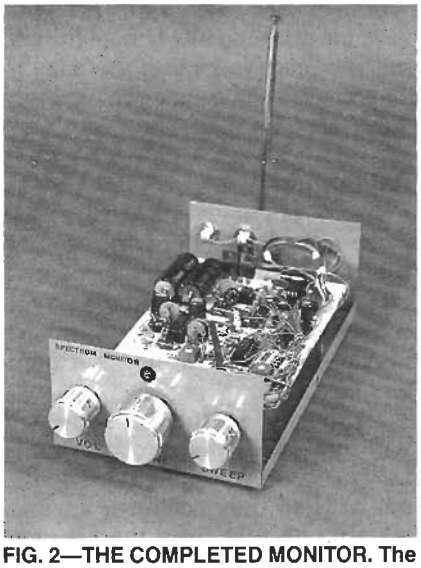


FIG. 2—THE COMPLETED MONITOR. The telescoping antenna is connected to J5 via a BNC-to-"F"-type adapter.

Figure 2 shows a photograph of the spectrum monitor with its case open. The coaxial cable in the center is the IF OUT from the tuner (J2), and the wiring for the front potentiometers and switches, as well as for the rear jacks is on the right so the PC board can be removed for maintenance. However, proper construction techniques should eliminate the need for maintenance. Note the positions of the IC's, Q1, and the PC-board-mounted potentiometers. The monopole antenna (ANT) is connected to J5 via a BNC-to-"F"-type adapter (PL3-J6), and gives good reception.

Checkout and setup

After everything is installed and wired, remove the DIP's and verify that the +5-volt and +10-volt supplies work. Replace the 555 (IC5), and verify the +25 volts from the voltage tripler and clamp. Replace the LM386 (IC4) and verify the audio by turning up the volume with the sweep off. Insert a little audio hum into pin 2 of the TDA7000 (IC6) socket by using a piece of wire to couple to your hand; if you don't hear anything, something's wrong.

Replace the NE5514 (IC7), turn on the sweep, and observe the HORIZ OUT (J4) on an oscilloscope. If you see a sawtooth, adjust the sweep frequency potentiometer R32 for a stable waveform. To lock to 60-Hz, use AC. With the oscilloscope sweep on line, adjust R32 for a single sweep waveform per 60-Hz cycle. The vertical output from J3 should be a straight line with a short +5-volt pulse, in sync with the horizontal sweep retrace portion.

Replace the TDA7000 (IC6); with the sweep off and the volume turned up, you should hear white noise. Tune the TDA7000 using C26 to 63 MHz, the middle of TV channel 3. You can tune the converter to a channel-3 TV station if you have one in your area. Disconnect the coaxial cable from IF OUT (J2), and use another cable to connect the IF OUT (J2) to a TV on channel 3, using the fine tuner to pick a station.

Without moving the fine tuner, reconnect the IF OUT to the TDA7000 simultaneously, and tune C26 to match the audio of the selected station. You could also use an RF generator producing a 63-MHz carrier with a modulated FM tone, if you prefer, but keep the level low, as the TDA7000 is quite sensitive.

With the sweep at maximum (fully clockwise), an oscilloscope displaying the VERT OUT (J3), and a small wire in J4, adjust R18 and C26 to produce a display with maximum sensitivity and clarity. Set the baseline, adjusting R25 so the display is as vertically large as possible, with no downward mirror image (lower portion of the signal envelope); some slight noise should show above the baseline. Repeat to maximize performance before closing the cabinet.

The two-color LED (D11) in the front panel should be green for receive/audio and red for sweep; both it and R4 are mounted off the PC board. When you rotate the center-frequency potentiometer R18, clockwise corresponds to a lower-central frequency, and counter-clockwise to a higher value. That is as if you were looking through a moving window at the spectrum, the window width determined by the sweep-width potentiometer R20.

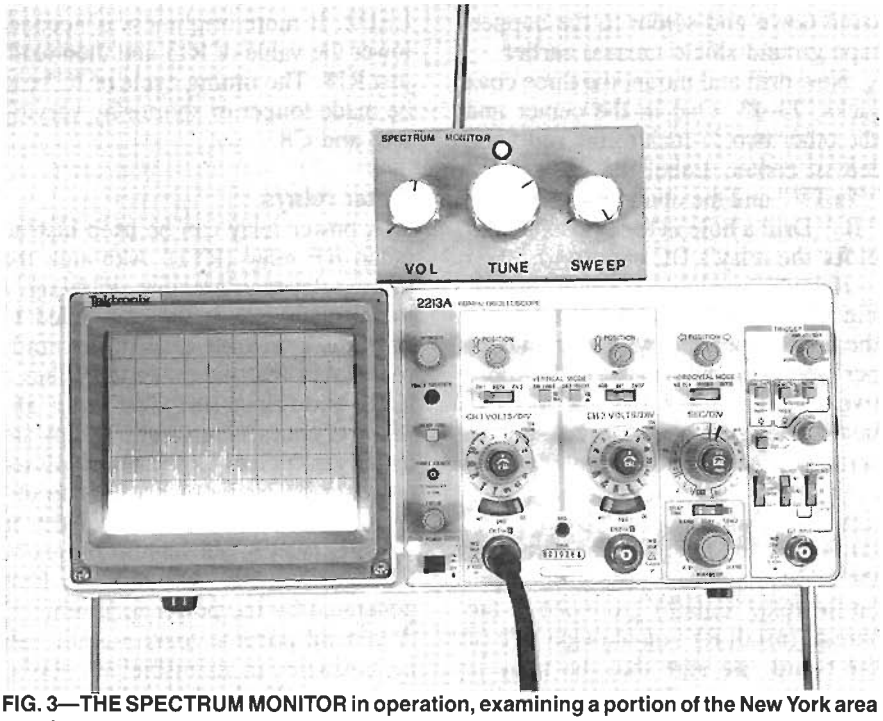


FIG. 3—THE SPECTRUM MONITOR in operation, examining a portion of the New York area spectrum.

Using the spectrum monitor

A photograph showing the spectrum monitor in operation, examining a portion of the New York area FM spectrum is shown in Fig. 3. The monitor has quite good RF sensitivity, so use an RF attenuator before J5 when making comparative level measurements, or when handling strong signals. Comparing RF levels is straightforward, with the accuracy limited only by the tuner gain linearity. With the exception of the extreme ends of the tuning range, most converters have fairly flat response.

The cheapest attenuator pads are the in-line "barrel" type used in cable TV, available in 3-, 6-, 10-, 12-, or 20-dB sizes, with "F"-type jacks. You can also use a switchable gain set as discussed in the Radio Amateur's

Handbook. To connect an oscilloscope to the spectrum monitor, set the vertical amplifier to DC mode at 1 volt/div, and the horizontal sweep to external (x-y mode). Hook the VERT OUT (J3) to the vertical amplifier (the y-axis), and the HORIZ OUT (J4) to the horizontal amplifier (the y-axis). The spectrum monitor outputs have +5-volts DC bias and 5-volts AC maximum swing. If the oscilloscope can't be offset enough in the DC mode, use AC coupling.

If the oscilloscope has no x-y mode, use the VERT OUT (J3) alone. It contains the positive blanking pulse mentioned earlier, and the oscilloscope can use that as the trigger in a free sweep. If you're running the spectrum monitor off AC, it'll sync with the 60-Hz line voltage, so line triggering will suffice. Don't overload the RF input, otherwise the display will clip on strong signals, and the front end of the tuner will either generate modulation products which will appear on the oscilloscope or be damaged. The spectrum monitor can be used with either a marker or RF generator of known output frequency to mark a specific value.

To use the spectrum monitor as a continuously tuned receiver, turn-off sweep potentiometer R20. The signal in the center of the oscilloscope screen will be demodulated, which is very useful in identifying an offending carrier, or in hearing FM noise. You'll be able to listen to signal levels that consumer FM receivers would have trouble with.

Some modifications

A couple of changes can make the tuned-receiver approach more useful. The first is to extend the frequency range downward. Converters typically contain high-pass filters to remove frequencies below 50 MHz, which can be shorted out with a wire and cutting the relevant foils.

Tapping the IF OUT (J2) lets you use the spectrum monitor as a cable converter. Use two 50-ohm resistors and a switch as a "Y" to feed both the TDA7000 (IC6) and a back-panel "F"-type jack. One way to find the center frequency is to tap pin 4 of the tuner (the FIRST LOCAL-OSCILLATOR TUNING VOLTAGE) to an outside pin jack for a high-impedance VOM or DMM. That lets you graph known frequencies and voltages to find unknown ones. **R-E**