# WARC and LF on the TR-7

## Will your TR-7 be ready when the new WARC bands arrive? Don't get caught short — the time is now! Here is an easy, inexpensive method for adding the new bands and more to this popular transceiver.

By Robert K. Morrow, Jr.,* WB6GTM

The Drake TR-7/DR-7 has been in production for a few years and has proven itself to be an outstanding transceiver. It is equipped with 1.5- to 30-MHz continuous receiver coverage and with transmit capability on all presently authorized amateur bands. Without the DR-7 digital-readout option, the receiver coverage is more limited, but the circuit described here will enhance the capabilities of this rig as well.

Another TR-7 option is the AUX-7 auxiliary program board, which is a small circuit board that plugs into the TR-7 chassis. This option allows the owner to install special ICs from the manufacturer, extending the receiver coverage below the 1.5 MHz lower limit and allowing the transmitter to operate in other band segments. In addition, the AUX-7 board provides crystal sockets to be used for fixed transmit or receive operation.

The AUX-7 features most useful to a ham would be the addition of transceive capability on the three new WARC band segments at 10, 18 and 24.5 MHz and the extension of receiver coverage down into the 1f region. (Would you believe 0 Hz?) This article provides details for the construction of a circuit board that will give your TR-7 the same capabilities as with the AUX-7. No modification to the rig is required, since this board simply plugs into the AUX-7 connector within the unit.

### Synthesizer Operation

Since this is intended to be a construction article, a detailed analysis of the TR-7 frequency synthesizer is not included. The service and instruction manuals describe the operation, and an excellent block diagram is included with the description.

The portion of the synthesizer relevant to this project is the *load number*, which is used to determine the lower end of the desired 500-kHz band segment tuned by the TR-7. This number is given by the formula

$$N = 86 - 2F \qquad \text{(Eq. 1)}$$

where N is the load number and F is the desired band segment in MHz. For example, one of the WARC bands is in the 24.5-MHz segment. The corresponding load number is $86 - [2\,(24.5)] = 37$. In a similar manner, load numbers may be calculated for any 500-kHz band segment within the tuning range of the TR-7.

### Circuit Description

The AUX-7 control-signal pinout is shown in Table 1. The aux rotary-switch pins (1-8) are set to +5 V dc as each is selected by the AUX PROGRAM switch on the TR-7 front panel. These act as diode program source voltages for the band-select, transmit-enable and load-number logic. The band-select lines (9-12) are used to extinguish the SET BAND light on the front panel when the main rotary band switch is set to the proper range, as shown in Table 2. When the 24.5-MHz band segment is selected with the AUX PROGRAM switch, for example, the SET BAND light will illuminate until the rotary band switch is set to the 22- to 30-MHz range. This ensures that the correct low- and high-pass filters are inserted. Incidentally, the transmitter will not operate until the SET BAND light is out, to prevent spurious radiation and possible output-transistor damage. The transmit-enable pin (14) is brought to +5 V to allow transmitter operation in the new WARC bands, when they become available.

The next eight lines (15-22) are set to the load number corresponding to the desired 500-kHz band segment. The first load number digit is converted to binary-coded decimal (BCD) and placed on lines B3-B0, and the BCD code for the second digit is placed on lines A3-A0. Earlier, we calculated that the 24.5-MHz segment required a load number of 37. In this case, B3-B0 would be 0011 (BCD 3), and A3-A0 would be 0111 (BCD 7).

How are these binary codes implemented? Each binary "1" is realized by connecting a diode from a +5-V source to the AUX-7 pin requiring the "1." A binary "0" is automatic; pull-down resistors[1] are placed in the circuit to ensure that a line will default to logic "0." (CMOS logic is used in the TR-7.) For

**Table 1**
**AUX-7 Plug Pin Functions**

| *Pin* | *Function* |
|---|---|
| 1-8 | Aux Rotary Switch |
| 9-12 | Band Select (A-D) |
| 13† | +10 V |
| 14 | Transmitter Enable |
| 15-18 | A3-A0 Load |
| 19-22 | B3-B0 Load |
| 23 | GND |
| 24† | Fixed Oscillator Out |
| 25† | +10 V Fixed |

†Not used in this circuit

Viewed from the front of the TR-7, the pins are numbered from left to right.

**Table 2**
**Band Select Codes**

| *Band (MHz)* | *Decimal Code* | *BCD (Pins 9-12)* |
|---|---|---|
| 0-2 | 2 | 0010 |
| 2-3 | 3 | 0011 |
| 3-4.5 | 4 | 0100 |
| 4.5-7 | 5 | 0101 |
| 7-10 | 6 | 0110 |
| 10-15 | 7 | 0111 |
| 15-22 | 8 | 1000 |
| 22-30 | 9 | 1001 |

*9792 Oma Pl., Garden Grove, CA 92641

example, let's completely outline the operation of the rig on the 24.5-MHz segment. We want this band to be selected by Aux Program 3 on the front panel and, of course, we want transmit capability. To implement this combination, we need the band select to be 1001 (BCD 9), the transmit enable to be activated, 0011 (BCD 3) to be on lines B3-B0, and 0111 (BCD 7) to be on lines A3-A0. From Table 1, it can be seen that pins 9, 12, 14, 16, 17, 18, 21 and 22 of the AUX-7 plug must be connected to pin 3, which becomes the + 5-V source when the AUX Program switch is in position 3. Diodes are used for the links so that isolation is provided from the other AUX Program lines.

### Construction and Installation

Assembly of the AUX-7 substitute board is straightforward. Fig. 1 gives the schematic diagram. The foil and component sides of the circuit board are illustrated in the etching pattern (page 39) and in Fig. 2. The circuit board measures 2-1/2 × 4-1/4 inches, and the resistors are mounted vertically. Half-watt or smaller resistors will fit easily. Both connectors are DIP solder-type, with 0.156 (5/32)-inch pin spacing. Although the AUX-7 connector has 25 pins, it is easier to assemble a 24-pin socket on the circuit board using two 10-pin and one 4-pin connector. Since pin 25 on this AUX-7 substitute circuit is unused, it may be left open. The part numbers shown in Fig. 2 are for vertically mounted connectors, which can be adjusted for horizontal mount by bending each pin down with needle-nose pliers.

To install the board, first remove the top cover of the TR-7. The large horizontal circuit board you now see is the DR-7 digital-readout board. (If you own a TR-7 without the digital-readout option, there will be a small jumper circuit board substituted for the larger DR-7. The AUX-7 plug is already exposed, so removal of the jumper board is not necessary.)

After removing all five top connectors to the DR-7, take out the single screw located near the left edge of the board, as viewed from the front of the transceiver. A blue wire and coaxial cable must be disconnected from the filter module, located to the left of the DR-7. Now, using the "bent coathanger" tool that came with the TR-7, or a suitable screwdriver, carefully lift the DR-7 board away from the rig, starting from the rear edge. A 12-pin, a 9-pin, and two 3-pin connectors are mounted on the underside of the DR-7 and are pulled free as the board is raised. Use care at this point to avoid damaging the digital displays, which are attached to the DR-7. As soon as the board is free of the fixed connectors, withdraw it from the rig, allowing the coaxial cable to slide out of the clearance hole (Fig. 3).

At this point, it should be obvious where to plug the AUX-7 substitute board; there is only one unused chassis-mounted connector available. Be sure the component side is facing the rear of the transceiver, and push this circuit board onto the connector as shown in Fig. 4. A TR-7 equipped with the DR-7 must have this option board in place to function properly. You will have to completely reassemble the transceiver, except for the cabinet, before the new AUX-7 substitute board can be tested. Use extreme care when replacing the DR-7 circuit board. Ensure that the bottom (foil side) pins are properly aligned with their sockets before carefully pushing the board into position.

### Operation

After replacing the DR-7 digital display, attach an antenna or dummy load to the TR-7, connect the power supply and a microphone or key, and turn on the

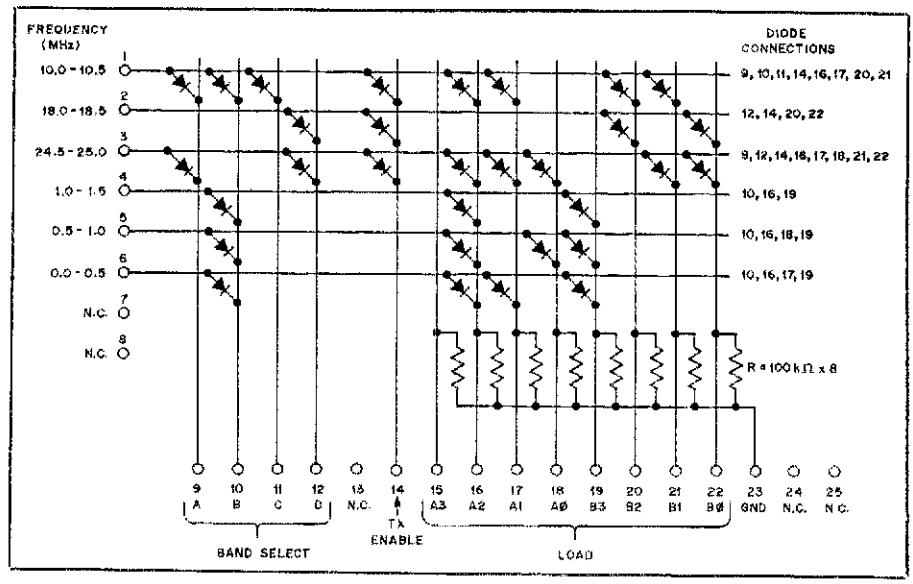



Fig. 1 — Schematic diagram of the AUX-7 substitute circuit. The pins of the AUX-7 connector are listed along the left and lower perimeter of the circuit. All diodes are 1N914, or equivalent. n.c. = no connection.

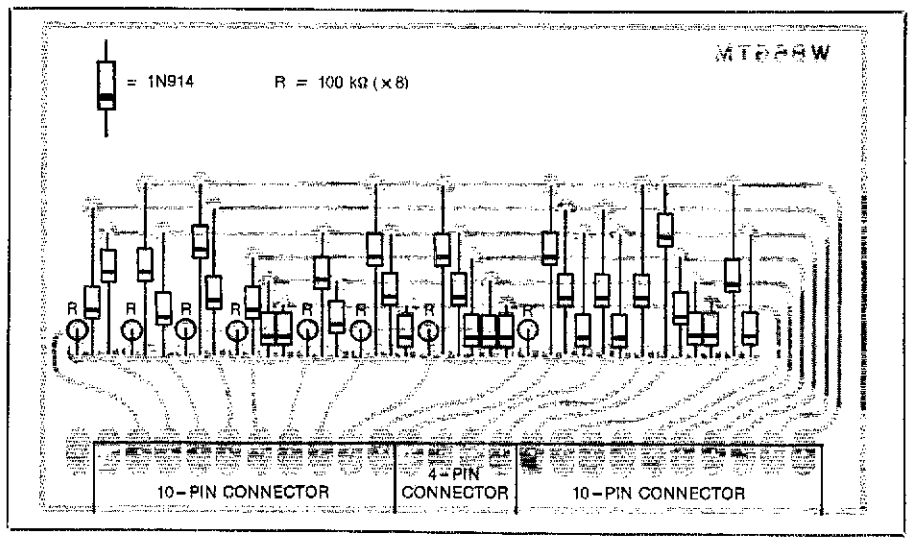



Fig. 2 — Parts-placement diagram for the TR-7 programming board. Components are mounted on the non-foil side. Gray areas represent unetched copper. The circuit-board etching pattern appears in the Hints and Kinks section of this issue. The connector consists of two 10-pin sockets (GC 41-210 or Molex 09-52-3103) and one 4-pin socket (GC 41-204 or Molex 09-52-3043).

[1]Certain earlier TR-7s already have 100-kΩ pull-down resistors for the load-number lines on the digital-control board, which is located just behind the AUX-7 plug. If your digital control board has nine integrated circuits on it, you have the old style, and will not need the resistors shown for this AUX-7 substitute circuit. The inclusion of these resistors should not cause any problems, however. All TR-7 transceivers have proper logic levels on the four band-select lines, so no extra resistors are needed in this circuit for AUX-7 lines 9-12.

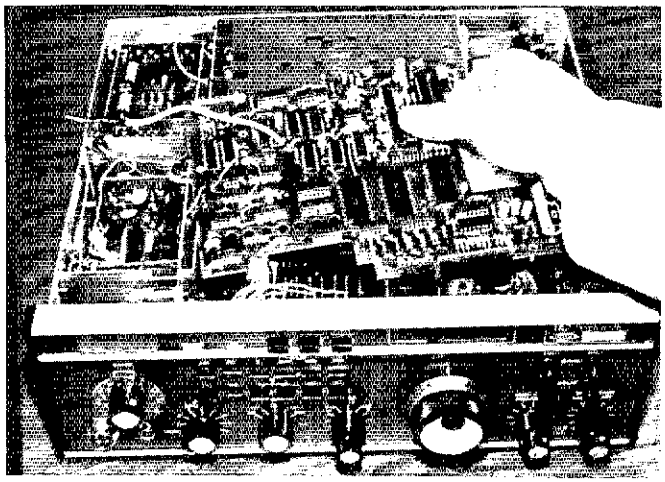


Fig. 3 — Removing the DR-7 digital display board from the TR-7.

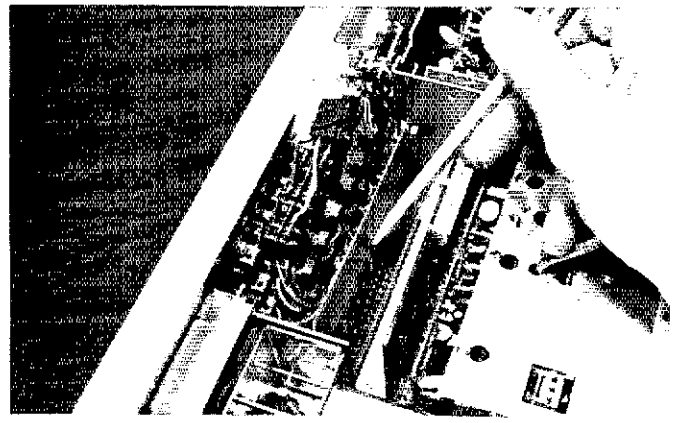


Fig. 4 — The pencil indicates where the AUX-7 substitute circuit board is mounted in the TR-7. Component side faces the rear. The pc connector shown near the middle finger is attached to the digital-control board.

transceiver. The rig should operate normally with the AUX PROGRAM switch set to NORM. Positions 1, 2 and 3 of the AUX PROGRAM switch should cause the rig to operate in the 10.0-, 18.0- and 24.5-MHz band segments, respectively, and the SET BAND light should extinguish only when the main band switch is set to the proper range for the particular band being used. Note that in some instances the synthesizer will not lock until the band switch is positioned correctly. Turn the CARRIER and MIC GAIN controls fully counterclockwise, to prevent rf transmission, and key the transmitter. As long as the SET BAND light is out, you should hear the transmit relay energize.

AUX PROGRAM switch positions 4, 5 and 6 should allow the TR-7 to receive the three 500-kHz band segments between 0 and 1.5 MHz. Maximum sensitivity in this region will be obtained by connecting the receive antenna to the vlf jack on the rear panel of the TR-7. This jack bypasses the antenna filter network, so the vlf antenna must be removed before transmitting or when receiving above 1.5 MHz. See the TR-7 instruction manual for more details.

**Conclusion**

The circuit provides an easy and inexpensive method for extending the capabilities of a popular transceiver. I have provided enough information to allow you to generate any combination of 500-kHz segments for this rig. A maximum of eight positions is available on the AUX PROGRAM switch, and the additional band capability should prove especially useful to those who own a TR-7 without continuous receiver coverage.

Even if you don't have access to photoetch equipment to make the printed-circuit board, it can still be done by drawing the circuit onto the foil with a resist marking pen. I produced mine in this manner, and it works perfectly.

If you have any questions about this circuit, I will try to answer them if an s.a.s.e. is included.

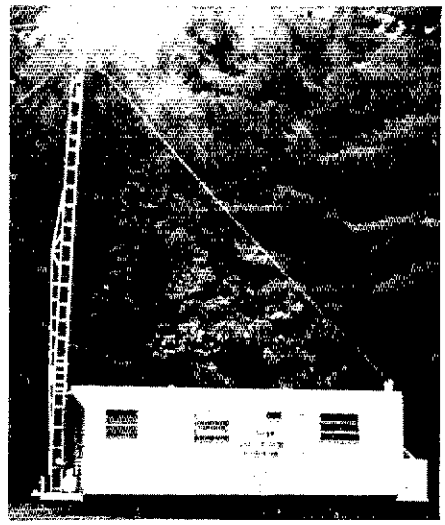
**Reference**

TR-7 Service Manual, R. L. Drake Co., Miamisburg, OH, Oct. 1980.

## Strays

### 1982 INTERNATIONAL BOY SCOUT CAMPOREE ON THE AIR

☐ Boy scouts from around the world will get a special introduction to Amateur Radio when the Boys' Life ARC station, K2BSA, goes portable from the Connecticut International Boy Scout Camporee, to be held July 11-17, 1982 in the foothills of the Berkshires near Winsted. Through the courtesy of station trustee Harry Harchar, W2GND, members of the Southcentral Connecticut ARA (formerly the Hamden ARA) will operate K2BSA/1 from their club's specially equipped van to enable visiting foreign scouts to hear



The SCARAVAN, with its three operating positions, 50-foot folding tower and TA-33 antenna, will keep scouts at the Connecticut International Boy Scout Camporee in touch with home. *(photo courtesy Vic Stancliff, W1LQZ)*

contacts with their own country. K2BSA/1 will operate 10, 15 and 20 meters on or near 28,650, 21,360 and 14,280 kHz at 0100-0200, 1400-1600 and 1700-2000 UTC. Contacts with any amateur stations will be welcome, and K2BSA/1 will QSL.

**I would like to get in touch with . . .**

☐ anyone who has a manual or knows how to program the cards for an SBE OPTI-SCAN Model 12SM. Ralph R. Minkler, K9ZCT, 6021 S. 1st St., Phoenix, AZ 85040.