TR5

H. F. TRANSCEIVER

by DRAKE.

DRAKE

TR5

H. F. TRANSCEIVER

INSTRUCTION
MANUAL

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SECTION I
INTRODUCTION

Figure 1-1 TR5 H.F. Transceiver

1-1. DESCRIPTION

The TR5 is a solid-state, broadband, SSB/CW transceiver which covers all amateur bands from 160 through 10 meters, including the new 12, 17 and 30 meter bands. The TR5 offers excellent sensitivity and selectivity, high dynamic range, digital frequency readout and full break-in CW operation.

A front panel switch allows the operator to select an optional crystal filter independent of the MODE switch. A wide range of optional crystal filter bandwidths are available, and installation of an accessory filter can be accomplished in minutes. The standard bandwidth is 2.3 kHz, and it is automatically selected in transmit to insure proper signal characteristics.

A passive double balanced mixer is employed in the receiver front end. This stage is preceded by a low noise, high dynamic range bipolar rf amplifier to provide good strong signal performance and weak signal sensitivity.

The digital frequency readout of the TR5 is derived from a true frequency counter to assure an accurate display of operating frequency. In addition, the tuning knob dial skirt is calibrated in 1 kHz increments to facilitate short frequency excursions.

The transmitter of the TR5 features a rugged, solid-state power amplifier section which has been designed for continuous duty in the SSB and CW modes. For more demanding duty cycles, such as SSTV or RTTY, the Model FA7 cooling fan is available. The transmitter section also features very low harmonic and spurious output, and is equipped with automatic high VSWR protection.

The VOX GAIN and DELAY controls are conveniently located on the front panel, and full break-in CW operation is obtained via a switch on the VOX DELAY control. VOX operation can be disabled by a front panel switch.

Other features include selectable AGC time constants, receiver incremental tuning (RIT), provision for an accessory noise blanker (NB5), and T/R switching connections for an external linear amplifier and/or receiver.

The modular construction of the TR5 reduces service time to a minimum. Each module is designed to perform a specific function, and this feature, combined with the open, accessible layout of the transceiver greatly simplifies any required alignment and troubleshooting. Liberal use is made of cable connectors, simplifying module removal

1-2. SPECIFICATIONS

GENERAL

Frequency Coverage:	1.8-2.0*, 3.5-4.0, 7.0-7.5, 10.0-10.5, 14.0-14.5, 18.0-18.5*, 21.0-21.5, 24.5-25.0*, 28.0-28.5*, 28.5-29.0, 29.0-29.7* MHz. (*With accessory range crystal). NOTE: See Section 4 for additional frequency coverage information.
Modes of Operation:	USB, LSB, CW
Frequency Stability:	Less than 1 kHz drift first hour. Less than 150 Hz per hour drift after first hour. Less than 100 Hz change for a ± 10% line voltage change.
Readout Accuracy:	± 10 ppm ± 100 Hz
Power Requirements:	13.6 VDC regulated, 2 A. 12 - 16 VDC unregulated, 0.8 V rms maximum ripple, 15 A.
Dimensions:	
Depth:	12.5 in. (31.75 cm), excluding knobs and connectors.
Width:	13.6 in. (34.6 cm)
Height:	4.6 in. (11.7 cm) excluding feet.
Weight:	14 lb. (6.35 kg)

RECEIVER

Sensitivity:	Less than 0.5 μV for 10 dB S+N/N except less than 1.0 μV, 1.8-2.0 MHz.
Selectivity:	2.3 kHz minimum at -6 dB. 4.1 kHz maximum at -60 dB. (1.8:1 shape factor)
Ultimate Selectivity:	Greater than 95 dB.
AGC:	Less than 5 dB output variation for 100 dB input signal change, referenced to AGC threshold.
Intermodulation: (20 kHz or greater spacing)	
Intercept Point:	Greater than 0 dBm.
Two-Tone Dynamic Range:	Greater than 85 dB.
IF Frequency:	5.645 MHz
IF Rejection:	50 dB, minimum.
Image Rejection:	60 dB, minimum below 14 MHz. 50 dB, minimum above 14 MHz.
Audio Output:	2 watts, minimum @ less than 10% THD (4 ohm load).
Spurious Response:	Greater than 60 dB down.

TRANSMITTER

Power Input (Nominal):	150 Watts, PEP or CW
Load Impedance:	50 ohms.
Spurious and Harmonic Output:	Greater than 40 dB down.
Intermodulation Distortion:	Greater than 30 dB below PEP.
Carrier Suppression:	Greater than 50 dB.
Undesired Sideband Suppression:	Greater than 60 dB at 1 kHz.
Duty Cycle:	
SSB, CW:	100%
Key Down (w/o FA7 Fan):	30%, 5 minutes maximum transmit
Key down (w/FA7 Fan):	100%
Microphone Input:	High Impedance
CW Keying:	Instantaneous full break-in, adjustable delay.

1-3. ACCESSORIES

The following accessory items provide additional operating capability and flexibility for the TR5, and are available through R. L. Drake Company authorized dealers.

A.C. POWER SUPPLY PS75, MODEL 1570

Fixed station operation of the TR5 requires a power supply capable of delivering 13.6 VDC regulated at 2 amperes and 12-16 VDC filtered at 15 amperes. The PS75 power supply meets this requirement, and is packaged in an attractive, vinyl-clad enclosure. The interconnecting cables are long enough to allow remote location (up to six feet) if desired.

SYNTHESIZED REMOTE VFO RV75, MODEL 1545

The RV75 Synthesized Remote VFO offers the operator a high degree of frequency control flexibility. The RV75 can be selected for transmit, receive or transceive frequency control or can be turned off to allow transceive frequency control from the TR5. In addition, two programmable fixed frequencies are provided in the RV75. The highly stable synthesizer offers 10 Hz resolution, and features automatic variable rate tuning to allow rapid frequency change and fine tuning with the same control. The unit is housed in an enclosure which is styled to match the TR5, and is supplied with complete operating and installation instructions.

NOISE BLANKER NB5, MODEL 1558

Provision has been made in the TR5 for plug-in installation of the NB5 Noise Blanker. The NB5 is useful in eliminating or reducing impulse noise (such as ignition noise) and some other types of interference (such as over the horizon radar). Receiver dynamic range is preserved by the use of a crystal filter in the NB5.

ANTENNA MATCHING NETWORK MN75, MODEL 1540

The MN75 Antenna Matching Network matches long wire and coax fed antennas, and covers the range 1.8-30.0 MHz. The optional Model 1510 B-1000 balun allows the use of balanced feedlines and/or wide impedance range flexibility. The MN75 handles up to 200 watts of input power and features a built-in rf wattmeter/VSWR bridge. A built-in antenna switch allows the selection of up to 3 antennas from the front panel.

EXTERNAL SPEAKER MS7, MODEL 1531

The MS7 External Speaker is intended for use in lieu of the speaker built into the TR5 in fixed station operation. The unit is housed in an enclosure which is styled to match the TR5 in appearance.

COOLING FAN FA7, MODEL 1529

Severe duty cycle applications of the TR5, such as extended SSTV or RTTY transmissions require the use of forced air cooling on the power amplifier heat sink. The Model 1529 FA7 Cooling Fan fulfills this requirement, and features quiet operation and convenient installation.

DESK MICROPHONE, MODEL 7077

The Model 7077 Desk Microphone is designed to match the audio characteristics of the TR5. The unit features a convenient desk stand and PTT or VOX operation.

ACCESSORY CRYSTAL FILTERS

Several accessory crystal filters are available for the TR5 as follows:

DRAKE TYPE	MODEL	6 dB BW	60 dB BW	USE
SL300	7021	0.3 kHz	0.7 kHz	CW
SL500	7022	0.5 kHz	1.1 kHz	CW
SL1000	7027	1.0 kHz	2.0 kHz	CW,RTTY
SL1800	7023	1.8 kHz	3.6 kHz	SSB,RTTY
SL4000	7026	4.0 kHz	8.0 kHz	AM
SL6000	7024	6.0 kHz	12.0 kHz	AM

Any one of these filters can be easily installed in the TR5 AUX filter position.

SPEECH PROCESSOR SP75, MODEL 1553

The SP75 Speech Processor is designed to provide an increase in average power/readability of a single sideband voice signal during weak signal, high interference conditions. The SP75 is connected between the microphone and microphone input of the single sideband transmitter, thus requiring no modification of the radio set. A front panel switch allows the processor to be switched in or bypassed as conditions warrant. Two additional inputs, such as a tape player or phone patch, may be switch selected in place of the normal microphone input.

ELECTRONIC KEYER CW75, MODEL 1507

The CW75 Electronic Keyer can be used to provide a keying function for virtually any type of transmitter

(cathode, grid-block or solid-state keying) as well as a code practice aid. The unit is styled to match the TR5.

The CW75 may be used with a straight key, semi-automatic key (bug) or squeeze paddle. When used with the latter, iambic operation is provided.

PHONE PATCH P75, MODEL 1520

The P75 is a hybrid phone patch for use with a transceiver or receiver/transmitter combination. The styling matches the TR5. The hybrid design nulls the receiver audio at the transmitter audio connections to allow VOX operation if desired.

The receiver audio input and transmitter audio output gain settings are adjustable by means of front panel controls. Speaker and microphone switching as well as phone line switching are controlled by the front panel on/off switch. This allows the phone patch to be activated at any time without connecting or disconnecting cables.

PORTABLE/MOBILE MOUNTING KIT MMK-7, MODEL 1335

The MMK-7 provides the necessary brackets, mounting hardware and cabling for mobile installation of the TR5. In addition, a new cabinet is supplied which features a built-in carrying handle.

NOTES:

SECTION II
INSTALLATION

2-1. UNPACKING

Carefully remove the TR5 from the shipping carton and examine it for evidence of damage. If any damage is found, immediately contact the transportation company responsible for delivery of the unit or return the unit to the dealer where the unit was purchased. Keep the shipping carton and all packing material for the transportation company to inspect. The original carton and packing material will make it much easier to return the unit, if necessary. Inspect the packing material for any accessories or printed matter before storing. Locate the registration card, fill out immediately, and return to the R. L. Drake Company to insure registration and validation of the warranty.

2-2. LOCATION

The location of the TR5 is not critical. However, care should be taken to insure that adequate clearance is provided to allow free circulation of air around the power amplifier heat sink. Do not cover the vents on top of the cabinet with books, papers, or other equipment as overheating may result.

2-3. MOBILE INSTALLATION

An accessory mobile mounting kit, the MMK7, is available for mobile installation of the TR5. The MMK7 contains all necessary hardware and cables for mobile operation of the TR5, and also includes detailed instructions covering installation and operation in a mobile or portable environment. The MMK7 also includes an alternator whine filter and power line fuse for mobile applications.

The following paragraphs cover antennas, power, microphone, and speaker requirements for mobile installation.

2-3.1 ANTENNA REQUIREMENTS

Install the mobile antenna as recommended by the antenna manufacturer. Connect a 50 ohm coaxial cable from the antenna to the SO-239 antenna connector at the rear of the TR5. Pay close attention to the antenna manufacturer's instructions for tuning and matching to insure proper operation of the TR5.

2-3.2 POWER REQUIREMENTS

CAUTION

Operation of the TR5 with an incorrect power source will result in serious damage and may void the warranty.

Operating voltage for the TR5 is 11 to 16 VDC. Voltages outside this range may either damage the transceiver or cause improper operation. The nominal recommended operating voltage is 13.6 VDC at a current of 2 amperes in receive and 15 amperes peak in transmit.

The rear panel power connector (P-404-AB) has a mating receptacle (S-404-CCT) which is polarized. See figure 2-1 for proper connections, and figure 2-2 for rear panel connector locations. Be sure to wire the power connector exactly as shown to avoid damage to the transceiver. It is recommended that #10 stranded wire be used to wire the power connector directly to the vehicle battery, and that a fuse or circuit breaker rated at 20 amperes be installed in the positive supply line close to the battery.

A defective generator or alternator diode may cause excessive generator noise or alternator whine. Defective ignition wiring or components may result in an undesirable level of ignition noise in the receiver. Reference texts such as *ARRL Handbook* provide additional details on treating these problems.

2-3.3 MICROPHONE REQUIREMENTS

Use a microphone with a flat frequency response. The microphone should have a cardiod pattern to reduce pickup from the back and sides. Connect the microphone as shown in figure 2-3.

2-3.4 EXTERNAL SPEAKER REQUIREMENTS

The TR5 has a built-in speaker. In high noise environments, however, it may be desirable to employ an external speaker located close to the operator. Use of an external speaker automatically disables the internal speaker.

DO NOT connect the TR5 to the speaker of the car radio. Install a separate 4 ohm speaker capable of handling at least 2 watts of audio. See figure 2-2 for location of the external speaker jack, which accepts a standard 2-circuit phone plug wired such that the tip is 'hot'.

Pin No.	Function
13	High current +13.6 Vdc
15	Low current +13.6 Vdc
14	Gnd
16	Gnd

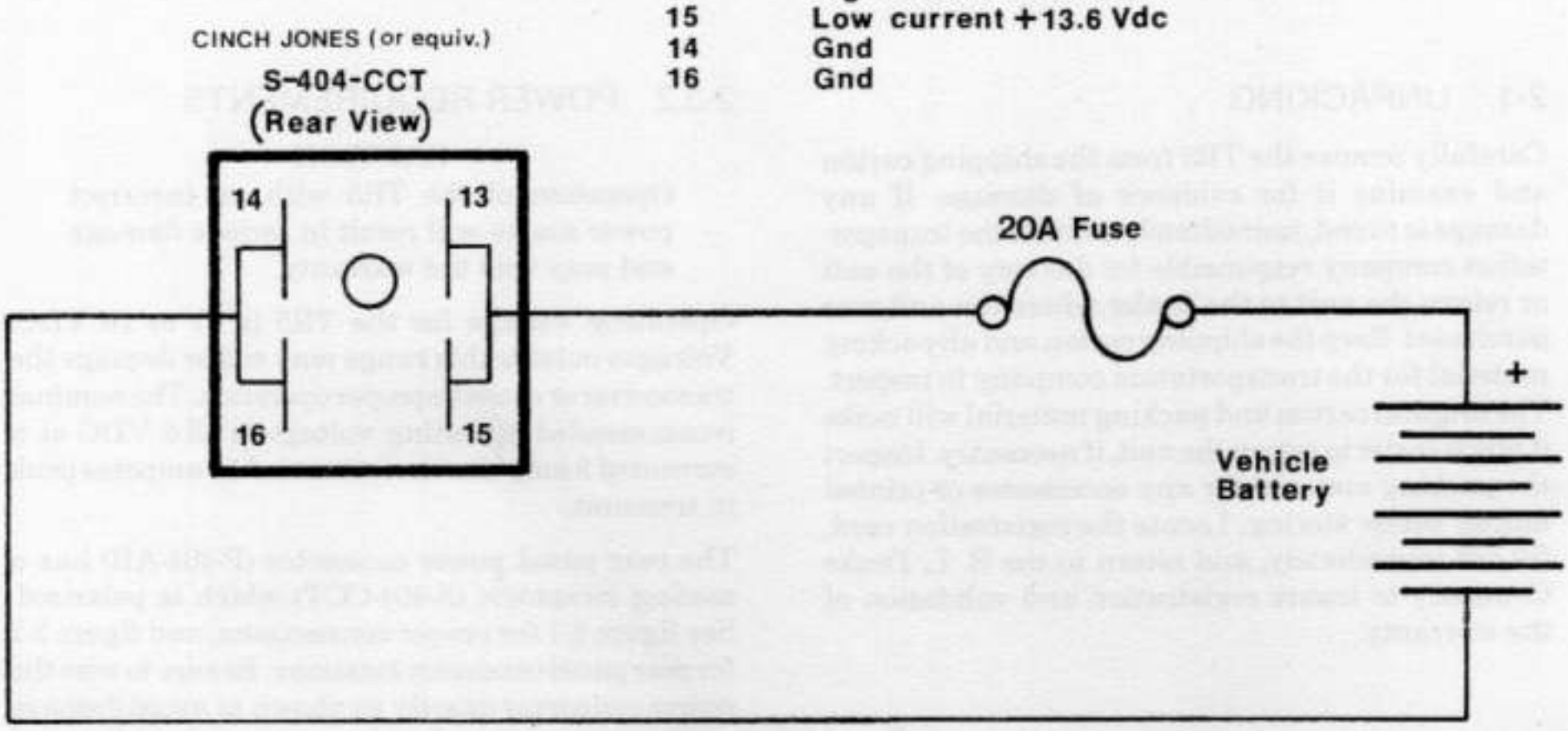

Figure 2-1 TR5 Power Connection

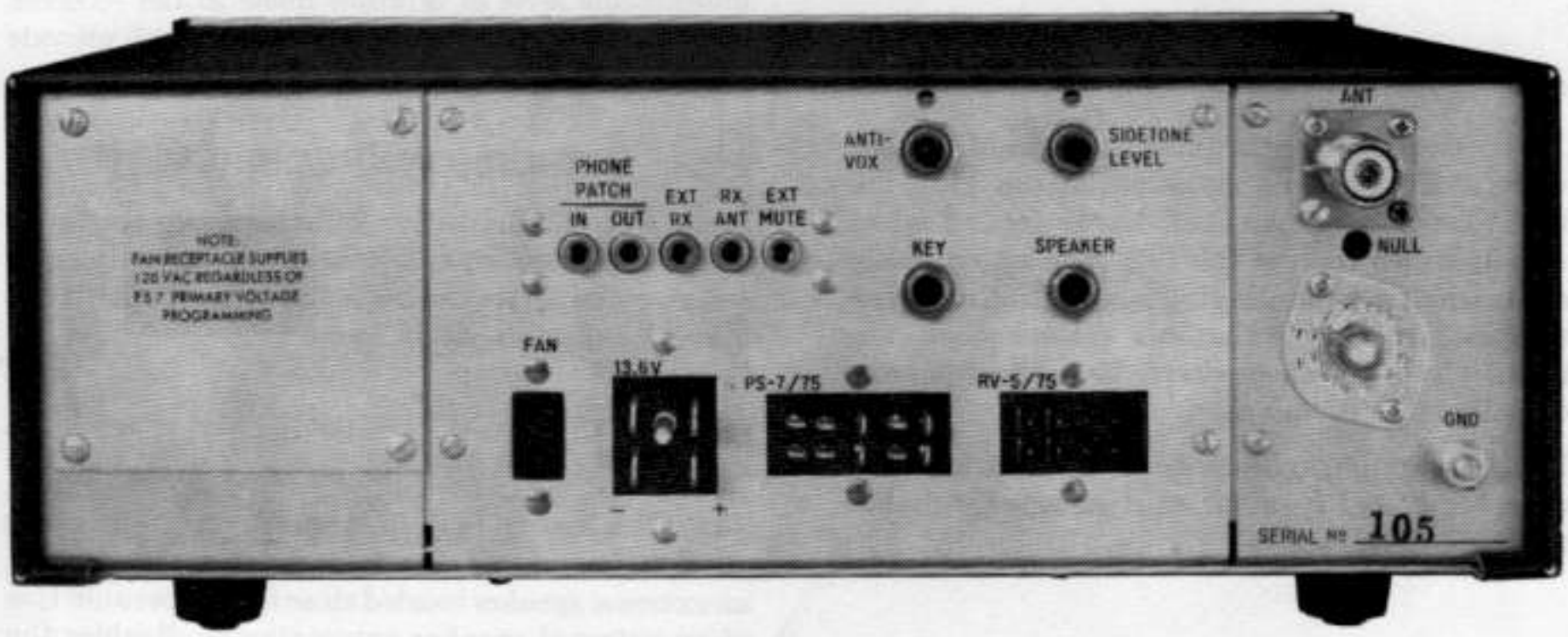

Figure 2-2 TR5 Rear Panel Connections

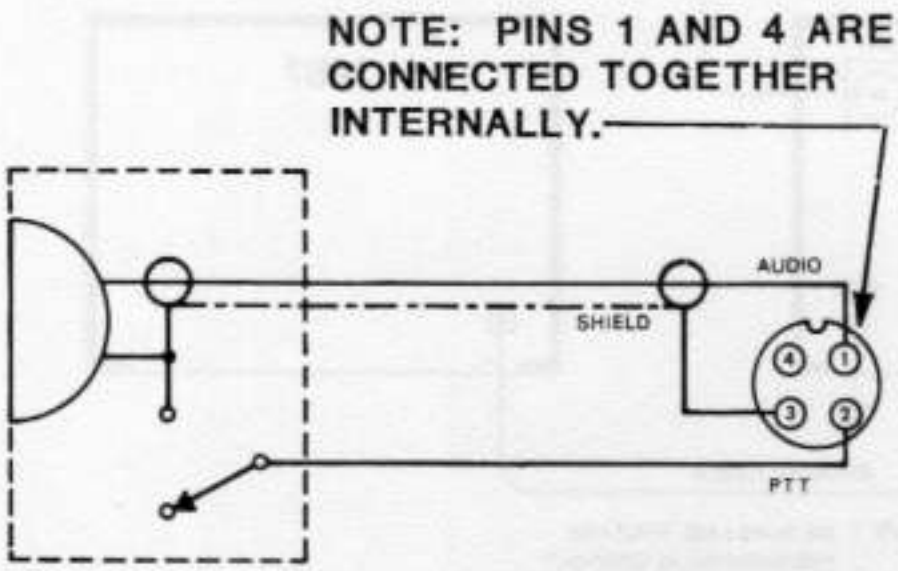

Figure 2-3 TR5 Microphone Connection

2-4. FIXED STATION INSTALLATION

See figures 2-4 and 2-5 for examples of fixed station installations.

2-4.1 ANTENNA REQUIREMENTS

The TR5 is designed for use with antenna systems having a nominal impedance of 50 ohms. Care should be exercised to reduce the VSWR of the antenna system to the lowest possible value for best operation. If the VSWR exceeds 2:1, the transmitter power output will be reduced to protect the output transistors. When using antennas which do not present a low VSWR, the use of a matching network such as those manufactured by the R. L. Drake Company is recommended. Additional information on antennas can be found in reference texts such as the *ARRL Handbook*.

2-4.2 POWER REQUIREMENTS

CAUTION

Operation of the TR5 with an incorrect power source will result in serious damage to the transceiver and may void the warranty.

The PS75 A.C. Power Supply is recommended for fixed station operation. It is designed to accomodate all operating requirements presented by the TR5. See figures 2-4 and 2-5 for interconnection details.

For general information regarding power sources other than the PS75, see section 2-3.2 of this manual.

2-4.3 MICROPHONE REQUIREMENTS

The R. L. Drake Model 7077 Desk Microphone is recommended for use in fixed station installations. The unit is supplied wired with a mating connector for the TR5.

A high impedance microphone should be used, and preamplified units are not recommended.

2-4.4 EXTERNAL SPEAKER REQUIREMENTS

The TR5 contains a built-in speaker; however, this speaker is located on the bottom of the radio. In many installations, the built-in speaker output will be blocked. In these instances, an external speaker is recommended. The MS7 Matching Speaker is designed for this application. See figure 2-2 for location of the external speaker jack.

If a speaker other than the MS7 is used, be sure that it is a 4 ohm speaker, capable of handling at least 2 watts of audio. The internal TR5 speaker is automatically disabled when an external speaker is connected.

2-4.5 VIEWING ANGLE

Refer to figure 2-6 for illustrations of viewing angle options. In order to change mounting feet, remove the bottom cover by removing the ten screws around the edge of the cover. Carefully slide the cover off toward the back of the TR5. Reinstall the cover by reversing this process.

CAUTION

Be sure that all power is removed before attempting any disassembly of the TR5. Potentially lethal voltages are exposed when the covers are removed. It is suggested that all accessories be unplugged from the TR5 before attempting to remove the covers.

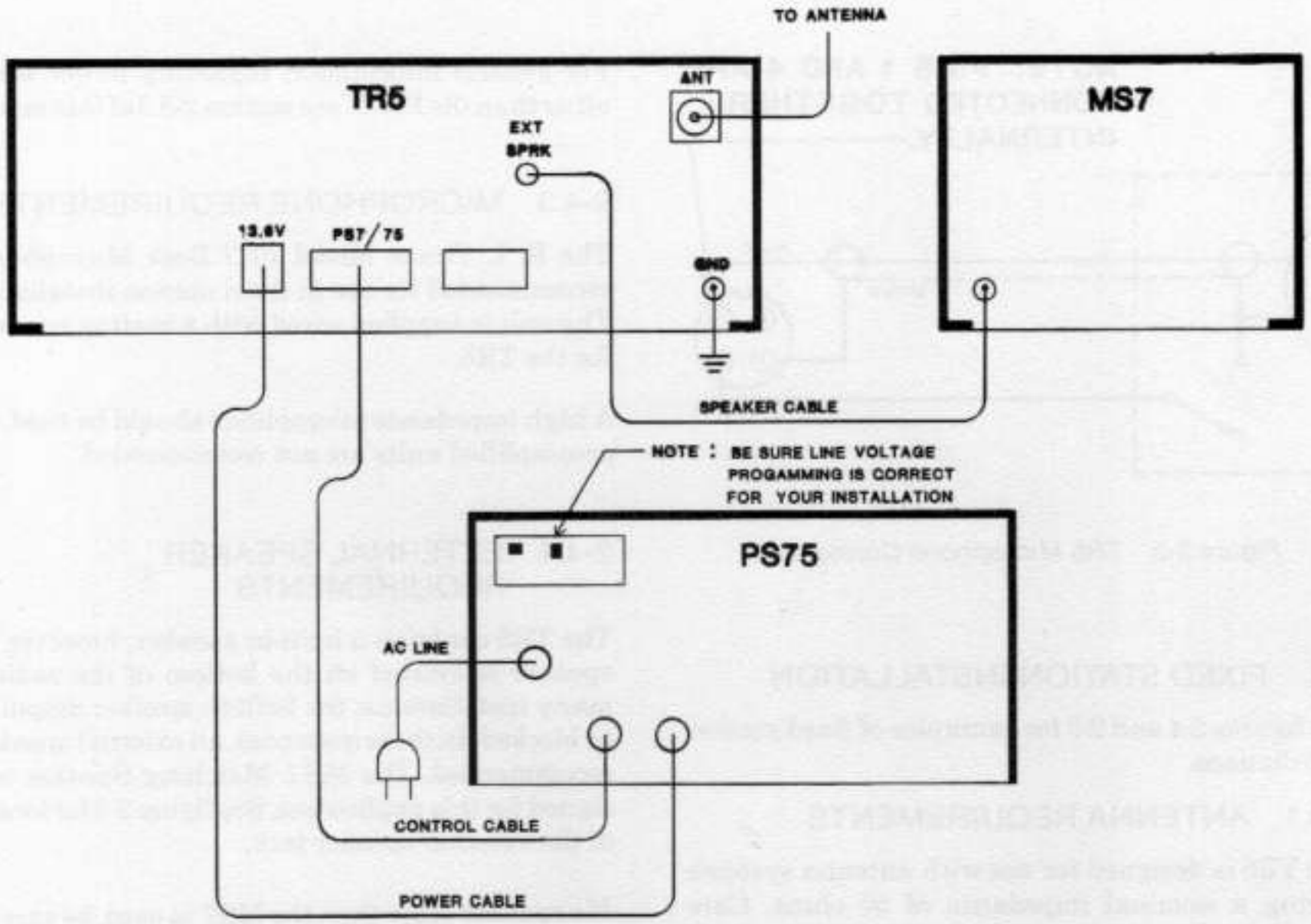

Figure 2-4 Connecting the PS75 Power Supply and MS7 Speaker

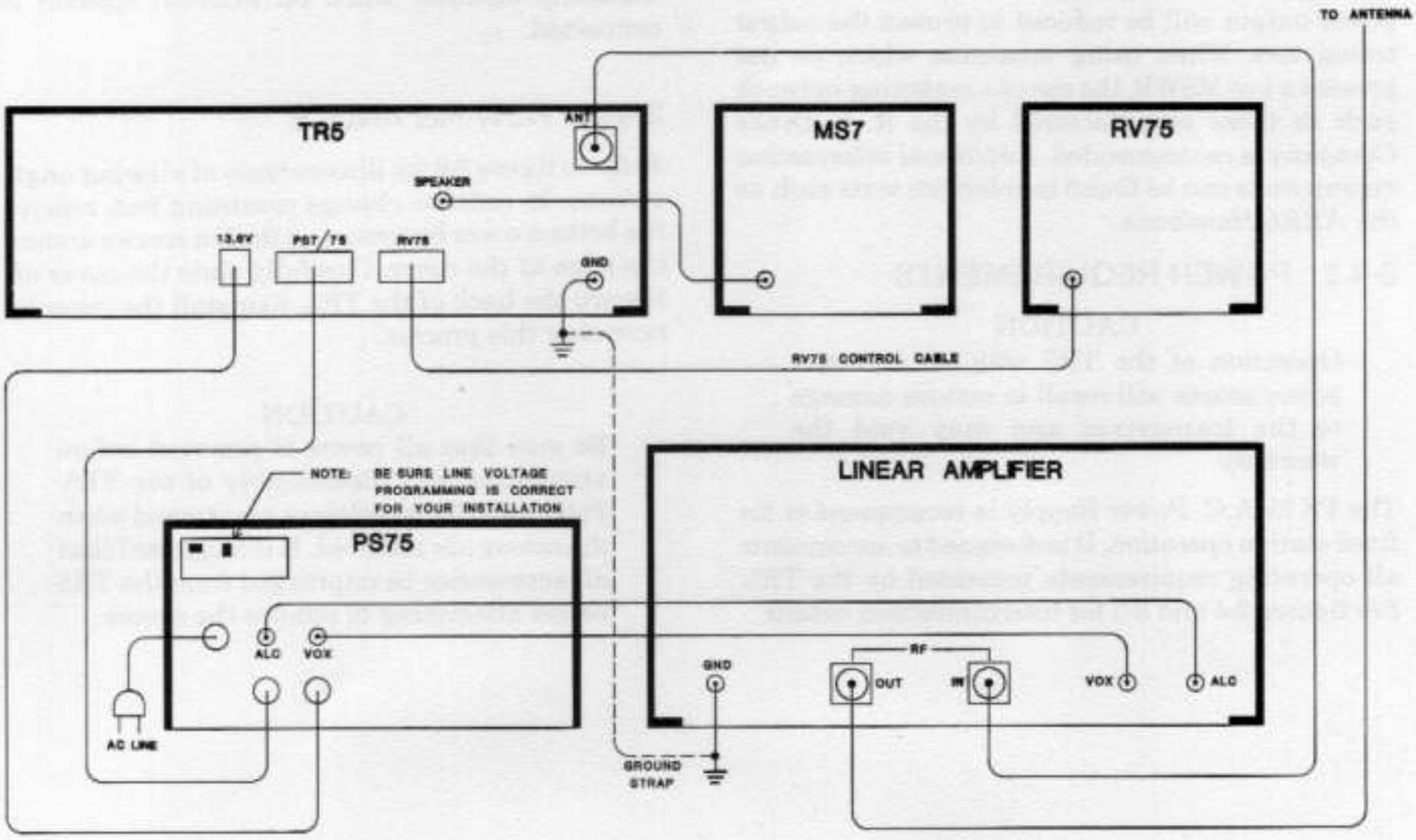

Figure 2-5 Connecting the RV75 Remote VFO and a Linear Amplifier

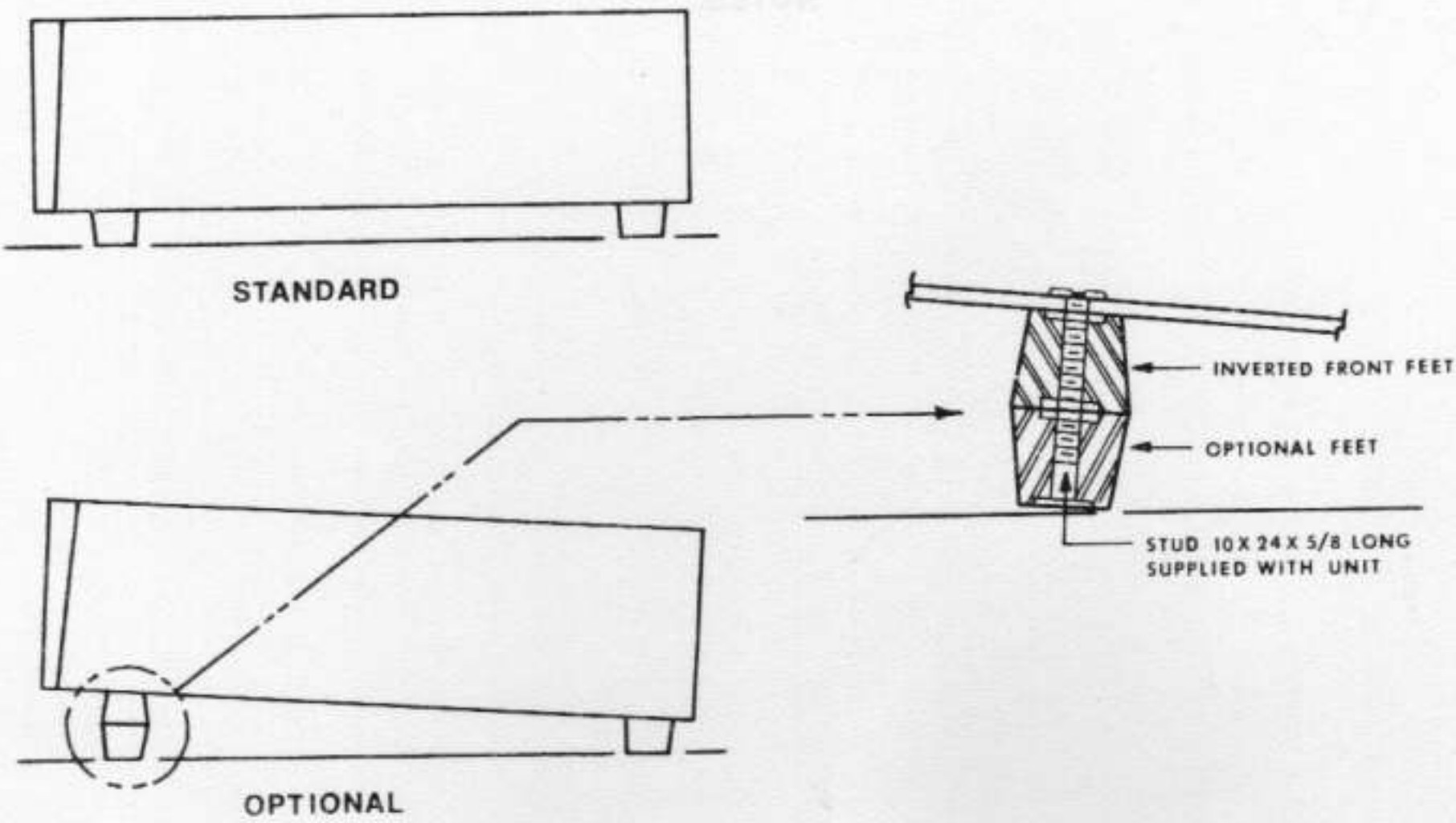

Figure 2-6 Viewing Angle Options

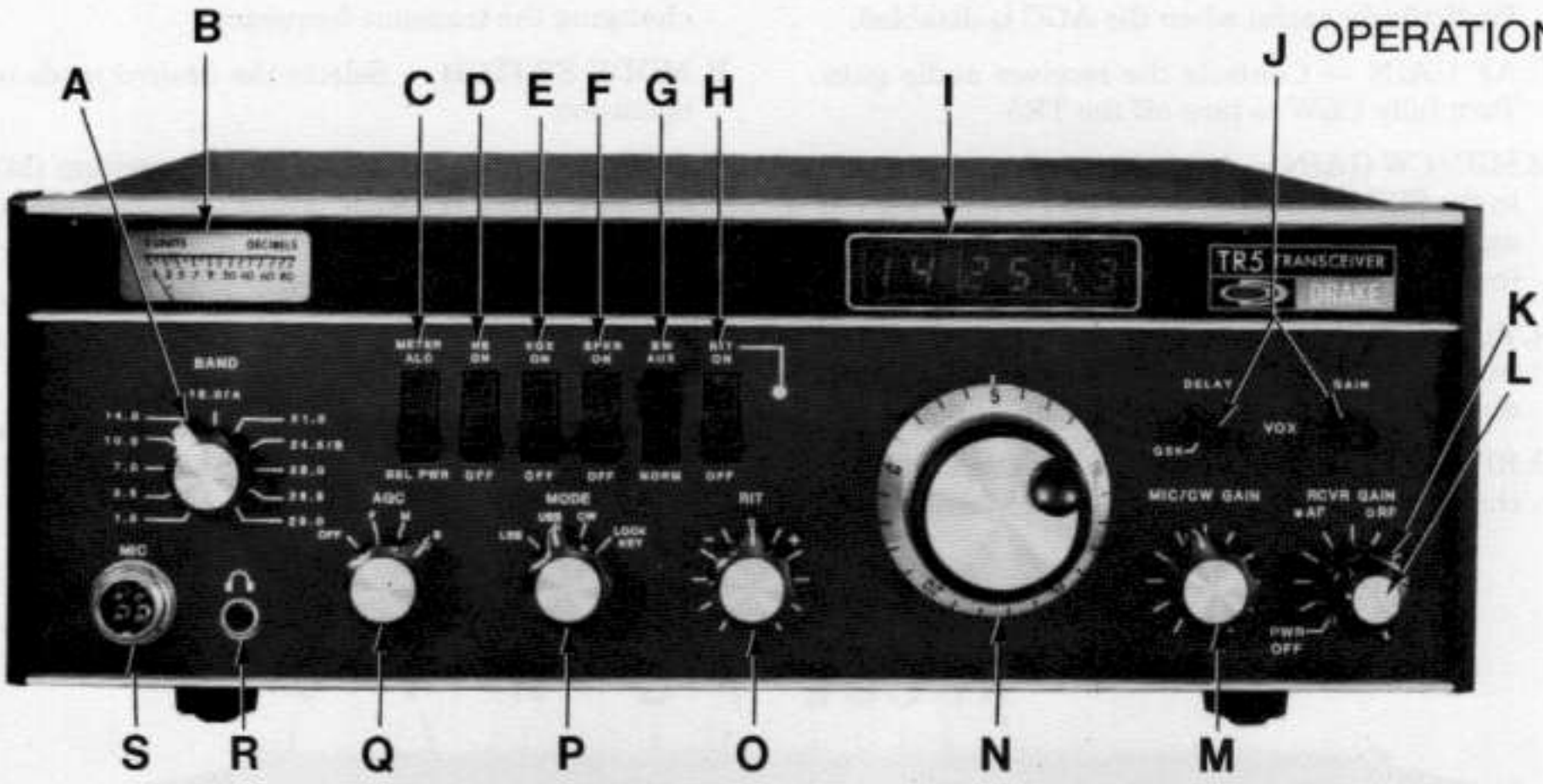

Figure 3-1 Front Panel Controls and Connections

3-1. FRONT PANEL CONTROLS AND CONNECTIONS

The following paragraphs describe all front panel controls and connections. Refer to figure 3-1 for the location of individual controls.

A. BANDSWITCH — Selects the desired band of operation. The low end of each 500 kHz range is indicated on the front panel.

B. METER — Indicates relative level of received signals in receive mode. Indicates relative power or ALC action in transmit mode.

NOTE

TR5 'S' Meter readings may not agree with other receivers due to differences in overall gain distribution. Such discrepancies are not indicative of relative sensitivity, and should be ignored.

C. METER SWITCH — Controls the meter function in transmit mode.

D. NB SWITCH — Enables the optional NB5 noise blanker.

E. VOX SWITCH — Enables the VOX circuitry in the SSB mode.

F. SPKR SWITCH — Controls either the internal or accessory external speaker. Does not affect the headphones.

G. BW SWITCH — Selects the optional crystal filter in the receive mode.

H. RIT SWITCH — Enables the front panel RIT control. A yellow LED indicator is turned on when the RIT is enabled as a reminder.

I. FREQUENCY READOUT — Presents a digital display of operating frequency to the nearest 100 Hz

J. VOX CONTROLS — Two VOX controls are provided on the front panel as follows:

1. VOX GAIN — Adjusts the gain of the VOX amplifier when the VOX switch is in the ON position.
2. VOX DELAY — Adjusts the VOX release time in all modes. A switch at full CCW rotation enables the full break-in mode (QSK) in the CW mode.

WARNING

Do Not operate SSB with the VOX DELAY control in the QSK position. Distortion of the transmitted signal will result.

K. RF GAIN — Controls the R.F. gain of the receiver. Particularly useful when the AGC is disabled.

L. AF GAIN — Controls the receiver audio gain. Turn fully CCW to turn off the TR5.

M. MIC/CW GAIN — Adjusts the microphone gain in the SSB modes and the carrier level in the CW and LOCK KEY modes. Clockwise rotation increases the output level.

N. TUNING DIAL — Adjusts the frequency of the transceiver. 1 kHz markings are provided on the dial skirt for operator convenience.

O. RIT CONTROL — When the RIT switch in ON, this control allows the receiver frequency to be varied over a nominal ±3 kHz range without changing the transmit frequency.

P. MODE SWITCH — Selects the desired mode of operation.

Q. AGC SWITCH — Selects fast (F), medium (M), and slow (S) decay speeds. Also allows the operator to disable the receiver AGC.

R. HEADPHONES — Provides a connection for headphones. Use of headphones does not mute the speaker.

S. MIC JACK — Provides a connection for microphone or other transmitter audio source.

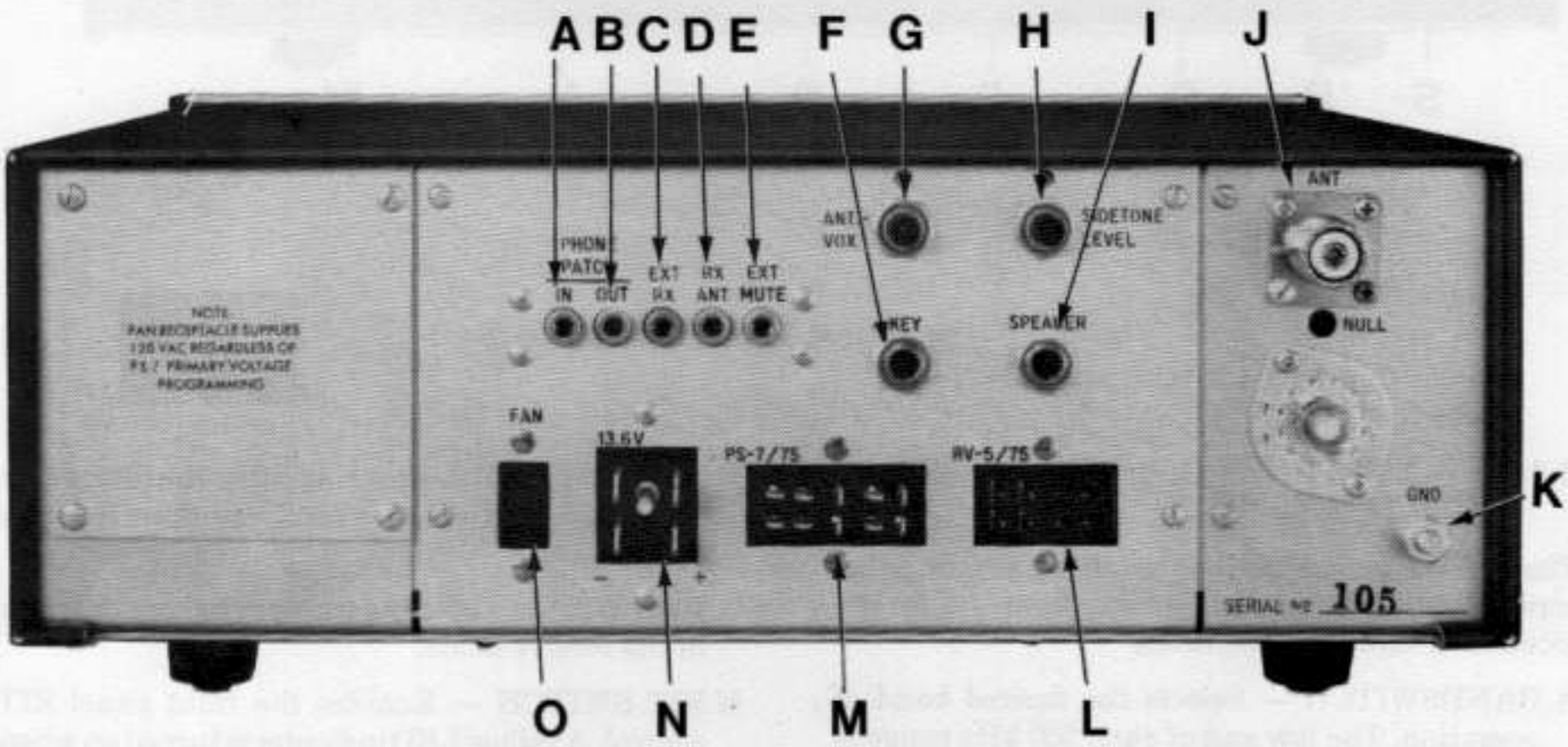

Figure 3-2 Rear Panel Controls and Connections

3-2. REAR PANEL CONTROLS AND CONNECTIONS

A. PHONE PATCH IN — Allows convenient connection of phone patch transmit audio. Can also be used with other accessories, such as RTTY terminal units.

B. PHONE PATCH OUT — Receiver audio output for phone patch. As with A above, can also be used for other purposes. This output is in parallel with the receiver loudspeaker.

C. EXT RX — This jack is normally internally jumpered to the RX ANT jack. If a separate receiver is used with the TR5, its antenna input can be connected to this jack, and the internal jumper plug on the rear panel of the TR5 removed. Due to the transmit/receive configuration necessary for proper operation of the TR5, the EXT RX jack connects to the main antenna through the low-pass filter. Because of this, the operating frequency of the external receiver should be equal to or less than the frequency of the TR5.

D. RX ANT — This jack is normally internally

jumpered to the EXT RX jack. If a separate receiver antenna is desired, it should be connected to this jack and the rear panel internal jumper plug removed. Reverse this process to restore normal operation.

E. EXT MUTE — Allows automatic muting of an external receiver. This line is grounded in receive and open in transmit; check to be sure that the receiver in use is compatible with such a connection. All receivers manufactured by the R. L. Drake Company are compatible.

F. KEY — Connection for key or keyer for CW use. Keyer should be capable of handling a *positive* keyline of 10 VDC @ 1 ma. Keyers designed for grid-block keying (negative voltage) will not provide proper operation. Plug should be wired so that the insulated tip is positive and the sleeve is ground.

G. ANTI-VOX — Adjusts the level of receiver audio output fed back to the VOX amplifier to prevent VOX tripping on received signals.

H. SIDETONE LEVEL — Adjusts the level of the built-in sidetone in the CW mode. The sidetone level is independent of the front panel AF GAIN control for maximum flexibility.

I. SPEAKER — Connection for an external 4 ohm speaker rated at 2 watts or more, such as the MS-7. Internal speaker is automatically muted when the external speaker is connected. Plug should be wired so that the tip is 'hot'.

J. ANT — Accepts standard PL-259 coax fitting for connection of the main antenna to the TR5.

K. GND — Connect to a good earth or water pipe ground to insure proper operation of the TR5.

L. RV75 — Mates with P-308-CCT plug. Provides all power, signal and control lines for the RV75.

M. PS7/75 — Mates with a S-310-CCT socket. VOX relay and linear amplifier ALC connections are available at this connector for use with accessories. When using the TR5 with either a PS7 or PS75, these signals are available at the rear of the power supply.

N. POWER INPUT — Mates with a S-404-CCT socket. See figure 3-2 for power connections.

O. FAN — 120 VAC outlet for use with Model FA7 fan accessory. Switched by front panel on/off switch when using either the PS7 or PS75.

3-3. INTERNAL CONTROLS AND ADJUSTMENTS

A. SIDETONE FREQUENCY — Refer to figure 3-3. The CW sidetone frequency can be adjusted by following the procedure detailed below.

WARNING

The removal of the bottom cover during the following procedure will expose potentially lethal voltages in the rear panel area of the TR5. Extreme caution should be exercised.

Remove the bottom cover of the TR5 by removing 10 screws around the edge of the cover. Carefully slide the cover off toward the rear of the radio. The CW sidetone can now be adjusted by rotating the indicated white variable resistor to achieve the desired pitch. Be careful not to disturb other controls. Refer to the alignment section of this manual if any other controls require adjustment. Reinstall the bottom cover with 10 screws.

B. RELATIVE POWER SENSITIVITY ADJUSTMENT — The relative power meter sensitivity has been set at the factory into a 50 ohm load. If this setting does not satisfy individual installation requirements, it can be adjusted.

Remove the cabinet from the TR5 by removing 8 screws, 4 on each side, and sliding it to the rear of the radio. Refer to figure 3-4, and identify the relative power sensitivity adjustment. Set this control for the desired meter action, and carefully replace the cabinet and 8 screws. Be careful not to disturb any other controls. Refer to the alignment section of this manual if any other controls require adjustment.

3-4. ACCESSORY FILTER INSTALLATION

Space has been provided in the TR5 for the installation of one accessory filter. To install the filter, remove the cabinet by removing 8 screws, 4 on each side, and sliding the cabinet toward the rear of the radio. Refer to figure 3-4 and identify the IF Selectivity Board. Remove this circuit board by unplugging three connectors, removing four screws (one at each corner) and carefully lifting it out of the radio. Be sure that you do not disturb any other connectors or controls in the process.

Install the accessory filter in the space provided. Tighten both filter mounting nuts *before* soldering the three pins to the board. Clip off the excess lengths of filter pins after soldering.

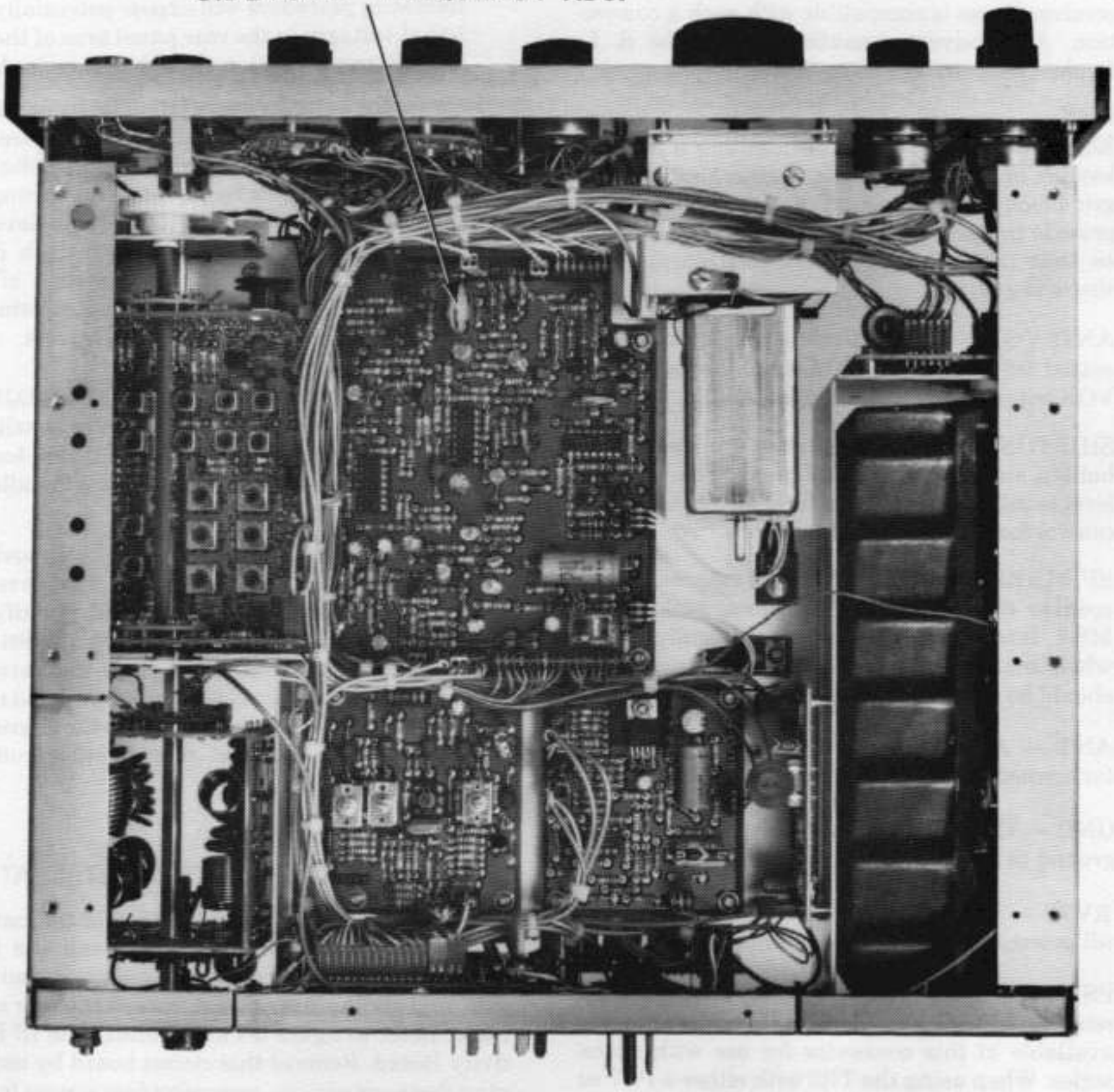

Figure 3-3 Adjusting TR5 Sidetone Frequency

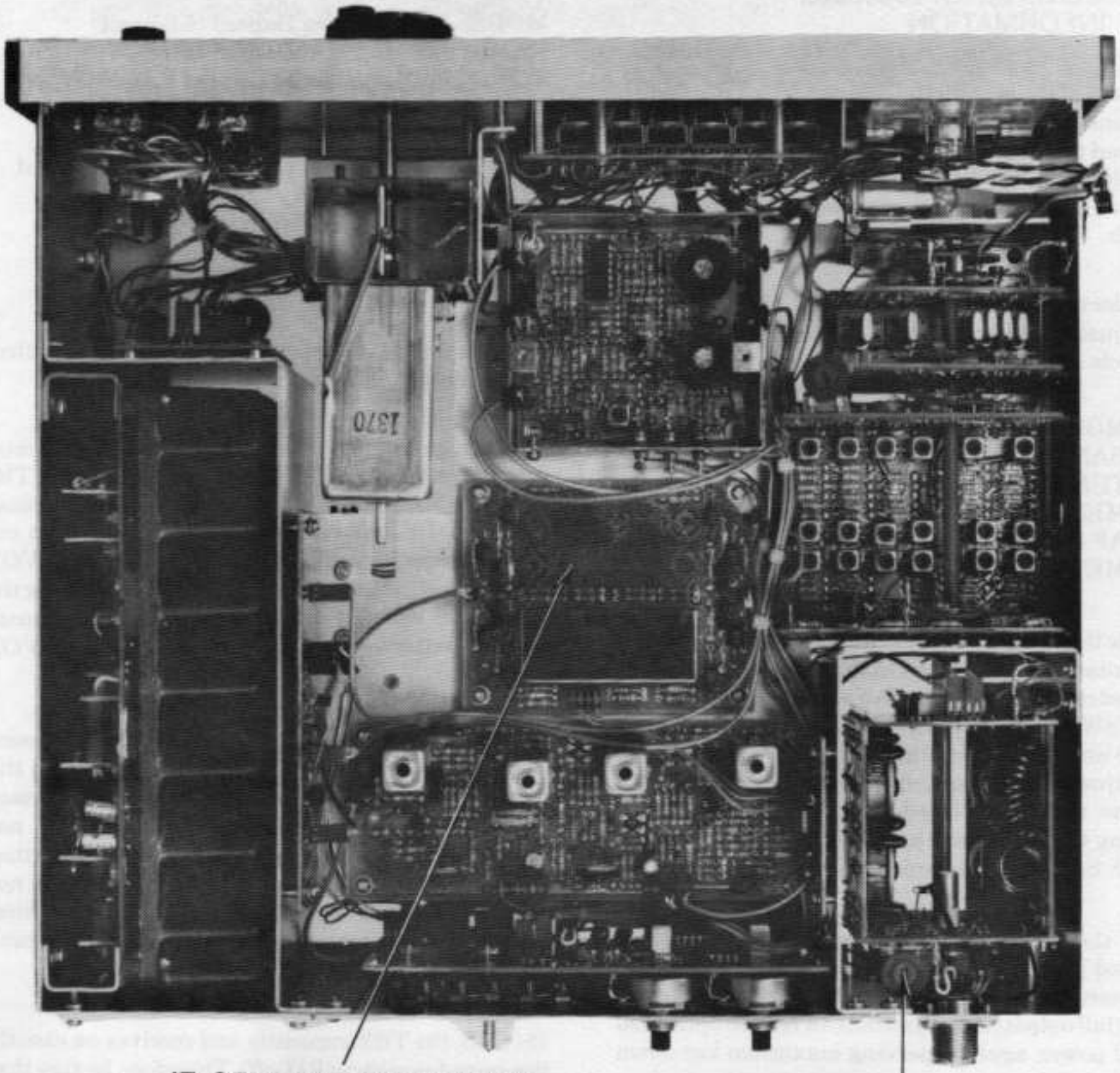

Figure 3-4 Relative Power Adjustment and Crystal Filter Installation

Reinstall the board by reversing the above procedure. Check to be sure that all connectors are properly oriented, and that no other connections or controls have been disturbed prior to attempting to operate the unit.

3-5. GENERAL OPERATING INFORMATION

Because of the broadband design of the TR5, there is no 'tune-up' required. It is desirable, however, that the load presented by the antenna be between 25 and 100 ohms (2:1 VSWR or less). If this is not the case, an antenna tuner can be used to provide the proper match.

In order to provide a carrier output to check VSWR or to adjust an antenna tuner, preset the front panel controls as follows:

MODE:	CW
BAND:	On Desired Band
TUNING:	Set to Desired Fequency
MIC/CW GAIN:	Fully counterclockwise
AF GAIN:	Power ON
METER:	ALC

Rotate the MODE switch to the LOCK KEY position and rotate the MIC/CW GAIN control clockwise to get just enough output to give a full scale reading on the VSWR meter of the antenna tuner or wattmeter (10-20 watts). Follow the manufacturer's instructions for adjusting the tuner, and be sure to observe the 5 minute maximum key-down time to avoid overheating the TR5 power amplifier. Rotate the MODE switch back to CW to unkey the radio.

Once the antenna or tuner has been adjusted at reduced power, the MIC/CW GAIN control can be increased until the ALC meter starts to move upscale (full output). Adjustments can now be optimized at full power, again observing maximum key-down limits.

The ALC system in the TR5 is operative in both the SSB and CW modes, and senses both forward and reflected power. As antenna line VSWR increases, the ALC will decrease the drive to the final amplifier to protect the output transistors. Thus, with high VSWR, The ALC meter will start to indicate at lower power levels, indicating that this circuit is working.

3-6. SSB OPERATION

In the following discussion, it is assumed that the TR5 has been matched to the antenna on the desired band as described in section 3-5.

For single sideband operation of the TR5, preset the front panel controls as follows:

MODE:	On Desired Sideband
BAND:	On Desired Band
TUNING:	Set to Desired Frequency
MIC/CW GAIN:	Fully Counterclockwise
RF GAIN:	Fully Clockwise
AF GAIN:	Set for Desired Audio Output
VOX GAIN:	Fully Counterclockwise
VOX DELAY:	At Minimum (*NOT* QSK)
VOX SWITCH:	ON
METER SWITCH:	ALC

In addition, set the rear panel ANTI-VOX control fully counterclockwise.

While speaking into the microphone in a normal voice, increase the VOX GAIN control until the TR5 switches to transmit reliably with speech. Increase the VOX DELAY control for the desired drop out time. If necessary, adjust the rear panel ANTI-VOX control to prevent received signals from tripping the VOX. The use of a microphone with a directional pick-up pattern will help to reduce undesired VOX tripping.

Again, speak into the microphone in a normal voice and increase the MIC/CW GAIN control until the meter indicates 2-4 'S' units of ALC action on voice peaks. Additional increase of this control will not increase power output, and may result in distortion of the transmitted signal. If VOX operation is not desired, place the VOX switch in the OFF position and use the microphone PTT switch for transmit/receive control.

On SSB, the TR5 transmits and receives on exactly the same frequency (RIT off). Therefore, be sure that you have signals tuned in so that voices sound normal before transmitting. Otherwise, you will not be transmitting exactly on frequency. Once contact has been established, the RIT control can be enabled and used for minor receive frequency corrections. The digital readout will show the operating frequency on both receive and transmit, thus indicating when reception and transmission are on different frequencies.

3-7. CW OPERATION

To operate CW, connect a key to the rear panel KEY jack. If an electronic keyer is used, connect it for cathode keying; i.e., a *positive* keyline voltage. Wire the keyer plug so that the tip is 'hot'.

The TR5 uses shifted carrier CW. This system shifts the transmit frequency by approximately 800 Hz from the receive frequency. Therefore, to transmit on the frequency of a recieved CW signal, the receiver should be tuned to produce a beat note of 800 Hz. The digital frequency display reads the transmit frequency in the CW mode.

To receive CW signals, place the MODE switch in the CW position. Tune in a CW signal for an audio pitch of about 800 Hz and adjust the AF GAIN control for a comfortable listening level. To transmit, close the key and adjust the MIC/CW GAIN control clockwise until the relative power meter stops increasing. Increasing the control further will not increase power output (due to ALC action), and may result in undesirable keying characteristics. The CW sidetone level is adjustable on the rear panel.

The TR5 uses automatic transmit/receive switching in the CW mode. This means that it will automatically transmit when the key is depressed and return to the receive condition when the key is released. The delay time from transmit to receive is adjustable with the front panel VOX DELAY control. At minimum delay (QSK position) the TR5 will operate full break-in at speeds up to 50 wpm. Be sure that the VOX DELAY control is fully CCW and switched into the QSK mode for full break-in operation.

Manual transmit/receive switching in the CW mode can be accomplished by connecting an external switch to the push-to-talk circuit of the MIC jack.

3-8. OPERATION NEAR BAND EDGES

When operating near the edge of an amateur band, be sure that the entire transmitted signal is within the band. On SSB, be sure to use the sideband that will be away from the band edge. On CW, the digital readout reads the transmit frequency, but the operator should allow 100 or 200 Hz for possible alignment error.

3-9. OPERATION WITH A LINEAR AMPLIFIER

The TR5 will drive most linear amplifiers. However, since the TR5 is rated at 150 watts PEP input, it is doubtful that it would be worthwhile to use a linear amplifier with a power input rating of less than 1000 or 2000 watts PEP. An amplifier with a tuned input will present a satisfactory load to the TR5. See figure 2-5 for typical interconnections.

If the linear amplifier is of the grounded cathode type with high impedance and/or high sensitivity input, it will be necessary to install a resistive pad between the amplifier input and the TR5. Such a pad must present a 50 ohm load impedance to the TR5, and must have adequate power dissipation capability.

Operation is exactly as described in previous sections. Note that the linear amplifier must be capable of full break-in operation in order for the TR5 to be able to work properly in the QSK mode. Follow the instructions provided by the manufacturer of the amplifier for tune-up and operation.

Care should be taken to avoid overdriving the linear amplifier. If the amplifier has an ALC output, it can be connected to the ALC input on the PS7 or PS75 to prevent overdrive, *provided that the amplifier in use generates a negative ALC voltage.*

The amplifier relay control line should be connected to the appropriate connector on the PS7 or PS75. Note that one side of this line is ground; if the linear in use requires an isolated set of relay contacts, a separate relay will be required.

NOTE

Be sure that your amplifier presents a 50 ohm characteristic impedance in the stand-by or bypass mode to avoid activating the VSWR protection circuitry in the TR5 when operating low power.

SECTION IV
THEORY OF OPERATION

4-1. GENERAL

The TR5 is a 150 watt HF single sideband transceiver which covers the 160 through 10 meter amateur bands. Full break-in CW operation is also provided. The TR5 features digital frequency readout, all solid-state design and wide receiver dynamic range. Some of the circuits are common to both the transmit and receive functions. Refer to the block diagram, figure 4-1, and the schematic diagram, figure 5-3, as required to supplement the following discussion.

4-2. INJECTION AND COUNTER CIRCUITRY

The local oscillator injection signal in the TR5 is developed by a premixer system. This system consists of the permeability tuned oscillator (PTO), the crystal oscillator module, and the premix/injection filter module.

In the crystal oscillator module, Q1301 is a grounded base oscillator. The frequency of the oscillator is controlled by a crystal selected by SW1301, and the output is tuned by L1301 in combination with C1310-1318. The crystal frequency is always 11.1 MHz above the low edge of the desired 500 kHz range. For example, the crystal for the 80 meter band is 3.5 + 11.1 = 14.6 MHz. Series resonant crystals are used, with a series resistance of less than 30 ohms. The holder is type HC-25/U. The output of the crystal oscillator is buffered by Q1302.

The output of the PTO is fed to the premixer through CR1601 and CR1602. These diodes form a switch which is controlled by Q1601, Q1602 and U1601. When the RV75 Remote VFO is in use, CR1601 and CR1602 are turned off and CR1603 is turned on. This switching action provides the necessary isolation between the two VFOs while allowing them to run continuously to insure stable operation. Receiver Incremental Tuning (RIT) control of the PTO is provided by U1602. R1614 allows centering the PTO within the RIT range when the RIT is off.

The PTO and crystal oscillator signals are applied to a balanced mixer consisting of Q1402 and Q1403 in the premix/injection filter module. A balanced mixer is used to provide adequate attenuation of the crystal oscillator signal, thus reducing spurious outputs and responses to a minimum. The output of the balanced premixer is buffered by Q1401, which is configured as an emitter follower, and routed by SW1401 to the appropriate filter for the band in use. The filters reduce the undesired premixer products to acceptable levels, and the desired injection signal is routed through SW1402 to an impedance stabilizing pad consisting of R1420, R1421 and R1422. Q1404 and Q1405 form a broadband amplifier to bring the injection signal up to a level adequate to drive the receive and transmit mixers.

A portion of the injection signal is routed to the digital display module through R1426. Q1501 and Q1502 are used to amplify the signal and isolate the counter circuitry from the remainder of the TR5. U1506 and U1507 form a divide-by-eight prescaler. This division is necessary to reduce flicker and ambiguity in the 100 Hz digit of the display. The prescaled input signal is counted by programmable counters U1508-1513, and the result is displayed via latch/decoder/drivers U1501-U1505. The 10 MHz digit is controlled by a bandswitch wafer, and is wired to read blank, 1 or 2 as appropriate for the band in use. Y1501 and U1518 are used to provide a stable time base oscillator. This signal is divided and processed by U1514, U1515, U1520 and U1504 to form the gate, latch and reset signals for controlling the counter.

The injection frequency is always above the operating frequency by an amount equal to the BFO frequency. The counters are programmed by a matrix consisting of CR1510-CR1518 to digitally subtract the BFO frequency from the count, resulting in an accurate display of the actual operating frequency. Since the BFO frequency changes with mode, a matrix is required to generate a separate preset for USB, LSB and CW/TUNE.

4-3. RECEIVER CIRCUITRY

Incoming signals from the antenna pass through the bandswitched low-pass filter module, which includes a reed relay antenna switch, to the rear panel EXT RX jack. If the rear panel jumper plug is in place, the signals then pass through a high-pass filter on the rear panel to eliminate broadcast band responses. A separate receiver and/or receive antenna can be connected in this path by removing the jumper plug and making the appropriate connections.

The output of the rear panel high-pass filter is connected to the receiver input of the BPF/RF amplifier module, where it is routed through a diode T/R switch and a master low-pass filter to one of nine band-pass filters which are bandswitch selected. The master low-pass filter is designed for a cut-off of approximately 35 MHz, and is employed to improve image rejection on the higher frequencies. The output of the selected band-pass filter is connected via the bandswitch to the input of Q701, which is a high dynamic range broad-band RF amplifier. The output of this amplifier is switched to the receive output of the BPF/RF amplifier module.

This signal is connected to the receiver input of the TX/RX mixer module, where it is combined with the output of the premix/injection filter module to create a 5.645 MHz intermediate frequency (IF) signal. This conversion is accomplished by a high-level double balanced mixer consisting of CR801-CR804 and associated components. The output of this mixer is amplified by a low-noise, high dynamic range junction FET amplifier (Q801) to insure adequate sensitivity and strong signal performance. AGC is applied to this stage via Q803 and Q804 in the presence of strong received signals to prevent receiver blocking. The IF signal is further amplified by a large signal bipolar device, Q802.

The 5.645 MHz IF signal from the TX/RX mixer module is connected to the input of the NB5 Noise Blanker. When installed, the accessory NB5 acts on noise pulses prior to the crystal filter to prevent ringing in the filter from stretching the pulses. Maximum noise blanker effectiveness is thus assured. If the accessory NB5 is not installed, the IF signal is passed through an IF switching board in the same location.

The output of the noise blanker or switching board is fed to the IF selectivity module. This board will accept one accessory filter in addition to the standard 2.3 kHz filter. These filters determine the overall bandwidth of the receiver, and are selected by PIN diode switching controlled from the front panel. Careful attention has been given to the design of the switching circuits to minimize stray coupling paths which would degrade the ultimate selectivity of the receiver. The result is very high rejection of unwanted off-channel signals.

Following the IF selectivity module, the 5.645 MHz IF signal is routed to the IF module. Q1101, Q1102, and Q1103 amplify the signal, and a portion of the output of Q1103 is used to develop an AGC control voltage which is applied to Q1101, Q1102, and the RX/TX mixer module for gain control. The same AGC signal is used to drive the S-meter circuit to provide signal strength information. AGC decay time constants and on/off conditon are controlled by a front panel switch.

The output of the IF module drives the audio/detector board. U1201 is a product detector, which mixes the IF signal with the BFO to demodulate the SSB IF signal. The resulting audio is amplified by Q1201, and fed through the front panel AF gain control to U1202, where it is amplified to a level sufficient to drive a speaker. A second input to U1202 is provided for the CW sidetone, and a separate output is connected through R1224 for anti-VOX operation.

The BFO signal is developed by a junction FET oscillator, Q501. The output of this oscillator is buffered by Q502 to prevent frequency pulling due to load changes. Crystal Y501 is pulled to the correct BFO frequencies by diode selected tuning networks which are controlled by the front panel MODE switch.

4-4. TRANSMITTER SECTION

In the transmit mode, audio signals from the MIC jack are applied to the VOX/Exciter module, where they are amplified and used to drive the VOX (U402) and balanced modulator (U403). The VOX circuit controls the T/R switching in the SSB mode via Q401, Q402 and Q412-Q417. A PTT input is provided for manual control. In CW, the key switches Q411 on and off. Q411, in turn, controls the T/R switching via CR411, keys sidetone oscillator Q418, and provides a keying input to the BFO module via CR413. CR414 allows the transceiver to be placed in the tune, or LOCK KEY mode without keying the sidetone oscillator. The VOX/Exciter module also houses the 10 volt regulator, consisting of U401, Q403 and Q404.

In the SSB mode, the 5.645 MHz double sideband output of the balanced modulator is routed through the noise blanker to the IF selectivity module. The signal is passed straight through the noise blanker for interconnection purposes only. The IF selectivity module rejects the undesired sideband, using the standard 2.3 kHz crystal filter. CR1001 and CR1002 form an AND gate to force the selection of the 2.3 kHz filter in the transmit mode.

The 5.645 MHz single sideband signal from the IF selectivity module is connected to summing amplifier Q1106 on the IF module. In the CW and LOCK KEY modes, the balanced modulator is disabled,

and the BFO signal is shifted and applied to Q1106 via keying diode CR1107.

The output of the summing amplifier is connected to a variable attenuator formed by CR1104 and associated components. This attenuator is controlled by the ALC circuitry. The forward and reflected outputs of the wattmeter circuit on the LPF module and the front panel MIC/CW GAIN control are connected to the ALC module. An input for a negative-going signal from a linear amplifier is also provided. These signals are processed and summed to create a controlling voltage for the attenuator, thus regulating the transmitter drive level. VSWR protection is accomplished in this manner, as well as providing gain control to prevent flattopping and overdrive.

The SSB/CW 5.645 MHz IF signal from the IF module is connected to the transmit input of the RX/TX mixer. U801 is used as a balanced mixer to convert the signal to the desired operating frequency. The balance control, R835, is adjusted to null the injection signal in the mixer output, thereby reducing transmitted spurious. Q805 amplifies and buffers the mixer output, which is connected to the front end/BPF board. This module filters the transmit signal to reduce undesired mixer products, and amplifies the desired signal to a level sufficient to drive the power amplifier module.

The power amplifier module consists of two boards, the predriver and the power amplifier. Overall module gain is set by R312 on the predriver board. The driver (Q201/202) and final amplifier (Q203/204) stages are operated in push-pull to reduce the level of even-order harmonics, thus easing the design requirements on the LPF module. Heavy amounts of inverse feedback are employed in the power amplifier to insure good linearity and stability. Diodes CR303, CR201 and CR202 are thermally bonded to the stages they control, thus allowing the bias applied to these stages to track the heat sink temperatures. This technique prevents thermal runaway.

The output of the power amplifier is connected to the LPF module to attenuate the harmonics developed in the power amplifier. The transmit signal then passes through the wattmeter to the rear panel antenna jack. CR104 and associated components form a voltmeter to provide a relative output indication. Meter sensitivity is adjusted by R105.

NOTES:

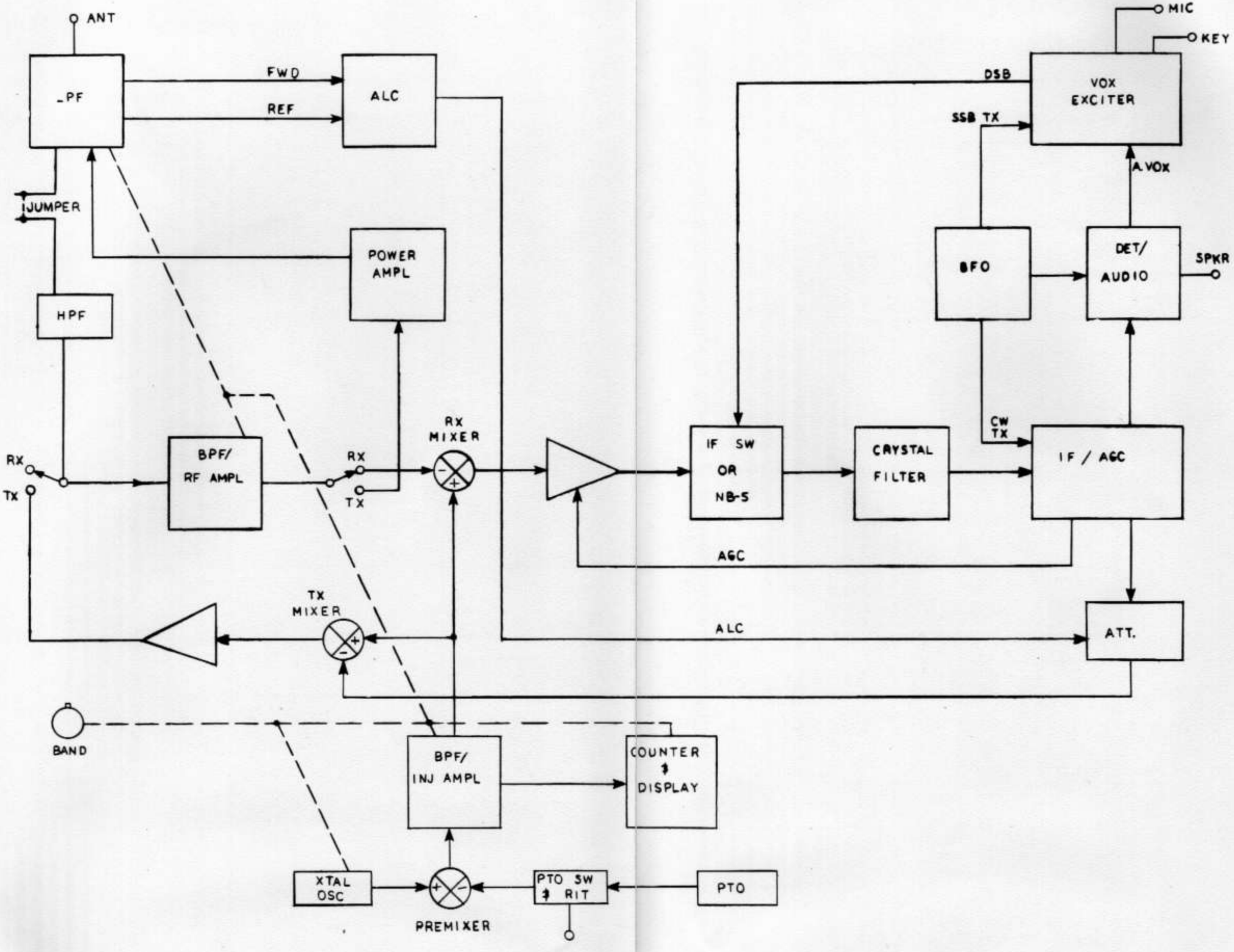

Figure 4-1 TR5 Block Diagram

SECTION V
MAINTENANCE

5-1. SERVICE INFORMATION

The R. L. Drake Company will check, align and repair your TR5 transceiver at the factory on a time and material basis. Warranty repair considerations are described on the inside front cover of this manual.

Please write or call the factory for authorization before returning your unit for alignment and/or service. Address your request for authorization to:

R. L. DRAKE COMPANY
540 Richard Street
Miamisburg, OH 45342
ATTN: Customer Service Department
Telephone: (513) 866-3211

WARNING

Extreme caution should be exercised when the top and bottom covers are removed. Primary line voltage is present at several points, and can cause a lethal electrical shock. Repairs and/or adjustments should be made by a qualified technician. Disconnect the power supply from the TR5 before removing covers.

5-2. TOP COVER REMOVAL

Remove the four screws on each side of the bottom of the top cover and remove the cover by sliding it to the rear of the transceiver.

5-3. BOTTOM COVER REMOVAL

Remove the ten screws holding the bottom cover and separate it from the chassis. Use caution, since the internal speaker is mounted to the bottom cover. Unplug the speaker cable from the rear panel board if the bottom cover is to be completely removed.

5-4. TROUBLESHOOTING

Careful consideration has been given to minimizing maintenance requirements in the design of the TR5. Solid state equipment seldom requires realignment, due to the low levels of heat generated during operation. However, it is possible that a problem might arise which cannot be resolved using the alignment and troubleshooting information in this chapter.

If this occurs, it is suggested that the TR5 be returned to the dealer, or you may write to the Customer Service Department at the address given in paragraph 5-1. Be sure to describe the malfunction in detail, including information regarding external connections, control settings, accessories in use, and serial number.

Before returning the unit for service, check the power supply fuse, the internal fuse (on the rear panel board), and all external connections. In addition, remove the top and bottom covers and inspect all wiring harness connectors to see that they are fully seated in the appropriate locations. The voltage and signal level charts, used with the schematic and block diagram, should be useful in isolating minor problems. However, no attempt should be made to service the TR5 unless you are thoroughly familiar with electronic circuitry and servicing techniques.

5-5. TEST EQUIPMENT

Alignment of the TR5 will require the following equipment.

a. An 11 megohm input VTVM w/RF probe
b. A non-reactive 50 ohm dummy load, such as the R. L. Drake DL-300.
c. An accurate wattmeter
d. A frequency counter
e. An accurate signal generator (optional)

5-6. ALIGNMENT PROCEDURES

The following alignment procedure is structured in such a manner that it may be entered at any point and followed to conclusion. That is, if you are sure that all adjustments preceeding those of interest are correct, you may start at the section which is applicable to the problem at hand. However, all sections following the starting point should be completed to insure proper operation. If any doubt exists, it is recommended that the entire procedure be executed. Refer to figures 5-1 and 5-2 for parts location.

5-6.1 10 VOLT ADJUSTMENT

Using and accurate voltmeter, measure the voltage on the 10 volt buss on the rear panel board. If necessary, adjust R441 (blue) on the VOX/Exciter board for the correct voltage (10 ± 0.25 volts).

5-6.2 BFO ALIGNMENT

Use an accurate counter in the following procedure to insure proper frequency response.

a) Unplug the coax from the product detector output of the BFO board. This connector is color coded brown. Attach the counter to this point.
b) Set the MODE switch to the LSB position, and adjust L501 for 5643.6 kHz.
c) Switch to USB, and adjust C502 for 5646.4 kHz.
d) Switch to CW, and adjust C504 for 5645.8 kHz.
e) Switch to Lock Key, and adjust C505 for 5645.0 kHz. Be sure MIC/CW is fully CCW before selecting Lock Key.

5-6.3 RECEIVER IF ALIGNMENT

This alignment should be necessary only when parts on the IF/AGC or RX/TX Mixer boards have been replaced.

a) Connect a signal generator to the antenna terminal. Set the TR5 and the generator to the same frequency.
b) Select the CW mode.
c) Adjust the signal generator for an S-meter reading of S-9.
d) Tune T1101, L1101, L1102 and T1102 on the IF/AGC board and L801 on the TX/RX Mixer board for maximum response. Keep the S-meter around S-9 by adjusting the generator output.

5-6.4 PREMIXER ALIGNMENT

Perform this procedure exactly as described below. Otherwise, birdies and spurious outputs may occur.

a) Tune the TR5 to 21.250 MHz.
b) Unplug the PTO coax from the front switch board of the Premixer module.
c) Connect the RF probe to the case of Q1405, and adjust R1410 for minimum output.
d) Reconnect the PTO coax, and adjust the premix filters as follows:

FREQUENCY	ADJUST FOR MAXIMUM
28.750 MHz	L1418, L1420
24.750 MHz	L1416, L1417*
21.250 MHz	L1414, L1415
18.250 MHz	L1412, L1413*
14.250 MHz	L1410, L1411
10.250 MHz	L1407, L1408
7.250 MHz	L1405, L1406
3.750 MHz	L1403, L1404
1.900 MHz	L1401, L1402*

* Do not adjust if necessary range crystals are not installed.

5-6.5 FRONT END ALIGNMENT

Be sure to observe the transmit duty cycle limitations during the following procedure.

a) Connect a wattmeter and dummy load to the TR5 antenna terminal.
b) Select the Lock Key mode, and use the MIC/CW Gain control to adjust the power output to approximately 30 watts (below ALC threshold).
c) Peak the power output in accordance with the following table, keeping the power output at 30 watts with the MIC/CW Gain. Be sure not to overheat the power amplifier during this adjustment.

FREQUENCY	ADJUST FOR MAXIMUM
28.750 MHz	L721, L722
24.750 MHz	L718, L720*
21.250 MHz	L716, L717
18.250 MHz	L714, L715*
14.250 MHz	L712, L713
10.150 MHz	L710, L711
7.150 MHz	L707, L708
3.750 MHz	L705, L706, L723, L724
1.900 MHz	L703, L704*

* Do not adjust if necessary range crystals are not installed.

5-6.6 TRANSMIT MIXER BALANCE

This adjustment can be ignored unless you have reason to believe your radio is transmitting spurious signals and/or you have made parts replacements on the board. Follow the procedure below.

a) Remove counter/display assembly.

b) Remove TX/RX Mixer top shield.
c) Unplug the transmit IF coax (coded blue) from the board.
d) Unplug the transmit drive coax (coded orange) and connect the RF probe to the mixer board at this point.
e) Set the BAND switch to 28.5 MHz and the MODE switch to Lock Key.
f) Adjust R835 (blue) on the mixer board for minimum voltage on the RF voltmeter. Return MODE switch to CW.
g) Remove RF probe and reinstall cables.
h) Reinstall the top shield and counter/display.

5-6.7 WATTMETER/ALC ADJUSTMENT

a) Attach the TR5 to a 50 ohm dummy load through an accurate wattmeter.
b) Tune the unit to 14.250 MHz and place the MODE switch in Lock Key.
c) Adjust the MIC/CW Gain control for 40 watts of output power (below ALC threshold).
d) Attach the VTVM to the reflected input to the ALC board (gray wire in the 3 pin connector).
e) Adjust C133 on the LPF module for a minimum VTVM reading. C133 is accessible through the rear panel, via the hole marked NULL.
f) Switch the MODE switch to CW, and the BAND switch to 28.5 MHz. Remove the VTVM.
g) Switch to Lock Key, and rotate the MIC/CW Gain fully CW. Adjust R616 on the ALC board for 50 watts of output. If necessary, transmitter gain can be increased with R312 (purple) on the predriver board.

NOTE

In a properly aligned TR5, R312 should not be adjusted above the 2 o'clock position. Transmitter instability may result above this setting.

h) Check the maximum power output on other bands. It should not exceed 90 watts.

5-7. PERIODIC ADJUSTMENTS

The adjustments described in this section can be made at any time, and do not interact with any other alignment procedures.

5-7.1 CARRIER BALANCE

a) Place the MODE switch in USB and depress the PTT switch. Turn the MIC/CW Gain fully CCW.
b) Turn in the signal on an external receiver loosely coupled to the dummy load.
c) Adjust the red carrier balance pot (R482) for minimum signal on the external receiver. Repeat on LSB, and adjust for best compromise between USB and LSB.

5-7.2 COUNTER TIME BASE

This procedure assumes that the BFO has been accurately adjusted as described in section 5-6.2. If there is reason to believe that the BFO adjustments are in error, they should be repeated before this adjustment is made.

a) Tune in either WWV or an accurate signal generator for zero beat, using USB or LSB. Do not use CW or 800 Hz error will be obtained. (If WWV is used, zero beat when modulation is off to insure accuracy.)
b) Adjust trimmer C1512 on counter assembly until the display reads the correct frequency.

5-7.3 RIT CENTERING

a) Turn on RIT switch and set the RIT control at center.
b) Tune in a signal on the TR5.
c) Turn off the RIT and adjust R1614 on the RIT/PTO switch board until the same signal is again in tune.
d) Switch the RIT on and off to verify that the RIT is centered.

5-7.4 S-METER ADJUSTMENT

a) Turn R1127 (black) fully CCW.
b) Turn R1142 (white) fully CW.
c) Adjust R1132 (green) to give a positive indication of about one S-unit.
d) Adjust R1142 (white) for a 2 S-unit rise above the setting obtained in step c.
e) Adjust R1132 (green) for zero meter reading
f) Turn the RF Gain fully CCW and adjust R1134 (black) for S9 + 70 db.

g) Return the RF Gain to its fully CW position and note that the S-meter is still on zero. Readjust R1132 (green) if necessary.
h) Adjust R1127 (black) CW to about 2/3 of the total CW rotation. If a signal generator is available, set R1127 so that 50 microvolts on 14.250 produces an S-9 signal.

5-8. ALIGNMENT ON OTHER RANGES

Due to the broadband nature of the output stage of the TR5, it is possible to cover frequencies other than those indicated by the bandswitch. This is accomplished by calculating the proper range crystal frequency for the desired 500 kHz range (see section 4-2) and referring to the following table for the proper bandswitch position. For example, if operation from 3.0-3.5 MHz is desired, the range crystal required would be 3.0 + 11.1 = 14.1 MHz. From the table, the crystal would be installed in place of the standard 14.6 MHz crystal supplied for 80 meters, and the bandswitch placed in the 3.5 position.

When changing ranges, the premixer alignment (5-6.4) and front end alignment (5-6.5) procedures should be performed.

TR5 FREQUENCY COVERAGE

Bandswitch Position	Standard Coverage	Coverage with New Crystal and/or Realignment
1.5 MHz	1.8-2.0 MHz	1.5-2.0 Mhz (any 200 kHz)
3.5 MHz	3.5-4.0 MHz	3.0-5.0 MHz (any 500 kHz)
NOTE: AVOID 5.0-6.5 MHz DUE TO 5.645 MHZ IF		
7.0 MHz	7.0-7.5 MHz	6.5-8.5 MHz (any 500 kHz)
10.0 MHz	10.0-10.5 MHz	8.5-10.5 MHz (any 500 kHz)
14.0 MHz	14.0-14.5 MHz	10.5-15.5 MHz (any 500 kHz)
18.0 MHz	18.0-18.5 MHz	16.0-20.0 (any 1 MHz)
21.0 MHz	21.0-21.5 MHz	19.0-22.0 MHz (any 1 MHz)
24.5 MHz	24.0-24.5 MHz	22.0-26.0 MHz (any 1.5 MHz)
28.0 MHz 28.5 MHz 29.0 MHz	28.0-29.7 MHz	2.6.0-30.0 MHz (any 2 MHz)

TABLE 1
TR5 TYPICAL OPERATING CONDITIONS

TYPICAL RECEIVER LEVELS

The following typical data will help to isolate a receiver problem to a circuit board for repair. The TR5 should be in USB or LSB receive, AGC on, with the RF Gain fully CW.

Connect Generator To	Frequency	Level Required for S-9
Antenna Terminal	On Channel	30-100 Microvolts
RX Mixer Input	On Channel	60-200 Microvolts
IF Selectivity Input	**5645 kHz**	400-600 Microvolts
IF/AGC Input	**5645 kHz**	250-450 Microvolts

TYPICAL TRANSMITTER LEVELS

The following typical levels will help to isolate a transmitter difficulty to a board or module for repair. The TR5 should be in Lock Key (transmit) on 14.250 MHz, with the MIC/CW Gain fully CW. Use a dummy load and observe the duty cycle limitations.

Circuit Test Point	RF Voltage (RMS)
BFO Output to IF	0.5 V
TX Mixer IF Input	1.0 V
TX Mixer Output	0.25 V
Predriver Input	0.25 V
Predriver Output	3.5 V

TABLE 2
DC VOLTAGE MEASUREMENTS

The following DC operating voltages were measured with the TR5 configured as follows:

BAND: 3.5
METER: ALC
NB: OFF
VOX: OFF
SPKR: OFF

BW: NORM
RIT: OFF
DELAY: QSK
AGC: F

MODE: USB
RIT: 0
MIC/CW GAIN: FULL CCW
RF GAIN: FULL CW

R Indicates Receive (PTT Open)
T Indicates Transmit (PTT Grounded)

REF. DES.	DEVICE TYPE		E	B	C
Q201, Q202	SRF2338 (Matched Set)	R	0	0	13.6
		T	0	0.7	13.6
Q203, Q204	MRF455 (Matched Set)	R	0	0	13.6
		T	0	0.7	13.6
Q205	EP487	R	0	0	0
		T	0.7	1.3	13.3
Q301	MPSH20	R	0	0	0
		T	2.1	2.9	13.3
Q302	MRF476	R	0	0	0
		T	0	0.7	13.3
Q401	2N4402	R	13.4	12.6	13.4
		T	13.3	13.3	0
Q402	2N3904	R	0	0.7	0
		T	0	0	13.3
Q403	2N5986		12.7	13.3	10
Q404	2N3904		6.3	6.9	12.7
Q405	2N4126		10	9.9	0
Q406	MPS6521		0	0	0
Q407	2N5953 (FET)		0 (GATE)	1 (SOURCE)	2.6 (DRAIN)
Q408	MPS6521		0.3	1.0	4.4
Q410	2N3904		3.6	4.3	9.1
Q411	2N4402	R	1.5	8.6	0.5
		T	3.1	9.9	0.3
Q412	2N3904	R	0	0.55	8.7
		T	0	0.36	0
Q413	2N4402	R	9.9	9.6	0
		T	9.9	9.0	9.8
Q414	2N3904	R	0	0.8	0
		T	0	0	9.9
Q415	2N4402	R	9.9	9.1	9.9
		T	9.9	9.7	0
Q416	MPS6521	R	0	0	13.4
		T	0	0.7	0
Q417	TIP32	R	13.4	13.4	0
		T	13.4	12.6	13.3
Q418	MPS6521		0	0.2	9.9
Q420	MPSH20	R	0	0	0
		T	5	5.7	9.8
Q501	2N5950 (FET)		0 (GATE)	0 (SOURCE)	8.7 (DRAIN)

REF. DES.	DEVICE TYPE		E	B	C
Q502	MPSH20		3.3	4.2	7.6
Q503	MPSH20		0	0	0
Q601	2N3904		0	0	2.6
Q701	2N5109		0.6	1.3	8.9
Q801	J310 (FET)	R	0 (GATE)	1.8 (SOURCE)	7.9 (DRAIN)
		T	0	0	0
Q802	2N5109		0.6	1.3	9.4
Q803	MPS6521	R	1.8	2.5	7.9
		T	0	0	0
Q804	TIS153 (FET)	R	08. (G_1 & G_2)	2.6 (SOURCE)	7.9 (DRAIN)
		T	0	0	0
Q805	2N4427	R	0	0	0
		T	1.3	2	8.5
Q901	2N4402	R	0	1	0
		T	9	8.3	9

REF. DES.	DEVICE TYPE		G_1	G_2	S	D
Q1101	TIS153	R	1.3	2.3	1.9	9.6
		T	0	0	0	0
Q1102	TIS153	R	1.3	2.3	2	9.5
		T	0	0	0	0
Q1103	TIS153	R	0	2.3	0.8	9.8
		T	0	0	0	0
Q1104	TIS153	R	0.7	0.7	2.4	9.9
		T	0	0	0	0

REF. DES.	DEVICE TYPE		E	B	C
Q1105	2N4402	R	9.9	9.5	1.5
		T	0	0	0
Q1106	2N3904	R	0	0	0
		T	2.5	3.2	9
Q1201	MPS6521	R	0.2	0.8	5.1
		T	0	0	0
Q1301	MPSH20		2.7	3.4	8.3
Q1302	MPSH20		3.0	3.8	8.6
Q1401	MPSH20		0.9	1.7	6.4
Q1402, Q1403	2N5953 (FET)		0 (GATE)	0.6 (SOURCE)	6.7 (DRAIN)
Q1404	MPSH20		0.7	1.4	6.9
Q1405	2N4402		1.3	1.9	8.6
Q1501	MPSH20		0.4	1.1	1.6
Q1502	2N4125		4.2	3.8	2.7
Q1503	2N3904		0	0.3	2.4
Q1504	2N3904		0	0.8	4.2
Q1601	2N3904		0	0	13.3
Q1602	2N3904		0	0	13.3
Q1701	2N3563		1.3	1.8	8.7
Q1702	2N5950 (FET)		0 (GATE)	1.6 (SOURCE)	7.2 (DRAIN)

REF. DES.	TYPE		PIN NO. 1	2	3	4	5	6	7	8	9	10	11	12	13	14
U401	MC1723		0	0	0	6.5	6.5	6.6	0	0	0.6	6.4	12.6	12.6	7.6	0
U402	LM324		0	0	0	10.0	0	4.6	0	0	1.6	0	0	0	0	0
U402	MC1496		2.8	2.2	2.2	2.8	0.9	6.3	0	5.5	0	5.5	0	6.2	0	0
U601	MC3401		0	0	0.4	0.4	0	0.4	0	0.3	0	0	0	0	0	6.0
U801	MC1496	R	0	0	0	0	0	0	0	0	0	0	0	0	0	0
		T	1.9	1.4	1.4	1.9	0.6	5.4	0	3.6	5.4	3.6	0	5.4	0	0
U1201	MC1496		3.2	2.5	2.5	3.2	1.0	7.0	0	6.0	0	5.0	0	7.0	0	0
U1202	TDA2002		0.6	0.6	0	6.0	12.6									
U1601	MC14016	R	8.6	0	8	8.6	12.4	12.4	0	8	8	0	8	0	0	12.6
		T	8.0	0	8	8.0	12.4	12.4	8	8.6	8	8	8.6	0	0	12.6
U1602	MC14016	R	3.6	3.6	3.6	3.6	9.4	0	0	3.6	3.6	3.6	3.6	9.4	0	9.4
		T	3.6	3.6	3.6	3.6	9.4	0	0	3.6	3.6	3.6	3.6	0	9.4	9.4

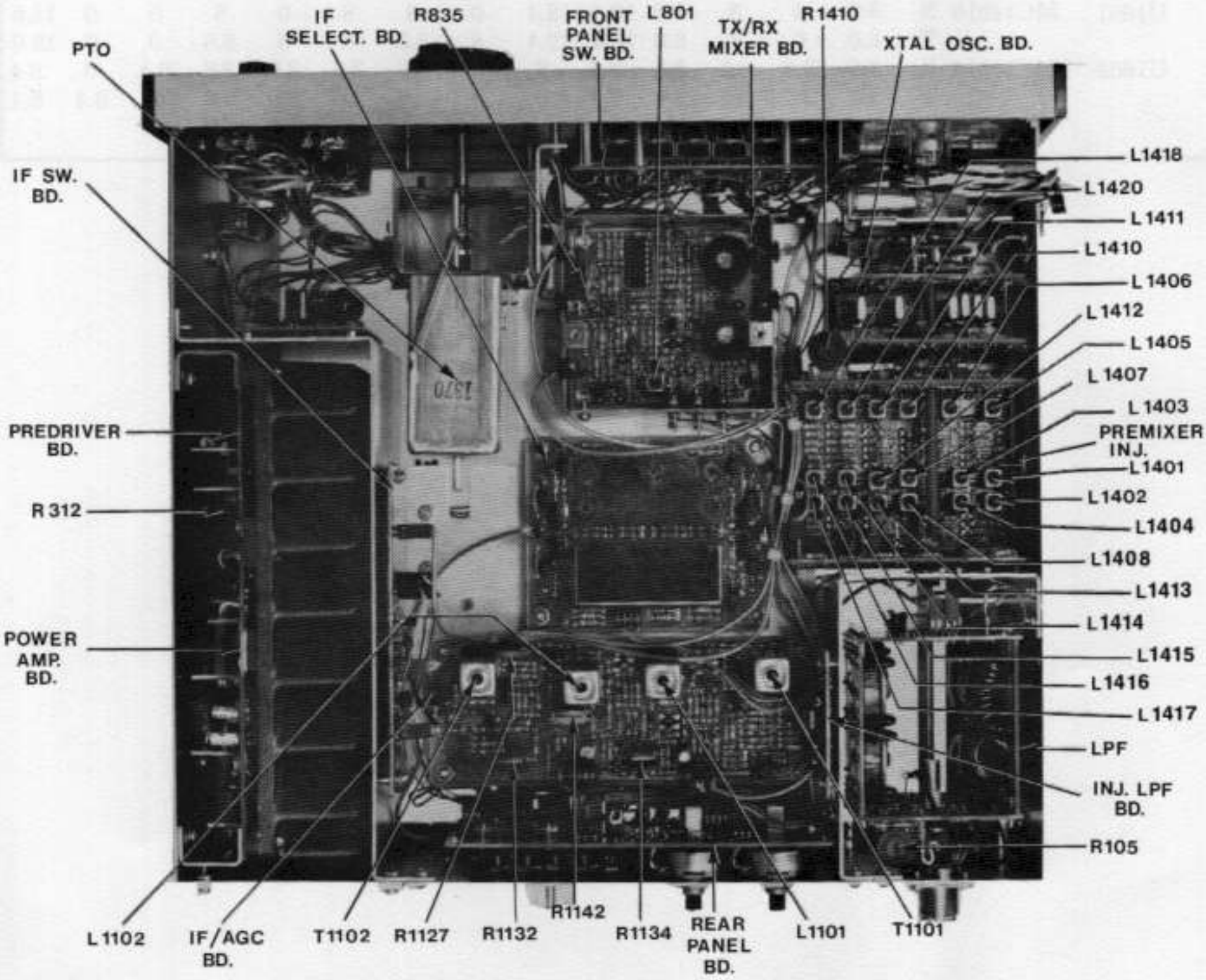

Figure 5-1 TR5 Top View

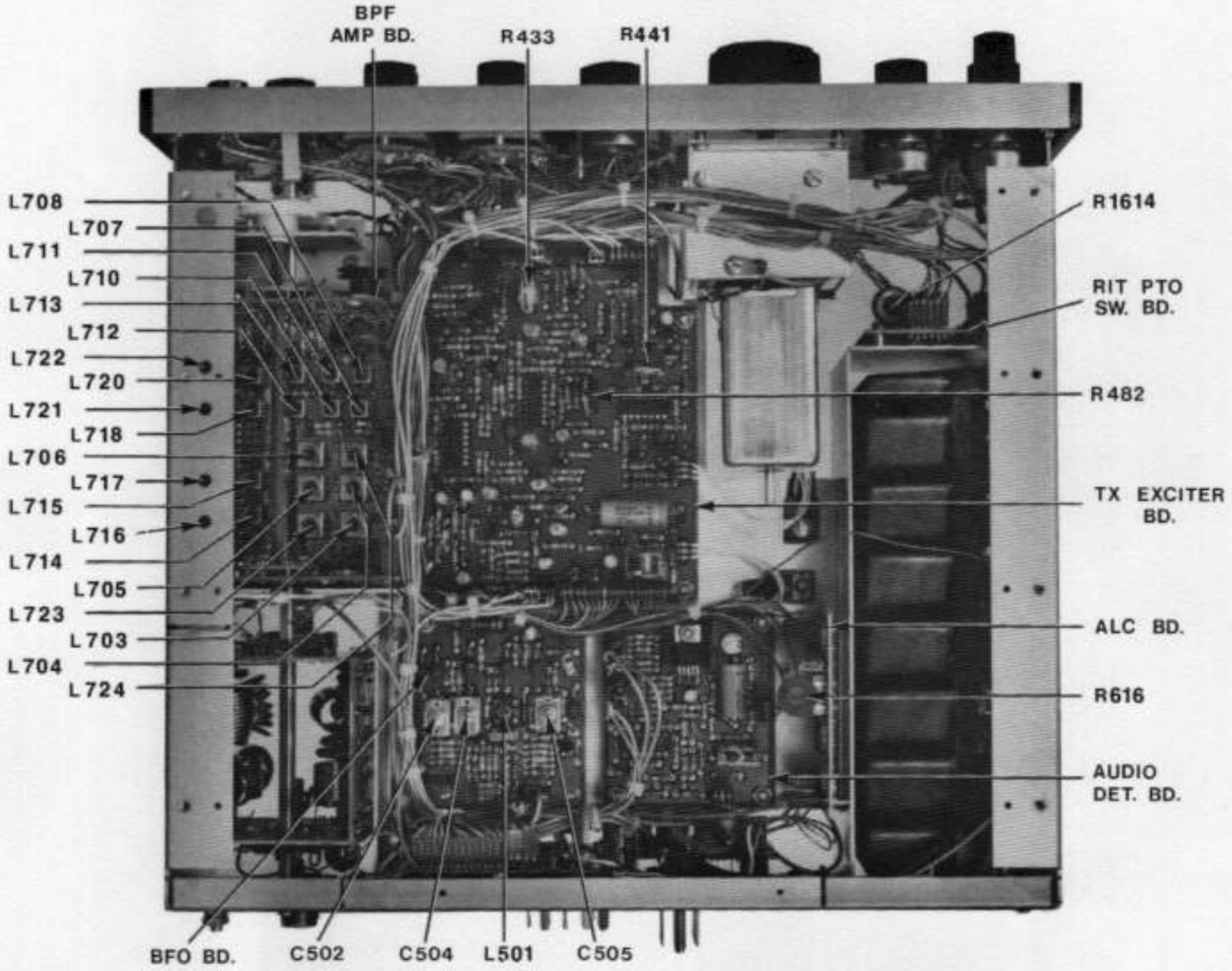

Figure 5-2 TR5 Bottom View