TECHNICAL MANUAL

HRO-600
RADIO RECEIVING SET

MANUSCRIPT

TABLE OF CONTENTS

TABLE OF CONTENTS (Cont)

TABLE OF CONTENTS (Cont)

LIST OF ILLUSTRATIONS

LIST OF TABLES

SECTION 1

GENERAL INFORMATION

1.1 INTRODUCTION

This technical manual provides general information, installation and operating instructions, and a listing of assemblies and chassis-mounted components of a maintenance significance for the Main Frame Assembly of Radio Receiving Set HRO-600. General information and instructions for major accessories used with the HRO-600 are contained within supplementary technical manuals.

1.2 DESCRIPTION

1.2.1 General

Radio Receiving Set HRO-600 is a solid-state, VLF/LF/MF/HF receiver covering the frequency range from 10 kHz to 30 MHz. Modes of operation are SSB, A3, A2, and A1. In an operational HRO-600, a frequency control plug-in unit is always installed within the Main Frame Assembly. There are three types of frequency control plug-in units: the Type 601 VFO (Search) Unit, the Type 602 Synthesizer Unit, and the Type 603 Fixed-Channel (12 crystal-controlled channels) Unit. An HRO-600 with a Type 601 Frequency Control Plug-In Unit is shown in Figure 1-1.

The Main Frame Assembly of the HRO-600 is also designed to accept an optional Type 650 FSK Converter. A special installation kit is furnished with the Type 650 converter. Other optional external accessories are also available for use with the HRO-600. These external accessories are as follows:

Figure 1-1. HRO-600 With Type 601 Plug-In Unit, Oblique view

a. Type 610 DC Power Supply

b. Type 640 ISB Adapter

c. Rack-Mounting Brackets.

1.2.2 HRO-600 Main Frame Assembly

The HRO-600 Main Frame Assembly consists of a rugged, dip-brazed, aluminum chassis and printed-circuit board basket, to which are attached a front panel, a rear panel, and top and bottom covers. The basic assembly is 5-1/4 inches high, 17 inches wide, and 15-1/2 inches deep. The main frame contains all receiver signal-path circuits from the antenna input through the line and speaker audio outputs. These circuits include an antenna attenuator, tunable preselector, frequency converters, i-f amplifiers, i-f filters, a-m and product detectors, and audio amplifiers. They also include a frequency synthesizer for a first mixer injection, a beat-frequency-oscillator (BFO), an encoder for

MHz selection, and a 115/230 volt ac power supply. The following controls and indicators are located on the front panel of the main frame:

- ANT. Selection Pushbuttons
- AGC DECAY Selection Pushbuttons
- MHz SELECT Switch and MHz Indicator
- AF GAIN Control
- PRESELECTOR ON-OFF Switch
- PRESELECTOR TUNE Control
- MODE Switch
- AGC Switch
- RF GAIN Control
- BFO Pitch Control
- BFO ON-OFF Switch
- LEVEL Meter
- METER Selection Pushbuttons
- LINE LEVEL Control
- PHONES Jack

The rear panel mounts the following facilities:

- Mixer injection input and output connectors
- Audio line and speaker output terminals
- AGC input and output terminals
- ISB AGC terminal
- Antenna input connector
- Broad-band and narrow-band i-f output terminals
- TTY output terminals
- Receiver muting and listen-thru terminals
- External frequency standard input connector
- Ac power input connector
- Spare terminals for future expansion of capabilities

When the main frame is augmented by one of the frequency control plug-in units, each of which is installed through the center of the front panel, the receiver is capable of operating at any frequency between 10 kHz and 30 MHz in the following reception modes:

AM

CW

SSB

FSK (Requires optional plug-in FSK converter, Type 650, or external audio equipment.)

FAX (Requires external audio terminal equipment.)

The proper filter is selected automatically in the SSB mode. The BFO is available in all other bandwidths, or it can be turned off for AM reception.

The main frame assembly is ruggedly built to ensure proper receiver operation in maritime or vehicular mobile environments, and the circuit design provides full rated performance throughout a temperature range of -20°C to +55°C, with relative humidity up to 95 percent.

1.3 SPECIFICATIONS

Frequency Coverage: 10 kHz to 30 MHz in thirty 1-MHz bands.

Reception Modes: A0, A1, A2, A3, A3a, A3j, A3h, (AM, CW, MCW, SSB), F1 (FSK) with optional Type 650 FSK Converter of external audio equipment, F4 (FAX) with external audio equipment.

Frequency Control: By synthesis of first injection (in 1-MHz bands) and VFO continuous tuning. Fixed-frequency crystal control or full synthesis options available.

Frequency Stability with Type 601 Plug-In Unit:

Versus temperature - drift less than 1000 Hz from 0°C to +50°C.

Versus time - less than ±20 Hz change in 15 minutes after 30-minute warm-up period.

Versus line-voltage change - less than ±20 Hz change for ±15-percent line-voltage change.

Frequency Stability with Types 602 and 603 Plug-In Units:

Versus temperature from 0°C to +50°C - less than ±1 PPM.

Versus time - less than 1 PPM per year.

Tuning Accuracy: ±50 Hz (Type 601 Plug-In Unit; ±10 Hz for Type 602 and 603) after frequency standard calibration.

BFO: Tunable ±3 kHz for A1 mode; synthesized for SSB operation.

Sensitivity: 0.75 μV (EMF) for 10 dB (S+N)/N ratio in 2.4 kHz bandwidth (approximately 12 dB noise figure).

RF Input Impedance: 50 ohms, unbalanced, or high-Z, as selected by front-panel pushbuttons.

Spurious Responses: Image rejection >90 dB; i-f rejection >90 dB; secondary image rejection >90 dB.

AGC Merit: Less than 10 dB output-level change for input-level change from 3 μV to.1 volt (EMF).

AGC Time Constant: Selectable at front panel. FAST (100 msec decay), MED (500 msec decay), SLOW (2 sec decay). Attack time constant approximately 15 msec.

Audio Outputs: Speaker output-1 watt at less than 10-percent distortion; Line output - 600-ohm impedance level at +0 dBm, with less than 2.5-percent distortion.

Audio Frequency Response: Flat within 3 dB from 200 Hz to 4.5 kHz.

RF Selectivity: Tunable preselector.

In-Band Intermodulation: The in-band products produced by two 100 mV tones are nominally more than 40 dB down at the audio terminals at a line output level of 0 dBm.

Blocking: A 0.1V (EMF) signal will cause less than a 3 dB drop in output, when spaced 5 kHz away from a 1000 μV (EMF) desired signal.

Cross-Modulation: A 30 mV (EMF) signal will generate a cross-modulation product, which will be more than 30 dB below the desired output of a 1000 μV (EMF) signal at a spacing of 10 kHz.

Front End Intermodulation: Any two 0.1V (EMF) at frequencies to produce I M products (one signal may be 30 kHz from desired frequency), will not produce an output equal to that caused by a desired 30 μV (EMF) signal.

Protection From Excessive RF Voltage on Antenna: Withstands 30V (EMF) for 15 minutes without damage.

Size: 5-1/4" H x 17" W x 15-1/2"D. Weight <40 lbs. Capable of being rack mounted.

Operating Temperature Range: -20°C to +55°C.

Humidity: To 95 percent.

Shock: Test Condition A of MIL-STD-202, Method 205 (15G).

Vibration: MIL-STD-167.

SECTION 2

INSTALLATION

2.1 INTRODUCTION

The following paragraphs of this section describe installation procedures for the Main Frame Assembly of Radio Receiving Set HRO-600. Installation procedures for major accessories used with the HRO-600 are described in supplementary technical manuals.

2.2 UNPACKING AND HANDLING

The HRO-600 is packed in accordance with best commercial practice. No special precautions are required during unpacking and handling of this unit. Normal care due to precision electronic equipment should, of course, be exercised. It is recommended that all packing material be retained for possible future use.

After unpacking the HRO-600, inspect it for evidence of external damage. If damage is evident, notify and file claim with the carrier.

2.3 ENVIRONMENTAL CONSIDERATIONS

The operating temperature range of the HRO-600 is -20°C (-4°F) to +55°C (+131°F). Its operating RH (relative-humdity) range is 0 percent to 95 percent.

The storage temperature range of the HRO-600 is -40°C (-40°F) to +80°C (+179°F). Its storage RH (relative-humdity) range is 0 percent to 100 percent.

2.4 MECHANICAL CONSIDERATIONS

The HRO-600 is 5-1/4 inches high, 17 inches wide, and 15-1/2 inches deep, and weighs approximately 40 pounds. It can be operated in any orientation. The standard HRO-600 is equipped with four mounting feet for table-top or desk installation. Optional mounting brackets provide for rack-mounted installation within a standard 19-inch rack. For rack-mounted installations, a panel space of 5-1/4 inches is required.

To convert the HRO-600 from the table-top or desk mounted configuration to the rack-mounted configuration, proceed as follows:

a. Remove the mounting feet from bottom of HRO-600 and replace with the screws and washers provided.

b. Remove three screws and three washers at front (top and bottom) and rear (bottom) of each side panel.

c. Using six screws and six washers, fasten optional mounting bracket to each side panel at front (top and bottom) and rear (bottom).

To convert the HRO-600 from the rack-mounted configuration to the table-top or desk mounted configuration, reverse the above procedure. The two-piece mounting feet are used at the front of the receiver.

2.5 ELECTRICAL CONSIDERATIONS

2.5.1 General

With the single exception of the PHONES jack connection, which is made at the front panel of the HRO-600, all external electrical connections to the HRO-600 are made at the rear panel. The rear panel of the HRO-600 also incorporates extensive patching facilities for internal signals. (Figure 2-1 illustrates the HRO-600 rear panel.) For certain installations, the internal wiring of the HRO-600 must be altered. All electrical connections pertinent to installation are discussed in the following paragraphs.

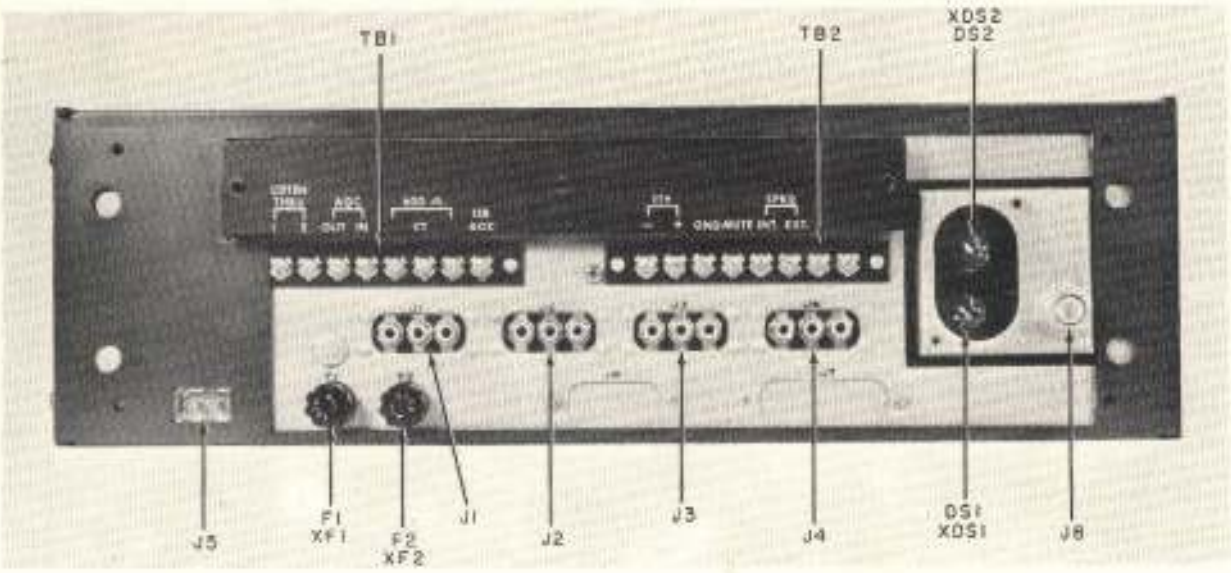


Figure 2-1. HRO-600, Rear Panel View

2.5.2 Listen-Thru Connections

Note

When listen-thru operation is desired, suitable MUTE connection must be made to TB2 (in addition to suitable LISTEN THRU connections to TB1). MUTE connection is discussed in paragraph 2.5.8.

When listen-thru operation is desired, the recommended procedure is as follows:

Note

If suitable potentiometer is not available, two fixed resistors of appropriate values may be employed in circuit configuration equivalent (for some setting of potentiometer) to that recommended.

a. Connect one end of 10K, 1/4 watt or greater, 10% potentiometer to LISTEN THRU No. 1 terminal of TB1 on rear panel.

b. Connect arm of potentiometer to LISTEN THRU No. 2 terminal of TB1 on rear panel.

c. Connect other end of potentiometer to one end of 8.2K, 1/4 watt or greater, 10%, fixed resistor.

d. Connect other end of fixed resistor to GND terminal of TB2 on rear panel.

2.5.3 AGC Connections

The HRO-600 provide AGC OUT and IN connections on the rear panel for greater flexibility and special-purpose use. The HRO-600 is shipped from the factory with the AGC OUT and IN terminals of TB1 connected together by means of a jumper. This jumper connection should never be removed under normal operating conditions. Its removal would disable both automatic and manual rf gain control circuits, and the HRO-600 would not operate correctly. (The setting of a front-panel switch determines whether automatic gain control (agc) is employed. With agc in use, it is still possible to reduce rf gain manually by means of the front-panel control. If agc is not used, this control alone determines rf gain.)

2.5.4 Audio Line Connections

The three 600Ω terminals of TB1 on the rear panel provide a center-tapped (C. T.) audio output signal for a 600-ohm audio line. Nominal audio signal level is 0 dBm; this level may be varied at least ±6 dBm by means of a front-panel control. The HRO-600 is shipped from the factory with all three 600Ω terminals open-circuited with

respect to the GND terminal of TB2 on the rear panel. If desired, any one of the three 600Ω terminals may be connected either to the TB2 GND terminal or to an external reference.

2.5.5 ISB AGC Connection

The purpose of the AGC ISB terminal of TB1 on the rear panel is to accept an AGC input from the external Type 630 ISB Adapter during independent-sideband operation. This enables the sideband channel receiving the stronger signal to control the rf gain of the amplifiers common to both channels.

2.5.6 TTY Connections

The purpose of the TTY - and + terminals of TB2 on the rear panel is to make available a TTY output for an external teletypewriter loop. These terminals can be used only when the HRO-600 is equipped with the optional internal Type 650 FSK Converter. If the FSK converter is used, refer to the supplementary technical manual covering the converter for details of operation.

2.5.7 Ground Connections

The purpose of the GND terminal of TB1 on the rear panel is to facilitate connection of other rear-panel TB1 and TB2 terminals to chassis ground. Such connections are discussed as applicable in the paragraphs covering other TB1 and TB2 terminals. The TB2 GND terminal also facilitates connection of external equipment to the HRO-600 chassis ground.

2.5.8 Muting Connection

The purpose of the MUTE terminal of TB2 on the rear panel is to accept a muting input (typically a transmitter key) from a source external to the HRO-600. A muting input is required during both fully

muted and listen-thru operation. (A listen-thru connection is required here and is discussed in paragraph 2.5.2.) For the MUTE terminal, the non-muting input is an open circuit (external to the HRO-600), and the muting input is a closed circuit to the GND terminal of TB2 on the rear panel of the HRO-600.

2.5.9 Speaker Connections

The HRO-600 is shipped from the factory wired to drive its own internal 8-ohm speaker. (Transfer from internal-speaker operation to headphone operation is accomplished by inserting the headphones plug into the PHONES jack on the front panel of the HRO-600.) For internal-speaker operation, the SPKR EXT and INT terminals of TB2 on the rear panel are connected together by means of a jumper, and the lead between PHONES jack J10 and transformer T1 (Figure 5-2) is connected to the green T1 lead.

The wiring of the HRO-600 can be readily altered to enable driving of either an 8-ohm or a 3.2-ohm external speaker. (As for internal-speaker operation, transfer from external-speaker operation to headphone operation is accomplished by inserting the headphones plug into the PHONES jack on the front panel.)

To convert the HRO-600 from internal-speaker operation to external-speaker operation, disconnect the jumper connection between the SPKR EXT and INT terminals of TB2 and connect the external speaker between the SPKR EXT and GND terminals of TB2. When an 8-ohm external speaker has been connected, this completes the conversion procedure. If a 3.2-ohm external speaker has been connected, disconnect the T1 jumper connecting the green T1 lead to the wire leading from PHONES jack J10 and connect the black T1 lead to that wire, to complete the conversion procedure. To reconvert the HRO-600, reverse the preceding procedures as applicable.

2.5.10 Second Injection Connections

The HRO-600 provides access to the second injection input and output for greater flexibility and special-purpose use. The HRO-600 is shipped from the factory with terminals J1-1 (second injection input) and J1-2 (second injection output) on the rear panel connected by means of an internal jumper. For normal operation, this jumper connection should never be removed, since its removal would disable the receiver.

2.5.11 ISB Output Connection

A 5 MHz ISB (independent-sideband) output is available at terminal J1-3 on the rear panel of the HRO-600. When the HRO-600 is used in conjunction with the optional external Type 630 ISB Adapter, this ISB output is connected to the ISB Adapter.

2.5.12 External Frequency Standard Connection

The purpose of terminal J2-1 on the rear panel of the HRO-600 is to accept a 1-volt rms calibration input from an external 1-MHz or 5-MHz frequency standard. In conjunction with the METER switch (CAL position) and LEVEL meter on the front panel of the HRO-600, the calibration input is used to calibrate the internal frequency standard of the frequency control plug-in unit in use. (A 5-MHz external frequency standard is preferable, since a stronger zero beat can be obtained.) Calibration of each type of frequency control plug-in unit is described in the supplementary technical manual for that unit.

2.5.13 BFO Connections

The HRO-600 provides access to the fixed BFO input and output for greater flexibility and special-purpose use. The HRO-600 is shipped from the factory with terminals J2-2 (BFO input) and J2-3

(BFO output) on the rear panel connected via an internal jumper. For normal operation, this jumper connection should never be removed, since its removal would disable product detection by the receiver in the SSB mode.

2.5.14 First Injection Connections

The HRO-600 provides access to the first injection input and output for greater flexibility and special-purpose use. The HRO-600 is shipped from the factory with terminals J3-1 (first injection output) and J3-2 (first injection input) connected via an internal jumper. For normal operation, this jumper connection should never be removed, since its removal would disable the receiver.

2.5.15 Second I-F Output Connection

A 5 MHz second i-f output is available at terminal J4-1 on the rear panel of the HRO-600. Nominal signal level is 5 mV into 50 ohms.

2.5.16 Spare Terminals

Two terminals of TB2 and terminals J3-3, J4-2, and J4-3 on the rear panel of the HRO-600 are spare terminals. These five terminals are provided to facilitate future expansion of the capabilities of the HRO-600.

2.5.17 Power Connections

The HRO-600 is operated from a primary ac power source of either 103.5 to 126.5 vac or 207 to 253 vac, 47 to 420 Hz, 60 watts. It is shipped from the factory wired for 115-vac operation.

Note

Refer to Figure 2-2 for the wiring configuration of the power transformer T3 terminal strip. Refer to Figure 5-~~3~~ 2 for the location of the transformer and terminal strip.

To convert the HRO-600 from 115-vac operation to 230-vac operation, proceed as follows:

a. Remove jumper connection between brown and white leads from power transformer T3.

b. Remove jumper connection between black and gray leads from power transformer T3.

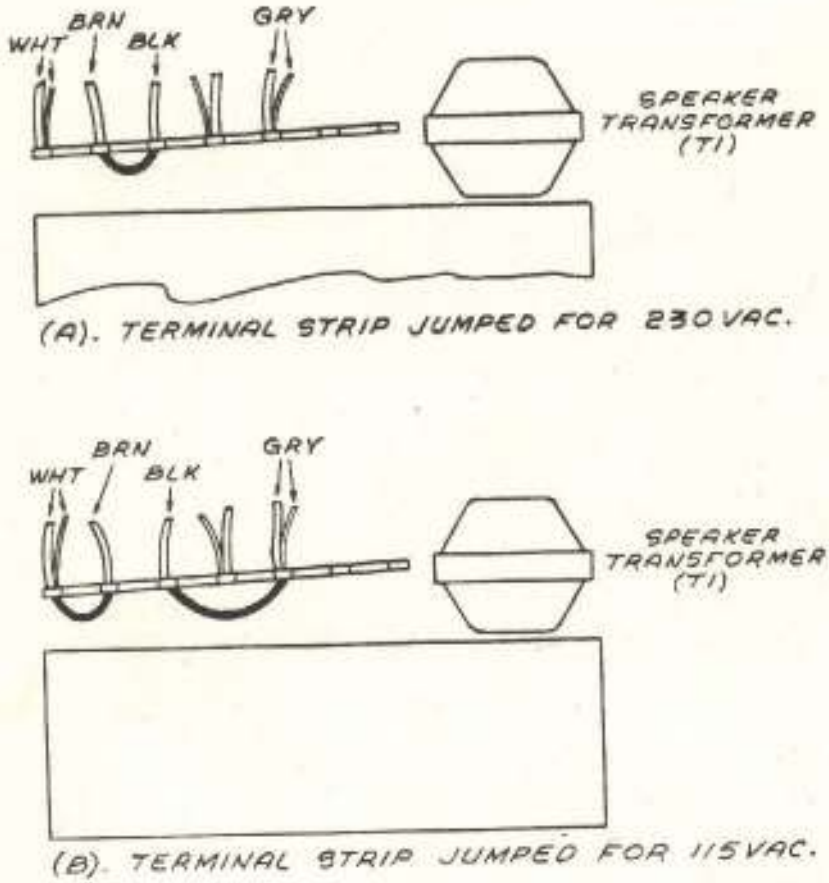


Figure 2-2. Power Transformer T3 Terminal Strip, Wiring Data

c. Connect brown and black leads from power transformer T3 together.

To convert the HRO-600 from 230-vac operation to 115-vac operation, proceed as follows:

a. Remove jumper connection between brown and black leads from power transformer T3.

b. Connect brown and white leads from power transformer T3 together.

c. Connect black and gray leads from power transformer T3 together.

CAUTION

Prior to making primary ac power connection, make certain that HRO-600 is correctly wired for primary ac power source to be employed.

Connect power cable supplied with HRO-600 between power connector J5 on rear panel of HRO-600 and suitable source of primary ac power.

2.5.18 Antenna Connection

The antenna input connector (J8) is provided on the rear panel of the HRO-600.

Connect antenna to connector J8 by means of suitable coaxial cable assembly. The mating connector for J8 is a PL-259 connector.

2.6 INSTALLATION CHECKOUT

2.6.1 General

After installation of the HRO-600 has been completed, perform the installation checkout procedures described in the following paragraphs.

Note

Functions and, as applicable, initial control settings for all front-panel controls and indicators are specified in Table 3-1 of Section 3.

2.6.2 Start-Up

To energize the HRO-600, proceed as follows:

a. Preset all controls on front panel to intial control settings specified in Table 3-1 of Section 3.

b. Rotate MODE control on front panel from OFF position to any operating position. The receiver is ready for instant use. A warm-up period of 30 minutes, either in standby or operation, will permit full stabilization of the circuits and performance in accordance with all specifications.

2.6.3 Reception Tests

The most straightforward technique for testing reception is normal operation of the HRO-600 to receive radio transmission with known characteristics. (Operating instructions for the HRO-600 are given in Section 3 of this technical manual.) It is recommended that at least one known transmission be monitored within each of the 35 rf bands

indicated by the front-panel MHz indicator and selected by the front-panel MHz SELECT control, and that each HRO-600 mode of operation be checked for at least one known transmission.

At locations where known transmissions are not available for all 35 rf bands, signal-generator techniques can be used to test reception within "empty" rf bands. For the frequency range from 50 kHz to 30 MHz, Hewlett-Packard Signal Generator Model 606 or its equivalent can be employed. In the case of frequencies below 50 kHz, it will probably be necessary to use an audio oscillator, and to take into account the typical 600-ohm signal output at a relatively high level.

Note

The frequency accuracy and stability of the HRO-600 are considerably better than those of typical audio oscillators and signal generators. If frequency discrepancies appear, it should be assumed that the HRO-600 display is correct.

2.6.4 BFO Test

With the BFO pitch control knob pushed in and any mode except SSB selected, the front-panel BFO pitch control should be rotated throughout its entire control range, with an unmodulated carrier tuned to the middle of the pass-band being received. As this control is rotated gradually from the - position through the 0 position to the + position, the BFO pitch should vary gradually from more than 3 kHz through 0 kHz to more than 3 kHz.

2.6.5 Line Level Test

During at least one reception of a signal of medium strength, the audio line circuits should be tested as follows:

a. If 600-ohm audio line has been connected to 600Ω terminals of TB1 on rear panel (refer to paragraph 2.5.4), proceed directly to following step b. If not, connect 600-ohm, 1/8 watt or greater, ±10% resistor between leftmost and rightmost 600Ω terminals, and proceed to following step b.

b. Set AGC control on front panel to ON position.

c. Rotate RF GAIN control on front panel to fully clockwise position.

d. Set AGC decay time constant for optimum reception by depressing one of three AGC DECAY selection pushbuttons (FAST, MED, or SLOW) on front panel.

e. Depress METER AF LINE selection pushbutton on front panel.

Note

Operation of front-panel LINE LEVEL control is independent of operation of front-panel AF GAIN control.

f. Verify that audio output line level, as measured by front-panel LEVEL meter, can be varied at least ±6 dBm about 0 dBm by means of front-panel LINE LEVEL control.

g. Set front-panel LINE LEVEL control for desired audio output line level, as measured by front-panel LEVEL meter.

2.6.6 Frequency Standard Test

The internal frequency standard of the particular type of frequency control plug-in unit in use is calibrated at the factory prior to shipment, and should usually require no recalibration at installation. If

an external 1 MHz or 5 MHz frequency standard with a frequency accuracy of ±1 pp 10^8 and an output level of 1 vac rms is available at the installation site, the internal frequency standard may be tested as follows:

Note

If choice between 1 MHz and 5 MHz external frequency standard is available, use of 5 MHz standard is recommended.

a. Connect external frequency standard to terminal J2-1 on rear panel.

b. Depress METER CAL selection pushbutton on front panel.

c. Verify that period of oscillation (one swing back and forth) of reading on front-panel LEVEL meter is 1 second or greater.

Note

If period of oscillation is less than 1 second, internal frequency standard of frequency control plug-in unit should be recalibrated. Calibration instructions are given in supplementary technical manual for particular type of frequency control plug-in unit in use.

Do not readjust the internal frequency standard unless the accuracy of the standard used for calibration is known positively. The frequency standard in the Type 602 Plug-In Unit may be more accurate than some secondary standards in common use.

SECTION 3

OPERATION

3.1 INTRODUCTION

The following paragraphs of this section describe operation procedures for the Main Frame Assembly of Radio Receiving Set HRO-600. Operation procedures for major accessories used with the HRO-600 are described in supplementary technical manuals.

3.2 OPERATING CONTROLS AND INDICATORS

A front panel view of an HRO-600 with a Type 601 Frequency Control Plug-In Unit is shown in Figure 3-1. Table 3-1 specifies the functions and, as applicable, the initial control settings for all controls and indicators located on the front panel of the HRO-600 Main Frame

Figure 3-1. HRO-600 With Type 601 Plug-In Unit, Front View

Assembly. The functions and the initial control settings for all controls and indicators located on the front panels of major HRO-600 accessories (such as frequency control plug-in units) are specified in the supplementary technical manuals for those accessories.

TABLE 3-1. HRO-600 MAIN FRAME ASSEMBLY, OPERATING CONTROLS AND INDICATORS

Control or Indicator	Function(s)	Initial Control Setting
ANT. Selection Pushbuttons HI-Z, -20 dB, and 50Ω)	Select input impedance (high or 50-ohm) presented to antenna by HRO-600, and degree (0 dB or 20 dB) to which output from rf preselector of HRO-600 is attenuated. When the pad is used, either the HI-Z or 50Ω button must be depressed simultaneously.	Immaterial
AGC DECAY Selection Pushbuttons (FAST, MED, and SLOW)	Select AGC decay time constant (FAST: 100 msec; MED: 500 msec; SLOW: 2 sec). (Three pushbuttons are mechanically interlocked to prevent depression of more than one at any one time. However, it is possible to override interlock. AGC attack time constant is fixed at approx. 15 msec.)	Immaterial
MHz Indicator	Indicates which one of 35 rf bands has been selected by MHz SELECT control. Bands are as follows:	

TABLE 3-1. HRO-600 MAIN FRAME ASSEMBLY, OPERATING CONTROLS AND INDICATORS (Cont)

Control or Indicator	Function(s)	Initial Control Setting
MHz Indicator (cont)	.016 - .031 .031 - .062 .062 - .125 .125 - .25 .25 - .5 .5 - 1 1 2 ' ' ' ' ' 28 29 — The indicator display the frequency band covered by the PRE-SELCTOR TUNE control.	
MHz SELECT Control	Selects one of 35 rf bands.	Immaterial
PRESELECTOR Switch	Bypasses rf preselector in OFF position; connects rf preselector into signal path in ON position. (Mounted concentric with TUNE control.)	ON
TUNE Control	Tunes Tunable Preselector. (Mounted concentric with PRE-SELECTOR ON-OFF switch.)	Immaterial
AF GAIN Control	Controls audio-frequency gain of speaker amplifier. (Operates independently of LINE LEVEL control.)	Fully Counterclockwise
MODE Control	Determines mode/bandwidth (OFF, STANDBY, LSB, USB, WIDE, INT, NAR, OR V. NAR) in which HRO-600 functions.	OFF

TABLE 3-1. HRO-600 MAIN FRAME ASSEMBLY, OPERATING CONTROLS AND INDICATORS (Cont)

Control or Indicator	Function(s)	Initial Control Setting
MODE Control (cont)	Note For frequencies of 1 MHz and above, USB and LSB positions of MODE control are designated in black; for frequencies below 1 MHz, USB and LSB positions of MODE control are designated in red.	OFF
AGC ON-OFF Switch	Disables AGC function in OFF position; in this case, rf gain is determined solely by setting of RF GAIN control. Enables AGC function in ON position; in this case, rf gain is determined by either setting of RF GAIN control or level of AGC voltage, whichever dictates lower rf gain. (AGC control is mounted concentric with RF GAIN control.)	ON
RF GAIN Control	Exercises sole control over rf gain of receiver when AGC control is in OFF position. When AGC control is in ON position, rf gain is determined by either level of AGC voltage or setting of RF GAIN control, whichever dictates lower rf gain. (RF GAIN control is mounted concentric with AGC control.)	Fully Clockwise

TABLE 3-1. HRO-600 MAIN FRAME ASSEMBLY, OPERATING CONTROLS AND INDICATORS (Cont)

Control or Indicator	Function(s)	Initial Control Setting
BFO Pitch Control	Deviates output from beat frequency oscillator (BFO) approximately ±3 kHz about 5 MHz when MODE control is in any operational position except SSB and BFO is ON; inoperational when BFO is OFF or SSB MODE is in use.	0
BFO ON-OFF	Turns BFO ON and OFF for all MODES except SSB	In (On)
LINE LEVEL Control	Controls audio-frequency gain of line amplifier. (Operates independently of AF GAIN control.)	Fully Counterclockwise
PHONES Jack	Facilitates connection of headset (not supplied with HRO-600) at front panel of HRO-600. When headset plug is inserted into PHONES jack, speaker (whether internal or external) is automatically disconnected.	Not Applicable
METER Selection Pushbuttons (CAL, RF IN, and AF LINE)	Select signal applied to LEVEL meter. When CAL pushbutton is depressed and suitable external 1 MHz or 5 MHz frequency standard is properly connected to HRO-600 (refer to paragraph 2.5.13), oscillations of LEVEL meter reading represent frequency discrepancy between external and internal frequency standards. Internal frequency standard is calibrated by maximizing period of oscillation. Procedures are described in supplementary technical manuals for frequency control plug-in units.	Immaterial

TABLE 3-1. HRO-600 MAIN FRAME ASSEMBLY
OPERATING CONTROLS AND INDICATORS (Cont)

Control or Indicator	Function(s)	Initial Control Setting
METER Selection Pushbuttons CAL, RF IN, and AF LINE) (cont)	When RF IN pushbutton is depressed, LEVEL meter reads level of rf input signal in dB above AGC threshold. When AF LINE pushbutton is depressed, LEVEL meter reads audio output line level in dBm. (Three pushbuttons are mechanically interlocked to prevent depression of more than one at any one time. However, it is possible to override interlock.)	
LEVEL Meter	Monitors level of signal applied by depressed METER selection pushbutton (CAL, RF IN, or AF LINE). (Refer to preceding discussion of functions of these pushbuttons.)	Not Applicable

3.3 OPERATING INSTRUCTIONS

3.3.1 General

The following paragraphs provide operating instructions for the basic HRO-600. Operating instructions for major accessories used with the HRO-600 are contained within the supplementary technical manuals for those accessories.

3.3.2 Start-Up

CAUTION

Prior to starting up the HRO-600, make sure that it has been properly installed in accordance with the instructions contained in Section 2 of this technical manual. In particular, make sure that the internal wiring of the HRO-600 is compatible with the external source of primary ac power.

To start up the HRO-600, proceed as follows:

a. Preset all controls on front panel to initial control settings specified in Table 3-1.

b. Rotate MODE control on front panel to any operating position. The receiver is ready for instant use. A warm-up period of 30 minutes, either in standby or operation, will permit full stabilization of the circuits and performance in accordance with all specifications.

3.3.3 Mode Selection

To select desired mode of operation, rotate MODE control on front panel to desired position (LSB, USB, WIDE, INT, NAR. or V. NAR).

Note

For frequencies of 1 MHz and above, USB and LSB positions of MODE control are designated in black; for frequencies below 1 MHz, USB and LSB positions of MODE control are designated in red.

Bandwidths (6 dB) for the six HRO-600 modes of operation are as follows:

LSB	2350 Hz (-350 Hz* to -2700 Hz*)
USB	2350 Hz (+350 Hz* to +2700 Hz*)
WIDE	8 kHz to 10 kHz
INT	2 kHz to 3 kHz
NAR	1 kHz to 2 kHz
V. NAR	300 Hz to 400 Hz

* With respect to 5 MHz

3.3.4 Tuning

The HRO-600 is tuned partially from the front panel of the Main Frame Assembly and partially from the front panel of the particular type of frequency control plug-in unit in use. This receiver exhibits a tuning range of 16 kHz to 30 MHz.

The MHz SELECT control on the front panel of the Main Frame Assembly controls bandswitching of the rf preselector, determines the tens and units MHz digits of the frequency to which the receiver is tuned (by controlling the injection to the first mixer), and selects the heterodyne configuration of the receiver. This control operates in conjunction with the MHz indicator on the front panel of the Main Frame Assembly. (For frequencies from 016.0 kHz to 999.9 kHz, the HRO-600 functions as a single-conversion superheterodyne receiver; for frequencies from 01.0000 MHz to 29.9999 MHz, the HRO-600 functions as a double-conversion superheterodyne receiver. During single-conversion operation, the "first" mixer is not used.) Further information regarding the MHz SELECT control and the associated MHz indicator is given in Table 3-1.

The TUNE control on the front panel of the Main Frame Assembly tunes the Type 640 Tunable Preselector when the HRO-600 is equipped with this type of rf preselector.

The PRESELECTOR control on the front panel of the Main Frame Assembly bypasses the rf preselector with a short circuit when in the OFF position, and connects the rf preselector into the signal path when in the ON position. For most applications, this control should be set to the ON position. However, the ANT. selection pushbutton must be set to the 50Ω position for reception with the PRESELECTOR control set to OFF. The OFF position may also be used when an additional 2 dB to 4 dB of sensitivity is desired and the lack of rf selectivity (other than 30 MHz low-pass filtering) within the HRO-600 can be tolerated.

The frequency control plug-in unit in use determines the hundreds, tens, units, and tenths kHz digits of the frequency to which the HRO-600 is tuned (by controlling the injection to the second mixer). For frequencies below 1 MHz, the "first" mixer is not used and the signal input to the "second" mixer is at the received frequency.) Operating instructions for each type of frequency control plug-in unit are given in the supplementary technical manual for that unit.

3.3.5 Antenna Matching

The three ANT. (antenna) selection pushbuttons (HI-Z, -20 dB, and 50Ω) on the front panel of the Main Frame Assembly select the input impedance (high or 50-ohm) presented to the antenna by the HRO-600, and the degree (0 dB or 20 dB) to which the output from the rf preselector of the HRO-600 is attenuated.

To select 0 dB of attenuation and high impedance, depress HI-Z ANT. selection pushbutton.

To select 0 dB of attenuation and 50-ohm impedance, depress 50Ω ANT. selection pushbutton.

To select 20 dB of attenuation and high impedance, simultaneously depress -20 dB and HI-Z ANT. selection pushbuttons.

To select 20 dB of attenuation and 50-ohm impedance, simultaneously depress -20 dB and 50Ω ANT. selection pushbuttons.

3.3.6 Gain Control

3.3.6.1 General

The rf gain of the HRO-600 may be controlled either automatically or manually. The respective audio gains of the speaker and line audio channels are controlled manually and independently.

3.3.6.2 RF Gain Control

To control the rf gain of the HRO-600 manually, rotate the AGC switch on the front panel to the OFF position and adjust the RF GAIN control on the front panel for the desired rf gain. Rotate the RF GAIN control counterclockwise to decrease rf gain and clockwise to increase rf gain.

Note

The AGC switch and the RF GAIN control are concentric controls.

To program the HRO-600 for fully automatic gain control, rotate the RF GAIN control on the front panel fully clockwise and rotate the AGC switch on the front panel to the ON position.

Note

During AGC operation, optimize reception through selection of AGC decay time constant. Depress AGC DECAY FAST (100 msec), MED (500 msec), and SLOW (2 sec) selection pushbuttons in turn, and then depress pushbutton that yields best reception. (AGC attack time constant is fixed at approx. 15 msec.)

To override automatic gain control when the AGC control is in the ON position, rotate the RF GAIN control as far counter-clockwise as necessary.

3.3.6.3 AF Gain Control

Note

The two front-panel audio gain controls (AF GAIN and LINE LEVEL) operate independently.

The AF GAIN control is used to adjust the gain of the audio speaker (or headphone) channel. Rotate this control counterclockwise to decrease channel gain and clockwise to increase channel gain.

The LINE LEVEL control is used to adjust the gain of the audio line channel. Rotate this control counterclockwise to decrease channel gain and clockwise to increase channel gain.

The line level may be monitored on the LEVEL meter when the METER AF LINE pushbutton is depressed.

3.3.7 BFO Operation

During LSB and USB operation, BFO injection frequency is synthesized at 5 MHz, and front-panel BFO control is inoperative. For A3 and A2 operation, an envelope detector (rather than product detector) is employed, and the BFO is switched off by pulling out the BFO pitch control knob. During A1 operation, the product detector is employed and the BFO is turned on by pushing the BFO pitch control knob in and adjusting to vary BFO injection frequency (approximately ±3 kHz about 5 MHz) for desired pitch. The BFO can be turned on or off in all MODE switch positions except SSB.

3.3.8 Headphone Operation

To disconnect the speaker in use (either external or internal) and substitute a pair of headphones, merely insert headphone plug into PHONES jack on front panel.

3.3.9 Monitoring Operations

The HRO-600 is monitored as follows:

a. By means of either an external or internal speaker, depending upon rear-panel connections made at installation. (Refer to paragraph 2.5.9.)

b. By means of a pair of headphones. (Refer to paragraph 3.3.8.)

c. By means of the front-panel LEVEL meter, used in conjunction with the front-panel METER selection pushbuttons (CAL, RF IN, and AF LINE).

(1) During normal operation, the METER CAL selection pushbutton is usually not depressed. This meter selection is made during the frequency standard test described in paragraph 2.6.6, and during calibration of the internal frequency standard.

(2) To monitor the rf input level in dB above AGC threshold, depress the METER RF IN selection pushbutton and observe the reading on the LEVEL meter.

(3) To monitor the audio output line level in dBm, depress the METER AF LINE selection pushbutton and observe the reading on the LEVEL meter.

3.3.10 Shutdown

If a 30-minute warm-up period (refer to paragraph 3.3.2) can be tolerated when HRO-600 is next started, rotate the MODE control on front panel to OFF position to shut down the HRO-600. When 30-minute warm-up period cannot be tolerated, when HRO-600 is next started, rotate MODE control on front panel to the STANDBY position to shut down.

Note

Warm-up period is necessary only to ensure operation in accordance with all performance specifications. HRO-600 operates immediately upon start-up.

SECTION 4

THEORY OF OPERATION

4.1 INTRODUCTION

This section presents the theory of operation for the Main Frame Assembly of Radio Receiving Set HRO-600. The theories of operation for major accessories used with the HRO-600 are given in the supplementary technical manuals for those accessories.

The following discussion is subdivided into individual discussions of signal-path circuits, injection circuits, AGC circuits, MHz selection circuits, and power-supply circuits. These discussions are based upon the servicing block diagram of Figure 5-7 in Section 5.

4.2 SIGNAL-PATH CIRCUITS

The 10 kHz - 30 MHz rf input signal for the HRO-600 is applied to the antenna connector (J8). Two incandescent lamps in the antenna input line protect the rf input circuitry of the HRO-600 against rf input signals of excessive strength. If an excessively strong rf input signal is applied, the filament resistance of the lamps increases, thus limiting the magnitude of the signal impressed upon the rf input circuitry.

The HI-Z (high impedance) and 50Ω ANT. selection pushbuttons (S9A and S9C, respectively) apply the rf input signal to the HRO-600 to either the high-impedance or the 50-ohm input of the rf preselector (A11).

Band selection for the rf preselector is accomplished by means of the MHz SELECT control on the front panel of the HRO-600. The

TUNE control on the front panel of the HRO-600 provides for continuous tuning within each rf band. The preselection circuits of the rf preselector can be bypassed by setting the PRESELECTOR control on the front panel of the HRO-600 to the OFF position with 50Ω button pushed in.

The preselector rf bands are as follows:

a. 0.016 - 0.031 MHz
b. 0.031 - 0.062 MHz
c. 0.062 - 0.125 MHz
d. 0.125 - 0.25 MHz
e. 0.25 - 0.5 MHz
f. 0.5 - 1. MHz
g. 1 - 2 MHz
h. 2 - 4 MHz
i. 4 - 8 MHz
j. 8 - 16 MHz
k. 16 - 30 MHz

When the -20 dB ANT. selection pushbutton (S9B) is released (not depressed), the rf signal output from the rf preselector is applied directly to the 30 MHz low-pass filter (FL10). If S9B is depressed, the rf preselector output is applied to FL10 through a 20 dB attenuator (R6, R7, and R8).

When the HRO-600 is tuned for signals from 16 kHz to 1 MHz, the rf signal output from FL10 is connected through relay assembly A16 to a 1.75 MHz low-pass filter, and the output from this filter is applied to the front end module (A2). When the HRO-600 is tuned for signals from 1 MHz to 30 MHz, the rf signal output from FL10 is connected through relay assembly A16 directly to the front end module (A2).

When the HRO-600 is tuned for signals from 10 kHz to 1 MHz, the front end module (A2) merely amplifies its rf input for application to the second mixer module (A4), via inductor L9 and relay assembly A13. When the HRO-600 is tuned for signals from 1 MHz to 30 MHz, the 1 MHz to 30 MHz signal frequency is subtracted from the 56 MHz to 84 MHz (in 1 MHz increments) first injection frequency to produce a variable 55 MHz to 54 MHz first intermediate frequency. (Injection circuits are discussed in paragraph 4.3.) In the latter case, the variable 55-54 MHz first i-f signal is passed through a 65-MHz low-pass filter (FL7) and connected through relay assembly A13 to the second mixer module (A4).

When the HRO-600 is tuned for signals from 10 kHz to 1 MHz, the 10 kHz to 1 MHz signal frequency is added to the 5 MHz to 4 MHz "second" injection frequency to produce a fixed 5 MHz "second" intermediate frequency. When the HRO-600 is tuned for signals from 1 MHz to 30 MHz, the 50 MHz to 49 MHz second injection frequency is subtracted from the variable 55 MHz to 54 MHz first intermediate frequency to produce a fixed 5 MHz second intermediate frequency. (Injection circuits are discussed in paragraph 4.3.)

The second mixer module (A4) produces fixed 5 MHz second i-f signals for application to the crystal intelligence filters of the HRO-600 and to the ISB output terminal (J1-3) on the rear panel of the HRO-600. These two signals are isolated from each other by means of a buffer amplifier within A4, and limited to an 8-10 kHz i-f bandwidth (6 dB) by means of a crystal filter within A4. (The signal made available at the ISB output terminal (J1-3) is intended for use by the optional external Type 630 ISB Adapter.)

One second i-f signal produced by the second mixer module (A4) is passed through the applicable crystal intelligence filter (FL1 through FL5, in the case of wideband operation, no filter is used. Crystal filters located within the second mixer module (A4) and the second i-f/agc module (A5) provide adequate intelligence filtering for wideband operation. These filters exhibit a 6-dB bandwidth of 8 kHz to 10 kHz.). The 5-MHz i-f output from the applicable crystal intelligence filter is re-applied to the second mixer module (A4) for further amplification. Module A4 provides the filtered and amplified fixed 5 MHz i-f input for the second i-f/agc module (A5). Selection of intelligence filter (FL1 through FL5) is controlled by the setting of the MODE control (S1) on the front panel of the HRO-600.

In response to its fixed 5-MHz second i-f input, the second i-f/agc module (A5) produces amplified and filtered 5-MHz i-f outputs for the BFO and product detector assembly (A10) and for application to the second i-f output terminal (J4-1) on the rear panel of the HRO-600, an AM output for the second injection/af amplifier assembly (A6), and AGC outputs for various stages of the signal-path circuits. (AGC circuits are discussed in paragraph 4.4) The two second i-f outputs from A5 are isolated from each other by means of a buffer amplifier within A5 and passed through a crystal filter with an 8-10 kHz i-f bandwidth (6 dB) within A5. When the optional internal Type 650 FSK Converter is employed, the second i-f signal applied to J4-1 is also applied to the FSK converter module (A8). Module A5 also accepts the muting and listen-thru inputs to the HRO-600, which are connected to the MUTE terminal of TB2 and to the LISTEN THRU terminals of TB1, respectively, on the rear panel of the HRO-600.

When the HRO-600 is in the LSB, USB, or BFO "ON" mode of operation, the audio signal input to the second injection/af amplifier module (A6) is obtained from the BFO and product detector assembly

(A10), via the MODE control (S1). When the BFO is "OFF", the audio signal input to the second injection/af amplifier module (A6) is obtained from the AM envelope detector in the second i-f/agc module (A5).

The BFO and product detector assembly (A10) is enabled (by a switched +18 vdc power input) only when the BFO is "ON" or during LSB or USB mode of operation. (When BFO is switched OFF, the A10 assembly is disabled.) For LSB and USB operation, the BFO portion of the A10 assembly merely functions as an amplifier for its 5-MHz fixed BFO injection. In this case, the BFO control (R18) on the front panel of the HRO-600 exercises no effect on the BFO injection frequency. During A1 operation, the 5-MHz fixed BFO injection is electronically disconnected (by a second and independent +18 vdc input) within the A10 assembly, and the BFO portion of the A10 assembly functions as a voltage-controlled oscillator. In this case, the BFO control (R18) on the front panel of the HRO-600 adjusts the oscillator control voltage, and thus varies the BFO injection frequency approximately ±3 kHz about its nominal center value of 5 MHz.

The af amplifier portion of the second injection/af amplifier module (A6) incorporates the audio line amplifier and the audio pre-amplifier for the speaker amplifier (A19). Line channel gain is adjusted by means of the LINE LEVEL control (R10) on the front panel of the HRO-600. Line transformer T2 provides the center-tapped 600-ohm audio line output from the HRO-600. This output is usually set at 0 dBm by means of the LINE LEVEL control (R10); the R10 control can be used to vary the level at least ±6 dBm about 0 dBm. The audio line output is available at the three 600Ω terminals of TB1 on the rear panel of the HRO-600.

The audio line output from A6 is also applied to a line-level amplifier/detector, which is mounted on the diode rectifier assembly (A18). This amplifier/detector provides the audio-line-level signal for the metering circuit associated with front-panel meter M1.

The speaker amplifier (A9) provides the audio-frequency (af) gain required to drive the internal 8-ohm speaker, an external 3.2-ohm or 8-ohm speaker, or external headphones. Speaker channel gain is adjusted by means of the AF GAIN control (R9) on the front panel of the HRO-600. Speaker transformer T1 is wired to provide a 3.2-ohm output impedance level when a 3.2-ohm external speaker is employed. When an 8-ohm speaker (either the internal speaker or an external one) or external headphones are employed, speaker transformer T1 is wired to provide an 8-ohm output impedance level. (The HRO-600 is shipped from the factory with speaker transformer T1 wired to provide an 8-ohm output impedance level.)

If external headphones are employed, the headphones plug is inserted into the PHONES jack (J10) on the front panel of the HRO-600. This disconnects the T1 output from the EXT SPKR terminal of TB2 on the rear panel of the HRO-600, and connects the T1 output to the external headphones. When external headphones are not employed, the T1 output is connected through PHONES jack J10 to the EXT SPKR terminal of TB2.

When the internal speaker of the HRO-600 is employed, the EXT and INT SPKR terminals of TB2 on the rear panel of the HRO-600 are connected together by means of a jumper. (The HRO-600 is shipped from the factory with this jumper connected.) If an external speaker is employed, the jumper connection is removed and the external speaker is connected between the EXT SPKR and GND terminals of TB2.

4.3 INJECTION CIRCUITS

4.3.1 General

The injection circuits of the HRO-600 Main Frame Assembly supply (as required) the 56-84 MHz first injection frequency (in 1 MHz increments), the 5-4 MHz or 50-49 MHz second injection frequency, and the 5 MHz (fixed or ±3 kHz) BFO injection frequency to the signal-path circuits. To provide these injection frequencies, the injection circuits obtain (as required) 5-4 MHz, 5 MHz ECL (emitter-coupled logic level), a 5 MHz FIXED BFO, and 45 MHz inputs from the frequency control plug-in unit (A1) in use, and five logic inputs from the MHz encoder (A9). (Plug-in unit A1 also supplies the CAL OUT signal, which is applied to the metering circuit associated with front-panel meter M1. During test or calibration of its internal frequency standard, the A1 unit activates the CAL OUT signal in response to its 1-MHz or 5-MHz EXT STD IN reference from an external frequency standard. The EXT STD IN reference is routed through the Main Frame Assembly. The theory of operation for the particular type of frequency control plug-in unit in use is discussed in the supplementary technical manual for that type of unit. In the case of the MHz selection circuits, the theory of operation is discussed in paragraph 4.5 of this technical manual.)

4.3.2 First Injection Circuits

When the HRO-600 is tuned for frequencies from 10 kHz to 1 MHz, the first injection synthesizer (A3) is disabled by removal of its switched +18 vdc power input. When the HRO-600 is tuned for frequencies from 1 MHz to 30 MHz, the first injection synthesizer (A3) is enabled by application of its switched +18 vdc power input. In the latter case, the A3 module synthesizes the 56-84 MHz first injection frequency in 1 MHz

increments. Synthesis is referenced to the 5 MHz ECL input to A3. The particular first injection frequency synthesized (56-84 MHz) is determined by the 2^0, 2^1, 2^2, 2^3, and 2^4 logic inputs to A3. As the MHz digit of the frequency to which the receiver is tuned is varied from 1 to 29, these five logic inputs represent decimal digits 29 through 1, respectively, in straight binary form. In other words, they represent the thirties complement of the MHz integer in straight binary form.

The 56-84 MHz first injection output from A3 is applied to the first injection output terminal (J3-1) on the rear panel of the HRO-600. Front-end module A2 obtains its 56-84 MHz first injection input from the first injection input terminal (J3-2) on the rear panel of the HRO-600. When the HRO-600 is to supply its own first injection, terminals J3-1 and J3-2 are connected by means of an internal jumper. (The HRO-600 is shipped from the factory with this jumper connected.) If the first injection is to be supplied by an external source, the jumper is removed and the external source is connected to J3-2.

4.3.3 Second Injection Circuits

When the HRO-600 is tuned for frequencies from 10 kHz to 1 MHz, the 5.00-4.00 MHz input from the frequency control plug-in unit (A1) is used directly as the 5.00-4.00 MHz second injection frequency. In this case, the 5.00-4.00 MHz input is connected through relay assembly A15, passed through 6-MHz low-pass filter FL8, and connected through relay assembly A14 to the second injection output terminal (J1-2) on the rear panel of the HRO-600.

When the HRO-600 is tuned for frequencies from 10 kHz to 1 MHz, the second injection portion of the second injection/af amplifier module (A6) is disabled by removal of its switched +18 vdc power input. In addition, the 5.00-4.00 MHz input to the A6 module is disconnected by

means of relay switching within the Main Frame Assembly, and the 45 MHz input to the A6 module is disabled within the frequency control plug-in unit by removal of the switched +18 vdc power input to that unit.

When the HRO-600 is tuned for frequencies from 1 MHz to 30 MHz, the second injection portion of the second injection/af amplifier module (A6) is enabled by application of its switched +18 vdc power input. In addition, the 5-4 MHz input to the A6 module is connected by means of relay switching within the Main Frame Assembly, and the 45 MHz input to the A6 module is enabled within the frequency control plug-in unit by application of the switched +18 vdc power input to that unit.

When the HRO-600 is tuned for frequencies from 1 MHz to 30 MHz, the 5-4 MHz input from the frequency control plug-in unit (A1) is connected through relay assembly A15, passed through 6-MHz low-pass filter FL6, and applied to the second injection/af amplifier module (A6). In this case, the A6 module synthesizes the 50-49 MHz second injection frequency. Synthesis is referenced to both the 45 MHz and 5-4 MHz inputs to A6. The 50-49 MHz second injection output from A6 is passed through 49-50 MHz bandpass filter FL9 and connected through relay assembly A14 to the second injection output terminal (J1-2) on the rear panel of the HRO-600.

Regardless of the frequency to which the HRO-600 is tuned, the second injection output is applied to the second injection output terminal (J1-2) on the rear panel of the HRO-600. Second mixer module A4 obtains its second injection input from the second injection input terminal (J1-1) on the rear panel of the HRO-600. When the HRO-600 is to supply its own second injection, terminals J1-1 and J1-2 are connected by means of an internal jumper. (The HRO-600 is shipped from the factory with this jumper connected.) If the second injection is to be supplied from an external source, the jumper is removed and the external source is connected to J1-1.

When the Type 601 VFO (Search) Frequency Control Plug-In Unit is in use, its 5-4 MHz input to the Main Frame Assembly varies in a continuous manner throughout its range. When the Type 602 Synthesizer Frequency Control Plug-In Unit is in use, its 5.0000-4.0001 MHz input to the Main Frame Assembly varies either in 100 Hz increments (fully synthesized operation) or in a virtually continuous manner (interpolation between increments) throughout its range. When the Type 603 Fixed-Channel Frequency Control Plug-In Unit is in use, its 5-4 MHz input to the Main Frame Assembly assumes any one of 12 switch-selected frequencies, each of which can be preselected (through selection of 12 crystals) for any value from 4 MHz to 5 MHz; a control on the front panel of the Type 603 permits moderate variation of each crystal-controlled frequency.

4.3.4 BFO Injection Circuits

Each type of frequency control plug-in unit provides a 5 MHz FIXED BFO output for the Main Frame Assembly of the HRO-600. This input is applied to the BFO output terminal (J2-3) on the rear panel of the HRO-600. The BFO and product detector assembly (A10) obtains its 5 MHz FIXED BFO input from the BFO input terminal (J2-2) on the rear panel of the HRO-600. When the HRO-600 is to supply its own fixed BFO injection, terminals J2-2 and J2-3 are connected by means of an internal jumper. (The HRO-600 is shipped from the factory with this jumper connected.) If the fixed BFO injection is to be supplied from an external source, the jumper is removed and the external source is connected to J2-2.

When the HRO-600 is in either the A2 or A3 mode of operation, the BFO and product detector assembly (A10) is disabled by removal of a switched +18 vdc power input via BFO ON-OFF switch. When the

HRO-600 is in the LSB, USB, or A1 mode of operation, the BFO and product detector assembly (A10) is enabled by application of this switched +18 vdc power input. (During A2 or A3 operation, the audio input to the af amplifier portion of the second injection/af amplifier module (A6) is obtained from the AM (envelope) detector of the second i-f/agc module (A5). During LSB, USB, or A1 operation, the audio input to the af amplifier portion of the second injection/af amplifier module (A6) is obtained from the product detector of the BFO and product detector assembly (A10).)

During LSB and USB operation, the "BFO" portion of the BFO and product detector assembly (A10) merely functions as an amplifier for its 5 MHz FIXED BFO input. For A1 operation, the 5 MHZ FIXED BFO signal is electronically disconnected (by application of a second switched +18 vdc power input) within A10. In this case, the BFO portion of A10 functions as an oscillator with a nominal center frequency of 5 MHz, which can be varied approximately ±3 kHz by means of the BFO control (R18) on the front panel of the HRO-600. For A3, A2 operation the BFO is turned OFF by pulling out the PITCH CONTROL knob.

4.4 AGC CIRCUITS

The second i-f/AGC module (A5) provides three AGC outputs (AGC REF, 5 MHz AGC, and RF AGC) to control the gain of the applicable signal-path circuits. Both AGC REF and 5 MHz AGC outputs are applied to the A5 module itself as inputs. The RF AGC output is connected to the AGC OUT terminal of TB1 on the rear panel of the HRO-600. Module A5 obtains its RF AGC input (from which its 5 MHz AGC output is developed) from the AGC IN terminal of TB1 on the rear panel of the HRO-600. When the HRO-600 is to supply its own RF AGC input, the AGC IN and AGC OUT terminals of TB1 are connected together by means of a jumper. (The HRO-600 is shipped from the factory

with this jumper connected.) If the RF AGC input is to be supplied from an external source, the jumper is disconnected and the external source is connected to the AGC IN terminal of TB1. The AGC IN terminal of TB1 is connected to the metering circuit associated with front-panel meter M1.

The 5 MHz AGC and AGC REF outputs from the second i-f/agc module (A5) are applied to the second mixer module (A4). Inductor L4 and capacitors C13 and C25 decouple the AGC REF input at A4. Inductor L5 and capacitor C14 decouple the 5 MHz AGC input at A4.

The internally generated RF AGC output from the second i-f/agc module (A5) is derived in one of four ways. When more than one way is in use, the higher or highest level (which corresponds to the lower or lowest rf gain) controls rf gain. The four levels involved are the automatic-gain-control (agc) level, the manual-gain-control (mgc) level, and either the muting level or the listen-thru level. AGC level is enabled or disabled by the front-panel AGC control (S4). MGC level is always determined by the setting of the front-panel RF GAIN control (R16). Muting or listen-thru level is dependent upon external connections (if any) made at the rear panel of the HRO-600. These connections are described in paragraphs 2.5.2 and 2.5.8.

4.5 MHz SELECTION CIRCUITS

The MHz selection circuits determine the rf band (if any) assigned to rf preselector A11 and the first injection frequency (if any) generated by first injection synthesizer A3. These circuits include the MHz SELECT control (S6), the MHz indicator with its associated microswitches (S7 and S10), the MHz encoder (A9), the motor (B1) with its associated control wafer (S8), and the motor control assembly (A17).

The rf preselector band (if any) and the first injection frequency (if any) are determined by the setting of the MHz SELECT control (S6). (Note that the 24-position S6 control has 35 distinct settings, as displayed by the MHz indicator.) The positions of the MHz SELECT control (S6) and of microswitch S10 on the MHz indicator determine which one of the 35 MHz selection lines is grounded.

The positions of the MHz SELECT control (S6) and of microswitch S7 determine whether the HRO-600 is tuned for a frequency above or below 1 MHz. In this case, the VLF/HF control signal for relay assemblies A13, A14, A15, and A16 is obtained from S6C.

The six MHz selection signals representing rf bands below 1 MHz are applied directly to the motor control wafer (S8). The 29 MHz selection signals representing rf bands above 1 MHz are applied to the MHz encoder (A9). This encoder provides 15 band-selection signals representing rf bands above 1 MHz for the motor control wafer (S8).

The preselector less-than-octave rf bands above 1 MHz are encoded into octave or (16-30MHz) slightly less than octave bands. This is accomplished by connecting the appropriate output lines from the MHz encoder (A9) together in "wired-or" groups.

In addition to its band-selection inputs, the motor control wafer (S8) obtains a bypass control input from the PRESELECTOR control switch (S5). When S5 is in the OFF position, the rf preselector is set so that all of its tuned circuits are bypassed. When S5 is in the ON position, the rf preselector is set so that the tuned circuit corresponding to the desired rf band is connected into the signal path. The setting of the preselector is controlled by the motor (B1), which obtains its input from the motor control assembly (A17) to which the motor control signal output from S8 is applied.

In addition to providing 15 band-selection outputs for the motor control wafer (S8), the MHz encoder (A9) provides five control outputs for the first injection synthesizer (A3). These five outputs determine the first injection frequency (56-84 MHz in 1-MHz increments) generated by A3. The 2^0, $\overline{2^1}$, 2^2, 2^3, and 2^4 control signals encode the thirties complement of the MHz integer (1-29) of the frequency to which the receiver is tuned in straight binary form. As the MHz integer is varied from 1 to 29 MHz (in 1-MHz increments), the encoded number varies from 29 to 1 and the first injection frequency varies from 56 to 84 MHz.

4.6 POWER-SUPPLY CIRCUITS

The power-supply circuits of the HRO-600 operate from a primary ac power source of 115 vac ±10%, 230 vac ±10%, 47 to 420 Hz, 60 watts. They provide all power required by an HRO-600 equipped with any combination of optional internal accessories.

The primary ac power source is connected to power connector J5 on the rear panel of the HRO-600 via the power cable supplied with the receiver. Each side of the input power line is fused by a 3-ampere slo-blo fuse (F1 or F2). For each position of the front-panel MODE control (S1) except the OFF position, fused primary ac power is applied to power transformer T3. (Transformer T3 can be wired for either 115-vac operation or 230-vac operation. The HRO-600 is shipped from the factory with T1 wired for 115-vac operation.)

The four secondary windings of power transformer T3 provide two 19-vac rms outputs, one 42-vac rms output, and one 375-vac rms output. From the two 19-vac outputs, the power supply regulator assembly (A7) and its associated circuitry (Q1 and Q2, R1 and R2, C1 and C2) develop -5 vdc and +5 vdc power outputs. From the 42-vac

output, the power supply regulator assembly (A7), the diode rectifier assembly (A18), and their associated circuitry (Q3 and Q4, R3 and C3) develop two +18 vdc power outputs. From the 375-vac output, the power supply regulator assembly (A7) develops +125 vdc and +250 vdc power outputs whenever the front-panel MODE control (S1) is in any position except the OFF or STANDBY position.

The +250 vdc power output is applied (through resistors R11 and R12) only to the frequency control plug-in unit (A1). Within the Type 601 VFO (Search) Unit, it is used to power the kHz display. It is not used in the Type 602 Synthesizer Unit or the Type 603 Fixed-Channel Unit.

The +125 vdc power output is applied only to the first injection synthesizer (A3) and the Type 602 synthesizer unit when used. Capacitor C27 provides decoupling at A3.

The +26 vdc power output present at terminal 2 of the power supply regulator assembly (A7) is applied to the motor control assembly (A17) and the motor (B1) of the Main Frame Assembly, and to the frequency control plug-in unit (A1). Within each type of frequency control plug-in unit, this output powers the oven that temperature-stabilizes the crystal-controlled frequency standard. (Type 602 does not use oven stablization.)

The +18 vdc audio power output obtained from the diode rectifier assembly (A18) is employed whenever the front-panel MODE control (S1) is any position except the OFF or STANDBY position. During operation of the HRO-600, it is applied to the speaker preamplifier of the second injection/af amplifier module (A6), to the speaker amplifier (A19), and to relay assemblies A13, A14, A15, and A16. Capacitor C12 provides decoupling at A6.

The +18 vdc power output present at terminal 1 of the power supply regulator assembly (A7) is applied as required to various components of the Main Frame Assembly and to the frequency control plug-in unit (A1). As shown in Figure 5-7, appropriate switching and decoupling are provided.

The +5 vdc power output present at terminal 8 of the power supply regulator assembly (A7) and the -5 vdc power output present at terminal 10 of the power supply regulator assembly (A7) are applied to various components of the Main Frame Assembly and to the frequency control plug-in unit (A1). As shown in Figure 5-7,, appropriate decoupling is provided.

SECTION 5

MAINTENANCE

5.1 INTRODUCTION

The following paragraphs of this section describe maintenance procedures for the Main Frame Assembly of Radio Receiving Set HRO-600. Maintenance procedures for major accessories used with the HRO-600 are described in supplementary technical manuals.

Note

The procedures contained in this section are the maximum which should be attempted in the field with limited test equipment. The referenced extender cards, cables, alignment tools, etc., can be ordered from National Radio Company, Inc., in the form of maintenance kit MK-1. Troubleshooting to piece part level should be attempted only in a well-equipped maintenance laboratory.

A detailed field service manual is available on special order, to enable qualified technicians to locate faulty components on complex subassemblies. Defective subassemblies may be returned to the factory or to authorized service stations for analysis and repair.

The following list of test equipment is recommended for maintenance and troubleshooting:

a. DC Voltmeter: 20,000 Ω/V, VOM or VTVM

b. RF Voltmeter: Boonton 91CA or equivalent

c. RF Signal Generator: Hewlett-Packard HP-606A or equivalent

d. Oscilloscope: Tektronix 585 or equivalent

e. Audio Power Meter: 8Ω to 1 watt

5.2 ALIGNMENT

5.2.1 General

CAUTION

When using the card puller to remove the four printed circuit cards listed below, additional coaxial connectors must be disconnected before the cards can be removed completely. The cables are long enough to allow the use of the extender card without disconnecting the coaxial cables. The cards are:

First-Injection-Synthesizer (A3)
Second Injection/AF Amplifier (A6)
Second Mixer (A4)
Front End (A2)

Alignment of the HRO-600 Main Frame Assembly consists of aligning the following components:

a. Power Supply Assembly (A7)

b. First Injection Synthesizer (A3)

c. Second Injection/AF Amplifier Module (A6)

d. Bandpass Filter (FL9)

e. Bandswitch Drive Motor (B1)

f. RF Preselector (A11), Type 640 Tunable Preselector

g. Front-End Module (A2), Second I-F/AGC Module (A5), and AGC Meter Sensitivity Control (R23)

h. BFO and Product Detector Assembly (A10)

Locations of internal controls are shown in Figures 5-1, 5-2, and 5-3. To permit adjustment of the controls mounted on the front-end module (A2), the second i-f/AGC module (A5), the second injection/af amplifier module (A6), and the first-injection-synthesizer module (A3), an extender card must be used. (See note under paragraph 5.1.) Remove cover plates as necessary and use extender card as necessary or convenient when aligning the Main Frame Assembly. All special alignment tools required, are contained in maintenance kit MK-1.

5.2.2 Power Supply Alignment

To align the power supply assembly (A7), proceed as follows:

Note

Any dc voltmeter with an accuracy of ±3 percent and an impedance of 1000 Ω/V, or more, is adequate.

a. Connect dc voltmeter (set for scale of 25 vdc or greater) between XA7-1 (+) and chassis ground (-).

b. Adjust potentiometer A7A1R6C for reading of 18 vdc on dc voltmeter.

c. Disconnect dc voltmeter.

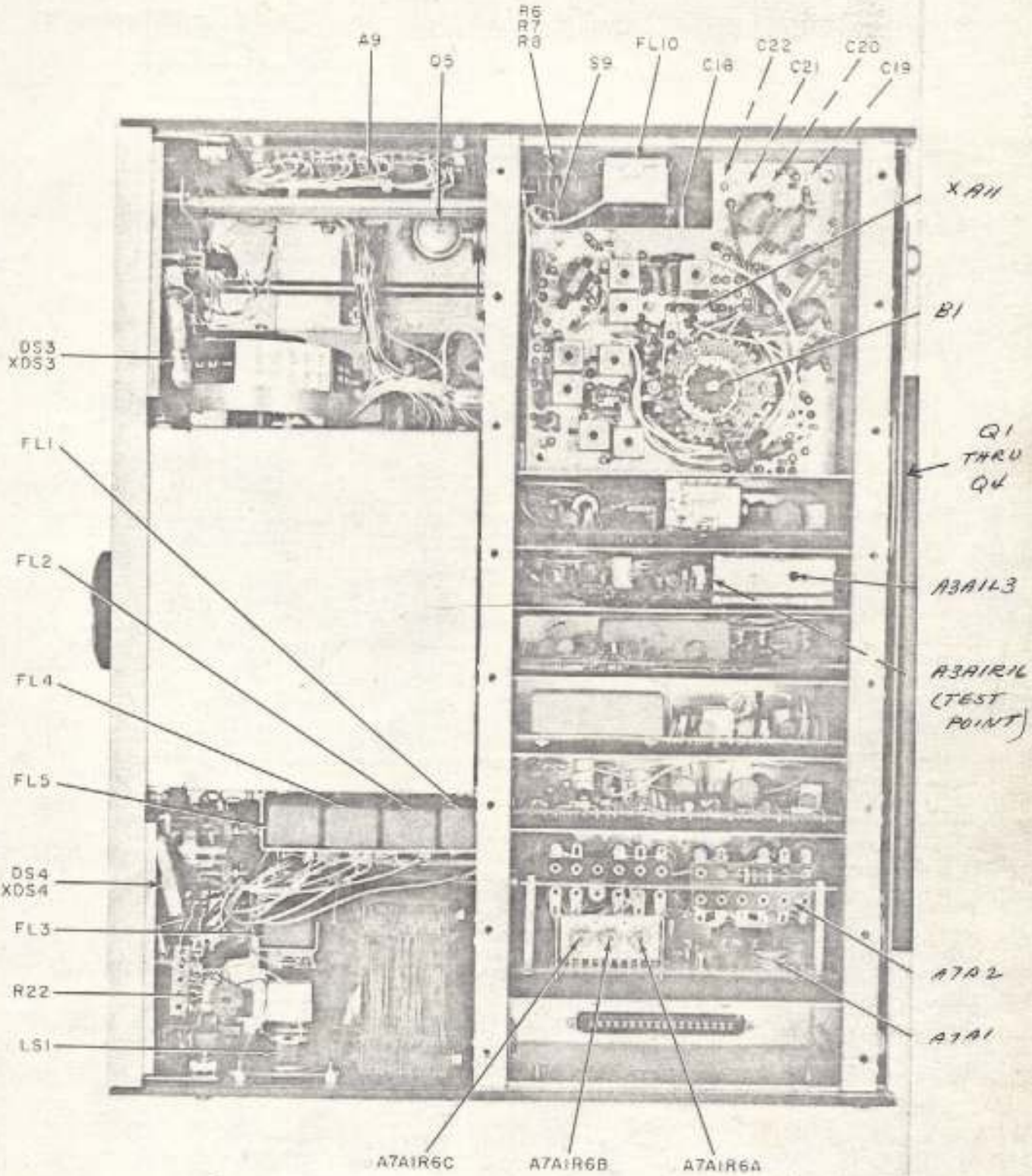
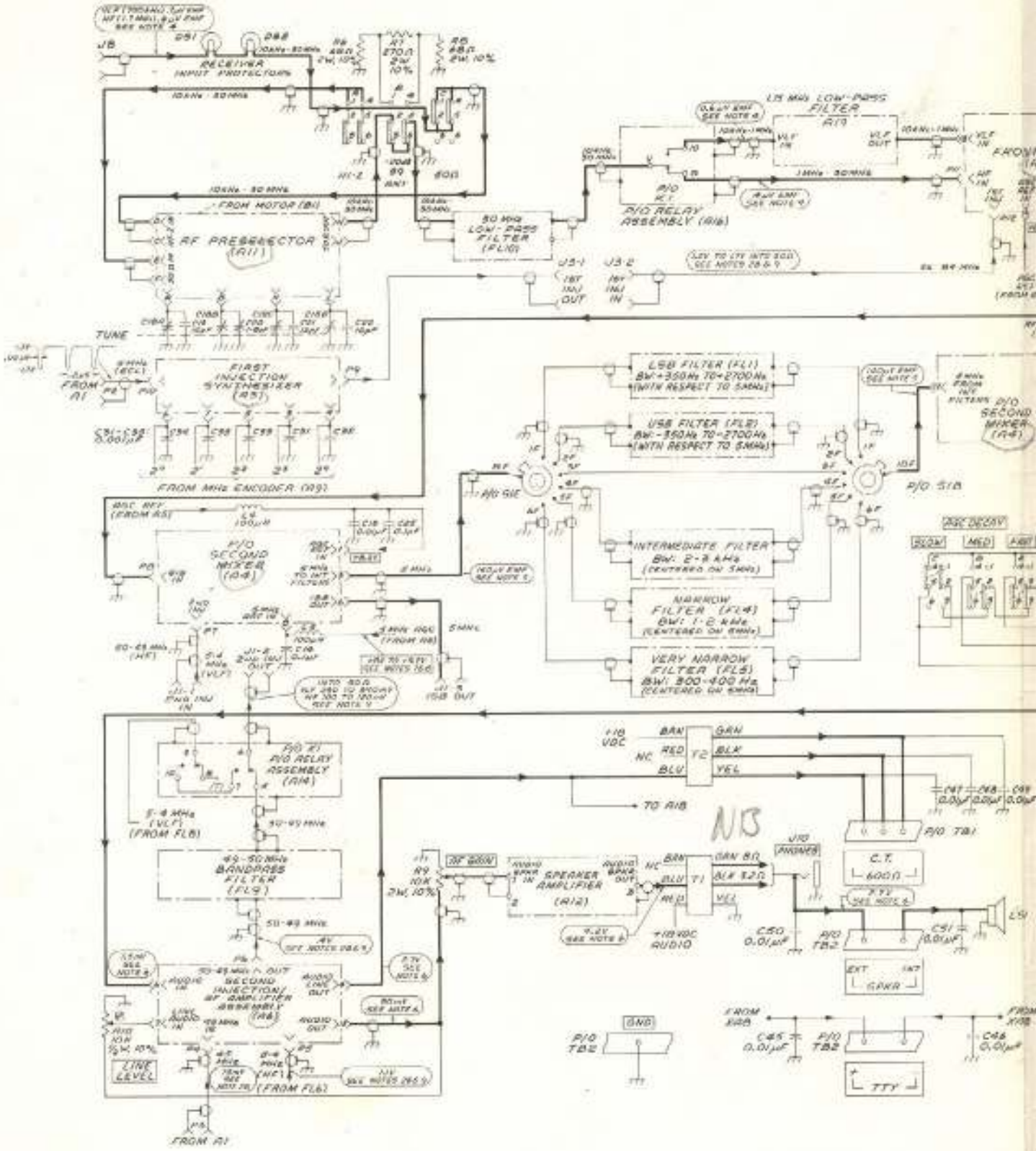
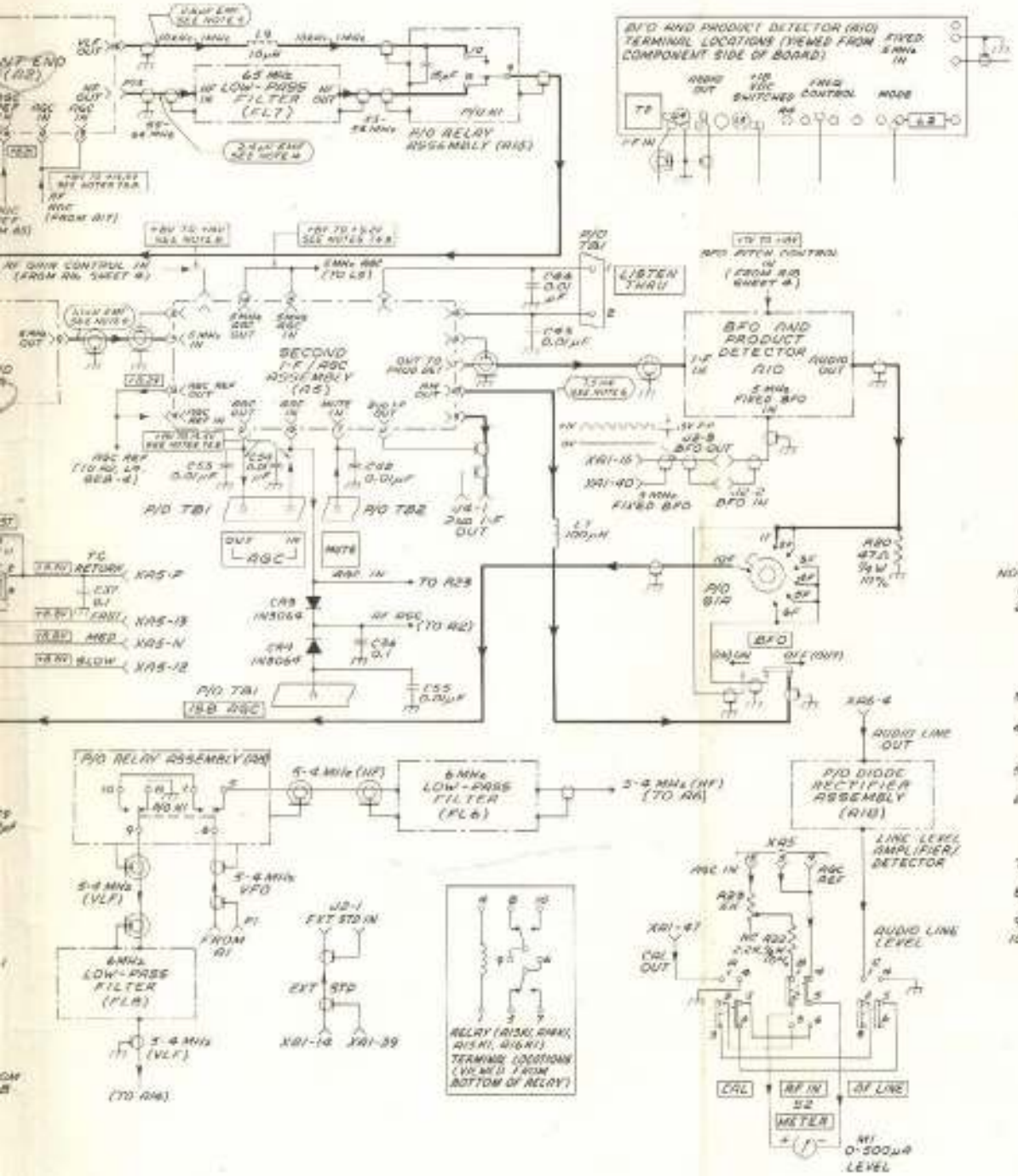

A9
D5
R6
R7
R8
S9
FL10
C18
C22
C21
C20
C19
XA11
B1
DS3
XDS3
FL1
FL2
FL4
FL5
DS4
XDS4
FL3
R22
LS1
Q1
THRU
Q4
A3A1L3
A3A1R1L
(TEST
POINT)
A7A2
A7A1
A7A1R6C
A7A1R6B
A7A1R6A

FIG. 5-1


RECEIVER INPUT PROTECTION
RF PRESELECTOR (A11)
TUNE
FIRST INJECTION SYNTHESIZER (A5)
FROM MHz ENCODER (A9)
FROM MOTOR (B1)
50 MHz LOW-PASS FILTER (FL10)
135 MHz LOW-PASS FILTER A19
P/O RELAY ASSEMBLY (A16)
LSB FILTER (FL1)
BW: +350 Hz TO +2700 Hz (WITH RESPECT TO 5 MHz)
USB FILTER (FL2)
BW: -350 Hz TO -2700 Hz (WITH RESPECT TO 5 MHz)
INTERMEDIATE FILTER
BW: 2-3 kHz (CENTERED ON 5 MHz)
NARROW FILTER (FL4)
BW: 1-2 kHz (CENTERED ON 5 MHz)
VERY NARROW FILTER (FL5)
BW: 300-400 Hz (CENTERED ON 5 MHz)
P/O SECOND MIXER (A4)
P/O A1
P/O A1 RELAY ASSEMBLY (A1K)
5-6 MHz (VLF) (FROM FL6)
49-50 MHz BANDPASS FILTER (FL9)
SECOND INJECTION/RF AMPLIFIER ASSEMBLY (A6)
LINE LEVEL
FROM A1
SPEAKER AMPLIFIER (A12)
+10 VDC AUDIO
P/O TB1
P/O TB2
C.T.
EXT
TTY
GND
FROM A9B
FROM A10B
NS



NOTES:

1. ALL VALUES ARE APPROXIMATE.
2. A. DC MEASUREMENT MADE WITH 11 MEG Ω INPUT VTVM.
   B. AC MEASUREMENT, HIGH IMPEDANCE PROBE UNLESS OTHERWISE INDICATED. AUDIO LEVELS MADE WITH AC VTVM, RF LEVELS MADE WITH RF VTVM.
3. WAVEFORMS TAKEN WITH 10 MEG INPUT, 100 MHz OSCILLOSCOPE.
4. APPROX LEVEL REQ'D TO OBTAIN 10dB S+N/N IN SSB MODE WITH PRESELECTOR OFF.
5. APPROX LEVEL REQ'D TO OBTAIN 50mW INTO 50Ω AT J9-1.
6. APPROX AUDIO LEVEL OBTAINED WITH GAIN CONTROLS AT MAX AND 46mV EMF ON XA5-1 IN SSB MODE OR 0.2V EMF 30% AM ON XA5-3, INT SW SPERRER LOAD 8Ω, LINE LOAD 600Ω.
7. VARIES WITH INPUT SIGNAL LEVEL WITH AGC SWITCHED ON.
8. VARIES WITH SETTING OF RF GAIN CONTROL.
9. VARIES WITH RECEIVER FREQUENCY.
10. ALL INPUTS FROM 50Ω IMPEDANCE SIGNAL GENERATOR.

Figure 5-7. HRO-600 Main Frame Assembly, Servicing Block Diagram (Sheet 1 of 4)

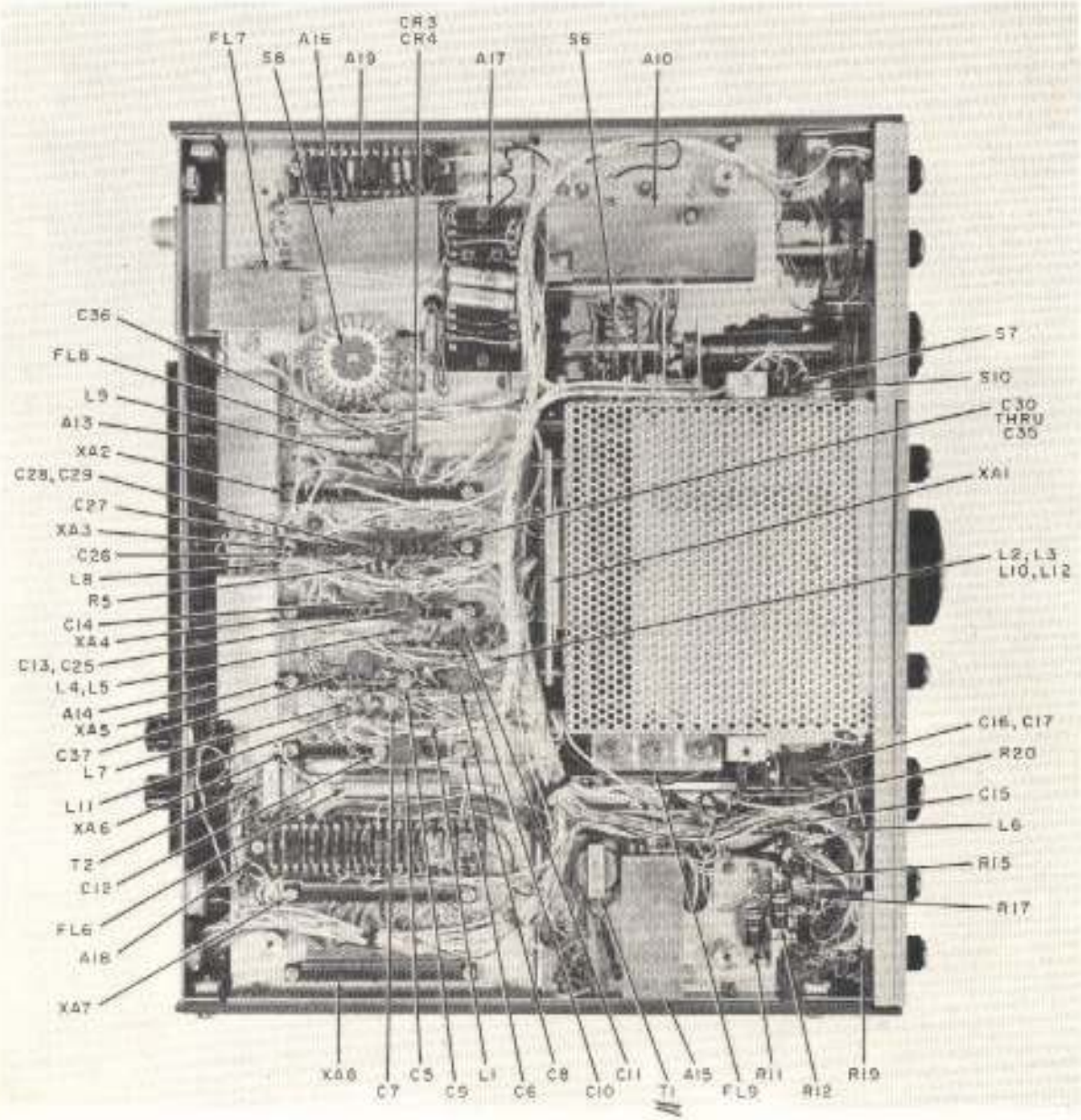


Figure 5-2. HRO-600, Bottom View With Cover Removed

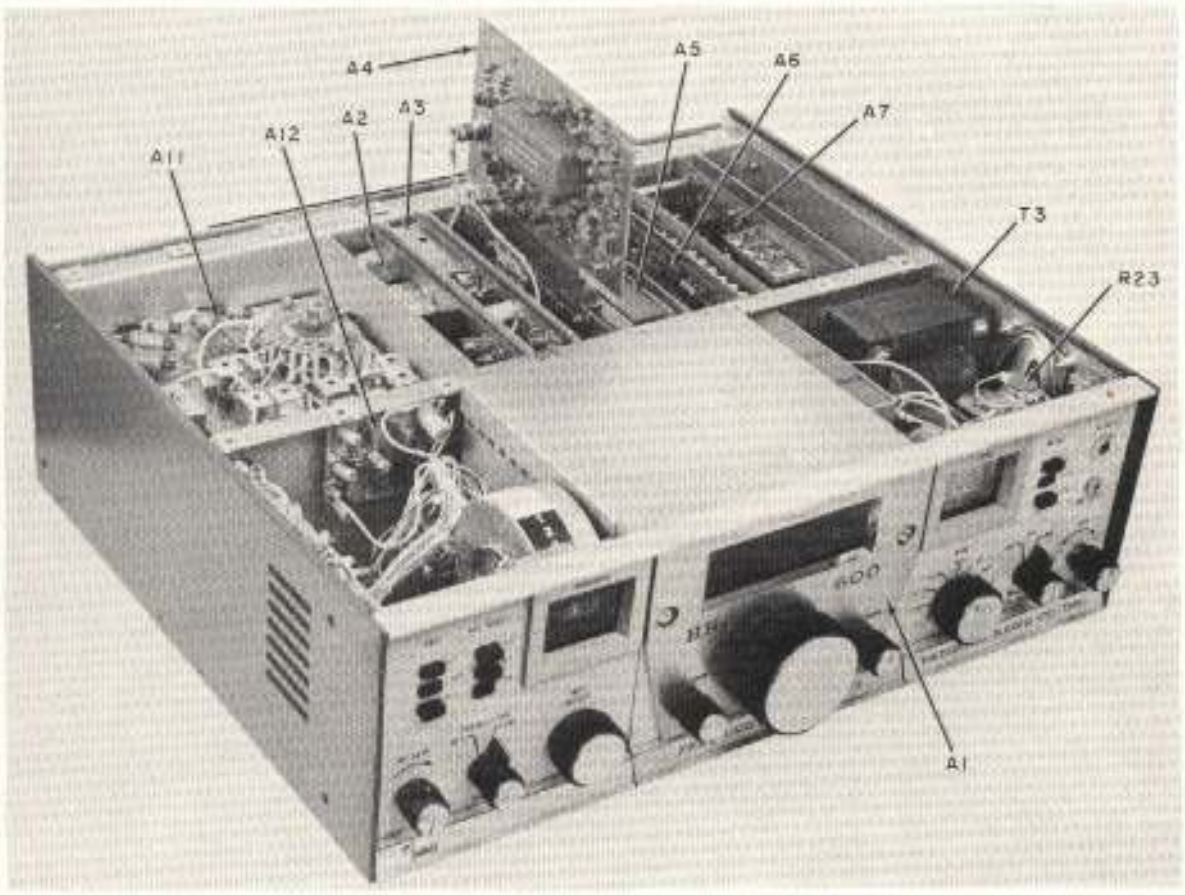


Figure 5-3. HRO-600, Modules Requiring Extension

d. Connect dc voltmeter (set for scale of 10 vdc or greater) between XA7-8 (+) and chassis ground (-).

e. Adjust potentiometer A7A1R6B for reading of 5 vdc on dc voltmeter.

f. Disconnect dc voltmeter.

g. Connect dc voltmeter (set for scale of 10 vdc or greater) between XA7-10 (-) and chassis ground (+).

h. Adjust potentiometer A7A1R6A for reading of 5.5 vdc on dc voltmeter.

i. Disconnect dc voltmeter.

5.2.3 First-Injection-Synthesizer Alignment

To align the first-injection-synthesizer module (A3) proceed as follows:

Note

Any dc voltmeter with an accuracy of ±5 percent and an impedance of 1000 Ω/V is adequate.

a. Connect dc voltmeter (set for scale of 100 vdc or greater) between test point terminal (+) of 10 K isolation resistor (A3R27) and chassis ground (-). (See Figure 5-1.)

b. Set front-panel MHz SELECT control for reading of 29 MHz on front-panel MHz indicator.

Note

To adjust inductor A3L3, use Micrometals Tool A or its equivalent.

c. Adjust inductor A3L3 for reading of 75 vdc to 80 vdc on dc voltmeter.

d. Disconnect dc voltmeter.

5.2.4 Second Injection/AF Amplifier Alignment

To align the second injection/af amplifier module (A6), proceed as follows:

Note

To align second injection/af amplifier module (A6), an extender card is required.

a. Tune HRO-600 for frequency of 1,500.0 kHz.

b. Connect rf voltmeter (set for scale of 3 vac rms or greater) between junction of resistors A6R19, A6R20, and A6R21, and chassis ground.

Note

To adjust inductor A6L10, use Micrometals Tool A or its equivalent.

c. Adjust inductor A6L10 for maximum reading on rf voltmeter. Voltage reading should be approximately 1 vac rms.

d. Disconnect rf voltmeter.

e. Connect electronic voltmeter (set for scale of 10 vdc or greater) between junction (+) of R5, R8, R9, R10, and L4 and chassis ground (-).

Note

To adjust inductor A6L3, use Micrometals Tool A or its equivalent.

f. Adjust inductor A6L3 for reading of 5.5 vdc on electronic voltmeter.

Note

If reading on electronic voltmeter fluctuates during performance of following step g or h, re-adjust inductor A6L3 to eliminate fluctuation.

g. Tune HRO-600 for frequency of 1,000.0 kHz, and verify that reading on electronic voltmeter remains steady (it will be higher than 5.5 vdc).

h. Tune HRO-600 for frequency of 1,999.9 kHz, and verify that reading on electronic voltmeter remains steady (it will be lower than 5.5 vdc).

i. Disconnect electronic voltmeter.

5.2.4.1 Bandpass Filter (FL9) Alignment

To align the bandpass filter (FL9), proceed as follows:

a. Tune the receiver to any band above 1 MHz and a frequency of 00.7500 MHz.

b. Connect a patch cable (part of maintenance kit MK-1) to J1-2 on the rear panel, and to a high impedance rf vtvm.

c. Adjust the three tuning slugs on FL9 for maximum indication on the rf vtvm.

d. Disconnect the patch cable.

5.2.5 Bandswitch Drive Motor Alignment

Note

The positioning scheme used causes the contact on the motor positioning switch (see Figure 5-2) to be off-center, since the motor stops immediately after the contact is broken. The purpose of this alignment procedure is to make this non-centered condition of the motor positioning contact correspond to a centered condition of the preselector bandswitch contact.

Refer to Figure 5-4 to locate preselector bandswitch contacts when in the "preselector off" condition.

To align the bandswitch drive motor (B1), proceed as follows:

a. Set PRESELECTOR ON-OFF switch on front panel of HRO-600 to OFF, the MODE switch to OFF, and disconnect the ac line from the rear panel.

b. Note the position of the preselector bandswitch rotor. It should be as illustrated in Figure 5-4. If not, loosen (do not remove) the two cross-recessed screws and nuts that secure the switch brackets. Turn the motor positioning switch wafer in the direction opposite to that in which you want the bandswitch to go (the bandswitch is viewed from the top; the motor positioning switch from the bottom). Tighten the screws and nuts.

c. Reconnect the ac line and set the MODE switch to any operating position.

d. Cycle the positioning circuit by setting the PRESELECTOR ON-OFF switch from OFF to ON, then OFF. Check that the bandswitch rotor contact is centered. If not, repeat steps (a) through (d).

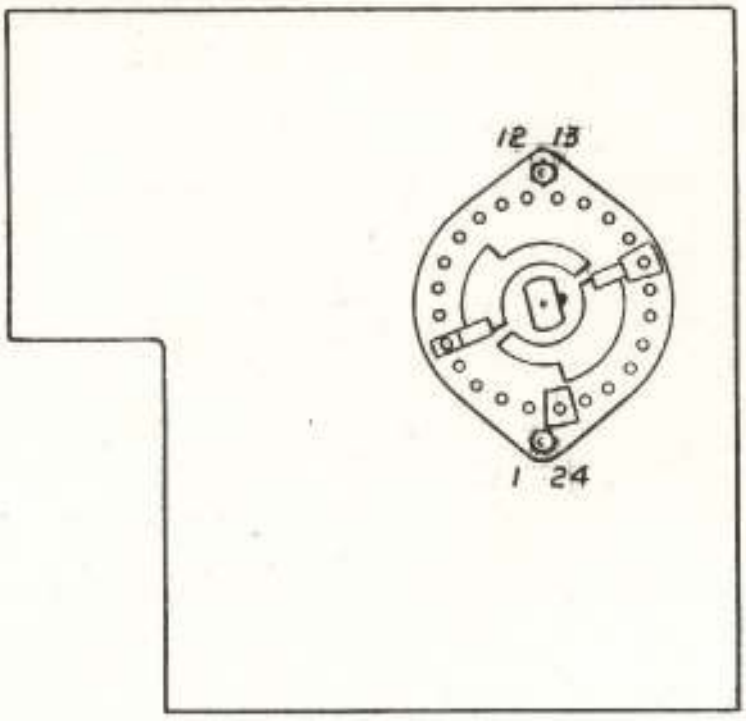


Figure 5-4. Orientation of Bandswitch Positions

5.2.6 RF Preselector Alignment

To align the rf preselector, proceed as follows:

a. Depress 50Ω ANT. selection pushbutton on front panel of HRO-600. Make sure that this pushbutton remains depressed, and that remaining two ANT. selection pushbuttons (-20 dB and HI-Z) are released (not depressed).

b. Depress RF IN METER selection pushbutton on front panel of HRO-600. Make sure that this pushbutton remains depressed, and that remaining two METER selection pushbuttons (CAL and AF LINE) are released (not depressed).

c. Set PRESELECTOR ON-OFF switch on front panel of HRO-600 to ON position.

d. Rotate TUNE control on front panel of HRO-600 fully counterclockwise, and then rotate this control 20 degrees clockwise.

e. Set AGC control on front panel of HRO-600 to ON position.

f. Rotate RF GAIN control on front panel of HRO-600 fully clockwise.

g. Connect output from 50Ω rf signal generator to ANT. connector (J8) on rear panel of HRO-600.

h. Set up signal generator and HRO-600 for 30 MHz by performing following substeps h(1) through h(5).

(1) Tune HRO-600 for reception of 30.0000 MHz signal.

(2) Set signal-generator output frequency at 30 MHz, as indicated by signal generator.

(3) Adjust signal-generator output level for mid-scale reading of LEVEL meter on front panel of HRO-600.

(4) Adjust signal-generator output frequency for maximum reading on LEVEL meter. (Reduce signal-generator output level as necessary to maintain meter reading on scale.)

(5) Re-adjust signal-generator output level for mid-scale reading on LEVEL meter.

i. Adjust capacitor C~~19~~ 21 for maximum reading on LEVEL meter. (Reduce signal-generator output level as necessary to maintain meter reading on scale.)

j. Set up signal generator and HRO-600 for 16 MHz by performing preceding substeps h(1) through h(5) for 16.0000 MHz (16 MHz) instead of 30.0000 MHz (30 MHz).

Note

To adjust inductors A11L3 through A11L10, use Micrometals Tool A or its equivalent.

k. Alternately adjust inductors A11L9 and A11L10 for maximum reading on LEVEL meter. (Reduce signal-generator output level as necessary to maintain meter reading on scale.) After completion of adjustments, A11L9 and A11L10 should be in approximately the same relative positions.

l. Repeat performance of steps h through k until no further maximization of LEVEL meter reading can be attained.

m. Set up signal generator and HRO-600 for 8 MHz by performing preceding substeps h(1) through h(5) for 8.0000 MHz (8 MHz) instead of 30.0000 MHz (30 MHz).

n. Alternately adjust inductors A11L7 and A11L8 for maximum reading on LEVEL meter. (Reduce signal-generator output level as necessary to maintain meter reading on scale.) After completion of adjustments, A11L7 and A11L8 should be in approximately the same relative positions.

o. Set up signal generator and HRO-600 for a 4 MHz by performing preceding substeps h(1) through h(5) for 4.0000 MHz (4 MHz) instead of 30.0000 MHz (30 MHz).

p. Alternately adjust inductors A11L5 and A11L6 for maximum reading on LEVEL meter. (Reduce signal-generator output level as necessary to maintain meter reading on scale.) After completion of adjustments, A11L5 and A11L6 should be in approximately the same relative positions.

q. Set up signal generator and HRO-600 for 2 MHz by performing preceding substeps h(1) through h(5) for 2.0000 MHz (2 MHz) instead of 30.0000 MHz (30 MHz).

r. Alternately adjust inductors A11L3 and A11L4 for maximum reading on LEVEL meter. (Reduce signal-generator output level as necessary to maintain meter reading on scale.) After completion of adjustments, A11L3 and A11L4 should be in approximately the same relative positions.

Note

No alignment of rf bands below 2 MHz is required.

s. Disconnect rf signal generator.

5.2.7 Front End, Second I-F, and AGC Alignment

To align the front end module (A2), the second i-f/agc module (A5), and the agc meter sensitivity control (R23), proceed as follows:

Note

To align A2 and A5 modules, an extender card is required.

a. Depress 50Ω ANT. Selection pushbutton on front panel of HRO-600. Make sure that this pushbutton remains depressed, and that remaining two ANT. selection pushbuttons (-20 dB and HI-Z) are released (not depressed).

b. Depress SLOW AGC DECAY selection pushbutton on front panel of HRO-600. Make sure that this pushbutton remains depressed, and that remaining two AGC DECAY selection pushbuttons (MED and FAST) are released (not depressed).

c. Depress RF IN METER selection pushbutton on front panel of HRO-600. Make sure that this pushbutton remains depressed, and that remaining two METER selection pushbuttons (CAL and AF LINE) are released (not depressed).

d. Set PRESELECTOR control on front panel of HRO-600 to ON position.

e. Set MODE switch on front panel of HRO-600 to WIDE position.

f. Set AGC switch on front panel of HRO-600 to ON position.

g. Rotate RF GAIN control on front panel of HRO-600 fully clockwise.

h. Disconnect normal RF AGC input lead from terminal XA2-4.

i. Connect 8-15 vdc variable dc power supply capable of delivering output current of 1 mA between terminal XA2-4 (+) and chassis ground (-).

Note

During performance of following steps, voltage output from variable dc power supply must be measured within accuracy of ±5 percent.

j. Connect output from 50-ohm rf signal generator to ANT. connector (J8) on rear panel of HRO-600.

Note

During performance of following steps, rf output from signal generator must be measured within accuracy of ±2 dB.

k. Rotate rf-amplifier agc-attack-threshold control (A2R20) fully counterclockwise.

l. Adjust variable dc power supply for +8.0 vdc output.

m. Set up signal generator and HRO-600 for 5.75 MHz by performing following sub-steps m(1) through m(5).

(1) Tune HRO-600 for reception of 5.7500 MHz signal.

(2) Set signal-generator output frequency at 5.75 MHz, as indicated by signal generator.

(3) Adjust signal-generator output level for mid-scale reading of LEVEL meter on front panel of HRO-600.

(4) Adjust signal-generator output frequency for maximum reading on LEVEL meter. (Reduce signal-generator output level as necessary to maintain meter reading on scale.)

(5) Readjust signal-generator output level for mid-scale reading on LEVEL meter.

Note

To adjust inductors A2L1 and A5L8, use Micrometals Tool A or its equivalent. To adjust three tuning slugs on first i-f filter (A2FL1), use Cambion Alignment Tool 1970-1 or its equivalent.

n. Alternately adjust first i-f amplifier tuning control (A2L1) and three tuning slugs on first i-f filter (A2FL1) for maximum indication on front-panel LEVEL meter.

Note

Peak of bandpass characteristic adjusted by second i-f amplifier tuning control (A5L8) is relatively broad.

o. Adjust second i-f amplifier tuning control (A5L8) for maximum indication on front-panel LEVEL meter.

p. Set MODE switch on front panel of HRO-600 to USB (black) position.

q. Depress AF LINE METER selection pushbutton on front panel of HRO-600. Make sure that this pushbutton remains depressed, and that remaining two METER selection pushbuttons (RF IN and CAL) are released (not depressed).

Note

During performance of following steps r through aa, nominal 1 kHz audio tone can be monitored by internal or external speaker or external headphones. Adjust AF GAIN control on front panel of HRO-600 as desired for comfortable listening level.

r. Increase signal-generator output frequency unit audio tone with nominal frequency of 1 kHz is detected.

s. Set signal generator for output level of 1.0 μV rms.

t. Adjust LINE LEVEL control on front panel of HRO-600 for 600 Ω LINE LEVEL dBm reading of 0 on front-panel LEVEL meter.

u. Adjust variable dc power supply for +15.0 vdc output.

v. Set signal generator for output level of 1.8 mV rms.

w. Adjust agc compensation control (A2R16) for 600Ω LINE LEVEL dBm reading of 0 on front-panel LEVEL meter.

x. Set signal generator for output level of 500 μV rms.

y. Adjust variable dc power supply for +11.8 vdc output.

z. Adjust rf-amplifier agc-attack-threshold control (A2R20) so that 600Ω LINE LEVEL dBm reading on front-panel LEVEL meter just barely decreases.

aa. Repeat performance of preceding steps u through z as necessary to optimize both adjustments.

ab. Disconnect variable dc power supply from HRO-600.

Note

During performance of following step ac, make sure that normal RF AGC input lead remains connected to terminal XA2-13.

ac. Reconnect normal RF AGC input lead to terminal XA2-4.

Note

LINE LEVEL control on front panel of HRO-600 may be used to facilitate measurements made with external audio power meter.

ad. Connect external 600-ohm audio power meter between two outer 600Ω terminals of TB1 on rear panel of HRO-600.

Note

During performance of following steps, make sure that no plug in inserted into PHONES jack on front panel of HRO-600.

ae. Connect vertical input of oscilloscope (set for internal sweep) between EXT SPKR and GND terminals of TB2 on rear panel of HRO-600.

Note

During performance of following steps, it is recommended that nominal 1 kHz audio signal displayed by oscilloscope also be monitored by means of a speaker (either the internal HRO-600 speaker or an external one). Adjust AF GAIN control on front panel of HRO-600 as desired for comfortable listening level.

af. Set basic agc-attack-threshold control (A5R30), agc-attack-time-constant control (A5R34), and agc-loop-gain control (A5R37) to their respective mid-positions.

ag. Depress RF IN METER selection pushbutton on front panel of HRO-600. Make sure that this pushbutton remains depressed, and that remaining two METER selection pushbuttons (CAL and AF LINE) are released (not depressed).

ah. Adjust 50-ohm rf signal generator for output level of 0.0 μV rms (zero output level).

ai. Adjust agc S-meter zero control (A5R41) for RF IN reading of 0 on front-panel LEVEL meter.

aj. Depress RF IN METER selection pushbutton on front panel of HRO-600. Make sure that this pushbutton remains depressed, and that remaining two METER selection pushbuttons (AF LINE and CAL) are released (not depressed).

ak. Adjust 50-ohm rf signal generator for output level of 1.5 μV rms.

al. Adjust basic agc-attack-threshold control (A5R30) so that RF IN reading on front-panel LEVEL meter just barely rises above 0 level. Record reading on external audio power meter.

Note

After reading has been recorded, do not change setting of front-panel LINE LEVEL control until after completion of following step ap.

am. Adjust 50-ohm rf signal generator for output level of 500 μV rms.

an. Adjust rf-amplifier agc-attack-threshold control (A2R20) so that RF IN reading on front-panel LEVEL meter just barely decreases.

ao. Adjust 50-ohm rf signal generator for output level of 1.5 V rms.

ap. Adjust agc-loop-gain control (A5R37) so that reading on external audio power meter is 9 dB greater than that recorded during performance of preceding step al.

aq. Repeat performance of preceding steps ag through ap as necessary to optimize all four adjustments.

Note

During adjustment of agc attack time constant, it is recommended that internal oscilloscope sweep speed be set for 5 msec/cm. At this setting, audio display will tend to "fill in", and thus facilitate time-constant measurement.

ar. Adjust 50-ohm rf signal generator for output level of 1.5 μV rms.

Note

Prior to performance of following step as, make sure that audio signal displayed by oscilloscope is at stable level (that is, that any decay time has elapsed).

as. Remove signal generator output and observe oscilloscope display to determine agc attack time constant. Increase signal-generator output level to 1.5 mV rms and rapidly put generator output into the receiver. Agc attack time constant is measured from point at which audio signal (after less rapid decrease) again assumes stable level. Value of this time constant should be approximately 15 msec.

at. Alternately adjust agc-attack-time constant control (A5R34) and repeat performance of preceding steps ar and as until agc attack time constant of approximately 15 msec is achieved.

au. Repeat performance of preceding steps ag through at as necessary to optimize all five adjustments.

av. Adjust 50-ohm rf signal generator for output level of 1.5 mV rms.

aw. Adjust agc meter sensitivity control (R23) for RF IN reading of 60 dB on front-panel LEVEL meter.

5.2.8 BFO and Product Detector Alignment

To align the BFO and product detector assembly (A10), proceed as follows:

a. Set MODE switch on front panel of HRO-600 to NAR or V. NAR position.

b. Set BFO control on front panel of HRO-600 to 0 position.

c. Tune HRO-600 for reception of any available transmitted carrier frequency.

Note

To adjust inductor A10L1, use Micrometals Tool A or its equivalent.

d. Adjust inductor A10L1 for zero beat, as monitored by speaker (either internal or external) or headphones.

5.3 TROUBLESHOOTING

Field troubleshooting of the HRO-600 Main Frame Assembly consists of isolating a trouble to a defective assembly, to a defective chassis or panel component, or to defective wiring. The HRO-600 contains either 17 or 18 electronic assemblies, which are as follows:

a. Frequency Control Plug-In Unit (A1), Type 601, Type 602, or Type 603.

b. Front End Module (A2)

c. First Injection Synthesizer Module (A3)

d. Second Mixer Module (A4)

e. Second I-F/AGC Module (A5)

f. Second Injection/AF Amplifier Module (A6)

g. Power Supply Module (A7)

h. Optional Type 650 FSK Converter Module (A8)

i. MHz Encoder Assembly (A9)

j. BFO and Product Detector Assembly (A10)

k. RF Preselector (A11)

l. Speaker Amplifier Assembly (A12)

m. Relay Assembly (A13)

n. Relay Assembly (A14)

o. Relay Assembly (A15)

p. Relay Assembly (A16)

q. Motor Control Assembly (A17)

r. Diode Rectifier Assembly (A18)

Troubleshooting of each of the three different types of frequency control plug-in unit is discussed in the supplementary technical manual for the particular unit. Whenever any of the remaining 16 or 17 electronic assemblies is found to be defective, it should be returned to National Radio Company, Inc., or to the Company's authorized representative, for troubleshooting and repair.

The basic troubleshooting references provided in this technical manual are the servicing block diagram of Figure 5-7 and the parts-location illustrations of Figures 5-1 and 5-2. A thorough knowledge of the theory of operation presented in Section 4 of this technical manual is highly desirable (if not absolutely essential) for effective trouble-shooting. (The theoretical discussion is also referenced to Figure 5-7.) Refer to Section 4 as necessary during performance of troubleshooting procedures.

Voltages and, where applicable, voltage waveforms are specified in Figure 5-7 for all key test points. In addition, Figure 5-7 specifies applicable tolerances, and the type(s) of test equipment required for each measurement. For troubleshooting of the major

portion of the signal-path circuits of the HRO-600, a combination of signal substitution and signal tracing is recommended. Accordingly, signal-substitution values are specified for the applicable signal-path circuits in Figure 5-7.

To check for defective wiring (short circuits or open circuits), it will sometimes be necessary or desirable to make continuity checks with an ohmmeter. Prior to making any such checks, de-energize the HRO-600 by rotating the MODE switch on the front panel of the Main Frame Assembly to the OFF position.

In some cases, a trouble may be due to misalignment of circuits on the HRO-600 Main Frame Assembly. Alignment procedures are given in paragraph 5.2.

Repair of the HRO-600 Main Frame Assembly is discussed in paragraph 5.4.

5.4 REPAIR

Field repair procedures applicable to the HRO-600 Main Frame Assembly involve straightforward removal and replacement of electrical and electronic components and electronic assemblies, and correction of defective wiring. To facilitate replacement, tag all disconnected leads whenever any wired-in electronic assembly is removed. Parts-location information for the HRO-600 Main Frame Assembly is shown in Figures 5-1 and 5-2.

To remove and replace the MHz encoder (A9), it is necessary to remove first the three shafts leading from the front-panel ANT. (antenna) selection pushbuttons (HI-Z, -20 dB, and 50Ω) to the associated switches. These shafts are disengaged by removal of cotter pins located near the rear of the front panel.

CAUTION

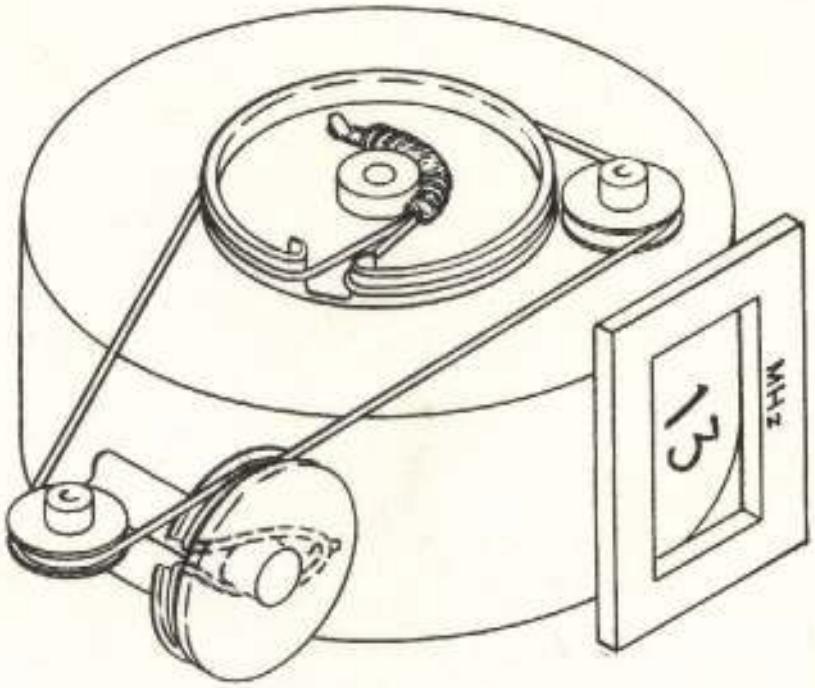
When dismounting the rear panel of the HRO-600, take care not to exert any strain on interconnecting wiring.

To remove and replace power-supply regulator transistors Q1 through Q4, it is necessary to dismount first the rear panel of the HRO-600 and then the black terminal-strip cover on this panel.

CAUTION

When removing or replacing the rf pre-selector (A11), lift straight up or push straight down to prevent exertion of undue strain on bandswitch shaft and/or bandswitch.

Within the Main Frame Assembly of the HRO-600, two spring-loaded string devices are employed. One provides mechanical coupling between the MHz SELECT control and the MHz indicator on the front panel of the Main Frame Assembly. The other provides mechanical coupling between the tuning shafts associated with the TUNE control on the front panel of the Main Frame Assembly. Correct routings of the MHz and tuning string drives are shown in Figure 5-5 and 5-6, respectively.



ROUTING WHEN MHz INDICATOR READS 13.

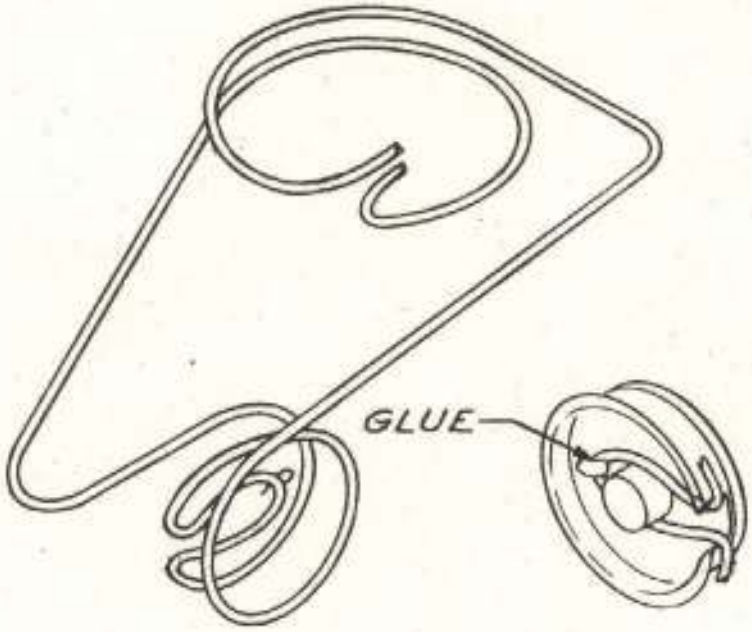


Figure 5-5. MHz Select String Drive Routing

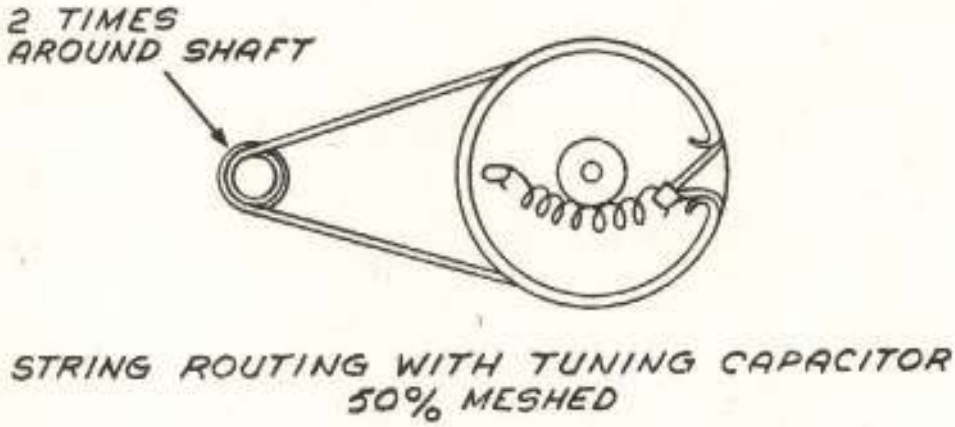
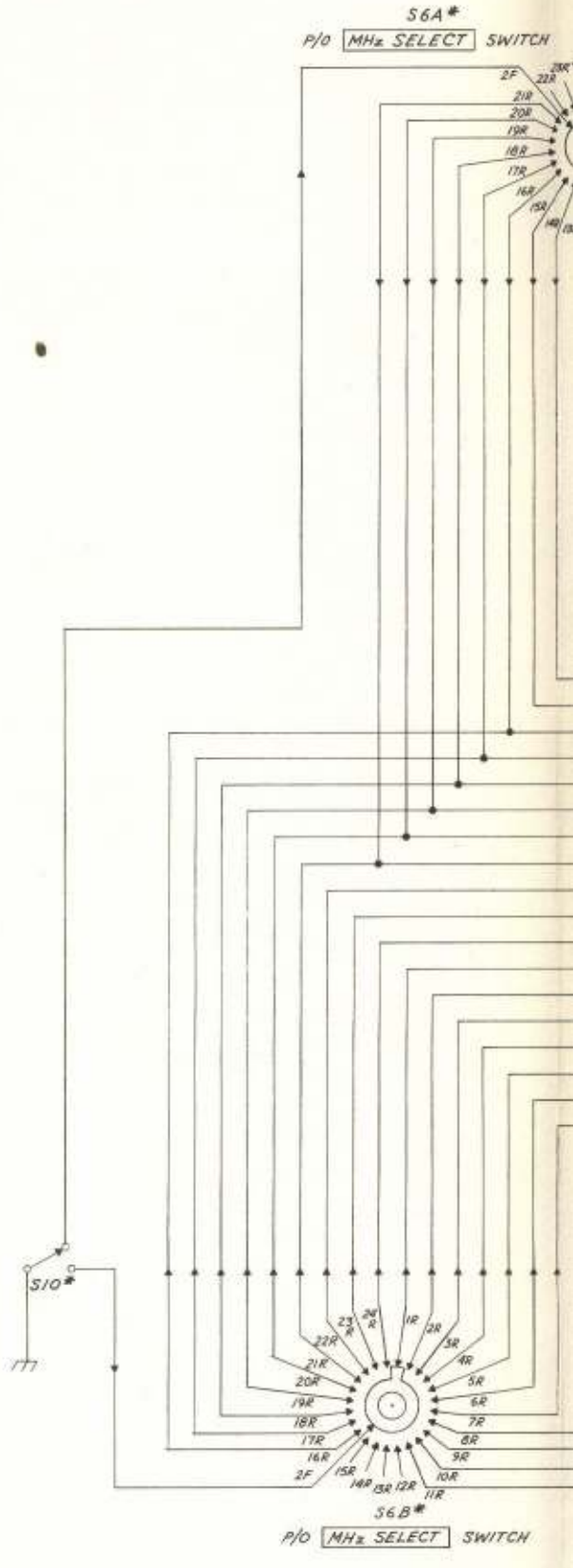
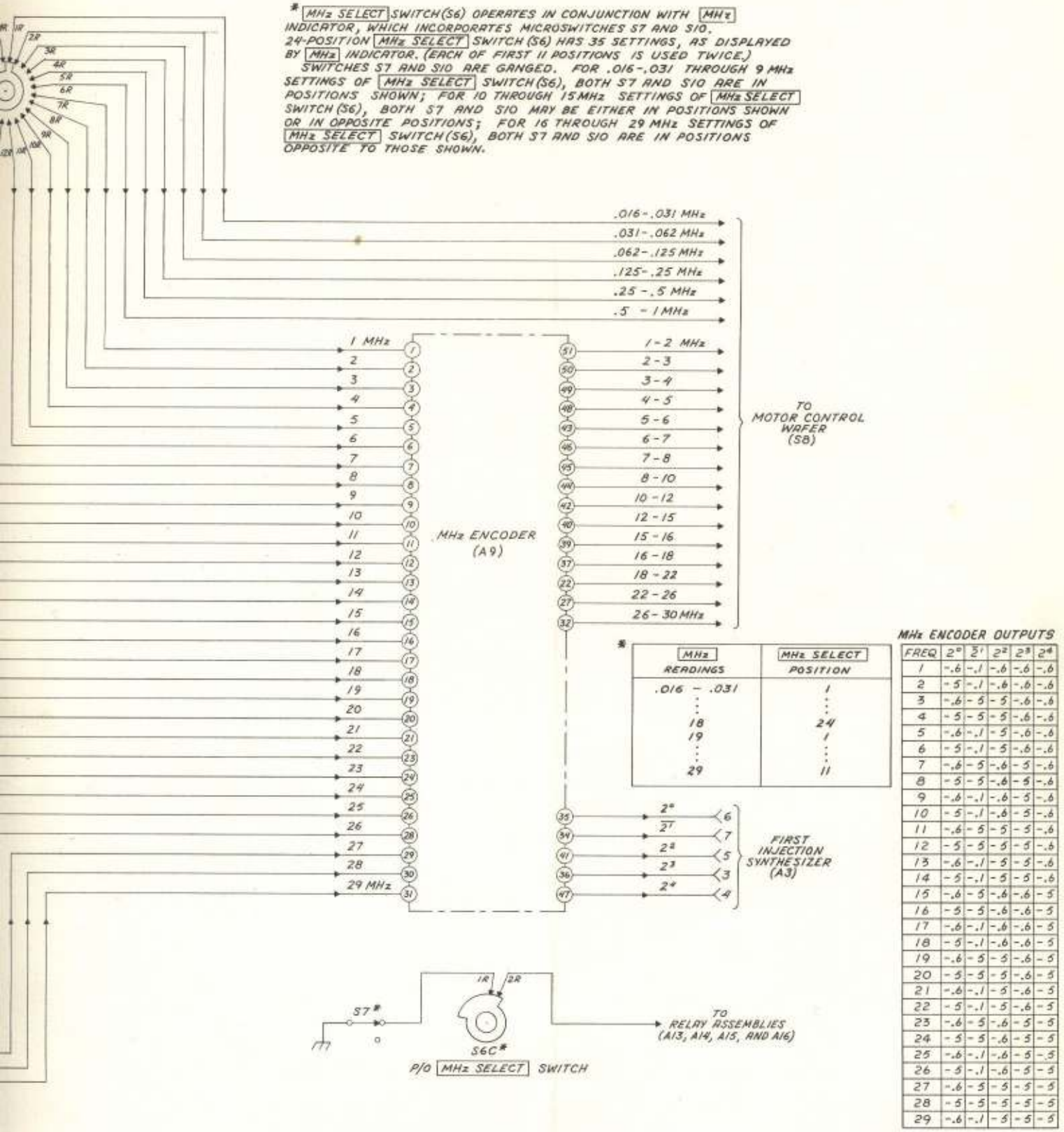


Figure 5-6. Preselector Tuning String Drive Routing


S6A*
P/O MHz SELECT SWITCH
2F
22R
21R
20R
19R
18R
17R
16R
15R
14R
S10*
23R
24R
1R
2R
3R
4R
5R
6R
7R
8R
9R
10R
11R
12R
13R
S6B*
P/O MHz SELECT SWITCH



* MHz SELECT SWITCH (S6) OPERATES IN CONJUNCTION WITH MHz INDICATOR, WHICH INCORPORATES MICROSWITCHES S7 AND S10. 24-POSITION MHz SELECT SWITCH (S6) HAS 35 SETTINGS, AS DISPLAYED BY MHz INDICATOR. (EACH OF FIRST 11 POSITIONS IS USED TWICE.) SWITCHES S7 AND S10 ARE GANGED. FOR .016-.031 THROUGH 9 MHz SETTINGS OF MHz SELECT SWITCH (S6), BOTH S7 AND S10 ARE IN POSITIONS SHOWN; FOR 10 THROUGH 15 MHz SETTINGS OF MHz SELECT SWITCH (S6), BOTH S7 AND S10 MAY BE EITHER IN POSITIONS SHOWN OR IN OPPOSITE POSITIONS; FOR 16 THROUGH 29 MHz SETTINGS OF MHz SELECT SWITCH (S6), BOTH S7 AND S10 ARE IN POSITIONS OPPOSITE TO THOSE SHOWN.

*

MHz READINGS	MHz SELECT POSITION
.016 - .031	1
⋮	⋮
18	24
19	1
⋮	⋮
29	11

MHz ENCODER OUTPUTS

FREQ	2^0	2^1	2^2	2^3	2^4
1	-.6	-.1	-.6	-.6	-.6
2	-5	-.1	-.6	-.6	-.6
3	-.6	-5	-5	-.6	-.6
4	-5	-5	-5	-.6	-.6
5	-.6	-.1	-5	-.6	-.6
6	-5	-.1	-5	-.6	-.6
7	-.6	-5	-.6	-5	-.6
8	-5	-5	-.6	-5	-.6
9	-.6	-.1	-.6	-5	-.6
10	-5	-.1	-.6	-5	-.6
11	-.6	-5	-5	-5	-.6
12	-5	-5	-5	-5	-.6
13	-.6	-.1	-5	-5	-.6
14	-5	-.1	-5	-5	-.6
15	-.6	-5	-.6	-.6	-5
16	-5	-5	-.6	-.6	-5
17	-.6	-.1	-.6	-.6	-5
18	-5	-.1	-.6	-.6	-5
19	-.6	-5	-5	-.6	-5
20	-5	-5	-5	-.6	-5
21	-.6	-.1	-5	-.6	-5
22	-5	-.1	-5	-.6	-5
23	-.6	-5	-.6	-5	-5
24	-5	-5	-.6	-5	-5
25	-.6	-.1	-.6	-5	-5
26	-5	-.1	-.6	-5	-5
27	-.6	-5	-5	-5	-5
28	-5	-5	-5	-5	-5
29	-.6	-.1	-5	-5	-5

Figure 5-7. HRO-600 Main Frame Assembly, Servicing Block Diagram (Sheet 2 of 4)

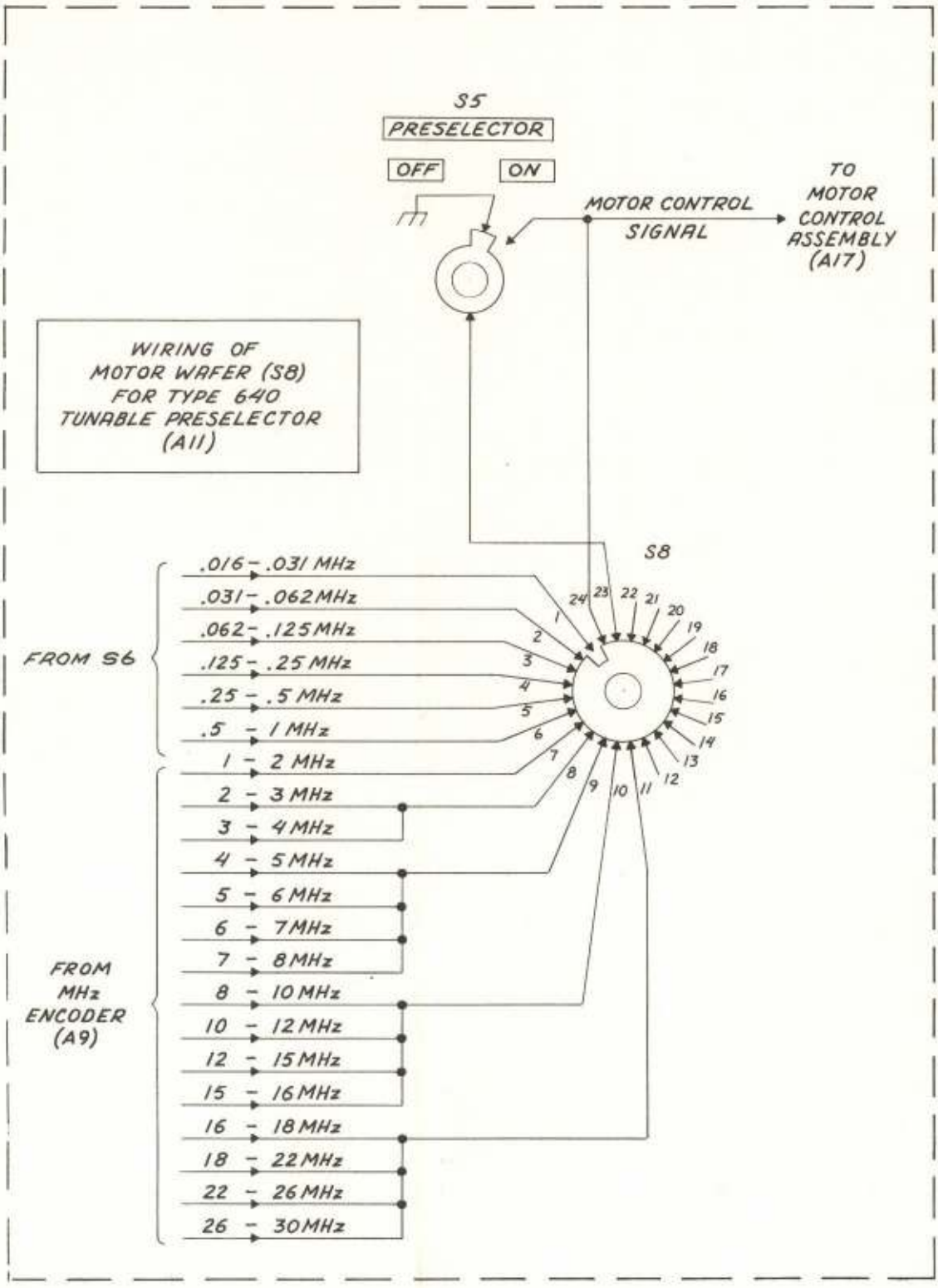
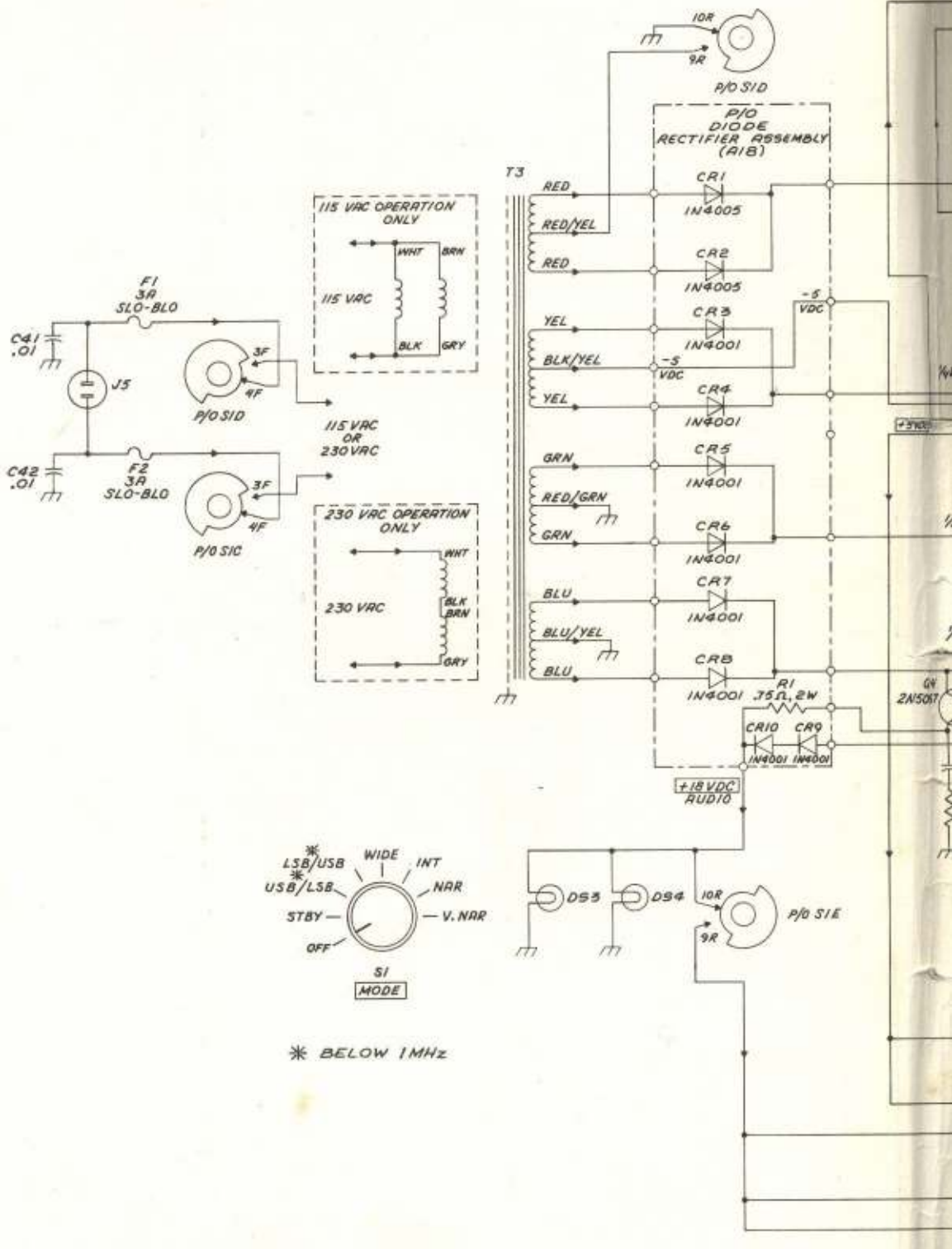


Figure 5-7. HRO-600 Main Frame Assembly, Servicing Block Diagram (Sheet 3 of 4)


10R
9R
P/O S1D
P/O
DIODE
RECTIFIER ASSEMBLY
(A18)
T3
RED
RED/YEL
RED
YEL
BLK/YEL
YEL
GRN
RED/GRN
GRN
BLU
BLU/YEL
BLU
CR1
IN4005
CR2
IN4005
CR3
IN4001
CR4
IN4001
CR5
IN4001
CR6
IN4001
CR7
IN4001
CR8
IN4001
-5 VDC
-5 VDC
R1
.75Ω, 2W
CR10
IN4001
CR9
IN4001
+18 VDC
AUDIO
115 VAC OPERATION ONLY
WHT
BRN
115 VAC
BLK
GRY
230 VAC OPERATION ONLY
WHT
BLK
BRN
230 VAC
GRY
F1
3A
SLO-BLO
C41
.01
J5
3F
4F
P/O S1D
115 VAC
OR
230 VAC
C42
.01
F2
3A
SLO-BLO
3F
4F
P/O S1C
LSB/USB
USB/LSB
WIDE
INT
NAR
V. NAR
STBY
OFF
S1
MODE
DS3
DS4
10R
9R
P/O S1E
Q4
2N5067
* BELOW 1 MHz

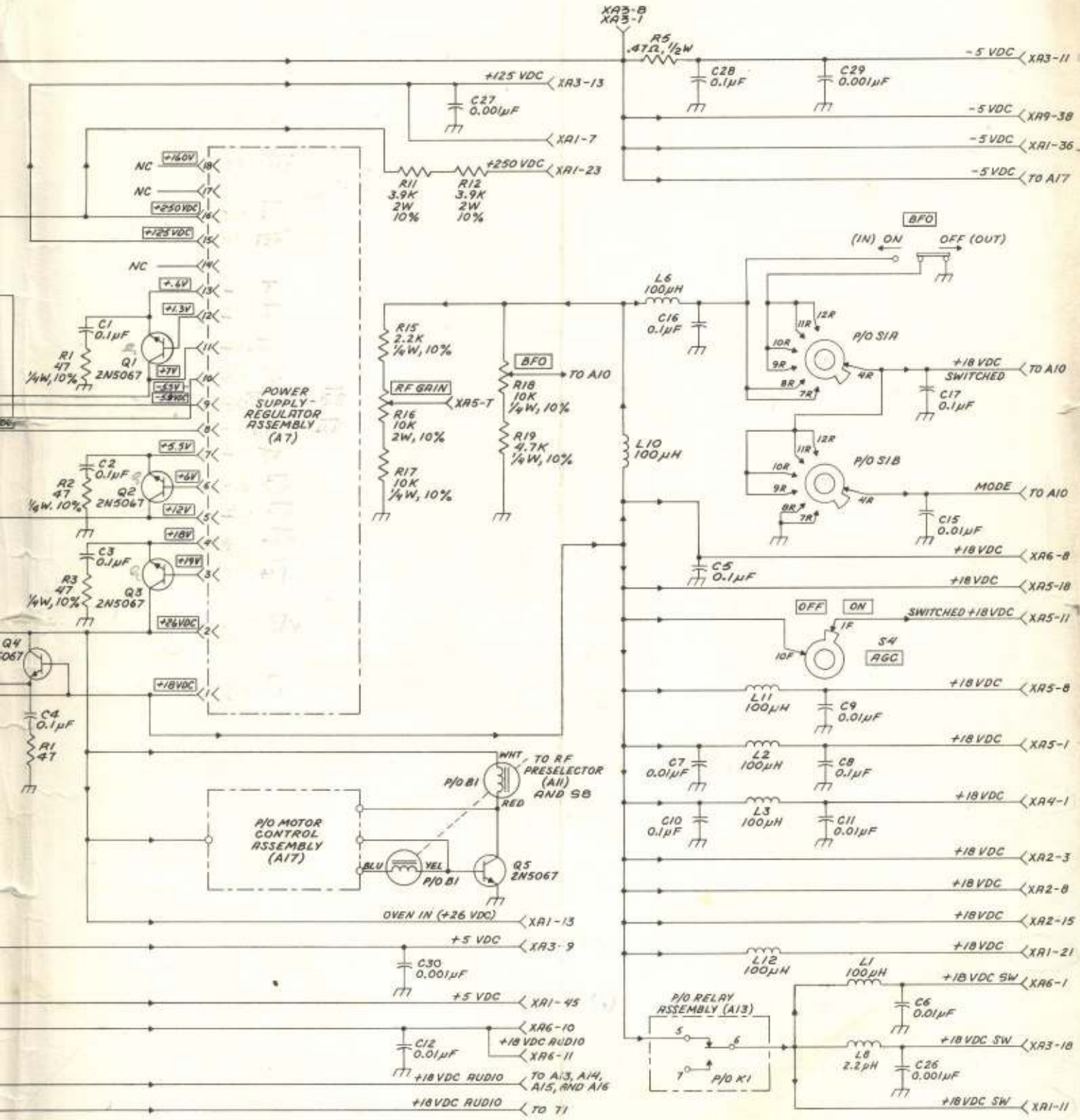


Figure 5-7. HRO-600 Main Frame Assembly, Servicing Block Diagram (Sheet 4 of 4)

SECTION 6

PARTS LIST

6.1 INTRODUCTION

This parts list identifies all assemblies, subassemblies and chassis-mounted components of maintenance significance for the Main Frame Assembly of the National Radio Company, Inc., (NRCI) manufactured Radio Receiving Set HRO-600. The parts list for major accessories used with the HRO-600 are contained within supplementary technical manuals.

6.2 PARTS LIST

Ref. Des.	Name and Identification	Fig. No.
	Receiver Assy: NRCI dwg A48177G1	1-1
A1	Frequency Control Assy, VFO: NRCI dwg A48100G1	5-3
A2	Front End PC Board: NRCI dwg D48300G1	5-3
A3	MHz Synthesizer PC Board: NRCI dwg D48448G1	5-3
A4	2nd Mixer PC Board: NRCI dwg D48079G1	5-3
A5	2nd IF/AGC PC Board: NRCI dwg D48295G1	5-3
A6	2nd INJ/AF Amplifier PC Board: NRCI dwg D48078G1	5-3
A7	Power Supply & Filter Assy: NRCI dwg C48223G1	5-3
A7A1	PC Board: NRCI dwg D48298G1	5-1
A7A2	Component Board: NRCI dwg D48217G1	5-1
A11	Tunable Preselector PC Board: NRCI dwg E48360G1	5-3
	Chassis Assy: NRCI dwg A48451G1	
A8	Not Used (Optional Equipment)	
A9	MHz Encoder PC Board: NRCI dwg E48289G1	5-1
A10	BFO & Prod Det PC Board: NRCI dwg C48284G1	5-2

Ref. Des.	Name and Identification	Fig. No.
A12	Speaker Amplifier PC Board: NRCI dwg C48543G1	5-3
A13	Relay Assy: NRCI dwg A48429G1	5-2
A14	Relay Assy: NRCI dwg A48429G2	5-2
A15	Relay Assy: NRCI dwg A48429G3	5-2
A16	Relay Assy: NRCI dwg A48429G4	5-2
A17	Motor Control Assy: NRCI dwg B48495G1	5-2
A18	Diode Assy: NRCI dwg B48496G1	5-2
A19	Low Pass Filter Assy: NRCI dwg B48570G1	5-2
B1	Motor: NRCI dwg A48507-1	5-1
C1 thru 4	Capacitor: Erie type 5815-000Y5U0104Z	2-1*
C5, 8, 10, 14, 16, 17, 25, 28, 36, 37		5-2
C6, 7, 9, 11, 12, 13, 15	Capacitor: Erie type 805-000-X5V0103Z	5-2
43, 44, 47 thru 55,		2-1*
C18	Capacitor: Preselector tuner	5-1
C19, 20, 22	Capacitor: MIL type DM10C100J0500WV4CR	5-1
C21	Capacitor: Erie type 538002A	5-1
C23, 24	Not Used	
C26, 27, 29 thru 35	Capacitor: Erie type 801-000-X5F0102K	5-2
C38 thru 40	Not Used	
C41, 42, 45, 46	Capacitor: Erie type 811-000-Z54-103M	2-1*
CR1, 2	Not Used	
CR3, 4	Semiconductor: MIL type 1N3064	5-2
DS1, 2	Lamp: Type 509	2-1
DS3, 4	Lamp: NRCI dwg A48241	5-1
F1, 2	Fuse: Littlefuse type 3AG	2-1
FL1	Filter: NRCI dwg A48506-6	5-1
FL2	Filter: NRCI dwg A48506-5	5-1
FL3	Filter: NRCI dwg A48506-4	5-1
FL4	Filter: NRCI dwg A48506-3	5-1
FL5	Filter: NRCI dwg A48506-2	5-1
FL6	Filter: NRCI dwg C48434G1	5-2
FL7	Filter: NRCI dwg C48461G1	5-2
FL8	Filter: NRCI dwg C48434G2	5-2
FL9	Filter: NRCI dwg C48519G2	5-2
FL10	Filter: NRCI dwg C48540G1	5-1
J1 thru 4	Connector: NRCI dwg A51084	2-1
J5	Connector: NRCI dwg A51081	2-1

* Located behind rear panel

Ref. Des	Name and Identification	Fig. No.
J6, 7	Not Used	
J8	Connector: NRCI dwg A51479-1	2-1
J9	Not Used	
J10	Connector: NRCI dwg A50793-3	3-1
L1 thru 7, 10, 11, 12	Choke: NRCI dwg R1550-37	5-2
L8	Choke: NRCI dwg R1550-17	5-2
L9	Choke: NRCI dwg C48304-33	5-2
LS1	Speaker: NRCI dwg A48166-1	5-1
M1	Meter: NRCI dwg A48487-1	3-1
Q1 thru 5	Transistor: MIL type 2N5067	5-1
R1 thru 4,	Resistor: MIL type RC07GF470K	2-1*
R20		5-2
R5	Resistor: MIL type RC20GFR47K	5-2
R6, 8	Resistor: MIL type RC42GF680K	5-1
R7	Resistor: MIL type RC42GF271K	5-1
R9	Resistor: 10K Linear	3-1
R10	Resistor: MIL type RV6NAYSD502A	3-1
R11, 12	Resistor: MIL type RC42GF392K	5-2
R13, 14	Not Used	
R15, 22	Resistor: MIL type RC07GF222K	5-1, 5-2
R16	Part of S4	3-1
R17	Resistor: MIL type RC07GF103K	5-2
R18	Resistor: NRCI dwg B52586-2	3-1
R19	Resistor: MIL type RC07GF472K	5-2
R21	Not Used	
R23	Resistor: 5K trimmer	5-3
S1	Switch: NRCI dwg A48453-1	3-1
S2, 3	Switch: NRCI dwg A48227-1	3-1
S4	Switch: NRCI dwg A48453-1	3-1
S5	Switch: NRCI dwg A48445-1	3-1
S6	Switch Assy: NRCI dwg B48463G1	5-2
S7, 10	Switch: type 12SM4	5-2
S8	Switch: NRCI dwg A48454-1	5-2
S9	Switch: NRCI dwg A48227-1	5-1
T1	Transformer: NRCI dwg A48231-1	5-2
T2	Transformer: Thordarson type TR1	5-2
T3	Transformer: NRCI dwg D48191-1	5-3
TB1, 2	Terminal Board: Alcom Metal type 4-3028	2-1
XA1	Connector: NRCI dwg A48233-2	5-2
XA2 thru 8	Connector: Amphenol type 225-21821-101	5-2
XA9, 10	Not Used	
XA11	Connector: Amphenol type 133-010-21	5-2
XDS1, 2	Lampholder: Leecraft type 10-13	2-1
XDS3, 4	Lampholder: NRCI dwg A48240-1	5-1
XF1, 2	Fuseholder: NRCI dwg A48224-1	2-1

* Located behind rear panel

TECHNICAL MANUAL

TYPE 601 VFO (SEARCH)
FREQUENCY CONTROL PLUG-IN

MANUSCRIPT

TECHNICAL MANUAL

TABLE OF CONTENTS

TABLE OF CONTENTS (Cont)

LIST OF ILLUSTRATIONS

LIST OF TABLES

SECTION 1

GENERAL INFORMATION

1.1 INTRODUCTION

This technical manual provides general information, installation and operating instructions, and a listing of assemblies and chassis-mounted components of maintenance significance for the Type 601 VFO (Search) Frequency Control Plug-In Unit, a major accessory of Radio Receiving Set HRO-600. It supplements the basic technical manual for the Main Frame Assembly of Radio Receiving Set HRO-600.

1.2 DESCRIPTION

The Type 601 VFO Frequency Control Plug-In Unit is specifically designed to convert the HRO-600 main frame assembly into a high performance search receiver. This plug-in unit is inserted into the main frame through an opening in the front panel of the main frame. The front panel of the plug-in unit contains its associated operating controls, and completes the receiver front panel.

The Type 601 contains a highly stable VFO, a crystal oscillator employed as the frequency standard for the receiver, and a frequency counter and display. The VFO operates in the frequency range from 5-4 MHz, and exhibits a frequency extension of more than 5 percent at each end of the range to provide tuning-band overlap.

The frequency counter is of integrated circuit design. Its time base is derived from the internal standard. The in-line frequency display is of the received frequency, and is derived from an offset

count of the VFO frequency. Four digits of frequency are displayed by the Type 601. These are the hundreds, tens, units, and tenths of kHz. (A two-digit MHz display on the front panel of the main frame is controlled by the MHz SELECT control.) Positive indication of operation in the overlap regions is provided by two lamps on the plug-in unit panel, which are activated by overflow from the counter. The display employs ordinary gas-discharge tubes.

The main tuning control employs a system of very smooth, self-adjusting, ball drives. The tuning knob is of large diameter. This, coupled with a fly-wheel on the main tuning shaft, provides for effortless search tuning in applications requiring continuous tuning.

The tuning ratio may be changed by the operator from approximately 5 kHz per turn to approximately 300 kHz per turn to permit rapid scanning from one end of each 1 MHz tuning band to the other. This is accomplished by means of a detented clutch arrangement, which is activated by pulling the main tuning knob. A lock on the main tuning shaft prevents accidental detuning during operation at a fixed frequency. A separate FINE TUNE control is provided for use in very critical tuning applications. This control provides 200 to 300 Hz of adjustment throughout 180 degrees of rotation.

The internal crystal oscillator may be accurately calibrated against an external frequency standard, through use of the meter on the main-frame panel as a calibration indicator. The frequency stability of the receiver, with the Type 601 frequency control unit installed, is better than 1000 Hz throughout the temperature range of 0°C to +50°C.

The Type 601 Frequency Control Plug-In Unit is shown in Figure 1-1.

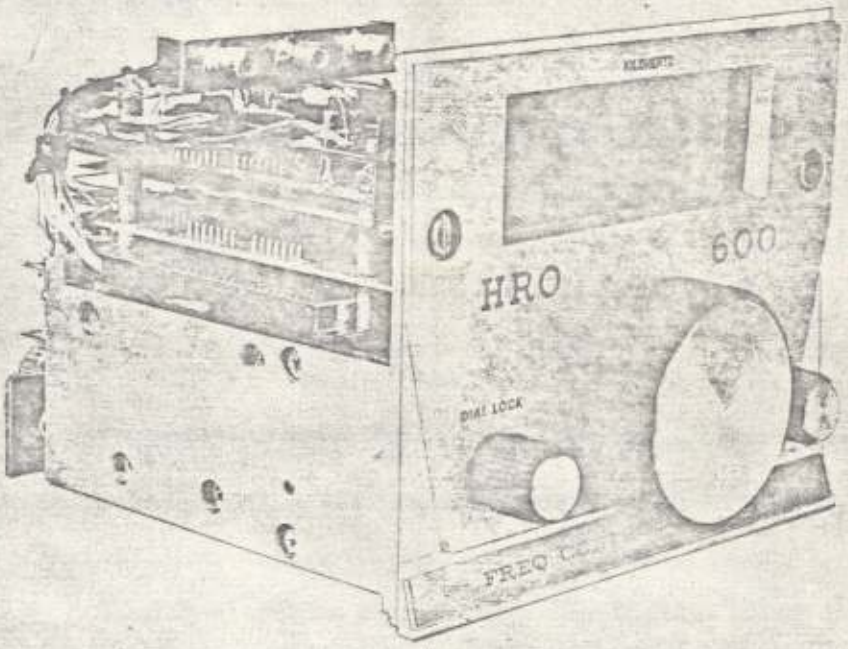


Figure 1-1. Type 601 VFO (Search) Frequency Control Plug-In Unit, Oblique View

SECTION 2

INSTALLATION

2.1 INTRODUCTION

The following paragraphs of this section describe installation procedures for the Type 601 VFO (Search) Frequency Control Plug-In Unit, a major accessory of Radio Receiving Set HRO-600. Installation procedures for the HRO-600 itself are described in the technical manual for the set.

Note

Usually, an HRO-600 is shipped from the factory with a frequency control plug-in unit installed within it, and no field installation of such a unit is required. The instructions given in this section describe installation of a frequency control plug-in unit into an HRO-600.

2.2 UNPACKING AND HANDLING

The Type 601 VFO (Search) Frequency Control Plug-In Unit is packed in accordance with best commercial practice. No special precautions are required during unpacking and handling of this unit. Normal care due to precision electronic equipment should, of course, be exercised. It is recommended that all packing material be retained for possible future use.

After unpacking the Type 601, inspect it for evidence of external damage. If damage is evident, notify and file claim with the carrier.

2.3 ENVIRONMENTAL CONSIDERATIONS

The operating temperature range of the Type 601 is -20°C (-4°F) to +55°C (+131°F). Its operating RH (relative-humidity) range is 0 percent to 95 percent.

The storage temperature range of the Type 601 is -40°C (-40°F) to +80°C (+179°F). Its storage RH (relative-humidity) range is 0 percent to 100 percent.

2.4 INSTALLATION PROCEDURE

To install the Type 601 within the HRO-600, proceed as follows:

a. Connect three color-coded coaxial cables to their respective jacks on the Type 601 Plug-In Unit.

b. Insert Type 601 through front panel of HRO-600 Main Frame Assembly and push in until front-panel screws of plug-in unit can be engaged.

c. Tighten two screws alternately, one turn at a time, until the plug-in unit is seated fully.

2.5 INSTALLATION CHECKOUT

Type 601 installation testing is conducted as part of the overall testing of the HRO-600. Installation checkout of the HRO-600 is described in the technical manual for the set.

SECTION 3

OPERATION

3.1 INTRODUCTION

The following paragraphs of this section describe operation procedures for the Type 601 VFO (Search) Frequency Control Plug-In Unit, a major accessory of Radio Receiving Set HRO-600. These procedures supplement the operation procedures described in the technical manual for the set.

3.2 OPERATING CONTROLS AND INDICATORS

A front panel view of a Type 601 VFO (Search) Frequency Control Plug-In Unit is shown in Figure 3-1. Table 3-1 specifies the functions

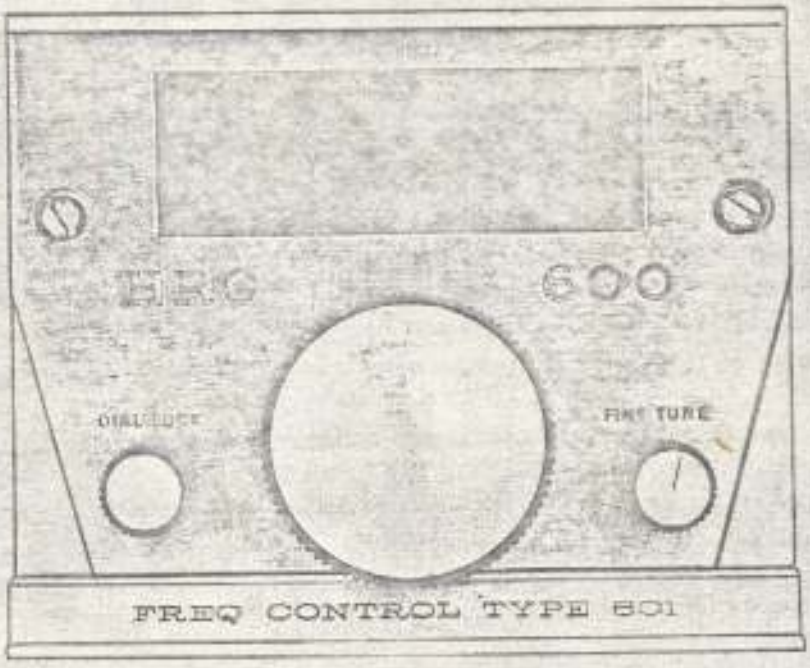


Figure 3-1. Type 601 VFO (Search) Frequency Control Plug-In Unit, Front View

and, as applicable, the initial control settings for all controls and indicators located on the front panel of the Type 601. The functions and, as applicable, the initial control settings for all controls and indicators located on the Main Frame Assembly of the HRO-600 are specified in the technical manual for the set.

TABLE 3-1. TYPE 601 VFO (SEARCH) FREQUENCY CONTROL PLUG-IN UNIT, OPERATING CONTROLS AND INDICATORS

Control or Indicator	Function(s)	Initial Control Setting
kHz Display	Displays hundred, tens, units, and tenths kHz digits of frequency to which receiver is tuned. Indicates band-overlap conditions by means of + (plus) and - (minus) indicators.	Not Applicable
DIAL LOCK Control	Locks main tuning dial when rotated fully clockwise.	Fully Clockwise
FINE TUNE Control	Varies frequency to which receiver is tuned 200 to 300 Hz when rotated through 180 degrees	Immaterial
Main Tuning Dial	Varies frequency to which receiver is tuned approximately 5 kHz per turn when pushed in and approximately 300 kHz per turn when pulled out.	Immaterial

3.3 OPERATING INSTRUCTIONS

3.3.1 General

The following paragraphs provide operating instructions for the Type 601 VFO (Search) Frequency Control Plug-In Unit. These instructions supplement the instructions in the technical manual for the set.

3.3.2 Start-Up

The Type 601 is started from the Main Frame Assembly of the HRO-600, as described in the technical manual for the set. Start-up of the HRO-600 automatically starts the Type 601.

Note

To achieve its rated frequency accuracy and stability specifications, the Type 601 requires a warm-up period of 30 minutes.

3.3.3 Tuning

To unlock main tuning dial, rotate DIAL LOCK control fully counterclockwise; to lock main tuning dial, rotate DIAL LOCK control fully clockwise.

Note

DIAL LOCK control exercises no effect on FINE TUNE control.

Use main tuning dial to set hundreds, tens, units, and tenths kHz digits of frequency to which receiver is tuned. When pulled out, main tuning dial varies frequency approximately 300 kHz per rotation; when pushed in, main tuning dial varies frequency approximately 5 kHz per rotation. Use FINE TUNE control as necessary to tune to desired frequency. This control varies frequency 200 Hz to 300 Hz for 180 degrees of rotation.

Monitor hundreds, tens, units, and tenths kHz digits of frequency to which receiver is tuned by observing kHz display.

Monitor presence or absence of band-overlap condition by observing kHz display. Illumination of + (plus) indicator signifies that 1 MHz must be added to tens/units MHz reading (0 through 29) of MHz indicator on front panel of Main Frame Assembly, in order to obtain frequency to which receiver is tuned. (For each of six bands below 1 MHz, tens/units MHz reading is, of course, 0.) Illumination of - (minus) indicator signifies that 1 MHz must be subtracted from tens/units MHz reading (0 through 29) of MHz indicator on front panel of Main Frame Assembly, in order to obtain frequency to which receiver is tuned. With regard to the rf preselection, no band-overlap operation is possible for five bands below 0.5 MHz, only positive (+) band-overlap operation is possible for .5-1 MHz band, and both positive (+) and negative (-) band-overlap operation is possible for 29 bands above 1 MHz. If no rf preselection is employed (that is, when PRESELECTOR control on front panel of Main Frame Assembly is in OFF position), only positive (+) band-overlap operation is possible for "six" bands below 1 MHz, and both positive (+) and negative (-) band-overlap operation is possible for 29 bands above 1 MHz. Nominal band-overlap frequency range is 100 kHz.

3.3.4 Shutdown

The Type 601 is shut down from the Main Frame Assembly of the HRO-600, as described in the technical manual for the set. Shutdown of the HRO-600 automatically shuts down the Type 601.

SECTION 4

THEORY OF OPERATION

4.1 INTRODUCTION

The following paragraphs of this section present the theory of operation for the Type 601 VFO (Search) Frequency Control Plug-In Unit, a major accessory of Radio Receiving Set HRO-600. The theory of operation for the HRO-600 itself is given in the technical manual for the set. The following discussion is based upon the servicing block diagram shown in Figure 5-4 of Section 5.

4.2 DISCUSSION

The Type 601 provides 5-4 MHz, 45 MHz, 5 MHz FIXED BFO, and 5 MHz ECL (emitter coupled logic) inputs for the injection circuits of the HRO-600 Main Frame Assembly. During test or calibration of its internal frequency standard, it also produces a CAL OUT signal for the metering circuit of the HRO-600 Main Frame Assembly, in response to its EXT STD IN reference. (The EXT STD IN reference is obtained from an external frequency standard, and is routed through the Main Frame Assembly to the Type 601.) Six dc power inputs (+18 VDC SW, OVEN IN (+26 VDC), +18 VDC, +250 VDC, -5 VDC, and +5 VDC) obtained from the Main Frame Assembly provide all operating power required by the Type 601.

The VFO and buffer assembly (A1A3) and the associated tuning capacitors produce the 5-4 MHz output for the Main Frame Assembly. By means of the main tuning dial and the FINE TUNE control on the

front panel of the Type 601, its 5-4 MHz VFO output can be varied in a continuous manner throughout its range and at least ±10 percent beyond. The front-panel DIAL LOCK control is used to lock and unlock the main tuning dial. However, it exercises no effect on the FINE TUNE control.

The frequency generator assembly (A1A2) produces the 45 MHz, 5 MHz FIXED BFO, and 5 MHz ECL outputs for the Main Frame Assembly. It also accepts the EXT STD IN reference and produces the CAL OUT signal during test and calibration of its internal frequency standard. When a 5-MHz external standard is employed, the frequency of the CAL OUT signal is equal to the difference between internally and externally generated 5-MHz frequencies. If a 1-MHz external standard is used, the frequency of the CAL OUT signal is equal to the difference between the internally generated 5-MHz frequency and the fifth harmonic (5 MHz) of the externally generated 5-MHz frequency. The internal frequency standard is controlled by an oven-enclosed crystal.

The counter/display driver assembly (A1A1) obtains a 5-4 MHz VFO input from the counter buffer assembly (A1A4) and a 100 kHz reference input from the frequency generator assembly (A1A2). In response to these inputs, it produces the 40 signal outputs, the fixed decimal-point (dp) output, and the eight STROBED B+ power outputs required by the front-panel kHz display (A1V1 through A1V4). Gas-discharge tubes V1 through V4 display the hundreds, tens, units, and tenths kHz digits of the frequency to which the receiver is tuned.

The counter/display driver assembly (A1A1) also provides the RESET and COUNT outputs required by the over/under detector of the frequency generator assembly (A1A2), and the STROBED B+ power output required by the front-panel over/under (+/-) display (A1DS1/A1DS2). Frequency generator assembly A1A2 provides the two signal

inputs required by the +/- display. Illumination of the + indicator signifies that 1 MHz must be added to the tens/units MHz reading (0 through 29) of the MHz indicator on the front panel of the Main Frame Assembly, in order to obtain the frequency to which the receiver is tuned. (For each of the six bands below 1 MHz, the tens/units MHz reading is, of course, 0.) Illumination of the - indicator signifies that 1 MHz must be subtracted from the tens/units MHz reading (0 through 29) of the MHz indicator on the front panel of the Main Frame Assembly, in order to obtain the frequency to which the receiver is tuned.

Within the Type 601, the six dc power supply inputs (+18 VDC SW, OVEN IN (+26 VDC), +18 VDC, +250 VDC, -5 VDC, and +5 VDC) obtained from the Main Frame Assembly are decoupled by A4C4 through A4C15 and A4L2 through A4L7. Counter/display driver A1A1 makes use of the decoupled +5 VDC and +250 VDC power inputs. Frequency generator assembly A1A2 makes use of the decoupled +18 VDC, OVEN IN (+18 VDC), +18 VDC SW, +5 VDC, and -5 VDC power inputs. Buffer assemblies make use of the decoupled +18 VDC power input. The VFO obtains a +10V supply from a zener diode on the VFO buffer assembly.

SECTION 5

MAINTENANCE

5.1 INTRODUCTION

The following paragraphs of this section describe maintenance procedures for the Type 601 VFO (Search) Frequency Control Plug-In Unit, a major accessory of Radio Receiving Set HRO-600. Maintenance procedures for the HRO-600 itself are described in the technical manual for the set.

5.2 ALIGNMENT

5.2.1 General

Alignment of the Type 601 consists of calibration of its frequency standard. Locations of internal controls are shown in Figure 5-1. To obtain access to these controls while the Type 601 is electrically connected to the HRO-600 Main Frame Assembly, a test cable is required. This test cable is part of Maintenance Kit MK-1, available from National Radio Company, Inc.

5.2.2 Frequency-Standard Calibration

5.2.2.1 General

Two basic techniques are available for calibrating the internal frequency standard of the Type 601. One makes use of an external 1 MHz or 5 MHz frequency standard with a frequency accuracy of 1 pp 10^8 or better and an output level of 1 vac rms, and the built-in

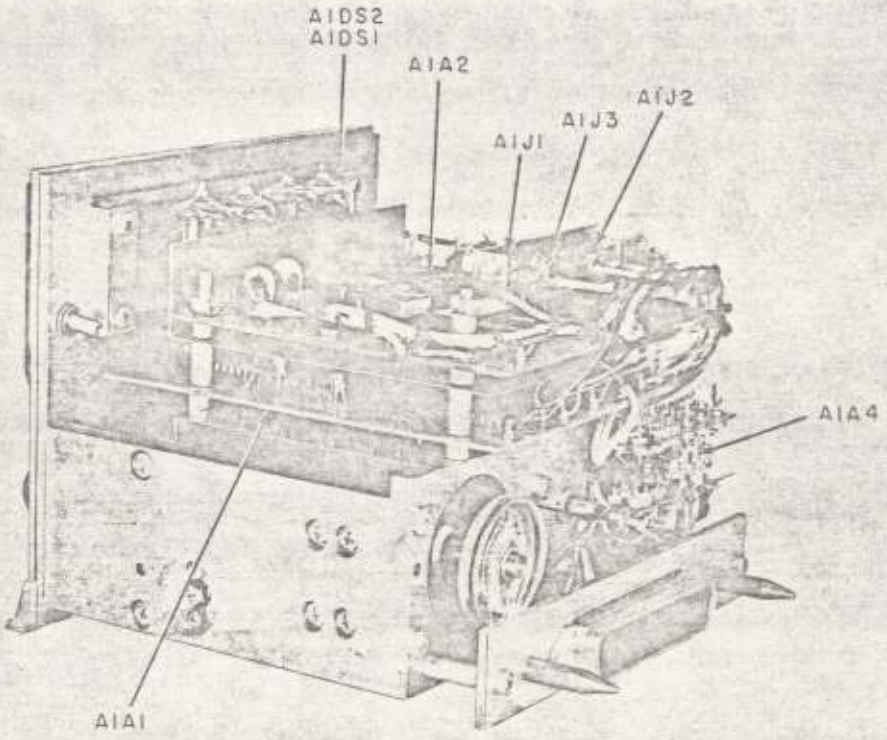


Figure 5-1. Location of Internal Controls

calibration circuitry of the basic HRO-600 and the Type 601. (If a choice between a 1 MHz and a 5 MHz external frequency standard is available, use of the 5 MHz standard is recommended.) The other makes use of the WWV transmission, and the receiving circuits of the basic HRO-600 and the Type 601. Since the latter technique is dependent upon the readout resolution (±50 Hz) of the Type 601 whereas the former is not, the former technique is more accurate. For this reason, the former technique is recommended whenever a suitable external frequency standard is available.

5.2.2.2 Calibration With External Frequency Standard

To calibrate the internal frequency standard of the Type 601 against an external frequency standard, proceed as follows:

a. Connect external frequency standard to terminal J2-1 on rear panel of HRO-600 Main Frame Assembly.

b. Depress METER CAL selection pushbutton on front panel of HRO-600 Main Frame Assembly.

c. Set up HRO-600 for reception of radio transmission or of output from signal generator or audio oscillator. (Refer to installation and operating instructions in Sections 2 and 3, respectively, of both this technical manual and technical manual for basic HRO-600.)

d. Rotate inductor A1A2L1 on frequency generator assembly (A1A2) counterclockwise until reception is lost. Note and record A1A2L1 setting.

Note

Loss of reception signifies that range of internal crystal frequency standard has been exceeded, and that this standard has ceased to oscillate.

e. Rotate inductor A1A2L1 on frequency generator assembly (A1A2) clockwise until reception is regained and then lost again. Note and record A1A2L1 setting.

f. Set inductor A1A2L1 on frequency generator assembly (A1A2) mid-way between settings recorded during performance of preceding steps d and e.

g. Alternately adjust capacitor A1A2C2 (and, if necessary, slightly readjust inductor A1A2L1 to allow enough A1A2C2 adjustment range) on frequency generator assembly (A1A2) for maximum period of oscillation, as indicated by reading of LEVEL meter on front panel of Main Frame Assembly. Period of oscillation (one swing back and forth of meter pointer) should be 1 second or greater.

h. Disconnect external frequency standard from terminal J2-1 on rear panel of HRO-600 Main Frame Assembly.

5.2.2.3 Calibration With WWV Transmission

To calibrate the internal frequency standard of the Type 601 against the WWV transmission, proceed as follows:

a. Connect 600Ω terminals of TB1 on rear panel of Main Frame Assembly to vertical input of oscilloscope.

b. Set oscilloscope for external sweep, and connect output from audio oscillator (external to HRO-600) to horizontal input of oscilloscope.

c. Set up HRO-600 for reception of highest-frequency (5, 10, 15, 20, 25, or 30 MHz) WWV transmission that can be detected readily. (Refer to installation and operating instructions in Sections 2 and 3, respectively, of both this technical manual and technical manual for basic HRO-600.)

d. Rotate inductor A1A2L1 on frequency generator assembly (A1A2) counterclockwise until reception is lost. Note and record A1A2L1 setting.

Note

Loss of reception signifies that range of internal crystal frequency standard has been exceeded, and that this standard has ceased to oscillate.

e. Rotate inductor A1A2L1 on frequency generator assembly (A1A2) clockwise until reception is regained and then lost again. Note and record A1A2L1 setting.

f. Set inductor A1A2L1 on frequency generator assembly (A1A2) mid-way between settings recorded during performance of preceding steps d and e.

g. Set audio oscillator for output of 1 Hz.

Note

During performance of following step h, adjust horizontal and vertical gain controls of oscilloscope as necessary to obtain circular oscilloscope presentation.

h. Alternately adjust capacitor A1A2C2 (and, if necessary, slightly readjust inductor A1A2L1 to allow enough A1A2C2 adjustment range) on frequency generator assembly (A1A2) for circular presentations. Circular presentation indicates that audio output frequency from HRO-600 is equal to audio output frequency (1 Hz) from external audio oscillator.

i. Disconnect vertical input of oscilloscope from 600Ω terminals of TB1 on rear panel of Main Frame Assembly.

j. Disconnect horizontal input of oscilloscope from output of audio oscillator.

5.2.3 Tank - Circuit Alignment

There is no alignment of the tank circuit required. The only adjustment required is for temperature compensation. This adjustment should be made only under controlled environmental conditions in a temperature-controlled chamber. No adjustment is necessary unless major parts replacement has been made in the VFO assembly.

5.3 TROUBLESHOOTING

Field troubleshooting of the Type 601 consists of isolating a trouble to a defective assembly, to a defective chassis or panel component, or to defective wiring. The Type 601 contains five assemblies: the counter/display driver assembly (A1); the frequency generator assembly (A2); and the VFO, VFO buffer, and counter buffer assembly. Whenever any of these assemblies is found to be defective, it should be returned to National Radio Company, Inc., or to the Company's authorized representative, for troubleshooting and repair.

To troubleshoot the Type 601, remove it from the front panel of the HRO-600 Main Frame Assembly, and reconnect it to the Main Frame Assembly with the test cable assembly. The basic troubleshooting references provided in this technical manual are the servicing block diagram of Figure 5-4 and the parts-location illustrations of Figures 5-1 and 5-2. A thorough knowledge of the theory of operation presented in Section 4 of this technical manual is highly desirable (if not absolutely essential) for effective troubleshooting. (The theoretical discussion is also referenced to Figure 5-4.) Refer to Section 4 as necessary during performance of troubleshooting procedures.

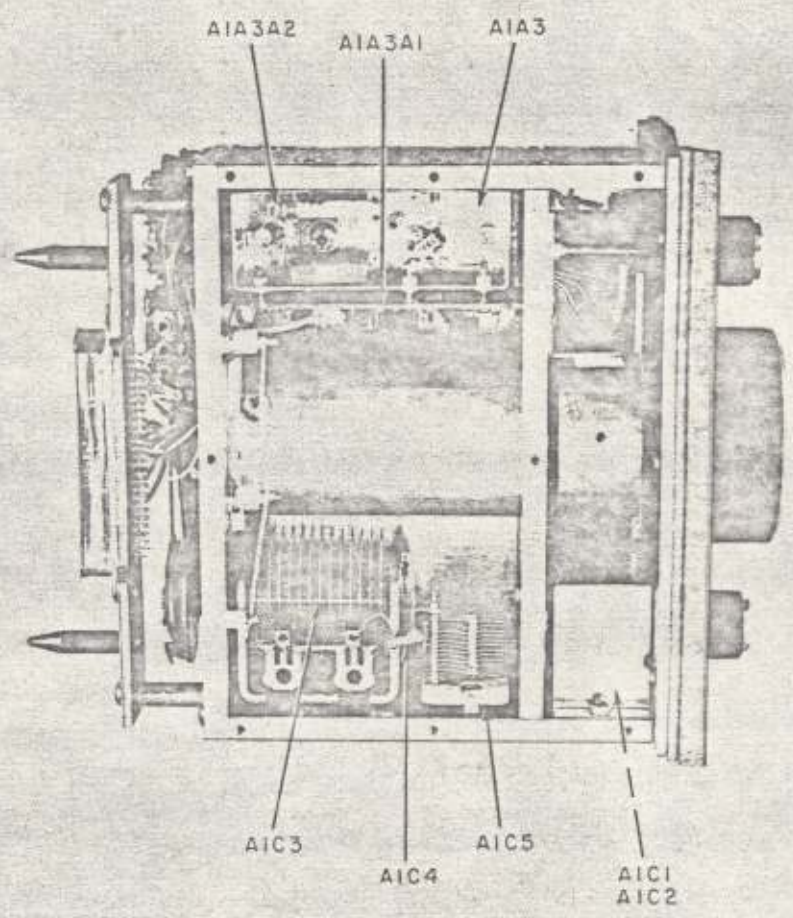
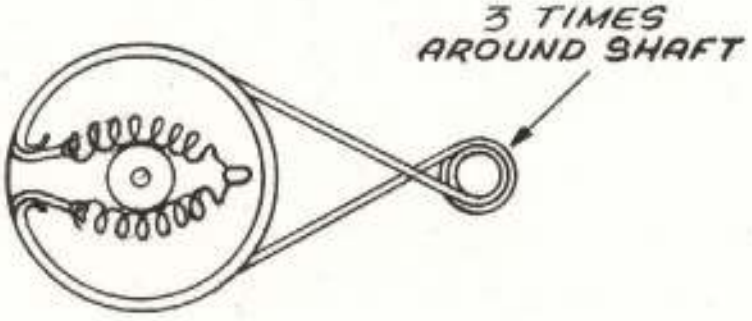


Figure 5-2. Locations of Key Components



STRING ROUTING WITH TUNING CAPACITOR
50% MESHED

Figure 5-3. String Drive Routing

Voltages and, where applicable, voltage waveforms are specified in Figure 5-4 for all key test points. In addition, Figure 5-4 specifies applicable tolerances, and the type(s) of test equipment required for each measurement.

To check for defective wiring (short circuits or open circuits), it will sometimes be necessary or desirable to make continuity checks with an ohmmeter. Prior to making any such checks, de-energize the Type 601 by rotating the MODE switch on the front panel of the Main Frame Assembly to the OFF position.

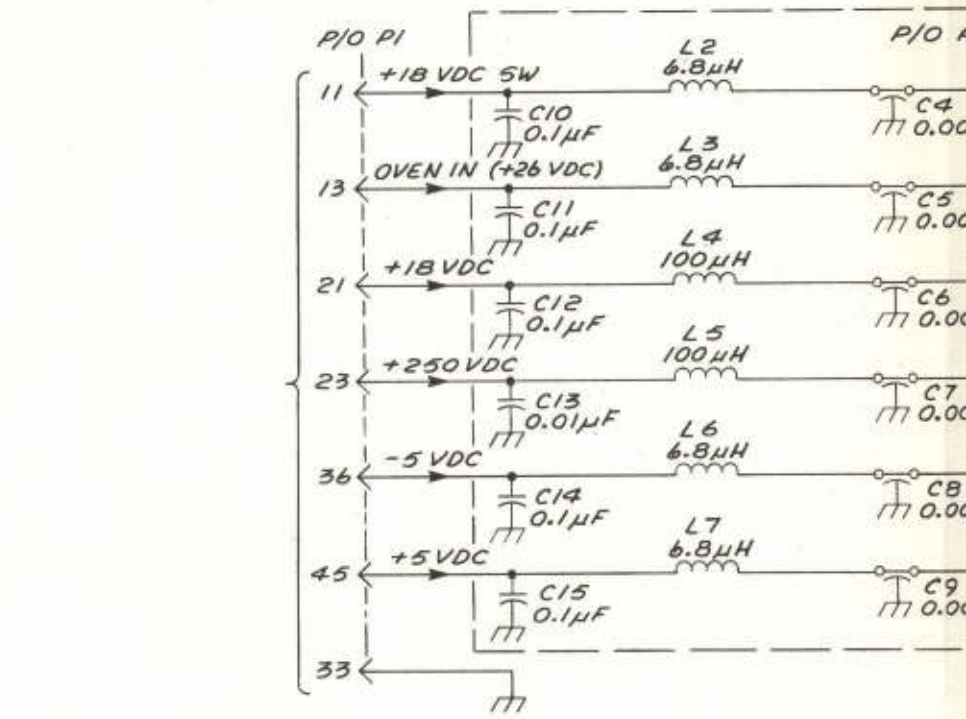
In some cases, a trouble may be due to misalignment of the Type 601. Alignment procedures are given in paragraph 5.2.

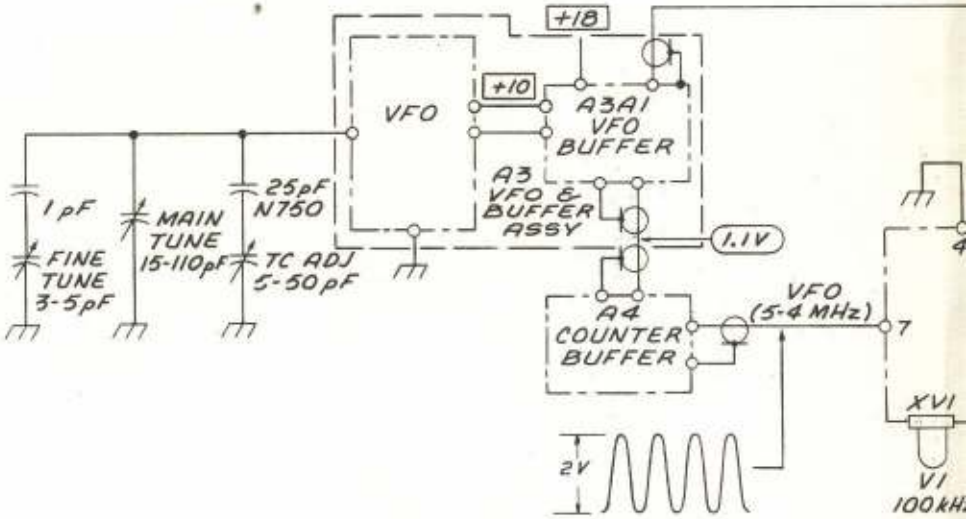
Repair of the Type 601 is discussed in paragraph 5.4.

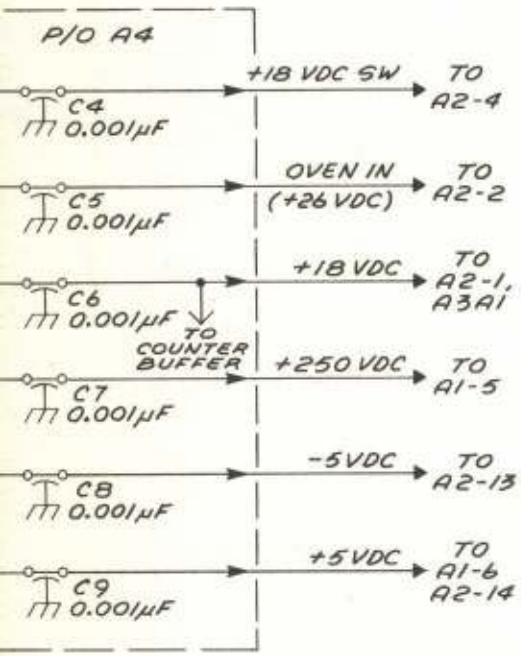
5.4 REPAIR

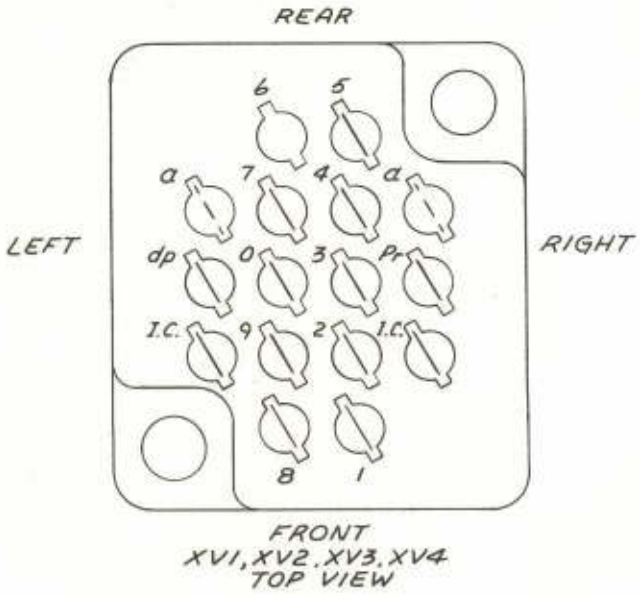
Field repair procedures applicable to the Type 601 involve straightforward removal and replacement of electrical components and electronic assemblies, and correction of defective wiring. To facilitate replacement, tag all disconnected leads whenever the counter/display driver assembly (A1), the frequency generator assembly (A2), the VFO, or the buffer assembly is removed. Parts-location information for the Type 601 is shown in Figures 5-1 and 5-2.

At the rear of the Type 601, a spring-loaded string drive provides mechanical coupling between the ball drive mechanism associated with the main tuning dial and the main tuning capacitor of the VFO tank circuit. To facilitate access to this string drive, the bracket on which the plug-in-unit connector is mounted should, without exertion of undue strain on the wiring, be unscrewed and moved out of the way. Correct routing of the string drive is shown in Figure 5-3.

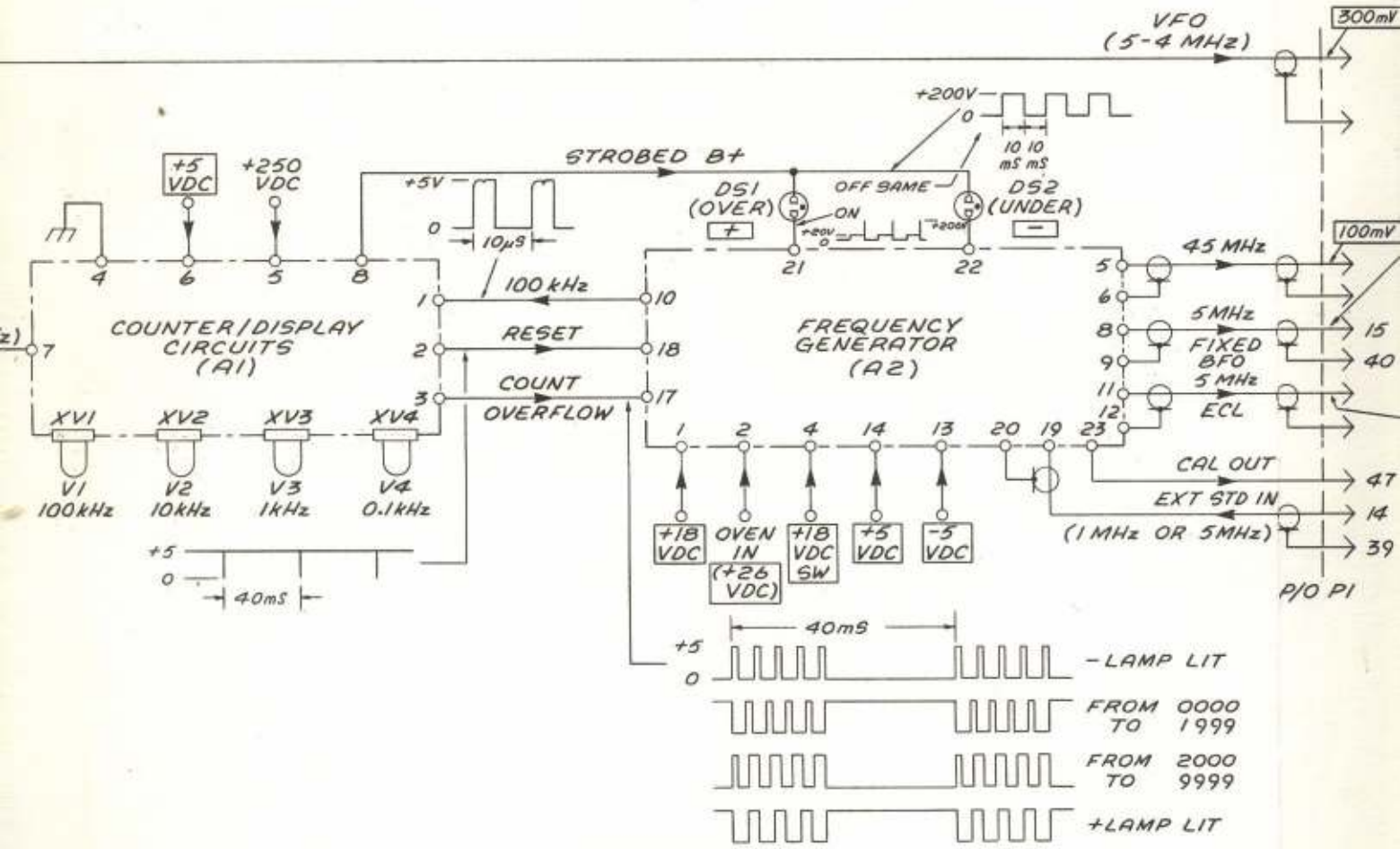

P/O P1
P/O
+18 VDC SW
OVEN IN (+26 VDC)
+18 VDC
+250 VDC
-5 VDC
+5 VDC
11
13
21
23
36
45
33
C10 0.1µF
C11 0.1µF
C12 0.1µF
C13 0.01µF
C14 0.1µF
C15 0.1µF
L2 6.8µH
L3 6.8µH
L4 100µH
L5 100µH
L6 6.8µH
L7 6.8µH
C4 0.00
C5 0.00
C6 0.00
C7 0.00
C8 0.00
C9 0.00


+18
+10
VFO
A3A1 VFO BUFFER
A3 VFO & BUFFER ASSY
1.1V
1 pF
FINE TUNE 3-5pF
MAIN TUNE 15-110pF
25pF N750
TC ADJ 5-50pF
A4 COUNTER BUFFER
VFO (5-4 MHz)
7
2V
XV1
V1
100kH





a = ANODE
dp = DECIMAL POINT
I.C. = INTERNAL CONN
Pr = PRIMER (NOT U
0-9 = CATHODES 0-9

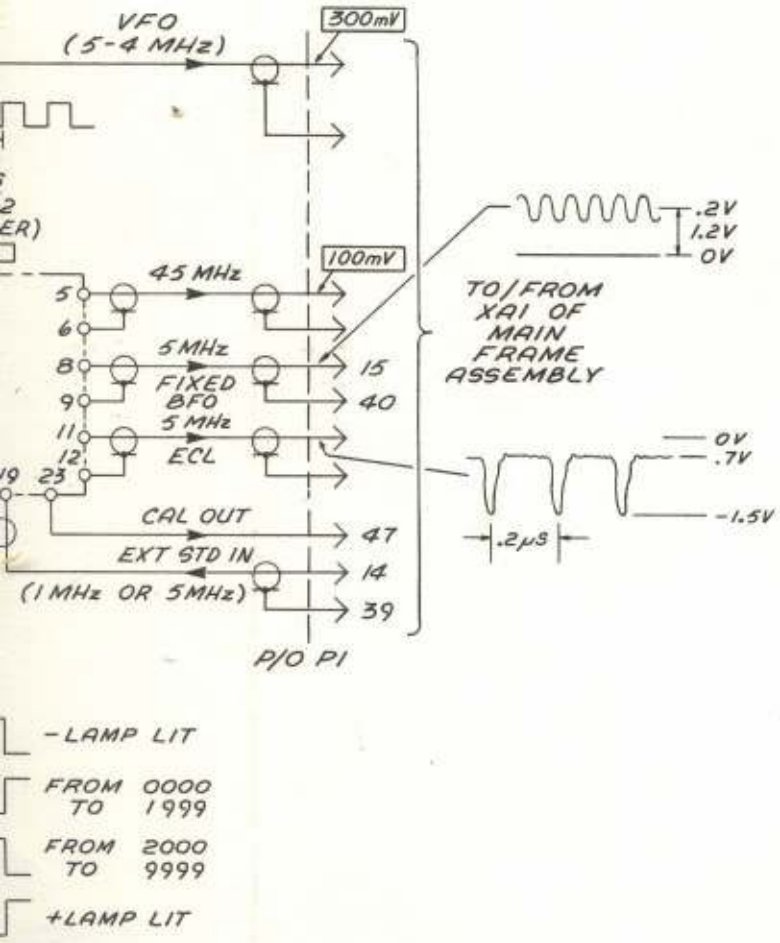


a = ANODE
dp = DECIMAL POINT
I.C. = INTERNAL CONNECTION
Pr = PRIMER (NOT USED
0-9 = CATHODES 0-9

GHT

NOTES:

1. ALL VALUES ARE APPROXIMATE.
2. A. ▭ DC MEASUREMENT MADE WITH 11 MEG Ω INPUT VTVM.
   B. ⬭ AC MEASUREMENT, HIGH IMPEDANCE PROBE UNLESS OTHERWISE INDICATED.
   AUDIO LEVELS MADE WITH AC VTVM.
   RF LEVELS MADE WITH RF VTVM.
3. WAVEFORMS TAKEN WITH 10 MEG INPUT, 100 MHz OSCILLOSCOPE.
4. VARIES WITH RECEIVER FREQUENCY.
5. WHEN INSTALLED WITHIN MAIN FRAME ASSEMBLY, REFERENCE DESIGNATION PREFIX IS A1.



-LAMP LIT
FROM 0000
TO 1999
FROM 2000
TO 9999
+LAMP LIT

Figure 5-4. Type 601 VFO (Search) Frequency Control Plug-In Unit, Servicing Block Diagram

SECTION 6

PARTS LIST

6.1 INTRODUCTION

This parts list identifies all assemblies, subassemblies and chassis mounted components of maintenance significance for the Type 601 VFO (Search) Frequency Control Plug-In Unit, a major accessory of the HRO-600 Radio Receiving Set. It supplements the parts list in the basic technical manual for the Main Frame Assembly of the HRO-600.

6.2 PARTS LIST

Ref. Des.	Name and Identification	Fig. No.
A1	Frequency Control Assy, VFO: Type 601, NRCI dwg A48100G1	1-1
A1A1	Frequency Counter Display Driver PC Board: NRCI dwg D48080G1	5-1
A1A2	Frequency Generator PC Board: NRCI dwg E48135G1	5-1
A1A3	VFO & Buffer Assy: NCRI dwg A48596G1	5-2
A1A4	Counter Buffer Assy: NRCI dwg A48589G1	5-1
A1C1	Capacitor: Type 301C0K109C	5-2
A1C2	Capacitor: Fine tune	5-2
A1C3	Capacitor: NRCI dwg C47372	5-2
A1C4	Capacitor: MIL type CC20UJ240K	5-2
A1C5	Capacitor: E. F. Johnson type 148-4	5-2
A1DS1, 2	Lamp: Alco Electric Products type PLN-100	5-1
A1J1, 2, 3	Connector: NRCI dwg A52584	5-1
A1A3A1	VFO Buffer PC Board: NRCI dwg D48436G1	5-2
A1A3A2	VFO: NRCI dwg A48588G1	5-2

TECHNICAL MANUAL

TYPE 602 SYNTHESIZER
FREQUENCY CONTROL PLUG-IN

MANUSCRIPT

SECTION 1

GENERAL INFORMATION

1.1 INTRODUCTION

This technical manual provides general information, installation and operating instructions, and a listing of assemblies and chassis-mounted components of maintenance significance for the Type 602 Synthesizer Frequency Control Plug-In Unit, a major accessory of Radio Receiving Set HRO-600. It supplements the basic technical manual for the Main Frame Assembly of Radio Receiving Set HRO-600.

1.2 DESCRIPTION

The Type 602 Synthesizer Frequency Control Plug-in is specifically designed to convert the HRO-600 main frame assembly into a high performance synthesized receiver. This plug-in unit is inserted into the main frame through an opening in the front panel of the main frame. The front panel of the plug-in unit contains its associated operating controls, and completes the receiver front panel.

The Type 602 contains a highly stable 5 MHz temperature compensated crystal oscillator employed as the frequency standard for the receiver, and a phase-locked oscillator which generates 5 MHz to 4.0001 MHz in 100 Hz steps in response to the settings of the front panel thumbwheel switches.

This phase-locked oscillator can also be "fine tuned" between 100 Hz points by front panel controls. There is also a circuit which permits comparison of the internal standard with an external 1 MHz or 5 MHz standard for calibration purposes. The frequency stability of the receiver, with the Type 602 Synthesizer installed, is equal to or better than +1 PPM v. s. temperature (0°C to +50°C) and v. s. time (1 year).

The Type 602 Synthesizer is shown in Figure .

SECTION 2

INSTALLATION

2.1 INTRODUCTION

The following paragraphs of this section describe installation procedures for the Type 602 Synthesizer Frequency Control Plug-In Unit, a major accessory of Radio Receiving Set HRO-600. Installation procedures for the HRO-600 itself are described in the technical manual for the set.

Note

Usually, an HRO-600 is shipped from the factory with a frequency control plug-in unit installed within it, and no field installation of such a unit is required. The instructions given in this section describe installation of a frequency control plug-in unit into an HRO-600.

2.2 UNPACKING AND HANDLING

The Type 602 Synthesizer is packed in accordance with best commercial practice. No special precautions are required during unpacking and handling of this unit. Normal care due to precision electronic equipment should, of course, be exercised. It is recommended that all packing material be retained for possible future use.

After unpacking the Type 602, inspect it for evidence of external damage. If damage is evident, notify and file claim with the carrier.

2.3 ENVIRONMENTAL CONSIDERATIONS

The operating temperature range of the Type 602 is -20°C (-4°F) to +55°C (+131° F). Its operating RH (relative-humidity) range is 0 percent to 95 percent.

The storage temperature range of the Type 602 is -40°C (-40°F) to +80° C (+179°F). Its storage RH (relative-humidity) range is 0 percent to 100 percent.

2.4 INSTALLATION PROCEDURE

To install the Type 602 within the HRO-600, proceed as follows:

a. Connect three color-coded coaxial cables to their respective jacks on the Type 602 Plug-In Unit.

b. Insert Type 602 through front panel of HRO-600 Main Frame Assembly and push in until front-panel screws of plug-in unit can be engaged.

c. Tighten two screws alternately, one turn at a time, until the plug-in unit is seated fully.

2.5 INSTALLATION CHECKOUT

Type 602 installation testing is conducted as part of the overall testing of the HRO-600. Installation checkout of the HRO-600 is described in the technical manual for the set.

SECTION 3

OPERATION

3.1 INTRODUCTION

The following paragraphs of this section describe operation procedures for the Type 602 Synthesizer Frequency Control Plug-In Unit, a major accessory of Radio Receiving Set HRO-600. These procedures supplement the operation procedures described in the technical manual for the set.

3.2 OPERATING CONTROLS

A front panel view of the Synthesizer is shown in Figure 3-1.

Figure 3-1. Type 602 Synthesizer Frequency Control Plug-In Unit, Front View

Table 3-1 specifies the functions and, as applicable, the initial control settings for all controls located on front panel of the Type 602. The functions and, as applicable, the initial control settings for all controls and indicators located on the Main Frame Assembly of the HRO-600 are specified in the technical manual for the main frame.

TABLE 3-1. TYPE 602 SYNTHESIZER FREQUENCY CONTROL PLUG-IN UNIT, OPERATING CONTROLS

Control	Function(s)	Initial Control Setting
kHz Thumb-wheel Switches	Set the hundreds, tens, units, and tenths kHz digits of frequency to which receiver is tuned (from 000.0 to 999.9).	Immaterial
FINE TUNE Enable Switch	Enable or disable the fine tune function.	OFF
FINE TUNE Control	When enabled, permits tuning between 100 Hz steps set by the thumbwheel switches.	Immaterial

3.3 OPERATING INSTRUCTIONS

3.3.1 General

The following paragraphs provide operating instructions for the Type 602 Synthesizer. These instructions supplement the instructions in the technical manual for the main frame.

3.3.2 Start-Up

The Type 602 is started from the Main Frame Assembly of the

HRO-600, as described in the technical manual for the main frame. Start-up of the HRO-600 automatically starts the Type 602.

Note

The Type 602 requires no warm-up period because no ovens are used to achieve stability.

3.3.3 Tuning

Use the thumbwheel switches to set the hundreds, tens, units and tenths kHz digits of the frequency desired. If the desired frequency is not an exact multiple of 100 Hz, set to the nearest 100 Hz increment, rotate the FINE TUNE enable switch to "fine tune" and adjust the FINE TUNE control for desired reception. The units and tens MHz are set by the MHz select on the Main Frame.

3.3.4 Shutdown

The Type 602 is shut down from the Main Frame Assembly of the HRO-600, as described in the technical manual for the main frame. Shut down of the HRO-600 automatically shuts down the Type 602.

SECTION 4

THEORY OF OPERATION

4.1 INTRODUCTION

The following paragraphs of this section present the theory of operation for the Type 602 Synthesizer Frequency Control Plug-In Unit, a major accessory of Radio Receiving Set HRO-600. The theory of operation for the HRO-600 itself is given in the technical manual for the set. The following discussion is based upon the servicing block diagram shown in Figure 5- of Section 5.

4.2 DISCUSSION

The Type 602 provides 5.0000-4.0001 MHz in 100 Hz steps, 45 MHz, 5 MHz Fixed BFO, and 5 MHz ECL (emitter coupled logic) inputs for the injection circuits of the HRO-600 Main Frame Assembly. During test or calibration of its internal frequency standard it also produces a CAL OUT signal for the metering circuit of the HRO-600 Main Frame Assembly, in response to its EXT STD IN reference. (The EXT STD IN reference is obtained from an external frequency standard, and is routed through the Main Frame Assembly to the Type 602.) Five dc power inputs (+18 VDC SW, +18 VDC, +125 VDC, -5 VDC, and +5 VDC) obtained from the Main Frame Assembly provide all operating power required by the Type 602.

The Type 602 contains three printed circuit assemblies (TCXO, Oscillator and Control, Main Board) and front panel mounted switches (frequency set thumbwheels, fine tune enable) and control pots (fine frequency, range centering).

The TCXO assembly (A2) produces the 45 MHz, 5 MHz Fixed BFO, and 5 MHz ECL outputs for the Main Frame Assembly. It also produces the 5 MHz T1, T2, 5 MHz 2^{nd}, and 90 MHz outputs used by the Main Board. It also accepts the EXT STD IN reference and produces the CAL OUT signal during test and calibration of its internal frequency standard. The internal standard is a 5 MHz temperature compensated crystal oscillator.

The Oscillator and Control assembly (A3) accepts a dc control voltage from the Main Board, amplifies, filters and then uses it to control the frequency of a 64 to 80 MHz oscillator which is applied to the Main Board.

The Main Board assembly (A1) contains all the remaining circuitry required to produce the phase-locked 5 to 4.0001 MHz output to the Main Frame Assembly in response to the setting of the front panel frequency select switches. It uses the 5 MHz T1, T2, 5 MHz 2^{nd} and 90 MHz inputs from the TCXO assembly and the 64 to 80 MHz from the Oscillator and Control assembly to produce a dc control voltage for the Oscillator and Control assembly and the 5 to 4.0001 MHz output for the Main Frame Assembly.

Within the Type 602 the five dc power supply inputs (+18 VDC SW, +18 VDC, +125 VDC, +5 VDC, -5 VDC) obtained from the main frame assembly are decoupled by C1 thru C4 and additional circuitry on the TCXO assembly.

SECTION 5

MAINTENANCE

5.1 INTRODUCTION

The following paragraphs of this section describe maintenance procedures for the Type 602 Synthesizer Frequency Control Plug-In Unit, a major accessory of Radio Receiving Set HRO-600. Maintenance procedures for the HRO-600 itself are described in the technical manual for the set.

Note

The procedures contained in this section are the maximum which should be attempted in the field with limited test equipment. The referenced extender cards, cables, alignment tools, etc., can be ordered from National Radio Company, Inc., in the form of maintenance kit MK-1. Troubleshooting to piece part level should be attempted only in a well-equipped maintenance laboratory.

A detailed field service manual is available on special order, to enable qualified technicians to locate faulty components on complex subassemblies. Defective subassemblies may be returned to the factory or to authorized service stations for analysis and repair.

5.2 ALIGNMENT

5.2.1 General

Alignment of the Type 602 consists of calibration of its frequency standard and alignment of the 45 MHz phase-locked oscillator, 90 MHz doubler, 64 to 80 MHz phase-locked oscillator and adjustment of the range centering control. Location of internal controls are shown in Figure . To obtain access to these controls while the Type 602 is electrically connected to the HRO-600 Main Frame Assembly, a test cable is required. This test cable is part of Maintenance Kit MK-1, available from National Radio Co., Inc.

5.2.2 Frequency Standard Calibration

5.2.2.1 General

The technique of calibrating the internal standard consists of comparing its frequency against an external reference and observing the beat (difference) frequency on the front panel meter of the Main Frame Assembly. An external standard with an accuracy of 1 PP10^6 or better at 1 MHz or 5 MHz (5 MHz preferred) and capable of delivering 1 VRMS into 50 ohms is required.

5.2.2 Calibration Procedure

To calibrate the internal frequency standard of the Type 602 against an external frequency standard proceed as follows:

Note

The internal standard is set at the factory within +5 $PP10^7$ and should not be reset unless the external reference is known to be at least 1 $PP10^8$.

a. Connect external frequency standard to J2-1 on rear panel of HRO-600 Main Frame Assembly.

b. Depress meter CAL selection push button on front panel of HRO-600 Main Frame Assembly.

c. Remove cover screw from TCXO to obtain access to calibration adjustment.

d. Adjust calibration control until meter oscillations are reduced to less than one per second. (This represents a frequency difference between the internal and external frequency standard of less than 1 Hz.)

5.2.3 Alignment of Oscillator and Control Assembly

To align the Oscillator and Control Assembly proceed as follows:

a. Disconnect the "control voltage in" connection (terminal 7) and substitute a voltage of 9.4 volts.

b. Adjust T1 until the output frequency measured at terminal 2 is 80 MHz.

c. Reconnect the "control voltage in" connection.

5.2.4 Alignment of TCXO assembly

5.2.4.1 Alignment of 45 MHz phase-locked oscillator

To align the 45 MHz phase-locked oscillator proceed as follows:

a. Monitor the DC voltage at the 45 MHz alignment test point shown in Figure .

b. Adjust L1 by screwing out the slug (reducing inductance) until the voltage at the test point no longer changes as the slug is screwed out. Note this voltage (it should be around 7 volts).

c. Adjust L1 by screweing the slug back in. A point will be reached where the voltage at the test point will change as the slug is adjusted.

d. Adjust L1 until the voltage at the test point under this "controlled" condition is the same as that voltage noted in step b.

5.2.4.2 Alignment of 90 MHz Doubler

To align the 90 MHz doubler proceed as follows:

a. Using a 100 MHz oscilloscope adjust both top and bottom slugs of T3 for maximum 90 MHz output as viewed on terminal 9.

5.2.5 Alignment of Range Centering Control

To align the range centering control (R3) proceed as follows:

a. Connect a frequency counter to the 4 to 5 MHz output of the Type 602 (J1, yellow).

b. Set the frequency select switches to all zeros and the fine tune enable switch to "fine tune".

c. Rotate the fine frequency control from one extreme to the other and note the frequency at the extremes of rotation. The output frequency should be adjustable at least +100 Hz around 5 MHz.

d. Set the frequency select switches to all nines and repeat step c. The output should now be adjustable at least +100 Hz around 4.0001 MHz.

e. Adjust R3 as necessary to obtain the "at least +100 Hz" change at both ends (all zeros and all nines).

5.3 TROUBLESHOOTING

Field troubleshooting of the Type 602 consists of isolating a trouble to a defective assembly, to a defective chassis or panel component, or to defective wiring. The Type 602 contains three assemblies: the main board assembly (A1), the TCXO assembly (A2) and the Oscillator and Control assembly (A3). Whenever any of these assemblies is found to be defective, it should be returned to National Radio Company, Inc. or to the Company's authorized representative, for troubleshooting and repair.

To troubleshoot the Type 602, remove it from the front panel of the HRO-600 Main Frame Assembly, and reconnect it to the Main Frame Assembly with the test cable assembly. The basic troubleshooting references provided in this technical manual are the servicing block diagram

of Figure and the parts location illustrations of Figures and . A thorough knowledge of the theory of operation to the level presented in Section 4 of this technical manual is highly desirable (if not absolutely essential) for effective troubleshooting. Refer to Section 4 as necessary during performance of troubleshooting procedures.

Voltages and, where applicable, voltage waveforms are specified in Figure for all key test points. Figure also specifies applicable tolerances, and the type(s) of test equipment required for each measurement.

To check for defective wiring (short circuits or open circuits) it will sometimes be necessary or desirable to make continuity checks with an ohmmeter. Prior to making any such checks, de-energize the Type 602 by rotating the MODE switch on the front panel of the Main Frame Assembly to the OFF position.

In some cases, a trouble may be due to misalignment of the Type 602. Alignment procedures are given in paragraph 5.2.

Due to the nature of phase-locked loops, it is very difficult to ascertain the malfunctioning circuit once the loop is broken. The following procedure is strongly recommended to determine the source of trouble. Use the information in Figure for levels, waveforms, etc.

a. Verify all dc supply voltage connections.

b. Check 5 MHz Fixed BFO, 5 MHz ECL, 5 MHz T1, T2, 5 MHz 2 , 45 MHz and 90 MHz outputs from TCXO assembly and check for their appearance at their respective destinations.

c. Check wiring to S2, R1, R2, R3 and S1.

d. Open loop by removing connection to terminal 7 of Oscillator and Control Assembly.

e. Substitute variable voltage supply at terminal 7 and adjust over a range of approximately 6.7 to 9.4 volts. The output at terminal 2 of the Oscillator and Control Assembly should vary from approximately 64 to 80 MHz respectively.

f. For the same range of substituted voltage, the frequency at terminal 34 of the Main Board Assembly (also J1, yellow) should be 1/16 of the frequency in step e.

If difficulty is encountered in step b. the TCXO assembly is at fault. If difficulty is encountered in step ~~3~~ e. the Oscillator and Control Assembly is at fault. If difficulty is encountered in step f. the Main Board is at fault.

g. Set the frequency select switches to all nines. Adjust the substitute voltage for 64 MHz (4 MHz at J1). Monitor the voltage at terminal 23 of the Main Board Assembly as the substitute voltage is varied slowly around its setting. The voltage at terminal 23 should be observed to change from

approximately 6.7 to 9.4 volts over a very small range of substitute voltage.

If difficulty is encountered in step g. the Main Board Assembly is at fault.

h. If all above steps are performed successfully and the unit still fails to operate when loop is closed by reconnecting wire to terminal 7 of Oscillator and Control Assembly, the problem could lie in either the Oscillator and Control Assembly or the Main Board Assembly. Both assemblies contain circuitry which affects the dynamic characteristics of the loop and the only way to find this kind of problem is either by substituting an assembly known to be reliable or by thoroughly checking the circuits involved. Therefore, if this type of problem is encountered, it is strongly recommended that the unit be returned to National Radio Company, Inc. or its authorized representative for repair.

5.4 REPAIR

Field repair procedures applicable to the Type 602 involve straightforward removal and replacement of electrical components and electronic assemblies, and correction of defective wiring. To facilitate replacement, tag all disconnected leads whenever any assembly is removed. Parts location information for the Type 602 is shown in Figures and .

SECTION 6

PARTS LIST

6.1 INTRODUCTION

This parts list identifies all assemblies, subassemblies and chassis mounted components of maintenance significance for the Type 602 Frequency Control Plug-In Unit, a major accessory of the HRO-600 Radio Receiving Set. It supplements the parts list in the basic technical manual for the Main Frame Assembly of the HRO-600.

6.2 PARTS LIST

Ref. Des.	Name and Identification	Fig. No.
A1	Frequency Control Assy, Type 602: NRCI dwg A48550G1	
A1A1	Main Synthesizer P.C. Board: NRCI dwg E48561G1	
A1A2	TCXO P.C. Board: NRCI dwg D48559G1	
A1A3	Oscillator-Control P.C. Board: NRCI dwg D48560G1	
A1C1, 2, 3	Capacitor: NRCI dwg A48550-37	
A1C4	Capacitor: NRCI dwg A48550-38	
A1CR1	Semi-conductor: MIL type 1N4148	
A1R1	Resistor: MIL type RV4NAYSD105A	
A1R2	Resistor: MIL type RC07GF105K	
A1R3	Resistor: NRCI dwg B52578-2	
A1R4	Resistor: MIL type RC07GF332K	
A1S1	Switch: NRCI dwg B50583-0	
A1S2	Switch: NRCI dwg A48562	

STANDARD WARRANTY

National Radio Company, Inc., (hereinafter called "Manufacturer") warrants that the equipment delivered under this sale is free from defects in workmanship or materials in normal use and operation. Manufacturer's only responsibility under this warranty is to repair or replace, without extra charge, any components or products of which Manufacturer is notified in writing within ninety (90) days after delivery to Buyer of defects in such components or products. Repairs hereunder may, at Manufacturer's option, be made at its plant or at Buyer's location.

The Manufacturer shall have the right, at its sole option, to inspect, either at its plant or at Buyer's location, any goods concerning which a claim is made hereunder, and the result or findings of such inspection(s) shall, in the absence of proof of arbitrary and capricious conduct by Manufacturer, be conclusive on the obligations of Manufacturer in connection herewith.

Any repair, alteration or replacement of components without the express written consent of the Manufacturer will be a violation of this warranty and will serve to remove all liability from the Manufacturer. Any misuse, neglect, accident, incorrect wiring, or use in violation of instructions furnished by the Manufacturer, or the removal, defacing or changing of any serial number(s) shall release the Manufacturer from all liability under this warranty and any other warranty express or implied.

Manufacturer makes no warranty in connection herewith whether of MERCHANTABILITY OR FITNESS, express or implied, and no representative or person is authorized to assume for the Manufacturer any other liability in connection with the sale of this equipment or to alter, amend or waive this warranty.

Manufacturer reserves the right to make any change in design or to make addition to, or improvements in, this equipment without imposing any obligations upon itself to install them in any equipment previously manufactured, provided that Manufacturer, at its sole option, may repair or replace components with such improved components.

Under no circumstances shall Manufacturer be responsible for consequential or foreseeable damages, so-called.

All claims under this warranty must be made in writing in or within ninety (90) days from delivery of the goods here involved to the Buyer. No suit shall be brought hereunder unless the same is commenced within fifteen (15) months from date of delivery of the goods here involved to the Buyer.

No item shall be returned to Manufacturer except with its prior written authorization, and any item so returned shall be marked or tagged to show the serial number of the machine from which it was removed.

Regarding goods returned to Manufacturer for repair under this warranty, the Buyer shall ship the same freight prepaid, and the Manufacturer shall return the same upon completion of appropriate repairs hereunder. Time is of the essence for any and all notices, claims or actions for which a time limit is set forth herein.

NATIONAL RADIO COMPANY, INC.
89 WASHINGTON ST., MELROSE, MASS. 02176

Should your new National Radio Company, Inc. equipment require servicing please do one of the following, whichever is most convenient:

1. Return it to the dealer from whom you purchased it.
2. Bring it to one of our authorized service agencies.
3. Write to the Service Manager, National Radio Company, Inc., 89 Washington Street, Melrose, Mass. 02176 (telephone 617-662-7700) and describe the difficulty. State type of unit and serial number. Describe as completely as possible the apparent defect.

If we feel that the unit should be returned to the factory, we will give you written authorization to ship the unit to us. Notify us that you are returning the unit and ship prepaid and fully insured in the original specially designed-shipping carton. NRCI shall thereupon act in accordance with the "Standard Warranty" a copy of which is printed above.

TCXO D48559

A2

OSC & CONTROL
D48560

A3

MAIN BOARD D48561

A1