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UNCLASSIFIED

TECHNICAL MANUAL

*for*

AF AMPLIFIER  
MODEL HFA-1  
(AM-3296/FRR-60(v))



THE TECHNICAL MATERIEL CORPORATION  
MAMARONECK, N. Y.                      OTTAWA, CANADA

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IN-3001E

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# THE TECHNICAL MATERIEL CORPORATION

C O M M U N I C A T I O N S   E N G I N E E R S

700 FENIMORE ROAD

MAMARONECK, N. Y.

## W a r r a n t y

The Technical Materiel Corporation, hereinafter referred to as TMC, warrants the equipment (except electron tubes, fuses, lamps, batteries and articles made of glass or other fragile or other expendable materials) purchased hereunder to be free from defect in materials and workmanship under normal use and service, when used for the purposes for which the same is designed, for a period of one year from the date of delivery F.O.B. factory. TMC further warrants that the equipment will perform in a manner equal to or better than published technical specifications as amended by any additions or corrections thereto accompanying the formal equipment offer.

TMC will replace or repair any such defective items, F.O.B. factory, which may fail within the stated warranty period, PROVIDED:

1. That any claim of defect under this warranty is made within sixty (60) days after discovery thereof and that inspection by TMC, if required, indicates the validity of such claim to TMC's satisfaction.
2. That the defect is not the result of damage incurred in shipment from or to the factory.
3. That the equipment has not been altered in any way either as to design or use whether by replacement parts not supplied or approved by TMC, or otherwise.
4. That any equipment or accessories furnished but not manufactured by TMC, or not of TMC design shall be subject only to such adjustments as TMC may obtain from the supplier thereof.

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Electron tubes furnished by TMC, but manufactured by others, bear only the warranty given by such other manufacturers. Electron tube warranty claims should be made directly to the manufacturer of such tubes.

TMC's obligation under this warranty is limited to the repair or replacement of defective parts with the exceptions noted above.

At TMC's option any defective part or equipment which fails within the warranty period shall be returned to TMC's factory for inspection, properly packed with shipping charges prepaid. No parts or equipment shall be returned to TMC, unless a return authorization is issued by TMC.

No warranties, express or implied, other than those specifically set forth herein shall be applicable to any equipment manufactured or furnished by TMC and the foregoing warranty shall constitute the Buyers sole right and remedy. In no event does TMC assume any liability for consequential damages, or for loss, damage or expense directly or indirectly arising from the use of TMC Products, or any inability to use them either separately or in combination with other equipment or materials or from any other cause.  
\*Electron tubes also include semi-conductor devices.

### *PROCEDURE FOR RETURN OF MATERIAL OR EQUIPMENT*

Should it be necessary to return equipment or material for repair or replacement, whether within warranty or otherwise, a return authorization must be obtained from TMC prior to shipment. The request for return authorization should include the following information:

1. Model Number of Equipment.
2. Serial Number of Equipment.
3. TMC Part Number.
4. Nature of defect or cause of failure.
5. The contract or purchase order under which equipment was delivered.

### *PROCEDURE FOR ORDERING REPLACEMENT PARTS*

When ordering replacement parts, the following information must be included in the order as applicable:

1. Quantity Required.
2. TMC Part Number.
3. Equipment in which used by TMC or Military Model Number.
4. Brief Description of the Item.
5. The *Crystal Frequency* if the order includes crystals.

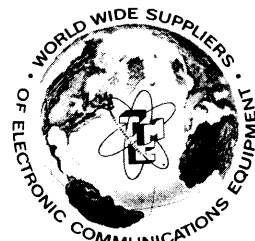
### *PROCEDURE IN THE EVENT OF DAMAGE INCURRED IN SHIPMENT*

TMC's Warranty specifically excludes damage incurred in shipment to or from the factory. In the event equipment is received in damaged condition, the carrier should be notified immediately. Claims for such damage should be filed with the carrier involved and not with TMC.

All correspondence pertaining to Warranty Claims, return, repair, or replacement and all material or equipment returned for repair or replacement, within Warranty or otherwise, should be addressed as follows:

THE TECHNICAL MATERIEL CORPORATION  
Engineering Services Department  
700 Fenimore Road  
Mamaroneck, New York

CHANGE NO. 1 HFA-1



INSTRUCTION BOOK CHANGE NOTICE

Date 4-17-64

Manual affected: AF Amplifier HFA-1 IN -3001E

Page 1-2. Table 1-1

Change tube type for V7002 and V7010 from 6BA8 to  
6BA6.

SHOULD ADDITIONAL COPIES OF THIS CHANGE NOTICE BE REQUIRED, PLEASE CONTACT:

THE TECHNICAL MATERIEL CORP., 700 Fenimore Road, Mamaroneck, New York

Attn.: Director of Eng. Services.



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Figure 1-1. AF Amplifier, Model HFA-1

# SECTION 1 GENERAL DESCRIPTION

## 1-1. PURPOSE OF EQUIPMENT

The HFA-1 Audio Amplifier (figure 1-1) provides dual-channel detection and high fidelity amplification of two independent 250-kc i-f input signals. Designed to operate in the CW, AM, and SSB modes of operation, the HFA-1 can either be integrated into a system, such as the DDR-5, or be used as an independent demodulator-amplifier.

## 1-2. DESCRIPTION OF EQUIPMENT

The HFA-1 is a rack-mounted dual-channel demodulator and amplifier. Capable of demodulating AM, CW, and SSB signals, it provides two independent audio outputs at 600 ohms (balanced and unbalanced) and 4-, 8-, and 16-ohm unbalanced outputs for speaker operation. Dual i-f outputs are also available for visual monitoring by means of TMC's Model DVM-4 Diversity Visual Monitor or other external i-f monitoring devices.

For easy operation all controls are located on the front panel. The audio level at each channel can be monitored with the two front panel meters. Provision is also made for aural monitoring of the two channels. All audio and power connections are made from the rear of the equipment. A separate power supply, such as TMC's Model HFP-1 Power Supply, is needed for this equipment.

## 1-3. ELECTRICAL CHARACTERISTICS

Signal Inputs	<ul style="list-style-type: none"> <li>a. 250-kc synthesized 1-volt carrier</li> <li>b. 250-kc reconstructed 1-volt carrier</li> <li>c. Two 250-kc i-f signals at 1 volt</li> </ul>
BFO	Two BFO front panel controls provides $\pm 5$ kc variation for CW or FSK reception
Audio Response	$\pm 1.5$ db, 20 to 20,000 cps per channel, 0-1 watt output

Distortion	Intermodulation and harmonic distortion at least 40 db down from 1 watt
Hum Level	At least 50 db down from 1 watt
Metering	Independent VU meters for monitoring low level 600-ohm channels.
Audio Outputs	<ul style="list-style-type: none"> <li>a. Two independent 0-1 watt output channels balanced or unbalanced (high level) 600 ohms</li> <li>b. Two independent 0-1 milli-watt metered outputs balanced or unbalanced (low level) 600 ohms</li> <li>c. Two independent 0-1 watt output terminals for 4, 8, and 16 ohms unbalanced</li> </ul>
Power Consumption	70 watts
Special Features	<ul style="list-style-type: none"> <li>a. Provisions on rear apron for connecting audio filter deck, HAF-1, by means of BNC type of connectors</li> <li>b. Two independent i-f outputs, 1 volt, 50 ohms (for use with DVM-4, etc.)</li> </ul>

## 1-4. MECHANICAL CHARACTERISTICS

Dimensions	19" x 20-1/4" x 7"
Weight	20 lbs
Components and Construction	All equipment manufactured in accordance with JAN/MIL specifications wherever possible

## 1-5. ELECTRON TUBE AND DIODE COMPLEMENT

Table 1-1 lists the electron tubes and diodes found in the HFA-1.

**TABLE 1-1. ELECTRON TUBE AND DIODE COMPLEMENT**

REFERENCE SYMBOL	TYPE	FUNCTION
V7001, V7009	6U8	BFO and Isolation Amplifier
V7002, V7010	6BA8	Isolation Amplifier
V7003, V7011	6BA7	Product Detector
V7004, V7012	6C4	Cathode Follower
V7005, V7013	12AX7	AF Amplifier
V7006, V7014	12AX7	AF Amplifier and Phase Inverter
V7007, V7008, V7015, V7016	6AK6	Power Amplifier
CR7000, CR7001	1N34	Detector

## SECTION 2 INSTALLATION

### 2-1. INITIAL INSPECTION

Each HFA-1 unit has been calibrated and tested at the factory before shipment. Upon arrival at the operating site, inspect the packing case and contents for possible damage. Unpack the equipment carefully. Inspect all packing material for parts which may have been shipped as "loose items."

With respect to damage to the equipment for which the carrier is liable, the Technical Materiel Corporation will assist in describing methods of repair and the furnishing of replacement parts.

### 2-2. MECHANICAL INSTALLATION

The HFA-1 is designed for rack mounting with all power and audio connections made to the rear. Designed with a standard 19-inch rack panel, the HFA-1's outline dimension drawing is shown in figure 2-1.

The HFA-1 can be supplied with slides for mounting in a suitable housing. To install a HFA-1 without

slides, place the unit into a suitable housing and secure the front panel to the housing with screws. To install a HFA-1 equipped with slides, set it in position on the tracks until the release buttons catch. Press the release buttons and push the HFA-1 into the equipment rack until the release buttons engage the holes in the equipment. After this, secure the front panel to the equipment rack with screws.

### 2-3. ELECTRICAL INSTALLATION

All necessary input and output connections for the HFA-1 are shown in figure 2-2. The power interconnect cable is connected to J7010 at the rear of the unit. All channel A connections are taken from jacks J7000 to J7005 and terminal board E7000 located on the right side of the rear of the unit. All channel B connections are taken from jacks J7007 to J7009, J7011 and J7012 and terminal board E7001 located on the left side of the rear of the unit.

Various input and output connections which are connected to the rear of the equipment are listed in table 2-1. Refer to this table and figure 2-2.

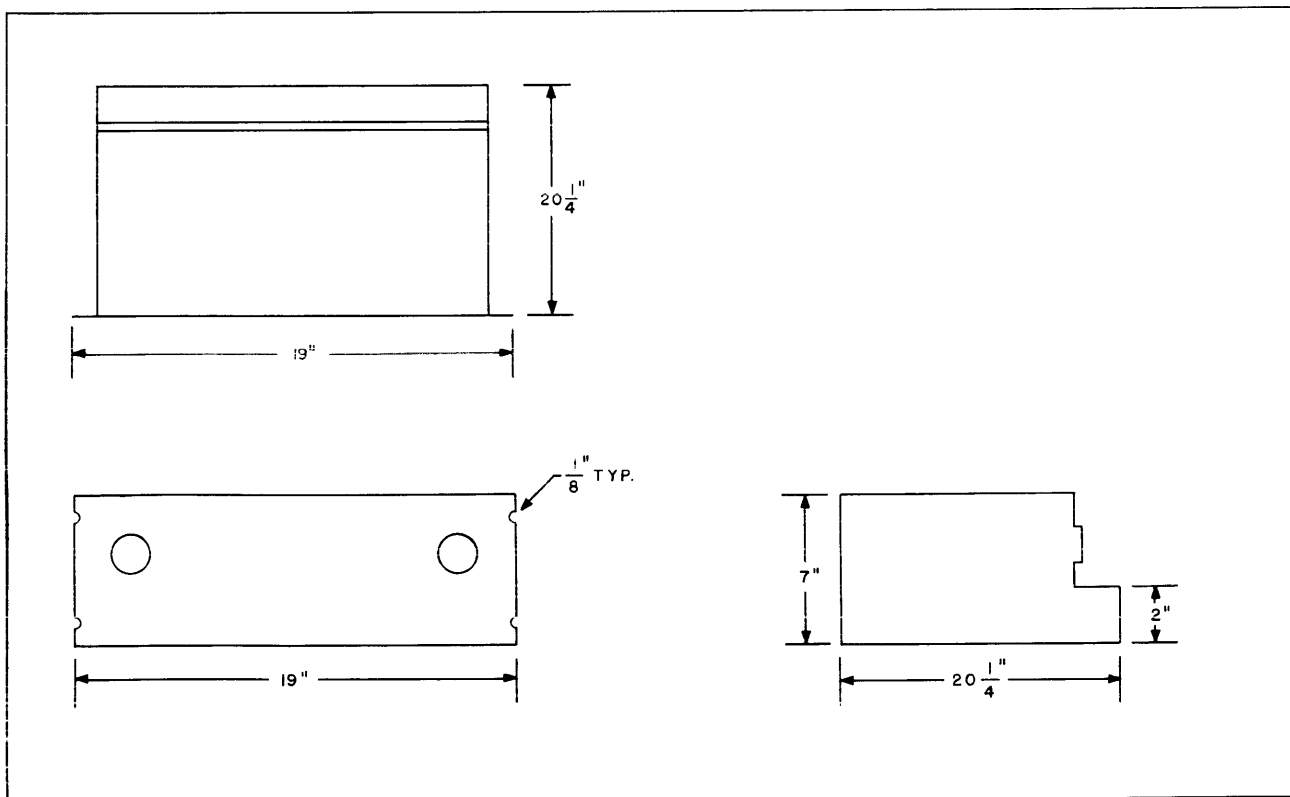


Figure 2-1. Outline Dimensional Drawing, Model HFA-1

**TABLE 2-1. INPUT AND OUTPUT CONNECTIONS**

INPUT OR OUTPUT DESIRED	CHANNEL	CONNECT TO	INPUT OR OUTPUT DESIRED	CHANNEL	CONNECT TO
250-kc i-f input	A	J7001	600-ohm, 0-1 mw balanced output	A	Terminals 10 and 8 on E7000
250-kc i-f output	A	J7000		B	Terminals 10 and 8 on E7001
250-kc i-f input	B	J7008	600-ohm, 0-1 watt balanced output	A	Terminals 5 and 7 on E7000
250-kc i-f output	B	J7007		B	Terminals 5 and 7 on E7001
Connection of HAF-1 audio filter*	A	Connect between J7004 and J7005	16-ohm speaker output	A	Terminals 4 and 1 on E7000
	B			B	Terminals 4 and 1 on E7001
Audio sync tone input	A	J7002	8-ohm speaker output	A	Terminals 3 and 1 on E7000
SYN carrier input	A and B	J7003		B	Terminals 3 and 1 on E7001
RCC carrier input	A and B	J7009	4-ohm speaker output	A	Terminals 2 and 1 on E7000
Diode load output	A	Terminals 11 and 1 on E7000		B	Terminals 2 and 1 on E7001
	B		Terminals 11 and 1 on E7001		

\*Should it be desirable not to use the audio filter, connect a cable between the two jacks.

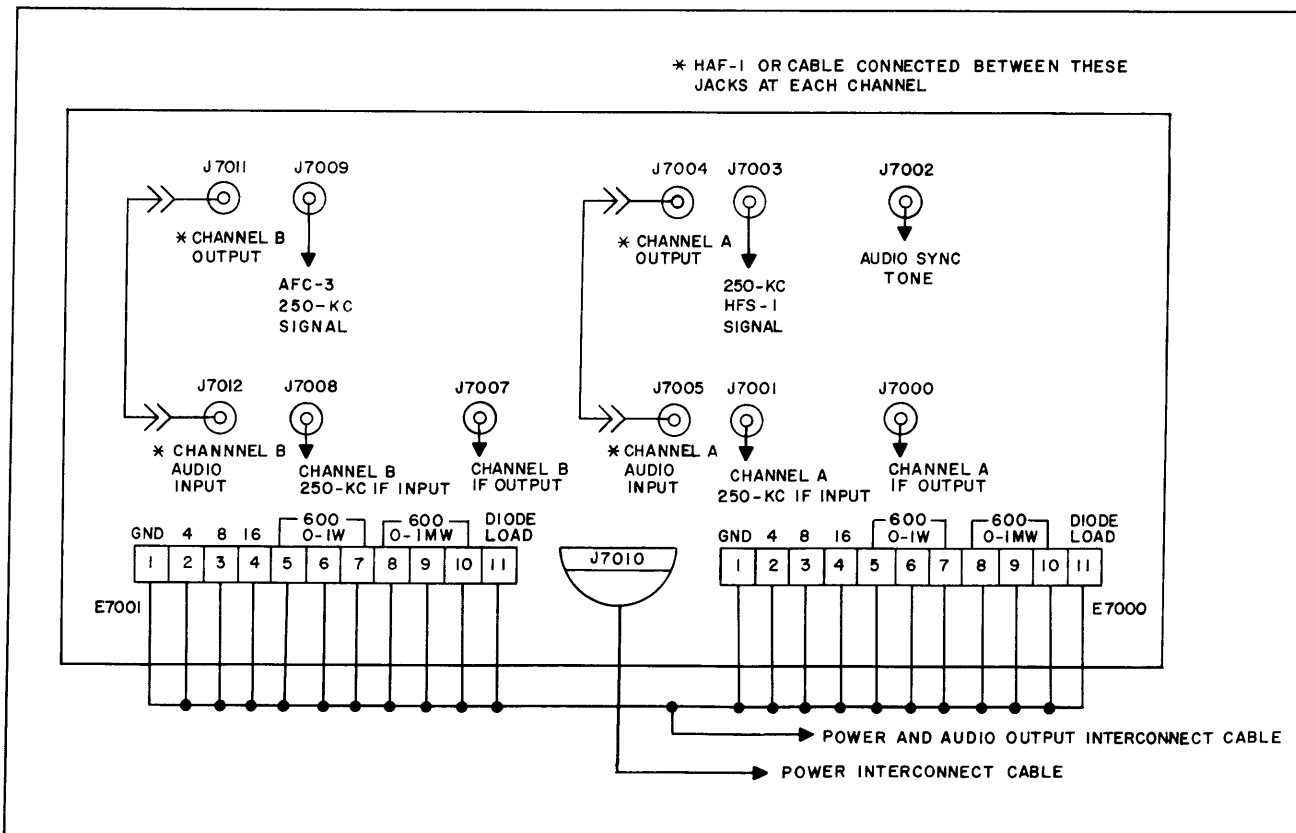


Figure 2-2. Interconnection Diagram, Model HFA-1

## SECTION 3 OPERATOR'S SECTION

### 3-1. GENERAL

The HFA-1 has been designed for maximum operating ease. Each channel has identical controls which are functionally grouped. If the HFA-1 is to be used as part of a TMC system, such as the DDR-5, the use of operating controls will vary to a great extent upon the diversity of the system in use. In this section, however, the HFA-1 will be discussed as a single unit.

### 3-2. OPERATING CONTROLS

Table 3-1 indicates the component designations and functions of the front panel controls. See figure 3-1 and refer to this table.

### 3-3. OPERATOR'S INSTRUCTIONS

After connecting all necessary audio and power connections, perform the following:

- a. Place POWER switch in OPERATE position.

- b. Place both channel A and B DETECTION switches in the mode of operation to be used.

- c. Adjust both LEVEL ADJUST controls until desired audio levels are indicated on the LINE LEVEL meters.

- d. For aural monitoring of the audio output, connect a headset to either or both PHONE jacks. The audio level in the headsets can be varied by the MONITOR controls.

- e. With CW operation, the channel A and B BFO controls can be varied to change the relative pitch of the audio output signals.

### 3-4. OPERATOR'S MAINTENANCE

Regularly check the equipment for dust, grease, corrosion, and other destructive elements which may affect its operation. Components should also be checked for charring, discoloration, and other symptoms of overheating.

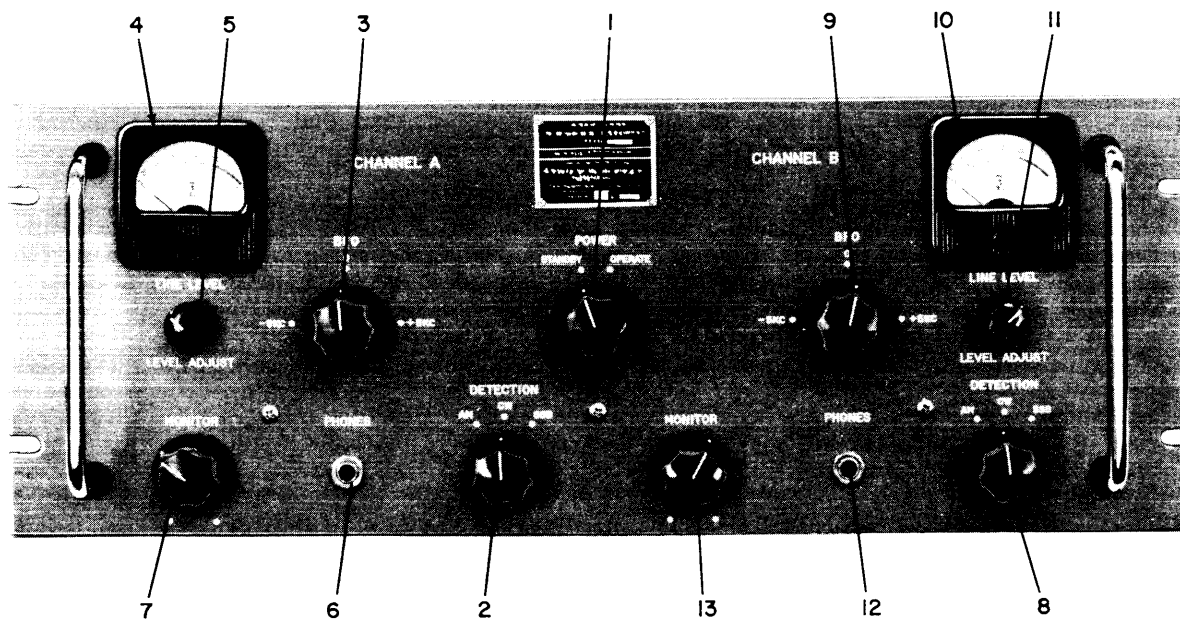


Figure 3-1. Front Panel View of HFA-1, Showing Operating Controls

If any malfunction occurs, the operator should immediately turn off equipment and visually inspect the equipment for simple defects such as wrong or missing connections, bad tubes, etc. If conditions warrant, see the troubleshooting section (Section 5) of this manual.

Excessive a-c hum in either or both channels can normally be controlled by hum balance controls R7000 and R7051. These controls, located on the top of the chassis, can be adjusted with a screwdriver.

**TABLE 3-1. OPERATING CONTROLS**

REFERENCE DESIGNATION	PANEL AND COMPONENT REFERENCE DESIGNATION	FUNCTION
1	POWER switch S7001	STANDBY position - operating voltages disconnected from unit. OPERATE position - operating voltages applied to unit.
<b>CHANNEL A CONTROLS</b>		
2	DETECTION switch S7002	Selects mode of detection. Operates in either AM, CW, or SSB mode, depending on position of switch.
3	BFO control C7053	Used with CW signals. Provides a signal either $\pm 5$ -kc (maximum) about 250-kc.
4	LINE LEVEL meter M7000	Indicates audio level across 0-1 mw output line.
5	LEVEL ADJUST control R7029	Varies audio output level.
6	PHONES jack J7006	A standard 600 or 8000-ohm headset is connected here to monitor audio output.
7	MONITOR control R7041	Varies signal levels in headset.
<b>CHANNEL B CONTROLS</b>		
8	DETECTION switch S7004	Selects mode of operation. Operates in either AM, CW, or SSB mode, depending on position of switch.
9	BFO control C7029	Used with CW signals. Provides a signal either $\pm 5$ -kc (maximum) about 250-kc.
10	LINE LEVEL meter M7001	Indicates audio level across 0-1 mw output line.
11	LEVEL ADJUST control R7080	Varies audio output level.
12	PHONES jack J7013	A standard 600 or 8000-ohm headset is connected here to monitor audio output.
13	MONITOR switch R7096	Varies signal levels in headset.

## SECTION 4 PRINCIPLES OF OPERATION

### 4-1. SIMPLIFIED BLOCK DIAGRAM ANALYSIS

(See figure 4-1.)

Audio Amplifier HFA-1 is a dual-channel demodulator-amplifier with provisions to demodulate and amplify dual 250-kc i-f signals. It has three modes of operation: AM, CW, and SSB. For purposes of discussion, however, and since both channels are nearly identical, only one channel will be covered.

The only difference between the two channels is that the channel A audio amplifier incorporates a provision for monitoring an audio sync tone when tuning the HFR-1 Continuous RF Tuner.

In the AM mode of operation, the AM signal is coupled directly to the AM detector where it is demodulated. The resulting audio signals are subsequently amplified by a series of amplifier tubes. With CW operation, the incoming 250-kc i-f signal is coupled to a product detector along with a variable 250-kc carrier insertion signal generated by the BFO. A difference frequency between the incoming CW signal and the 250-kc carrier signal is generated in the product detector. The resultant audio signals are then amplified through a series of audio amplifiers. In the SSB mode of operation, the incoming 250-kc i-f signals are coupled to the product detector along with an externally generated 250-kc carrier insertion signal. The resultant audio signals are then amplified by the audio amplifier stages.

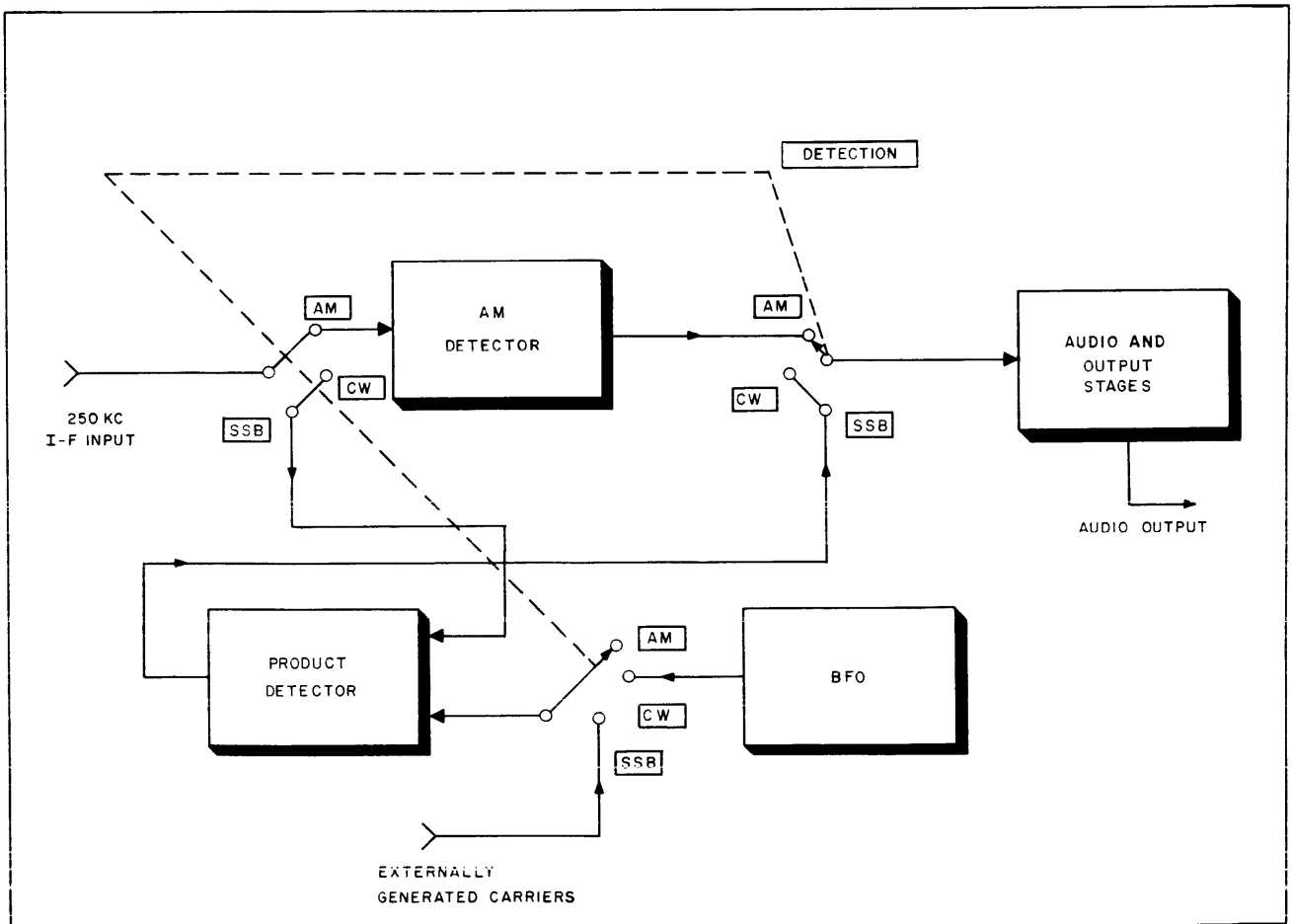


Figure 4-1. Simplified Block Diagram, Model HFA-1



## 4-2. DETAILED BLOCK DIAGRAM ANALYSIS

(See figure 4-2.)

As mentioned previously, the circuitry of the two channels are nearly identical; the difference being that there is provision in the channel A audio amplifier for monitoring an audio sync tone when tuning the HFR-1 Continuous RF Tuner. Because of the similarity, only channel A will be discussed.

In AM operation, the 250-kc i-f input signal is coupled through jack J7001 and applied to isolation amplifier V7002 and to the AM position of DETECTION switch S7002. The output from V7002 is coupled to i-f output jack J7000. With S7002 in the AM position, the input signal is applied to AM detector CR7000 where it is demodulated. The resulting audio output is used as a diode load output and is also coupled to cathode follower V7004. The output from V7004 is coupled to 1st audio amplifier V7005A through the HAF-1 Audio Filter, which is normally connected between jacks J7004 and J7005. The HFA-1 provides low pass and high pass cut-off points in selectable steps between 100 cycles and 10 kc. This arrangement allows selection of a suitable audio bandpass to obtain maximum intelligence from the demodulated signal. In lieu of using the HAF-1, a jumper cable must be connected between jacks J7004 and J7005. The amplified output from V7005A is coupled through the normally closed contacts of audio sync tone relay K7001 and LEVEL ADJUST control R7029 to 2nd and 3rd audio amplifiers V7005B and V7006A respectively. Energizing K7001 disconnects the audio amplifier stages from the previous stages and allows use of the audio amplifier stages for aural indication of the previously mentioned audio sync tone. The output signal from V7006A is applied to phase inverter V7006B where it is split into two equal and opposite phases and applied to push-pull amplifiers V7007 and V7008. Various balanced and unbalanced outputs are tapped from output transformer T7003. A LINE LEVEL meter connected across the 600-ohm line provides continuous visual monitoring of the output signal level. The output may also be aurally monitored by connecting headphones to PHONES jack J7006. MONITOR control R7041 varies the signal level in the headphones.

In CW operation, the 250-kc i-f input signal is coupled through jack J7001 and then applied through DETECTION switch S7002 to product detector V7003 along with a variable 250-kc carrier insertion signal. The carrier insertion signal is generated by beat-frequency oscillator V7001A and coupled to V7003 through DETECTION switch S7002 and isolation amplifier V7001B. The resultant audio output from V7003 consists of the difference frequency between the two inputs. This audio signal is coupled to cathode follower V7004. From this point in the circuit, CW signals are amplified in exactly the same manner as AM signals.

In the SSB mode of operation, the signals are detected and amplified in much the same way as in CW operation. The only difference being that the carrier insertion signal is generated from an external source. Both the HFS-1 Control Standard and Synthesizer and AFC-3 Automatic Frequency Control Units generate 250-kc carriers. The AFC-3, itself, generates both a recon-

structed carrier (RCC) and oscillator generated carrier; the selected carrier being dependent on the position of the CARRIER SELECTOR switch at the AFC-3. The AFC-3 carrier is coupled through J7009 and contacts of relay K7000 to isolation amplifier B7001B. The HFS-1 carrier is coupled to V7001B through J7003 and K7000. Energizing relay K7000 disconnects the HFS-1 carrier and substitutes the AFC-3 signal as the carrier insertion signal.

## 4-3. DESCRIPTION OF 250-KC ISOLATION AMPLIFIER

Isolation amplifier V7002, although physically located in the HFA-1, performs no function associated with the HFA-1 circuitry. The isolation amplifier serves as an isolation stage between the i-f input and the input to the Diversity Visual Monitor, Model DVM-4, which displays the signal(s) present on the i-f carrier.

Isolation amplifier V7002 is a conventional pentode type i-f amplifier tuned to 250-kc by permeability tuned inductance T7000 and its associated capacitors. The i-f input is coupled to V7002 through jack J7001. The i-f output from the isolation amplifier is coupled to jack J7000 from a secondary winding on T7000.

## 4-4. ANALYSIS OF AM OPERATION

(See figure 4-3.)

### a. AM DETECTION.

The 250-kc signal which is coupled to i-f isolation amplifier V7002 from i-f input jack J7001 is also coupled to DETECTION switch S7002C. With S7002C in the AM position, the AM signal is coupled to an AM detector circuit, comprised of T7002, CR7000, R7019-R7021, and C7081 and C7019. The AM detector demodulates the signal, extracting the audio intelligence from the carrier. The resulting intelligence is coupled through S7002C to the audio stages consisting of a cathode follower input, three voltages amplifier stages, a phase inverter stage, and a push-pull output stage.

### b. AUDIO STAGES. (See figure 4-4.)

The demodulated signal from S7002C is coupled to the grid of cathode follower V7004 which has a high input impedance, to insure minimum loading on the detector circuits, and a low output impedance (1000 ohms), to match the input impedance of either the HAF-1 Audio Filter or first audio amplifier stage. Audio output from the cathode of V7004 is coupled to jack J7004. From this jack the audio is coupled to the grid of amplifier V7005A either through the HAF-1 Audio Filter, connected between jacks J7004 and J7005, or by a jumper cable connected between these jacks. Use of the HAF-1 provides low pass and high pass cut-off points in selectable steps from 100 cycles to 10 kilocycles. This arrangement permits selection of a suitable audio bandpass to obtain maximum intelligence from the demodulated signal. For a description of the audio filter refer to the technical manual for Audio Filter Model HAF-1.

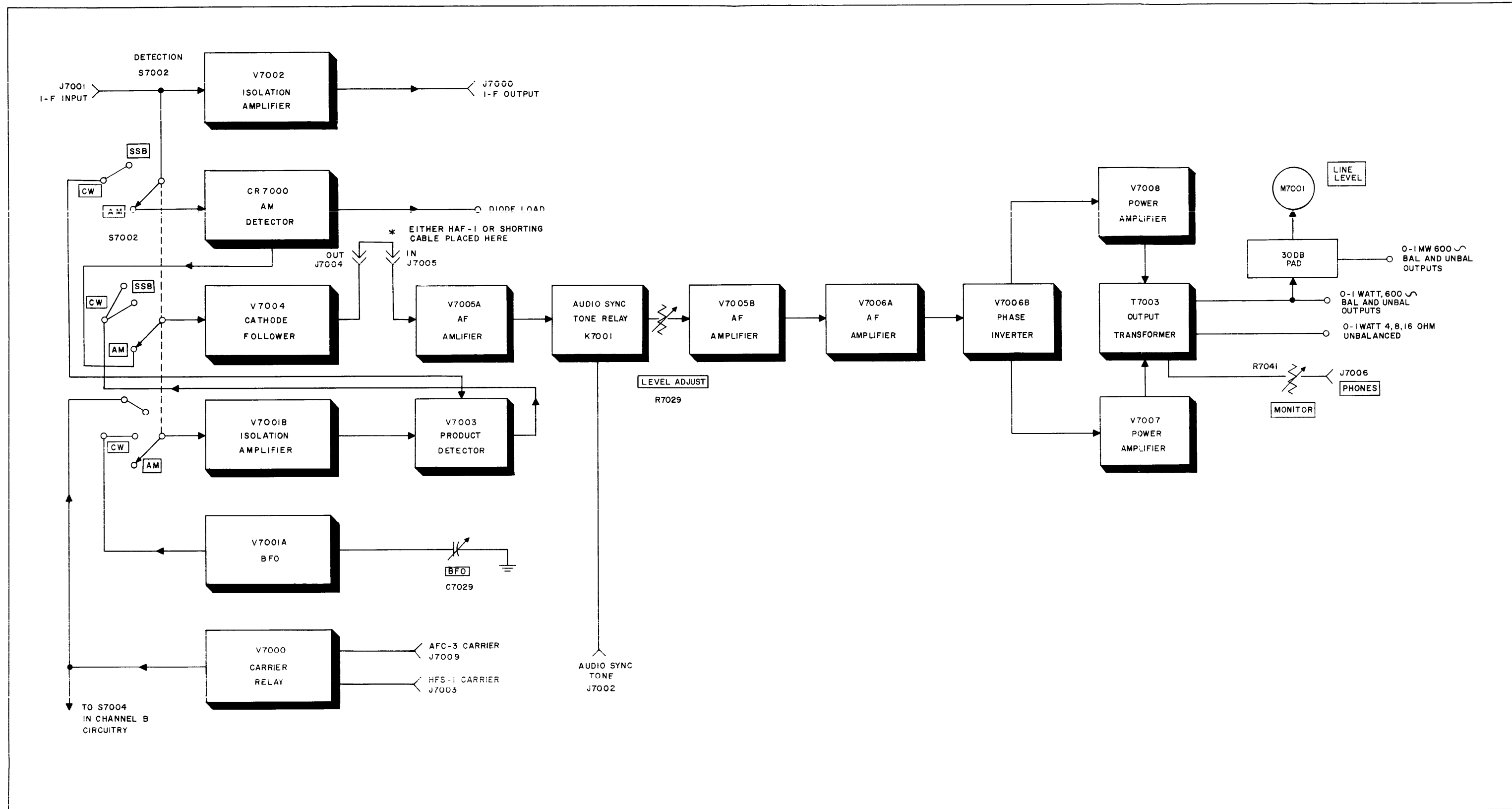


Figure 4-2. Channel A, Block Diagram, Model HFA-1

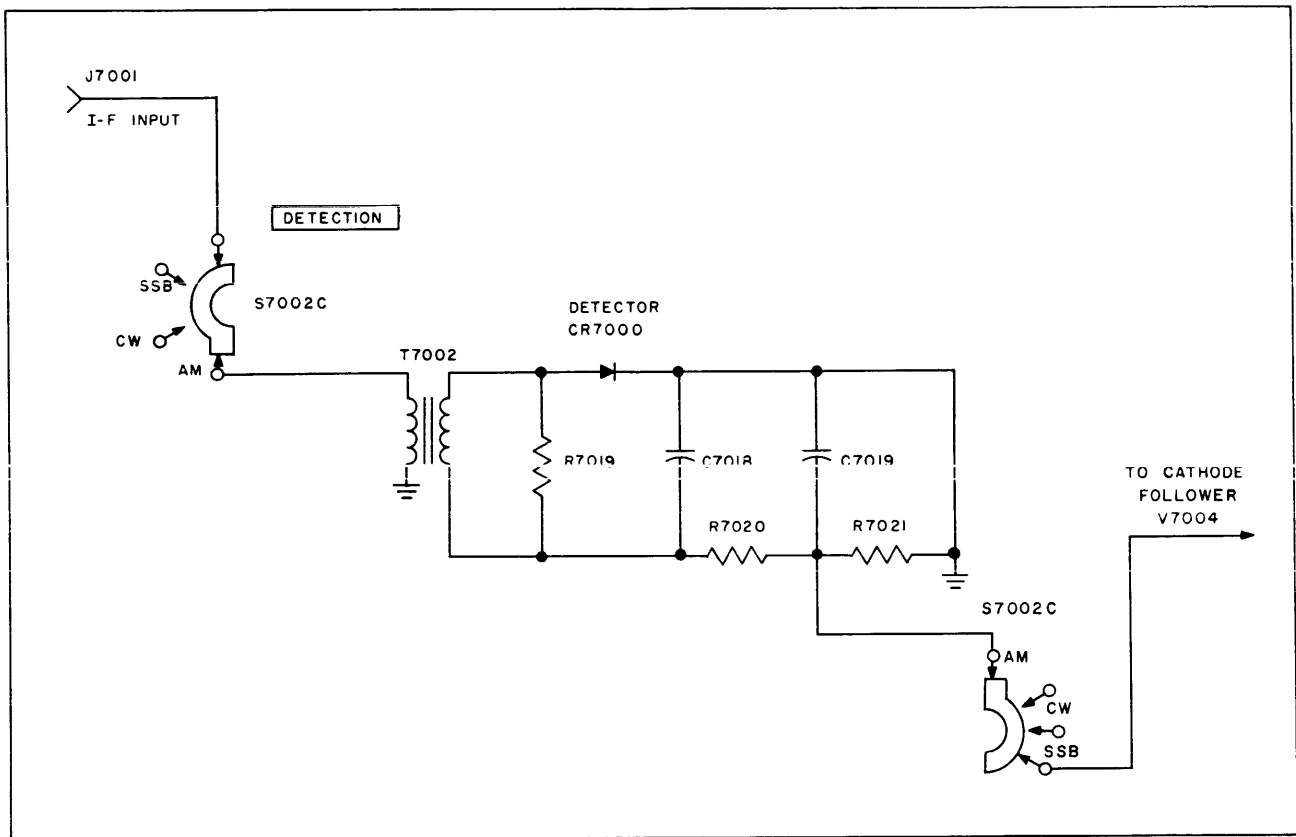


Figure 4-3. AM Operation, Simplified Schematic Diagram

V7005 is a conventional audio amplifier utilizing a large cathode bypass capacitance to insure good low frequency response. The audio signal from amplifier stage V7005A is coupled to amplifier stage V7005B through the contacts of normally deenergized relay K7001 and LEVEL ADJUST control R7029. When relay K7001 is energized, the output from amplifier V7005A is disconnected from the following amplifier stages and the audio sync tone from the HFS-1 Frequency Synthesizer and Standard is connected in its place. This arrangement permits aural monitoring of a zero beat for precise tuning of the HFR-1 Continuous RF Tuner. LEVEL ADJUST R7029, by controlling the signal level applied to V7005B, can vary the output level of the audio amplifier. Degenerative feedback from the 16-ohm tap on the output transformer is applied to the cathode of V7005B to improve the frequency response and increase the stability of the audio amplifier. The output from V7005B is applied to amplifier V7006A for further amplification of the audio signal. From V7006A the signal is coupled to phase inverter V7006B which splits the signal into two opposite and equal phases. The split signal is then applied to push-pull amplifiers V7007 and V7008. Transformer T7003 is a load for the push-pull amplifier stage. Two secondary windings are incorporated into this transformer. One winding provides unbalanced 4, 8, and 16-ohm outputs to terminals 2, 3, and 4, respectively on terminal board E7000 for direct loud-speaker connection. PHONES jack J7006, connected through MONITOR control R7041 to the 4-ohm tap, per-

mits headphone monitoring of the channel. The MONITOR control sets the audio level in the phones. The other secondary winding provides 600-ohm, 1-watt balanced or unbalanced outputs at terminals 5, 6, and 7 of E7000. For test or alignment purposes, load resistor R7046 may be placed across the 600-ohm, 1-watt line by operation of Load In-Out switch S7003. A 30-db pad connected to terminals 5, 6, and 7 of E7000 provides a 600-ohm, balanced or unbalanced, 1-milliwatt output at terminals 8, 9, and 10.

#### c. CHANNEL B AUDIO STAGES.

The operation of the channel B audio stages is exactly the same as that of channel A, except the fact that no audio sync tone can be applied to the audio stages in place of the demodulated signal.

#### 4-5. ANALYSIS OF CW OPERATION

(See figure 4-5.)

CW signals are coupled from i-f in jack J7001 to S7002C. With S7002 in the CW position, the CW signals are coupled to product detector V7003.

When the HFA-1 is operated in the CW mode, the carrier insertion signal is generated by variable beat-frequency oscillator (BFO) V7001A a modified Colpitts (Vackar) oscillator. The feedback circuit of this oscillator consists of inductor L7000 in combination with variable capacitors C7053, C7006 and C7008, fixed capacitors C7005 and C7009, and capacitor voltage divi-

ders C7010 and C7065. Variable capacitor C7053 is the channel A BFO control and is used to vary the operating frequency of the oscillator approximately  $\pm 5$ -kc each side of 250-kc. Trimmers C7008 and C7006 serve as tracking adjustments at the low and high end respectively of the BFO tuning range. The r-f output from the BFO is coupled to isolation amplifier V7001B by DETECTION switch S7002B when the switch is placed in the CW position. When the DETECTION switch is in either the AM or SSB position, the r-f output from the BFO is grounded and C7064 is inserted between the cathode of V7001A and ground to disable the oscillator.

Isolation amplifier V7001B is a conventional narrow-band r-f amplifier which amplifies the carrier insertion signal and isolates the product detector from the BFO. The plate circuit of V7001B, consisting of tuned circuit L7011 and its associated circuitry, is highly tuned to 250 kc. The amplified output from V7001B is coupled through capacitor C7066 to product detector V7003.

Product detector V7003, a pentagrid converter, is used to demodulate both CW and SSB signals. The carrier insertion signal from the BFO is applied to the oscillator grid (pin 2) of V7003 while the CW signal is applied to its control grid (pin 7). Since the plate current of V7003 is controlled by the signals on both grids, the plate current will contain frequencies equal to the sum and difference between the i-f and carrier frequencies. Also present in the plate circuit are frequencies equal to the i-f and carrier frequencies. A low pass filter consisting of R7017, C7016, R7018, and C7017 suppress all frequencies except the difference frequency. This difference frequency is the audio output and is coupled to the cathode follower input stage.

The extracted intelligence is amplified in much the same manner as AM signals. For a detailed description of the audio stages see paragraph 4-3b. The operation of channel B is exactly the same as the operation of channel A.

#### **4-6. ANALYSIS OF SSB OPERATION**

(See figure 4-6.)

SSB signals are coupled from i-f in jack J7001 to switch S7003C. With S7003C in the SSB position, the SSB signals are coupled to product detector V7003.

For SSB operation, 250-kc carrier insertion signals may be selected from either the Model AFC-3 Automatic Frequency Control Unit or the Model HFS-1 Control Standard and Synthesizer Unit. In the AFC-3 itself, either a locally generated carrier or reconstructed carrier (RCC) may be used; the particular carrier is selected by AFC-3's CARRIER SELECTOR switch. These signals are applied to jacks J7009 and J7003 respectively and are selected for use by switch contacts operated by relay K7000. Placing the AFC OFF-ON switch (located on the Model HFI-1 Intermediate Frequency Amplifier Unit) in the ON position energizes relay K7000. This action disconnects the synthesizer carrier insertion signal from the input of the isolation amplifier and connects the carrier generated in the AFC-3 in its place. When relay K7000 is de-energized, the 250-kc synthesizer carrier insertion signal is coupled to isolation amplifier V7001B. When the DETECTION switch is in the AM or CW position, the external carrier insertion signal is disconnected from the isolation amplifier.

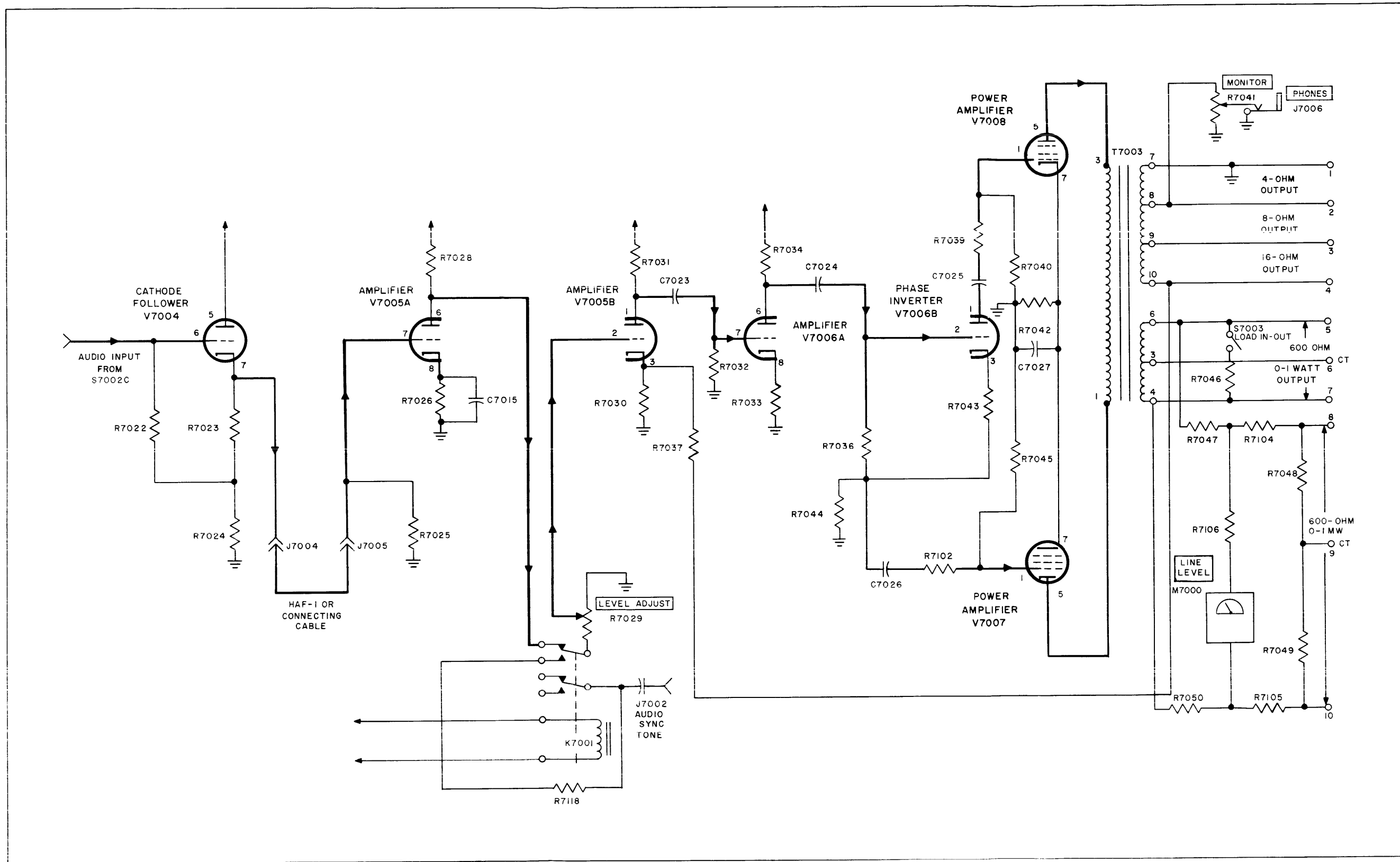


Figure 4-4. Amplifier and Audio Stages, Simplified Schematic Diagram

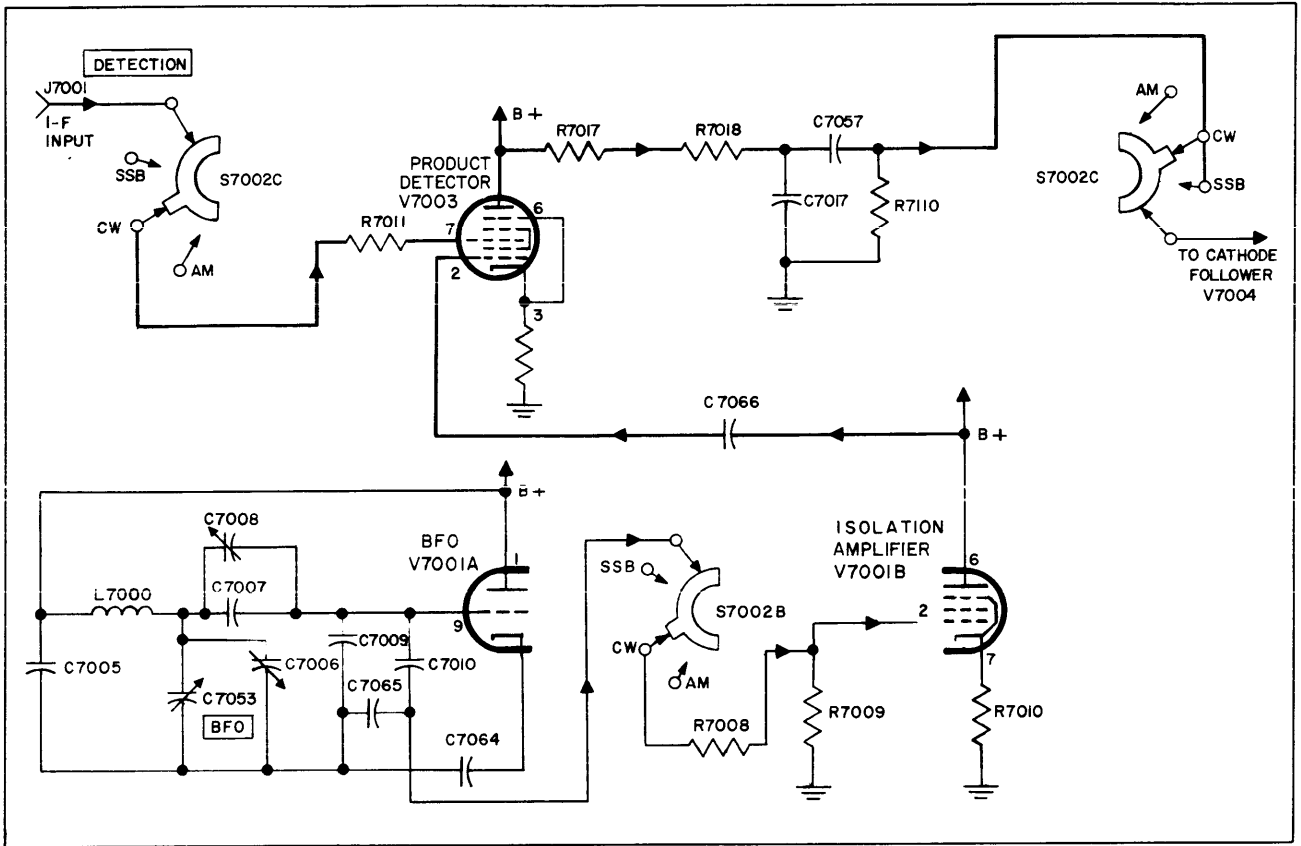


Figure 4-5. CW Operation, Simplified Schematic Diagram

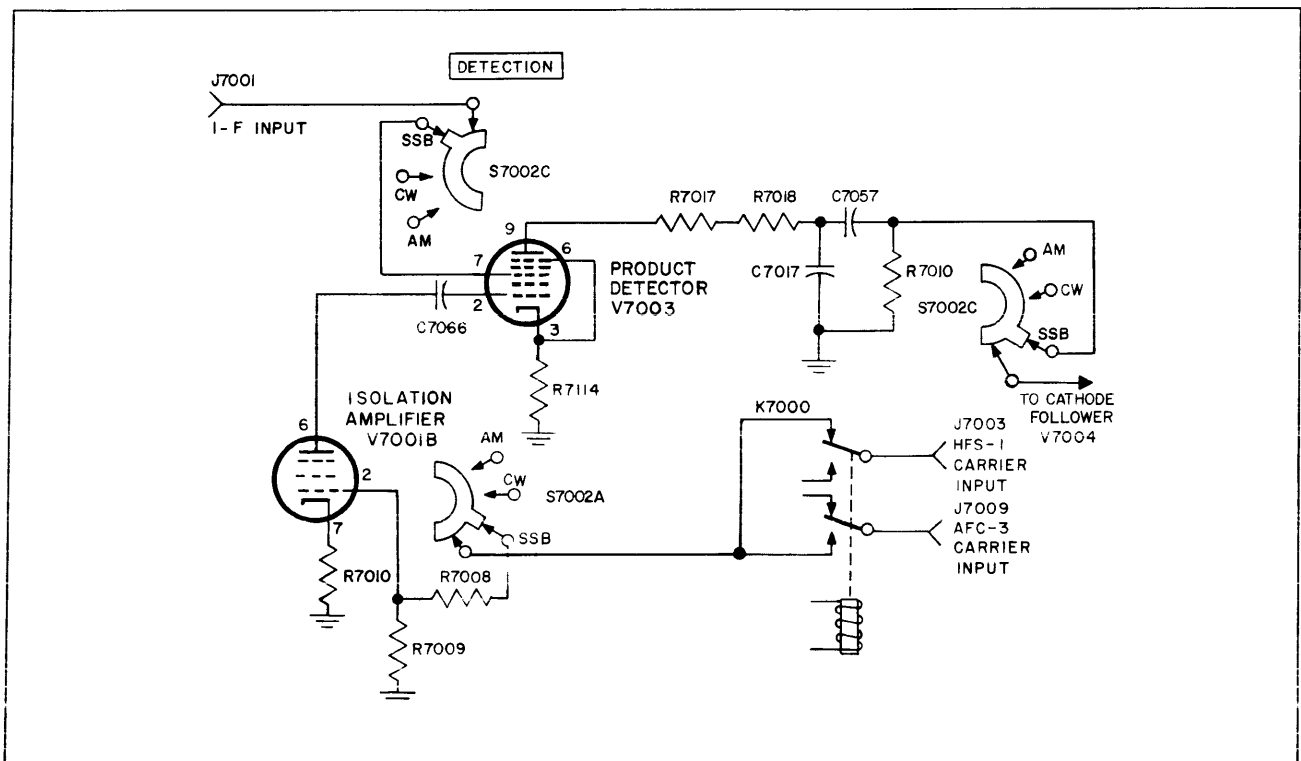


Figure 4-6. SSB Operation, Simplified Schematic Diagram

## SECTION 5 TROUBLESHOOTING

### 5-1. GENERAL

This section discusses troubleshooting of the HFA-1 at the organizational level. A preliminary inspection procedure is given to aid in a visual analysis of conditions that may have caused the equipment breakdown. This preliminary inspection is followed by a systematic analysis of troubleshooting. An overall troubleshooting chart indicates the functional section at fault within the equipment while the functional section troubleshooting chart indicates the particular part at fault within the functional part.

### 5-2. TEST EQUIPMENT NEEDED

The test equipment required for troubleshooting the HFA-1 is listed in table 5-1, below.

**TABLE 5-1. TEST EQUIPMENT**

NAME	MODEL
RF VTVM	Ballantine 314 or equivalent
VTVM	Hewlett-Packard 410B or equiv.
RF Generator	Standard Measurements Model 82 or equivalent

### 5-3. OVERALL TROUBLESHOOTING

a. **PRELIMINARY CHECK.** A preliminary check should be performed on the HFA-1, while it is turned off, in an effort to locate defective parts and to correct conditions which might lead to a breakdown of components. Table 5-2 lists the preliminary inspection procedures.

b. **TEST EQUIPMENT AND SPECIAL TOOLS.** See paragraph 5-2.

c. **UNIT TROUBLESHOOTING CHART.** Table 5-3 outlines a systematic approach to troubleshooting the unit in determining what particular functional section is at fault. Both the SSB and CW modes of operation are tested using the CW mode of operation since both of these modes are primarily the same circuitry. Prior to testing the unit in either CW or SSB, do the following:

(1) Make sure entire system is aligned and operating properly. The 0-1 mw output terminals (terminals 8 and 10 on E7000 and E7001) must be terminated with a 600-ohm load.

(2) Tune the HFA-1 as follows:

(a) Throw STANDBY-OPERATE switch in OPERATE position.

(b) Place both LEVEL ADJUST controls in mid-position.

(c) Place BFO controls in 0 position.

(d) Place DETECTION switch in CW position.

(e) Load Out-In switches S7003 and S7005 are placed in Out position.

(3) Place IF BANDWIDTH KC controls on Model HFI-1 IF Amplifier unit in the 6 DSB position.

(4) Place NOISE SILENCER-OFF-ALIGNMENT SIGNAL switch on the Model HFR-1 Continuous RF Tuner Unit in ALIGNMENT SIGNAL position.

(5) Throw all HIGH and LOW CUTOFF switches on the Model HAF-1 Audio Filter unit in OUT position.

(6) Adjust the channel A and B BFO controls for a peak indication on the LINE LEVEL meters. Adjust both LEVEL ADJUST controls for a reading of 0 vu on the LINE LEVEL meters.

If it is desired to test the unit in the AM mode of operation instead of CW or SSB, do the following:

(1) Connect a 0.6-volt, 250-kc signal, 50 percent modulated with 1-kc, to J7001 or J7008 (depending on which channel is to be tested) Rotate DETECTION switch to AM position.

(2) Throw Load Out-In switch S7003 or S7005 in In position.

### 5-4. FUNCTIONAL SECTION TROUBLESHOOTING

a. **PRELIMINARY CHECK.** The HFA-1 should be visually checked in an effort to locate troublespot. See table 5-2 for a guide in performing the preliminary check.

b. **TEST EQUIPMENT.** The test equipment needed to troubleshoot the functional sections is listed in table 5-1.

c. **TROUBLESHOOTING AIDS.** A voltage and resistance chart is given in table 5-5. Refer to this chart and figures 5-1 and 5-2 when troubleshooting.

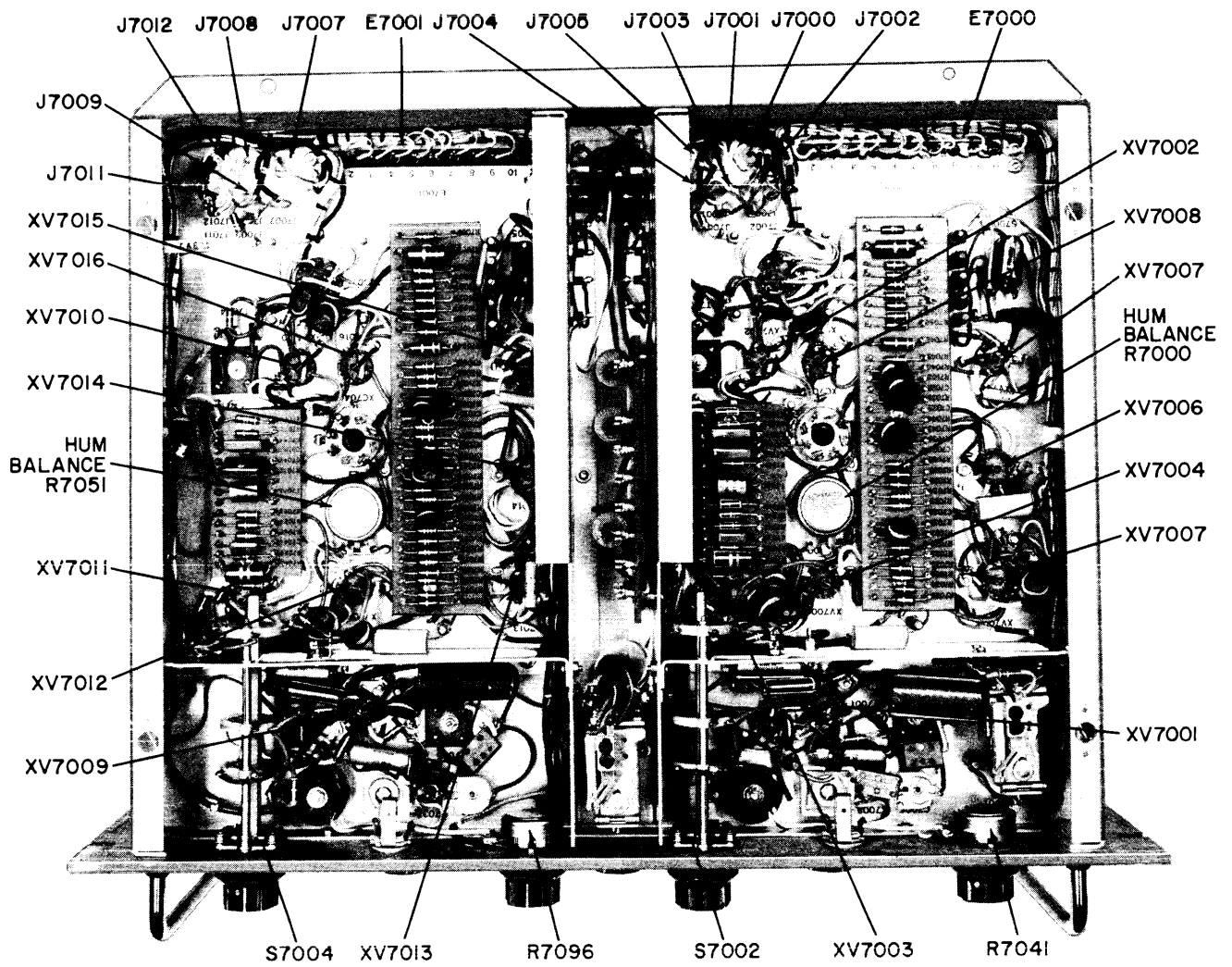


Figure 5-1. Model HFA-1, Bottom View



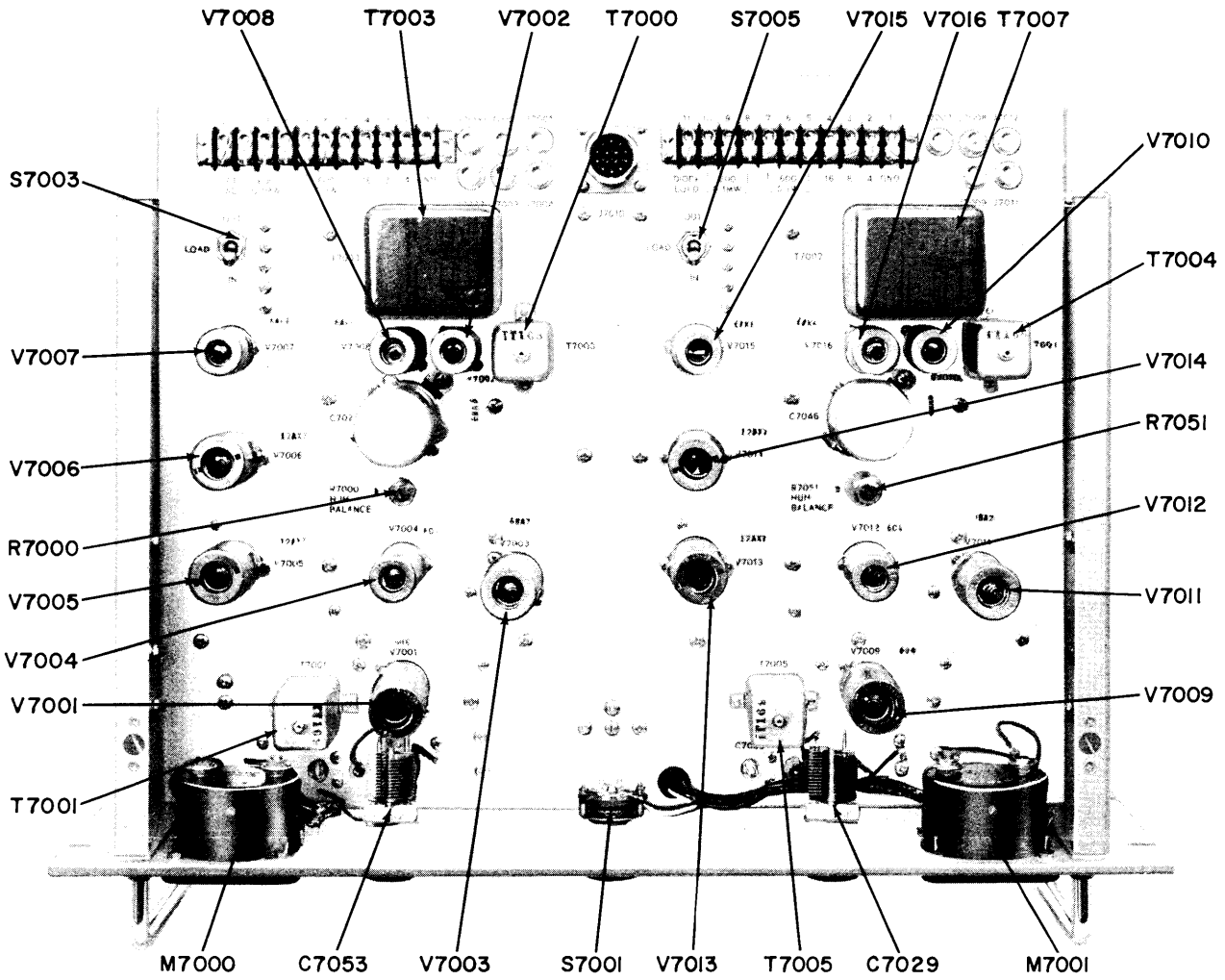


Figure 5-2. Model HFA-1, Top View

d. FUNCTIONAL SECTION TROUBLESHOOTING CHART. Table 5-4 outlines a systematic approach to troubleshooting the various functional sections of the

HFA-1. However, before troubleshooting the equipment, refer to paragraph 5-3c to determine initial test conditions.

**TABLE 5-2. PRELIMINARY INSPECTION PROCEDURES**

WHAT TO INSPECT	DEFECTS TO LOOK FOR	REMEDIES
Electrical power jack J7010. switch S7001. power input cable.	Broken jack, switch, frayed cables, broken connections. Dirt, oil, corrosion.	Replace defective parts. Clean if necessary.
Meters M7001, M7002.	Bent indicator, cracked case, or broken glass.	Replace defective meter.
Knobs, screws, connectors.	Looseness.	Tighten.
Switches	Bad connections, broken wipers.	Fix connections or replace switch.
Wiring	Loose or frayed wires.	Resolder or rewire.
Solder joints	Loose or cold solder connections. Corroded connections.	Resolder. Clean and resolder.
Resistors	Cracks, chipping, blistering, discolorations, and other signs of overheating.	Replace defective resistor.
Capacitors	Leaks, bulges, discoloration.	Replace defective capacitor.
Tubes	Poor seating. Open filaments. Overheating caused by internal shorts.	Press tubes firmly in sockets. Replace. Replace.

**TABLE 5-3. UNIT TROUBLESHOOTING CHART**

STEP	PRELIMINARY ACTION	NORMAL INDICATION	NEXT STEP
1	Set unit up for channel A CW operation.	LINE LEVEL meter M7000 indicates 0 vu.	If indication is normal, proceed to step 2.
2	Set up the unit for channel B CW operation.	LINE LEVEL meter M7001 indicates 0 vu.	If indication is normal, proceed to step 3.  If indication is abnormal, see step 9 in table 5-4.
3	Connect VTVM across i-f out jack J7000.	VTVM indicates 1 vac.	If indication is normal, proceed to step 4.  If indication is abnormal, see step 17 in table 5-4.
4	Connect VTVM across i-f out jack J7007.	VTVM indicates 1 vac.	If indication is normal, proceed to step 5.  If indication is abnormal, see step 19 in table 5-4.
5	Set up the unit for AM operation in channel A.	LINE LEVEL meter M7000 indicates 0 vu.	If indication is normal, proceed to step 6.  If indication is abnormal, see step 21 in table 5-4.
6	Set up the unit for AM operation in channel B.	LINE LEVEL meter M7001 indicates 0 vu.	If indication is abnormal, see step 23 in table 5-4.

**TABLE 5-4. FUNCTIONAL SECTION TROUBLESHOOTING CHART**

STEP	POINT	PRELIMINARY ACTION	NORMAL INDICATION	NEXT STEP
1	①	<p>Connect VTVM across 600-ohm load at terminals 8 and 10 on E7000.</p> <p>Connect headset to PHONES jack J7006 and vary MONITOR control.</p> <p>Connect VTVM across other terminals on E7000 and check voltages.</p>	<p>VTVM indicates 24 vac. M7000 indicates 0 vu.</p> <p>Audio signal heard in headset.</p> <p>Audio signals should be present at each output.</p>	<p>If VTVM indication is normal yet M7000 doesn't indicate, check M7000, and R7106</p> <p>If M7000 indication is normal yet VTVM abnormal, check E7000, R7104, R7048, R7049, R7105.</p> <p>If indication is abnormal, check R7041, T7003, and J7006.</p> <p>If both indications are abnormal, proceed to step 2.</p> <p>If indication is abnormal, check E7000 and wiring.</p>
2	Ⓐ1	Connect VTVM to pin 6 of V7004.	VTVM indicates 0.05 vac.	<p>If indication is normal proceed to step 6.</p> <p>If indication is abnormal check S7002 and V7003 and associated circuitry.</p> <p>If indication is still abnormal proceed to step 3.</p>
3	Ⓐ2	Connect VTVM to pin 7 of V7003.	VTVM indicates 0.035 vac.	<p>If indication is normal, proceed to step 4.</p> <p>If indication is abnormal, check J7001, S7002C, R7011, and signal source.</p>
4	Ⓐ3	Connect VTVM to pin 2 of V7003.	VTVM indicates 9.5 vac.	<p>If indication is normal, proceed to step 6.</p> <p>If indication is abnormal, check V7001.</p> <p>If indication is still abnormal proceed to step 5.</p>
5	Ⓐ4	Connect VTVM to pin 2 of V7001.	VTVM indicates 0.88 vac.	<p>If indication is normal, proceed to step 6.</p> <p>If indication is abnormal, check S7002B, V7001, and associated circuitry.</p>
6	Ⓐ5	Connect VTVM to pin 2 of V7005.	VTVM indicates 0.10 vac.	<p>If indication is normal, proceed to step 7.</p>

**TABLE 5-4. FUNCTIONAL SECTION TROUBLESHOOTING CHART (cont'd)**

STEP	POINT	PRELIMINARY ACTION	NORMAL INDICATION	NEXT STEP
7	(A6)	Connect VTVM to pin 1 at V7008 and then pin 1 at V7007.	VTVM indicates 3.5 vac at each grid.	<p>If indication is abnormal, check R7029, K7001 and associated circuitry, V7005, V7004, and either the HAF-1 or shorting cable.</p> <p>If indication is normal, proceed to step 8.</p>
8	(A7)	Connect VTVM across terminals 4 and 6 on T7003.	VTVM indicates 24 vac.	<p>If indication is abnormal, check V7005 and V7006 and associated circuitry.</p> <p>If indication is abnormal, check T7003, T7008, and V7007.</p>
9	2	Connect VTVM across 600-ohm load at terminals 8 and 10 on E7001.	VTVM indicates 24 vac. M7001 indicates 0 vu.	<p>If VTVM indication is normal, yet M7001 doesn't indicate check M7001 and R7109.</p> <p>If M7001 indication is normal, yet VTVM abnormal, check E7001, R7107, R7108, R7100, R7099.</p>
		Connect headset to PHONES jack J7013 and vary MONITOR control.	Varying audio signal heard in headset.	If indication is abnormal, check T7007, R7096, and J7013.
		Connect VTVM across other terminals on E7001 and check voltages.	Audio signals should be present at each output.	If indication is abnormal, check E7001 and circuitry.
10	(B1)	Connect VTVM to pin 6 of V7012.	VTVM indicates 0.005 vac.	<p>If indication is normal, proceed to step 4.</p> <p>If indication is abnormal, check S7004 and V7011 and associated circuitry.</p>
11	(B2)	Connect VTVM to pin 7 of V7011.	VTVM indicates 0.035 vac.	<p>If indication is normal, proceed to step 12.</p> <p>If indication is abnormal, check J7008, S7004C, R7066, and signal source.</p>
12	(B3)	Connect VTVM to pin 2 of V7011.	VTVM indicates 9.5 vac.	<p>If indication is normal, proceed to step 14.</p> <p>If indication is abnormal, check V7009.</p>
				If indication is still abnormal, proceed to step 13.
13	(B4)	Connect VTVM to pin 2 of V7009.	VTVM indicates 0.88 vac.	If indication is normal, proceed to step 14.

**TABLE 5-4. FUNCTIONAL SECTION TROUBLESHOOTING CHART (continued)**

STEP	POINT	PRELIMINARY ACTION	NORMAL INDICATION	NEXT STEP
14	(B5)	Connect VTVM to pin 2 of V7013.	VTVM indicates 0.10 vac.	If indication is abnormal, check S7004B, V7009, and associated circuitry.  If indication is normal, proceed to step 15.  If indication is abnormal, check R7080, V7013, V7012, and associated circuitry.
15	(B6)	Connect VTVM to pin 1 at V7015 and V7016.	VTVM indicates 3.5 vac at each grid.	If indication is normal, proceed to step 16.  If indication is abnormal, check V7013 and V7014 and associated circuitry.
16	(B7)	Connect VTVM across terminals 4 and 6 on T7007.	VTVM indicates 24 vac.	If indication is abnormal, check T7007, V7015, and V7016.
17	(3)	Connect VTVM across i-f output jack J7000.	VTVM indicates 1 vac.	If indication is abnormal, proceed to step 18.
18	(C1)	Connect VTVM to pin 1.	VTVM indicates 0.64 vac.	If indication is normal, check J7001 and signal source.  If indication is abnormal, check V7002 and associated circuitry.
19	(4)	Connect VTVM across i-f output jack J7007.	VTVM indicates 1 vac.	If indication is abnormal, proceed to step 20.
20	(D1)	Connect VTVM to pin 1 of V7010.	VTVM indicates 0.64 vac.	If indication is normal, check J7008 and associated circuitry.  If indication is normal, check V7010 and associated circuitry.
21	(5)	Rotate channel A DETECTION switch to AM position.  Connect a 0.6 volt 250-kc signal 50% modulated with 1 kc to J7001.  Connect VTVM across R7046 and adjust LEVEL ADJUST so that LINE LEVEL meter indicates 0 vu.  Place S7003 in In position.	VTVM indicates 24 vac.	If indication is abnormal, proceed to step 22.
22	(E1)	Connect VTVM across primary (terminals 3 and 6) of T7002.	VTVM indicates input signal (0.6 vac).	If indication is normal, check CR7000 and detector circuitry and S7002.

**TABLE 5-4. FUNCTIONAL SECTION TROUBLESHOOTING CHART (c nt'd)**

STEP	POINT	PRELIMINARY ACTION	NORMAL INDICATION	NEXT STEP
23	⑥	<p>Rotate channel B DETECTION switch to AM position.</p> <p>Connect a 0.6 volt 250-kc signal 50% modulated with 1 kc to J7008.</p> <p>Connect VTVM across R7097 and adjust LEVEL ADJUST so that LINE LEVEL meter indicates 0 vu.</p> <p>Place S7005 in load In position.</p>	VTVM indicates 24 vac.	<p>If indication is abnormal, check T7002, S7002, J7001 and signal source.</p> <p>If indication is still abnormal, the trouble is in the audio stages. See step 1 above.</p> <p>If indication is abnormal, proceed to step 24.</p>
24	ⓕ1	Connect VTVM across primary (terminals 3 and 6) of T7006.	VTVM indicates input signal (0.6 vac).	<p>If indication is normal, check CR7001 and detector circuitry and S7004.</p> <p>If indication is abnormal, check T7006, S7004, J7008 and signal source.</p> <p>If indication is still abnormal, the trouble is in the audio stages. See step 9 above.</p>

**TABLE 5-5. VOLTAGE AND RESISTANCE MEASUREMENTS**

TUBE	TYPE OF MEASUREMENT	SOCKET PIN NUMBERS								
		1	2	3	4	5	6	7	8	9
V7007 V7008 V7015 V7016	DC	0	10	Fil	Fil	180	190	10	NC	NC
	Ohms	470K	330	Fil	Fil	4 meg	4 meg	330	NC	NC
V7006 V7014	DC	170	12	14.5	Fil	Fil	160	0	0.8	Fil
	Ohms	4 meg	1 meg	43K	Fil	Fil	4 meg	1 meg	1K	Fil
V7005 V7013	DC	120	0	0.6	Fil	Fil	95	0	0.42	Fil
	Ohms	4 meg	1 to 5 meg*	1K	Fil	Fil	4 meg	1K	1K	Fil
V7004 V7012	DC	NC	NC	Fil	Fil	100	31	32	NC	NC
	Ohms	NC	NC	Fil	Fil	4 meg	66K	10.5K	NC	NC
V7003 V7011	DC	100	-8.2	1	Fil	Fil	1	0	NC	130
	Ohms	4 meg	22K	100	Fil	Fil	100	47	NC	4 meg
V7001 V7009	DC	130	-.34	100	Fil	Fil	120	1.4	0	-5.5
	Ohms	4 meg	**	4 meg	1	0	4 meg	220	0	100K
V7002	DC	0	2.1	Fil	Fil	155	110	2.1	NC	NC
	Ohms	***	180	Fil	Fil	4 meg	4 meg	180	NC	NC

**NOTES:**

1. DC Measurements: Voltages were taken with a Hewlett-Packard Model 410B from pin to ground. The unit was interconnected into a system with the i-f inputs disconnected. The TUNE/SYNC/OPERATE switch on the HFR-1 was set in TUNE position. On the HFA-1, the STANDBY/OPERATE switch placed in OPERATE; LEVEL ADJUST rotated to mid-position; BFO control at 0; and DETECTION switches at CW.
2. Resistance Measurements: Readings taken from pin to ground with a Hewlett-Packard Model 410B VTVM. For measurement, the unit was removed from the cabinet and all plug and connections removed.
3. The word "Fil" means filament connection.

\* Depends on setting of LINE LEVEL control.

\*\* 100K for CW and AM settings of DETECTION switch; 5K for SSB position.

\*\*\* 47 ohms for CW and SSB positions of DETECTION switch; 1.5 ohms for AM position.



## SECTION 6 MAINTENANCE

### 6-1. INTRODUCTION

Maintenance may be divided into three categories: operator's maintenance, preventive maintenance, and corrective maintenance. The operator's maintenance, normally the maintenance carried out by the operator as he works with the equipment, is in Section 3 of this manual. Preventive and corrective maintenance procedures are given in this section.

The HFA-1 has been designed to provide long-term, trouble-free operation under continuous duty conditions. It is recommended that any necessary maintenance be done by a competent maintenance technician familiar with troubleshooting techniques. If the trouble cannot be corrected by following the procedures in this section and Section 5, it is recommended that the HFA-1 be returned to the Technical Materiel Corporation for servicing.

### 6-2. PREVENTIVE MAINTENANCE

In order to prevent failure of the equipment due to corrosion, tube failure, dust, or other destructive elements, it is suggested that a schedule of preventive maintenance be set up and adhered to.

At periodic intervals (at least every six months) the equipment should be removed from the rack for cleaning and inspection. All accessible covers should be removed and the wiring and all components inspected for dirt, corrosion, charring, discoloring, or grease. Dust may be removed with a soft brush. Remove dirt or grease from electrical parts with carbon tetrachloride. Remove dirt or grease from other parts with any good dry cleaning fluid.

**WARNING**

When using carbon tetrachloride, make certain that adequate ventilation exists. Avoid prolonged contact with skin.

The preliminary inspection procedure outlined in table 5-2 can be used as a guide to preventive maintenance. By regularly performing these maintenance procedures the unit can be kept substantially trouble-free.

### 6-3. CORRECTIVE MAINTENANCE

a. GENERAL. The corrective maintenance procedures are essentially Technical Materiel Corporation's factory alignment procedures modified for use in the field. Alignment procedures for the various functional sections are given in paragraphs 6-3c through 6-3h.

b. TEST EQUIPMENT. Table 6-1 lists the equipment needed for the alignment of the various functional sections.

**TABLE 6-1. TEST EQUIPMENT**

Equipment	Model
RF VTVM	Ballantine Model 314 or equivalent
VTVM	Hewlett-Packard Model 410B or equivalent
2 RF Generators	Measurements Corp. Model 82 or equivalent
Audio Generator	Hewlett-Packard 200 AB or equivalent
Power Supply	TMC HFP-1 Power Supply or equivalent
Frequency Counter	Hewlett-Packard Model 523C or equivalent
2 Resistors	600 ohms, 1/2 watt
2 Resistors	50 ohms, 1 watt (BNC Termination)
Headphones	8,000 ohms
2 RG-58/U Cables	

c. ALIGNMENT OF CHANNEL A PRODUCT DETECTOR.

- (1) Place DETECTION switch in SSB position and Load In-Out switch S7003 to In position.
- (2) Connect r-f generator to J7003 and set it to generate a 250-kc CW output at one volt.
- (3) Connect an r-f VTVM to pin 2 of V7003.
- (4) Adjust L7011 tuning slug to obtain maximum reading (approximately 10 volts).
- (5) Connect an r-f VTVM across R7046 and turn LEVEL ADJUST control fully counterclockwise.

(6) Connect second r-f generator to J7001 and adjust generator output to 250.2-kc at one volt. Rotate LEVEL ADJUST clockwise to obtain a 0 VU reading on LINE LEVEL meter. R-f VTVM should read 24 vac.

(7) Disconnect both r-f generators. Switch r-f VTVM to a low range and adjust hum balance control R7000 for a minimum reading. Then reconnect r-f generators.

(8) Reduce 250.2-kc signal at J7001 to 0.76 volts and rotate LEVEL ADJUST control to obtain 0 VU. This is to insure sufficient gain in the amplifier for a reduced i-f input due to AGC action.

#### d. ALIGNMENT OF CHANNEL B PRODUCT DETECTOR.

(1) Place DETECTION switch in SSB position and Load In-Out switch S7005 to In position.

(2) Connect r-f generator to J7003 and adjust generator to produce a 250-kc CW output at one volt.

(3) Connect an r-f VTVM to pin 2 of V7011.

(4) Adjust L7012 tuning slug to obtain a maximum reading (approximately 10 volts).

(5) Connect r-f VTVM across R7097 and turn LEVEL ADJUST control to full counterclockwise position.

(6) Connect second r-f generator to J7008 and adjust generator output to 250.2-kc at one volt. Rotate LEVEL ADJUST clockwise to obtain a 0 VU reading on LINE LEVEL meter. R-f VTVM should read 24 vac.

(7) Disconnect both r-f generators. Switch r-f VTVM to a low range and adjust hum balance control R7051 for a minimum reading. Then reconnect r-f generators.

(8) Reduce 250.2-kc signal at J7008 to 0.76 volts and rotate LEVEL ADJUST control to obtain 0 VU. This is to insure sufficient gain in the amplifier for a reduced i-f input due to AGC action.

#### e. CHANNEL A BFO AND PHONES MONITOR ALIGNMENT.

(1) Turn DETECTION switch to CW position. Rotate BFO capacitor C7053 to the 0 position. The capacitor should be meshed half way.

(2) Turn capacitors C7006, C7008, C7032, and C7030 to mid-capacity.

(3) Connect the frequency counter to pin 2 of V7001. The counter reading should be in the vicinity of 250 kc.

(4) Rotate BFO control to -5 KC and adjust C7006 to obtain a reading of approximately 254.2 kc

on the frequency counter. Then rotate BFO control to +5 KC position and adjust C7008 to obtain approximately 254.2 kc on the frequency counter.

(5) Repeat steps (3) and (4) above until one even deviation from the center frequency (250 kc) is obtained. The deviation should be 4.2 kc or greater. Disconnect counter.

(6) Connect r-f generator to J7001 and adjust generator for a 250-kc  $\pm 1$ -cycle output at 1 volt.

(7) Set LEVEL ADJUST control to obtain 0 VU on LINE LEVEL meter. Connect r-f VTVM across R7046. VTVM should indicate 24 vac  $\pm 2$  volts.

(8) Rotate BFO control from -5 KC to +5 KC. The VU meter should not vary more than 1 VU.

(9) Insert earphones into PHONES jack J7006 and turn MONITOR control R7041 fully clockwise. A changing beat note, between 20 and 4,200 cps, should be heard during rotation of the BFO control.

(10) Connect the r-f VTVM to the slider of MONITOR control R7041. A reading of 2.2 volts  $\pm 0.5$  volts should be obtained.

#### f. CHANNEL B BFO AND PHONES MONITOR ALIGNMENT.

(1) Turn DETECTION switch to CW position. Rotate BFO capacitor C7029 to the 0 position. The capacitor should be meshed half way.

(2) Connect the frequency counter to pin 2 of V7009. The counter should indicate about 250 kc.

(3) Rotate BFO control to -5 KC and adjust C7030 to obtain a reading of approximately 254.2 kc on the frequency counter. Then rotate BFO control to +5 KC position and adjust C7032 to obtain approximately 245.8-kc reading on the counter.

(4) Repeat steps (2) and (3) above until one even deviation from the center frequency (250 kc) is obtained. The deviation should be 4.2 kc or greater. Disconnect counter.

(5) Connect r-f generator to J7008 and adjust generator for 250 kc  $\pm 1$ -cycle output at 1 volt.

(6) Set LEVEL ADJUST control to obtain 0 VU on LINE LEVEL meter. Connect r-f VTVM across R7097. VTVM should indicate 24 vac  $\pm 2$  volts.

(7) Rotate BFO control from -5 KC to +5 KC. The VU meter should not vary more than 1 VU.

(8) Place earphones into PHONES jack J7013 and turn MONITOR control R7096 fully clockwise. A changing beat note, between 20 and 4,200 cps, should be heard during rotation of the BFO control.

(9) Connect r-f VTVM to the slider of MONITOR control R7096. VTVM should read 2.2 volts  $\pm 0.5$  volts.

g. CHANNEL A ISOLATION AMPLIFIER ALIGNMENT.

(1) Connect a 50-ohm, 1 watt, resistor to i-f output jack J7000. Connect r-f VTVM across this resistor.

(2) Connect r-f generator to J7001.

(3) Adjust T7000 slug for maximum indication. The reading should be one volt or better.

h. CHANNEL B ISOLATION AMPLIFIER ALIGNMENT.

(1) Connect a 50-ohm, 1 watt, resistor to i-f output jack J7007. Connect r-f VTVM across resistor.

(2) Connect r-f generator to J7008.

(3) Adjust T7004 slug for maximum indication. The reading should be one volt or better.

## **SECTION 7**

### **PARTS LIST**

#### **7-1. INTRODUCTION**

Reference designations have been assigned to identify all maintenance parts of the equipment. They are used for marking the equipment (adjacent to the part they identify) and are included on drawings, diagrams, and the parts list. The letters of a reference designation indicate the kind of part (generic group) such as resistor, amplifier, electron tubes, etc. The number differentiates between parts of the same generic group. Parts of the same first major unit are numbered from 1 to 199, parts of the second 201 to 299, etc. Sockets associated with a particular plug-in device, such as electron tube or fuse, are identified by a reference

designation which includes the reference designation of the plug-in device. For example, the socket for fuse F7 is designated XF7. The parts for each major unit are grouped together. Column 1 lists the reference series of each major unit, followed by the reference designations of the various parts in alphabetical and numerical order. Column 2 gives the same and describes the various parts. Major part assemblies are listed in their entirety; subparts of a major assembly are listed in alphabetical and numerical order with reference to its major assembly. Column 3 indicates how the part is used within a major component. Column 4 lists each Technical Materiel Corporation part number.

**PARTS LISTS AF AMPLIFIER, MODEL HFA-1**

REF SYMBOL	DESCRIPTION	FUNCTION	TMC PART NUMBER
C7000	CAPACITOR, FIXED, CERAMIC DIELECTRIC: 2000 uuf; $\pm 20\%$ ; 500 vdcw; feedthru type.	RF Bypass	CK70A202M
C7001	Same as C7000.	RF Bypass	
C7002	CAPACITOR, FIXED, CERAMIC DIELECTRIC: 20,000 uuf; $+80\%$ - $20\%$ ; 500 vdcw.	Filter Network	CC-100-24
C7003	CAPACITOR, FIXED, CERAMIC DIELECTRIC: 10,000 uuf; GMV: 500 vdcw.	Filter Network	CC 100-16
C7004	Same as C7003.	Filter Network	
C7005	CAPACITOR, FIXED, PLASTIC DIELECTRIC: .01 uf; $\pm 1\%$ , 200 vdcw.	Freq. Det. Network	CX-104-34
C7006	CAPACITOR, VARIABLE, CERAMIC DIELECTRIC: 4.5 to 25.0 uuf; 500 vdcw.	Trimmer	CV11A250
C7007	CAPACITOR, FIXED, MICA DIELECTRIC: 1100 uuf; $\pm 5\%$ , 500 vdcw.	Freq. Det. Network	CM20D112J
C7008	CAPACITOR, VARIABLE, MICA DIELECTRIC: 65 to 340 uuf; 250 vdcw.	Trimmer	CV-103-303
C7009	Same as C7005.	Freq. Det. Network	
C7010	CAPACITOR, FIXED, MICA DIELECTRIC: 100 uuf; $\pm 10\%$ ; 500 vdcw.	Voltage Divider	CM15B101K
C7011	CAPACITOR, FIXED, CERAMIC DIELECTRIC: .1 uf; $+80\%$ - $20\%$ ; 500 vdcw.	Cathode Bypass	CC-100-32
C7012	Same as C7011.	Screen Bypass	
C7013	Same as C7011.	Cathode Bypass	
C7014	CAPACITOR, FIXED, ELECTROLYTIC: 20 uf; 250 vdcw; polarized tubular case.	B+ Bypass	CE-103-5
C7015	CAPACITOR, FIXED, ELECTROLYTIC: tantalum; 50 uf; $\pm 50\%$ - $15\%$ ; 60 vdc; polarized; tublar case.	Cathode Bypass	CE-107-1
C7016	CAPACITOR, FIXED, MICA DIELECTRIC: 330 uuf; $\pm 10\%$ ; 500 vdcw.	Filter Network	CM15B331K
C7017	CAPACITOR, FIXED, MICA DIELECTRIC: 27 uuf; $\pm 10\%$ ; 500 vdcw.	Filter Network	CM15B270K
C7018	CAPACITOR, FIXED, MICA DIELECTRIC: 820 uuf; $\pm 10\%$ ; 500 vdcw.	Filter Network	CM20C821K
C7019	CAPACITOR, FIXED, MICA DIELECTRIC: 560 uuf; $\pm 5\%$ ; 500 vdcw.	Filter Network	CM20C561J
C7020	CAPACITOR, FIXED, CERAMIC DIELECTRIC: .22 uf; $+80\%$ - $20\%$ ; 10 vdcw.	Coupling	CC-100-33

**PARTS LISTS AF AMPLIFIER, MODEL HFA-1 (cont'd)**

REF SYMBOL	DESCRIPTION	FUNCTION	TMC PART NUMBER
C7021 A, B, C	CAPACITOR, FIXED, ELECTROLYTIC: triple section; 20 uf; each section; 450 vdcw; polarized; tubular case; plug-in-type.	B+ Bypass	CE-108-1
C7022	CAPACITOR, FIXED, CERAMIC DIELECTRIC: 3,000 uuf; GMV; 200 vdcw.	Plate Bypass	CC-100-31
C7023	CAPACITOR, FIXED, PLASTIC DIELECTRIC: 1.0 uf; ±20%; 600 vdcw.	Coupling	CN112B105M2
C7024	Same as C7002.	Coupling	
C7025	Same as C7002.	Coupling	
C7026	Same as C7002.	Coupling	
C7027	Same as C7015.	Cathode Bypass	
C7028	Same as C7005.	Freq. Det. Network	
C7029	CAPACITOR, VARIABLE AIR DIELECTRIC: 5.5 uuf to 100 uuf; 600 v RMS.	BFO Pitch	CT-100-2
C7030	Same as C7006.	Trimmer	
C7031	Same as C7007.	Freq. Det. Network	
C7032	Same as C7008.	Trimmer	
C7033	Same as C7005.	Freq. Det. Network	
C7034	Same as C7010.	Voltage Divider	
C7035	Same as C7002.	Screen Bypass	
C7036	Same as C7011.	Cathode Bypass	
C7037	Same as C7011.	Screen Bypass	
C7038	Same as C7011.	Cathode Bypass	
C7039	Same as C7014.	B+ Bypass	
C7040	Same as C7015.	Cathode Bypass	
C7041	Same as C7016.	Filter Network	
C7042	Same as C7017.	Filter Network	
C7043	Same as C7018.	Filter Network	
C7044	Same as C7019.	Filter Network	
C7045	Same as C7020.	Coupling	
C7046	Same as C7021A, B, C.	B+ Bypass	
C7047	Same as C7002.	Coupling	
C7048	Same as C7002.	Plate Bypass	

**PARTS LISTS AF AMPLIFIER, MODEL HFA-1 (cont'd)**

REF SYMBOL	DESCRIPTION	FUNCTION	TMC PART NUMBER
C7049	Same as C7002.	Coupling	
C7050	Same as C7002.	Coupling	
C7051	Same as C7002.	Coupling	
C7052	Same as C7015.	Cathode Bypass	
C7053	Same as C7029.	BFO Pitch	
C7054	Same as C7002.	Screen Bypass	
C7055	Same as C7003.	Filter Network	
C7066	Same as C7003.	Filter Network	
C7057	Same as C7011.	TC Network	
C7058	Same as C7011.	TC Network	
C7059	Same as C7011.	B+ Bypass	
C7060	Same as C7002.	Coupling	
C7061	Same as C7011.	B+ Bypass	
C7062	Same as C7023.	Coupling	
C7063	Same as C7002.	Coupling	
C7064	NOT USED.		
C7065	CAPACITOR, FIXED, MICA DIELECTRIC: 270 uuf; $\pm 10\%$ ; 500 vdcw.	Voltage Divider	CM15B271K
C7066	CAPACITOR, FIXED, MICA DIELECTRIC: 1000 uuf; $\pm 5\%$ ; 500 vdcw.	Coupling	CM20C102J
C7067	CAPACITOR, FIXED, MICA DIELECTRIC: 110 uuf; $\pm 10\%$ ; 500 vdcw.	Bypass	CM15B111K
C7068	Same as C7011.		
C7069	Same as C7023.	Coupling	
C7070	NOT USED.		
C7071	Same as C7065.	Voltage Divider	
C7072	Same as C7066.	Coupling	
C7073	Same as C7067.	Bypass	
C7074	Same as C7011.	Screen Bypass	
C7075	Same as C7023.	Coupling	
C7076	Same as C7011.	Coupling	

**PARTS LISTS AF AMPLIFIER, MODEL HFA-1 (cont'd)**

REF SYMBOL	DESCRIPTION	FUNCTION	TMC PART NUMBER
C7077	Same as C7011.	Coupling	
CR7000	SEMICONDUCTOR DEVICE, DIODE: germanium max peak inverse volts 60 v; continuous average forward current 50 ma; max peak forward recurrent 150 ma; max surge current 500 ma; max inverse current 800 ua; at -50 v or 50 ua at - 10 v.	Detector	1N34
CR7001	Same as CR7000.	Detector	
E7000	TERMINAL BOARD: barrier type; eleven single screw terminals and feedthru solder lugs, 8-32; phenolic body.	Output Terminal Strip	TM-111-1
E7001	Same as E7000.	Output Terminal Strip	
J7000	CONNECTOR, RECEPTACLE, ELECTRICAL: single contact; female.	IF Out	UG-625/U
J7001	Same as J7000.	IF Input	
J7002	Same as J7000.	Audio Sync Tone	
J7003	Same as J7000.	250-Kc Sync Input	
J7004	Same as J7000.	Audio Out	
J7005	Same as J7000.	Audio In	
J7006	JACK, TELEPHONE: closed circuit type; 3 contacts; 1/4 in. dia hole.	Phones Monitor	JJ-089
J7007	Same as J7000.	IF Output	
J7008	Same as J7000.	IF Input	
J7009	Same as J7000.	RCC Input	
J7010	CONNECTOR, RECEPTACLE, ELECTRICAL: 14 #16 male contacts, rated at 17.0 amperes.	Power Input	JJ-200-2
J7011	Same as J7000.	Audio Out	
J7012	Same as J7000.	Audio In	
J7013	Same as J7006.	Phones Monitor	
K7000	RELAY, ARMATURE: coil resistance, 20,000 ohms dc; 80 vdc operating voltage; contacts rated at 230 vac max at 0.5 amp double pole, double throw.	RCC/SNY Selector	RL-105
K7001	Same as K7000.	Audio Sync Tone	



**PARTS LISTS AF AMPLIFIER, MODEL HFA-1 (c nt'd)**

REF SYMBOL	DESCRIPTION	FUNCTION	TMC PART NUMBER
L7000	COIL, RADIO FREQUENCY: fixed; operating frequency 250-kc; .35 mh at 1-kc; 1.7 ohm dc resistance; 10 ma current rating.	Freq. Det. Network	CL-289
L7001	COIL, RADIO FREQUENCY: fixed; inductance, .5 mh; resonant frequency .40 mc; max dc resistance 110 ohms.	Filter Network	CL-226-5
L7002	Same as L7001.	Filter Network	
L7003	Same as L7000.	Freq. Det. Network	
L7004	COIL, RADIO FREQUENCY: inductance 4.0 uh, $\pm 10\%$ ; approximate dc rating .15 ohms.	Filter Network	CL-105-2
L7005	Same as L7004.	Filter Network	
L7006	Same as L7001.	Filter Network	
L7007.1	CORE, TORIOD: bead type; powder iron.	Freq. Det. Network	
L7007.2	Same as L7007.1.	Freq. Det. Network	
L7007.3	Same as L7007.1.	Freq. Det. Network	
L7007.4	Same as L7007.1.	Freq. Det. Network	
L7007.5	Same as L7007.1.	Freq. Det. Network	
L7008.1	Same as L7007.1.	Freq. Det. Network	
L7008.2	Same as L7007.1.	Freq. Det. Network	
L7008.3	Same as L7007.1.	Freq. Det. Network	
L7008.4	Same as L7007.1.	Freq. Det. Network	
L7008.5	Same as L7007.1.	Freq. Det. Network	
L7009.1	Same as L7007.1	Freq. Det. Network	
L7009.2	Same as L7007.1.	Freq. Det. Network	
L7009.3	Same as L7007.1.	Freq. Det. Network	

**PARTS LISTS AF AMPLIFIER, MODEL HFA-1 (cont'd)**

REF SYMBOL	DESCRIPTION	FUNCTION	TMC PART NUMBER
L7009.4	Same as L7007.1.	Freq. Det. Network	
L7009.5	Same as L7007.1.	Freq. Det. Network	
L7010.1	Same as L7007.1.	Freq. Det. Network	
L7010.2	Same as L7007.1.	Freq. Det. Network	
L7010.3	Same as L7007.1.	Freq. Det. Network	
L7010.4	Same as L7007.1.	Freq. Det. Network	
L7010.5	Same as L7007.1.	Freq. Det. Network	
L7011	COIL, RADIO FREQUENCY: tuned; 250-kc operating frequency; primary inductance 300 uh, $\pm 10\%$ ; consists of two capacitors, one 20,000 uuf and one 1000 uuf, two resistors, one 6800 ohms and one 22,000 ohms; aluminum case.	RF Tuned	AC-151
L7012	Same as L7011.	RF Tuned	
M7000	METER, AUDIO LEVEL: minus 20 to plus 3 db, 0 to 100% scale; ballistic movement; internal impedance 3900 ohms; standard 2-3/16 in. rectangular case.	Audio Level Ind.	MR-154
M7001	Same as M7000.	Audio Level Ind.	
R7000	RESISTOR, VARIABLE, COMPOSITION: 100 ohms; $\pm 10\%$ ; 2 watts.	Hum Balance	RV4ATXA101A
R7001	RESISTOR, FIXED, COMPOSITION: 10,000 ohms; $\pm 10\%$ ; 1/2 watt.	Plate Decoupling	RC20GF103K
R7002	RESISTOR, FIXED, COMPOSITION: 100,000 ohms; $\pm 10\%$ ; 1/2 watt.	Grid Leak	RC20GF104K
R7003	RESISTOR, FIXED, COMPOSITION: 22,000 ohms; $\pm 10\%$ ; 1/2 watt.	Screen Grid Dropping	RC20GF223K
R7004	RESISTOR, FIXED, COMPOSITION: 3300 ohms; $\pm 10\%$ ; 1/2 watt.	Plate Load	RC20GF332K
R7005	RESISTOR, FIXED, COMPOSITION: 180 ohms; $\pm 10\%$ ; 1/2 watt.	Cathode Bias	RC20GF181K
R7006	RESISTOR, FIXED, COMPOSITION: 27,000 ohms; $\pm 10\%$ ; 1/2 watt.	Screen Grid Dropping	RC20GF273K

**PARTS LISTS AF AMPLIFIER, MODEL HFA-1 (c nt'd)**

REF SYMBOL	DESCRIPTION	FUNCTION	TMC PART NUMBER
R7007	RESISTOR, FIXED, COMPOSITION: 4700 ohms; ±10%; 1/2 watt.	Plate Load	RC20GF472K
R7008	RESISTOR, FIXED, COMPOSITION: 47 ohms; ±10%; 1/2 watt.	Parasitic Supp.	RC20GF470K
R7009	Same as R7002.	Grid Leak	
R7010	RESISTOR, FIXED, COMPOSITION: 220 ohms; ±10%; 1/2 watt.	Cathode Bias	RC20GF221K
R7011	RESISTOR, FIXED, COMPOSITION: 820 ohms; ±10%; 1/2 watt.	Volt Divider	RC20GF821K
R7012	RESISTOR, FIXED, COMPOSITION: 10,000 ohms; ±10%; 2 watts.	Volt Divider	RC42GF103K
R7013	Same as R7001.	Plate Load	
R7014	Same as R7007.	Plate Decoupling	
R7015	Same as R7008.	Cathode Bias	
R7016	Same as R7008.	Cathode Bias	
R7017	Same as R7001.	Plate Decoupling	
R7018	Same as R7002.	Filter Network	
R7019	Same as R7007.	Transformer Load	
R7020	RESISTOR, FIXED, COMPOSITION: 47,000 ohms; ±10%; 1/2 watt.	Filter Network	RC20GF473K
R7021	RESISTOR, FIXED, COMPOSITION: 1200 ohms; ±10%; 1/2 watt.	Detector Load	RC20GF122K
R7022	RESISTOR, FIXED, COMPOSITION: 56,000 ohms; ±10%; 1/2 watt.	Grid Leak	RC20GF563K
R7023	RESISTOR, FIXED, COMPOSITION: 470 ohms; ±10%; 1/2 watt.	Cathode Bias	RC20GF471K
R7024	Same as R7001.	Cathode Bias	
R7025	RESISTOR, FIXED, COMPOSITION: 1000 ohms; ±10%; 1/2 watt.	Grid Leak	RC20GF102K
R7026	Same as R7025.	Cathode Bias	
R7027	Same as R7001.	Plate Decoupling	
R7028	RESISTOR, FIXED, COMPOSITION: 12,000 ohms; ±10%; 1/2 watt.	Plate Load	RC20GF123K
R7029	RESISTOR, VARIABLE, COMPOSITION: 1.0 megohm; ±10%; 2 watts.	Audio Level	RV4ATRD105A
R7030	Same as R7025.	Cathode Bias	

**PARTS LISTS AF AMPLIFIER, MODEL HFA-1 (c nt'd)**

REF SYMBOL	DESCRIPTION	FUNCTION	TMC PART NUMBER
R7031	RESISTOR, FIXED, COMPOSITION: 33,000 ohms; ±10%; 1/2 watt.	Plate Load	RC20GF333K
R7032	RESISTOR, FIXED, COMPOSITION: 1.0 megohm; ±10%, 1/2 watt.	Grid Leak	RC20GF105K
R7033	Same as R7025.	Cathode Bias	
R7034	Same as R7031.	Plate Load	
R7035	Same as R7001.	Plate Decoupling	
R7036	Same as R7032.	Grid Leak	
R7037	Same as R7031.	Feedback	
R7038	RESISTOR, FIXED, COMPOSITION: 39,000 ohms; ±10%; 1/2 watt.	Plate Load	RC20GF393K
R7039	Same as R7008.	Parasitic Supp.	
R7040	RESISTOR, FIXED, COMPOSITION: 470,000 ohms; ±10%; 1/2 watt.	Grid Leak	RC20GF474K
R7041	RESISTOR, VARIABLE, COMPOSITION: 1000 ohms; ±10%; 2 watts.	Monitor Gain	RV4ATRD102A
R7042	RESISTOR, FIXED, COMPOSITION: 330 ohms; ±10%; 1 watt.	Cathode Bias	RC32GF331K
R7043	RESISTOR, FIXED, COMPOSITION: 3900 ohms; ±10%; 1/2 watt.	Cathode Bias	RC20GF392K
R7044	Same as R7038.	Cathode Bias	
R7045	Same as R7040.	Grid Leak	
R7046	RESISTOR, FIXED, COMPOSITION: 560 ohms; ±10%; 2 watts.	Load	RC42GF561K
R7047	Same as R7007.	30 db Pad	
R7048	RESISTOR, FIXED, COMPOSITION: 330 ohms; ±10%; 1/2 watt.	30 db Pad	RC20GF331K
R7049	Same as R7048.	30 db Pad	
R7050	Same as R7007.	30 db Pad	
R7051	Same as R7000.	Hum Balance	
R7052	Same as R7001.	Plate Load	
R7053	Same as R7002.	Grid Leak	
R7054	Same as R7003.	Screen Grid Dropping	
R7055	Same as R7004.	Plate Load	

**PARTS LISTS AF AMPLIFIER, MODEL HFA-1 (cont'd)**

REF SYMBOL	DESCRIPTION	FUNCTION	TMC PART NUMBER
R7056	Same as R7005.	Cathode Bias	
R7057	Same as R7006.	Screen Grid Dropping	
R7058	Same as R7007.	Plate Load	
R7059	Same as R7008.	Parasitic Supp.	
R7060	Same as R7002.	Grid Leak	
R7061	Same as R7010.	Cathode Bias	
R7062	Same as R7011.	Voltage Divider	
R7063	Same as R7012.	Voltage Divider	
R7064	Same as R7001.	Plate Load	
R7065	Same as R7007.	Plate Decoupling	
R7066	Same as R7008.	Cathode Bias	
R7067	Same as R7008.	Cathode Bias	
R7068	Same as R7001.	Plate Decoupling	
R7069	Same as R7002.	Filter Network	
R7070	Same as R7007.	Transformer	
R7071	Same as R7020.	Filter Network	
R7072	Same as R7022.	Grid Leak	
R7073	Same as R7021.	Diode Load	
R7074	Same as R7023.	Cathode Bias	
R7075	Same as R7001.	Cathode Bias	
R7076	Same as R7025.	Grid Leak	
R7077	Same as R7001.	Plate Decoupling	
R7078	Same as R7028.	Plate Load	
R7079	Same as R7025.	Cathode Bias	
R7080	Same as R7029	Line Level	
R7081	Same as R7025.	Cathode Bias	
R7082	Same as R7031.	Plate Load	
R7083	Same as R7032.	Grid Leak	
R7084	Same as R7025.	Cathode Bias	

**PARTS LISTS AF AMPLIFIER, MODEL HFA-1 (c nt'd)**

REF SYMBOL	DESCRIPTION	FUNCTION	TMC PART NUMBER
R7085	Same as R7031.	Plate Load	
R7086	Same as R7001.	Plate Decoupling	
R7087	Same as R7038.	Plate Load	
R7088	Same as R7032.	Grid Leak	
R7089	Same as R7031.	Feedback	
R7090	Same as R7008.	Parasitic Supp.	
R7091	Same as R7043.	Cathode Bias	
R7092	Same as R7038.	Cathode Bias	
R7093	Same as R7040.	Grid Leak	
R7094	Same ar R7042.	Cathode Bias	
R7095	Same as R7040.	Grid Leak	
R7096	Same as R7041.	Monitor Gain	
R7097	Same as R7046.	Load	
R7098	Same as R7100.	30 db Pad	
R7099	Same as R7048.	30 db Pad	
R7100	Same as R7048.	30 db Pad	
R7101	Same as R7007.	30 db Pad	
R7102	Same as R7008.	Parasitic Supp.	
R7103	Same as R7008.	Parasitic Supp.	
R7104	RESISTOR, FIXED, COMPOSITION: 91 ohms; $\pm 10\%$ ; 1/2 watt.	30 db Pad	RC20GF910K
R7105	Same as R7104	30 db Pad	
R7106	RESISTOR, FIXED, COMPOSITION: 3600 ohms; $\pm 10\%$ ; 1/2 watt.	30 db Pad	RC20GF362K
R7107	Same as R7104.	30 db Pad	
R7108	Same as R7104.	30 db Pad	
R7109	Same as R7106.	30 db Pad	
R7110	Same as R7002.	TC Network	
R7111	Same as R7002.	TC Network	
R7112	RESISTOR, FIXED, COMPOSITION: 100 ohms; $\pm 10\%$ ; 1/2 watt.	Isolation	RC20GF101K

**PARTS LISTS AF AMPLIFIER, MODEL HFA-1 (cont'd)**

REF SYMBOL	DESCRIPTION	FUNCTION	TMC PART NUMBER
R7113	Same as R7008.	Terminating	
R7114	Same as R7112.	Isolation	
R7115	Same as R7008.	Terminating	
R7116	RESISTOR, FIXED, COMPOSITION: 33,000 ohms; ±10%; 1 watt.	Current Limiting	RC32GF333K
R7117	Same as R7116.	Current Limiting	
R7118	Same as R7040	Voltage Divider	
R7119	Same as R7020.	Voltage Divider	
R7120	Same as R7007.	Isolation	
R7121	Same as R7007.	Isolation	
S7000	NOT USED.		
S7001	SWITCH, ROTARY: two position; 1 section; contact rating 5 amps, 28 vdc and 0.5 amps, 110 vac.	Power ON-OFF	SW-150
S7002 A, B, C	SWITCH, ROTARY: 3 section; 3 positions; non- shorting type contacts; contact rating 1/4 amp at 250 vdc.	Detection	SW-301
S7003	SWITCH, TOGGLE: single pole, single throw; contact rating 3 amp - 125 v or 6 amp - 125 v.	Load	ST-103-1-62
S7004 A, B, C	Same as S7002A, B, C	Detection	
S7005	Same as S7003.	Load	
T7000	TRANSFORMER, RADIO FREQUENCY: tuned; operating frequency 250 kc; inductance 610 uh, ±10% in primary, .3 uh, ±10% in secondary, consists of two capacitors one 560 uuf, one 20,000 uuf.	Isolation Ampl.	TT-168
T7001 T7001	NOT USED.		
T7002	TRANSFORMER, PULSE: 3 wings; winding no. 1 4.7 mh; turns ratio 5:5:1.	Detector	TF-228-K-15
T7003	TRANSFORMER, AUDIO FREQUENCY: primary impedance, 10,000 ohms CT; secondary impedance no. 1, 4 ohms, 8 ohms, 16 ohms, secondary impedance no. 2, 600 ohms CT; hermetically sealed case.	Audio Output	TF-237
T7004	Same as T7000.	Isolation Ampl.	
T7005	NOT USED.		

**PARTS LISTS AF AMPLIFIER, MODEL HFA-1 (c nt'd)**

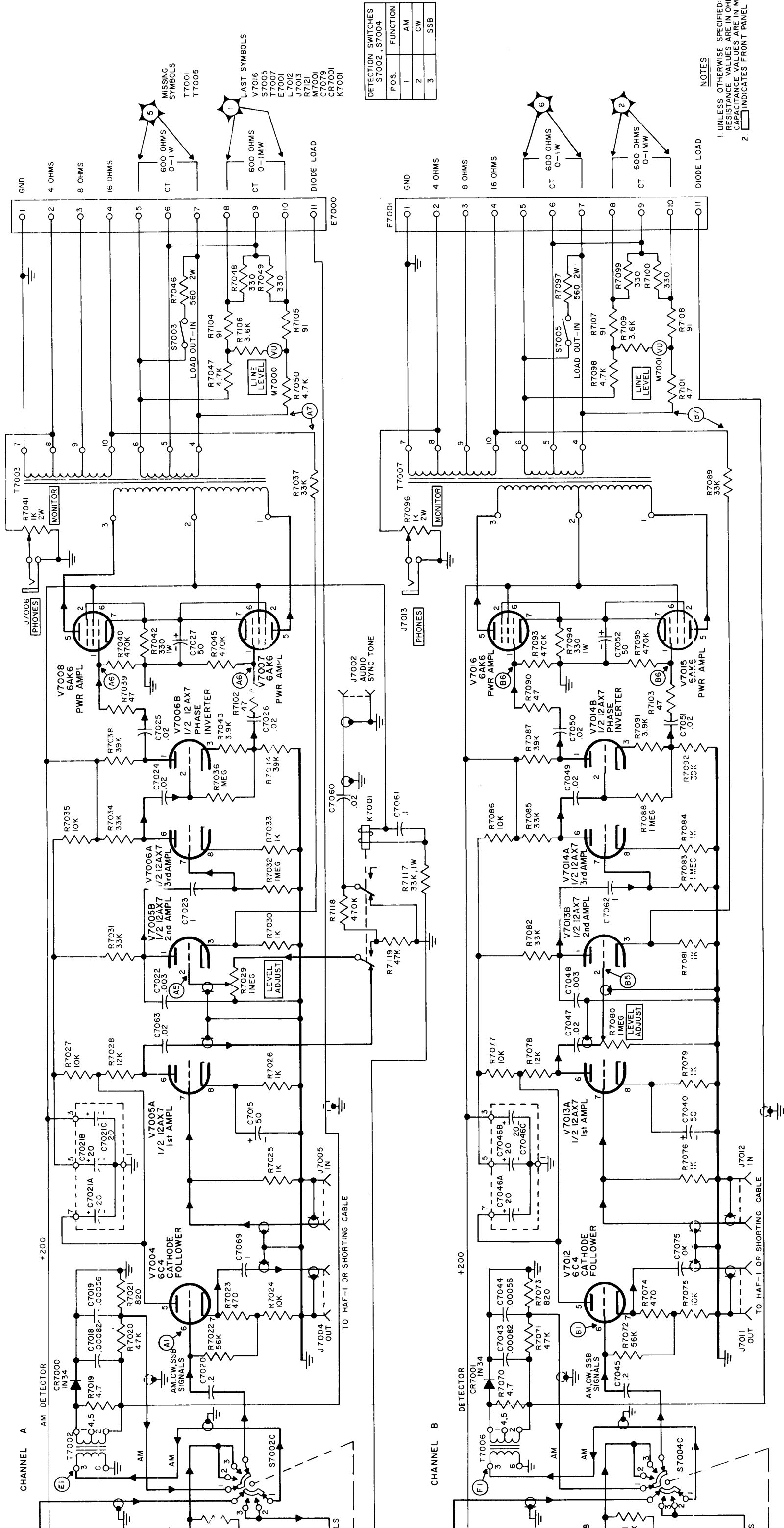
REF SYMBOL	DESCRIPTION	FUNCTION	TMC PART NUMBER
T7006	Same as T7002.	Detector	
T7007	Same as T7003.	Load	
V7000	NOT USED.		
V7001	TUBE, ELECTRON: medium-mu triod sharp cutoff pentode; 9 pin miniature.	BFO & Isolation Ampl.	6U8
V7002	TUBE, ELECTRON: remote cutoff pentode: 7 pin miniature.	IF Isolation Ampl.	6BA6
V7003	TUBE, ELECTRON: pentagrid converter; 9 pin miniature.	Product Detector	6BA7
V7004	TUBE, ELECTRON: power triode; 7 pin miniature.	Cathode Follower	6C4
V7005 A, B	TUBE, ELECTRON: high mu triode twin triode; 9 pin miniature.	1st & 2nd AF Ampl.	12AX7
V7006 A, B	Same as V7005A, B.	3rd AF Ampl & Phase Inverter	
V7007	TUBE, ELECTRON: power amplifier pentode; 7 pin miniature.	Power Ampl.	6AK6
V7008	Same as V7007.	Power Ampl.	
V7009 A, B	Same as V7001A, B.	BFO & Isolation Ampl.	
V7010	Same as V7002.	IF Isolation Ampl.	
V7011	Same as V7003.	Product Detector	
V7012	Same as V7004.	Cathode Follower	
V7013 A, B	Same as V7005A, B	1st & 2nd AF Ampl.	
V7014 A, B	Same as V7005A, B.	3rd AF Ampl. & Phase Inverter	
V7015	Same as V7007.	Power Ampl.	
V7016	Same as V7007.	Power Ampl.	
XC7021	SOCKET, TUBE ELECTRON: octal type.	C7021 Socket	TS101P01
XC7046	Same as XC7021.	C7046 Socket	
XV7000	NOT USED.		
XV7001	SOCKET, TUBE ELECTRON: 9 pin miniature.	V7001 Socket	TS103P01
XV7002	SOCKET, TUBE ELECTRON: 7 pin miniature.	V7002 Socket	TS102P01
XV7003	Same as XV7001.	V7003 Socket	



**PARTS LISTS AF AMPLIFIER, MODEL HFA-1 (cont'd)**

REF SYMBOL	DESCRIPTION	FUNCTION	TMC PART NUMBER
XV7004	Same as XV7002.	V7004 Socket	
XV7005	Same as XV7001.	V7005 Socket	
XV7006	Same as XV7001.	V7006 Socket	
XV7007	Same as XV7002.	V7007 Socket	
XV7008	Same as XV7002.	V7008 Socket	
XV7009	Same as XV7001.	V7009 Socket	
XV7010	Same as XV7002.	V7010 Socket	
XV7011	Same as XB7001.	V7011 Socket	
XV7012	Same as XV7002.	V7012 Socket	
XV7013	Same as XV7001.	V7013 Socket	
XV7014	Same as XV7001.	V7014 Socket	
XV7015	Same as XV7002.	V7015 Socket	
XV7016	Same as XV7002.	V7016 Socket	

**SECTION 8**  
**SCHEMATIC DIAGRAMS**



DETECTION SWITCHES		
POS.	FUNCTION	
1	AM	
2	CW	
3	SSB	

- NOTES
- UNLESS OTHERWISE SPECIFIED: RESISTANCE VALUES ARE IN OHMS, 1/2 WATT CAPACITANCE VALUES ARE IN MICROFARADS
  - INDICATES FRONT PANEL CONTROL

Figure 8-1. AF Amplifier, Model HFA-1, Schematic Diagram

