STATION SERVICING MANUAL
RA6778C
LF/HF RECEIVER

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NOTE

This manual contains information on Installation and Operating procedures associated with the RA6778C Receiver. Refer to the Depot Manual for detailed technical information on the Theory of Operation and Maintenance procedures.

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TABLE OF CONTENTS

TABLE OF CONTENTS (Cont.)

LIST OF ILLUSTRATIONS

LIST OF TABLES

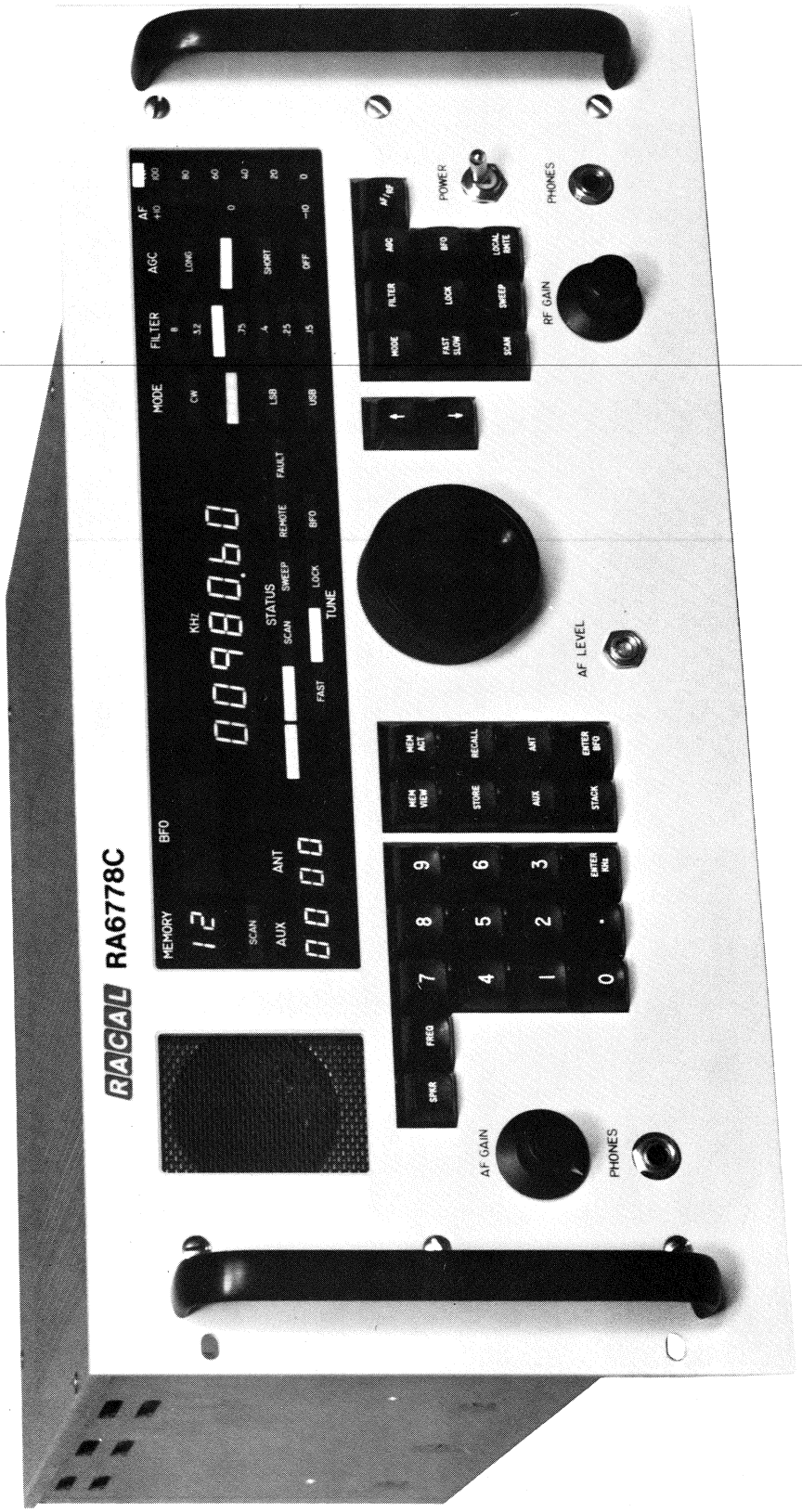

Figure 1-1. Overall View, RA6778C Receiver

CHAPTER 1
GENERAL INFORMATION

1.1 INTRODUCTION

The RA6778C LF/MF/HF communications receiver is a fully synthesized, tunable, solid state receiver, suitable for all forms of reception and monitoring over the wide frequency band of 10 KHz to 30 MHz. The front panel controls permit local selection of receiver parameters and provisions have been made for optional remote control operation from an external digital command unit or computer. Push button controls located on the front panel of the receiver provide for rapid selection of tuned frequency and mode of reception; an additional manual tuning knob is present for fine adjustments of tuned frequency and BFO settings. The receiver is capable of storage and recall of 90 different frequency and mode settings. Additionally, this stored information is protected against power interruptions by an internal back up power source. Receiver parameters are shown on the front panel by LED displays.

The receiver provides reception capabilities for LSB/USB (A3J), AM (A3) and CW (A1). Table 1-1 is an explanation of the International Reception Mode Codes.

TABLE 1-1.
RECEPTION MODE CODES

Complete Designation Example:

2 A 2 H

Bandwidth in kHz

Type of Transmission

A = AM
F = FM
P = PCM

Purpose

0 = No modulation
1 = Telegraphy (on-off)
2 = Telegraphy (modulation)
3 = Telephony
4 = Facsimile
5 = Television
6 = Duplex Telegraphy
7 = Multichannel Telegraphy
9 = None of the above

Supplementary Characteristics

A = Single Sideband reduced carrier
B = Two independent sidebands
C = Single sideband, vestigial
D = AM pulse
E = Pulse width modulation
H = Single sideband, full carrier
J = Single sideband, suppressed carrier
(None) = Double sideband, full carrier

Abbreviations:

AFC = Automatic Frequency Control
AM = Amplitude Modulation
CW = Continuous Wave
FM = Frequency Modulation (or Phase)
FSK = Frequency Shift Keying
ISB = Independent Sideband
LSB = Lower Sideband
MCW = Modulated Continuous Wave
PCM = Pulse Coded Modulation
SSB = Single Sideband
USB = Upper Sideband
DSB = Double Sideband

The built-in frequency synthesizer is phase-locked to the output of a frequency standard covering the full receiver tuning range of 10 KHz to 30 MHz. The synthesizer is tunable in increments of 10 Hz. A separate frequency synthesizer is used to generate the ± 8 kHz BFO offset adjustable in increments of 10 Hz.

The RA6778C Receiver has a total of seven filters. One of the seven is a 3.2 kHz symmetrical filter used for USB and LSB as well as AM and CW reception. Other filters supplied include the bandwidths of 0.150, 0.250, 0.425, 0.750, 1.25 and 8 kHz.

1.2 EQUIPMENT DESCRIPTION

1.2.1 Functional Description

Figure 1-2 is a simplified block diagram of the RA6778C Receiver. The digital or manual inputs descretely select the receiver tuned frequency in 10 Hz increments, AGC ON/OFF, AGC time constants, the detection mode, IF Bandwidth and BFO (LLO) frequency.

The input signal from the antenna is applied through a 32 MHz low pass filter, to the first mixer, where it is combined with the variable frequency output from the synthesizer. This frequency, in the 35.410 to 65.4 MHz range, is selected by external controls, and is dependent on the frequency of operation. This synthesizer is tuned in 10 Hz or greater steps by a command from the local or remote tuning control logic.

The IF output from the first mixer is fed via a 35.4 MHz band pass filter and an IF amplifier to the second mixer, where it is combined with a 34 MHz output from the synthesizer to provide a 1.4 MHz IF output. Dependent upon the mode selected, the 1.4 MHz signal is then fed to the SSB or IF selectivity filters.

The output from the selected filter passes via the main IF amplifier to an AGC amplifier and detector, which controls the gain of the various IF amplifier stages, and to the detector stage. A product detector is provided for the CW/SSB modes, and an envelope detector for DSB.

The RA6778C Receiver may be controlled via a character-oriented, serial asynchronous command message.

1.2.2 Mechanical Description

A rigid, die-cast, full width chassis provides the basis for the main frame of the receiver. Mounted within compartments on the underside of this chassis are the mixer boards and a portion of the frequency synthesizer circuitry. On the top side of the chassis there are up to seven printed circuit modules for the signal chain and synthesizers, as well as three digital circuit cards which comprise the control and interface section of the receiver. Also mounted on the top of the chassis is the frequency standard module and the power supply. The power supply regulators are mounted on the rear of the power supply module. All modules are accessible for maintenance and can be removed or replaced using simple hand tools without use of a soldering iron.

Figure 1-3 is the top view of the RA6778C Receiver, and Figure 1-4 is the bottom view.

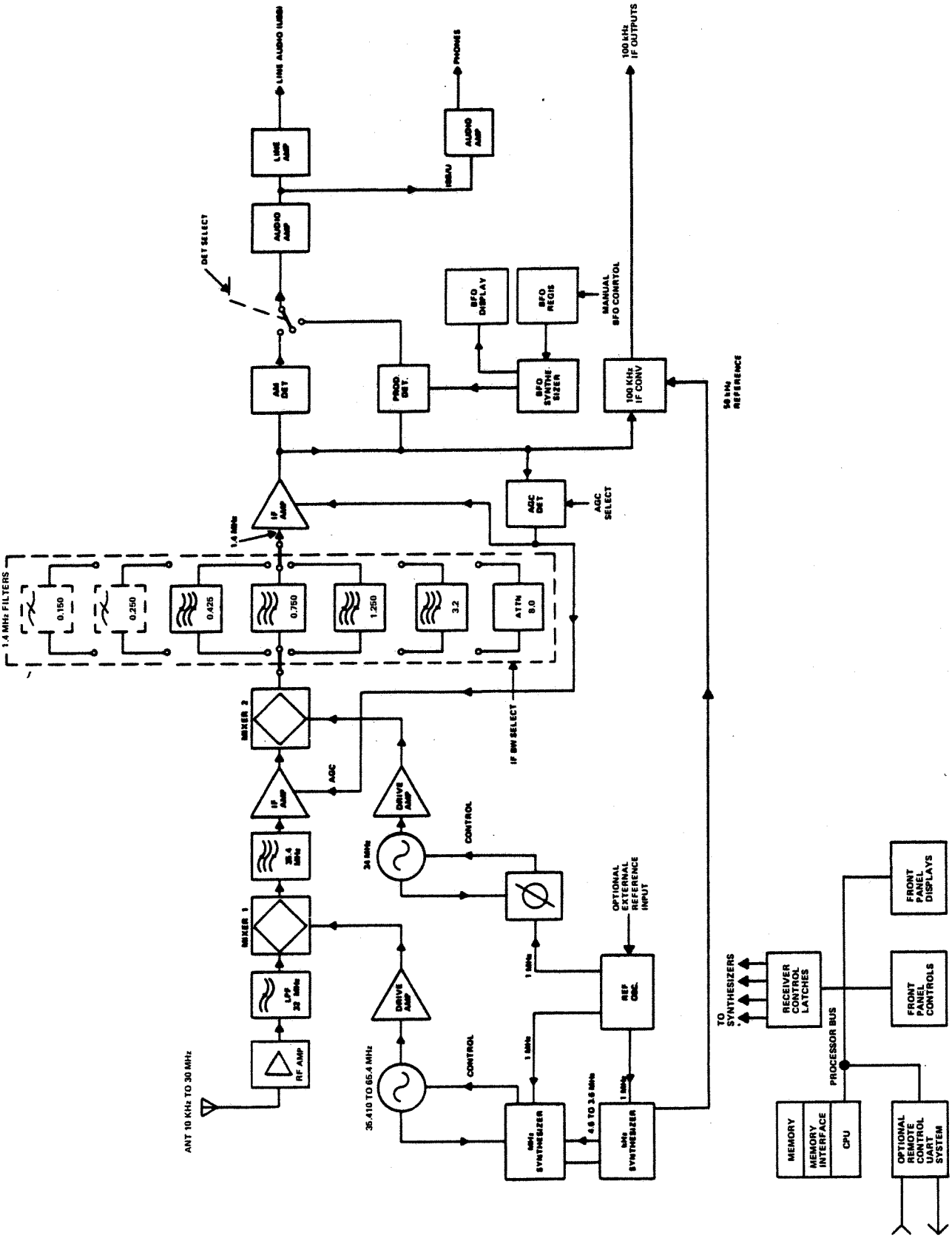

Figure 1-2. Simplified Block Diagram, RA6778 Receiver

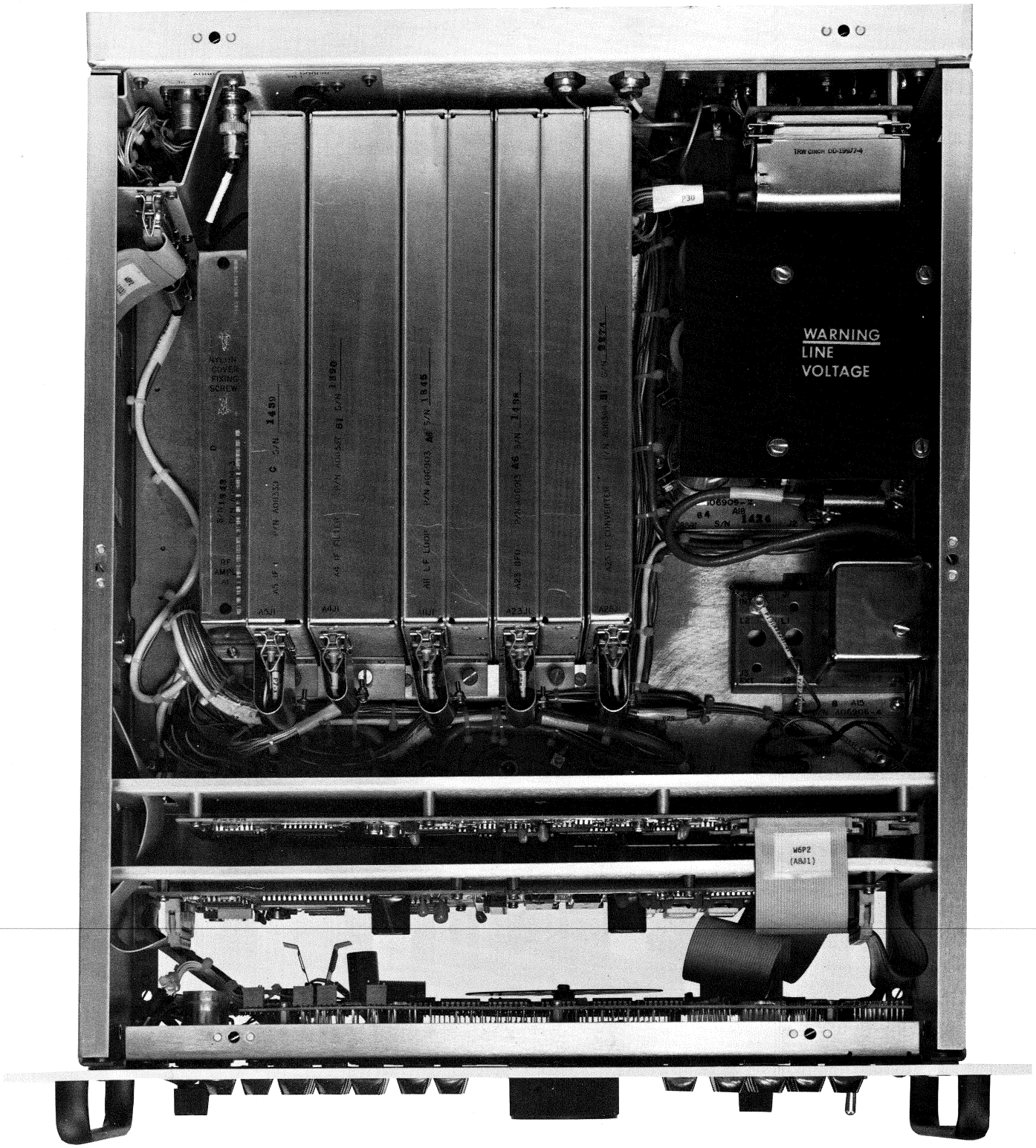

Figure 1-2. Top View, RA6778C Receiver

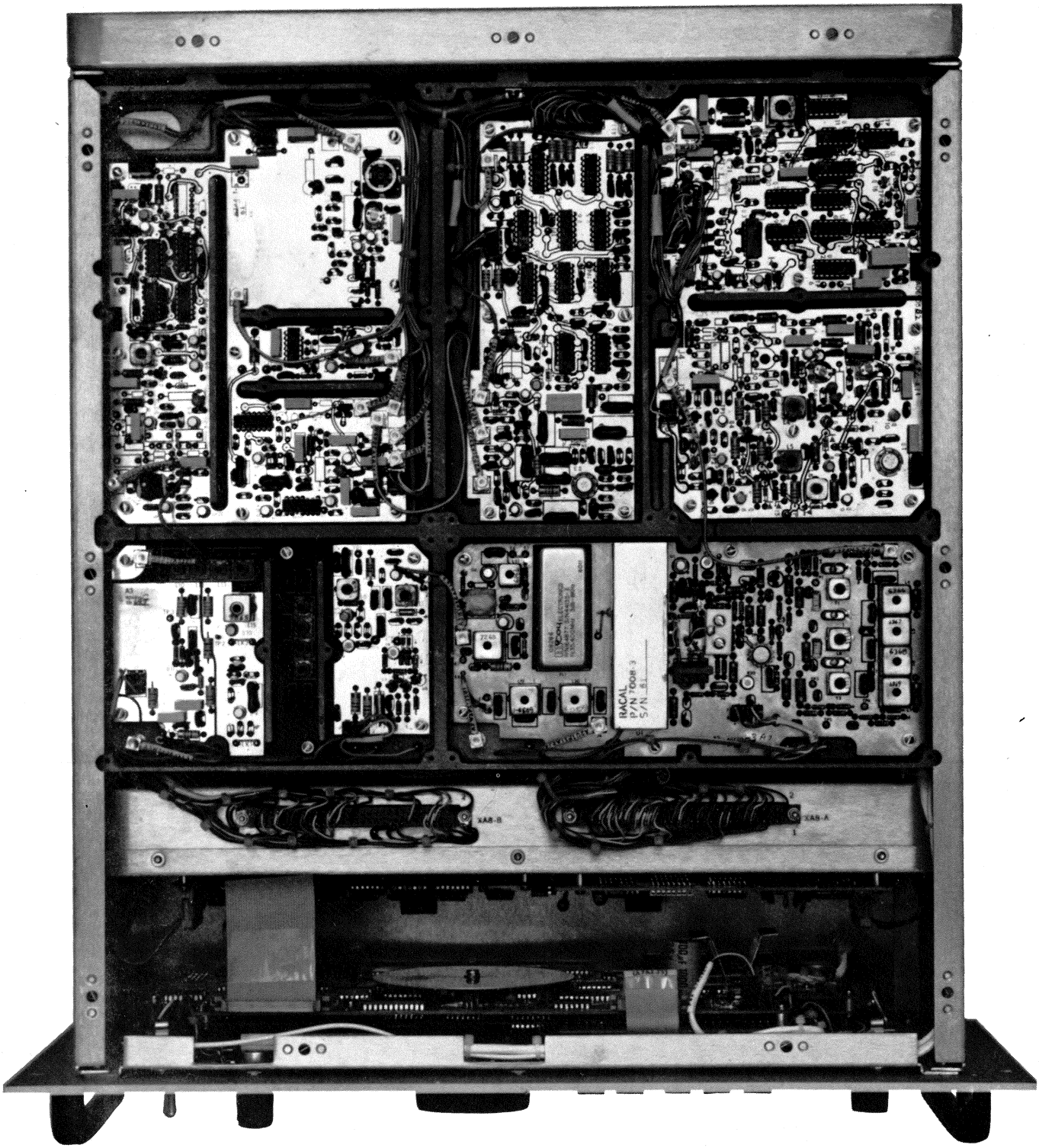

Figure 1-3. Bottom View, RA6778C Receiver

1.3 REFERENCE DATA

1.3.1 Table 1-2 describes and identifies the various modules constituting the RA6778C communications Receiver. For a complete listing of the parts contained within the modules, mating connectors and other electrical parts, refer to the RA6778C Depot Manual. Paragraph 1-4 gives technical specifications for the RA6778C Receiver.

TABLE 1-2
RA6778 HF COMMUNICATIONS RECEIVER MODULES

Quantity	Part Number	Reference Designation	Module Name
1	06894-3	A1	RF Amplifier
1	07215-4	A2	First Mixer
1	06896-2	A3	Second Mixer
1	08337	A4	IF Filter
1	08339	A5	IF Amplifier
1	08686	A6	Microcomputer I/O
1	08698-1	A7	Front Panel
1	08356-1	A8	Receiver Latch
1	06903	A11	LF Loop Synthesizer
1	06904	A13	Transfer Loop
1	06905	A14	HF Loop Synthesizer
1	06906-4	A15	Frequency Standard
1	08744-1	A16	34 MHz Generator
1	06909-2	A18	Power Supply
1	06913	A23	BFO Synthesizer
1	08344	A25	100 kHz IF Converter

1.4 TECHNICAL SPECIFICATIONS

Frequency Range: 10 KHz - 30 MHz

Frequency Selection: 10 HZ increments

Frequency Tuning: By keyboard entry or continuous tuning with selectable fast (100 Hz) and slow (10 Hz) increments. BFO continuous in 10 Hz increments.

Frequency Indication: (a) 7 digit electronic readout of tuned frequency to 10 Hz.
(b) 3 digit and sign readout of BFO relative to IF center +/– 8 KHz.

Frequency Stability: +/– 1 part in 10^7 using internal 5 MHz reference oscillator. Provision for an external 1 MHz reference input. 0 dBm nominal into 50 ohms.

Modes of Operation: USB/A3J upper side band; LSB/A3J lower side band; CW/A1 continuous wave; AM/A3 amplitude modulation.

IF Filter Specifications:

Nominal 3 db BW	Minimum 3 db Bandwidth (Referenced to nominal centre frequency)	Maximum 60 db Bandwidth (Referenced to nominal centre frequency)
150 Hz	±55 Hz	±210 Hz (Note 3)
250 Hz	±105 Hz	±335 Hz (Note 3)
425 Hz	±190 Hz	±545 Hz (Note 3)
750 Hz	±375 Hz	±940 Hz
1.25 kHz	±625 Hz	±1.560 kHz
3.2 kHz	±1.6 kHz	±2.3 kHz
8 kHz	±4 kHz	±10 kHz

USB Filter characteristics as for 3.2 kHz above – effective c.f. + 1.85 kHz
LSB Filter characteristics as for 3.2 kHz above – effective c.f. – 1.85 kHz

Notes:
1. I.F. and audio outputs of receiver (in manual r.f. gain) shall not vary more than ±2 db for any filter selection (CW mode).
2. The above characteristics shall apply over the life (15 years) of the receiver.
3. The measured shape factor 3 db to 60 db shall be less than 2.5:1.

Input Impedance: 50 ohms nominal, 2.1 VSWR; type BNC connector.

AGC: Range: an increase from 1 microvolt (–113 dbm) to 100 mV will produce an output change of less than 6 dB. Time constants (USB/LSB): Attack: <15 msec. Decay: Short <50 msec; Med 1 +/– .25 sec; Long: 5 +/– 1 sec.

Noise Figure:

The noise figure does not exceed 12 db over the frequency range 100 kHz to 29.99999 MHz. The noise figure may degrade below 100 kHz, however the rate of degradation does not exceed 6 db per octave.

Sensitivity:

Sensitivity shall be a minimum of 10 dB signal to noise ratio over the frequency range and signal levels as indicated at the various bandwidths.

IF BW kHz	SIGNAL LEVEL – MICROVOLTS		
	10 kHz	100 kHz	29.9 MHz
8.0	N/A	0.7	0.7
3.2	2.5	0.3	0.3
1.25	1.7	0.2	0.2
0.75	1.3	0.16	0.17
0.4	1.0	0.14	0.14
0.25	0.7	0.09	0.09
0.15	0.6	0.07	0.07

Cross Modulation:

Cross modulation appearing upon a –87 dbm unmodulated desired signal from a 30% modulated interfering signal is less than 3% under the following conditions:

(1) the receiver is tuned to the unmodulated signal
(2) the modulated signal is 90 db in amplitude above the unmodulated signal
(3) the frequency separation of the signals is 100 kHz

This specification applies to all IF bandwidths and with AGC on.

Out of Band Intermodulation Distortion:

Signals at a level of –24 dm, one removed a maximum of 30 kHz from the tuned frequency, one removed a minimum of 30 kHz, and at any frequency from 10 kHz to 30 MHz which produces third order intermodulation products within the passband, do not produce intermodulation products greater than 87 db below either interfering signal when referenced to the input.

Intercept Point:

The third order input intercept point is at least +20 dbm for signals at least 30 kHz removed from the receiver tuned frequency.

In-Band Intermodulation Distortion:

All spurious audio responses produced by two in band CW test signals are at least 40 db below the audio output produced by the test signals when the receiver is operating with the product detector and long AGC. The CW test signals shall be separated by 100 Hz and shall be at a level of –24 dbm. In band IF intermods are at least 50 db below the IF output produced by the test signals under the same test conditions.

Spurious Response	
External	External signals removed 20 kHz or more from a wanted signal at −113 dbm, are greater than −33 dbm to degrade the wanted signal (S + N)/N ratio by 3 db.
Internal	Internally generated spurious signals are less than −123 dbm input equivalent. This figure applies at all frequencies including fundamental and harmonics of digital clock circuits for the remote control system.
Image and IF Rejection:	All image and IF responses are at least 80 db below the test signal, using the product detector, AGC on and with any IF bandwidth selected.
Antenna Re-radiation:	Conducted radiation from the antenna input into a load of 50 ohms is less than 10 uV throughout the frequency range 10 kHz −1 GHz.
Impulse Response:	The receiver is designed to recover rapidly from in-band impulses.
Audio Line Output:	The output impedance is 600 ±30 ohms balanced with ungrounded center tap. The audio output to line is at least + 3 dbm, into a 600 ohm load, when a −97 dbm unmodulated signal is applied to the receiver and detected by the receiver with the product detector and when the output frequency is a 1 kHz tone.
Phone Output:	Two phone jacks are provided and connected in parallel. The audio output level to the phone jacks shall total 20 mW minimum at 5% maximum distortion under the input conditions listed above.
Speaker Output:	The internal speaker provides an output with less and 5% distortion under the input conditions listed above. The headphone AF gain control also controls the loudness of the internal speaker signal.
Frequency Response:	The frequency response of the line and phone outputs is ±3 db from 250 Hz to 10 kHz, relative to 1 kHz. The frequency response of the internal speaker is ±3 db from 500 Hz to 5 kHz, relative to 1 kHz.
IF Outputs:	The receiver provides two post IF filtered 100 kHz IF outputs. The sidebands at these outputs bear the same relationship to the carrier as the transmitted signal. The IF outputs are between 100mV and 120mV into 50 ohms for an input signal of −113 dbm. IF output impedance is 50 ohms and there is a 30 db isolation between the two outputs.

Rear Panel Connectors:	Antenna input connector, J1 Digital I/O connector, J2 Antenna switch select connector, J3 AGC Det./Aux. switch/AF output connector J4 IF output connectors (BNC), J5 and J6 1 MHz STD input connector (BNC), J8 1 MHz STD output connector, J7 Power input connector Ground terminal.
Remote Control:	Full remote control of the following receiver parameters by serial asynchronous, character oriented data at 9.6 kilobaud MIL-STD-188C Type E format compatable. (a) Tuned frequency (b) BFO Tuning (c) Bandwidth (d) Detection Mode (e) AGC Time Constants (f) Memory Load (g) Antenna Select (for g&h, there are TTL compatable (h) Auxillary Select output to external devices).
Status Indication:	Front panel indication of status under remote control, remote indication of status under local or remote control.
Front Panel Controls and Indicators:	Frequency control keyboard KHz/BFO frequency control (rotary) Tuning selector keys, FAST/SLOW, LOCK, and BFO with LED indicators MHz/KHz 7 digit decimal display BFO 3 digit display with sign (polarity) MODE selector key USB, LSB, CW and AM with LED indicators AGC selector key OFF, SHORT, MEDIUM and LONG with LED indicators FILTER selector key .15, .25, .425, .75, 1.25, 3.2 and 8 with LED indicators Memory View and Memory Active selector keys with two digit decimal display of location of memory Increment keyed parameter Decrement keyed parameter STORE memory load RECALL memory recall STACK recalls previous settings LOCAL/REMOTE key with LED indicator AF GAIN control AUX select with two digit decimal indicator ANT select with two digit decimal indicator RF GAIN control Meter Meter switch AF/RF positions AF LEVEL pre set line level control Speaker Speaker on/off switch

	Phone Jacks FAULT LED indicator POWER switch SCAN mode select with LED indicator SWEEP mode select with LED indicator
Environment	a. Operating Temperature: 0^{o} to $+55^{o}$ C. b. Storage Temperature: -62^{o} to $+71^{o}$ C. c. Humidity: 10% to 95% d. Shock: MIL-STD-810B, Methods 16, Procedure V. e. Vibration; MIL-STD-810B, Method 514, Procedure XI, Part 1.
Primary Power	120/240 volts, ± 10%, 48 – 420 Hz, single phase.
Dimensions	Suitable for 19 in. (48.3 cm.) rack or desk top console mounting Height: 8.75 in. (22.2 cm.) Width: 19 in. (48.3 cm.) Depth: 19.9 in. (50.6 cm.)
Weight (approx.)	45 lbs. (20.3 kg.)

1.5 MEMORY DUMP

The RA6778C contains 90 memory channels for storage of Receiver settings. A particular channels information is automatically dumped when new Receiver settings are entered through the STORE pushbutton. A switch U23-2 located on circuit card A6A1 provides for dumping the entire 90 channels. To clear all information from all channels set the switch to the ON position. The switch must then be set back to the OFF position before new information can be stored in any channel.

CHAPTER 2
INSTALLATION

2.1 INTRODUCTION

This chapter describes the unpacking, installation, initial checkout and turn-on procedures necessary for proper operation of the RA6778C Communications Receiver. The remote control transmission, receiving and data format requirements are also described.

2.2 INTERFACE REQUIREMENTS

All connections except for the headphones are made from the rear of the receiver.

2.2.1 Rear Panel Connections

A brief description of each rear panel connection is given in the following paragraphs. Figure 2-1 is a view of the receiver rear panel.

a. POWER Input Connector, A18J1
The ac power input connection is made through a three-conductor connector (Racal No. 51069). If the receiver is to be operated with 240 volts ac, refer to Figure 2-3.

b. Coaxial Jacks
Table 2-1 is a listing of all the coaxial connectors at the rear of the RA6778C. All are 50 ohms, BNC type, requiring a UG-88B or equivalent mating connector (Racal Part No. 60036).

c. AUX. SW Connector, J4
The four TTL compatible auxiliary switch outputs are present on this connector. Refer to Table 2-2 for pin-out identification.

d. DIGITAL I/O Connector, J2
A 37-pin connector is wired to output the audio line outputs, AGC Detector bus, /FAULT indicator line and to accept the remote control data. Table 2-3 lists and identifies the interface connections.

e. ANT. SW/SELECT Connector, J3
This connector provides TTL compatible outputs for selection of an external antenna. The six output data lines can form up to 64 discrete selection codes. An additional output is provided to indicate the LOCAL/REMOTE status of the receiver. Refer to Table 2-4 for connector pin assignment.

f. Terminal Strip TB1
The audio line outputs, AGC detector bus and /FAULT indicator line are present on this terminal strip. Refer to Table 2-5 for terminal assignments.

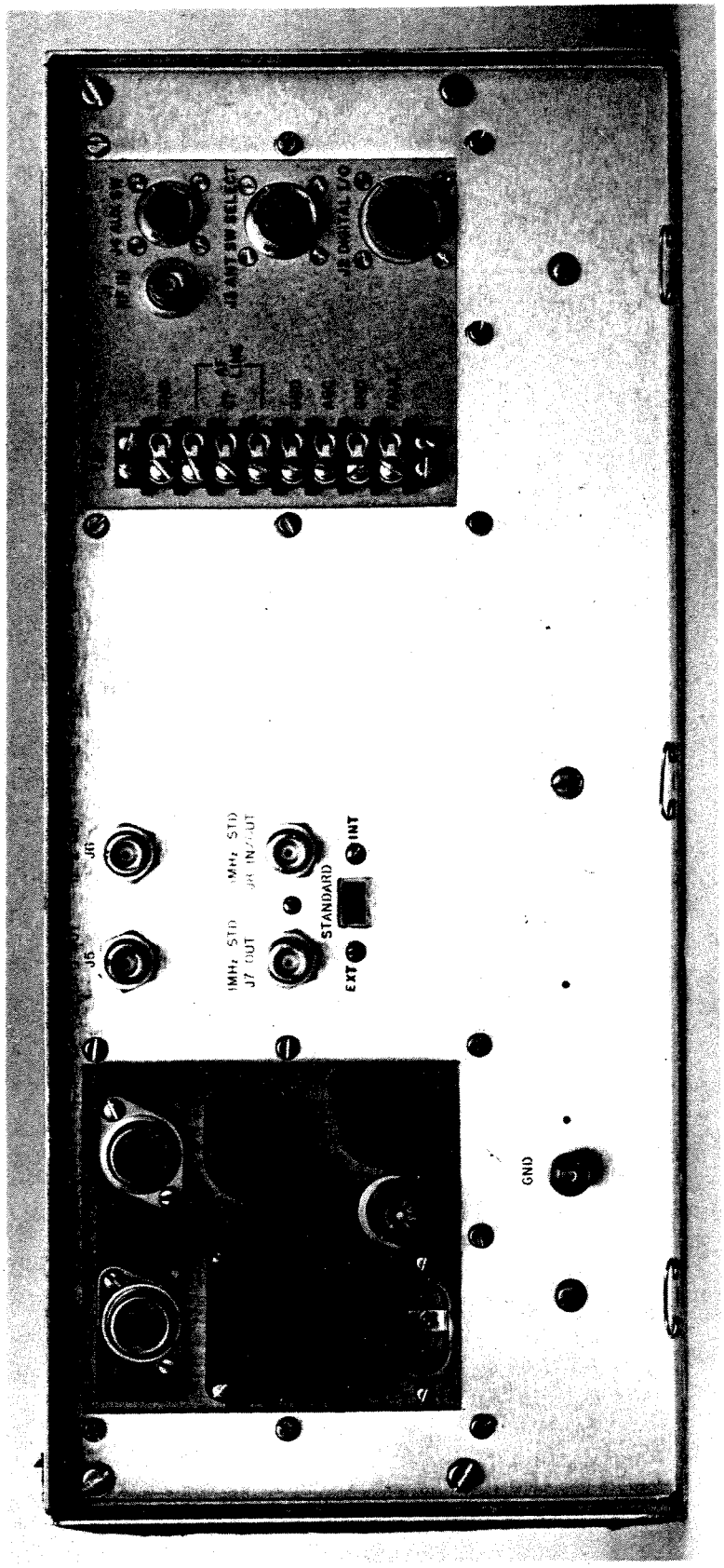

Figure 2-1. Rear View

TABLE 2-1. COAXIAL CONNECTORS

Ref. Desig.	Nomenclature	Function
J1	RF IN	Connects to unbalanced transmission line for RF input.
J8	1 MHz STD IN/OUT	Accepts an external 1 MHz frequency standard. 0 dBm Nom., 50Ω (if internal standard is not used). When internal standard is used J8 is connected in parallel with J7.
J5, J6	IF OUT	Two separate IF outputs for connection to external equipment. Nominal level, 100 - 120 mV into 50 ohms for input of −113 dB. Nominal IF frequency is 100 kHz.
J7	1 MHz STD OUT	1 MHz Internal standard output. Output level of 0 dBm ±6 dB into 50 ohms.

TABLE 2-2. AUX. SW CONNECTOR, J4

Pin	Signal
A	Ground
B	'1'
C	'2'
D	'4'
E	'8'

(B, C, D, E: TTL AUX. Switch Outputs)

TABLE 2-3. DIGITAL I/O CONNECTOR, J2

Pin	Signal	Pin	Signal
A	Main Ground	L	/FAULT
B	Data In	M	Address B1
C	Data In Ground	N	Address B2
D	Data Out	P	Address B3
E	Data Out Ground	R	Address B4
F	AF Line	S	Address B5
G	AF CT	T	Address B6
H	AF Line	U	AGC Detector
J	AF Ground	V	AGC Detector
K	Remote/Local		

TABLE 2-4. ANT. SW/SELECT CONNECTOR, J3

Pin	Signal	
A	LOCAL/REMOTE	
B	'1'	TTL Compatible outputs to external antenna switching equipment.
C	'2'	
D	'4'	
E	'8'	
F	'16'	
G	'32'	
H	Ground	

TABLE 2-5. TERMINAL STRIP TB1

Pin	Signal
1	Ground
2	AF Line
3	AF CT (Center tap, ungrounded)
4	AF Line
5	AF Ground
6	AGC Detector
7	AGC Detector Ground
8	/FAULT

2.2.2 Ground Terminal

A terminal has been provided on the rear panel as a master ground to be connected to the ground system of the cabinet or rack housing the equipment.

2.3 PREPARATION FOR USE

2.3.1 General Inspection

Check the receiver thoroughly for transit damage and ensure that the unit is clear and free from residual packing material.

Check all controls and switches for correct mechanical action, i.e., freedom from binding, scraping or interference of parts.

2.3.2 Installation

To install the receiver in a rack or cabinet, check for adequate space to accommodate cabling and wires to the rear of the unit. Check for any possible interference of parts. Secure by fastening four front panel mounting screws, into the rack or cabinet. For normal installation the Receiver will also be supported by rack mounted runners or slides.

Connect all wires and cabling. Refer to paragraph 2.2.1 for description of connectors and terminals for interconnections with other units and any peripheral equipment.

2.3.3 Main ac Power Input

Check that the ac line supply is of the proper voltage and frequency. If operation at 240 volts is desired, refer to paragraph 2.3.6 prior to turning receiver on.

CAUTION

The supply voltage should remain within 10% of 120 V. A lower voltage can cause the internal regulation circuits to trip and a higher voltage can cause excessive internal temperatures.

2.3.4 Front Panel Indicators

The following indicators are located on the front panel of the RA6778C Receiver. Refer to Figure 2-2.

Frequency kHz: Seven segment LEDS indicates 7 digits in kHz to 10 Hz resolution

BFO: Seven segment LEDS indicates BFO in 3 digits in kHz with + or – indicator for direction of offset.

MEMORY: Seven segment LEDS indicates Memory positions in 2 digits 0 - 90 with SCAN display. Blinks when new channel may be selected.

AUX: Seven segment LEDS indicates auxiliary device selected in 2 digits. Blinks when auxilliary is selected indicating change may be entered.

ANT: Seven segment LEDS indicates antenna selection in 2 digits. Blinks when ANT is selected indicating change may be entered.

STATUS: Six individual LEDS that indicate the status of the Receiver as follows:

- MEM: Indicates when memory mode is active.
- VIEW: Indicates when memory positions are accessable for view or selection. Blinks when display does not coincide with Receiver setting.
- SCAN: Indicates when Receiver is in channel scan mode.
- SWEEP: Indicates when Receiver is scanning preset frequencies in preset increments.

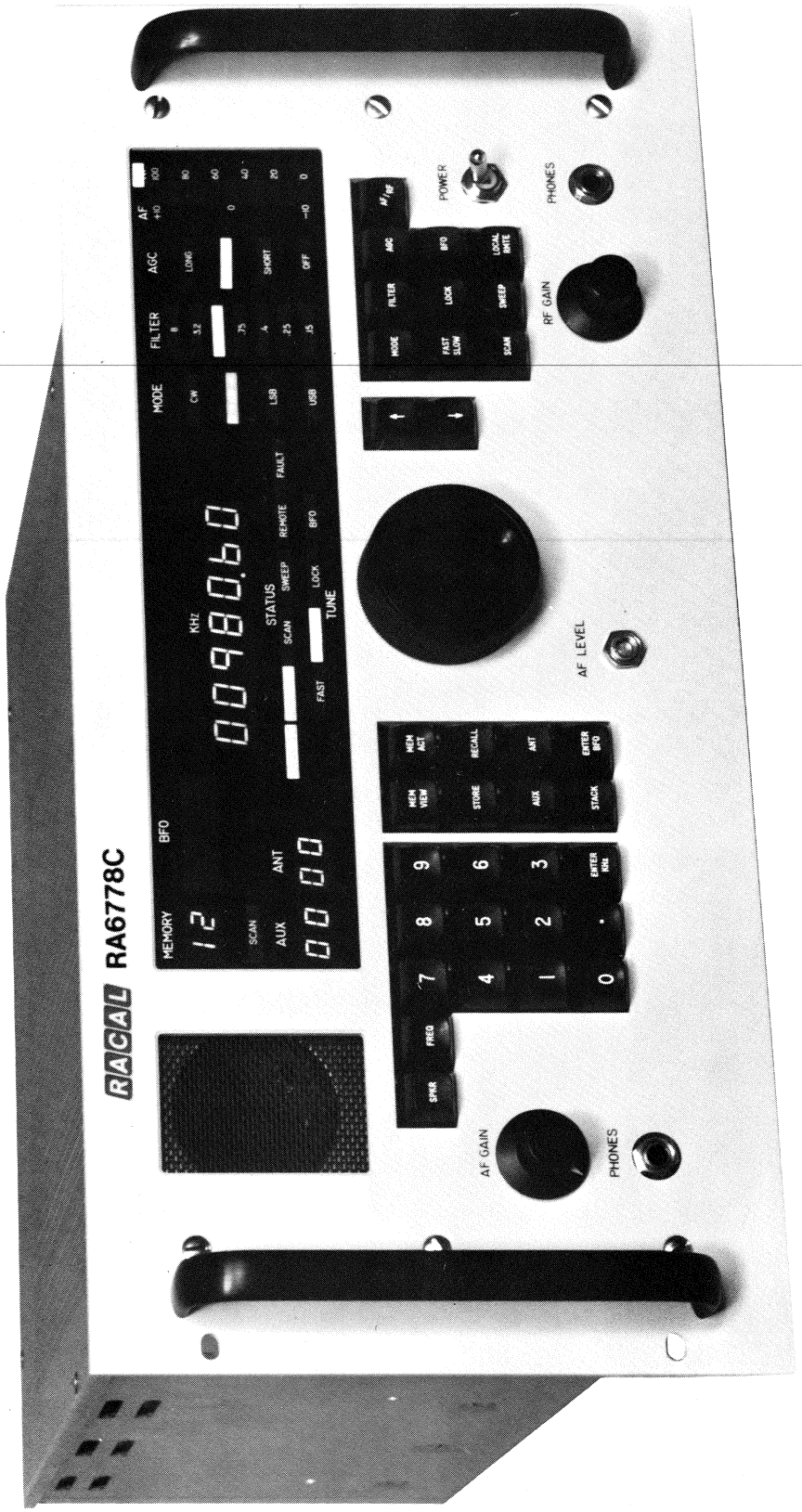

Figure 1-1. Overall View, RA6778C Receiver

REMOTE: Indicates when Receiver is selected for operation from a remote location.

FAULT: Indicates steady when a fault exists in the Synthesizer, flashes when parity error exists.

TUNE: Four individual LEDS that indicate the status of Receiver tuning as follows:

FAST: Indicates when FAST (100 Hz) increment tuning can be entered thru the tuning knob.

SLOW: Indicates when SLOW (10 Hz) increment tuning can be entered thru the tuning knob.

LOCK: Indicates when tuning knob is disabled.

BFO: Indicates when BFO frequency can be entered either thru tuning knob or frequency keys.

MODE: Four individual LEDS that indicate Receiver mode of operation; CW, AM, USB or LSB. The current mode will blink when mode may be changed.

FILTER: Seven individual LEDS that indicate the bandwidth filter selected; .15, .25, .4, .75, 1.25, 3.2 or 8 kHz. The current bandwidth will blink when bandwidth filter can be changed.

AGC: Four individual LEDS that indicate status of AGC mode; SHORT, MED or LONG attack times and OFF which indicate manual control of threshold.

AF/RF: Indicates signal level of AF or RF as selected thru AF/RF pushbutton.

2.3.5 Front Panel Controls

The following controls are located on the front panel of the RA6778C Receiver. Refer to Figure 2-2.

Power On/Off Switch
RF gain control, sets receiver gain when AGC is in MAN.
AF gain control, sets speaker level
AF level control, sets line output audio level
Main tuning knob, allows fine adjustments to tuned frequency or BFO setting after selection of frequency by key pad controls

Pushbutton key pad controls:

Numeric keys 0 through 9, decimal:	Used for entry of frequency data.
FAST/SLOW:	Used to determine rate at which tuning knob changes displayed frequency.
LOCK:	Used to disable tuning knob.

BFO:	Permits main tuning knob to be used to set BFO frequency in CW mode.
FREQ:	Enables numeric keys 0 through 9 and decimal when changing frequency.
ENTER KHZ:	Enters keyed frequency to receiver or memory.
ENTER BFO:	Enters keyed frequency to BFO. Subsequent depression will change sign.
LOCAL/REMOTE:	Transfers control of receiver to remote control device.
AGC:	Allows changing the AGC mode through the UP/DOWN keys. When in MAN position permits gain to be set manually by use of front panel RF gain control.
MODE:	Allows changing detection mode of receiver through the UP/DOWN keys; will automatically select appropriate filter when LSB or USB is selected.
FILTER:	Allows discrete selection of bandwidth, through UP/DOWN keys, in all reception modes except LSB or USB.
MEM VIEW:	Provides access to the 90 memory positions for view or change by front panel controls. The receiver is not effected, remaining tuned to the settings before MEM VIEW was depressed. Channels are addressed by the keypad or the UP/DOWN keys. Depressing the key a second time returns control to the front panel.
MEM.ACTIVE:	Same as the MEM VIEW except the receiver is tuned to each channel as it is addressed and memory channel contents cannot be altered (except SCAN flag).
STORE:	In MEM VIEW mode allows entire current receiver set up to be loaded into memory.
RECALL:	In MEM VIEW mode allows the addressed memory channel contents to be loaded into the receiver buffer.
STACK:	Exchanges current receiver settings with the settings previously stored in the stack. The stack buffer is also loaded when FREQ is depressed to initiate frequency entry and when the memory mode is selected.
↑(UP):	Works in conjunction with MODE, FILTER, AGC, MEM, ANT and AUX. Pressing the key will cause the associated function to increment. After holding the key for a while the function will increment at a steady rate. (Incrementing above maximum will wrap around to zero.)
↓(DOWN):	Same as UP except the function will decrement.
SCAN:	In MEM or MEM ACTIVE modes the scan button toggles the scan flag associated with each channel. In the receive mode, the scan button will cause the receiver to enter the channel scan mode.

SWEEP:	Allows the receiver to enter the sweep mode which scans between preset frequencies in preset frequency increments.
SPKR:	Enables or disables the front panel speaker on alternate pushes.
AF/RF:	Toggles the meter display from RF to AF and back. Either AF or RF is illuminated at top of meter display.
AUX:	Allows the Auxiliary device to be altered by keypad or UP/DOWN keys.
ANT:	Allows the Antenna to be altered by keypad or UP/DOWN keys.

2.3.6 Power Source Connections

A three-conductor power cord is normally supplied with the receiver for connection to the power input plug. The connector has the following pin assignments, as viewed from the rear panel:

Left Pin:	LINE
Center Pin:	GROUND
Right Pin:	NEUTRAL

RA6778C Receivers are normally wired for operation with a 120 volt, +10%, 48 to 420 Hz ac source. For receiver operation with a 240 volt source, the receiver must be modified as follows:

a. Disconnect the receiver from the power source and all ancillary equipment.

b. Remove the receiver top cover.

c. Remove the protective cover from the A18 power supply module to expose the power transformer terminals.

d. Make the appropriate connections to the split primary windings of the power transformer in accordance with Figure 2-3A. (Figure 2-3B is included for reference.)

e. Replace the A18 protective cover and the receiver top cover.

CAUTION

Soldering iron should not exceed 40 watts in order to prevent insulation damage.

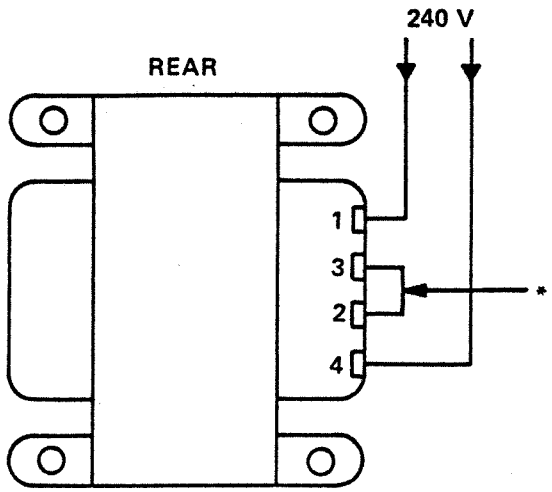

Figure 2-3A. 240 Volt Operation

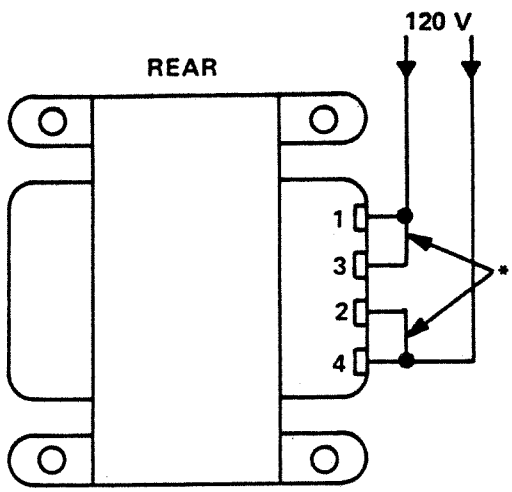

Figure 2-3B. 120 Volt Operation

*ADD JUMPERS AS REQUIRED

2.3.7 Headphone Connections

Two phone jacks are provided on the front panel. These jacks are used with a PL55 plug, Racal Part No. 61501.

2.3.8 (For part numbers of matching connectors refer to Chapter 6)

2.4 INITIAL TURN-ON AND PRELIMINARY CHECKS

2.4.1 Turn-On Procedures

After the preliminary steps and precautions given in paragraph 2.3 have been accomplished, the equipment may be turned on according to the following steps:

a. Verify that front panel POWER switch is off.

b. Connect the power cord to the main ac power source.

c. Turn on front panel POWER switch.

d. Observe that the FAULT light remains out after possibly flashing momentarily.

2.4.2 Operational Check

Refer to the appropriate system technical manual and perform any required system checks related to the installed equipment.

2.4.3 Line Level Adjustment

The following procedure is given for adjustment of the audio line level, required upon installation of the receiver.

a. Set the front panel POWER switch to the Off position.

b. Install a 600 ohm load across the AF LINE output terminals on the TB1 back panel terminal strip.

c. Connect the CW output from a signal generator set to a frequency of 3.5000 MHz and an output of –97 dBm, to the RF IN connector J1 on the rear panel.

d. Turn the POWER switch to ON.

e. Press the MEM VIEW twice (to exit memory).

f. Press FREQ. 0, 3, 5, 0, 1, 8, 0, Enter kHz.

g. Press MODE switch UP/DOWN until LSB is indicated.

h. Press AGC key and UP/DOWN until FAST is indicated.

i. Press AF/RF switch to obtain AF meter indication.

j. Using a thin screwdriver, adjust the AF LEVEL control on the receiver front panel for a 1 mW audio output level, as indicated by zero on the meter.

k. Turn POWER switch to Off and disconnect the generator.

l. Remove the 600 ohm load from the audio output.

2.5 REMOTE CONTROL

2.5.1 Remote Control and Status Data

The receiver will receive, act on, and send information using a serial asynchronous, character oriented data technique. Connection to the remote controller is made through back panel digital I/O connector J2 (Table 2-3). Separate lines are provided for receive and transmit functions (Data In and Data Out, pins B and D of J2).

2.5.2 Data Transmission Rate

The receiver will receive and transmit control data at 9600 baud.

2.5.3 Data Levels

The receiver will accept and transmit data in accordance with MIL-STD-188C with respect to impedance waveshape and sensitivity. Signal levels are bipolar ±(6 volts ±1 volt).

2.5.4 Data Transmitter Driver

The data transmitter driver is a tri-state device. Unless data is being transmitted, the driver will present a high impedance to the monitor output line.

2.5.5 Data Words

The data words are 10 unit characters, including one start bit, seven data bits, one parity bit and one stop bit.

2.5.6 Parity Bit

The receiver is capable of accepting data with odd, or even parity or of ignoring the parity bit. The choice is determined by internal switches on module A6. Parity failure will prevent the receiver from acting on the current word and blink the FAULT LED until the next correctly received word. The switch assembly U23 is located on the A6A1 board and contains six single pole single throw switches which controls parity and memory dump through the ON and OFF position of each switch.

Switch 1: Not used
Switch 2: ON dumps memory, OFF provides for memory loading.
Switch 3: ON selects odd parity, OFF selects even parity. (Must be enabled thru switch 4)
Switch 4: ON enables parity, OFF disables parity.
Switch 5: Not used
Switch 6: ON selects MS188 polarity, OFF selects RS232 polarity.

2.5.7 Command Data Format

The receiver will accept a command word having the 19 characters shown in Figure 2-4, except that the MONITOR ONLY command word will have the first 2 characters only, and the FREQ CHANGE ONLY command word will have the first 10 characters only. Refer to paragraph 2.5.10.

2.5.8 Monitor Data Format

The receiver, upon receipt of the commands 'MONITOR ONLY' or 'COMMAND and MONITOR will automatically transmit a monitor word including fault status as shown in Figure 2-4. Characters 2 and 3 of the monitor word will contain the same information as the command word.

This monitor transmission will begin within 15 ±5 mS of the time of receipt of the last character of the last command.

2.5.9 Receiver Address

The first character of each command or monitor word is a unique character used as a synchronization character and as the receiver address. Data bit seven (b6) is always in the 'one' state, and the receiver will sense this b6 condition and recognize the first six data bits b0 (LSB) through b5 (MSB) as the receiver address

2.5.10 Data Information Definition (DID)

The second character of each command word will define the command function as follows:

Code	Command	Minimum Length (Characters)
0	Load Receiver	19
1	Monitor Receiver	2
2	Load Memory	19
3	Monitor Memory	3
4	Load & Monitor Receiver	19
5	Load & Monitor Memory	19
6	Load Receiver Freq. Only	10
7	Load Memory Freq. Only	10
8	Set Receiver to Local Mode	2
9	Set Receiver to Remote Mode	2

2.5.11 Memory Location

The third character of the command word will indicate the memory channel into which the following data is to be located if, and only if, the DID indicates a 'Memory Load' command. If 'Memory Load' is not indicated this character indicates memory 'zero.' Bit b0 is the least significant bit and b5 the most significant. It will be possible to load any of the memory channels between 0 and 63 remotely.

2.5.12 RF Tuning

The RF data is specified as BCD, true RF input frequency, in 10 Hz increments and is determined by characters 4 (10 MHz) through 10 (10 Hz) in the command and monitor word. Bit b0 is the least significant and b3 is the most significant bit, (b1 is MSB in 10 MHz character).

Data Function	b6	b5	b4	b3	b2	b1	b0		Character Number
Sync Address	1	x	x	x	x	x	x	1	1
Command	0	DC	DC	x	x	x	x		2
Memory Location	0	x	x	x	x	x	x		3
10 MHz	0	DC	DC	x	x	x	x		4
1 MHz	0	DC	DC	x	x	x	x		5
100 kHz	0	DC	DC	x	x	x	x		6
10 kHz	0	DC	DC	x	x	x	x		7
1 kHz	0	DC	DC	x	x	x	x		8
100 Hz	0	DC	DC	x	x	x	x		9
10 Hz	0	DC	DC	x	x	x	x		10
Mode	0	DC	DC	x	x	x	x		11
Bandwidth	0	DC	DC	DC RL	x	x	x		12
AGC	0	DC	DC	DC F	x	x	x		13
RF ATTEN	0	DC	DC	x	x	x	x		14
BFO 1 kHz	0	DC	DC	x	x	x	x		15
BFO 100 Hz	0	DC	DC	x	x	x	x		16
BFO 10 Hz	0	DC	DC	x	x	x	x		17
Antenna	0	x	x	x	x	x	x		18
Auxiliary	0	DC	DC	x	x	x	x		19

For items in the box, the item above the line reflects the command information while the data below the line reflects the monitor information.

Figure 2-4. Receiver Data Format

2.5.13 Mode

The mode control is determined by bits 0-3 of character 11. The data will conform to the following code:

Code	Mode
1	USB
2	LSB
3	CW
4	AM

Bit 3 will determine the side to which the BFO is set when in the CW mode as follows:

Bit	Offset
0	BFO above carrier frequency
1	BFO below carrier frequency

2.5.14 BFO Tuning

The BFO frequency is BCD, relative to IF center frequency 0.00 to 7.99 kHz in 10 Hz increments, and is determined by characters 15 (1 kHz), 16 (100 Hz) and 17 (10 Hz) of the command and monitor word, b0 is the least significant bit.

2.5.15 Bandwidth/Local/Remote

The bandwidth is determined by character 12 of the command or monitor word. By bits 0, 1 and 2 as follows:

Code	Bandwidth
1	0.15
2	0.25
3	0.425
4	0.75
5	1.25
6	3.2
7	8.0

In the monitor mode bit 3 of character 12 determines the Remote/Local status of the receiver.

Bit 3	Status
0	Local
1	Remote

In the command mode bit 3 reverts to a don't care state.

2.5.16 AGC/Fault

2.5.16.1 Command AGC

Bits 0 and 1 of character 13 determine the gain mode of the receiver as follows:

Code	Gain Control
0	MGC
1	AGC fast
2	AGC medium
3	AGC slow

Bit 2 is used to determine dump status. When bit 2 is high then, on the execution of a frequency command the AGC will be dumped. This is valid only for the load receiver commands 0 and 6.

2.5.16.2 Monitor

Bit 3 of character 13 is used as a fault indicator when the receiver is in the monitor mode. When in the command mode bit 3 reverts to a don't care state.

2.5.16.3 Remote Gain Control

Character 14 of the command or monitor word is used to determine the degree of control by a 4 bit binary code bits 0 thru 3. Maximum gain shall be determined by 0000 and minimum gain by 1111. The remote RF gain control provides a total reduction in receiver gain of at least 100 dB in equal steps ±3 dB.

2.5.17 Antenna Select

Character 18 of the command and monitor word represents the remote antenna selection as a binary number where b0 is the least significant bit and b5 is the most significant bit.

2.5.18 Auxiliary Unit Select

Character 19 of the command and monitor word represents the auxiliary unit selection as a binary number where b0 is the least significant bit and b3 is the most significant bit. Bits b4 and b5 shall remain at '1.'

CHAPTER 3
OPERATION

3.1 INTRODUCTION

This chapter provides operating instructions for the RA6778C Communications Receiver. Prior to operating the receiver for the first time, follow all instructions and preliminary checks given in Chapter 2.

3.2 FUNCTION OF CONTROLS

Paragraphs 2.3.4, and 2.3.5 describe all of the switches, controls and indicators which are installed on the front panel, and which are required for the operation of the receiver.

NOTE

Before using the receiver, verify that the correct ac power is used as described in paragraph 2.3.6.

3.3 MAIN PRINCIPLES OF OPERATION

(a) The selection of a function for control will be done by depressing a key. The associated status display will blink (90% lit 10% dark) to draw the operators attention to the display area involved.

Exceptions: Frequency Entry
Remote/Local, SCAN, and SWEEP mode selection.
Store and Recall
Speaker on/off
Meter select AF/RF
Tuning rate and BFO selections
Stack

(b) Subsequent to function selection where a display area starts to blink, the receiver functions can be altered by using the keypad (digits 0 to 9 and decimal point) or the ↑ ↓ keys. Blinking will cease and the function will be deactivated whenever:

i) Any other function is selected for control or;
ii) The function key is depressed a second time; or
iii) A period of several seconds elapses

Exceptions: –Blinking memory channel digits, indicating a new channel number which can be selected from keypad or ↑ ↓ keys, will not deactivate after several seconds elapse. This applies in MEM VIEW and MEM ACTIVE modes.

–In MEM VIEW mode 'VIEW' status display will blink continuously to alert the operator that the front panel display does not coincide with receiver settings.

3.3.1 Digits 0 to 9 and Decimal Point Keys

These are used to enter frequencies or to make rapid selection of memory channel and antenna or auxiliary number.

3.3.2 ↓ (Down) Key

This key works in conjunction with Mode, Filter, Agc, Memory, Antenna and Auxiliary. When any of these functions has been selected as indicated by a blinking display, pressing the ↓ key will cause the associated function to decrement. After holding the key for a while, the function will begin to decrement at a steady rate, (decrementing below zero or lowest setting will wrap around to the maximum or uppermost setting).

3.3.3 ↑ (Up) Key

This key works in conjunction with Mode, Filter, Agc, Memory, Antenna and Auxiliary. When any of these functions has been selected as indicated by a blinking display, pressing the up key will cause the associated function to increment. After holding the key for a while, the function will begin to increment at a steady rate, (incrementing above the maximum or uppermost setting will wrap around to zero or lowest setting).

3.4 RECEIVER TUNING

The tuning of receiver frequency may be accomplished by using the main TUNING knob, or by direct keyboard entry of a desired frequency.

If the main TUNING knob is used to tune the receiver frequency, the tuning rate must first be selected using the FAST/SLOW pushbutton switch. When the desired rate is selected, the corresponding LED indicator of the tuning group should illuminate, confirming the rate selection. The kHz numerical display will change continuously in response to knob rotation, with clockwise rotation increasing frequency and counterclockwise rotation decreasing frequency. When the upper frequency limit of 29.999999 is reached, continued clockwise rotation of the tuning knob will cause the frequency to reset to the lower limit of 0.000000 and continue incrementing. Similarly, continued counterclockwise knob rotation past the lower frequency limit will result in a reset to the highest frequency and continued decrementing. The two tuning rates increment or decrement the frequency as follows:

FAST – 100 Hz steps (10kHz per turn)
SLOW – 10 Hz steps (1kHz per turn)

A desired frequency may be entered directly by first pressing the FREQ key. This key is used to initiate the frequency entry process. Pressing the key blanks the frequency display to indicate that frequency entry is expected and stores the current receiver setup in the STACK memory. The actual receiver settings are not altered during frequency entry until ENTER kHz is depressed. Frequency entry is done in kHz, in a free format and appears in the receiver display starting at the right hand digit (similar to a calculator display). When the frequency has been entered and is correct the receiver or memory channel can be loaded by pressing ENTER kHz. During Frequency entry the process can be restarted by depressing FREQ again, or the previous receiver setting can be recalled by pushing the STACK key.

Examples:

To enter 15 kHz key FREQ, 1, 5, ENTER kHz
To enter 2953.10 kHz key FREQ, 2, 9, 5, 3, ., 1 ENTER kHz

Note: The LOCK key disables all tuning knob operation. This mode is displayed in the Tune display.

3.5 BFO TUNING

The tuning knob controls the BFO offset only when the CW mode is selected and the BFO pushbutton is pressed. When in CW, the first press of the BFO pushbutton enables the tuning knob to tune the BFO frequency. From then on this pushbutton toggles the BFO sign. The BFO numerical display shows offset in kHz above (+) or below (−) center frequency. Maximum range of the BFO control is ±8.00, kHz, and continued rotation of the knob beyond this range will have no effect.

The BFO offset may also be entered through the keypad. The ENTER BFO key will function the same way that ENTER kHz does except that the frequency entered in kHz will be loaded into the BFO when ENTER BFO is depressed. The frequency display will then return to its previous setting. Subsequent depressions of ENTER BFO will change the sign of the BFO. The operation of the BFO Key is completely independent of ENTER BFO.

Example:

To enter a BFO offset of −2.7 kHz Key FREQ, 2, ., 7, ENTER BFO ENTER BFO
To enter a BFO offset of +1 kHz Key FREQ, 1, ENTER BFO

3.6 MODE SELECTION

When pressed, the mode key allows the receiver mode to be changed by the Up/Down keys. This is indicated by blinking of the currently selected mode. Mode change may be terminated by pressing any function key, including Mode. During MODE selection the currently selected mode will blink and the alternative modes available will be visible, this will also apply for AGC and FILTER functions.

3.7 FILTER SELECTION

If in AM or CW detection modes, pressing the filter key allows the selection of a new IF bandwidth through the use of the Up/Down keys. The current bandwidth blinks to indicate that bandwidths may be changed. This operation may be terminated by pressing any function key, including Filter.

3.8 AGC SELECTION

When pressed, the AGC key allows selection of the AGC/MGC mode of the receiver through the use of the Up/Down keys. The current AGC/MGC setting shall blink to indicate that this function may be changed. AGC/MGC change may be terminated by pressing any function key including AGC.

The RF Gain knob sets the manual gain level of the receiver when local manual gain has been selected.

3.9 MEM VIEW

The MEM View key places the front panel in the memory view mode without altering the actual receiver. The controls and displays affect the channel whose number is displayed in the memory display. The status display shows a steady 'MEM' display and a blinking 'VIEW' display. Initially after depressing MEM VIEW the memory channel last addressed will be displayed and the memory channel display digits will blink to indicate that the keypad or the ↑ ↓ keys may be used to select another channel. If another function such as mode is selected for control then the channel display digits will stop blinking and the mode display will blink as in normal receiver operation. All front panel controls operate only on the contents of the memory channel addressed, the physical receiver remains tuned to the same settings as before MEM VIEW was depressed. MEM VIEW mode may be cancelled by pressing RECALL to tune the receiver to one of the memory channels or by pressing MEM VIEW again to return the receiver to its previous setting. On exit from MEM VIEW using 'RECALL' the channel number display will remain lit indicating which memory channel was last used, when any receiver setting is altered this display will extinquish.

Note: To reenable the blinking channel digits in MEM VIEW (after some other function has been selected) in order to select another memory channel 'MEM VIEW' must be depressed twice.

3.10 MEM ACTIVE

This MEM ACTIVE key functions similar to MEM VIEW except that

(a) The receiver is tuned to each channel as it is addressed.
(b) The 'VIEW' display is not illuminated.
(c) Memory channel contents cannot be altered by front panel controls except that the SCAN key will toggle the scan flag associated with each channel.

As soon as a front panel control is altered 'MEM ACTIVE' mode will terminate. MEM ACTIVE may be cancelled by depressing MEM ACTIVE again to return to the previous receiver setting or by selecting any front panel option for control.

3.11 STORE

In the MEM VIEW mode pressing the STORE key causes the entire current receiver setup to be loaded into the current channel whose number is displayed in the memory display.

3.12 RECALL

Pressing the RECALL key while in the MEM VIEW mode causes the current data in the channel whose number is displayed in the Memory display to be loaded into the receiver buffer.

Note: The tuning rate selected while in MEM VIEW mode will be 'LOCK'. On RECALL the tuning rate selected will be the rate last selected before the 'STORE' key was depressed.

3.13 STACK

The STACK key is used to exchange the current receiver settings with the settings previously stored in the stack buffer. The two sets of settings are swapped between the receiver and the stack buffer on each depression of the STACK key.

Note that the stack buffer is loaded with the current receiver settings each time STACK is depressed as above, when FREQ is depressed to initiate frequency entry, and when a Memory mode is selected. STACK may be used to recall the previous settings after return from MEM ACTIVE or MEM VIEW modes.

3.14 SCAN

In the MEM VIEW and MEM ACTIVE modes the Scan button toggles the Scan flag associated with each channel. The current setting of the Scan flag may be seen in the display to the left of the memory channel number. When in the receiver mode, the Scan button shall cause the receiver to enter the Channel (cell) Scan mode. Starting with the current channel, which must have been set up with Recall or MEM ACTIVE, the processor will load in turn each of the channels in this decade that has its scan flag set. The dwell on each channel is now determined from the keyboard. 0 sets 100 ms dwell, while 9 selects 10 seconds dwell. The intervening numbers select rates in between. The Scan mode may be stopped by pressing Scan again. When in the Scan mode no front panel controls are operative except as indicated above, and the Local Remote button.

3.15 SWEEP

Sweep is a mode that allows the Receiver to be scanned from F1 through F2 in steps of F3. The dwell time for each step is determined, when in the SWEEP mode as in Scan above. F1, F2, and F3 may be located in any three consecutive memory channels. The channel containing F1 must have been last loaded by a Recall, or viewed by MEM VIEW. Scan starting procedure is as follows: Select F1 channel. For our example use channel 23. Preset in channel 23 all the receiver parameters for the Sweep such as detection mode, bandwidth, and agc. Also preset in channel 23 the start frequency for the Sweep. In channel 24 preset the top frequency for the Sweep. All other information in channel 24 will be ignored. In channel 25 preset the step size for the Sweep. All other information in channel 25 will be ignored. To begin the Sweep, return to channel 23 and press Recall. This sets up the receiver at its starting point. Now press SWEEP. The Sweep will be begun at the current frequency, and will then advance in steps of F3 Hz until frequency F2 is exceeded. Then channel 23 will be automatically recalled and the Sweep repeated. Dwell time per step may now be controlled from the numeric pad, 0 sets 10 ms dwell while 9 selects 1 second dwell. The Sweep may be stopped at any time by pressing Sweep. During Sweep only the rate controls, Sweep, and Remote Local controls will operate. To interrupt sweeping depress SWEEP again (front panel controls are now operative). To resume from current front panel settings depress Sweep again.

3.16 AUX

Pressing the AUX key will allow the Auxiliary device to be altered either by the ↑ ↓ push buttons or by the entry of a two digit number from the keypad. This mode may be terminated either by pressing AUX again, or by pressing any function key on the keyboard. The AUX digits will blink when AUX is selected.

3.17 ANT

Pressing the ANT key will allow the antenna to be altered either by the ↑↓ push buttons or by the entry of a two digit number from the keypad. This mode may be terminated either by pressing 'ANT' again, or by pressing any function key on the keyboard. The ANT digits will blink when ANT is selected.

3.18 LOCAL REMOTE

The LOCAL REMOTE key toggles the receiver from front panel control to digital control from outside the receiver. When in the Remote mode the Remote display in Status is illuminated. When in the Remote mode the operator may monitor information in any channel or in the receiver itself, however he may not change that information.

3.19 AF/RF

The AF/RF key is used to toggle the meter display from RF signal strength to line audio and back. The current selection is displayed with either AF or RF illuminated at the top of its respective meter display.

3.20 AF LEVEL ADJUSTMENT

The front panel AF Level adjustment controls the level of the signal fed out the line audio outputs. This level is what is displayed on the meter in the AF monitoring position.

3.21 SPKR

The SPKR key serves to enable or disable the front panel speaker on alternate pushes.

3.22 AF GAIN KNOB

The AF GAIN knob controls the level of the audio at both the headphone jacks and at the internal speaker.

3.23 POWER FAIL

The control section contains circuitry for the retention of receiver and memory settings in the event of power failure. This function is entirely automatic, and will retain the last settings entered into any particular location without any additional action on the part of the operator.

CHAPTER 4
THEORY OF OPERATION

4.1 INTRODUCTION

This chapter describes the principles of operation for the RA6678C Communications Receiver. Figure 4-1 is an overall functional block diagram for the receiver which may be divided into four major sections: the RF/IF/AF section, the frequency synthesizer, the front panel and control section, and the power supply. The chapter has been arranged to cover these sections in that order.

4.2 RF/IF/AF SECTION

The RF/IF/AF section comprises the low pass filter and RF amplifier A1, the first mixer, A2, the second mixer A3, the IF filter assembly A4, the IF amplifier A5, and the 100 kHz IF converter A25. The input to the RF/IF/AF section is received at the RF IN connector J1.

4.2.1 RF Amplifier A1

The RF input, through back panel connector J1, comes into the RF amplifier module A1 to drive a two section elliptical low pass filter with cut-off frequency of 35 MHz. The filtered output is then applied to a wideband amplifier. The amplified output then drives a 5 section elliptical filter. This filter has a cut-off frequency of 32 MHz and is designed to provide the necessary protection to the receiver from image signals (receiver tuned frequency +2 X 35.4 MHz) and from signals at the first intermediate frequency of 35.4 MHz. The filter also eliminates first local oscillator conductance back to the antenna. This filter output then drives the 1st mixer module A2.

4.2.2 First Mixer A2

The function of the 1st Mixer module is to convert the incoming RF signal to the first intermediate frequency of 35.4 MHz. This is accomplished by mixing the incoming RF signal with the 1st LO((local oscillator) frequency (in the range of 35.410 to 65.4 MHz) derived from the synthesizers.

The RF signal from the A1 module drives one input to mixer 1 through a lowpass filter (32 MHz cut-off). The second input to this mixer is the 1st LO from the synthesizer section. This 1st LO signal from the synthesizer, comes into module A2 and goes on through a filter and drive amplifier to drive the mixer. The mixer output goes through a roofing filter to drive its output drive amplifier. The roofing filter passes the 35.4 MHz center frequency mixing product.The 3 dB bandwidth of this filter is 8 kHz, and defines the widest bandwidth available in the receiver.

4.2.3 Second Mixer A3

The second mixer module, A3, contains an amplifier-attenuator, filter and mixer 2. The 35.4 MHz output from the A2 module is applied the amplifier-attenuator stage. The output level from this stage is controlled by the AGC signal from the IF AMP module A5. This output then goes through a 35.4 MHz bandpass filter to drive one input of mixer 2. The second input to this mixer, through a 34 MHz tuned bandpass filter, is the 2nd LO 34 MHz signal from the 34 MHz generator A16. Thus, the mixer 2 output will contain the difference frequency which is the 1.4 MHz IF.

4.2.4 IF Filter A4

The 1.4 MHz IF output from the 2nd mixer is applied the IF filter module A4. This module contains the crystal filters used in the control of the received signal selectivity. The selected filter, through the front panel or by remote control command, is switched to receive the 1.4 MHz IF signal. The switched filter allows through, to its output, the selected bandpass centered about the 1.4 MHz IF. It should be noted that when the widest band (8 kHz) is selected, an attenuator (simulating the insertion loss of a filter) is used in place of a filter.

4.2.5 IF Amplifier A5

The filtered 1.4 MHz output from A4 goes into the IF amplifier module A5. This contains the 1.4 MHz IF stage, the AGC and audio detectors and the audio amplifiers. The input signal drives the amplifier whose gain is controlled by the AGC signal. The AGC signal is generated by the AGC detector in accordance with the AGC mode selections on the front panel or commands from the remote controller. The amplifier output drives the AM and Product Detectors. Dependent on the detection mode selected by the front panel or remote control, detected audio output from one of these detectors is selected (by switching) to drive the audio pre-amplifier. It should be noted that the second input to the product detector is the BFO 1.4 MHz $\pm$8 kHz signal from the BFO synthesizer (A23) and 34 MHz Generator (A16) modules. The audio amplifier then drives the line and phones amplifiers which yield the audio line, phones (and speaker) outputs from the receiver.

4.2.6 100 kHz IF Converter A25

The 1.4 MHz IF signal out of the IF filter module, A4, is also fed into the 100 kHz IF converter module A25. This module converts, using the superheterodyne principle, the 1.4 MHz IF signal to a 100 kHz IF signal. The 1.4 MHz IF signal is fed to one input of a mixer. A 1.500 MHz signal is fed to the second input of this mixer which yields the difference 100 kHz IF. The 1.500 MHz signal is derived from a voltage controlled oscillator which is phase locked to the 50 kHz reference supplied by the 34 MHz generator module A16. The 100 kHz IF output from the mixer is fed to two separate output amplifiers which yield the two 100 kHz IF outputs at the receiver back panel from connectors J5 and J6.

4.3 FREQUENCY SYNTHESIZER SECTION

As described above, three injected frequencies are supplied by the synthesizers. These are the variable 35.140 – 65.4 MHz 1st LO supplied the first mixer, the fixed 34 MHz 2nd LO supplied the second mixer and the 1.400 $\pm$ .008 MHz supplied the product detector.

The indirect method of frequency synthesis is used where the required output frequencies are derived from voltage controlled oscillators (VCO's) which are phase locked to a common frequency source. All generated frequencies are derived from a 5 MHz internal frequency standard or an external 1 MHz frequency standard.

4.3.1 5 MHz Frequency Standard A15

As indicated in Figure 4-1 the internal 5 MHz frequency standard is contained in module A15. The output of this module is fed into the 34 MHz generator module A16.

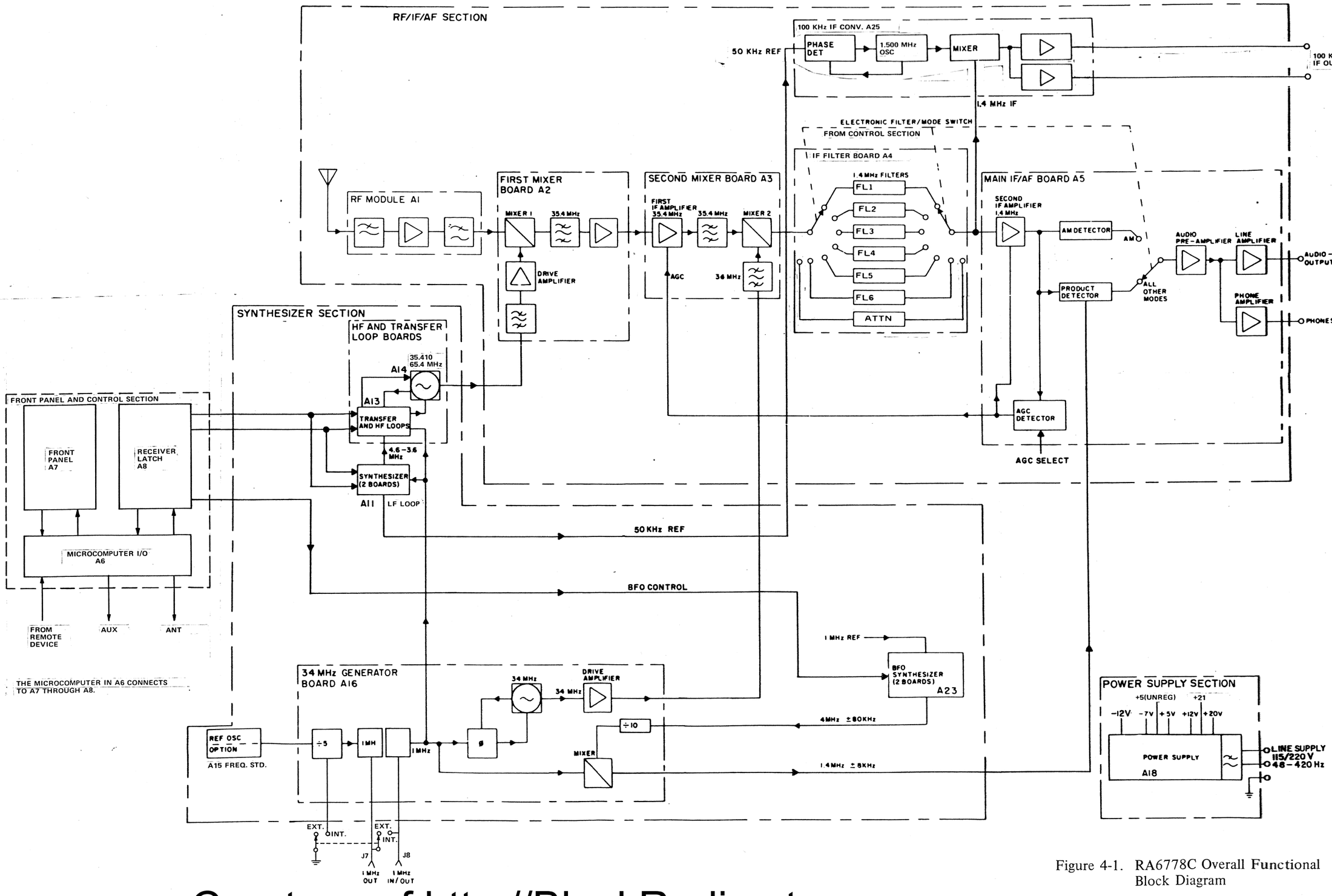

Figure 4-1. RA6778C Overall Functional Block Diagram

4.3.2 34 MHz Generator A16

In the 34 MHz generator, A16, the 5 MHz signal from the internal standard is divided by 5 to yield the 1 MHz reference. This comes out of the rear panel through connector J7. The rear panel standard select switch may select the internal or external standard. The 1 MHz external reference standard may be connected through rear panel connector J8. If the internal reference is selected, the switch allows the 1 MHz internal standard through to the synthesizers. Here the 1 MHz internal standard is also output (by the select switch) through rear panel connector J8. If an external 1 MHz standard is connected to J8 and the standard select switch set to external, this external standard will be sent through to the synthesizers. It will be noted that the standard select switch, when in the external position, disables the output of the $\div 5$ circuitry so that there is no internal standard output.

The 34 MHz generator contains a 34 MHz voltage controlled oscillator (VCO) which is phase locked with the 1 MHz standard frequency. The comparator, which compares the VCO frequency with the standard, supplies the control voltage to lock the VCO at 34 MHz. The 34 MHz output, through a drive amplifier, goes on to drive the 2nd mixer, as described previously.

4.3.3 BFO Synthesizer A23

The 1 MHz reference is also supplied the BFO synthesizer module A23. This module, consisting of two boards A23A1 and A23A2, produces a synthesized frequency centered about 4.0 MHz with an offset proportional to the BFO offset frequency selected by the front panel controls or remote controller. This is synthesized from a series of cascaded phase locked loops where the divided output from one loop becomes the phase detector input to the next loop.

This output frequency, in the range 4.0 MHz $\pm$80 kHz, is fed into a divide by 10 circuit in the 34 MHz generator module. The divide by 10 output is then mixed with the 1 MHz reference to yield the mixer sum of output frequency in the range 1.4 MHz $\pm$ 8 Hz. This output is then fed to the product detector in the IF amplifier module A5, as described previously.

4.3.4 HF Synthesizer

The 35.410 to 65.4 MHz 1st LO signal, required by the 1st mixer is generated in the LF loop (A11), HF Loop (A13) and Transfer Loop (A14) modules. The required frequency is controlled by the frequency selections received from the front panel controls or remote controller through the latch module A8. This frequency is synthesized, in these modules, through five cascaded phase locked loops where the output from one loop becomes the phase detector input to the next loop. The basic reference is the 1 MHz standard obtained from the 34 MHz generator module A16. The LF loop (A11), which consists of two boards A11A1 and A11A2, synthesizes the low frequencies in the range 4.6 - 3.6 MHz. This drives the transfer and HF loop modules where the reuqired 1st LO frequency in the range 35.410 – 65.4 MHz is synthesized.

4.4 FRONT PANEL AND CONTROL SECTION

The front panel and control section contains the front panel controls and displays, the remote controller interface, the microcomputer for computation, memory and control and the latch to interface the controls to the receiver circuitry. This section is housed on the Front Panel module, A7, the Microcomputer I/O module A6 and the Latch module A8.

4.4.1 Front Panel A7

The front panel module is comprised of two boards, A7A1 and A7A2. These contain the panel controls and panel displays. The boards interface with the microcomputer I/O module. The A7A2 board contains the panel switches while the A7A1 board contains the panel displays.

4.4.2 Microcomputer I/O A6

The microcomputer I/O module A6 is comprised of two boards A6A1 and A6A2. A6A2 contains the microcomputer and A6A1 contains the I/O interfaces which interfaces with the remote controller and provides the AUX and ANT outputs.

The microcomputer performs the following functions:

a) Reads front panel controls.
b) Controls display of information on front panel.
c) Computes and relays data to receiver circuits.
d) Receives commands from and sends data to remote controller.
e) Memory retention during power failure of receiver settings and up to 90 pre-sets.
f) Initializes circuits following power application.
g) Monitors and displays receiver status.

The module A6A1 interfaces the microcomputer to the remote controller. Here the receiver data from the microcomputer is converted to the required serial data stream format and sent to the remote controller while the serial data stream from the remote controller is converted to the form required by the microcomputer.

4.4.3 Latch A8

The latch module, A8, receives the control signals from the microcomputer and relays these signals to the appropriate circuitry in the receiver. The front panel connections to and from the microcomputer are made through the A8 module.

4.5 POWER SUPPLY SECTION

A single power supply module, A18, supplies all voltages required by the receiver.

4.5.1 Power Supply A18

The power supply module, A18, supplies the following voltages; −12, −7, +20, +12 and +5 regulated and +21 and +5 unregulated.

CHAPTER 5
TROUBLESHOOTING PROCEDURES

5.1 INTRODUCTION

This chapter contains a set of general troubleshooting procedures for the RA6778C Communications Receiver. General procedures have been provided for the isolation of malfunctions to one or more modules/boards. All procedures should be performed by a qualified technician with adequate training in electronic theory and practice including digital and RF circuitry. The technician should also be thoroughly familiar with and skillful in the use of handtools and electronic test equipment.

Figure 5-1 is a signal flow diagram for the receiver; Figure 5-2 is a fault finding chart to aid in module troubleshooting; Figure 5-3 is an RF level diagram for RF checks; and Figure 5-6 is the RA6778C Receiver Assembly Schematic. Figure 5-4 is a top view of the RA6778C with the top cover removed while Figure 5-5 is a bottom view with the bottom cover removed.

If specified performance cannot be obtained, then a fault must be suspected. When a module has been determined to be defective or suspected, it may be removed and replaced with one known to be in good operating condition.

For operating instructions, refer to Chapter 3 of this manual.

5.2 SAFETY PRECAUTIONS

Observe all safety regulations. Do not replace modules with the ac line cord plugged in or external power supplies turned on. Dangerous potentials may exist with the power in the off position due to charges retained by capacitors. Remove power and discharge large capacitors before touching a circuit. Printed circuit boards containing MOS type IC's should also be properly handled to avoid possible damage from static discharges by carefully grounding all persons and objects prior to contact, and by storing boards in conductive plastic protective wrappers or envelopes, or the use of conductive shunts on the edge connector.

WARNING

The high voltage used in this equipment may be dangerous to personnel.
Use caution when servicing the power supplies or their load components.

5.3 EQUIPMENT REQUIRED

5.3.1 List of Test Equipment

Table 5-1 is a list of test equipment recommended for conducting troubleshooting and maintenance procedures. They are recommended in order to properly probe the RA6778C for faulty conditions.

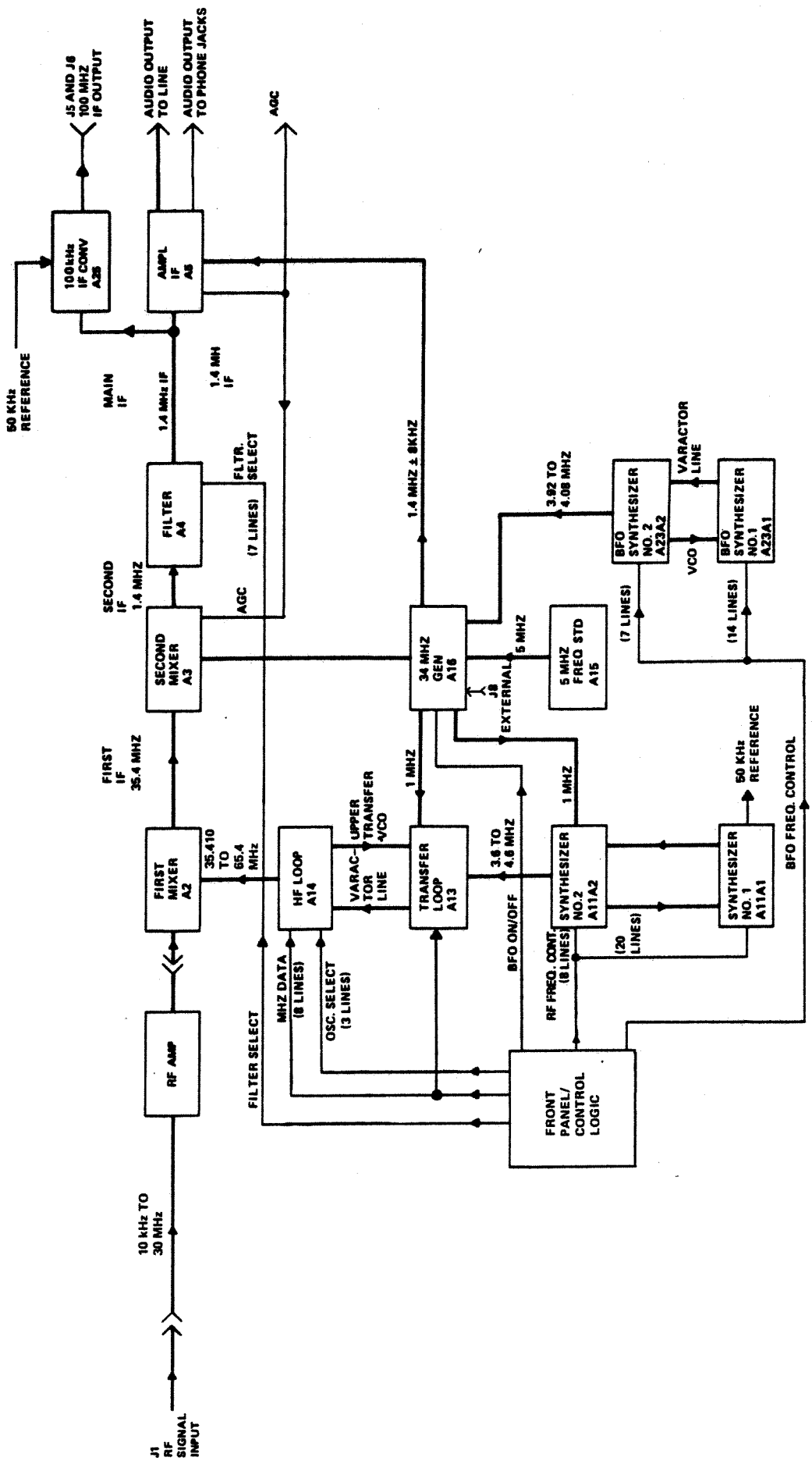

Figure 5-1. Signal Flow Diagram RA6778

FAULT SYMPTOMS	BOARD/MODULE PROBABLE FAULT																					
	A1	A2	A3	A4	A5	A6A1	A6A2	A7A1	A7A2	A8	A11A1	A11A2	A13	A14	A15	A16	A17	A18	A23A1	A23A2	A25
	CHECK BOARD ACCORDING TO NUMBER ORDER.																					
All voltages low																		1			
+5V only						11	7	9	8	10	2	2	3	4		6		1			5
−7V only		3	2		5								6					1			4
+20V only		8			2			9			3	3		4	6	7		1	7	7	
+12V only		2	3	4	5		10	11		12			7	8		9	10	1			6
+21V only															1						
Low Drive Level		1												3	2						
All Synthesizer OOL															1	2					
Fault Indication											2	2	3	4	1				5	5	
OOL A11											1	1									
OOL A13													1	2							
OOL A14														1							
OOL A23																			1	1	
Incorrect Filter/Mode Select				2																	
LO Wrong Frequency											3	3	4	5	2						
34 MHz Wrong Frequency															2	3					
LLO Wrong Frequency															2	3			4	4	
RF CHECKS																					
Incorrect AGC Knee			1																		
No AGC Control			1																		
No Audio O/P														1							
No LO Power		1												2							
No 34 MHz OSC			2													1					
No LLO (1.4 MHz)																1			2	2	
Low Sensitivity	√	√	√	√	√																
High Re-Radiation	1	2																			
Filter Passband Response		2		1																	
No IF Output				2							3										1
Displays Incorrect							2		1	3							1				
Front Panel Keys Inoperative							2	1		3											
Remote Control Inoperative						1	2			3											

NOTE: Refer to Figures 5-3 and 5-6 for location of test points for the modules.

Figure 5-2. Fault Finding Chart

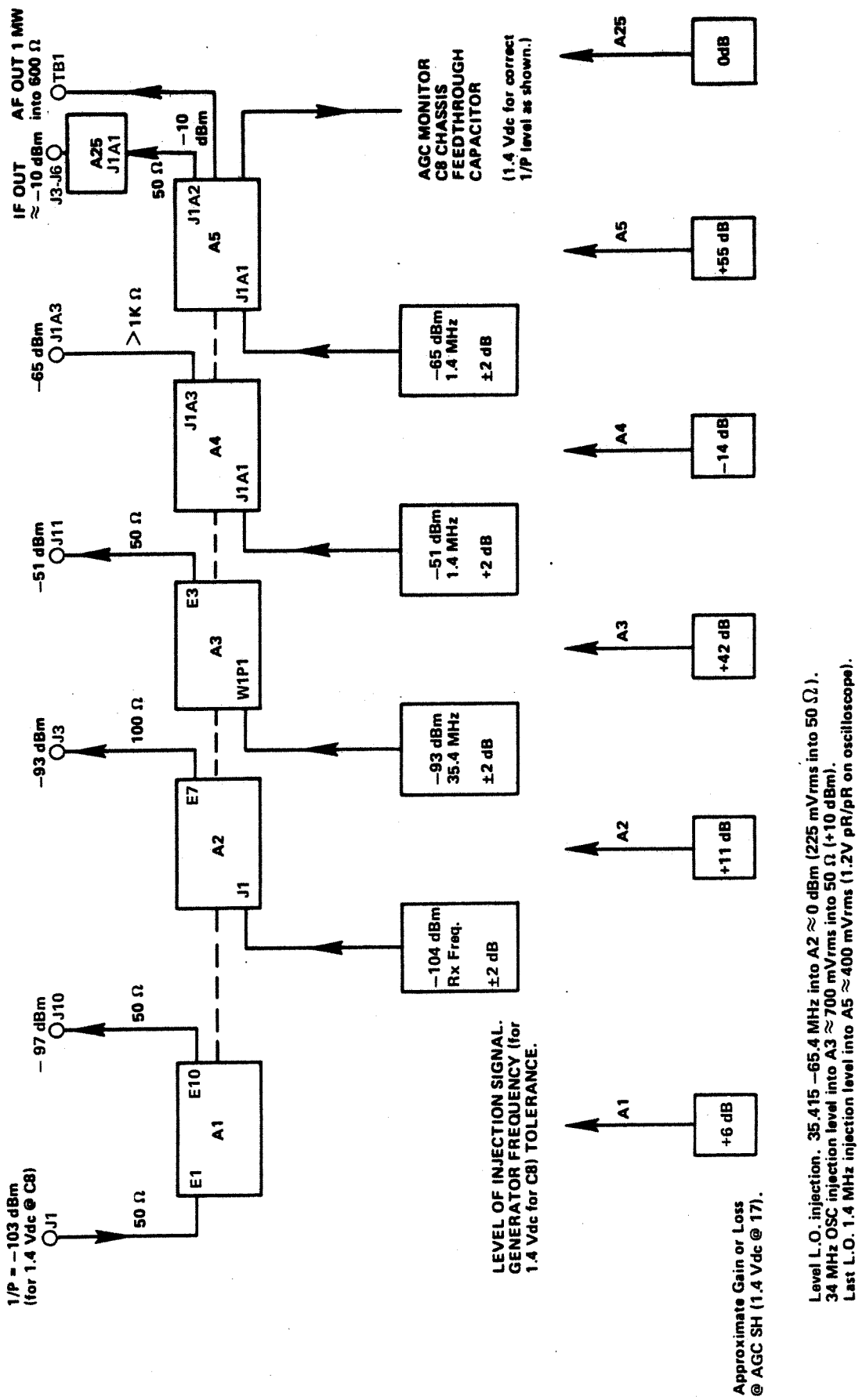

Figure 5-3. Signal Level Diagram, RF Path

TABLE 5-1
LIST OF TEST EQUIPMENT

Item	Description	Recommended Instrument or Equal
1	2 ea. HF Signal Generator	HP8640A
2	1 ea. AF Signal Generator	HP200CD
3	1 ea. Frequency Counter	Hewlett Packard 5327C
4	1 ea. Oscilloscope	Tektronics 465
5	1 ea. RF Voltmeter	Boonton 91H
6	1 ea. Digital Multimeter	Fluke 8000A
7	1 ea. Multimeter	Simpson 260
8	1 ea. AF VTVM	HP400E
9	1 ea. Pulse Generator	GR1217C/1201C
10	1 ea. Spectrum Analyzer	HP8552B/8553B, with 141T Display
11	1 ea. Tracking Generator	HP8443A
12	1 ea. Frequency Standard	HP105A/B

5.3.2 Special Tools

No special tools are required for replacing modules other than a set of standard hand-tools (long-nose pliers, screw drivers and wrenches).

5.4 GENERAL PROCEDURES

Chapter 3 describes the normal operation of the receiver. When normal operation is not obtained, note abnormal symptoms and refer to the fault finding chart Figure 5-2. Also, if the fault indicator on front panel is on, note which of the four fault indicator lights on module A8 are on. These should indicate the one or more specific modules that may be at fault. Where further isolation to a module is required refer to the signal flow diagram, Figure 5-1 and the receiver schematic, Figure 5-6. Using the instruments listed in Table 5-1, as required, inject test signals, as appropriate, to verify signal paths through a module or group of modules. Figures 5-4 and 5-5 show the location of modules in the receiver.

5.4.1 RF Signal Path

Figure 5-3 is a signal level diagram for signals in the RF path, modules A1 through A5 and A25. This shows the level of signals into and out of these modules for normal operation.

5.4.2 Synthesizers

Figures 5-1 and 5-3 indicate the signal frequencies and levels of the three LO synthesized frequencies during normal operation. The 1st LO synthesized frequency, in the range 35.140 MHz to 65.4 MHz, should be the tuned frequency +35.400000 MHz. Also the 3rd LO, to the product detector in module A5, in the range 1.4 MHz $\pm$.8 kHz, should be 1.400000 MHz + or – the selected BFO offset frequency.

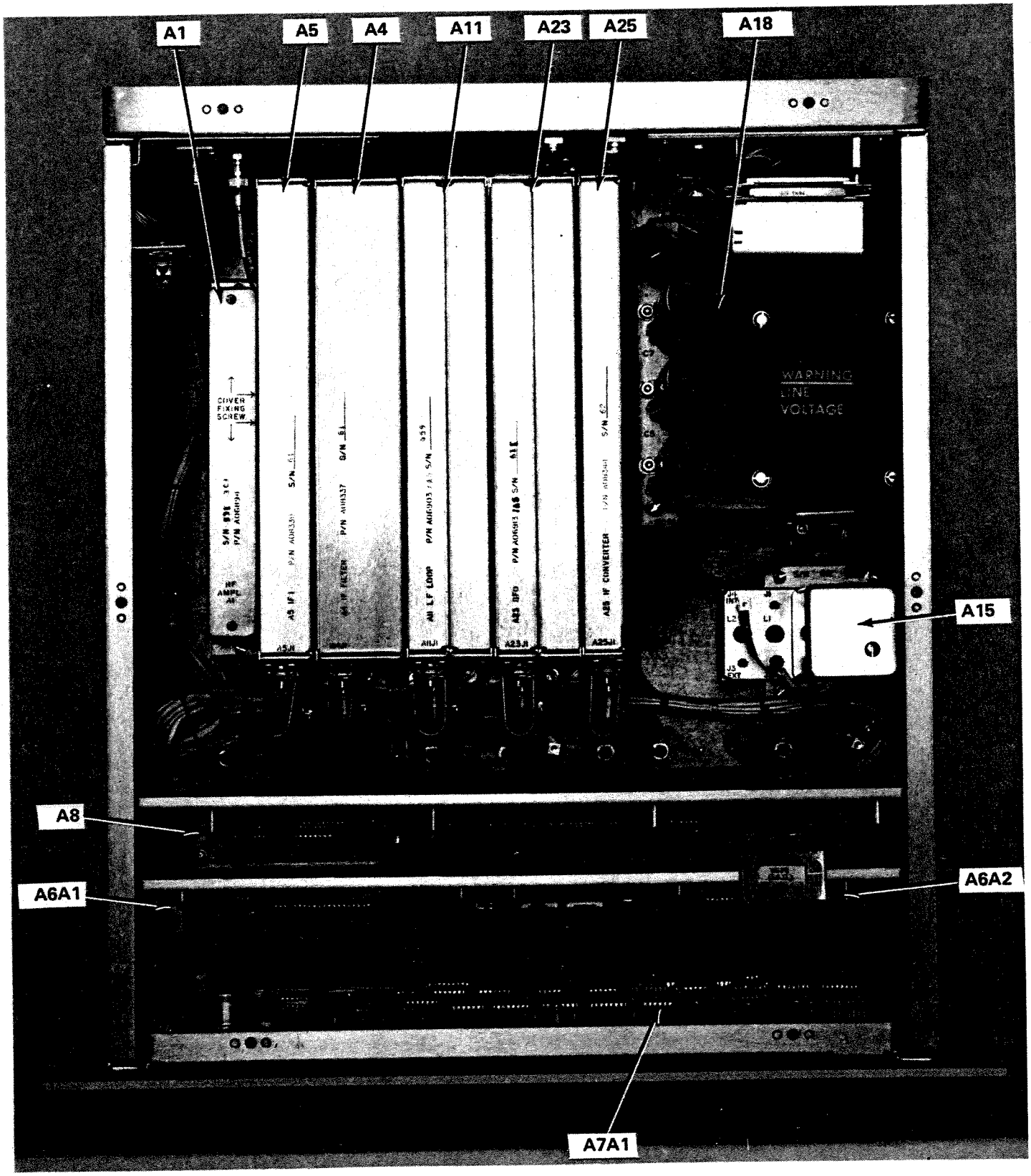

Figure 5-4. Location of Modules, Receiver Top View

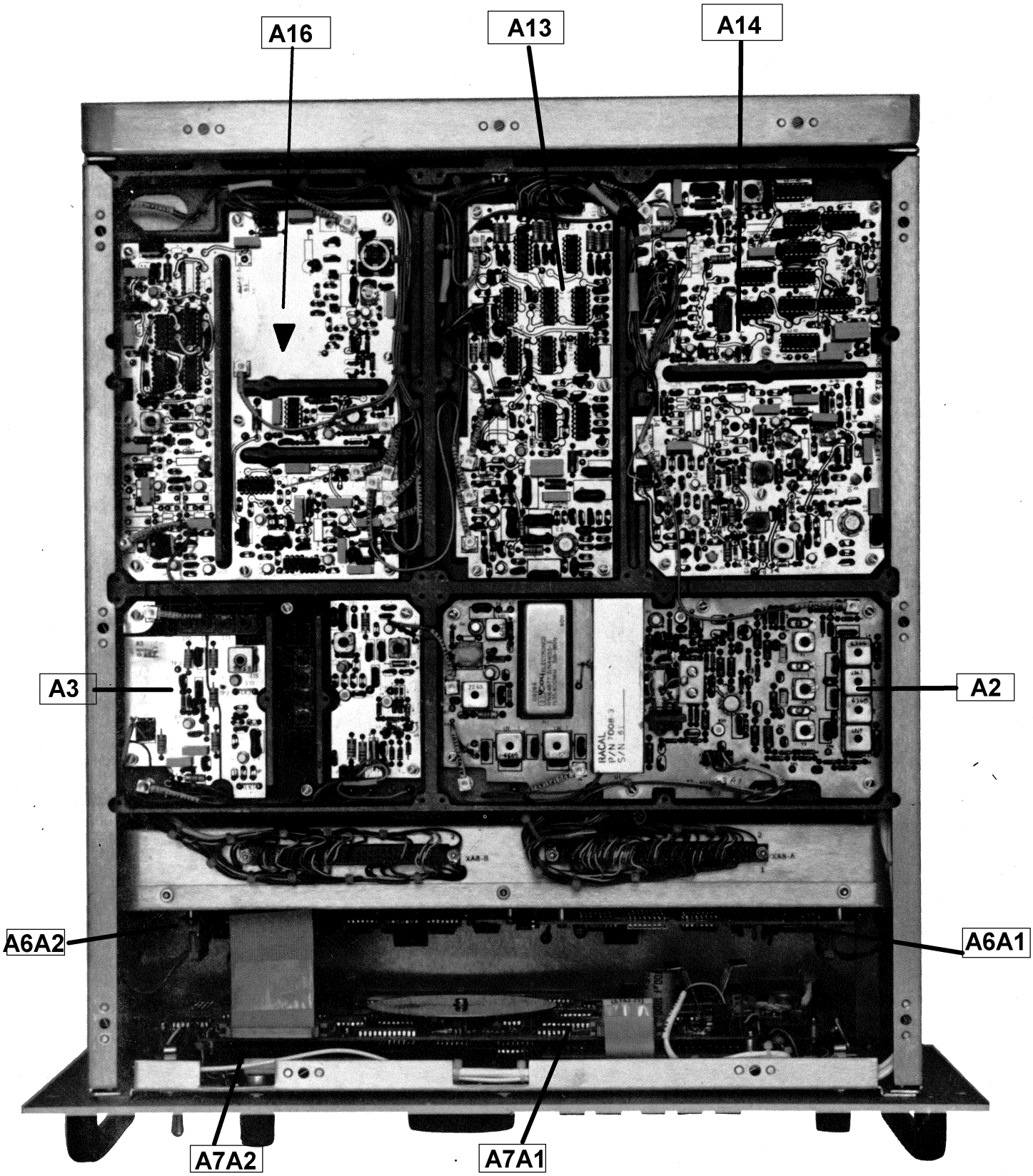

Figure 5-5. Location of Modules, Receiver Bottom View

5.4.3 Power Supply

The power supply output voltages for normal operation are as follows:

A18 Module Pin No.	Voltage
J1-17	−12 ±0.5
J1-14	−7 ±0.5
J1-4	+20 ±1.0
J1-7	+12 ±0.5
J1-11	+5, +0.5, −0.2

Before replacing the power supply module, A18, assure that no short circuit conditions exist on any power supply bus.

5.4.4 Control and Display

Local control and displays are affected by the A7A1, A7A2 and A6A2 modules. Before replacing these modules ensure that all connections and connectors are properly seated and secured.

Remote control malfunctions are likely to be confined to fault conditions existing in the A6A1 module or the associated remote control connections.

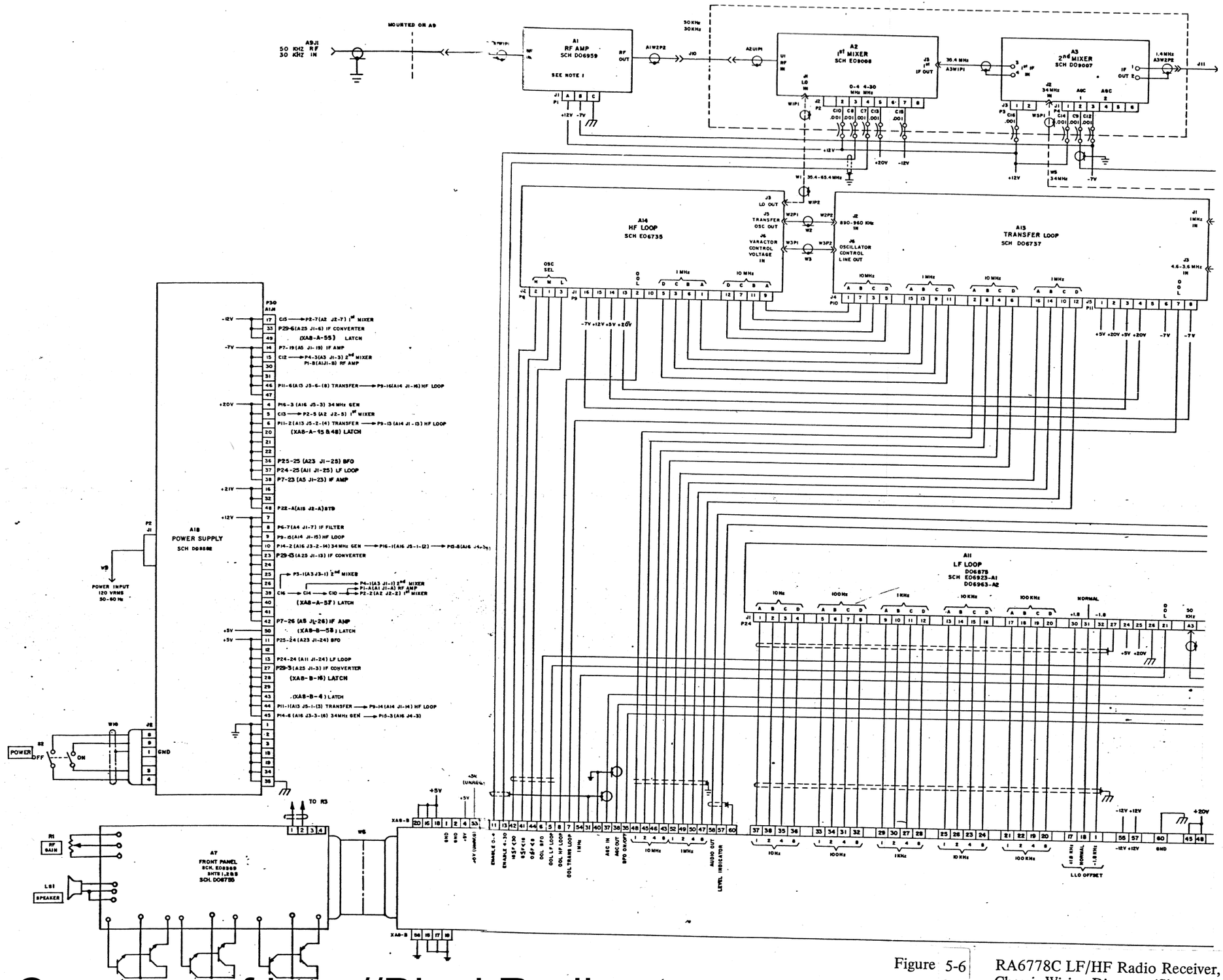

Figure 5-6 RA6778C LF/HF Radio Receiver, Chassis Wiring Diagram (Sheet 1 of 3)

Figure 5-6 RA6778C LF/HF Radio Receiver, Chassis Wiring Diagram (Sheet 2 of 3)

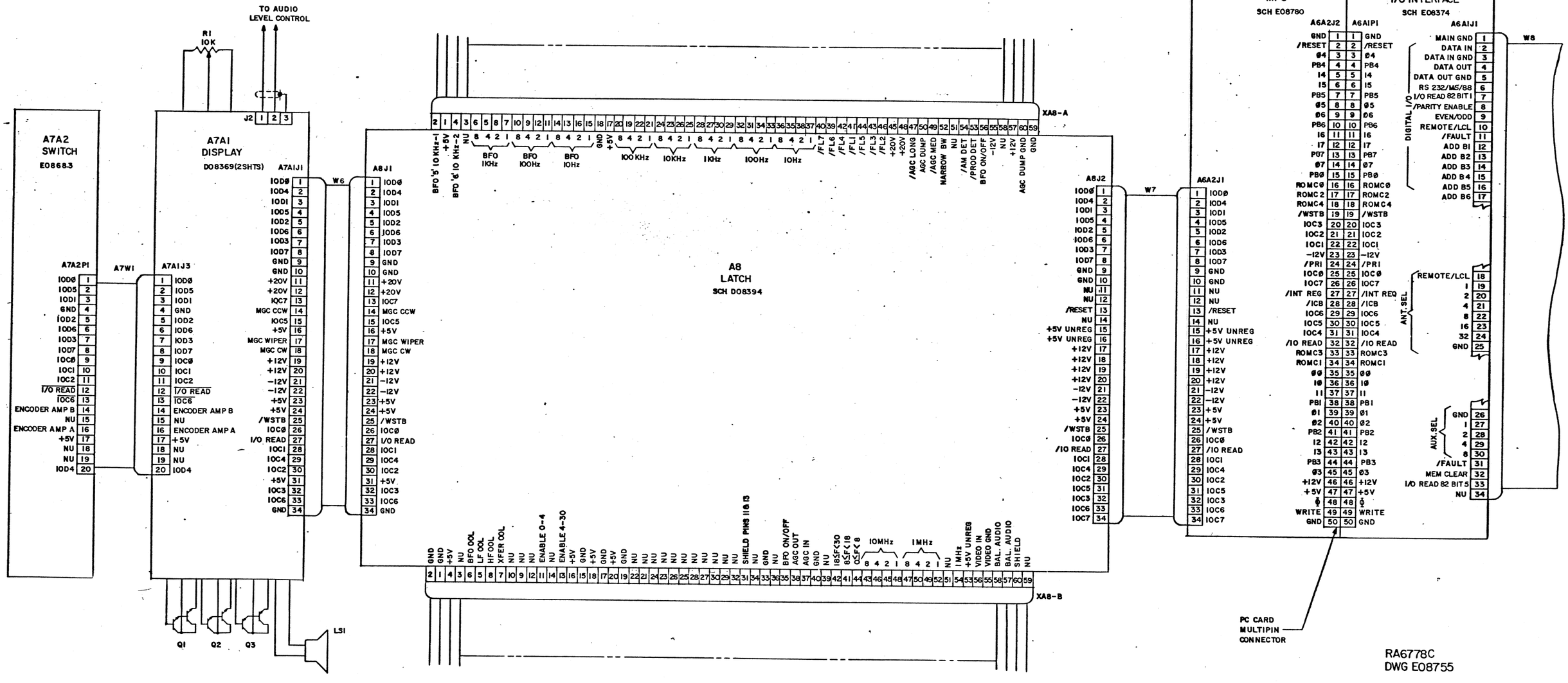

Figure 5-6 RA6778C LF/HF Radio Receiver, Chassis Wiring Diagram (Sheet 3 of 3

CHAPTER 6
PARTS LIST

6.1 INTRODUCTION

Table 6-1 lists all modules, connectors and other replaceable electrical parts contained on the main chassis of the RA6778C Receiver. The modules and parts are listed in order of reference designation with Table references included under the Description Column for all modules and circuit cards. These Table references are to be found in the Depot manual where a complete parts list for each module or circuit card is contained. For instance, Table 6-2 would be found in Chapter 6 of the Depot manual and will provide a complete parts list for that particular circuit card. Illustrations are also included in each chapter of the Depot manual showing location of parts.

TABLE 6-1. PARTS LIST, RA6778C RECEIVER, MAIN CHASSIS COMPONENTS

Reference Designation	Description	RACAL Number	Manufacturer /MIL Part Number
A1	RF Amplifier Module Assembly (See Table 2-2 for further breakdown)	06894-3	
A2	First Mixer Circuit Card Assembly (See Table 3-2 for further breakdown)	07215-4	
A3	Second Mixer Circuit Card Assembly (See Table 4-2 for further breakdown)	0896-2	
A4	IF Filter Module Assembly (See Table 5-3 for further breakdown)	08337	
A5	IF Amplifier Module Assembly (See Table 6-2 for further breakdown)	08339	
A6	Microcomputer Module Assembly (See Table 7-2 for further breakdown)	08686	
A6A1	Asynchronous Interface Circuit Card Assembly (See Table 7-3 for further breakdown)	08373	
A6A2	Microprocessor Circuit Card Assembly (See Table 7-4 for further breakdown)	09042	
A7	Panel Board Module Assembly (See Table 8-2 for further breakdown)	08698-1	
A7A1	Front Panel Circuit Card Assembly (See Table 8-3 for further breakdown)	08343-1	
A7A2	Front Panel Switch Circuit Card Assembly (See Table 8-4 for further breakdown)	08681-1	
A8	Receiver Latch Circuit Card Assembly (See Table 9-2 for further breakdown)	08356-1	
A11	Upper/Lower Loop Synthesizer Module Assembly (See Table 10-3 for further breakdown)	06903	
A13	Transfer Loop Circuit Card Assembly (See Table 11-5 for further breakdown)	06904	
A14	HF Loop Circuit Card Assembly (See Table 12-6 for further breakdown)	06905	
A15	Frequency Standard Module Assembly (See Table 13-2 for further breakdown)	06906-4	
A16	34 MHz Generator Circuit Card Assembly (See Table 14-2 for further breakdown)	08744-1	
A18	Power Supply Module Assembly (See Table 15-3 for further breakdown)	06909-2	

TABLE 6-1. PARTS LIST, RA6778C RECEIVER, MAIN CHASSIS COMPONENTS (Cont.)

Reference Designation	Description	RACAL Number	Manufacturer /MIL Part Number
A23	BFO Module Assembly (See Table 16-3 for further breakdown)	06913	
A25	IF Converter Module Assembly (See Table 17-2 for further breakdown)	08344	
C1-6, 11	Not Used		
C7-10, 12-17	Capacitor, Feed-through, 1000 pF, +20% (AVX)	26406	BSF-1BBGP102M
J1	Connector, Coaxial BNC	60056	UG492A/U
J2	Connector, Digital I/O	61279	MS83723-O1R-1419N
J3	Connector, Antenna Select	61094	MS83723-01R-1210-N
J4	Connector, Auxilliary Select	61277	MS83723-01R-1006N
J5, 6	Connector, BNC, IF Output	60046	KC19-110
J7, 8	Connector, BNC, 1 MHz Reference	60002	051-075-0000
J9	Not Used		
J10, 11	Connector, SMB-SMB Bulkhead	60057	
J12	Connector, MA-9P Plug	61165	DEMA-9P
J13	Connector, DC 27 Pin	61300	
J14, 15	Connector, Phone Jack	61502	JJ-034
LS1	Loudspeaker, 16 ohms, 1.5 watts (Quom)	42759	25A07Z16
P6	Connector, P/0 Main Harness (Cannon)	61172	DBM-13W35
P28	Connector, P/0 Main Harness (Cannon)	61166	D-MA-9S
Q1, 2	Transistor, Darlington, PNP	32520	MJE-700-PNP
Q3	Transistor, Darlington, NPN	32519	MJE-800-NPN
R1	Resistor, Variable, 1K ohms, 1/3W	08764	
R2	Resistor, Variable, 10K ohms, 1/3W	08765	
R3	Resistor, Variable, 10K ohms, 1/3W	08764	
S1	Switch, DPDT, Continental slide	52425	GF326
S2	Switch, DPDT (Alco)	50019	

TABLE 6-1. PARTS LIST, RA6778C RECEIVER, MAIN CHASSIS COMPONENTS (Cont.)

Reference Designation	Description	RACAL Number	Manufacturer /MIL Part Number
TB1	Terminal, AF line out (Cinch)	70337	164-Y
W1	Cable, 1st L.O. A2-A14	07042-1	
W2	Cable, Transfer Oscillator, A13-A14	07042-2	
W3	Cable, Varactor, A13-A14	07042-3	
W4	Cable, 1 MHz, A13-A16	07042-4	
W5	Cable, 34 MHz, A16-A3	07042-5	
W6	Cable, Ribbon, Front Panel Latch	08620	
W7	Cable, Ribbon, Latch-Microcomputer	08622	
W8	Cable, Ribbon, A6-Connector Mounting	08619	
W9	Cable, Power Cable In (Beldon)	57023	17258-B
W10	Cable, Power Cable	07130	
XA8A, XA8B	Connector, PC Card Edge	61293	