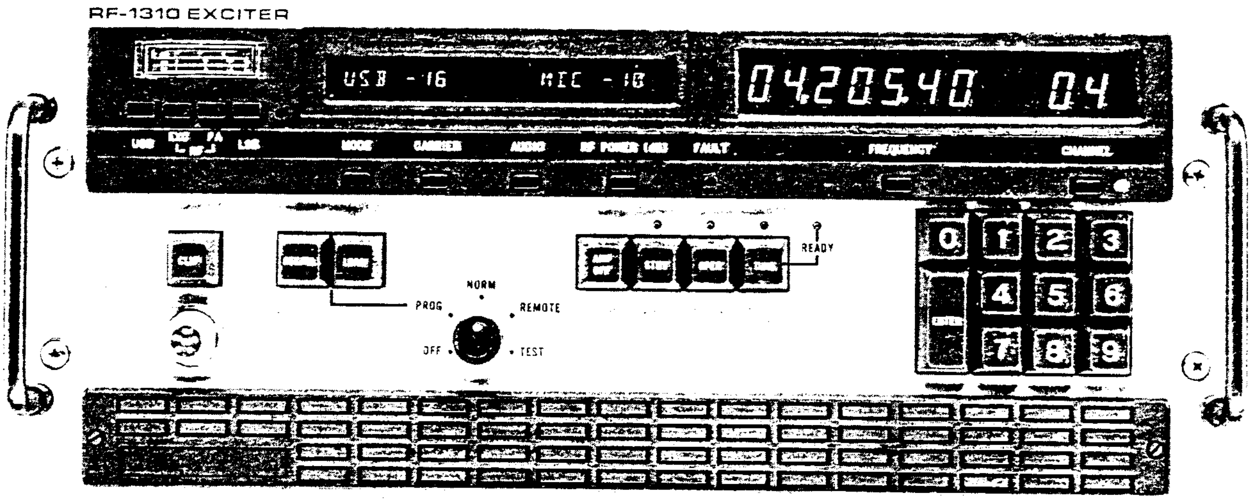
RF-1310 SERIES EXCITER

INSTRUCTION MANUAL



1310-074P

RF-1310 MF/HF SSB Synthesized Exciter

SECTION 1

GENERAL INFORMATION

1.1 SCOPE

Users of this manual should have a basic understanding of radio and digital electronics.

1.2 INTRODUCTION

The RF-1310 is a high performance fully synthesized independent sideband exciter. The microprocessor based design makes the RF-1310 easy to use and maintain while ensuring the unit will meet the needs of the future. The exciter yields a nominal 100 mW RF output over a frequency range of 405 kHz to 29.99999 MHz. It is compatible with high performance transmitter systems including the RF-130, RF-745, and RF-1130. The RS-232 and RS-422 compatible remote control interface allows the RF-1310 to be used in computer controlled, integrated communication networks.

The RF-1310 offers fully programmable or manual operation. Up to 100 channels can be preprogrammed with frequency, operating mode, audio source, and output power level. A front panel keypad is provided to make quick, accurate channel and frequency selection. Frequency selections can be made in 10 Hz increments across the entire frequency range. Mode, audio source, and carrier suppression levels are selected by push-buttons. Operating modes include USB, LSB, 2ISB, AME, FM, MCW, CW, FSK, AFSK, and 4 ISB (optional). Large front panel vacuum fluorescent displays are used to display operating parameters.

Power amplifier modes and output level are controlled from the exciter front panel. The PA output level can be attenuated up to 50 dB in 1 dB steps via the exciter's front panel keypad. The exciter can provide automatic power control in systems where power level feedback lines are present.

The built-in test equipment (BITE) feature diagnoses and isolates faults to the module level. Easily understandable fault codes are displayed to identify faulty assemblies.

Major assemblies are easily identified and replaced. Major assembly locations are shown in the Major Assembly Location and Interconnect section of this manual.

Options for the RF-1310 include:

- Delay compensated filters; RF-1311-02
- Internal postselector; RF-1317
- 4 ISB operation; RF-1314

The advanced design of the RF-1310 Exciter allows it to be modified and adapted to special applications. Harris/RF Communications Systems Division specializes in developing complete system packages to meet customer needs. Questions concerning any special requirements should be directed to:

Harris Corporation/RF Communications Group
1680 University Avenue
Rochester, New York 14610, USA
Phone: (716)/244-5830
Cable: RFCOM; Rochester, New York
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SECTION 2

INSTALLATION

2.1 INTRODUCTION

The following paragraphs provide unpacking and inspection information, equipment installation, mounting instructions, interconnection data, and initial setup and alignment procedures.

2.2 UNPACKING AND INSPECTION

Carefully open the shipping carton and check the contents against the packing list secured to the outside of the container. Inspect all items for signs of damage. Immediately notify the carrier if any damage is discovered. Save all packing material for possible reshipment.

2.3 ANCILLARY KIT

Items that are supplied in the RF-1310 Ancillary Kit, 10121-0021 are listed in table 2-1.

Table 2-1. Ancillary Kit (10121-0021)

Quantity	Part Number	Description
5	F03-0002-005	Fuse, 1/8 amp, slow-blow
5	F03-0002-010	Fuse, 1/4 amp, slow-blow
5	F03-0002-019	Fuse, 1 amp, slow-blow
5	F03-0002-022	Fuse, 3AG, 1-1/2 amp, slow-blow
3	J65-0008-103	Jumper
1	W-0023	Cord, Line, 6 feet
1	Z80-0001-000	Tool, Tuning
1	919-5000	Microphone
1	J22-0001-001	Connector, Type D, 25 pin
1	J22-0010-000	Connector, Type D, 37 pin
1	J55-0015-825	Shell, D Connector*
1	J55-0015-837	Shell, D Connector*

* NOTE: The two D connector shells are provided with various sized grommets to accommodate different sized cables.

2.4 POWER REQUIREMENTS

The RF-1310 requires 100, 120, 220, or 240 Vac, 47 to 420 Hz single-phase power at 100 watts, nominally. Ac power selection is normally factory set to 120 Vac. To select a different range, first turn the front panel power switch off, then remove the ac power cord at the rear panel. Slide the plastic cover out of the way to expose the fuseholder and remove the fuse by pulling on the lever labeled FUSE PULL. Grasp the small PC card (located to the left of the fuseholder) with needlenose pliers and pull the card straight out. This card will be labeled with the numbers 100, 120, 220, and 240 Vac. Orient this card so that the desired range faces the fuseholder, and is the only number visible once the card has been reinserted. Reinsert the appropriate slow-blow fuse (1.5 ampere for 120 Vac operation or 1 ampere for 240 Vac operation). A switch on the A23 assembly must be set for 100/120 or 220/240 Vac operation. This switch may be accessed by removing the top cover. See figure 2-1 for switch location. Reconnect power cord.

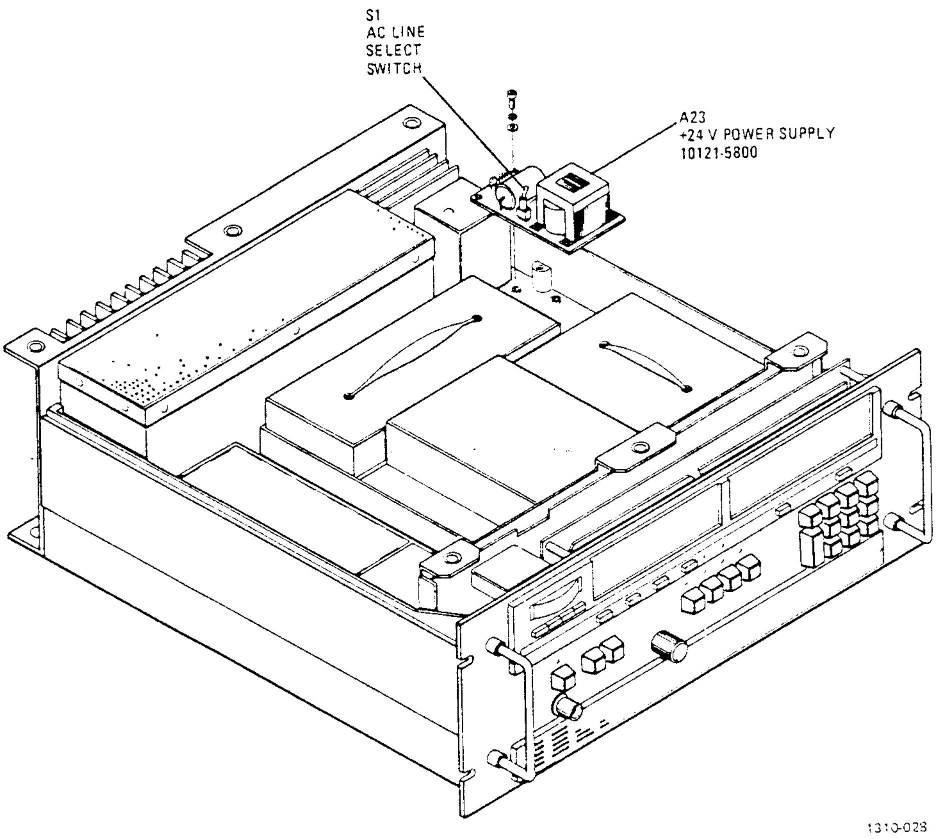


Figure 2-1. A23 Ac Line Select Switch Location

2.5 MECHANICAL INSTALLATION

The RF-1310 may be stack mounted or rack mounted into a standard 19-inch equipment rack. See figures 2-2 and 2-3 for mounting information. Note that two different mounting brackets are supplied for rack mounting. PN 10073-1010 fits the left side of the RF-1310 and PN 10073-1014 fits the right side. The detail drawing in figure 2-3 shows the left side bracket.

2.6 INPUT/OUTPUT CONNECTIONS

The RF-1310 Exciter is used in a transmitting system independent of all other equipment. It requires power and Exciter to PA connections. Other input/output connectors are used to expand and integrate features of the exciter. Input and output connectors are shown and described in figure 2-4.

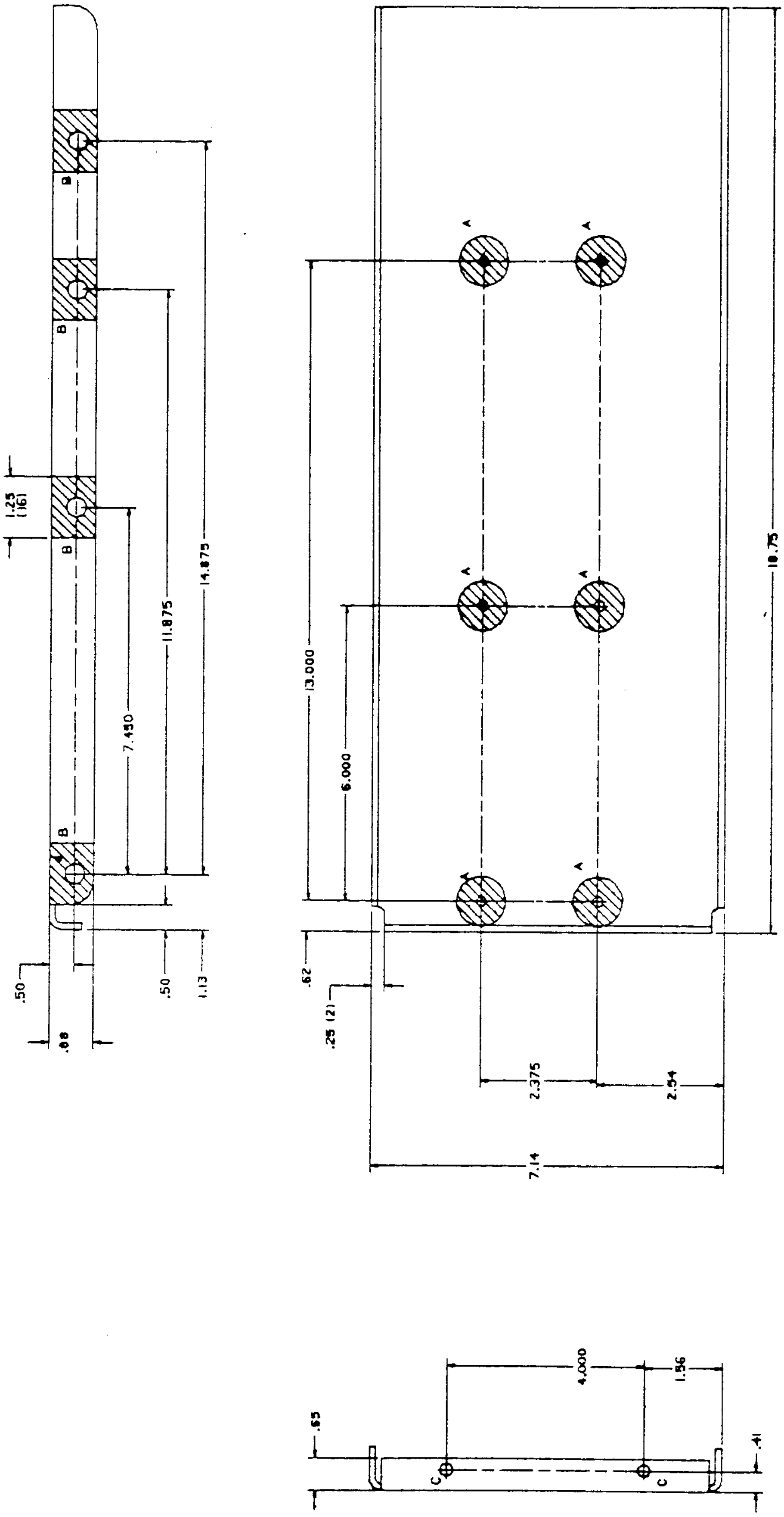


Figure 2-2. RF-1310 Stack Mount Dimensions

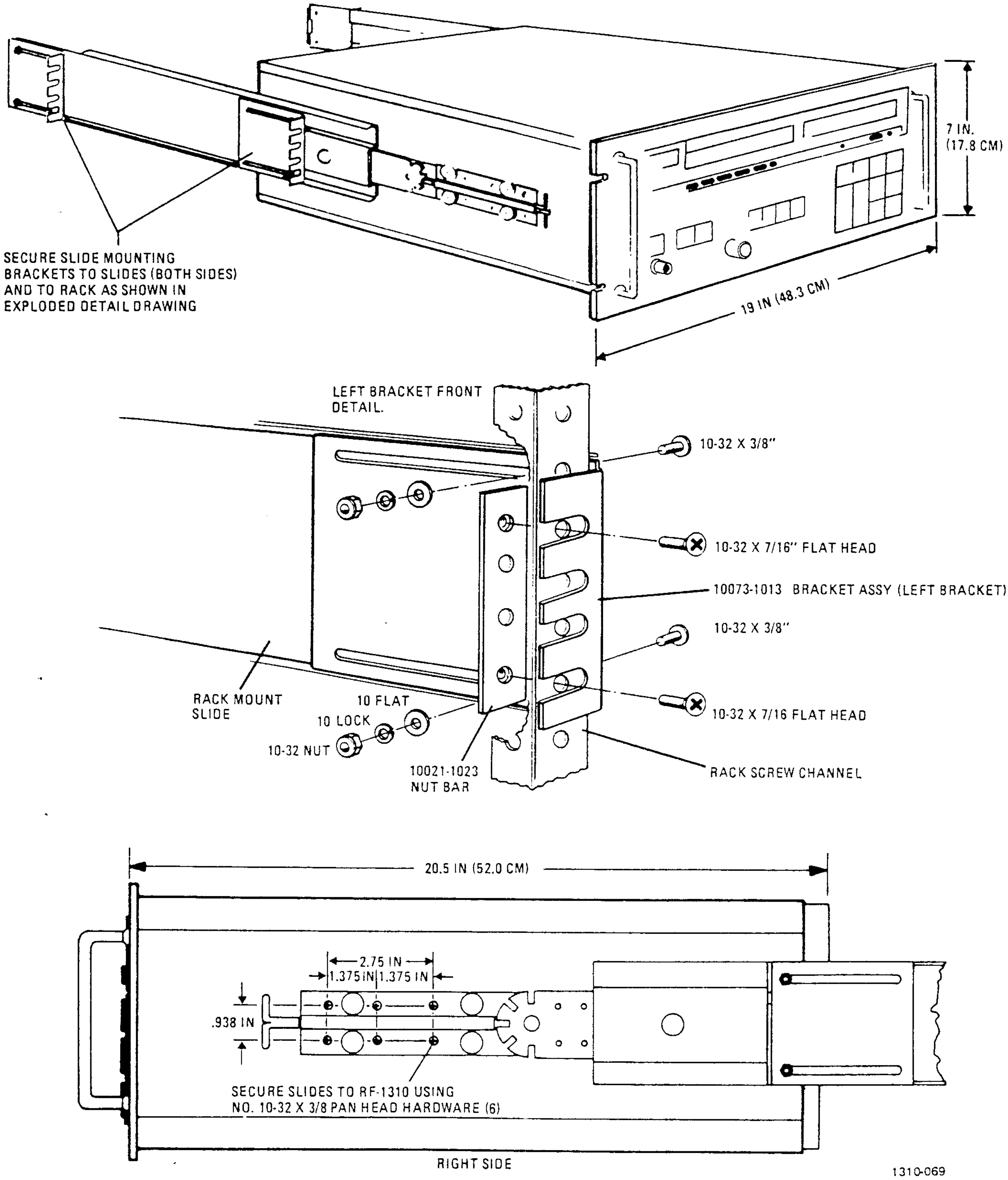


Figure 2-3. RF-1310 Rack Mounting Details

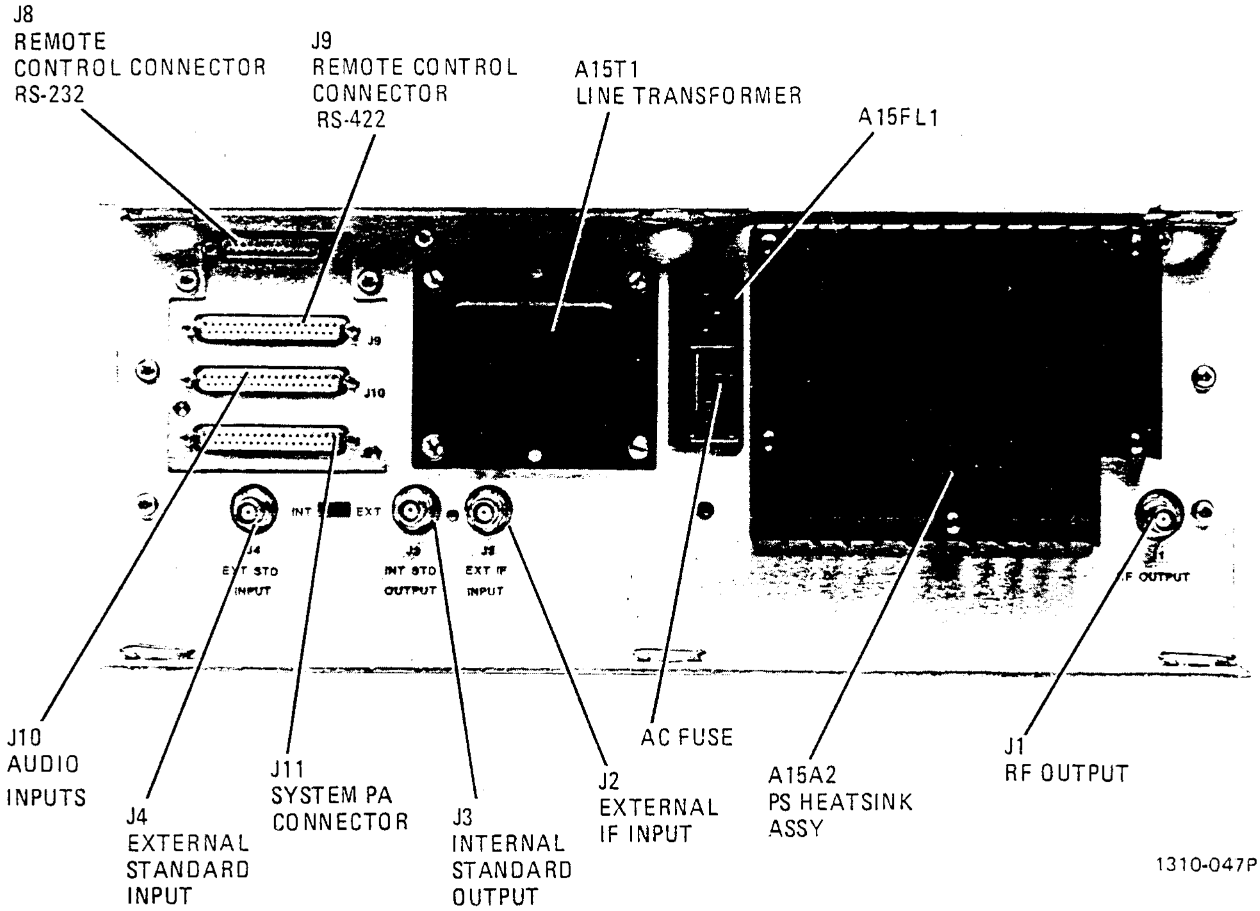


Figure 2-4. RF-1310 Rear Panel Connections

All RF type connectors are standard BNC, 50-ohm connections. All rear panel connector pins are listed and described in tables 2-2 through 2-6.

Table 2-2. Coaxial Connectors

Connector	Function	Signal	Type
J1	RF Output	405 kHz - 29.99999 MHz, 100 mW PEP, 50 ohms	BNC
J2	External IF In	455 kHz, 50 ohms, 22 mV_{rms}	BNC
J3	Internal Frequency Standard Output	Approximately .5 - 1 V_{rms}/50 ohms 1, 5, or 10 MHz	BNC
J4	External Frequency Standard Input	1, 5, or 10 MHz - Depends on Internal Standard. Approximately .5 - 1 V_{rms}/50 ohms.	BNC

Table 2-3. Connector J8 - RS-232 Remote Control Signals

Connector Pin	Signal	Exciter Input or Output	Description
J8-1	SHIELD (GND)		Shield Connection
J8-2	RS-232 OUT	O	RS-232 Transmit
J8-3	RS-232 IN	I	RS-232 Receive
J8-4	FSK OUT (-)	O	FSK Modem, 600 ohms
J8-5	FSK IN (+)	I	FSK Modem, 600 ohms
J8-6	ID0	I	Remote Identification, Bit 0
J8-7	RS-232 SIG GND		Signal Ground
J8-8	ID1	I	Remote Identification, Bit 1
J8-9	ID4	I	Remote Identification, Bit 4
J8-10	BAUD 1	I	Remote Baud Rate, Bit 1
J8-11	BAUD 2	I	Remote Baud Rate, Bit 2
J8-12 through J8-14	NC		
J8-15	ID3	I	Remote Identification, Bit 3
J8-16	ID2	I	Remote Identification, Bit 2
J8-17	ID5	I	Remote Identification, Bit 5
J8-18	ID6	I	Remote Identification, Bit 6
J8-19	GND		Ground
J8-20, J8-21	NC		
J8-22	BAUD 3	I	Remote Baud Rate, Bit 3
J8-23	BAUD 0	I	Remote Baud Rate, Bit 0
J8-24, J8-25	NC		

(J8 is a 25 pin D connector, PN J22-0035-001)

Table 2-4. Connector J9 - RS-449 Remote Control Signals

Connector Pin	Signal	Exciter Input or Output	Description
J9-1, J9-2	NC		
J9-3	BUS REQUEST	I	Tristate Request
J9-4	RS-422 OUT (+)	O	RS-422 Transmit
J9-5	NC		
J9-6	RS-422 IN (+)	I	RS-422 Receive
J9-7 through J9-18	NC		
J9-19	GND	O	
J9-20	RS-422 IN (-)	I	RS-422 Receive
J9-21	BUS AVAILABLE	O	Tristate Confirm
J9-22 through J9-36	NC		
J9-37	RS-422 OUT (-)	O	RS-422 Transmit

(J9 is a 37 pin D connector, PN J22-0035-002)

Table 2-5. Connector J10 - Audio and Miscellaneous Signals

Connector Pin	Signal	Exciter Input or Output	Description
J10-1	Rear Serial Data	O	TTL Levels
J10-2	Spare		
J10-3	Rear Serial Clock	O	TTL Levels; occurs only when data is sent
J10-4	Fault	O	TTL HI = Fault LED On
J10-5	REMOTE IN 1	I	Remotely Monitored Input, TTL
J10-6	INTERNAL KEY	O	TTL LO = Exciter Keyed
J10-7	AUX PTT KEY	I	LO = Key Down
J10-8	Spare		
J10-9	AUX CW KEY	I	TTL LO = Key Down
J10-10, J10-11	NC		
J10-12	AUX AUDIO 2	I	600 Ohms Balanced; 0 dBm, Nominal
J10-13	NC		
J10-14	LSB AUDIO INPUT	I	600 Ohms, Balanced Transformer; 0 dBm, Nominal
J10-15	XMIT MUTE	O	TTL LOW = System Keyline Active
J10-16	REM OUT 0	O	Remotely Controlled Output, TTL
J10-17	FSK KEY	I	RS-232 FSK Data Input
J10-18	SERIAL ENABLE 1	O	Strobes Rear Serial Data into External Device
J10-19	PRIMARY FAIL	O	+5 V = Primary Failure
J10-20	REMOTE IN 0	I	Remotely Monitored Input, TTL
J10-21	GND		Audio Shield Ground
J10-22, J10-23	AUX AUDIO 1	I	600 Ohms Balanced; 0 dBm, Nominal
J10-24	CW SIDE TONE	O	Approximately 1200 Hz; 50 mV_{rms}/600 ohms
J10-25	GND		Audio Shield Ground
J10-26	USB AUDIO INPUT	I	600 Ohms Balanced Transformer; 0 dBm
J10-27	NC		
J10-28	USB AUDIO INPUT	I	600 Ohms Balanced Transformer; 0 dBm, Nominal
J10-29	AUX AUDIO 2	I	600 Ohms Balanced; 0 dBm, Nominal
J10-30	NC		
J10-31	REMOTE OUT 1	O	Remotely Controlled Output, TTL
J10-32	SERIAL ENABLE 2	O	Strobes Rear Serial Frequency Data into External Device
J10-33	LSB AUDIO IN CENTER TAP		Transformer Center Tap
J10-34	USB AUDIO IN CENTER TAP		Transformer Center Tap
J10-35	LSB AUDIO INPUT	I	600 Ohms Balanced Transformer; 0 dBm, Nominal
J10-36, J10-37	AUX AUDIO 3	I	600 Ohms Balanced; 0 dBm, Nominal

(J10 is a 37 pin D connector, PN J22-0035-002)

Table 2-6. Connector J11 - System and PA Connections

Connector Pin	A18A2 Signal Names (10121-6370 Version)	A18A2 Signal Names (10121-6350 Version)	Exciter Input or Output
J11-1	PA BND SW CODE C	PA BND SW CODE C	O
J11-2	STANDBY READBACK	NC	I
J11-3	PA BND SW CODE A	PA BND SW CODE E	O
J11-4	NC	NC	I
J11-5	TUNE CMD 1	BYPASS REQUEST	I
J11-6	SYS KEY	SYS KEY	I/O
J11-7	10 KW FORWARD (APC)	APC	I
J11-8	CHASSIS GND	NC	
J11-9	PTT RTN	PTT RTN	O
J11-10	NC	NC	I
J11-11	PA READY	SYSTEM KEY LINE INTLK	I
J11-12	TUNE ENABLE	SYS TUNE PWR REQUESTS	O
J11-13	NC	PA CLASS	O
J11-14	PA BYPASS	BYPASS	I
J11-15	PPC	NC	I
J11-16	STBY CMD	STBY CMD	O
J11-17	NC	NC	
J11-18	PA BND SW CODE D	PA BND SW CODE B	O
J11-19	OPER CMD	OPER CMD	O
J11-20	NC	NC	
J11-21	10 KW REFLECTED	NC	
J11-22	TGC	NC	I
J11-23	CW/KEY	CW/KEY	I
J11-24	FAULT	PA FAULT	I
J11-25 through J11-28	N/C	N/C	
J11-29	OPER READBACK	NC	I
J11-30	NC	PTT KEY (FLOAT + 12 V)	I
J11-31	NC	NC	
J11-32	TUNE CMD 2	NC	I
J11-33, J11-34	NC	NC	
J11-35	PA BND SW CODE B	PA BND SW CODE D	O
J11-36	PA BND SW CODE E	PA BND SW CODE A	O
J11-37	INHIBIT	SYSTEM RETUNE CMD	O

J11 is a 37 pin D connector, PN J22-0035-002)

NOTE

The signal names shown in table 2-6 are the most commonly used signal names for the two versions of the A18A2 System Interface. Some signal names may change at the exciter/ PA interface. Consult the appropriate system manual for specific system signals.

2.7 INITIAL SETUP AND ADJUSTMENTS

The advanced design of the RF-1310 Exciter minimizes initial setup and adjustment procedures. The initial setup and adjustment should include:

- Connecting memory backup battery
- Adjusting front panel display brightness
- Adjusting LSB and USB audio input levels
- Adjusting VOX sensitivity and threshold
- Adjusting maximum rf output level
- Setting system interface switches
- Setting remote control interface configuration (if used)

Some adjustments may be system specific. Consult the specific system manual for additional setup and adjustment procedures before attempting to operate the exciter in a transmitting system.

CAUTION

Do not short out the memory backup battery terminals. This could result in severe circuit damage.

2.7.1 Connecting Memory Backup Battery

A ni-cad battery is used to keep the RAM memory alive when power is removed from the exciter. The backup battery is located on the A14 Control Board assembly. The backup battery jumper must be inserted between E1 and E2 on the A14 Control Board assembly to activate the keep alive circuit. See subsection A14 for location of the assembly and the jumper.

2.7.2 Adjusting Front Panel Display Brightness

Potentiometer R29 on Front Panel Driver Board assembly A13A2 is used to adjust the brightness of the vacuum flourescent displays. R29 can be accessed by removing the top chassis cover or tilting the front panel assembly forward. R29 can be adjusted with a small screwdriver and is identified in subsection A13.

2.7.3 USB and LSB Audio Level Adjust

USB and LSB audio levels are adjustable from the front panel. Adjustment potentiometers are accessed through holes located next to the USB and LSB meter select pushbutton switches on the front panel.

Turn the potentiometer to full clockwise (cw) for full rf power output with -26 to + 10 dBm audio input (ALC on). If ALC is off, adjusting the potentiometer counterclockwise (ccw) will reduce audio gain and rf power output level.

2.7.4 VOX Adjustments

Vox operation is an option, selectable during programming on the A14 Control Board assembly. See subsection A14 for explanation of VOX option selection.

VOX sensitivity and hangtime are adjusted on the A5A1 Audio 1 assembly. VOX is adjusted by R41 and hangtime is adjusted by R46. See subsection A5A1 for adjustment locations and VOX circuit description.

The sensitivity adjustment (R41) sets the threshold to where the audio input will key the exciter. Sensitivity can be adjusted so that the exciter will be keyed by an audio input level between -26 and + 10 dBm. Hangtime is the length of time the exciter remains keyed after the audio input drops below the VOX threshold. The hangtime can be adjusted from 0.1 to 3.0 seconds.

2.7.5 RF Output Adjust

The maximum RF output is adjustable over an 8 dB range. R26 on the Converter assembly A2 is normally set so the exciter has a nominal 100 mW output. The location of R26 is shown in subsection A2.

2.7.6 System Interface Switches and Adjustments

All of the switch settings and adjustments on the System Interface Assembly A18 are system specific. See the specific system manual in order to determine what the switch settings and adjustments should be. Switches and adjustments are described in subsection A18.

2.7.7 Remote Control Interface Configuration

For remote control interface configuration setup procedure, see unit instruction subsection A17.

2.7.8 Signal Generator Mode

The exciter may be used as a frequency synthesized signal generator. This feature can be used to check the exciter's own performance or to troubleshoot other equipment. It provides a nominal 100 mW rf output from 0.1 to 30 MHz. Frequency and rf output power reduction are front panel selectable.

To select signal generator mode, set switch A18A1S1-4 SIG GEN/NORM to OPEN. See subsection A18A1 for the location of the switch.

SECTION 3

OPERATION

3.1 INTRODUCTION

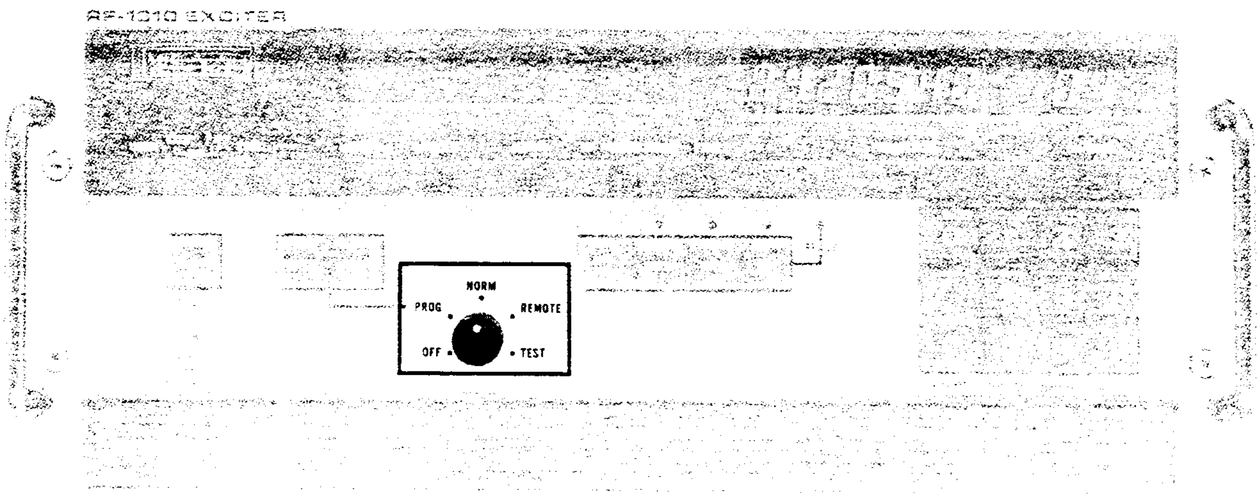
This section describes the front panel controls and indicators of the RF-1310 and their general operation. Actual operation depends on the specific application and built-in optional features. Consult the system manual before attempting to operate the exciter in an operational system.

3.2 CONTROL AND INDICATOR

The controls and indicators are arranged in functional groups and described in paragraphs 3.2.1 through 3.2.7.

3.2.1 Rotary Switch

The On/Off rotary switch is shown and described in figure 3-1.



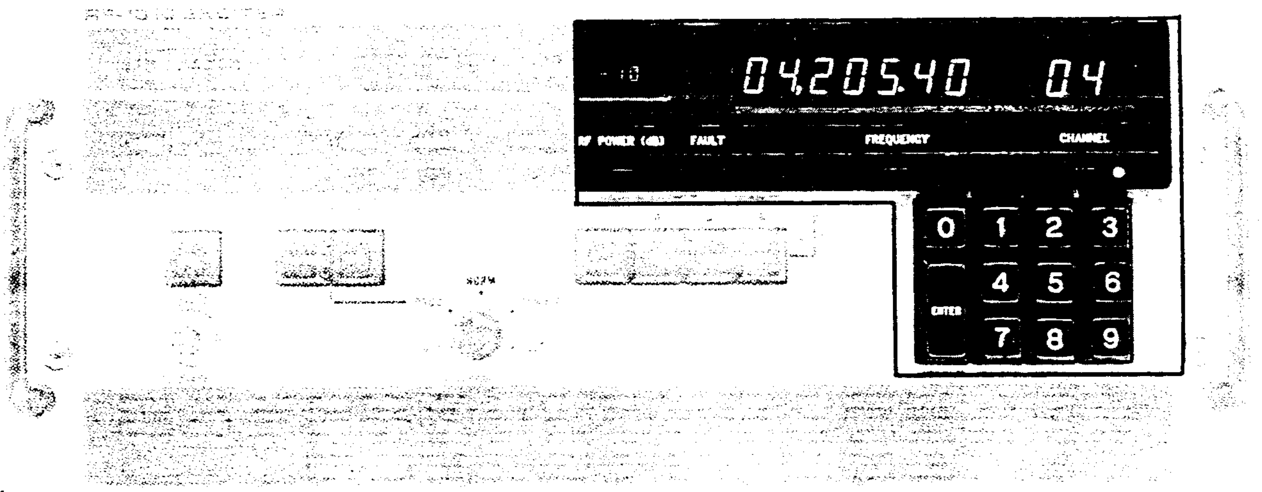
SWITCH POS.	FUNCTION	SWITCH POS.	FUNCTION
OFF	POWER IS DISCONNECTED FROM ALL ASSEMBLIES EXCEPT FREQ. STD. OVEN. POWER IS SUPPLIED TO ALL ASSEMBLIES WHEN SWITCH IS IN ANY OTHER POSITION.	NORM	PLACES EXCITER IN LOCAL OPERATING MODE.
PROG	PLACES EXCITER IN PROGRAM MODE AND ENABLES **RECALL** AND **LOAD** SWITCHES. EXCITER IS NOT OPERATIONAL WHILE IN PROGRAM MODE.	REMOTE	PLACES EXCITER IN REMOTE OPERATING MODE. DISABLES ALL FRONT PANEL CONTROLS.
		TEST	INITIATES **BITE** FEATURE.

1310-060

Figure 3-1. On/Off and Mode Select Rotary Switch

3.2.2 Keypad Entries (Channel, Frequency, and RF Power)

The keypad is used to change the channel, frequency, and RF power displays. The ENTER key is used to place the displayed data into the exciter's memory. The displays will dim as they are changed. The displays return to full brightness when the ENTER key is pressed. LED indicators next to CHANNEL, FREQUENCY, and RF POWER pushbuttons light to indicate which display will be changed by keypad entries. All three functions can be selected in normal and program operating modes. Figure 3-2 shows and describes the keypad entries.



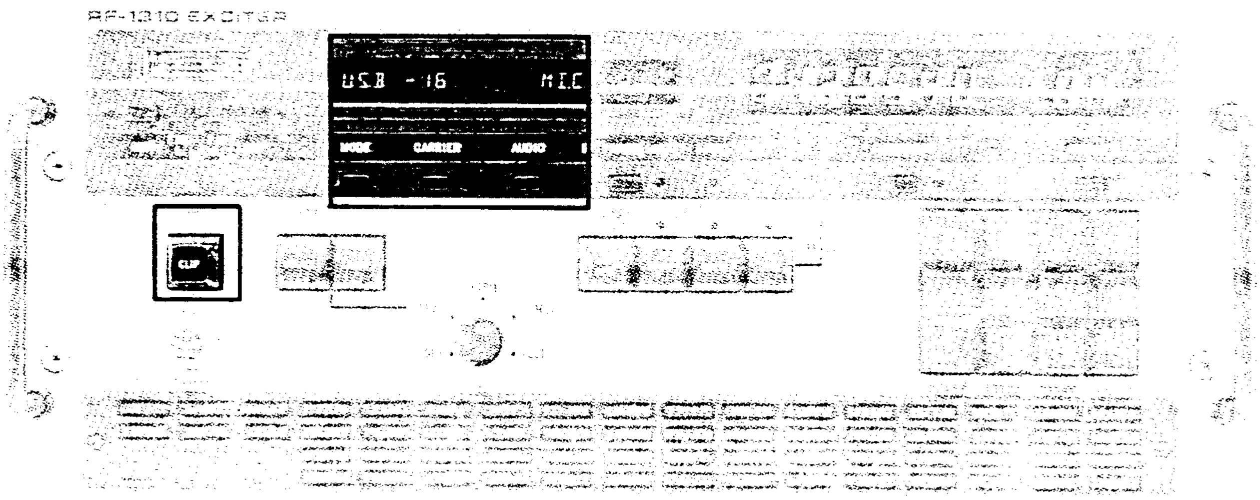
CONTROL/ INDICATOR	FUNCTION	CONTROL/ INDICATOR	FUNCTION
CHANNEL	DEDICATES KEYPAD TO CHANGING CHANNEL DISPLAY AND ENTERING NEW CHANNEL NUMBERS. THE TENS DIGIT IS ENTERED FIRST AND THEN THE ONES DIGIT.	RF POWER (DB)	DEDICATES KEYPAD TO CHANGING THE RF POWER DISPLAY. THE OPERATOR CAN REDUCE THE PA OUTPUT BY UP TO 50 DB. THE DISPLAY INDICATES THE SELECTED POWER REDUCTION. THE TWO DIGITS ARE ENTERED FROM LEFT TO RIGHT.
FREQUENCY	DEDICATES KEYPAD TO CHANGING FREQUENCY DISPLAY AND ENTERING A NEW FREQUENCY SELECTION. DIGITS ARE ENTERED FROM LEFT TO RIGHT.	ENTER	ENTERS ENABLED DISPLAY INTO THE EXCITER'S RAM MEMORY.

1310-061

Figure 3-2. Keypad Entries

3.2.3 Mode, Carrier Suppression, Audio Input, and Clip Select

The MODE, CARRIER, and AUDIO pushbuttons are used to select the mode of operation, carrier suppression, and audio source for each channel. The operator can step through the options for each parameter by pushing and releasing the respective button. Options will appear on the display above the button. The exciter will scroll through the available options continuously when the operator holds down the button for a parameter. The CLIP pushbutton enables or disables the clip function. Figure 3-3 shows and describes the MODE, CARRIER, AUDIO, and CLIP controls.



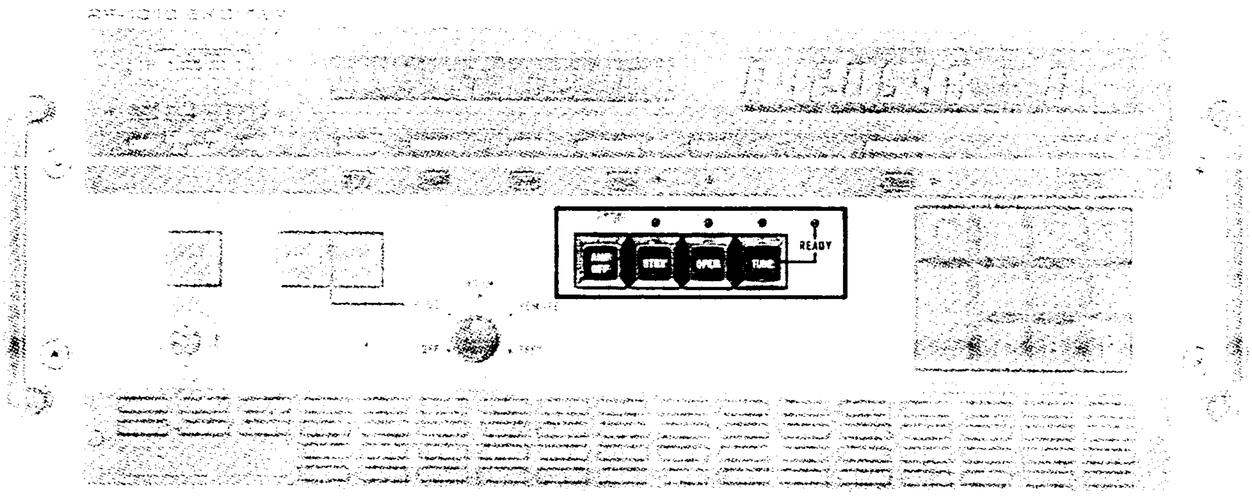
CONTROL/ DISPLAY	FUNCTION	CONTROL/ DISPLAY	FUNCTION
MODE	CONTROLS DISPLAY AND SELECTION OF EXCITER OPERATING MODE. AVAILABLE MODES ARE **USB, LSB, 2ISB (ISB), 4ISB (4SB), MCW, FM, FSK, CW, AFSK (AFK)**, AND **AM**. 4ISB OPERATION IS OPTIONAL.	AUDIO	CONTROLS DISPLAY AND SELECTION OF AUDIO SOURCE. REFER TO TABLE 3-1.
CARRIER	CONTROLS DISPLAY AND SELECTION OF CARRIER SUPPRESSION. SELECTIONS ARE LIMITED BY OPERATING MODE. FOR USB, LSB, 2ISB AND 4ISB, -16 DB, -26 DB AND -INFINITY (BLANK DISPLAY) ARE SELECTABLE. FOR AM LEVEL IS SET AT -6 DB AND CANNOT BE CHANGED. FOR CW, FM, FSK AND AFSK, THE DISPLAY WILL BE BLANK.	CLIP	ENABLES OR DISABLES CLIPPER CIRCUIT IN EXCITER. LED IS ON WHEN ENABLED. MAY BE ENABLED ONLY IN USB, LSB, 2ISB, 4ISB, AND AM MODES.

1310-062

Figure 3-3. MODE, CARRIER, AUDIO, and CLIP Controls

3.2.4 Power Amplifier Controls and Indicators (AMP OFF, STBY, OPER, and TUNE)

The AMP OFF, STBY, OPER, and TUNE pushbuttons are used to control the system power amplifier (PA). The LED indicators located above the switches indicate the status of the PA. The controls are shown and described in figure 3-4. The operator should refer to the specific system manual for a detailed description of PA operation.



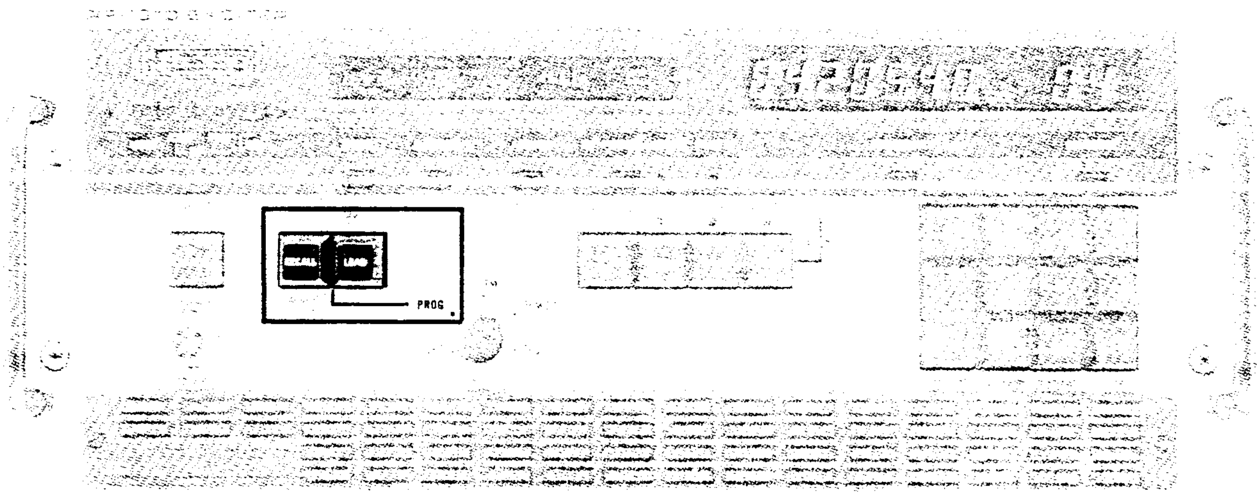
CONTROL/ INDICATOR	FUNCTION	CONTROL/ INDICATOR	FUNCTION
AMP OFF	USED TO TURN PA OFF. CAN BE ACTIVATED WHEN PA IS IN STANDBY OR OPERATE MODES. PA IS FORCED TO **AMP OFF** STATE UPON EXCITER POWER-UP.	OPER	PLACES PA IN OPERATE MODE. IN MOST SYSTEMS PA WILL NOT BECOME OPERATIONAL UNTIL WARM-UP IS COMPLETE.
STBY	PLACES PA IN STANDBY.	TUNE	SWITCH USED TO START TUNE SEQUENCE IN PA AND COUPLER. **TUNE LED** IS LIT DURING TUNING SEQUENCE OR FOR TUNE REQUEST. **READY LED** IS LIT WHEN TUNING IS COMPLETE.

1310-063

Figure 3-4. Power Amplifier Controls and Indicators

3.2.5 RECALL and LOAD

The RECALL and LOAD pushbutton switches are enabled only when the exciter is in program mode. They are used to program frequency, operating mode, carrier suppression level, audio source, clip, and RF power level for each channel. The switches are shown and described in figure 3-5.



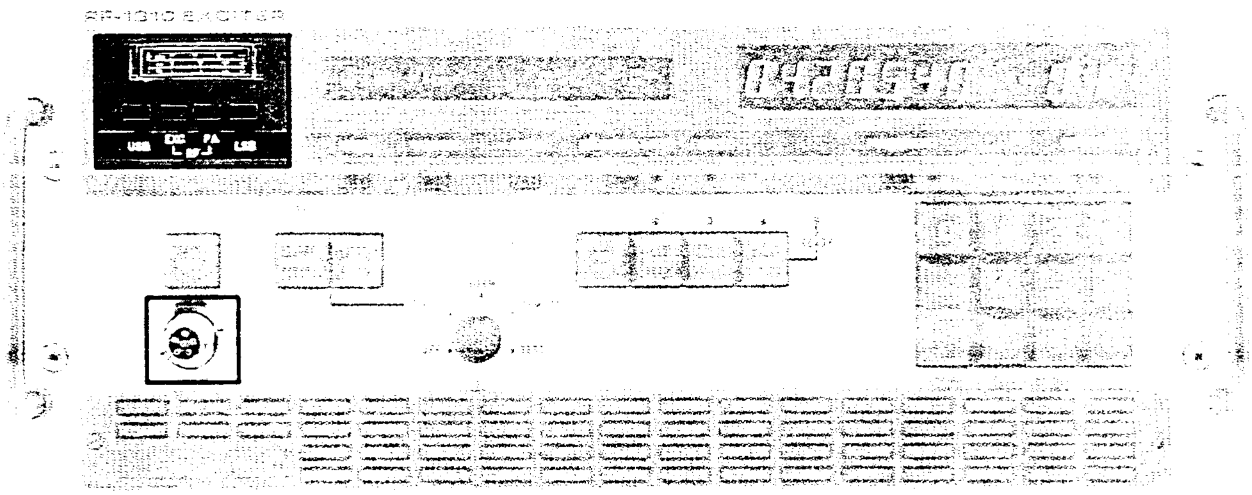
CONTROL	FUNCTION	CONTROL	FUNCTION
LOAD	LOADS ALL DISPLAYED INFORMATION INTO MEMORY.	RECALL	RECALLS AND DISPLAYS OPERATING PARAMETERS FOR SELECTED CHANNEL.

1310-064

Figure 3-5. RECALL and LOAD Controls

3.2.6 USB, EXC, PA, LSB Meter Select Switches, and Microphone Jack

The meter in the upper left hand corner of the front panel indicates audio and RF signal levels. The four meter select switches are shown and described in figure 3-6. The switches are spring loaded and interconnected so only one function may be selected at a time.



CONTROL	FUNCTION	CONTROL	FUNCTION
USB	SELECTS METER TO INDICATE USB AUDIO SIGNAL LEVEL ON THE AUDIO ASSEMBLY A5.	AUDIO INPUT ADJUST PORTS	SCREWDRIVER-ADJUSTABLE CONTROLS FOR THE USB AND LSB AUDIO SIGNAL LEVEL ARE ACCESSED THROUGH PORTS ADJACENT TO THE USB AND LSB SWITCHES.
LSB	SELECTS METER TO INDICATE THE LSB AUDIO SIGNAL LEVEL ON THE AUDIO ASSEMBLY A5.	MICROPHONE JACK	-56 DBM NOMINAL INPUT LEVEL INTO 150 OHMS.
EXC	SELECTS METER TO INDICATE THE RF SIGNAL LEVEL AT THE EXCITER OUTPUT. (ACCURATE WHEN OPERATING INTO A 50 OHM LOAD).		
PA	SELECTS METER TO INDICATE THE RF SIGNAL LEVEL AT THE PA OUTPUT.		

1310-065

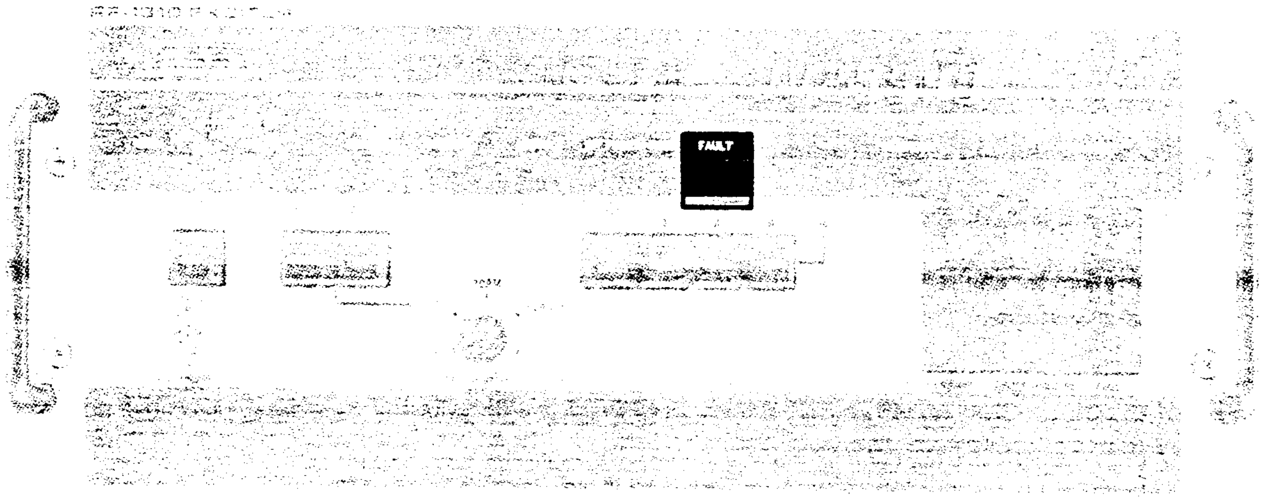
Figure 3-6. Meter Select Switches

3.2.7 FAULT Indicator

NOTE

A fault indication may occur at initial turn on and will remain until the frequency standard stabilizes. See table 5-1 in the maintenance section.

The red FAULT LED indicates that a fault condition exists in the exciter or transmitter system. The indicator is shown and described in figure 3-7. The test mode can be used to isolate and diagnose most fault conditions.



FAULT CONDITIONS DURING NORMAL OPERATION
1. ANY PLL IS OUT-OF-LOCK.
2. POWER SUPPLY VOLTAGE IS OUT OF TOLERANCE.
3. PA FAULT (IF PA FAULT READ BACK LINES ARE PROVIDED).

1310-066

Figure 3-7. FAULT Indicator

3.3 OPERATING GUIDELINES AND CONSIDERATIONS

Operating procedures for the RF-1310 Exciter are system specific and beyond the scope of this manual. The following paragraphs describe the operation of an RF-1310 Exciter installed in a typical system.

3.3.1 Power Up

The exciter enters the power up mode when the rotary switch on the front panel is moved from the OFF position to the PROG, NORM, REMOTE, or TEST position. When the exciter is turned on, the front panel displays and indicators will all be lit while the exciter performs a brief self test. If no faults were detected, the exciter enters the mode of operation selected by the rotary switch. The displays will show the channel (if used), frequency, mode, carrier suppression level, audio source, RF power reduction level, and clip state that were selected when the exciter was turned off (if memory contains valid data). If the data has been lost or corrupted, the frequency display will be all zeros, the mode display will be USB, the carrier display will be blank (infinity), and the RF power display will show -00.

3.3.2 Operating in Normal Mode

The exciter is in the normal mode when the front panel rotary switch is in the NORM position. The normal mode is used for local control of the exciter. The exciter may also be preprogrammed.

3.3.2.1 Operating a Programmed Exciter in Normal Mode

Up to one hundred channels can be programmed with all operating parameters, including frequency, mode, carrier suppression level, audio source, RF power reduction, and clip status. To operate the exciter the user must:

a. Press and release the CHANNEL pushbutton switch.

b. Enter the desired channel number on the keypad.

c. Press and release the ENTER key.

Operating parameters for the selected channel will be displayed as they were programmed. After the channel selection is complete, the operator can proceed to system tuneup per the system manual instructions.

The operator can change any of the operating parameters at any time without changing the stored channel data. If any of the parameters are changed, the channel display will go blank to indicate that the displayed parameters were not recalled from memory.

3.3.2.2 Operating an Unprogrammed Exciter in Normal Mode

To operate an unprogrammed exciter, or to select operating parameters not associated with a programmed channel, the operator must enter all operating parameters individually. No entries will be made in the channel display and it will be blank.

3.3.2.2.1 Frequency Entries

To enter a frequency:

a. Press and release the FREQUENCY pushbutton switch. The indicator next to the switch will light.

b. Enter the frequency in the display on the keypad. The numbers will be entered from left to right and the digits will be at half brightness. The entry can be aborted by pressing and releasing the FREQUENCY pushbutton switch and the display will return to previous display.

c. Press and release the ENTER key to complete the entry. The display will go to full brightness.

3.3.2.2.2 Mode Selection

To select a mode, press and hold the MODE switch until the desired mode appears on the display. Then release the switch. The 4 ISB mode (displayed as 4SB) is an optional operating feature. The 4SB display will appear only on exciters with the installed option. The exciter can be configured for AM or AME operation. The display will indicate AM for either configuration.

3.3.2.2.3 Carrier Suppression Level Selection

The operator can select one of three carrier suppression levels when in the USB, LSB, 2ISB, or 4ISB modes. The choices in these modes are -16 dB, -26 dB, and -infinity or, optionally, -10 dB, -20 dB, and -infinity. Selections are made by pressing and holding the CARRIER switch until the desired level appears on the display above the switch, and then releasing the switch. For -infinity, the operator selects the blank display. Carrier suppression is automatically set at -6 dB for the MCW and AM operating modes. The CARRIER display is blank when operating in FM, FSK, CW, or AFSK modes.

3.3.2.2.4 Audio Source Selection

The RF-1310 Exciter has a total of six audio inputs. They include the front panel microphone jack and five rear panel 600-ohm input ports LSB, USB, AUX 1, AUX 2, and AUX 3. Allowable audio sources are limited by the selected mode listed in table 3-1.

Table 3-1. Audio Source Selection

Mode	Selectable Audio Inputs
USB	MIC, AUX 1, AUX 2, AUX 3, and USB.
LSB	MIC, AUX 1, AUX 2, AUX 3, and LSB.
2ISB, 4ISB	Same as for USB and LSB modes. Same source can be used for both side bands.
FM	MIC, AUX 1, AUX 2, AUX 3, and LSB.
CW, MCW, FSK	No audio inputs are selected for these modes. Display will be blank.
AFSK	AUX 1, AUX 2, AUX 3, and USB.
AM	MIC, AUX 1, AUX 2, AUX 3, and USB.

To select an audio source for USB, LSB, FM, AFSK, or AM modes, simply press and hold the AUDIO switch until the desired source appears on the display above the switch. For the 2ISB and 4ISB modes, the display will list two audio sources. The source for USB will be displayed on the right, the source for LSB will be displayed on the left. The sources displayed will be those last used in the USB and LSB modes. To change the selection for the 2ISB and 4ISB modes, the operator must place the exciter in the individual operating modes.

3.3.2.2.5 RF Power Control

The operator can reduce the system rf output level by up to 50 dB. The amount of attenuation is displayed above the RF POWER switch. A 00 display indicates that the system output is at its nominal level. To change the display the operator must:

a. Press and release the RF POWER switch. The LED next to the indicator will light.

b. Use the keypad to change the display. Digits are entered from left to right and are dimmed to half brightness as they are changed.

c. Press and release the ENTER key to complete the entry. The display will return to full brightness.

3.3.2.2.6 CLIP Switch

Clipping is used to limit the peak amplitude of the audio signal so the HF radio signal will have a higher average power level. The clipping feature can be selected in the USB, LSB, 2ISB, 4ISB, and AM modes. The feature may not be selected in the FM, FSK, AFSK, CW, and MCW modes. The CLIP pushbutton switch on the exciter front panel is used to enable and disable the clipping circuit. The LED above the switch is lit when the circuit is enabled.

The gain of the clipping amplifier is adjustable, thereby yielding a variable clipping level from 3 dB to 15 dB. Detailed discussion of the clipping circuit and clipping level adjustments are described in subsection A5A2.

3.3.3 Power Amplifier Control

The AMP OFF, STBY, OPER, and TUNE switches are used to control the power amplifier (PA). LEDs above the switches indicate the status of the PA. System response to these controls will depend upon the particular application. The AMP OFF switch is used to turn the PA off. The PA will be forced to AMP OFF status when the exciter is turned on. Pressing and releasing the STBY switch places the PA in standby. The OPER switch is used to change the PA status to operational. Most power amplifiers require a warmup period before they become operational. The length of the warmup period and the way the PA responds to the OPER switch is system dependent.

The TUNE switch is used to initiate a tune sequence in the PA and antenna coupler if used. The meaning of TUNE and READY indicators is system dependent. Generally, these indicators are both off when the exciter is turned on. After a frequency has been selected and the PA is operational, the tune sequence can be initiated. In most systems, the TUNE indicator will be lit during the tuning sequence. Upon completion of the sequence, the TUNE indicator turns off and the READY indicator comes on.

In some systems, the TUNE indicator is used to show the state of the Tune Power Request Line. In these systems, the TUNE indicator will be lit during the tuning sequence and when the coupler is requesting tuning power.

3.4 PROGRAMMING CHANNELS

Follow the instructions below to program channels:

a. Select PROG position on rotary switch.

b. Press CHANNEL button, and select channel number via keyboard.

c. Press any of the following buttons to select desired conditions in any order:

- FREQUENCY (Keyboard selectable)
- MODE (Scroll function)
- CARRIER (If valid for mode chosen, scroll function)
- AUDIO (If valid for mode chosen, scroll function)
- RF POWER (Keyboard selectable)
- CLIP (If valid for mode chosen)

For example, to program channel 4 to the following conditions, perform steps a through k:

- FREQUENCY = 10.015 MHz
- MODE = USB
- CARRIER = -16 dB
- AUDIO = MIC
- RF POWER = -5 dB
- CLIP = ON

a. Select PROG position on rotary switch.

b. Press CHANNEL button. Use keyboard to enter 04. Press ENTER.

c. Press FREQUENCY button. Use keyboard to enter 1001500. Press ENTER.

d. Press MODE button. Scroll to USB.

e. Press CARRIER button. Scroll to -16 dB.

f. Press AUDIO button. Scroll to MIC.

g. Press RF POWER button. Use keyboard to enter 05. Press ENTER.

h. Press CLIP button if LED is not already on.

i. Press LOAD button. Channel 4 has now been programmed.

j. To program another channel, press CHANNEL button, and begin process again with new parameters.

k. To conclude programming, place rotary switch in any other position.

Programmed channels are stored in a battery backed up CMOS RAM. At powerup, the microprocessor checks the validity of the RAM and alerts the operator in case of failure by displaying a message on the alphanumeric display on the exciter front panel. Loss or damage to data for any single channel can be detected on powerup, and will cause a reinitialization of that channel to a default of 00.00000 MHz, USB, carrier suppression at - infinity, power reduction 00 dB. Such a frequency will disable keylines, so that the operator will note the channel was lost.

3.4.1 Recall Function

The recall function allows the operator to view the stored parameters of any channel while programming other channels, without affecting the contents of any channel.

To use RECALL, the exciter must be in the PROG mode. To view the contents:

a. Press CHANNEL.

b. Enter the channel number via the keyboard.

c. Press RECALL.

The display will be updated to the contents of the recalled channel.

3.5 REMOTE

The REMOTE position on the rotary switch puts the exciter into remote control. When switched into REMOTE, the exciter is set up to the parameters last used in REMOTE, and put into standby. When the exciter is under remote control, all pushbuttons are ignored except the ENTER button. If the exciter is under remote control and the ENTER button is held depressed for several seconds, the alphanumeric display will momentarily show both the baud rate and address that the exciter is configured to for remote control purposes.

3.6 RF-1310 TEST MODE

The test mode is entered by selecting the TEST position on the exciter rotary switch. Unless in Amp Off state, the exciter immediately enters standby status, then goes into self test, starts a lamp test on the front panel, and performs the following checks:

a. Processor program ROM validity

b. Processor RAM memory functionality

c. Synthesizer lock and data word tests

d. A/D measurement test

e. IF signal path checks

f. RF signal path checks

g. System interface assembly test

h. Remote test

The alphanumeric display informs the operator of test results by displaying the faulty module number and a fault code for that module, or the message "TEST PASSED". If all tests pass, but the exciter is using the secondary frequency standard, the alphanumeric display shows "PRI FREQ STD FAIL". The STBY or AMP OFF LEDs remain lit after execution of BITE. Turn selector switch to NORMAL to return to regular exciter operation. The Maintenance section of this manual details the BITE tests as well as the module fault codes.

SECTION 4

THEORY OF OPERATION

4.1 INTRODUCTION

This section provides a general description of the RF-1310 functional elements. The description is broken into three parts. The first part (paragraph 4.2) describes the audio IF and RF signal paths. The second part (paragraph 4.3) describes the frequency synthesizer. The third part (paragraph 4.4) describes the operation of some circuits and devices that are used extensively in the exciter, including phase lock loops and charge pumps. A dBm to V_{rms} conversion table is also included in this section.

Detailed description of individual assemblies are included in the unit instruction section.

4.2 EXCITER SIGNAL PATH

The primary function of the RF-1310 Exciter is to generate a high frequency radio signal that carries selected audio signals or digital data. Generally, signal processing involves mixing an internally generated 455 kHz carrier with two local oscillator signals to produce an RF output between 0.4 and 30 MHz. The 455 kHz carrier is either modulated by a selected audio input in USB, LSB, ISB, AM, or FM modes or controlled by digital inputs in CW or FSK modes. In the CW mode, the input turns the 455 kHz carrier on and off. In the FSK mode, digital inputs shift the carrier by up to ± 1 kHz. Signal path filtering and automatic level control (ALC) circuits ensure that the exciter produces a spurious free output signal with a constant power level.

The signal path is shown in figure 4-1 and is made up of the following assemblies.

- Audio Assembly A5
- Combiner Assembly A4
- Converter Assembly A2
- Output Amplifier Assembly A1
- System Interface Assembly A18

The 455 kHz carrier, 40 MHz local oscillator number 2 (LO 2) signal and 40.465 to 70.455 MHz local oscillator number 1 (LO 1) signal are generated by the frequency synthesizer. Control signals and BITE features are provided by Control Assembly A14.

4.2.1 Audio Assembly A5

The role of Audio Assembly A5 depends on the exciter operating mode. In the USB, LSB, ISB, and AM modes, A5 selects and amplifies the audio inputs and then mixes it with a 455 kHz carrier. The product of this processing is a 455 kHz double sideband suppressed carrier USB or LSB IF signal at -20 dBm that is sent to Combiner Assembly A4 for filtering and amplification. The A5 assembly is equipped with two independent audio channels. One is used in USB and AM modes, the other is used in LSB and FM modes. Both are operational during ISB operation.

Both channels are equipped with automatic level control (ALC) to maintain proper audio path gain. Audio signals may be input via the front panel microphone at a nominal -56 dBm or any of the rear panel ports at levels between -26 and + 10 dBm. The 455 kHz USB and LSB IF signals can be gated through clipper networks to reduce the peak-to-average ratio and thereby increase the power output level. This feature is enabled by the CLIP switch on the front panel.

In the FM operating mode, the selected audio input is amplified by the A5 assembly and then sent to Carrier Generator Assembly A11. The carrier is modulated on the A11 assembly and sent back to A5. The modulated carrier is attenuated to -10 dBm and sent to the A4 assembly.

For CW and FSK, the audio processing circuits are not used. In these modes, the A5 assembly simply attenuates the 455 kHz carrier signal generated by the A11 assembly before it is passed to the A4 assembly.

The Audio Assembly is also equipped with a sidetone generator that can be monitored by the operator during CW transmissions.

A voice operated transmit (VOX) circuit on the A5 assembly can be used to key the radio in USB, AM, AFSK and 2ISB modes when a microphone is the source of the audio input. The VOX sensitivity and hangtime are adjusted on A5.

4.2.2 Combiner Assembly A4

Combiner Assembly A4 performs the following four main signal processing functions.

- Selects and filters the 455 kHz USB IF, 455 kHz LSB IF, or 455 kHz carrier.
- Combines USB IF and LSB IF signals for 2ISB operation. Also combines an external 455 kHz IF signal with these for optional 4ISB operation.
- Reinserts carrier for AM signal or reduced carrier for USB and LSB signal.
- Uses an automatic level control (ALC) circuit to maintain a constant -20 dBm PEP 455 kHz IF output level.

Signal and filter selection is mode dependent. For sideband modes, filtering produces pure USB and LSB signals for broadcasting. In other modes, the filters narrow the bandwidth to reduce noise. The mode to filter relationship is summarized in table 4-1.

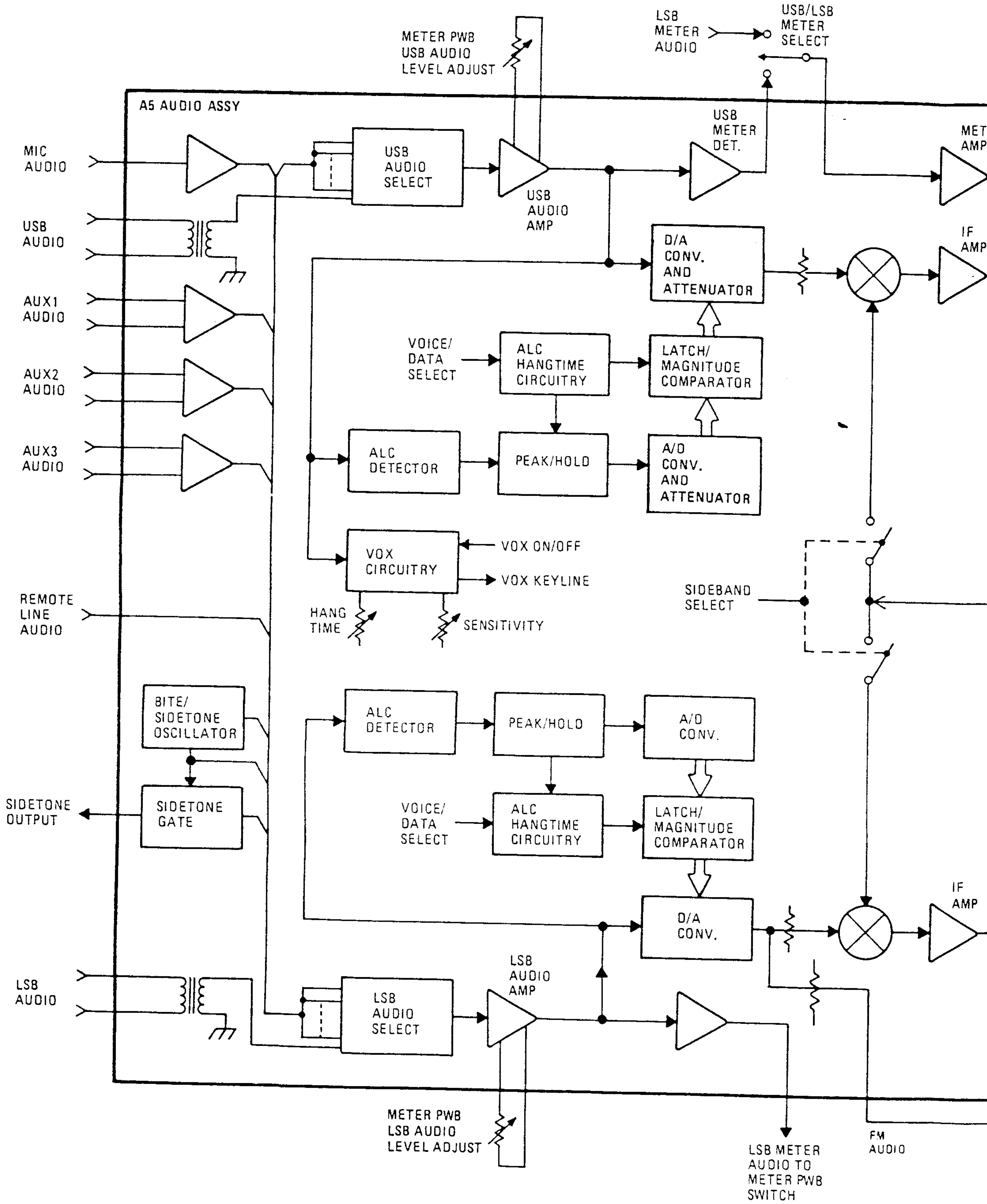
4.2.3 Converter Assembly A2

Converter Assembly A2 employs signal mixing and filtering to convert the filtered 455 kHz IF signal to an RF signal between 0.4 and 30 MHz. The filtered 455 kHz IF signal output by the A4 assembly is mixed with the 40 MHz LO 2 signal to produce a 40.455 MHz second IF signal. This signal is amplified and narrowband filtered before it is mixed with the variable LO 1 signal. The frequency of LO 1 is variable between 40.465 MHz and 70.455 MHz in 1 Hz steps and is 40.455 MHz above the selected transmit frequency. The mixer produces an RF signal between 0.4 and 30 MHz. The RF signal is filtered and amplified to produce an A2 assembly output signal with a nominal + 6 dBm PEP level.

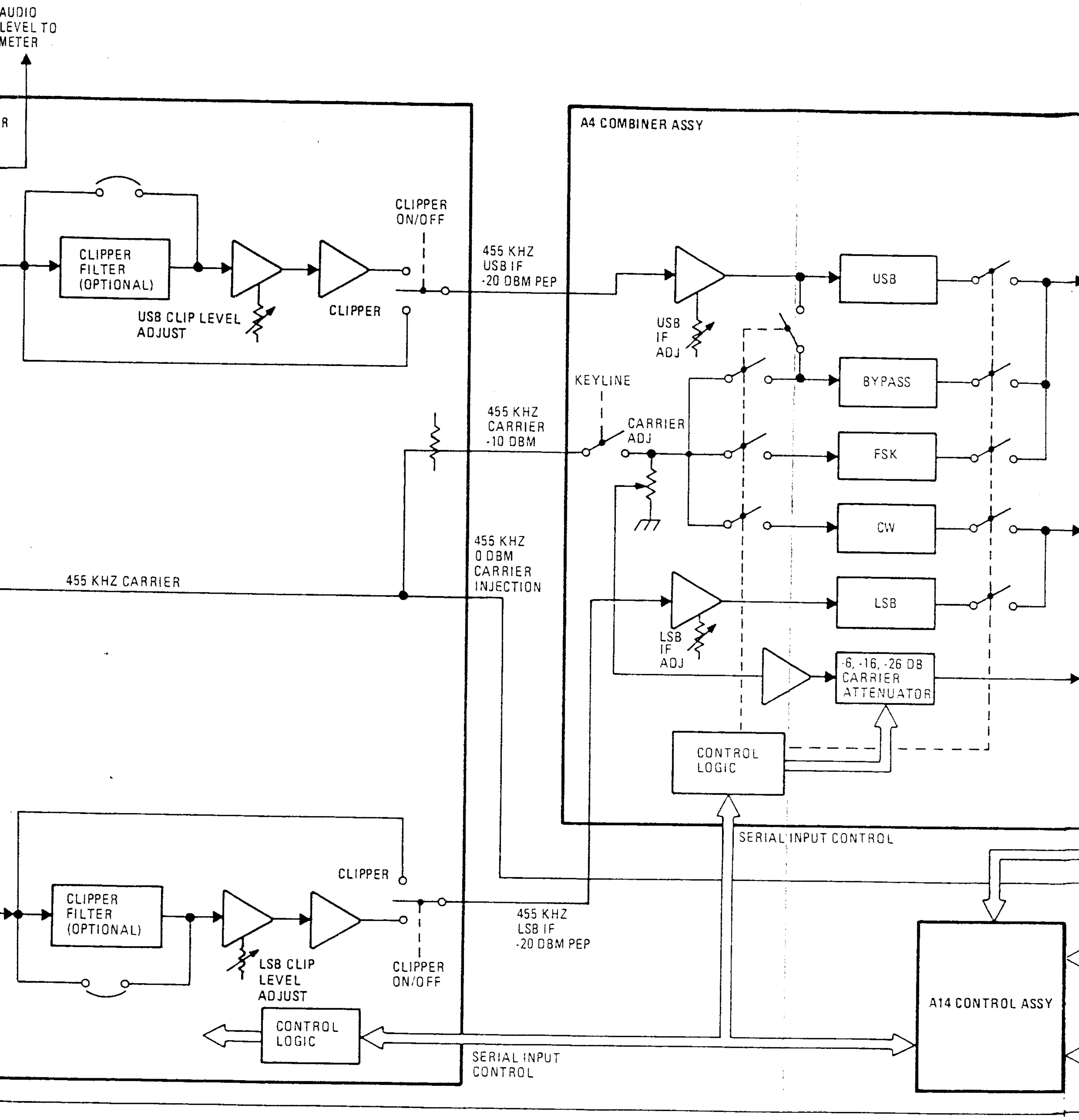
4.2.4 Output Amplifier Assembly A1

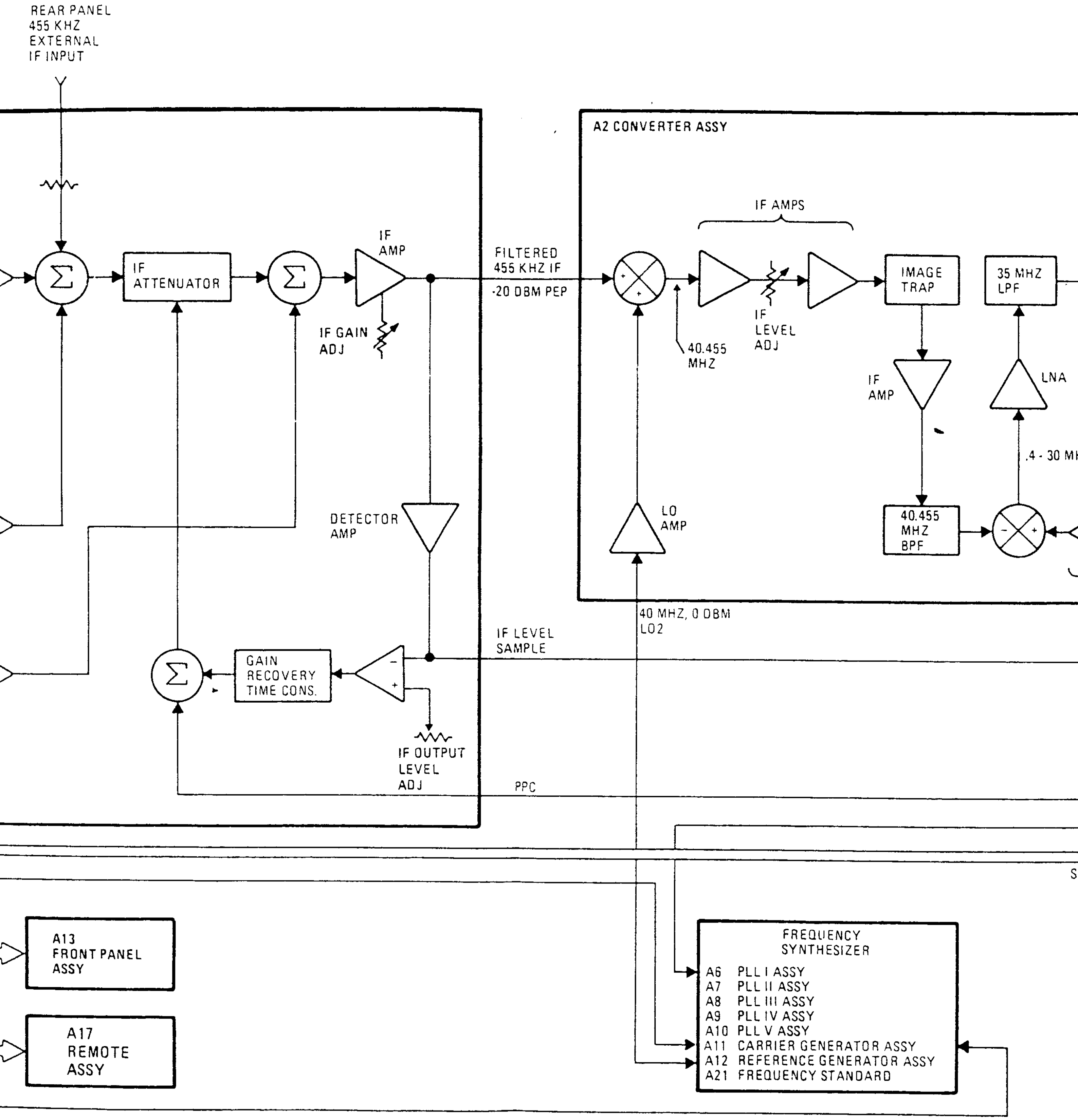
Output Amplifier Assembly A1 can amplify the A2 output up to greater than + 20 dBm (100 mW) PEP, + 26 dBm (400 mW) maximum. The output of the A1 assembly normally drives the power amplifier in a transmitter system.

Two adjustable attenuators are built into the signal path on the A1 assembly. These provide up to 63-7/8 dB of attenuation in 1/8 dB steps. The attenuators can function as part of a RF ALC circuit that responds to feed-



A5 AUDIO ASSY
METER PWB
USB AUDIO
LEVEL ADJUST
LSB
METER
AUDIO
USB/LSB
METER
SELECT
MIC
AUDIO
USB
AUDIO
SELECT
USB
AUDIO
AMP
USB
METER
DET.
MET
AMP
USB
AUDIO
AUX1
AUDIO
AUX2
AUDIO
AUX3
AUDIO
D/A
CONV.
AND
ATTENUATOR
IF
AMP
VOICE/
DATA
SELECT
ALC
HANGTIME
CIRCUITRY
LATCH/
MAGNITUDE
COMPARATOR
ALC
DETECTOR
PEAK/HOLD
A/D
CONV.
AND
ATTENUATOR
VOX
CIRCUITRY
VOX ON/OFF
VOX KEYLINE
HANG
TIME
SENSITIVITY
SIDEBAND
SELECT
REMOTE
LINE
AUDIO
BITE/
SIDETONE
OSCILLATOR
SIDETONE
GATE
SIDETONE
OUTPUT
ALC
DETECTOR
PEAK/HOLD
A/D
CONV.
VOICE/
DATA
SELECT
ALC
HANGTIME
CIRCUITRY
LATCH/
MAGNITUDE
COMPARATOR
D/A
CONV.
IF
AMP
LSB
AUDIO
LSB
AUDIO
SELECT
LSB
AUDIO
AMP
METER PWB
LSB AUDIO
LEVEL ADJUST
LSB METER
AUDIO TO
METER PWB
SWITCH
FM
AUDIO


AUDIO LEVEL TO METER
R
CLIPPER FILTER (OPTIONAL)
USB CLIP LEVEL ADJUST
CLIPPER
CLIPPER ON/OFF
455 KHZ USB IF -20 DBM PEP
A4 COMBINER ASSY
USB IF ADJ
USB
BYPASS
FSK
CW
LSB
KEYLINE
455 KHZ CARRIER -10 DBM
CARRIER ADJ
455 KHZ CARRIER
455 KHZ 0 DBM CARRIER INJECTION
LSB IF ADJ
-6, -16, -26 DB CARRIER ATTENUATOR
CONTROL LOGIC
SERIAL INPUT CONTROL
CLIPPER
CLIPPER FILTER (OPTIONAL)
LSB CLIP LEVEL ADJUST
CLIPPER ON/OFF
455 KHZ LSB IF -20 DBM PEP
CONTROL LOGIC
SERIAL INPUT CONTROL
A14 CONTROL ASSY



REAR PANEL
455 KHZ
EXTERNAL
IF INPUT
IF
ATTENUATOR
IF
AMP
IF GAIN
ADJ
FILTERED
455 KHZ IF
-20 DBM PEP
DETECTOR
AMP
GAIN
RECOVERY
TIME CONS.
IF OUTPUT
LEVEL
ADJ
IF LEVEL
SAMPLE
PPC
A2 CONVERTER ASSY
IF AMPS
IF
LEVEL
ADJ
40.455
MHZ
IMAGE
TRAP
35 MHZ
LPF
IF
AMP
LNA
.4 - 30 M
40.455
MHZ
BPF
LO
AMP
40 MHZ, 0 DBM
LO2
A13
FRONT PANEL
ASSY
A17
REMOTE
ASSY
FREQUENCY
SYNTHESIZER
A6 PLL I ASSY
A7 PLL II ASSY
A8 PLL III ASSY
A9 PLL IV ASSY
A10 PLL V ASSY
A11 CARRIER GENERATOR ASSY
A12 REFERENCE GENERATOR ASSY
A21 FREQUENCY STANDARD

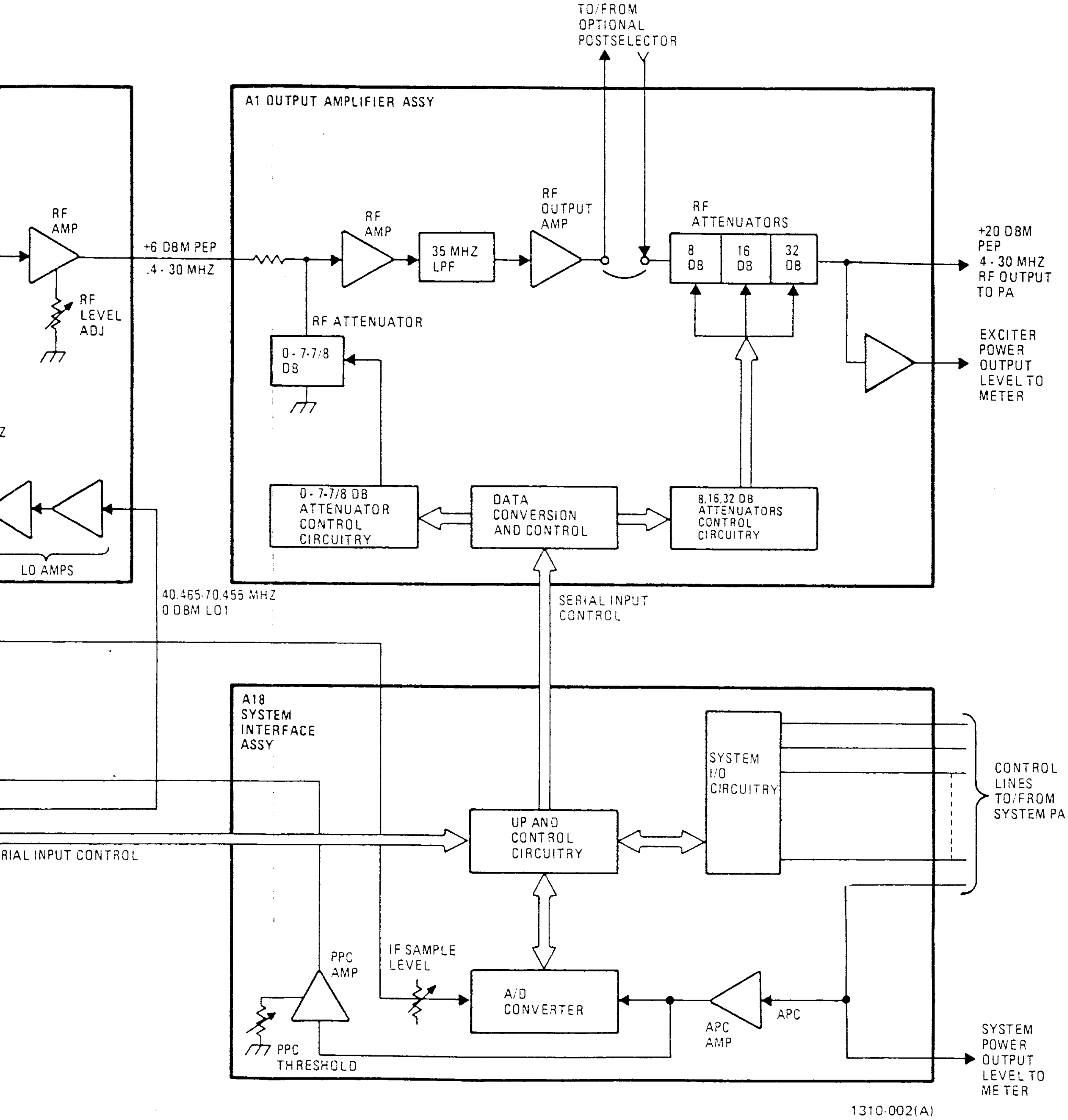


Figure 4-1. RF-1310 Signal Path Functional Block Diagram

Table 4-1. Combiner Assembly Filter Selection

Mode	Unfiltered 455 kHz First IF Source	Filter(s) Selected	Typical Filter Bandwidth
USB	Audio Assembly	USB	3.2 kHz, offset
LSB	Audio Assembly	LSB	3.2 kHz, offset
2ISB	Audio Assembly	USB and LSB	3.2 kHz (each filter), offset
AME	Audio Assembly	USB	3.2 kHz, offset
AM	Audio Assembly	Bypass	16 kHz, centered
FM	Carrier Generator Assembly	Bypass	16 kHz, centered
CW	Carrier Generator Assembly	CW	300 Hz, centered
FSK	Carrier Generator Assembly	FSK	3 kHz, centered

back from the PA to maintain a constant transmitter output signal level. The attenuators also respond to the front panel RF POWER control to insert up to 50 dB attenuation in 1 dB steps into the RF signal path for operation at reduced output power levels. The RF signal can be diverted to an optional postselector before passing through the last attenuator stage.

4.2.5 System Interface Assembly A18

System Interface Assembly A18 provides the control interface to the transmitter system through the power amplifier. The A18 assembly, equipped with a microprocessor, generates control signals, and monitors system functions during tuning as well as normal operation. It also processes the average and peak power control (APC and PPC) signals from the power amplifier which are used to maintain constant transmitter rf output level.

4.2.6 Gain Distribution

The normal gain or attenuation of each element of signal path is shown in figure 4-2.

4.3 FREQUENCY SYNTHESIZER

4.3.1 Introduction

This section describes the frequency synthesis scheme that is utilized to generate an rf output in the range of 400 kHz to 30 MHz with a 10 Hz resolution.

The main function of the frequency synthesizer is to provide a variable output frequency that functions as Local Oscillator (LO) 1 injection for the Converter A2 mixer. LO 1 will have the following characteristics:

a. Tuning range of 40.465 MHz to 70.455 MHz.

b. Provide 10 Hz resolution over the 30,000,000 Hz tuning range.

c. Tune in less than 20 milliseconds.

The Frequency Synthesizer consists of the following assemblies:

- PLL 1 Assembly A6
- PLL 2 Assembly A7
- PLL 3 Assembly A8
- PLL 4 Assembly A9
- PLL 5 Assembly A10
- Reference Generator Assembly A12
- Frequency Standard Assembly A21

Reference Generator Assembly A12 provides the 40.000000 MHz LO 2 injection for the A2 assembly's signal conversion of the 455 kHz first IF to a 40.455 MHz second IF.

Carrier Generator Assembly A11 is a frequency synthesizer covering a much smaller frequency range of 454 kHz to 456 kHz. The Carrier Generator Assembly generates the 455 kHz carrier, FM, and FSK signals.

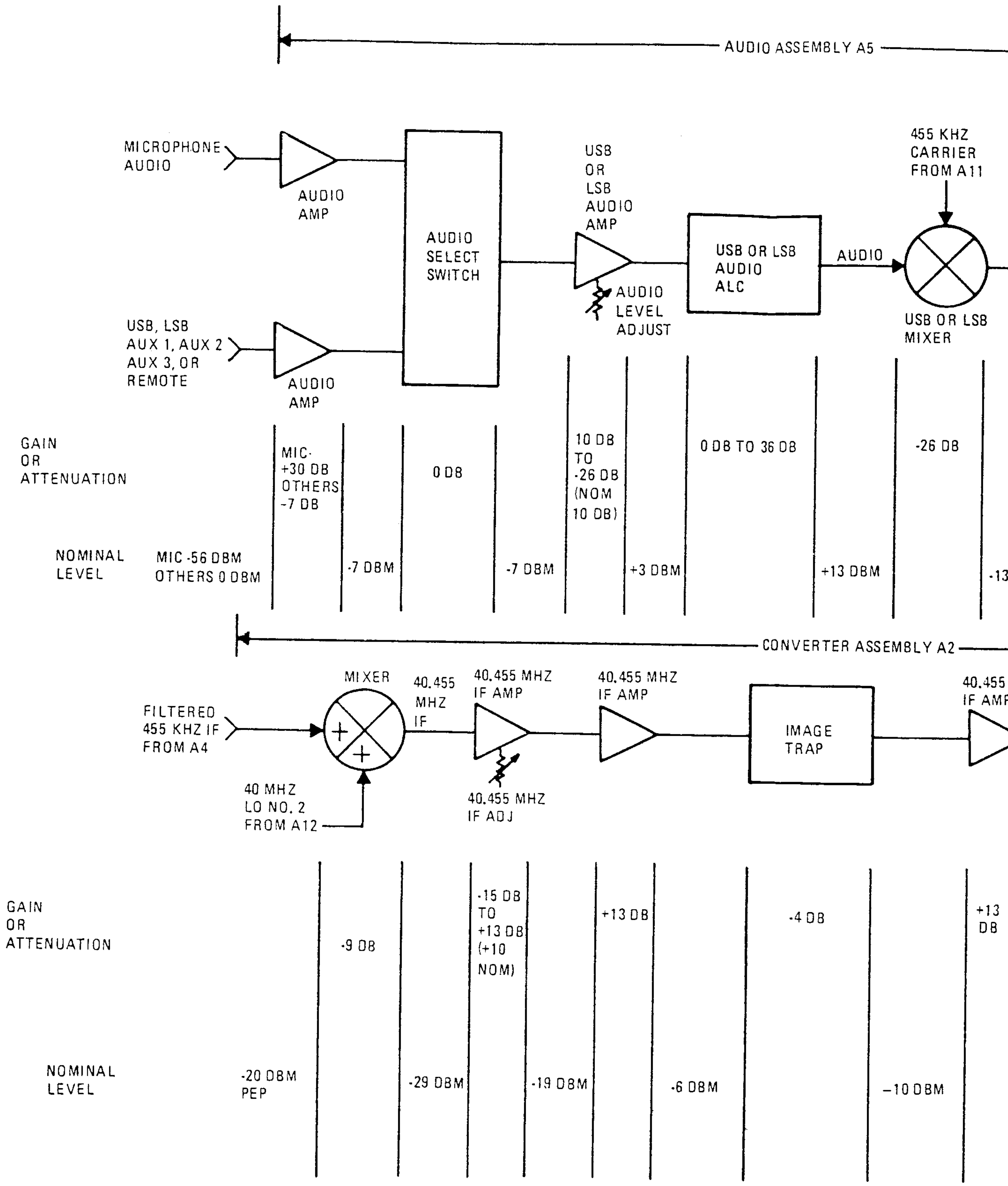
Note that figure 4-3 shows a complete frequency synthesizer simplified block diagram and figure 4-4 shows how to compute the intermediate frequencies produced by the synthesizer assemblies for any given exciter output frequency. Other information which may be helpful (towards the end of this section) is the discussion of programmable divide-by-N phase locked loops and frequency resolution reduction techniques. All these assemblies are discussed in detail in their respective subsections.

4.3.2 Frequency Synthesizer Operation

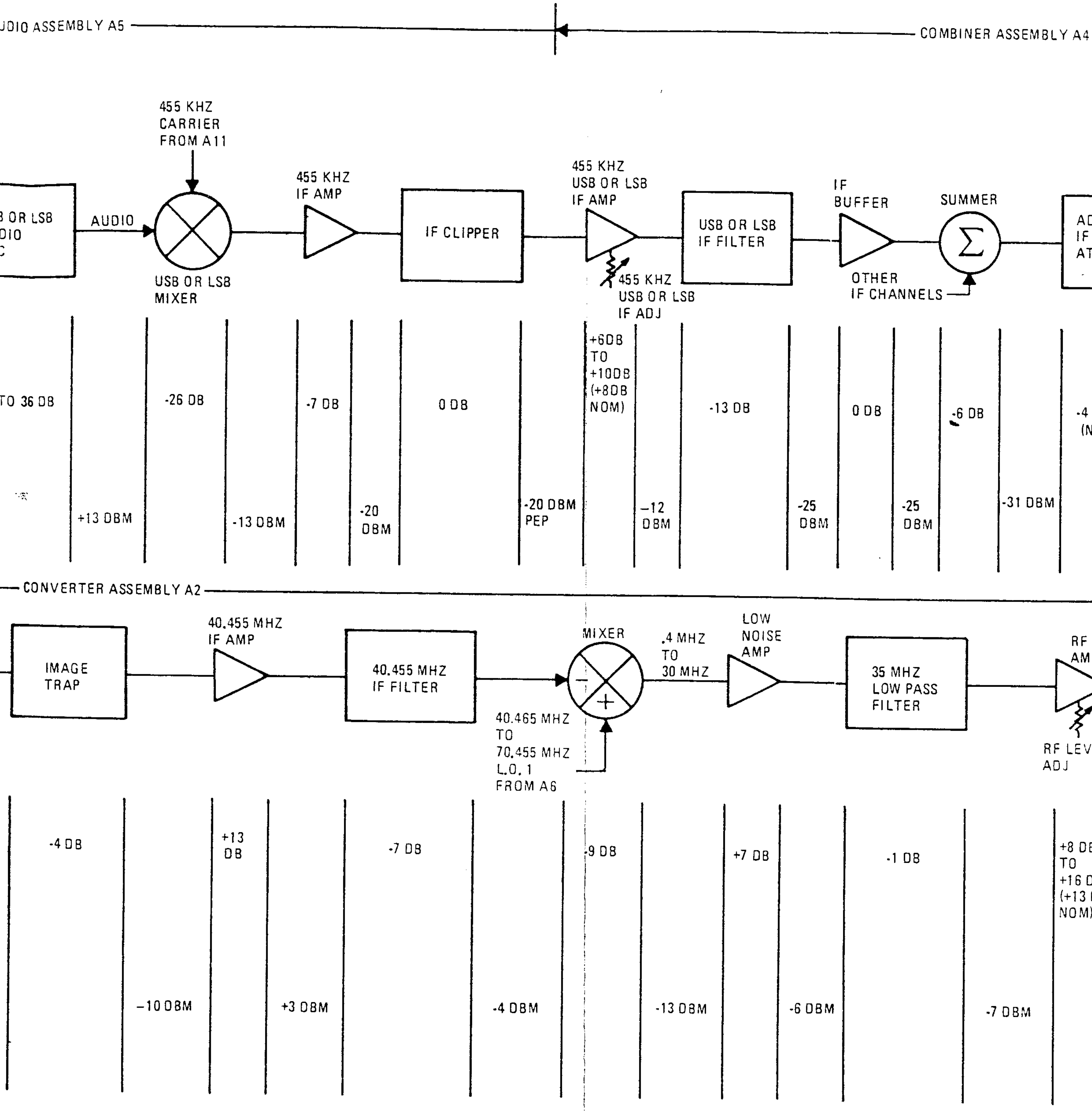
The synthesizer generates LO 1 frequencies between 40.465000 MHz and 70.455000 MHz with a 1 Hz resolution.

The LO 1 signal is produced by combining the signals generated by the A7, A8, and A10 phase lock loop assemblies. The frequencies of the signals generated by these PLL assemblies are defined by specific groups of digits extracted from the transmit frequency. The frequency of the signal generated by A7 is defined by the three most significant digits (10^7, 10^6, and 10^5 places) of the transmit frequency. The frequency of the signal generated on A8 is defined by the digits in the 10^4 and 10^3 places of the transmit frequency. The frequency of the signal generated on A8 is defined by the three least significant digits (10^2, 10^1, and 10^0 places) of the transmit frequency. The least significant digit is not displayed and is always zero. Each of the three PLL assemblies employs a VCO and a programmable divide-by-N counter in a feedback loop to generate its signal.

The LO 1 frequency is determined on Control Board Assembly A14 and will always be 40.455 MHz above the transmit frequency. The digits of the desired transmit frequency (entered on the front panel frequency display) are divided into three groups. The three most significant bits are in one group, the digits in the 10^4 and 10^3 places are in the second group, and the three least significant digits are in the third group. A number, N, is derived for each group of digits. The values of N for the first, second, and third groups of digits are sent to the A7, A8, and A10 assemblies, respectively, on a serial data stream. The values of N are written into the programmable divide-by-N counters on the three PLL assemblies. The N values ultimately determine frequencies of the signals generated by the VCO on the A7, A8, and A10 assemblies. A change in the front panel frequency display will change the value of N and the VCO frequency for one or more of the PLL A7, A8, and A10 assemblies.



AUDIO ASSEMBLY A5
MICROPHONE AUDIO
AUDIO AMP
AUDIO SELECT SWITCH
USB OR LSB AUDIO AMP
AUDIO LEVEL ADJUST
USB OR LSB AUDIO ALC
AUDIO
455 KHZ CARRIER FROM A11
USB OR LSB MIXER
USB, LSB AUX 1, AUX 2 AUX 3, OR REMOTE
AUDIO AMP
GAIN OR ATTENUATION
MIC- +30 DB OTHERS -7 DB
0 DB
10 DB TO -26 DB (NOM 10 DB)
0 DB TO 36 DB
-26 DB
NOMINAL LEVEL
MIC -56 DBM OTHERS 0 DBM
-7 DBM
-7 DBM
+3 DBM
+13 DBM
-13
CONVERTER ASSEMBLY A2
MIXER
FILTERED 455 KHZ IF FROM A4
40 MHZ LO NO. 2 FROM A12
40.455 MHZ IF
40.455 MHZ IF AMP
40.455 MHZ IF ADJ
40.455 MHZ IF AMP
IMAGE TRAP
40.455 IF AMP
GAIN OR ATTENUATION
-9 DB
-15 DB TO +13 DB (+10 NOM)
+13 DB
-4 DB
+13 DB
NOMINAL LEVEL
-20 DBM PEP
-29 DBM
-19 DBM
-6 DBM
-10 DBM



UDIO ASSEMBLY A5
COMBINER ASSEMBLY A4
455 KHZ CARRIER FROM A11
B OR LSB DIO C
AUDIO
USB OR LSB MIXER
455 KHZ IF AMP
IF CLIPPER
455 KHZ USB OR LSB IF AMP
455 KHZ USB OR LSB IF ADJ
USB OR LSB IF FILTER
IF BUFFER
SUMMER
OTHER IF CHANNELS
AD IF AT
TO 36 DB
-26 DB
-7 DB
0 DB
+6DB TO +10DB (+8DB NOM)
-13 DB
0 DB
-6 DB
-4 (N
+13 DBM
-13 DBM
-20 DBM
-20 DBM PEP
-12 DBM
-25 DBM
-25 DBM
-31 DBM
CONVERTER ASSEMBLY A2
IMAGE TRAP
40.455 MHZ IF AMP
40.455 MHZ IF FILTER
MIXER
40.465 MHZ TO 70.455 MHZ L.O. 1 FROM A6
.4 MHZ TO 30 MHZ
LOW NOISE AMP
35 MHZ LOW PASS FILTER
RF AM
RF LEV ADJ
-4 DB
+13 DB
-7 DB
-9 DB
+7 DB
-1 DB
+8 DE TO +16 D (+13 NOM)
-10 DBM
+3 DBM
-4 DBM
-13 DBM
-6 DBM
-7 DBM

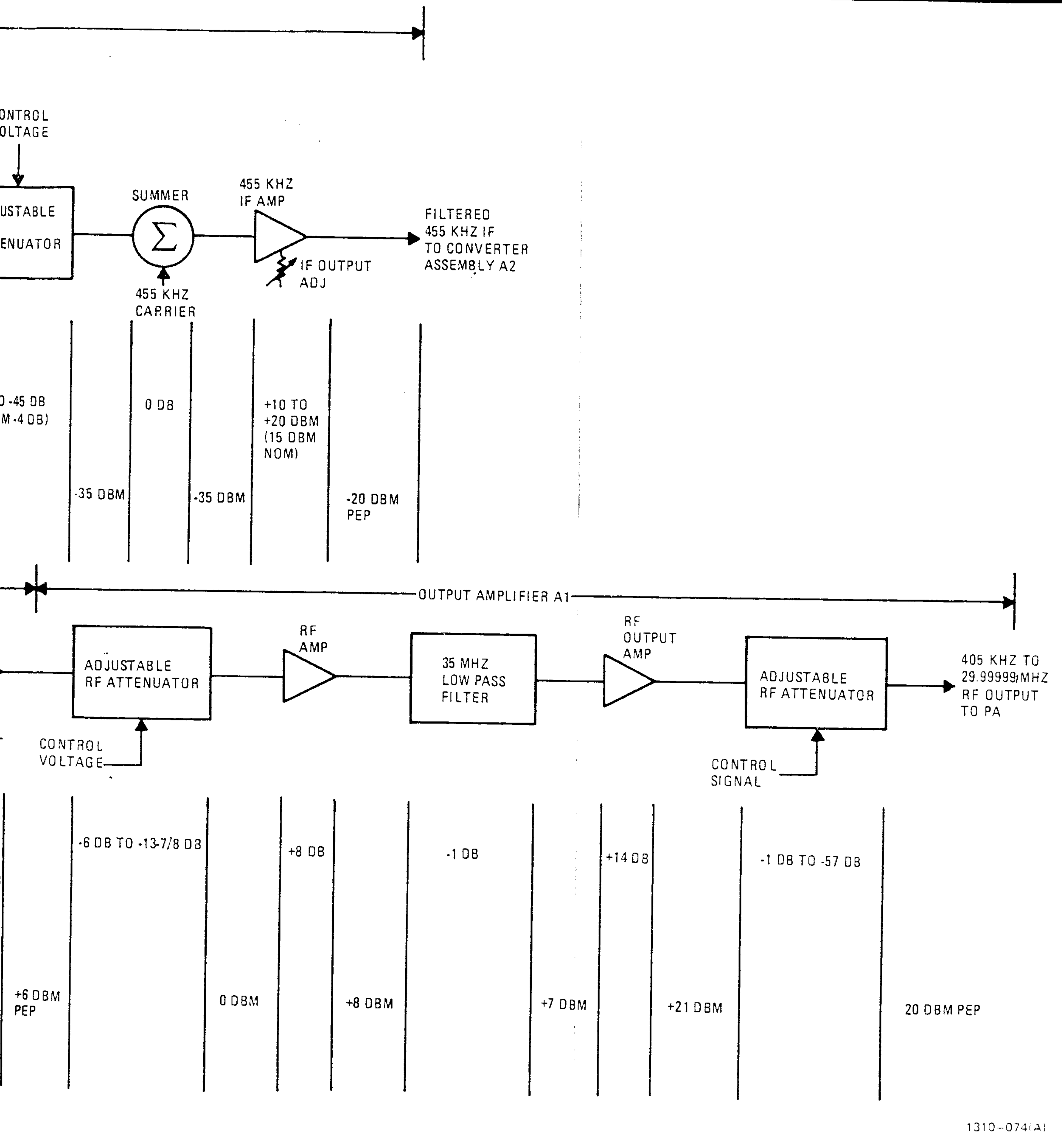
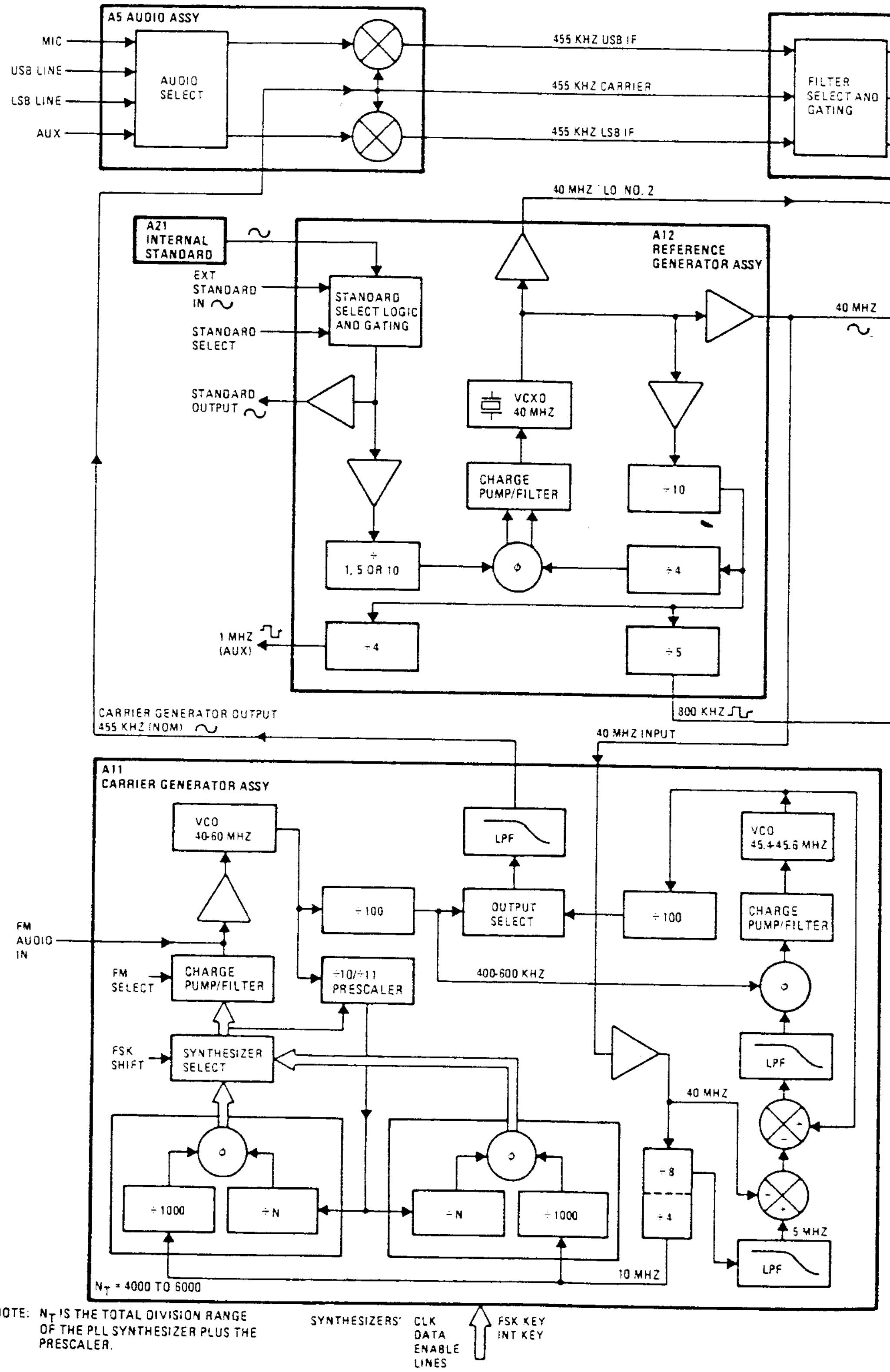


Figure 4-2. RF-1310 Signal Path Gain Distribution



NOTE: N_T IS THE TOTAL DIVISION RANGE OF THE PLL SYNTHESIZER PLUS THE PRESCALER.

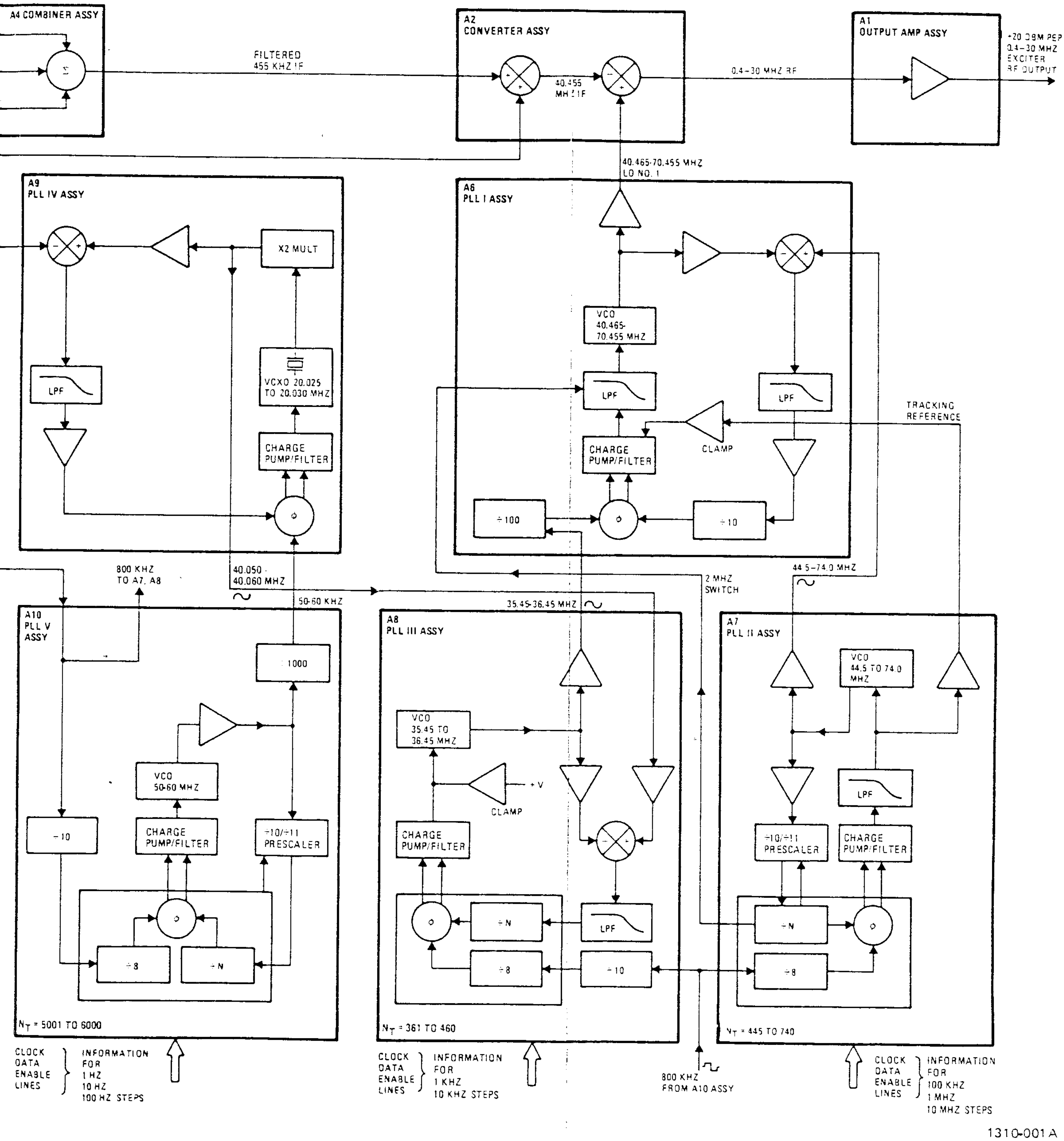


Figure 4-3. RF-1310 Frequency Synthesizer Functional Block Diagram

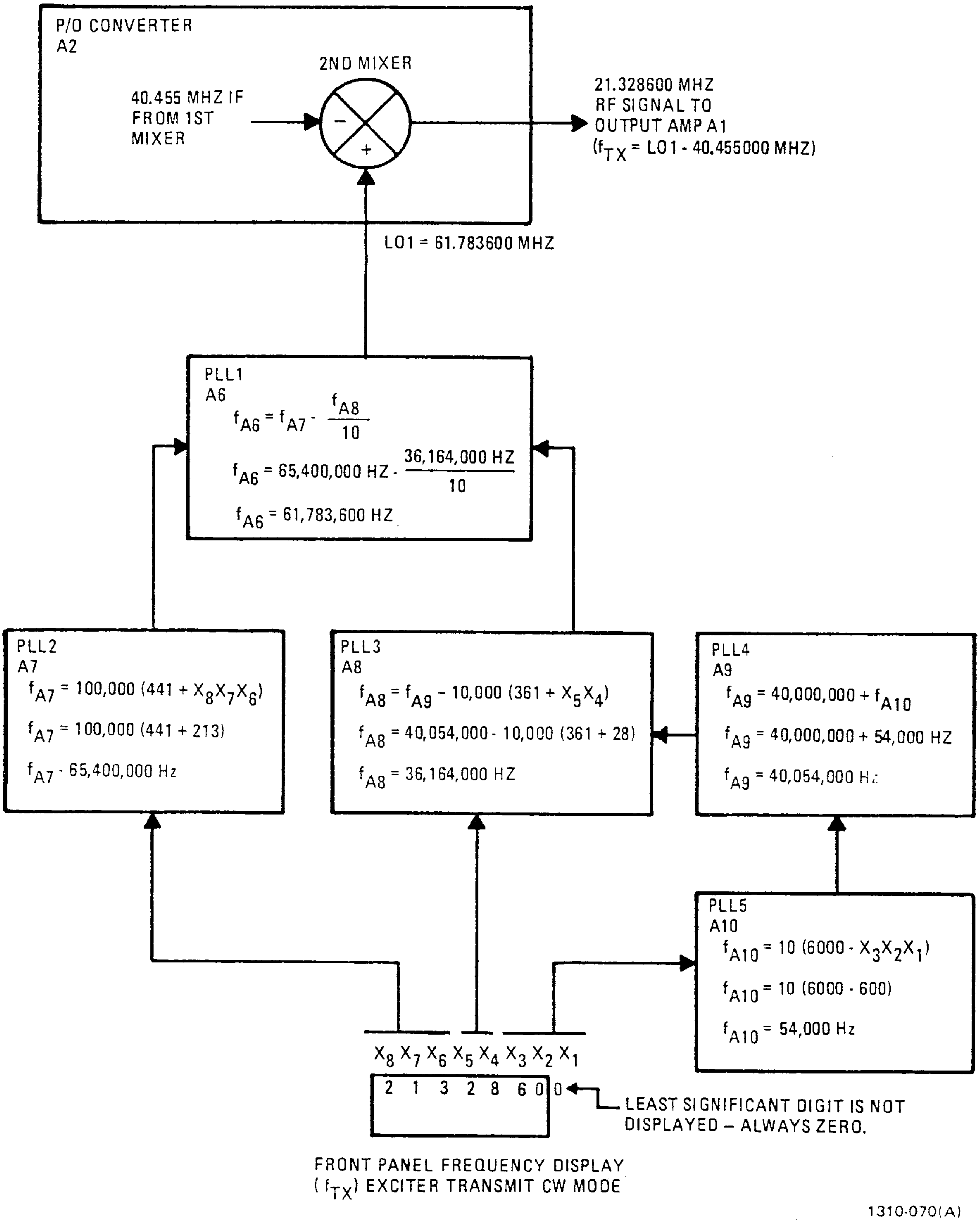


Figure 4-4. Frequency Synthesizer Tuning Example

The outputs of the A7, A8, and A10 assemblies undergo further processing in the synthesizer chain before they are combined in the A6 assembly. The result of the combination of these three unique frequencies is a single unique frequency directly relating to the values of the exciter's displayed frequency. Furthermore, it is controllable to 1 Hz accuracy, and is used as the LO 1 injection for Converter Assembly A2 mixer U2 to tune the exciter. Note that although the synthesizer itself has 1 Hz accuracy, the actual transmit resolution is 10 Hz, since the 1 Hz tune increment is forced to zero and not displayed.

4.3.3 Reference Generator Assembly A12 and Frequency Standard Assembly A21

Frequency Standard Assembly A21 establishes the exciter's frequency stability and accuracy. The stability is 1 x 10^{-8} at either 1 MHz, 5 MHz, or 10 MHz. The frequency standard is used in a phase lock loop (PLL) on the A12 assembly to stabilize the 40 MHz voltage controlled crystal oscillator (VCXO). PLL references on all other assemblies are derived from this VCXO. The A12 assembly also provides 40 MHz LO 2 to the A2 assembly for signal path conversion of the 455 kHz IF to 40.455 MHz.

4.3.4 PLL 5 Assembly A10

The A10 assembly is a programmable divide-by-N PLL that provides the 1 Hz, 10 Hz, and 100 Hz tuning increments (the three least significant digits) in the LO 1 output signal. The A10 output is from 50 to 60 kHz in 10 Hz controllable steps. The output frequency is 10 (6000 - $X_3X_2X_1$) Hz, where $X_3X_2X_1$ are the three least significant digits of the transmit frequency. The least significant digit, X_1, is not displayed and is always zero.

4.3.5 PLL 4 Assembly A9

The A9 assembly is a translational type phase locked loop which converts the low frequency A10 output of 50 to 60 kHz in 10 Hz increments into 40.05 to 40.06 MHz in 10 Hz increments. The A9 assembly provides the intermediate signal processing required before the A10 output can be combined with the PLL 3, A8, 10 kHz, and 1 kHz tuning increments. The A9 output frequency may be computed from the formula 40,000,000 + 10 (6000 - $X_3X_2X_1$) Hz, where $X_3X_2X_1$ are the three least significant digits of the transmit frequency. The least significant digit is always zero.

4.3.6 PLL 3 Assembly A8

The A8 assembly is a programmable divide-by-N and translation PLL which performs the following two functions:

- Generation of the 10 kHz and 1 kHz tuning increments (10^4 and 10^3 places in the LO 1 frequency) for LO 1 output
- Combination of these increments with the 100 Hz, 10 Hz, and 1 Hz tuning increments provided by the A9 assembly

The A8 assembly output frequency can be determined by the following formula. Given that $X_3X_2X_1$ are the values of the three least significant digits of the transmit frequencies, and that X_5X_4 are the values of the 10^4 and 10^3 digits of the transmit frequency, A8 frequency = [40,000,000 + 10 (6000 - $X_3X_2X_1$)] - [10,000 (361 + X_5X_4)] Hz. The A8 output frequency range is 35.45 MHz to 36.45 MHz. X_1 is not displayed on the front panel and is always zero.

4.3.7 PLL 2 Assembly A7

The A7 assembly is a programmable divide-by-N PLL which provides the 10 MHz, 1 MHz, and 100 kHz tuning increments (three most significant digits) in the LO 1 output. The A7 assembly output is from 44.1 MHz to 74.0 MHz in 100 kHz controllable steps.

The A7 assembly output frequency is equal to 100,000 (441 + $X_8X_7X_6$), where $X_8X_7X_6$ is the value of the three most significant digits of the transmit frequency.

4.3.8 PLL 1 Assembly A6

The A6 assembly is a translation type PLL which combines the tuning increments for the LO1 output from assemblies A7, A8, A9, and A10. The output signal will be the LO 1 injection signal. It will be variable from 40.465 kHz to 70.455 MHz in 10 Hz controllable steps. Given a transmit frequency of $X_8X_7X_6X_5X_4X_3X_2X_1$ Hz where X_8 through X_2 are the digits from the front panel frequency display and X_1 is zero, the A6 assembly output and LO 1 frequency will be:

$$f_{A6} = f_{A7} - \frac{f_{A8}}{10}$$

where

$$f_{A7} = (441 + X_8X_7X_6)\ 100{,}000\ \text{Hz}$$

$$f_{A8} = [40{,}000{,}000 + 10\,(6000 - X_3X_2X_1)] - [10{,}000\,(361 + X_5X_4)]\ \text{Hz}$$

This signal will always be tuned exactly 40.455 MHz above the exciter transmit frequency.

4.3.9 Carrier Generator

The Carrier Generator Assembly has three main functions:

- Generation of a 455 kHz intermediate frequency carrier for CW mode, sideband carrier injection, or AM carrier reinsertion
- Direct narrowband (8 kHz deviation) FM modulation of 455 kHz carrier with audio from the A5 assembly
- Generation of FSK tones centered at 455 kHz with up to ± 1 kHz tone separation and 1 Hz resolution

The assembly receives control signals from the A14 assembly, a 40 MHz reference signal from the A12 assembly, and a FM audio input from A5. The nominal 455 kHz carrier generator output is sent to Audio Assembly A5. The assembly employs two interrelated phase locked loops and two VCOs to generate the carrier signals needed for the various modes of operation.

4.3.10 Frequency Synthesizer Tuning Example

The output frequencies of the A10, A9, A8, A7, and A6 assemblies at any given transmit frequency can be determined from the example shown in figure 4-4. Assume a transmit frequency f_o = 21,328,600 Hz and that $X_8X_7X_6X_5X_4X_3X_2X_1$ represent the values of the 10 MHz through 1 Hz positions. The exciter has a 10 Hz resolution so the X_1 digit is always zero and is not displayed on the front panel.

To calculate the frequency of the output signal from each assembly, start at the A10 assembly, then move on to the A9, A8, A7, and A6 in that order. The answer can always be checked since the following formula must always be true.

$$f_{LO\,1} = f_{TX} + 40.455\ \text{MHz}$$

Here,

$$f_{TX} = 21.328{,}600\ \text{MHz}$$

therefore,

$f_{LO\,1}$ = 21.328,600 MHz + 40.455 MHz
61.783,600 MHz (which agrees with the result of figure 4-4)

4.4 PHASE LOCK LOOP THEORY AND DBM TO V_{rms} CONVERSION

4.4.1 Conversion Between dBm and V_{rms}

Power levels in this manual are stated in dBm, or decibels with respect to 1 milliwatt. For example, +6 dBm means 6 dB more than (above) 1 mW, or 4 mW. Similarly, -6 dB less than (below) 1 mW, or 0.25 mW (250 uW). Notice that every value of dBm corresponds to a particular amount of power. If the impedance in which this power is dissipated is known, the corresponding voltage and current can be determined. Table 4-2 lists 50 ohm voltage equivalents for many dBm power levels. Note that for negative values of dBm, voltages are read in either of the two left-hand columns. For positive values of dBm, voltages are read in the right-hand column. For example, -6 dBm is 0.112 V (112 mV), across 50 ohms, while +6 dBm is 0.446 V. Similarly, -20 dBm equals 22.4 mV, while +20 dBm equals 2.24 volts (across 50 ohms).

Table 4-2. Conversion of dBm to V_{rms} across 50 ohms
(0 dBm = 1 mW)

(Negative dBm)		(Position dBm)	
Volts	Millivolts	dBm	Volts
.224	224	0	.224
.199	199	1	.251
.178	178	2	.282
.158	158	3	.316
.141	141	4	.354
.126	126	5	.398
.112	112	6	.446
	99.9	7	.501
	89.0	8	.562
	79.3	9	.630
	70.7	10	.707
	63.0	11	.793
	56.2	12	.890
	50.1	13	.999
	44.6	14	1.12
	39.8	15	1.26
	35.4	16	1.41
	31.6	17	1.58
	28.2	18	1.78
	25.1	19	1.99
	22.4	20	2.24
	19.9	21	2.51
	17.8	22	2.82
	15.8	23	3.16
	14.1	24	3.54

Table 4-2. Conversion of dBm to V_{rms} across 50 ohms
(0 dBm = 1 mW) (Cont.)

(Negative dBm)		(Position dBm)	
Volts	Millivolts	dBm	Volts
	12.6	25	3.98
	12.0	25.41	4.17
	11.2	26	4.46
	10.0	27	5.01
	8.90	28	5.62
	7.93	29	6.30
	7.07	30	7.07
	3.98	35	12.6
	2.24	40	39.8
	0.707	50	70.7

4.4.2 Phase Locked Loops (PLL)

The basic phase locked loop (PLL) consists of the following four components:

- phase detector (or comparator)
- lowpass filter
- voltage controlled oscillator (VCO)
- divider (counter)

The counter component may be either a fixed or programmable divider.

4.4.2.1 Basic Phase Locked Loop

Figure 4-5 shows the four basic components of a phase locked loop. PLL operation involves comparing the frequency and phase of an incoming reference signal to the output of the voltage controlled oscillator (VCO). If the two signals differ in frequency and/or phase, an error voltage is generated by the phase detector and applied to the VCO. This causes the VCO output frequency to change in the direction required for decreasing the frequency/phase difference. The correction process continues until phase lock is achieved.

Dividing a VCO frequency output by two before applying it to the phase detector results in an error voltage that drives the VCO to twice the reference frequency. A divide-by-three action results in an error voltage that drives the VCO to three times the reference frequency. From this, the following relationship can be given, $f_{VCO} = N(f_{REF})$.

4.4.2.2 PLL Programmable Counters

An example of the basic phase locked loop technique, using numbers, will provide an understanding of its actual operation. Referring to figure 4-6, the desired frequency is obtained by programming the variable divider through selectable inputs. Assuming the VCO is locked at the desired frequency of 1 MHz, this signal enters the input of the divide-by-100 counter (divider). The counter emits a pulse at its output each time 100

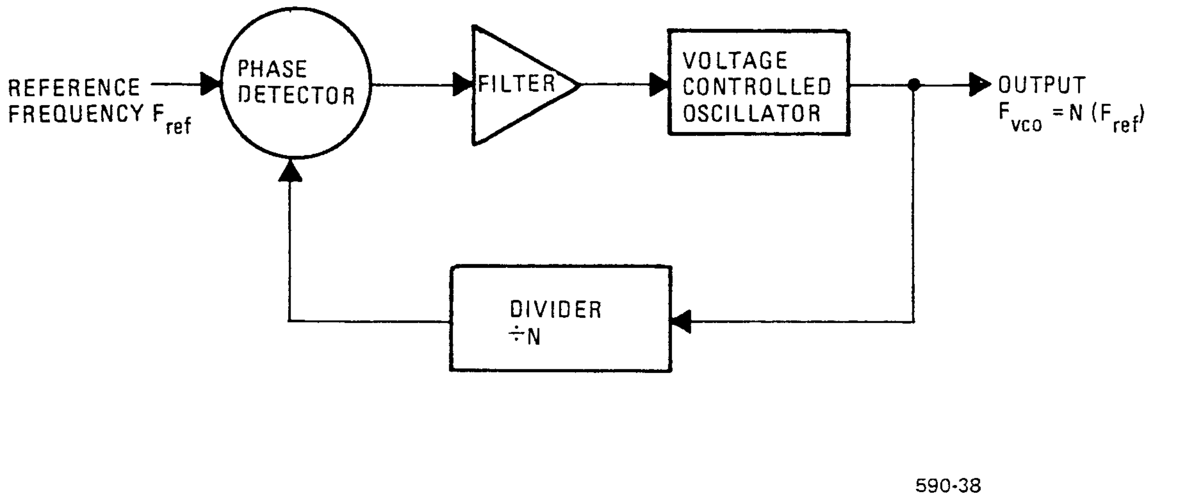


Figure 4-5. Basic Phase Locked Loop

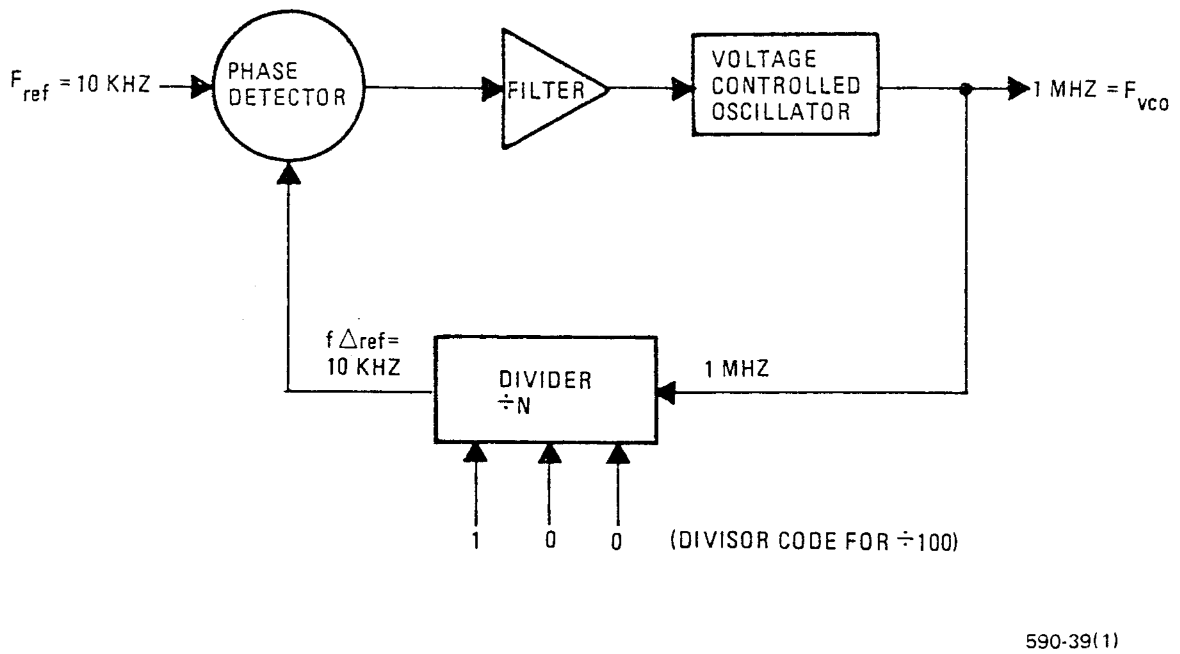


Figure 4-6. Programmable Phase Lock Loop

pulses enter its input. Therefore, dividing the 1 MHz input by 100 results in an output of 10 kHz. This 10 kHz signal is compared to the reference frequency of 10 kHz indicating a locked situation. If the divider's output had been less than 10 kHz, the phase detector would have produced an error voltage to drive the VCO to a higher frequency. Similarly, if the divider's output had been greater than 10 kHz, the VCO would have been driven to a lower frequency. Note that the phase lock loop output is dependent upon the selectable inputs of the variable divider. The RF-1310 provides this input to the divide-by-N counter in the form of a serial data command word. The coding of this word determines the divisor ratio of the counter, and is supplied (under microprocessor control) from the information supplied by the front panel frequency select controls.

4.4.2.3 PLL Prescaling Operation

A variation of the basic PLL which involves division of the feedback VCO signal prior to application to the divide-by-N counter is shown in figure 4-7. The total divider portion of the PLL now consists of two programmable counters and a two modulus prescaler.

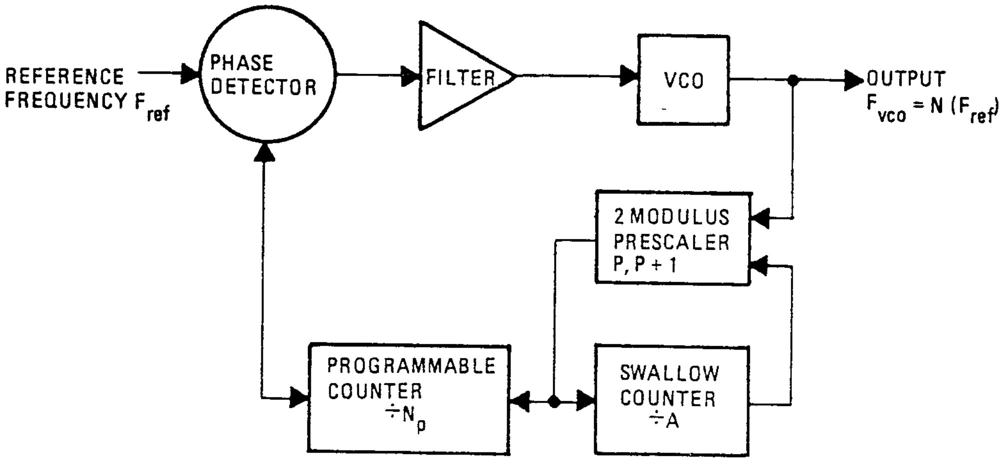


Figure 4-7. Phase Lock Loop Prescaling Technique

The two modulus prescaler begins operation by dividing the VCO output by the higher of its two possible divisors, P + 1. The programmable divide-by-N counter counts the number of pulses from the prescaler. The swallow counter controls the number of times that the prescaler will be allowed to divide by P + 1 (to be precise, A times.) After the swallow counter reaches A counts, it instructs the prescaler to change its division ratio to P. (Note that the RF-1310 uses this scheme on the A7 and A10 assemblies, where the prescaler is a divide-by-10/divide-by-11 counter. The divide-by-N and swallow counter are counters internal to the PLL synthesizer IC.

In operation, the prescaler divides by P + 1, A times. For every P + 1 pulse from the prescaler, both the A counter and Np counter are decreased by 1. The prescaler divides by P + 1 until counter A reaches its zero state. At this point, the modulus of the prescaler changes to P. The prescaler then divides by P until the remaining count, (Np-A) in the Np counter, decreases to zero. At this time, the Np output emits a pulse while the A and Np counters reset. The cycle then repeats.

An example of the two modulus prescaling technique is given in figure 4-8 and table 4-3. For illustrative purposes, a VCO output of 50.7 MHz is derived.

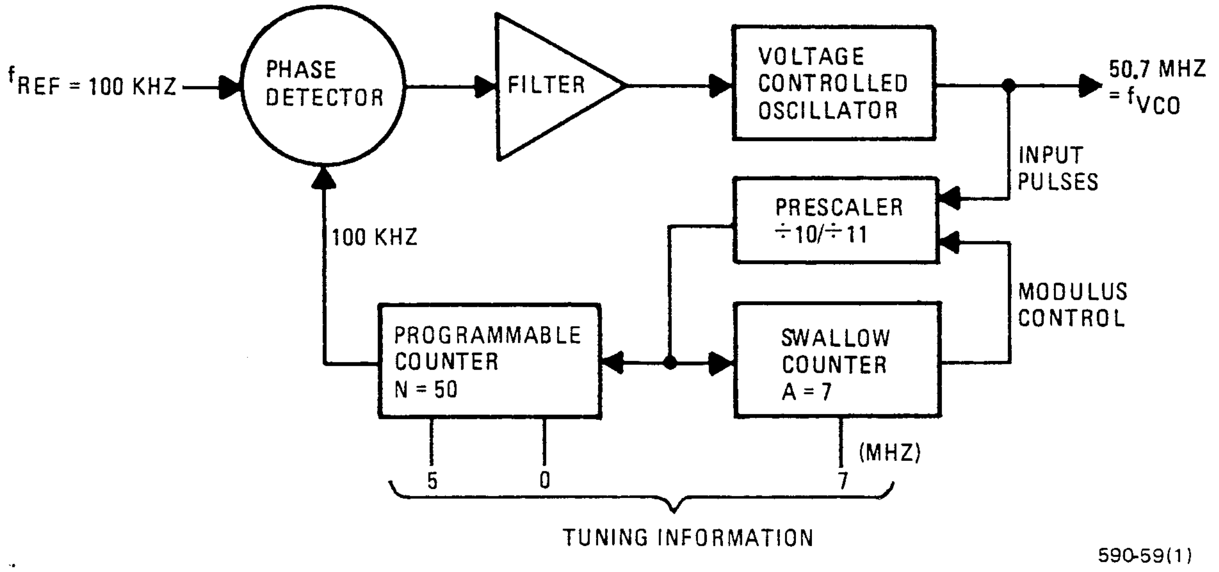


Figure 4-8. Prescaling Technique Example

Table 4-3. Prescaling Technique Example

Input Pulses	Prescaler Counts	Swallow Counter	Programmable Counter
0	0	7	50
11	11	6	49
22	11	5	48
33	11	4	47
44	11	3	46

Table 4-3. Prescaling Technique Example (Cont.)

Input Pulses	Prescaler Counts	Swallow Counter	Programmable Counter
55	11	2	45
66	11	1	44
77	11	0	43
87	10	0	42
97	10	0	41
107	10	0	40
477	10	0	3
487	10	0	2
497	10	0	1
507	10	0	0

507 input pulses = 1 output pulse

The two most significant digits, 5 and 0, are selected into the programmable counter. The least significant digit, 7, is selected into the swallow counter. Under locked conditions, the divider has an input (f_{VCO}) of 50.7 MHz, and an output of 100 kHz.

To produce a 100 kHz signal from the 50.7 MHz f_{VCO} signal, a divisor ratio of (50.7 divided by 100) or 507 is required. Table 4-3 shows a count sequence of 507 input pulses resulting in 1 output pulse. Similarly, a 50.7 MHz input results in a 100 kHz output.

The programmable divide-by-N counter emits a pulse every time it counts 50 input pulses. With the swallow counter set to seven, the prescaler divides by 11, seven times, and then switches to dividing by 10. At this point, the divide-by-N counter needs 43 input pulses before emitting an output pulse. The prescaler will now divide-by-10, 43 times, to finish the count sequence. With seven counts of 11 (7 x 11 = 77) and 43 counts of 10 (43 x 10 = 430), one pulse emits from the programmable counter every (77 + 430) or 507 input pulses.

4.4.3 Charge Pumps

The charge pump is the basic circuit employed in the RF-1310 to convert the PLL phase comparator complementary pulse output error signals into an analog dc VCO control voltage. The three basic components of a charge pump circuit are a current source, a current sink, and an output filter. Figure 4-9 shows a typical charge pump circuit.

4.4.3.1 Phase Detector Outputs

The phase detector compares the phase and/or frequency of two inputs (f_{VCO} and f_{REF}) and produces an output error signal at one of its two outputs ($\varnothing_V$ or $\varnothing_R$) whenever the inputs are not equal. The pulse widths of these output signals are directly proportional to the phase error of the two input signals.

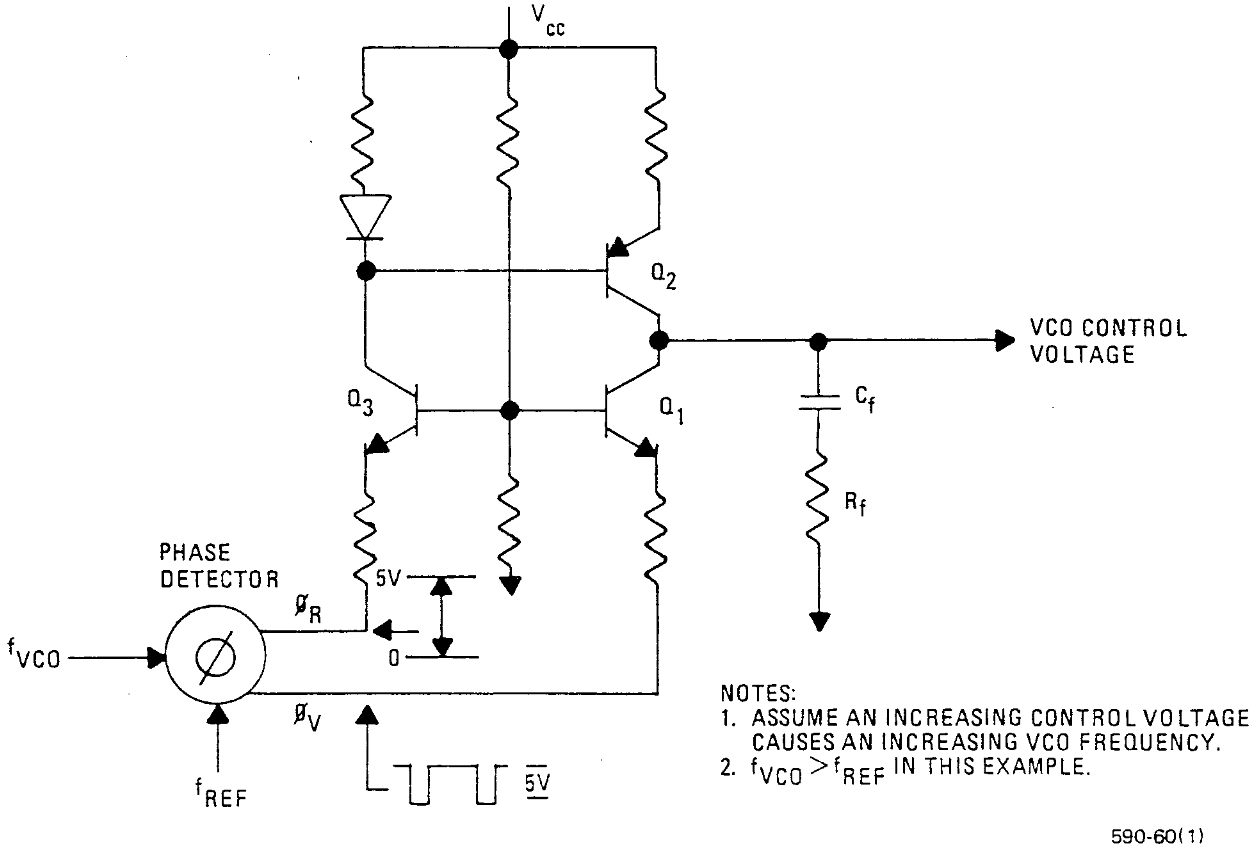


Figure 4-9. Basic Charge Pump Circuit

If the frequency f_{VCO} is greater than f_{REF} or if the phase of f_{VCO} is leading, then error information is provided by $Ø_V$ pulsing low. $Ø_R$ remains essentially high. (This is the situation shown in figure 4-9).

If the frequency f_{VCO} is less than f_{REF} or if the phase of f_{VCO} is lagging, then error information is provided by $Ø_R$ pulsing low. $Ø_V$ remains essentially high.

If the frequency of f_{VCO} = f_{REF} and both are in phase, then both $Ø_V$ and $Ø_R$ remain high, except for a short time period when both pulse low in phase. This time period is too short to affect the charge pump's lead-lag filter network C_f-R_f and is ignored.

4.4.3.2 Charge Pump Operation

The charge pump circuit functions as a current source/current sink network to lead-lag filter network C_f-R_f. Q2 and Q3 function as a current source to dump charge into the filter network, while Q1 functions as a current sink to pull charge out of the network. The net result is that the output voltage across the network rises when C_f charges and falls when C_f discharges.

Assume that f_{VCO} is greater than f_{REF} as shown in figure 4-9. Output $Ø_R$ remains high, holding Q3 off. Output $Ø_V$ pulses low, turning Q1 on. This provides a low impedance discharge path to ground for C_f. As C_f discharges, the charge pump output voltage (VCO control voltage) decreases, causing f_{VCO} to decrease.

Now assume that f_{VCO} is less than f_{REF}. $Ø_V$ remains high, holding Q1 off. $Ø_R$ pulses low, turning on Q3, and allowing Q2 to turn on and dump charge into C_f. This causes the VCO control voltage to increase, causing f_{VCO} to increase.

SECTION 5

MAINTENANCE

5.1 INTRODUCTION

This section contains general information concerning preventive and as required maintenance of the RF-1310 Exciter. The solid state design has minimized regular maintenance. The built-in test feature has automated most troubleshooting. Procedures for testing individual assemblies are contained in the unit instruction subsections.

5.2 PREVENTIVE MAINTENANCE

The only item that requires regular maintenance is the exciter air filter. The filter should be removed and cleaned periodically at a frequency determined by the operating environment. The filter is located behind the grill on the lower part of the front panel.

To remove the filter:

a. Remove the two screws that secure the grill to the front panel.

b. Remove the grill.

c. Pull out the filter.

The filter can be washed with a diluted, soap solution. Dry the filter completely before replacement.

CAUTION

Some of the assemblies in the RF-1310 contain static sensitive devices. To protect static sensitive devices from damage, follow the suggested precautions.

- Keep all static sensitive devices in their protective packaging until needed. This packaging is usually conductive and should provide adequate protection for the device. Storing or transporting static sensitive devices in conventional plastic containers could be destructive to the device.
- Disengage power prior to insertion or extraction of sensitive devices. This also applies to PWBs containing sensitive devices.
- Double check test equipment voltages and polarities prior to conducting any tests. Verify that no transients exist.
- Use only soldering irons and tools that are properly grounded. Ungrounded soldering tips will destroy these devices. SOLDERING GUNS MUST NEVER BE USED.
- Avoid contact with the leads of the device. The component should always be handled very carefully by the ends or the side opposite the leads.
- Avoid contact between PWB circuits or component leads and synthetic clothing while handling static sensitive devices or assemblies containing them.

5.3 BUILT-IN TEST EQUIPMENT (BITE) SELF-DIAGNOSTICS

NOTE

A fault indication may occur at initial turn on and will remain until the frequency standard stabilizes. See table 5-1.

The RF-1310 Exciter has the capability of extensive self testing in the event of a failure. The general types of tests and the assemblies affected are:

a. Control Circuits Tests

- Control Board Assembly A14
- Driver Board Assembly A13A2
- Display Board Assemblies A13A4 and A13A5
- System Interface Assembly A18
- Remote Control Assembly A17

b. Frequency Synthesizer Tests

- Reference Generator Assembly A12 and Frequency Standard Assembly A21
- Carrier Generator Assembly A11
- PLL 5 Assembly A10
- PLL 4 Assembly A9
- PLL 3 Assembly A8
- PLL 2 Assembly A7
- PLL 1 Assembly A6

c. Signal Path Tests

- Carrier Generator Assembly A11
- Audio Assembly A5
- Combiner Assembly A4
- Up/Down Converter A2
- Output Amplifier Assembly A1

d. Power Supply Tests

Power Supply Assembly A15

Most of these tests can be automatically performed by turning the front panel selector switch to TEST. When the switch is in the TEST position, all exciter front panel controls become inoperative.

The normal length of the self test is approximately 8 seconds. All tests are performed sequentially in their order of importance.

If a fault exists in a particular assembly, that assembly number and the corresponding fault code (defining the type of failure) will be displayed on the exciter front panel alphanumeric display. See table 5-1 for a listing of assembly numbers and fault codes. For example, if the transmission of LSB signals became difficult (due to unknown reasons), initiate the self test by rotating the selector switch to TEST. The display may indicate ASSY 04 FAULT 02. Table 5-1 lists the fault codes and their description.

At the end of all assembly testing, a check will be made to see if the primary frequency standard has failed. If it has, the secondary standard will take over, and the front panel will display the message PRI FREQ STAN FAIL. If there is no secondary standard, BITE may have failed much earlier in the test.

If no faults were found during the self testing, the front panel will display
---TEST PASSED---.

Table 5-1 Fault Code Listing

Assembly No.	Fault Code	Description
A1	1	Output Amplifier Assembly Failure
A2	1	Up/Down Converter Failure
A4	1	Bypass Signal Path Fault
	2	LSB Filter
	3	USB Filter
	4	CW Filter
	5	FSK Filter
	6	-16 dB Insertion
	7	-26 dB Insertion
	8	PPC Failure
	9	AM Path Failure
	10	ISB Path Failure
A5	1	USB IF
	2	LSB IF
	3	USB ALC
	4	LSB ALC
	5	Serial Data
A6	1	PLL 1 Out-Of-Lock
A7	1	Serial Data
	2	PLL 2 Out-Of-Lock

Table 5-1 Fault Code Listing (Cont.)

Assembly No.	Fault Code	Description
A8	1	Serial Data
	2	PLL 3 Out-Of-Lock
A9	1	PLL 4 Out-Of-Lock
A10	1	Serial Data
	2	PLL 5 Out-Of-Lock
A11	1	Carrier Generator 1 Serial Data
	2	Carrier Generator 1 Serial Data
	3	Carrier Generator 1 Out-Of-Lock
	4	Carrier Generator 2 Out-Of-Lock
	5	45 MHz Out-Of-Lock
	6	Carrier Generator Output Fail
	7	FM Mode Select
A12	1	1 MHz Reference
	2	800 kHz Reference
	3	40 MHz PLL Out-Of-Lock
	4	Primary Standard Fail This error code reported back to remote only.
A13		No Fault Codes (Converter Module)
A14	1	PROM Checksum Failure
	2	Parallel/Serial Conversions
	3	CMOS RAM Failure
	4	Serial Data Input
	5	Keyline Logic Failure
	6	8255 Output Port Failure
	7	A/D Timing Failure
	8	A/D +5 Reference Failure
	9	A/D Ground Failure
A15		No Fault Codes (Linear Power Supply)
A17	1	LCU PROM
	2	LCU Communication
	3	LCU Interface
A18	1	Serial Communications
	2	ROM Failure
	3	RAM Failure
	4	I/O Failure
	5	Output Amp Communication
	6	A-to-D EOC Failure
	7	A-to-D Conversion Error

5.3.1 Continuous Self-Test Monitoring

Certain critical circuits which may adversely affect exciter operation or cause physical damage if they malfunction are continuously monitored. These circuits are:

a. Power Supply Assembly A15. All power lines distributed to the exciter are continuously monitored for acceptable voltage limits.

b. All Synthesizer Phase Lock Loop (PLL) Assemblies (A6, A7, A8, A9, and A10). These PLLs are continually monitored for a locked condition, indicating a stable transmitting frequency.

Failure of the A6, A7, A8, A9, A10, or A15 assemblies will cause the front panel FAULT LED to light any time the exciter is on.

5.3.2 Self-Test Operation

The RF-1310 self-test procedure consists of a series of tests and measurements that verify the proper operation of the exciter. These tests are performed sequentially. If a failure is encountered, the test will stop at that failure. The test will only continue past that failure by removing the cause of that failure.

NOTE

If one failure is found, there may be other failures that will not be indicated until the first failure is corrected.

The self-test procedure is performed under three conditions. First, tests involving digital type levels (logic 1 and 0) are performed in order of their importance. Next, the exciter signal path is tested for performance. Part of this test is performed using the BITE oscillator on the A5 assembly, and part is performed at the operating frequency that the exciter was last tuned to before entering BITE.

The tests performed during BITE are described in the following paragraphs. It may be necessary to refer to the specific circuit schematics under discussion. These schematics are in the assembly subsections.

5.3.2.1 Lamp Test

The first test performed is the lamp test. All LEDs and segments of the 10-and 20-character displays located on the front panel are lit. This condition is maintained for approximately 4 seconds and allows the operator to examine all front panel indicators while the remainder of the exciter testing is being accomplished.

5.3.2.2 ROM Test (A14 Assembly)

The Control Board Assembly A14 ROM test is performed next. U19 and U20 contain all the firmware used to control the main exciter functions and are tested to determine that the information they contain is correct. If any of these are found to have a problem, the corresponding fault message will be displayed on the front panel. These devices are factory programmed.

5.3.2.3 RAM Test (A14 Assembly)

The next test performed is the RAM test. This test will determine the read/write capability of the 2K CMOS RAM U18 located on Control Board Assembly A14. If a fault exists, the appropriate fault code will be displayed on the front panel.

5.3.2.4 Output Port Test (A14 Assembly)

On Control Board Assembly A14, U13 is tested for its ability to read and write, to and from its individual ports which control many functions in the exciter. Any error will cause the appropriate fault code to be displayed on the front panel.

5.3.2.5 Serial/Parallel Test (A14 Assembly)

This test determines the ability of Control Board Assembly A14 to read in the parallel lines and convert them to serial data. U6, U10, U15, U25, multiplexer U11, and the serial clock circuitry are tested. Any error will cause the appropriate fault code to be displayed on the front panel.

5.3.2.6 A-to-D Converter Test (A14 Assembly)

A-to-D converter U21 on the A14 assembly is tested for its ability to make analog-to-digital conversions properly and within acceptable time limits. Any error will cause the appropriate fault code to be displayed on the front panel.

5.3.2.7 Keyline Tests (A14 Assembly)

The circuitry involved in reading and activating the exciter keylines is tested next. In order for this test to actually verify keyline performance, either of the auxiliary keylines or the VOX keyline must be activated and held before entering BITE. If they are not, this test will simply be passed over and the rest of BITE will continue. The affected ICs are U1, U2, and U3. Any error will cause the appropriate fault code to be displayed on the front panel.

NOTE

If the CW and PTT keylines are both keyed, BITE will display A14-05, Keyline Logic Failure.

5.3.2.8 Serial Data Tests (A14 Assembly)

The operation of the parallel-in/serial-out shift register U17 on Control Board Assembly A14 and the capability of all synthesizers (including the Carrier Generator) to accept serial data from the control board will now be tested. If a synthesizer fails to receive data correctly, then that assembly will be identified as having failed. If there is a problem with all the synthesizers reading correctly, then it will be assumed that the Control Board is at fault.

The synthesizer PLLs are first loaded with all zeros and tested. They are then loaded with 00000000 00000000 00100000 binary. The one (1) bit will set the serial check lines on the PLL's to 1. This bit is then read back and tested for all PLLs. If the bit has not been set to 1, a fault has occurred, and the appropriate fault code will be displayed on the front panel.

5.3.2.9 System Interface Tests (A18 Assembly)

At this point, System Interface Assembly A18 begins its own self test. If there is an error in properly receiving this start message, a communications error is generated and displayed on the front panel. If everything is received properly, the A18 BITE will run on its own and main BITE will continue. Later in the main BITE, results from the system interface test will be received and interpreted.

5.3.2.10 Audio Serial Tests (A5 Assembly)

Audio Assembly A5 is tested separately for its ability to accept serial data from the control board. A check bit on A5, U26, will be tested to see if it can be accurately controlled. If any problem is encountered, the appropriate fault code will be displayed on the front panel.

5.3.2.11 Reference Generator Test (A12 Assembly)

Reference Generator Assembly A12 is tested next. The 40 MHz lock bit is read and tested for a locked condition (logic 0 = lock). If detected as being out of lock, the appropriate fault code and assembly number will be displayed on the front panel.

The 1 MHz and 800 kHz detect lines are read, and if a logic 1 is read indicating a fault, the appropriate fault code and assembly number are displayed on the front panel.

5.3.2.12 Phase Locked Loop (PLL) Tests

PLL 5, PLL 4, PLL 3, PLL 2, PLL 1, and Carrier Generator PLLs CG I and CG II will now be tested to ensure that they can be tuned over their entire range. For the synthesizer PLLs, the testing is done in three frequency ranges as listed in table 5-2.

Table 5-2. PLL Frequency Range

PLL Range	Exciter Frequency
LOW	00,000.000 kHz
MID	15,050.500 kHz
HIGH	29,999.999 kHz

Carrier Generator Assembly A11 PLLs CG I and CG II will also be tested in three frequency ranges. Those ranges are listed in table 5-3.

Table 5-3. A11 Assembly Frequency Range

PLL Range	Carrier Generator Frequency
LOW	454.000 kHz
MID	455.117 kHz
HIGH	456.000 kHz

At each frequency, all PLLs are tested to determine the status of their respective lock lines. They are tested in order, starting with PLL 5 and finishing with CG II. If a fault occurs, the appropriate fault code and assembly number will be displayed on the front panel.

5.3.2.13 System Interface Assembly Tests (A18 Assembly)

At this point, the results of the System Interface Assembly BITE tests will be interpreted. Tested on the A18 assembly will be:

- Serial communications U6 and ROM U8
- RAM contained in U9
- I/ O ports of A18A2 Assembly
- Communications to Output Amp Assembly A1-U9 and associated circuitry
- A-to-D converter U11.

If any errors are found, the appropriate fault code will be displayed on the front panel.

5.3.2.14 Carrier Generator Test (A11 Assembly)

Next, Carrier Generator Assembly A11 will be tested for its ability to generate the appropriate carrier signal. It will be tested to verify its ability to generate a signal at 455 kHz and 454.55 kHz (the FM loop). If any error in generating these signals is found, the appropriate fault code will be displayed on the front panel.

5.3.2.15 Audio Assembly Test (A5 Assembly)

Proper selection of signal paths are verified. The USB and LSB audio and both IF paths are tested for the ability to pass signals. The operation of the ALC on both audio paths will also be tested by applying two different audio input signal levels. The test signals are supplied by the BITE oscillator.

If any error is found, the appropriate error code will be displayed.

The output detect on each of the IF paths will be checked. They will be verified for the proper output and control. Any discrepancies will result in a fault code.

5.3.2.16 Combiner Assembly Tests (A4 Assembly)

The Combiner Assembly test includes the control and passing of signals through each one of the filters and the ISB leveling loop.

First, the ability for a signal (the BITE oscillator from the previous audio tests) to be passed through both the USB and LSB filters will be checked. If this is determined to be functional, then one of the filters will be deselected and the output of the combiner tested to determine if the level is up to full output, indicating proper operation of the ISB leveling loop. An error in any of these steps will generate the appropriate fault code on the front panel. At this point, the BITE oscillator on the A5 assembly is no longer needed, so it is disabled for the remainder of the exciter self test.

Next, the three filter paths CW, FSK, and BYPASS will be tested for control and passage of the 455 kHz Carrier Generator signal. If any of the filters has a problem, that filter's fault code will be displayed on the front panel.

Finally, the AM filter path and the two carrier insertion levels are tested. The AM filter will only be selected and tested for its ability to pass a signal. Alternately, each carrier level will be selected and the output verified for much lower levels. Any failures will be displayed on the front panel.

5.3.2.17 Electronic Keyer Test (A3 Assembly)

At this point, the exciter will be tuned to whatever frequency was selected on the front panel when BITE was initiated and remain there for the remainder of all tests. The up/down converter will be checked for proper output as well as internal keyline response, and any problems will cause the appropriate fault code to be displayed on the front panel.

5.3.2.18 Output Amp Test (A1 Assembly)

The Output Amp Assembly test includes an output level check and the control and response of the three digital attenuators.

Initially, all three digital attenuators are switched out to remove all attenuation. This will obtain full rf output. The output level is then read and stored. Each attenuator is switched in separately and the output power is monitored and compared to the full output reading. This determines if the amount of attenuation is correct.

5.3.2.19 Frequency Standard Detect

If all exciter tests have passed to this point, then the PRI FAIL line originating from Reference Generator Assembly A12 will be tested. If this line indicates the primary frequency standard has failed (fail = 1), then the message PRI FREQ STAN FAIL is displayed on the front panel. No fault code or assembly number will appear. As was stated earlier, this means that the primary frequency standard has failed and the exciter is operating on its secondary standard. If no secondary standard exists, the exciter may have failed BITE much earlier in the PLL tests.

5.3.2.20 LCU Test Option (A17 Assembly)

The last test is on Remote Control Assembly A17. The information used to control these tests is contained within the Remote Control Assembly firmware. Once it is determined that the Remote assembly is installed, then the Remote assembly will test its UART, the LCU ROM, and the RS-422 interface circuitry. If any of these are found to be at fault, the corresponding fault code is displayed on the front panel. The LCU also reports any self-test pass/fail conditions that may occur as a result of running BITE to the remote site.

If no errors are found during the self-test procedure, the front panel displays ---TEST PASSED---. This indicates that the radio is functioning properly.

5.4 SELF-TEST SEQUENCE SUMMARY

The RF-1310 self tests are done in the order of assembly importance. If a fault is discovered during testing, this failure must be corrected before the remaining tests are attempted.

Table 5-4 lists the order of testing from the first to the last test.

Table 5-4. Self-Test Sequence Summary

Sequence	Summary
1.	ROM Test - Assembly A14
2.	RAM Test - Assembly A14
3.	Output Port Test - Assembly A14
4.	Parallel/Serial Conversions - Assembly A14
5.	A-to-D Converter Test - Assembly A14

Table 5-4. Self-Test Sequence Summary (Cont.)

Sequence	Summary
6.	Keyline Tests - Assembly A14
7.	Serial Data Tests
7.1	Assembly A14
7.2	Assembly A11
7.3	Assembly A7
7.4	Assembly A10
7.5	Assembly A8
8.	System Interface - Assembly A18
8.1	BITE Start-Communications Error
9.	Audio Serial Test - Assembly A5
10.	Reference Generator Tests - Assembly A12
10.1	1 MHz Reference
10.2	800 kHz Reference
10.3	40 MHz Phase-Locked-Loop
11.	Phase Locked Loops
11.1	Assembly A10 - PLL V
11.2	Assembly A9 - PLL IV
11.3	Assembly A8 - PLL III
11.4	Assembly A7 - PLL II
11.5	Assembly A6 - PLL I
11.6	Assembly A11
11.6.1	CG I
11.6.2	CG II
11.6.3	45 MHz Out Of Lock
12.	System Interface Tests - Assembly A18
12.1	Serial Communication - A14
12.2	ROM
12.3	RAM
12.4	I/O Read/Write
12.5	Output Amp Communication
12.6	A-to-D Level Conversions
13.	Carrier Generator Test - Assembly A11
13.1	CG Output
13.2	FM Select
14.	Audio Tests - Assembly A5
14.1	USB ALC
14.2	LSB ALC
14.3	USB IF
14.4	LSB IF

Table 5-4. Self-Test Sequence Summary (Cont.)

Sequence	Summary
15.	Combiner Tests - Assembly A11
15.1	ISB Path
15.2	LSB Filter
15.3	USB Filter
15.4	CW Filter
15.5	FSK Filter
15.6	Bypass Path
15.7	AM Filter
15.8	16 Carrier Insertion
15.9	26 Carrier Insertion
16.	Up/Down Converter Detector Test - Assembly A2
17.	Output Amp Tests - Assembly A1
17.1	Control
17.2	32 dB Attenuator
17.3	16 dB Attenuator
17.4	8 dB Attenuator
18.	Primary Fail Detect Test
19.	Remote Control Tests - Assembly A17
19.1	PROM Test
19.2	Communications Test
19.3	Interface Test

5.5 EXCITER CHECKOUT

The following paragraphs verify that the exciter is functional. At this point, the operator should read and understand the operation section of this manual.

5.5.1 Exciter Output Power and Frequency Validation

a. With ac power disconnected, remove exciter top and bottom covers.

b. Lower the front panel by loosening the four captive screws behind the front panel handles, and pivoting the front panel down.

c. Check that the Control Assembly A14 backup battery jumper is properly installed between terminals E1 and E2.

d. Reinstall the front panel.

e. Configure the exciter as described in the Installation section, paragraph 2.4, Power Requirements. Connect the exciter line cord to the appropriate ac power source. Allow the frequency standard to stabilize for about 15 minutes before proceeding.

f. Check that the Ext. cw key is open. Place the front panel rotary function switch to NORM. The exciter is now on and conducting a turn-on self test. The test will run for about 1 second, during which time all displays (alphanumeric VFDs and green LEDs) should turn on. If all self-tests pass, then the exciter displays will reset to indicate the settings that existed the last time the exciter was on. If any tests fail, a fault code will be displayed in the left side alphanumeric display. The operator should then proceed to the BITE information in the Maintenance section of this manual, and locate the indicated fault code listed in the fault code table. Any fault should be repaired before proceeding.

g. Connect the test equipment as shown in figure 5-1.

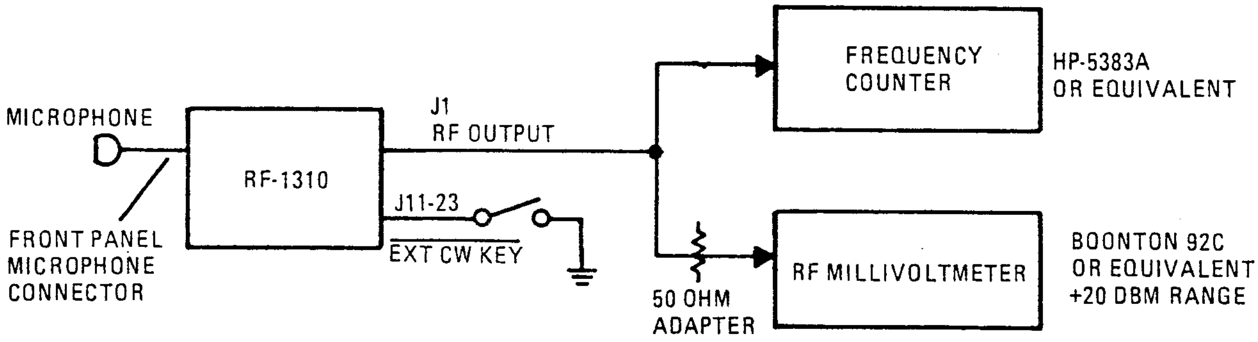


Figure 5-1. RF Output Validation

h. Place System Interface Assembly A18A1 switch S1-4 open. This places the exciter in a signal generator mode.

i. Press STANDBY and OPERATE buttons. OPERATE, READY, and FREQUENCY LEDs will turn on.

j. Press 0, 2, 0, 0, 0, 0, and 0 at keyboard. Press ENTER.

k. Press the MODE button, and scroll the display to CW.

l. Press the POWER button. Using the keypad, press 0 twice. Press ENTER. Power display will read -00, LED will be on.

m. Close the EXT CW KEY at J11-23. RF output power should appear at J1, nominally +20 dBm, at the front panel displayed frequency (02,000.00 kHz).

n. Press the meter EXC RF switch. The front panel meter should indicate 100 mW (nominally).

o. Open the EXT CW KEY. Enter a new frequency by pressing the appropriate keypad numerals. Press ENTER. Close EXT CW KEY. The new output frequency should agree with the displayed front panel frequency. Open the EXT CW KEY.

p. The ability of the exciter to properly tune and output full power has now been verified. If a further check of other capabilities is desired, proceed.

5.5.2 Channel Programming Validation

Perform Installation section, paragraph 2.6 before proceeding. The following verifies the ability of the exciter to program channels.

5.5.2.1 Programming the First Channel

a. Select PROG position of rotary function switch.

b. Press 0 and 1 at the keyboard. Press ENTER.

c. Press FREQUENCY button, press 1, 0, 0, 0, 0, 0, and 0 at the keyboard. Press ENTER.

d. Press MODE button until FSK mode is scrolled.

e. Press RF POWER button. Press 1 and 0 at the keyboard, and then press ENTER.

f. Press LOAD button.

5.5.2.2 Programming the Second Channel

a. Press CHANNEL. Press 0 and 2 at keyboard. Press ENTER.

b. Press FREQUENCY. Press 2, 0, 0, 0, 0, 0, and 0 at keyboard. Press ENTER.

c. Press MODE button until USB mode is scrolled.

d. Press CARRIER button until -10 or -16 is scrolled.

e. Press AUDIO button until MIC is scrolled.

f. Press RF POWER. Press 0 and 5 at keyboard. Press ENTER.

g. Press CLIP button to cause LED above button to turn on.

h. Press LOAD to load channel information. The second channel has now been programmed.

5.5.2.3 Recalling Channels

a. Place rotary function switch to NORM. Display should revert to values entered before channel programming validation began.

b. Press CHANNEL. Press 0 and 1 at keyboard. Press ENTER. Front panel displays should indicate:

Mode	Carrier	Audio	RF Power	Frequency	Channel
FSK	blank	blank	-10	10,000.00	01

The CHANNEL LED should be on.

c. Press 0 and 2 at keyboard. Press ENTER. Front panel displays should register:

Mode	Carrier	Audio	RF Power	Frequency	Channel
USB	-10 or -16	MIC	-05	20,000.00	02

The CHANNEL and CLIP LEDs should be on.

d. Programming validation has now been completed.

5.5.2.4 Full Self Test

a. To run a more comprehensive self test than exists during the power on self test, place the rotary function switch to TEST. All displays will light during self test. If no failures exist at the end of the self test (approximately 8 seconds), the displays will read - - - TEST PASSED - - -. If a failure does occur, a fault code will appear in the left hand display. If a fault code appears, refer to the BITE information in the Maintenance section of this manual.

b. Set rotary switch to OFF. Set A18A1 switch S1-4 closed (NORM). Replace top and bottom exciter covers. All initial turn on tests are now complete.