NOTE: THIS SERVICING GUIDE ALSO APPLIES TO THE "APCOR" EMS REPEATER AND TO THE MTR300 MOUNTAINTOP REPEATER.

NST NATIONAL SERVICE TRAINING
PLANTATION, FLORIDA

PORTABLE PRODUCTS

SERVICING

MX300 "HANDIE-TALKIE"

PORTABLE RADIOS

PREPARED BY
NATIONAL SERVICE TRAINING CENTER
PLANTATION, FLORIDA
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NATIONAL SERVICE TRAINING
PLANTATION, FLORIDA

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MOTOROLA
Communications and Electronics Inc.

I. INTRODUCTION

The MX300 series "Handie-Talkie" FM Portable Two-Way radio was first introduced to the field in April, 1975. The "MX300" radio incorporates a modular plug-in design with extensive use of thick and thin film hybrid circuitry.

This use of hybrid microelectronic technology has made the "MX300" radio a high performance, extremely versatile unit, easily adapted to the most complex user requirements. Specialized servicing techniques and test equipment are required for proper system maintenance and operation.

Each section in this Technician's Guide will address an area pertinent to the "MX300" series radio. The information covers recommended test equipment and service aids, performance tests and specifications, alignment, troubleshooting, and repair of the unit.

In radio servicing, the results that you obtain are directly related to the available test equipment, technical knowledge and skills, and the effort extended by the technician. This booklet has been produced in order to help the technician extend a maximum effort in the basically critical areas of "MX300" and "MX300-S" radio maintenance.

Section VIII of this guide covers the troubleshooting and repair of the synthesizer section of the "MX300-S" radio. This section will cover only the different modules used in the synthesized radio. Once a problem has been diagnosed to the receiver or transmitter itself, then using the standard troubleshooting charts in sections V and VI should isolate the problem.

Finally, it is suggested that MAV-PACK PQD covering the "MX300" Series Radio be obtained and reviewed if the Technician is not familiar with the theory of operation of the "MX300" radio.

NOTE

This booklet is designed to be used in conjunction with the following manuals and supplements:

Publication Name	Motorola Manual Number
Theory/Maintenance Manual	68P81013C70
VHF Service Sheet	68P81013C71
UHF Service Sheet	68P81013C75
800 MHz Service Sheet	68P81015C85
VHF "MX300-S" Portable Service Sheet	68P81022C10
UHF "MX300-S" Portable Service Sheet	68P81022C15
"MX300-S" Radio- Instruction Manual Revision	FMR-894-A

MOTOROLA
Communications and Electronics Inc.

II. TEST EQUIPMENT

The ease with which radio performance tests can be performed or a malfunction analyzed is directly related to the scope and capability of the test equipment being used. (All of the servicing data included in this publication was compiled using the test equipment outlined here.)

It is recommended that the equipment here described, or its equivalent, be used as a guide for the initial purchase, addition to, or replacement of existing equipment.

R-2001A COMMUNICATIONS SYSTEMS ANALYZER - This piece of test equipment utilizes a microprocessor to control more than 15 different functions associated with performing test and analyzing problems within the MX300 series radios. It is strongly suggested that the prospective user requiring new or replacement test equipment investigate the single-unit capabilities of the R-2001A Communications System Analyzer.

Some of the functions include:

1. RF Signal Generator (AM, FM, CW, DSB Generator.
2. Wattmeter (internal or external in-line).
3. Digital Voltmeter.
4. General Purpose Oscilloscope.
5. AC Voltmeter (good to -40 dBm).
6. SINAD Meter.
7. RF Monitor Receiver Function.
8. Modulation Measurement.
9. Spectrum Analyzer.
10. Duplex Generator.
11. Low Range Frequency Counter (10 Hz to 35 MHz).
12. Sweep Generator.
13. Code Synthesizer.
14. Internal 1 KHz Oscillator.
15. Programmable RF and "PL," "DPL" memory.

The following list of test equipment is duplicated in the R-2001A Communications Systems Analyzer:

SERVICE MONITOR - Used as an RF signal generator, IF generator, frequency meter, deviation meter, and general purpose oscilloscope.

Motorola R-1200A Series Service Monitor

SINAD METER - Used for checking 12 dB SINAD of the receiver.

Motorola R-1013A SINAD Meter

WATTMETER - Used to measure transmitter power. Must be terminated in 50 ohms.

Motorola S-1350A Wattmeter with plug-in elements
Bird Model 6154 0-2, 0-10 watt scales.

AC VOLTMETER - For measuring discriminator, squelch and audio stages in alignment and troubleshooting. Measurement to -90 dBm is preferred.

Hewlett Packard 400FL AC Voltmeter

DC MULTIMETER - General purpose instrument for receiver and transmitter alignment and troubleshooting.

Motorola S-1063A Analog Multimeter
Motorola R-1001A Digital Multimeter

OSCILLOSCOPE - General troubleshooting of audio, squelch, and various signaling options.

Motorola R-1004A Dual Trace Oscilloscope

CODE SYNTHESIZER - For modulating the RF signal generator with the proper "Private-Line," "Digital Private-Line," "Selective Call," or IMTS test signals.

Motorola R-1100A Code Synthesizer

The following items are not included in the R-2001A but are recommended for servicing the MX300 Radio.

RF MILLIVOLTMETER - For measuring RF sections of the receiver and transmitter. Must be used with a 100:1 adaptor for measurements over 3 VRF.

Motorola S-1339A RF Millivoltmeter
RTL-4040A High Voltage Probe

BENCH POWER SUPPLY - 0 to 20 VDC, current limiting power supply, with meter range selection of both voltage and current meters.

Motorola S-1347B or S-1348B (Programmable)

In general, a fully functional test equipment bench position for the MX300 radio could be set up using:

1. R-2001A Communications Systems Analyzer.
2. HP 400FL AC Voltmeter (has -90 dBm sensitivity).
3. S-1339A RF Millivoltmeter.
4. S-1347B Bench Power Supply.

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III. SERVICE AIDS & REPAIR TOOLS

In addition to the test equipment recommendations detailed in Section II, there are other items of specialized servicing equipment needed to properly service the "MX300" radio. The following list names and briefly describes the more important servicing items for the "MX300" portable radio.

RTX-4005A PORTABLE RADIO TEST SET - Used in conjunction with a special test cable to plug into the Converta-Com radio connector on the side of the "MX300" radio. This test set provides access to many of the radio functions needed for performance and trouble-shooting of both transmitter and receiver sections.

RTK-4021A TEST SET CABLE - Mates with the "MX300" radio Converta-Com side connector and provides the input connection to the RTX-4005A. It also provides a male BNC connector for RF input/output connections to the RF side connector jack. (Used for all "MX300" radios, but is the only acceptable cable for 800 MHz.)

ST-1175 BATTERY BLOCK - Provides a simple means of connecting a power supply to the radio. Incorporated in the battery block are reverse polarity and over voltage protection circuits.

ST-1177 BATTERY TESTER - Allows an MX300 radio battery to be tested under simulated load conditions.

ST-1176 CHARGER TESTER- Used to check the charging current, rapid charging switchover point of MX300 radio chargers.

SKN-6028A RF ADAPTER CABLE - This cable will be used to connect test equipment; either a wattmeter or signal generator, to the RF jack on the side of the MX300 radio. This cable is part of the RTK-4021A test cable.

ST-1179 MODULE PUSH TOOL KIT - A tool that will permit easy removal of modules.

ST-1181 TUNING TOOL KIT - Used to tune up the preselector and channel elements.

ST-1180 RF JACK/PRESELECTOR SPANNER WRENCH- Aids in the removal of RF jack and preselector housing nuts.

RSX-1002A POWER DESOLDERING SYSTEM - This tool is excellent for removing discrete components, the control flex, or module sockets from the four layer printed circuit board without damaging the board. The system is composed of a temperature controlled desoldering handpiece, a power unit which develops the vacuum to draw molten solder out of the plated holes of the board, and a regular temperature controlled soldering iron for normal soldering operation. This desoldering system is similar to the Pace desoldering system.

ST-1087 WELLER W-TCP-N SOLDERING STATION - Utilizes a closed loop temperature controlled tip system. Tips available in 700°, 800°, and 900° temperatures. Recommended tips for portable applications are:

ST-1088	1/32" conical flat 800° tip.
ST-1167	Screwdriver, 1" reach 800° tip

ST-726 2oz. Bulb Solder Remover with ST-727 replacement tip.

ST-1163 - PRECISTA Vacuum Desolder Pump with ST-1164 replacement tip.

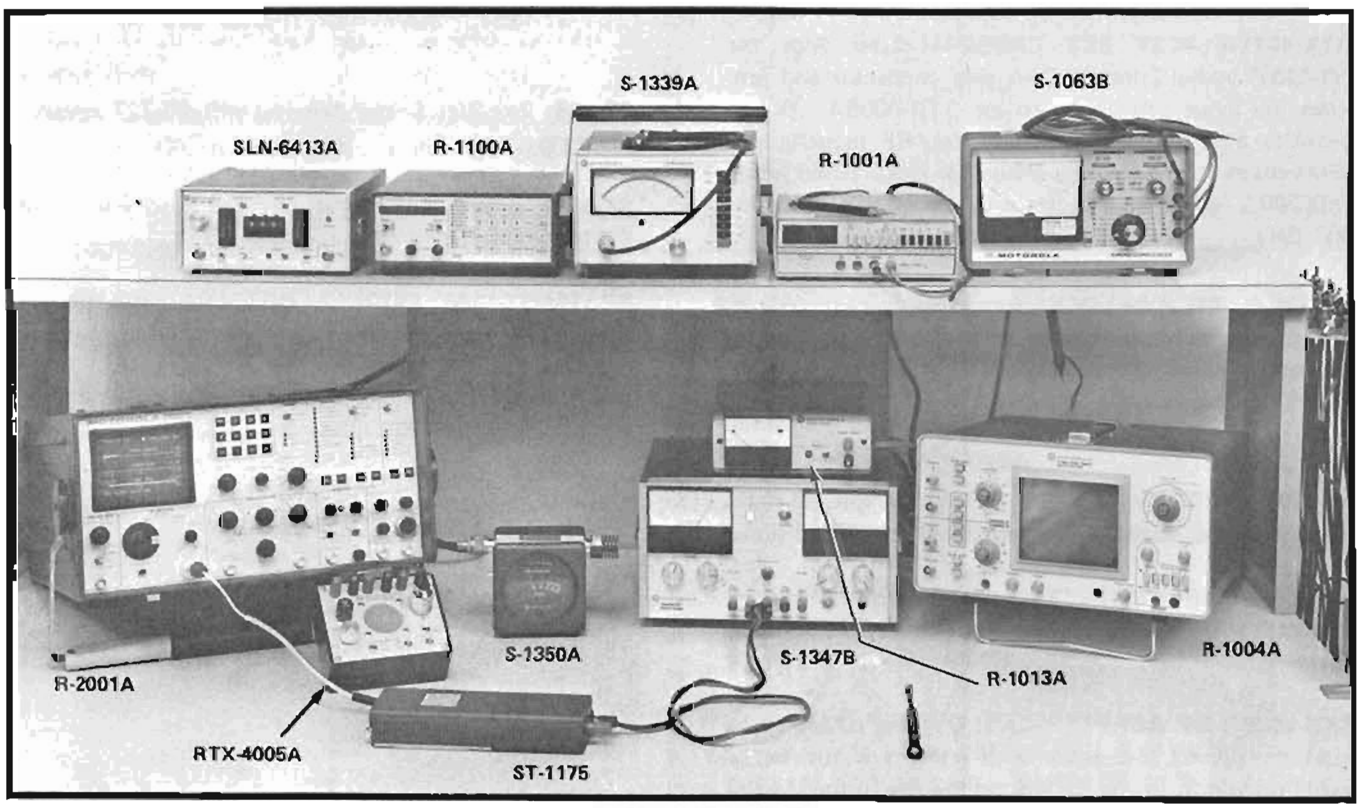
ST-1144/ST-1146 MODULE DESOLDERING IRON - Allows convenient removal of soldered in flex circuits and modules without damaging the circuit board. Three solder reservior tips: 66-84208D36 small, 66-84208D37 medium, and 66-84208D38 large.

HAND TOOLS AS FOLLOWS:

1. 3/16" Slotted Flat-Blade Screwdriver.
2. Phillips Screwdriver - No. 1 Point Size.
3. Needle Nose Pliers, ST-202.
4. Prober (Dental Pick), 66-84253C73.
5. Wire Cutters, ST-200.
6. Wire Strippers, ST-562.
7. Seizers (Hemostats), 66-93117C01.
8. Tweezers, ST-492.
9. Solvent - Pure Isopropyl Alcohol (refer to Service and Repair Note 790).
10. Solvent Brush - 1/2" trim paint brush with bristles cut to 1/2" length.

SOLDER - It is recommended that a top quality solder be used in any repair work performed on the "MX300" radio. Rosin core solder .030" or .031" in diameter and 63/37 or 60/40 tin/lead composition has proved to be the most successful. DO NOT use acid core solder.

It is advised that the Technician read the "Portable Products Repair Guide," number TT-901 before attempting any repair on the "MX300" radios. This Technician's Guide provides much valuable information as to the proper tools and methods to use when repairing the "MX300" or "MX300-S" radio.

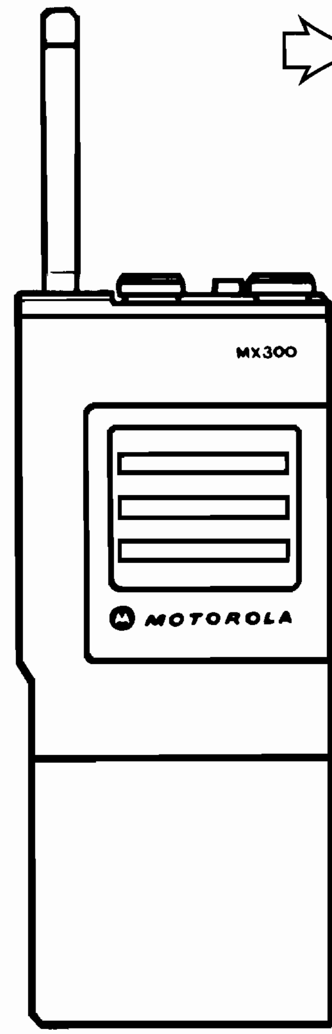


TYPICAL TEST BENCH SET UP

IV.

PERFORMANCE

CHECKS/ALIGNMENT



When analyzing a problem in an MX300 radio, certain performance checks are used to isolate the problem. These checks are divided between the receiver and transmitter. Once these checks show the area of the problem, the following section, labelled TROUBLESHOOTING, will lead the technician to the faulty part or module.

The following performance checks are common to most portable products. The peculiarities involved with making these checks on an MX300 radio will be discussed in detail. An understanding of the mechanics involved to perform these checks, along with proper interpretation of the results, is essential to efficient radio servicing.

RECEIVER PERFORMANCE CHECKS

20 dB QUIETING SENSITIVITY - This is used as an overall test of how well a received signal will quiet the receiver. The test is accomplished using an **unmodulated** input signal. Thus, the radio can still have a problem recovering a modulated (or voice) signal. A 12 dB SINAD test, discussed later in this section, will help locate a problem in this area.

To perform the test:

1. Unsquelch the radio and adjust the volume control for a noise level of 1.75 VAC at the audio output. This level can be read using an AC voltmeter across the speaker terminals with the RTX-4005A test set.

2. Increase the unmodulated carrier signal from the signal generator (that is connected to the ANT input) until a 20 dB reduction in audio level is seen on the AC voltmeter. This should occur by:

   VHF
   STD. - .5 u Volts
   With RF Preamp - .25 u Volts

   UHF
   450 MHz Band - .5 u Volts
   800 MHz Band - .5 u Volts

CARRIER SQUELCH SENSITIVITY - This performance check, along with the next check, PL squelch sensitivity, will provide the technician with valuable information as to the gain that the amplifiers provide to the unmodulated carrier. How much gain the amplifiers provide through the receiver will be the squelch sensitivity, given in microvolts. To perform this test, follow these steps:

1. Unsquelch the radio and adjust the volume control for a reading of 1.75 VAC on the AC voltmeter.

2. Now, rotate the squelch control until the receiver squelches (point where the noise from the speaker just ceases).

3. With a signal generator hooked to the antenna input, inject an unmodulated carrier into the radio. Slowly increase the signal level until noise is again present at the speaker (the AC voltmeter should indicate this).

4. The amount of signal level needed to turn on the audio stages should be:

   VHF
   STD. - .25 u Volts
   With RF Amp. - .13 u Volts

   UHF
   450 MHz Band - .25 u Volts
   800 MHz Band - .25 u Volts

NOTE: The squelch sensitivity (threshold squelch) should always be 1/2 the 20 dB quieting level. If not, a problem can be pinpointed to RF regeneration or a noisy RF stage.

"PRIVATE-LINE" SQUELCH SENSITIVITY - This squelch test follows the carrier squelch sensitivity test and verifies the proper operation of the sub-audible tone coded squelch or digital coded squelch option that Motorola terms "PL" or "Private-Line" or "DPL" or "Digital Private-Line." Perform the test as follows:

1. **Adjust the carrier squelch control to minimum (squelch fully open, audio heard at speaker output).**

2. Switch the "PL" or "DPL" squelch switch "on" and squelch the radio.

3. Modulate an on frequency RF carrier with the proper "PL" or "DPL" frequency, and adjust the carrier deviation to ±750 Hz.

4. Connect the signal generator to the receiver's RF input and increase the carrier signal level until the receiver unsquelches. Read the "PL" or "DPL" squelch sensitivity on the signal generator output.

12 dB SINAD - A SINAD test is designed to check how well a receiver amplifies and reproduces a modulated signal. This test will give the technician an indication of where the problem lies in an MX300 receiver. To perform this test, a MOTOROLA R-1013A SINAD meter can be used, following the steps indicated:

1. Connect the receiver's antenna input to a signal generator adjusted to the standard signal input, (1000 microvolts, 1000 Hz, ±3 KHz deviation).

2. Monitor the receiver's audio output and adjust the volume control for rated audio (3.5 VAC).

3. Remove the connection to the AC voltmeter and re-connect to the SINAD meter input.

4. Decrease the RF output of the signal generator until the 12 dB SINAD point is reached on the SINAD meter. Read the test result, in microvolts, on the RF output of the signal generator. This level should be:

VHF
STD. - .35 u Volts
With RF Preamp - .18 u Volts

UHF
450 MHz Band - .35 u Volts
800 MHz Band - .35 u Volts

Note that the SINAD meter may be used to perform receiver alignments as well, and is a very versatile tool for nearly all receivers. It is suggested that the technician locate and familiarize him/herself with the available information regarding SINAD.

RATED AUDIO (Audio Power Output and Harmonic Distortion) - The rated audio output is the combination of audio power output delivered to the receiver's design load, harmonic distortion content, and maximum allowable current drain for the given model radio. This is the preliminary reference adjustment for performing the 12 dB SINAD measurement, and also provides the noise voltage reference for the 20 dB quieting test (one-half the rated audio voltage).

To perform the rated audio output test, apply a standard signal to the receiver's antenna input

1. Adjust the volume control for 3.5 VAC on the AC voltmeter (this is for a 600 ohm AC voltmeter and represents 500 milliwatts of audio power across a 24 ohm load).

2. Observe the current drain of the receiver (it should be at or below 170 ma for a simple carrier squelch VHF radio, for example).

3. Audio distortion, if measured, should be at or below 3% maximum.

RECEIVER FREQUENCY

There are three methods of checking the receiver's channel element frequency. If the channel element is off frequency, then quieting checks will prove fruitless.

In the standard MX300 radios the channel elements can be adjusted by using the individual controls located on each element. To check the frequency of the channel elements in the standard radio, proceed as follows:

1. Using a service monitor in the receive mode, dial in the frequency that is 17.9 MHz below the received carrier.

2. With a BNC coaxial cable connected to the RF input jack on the service monitor, and the other end terminated with a TEK-10 probe, measure the receiver injection frequency on the service monitor. On a VHF receiver, the receiver injection will be present on M1. On UHF receivers, pin 7 of the preselector must be probed.

3. The error meter will now indicate whether or not the channel element needs adjusting.

A quicker method of checking injection frequency is using the "sniffing" method. This is similar to the probing method, except no physical contact to the radio is necessary in order to check the receiver's channel element frequency. To perform this, follow the same procedure as the probing method, except don't hook up a TEK-10 probe. Instead, simply place an antenna on the end of the coaxial cable and put the antenna alongside the back of the radio. The service monitor should indicate a received signal.

The third method requires the use of a digital voltmeter, a 21.4 MHz oscillator, and a signal generator. Begin by injecting a 21.4 MHz signal using the oscillator into the IF chain. This can be accomplished by laying the antenna of the oscillator box near the IF strip. The radio should quiet. Record the DC voltage at pin 7 of the discriminator module (U6).

Now, using a signal generator, establish a strong on carrier signal into the RF input of the radio. The digital voltmeter should indicate the same DC voltage.

Receiver frequency should be within:

VHF & UHF (450 MHz)	UHF (800 MHz)
± .005% of Carrier	± .002% of Carrier

TRANSMITTER PERFORMANCE CHECKS

There are five checks that should be performed on an MX300 transmitter. All checks should be conducted with the RF side connector hooked up to an RTK-4021 test cable or SKN-6028A RF adapter cable and terminated in a 50 ohm wattmeter.

TRANSMITTER FREQUENCY - Set the transmit frequency of the channel under test on the service monitor. Making sure the power supply is set for 7.5 volts DC, key the radio for at least five seconds. Observe any error on the error meter of the service monitor. The accuracy of this measurement is dependent on environment and should be at room temperature (68^{o} - 80^{o}F). Any error should be within:

VHF & UHF (450 MHz)
±.0005% of Carrier

UHF (800 MHz)
±.00025% of Carrier

TRANSMITTER DEVIATION - Set the service monitor up as in the previous check. Inject a 1000 Hz signal at 25 mV AC into the audio input jacks on the RTX-4005A test set. Set the 1000 Hz signal to 25 mV AC by hooking the AC voltmeter to the AC/DC jacks on the test set and set the level for 25 mV AC. Insure the test set function switch is set on the mic position.

Key the transmitter and observe the deviation meter on the service monitor. FCC limits are ±5 KHz for 100% modulation.

TRANSMITTER RF POWER OUTPUT - Using the RF cables previously mentioned, key the transmitter and read the power output on the wattmeter.

VHF	UHF
H23AAU/SSU - 1 Watt	450 MHz
H33AAU/SSU - 2.5 Watt	H24AAU/SSU - 1 Watt
H43AAU/SSU - 6 Watt	H34AAU/SSU - 2 Watt
	H44AAU/SSU - 5 Watt
	800 MHz
	H35AAU - 1.5 Watt

While keying the transmitter, record the current drain of the radio. The efficiency of the radio will be indicated if the rated power is reached at or below the rated current of the model

VHF	UHF
	450 MHz
H23AAU - 720 mA max.	H24AAU - 820 mA max.
H33AAU - 1270 mA max.	H34AAU - 1225 mA max.
H43AAU - 2640 mA max.	H44AAU - 2740 mA max.
H23SSU - 740 mA max.	H24SSU - 845 mA max.
H33SSU - 1290 mA max.	H34SSU - 1250 mA max.
H43SSU - 2680 mA max.	H44SSU - 2765 mA max.
	800 MHz
	H35AAU - 1050 mA max.

For "PL" models, add 4 mA to all of the above readings.

NOTE: The MX300 radio is capable of delivering higher RF power than those specified. However, higher power levels will result in increased transmitter current consumption which may limit battery life.

MODULATION SENSITIVITY - To check the modulation sensitivity of the transmitter, perform the deviation check for ±5 KHz. Then decrease the level of the 1000 Hz tone until ±3 KHz is indicated on the deviation meter. This level should be less than 3 millivolts.

If the radio fails one or more of the performance checks by a marginal amount, realignment would be the next step. If, however, the radio fails one or more of the checks by a gross amount, realignment will probably be of no avail, and the troubleshooting section of this guide should be consulted.

ALIGNMENT - PRELIMINARY

Prior to attempting an alignment on the receiver or transmitter, the radio and its associated test equipment must be hooked up properly. The following diagram should help the Technician in hooking up the MX300 radio properly.

A few items to note concerning Figure 1:

1. The RTX-4005A test set is shown in the center of the diagram as well as in a close up at the lower left.

2. If an R-2001 system analyzer is not available, a wattmeter will be required to read the output power of the transmitter. A signal generator will, none-the-less, be needed to inject an on frequency signal for checking the receiver.

3. Never align the radio using a battery. Always use the ST-1175 battery block. A weak battery will give indications that the radio needs troubleshooting when, in fact, all that is needed is a fresh battery.

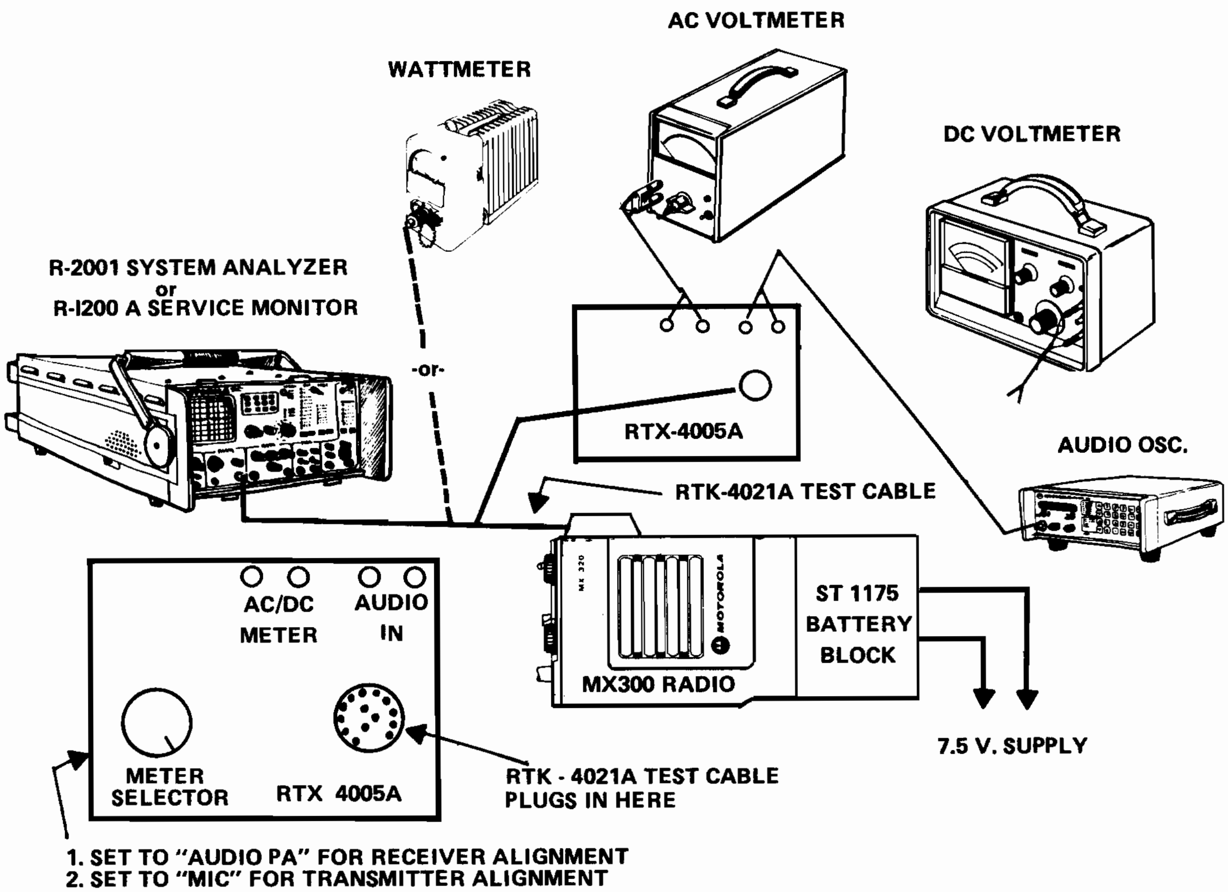


FIG. 1

VHF ALIGNMENT

FOR STANDARD MX300 RADIOS (H23,33,&43 AAU MODELS)

RECEIVER

1. Connect the radio as shown in Figure 1.

2. Using the DC meter, peak L4 for maximum DC at M1.

3. Move the DC meter to M2 and peak Z5, Z6, and Z7 for a peak indication.

4. Using a service monitor, set the frequency to 21.4 MHz below the received carrier. Now probe M1 with a TEK-10 isolation probe connected to the signal input on the service monitor. Any error will be indicated on the error meter. Adjust the channel element for zero error. Repeat this for all the channel elements.

5. With an on frequency carrier injected into the side connector, put an AC meter on the AC/DC metering jacks on the test set. Maintaining an input level sufficient to give 20 dB quieting (to prevent front end saturation), tune Z1, Z2, Z3, and Z4 for best quieting (lowest reading).

TRANSMITTER

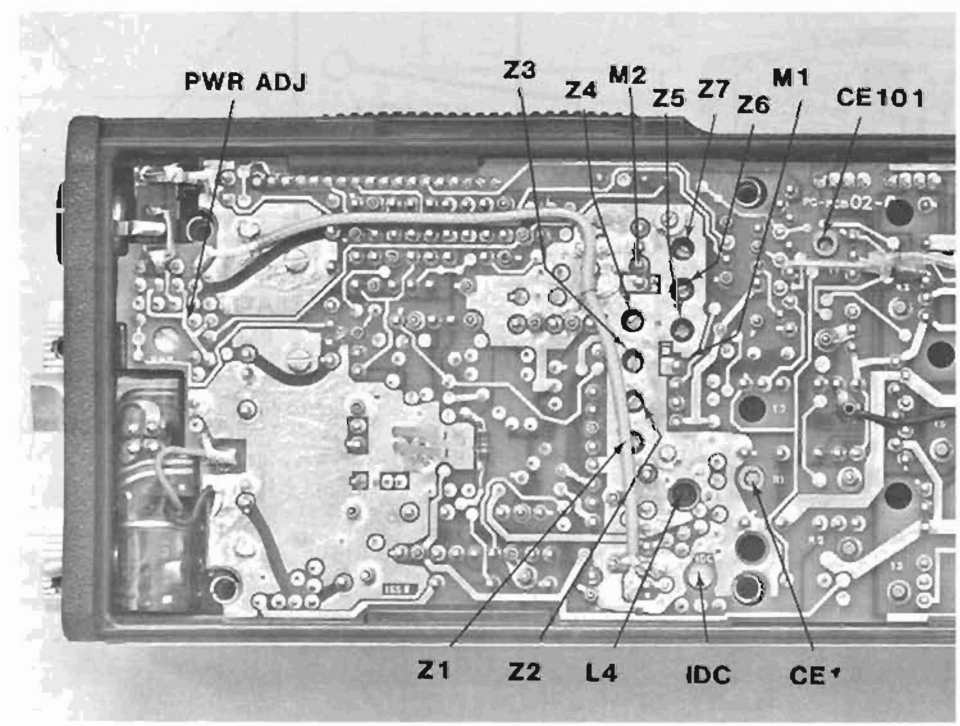
1. Set up the radio as shown in Figure 1.

2. Set the service monitor for the transmit frequency and key the radio. Adjust the transmit channel element for zero error on the service monitor.

3. Set R107, the power adjust potentiometer, for the proper rated power output, 1, 2.5, or 6 Watts

4. While the transmitter is keyed, observe the current meter. At rated power, current should be within the limits set forth in the performance checks.

5. Apply a 1000 Hz tone at a 25 millivolts AC level to the audio in jacks on the test set and adjust R102 for ±5 KHz deviation on the service monitor.



VHF ALIGNMENT POINTS

UHF ALIGNMENT
FOR STANDARD MX 300 RADIOS

RECEIVER (H24,34,&44 AAU MODELS)

1. Connect the radio as shown in Figure 1.

2. With the DC meter, peak Z6 and Z7 for maximum voltage at M2.

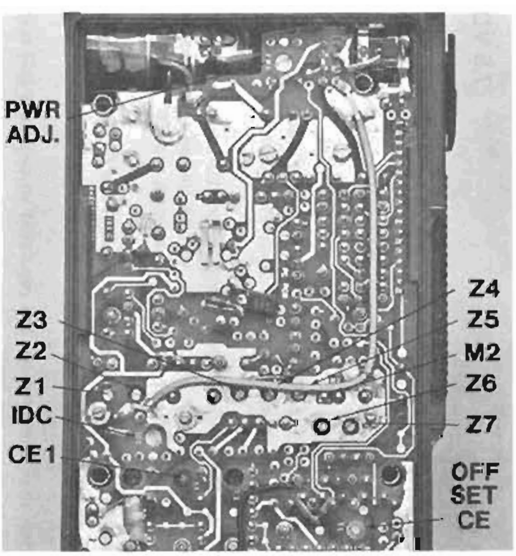
3. Using a service monitor, set the frequency to 21.4 MHz below the receiver carrier. With a TEK-10 probe connected to pin 7 of the preselector, measure the error of the channel element on the service monitor. Adjust the channel elements for zero error on the monitor.

4. Inject an on frequency carrier into the side connector RF jack and connect an AC voltmeter to the RTX-4005A test set. Maintaining a 20 dB quieting level to prevent front end saturation, tune Z1 through Z5 for best quieting (lowest reading).

800 MHZ (H35AAU MODELS)

1. Connect the radio as shown in Figure 1.

2. Using a service monitor, set the frequency to 21.4 MHz below received carrier. With a TEK-10 probe connected to pin 19 of U3, measure the error of the channel element on the service monitor. Adjust the channel elements for zero error on the monitor.



UHF ALIGNMENT POINTS

TRANSMITTER (H24,34,&44 AAU MODELS)

NOTE

Prior to setting the transmitter on frequency, insure the receiver has been aligned.

1. Set up the test equipment as shown in Figure 1.

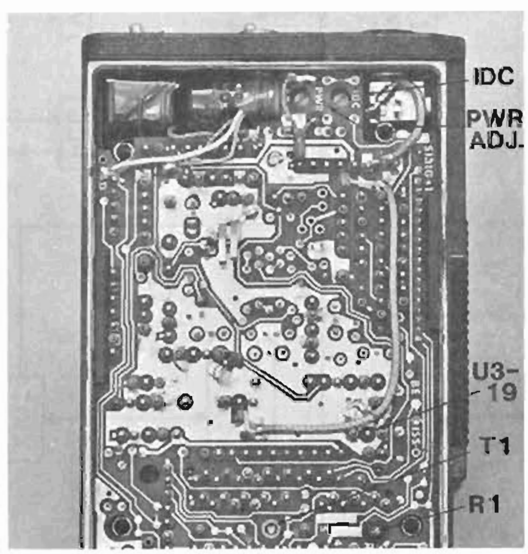
2. With the service monitor set for the transmit frequency, key the radio into a wattmeter. Adjust R107 for rated power output (1, 2, or 5 Watts). While the radio is keyed, record the current drawn by the transmitter. It should fall within the limits specified in the transmitter performance checks mentioned previously in this guide.

3. Adjust the channel element warping adjustment for zero error on all channels.

4. Apply a 1000 Hz tone at a level of 25 millivolts AC to the audio input jacks on the test set. R102, the deviation adjust, should be set for ± 5 KHz on the deviation meter on the service monitor.

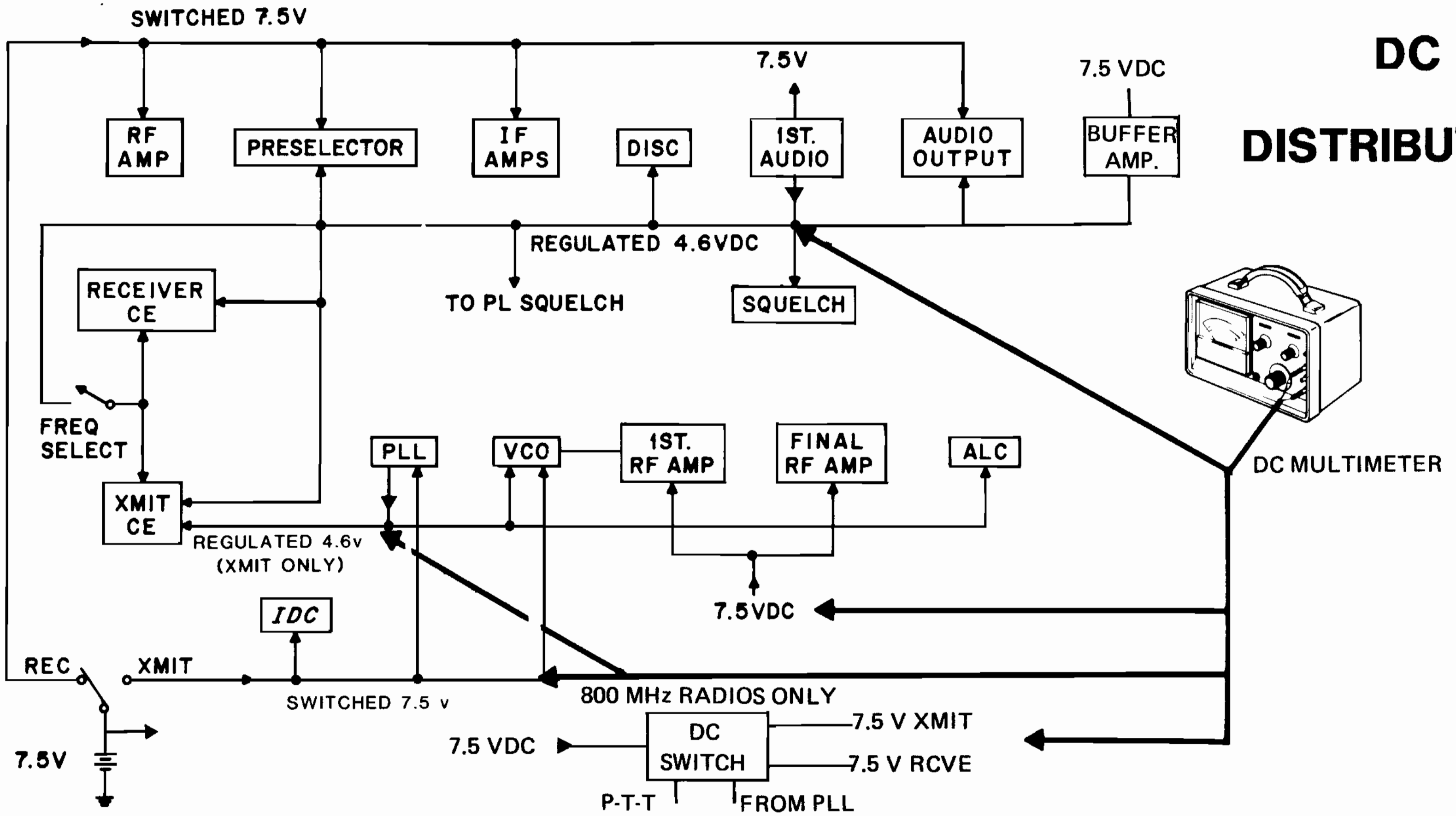
800 MHZ (H35AAU MODELS)

Perform all the above checks. Also, with the transmitter keyed, adjust the power control, R107 for 1.5 watts output at the antenna.



800 MHz ALIGNMENT POINTS

DC DISTRIBUTION



DC DISTRIBUTION

Probably the last thing a technician checks when troubleshooting a radio is the supply voltages to the modules. Much time can be gained when troubleshooting if the technician would measure the voltages necessary to operate the modules. An amplifier cannot amplify if it does not have any supply voltages to bias the stages on.

This diagram shows where the different voltages in the VHF and 450 MHz UHF radios go. More important, it shows where these voltages are developed. Voltages such as the regulated 4.6 volts, transmit and receive, will be routed to the necessary modules. Notice that the regulated 4.6 VDC coming from the 1st audio module goes to the receiver as well as the transmit channel element. This would indicate that failure of this regulator can disable the receiver and the transmitter.

When working on the 800 MHz radio, the P-T-T relay has been replaced by U11, the DC switch and power set module. This module, will receive 7.5 VDC from the battery and switch this voltage from the receiver (R voltage) to the transmitter (T voltage) upon command of the P-T-T ground and the phase locked loop signal on Pin 2 of U11.

Other than that change, the regulated voltages are still applied to the same modules as in the VHF and UHF models. Finally, when all else fails, and neither the transmitter or receiver operate, check the fuse!

V. RECEIVER TROUBLESHOOTING

This section of the Technicians Guide pertains to finding a a trouble in the receiver section of the MX300 radio.

The first three pages concern themselves with isolating the problem section of the receiver. The Block Diagram, 12 dB quieting check and the RF/IF isolation test will show the Technician which section to begin with.

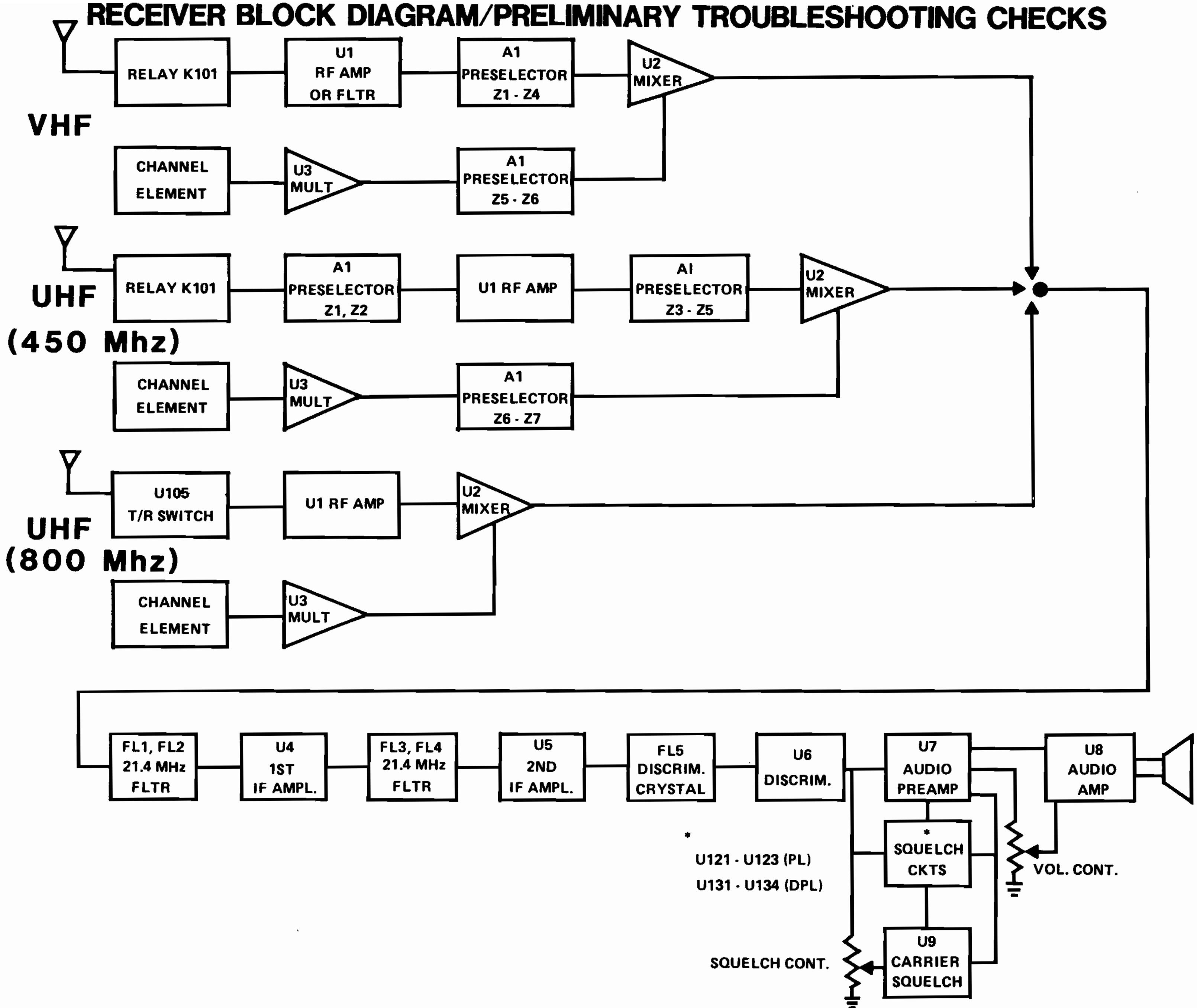
Following that, the front end of the VHF, UHF and 800 MHz receivers are detailed. Depending on the type radio, the proper schematic should be consulted.

NOTE

> Following page 33, there are overall schematics of the three radios as well as board overlays. The board overlays have been laid out so that the Technician can fold out the proper overlay and still consult the troubleshooting diagrams. This should make locating module pins easier.

After the front end diagrams, the receivers are practically identical and will be treated as such. Using these diagrams will help the Technician locate a malfunction faster and put the radio back in proper operation quicker.

RECEIVER BLOCK DIAGRAM/PRELIMINARY TROUBLESHOOTING CHECKS



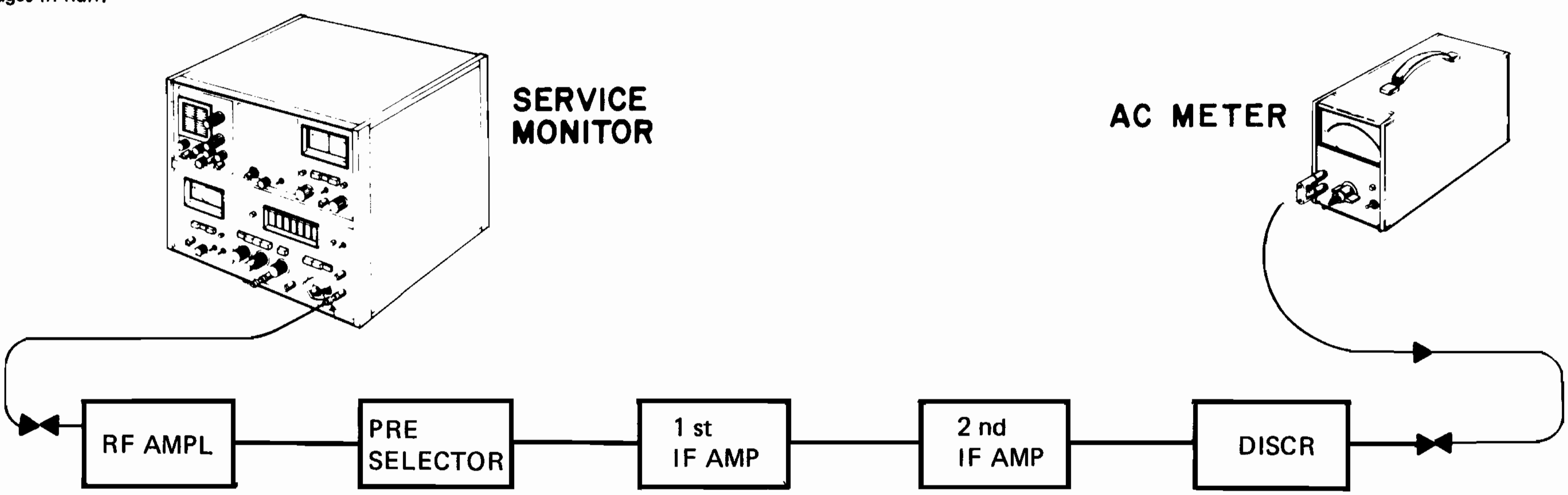
The following two checks will help the technician to locate a problem area in the radio.

Before these two checks are discussed, it must be determined if a problem does actually exist with the circuitry, or does the radio simply require realignment. If the RF level for 20 dB quieting is marginal (1 uV - 2 uV), realignment will probably resolve the problem. If troubleshooting is required, a 12 dB quieting check will normally be the first test performed. This test will split the receiver in half at the output of the discriminator.

12 dB QUIETING

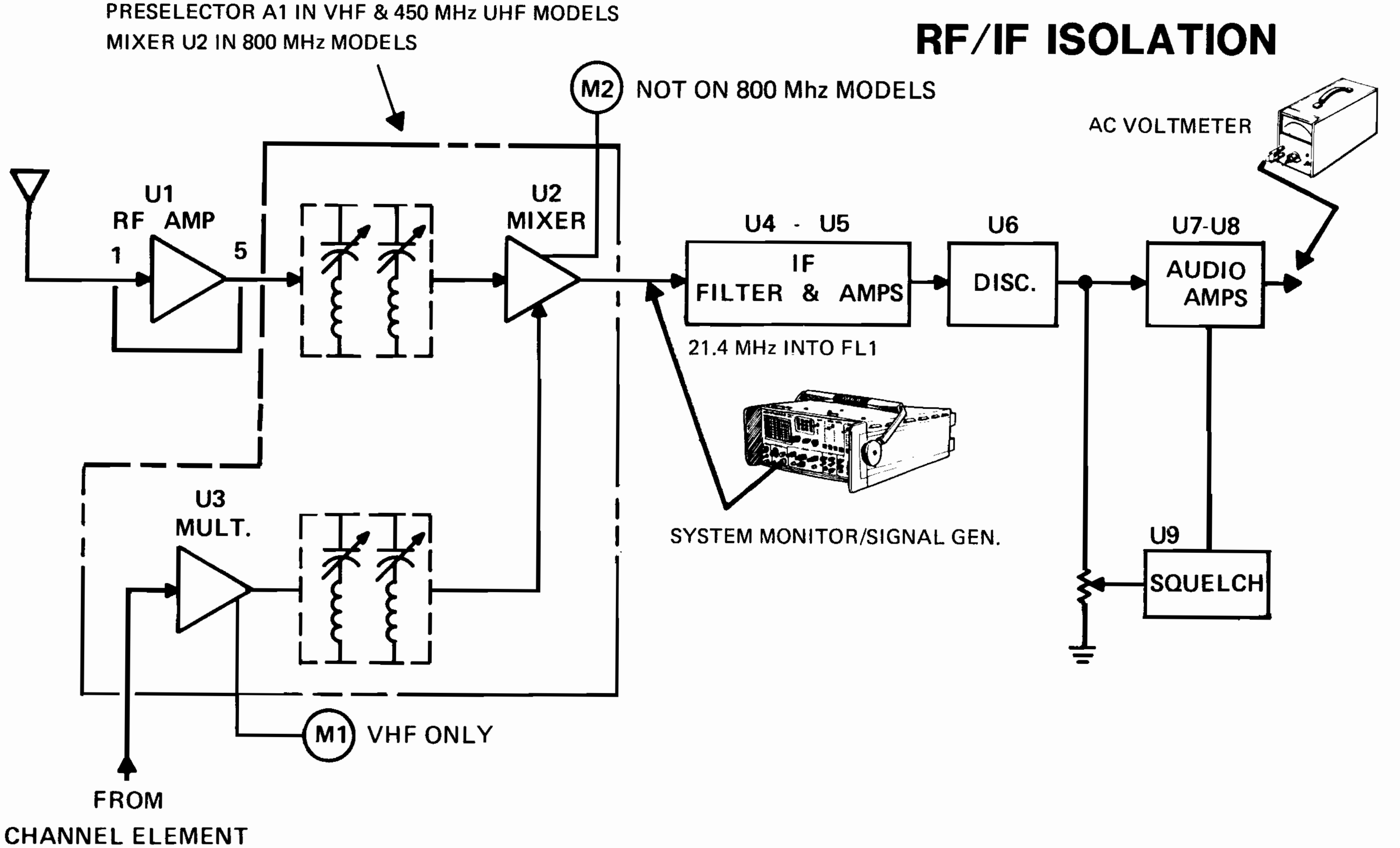
To perform a 12 dB quieting check, monitor the output of the discriminator. This can be accomplished with the RTX-4005A test set and RTK-4021A test set cable. With the AC meter connected to the AC/DC metering posts on the test set and no signal injected, the idle noise should be between 250 mV and 400 mV (-10 dBm to -6 dBm). With a service monitor or signal generator, inject an on carrier signal into J401, the side connector RF jack. Increase the RF level until the AC meter indicates a noise quieting of 12 dB. This should occur by .5 uV or less.

If the noise does quiet by 12 dB, the problem will be located past the discriminator, in the audio stages. If 12 dB quieting cannot be reached by .5 uV or less, further troubleshooting is indicated in this area of the radio. To further isolate this area, the following test, called the RF/IF isolation test, will split the previous stages in half.



CONDITION	SERVICE MONITOR	DISCR OUTPUT
NOISE	NO SIGNAL	250 mV TO 400 mV -10 dBm TO -6 dBm
CARRIER INJECTED	.5 uV OR LESS	60 mV TO 100 mV -22 dBm TO -18 dBm

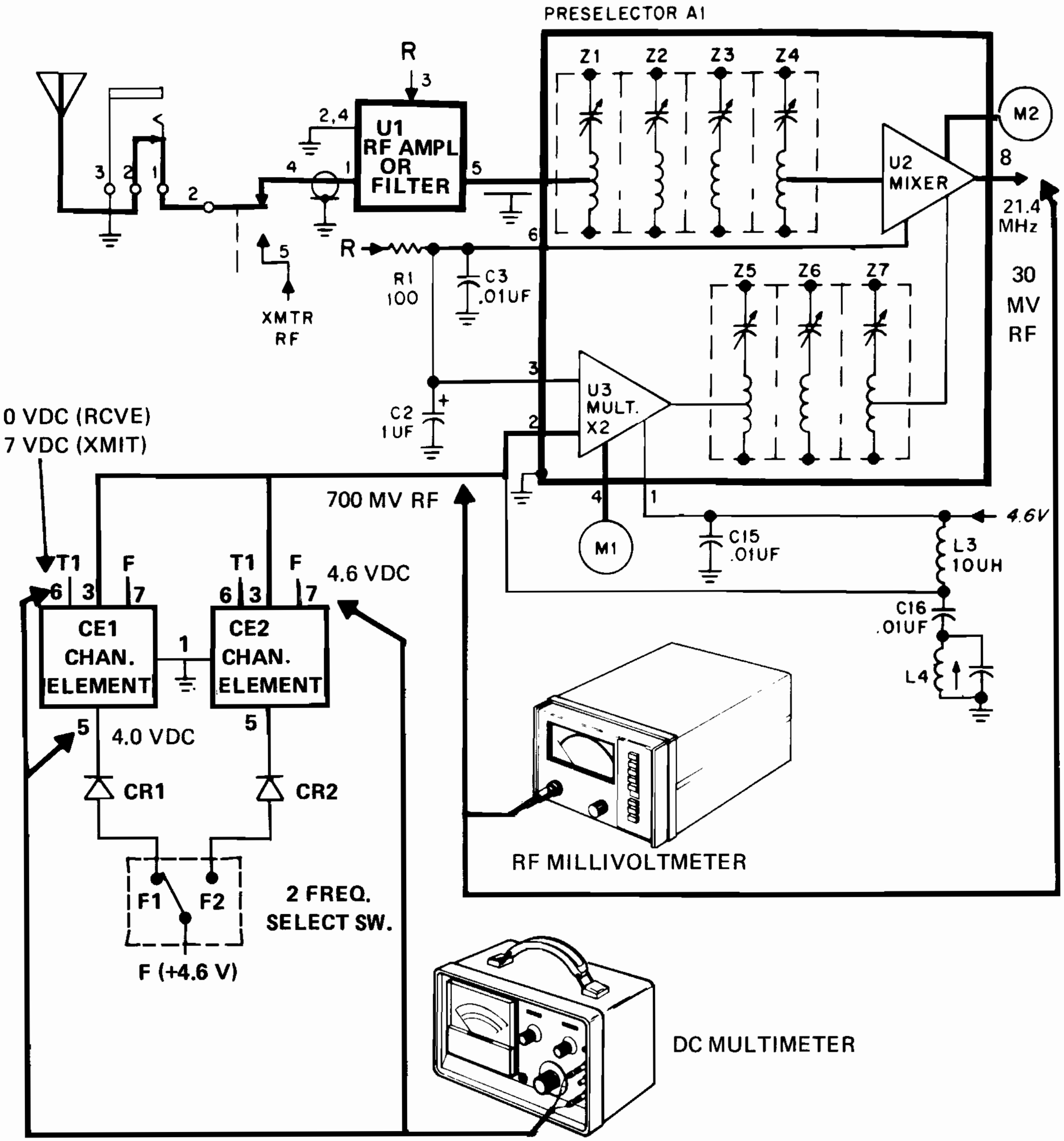
RF/IF ISOLATION



This test will show the technician whether the problem area lies in the RF section or the IF amplifier section. Using a TEK-10 probe, inject a 21.4 MHz signal into the first IF filter, FL1.

While monitoring the audio output with the AC voltmeter, increase the output level of the signal generator. The audio noise level at the output should decrease by 15 - 20 dB. If the noise level does quiet by that amount, that indicates that the IF amplifiers, crystal filters, and discriminator circuitry are operating properly, and the problem lies in the RF amp/preselector modules and associated circuitry.

These two checks, "12 dB Quieting," and "RF/IF Isolation," will be used to split the receiver in half and allow the technician to locate a problem faster. The next set of tests will be used to further isolate the faulty module or component.



RECEIVER
FRONT END TROUBLESHOOTING

If, by performing the RF/IF isolation check, the problem appears to be located in the RF section, further checks should be taken in this area.

The following three diagrams will show the Technician the points to check while working on the VHF or UHF front end.

VHF FRONT END

No quieting or high quieting may indicate a problem with the RF amplifier, U1, preselector A1, or the channel element injection.

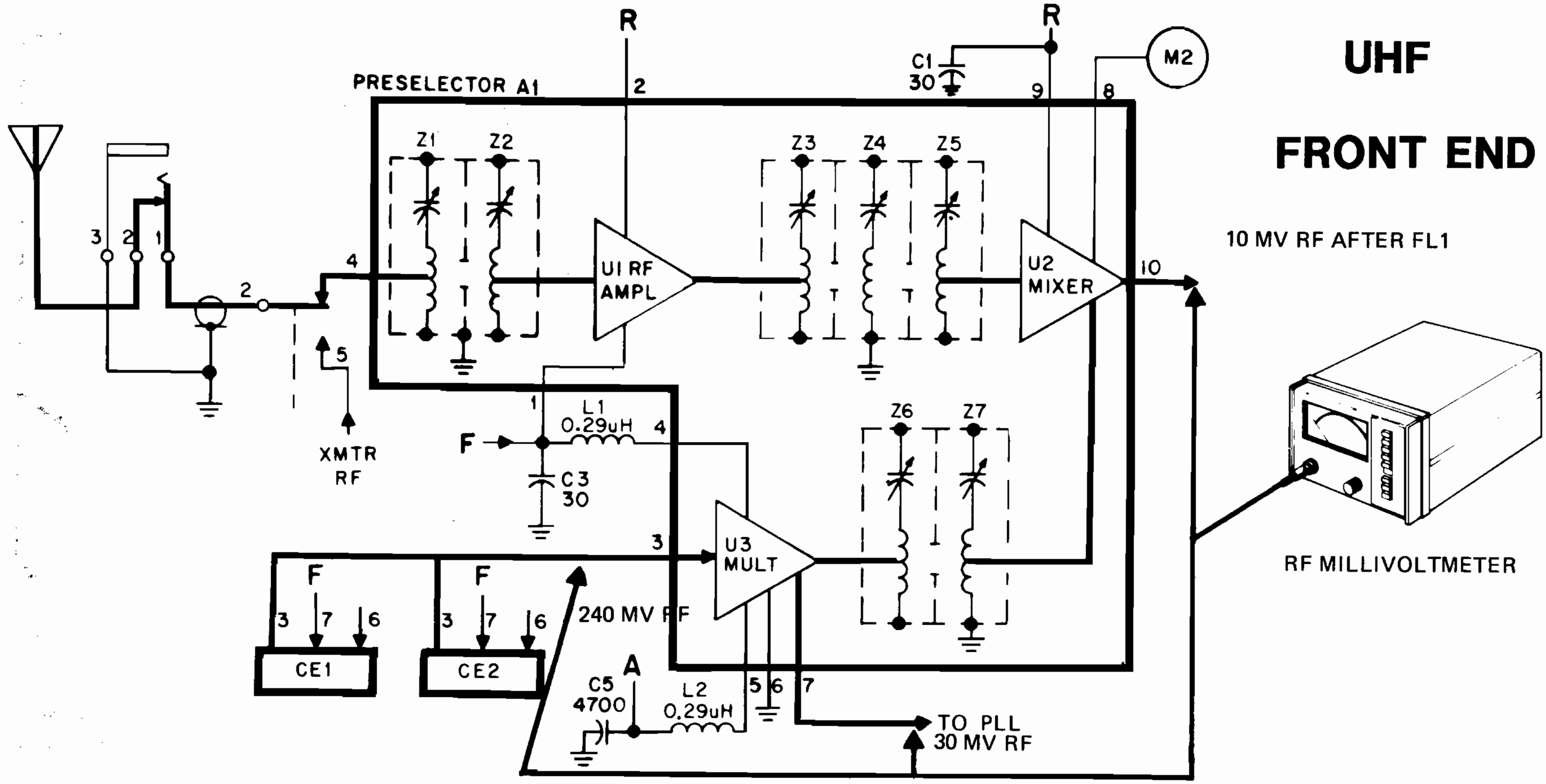
Using a sensitive RF millivoltmeter, measure the channel injection of CE1 and CE2. At pin 2 of the preselector minimum channel element injection will be 240 millivolts, normal level is 700 millivolts. No indication here will lead the Technician back to reading DC voltages around the channel elements. Pin 5 should be approximately 4.0 V when the frequency select switch is on that channel. Pin 7 will be 4.6 volts and pin 6 will be 0 volts when the unit is in receive, and 7.0 volts when in transmit. Once the injection signal enters the preselector module, the only other check will be the output of the preselector at pin 8. Using an RF millivoltmeter and a standard signal input, this level is normally approximately 30 millivolts.

The easiest way to detect a problem in the preselector is by trying to tune the cavities, Z1 through Z7. If, when adjusting the cavities, sloppy peaks are noticed, chances are the preselector is bad and should be replaced. Sloppy peaks are indicated by slow peaks on the meter (or no peaks, for that matter), or a dip and then a peak. Before replacing the preselector, check all the supply voltages around the preselector.

NOTE:

Be aware that although module pins located on the back of the printed circuit board are protected internally against shorts to ground, there are three points where caution must be exercised. When taking measurements, be careful not to short M1, M2, or the output of the preselector to ground. This can cause the fuse to blow, or worse yet, the module to short out.

UHF FRONT END



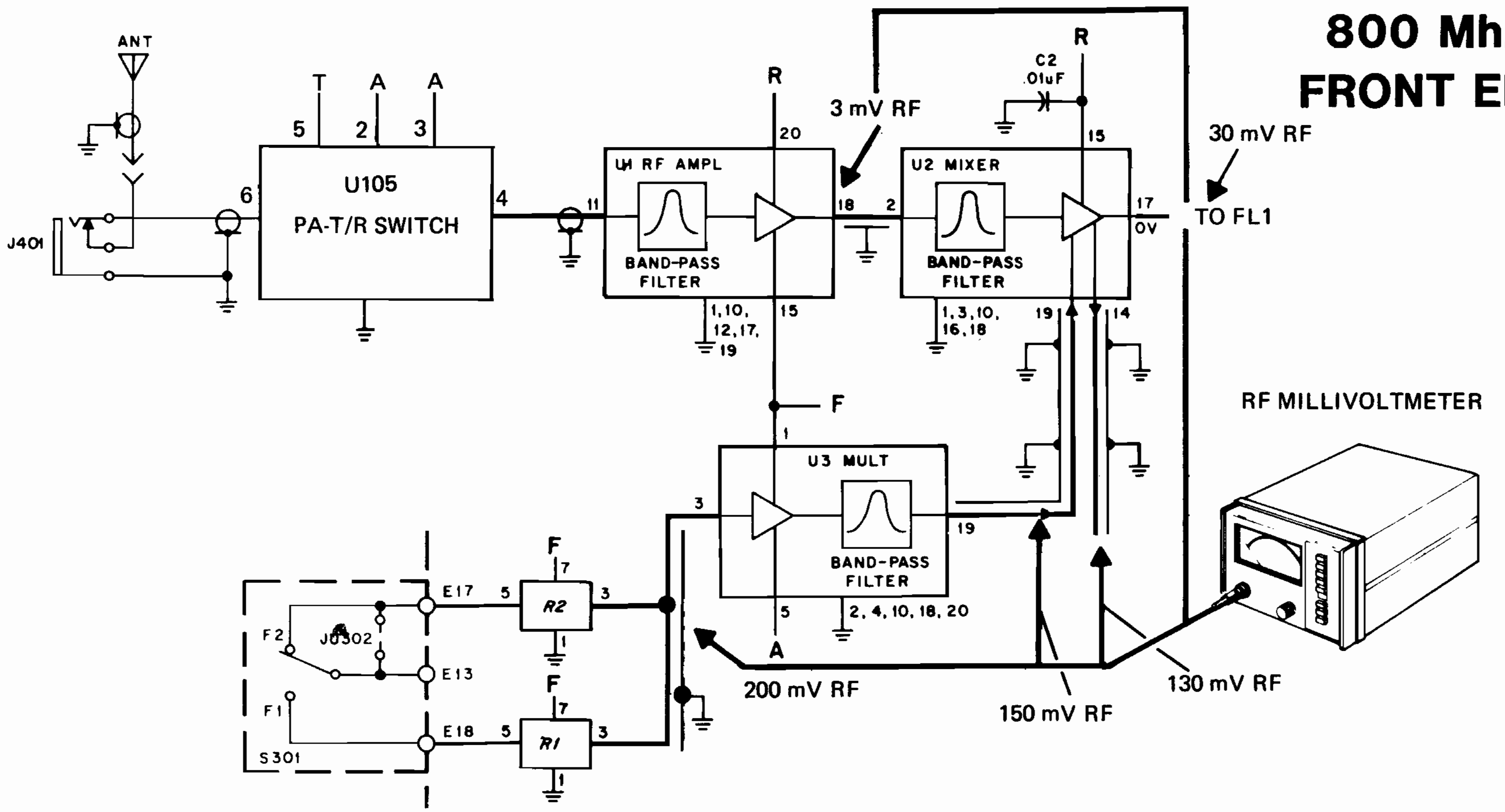
As with the VHF receiver, troubleshooting the UHF front end will require the use of a sensitive RF millivoltmeter. This will enable the technician to take RF levels around the preselector.

No quieting at all can easily indicate a problem with the injection from the channel element. A level of 240 millivolts RF is the minimum signal that should be seen at Pin 3 of preselector A1. If no level is seen there, then a check of the DC levels around the selected channel element with a multimeter is in order. To determine if U3, the multiplier is operating, a good check would be to check the level at Pin 7 of U3. This level should be approximately 30 millivolts RF. Following that check, the only other check one should take would be to check Pin 3 of the 1st IF XTAL filter, FL1. With a frequency counter, 21.4 MHz should be seen. An RF millivoltmeter will indicate approximately 10 millivolts.

Keep in mind that a trouble in the 450 MHz UHF preselector can cause a no transmit, good receive problem. This is due to the fact that an additional amplifier in the multiplier, U3 is turned on during transmit, allowing a higher level of signal to the phase lock loop module, U102. This level is approximately 200 mV RF and will be mentioned again when transmitter troubleshooting is discussed.

Besides these checks, the same indications that were observed in the VHF should be looked for here. Items such as sloppy peaks, no peaks, intermittent output can all point to a bad preselector, which will then require the replacement of the bad module. Before doing that, however, always check the supply voltages around the preselector.

800 Mhz FRONT END



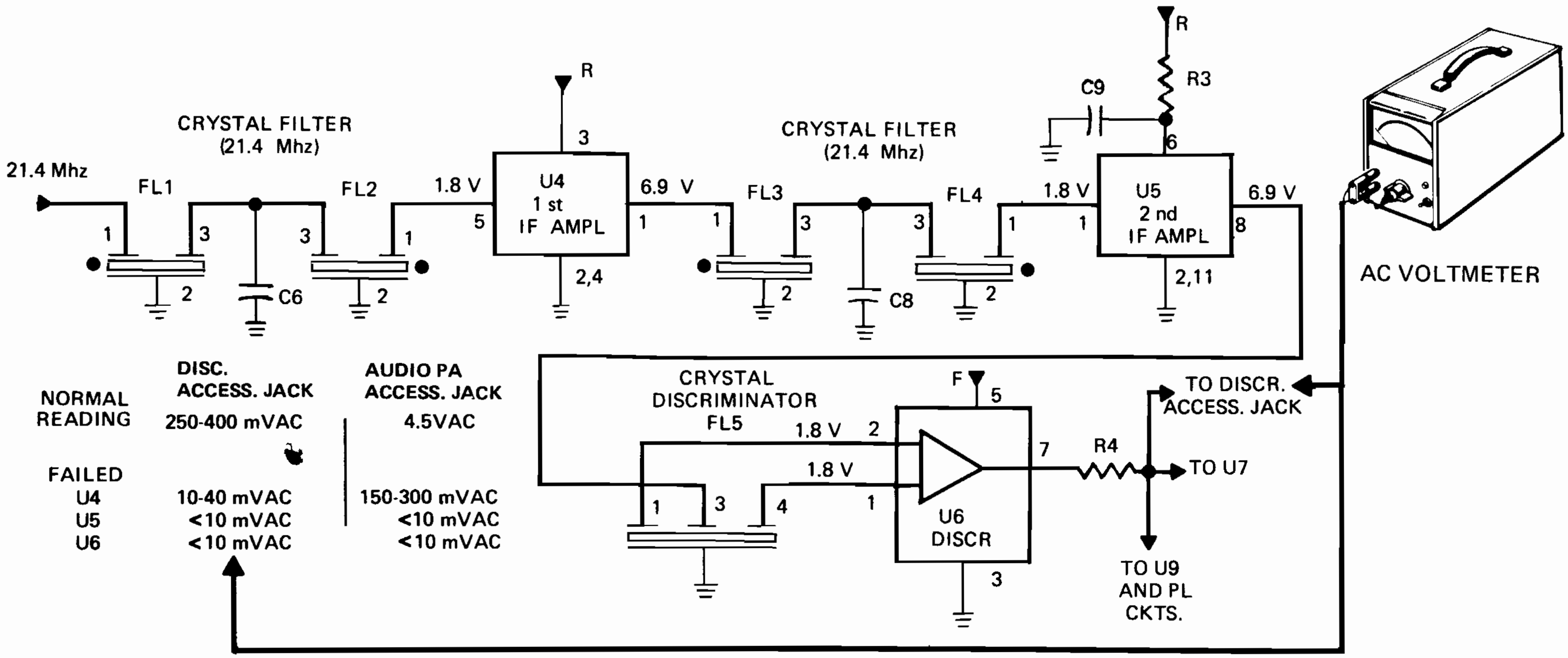
The 800 MHz front end has no preselector. All the modules are tuned wide enough to accept the frequency limits.

When checking the 800 MHz front end, consideration must be given to the test equipment used. Make sure that the RF millivoltmeter being used will respond to this frequency range. The Motorola S1339A RF millivoltmeter was used for these readings and will respond to these frequencies.

A 200 millivolt RF reading on the output (Pin 3) of the channel elements is normal. At the output of the multiplier (U3), Pin 19, a level of approximately 150 millivolts is typical. If these levels are not present, or low, a check of the DC voltages around the module should be made. With a standard signal input at the antenna, a level of 3 millivolts RF will be present at Pin 2 of U2. Thirty (30) millivolts RF at 21.4 MHz should be the signal at Pin 17, U2.

Low or no signals at these points would indicate a faulty module. DC voltages around the modules should be checked first with a multimeter.

IF/DISCRIMINATOR STAGES



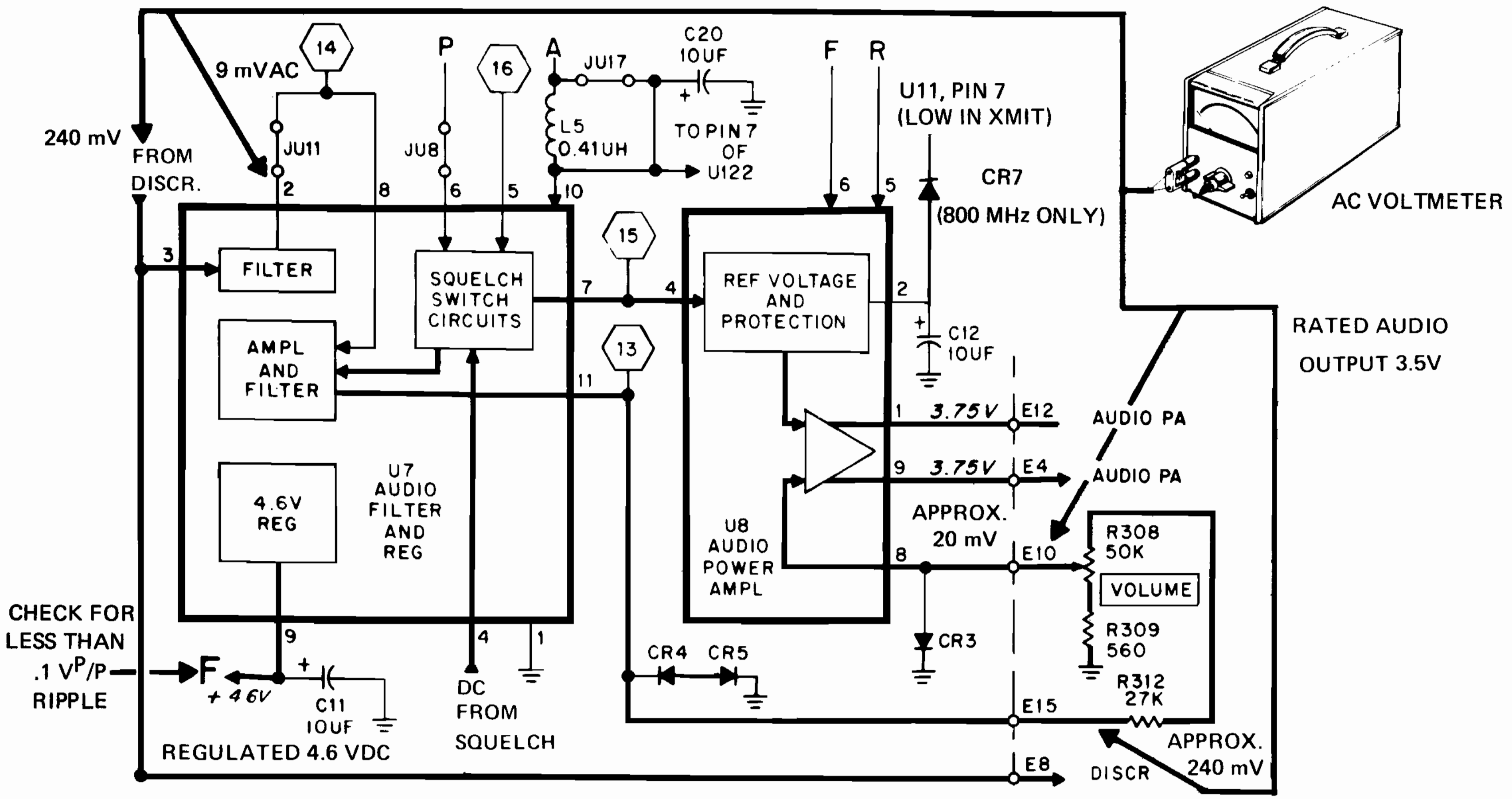
	DISC. ACCESS. JACK	AUDIO PA ACCESS. JACK
NORMAL READING	250-400 mVAC	4.5VAC
FAILED		
U4	10-40 mVAC	150-300 mVAC
U5	<10 mVAC	<10 mVAC
U6	<10 mVAC	<10 mVAC

If a problem is indicated in the IF stages, the proper way to troubleshoot these stages is by using idle noise gain measurements. Each module will generate its own inherent noise and also amplify the noise at its input. By knowing the noise levels, the receiver's IF strip can be easily analyzed.

Referring to the chart shown above, the normal noise level at the discriminator output is 250 - 400 mV AC. Depending upon what stage is faulty, the noise level will be decreased. For instance, if U4, the first IF amp, failed, the audio noise level at the discriminator output would decrease to 10 to 40 mV AC. This indicates that the noise being generated prior to U4 is not getting through U4. One very important consideration is that the crystal filters can also give the same indication as U4. The maximum loss of signal from the input of FL1 to the output of FL2 is 2 dB to 4 dB; any more indicates a bad crystal filter and both filters should be replaced. If U4 is suspect, remember to check the voltages on pins 5 and 1. If these voltages are not present, a check on the supply voltage would be in order. If supply voltages are present, U4 should be replaced.

The noise level table can also be used to isolate a faulty U5 or U6 module, as well as the filters around them. One thing to keep in mind when checking U7 is that the discriminator reading can be either less than 15 mV AC or 250 to 400 mV AC, depending upon where in U7 the problem lies (loading effect). A better way to localize U7 is to move the audio voltmeter to the audio output. This will show whether the problem lies in U7, U8, or prior to U6. Once a problem is located to U7, U8, or the squelch module, U9, audio measurements should be taken.

AUDIO AMPLIFIERS



AUDIO PREAMP-U7

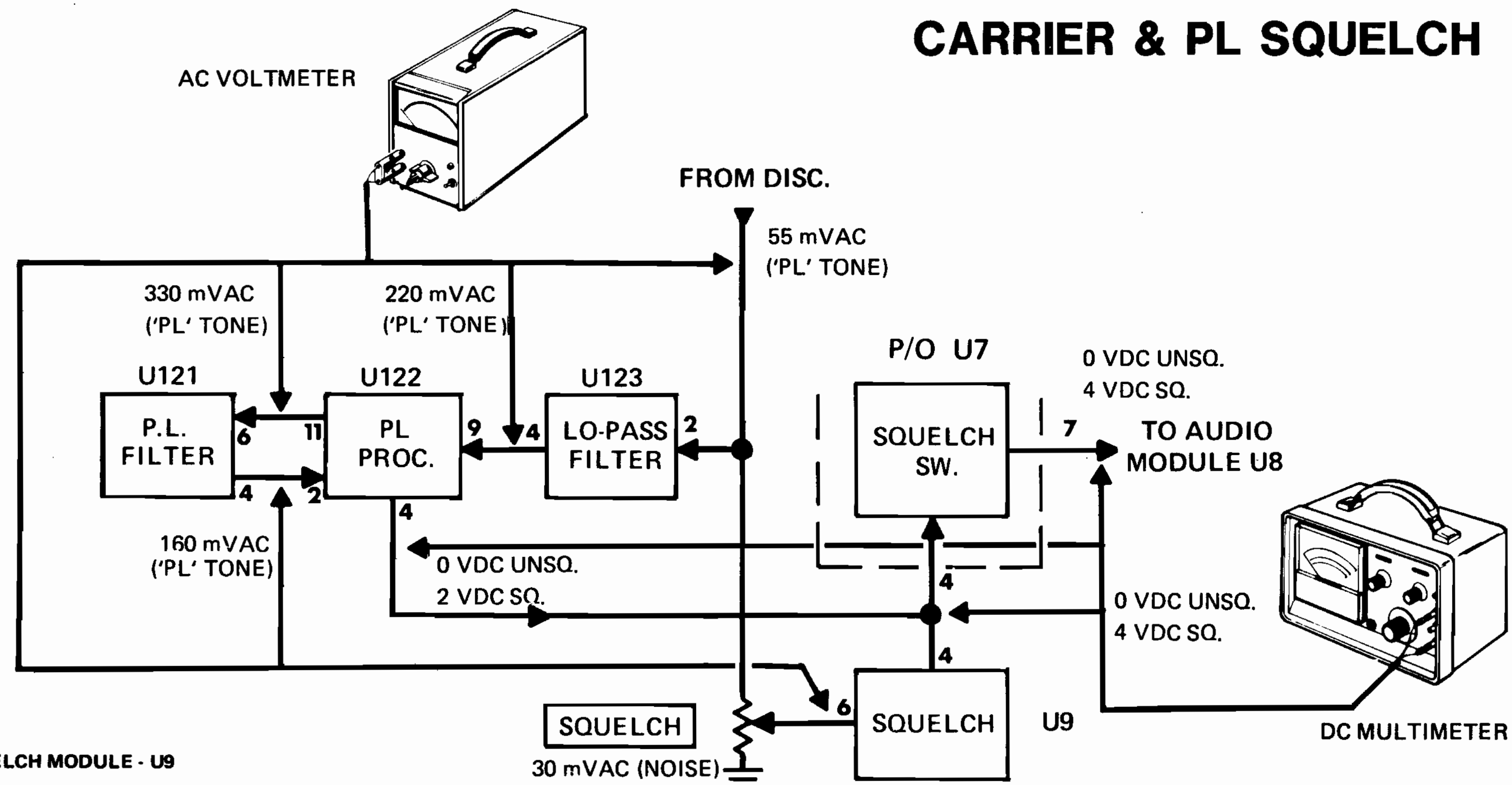
Audio and squelch circuit troubleshooting will require the use of an AC voltmeter or oscilloscope. If, by using the previous noise level chart, the problem is isolated to the audio circuits, then standard audio signal tracing is advised. Begin by injecting a standard signal input at the antenna. That is, a 1000 uv carrier modulated 3 KHz at 1000 Hz. Using an AC voltmeter, a level of approximately 240 mv should be read at Pin 3 of U7. At Pin 2, the level should now be 9 mVAC.

AUDIO POWER AMP-U8

The next measurement should be taken at Pin 11 of U7, where the level should now indicate approximately 240 mVAC. This signal will be present only if the squelch circuits are allowing the audio through. More troubleshooting on the squelch circuits will be covered in the next few pages.

Following Pin 11 of U7, the signal will now pass thru the volume control and be seen on Pin 8 of U8. The level on Pin 8 will be determined by the setting of the volume control. From Pin 8, the next level should be read with an AC voltmeter across the speaker terminals. A no signal indication would next lead the technician to Pins 1 and 9 of U8, where the level should be at 3.5 volts at maximum volume. A DC voltage of 3.75 volts will also be present when the radio is unsquelched. Any loss of these voltages will indicate a faulty U7 or U8 module. One additional check to be made in U7 if no audio is heard thru the speaker would be at Pin 9 of U7. Measure the ripple content of this voltage with an oscilloscope. It should be less than .1 volt P/P. Anymore than this level, the squelch module detects this as noise and locks up the squelch circuits.

CARRIER & PL SQUELCH



SQUELCH MODULE - U9

In order for the audio circuits to allow audio thru, Pin 4 of U7 should indicate 0 volts DC. This will cause the squelch switch in U7 (at Pin 7) to also drop down to 0 VDC.

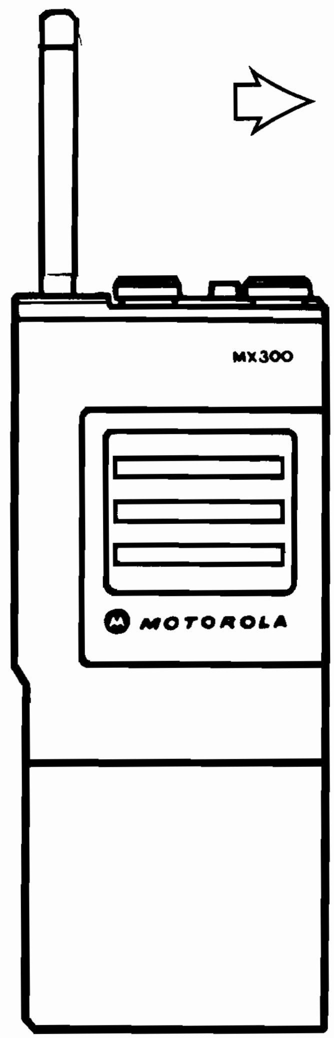
If a carrier squelch problem is suspected, one of the first checks to make would be Pin 6 of U9, the squelch module. Using an AC voltmeter, the level at Pin 6 should be less than 30 mVAC of noise to open the squelch. This level is controlled by the squelch potentiometer. By varying the level around 30 mVAC, Pin 4 of U9 should change from 0 VDC to open the audio to 4 VDC to lock up the audio. If this does not occur, then U9 should be replaced.

TONE PL MODULES

A PL squelch problem will usually be indicated by a level of 2 VDC at Pin 4 of U7. This indicates that the PL processor, U122, is turning on the squelch switch in U7, thus turning off the audio circuits. To isolate a faulty module, begin by injecting the standard signal with PL tone of the proper frequency into the radio. As the figure above shows, a level of 55 millivolts AC should be present at the input to U123; moving the AC voltmeter to Pin 4 of U123, the level should now be 220 mVAC of PL tone. The input to the active filter, Pin 6 of U121 should be 330 mVAC and its output at Pin 4 will be 160 mVAC. Once that signal has been detected by U122, the output at Pin 4 should drop to 0 volts DC. That will turn on the squelch switch in U7 to pass the audio.

DPL squelch checks can be found in MOTOROLA'S "TECHNICIAN INFORMATION BULLETIN." TT-500. This publication is available from Motorola Literature Distribution in Schaumburg, Illinois.

VI. TRANSMITTER TROUBLESHOOTING



VHF/UHF TRANSMITTER TROUBLESHOOTING

Troubleshooting a faulty transmitter will require the use of a low multi-scale (0-1, 0-3 amps) ammeter, as used in the Motorola S1347B power supply. The reason for this is because most of the transmitter modules operate class C and will not be turned on unless there is a signal input. Thus, the current that is drawn by the radio will give the technician information as to what modules are turned on and what modules are not. The diagram below reflects the proper current drawn by the radio for the preceding stages, but not the stage indicated by the arrow. For an example, if after keying either a VHF or UHF radio, the power supply current meter shows that the radio is drawing less than 200 mA, then that indicates the class C stages are not getting a signal, and U103 is not producing an output. One should begin troubleshooting with the channel element, IDC module or phase locked loop circuitry.

Keep in mind that the current readings on the following page indicate the sum current drawn by the preceeding stages. The arrow indicates where one should begin troubleshooting.

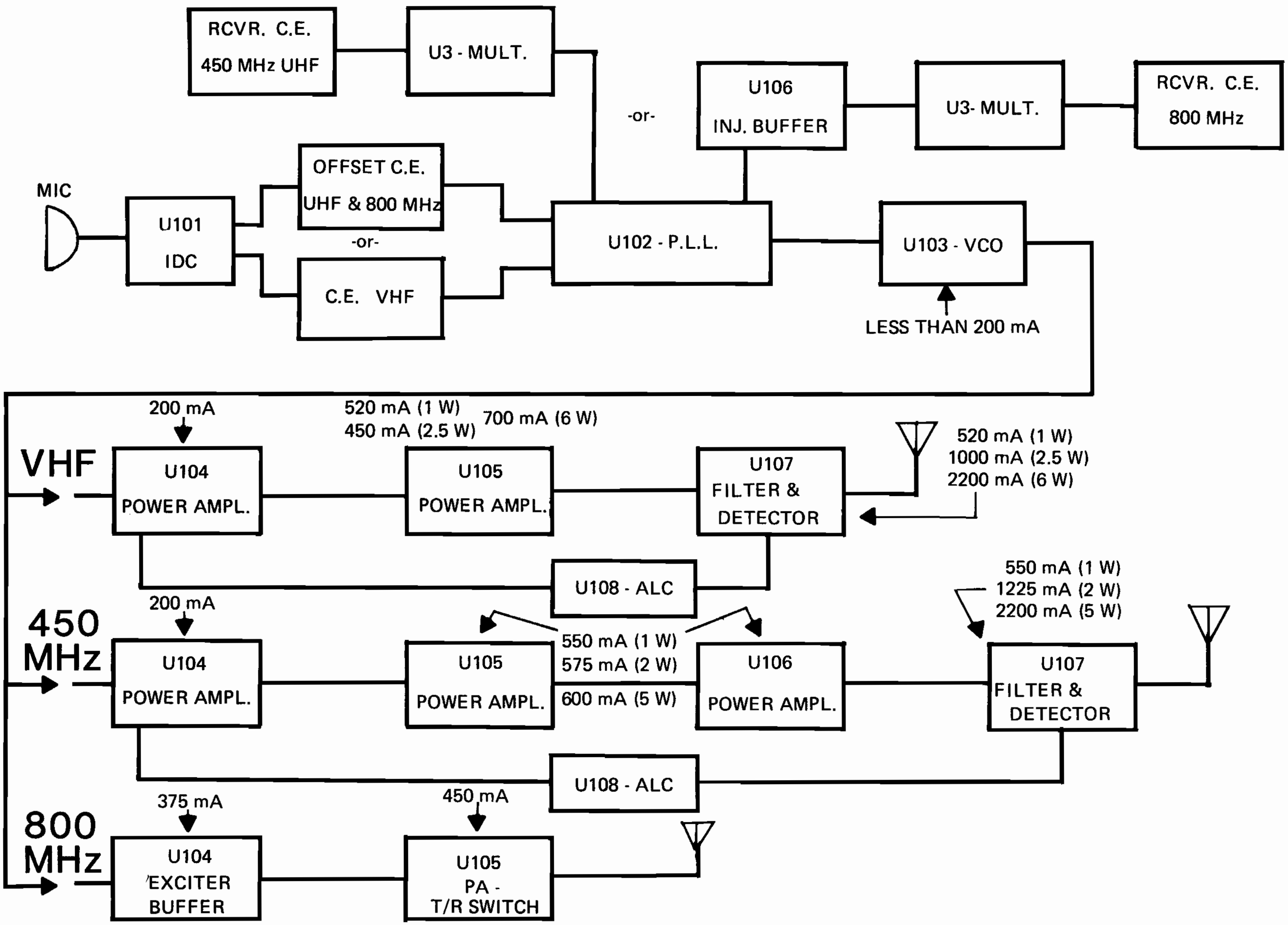
If, after keying the transmitter, the radio draws full rated current, begin troubleshooting the RF line from the PA output to the antenna.

NOTE

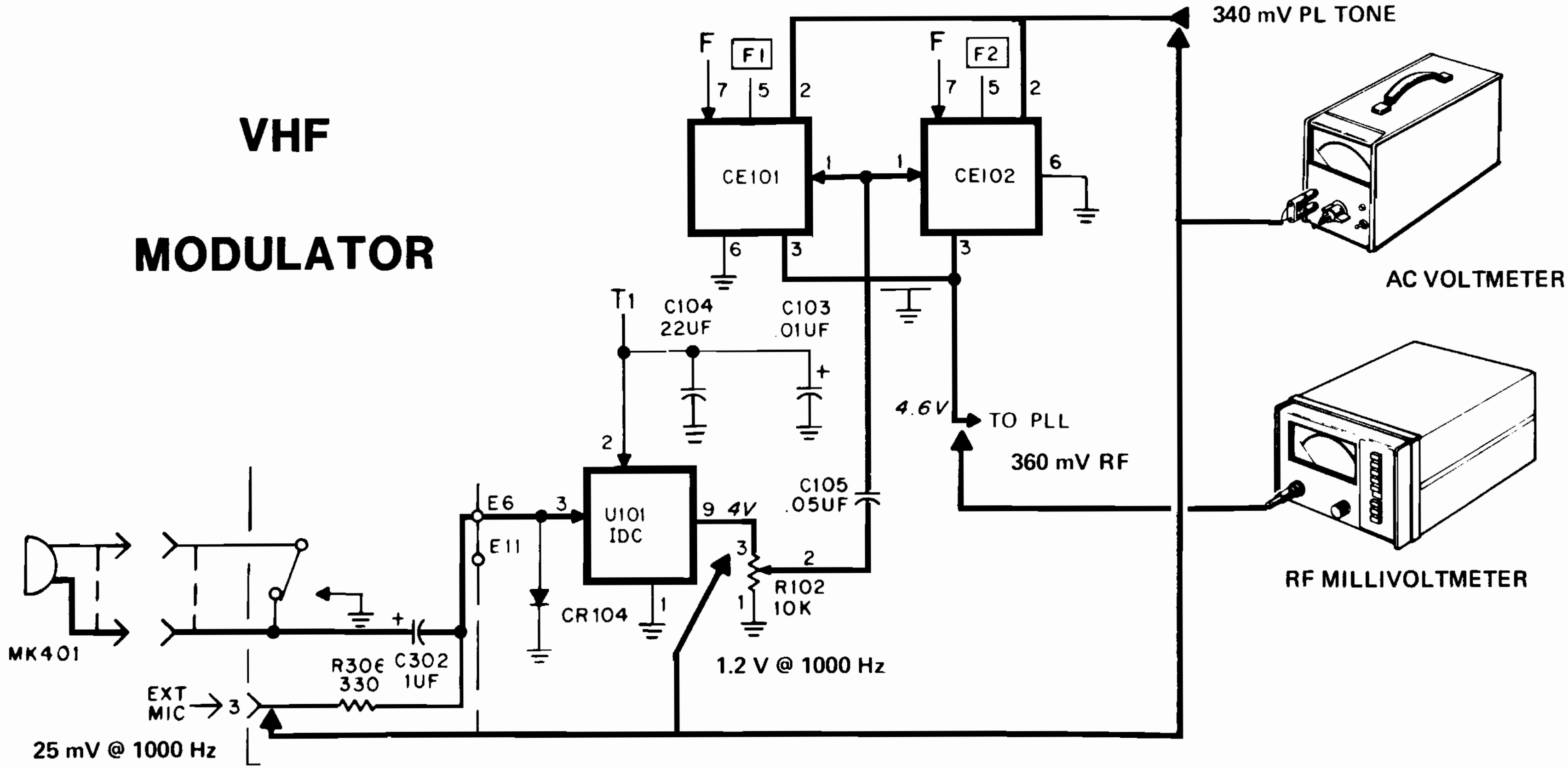
The following table is a list of all modules, relays & indicators not mentioned in the diagram on the following page. As it is nearly impossible to connect an ammeter in series with a module in the MX300 radio, this table is provided for information purposes only.

COMPONENT/MODULE	APPROXIMATE CURRENT DRAWN
K101 (VHF & 450 MHz UHF)	40 mA
U11 (800 MHz)	30 mA
TRANSMIT LED	15 mA
IDC (U101) MODULE	10 mA
CHANNEL ELEMENT	6 mA
VCO (U103) - VHF	43 mA
VCO (450 MHz) UHF	70 mA
VCO (800 MHz) UHF	195 mA
P.L.L. (U102) VHF, UHF	60-70 mA
(800 MHz) UHF	50 mA

VHF/UHF TRANSMITTER TROUBLESHOOTING



VHF MODULATOR



Once a problem has been diagnosed to the audio stages by using current checks, then troubleshooting in the modulator stages is warranted.

An additional symptom that would indicate audio troubleshooting is necessary would be a condition where the radio meets power output and frequency limits, but no (or low) audio can be processed thru to the antenna.

IDC MODULE – U101

To begin with, the first place to check would be the microphone. Using the RTX-4005 test set, place the meter selector switch to "MIC," and hook up the AC voltmeter to the "AC/DC MTR" binding post. Now, with the radio keyed with the PTT switch ON THE RADIO, and either whistling or a loud "FOUR" should produce an indication of 25 millivolts minimum on the meter. If not, then the wiring should be checked, and finally, the microphone replaced.

With the microphone checked and working, the next step would be to inject a 1000 Hz tone at a level of 25 millivolts AC into the "EXTERNAL MIC" input at the accessory jack.

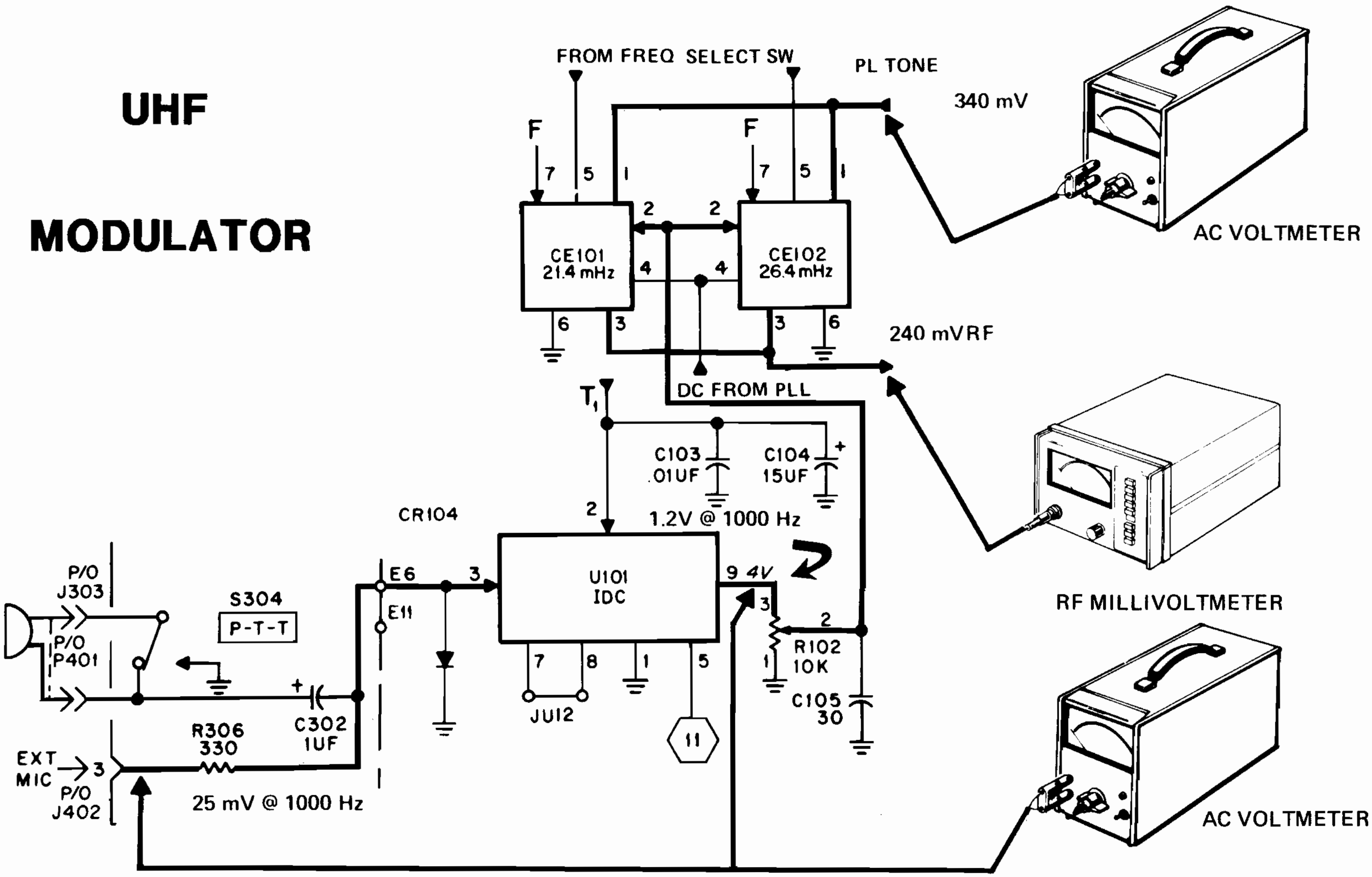
NOTE

When injecting the 1000 Hz tone, put the audio tone in on the "AUDIO IN" jacks and measure the level at the AC/DC metering jacks. Failure to do this will result in a much higher level going into the radio and cause over modulation.

Continued on UHF modulator schematic

UHF

MODULATOR



With the radio keyed, the level at Pin 9 of U101 should be approximately 1.2 VAC at 1000 Hz. If an oscilloscope is used, then a waveform that's into clipping will be observed. The level at Pin 1 (VHF radios) or Pin 2 (UHF radios) of the channel elements should be able to be varied by adjusting the IDC control, R102, from 0 to 1.7 VAC. While making these checks, also check Pin 2 (VHF radios) or Pin 1 (UHF radios) of the channel elements for the correct level of PL tone.

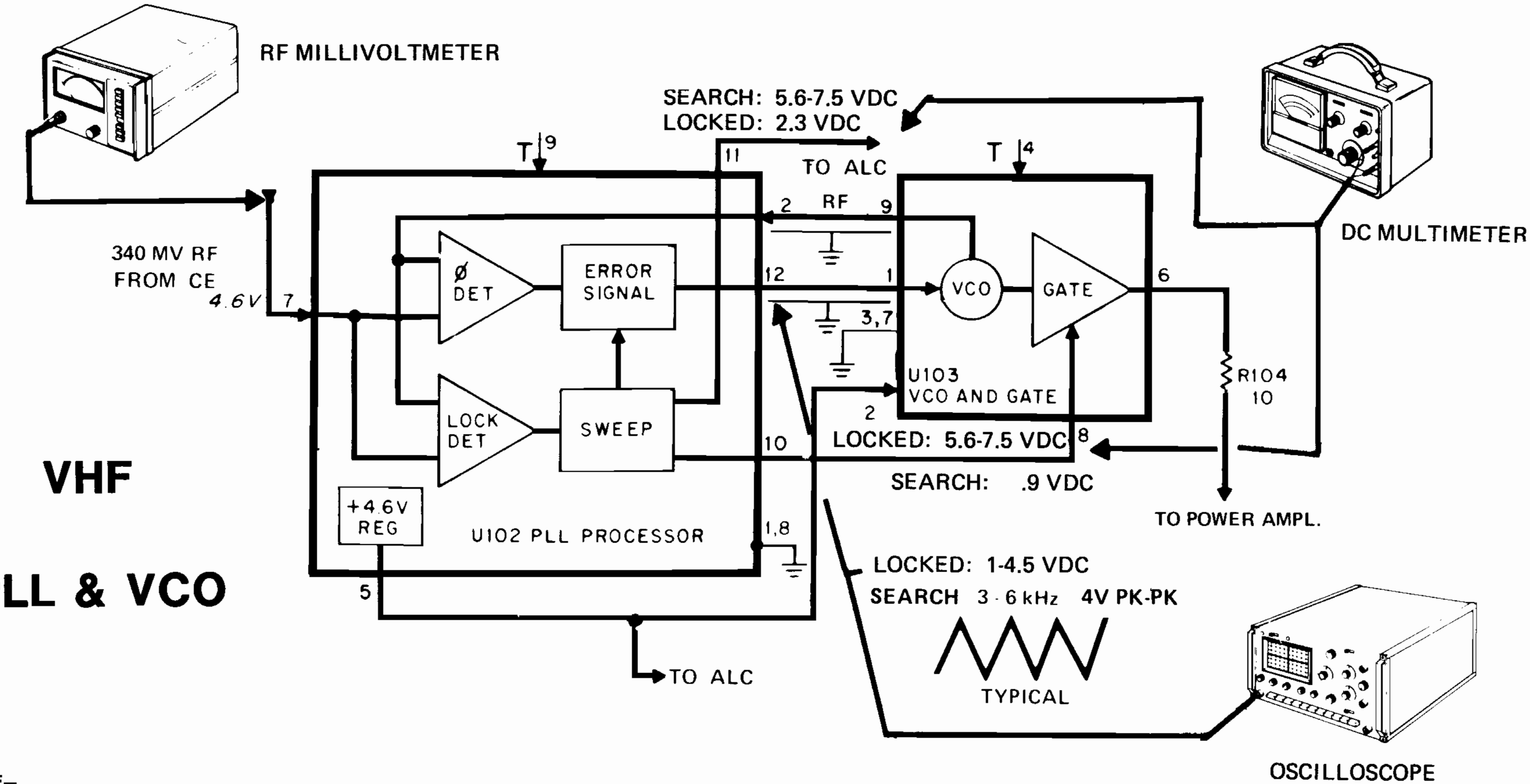
CHANNEL ELEMENT ACTIVITY –

Finally, with a RF millivoltmeter, the level at Pin 3 (VHF and UHF radios) should be 360 millivolts (VHF) or 240 millivolts (UHF). With a service monitor, Pin 3 (VHF) should indicate the channel element frequency at ±1.6 KHz deviation. On UHF radios, the offset frequency at ±5 KHz deviation will be observed.

If no signal or low signal is observed, then check the DC voltages around U101 and the channel elements. Finally, replacement would be warranted if all checks out okay, but still no output.

VHF

PLL & VCO



VHF–

When current measurements on the transmitter indicate that the phase locked loop (PLL) is not functioning properly, then troubleshooting U102 and U103 is required.

VCO MODULE - U103

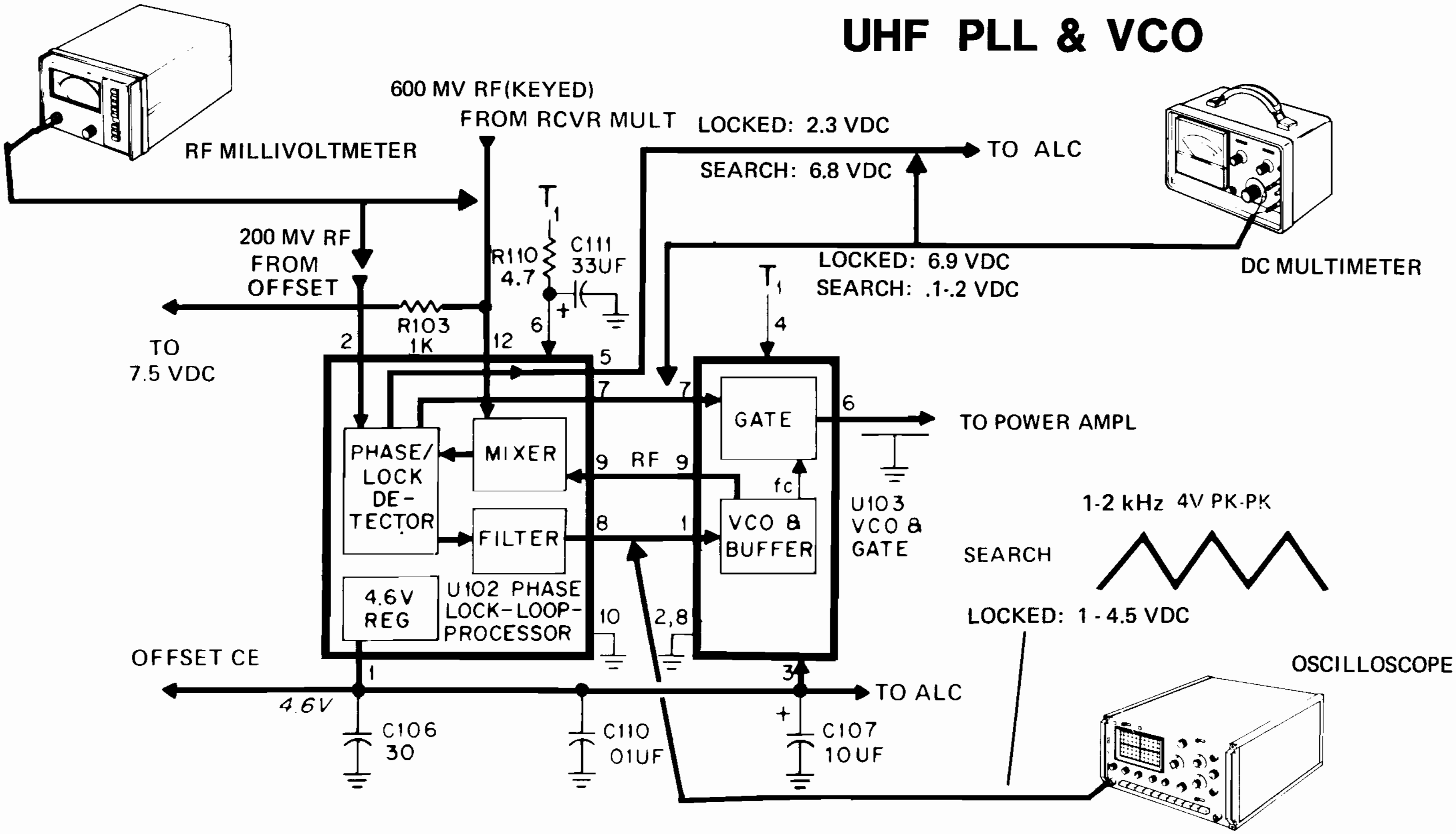
The first step would be to check Pin 1 of U103 with an oscilloscope. If the PLL is locked on frequency, a DC voltage will be present between 1 VDC and 4.5 VDC If, when using the oscilloscope, a sawtooth waveform of approximately 4 volts peak-to-peak is observed, then the PLL is not locking on frequency.

PLL PROCESSOR - U102

Two DC voltage checks can now be made. Measure Pin 11 and Pin 10 of U102 for the indicated voltages. If these voltages indicate a sweep mode, then the DC operating voltages should now be checked.

If the problem appears to be within U102 or U103, then U102 should be replaced, as this module contains most of the circuitry. If the sawtooth waveform is still present, then replace U103.

UHF PLL & VCO



The UHF Phase-Locked-Loop can be analyzed in a similar manner as the VHF circuitry.

To isolate the PLL circuitry, current measurements should be used. Once U102 and U103 is isolated, then readings with an RF millivoltmeter, DC multimeter or oscilloscope would be warranted.

VCO MODULE – U103

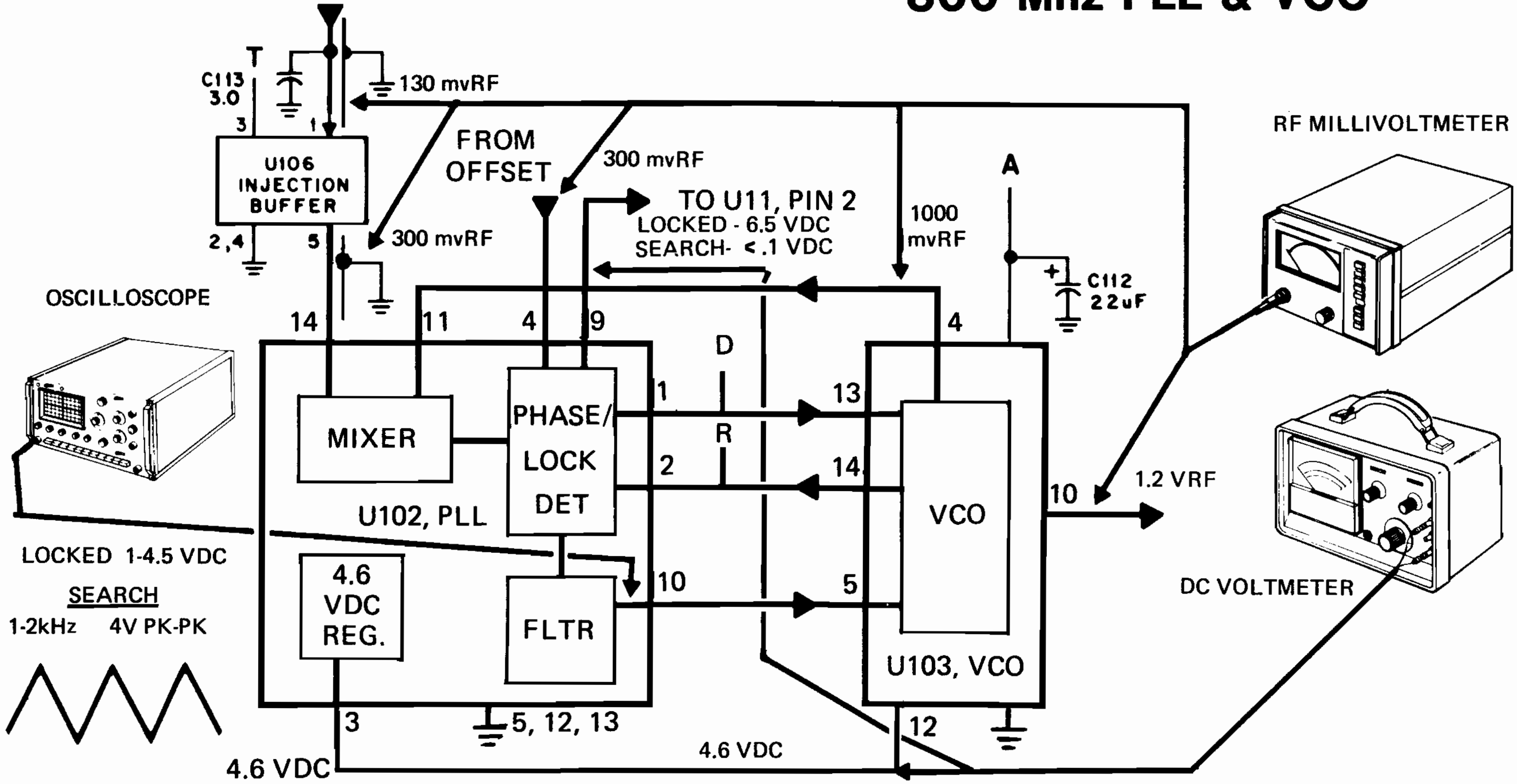
Checking pin 1 of U103 would be the first step. A normal reading of 1 to 4.5 VDC will indicate the PLL is locked on frequency. A sawtooth frequency, as seen with an oscilloscope, will indicate that the PLL is not locking on frequency.

PLL PROCESSOR – U102

If a sawtooth waveform is present at pin 1 of U103, two DC voltages, at pin 5 and pin 7 of U102 should be checked. Some recent radios no longer have a gate in U103, so the voltage at pin 7 will always indicate 6.9 VDC.

If the DC voltages indicate a search mode, then the input RF levels to U102 at pin 2 and 12 should be checked.
U102 should be replaced first as it contains most of the circuitry, and then U103 if U102 does not solve the problem.

800 Mhz PLL & VCO



The 800 MHz PLL circuitry is very similar, in operation, to the 450 MHz UHF phase-locked-loop. Troubleshooting this circuit will again require the use of a oscilloscope, DC voltmeter and RF millivoltmeter.

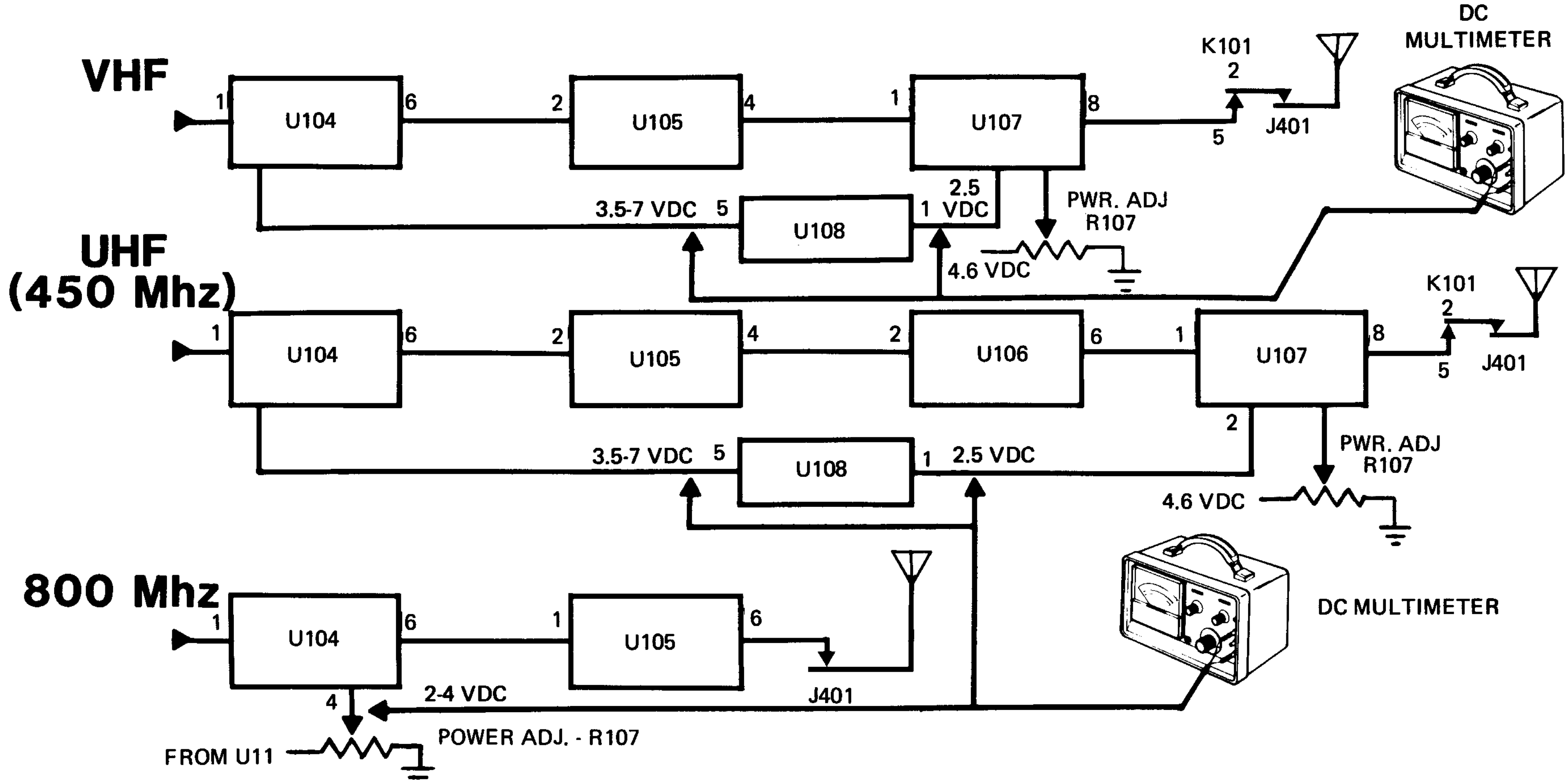
VCO MODULE – U103
Once a current measurement on the power supply localizes the VCO and PLL processor, then the first check would be to make a DC voltage reading on pin 5 of U103 for a DC voltage or a sweep voltage of 4 volts peak-to-peak. If, the VCO is in a sweep mode, then further checking in the phase-locked-loop, U102 will be necessary.

PLL PROCESSOR MODULE – U102
When checking this module, the first step would be at pin 14, for the correct RF level. Also, pin 4 should be approximately 300 mv RF. If these voltages are not present, DC voltages around U102 as well as U106 should be checked.

Finally, if replacement is warranted, change U102 first, as it contains most of the circuitry.

An added note - on pins 1 and 2 of U102, there is an "R" and "D" line. These lines go to the top of the radio and will switch 4.5 VDC to the PLL circuitry to allow a "REPEAT" or "DIRECT" mode of operation.

POWER AMPLIFIER STAGES



A low or no power indication may mean that the power amplifier stages are not working properly.

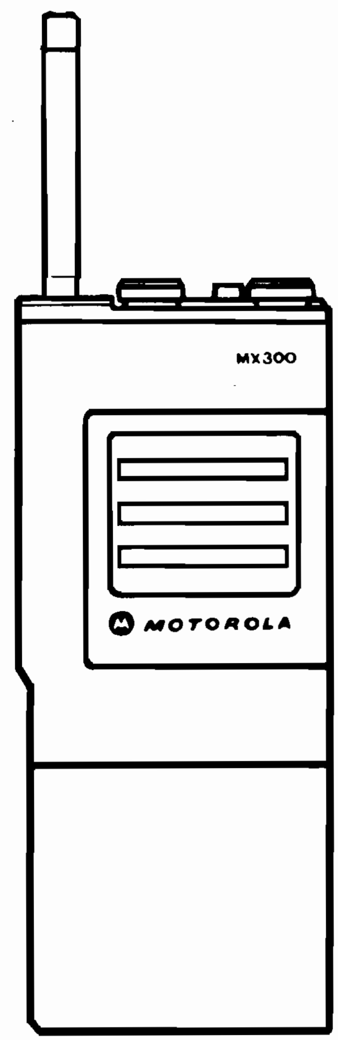
As the RF levels at the output of the RF stages are normally too high to be read on an RF millivoltmeter, the easiest way to troubleshoot these stages would be by using the current readings obtained on the power supply current meter and the DC voltage checks around the modules. Using the chart located at the front of this section, current readings can indicate which of the stages are faulty.

VHF and 450 MHz UHF Radios – One of the first checks to take if there is low or no power will be to measure the DC voltage at Pin 1 of U108, the ALC module. This voltage should be approximately 2.5 volts DC. The output of U108, Pin 5, should also vary from 3.5 VDC minimum to 7.0 VDC by varying the power control, R107. If the voltage at Pin 5 is within normal limits and there is still no output power, check the current drawn. If normal, then changing the filter module, U107, should correct the problem. Also, check the RF path thru the relay, K101 and the side connector, J401.

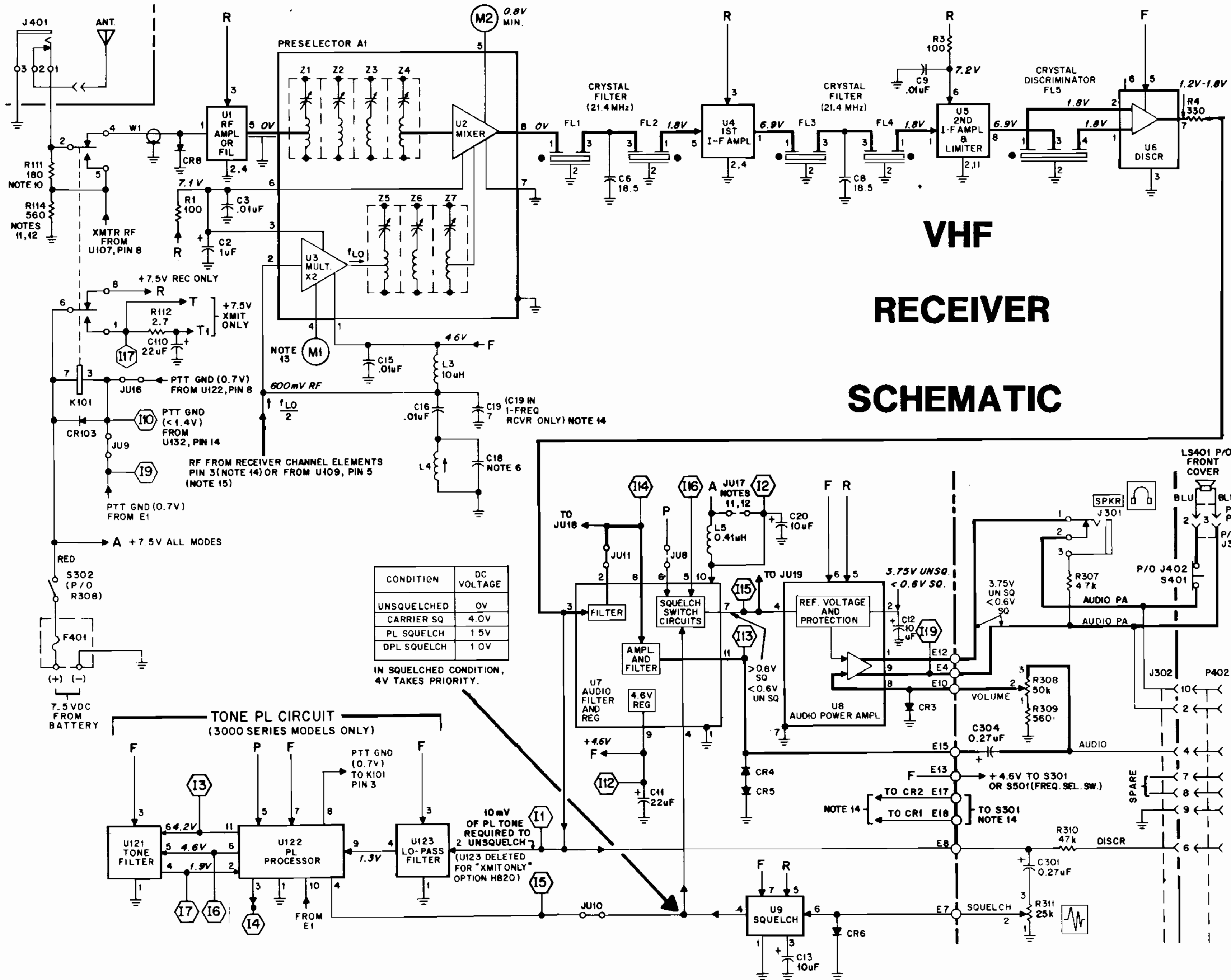
800 MHz Radios – When servicing an 800 MHz transmitter, the same procedure of current checks can be made. As there is only one power rating, 1 watt, there is no ALC module. The power adjust, R107 will adjust the conduction of an amplifier within U104 by varying the DC voltage at Pin 4 of that module. The DC voltages at Pin 4 should be able to be varied from approximately 4 volts DC (for maximum power) to 2 volts DC (for minimum power). Low or no voltage there would indicate a problem with the power adjust, R107, or the thermistor, RT101. If these check out okay, then the voltages around U11 should be checked and finally, U11 be replaced if the voltages are normal.

(Page 34 is blank)

VII. SCHEMATICS & OVERLAYS

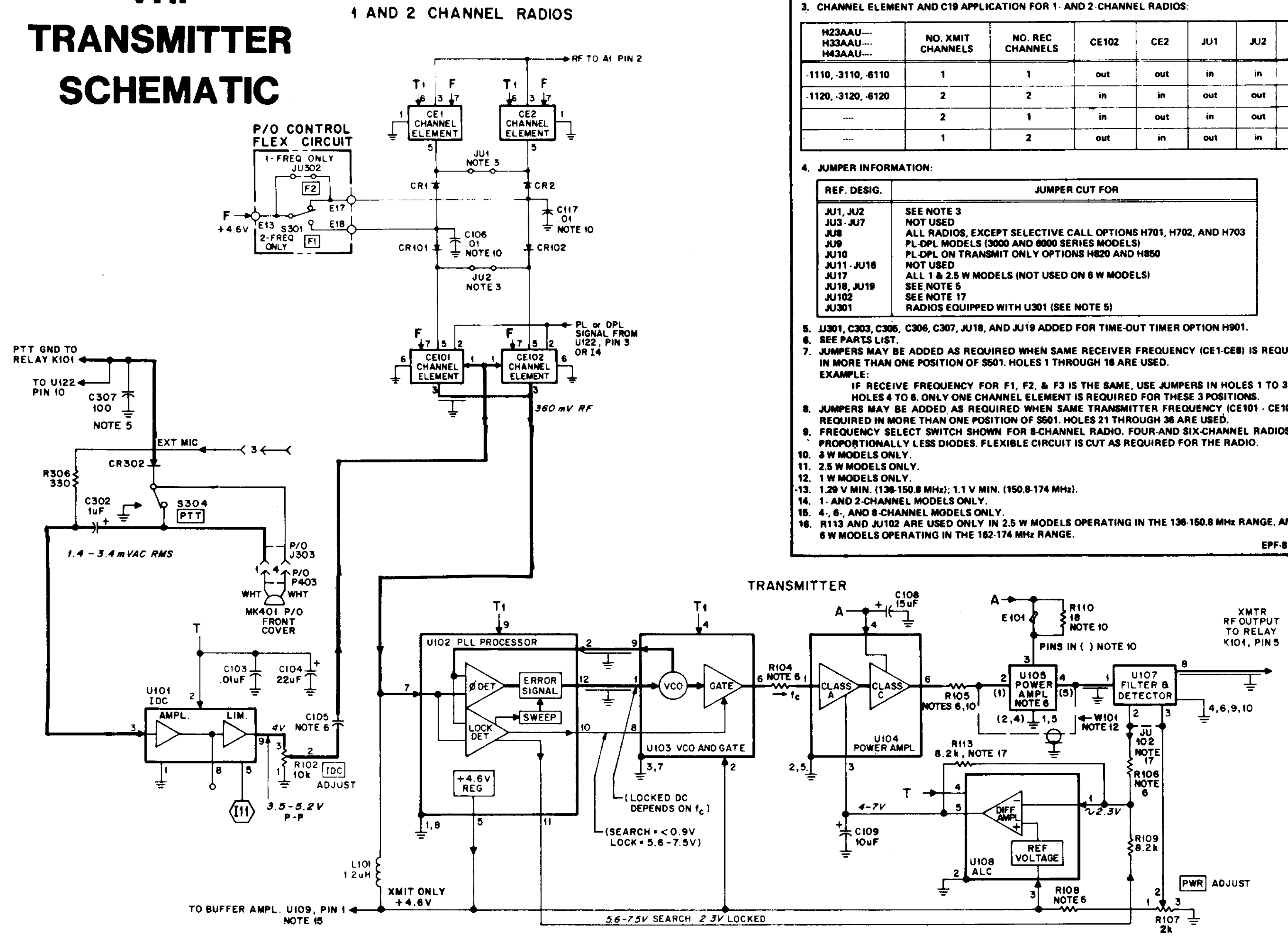


VHF RECEIVER SCHEMATIC



CONDITION	DC VOLTAGE
UNSQUELCHED	0V
CARRIER SQ	4.0V
PL SQUELCH	1.5V
DPL SQUELCH	1.0V

VHF TRANSMITTER SCHEMATIC



SCHEMATIC DIAGRAM NOTES:

1. ◯ INDICATES CONNECTION POINT TO INTERCONNECT FLEXIBLE CIRCUIT.
2. UNLESS OTHERWISE STATED, RESISTANCES ARE IN OHMS, CAPACITANCES ARE IN pF.
3. CHANNEL ELEMENT AND C19 APPLICATION FOR 1- AND 2-CHANNEL RADIOS:

H23AAU---- H33AAU---- H43AAU----	NO. XMIT CHANNELS	NO. REC CHANNELS	CE102	CE2	JU1	JU2	C19
-1110, -3110, -6110	1	1	out	out	in	in	in
-1120, -3120, -6120	2	2	in	in	out	out	out
....	2	1	in	out	in	out	in
....	1	2	out	in	out	in	out

4. JUMPER INFORMATION:

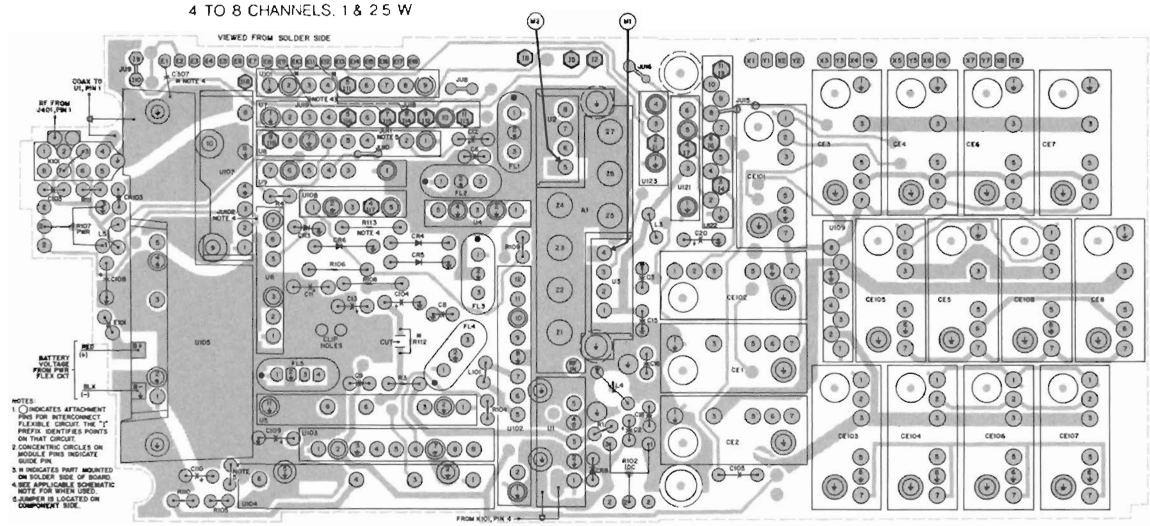
REF. DESIG.	JUMPER CUT FOR
JU1, JU2	SEE NOTE 3
JU3 - JU7	NOT USED
JU8	ALL RADIOS, EXCEPT SELECTIVE CALL OPTIONS H701, H702, AND H703
JU9	PL-DPL MODELS (3000 AND 6000 SERIES MODELS)
JU10	PL-DPL ON TRANSMIT ONLY OPTIONS H820 AND H850
JU11 - JU16	NOT USED
JU17	ALL 1 & 2.5 W MODELS (NOT USED ON 6 W MODELS)
JU18, JU19	SEE NOTE 5
JU102	SEE NOTE 17
JU301	RADIOS EQUIPPED WITH U301 (SEE NOTE 5)

5. U301, C303, C305, C306, C307, JU18, AND JU19 ADDED FOR TIME-OUT TIMER OPTION H901.
6. SEE PARTS LIST.
7. JUMPERS MAY BE ADDED AS REQUIRED WHEN SAME RECEIVER FREQUENCY (CE1-CE8) IS REQUIRED IN MORE THAN ONE POSITION OF S501. HOLES 1 THROUGH 16 ARE USED.
   EXAMPLE:
   IF RECEIVE FREQUENCY FOR F1, F2, & F3 IS THE SAME, USE JUMPERS IN HOLES 1 TO 3 AND HOLES 4 TO 6. ONLY ONE CHANNEL ELEMENT IS REQUIRED FOR THESE 3 POSITIONS.
8. JUMPERS MAY BE ADDED AS REQUIRED WHEN SAME TRANSMITTER FREQUENCY (CE101 - CE108) IS REQUIRED IN MORE THAN ONE POSITION OF S501. HOLES 21 THROUGH 36 ARE USED.
9. FREQUENCY SELECT SWITCH SHOWN FOR 8-CHANNEL RADIO. FOUR-AND SIX-CHANNEL RADIOS USE PROPORTIONALLY LESS DIODES. FLEXIBLE CIRCUIT IS CUT AS REQUIRED FOR THE RADIO.
10. 6 W MODELS ONLY.
11. 2.5 W MODELS ONLY.
12. 1 W MODELS ONLY.
13. 1.29 V MIN. (136-150.8 MHz); 1.1 V MIN. (150.8-174 MHz).
14. 1- AND 2-CHANNEL MODELS ONLY.
15. 4-, 6-, AND 8-CHANNEL MODELS ONLY.
16. R113 AND JU102 ARE USED ONLY IN 2.5 W MODELS OPERATING IN THE 136-150.8 MHz RANGE, AND IN 6 W MODELS OPERATING IN THE 162-174 MHz RANGE.

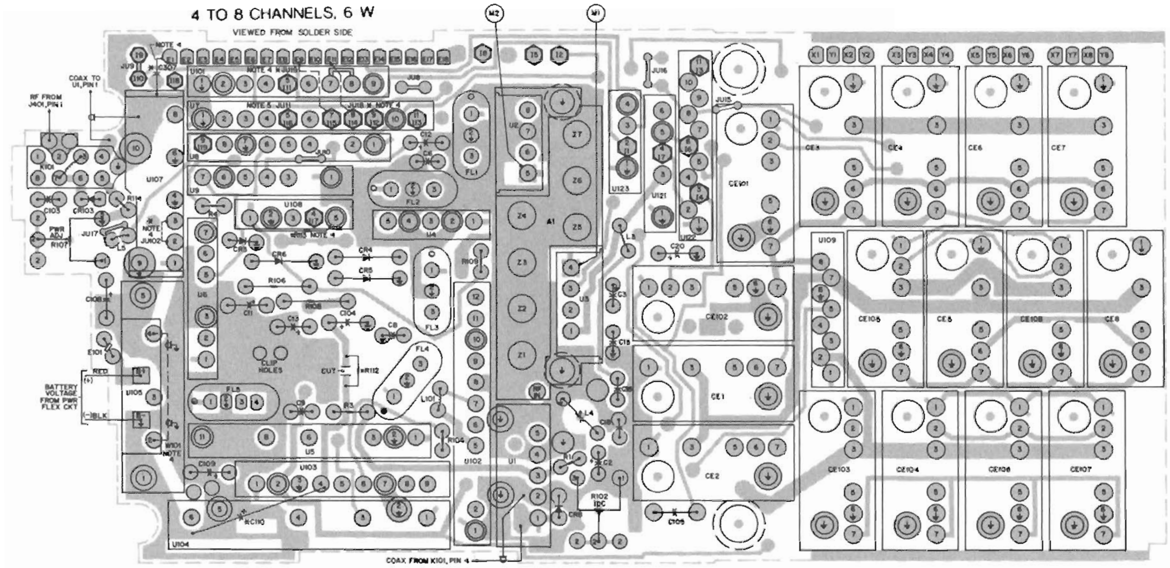
EPF-8170-A

VHF
BOARD OVERLAY
1 & 2.5 WATT MODELS
4 TO 8 CHANNELS

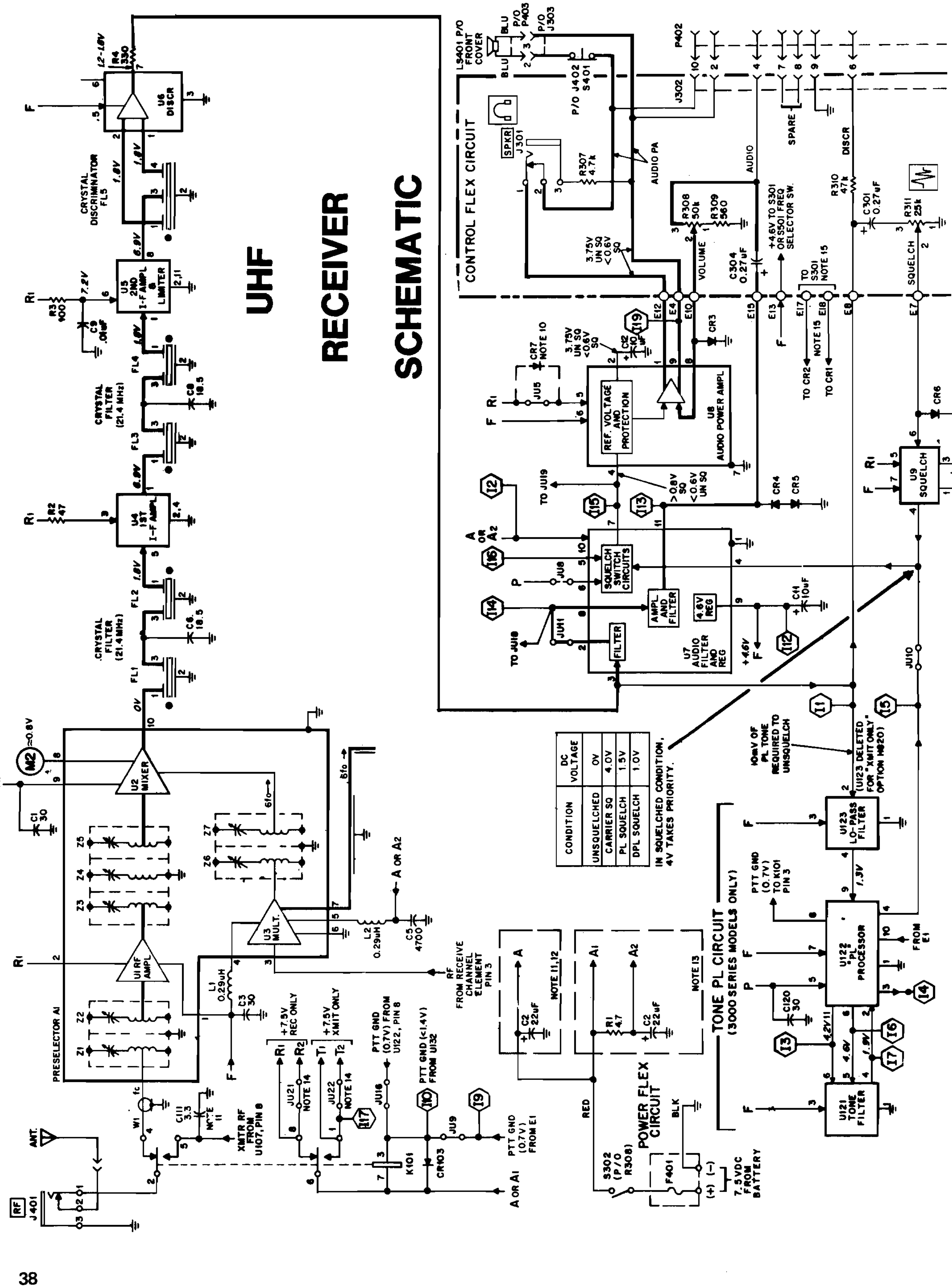
4 TO 8 CHANNELS, 1 & 2.5 W



4 TO 8 CHANNELS, 6 W

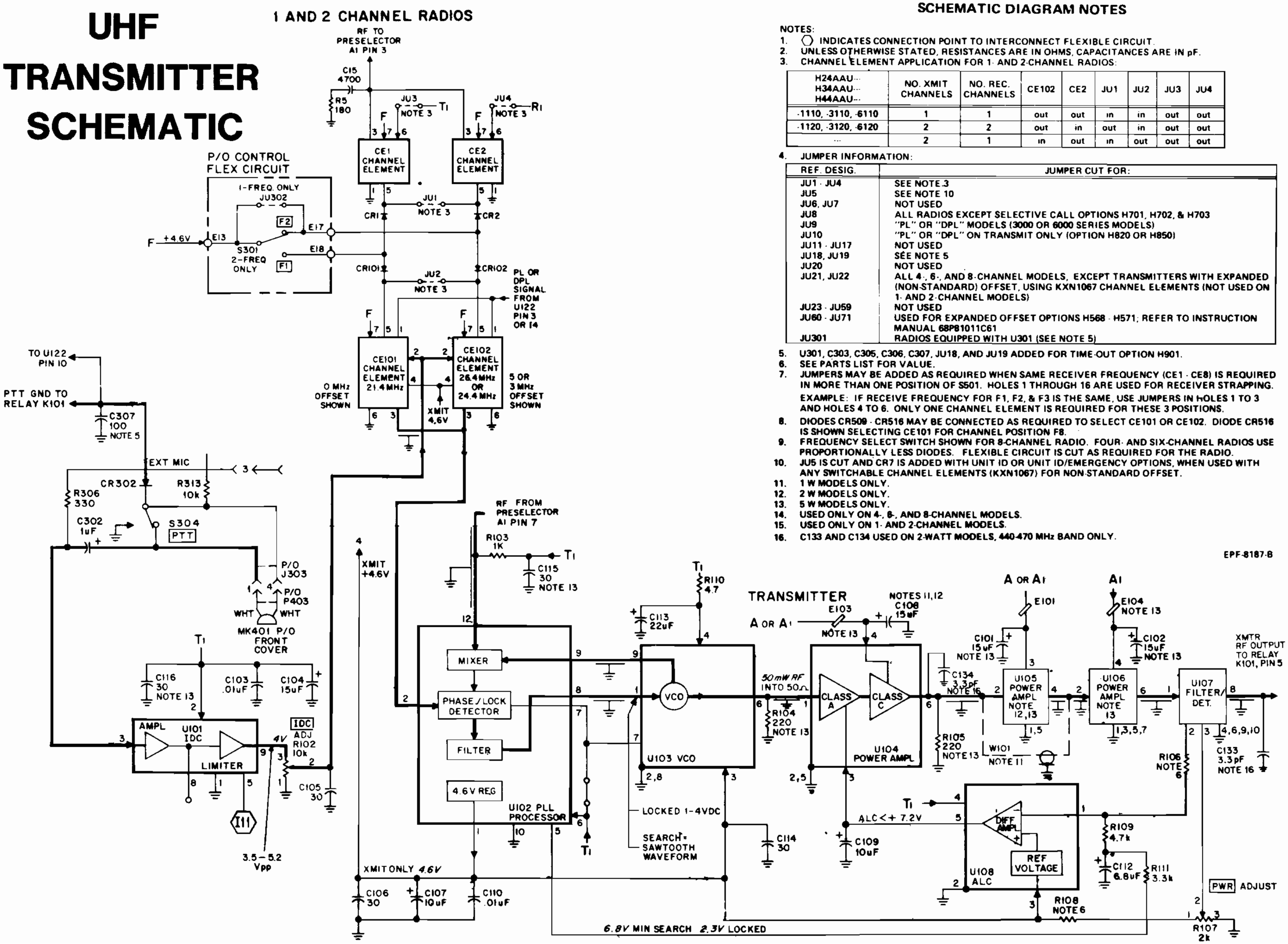


VHF
BOARD OVERLAY
6 WATT MODELS
4 TO 8 CHANNELS



CONDITION	DC VOLTAGE
UNSQUELCHED	0V
CARRIER SQ	4.0V
PL SQUELCH	1.5V
DPL SQUELCH	1.0V

UHF TRANSMITTER SCHEMATIC



SCHEMATIC DIAGRAM NOTES

NOTES:

1. ◯ INDICATES CONNECTION POINT TO INTERCONNECT FLEXIBLE CIRCUIT.
2. UNLESS OTHERWISE STATED, RESISTANCES ARE IN OHMS, CAPACITANCES ARE IN pF.
3. CHANNEL ELEMENT APPLICATION FOR 1- AND 2-CHANNEL RADIOS:

H24AAU--- H34AAU--- H44AAU---	NO. XMIT CHANNELS	NO. REC. CHANNELS	CE102	CE2	JU1	JU2	JU3	JU4
-1110, -3110, -6110	1	1	out	out	in	in	out	out
-1120, -3120, -6120	2	2	out	in	out	in	out	out
...	2	1	in	out	in	out	out	out

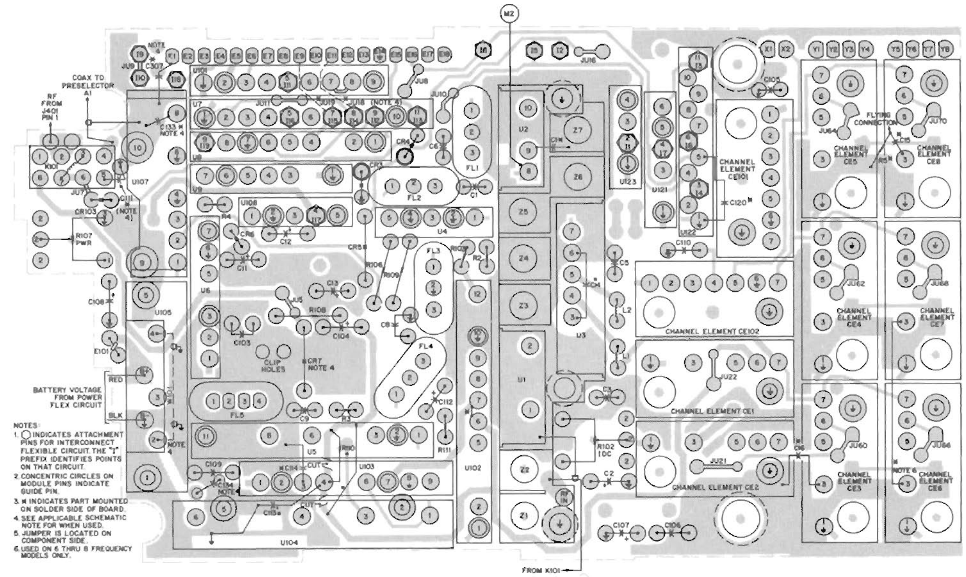
4. JUMPER INFORMATION:

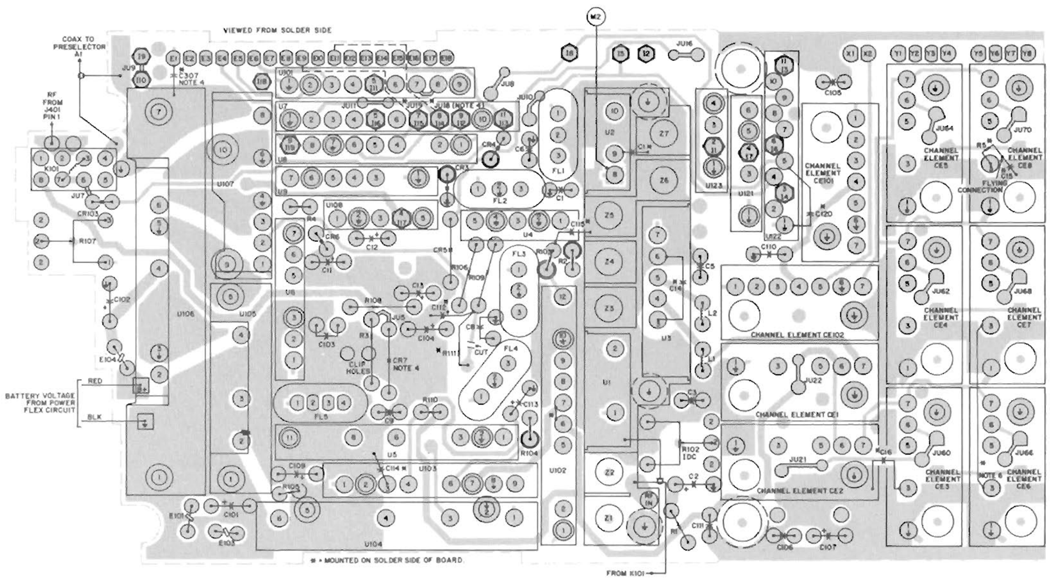
REF. DESIG.	JUMPER CUT FOR:
JU1 - JU4	SEE NOTE 3
JU5	SEE NOTE 10
JU6, JU7	NOT USED
JU8	ALL RADIOS EXCEPT SELECTIVE CALL OPTIONS H701, H702, & H703
JU9	"PL" OR "DPL" MODELS (3000 OR 6000 SERIES MODELS)
JU10	"PL" OR "DPL" ON TRANSMIT ONLY (OPTION H820 OR H850)
JU11 - JU17	NOT USED
JU18, JU19	SEE NOTE 5
JU20	NOT USED
JU21, JU22	ALL 4-, 6-, AND 8-CHANNEL MODELS, EXCEPT TRANSMITTERS WITH EXPANDED (NON-STANDARD) OFFSET, USING KXN1067 CHANNEL ELEMENTS (NOT USED ON 1- AND 2-CHANNEL MODELS)
JU23 - JU59	NOT USED
JU60 - JU71	USED FOR EXPANDED OFFSET OPTIONS H568 - H571; REFER TO INSTRUCTION MANUAL 68P81011C61
JU301	RADIOS EQUIPPED WITH U301 (SEE NOTE 5)

5. U301, C303, C305, C306, C307, JU18, AND JU19 ADDED FOR TIME-OUT OPTION H901.
6. SEE PARTS LIST FOR VALUE.
7. JUMPERS MAY BE ADDED AS REQUIRED WHEN SAME RECEIVER FREQUENCY (CE1 - CE8) IS REQUIRED IN MORE THAN ONE POSITION OF S501. HOLES 1 THROUGH 16 ARE USED FOR RECEIVER STRAPPING.
   EXAMPLE: IF RECEIVE FREQUENCY FOR F1, F2, & F3 IS THE SAME, USE JUMPERS IN HOLES 1 TO 3 AND HOLES 4 TO 6. ONLY ONE CHANNEL ELEMENT IS REQUIRED FOR THESE 3 POSITIONS.
8. DIODES CR509 - CR516 MAY BE CONNECTED AS REQUIRED TO SELECT CE101 OR CE102. DIODE CR516 IS SHOWN SELECTING CE101 FOR CHANNEL POSITION F8.
9. FREQUENCY SELECT SWITCH SHOWN FOR 8-CHANNEL RADIO. FOUR- AND SIX-CHANNEL RADIOS USE PROPORTIONALLY LESS DIODES. FLEXIBLE CIRCUIT IS CUT AS REQUIRED FOR THE RADIO.
10. JU5 IS CUT AND CR7 IS ADDED WITH UNIT ID OR UNIT ID/EMERGENCY OPTIONS, WHEN USED WITH ANY SWITCHABLE CHANNEL ELEMENTS (KXN1067) FOR NON-STANDARD OFFSET.
11. 1 W MODELS ONLY.
12. 2 W MODELS ONLY.
13. 5 W MODELS ONLY.
14. USED ONLY ON 4-, 6-, AND 8-CHANNEL MODELS.
15. USED ONLY ON 1- AND 2-CHANNEL MODELS.
16. C133 AND C134 USED ON 2-WATT MODELS, 440-470 MHz BAND ONLY.

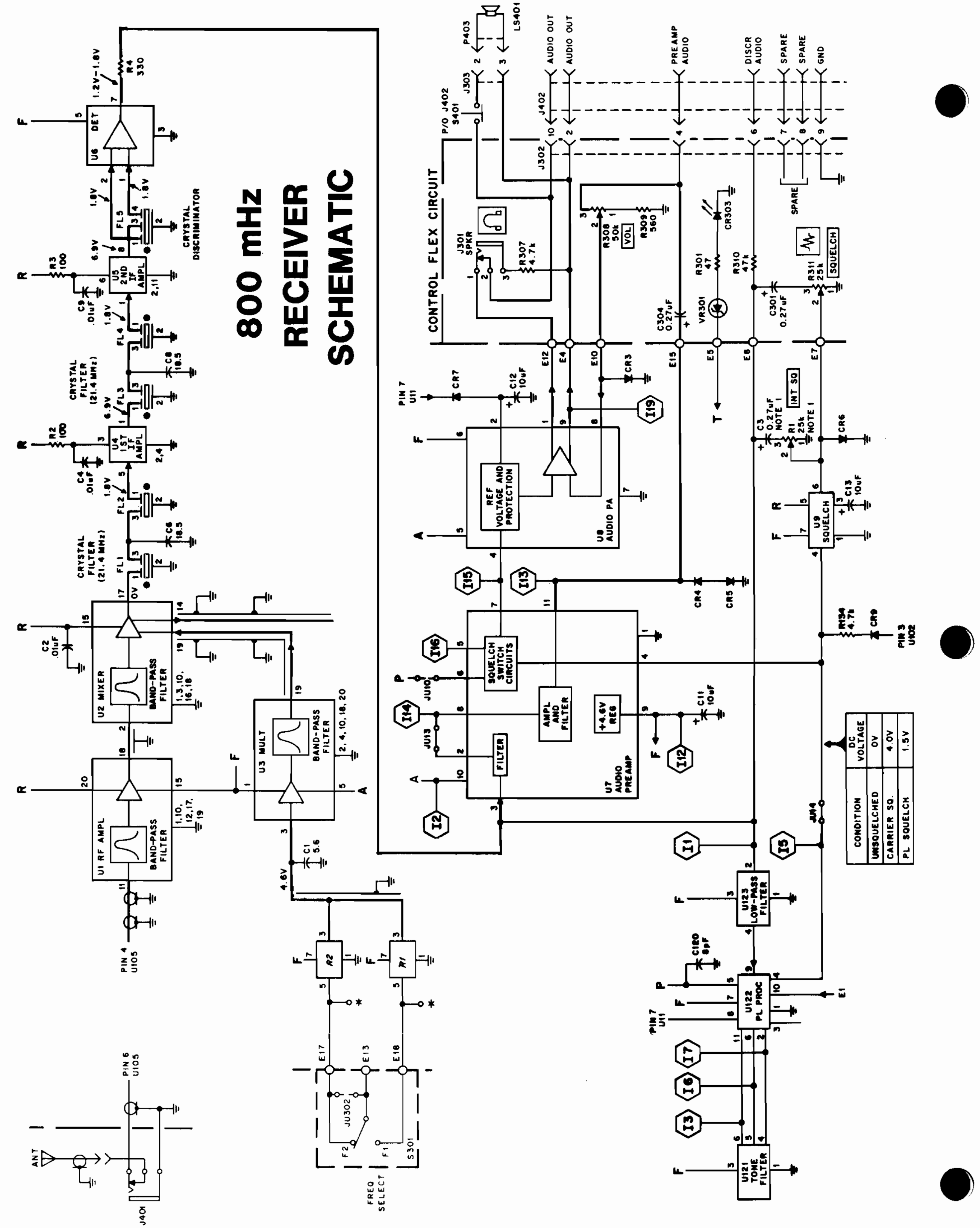
EPF-8187-B

UHF
BOARD OVERLAY
1 & 2 WATT MODELS
4 TO 8 CHANNELS





UHF
BOARD OVERLAY
5 WATT MODEL
4 TO 8 CHANNELS

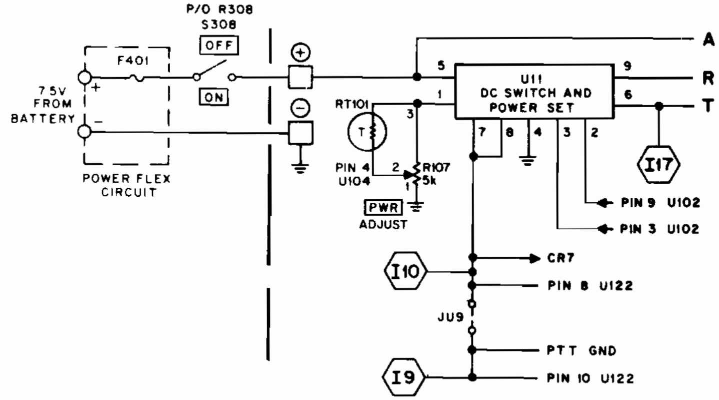


CONDITION	DC VOLTAGE
UNSQUELCHED	0V
CARRIER SQ.	4.0V
PL SQUELCH	1.5V

800mHz

TRANSMITTER

SCHEMATIC

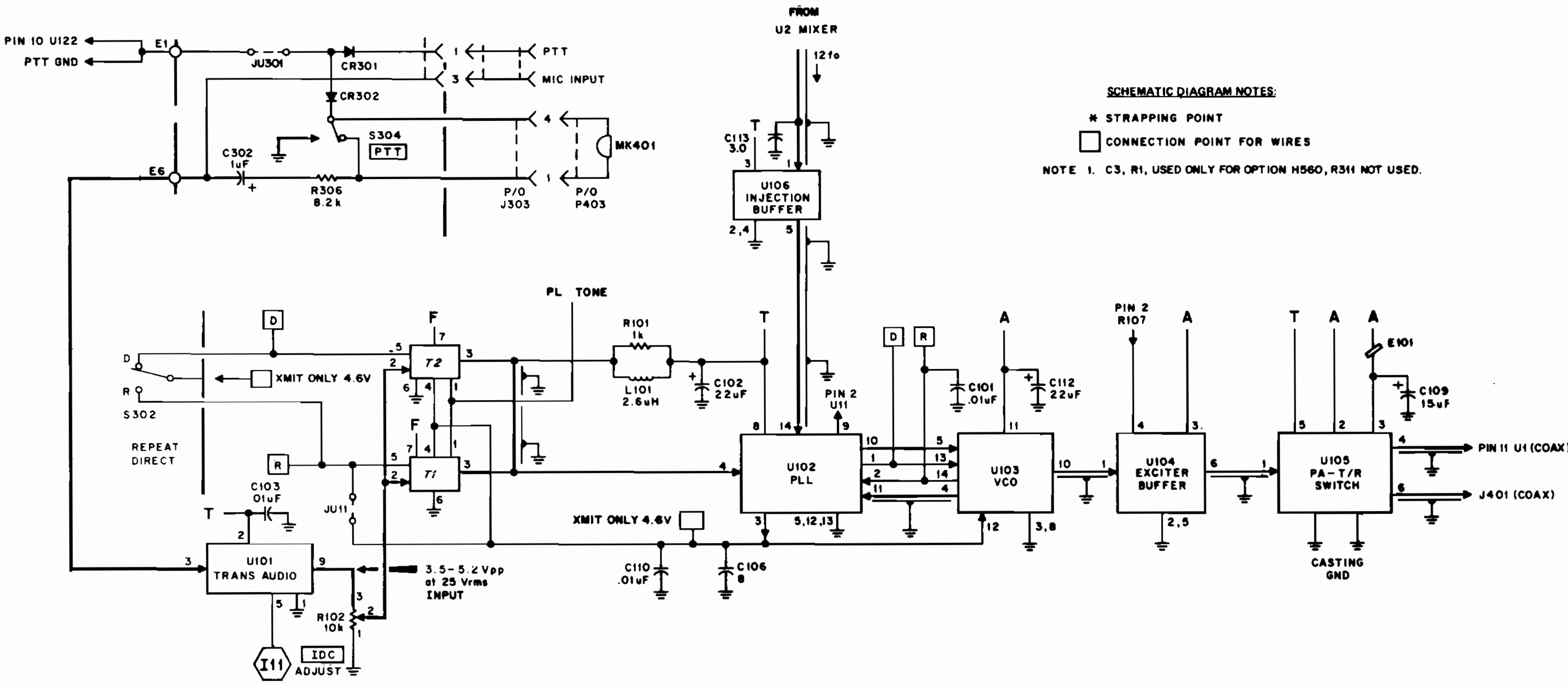


SCHEMATIC DIAGRAM NOTES:

✱ STRAPPING POINT

☐ CONNECTION POINT FOR WIRES

NOTE 1. C3, R1, USED ONLY FOR OPTION H560, R311 NOT USED.

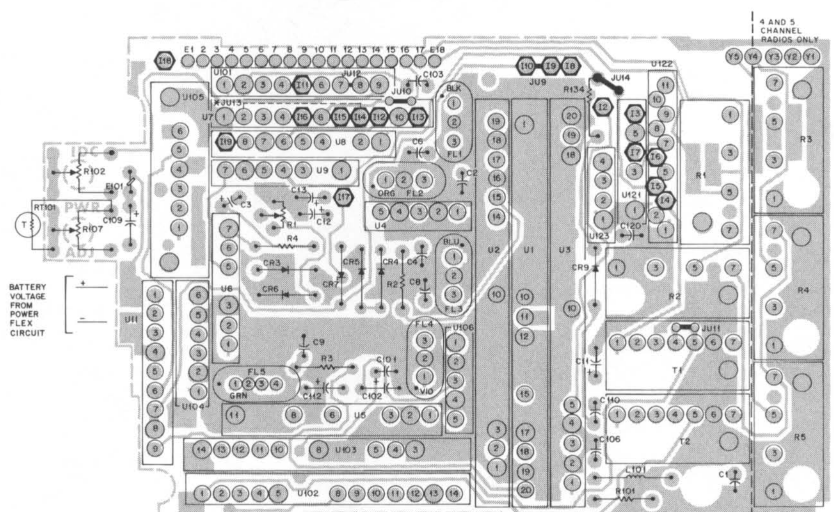


800 mHz

BOARD OVERLAY

1.5 WATT MODEL

1 TO 5 CHANNELS



* = LOCATED ON COMPONENT SIDE.
** = LOCATED ON SOLDER SIDE.

1. ⬡ INDICATES ATTACHMENT PINS FOR INTERCONNECT FLEXIBLE CIRCUIT. THE "I" PREFIX IDENTIFIES POINTS ON THAT CIRCUIT.
2. LARGER CIRCLES ON NUMBERED MODULE PINS INDICATE GUIDE PINS.

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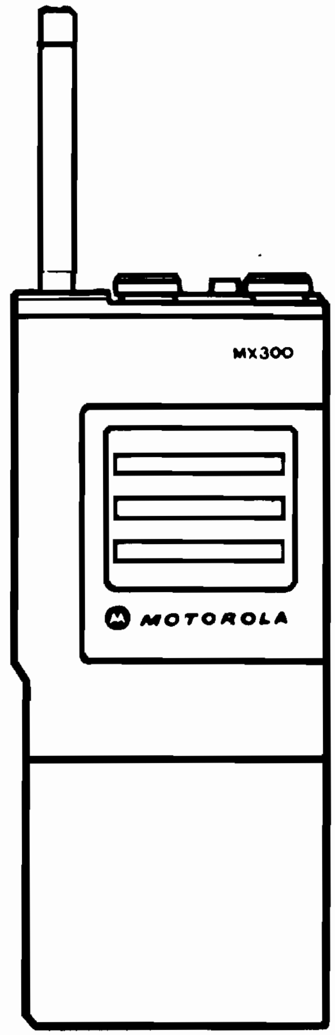
VIII.

"MX300-S" RADIO

ALIGNMENT &

TROUBLESHOOTING



SYNTHESIZED MX300 RADIOS
VHF - (H23, 33 & 43 SSU MODELS)
UHF - (H24, 34 & 44 SSU MODELS)

INTRODUCTION

The primary differences between the standard MX300 radio and the MX300-S radio is the way the injection frequency is developed for the transmitter and receiver. A frequency synthesizer is used to generate a possible total of 96 different frequencies, 48 receive and 48 transmit.

PERFORMANCE CHECKS

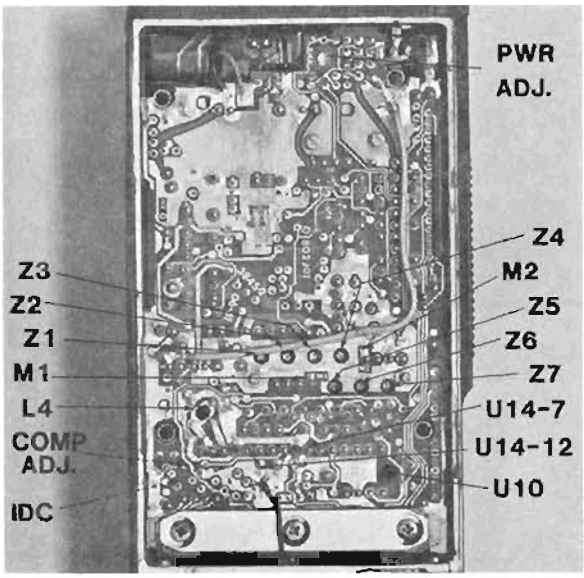
When performing receiver and transmitter checks, the Technician should follow section four of this guide. All the receiver and transmitter checks can be used for the synthesized radio.

UHF & VHF RECEIVER ALIGNMENT

1. Connect the radio as shown in Figure 1 on Page 11.
2. To adjust the synthesizer, follow the procedure outlined on the next page, using the VHF or UHF as applicable:
3. Using a service monitor, check and adjust the warp coil on U10 (if necessary) for the following radios:

   VHF Radios - Pin 7 of U14 for the carrier frequency minus 21.4 MHz divided by 2.

   UHF Radios - Pin 7 of the preselector (A1) for the carrier frequency minus 21.4 MHz.
4. Now, follow the procedure outlined on Page 12 or 13 of this guide to complete the alignment of the receiver.



VHF ALIGNMENT POINTS

VHF & UHF TRANSMITTER ALIGNMENT

1. Set the radio to the highest transmit frequency. Using a DC multimeter, measure the voltage on Pin 12 of U14. On VHF radios, it should be a maximum of 4.75 VDC. On UHF radios, 4.2 VDC is the maximum. If this voltage is higher, perform the synthesizer adjustments.
2. Now set the radio to the lowest transmit frequency. The voltage on Pin 12 of U14 should be a minimum of 1.3 VDC (VHF radios) or 1.8 VDC (UHF radios). Again, if this voltage is lower, then the synthesizer adjustment should be completed before proceeding.
3. While keying the transmitter, adjust R107, the power control for:

	Model	Power Rating
VHF	H23SSU	1 Watt
	H33SSU	2.5 Watts
	H43SSU	6 Watts
UHF	H24SSU	1 Watt
	H34SSU	2 Watts
	H44SSU	5 Watts

4. To set the correct deviation, inject a 1000 Hz tone at a level of 25 mV into the audio in jacks on the test set.
5. With the transmitter keyed, adjust R102 for a deviation of ±5 KHz on the service monitor.
6. VHF RADIOS ONLY

   On DPL and PL models, perform the following compensation adjustment:

   a. Remove U121 (in PL models) or U131 (in DPL models).

   b. Using a square wave generator set at 20 Hz, 1 V p/p, inject the signal into interconnect point 4 or Pin 2 of U131.

   NOTE

   If a square wave generator is not available, then inject a DPL code (using the DPL test set - SLN6413) of 000, at a level of 1 V p/p.

   c. Adjust R5 for a proper square wave as seen on the service monitor. The transmitter alignment in the service sheet shows the correct waveform.
7. UHF RADIOS ONLY

   Adjust CE101 for the proper transmit frequency as seen on the service monitor.

VHF SYNTHESIZER ADJUSTMENT PROCEDURE

FREQUENCY	PROCEDURE
136 - 174 MHz	Synthesizer adjustment requires the radio to be set to a specific frequency determined by the bandsplit and the transmit-receive separation. Determine the lowest receive frequency (LRF) and the lowest transmit frequency (LTF). Then follow the tuning procedure for the applicable bandsplit.
136 - 150.8 MHz (Low Split)	If the LTF is 1.0 MHz or more <u>below</u> the LRF (i.e., LRF – LTF ≥ 1.0 MHz), follow procedure A. If this condition is <u>not</u> met, use procedure B.
150.8 - 162 MHz (Mid Split)	If the LRF is 0.5 MHz or more <u>below</u> the LTF (i.e., LTF – LRF ≥ 0.5 MHz), follow procedure B. If this condition is <u>not</u> met, use procedure A.
162 - 174 MHz (High Split)	If the LRF is 1.0 MHz or more <u>below</u> the LTF (i.e., LTF – LRF ≥ 1.0 MHz), follow procedure B. If this condition is <u>not</u> met, use procedure A.
136 - 174 MHz	A. Set frequency selector switch (and optional zone switch if installed) to the LTF. Key the transmitter with the PTT switch (or the switch on the test set if used) and adjust L4 (VCO coil) until the voltage measured at pin 12 of U14 is 1.4 ±0.1 Vdc.* B. Set frequency selector switch (and optional zone switch if installed) to the LRF, and adjust L4 (VCO coil) until the voltage measured at pin 12 of U14 is 1.4 ±0.1 Vdc.*

*Remove tuning tool when measuring voltage.

UHF SYNTHESIZER ADJUSTMENT PROCEDURE

FREQUENCY	PROCEDURE
403 - 512 MHz	Synthesizer adjustment requires the radio to be set to a specific frequency determined by the bandsplit and the transmit-receive separation. Determine the lowest receive frequency (LRF) and the lowest transmit frequency (LTF). Then follow the tuning procedure for the applicable bandsplit.
403 - 430 MHz	If LRF is less than LTF, and LTF – LRF ≥ 2.2 MHz. follow procedure B. If not, use procedure A.
440 - 512 MHz	If LTF is less than LRF, and LRF – LTF ≤ 0.2 MHz. follow procedure A. If not, use procedure B. NOTE: The proper tuning frequency is noted by an asterisk (*) on the frequency label.
403 - 512 MHz	A. Set frequency to the LTF. Key the transmitter and adjust L4 (VCO coil) until the voltage measured at pin 12 of U14 is 1.8 ±0.1 Vdc.** (Use 50-ohm load when transmitting.) B. Set frequency to the LRF, and adjust L4 (VCO coil) until the voltage measured at pin 12 of U14 is 1.8 ±0.1 Vdc.

** NOTE: Remove tuning tool when measuring voltage.

TROUBLESHOOTING

With the introduction of a radio capable of 48 channels, there can be considerable time spent on a radio sent to the shop marked "RADIO'S DEAD." With no other information than that, you, as a Technician will have to switch thru a maximum of 48 receive frequencies and a possibility of 48 different transmit frequencies to find out what's happening. A big benefit to the Technician would be to get the user to tell you "CHANNEL 3, ZONE A TRANSMITTER IS DEAD," for instance.

Once a problem has been determined to be present, the Technician must now isolate the trouble between the synthesizer section and the remaining radio circuits. A quick check of the synthesizer would be to probe pin 12 of U14 with a DC multimeter. The voltage here should be between 1.5 VDC and 4.5 VDC volts DC and should be variable with L4.

If the voltage here cannot be varied, or not within the specified range, then following the charts on the next few pages should isolate the defective modules.

If it becomes necessary to take voltage/signal readings on U11 or U13, then proceed as follows:

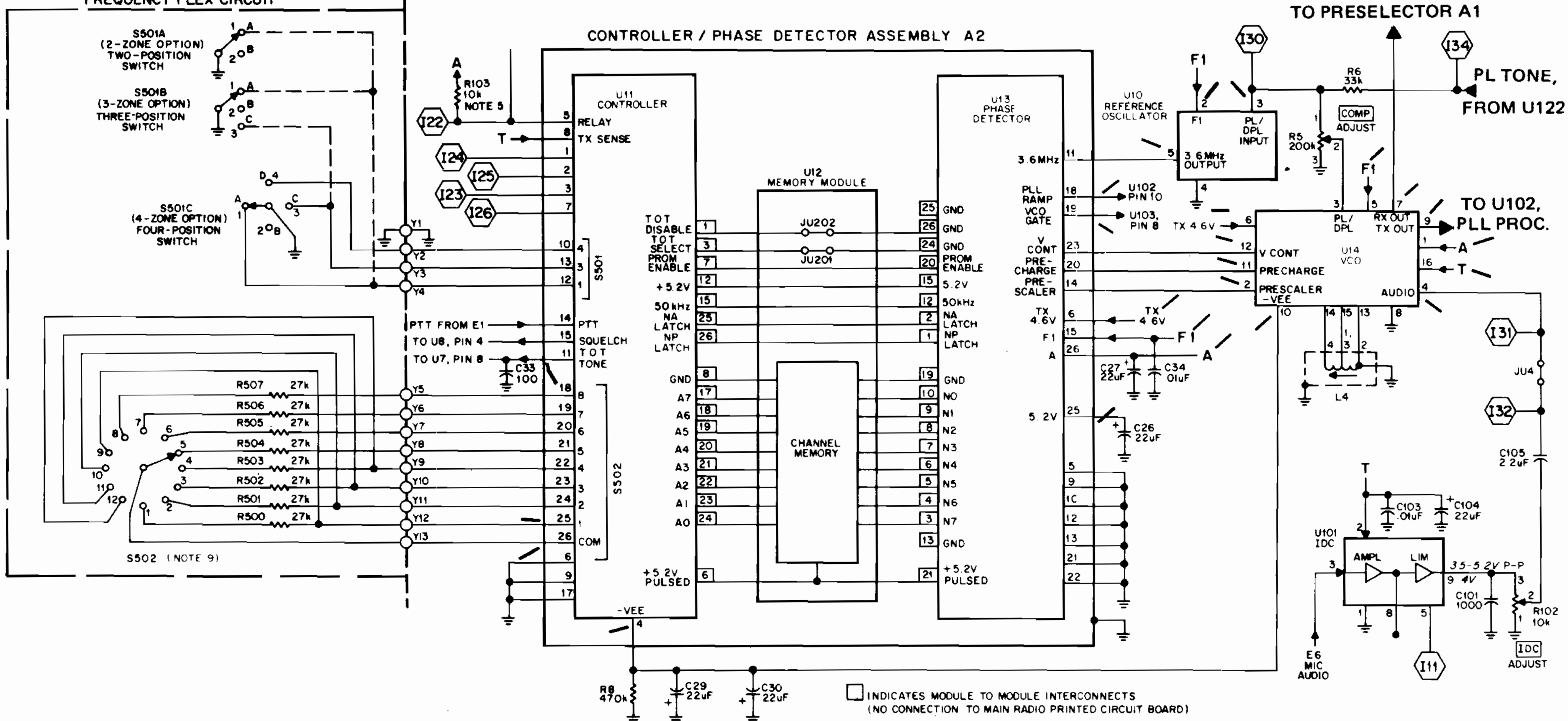
1. With the radio turned off, carefully remove the three screws securing the plate and insulator to the controller assembly.
2. Now, remove the middle screw from the plate and reinsert it into the middle hole thru the printed circuit board to the controller assembly.
3. Carefully tighten the screw into the controller assembly and take the necessary readings to isolate the problem.

NOTE

Do not disassemble the controller/phase detector assembly. The alignment of the module is critical to the proper operation of the radio. If a controller/phase detector, module is suspected faulty, change the entire module by following the procedure outlined in FMR-894-A. This should be followed closely so as not to damage the substrate or misalign the modules.

If the problem is not in the synthesizer, then the standard troubleshooting section of this Technician's Guide should be consulted.

VHF SYNTHESIZER



* Indicates signal originates in this module.

U14 Checks - in the following order

Pin 7 - 600 mV RF *
Pin 9 - 400 mV RF keyed *
Pin 12 - 1.5 - 4.5 VDC
Pin 11 - 1.5 - 4.5 VDC
Pin 5 - 4.6 VDC
Pin 6 - 4.6 V keyed
Pin 2 - 200 mV RF *
Pin 10 - -3.8 VDC
Pin 4 - 300 mV p/p (with 1000 Hz input)
Pin 1 - 7.5 VDC
Pin 16 - 7.5 VDC keyed

U10 Checks

Pin 5 - 1.5 V RF *
Pin 2 - 4.6 VDC
Pin 3 - 200 mVAC

U11 Checks

Pins 18 - 25 - 4.6 VDC when Ch. 1 - 8 selected
5.2 VDC when Ch. 9 - 12 selected (pins 22 - 25)
Pin 4 - -3.8 VDC *
Pin 26 - 5.2 VDC *

U13 Checks

Pin 15 - 4.6 VDC
Pin 26 - 7.5 VDC
Pin 6 - 4.6 VDC keyed
Pin 25 - 5.2 VDC *
Pin 18 - 6.4 VDC keyed
0 VDC unkeyed
Pin 19 - 6.6 VDC (locked) *

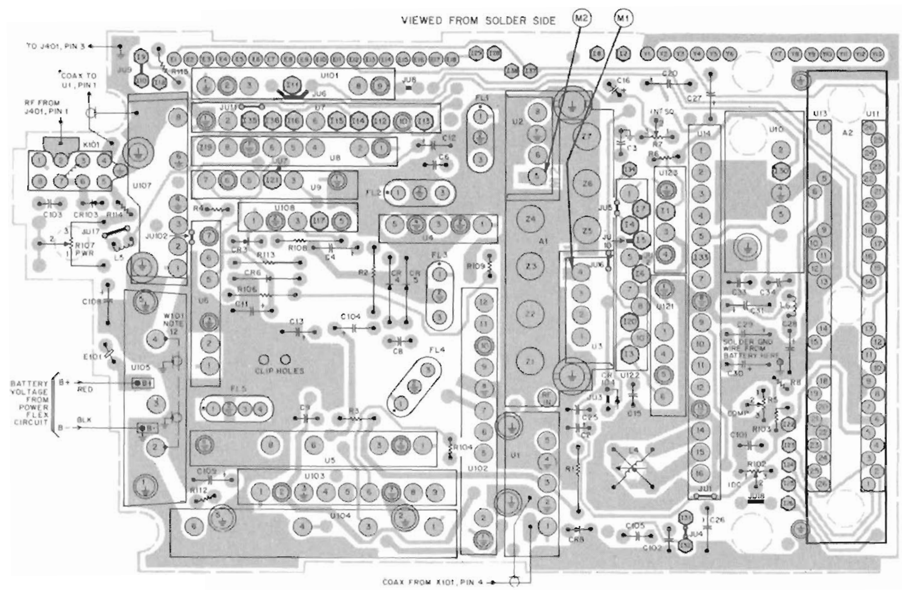
If the voltages around the module are low or zero, then trace back to the origin of the signal and make the appropriate checks. Replacement of the module is warranted if it appears faulty.

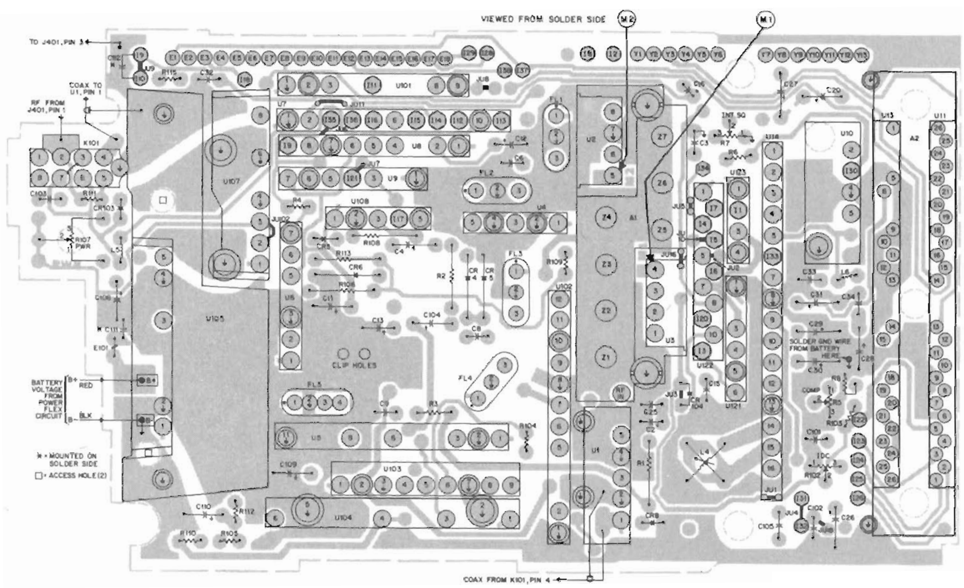
VHF

OVERLAY

1 & 2.5 WATT MODELS

1-48 CHANNELS





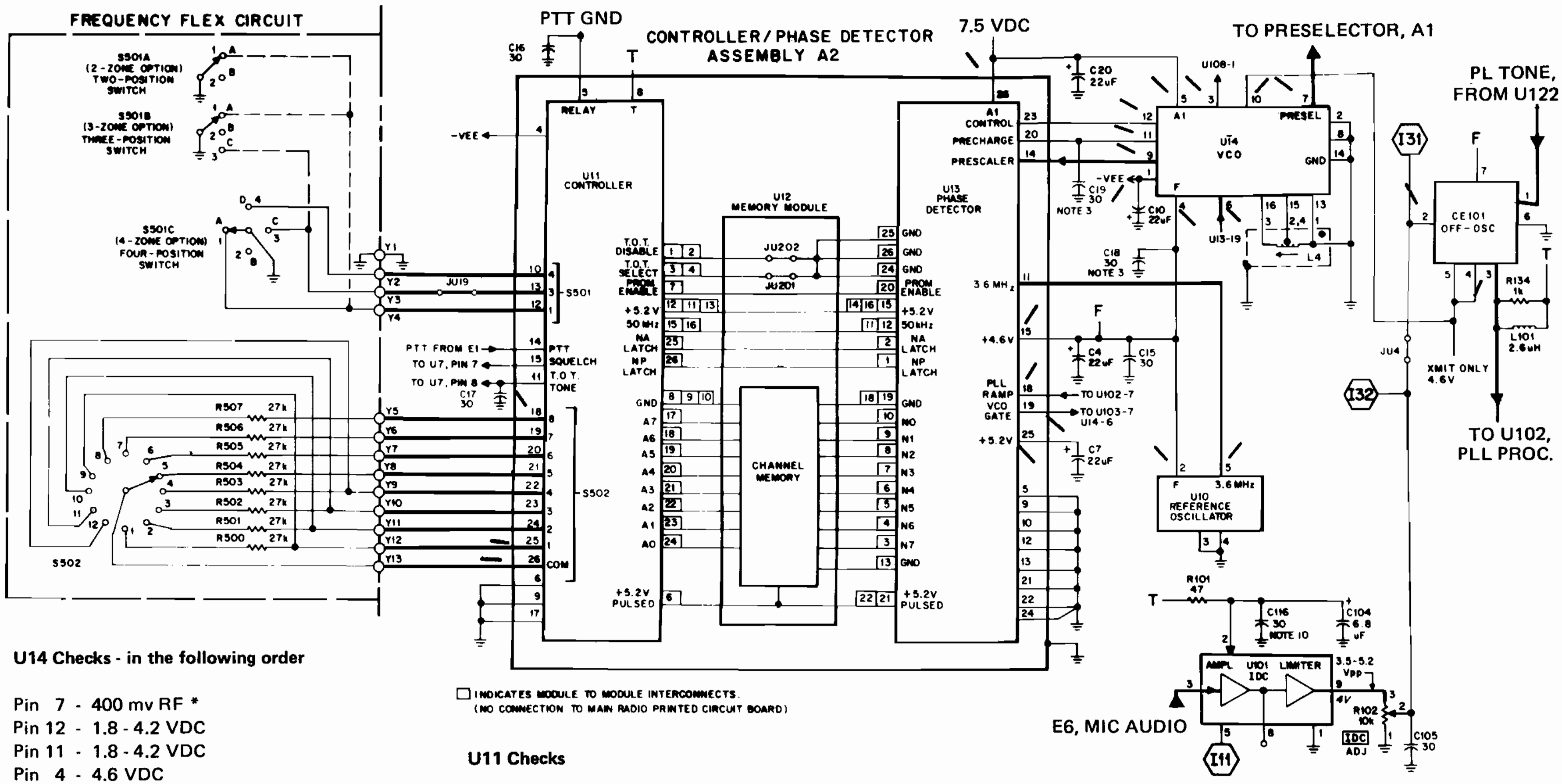
VHF

OVERLAY

6 WATT MODEL

1-48 CHANNELS

UHF SYNTHESIZER



U14 Checks - in the following order

Pin 7 - 400 mv RF *
Pin 12 - 1.8 - 4.2 VDC
Pin 11 - 1.8 - 4.2 VDC
Pin 4 - 4.6 VDC
Pin 10 - 4.6 VDC keyed
Pin 9 - 200 mv RF *
Pin 1 - -3.8 VDC
Pin 6 - 6.5 VDC keyed
Pin 5 - 7.5 VDC
Pin 3 - 2.5 VDC keyed *

U10 Checks

Pin 5 - 1.5 v RF *
Pin 2 - 4.6 VDC

U11 Checks

Pins 18-25 - 4.6 VDC when Ch. 1-8 selected
5.2 VDC when Ch. 9-12 selected (pins 22-25)
Pin 4 - -3.8 VDC *
Pin 26 - 5.2 VDC

U13 Checks

Pin 15 - 4.6 VDC
Pin 26 - 7.5 VDC
Pin 25 - 5.2 VDC *
Pin 18 - 6.4 VDC keyed
0 VDC unkeyed
Pin 19 - 6.6 VDC keyed *

CE101

Pin 3 - 200 mv RF keyed *
7.5 VDC keyed
Pin 2 - 3.5 V p/p keyed (with 1000 Hz input)
Pin 1 - 1.2 V p/p keyed (PL tone)

* Indicates signal originates in this module.

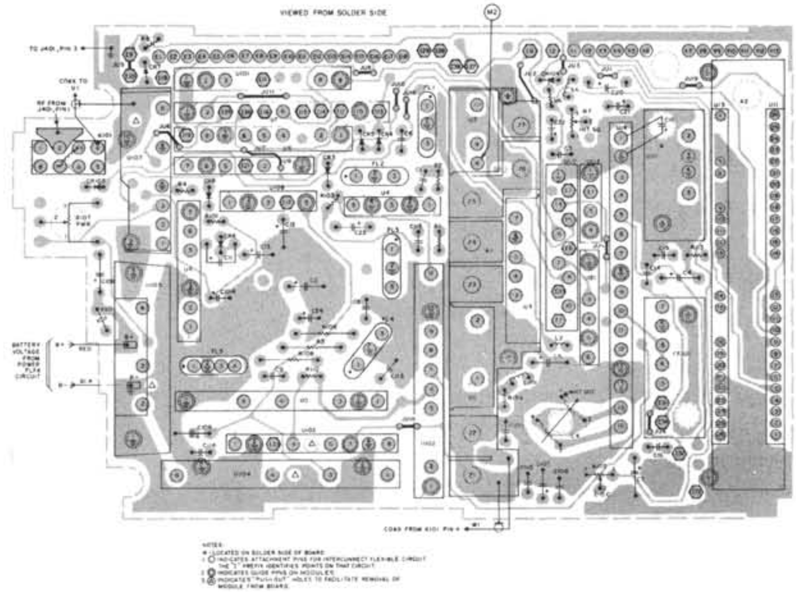
If the voltages around the module are low or zero, then trace back to the origin of the signal and make the appropriate checks. Replacement of the module is warranted if it appears faulty.

UHF

OVERLAY

1 & 2 WATT MODELS

1-48 CHANNELS

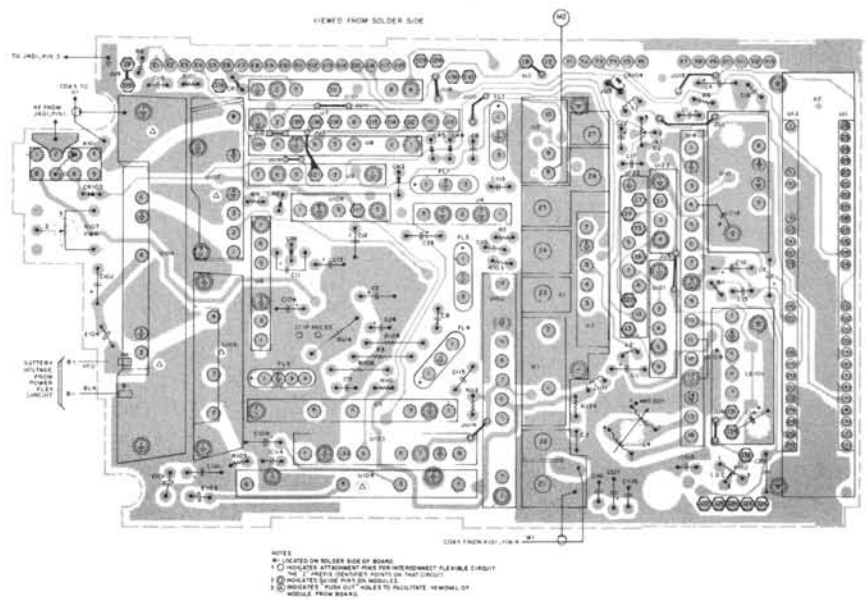


UHF

OVERLAY

5 WATT MODEL

1-48 CHANNELS



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