

**OPERATION AND MAINTENANCE MANUAL
FOR THE
ASTRO 200A**

The logo for CIR Industries, Inc. features a thick black vertical bar on the left and a thick black horizontal bar on the bottom. The text "CIR INDUSTRIES, INC." is positioned to the right of the vertical bar and above the horizontal bar.

CIR INDUSTRIES, INC.

OPERATION AND MAINTENANCE MANUAL
FOR THE
ASTRO 200A SSB TRANSCEIVER

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Welcome to the ranks of ASTRO 200A owners!
This manual has been prepared to help you
get the most pleasure from your transceiver.
It contains information about operating
procedures, technical specifications, theory
of operation and instructions for calibration,
service and repair. We urge you to read it
from cover to cover before applying power to
this transceiver.

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19.0 DIGITAL SYNTHESIZER DETAILED DISCUSSION

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B. Minor Loop

C. Up/Down Counter

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LIMITED WARRANTY

CIR Industries, Inc. warrants to the original purchaser that this product shall be free from defects in material (except RF output transistors) and workmanship under normal use and service for 6 (six) months from the date of retail purchase. CIR will, free of charge, repair or replace, at its option, any part (s) which are found to have become defective through normal use, provided that the transceiver is returned prepaid within 6 (six) months from date of purchase to: CIR Industries, Inc., 1648 N. Magnolia Ave., El Cajon, California, 92020, Attention: Customer Service.

To obtain such warranty service, the original purchaser must return the appropriate warranty card to CIR within 10 days after purchase, or send with your transceiver a copy of proof of purchase (sales receipt). Transceivers returned without proof of purchase, and with no warranty card on file, will be serviced "Out of Warranty" at our prevailing service rates.

This warranty does not apply to any article which has been subjected to misuse, neglect or accident, or a transceiver that has been serviced by anyone

other than CIR. This warranty contains the entire obligation of CIR and no other warranties expressed or implied or statutory are given. In no event shall CIR be liable for consequential damages.

WARNING NOTE

DO NOT APPLY POWER TO THIS TRANSCEIVER
UNTIL THIS MANUAL IS READ AND UNDERSTOOD.

PROPRIETARY STATEMENT

The information contained in this document is the property of CIR in conjunction with operating and maintaining the Astro-200A transceiver. This information may not be copied, reprinted, or disclosed to a third party, either wholly or in part, without the written consent of CIR Industries, Inc.

1.0 INTRODUCTION

The ASTRO-200A is a digitally tuned 80M-10M SSB transceiver. The built-in digital synthesizer with LED readout provides over 40,000 crystal controlled frequencies with 100Hz resolution. By pressing a momentary switch, the operator tunes the transceiver without dial moving parts. The frequency accuracy can be calibrated to WWV with the built-in 10MHz WWV receiver. No crystal calibration is necessary. Total RF band-pass filtering is built-in to provide maximum protection for TVI and harmonic suppression. Selectable USB or LSB along with extended band coverage offers additional flexibility. Excellent selectivity is achieved with an 8 pole crystal filter in the IF circuitry. CW operation features include semi break-in CW with adjustable delay and sidetone. VOX, noise blanker, squelch, and variable speech processing circuitry complete the total line of built-in operational capability.

2.0 SPECIFICATIONS

General Specifications: Frequency Coverage
(In 100Hz Steps)

3.5000 MHz	to	3.9999 MHz
7.0000 MHz	to	7.4999 MHz
14.0000 MHz	to	14.4999 MHz
21.0000 MHz	to	21.4999 MHz
28.0000 MHz	to	29.9999 MHz

Frequency Control: Stable digital frequency synthesizer with crystal reference oscillator, 100Hz digital readout resolution. 20Hz drift, after warm-up. Frequency accuracy calibration equal to WWV. Additional FINE tuning control allows +50Hz for continuous band coverage.

External Frequency Control: Rear socket for external VFO or synthesizer input for crossband operation. Frequency input coverage same as that with built-in synthesizer.

Modes of Operation: SSB with selectable sideband. CW with automatic 1KHz offset on transmit. Semi break-in with adjustable delay and sidetone is standard.

Power Input Required: 12-14 VDC negative ground only. (No damage 10V-15VDC). 20 Ampere peak current.

Electromagnetic Interference:

Transmit:

- a. 5 element TVI low pass filter at antenna connector.
- b. 3 element low pass filter for each band except 10M has 5 element low pass filter.

Receive:

- a. 2 pole bandpass filter for each band.
- b. 5 element 10 meter low pass filter at antenna connector.

Dimensions: 2.8" H x 9.5" W x 12.1" D
(Depth includes heatsink).
7.2cm x 24.13cm x 30.8cm
(Depth includes heatsink).
Weight 8 pounds (3.6kg).

Rear Panel Connectors:

Accessory Connector

Pin Number	Function
1	Key
2	13.6VDC Switched Output
3	Transistor Switch, open Collector ("on" in transmit)
4	Receiver-on, 8VDC
5	Mod in
6	Ground
7	Ext. LO input (1V P-P)
8	External ALC
9	Ext. LO gate 12VDC = Ext. LO on
10	Audio Output 1 Watt into 8 ohms

Power Connector

Function

1	Ground
2	Ground
3	13.6VDC Input
4	13.6VDC Output, Switched
5	13.6VDC to Power Amp
6	13.6VDC to Power Amp

Antenna Connector: UHF type.

Audio Output Connector: RCA phono type.

Typical Receiver Specifications:

Circuit Design: Direct conversion to 5.6MHz IF using double balanced mixer. Exceptional immunity to overload and cross modulation.

Sensitivity: $0.3\mu\text{V}$ for $10\text{dB } \frac{\text{S+N}}{\text{N}}$

Selectivity: Crystal ladder 8 pole filter. Bandwidth 2700Hz @ 6dB down, 4300 @ 60dB down. 1.6 shape factor.

Image Rejection: 50dB.

Internally Generated Spurious Response: $0.5\mu\text{V}$ equivalent input signal.

AGC: 6dB change in audio level over input range of $1.0\mu\text{V}$ to $.1\text{V}$ (100dB).

Audio Output: 1 Watt available @ <10% distortion, 300-3000Hz, 8 ohms.

Meter: S-Unit from 1-9, 20, 40, and 50dB over S-9.

Typical Transmitter Specifications:

Circuit Design: Broadband design to eliminate the need for tuning. Excellent harmonic and TVI suppression. ALC; Provision for external ALC input, positive going.

Frequency Control: By synthesizer with 6 digit readout to 100Hz. Fine frequency control allows adjustment ±50Hz from indicated frequency.

Power Input: 200 Watts PEP input at 13.6VDC input.

Power Output: 100 Watt PEP into 50 Ohm non-reactive load at 13.6VDC input, 80M through 15M. 80 watt PEP 10M band.

Unwanted Sideband Rejection: >60dB down at 1000Hz audio.

Harmonic Output: >45dB below peak power level.

Carrier Suppression: >50dB down.

Spurious Output: >45dB below peak power level.

Transmit Control for SSB: PTT and VOX standard.

CW Transmit: Semi break-in with sidetone standard.
Automatic 1KHz offset on transmit frequency.

Microphone Input: 50K ohm input impedance.

Microphone Provided: Dynamic Mike, 500 ohm impedance with up-down tuning provided.

Audio Response: 300 to 3000Hz +6dB.

Meter: Reads ALC on transmit, or forward and reflected power. Full scale equals 100W output into 50 Ohm non-reactive load in forward power position.

Cooling: Large capacity heat sink fins supplied. For SSTV, RTTY, and semi-continuous transmit, forced air cooling such as a small muffin fan on heat sink fins required.

3.0 REQUIREMENTS FOR OPERATION

A. AC Operation

The ASTRO-200A Transceiver requires +13.6VDC at up to 20 amperes in transmit mode. For operation from 110/220 VAC at 50/60Hz the matching Speaker/Power Supply is recommended.

If other than the recommended power supply is used the following requirements must be met by the power supply to assure satisfactory performance:

1. Output voltage 13.6VDC
2. Load Regulation 13.0VDC @ 20 amp

3. Ripple 0.25Vpp @ 20 amp

Note: All parameters measured at input connector of transceiver.

B. DC Operation

For operation from battery supplies (with or without alternator/generator charging) several points must be noted for proper operation:

1. Excessive noise on the power leads may cause damage due to over voltage or reverse voltage. Large voltage transients may be caused by activating motors, solenoids, and similar electromechanical devices connected to the same battery supply.

2. Because of the large currents (up to 20 amps) required by the power amplifier it is not possible to switch the transmitter supply on and off with the front panel power switch. Voltage for the transmitter power amplifier is supplied directly from Pins 5 and 6 of the power connector. This connection allows a leakage current of up to 50ma to flow at all times the transceiver is connected to the battery. This could discharge the battery if the unit is left connected for extended periods without charging.

3. The large current requirements also prohibit

the use of a series reverse polarity protection diode in the set. Please note:

WARNING - CONNECTION OF DC SUPPLY VOLTAGE WITH REVERSED POLARITY WILL DESTROY THE TRANSMITTER POWER AMPLIFIER AND CAUSE SERIOUS DAMAGE TO THE TRANSCEIVER.

In a mobile application the operator may wish to install an external reverse polarity protection circuit. A typical circuit is shown below (figure 3-1). A power cable assembly, part number MPC-200, is available from your CIR dealer. This assembly provides the power connector, built-in diode, inline fuse and 10 foot power leads.

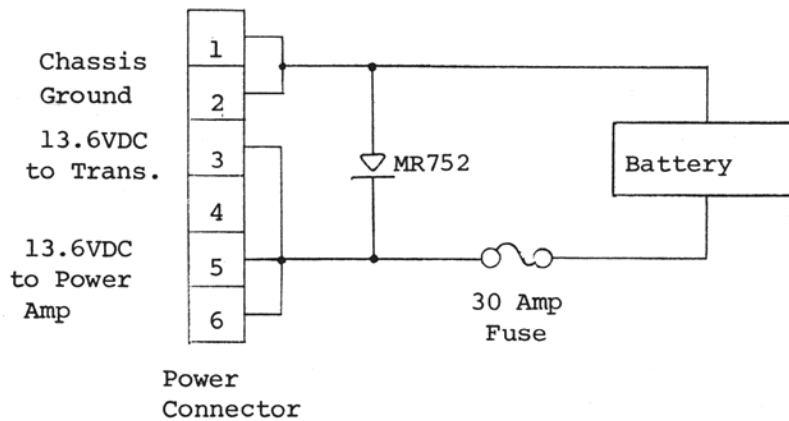


Figure 3-1

4. The transceiver is rated for operation at 13.6VDC; the normal operation voltage of a 12.6VDC battery system with alternator/generator operating. In a typical mobile application the transceiver may be several feet from the battery power source. For completely satisfactory operation (but at reduced peak transmitter power) the supply voltage at the transceiver power connector should never drop below 12.0VDC. For safe operation the resistance of the power leads should not exceed 0.04 ohms. Listed below is the maximum recommended length of power lead vs wire gauge. Remember the length listed is total wire length; the distance to the battery is only one half this distance (hot lead and its return).

<u>Gauge</u>	<u>Total Length</u>
8	60 feet
10	39 feet
12	24 feet
14	15 feet
16	10 feet

C. Antenna

The ASTRO-200A transceiver is provided with a forward and reflected power meter for approximate VSWR readings. The antenna may be of any type selected by the operator, provided the VSWR is 2:1 or less. For antennas that are not designed with a VSWR of 2:1 or less

an antenna matching network should be installed between the transceiver and the antenna. For tune up procedure see section 6 paragraph B, Transmitter Tuning.

D. Microphone

The microphone input is high impedance, approximately 50K ohms. Almost any standard microphone will provide satisfactory performance. The transceiver is supplied with a microphone that has self-contained tuning controls for slow scanning and single 100Hz step tuning.

If the operator should prefer a desk or other type microphone a mating connector type NC-518 wired to the microphone cable according to figure 3-2 is required. It is necessary to use a four wire microphone with the microphone pair connected to "MOD IN" and "GROUND", and the key pair connected to "11VDC" and "PTT".

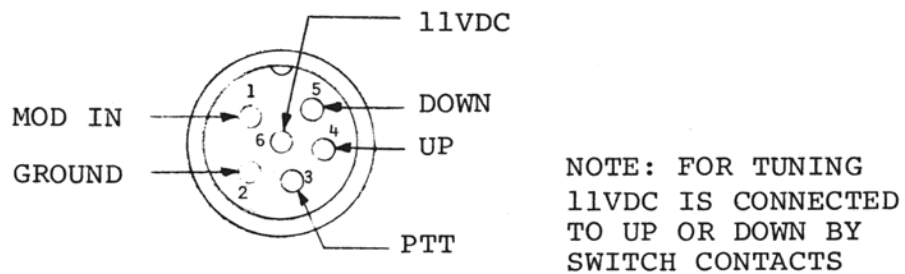


FIGURE 3-2

E. Speaker/Headphones

Transceiver audio output is available to drive an external speaker from either a RCA type jack directly below the accessory connector or from pin 11 of the accessory connector. Speaker impedance should be between 3.2 and 8 ohms nominal.

The available Speaker/Power Supply unit has a speaker matched to the transceiver audio system. The Speaker/Power Supply unit has preassembled cables for audio and main power. The ASTRO-200A system Interconnect Diagram details these functions.

4.0 INSTALLATION

A. Accessories included in Package

1. Microphone with attached connector.
2. Accessory mating connector (86CP11).
3. Power mating connector (S306CCT).
4. RCA phone plug.
5. Owners Manual.

B. Location/Ventilation

1. Fixed. The transceiver is designed to be table top mounted in any available location. The only limitations are associated with transmitter power amplifier cooling. The heatsink provided is adequate for normal voice communication, however

space must be allowed around the unit for convection cooling. It is recommended that a clear space of at least 2 inches above and to the rear of the heat-sink be provided.

For continuous or semicontinuous transmitter operation a small fan should be used to force cooling air over the heatsink. For best cooling efficiency the fan should be located below the heatsink with airflow directed upward through the heatsink fins.

2. Mobile. A simple mobile mounting bracket is available. Or the operator may choose to fabricate his own. In any case the only critical factors are:

- a. Maintain cooling space as mentioned above.
- b. Mount unit in a manner to minimize shock and vibration. Using the available mobile mount, installation in cars and trucks should be simple and trouble free.
- c. Power connection should be made per Requirements for Operation section; item 3.0B, DC OPERATION.

C. Cabling

1. Antenna. The antenna connector on the transceiver is UHF type. Connection to the antenna should be made with coaxial cable of 50 ohm characteristic impedance. For runs up to 50 feet RG58A/U cable, or equivalent, is recommended. For runs

greater than 50 feet RG8A/U, or equivalent, is recommended for best performance.

2. Power. See Requirements for Operation section.

3. Grounding. For best performance the transceiver should be grounded to a good earth ground by the grounding screw located just below the accessory connector. The ground lead should be as short as practical. The lead should be made from 14 gauge wire or equivalent.

D. Linear Amplifier Interface

The ASTRO-200A will interface directly with linear amplifiers which require grounding a positive voltage; for example, provide a ground for a relay coil in the linear. Pin 3 of the accessory connector is a transistor open collector to be used to provide the ground for the linear relay coil. Since pin 3 is a transistor used as a switch to chassis ground it has certain operating limitations:

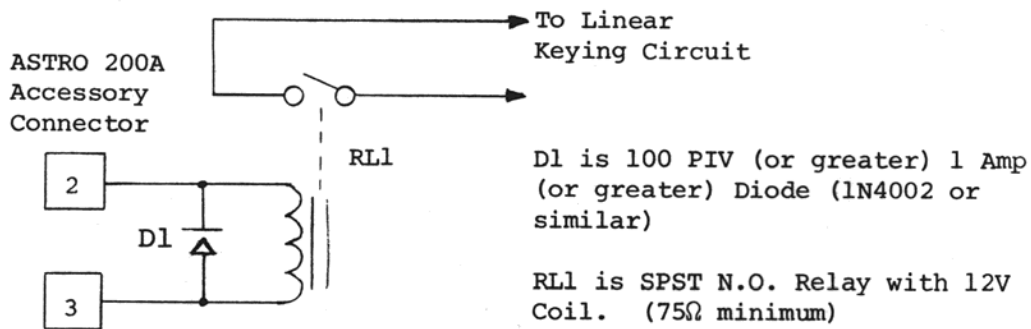
1. Voltage applied to pin 3 must not exceed 35VDC with transistor switch off ("receive" mode of transceiver).

2. Current into pin 3 must not exceed 200 ma with transistor switch on ("transmit" mode of transceiver). Most linear amplifier relay coils fall within these

operating bounds.

If the linear amplifier keying requires the connection of a negative voltage, an external relay must be used.

The circuit shown below can be used to provide the needed relay contacts.



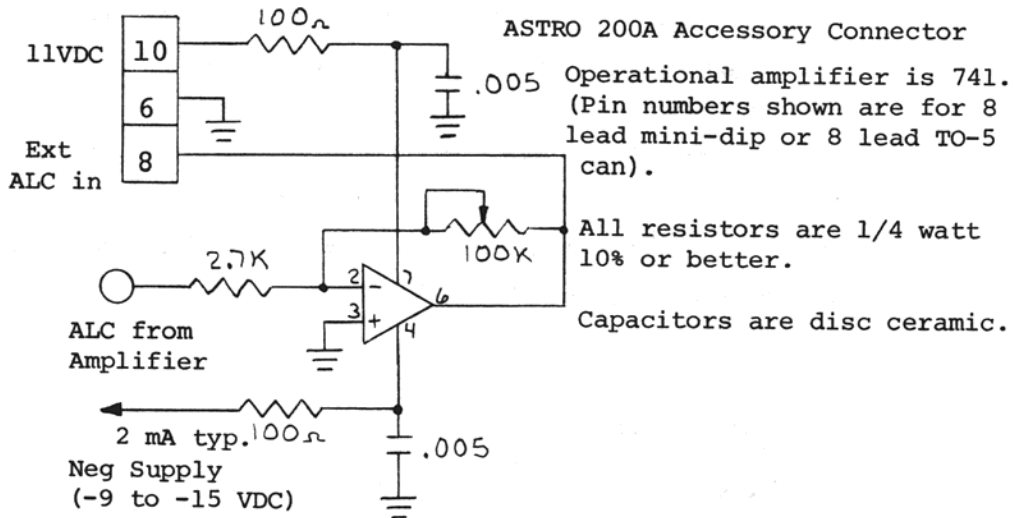
ALC Considerations

The ASTRO-200A requires a positive-going voltage to reduce transmitter power. Although the internal ALC system is disabled in the CW mode, the external ALC input is still active. In many applications use of external ALC is not necessary; the ASTRO-200A internal ALC, and Mic gain controls can be used to set the

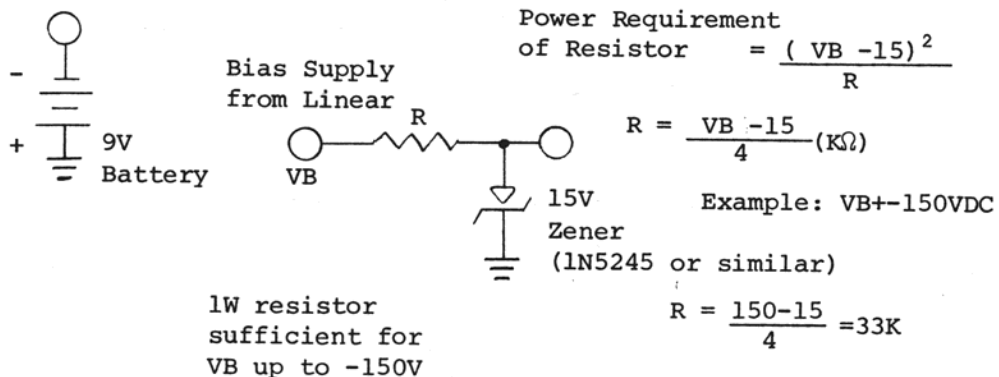
drive to correct power for the linear amplifier.

In cases where external ALC is necessary the following information will illustrate proper interface circuits.

Most linear amplifiers designed for use with tube type exciters have a negative going ALC output signal. The circuit below can be used to convert the negative signal from the amplifier to a positive signal required by the ASTRO-200A. After installation, adjust the variable resistor for proper operation.

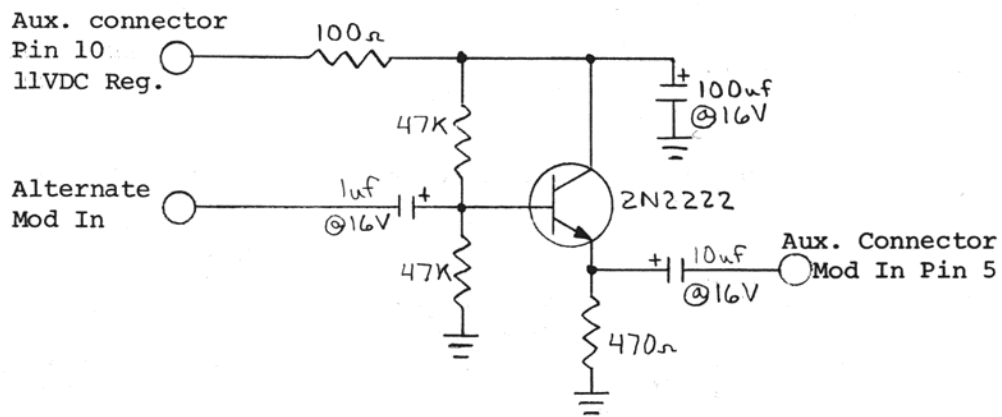


Suggested methods of obtaining the required negative voltage.



E. OTHER FORMS OF MODULATION

For modulation formats other than Voice, for example SSTV or RTTY, a second modulation input is provided on the accessory connector, pin 5. For optimum linearity these signals should be approximately .15V peak to peak (about .05V rms) maximum. The Mic gain can be adjusted so that peak signals just start ALC to function. In an ideal system the alternate modulation level might be set with a separate control so that the MIC GAIN can be set for voice and not reset when other modulation is turned on. When the tuning microphone is in place the auxiliary modulation input impedance is about 1K ohms. It is therefore necessary that the output impedance of the alternate modulation generator be low also. If this is not the case a buffer emitter follower may be necessary; as shown below (Figure 4-4):



Emitter follower Input impedance 20K Ohm, gain times one.

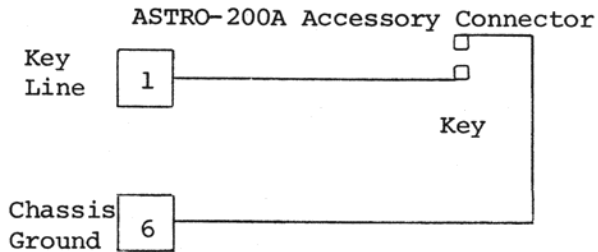
FIGURE 4-4

F. CW KEY CONNECTION

CW operation can be keyed from either of two connections:

1. Accessory connector:

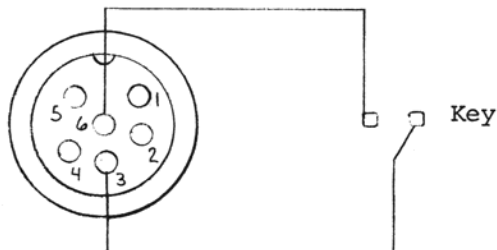
Pin 1 is the key connection and is normally about 12VDC with key open. To key the transmitter Pin 1 should be connected to chassis ground through the key contacts as shown below.



In this mode about 35 ma will be conducted through the closed key contacts.

2. Mic connector:

For CW operation from the mic connector the key contacts must connect pins 6 and 3 of the connector as shown below.



In this mode about 10 ma will be conducted through the closed key contacts.

5.0 OPERATING CONTROLS, AND CONNECTORS

A. Front Panel

Each front panel control and function is described herein to assist the operator in understanding the operation of the transceiver. From left to right: See figure 5-1 for transceiver Front Panel layout.

Mic Connector: Six pin connector for connection of the supplied microphone. In addition to the standard voice and PTT function the connector provides pins for slow up and down tuning of the transceiver. See Requirements for Operation part D, Microphone, for connection diagram.

Squelch: This control is both noise blanker and squelch. The rotation of the control sets the squelch level of the receiver. When the knob is pulled out, the noise blanker circuit is activated.

Meter: Selects the information to be indicated on the meter. In normal operating mode, the switch would be in the ALC position. In this mode, while receiving, the meter will indicate signal strength to S-9, and 20, 40, and 50dB over. REF (reflected) and

FWD (forward) relative power indication positions may be used to determine VSWR and power output during transmit operation of the transceiver. The meter is factory calibrated to read 100 Watts output full scale into a 50 Ohm non-reactive load when the meter is set to the FWD position. VSWR (REF) readings on the meter are relative to a full scale power reading in the FWD position.

AF Gain: Sets the audio level to the external speaker.

MIC Gain: In SSB mode, this control sets the audio level to the transmitter. Since ALC sets the maximum power output, any increase in the MIC gain beyond a nominal mid-point reading on peak modulation (ALC meter setting) will increase the voice compression, allowing operator control of speech processing. This, in turn, will increase the average power output level. In CW mode, the MIC GAIN control is turned clockwise, RF output is decreased. With CW key down and meter in FWD position, the power output can be set to desired output with MIC GAIN control.

Function: Selects mode of operation. USB (upper sideband), LSB (lower sideband), CWW (CW sideband with 2.7KHz filter), CWN (CW narrowband with optional 400Hz filter), WWV (10MHz receive only). CWN position is inoperative when 400Hz optional filter is not installed. WWV is operative regardless of band switch position.

PTT/VOX: Push-to-talk and VOX circuitry are standard features. This toggle switch selects the mode of operation.

RF Attn: RF attenuation of a nominal 16dB may be switched in for strong signal reception.

DIM: The DIM position reduces the digital display intensity for use in low ambient light level conditions.

ON/POWER: Turns on DC power to the transceiver with the exception of the RF power output transmit circuitry. (The RF power amp DC buss is connected to the DC input connector and is not switched in the radio).

Band: Selects the desired operating band 80M through 10M.

Fast: Momentary toggle switch for frequency tuning. When the switch is pushed up, the carrier frequency is increased toward the top of the band. When the switch is pushed down, the carrier frequency is decreased toward the bottom of the band. The rate of frequency change is approximately 20kHz/sec.

Slow: Momentary toggle switch for frequency tuning. This switch operates in the same manner as the FAST

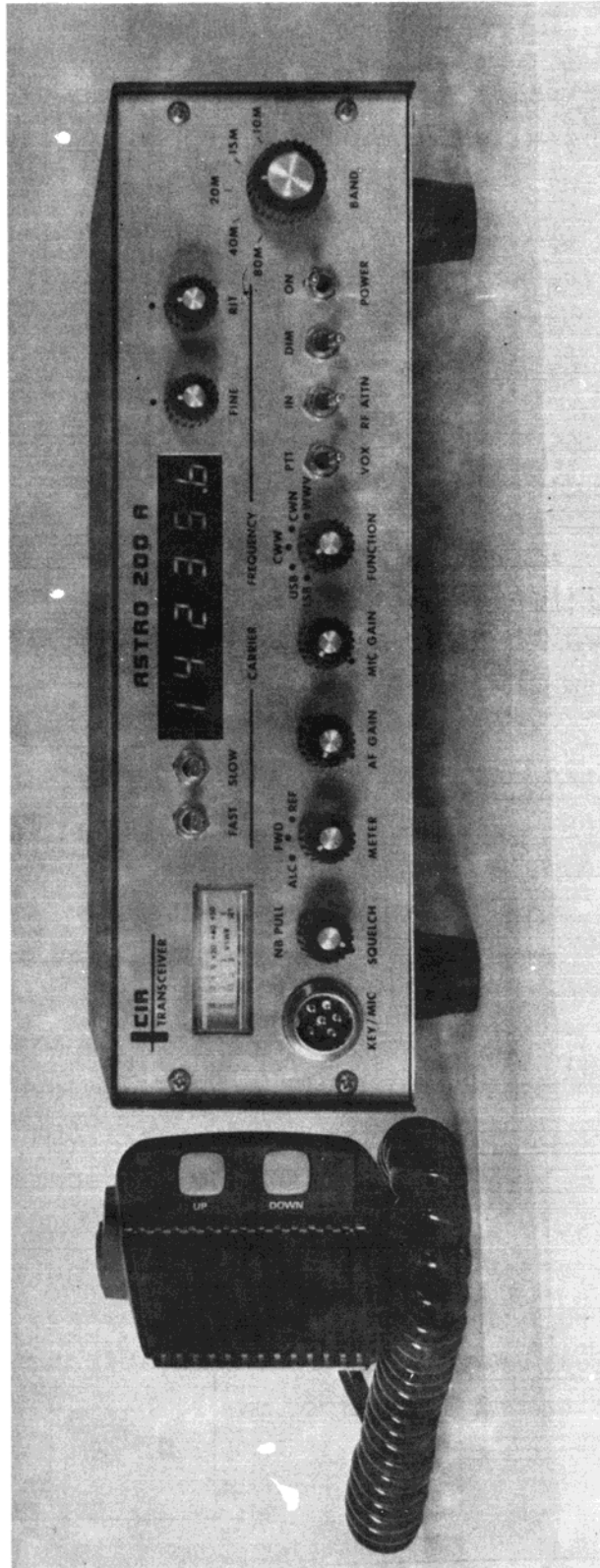
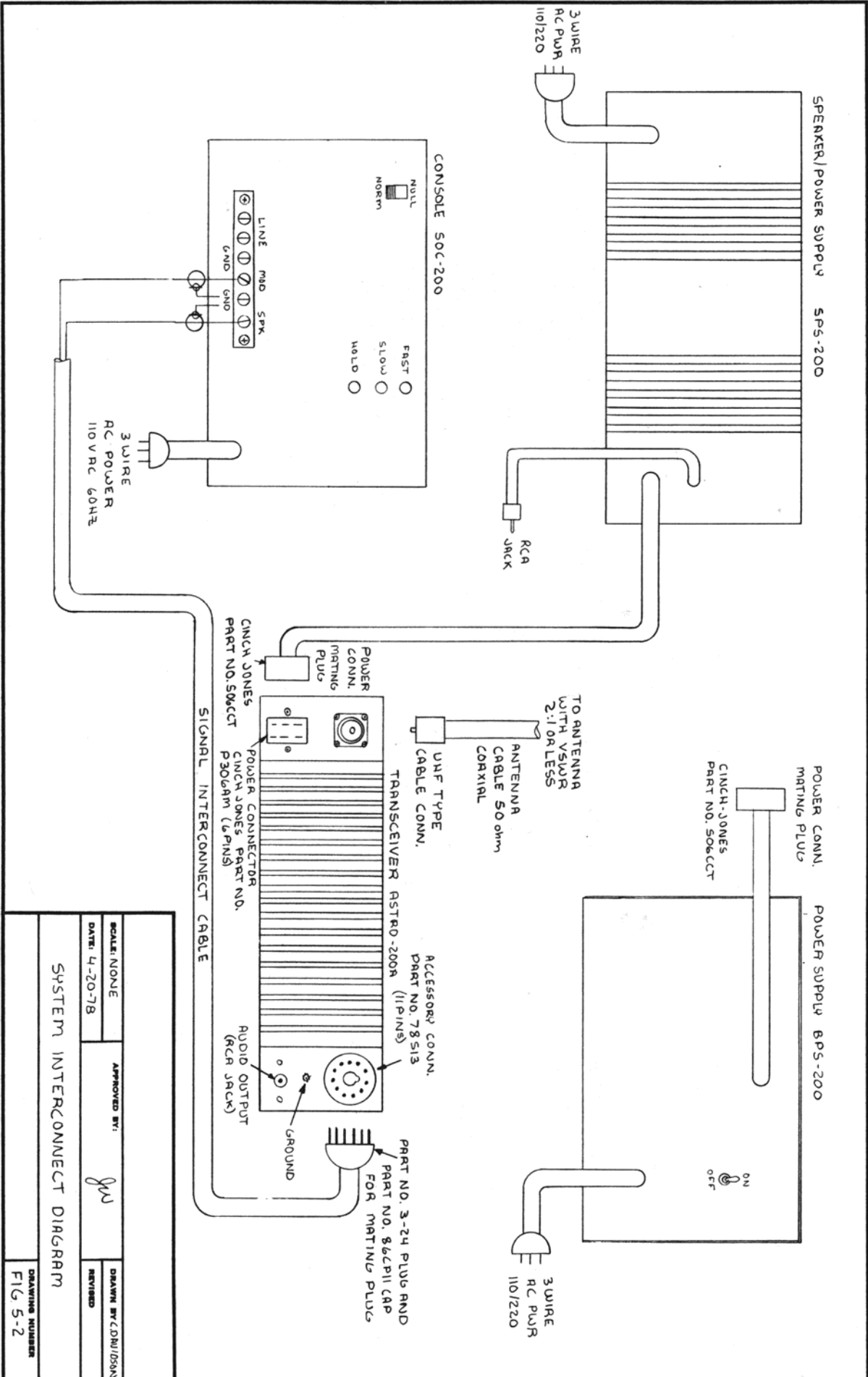


FIG. 5-1



SCALE: NONE		APPROVED BY: <i>[Signature]</i>	
DATE: 4-20-78		DRAWN BY: CDW/JDS/AN	
		REVIEWED	
SYSTEM INTERCONNECT DIAGRAM			
DRAWING NUMBER			FIG 5-2

switch, except at a rate of about 400Hz/sec. Tuning in single 100Hz steps can be accomplished by a "push and release" momentary action of this switch.

Digital Readout: A six digit LED readout gives the carrier frequency in kHz to the nearest 100Hz. This frequency indication is the carrier frequency when the FINE and RIT controls are straight up (zero position).

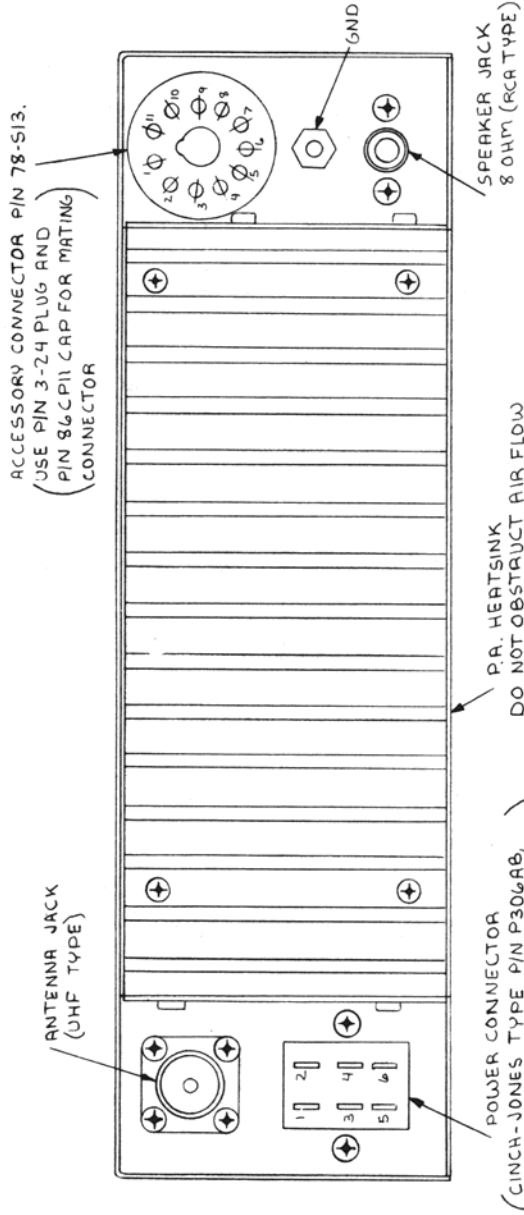
Fine: This control moves the operating carrier frequency to greater than +50Hz from the digitally indicated LED frequency. This allows operation in between the 100Hz steps of the digital synthesizer.

Rit: This control moves the receiver carrier frequency from the transmitting carrier frequency by greater than +50Hz.

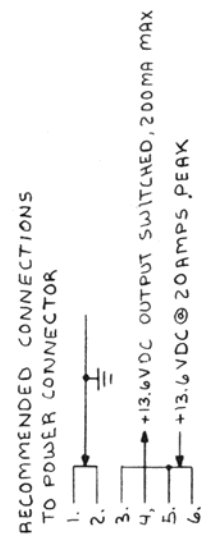
B. Rear Panel

Each rear panel connector, as well as a total system hook up is shown by System Interconnect Diagram (Figure 5-2). In addition more detailed transceiver connections are shown by the Back Plate Outline drawing (Figure 5-3). Referring to the back plate outline drawing it should be noted that pins 3,5, and 6 should be connected in parallel on the power connector. This will provide power to the transmitter through pins 5 and 6, and power to the remainder of the

ACCESSORY CONNECTOR	
FN	FUNCTION
1	V LINE - DIRECT CONNECTION TO INTERNAL PTT BDS.
2	13.6 VDC OUTPUT @ 200 mA MAX SWITCHED BY TRANSCIEVER POWER SWITCH.
3	TRANSISTOR SWITCH, OPEN COLLECTOR "ON" IN TRANSMIT, CURRENT LIMIT 200 mA "ON", VOLTAGE LIMIT 35 VDC "OFF".
4	"RECEIVER ON" SIGNAL, 8VDC AT 2 mA MAX WHEN RECEIVER ON, 0VDC FOR RECEIVER OFF.
5	MOD IN - PARALLEL WITH FRONT PANEL MIC. INPUT IMPEDANCE ABOUT 1K.
6	GROUND
7	EXT. LQ INPUT (IVP-P).
8	EXTERNAL ALC CONTROL INPUT POSITIVE GOING 0 TO 8VDC RANGE.
9	EXT. L.O. GATE, 12VDC = EXT. L.O. ON.
10	11VDC REGULATED OUTPUT 50 mA MAX.
11	AUDIO OUTPUT 1WATT, 8 OHM IMPEDANCE



POWER CONNECTOR	
PIN	FUNCTION
1	GROUND
2	GROUND
3	Vcc INPUT
4	Vcc OUT/SWITCHED
5	P.A. Vcc
6	P.A. Vcc



SCALE: NONE	APPROVED BY: <i>jm</i>	DRAWN BY: C. DAVIDSON
DATE: 4-20-78	REVISED	
BACK PLATE OUTLINE		
		DRAWING NUMBER FIG. 5-3

transceiver through pin 3. NOTE: NO reverse polarity protection is provided. See Requirements for Operation part 2, DC Operation.

6.0 OPERATING INSTRUCTIONS

A. Frequency Tuning

All-electronic tuning of digitally synthesized HF transceivers is a new state-of-the-art technology which offers many advantages over the older, more conventional knob-VFO configuration. These advantages include precise frequency setting, no backlash, no mechanical interconnections, and, of course, a more precise tuning method of finding signals down in the noise.

In order to utilize the full potential of all-electronic tuning and realize the many advantages over the conventional methods, the operator must understand not only what is taking place in the tuning operation, but he must learn the easy operating techniques of such a revolutionary development in order to make use of these inherent advantages.

The ASTRO-200A has two toggle tuning switches for frequency selection. Functionally, they operate in the following manner:

The 'FAST' toggle switch is for rapid frequency

tuning. When this switch is pushed up, the carrier frequency is increased toward the top of the band. If the switch is held up through the maximum frequency, the synthesizer loops back to a frequency below the top band edge and again continues to increase. When the switch is pushed down, the carrier frequency is decreased toward the bottom of the band. When the switch is held down through the low end of the band, the synthesizer locks the carrier frequency to the lowest frequency in the band.

The 'SLOW' momentary switch operates in the same manner as the 'FAST' switch except at a much slower tuning rate. The 'SLOW' tune rate is set so that the operator will not miss hearing a threshold level signal as he tunes through the signal.

There is a built-in delay when the operator first activates these switches before the up/down circuits are enabled. This delay enables the operator to have positive control over tuning to an anticipated particular spot in the band.

After acquiring minimal operator experience, one learns when to release the pressure as a signal is approached, Then if desired, a single push up or down allows the synthesizer to move the carrier frequency up or down in 100Hz steps.

B. Transmitter Tuning

The transmitter is designed to operate into a 50 Ohm load impedance with a VSWR of 2:1 or less. No transmitter tuning is required if a matched antenna is used in the usual operating bands. If the antenna has an unknown VSWR the proper tune-up procedure is as follows:

With an antenna of unknown characteristics it will be necessary to install an antenna tuner between the ASTRO-200A and the antenna. To properly adjust the antenna tuner set the function switch to CWW mode and the mic gain to full clockwise rotation. Activate the transmitter by CW key or microphone switch and set forward power with the mic gain control to about mid scale with the meter switch in the FWD position. This gives about 25 Watt output to the antenna. Put the meter switch in the REF position and adjust the antenna tuner per the tuner instructions to achieve minimum needle deflection in the REF reading.

NOTES:

1. It is not always possible to achieve fullscale deflection in FWD mode because the VSWR shutdown will limit output when operating into a mismatch.

2. Never exceed fullscale in FWD during CW operation or tuning operation. This will generate excessive power output and may cause amplifier damage.

C. Transmitter ALC Operation

The ALC (automatic level control) is designed to maintain an average power (as opposed to the more usual peak power control). The ALC is set at the factory to hold an average power of 40 watts. This results in speech peak powers considerably in excess of 100 watts, and 40 watts on a single tone. This form of ALC allows the variable speech compression to function. Normal Mic Gain setting is between 9:00 and 12:00 position for linear operation. If greater "punch" is required the Mic Gain control can be turned up to provide greater compression and average power. Since ALC holds 40 watts average power, and total transmitter gain reduces on 10M band, it is normal to get very little ALC action on 10M, except for high compression Mic Gain settings.

The average ALC circuits are not operative in CW modes and power is set by the mic gain control.

In addition to the average ALC control a VSWR sensitive ALC is provided to limit RF output to about 75 - 90 watts, into a VSWR of 2:1. The power output is progressively reduced as VSWR increases. For a VSWR of about 1.7 or less this shutdown mode is not in operation. The VSWR shutdown operates in any transmitter mode.

7.0 THEORY OF OPERATION

A. General Description

The ASTRO-200A transceiver is constructed of essentially plug-in circuit boards providing easy access to all key signal and test points.

Figure 7-1 shows the functional block diagram of the ASTRO-200A illustrating signal path flow. The transceiver utilizes generally separate receiver and transmitter circuitry for optimum performance. The receiver is single conversion with PIN diode AGC to achieve greater than 100dB dynamic range. The transmitter utilizes broadband circuits through-out to eliminate alignment problems. Bandpass filters for each band and a double balanced transmitter mixer assure freedom from TVI and band splatter. The balanced modulator gives greater than 50dB carrier suppression.

Figure 7-2 is a top inside view of the ASTRO-200A, illustrating the location of functional circuits and controls on the top side of the transceiver.

B. Digital Synthesizer

The digital synthesizer is the heart of the versatility of the ASTRO-200A transceiver. Before describing the operation of this particular synthesizer, it is informative to review the fundamental operation of a basic

phase locked loop. Figure 7-3 illustrates a simple form of a phase locked loop in a block diagram form.

The desired output frequency is phase locked, i.e. frequency stable, to a crystal reference oscillator. In this example loop, the desired output frequency has the long term stability characteristics of the stable reference oscillator -- hence, crystal stability for all frequencies over the entire VCO band of operation. The x_0 is selected to operate at a frequency that is applicable to the particular frequency scheme of the radio, and optimum as far as a stable operating crystal frequency is concerned.

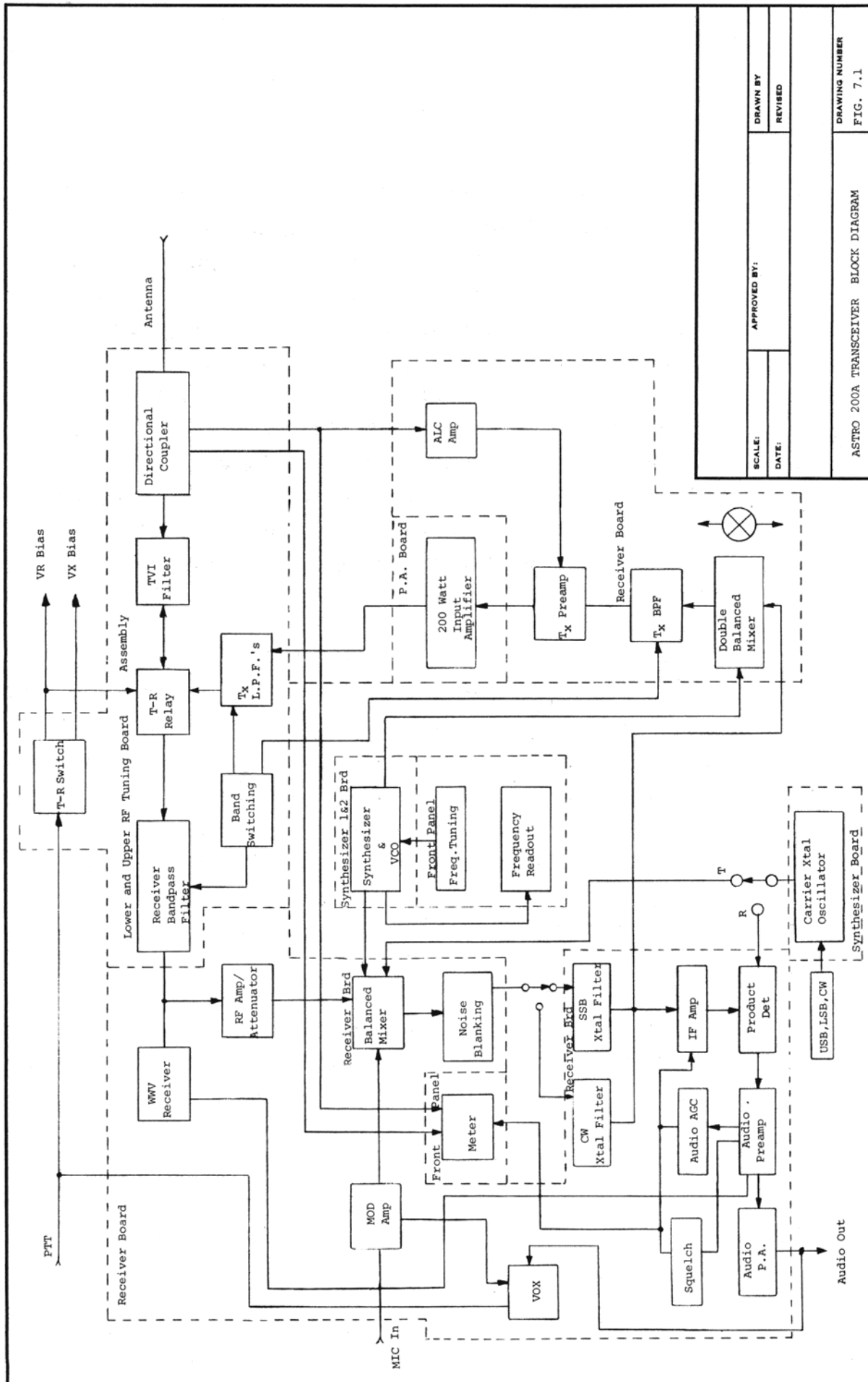
The output of the reference oscillator is divided by some number N such that the reference frequency F_r is compatible with the phase detector and the divided frequency from the voltage controlled oscillator (VCO). This reference frequency F_r also determines the digital frequency step resolution of the synthesizer, i.e. for a 100Hz F_r , the synthesizer can produce phase locked output frequencies in 100Hz steps.

The VCO operates over a band of desired output frequencies. The frequency of the VCO is determined by a DC control voltage. One of the outputs of the VCO is the desired output frequency. A second output is divided by some number M , and F_s is fed to the phase detector.

If $F_S = F_R$, the output of the phase detector will be some DC voltage, and for discussion purposes, let's say zero volts. If the VCO output frequency increases, the loop frequency, F_S , will increase, and the phase detector sees an increasing phase with respect to its stable reference F_R . The output of the phase detector will be a DC voltage that is filtered through a low pass filter which drives the VCO to the exact frequency such that $F_R = F_S$ and thus "locks" the loop. If the VCO output frequency decreases, the phase detector DC output is of the opposite polarity and the DC control voltage drives the VCO in the opposite direction to regain $F_S = F_R$.

Again, for discussion purposes, let's assume a 10MHz reference oscillator frequency and N is 100,000. This establishes $F_R = 100\text{Hz}$. Now, let's assume that we desire a stable 5MHz output frequency. If M is 50,000, then $F_S = 100\text{Hz}$ and the phase detector and filter will keep zero voltage applied to the VCO, or will correct the frequency to zero error with the proper DC error voltage. This action phase locks the 5MHz output to the 10MHz reference oscillator.

Now, let's say we want to change our desired output frequency to 5.5MHz. We need only to change the programmable divider M to 55,000, then the $F_S = 100\text{Hz}$ for a 5.5MHz desired output frequency and the loop will acquire phase lock.



11X17 PRINTED ON NO. 1000H CLEARPRINT

SCALE:		APPROVED BY:	DRAWN BY:
DATE:			
ASTRO 200A TRANSCIVER BLOCK DIAGRAM		DRAWING NUMBER	
		FIG. 7.1	

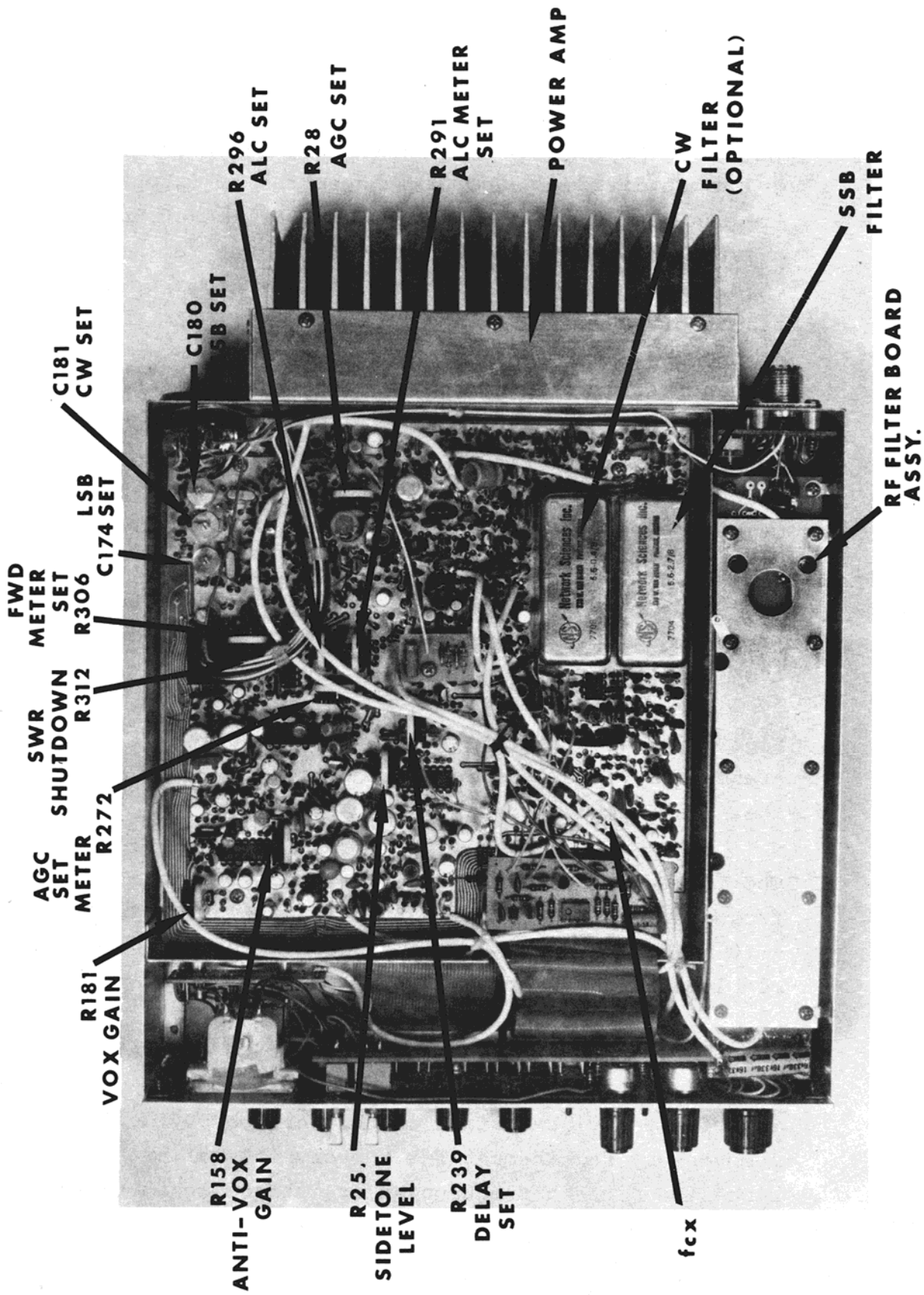


FIG 7.2

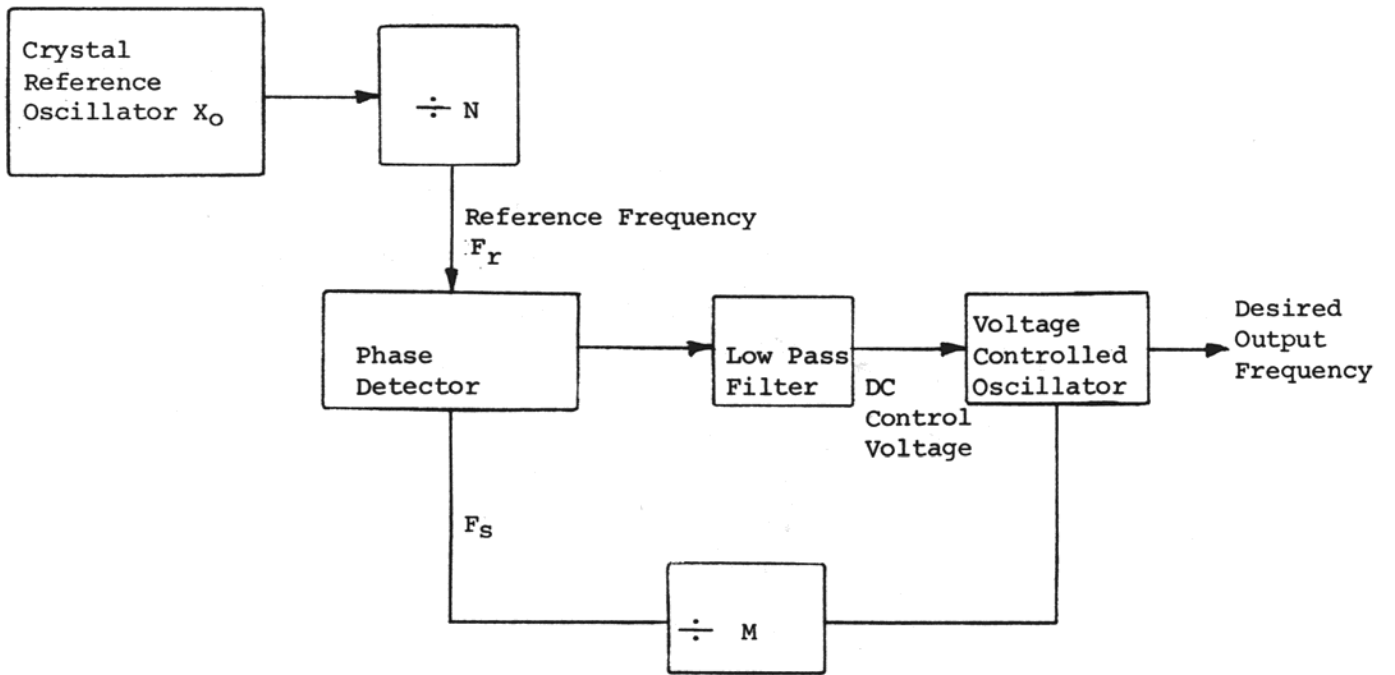
It is now clear that by merely changing M, the programmable divider, a complete spectrum of output frequencies may be derived, each phase locked to the crystal stable reference oscillator. One further note, the output of the phase detector could be any reasonable DC voltage range compatible to the VCO design (not necessarily centered around zero volts) and an increase in the zero "error" or control voltage from its zero error reference will drive the VCO in the opposite direction. In each case, the error voltage drives the VCO output frequency such that F_s will equal F_r .

The frequency synthesizer in the ASTRO-200A utilizes these fundamental principles in a two phase locked loop design.

Figure 7-4 is a picture of the inside bottom of the transceiver illustrating the location of the synthesizer circuit boards of the ASTRO-200A.

The frequency synthesizer generates crystal controlled frequencies in 100Hz steps for all amateur bands 80 - 10 meters. Figure 7-5 is a block diagram of the complete synthesizer.

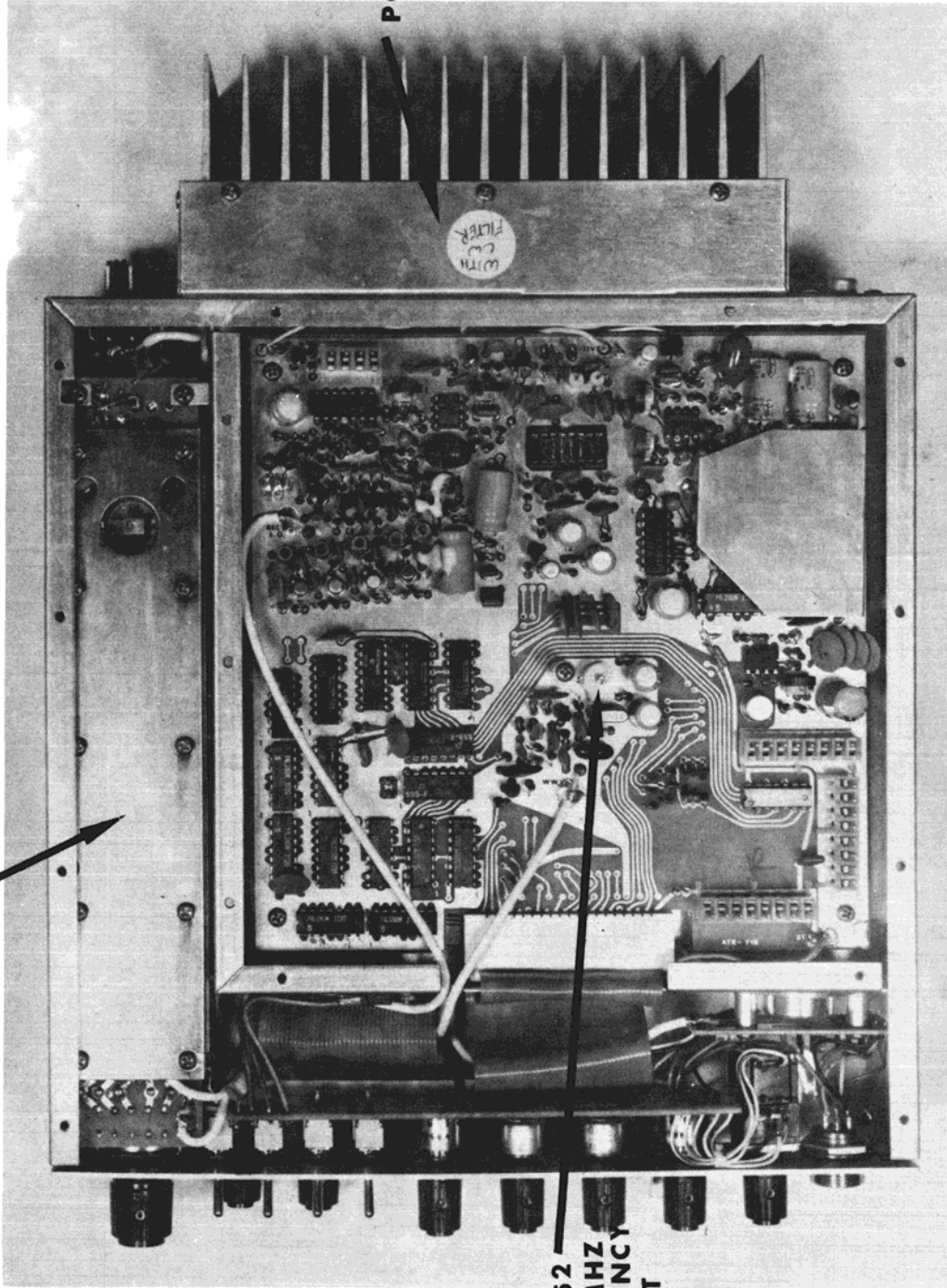
Two phase locked loops (PLL) are used to generate the crystal controlled frequencies. (It is again noted that frequency generation of this nature obviously removes any requirement for the crystal calibrator since the derived frequencies are phase locked to the crystal controlled reference oscillator).



BASIC PHASE LOCKED LOOP

Figure 7-3

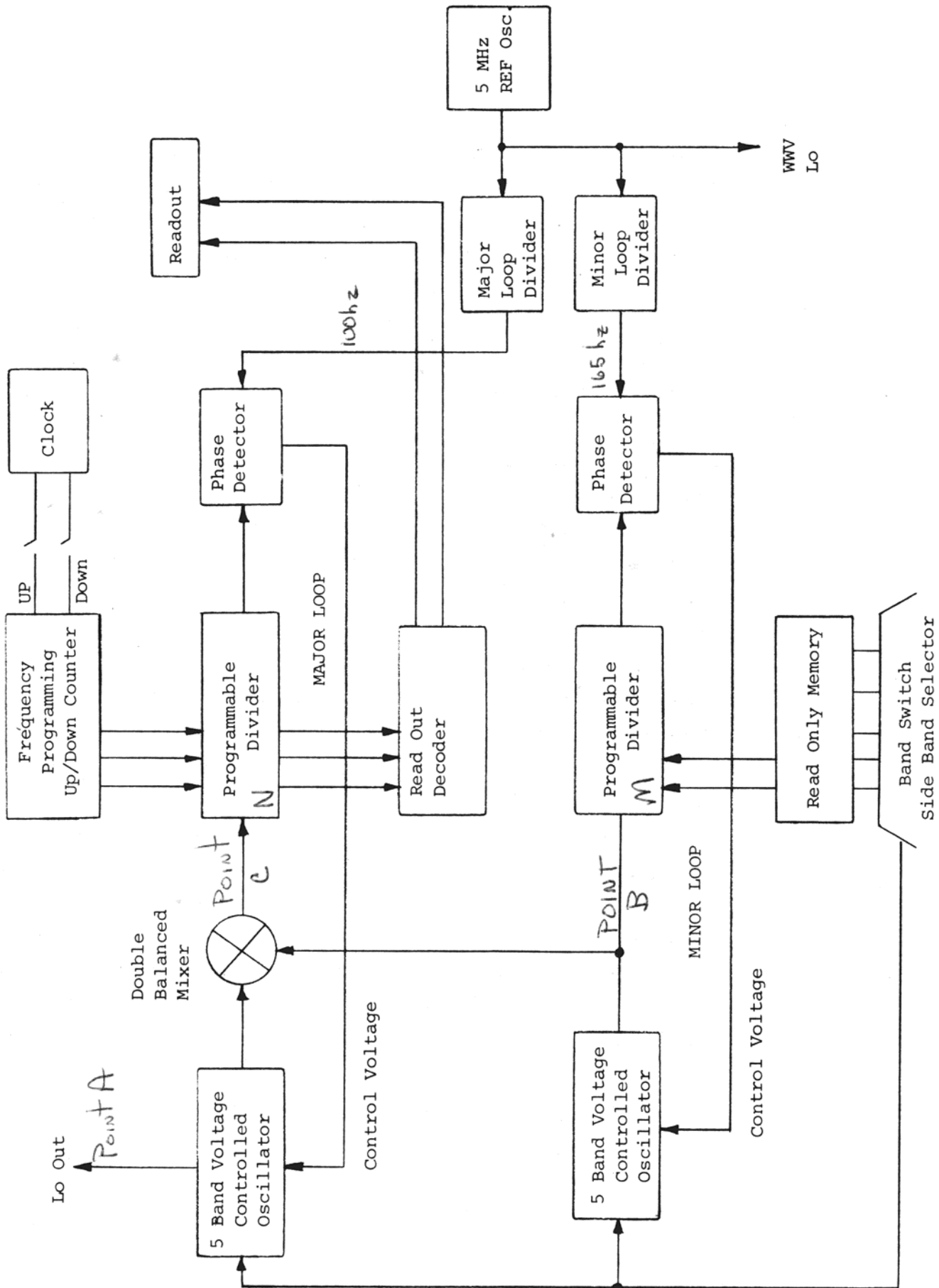
RF FILTER BOARD
ASSY.



POWER AMP

C52
5 MHz
FREQUENCY
SET

FIG 7.4



DIGITAL SYNTHESIZER

Figure 7-5

The major phase locked loop generates the local oscillator frequencies for both the transmitter and receiver. The 100Hz steps are derived from a programming code generated by the up/down counter. The code is selected by front panel frequency selecting switches. These switches gate a clock signal to the up or down counter input to raise or lower the local oscillator frequency.

The minor loop is used to off-set the local oscillator frequency to a value compatible with the programming divider clock rate. The minor loop frequency is also programmed to account for the sideband selected, and selected band.

Both phase locked loops are referenced to a stable 5MHz crystal oscillator -- hence, the very stable frequency characteristic of the ASTRO-200A.

With WWV receiver, this reference oscillator can be set to WWV accuracy for exact frequency operation.

The status of the major loop is monitored by the readout decoder and the selected loop frequency is translated to the carrier frequency readout. The readout is a six digit LED display. The display resolution is to the nearest 100Hz.

The following schematics provide the complete circuit

details of the two synthesizer boards mounted in the bottom of the radio:

ATR-157 Synthesizer #1 Schematic
ATR-169 Synthesizer #2 Schematic (Sheet 1 of 2)
ATR-169 Synthesizer #2 Schematic (Sheet 2 of 2)

C. Receiver

In following the receiver theory of operation discussion, reference is made to the following schematics:

ATR-184 RF Filter and Band Switch Schematic
 Assembly
ATR-175 Receiver Board Schematic (Sheet 1 of 3)
ATR-175 Receiver Board Schematic (Sheet 2 of 3)
ATR-175 Receiver Board Schematic (Sheet 3 of 3)

The ASTRO-200A incorporates RF bandpass filtering ahead of a single conversion to the 5.6MHz IF circuitry. There is a 30MHz low pass filter for each of the five operating bands of the transceiver. In addition, the filter assembly incorporates a 10MHz bandpass filter for the WWV receiver. This RF filtering is located on two circuit boards integral to the band select switch and T-R relay.

The output of the RF filter assembly is fed to the receiver board via coax cable. The RF input is amplified through a dual gate MOS FET and emitter

follower compound amplifier before being applied to the double balanced first mixer. This RF amplifier maintains the receiver threshold essentially constant, up through 30MHz.

The source of the input FET amplifier incorporates a feedback signal attenuator for RF gain control of very large input signal levels.

The receiver local oscillator frequency is applied to the receiver mixer with the RF amplified input signal. The frequency of the receiver local oscillator is determined by the mode of operation selected, and is generated by the frequency synthesizer.

The output of the receiver mixer is transformer coupled to a push-pull IF amplifier and fed through either the 5.6MHz sideband filter, or the 5.6MHz 400Hz narrow band CW filter, to additional IF gain stages. The selection of the filter is made through front panel controls which direct diode and transistor logic for the proper filter selection.

PIN diode AGC control is incorporated in the IF amplifier stages. The IF output is applied to a product detector as is the proper carrier frequency. The audio output is then fed to the audio amplifier circuits. The audio amplifier is an IC, LM380N.

The meter circuits for ALC, AGC (receive level), and carrier power are also incorporated on the receiver circuit board. In addition, the microphone preamplifier and amplifier, the diode logic for the sidetone CW operation, and the receiver delay circuitry are on this board. Adjustments for VOX, anti-VOX, sidetone, meter functions, ALC, AGC, and receiver delay time are available.

The WWV receiver is also located on the receiver board. The signal from the WWV 10MHz filter is fed to a dual gate MOS FET for direct conversion to audio, utilizing the 5.0MHz reference oscillator as the local oscillator. The signal is amplified by an operational amplifier and passes through a two pole active low pass filter. The output of the filter is coupled to the volume control.

The noise blanker circuit accepts the wide band IF signal, amplifiers the WBIF in two tuned stages, and drives two separate detectors; one average detector for wide band signal and noise, and a second pulse detector. The IF bandwidth of the noise blanker is set to optimize S/N of the unwanted impulse noise. The output of the average detector is used to generate the WBIF AGC signal. The pulse detector feeds a comparator to generate the blanking pulse. This pulse blanks the received signal prior to the narrowband crystal filter to minimize filter ringing on impulse noise.

D. Transmitter

The transmitter circuits are shown schematically on the previously mentioned receiver board drawings, and Drawing ATR-190, Power Amplifier Board Schematic.

On the receiver board, the modulation input is applied to the first mixer as is the appropriate carrier frequency. The output of this mixer is a 5.6MHz sideband signal (or CW as selected) which is transformer coupled to the push-pull 5.6MHz amplifier. The sideband signal is filtered by the crystal sideband filter and followed by an emitter follower. The output of the emitter follower is fed to the transmitter mixer with the synthesizer derived local oscillator to give the proper RF sideband frequency f_x . The CW output is generated in a similar manner and transmitted on upper-sideband, 1KHz up from the indicated carrier frequency. The transmitter mixer output is fed to the transmitter preamplifier. The transmitter preamplifier supplies required linear amplification before going to the bandpass filters and the power amplifier board. The bandpass filters present a clean spectrum to the power amplifier.

The power amplifier circuit board has three stages with the last two connected in a push-pull configuration. This amplifier will supply 100 Watts PEP across each band.

WARNING: For maximum power transistor life, 100 Watt (full scale on FWD position of meter) CW output should not be exceeded.

The microphone amplifier utilizes logarithmic response to compress the audio peaks and improve voice average power. The log amplifier is followed by a two pole active filter to limit voice bandwidth to 3KHz. The microphone gain in USB or LSB operation will progressively increase the drive level to the power amplifier. This allows operator controlled RF compression.

8.0 CALIBRATION, SERVICE, AND REPAIR

Most circuit alignment and calibration is factory performed at final check-out and bake-in, and should require no further adjustment. In cases where it becomes necessary for some reason to align circuits other than those described in this section, it is recommended that the unit be returned to the factory for a complete alignment and check-out.

Operator-owner calibration and alignment may be desirable for the following function.

A. Carrier Oscillator Frequency Alignment

NOTE: For setting frequency on USB and LSB, the MIC GAIN should be full CCW and key down to activate f_{cx} signal with minimum transmitter power. For setting CWW, MIC GAIN should be full CW and key down. These tests should be performed with transmitter loaded into a dummy load to prevent unwanted transmissions.

Refer to Figure 7.2 for location of adjustments and circuit board. A frequency counter should be connected to f_{cx} (place probe on center connector at the coax connection). With the front panel switch in USB and the FINE and RIT controls at the 12 o'clock position, adjust C180 until the frequency on the counter is 5.601650MHz.

With the front panel switch in the LSB position, adjust C174 until the frequency on the counter is 5.598350MHz. With the front panel switch in the CWW position, adjust C 204 until the counter reads 5.600600MHz.

B. Reference Oscillator Calibration

Refer to Figure 7.4 and 7.2 for the circuit board location of C52 and the coax 5MHz input to the WWV receiver. This oscillator may be calibrated with either a counter, or the WWV receiver. If the WWV receiver is employed, select the WWV receiver position on the front panel and adjust C52 for a zero beat in the received WWV signal. An oscilloscope monitoring the audio signal is helpful in this. If a counter is used, connect it to the 5MHz coax input to the WWV receiver input point with the counter probe and adjust C52 to 5.000000MHz.

C. Receiver Delay Adjustment

Refer to Drawing Number ATR-176, Receiver Board Layout, and Figure 7.2 for the location of R239 on the receiver circuit board. R239 adjusts the time delay from the time the VOX or key is released, until the receiver circuitry is activated. This adjustment is not critical and may be set to individual operator preferences.

D. VOX Trip and Anti-Trip Adjustments

Refer to Drawing Number ATR-176, Receiver Board Layout, and Figure 7.2 for location of R181 and R158. R181 sets the gain of the VOX activation level and R158 sets the anti-VOX level.

E. Synthesizer Notes

The synthesizer design incorporates essentially non-adjustable components throughout the logic scheme and routine maintenance or tuning is not required. It should be noted that it will not be possible to see many of the pulses in the digital circuits with the normally used general purpose oscilloscope. These circuits require precision high speed oscilloscopes in order to accurately trace the synthesizer waveforms. Further, test equipment used at many of the circuit points will cause erroneous data, including synthesizer loop unlocking, due to loading or peripheral effect of the test equipment.

F. Power Meter, Reflected Power Meter Adjustment

Refer to Drawing Number ATR-176, Receiver Board Layout, and Figure 7.2 for the location of R306 and R312. R306 calibrates the forward power reading while R312 calibrates the VSWR shutdown of power. The RF output cable should be connected to a through

line calibrated Wattmeter and terminated into a 50 Ohm non-reactive load. With the function selector in the CWW position, and meter switch in FWD position, key the microphone and set the MIC gain for 100 Watts as indicated on the through-line Wattmeter. Now set R306 for full scale indication on the ASTRO-200A meter.

To set VSWR shut-down it is necessary to load the transmitter with a known 2:1 VSWR; for example two 50 ohm loads in parallel. With the mic gain in the full counter clockwise position key the transmitter and adjust R312 to limit power output to about 90 watts. With this adjustment the VSWR should read about 2 in the REF meter mode.

NOTE: DO NOT OPERATE TRANSMITTER INTO MISMATCH ANY LONGER THAN NECESSARY TO MAKE SHUT-DOWN ADJUSTMENT.

G. ALC Set

Refer to figure 7.2 and Drawing ATR-176 for location of R296. Terminate the transceiver with a 50 ohm load. Set MIC GAIN full clock-wise, meter mode FWD, Key transmitter, and whistle into microphone. Adjust R296 to a meter reading equivalent to +30dB on the S scale. This will set the ALC to hold an average power of 40 watts.

H. ALC Meter Sensitivity

Refer to Figure 7.2 and Drawing ATR-176, for the location of R291. To adjust ALC meter sensitivity set function switch to CWW, meter mode to ALC, and MIC GAIN full clockwise. Key transmitter and note minimum RF power output. Adjust R291 for full scale meter deflection.

I. AGC Setting

Refer to figure 7.2 and Drawing ATR-176 for location of R280. To adjust receiver for proper AGC threshold, inject a signal in the 20M band at 1.5 μ volt level and tune receiver for about a 1KHz signal at the speaker. Set R280 for a meter reading of S-3.

J. AGC Meter Set

Using the same set up as in I above increase the signal level to 50 μ volts and adjust R272 to give a meter reading of S-9.

K. Sidetone Level Set

Refer to Figure 7.2 and Drawing Number ATR-176, Receiver Board Layout, for R257 location. This control sets the audio listening level for CW sidetone during CW operation.

L. Component Replacement and Repair Notes

Should component replacement be necessary, it must be recognized that the circuit boards in the ASTRO-200A utilize plated-through holes. Therefore, in order to remove components without destroying etch, the solder must be removed before the component is removed. Solder wick dipped in flux should be laid over the joint to be de-soldered. Apply heat with a 25 Watt iron over the braid (wick) and "wick" off the solder. Do not force pull out the component. They will come much easier and leave the etch if all solder is removed first. Do not use large hot irons for repair work.

9.0 OPERATING NOTES

A. External Local Oscillator

The ASTRO-200A may be tuned by means of an external local oscillator. The transistor switch for this function is on the receiver board. (See ATR-175, Sheet 3). Q22 and Q23 are connected as a differential switch. To activate the external L.O. function, a 12 to 15VDC gating signal is applied to Pin 9 of the accessory connector. This gating voltage turns on Q22 and turns off Q23. An L.O. signal of about 0dBm (.2Vrms) should be supplied by coax to Pins 7 and 6 of the accessory connector. This gating has no effect

on synthesizer tuning and does not effect the frequency readout.

The external L.O. Frequency may be determined by the following formula:

$$\begin{aligned} f_{LO} \text{MHz} &= (f_{\text{tune}} \text{MHz} + 5.6 \text{MHz}) \pm .00165 \text{MHz} \\ &+ .00165 \text{MHz for USB} \\ &- .00165 \text{MHz for LSB} \end{aligned}$$

For example: Suppose the desired tuned frequency is 21.00000MHz - USB, then:

$$f_{LO} \text{MHz} = 21.00 + 5.6 + .00165 = 26.60165 \text{MHz}$$

It should be noted that frequencies slightly outside the specified bands can be tuned with only minor loss in performance.

B. Synthesizer

The operational characteristics of a complete digitally synthesized transceiver are superior to the traditional VFO or phase locked loop VFO approach to frequency generation. Upon initial turn-on of the unit, about one minute is required for both synthesizer loops to lock. When changing from one band to another, about 15 seconds are required for the synthesizer loops to stabilize.

After the loops have stabilized, it is not necessary

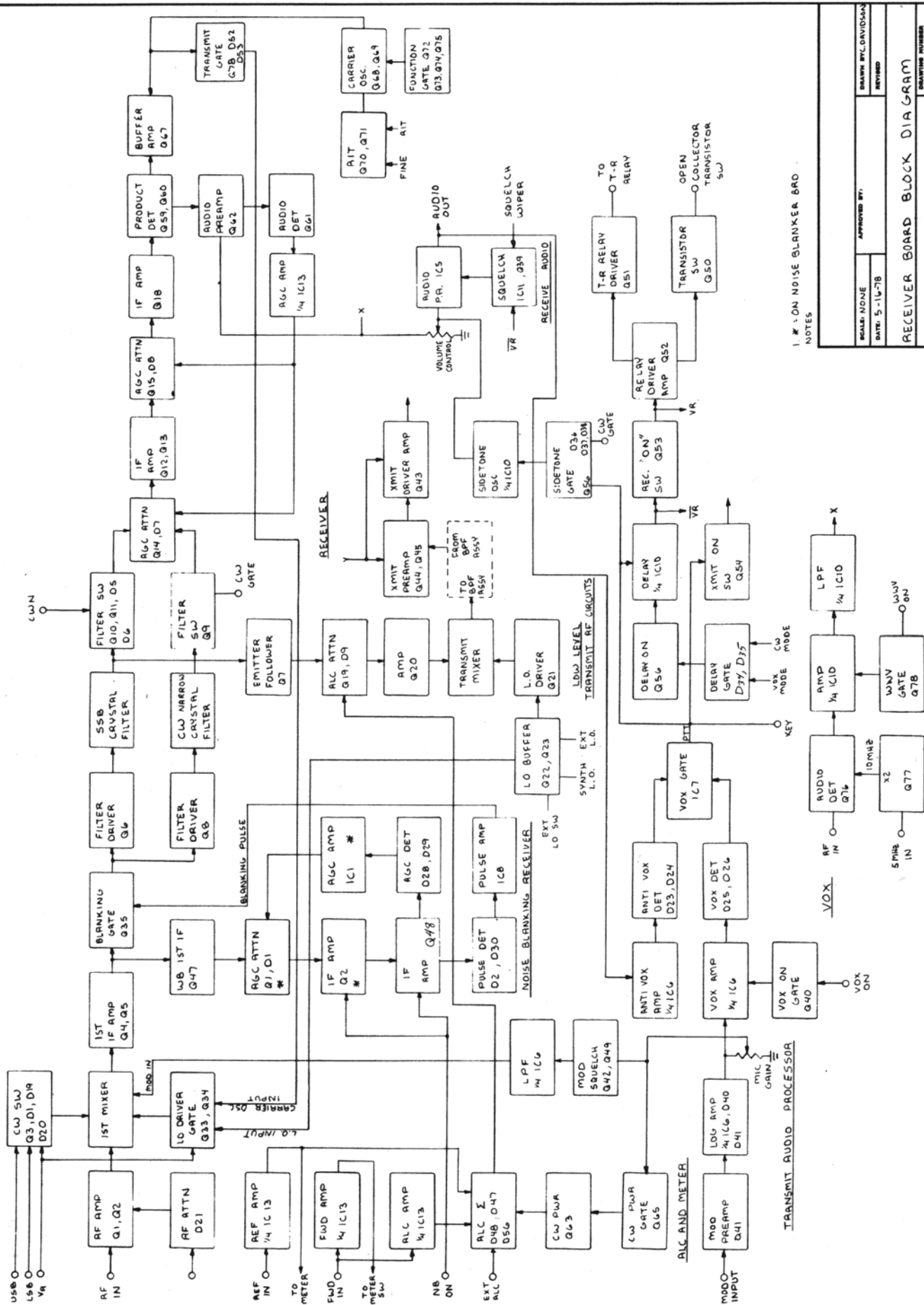
to wait for the loops to stabilize while tuning within a band.

C. Grounding

As with all H.F. transceiving equipment, a good earth (or car frame) ground is important for optimum performance.

D. Mobile Operation

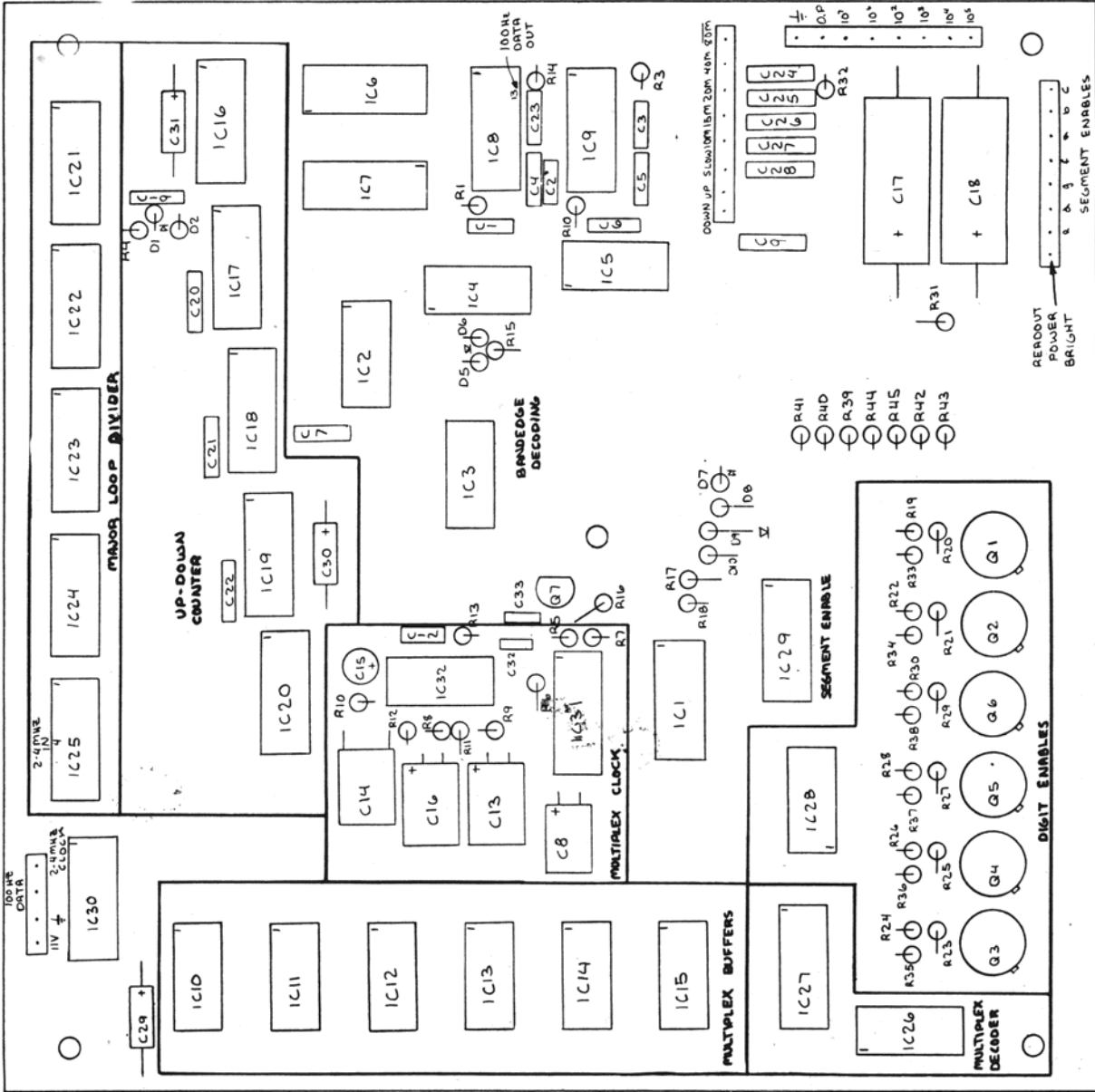
The ASTRO-200A will give stable performance in mobile operation. Electronic tuning is a major improvement in tuning ease and stability, especially in a moving vehicle. It should be noted that a slight frequency shift will be noticed if the bottom cover is deformed or hit. With the unit mounted in a good mobile mount, vehicle vibration, even in off-road vehicles, will not generate frequency shifts.



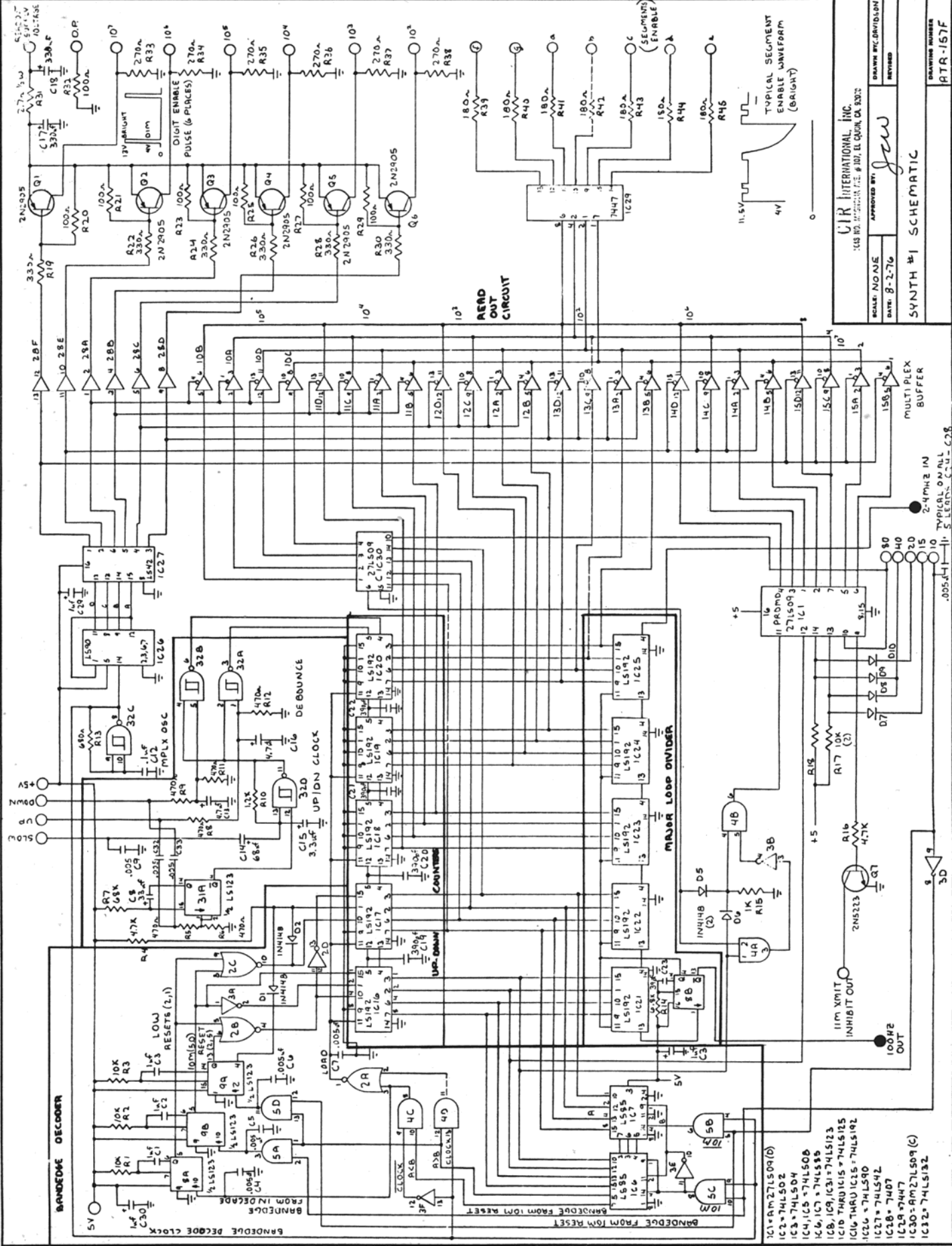
1 # 1 ON NOISE BLANKER BAD
NOTES

DESIGNED BY: DAVIDSON	APPROVED BY:
DATE: 5-14-78	REVISION:
RECEIVER BOARD BLOCK DIAGRAM	
DRAWING NUMBER:	

WJW

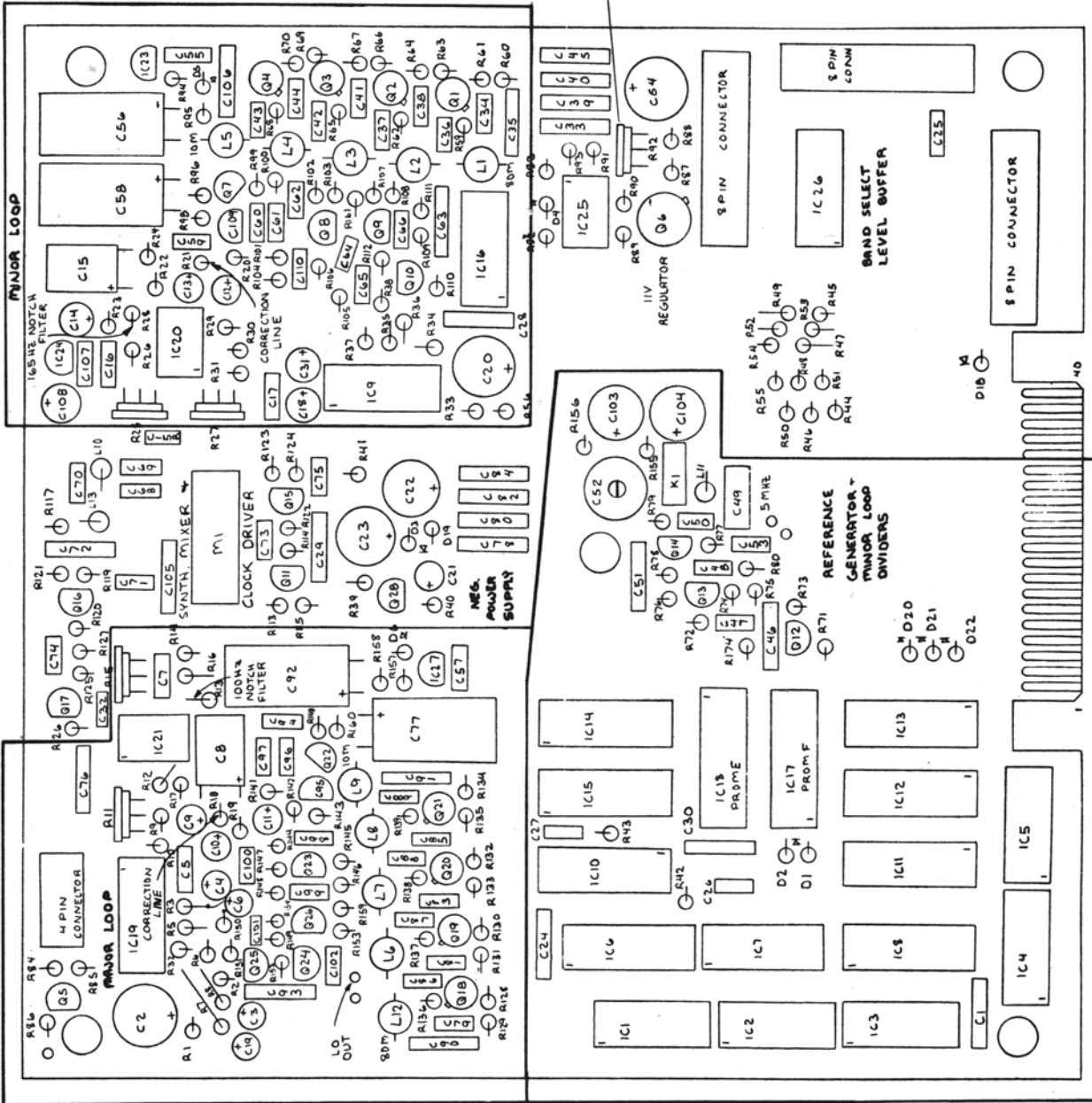


E	REPLACED D3, D4 WITH C32 + C33 WITH .005 UF	C07-21-77	
D	DELETED C10, C11 FROM LAYOUT.	C07-21-77	7-7-77 jaw
C	ADDED R10, C16 TO LAYOUT. CORRECTED REFERENCE NUMBERS	C05-5-77	5-5-77 jaw
B	REVISED - REDRAWN INCREASING SIZE 2:1 FOR CLARITY	C03-11-77	3-2-77 jaw
DESCRIPTION REVISIONS		DATE	APP'D
SCALE: NONE		APPROVED BY:	DESIGNED BY: C.D.R. V. D. G.
DATE: 3-1-77			REVISION:
CIR INDUSTRIES, INC. 111 W. MANCINI AVE. #101, EL CAJON, CA 92020			
SYNTH. #1 LAYOUT		DRAWING NUMBER ATR-158E	



CIR INTERNATIONAL, INC.
 143 RD. WASHINGTON, D.C. #107, EL CAJON, CA. 92023
 SCALE: NO. N/E
 DATE: 8-7-70
 APPROVED BY: *Jew*
 DRAWN BY: DIVISION
 REVISION
 SYNTH #1 SCHEMATIC
 DRAWING NUMBER: ATR-157F

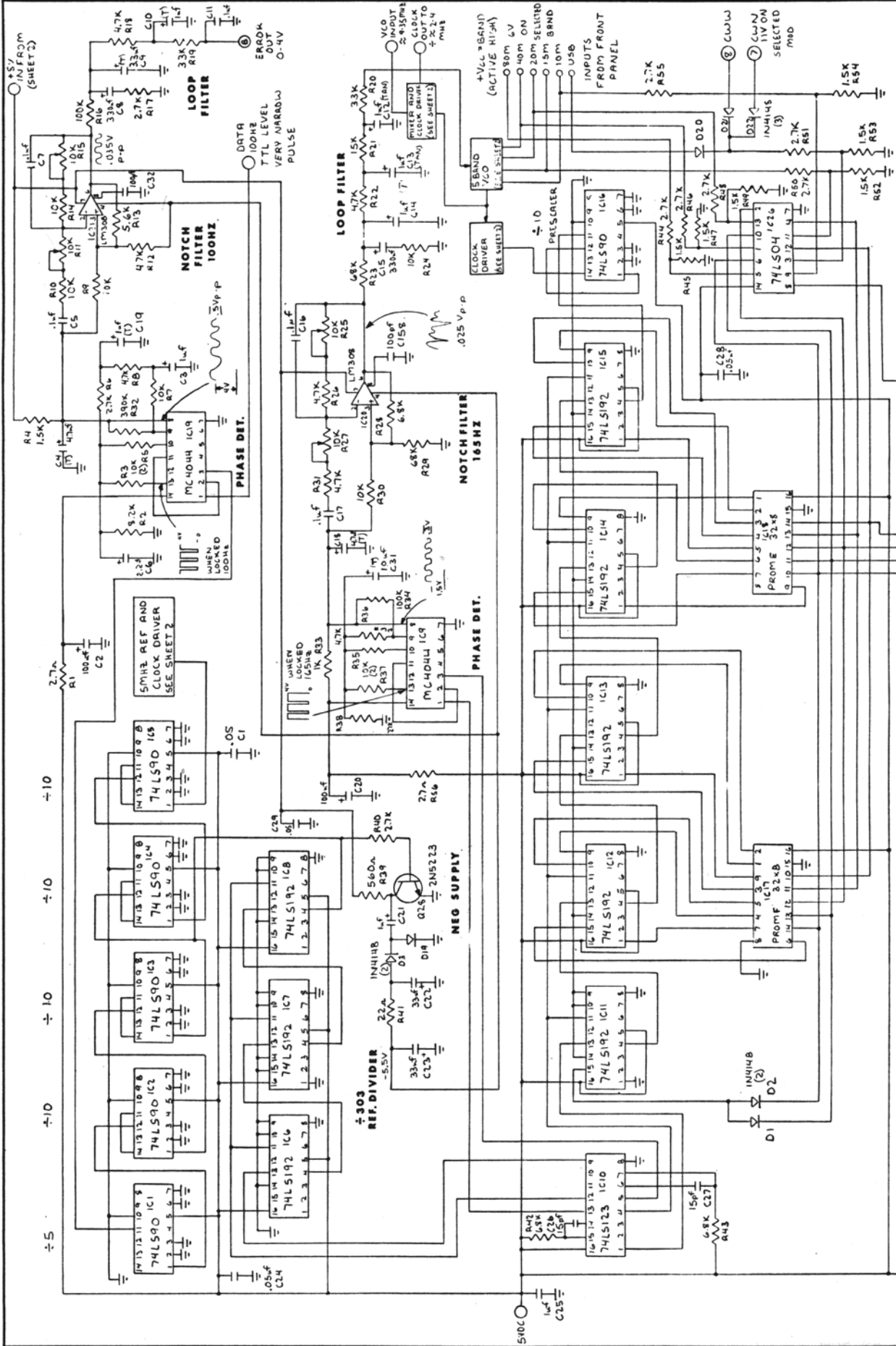
- IC1 = AM27LS09 (D)
- IC2 = 74LS02
- IC3 = 74LS04
- IC4, IC5 = 74LS08
- IC6, IC7 = 74LS59
- IC8, IC9, IC10, IC11 = 74LS123
- IC10 = 74LS105 = 74LS125
- IC12 = 74LS90
- IC13 = 74LS42
- IC14 = 7407
- IC15 = AM27LS09 (C)
- IC16 = 74LS123



REV	DESCRIPTION	DATE	APPROVED BY
G	ADDED NEW MIXER CIRCUIT TO LAYOUT	10-5-77	jen
F	CHANGED LAYOUT TO MATCH LATEST CIRCUIT BRD	7-7-77	jen
E	DELETE C73 ADDRESS, C73 MOVED R105, C64	5-24-77	jen
D	CORRECTED TRANSISTORS ON LAYOUT ADDING TABS ON THEM	4-19-77	ADF
C	CHANGED COLORS ON Z BEAD TRANSFORMERS	3-10-77	ADF
B	DELETED C47 MOVED R32, R34, C101	3-5-77	jen
A	ADDED COLORS TO Z BEAD TRANSFORMERS	3-1-77	jen
1	1/2R DESCRIPTION	CO 2-23-77	APPD

NAME: NONE DATE: 2-11-77		APPROVED BY: <i>jen</i>
SYNTH #2 LAYOUT		REVISIONS
DRAWING NO. 010104		DRAWING NUMBER ATR-170G

1.1 SET OF MATCHED DIODES D14, D15, D16, D17
 NOTES

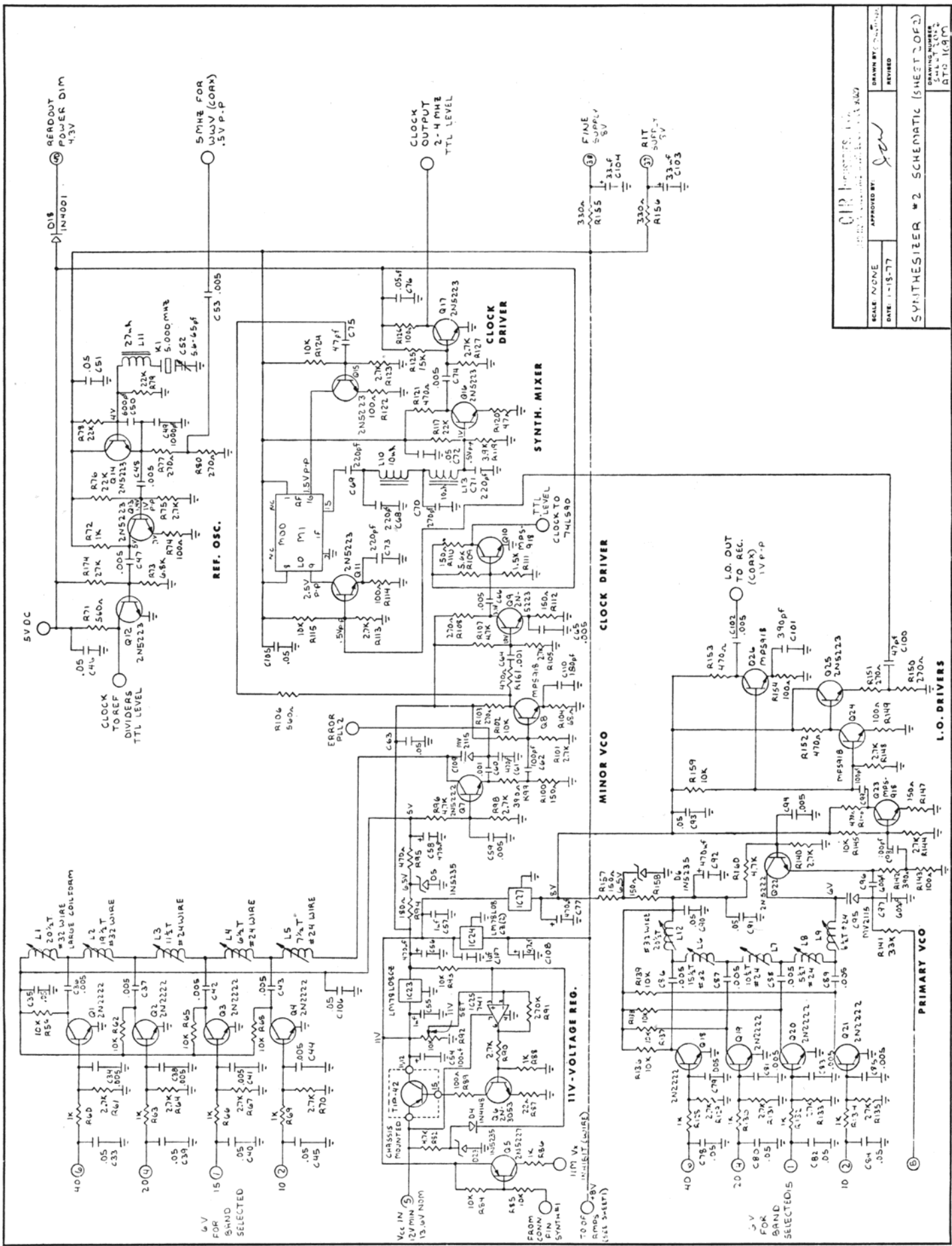


SCALE NONE		APPROVED BY: <i>gaw</i>		DRAWN BY: C. DAVIDSON	
DATE: 5-5-76				REVISION	
SYNTHESIZER #2 SCHEMATIC (SHEET 1 OF 2)					
				QUANTITY ORDERED: 100	
				PART NUMBER: ATR-167 (P)	

ACTIVE LOW
OUTPUTS TO SYNTH
#1 BOARD

MINOR LOOP DIVIDER

0.05uF
C30



SCALE NONE	APPROVED BY <i>[Signature]</i>	DATE 1-15-77	REVISION
SYNTHESIZER #2 SCHEMATIC (SHEET 2 OF 2)			
DRAWING NUMBER: 810149M			

II DETAILED DESCRIPTION

1.0 GENERAL COMMENTS

In the following sections each circuit function is described in the following format:

1. Brief functional description including typical operating characteristics.
2. Expanded schematic with typical operating voltages.

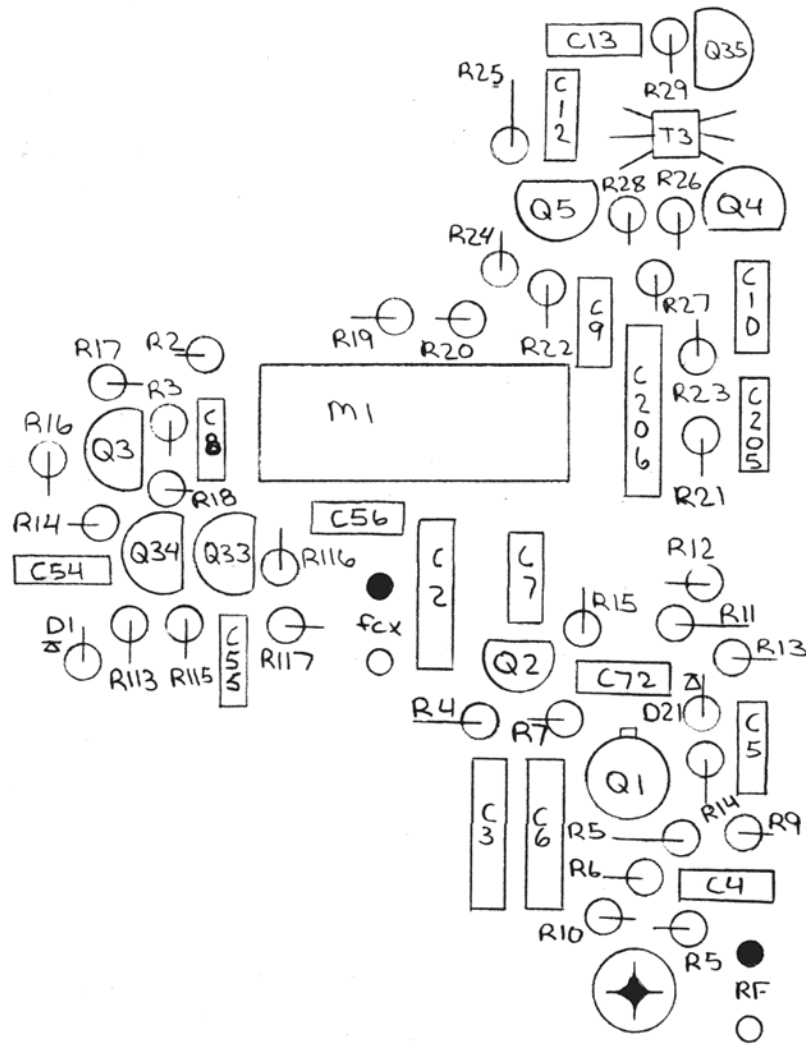
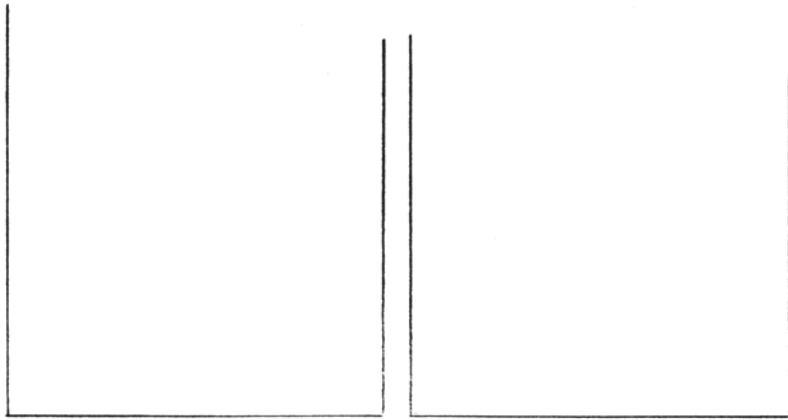
3. Expanded layout with test points noted.

2.0 RF AMP, 1st MIXER, 1st IF AMP, AND BLANKING GATE

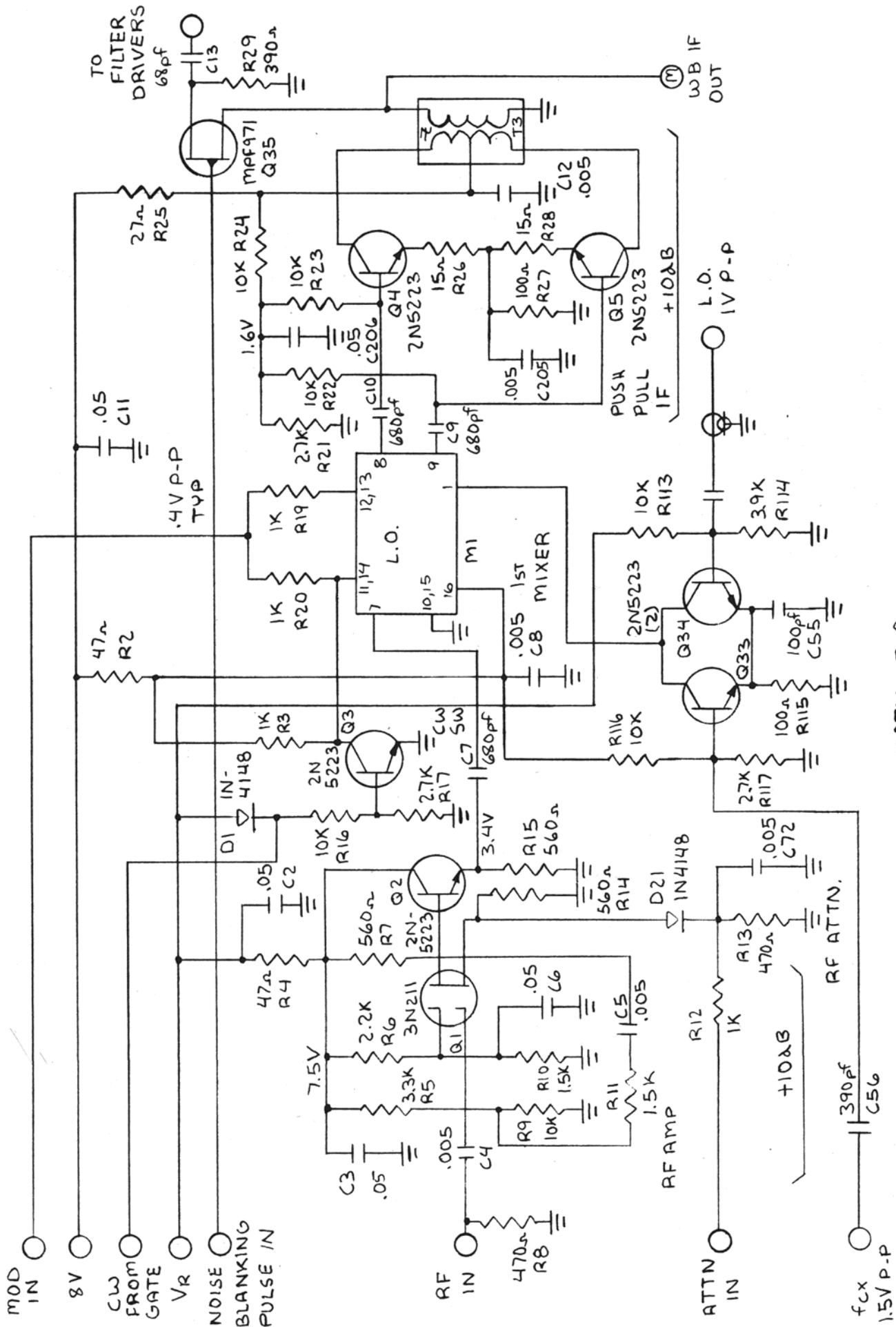
Received input signal is amplified 10dB by the RF feedback amplifier couple Q1 and Q2. Amplified RF signal is fed to the 1st mixer. L.O. is supplied to the mixer by the driver Q34. In the transmit mode carrier oscillator signal is fed by Q33. Transistors Q33 and Q34 are an emitter coupled switch pair.

The mixer balanced output is fed to a push-pull 1st IF amp. This amplifier feeds the crystal filter drivers Q6 and Q8 through the blanking gate Q35.

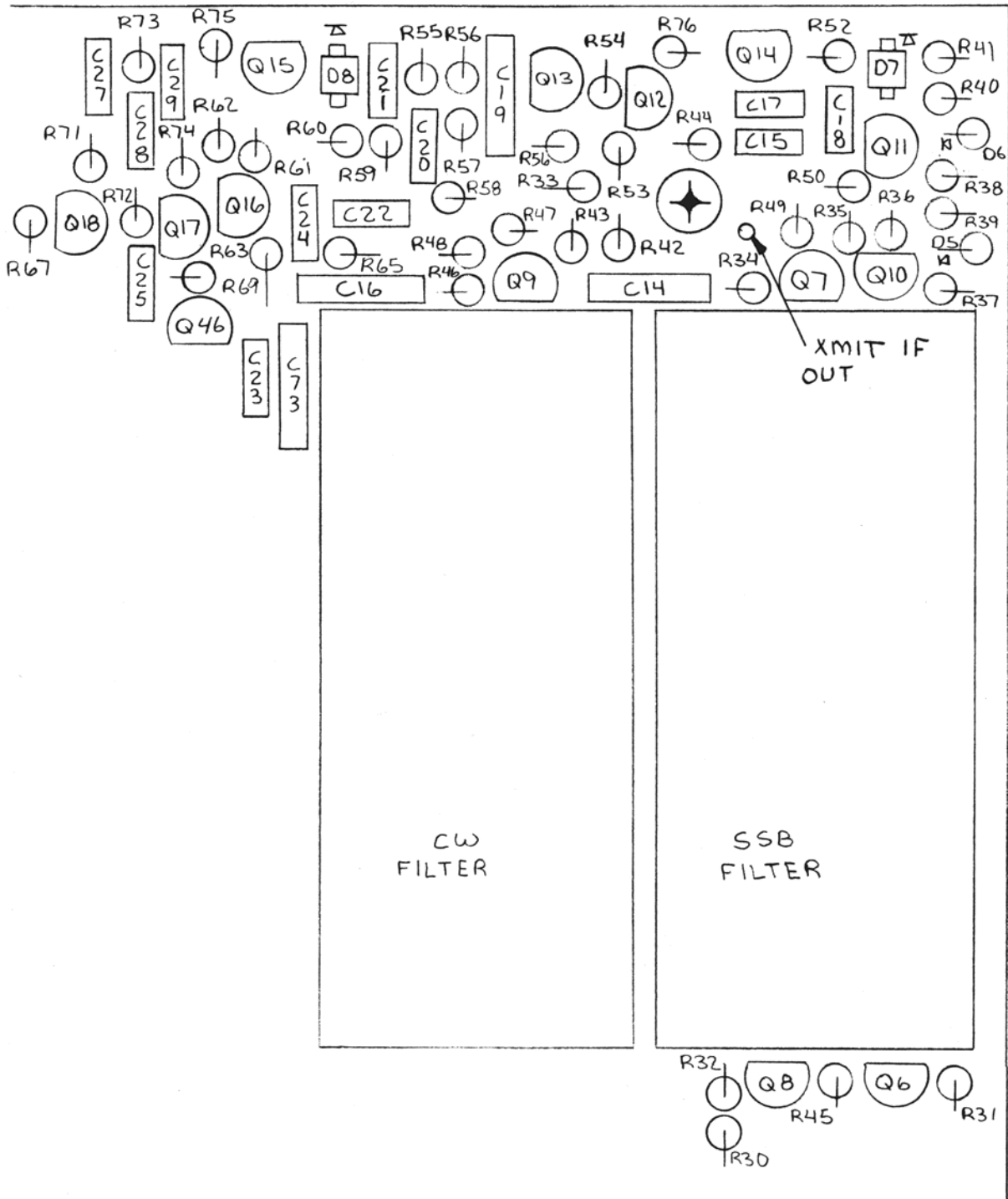
In the SSB transmit mode modulation is applied through R19 and R20. For CW transmit the mixer is unbalanced by Q3 thus allowing carrier signal feedthrough.



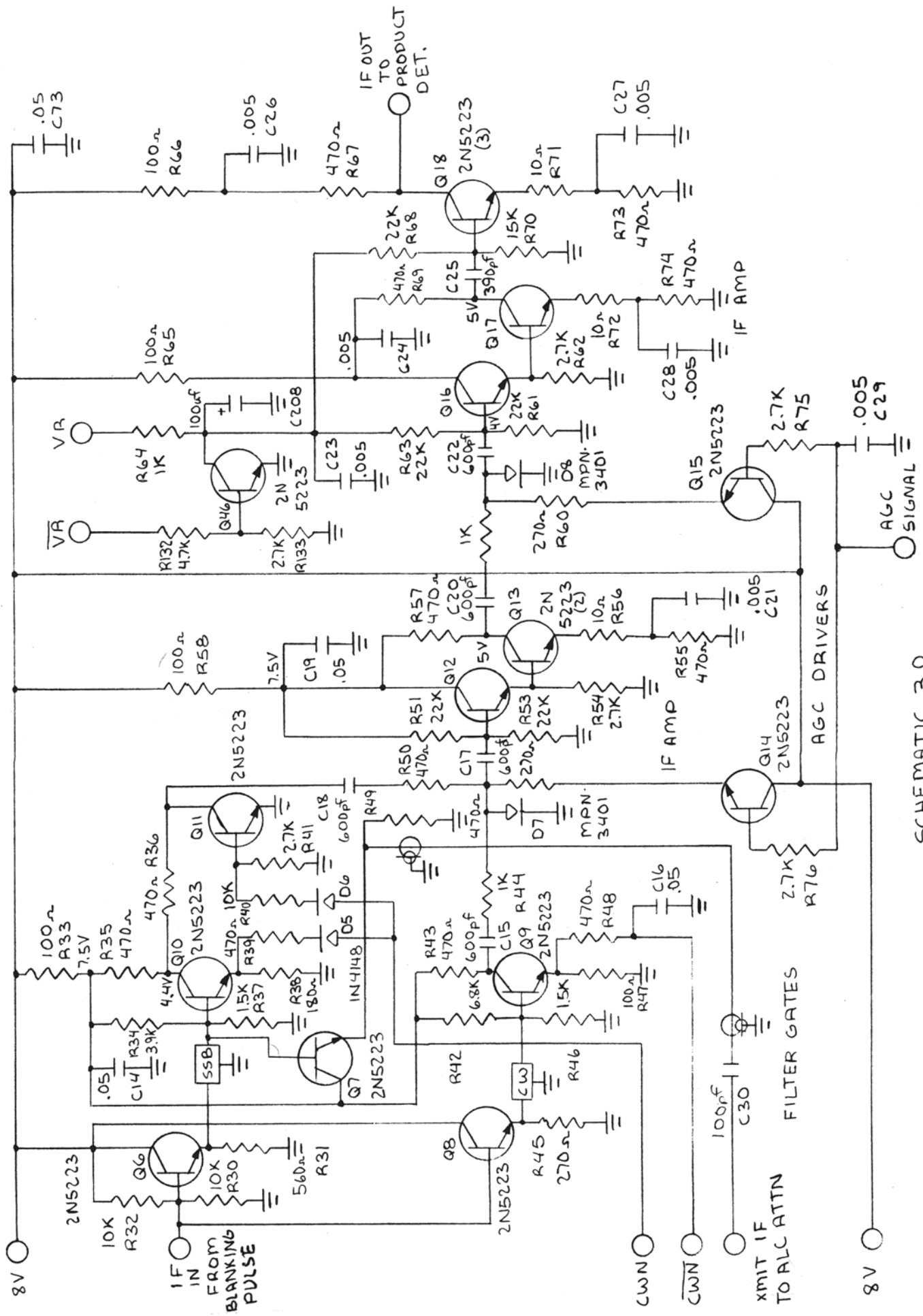
LAYOUT 2.0



SCHEMATIC 2.0



LAYOUT 3.0



SCHEMATIC 3.0

RF attenuation function is performed by applying reverse bias to D21.

No adjustments are necessary on these circuits. Nominal gain through these stages is net 20dB.

3.0 CRYSTAL FILTER SWITCHING, IF AMP AND AGC ATTN.

Each of the two (CWN filter optional) crystal filters are driven by emitter followers. The output of each filter is coupled to amplifier transistors Q9 and Q10.

Transistor Q7 is a buffer emitter follower that drives the ALC attenuator. Transistors Q9, Q10, and Q11 switch the signal path to connect either the SSB filter or the CWN filter.

The switching transistor outputs are summed by resistors that feed the first AGC attenuator. Each of the two AGC attenuators has greater than 50dB attenuation. The remaining circuits are three RC coupled IF amplifiers.

Transistor Q46 is a switch used to instantly cut off the receiver when the transmitter is keyed. Capacitor C208 delays receiver turn-on when Key is released for 10 milliseconds.

No adjustments are necessary on these circuits.

4.0 PRODUCT DETECTOR AND AUDIO AGC

The product detector is an emitter coupled pair Q59 and Q60. The product detector output is amplified by Q62 and the audio is detected by Q61. The detected audio drives the AGC amplifier; which in turn drives the AGC attenuator circuits.

Automatic noise limiter (ANL) diodes are used to clip noise spikes about 6-10dB greater than average audio level. This prevents excessive popping or AGC pumping.

Alignment:

AGC threshold: Adjust R280 for an AGC reading of S-3 at a receiver input of 1.5 μ volts.

5.0 AUDIO POWER AMP AND SQUELCH

Audio power output is generated by IC5, and two squelch functions are generated by IC11 and Q39. IC11 squelches audio as a function of front panel control and signal AGC level. Transistor Q39 squelches audio in the transmit mode.

6.0 CARRIER OSCILLATOR

The carrier oscillator generates the carrier frequency

for the product detector and the first mixer in the transmit mode. Three frequencies are generated:

1. USB 5.60165MHz
2. CW (transmit only) 5.60060MHz
3. LSB 5.59835MHz

Two crystals are used to generate the three frequencies. Switching logic for CW mode is controlled by Q74 and Q75 along with D55 through D58. Transistors Q72 and Q73 select either USB or CW frequencies. Transistors Q68 and Q69 form a crystal oscillator pair. Bias is applied to the proper transistor to generate the desired frequency. Transistor Q67 is the driver to the product detector. Q78 is the driver to the first mixer (balanced modulator mode). RIT frequency control voltage is gated to the varicaps (C170 and C179) through a FET switch (Q70). The switch is controlled by Q71.

Alignment:

1. Tune L11 for maximum amplitude at base of Q60 in product detector (R268).
2. In receive mode set oscillator frequencies as follows:
 - a. USB set C180 for output at R268 equal to 5.60165MHz +10Hz.
 - b. LSB set C174 for output at R268 equal to 5.60165MHz +10Hz.
 - c. CW transmit set C204 for output of Q78 to 5.60060MHz +10Hz. This test must be made in transmit mode and care must be taken to load transmitter with dummy load to prevent undesired transmission.

Note: This frequency can be coupled from the test pin shown in section A at f_{cx} .

7.0 ALC AND METER DRIVERS

Maximum transmitter power can be controlled by one of 4 sources. These are diode "or" coupled to the ALC attenuator. The controls are:

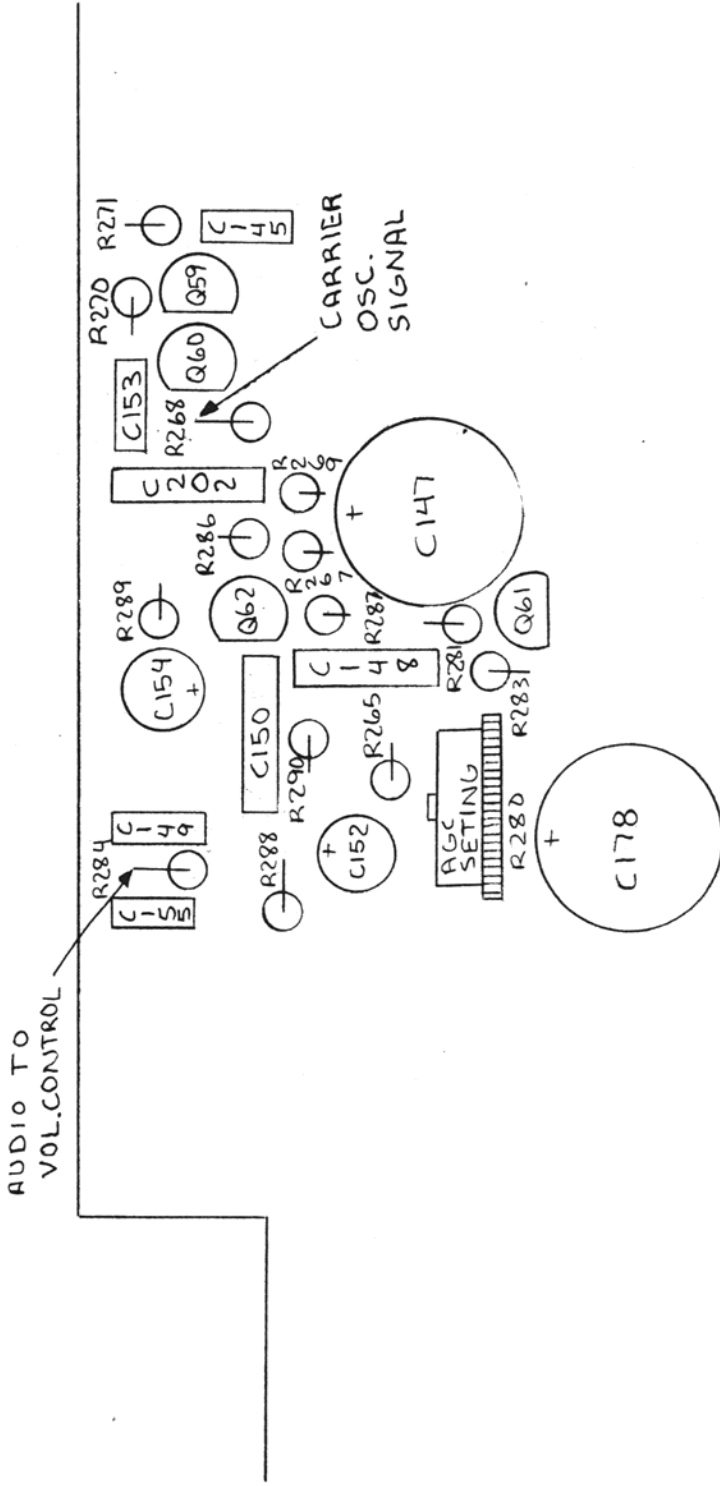
1. Average power detector
2. Reflected power detector
3. CW power set (overrides average power in CW mode)
4. External control.

ALC and Receiver AGC are diode coupled to the meter to read in the ALC meter position.

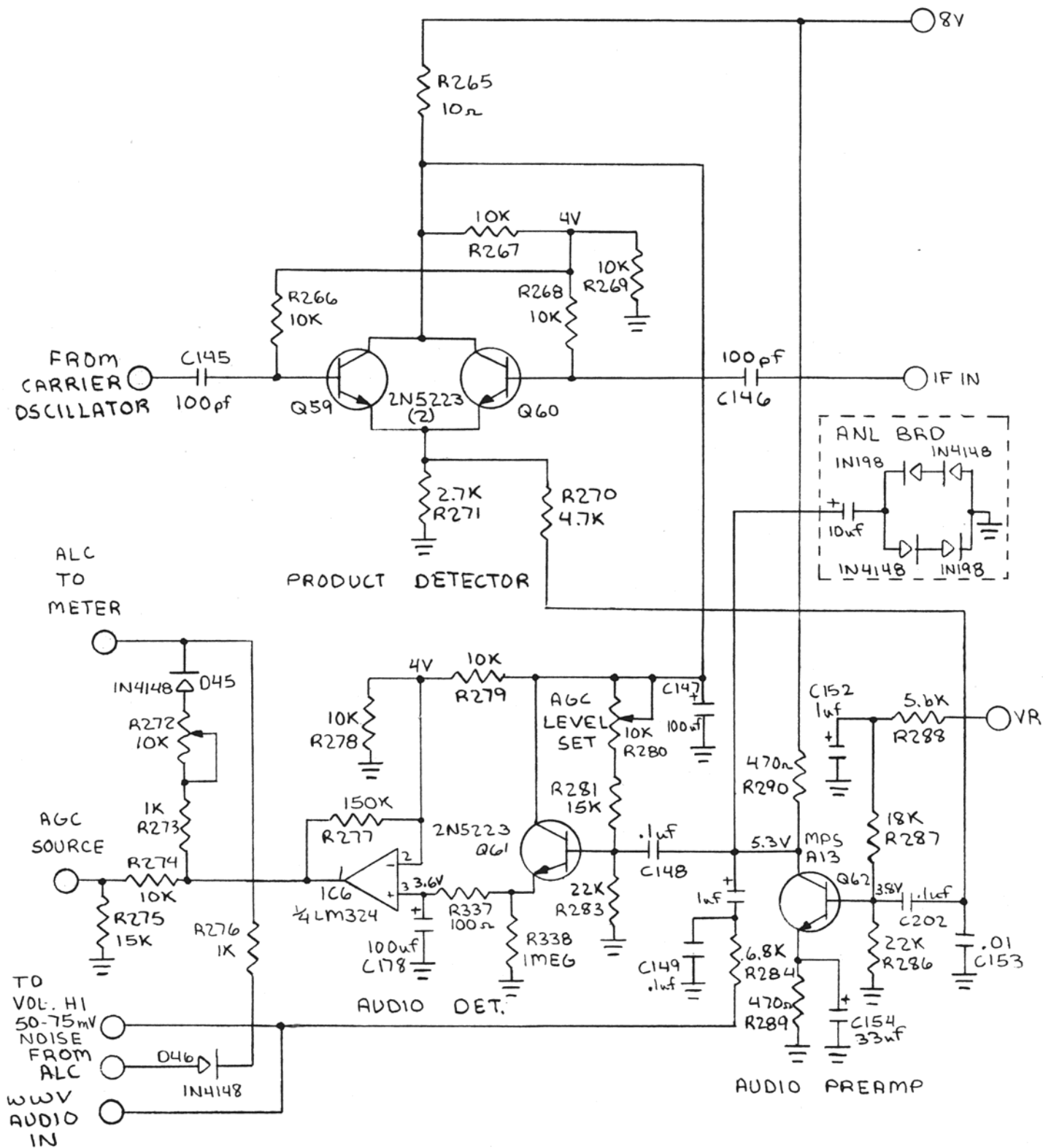
FWD and REF meter readings are derived from buffer amps and signals from the SWR board.

Alignment:

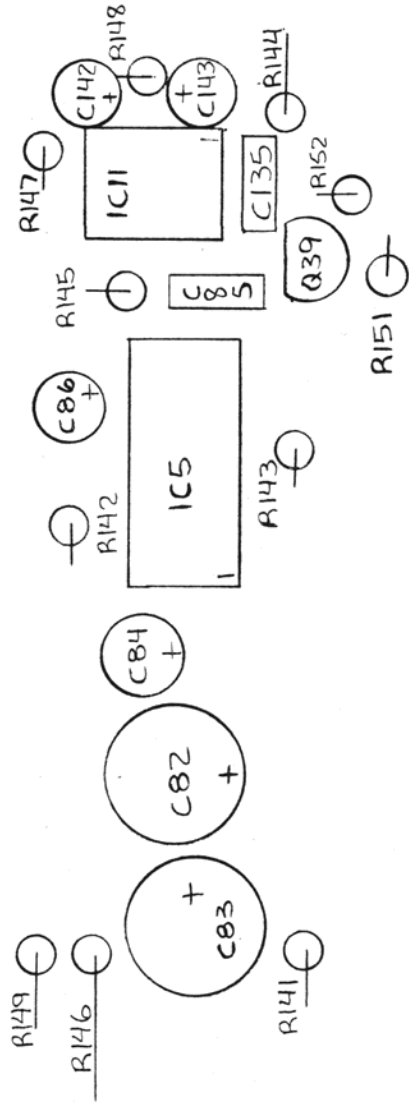
1. AGC. With 50 μ volt signal to receiver adjust R272 for AGC meter reading of S-9.
2. ALC. a. Meter set: In CW turn mic gain full clockwise. With key down adjust R291 for just over full scale deflection.
 - b. Average power control settings:
In a SSB mode set mic gain to 12:00 position whistle loudly into mic and set R296 to hold an average power



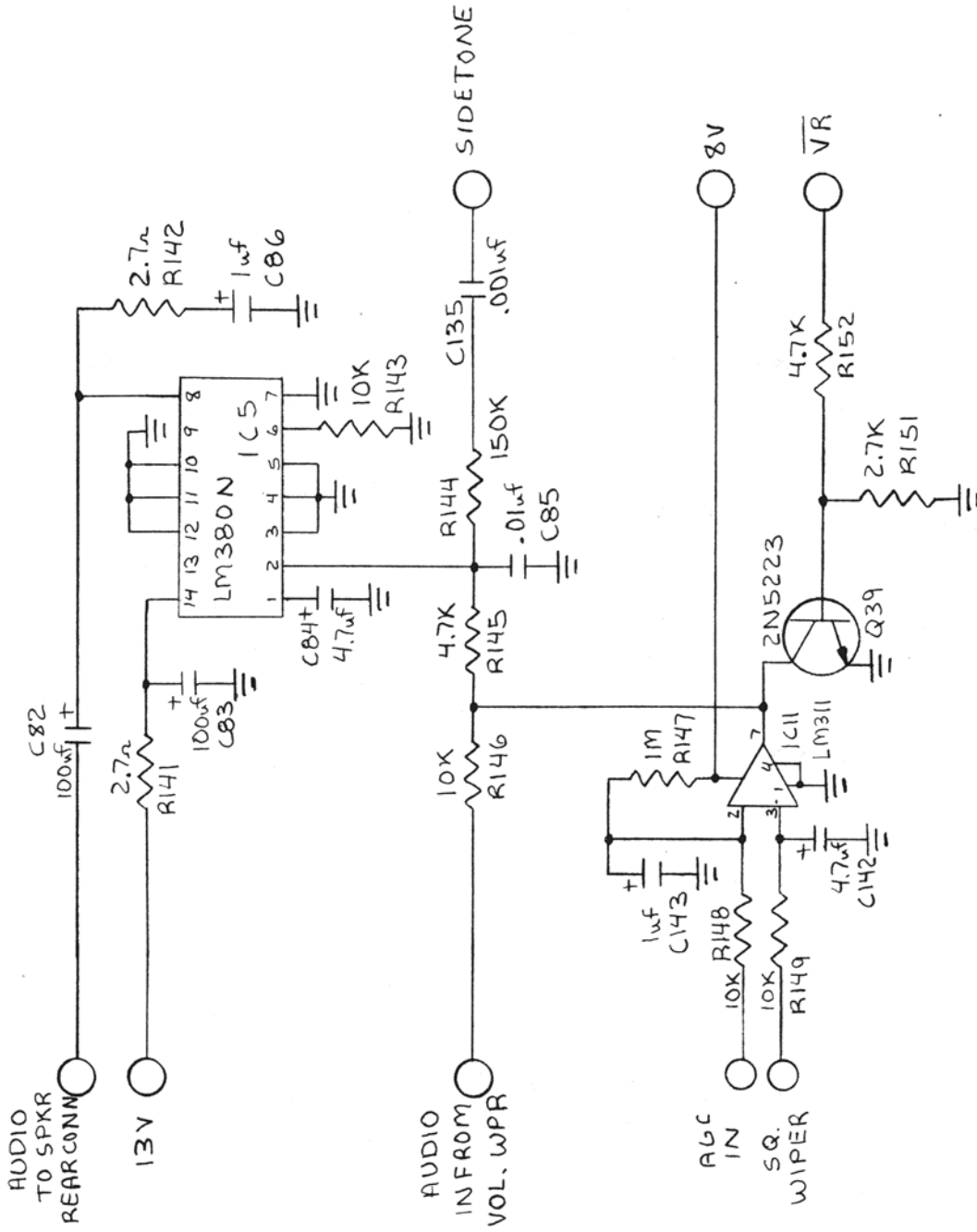
LAYOUT 4.0



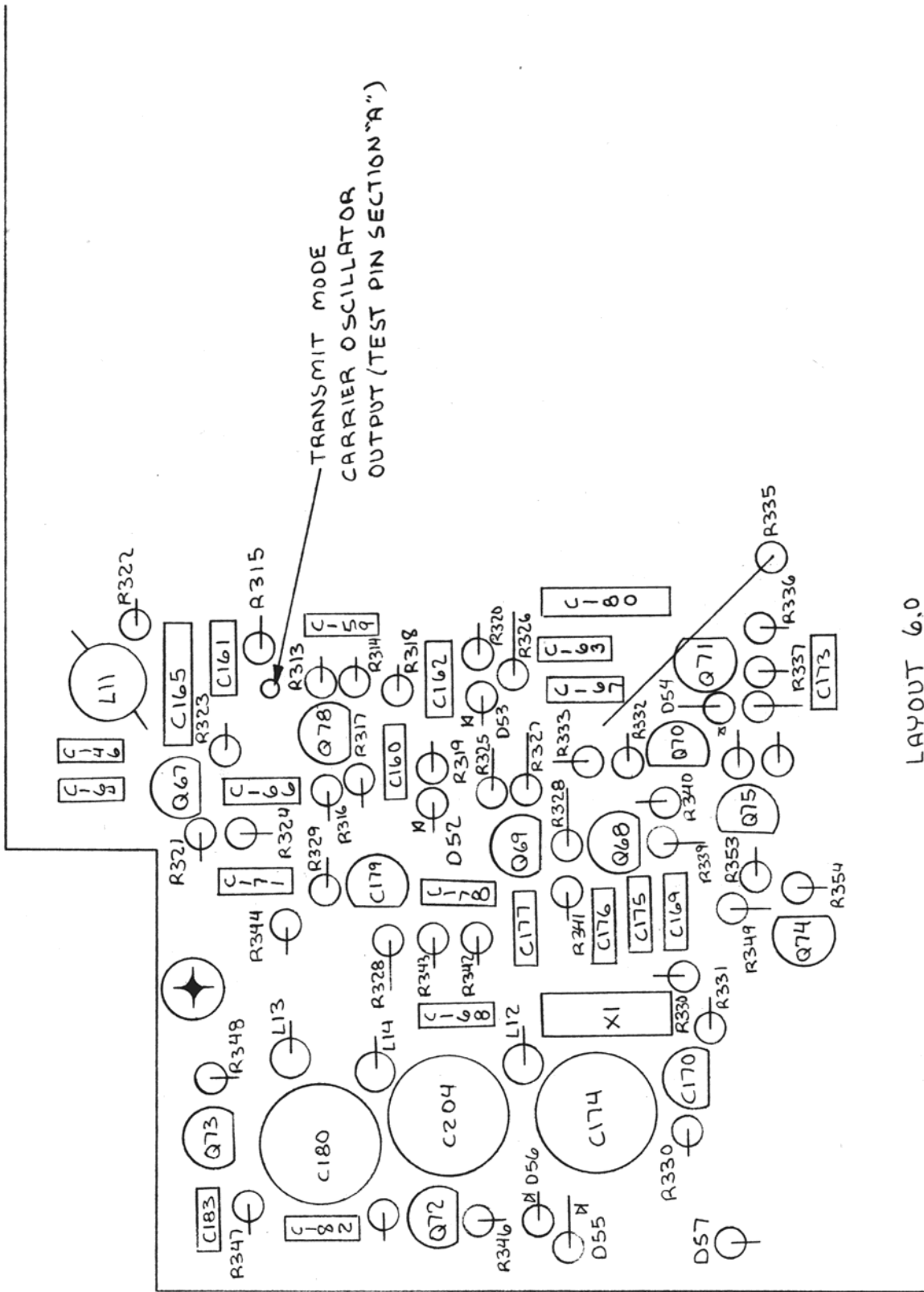
SCHEMATIC 4.0



LAYOUT 5.0



SCHEMATIC 5.0



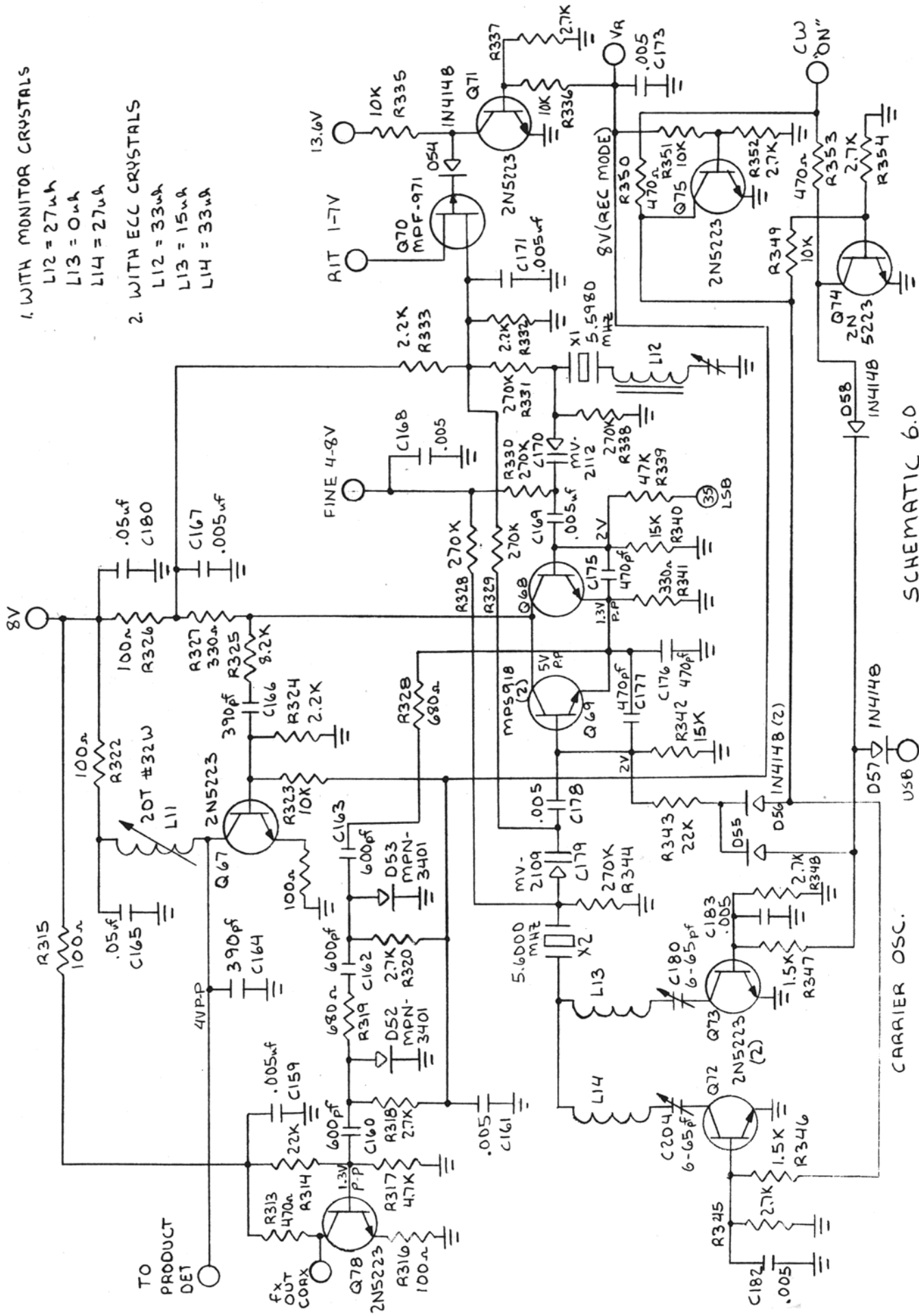
LAYOUT 6.0

1. WITH MONITOR CRYSTALS

- L12 = 27 μ h
- L13 = 0 μ h
- L14 = 27 μ h

2. WITH ECC CRYSTALS

- L12 = 33 μ h
- L13 = 15 μ h
- L14 = 33 μ h



SCHEMATIC 6.0

CARRIER OSC.

USB

of 40 watts. This results in a peak power in excess of 100 watts.

c. REF power control settings:

In the CW mode load the transmitter with a 2:1 VSWR (use two dummy loads in parallel). Set the mic gain full counter-clockwise (max power). Key down and adjust R312 to limit power to 100 watts or less on all bands.

d. FWD power set: In the CW

mode with a matched load set the mic gain to generate 100 watts. Adjust R306 for full scale deflection in the FWD meter position.

8.0 TRANSMIT MIXER AND ALC ATTENUATOR

The transmit mixer sums the sideband modulated signal with LO to generate the desired transmit signal. The sideband signal is fed to the ALC attenuator composed of D9 and Q19. The level controlled signal feeds the mixer signal driver Q20. The LO is fed to the buffer and LO switching amp composed of Q22 and Q23. The buffered output drives the mixer LO driver Q21. Mixer output is taken directly to the transmit preamp.

Alignment:

Tune L6 for maximum signal on the collector of Q20. For this test unit should be set to CW mode and mic gain set full counter-clockwise (max power out).

9.0 TRANSMIT PREAMPLIFIER

The transmit preamplifier is a wideband three transistor circuit intended to raise the transmit mixer output to a level of 6 to 8Vpp. Transistors Q44 and Q45 are a low level feedback couple used to drive a transformer coupled driver stage (Q43).

No adjustments are necessary to this circuit.

10.0 VOX AND TRANSMIT SPEECH PROCESSOR

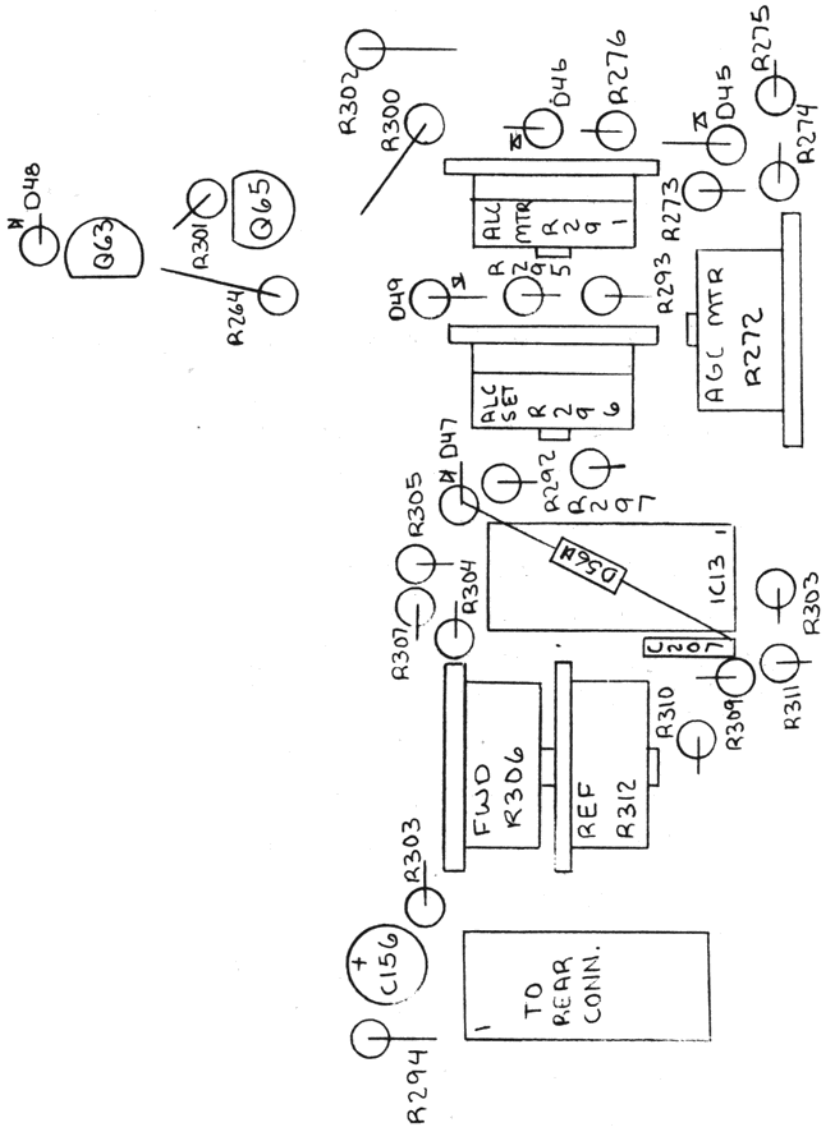
Microphone signals are coupled to the preamplifier, Q41, and then to the log amp, 1/4IC6. The log amp output is coupled to the mic gain control and to the VOX input. Signals from the mic gain wiper are fed to the modulation lowpass filter through the modulation squelch circuit, Q42, and Q49.. Modulation signals are squelched in receive mode and CW mode.

The output of the log amp also drives the VOX amp (1/4 IC6). VOX action is activated by turning the VOX squelch transistor (Q40) off. Antitrip is derived by coupling the audio output signal to the antitrip amp (1/4 IC6). The outputs of the VOX amp/detector and the antitrip amp/detector are summed and compared to a reference level by IC7. The output of IC7 activates the key (PTT) line.

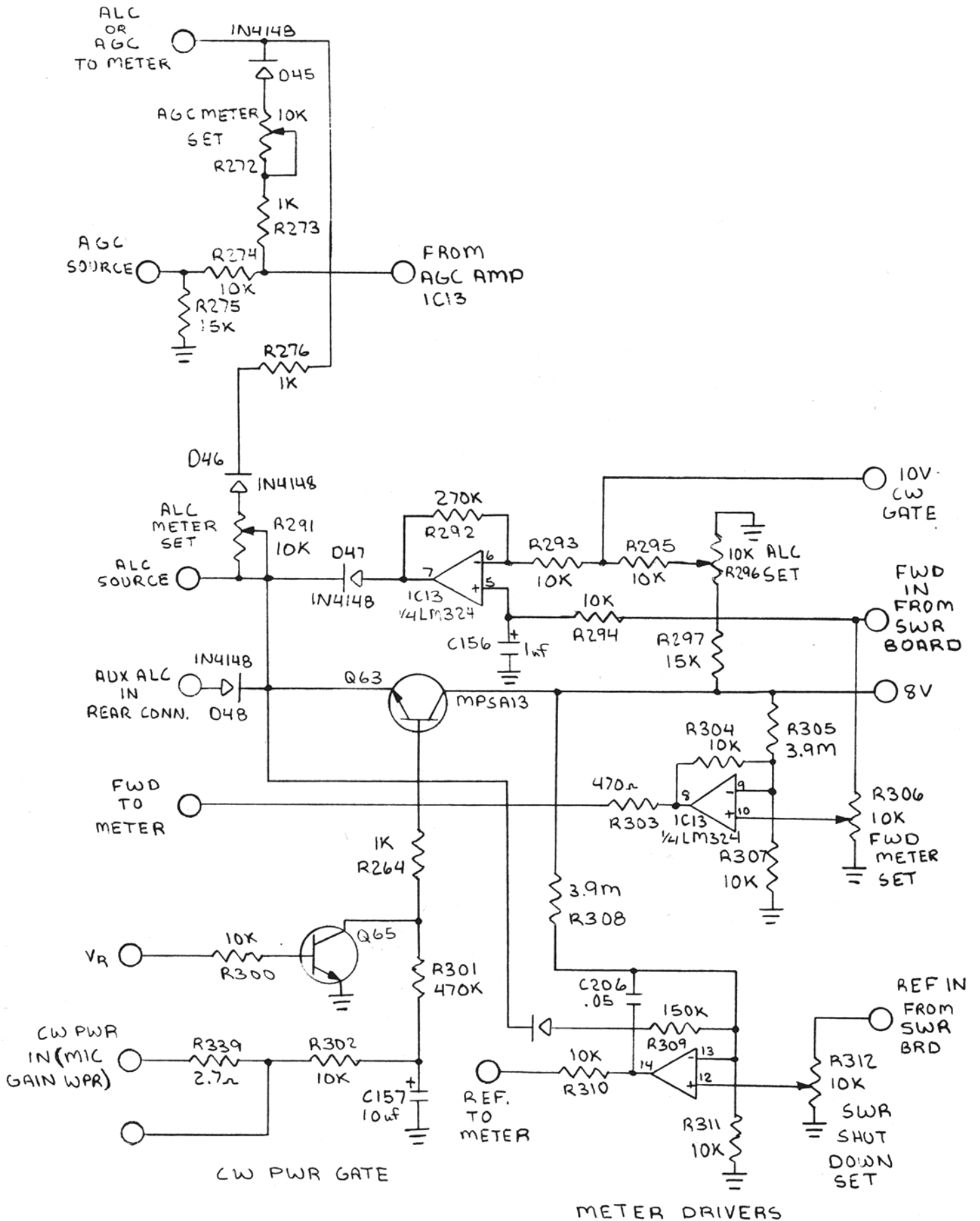
Adjustments: Antitrip sensitivity R178

VOX sensitivity R181

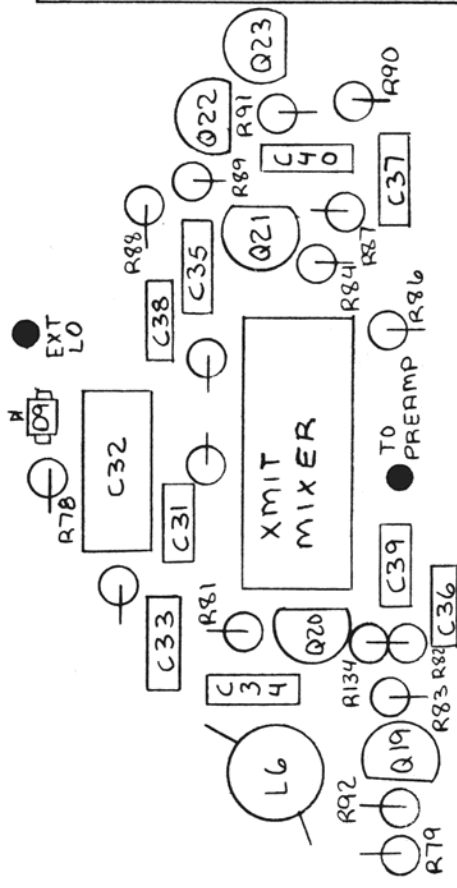
These are operator adjusted to suit operating conditions. These circuits are located in area "G".



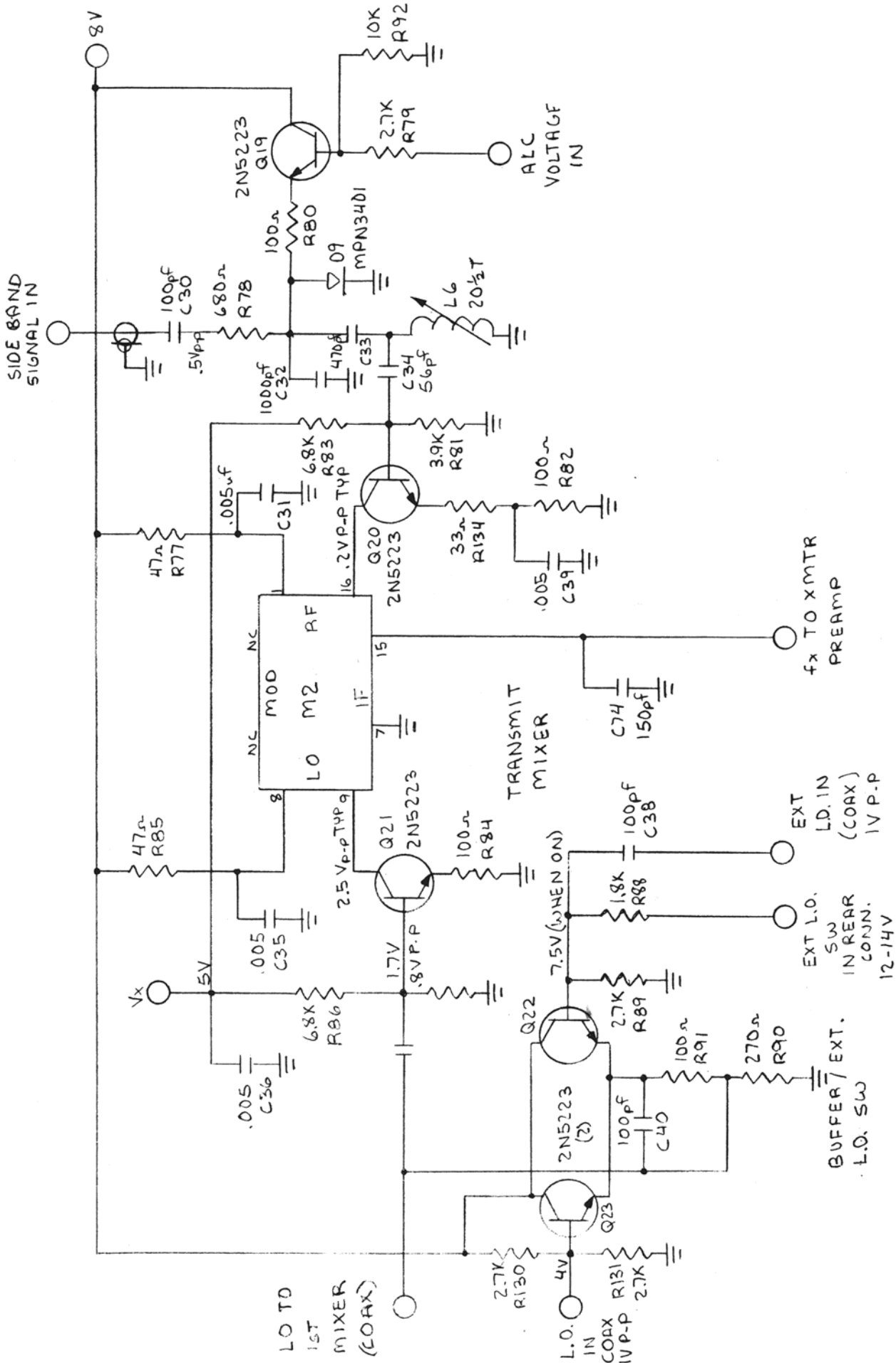
LAYOUT 7.0



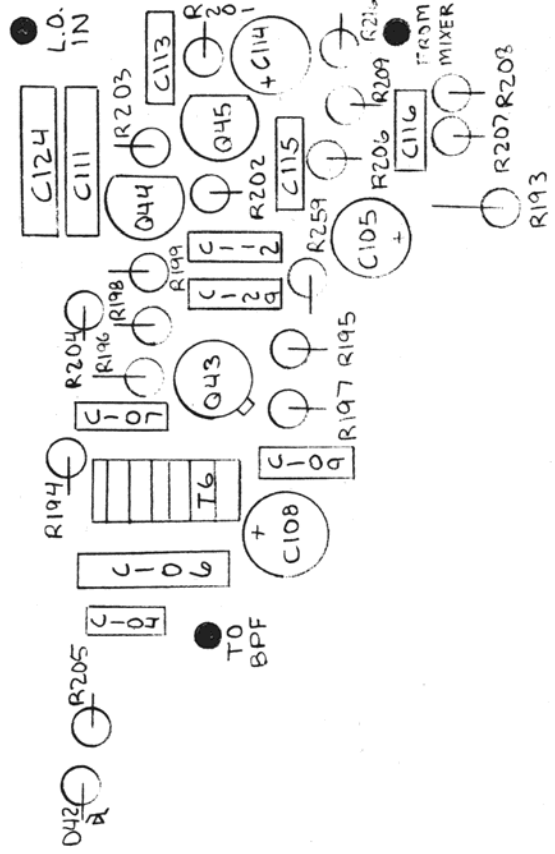
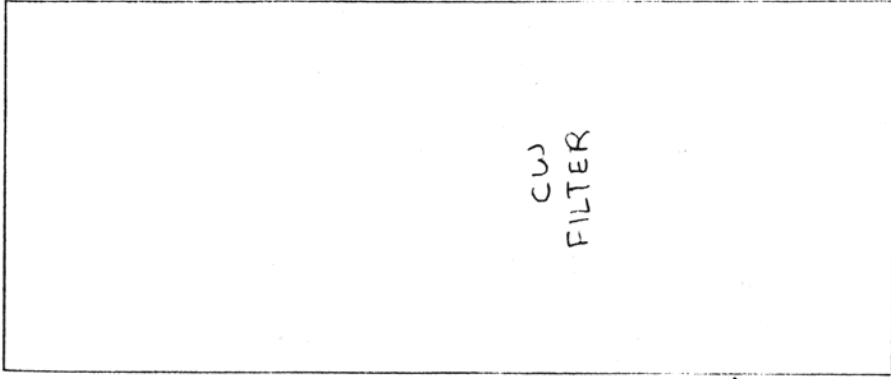
SCHEMATIC 7.0



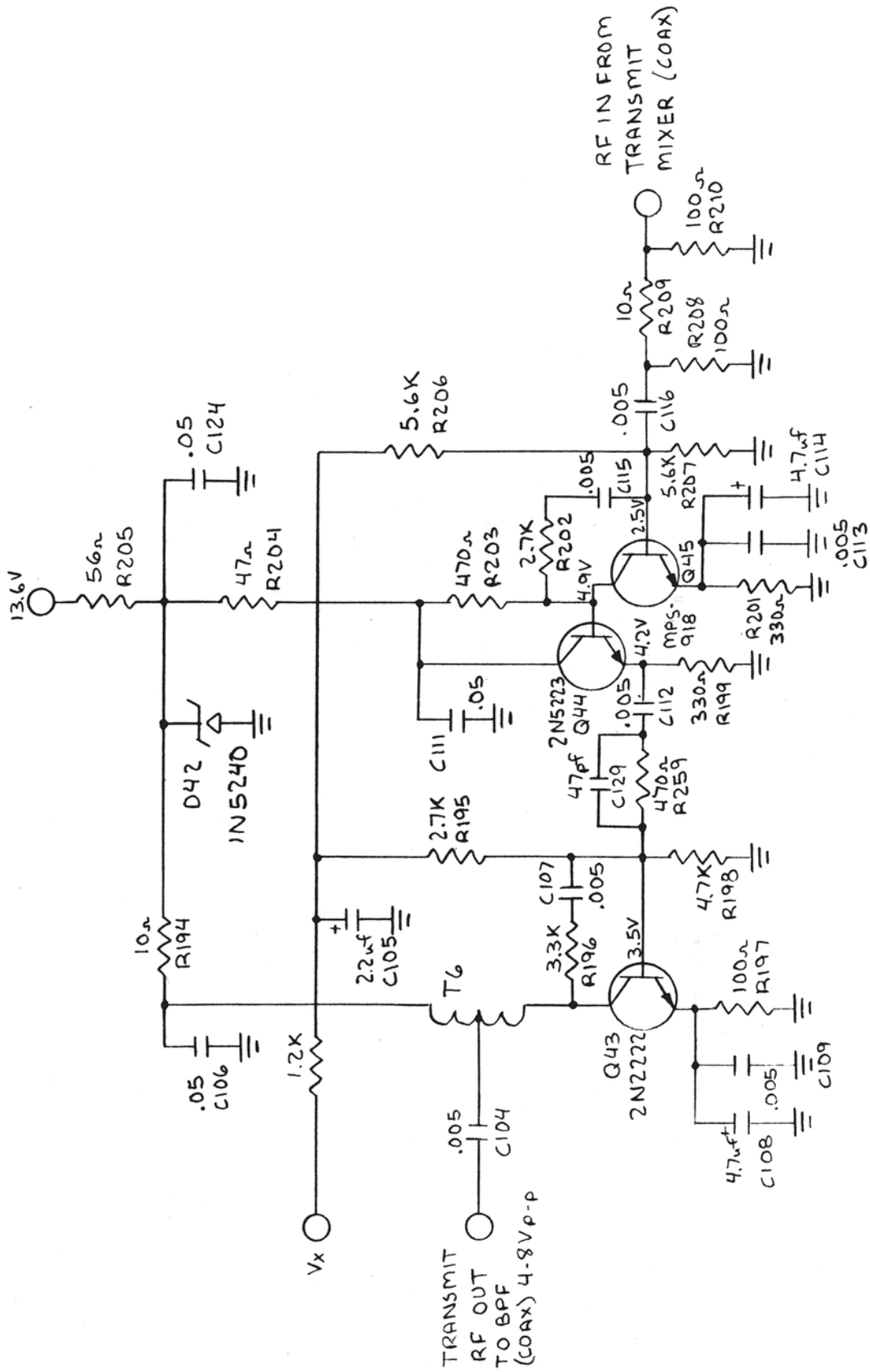
LAYOUT 8.0



SCHEMATIC 8.0

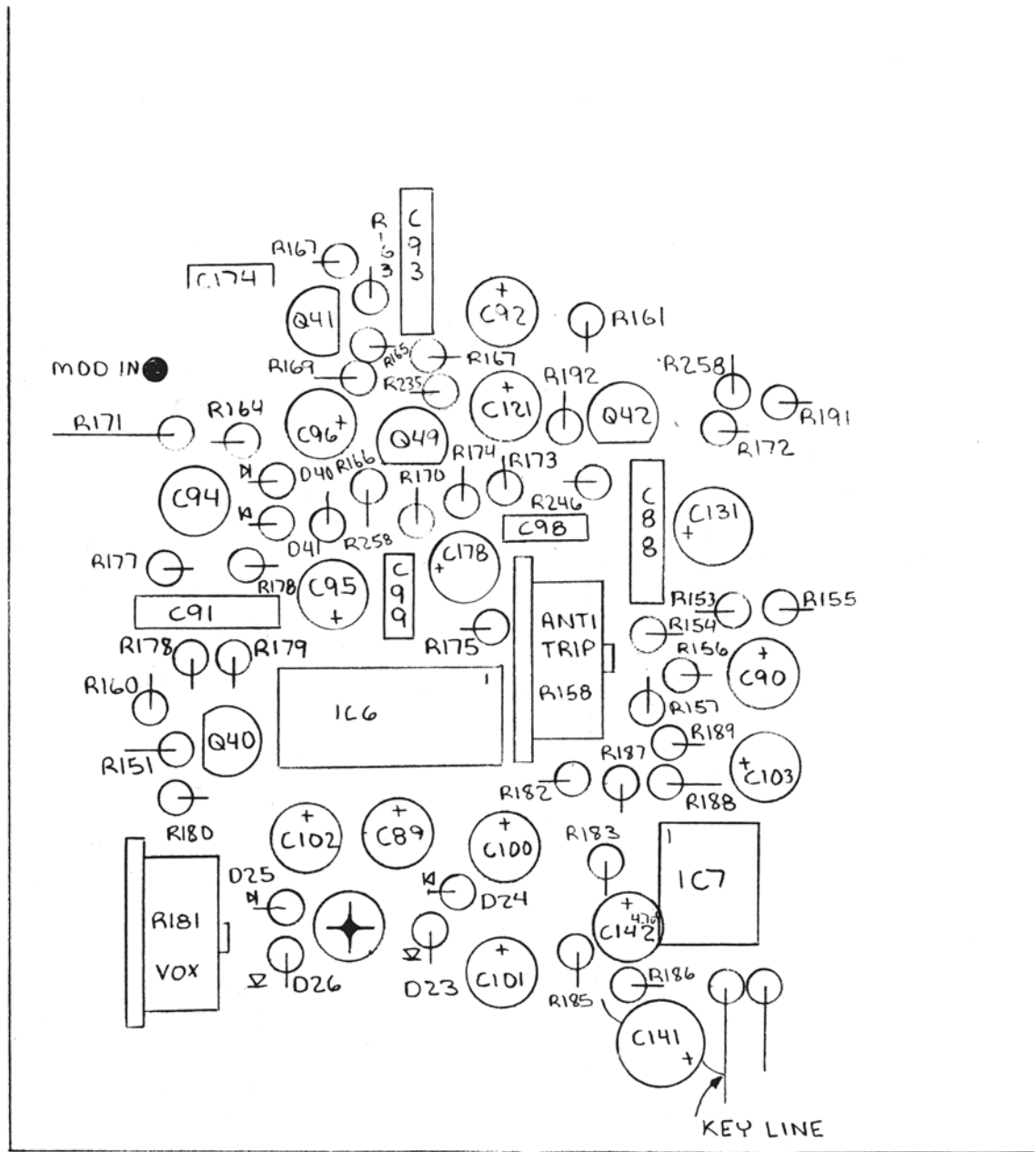


LAYOUT 9.0

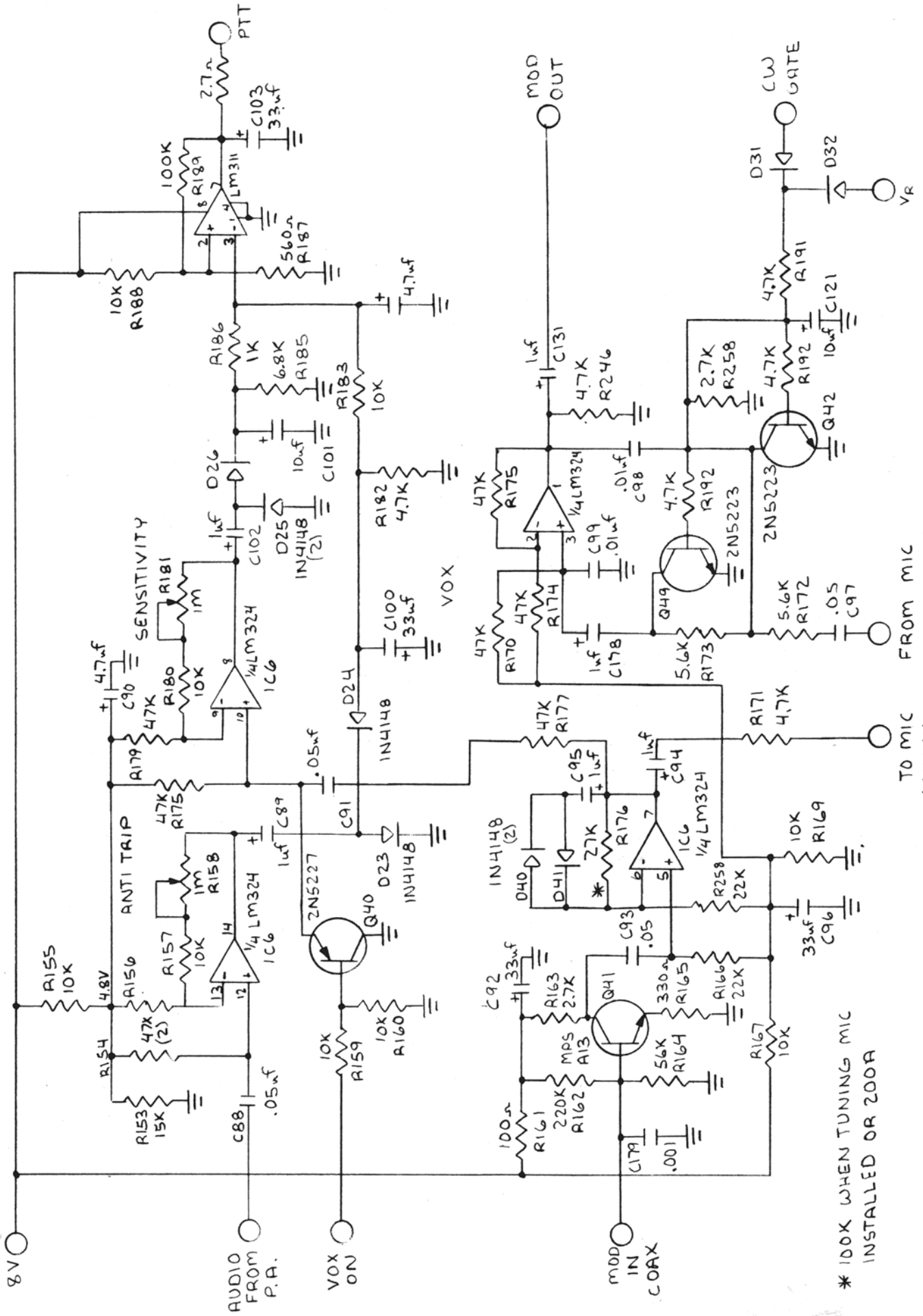


TRANSMIT PREAMP

SCHEMATIC 9.0



LAYOUT 10.0



* 100K WHEN TUNING MIC
INSTALLED OR 200R

TO MIC
GAIN HI

FROM MIC
GAIN WIPER

SCHEMATIC 10.0

11.0 WWV RECEIVER

The WWV receiver is a direct audio conversion type. Usual sensitivity is better than 2u volts. Audio noise output is normally 6 to 10dB less than SSB mode. Local oscillator for the receiver is the 5MHz crystal reference multiplied by 2 by Q77. The receiver circuits are located in area "H" of the receiver board.

Alignment: 1. Tune L15 for maximum audio output.
2. Tune L16 for maximum 10MHz at collector of Q77. Typical audio output is .1Vpp at pin 14 of IC10 with 5u volt input.

12.0 T-R SWITCHING, DELAY AND SIDETONE

T-R switching is controlled by a combination of diode gates and the PTT line. Receiver turn on delay is controlled by Q56 in the CW and VOX modes. Transistor Q54 is the transmit voltage switch and Q53 is the receive voltage switch. The receive switch also turns on Q52 which in turn operates the relay drivers Q51 and Q50.

In the CW mode the sidetone oscillator (1/4 IC10) supplies an audio pulse to the Audio power amplifier each time the key line is grounded. Transistor Q56 acts as a squelch to the oscillator in modes other than CW.

Adjustments: 1. Sidetone level: Set R257 to give desired sidetone level.

2. Delay: Set R239 to give desired receiver turn on delay.

These circuits are found in area "E".

13.0 NOISE BLANKING

Noise blanking action is performed by a wideband IF amplifier with self-contained AGC loop. The NB circuits are contained on the main receiver board in section "A" and on the small auxiliary noise blanking board. The signal is amplified by Q47, Q48 and Q2. The average detector D28 and D29 feed the AGC amplifier and AGC attenuator on the noise blanker board. The pulse detector, D30 and D2 drives a comparator, IC8. If the pulse amplitude is greater than a fixed reference a blanking pulse is generated.

Alignment: With the set turned to an input signal of about 100u volts tune L9 and L10 for maximum output on D30.

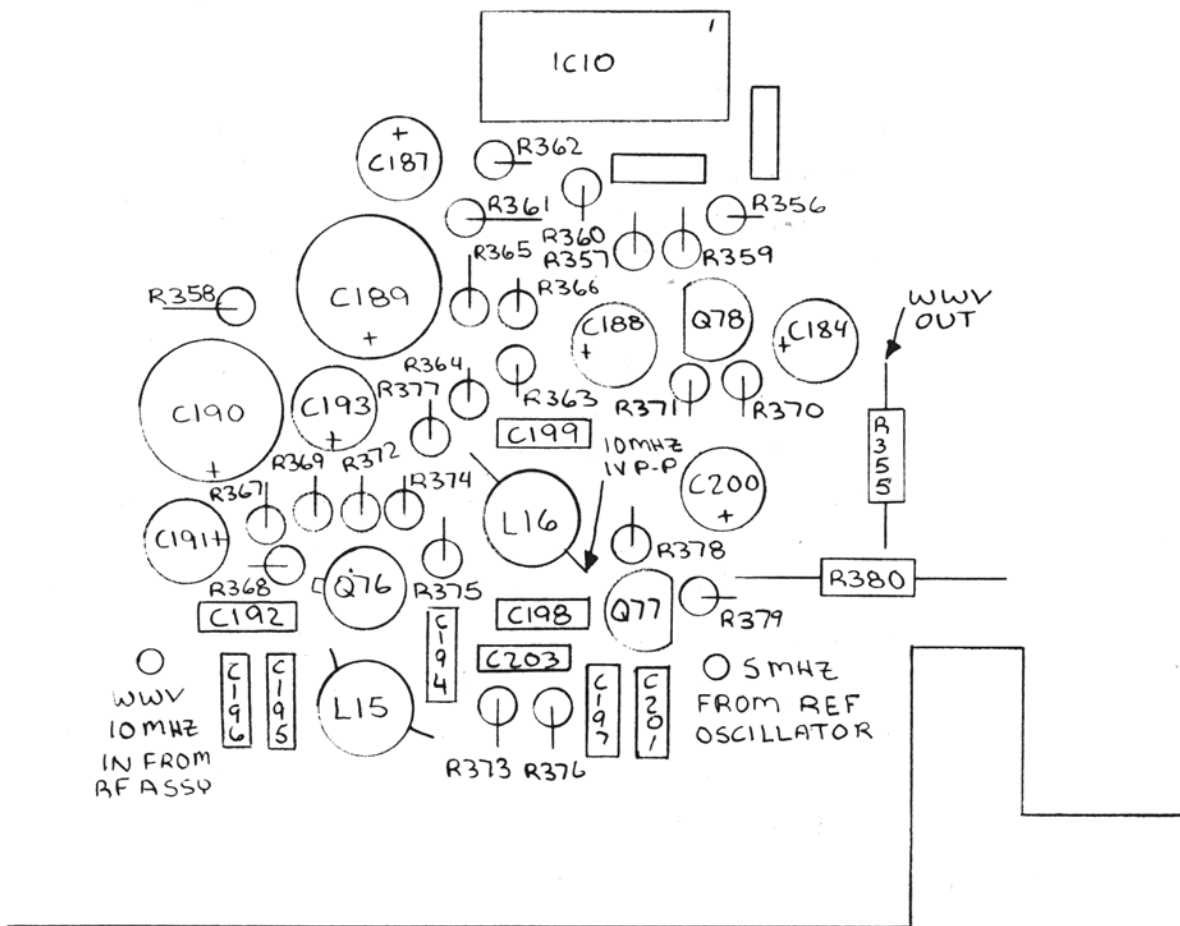
14.0 SWR/WATTMETER CIRCUIT

The forward and reflected power meter bridge is mounted to the inside chassis on the antenna connector. The bridge is a standard configuration.

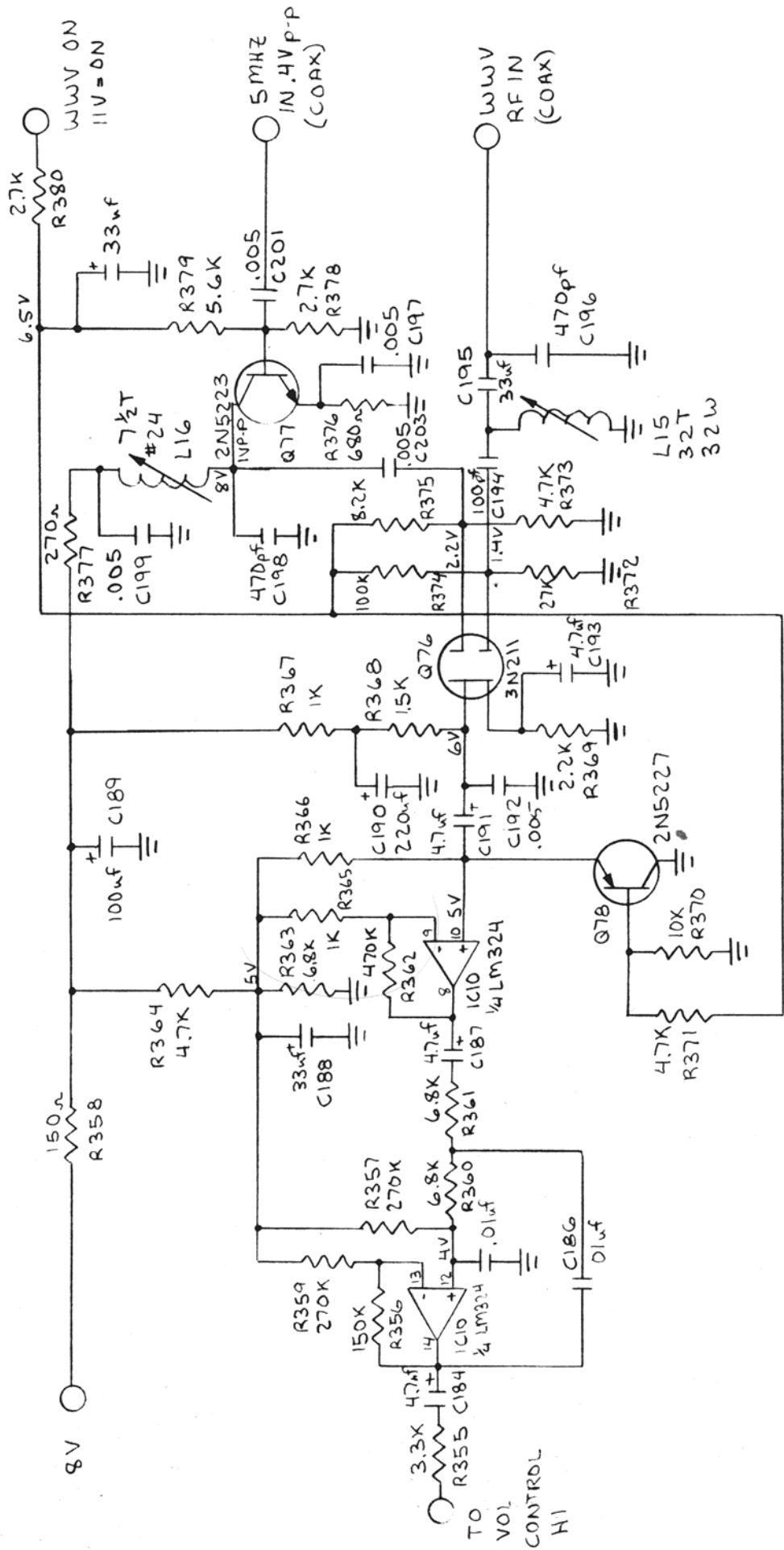
Adjustment: Set C3 for flat response of power shut down circuit when transmitting into a VSWR + 2:1. Power should limit between 80 and 105 watts on all bands 80 thru 15M. Since power output on 10M band is lower the available output may limit in the 70-80 watt area on 10M.

15.0 POWER AMPLIFIER

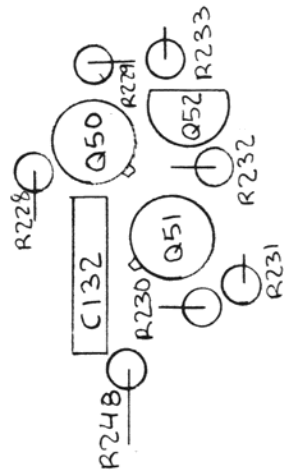
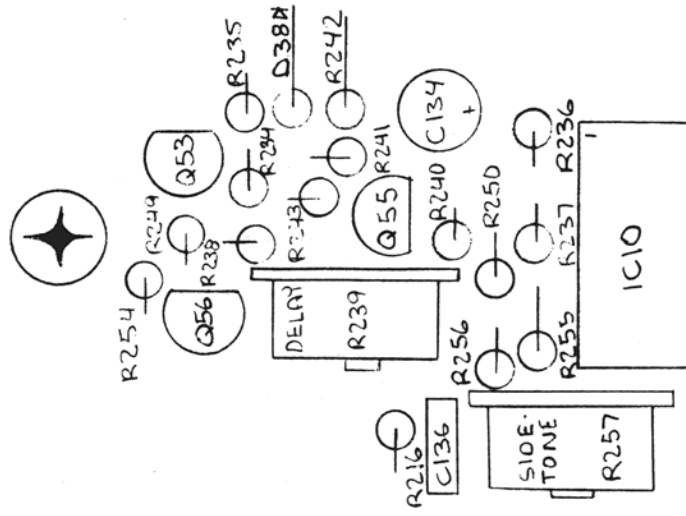
The power amplifier is mounted on the rear of the unit. The amplifier is a three stage design; the first, biased



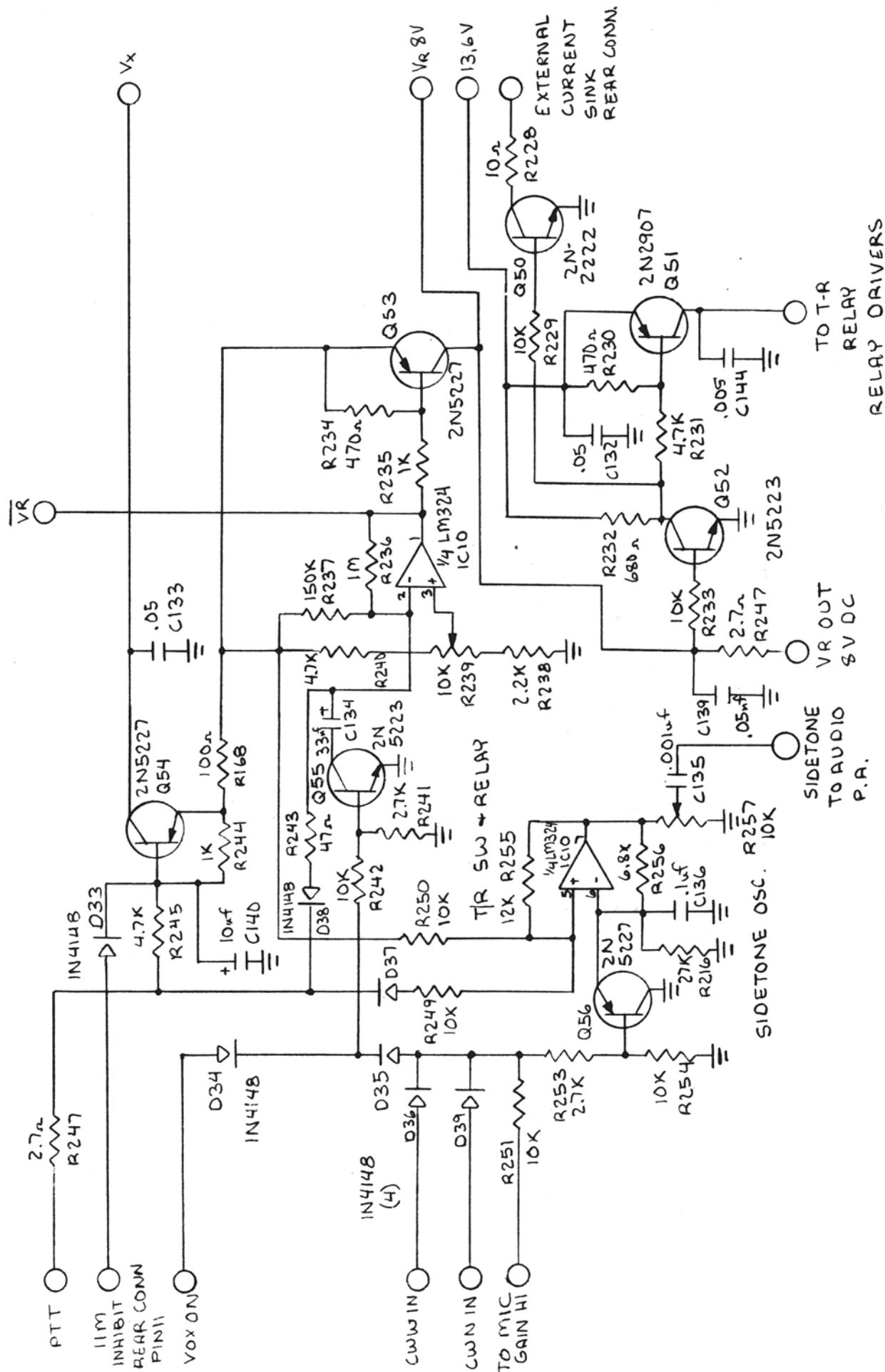
LAYOUT 11.0



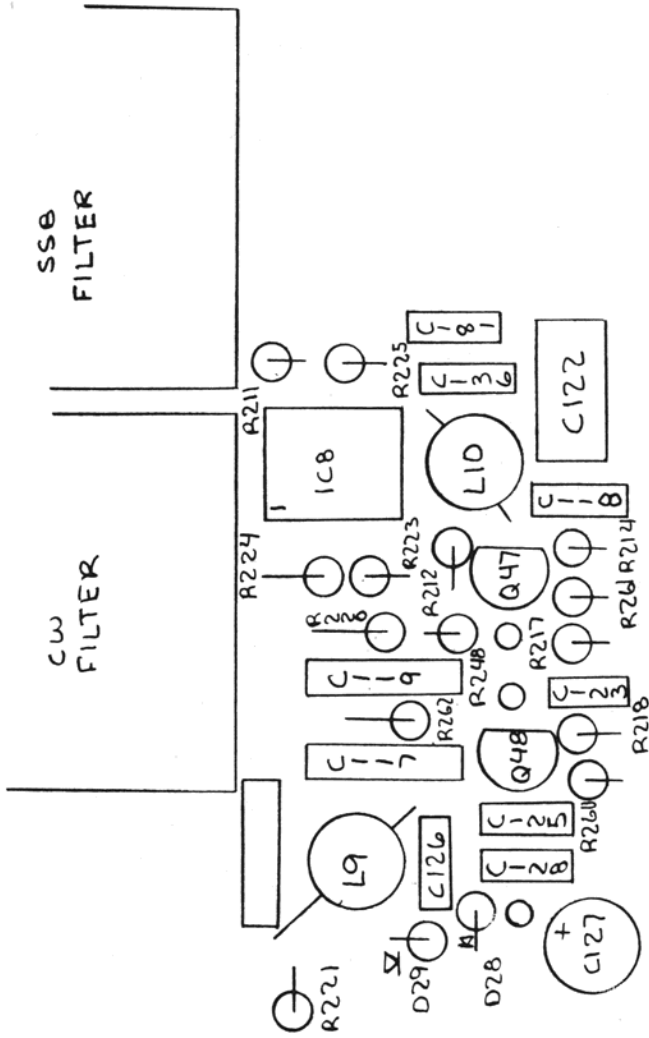
WWV REC.
SCHEMATIC 11.0



LAYOUT 12.D

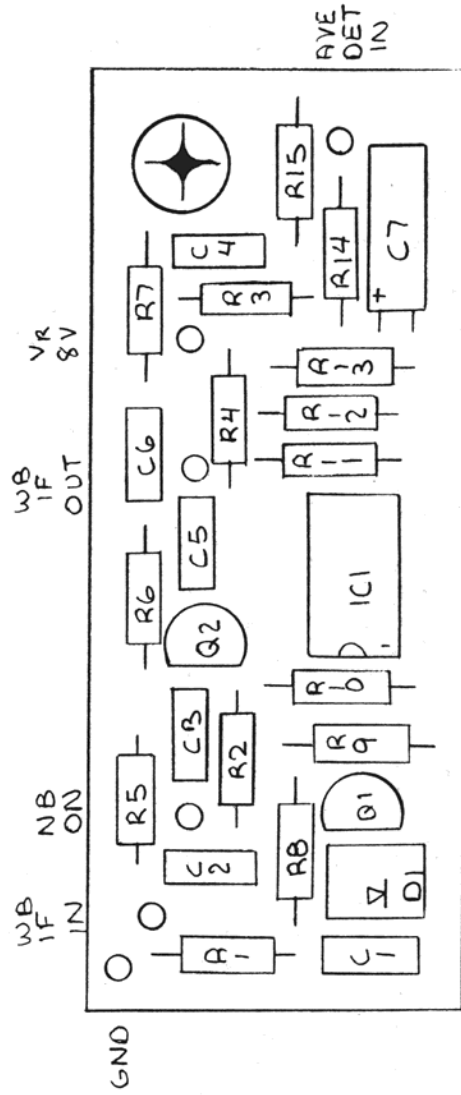


SCHEMATIC 12.0



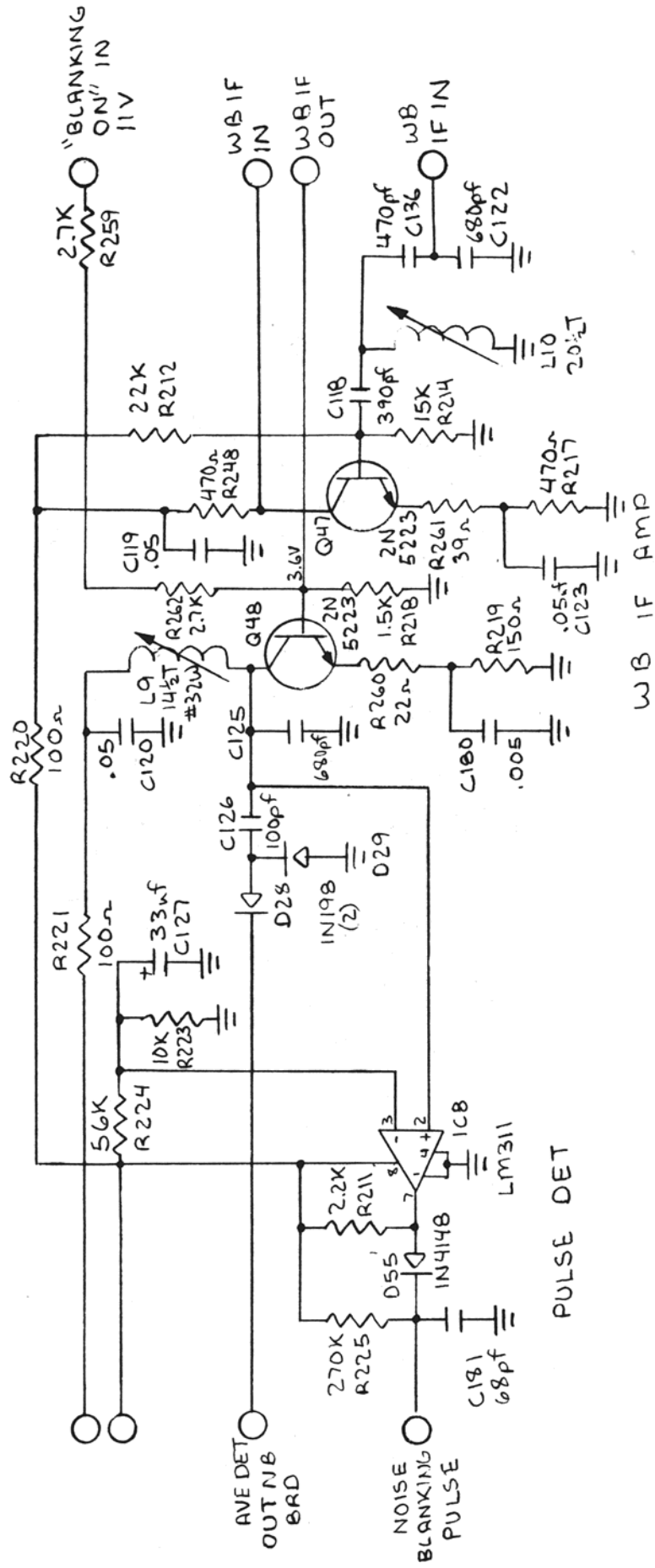
REC BRD N.B. CIRCUIT

LAYOUT 13 PAGE 10F2

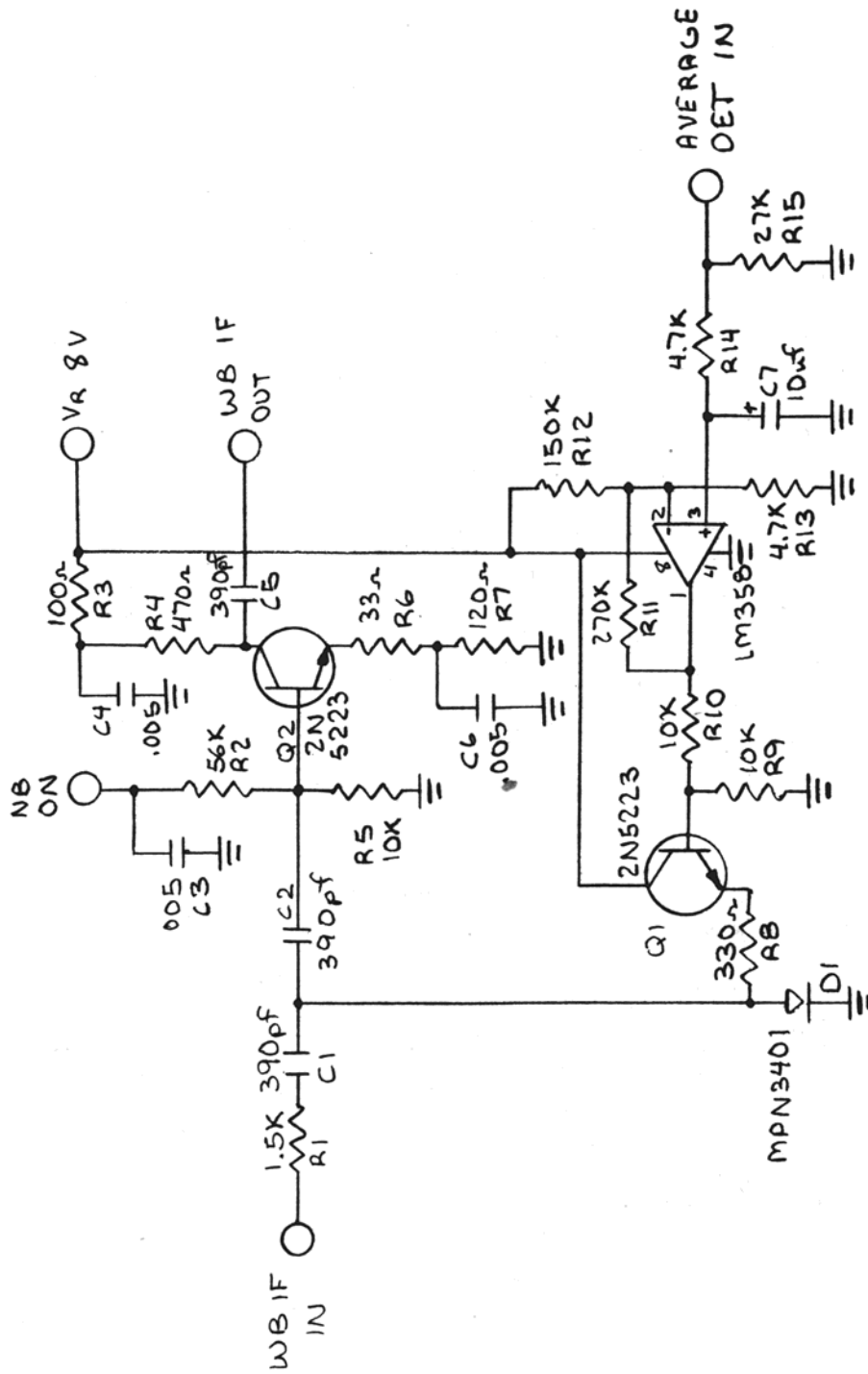


N.B. BOARD LAYOUT

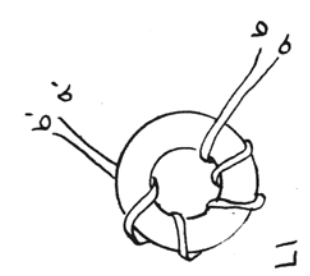
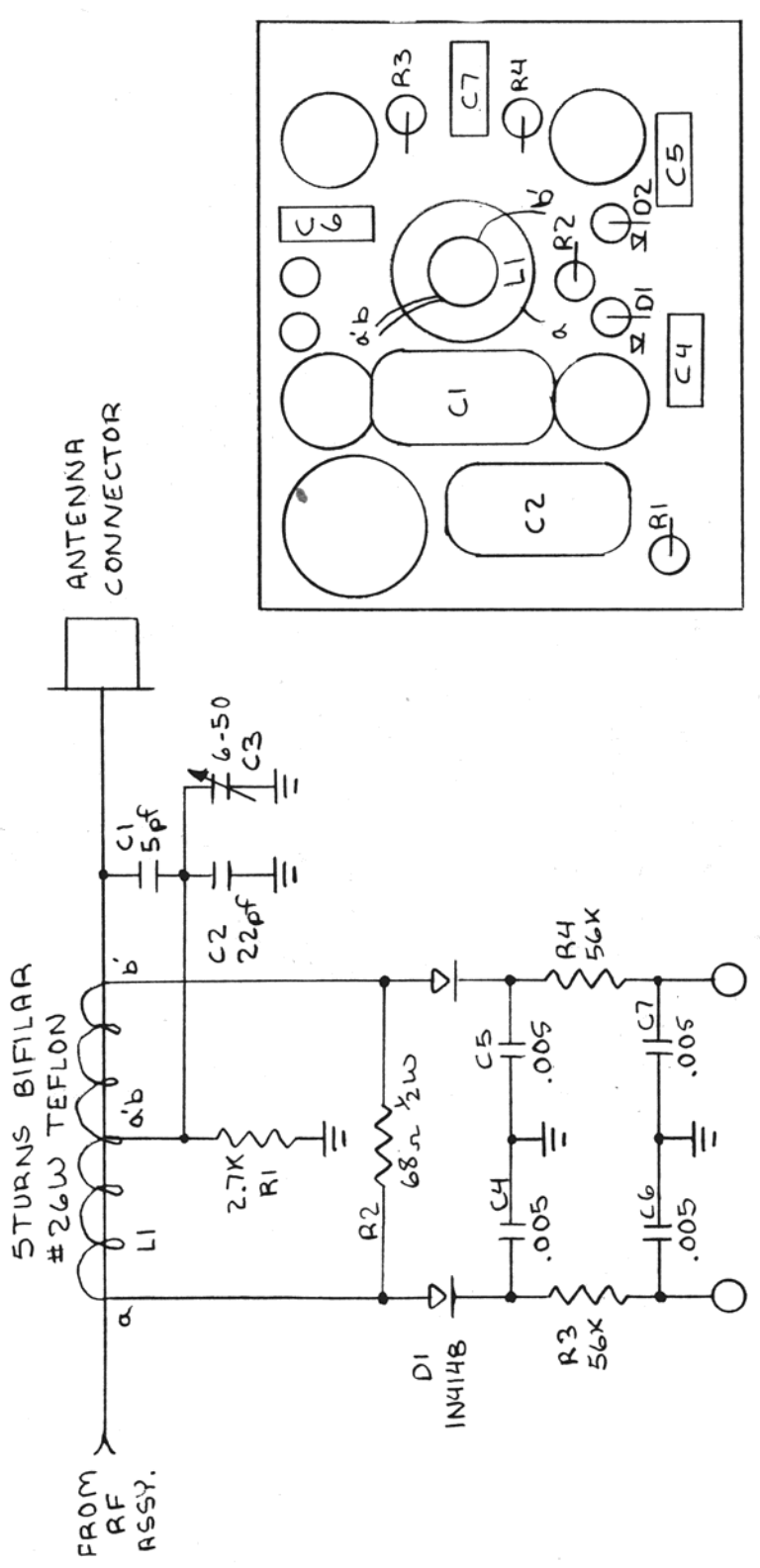
LAYOUT 13.0 PAGE 2 OF 2



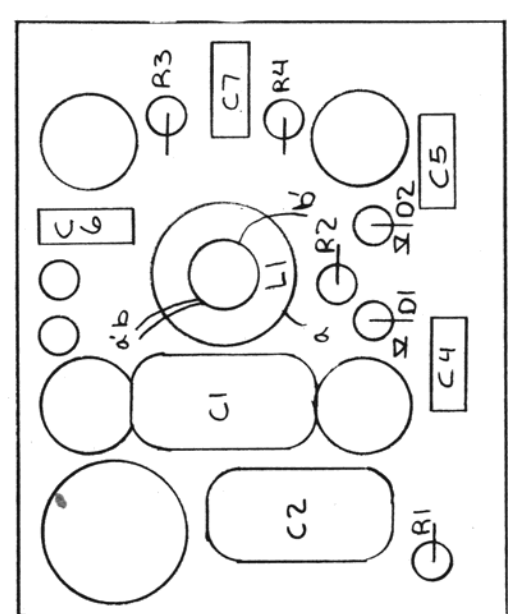
NOISE BLANKING
RECEIVER BRD



N.B. BOARD SCHEMATIC
 SCHEMATIC 13 PAGE 2 OF 2



STURNS
THRU
CENTER
#26
TEFLON
WIRE



SCHEMATIC + LAYOUT 14.D

class A and the last two push-pull stages class B. The typical midband gain is 40dB. Since collector to base feedback is used only input and output waveforms are truly meaningful. However, collector waveforms on each pair should appear balanced. Normally transistors should be replaced in pairs.

Due to the high current drawn by the amplifier (up to 20 amps) collector voltage is present at all times. Therefore even with the set turned off a small leakage current flows (15-20 ma typical). Grounding the PTT line turns Q6 on and applies bias to all stages.

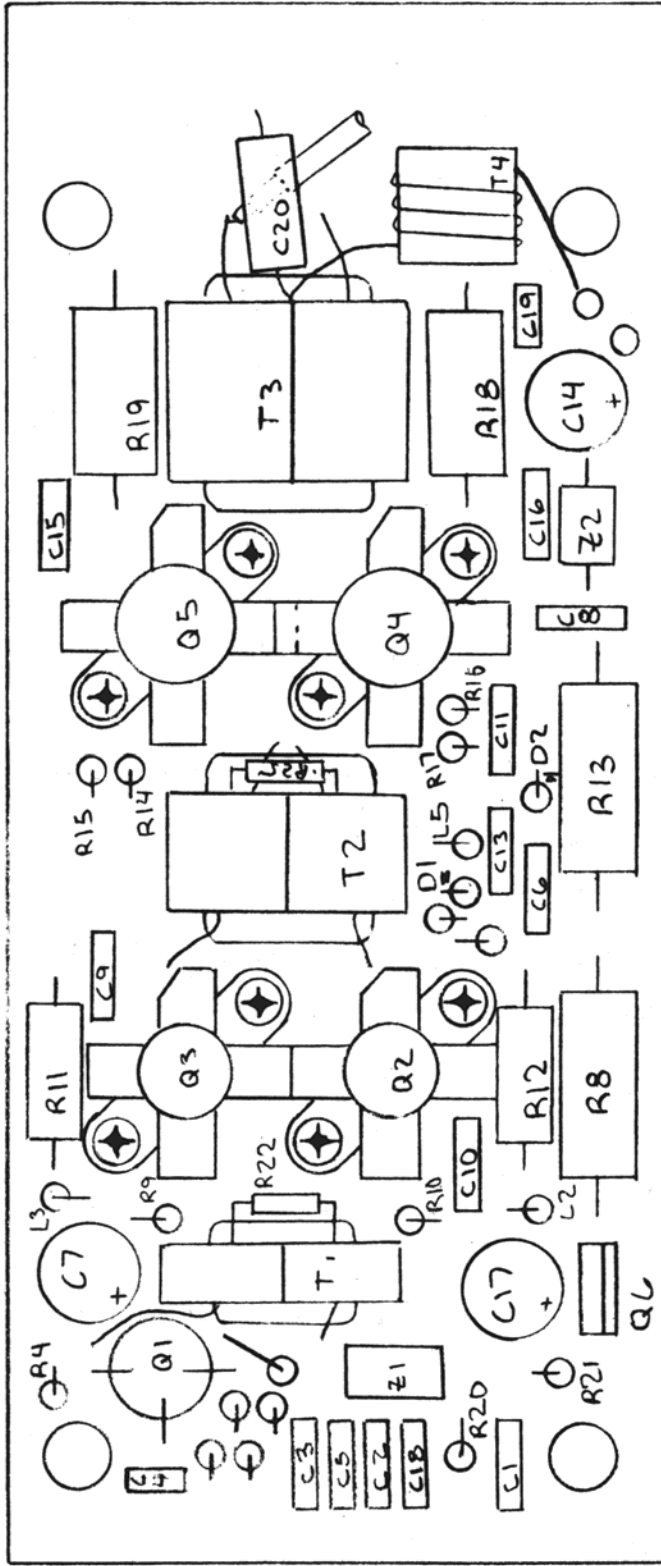
16.0 RF TUNING ASSEMBLY

The RF tuning assembly contains three sets of filters controlled by the band switch. One set of bandpass filters for transmit, and one set for receiver, plus the transmit output lowpass filters. The 5 element 10M lowpass filter is always inline. In addition to the filters the assembly also contains the T-R relay and voltage switching to indicate the band for other circuits.

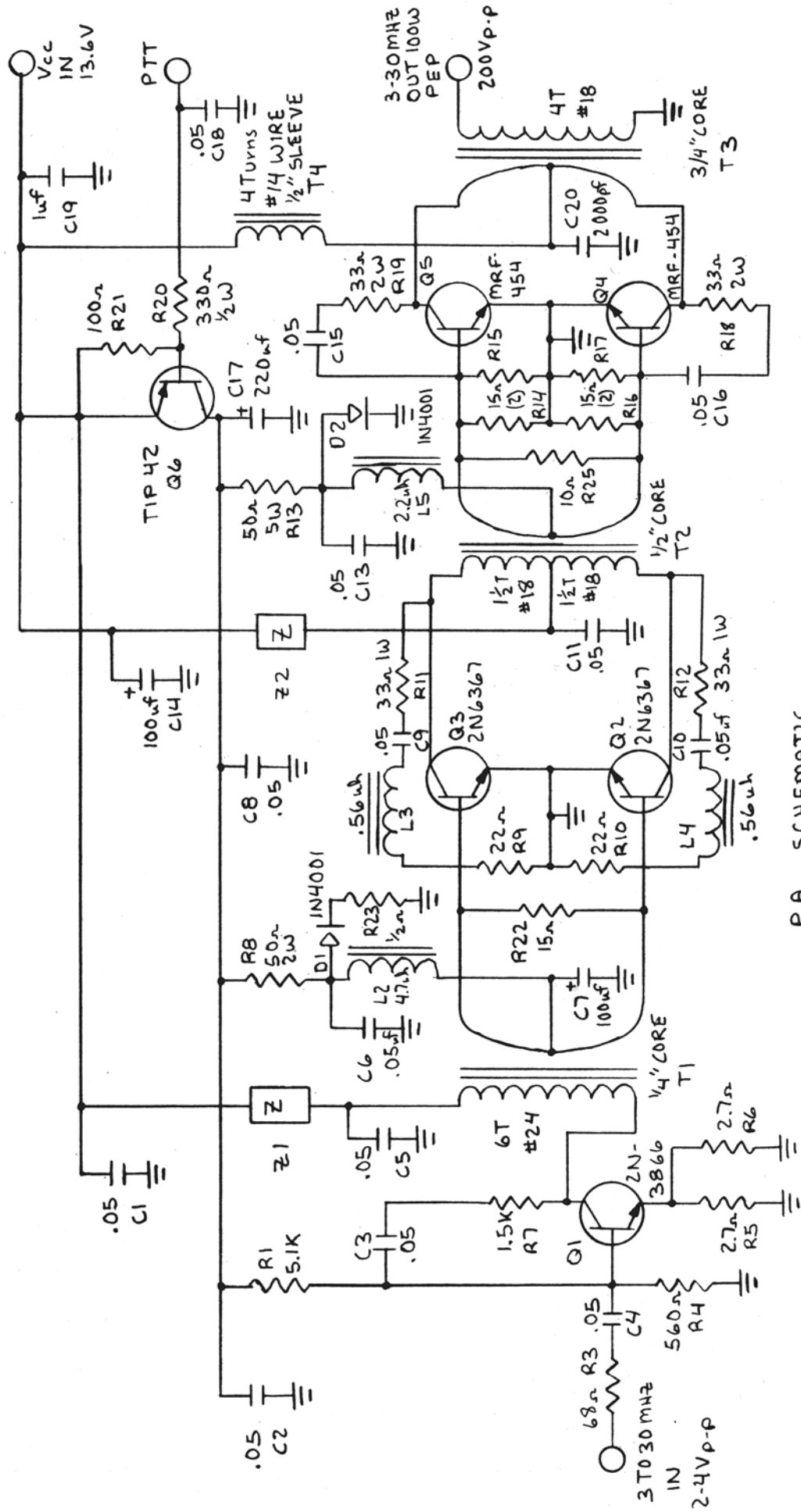
Alignment: Filter coils should be tuned to center filter response in the bands as listed below:

1. Receiver

Band	L numbers	Frequency MHz
80	101,102	3.5 - 4.5
40	103,104	7.0 - 7.5
20	105,106	14.0 -14.5
15	107,108	21.0 -21.5
10	109,110	28.0 -30.0
WWV	111	10.0

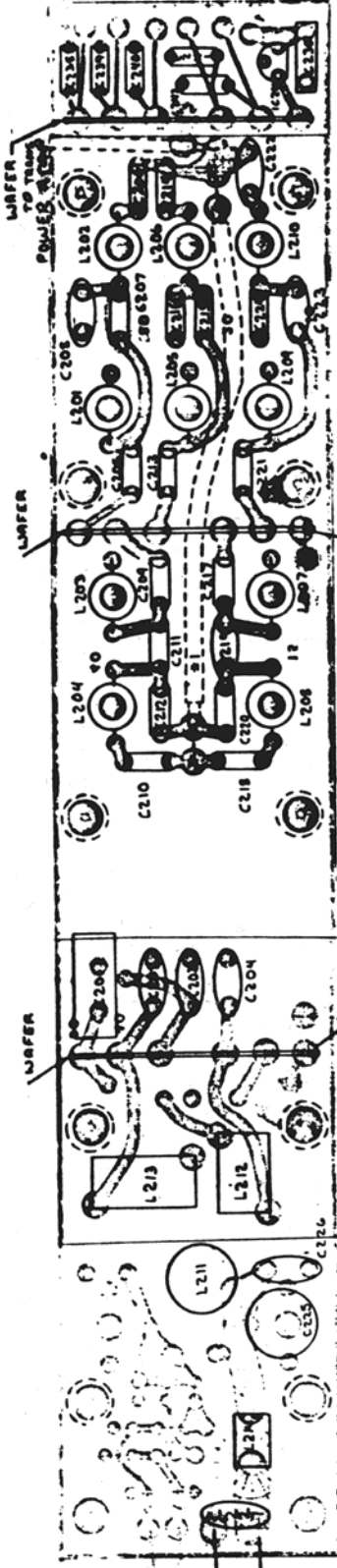


LAYOUT 15



P.A. SCHEMATIC

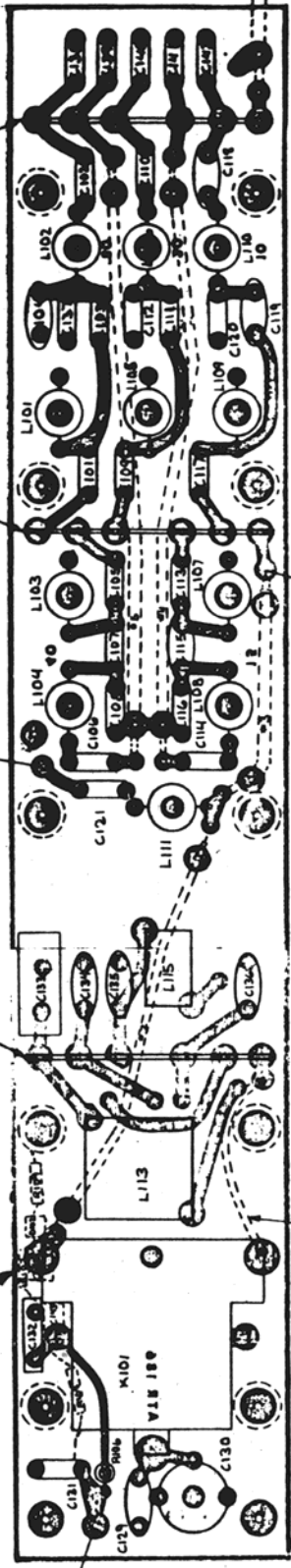
SCHEMATIC 15



COAX FROM
TRANS PAF AMP
TRANSMIT BPF IN

FROM PA LPF IN
UPPER BOARD

FOR TEST RECEIVER
BPF IN



WIRE #18 GAUGE
1.25 APPROX.

COAX
TO RFAMP
RECEIVE BPF
OUT

LOWER BOARD

LAYOUT 16

2. Transmit

Band	L numbers	Frequency MHz
80	201,202	3.5 - 4.5
40	203,204	7.0 - 7.5
20	205,206	14.0 - 14.5
15	207,208	21.0 - 21.5
10	209,210	28.0 - 30.0

3. Transmit: Fixed elements

17.0 VOLTAGE REGULATORS AND NEGATIVE POWER SUPPLY

The transmitter power amplifier, audio power amplifier, and readout bright voltage are all unregulated input voltage. All other circuits operate from multiple regulated voltages. On synth #2 circuit board is the system 11V regulator. This feedback type regulator can operate with input supply voltages as low as 11.7 VDC and still hold regulation. The 8V regulator IC23 is used as the reference for regulator feedback amplifier IC25. Transistor Q6 and the chassis mounted TIP-42 form the active pass network. Diodes D23 and D4 are a start up network. All circuits in the unit (except those mentioned above) are supplied by this 11V regulator. In most cases the circuits operate on 8VDC supplied by local on board regulators or 5VDC supplied by chassis mounted regulators.

To supply the required negative supply voltage for some operational amplifiers a TTL divider signal is used to drive a buffer switch (Q28) on the synth. #2 board. The buffer output is AC coupled and rectified to give an output of about -5VDC.

18.0 DIGITAL SYNTHESIZER GENERAL DISCUSSION

In general the digital synthesizer can be broken down to 6 basic components:

A. Major Loop

The major loop VCO output operates at the desired LO frequency. The VCO operates at $N \cdot 100\text{Hz}$ where N is programmable divider number.

B. Minor Loop

The minor loop output is mixed with the major loop output to give a constant frequency input to the programmable divider. This allows the same values of N for all bands. In addition the minor loop frequency is altered to correct for sideband selected.

C. Up/Down Counter

This counter is clocked up or down by the tuning switches to alter the program in the programmable counter and hence the LO frequency.

D. Bandedge Decoder

Bandedge decoding is done by comparing the programming number with an allowed number set. If the programming number is out of preset bounds the up/down counter is reset to the nearest band edge.

E. Reference Generator

The basic frequency standard for the entire system is

a 5MHz crystal oscillator. This oscillator is used in three ways:

- a. LO for WWV receiver
- b. Divided by 5×10^4 to generate 100Hz reference for major loop.
- c. Divided by 3.03×10^4 to generate 165.0165Hz reference for minor loop.

F. Readout

The status of the program number is adjusted to match frequency and fed to an LED multiplexing system. (See table 1).

19.0 DIGITAL SYNTHESIZER DETAILED DISCUSSION

In this section each of the major components are described in detail. Exact frequencies and divider numbers for each band are listed in table 1.

A. Major Loop

Circuits discussed herein are on Synth #2 circuit board unless noted otherwise.

The major loop VCO is a 5 band LC oscillator (Q22) with each band selected by switching on the desired transistor switch (Q18 through Q21). Frequency change is by control voltage applied to R141 to control the capacity of C95; a varicap diode. Bias voltage for the varicap and oscillator transistor is double regulated by D6 and IC27. VCO output is buffered and isolated by transistors Q23 through Q26. One buffered output is the transceiver L.O. and the other drives

one input of the synthesizer mixer.

The mixer output drives the programmable divider to generate the "data" input to the frequency/phase detector, IC19. The data input is coupled to pin 1 of IC19, but due to the high divider number the TTL pulse is very difficult to see on a scope. Its presence can be inferred by pulse waveforms on pins 13 or 10. The 100Hz data pulse may also be checked with a counter. Pin 8 is the semi-filtered DC correction voltage. IC21 is a notch filter to remove 100Hz components from the correction voltage. This notch filter is followed by a passive RC filter network which feeds R141.

The programmable divider is on the Synth #1 circuit board and consists of IC's 21 through 25. The divider reset pulse and the data output pulse is generated by a oneshot multivibrator 1/2 IC8. Input frequency range to the divider is 2-4MHz.

Major loop alignment: VCO adjustment must be made in sequence 10M, 15M, 20M, 40M, and 80M. Adjustments should be made with each band at the lowest frequency in each band. Tune each coil for a correction voltage of $2.5V \pm .25V$ measured on R18. For units that tune 27MHz the correction voltage on 10M is set to 3.0VDC. To adjust the notch filter set R11 and R15 for minimum amplitude waveform as shown on schematic.

B. Minor Loop

All circuits of minor loop are on Synth #2 circuit board. The minor loop VCO operation is similar to

The major loop VCO. The output of buffer, Q8, drives the second input of the synthesizer mixer. The mixer output is the difference of the two VCO inputs.

The buffer output is a TTL compatible clock to drive a high speed divide by 10 prescaler, IC16. The output of IC16 is approximately .7 to 3.15MHz depending on band and sideband selected. This output drives a 5 stage counter, IC11 through 15. This counter uses a similar reset and data output one-shot MV, 1/2 IC10. Program for the divider is derived from two 32 x 8 PROMS, IC's 17 and 18. The sideband and operating band are the inputs to generate correct program code.

Frequency/phase detector, notch filter (tuned to 165 Hz), and RC filter operation are similar to the major loop.

Minor loop alignment: As with the major loop the VCO must be aligned in order 10M through 80M. The correction voltage on each band should be set to 1.6V \pm .2VDC as measured on R21. To adjust the VCO it is necessary to remove the brass shield by unsoldering the three corners. To adjust the notch filter set R25 and R27 for minimum amplitude waveform as shown on schematic. This waveform will vary somewhat in size and shape depending on band.

C. Up-Down Counter

This circuit is on the Synth #1 circuit board. The

up-down counter is a 5 stage ripple counter with BCD outputs on each stage to program corresponding stages of the major loop divider. IC's 16 through 20 comprise this divider.

Clocking of this divider is done by gating the output of a multivibrator 1/4 IC32 through an up or down gate to the correct input of the counter. These up or down gates associated with the oneshot MV, 1/2 IC31 form a debounce circuit and a slight start delay to permit single stepping the synthesizer. The rate is varied by the time constant capacitor selected.

The BCD program numbers available are limited by the bandedge decoder which resets the up-down counter at preset limits.

No adjustment or alignment is necessary.

D. Bandedge Decoder

Bandedge decoding is done by checking the program of the two most significant digits of the major loop divider. A greater-than or less-than comparison is done by IC's 6 and 7. These magnitude comparitors alternately look for divider numbers greater than upper limits or lower than lower limits. If an out of bounds condition is found the up-down counter is reset and a correct number is preset in the counter. A series of gates and oneshot MV's are used for timing, and program resets for the up-down counter.

E. Reference Generator

The reference oscillator and its associated dividers are located on Synth #2 circuit board.

Basic frequency reference for the transceiver is derived from a 5MHz crystal oscillator. This oscillator drives a pair of divider chains to generate 100Hz TTL for the major loop and 165Hz TTL for the minor loop. IC's 4 and 5 divide the 5MHz by 100. For the major loop IC's 1 through 3 divide the output of IC4 by 500 to generate the 100Hz TTL reference for the major loop. For the minor loop IC's 6 through 8 divide the output of IC4 by 303 to generate the 165Hz reference for the minor loop. The divide by 303 circuit is similar to the other ripple counters in the synthesizer in that it uses a oneshot MV to generate the divider reset and the reference pulse to the minor loop frequency/phase detector.

The 5MHz output is also used to provide the drive to the WWV receiver L.O. multiplier.

F. Readout Circuits

All readout circuits are located on Synth #1 circuit board. Information regarding band and divider number is fed to PROMS, IC1 and IC30, and to the multiplex buffers IC's 10 through 15.

Basic function is as follows: A Schmitt trigger gate is used as a multiplex clock oscillator. This oscillator drives a BCD counter (IC26) which in turn drives

a BCD to decimal decoder (IC27). The decoded outputs are used to drive digit enable circuits, and the multiplex buffers. The multiplexed digit data is fed to a BCD to 7 segment decoder (IC29).

BAND	FREQ	S.B.	1st L.O.	SYNTH L.O.	SYNTH MIXER MHz	N REF= 100Hz	M REF= 165.0165Hz
80M	3.5	USB	9.10165	7.00165	2.1000	21000	42430
		LSB	9.09835	6.99835			42410
	4.0	USB	9.60165		2.6000	26000	
		LSB	9.59835				
40M	7.0	USB	12.60165	10.50165	2.1000	21000	63640
		LSB	12.59835	10.49835			63620
	7.5	USB	13.10165		2.6000	26000	
		LSB	13.09835				
20M	14.0	USB	19.60165	17.50165	2.1000	21000	106060
		LSB	19.59835	17.49835			106040
	14.5	USB	20.10165		2.6000	26000	
		LSB	20.09835				
15M	21.0	USB	26.60165	24.50165	2.1000	21000	148480
		LSB	26.59835	24.49835			148460
	21.5	USB	27.10165		2.6000	26000	
		LSB	27.09835				
10M	28.0	USB	33.60165	31.50165	2.1000	21000	190900
		LSB	33.59835	31.49835			190880
	29.999	USB	35.60065		4.0990	40990	
		LSB	35.59735				

TABLE 1

TROUBLE SHOOTING GUIDE

Most frequent problems & causes.

Transmitter:

<u>Symptom</u>	<u>Possible Cause</u>	<u>Remarks</u>
No power out (or low power out)	No DC power to P.A.	-----
	No drive to P.A.	In CW mode check output of transmit preamp to determine if fault is in drive or P.A. If drive ok see below. If no drive trace f_{cx} & LO circuits to determine fault.
	Power Amplifier failure	If maximum power output is 1-10 Watts the cause is usually burned out final transistors. If power output is about 50 watts usually 1 of the final pair is blown. The final transistors should always be replaced in pairs. If finals are blown this is usually caused by overheating of heatsink. Either due to excessive power output or lack of cooling air.
	Driver Transistor failure	Driver failure is unusual & symptoms are similar to final problems. Ohmic or signal tracing tests can be used to determine failed devices. Note: The power amplifier may be operated opened away from main chassis but care must be used to prevent shorting and overheating.

Reverse or Over Voltage Since the PA is connected directly to the Vcc bus, over or reverse voltage will destroy all r transistors in the PA. Damage to other circuits in set is minimal. For operation where reverse connection is likely an available diode protected & fused cable should be used.

T-R Relay Since the antenna is connected to the transmitter through the normally closed contacts of the relay this failure mode is unusual. If a problem occurs it can usually be corrected by cleaning contacts with WD-40. The contacts are available through a .5 inch hole in the bottom of the RF assembly.

Receiver:

<u>Symptom</u>	<u>Possible Cause</u>	<u>Remarks</u>
No noise or received signal.	No Vr	Check for Vr on R63.
	No Supply Voltage	Check for 8V at outputs of 8V IC voltage regulators IC's 1 and 4.
	No Carrier Oscillator	Change modes USB to LSB for example to determine if oscillator is functional on other modes. Oscillator output is available on R268.

No audio output	Noise or audio present at R284? Yes: Check signal path to audio PA through volume control. No: Check signal path through receiver.
Reduced Threshold 10 to 40dB	
T-R Relay	Check voltage to relay coil at bottom rear of RF assembly. In receive mode is voltage about 12VDC? No: Check relay driver Q51. Yes: Check for relay pull in. Observe through .5 inch hole in bottom of RF assembly. Note proper seating of contacts & complete pull in of coil. Clean contacts with WD-40.
RF Amp.	Is RF amp gain 10dB? Measure gain from cable input to emitter of Q2 using low-capacity probe & high speed scope. Yes: ok No: Check bias on Q2, if ok replace Q1.
L.O. Signal	Is LO at base of Q34 about 1Vpp? Yes: Check collector for about 2Vpp. No: Check signal path back to LO input cable from Synthesizer.

Readout

5 of any one segment always on
(any degree of brightness)

Sixth digit--the one digit with segment off should be replaced.

Incorrect numbers displayed

Does movement of synth boards cause display to change?

Yes: Check for parts shorting between boards & clean contacts of connectors.

No: Most likely cause of fault is IC29 on synth #1, segment enable.

No Display

Are bright & dim voltages present?

Yes: Check inter-board connectors for digit enable & segment enable pulses.

Synthesizer:

Frequency fails to lock:

Is Minor loop locked? This is determined by fixed correction voltage near 1.5VDC & fixed pulse pattern on IC9 pin 13.

Yes: Proceed to major loop.

No: Are data and reference present at pins 1 & 3 of IC9? These are narrow pulses and it may require a counter to determine their presence. The counter should read 165Hz.

If no data is present at pin 1 of IC9 check VCO clock output on pin 14 of IC16 and signal trace IC16 output (pin 11) through the divider chain IC's 15 through 11. IC10 is a oneshot MV that provides reset for the counters and data signal to IC9.

If no reference signal is present at IC9, pin 3 check the 5MHz clock signal at pin 1 of IC5. Signal trace divider signal through IC's 5, 4, 8, 7 and 6. IC10 provides a similar function to this divider as the data divider.

If data and reference signals are present; are pulses present at either pin 10 or pin 13 of IC9? If not replace IC9.

If pulses are present at either pin 10 or 13 is a slowly varying DC level present at pin 8 of IC9. If not replace IC9. If this signal is present trace it through the notch filter (IC20) and the loop filters to the VCO input.

Is the major loop locked? Yes: System is operational

No: Proceed by signal tracing in a manner similar to the minor loop.

Check for data and reference present at pins 1 and 3 of IC19. The data rate is 100Hz.

The reference divider chain is composed of IC's 5 through 1.

If reference is normal check for VCO operation. If VCO is normal signal trace through synthesizer mixer and clock driver to determine that the 2 to 4MHz clock is present. If clock is present determine if 100Hz data is present at output of major loop divider.

Check IC19 in a manner similar to IC9.

Frequency fails to scan:

1. Does unit fail to scan on both fast and slow?

Yes: Is 11V present at tuning switches?

Yes: Signal trace control voltages to synth #1 board and to IC's 31 and 32. With tuning switch depressed, check IC32 pin 11 for clock. Signal trace through pin 6 for "down" and pin 3 for "up"

If clock is present at pins 3 or 6 trace signal through programming ripple counter, IC's 16 through 20.

No: Signal trace switch and tracks. Determine plated through holes are making through contact.