# OWNER'S
# OPERATION
# MANUAL

## ASTRO-103
## SSB TRANSCEIVER



CUBIC COMMUNICATIONS, INC.
*A member of the Cubic Corporation family of companies*

# OWNER'S OPERATION MANUAL

# FOR THE

# ASTRO-103 SSB TRANSCEIVER


**CUBIC COMMUNICATIONS**

*A member of the Cubic Corporation family of companies*

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Welcome to the ranks of ASTRO-103 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.

## WARNING NOTE

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

## PROPRIETARY STATEMENT

# LIMITED WARRANTY

## SCOPE OF WARRANTY - FREE PARTS AND LABOR

All of the Cubic Communications, Inc. (CCI) products are warranted against defects in material and workmanship. During the warranty period, CCI or an authorized CCI service station will provide to you, free of charge, both parts (except RF output transistors) and labor necessary to correct any defect in material or workmanship. Periodic checkups and voltage conversion are not covered by this warranty. All implied warranties, except to the extent specified by applicable law, shall have no greater duration than the warranty period set forth for this unit. No warranties, whether express or implied, including warranties of merchantability or fitness, shall apply to this product after the warranty period has expired. Under no circumstances shall CCI be held liable for any loss or damage, direct or consequential, arising out of the use of, or inability to use, this product.

## WARRANTY PERIOD

Cubic Communications, Inc. products are warranted for ninety days from the date of the original purchase.

## PURCHASER'S RESPONSIBILITIES

You, as the purchaser of a new CCI product, must do the following to qualify for warranty service:

1. Retain your sales slip or other proof of purchase or send in your warranty registration card to avoid unnecessary difficulties in determining your eligibility for warranty work.
2. Notify your nearest authorized CCI service center or CCI as soon as possible after discovery of a possible defect with the model, serial, and warranty registration (if any) numbers and a detailed description of the problem, including details on the electrical connection to associated equipment and the list of all such equipment.
3. Make your CCI product available to an authorized CCI service center for inspection and approved warranty service or ship your CCI product, in its original container or equivalent, fully insured and shipping charges prepaid, to CCI.

## PROPER MAINTENANCE AND USE

This warranty will not apply to any failure that CCI determines is due to any of the following:

1. Improper maintenance or repair, including the installation of parts or accessories that do not conform to the quality and specifications of the original parts.
2. Misuse, abuse, neglect, including improper installation.
3. Accidental or intentional damage.

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## 1.0 INTRODUCTION

The Cubic ASTRO-103 is a 160M through 10M (including the newly designated bands at 30, 17 and 12M) SSB amateur transceiver that features dual PTO's and frequency counter for split frequency operation with digital frequency readout. Frequency selection is the only tuning necessary when operating into a matched antenna with a VSWR of 1.7:1 or less. The ASTRO-103 represents an additional capability over the field-proven ASTRO-102BX, including the new bands, RTTY mode, and auxiliary receive antenna input.

Standard features include: Full break-in or semi-break-in CW operation; two position CW transmit pulse shaping; VOX; noise blanker, SSB transmit speech processor; true RF and IF gain controls, peak reading wattmeter with FWD, REF, and ALC positions; variable AGC decay, passband tuning; and audio notch filter. An optional narrowband crystal CW filter is available. The basic single conversion design has been proven in thousands of the popular Cubic transceivers. Mechanical and electrical designs are exception for years of trouble-free operation, even in a rugged mobile environment.

The unit is designed for fixed and mobile use with minimum interconnections. For fixed station operation an auxiliary speaker/power supply, Model PSU-6, provides 13.6 VDC from 115/230 VAC. A matching antenna tuner, Model ST-2B or ST-3B, is also available.

## 2.0 SPECIFICATIONS

General Specifications:

Frequency Coverage*

| | | |
|---|---|---|
| 160M | 1.8- 2.0 | MHz |
| 80M | 3.5- 4.0 | MHz |
| 40M | 7.0- 7.5 | MHz |
| 30M | 10.0-10.5 | MHz |
| 20M | 14.0-14.5 | MHz |
| 17M | 18.0-18.5 | MHz |
| 15M | 21.0-21.5 | MHz |
| 12M | 24.5-25.0 | MHz |
| 10M | 28.0-28.5 | MHz |
| | 28.5-29.0 | MHz |
| | 29.0-29.5 | MHz |
| | 29.5-29.999 | MHz |

*Approximate 50 to 100 KHz overrange on each band.

Frequency Control: Dual PTO (Permeability Tuned Oscillator) with 6 digit frequency counter and RIT control.

PTO Modes of Operation: A only, Receive A-Transmit B; B only, Receive B-Transmit A, External.

Modes of Operation: SSB with selectable sideband. CW with automatic 800 Hz offset on transmit and full or semi-break-in. CWN and RTTY modes with optional narrowband crystal filter. (CWN mode is CW with 400 Hz bandwidth crystal filter in receive; RTTY mode is LSB with 400 Hz bandwidth crystal filter in receive.)

Power Input Required: 12-14 VDC negative ground only. No damage 10-15 VDC. 20 amperes peak current.

Electromagnetic Interference:

Transmit: Five element lowpass filter on each band.

Receive: Three pole bandpass filter on each band.

Dimensions: 6.375" H x 14.25" W x 13.25" D
16.2cm x 36.2cm x 33.7cm
Weight: 23.5 pounds (10.6kg)

Rear Panel:

Power Connector:

| | |
|---|---|
| Pin 1 | 13.6 VDC |
| 2 | Ground |
| 3 | Ground (used for tuner meter lamps) |
| 4 | 13.6 VDC |
| 5 | Ground |
| 6 | 13.6 VDC fused to 3 amps (used for tuner meter lamps) |

Antenna Connector: UHF SO-239

External Speaker/ Phones: Phone Jack

External Relay: RCA phono jack

Key: RCA phono jack

EXT Modulation: RCA phono jack

Fuse: 3 amp fast blow

External L.O.: RCA phono jack

Auxiliary Antenna: RCA phono jack; Slide switch chooses auxiliary receive antenna or common antenna with transmit

Typical Receiver Specifications:

Circuit Design: Single conversion to 9.00165 MHz IF using double balanced mixer. Exceptional immunity to overload and cross modulation.

Receiver Sensitivity: 10dB $\frac{S+N}{N}$ Typ. at .35 uV

Image Rejection: Better than 60dB

Receiver Selectivity: SSB and CW--2.4 kHz bandwidth, two 8-pole crystal filters with shape factor 1.4:1, 6dB to 100dB (16 pole equivalent)
CWN and RTTY--400 Hz bandwidth. 6-pole crystal filter in series with one 8-pole SSB filter (optional)

Passband Tuning: SSB and CW--eight-pole continuously variable highpass or lowpass. LED readout shows approximate audio bandpass.

CWN and RTTY--four-pole crystal filter continuously tunable over 300-3000 Hz LED readout shows approximate audio bandpass

Dynamic Range: AGC greater than 100dB; third order intercept +5dBm (intermod products down 90dB at -40dBm input)

Audio Output Power: Greater than 3 watts into 4 ohms

Meter: S-unit from 1-9, 20, 40, and 60dB over S-9

Typical Transmitter Specifications:

| | |
|---|---|
| Circuit Design: | Conversion from 9.00165 MHz IF. ALC limits SSB peak output power and CW output power to 100 watts. |
| Power Input: | 235 watts PEP input at 13.6 VDC input |
| Power Output: | 100 watts PEP into 50 ohm non-reactive load at 13.6 VDC input |
| Unwanted Sideband Rejection: | 60dB down at 1000 Hz audio |
| Harmonic Output: | 45dB below peak power level |
| Carrier Suppression: | 50dB below peak power level |
| Spurious Output: | 55dB below peak power level |
| Transmit Control for SSB: | PTT and VOX Standard |
| CW Transmit: | Full or semi-break-in with sidetone standard. Automatic 800 Hz offset on transmit frequency |
| Microphone Input: | 47K ohm input impedance |
| Audio Response: | 300 to 3000 Hz $\pm$6dB |
| Meter: | Reads peak power selected by meter switch; Forward power 100 watts fullscale, reflected power 10 watts fullscale, or ALC (automatic level control) |
| Cooling: | Large capacity heatsink fins supplied. For SSTV, RTTY, and semi-continuous transmit forced air cooling (such as a small muffin fan) on heatsink fins required |

VSWR Shutdown: Full power up to VSWR = 1.7:1

Approximate limit ratio as follows:

| VSWR | Percent Power |
|---|---|
| 1.7 | 100% |
| 2.0 | 80% |
| 3.0 | 60% |
| Open or Short | 25% (equivalent voltage) |

## 3.0 REQUIREMENTS FOR OPERATION

### A. AC OPERATION

The ASTRO-103 Transceiver requires +13.6 VDC at up to 20 amperes in transmit mode. For operation from 110/220 VAC at 50/60 Hz, the PSU-6 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 13.6 VDC
2. Load Regulation 13.0 VDC @ 20 amp
3. Ripple 0.25 Vpp @ 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 electro-mechanical devices connected to the same battery supply. In mobile use it is always advisable to start engine with set turned off.

2. Power to the radio, except for power to the power amplifier, is controlled by the front panel on/off switch. Because of the large currents (up to 20 amps) required by the power amplifier, it is not possible to switch the power amplifier transmitter supply on and off with the front panel power switch. Voltage for the transmitter power amplifier is supplied directly from Pins 1 and 4 of the power connector. This connection allows a leakage current of up to 20ma 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. For example, a fully charged 60 AH battery will discharge in about 120 days.

3. Reverse polarity protection is provided by an internal shunt connected diode. For this reverse protection diode to function properly, an external 20 ampere inline fuse is required. The 3 ampere fuse located on the rear panel is to protect all circuits in the set except the power amplifier from over voltage or short circuit, not reverse voltage.

4. The transceiver is rated for operation at 13.6 VDC which is the normal operating voltage of a 12.6 VDC 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 11.0 VDC. 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. The length listed is the distance to the battery and assumes both the hot lead and its return are the same gauge.

| Gauge | Total Length |
|---|---|
| 8 | 30 feet |
| 10 | 20 feet |
| 12 | 12 feet |
| 14 | 7 feet |
| 16 | 5 feet |

C. ANTENNA

The antenna may be of any type selected by the operator, provided the VSWR is 1.7:1 or less. For antennas that are not designed with a VSWR of 1.7:1 or less, an antenna tuner such as the Cubic ST-2B or ST-3B 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 47K ohms. Almost any standard microphone will provide satisfactory performance. Figure 3-1 depicts the microphone connection using a standard phone jack. The Morse key may also be connected through this jack using the tip and sleeve. The key may also be connected through the rear panel by an RCA type connector. In the CW mode the microphone switch may also be used as a CW key because microphone audio is muted in CW mode.

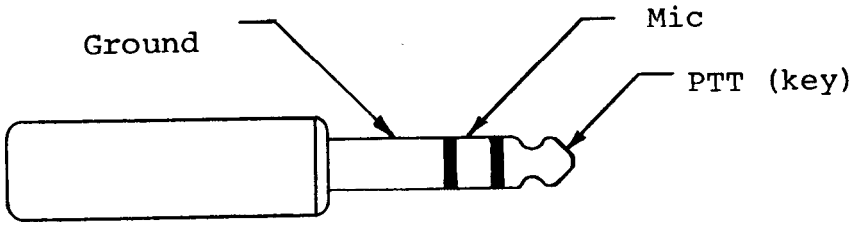



FIGURE 3-1

Both mobile and desk type microphones are available from Cubic; for mobile use Model 404, and for desk use Model 444. The microphone manufacturer's instructions should be followed in connecting the microphone cable to the plug. Many microphones require that the push-to-talk button must be pressed to connect the microphone element in the radio input. For VOX operation, this feature must be disabled by opening the microphone case and jumpering the switch section that controls the microphone element connections.

E. SPEAKER/HEADPHONES

The unit comes equipped with a built-in speaker. Audio output is also available to drive an external speaker or headset from a phone jack on the rear panel. 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-103 Main Chassis and Interconnect diagram details these functions.

## 4.0 INSTALLATION

### A. ACCESSORIES INCLUDED IN PACKAGE

1. Power mating connector
2. RCA Phono Plug (3)
3. Owner's Manual
4. Audio Phone Plug
5. Rubber Feet (2) and Mounting Screws

### 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 SSB or CW 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 heatsink be provided.

For continuous or semi-continuous 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.

Two large rubber feet are provided to replace the standard tilt stand if desired to match other equipment (e.g. 1500ZA Linear Amplifier, ST-2B Antenna Tuner). Use the center hole provided at each foot location.

2. Mobile. While the ASTRO-103 is designed primarily as a base station transceiver, excellent mobile performance can be expected if the unit is mounted in accordance with the factors listed below.

a. Maintain cooling space as mentioned above
b. Mount the unit in a manner to minimize shock and vibration. The mobile mount must be designed to fit individual requirements, however, installation in cars and trucks should be simple and trouble free.
c. Power connection should be made per Requirements for Operation section; Paragraph 3.0, B, DC Operation.

C. CABLING

1. Antenna. The antenna connector on the transceiver is SO-239 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 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 power amplifier heatsink. 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-103 will interface directly with the Cubic 1500ZA and other linear amplifiers that require a grounded contact for operation. The RCA type connector, EXT RLY is connected to a normally open transistor collector. The transistor switch is intended to provide a low resistance path to ground for a positive voltage to key a linear amplifier. The transistor is revers polarity protected. Signal characteristics are as follows:

| | |
|---|---|
| Maximum Applied Voltage | 200 VDC |
| Maximum Input Current (Switch On) | 200 ma |
| Resistance to Ground (Switch On) | 10 ohms in series with diode |

Amplifiers requiring control of a negative voltage, voltages or currents higher than the above values, or metallic contact switching can be accommodated with an external relay between the Cubic transceiver and the other make linear amplifier.

The external relay should have its coil connected between the transceiver power supply and the transceiver EXT RLY jack. A relay with a nominal 12 volt coil is required such as the Cubic 111-015 or equivalent. A set of normally open contacts on the relay is then connected to the appropriate point on the linear amplifier. A schematic diagram of this connection is shown in Figure 4-1.

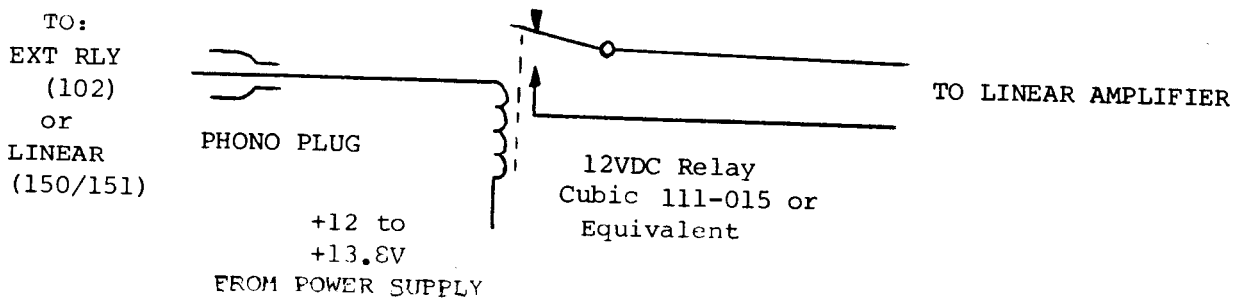



FIGURE 4-1

The external relay will probably not be fast enough to operate in full break-in mode. Therefore, when operating CW the break-in switch should be set to the SEMI mode. VOX operation in SSB mode will be possible, although the DELAY control may be advanced slightly to insure that the linear amplifier does not drop out between syllables, thus cutting off the first part of the next syllable.

## E. OTHER FORMS OF MODULATION

For modulation formats other than voice, for example SSTV or RTTY, the modulation can be introduced through the front panel MIC input jack or the rear panel RCA connector labeled EXT MOD. Both inputs are in parallel, but isolated from each other. It should be noted that <u>both</u> inputs are always on in SSB modes and off in CW modes.

NOTE: The RTTY mode is the same as LSB mode, but switches in optional CW narrow filter.

## F. CW KEY CONNECTION

The CW key can be connected through the front panel MIC connector. The MIC connections are shown in Figure 3-1.

The key input requires a ground to activate the transmitter. The key line is normally at 4 VDC in the receive mode and will draw less than 5.0ma in key down mode. The key may also be connected through an RCA connector on the rear panel. This connection permits permanent CW hookup.

## G. MOBILE

For best mobile performance it is necessary to assure each factor in the installation is optimum. Major considerations are listed below:

1. Grounding. Assure ASTRO-103 chassis is groundec to vehicle frame by low impedance path.

2. Power Cable. Assure connections and requirement of Requirements for Operation, Section 3.0, Paragraph B are

3. Antenna and Cable. For satisfactory performance is necessary to assure the unit operates into a VSWR of less than 1.7:1. To assure an optimum installation, a Cubic M34 mobile antenna should be used with RG58/U coaxial cable, or equivalent. To extend available usable bandwidth, an impeda transformer such as the Cubic MMBX can be used.

4. Microphone. See Section 3, paragraph D.

5. Mounting. See Section 4, paragraph B-2.

## 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. See Figure 5-1 for transceiver front panel layout, and Figure 5-2 for rear panel layout. From left to right:

Key/Mic Connector: Standard phone jack connection of microphone or key. See Paragraph 3.0D and Figure 3-1 for connections.

IF GAIN/AGC DECAY -- Dual Control: The IF GAIN is the inner knob of the control concentric pair. The IF GAIN can be used to reduce receiver gain below that held by internal AGC. The outer knob is the AGC DECAY control. This control sets the AGC decay or "hang" time. Full counterclockwise is zero hang time and full clockwise is several seconds hang time. For average conditions 10 o'clock to 12 o'clock setting should be used.

Passband Tuning: Sets IF bandwidth with either highpass or lowpass cutoff. Rotation clockwise cuts low frequency audio, counterclockwise rotation cuts high frequency audio. The effective audio passband is shown by the eight LED passband indicators.

AF GAIN/RF GAIN: The RF GAIN is the outer control of the concentric pair. The inner control sets the AF GAIN and is also the power on/off switch.

MIC GAIN: MIC GAIN control sets level of modulation signal in SSB operation. In CW operation the control serves as RF output power control.

Notch Filter: High Q audio notch filter is used to reduce hetrodyne tones. Full clockwise tunes approximately 3 kHz; full counterclockwise tunes approximately 300 Hz. Set to null objectionable tone.

Meter Switch: Selects desired meter mode in transmit. FWD is peak forward power, 100 watts fullscale. REF is peak reflected power, 10 watts fullscale. ALC indicates relative amount of ALC generated.

Meter: Quad function meter reads S units to S-9 and dB above S-9 to 60dB in receive mode. Reads forward power, reflected power, or ALC in transmit mode. ALC readings consistently into red zone indicate transmitter overdrive.

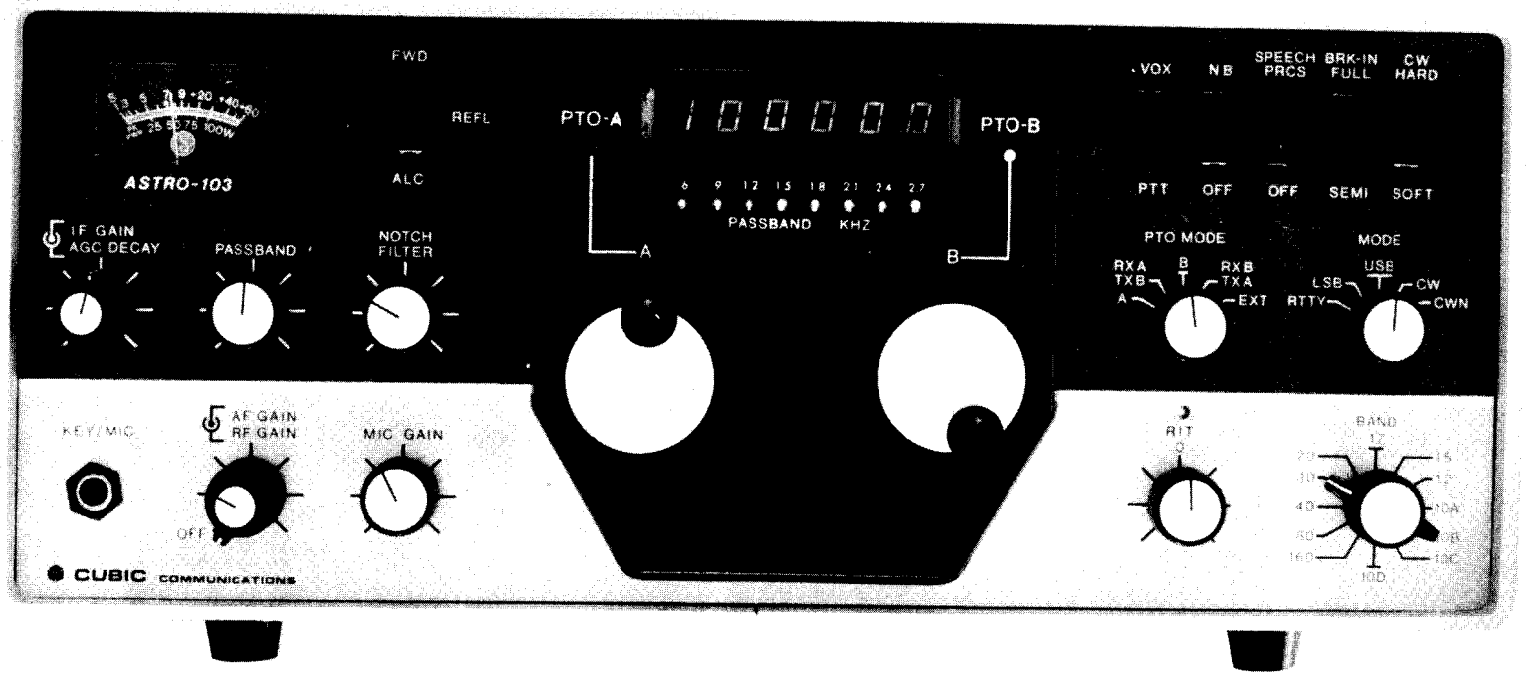



**FIGURE 5-1**

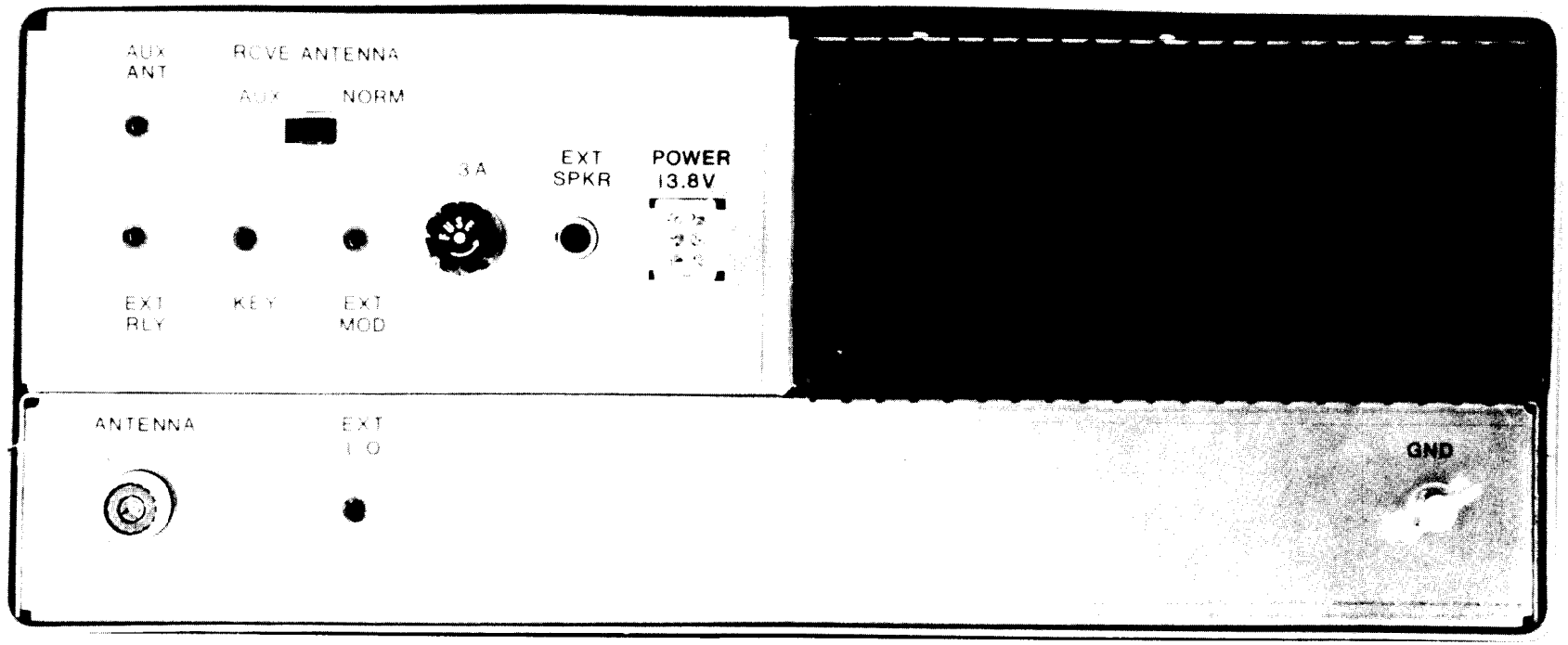



**FIGURE 5-2**

PTO-A or PTO-B: Frequency tuning as selected by either tuning knob. The active PTO is selected by the PTO mode switch, and is indicated by an orange LED above the designator label. Tuned frequency is indicated by the counter.

PTO Mode: Selects PTO mode of operation: A only; Receive A-Transmit B; B only; Receive B-Transmit A; External.

Mode: Switch selects desired sideband or CW function. The CWN position activates the optional narrowband IF crystal filter. The RTTY position activates the narrowband filter in Lower Sideband mode.

RIT: Fine tuning control allows receive frequency only to be varied by about ±2 kHz.

Band: Provides coverage of the 9 Amateur bands (160M through 10M) in twelve ranges (the 10 meter band is subdivided into four ranges).

VOX/PTT: Selects VOX (Voice Operated Transmit) or PTT (Push-to-Talk) mode for SSB operation.

NB: Noise blanker minimizes effects of pulse type noise such as automobile ignition.

Speech Processor: Speech processor used with MIC LEVEL control to set degree of audio clipping.

Break-in Full/Semi: Selects receiver mode when operating in CW or CWN.

CW Hard/Soft: Selects hard or soft CW rise and decay time of transmitted signal.

B. REAR PANEL

External Speaker Connection: The receiver audio is available for external speaker or headphone connection at the rear panel jack labeled EXT SPKR. This jack accepts a standard single circuit plug to which the speaker or headphones are connected. The external device is automatically connected and the internal speaker disconnected when the plug is inserted. The external speaker impedance may be anywhere between 3.2 and 8 ohms.

Auxiliary Switching: External devices may be keyed in unison with the unit through the EXT RELAY jack on the rear panel. This jack requires the insertion of an RCA type phono plug to make connection to the internal transistor switch. The center connection of the plug is connected to chassis ground through 10 ohms when the unit is keyed.

Key: The transmitter may be keyed on by grounding the center connection of the RCA jack labeled KEY.

Modulation: An auxiliary modulation input for AFSK or other uses is connected through the jack labeled EXT MOD. This input is summed with the normal mic input and level is controlled by MIC GAIN control.

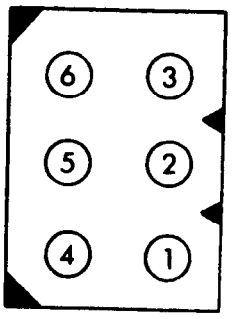
External L.O.: For tuning by external means a local oscillator signal may be injected through the jack labeled EXT L.O. The external L.O. signal should be set to approximately 0dBm. The L.O. frequency is determined by the formula:

$f_{LO} = f_{carrier} + 9.0000$ MHz on LSB and $f_{LO} = f_{carrier} + 9.0033$ MHz on USB and CW

Receive Antenna Switch: This switch provides the operator with the choice of using a common antenna for receive and transmit or switching to an auxiliary antenna for receive. This is used primarily when an external linear amplifier is used and full break-in CW operation is desired.

Auxiliary Antenna: When above switch is in "AUX" position, this RCA jack is connected to the receiver.

Power: The unit operates on 13.6 VDC at up to 20 amps. The power connector uses two parallel input pins for this current and its return leads. Figure 5-3 shows the pin layout and function.




| Pin | Function |
|---|---|
| 1 | 13.6V in |
| 2 | Ground |
| 3 | Ground |
| 4 | 13.6V in |
| 5 | Ground |
| 6 | 13.6V out |

FIGURE 5-3

NOTE: Pins 6 and 3 used to power ST-2B or ST-3B tuner meter lamps, and are fused by the 3A rear panel fuse.

Fuse: A Littlefuse, P/N 312002 or equivalent 3 ampere fast blow fuse is used to protect internal circuits. An external fuse is required for reverse polarity protection, as described in Section 1, paragraph B.3.

Antenna Connector: SO-239 type for use with 50 ohm coaxial systems.

## 6.0 OPERATING INSTRUCTIONS

### A. RECEIVER OPERATION

The ASTRO-103 is normally in the receive mode of operation unless either of the two key line pins are connected to chassis ground by a path of 100 ohms or less or the VOX is activated. Except for the power amplifier, power is applied to the unit through the front panel on/off switch. Power is applied directly to the power amplifier whenever a power source is connected. If the PSU-6 AC Power Supply is providing power, its power switch must be on. The correct power-on condition is indicated by a frequency display and meter backlight on the ASTRO-103.

#### SSB OPERATION

To operate the ASTRO-103 in the SSB receive mode, set the controls as follows:

| | |
|---|---|
| IF GAIN | Full Clockwise |
| AGC DECAY | 12 O'Clock |
| PASSBAND | 12 O'Clock |
| AF GAIN | At desired listening level |
| RF GAIN | Full Clockwise |
| NOTCH FILTER | Either full clockwise or full counterclockwise |
| MIC GAIN | Full Counterclockwise |
| METER SWITCH | N/A |
| PTO-A | Set at desired frequency as described below |
| PTO-B | Set at desired frequency as described below |
| PTO MODE | To desired PTO |
| MODE | LSB or USB |
| RIT | Knob to 12 O'Clock-Push for on |
| BAND | To desired band |
| VOX/PTT | PTT |
| NOISE BLANKER | Off |
| SPEECH PROCESSOR | N/A |
| BREAK-IN | N/A |
| CW HARD/SOFT | N/A |

NOTE: With the exception of frequency selection all preselection and band tuning is preset by the band switch. In the case of a mismatched antenna see discussion in transmitter tune up section.

Frequency Selection: The frequency of the PTO selected by the PTO Mode Switch is displayed on the digital readout. PTOs A and B can be individually set to any frequency within the selected band to permit instantaneous frequency change when switching between transmit and receive modes. However, the transmit PTO must be tuned in an off-air condition, that is, temporarily selected as the receive PTO. After both PTOs have been set to the desired frequencies, the transmit PTO frequency will be automatically selected whenever the MIC is keyed. Normally the transmit PTO is tuned by listening in the receive mode for the desired operating frequency.

The dual PTO function may also be used to "remember" a previously tuned frequency, since switching to a pre-set PTO recalls that frequency.

RIT: The RIT is a push on/off switch and control used to fine adjust the receive frequency approximately ±2 kHz in receive only. A red light above the control indicates when the RIT is activated. The 12 O'Clock position is the same as off; turning CCW decreases the receiving frequency, turning CW increases the receiving frequency. In transmit the RIT function is disabled as indicated by the red light.

RF GAIN: The RF GAIN control adjusts the gain of the preselector amplifier to reduce the effects of strong signals overloading the receiver. The normal setting is fully clockwise; turning the control fully counterclockwise reduces RF GAIN by approximately 50dB.

IF GAIN Control: The IF GAIN control is normally at the full clockwise (maximum) position to realize the maximum sensitivity of the receiver. When a relatively strong signal is received, it will quiet the receiver background noise. However, during extended speech pauses, the AGC will decrease and the background noise will return until the operator resumes talking. Reducing the sensitivity of the receiver with the IF GAIN control will minimize this effect. The IF GAIN control operates on the AGC line to reduce the receiver sensitivity. Note that turning the control counterclockwise, in the absence of a signal, causes the S-Meter to deflect upwards. The position of the S-Meter, under such no-signal conditions, indicates the level of the signal that must be received to be heard. If the IF GAIN control is turned counterclockwise while receiving a signal to the point where the meter does not fall back during speech pauses, the background noise will not be heard.

PASSBAND: In SSB operation the PASSBAND control reduces the overall IF passband by raising the low frequency limit or lowering the high frequency limit to reduce interference. This method of passband tuning assures that, as interference is removed on one side of the desired signal, it is not introduced on the other side. The passband limits are indicated by LEDs on the PASSBAND scale. In the 12 o'clock position of the control all LEDs are on; turning the PASSBAND control clockwise limits lower audio frequencies, counterclockwise limits upper audio frequencies.

AGC DECAY: The AGC DECAY control adjusts the time required for the AGC to recover from a strong signal. The setting is determined by receive conditions and mode of operation. During strong signals, the decay is adjusted to maintain the same level of gain between syllables such that noise is not heard as the AGC decays. During weaker signals or transient conditions, reception can be significantly improved by reducing the AGC decay. During round-table operation with stations of varying strength, reduced AGC decay will prevent losing the first few words from a weak station When strong pulse interference of the Loran or "woodpecker" type is encountered, reception can often be restored by reducing the AGC DECAY to near zero.

NOISE BLANKER: The NOISE BLANKER (NB) will minimize the effects of pulse type noise such as automobile ignition noise. It is placed in operation by placing the NB switch in the NB position.

NOTCH FILTER: The NOTCH FILTER provides a very sharp rejection of an interfering frequency in the 300 Hz-3000 Hz audio range. The normal setting is either FCW or FCCW. An offending signal is eliminated by estimating the frequency of the tone by ear and using the scale as a rough guide, high frequency to the right, low frequency to the left. A very careful adjustment will be needed to find the exact position of null as the NOTCH FILTER is very sharp.

## CW OPERATION

For receive CW operation the function is identical to SSB except for mode selection and break-in selection. The mode should be set to CW or CWN as desired. The CWN position activates the optional narrowband crystal IF filter. This filter has 400 Hz bandwidth. By tuning incoming signals to approximately 800 Hz audio note, transmit frequency will be the same as receive frequency. (This is true only when RIT if off.)

The PASSBAND tuning control allows for selection of the desired audio pitch in the CWN mode and also allows for selecting of signals of different pitches without moving the PTO knob.

Semi-Break-in or full-break-in can be switch selected. In semi-break-in the delay adjustment is available on the left side of the unit (see Figure 8-3).

RTTY OPERATION

For receiving RTTY signals the function can be thought of as LSB with the optional CW narrowband filter. LSB provides the proper inversion of the sense of the audio frequency shift such that the lower audio tone is the mark and the upper tone is the space. The PASSBAND tuning control needs to then be adjusted to properly enclose the audio frequencies that the external RTTY filters are tuned to. The narrowband filter gives the necessary selectivity for the standard 170 Hz shift with the center frequency set to approximately 2200 Hz.

B. TRANSMITTER OPERATION

SINGLE SIDEBAND OPERATION

The ASTRO-103 is placed in the SSB transmit mode by first setting up the dual PTOs as described under paragraph A of this section, Receiver Operation.

Transmitter Tuning: The transmitter is designed to operate into a 50 ohm load impedance with a VSWR of 1.7:1 or less. No transmitter tuning is required if a matched antenna is used in the usual operating bands. Press the microphone button (or activate VOX) and, while speaking into the microphone, rotate the MIC GAIN control slowly in the clockwise direction until the METER (set to FWD) deflects up to 100 watts on voice peaks. Alternately, the ALC voltage can be monitored as an indication of peak output if a high SWR causes reduction in power output as explained below. In any case the METER should just read to 100 watts or the red ALC zone on occassional voice peaks when MIC GAIN is set correctly. 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, such as CCI ST-2B or ST-3B, between the ASTRO-103 and the antenna. To properly adjust the antenna tuner, set the function switch to CW mode and the MIC GAIN to

full counterclockwise rotation. Activate the transmitter by CW key or microphone switch and, with the front panel meter switch set to FWD, set forward power with the MIC GAIN control for about 20 watts output to the antenna. Switch the meter to REFL and adjust the antenna tuner controls for minimum reflected power. After verifying 20 watts forward power and no reflected power, briefly adjust the MIC GAIN control for 100 watts forward power and fine tune the antenna for minimum reflected power.

NOTE: Output power is limited to 100 watts by the ALC. Increasing the MIC GAIN beyond the 100 watt level will cause no further increase in the forward power meter reading. Care should be taken not to exceed the 100 watt level, since a higher drive level will cause compression and reduced audio intelligibility.

It is not always possible to achieve full scale power because the VSWR shutdown will limit output when operating into a mismatch. The transmit power reduction as a function of VSWR is a slow, gradual power reduction to protect the transmitter, but still permit operation in the event VSWR rises above 1.7:1. Listed below is the approximate power available vs VSWR.

| VSWR | Power Watts (%) |
|---|---|
| 1:1 | 100 |
| 1.7:1 | 100 |
| 2:1 | 80 |
| 3:1 | 60 |
| | 25 (voltage equivalent) |

Speech Processor: The Speech Processor is used in the SSB transmit mode to increase transmitter average audio power. The processor is a logarithmic clipper which reduces the peak-to-average power ratio. The amount of processing can be adjusted by varying the position of the MIC LEVEL control accessable through the left side of the top cover, rear hole (see Figure 8-3). This control adjusts the level of mic audio into the processor. By increasing the MIC LEVEL (and reducing the MIC GAIN to maintain constant drive power) the amount of processing is increased. The normal setting of this control, which is also used to compensate for different microphone output levels, is found by turning speech processor off, setting MIC GAIN to approximately 10 to 12 o'clock and adjusting MIC LEVEL for normal output when speaking into the microphone, as explained under "Transmitter Tuning."

## VOX OPERATION

The ASTRO-103 is equipped with a VOX feature as standard equipment. It operates in the SSB mode. A switch labeled VOX/PTT selects between the push-to-talk and VOX modes. When shipped, the VOX controls were preset for normal operation with a high impedance microphone. The VOX will key the radio as soon as the operator speaks into the microphone and provide a delay before returning to the receive condition. The delay is independent of the loudness of the operator's voice. For adjusting VOX controls see paragraph 8E.

## CW OPERATION

The ASTRO-103 is placed in the transmit CW mode by first setting the receiver to desired modes, i.e., CW or CWN, and SEMI or FULL Break-in. Selection of CW HARD/SOFT is determined by keying speed. Slow speed CW produces a more pleasing sound in the SOFT position. At speeds approaching 25 wpm, the HARD position will result in better CW clarity. The key can be used with either the front panel microphone connector (see paragraph 3-D for connection) or the rear panel auxiliary key plug (RCA type). The key may be left connected to the auxiliary input and the microphone to the MIC connector for convenient change from SSB to CW Mode.

The unit is now ready to transmit CW except for power output adjustment. To set power output, with key down rotate the MIC GAIN control clockwise until FWD power output is as desired on the built-in Watt Meter. Do not attempt to exceed 100 watts CW output as the ALC will distort the CW waveshape.

NOTE: Most linear amplifiers will not allow full break-in CW operation because the relay in the linear cannot follow the CW keying. Semi-break-in operation is recommended when a linear amplifier of this type is used. Alternatively, an auxiliary antenna can be connected to the rear panel AUX ANT jack with the switch set to AUX.

## RTTY AND SSTV OPERATION

During SSB and CW operation, the power output of the ASTRO-103 is 100 watts peak. However, the duty cycle on CW is low and on SSB the average power is considerably less than 100 watts. If the ASTRO-103 is operated at 100 watts continuously in radio teletype (RTTY) or slow scan TV (SSTV) service, the average power dissipation is over 100 watts, which could overheat the power amplifier transistors and could cause a catastrophic failure. To avoid overheating during these types of operations, direct the air from a fan to the heatsink on the rear panel of the ASTRO-103 or reduce output power to not more than 50 watts.

## 7.0 THEORY OF OPERATION

### A. GENERAL DESCRIPTION

The ASTRO-103 is constructed using modular, plug-in circuit board techniques. Figures 7-1 and 7-2 are functional block diagrams of the receive mode and transmit mode.

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 to eliminate alignment problems. Three pole bandpass preselector filters for each band plus double balanced modulator and mixers assure excellent spurious free performance.

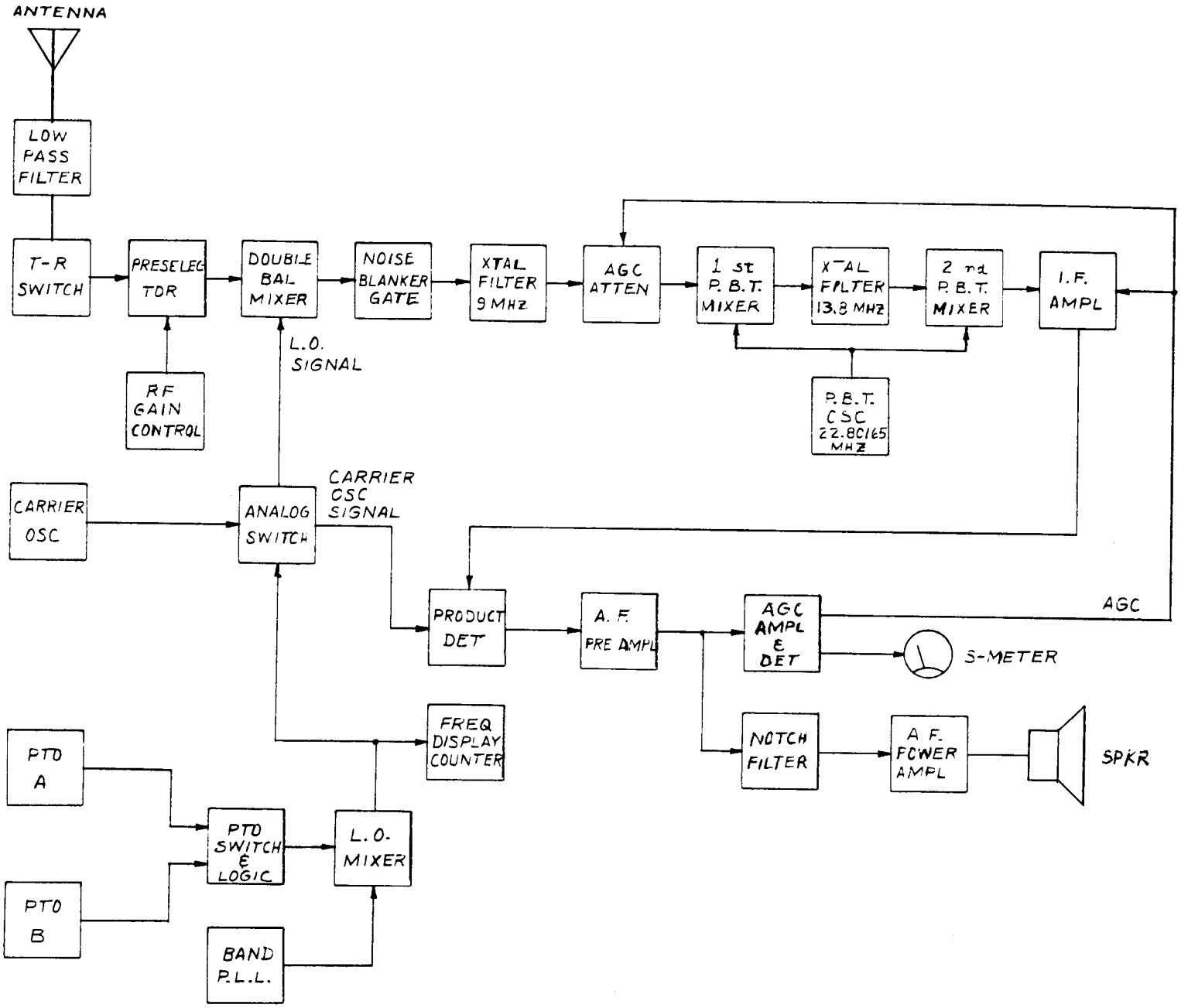
### B. FUNCTIONAL DESCRIPTION

The following functional descriptions of the ASTRO-103 are divided into three sections. The first, referenced to Figure 7-1, describes the unit operating in the receive mode. The second, referenced to Figure 7-2, describes the unit operating in transmit mode. The third section describes the oscillator system.

The CW mode is not covered in these discussions since, in most respects, the system is operating as in the USB mode.

1. Receive Mode. The ASTRO-103 receiver incorporates a unique T-R switch to eliminate the need for a high power T-R relay. The transmit power amplifier is always connected to the antenna through the lowpass filter assembly. In receive mode, the power transistors are biased off, thereby creating an open circuit on the transmitter output transformer. The receiver input is coupled to the transmitter output transformer secondary through a high speed reed relay. This relay and the direct transformer coupling of the power amplifier permit full break-in operation in CW mode. The received signal is therefore filtered by the lowpass filters and then coupled through the reed relay to the preselector bandpass filter.

The preselector filters are PIN-diode switched for each band of operation. Each filter has three sections fixed tuned for the particular band selected. This signal is then fed to a dual gate MOS FET RF amplifier. The gain of the RF amplifier is tailored with a rising characteristic versus frequency to optimize receiver performance of each band. This means receiver gain and threshold are better on the 15 and 10 meter bands where atmospheric noise is much less. On the 40 and 80 meter bands RF gain

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| | | |
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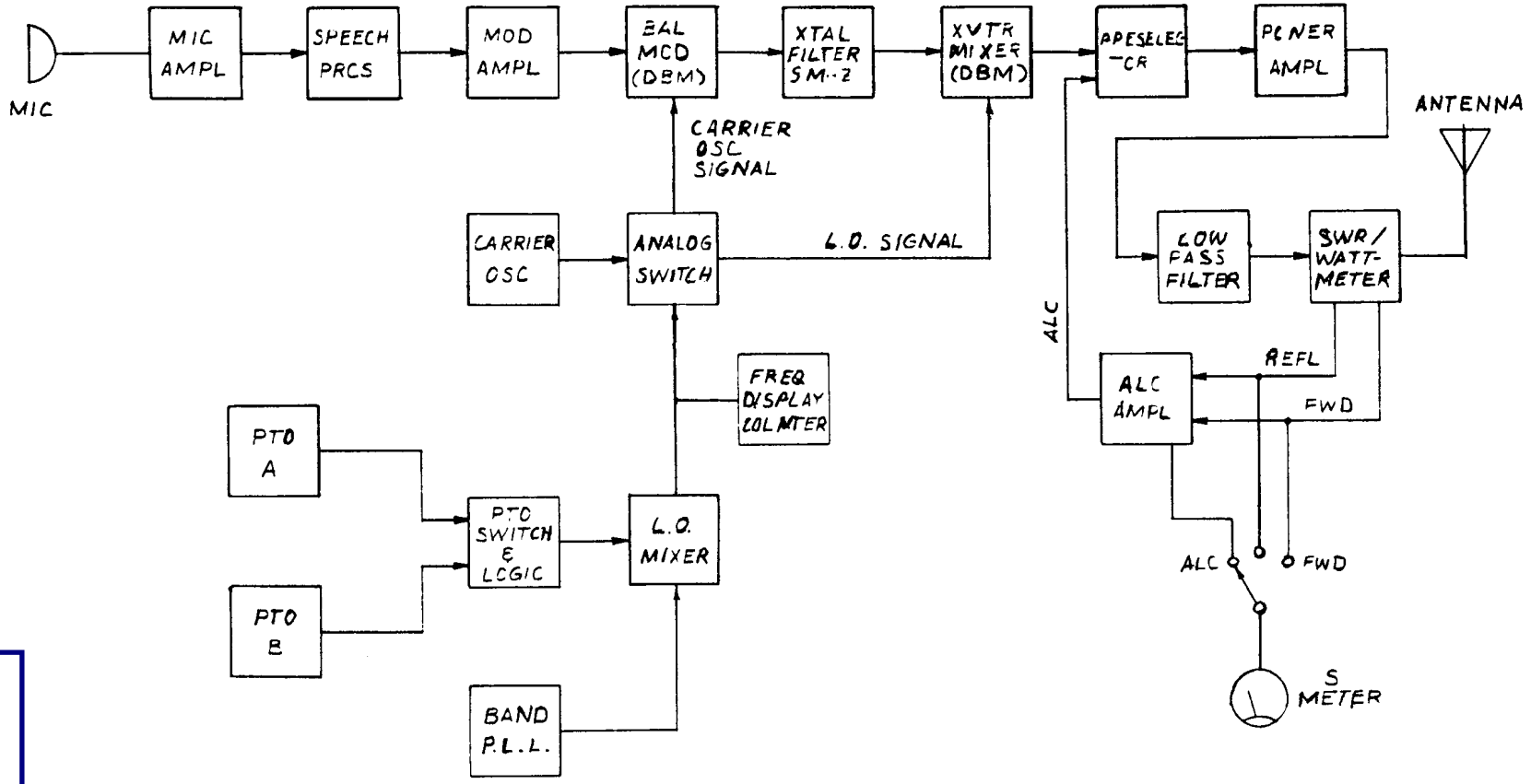
RECEIVE MODE BLOCK DIAGRAM

DRAWING NUMBER FIG. 7-1





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TRANSMIT MODE BLOCK DIAGRAM

DRAWING NUMBER FIG 7-2

is reduced 4 to 6dB to reduce the effect of much higher atmospheric noise levels. The front panel RF GAIN control adjusts the voltage on gate 2 of the RF amplifier to allow the RF gain to be reduced up to 50dB in the presence of strong signals.

The RF amplifier feeds the single conversion receiver. The receive input mixer is a double balanced diode ring type with the LO 9.0033 MHz above the tuned frequency in USB and CW modes, and 9.0000 MHz above the tuned frequency in LSB and RTTY modes. The mixer is followed by a noise blanker gate, which is controlled by the output of the noise blanker board. The function of this circuit is to turn off the receiver signal path when an interfering noise pulse occurs.

The output of the noise blanker gate is coupled to a crystal filter with a passband of 9.0003 MHz to 9.0030 MHz. The signal is then coupled through the AGC attenuator, which is gain controlled to maintain optimum dynamic range under AGC control.

The signal is then mixed with the output of the passband tuning oscillator. The output of the mixer is approximately 13.8 MHz. The exact frequency is determined by the passband tuning oscillator setting. This 13.8 MHz signal is filtered by another 8-pole crystal filter and remixed to return it to the original frequency. The second PBT mixer output is then amplified by an integrated circuit IF amplifier stage with approximately 70dB of available gain.

After the IF amplifier, the signal drives an emitter-coupled product detector. The detected audio output is amplified by the audio preamplifier. This preamplifier output is used to derive the audio AGC. To generate AGC, the preamplifier output is detected and filtered by a peak detector and lowpass filter. The filter output is compared to a fixed voltage reference and, if greater than the reference, it is amplified and fed to the AGC attenuators. By this means, the peak audio level is held nearly equal to a fixed value. A second output of the audio preamplifier feeds the AF GAIN control, the notch filter, and the audio power amplifier.

2. Transmit Mode. A block diagram of the unit when operating in the transmit mode is shown in Figure 7-2. Microphone audio is amplified in the MIC AMP stage. The output of the MIC AMP passes through the internal MIC LEVEL adjustment which sets the audio level into the speech processor. The front panel MIC GAIN control sets the output level of the speech processor. In this way, the modulation level can be adjusted independently of the speech compression level. The speech processor is controlled by the front panel on/off control.

The output signal from the MIG GAIN control feeds the modulation amplifier. The output of the modulation amplifier is one input into the balanced modulator. The carrier oscillator is the second input. The balanced modulator produces two audio sidebands, adjacent to the suppressed carrier. The crystal filter removes one sideband and provides additional suppression of the carrier. The single sideband output of the crystal filter is mixed with the output of the L.O. Board in the transmit mixer. The difference of these two inputs is the signal at the operating frequency. That signal is amplified in the 3 section preselector filter amplifier and the other mixer products are attenuated.

The output of the preselector is then amplified to 100 watts by the power amplifier. The lowpass filter attenuates harmonics of the operating frequency that may have been generated in the transmit mixer or power amplifier. The Automatic Level Control (ALC) will produce an ALC signal for the preselector whenever the peak power exceeds 100 watts or when the standing wave ratio of the transmission line between the ASTRO-103 output and the antenna is 1.7:1 or greater and the voltage or current on the transmission line is equal to that for a 100 watt peak signal. An amplifier in the preselector amplifies the ALC voltage which is applied to gate 2 of the preselector amplifier.

The SWR/Wattmeter Board is a passive circuit which senses power flow in both directions between the lowpass filter and the antenna. The two outputs from the directional coupler are provided to the front panel meter and the ALC circuits on the preselector board.

3. Oscillator System. The output of the local oscillator section is the injection signal to the double balanced mixer in receive mode and to the transmit mixer in transmit. This signal is controlled by switching on the exciter board. The L.O. signal is equal to the desired operating frequency plus 9 MHz in LSB and RTTY modes and 9.0033 MHz in USB and CW. This signal is generated by mixing the selected PTO with the band VCO signal and filtering the difference in the premixer bandpass filters, one for each of the bands. The band VCO is controlled by a phase-lock loop programmed by the bandswitch to provide the desired output frequency.

The PTO control board feeds one of the two PTO outputs to the L.O. mixer. Both PTOs are operating at all times, however, the output from the PTO which is not selected is attenuated approximately 100dB. The output from the selected PTO is amplified to the input level required by the L.O. mixer amplifier.

The carrier oscillator is used to produce a difference frequency output from the product detector in receive and to generate the basic signal in transmit. It's frequency is 9.0000 MHz in LSB and RTTY modes, 9.0033 MHz in USB and CW receive mode, and 9.0025 MHz in CW transmit.

## 8.0 ALIGNMENT

Most circuit alignment and calibration is factory performed at final check-out, 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.

Figures 8-1 through 8-3 are top, bottom, and left side views with adjustment locations noted.

Component designators used in this section consist of one or two letters followed by four digits. The first digit indicates board or location of component, the other three digits are sequential starting with 101. Example: Q6101

| | |
|---|---|
| Q | Transistor |
| 6 | PA Board |
| 101 | Sequential Number |

Consult main chassis interconnect diagram for series number of each board or location.

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

A. CARRIER OSCILLATOR FREQUENCY

Connect a 10:1 probe to Pin 9 of double balanced mixer Z2101. Connect the probe output to the high impedance input of a frequency counter. Terminate the antenna connector in a 50 ohm dummy load.

1. With MODE switch in the LSB position and MIC GAIN full CCW, key transmitter and adjust C-2194 for a reading of 9000.00 kHz.

2. With MODE switch in the USB position and MIC GAIN in full CCW, key transmitter and adjust C-2197 for a reading of 9003.30 kHz.

3. With MODE switch in the CW position and MIC GAIN in full CCW, key transmitter and adjust C-2199 for a reading of 9002.50 kHz.

4. Repeat Steps 1 through 3 as necessary to get all readings with ±10 Hz.

B. SIDETONE ADJUSTMENT

1. Insure MIC GAIN control is maximum CCW.

2. Switch unit to CW mode and key unit with CW key or microphone push-to-talk.

3. Adjust R-4124 for desired volume.

C. AGC AND S-METER

1. Insure VOX/PTT switch is in PTT position, and MODE switch is in LSB position. Remove microphone or CW key from MIC jack.

2. Connect RF signal generator to antenna jack. Tune to 14200 kHz, CW output, 50 uv (-73dBm).

3. Tune unit to receive signal generator and adjust for approximately 1 kHz audio note in speaker.

4. Connect AC voltmeter to cathode end of CR-4123 (AF Board).

5. Adjust R4101 until voltmeter reads .21 vrms on high pin of volume control.

6. Adjust R4110 for an indication of S-9 on S-Meter.

7. Remove signal generator from antenna jack.

D. FWD/REFL POWER

1. Connect an accurate power meter terminated in a 50 ohm dummy load to the antenna connector.

2. Assure that the FWD meter reading is within 10% of power meter reading.

3. Connect two dummy loads through a T-connector and a short length of coaxial to simulate 2:1 VSWR.

4. The REFL meter reading should be within 10% of power meter reading in reflected mode. If either of these indications need alignment, adjust R9147 for FWD and R9149 for REFL. These controls are located on the distribution board.

E. VOX

Three VOX adjustments are available on the left side of the unit. These are R4140 (VOX Gain), R4149 (VOX Antitrip), and R4144 (VOX Delay).

These adjustments are factory set for average operating conditions, but can easily be reset to suit the operator's microphone and noise environment. It is good practice to operate VOX gain set to lowest gain consistent with reliable operation. Delay is set to operator's preference (usually .1 to .2 seconds).

VOX Adjustment Procedure:

1. Tune Transceiver for normal voice operation.

2. Rotate the transceiver MIC GAIN fully counterclockwise. This will prevent audio from being transmitted but will not effect VOX operation.

3. Reduce receiver gain until no sound is heard in the speaker. This will prevent sounds from the receiver speaker from tripping the VOX during initial adjustments.

4. Place VOX/PTT switch in VOX position.

5. While speaking into the microphone in a normal manner, slowly rotate the VOX GAIN control clockwise until the VOX keys the transmitter. Do not use more VOX GAIN than necessary to assure positive operation at normal voice levels.

6. Increase the receiver gain until received signals are at a normal voice volume level. These signals will trip the VOX when picked up by the microphone.

7. With the microphone held in the normal operation position, very slowly increase the ANTI-VOX until received signals do not trip the VOX.

NOTE: Excessive ANTI-VOX gain will cause received signals to control the transceiver so that no amount of sound at the microphone will key the transmitter. Satisfactory balance between the VOX GAIN and ANTI-VOX is easily obtained when the microphone is a foot or more from the speaker.

8. Adjust the DELAY control until the transmitter stays on for the desired interval after you stop talking.

NOTE: A little experimenting on the air will reveal that only a small portion of the first spoken syllable is lost when the VOX is activated. VOX GAIN and ANTI-VOX do not effect delay time.

F. RIT CENTER ADJUSTMENT

1. Tune to a CW signal using PTO-A.

2. Adjust RIT control to center position and switch it on and off while adjusting RIT-A center control (R7536) until the tone does not change.

3. Tune to a CW signal using PTO-B.

4. Repeat Step 2. while adjusting RIT-B center control (R7532).

G. CW DELAY ADJUSTMENT

CW delay is operable only in Semi-Break-in Mode to adjust the period the radio will remain in the transmit condition between key characters. This adjustment is dependent on operator preference. Normally more delay is used for slower keying speeds.

Adjust R4179 on the Audio board for the desired delay.

## H. NOTCH FILTER ADJUSTMENT

1. Connect a signal generator adjusted to the receive frequency to the antenna connector. Adjust the signal generator output level to at least 50 uv.

2. Connect an oscilloscope or audio voltmeter to the speaker terminals.

3. Adjust the active PTO for a frequency on the receiver speaker of approximately 1650 Hz.

4. Rotate the front panel NOTCH FILTER control to reduce the signal as much as possible.

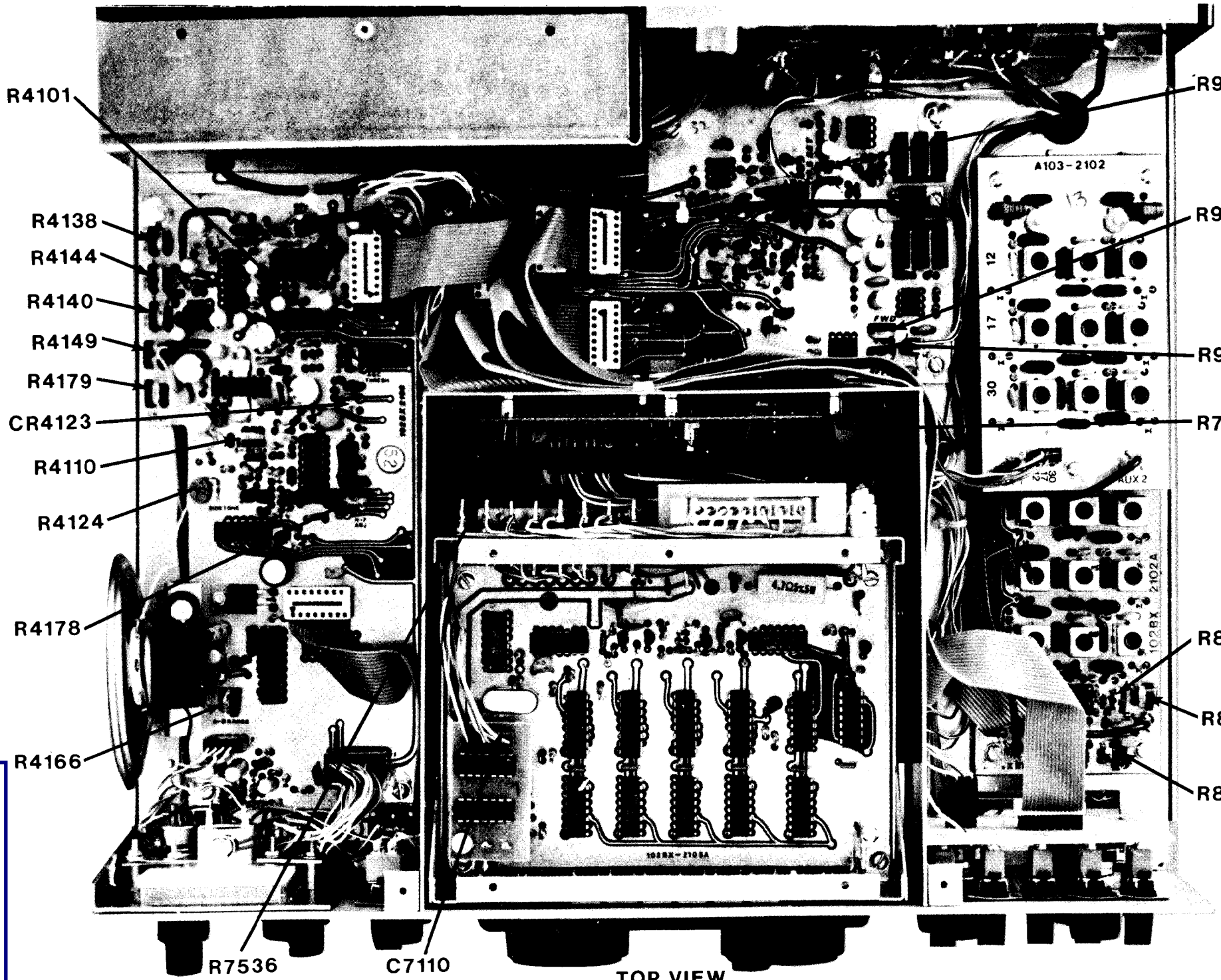
5. Adjust the Notch Adjust (R4178) on the Audio board to achieve the best notch.

6. Alternate Steps 4. and 5. for optimum notch.

7. Check operation of the front panel NOTCH FILTER control at several points in the audio range to verify notch at high and low frequencies.

## I. COMPONENT REPLACEMENT AND REPAIR NOTES

Should component replacement be necessary, it must be recognized that many of the circuit boards in the ASTRO-103 utilize plated-through, double-sided, copper clad. 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.




TOP VIEW
FIGURE 8-1

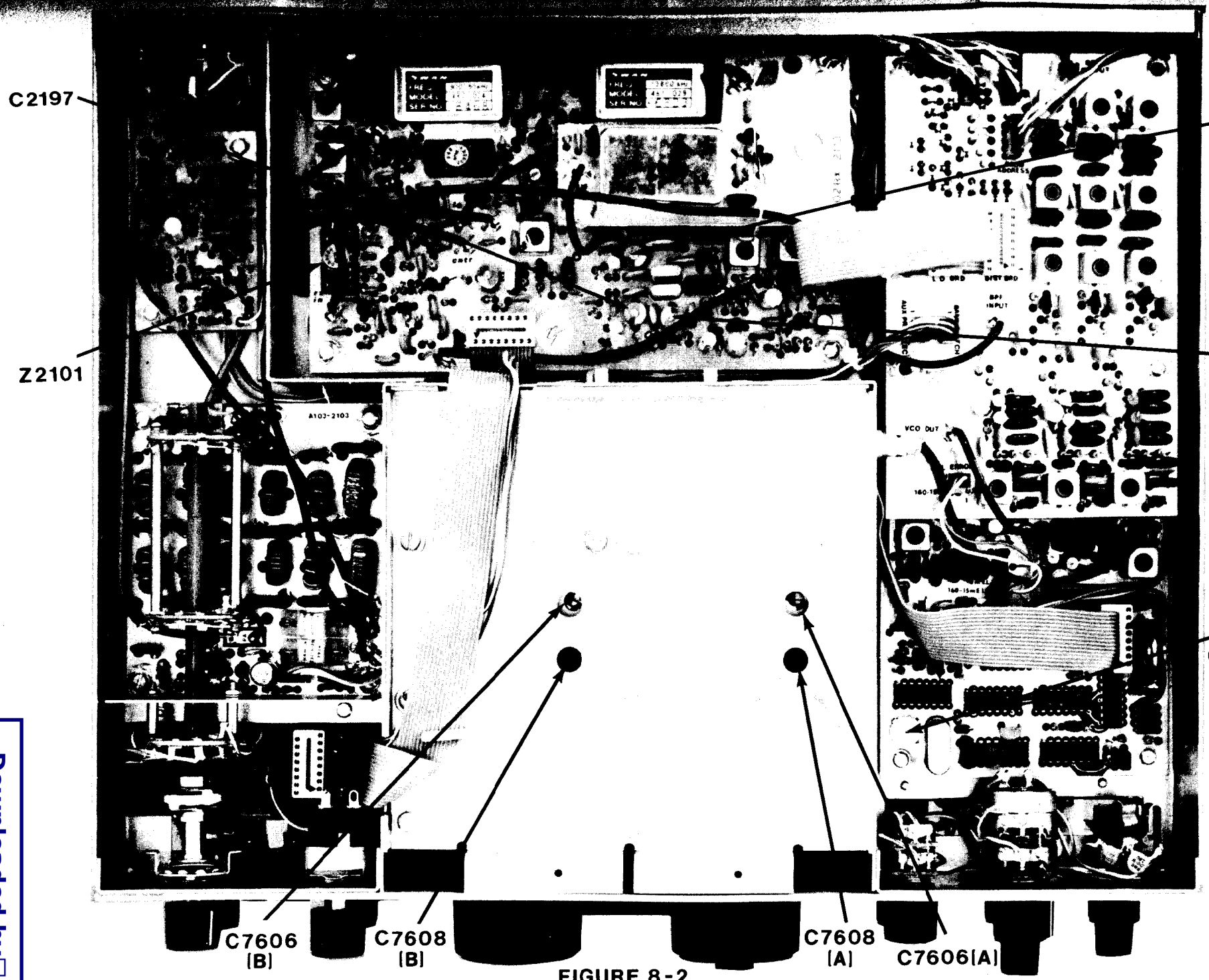



FIGURE 8-2
BOTTOM VIEW

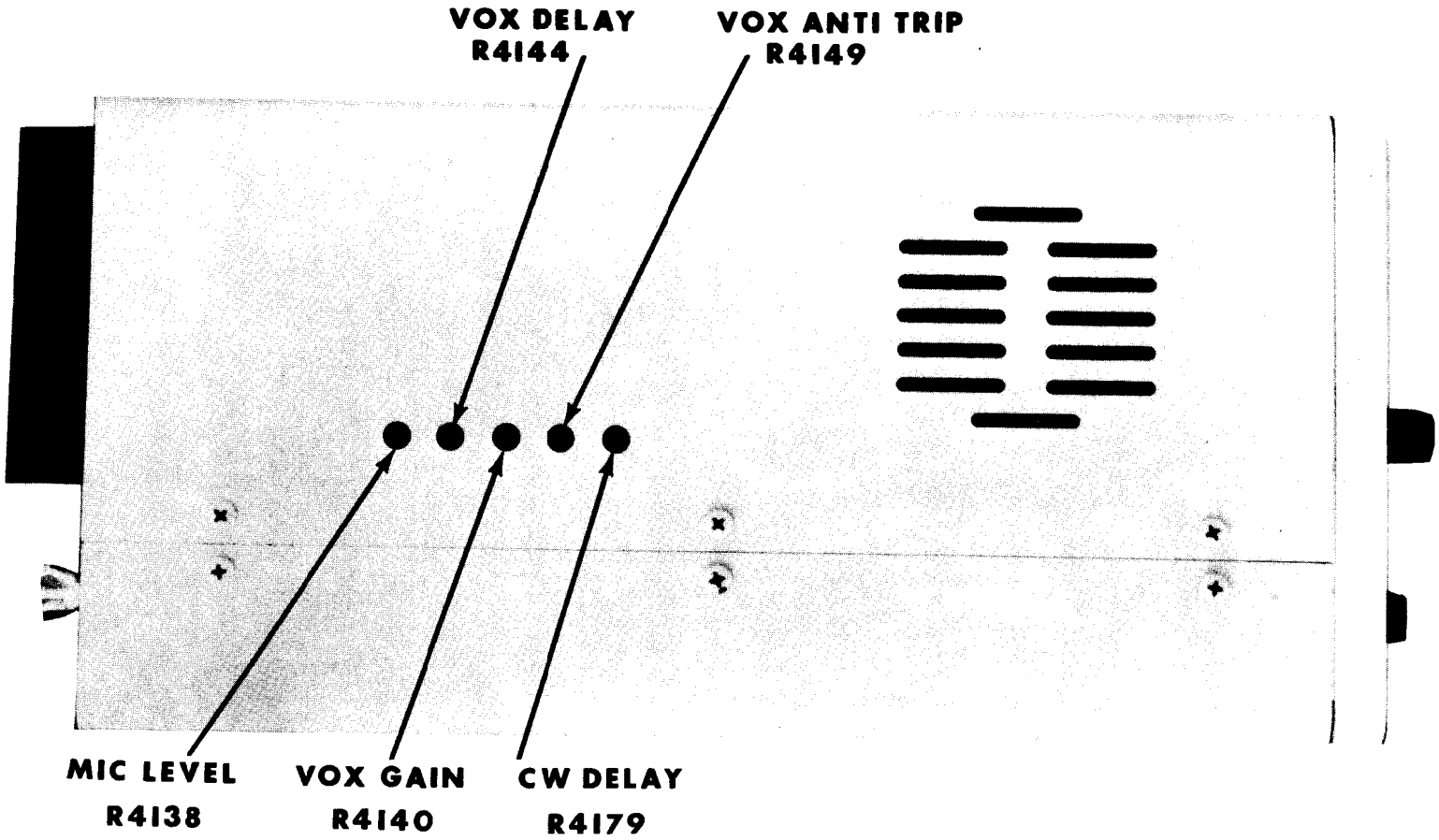



FIGURE 8-3
LEFT SIDE VIEW