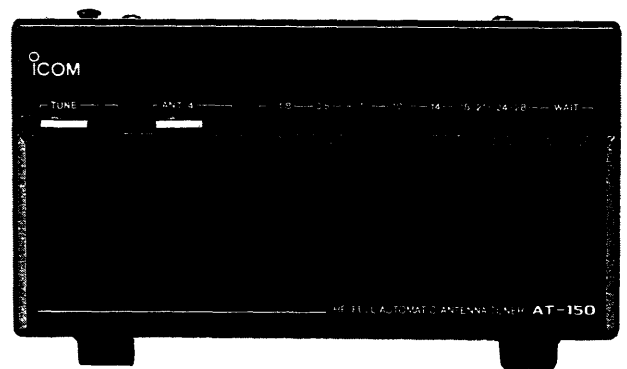


ICOM

INSTRUCTION MANUAL

HF AUTOMATIC
ANTENNA TUNER
AT-150



Icom Inc.

FOREWORD

Thank you for choosing this ICOM product.

The AT-150 is an HF Automatic Antenna Tuner developed by ICOM utilizing the latest electronics technology and precise, advanced engineering.

To fully enjoy the benefits of this high-performance antenna tuner, please study this instruction manual thoroughly prior to operation. Also, feel free to contact an authorized ICOM dealer if you have any questions relating to the operation of this model.

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SECTION 1 SPECIFICATIONS

Number of semiconductors	:	Transistors 24 ICs 10 Diodes 61
Frequency range	:	1.8MHz ~ 2.0MHz 3.4MHz ~ 4.1MHz 6.9MHz ~ 7.5MHz 9.9MHz ~ 10.5MHz 13.9MHz ~ 14.5MHz 17.9MHz ~ 18.5MHz 20.9MHz ~ 21.5MHz 24.4MHz ~ 25.1MHz 27.9MHz ~ 30.0MHz
Input impedance	:	50 Ω
Output matching range	:	16.7 ~ 150 Ω unbalanced VSWR 3:1 or less
Input power capability	:	100W (200W PEP)
Minimum power input	:	8W
Band switching time	:	3 seconds or less
Auto-tuning time	:	3 seconds or less
Auto-tuning accuracy	:	VSWR 1.2:1 or less
Insertion loss	:	0.5dB or less (after tuning)
Current consumption	:	0.5A maximum (at 13.8V DC)
Ground polarity	:	Negative ground
Usable temperature range	:	-10°C ~ +60°C
Dimensions	:	94mm(H) x 180mm(W) x 239mm(D)
Weight	:	3.1kg

*** RAPID TUNEUP**

A newly developed detection circuit determines the position of both input and output variable capacitors, plus the required tuning direction. Separate, powerful motors quickly tune the capacitors for a completely matched antenna system.

*** AUTOMATIC BAND SELECTION**

Instant band changes are possible with an ICOM HF transceiver.

*** PRESET CONTROLS PROVIDED**

Conveniently located controls allow one frequency per band to be tuned in advance. This feature reduces the tuneup time required at power-on or when band switching.

*** BUILT-IN ANTENNA SWITCHING CIRCUIT**

The AT-150 selects one of four antennas automatically when a new band is chosen. And, switches are available to independently program the exact antenna you wish to use on a particular band. Even when the auto-tune circuit is turned off, the AT-150 still functions as an automatic antenna switch when used with the ICOM HF transceiver.

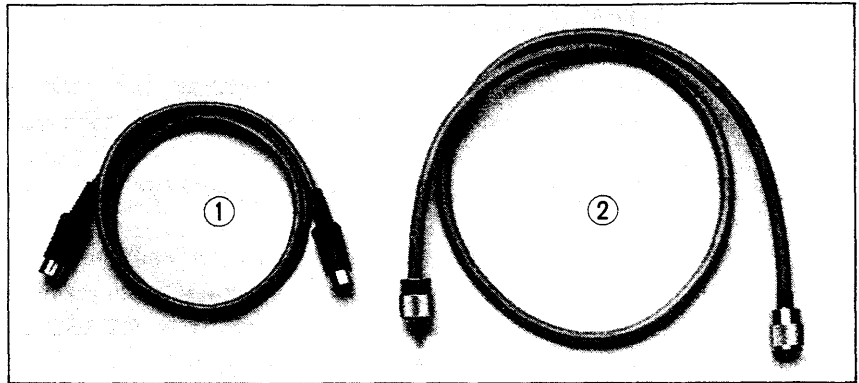
SECTION 3 INSTALLATION

UNPACKING

Carefully remove your antenna tuner from the packing carton and examine it for signs of shipping damage. Notify the delivering carrier or dealer immediately, stating full details, should any damage be apparent. We recommend you keep the shipping carton for storing, moving or reshipping the tuner if necessary. Accessories are packed with the tuner. Make sure you have removed all equipment and parts before discarding the packing material.

Accessories included :

- ① Accessory cable (1 meter).
- ② Coaxial cable (1 meter).



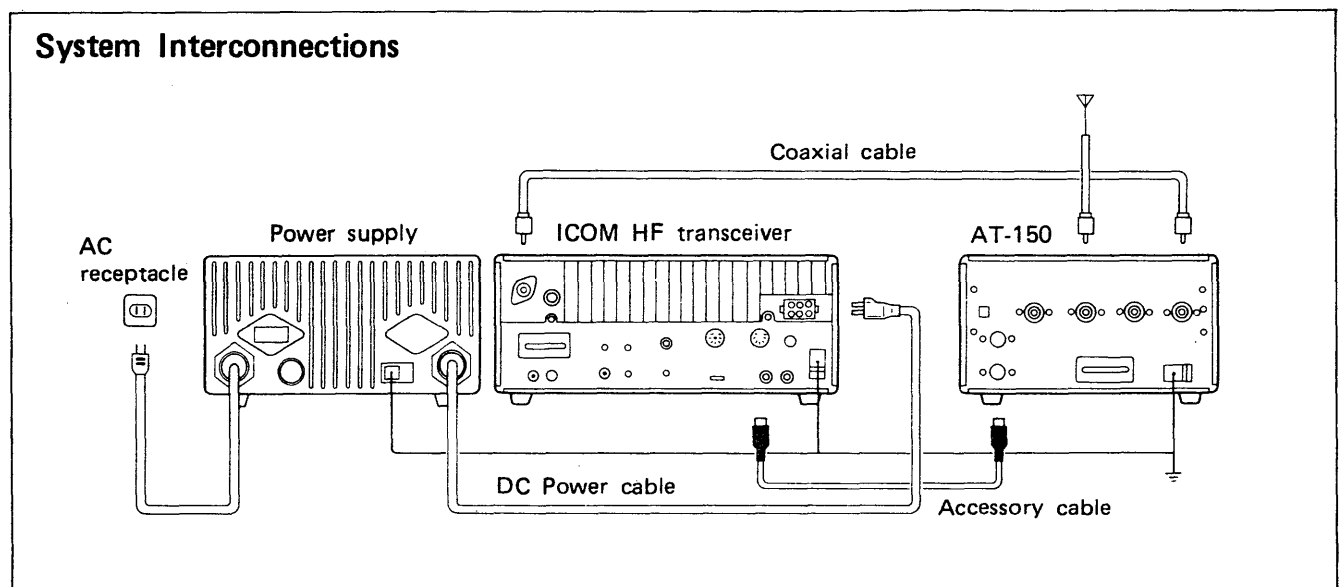
RECOMMENDATIONS FOR INSTALLATION

Avoid installing the AT-150 in direct sunlight, high temperatures, areas with excessive dust or humidity, and locations where the tuner will be subjected to abnormal shocks or vibrations.

Place the unit so the switches can be operated and the LED indicators can be seen easily.

POWER SUPPLY

The transceiver supplies the power required by the AT-150 to the ACC socket on the rear panel via the supplied accessory cable.

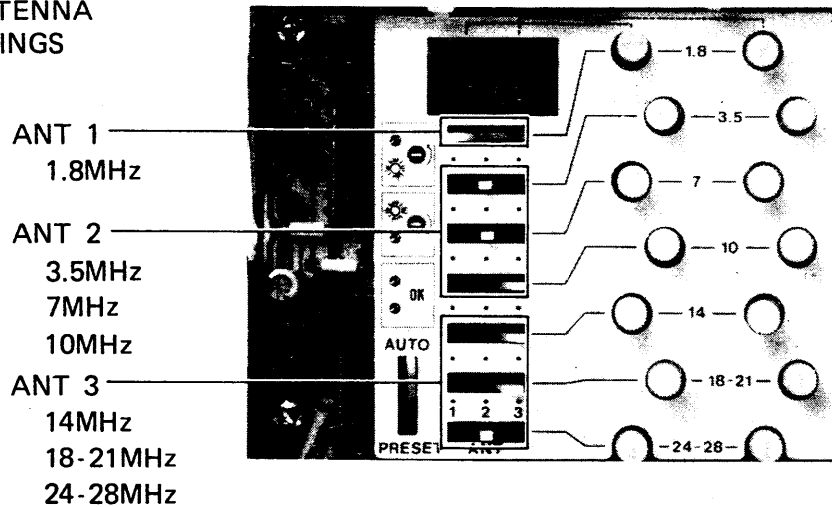


CABLE CONNECTIONS

Connect the AT-150 to the transceiver and the antennas as shown in the diagram. Also, connect a common ground to both units to prevent any possibility of television (TVI) or broadcast band (BCI) interference.

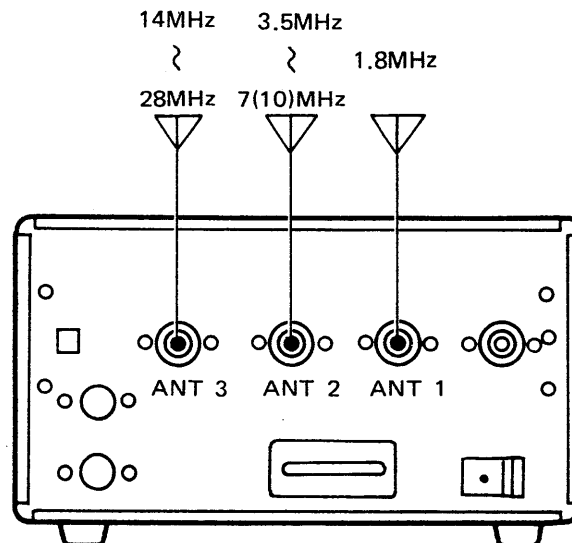
Of the four antenna connectors provided on the rear panel of the AT-150, three of them (ANT1, ANT2, ANT3) accept coaxial cable feedlines. Each of these three antenna systems can be connected to the transceiver for operation on any amateur band by using the switches located inside the hatch cover on the top of the AT-150.

● EXAMPLE ANTENNA SWITCH SETTINGS



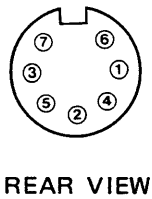
NOTE : The switches are set for operation with the antenna system shown.

● EXAMPLE ANTENNA SYSTEM



ANT4 can be connected by means of the front panel switch. A long wire antenna for general coverage reception could be attached to this connector.

In all four cases, the antennas may be used for transmitting if the VSWR is kept at 3 : 1 or less.

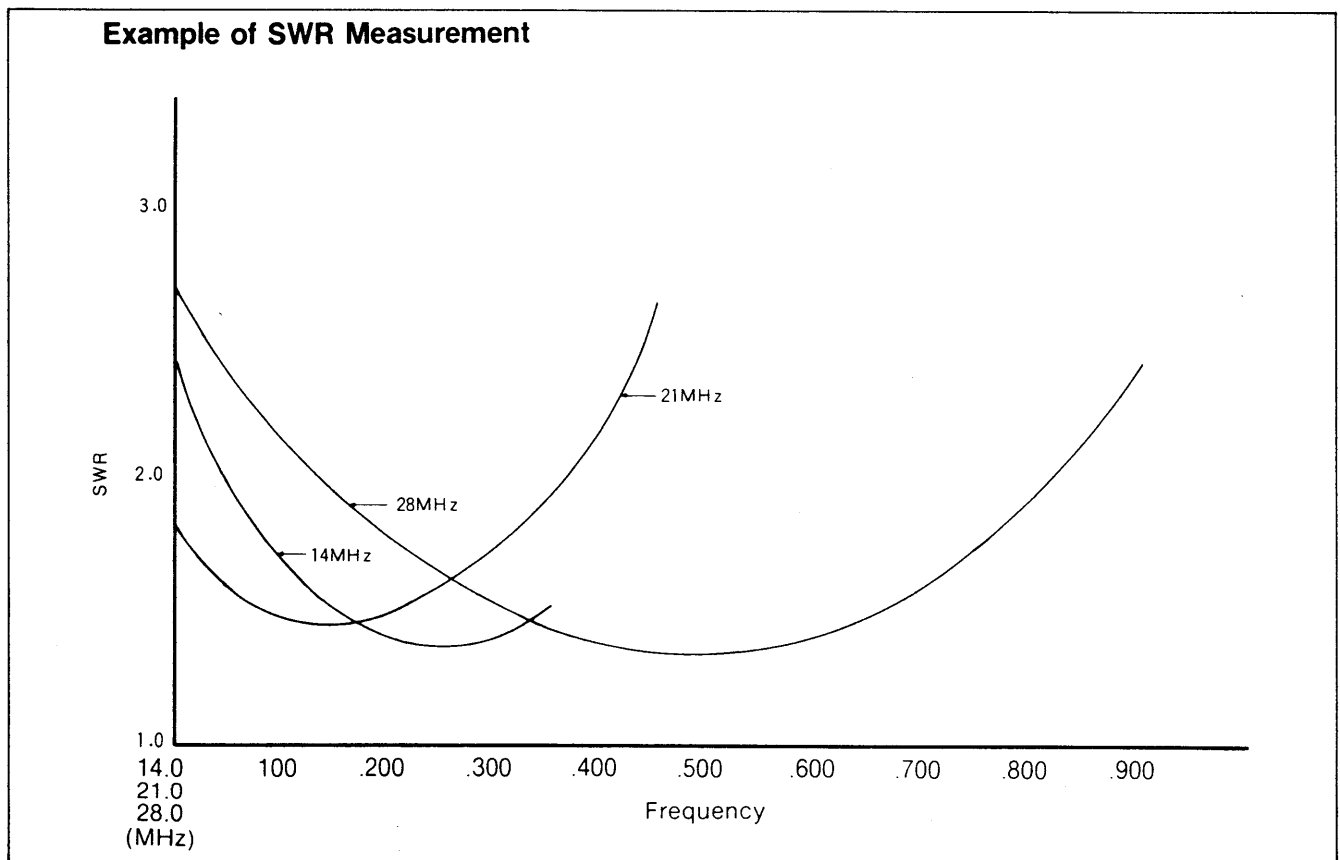


Pin No.	Description	Explanation
1	8V	Reference voltage for band switching.
2	GND	Ground.
3	---	Not used.
4	BAND	Input for external band switching signal.
5	---	Not used.
6	---	Not used.
7	13.8V	13.8V DC input terminal interlocked with the power switch on the transceiver.

NOTE : The two ACC sockets are connected in parallel.

ANTENNA

Since no single antenna tuner is universally effective for all kinds of antennas, a complete understanding of the state of the antenna system is essential to obtain better operating results from the tuner.



Suppose a typical tribander antenna covering 14MHz, 21MHz and 28MHz has VSWR values as shown in the diagram.

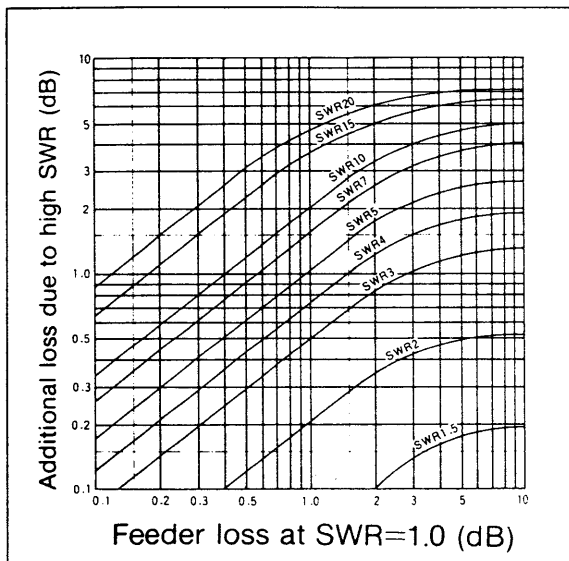
The antenna appears to offer a matched condition in the SSB portion of 14MHz and 28MHz as well as the CW portion of 21MHz. An antenna tuner may not be required while operating in these areas of the bands.

But, operation in the CW portions of 14MHz and 28MHz or in the SSB portions of 21MHz, where the VSWR is poor and the antenna does not match the output impedance of the transceiver, could give unsatisfactory results.

The role of the antenna tuner in this case is to match the impedances of the transceiver and the antenna system. Although the impedances can be matched, the tuner cannot eliminate coaxial cable loss due to a poor VSWR. Additionally, the loading of the transceiver's final amplifier stage is improved and harmonic generation is reduced.

For your reference, the included graph shows the relationship of coaxial cable loss versus VSWR.

Additional loss due to high SWR



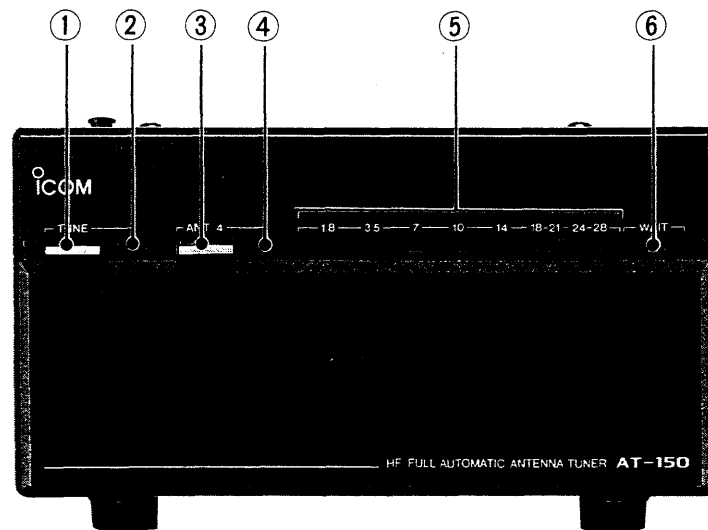
Loss of Coaxial Cable

Frequency MHz Coaxial cable	Loss per 10m (dB)				
	3.5	7	14	21	28
3C-2V	0.25	0.35	0.50	0.61	0.71
5C-2V	0.16	0.23	0.32	0.39	0.46
7C-2V	0.13	0.18	0.26	0.32	0.37
10C-2V	0.11	0.15	0.22	0.28	0.31
5D-2V	0.18	0.25	0.37	0.45	0.51
8D-2V	0.12	0.17	0.23	0.20	0.35
RG-58/U	0.23	0.33	0.49	0.56	0.76
RG-59/U	0.21	0.30	0.43	0.51	0.59
RG-8/U	0.10	0.15	0.21	0.26	0.31
RG-11/U	0.12	0.18	0.26	0.32	0.38

This table shows the attenuation per 10 meters when used at SWR=1.0. The values given in this table are nominal, and may differ somewhat from actual values. The loss tends to increase due to secular change.

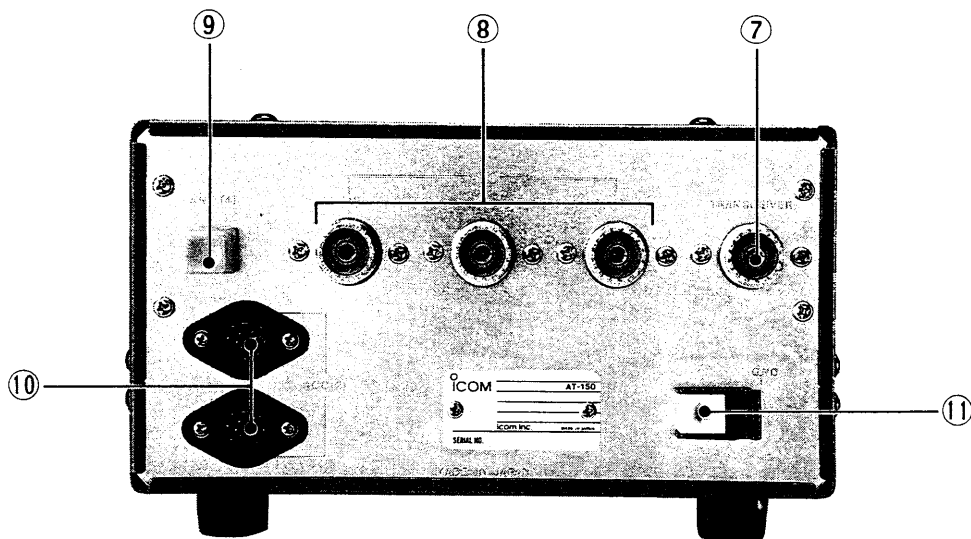
SECTION 4 CONTROL FUNCTIONS

FRONT PANEL



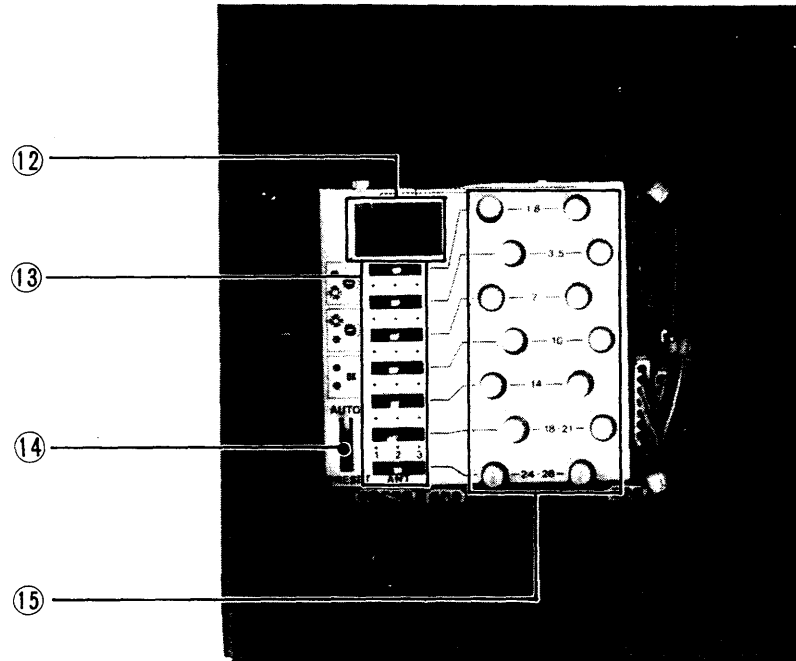
- ① **TUNE SWITCH** Switches the automatic tuner circuit. When the switch is pushed IN, the TUNE indicator lights and the AT-150 acts as an automatic antenna tuner. When the switch is OUT, the output power from the transceiver is fed directly to the antenna, and the AT-150 acts as an automatic antenna switch.
- ② **AUTO-TUNE INDICATOR** Lights when the auto-tune function is activated by pushing the TUNE switch IN.
- ③ **ANT4 SWITCH** Connects the antenna attached to the ANT4 connector on the rear panel to the transceiver directly if the TUNE switch is OUT, or via the auto-tune circuit if the switch is IN.
- ④ **ANT4 INDICATOR** Lights when the ANT4 switch is pushed IN to select the antenna connected to the ANT4 connector on the rear panel.
- ⑤ **BAND INDICATORS** Indicates the amateur band on which the AT-150 is ready to operate. The band indication must agree with the amateur band selected by the transceiver. When using the general coverage receiver, the BAND indicators show the approximate frequency being tuned by the receiver.
- ⑥ **WAIT INDICATOR** Lights while the tuning capacitors are moving to the preset positions, or immediately after the power is turned ON. Also lights when the frequency band is changed. DO NOT transmit while the WAIT indicator is continuously ON.

REAR PANEL



- ⑦ **RF INPUT CONNECTOR** Connect the supplied coaxial cable from the antenna connector of the transceiver here.
- ⑧ **ANTENNA CONNECTORS (1), (2), (3)** Connect the transmission lines from three different antennas here. Use PL-259 connectors on the transmission lines. Any antenna may be used on any band by programming the switches under the hatch cover on the top of the AT-150.
- ⑨ **ANTENNA CONNECTOR (4)** Connect the feedline from a long wire antenna here. Use the ANT4 switch on the front panel to select this antenna.
- ⑩ **ACCESSORY SOCKETS** Connect the supplied accessory cable from the ACC(2) socket on the transceiver to either of these sockets. Turn OFF the power on the transceiver while connecting this accessory cable.
- ⑪ **GROUND TERMINAL** To reduce the risk of electrical shock, television (TVI) or broadcast band (BCI) interference and other problems, be sure to ground the AT-150 at this terminal. Use a heavy gauge wire or metal strap and keep the length as short as possible for best results.

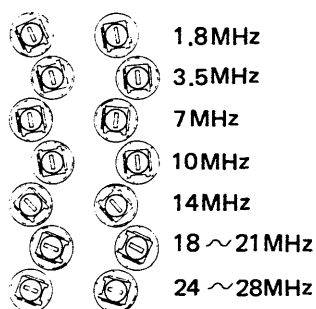
**TOP PANEL
(HATCH COVER CONTROLS)**



- | | | |
|---|--------------------------------|--|
| ⑫ | PRESET INDICATORS | Indicate the direction to tune the PRESET controls for a matched condition when the AUTO/PRESET switch is set to AUTO. All LEDs are OUT when the preset is complete. See SECTION 5 for more information. |
| ⑬ | ANTENNA SELECTORS | Select antenna (1), (2) or (3) for each frequency band independently with these switches. |
| ⑭ | AUTO-TUNE/PRESET SWITCH | Selects either AUTO-TUNE or PRESET operation. This switch should be in the AUTO position for normal operation. |
| ⑮ | PRESET CONTROLS | Preset the input and output matching capacitors for each frequency band using these controls. |

The purpose of the PRESET controls are to adjust the variable tuning capacitors for the approximate area of each band on which you intend to operate. It is not mandatory to set the PRESET controls since the tuner automatically adjusts the matching capacitors when transmitting on a new frequency if the AUTO/PRESET switch is at AUTO. However, if the presetting is done when you first install the AT-150, the time required for the automatic tuning function to finely adjust the capacitors for a specific operating frequency is reduced.

PRESET OPERATION



Approximate positions of the PRESET controls for 50 Ω antenna systems.



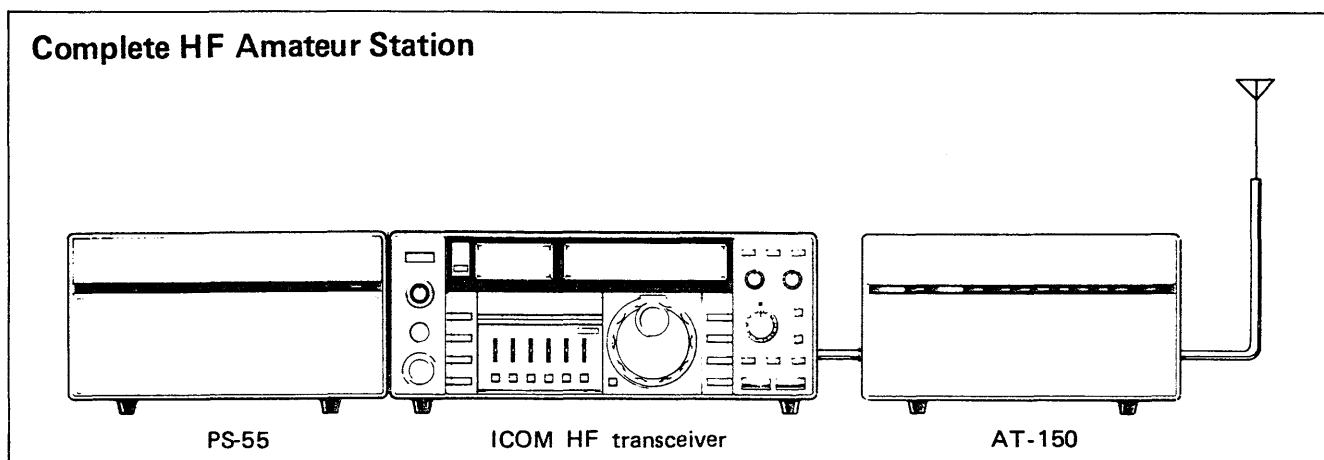
* Note the position of the marker when setting each PRESET control.

1) Connect the AT-150 and the transceiver as shown in SECTION 3. Use the built-in meter in the transceiver for making VSWR measurements.

2) Push the TUNE switch IN. The green LED indicator to the right of the switch lights. Check that the AUTO/PRESET switch inside the top hatch cover is in the AUTO position.

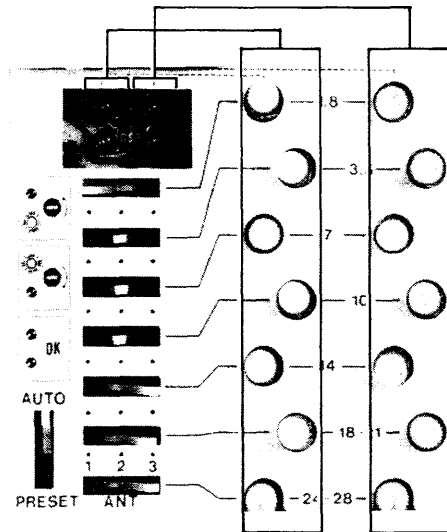
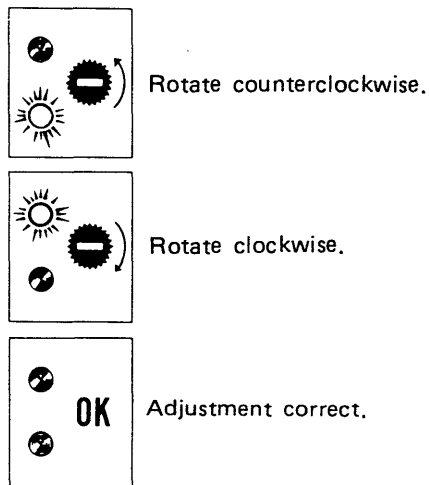
3) Verify that the frequency band selected on the transceiver is the same as the band selected by the tuner as indicated by the green LED lights on the front panel of the AT-150. Select a frequency on the transceiver in the area of the band on which you plan to operate.

4) Transmit a steady carrier using the FM mode with about 10 watts. Confirm the auto-tuning function operates correctly resulting in a low VSWR. Stop transmitting. See the section below, AUTO-TUNING FAILS TO OPERATE, if the auto-tuning function does not operate.



5) Adjust the two PRESET controls located under the hatch cover on the top of the AT-150 corresponding to the selected band until all four red LED indicators under the hatch cover are not lit. Use the left PRESET control for the two left LEDs, and the right PRESET control for the two right LEDs. This completes presetting for this band.

6) Perform steps 3) through 5) on each frequency band you plan to operate.



AUTO-TUNING FAILS TO OPERATE

If the auto-tuning function does not operate correctly in step 4) above, possible causes are :

1) The antenna system VSWR exceeds 3:1.

The antenna needs adjustment to bring the VSWR below 3:1. Sometimes, the following procedure allows the tuner to operate correctly.

a) Place the AUTO/PRESET switch under the AT-150 hatch cover to the PRESET position, and adjust the two PRESET controls alternately to obtain a minimum VSWR reading (1:1 if possible) while transmitting a steady carrier using the FM mode. Stop transmitting. The tuning capacitors are now set at the optimal position for the frequency selected.

b) Reset the AUTO/PRESET switch to the AUTO position.

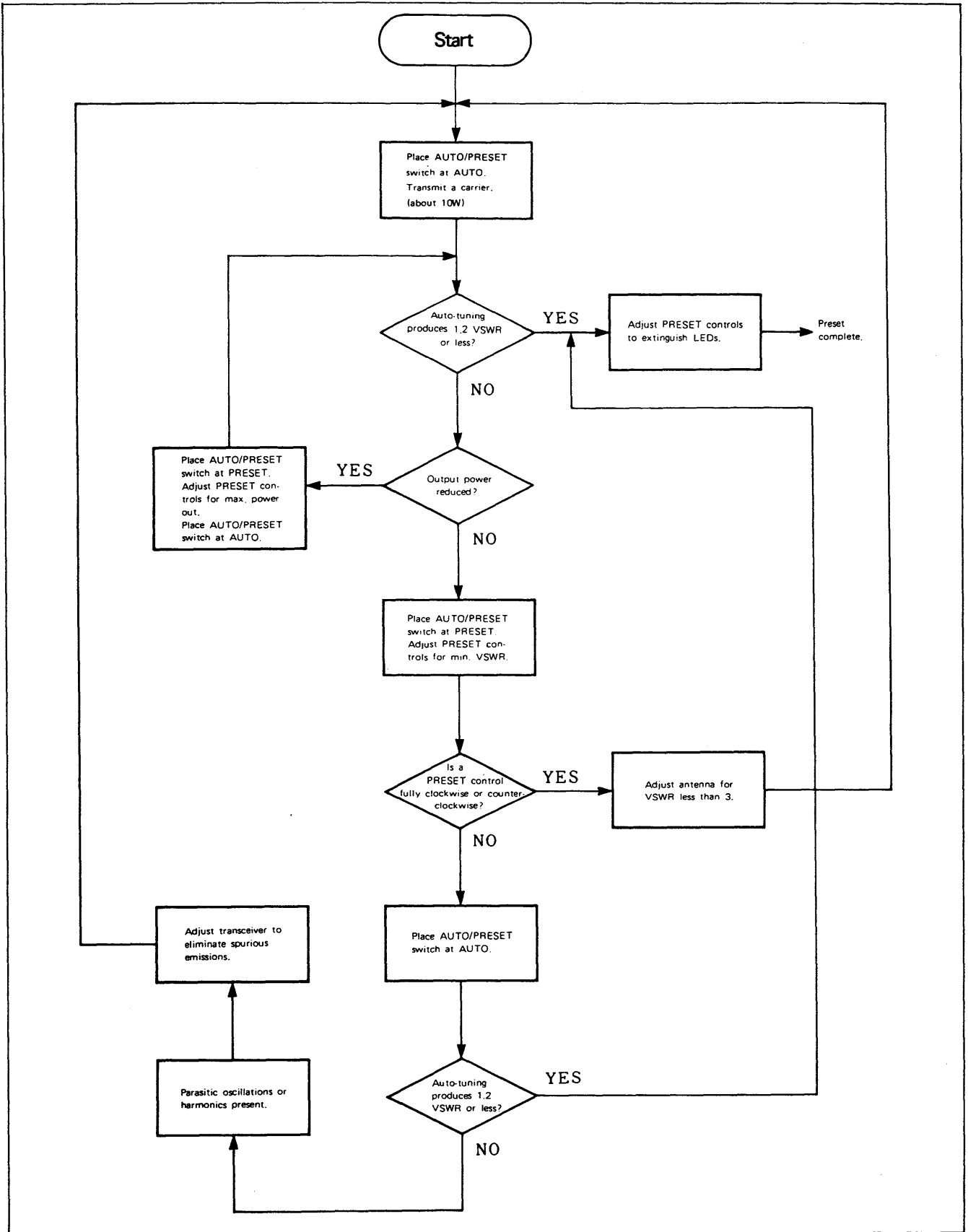
- 2) The transceiver protection circuit has operated resulting in a lower transmit output.
 - a) Place the AUTO/PRESET switch under the AT-150 hatch cover to the PRESET position, and adjust the two PRESET controls alternately while transmitting a steady carrier using the FM mode. Tune for maximum power output while watching the relative power meter on the transceiver. Stop transmitting.
 - b) Reset the AUTO/PRESET switch to the AUTO position.

After completing steps 1) or 2), transmit a steady carrier, and the auto-tune function should operate normally. Continue with the preset directions beginning with step 3) under PRESET OPERATION.

POINTS TO REMEMBER

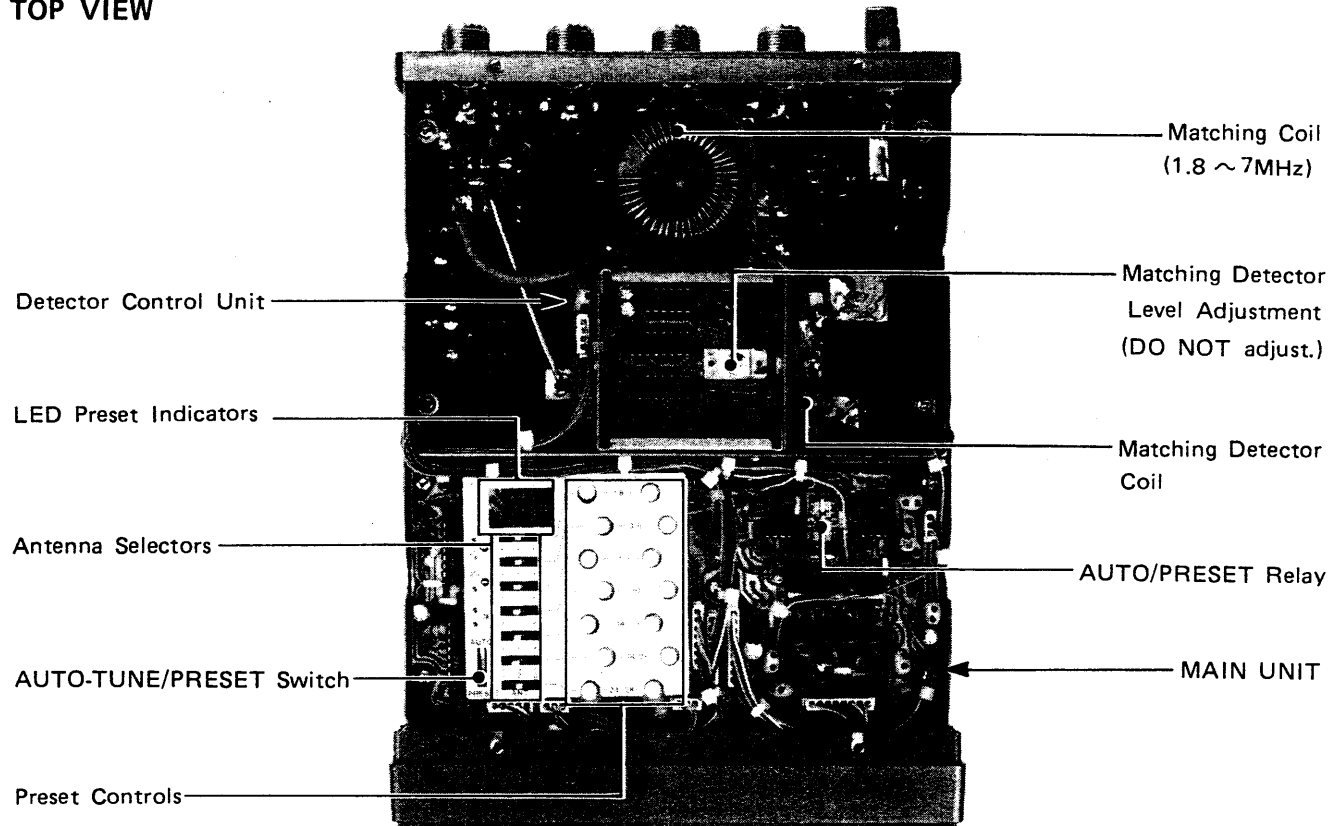
- 1) The variable capacitors, coils and relays used in the AT-150 have reasonable design allowances, however it is advisable not to exceed the recommended specifications for voltage and power as stated at the front of this manual.
- 2) Do not change frequency bands while transmitting, nor attempt to transmit while the antenna connectors are unloaded or shorted. Either action could damage the final transistors of the transceiver.
- 3) **NEVER** transmit while the WAIT light is continuously ON. It is normal for the WAIT light to be lit briefly at the beginning of a transmission.
- 4) Coaxial cable is not designed to be used as a feedline in systems with a high VSWR. Therefore, keep your antenna system VSWR as low as possible to eliminate excessive power loss. The AT-150 can only perform impedance conversions, it cannot reduce cable losses.
- 5) Use a dry, soft cloth to clean the AT-150 when it becomes dusty or soiled. Do not use thinner or other organic solvents which may damage the finish of the unit or cause peeling of the paint.

FLOW CHART FOR PRESET OPERATION

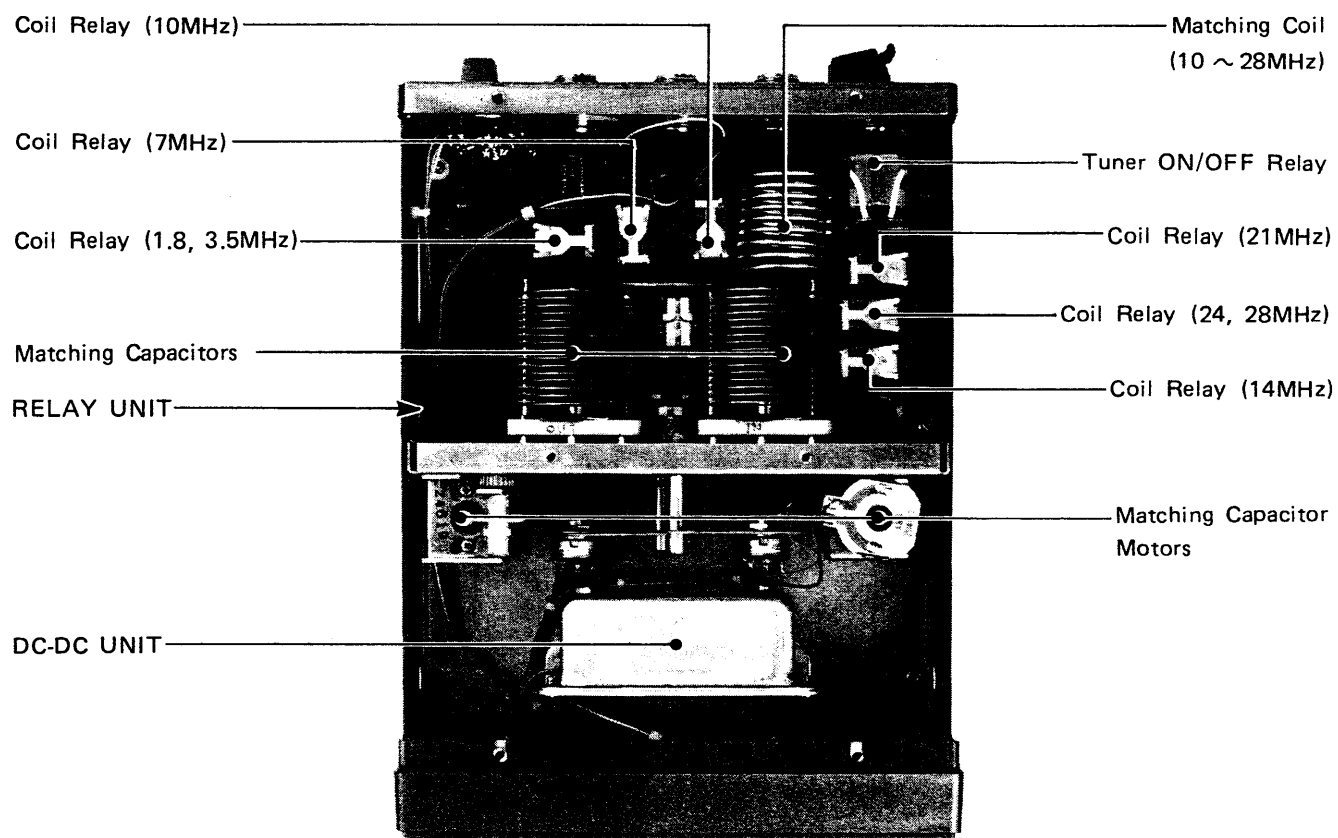


SECTION 6 INSIDE VIEWS

TOP VIEW



BOTTOM VIEW



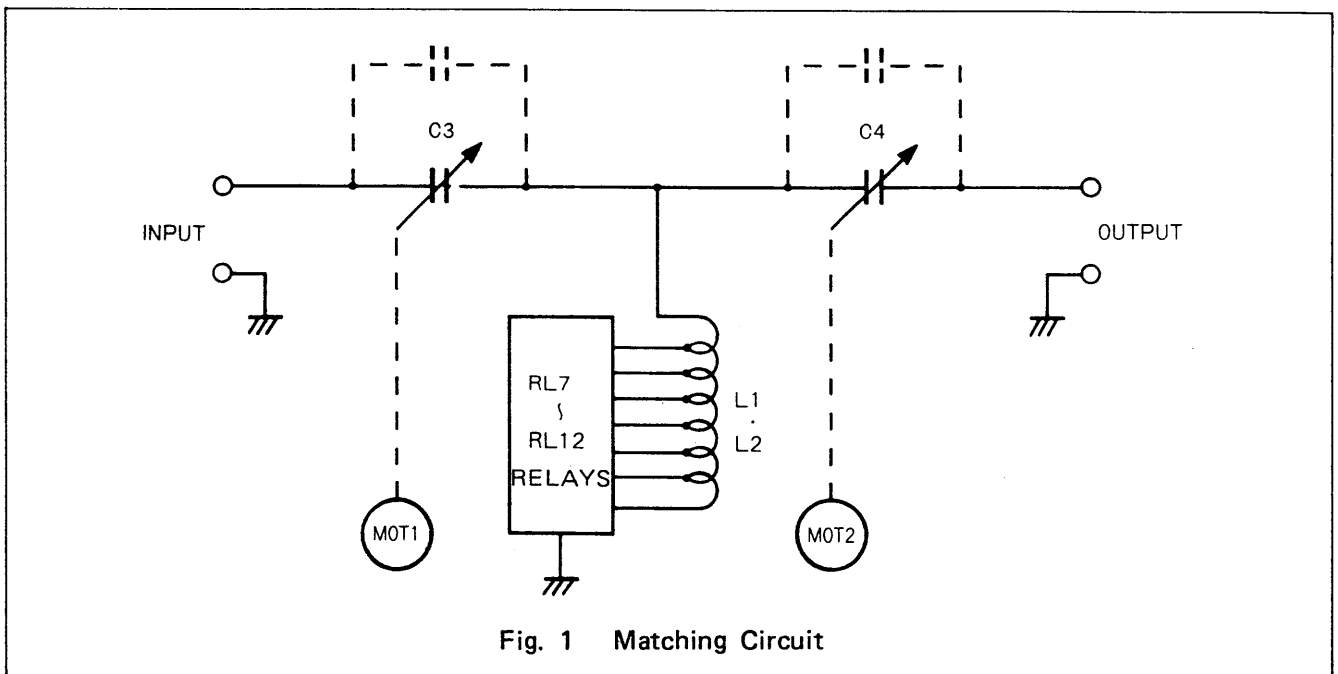
INTRODUCTION

The AT-150 is an automatic antenna tuner with major circuits including: 1) Matching Circuit, 2) Detector (DET) Circuit, 3) Control Circuit, 4) Preset Control Circuit, 5) Wait Circuit, 6) Band Switching Circuit and 7) Power Circuit(DC-DC).

MATCHING CIRCUIT

The matching circuit is shown in Fig. 1. The variable capacitors, C3(input side) and C4(output side), are connected to their respective motors. The control circuit supplies signals which position these capacitors to match the impedance of the transceiver and the antenna system.

The taps of coils L1 and L2 are automatically set to the band designated by relays RL7 through RL12. By using two separate motors which rotate both the input and output capacitors simultaneously, the AT-150 has a faster overall tuning speed than conventional models.



DETECTOR CIRCUIT

The detector circuit measures the resistive and reactive components of the load, and passes these values to the control circuit.

L1, D1 and D2 detect the resistive components. The detection voltage for a 50 ohm resistive impedance at the output is 0V, whereas resistive components less than 50 ohms produce positive detection voltages and components more than 50 ohms produce negative voltages.

The high frequency current detected by L1 and R5, and the high frequency voltage detected by C3 through C5 are applied to phase comparators IC1 through IC3 via TTL buffers Q1 and Q2, respectively. Thus, the reactive components are detected as positive or negative detection voltages corresponding to the delay or advance of current versus voltage.

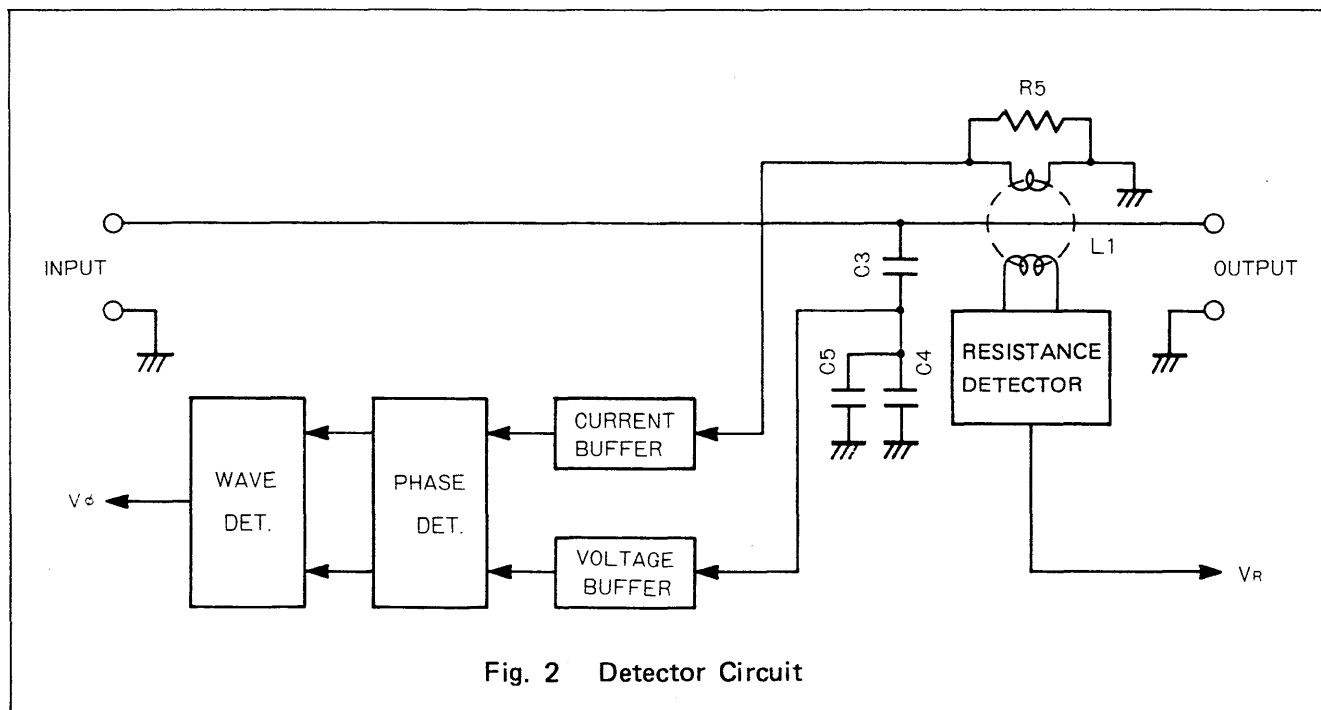


Fig. 2 Detector Circuit

**CONTROL CIRCUIT
(MAIN UNIT)**

The resistive (V_R) and reactive (V_ϕ) detection voltages from the detector circuit are fed to IC1A and IC2B for voltage amplification. After current amplification by Q1 through Q4, V_ϕ and V_R drive motors MOT1 and MOT2.

**PRESET CONTROL CIRCUIT
(MAIN UNIT)**

R5 through R11, and R12 through R18 on the MAIN unit are variable resistors that may be used to preset the variable tuning capacitors for a particular frequency on each frequency band. These resistors are located under the hatch cover on the top of the AT-150.

With the AUTO/PRESET switch set at the PRESET position and immediately after applying power or changing bands, the voltages divided by R5 through R11 and R12 through R18, plus the voltages from R19, R20, R31, R32 and variable resistors R1, R2 coupled to the variable tuning capacitors, are all applied to IC1A and IC2B for comparative amplification. The output drives the motors which position the tuning capacitors.

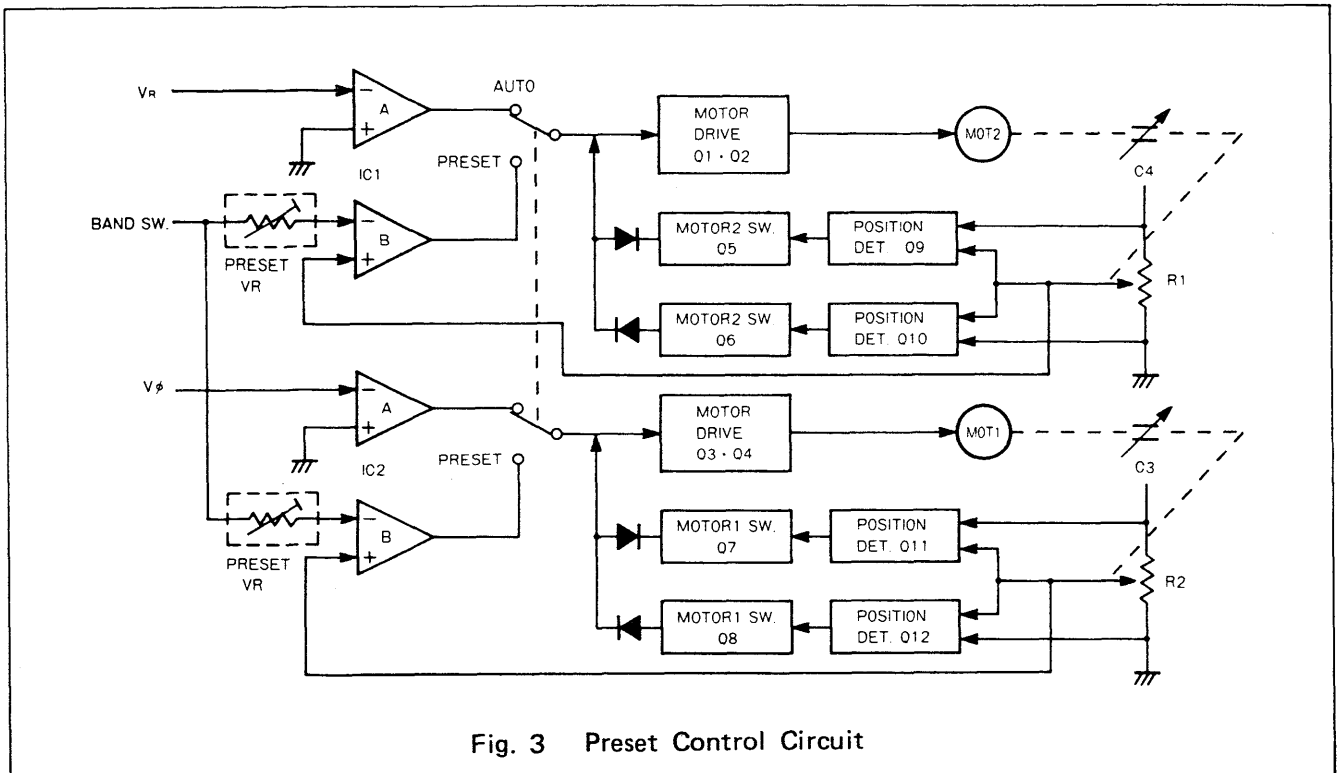


Fig. 3 Preset Control Circuit

WAIT CIRCUIT

The wait circuit automatically adjusts the tuning capacitors to the preset positions after a band change and then reselects the auto-tuning mode.

Relay RL1 switches the outputs from IC1 and IC2. D27 through D34, D39, D40 and D15, detect the voltages output from the common terminals of relay RL1 to drive the WAIT LED on the AT-150 front panel.

The WAIT LED lights while the tuning capacitors are automatically set to the preset positions, and whenever the VSWR is too high (above 3:1) to permit proper tuning.

BAND SWITCHING CIRCUIT

The band switching circuit, including a band switching IC(IC2) and an A/D converter for automatic band changing, controls the automatic operation of the AT-150 when used with the IC-735 HF transceiver.

The transceiver applies band step voltages to IC1 pin 9 via the buffer circuit Q1 and Q2. An 8 volt reference voltage is also applied to IC1 pin 7. The value of the band step voltage determines which of the IC1 outputs, pins 1 through 6 or 11 through 16, pass a signal to IC2 in order to select the correct band.

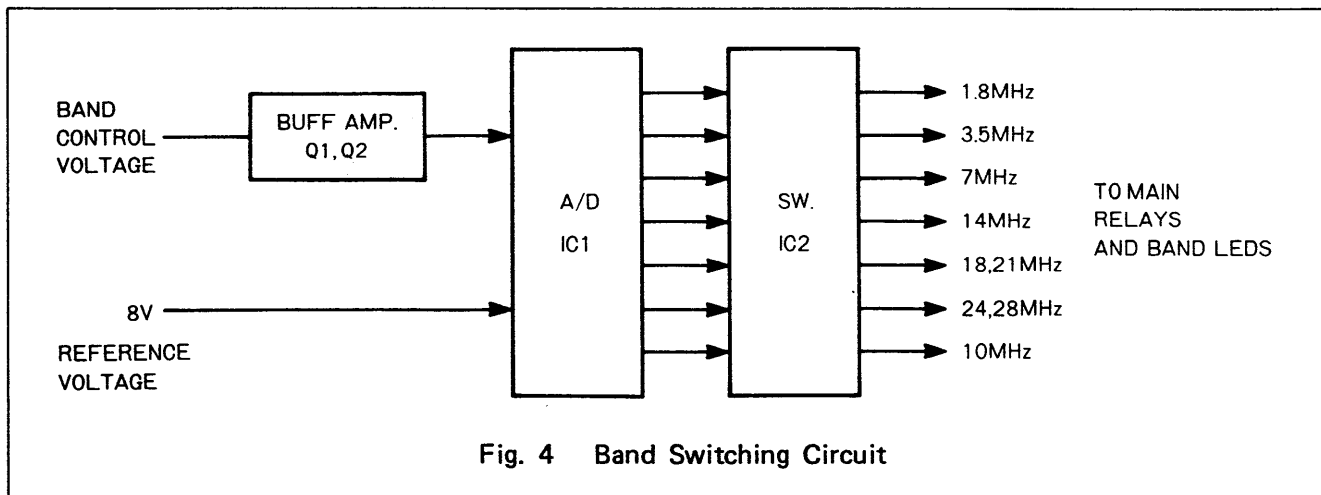


Fig. 4 Band Switching Circuit

POWER CIRCUIT (DC-DC UNIT)

The power circuit generates negative voltages by converting the DC input to an AC voltage (about 16kHz) with multivibrator Q1, Q2 and L2. After fullwave rectifying the AC by D3 and D4, negative voltages equivalent to the input voltages are obtained.

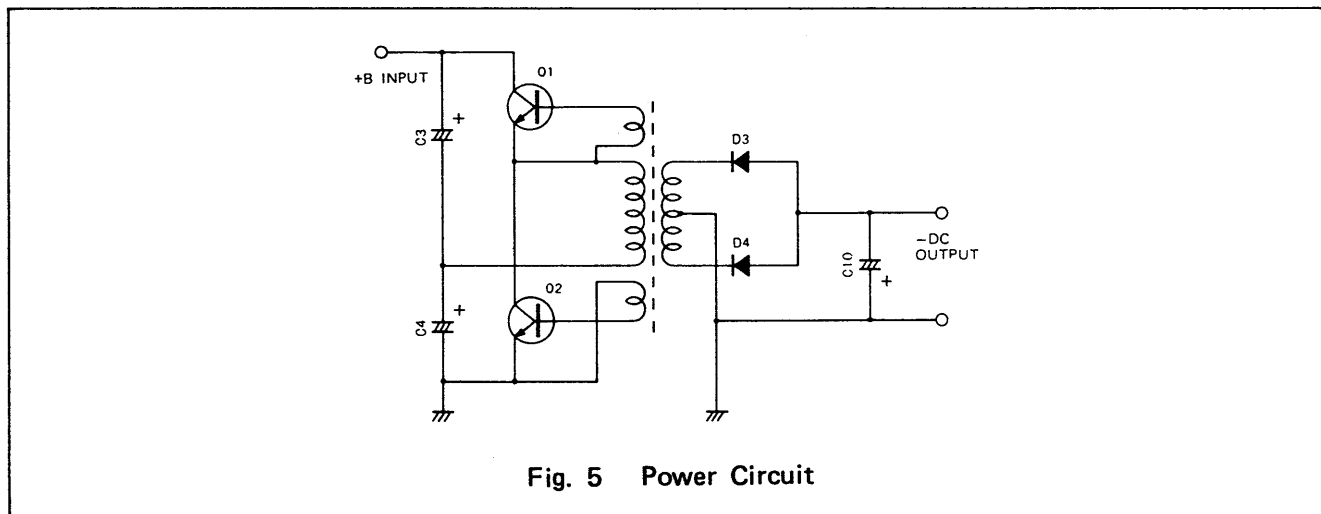


Fig. 5 Power Circuit

SECTION 8 BLOCK DIAGRAM

