

IC-AT500

IC-AT100

HF FULL AUTOMATIC ANTENNA TUNER

INSTRUCTION MANUAL

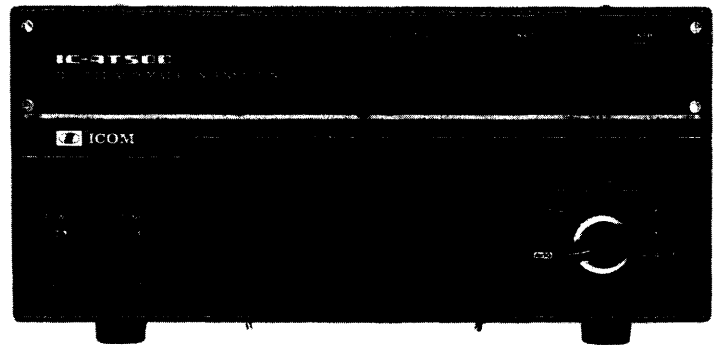


TABLE OF CONTENTS

I. SPECIFICATIONS	1
II. DESCRIPTION	2
III. INSTALLATION	3
IV. CONTROL FUNCTIONS	9
V. OPERATION	12
VI. INSIDE VIEWS	15
VII. THEORY OF OPERATION	17
VIII. BLOCK DIAGRAM	21
IX. P.C. BOARD LAYOUT	SEPARATE
X. SCHEMATIC DIAGRAM.....	SEPARATE

SECTION I SPECIFICATIONS

Number of Semiconductors:	Transistor	36
	IC	10
	Diode	55 (IC-AT100:49)
Frequency Range:	1.8 ~ 2.0 MHz (IC-AT100: tuner is bypassed)	
	3.5 ~ 4.0 MHz	
	7.0 ~ 7.3 MHz	
	10.0 ~ 10.5 MHz	
	14.0 ~ 14.5 MHz	
	18.0 ~ 18.5 MHz	
	21.0 ~ 21.5 MHz	
	28.0 ~ 30.0 MHz	
	(Auto band switching with IC-701/720/720A/730)	
Power Capability:	500W (continuous)/1 kW (PEP)	
	(IC-AT100: 100W/200W PEP)	
Impedance Matching:	16.7 ~ 150Ω to 50Ω resistive	
Output Terminals:	4 coaxial connectors	
Minimum Tune-up Power:	50W (IC-AT100: 8W)	
Tune-up Time:	4 ~ 7 seconds (when operating band has been changed)	
	Less than 3 seconds (on the same band)	
Matching Accuracy (VSWR):	Less than 1.2 (when auto-tuning)	
Insertion Loss:	Less than 0.5 dB (when tuned up)	
Power Supply Requirements:	13.8V DC (negative ground) ±15% 0.5A max	
	117V AC or 230V AC ±10% 13W max	
Usable Condition:	Temperature -10°C ~ 60°C	
Dimensions:	241(W) × 111(H) × 300(D) mm	
Weight:	6.4 kg (IC-AT100: 5.0 kg)	

SECTION II DESCRIPTION

QUICK TUNING UP

New developed detector circuit detects resistance and reactance of the load, and controls powerful motors to tune two variable capacitors. So the tune-up time is very short.

AUTO BAND SWITCHING

When the IC-720A or IC-701, or IC-720 or IC-730 (optional LDA unit installed) is used, band switching of this tuner can be controlled by the band switch of the IC-720/720A/730/701. This tuner has dual accessory sockets, so the auto band switching function can be used for IC-2KL linear amplifier at the same time.

PRE-SETTABLE

The matching circuit can be preset for each band, so you can make quick QSY's, and have trouble-free operation.

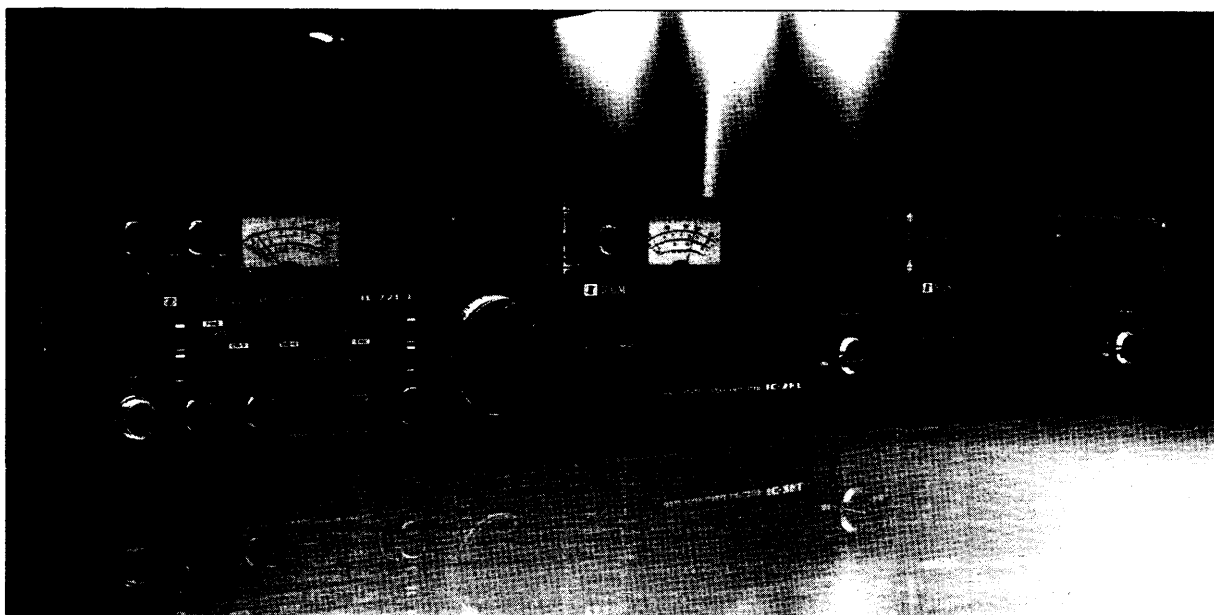
FOUR ANTENNA CONNECTORS

This tuner has four coaxial sockets for antennas, and selects the suitable antenna for each band automatically.

When the TUNER switch is turned off, this tuner can be used as an automatic antenna selector.

TWO-WAY POWER SOURCE

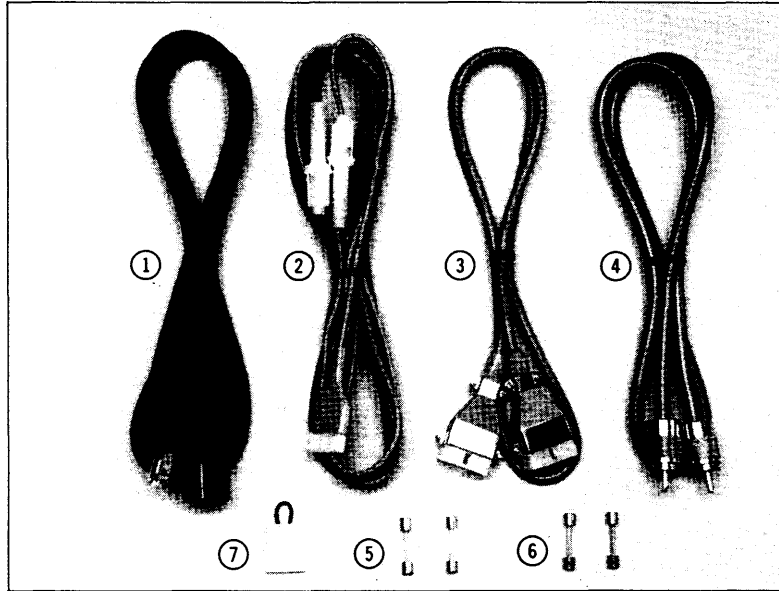
This tuner can be used with 13.8V DC or 117V AC (or 230V AC).



SECTION III INSTALLATION

UNPACKING

Carefully remove your tuner from the packing carton and examine it for signs of shipping damage. Should any be apparent, notify the delivering carrier or dealer immediately, stating the full extent of the damage. It is recommended you keep the shipping carton. In the event storage, moving, or reshipment becomes necessary, they come in handy. Accessory hardware, cables, etc., are packed with the tuner. Make sure you have not overlooked anything.



1. AC Power Cord	1	5. Spare Fuse (0.2A or 0.1A) for AC	2
2. DC Power Cord	1	6. Spare Fuse (3A) for DC	2
3. Control Cable (1m)	1	7. Jumper Plug	1
4. Coaxial Cable (1m with PL-259's)	1		(Inserted in the DC power socket)

RECOMMENDATIONS FOR INSTALLATION

1. Avoid placing the tuner in direct sunlight, high temperature, dusty or humid places.
2. Place the unit so that the controls and switches can easily be handled and the indications can easily be read.
3. For mobile installation, select the best location that can stand the weight of the unit and that does not interfere with your driving in any way.
4. Use the Ground Lug!

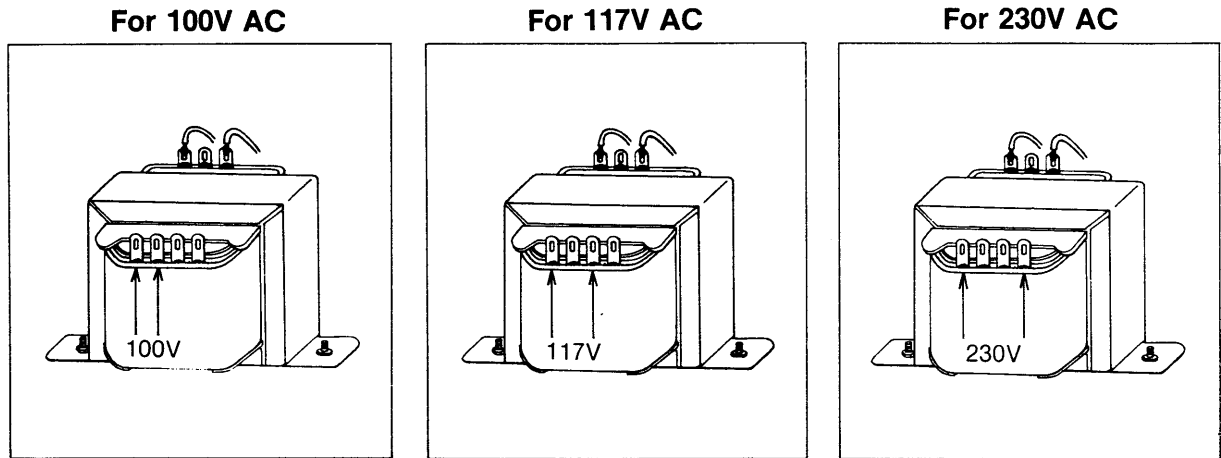
POWER SUPPLY

For AC operation:

The tuner has a built-in AC power supply. Connect the supplied AC power cord to the AC power socket on the rear panel of the unit, and the opposite side plug of the power cord into any convenient AC power outlet. Be sure that the jumper plug is inserted to the DC power socket on the rear panel, and the AC/DC switch is set at the AC position.

When you wish to use the tuner with an AC power supply voltage other than the original one, you must make internal wiring modifications as per the following drawings.

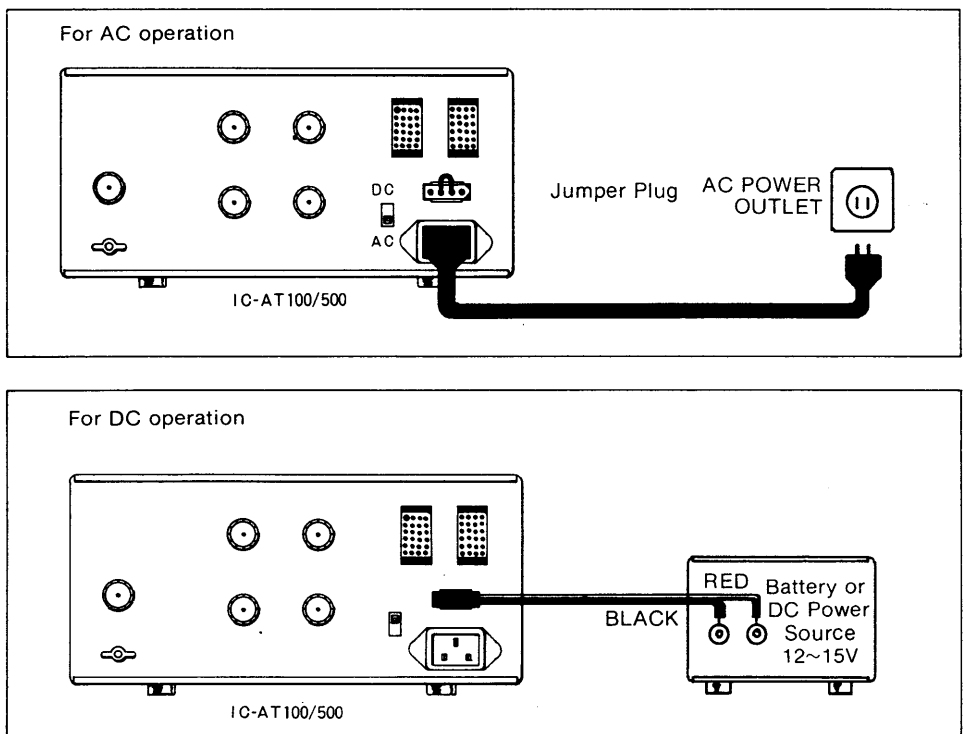
Power transformer's primary wiring:



For DC operation:

If you would like to use your car battery or any other DC power supply, be sure that its output voltage is 12~15V and the current capacity is at least 0.5A.

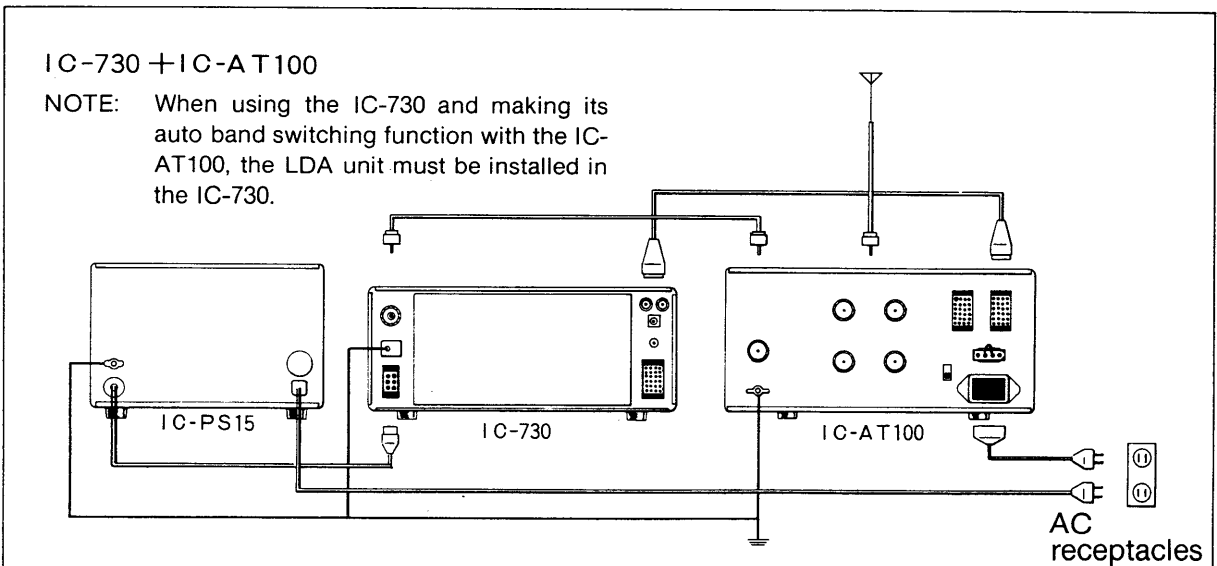
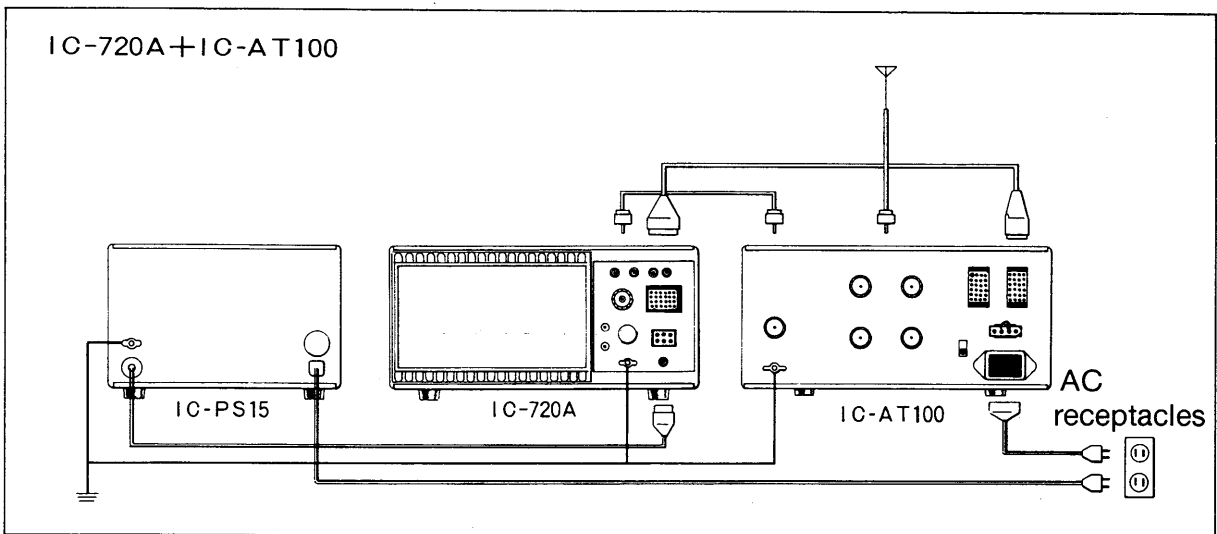
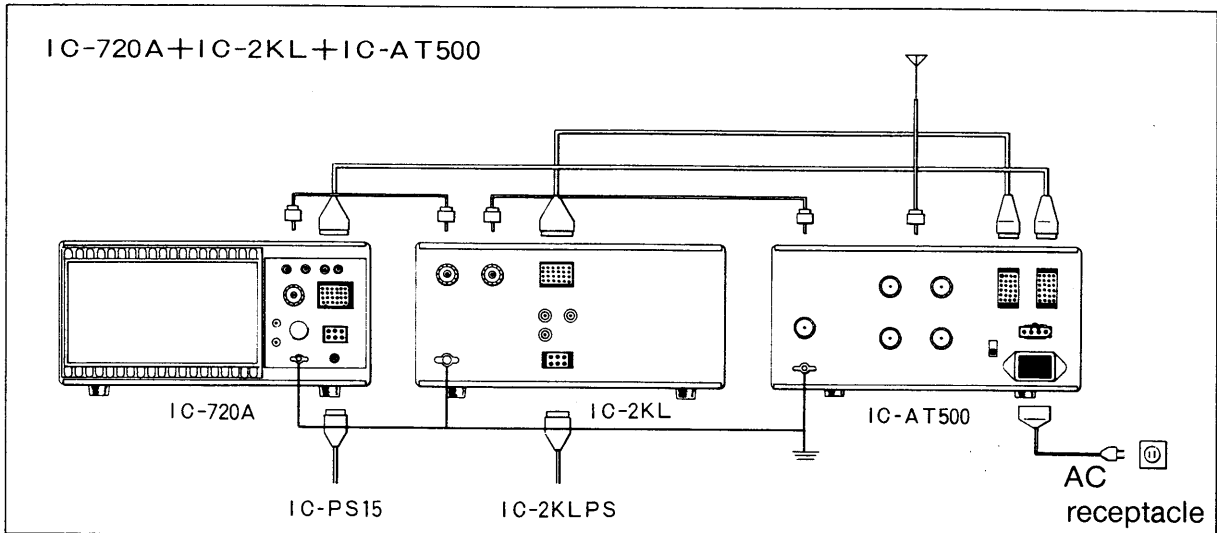
The connection of the DC power cord supplied with the tuner is done in the following way: First make sure that the power switch of the unit is in the OFF position and the DC/AC switch is in the DC position. Connect the cord to the DC power supply with the RED lead to the positive terminal and the BLACK lead to the negative terminal. (Reverse connection will cause the protection circuit to operate and blow the fuse.) Connect the DC plug to the DC power socket on the rear panel of the unit. Refer to the drawing below.



CABLE CONNECTIONS

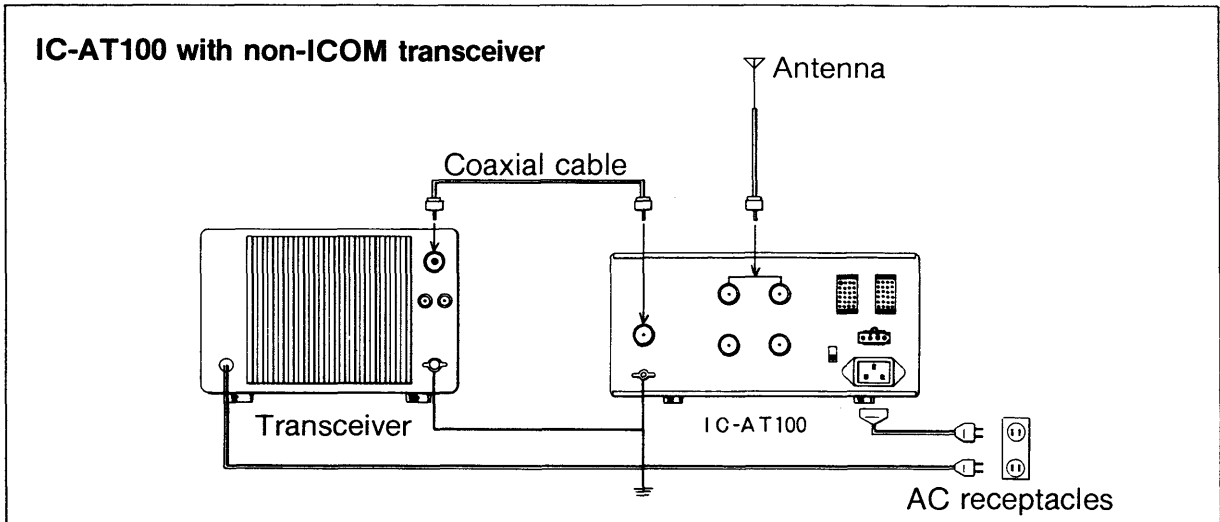
Connect the supplied cables with the transceiver, linear amplifier and antenna tuner according to the following illustrations.

For the connection between the antenna terminal(s) and antenna(s), refer to section "Antenna terminal" on page 6. In order to prevent electrical shocks, TVI, BCI and other problems, be sure to connect a heavy wire, as short as possible, from a good earth point to the ground terminal of the sets.



When using a transceiver other than an ICOM transceiver, the auto band switching function does not work. In this case, set the band switch of the IC-AT500/AT100 to the same band as your transceiver manually.

The control cable is not needed for this connection. Refer to the following illustration.

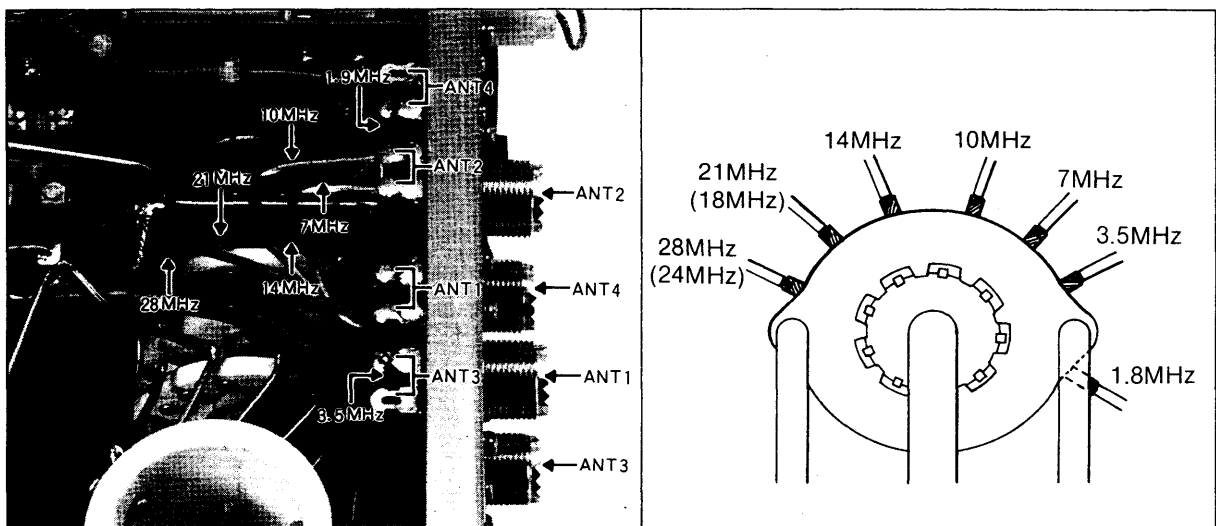


Antenna terminal

This tuner is provided with four antenna terminals, connected as follows at the time of shipment.

	ANT4	ANT3	ANT2	ANT1
IC-AT100	1.8 MHz	3.5 MHz	7-10 MHz	14-21-28 MHz (18) (24)
IC-AT500	1.8 MHz	3.5 MHz	7-10 MHz	14-21-28 MHz (18) (24)

(IC-AT100: The tuner circuit is bypassed on 1.8 MHz.)



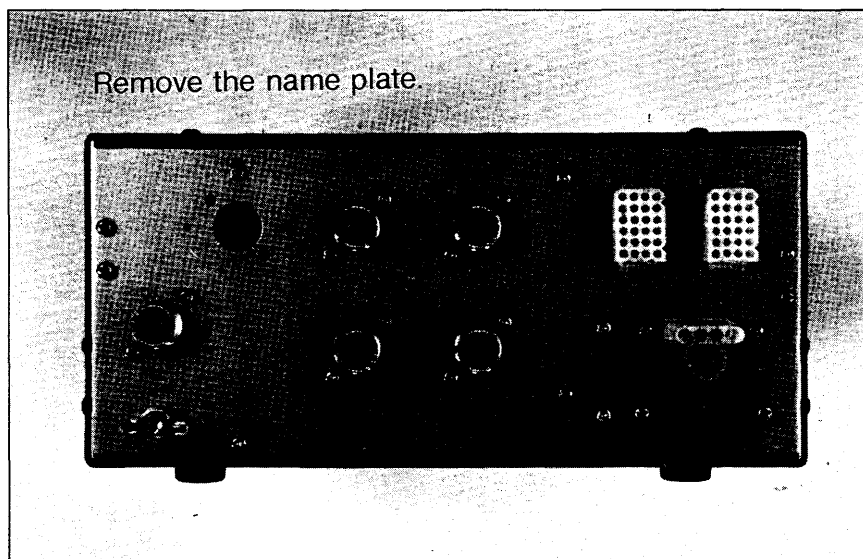
Changing the antenna terminal connections

When you wish to use connections other than the original one, the connections can be changed by changing the internal wiring according to your antenna(s). Follow the steps below.

- (1) Disconnect the tuner from the AC power supply, antenna and transceiver, and remove the top cover from the tuner.
- (2) Internal wiring is as shown in the above illustrations. Connect the wires according to the antenna for the band used. After changing the connections, confirm that the solder has been correctly and firmly applied.

Addition of Antenna Terminal

The tuner has a space for an additional antenna connector under the name plate on the rear panel. If you wish to use an additional connector, remove the name plate and mount an SO-239 coaxial chassis connector to this space.



ANTENNA

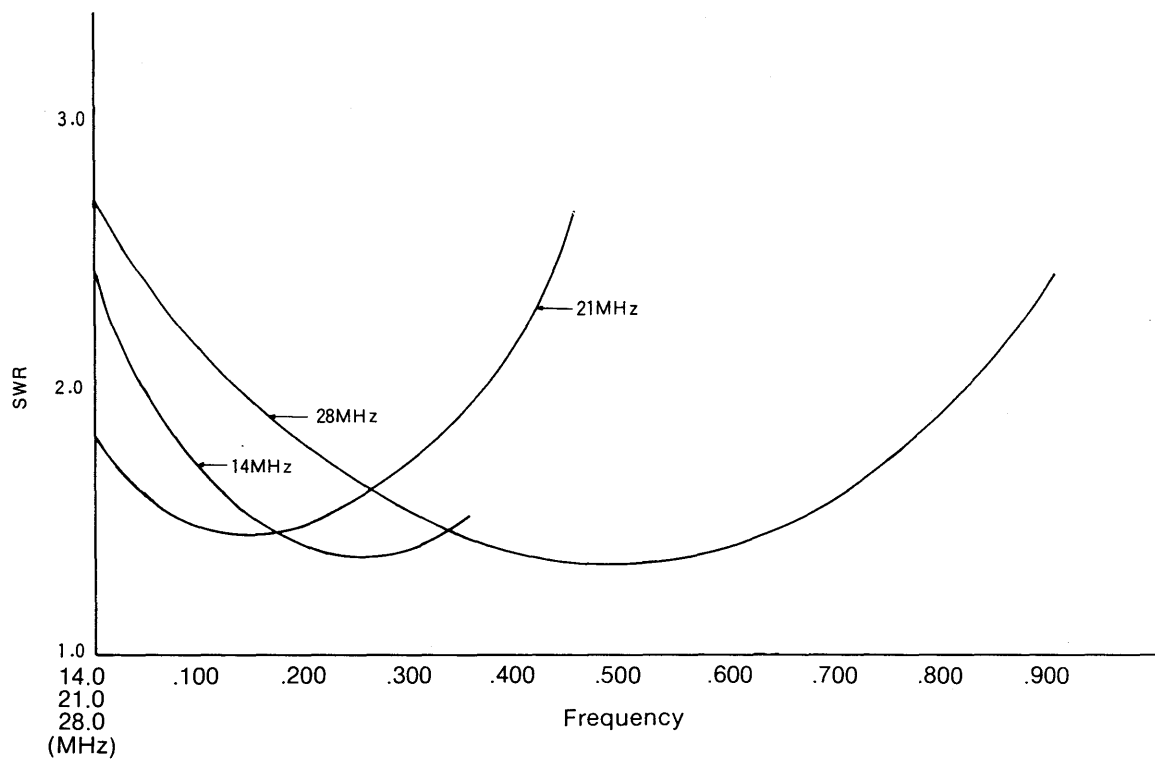
This antenna tuner may not be effective with all antennas. Correct understanding of the antenna conditions will ensure effective use of this tuner. For example, let us suppose a tri-band antenna (covering 14, 21 and 28 MHz) is used.

This antenna is matched to the SSB frequencies on 14 and 28 MHz. On 21 MHz, it seems to be matched close to CW frequency. The antenna tuner may not be necessarily close to the matched frequency, but the output of the transceiver cannot be matched to CW frequency on 14 and 28 MHz with high SWR and to SSB frequency on 21 MHz.

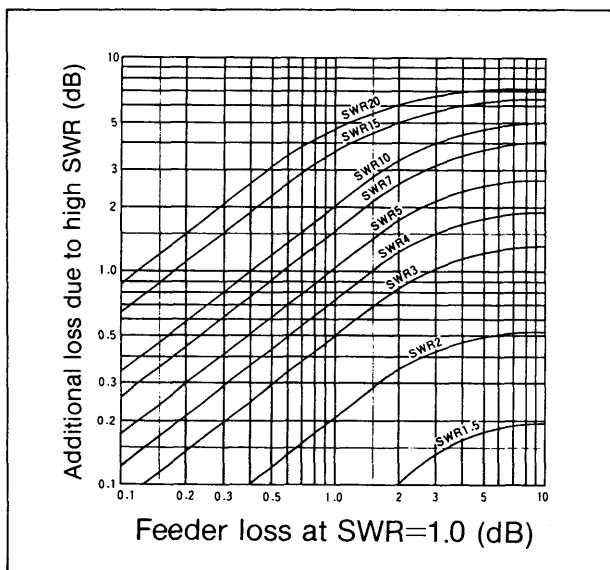
This antenna tuner is designed for such matching. The loss of the coaxial cable caused by high SWR cannot be improved, but use of this antenna tuner greatly alleviates overload for the final stage of the transceiver and eliminates harmonic radiation effectively.

For your reference, the following shows graphically the loss of the coaxial cable due to high SWR.

Example of SWR Measurement



Additional loss due to high SWR



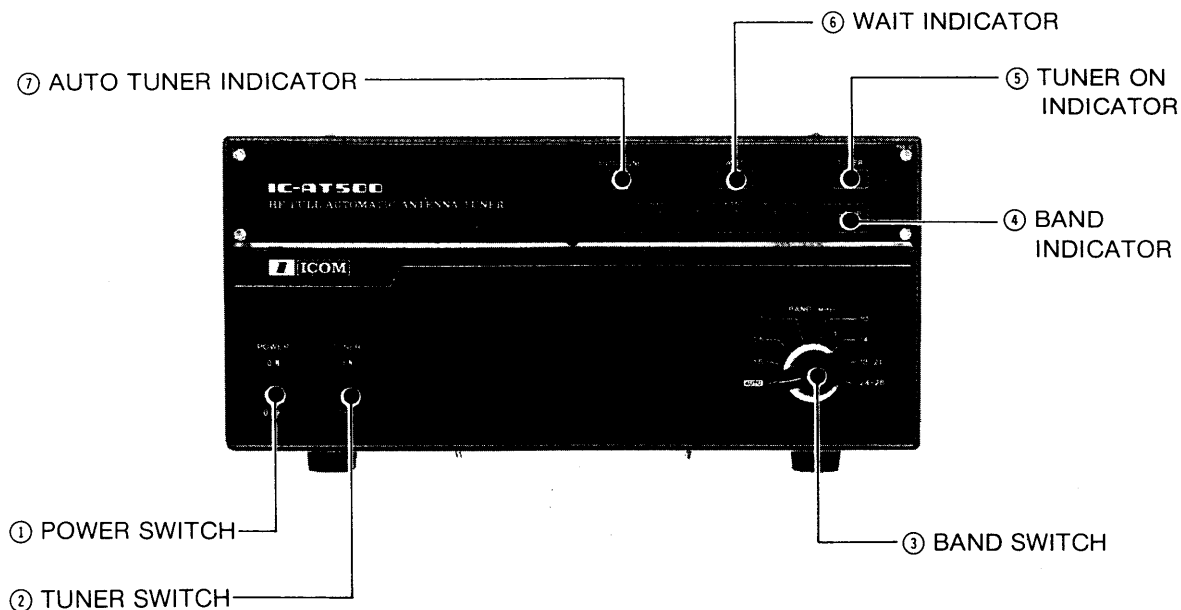
Loss of Coaxial Cable

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 IV CONTROL FUNCTIONS

FRONT PANEL



1. POWER SWITCH

Switches the supplied power, either AC or DC, to the set.

2. TUNER SWITCH

Switches the tuner circuit. In the ON position, the ⑤ TUNER ON INDICATOR is lit and the set acts as an antenna tuner. In the OFF position, the tuner does not work and the output power of the transceiver is fed directly to the antenna.

3. BAND SWITCH

Selects the operating band of the set. When you use the IC-701 or IC-720A, or IC-720 or IC-730 which has the optional LDA unit installed, set the BAND SWITCH in the AUTO position, then the operating band will follow that selected by the transceiver.

4. BAND INDICATOR

Indicates the operating band of the set. Make sure the band is the same band as the transceiver.

5. TUNER ON INDICATOR

Illuminates when the ② TUNER SWITCH is turned ON.

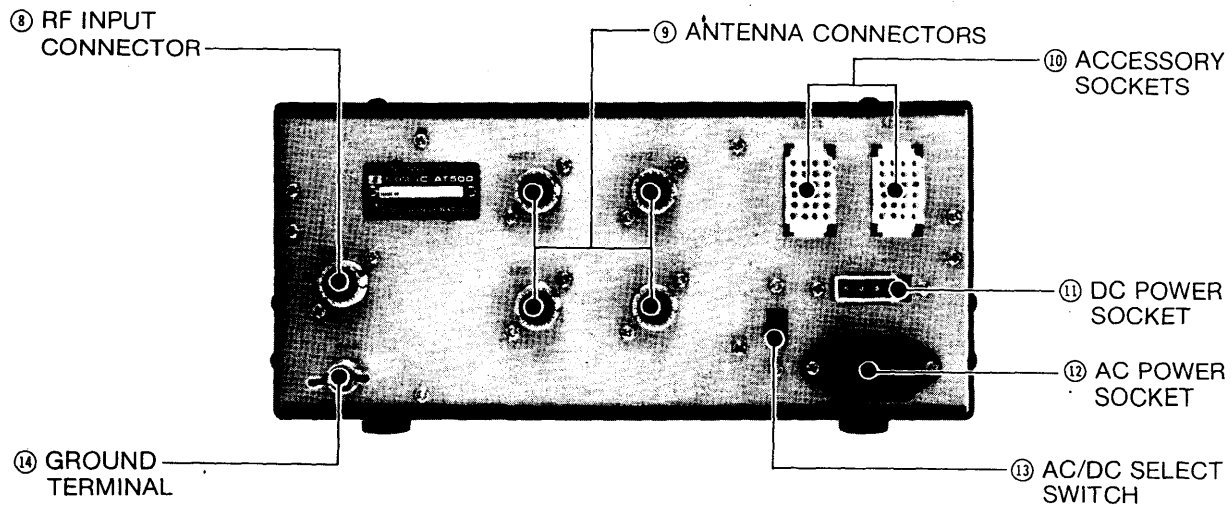
6. WAIT INDICATOR

Illuminates when the set is being preset, just after the power switch has been turned ON or the operating band has been changed. Don't transmit while this indicator is lit.

7. AUTO TUNE INDICATOR

Illuminates when the set is in the auto-tune condition.

REAR PANEL



8. RF INPUT CONNECTOR

Connects the supplied coaxial cable from the antenna connector of the transceiver or the linear amplifier.

9. ANTENNA CONNECTORS

Connects an antenna feeder with a PL-259 connector for each. A suitable antenna for each band will be selected by the band switch of the transceiver automatically. Refer to page 6 for details.

10. ACCESSORY SOCKETS

Connects the control cable from the transceiver and a linear amplifier (if used). You do not need to use these sockets when using a non-ICOM transceiver. (Refer to connections on page 16.)

11 DC POWER SOCKET

Connect the included DC power cable when DC operation is required. Connect the included jumper plug to this socket when AC operation is required.

12. AC POWER SOCKET

Connect the included AC power cable to this connector and the included jumper plug to the DC power connector for AC operation.

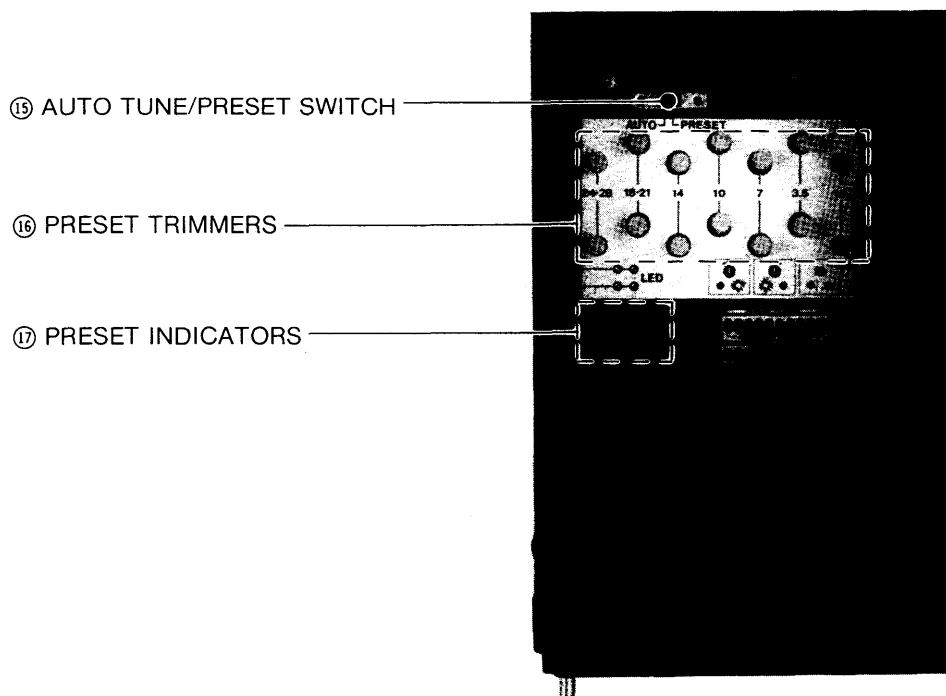
13. AC/DC SELECT SWITCH

Selector for AC operation or DC operation.

14. GROUND TERMINAL

To prevent electrical shock, TVI, BCI and other problems, be sure to ground the equipment through the GROUND TERMINAL. For best results use as heavy a gauge wire or strap as possible and make the connection as short as possible.

CONTROLS UNDER ACCESS COVER



15. AUTO TUNE/PRESET SWITCH

Switches to auto tune condition or the preset condition. When this tuner is in operation, set this switch in the AUTO position.

16. PRESET TRIMMERS

Preset the input and output matching capacitors for each band. Refer to Preset Operating on page 12.

17. PRESET INDICATORS

Indicates the matching condition for the presetting. When the matching is performed, all LED's will go out.

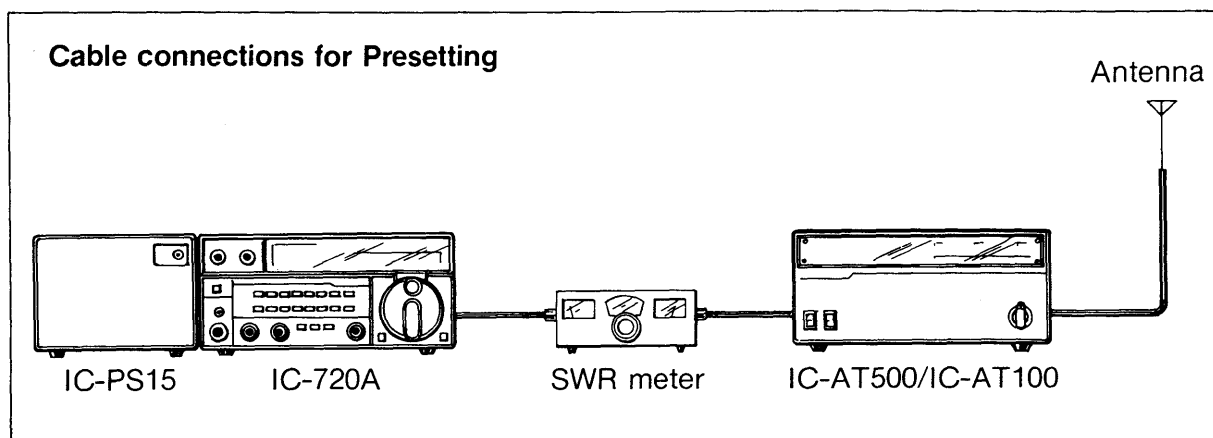
SECTION V OPERATION

Before using this tuner for the first time or after changing the antenna, carefully confirm that the connections conform to the connection procedure given in the section "CABLE CONNECTIONS" on page 4, and perform the following presetting.

Preset Operation

Presetting is an operation to set the variable capacitor to the optimum condition immediately after turning ON the power supply of this tuner or after switching the band.

(1) Connect the tuner with the transceiver, antenna and SWR meter as follows:



- (2) Turn ON the POWER switch and TUNER switch. Confirm that the AUTO/PRESET switch inside the top cover is set in the AUTO position.
- (3) Confirm that the bands of the transceiver, this tuner and the antenna are matched to one another, and transmit power 50 to 100W (IC-AT100: 10W) in the RTTY or CW mode. After confirming that the AUTO TUNE has operated and the reading of the SWR meter is reduced, stop transmitting.
- (4) Turn the two PRESET controls according to the bands inside the top cover, so that both upper and lower LED's go off. The preset operation for this band is now completed. Repeat the same procedure for other bands.

When the AUTO TUNE fails to operate:

If the AUTO TUNE fails to operate in the step (2) above, the trouble is attributable to the following causes:

1. The antenna SWR is 3 or more.

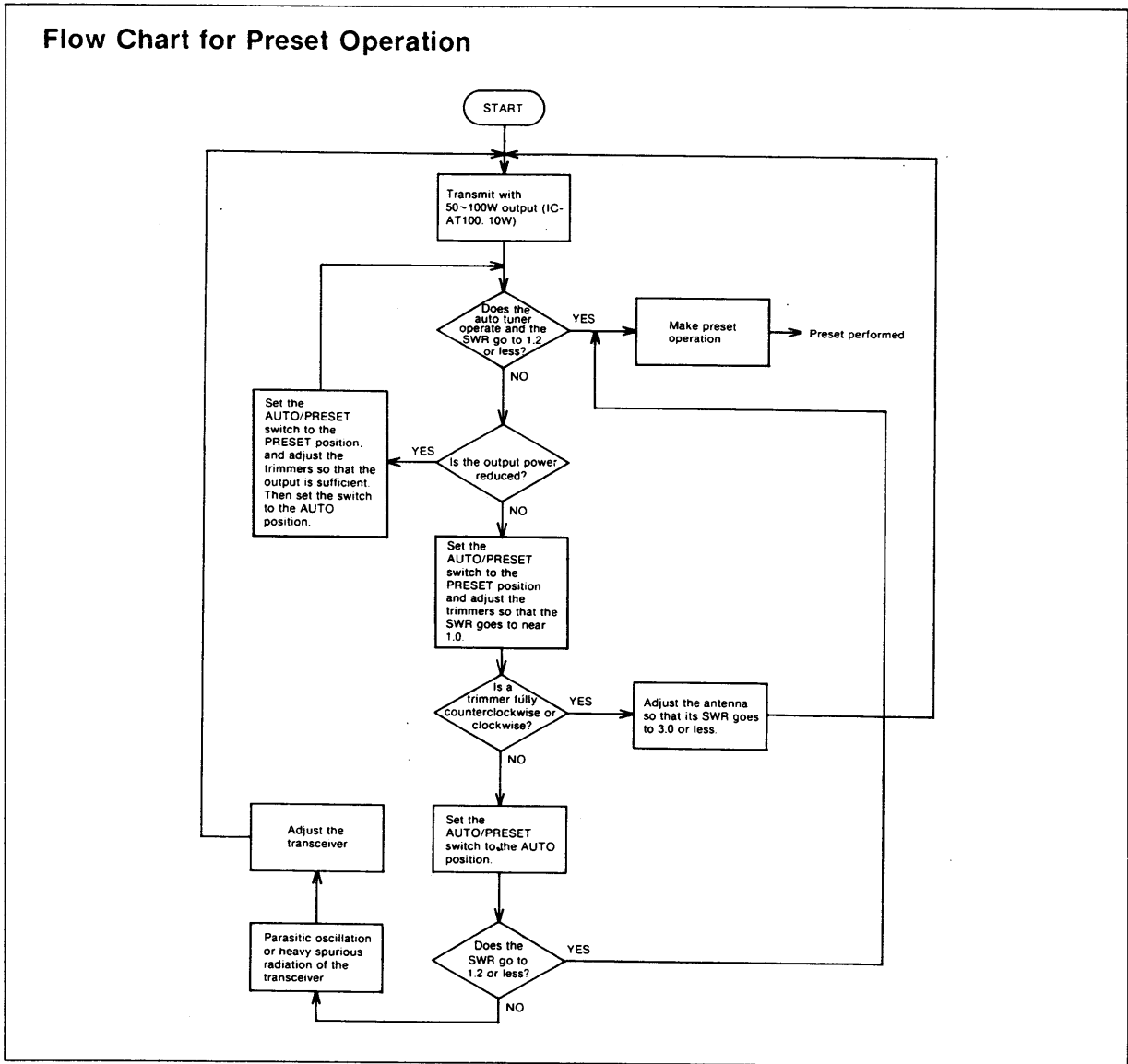
The antenna must be adjusted to minimize its SWR. In this case, the tuner may be operated by the following procedures:

- (1) Set the AUTO/PRESET switch inside the top cover to the PRESET position, and turn the two trimmers for the operating band alternately so that the SWR meter will indicate "1.0".
- (2) The matching capacitors are now set to the optimum condition, so set the AUTO/PRESET switch to the AUTO position.

2. When the transmission output is reduced by the function of the transceiver protection circuit:

- (1) Set the AUTO/PRESET switch to PRESET, and turn the two trimmers for the operating band alternately. Observe the SWR meter to obtain sufficient output from the transceiver.
- (2) When sufficient output has been obtained, set the AUTO/PRESET switch to the AUTO position, and restart transmission.
If the AUTO TUNE operates, stop the transmission, and perform the preset operation according to the previous step (3).

Flow Chart for Preset Operation



CAUTIONS

To ensure correct operation of the tuner, carefully observe the following cautions:

- (1) The variable capacitors, coil and rotary switch of this tuner are designed to have more than sufficient capacity; however, they may be burned or damaged if greater than rated power is input. Take sufficient care to prevent this.

- (2) If the POWER switch and TUNER switch are turned ON or OFF, or the band switch is turned during transmission, a momentary unloaded condition may occur, damaging the final transistor(s) of the transceiver. This must be carefully avoided.
- (3) Do NOT start transmission when the WAIT indicator lights immediately after turning ON the power or after switching the operating band.
- (4) The coaxial cable is not designed for use at a high SWR condition, so keep the antenna at the lowest possible SWR.
It should be noted that use of this tuner allows the impedance to be matched and the power to be fed effectively, but does not change the loss of the coaxial cable.

MAINTENANCE

Cleaning the Set

If the set has dust or stains, wipe them off with a soft cloth. Never use thinner or other organic solvent, as this may cause the paint to peel off.

Replacing the Fuse

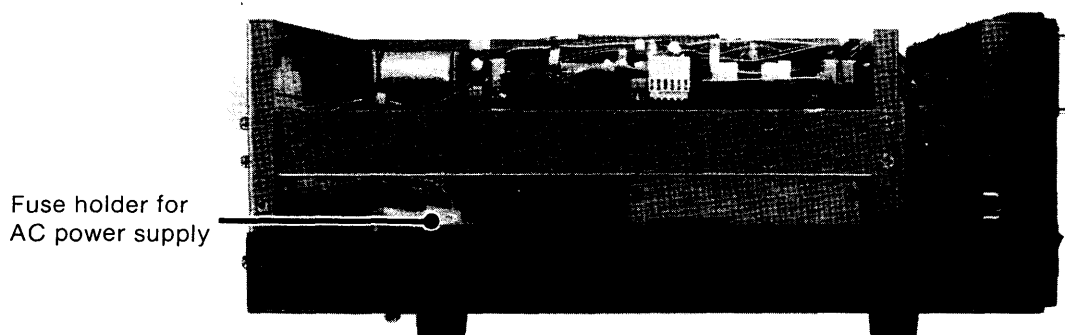
When the fuse has blown and the set fails to operate, remove the cause of the trouble, and replace the fuse with a rated one (0.2A for 117V AC, 0.1A for 230V AC, 3A for the DC power cord).

1. Replacing the AC Fuse

The fuse holder is located inside the tuner. Remove the top cover to replace the fuse.

2. Replacing the DC Cord Fuse

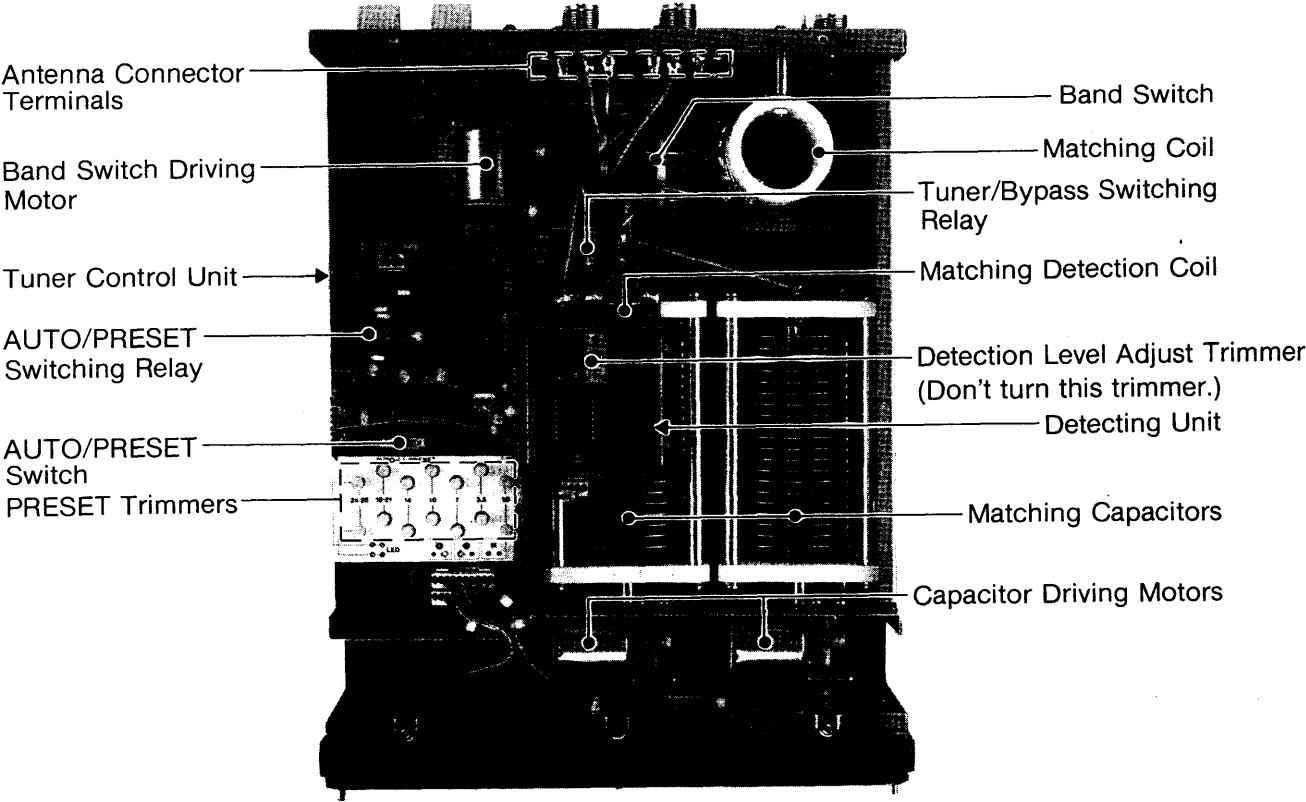
If the fuse of the DC power cord has blown, replace it with the rated one.



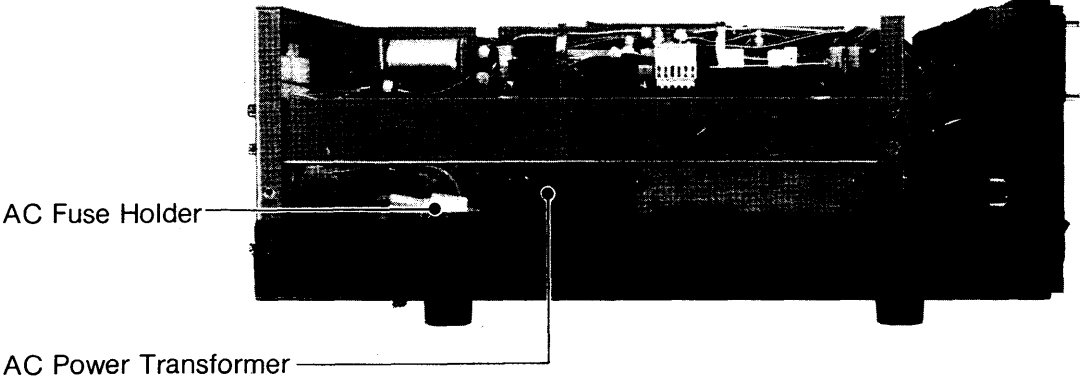
SECTION VI INSIDE VIEWS

IC-AT500

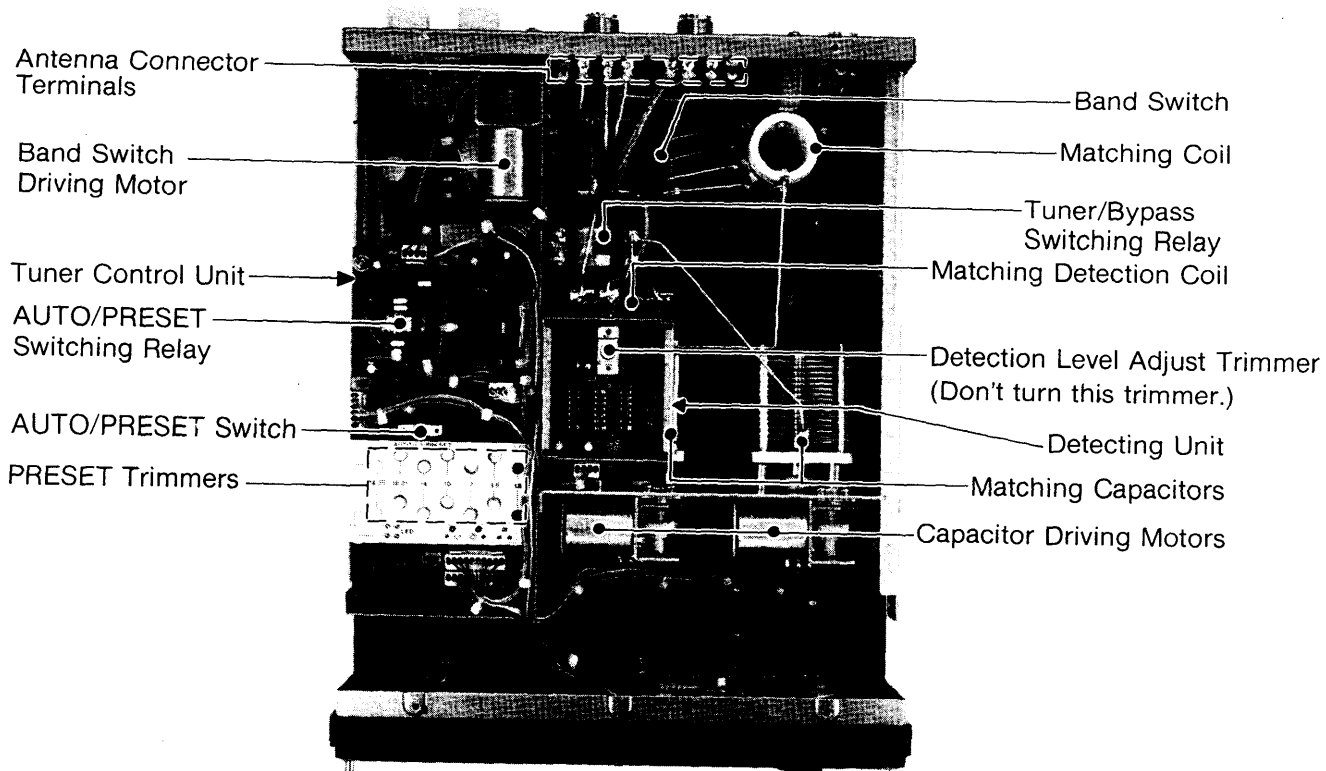
TOP VIEW



SIDE VIEW

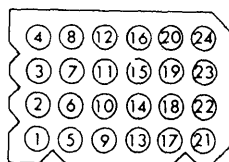


IC-AT100



ACC SOCKET CONNECTIONS

The table below shows terminal connections for the accessory socket.



Outside view

PIN No.	FUNCTION
1.~ 2.	NC (no connection).
3.	Connected to transmit switch circuit. When grounded, the transceiver operates in the transmit mode.
4.~ 6.	NC.
7.	Output for external ALC voltage.
8.	Ground.
9.~11.	NC.
12.	Input for band switching control reference voltage (8V).
13.	Input for band switching control voltage.
14.~24.	NC.

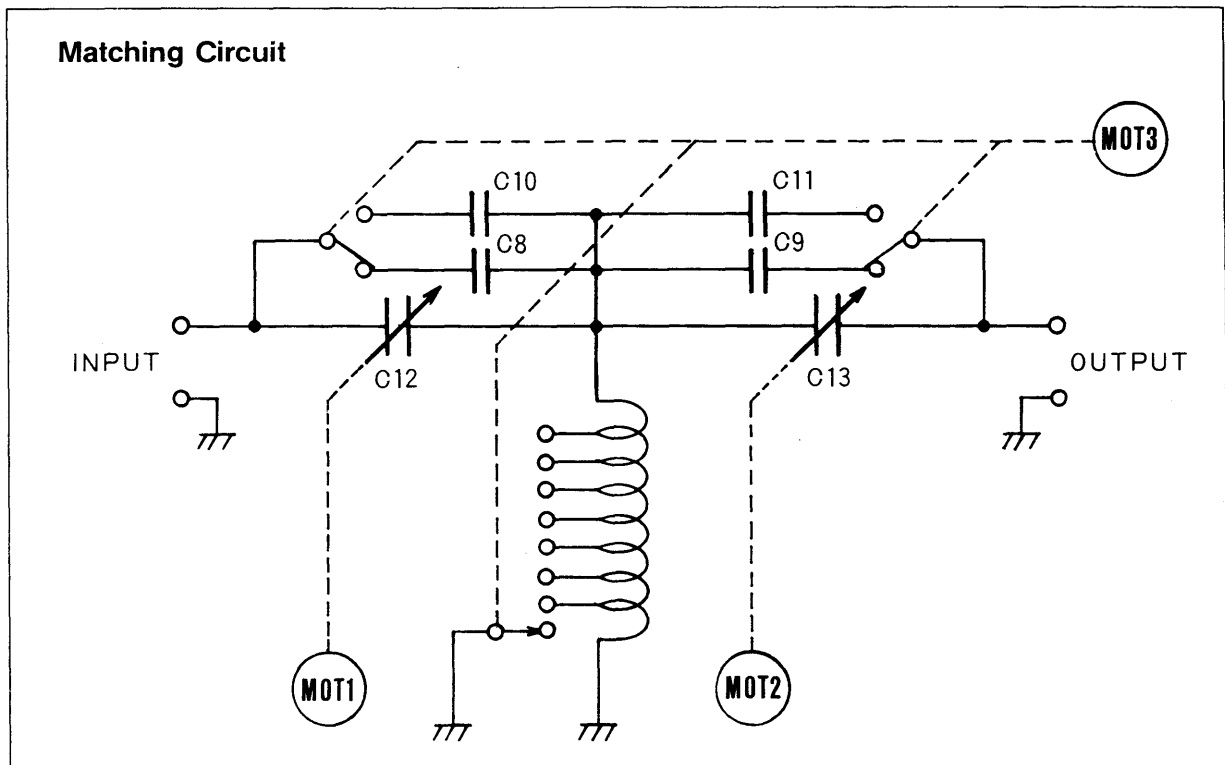
SECTION VII THEORY OF OPERATION

Outline

This tuner is a fully automatic antenna tuner for HF band, and is comprised of (1) matching circuit, (2) detecting circuit (DET), (3) control circuit, (4) preset control circuit, (5) rotary switch control circuit, (6) WAIT circuit, (7) BAND switch circuit and (8) POWER circuit.

(1) Matching Circuit

The matching circuit is shown in the following illustration. Input variable capacitor C12 and output variable capacitor C13 are connected to the motors, and are automatically set to the preset position for each band or proper position controlled by the control circuit. The tap of coil L2 is automatically set to the band specified by the rotary switch control circuit. The input and output variable capacitors are driven independently by the respective motors at the same time. This feature substantially reduces the tuning time, compared to a conventional device. Coil L2 uses the large-diameter steatite bobbin and large conductor to minimize the insertion loss for matching.



(2) Detecting Circuit

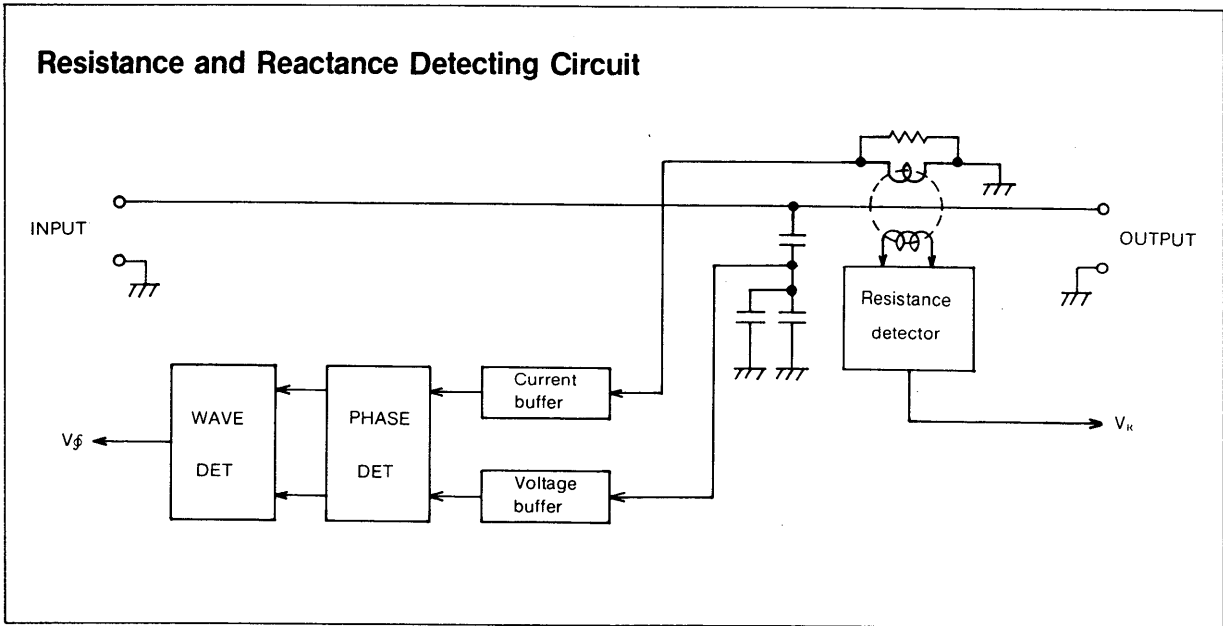
The detecting circuit detects the resistance and reactance of the load, and sends them to the control circuit.

The resistance is detected by L1, D1 and D2. The detecting voltage is 0V when the resistance is 50Ω. When the resistance is less than 50Ω, the positive voltage is put out; when the resistance is more than 50Ω, the negative voltage is put out.

The high frequency current detected by L1 and R5 and high frequency voltage detected by C3~C5 are sent to phase comparators IC3~IC4 through TTL buffers of Q1 and Q2, respectively, to detect the reactance. Positive or negative voltage is put out from IC4, according to the delay or advance of the current with respect to voltage.

The detecting circuit is given in the following block diagram.

Resistance and Reactance Detecting Circuit

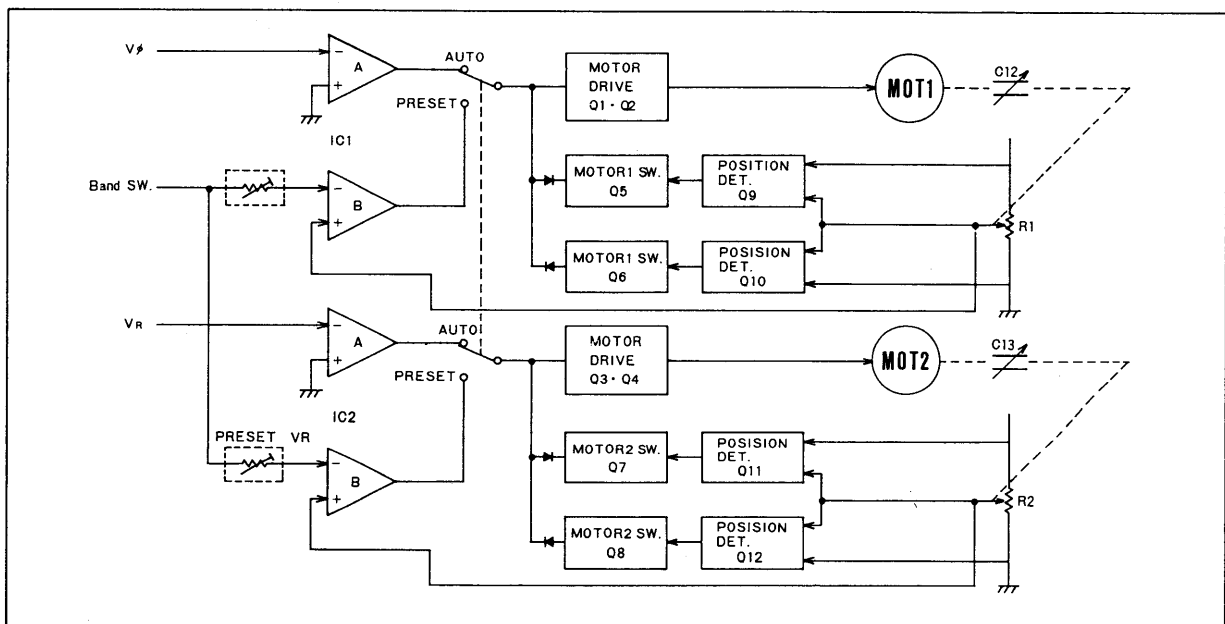


(3) Control Circuit (MAIN)

The resistance component detecting voltage (V_R) and reactance component detecting voltage (V_ϕ) obtained in the detecting circuit are fed to IC1A and IC2B, where the voltage is amplified; the current is amplified by Q1~Q4. This is used to drive the motors (MOT1 and MOT2).

(4) Preset Control Circuit (MAIN)

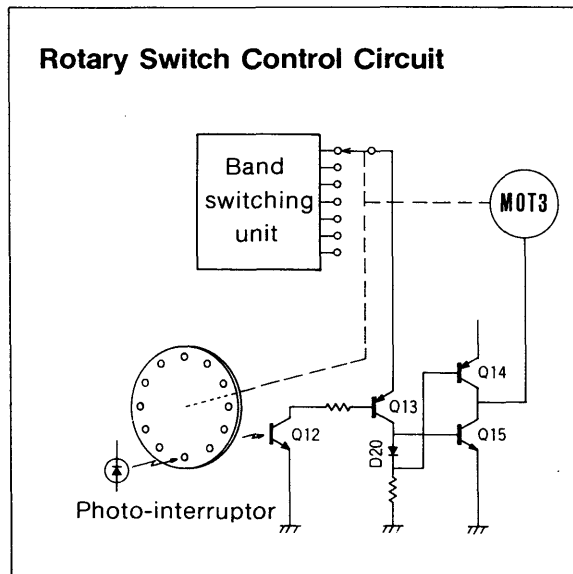
R1~R7 and R8~R14 of the main unit are trimmer resistors to determine the preset position of the variable capacitors for each band. They are mounted inside the top cover. When the AUTO/PRESET switch inside the top cover is set to PRESET, or power is turned ON, or immediately after the operating band is switched, the voltage divided by one of the trimmer resistors R1~R7, R15 and R16, and the voltage obtained through control R1 which is directly coupled to the variable capacitor are compared and amplified by IC1B. By a similar operation, the voltage divided by one of R8~R14, R25 and R26, and the voltage from R2 are compared and amplified by IC2A. These drive the motors and determine the positions of the variable capacitors.



(5) Rotary Switch Control Circuit (MAIN-EF)

This circuit is designed to set the rotary switch position to the desired operating band. If the rotary switch position is not set to the band, the emitter voltage of Q13 will become zero. Then Q14 will be turned ON and Q15 will be turned OFF, applying power to the motor (MOT3).

When the rotary switch position is set to the desired band through the motor operation, and the slit of the gear directly coupled to the rotary switch shaft comes to the center of the photo-interrupter, its photo-transistor will be turned ON, and Q13 will become conductive; then Q14 will be turned OFF and Q15 ON, stopping the motor. So the rotary switch can be stopped at the center of the contact plate at any time.



(6) WAIT Circuit

To make the operating condition immediately after switching the band, this circuit operates to set the variable capacitors to the preset positions, and then to reset it to AUTO TUNE operation.

In the rotary switch control circuit (see (5)) when the band is switched, the time constant circuit (C59, R53) operates. Q17 is turned ON by the Schmitt trigger circuit (Q16, Q21), and the PRESET mode is obtained by relay RL1.

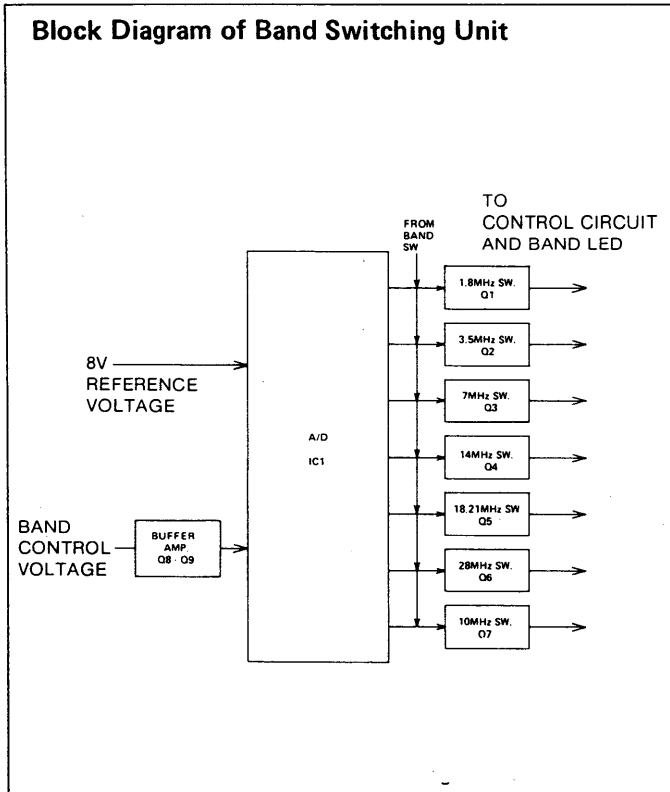
After about three seconds, Q17 is turned OFF, and the tuner is set in the AUTO TUNE mode.

Q18 changes the mode to the preset mode when the tuner is turned OFF (TUNER switch is set to the OFF position). Q19 and Q20 light the AUTO-TUNE indicator in the AUTO TUNE mode.

(7) BAND Switch Circuit (BAND SW)

This circuit consists of the band switching transistors (Q1~Q7) and A/D converter (IC1) for automatic band switching. When this device is operated in the automatic mode using ICOM's HF transceiver, the band control voltage output from the transceiver is applied to pin 9 of IC1 through buffers Q8 and Q9. In the same way, the reference voltage (8V) is also applied to pin 7. Then IC1 sets one of pins 1~6 and 11~16 to the ground level, according to the voltage applied to pin 9, turning ON one of the transistors Q1~Q7.

When the band switching is done manually, one of the bases of Q1~Q7 is set to the ground level, so the transistor according to the selected band is turned ON.



Band Control Voltage Chart

BAND (MHz)	Band Control Voltage
1.8	7.0 ~ 8.0V
3.5	6.0 ~ 6.5V
7	5.0 ~ 5.5V
14	4.0 ~ 4.5V
18 - 21	3.0 ~ 3.5V
24 - 28	2.0 ~ 2.5V
10	0 ~ 1.2V

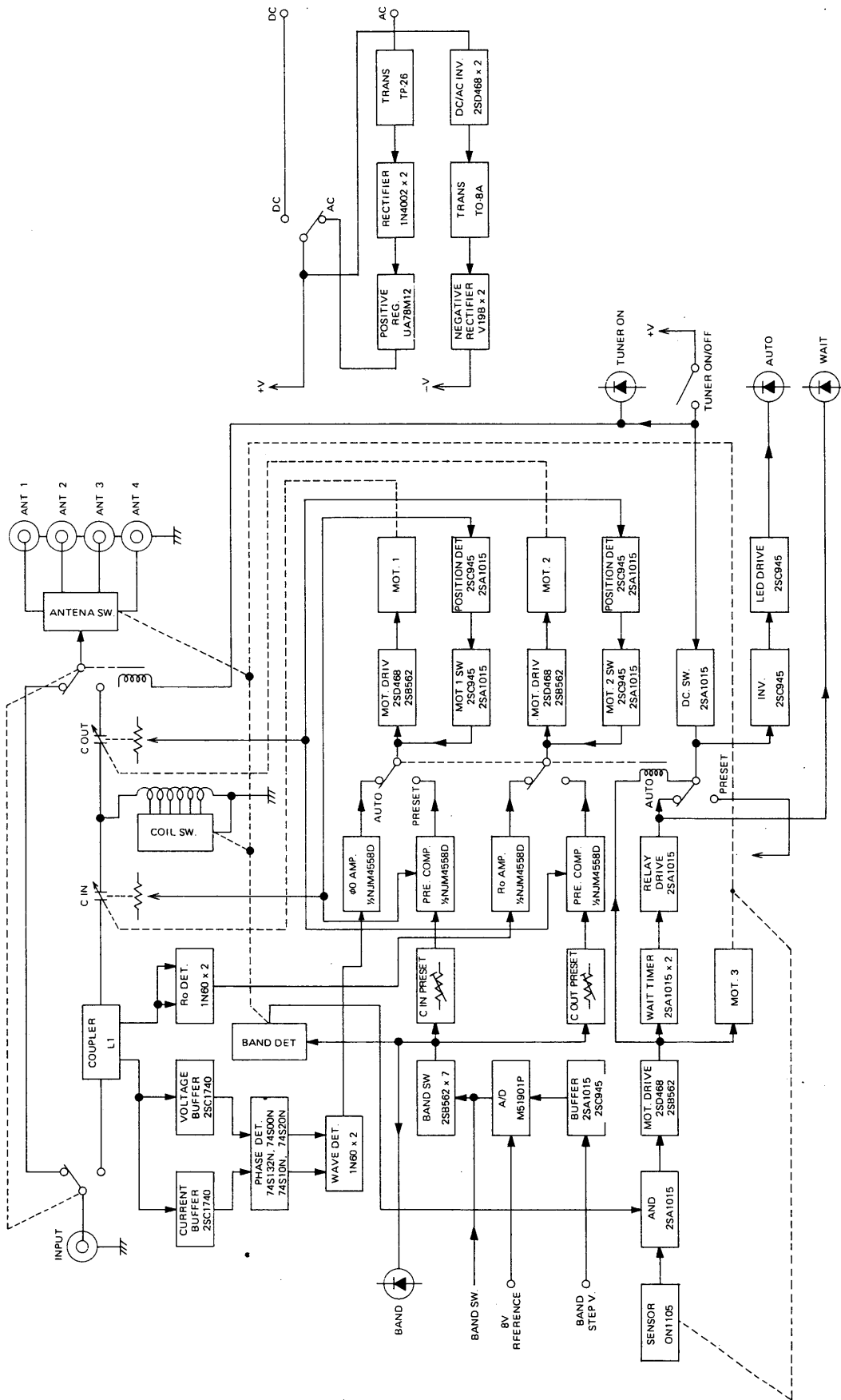
(8) Power Circuit (EF-DC-DC)

This tuner has two power supplies: one is to produce the 13.8V DC from AC power, while the other is to produce -13.8V DC from +13.8V DC (DC/DC converter).

When AC power is used, the AC voltage stepped down by the power transformer L1, is full-wave rectified by D1 and D2, and is smoothed by C16. After that, the regulated voltage (12V) obtained from voltage regulator IC2, is sent to each circuit.

In the DC/DC converter, a frequency of about 16 kHz is oscillated by Q1 and Q2 and rectified by D3 and D4; thus, a negative voltage approximately the same as the input voltage is obtained.

SECTION VIII BLOCK DIAGRAM





ICOM INCORPORATED
1-6-19, KAMI KURATSUKURI, HIRANO-KU,
OSAKA JAPAN