

# IC-720

## HF ALLBAND TRANSCEIVER GENERAL COVERAGE RECEIVER

### INSTRUCTION MANUAL





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## SECTION I SPECIFICATIONS

### GENERAL

#### Number of Semi-Conductors:

Transistors	104
FET	17
IC (Includes CPU)	55
Diodes	244

#### Frequency Coverage:

Ham Band	1.8MHz ~ 2.0MHz
	3.5MHz ~ 4.1MHz
	6.9MHz ~ 7.5MHz
	9.9MHz ~ 10.5MHz
	13.9MHz ~ 14.5MHz
	17.9MHz ~ 18.5MHz
	20.9MHz ~ 21.5MHz
	24.5MHz ~ 25.1MHz
	28.0MHz ~ 30.0MHz

#### General Cover (Receive Only)

0.1MHz ~ 30.0MHz
Thirty 1MHz Segments

### TRANSMITTER

#### RF Power:

SSB (A <sub>3</sub> J)	200 Watts PEP input
CW (A <sub>1</sub> ), RTTY (F <sub>1</sub> )	200 Watts input
Continuously Adjustable Output power	10 Watts~Max.
AM (A <sub>3</sub> )	40 Watts output

#### Emission Mode:

A <sub>3</sub> J	SSB (Upper sideband and Lower sideband)
A <sub>1</sub>	CW
F <sub>1</sub>	RTTY (Frequency Shift Keying)
A <sub>3</sub>	AM

#### Harmonic Output:

More than 40dB below peak power output

#### Spurious Output:

More than 60dB below peak power output

#### Carrier Suppression:

More than 40dB below peak power output

#### Unwanted Sideband:

More than 40dB down at 1000Hz AF input

#### Microphone:

Impedance 1300 ohms

Input Level 120 millivolts typical

Dynamic or Electret Condenser Microphone with Preamplifier

#### Frequency Control:

CPU based 10Hz step Digital PLL synthesizer.

Independent Transmit-Receive Frequency Available on same band.

#### Frequency Readout:

6 digit 100Hz readout.

#### Frequency Stability:

Less than 500Hz after switch on 1 min to 60 mins, and less than 100Hz after 1 hour. Less than 1KHz in the range of -10°C to +60°C.

#### Power Supply Requirements:

DC 13.8V ±15% Negative ground Current drain 20A max. (at 200W input)

AC power supply is available for AC operation.

#### Antenna Impedance:

50 ohms Unbalanced

#### Weight:

7.5Kg

#### Dimensions:

111mm(H) x 241mm(W) x 311mm(L)

### RECEIVER

#### Receiving System:

Quadruple Conversion Superheterodyne with continuous Bandwidth Control.

#### Receiving Mode:

A<sub>1</sub>, A<sub>3</sub>J (USB, LSB) F<sub>1</sub> (Output FSK audio signal), A<sub>3</sub>

#### IF Frequencies:

1st	39.7315MHz
2nd	9.0115MHz
3rd	10.75MHz
4th	9.0115MHz

with continuous Bandwidth Control

#### Sensitivity:

Less than 0.25 microvolts for 10dB S+N/N

#### Selectivity:

SSB, CW, RTTY	±1.15KHz at -6dB (Adjustable to ±0.4KHz Min)
	±2.1KHz at -60dB
CW-N	±250Hz at -6dB (when optional filter Installed)
	±750Hz at -60dB
AM	±3.0KHz at -6dB ±9.0KHz at -60dB (when optional filter installed)
	±2.6KHz at -6dB ±6.0KHz at -60dB

#### Spurious Response Rejection Ratio:

More than 60dB

#### Audio Output:

More than 2 Watts

#### Audio Output Impedance:

8 ohms

Specifications are approximate and are subject to change without notice or obligation.

## SECTION II FEATURES

### FEATURES:

Congratulations on the purchase of ICOM's IC-720. This fine piece of equipment represents ICOM's advanced digital technology and knowledge in the field that have produced an HF transceiver with a general coverage receiver, from 100KHz to 30MHz in 1MHz steps. This, combined with features ICOM has found, are most wanted by Amateurs, serves to make this the finest in the HF field. The all solid state circuits, driver and final power stages provide about 100 Watts output with all the attendant convenience and long life. The IC-720 is an all mode, 30 band transceiver offering SSB, CW, and RTTY.

With the Band Up/Down control the frequency can be changed in 1MHz steps in the General Coverage mode, and will change the Ham bands from one band to the next when pushed. The band change will continue up to 28MHz, then revert to the lowest band if pushed continuously.

### DUAL 10Hz STEP DIGITAL VFO

The dual digital VFO consists of the PLL Unit which has a triple looped Phase Locked Loop and the LOGIC Unit to control the PLL which has a Microcomputer Control System.

Three tuning frequency resolutions of 10Hz, 100Hz and 1KHz steps are selectable with the TS button and the DIAL SELECT switch.

Two separate VFO's can be used independently in the SIMPLEX operation, and any desired frequency split transmit/receive in the DUPLEX operation.

### OUTSTANDING RECEIVER PERFORMANCE

The IC-720 employs a dual conversion superheterodyne system which has the first IF 39.7315MHz and a second IF 9.0115 MHz.

The RF amplifier circuit is a wide band push-pull amplifier using low-noise and wide dynamic range junction FET's, and the mixer is a high level Double Balanced Mixer developed by ICOM.

These advanced devices and systems give higher spurious response rejection ratio, higher sensitivity, and wider dynamic range.

### PASS BAND TUNING AND SPEECH PROCESSOR

The IC-720 has a built-in Pass Band Tuning system developed by ICOM that allows you to continuously adjust the pass band of the IF. By turning the control, you can eliminate interference from a nearby signal, thus providing clear reception. It can also be used as a tone control. During transmit, the Pass Band Tuning circuit can be used as a Speech Processor providing increased "talk power" for outstanding DXing.

### ADDITIONAL CIRCUITS

The IC-720 has a built-in Noise Blanker, VOX, CW Monitor, APC, SWR detector, and many other circuits for your convenience.

The IC-720 has everything you need to really enjoy HF operation, in an extremely compact, rugged transceiver.

### WARC '79 FREQUENCIES

All the frequencies approved during the conference are in! Keeping up with the future ICOM again leads the field. No need for plug-ins, the frequencies are there.

## SECTION III INSTALLATION

BE SURE TO READ THE FOLLOWING INSTRUCTIONS BEFORE USE

### 3 - 1 UNPACKING

Carefully remove the transceiver and accessories from the shipping carton and examine them for damage incurred during shipping. If damage is found, notify the shipping agents or dealer immediately stating the full extent of the damage. It is recommended that you retain the shipping cartons for storage, re-shipping, or moving. Make sure that you have not overlooked any of the accessories packed. The photo below shows all the items that are packed in the carton.



- |   |   |
|---|---|
| 1. Microphone (IC-HM7) . . . . .  | 1 |
| 2. DC Power Cord . . . . .  | 1 |
| 3. Pin Plugs (Scope Terminal Plug, Transverter Terminal Plug) . . . . . | 2 |
| 4. External Speaker Plug . . . . .                                      | 1 |
| 5. Key Plug . . . . .   | 1 |
| 6. Spare Fuses (20 Amp) . . . . .                                       | 2 |

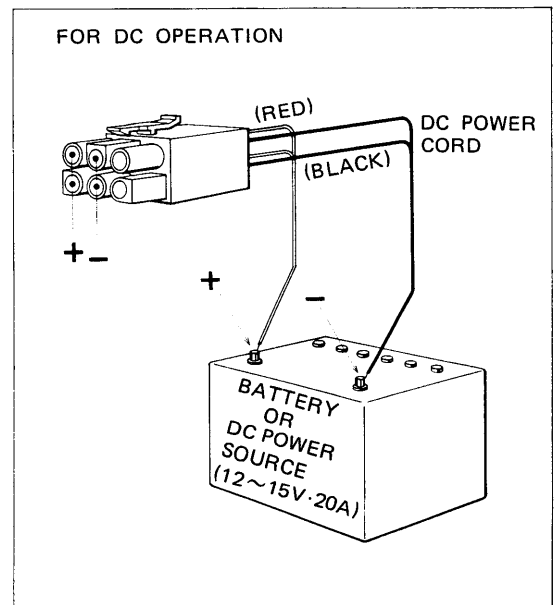
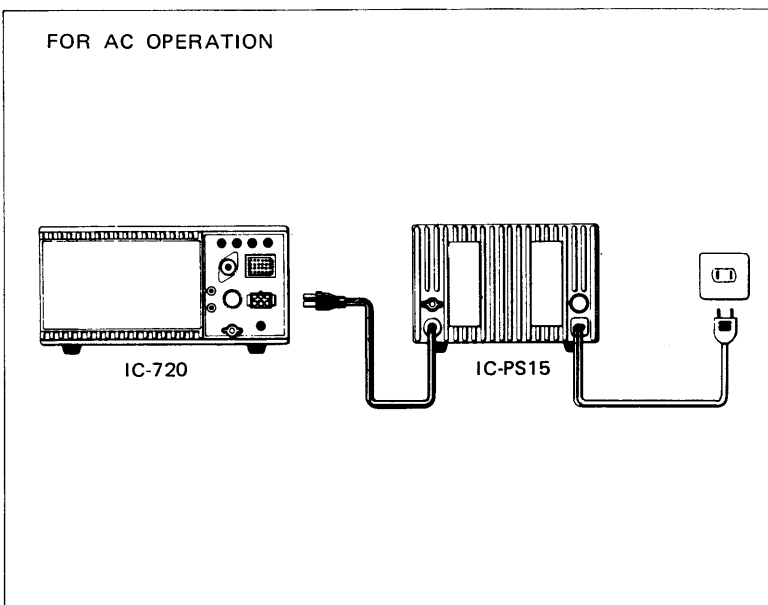
### 3 - 2 INSTALLATION RECOMMENDATIONS

1. It is recommended that the transceiver be placed in a location away from direct sunlight, high temperatures, dust, and high humidity.
2. During transmission the right side of the unit, as you face the set, will usually become relatively warm since it is used as a heatsink. Allow at least one inch (3cm) clearance from other equipment to provide good air circulation. The rear PA heatsink should also have good ventilation; avoid heater or air conditioner ducts.
3. Locate the set so that controls are readily accessible, and so the meter can be easily read.
4. An optional bracket is available for mobile operation. Select the best location for mounting that will accommodate the weight of the set, and not interfere with driving.
5. Be sure to hook up to the ground lug!

### 3 - 3 POWER SUPPLY

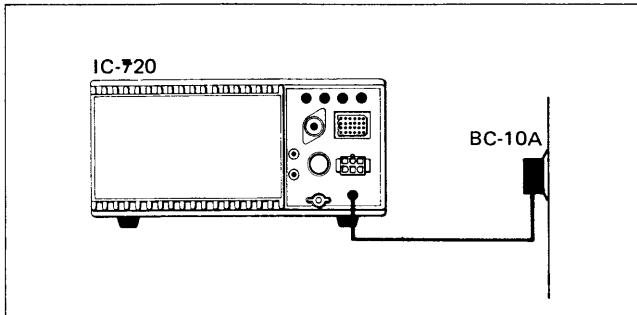
For AC operation, the IC-PS15 is recommended. For mobile operation, or if another power supply is used, be certain that it provides 12 - 15 volts and at least 20 Amps. The maximum power consumption of the transceiver is 16 - 20 Amps, so keep in mind that if the unit is installed in an automobile it is turned on after the engine is started. Pay close attention to the battery and wiring conditions.

To connect the DC power cord supplied with the set, do the following: First make sure the Power Switch is Off, and the set is in the Receive mode. Connect the cord to the power supply using the red wire for the positive (+) side, and the black wire for the negative (-) side (Reversing the connections will cause the protection circuit to blow the fuse.) Connect the DC plug to the IC-720 as shown in the drawing below.



### 3 - 4 MEMORY BACK-UP

To retain the memory in the CPU, keeping the operating frequencies of the VFOs even when the main Power Switch is turned off, hook up a power source of 9 to 12 Volts DC to the Memory Back-Up terminal on the rear panel. For mobile installation this can be accomplished by direct connection to the car battery, since the current drain is low. For AC operation it is recommended that the optional BC-10A be used.



### 3 - 5 ANTENNA

The antenna is the single most important piece of equipment, other than the transceiver. An inferior antenna will result in reduced performance. With a quality antenna and a feed of 50 ohms impedance matching the excellent performance are easily attained.

Install a high performance antenna for the band(s) on which you wish to operate, placing it as high as possible, and insuring that all connections are securely made. Loose connections, poor soldering, or faulty connectors will greatly effect performance. In the case of mobile antennas make sure they are connected to a good ground on the body of the car.

The output of the transceiver is quite high so make sure you do not connect the antenna connector to open lines or transmit under mis-matched conditions. To do either can result in overload of the final stage and damage or malfunction of the set.

#### WARNING:

DO NOT OPERATE THE SET WITHOUT A WELL-GROUNDED ANTENNA TO PROTECT THE TRANSCIEVER AGAINST MIS-MATCH. USE OF A BALUN FOR MATCH IS HIGHLY RECOMMENDED. FAILURE TO DO SO CAN RESULT IN DESTRUCTION OF FINALS.

### 3 - 6 GROUND

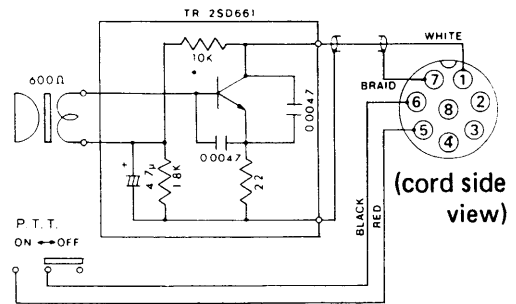
To eliminate the danger of electrical shocks, TVI, BCI, and other problems be sure to connect a heavy ground wire, as short as possible, to the ground lug on the rear panel.

### 3 - 7 MICROPHONE

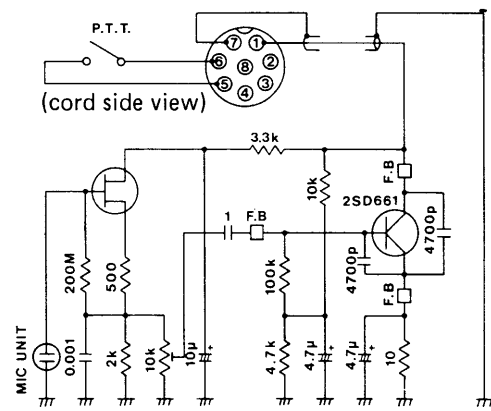
The microphone supplied with the IC-720 is the IC-HM7 which contains a pre-amplifier. The optional electret condenser type stand microphone IC-SM5 can be used. (The optional IC-SM5, a desk top type microphone also contains also a pre-amplifier.)

Their circuit diagrams are shown below.

Schematic diagram of IC-HM7



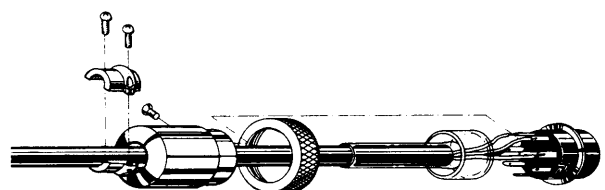
Schematic diagram of IC-SM5



Should you wish to use a different microphone make certain it has a proper pre-amplifier.

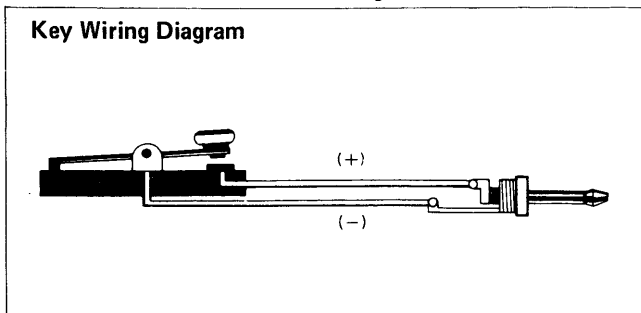
Particular care should be exercised in wiring, as the internal electrical switching system is dependent upon it. See the schematic for the proper hook up.

Microphone plug exploded View



### 3 - 8 CW KEY

For CW, a plug is supplied for connection to the key. Proper connection is shown below. In the event the terminals have polarity, be sure to connect with proper polarity. When switching with semiconductors or relays with resistors in the circuit voltage must be adjusted to below 0.4 Volts.



### 3 - 9 RTTY

Accessory socket pins 8 (ground) and 9 should be connected to the teletypewriter through a high speed relay or level converter to TTL level, the tones for the terminal unit are available from pin 4. For further details see the chapters on "Use of RTTY" and "Transmit and Receive."

### 3 - 10 EXTERNAL SPEAKER

The IC-720 has an internal speaker, but if desired an external speaker of 8 ohms impedance can be connected to the external speaker jack on the rear panel. When connected the internal speaker is disabled.

### 3 - 11 HEADPHONES

Any good headphone set, of 4 - 16 ohms impedance may be used. When the jack is inserted halfway both the internal speaker and the headphones will operate - a convenience when recording, or others are listening. A tape recorder can be connected to the headphone jack to record contacts. When the plug is fully inserted only the headphones will function. Stereo headphones can be used, but in the half-plugged position only one earphone will operate.

### 3 - 12 ANTENNA

Any amateur band antenna of 50 ohms impedance can be used with the IC-720, wire, vertical, or rotary beam. It is highly recommended that a high quality antenna be used - the few dollars invested will more than pay for the antenna in the long run. Careful installation will also pay dividends, follow the manufacturers instructions explicitly. Loose connections or connectors will cause many problems.

Since the IC-720 has a General Coverage receiver it is recommended that a long-wire general coverage antenna and an antenna coupler be used. The antenna's impedance should be 50 ohms. To attempt to use the Ham band antenna for general coverage reception could result in mismatching, and attendant poor reception.

In mobile operation choice of antennas is as important as fixed operation. Be sure that the antenna's ground connection is made to the car body or chassis firmly, that the impedance is 50 ohms, and that the match is good.

### 3 - 13 POWER SUPPLY

It is recommended that you use the IC-PS15 as a power supply for base operation. If you wish to use another type power supply make sure that it meets the voltage, current requirements. Note carefully the overvoltage protection, for a runaway regulator can destroy the IC-720; be especially careful that more than 16 Volts cannot be supplied to the transceiver. Do not connect the power supply, antenna, accessory plug, or microphone with the Power Switch in the on position. Be especially careful not to transmit without an antenna or dummy load hooked up. If the fuse blows replace it with a 20 Amp fuse, only after fixing the cause. Do not turn the Power Switch on and off repeatedly for this way cause the readout to mis-display. Should this occur, turn the set off and wait for approximately 30 seconds before turning it back on.

### 3 - 14 CAUTIONS

As the unit has already been closely adjusted with highly sophisticated measuring instruments, never tamper with the turnable resistors, coils, trimmers, etc.

C-MOS is used in the Logic unit as well as the PLL. C-MOS ICs are very susceptible to excessive static charges and over current and care must be used when handling them. Therefore, avoid touching the Logic unit and the nearby circuitry unless absolutely necessary. When it is necessary to check the circuitry, observe the following points.

Ground all measuring instruments, the soldering iron, and other tools. Do not connect or disconnect the C-MOS IC from its socket, or solder it when the power is on. Do not apply voltage of less than  $-0.5$  or more than  $+5$  Volts to the input terminals of the IC. DO NOT MEASURE WITH AN OHMMETER.

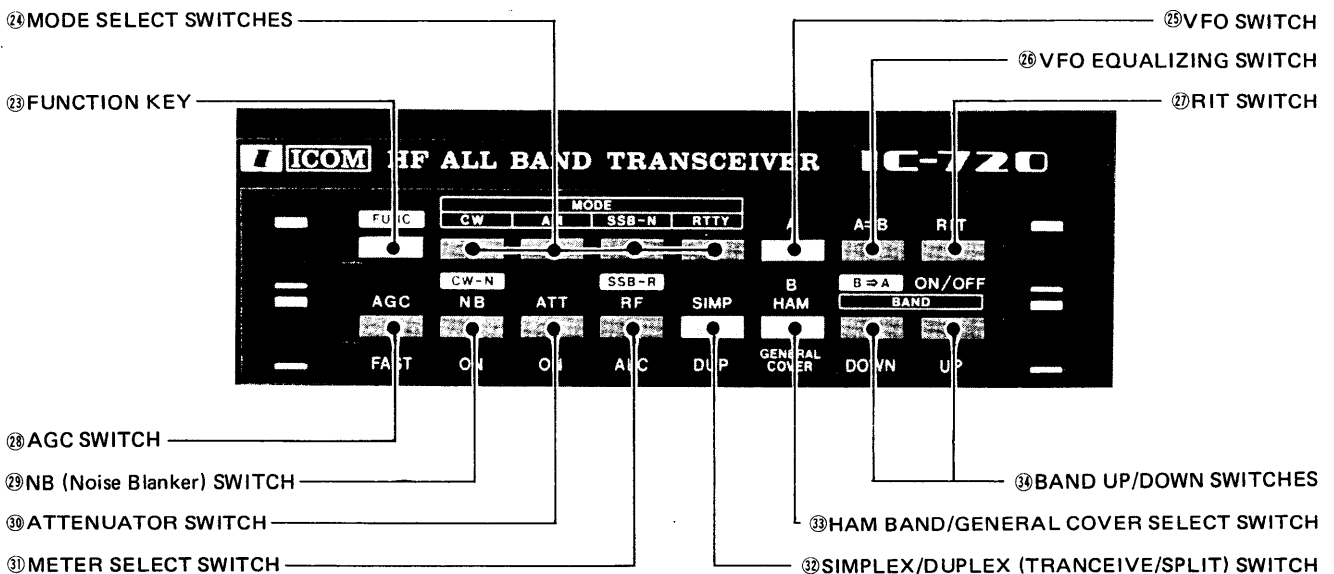
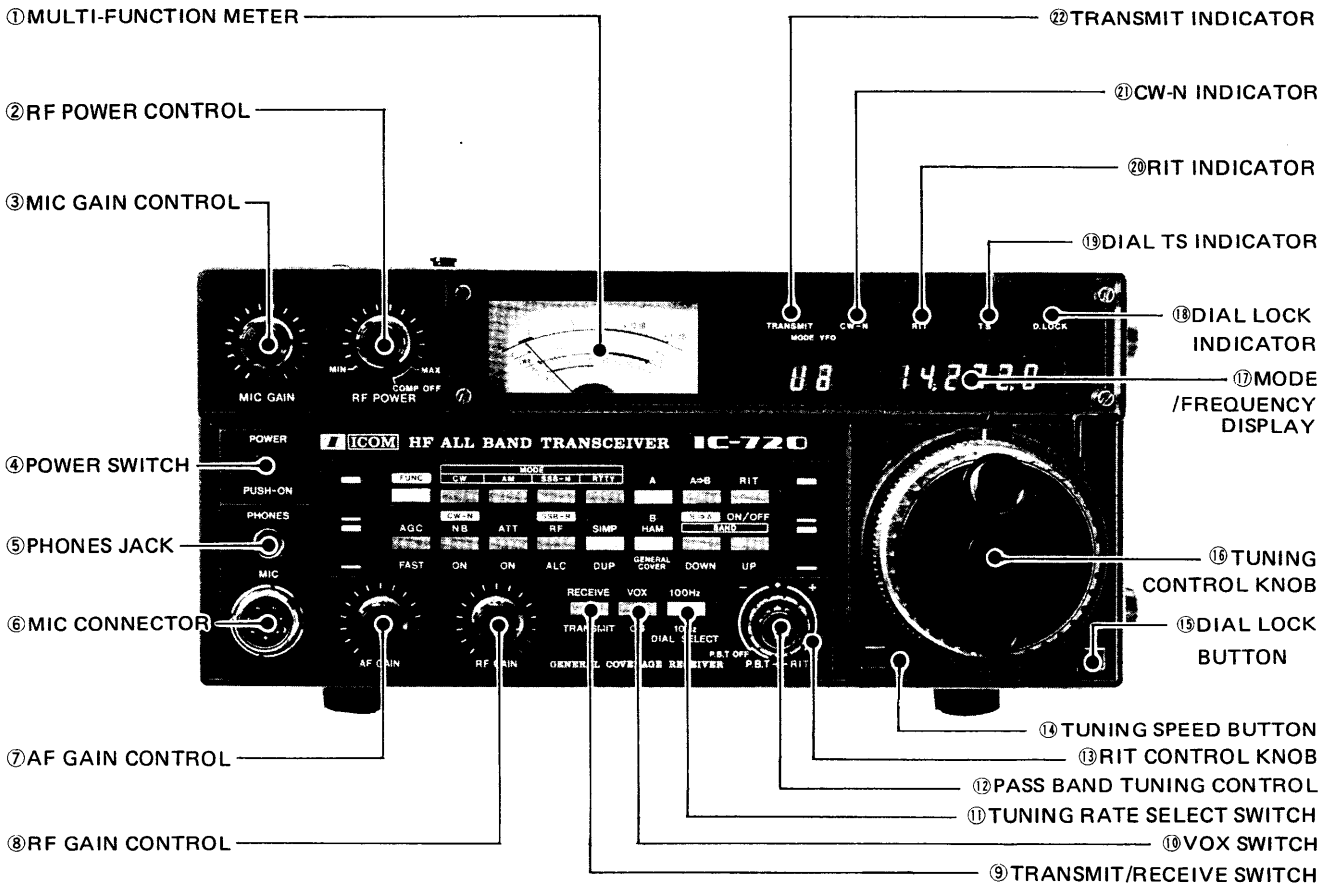
### 3 - 15 COOLING FAN

The rear of the PA unit is designed to provide for adequate cooling, but with 200 Watts input the final stage produces quite a bit of heat, and its temperature may rise during prolonged transmissions. The fan is connected to a temperature monitoring circuit which monitors the temperature of the final stage. The fan operates as follows:

1. The fan does not operate normally in the receive mode, but will run all the time in transmit.
2. When the temperature rises to a point detected by the monitor circuit the fan will operate during both transmit and receive to provide additional cooling.
3. If the temperature rises to a danger limit the fan will run much more rapidly. At this time stop transmitting and investigate the cause of overheating i.e. antenna mis-match, etc. Correct the cause of the overheating before starting to transmit again.

# SECTION IV OPERATING CONTROLS

## 4-1 FRONT PANEL





## 1. MULTI-FUNCTION METER

When in the receive mode the meter acts as a S meter regardless of the position of the meter select switch. Signal strength is indicated on a scale of S1-S9, and S9+20dB to S9+40dB.

In the transmit mode the meter has three functions which are selected by the Meter Select Switch (31) and the IC Meter Switch inside the top access cover. They are as follows:

Ic; Indicates the collector current of the final transistors.

Po; Indicates the relative output power. SWR can be measured by placing the switch located inside the top cover to the SWR position.

ALC; In this position the meter functions when the RF output reaches a certain level.

## 2. RF POWER CONTROL

The IC-720 has a built-in speech processor which is turned on by turning the control counterclockwise, from the COMP. off. (a click will be heard.) When on, it functions as the RF Drive Control, as explained in the Mic Gain Control paragraph. In CW, SSB and RTTY modes it operates as the output level control of the IC-720. When this function is not desired the control should be turned completely clockwise until off, and a click is heard.

## 3. MIC GAIN CONTROL

Adjusts the level of modulation of the input of the microphone. Clockwise rotation increases the microphones gain. As input will vary with different microphones and different voices the knob should be turned until the Multi-Function Meter needle, set in the ALC mode, begins to move slightly in the ALC zone. In SSB and AM modes when the RF Speech Processor is in use the Mic Gain Control sets the clipping limits, while the RF Power Control sets the RF drive level to the maximum power level, where ALC starts at the saturation point of the amplifiers.

## 4. POWER SWITCH

A push-lock type switch to turn the set on and off, when the IC-PS15 is used it also acts as the on/off switch for that unit. When pushed again it will unlock and power is cut off to all circuits, except the PA unit. (Note: When the IC-BC10A is used power will also be supplied to the memories.)

## 5. PHONES JACK

Accepts a standard 1/4 inch headphone plug for headphones of 4 ~ 16 ohms. Stereo phones can be used without modification.

## 6. MIC CONNECTOR

Connect the supplied microphone. If you wish to use another microphone see the hookup diagram on page 4.

## 7. AF GAIN CONTROL

Controls audio in the receive mode, turn clockwise to increase the level.

## 8. RF GAIN CONTROL

Controls gain of the RF section in the receive mode. Clockwise rotation increases the gain, as the control is turned counterclockwise the needle of the multi-function meter will rise, and only signals that exceed the level indicated will be heard.

## 9. TRANSMIT/RECEIVE (T/R) SWITCH

This switch is for manually switching from transmit to receive and vice versa. Set the switch to RECEIVE (out) and the IC-720 is in the receive mode. Set the switch to TRANSMIT (in) and it switches to transmit. When the VOX switch set to on the T/R switch must be in the RECEIVE position.

## 10. VOX SWITCH

Turns the VOX on and off. In SSB mode switching is accomplished by voice detection, in CW mode semi break-in switching is provided.

## 11. TUNING RATE SELECT SWITCH

The Small Vernier marks on the tuning knob are changed to correspond to 10Hz steps or 100Hz steps which is selected by this switch.

## 12. PB TUNE (PASS BAND TUNING) CONTROL

Allows continuous tuning of the pass-band selectivity by moving the filter up to 700Hz from the upper or lower side in SSB, CW and RTTY. Not only improves selectivity, but also can improve the audio tone. Normal position is in the center (12 o'clock) position and is 2.3KHz wide in SSB.

## 13. RIT CONTROL

Shifts the receive frequency  $\pm 800$ Hz either side of the transmit frequency. On is indicated by a LED lighting. Rotation toward the + side raises receiver frequency, toward - the opposite. If the tuning knob is moved one increment while this control is on it will automatically be pulsed off. This feature makes it unnecessary to manually turn off the RIT when changing operating frequencies. The shift of frequency is not shown on the display.

## 14. TUNING SPEED BUTTON

Push this button and the Dial TS indicator lights and the vernier marks on the tuning knob correspond to 1KHz steps. This turns off the 100Hz digit on the display. When the control is turned off the transceiver reverts to its former condition. This control is convenient for quick QSYs over a great frequency range.

## 15. DIAL LOCK BUTTON

After a frequency is set pushing this button will electronically lock the VFO, and the Dial Lock LED lights. To change frequencies the button must be pushed again. Turning off the power will also release the dial lock, and clear the displayed frequency.

## 16. TUNING CONTROL KNOB

Clockwise rotation increases the frequency, and counterclockwise the reverse. The frequency change is selectable through the use of Tuning Rate Select Switch and the Tuning Speed button.

One complete rotation of the tuning knob results in a 1KHz frequency increase or decrease in 10Hz steps, 10KHz in 100Hz steps and 100KHz in 1KHz steps.

#### 17. MODE/FREQUENCY DISPLAY

The frequency of the IC-720 is displayed on a luminescent display tube. Since the 1MHz and 1KHz decimal points are displayed, the frequency can easily be read. The frequencies indicated are the carrier frequencies of each mode in AM, USB, LSB and CW. In the RTTY mode, the mark frequency is displayed.

Remember, if you turn the RIT control on to change the receive frequency and rotate the RIT control knob, the frequency displayed will not change.

#### 18. DIAL LOCK INDICATOR.

Lights when the Dial Lock is activated.

#### 19. DIAL TUNING SPEED (TS) INDICATOR

Lights when tuning speed is selected.

#### 20. RIT INDICATOR

Lights when the RIT is on.

#### 21. CW-N (CW NARROW) INDICATOR

Lights when CW narrow is selected. The LED will light even though the crystal filter option is not installed.

#### 22. TRANSMIT INDICATOR

Lights when the transceiver is in the transmit mode.

#### 23. FUNCTION KEY

Extends the functions of the CW and SSB Mode switches, plus the VFO Equalizing Switch, by pushing this key switch.

#### 24. MODE SELECT SWITCHES

Selects any one of four operating modes by simply pushing the desired switch. Additionally, the CW and SSB switches have dual functions.

- CW: Push the button for normal CW operation.
- CW Narrow: First push the Function button then the CW button, this will select CW Narrow. This mode is functional only when the optional narrow crystal filter is installed.
- SSB-N: For normal SSB operation, Upper sideband for 10MHz band, and above, and Lower sideband for 9MHz and below.
- SSB-R: To reverse the above first push the Function button and then the SSB button.
- AM Button: Selects the AM mode. (Note: When the optional filter is installed the PBT can be used in the AM mode.)
- The RTTY button. Selects RTTY.

#### 25. VFO SWITCH

You can select either of the built-in VFOs with this switch. It will also work in conjunction with the SIMP/DUP switch in the following manner.

- A. (Simplex) Selects the "A" VFO for both transmit and receive.
- A. (Duplex) Selects "A" VFO for receive and "B" VFO for transmit.
- B. (Simplex) Selects the "B" VFO in both transmit and receive.
- B. (Duplex) Selects "B" VFO for receive and "A" VFO for transmit.

**NOTE:** The set will not transmit in the GENERAL COVER Mode.

The frequencies on both VFOs will be retained in the CPU memory if you switch from "A" to "B", or the reverse.

#### 26. VFO A=B (Equalizing) SWITCH

This is a dual function switch. When the button alone is pushed "B" VFO will switch to the same frequency as "A" VFO. If the Function button is pushed first, then the button, "A" VFO will switch to the same frequency as "B" VFO.

#### 27. RIT SWITCH

Push once for on; if off is desired push the switch again. When the RIT is on the RIT LED will light. (Note: The RIT will also pulse off when the main tuning knob is turned.)

#### 28. AGC (AUTOMATIC GAIN CONTROL) SWITCH

For changing the time-constant of the AGC circuit. With the switch in the AGC position (out) the AGC voltage is released slowly for SSB reception., when the switch is in the Fast position (in) the AGC voltage is released faster and is better for stations that fade quickly in the CW mode.

#### 29. NB (NOISE BLANKER) SWITCH

Specially designed for the IC-720 this noise blanker will serve to lessen noise of a pulse type, the noise blanker is on when the button is in.

#### 30. ATT (ATTENUATION) SWITCH

When nearby signals interfere with reception, or make "S" readings difficult push the switch in, this removes the RF Amplifier from the receiving circuit, and an attenuator is put into the circuit. For normal operation leave it in the off (out) position.

#### 31. METER SELECT SWITCH

Selects meter function in the transmit mode.

#### 32. SIMPLEX/DUPLEX (TRANSEIVE/SPLIT)

Selects the relationship of the two VFO's. In the SIMPLEX (out) position, one VFO is for both transmit and receive. In the DUPLEX (in) position, one VFO is for transmit and the other is for receive.

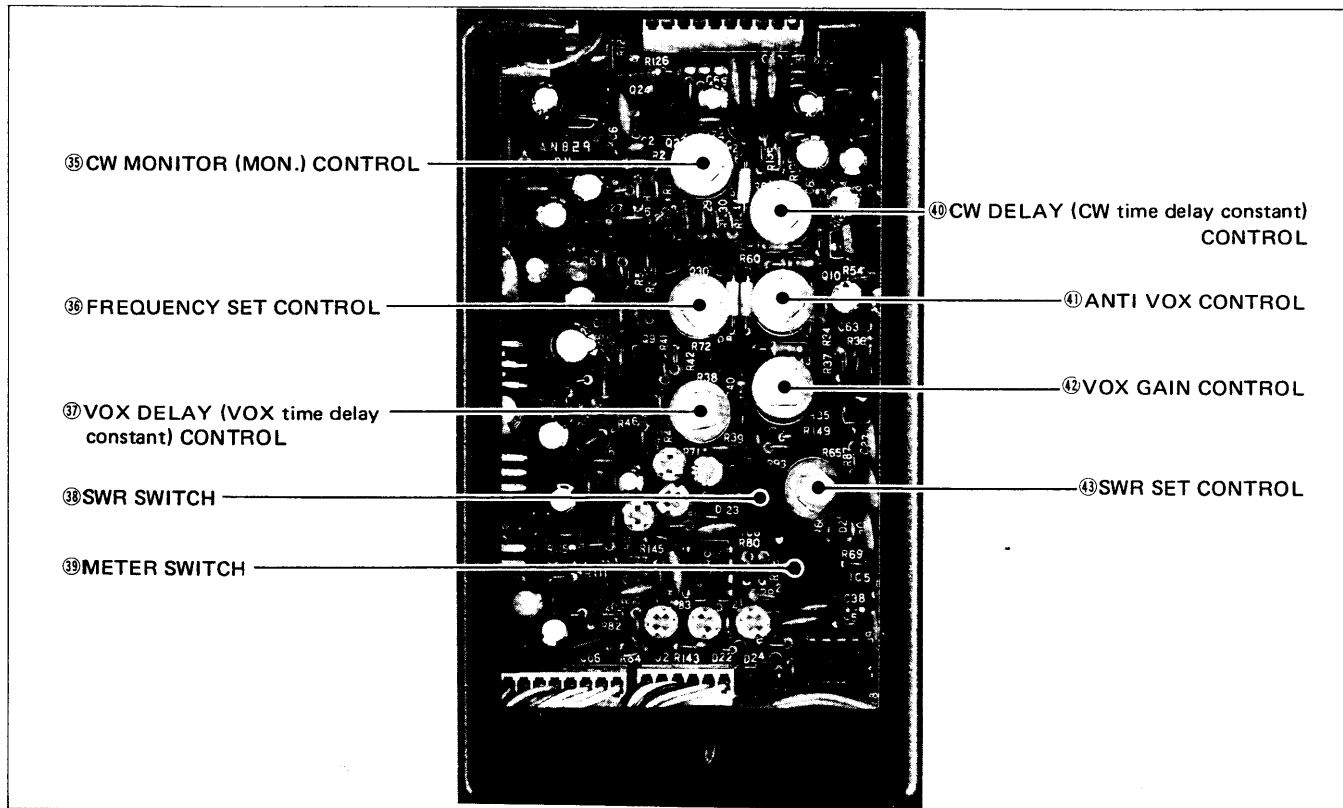
### 33. HAM BAND/GENERAL COVER SELECT SWITCH

In the Ham (out) position the transceiver functions in any of nine Ham bands between 1.8MHz and 28MHz. In the General Coverage position (in) the set functions as a general coverage receiver between 0.1MHz and 29MHz. (the set will not transmit in this mode.)

### 34. BAND UP/DOWN SWITCHES

Changes the operating band up or down. When in the Ham Band mode this switch will move the transceiver to the next band with each push. When in the General Coverage mode the band changes up or down in 1MHz segments. When the set reaches the highest band in either mode it will automatically return to the lowest band, or vice versa.

## 4-2 CONTROLS UNDER THE ACCESS COVER



### 35. CW MONITOR (MON.) CONTROL

This control adjusts the volume of the side tone (monitor) during CW transmit, adjust to your listening level.

### 36. FREQUENCY SET CONTROL

This control is for fine adjustment of the reference frequency of the PLL unit, which is local oscillator frequency. Do not turn it unless you want to change the frequency.

### 37. VOX DELAY CONTROL

Sets the time constant of the transmit to receive switching, should be adjusted to switch when you start speaking, and not during short pauses in speech.

### 38. SWR SWITCH

When measuring SWR, calibration set, and SWR reading the functions are selected with this switch. When reading SWR make sure the meter switch is in the Po setting.

### 39. METER SWITCH

When the meter switch on the front panel is in the RF position, this switch is used to select indication of the collector current of the final transistors, or relative output power.

### 40. CW DELAY CONTROL

In Semi-break-in operation, this controls the TX/RX switchover time-delay. Adjust to suit your keying speed. (Note: If the delay is set to the limit it will reach almost full break-in CW.)

### 41. ANTI-VOX CONTROL

In (SSB and AM) VOX operation the set can occasionally be keyed from audio from the speaker in the set, causing a switch to transmit. This can be prevented by adjusting the input level with the Anti-Vox and the VOX-Gain controls to the level where the VOX operates only when speaking into the microphone.

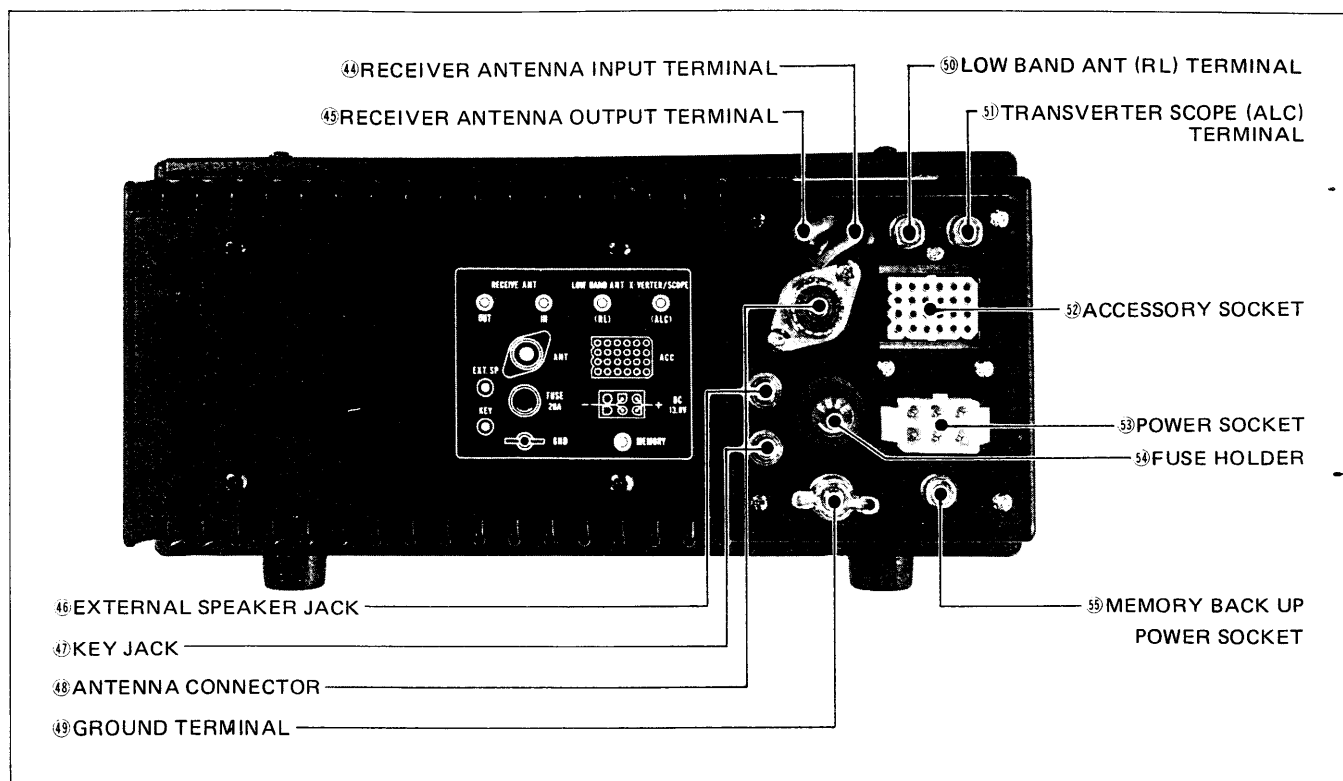
### 42. VOX GAIN CONTROL

Adjusts input to the VOX, set so the (SSB and AM) VOX operates during normal speech into the microphone.

### 43. SWR SET CONTROL

Use to calibrate the meter needle, set to the Po Set position when determining the value of SWR. Functions only when the meter switch is in the Po setting and the transceiver is transmitting a carrier.

## 4-3 REAR PANEL CONNECTIONS



### 44. RECEIVER ANTENNA INPUT TERMINAL

This is an input terminal which is connected directly to the receiver.

### 45. RECEIVER ANTENNA OUTPUT TERMINAL

Received signals are conducted here after passing through the antenna switching circuit. Normally the receiver in and out terminals are jumpered, and this terminal is used only when another receiver is connected, or a pre-amplifier is connected to the IC-720.

### 46. EXTERNAL SPEAKER JACK

For connection of an external speaker of 8 ohms. The internal speaker is disabled when this jack is used.

### 47. KEY JACK

For CW operation, connect the key here. For electronic keying the terminal voltage must be less than 0.4V DC.

### 48. ANTENNA (ANT) CONNECTOR

This is used to connect the antenna to the set. Its impedance is 50 ohms. Connection must be with a PL259 connector.

### 49. GROUND TERMINAL

To prevent electrical shock, TVI, BCI, and related problems it is very important that a good ground be hooked up with as heavy and short a wire as possible. This holds true in both fixed and mobile installations.

### 50. LOW BAND ANTENNA TERMINAL (RL)

For connection of a low band antenna.

By turning the internal switch, it can be used as a Tx/Rx relay control. Switching for this terminal can be accomplished with +24V, 1A DC. Do not exceed this limit.

### 51. TRANSVERTER SCOPE (ALC) TERMINAL.

1. For connection of a panadaptor or panascope to observe the 39.7315MHz IF signal of the receiver, and also signals of a selected bandwidth.
2. Using a suitable transverter VHF and UHF operations are possible with the IC-720. The output is a few milliwatts, refer to the instructions for transverters for proper hookup. By moving the 2-pin plug this terminal can be used as an external ALC input, see page 28.

### 52. ACCESSORY (ACC) SOCKET

External accessories and controls can be used with the IC-720, connected to this socket. NOTE: Pin 10, 11, 18 ~ 24 are for digital control and are connected to the input of the C-MOS-IC, do not apply any voltages not within 0.5 to +5 Volts. For details refer to page 20.

### 53. POWER SOCKET

For connection of the IC-PS15's DC power cord, or other suitable power supply.

### 54. FUSE HOLDER

This holds the fuse for the DC power circuit. If the fuse is blown, replace it with a new 20 Amp fuse after checking the cause. Open the fuse holder with a Phillips head driver.

### 55. MEMORY BACKUP POWER SOCKET

For connection of a 9 ~ 12V DC power supply. For mobile installation connection to the vehicle's battery can be made the current drain is low, for fixed installation use of the IC-BC10A is recommended.

## SECTION V OPERATING INSTRUCTIONS

### 5 - 1 HOW TO TUNE

The following instructions are for tuning in any mode. Please read carefully and understand fully before turning the unit on. Proper tuning is necessary for optimum operation.

#### 5 - 1 - 1 TUNING KNOB

The transmit or receive frequency is displayed on 7 segment Electroluminescent display down to 100Hz digits. With all buttons in their normal (out) position, rotating the tuning knob clockwise increases the frequency, while turning counter-clockwise decrease the frequency in 100Hz steps. (or 10Hz steps, it depends on Tuning Rate Select switch position) The smaller vernier marks on the knob represent 10Hz and the larger marks represent 100Hz. One complete rotation of the tuning knob results in 10KHz, 1KHz frequency increase or decrease. When you receive your set, calibration of the tuning knob may be desirable, as the large increments may not correspond exactly to a change of 1KHz displayed on the readout. Exact calibration is not necessary as the displayed frequency will always be correct but you may calibrate the scale on the tuning knob for use as an analog type frequency display. To calibrate, set a large increment on the tuning scale to line up with the indicator arrow directly above the scale and then turn on the power.

To calibrate the scale during operation, if desired, set the frequency readout to 0.0KHz, push the dial lock button, then set the large increment on the tuning scale to line up with the indicator arrow and then push the dial lock button again.

The tuning knob scale may require recalibration if you:

1. Turn the knob while the frequency is locked by use of the Dial Lock Button.
2. Turn the knob beyond the band edge.

On all but the 28MHz band, the displayed frequency will not go beyond the highest band edge even by turning the tuning knob clockwise, or beyond the lowest band edge by turning the knob counter-clockwise. On the 28MHz band, since this band width is much wider than the others, the IC-720 provides "automatic revert" over either MHz for operating convenience. When the frequency display shows 29.999.9MHz and the tuning knob is turned clockwise, the displayed frequency jumps down to 29.000.0MHz and continues up from there. Likewise, by continuing to turn counter-clockwise beyond the bottom edge of the band, the frequency jumps up from 29.000.0MHz to 29.999.9MHz and goes down from that point. The same holds true for the 28MHz segment.

The displayed frequency shows the carrier frequency in the USB, LSB, AM and CW modes, and the Mark frequency in the RTTY mode.

#### 5 - 1 - 2 DIAL SELECT BUTTON

Pushing the Dial Select Button will change the basic tuning rate of the set. In its normal out position the tuning rate is 100Hz. When pushed in the tuning rate becomes 10Hz. The 10Hz may be read from the increments on the tuning knob.

#### 5 - 1 - 3 TUNING SPEED BUTTON

Pushing the Tuning Speed Button will illuminate the dial fast LED and the tuning rate is changed to correspond to 1KHz steps. The last significant-digit on the display is blanked. When the Tuning Speed Button is depressed again, the dial fast display LED goes off and the tuning rate will again correspond to 100Hz (10Hz) steps. This button will allow you to quickly QSY over a great frequency range.

#### 5 - 1 - 4 DIAL LOCK BUTTON

After the IC-720 is set at a certain frequency for rag chewing, mobile operation, etc., pushing the Dial Lock button will illuminate the Dial Lock LED and the VFO is locked at the displayed frequency, thus inactivating the operation of the tuning knob. To change the frequency, the Dial Lock must first be disengaged by pushing the dial lock button again. The Dial Lock display LED will go off, and the frequency will change with the direction of the tuning knob rotation. Turning off the power will release the Dial Lock.

#### 5 - 1 - 5 VFO SELECT SWITCH

The CPU in the IC-720 contains two "VFO's" for both receiving and transmitting. The VFO's are labeled "A" VFO and "B" VFO and are selectable with the VFO Select Switch. This dual VFO system gives the IC-720 many very convenient features. Please read this section very carefully and perform the operation several times until you are comfortable with the system.

1. "A" VFO is for both transmitting (ham bands only) and receiving and is selected by placing the VFO Select switch in the "A" position. The transmit and receive frequency will be controlled by "A" VFO, displayed on the frequency readout, and stored in "A" memory.
2. "B" VFO is for both transmittin (ham bands only) and receiving and is selected by placing the VFO Select switch in the "B" position. The transmit and receive frequency will be controlled by "B" VFO, displayed on the frequency readout, and stored in "B" memory.

#### FOR EXAMPLE:

If the band switch is set to the 7MHz band, when the set is turned on, 7.100.0 will be displayed on the readout.

This will occur whether the VFO switch is in either the "A" or "B". Rotating the tuning knob clockwise will increase the frequency in 100Hz (10Hz) steps. Rotating the tuning knob counter-clockwise will decrease the frequency in 100Hz (10Hz) steps.

Switching from one VFO to the other VFO does not clear the first VFO. The frequency is retained in the VFO's memory.

## EXAMPLE

If 14.125.0MHz is set with "A" VFO, and the VFO switch is set to "B" VFO, the frequency readout will show "B" VFO's frequency, but 14.125.0MHz is still stored in "A" VFO's memory. Returning the VFO switch to "A" VFO position, and 14.125.0 will be displayed on the readout. Accordingly, if the switch is placed in the "B" VFO position, the frequency that was set with the "B" VFO will appear. This allows you to set a certain frequency with one VFO, work up and down the band with the other VFO, and periodically check the set frequency simply by switching between "A" and "B" VFO. It also allows you to search for a clear frequency with one VFO, while keeping your operating frequency on the other VFO. When you have found a clear frequency, switch back to your operating frequency, inform the station you are in contact with of the new frequency, and switch back.

It's that simple!

The IC-720 will perform this operation even on two different bands. A frequency is set in either "A" or "B" VFO on one band, the VFO switch is set to the other VFO, and the band set to any other band you wish to work.

## EXAMPLE:

Set "A" VFO to 14.255.0MHz. Set the VFO switch to "B" VFO. Switch to the 21MHz band. The frequency readout will read 21.100.0MHz. Operate anywhere you wish with "B" VFO. When you want to return to 14.255.0MHz, switch back to VFO A. The frequency readout will show 14.255.0MHz.

## 5 - 1 - 6 SIM/DUPLEX SWITCH

This will allow you to operate split transmit/receive frequencies in the same band.

## EXAMPLE:

Set "A" VFO to 14.350.0MHz and "B" VFO to 14.255.0MHz.

Return the VFO Switch to VFO A then set the Sim/Duplex Switch to the Duplex position. 14.350.0MHz will shown on the readout during receive ("A" VFO) and 14.255.0MHz during transmit ("B" VFO). You are now receiving on 14.350.0MHz and transmitting on 14.255.0MHz. Setting the VFO select switch to VFO B to reverses the above.

## 5 - 1 - 7 HAM/GENERAL COVERAGE SWITCH

This two position switch selects the range of frequencies to be covered by the Band Push Buttons. In the Ham (out) position the frequencies available are those of the 9 amateur bands. Pushing either the UP or DOWN buttons increments the transceiver one ham band at a time. In the general coverage mode (in) the unit operates as a receiver in the range .1 to 30MHz. The Band Switches move the frequency up and down in 1MHz steps.

## 5 - 1 - 8 BAND CHANGING BUTTON

These buttons labeled UP and DOWN increment the radio one band at a time in the desired direction. Note that the normal sideband mode is automatically selected for the band in use.

## 5 - 1 - 9 VFO EQUALIZING SWITCH

This switch allows either VFO's to be brought to the exact frequency of the other VFO without turning the tuning knob.

## FOR EXAMPLE:

Set a VFO to 14.255.0MHz. Go to B VFO and set it to 7.105.0MHz. Go back to A VFO. Push the VFO Equalizing Switch. Go to VFO B. VFO B's frequency is now the same as VFO A's (14.255.0MHz). To reverse this (A the same as B), push the Function button first.

## 5 - 1 - 10 RIT (RECEIVER INCREMENTAL TUNING)

By using the RIT circuit, you can shift the receive frequency  $\pm 800$ Hz either side of the transmit frequency without moving the transmit frequency itself. Therefore, when you get a call slightly off frequency, or when the other station's frequency has shifted, you can tune in the frequency without disturbing the transmitting frequency. By pushing the RIT switch once the RIT circuit is turned on and the RIT LED is lit.

The receive frequency is shifted with the RIT knob.

When the RIT knob is in the "0" position, the transmitting and receiving frequencies are the same.

Rotating the control to the (+) side raises the receiving frequency, and rotating to the (-) side lowers the frequency. To turn off the RIT control, again push on the RIT switch and the RIT LED will go off. When the RIT circuit is off, the transmit and receive frequencies are the same regardless of the setting of the RIT control knob.

When the RIT circuit is on, if the tuning knob is moved by one increment, the RIT circuit is automatically pulsed off.

**Note:** The RIT circuit is operational when the frequency is locked with the dial lock button. The frequency shifted by turning the RIT control is not indicated on the frequency display. When the transmitting and receiving frequencies differ by more than 800Hz, use "A" and "B" VFOs.

## 5 - 1 - 11 DIGITAL DISPLAY READOUT

When the transceiver is first turned on and set in an operating mode the following readouts will appear:

- SSB 

L	2	7	1	0	0	0
---	---	---	---	---	---	---

 (This does not hold true if the Memory Backup is in use.) If the Function Switch is pushed and then the SSB button USB will be selected. In that case, the readout will be:

- b. CW or CW N (Narrow):  $[ \text{A} ]$  7099.4
- c. AM:  $\text{A} \text{A}$  7100.0
- d. RTTY:  $\text{r} \text{A}$  7099.4
- e. General Coverage:  $\text{U} \text{A}$  7097.0

The display will automatically select USB when set to 10MHz and above, and LSB 9MHz and below. If reverse SSB is desired push the Function button then push the SSB button.

## 5 - 2 SSB OPERATION

### 5 - 2 - 1 RECEIVING

After connecting an antenna, microphone, etc, set the knobs and switches as follows:

Before turning the set on, be sure that the Ham Band/General Coverage is in the Ham Band position (out), Transmit-Receive is in Receive (out), VOX off (out) ATT off (out), AGC slow (out), Noise Blanker (NB) off (out), AF Gain Control completely counterclockwise, RF Gain Control completely clockwise, Pass Band Tuning (PBT) is turned completely counterclockwise to off (a click will be heard), Receiver Incremental Tuning (RIT) button off (out). Other controls are not related to receiving, disregard them for this period.

Turn on the Power Switch, the display will read  $[ \text{L} \text{A} ]$   $[ 7100.0 ]$ , next, push the Band Up or Down Button to select the frequency you wish to listen to, turn the AF Gain Control slowly clockwise until a comfortable listening level is reached. Rotate the Tuning Knob until a signal is received. The Meter will indicate the signal strength, for more accurate tuning push the Dial Select button in for 10Hz and tune to the highest meter reading. If the signal you have selected is on the opposite sideband and you cannot receive it clearly push the Function button and then the SSB button, reversing the sideband. With the Dial Select but on (in) the tuning change is 10Hz, therefore the maximum possible difference in your reception and the signal's frequency is 5Hz. This difference is negligible and indeed, may be difficult to detect. This system, as opposed to continuously variable frequency systems provides more accurate and convenient tuning.

### 5 - 2 - 2 NB (Noise Blanker)

Push the Noise Blanker button in when there is pulse-type noise present, such as ignition noise from automobile generators or alternators, etc, Noise will be suppressed, and weak signals heard more clearly. The Noise Blanker is less effective against strong signals on a nearby frequency, or continuous (not pulse) noise.

### 5 - 2 - 3 AGC (Automatic Gain Control)

The IC-720 has a "hang" AGC system which holds the peak voltage of rectified AF signals from the detector circuit for a predetermined period. During normal pauses in speech noise will not be heard. The Multi-Function Meter also will "hang" for a period to facilitate "S" readings.

When signals are received that have short interval fading push the AGC button in for FAST. This will turn the hang AGC circuit off, and the time constant will be shortened. Always use the Fast position for RTTY.

### 5 - 2 - 4 ATT (ATTENUATOR)

When strong nearby signals make "S" reading difficult, or reception poor, push the ATT button. Doing so inserts a 20dB attenuator into the receiving antenna circuit. This serves to provide more stable reception and reduce interfering signals. Normally the button should be left in the off position (out).

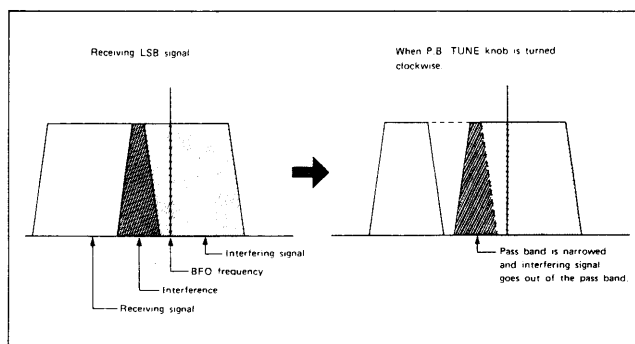
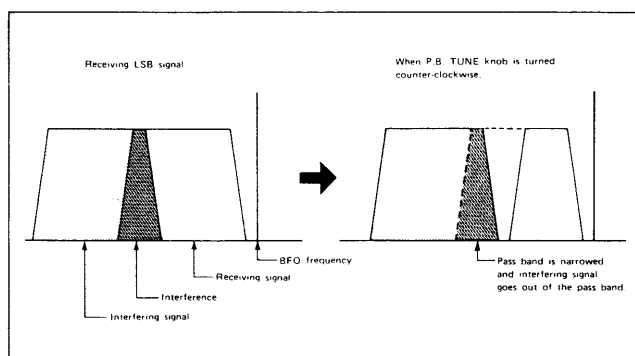
### 5 - 2 - 5 P.B. (PASS BAND) TUNING

Pass Band Tuning is a system in the receive mode to narrow the band width (selectivity) of the frequencies that will pass through the crystal filter electrically from either the upper or lower side continuously by up to .7KHz. This is very effective in reducing interference from nearby signals.

To use the PBT system, rotate the PBT control clockwise until it clicks on and continue rotating it to its mid range position. This is the widest position and is equivalent to the bandwidth in the off position.

For example, while receiving in the LSB mode, if you get interference from a lower frequency (interfering signals are high pitched tones), narrow the band width by turning the P.B. tuning control counter-clockwise. When the interfering signals are low pitched tones, they are from a higher frequency, and you should narrow the band width by turning the P.B. tuning control clockwise.

When receiving in the USB mode, the band width is narrowed in the opposite manner. Interference from a higher frequency will be high pitched tones, and the P.B. tuning control should be turned clockwise. Interference from a lower frequency will be low pitched tones and the P.B. tuning control is turned counter clockwise.



### 5 - 2 - 6 TRANSMITTING

Before transmitting, listen in the receive mode to make sure your transmission will not interfere with other communications. If possible, use a dummy load for adjustment instead of an antenna. Set knobs and switches as follows.

MIC GAIN                      CENTER  
RF POWER CONTROL        OFF (clockwise until it "clicks")  
METER SELECT SWITCH     ALC

Other knobs and switches are left in the same positions as for receiving. When the T/R switch is moved to transmit, or when the PTT (push to talk) switch on the microphone is depressed, the transmit LED is illuminated. By speaking into the microphone, the meter needle will move according to the strength of your voice and SSB signals will be transmitted. Set the MIC Gain control so that the meter needle stays well within the blue ALC zone at voice peaks. Change to the receive mode by moving the T/R switch to receive, or release the microphone PTT switch.

### 5 - 2 - 7 HOW TO USE THE SPEECH PROCESSOR

The Pass Band Tuning system acts as a low distortion RF Speech Processor. This enables greater talk power and better results in DX operation. Follow the steps below for use of the RF Speech Processor:

MIC GAIN CONTROL        Set to the CENTER  
                                      (12 o'clock) position.  
RF POWER CONTROL        Turn from the "COMP" Off  
                                      position until it "Click" On.

Switch to transmit and turn the RF POWER CONTROL counter clockwise while speaking into the microphone until you obtain the desired RF "PEAK" output power of between 10 watt and 100 watts (approximately).

Adjust the MIC GAIN CONTROL to a point where the RF "AVERAGE" output power just saturates.

The Speech Processor should be turned OFF or MIC GAIN CONTROL carefully set for minimum compression for all communication other than DX operation for a very natural voice quality.

### 5 - 2 - 8 HOW TO USE THE VOX CIRCUIT

The IC-720 has a built-in VOX (voice operated relay) which allows automatic T/R switching by voice signals into the microphone. For VOX use, set the knobs inside the top access cover as follows:

VOX GAIN CONTROL        FULLY COUNTER-CLOCKWISE  
ANTI VOX CONTROL        FULLY COUNTER-CLOCKWISE  
VOX DELAY CONTROL        FULLY CLOCKWISE

Push the VOX switch on the front panel to the on (in) position. Leaving the T/R switch in the receive position and without pushing the PTT switch, turn the VOX gain control clockwise while speaking into the microphone. At a certain point, the T/R switching circuit will be activated by your voice. This is the proper position for the VOX Gain control. Set the VOX Gain control at a level which provides for T/R switching at your normal voice level. Transmit-release time (the time delay before the set automatically returns to receive when you stop talking) is controlled by the VOX delay control. Turning the control counter-clockwise makes the time shorter. Set it at a position which is comfortable and which allows for short pauses in normal speech.

Adjust the ANTI VOX control so that the VOX circuit is not activated by sounds from the speaker by turning the control clockwise while receiving a signal.

## 5 - 3 CW OPERATION

### 5 - 3 - 1 RECEIVING

For CW reception, PUSH the MODE Switch for CW or CW-N position. Other switches and knobs are set the same as for SSB reception.

In addition to a crystal band pass filter, a Narrow filter is optional for this unit. When the MODE Select Switch is set at the CW-N position, this filter is activated and the total selectivity of CW reception is improved. Also, with this filter, internal noise is reduced for comfortable CW reception and an improved signal to noise (S/N) ratio.

If the optional CW filter is not installed the CW-N position will have the same selectivity as the CW position.

### 5 - 3 - 2 TRANSMITTING

Insert the keyer plug into the KEY Jack on the rear panel of the unit, and set knobs and switches as follows:

RF POWER CONTROL        OFF (Fully clockwise)  
METER SELECT SWITCH     RF POSITION

Other knobs and switches are set the same as for CW reception.

By setting the T/R switch to Transmit, the transmit LED is lit and shows that you are ready for CW transmission. When you key the keyer, the meter needle moves and your CW signal is transmitted. To decrease the transmitting power, turn the RF POWER Control counter clockwise to on and rotate to adjust while watching the meter needle on the Po scale for the desired output power.



### 5-3-3 CW SIDE-TONE (MONITOR)

When keying the side-tone oscillator is activated and a 800Hz tone will be heard. The loudness of the tone is controlled by the CW Moni Control located under the top access cover. Rotating the control clockwise will increase the loudness. This tone is also audible in the receive mode and can be used for code practice, adjustment of the keyer, etc.

### 5-3-4 SEMI BREAK-IN OPERATION

The IC-720 has Semi Break-In CW capability when using the VOX function. When keying, the unit is automatically set in the transmit mode. After keying, it is returned to the receive mode, also automatically, after a given transmit-release delay time constant. Leave the T/R switch in the Receive position, and set the VOX switch in the on (IN) position.

The transmit release delay time constant is set by adjusting the CW DELAY Control located under the TOP access cover. Turning the CW DELAY Control clockwise will make the transmit release time longer. Set for your keying speed.

## 5-4 RTTY OPERATION

For RTTY operation, a teletypewriter and a demodulator (terminal unit) which is operational with audio input are required. Any demodulator with 2125/2295MHz, narrow, 170Hz shift can be used. Filters can be used with the IC-720. Fine adjustment of the MARK frequency can be done by adjusting the variable capacitor located next to the internal fan accessible through the bottom cover.

### 5-4-1 RECEIVING

Audio signals for the demodulator can be supplied from Pin 4 of the ACC socket on the rear panel, or from the PHONES jack on the front panel. The level of the audio signals from Pin 4 of the ACC socket does not vary by turning the AF GAIN Control.

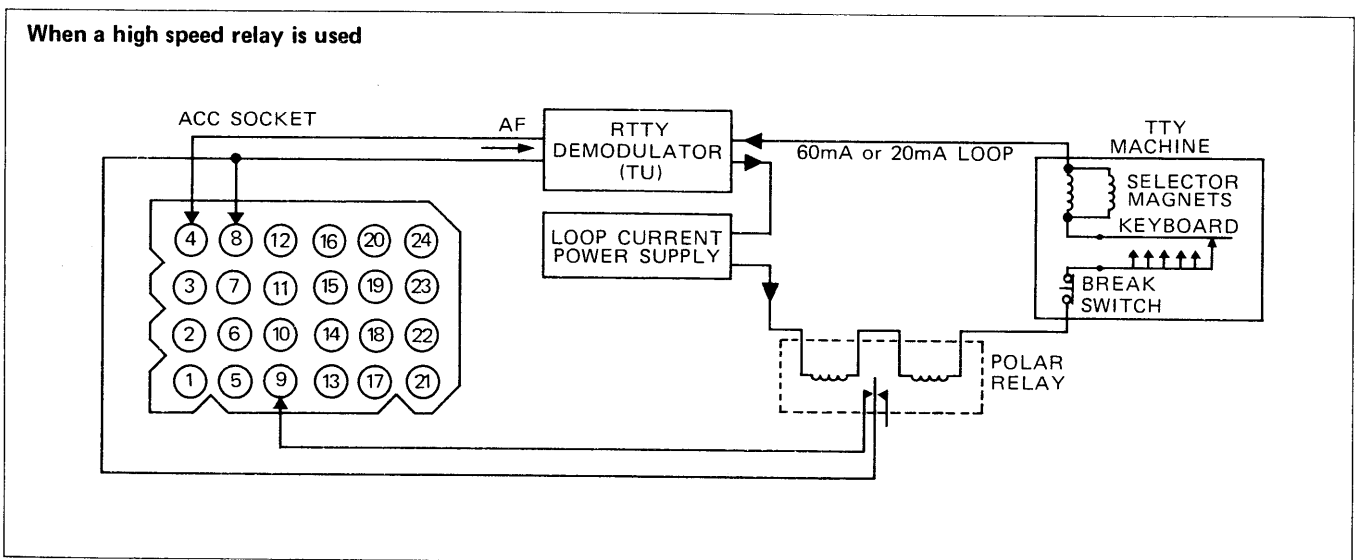
Set the MODE Switch to RTTY. The frequencies for NARROW shift are 2295MHz for SPACE and 2125Hz for MARK.

If you have an AFSK generator, set the MODE Select Switch on LSB for RTTY operation. Also turn the P.B. Tune control fully clockwise for clear reception.

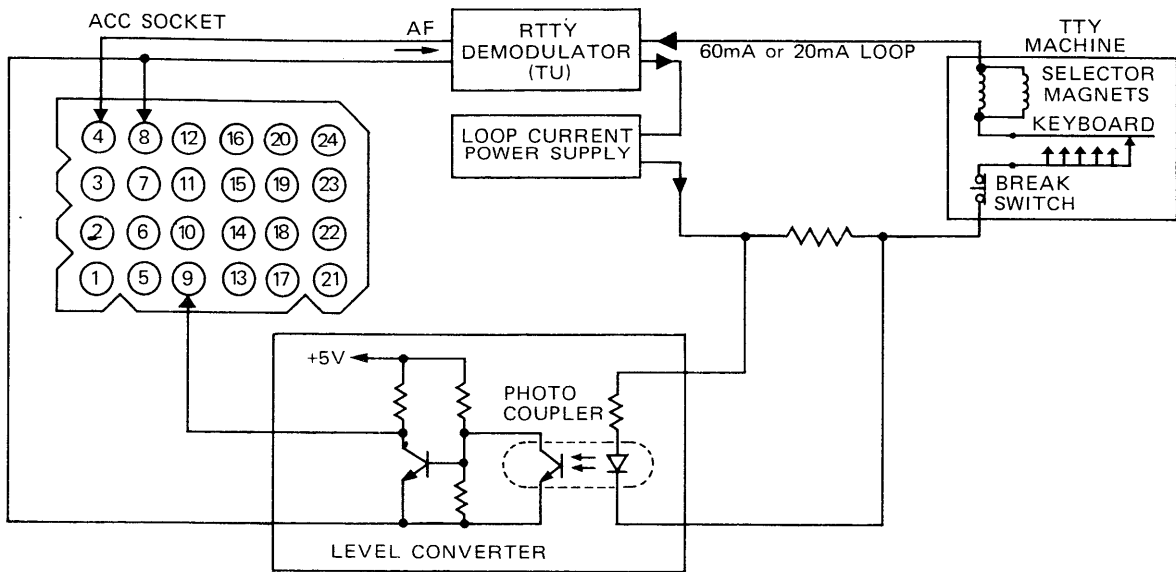
### 5-4-2 TRANSMITTING

For keying of the Frequency Shift Keying (FSK) circuit insert a high speed relay's coil into the loop current circuit of the teletypewriter, and connect the relay contacts to Pins, 8 and 9 of the ACC Socket on the rear panel. The relay contacts make during the Space and break during the Mark, as shown in the drawing.

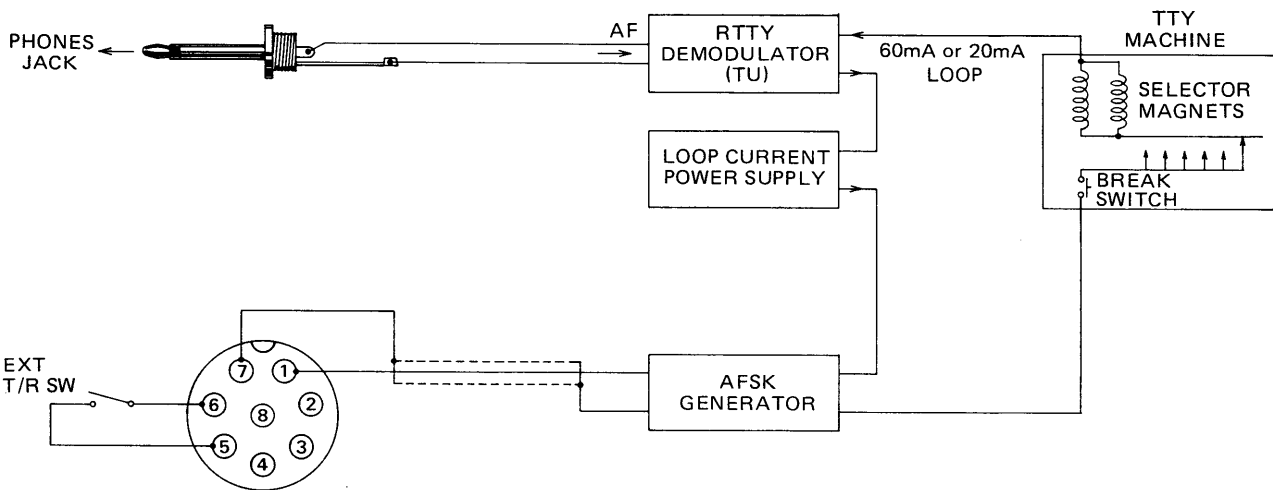
When a level converter for TTL level signals is used, connect the output of the converter to Pins 8 (ground) and 9 of the ACC Socket Apply High level (5V) signals for the Mark, and Low (0V) for the Space. When using an AFSK generator that has 2125Hz for Mark and 2295 for Space, connect the output signals for the AFSK to the Mic connector on the front panel and set the Mode to LSB. (See other operations chapter.) Doing this, you can use the VOX operation available in this mode, and receive/transmit changeover is very easy.



**When a level converter is used**



**When a AFSK generator is used**



**5 - 5 AM OPERATION**

**5 - 5 - 1 RECEIVING**

The setup for receiving of AM signals is the same as that for SSB reception. All controls for receiving function the same as for SSB.

The normal AM filter is selected automatically in the AM mode unless the optional AM filter is installed. See the specifications page

When tuning an AM signal, tune for maximum signal strength as indicated on the S meter.

## 5 - 5 - 2 AM TRANSMITTING

- a. Set the controls the same as for SSB.
- b. Set the Meter Select button to RF (out), and push the transmit button (in) or depress the PTT switch on the microphone - the Transmit LED will light. Speak into the microphone in a normal level voice, the meter needle will move to indicate the output RF. (The maximum carrier Power in AM is 40W.)
- c. With the Compressor Control in the off position the RF output cannot be varied. Turn the Compressor on, completely counterclockwise, and then while speaking into the microphone carefully rotate the knob clockwise

## 5 - 5 - 2 TRANSMITTING

Transmitting AM signals is essentially the same as SSB transmission. The maximum carrier power in AM is 40W.

The VOX and speech compressor are not operable in AM.

## 5 - 6 OTHER OPERATIONS

### 5 - 6 - 1 VSWR READING

To use the IC-720's built-in SWR Meter set the Meter Select Switch (inside access cover) to the Po position, push the Receive/Transmit button to Transmit, and push the RTTY button. Adjust the SWR Set Control inside the access cover so that the meter needle points to SET on the scale. Now, move the SWR Switch to the SWR position, the SWR will be indicated on the meter scale. This set is built to handle VSWR of up to 2 : 1, but it is highly recommended that the antenna(s) be adjusted for the lowest possible VSWR. After taking the reading return the SWR Switch to the Set position. BE SURE THAT THE ANTENNA IMPEDANCE IS 52 OHMS AND THAT THERE IS A BALUN IN THE ANTENNA TO PREVENT DC BEING CARRIED DOWN THE COAX FEED!, TO FAIL TO DO SO CAN DAMAGE THE TRANSCEIVER.

The final transistors in the IC-720 are of excellent design, and are protected by circuits incorporated in the set. They can be expected to have an indefinite life for there are no cathodes to burn out. However, they can be destroyed by abuse and then have to be replaced.

When in doubt about antenna systems, use the lowest power setting possible to achieve meaningful readings. Use a good tuner or transmatch when necessary. Always use caution and exercise judgement when testing RF power generators.

### 5 - 6 - 2 WWV RECEPTION

Since the IC-720 has a General Coverage receiver built-in WWV reception is very simple. Merely push the General Coverage button and MODE switch to the USB or CW position, tune to 15.000.0 and the signal will be heard. This can be used to align a frequency counter, marker oscillator, or the frequency display.

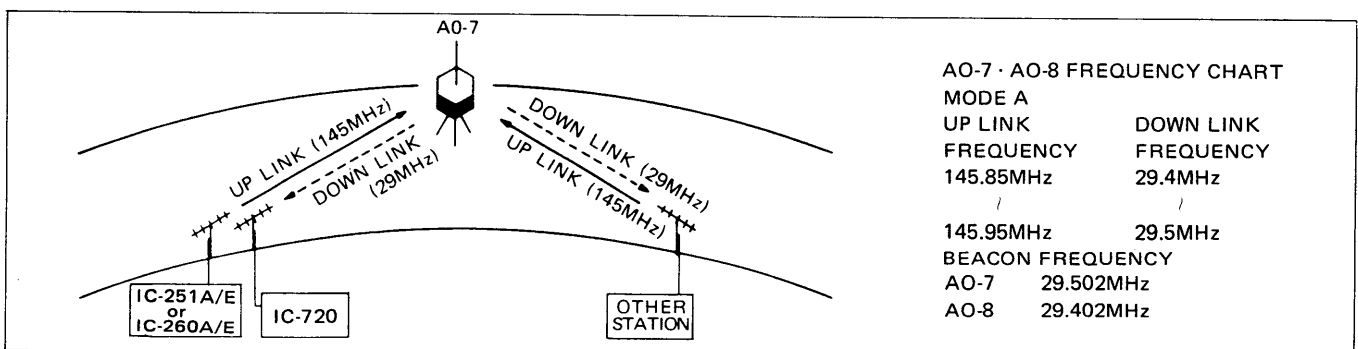
### 5 - 6 - 3 SIMPLE FREQUENCY ALIGNMENT

A very sophisticated frequency counter, and other very accurate equipment are needed to fully align the IC-720, However, simple frequency alignment can be accomplished utilizing the WWV signal.

- a. Tune to 15.000.0 and make sure you are clearly receiving the WWV signal.
- b. Push the CW button; a 800Hz beat will be heard.
- c. Short the Key jack on the rear panel so that the CW side-tone is audible.
- d. Rotate the Frequency Set Control, located under the top access cover so that the two tones are the same pitch. If the tones are difficult to adjust because of a difference in their strength, adjust the CW sidetone level with the CW Moni Control, located nearby, until the levels are the same.
- e. WHEN ALIGNING THE FREQUENCY DO NOT PUT THE UNIT IN THE TRANSMIT MODE. Be sure that the Receive/Transmit button is out, that the VOX is off (out), and that you do not touch the PTT Switch on the microphone.

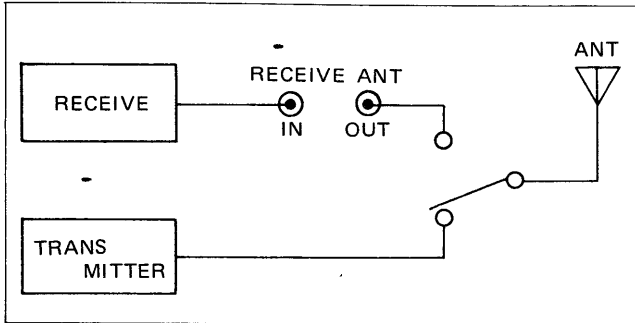
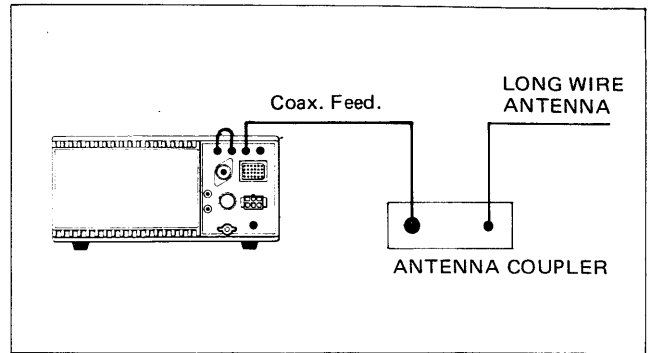
### 5 - 6 - 4 SATELLITE COMMUNICATION

At present there are two active satellites for amateur use, with more being planned. OSCAR 7 and OSCAR 8 launched in 1974 and 1978, respectively. Satellite communications can be made using an IC-251A/E or IC-260A/E for transmitting and the IC-720 for receiving. For operation, and frequency information, refer to the chart below. Communication satellites move at very high speeds, the down-link signals can be heard at a higher frequency than the receive frequency as the satellite approaches, and a lower frequency as it travels further away. Further information on satellite communication can be found in various amateur periodicals and books.



### 5-6-5 LOW BAND ANTENNA CONNECTION

A long wire antenna for the general coverage receiver is recommended. There are several makes on the market, or one can be self constructed, taking care to follow manufacturer's instructions, or other instructions, with regard to connections, etc. The use of an antenna coupler is necessary, and again, it is suggested that a balun be put in the line to guard against DC travelling down the coax feed. The proper connection is shown below.



1. A receiving pre-amplifier (connect between receiver input and receive out terminals.) (Fig. 1)
2. A separate receiver (connect to the receiver antenna output terminal and Pins 2 and 3 of the Accessory socket with a small 12V DC relay to control the receiver.) (Fig. 2)
3. Separate receive and transmit antennas. (Connect the receive antenna to the Receive Ant Out jack, and the transmit antenna to the Antenna Connector.) (Fig. 3)

### 5-6-6 RECEIVE ANTENNA TERMINALS

The Receive In Jack is connected to the input of the receiving section, and the Receive Out Jack is connected to the antenna connector through the internal T/R antenna switching circuit. Normally, these two jacks are jumpered, but they can be used for:

Fig. 1 Connection of a pre-amplifier

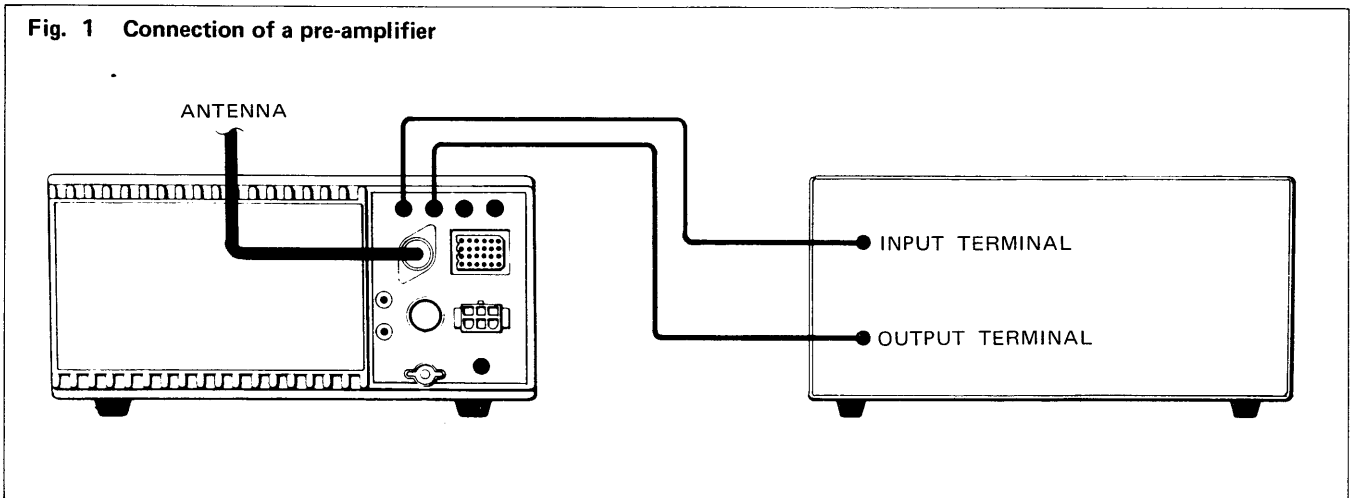
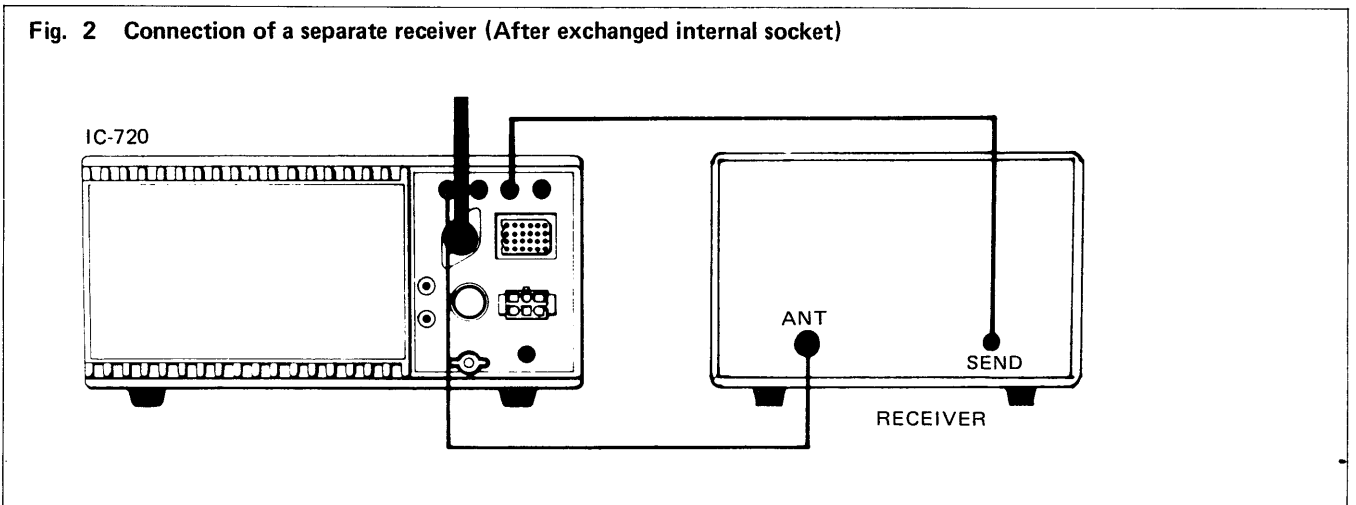
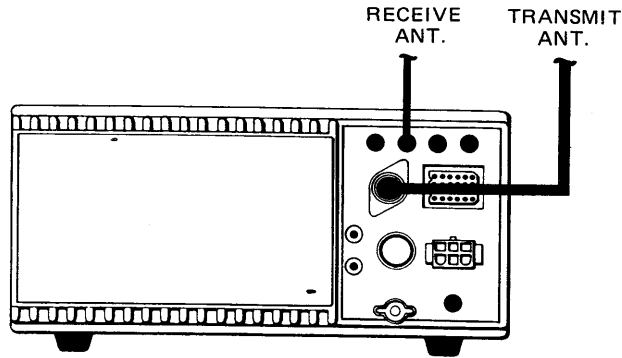


Fig. 2 Connection of a separate receiver (After exchanged internal socket)

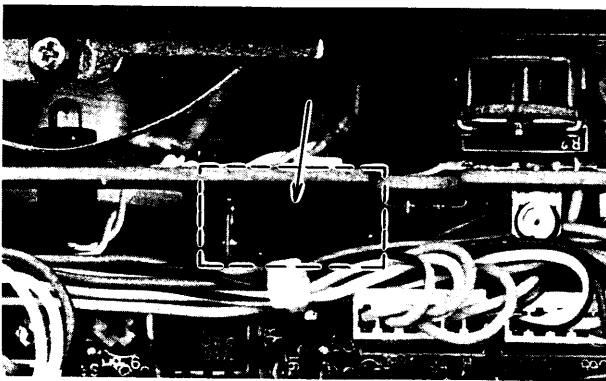


**Fig. 3 Connection of separate antennas**



**5-6-7 RIT CONTROL SWITCH**

If you do not wish the RIT to pulse off automatically when the tuning knob is turned the switch shown below will allow this function. If this is done it is important that the RIT be at the 12 o'clock position during tuning performed with the Tuning Knob.



**5-6-8 LINEAR AMPLIFIER OR TRANSVERTER CONNECTION**

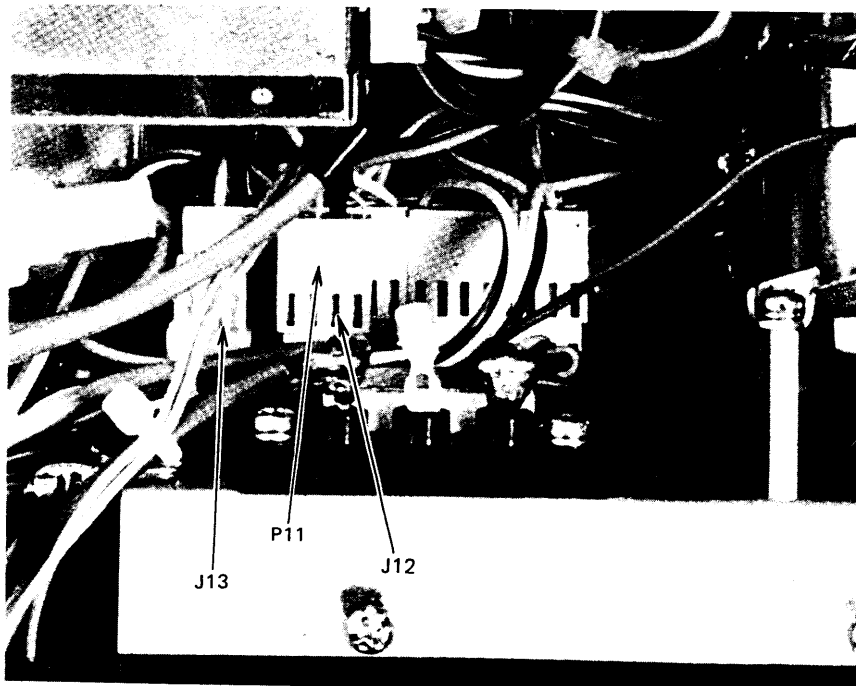
The jacks on the rear panel marked Low Band ANT (RL) and X-verter/Scope (ALC) are dual function, running from these two jacks on the interior of the set are wires which are connected to Plug P-11. When this plug is connected to J-12 scope and transverter functions are available, when connected to J-13 there is a relay built-in for keying a linear, and the input for ALC from the linear. For linear amplifier hookup the RL Jack is for an internal relay and the ALC Jack is for ALC input.

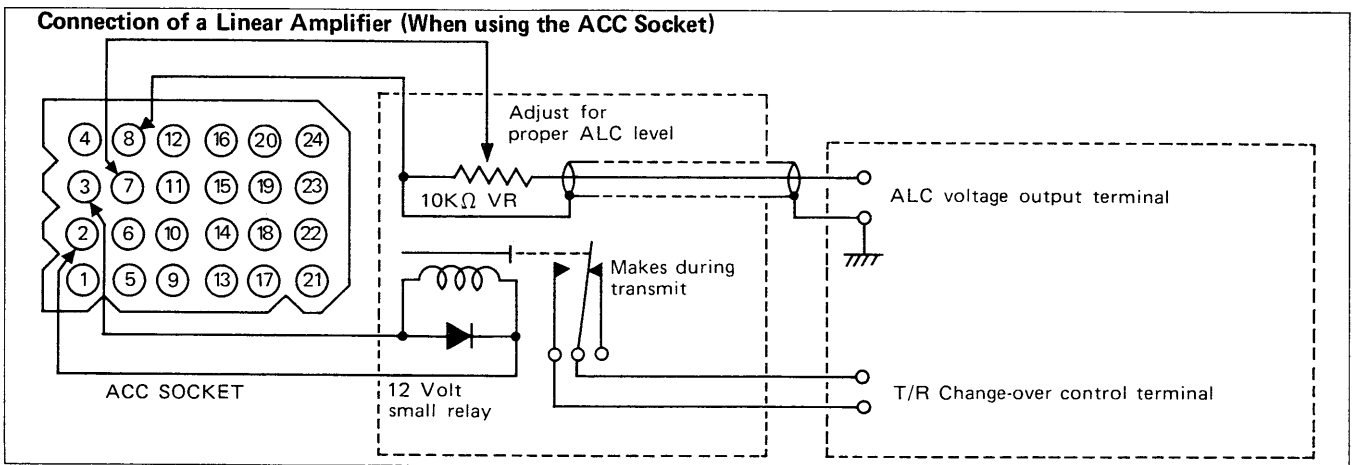
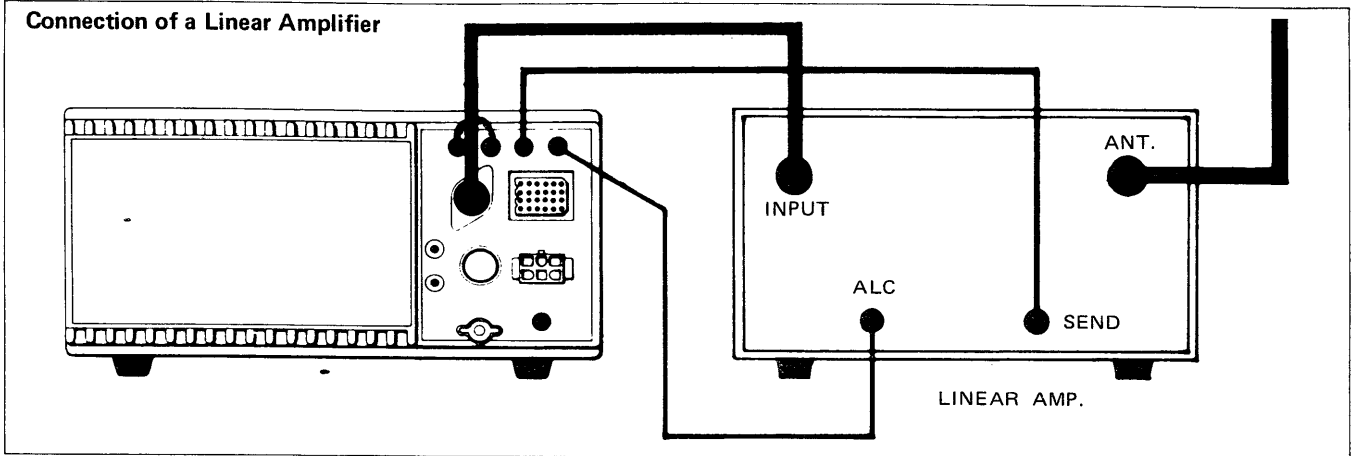
**Transverter INPUT/OUTPUT Frequency**

Output Frequency	Transceiver Frequency
50MHz	20 ~ 24MHz
144MHz	24 ~ 26MHz
430MHz	20 ~ 30MHz

- Input/Output Level
  - Transmit 80% of Output -5dB
  - Receive 0dB SN10dB

**Change of plug**





### 5 - 6 - 9 ACCESSORY SOCKET

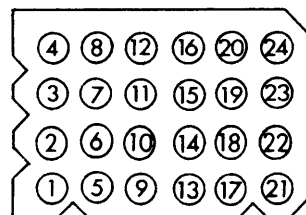
Various functions are available through the accessory socket such as frequency control, modulation output, receiver output, T/R changeover, and so forth. The table below shows those terminals.

#### ACC SOCKET CONNECTIONS

Pin No.	Function
1.	NC (No connection).
2.	13.8 VDC, when Power Switch is on.
3.	Connected to PTT, T/R Button, when grounded switches set to Tx.
4.	Output from receiver detector stage, fixed regardless of AF output or gain.
5.	Output from Transmitter Mic. Amp. stage.
6.	9V DC available in transmit, relay cannot be remotely actuated.
7.	Input to for external ALC voltage.
8.	Ground
9.	Input for RTTY keying, Mark, High Level, Space, Low Level.
10.	Transverter A signal input.
*11.	Transverter B signal input.
12.	8 VDC reference voltage, relay cannot be remotely actuated.
13.	Input for external band switching.
14.	+9V input for CW keying.
15.	Input for Noise Blanker gate control.

Pin No.	Function
*16.	DBC external control input signal.
17.	NC
*18.	RC external control signal input.
*19.	DV external control signal input.
*20.	RT external control signal input.
*21.	DB1 external control data input/output.
*22.	DB2 external control data input/output.
*23.	DB4 external control data input/output.
*24.	DB8 external control data input/output.

\* These terminals are directly connected to the Logic IC, internally, be sure to use voltages within -3 to +5.3 only.



Outside view

## SECTION VI THEORY OF OPERATION

The IC-720 uses a phase-locked-loop (PLL) consisting of three loops for the local oscillator for both transmit and receive. The PLL is controlled by a Microcomputer system. The basic circuit uses an up-conversion with a First IF of 39.7531MHz and a Second IF of 9.0115MHz. Included within the IF Unit is the Pass Band Tuning circuit. Altogether there are ten units in the IC-720, with overall control exercised by the Logic Unit. The units are:

### 6 - 1 SWR UNIT

A detector in this unit monitors antenna conditions and controls SWR.

#### 6 - 1 - 1 RF AMPLIFIER CIRCUIT

This is a broad-range RF Amplifier that uses push-pull junctions of FETs, 2SK125s, to achieve low noise and a wide dynamic range.

#### 6 - 1 - 2 ANTENNA CIRCUIT

When a signal is received by the antenna it passes through the SWR Unit and is fed into the Low Pass Filter, then again sent to the SWR Unit, then amplified by a wide-range amplifier about 10dB. When the Attenuator is turned on, the signal bypasses the RF Unit and goes directly to the Attenuator Circuit and is attenuated 20dB. During transmit signals pass through the Low Pass Filter Unit and then are applied to the antenna terminal.

### 6 - 2 LOW-PASS FILTER UNIT

The Low-Pass Filter Unit has a low-pass for each band, a rotary relay switch, the low-pass filter circuit, and a diode matrix which takes the signal from the Logic Unit and processes it for the realy control voltage. During receive the signal from the SWR Unit passes through the Low-Pass Filter Unit which switches for the proper band eliminating the undesired signals from out-of-band, and then is sent again to the SWR Unit. During transmit, the output signal from the PA Unit is fed to the Low-Pass Filter to achieve the proper band and eliminate all harmonic components, then goes to the SWR Unit.

### 6 - 3 RF UNIT

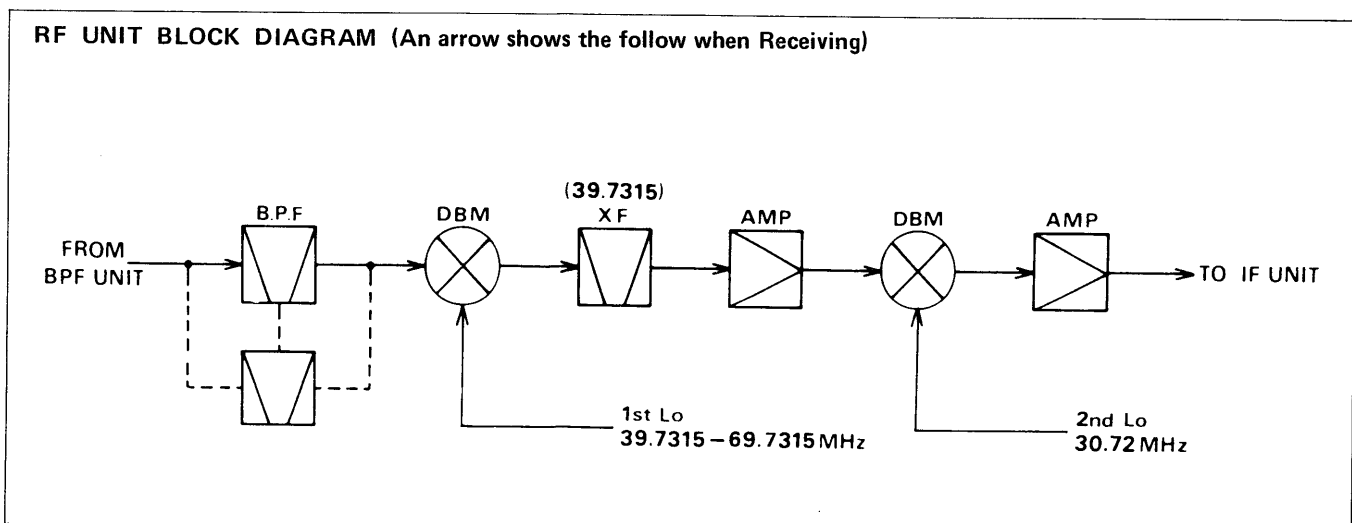
Composed of a Band-Pass Filter for receive, 1st Mixer, 2nd Mixer, 1st IF, Noise Blanker, etc. During receive, the Logic Unit sends the appropriate signal to the Pass Band Filter which chooses the suitable pass band signal, then is fed to the 1st Mixer, which is a double balanced mixer (DBM), where it is mixed with the 1st Local Oscillator signal from the PLL, becoming a 39MHz signal, passes through the monolithic filter and is sent to the 2nd Mixer after amplification. In the 2nd mixer, also a DBM, the signal is mixed with the signal of the 2nd Local Oscillator from the PLL and a 9MHz signal is obtained, again amplified, and sent to the IF Unit. The circuit for the Noise Blanker consists of a noise amplifier, a noise detector and a monolithic multivibrator which blocks the IF Amplifier when noise is present.

In transmit the 9MHz signal from the IF Unit is mixed with the signal of the 2nd Mixer, then the 1st Mixer, the reverse of receive, then to the Pass Band Filter, a Double Balanced Mixer especially developed by ICOM which has an 18dBm intercept point.

The figure below shows the Block Diagram of the RF Unit, with receive indicated by the lines at the bottom.

### 6 - 4 IF UNIT

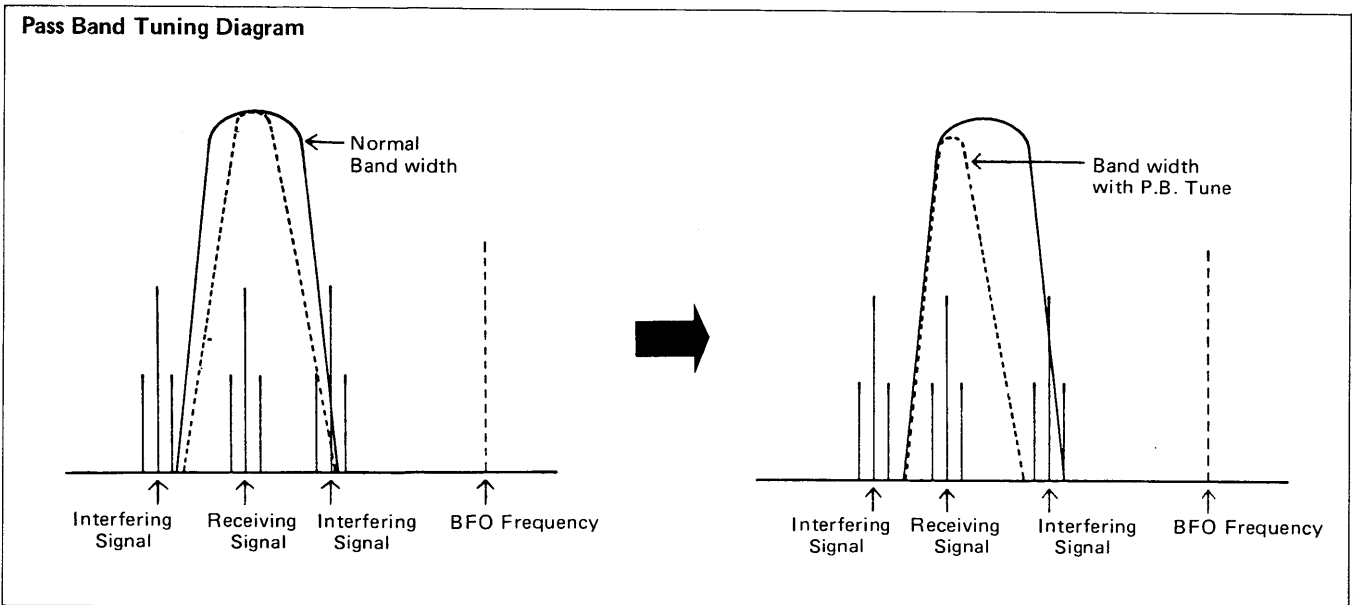
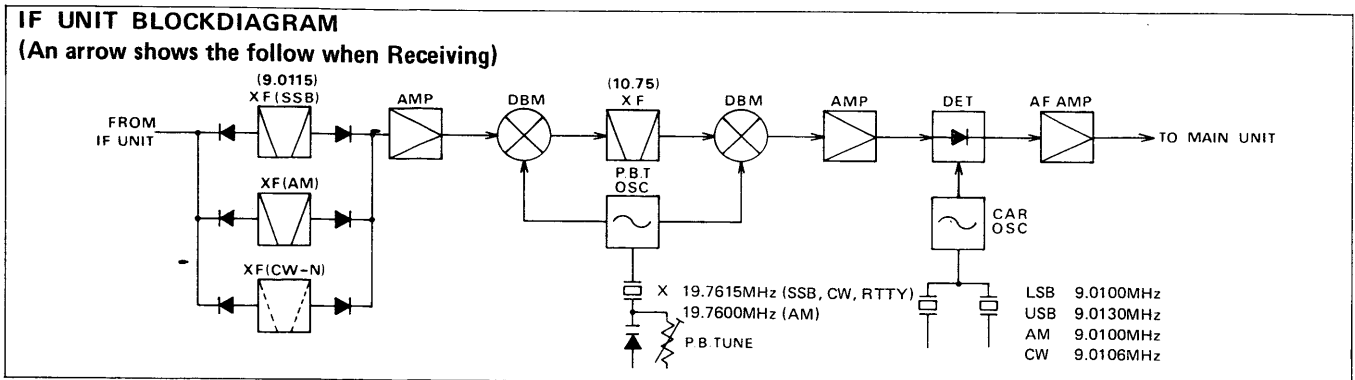
Composed of a crystal filter for SSB, AM, and CW, and a Narrow CW Filter option, IF Amplifier, Pass Band Tuning circuit, RF Speech Processor, BFO Oscillator, and the SSB, AM Detector. During receive, the signal from the RF Unit is fed to the crystal filter to the IF Amplifier, then to the Pass Band Tuning circuit composed of a DBM (as shown in the preceding figure), a crystal filter, and the VXO circuit. When the P.B.T. is turned on the VXO frequency can be changed  $\pm 1.5\text{KHz}$ . The circuit makes a choice of what frequencies will pass electrically through the crystal filter. The following figures will explain the PBT circuit more clearly.



The PBT will operate in all modes except AM. When the optional AM filter (FL 34) is installed the PBT will function in that mode. When the PBT is turned on the signal is sent to a second DBM then to the BFO Signal Detector, then to the Main Unit AF Amplifier. In the case of AM, the signal goes to the AM Detector Circuit, then to the Main Unit AF Amp. In SSB Transmit (USB or LSB) the audio signal and

BFO signal go to the DBM where a double sideband signal is produced, then to the SSB Filter where USB or LSB is selected.

During CW or AM transmit the BFO signal is sent directly to the RF Unit, thus the BFO signal is the carrier frequency.



## 6 - 5 MAIN UNIT

Composed of the AF Amplifier, Microphone Amplifier, VOX Circuit, Anti-VOX Circuit, CW Break-in Circuit, CW Monitor, ALC, APC, Regulator Circuit, and the Meter Control Circuit. In receive, the IF Detector selects the AF signal which is sent to the Main Unit where a high-quality IC acts as the AF Amplifier and is then fed to the speaker.

**VOX Operation:** An Anti-Vox mute voltage prevents the audio signal from reaching the AF Amplifier.

**CW Break-in:** The keyed signal is sent to the pulse phase oscillator and the output fed to the AF Amplifier.

In transmit the output of the Microphone Amplifier goes to the IF Unit's circuit.

**Protective Circuit:** The SWR ratio is monitored as is the final's collector current and the ALC Circuit. If some mishap occurs, such as mis-match or a short, this circuit acts to prevent destruction of the finals.

## 6 - 6 DRIVER UNIT

The transmit signal from the RF Unit is amplified to 6 Watts in the Driver Unit, which is composed of the 1st and 2nd Amplifiers, Class A, and the 3rd Amplifier which is a push-pull amplifier. All are wideband amplifiers.

## 6 - 7 PA UNIT

This unit is made up of a class AB push-pull wideband amplifier, a negative feedback circuit for balancing the gain of the transmitter output, and a thermal switch that monitors the temperature of the cooling fan and its speed. In transmit, the signal from the Driver Unit is sent to this unit and amplified to 100 Watts.

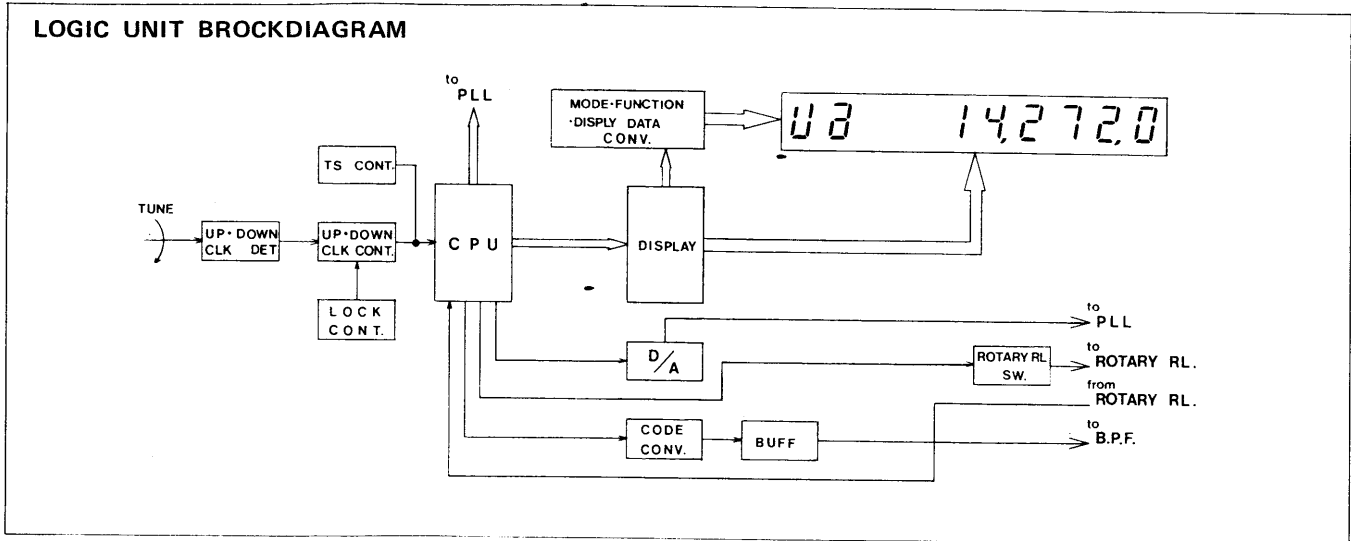
## 6 - 8 LOGIC UNIT

This unit is composed of an incorporated CPU for treating data such as up/down signal detection control, the dial lock control circuit, the speed tuning circuit, the rotary relay control circuit, code changer circuit, and the I/O control circuit.



Directly connected to the tuning knob is a rotary encoder, when this encoder sends a signal to the up/down control circuit, composed of a 4 bit CPU, the synchronized up/down counter, an output gate, and a transmission gate. When the signal to the CPU is a "soft" program, the CPU detects up/down and the readout clock signal is in proportion to

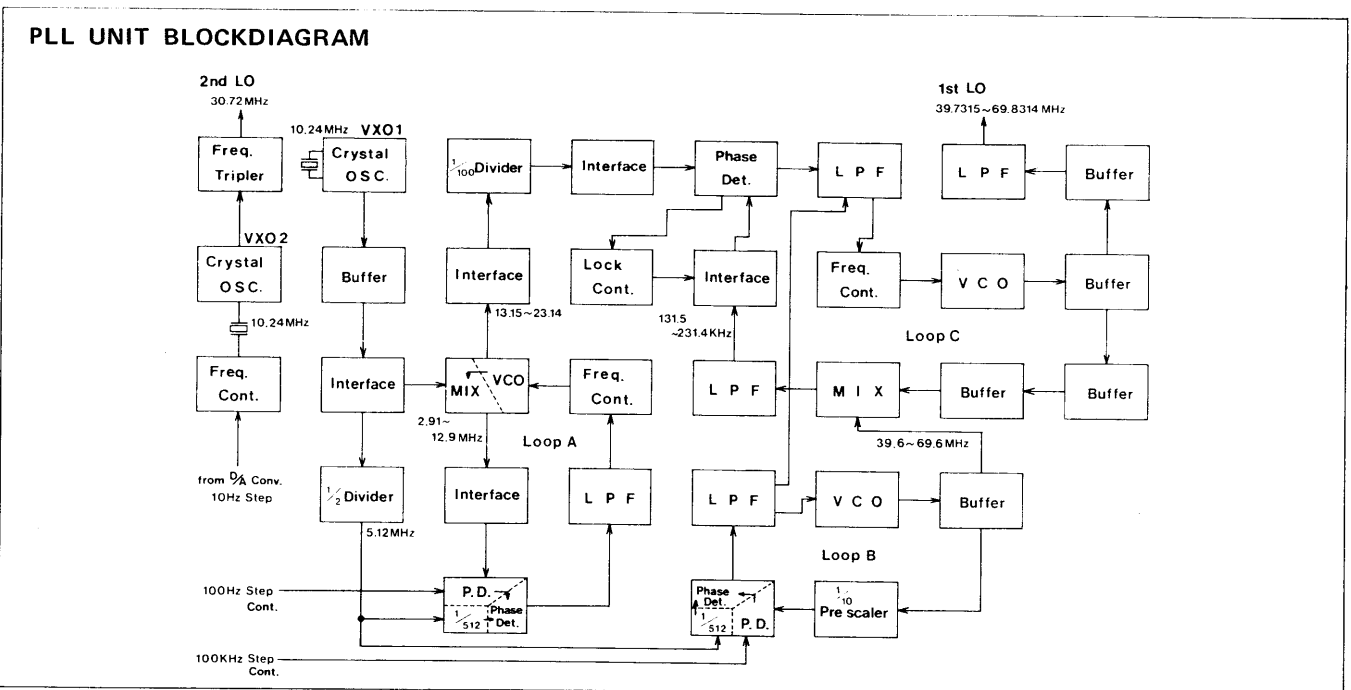
the rotation of the tuning knob. The input to the CPU is determined by the selected mode and band. From the CPU the data is sent to the I/O for output control, the PLL Unit, the LED Control IC, and the I/O input control.



### 6-9 PLL UNIT

This unit is composed of three Phase-Locked Loops, two VXOs, and the multiplex circuit. One VXO operates the multiplex and provides control for the 100Hz and 1KHz steps of the lowest two digits of the VCO output frequency. Control for less than 100Hz of the frequency is provided by the VXO in the PLL Unit. The reference frequency output of the VXO is determined by a crystal with an output

frequency of 10.24MHz, which is multiplied by 3 to obtain the Local Oscillator frequency (2). The loops, A, B, and C are controlled by the output of the reference frequency of VXO (1). Loop A is controlled by the frequency of a 1/2 divider, while the output frequency of Loop A also controls the frequencies of less than 100KHz to provide a reference frequency for Loop C. Frequencies between 100KHz and 10MHz are controlled by the output of Loops B and C.



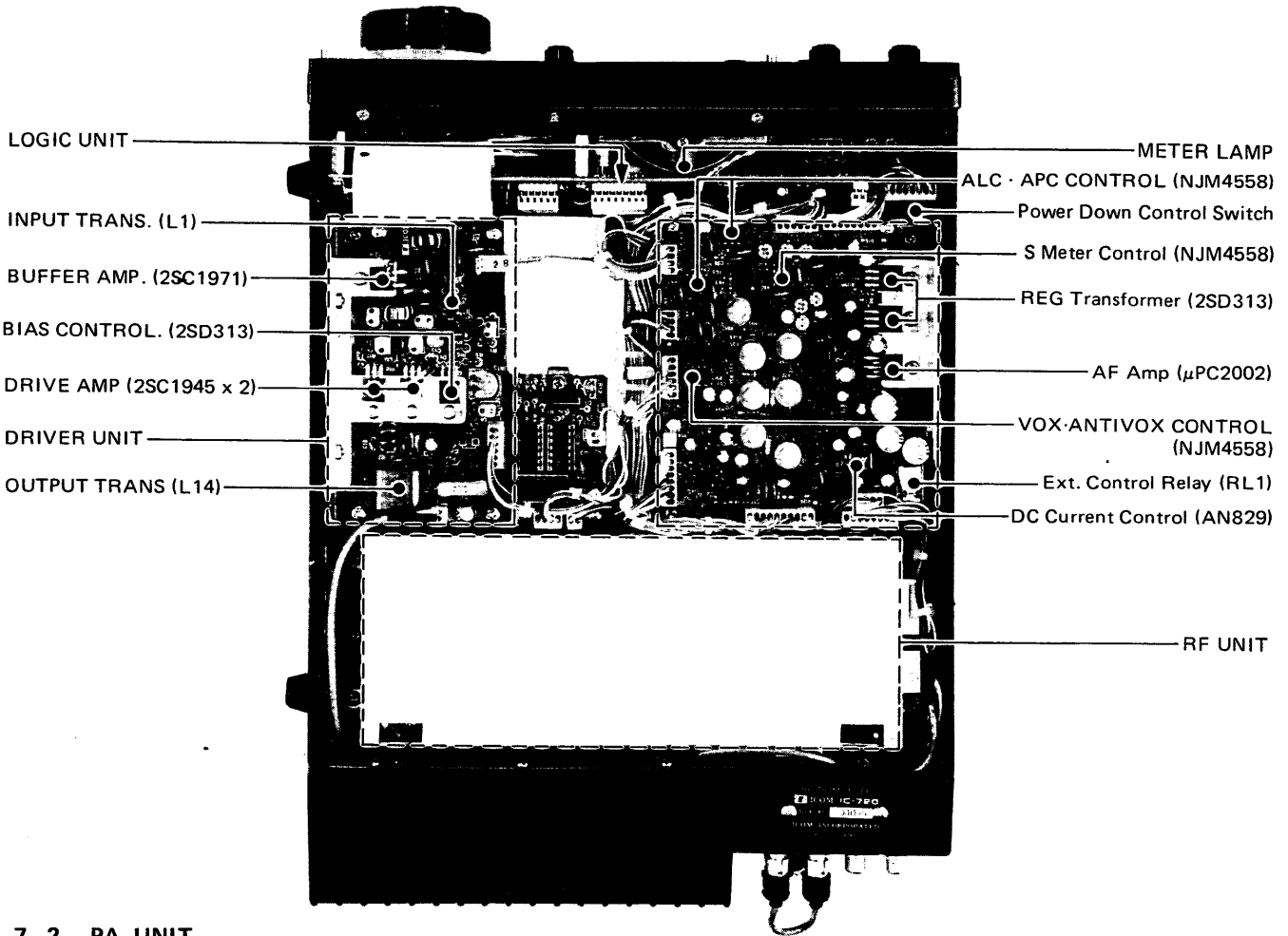
### 6-10 RTTY UNIT

In transmit this unit provides the Mark frequency and Space frequency for RTTY. From the Accessory Socket on the rear panel it provides the source for a demodulator in receive. During transmit, it controls the oscillator of a teletypewriter when it is connected to the Accessory Socket. The Mark signal is 9.0106MHz and the Space

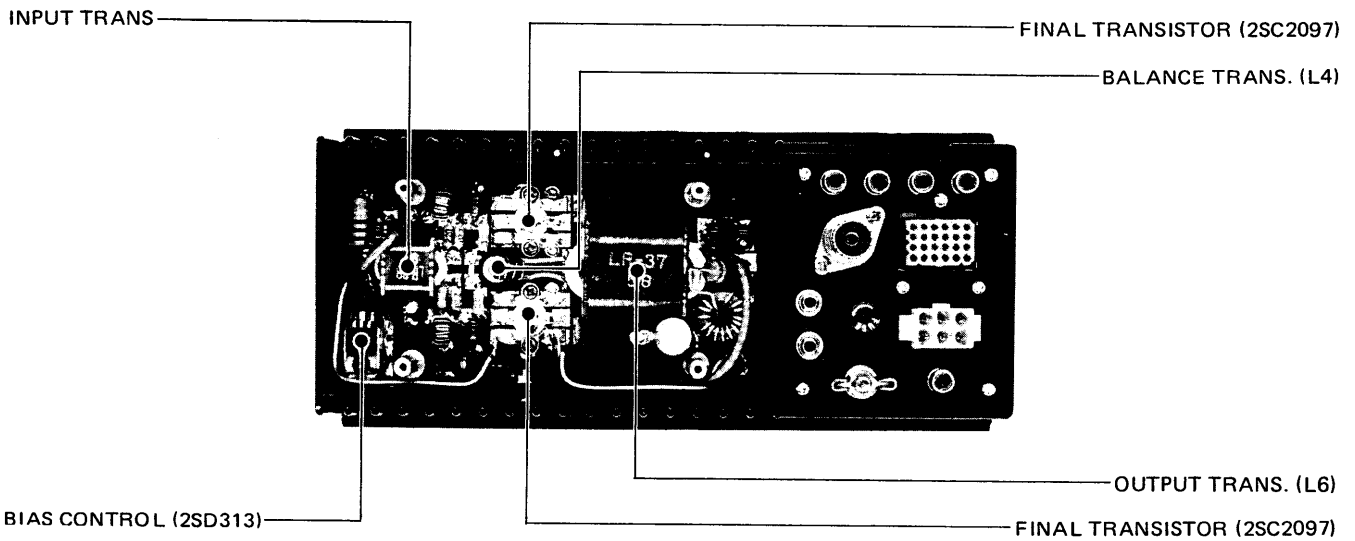
signal is 9.01077MHz, both of which are generated by the RTTY Unit. These signals are sent directly to the RF Unit's 2nd mixer and 1st mixer then to the Double Balanced Modulator where they are modulated by the signals from the PLL Unit local oscillator, the frequency obtained is sent through the Band Pass Filter to the Driver Unit.

# SECTION VII OPTION DESCRIPTION/INSTALLATION

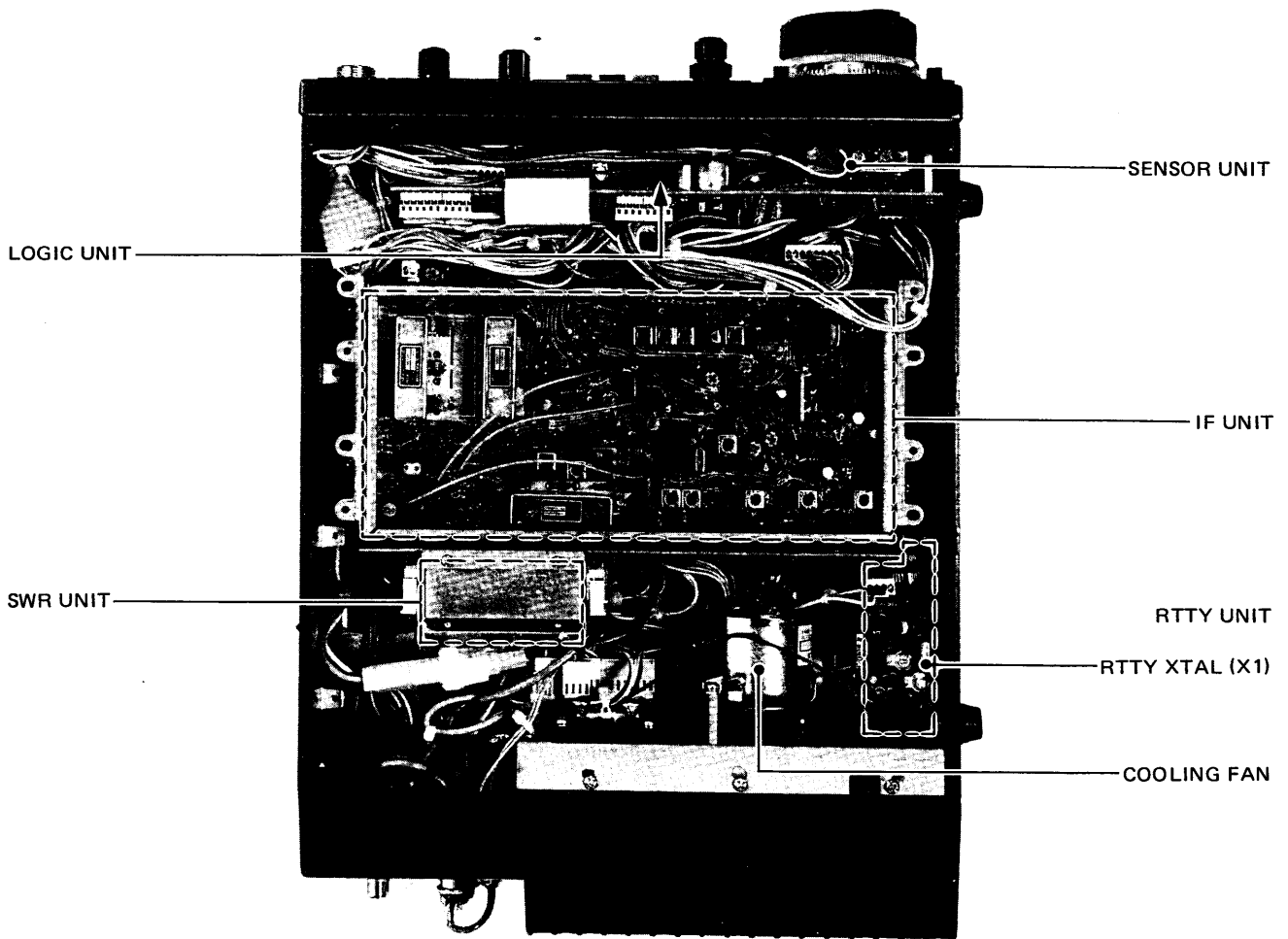
## 7-1 TOP VIEW



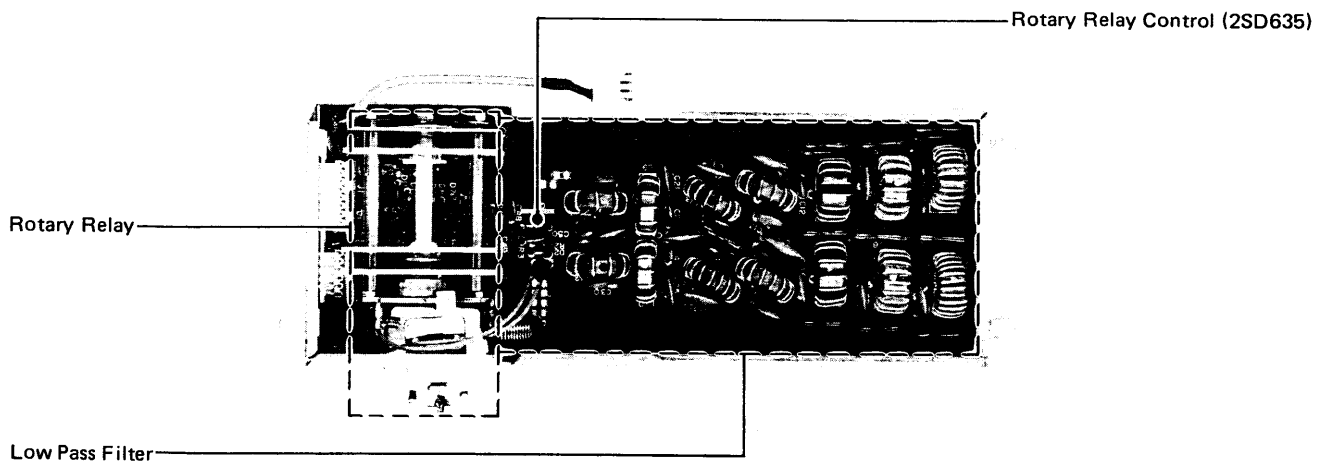
## 7-2 PA UNIT



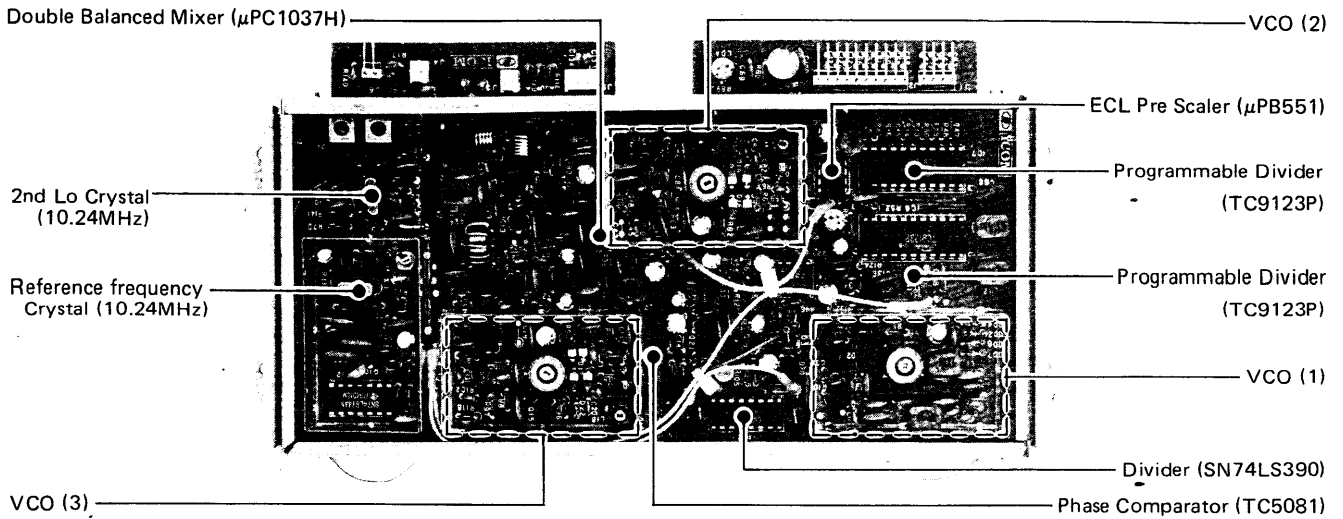
7-3 BOTTOM VIEW



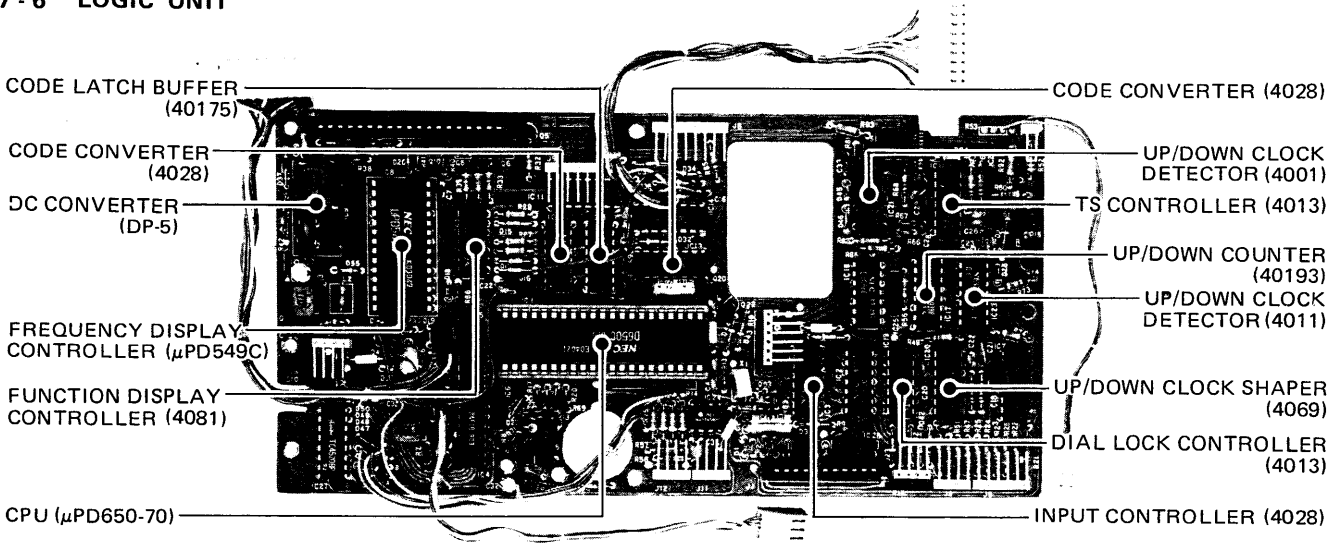
7-4 LPF UNIT.



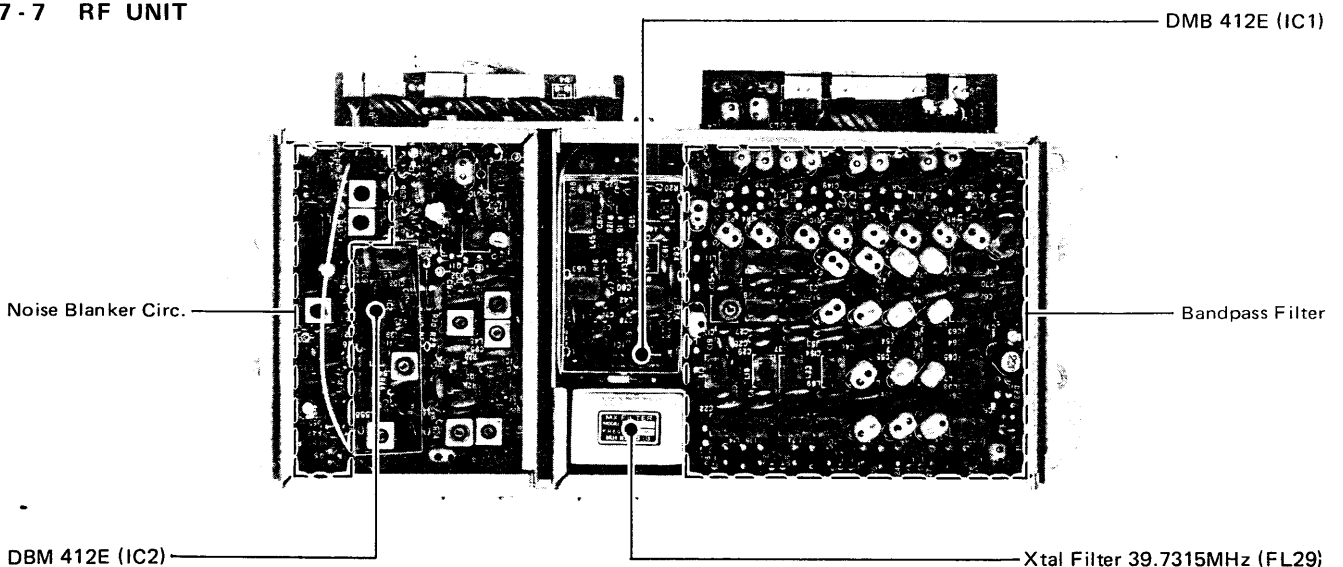
### 7-5 PLL UNIT



### 7-6 LOGIC UNIT



### 7-7 RF UNIT



## SECTION VIII. SIMPLE TROUBLESHOOTING

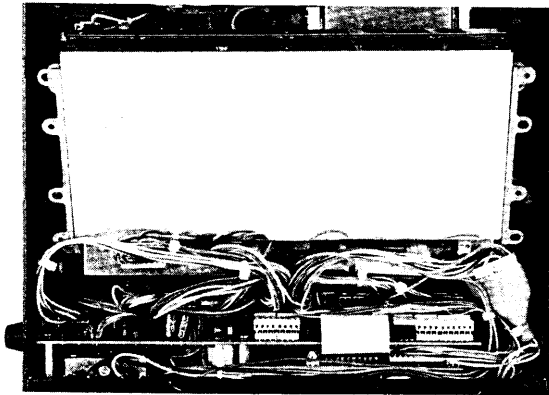
### 8-1 FILTERS FOR AM and CW NARROW

The following tools are needed for the installation of all options:

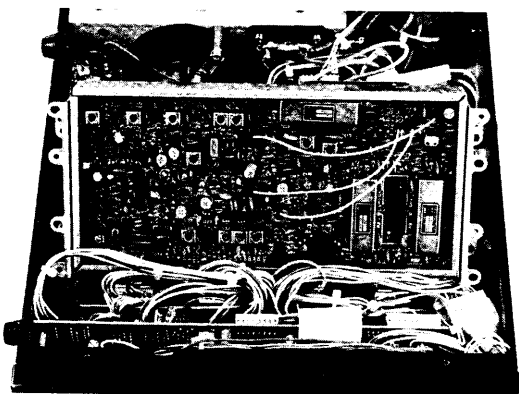
Phillips Screwdriver	Diagonal cutters
Screwdriver	Soldering Iron (40W)
Solder	Soldering tool
De-soldering braid	

Before performing any work on the set, make sure that the power cord is detached from the transceiver.

1. Remove the bottom cover.
2. Remove the four bolts at each end of the IF Unit (see photo). Tilt the unit back toward you, being careful not to damage the sockets and plugs that are installed at the bottom of the IF Unit.



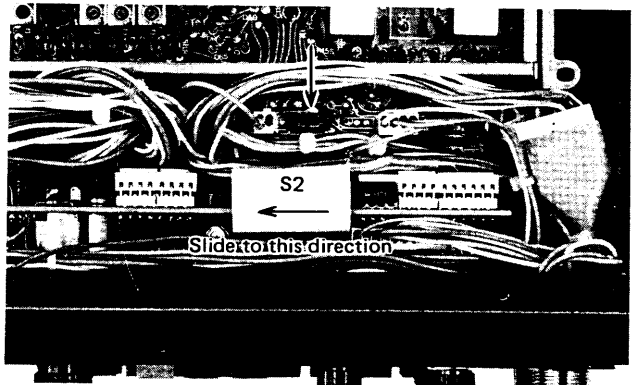
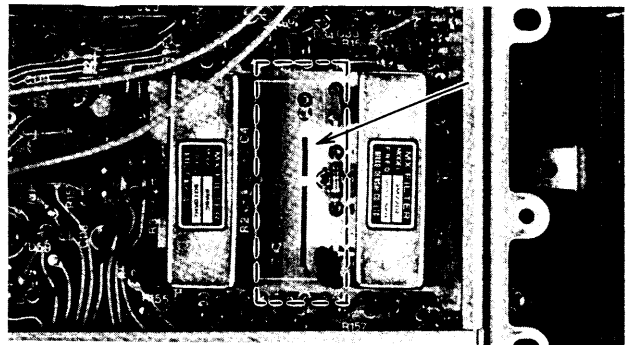
3. Using the screwdriver pry the cover of the IF Unit off, exercise care to prevent bending the shield cover.



#### 8-1-1 Installation of CW Narrow Filter

The location for the filter is shown in the photo below. The holes for mounting the legs and the leads of the filter are predrilled. Be sure to orient the filter so that the label on the top of the unit is facing the same direction as the other two filters already mounted in the set. Insert the filter flush with the board, bend the leads and legs flush with the opposite side of the board and solder them in. Trim the leads even with the solder points. This completes the installation. Replace the IF Unit, and the bolts. Move Switch S2 in the direction shown. Replace the bottom cover.

Location of CW Narrow Filter

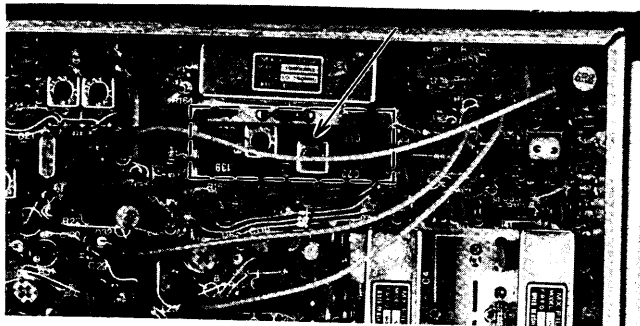


#### 8-1-2 Installation of AM Filter

Follow steps 1 through 3 of the CW Narrow Filter instructions. Remove the LC Filter parts (coil and capacitor shown in photo), taking care not to damage the printed pattern of the board. The holes must be clear of solder when these components are removed.

Plug the AM Filter into the board, making sure that it is oriented with the label on the top of the filter matching the label on the adjoining filter. Bend the legs and leads flush with the board, solder them in, and trim the leads flush with the solder points. This completes the installation. Replace the IF Unit, the bolts, and the bottom cover.

#### Location of LC Filter



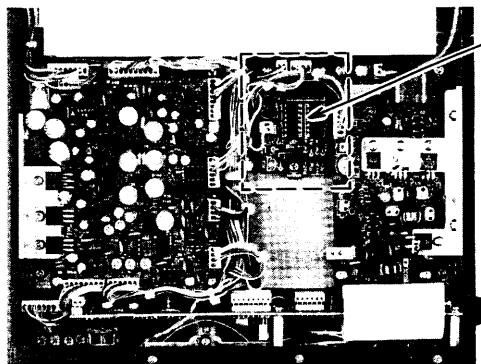
#### 8-1-3 Installation of LDA Unit

With this unit installed will provide automatic switching, through an antenna coupler, of antennas from Ham to General coverage. However, it will not automatically switch for 18MHz and 28MHz. The output signal of the unit is sent to Pin 13 of the Accessory Socket.

Remove the top cover, being careful of the speaker leads. The location provided for the LDA Unit is shown in the photo.

Mount the unit with the bolts provided, make sure that the unit is firmly mounted. There are three sockets with leads, plug the four-pin socket to the four-pin plug mounted on the board, the two-pin socket with a single lead plugs into the twopin plug on your left when standing in front of the IC-720, the two-pin socket with two leads plugs into the two-pin plug at the back of the LDA Unit. This completes the installation.

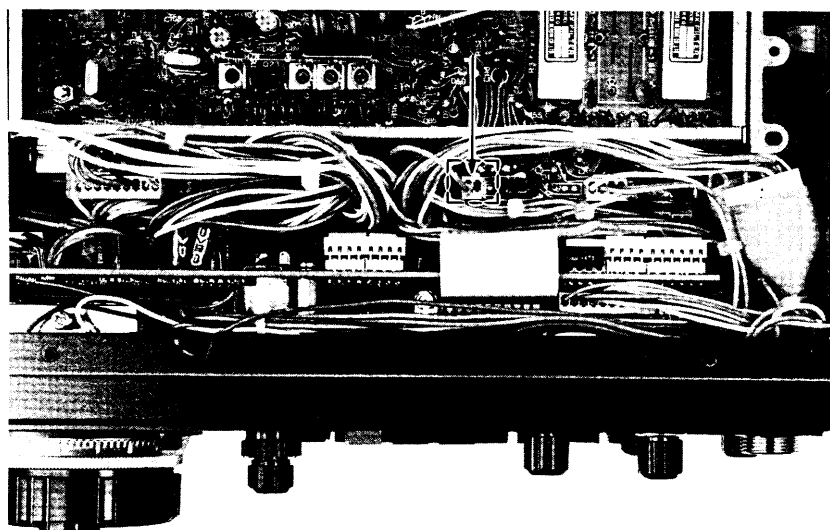
#### Location of LDA Unit



## TRANSVERTER AND SCOPE USE

The IC-720 has provisions for Transverter or Scope, panadaptor or panascope. Follow these instructions, as well as the instructions for the transverter or scope, for proper use:

Follow steps 1 and 2 of Section 7. At the bottom of the IF Unit is the RF Unit. There are four pins in the area outlined, the two on the right are for scope use, and the two on the left for transverter. The socket will be plugged in to the transverter location when you receive the set. The output is a few milliwatts. After plugging the socket in the desired location carefully replace the IF Unit, and the bottom cover.



## SECTION X TROUBLE SHOOTING

Your IC-720 has been carefully adjusted at the factory prior to shipping. The chart below has been provided to help you correct problems which are not equipment malfunctions. If you are unable to locate the trouble, or correct the fault please contact your dealer or the nearest ICOM Service Center.

Problem	Possible Cause	Solution
1. Power does not come on when the switch is pushed.	Power cable is improperly connected. Power cord is connected with the polarity reversed.  Blown fuse.  IC-PS15 MAIN switch is in the OFF position.	Carefully reconnect power cable.  Disconnect the power cord, replace the blown fuse, then reconnect the power cord observing proper polarity.  Check for the cause, then replace the fuse with a spare one.  If using an IC-PS15, also check it's fuse.  Place MAIN switch in ON position.
2. No sound comes from the speaker.	AF GAIN Control knob is completely counterclockwise.  The unit is in the transmit mode, either by the T/R switch or the PTT switch on the microphone.  The external speaker cable is connected to the unit but not to the external speaker jack on the power supply, or external speaker.  The internal speaker cable is not connected.  A headphone is connected to the PHONES jack.	Turn the knob clockwise to a suitable level.  Put the unit in the receive mode.  Connect the cable to the speaker jack on the IC-PS20, or external speaker.  Connect the speaker connection.  Unplug the headphone.
3. Sensitivity is low and only strong signals are audible.	RF GAIN Control knob is turned fully Counterclockwise.  The antenna feed line is cut or shorted.  The Attenuator is on.	Turn the RF Gain control knob fully clockwise.  Check the feed line and correct any improper condition.  Turn the Attenuator off.
4. During receive, the "S" meter is higher than the "0" position even when there is no signal.	RF GAIN Control knob is turned fully counter clockwise.	Turn the knob fully clockwise.
5. Only incomprehensible voices are heard during SSB reception.	Receiving the wrong sideband.	Set the sideband opposite the one you are using, either USB or LSB.
6. The tone of the received signal is very high or low pitched.	Maladjustment of the P.B. Tune control.	Set the P.B. Tune control knob to the clear tone position.
7. No output power or low output power.	MIC GAIN setting is too low.  When SSB is desired, but the MODE switch is in the CW or CW-N position.  PTT switch is not functioning due to improper connection of the mic connector.  The antenna feed line is cut or shorted.	Turn the MIC GAIN Control clockwise to the center (12 o'clock) position.  Set the MODE switch to the SSB (USB or LSB) position.  Using a screw driver, slightly spread the prongs of the mic connector for better contact.  Check the antenna feed line and correct any improper connection.
8. The receive mode functions properly and your signals are transmitted, but you are unable to make contact with another station.	The SIMP/DUP Select is in the DUP position.  The receive frequency is offset from the transmit frequency by the RIT control.	Set the SIMP/DUP Select to the SIMP position.  Turn off the RIT, or set the RIT control knob to the center (12 o'clock) position.
9. The right side of the unit case becomes a little hot.	As the right side of the case is used as a heat sink for the transmitter driver transistor, even during normal operation, it may get as hot as 35°C (63°F) above room temperature.	Make sure that the area around the unit has as much ventilation as possible.
10. The heat sink on the rear panel becomes hot.	The heat sink on the rear panel is for the final transistors and may become as hot as 40°C (72°F) above room temperature.	Make sure the area around the unit has as much ventilation as possible.

Problem	Possible Cause	Solution
11. The RIT LED goes out even though you did not depress the RIT ON/OFF switch to turn it OFF.	The RIT is automatically turned off when the Tuning Knob is rotated unless the interior RIT control switch is in the off position. The Power switch has been turned off.	You may change the unit so that the automatic RIT OFF function does not operate when you rotate the Tuning knob. (See page 13.)  Depress the RIT ON/OFF switch again to turn on the RIT.
12. The frequency does not change by rotating the Tuning knob.	DIAL LOCK is engaged.	Disengage the DIAL LOCK by pressing the DIAL LOCK button.
13. An abnormal figure is displayed on an LED, or an LED fails to illuminate.	The Power switch was turned off and on too quickly.	Turn the Power switch off, wait a few seconds, and then turn it on again.
14. An unusual amount of distortion and/or noise in the transmit signal.	The MIC GAIN is too high when the RF Speech Processor is on.	While watching the meter in the ALC mode, turn the MIC GAIN control counterclockwise so that the meter indicates approximately 0dB at the voice peak.
15. Unable to key when using an electronic keyer.	The Switching circuit of the electronic keyer does not close completely.  Polarity of the connection wires from the keyer is reversed.  The MODE switch is not in the CW or CW-N position.	Replace the keyer with one having a voltage of less than .4V between the two keying lines at the key down position, or modify your keyer so that the voltage is less than .4 Volts.  Connect the keyer wires observing proper polarity.  Place the MODE switch in the CW or CW-N position.
16. In the AM mode there is no modulation.	Mic Gain is too low. Mic connector loose, or microphone inoperable.	Adjust the Mic Gain clockwise. Check and tighten mic connections, replace mic if necessary.
17. When the set has been tuned to a freq other than 7.100MHz Ham, or 15.0000MHz Gen Coverage, and the set goes to one of those freqs when turned on.	Memory Backup is not connected to a power supply, or Memory Backup Power Supply has failed.	Check Memory Backup Power Supply for loose connections, or faults.





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